Rexroth Frequency Converter

EFC x610 Series
EFC 3610 / EFC 5610

Operating Instructions
R912005854

Edition 09

Record of Revision

Edition	Release Date	Notes
DOK-RCON03-EFC-X610***-IT01-EN-P	2014.10	First release
DOK-RCON03-EFC-X610***-IT02-EN-P	2014.12	New functions
DOK-RCON03-EFC-X610***-IT03-EN-P	2015.05	New functions
DOK-RCON03-EFC-X610***-IT04-EN-P	2015.11	New functions
DOK-RCON03-EFC-X610***-IT05-EN-P	2016.04	New functions
DOK-RCON03-EFC-X610***-IT06-EN-P	2017.02	New functions
DOK-RCON03-EFC-X610***-IT07-EN-P	2017.08	New functions
DOK-RCON03-EFC-X610***-IT08-EN-P	2018.04	New functions
DOK-RCON03-EFC-X610***-IT09-EN-P	2020.04	New functions

Version Matching Table

Firmware	Operating Instructions	Quick Start Guide
01V20	Edition 02	Edition 02
03V02	Edition 03	Edition 04
03V08	Edition 04	Edition 06
03V12	Edition 05	Edition 07
03V20	Edition 06	Edition 09
03V24	Edition 07	Edition 11
03V26	Edition 08	Edition 12
03V34	Edition 09	Edition 13

Copyright

Liability

The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

RS-d33581b237a10e320a6846a50131ac32-9-en-US-18

D Deutsch	USA English	F Français
WARNUNG Lebensgefahr bei Nichtbeachtung der nachstehenden Sicherheitshinweise! Nehmen Sie die Produkte erst dann in Betrieb, nachdem Sie die mit dem Produkt gelieferten Unterlagen und Sicherheitshinweise vollständig durchgelesen, verstanden und beachtet haben. Sollten Ihnen keine Unterlagen in Ihrer Landessprache vorliegen, wenden Sie sich an Ihren zuständigen Rexroth-Vertriebspartner. Nur qualifiziertes Personal darf an Antriebskomponenten arbeiten. Nähere Erläuterungen zu den Sicherheitshinweisen entnehmen Sie Kapitel 1 dieser Dokumentation.	**WARNING Danger to life in case of non-compliance with the below-mentioned safety instructions!** Do not attempt to install or put these products into operation until you have completely read, understood and observed the documents supplied with the product. If no documents in your language were supplied, please consult your Rexroth sales partner. Only qualified persons may work with drive components. For detailed explanations on the safety instructions, see chapter 1 of this documentation.	**AVERTISSEMENT Danger de mort en cas de non-respect des consignes de sécurité figurant ci-après !** Ne mettez les produits en service qu'après avoir lu complètement et après avoir compris et respecté les documents et les consignes de sécurité fournis avec le produit. Si vous ne disposez pas de la documentation dans votre langue, merci de consulter votre partenaire Rexroth. Seul un personnel qualifié est autorisé à travailler sur les composants d'entraînement. Vous trouverez des explications plus détaillées relatives aux consignes de sécurité au chapitre 1 de la présente documentation.
WARNUNG Hohe elektrische Spannung! Lebensgefahr durch elektrischen Schlag! Betreiben Sie Antriebskomponenten nur mit fest installiertem Schutzleiter. Schalten Sie vor Zugriff auf Antriebskomponenten die Spannungsversorgung aus. Beachten Sie die Entladezeiten von Kondensatoren.	**WARNING High electrical voltage! Danger to life by electric shock!** Only operate drive components with a permanently installed equipment grounding conductor. Disconnect the power supply before accessing drive components. Observe the discharge times of the capacitors.	**AVERTISSEMENT Tensions électriques élevées ! Danger de mort par électrocution !** N'exploitez les composants d'entraînement que si un conducteur de protection est installé de manière permanente. Avant d'intervenir sur les composants d'entraînement, coupez toujours la tension d'alimentation. Tenez compte des délais de décharge de condensateurs.
WARNUNG Gefahrbringende Bewegungen! Lebensgefahr! Halten Sie sich nicht im Bewegungsbereich von Maschinen und Maschinenteilen auf. Verhindern Sie den unbeabsichtigten Zutritt für Personen. Bringen Sie vor dem Zugriff oder Zutritt in den Gefahrenbereich die Antriebe sicher zum Stillstand.	**WARNING Dangerous movements! Danger to life!** Keep free and clear of the ranges of motion of machines and moving machine parts. Prevent personnel from accidentally entering the range of motion of machines. Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.	**AVERTISSEMENT Mouvements entraînant une situation dangereuse ! Danger de mort !** Ne séjournez pas dans la zone de mouvement de machines et de composants de machines. Évitez tout accès accidentel de personnes. Avant toute intervention ou tout accès dans la zone de danger, assurez-vous de l'arrêt préalable de tous les entraînements.

D Deutsch	USA English	F Français
WARNUNG **Elektromagnetische / magnetische Felder! Gesundheitsgefahr für Personen mit Herzschrittmachern, metallischen Implantaten oder Hörgeräten!** Zutritt zu Bereichen, in denen Antriebskomponenten montiert und betrieben werden, ist für oben genannten Personen untersagt bzw. nur nach Rücksprache mit einem Arzt erlaubt.	**WARNING** **Electromagnetic / magnetic fields! Health hazard for persons with heart pacemakers, metal implants or hearing aids!** The above-mentioned persons are not allowed to enter areas in which drive components are mounted and operated, or rather are only allowed to do this after they consulted a doctor.	**AVERTISSEMENT** **Champs électromagnétiques / magnétiques ! Risque pour la santé des porteurs de stimulateurs cardiaques, d'implants métalliques et d'appareils auditifs !** L'accès aux zones où sont montés et exploités les composants d'entraînement est interdit aux personnes susmentionnées ou bien ne leur est autorisé qu'après consultation d'un médecin.
VORSICHT **Heiße Oberflächen (> 60 °C)! Verbrennungsgefahr!** Vermeiden Sie das Berühren von metallischen Oberflächen (z. B. Kühlkörpern). Abkühlzeit der Antriebskomponenten einhalten (mind. 15 Minuten).	**CAUTION** **Hot surfaces (> 60 °C [140 °F])! Risk of burns!** Do not touch metallic surfaces (e.g. heat sinks). Comply with the time required for the drive components to cool down (at least 15 minutes).	**ATTENTION** **Surfaces chaudes (> 60 °C)! Risque de brûlure !** Évitez de toucher des surfaces métalliques (p. ex. dissipateurs thermiques). Respectez le délai de refroidissement des composants d'entraînement (au moins 15 minutes).
VORSICHT **Unsachgemäße Handhabung bei Transport und Montage! Verletzungsgefahr!** Verwenden Sie geeignete Montage- und Transporteinrichtungen. Benutzen Sie geeignetes Werkzeug und persönliche Schutzausrüstung.	**CAUTION** **Improper handling during transport and mounting! Risk of injury!** Use suitable equipment for mounting and transport. Use suitable tools and personal protective equipment.	**ATTENTION** **Manipulation incorrecte lors du transport et du montage ! Risque de blessure !** Utilisez des dispositifs de montage et de transport adéquats. Utilisez des outils appropriés et votre équipement de protection personnel.
VORSICHT **Unsachgemäße Handhabung von Batterien! Verletzungsgefahr!** Versuchen Sie nicht, leere Batterien zu reaktivieren oder aufzuladen (Explosions- und Verätzungsgefahr). Zerlegen oder beschädigen Sie keine Batterien. Werfen Sie Batterien nicht ins Feuer.	**CAUTION** **Improper handling of batteries! Risk of injury!** Do not attempt to reactivate or recharge low batteries (risk of explosion and chemical burns). Do not dismantle or damage batteries. Do not throw batteries into open flames.	**ATTENTION** **Manipulation incorrecte de piles! Risque de blessure!** N'essayez pas de réactiver des piles vides ou de les charger (risque d'explosion et de brûlure par acide). Ne désassemblez et n'endommagez pas les piles. Ne jetez pas des piles dans le feu.

E Español	P Português	I Italiano
ADVERTENCIA ¡Peligro de muerte en caso de no observar las siguientes indicaciones de seguridad! Los productos no se pueden poner en servicio hasta después de haber leído por completo, comprendido y tenido en cuenta la documentación y las advertencias de seguridad que se incluyen en la entrega. Si no dispusiera de documentación en el idioma de su país, diríjase a su distribuidor competente de Rexroth. Solo el personal debidamente cualificado puede trabajar en componentes de accionamiento. Encontrará más detalles sobre las indicaciones de seguridad en el capítulo 1 de esta documentación.	**ATENÇÃO Perigo de vida em caso de inobservância das seguintes instruções de segurança!** Utilize apenas os produtos depois de ter lido, compreendido e tomado em consideração a documentação e as instruções de segurança fornecidas juntamente com o produto. Se não tiver disponível a documentação na sua língua, dirija-se ao seu parceiro de venda responsável da Rexroth. Apenas pessoal qualificado pode trabalhar nos componentes de acionamento. Explicações mais detalhadas relativamente às instruções de segurança constam no capítulo 1 desta documentação.	**AVVERTENZA Pericolo di morte in caso di inosservanza delle seguenti indicazioni di sicurezza!** Mettere in funzione i prodotti solo dopo aver letto, compreso e osservato per intero la documentazione e le indicazioni di sicurezza fornite con il prodotto. Se non dovesse essere presente la documentazione nella vostra lingua, siete pregati di rivolgervi al rivenditore Rexroth competente. Solo personale qualificato può eseguire lavori sui componenti di comando. Per ulteriori spiegazioni riguardanti le indicazioni di sicurezza consultare il capitolo 1 di questa documentazione.
ADVERTENCIA ¡Alta tensión eléctrica! ¡Peligro de muerte por descarga eléctrica! Active sólo los componentes de accionamiento con el conductor protector firmemente instalado. Desconecte la alimentación eléctrica antes de manipular los componentes de accionamiento. Tenga en cuenta los tiempos de descarga de los condensadores.	**ATENÇÃO Alta tensão elétrica! Perigo de vida devido a choque elétrico!** Opere componentes de acionamento apenas com condutores de proteção instalados. Desligue a alimentação de tensão antes de aceder aos componentes de acionamento. Respeite os períodos de descarga dos condensadores.	**AVVERTENZA Alta tensione elettrica! Pericolo di morte in seguito a scosse elettriche!** Mettere in esercizio i componenti di comando solo con conduttore di messa a terra ben installato. Staccare l'alimentazione prima di intervenire sui componenti di comando. Osservare i tempi di scarica del condensatore.
ADVERTENCIA ¡Movimientos peligrosos! ¡Peligro de muerte! No permanezca en la zona de movimiento de las máquinas ni de sus piezas. Impida el acceso accidental de personas. Antes de acceder o introducir las manos en la zona de peligro, los accionamientos se tienen que haber parado con seguridad.	**ATENÇÃO Movimentos perigosos! Perigo de vida!** Não permaneça na área de movimentação das máquinas e das peças das máquinas. Evite o acesso involuntário para pessoas. Antes de entrar ou aceder à área perigosa, imobilize os acionamentos de forma segura.	**AVVERTENZA Movimenti pericolosi! Pericolo di morte!** Non sostare nelle zone di manovra delle macchine e delle loro parti. Impedire un accesso non autorizzato per le persone. Prima di accedere alla zona di pericolo, arrestare e bloccare gli azionamenti.

E Español	P Português	I Italiano
ADVERTENCIA ¡Campos electromagnéticos/magnéticos! ¡Peligro para la salud de las personas con marcapasos, implantes metálicos o audífonos! El acceso de las personas arriba mencionadas a las zonas de montaje o funcionamiento de los componentes de accionamiento está prohibido, salvo que lo autorice previamente un médico.	**ATENÇÃO Campos eletromagnéticos / magnéticos! Perigo de saúde para pessoas com marcapassos, implantes metálicos ou aparelhos auditivos!** Acesso às áreas, nas quais os componentes de acionamento são montados e operados, é proibido para as pessoas em cima mencionadas ou apenas após permissão de um médico.	**AVVERTENZA Campi elettromagnetici / magnetici! Pericolo per la salute delle persone portatrici di pacemaker, protesi metalliche o apparecchi acustici!** L'accesso alle zone in cui sono installati o in funzione componenti di comando è vietato per le persone sopra citate o consentito solo dopo un colloquio con il medico.
ATENCIÓN ¡Superficies calientes (> 60 °C)! ¡Peligro de quemaduras! Evite el contacto con las superficies calientes (p. ej., disipadores de calor). Observe el tiempo de enfriamiento de los componentes de accionamiento (mín. 15 minutos).	**CUIDADO Superfícies quentes (> 60 °C)! Perigo de queimaduras!** Evite tocar superfícies metálicas (p. ex. radiadores). Respeite o tempo de arrefecimento dos componentes de acionamento (mín. 15 minutos).	**ATTENZIONE Superfici bollenti (> 60 °C)! Pericolo di ustioni!** Evitare il contatto con superfici metalliche (ad es. dissipatori di calore). Rispettare i tempi di raffreddamento dei componenti di comando (almeno 15 minuti).
ATENCIÓN ¡Manipulación inadecuada en el transporte y montaje! ¡Peligro de lesiones! Utilice dispositivos de montaje y de transporte adecuados. Utilice herramientas adecuadas y equipo de protección personal.	**CUIDADO Manejo incorreto no transporte e montagem! Perigo de ferimentos!** Utilize dispositivos de montagem e de transporte adequados. Utilize ferramentas e equipamento de proteção individual adequados.	**ATTENZIONE Manipolazione inappropriata durante il trasporto e il montaggio! Pericolo di lesioni!** Utilizzare dispositivi di montaggio e trasporto adatti. Utilizzare attrezzi adatti ed equipaggiamento di protezione personale.
ATENCIÓN ¡Manejo inadecuado de las pilas! ¡Peligro de lesiones! No trate de reactivar o cargar pilas descargadas (peligro de explosión y cauterización). No desarme ni dañe las pilas. No tire las pilas al fuego.	**CUIDADO Manejo incorreto de baterias! Perigo de ferimentos!** Não tente reativar nem carregar baterias vazias (perigo de explosão e de queimaduras com ácido). Não desmonte nem danifique as baterias. Não deite as baterias no fogo.	**ATTENZIONE Utilizzo inappropriato delle batterie! Pericolo di lesioni!** Non tentare di riattivare o ricaricare batterie scariche (pericolo di esplosione e corrosione). Non scomporre o danneggiare le batterie. Non gettare le batterie nel fuoco.

S Svenska	DK Dansk	NL Nederlands
VARNING Livsfara om följande säkerhetsanvisningar inte följs! Använd inte produkterna innan du har läst och förstått den dokumentation och de säkerhetsanvisningar som medföljer produkten, och följ alla anvisningar. Kontakta din Rexroth-återförsäljare om dokumentationen inte medföljer på ditt språk. Endast kvalificerad personal får arbeta med drivkomponenterna. Se kapitel 1 i denna dokumentation för närmare beskrivningar av säkerhetsanvisningarna.	**ADVARSEL Livsfare ved manglende overholdelse af nedenstående sikkerhedsanvisninger!** Tag ikke produktet i brug, før du har læst og forstået den dokumentation og de sikkerhedsanvisninger, som følger med produktet, og overhold de givne anvisninger. Kontakt din Rexroth-forhandler, hvis dokumentationen ikke medfølger på dit sprog. Det er kun kvalificeret personale, der må arbejde på drive components. Nærmere forklaringer til sikkerhedsanvisningerne fremgår af kapitel 1 i denne dokumentation.	**WAARSCHUWING Levensgevaar bij niet-naleving van onderstaande veiligheidsinstructies!** Stel de producten pas in bedrijf nadat u de met het product geleverde documenten en de veiligheidsinformatie volledig gelezen, begrepen en in acht genomen heeft. Mocht u niet beschikken over documenten in uw landstaal, kunt u contact opnemen met uw plaatselijke Rexroth distributiepartner. Uitsluitend gekwalificeerd personeel mag aan de aandrijvingscomponenten werken. Meer informatie over de veiligheidsinstructies vindt u in hoofdstuk 1 van deze documentatie.
VARNING Hög elektrisk spänning! Livsfara genom elchock! Använd endast drivkomponenterna med fastmonterad skyddsledare. Koppla bort spänningsförsörjningen före arbete på drivkomponenter. Var medveten om kondensatorernas urladdningstid.	**ADVARSEL Elektrisk højspænding! Livsfare på grund af elektrisk stød!** Drive components må kun benyttes med et fast installeret jordstik. Sørg for at koble spændingsforsyningen fra, inden du rører ved drive components. Overhold kondensatorernes afladningstider.	**WAARSCHUWING Hoge elektrische spanning! Levensgevaar door elektrische schok!** Bedien de aandrijvingscomponenten uitsluitend met vast geïnstalleerde aardleiding. Schakel voor toegang tot aandrijvingscomponenten de spanningsvoorziening uit. Neem de ontlaadtijden van condensatoren in acht.
VARNING Farliga rörelser! Livsfara! Uppehåll dig inte inom maskiners och maskindelars rörelseområde. Förhindra att obehöriga personer får tillträde. Innan du börjar arbeta eller vistas inom drivsystemets riskområde måste maskinen vara stillastående.	**ADVARSEL Farlige bevægelser! Livsfare!** Du må ikke opholde dig inden for maskiners og maskindeles bevægelsesradius. Sørg for, at ingen personer kan få utilsigtet adgang. Stands drevene helt, inden du rører ved drevene eller træder ind i deres fareområde.	**WAARSCHUWING Risicovolle bewegingen! Levensgevaar!** Houdt u niet op in het bewegingsbereik van machines en machineonderdelen. Voorkom dat personen onbedoeld toegang verkrijgen. Voor toegang tot de gevaarlijke zone moeten de aandrijvingen veilig tot stilstand gebracht zijn.

S Svenska	DK Dansk	NL Nederlands
⚠ VARNING Elektromagnetiska/ magnetiska fält! Hälsofara för personer med pacemaker, implantat av metall eller hörapparat! Det är förbjudet för ovan nämnda personer (eller kräver överläggning med läkare) att beträda områden där drivkomponenter är monterade och i drift.	**⚠ ADVARSEL Elektromagnetiske/magnetiske felter! Sundhedsfare for personer med pacemakere, metalliske implantater eller høreapparater!** For disse personer er der adgang forbudt eller kun adgang med tilladelse fra læge til de områder, hvor drive components monteres og drives.	**⚠ WAARSCHUWING Elektromagnetische / magnetische velden! Gevaar voor de gezondheid van personen met pacemakers, metalen implantaten of hoorapparaten!** Toegang tot gebieden, waarin aandrijvingscomponenten worden gemonteerd en bediend, is verboden voor voornoemde personen of uitsluitend toegestaan na overleg met een arts.
⚠ OBSERVERA Varma ytor (> 60 °C)! Risk för brännskador! Undvik att vidröra metallytor (t.ex. kylelement). Var medveten om att det tar tid för drivkomponenterna att svalna (minst 15 minuter).	**⚠ FORSIGTIG Varme overflader (> 60 °C)! Risiko for forbrændinger!** Undgå at berøre metaloverflader (f.eks. køleelementer). Overhold drive components nedkølingstid (min. 15 min.).	**⚠ VOORZICHTIG Hete oppervlakken (> 60 °C)! Verbrandingsgevaar!** Voorkom contact met metalen oppervlakken (bijv. Koellichamen). Afkoeltijd van de aandrijvingscomponenten in acht nemen (min. 15 minuten).
⚠ OBSERVERA Felaktig hantering vid transport och montering! Skaderisk! Använd passande monterings- och transportanordningar. Använd lämpliga verktyg och personlig skyddsutrustning.	**⚠ FORSIGTIG Fejlhåndtering ved transport og montering! Risiko for kvæstelser!** Benyt egnede monterings- og transportanordninger. Benyt egnet værktøj og personligt sikkerhedsudstyr.	**⚠ VOORZICHTIG Onjuist gebruik bij transport en montage! Letselgevaar!** Gebruik geschikte montage- en transportinrichtingen. Gebruik geschikt gereedschap en een persoonlijke veiligheidsuitrusting.
⚠ OBSERVERA Felaktig hantering av batterier! Skaderisk! Försök inte återaktivera eller ladda upp batterier (risk för explosioner och frätskador). Batterierna får inte tas isär eller skadas. Släng inte batterierna i elden.	**⚠ FORSIGTIG Fejlhåndtering af batterier! Risiko for kvæstelser!** Forsøg ikke at genaktivere eller oplade tomme batterier (eksplosions- og ætsningsfare). Undlad at skille batterier ad eller at beskadige dem. Smid ikke batterier ind i åben ild.	**⚠ VOORZICHTIG Onjuist gebruik van batterijen! Letselgevaar!** Probeer nooit lege batterijen te reactiveren of op te laden (explosiegevaar en gevaar voor beschadiging van weefsel door cauterisatie). Batterijen niet demonteren of beschadigen. Nooit batterijen in het vuur werpen.

FIN Suomi	PL Polski	CZ Český
VAROITUS Näiden turvaohjeiden noudattamatta jättämisestä on seurauksena hengenvaara! Ota tuote käyttöön vasta sen jälkeen, kun olet lukenut läpi tuotteen mukana toimitetut asiakirjat ja turvallisuusohjeet, ymmärtänyt ne ja ottanut ne huomioon. Jos asiakirjoja ei ole saatavana omalla äidinkielelläsi, ota yhteys asianomaiseen Rexrothin myyntiedustajaan. Käyttölaitteiden komponenttien parissa saa työskennellä ainoastaan valtuutettu henkilöstö. Lisätietoa turvaohjeista löydät tämän dokumentaation luvusta 1.	**OSTRZEŻENIE Zagrożenie życia w razie nieprzestrzegania poniższych wskazówek bezpieczeństwa!** Nie uruchamiać produktów przed uprzednim przeczytaniem i pełnym zrozumieniem wszystkich dokumentów dostarczonych wraz z produktem oraz wskazówek bezpieczeństwa. Należy przestrzegać wszystkich zawartych tam zaleceń. W przypadku braku dokumentów w Państwa języku, prosimy o skontaktowanie się z lokalnym partnerem handlowym Rexroth. Przy zespołach napędowych może pracować wyłącznie wykwalifikowany personel. Bliższe objaśnienia wskazówek bezpieczeństwa znajdują się w Rozdziale 1 niniejszej dokumentacji.	**VAROVÁNÍ Nebezpečí života v případě nedodržení níže uvedených bezpečnostních pokynů!** Před uvedením výrobků do provozu si přečtěte kompletní dokumentaci a bezpečnostní pokyny dodávané s výrobkem, pochopte je a dodržujte. Nemáte-li k dispozici podklady ve svém jazyce, obraťte se na příslušného obchodního partnera Rexroth. Na komponentách pohonu smí pracovat pouze kvalifikovaný personál. Podrobnější vysvětlení k bezpečnostním pokynům naleznete v kapitole 1 této dokumentace.
VAROITUS Voimakas sähköjännite! Sähköiskun aiheuttama hengenvaara! Käytä käyttölaitteen komponentteja ainoastaan maadoitusjohtimen ollessa kiinteästi asennettuna. Katkaise jännitteensyöttö ennen käyttölaitteen komponenteille suoritettavien töiden aloittamista. Huomioi kondensaattoreiden purkausajat.	**OSTRZEŻENIE Wysokie napięcie elektryczne! Zagrożenie życia w wyniku porażenia prądem!** Zespoły napędu mogą być eksploatowane wyłącznie z zainstalowanym na stałe przewodem ochronnym. Przed uzyskaniem dostępu do podzespołów napędu należy odłączyć zasilanie elektryczne. Zwracać uwagę na czas rozładowania kondensatorów.	**VAROVÁNÍ Vysoké elektrické napětí! Nebezpečí života při zasažení elektrickým proudem!** Komponenty pohonu smí být v provozu pouze s pevně nainstalovaným ochranným vodičem. Než začnete zasahovat do komponent pohonu, odpojte je od elektrického napájení. Dodržujte vybíjecí časy kondenzátorů.
VAROITUS Vaarallisia liikkeitä! Hengenvaara! Älä oleskele koneiden tai koneenosien liikealueella. Pidä huolta siitä, ettei muita henkilöitä pääse alueelle vahingossa. Pysäytä käyttölaitteet varmasti ennen vaara-alueelle koskemista tai menemistä.	**OSTRZEŻENIE Niebezpieczne ruchy! Zagrożenie życia!** Nie wolno przebywać w obszarze pracy maszyny i jej elementów. Nie dopuszczać osób niepowołanych do obszaru pracy maszyny. Przed dotknięciem urządzenia/ maszyny lub zbliżeniem się do obszaru zagrożenia należy zgodnie z zasadami bezpieczeństwa wyłączyć napędy.	**VAROVÁNÍ Nebezpečné pohyby! Nebezpečí života!** Nezdržujte se v dosahu pohybu strojů a jejich součástí. Zabraňte náhodnému přístupu osob. Před zásahem nebo vstupem do nebezpečného prostoru bezpečně zastavte pohony.

FIN Suomi	PL Polski	CZ Český
VAROITUS Sähkömagneettisia/magneettisia kenttiä! Terveydellisten haittojen vaara henkilöille, joilla on sydämentahdistin, metallinen implantti tai kuulolaite! Yllä mainituilta henkilöiltä on pääsy kielletty alueille, joilla asennetaan tai käytetään käyttölaitteen komponentteja, tai heidän on ensin saatava tähän suostumus lääkäriltään.	**OSTRZEŻENIE Pola elektromagnetyczne / magnetyczne! Zagrożenie zdrowia dla osób z rozrusznikiem serca, metalowymi implantami lub aparatami słuchowymi!** Wstęp na teren, gdzie odbywa się montaż i eksploatacja napędów jest dla ww. osób zabroniony względnie dozwolony po konsultacji z lekarzem.	**VAROVÁNÍ Elektromagnetická/ magnetická pole! Nebezpečí pro zdraví osob s kardiostimulátory, kovovými implantáty nebo naslouchadly!** Výše uvedené osoby mají zakázán přístup do prostorů, kde jsou montovány a používány komponenty pohonu, resp. ho mají povolen pouze po poradě s lékařem.
HUOMIO Kuumia pintoja (> 60 °C)! Palovammojen vaara! Vältä metallipintojen koskettamista (esim. jäähdytyslevyt). Noudata käyttölaitteen komponenttien jäähtymisaikoja (väh. 15 minuuttia).	**PRZESTROGA Gorące powierzchnie (> 60 °C)! Niebezpieczeństwo poparzenia!** Unikać kontaktu z powierzchniami metalowymi (np. radiatorami). Przestrzegać czasów schładzania podzespołów napędów (min. 15 minut).	**UPOZORNĚNÍ Horké povrchy (> 60 °C)! Nebezpečí popálení!** Nedotýkejte se kovových povrchů (např. chladicích těles). Dodržujte dobu ochlazení komponent pohonu (min. 15 minut).
HUOMIO Epäasianmukainen käsittely kuljetuksen ja asennuksen yhteydessä! Loukkaantumisvaara! Käytä soveltuvia asennus- ja kuljetuslaitteita. Käytä omia työkaluja ja henkilökohtaisia suojavarusteita.	**PRZESTROGA Niewłaściwe obchodzenie się podczas transportu i montażu! Ryzyko urazu!** Stosować odpowiednie urządzenia montażowe i transportowe. Stosować odpowiednie narzędzia i środki ochrony osobistej.	**UPOZORNĚNÍ Nesprávné zacházení při přepravě a montáži! Nebezpečí zranění!** Používejte vhodná montážní a dopravní zařízení. Používejte vhodné nářadí a osobní ochranné vybavení.
HUOMIO Paristojen epäasianmukainen käsittely! Loukkaantumisvaara! Älä yritä saada tyhjiä paristoja toimimaan tai ladata niitä uudelleen (räjähdys- ja syöpymisvaara). Älä hajota paristoja osiin tai vaurioita niitä. Älä heitä paristoja tuleen.	**PRZESTROGA Niewłaściwe obchodzenie się z bateriami! Ryzyko urazu!** Nie próbować reaktywować i nie ładować zużytych baterii (niebezpieczeństwo wybuchu oraz poparzenia żrącą substancją). Nie demontować i nie niszczyć baterii. Nie wrzucać baterii do ognia.	**UPOZORNĚNÍ Nesprávné zacházení s bateriemi! Nebezpečí zranění!** Nepokoušejte se znovu aktivovat nebo dobíjet prázdné baterie (nebezpečí výbuchu a poleptání). Nerozebírejte ani nepoškozujte baterie. Neházejte baterie do ohně.

SLO Slovensko	SK Slovenčina	RO Română
⚠ OPOZORILO Življenjska nevarnost pri neupoštevanju naslednjih napotkov za varnost! Izdelke začnite uporabljati šele, ko v celoti preberete, razumete in upoštevate izdelkom priloženo dokumentacijo in varnostne napotke. Če priložena dokumentacija ni na voljo v vašem maternem jeziku, se obrnite na pristojnega distributerja Rexroth. Samo kvalificirano osebje sme delati na pogonskih komponentah. Podrobnejša pojasnila o varnostnih navodilih najdete v poglavju 1 v tej dokumentaciji.	**⚠ VAROVANIE Nebezpečenstvo ohrozenia života pri nedodržiavaní nasledujúcich bezpečnostných pokynov!** Výrobky uvádzajte do prevádzky až potom, čo ste úplne prečítali, pochopili a zobrali do úvahy podklady a bezpečnostné pokyny dodané s výrobkom. Ak by ste nemali k dispozícii žiadne podklady v jazyku svojej krajiny, obráťte sa prosím na svojho príslušného predajcu Rexroth. Na komponentoch pohonu smie pracovať iba kvalifikovaný personál. Bližšie vysvetlenia k bezpečnostným pokynom zistite z kapitoly 1 tejto dokumentácie.	**⚠ AVERTIZARE Pericol de moarte în cazul nerespectării următoarelor instrucțiuni de siguranță!** Punerea în funcțiune a produselor trebuie efectuată după citirea, înțelegerea şi respectarea documentelor şi instrucțiunilor de siguranță, care sunt livrate împreună cu produsele. În cazul în care documentele nu sunt în limba dumneavoastră maternă, vă rugăm să contactați partenerul de vânzări Rexroth. Numai un personal calificat poate lucra cu componentele de acționare. Explicații detaliate privind instrucțiunile de siguranță găsiți în capitolul 1 al acestei documentații.
⚠ OPOZORILO Visoka električna napetost! Življenjska nevarnost zaradi električnega udara! Pogonske komponente uporabljajte samo s fiksno nameščenim zaščitnim vodnikom. Pred dostopom do pogonske komponente odklopite napajanje. Upoštevajte čase praznjenja kondenzatorjev.	**⚠ VAROVANIE Vysoké elektrické napätie! Nebezpečenstvo ohrozenia života v dôsledku zásahu elektrickým prúdom!** Komponenty pohonu prevádzkujte iba s pevne nainštalovaným ochranným vodičom. Pred prístupom na komponenty pohonu odpojte zdroj napätia. Rešpektujte časy vybitia kondenzátorov.	**⚠ AVERTIZARE Tensiune electrică înaltă! Pericol de moarte prin electrocutare!** Exploatați componentele de acționare numai cu împământarea instalată permanent. Înainte de intervenția asupra componentelor de acționare, deconectați alimentarea cu tensiune electrică. Țineți cont de timpii de descărcare ai condensatorilor.
⚠ OPOZORILO Nevarni premiki! Življenjska nevarnost! Ne zadržujte se v območju delovanja strojev. Preprečite nenadzorovan dostop oseb. Pred prijemom ali dostopom v nevarno območje varno zaustavite vse gnane dele.	**⚠ VAROVANIE Pohyby prinášajúce nebezpečenstvo! Nebezpečenstvo ohrozenia života!** Nezdržiavajte sa v oblasti pohybu strojov a častí strojov. Zabráňte nepovolanému prístupu osôb. Pred zásahom alebo prístupom do nebezpečnej oblasti uveďte pohony bezpečne do zastavenia.	**⚠ AVERTIZARE Mişcări periculoase! Pericol de moarte!** Nu staționați în zona de mişcare a maşinilor şi a componentelor în mişcare a maşinilor. Împiedicați accesul neintenționat al persoanelor în zona de lucru a maşinilor. Înainte de intervenția sau accesul în zona periculoasă, opriți în siguranță componentele de acționare.

SLO Slovensko	SK Slovenčina	RO Română
⚠ OPOZORILO **Elektromagnetna / magnetna polja! Nevarnost za zdravje za osebe s spodbujevalniki srca, kovinskimi vsadki ali slušnimi aparati!** Dostop do območij, v katerih so nameščene delujoče pogonske komponente, je za zgoraj navedene osebe prepovedan oz. dovoljen samo po posvetu z zdravnikom.	**⚠ VAROVANIE** **Elektromagnetické/magnetické polia! Nebezpečenstvo pre zdravie osôb s kardiostimulátormi, kovovými implantátmi alebo načúvacími prístrojmi!** Prístup k oblastiam, v ktorých sú namontované a prevádzkujú sa komponenty pohonu, je pre hore uvedené osoby zakázaný resp. je dovolený iba po konzultácii s lekárom.	**⚠ AVERTIZARE** **Câmpuri electromagnetice / magnetice! Pericol pentru sănătatea persoanelor cu stimulatoare cardiace, implanturi metalice sau aparate auditive!** Intrarea în zone, în care se montează sau se exploatează componente de acționare, este interzisă pentru persoanele sus numite respectiv este permisă numai cu acordul medicului.
⚠ POZOR **Vroče površine (> 60 °C)! Nevarnost opeklin!** Izogibajte se stiku s kovinskimi površinami (npr. hladilnimi telesi). Upoštevajte čas hlajenja pogonskih komponent (najm. 15 minut).	**⚠ UPOZORNENIE** **Horúce povrchy (> 60 °C)! Nebezpečenstvo popálenia!** Zabráňte kontaktu s kovovými povrchmi (napr. chladiacimi telesami). Dodržiavajte čas vychladenia komponentov pohonu (min. 15 minút).	**⚠ ATENȚIE** **Suprafețe fierbinți (> 60 °C)! Pericol de arsuri!** Nu atingeți suprafețele metalice (de ex. radiatoare de răcire). Respectați timpii de răcire ai componentelor de acționare (min. 15 minute).
⚠ POZOR **Nestrokovno ravnanje med transportom in namestitvijo! Nevarnost poškodb!** Uporabljajte ustrezne pripomočke za nameščanje in transport. Uporabite ustrezno orodje in osebno zaščitno opremo.	**⚠ UPOZORNENIE** **Neodborná manipulácia pri transporte a montáži! Nebezpečenstvo poranenia!** Používajte vhodné montážne a transportné zariadenia. Používajte vhodné náradie a osobné ochranné prostriedky.	**⚠ ATENȚIE** **Manipulare necorespunzătoare la transport şi montaj! Pericol de vătămare!** Utilizați dispozitive adecvate de montaj şi transport. Folosiți instrumente corespunzătoare şi echipament personal de protecție.
⚠ POZOR **Nepravilno ravnanje z baterijami! Nevarnost poškodb!** Ne poskušajte ponovno aktivirati ali napolniti praznih baterij (Nevarnost zaradi eksplozij ali jedkanja). Ne razstavljajte ali poškodujte nobenih baterij. Baterij ne mečite v ogenj.	**⚠ UPOZORNENIE** **Neodborná manipulácia s batériami! Nebezpečenstvo poranenia!** Nepokúšajte sa reaktivovať alebo nabíjať prázdne batérie (nebezpečenstvo výbuchu a poleptania). Batérie nerozoberajte ani nepoškodzujte. Nehádžte batérie do ohňa.	**⚠ ATENȚIE** **Manipulare necorespunzătoare a bateriilor! Pericol de vătămare!** Nu încercați să reactivați sau să încărcați bateriile goale (pericol de explozie şi pericol de arsuri). Nu dezasamblați şi nu deteriorați bateriile. Nu aruncați bateriile în foc.

H Magyar	BG Български	LV Latviski
⚠ FIGYELMEZTETÉS! Az alábbi biztonsági útmutatások figyelmen kívül hagyása életveszélyes helyzethez vezethet! Üzembe helyezés előtt olvassa el, értelmezze, és vegye figyelembe a csomagban található dokumentumban foglaltakat és a biztonsági útmutatásokat. Amennyiben a csomagban nem talál az Ön nyelvén írt dokumentumokat, vegye fel a kapcsolatot az illetékes Rexroth-képviselővel. A hajtás alkatrészein kizárólag képzett személy dolgozhat. A biztonsági útmutatókkal kapcsolatban további magyarázatot ennek a dokumentumnak az első fejezetében találhat.	**⚠ ПРЕДУПРЕЖДЕНИЕ Опасност за живота при неспазване на посочените по-долу инструкции за безопасност!** Използвайте продуктите след като сте се запознали подробно с приложената към продукта документация и указания за безопасност, разбрали сте ги и сте се съобразили с тях. Ако текстът не е написан на Вашия език, моля обърнете се към Вашия компетентен търговски представител на Rexroth. Със задвижващите компоненти трябва да работи само квалифициран персонал. Подробни пояснения към инструкциите за безопасност можете да видите в Глава 1 на тази документация.	**⚠ BRĪDINĀJUMS Turpinājumā doto drošības norādījumu neievērošana var apdraudēt dzīvību!** Sāciet lietot izstrādājumu tikai pēc tam, kad esat pilnībā izlasījuši, sapratuši un ņēmuši vērā kopā ar izstrādājumu piegādātos dokumentus. Ja dokumenti nav pieejami Jūsu valsts valodā, vērsieties pie pilnvarotā Rexroth izplatītāja. Darbus pie piedziņas komponentiem drīkst veikt tikai kvalificēts personāls. Detalizētus paskaidrojumus attiecībā uz drošības norādījumiem skatiet šī dokumenta 1. nodaļā.
⚠ FIGYELMEZTETÉS! Magas elektromos feszültség! Életveszély áramütés miatt! A hajtás alkatrészeit csak véglegesen telepített védővezetővel üzemeltesse! Mielőtt hozzányúl a hajtás alkatrészeihez, kapcsolja ki az áramellátást. Ügyeljen a kondenzátorok kisülési idejére!	**⚠ ПРЕДУПРЕЖДЕНИЕ Високо електрическо напрежение! Опасност за живота от удар от електрически ток!** Работете със задвижващите компоненти само при здраво закрепен заземяващ проводник. Преди работа по задвижващите компоненти, изключете захранващото напрежение. Обърнете внимание на времето за разреждане на кондензаторите.	**⚠ BRĪDINĀJUMS Augsts elektriskais spriegums! Dzīvības apdraudējums elektriskā trieciena dēļ!** Piedziņas komponentus darbiniet tikai ar fiksēti uzstādītu zemējumvadu. Pirms darba pie piedziņas komponentiem atslēdziet elektroapgādi. Ņemiet vērā kondensatoru izlādes laikus.
⚠ FIGYELMEZTETÉS! Veszélyes mozgás! Életveszély! Ne tartózkodjon a gépek és a gépalkatrészek mozgási területén belül! Illetéktelen személyeket ne engedjen a gép közelébe! Mielőtt beavatkozik, vagy a veszélyes zónába belép a hajtásokat biztonságosan állítsa le.	**⚠ ПРЕДУПРЕЖДЕНИЕ Опасни движения! Опасност за живота!** Не стойте в обсега на движение на машините и частите на машините. Не допускайте непреднамерен достъп на хора. Преди работа или влизане в опасната зона, спрете надеждно приводния механизъм.	**⚠ BRĪDINĀJUMS Bīstamas kustības! Dzīvības apdraudējums!** Neuzturieties mašīnu un mašīnas detaļu kustību zonā. Novērsiet nepiederošu personu piekļūšanu. Pirms darba bīstamajās zonās pilnībā apstādiniet piedziņu.

H Magyar	BG Български	LV Latviski
⚠ FIGYELMEZTETÉS! Elektromágneses / mágneses mező! Káros hatással lehet a szívritmus-szabályozó készülékkel, fémbeültetéssel vagy hallókészülékkel rendelkezők egészségére! Azokra a területekre, ahol hajtások alkatrészeit szerelik és üzemeltetik, a fent említett személyeknek tilos a belépés, illetve csak orvosi konzultációt követően szabad az adott területekre lépniük.	**⚠ ПРЕДУПРЕЖДЕНИЕ Електромагнитни / магнитни полета! Опасност за здравето на хора със сърдечни стимулатори, метални импланти или слухови апарати!** Достъпът за гореспоменатите лица до зони, в които ще се монтират и ще работят задвижващи компоненти се забранява, или разрешава само след консултация с лекар.	**⚠ BRĪDINĀJUMS Elektromagnētiskais / magnētiskais lauks! Veselības apdraudējums personām ar sirds stimulatoriem, metāliskiem implantiem vai dzirdes aparātiem!** Tuvošanās zonām, kurās tiek montēti un darbināti piedziņas komponenti, iepriekš minētajām personām ir aizliegta, respektīvi, atļauta tikai pēc konsultēšanās ar ārstu.
⚠ VIGYÁZAT! Forró felületek (> 60 °C)! Égésveszély! Ne érjen hozzá fémfelületekhez (pl. hűtőtestekhez)! Vegye figyelembe a hajtás alkatrészeinek kihűlési idejét (min. 15 perc)!	**⚠ ВНИМАНИЕ Горещи повърхности (> 60 °C)! Опасност от изгаряне!** Не докосвайте метални повърхности (например радиатори). Съблюдавайте времето на охлаждане на задвижващите компоненти (мин. 15 минути).	**⚠ UZMANĪBU Karstas virsmas (> 60 °C)! Apdedzināšanās risks!** Neskarieties pie metāliskām virsmām (piemēram, dzesētāja). Ļaujiet piedziņas komponentiem atdzist (min. 15 minūtes).
⚠ VIGYÁZAT! Szakszerűtlen kezelés szállításkor és szereléskor! Sérülésveszély! A megfelelő beszerelési és szállítási eljárásokat alkalmazza! Használjon megfelelő szerszámokat és személyes védőfelszerelést!	**⚠ ВНИМАНИЕ Неправилно боравене по време на транспорт и монтаж!Опасност от нараняване!** Използвайте подходящо монтажно и транспортно оборудване. Използвайте подходящи инструменти и лични предпазни средства.	**⚠ UZMANĪBU Nepareizi veikta transportēšana un montāža! Traumu gūšanas risks!** Izmantojiet piemērotas montāžas un transportēšanas ierīces. Izmantojiet piemērotus instrumentus un individuālos aizsardzības līdzekļus.
⚠ VIGYÁZAT! Akkumulátorok szakszerűtlen kezelése! Sérülésveszély! Üres akkumulátorokat ne aktiváljon újra, illetve ne töltsön fel (robbanás- és marásveszély)! Az akkumulátorokat ne szedje szét, és ne rongálja meg! Az akkumulátort ne dobja tűzbe!	**⚠ ВНИМАНИЕ Неправилно боравене с батерии! Опасност от нараняване!** Не се опитвайте да активирате отново или да зареждате разредени батерии (Опасност от експлозия и напръскване с агресивен агент). Не разглобявайте и не повреждайте батерии. Не хвърляйте батерии в огън.	**⚠ UZMANĪBU Nepareiza bateriju lietošana! Traumu gūšanas risks!** Nemēģiniet no jauna aktivizēt vai uzlādēt tukšas baterijas (eksploziju un ķīmisko apdegumu draudi). Neizjauciet un nesabojājiet baterijas. Nemetiet baterijas ugunī.

LT Lietuviškai	EST Eesti	GR Ελληνικά
⚠ ĮSPĖJIMAS Pavojus gyvybei nesilaikant toliau pateikiamų saugumo nurodymų! Naudokite gaminį tik kruopščiai perskaitę prie jo pridėtus aprašus, saugumo nurodymus. Susipažinkite su jais ir vadovaukitės naudodami gaminį. Jei Jūs negavote aprašo gimtąja kalba, kreipkitės į įgaliotus Rexroth atstovus. Prie pavaros komponentų leidžiama dirbti tik kvalifikuotam personalui. Išsamesnius saugumo nurodymų paaiškinimus rasite šios dokumentacijos 1 skyriuje.	**⚠ HOIATUS Alljärgnevate ohutusjuhiste eiramine on eluohtlik!** Võtke tooted käiku alles siis, kui olete toodetega kaasasolevad materjalid ning ohutusjuhised täielikult läbi lugenud, neist aru saanud ja neid järginud. Kui Teil puuduvad emakeelsed materjalid, siis pöörduge Rexrothi kohaliku müügiesinduse poole. Ajamikomponentidega tohib töötada üksnes kvalifitseeritud personal. Täpsemaid selgitusi ohutusjuhiste kohta leiate käesoleva dokumentatsiooni peatükist 1.	**⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Κίνδυνος θανάτου σε περίπτωση μη συμμόρφωσης με τις παρακάτω οδηγίες ασφαλείας!** Θέστε το προϊόν σε λειτουργία αφού διαβάσετε, κατανοήσετε και λάβετε υπόψη το σύνολο των οδηγιών ασφαλείας που το συνοδεύουν. Εάν δεν υπάρχει τεκμηρίωση στη γλώσσα σας, απευθυνθείτε σε εξουσιοδοτημένο αντιπρόσωπο της Rexroth. Μόνο εξειδικευμένο προσωπικό επιτρέπεται να χειρίζεται στοιχεία μετάδοσης κίνησης. Περαιτέρω επεξηγήσεις των οδηγιών ασφαλείας διατίθενται στο κεφάλαιο 1 της παρούσας τεκμηρίωσης.
⚠ ĮSPĖJIMAS Aukšta elektros įtampa! Pavojus gyvybei dėl elektros smūgio! Pavaros komponentus eksploatuokite tik su fiksuotai instaliuotu apsauginiu laidu. Prieš prieidami prie pavaros komponentų išjunkite maitinimo įtampą. Atsižvelkite į kondensatorių išsikrovimo trukmę.	**⚠ HOIATUS Kõrge elektripinge! Eluohtlik elektrilöögi tõttu!** Käitage ajamikomponente üksnes püsivalt installeeritud maandusega. Lülitage enne ajamikomponentidega tööde alustamist toitepinge välja. Järgige kondensaatorite mahalaadumisaegu.	**⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Υψηλή ηλεκτρική τάση! Κίνδυνος θανάτου από ηλεκτροπληξία!** Θέτετε σε λειτουργία τα στοιχεία μετάδοσης κίνησης μόνο εφόσον έχει τοποθετηθεί καλά προστατευτικός αγωγός γείωσης. Πριν από οποιαδήποτε παρέμβαση, αποσυνδέστε την τροφοδοσία των στοιχείων μετάδοσης κίνησης. Λάβετε υπόψη τους χρόνους αποφόρτισης των πυκνωτών.
⚠ ĮSPĖJIMAS Pavojingi judesiai! Pavojus gyvybei! Nebūkite mašinų ar jų dalių judėjimo zonoje. Neleiskite netyčia patekti asmenims. Prieš patekdami į pavojaus zoną saugiai išjunkite pavaras.	**⚠ HOIATUS Ohtlikud liikumised! Eluohtlik!** Ärge viibige masina ja masinaosade liikumispiirkonnas. Tõkestage inimeste ettekavatsematu sisenemine masina ja masinaosade liikumispiirkonda. Tagage ajamite turvaline seiskamine enne ohupiirkonda juurdepääsu või sisenemist.	**⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Επικίνδυνες τάσεις! Κίνδυνος θανάτου!** Μην στέκεστε στην περιοχή κίνησης μηχανημάτων και εξαρτημάτων. Αποτρέπετε την τυχαία είσοδο ατόμων. Πριν από την παρέμβαση ή πρόσβαση στην περιοχή κινδύνου, μεριμνήστε για την ασφαλή ακινητοποίηση των συστημάτων μετάδοσης κίνησης.

LT Lietuviškai	EST Eesti	GR Ελληνικά
⚠ ĮSPĖJIMAS Elektromagnetiniai / magnetiniai laukai! Pavojus asmenų su širdies stimuliatoriais, metaliniais implantais arba klausos aparatais sveikatai! Prieiga prie zonų, kuriose montuojami ir eksploatuojami pavaros komponentai, aukščiau nurodytiems asmenims yra draudžiama arba leistina tik pasitarus su gydytoju.	**⚠ HOIATUS Elektromagnetilised / magnetilised väljad! Terviseohtlik südamestimulaatorite, metallimplantaatide ja kuulmisseadmetega inimestele!** Sisenemine piirkondadesse, kus toimub ajamikomponentide monteerimine ja käitamine, on ülalnimetatud isikutele keelatud või lubatud üksnes pärast arstiga konsulteerimist.	**⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Ηλεκτρομαγνητικά/μαγνητικά πεδία! Κίνδυνος για την υγεία ατόμων με καρδιακούς βηματοδότες, μεταλλικά εμφυτεύματα ή συσκευές ακοής!** Η είσοδος σε περιοχές όπου πραγματοποιείται συναρμολόγηση και λειτουργία στοιχείων μετάδοσης κίνησης απαγορεύεται στα προαναφερθέντα άτομα, εκτός αν τους έχει δοθεί σχετική άδεια κατόπιν συνεννόησης με γιατρό.
⚠ PERSPĖJIMAS Karšti paviršiai (> 60 °C)! Nudegimo pavojus! Venkite liesti metalinius paviršius (pvz., radiatorių). Išlaikykite pavaros komponentų atvėsimo trukmę (bent 15 minučių).	**⚠ ETTEVAATUST Kuumad välispinnad (> 60 °C)! Põletusoht!** Vältige metalsete välispindade (nt radiaatorid) puudutamist. Pidage kinni ajamikomponentide mahajahtumisajast (vähemalt 15 minutit).	**⚠ ΠΡΟΣΟΧΗ Καυτές επιφάνειες (> 60 °C)! Κίνδυνος εγκαύματος!** Αποφεύγετε την επαφή με μεταλλικές επιφάνειες (π.χ. μονάδες ψύξης). Λάβετε υπόψη το χρόνο ψύξης των στοιχείων μετάδοσης κίνησης (τουλάχιστον 15 λεπτά).
⚠ PERSPĖJIMAS Netinkamas darbas transportuojant ir montuojant! Susižalojimo pavojus! Naudokite tinkamus montavimo ir transportavimo įrenginius. Naudokite tinkamus įrankius ir asmens saugos priemones.	**⚠ ETTEVAATUST Asjatundmatu käsitsemine transportimisel ja montaažil! Vigastusoht!** Kasutage sobivaid montaaži- ja transpordiseadiseid. Kasutage sobivaid tööriistu ja isiklikku kaitsevarustust.	**⚠ ΠΡΟΣΟΧΗ Ακατάλληλος χειρισμός κατά τη μεταφορά και συναρμολόγηση! Κίνδυνος τραυματισμού!** Χρησιμοποιείτε κατάλληλους μηχανισμούς συναρμολόγησης και μεταφοράς. Χρησιμοποιείτε κατάλληλα εργαλεία και ατομικό εξοπλισμό προστασίας.
⚠ PERSPĖJIMAS Netinkamas darbas su baterijomis! Susižalojimo pavojus! Nebandykite tuščių baterijų reaktyvuoti arba įkrauti (sprogimo ir išėsdinimo pavojus). Neardykite ir nepažeiskite baterijų. Nemeskite baterijų į ugnį.	**⚠ ETTEVAATUST Patareide asjatundmatu käsitsemine! Vigastusoht!** Ärge üritage kunagi tühje patareisid reaktiveerida või täis laadida (plahvatus- ja söövitusoht). Ärge demonteerige ega kahjustage patareisid. Ärge visake patareisid tulle.	**⚠ ΠΡΟΣΟΧΗ Ακατάλληλος χειρισμός μπαταριών! Κίνδυνος τραυματισμού!** Μην επιδιώκετε να ενεργοποιήσετε ξανά ή να φορτίσετε κενές μπαταρίες (κίνδυνος έκρηξης και διάβρωσης). Μην διαλύετε ή καταστρέφετε τις μπαταρίες. Μην απορρίπτετε τις μπαταρίες στη φωτιά.

CN 中文
⚠ 警告 **如果不按照下述指定的安全说明使用，将会导致人身伤害！** 在没有阅读，理解随本产品附带的文件并熟知正当使用前，不要安装或使用本产品。 如果没有您所在国家官方语言文件说明，请与 Rexroth 销售伙伴联系。 只允许有资格人员对驱动器部件进行操作。 安全说明的详细解释在本文档的第一章。
⚠ 警告 **高电压！电击导致生命危险！** 只有在安装了永久良好的设备接地导线后才可以对驱动器的部件进行操作。 在接触驱动器部件前先将驱动器部件断电。 确保电容放电时间。
⚠ 警告 **危险运动！生命危险！** 保证设备的运动区域内和移动部件周围无障碍物。 防止人员意外进入设备运动区域内。 在接近或进入危险区域之前，确保传动设备安全停止。
⚠ 警告 **电磁场/磁场！对佩戴心脏起搏器、金属植入物和助听器的人员会造成严重的人身伤害！** 上述人员禁止进入安装及运行的驱动器区域，或者必须事先咨询医生。
⚠ 小心 **热表面（大于 60 度）！灼伤风险！** 不要触摸金属表面（例如散热器）。驱动器部件断电后需要时间进行冷却（至少 15 分钟）。
⚠ 小心 **安装和运输不当导致受伤危险！当心受伤！** 使用适当的运输和安装设备。 使用适合的工具及用适当的防护设备。
⚠ 小心 **电池操作不当！受伤风险！** 请勿对低电量电池重新激活或重新充电（爆炸和腐蚀的危险）。 请勿拆解或损坏电池。请勿将电池投入明火中。

Table of Contents

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

1 Safety Instructions for Electric Drives and Controls

1.1 Definitions of Terms

Documentation

A documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, mounting, installing, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Instruction Manual, Commissioning Manual, Application Description, Assembly Instructions, Project Planning Manual, Safety Notes, Product Insert, etc.

Component

A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control System

A control system comprises several interconnected control components placed on the market as a single functional unit.

Device

A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Electrical Equipment

Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Electric Drive System

An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

Installation

An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine

A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer

The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product

Examples of a product: Device, component, part, system, software, firmware, among other things.

Qualified Persons

In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them

2) to be trained or instructed to maintain and use adequate safety equipment

3) to attend a course of instruction in first aid

User

A user is a person installing, commissioning or using a product which has been placed on the market.

1.2 Explanation of Signal Words and the Safety Alert Symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

1.3 General Information

1.3.1 Using the Safety Instructions and Passing Them on to Others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Bosch Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

1.3.2 Requirements for Safe Use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Bosch Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in

which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive. Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged. When the internal EMC filter is disconnected, the drive is not EMC compatible.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user must take into account

- European countries: In accordance with European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

1.3.3 Hazards by Improper Use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

1.4 Instructions with Regard to Specific Dangers

1.4.1 Protection Against Contact With Electrical Parts and Housings

☞ This section concerns components of the electric drive and control system with voltages **higher than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **5 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.

1.4.2 Protective Extra-Low Voltage as Protection Against Electric Shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Bosch Rexroth, all connections and terminals with voltages between 5 and 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits higher than 50 volts (e.g., the mains connection) are connected to Bosch Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

1.4.3 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control

and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

1.4.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors or permanent magnets of electric motors represent a serious danger to persons with heart pacemakers, metal implants and hearing aids.

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric components!

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the electric drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs so greatly that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above.

1.4.5 Protection Against Contact with Hot Parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

1.4.6 Protection During Handling and Mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

2 Important Directions for Use

2.1 Appropriate Use

Bosch Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products can only be used in the appropriate way. Otherwise, situations resulting in property damage and personal injury may occur.

☞ Bosch Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the rights to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Bosch Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied.

- Personnel that in any way or form use our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the products take the form of hardware, they must remain in their original state, in other words, no structural changes are permitted.
- It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

2.2 Inappropriate Use

Using the frequency converters outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "**inappropriate use**".

Frequency converters shall not be used under following conditions:

- They are subject to operating conditions that do not meet the specified ambient conditions. These include, for example, operation under water, extreme temperature fluctuations or extremely high temperatures.
- Furthermore, the frequency converters shall not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

3 Documentation Information

3.1 About this Documentation

This **Operating Instructions** contains necessary data and information related to the product, which is the basis for any of other types of documentation.

⚠ WARNING

Personal injury or property damage caused by incorrect operations of applications, machines and installations!

Do not attempt to install or put the product into operation until you have completely read and understood the descriptions in this documentation!

3.2 Relevant Software

- IndraWorks

  Click www.boschrexroth.com, choose "Products > Electric Drives and Controls > Engineering > Software tools > IndraWorks Engineering > Downloads", then download the software package.

- ConverterWorks

  Click www.boschrexroth.com, choose "Products > Electric Drives and Controls > Frequency Converters > EFC3610 (EFC5610) > Downloads", then download the software package.

3.3 Reference

For documentation available in other type or language, please consult your local **Bosch Rexroth** sales partner or check:

www.boschrexroth.com/various/utilities/mediadirectory/

Documentation type	Short text / Type code	Material number
Operating Instructions	DOK-RCON03-EFC-x610***-ITRS-EN-P	R912005854
Quick Start Guide	DOK-RCON03-EFC-x610***-QURS-EN-P	R912005856
Safety Instructions	DOK-RCON**-SAFETY*****-SARS-BP-P	R911339218
	DOK-RCON**-SAFETY*****-SARS-DE-P	R911339363
	DOK-RCON**-SAFETY*****-SARS-EN-P	R911339362
	DOK-RCON**-SAFETY*****-SARS-ES-P	R911339216
	DOK-RCON**-SAFETY*****-SARS-FR-P	R911339213
	DOK-RCON**-SAFETY*****-SARS-IT-P	R911339215
	DOK-RCON**-SAFETY*****-SARS-RU-P	R911339217
	DOK-RCON**-SAFETY*****-SARS-ZH-P	R912004727
Instruction Manual (UL)	DOK-RCON01-REX*F*UL***-INRS-EN-P	R912004711
Mounting Instructions (Extension Card Module)	DOK-RCON0*-XFC-X610***-ASRS-EN-P	R912006261
Product Insert (I/O Module)	DOK-RCON0*-XFC-X610***-ISRS-EN-P	R912006326
Product Insert (PROFIBUS Card)	DOK-RCON0*-XFC-X610COM-ISRS-EN-P	R912006458
Product Insert (CANopen Card)	DOK-RCON0*-XFCX610*CAN-ISRS-EN-P	R912006723
Product Insert (Multi-Ethernet Card)	DOK-RCON0*-XFCX610*MUL-ISRS-EN-P	R912006847
Product Insert (Assembled Extension Module)	DOK-RCON0*-INT*EXT*MOD-ISRS-EN-P	R912006859
Instruction Manual (CANopen Card)	DOK-RCON0*-XFCX610*CAN-ITRS-EN-P	R912006713
Instruction Manual (Multi-Ethernet Card)	DOK-RCON0*-XFCX610*MUL-ITRS-EN-P	R912006860
Operating Instructions (Brake Chopper)	DOK-RCON03-EFC*BRAKE**-ITRS-EN-P	R912007235
Product Insert (Encoder Card)	DOK-RCON0*-ABZ*ENCODER-ISRS-EN-P	R912004809
Product Insert (Resolver Card)	DOK-RCON0*-RESOL**CARD-ISRS-EN-P	R912007839

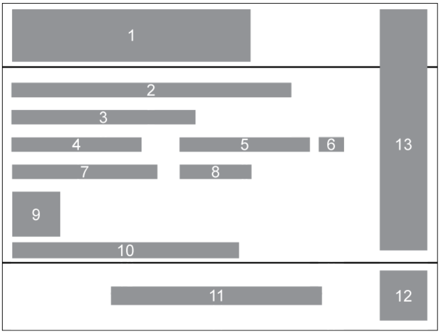
Tab. 3-1: Documentation overview

4 Delivery and Storage

4.1 Product Identification

4.1.1 Packing Nameplate

Check if the model information on the packing nameplate is the same as you ordered **immediately** after receipt. If the model is wrong, please contact Bosch Rexroth distributor.

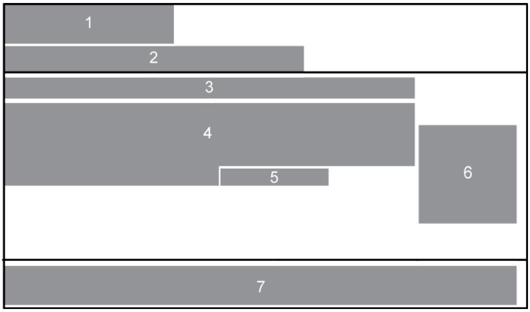


1 Product series
2 Short text / Type code
3 Volume
4 Net weight
5 Material number
6 Product version index
7 Mass weight
8 Production week: e.g., 14W20 means week 20 in 2014
9 Product QR code
10 Serial number
11 Manufacturer
12 QR code (Internal use)
13 Certification

Fig. 4-1: Packing nameplate

4.1.2 Product Nameplate

Check if the model information on product nameplate is the same as you ordered **immediately** after unpacking. If the model is wrong, please contact Bosch Rexroth distributor.



1 Brand logo
2 Product series
3 Short text / Type code
4 Technical data
5 Production week: e.g., 14W20 means week 20 in 2014
6 Product QR code
7 Manufacturer

Fig. 4-2: Product nameplate1

1 Certification

Fig. 4-3: Product nameplate2

4.2 Remove from Packing Box

There are four eyebolts on the side of the device for user to remove (or lift) the device from packing box.

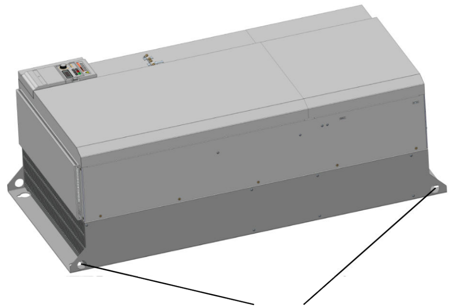


Fig. 4-4: Eyebolts for lifting and mounting

4.3 Visual Inspection

Check the product for transport damages, e.g. deformation or loose parts, immediately after unpacking. In case of damage, contact the forwarder at once and arrange for a thorough review of the situation.

☞ This is also applicable if the packaging is undamaged.

4.4 Scope of Supply

If any of the following standard supply items is missing, please contact Bosch Rexroth distributor.

- Frequency Converter EFC x610 (According to type code)
- Safety Instructions (Multi-lingual)
- Quick Start Guide
- Instruction Manual (UL)

4.5 Transport of the Components

Description	Symbol	Unit	Value
Temperature range	T_{a_tran}	°C	-25...70
Relative humidity	–	%	5...95
Absolute humidity	–	g/m^3	1...60
Climate category (IEC 721)	–	–	2K3
Moisture condensation	–	–	not allowed
Icing	–	–	not allowed

Tab. 4-1: Transport conditions

4.6 Storage of the Components

⚠ CAUTION

Damage to the components caused by long storage periods!

A frequency converter contains electrolytic capacitors which may deteriorate during storage.

When storing these components for a long period of time, remember to operate them once a year:

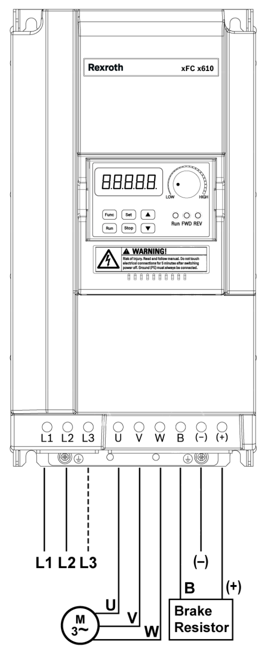
- Run Frequency Converter EFC x610 under power U_{LN} for at least 1 hour.
- For more information of electrolytic capacitors, please contact service.

Description	Symbol	Unit	Value
Temperature range	T_{a_store}	°C	-20...60
Relative humidity	–	%	5...95
Absolute humidity	–	g/m^3	1...29
Climate category (IEC 721)	–	–	1K3
Moisture condensation	–	–	not allowed
Icing	–	–	not allowed

Tab. 4-2: Storage conditions

5 Drive System Overview

Name	1P 200 VAC	3P 200 VAC 380 VAC	Description
Power supply	L1 L2	L1 L2 L3	**Power supply** Ensure that the power supply meets the rated values specified in this documentation.
Fuse			**Fuse** A frequency converter may take a high input current when being switched on. Please select an appropriate fuse.①
Electromagnetic contactor			**Electromagnetic contactor (MC)** MC is used for complete power shut down of frequency converter instead of START and STOP inputs. ②
AC input choke			**AC input choke** An AC input choke is recommended to improve power factors. The wiring length must be less than 10 m.
EMC filter			**EMC filter**
Frequency converter	N N		**Frequency converter** See the figure on the right side for connections of other accessories.
AC output choke			**AC output choke** It is recommended to use an AC output choke and multi-conductor twisted cables in order to avoid motor insulation destruction. ③
Motor	M 3~		**Motor**



Caution:
For a 1P 200 VAC frequency converter, removing the cover of terminal L3 is not allowed. ④

Fig. 5-1: Drive system overview

①: To select an appropriate fuse, see chapter 8.2.1 "Power Cables" on page 58.

②: Frequently switching on and off contactor will shorten the life time of relay contacts and DC-bus capacitors, and may destroy the resistor for capacitor charging and current limitation. We recommend that the interval time of switch-on and off should be greater than 15min/times

③: Whether using an AC output choke or not depends on the factors of: the length, shielding and distribution capacitance of the motor cables, as well as the insulation of the motor.

④: The covers of terminal (+), (-) and B can be removed as needed.

6 Frequency Converter Overview

6.1 Product Features

6.1.1 Input

Power supply voltage	1P 200...240 VAC (-10 % / +10 %) (IT-Net, TN-Net) 3P 200...240 VAC (-10 % / +10 %) (IT-Net, TN-Net) 3P 380...480 VAC (-15 % / +10 %) (IT-Net, TN-Net)
Power supply frequency	50 / 60 Hz (±5 %)

6.1.2 Output

Rated voltage	Corresponding to input voltage
Rated power	0.4...2.2 kW (1P 200 VAC) 0.4...11 kW (3P 200 VAC) 0.4...160 kW (3P 380 VAC)
Rated frequency[1)]	0.00...400.00 Hz
Default carrier frequency	0K40...4K00: 6k 5K50...22K0 (Heavy Duty[2)]): 6k 5K50...22K0 (Normal Duty[2)]): 4k 30K0...90K0: 4k 110K...160K: 2k
Carrier frequency range	0.4...22 kW: 1...15 kHz 30...160 kW: 1...12 kHz
Efficiency	> 95 %
Overload capability	Heavy Duty*: 200 % of rated current for 1 s [3)] Heavy Duty: 150 % of rated current for 60 s [4)] Normal Duty*: 120 % of rated current for 60 s [5)]
dv / dt (Without filter)	< 5kV / us

[1]: The rated output frequency of the high frequency modelis 0...1,000 Hz.

[2]: Heavy Duty / Normal Duty are applicable for models 5K50 and above. Only Heavy Duty is available for 3P 200 VAC models.

[3]: 200 % of HD rated current for 1 s, and then 19 s with rated current for recovery from the overload influence, after this comes next overload period.

[4]: 150 % of HD rated current for 60 s, and then 540 s with rated current for recovery from the overload influence, after this comes next overload period.

[5]: 120 % of ND rated current for 60 s, and then 540 s with rated current for recovery from the overload influence, after this comes next overload period.

3P 200...240 VAC models only have Heavy Duty application, the overload capability of 3P 200...240 VAC models is the same as that of 3P 380 VAC models.

6.1.3 V/f Control Performance

V/f curve	Linear mode, square curve mode, user-defined multi-point curve mode
Speed regulation range	1:50
Start-up torque	150 % of rated torque at 3.00 Hz 100 % of rated torque at 1.50 Hz

6.1.4 SVC Control Performance

Speed regulation range	1:200
Start-up torque	200 % of rated torque at 0.50 Hz

6.1.5 Main Functions

Frequency setting resolution	Analog setting: 1/1,000 of maximum frequency Digital setting: 0.01 Hz
Frequency setting accuracy	Analog setting: ±0.1 % of maximum frequency (25 ℃ ± 10 ℃) Digital setting: ±0.01 % of maximum frequency (-10...50 ℃)
Acceleration / deceleration curve mode	Linear, S-curve 8 sets of acceleration / deceleration time: 0.1...6,000.0 s
Stop DC-braking	DC-braking initial frequency: 0.00...50.00 Hz DC-braking time: 0.0...20.0 s Stop DC-braking current: 0.0...150.0 %
Jog function	Jog frequency range: 0.00 Hz...maximum output frequency Jog acceleration / deceleration time: 0.1...6,000.0 s
Multi-speed control	16 stages by digital input control
Simple PLC control	16 stages with pause / stop control
PID control	PID control with sleep / wake function
Digital input	5 digital inputs support PNP and NPN wiring, X5 supports 50.0 kHz pulse input
Analog input	2 Analog inputs: 0 / 2...10 V or 0 / 4...20 mA
Digital output	1 Open collector output, supports 32.0 kHz pulse output and pull-up and pull-down wiring 1 Relay output
Analog output	Analog output 0/2...10 V or 0/4...20 mA
Other functions	Carrier frequency automatic adjustment, first and second frequency setting source, slip compensation, torque boost, automatic voltage stabilization, power loss restart, 2-wire / 3-wire control, quick start parameters, parameter replication, output current limitation, power fault ride-through, safe torque off (STO), etc.

6.1.6 Communication

Standard communication protocol	Modbus
Standard communication interface	RS485
Optional communication protocol and interface	Depending on communication module (Needs to be ordered additionally)

6.1.7 Operating Panel

LED panel	**Display:** Display parameters, settings, status codes, warning codes and error codes **Buttons:** Set parameters, switch display, reset warnings, execute run and stop command, increase or decrease parameter group / code / value **Potentiometer:** Set frequency **Indicator:** Run, FWD, REV
Dust cover	Indicating Run, FWD, REV and Power*

☞ *: Indicator is displayed only if the extension module is not used.

6.1.8 Protection

Over current protection, over- / under- voltage protection, surge current / short circuit protection, input / output phase loss protection, converter over- / under- temperature protection, motor overload protection, motor over temperature protection, direction lock protection, analog input broken wire detection, etc.

6.1.9 Conditions

Rated ambient temperature	-10...45 ℃
Derating / ambient temperature	1.5 % / 1 ℃ (45...55 ℃)
Rated storage temperature	-20...60 ℃
Rated altitude	≤ 1,000 m
Derating / altitude	1 % / 100 m (1,000...4,000 m)
Relative humidity	≤ 90 % RH (No condensation)
Degrees of protection	IP 20 (Control cabinet mounting)
Degrees of pollution	2 (EN 50178)
Vibration	10 Hz ≤ f ≤ 57 Hz amplitude: 0.075 mm 57 Hz < f ≤ 150 Hz acceleration: 1 g
Mounting mode	Wall mounting DIN rail mounting
Cooling type	● Natural cooling: 1P 200 / 3P 380 VAC: ≤ 0K75 3P 200 VAC: 0K40 ● Enforced air cooling: 1P 200 / 3P 380 VAC: ≥ 1K50 3P 200 VAC: 0K75...11K0 ● Cold plate: 1P200VAC 0.4...2.2kW 3P400VAC 0.4...4kW
Certification	CE (applicable to 0K40...160K) UL/cUL (applicable to 0K40...160K) EAC (applicable to 0K40...160K) RCM (applicable to 0K40...90K0)

6.2 Technical Data

6.2.1 Electric Data

Model	Motor power [kW]	200 V / 240 V Input current [A]	200 V / 240 V Output current [A]	Output capacity [kVA]
0K40	0.4	6.2 / 5.1	2.4 / 2.0	0.8
0K75	0.75	10.1 / 8.4	4.1 / 3.4	1.4
1K50	1.5	16.2 / 13.5	7.3 / 6.1	2.5
2K20	2.2	22.3 / 18.6	10.1 / 8.4	3.5

Tab. 6-1: 1P 200 VAC 0K40...2K20 electric data

Model	Motor power [kW]	200 V / 240 V Input current [A]	200 V / 240 V Output current [A]	Output capacity [kVA]
0K40	0.4	3.6 / 3.0	2.4 / 2.0	0.8
0K75	0.75	5.8 / 4.9	4.1 / 3.4	1.4
1K50	1.5	9.4 / 7.8	7.3 / 6.1	2.5
2K20	2.2	12.9 / 10.7	10.1 / 8.4	3.5
3K00	3.0	16.5 / 13.8	13.4 / 11.2	4.7
4K00	4.0	21.6 / 18.0	17.5 / 14.6	6.1
5K50	5.5	28.9 / 24.1	23.4 /19.5	8.1
7K50	7.5	38.8 / 32.4	31.1 / 25.9	10.8
11K0	11.0	51.8 / 43.2	44.9 / 37.4	15.5

Tab. 6-2: 3P 200 VAC 0K40...11K0 electric data

☞ 3P 200 VAC: available with ONLY EFC 5610.

Model	Motor power [kW]	380 V / 480 V Input current [A]	380 V / 480 V Output current [A]	Output capacity [kVA]
0K40	0.4	1.5 / 1.2	1.3 / 1.1	0.9
0K75	0.75	2.6 / 2.0	2.3 / 1.8	1.5
1K50	1.5	4.8 / 3.8	4.0 / 3.2	2.7
2K20	2.2	6.8 / 5.4	5.6 / 4.4	3.7
3K00	3.0	9.1 / 7.2	7.4 / 5.9	4.9
4K00	4.0	11.9 / 9.4	9.7 / 7.7	6.4

Tab. 6-3: 3P 380 VAC 0K40...4K00 electric data

Model	Motor power Heavy Duty [kW]	380 V / 480 V Input current [A]	380 V / 480 V Output current [A]	Output capacity [kVA]
5K50	5.5	15.7 / 12.4	12.7 / 10.0	8.3
7K50	7.5	21.0 / 16.7	16.8 / 13.3	11.1
11K0	11.0	28.0 / 22.2	24.3 / 19.2	16.0
15K0	15.0	37.8 / 29.9	32.4 / 25.6	21.3
18K5	18.5	45.8 / 36.3	39.2 / 31.0	25.8
22K0	22.0	52.7 / 41.7	45.0 / 36.0	29.7
30K0	30.0	56.8 / 44.9	60.8 / 48.1	40.0
37K0	37.0	69.6 / 55.1	73.7 / 58.3	48.5
45K0	45.0	86.0 / 68.0	89.0 / 71.0	58.6
55K0	55.0	105.0 / 83.0	108.0 / 86.0	71.3
75K0	75.0	140.0 / 111.0	147.0 / 116.0	96.6
90K0	90.0	167.0 / 133.0	176.0 / 139.0	115.7
110K	110.0	205.0 / 162.0	212.0 / 168.0	139.6
132K	132.0	252.0 / 200.0	253.0 / 200.0	166.0
160K	160.0	305.0 / 242.0	303.0 / 240.0	199.0

Tab. 6-4: 3P 380 VAC 5K50...160K, electric data, Heavy Duty

☞ 30K0...160K: available with ONLY EFC 5610.

Please select the current rating of frequency converter according to the motor rated current on the nameplate.

Model	Motor power Normal Duty [kW]	380 V / 480 V Input current [A]	380 V / 480 V Output current [A]	Output capacity [kVA]
5K50	7.5	21.0 / 16.7	16.8 / 13.3	11.1
7K50	11.0	28.0 / 22.2	24.3 / 19.2	16.0
11K0	15.0	37.8 / 29.9	32.4 / 25.6	21.3
15K0	18.5	45.8 / 36.3	39.2 / 31.0	25.8
18K5	22.0	52.7 / 41.7	45.0 / 36.0	29.7
22K0	30.0	71.2 / 56.3	60.8 / 48.0	40.0
30K0	37.0	69.6 / 55.1	73.7 / 58.3	48.5
37K0	45.0	84.2 / 66.6	89.1 / 70.5	58.7
45K0	55.0	105.0 / 83.0	108.0 / 86.0	71.3
55K0	75.0	140.0 / 111.0	147.0 / 116.0	96.6
75K0	90.0	167.0 / 133.0	176.0 / 139.0	115.7
90K0	110.0	205.0 / 162.0	212.0 / 168.0	139.6
110K	132.0	252.0 / 200.0	253.0 / 200.0	166.0

Model	Motor power Normal Duty [kW]	380 V / 480 V Input current [A]	380 V / 480 V Output current [A]	Output capacity [kVA]
132K	160.0	305.0 / 242.0	303.0 / 240.0	199.0
160K	200.0	383.0 / 303.0	380.0 / 300.0	250.0

Tab. 6-5: 3P 380 VAC 5K50...160K, electric data, Normal Duty

☞ 30K0...160K: available with ONLY EFC 5610.

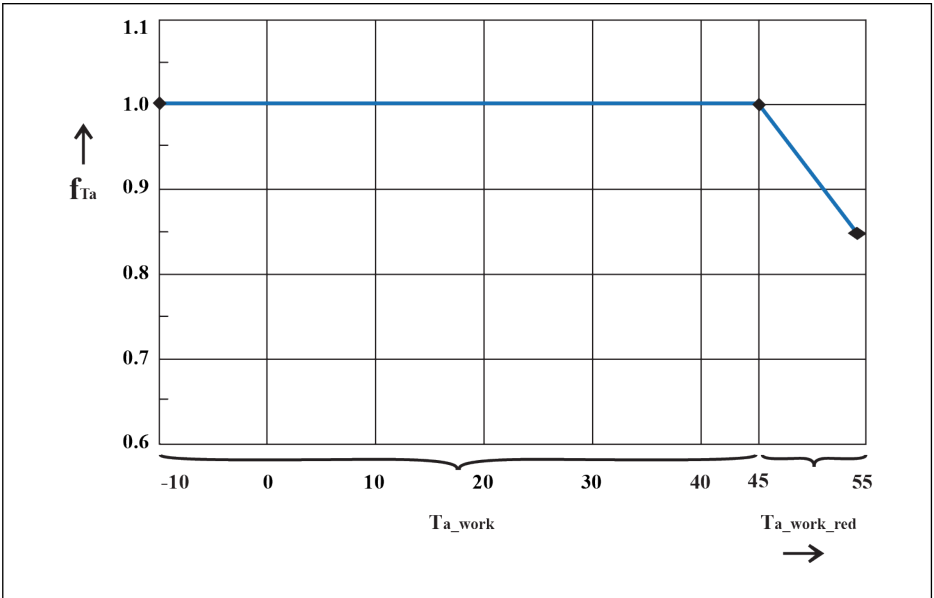
Please select the current rating of frequency converter according to the motor rated current on the nameplate.

6.2.2 Derating of Electric Data

Derating and ambient temperature

The ambient temperature for Frequency Converter EFC x610 is -10...55 ℃. Out of this range, there will be no possibility to install and run the frequency converter, even the performance data have been additionally reduced.

- If the ambient temperature is -10...45 ℃, there will be no need for derating.
- If the ambient temperature is 45...55 ℃, derating must be performed as indicated in the figure below.



f_{Ta}	Load factor	Ta_work_red	Ambient temperature range for operation with reduced rated data
Ta_work	Ambient temperature range for operation with rated data		

Fig. 6-1: Derating and ambient temperature (℃)

Derating and mains voltage

Reduce overcurrent based on mains voltage.

Frequency Converter EFC x610 is thermally dimensioned for the rated current. This rated current is available with the specified rated voltage. With deviating voltages in the permissible range, please pay attention to the following:

- $U_{mains} < U_{rated}$:

  With mains voltage below the rated voltage, no higher current may be withdrawn to ensure that the dissipated power remains.

- $U_{mains} > U_{rated}$:

  With mains voltage above the rated voltage, a reduction of the permissible output permanent current takes place to compensate for the increased switching losses.

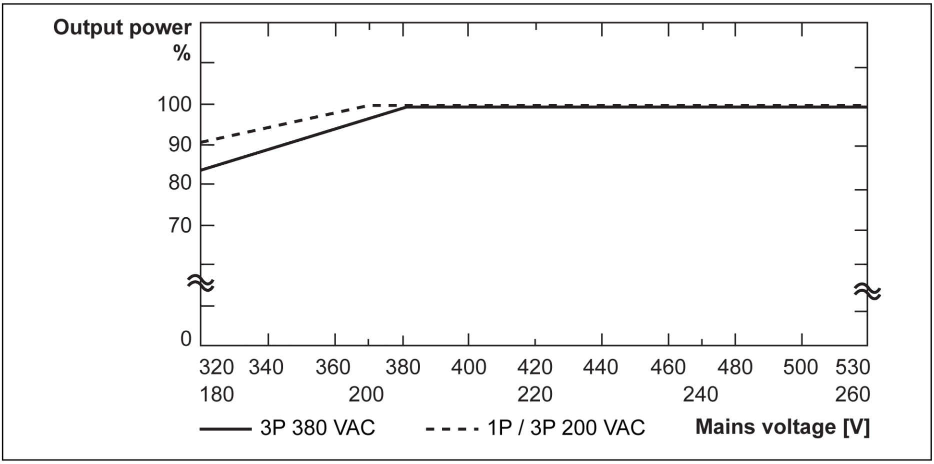
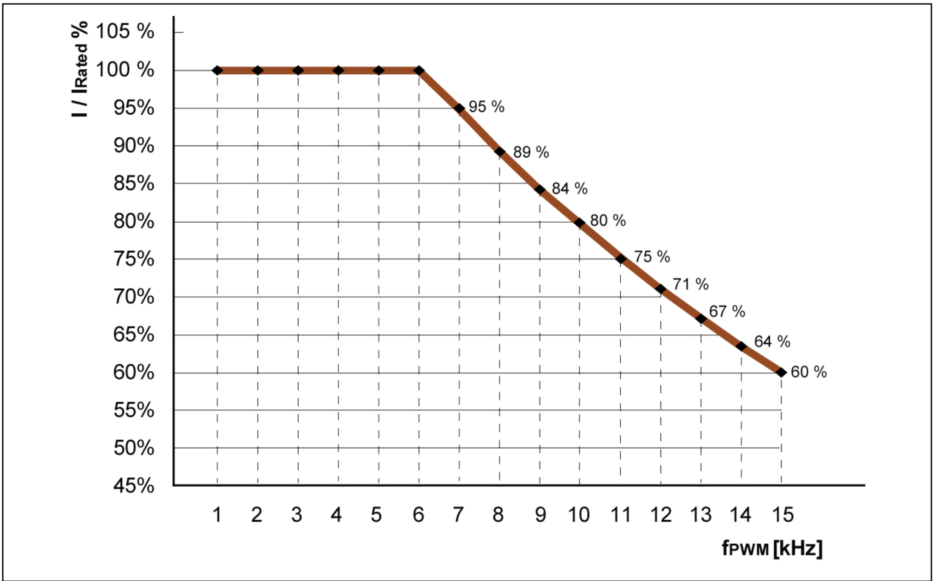


Fig. 6-2: Derating and mains voltage

- 1P 200 VAC / 3P 200 VAC: 1 % power derating every 2 V lower than 200 V.
- 3P 380 VAC: 1 % power derating every 4 V lower than 380 V.

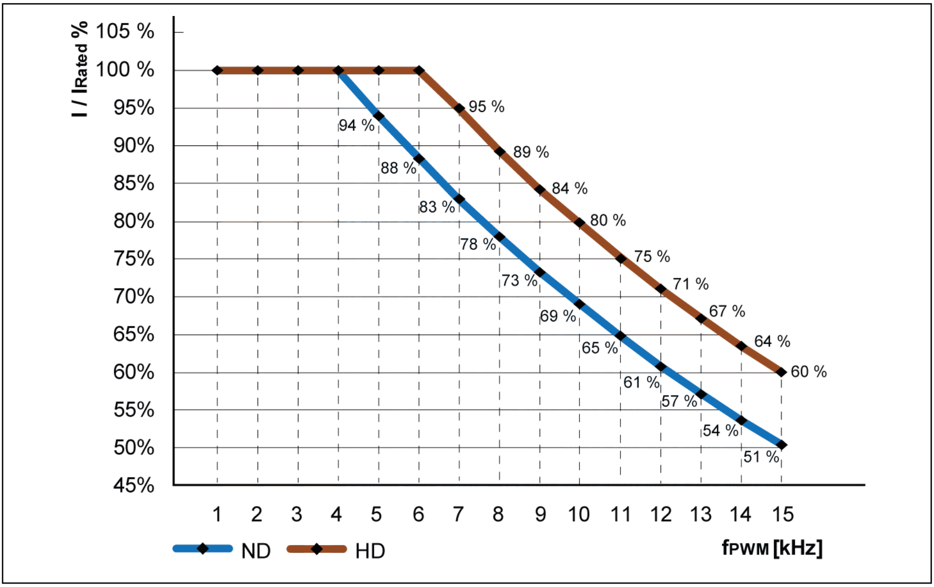
Derating and carrier frequency

In case of higher carrier frequency, the output current is reduced so that the power dissipation in power section remains more or less constant. The figure below shows the current reduction based on the carrier frequency for the frequency converters:



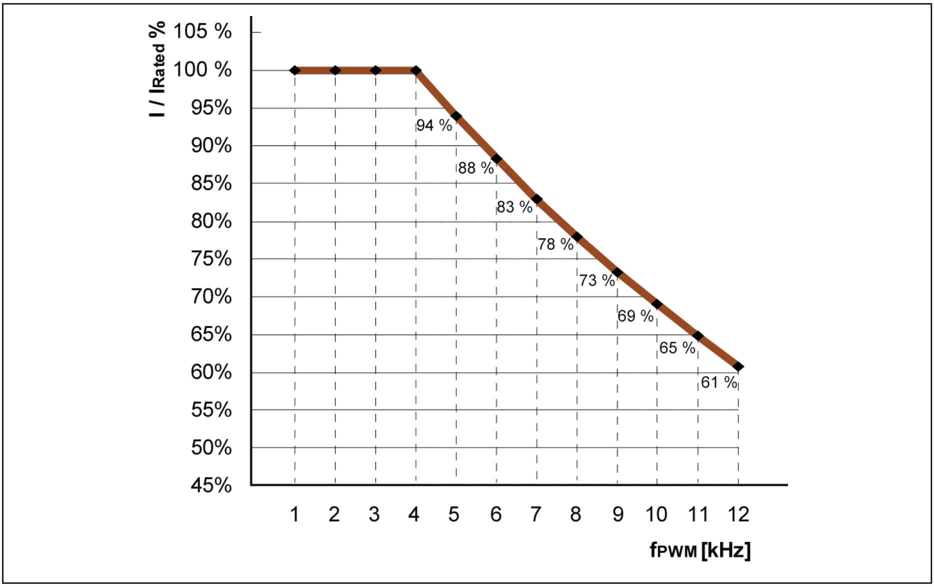
I / I_{rated} % Percentage of rated output current
f_{PWM} PWM or carrier frequency

Fig. 6-3: Derating and carrier frequency for 0K40...4K00 models



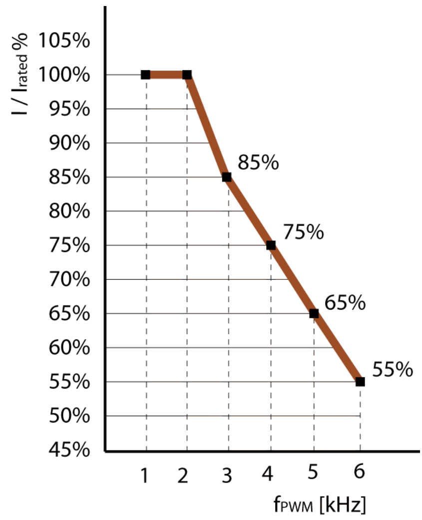
I / I_{rated} %	Percentage of rated output current	ND	Normal Duty
f_{PWM}	PWM or carrier frequency	HD	Heavy Duty

Fig. 6-4: Derating and carrier frequency for 5K50...22K0 models



I / I_{rated} % Percentage of rated output current
f_{PWM} PWM or carrier frequency

Fig. 6-5: Derating and carrier frequency for 30K0...90K0 models (Normal Duty and Heavy Duty)



I / I_{rated} % Percentage of rated output current
f_{PWM} PWM or carrier frequency

Fig. 6-6: Derating and carrier frequency for 110K...160K models (Normal Duty and Heavy Duty)

6.2.3 Maximum Length of Motor Cables

Model	Configuration	Maximum length of motor cables	
		C3 [m]	C1 [m]
0K40...4K00	EFC x610 (internal EMC filter)	15	–
	EFC x610 (internal EMC filter) + External mains EMC filter	50	15
5K50...18K5	EFC x610 (internal EMC filter)	30	–
	EFC x610 (internal EMC filter) + External mains EMC filter	50	15
22K0	EFC x610 (internal EMC filter)	30	–
	EFC x610 (internal EMC filter) + External mains EMC filter	50	–
30K0...37K0	EFC x610 (internal EMC filter)	50	–
	EFC x610 (internal EMC filter) + External mains EMC filter	100	–
45K0...90K0	EFC x610 (internal EMC filter)	50	–
	EFC x610 (internal EMC filter) + External mains EMC filter	100	–
110K...160K	EFC x610 (internal EMC filter)	75	–
	EFC x610 (internal EMC filter) + External mains EMC filter	150	–

Tab. 6-6: 1P 200 VAC / 3P 380 VAC maximum length of motor cables

Model	Configuration	Maximum length of motor cables	
		C3 [m]	C1 [m]
0K40...2K20	EFC x610 (internal EMC filter)	15	–
	EFC x610 (internal EMC filter) + External mains EMC filter	50	15
4K00...11K0	EFC x610 (internal EMC filter)	30	–
	EFC x610 (internal EMC filter) + External mains EMC filter	50	15

Tab. 6-7: 3P 200 VAC maximum length of motor cables

1. ONLY CONDUCTED EMISSION can be guaranteed for C1.
2. SHIELDED MOTOR CABLES are used in test.
3. Longer motor cable length is possible with an additional output choke.

6.2.4 Minimum Inductance Between Two Motor Terminals

The following formula is used to calculate the minimum inductance between two motor terminals:

$L_{\_min} = U_{\_DC} / (8 \times f_{\_PWM} \times \sqrt{2} \times I_{\_nom} \times 0.2)$ (in mH)

$U_{\_DC}$: DC-link voltage

$f_{\_PWM}$: Desired switching frequency in kHz

$I_{\_nom}$: Output current according to the type code (rms value)

7 Frequency Converter Mounting

7.1 Installation Conditions

The frequency converter must be vertically installed.

If one frequency converter is arranged above another, make sure the upper limit of air temperature into the inlet is not exceeded (see chapter 6.1.9 "Conditions" on page 24). An air guide is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter if the upper limit of air temperature is exceeded.

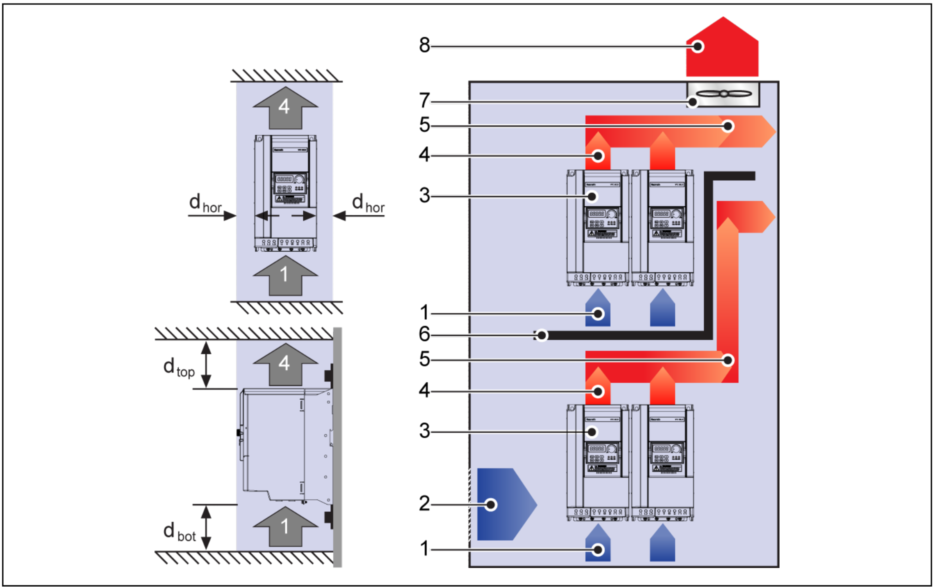


Fig. 7-1: Mounting distance and arrangement

d_{hor} (Distance horizontal):

d_{hor} = 0 mm (0K40...22K0); d_{hor} = 10 mm (30K0...160K)

d_{top} (Minimum top distance):

d_{top} = 125 mm (0K40...90K0); d_{top} = 400 mm (110K...160K)

d_{bot} (Minimum bottom distance):

d_{bot} = 125 mm (0K40...90K0); d_{bot} = 400 mm (110K...160K)

1: Air inlet at frequency converter; 2: Air inlet at control cabinet

3: Frequency converter; 4: Air outlet at frequency converter

5: Heated air conveying direction; 6: Air guide in control cabinet

7: Fan in control cabinet; 8: Discharge of heated air

7.2 Heat Dissipation

1P 200 VAC

Frame	Model	Heat dissipation	
		[W]	[BTU/h]
B	0K40	40	136
B	0K75	70	256
C	1K50	120	409
D	2K20	165	563

Tab. 7-1: 1P 200 VAC heat dissipation

3P 200 VAC

Frame	Model	Heat dissipation	
		[W]	[BTU/h]
B	0K40	37	126
C	0K75	75	256
D	1K50	135	461
D	2K20	180	614
E	3K00	210	714
E	4K00	255	867
F	5K50	320	1,088
F	7K50	435	1,479
G	11K0	640	2,176

Tab. 7-2: 3P 200 VAC heat dissipation

3P 380 VAC

Frame	Model	Heat dissipation	
		[W]	[BTU/h]
B	0K40	20	68
B	0K75	37	126
C	1K50	75	256
C	2K20	99	338
D	3K00	135	461
D	4K00	180	614
E	5K50	210	714
E	7K50	255	867

Frame	Model	Heat dissipation	
		[W]	[BTU/h]
F	11K0	320	1,088
F	15K0	435	1,479
G	18K5	530	1,802
G	22K0	640	2,176
H	30K0	745	2,533
H	37K0	874	2,972
I	45K0	1,405	4,794
I	55K0	1,951	6,658
J	75K0	2,074	7,076
J	90K0	2,653	9,051
K	110K	2,530	8,602
K	132K	2,772	9,425
L	160K	3,813	13,002

Tab. 7-3: 3P 380 VAC heat dissipation

7.3 Air Flow of Fans

1P 200 VAC

Frame	Model	Fan for heat sink		Fan for internal components	
		[CFM]	[m^3/min]	[CFM]	[m^3/min]
B	0K40	–	–	–	–
B	0K75	–	–	–	–
C	1K50	19.20	0.54	–	–
D	2K20	19.20	0.54	–	–

Tab. 7-4: 1P 200 VAC air flow of fans

☞ 1P 200 VAC: Models 1K50...2K20 have only one fan for heat sink.

3P 200 VAC

Frame	Model	Fan for heat sink		Fan for internal components	
		[CFM]	[m^3/min]	[CFM]	[m^3/min]
B	0K40	–	–	–	–
C	0K75	19.20	0.54	–	–
D	1K50	19.20	0.54	–	–
D	2K20	19.20	0.54	–	–
E	3K00	40.00	1.13	32.17	0.91
E	4K00	40.00	1.13	32.17	0.91
F	5K50	56.50	1.60	34.90	0.99
F	7K50	56.50	1.60	34.90	0.99
G	11K0	49.20	1.39	47.60	1.35

Tab. 7-5: 3P 200 VAC air flow of fans

☞ 3P 200 VAC:

- Models 3K00 and above have only one fan for internal components.
- Models 0K75...4K00 have only one fan for heat sink.
- Models 5K50 and above have TWO fans for heat sink.

3P 380 VAC

Frame	Model	Fan for heat sink		Fan for internal components	
		[CFM]	[m^3/min]	[CFM]	[m^3/min]
B	0K40	–	–	–	–
B	0K75	–	–	–	–
C	1K50	19.20	0.54	–	–
C	2K20	19.20	0.54	–	–
D	3K00	19.20	0.54	–	–
D	4K00	19.20	0.54	–	–
E	5K50	40.00	1.13	32.17	0.91
E	7K50	40.00	1.13	32.17	0.91
F	11K0	56.50	1.60	34.90	0.99
F	15K0	56.50	1.60	34.90	0.99
G	18K5	40.00	1.13	34.90	0.99
G	22K0	49.20	1.39	47.60	1.35
H	30K0	120.20	3.40	–	–
H	37K0	120.20	3.40	–	–
I	45K0	215.74	6.11	–	–
I	55K0	215.74	6.11	–	–
J	75K0	215.74	6.11	–	–
J	90K0	215.74	6.11	–	–
K	110K	243.64	6.90	–	–
K	132K	243.64	6.90	–	–
L	160K	243.64	6.90	–	–

Tab. 7-6: 3P 380 VAC air flow of fans

☞ 3P 380 VAC:

- Models 5K50...22K0 have only one fan for internal components.
- Models 30K0 and above have no fan for internal components.
- Models 1K50...7K50 have only one fan for heat sink.
- Models 11K0...90K0 have TWO fans for heat sink.
- Models 110K...160K have THREE fans for heat sink.

7.4 Figures and Dimensions

7.4.1 Figures

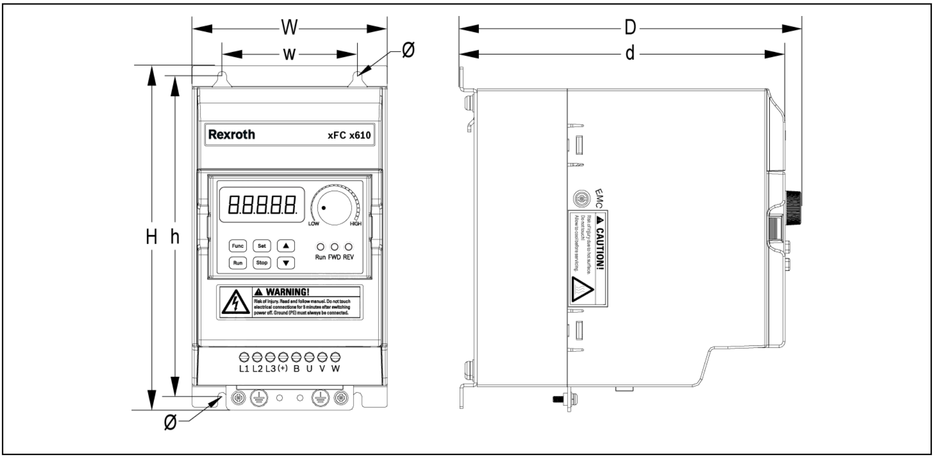


Fig. 7-2: EFC x610 0K40...4K00 dimensions figure (1P 200 VAC / 3P 380 VAC)

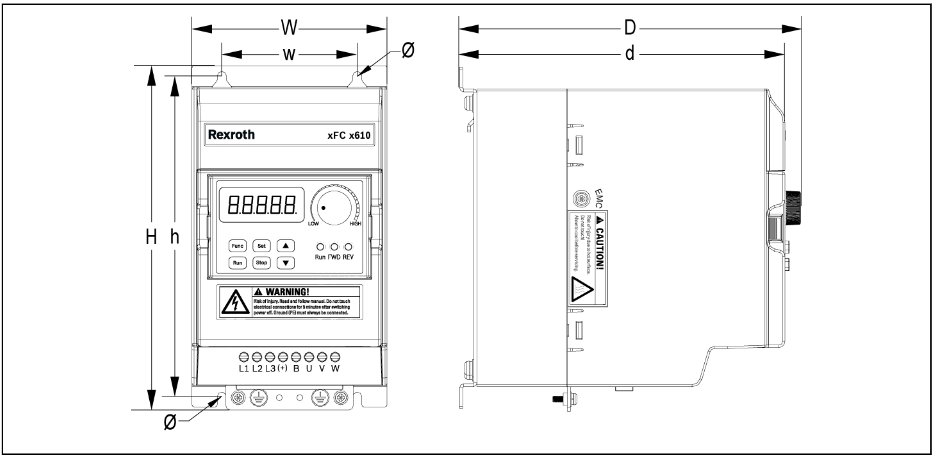


Fig. 7-3: EFC x610 0K40...2K20 dimensions figure (3P 200 VAC)

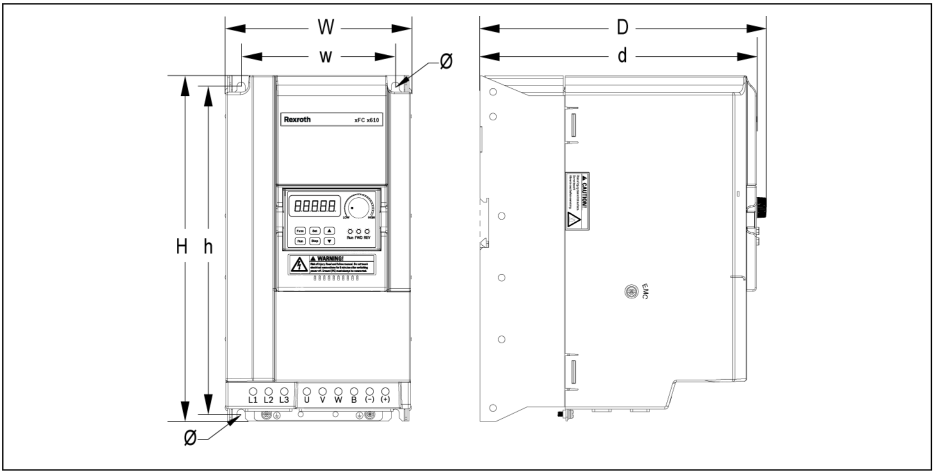


Fig. 7-4: EFC x610 3K00...11K0 dimensions figure (3P 200 VAC)

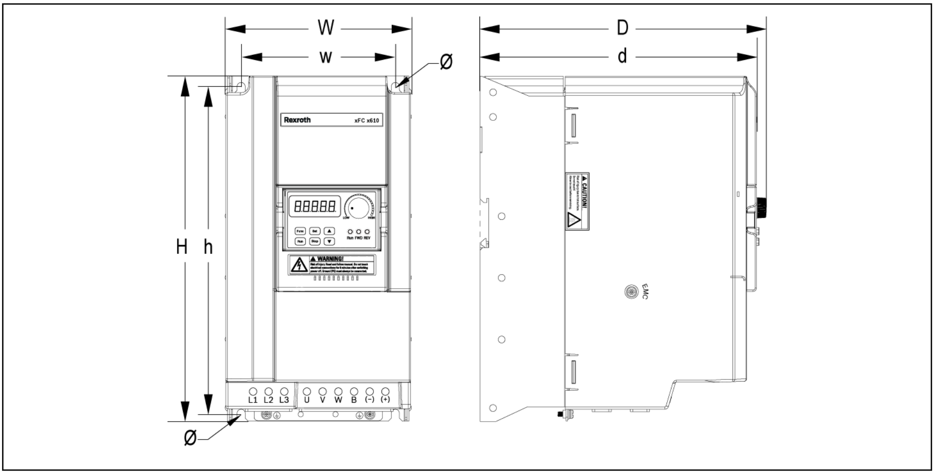


Fig. 7-5: EFC x610 5K50...22K0 dimensions figure (3P 380 VAC)

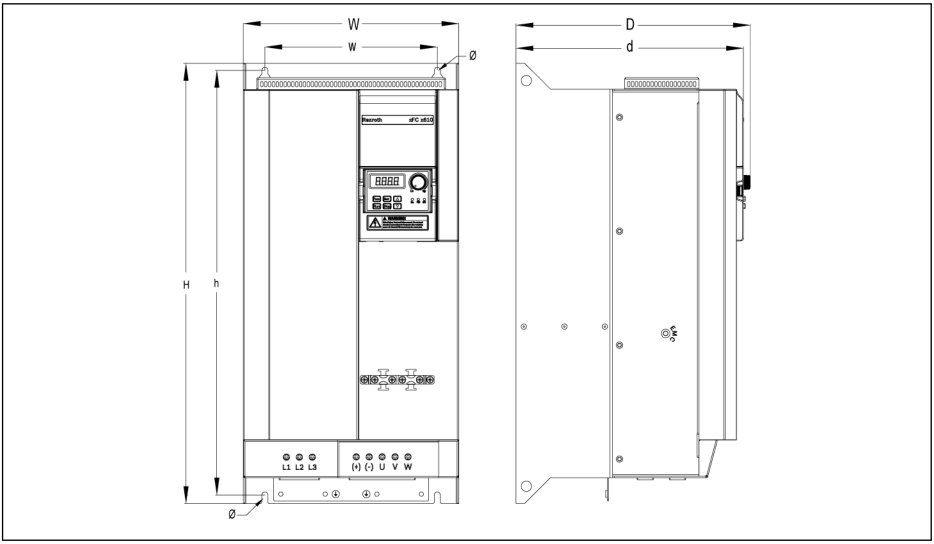


Fig. 7-6: EFC 5610 30K0...37K0 dimensions figure (3P 380 VAC)

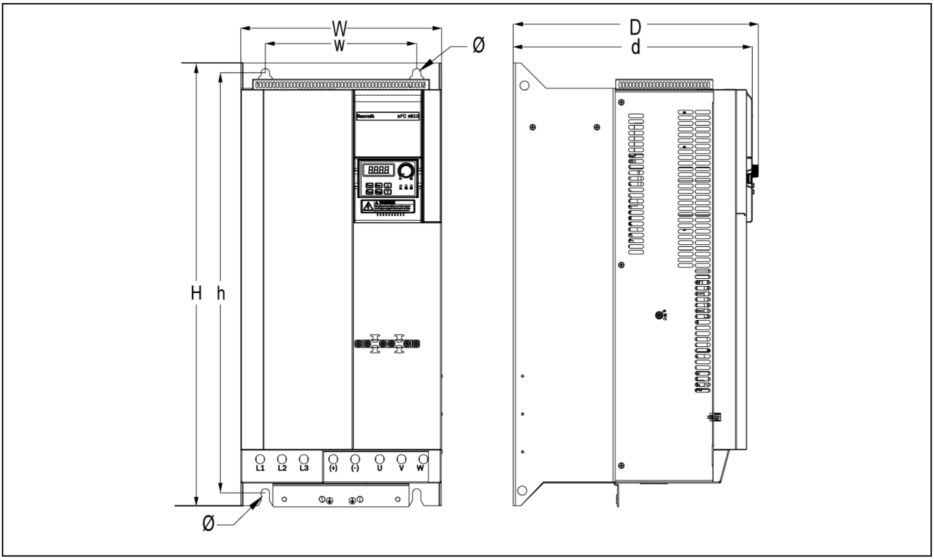


Fig. 7-7: EFC 5610 45K0...55K0 dimensions figure (3P 380 VAC)

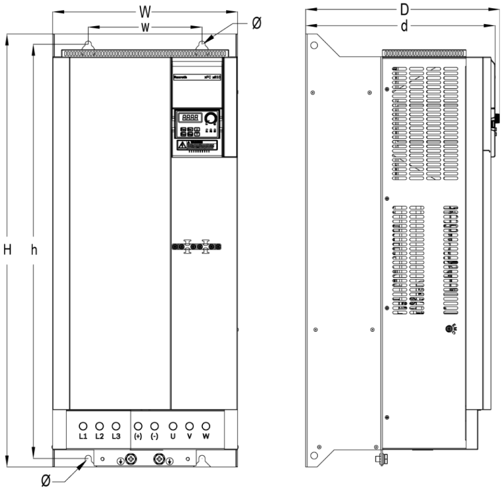


Fig. 7-8: EFC 5610 75K0...90K0 dimensions figure (3P 380 VAC)

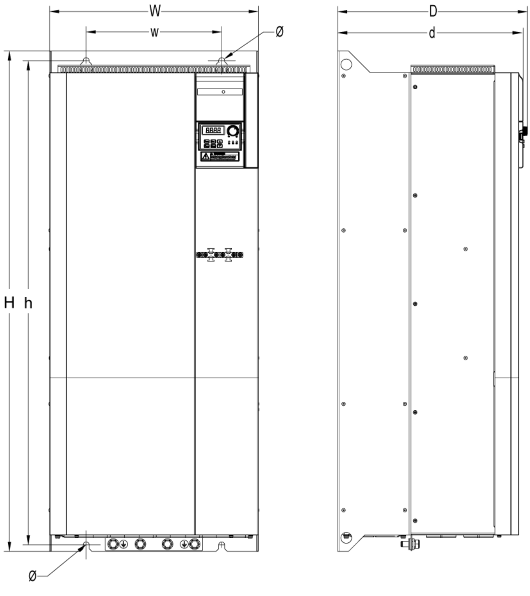


Fig. 7-9: EFC 5610 110K...132K dimensions figure (3P 380 VAC)

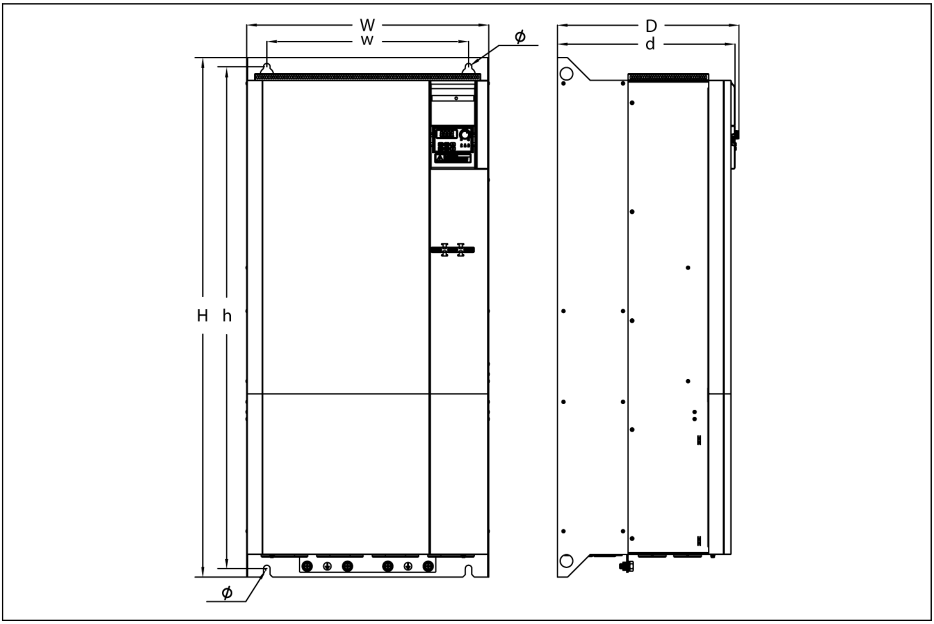


Fig. 7-10: EFC 5610 160K dimensions figure (3P 380 VAC)

7.4.2 Dimensions

Frame	Model①	Dimensions [mm]							Screw size②	Net weight [kg]
		W	H	D④	w	h	d④	Ø		
B	0K40	95	166	167	66	156	159	4.5	M4	1.5
B	0K75	95	166	167	66	156	159	4.5	M4	1.5
C	1K50	95	206	170	66	196	162	4.5	M4	1.9
D	2K20	120	231	175	80	221	167	4.5	M4	2.6

Tab. 7-7: EFC x610 1P 200 VAC dimensions

Frame	Model①	Dimensions [mm]							Screw size②	Net weight [kg]
		W	H	D④	w	h	d④	Ø		
B③	0K40	95	166	167	66	156	159	4.5	M4	1.5
C③	0K75	95	206	170	66	196	162	4.5	M4	1.9
D③	1K50	120	231	175	80	221	167	4.5	M4	2.6
D③	2K20	120	231	175	80	221	167	4.5	M4	2.6
E③	3K00	130	243	233	106	228	225	6.5	M6	3.9
E③	4K00	130	243	233	106	228	225	6.5	M6	4.3
F③	5K50	150	283	233	125	265	225	6.5	M6	5.7
F③	7K50	150	283	233	125	265	225	6.5	M6	6.4
G③	11K0	165	315	241	140	300	233	6.5	M6	8.5

Tab. 7-8: EFC x610 3P 200 VAC dimensions

Frame	Model①	Dimensions [mm]							Screw size②	Net weight [kg]
		W	H	D④	w	h	d④	Ø		
B	0K40	95	166	167	66	156	159	4.5	M4	1.5
B	0K75	95	166	167	66	156	159	4.5	M4	1.5
C	1K50	95	206	170	66	196	162	4.5	M4	1.9
C	2K20	95	206	170	66	196	162	4.5	M4	1.9
D	3K00	120	231	175	80	221	167	4.5	M4	2.6
D	4K00	120	231	175	80	221	167	4.5	M4	2.6
E	5K50	130	243	233	106	228	225	6.5	M6	3.9
E	7K50	130	243	233	106	228	225	6.5	M6	4.3
F	11K0	150	283	233	125	265	225	6.5	M6	5.7
F	15K0	150	283	233	125	265	225	6.5	M6	6.4
G	18K5	165	315	241	140	300	233	6.5	M6	8.0

Frame	Model①	Dimensions [mm]							Screw size②	Net weight [kg]
		W	H	D④	w	h	d④	Ø		
G	22K0	165	315	241	140	300	233	6.5	M6	8.5
H③	30K0	250	510	272	200	492	264	7.0	M6	27.5
H③	37K0	250	510	272	200	492	264	7.0	M6	29.5
I③	45K0	265	585	325	200	555	317	11.0	M10	39.0
I③	55K0	265	585	325	200	555	317	11.0	M10	42.0
J③	75K0	325	760	342	200	727	334	11.0	M10	54.0
J③	90K0	325	760	342	200	727	334	11.0	M10	61.0
K③	110K	385	923	350	250	893	342	11.0	M10	71.7
K③	132K	385	923	350	250	893	342	11.0	M10	76.6
L③	160K	480	1030	360	400	995	352	13.0	M12	108.0

Tab. 7-9: EFC x610 3P 380 VAC dimensions

- ①: For complete type code for frequency converter, see chapter 19.2 "Appendix II: Type Coding" on page 573.

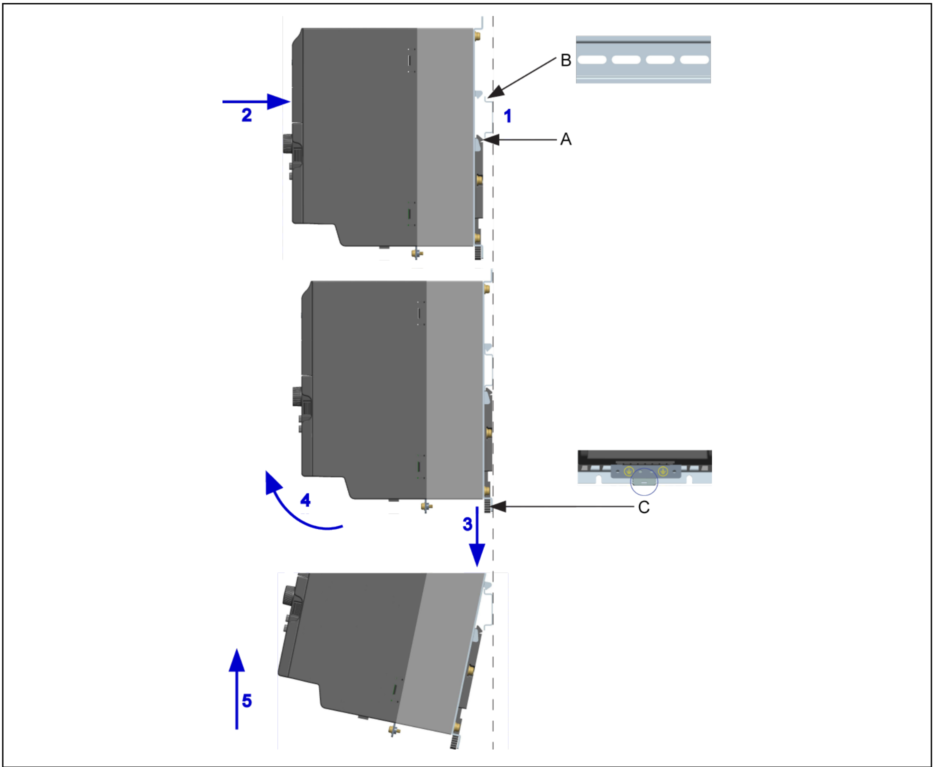
  E.g., type code for EFC 5610 5K50 (3P 380 VAC model) is:

  EFC5610-5K50-3P4-MDA-7P-NNNNN-NNNN.
- ②: 4 screws are needed for mounting of EFC x610.
- ③: ONLY available with EFC 5610.
- ④: Add **35 mm** to dimension **D** and **d** when extension module is used and installed.

7.4.3 DIN Rail Mounting

Besides wall mounting with screws, below models (does not include cold plate models) also provide DIN rail mounting.

- 1P 200 VAC: 0K40...2K20
- 3P 200 VAC: 0K40...4K00
- 3P 380 VAC: 0K40...7K50



A Mounting buckle
B Mounting rail
C Disassembly handle

Fig. 7-11: DIN rail mounting and disassembly

Mounting steps:

1: Hold the frequency converter and keep component A and the lower edge of component B at the same position level.

2: Push the frequency converter horizontally till a buckle sound indicates a successful mounting.

Disassembly steps:

3: Pull down component C and hold it.

4: Rotate the frequency converter to an appropriate angle as the arrow indicates.

5: Lift the frequency converter upwards.

7.5 Installation of Cold Plate Models

7.5.1 Installation Conditions

See chapter 7.1 "Installation Conditions" on page 36.

7.5.2 Heat Dissipation

Frame	Model	Cold plate loss [W]	Heat dissipation	
			[W]	[BTU/h]
B	0K40	20	40	136
B	0K75	35	70	256
C	1K50	52	120	409
D	2K20	94	165	563

Tab. 7-10: Heat dissipation of EFC 5610 1P 200 VAC (cold plate models)

Frame	Model	Cold plate loss [W]	Heat dissipation	
			[W]	[BTU/h]
B	0K40	15	20	68
B	0K75	24	37	126
C	1K50	45	75	256
C	2K20	54	99	338
D	3K00	86	135	461
D	4K00	106	180	614
E	5K50	146	210	714
E	7K50	203	255	867
F	11K0	276	320	1088
F	15K0	375	435	1479

Tab. 7-11: Heat dissipation of EFC 5610 3P 380 VAC (cold plate models)

7.5.3 Figures and Dimensions

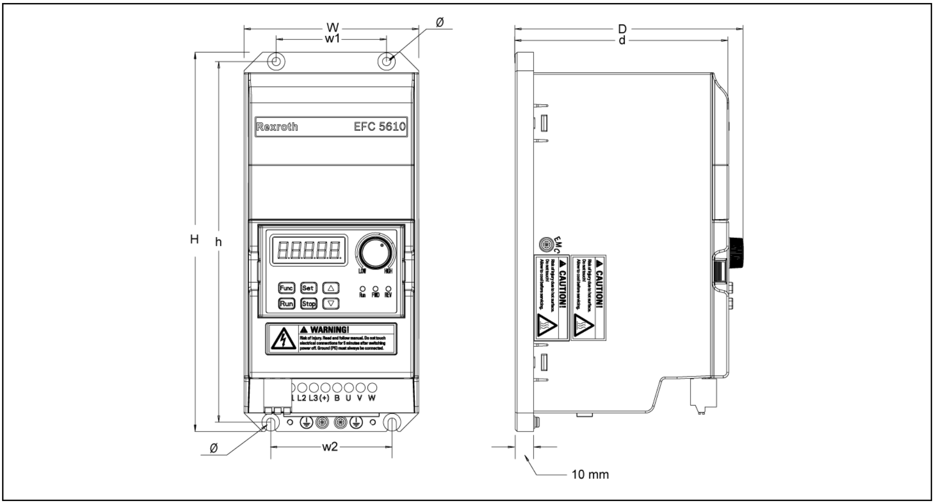


Fig. 7-12: EFC 5610 0K40...4K00 dimensions figure (cold plate models)

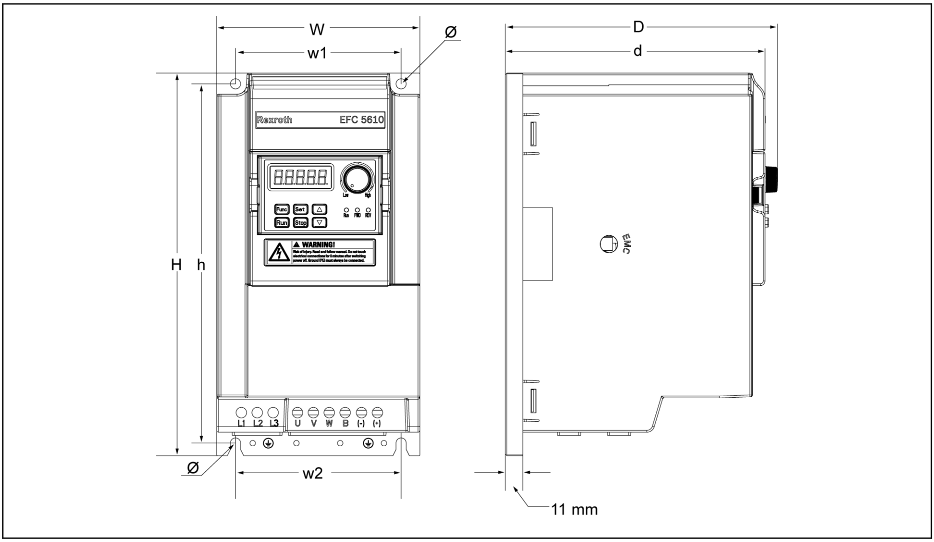


Fig. 7-13: EFC 5610 5K50...15K0 dimensions figure (cold plate models)

☞ Cold plate models do not contain fan units.

Frame	Model①	Dimensions [mm]								Screw size②	Net weight [kg]
		W	H	D③	w1	w2	h	d③	Ø		
B	0K40	95	166	124	60	66	156	116	4.5	M4	1.0
B	0K75	95	166	124	60	66	156	116	4.5	M4	1.0
C	1K50	95	206	124	60	66	196	116	4.5	M4	1.2
D	2K20	120	231	124	60	66	221	116	4.5	M4	1.5

Tab. 7-12: EFC 5610 1P 200 VAC dimensions (cold plate models)

Frame	Model①	Dimensions [mm]								Screw size②	Net weight [kg]
		W	H	D③	w1	w2	h	d③	Ø		
B	0K40	95	166	124	60	66	156	116	4.5	M4	1.1
B	0K75	95	166	124	60	66	156	116	4.5	M4	1.1
C	1K50	95	206	124	60	66	196	116	4.5	M4	1.4
C	2K20	95	206	124	60	66	196	116	4.5	M4	1.4
D	3K00	120	231	124	60	66	221	116	4.5	M4	1.8
D	4K00	120	231	124	60	66	221	116	4.5	M4	1.8
E	5K50	130	245	175	106	106	230	167	6.5	M6	3.5
E	7K50	130	245	175	106	106	230	167	6.5	M6	3.5
F	11K0	150	285	175	125	125	270	167	6.5	M6	5.0
F	15K0	150	285	175	125	125	270	167	6.5	M6	5.5

Tab. 7-13: EFC 5610 3P 380 VAC dimensions (cold plate models)

☞

- ①: For complete type code of frequency converter, see chapter 19.2 "Appendix II: Type Coding" on page 573.
- ②: 4 screws are needed for mounting.
- ③: Add **35 mm** to dimension **D** and **d** when extension module is used and installed.

7.5.4 Use of Thermal Compound Paste (Only for Cold Plate Models)

To use the thermal compound paste, the surface of heatsink and cold plate must be free from dust, dirt, oil and particles.

In addition, the heatsink surface must meet the following three conditions:

- Minimum surface flatness: 50 μm (DIN EN ISO 1101)
- Maximum surface roughness: 6 μm (DIN EN ISO 4287)
- Maximum peak-valley height of the surface: 10 μm (DIN EN ISO 4287)

☞ It is recommended to use P12 thermal compound paste from Wacker Chemie. It should be applied evenly. The maximum thickness is 100 μm.

After the use of thermal paste, tighten four fastening screws by following procedure.

1. Fix the screws with 0.5 Nm (hand tight, crosswise) in the sequence:

   1 -> 2 -> 3 -> 4

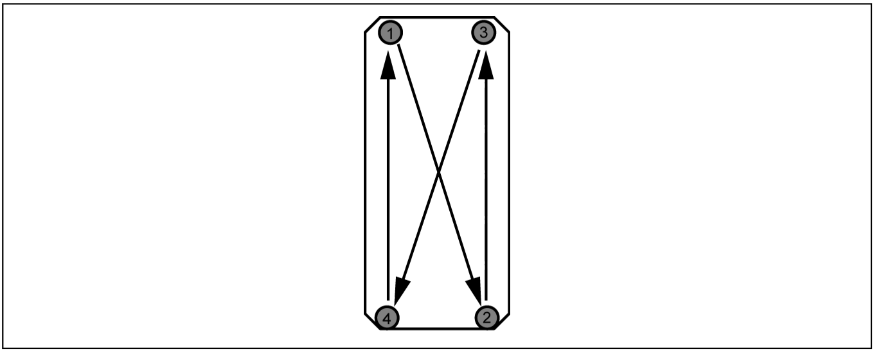


Fig. 7-14: Tightening sequence to mount the module to the heatsink

2. Tighten the screws with 2.0...2.5 Nm in the same sequence (crosswise):

   1 -> 2 -> 3 -> 4

☞ Tighten the screws with specified torques. Failure to do so, may inhibit drive cooling and cause possible damage to the drive.

7.5.5 Selecting an External Heat Sink

The heat transfer principle from the cold plate to the heat sink ambient air is shown as below:

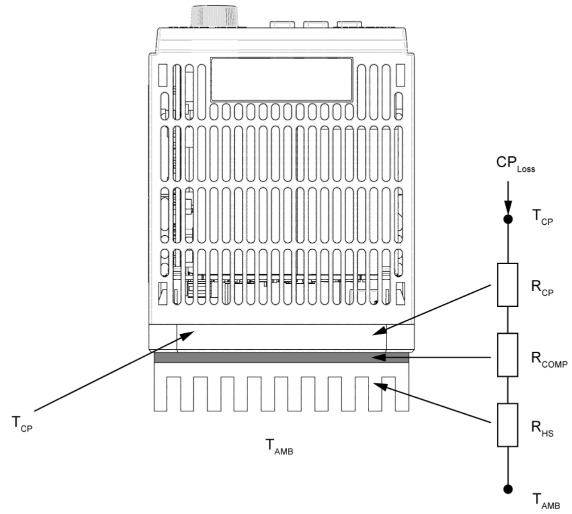


Fig. 7-15: Thermal equivalent circuit

- Temperature around the cold plate must be not more than 45 °C.
- Temperature of the cold plate must be not more than 70 °C.

The formula to calculate the maximum thermal resistance of the heat sink is as follows:

$$R_{HSmax} = \frac{T_{CPmax} - T_{AMB}}{CP_{Loss}} - R_{CP} - R_{COMP}$$

Fig. 7-16: Calculation formula of thermal resistance

CP_{Loss}: Cold plate loss [W]

T_{CPmax}: Maximum cold plate temperature [°C]

R_{CP}: Equivalent thermal resistance of cold plate [°C/W]

R_{HSmax}: Thermal resistance of external heat sink [°C/W]

T_{AMB}: External heat sink ambient temperature [°C]

R_{COMP}: Thermal resistance between cold plate and external heat sink [°C/W]

The thermal resistance between the cold plate and the external heat sink can be calculated by:

$$R_{COMP} = \frac{t_{com}}{k_{com} A_{com}}$$

Fig. 7-17: Calculation formula of R_{COMP}

t_{com}: The thickness of thermal compound paste [μm]

k_{com}: Thermal conductivity of thermal compound paste [W/m·°C]

A_{com}: Heat transfer area between cold plate and external heat sink [m^2]

☞

- Use the formulas above to calculate the maximum thermal resistance of external heat sink R_{HSmax}. Select a heat sink with a smaller thermal resistance than R_{HSmax}. The heat sink dimensions should be closed to the cold plate dimensions.
- Due to uneven heat transfer across the cold plate (by arrangement of internal components), the effective area for heat transfer is about 70 % of cold plate area. This must be considered when calculating the thermal resistance.
- For a given ambient temperature T_{AMB}, the maximum cold plate temperature T_{CPmax} must not exceed 70 °C. As R_{CP} and R_{COMP} is essentially fixed, this condition must be satisfied with a proper heat sink selection.

The table below shows the typical values of thermal resistance of cold plate.

Model	R_{CP} [°C/W]
0K40	0.107
0K75	
1K50	0.114
2K20	
3K00	0.098
4K00	
5K50	0.093
7K50	
11K0	0.084
15K0	

Tab. 7-14: Typical values of thermal resistance of cold plate

☞

- If the dimensions of heat sink are much larger than the cold plate, or if multiple drives are installed on one heat sink, it may be necessary to apply correction factors to calculate the thermal resistance value. Contact the heat sink manufacturer.
- It is recommended that the calculated R_{HS} is multiplied by 0.7 to obtain a resistance value with a reasonable safety margin in order to ensure tripless drive operation.

8 Frequency Converter Wiring

8.1 Wiring Diagram

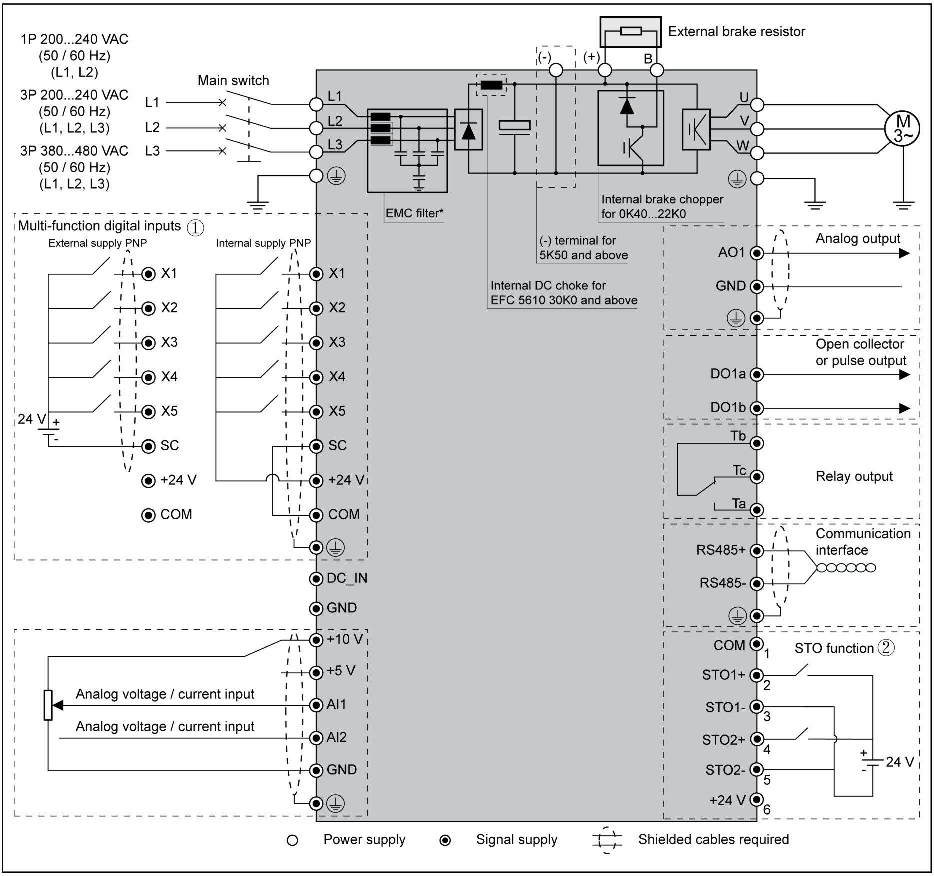


Fig. 8-1: Wiring diagram

- For cable size, fuse, screw torque, see chapter 8.2 "Cable Specifications" on page 58.
- For terminals, see chapter 8.3 "Terminals" on page 66.
- ①: NPN modes, see fig. 8-10 "Digital input NPN / PNP wiring" on page 75.
- ②: STO (Safe Torque Off) function is only available on EFC 5610 models.
- *: Can be disconnected by disassembly of a screw.
- Pulse input can be **ONLY** set via 'Multi-function digital input X5'.
- When analog current input function is applied, the supply voltage of analog input terminal can not exceed +5 V.

8.2 Cable Specifications

8.2.1 Power Cables

Cable specification for international without USA / Canada

- Use copper wires specified for 90 ℃ or above.
- Insulation based on IEC60364-5-52.
- Cable with concentric shielding must be used.
- According to IEC61800-5-1, PE cable must be at least 10 mm^2 or a double PE cable must be used.
- *: If additional labels available with the terminals of 0K40...7K50, please refer to the torque data on labels.

EFC x610 Model	Fuse (gG)	Power cables installation mode			PE Cable	Torque / Screw
		B1	B2	E		
	[A]	[mm^2]			[mm^2]	[N·m / lbf·in] (Mx)
0K40	10.0	2.5	2.5	2.5	10.0 2.5*2	0.8* / 7.0 (M3)
0K75	16.0	2.5	2.5	2.5	10.0 2.5*2	0.8* / 7.0 (M3)
1K50	25.0	4.0	4.0	2.5	10.0 4.0*2	0.8* / 7.0 (M3)
2K20	32.0	6.0①	6.0①	4.0	10.0 6.0*2	0.8* / 7.0 (M3)

Tab. 8-1: 1P 200 VAC fuse and cable dimensions for international without USA / Canada

①: Stranded with ferrule without plastic sleeve.

EFC x610 Model	Fuse (gG)	Power cables installation mode			PE Cable	Torque / Screw
		B1	B2	E		
	[A]	[mm^2]			[mm^2]	[N·m / lbf·in] (Mx)
0K40	10.0	2.5	2.5	2.5	10.0 2.5*2	0.8* / 7.0 (M3)
0K75	10.0	2.5	2.5	2.5	10.0 2.5*2	0.8* / 7.0 (M3)
1K50	20.0	4.0	4.0	2.5	10.0 4.0*2	0.8* / 7.0 (M3)

EFC x610 Model	Fuse (gG)	Power cables installation mode			PE Cable	Torque / Screw
		B1	B2	E		
	[A]	[mm²]			[mm²]	[N·m / lbf·in] (Mx)
2K20	20.0	4.0	4.0	2.5	10.0	0.8* / 7.0 (M3)
					4.0*2	
3K00	32.0	6.0	6.0	4.0	10.0	1.20* / 10.5 (M4)
					6.0*2	
4K00	40.0	6.0	10.0	6.0	10.0	1.20* / 10.5 (M4)
					6.0*2	
5K50	50.0	10.0	10.0	10.0	10.0	1.2 / 15.0 (M4)
7K50	50.0	10.0	10.0	10.0	10.0	1.2 / 15.0 (M4)
11K0	100.0	25.0	35.0	25.0	25.0	3.73 / 33.0 (M5)

Tab. 8-2: 3P 200 VAC fuse and cable dimensions for international without USA / Canada

EFC x610 Model	Fuse (gG)	Power cables installation mode			PE Cable	Torque / Screw
		B1	B2	E		
	[A]	[mm²]			[mm²]	[N·m / lbf·in] (Mx)
0K40	6.0	2.5	2.5	2.5	10.0	0.8* / 7.0 (M3)
					2.5*2	
0K75	10.0	2.5	2.5	2.5	10.0	0.8* / 7.0 (M3)
					2.5*2	
1K50	10.0	2.5	2.5	2.5	10.0	0.8* / 7.0 (M3)
					2.5*2	
2K20	16.0	2.5	2.5	2.5	10.0	0.8* / 7.0 (M3)
					2.5*2	
3K00	20.0	4.0	4.0	2.5	10.0	0.8* / 7.0 (M3)
					4.0*2	
4K00	20.0	4.0	4.0	2.5	10.0	0.8* / 7.0 (M3)
					4.0*2	
5K50	32.0	6.0	6.0	4.0	10.0	1.20* / 10.5 (M4)
					6.0*2	
7K50	40.0	6.0	10.0	6.0	10.0	1.20* / 10.5 (M4)
					6.0*2	
11K0	50.0	10.0	10.0	10.0	10.0	1.2 / 15.0 (M4)
15K0	50.0	10.0	10.0	10.0	10.0	1.2 / 15.0 (M4)
18K5	80.0	25.0	25.0	16.0	16.0	3.73 / 33.0 (M5)
22K0	100.0	25.0	35.0	25.0	25.0	3.73 / 33.0 (M5)

EFC x610 Model	Fuse (gG)	Power cables installation mode			PE Cable	Torque / Screw
		B1	B2	E		
	[A]	[mm^2]			[mm^2]	[N·m / lbf·in] (Mx)
30K0	125.0	35.0	50.0	35.0	25.0	3.80 / 33.6 (M6)
37K0	125.0	35.0	50.0	35.0	35.0	3.80 / 33.6 (M6)
45K0	160.0	50.0	70.0	50.0	35.0	31.1 / 275.0 (5/16 in)
55K0	200.0	70.0	95.0	70.0	50.0	31.1 / 275.0 (5/16 in)
75K0	250.0	120.0	150.0	95.0	95.0	31.1 / 275.0 (5/16 in)
90K0	250.0	120.0	150.0	95.0	95.0	31.1 / 275.0 (5/16 in)
110K	315.0	120.0	150.0	120.0	95.0	15.0 / 132.7 (M10)①
		95.0*2	95.0*2	95.0*2		8.0 / 70.8 (M8)②
132K	315.0	185.0	240.0	185.0	120.0	15.0 / 132.7 (M10)①
		95.0*2	95.0*2	95.0*2		8.0 / 70.8 (M8)②
160K	400.0	120*2	150*2	120*2	150.0	15.0 / 132.7 (M10)②

Tab. 8-3: 3P 380 VAC fuse and cable dimensions for international without USA / Canada

☞ ① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 110K and above. ① is the torque and screw of single cable and ② is the torque and screw of double cable.

Cable specification for USA / Canada

☞

- The data listed in the table below are only used to select fuse and cable dimensions for USA / Canada.
- Must use copper wires of 75 ℃ or above according to UL 508C.
- It is recommended to use shielded cables to connect the motor.
- *: If additional labels available with the terminals of 0K40...7K50, please refer to the torque data on labels.

EFC x610 Model	Fuse (Class J) [A]	Power cables [AWG]	PE Cable [AWG]	Torque / Screw [N·m / lb·in] (Mx)
0K40	10.0	14	8	0.8* / 7.0 (M3)
0K75	15.0	14	8	0.8* / 7.0 (M3)
1K50	25.0	10	8	0.8* / 7.0 (M3)
2K20	30.0	10	8	0.8* / 7.0 (M3)

Tab. 8-4: 1P 200 VAC fuse and cable dimensions for USA / Canada

EFC x610 Model	Fuse (Class J) [A]	Power cables [AWG]	PE Cable [AWG]	Torque / Screw [N·m / lbf·in] (Mx)
0K40	10.0	14	8	0.8* / 7.0 (M3)
0K75	10.0	14	8	0.8* / 7.0 (M3)
1K50	20.0	12	8	0.8* / 7.0 (M3)
2K20	20.0	12	8	0.8* / 7.0 (M3)
3K00	30.0	10	8	1.2* / 10.5 (M4)
4K00	40.0	8	8	1.2* / 10.5 (M4)
5K50	50.0	8	8	1.2 / 15.0 (M4)
7K50	60.0	6	6	1.2 / 15.0 (M4)
11K0	100.0	2	4	3.73 / 33.0 (M5)

Tab. 8-5: 3P 200 VAC fuse and cable dimensions for USA / Canada

EFC x610 Model	Fuse (Class J) [A]	Power cables [AWG]	PE Cable [AWG]	Torque / Screw [N·m / lb·in] (Mx)
0K40	6.0	14	8	0.8* / 7.0 (M3)
0K75	10.0	14	8	0.8* / 7.0 (M3)
1K50	10.0	14	8	0.8* / 7.0 (M3)
2K20	15.0	14	8	0.8* / 7.0 (M3)

EFC x610 Model	Fuse (Class J) [A]	Power cables [AWG]	PE Cable [AWG]	Torque / Screw [N·m / lb·in] (Mx)
3K00	20.0	12	8	0.8* / 7.0 (M3)
4K00	20.0	12	8	0.8* / 7.0 (M3)
5K50	30.0	10	8	1.20* / 10.5 (M4)
7K50	40.0	8	8	1.20* / 10.5 (M4)
11K0	50.0	8	8	1.2 / 15.0 (M4)
15K0	60.0	6	6	1.2 / 15.0 (M4)
18K5	80.0	4	6	3.73 / 33.0 (M5)
22K0	100.0	2	4	3.73 / 33.0 (M5)
30K0	100.0	2	4	3.80 / 33.6 (M6)
37K0	125.0	1	3	3.80 / 33.6 (M6)
45K0	150.0	1 / 0	1	31.1 / 275.0 (5/16 in)
55K0	175.0	2 / 0	1 / 0	31.1 / 275.0 (5/16 in)
75K0	225.0	4 / 0	3 / 0	31.1 / 275.0 (5/16 in)
90K0	250.0	250 kcmil	3 / 0	31.1 / 275.0 (5/16 in)
110K	300.0	400 kcmil	3 / 0	15.0 / 132.7 (M10)①
		3 / 0 * 2		8.0 / 70.8 (M8)②
132K	350.0	500 kcmil	250 kcmil	15.0 / 132.7 (M10)①
		250 kcmil * 2		8.0 / 70.8 (M8)②
160K	450.0	350 kcmil * 2	350 kcmil	15.0 / 132.7 (M10)②

Tab. 8-6: 3P 380 VAC fuse and cable dimensions for USA / Canada

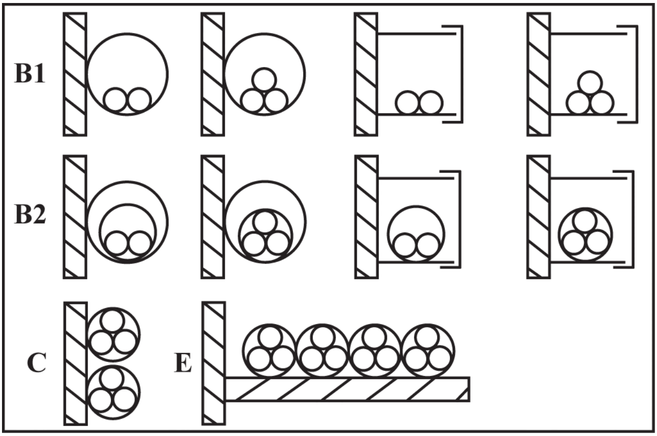
☞ ① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 110K and above. ① is the torque and screw of single cable and ② is the torque and screw of double cable.

Dimensioning variables of the table values

1. **Installation types:**
   - B1 according to IEC 60364-5-52, e.g. stranded wires routed in cable duct
   - B2 according to IEC 60364-5-52, e.g. multi-core line routed in cable duct
   - E according to EN 60204-1, e.g. multi-core line routed on open cable tray
   - According to NFPA 79 (external wiring), UL 508A (internal wiring), NEC, NFPA 70:
     - 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor
     - Routed in pipe on the wall

     Internal wiring: Routing inside of control cabinet or of devices.

     Field wiring: Routing of cross sections of terminal connectors wired by the user (in the field).



B1 Conductors in installation pipes and in installation channels that can be opened
B2 Cables or lines in installation pipes and in installation channels that can be opened
C Cables or lines on walls
E Cables or lines on open cable trays

Fig. 8-2: Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

2. **Recommendation for design of the fuses:**
   - **International except for USA / Canada:** Class gL-gG; 500 V, 690 V; design NH, D (DIAZED) or D0 (NEOZED).

☞ **Characteristics**

In the case of error (e.g. ground error at connections L+, L-), fuses of characteristic **gL** (general-purpose fuse link for cables and lines) and **gG** (general-purpose fuse link for general installations) protect the **lines** in the frequency converter system.

To **protect the semiconductors** in the frequency converters, you can use fuses of characteristic **gR**.

- USA / Canada: Class J; 600 V

8.2.2 Control Cables

The following requirements are applicable to the signal connection wiring:

- Flexible cables with wire end sleeves
- Cable cross-section: 0.2...1.0 mm^2
- Cable cross-section for connectors with insulation sleeves: 0.25...1.0 mm^2
- Analog inputs AI1, AI2, EAI1, EAI2, +10 V, +5 V and GND: use shielded cables
- Digital inputs X1...X5, EX1...EX5, SC, shielded cables recommended
- Analog outputs AO1, EAO and GND: use shielded cables
- RS485 communication: use shielded twisted pair cables

- EAI1, EAI2, EX1...EX5 and EAO belong to I/O card.
- For STO wiring specification, see chapter 14.2.2 "Cable Definition" on page 492.

Recommendations on cable insulation stripping:

Please strip the insulation of control cables according to the dimensions given below. Too long stripping may cause short circuit of adjacent cables; too short stripping may lead to cables becoming loose.

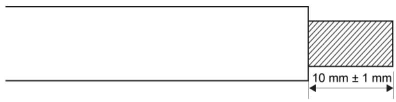


Fig. 8-3: Cable insulation stripping length

Please follow the steps below for wiring of control terminals.

Step 1: Switch off the frequency converter before performing wiring.

Step 2: Deactivate the control signals in the wiring process.

Step 3: Switch on the frequency converter.

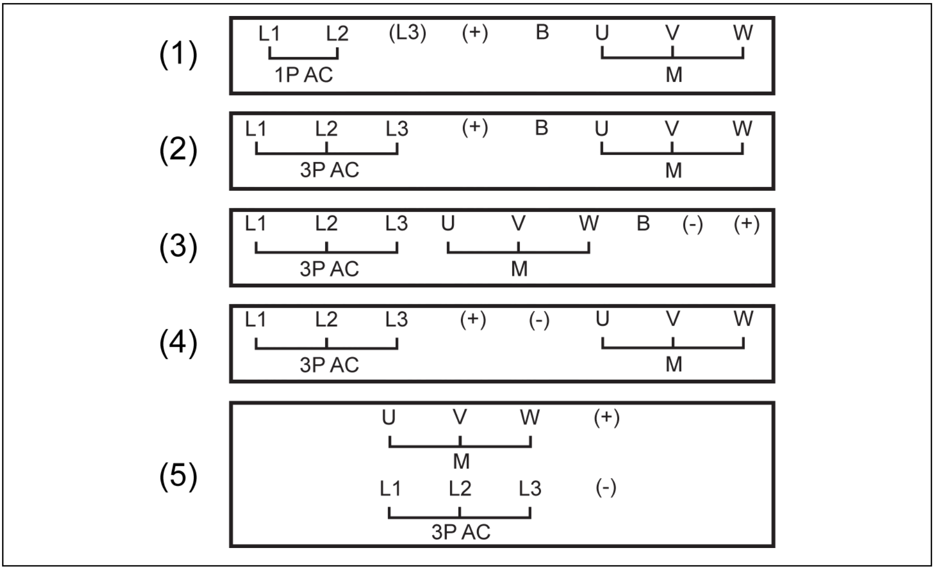
Step 4: Set respective parameters.

Step 5: Activate respective control signals.

8.3 Terminals

8.3.1 Power Terminals

Power Terminals Figure



(1) 1P 200 VAC 0K40...2K20
(2) 3P 200 VAC 0K40...2K20 / 3P 380 VAC 0K40...4K00
(3) 3P 200 VAC 3K00...11K0 / 3P 380 VAC 5K50...22K0
(4) 3P 380 VAC 30K0...90K0
(5) 3P 380 VAC 110K...160K
1P AC: Single phase AC power supply
3P AC: Three phases AC power supply
M: For three phases motor connection

Fig. 8-4: Power terminals

Power Terminals Description

Terminal	Description
L1, L2	Mains supply input terminals
U, V, W	Converter output terminals
B	External brake resistor terminal
(+)	DC positive bus terminal

Tab. 8-7: 1P 200 VAC power terminals description

Terminal	Description
L1, L2, L3	Mains supply input terminals
U, V, W	Converter output terminals

Terminal	Description
B	External brake resistor terminal
(-)	DC negative bus terminal (only available with models of 5K50 and above)
(+)	DC positive bus terminal

Tab. 8-8: 3P 200 / 380 VAC power terminals description

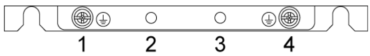


Fig. 8-5: Grounding and PE terminals

1: Grounding terminal for mains cables

2: Reserved for PE / shielding adapter (Order additionally)

3: Reserved for PE / shielding adapter (Order additionally)

4: Grounding terminal for motor cables

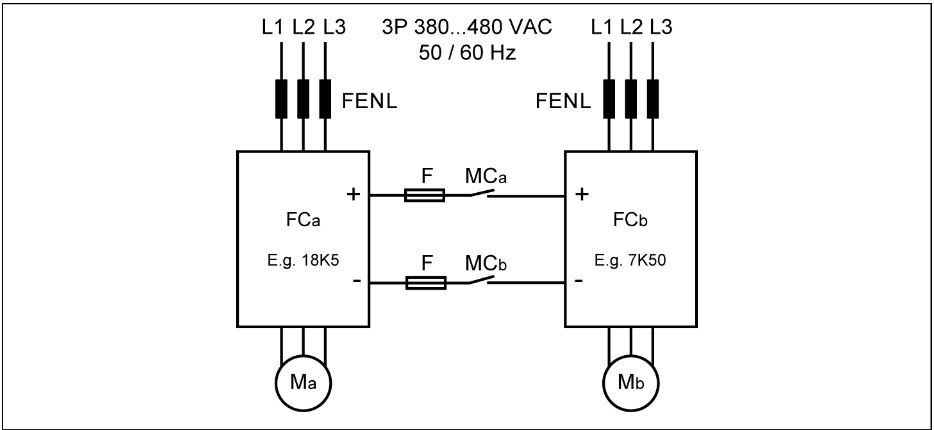
Fig. 8-6: Connection screw for internal EMC filter

The connection screw for the internal EMC filter as shown in the figure above is located at the side of the frequency converter.

- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive.
- Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged.
- When the internal EMC filter is disconnected, the drive is not EMC compatible.

Notes on DC-bus terminals

Wiring of DC-bus in parallel



FENL	Mains choke	MC_a	Magnetic contactor a
FC_a	Frequency converter a	MC_b	Magnetic contactor b
FC_b	Frequency converter b	M_a	Motor a
F	Fuse	M_b	Motor b

Fig. 8-7: Wiring of DC-bus in parallel

Conditions for DC-bus in parallel

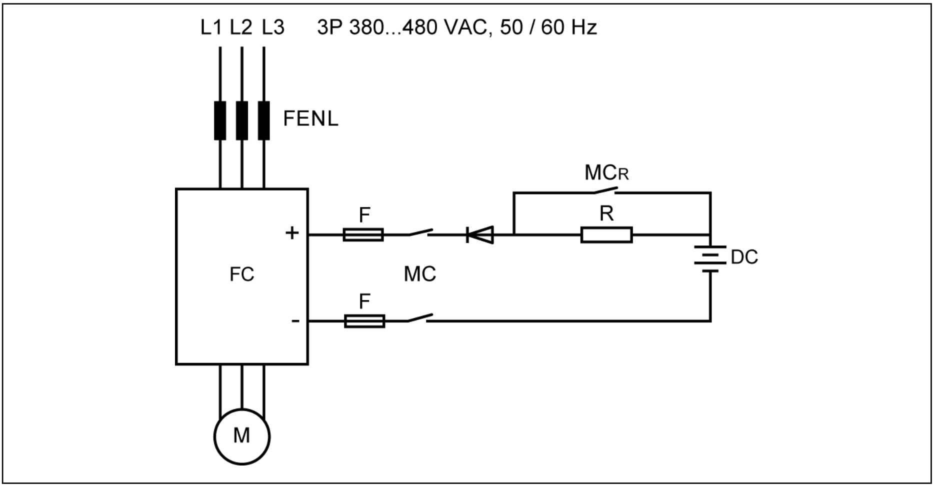
- In the above typical application, FC_b runs in generation mode and FC_a runs in motor mode. The power rating of FC_a normally should be 3 levels higher than that of $FC_b$to ensure ΣPM>ΣPG, and the generated energy can be consumed properly.

  E.g., FC_b is 7K50, FC_a needs to be 18K5 (11K0 and 15K0 in between)
- DC-bus voltage is within the specified range: 457...745 V.
- Use mains choke.
- Select fuses according to FC_b which runs in generator mode, see chapter "DC-bus fuse specification" on page 71.
- Use external brake resistor to keep the DC-bus voltage within the normal range, especially when converter a is running with light load instead of full load.
- Switch on mains supply to the frequency converters first, and then close MC_a and MC_b after the LED display is active with both frequency converters. The contactor MC_a and MC_b will be switched off by the respective relay output of the frequency converter when an error happens to any of the two frequency converters.

- Select contactors according to the current ratings in chapter "DC-bus fuse specification" on page 71.
- Connect the relay output of FC_a to MC_a, FC_b to MC_b.
- Set [E2.15] = '14: Converter error' to control MC_a by relay output of FC_a.
- Set [E2.15] = '14: Converter error' to control MC_b by relay output of FC_b.

By default, the relay output in inactive when the frequency converter is not running.

Wiring of DC-bus with external DC power supply



FENL	Mains choke
FC	Frequency converter
F	Fuse
MC	Magnetic contactor
MC_R	Magnetic contactor of softstart resistor
DC	External DC power supply
M	Motor
R	Softstart resistor

Fig. 8-8: Wiring of DC-bus with external DC power supply

Conditions for DC-bus with external DC power supply

- DC-bus voltage is within the specified range: 457...745 V.
- Use mains choke.
- Select fuses according to chapter "DC-bus fuse specification" on page 71.
- Use the relay output of the frequency converter to control the contactor MC of the DC-bus. The contactor will be switched off by the relay output once the frequency converter encounters an error.
- For 5K50...18K5 models, select the external softstart resistor according to the allowed maximum charging current defined in the table below.

Model	Maximum charging current [A]
5K50	25
7K50	35
11K0	50
15K0	75
18K5	100
22K0...90K0	–①
110K	300
132K	350
160K	450

Tab. 8-9: Allowed maximum charging current

①: 22K0...90K0 models do not need external softstart resistor.

- Set [E2.15] = '14: Converter error' to control MC by relay output of FC. Connect relay output of FC to MC.

By default, the relay output is inactive when there is no error. Please use an additional device to keep the relay output status when the frequency converter is switched off without power input. Without such a device, the relay output will be restored to be inactive as the frequency converter will lose the control.

⚠ WARNING

The external softstart circuit must be properly controlled to avoid direct charging of the capacitor with external DC power supply, especially when DC power supply is the only power source for the frequency converter.

- Use a diode to ensure the current is always in the direction of flowing-in the frequency converter.

DC-bus fuse specification

The fuse rating depends on the fuse type (gG) and the temporary overload capability of the frequency converter.

☞ If no overload happens in an application, the fuses can be selected directly according to the power rating of the frequency converter.

Recommended fuse ratings at DC-bus voltage of 513 V are shown in the table below.

Model	Motor power [kW]	Motor efficiency	DC-current [A]	gG fuses [A]
5K50	5.5	85.8 %	12.5	16
7K50	7.5	87.1 %	16.8	25
11K0	11.0	88.5 %	24.2	35
15K0	15.0	89.5 %	32.7	50
18K5	18.5	90.1 %	40.0	50
22K0	22.0	90.6 %	52.7	63
30K0	30.0	91.5 %	71.1	80
37K0	37.0	92.1 %	87.1	100
45K0	45.0	92.6%	94.7	125
55K0	55.0	93.1%	115.2	125
75K0	75.0	93.7%	156.0	200
90K0	90.0	94.0%	186.6	200
110K	110.0	94.6%	226.7	250
132K	132.0	94.8%	271.4	300
160K	160.0	94.8%	353.0	400

Tab. 8-10: Recommended fuse ratings

$I_{DC} = P_{Motor} / (V_{DC} \times \eta_{Motor})$

$V_{DC} = 1.35 \times V_{in}$

V_{in} is the RMS value of the AC input voltage.

For example, if V_{DC} = 513 V, the equivalent V_{in} = 380 V.

The recommended fuse rated current is calculated based on the selected motor. In actual application, please check the value according to the equation above and the actual motor efficiency.

8.3.2 Control Terminals

Control terminals figure

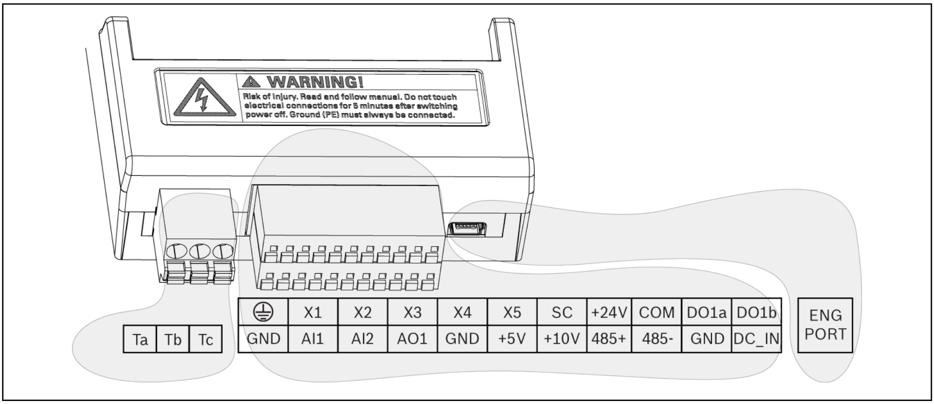


Fig. 8-9: Control circuit terminals

⚠ CAUTION	The frequency converter might be damaged!

Please make sure that the power supply of the frequency converter has been switched off before plugging or unplugging the connector.

☞ The terminal blocks provide wiring connection points only. Additional measures by the user need to be taken to provide strain relief or other types of cable restraints.

Control terminals description

Digital inputs

Terminal	Signal function	Description	Signal requirement
X1...X5	Multi-function digital inputs	See chapter "E1: Input terminal parameters" on page 597	Inputs via opto-electric couplers: 24 VDC, 8 mA / 12 VDC, 4 mA Pulse input: Max. 50.0 kHz
X5 (multiplex)	Pulse input		
SC	Shared connection of digital inputs	Shared connection for isolation opto-electric couplers	–
+24 V	Power supply for digital inputs	COM is reference Isolated from GND	Max. output current: 100 mA
COM			

Analog inputs

Terminal	Signal function	Description	Signal requirement
+10 V	Power supply for analog inputs	GND is reference	Max. output current: 30 mA
+5 V			Max. output current: 10 mA
AI1	Analog input 1 (Voltage or current sensitive, configurable)	Analog voltage / current inputs are used as external frequency setting channels To switch between voltage and current or to set the input related functions, see chapter "E1: Input terminal parameters" on page 597	Voltage input range: 0/2...10 V Input impedance: 27 kΩ Resolution: 1/1,000 Current input range: 0/4...20 mA Input impedance: 250 Ω Resolution: 1/1,000
AI2	Analog input 2 (Voltage or current sensitive, configurable)		
GND	Shared connection of analog inputs	Isolated from COM	–
⏚	Shielding connection	Connected with grounding terminals on heatsink internally	–

Digital outputs

Terminal	Signal function	Description	Signal requirement
DO1a	Open collector output or pulse output	See chapter "E2: Output terminal parameters" on page 600 COM is reference	Open collector output: Max. 30 VDC, 50 mA Pulse output Max. frequency: 32.0 kHz
DO1b			
Ta	Relay changeover contacts	See chapter "E2: Output terminal parameters" on page 600	Rated capacity: 240 VAC, 3 A; 30 VDC, 3 A
Tc			
Tb	Relay shared contact		

Analog outputs

Terminal	Signal function	Description	Signal requirement
AO1	Analog output	See chapter "E2: Output terminal parameters" on page 600	Voltage output: 0...10 V Maximum load current for voltage output: 5 mA Current output: 0...20 mA Maximum load resistance for current output: 500 Ω
GND	Shared connection	Isolated from COM	–

Modbus communication

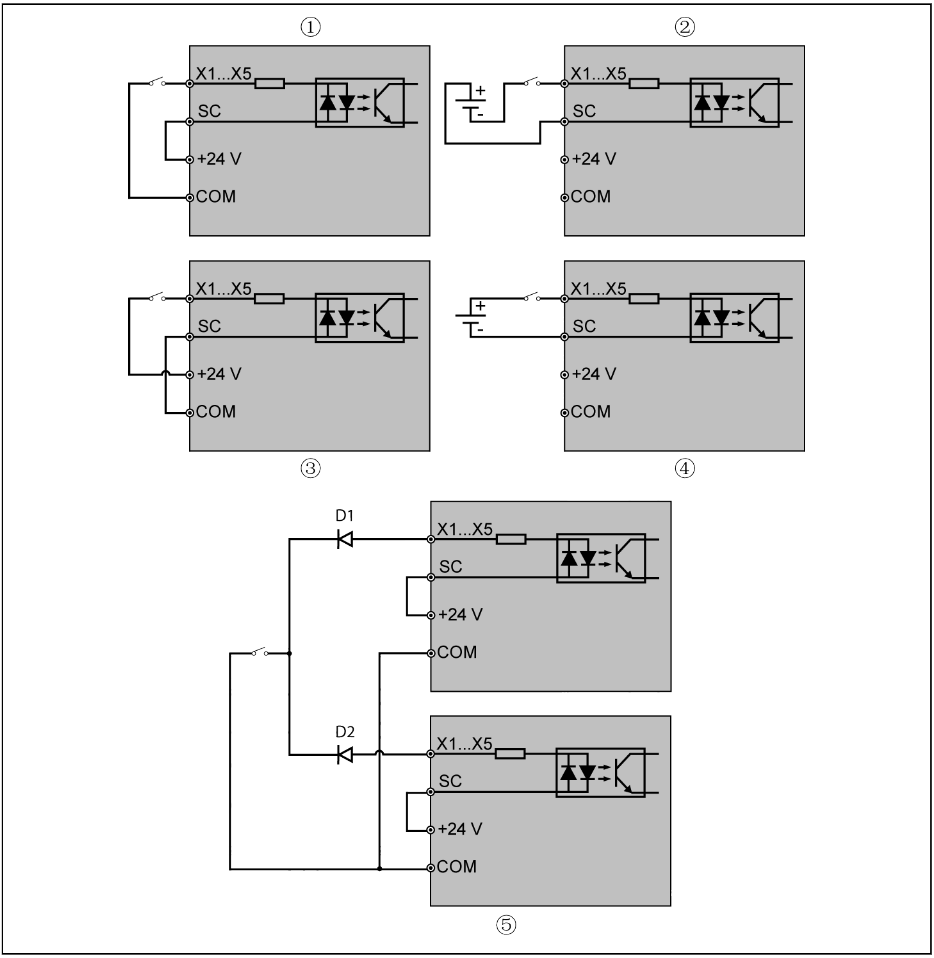
Terminal	Signal function	Description	Signal requirement
485+	Positive differential signal	GND is reference	–
485-	Negative differential signal		

External power supply

Terminal	Signal function	Description	Signal requirement
DC_IN	Auxiliary power supply for control board	External +24 V supply input for control and panel boards (**NOT** used for digital inputs)	Rated capacity: 24 V (-10...+15 %) 200 mA
GND	Shared connection	Isolated from COM	–

DC_IN power is used for keeping the control section, display and extension cards powered. If applied with Multi-ethernet card keep the communication up. For commissioning and parameterization, AC line voltage is required. Reverse connection of DC_IN and GND may cause damage to the device which is connected to USB port.

Digital input NPN / PNP wiring

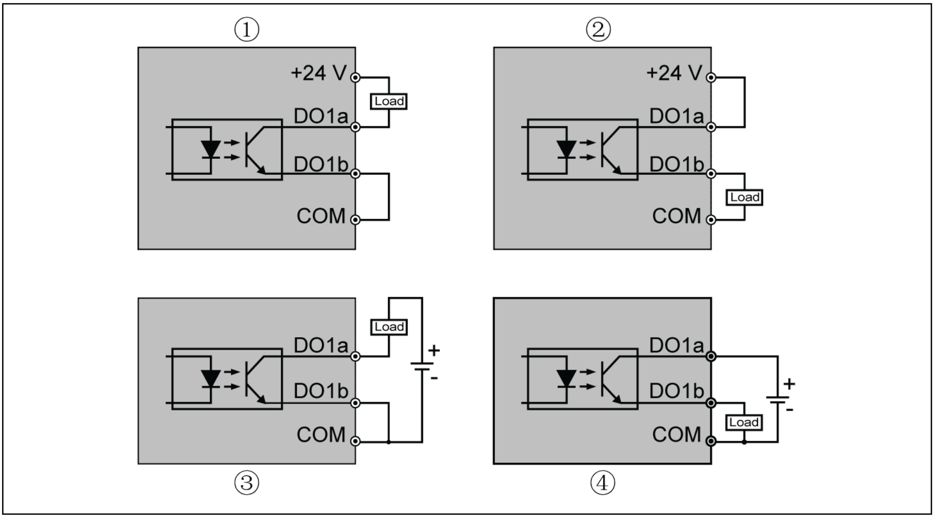


① NPN wiring with internal power supply
② NPN wiring with external power supply
③ PNP wiring with internal power supply
④ PNP wiring with external power supply
⑤ Parallel connection of DI terminals (NPN wiring with internal power supply)

Fig. 8-10: Digital input NPN / PNP wiring

⑤: When using this connection mode, it is necessary to connect the diode (diode anode connects the DI terminal) in series between the DI terminals of the two converters, and the diode must meet the conditions of "IF > 10 mA, μF < 1 V", otherwise the converter will misoperate.

Digital output DO1a, DO1b load pull-up / pull-down wiring



① Load pull-up wiring with internal power supply
② Load pull-down wiring with internal power supply
③ Load pull-up wiring with external power supply
④ Load pull-down wiring with external power supply

Fig. 8-11: Digital output DO1a, DO1b load pull-up / pull-down wiring

- For internal supply, ONLY USE terminal +24 V and NEVER USE terminal +10 V or +5 V!
- For external supply, its reference ground MUST be connected to terminal COM!

Analog input terminals (AI1, AI2, EAI1, EAI2, +10 V, +5 V, Earth and GND)

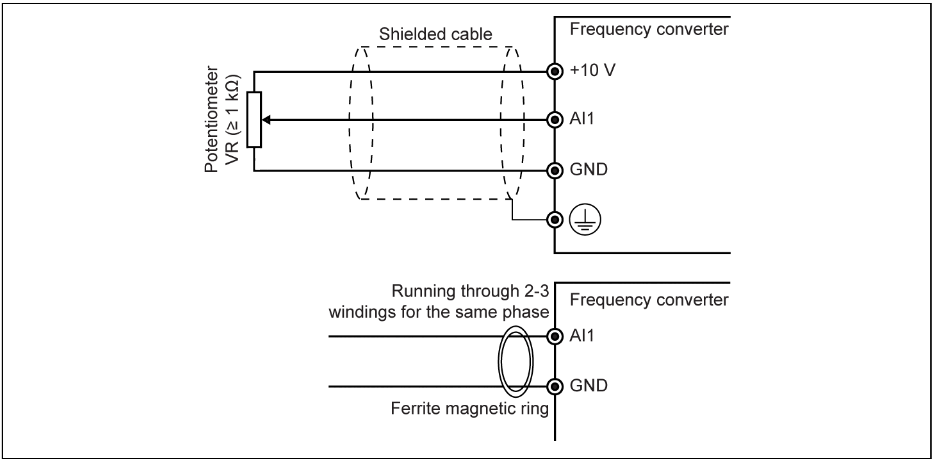
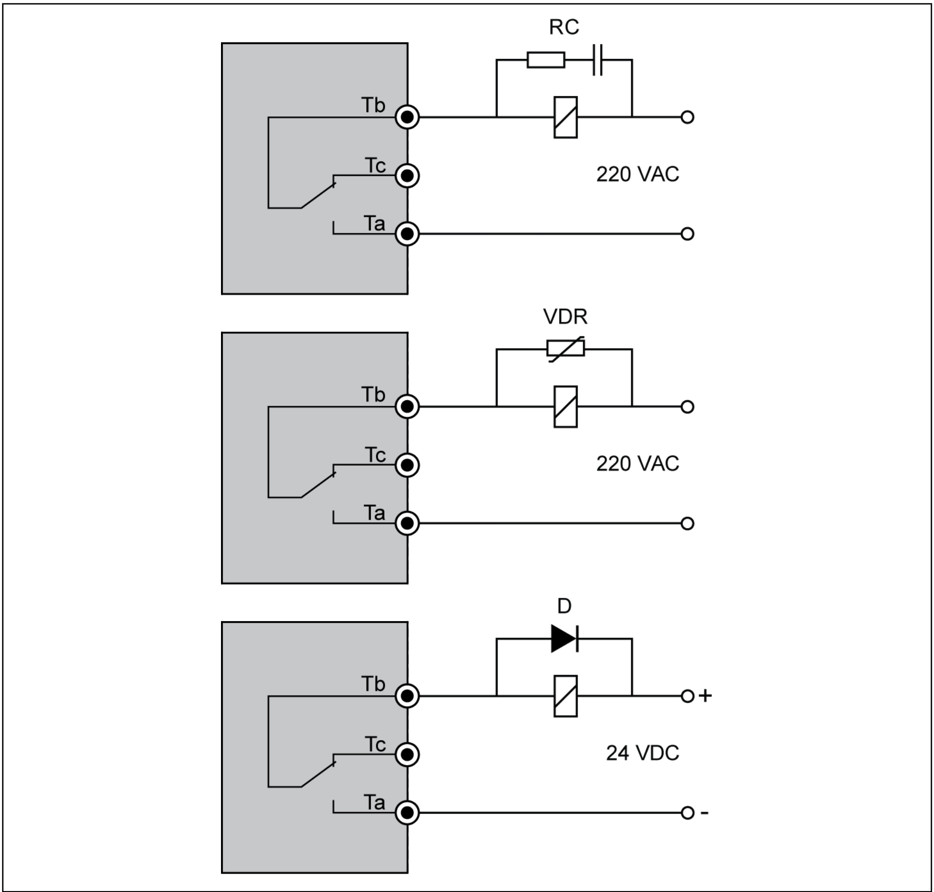


Fig. 8-12: Analog input terminals

- The figure for AI2 and +5 V is similar to the figure above.
- Incorrect operation may occur due to interference on the analog signal. In such cases, connect a ferrite magnetic ring at the input side of the analog signal, as shown above.
- The above figure is also valid for analog input EAI1, EAI2 on I/O card.
- When analog current input function is applied, the supply voltage of analog input terminal can not exceed +5 V.

Relay output terminals

When relay output terminals are connected with inductive loads (relays, contactors, solenoid valves, motors, etc.), following noise suppression circuits need to be applied at the coils of the inductive loads, as close as possible to the inductive loads, in order to reduce the electromagnetic interference generated from inductive load action.



Tb	Shared terminal	**RC**	RC filtering
Tc	Normally closed contact	**VDR**	Varistor
Ta	Normally open contact	**D**	Diode

Fig. 8-13: Noise suppression circuits for relay output terminals

Notes on DC_IN terminal

Converter in running status: Converter stops with error 'UE-1' at AC power loss

Conditions	Description
DC_IN power is available	'UE-1' remains to be displayed on the panel 'Power loss restart' function does NOT work Converter can NOT be started by any command source **Limited* Parameters** can be viewed but can NOT be modified
DC_IN power is unavailable	Converter panel blackout after a short time
AC power resumes	Converter will remain in stop state, 'UE-1' can be reset 'Power loss restart' function works

Tab. 8-11: Power loss in running status

Converter in stopped status: 'P.oFF' will be displayed at AC power loss

Conditions	Description
DC_IN power is available	'P.oFF' remains to be displayed on the panel Converter can NOT be started by any command source **Limited* Parameters** can be viewed but can NOT be modified
DC_IN power is unavailable	Converter panel blackout after a short time
AC power resumes	Converter will remain in stop state, 'P.oFF' disappears automatically

Tab. 8-12: Power loss in stopped status

☞ DC_IN power is used for keeping the control section, display and extension cards powered. If applied with Multi-ethernet card keep the communication up. For commissioning and parameterization, AC line voltage is required.

Limited* Parameters

Code	Name	Code	Name
b0.00	Access authority setting	E9.01	Automatic error reset interval
E0.45	Power loss restart mode	E9.05	Last error type
E0.46	Power loss restart delay	E9.06	Second last error type
E8.00	Communication protocol	E9.07	Third last error type
E8.01	Communication error detection time	E9.10	Output frequency at last error
E8.02	Communication error protection mode	E9.11	Setting frequency at last error
E8.10	Modbus baud rate	E9.12	Output current at last error
E8.11	Modbus data format	E9.13	Output voltage at last error
E8.12	Modbus local address	E9.14	DC bus voltage at last error
E9.00	Automatic error reset attempts	E9.15	Power module temperature at last error

Tab. 8-13: Limited parameters

☞ Make sure that the voltage on DC_IN terminal is within 20...28 V, otherwise error code 'EPS-' will be displayed.

8.3.3 Safe Torque Off (STO) Terminals

Terminal Definition

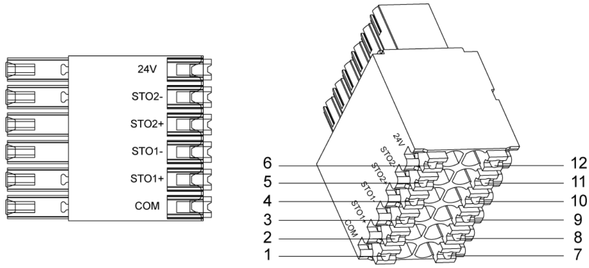


Fig. 8-14: STO terminals

Connection	Signal name	Function
1 / 7	COM	COM is the reference of +24 V
2 / 8	STO1+	Input channel 1
3 / 9	STO1-	The reference of Input channel 1
4 / 10	STO2+	Input channel 2
5 / 11	STO2-	The reference of Input channel 2
6 / 12	+24 V	Power supply

Tab. 8-14: Terminal definition

The 12-pin socket has two rows of connectors which are bridged for easy wiring.

9 Electromagnetic Compatibility (EMC)

9.1 EMC Requirements

9.1.1 General Information

The electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:

- Sufficient noise immunity of an electric installation or an electric device against external electric, magnetic or electromagnetic interference via lines or through air.
- Sufficiently low noise emission of electric, magnetic or electromagnetic noise of an electric installation or an electric device to other surrounding devices via lines or through air.

9.1.2 Noise Immunity in the Drive System

Basic structure for noise immunity

The figure below illustrates the interference for definition of noise immunity requirements in the drive system.

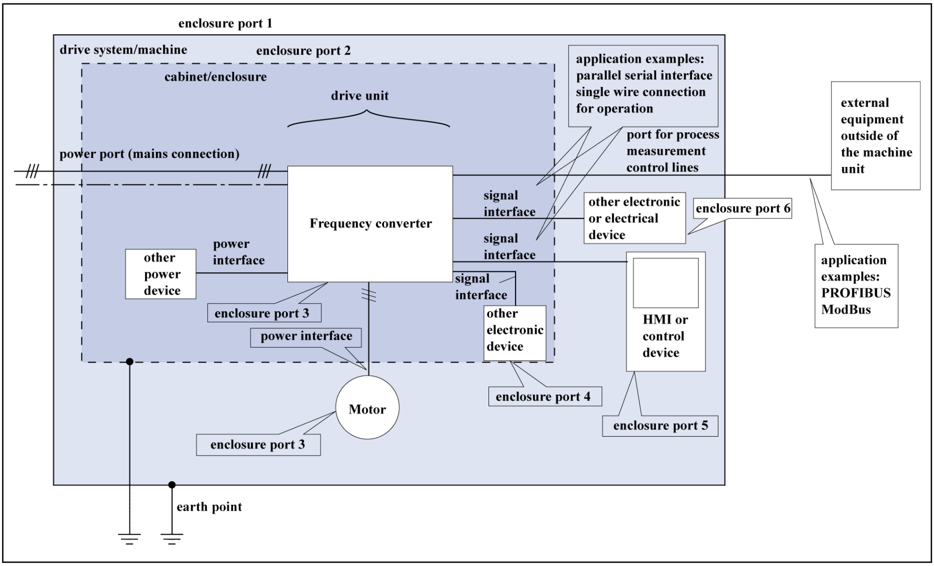


Fig. 9-1: Noise immunity in the drive system

Minimum immunity requirements for PDSs intended for use in the second environment

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance criterion)
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80...1000 MHz 10 V/m 1.4...2.0 GHz 3 V/m 2.0...2.7 GHz 1 V/m 80 % AM (1 kHz)	A
Power ports	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz	B
	Surge 1.2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV [a], 2 kV [b]	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0.15...80 MHz 10 V 80 % AM (1 kHz)	A
Power interfaces	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
Signal interfaces	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0.15...80 MHz 10 V 80 % AM (1 kHz)	A
Ports of process measurement control lines	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0.15...80 MHz 10 V 80 % AM (1 kHz)	A

Tab. 9-1: Minimum immunity requirements for PDSs intended for use in the second environment

Minimum immunity requirements for PDSs intended for use in the first environment

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance criterion)
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 ~ 1000 MHz 3 V/m 1.4 ~ 2.0 GHz 3 V/m 2.0 ~ 2.7 GHz 1 V/m 80 % AM (1 kHz)	A
Power ports	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz	B
	Surge 1.2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV [a], 2 kV [b]	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0.15 ~ 80 MHz 3 V 80 % AM (1 kHz)	A
Power interfaces	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
Ports of process measurement control lines	Fast transient-burst	IEC 61000-4-4	0.5 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0.15 ~ 80 MHz 3 V 80 % AM (1 kHz)	A

CD: Contact discharge
AD: Air discharge
AM: Amplitude modulation

[a]: Coupling line to line
[b]: Coupling line to earth

Tab. 9-2: Minimum immunity requirements for PDSs intended for use in the first environment

Category C1 is only for conducted emission, radiated emission needs checking with metallic cabinet. For installation, see chapter 9.3 "EMC Measures for Design and Installation" on page 92.

Evaluation criterion

Evaluation criterion	Explanation (abbreviated form from EN 61800-3)
A	Deviations within allowed range
B	Automatic recovery after interference
C	Switched off without automatic recovery. Device remains undamaged

Tab. 9-3: Evaluation criterion

9.1.3 Noise Emission of the Drive System

Causes of noise emission

Controlled variable-speed drives contain converters containing snappy semiconductors. The advantage of modifying the speed with high precision is achieved by means of pulse width modulation of the converter voltage. This can generate sinusoidal current with variable amplitude and frequency in the motor.

The steeper voltage rises, the higher clock rate and the resulting harmonics cause unwanted but physically unavoidable emission of interference voltage and interference fields (wide band interference). The interference mainly is asymmetric interference against ground.

The propagation of this interference strongly depends on:

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- radiation conditions
- wiring and installation

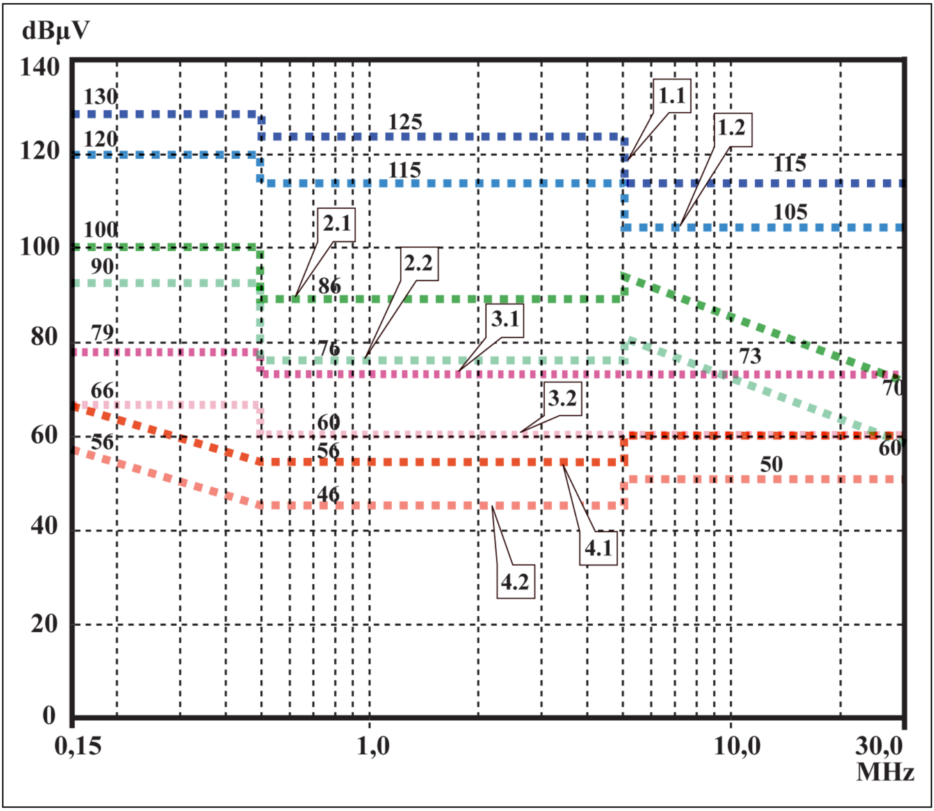
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

Limit values for line-based disturbances

According to IEC EN 61800-3 or CISPR 11 (corresponds to EN 55011), the limit values in the table below are distinguished. For this documentation both standards are combined in the limit value classes A2.1 to B1.

IEC / EN 61800-3	CISPR 11	Explanation	In this document	Curves of limit value characteristic
Category C4 2nd environment	None	One of the following 3 requirements must have been fulfilled: ● Mains connection current > 400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter. ● Adjust limit values to use and operation on site. ● User has to carry out and provide evidence of EMC planning.	None	–
Category C3 2nd environment	Class A; group 2, I>100 A	Limit value in industrial areas to be complied with for applications operated at supply mains with nominal current > 100 A	A2.1	1.1 1.2
Category C3 2nd environment	Class A; group 2, I≤100 A	Limit value in industrial areas to be complied with for applications operated at supply mains with nominal current ≤ 100 A	A2.2	2.1 2.2
Category C2 1st environment	Class A; group 1	Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas to be complied with	A1	3.1 3.2
Category C1 1st environment	Class B; group 1	Limit value in residential areas to be complied with	B1	4.1 4.2

Tab. 9-4: Limit values for line-based disturbances



1.1 C3 2nd environment, QP, I > 100 A (class A, group 2, I > 100 A)
1.2 C3 2nd environment, AV, I > 100 A (class A, group 2, I > 100 A)
2.1 C3 2nd environment, QP, I ≤ 100 A (class A, group 2, I ≤ 100 A)
2.2 C3 2nd environment, AV, I ≤ 100 A (class A, group 2, I ≤ 100 A)
3.1 C2 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class A, group 1)
3.2 C2 1st environment, AV (1st environment, even if source of interference in 2nd environment) (class A, group 1)
4.1 C1 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class B, group 1)
4.2 C1 1st environment, AV (1st environment, even if source of interference in 2nd environment) (class B, group 1)

Fig. 9-2: Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range

- Limit value for 1st environment is also relevant, if source of interference of 2nd environment affects 1st environment
- Designations “class” and “group” according to CISPR 11
- QP: measuring method quasi peak measurement
- AV: measuring method arithmetic averaging

Second Environment, Industrial Area

Facilities not directly connected to a low-voltage mains to supply buildings in residential areas.

If the limit values in an industrial area separated from public supply by a transformer station only have to be complied with at the property boundary or in the neighboring low-voltage mains, the filter might not be necessary. In the vicinity such as measuring sensors, measuring lines or measuring devices, it is normally required to use the interference suppression filter.

Increasing the noise immunity of a sensitive device can often be the economically better solution compared to measures of interference suppression at the drive system of installation.

First Environment

Environment containing residential areas and facilities directly connected, without interstage transformer, to a low-voltage mains supplying buildings in residential areas.

Medium-sized manufacturing plants and industrial establishments can be connected to the public low-voltage mains together with residential buildings. In this case there is a high risk for radio and television reception if there are not any measures for radio interference suppression taken. Therefore, the indicated measures are generally recommended.

Nominal Current of Supply Mains

The nominal current of the supply mains (> 100 A or ≤ 100 A) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply company.

Since it is impossible to obtain the lower limit values for residential areas with all applications by means of usual measures (like in the case of large and electrically not closed installations, longer motor cables or a large number of drives), the following note included in EN 61800-3 has to be observed.

According to standard EN 61800-3:

The drive system of standard EFC x610 with internal EMC filter, is product of category C3 and applicable to industrial environment.

⚠ WARNING

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

See the following chapters for the limit classes (as per categories C1, C2, C3, C4 according to EN 61800-3) which can be reached for Bosch Rexroth Frequency Converter EFC x610.

9.2 Ensuring the EMC Requirements

Standards and Laws

On the European level there are the EU Directives. In the EU states these Directives are transformed into laws valid on a national level. The relevant directive for EMC is EU Directive 2004/108/EC which was transformed on the national level in Germany into the law EMVG ("Law concerning electromagnetic compatibility of devices") of 2008-02-26.

EMC Properties of Components

Drive and control components by Rexroth are designed and built, in accordance with the present state-of-the-art of standardization, according to legal regulations of the EU Directive EMC 2004/108/EC and the German law.

The compliance with EMC standards was tested by means of a typical arrangement with a test setup conforming to standard with the indicated external EMC filter.

- Category C3 requirements according to product standard EN 61800-3 have been complied with for EFC x610.
- Minimum immunity requirements in the second environment according to product standard EN 61800-3 have been complied with for EFC x610.

Applicability for End Product

Measurements of the drive system with an arrangement typical for the system are not in all cases applicable to the status in a machine or installation. Noise immunity and noise emission strongly depend on:

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- radiation conditions
- wiring and installation

In addition, the required measures depend on the requirements of electric safety technology and economic efficiency in the application.

In order to prevent interference as far as possible, please read through and follow the detailed descriptions regarding on mounting and installation in this documentation.

Cases to Distinguish for Declaration of EMC Conformity

For validity of the harmonized standards, we distinguish the following cases:

- Case 1: Delivery of the drive system.

  According to the regulations, EFC x610 drive system is complied with product standard EN 61800-3 C3. The drive system is listed in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.

- Case 2: Acceptance test of a machine or installation with the installed drive systems.

  The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In the last years, some new product standards were created at present.

These new product standards contain references to the product standard EN 61800-3 for drives or specify higher-level requirements demanding increased filter and installation efforts. When the machine manufacturer wants to put the machine/installation into circulation, the product standard relevant to his machine/ installation has to be complied with for his end product “machine/installation”. The authorities and test laboratories responsible for EMC normally refer to this product standard.

This documentation specifies the EMC properties which can be achieved, in a machine or installation, with a drive system consisting of the standard components.

It also specifies the conditions under which the indicated EMC properties can be achieved.

9.3 EMC Measures for Design and Installation

9.3.1 Rules for Design of Installations with Drive Controllers in Compliance with EMC

The following rules are the basics for designing and installing drives in compliance with EMC:

Mains Filter

Correctly use a mains filter recommended by Rexroth for radio interference suppression in the mains supply of the drive system.

Control Cabinet Grounding

Connect all metal parts of the cabinet with one another over the largest possible surface area to establish a good electric connection. This, too applies to the mounting of the external mains filter. If required, use serrated washers which cut through the paint surface. Connect the cabinet door to the control cabinet using the shortest possible grounding straps.

Line Routing

Avoid coupling routes between lines with high potential of noise and noise-free lines; therefore, signal, mains and motor lines and power cables have to be routed separately from another. Minimum distance: 10 cm. Provide separating sheets between power and signal lines. Ground separating sheets several times.

The lines with high potential of noise include:

- Lines at the mains connection (incl. synchronization connection)
- Lines at the motor connection
- Lines at the DC-bus connection

Generally, interference injections are reduced by routing cables close to grounded sheet steel plates. For this reason, cables and wires should not be routed freely in the cabinet, but close to the cabinet housing or mounting panels. Separate the incoming and outgoing cables of the radio interference suppression filter.

Interference Suppression Elements

Provide the following components in the control cabinet with interference suppression combinations:

- Contactors
- Relays
- Solenoid valves
- Electromechanical operating hours counters

Connect these combinations directly at each coil.

Twisted Wires

Twist unshielded wires belonging to the same circuit (feeder and return cable) or keep the surface between feeder and return cable as small as possible. Wires that are not used have to be grounded at both ends.

Lines of Measuring Systems

Lines of measuring systems must be shielded. Connect the shield to ground at both ends and over the largest possible surface area. The shield may not be interrupted, e.g. using intermediate terminals.

Digital Signal Lines

Ground the shields of digital signal lines at both ends (transmitter **and** receiver) over the largest possible surface area and with low impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

Analog Signal Lines

Ground the shields of analog signal lines at one end (transmitter **or** receiver) over the largest possible surface area and with lower impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

Connection of Mains Choke

Keep connection lines of the mains choke at the drive controller as short as possible and twist them.

Installation of Motor Power Cable

- Use shielded motor power cable or run motor power cables in a shielded duct
- Use the shortest possible motor power cable
- Ground shield of motor power cable at both ends over the largest possible surface area to establish a good electric connection
- It is recommended to run motor lines in shielded form inside the control cabinet
- Do not use any steel-shielded lines
- The shield of the motor power cable must not be interrupted by mounted components, such as output chokes, sine filter or motor filters
- Both ends of choke earth should connect to shield to ensure it is continuous

9.3.2 EMC-optimal Installation in Facility and Control Cabinet

General Information

For EMC-optimal installation, a special separation of the interference-free area (mains connection) and the interference-susceptible area (drive components) is recommended, as shown in the figures below.

☞

- For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.
- Frequency converters need to be mounted in metal cabinet and connected to power supply with grounding.
- For motor cables used in the EMC test of the frequency converters, see chapter 6.2.3 "Maximum Length of Motor Cables" on page 34.
- For the end application system with frequency converters, the conformity of EMC directions needs to be confirmed.

Division into Areas (zones)

Exemplary arrangements in the control cabinet: See chapter 9.3.3 "Control Cabinet Mounting according to Interference Areas – Exemplary Arrangements" on page 96.

We distinguish three areas:

1. Interference-free area of control cabinet **(area A):**
   - Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines
   - All components that are not electrically connected with the drive system
2. Interference-susceptible area **(area B):**
   - Mains connections between drive system and mains filter for drives, mains contactor
   - Interface lines of drive controller
3. Strongly interference-susceptible area **(area C):**
   - Motor power cables including single cores

Never run lines of one of these areas in parallel with lines of another area so that there is not any unwanted interference injection from one area to the other and that the filter is jumped with regard to high frequency. Use the shortest possible connecting lines.

Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.

Badly grounded control cabinet doors act as antennas. Therefore, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 mm^2 or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

9.3.3 Control Cabinet Mounting according to Interference Areas – Exemplary Arrangements

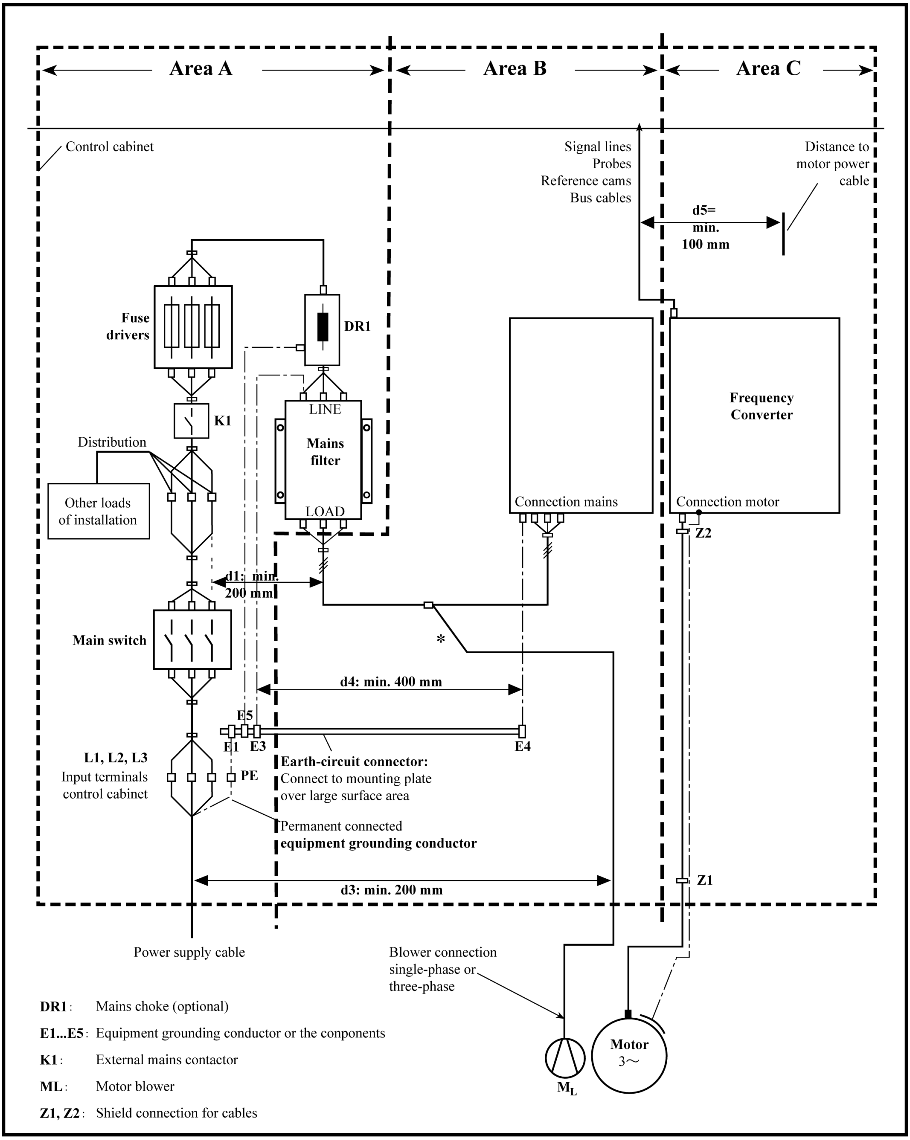


Fig. 9-3: Control cabinet mounting according to interference areas – exemplary arrangements

9.3.4 Design and Installation in Area A – Interference-free Area of Control Cabinet

Arrangement of the Components in the Control Cabinet

Comply with a distance of at least 200 mm (distance d1 in the figure):

- Between components and electric elements (switches, pushbuttons, fuses, terminal connectors) in the interference-free area A and the components in the two other areas B and C

Comply with a distance of at least 400 mm (distance d4 in the figure):

- Between magnetic components (such as transformers, mains chokes and DC-bus chokes that are directly connected to the power connections of the drive system) and the interference-free components and lines between mains and filter including the mains filter in area A

If these distances are not kept, the magnetic leakage fields are injected to the interference-free components and lines connected to the mains and the limit values at the mains connection are exceeded in spite of the installed filter.

Cable Routing of the Interference-free Lines to the Mains Connection

Comply with a distance of at least 200 mm (distance d1 and d3 in the figure):

- Between supply feeder or lines between filter and exit point from the control cabinet in area A and the lines in area B and C

If this is impossible, there are two alternatives:

1. Install lines in shielded form and connect the shield at several points (at least at the beginning and at the end of the line) to the mounting plate or the control cabinet housing over a large surface area.
2. Separate lines from the other interference-susceptible lines in areas B and C by means of a grounded distance plate vertically attached to the mounting plate.

Install the shortest possible lines within the control cabinet and install them directly on the grounded metal surface of the mounting plate or of the control cabinet housing.

Mains supply lines from areas B and C must not be connected to the mains without a filter.

☞ In case you do not observe the information on cable routing given in this section, the effect of the mains filter is totally or partly neutralized. This will cause the noise level of the interference emission to be higher within the range of 150 kHz to 40 MHz and the limit values at the connection points of the machine or installation will thereby be exceeded.

Routing and Connecting a Neutral Conductor (N)

If a neutral conductor is used together with a three-phase connection, it must not be installed unfiltered in areas B and C, in order to keep interference off the mains.

Motor Blower at Mains Filter

Single-phase or three-phase supply lines of motor blowers, that are usually routed in parallel with motor power cables or interference-susceptible lines, must be filtered:

- In frequency converter with **only infeeding supply units**, via the available three phase filter of the frequency converter

When switching power off, make sure the blower is not switched off.

Loads at Mains Filter of frequency converter

- Only operate allowed loads at the mains filter of the frequency converter!

Shielding Mains Supply Lines in Control Cabinet

If there is a high degree of interference injection to the mains supply line within the control cabinet, although you have observed the above instructions (to be found out by EMC measurement according to standard), proceed as follows:

- Only use shielded lines in area A
- Connect shields to the mounting plate at the beginning and the end of the line by means of clips

The same procedure may be required for long cables of more than 2 m between the point of power supply connection of the control cabinet and the filter within the control cabinet.

Mains Filters for AC Drives

Ideally, mount the external mains filter on the parting line between area A and B. Make sure the ground connection between filter housing and housing of the drive controllers has good electrically conductive properties.

If **single-phase** loads are connected on the load side of the external filter, their current may be a maximum of 10 % of the three-phase operating current. A highly imbalanced load of the external filter would deteriorate its interference suppression capacity.

If the mains voltage is higher than 480 V, connect the external filter to the output side of the transformer instead of the supply side of the transformer.

Grounding

In the case of bad ground connections in the installation, the distance between the lines to the grounding points E1, E2 in area A and the other grounding points of the frequency converter should be at least d4 = 400 mm, in order to minimize interference injection from ground and ground cables to the power input lines.

See also "Division into Areas (zones)" on page 94.

Point of Connection for Environment Grounding Conductor at Machine, Installation, Control Cabinet

The equipment grounding conductor of the power cable of the machine, installation or control cabinet has to be permanently connected at point PE and have a cross section of at least 10 mm^2 or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN 61800-5-1: 2007, section 4.3.5.4). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must be accordingly bigger.

9.3.5 Design and Installation in Area B – Interference-susceptible Area of Control Cabinet

Arranging Components and Lines

Modules, components and lines in area B should be placed at a distance of at least d1 = 200 mm from modules and lines in area A.

Alternative: Shield modules, components and lines in area B by distance plates mounted vertically on the mounting plate from modules and lines in area A or use shield lines.

Only connect control voltage connections in the frequency converter to the mains via a mains filter. See "Division into Areas (zones)" on page 94.

Install the shortest possible lines between drive controller and filter.

Control Voltage or Auxiliary Voltage Connection

Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from area B and C of the frequency converter.

Run the connection between control voltage connection of the frequency converter and power supply unit used through area B over the shortest distance.

Line Routing

Run the lines along grounded metal surfaces, in order to minimize radiation of interference fields to area A (transmitting antenna effect).

9.3.6 Design and Installation in Area C – Strongly Interference-susceptible Area of Control Cabinet

Area C mainly concerns the motor power cables, especially at the connection point of the drive controller.

Influence of the Motor Power Cable

The longer the motor cable, the greater its leakage capacitors. To comply with a certain EMC limit value, the allowed leakage capacitance of he mains filter is limited.

- Run the shortest possible motor power cables.

Routing the Motor Power Cables and Motor Encoder Cables

Route the motor power cables and motor encoder cables along grounded metal surfaces, both inside the control cabinet and outside of it, in order to minimize radiation of interference fields. If possible, route the motor power cables and motor encoder cables in metal-grounded cable ducts.

Route the motor power cables and motor encoder cables

- with a distance of at least **d5 = 100 mm** to inference-free lines, as well as to signal cables and signal lines

  (alternatively separated by a grounded distance plate)
- in separate cable ducts, if possible

Routing the Motor Power Cables and Mains Connection Lines

For frequency converters (drive controllers with individual mains connection), route motor power cables and (unfiltered) mains connection lines **in parallel for a maximum distance of 300 mm**. After that distance, route motor power cables and power supply cables in opposite directions and preferably in separate **cable ducts.**

Ideally, the outlet of the motor power cables at the control cabinet should be provided in a distance of at least **d3 = 200 mm** from the (filtered) power supply cable.

9.3.7 Ground Connections

Housing and Mounting Plate

By means of appropriate ground connections, it is possible to avoid the emission of interference, because interference is discharged to ground on the shortest possible way.

Ground connections of the metal housings of EMC-critical components (such as filters, devices of the frequency converter, connection points of the cable shields, devices with microprocessor and switching power supply units) have to be well contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate. The best solution is to use a zinc-coated mounting plate. Compared to a lacquered plate, the connections in this area have a good long-time stability.

Connection Elements

For lacquered mounting plates, always use screw connections with tooth lock washers and zinc-coated, tinned screws as connection elements. At the connection points, remove the lacquer so that there is safe electric contact over a large surface area. You achieve contact over a large surface area by means of bare connection surfaces or several connection screws. For screw connections, you can establish the contact to lacquered surfaces by using tooth lock washers.

Metal Surfaces

Always use connection elements (screws, nuts, plain washers) with good electroconductive surface.

Bare zinc-coated or tinned metal surfaces have **good electroconductive properties**.

Anodized, yellow chromatized, black gunmetal finish or lacquered metal surfaces have **bad electroconductive properties**.

Ground Wires and Shield Connections

For connecting ground wires and shield connections, it is not the cross section but the size of contact surface that is important, as the high-frequency interference current mainly flow on the surface of the conductor.

9.3.8 Installing Signal Lines and Signal Cables

Line Routing

The following measures are recommend:

- Route signal and control lines separately from the power cables with a minimum distance of d5 = 100 mm (see "Division into Areas (zones)" on page 94) or with a grounded separating sheet. The optimum way is to route them in separate cable ducts. If possible, lead signal lines into the control cabinet at one point only.
- If signal lines are crossing power cables, route them in an angle of 90° in order to avoid interference injection.
- Ground spare cables, that are not used and have been connected, at least at both ends so that they do not have any antenna effect.
- Avoid unnecessary line lengths.
- Run cables as close as possible to grounded metal surfaces (reference potential). The ideal solution are closed, grounded cable ducts or metal pipes which, however, is only obligatory for high requirements (sensitive instrument leads).
- Avoid suspended lines or lines routed along synthetic carries, because they are functioning like reception antennas (noise immunity) and like transmitting antennas (emission of interference). Exceptional cases are flexible cable tracks over short distances of a maximum of 5 m.

Shielding

Connect the cable shield immediately at the devices in the shortest and most direct possible way and over the largest possible surface area.

Connect the shield of analog signal lines at one end over a large surface area, normally in the control cabinet at the analog device. Make sure the connection to ground/housing is short and over a large surface area.

Connect the shield of digital signal lines at both ends over a large surface area and in short form. In the case of potential differences between beginning and end of the line, run an additional bonding conductor in parallel. This prevents compensating current from flowing via the shield. The guide value for the cross section is 10 mm^2.

You absolutely have to equip separate connections with connectors with grounded metal housing.

In the case of non-shielded lines belongs to the same circuit, twist feeder and return cable.

9.3.9 General Measures of Radio Interference Suppression for Relays, Contactors, Switches, Chokes and Inductive Loads

If, in conjunction with electronic devices and components, inductive loads, such as chokes, contactors, relays are switched by contacts or semiconductors, appropriate interference suppression has to be provided for them:

- By arranging free-wheeling diodes in the case of d.c. operation
- In the case of a.c. operation, by arranging usual RC interference suppression elements depending on the contactor type, immediately at the inductance

Only the interference suppression element arranged immediately at the inductance does serve this purpose. Otherwise, the emitted noise level is too high which can affect the function of the electronic system and of the drive.

If possible, mechanical switches and contacts should only be realized as snap contacts. Contact pressure and contact material must be suited for the corresponding switching current.

Slow-action contacts should be replaced by snap switches or by solid-state switches, because slow-action contacts strongly bounce and are in an undefined switching status for a long time which emits electromagnetic waves in the case of inductive loads. These waves are an especially critical aspect in the case of manometric or temperature switches.

10 Operating Panel and Dust Cover

10.1 LED Panel

The LED panel is removable and composed of two areas: display and buttons. The display shows mode settings and operating state of the frequency converter. The buttons allow users to program the frequency converter.

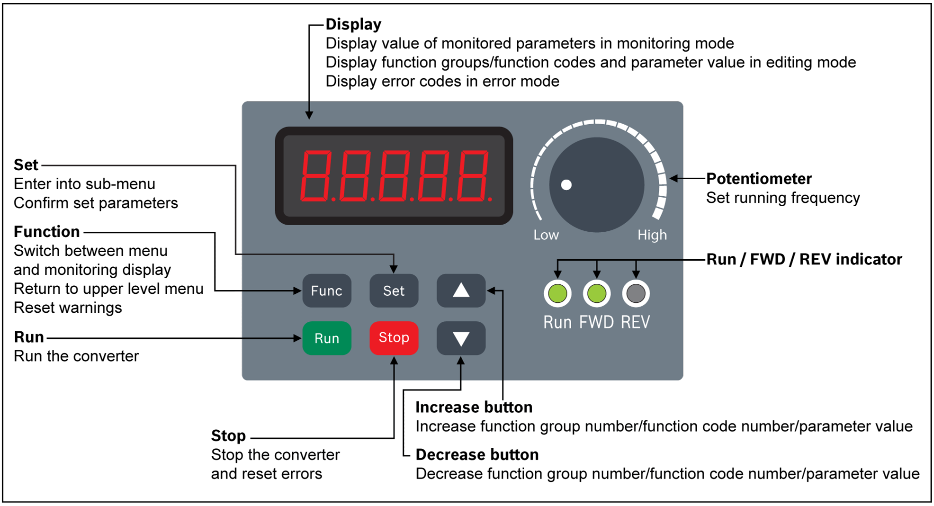


Fig. 10-1: LED panel

10.2 LED Display

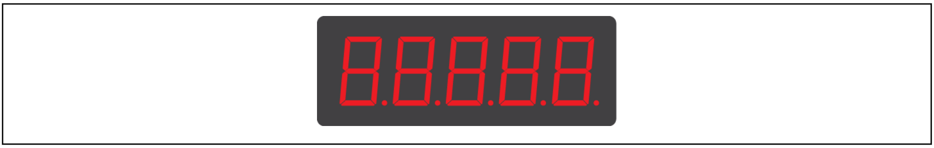


Fig. 10-2: LED display

10.3 Dust Cover

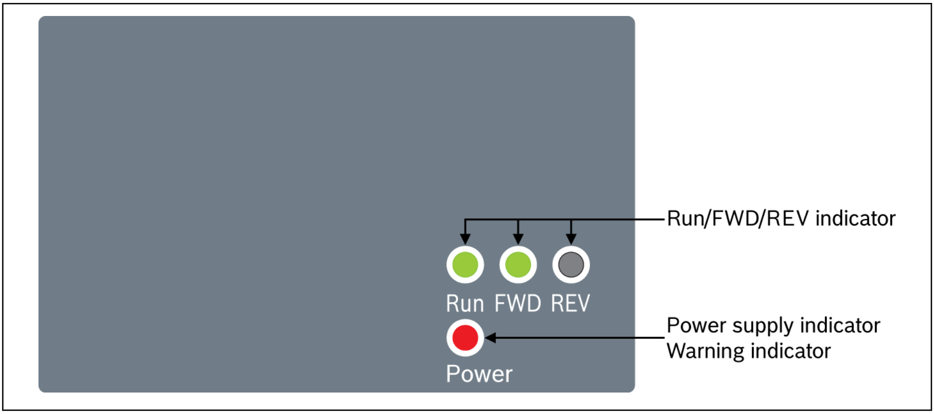


Fig. 10-3: Dust cover

Frequency Converter EFC x610 are available with **Dust Cover** instead of **LED Panel** on demand. To operate frequency converters with **Dust Cover**,

- Order an **LED Panel** additionally, and then set the frequency converter with chapter 12.1.3 "Parameter Copy" on page 121.

10.4 LED Indicator

Mode	Run	FWD	REV	Power①
Power off	Off	Off	Off	Off
Ready	Off	Green / Off	Off / Green	Red
Run (FWD)	Green	Green	Off	Red
Run (REV)	Green	Off	Green	Red
Run pending DC-braking at start Direction change dead time	Blinks in green (Short green long dark)	Green / Off	Off / Green	Red
Deceleration stop phase DC-braking at stop	Blinks in green (Short dark long green)	Green / Off	Off / Green	Red
Warning with FWD	Green	Green	Off	Blinks in red (Short dark long red)
Warning with REV	Green	Off	Green	Blinks in red (Short dark long red)
Warning at stop	Off	Green / Off	Off / Green	Blinks in red (Short dark long red)
Error	Off	Green / Off	Off / Green	Blinks in red (Short red long dark)

Tab. 10-1: LED indicator status

- ①: Available on dust cover or when neither the LED panel nor the dust cover is installed.
- The frequency converter stops if FWD and REV commands are active at the same time.

10.5 Operating Descriptions

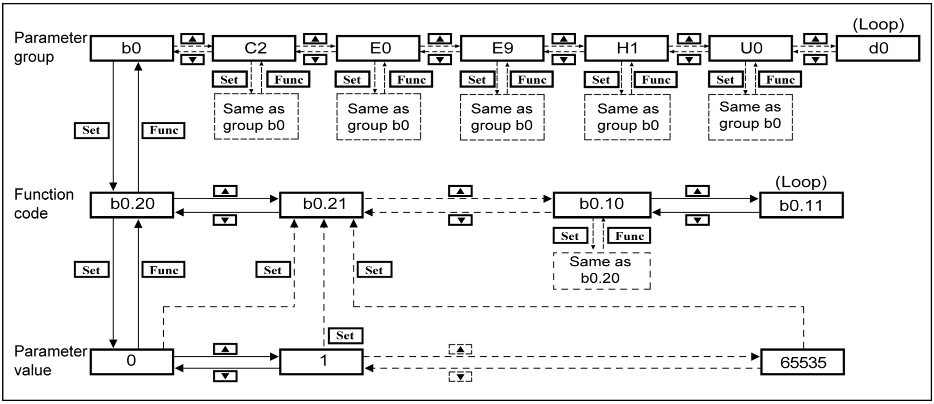


Fig. 10-4: Operating mode

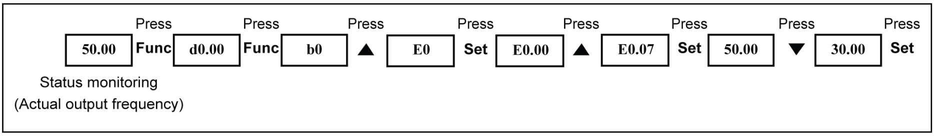


Fig. 10-5: Operating example

10.6 Fast Access to Parameters with Button Combinations

EFC x610 provides fast access to parameters within a parameter group with '**<Func> + <▲>**' or '**<Func> + <▼>**' combinations. This function is only valid for the tens digit of the function code index '□□.**x**□'.

- Pressing '**<Func> + <▲>**' once: '□□.**x**□' is changed to '□□.**x+1**□'
- Pressing '**<Func> + <▼>**' once: '□□.**x**□' is changed to '□□.**x-1**□'

Example: The frequency converter is now displaying 'E0.07' after setting with **<Func>**, **<Set>**, **<▲>** and **<▼>** buttons.

If 'E0.**1**7' needs to be displayed based on 'E0.**0**7', **<▲>** button has to be pressed for 10 times in the traditional way as described in the above figure. However, with button combination function, it is only necessary to press '**<Func> + <▲>**' buttons once.

- The parameter fast access function is only available when [b0.00] = 0, 1, or 2, unavailable with parameters in groups '-PF-' or '-EP-'
- Press **<Func>** button and do not release it until **<▲>** or **<▼>** button has been pressed.
- Press **<▲>** or **<▼>** button within 2 s if **<Func>** button is pressed.
- If the index of parameters is not continuous in a specific parameter group, the adjacent parameter will be accessed. For example, the display of 'E0.01' should be changed to 'E0.11' with '**<Func> + <▲>**' button function. However, parameter E0.11 is unavailable in group E. While the adjacent parameter is E0.15. In this case, 'E0.15' is accessed and displayed.

10.7 Digit Shifting Function for Modification of Parameter Values

EFC x610 also provides the digit shifting function for modification of parameter values. To activate this function, press '<Func> + <▲>' or '<Func> + <▼>' once when the frequency converter is displaying a certain parameter value. After this action, the unit digit of the value blinks.

To select the digit for modification, press the following button combinations.

- Pressing '<Func> + <▲>' once: the blinking digit is shifted one digit leftwards.
- Pressing '<Func> + <▼>' once: the blinking digit is shifted one digit rightwards.

Example: [E0.07] = 35.40. The frequency is now displaying '35.40'.

If the value '35.40' needs to be modified to be 15.40, execute the following steps.

- Step 1: Pressing '<Func> + <▲>' or '<Func> + <▼>' once to activate the digit function. '3**5**.40' is displayed with the unit digit '5' blinking.
- Step 2: Pressing '<Func> + <▲>' again to shift the blinking digit leftwards. '**3**5.40' is displayed with tens digit '3' blinking.
- Step 3: Pressing <▼> twice to change the tens digit '3' to be '1'. '**1**5.40' is displayed with tens digit '1' blinking.
- Step 4: Pressing <Set> to save the modified parameter value '15.40'. The display returns back to an upper menu level to show the next parameter with 'E0.08' displayed.

- The digit shifting function is only available for parameters with values and unavailable for parameter with options.
- Press <Func> button and do not release it until <▲> or <▼> button has been pressed.
- Press <▲> or <▼> button within 2 s if <Func> button is pressed.
- Press <Func> button over 2 s without pressing any other button to cancel the uncompleted setting with button combinations.

10.8 LCD Panel

10.8.1 LCD Panel Introduction

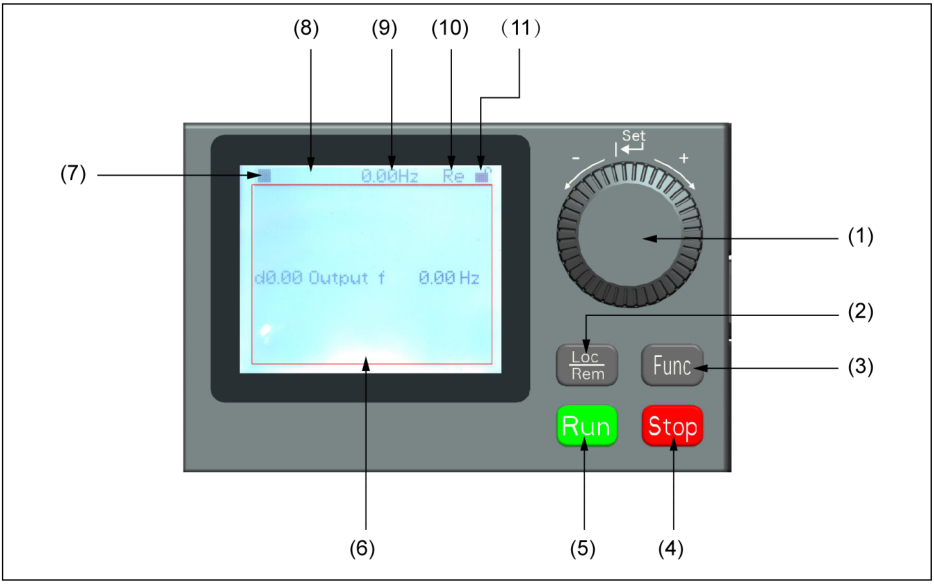


Fig. 10-6: LCD panel appearance

(1) Navigation button

1. Scroll between parameter and group code
2. Set the parameter value

(2) Loc / Rem button: Switch between "Remote" & "Local".

(3) Func button: Enter the parameter group screen and go back to previous screens.

(4) Stop button: Stop the frequency converter.

(5) Run button: Start the frequency converter.

(6) Text area: Used for displaying:

1. Parameter monitoring screen
2. Parameter group / Parameter code
3. Parameter name
4. Parameter value and unit
5. Other screens: Error / Warning display screen, welcome screen, customer information message screen

(7) Run / Stop status: It displays information regarding run / stop and forward / reverse state of the frequency converter. Details are shown in the table below.

Frequency converter status	Details
• Running at 0 Hz (set RefDir: FWD)	▶▶: Blinking ◀◀: Invisible ■: Invisible
• Running at 0 Hz (set RefDir: REV)	▶▶: Invisible ◀◀: Blinking ■: Invisible
• Frequency converter in RUN state (set RefDir: REV)	▶▶: Invisible ◀◀: Shown solid, not blinking ■: Invisible
• Frequency converter in RUN state (set RefDir: FWD)	▶▶: Shown solid, not blinking ◀◀: Invisible ■: Invisible

Tab. 10-2: Frequency converter status

(8) Error / Warning information: Error / Warning code will be displayed in this sector. Please refer to chapter 13 "Diagnosis" on page 468 for details.

(9) Permanent monitoring: By default, its display as "Actual output frequency" is set by parameter U2.09. Value and unit of parameter will be displayed.

(10) Re / Lo: **Re** stands for 'Remote' and **Lo** for 'Local'. Its display is set via **Loc / Rem** button or parameter U2.03.

(11) Panel Locked / Unlocked: Panel can be locked by the following ways:

- Setting [U2.02] to '1', or
- Pressing **Func** button with **Loc** button for longer than 3 s.

Panel can be unlocked by the following ways:

- Setting [U2.02] to '0' (only in communication mode), or
- Pressing **Func** button with **Loc** button for longer than 3 s.

10.8.2 Operating Example

Please follow the steps below to set parameter [b0.10] to '1: Restore to default settings' through LCD panel.

1. Press **Func** button.
2. Rotate **Navigation button** to select parameter group b0.
3. Press **Navigation button** and rotate it to select parameter b0.10.
4. Press **Navigation button** and rotate it to select parameter value '1: Restore to default settings'.
5. Press **Navigation button** to finish setting.

11 Quick Start

11.1 Checklist before Quick Start

11.1.1 Step 1: Check application conditions

Rated ambient temperature	-10...45 ℃
Derating / ambient temperature	1.5 % / 1 ℃ (45...55 ℃)
Rated storage temperature	-20...60 ℃
Rated altitude	≤ 1,000 m
Derating / altitude	1 % / 100 m (1,000...4,000 m)
Mounting mode (Wall mounting)	Wall mounting, DIN rail mounting

Tab. 11-1: Application conditions checklist

See also in chapter 6.1.9 "Conditions" on page 24.

11.1.2 Step 2: Check mounting conditions

Converter mounting direction	Vertical
Minimum top space	d_{top} = 125 mm
Minimum bottom space	d_{bot} = 125 mm
One converter is arranged above another	Air guide available is required in between
Mounting screws	4 x M6, no loose screws

Tab. 11-2: Mounting conditions checklist

See also in chapter 7.1 "Installation Conditions" on page 36.

11.1.3 Step 3: Check the wiring

Mains connection	Connect L1, L2, (L3) of converter to mains accordingly
Motor connection	Connect U, V, W of converter to motor accordingly
Grounding	Must be securely connected
Shielding	Must be securely connected
Power cables	Must observe chapter 8.2.1 "Power Cables" on page 58
Control terminals connection	Must be securely connected
Control cables	Must observe chapter 8.2.2 "Control Cables" on page 65
EMC	Must observe chapter 9 "Electromagnetic Compatibility (EMC)" on page 82
Switches	Must be switched off
Load	Must be disconnected

Tab. 11-3: Wiring checklist

11.2 Quick Start Parameters

Code	Name	Setting range	Default	Min.	Attri.
C0.05	Carrier frequency	DOM	DOM	1	Run
C1.05	Motor rated power	0.1...1,000.0 kW	DOM	0.1	Stop
C1.06	Motor rated voltage	0...480 V	DOM	1	Stop
C1.07	Motor rated current	0.01...655.00 A	DOM	0.01	Stop
C1.08	Motor rated frequency	5.00...400.00 Hz	50.00	0.01	Stop
C1.09	Motor rated speed	1...60,000 rpm	DOM	1	Stop
C2.00	V/f curve mode	0: Linear 1: Square 2: User-defined	0	–	Stop
E0.00	First frequency setting source	0...21	0	–	Stop
E0.01	First run command source	0...2	0	–	Stop
E0.07	Digital setting frequency	0.00...[E0.09] Hz	50.00	0.01	Run
E0.08	Maximum output frequency	50.00...400.00 Hz	50.00	0.01	Stop
E0.09	Output frequency high limit	[E0.10]...[E0.08] Hz	50.00	0.01	Run
E0.10	Output frequency low limit	0.00...[E0.09] Hz	0.00	0.01	Run
E0.17	Direction control	0: Forward / Reverse 1: Forward only 2: Reverse only 3: Swap default direction	0	–	Stop
E0.25	Acceleration / deceleration curve mode	0: Linear mode 1: S-curve	0	–	Stop
E0.26	Acceleration time	0.1...6,000.0 s	DOM	0.1	Run
E0.27	Deceleration time	0.1...6,000.0 s	DOM	0.1	Run
E0.35	Start mode	0: Start directly 1: DC-braking before start 2: Start with speed capture 3: Automatic start / stop according to setting frequency	0	–	Stop
E0.50	Stop mode	0: Decelerating stop 1: Freewheeling stop 1 2: Freewheeling stop 2	0	–	Stop

Tab. 11-4: Quick start parameters

11.3 Control the Motor

⚠ WARNING

Ensure the enclosure is in place before the device is powered on. Wait for at least **5 minutes** after powering off to allow the DC capacitor being discharged, and do not remove the cover during this period!

Step	Operation	Description
1	Rotate the potentiometer counterclockwise (leftwards) to the greatest extent	Output frequency setting is 0.00
2	Press **<Run>** button	Control command active, 0.00 is displayed
3	Rotate the potentiometer clockwise (rightwards) slowly till 5.00 is displayed	The motor starts to run
	Observe the running status:	**Recommended operation:**
	If the motor runs in the correct direction If the motor runs steadily If there is any abnormal noise or problem	Stop the motor immediately by switching off the power if any abnormality occurs Restart commissioning only after error causes have been removed
4	Rotate the potentiometer clockwise	The motor accelerates
5	Rotate the potentiometer counterclockwise	The motor decelerates
6	Press **<Stop>** button	Stop command activated, the motor stops
7	Check parameters without load	Settings according to actual applications
8	Check parameters with load	Settings according to actual applications

Tab. 11-5: Motor controlling procedure

- With AC mains voltage, EFC x610 will generate output if pressing down the **<Run>** button (or 'Control by terminals' is activated).
- By default, EFC x610 is set as:
  - The frequency converter is started or stopped by the operating panel.
  - The output frequency is set by the potentiometer on the operating panel.
- With AC mains voltage, please confirm:
  - The setting frequency is displayed (no error display).
  - The monitoring parameter is consistent with the actual situations.
- By default, **Output frequency** in run status and **Setting frequency** in stop status are displayed as the monitoring parameters, which can be changed to other parameters with parameters U1.00 and U1.10. The default settings are based on standard applications with standard motors.

☞ For frequency converters with dust cover, it is recommended to install an LED panel to perform the above operations.

11.4 Motor Parameters Auto-Tuning

For SVC control and applications with higher requirement to control accuracy in V/f control, motor parameter auto-tuning is necessary. Two modes of auto-tuning are available, static auto-tuning and rotational auto-tuning. The former mode is enough for V/f mode and the latter is used **mainly** for SVC control. For details, seechapter 12.3.2 "Motor Parameter Tuning" on page 152.

11.5 Possible Errors during Quick Start and Respective Solutions

Errors	Solutions
Over current (SC, OC-1 or OC-2) occurs during acceleration	Increase the acceleration time
Over voltage (OE-3) occurs during deceleration	Increase the deceleration time
Over current (SC, OC-1 or OC-2) occurs immediately after pressing the **<Run>** button	Incorrect wiring. Check if U, V, W outputs of the main circuit are shorted or grounded
The motor runs in the direction opposite to expected	Change the sequence of any two phases of U, V and W
The motor vibrates and runs in uncertain directions after each starting	One phase of U, V and W is disconnected (output phase loss)

Tab. 11-6: Solutions for simple errors during commissioning

11.6 Restoring Parameters to Factory Defaults

If the frequency converter fails to run the motor due to incorrect parameter settings, a simple solution is to initialize the parameters to factory defaults. Setting [b0.10] = 1 will start initialization.

Please be sure that the parameter settings match with the motor and the field applications after factory defaults restore. Adjust the parameter settings after factory defaults restore if necessary.

Output frequency	Set by the potentiometer (E0.00)
Acceleration / deceleration time	Linear, Acc. for 5 s / Dec. for 5 s (E0.26, E0.27)
Protection mode in case of motor overload or overheat	Motor rated current (C1.07), Motor thermal model protection time constant (C1.74), low speed derating frequency (C1.75), and zero speed load (C1.76)
Operating panel operation	**<Run>**, **<Stop>** buttons as command sources, potentiometer as frequency setting source
V/f curve mode	Linear

Tab. 11-7: Parameter settings by factory defaults

12 Functions and Parameters

12.1 b0: Basic System

12.1.1 Access Authority Setting

This function is used to set parameters or read parameter settings in a fast way. Five access modes are available with parameter b0.00.

Code	Name	Setting range	Default	Unit	Step	Attri.
b0.00	Access authority setting	0...4	0	-	–	Run

Setting range of b0.00:

- **0: Basic parameters**

  b0, d0, C0, E0, U0, U1, U2, -EP- are visible.

- **1: Standard parameters**
  - For EFC 5610, b0, d0, C0, C1, C2, C3, E0, E5, E8, U0, U1, U2, -EP- are visible.
  - For EFC 3610, b0, d0, C0, C1, C2, E0, E5, E8, U0, U1, U2, -EP- are visible.
- **2: Advanced parameters**
  - For EFC 5610, b0, d0, C0, C1, C2, C3, E0, E1, E2, E3, E4, E5, E8, E9, H0, H1, H2, H3, H4, H8, H9, U0, U1, U2, F0, -EP- are visible.
  - For EFC 3610, b0, d0, C0, C1, C2, E0, E1, E2, E3, E4, E5, E8, E9, H0, H1, H2, H3, H4, H8, H9, U0, U1, U2, F0, -EP- are visible.
- **3: Start-up parameters**

  b0, d0, -St-, -EP- are visible.

- **4: Modified parameters**
  - b0, d0, -PF-, -EP- are visible.
  - -PF- group consists of only modified parameters which are different from the default setting. Parameter settings can be modified directly in -PF- group.
  - If a parameter in -PF- group was changed back to its default setting is still visible in -PF- group. It is invisible once the group has been exited and re-accessed.
  - Parameters b0.10, b0.11, b0.20, b0.21, C0.53, C1.01, E9.05...E9.07, E9.10...E9.15, H8.87, H9.97 are excluded from this function.
  - If -PF- group is accessed if no parameter is different from default the warning message noCP will be displayed for 1.5s, then it will fall back to group selection screen.

Code	Name	Code	Name
C0.05	Carrier frequency	E0.08	Maximum output frequency
C1.05	Motor rated power	E0.09	Output frequency high limit
C1.06	Motor rated voltage	E0.10	Output frequency low limit
C1.07	Motor rated current	E0.17	Direction control
C1.08	Motor rated frequency	E0.25	Acceleration / Deceleration curve mode
C1.09	Motor rated speed	E0.26	Acceleration time
C2.00	V/f curve mode	E0.27	Deceleration time
E0.00	First frequency setting source	E0.35	Start mode
E0.01	First run command source	E0.50	Stop mode
E0.07	Digital setting frequency		

Tab. 12-1: -St- group contents

-EP- group is only visible if there are erroneous parameters during parameter restore (error E.Par).

☞

- Parameters which are linked to an extension are only shown if the corresponding card is installed.

  Example: Groups H1...H9 will only be shown if the related extension card is installed.
- Group U2 will only be shown if a LCD panel is installed. At the same time, because LED panel is uninstalled, U1 will not be visible any longer.
- ASF related parameter groups F1...F3 will only be shown if an ASF is loaded and b0.00 = 2.

12.1.2 Parameter Initialization

This function is used to restore the parameters back to the factory defaults.

Code	Name	Setting range	Default	Unit	Step	Attri.
b0.09	Parameter initialization setting	1: Base device and non fieldbus options 2: Fieldbus options 3: Base device, non fieldbus and fieldbus options	1	–	–	Stop
b0.10	Parameter initialization	0...2	0	–	–	Stop

Setting range of b0.10:

- **0: Inactive**

  This parameter will be reset to 0 automatically after parameter initialization is finished.

- **1: Restore to default settings**

  Parameters will be restored to factory default based on the setting of b0.09:

  - b0.09 = 1: b0, d0, C0, C1, C2, C3, E0, E1, E2, E3, E4, E5, E8, E9, H0, H8, H9, U0, U1, U2, F0, F1, F2, F3
  - b0.09 = 2: H1, H2, H3, H4
  - b0.09 = 3: All parameters are restored to factory default

  Following parameters will not be cleared, independent of the setting of b0.09:

  - C0.51 (Fan total running time)
  - E9.05...E9.07, E9.10...E9.15, E9.97...E9.99 (Error records)
  - d0.23 (Power stage running time)

- **2: Clear error and warning record**

  Parameters E9.05...E9.07 and E9.10...E9.15, E9.97...E9.99 will be cleared.

12.1.3 Parameter Copy

This function is used to copy parameter settings between multiple frequency converters via the operating panel. Parameters can be stored on the panel of the frequency converter, after the panel is plugged into a different converter the same settings can be copied to this converter.

Code	Name	Setting range	Default	Unit	Step	Attri.
b0.11	Parameter copy	0...2	0	–	–	Stop

Setting range of b0.11:

- **0: Inactive**

  This parameter will be reset to 0 automatically after parameter copy is finished.

- **1: Backup parameters to panel**

  All customer parameter settings are copied to the panel.

- **2: Restore parameters from panel**

  All customer parameters settings are restored from the panel.

The following parameters are not included in parameter copy function:

- Read only parameters(d0 group, F0 group, C0.51, E9.05...E9.99, U0.99, H0.01, H0.02, H0.03, H0.18, H0.19, H0.20, H0.30, H0.23, H0.33, H1.01, H1.02)
- Panel parameters(U1 group, U2 group)
- Auto reset after execution parameters(b0.09, b0.10, b0.11, b0.20, b0.21, C0.53, C1.01)
- Real time data parameters(E2.20, E2.28, H0.00, H0.10, H0.12, H0.14, H0.15, H0.16, H0.50, H8.23, H8.28)
- MEP card parameters(H3 group, H4 group)
- Diagnosis parameters(H8.87, H9.97)

All other operations will be inactive during parameter replication. The panel can't be operated, data can't be accessed with engineering tools or fieldbus until the operation is finished.

When a parameter restore is started, all the parameters on the device will be set to the initial values first, this ensures a compatible behavior also over different firmware versions.

The state of progress during the operation is shown in the panel as below:

Display in the panel	State of progress
"-"	0...25% finished
"--"	26...50% finished
"---"	51...75% finished
"----"	76...100% finished

Tab. 12-2: State of progress

If parameter restore is triggered via communication it may lead to a communication breakdown if the parameters in the backup are not set according to the current settings.

If the panel is unplugged during the backup process the parameter image in the panel is not valid and can't be restored to another device. If the panel is unplugged during restore process the state of the converter is undefined. Process has to be repeated or default values have to be loaded.

When the parameter backup was taken with a different firmware version then the restore is done, some parameters might not be available, those will be set to initial values.

If a parameter from a backup has a different value range (e.g. from different device class) the error E.Par will be shown. Parameters which are set to invalid values will be shown in -EP- group.

If one or more parameters in the backup are not found in the device they will be skipped during parameter restore without notification.

12.1.4 Parameter Set Switch

This function allows to switch between two sets of parameters. It is used if the motors are switched at the output of the frequency converter and two motors should be driven by one device.

Code	Name	Setting range	Default	Unit	Step	Attri.
b0.12	Parameter set selection	0: Parameter set 1 active 1: Parameter set 2 active	0	–	–	Stop

Following parameters are inside the switchable parameter set:

Code	Name	Code	Name
C0.00*	Control mode	C1.71	Motor overload pre-warning delay
C1.00*	Motor type	C1.74	Motor thermal model protection time constant
C1.05	Motor rated power	C1.75	Low speed derating frequency
C1.06	Motor rated voltage	C1.76	Zero speed load
C1.07	Motor rated current	C2.00	V/f curve mode
C1.08	Motor rated frequency	C2.01	V/f frequency 1
C1.09	Motor rated speed	C2.02	V/f voltage 1
C1.10	Motor rated power factor	C2.03	V/f frequency 2
C1.11	Motor poles	C2.04	V/f voltage 2
C1.12	Motor rated slip frequency	C2.05	V/f frequency 3
C1.13	Motor inertia mantissa	C2.06	V/f voltage 3
C1.14	Motor inertia exponent	C2.07	Slip compensation factor
C1.20	Motor no-load current	C2.21	Torque boost setting
C1.21	Stator resistance	C2.22	Automatic torque boost factor
C1.22	Rotor resistance	E0.00	First frequency setting source
C1.23	Leakage inductance	E0.01	First run command source
C1.24	Mutual inductance	E0.07	Digital setting frequency
C1.69	Motor thermal model protection setting	E0.09	Output frequency high limit
C1.70	Motor overload pre-warning level		

Tab. 12-3: Parameter set contents

☞ *: C0.00 and C1.00 are ONLY included in the switchable parameter set for EFC 5610.

Parameter set switch can be carried out in 2 different ways:

- By parameter b0.12:

  When the value is changed the parameter set according to the parameter will be loaded. A parameter set switch can only be carried out in STOP mode. During power up parameter set is loaded according to setting of b0.12, if none of the digital inputs is used to switch between the parameters sets.

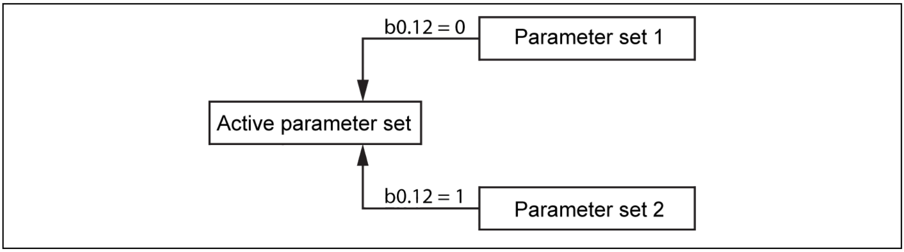


Fig. 12-1: Parameter set selection by b0.12

- By digital input:

  Parameter set switch will be carried out with an digital input if one of the parameters E1.00...E1.04 or H8.00...H8.04 is set to option “46: Parameter set selection”. If one of the digital inputs is configured to option 46 it will override the setting of b0.12 and load the parameter set according to the digital input during power up. If an attempt to change [b0.12] as long as a digital input is configured, 'S.Err' will be shown.

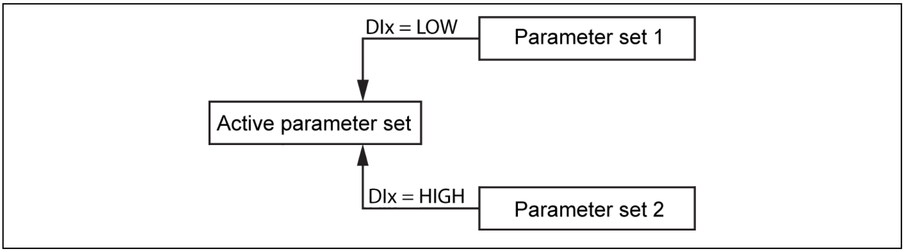


Fig. 12-2: Parameter set selection by digital input

Terminal value is considered for active parameter set selection only during STOP mode. If converter is in RUN, terminal value change will be ignored for parameter set selection. After STOP, parameter switching will be triggered once again, if the configured terminal value is not matching active parameter set.

Parameter set switch and other commands (e.g. RUN) can be given at the same time, but all other commands will be delayed until the parameter set switch is finished and triggered afterwards. If a parameter set switch is initiated during another parameter set switch in progress, the first switch will be finished and then the second switch will be carried out directly after the first one.

During parameter default loading both parameter sets will be restored to default values. During parameter set switch from set 1 to set 2, “PAr2” will be displayed on panel and during switching from set 2 to set 1, “PAr1” will be displayed with the following restrictions.

☞ During parameter backup both sets will be copied and during restore both sets will be restored.

If any parameter data status is found invalid (e.g. from restore with different device), invalid data status parameter will be skipped and continue with update of other parameters.

12.1.5 Password Protection

Two kinds of passwords are available, user password and manufacturer password:

- User password: used to protect parameter settings from unauthorized or unintended changes.
- Manufacturer password: used for service purposes ONLY.

Code	Name	Setting range	Default	Unit	Step	Attri.
b0.20	User password	0...65,535	0	–	1	Run
b0.21	Manufacturer password	0...65,535	0	–	1	Run

Both passwords always read as 0.

Possible operations with passwords are as below:

- **Set user password**

  The default setting of user password is '0' (inactive). Enter any integer number between 1 and 65,535.
- **Change user password**

  Enter the existing user password and then modify to the value of any integer number between 1 and 65,535.
- **Clear user password**

  Enter the existing user password and modify to ‘0’ to deactivate the password protection. If the super user password is entered the user password will be cleared directly.

When a user password is set all parameters can only be changed if the correct password (user or manufacturer) was input by the user. Parameter b0.00 can always be changed as this just changes the view, but does not allow other parameters to be changed.

If the user password can’t be remembered anymore or was set by accident, our service department can help with a super user password.

User password protection does not affect frequency adjustment with Up and Down buttons in running status or frequency saving.

After a boot process the password protection will be active if the password protection is activated.

12.1.6 High Frequency Mode

This parameter allows to switch between two frequency modes: low frequency mode and high frequency mode.

Code	Name	Setting range	Default	Unit	Step	Attri.	Device
b0.22	Device frequency mode	0: Low frequency mode 1: High frequency mode	1	-	1	Stop	VFC3610 3P 0.4...22kW EFC5610 3P 1.5...45kW

- **Low frequency mode**

  In low frequency mode, device can reach up to 400 Hz. Resolution of frequency parameters is 2 decimals in this mode. Range of E0.08 parameter is 50.00 to 400.00 Hz.

- **High frequency mode**

  In high frequency mode, device can reach up to 1000 Hz. Resolution of frequency parameters is 1 decimal in this mode. Range of E0.08 parameter is 50.00 to 1000.0 Hz.

☞ VFC3610 3P 0.4...22kW

- b0.22 will not be reset to defaults when factory resets is done (b0.10=1).
- High frequency mode only works in V/F control mode.

12.2 C0: Power Control

12.2.1 Control Mode Selection

This function is used to select control mode for EFC 5610.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.00	Control mode	0: V/f control 1: Sensorless vector control 2: Vector control with encoder	0	–	–	Stop

Setting range of C0.00:

- 0: V/f control

  Used for pump and fan applications and other application without high requirement for the load, it also can be used for the application when one converter drives more motors.

  With this control mode C2-group parameters are used for configuration.

- 1: Sensorless vector control*

  Used for application which require higher performance control, one converter can only drive one motor.

  With this control mode C3-group parameters are used for configuration.

- 2: Vector control with encoder*

  Used for application which require high speed or torque control accuracy, one converter can only drive one motor.

  Can be activated only if an encoder card is mounted to the frequency converter.

  With this control mode C3-group parameters are used for configuration.

(1) Synchronous motor control is only active with sensorless vector control for EFC 5610.

(2) *: The functions of sensorless vector control, vector control with encoder and synchronous motor control are not suitable for 1 kHz model.

(3): Vector control with encoder mode(C0.00=2) not support synchronous motor with ABZ encoder.

12.2.2 Normal Duty / Heavy Duty Setting

This function is used to set duty rating according to the load type of application.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.01	Normal / Heavy duty setting	0: Normal duty (ND) 1: Heavy duty (HD)	1	–	–	Stop

For some light load application, it is possible to use a lower power size frequency converter to drive a higher power size motor with normal duty setting.

- After parameter initialization the device and motor settings will be set to HD mode
- Switching from HD to ND will cause motor parameters reset to default value of normal duty, and vice versa.
- Switching from HD to ND will cause carrier frequency reset to default value of normal duty, and vice versa.

☞ This function is only available for 5.5kW and above devices.

Overload capability and output current in ND and HD modes are shown as below:

Overload (%)	HD	ND
110	-	200
120	400	60
130	149	22
140	88	13
150	60	10
160	42	-
170	13	-
180	3.2	-
190	1.5	-
200	1.0	-

12.2.3 Carrier Frequency Setting

This function is used to set proper carrier frequency for drive.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.05	Carrier frequency	DOM	DOM	kHz	1	Run
C0.06	Carrier frequency automatic adjustment	0: Adjustment with temperature inactive 1: Adjustment with temperature active 2: Fixed carrier frequency	1	–	–	Stop

C0.05 setting range and default:

Product	Model	Setting range	Default	
			HD	ND
EFC x610	0K40...4K0	1...15 kHz	6 kHz	-
	5K50...22K0	1...15 kHz	6 kHz	4 kHz
	30K0...90K0	1...12 kHz	4 kHz	4 kHz
	110K...160K	1...12 kHz	2 kHz	2 kHz

Tab. 12-4: C0.05 setting range and default

☞ For SVC mode, the actual highest carrier frequency is 10kHz, even though the setting value is higher

The influence of carrier frequency on heat dissipation, noise level, and leakage current and interference is shown as below:

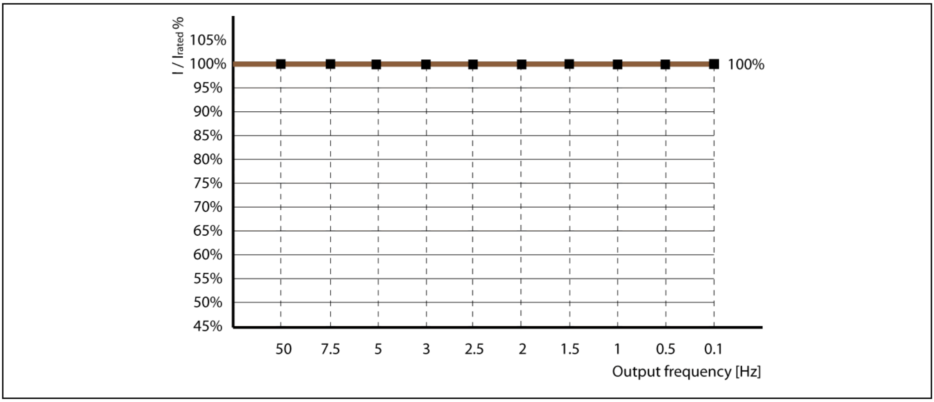
	Heat dissipation	Noise	Leakage current and interference
Higher carrier frequency	Higher	Lower	Higher
Lower carrier frequency	Lower	Higher	Lower

Tab. 12-5: Influence of carrier frequency

With C0.06 = 1, the carrier frequency will be changed automatically to keep the power module temperature within a normal range, but this could cause motor noise swing.

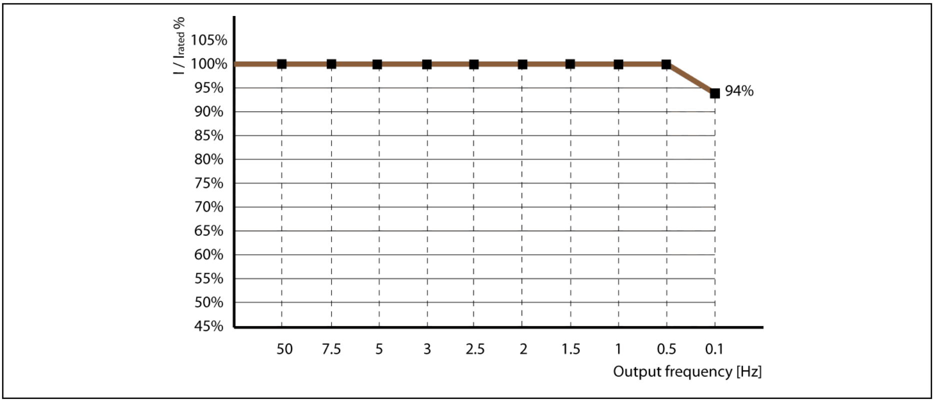
With C0.06 = 2, the carrier frequency is always fixed to C0.05.

Derating figures for the output power are shown as the figures below:



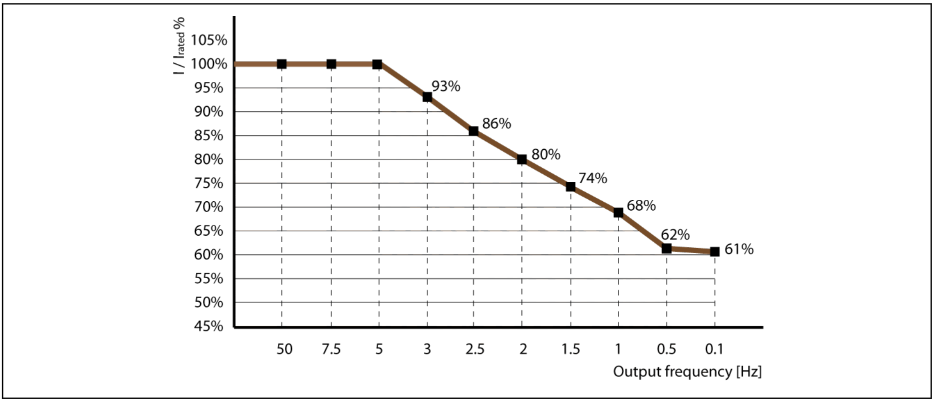
I / I_{rated} % Percentage of rated output current

Fig. 12-3:



I / I_{rated} % Percentage of rated output current

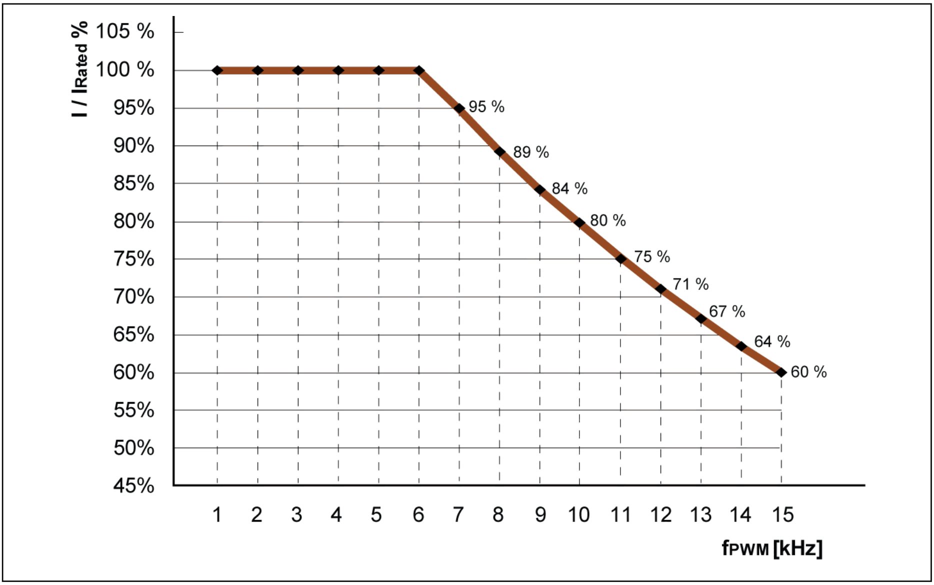
Fig. 12-4:



I / I_{rated} % Percentage of rated output current

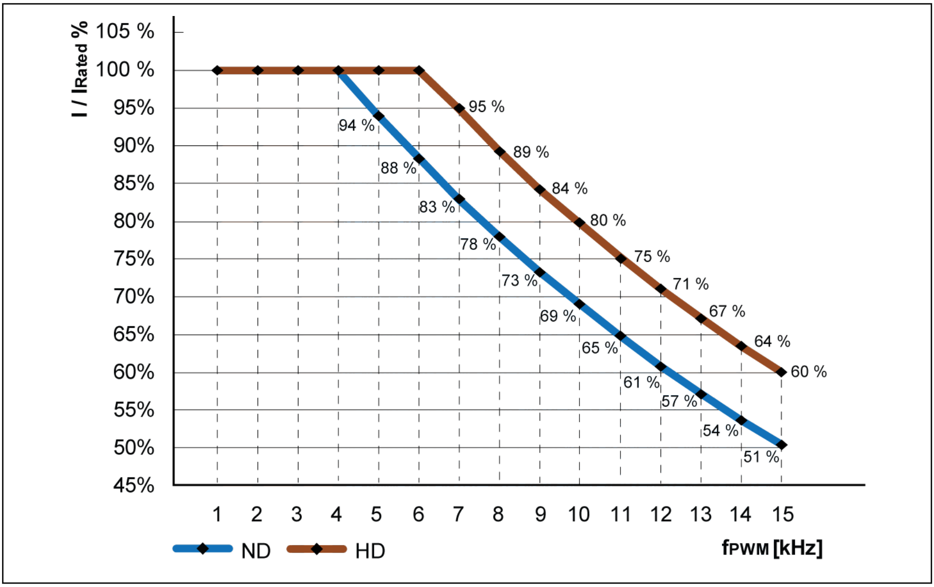
Fig. 12-5:

Derating figures related to carrier frequency are shown as the figures below:



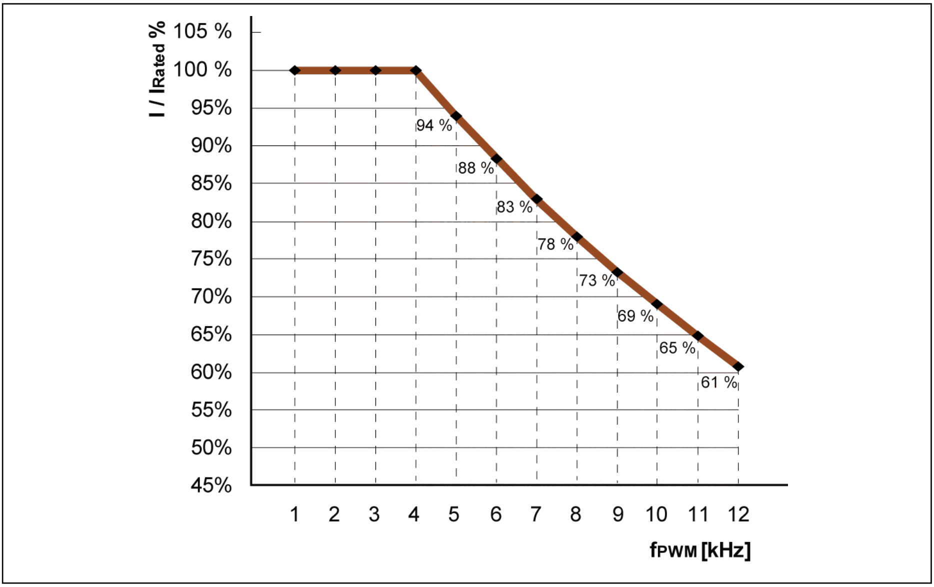
I / I_{rated} % Percentage of rated output current
f_{PWM} PWM or carrier frequency

Fig. 12-6: Derating and carrier frequency for 0K40...4K00 models



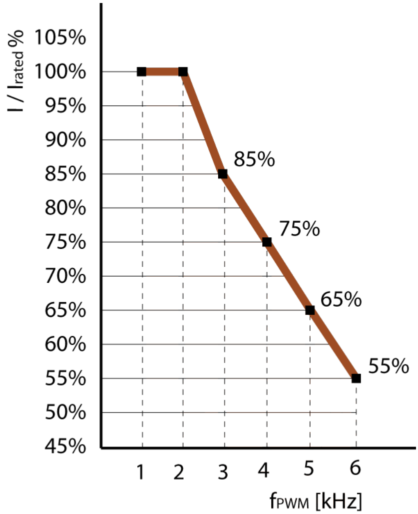
I / I_{rated} %	Percentage of rated output current	ND	Normal Duty
f_{PWM}	PWM or carrier frequency	HD	Heavy Duty

Fig. 12-7: Derating and carrier frequency for 5K50...22K0 models



I / I$_{rated}$ % Percentage of rated output current
f$_{PWM}$ PWM or carrier frequency

Fig. 12-8: Derating and carrier frequency for 30K0...90K0 models (Normal Duty and Heavy Duty)



I / I_{rated} % Percentage of rated output current
f_{PWM} PWM or carrier frequency

Fig. 12-9: Derating and carrier frequency for 110K...160K models (Normal Duty and Heavy Duty)

- C0.06 = 0 or 1: when output frequency is lower than 10Hz, the carrier frequency will be reduced automatically.
- C0.06 = 2: the carrier frequency is constant and will not change according to temperature and frequency.
- To achieve optimized performance, the carrier frequency setting should follow the equation: [C0.05] ≥ 10 x [E0.08].

12.2.4 PWM Mode

This function is used to set the PWM mode for drive.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.07	PWM mode	0: SVPWM 1: SVPWM with Overmodulation 2: DPWM 3: DPWM with Overmodulation	DOM	–	–	Run
C0.08	DPWM switchover frequency upper limit	8.00...400.00	12.00	Hz	0.01	Run

C0.07 Setting range and default:

Model	Setting range	Default
0K40...22K0	0...1	0
30K0...160K	0...3	0

SVPWM mode is 7 segment continuous modulation, this mode has higher switching losses and lower current ripple.

DPWM mode is 5-segment discontinuous modulation, this mode has lower switching losses and higher current ripple, but may cause the motor not stable when higher output frequency.

In the overmodulation range, the converter can increase the output voltage by increasing the utilization rate of DC bus voltage.

Only in DPWM modes the parameter C0.08 is active. If the output frequency with slip compensation is above this limit then the DPWM mode is active.

☞ Selecting overmodulation doesn't mean that the output voltage is directly increased in all cases. If overmodulation is selected then the final output voltage is only increased if it is needed from demanded output voltage. In that case the overmodulation can provide a further increase of output voltage. But the output voltage is no longer sinusoidal.

This may cause more current distortion or noise effects.

12.2.5 Automatic Voltage Stabilization

This function is used to keep the output voltage constant within the output capability, when the rated voltage deviation is inputted.

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Unit</th><th>Step</th><th>Attri.</th></tr>
<tr><td>C0.10</td><td>Automatic voltage stabilization</td><td>0: Always active
1: Always inactive
2: Inactive only during deceleration</td><td>0</td><td>–</td><td>–</td><td>Stop</td></tr>
<tr><td rowspan="3">C0.11</td><td rowspan="3">Automatic voltage stabilization reference voltage</td><td>1P200 VAC: 180...264 V</td><td rowspan="2">220</td><td rowspan="3">V</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P200 VAC: 180...264 V</td></tr>
<tr><td>3P380 VAC: 323...528 V</td><td>380</td></tr>
</table>

Setting range of C0.10:

- **0: Always active**

  Constant voltage control is enabled, the converter will automatically control the output voltage within motor rated voltage, and the output voltage will not be higher than motor rated voltage.

- **1: Always inactive**

  Constant voltage control is disabled, then the output voltage will be in direct proportion to the input voltage.

- **2: Inactive only during deceleration**

  Constant voltage control is disabled during deceleration. This function can effectively reduce the 'OE' error for fast deceleration application.

In some application which require quick stop, automatic voltage stabilization function should be closed (C0.10 = 1 or 2). In this case the motor is in generation mode, braking torque produced by regeneration voltage will be helpful for the motor quick stop, so that over voltage error can be avoided, then in deceleration process, when DC-bus voltage is higher than the reference voltage set by C0.11, the output voltage will be higher, but it may cause motor overheat.

- When C0.10 = 1 or 2, output voltage might be higher than motor rated voltage.
- C0.11 is only active when C0.10 =1 or 2, it should be set according to mains voltage.

12.2.6 Brake Chopper Control

This function is used to get better braking performance via braking resistor.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.15	Brake chopper start voltage	1P 200 VAC: 300...390 V	385	V	1	Stop
		3P 200 VAC: 300...390 V				
		3P 380 VAC: 600...785 V	770			
C0.16	Brake chopper duty cycle	1...100%	220	–	1	Stop

Brake chopper control:

- Enable resistor braking function by setting [C0.25] = 2 or 3.
- Set braking start voltage via [C0.15] according to power supply and load inertia. When DC-bus voltage is higher than [C0.15], the brake chopper switches on / off according to the duty [C0.16] with an internal hysteresis.
- Set braking duty cycle via [C0.16] according to actual application, excessive low setting of [C0.16] may bring overvoltage error during braking.

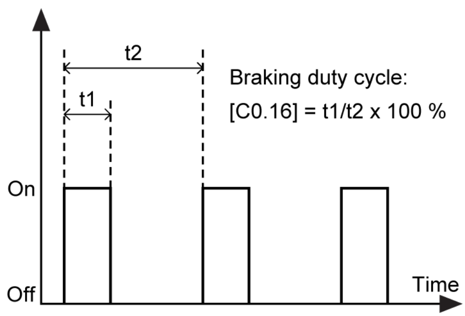


Fig. 12-10: Braking duty cycle

t1 = t2 x [C0.16] / 100 %; t2 = 1 / 100 Hz = 10 ms

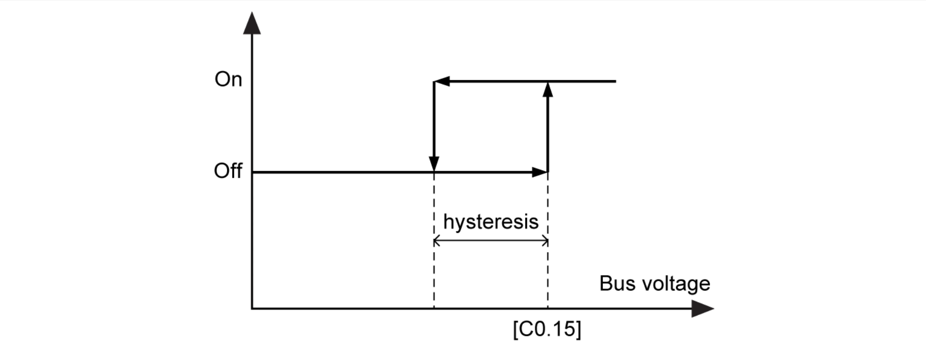


Fig. 12-11: Hysteresis

The hysteresis for different models is as listed below:

- 1P 200 VAC / 3P 200 VAC: 10 V
- 3P 380 VAC: 15 V

☞ For power size >= 30 kW, there is no internal brake chopper, [C0.15] and [C0.16] are not visible.

12.2.7 Overvoltage suppression

This function is used to adjust the active slip compensation factor in order to match the higher mechanical speed due to reciprocating load characteristic.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.23	Overvoltage suppression adjustment gain	0.00...10.00	1.00	–	0.01	Run

Basic principle of reciprocating load application:

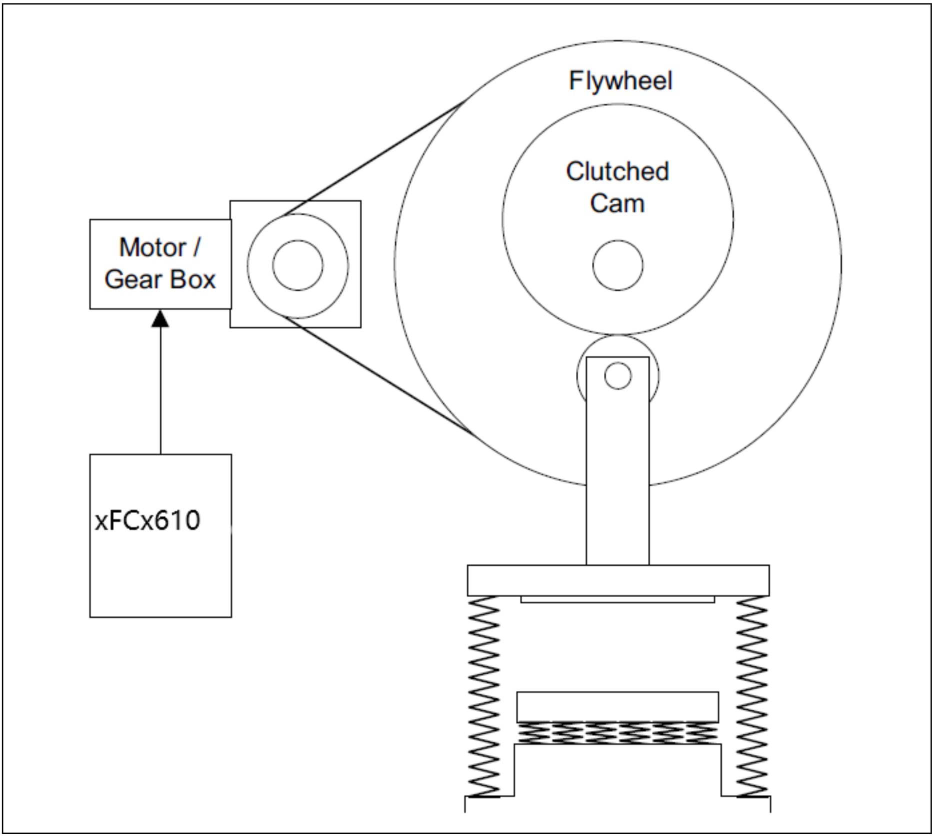


Fig. 12-12: Basic principle of reciprocating load

The character of load torque is kind of sine wave:

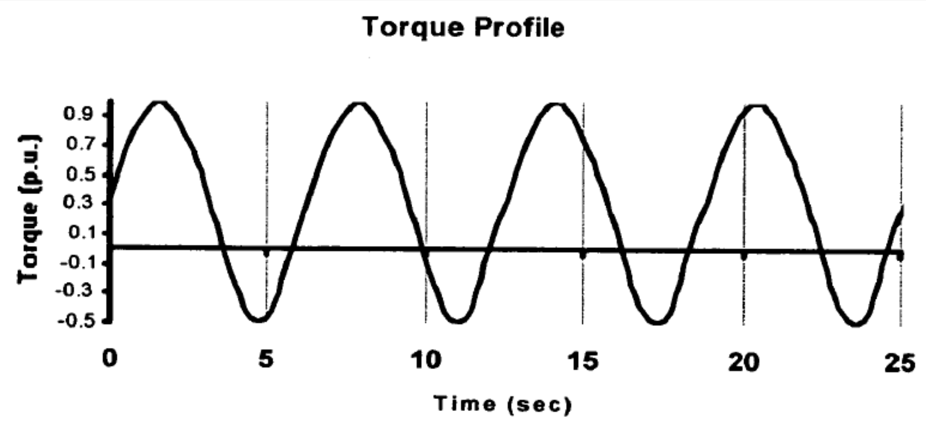


Fig. 12-13: Torque profile of reciprocating load

From the torque profile, the drive will work partly at motoring mode and partly at generating mode. In generating mode, the drive tends to be overvoltage of DC bus capacitor, in order to suppress the overvoltage, actual output frequency to the motor has to be adapted with the load torque.

In EFCx610, this is realized by adjusting the effective slip compensation factor when in generating mode via C0.23, so the resulting slip compensation factor will be:

$$Factor_{slip\_comp} = \begin{cases} C2.07, & motoring\ mode \\ C0.23 * |C0.26 - Udc|, & generating\ mode \end{cases}$$

Fig. 12-14: Calculation formula

1. This overvoltage suppression mode only works in V/f control.
2. Proper parameters setting for C0.23 depends on the load. During commissioning, if the actual output frequency still can not catch up with real mechanical velocity which can trigger overvoltage error, E0.08 and E0.09 might be adjusted since these will limit the actual output frequency.
3. This overvoltage suppression function cannot be used to shorten the actual deceleration time on application with large loads, so it is strongly recommended to set stop mode (E0.50) to 1 (freewheeling to stop 1).
4. This overvoltage suppression mode is **NOT** active when the output frequency is at upper limit (E0.09). This is because this function needs frequency space room to adjust.

12.2.8 Overvoltage Prevention Mode

This function is used to select proper mode to prevent overvoltage during deceleration caused by heavy load or too short deceleration time.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.25	Overvoltage prevention mode	0…4	3	–	1	Stop

Setting range:

- 0: Stall overvoltage protection is disabled, resistor braking is disabled.
- 1: Stall overvoltage protection is enabled, adjust protection level via [C0.26], resistor braking is disabled.
- 2: Stall overvoltage protection is disabled, resistor braking is enabled, adjust braking start voltage and duty cycle via [C0.15] and [C0.16].
- 3: Both stall overvoltage protection and resistor braking are enabled.
- 4: Reciprocating load mode, used when the drive controls rotating machinery where part of the machine's cycle creates a cyclic regenerative (over-hauling) load, adjust overvoltage suppression adjustment gain via [C0.23].

☞

- Please select freewheeling to stop when this function is activated.
- This function is only used for V/f control.

12.2.9 Stall Overvoltage Prevention

This function is used to automatically adjust the deceleration process to prevent over voltage error.

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Unit</th><th>Step</th><th>Attri.</th></tr>
<tr><td rowspan="3">C0.24</td><td rowspan="3">Stall overvoltage hysteresis voltage</td><td rowspan="3">0...100 V</td><td>1P 200 VAC: 30</td><td rowspan="3">V</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 30</td></tr>
<tr><td>3P 380 VAC: 50</td></tr>
<tr><td rowspan="3">C0.26</td><td rowspan="3">Stall overvoltage prevention level</td><td>1P 200 VAC: 300...390 V</td><td rowspan="2">385</td><td rowspan="3">V</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 300...390 V</td></tr>
<tr><td>3P 380 VAC: 600...785 V</td><td>770</td></tr>
</table>

Enable the function by setting [C0.25] =1 or 3.

With this function, the frequency converter detects the DC-bus voltage and compare it with [C0.26] during deceleration:

- [DC-bus voltage] > [C0.26]: Output frequency stops decreasing
- [DC-bus voltage] < [C0.26] - [C0.24]: Output frequency resumes decreasing

The typical behavior of stall overvoltage prevention is shown as the figure below:

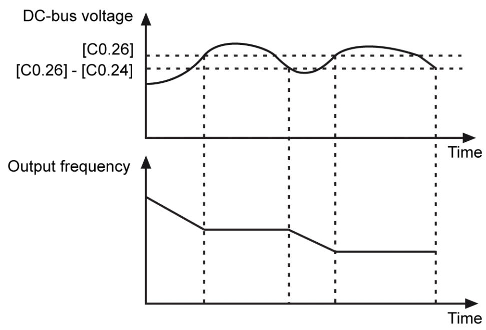


Fig. 12-15: Stall overvoltage prevention during deceleration

☞ Enable stall overvoltage prevention function may cause the actual deceleration time is longer than expected. If the deceleration time needs to be accurate only resistor braking should be used.

12.2.10 Stall Overcurrent Prevention

This function is used to prevent the frequency converter from overcurrent when the load is excessively heavy or the acceleration time is excessively short. This function is always active during acceleration or at constant speed.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.27	Stall overcurrent prevention level	20.0...[C2.42]	150.0	-	0.1	Stop

This function is always enabled and only controlled by the setting current level.

With this function, the frequency converter detects the output current and compares it with the level set in [C0.27] during acceleration and at constant speed:

- [Output current] > [C0.27]

  Output frequency stops increasing during acceleration or decreases with the set deceleration time at constant speed.

- [Output current] < [C0.27]

  Output frequency resumes increasing during acceleration or increases back to the setting frequency with the set acceleration time at constant speed.

Behavior of stall overcurrent prevention during acceleration is shown as the figure below:

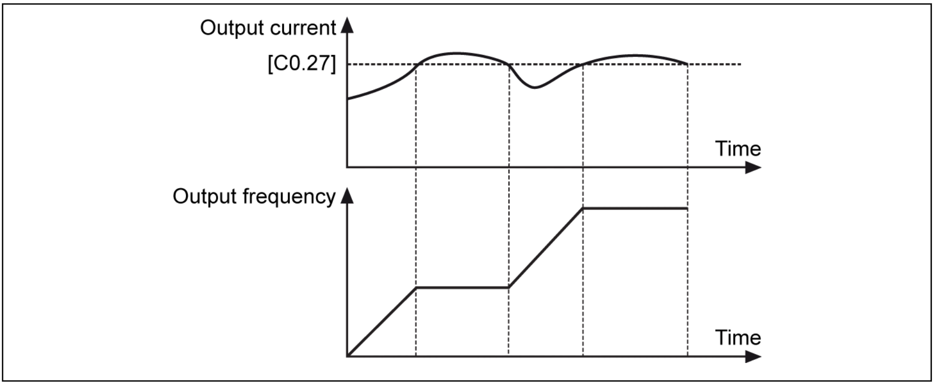


Fig. 12-16: Stall overcurrent during acceleration

- [Output current] > [C0.27]

  The output frequency stops increasing.

- [Output current] < [C0.27]

  The output frequency resumes increasing to the setting frequency with defined acceleration time.

Behavior of stall overcurrent at constant speed is shown as the figure below:

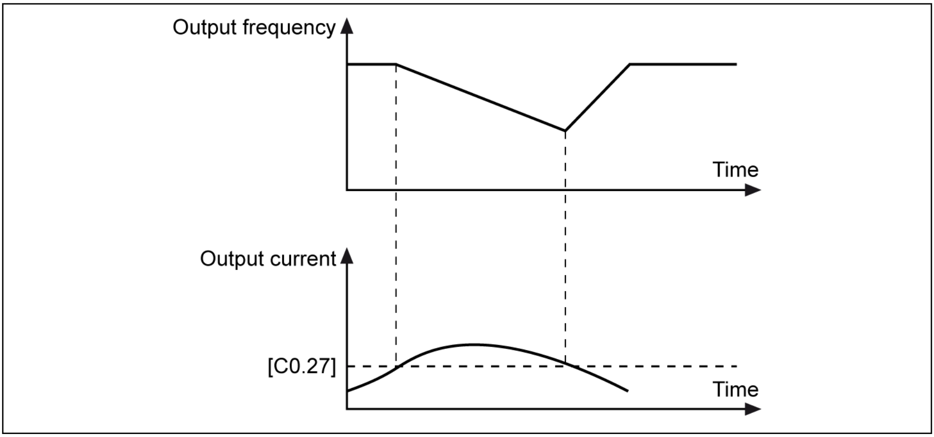


Fig. 12-17: Stall overcurrent at constant speed

- [Output current] > [C0.27]

  The output frequency decreases till the output current is lower than [C0.27] with defined deceleration time.

- [Output current] < [C0.27]

  The output frequency increases to the setting frequency with defined acceleration time.

☞ This function can have influence on the speed accuracy during constant running and on the acceleration performance.

12.2.11 Phase Loss Protection

This function is used to detect input or output phase losses.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.28	Phase loss protection mode	0...3	3	-	-	Run

Setting range:

- 0: Both input and output phase loss protection active
- 1: Only input phase loss protection active
- 2: Only output phase loss protection active
- 3: Both input and output phase loss protection inactive

Phase loss protection will detect missing phases in the input or output line. Input phase loss detection will protect the converter power stage from overload, output phase loss detection will protect the motor phases from overload.

Both input and output phase loss protection will only work if the converter is in RUN state.

An input phase loss can also be triggered by line voltage imbalance or deterioration of DC-bus capacitors. The input phase loss cannot be detected in the following conditions:

- The output current is lower than 30 % of converter rated current
- During motor deceleration

The output phase loss has a dead zone in the following cases:

- The output frequency is lower than 1.00 Hz
- During DC-braking
- During restarting with speed capture
- During motor parameters auto-tuning
- Wrong settings of parameter C1.07 "Motor rated current"

Input phase loss protection only works on 3x400V devices.

12.2.12 Converter Overload Pre-Warning

Converter overload pre-warning will be notified if the load for the converter is too high for a defined time.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.29	Converter overload pre-warning level	20.0...200.0	110.0	-	0.1	Stop
C0.30	Converter overload pre-warning delay	0.0...20.0	2.0	s	0.1	Stop

When the frequency converter output current is higher than [C0.29] "Converter overload pre-warning level" and lasts for longer than [C0.30] "Converter overload pre-warning delay", the "Converter overload pre-warning" signal will be active on the selected digital output terminal. The signal will be immediately inactive when the output current is lower than [C0.29].

Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.01, H9.02, H9.03 can be set to "11: Converter overload pre-warning" to configure the digital outputs to show this warning.

Behavior of converter overload pre-warning is shown as the figure below:

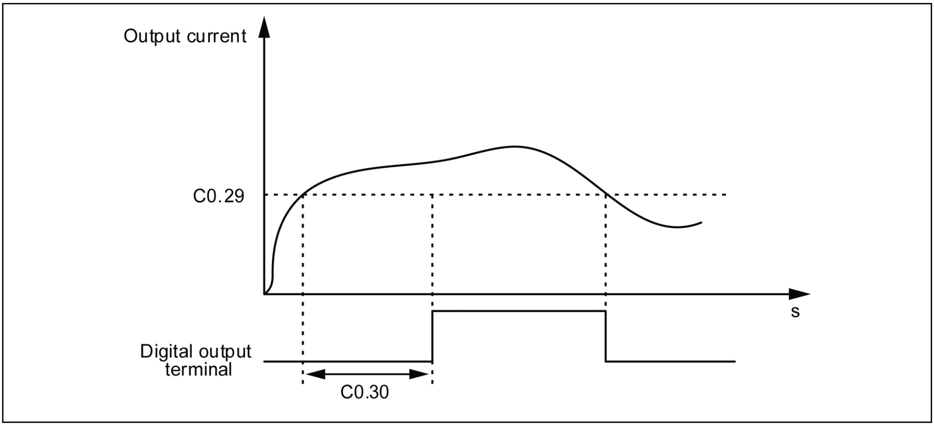


Fig. 12-18: Converter overload pre-warning

The actual overload pre-warning level will be reduced by the carrier frequency output current derating by the equation:

[Actual overload pre-warning level] = [C0.29] x [Derating percentage]

This derating percentage can be found in the hardware specification for each device.

12.2.13 Power Loss Ride-Through

This function is helpful for continuing running of frequency converter when temporary power loss occurs.

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Unit</th><th>Step</th><th>Attri.</th></tr>
<tr><td>C0.40</td><td>Power loss ride-through mode</td><td>0: Inactive
1: Output disabled
2: Regain kinetic energy
3: Regain kinetic energy, decelerate to stop</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>C0.41</td><td>Power loss ride-through recovery delay</td><td>0.10...30.00 s</td><td>0.50</td><td>s</td><td>0.01</td><td>Stop</td></tr>
<tr><td rowspan="3">C0.42</td><td rowspan="3">Power loss ride-through action voltage</td><td>1P 200 VAC: 216...366 V</td><td rowspan="2">240</td><td rowspan="3">V</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 216...366 V</td></tr>
<tr><td>3P 380 VAC: 406...739 V</td><td>440</td></tr>
<tr><td rowspan="3">C0.43</td><td rowspan="3">Power loss ride-through recover voltage</td><td>1P 200 VAC: 223...373 V</td><td rowspan="2">250</td><td rowspan="3">V</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 223...373 V</td></tr>
<tr><td>3P 380 VAC: 413...746 V</td><td>450</td></tr>
<tr><td>C0.44</td><td>Power loss ride-through deceleration time</td><td>0.1...6000.0 s</td><td>5.0</td><td>s</td><td>0.1</td><td>Stop</td></tr>
</table>

When AC power is lost or not stable for a short time, the frequency converter will enter the power fault ride-through mode as long as the DC-bus voltage is still maintained stable:

- For 1P 200 VAC, DC-bus voltage is above 180 V
- For 3P 380 VAC, DC-bus voltage above 370 V

The power fault ride-through operation will be decided by the selected options as below:

1. The frequency converter output will be switched off

   When the power supply resumes, the frequency converter will execute speed capture and resume its previous operation, example for 3-Phase Device actual minimum action voltage and recover voltage:

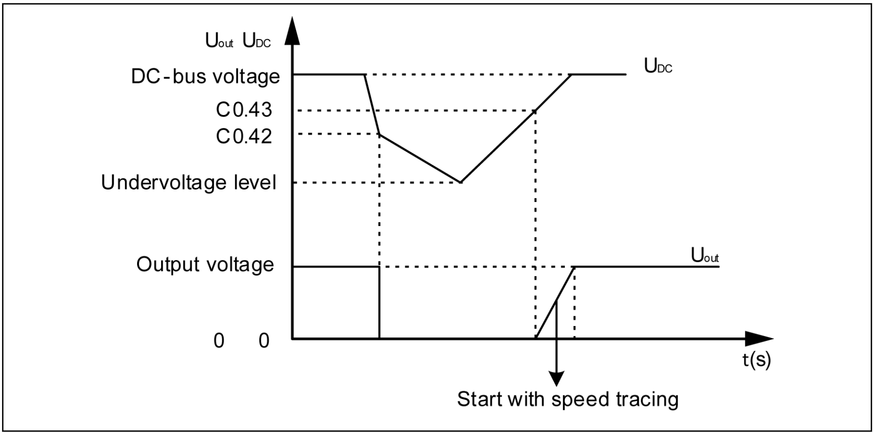


Fig. 12-19: Power loss ride-through mode 1

2. The frequency converter will decrease the output frequency to regain the kinetic energy from the rotating motor, to stabilize the DC bus voltage

   When DC bus voltage is recovered, then converter output frequency will rise again and converter will enter the normal running mode, example for 3-phase device actual minimum action voltage and recover voltage:

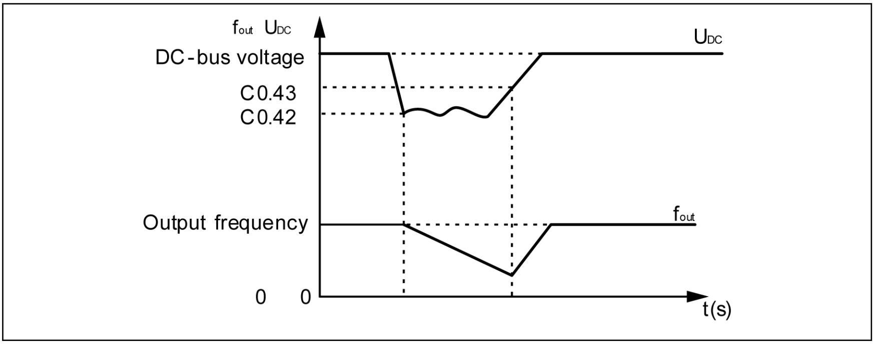


Fig. 12-20: Power loss ride-through mode 2

3. The frequency converter regains kinetic energy from the motor in generator mode with a defined ramp (defined by deceleration time [C0.44] which is the time from [E0.08] to 0Hz). Even when the power supply comes up again before the kinetic energy is consumed the drive will continue to decelerate down to stop. When the kinetic energy is consumed and the drive reaches the power fail voltage level the drive will be shut down, example for 3-phase device actual minimum action voltage and recover voltage:

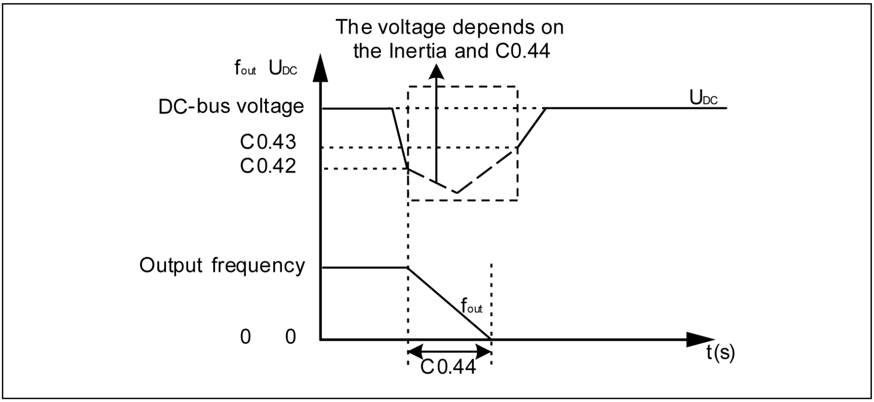


Fig. 12-21: Power loss ride-through mode 3

When option 3 is selected, special care must be taken by configuration of the deceleration time. If the time is too short overvoltage will occur. If the time is too long undervoltage will occur. For overvoltage a braking resistor may be used.

12.2.14 Fan Control and Maintenance

This function is used to set the running mode of both the fan for the heat sink and the capacitor fan, and to remind users maintaining the fan for the heat sink in time. The maintenance time can be set according to the actual application conditions.

Code	Name	Setting range	Default	Unit	Step	Attri.
C0.50	Fan control	0: Automatically controlled 1: Always on 2: On when converter run	0	-	-	Run
C0.51	Fan total running time	0...65,535 h	0	h	1	Read
C0.52	Fan maintenance time	0...65,535 h (0: Inactive)	0	h	1	Stop
C0.53	Fan total running time reset	0: Inactive 1: Active Reset to '0' after action is executed	0	-	-	Run

Setting range:

- **C0.50 = 0: Automatically controlled**

  The fan for the heat sink is by default switched on / off automatically according to the temperature of the heat sink. In this mode, the noise level of the frequency converter can be reduced.

- **C0.50 = 1: Always on**

  The fan for the heat sink and the fan for electrolytic capacitor are switched on and running all the time once the frequency converter is powered on. In this mode, a better cooling performance of the frequency converter can be achieved.

- **C0.50 = 2: On when converter run**

  The fan for the heat sink and the fan for electrolytic capacitor on when converter runs, and off when converter stops.

To use the fan maintenance reminder function, take the following steps:

Step 1: Set the maintenance time of the fan properly

Set parameter C0.52 'Fan maintenance time' according to the actual application conditions.

Step 2: Observe the fan lifetime status at warning

When [C0.51] 'Fan total running time' is higher than [C0.52] 'Fan maintenance time', a warning code 'FLE' (Fan maintenance period expired) is displayed on the operating panel.

- Pause the display of the warning code 'FLE' by pressing the <Func> button.
- Perform fan maintenance or replacement.

Step 3: Reset the fan lifetime counter after fan maintenance or replacement

- Set parameter C0.53 'Fan total running time reset' to '1: Active'.

After the execution, [C0.53] and [C0.51] will be reset to '0' automatically. By now, the warning code 'FLE' is cleared completely.

- Adjust the value of C0.52 'Fan maintenance time' if necessary.

☞ If C0.50 = "0: Automatically controlled", when the converter runs, the fan for electrolytic capacitor is switched on; When the converter stops, the fan for electrolytic capacitor is switched off.

12.3 C1: Motor and System

12.3.1 Motor Type Selection

This function is used to select which type of motor is connected.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.00	Motor type	0: Asynchronous motor 1: Synchronous motor	0	–	–	Stop

- Synchronous motor is only for EFC 5610.
- After setting C1.00 to '1', the parameter C0.00 (the control mode) will be modified automatically to '1', and user can modify C0.00 to '2' manually.

12.3.2 Motor Parameter Tuning

The auto-tuning function will determine the motor parameters and adjust the control accordingly.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.01	Motor parameter tuning	0: Inactive 1: Static auto-tuning 2: Rotational auto-tuning	0	-	-	Stop
C1.02	Expert mode	0: Standard mode 1: Expert mode	0	-	-	Stop

- C1.02 = 0: every change of a motor parameter leads to a recalculation based on the ascending rule.
- C1.02 = 1: Only for commissioning by manufacturer.

The application level and setting order of motor parameters

As shown in the table below, the motor control parameters are divided into 4 application levels that are interrelated on certain computational basis. In the process of parameter setting, the level attribute is a defining factor for the setting of the parameter value.

Code	Name	Level
C0.00	Control mode	Top level
C0.01	Normal / Heavy duty setting	
C1.00	Motor type	
C1.01	Motor parameter tuning	

Code	Name	Level
C1.05	Motor rated power	Nameplate level
C1.06	Motor rated voltage	
C1.07	Motor rated current	
C1.08	Motor rated frequency	
C1.09	Motor rated speed	
C1.10	Motor rated power factor	
C1.11	Motor poles	
C1.12	Motor rated slip frequency	Physical parameter level
C1.13	Motor inertia mantissa	
C1.14	Motor inertia exponent	
C1.15	Torque constant	
C1.20	Motor no-load current	
C1.21	Stator resistance	
C1.22	Rotor resistance	
C1.23	Leakage inductance	
C1.24	Mutual inductance	
C1.25	Rotor leakage inductance	
C2.43	Current limitation proportional gain	Control parameter level
C2.44	Current limitation integral time	
C3.00	Speed loop proportional gain 1	
C3.01	Speed loop integral time 1	
C3.02	Speed loop proportional gain 2	
C3.03	Speed loop integral time 2	
C3.05	Current loop proportional gain	
C3.06	Current loop integral time	

Tab. 12-6: The application level of motor parameters

The user shall follow the order as specified below to set or modify the parameters if it is needed, Top level -> Nameplate level -> Physical parameter level -> Control parameter level.

Taking the example of SVC control for asynchronous motor, the user shall first set top level parameters, C0.00, C0.01 and C1.00, and next set the nameplate level parameters, C1.05...C1.10, and in the end execute parameter auto-tuning to acquire the parameters of physical parameter level and control parameter level.

If the user does not conform to the order as specified above, this would cause undesired change to the parameter setting.

For example, if by applying the parameter auto-tuning function, the user goes first to set the parameters of physical parameter level and control parameter level, and next execute the modify to the parameters of top level or nameplate level. After all, this would activate the internal computation function of motor parameters that end up with the change to the parameters of physical parameter level and control parameter level, namely the parameters defined after C1.12.

Auto-tuning of Motor Parameters

Check and make sure the following points before auto-tuning:

- The motor is in standstill and not at high temperature.
- The power rating of the frequency converter is close to that of the motor.
- For permanent magnetized synchronous motor, set C1.05, C1.07, C1.09, C1.11 based on motor nameplate data. C1.08 will be calculated by tuning, user can also set this parameter.

  If motor poles is unavailable on the nameplate, it can be calculated by **p = 60 f / n** (p: pole pairs; f: motor rated frequency; n: motor rated speed)
- For asynchronous motor, set C1.05...C1.09 based on motor nameplate data.
- If the power factor data is unavailable on the nameplate, keep the default setting of C1.10.
- Set E0.08, E0.09 according to motor parameters and actual application conditions.

Set auto-tuning mode and start motor parameter auto-tuning:

- **C1.01 = 0: Inactive**

  Auto-tuning is by default inactive. If the function was used it will reset to this value after function is finished.
- **C1.01 = 1: Static auto-tuning**

  Static auto-tuning is recommended to use as standard for all applications using V/f control. For vector control it can be used in case the load can't be disconnected.
- **C1.01 = 2: Rotational auto-tuning**

  Rotational auto-tuning is recommended to use as standard for all applications using vector control. The load must be disconnected during rotational auto-tuning.

  If encoder card is installed for vector control with encoder, related encoder parameters need to be set:

  – If ABZ card is used, set H7.20 'Pulses per revolution of encoder' according to the encoder.

  – If resolver card is used, set H7.31 'Resolver poles' according the datasheet of resolver.

Press the **<Run>** button on the operating panel when the setting is finished for auto-tuning. In the process of auto-tuning, a status code 'tUnE' will be displayed on the operating panel. When the auto-tuning process is completed, the status code disappears and the settings of the following parameters will be obtained automatically:

Static auto-tuning	Rotational auto-tuning	Parameters obtained by auto-tuning
√	√	C1.12: Motor rated slip frequency **(Only for asynchronous motor)**
–	√	C1.13: Motor inertia mantissa
–	√	C1.14: Motor inertia exponent
√	√	C1.20: Motor no-load current
√	√	C1.21: Stator resistance
√	√	C1.22: Rotor resistance **(Only for asynchronous motor)**
√	√	C1.23: Leakage inductance
√	√	C1.24: Mutual inductance **(Only for asynchronous motor)**
√	√	C1.25: Rotor leakage inductance
√	√	C3.00: Speed loop proportional gain 1
√	√	C3.01: Speed loop integral time 1
√	√	C3.05: Current loop proportional gain
√	√	C3.06: Current loop integral time
–	√	C3.22: Encoder commutation offset **(Only for encoder card)**
–	√	H7.01: Encoder direction **(Only for encoder card)**

Tab. 12-7: Parameters obtained by auto-tuning

☞

- C1.01=2: Rotational auto-tuning is only for EFC 5610.
- Disconnect the load from the motor shaft for rotational auto-tuning.

12.3.3 Motor Name Plate Data

This function is about motor nameplate parameters configuration, most of motor data are available on the motor nameplate, based on which the following parameters of the frequency converter need to be set accordingly.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.05	Motor rated power	0.1...1,000.0 kW	DOM	kW	0.1	Stop
C1.06	Motor rated voltage	0...480 V	DOM	V	1	Stop
C1.07	Motor rated current	0.01...655.00 A (0.4...37 kW)	DOM	A	0.01	Stop
		0.1...6550.0 A (45 kW and above)			0.1	
C1.08	Motor rated frequency	5.00...400.00 Hz	50.00	Hz	0.01	Stop
C1.09	Motor rated speed	1...60,000	DOM	-	1	Stop
C1.10	Motor rated power factor	0.00...0.99	0.00	-	0.01	Stop
C1.11	Motor poles	2...256	4	-	1	Stop

The input of rating plate data must correspond with the wiring of the motor (star / delta). This means, if delta wiring is used for the motor, delta rating plate data has to be entered:

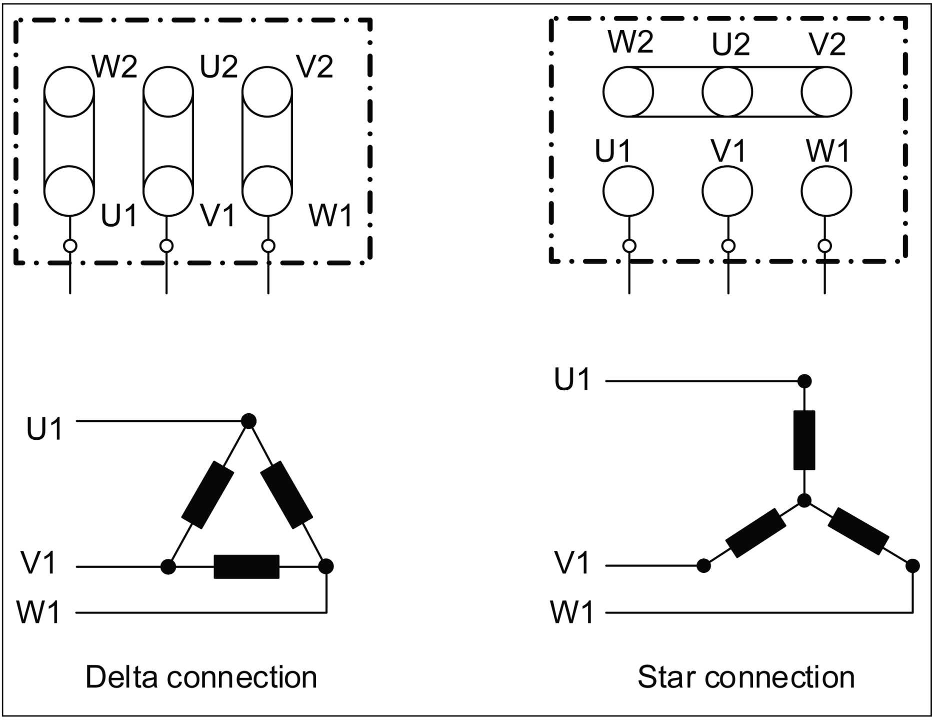


Fig. 12-22: Wiring of the motor

If the parameters above cannot be acquired from the motor nameplate. These parameters can be calculated according to the following steps or auto tuning. Only for synchrounus motors MSK. For the new MS2N motors the data can be find in the MS2N instruction manual.

1. Choose motor rated speed Nn as required.
2. Select "speed-torque" characteristic curve according to the actual working conditions, and derive torque Mn at the rated speed.
3. Rated power is calculated by Pn = (Mn x Nn x 2π) / 60.
4. Acquire torque constant km-n and number of pole pairs o from Rexroth motor instruction.
5. Rated current is calculated by In = Mn / (Km-n).
6. Rated frequency is calculated by fn = o x Nn / 60.
7. The number of motor poles equals to 2 x o.

Take the motor MSK071C-0450-NN as an example. The required motor rated speed is 1,500 rpm, motor works continuously and the housing temperature rise must not exceed 60 ℃. The parameters are calculated as follows.

According to the operation mode and temperature rise requirement, select S1 (60K) curve and derive Mn as 7.5 Nm, as shown in the following figure.

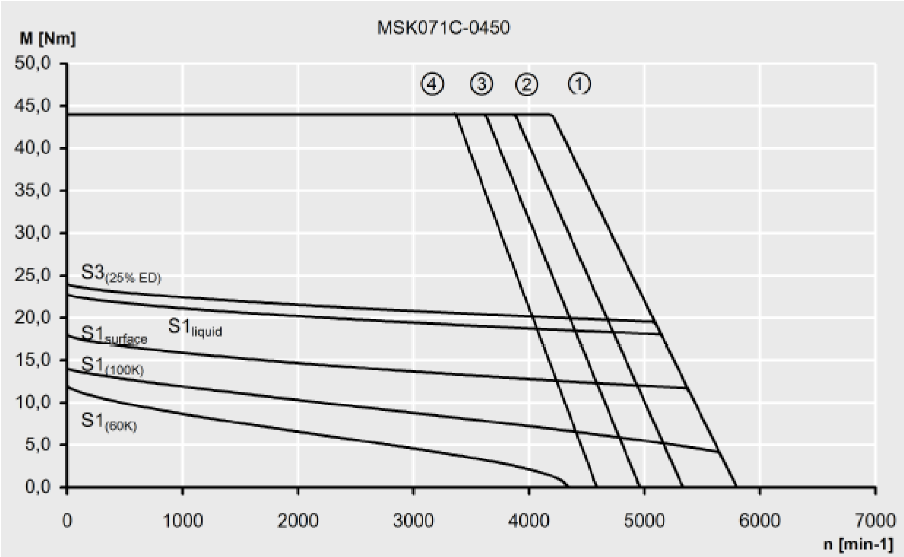


Fig. 12-23: Speed-torque characteristic curve

The torque constant Km-n of this motor is 1.49 Nm/A, the number of pole pairs o is 4.

Thus, the parameters can be calculated as:

Rated power is Pn = (Mn x Nn x 2π) / 60 = 1.2 kW

Rated current is In = Mn / (Km-n) = 5 A

Rated frequency is fn = o x Nn / 60 = 100 Hz

The number of pole pairs is 2 x o = 8

☞

- For the C1.09 'motor rated speed', do not put in the synchronous speed for an asynchronous motor.
- C1.10 = 0.00: Automatically identified; C1.10 = 0.01...0.99: Power factor setting.
- If the data for C1.10 'Motor rated power factor' is not available on the motor nameplate, keep its default setting '0.00: Automatically identified'. However, the rotational auto-tuning performance may be affected.

12.3.4 Motor Internal Data

This function is about motor internal data, which can be calculated internally or input by users.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.12	Motor rated slip frequency	0.00...60.00 Hz	DOM	Hz	0.1	Stop
C1.13	Motor inertia mantissa	1...5,000	DOM	-	1	Stop
C1.14	Motor inertia exponent	0...7	DOM	-	1	Stop
C1.15	Torque constant	0.01...200.00 Nm/A	DOM	Nm/A	0.01	Stop
C1.16	Back emf voltage constant	0.0 ... 6550.0 V/ 1000 min^{-1}	0.0	V/1000 min^{-1}	0.1	Read
C1.17	Motor rated torque	0.0...6553.5 N.m	DOM	N.m	0.1	Read
C1.20	Motor no-load current	0.00...[C1.07] A (0.4...37 kW)	DOM	A	0.01	Stop
		0.0...[C1.07] A (45 kW and above)			0.1	
C1.21	Stator resistance	0.00...50.00 Ω (0.4...37 kW)	DOM	Ω	0.01	Stop
		0.000...50.000 Ω (45 kW and above)			0.001	
C1.22	Rotor resistance	0.00...50.00 Ω (0.4...37 kW)	DOM	Ω	0.01	Stop
		0.000...50.000 Ω (45 kW and above)			0.001	
C1.23	Leakage inductance	0.00...600.00 mH	DOM	mH	0.01	Stop
C1.24	Mutual inductance	0.0...6,000.0 mH	DOM	mH	0.1	Stop
C1.25	Rotor leakage inductance	0.00...600.00 mH	DOM	mH	0.01	Stop

Motor rated slip frequency

By default, C1.12 (Motor rated slip frequency) will be set automatically according to the basic motor parameters. The value can be adjusted with the following equations:

- $n_s = f_n \times 60 / p$
- $s = (n_s - n_n) / n_s$
- $fs = s \times f_n$

n_s: synchronous speed; f_n: rated frequency

p: numbers of pole pairs; s: rated slip

n_n: rated speed; f_s: rated slip frequency

Motor no-load current

The actual no-load current is limited to be less than 75 % of the motor rated current.

Example

[C1.07] = 2.06, then set [C1.20] = 2.06, the actual setting value is 1.54.

Motor inertia mantissa and Motor inertia exponent

The inertia parameter C1.13 and C1.14 is defined as:

$J = [C1.13] \times 10^{-[C1.14]}$

J - Inertia, Unit: $Kg.m^2$

Accurate system inertia is important for achieving the optimal control performance. If by using the default inertia value fail to achieve the required control performance, the following three methods can be used to obtain the inertia value:

1. Run rotational auto-tuning (C1.01 = 2) and the motor inertia can be obtained automatically. This method is recommended if the motor is disconnectable from the load.
2. Look up for the inertia value on the nameplate of synchronous motor or in the datasheet of motor manufacturer.
3. If the inertia value is not available on the nameplate or in the datasheet, neither the motor load is removable that allows for the execution of the rotational auto-tuning, derive an estimated value according to the formula below and make fine tuning for better control effect.

   $J = \frac{1}{2} \times m \times r^2$

   m - Rotor weight of synchronous motor, unit: kg

   r - Rotor radius of synchronous motor, unit: m

   In case rotor weight and rotor radius are not available, the following formula can be used for rough estimation of inertia.

   $J = \frac{1}{2} \times k \times M \times R^2$

   M - Total weight of synchronous motor, unit: kg

   R - Stator radius of synchronous motor, unit: m

   k - Coefficient, generally ranging from 1/32 to 1/8. For compact motor, such as servo motor, a bigger value could be selected, while for general asynchronous motor, a smaller value may be more suitable.

Due to the fact that the actual inertia is not obtainable through static auto tuning, and additionally if the default inertia could not meet the control requirement, only method 2 and method 3 shall be used for identifying the inertia value.

☞ C1.13 and C1.14 are only available for EFC 5610.

12.3.5 Motor Thermal Model

This function is designed to protect the motor from over-temperature according internal thermal model.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.69	Motor thermal model protection setting	0: Inactive 1: Active	0	-	-	Stop
C1.74	Motor thermal model protection time constant	0.0...400.0 min	DOM	min	0.1	Stop

[C1.74] is obtained by the equation below:

$$[C1.74] = \frac{Cv * M}{9 * [C1.21] * [C1.07]^2 * 60}$$

Cv: Specific heat capacity (J/kg)
Cv of iron (Fe): 450 J/kg
Cv of aluminum (Al): 900 J/kg
M: Motor weight (kg)

Fig. 12-24: Motor thermal protection time constant

Increase the value of C1.74 'Motor thermal model protection time constant' appropriately if motor overload protection error code 'OL-2' occurs frequently. This function can be disabled by setting [C1.69] = 0, if necessary.

☞ Ensure that the converter output current does not exceed 110 % of the [C1.07] 'Motor rated current'.

Motor derating frequency at low speed

This function is used to reduce the overload and thermal risks as motors have worse cooling performance at low speed compared with it at rated speed.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.75	Low speed derating frequency	0.10...300.00	25.00	-	0.01	Run
C1.76	Zero speed load	25.0...100.0 %	25.0	-	0.1	Run

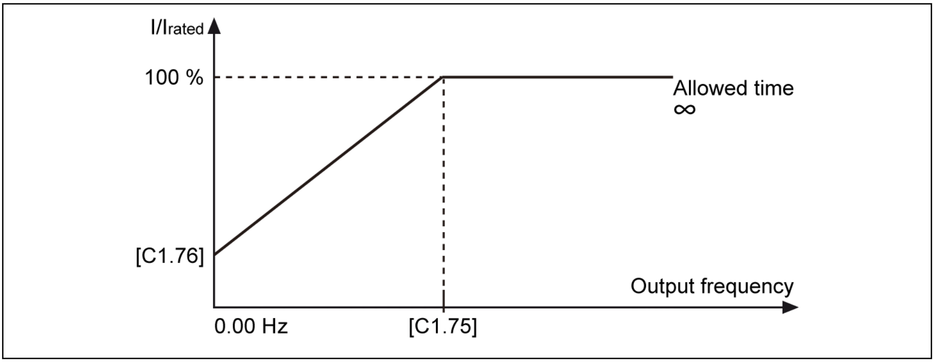


Fig. 12-25: Derating at low speed

- Low speed derating frequency

  When the output frequency is higher than [C1.75] 'Low speed derating frequency', the allowed continuous current is [C1.07] 'Motor rated current'.

  When the output frequency is lower than [C1.75], the allowed continuous current is reduced according to the above curve, with the lowest value to [C1.76] 'Zero speed load' at standstill.

- Zero speed load

  Zero speed load is the allowed continuous current (percentage of rated current) at standstill.

☞ For a motor with external cooling, [C1.76] 'Zero speed load' is set to 100 %, and the low speed derating function is inactive.

12.3.6 Motor Overload Pre-Warning

This function is used to monitor if the load for the motor is too high for a defined time, it will not lead to a device stop running but a digital output signal.

Code	Name	Setting range	Default	Unit	Step	Attri.	Device
C1.69	Motor thermal model protection setting	0: Inactive 1: Thermal model active 2: Current monitoring active	0	-	-	Stop	All
C1.70	Motor overload pre-warning level	100.0...250.0 %	100.0	-	0.1	Run	All
C1.71	Motor overload pre-warning delay	0.0...20.0	2.0	-	0.1	Run	All

- C1.69=0 or 1

  When the output current exceeds the threshold defined by C1.70 'Motor overload pre-warning level' and lasts for C1.71 'Motor overload pre-warning delay', the "Motor overload pre-warning" signal will be active on the selected digital output terminal. The signal will be immediately inactive when the output current is lower than [C1.71].

  Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.10, H9.02, H9.03 can be set to "12: Motor overload pre-warning" to configure the digital outputs to show this warning.

  Behavior of motor overload pre-warning is shown as the figure below:

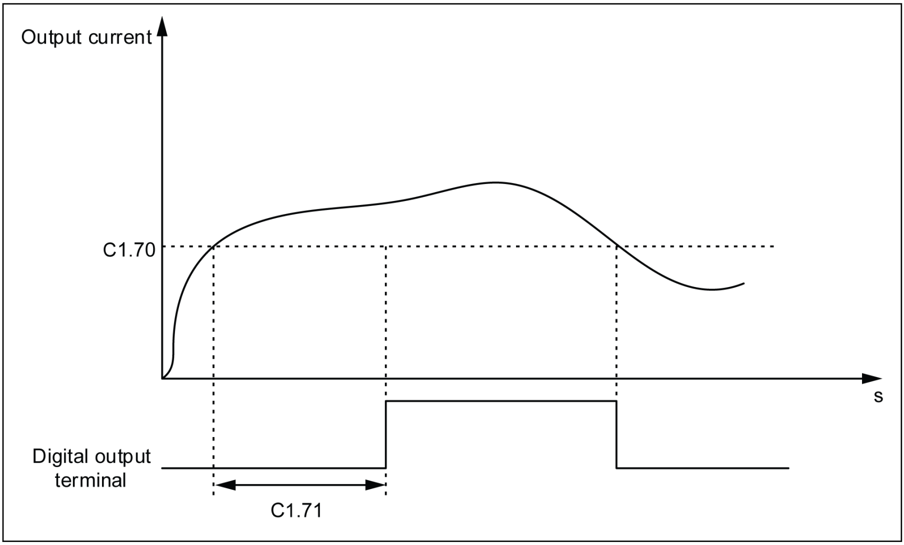


Fig. 12-26: Motor overload pre-warning

- C1.69=2

  When the output current exceeds the threshold defined by C1.70 'Motor overload pre-warning level' and lasts for C1.71 'Motor overload pre-warning delay', the device stops running and error OL-2 is displayed.

  Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.10, H9.02, H9.03 can be set to "14: Converter error " to configure the digital outputs to show this error.

  Behavior of motor overload pre-warning is shown as the figure below:

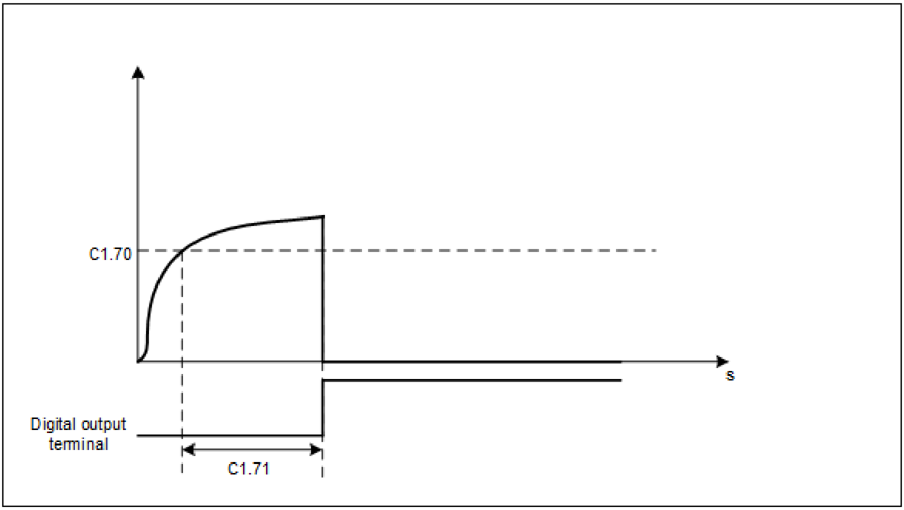


Fig. 12-27: Motor overload pre-warning

12.3.7 Motor Thermal Sensor Selection

This function is used to protect the motor against overheat. The analog voltage input can be used as temperature signal input.

Code	Name	Setting range	Default	Unit	Step	Attri.
C1.72	Motor thermal sensor type	0: KTY84/130 (PTC) 2: PT100 3: PT1000 4: TDK G1551_8320 (NTC)	0	-	-	Stop
C1.73	Motor thermal sensor protection level	0.0...10.0 V	2.0	V	0.1	Stop

To connect a temperature sensor to the converter, external wiring outside the converter is required.

For a temperature sensor with voltage supply, use terminals +10 V, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

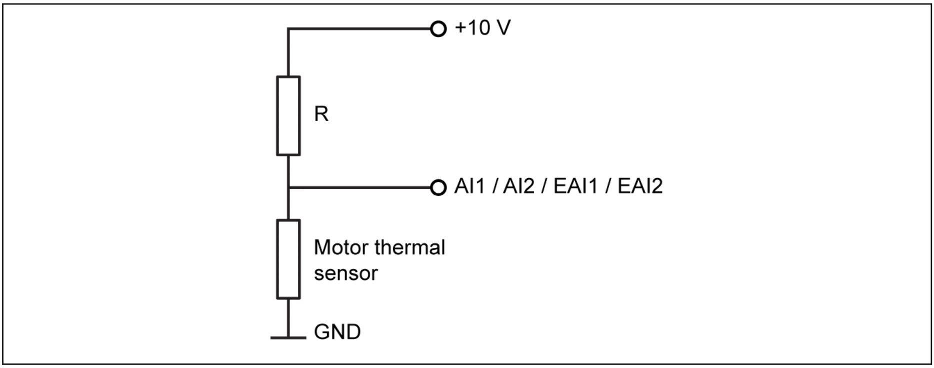


Fig. 12-28: Temperature sensor with voltage supply

For a temperature sensor with current supply, use terminals AO1 / EAO, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

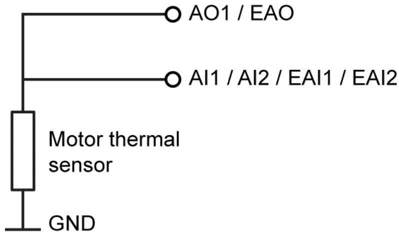


Fig. 12-29: Temperature sensor with current supply

Activate the function of temperature monitoring with temperature sensor:

Parameter [E1.60] 'Motor temperature sensor channel' is used enable to the protection with sensor.

Select the sensor type:

- [C1.72] = 0: KTY84/130

  For KTY84/130 sensors, the value of resistor R in the figure should be close to the sensor resistance when the motor is at high temperature.

- [C1.72] = 2: PT100

  For a good resolution of temperature with PT100 sensors, the value of resistor R in the figure should be close to the sensor resistance at the motor temperature limit.

- [C1.72] = 3: PT1000

  For PT1000 sensors, the relationship between the resistor R and the motor temperature is:

  -30 ℃: 882 Ω

  0 ℃: 1,000 Ω

  200 ℃: 1,758 Ω

- [C1.72] = 4: TDK G1551_8320 (NTC)

Supply source to the temperature sensor:

- If [E2.26] = '11: Motor temperature sensor power supply' (or [H8.26] = 11), the analog output is shifted with current supply mode regardless of the setting of E2.25 (or H8.25). In this case, the output current on the selected analog output terminal is:
  – [C1.72] = 0, output current = 1.6 mA
  – [C1.72] = 2, output current = 9.1 mA
  – [C1.72] = 3, output current = 1 mA
  – [C1.72] = 4, output current = 4 mA
- If [E2.26] ≠ 11, the AO output mode is resumed to [E2.25] 'AO1 output mode' automatically.

- If [H8.26] ≠ 11, EAO output mode is resumed to [H8.25] 'EAO output mode' automatically.

Set the motor protection level

Set C1.73 'Motor thermal sensor protection level' according to the characteristic of the temperature sensor. The setting value corresponds to the voltage value detected by of analog input.

Example: If [C1.72] = 0, 2, 3, [C1.73] = 2, it represents 2 V, and the frequency converter stops with error code 'Ot' displayed on the operating panel when the voltage level on analog input is higher than 2 V; if [C1.72] = 4, [C1.73] = 2, it represents 2 V, and the frequency converter stops with error code 'Ot' displayed on the operating panel when the voltage level on analog input is lower than 2 V.

12.4 C2: V/f Control

12.4.1 V/f Curve Setting

This function is used to adjust the output voltage in accordance with the V/f curve.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.00	V/f curve mode	0: Linear 1: Square 2: User-defined 3: V/f separation	0	-	-	Stop
C2.01	V/f frequency 1	0.00...[C2.03] Hz	0.00	Hz	0.01	Stop
C2.02	V/f voltage 1	0.0...120.0 %	0.0	-	0.1	Stop
C2.03	V/f frequency 2	[C2.01]...[C2.05] Hz	0.00	Hz	0.01	Stop
C2.04	V/f voltage 2	0.0...120.0 %	0.0	-	0.1	Stop
C2.05	V/f frequency 3	[C2.03]...[E0.08] Hz	50.00	Hz	0.01	Stop
C2.06	V/f voltage 3	0.0...120.0 %	100.0	-	0.1	Stop
C2.08	V/f separation output voltage source selection	0: Panel potentiometer 1: Panel button setting 2: AI1 analog input 10: X5 pulse input 20: Communication (Modbus 0x7F0B/Field-bus extension card H0.50) 22: Digital setting 23: Voltage PID control	22	-	-	Stop
C2.09	V/f separation output voltage digital setting	0.00...100.00 %	0.00	-	0.01	Run
C2.10	V/f separation output voltage acceleration time	0.0...6,000.0 s	0.0	-	0.1	Run
C2.11	V/f separation output voltage deceleration time	0.0...6,000.0 s	0.0	-	0.1	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.12	V/f separation stop mode selection	0: Voltage and frequency decelerates independently 1: Voltage decelerates to zero, then frequency decelerates to zero	0	-	-	Run
C2.13	V/f separation boost factor	0.00...100.00	0.00	-	0.01	Run

The frequency converter provides four curve modes:

- **0: Linear**

  This mode refers to linear voltage / frequency control, which is used for normal constant torque loads.

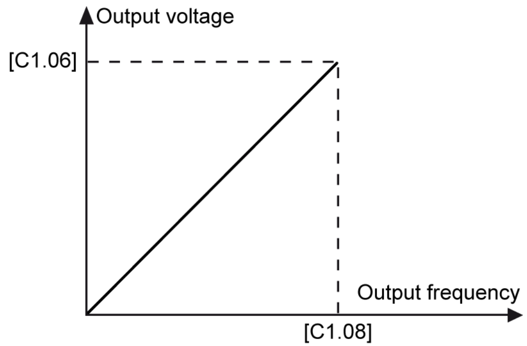


Fig. 12-30: Linear V/f curve

- **1: Square**

  This mode refers to square voltage / frequency control, which is used for variable torque loads of fans, pumps, etc.

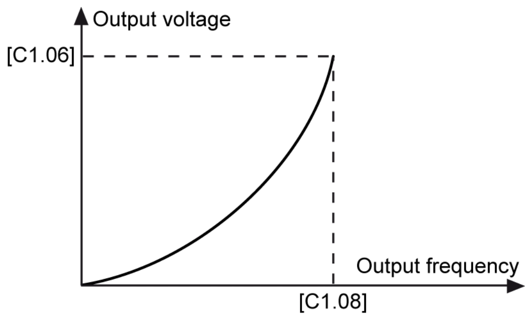


Fig. 12-31: Square V/f curve

- **2: User-defined**

  This mode refers to voltage / frequency control with curve defined according to actual application, which is used for special loads of dewatering machines, centrifuges, etc.

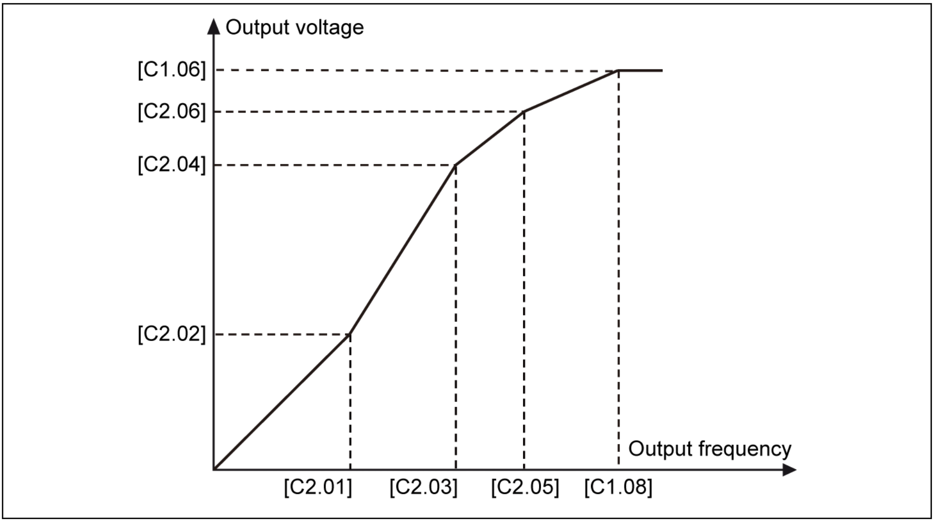


Fig. 12-32: User-defined V/f curve

Each of the three V/f frequency points is limited by the neighboring V/f frequency points. In general, each V/f frequency point shall be set according to following sequence: 0 ≤ [C2.01] ≤ [C2.03] ≤ [C2.05] ≤ [C1.08].

There are two modes of user-defined V/f curve:

1. User-defined V/f curve when [C2.05] ≤ [C1.08]

   In this mode, the output voltage is limited to 100 % even if [C2.06] 'V/f voltage 3' is higher than 100 %.

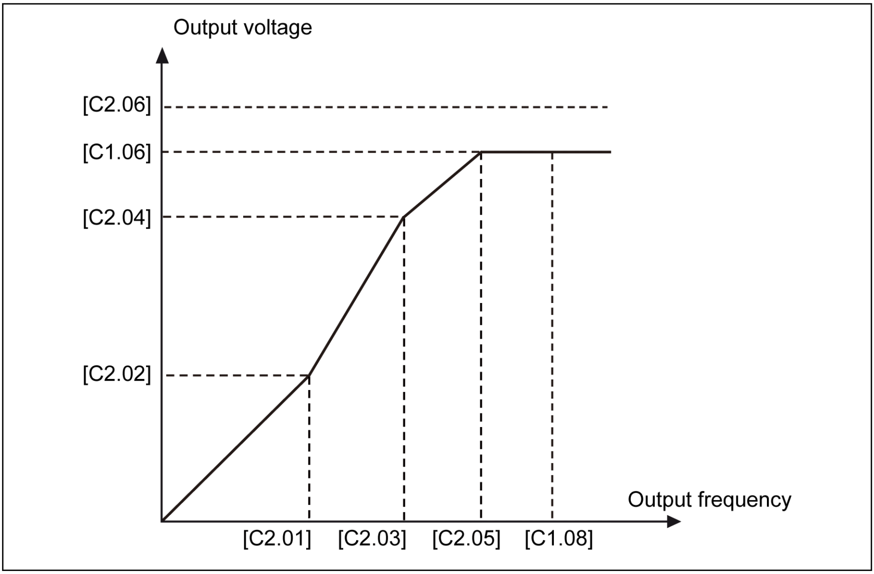


Fig. 12-33: User-defined V/f curve when [C2.05] ≤ [C1.08]

2. User-defined V/f curve when [C2.05] ≥ [C1.08]

   In field weakening range, output voltage needs to be higher than the rated voltage. In this case,

   - The maximum value of C2.05 'V/f frequency 3' can be higher than [C1.08] 'Motor rated frequency'.
   - The maximum value of C2.06 'V/f voltage 3' can be higher than 100 %.

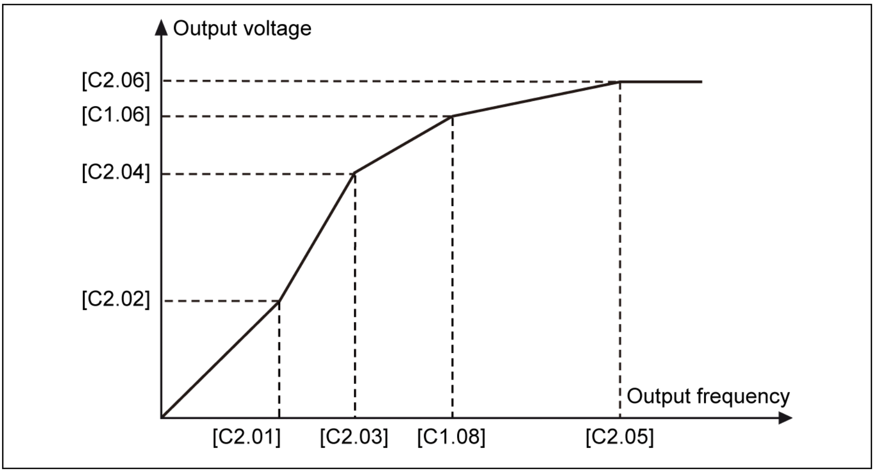


Fig. 12-34: User-defined V/f curve when [C2.05] ≥ [C1.08]

- **3: V/f separation**

  In case of V/f separation mode, voltage is not derived from the frequency instead user can control the voltage and frequency independently. In this mode, keeping the frequency constant, voltage can be varied and vice-versa. So that any curve can be followed based on the load requirements.

The voltage source selection can be made by setting the parameter C2.08 with the following options.

C2.08 setting range:

- **0: Panel potentiometer**

  The V/f separation output voltage is set by adjusting the potentiometer on the operating panel.

- **1: Panel button setting**

  Press **<▼>** and **<▲>** button on the operating panel will decrease and increase the V/f separation output voltage. The setting value will be saved to C2.09.

- **2: AI1 analog input**

  For AI1 analog input, curves are not considered. Maximum value of analog input will be directly converting to motor rated voltage.

- **10: X5 pulse input**

  For X5 pulse input, curves are not considered. Maximum value of pulse input will be directly converting to motor rated voltage.

- **20: Communication**

  The voltage command values are given in percentage through Modbus or any other Fieldbus communication. If Modbus is selected as communication channel for voltage command value, data is written through the register address 0x7F0B. If other Fieldbus communication is selected as channel for voltage command value, data can be written through the parameter H0.50.

- **22: Digital setting**

  C2.09 is used for setting the voltage in percentage value through panel or ConverterWorks.

- **23: Voltage PID control**

  The voltage reference value will be set by the PID output. In this mode the reference/feedback source of PID is limited:

  - E4.00 Valid voltage sources: Panel potentiometer, panel button digital setting, AI1, pulse train and communication
  - E4.01 Valid voltage sources: AI1 and pulse train output

    When the PID reference source is selected as panel button digital setting, the reference value will be saved to C2.09.

C2.10 'V/f separation output voltage acceleration time' is the time for V/f separation output voltage increase from 0 V to motor rated voltage.

C2.11 'V/f separation output voltage deceleration time' is the time for V/f separation output voltage decrease from motor rated voltage to 0 V.

The voltage boost is calculated as the following way:

Voltage boost (%) = (Factor [C2.13] * Total current * 100) / (Motor rated voltage)

Output voltage (%) = Set voltage (%) + Voltage boost (%)

Device has to start directly when 'RUN' command is issued irrespective of 'START' mode E0.35. Device has to stop directly when 'STOP' command is issued irrespective of 'STOP' mode E0.50. But it has to stop based on the new V/f separation 'STOP' mode C2.12.

Whenever V/f separation mode is enabled, setting voltage can be displayed through display parameter d0.09.

12.4.2 Slip Compensation

This function is used to compensate the speed difference caused by the load in the case of V/f control, to ensure that the rotator’s speed is close to the synchronous speed and improve the mechanical behavior of the motor.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.07	Slip compensation factor	0...200 %	0	–	1	Run

The actual slip compensation is calculated from [C1.12] 'Motor rated slip compensation' and [C2.07] 'slip compensation factor':

- 0 %: No slip compensation

  The slip compensation function is deactivated.
- 1...100 %: Full slip compensation

  Example: [C1.12] = 2.50 Hz, [C2.07] = 100 %

  The actual slip compensation is 2.50 Hz x 100 % = 2.50 Hz.
- 101...200 %: Over slip compensation

  Example: [C1.12] = 2.50 Hz, [C2.07] = 200 %

  The actual slip compensation is 2.50 Hz x 200 % = 5.00 Hz.

12.4.3 0 Hz Output Mode

This function is used in some application when no torque output is required in 0 Hz.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.20	0 Hz output mode	0: No output 1: Standard	1	–	1	Stop

Setting range:

- 0: No output

  No any torque output in this mode.
- 1: Standard

  There is certain torque output in this mode.

12.4.4 Torque Boost Setting

The torque boost function is used to obtain higher output torque and better stabilization by boosting the output voltage, especially at low speed.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.21	Torque boost setting	0.0 %: Automatic boost 0.1... 20.0 %: Manual boost	DOM	–	0.1	Run
C2.22	Automatic torque boost factor	0...320 %	50	–	1	Run

- **Manual torque boost with linear or user-defined V/f curve**

  In this V/f curve, the output voltage starts to be boosted when the output frequency is lower than half of [C1.08].

  Example: If [C1.08] = 50.00 Hz, then torque boost function is active when output frequency is lower than 25.00 Hz.

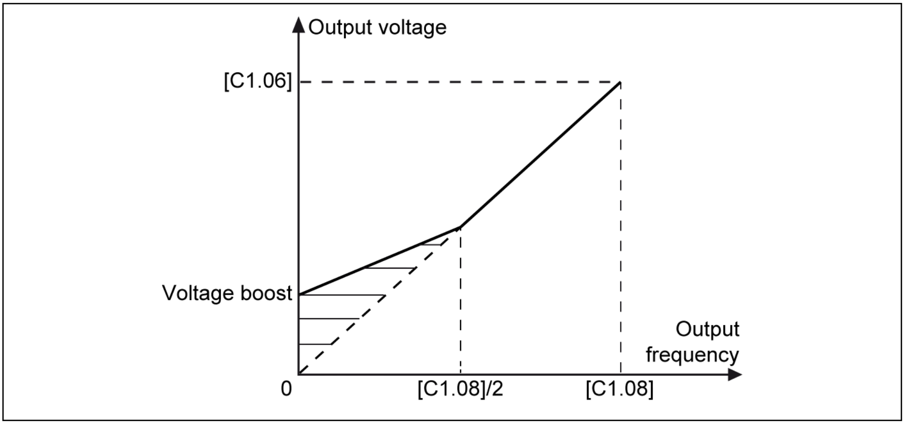


Fig. 12-35: Manual torque boost with linear or user-defined V/f curve

[C2.21] is the voltage boost value at 0.00 Hz. The actual voltage boost values for other frequency points decreases in linear along with output frequency increase.

- **Manual torque boost with square curve**

  In this square V/f curve, the output voltage starts to be boosted when the output frequency is lower than [C1.08].

  Example: If [C1.08] = 50.00 Hz, then torque boost function is active when the output frequency is lower than 50.00 Hz.

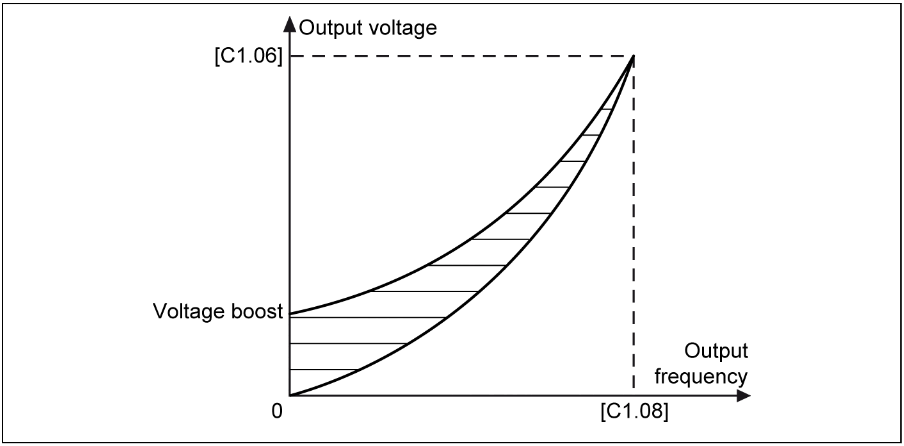


Fig. 12-36: Manual torque boost with square curve

In automatic boost mode, the output voltage boost percentage is determined automatically by the output frequency and the load current. The linear and square V/f curves for automatic torque boost are shown as figures below:

- **Automatic torque boost with linear V/f curve**

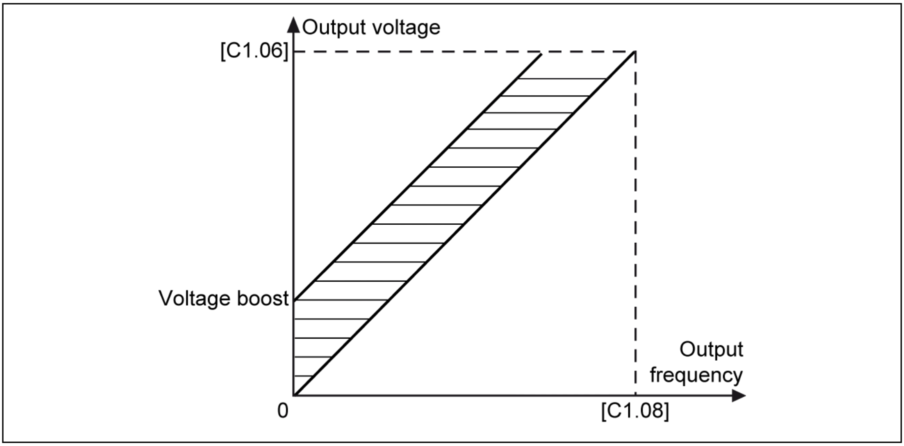


Fig. 12-37: Automatic torque boost with linear V/f curve

- **Automatic torque boot with square V/f curve**

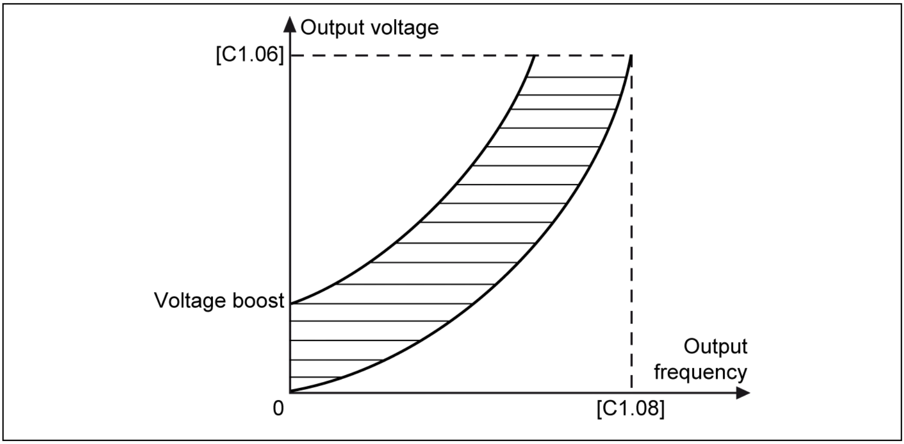


Fig. 12-38: Automatic torque boot with square V/f curve

For further adjustment of the voltage boost, set parameter C2.22 'Automatic torque boost factor'. Its default value 50 % means no adjustment. The calculation equation is shown as below:

[Voltage boost] = $\sqrt{3}$ x 0.5 x I_1 x R_1 x [C2.22]

R_1: stator resistance

I_1: stator current

12.4.5 Heavy Load Stabilization

This function is used to suppress the output voltage oscillation caused by large impact to DC-bus voltage in case of heavy load.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.23	Heavy load stabilization	0: Inactive 1: Active	1	–	–	Run

Setting range:

- **0: Inactive**

  Heavy load stabilization function inactive.
- **1: Active**

  Heavy load stabilization function active.

This function can lead to slightly lower output voltage to the motor.

12.4.6 Light Load Oscillation Damping

This function is used to suppress the motor oscillation in the case of light load or no load.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.24	Light load oscillation damping factor	0...5,000 %	300	–	1	Run
C2.25	Light load oscillation damping filter factor	10...2,000 %	30	–	1	Run

1. [C2.24] = 0 %: Oscillation suppression is inactive.
2. Increasing [C2.24] brings a better effect of oscillation suppression, but excessive increase leads to unstable running of the motor.
3. [C2.25] = 100 %: This setting can suppress oscillation in most situations.
4. Adjustment of [C2.25] is helpful in the following conditions:
   - Increase [C2.25] if the oscillation damping performance is not obvious, but excessive increase leads to slow suppression.
   - Decrease [C2.25] if the oscillation occurs at low speed.

12.4.7 Current Limitation

This function is used to avoid the tripping caused by over current when the load has large inertia or sudden changes.

Code	Name	Setting range	Default	Unit	Step	Attri.
C2.40	Current limitation mode	0...2	2	–	–	Stop
C2.42	Current limitation level	20...250 %	150	–	1	Stop
C2.43	Current limitation proportional gain	0.000...10.000	DOM	–	0.001	Stop
C2.44	Current limitation integral time	0.001...10.000	DOM	–	0.001	Stop

- **C2.40 = 0: Always inactive**

  Current limitation control function is inactive.
- **C2.40 = 1: Inactive at constant speed**

  Current limitation control is active during acceleration and deceleration, but inactive at constant speed.
- **C2.40 = 2: Active at constant speed**

  Current limitation control is active during acceleration, deceleration and at constant speed.

The current regulator is a PI regulator with configurable P factor and I factor.

- The higher value of C2.43 'Current limitation proportional gain', the faster the current suppression, but too high value of C2.43 will cause oscillation.
- The shorter value of C2.44 'Integral time', the more quick response of current suppression, but too short value of C2.44 will cause oscillation.

The default settings of C2.43 and C2.44 can meet requirements in most applications. If slight adjustment is necessary, increase [C2.43] first with no oscillation, and then decrease [C2.44] to achieve fast response without overshooting.

[C0.27] 'Stall overcurrent prevention level' should be smaller than [C2.42] 'Automatic current limitation level', otherwise a warning code 'PrSE' will be displayed on the operating panel and parameter setting can not be saved.

12.5 C3: Vector Control

12.5.1 Speed Loop Setting

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.00	Speed loop proportional gain 1	0.00...655.35	DOM	-	0.01	Run
C3.01	Speed loop integral time 1	0.01...655.35 ms	DOM	ms	0.01	Run
C3.02	Speed loop proportional gain 2	0.00...655.35	DOM	-	0.01	Run
C3.03	Speed loop integral time 2	0.00...655.35 ms	DOM	ms	0.01	Run
C3.10	Speed loop switching frequency 1	0.00...[C3.11]	4.00	Hz	0.01	Stop
C3.11	Speed loop switching frequency 2	[C3.10]...[C1.08]	6.00	Hz	0.01	Stop

Frequency converter can select different PI parameter while they are running in different frequency. When the running frequency is lower than switch frequency 1 (C3.10), speed loop PI tuned parameters are C3.00 and C3.01. When the running frequency is higher than switch frequency 2 (C3.11), speed loop PI tuned parameters are C3.02 and C3.03. The speed loop PI parameters that between switch frequency 1 and switch frequency 2 are the linear switch of two group parameters. It is shown as figure below:

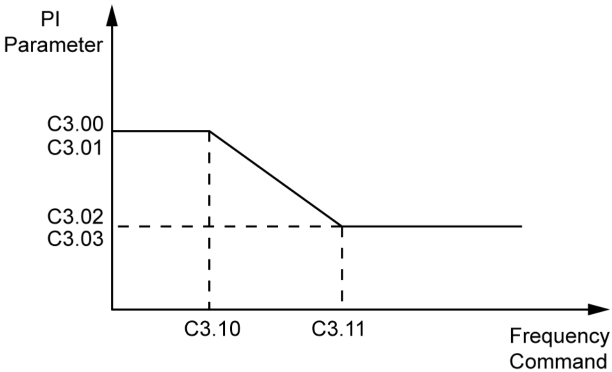


Fig. 12-39: PI parameters

The velocity dynamic response characteristic of vector control can be tuned by setting the proportional coefficient and integral time of speed regulator.

Increase the proportional gain or reduce the integral time can speed up the dynamic response of speed loop. But higher proportional gain or lower integral time may cause the system oscillation, it is suggested that:

If the default parameter value can not satisfy the requirement, it can be adjusted according to the actual needs based on the default value: increase the proportional gain to ensure the system dose not oscillation, then reduce the integral time, so that the system has a faster response characteristic and a smaller overshoot.

☞ If the PI parameters are not set properly, it may lead to speed excessive overshoot or overvoltage fault during overshoot drops.

12.5.2 Current Loop Setting

The current loop parameters are calculated based on the motor parameter. In most cases it is not advised to change them. But if the motor is running at low frequency (under 3 Hz) but not smooth enough, the proportional gain of the current loop can be set bigger.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.05	Current loop proportional gain	0.1...1,000.0	DOM	–	0.1	Run
C3.06	Current loop integral time	0.01...655.35 ms	DOM	ms	0.01	Run

12.5.3 Torque Limitation

This function defines the torque limitation when the frequency converter is running in speed control mode.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.20	Low speed torque limitation	1...200 %	100	–	1	Stop
C3.44	Torque positive limit	0.0...200.0 %	150.0	–	0.1	Run
C3.45	Torque negative limit	0.0...200.0 %	150.0	–	0.1	Run
C3.47	Torque limitation reference selection at speed control mode	0: Parameter C3.44 and C3.45 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: Communication (Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15) 5: EAI2 analog input	0	–	–	Stop

C3.20 “low speed torque limitation” only works in sensorless vector control mode and limits the torque output at “low speed area”. Its value means the percentage of the rated torque. The “low speed area” and “high speed area” are switched by a hysteresis shown in the figure below, which is related to the rated frequency and rated voltage of the motor.

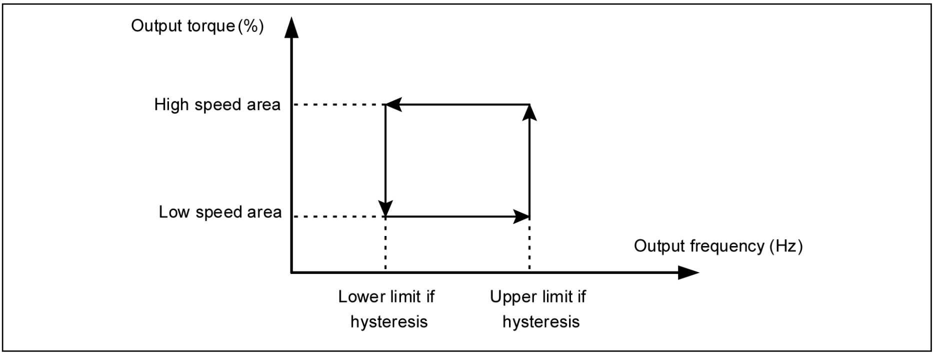


Fig. 12-40: Low speed torque limitation hysteresis

The hysteresis is calculated by the following equations:

- Lower limit of hysteresis = 15.2 * rated frequency / rated voltage
- Upper limit of hysteresis = 22.8 * rated frequency / rated voltage

For sensorless vector control, the output torque in “high speed area” is limited by the reference selected by C3.47.

For vector control with encoder, the output torque in both areas are limited by the reference selected by C3.47.

C3.47 setting range:

- C3.47 = 0: Parameter C3.44 and C3.45

  C3.44 “Torque positive limit” is used to set the limit maximum value of positive torque of the frequency converter.

  C3.45 “Torque negative limit” is used to set the limit minimum value of the negative torque of the frequency converter.

  The reference torque direction will be set by [U0.00] or external terminals:

  – If [E0.01] = 0 “Operating panel”, the reference torque direction will be set by [U0.00]. [U0.00] = 0 “Forward” means the reference torque direction is positive. [U0.00] = 1 “Reverse” means the reference torque direction is negative.

  – If [E0.01] = 1 “Multi-function digital input”, the reference torque direction will be determined according to running direction which is controlled by external terminals. (“Forward” corresponding to “Positive” and “Reverse” corresponding to “Negative”.
- C3.47 = 1: AI1 analog input

  The range of AI1 corresponds to the 0.0...200.0% rated torque.
- C3.47 = 2: AI2 analog input

  The range of AI2 corresponds to the 0.0...200.0% rated torque.
- C3.47 = 3: EAI1 analog input

  The range of EAI1 corresponds to the 0.0...200.0% rated torque.
- C3.47 = 4: Communication

  Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14.

  Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15.
- C3.47 = 5: EAI2 analog input

  The range of EAI2 corresponds to the 0.0...200.0% rated torque.

12.5.4 Encoder Settings

This function is used to set filter time and encoder commutation offset in vector control mode.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.21	Speed filter time	0...100.0 ms	2.0	ms	0.1	Stop
C3.22	Encoder commutation offset	0.0...360.0°	360.0	°	0.1	Run

C3.21 is used for both sensorless vector control and vector control with encoder. With a longer speed filter time, which suppress the impact of the spikes, the motor can be more stable, but this could make the dynamic performance worse. With a shorter filter time, the system has a faster dynamic performance, but less stable because of the possible spikes.

Because the 0 position of the encoder may not match the 0 position of the motor perfectly, encoder commutation offset C3.22 should be considered. The offset can be automatically calculated during the rotational auto-tuning.

12.5.5 Speed Monitor

The speed monitor will monitor the speed difference between setting point and actual frequency as well as of maximum frequency and actual frequency. In case of problems it will show error SPE-.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.25	Speed monitor timeout	0.0...6,553.5	5.0	s	0.1	Stop
C3.26	Speed monitor maximum speed difference	0.00...655.35	10.00	Hz	0.01	Stop

12.5.6 Fieldweakening control for PMSM

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.30	Maximum FW current factor for SM	1...95	75	%	1	Stop

This parameter is the maximum allowed percent of motor rated current C1.07, it is used when PMSM runs in field weakening area, or called constant power region.

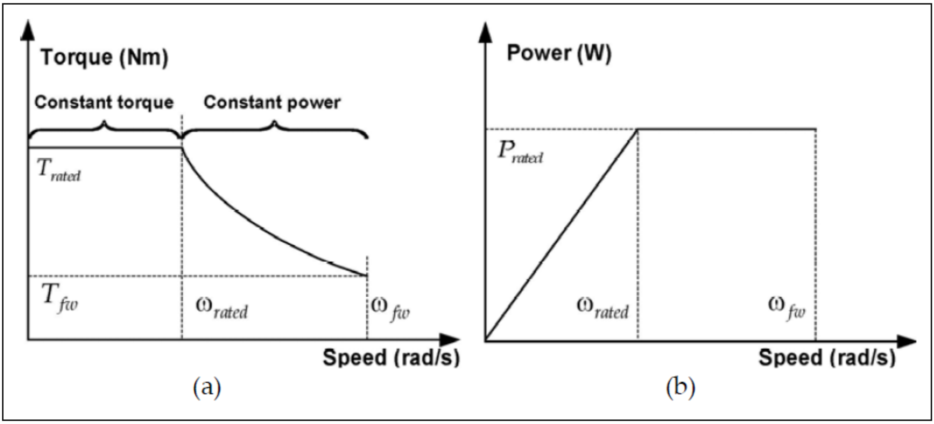


Fig. 12-41: Torque characteristics and power versus speed curves

In order to reach higher running speed for PMSM, field weakening control is needed to offset the effect of EMF, which occupies the main part of needed output voltage in higher speed region. With field weakening control, the regulator has more capability to regulate the output voltage to increase the running speed for PMSM, this is achieved via modifying this parameter.

☞ In some application fields, it is NOT allowed for motor to run beyond the rated speed, so C3.30 should be set to a smaller value; For some application fields, with increasing of C3.30, the running speed can be reached at a higher level. But please be aware that higher field weakening current might lead to the irreversible demagnetizing of permanent magnet mounted on the rotor, and also higher EMF with higher running speed would lead to the damage of the drive.

12.5.7 Torque Control

This function is about torque control, the motor will keep the output torque as the setting value until it reaches the speed limit.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.38	Forward frequency limitation at torque control mode	0.00...[E0.09] Hz	50.00	Hz	0.01	Run
C3.39	Reverse frequency limitation at torque control mode	0.00...[E0.09] Hz	50.00	Hz	0.01	Run
C3.40	Torque control mode	0: Activated by digital inputs 1: Always active 2: Communication (Bit 8 of Modbus 0x7F00) (Bit 9 of extension card H0.00)	0	–	–	Stop
C3.41	Torque reference channel	0: AI1 analog input 1: AI2 analog input 2: Panel potentiometer 3: EAI1 analog input 4: Pulse input via DI5 5: Parameter setting C3.46 6: Communication (Modbus 0x7F02/Fieldbus extension card H0.12) 7: EAI2 analog input	0	–	–	Stop
C3.42	Torque reference minimum value	0.0 %...[C3.43]	0.0	–	0.1	Run
C3.43	Torque reference maximum value	[C3.42]...200.0 %	150.0	–	0.1	Run
C3.46	Digital torque reference setting	0.0...200.0 %	150.0	–	0.1	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.48	Speed limitation reference selection at torque control mode	0: Parameter C3.38 and C3.39 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: Communication (Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16) 5: EAI2 analog input	0	–	–	Stop
C3.49	Torque command ramp	0.0...5.0 s	0	s	0.1	Stop

Torque control activation mode

Parameter C3.40 'Torque control mode' is used to set the activation mode of torque control.

C3.40 setting range:

- [C3.40] = 0: Activated by digital inputs

  The corresponding parameter [E1.00] ... [E1.04], [H8.00] ... [H8.04] of the selected digital input needs to be set as 23: Torque / speed control switch. Please keep in mind that with this setting the switch can also happen when the converter is in run.
- [C3.40] = 1: Always active

  Torque control mode is selected.
- [C3.40] = 2: Communication

  -bit8 of Modbus 0x7F00 = 1: torque control enable

  -bit8 of Modbus 0x7F00 = 0: torque control disabled

  -bit9 of extension card H0.00 = 1: torque control enable

  -bit9 of extension card H0.00 = 0: torque control disabled

Torque reference channel

Parameter C3.41 'Torque reference channel' is used to set torque reference channel.

Parameters C3.42 'Torque reference minimum value' and C3.43 'Torque reference maximum value' are used to define the curve characteristic for the torque reference.

Torque curve is defined as below:

- When [C3.41] = 0, 1, 2, 3, 4 or 7, and EAI1/EAI2 input is non -10 V to 10 V, C3.42 and C3.43 are used to define curve:

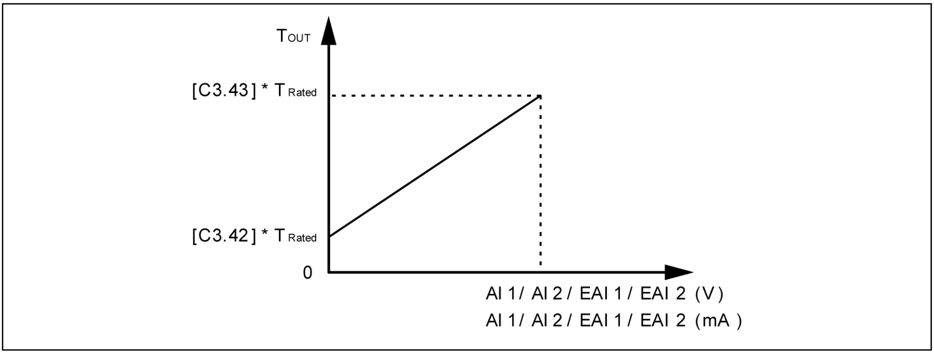


Fig. 12-42: Torque reference characteristic curve

- When [C3.41]=3, 7 and EAI1/EAI2 input is -10 V to 10 V, C3.43 is used to define curve:
  - [H8.06] / [H8.31] = 0 or 1

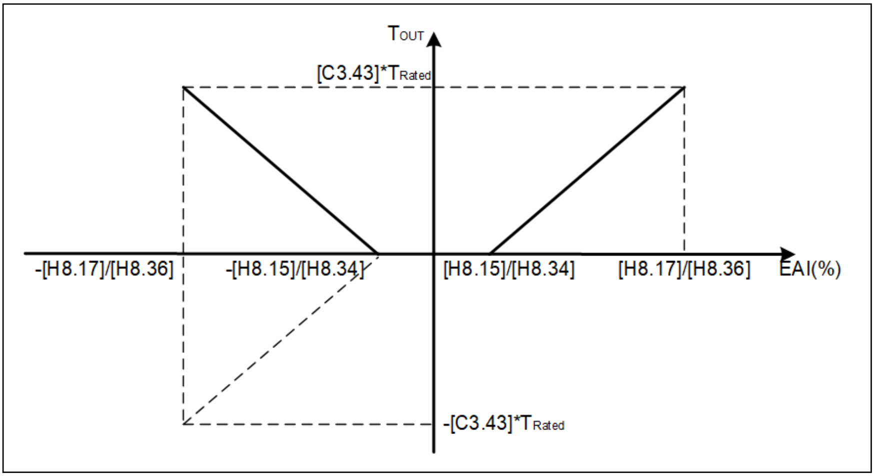


Fig. 12-43: Torque curve 1

  - [H8.06] / [H8.31] = 2

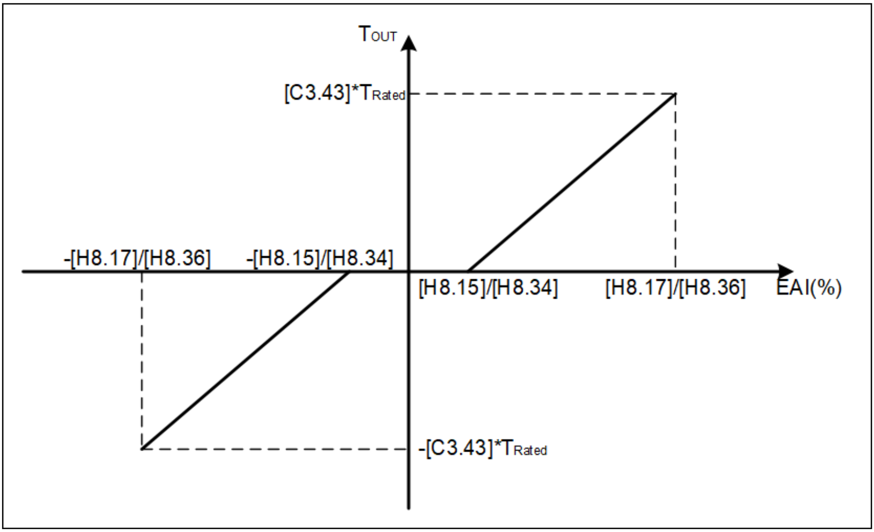


Fig. 12-44: Torque curve 2

Speed limitation at torque control mode

In torque control mode the motor speed is limited by C3.48 'Speed limitation reference selection at torque control'.

C3.48 setting range:

- C3.48 = 0: Parameter C3.38 and C3.39

  C3.38: Forward frequency limitation at torque control mode

  C3.39: Reverse frequency limitation at torque control mode
- C3.48 = 1: AI1 analog input

  Analog input AI1, scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 2: AI2 analog input

  Analog input AI2, scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 3: EAI1 analog input

  Analog input EAI1 scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 4: Communication

  Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16.
- C3.48 = 5: EAI2 analog input

  Analog input EAI2, scaled to 0.00...E0.09 based on analog input curve.

Torque command ramp setting

Torque command ramp [C3.49] is the time for torque command increase from 0 to C1.17 'motor rated torque'.

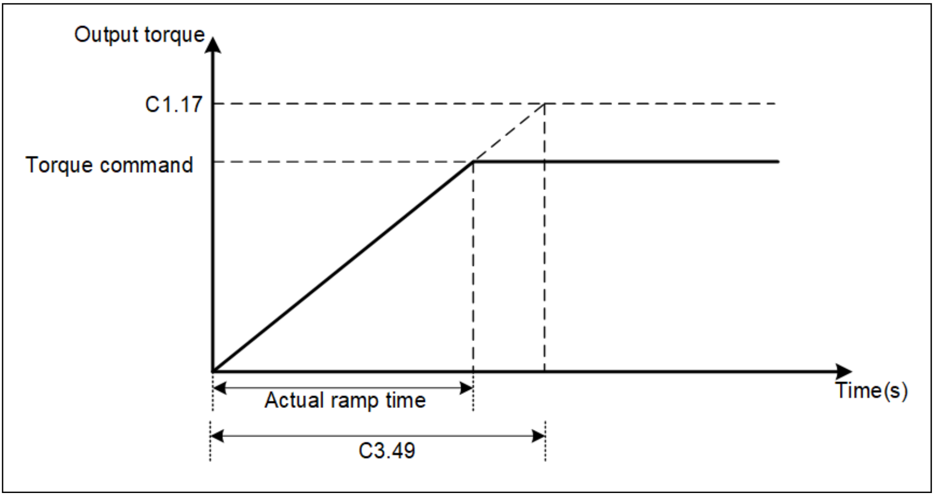


Fig. 12-45: Torque command ramp

12.5.8 Initial Angle Detection

Initial rotor angle detection is automatically checking the rotor position before the motor startup. The advantage of this function is to prevent the reverse running at the startup, the disadvantage is extended startup time with moderate amount of noises.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.50	Initial angle detection current	50...150 %	80	-	1	Stop
C3.51	Initial angle detection mode	0...2	2	-	-	Stop

C3.50 is to set the current value to be used for checking the rotor initial position. The smaller the current, the smaller noise generation over the time of checking. However current input too small may decrease the accuracy of the checking result.

C3.51 is to set initial position angle checking mode:

- C3.51 = 0: No detection

  Possible to have the reverse running at the startup.
- C3.51 = 1: Detection when first power on

  Applicable for small inertia systems which do NOT allow reverse running at the startup and cause no change to rotor position after the system stop.
- C3.51 = 2: Detection at every running

  Normally the checking shall be performed on the rotor initial position at each startup. Set C3.51 to '2' for the applications which do NOT allow the reverse running at startup and cause change to the rotor position after system stop.

12.5.9 SVC switch point

The two parameters are switching points used between low frequency area and high frequency area.

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.52	SVC regulation area lower frequency	0.00...600	DOM	Hz	0.01	Stop
C3.53	SVC regulation area upper frequency	0.00...600	DOM	Hz	0.01	Stop

C3.52: this parameter is the switching point where the high frequency area decelerate to the low frequency area.

C3.53: this parameter is the switching point where the low frequency area accelerate to the high frequency area.

12.5.10 Speed Damping Factor for SVC

Code	Name	Setting range	Default	Unit	Step	Attri.
C3.04	Speed observer harmonics damping factor	0.10...20.00	0.66	-	0.01	Stop
C3.54	SVC damp factor enhance upper frequency	DOM	DOM	Hz	0.01	Stop
C3.55	SVC damp factor enhance coefficient	1...20	1	-	1	Stop

C3.04 is a specified parameter for speed observer in sensorless vector control. It can affect the level of the harmonics, which presents in the observed speed and is caused by the offset and harmonics of the input values of the speed observer (voltage, current), especially in the speed area below 20% of the rated motor speed.

The default value of C3.04 can cover most application cases. Only if the motor runs not smoothly in SVC mode and other control parameters can't help to improve it, C3.04 can be set with a higher value by setting step size 0.3 ~ 0.5. Please note that high C3.04 has a negative influence on the loading performance.

C3.54 and C3.55 are used to enhance damping factor in the SVC low speed area. Normally, only increasing C3.54 can satisfy the need of enhancing the damping factor. But C3.54 can not be too high, otherwise speed fluctuation will occur. Now C3.55 can be used, increasing C3.55 also can enhance the damping factor.

12.6 d0: Basic Monitoring

This part is about basic monitoring parameters.

Code	Name	Minimum unit	Attri.
d0.00	Output frequency	0.01 Hz	Read
d0.01	Actual speed	1 rpm	Read
d0.02	Setting frequency	0.01 Hz	Read
d0.03	Setting speed	1 rpm	Read
d0.04	User-defined setting speed	0.1	Read
d0.05	User-defined output speed	0.1	Read
d0.06	Encoder frequency	0.01	Read
d0.07	Encoder speed	1	Read
d0.09	V/f separation setting voltage	0.01 V	Read
d0.10	Output voltage	1 V	Read
d0.11	Output current	0.1 A	Read
d0.12	Output power	0.1 kW	Read
d0.13	DC-bus voltage	1 V	Read
d0.14	Energy saving counter kWh	0.1 kWh	Read
d0.15	Energy saving counter MWh	1 MWh	Read
d0.16	Output torque	0.1 %	Read
d0.17	Setting torque	0.1 %	Read
d0.18	FWD speed limitation setting	0.01 rpm	Read
d0.19	REV speed limitation setting	0.01 rpm	Read
d0.20	Power module temperature	1 ℃	Read
d0.21	Actual carrier frequency	1 kHz	Read
d0.23	Power stage running time	1 h	Read
d0.30	AI1 input	0.01 V / 0.01 mA	Read
d0.31	AI2 input	0.01 V / 0.01 mA	Read
d0.33	I/O card EAI1 input	0.01 V / 0.01 mA	Read
d0.34	I/O card EAI2 input	0.01 V / 0.01 mA	Read
d0.35	AO1 output	0.01 V / 0.01 mA	Read
d0.37	I/O card EAO output	0.01 V / 0.01 mA	Read
d0.38	IO plus card TSI input signal value	0.001 V	Read
d0.40	Digital input 1	–	Read
d0.43	I/O card digital input	–	Read
d0.45	DO1 output	–	Read
d0.47	I/O card EDO1 output	–	Read
d0.48	I/O card EDO2 output	–	Read
d0.50	Pulse input frequency	0.01 kHz	Read

Code	Name	Minimum unit	Attri.
d0.55	Pulse output frequency	0.1 kHz	Read
d0.60	Relay output	–	Read
d0.62	I/O card relay output	–	Read
d0.63	Relay card output	–	Read
d0.70	PID reference engineering value	0.1	Read
d0.71	PID feedback engineering value	0.1	Read
d0.80	ASF Display00	–	Read
d0.81	ASF Display01	–	Read
d0.82	ASF display02	–	Read
d0.83	ASF display03	–	Read
d0.84	ASF display04	–	Read
d0.85	ASF display05	–	Read
d0.86	ASF display06	–	Read
d0.87	ASF display07	–	Read
d0.88	ASF display08	–	Read
d0.89	ASF display09	–	Read
d0.98	High resolution output current	0.01 A	Read
d0.99	Firmware version	0.01	Read

12.7 d1: Enhanced Monitoring

This part is about enhanced monitoring parameters, which are not visible via Panel, but can be scoped in IndraWorks.

Code	Name	Minimum unit	Attri.
d1.00	Phase current U [A]	0.1 A	Read
d1.01	Phase current V [A]	0.1 A	Read
d1.02	Phase current W [A]	0.1 A	Read
d1.05	Current Id filtered Display	0.01 A	Read
d1.06	Current Iq filtered Display	0.01 A	Read
d1.10	Signed rotor frequency	0.1 Hz	Read
d1.11	Rotor speed	1 rpm	Read
d1.12	Signed encoder frequency	0.1 Hz	Read
d1.15	High resolution output power	0.01 kW	Read
d1.20	Encoder angle	0.01 °	Read

12.8 E0: Set Point and Control

12.8.1 Frequency Setting Source

Different frequency setting sources can be selected by setting parameter E0.00 'First frequency setting source' or E0.02 'Second frequency setting source'.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.00	First frequency setting source	0...21	0	-	-	Stop
E0.02	Second frequency setting source	0...21	2	-	-	Stop

Setting range of E0.00, E0.02:

- 0: Panel potentiometer

  The setting frequency is set by adjusting the potentiometer on the operating panel. By default, the first frequency setting source is from the potentiometer on the operating panel. To adjust the output frequency, follow the instructions below:

  – Rotate the potentiometer counterclockwise (leftwards)

    The output frequency decreases, and the motor decelerates.

  – Rotate the potentiometer clockwise (rightwards)

    The output frequency increases, and the motor accelerates.

- 1: Panel button setting

  The setting frequency is set by parameter E0.07 'Digital setting frequency'. Pressing <▼> and <▲> buttons on the operating panel will decrease and increase the output frequency respectively when the frequency converter is running.

- 2: AI1 analog input

  The setting frequency is set by analog input AI1 input. When AI1 is used as the frequency setting source, the relationship between AI1 and the setting frequency is shown as the figure below:

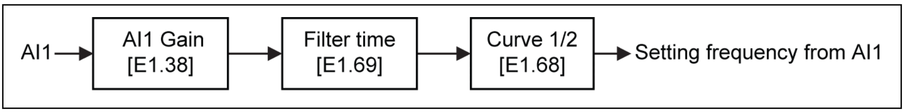


Fig. 12-46: AI1 setting frequency

- 3: AI2 analog input

  The setting frequency is set by analog input AI2 input. When AI2 is used as the frequency setting source, the relationship between AI2 and the setting frequency is shown as the figure below:

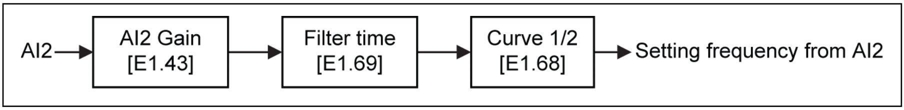


Fig. 12-47: AI2 setting frequency

- **4: EAI1 analog input**

  The setting frequency is set by analog input EAI1 input. When EAI1 is used as the frequency setting source, the relationship between EAI1 and the setting frequency is shown as the figure below:

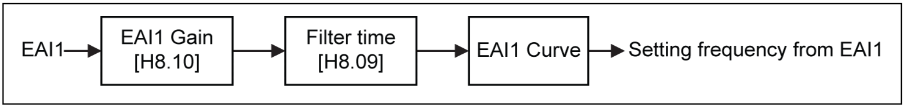


Fig. 12-48: EAI1 setting frequency

- **5: EAI2 analog input**

  The setting frequency is set by EAI2 analog input. When EAI2 is used as the frequency setting source, the relationship between EAI2 and the setting frequency is shown as the figure below:

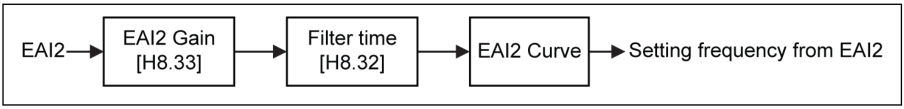


Fig. 12-49: EAI2 setting frequency

- **10: X5 pulse input**

  The setting frequency is set by pulse input via X5 input. When X5 pulse input is used as the frequency setting source, the setting frequency can be changed by changing the pulse frequency. The relationship between X5 pulse input and the setting frequency is shown as the figure below:

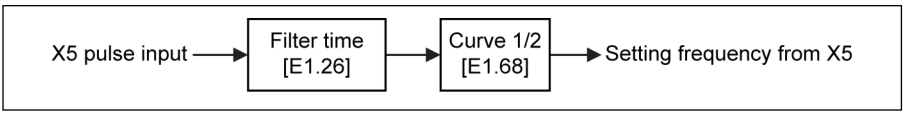


Fig. 12-50: X5 setting frequency

- **11: Digital input Up / Down command**

  The setting frequency is set by command of Up / Down / Reset via digital inputs. The setting frequency will increase with Up command active, decrease with Down command active, reset to '0' with Reset command active.

  Any three digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 can be set to 20 'Frequency Up command' and 21 'Frequency Down command' and 22 'Up/Down command reset' to define this function.

  For digital input Up / Down change rate and digital input Up / Down initial frequency, see parameter E1.16 and E1.17.

- **20: Communication**

The setting frequency is set by engineering software, PLC or other external device via Modbus protocol.

- **21: Multi-speed settings**

  The setting frequency is set by multi-speed settings, see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262 for details.

Frequency setting source switching

When [E0.04] = 0, 'Frequency setting source combination' is inactive. The setting frequency can be switched between the first and second frequency setting source by setting digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 to 30 'Second frequency setting source activation'. The active / inactive of the selected digital input is triggered by voltage level, instead of the edge.

If status of the selected digital input is changed when frequency converter is running, the frequency setting source will be switched instantly and the frequency converter will accelerate / decelerate according to the actual setting frequency of respective frequency setting source.

To use the frequency setting source switching function, take the following steps:

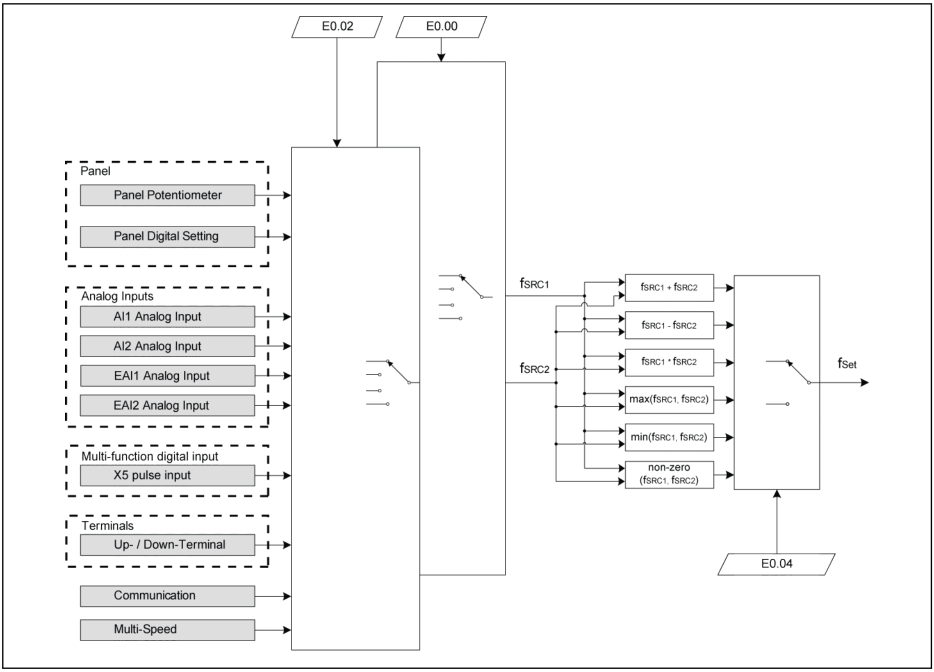
- **Step 1**: Check and be sure that [E0.04] = '0: No combination';
- **Step 2**: Select the second frequency setting source by setting parameter E0.02;
- **Step 3**: Configure the setting frequency for the selected frequency setting source;
- **Step 4**: Select a digital input terminal, and set its function to '30: Second frequency setting source activation'.

Example: [E0.00] = '0: Panel potentiometer', the setting frequency of the first frequency setting source is 30.00 Hz. [E0.02] = '3: AI2 analog input', the setting frequency of the second frequency setting source is 50.00 Hz. Set [E1.00] = 30, X1 is used to switch the setting frequency between the first and the second frequency sources.

- When X1 input is inactive, the actual setting frequency is 30.00 Hz set by panel potentiometer.
- When X1 input is active, the actual setting frequency is 50.00 Hz set by AI2 input and the converter accelerates from 30.00 Hz to 50.00 Hz.

Frequency setting sources combination

It is possible to combine the two frequency setting sources for complicated applications:



f_{SRC1} First frequency setting source

f_{SRC2} Second frequency setting source

f_{Set} Setting frequency

Fig. 12-51: Frequency setting sources combination

Related parameter:

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.04	Frequency setting source combination	0...6	0	-	-	Stop

Setting range of E0.04:

- **0: No combination**

  By default, actual setting frequency is set by 'First frequency setting source'. 'Second frequency setting source' can be activated by setting one of digital inputs to 30 'Second frequency setting source activation'.

- **1: First frequency setting + Second frequency setting**

  The actual setting frequency is the result of the addition operation of the first and second frequency setting sources.

- **2: First frequency setting - Second frequency setting**

  The actual setting frequency is the result of the subtraction operation of the first and second frequency setting sources.

- **3: First frequency setting * Second frequency setting**

The actual setting frequency is the result of the multiplication operation of the first and second frequency setting sources.

- 4: Bigger one of 2 sources

  The actual setting frequency is the bigger one of the first and second frequency setting sources.

- 5: Smaller one of 2 sources

  The actual setting frequency is the smaller one of the first and second frequency setting sources.

- 6: Valid which channel is non-zero

  If the first frequency setting sources ≠ 0Hz and the second frequency setting sources ≠ 0Hz; then the actual setting frequency is the first frequency setting sources

  If the first frequency setting sources ≠ 0Hz and the second frequency setting sources = 0Hz; then the actual setting frequency is the first frequency setting sources

  If the first frequency setting sources = 0Hz and the second frequency setting sources ≠ 0Hz; then the actual setting frequency is the second frequency setting sources

  If the first frequency setting sources = 0Hz and the second frequency setting sources = 0Hz; then the actual setting frequency is 0Hz.

To use the frequency setting source combination function, take the following steps:

- Step 1: Be sure that no digital inputs is set to '30: Second frequency setting source activation' to deactivate the frequency setting source switching function;
- Step 2: Set parameter E0.00 and E0.02 to select the first and second frequency setting sources;
- Step 3: Set parameter E0.04 according to the actual application.

☞ The result of the combination is always limited within the range of 0.00...[E0.09] Hz.

12.8.2 Run Command Source

Different run command sources can be selected by setting parameter E0.01 'First run command source' or E0.03 'Second run command source'.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.01	First run command source	0...2	0	-	-	Stop
E0.03	Second run command source	0...2	1	-	-	Stop

Setting range of E0.01, E0.03:

- **0: Operating panel**

  Control the frequency converter for run and stop with <Run>, <Stop> buttons on the operating panel.

  Control the running direction by setting parameters U0.00 'Direction control by panel' and E0.17 'Direction control'.

- **1: Multi-function digital input**

  Control the frequency converter for run, stop and running direction by setting digital inputs.

- **2: Communication**

  Control the frequency converter for run, stop and running direction with Modbus communication protocol.

  The run command can be switched between the first and second frequency setting source by setting digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 to 31 'Second run command source activation'. The active / inactive of the selected digital input is triggered by voltage level, instead of the edge.

  If status of the selected terminal is changed when converter is running, the run command source will be switched and the converter will freewheel to stop.

12.8.3 Digital Setting Frequency

This function defines the digital setting frequency and four different saving modes during fine tuning of the setting frequency by using <▲> / <▼> or digital inputs, so that unexpected data loss in commissioning or actual application engineering process can be avoided.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.06	Digital setting frequency saving mode	0...4	0	-	-	Stop
E0.07	Digital setting frequency	0.00...[E0.09] Hz	50.00	Hz	0.01	Run

When parameter E0.00 'First frequency setting source' or E0.02 'Second frequency setting source' is set to 1 'Panel button setting', the setting frequency is set by parameter E0.07 'Digital setting frequency'. Pressing <▲> and <▼> buttons on the operating panel will decrease and increase the output frequency respectively when the frequency converter is running.

During fine tuning of the setting frequency by using <▲> / <▼> or digital inputs in the actual application engineering process, E0.06 'Digital setting frequency saving mode' defines the following saving modes:

- 0: Not saved when powered off or stopped
- 1: Not saved when powered off; saved when stopped
- 2: Saved when powered off; not saved when stopped
- 3: Saved when powered off or stopped
- 4: Not saved when powered off; memorized when stopped

12.8.4 Frequency Limitations

This function defines direct output frequency limitation, reverse running frequency, and behavior at low speed running.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.08	Maximum output frequency	50.00...400.00 Hz	50.00	Hz	0.01	Stop
E0.09	Output frequency high limit	[E0.10]...[E0.08] Hz	50.00	Hz	0.01	Run
E0.10	Output frequency low limit	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E0.11	Reverse running frequency	0.00...[E0.09] Hz	0.00	Hz	0.01	Stop
E0.15	Low speed running setting	0: Run with 0.00 Hz 1: Run with low limit frequency	0	-	-	Stop
E0.16	Low speed frequency hysteresis	0.00...[E0.10] Hz	0.00	Hz	0.01	Stop

Direct output frequency limitation:

- E0.08 'Maximum output frequency'

  The allowed maximum output frequency of the frequency converter.

- E0.09 'Output frequency high limit'

  The allowed maximum output frequency according to the requirements in actual applications.

- E0.10 'Output frequency low limit'

  The allowed minimum output frequency according to the requirements in actual applications.

E0.11 'Reverse running frequency'

- E0.11 'Reverse running frequency'

  When frequency converter's running direction is "reverse", the setting frequency is decided by the value of E0.11 if the reverse running frequency parameter (E0.11) is configured to a non-zero value.

Reverse running frequency is ONLY active when converter is NOT running in multi-speed, simple PLC, or PID control mode.

Behavior at low speed running:

By default, the frequency converter runs at 0 Hz when the output frequency is lower than [E0.10] 'Output frequency low limit'.

- [E0.15] = 0: Running at 0.00 Hz

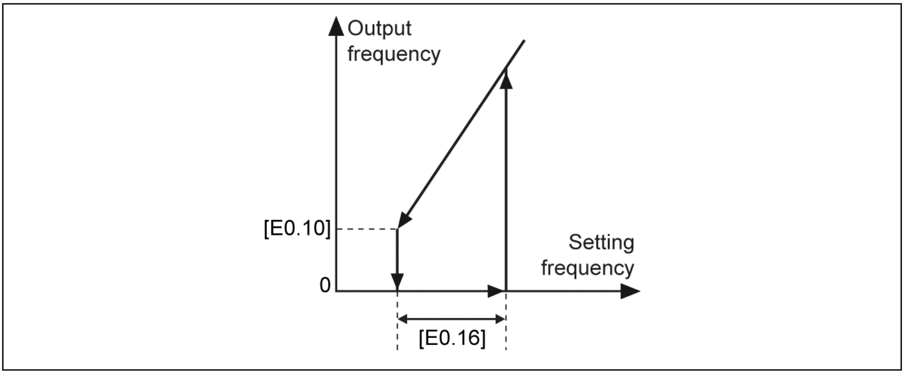


Fig. 12-52: Running at 0 Hz

For applications, in which the running frequency cannot be too low, define the low limit frequency running mode when the output frequency is lower than [E0.10] 'Output frequency low limit'.

- **[E0.15] = 1: Running with low limit frequency**

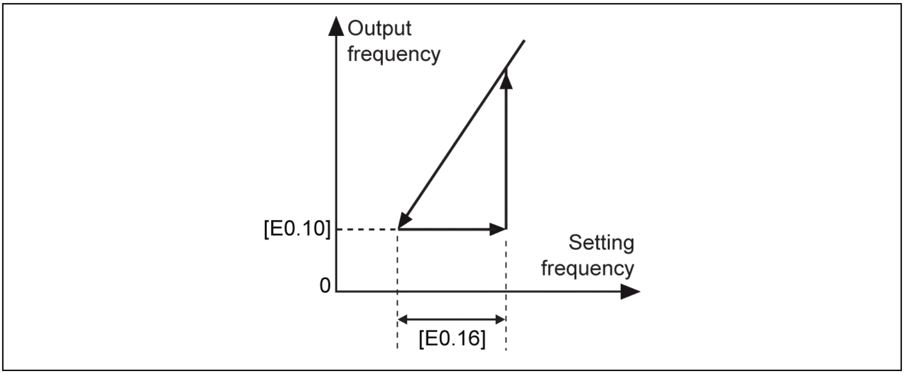


Fig. 12-53: Run with low limit frequency

A hysteresis band is set by [E0.16]. If actual setting frequency is higher than [E0.10] + [E0.16] again, the output frequency will accelerate from [E0.10] to the setting frequency according to the actual acceleration time.

If [E0.10] < [E0.16], [E0.16] will be set as [E0.10] automatically.

12.8.5 Direction Control

This function defines the rotation direction control with adjustable dead zone.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.17	Direction control	0: Forward / Reverse 1: Forward only 2: Reverse only 3: Swap default direction	0	-	-	Stop
E0.18	Direction change dead time	0.0...60.0 s	1.0	-	0.1	Stop

The actual direction of converter is controlled by the configuration of parameter [U0.00] 'Direction control by panel' and [E0.17] 'Direction control'.

[E0.17] setting		[U0.00] setting	Actual direction
0	Forward / Reverse	Forward	Forward
		Reverse	Reverse
1	Forward only	Forward	Forward
		Reverse	Converter stop and show error code 'dir1'
2	Reverse only	Forward	Converter stop and show error code 'dir2'
		Reverse	Reverse
3	Swap default direction	Forward	Reverse
		Reverse	Forward

Tab. 12-8: Direction configuration

A dead time exists if the direction is changed from forward / reverse to reverse / forward, which can be defined according to actual application.

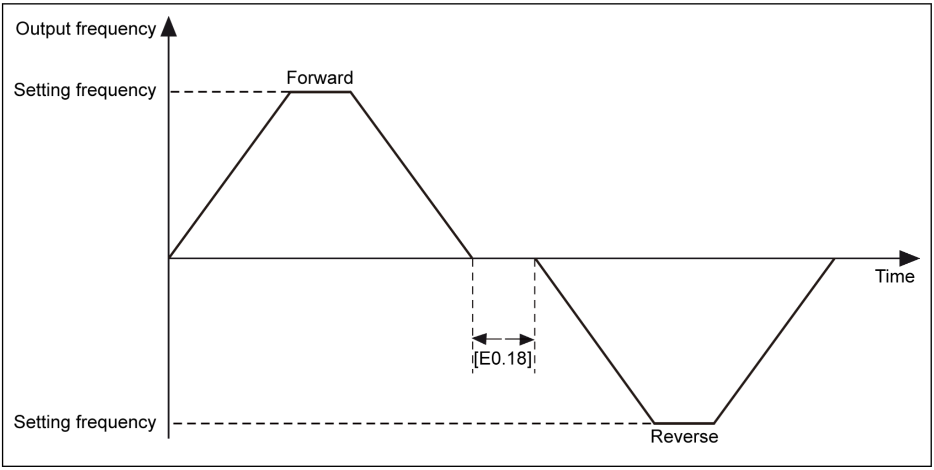


Fig. 12-54: Direction change dead time

12.8.6 Acceleration and Deceleration Setting

This function defines the configuration of acceleration and deceleration process.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.25	Acceleration / deceleration curve mode	0: Linear mode 1: S-curve	0	-	-	Stop
E0.26	Acceleration time	0.1...6,000.0 s	DOM	s	0.1	Run
E0.27	Deceleration time	0.1...6,000.0 s	DOM	s	0.1	Run
E0.28	S-curve starting phase factor	0.0...40.0 %	20.0	-	0.1	Stop
E0.29	S-curve stopping phase factor	0.0...40.0 %	20.0	-	0.1	Stop

'Acceleration time' is the time for frequency increase from 0.00 Hz to [E0.08] 'Maximum output frequency'.

'Deceleration time' is the time for frequency decrease from [E0.08] 'Maximum output frequency' to 0.00 Hz.

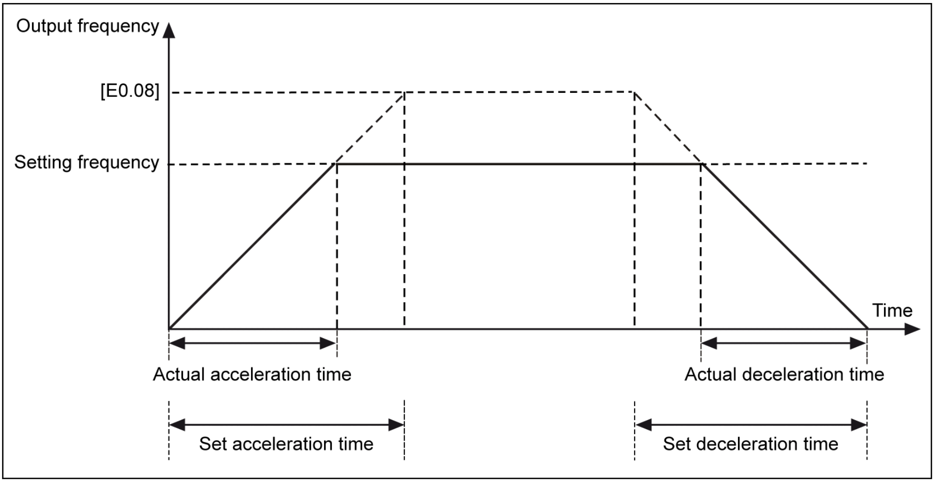


Fig. 12-55: Acceleration and deceleration time

There are eight groups of acceleration / deceleration time which is selected with external control terminals. Group E0.26 and E0.27 is used as default value if no acceleration / deceleration time terminal is defined. For using of other acceleration / deceleration time which is defined by E3.10...E3.23, up to three terminals of E1.00...E1.04 and H8.00...H8.04 should be selected to '10: Acceleration / deceleration time 1 activation', '11: Acceleration / deceleration time 2 activation' and '12: Acceleration / deceleration time 3 activation'. See chapter 12.11.1 "Simple PLC and Multi-Speed Setting" on page 262.

Two curve modes are available for acceleration / deceleration which is defined by [E0.25] : 'linear curve' and 'S-curve'.

- [E0.25] = 0: Linear mode

Linear mode is used for normal application situations:

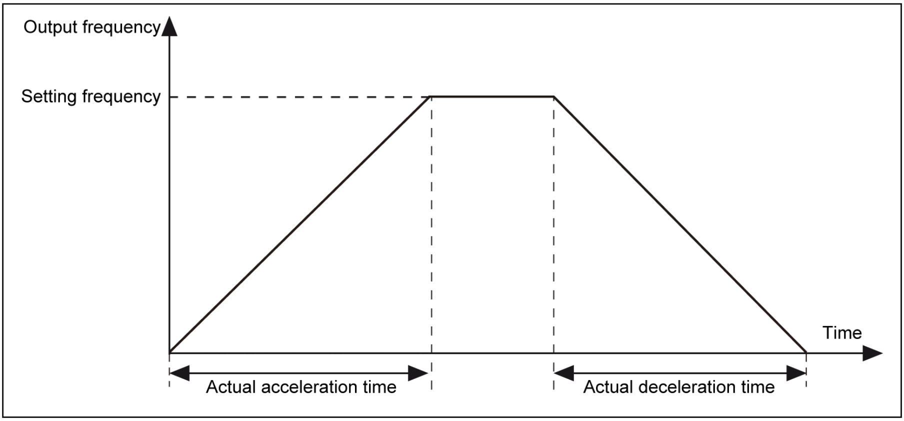
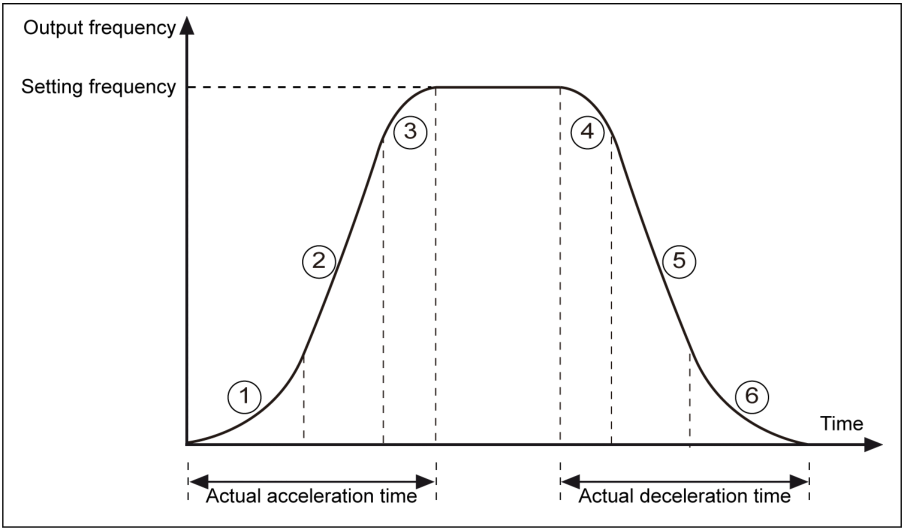


Fig. 12-56: Linear mode acceleration and deceleration

- [E0.25] = 1: S-curve

  S-curve mode is used to achieve a smooth starting or stopping:



① [E0.28] Acceleration starting phase
③ [E0.29] Acceleration stopping phase
④ [E0.28] Deceleration starting phase
⑥ [E0.29] Deceleration stopping phase

Fig. 12-57: S-curve acceleration and deceleration

Stage ①, ③: a percentage of setting acceleration time.

Stage ④, ⑥: a percentage of setting deceleration time.

12.8.7 Start Mode Configuration

This function defines different start modes in different applications.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.35	Start mode	0: Start directly 1: DC-braking before start 2: Start with speed tracing 3: Automatic start / stop according to setting frequency	0	-	-	Stop
E0.36	Start frequency	0.00...50.00 Hz	0.05	Hz	0.01	Stop
E0.37	Start frequency holding time	0.0...20.0 s	0.0	s	0.1	Stop
E0.38	Start DC-braking time	0.0...20.0 s (0.0: Inactive)	0.0	s	0.1	Stop
E0.39	Start DC-braking current	0.0...150.0 %	0.0	-	0.1	Stop
E0.41	Automatic start / stop frequency threshold	0.01...[E0.09] Hz	16.00	Hz	0.01	Stop
E0.42	Speed tracing voltage recovery ratio	0...20	10	-	1	Stop
E0.43	Speed tracing deceleration time	0.5...20.0s	2.0	s	0.1	Stop

Start directly

This mode is used in applications with high static friction torque and low load inertia. The frequency converter runs at [E0.36] 'Start frequency' for [E0.37] 'Start frequency holding time', and then accelerates/decelerates to setting frequency with defined acceleration/deceleration time.

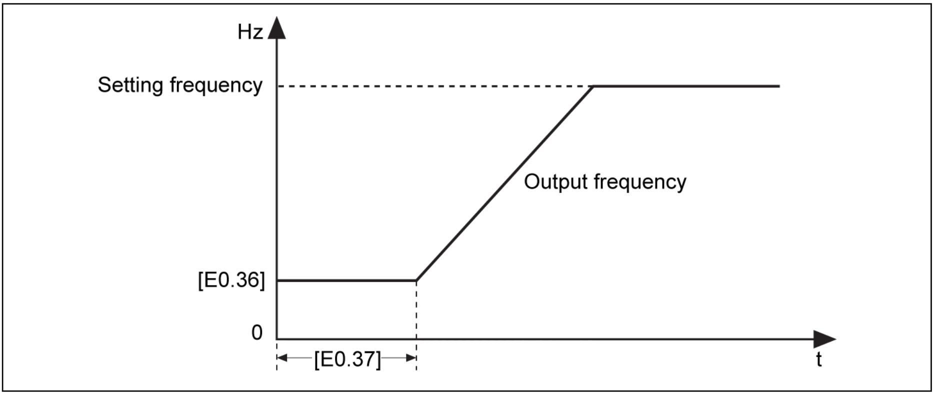


Fig. 12-58: Start directly

Set parameter E0.37 'Start frequency holding time' to a non-zero value when the motor needs to be started with certain start frequency.

DC-braking before start

'DC-braking before start' is used in applications where the load may encounter forward / reverse rotation when the frequency converter is in stop mode. The larger DC-braking current, the larger braking force. However, the withstanding capability of the motor has to be considered before use the DC-braking function.

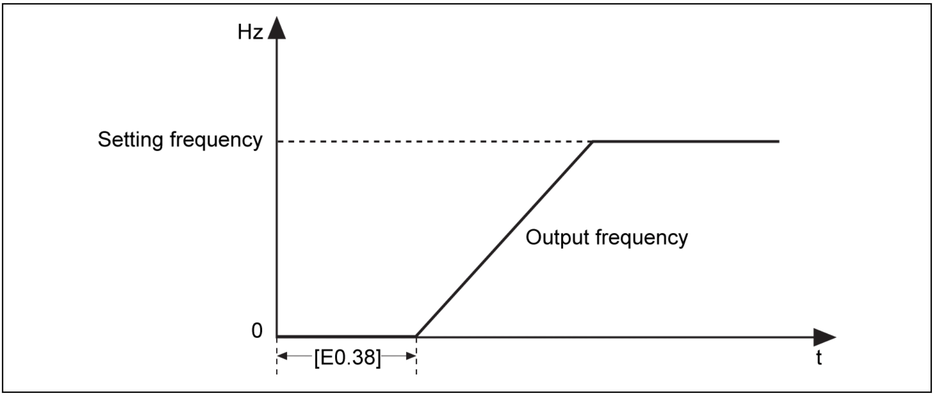


Fig. 12-59: DC-braking before start

- When [E0.38] ≠ 0, DC-braking will be executed before the frequency converter starting to accelerate to [E0.36] 'Start frequency', the braking current is decided by [E0.39].
- When [E0.38] = 0, the converter starts at the starting frequency.

[E0.39] 'Start DC-braking current' is the percentage of frequency converter rated current.

Start with speed tracing

This mode is used after transient power fault in applications with a large inertia load. The frequency converter firstly identifies the rotation speed and direction of the motor, and then starts with the current frequency of the motor to realize smooth starting without shock to the rotating motor.

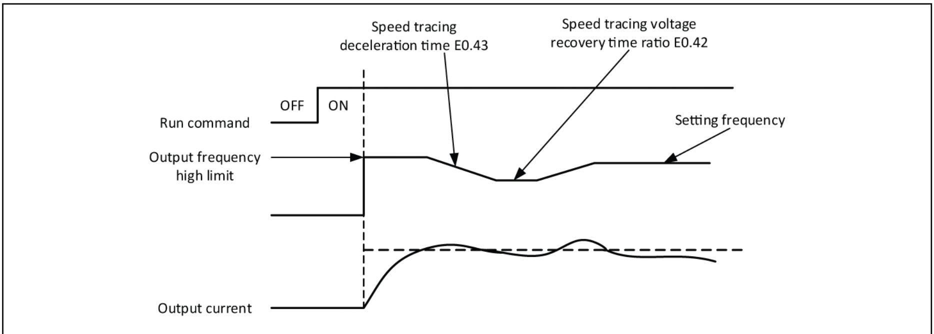


Fig. 12-60: Start with speed tracing

E0.42 sets the time ratio for the drive to restore the output voltage to the level specified by the V/f mode after speed tracing. The larger setting value is, the faster voltage recovery is. But the setting value is too large will cause an overcurrent. In the low-power converter this value can be set larger, in the high-power converter this value should be set smaller.

E0.43 is the deceleration time for the speed tracing.

Automatic start / stop according to setting frequency

This function defines converter automatic start / stop according to setting frequency.

With this function, the converter starts when the setting frequency from analog input is higher than the threshold, and stops when the setting frequency from analog input is lower than the threshold. The threshold is set by parameter E0.41 'Automatic start / stop frequency threshold'.

To use this function, follow the rules below:

- The frequency setting source should be set to analog inputs.
- The first and second run command source should be set to '0: Panel'.

Related parameters setting:

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.35	Starting mode	3: Auto start / stop according to setting frequency	0	-	-	Stop
E0.00	First frequency setting source	2: AI1 analog input 3: AI2 analog input 4: EAI1 analog input 5: EAI2 analog input	0	-	-	Stop
E0.02	Second frequency setting source		2	-	-	Stop
E0.01	First run command source	0: Panel	0	-	-	Stop
E0.03	Second run command source		1	-	-	Stop

The logic of automatic start or stop according to frequency threshold is shown as below:

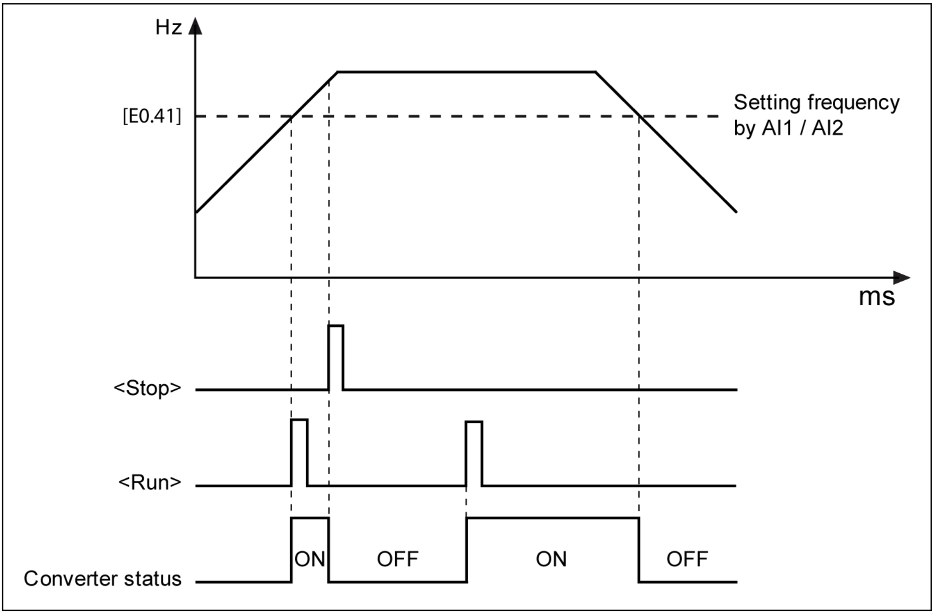


Fig. 12-61: Automatic start or stop according to frequency threshold

When the setting frequency is higher than [E0.41], the frequency converter starts and runs to the setting frequency automatically.

1. Pressing <Stop> at this time, the frequency converter stops.
2. Pressing <Run> again, the frequency converter runs again.

When the setting frequency is lower than [E0.41], the frequency converter stops automatically.

☞

- If the threshold [E0.41] is set higher than the setting frequency high limit [E0.09], the threshold will be limited to the high limit [E0.09].
- Make sure that:

  1. The first and the second run command sources are both via panel.

  2. The active frequency setting source is via analog inputs.

  3. The simple PLC, PID control and jog function are deactivated.

  Otherwise, E0.35 'Starting mode' cannot be set to '3: Auto start / stop according to setting frequency'. In this case, warning code 'PrSE' will be displayed and the frequency converter keeps in stop status.

12.8.8 Power Loss Restart

Power loss restart

This function allows the converter to start running automatically after power on if the converter was running before power off.

Related parameters:

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.45	Power loss restart mode	0: Inactive 1: Active for panel control 2: Active for digital input control	0	-	-	Stop
E0.46	Power loss restart delay	0.0...10.0	10.0	s	0.1	Stop

Setting range of E0.45:

- **E0.45=0: Inactive**

  Power loss restart feature is disabled.

- **E0.45=1: Active for panel control**

  When [E0.01]/[E0.03] = 0 (Operating panel), if the converter is running before power off, then converter will automatically start after waiting for the time of [E0.46] after power-on.

- **E0.45=2: Active for digital input control**

  When [E0.01]/[E0.03] = 1 (Multi-function digital input), if the converter is running before power off, then converter will automatically start after waiting for the time of [E0.46] after power-on.

- Power loss restart function is active for panel and digital input control only.
- When E0.45 select "1" or "2", if the power supply of frequency converter and the error "UE-1" recover within the time of [E9.01], the frequency converter will restart.

⚠ WARNING **The power loss restart function may cause damage to people and equipment!**

The power loss restart function can make the frequency converter run automatically after the power supply is restored, which may cause damage to people and equipment.

12.8.9 Stop Mode Configuration

This function defines different stop modes for different applications.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.50	Stop mode	0: Decelerating stop 1: Freewheeling stop 1 2: Freewheeling stop 2	0	-	-	Stop

Setting range of E0.50:

- **[E0.50] = 0: Decelerating stop**

  The motor decelerates to stop according to the defined deceleration time.

  In this stop mode DC-braking can be activated by parameter settings or by digital inputs.

- **[E0.50] = 1: Freewheeling stop 1**

  Once the stopping command is activated, the converter stops output and the motor mechanically freewheels to stop.

  'Freewheeling stop' can also be activated by digital inputs. When the digital input signal is active, the frequency converter freewheels to stop. If the digital input signal is inactive and a run command is active, the frequency converter resumes the previous running status.

- **[E0.50] = 2: Freewheeling stop 2**
  - When stopping command is active, the motor freewheels to stop as [E0.50] = 1.
  - When direction command is changed during running, the motor decelerates to stop according to the defined deceleration time as [E0.50] = 0.

☞ If an error occurs due to too fast deceleration, increase the deceleration time or calculate if additional resistor braking is necessary.

12.8.10 Stop DC-braking

This function defines DC-braking during deceleration to stop.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.47	Run command priority	0: High priority 1: Low priority	0	-	-	Stop
E0.51	Stop DC-braking waiting time	0.00…100.00 s	0.00	s	0.01	Stop
E0.52	Stop DC-braking initial frequency	0.00…50.00 Hz	0.00	Hz	0.01	Stop
E0.53	Stop DC-braking time	0.0…20.0 s (0.0: Inactive)	0.1	s	0.1	Stop
E0.54	Stop DC-braking current	0.0…150.0 %	0.0	-	0.1	Stop

Setting range of E0.50:

- E0.47 = 0: High priority

  If run command comes during stop DC braking, stop DC braking will be stopped and run command is active.
- E0.47 = 1: Low priority

  If run command comes during stop DC braking, run command will get active after stop DC braking finish.

'DC-braking to stop' can be activated in two ways:

1. By parameter settings

   During decelerating stop process, if 'Output frequency' is lower than [E0.52] 'Stop DC-braking initial frequency' and 'Stop DC-braking time' [E0.53] ≠ 0, then DC-braking is activated. The 'Stop DC-braking current' is decided by [E0.54]:

   - [E0.50] = 0;
   - [E0.53] > 0;
   - [E0.54] > 0;
   - [Output frequency] ≤ [E0.52].

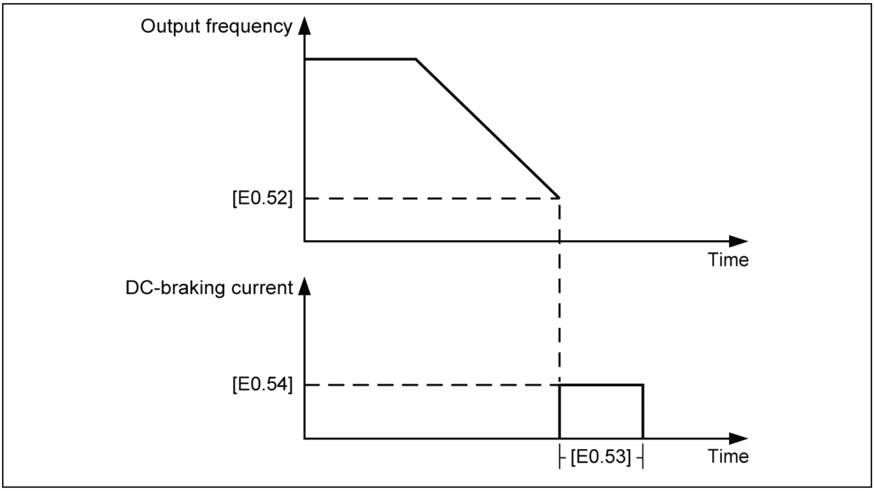


Fig. 12-62: Stop DC-braking_1

2. **By digital inputs**

   During decelerating stop process, if 'Output frequency' is lower than [E0.52] 'Stop DC-braking initial frequency' and the defined digital input signal is active, then DC-braking is activated:

   - Any one of digital inputs is set to '16: Stop DC-braking activation'.
   - [E0.50] = 0.
   - DC-braking starts when the defined digital input signal is active and [Output frequency] ≤ [E0.52], and stops when digital input is inactive. There is no time limitation.

With some special cases when 'DC-braking to stop' is activated by parameter setting and meanwhile digital input active, please see figures below:

Case 1: Xn active before the DC braking starts and inactive before [E0.53] ends.

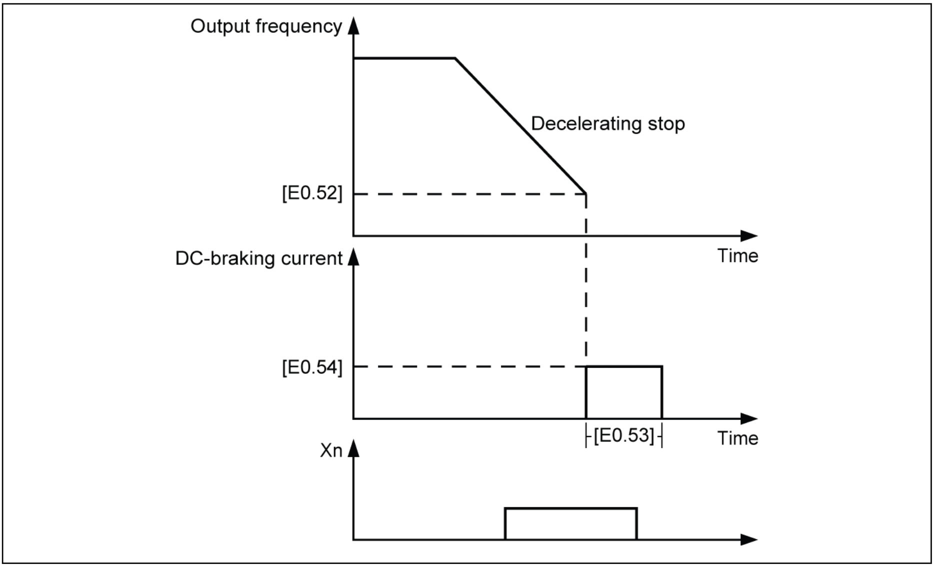


Fig. 12-63: Stop DC-braking_2

Case 2: Xn active after the DC braking starts and inactive before [E0.53] ends.

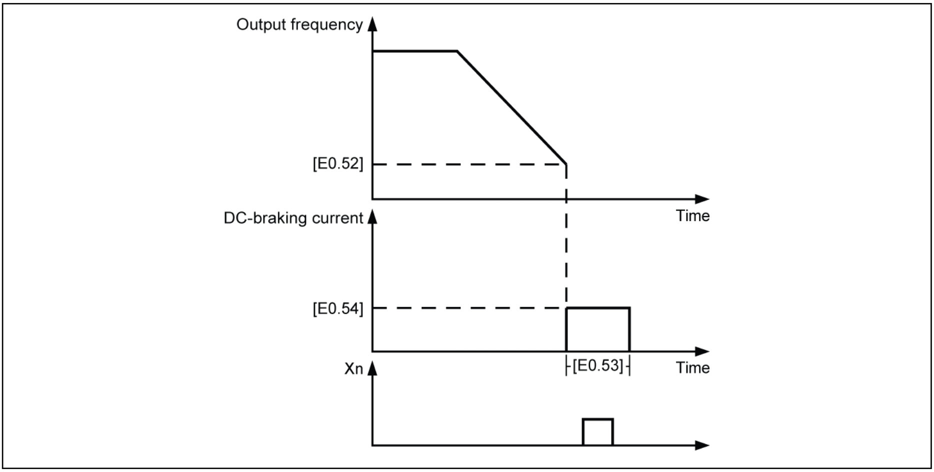


Fig. 12-64: Stop DC-braking_3

Case 3: Xn active before the DC braking starts and inactive after [E0.53] ends.

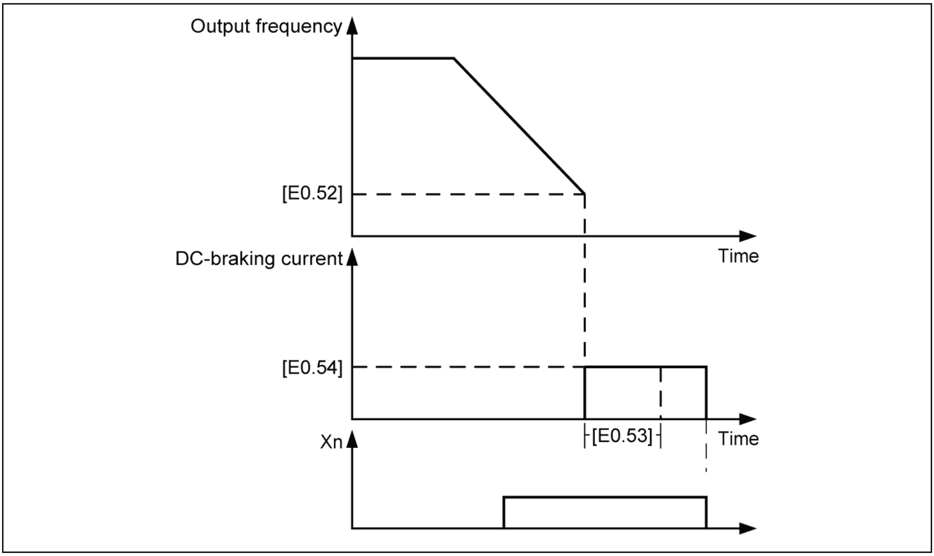


Fig. 12-65: Stop DC-braking_4

Case 4: Xn active after the DC braking starts and inactive after [E0.53] ends.

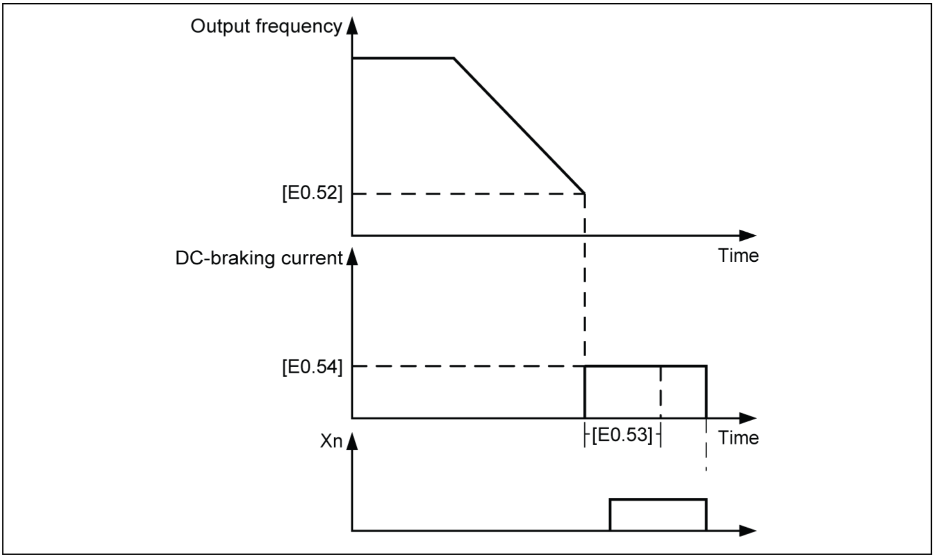


Fig. 12-66: Stop DC-braking_5

12.8.11 Overexcitation Braking

Overexcitation braking is used to obtain an optimized braking performance of the frequency converter in V/f control mode. To realize this function, increase 'Converter output voltage' by fine tuning of parameter E0.55 'Overexcitation braking factor' during deceleration process.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.55	Overexcitation braking factor	1.00...2.00	1.10	-	0.01	Run

- When [E0.55] = 1.00, 'Overexcitation braking' is inactive.
- A higher factor brings a higher braking force.

However, an excessive high factor may trigger errors of overcurrent (OC-1, OC-2, OC-3), converter overload (OL-1), motor overload (OL-2), or surge current / short circuit (SC). Reduce the setting of the factor in such cases.

12.8.12 Emergency Stop

This function defines the stop mode when emergency stop is activated (E-st is shown on panel) through digital input or control word via field bus.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.56	Emergency stop action	0: Freewheeling stop 1: Decelerating stop	0	-	-	Stop
E0.57	Emergency stop deceleration time	0.1...6,000.0 s	5.0	s	0.1	Run

Setting range of E0.56:

- **[E0.56] = 0: Freewheeling stop**

  Once the emergency stop command is activated, the converter stops output and the motor mechanically freewheels to stop.

- **[E0.56] = 1: Decelerating stop**

  The motor decelerates to stop according to the deceleration time defined by E0.57 'Emergency stop deceleration time'.

12.8.13 Jog Function

This function is used for flexible control. When command comes, the motor runs with predefined speed, after command inactive, the motor goes back to previous status.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.60	Jog frequency	0.00...[E0.08] Hz	5.00	Hz	0.01	Run
E0.61	Jog acceleration time	0.1...6,000.0 s	5.0	s	0.1	Run
E0.62	Jog deceleration time	0.1...6,000.0 s	5.0	s	0.1	Run

The 'Jog command' has a higher priority than and is independent of the 'Run / Stop command'. This function can ONLY be set by digital input or communication.

To use this function, take the following steps:

Step 1: Select any 2 digital inputs

Set any 2 digital inputs of E1.00...E1.04 and H8.00...H8. 04 to 37 'Forward jog' and 38 'Reverse jog'.

Step 2: Set respective parameters

Set Jog function parameters E0.60...E0.62 according to application.

Once the 'Jog command' is active, the frequency converter runs immediately to [E0.60] 'Jog frequency' with acceleration / deceleration time defined by 'Jog acceleration time' [E0.61] / 'Jog deceleration time' [E0.62] no matter the converter is running or not. When 'Jog command' is inactive, the motor resumes the previous status.

- **Converter is at stop**
  - 'Jog command' active: Accelerate to [E0.60] 'Jog frequency' according to [E0.61] 'Jog acceleration time'.
  - 'Jog command' inactive: Deceleration time is according to [E0.62] 'Jog deceleration time'.
- **Converter is running**
  - **Output frequency' is higher than 'Jog frequency'**
    - 'Jog command' active: Decelerate to [E0.60] 'Jog frequency' according to [E0.62] 'Jog deceleration time'.
    - 'Jog command' inactive: Accelerate to previous 'Setting frequency' according to [E0.26] 'Acceleration time'.
  - **Output frequency' is higher than 'Jog frequency'**
    - 'Jog command' active: Accelerate to [E0.60] 'Jog frequency' according to [E0.61] 'Jog acceleration time'.
    - 'Jog command' inactive: Decelerate to prior 'Setting frequency' according to [E0.27] 'Deceleration time'.

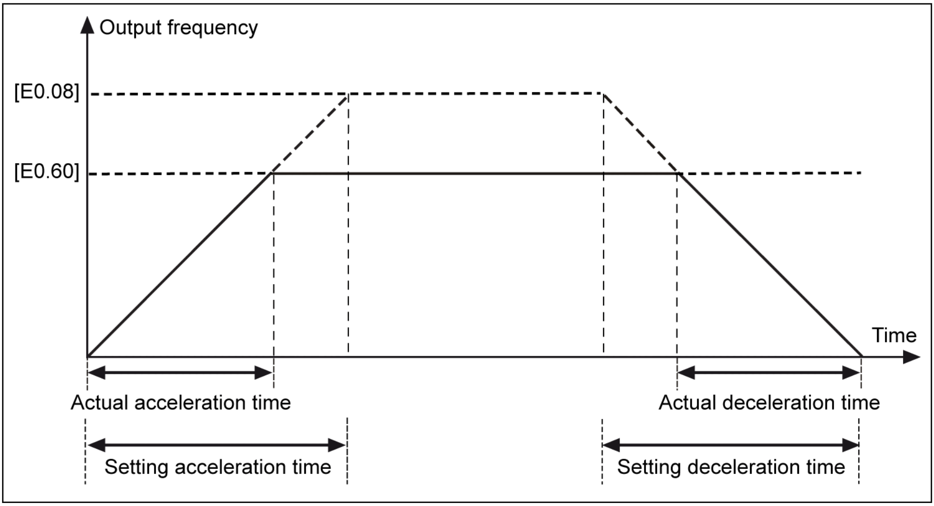


Fig. 12-67: Jog acceleration / deceleration time

Forward jog	Reverse jog	Running status
Active	Active	Stop
Active	Inactive	Jog forward
Inactive	Active	Jog reverse

Tab. 12-9: Jog configuration

☞ If the jog command direction does not match the current jog running direction, the converter will stop according to [E0.50] 'Stop mode'.

12.8.14 Skip Frequency

This function is implemented to define a few skip frequencies to avoid the mechanical resonance . If the running frequency is in the hysteresis range of defined skip frequency, the frequency is set to the upper/lower limit automatically to skip this frequency area.

Code	Name	Setting range	Default	Unit	Step	Attri.
E0.70	Skip frequency 1	0.00...[E0.09] Hz	0.00	Hz	0.01	Stop
E0.71	Skip frequency 2	0.00...[E0.09] Hz	0.00	Hz	0.01	Stop
E0.72	Skip frequency 3	0.00...[E0.09] Hz	0.00	Hz	0.01	Stop
E0.73	Skip frequency range	0.00...30.00 Hz	0.00	-	0.01	Stop
E0.74	Skip window acceleration factor	1...100	1	-	1	Stop

The setting ranges of the three skip frequencies are shown in the figure below:

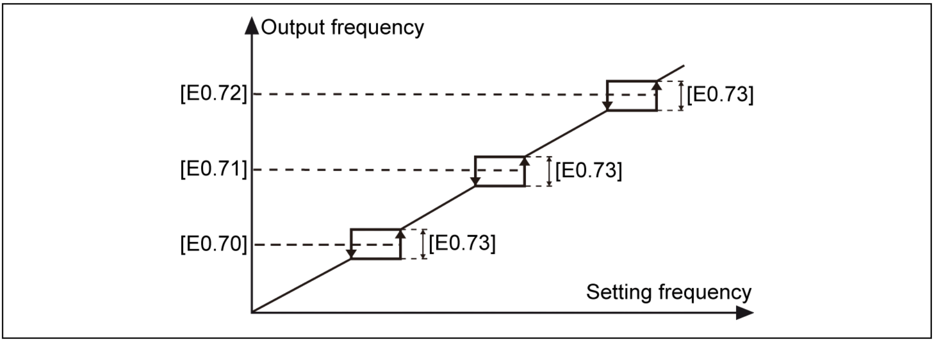


Fig. 12-68: Skip frequency 1

Skip frequency points are defined by parameters E0.70...E0.72. Skip frequency range or boundaries are defined by parameter E0.73 as listed below:

- [Upper boundary frequency] = [Skip frequency] + [E0.73]/2
- [Lower boundary frequency] = [Skip frequency] - [E0.73]/2

If the current 'Output frequency' is higher than the 'Upper boundary frequency', and the target 'Setting frequency' is within the 'Skip frequency range', the actual output frequency will be limited to 'Upper boundary frequency'.

If the current 'Output frequency' is lower than the 'Lower boundary frequency', and the target 'Setting frequency' is within the 'Skip frequency range', the actual output frequency will be limited to 'Lower boundary frequency'.

If the current 'Output frequency' is within the 'Skip frequency range' and the target 'Setting frequency' is also within the range, the actual output frequency is previous output frequency.

☞

- If the lower frequency of one active skip frequency range is below zero, the lower frequency is limited to 0Hz.

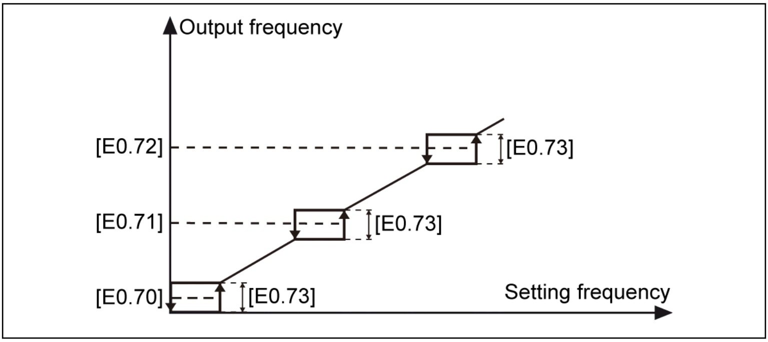


Fig. 12-69: Skip frequency 2

- It would be suggested to users not to make the three frequency ranges overlap or nest in each other. However, if users do set parameters like this by mistake, the following measure be considered.

  Setting range by users:

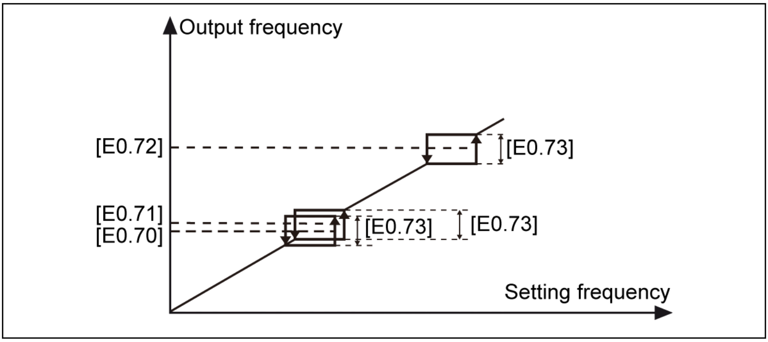


Fig. 12-70: Skip frequency 3

Actual skip range:

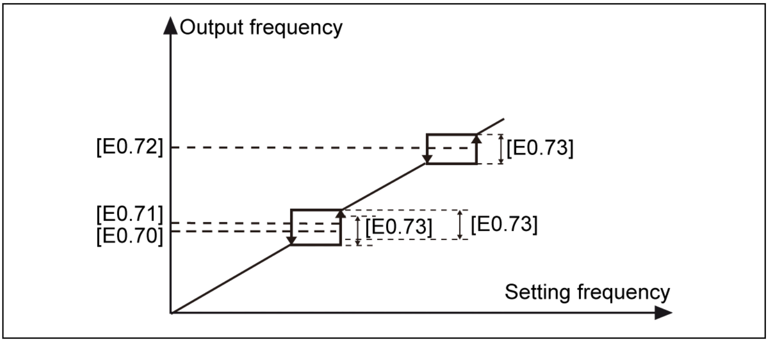


Fig. 12-71: Skip frequency 4

Parameter E0.74 is used to control the acceleration / deceleration speed inside the skip-window, the range for this factor is 1 (normal speed) to 100 (100 times speed of the normal speed). The actual acceleration / deceleration time for skip frequency is shorter than the setting value when the factor is higher than 1.

Acceleration / deceleration curve mode is S-curve(E0.25 = 1) in skipping Window:

- In the linear phase of S-curve, if E0.74 'Skip window acceleration factor' is above 1 and S-curve ramp is active, the change of acceleration will happen directly with a corner (no S-shaped curve) as long as the acceleration/ deceleration is :

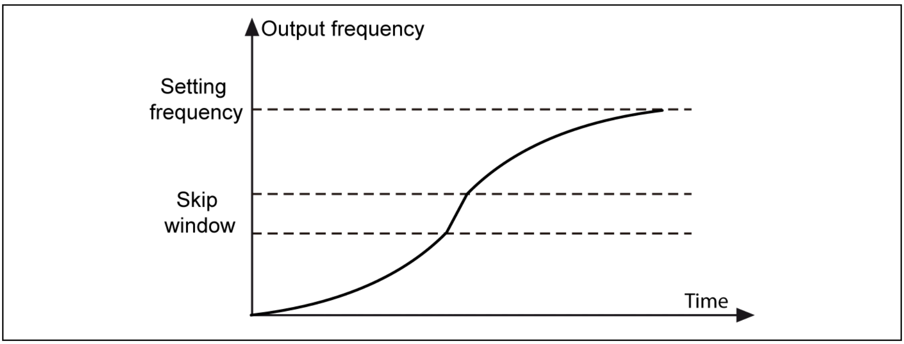


Fig. 12-72: Skip frequency 5

- In the start or end S-curve phase, E0.74 'Skip window acceleration factor' will not be active. There will be no higher acceleration or deceleration:

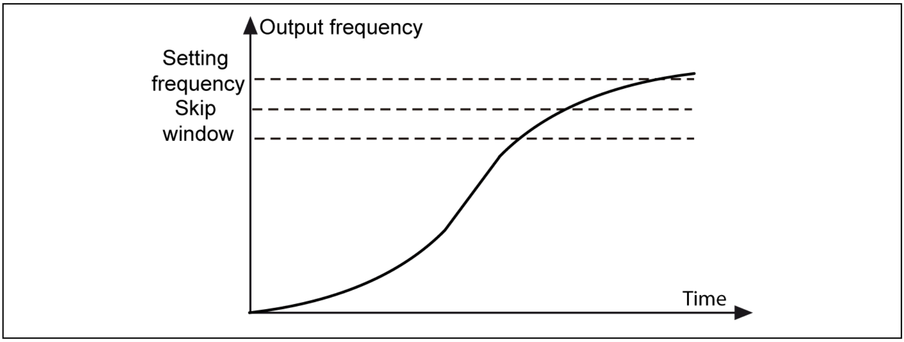


Fig. 12-73: Skip frequency 6

- If [E0.73] = 0.00, 'Skip frequency' function is inactive.
- If skip frequency is set to 0Hz, this skip frequency point is inactive.
- If acceleration or deceleration is stopped by stall protection (over current or over voltage), stall protection has priority. The frequency converter is running with constant output frequency inside the skip-window as long as stall protection is active.

12.9 E1: Input Terminal

12.9.1 Digital Input Configuration

This function defines 5 multi-function digital inputs with PNP and NPN wiring.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.00	X1 input	0...51	35	-	-	Stop
E1.01	X2 input		36	-	-	Stop
E1.02	X3 input		0	-	-	Stop
E1.03	X4 input		0	-	-	Stop
E1.04	X5 input		0	-	-	Stop

Setting range of E1.00...E1.04:

- **0: Inactive**

  No function assigned.
- **1: Multi-speed control input 1**
- **2: Multi-speed control input 2**
- **3: Multi-speed control input 3**
- **4: Multi-speed control input 4**

  16 multi-speeds are available by combination of 4 terminals, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.
- **10: Acceleration / deceleration time 1 activation**
- **11: Acceleration / deceleration time 2 activation**
- **12: Acceleration / deceleration time 3 activation**

  Used to switch between 8 groups of acceleration / deceleration time, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.
- **15: Freewheeling stop activation**

  'Freewheeling stop activation' generates a stop command and forces the frequency converter to freewheel to stop regardless of the stopping mode configured by E0.50.
- **16: Stop DC-braking activation**

  This function is used when stopping mode is set with [E0.50] = '0: Decelerating stop', details see chapter 12.8.9 "Stop Mode Configuration" on page 216.
- **20: Frequency Up command**
- **21: Frequency Down command**
- **22: Up / Down command reset**

  Used to change the output frequency, details see chapter 12.9.3 "Digital Input Frequency Change Function" on page 239.
- **23: Torque / speed control switch**

Used to switch between torque control mode and speed control mode. If the defined switch is open, speed control mode is selected; If the defined switch is closed, torque control mode is selected.

- **25: 3-wire control**

  Used for the 3-wire control mode, details see chapter 12.9.2 "2- and 3-Wire Control" on page 234.

- **26: Simple PLC stop**
- **27: Simple PLC pause**

  Used for the simple PLC to stop and pause a PLC cycle, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- **30: Second frequency setting source activation**

  Used for switching to the second frequency setting source, details see chapter 12.8.1 "Frequency Setting Source" on page 197.

- **31: Second run command source activation**

  Used for switching to the second run command source, details see chapter 12.8.2 "Run Command Source" on page 202.

- **32: Error signal N.O. contact input**
- **33: Error signal N.C. contact input**

  Used for receive error signal from external sources. The frequency converter stops once an external error signal is active and the error code 'E-St' will be displayed on the operating panel if one X1...X5 or EX1...EX5 input is defined as either 'Error signal N.O. contact input' or 'Error signal N.C. contact input'.

  – 32: Error signal N.O. contact input
    – If the defined switch is closed, the external error signal is active.
    – If the defined switch is open, the external error signal is inactive.
  – 33: Error signal N.C. contact input
    – If the defined switch is open, the external error signal is active.
    – If the defined switch is closed, the external error signal is inactive.

  The converter will stop when the external error signal is active, and the stop mode is defined by E0.56 'Emergency stop action', please see chapter 12.8.9 "Stop Mode Configuration" on page 216 for the detailed information.

  Example:

  Set [E1.00] = '32: Error signal N.O. contact input' **or**

  Set [E1.01] = '33: Error signal N.C. contact input'

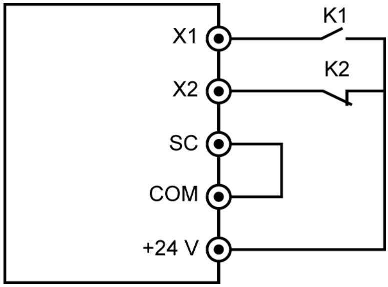


Fig. 12-74: Error signal

The frequency converter stops and indicates error code 'E-St' if K1 is closed.

Or the frequency converter stops and indicates error code 'E-St' if K2 is open.

- 34: Error reset

  Used for error reset operation. The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset signal' is edge sensitive.

- 35: Forward running (FWD)
- 36: Reverse running (REV)

  Used for Run / Stop command control, details see chapter 12.8.2 "Run Command Source" on page 202.

- 37: Forward jog
- 38: Reverse jog

  See chapter 12.8.13 "Jog Function" on page 223.

- 39: Counter input
- 40: Counter reset

  See chapter 12.10.6 "Pulse Counter Function" on page 260.

- 41: PID deactivation

  See chapter 12.12 "E4: PID Control" on page 276.

- 46: User parameter set selection

  Used to switch between two sets of parameters, details see chapter 12.1.4 "Parameter Set Switch" on page 123.

- 47: Pulse input mode activation (ONLY for X5 input)

  See chapter 12.9.4 "Pulse Input Configuration" on page 241.

- 48: Motor overheating error N.O. contact input
- 49: Motor overheating error N.C. contact input

  Used for receive motor overheating error signal from external sources. The frequency converter stops once an external motor overheating error signal is active and the error code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating error N.O. contact input' or 'Motor overheating error N.C. contact input'.

- 48: Motor overheating error N.O. contact input
  - If the defined switch is closed, the motor overheating error signal is active.
  - If the defined switch is open, the motor overheating error signal is inactive.
- 49: Motor overheating error N.C. contact input
  - If the defined switch is open, the motor overheating error signal is active.
  - If the defined switch is closed, the motor overheating error signal is inactive.

Example:

Set [E1.00] = '48: Motor overheating error N.O. contact input' or

Set [E1.01] = '49: Motor overheating error N.C. contact input'

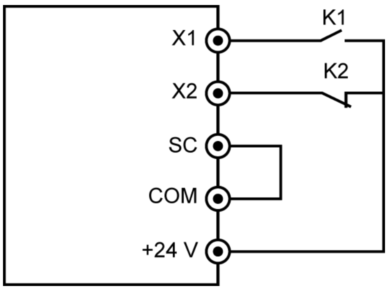


Fig. 12-75: Error signal

The frequency converter stops and indicates error code 'Ot' if K1 is closed. Or the frequency converter stops and indicates error code 'Ot' if K2 is open.

- **50: Motor overheating warning N.O. contact input**
- **51: Motor overheating warning N.C. contact input**

Used for receive motor overheating warning signal from external sources. Warning code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating warning N.O. contact input' or 'Motor overheating warning N.C. contact input'.

- 50: Motor overheating warning N.O. contact input
  - If the defined switch is closed, the motor overheating warning signal is active.
  - If the defined switch is open, the motor overheating warning signal is inactive.

– 51: Motor overheating warning N.C. contact input
  – If the defined switch is open, the motor overheating warning signal is active.
  – If the defined switch is closed, the motor overheating warning signal is inactive.

Example:

Set [E1.00] = '50: Motor overheating warning N.O. contact input' or

Set [E1.01] = '51: Motor overheating warning N.C. contact input'

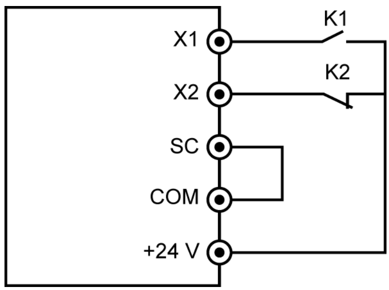


Fig. 12-76: Error signal

The frequency indicates warning code 'Ot' if K1 is closed. Or the frequency converter indicates warning code 'Ot' if K2 is open.

Digital input status is monitored by parameter d0.40 'Digital input 1'.

12.9.2 2- and 3-Wire Control

This function defines 5 modes when use digital input to trigger FWD and REV running.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.15	2-wire/3-wire control mode	0: 2-wire forward / stop, reverse / stop 1: 2-wire forward / reverse, run / stop 2: 3-wire control mode 1 3: 3-wire control mode 2 4: 1-wire control	0	-	-	Stop

Setting range of E1.15:

- **0: 2-wire forward / stop, reverse / stop**

  Step 1: Activate 2-wire control mode 1

  Set [E1.15] = '0: 2-wire forward / stop, reverse / stop'.

  Step 2: Define two digital inputs

  – Set one of digital inputs as '35: Forward running (FWD)'

  – Set one of digital inputs as '36: Reverse running (REV)'

Example:

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)'.

Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)'.

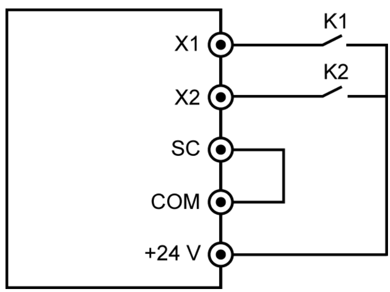


Fig. 12-77: 2-wire control mode 1

The control logic is shown in the table below:

K1	K2	Running status
Open	Open	Stop
Closed	Open	Running forward

K1	K2	Running status
Open	Closed	Running reverse
Closed	Closed	Stop

Tab. 12-10: 2-wire control mode 1 configuration

☞ If switch K1 and K2 are closed at the same time, the frequency converter stops according to [E0.50] 'Stop mode' and both FWD and REV LED indicators are lighted during stop status.

- 1: 2-wire forward / reverse, run / stop

  Step 1: Activate 2-wire control mode 2

  Set [E1.15] = '1: 2-wire forward / reverse, run / stop'.

  Step 2: Define two digital inputs

  – Set one of digital inputs as '35: Forward running (FWD)'

  – Set one of digital inputs as '36: Reverse running (REV)'

Example:

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)'.

Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)'.

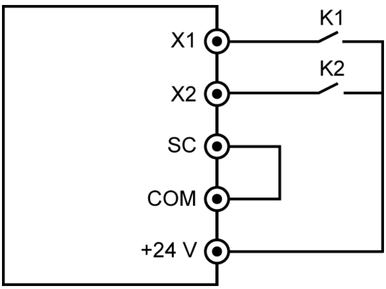


Fig. 12-78: 2-wire control mode 2

The control logic is shown in the table below:

K1	K2	Running status
Open	Open	Stop
Closed	Open	Running forward
Open	Closed	Stop
Closed	Closed	Running reverse

Tab. 12-11: 2-wire control mode 2 configuration

- 2: 3-wire control mode 1

  Step 1: Define 3 digital inputs

– Set one of digital inputs as '35: Forward running (FWD)'
– Set one of digital inputs as '36: Reverse running (REV)'
– Set one of digital inputs as '25: 3-wire control'

To use 3-wire function, define the digital inputs first, and then activate the control mode. Otherwise, warning code 'PrSE' will be displayed on the operating panel.

To deactivate the 3-wire function, deactivate the control mode first, and then deactivate the function assignment of '25: 3-wire control'. Otherwise, warning code 'PrSE' will be displayed.

Step 2: Activate 3-wire control 1

Set [E1.15] = '2: 3-wire control mode 1'.

Example:

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)', edge-sensitive.

Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)', level-sensitive.

Connected switch K3 to X3, and set [E1.02] = '25: 3-wire control', level-sensitive.

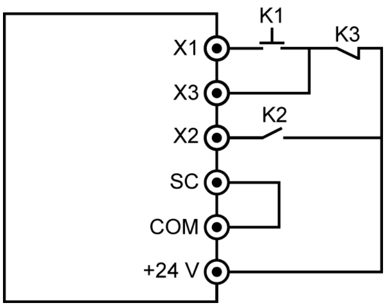


Fig. 12-79: 3-wire control 1

The control logic is shown in the table below:

K3	K1	K2	Running status
Open	Inactive / Edge	Open / Closed	Stop
Open	Inactive / Edge	Open / Closed	Stop
Closed	Edge	Open	Running forward
Closed	Inactive / Edge	Closed	Running reverse

Tab. 12-12: 3-wire control configuration

- **3: 3-wire control mode 2**

Different from the 3-wire control mode 1, 3-wire control mode 2 has an edge sensitive characteristic for direction control terminals.

Step 1: Define 3 digital inputs

– Set one of digital inputs as '35: Forward running (FWD)'
– Set one of digital inputs as '36: Reverse running (REV)'
– Set one of digital inputs as '25: 3-wire control'

Step 2: Activate 3-wire control 2

Set [E1.15] = '3: 3-wire control mode 2'.

Example:

Connected K1 to X1, set [E1.00] = '35: Forward running (FWD)', edge-sensitive.

Connected K2 to X2, set [E1.01] = '36: Reverse running (REV)', edge-sensitive.

Connected K3 to X3, set [E1.02] = '25: 3-wire control', level-sensitive.

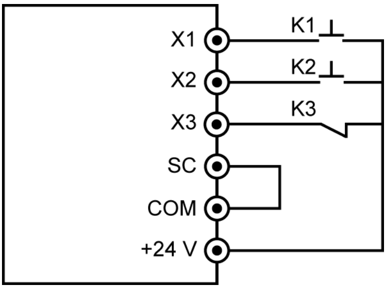


Fig. 12-80: 3-wire control mode 2

K3	K1	K2	Running status
Open	Edge / Inactive	Edge / Inactive	Stop
Closed	Edge	Inactive	Running forward
Closed	Inactive	Edge	Running reverse
Closed	Edge	Edge	No change

Tab. 12-13: 3-wire control configuration

- **4: 1-wire control**

  1-wire control mode is Run /Stop mode, it is used for multi-speed function when 9 or more stages were selected.

  Step 1: Define 1 digital input

  Set one of digital inputs as '35: Forward running (FWD)'.

  Step 2: Activate 1-wire control

  Set [E1.15] = '4: 1-wire control'.

  Example:

  Connect K5 to X5, set [E1.04] = '35: Forward running (FWD)'.

  The control logic is shown in the table below:

K5	Status
Inactive	Stop
Active	Run

Tab. 12-14: 1-wire control configuration

Detailed multi-speed information refer to chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

In 2-wire / 3-wire running control, check and ensure that the direction setting meets the requirement in the actual application. If the direction command is changed when the frequency converter is running, [E0.18] 'direction change dead time' is active.

12.9.3 Digital Input Frequency Change Function

This function allows to adjust the setting frequency by digital input Up / Down command in RUN state.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.17	Digital input Up / Down initial frequency	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E1.16	Digital input Up / Down change rate	0.10...100.00 Hz/s	1.00	Hz/s	0.01	Run

The setting frequency can be adjusted with command of Up / Down / Reset, by setting the status of digital inputs. The setting frequency will increase with Up command active, decrease with Down command active, reset to '0' with Reset command active.

To use this function, take the following steps:

Step 1: Set the frequency setting source

Set either E0.00 'First frequency setting source' or E0.02 'Second frequency setting source' to '11: Digital input Up / Down command'. If the active frequency command input channel ([E0.00] or [E0.02]) is set to 11, the [E1.17] will be taken as the current set frequency.

Step 2: Select any 3 digital inputs and define functions accordingly

Set any 3 digital inputs of E1.00... E1.04 and H8.00...H8.04 to '20: Frequency Up command', '21: Frequency Down command' and '22: Up / Down command reset'.

Step 3: Set the change rate and initial frequency for Up / Down operation

Set E1.16 'Digital input Up / Down change rate' and E1.17 'Digital input Up / Down initial frequency' according to the application.

Example:

[E1.00] = 20, [E1.01] = 21, [E1.02] = 22

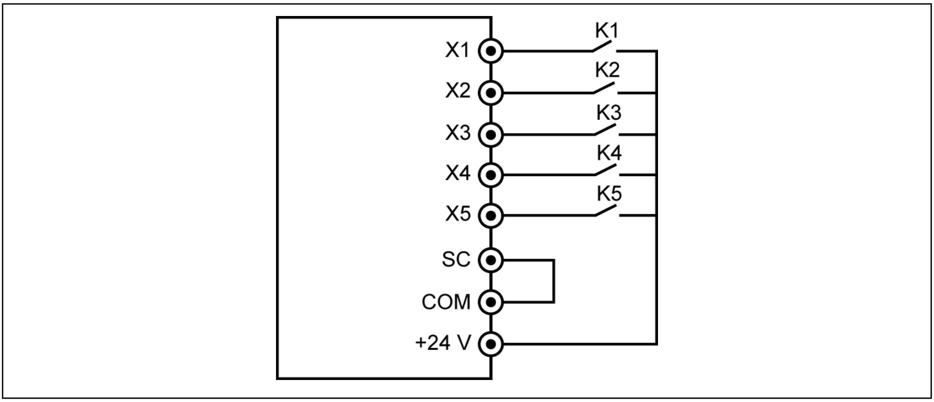


Fig. 12-81: External control terminals

Connect switch K1 to X1, and set [E1.00] = '20: Frequency Up command'.

Connect switch K2 to X2, and set [E1.01] = '21: Frequency Down command'.

Connect switch K3 to X3, and set [E1.02] = '22: Up / Down command reset'.

The combination of the control terminals are described in the table below:

K1	K2	K3	Response of setting frequency
Closed / Open	Closed / Open	Closed	Is reset to 0.00 Hz
Closed	Open	Open	Increases with the change rate defined by [E1.16]
Open	Closed	Open	Decreases with the change rate defined by [E1.16]
Open	Open	Open	No change
Closed	Closed	Open	No change

Tab. 12-15: K1, K2, K3 settings

Up / Down / Reset command is only active when the frequency converter is running. Whether the setting frequency modified by Up / Down terminals will be saved or not after power off depends on [E0.06], see chapter 12.8.3 "Digital Setting Frequency" on page 203.

12.9.4 Pulse Input Configuration

The pulse input is required to be input via digital input terminal with frequency up to 50kHz, and X5 digital input is used to receive this pulse signal with a 30...70 % duty ratio.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.25	Pulse input maximum frequency	0.0...50.0 kHz	50.0	kHz	0.1	Run
E1.26	Pulse input filter time	0.000...2.000 s	0.100	s	0.001	Run

This pulse input can be used in 3 purposes:

- Frequency setting source

  See chapter 12.8.1 "Frequency Setting Source" on page 197.
- PID reference
- PID feedback

  See chapter 12.12 "E4: PID Control" on page 276.

To use 'X5 pulse input' as the frequency source, take following steps:

Step 1: Activate terminal 'X5 input' with pulse input function

Set [E1.04] 'X5 input' to 47: Pulse input mode activation.

Step 2: Set the maximum input frequency and filter time

Set [E1.25] 'Pulse input maximum frequency' and [E1.26] 'Pulse input filter time' according to application.

Step 3: Select pulse input curve

[E1.68]	bit 2	bit 1	bit 0	Curve for AI1	Curve for AI2	Curve for pulse input
0	0	0	0	1	1	1
1	0	0	1	2	1	1
2	0	1	0	1	2	1
3	0	1	1	2	2	1
4	1	0	0	1	1	2
5	1	0	1	2	1	2
6	1	1	0	1	2	2
7	1	1	1	2	2	2

Tab. 12-16: Curve configuration

[E1.70]...[E1.73] are used to define characteristics of curve 1, and [E1.75]...[E1.78] are used to define characteristics of curve 2. Detailed curve setting see chapter 12.9.5 "Analog Input Configuration" on page 242.

Pulse input frequency is monitored by parameter d0.50 'Pulse input frequency'.

12.9.5 Analog Input Configuration

This function is implemented to configure the analog command value input of external analog input AI1 and AI2.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.35	AI1 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	2	-	–	Run
E1.40	AI2 input mode		1	-	–	Run
E1.38	AI1 gain	0.00...10.00	1.00	-	0.01	Run
E1.43	AI2 gain	0.00...10.00	1.00	-	0.01	Run
E1.68	Analog input curve setting	0...7	0	-	–	Run
E1.69	Analog input filter time	0.000...2.000 s	0.100	s	0.001	Run
E1.70	Input curve 1 minimum	0.0 %...[E1.72]	0.0	-	0.1	Run
E1.71	Input curve 1 minimum frequency	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E1.72	Input curve 1 maximum	[E1.70]...100.0 %	100.0	-	0.1	Run
E1.73	Input curve 1 maximum frequency	0.00...[E0.09] Hz	50.00	Hz	0.01	Run
E1.75	Input curve 2 minimum	0.0 %...[E1.77]	0.0	-	0.1	Run
E1.76	Input curve 2 minimum frequency	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E1.77	Input curve 2 maximum	[E1.75]...100.0 %	100.0	-	0.1	Run
E1.78	Input curve 2 maximum frequency	0.00...[E0.09] Hz	50.00	Hz	0.01	Run

To configure these two inputs AI1 and AI2, take the following steps:

Step 1: Select the input mode

Set [E1.35] to select the input mode of AI1 and [E1.40] to select the input mode of AI2.

Step 2: Set the channel gain and filter time

[E1.38] is for AI1 gain and [E1.43] is for AI2 gain.

Parameter [E1.69] is used to define the analog channel filtering time constant for processing of input signals. Longer filtering time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.

Step 3: Select input curve

There are two analog input curves that can be selected by [E1.68], AI1 and AI2 inputs can use both curve 1 and curve 2.

[E1.68]	bit 2	bit 1	bit 0	Curve for AI1	Curve for AI2	Curve for pulse input
0	0	0	0	1	1	1
1	0	0	1	2	1	1
2	0	1	0	1	2	1
3	0	1	1	2	2	1
4	1	0	0	1	1	2
5	1	0	1	2	1	2
6	1	1	0	1	2	2
7	1	1	1	2	2	2

Tab. 12-17: Curve configuration

[E1.70]...[E1.73] are used to define characteristics of curve 1:

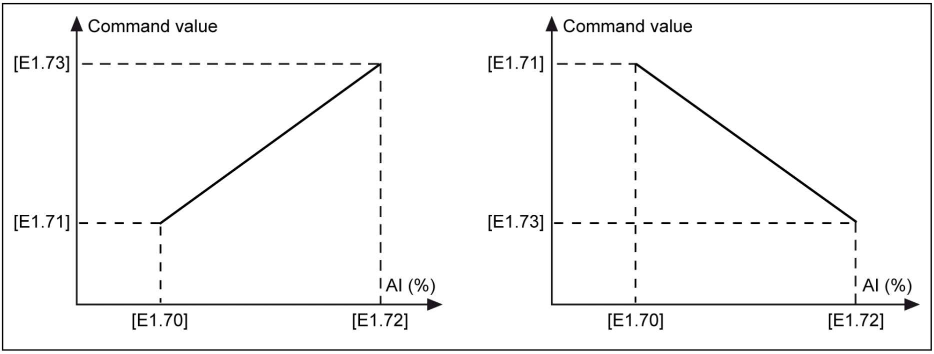


Fig. 12-82: Curve 1

[E1.75]...[E1.78] are used to define characteristics of curve 2:

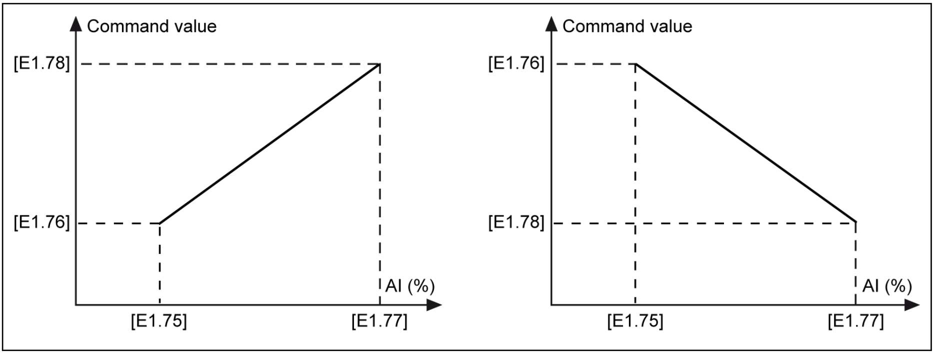


Fig. 12-83: Curve 2

☞ Analog input status is monitored by parameter d0.30 'AI1 input' / d0.31 'AI2 input'.

Analog Input Broken Wire Detection

If '4...20 mA' or '2...10 V' is selected for analog inputs (AI1, AI2 and EAI1, EAI2), then this function can detect the input missing possibly due to the cable disconnection. Once the broken wire is detected, the frequency converter can either continue running with warning (Warning code: Aib-) or stop with error (Error code: AibE), which can be configured by parameter E1.61.

Related parameter:

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.61	Broken wire protection	0: Inactive 1: Warning 2: Error	0	-	-	Stop

Setting range of E1.61:

- **0: Inactive**

  There is no reaction on the output frequency (broken wire disable, no warning display and stop command).

- **1: Warning**

  There is warning reaction will be enabled and warning message will be displayed with warning code "Aib-".

- **2: Error**

  There is error reaction will be enabled, then stop command will be raised and error message will be displayed with error code of "AibE".

For 4...20 mA analog input, if the current drops below 4mA – 10% = 3.6mA, the action according to the parameter E1.61 will be performed.

For 2...10 V analog input, if the voltage drops below 2V – 7.5% = 1.85V, the action according to the parameter E1.61will be performed.

12.9.6 Motor Temperature Sensor Channel

This function defines the motor temperature sensor channel selection when protect the motor from overheat.

Code	Name	Setting range	Default	Unit	Step	Attri.
E1.60	Motor temperature sensor channel	0: Inactive 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: EAI2 analog input 5: TSI input (only for IO plus card)	0	-	-	Stop

Setting range of E1.60:

- 0: Inactive

  Inactivate the function of temperature monitoring with temperature sensor:
- 1: AI1 analog input

  Motor temperature sensor channel is AI1.
- 2: AI2 analog input

  Motor temperature sensor channel is AI2.
- 3: EAI1 analog input

  Motor temperature sensor channel is EAI1.
- 4: EAI2 analog input

  Motor temperature sensor channel is EAI2.
- 5: TSI input (only for IO plus card)

  Motor temperature sensor channel is TSI when IO plus card was used.

☞ AI1 / AI2 / EAI1 / EAI2 will be automatically set as voltage input mode when [E1.60] = 1...4.

12.10 E2: Output Terminal

12.10.1 Digital Output Configuration

This function defines the open collector output for system state monitoring.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.01	DO1 output setting	0...25	1	-	-	Stop
E2.20	DO1/relay1 output values from extension card fieldbus communication	Bit0: 0 (open collector is opened); 1(open collector is closed) Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed)	0x00000	-	-	Run

Setting range of E2.01:

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 210 and chapter 12.8.9 "Stop Mode Configuration" on page 216.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.

☞ There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 258.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 258.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 146.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 163.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 229 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 276.

- **19: Pulse output mode enable**

  See chapter 12.10.2 "Pulse Output Setting" on page 249.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**

  – For modbus mode, the output is defined by bit0 of register 0x7F08, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 of register 0x7F08 is '1', open collector is closed.

- For other fieldbus mode, the output is defined by bit0 of parameter E2.20, when bit0 of E2.20 is '0', open collector is opened; when bit0 of E2.20 is '1', open collector is closed.

- 25: Converter error or warning

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.

☞ Digital output status is monitored by parameter d0.45 'DO1 output'.

12.10.2 Pulse Output Setting

This function defines pulse train output functionality up to 32 kHz for open collector output.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.02	DO1 pulse output setting	0: Converter output frequency 1: Converter output voltage 2: Converter output current 3: Setting torque 4: Output torque	0	-	-	Stop
E2.03	Pulse output maximum frequency	0.1...32.0 kHz	32.0	kHz	0.1	Run

Before using DO1 pulse output mode, first set E2.01 to '19: Pulse output mode enable' so that pulse train output functionality is enabled through the open collector output.

Pulse train output characteristics:

- Frequency range: 1Hz to 32.0 kHz
- Duty cycle range: 40% ~ 60%
- Maximal pulse train output frequency: as specified by [E2.03] parameter

Setting range of E2.02:

- **E2.02 = 0: Converter output frequency**

  Pulse train output 1 Hz to [E2.03] corresponds to output frequency 0 to [E0.09] output frequency high limit.

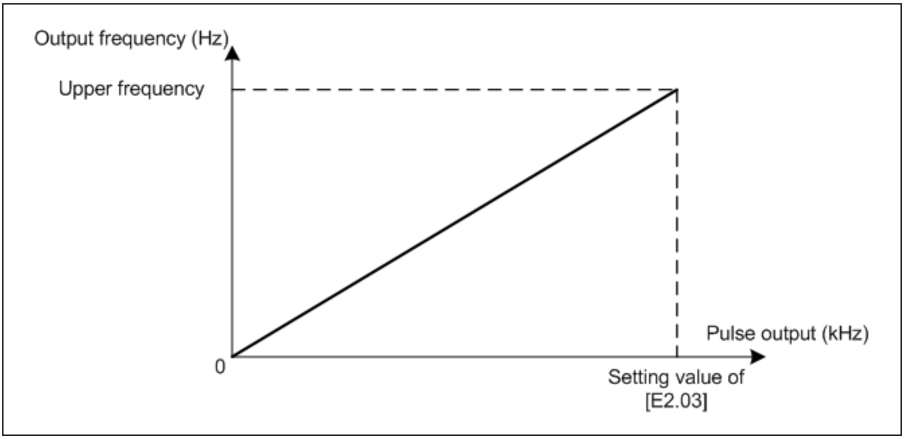


Fig. 12-84: Converter output frequency

- **E2.02 = 1: Converter output voltage**

Pulse train output 1 Hz to [E2.03] corresponds to output voltage 0 to max. voltage (1P200V: 250V; 3P400V: 500V).

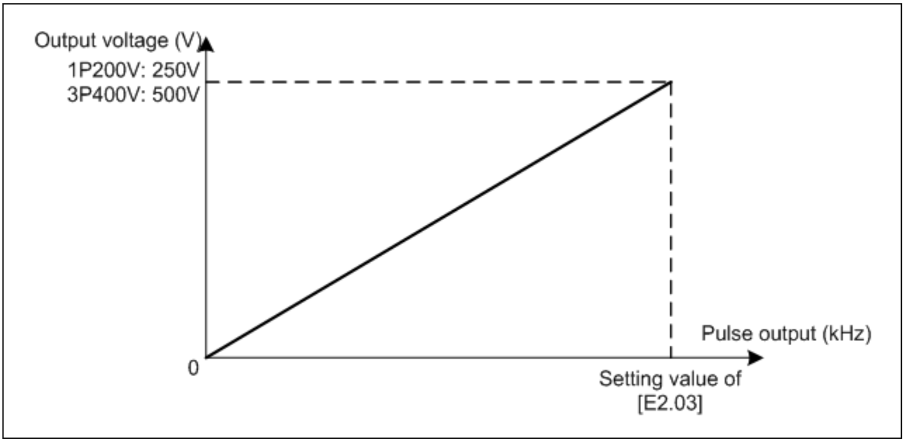


Fig. 12-85: Converter output voltage

- **E2.02 = 2: Converter output current**

  Pulse train output 1 Hz to [E2.03] corresponds to output current 0 to (2 * converter rated current).

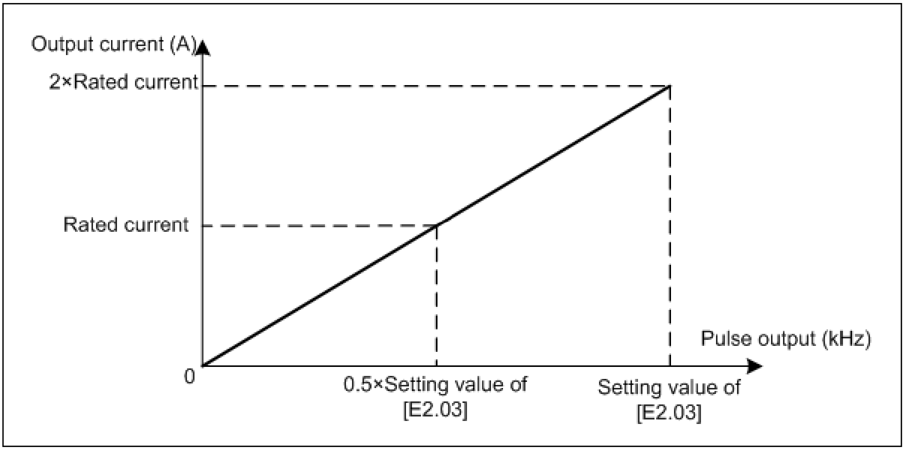


Fig. 12-86: Converter output current

- **E2.02 = 3: Setting torque**

  Pulse train output 1 Hz to [E2.03] corresponds to setting torque value of C3.42 to C3.43.

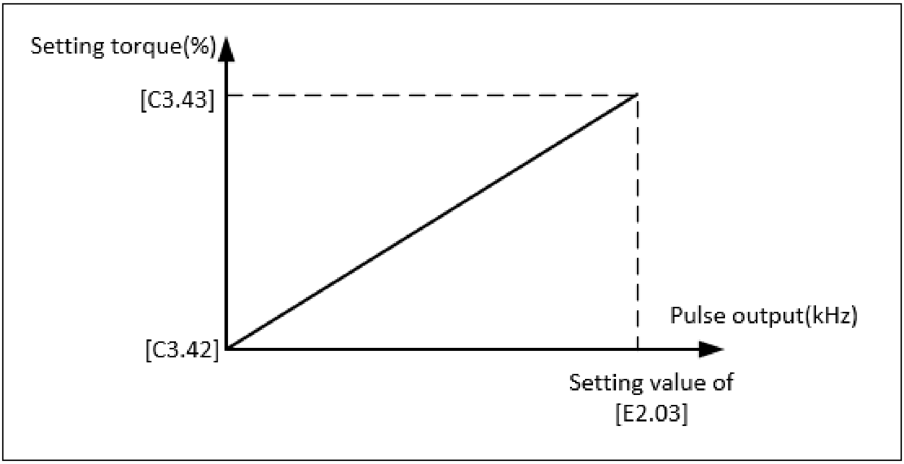


Fig. 12-87: Setting torque

- **E2.02 = 4: Output torque**

  Pulse train output 1 Hz to [E2.03] corresponds to output torque value of C3.42 to C3.43.

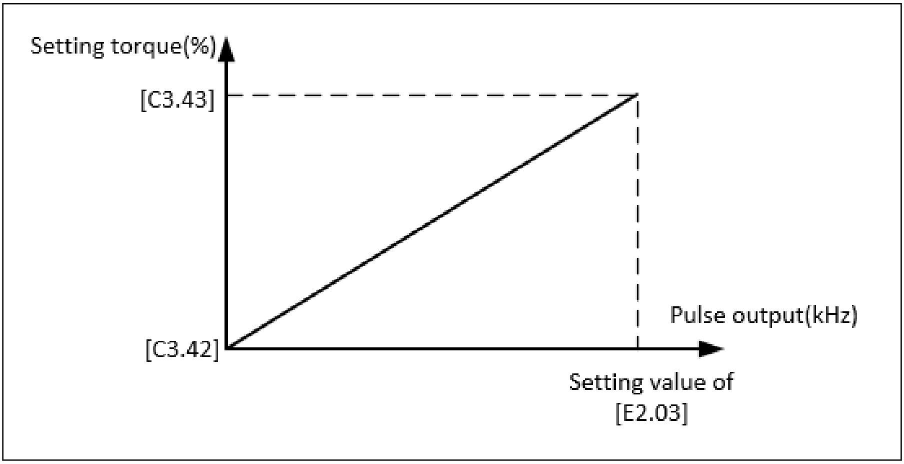


Fig. 12-88: Output torque

12.10.3 Relay Output

This function defines the relay output for system state monitoring.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.15	Relay 1 output selection	0...25	1	-	-	Stop
E2.20	DO1/relay1 output values from extension card fieldbus communication	Bit0: 0 (open collector is opened); 1(open collector is closed) Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed)	0x00000	-	-	Run

Setting range of E2.15:

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 210 and chapter 12.8.9 "Stop Mode Configuration" on page 216.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.

There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 258.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 258.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 146.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 163.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 229 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 276.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**
  - For modbus mode, the output is defined by bit0 of register 0x7F08, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 of register 0x7F08 is '1', open collector is closed.
  - For other fieldbus mode, the output is defined by bit0 of parameter E2.20, when bit0 of E2.20 is '0', open collector is opened; when bit0 of E2.20 is '1', open collector is closed.

- **25: Converter error or warning**

The output is active when the frequency converter encounters error / warning.

The output is inactive when the frequency converter without error / warning.

☞ Digital output status is monitored by parameter d0.45 'DO1 output'.

12.10.4 Analog Output Configuration

The analog output terminal may output 0...10V voltage signals or 0...20mA current based on some system variables with adjustable gain setting.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.25	AO1 output mode	0: 0...10 V 1: 0...20 mA 3: 2...10V 4: 4...20 mA	0	-	-	Run
E2.26	AO1 output setting	0: Output frequency 1: Setting frequency 2: Output current 4: Output voltage 5: Output power 6: AI1 analog input 7: AI2 analog input 8: EAI1 analog input 9: EAI2 analog input 11: Motor temperature sensor power supply 12: Parameter setting from communication 13: Setting torque 14: Output torque	0	-	-	Run
E2.27	AO1 gain	0.00...10.00	1.00	-	0.01	Run
E2.28	AO1 value in percentage from extension card Fieldbus communication	0.00...100.00 %	0.00	-	0.01	Run
E2.40	Rated voltage	1P 200...240 VAC	220	VAC	1	Stop
		3P 200...240 VAC	220			
		3P 380...480 VAC	380			
E2.50	Output curve 1 minimum	0.0 %...[E2.52]	0.0	-	0.1	Run
E2.51	Output curve 1 minimum value	0.00...100.00 %	0.00	-	0.01	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.52	Output curve 1 maximum	[E2.50]...100.0 %	100.0	-	0.1	Run
E2.53	Output curve 1 maximum value	0.00...100.00 %	100.00	-	0.01	Run

Analog output configuration step:

- **Step 1: Set AO1 output mode**

  E2.25 is for AO1 output mode selection, 0 is for voltage mode and 1 is for current mode.

- **Step 2: Select AO1 output signal**

  E2.26 setting range:

  – **E2.26 = 0: Output frequency**

    Represents the actual output frequency between 0.00...[E0.08] Hz.

  – **E2.26 = 1: Setting frequency**

    Represents the setting frequency between 0.00...[E0.08] Hz.

  – **E2.26 = 2: Output current**

    Represents the 0...2 x [rated current].

  – **E2.26 = 4: Output voltage**

    Represents 0...1.2 x [rated voltage], which is defined by parameter E2.40.

  – **E2.26 = 5: Output power**

    Represents 0...1.2 x [rated power].

  – **E2.26 = 6: AI1 Analog input**

    Represents AI1 input value.

  – **E2.26 = 7: AI2 Analog input**

    Represents AI2 input value.

  – **E2.26 = 8: EAI1 analog input**

    Represents EAI1 analog input value from I/O card or I/O plus card.

  – **E2.26 = 9: EAI2 analog input**

    Represents EAI2 analog input value from I/O plus card.

  – **E2.26 = 11: Motor temperature sensor power supply**

    Provides current source for motor temperature sensor, see chapter 12.3.7 "Motor Thermal Sensor Selection" on page 166.

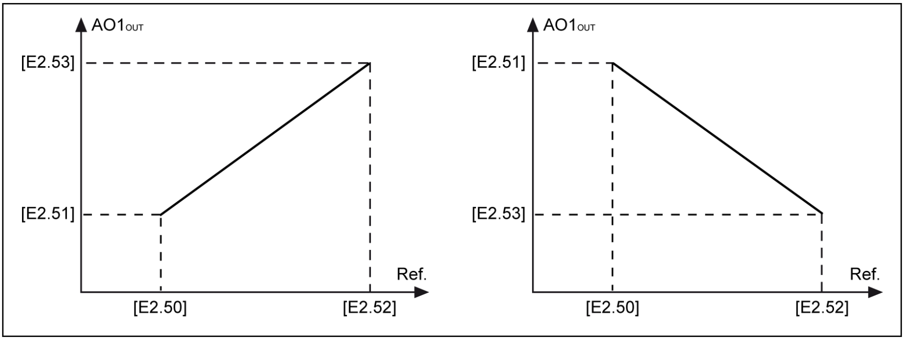
  – **E2.26 = 12: Parameter setting from communication**

    – For Modbus mode, the output is defined by register 0x7F06. The value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).

    – For other Fieldbus mode, the output is defined by parameter E2.28.

- **E2.26 = 13: Setting torque**
  Represents range of setting torque selected using C3.42 and C3.43.
- **E2.26 = 14: Output torque**
  Represents range of output torque selected using C3.42 and C3.43.

- **Step 3: Set AO1 filter time and output curve**



$AO1_{OUT}$ AO1 output
Ref. Reference

Fig. 12-89: AO1 output curve

Analog output status is monitored by parameter d0.35 'AO1 output'.

12.10.5 Frequency Detection Function

This function is used to detect the difference between the output frequency and the setting frequency, the indication signal can be used for further engineering in the application.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.70	Frequency detection width	0.00...400.00 Hz	2.50	Hz	0.01	Run
E2.71	Frequency detection level FDT1	0.00...400.00 Hz	50.00	Hz	0.01	Run
E2.72	Frequency detection level FDT1 width	0.00...[E2.71] Hz	1.00	Hz	0.01	Run
E2.73	Frequency detection level FDT2	0.00...400.00 Hz	25.00	Hz	0.01	Run
E2.74	Frequency detection level FDT2 width	0.00...[E2.73] Hz	1.00	Hz	0.01	Run

- **Frequency Arrival**

  Parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 can be set to '4: Speed arrival' to configure the digital outputs to show this function.

  The 'Speed arrival' signal is active on the selected output terminal when the difference between the 'Output frequency' and the 'Setting frequency' is within the range set by parameter E2.70 'Frequency detection width':

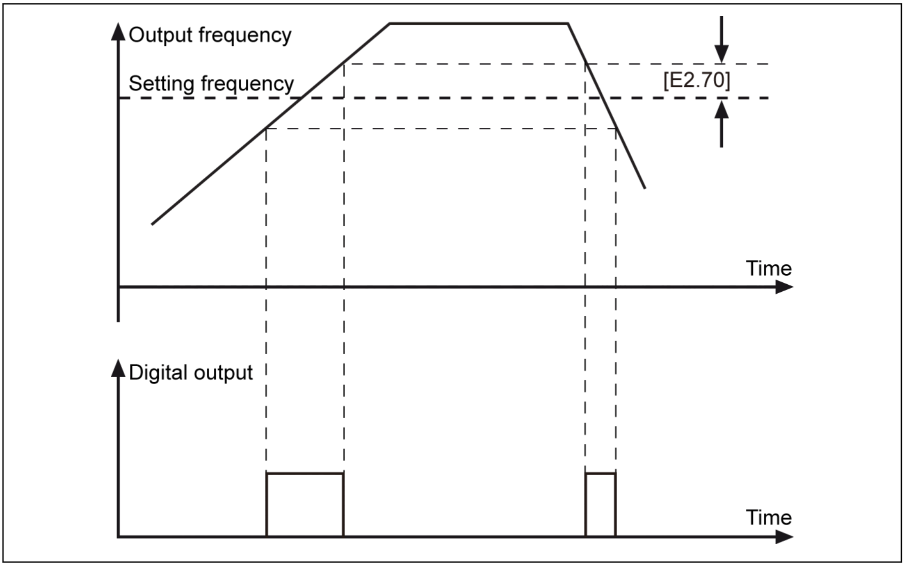


Fig. 12-90: Frequency arrival

- **Frequency Level Detection**

  Parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 can be set to '**5: Frequency level detection signal (FDT1)**' or '**6: Frequency level detection signal (FDT2)**' to configure the digital outputs to show this function.

  The indication signal is active when the output frequency is **HIGHER** than the frequency detection level, and inactive when the output frequency is **LOWER** than the frequency detection level minus frequency detection level width.

  The selected digital output signal and status are as below:

  – 5: Frequency level detection signal (FDT1)
    – Active when 'Output frequency' is higher than [E2.71]
    – Inactive when 'Output frequency' is lower than [E2.71] - [E2.72]
  – 6: Frequency level detection signal (FDT2)
    – Active when 'Output frequency' is higher than [E2.73]
    – Inactive when 'Output frequency' is lower than [E2.73] - [E2.74]

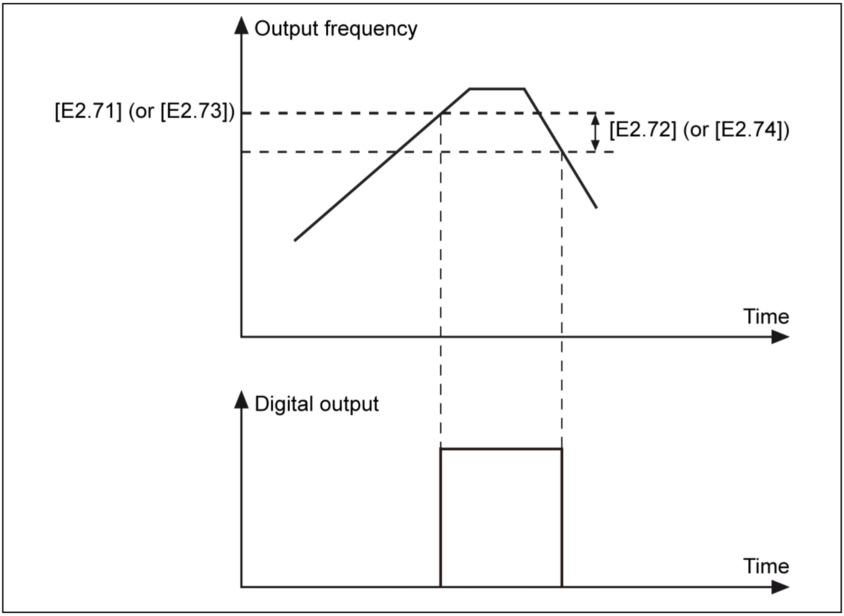


Fig. 12-91: Frequency level detection

12.10.6 Pulse Counter Function

The internal counter counts the input pulses received from 'Digital input' and compares it with the setting value of 'Counter middle value' or 'Counter target value'.

Code	Name	Setting range	Default	Unit	Step	Attri.
E2.80	Counter middle value	0...[E2.81]	0	-	1	Run
E2.81	Counter target value	[E2.80]...9,999	0	-	1	Run

Digital input E1.00... E1.04 and H8.00...H8.04 can be set to '39: Counter input' as pulse input.

By setting parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 to '16: Counter target value arrival' or '17:Counter middle value arrival' output signal will be indicated via DO or Relay output when the counter value equals to that of setting value.

The counter is cleared and the DO or Relay output signal is reset by a valid edge signal of another digital input E1.00... E1.04 and H8.00...H8.04 defined as '40:Counter reset'.

Example:

X1 input is defined as '39: Counter input'.

X2 input is defined as '40: Counter reset'.

The wiring is shown as the figure below:

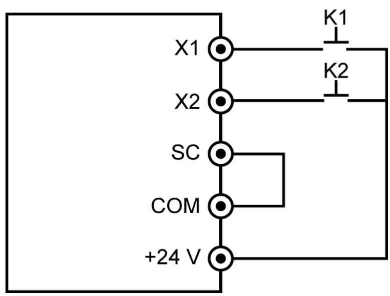


Fig. 12-92: Digital input configuration

Connected K1 to X1, and set [E1.00] = '39: Counter input'.

Connected K2 to X2, and set [E1.01] = '40: Counter reset'.

K1	K2	Running status	Status
Inactive	Inactive	–	–
Edge	Inactive	Counter value = [E2.80] / [E2.81]	Internal counter value stays at [E2.80] / [E2.81] Digital output is active
Edge	Edge	Counter is reset	Internal counter value is reset to ‘0’ Digital output is inactive

Tab. 12-18: Counter function

'DO1 output' or 'Relay 1 output' signal and status are as below:

- [E2.01] / [E2.15] = '16: Counter target value arrival'

  When the internal counter receives from 'X1 input' the number of input pulse, which equals to [E2.81] 'Counter target value'.
- [E2.01] / [E2.15] = '17: Counter middle value arrival'

  When the internal counter receives from 'X1 input' the number of input pulse, which equals to [E2.80] 'Counter middle value'.

The signal is reset by the next valid edge signal of 'X2 input' which is defined as '40: Counter reset'.

Example:

[E2.80] = 5, [E2.81] = 8

The output behavior is described as below:

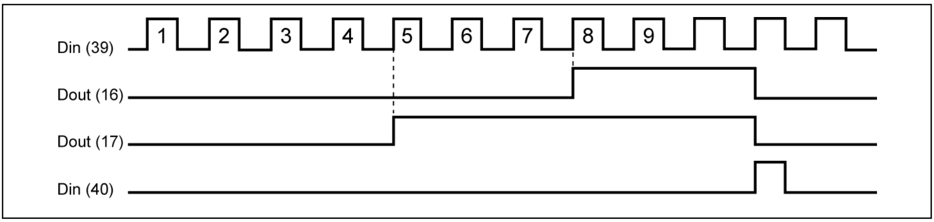


Fig. 12-93: Output behavior

- If the setting of any parameter E2.80, E2.81 and / or the status of the defined digital inputs is changed, the counter value will be reset and the digital outputs will be inactive immediately.
- The allowed maximum digital input frequency is 50 Hz and the allowed minimum pulse width (both active and inactive) is higher than 8 ms.

12.11 E3: Multi-Speed and Simple PLC

12.11.1 Simple PLC and Multi-Speed Setting

Parameters

PLC is an automatic running mode according to the preset acceleration /deceleration time, running frequency, running time and rotation direction.

The multi-speed control shares some parameters with simple PLC control. If this control mode is active, the corresponding external terminals should be configured with correct values to realize this function.

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.00	Simple PLC running mode	0: Inactive 1: Stop after selected cycle 2: Continuously cycling 3: Run last stage after selected cycle	0	-	–	Stop
E3.01	Simple PLC time multiplier	1...60	1	-	1	Stop
E3.02	Simple PLC cycle number	1...1,000	1	-	1	Stop
E3.10	Acceleration time 2	0.1...6,000.0 s	10.0	s	0.1	Run
E3.11	Deceleration time 2	0.1...6,000.0 s	10.0	s	0.1	Run
E3.12	Acceleration time 3	0.1...6,000.0 s	10.0	s	0.1	Run
E3.13	Deceleration time 3	0.1...6,000.0 s	10.0	s	0.1	Run
E3.14	Acceleration time 4	0.1...6,000.0 s	10.0	s	0.1	Run
E3.15	Deceleration time 4	0.1...6,000.0 s	10.0	s	0.1	Run
E3.16	Acceleration time 5	0.1...6,000.0 s	10.0	s	0.1	Run
E3.17	Deceleration time 5	0.1...6,000.0 s	10.0	s	0.1	Run
E3.18	Acceleration time 6	0.1...6,000.0 s	10.0	s	0.1	Run
E3.19	Deceleration time 6	0.1...6,000.0 s	10.0	s	0.1	Run
E3.20	Acceleration time 7	0.1...6,000.0 s	10.0	s	0.1	Run
E3.21	Deceleration time 7	0.1...6,000.0 s	10.0	s	0.1	Run
E3.22	Acceleration time 8	0.1...6,000.0 s	10.0	s	0.1	Run
E3.23	Deceleration time 8	0.1...6,000.0 s	10.0	s	0.1	Run
E3.40	Multi-speed frequency 1	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.41	Multi-speed frequency 2	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.42	Multi-speed frequency 3	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.43	Multi-speed frequency 4	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.44	Multi-speed frequency 5	0.00...[E0.09] Hz	0.00	Hz	0.01	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.45	Multi-speed frequency 6	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.46	Multi-speed frequency 7	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.47	Multi-speed frequency 8	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.48	Multi-speed frequency 9	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.49	Multi-speed frequency 10	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.50	Multi-speed frequency 11	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.51	Multi-speed frequency 12	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.52	Multi-speed frequency 13	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.53	Multi-speed frequency 14	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.54	Multi-speed frequency 15	0.00...[E0.09] Hz	0.00	-	0.01	Run
E3.59	Stage 0 frequency source	0: Digital setting frequency 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: X5 pulse input 5: Communication 6: Panel potentiometer 7: Digital input up/down command 8: EAI2 analog input	0	-	–	Stop

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.60	Stage 0 action	011, 012, 013, 014, 015, 016 ,017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188	011	-	–	Stop
E3.62	Stage 1 action		011	-	–	Stop
E3.64	Stage 2 action		011	-	–	Stop
E3.66	Stage 3 action		011	-	–	Stop
E3.68	Stage 4 action		011	-	–	Stop
E3.70	Stage 5 action		011	-	–	Stop
E3.72	Stage 6 action		011	-	–	Stop
E3.74	Stage 7 action		011	-	–	Stop
E3.76	Stage 8 action		011	-	–	Stop
E3.78	Stage 9 action		011	-	–	Stop
E3.80	Stage 10 action		011	-	–	Stop
E3.82	Stage 11 action		011	-	–	Stop
E3.84	Stage 12 action		011	-	–	Stop
E3.86	Stage 13 action		011	-	–	Stop
E3.88	Stage 14 action		011	-	–	Stop
E3.90	Stage 15 action		011	-	–	Stop
E3.61	Stage 0 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.63	Stage 1 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.65	Stage 2 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.67	Stage 3 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.69	Stage 4 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.71	Stage 5 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.73	Stage 6 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.75	Stage 7 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.77	Stage 8 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.79	Stage 9 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.81	Stage 10 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.83	Stage 11 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.85	Stage 12 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.87	Stage 13 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.89	Stage 14 running time	0.0...6,000.0 s	20.0	s	0.1	Stop
E3.91	Stage 15 running time	0.0...6,000.0 s	20.0	s	0.1	Stop

Multi-Speed Setting

Multi-speed function offers flexible, switchable 16 independent stages of setting frequency. The rotation direction of each stage depends on both the 'Stage action' and the 'Run command source', see the table below:

Frequency source	Run command source	Rotation direction	Acc. / Dec. time
Multi-speed	Operating panel	[E3.60], [E3.62], [E3.64], [E3.66] [E3.68], [E3.70], [E3.72], [E3.74] [E3.76], [E3.78], [E3.80], [E3.82] [E3.84], [E3.86], [E3.88], [E3.90]	[E0.26] / [E0.27] [E3.10] / [E3.11] [E3.12] / [E3.13] [E3.14] / [E3.15] [E3.16] / [E3.17] [E3.18] / [E3.19] [E3.20] / [E3.21] [E3.22] / [E3.23]
	External terminals	8 or less stages: 2-wire control 9 or more stages: parameters	
	Communication	Set by communication	

Tab. 12-19: Setting frequency and multi-speed settings

To configure the multi-speed settings, take the following steps:

Step 1: Activate multi-speed function

Set E0.00 or E0.02 to '21: Multi-speed settings' to activate multi-speed function.

Step 2: Select any 4 digital inputs and define functions accordingly

Select any 4 digital inputs of E1.00...E1.04, H8.00...H8.04 to '1: Multi-speed control input 1', '2: Multi-speed control input 2', '3: Multi-speed control input 3', '4: Multi-speed control input 4'.

Assign functions to digital inputs properly when 'Acceleration / deceleration time activation' and '2-wire / 3-wire running control' are also necessary defined via digital inputs.

Step 3: Configure the setting frequency for each stage

If the setting frequency of next stage is lower than that of the current stage, it will decelerate to the next stage with the deceleration time of the current stage; if the setting frequency of next stage is higher than that of the current stage, it will accelerate to the next stage with the acceleration time of next stage.

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.40	Multi-speed frequency 1	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.41	Multi-speed frequency 2	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.42	Multi-speed frequency 3	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.43	Multi-speed frequency 4	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.44	Multi-speed frequency 5	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.45	Multi-speed frequency 6	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.46	Multi-speed frequency 7	0.00...[E0.09] Hz	0.00	Hz	0.01	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.47	Multi-speed frequency 8	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.48	Multi-speed frequency 9	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.49	Multi-speed frequency 10	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.50	Multi-speed frequency 11	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.51	Multi-speed frequency 12	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.52	Multi-speed frequency 13	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.53	Multi-speed frequency 14	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E3.54	Multi-speed frequency 15	0.00...[E0.09] Hz	0.00	-	0.01	Run

Step 4: Set the acceleration time / deceleration time, rotation direction for each stage

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Unit</th><th>Step</th><th>Attri.</th></tr>
<tr><td>E3.60</td><td>Stage 0 action</td><td rowspan="16">011, 012, 013, 014, 015, 016 , 017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.62</td><td>Stage 1 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.64</td><td>Stage 2 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.66</td><td>Stage 3 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.68</td><td>Stage 4 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.70</td><td>Stage 5 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.72</td><td>Stage 6 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.74</td><td>Stage 7 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.76</td><td>Stage 8 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.78</td><td>Stage 9 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.80</td><td>Stage 10 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.82</td><td>Stage 11 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.84</td><td>Stage 12 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.86</td><td>Stage 13 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.88</td><td>Stage 14 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E3.90</td><td>Stage 15 action</td><td>011</td><td>-</td><td>–</td><td>Stop</td></tr>
<tr><td>E0.26</td><td>Acceleration time</td><td>0.1...6,000.0 s</td><td>DOM</td><td>s</td><td>0.1</td><td>Run</td></tr>
<tr><td>E0.27</td><td>Deceleration time</td><td>0.1...6,000.0 s</td><td>DOM</td><td>s</td><td>0.1</td><td>Run</td></tr>
<tr><td>E3.10</td><td>Acceleration time 2</td><td>0.1...6,000.0 s</td><td>10.0</td><td>s</td><td>0.1</td><td>Run</td></tr>
<tr><td>E3.11</td><td>Deceleration time 2</td><td>0.1...6,000.0 s</td><td>10.0</td><td>s</td><td>0.1</td><td>Run</td></tr>
</table>

Code	Name	Setting range	Default	Unit	Step	Attri.
E3.12	Acceleration time 3	0.1...6,000.0 s	10.0	s	0.1	Run
E3.13	Deceleration time 3	0.1...6,000.0 s	10.0	s	0.1	Run
E3.14	Acceleration time 4	0.1...6,000.0 s	10.0	s	0.1	Run
E3.15	Deceleration time 4	0.1...6,000.0 s	10.0	s	0.1	Run
E3.16	Acceleration time 5	0.1...6,000.0 s	10.0	s	0.1	Run
E3.17	Deceleration time 5	0.1...6,000.0 s	10.0	s	0.1	Run
E3.18	Acceleration time 6	0.1...6,000.0 s	10.0	s	0.1	Run
E3.19	Deceleration time 6	0.1...6,000.0 s	10.0	s	0.1	Run
E3.20	Acceleration time 7	0.1...6,000.0 s	10.0	s	0.1	Run
E3.21	Deceleration time 7	0.1...6,000.0 s	10.0	s	0.1	Run
E3.22	Acceleration time 8	0.1...6,000.0 s	10.0	s	0.1	Run
E3.23	Deceleration time 8	0.1...6,000.0 s	10.0	s	0.1	Run

The digit definition for each stage action is as the figure below:

Digit:	Hundreds	Tens	Unit
Example:	0	1	1

Rotation direction

Forward (FWD)...............= 0
Reverse (REV)................= 1

Acceleration time

[E0.26] Acceleration time .... = 1
[E3.10] Acceleration time 2.............= 2
[E3.12] Acceleration time 3.............= 3
[E3.14] Acceleration time 4.............= 4
[E3.16] Acceleration time 5............. = 5
[E3.18] Acceleration time 6.............= 6
[E3.20] Acceleration time 7.............= 7
[E3.22] Acceleration time 8.............= 8

Deceleration time

[E0.27] Deceleration time............................... = 1
[E3.11] Deceleration time 2............................ = 2
[E3.13] Deceleration time 3............................= 3
[E3.15] Deceleration time 4............................= 4
[E3.17] Deceleration time 5............................ = 5
[E3.19] Deceleration time 6............................ = 6
[E3.21] Deceleration time 7............................= 7
[E3.23] Deceleration time 8............................= 8

Fig. 12-94: Bit definition of rotation direction, acceleration and deceleration time

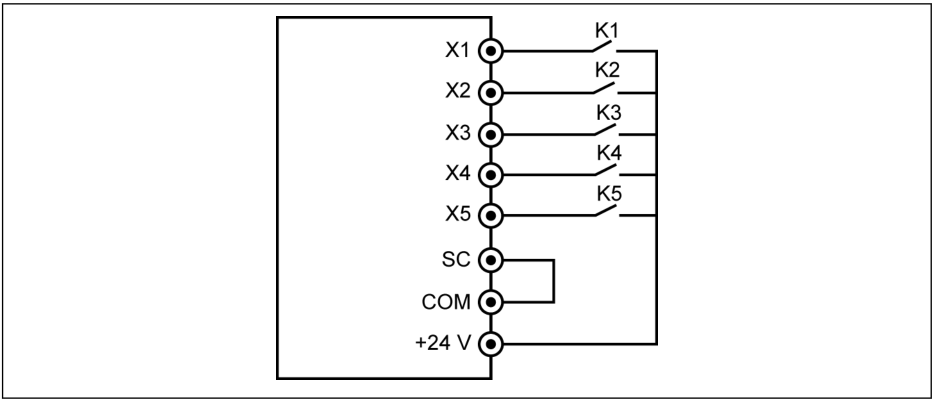


Fig. 12-95: Multi-speed control via digital inputs

Case 1: 8 or less stages

Set [E1.15] = 0 or 1 first.

Connect switch K1 to X1, and set [E1.00] = '1: Multi-speed control input 1'.

Connect switch K2 to X2, and set [E1.01] = '2: Multi-speed control input 2'.

Connect switch K3 to X3, and set [E1.02] = '3: Multi-speed control input 3'.

Connect switch K4 to X4, and set [E1.03] = '35: Forward running (FWD)'.

Connect switch K5 to X5, and set [E1.04] = '36: Reverse running (REV)'.

K3	K2	K1	Setting frequency	Acc. / Dec. time
Open	Open	Open	[E0.07]	[E0.26] / [E0.27]
Open	Open	Closed	[E3.40]	[E3.10] / [E3.11]
Open	Closed	Open	[E3.41]	[E3.12] / [E3.13]
Open	Closed	Closed	[E3.42]	[E3.14] / [E3.15]
Closed	Open	Open	[E3.43]	[E3.16] / [E3.17]
Closed	Open	Closed	[E3.44]	[E3.18] / [E3.19]
Closed	Closed	Open	[E3.45]	[E3.20] / [E3.21]
Closed	Closed	Closed	[E3.46]	[E3.22] / [E3.23]

Tab. 12-20: Multi-speed settings for 8 or less stages

The running logic for K4 and K5 see chapter 12.9.2 "2- and 3-Wire Control" on page 234 E1.15 = '0: 2-wire forward / stop, reverse / stop' and E1.15 = '1: 2-wire forward / reverse, run / stop'.

Case 2: 9 or more stages

Set [E1.15] = 4 first.

Connect switch K1 to X1, and set [E1.00] = '1: Multi-speed control input 1'.

Connect switch K2 to X2, and set [E1.01] = '2: Multi-speed control input 2'.

Connect switch K3 to X3, and set [E1.02] = '3: Multi-speed control input 3'.

Connect switch K4 to X4, and set [E1.03] = '4: Multi-speed control input 4'.

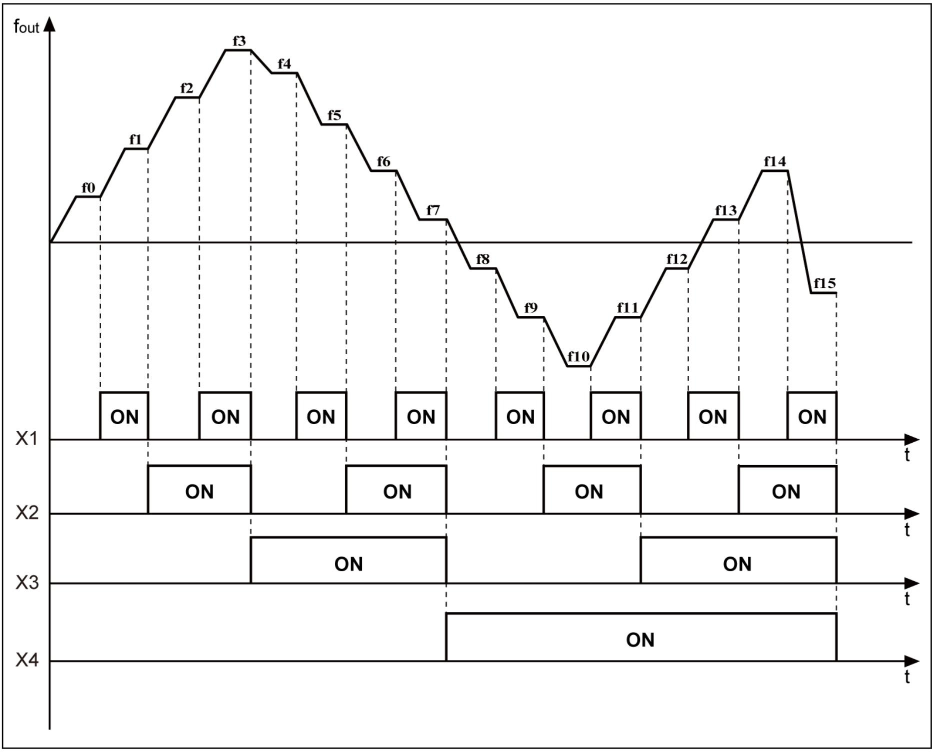
Connect switch K5 to X5, and set [E1.04] = '35: Forward running (FWD)'.

K4	K3	K2	K1	Setting frequency	Acc. / Dec. time
Open	Open	Open	Open	[E0.07]	[E0.26] / [E0.27]
Open	Open	Open	Closed	[E3.40]	[E3.10] / [E3.11]
Open	Open	Closed	Open	[E3.41]	[E3.12] / [E3.13]
Open	Open	Closed	Closed	[E3.42]	[E3.14] / [E3.15]
Open	Closed	Open	Open	[E3.43]	[E3.16] / [E3.17]
Open	Closed	Open	Closed	[E3.44]	[E3.18] / [E3.19]
Open	Closed	Closed	Open	[E3.45]	[E3.20] / [E3.21]
Open	Closed	Closed	Closed	[E3.46]	[E3.22] / [E3.23]
Closed	Open	Open	Open	[E3.47]	[E0.26] / [E0.27]
Closed	Open	Open	Closed	[E3.48]	[E3.10] / [E3.11]
Closed	Open	Closed	Open	[E3.49]	[E3.12] / [E3.13]
Closed	Open	Closed	Closed	[E3.50]	[E3.14] / [E3.15]
Closed	Closed	Open	Open	[E3.51]	[E3.16] / [E3.17]
Closed	Closed	Open	Closed	[E3.52]	[E3.18] / [E3.19]
Closed	Closed	Closed	Open	[E3.53]	[E3.20] / [E3.21]
Closed	Closed	Closed	Closed	[E3.54]	[E3.22] / [E3.23]

Tab. 12-21: Multi-speed settings for 9 or more stages

K5	Status
Inactive	Stop
Active	Run

Tab. 12-22: Run / Stop control via K5



f_{out} Output frequency
t Time

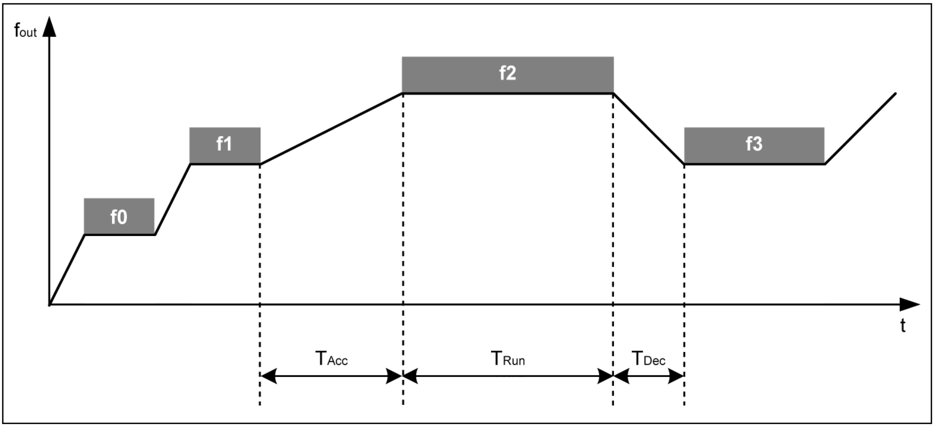
ON Digital input switched on

Fig. 12-96: Multi-speed stage transition

Simple PLC setting

Simple PLC is an automatic running mode based on the current acceleration / deceleration time, setting frequency, duration and rotation direction.

Simple PLC consists of 16 stages, each of which has its own settings of acceleration time, deceleration time, setting frequency, rotation direction and duration. An example of simple PLC control is shown in the figure below:



f_{out} Output frequency
t Time
T_{Acc} Acceleration time
T_{Run} Stage running time
T_{Dec} Deceleration time

Fig. 12-97: Example of simple PLC control

Frequency source	Run command source	Rotation direction and Acc. / Dec. time
Simple PLC	Operating panel	[E3.60], [E3.62], [E3.64], [E3.66]
	Multi-function digital input	[E3.68], [E3.70], [E3.72], [E3.74]
	Communication	[E3.76], [E3.78], [E3.80], [E3.82]
		[E3.84], [E3.86], [E3.88], [E3.90]

Tab. 12-23: Simple PLC configuration

Set the Simple PLC Mode:

- **E3.00 = 0: Inactive**

  Simple PLC inactive.

- **E3.00 = 1: Stop after selected cycle**

  In this mode, the frequency converter decelerates to 0.00 Hz after the last stage of simple PLC, and then stops according to the configured stopping mode.

- **E3.00 = 2: Continuously cycling**

  In this mode, the frequency converter decelerates to 0.00 Hz after the last stage of simple PLC, and then starts a new cycle automatically.

- **E3.00 = 3: Run last stage after selected cycle**

  In this mode, the frequency converter keeps running at the setting frequency of the last stage of simple PLC.

The actual duration for each stage is defined by following equation (Take stage 0 as an example):

T_{Run} = [E3.61] x [E3.01]

Based on the equation above, the maximum duration of one cycle is:

8 x 6,000.0 s x 60 = 800 hours.

For the settings of acceleration time, deceleration time, setting frequency, rotation direction of each 16 stages definition, see multi-speed setting above.

- If a stage running time is set to 0, simple PLC skips that stage.
- 'PID control' has a higher priority than 'Simple PLC control'. To use 'Simple PLC control', deactivate 'PID control' first.

Stop and Pause Simple PLC Control

Active 'Simple PLC control' can be stopped or paused by configuration of digital inputs E1.00...E1.04, H8.00...H8.04 to '26: Simple PLC stop' or '27: Simple PLC pause'.

- **26: Simple PLC stop**

  The frequency converter stops output till next 'Run command' is active, and the motor freewheels to stop.
- **27: Simple PLC pause**

  'PLC control' is paused and the frequency converter decelerates to run at 0 Hz till the pause signal is inactive.

A typical simple PLC pause process is as listed in the table below:

Step	Simple PLC pause	Run command	Converter status	Description
1	Inactive	Active	Run	Simple PLC cycles with each stage
2	Active	Active	Decelerating to 0 Hz (No stop DC-braking)	Dec. time is according to current simple PLC stage setting
3	Inactive	Active	Accelerate to previous stage	Acc. Time is according to previous simple PLC stage setting before pause
4	Inactive	Inactive	Stop	Stop according to [E0.50]
5	Inactive	Active	Run	Restart from 1st simple PLC stage

Tab. 12-24: Typical simple PLC pause process

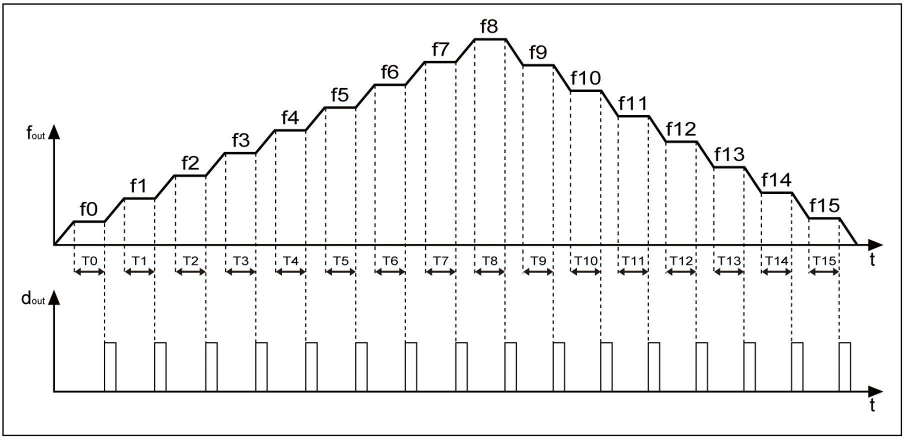
Indication of Simple PLC Status

An indication signal is active via 'DO output' or 'Relay output' when a simple PLC cycle or stage is complete.

Define the output with respective indication signals by setting E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 to '7: Simple PLC stage complete' or '8: Simple PLC cycle complete'.

- **7: Simple PLC stage complete**

  When a stage is complete, a pulse signal is active for the duration of 0.5 s. Any stage with running time of 0.0 s will be skipped without pulse output.



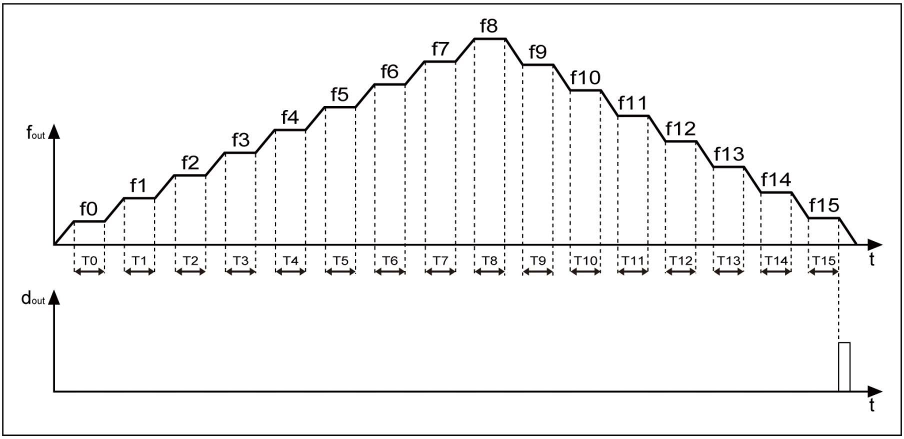
f_{out} Output frequency **t** Time
d_{out} Digital output

Fig. 12-98: Simple PLC stage complete

1. If the running time of one stage is so short that it finishes before the 'Simple PLC stage complete' signal of the previous stage is deactivated, the signal remains active and the pulse duration calculation is restarted.
2. If the setting frequency of next stage is lower than that of the current stage, the frequency converter decelerates to the next stage with the deceleration time of current stage.
3. If the setting frequency of next stage is higher than that of the current stage, the frequency converter accelerates to the next stage with the acceleration time of next stage.

- **8: Simple PLC cycle complete**

  When a cycle is complete, a pulse signal is active for the duration of 0.5 s.



f_{out} Output frequency
d_{out} Digital out
t Time

Fig. 12-99: Simple PLC cycle complete

12.12 E4: PID Control

12.12.1 PID Control Setting

Parameters

PID control is used in process controls such as flow control, pressure control, temperature control, and in control of other engineering values. In PID control, a negative feedback system is formed with proportional, integral and derivative operations based on the differences between reference values and their feedback. In this way, the difference between the actual output and the reference is reduced.

Code	Name	Setting range	Default	Unit	Step	Attri.
E4.00	PID reference channel	0: Inactive 1: Panel potentiometer 2: Panel button 3: AI1 analog input 4: AI2 analog input 5: X5 pulse input 6: EAI1 analog input 7: Communication 8: Analog reference E4.03 9: Speed reference E4.04 10: EAI2 analog input	0	-	–	Stop
E4.01	PID feedback channel	0: AI1 analog input 1: AI2 analog input 2: X5 pulse input 3: EAI1 analog input 4: Encoder card speed 5: EAI2 analog input	0	-	–	Stop
E4.02	PID reference / feedback factor	0.01…100.00	1.00	-	0.01	Run
E4.03	PID engineering analog reference	0.00…10.00	0.00	-	0.01	Run
E4.04	PID engineering speed reference	0…30,000 rpm	0	rpm	1	Run
E4.05	PID feedback polarity	0: Positive; 1: Negative	0	-	–	Stop
E4.15	Proportional gain - P	0.000…60.000	1.500	-	0.001	Run

Code	Name	Setting range	Default	Unit	Step	Attri.
E4.16	Integral time - Ti	0.00...100.00 s (0.00: no integral)	1.50	s	0.01	Run
E4.17	Derivative time - Td	0.00...100.00 s (0.00: no derivative)	0.00	s	0.01	Run
E4.18	Sampling period - T	0.01...100.00 s	0.50	s	0.01	Run
E4.19	PID feed forward dynamic limit	0.00...100.00 %	10.00	-	0.01	Run
E4.20	PID feed forward minimum value	0.00...100.00 %	0.00	-	0.01	Run
E4.30	PID deadband	0.0...20.0 %	2.0	-	0.1	Run
E4.31	PID regulation mode	0, 1	0	-	–	Run
E4.32	PID engineering value detection width	0.01...100.00	1.00	-	0.01	Run
E4.33	PID feed forward settings	0: Inactive; 1: Active	0	-	–	Stop

The basic control principle is shown as the figure below:

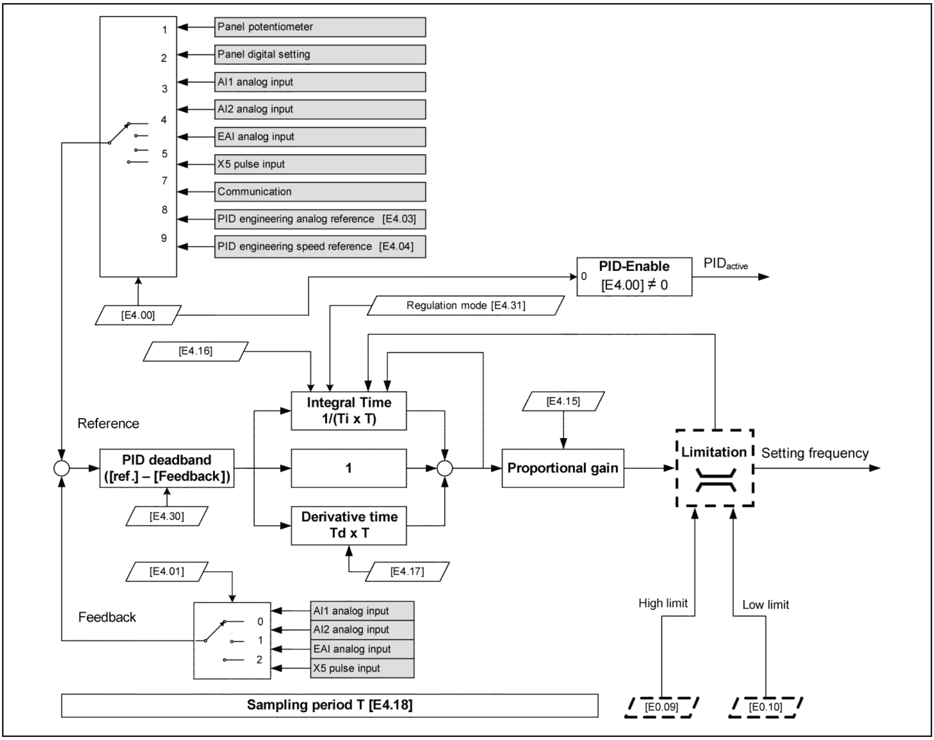


Fig. 12-100: PID control principle

Selecting the Reference and Feedback

Before using PID control function make sure [E1.00]...[E1.04] ≠ '41: PID deactivation'.

Take the following steps to configure the PID reference:

Step 1: Select the PID reference channel

- **[E4.00] = 0: Inactive**

  The PID control function is inactive.

- **[E4.00] = 1: Panel potentiometer**

  The reference value is set by adjusting the potentiometer on the operating panel.

- **[E4.00] = 2: Panel button**

  The reference value is set by E0.07 'Digital setting frequency', which can be decreased or increased by pressing the **<▼>** or **<▲>** buttons on the operating panel respectively when the frequency converter is running.

- **[E4.00] = 3: AI1 analog input**

The reference value is set by AI1 analog input.

- **[E4.00] = 4: AI2 analog input**

  The reference value is set by AI2 analog input.
- **[E4.00] = 5: X5 pulse input**

  The reference value is set by pulse signal via X5 input.
- **[E4.00] = 6: EAI1 analog input**

  The reference value is set by EAI1 analog input.
- **[E4.00] = 7: Communication**

  The reference value is set by engineering software, PLC or other external devices via Modbus or other communication.
- **[E4.00] = 8: Analog reference E4.03**

  The reference value is set by parameter E4.03.
- **[E4.00] = 9: Speed reference E4.04**

  The reference value is set by parameter E4.04.
- **[E4.00] = 10: EAI2 analog input**

  The reference value is set by EAI2 analog input.

Step 2: Select the PID feedback channel

- **[E4.01] = 0: AI1 analog input**

  Feedback value is set by AI1 analog input.
- **[E4.01] = 1: AI2 analog input**

  Feedback value is set by AI2 analog input.
- **[E4.01] = 2: X5 pulse input**

  Feedback value is set by X5 pulse input.
- **[E4.01] = 3: EAI1 analog input**

  Feedback value is set by EAI1 analog input.
- **[E4.01] = 4: Encoder card speed**

  Feedback value is set by encoder card speed.
- **[E4.01] = 5: EAI2 analog input**

  Feedback value is set by EAI2 analog input.

PID feedback polarity

Code	Name	Setting range	Default	Unit	Step	Attri.
E4.05	PID feedback polarity	0: Positive 1: Negative	0	-	-	Stop

By default, E4.05 is ‘0: Positive’, “**Reference- Feedback**” is used for PID regulation, which is used when feedback value will **rise** when output frequency **rises**.

When E4.05 is set to ‘1: Negative’, then **“Feedback- Reference”** is used for PID regulation, which is used when feedback value will **drop** when output frequency **rises**.

E4.05	PID Output	PID Feedback
0: Positive	↑	↑
	↓	↓
1:Negative	↑	↓
	↓	↑

Tab. 12-25: PID feedback polarity

Control Loop Configuration

Code	Name	Setting range	Default	Unit	Step	Attri.
E4.15	Proportional gain - P	0.000...60.000	1.500	-	0.001	Run
E4.16	Integral time - Ti	0.00...100.00 s (0.00: no integral)	1.50	s	0.01	Run
E4.17	Derivative time - Td	0.00...100.00 s (0.00: no derivative)	0.00	s	0.01	Run
E4.18	Sampling period - T	0.01...100.00 s	0.50	s	0.01	Run

Proportional gain - P: Decides the gain of deviation

- Larger P means larger scale and faster response, but excessively large P leads to oscillation.
- P cannot eliminate deviation completely.

Integral time - Ti: Used to eliminate the deviation

- Smaller Ti means faster response of the frequency converter to deviation changes, but excessively small Ti leads to oscillation.
- If Ti = 0, integration is deactivated during PID control.
  - Integration stops but the integral value is kept.
  - Integration continues if Ti ≠ 0.

Derivative time - Td: Used to respond fast to changes of deviation between reference and feedback.

- Larger Td means faster response, but excessively large Td leads to oscillation.
- If Td = 0, derivative is deactivated during PID control.

  Derivative stops and its value is reset to '0'.

Sampling period - T: Sampling time in PID control

The value should match with the selected time constant Ti or Td, normally shorter than 1/5 of the time constant.

PID Regulation Mode Setting

Parameter [E4.30] 'PID deadband' is used to set the limit of the deviation between reference and feedback value. When the difference is within the defined 'PID deadband', PID control stops to bring a stable output.

When the PID output reaches [E0.09] 'Output frequency high limit' or [E0.10]'Output frequency low limit' in PID control, following modes that is defined by Parameter [E4.31] 'PID regulation mode' are available for PID regulation:

[E4.31] = 0: Stop integral regulation when frequency arrives at upper / lower limit

When the difference between the reference values and the feedback values changes, the integral value follows immediately the difference. When the setting frequency reaches the limits, the integration stops, and the integral value remains unchanged. This mode is used in applications with fast change reference values.

[E4.31] = 1: Continue integral regulation when frequency arrives at upper / lower limit

When the PID output reaches the limits, the integral continues up to its possible numerical limit.

This mode is used in applications with stable reference values. When the difference between reference and feedback changes, more time is needed to eliminate the impact of accumulated integral regulation before the integral value can follow the change in the trend.

PID Feedforward Control

PID feedforward controls the process item through amending the output frequency setting with the fine tuning signal of PID output. Before using this function, users need set [E4.00] ≠ 0, and E4.33 should be set refer to the following choice:

- 0: PID feedforward inactive. If [E4.00] ≠ 0, the given frequency is set by PID output.
- 1: PID feedforward activate. If [E4.00] ≠ 0, the given frequency is set by the result of PID output plus the main frequency setting; the given frequency is set by parameter E0.00 "First frequency setting source", and be obtained through Acc / Dcc module.

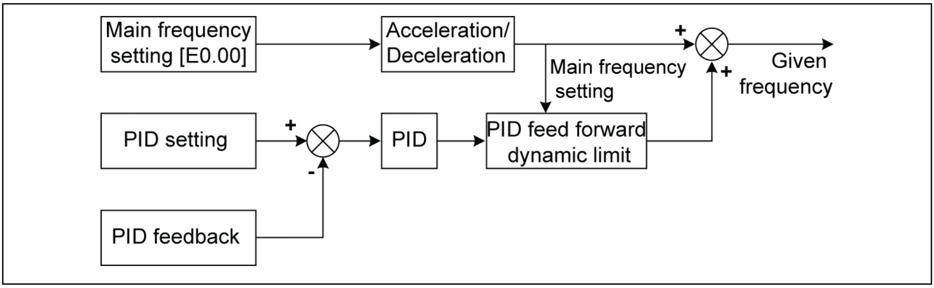


Fig. 12-101: PID feedforward

The parameters E4.19 and E4.20 are both used for limiting the value of PID feed-forward. E4.19 is the percentage relative to the main frequency, and E4.20 is the percentage relative to E0.08.

So, the range of PID feedforward frequency is:

-Min{[E4.19] × Main frequency + [E4.20] × [E0.08], [E0.09]}...Min{[E4.19] × Main frequency + [E4.20] × [E0.08], [E0.09]}

PID Deactivation by Digital Input

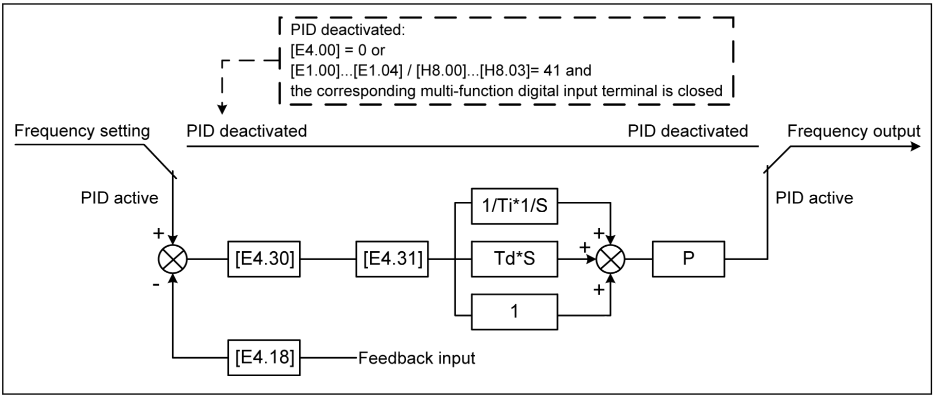


Fig. 12-102: PID deactivation by digital input

The PID control is deactivated in the following ways:

- 'PID reference channel' [E4.00] = '0: No PID control' or
- 'X1...X4 input' [E1.00]...[E1.04] or 'EX1...EX4 input' [H8.00]...[H8.03] = '41: PID deactivation' and respective multi-function digital input terminal is active.

PID Status Indication

[E4.32] 'PID engineering value detection width' is used to set the tolerance window between [d0.70] 'PID reference engineering value' and [d0.71] 'PID feedback engineering value'. When the difference between reference and feedback is within the detection width, the value arrival signal will be active via DO1 output.

Set [E4.32] = │[d0.70] - [d0.71]│/[d0.70] x 100 %

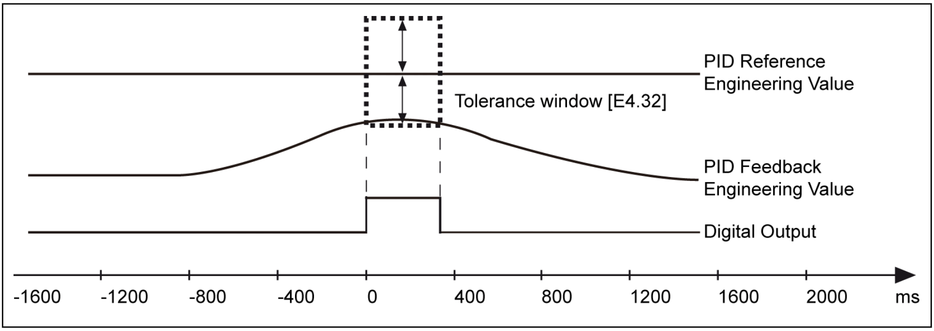


Fig. 12-103: PID engineering value detection width

12.13 E5: Extended Application Functions

12.13.1 High Resolution Current Display

E5.01 is used to set the time constant of dynamic output current in applications where a high resolution value with two decimals are required for monitoring or control.The high resolution output current can be monitored via d0.98.

Code	Name	Setting range	Default	Unit	Step	Attri.
E5.01	High resolution output current filter time	5...500 ms	40	ms	1	Run

12.13.2 Speed Display Scaling

This function is used to display an engineering value which is convenient for the application engineering with scaling the output value.

Code	Name	Setting range	Default	Unit	Step	Attri.
E5.02	User-defined speed scaling factor	0.01...100.00	1.00	-	0.01	Run

Follow the equations below:

- User-defined setting speed:
  [d0.04] = [d0.02] x [E5.02]
- User-defined output speed:
  [d0.05] = [d0.00] x [E5.02]

12.13.3 Pump Dry and Leakage Protection

This function defines two modes of pump protection:

- Pump dry protection: Protecting the pump from running without water load (e.g., water pump without water)
- Pump leakage protection: Protecting the pump from running with leakage

Both protection modes are realized by comparing the PID feedback with the PID reference when the frequency converter is running at [E0.09] 'Output frequency high limit'.

Code	Name	Setting range	Default	Unit	Step	Attri.
E5.05	Pump dry protection threshold	0.0 %... [E5.08]	30.0	-	0.1	Run
E5.06	Pump dry protection delay	0.0...300.0 s (0.0 s: Inactive)	0.0	-	0.1	Run
E5.07	Pump dry protection delay at start-up	0.0...300.0 s	30.0	s	0.1	Run
E5.08	Pump leakage protection threshold	0.0...100.0 %	50.0	-	0.1	Run
E5.09	Pump leakage protection delay	0.0...600.0 s (0.0 s: Inactive)	0.0	s	0.1	Run
E5.10	Pump leakage protection delay at start-up	0.0...600.0 s	60.0	s	0.1	Run

The conditions to trigger the pump dry protection:

- Frequency converter runs at the [E0.09] 'Output frequency high limit'
- ([PID feedback] ÷ [PID reference]) < [E5.05] 'Pump dry protection threshold'
- Duration ≥ [E5.06] 'Pump dry protection delay'

When the pump dry protection is triggered, the error code 'Pdr' will be displayed on the operating panel. The error message '24: Pdr, pump dry' can be read via parameters E9.05...E9.07.

The conditions to trigger the pump leakage protection:

- Frequency converter runs at the [E0.09] 'Output frequency high limit'
- ([PID feedback] ÷ [PID reference]) < [E5.08] 'Pump leakage protection threshold'
- Duration ≥ [E5.09] 'Pump leakage protection delay'

When the pump leakage protection is triggered, the warning code 'PLE' will be displayed on the operating panel.

- The 'Pump dry protection delay at start-up' E5.07 and the 'Pump leakage protection delay at start-up' E5.10 are used to prevent the two modes of protection at start-up process.
- These two modes of protection are only valid when PID control is enabled.

12.13.4 Sleep Function

This function is used to achieve the maximum extent of energy-saving according to type of loads in actual applications.

Code	Name	Setting range	Default	Unit	Step	Attri.
E5.15	Sleep level	0.00...[E0.09] Hz	0.00	Hz	0.01	Run
E5.16	Sleep delay	0.0...3,600.0 s	60.0	s	0.1	Run
E5.17	Sleep boost time	0.0...3,600.0 s	0.0	s	0.1	Run
E5.18	Sleep boost amplitude	0.0...100.0 %	0.0	-	0.1	Run
E5.19	Wake up level	0.0...100.0 %	0.0	-	0.1	Run
E5.20	Wake up delay	0.2...60.0 s	0.5	-	0.1	Run

E5.18 and E5.19 are the percentage of PID reference.

The frequency converter may go into the sleep mode when all the conditions below are met:

- [PID feedback] > [E5.19] 'Wake up level'
- [PID output] < [E5.15] 'Sleep level'
- [Duration] t ≥ [E5.16] 'Sleep delay'

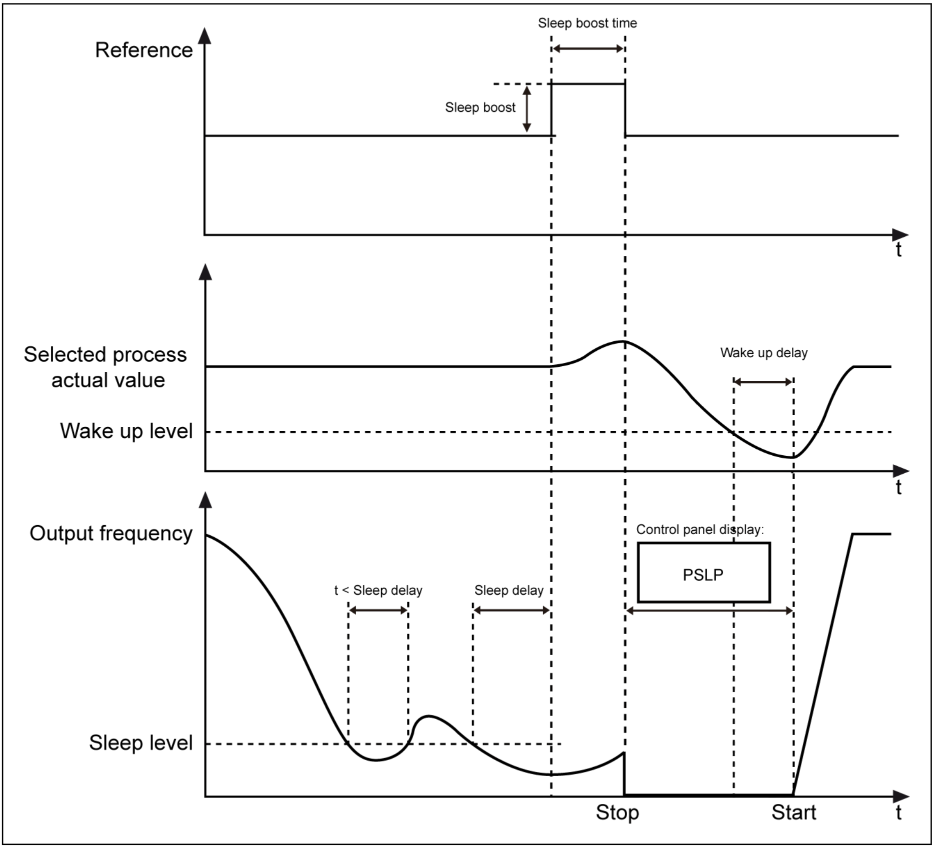


Fig. 12-104: Sleep and wake up process

After [E5.16] 'Sleep delay', the PID controller boosts up with [E5.18] 'Sleep boost amplitude' within [E5.17] 'Sleep boost time', and then enters to sleep mode. In sleep mode, the frequency converter stops output with 'PSLP' displayed on the operating panel.

[Sleep boost] = [E5.18] x [PID reference]

During sleeping, the frequency converter monitors the actual PID feedback and wakes up when the following two conditions are met:

- [PID feedback] < [E5.19] 'Wake up level'
- [Duration] t ≥ [E5.20] 'Wake up delay'

The frequency converter resumes to its previous running status after waking up.

12.14 E8: Standard Communication

12.14.1 Modbus Protocol

Brief Introduction

EFC x610 frequency converters provide standard RS485 communication interface to realize the communication between the master and slaves via Modbus protocol. With the help of a PC, a PLC or an external computer a 'single master / multiple slaves' network control can be realized (setting of frequency control command and running frequency, modification of parameters, monitoring of frequency converter running status and error messages) to address the specific requirements of applications.

☞ User parameters of the frequency converter can be written via communication interface for 150,000 times.

Protocol Description

Protocol introduction

- Modbus is a master / slave protocol. Only one device may send commands in the network at a particular time.
- The master station manages message exchange by polling the slave stations. Unless being approved by the master station, no slave station may send message. In case of an error during data exchange, if no response is received, the master station will query the slave stations absent from the polling.
- If a slave station is unable to recognize a message from the master station, an exception response will be sent to the master station.
- Slave stations cannot communicate with each other but through the master's software which reads data from one slave station and sends them to another. There are two types of dialogs between the master station and the slave stations:
  - The master station sends a request to a slave station and waits for its response.
  - The master station sends a request to all slave stations and does not wait for their response (broadcasting).

Transmission

The transmission is of RTU (Remote Terminal Unit) mode with frames containing no message header or end mark. A typical RTU frame format is shown below:

Slave address	Function code	Data	CRC
1 byte	1 byte	0...252 byte(s)	CRC low|CRC high

Tab. 12-26: Typical RTU frame format

- Data are transmitted in binary codes.
- CRC: Cyclic redundancy code.

- The address 0 is reserved as broadcast address.
- All slave nodes must recognize the broadcast address for writing function (no need of reply).
- The master node has no specific address, only the slave nodes must have addresses (1...247).

For RTU transmission mode, four types of character format are shown below:

- 1 start bit, 8 data bits, 1 stop bit, no parity
- 1 start bit, 8 data bits, 1 stop bit, even parity
- 1 start bit, 8 data bits, 1 stop bit, odd parity
- 1 start bit, 8 data bits, 2 stop bits, no parity

The character or byte is sent in the following sequence (from left to right):

<-Least significant bit (LSB)					Most significant bit (MSB)->					
Start	1	2	3	4	5	6	7	8	Stop	–
Start	1	2	3	4	5	6	7	8	Even	Stop
Start	1	2	3	4	5	6	7	8	Odd	Stop
Start	1	2	3	4	5	6	7	8	Stop	Stop

Tab. 12-27: RTU transmission mode

Message frames are separated by a silent interval of at least 3.5 characters' time. The entire frame must be transmitted as a continuous stream of bytes. If the interval of two separated frames is less than 3.5 characters' time, then the slave address of second frame will be treated as the part of first frame by mistake, due to the confusion of the frames, the CRC check will fail and lead to communication fault. If a silent interval of more than 1.5 characters' time occurs between two bytes, the message frame is regarded incomplete and discarded by the receiver.

Modbus Interface

The Modbus communication is via RS485 interface, see descriptions on RS485+ and RS485- in chapter 8.1 "Wiring Diagram" on page 56 and chapter 8.3.2 "Control Terminals" on page 72.

Modbus Function and Message Format

Supported functions

The main function of Modbus is to read and to write parameters. Different function codes decide different operation requests. Modbus functions managed by EFC x610 and their limits are shown in the table below:

Code	Function name	Broadcast	Max. value of N
3 = 0x03	Read N register words	NO	16
6 = 0x06	Write one register word	YES	–
8 = 0x08	Diagnosis	NO	–
16 = 0x10	Write N register words	YES	16
23 = 0x17	Read/write N register words	NO	16

Tab. 12-28: EFC x610 Modbus functions and limits

'Read' and 'Write' are considered from the prospect of the master station.

Modbus message formats are different according to the function codes shown below.

<table>
<tr><td rowspan="2">Slave No.</td><td rowspan="2">0x03</td><td>Address of 1st word</td><td>Number of words</td><td>CRC16</td></tr>
<tr><td>Hi | Lo</td><td>Hi | Lo</td><td>Lo | Hi</td></tr>
</table>

Tab. 12-29: Function 3_Request from the master

<table>
<tr><td rowspan="2">Slave No.</td><td rowspan="2">0x03</td><td>Number of bytes</td><td>1st word value</td><td>–</td><td>Last word value</td><td>CRC16</td></tr>
<tr><td>Depends on master request</td><td>Hi | Lo</td><td>–</td><td>Hi | Lo</td><td>Lo | Hi</td></tr>
</table>

Tab. 12-30: Function 3_Response from the slave

<table>
<tr><td rowspan="2">Slave No.</td><td rowspan="2">0x06</td><td>Address of word</td><td>Value of word</td><td>CRC16</td></tr>
<tr><td>Hi | Lo</td><td>Hi | Lo</td><td>Lo | Hi</td></tr>
</table>

Tab. 12-31: Function 6_Master request and slave response (in same format)

Slave No.	0x08	Test word 1	Test word 2	CRC16
		Hi | Lo	Hi | Lo	Lo | Hi

Tab. 12-32: Function 8_Master request and slave response (in same format)

Slave No.	0x10	Address of 1st word	Number of words	Number of bytes	1st word value	–	Last word value	CRC16
		Hi | Lo	Hi | Lo		Hi | Lo	–	Hi | Lo	Lo | Hi

Tab. 12-33: Function 16_Request from the master

Slave No.	0x10	Address of 1st word	Number of words	CRC16
		Hi | Lo	Hi | Lo	Lo | Hi

Tab. 12-34: Function 16_Response from the slave

Slave No.	0x17	Address of 1st word to be read	Number of words to be read	Address of 1st word to be written
		Hi | Lo	Hi | Lo	Hi | Lo

Number of words to be written	Number of bytes to be written	Value of 1st word to be written	–	Value of last word to be written	CRC16
Hi | Lo		Hi | Lo	–	Hi | Lo	Lo | Hi

Tab. 12-35: Function 23_Request from the master

Slave No.	0x17	Number of bytes	1st word value read	–	Last word value read	CRC16
			Hi | Lo	–	Hi | Lo	Lo | Hi

Tab. 12-36: Function 23_Response from the slave

Function example

Function 0x03: Read N register words, range: 1...16

Example: It is necessary to read 2 continuous words starting from communication register 3000H of the slave frequency converter addressed at 01H. The frame structure is described in the tables below.

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	03H
Higher byte of start address	30H
Lower byte of start address	00H
Higher byte of data	00H
Lower byte of data	02H
CRC lower byte	CBH
CRC higher byte	0BH
Message end	Transmission time for 3.5 bytes

Tab. 12-37: Function 0x03_Request from RTU master

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	03H
Bytes of data	04H
Higher byte of data in register 3000H	00H
Lower byte of data in register 3000H	14H
Higher byte of data in register 3001H	00H
Lower byte of data in register 3001H	02H
CRC lower byte	3BH
CRC higher byte	F6H
Message end	Transmission time for 3.5 bytes

Tab. 12-38: Function 0x03_Response from RTU slave

Function 0x06: Write one register word

⚠ CAUTION

Frequent writing may damage the internal registers!

- When data is written into the internal registers, there is a limit on the writing times. The register address may be damaged once the writing times is beyond the writing limit. So please avoid frequent writing!
- For details of user writing permission, please see chapter 19.3.1 "Terminology and Abbreviation in Parameter List" on page 581.

Example: Write 0000H to communication register address 3002H of the slave frequency converter with address 01H. The frame structure is described in the tables below:

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	06H
Higher byte of write register address	30H
Lower byte of write register address	02H
Higher byte of write data	00H
Lower byte of write data	00H
CRC lower byte	27H
CRC higher byte	0AH
Message end	Transmission time for 3.5 bytes

Tab. 12-39: Function 0x06_Request from RTU master

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	06H
Higher byte of write register address	30H
Lower byte of write register address	02H
Higher byte of write data	00H
Lower byte of write data	00H
CRC lower byte	27H
CRC higher byte	0AH
Message end	Transmission time for 3.5 bytes

Tab. 12-40: Function 0x06_Response from RTU slave

Function 0x08: Diagnostics

Example: To test the communication loop of 2 continuous words 1234H and 5678H with frequency converter slave address 01H, the frame structure is described in the tables below:

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	08H
Higher byte of sub-function	00H
Lower byte of sub-function	00H
Higher byte of test word 1	12H
Lower byte of test word 1	34H
Higher byte of test word 2	56H
Lower byte of test word 2	78H
CRC lower byte	73H
CRC higher byte	33H
Message end	Transmission time for 3.5 bytes

Tab. 12-41: Function 0x08_Request from RTU master

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	08H
Higher byte of sub-function	00H
Lower byte of sub-function	00H
Higher byte of test word 1	12H
Lower byte of test word 1	34H
Higher byte of test word 2	56H
Lower byte of test word 2	78H
CRC lower byte	73H
CRC higher byte	33H
Message end	Transmission time for 3.5 bytes

Tab. 12-42: Function 0x08_Response from RTU slave

Function 0x10: Write N register words, range: 1...16

Example: To modify 2 continuous registers start from 4000H with words 0001H and 0000H with slave frequency converter address 01H. The frame structure is described in the tables below:

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	10H
Higher byte of write register start address	40H
Lower byte of write register start address	00H
Higher byte of register number	00H
Lower byte of register number	02H
Bytes of data	04H
Higher byte of data in register 4000H	00H
Lower byte of data in register 4000H	01H
Higher byte of data in register 4001H	00H
Lower byte of data in register 4001H	00H
CRC lower byte	93H
CRC higher byte	ACH
Message end	Transmission time for 3.5 bytes

Tab. 12-43: Function 0x10_Request from RTU master

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	10H
Higher byte of write register start address	40H
Lower byte of write register start address	00H
Higher byte of register number	00H
Lower byte of register number	02H
CRC lower byte	54H
CRC higher byte	08H
Message end	Transmission time for 3.5 bytes

Tab. 12-44: Function 0x10_Response from RTU slave

Function 0x17: Read/Write N register words, range: 1...16

Example: To read data in 2 continuous registers starting from address 3000H, write 0001H and 0000H to 2 continuous registers starting from address 4000H. The frame structure is described in the tables below:

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	17H
Higher byte of read register start address	30H
Lower byte of read register start address	00H
Higher byte of read register number	00H
Lower byte of read register number	02H
Higher byte of write register start address	40H
Lower byte of write register start address	00H
Higher byte of write register number	00H
Lower byte of write register number	02H
Bytes of data for writing	04H
Higher byte of data in register 4000H	00H
Lower byte of data in register 4000H	01H
Higher byte of data in register 4001H	00H
Lower byte of data in register 4001H	00H
CRC lower byte	E6H
CRC higher byte	B3H
Message end	Transmission time for 3.5 bytes

Tab. 12-45: Function 0x17_Request from RTU master

Message start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	17H
Bytes of read register	04H
Higher byte of read register 3000H	00H
Lower byte of read register 3000H	14H
Higher byte of read register 3001H	00H
Lower byte of read register 3001H	02H
CRC lower byte	38H
CRC higher byte	E2H
Message end	Transmission time for 3.5 bytes

Tab. 12-46: Function 0x17_Response from RTU slave

Error code and exception code

If a slave receives the request without a communication error, but cannot handle it, the slave will return an exception response which includes error code and exception code informing the master of the nature of the error. The error code is formed by setting the MSB of the function code to 1 (i.e. function code plus with 0x80, like 0x83, 0x86, 0x90, 0x97), then the exception response has a format shown below.

Slave No.	Error code	Exception code	CRC16
			Lo | Hi

Exception codes for EFC x610 frequency converters:

- 1 = Parameter cannot be modify owing to user password locked
- 2 = The function requested is not recognized by the slave, i.e. not equal to 3, 6, 8, 16 or 23
- 3 = The word address indicated in the request do not exist in the slave
- 4 = The word values indicated in the request are not permissible in the slave
- 5 = Parameters cannot be modify in run mode
- 6 = Parameters are read-only that cannot be modified
- 7 = Invalid operation which is decided by the function of frequency converter(*)
- 9 = EEPROM read/write error
- B = Function code 3, read range exceeds 16

(*) includes situations listed below:

- Write operations on b0.11 'Parameter copy', U1.00 'Run monitoring display', U1.10 'Stop monitoring display' and C1.01 'Motor parameter tuning', are prohibited.
- Write operations on b0.20 'User password', b0.21 'Manufacture password' and b0.10 'Parameter initialization' only support function 6.
- Multi-function digital input terminals (E1.00...E1.04) writing operation do not permit repeated non-zero value.

Communication Mapping Register Address Distribution

Frequency converter parameter address

Frequency converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in frequency converter parameter registers via Modbus communication. The characteristics and scope of reading and writing function codes are in compliance with the frequency converter function code description. The address of a frequency converter parameter register is composed of a higher byte representing the function code group and a lower byte representing the index in the group. The groups are mapped as follows:

Address high byte	0x00	0x20	0x21	0x22	0x23	0x30	0x31	0x32	0x33	0x34
Group	b0	C0	C1	C2	C3	E0	E1	E2	E3	E4
Address high byte	0x35	0x38	0x39	0x60	0x61	0x68	0x69	0x40	0x41	0x10
Group	E5	E8	E9	H0	H1	H8	H9	U0	U1	d0

Tab. 12-47: Frequency converter parameter registers

Parameters of the monitoring group (Group d0) are always write-protected.

Examples:

To read out the module temperature (d0.20) of EFC x610 frequency converter, use register address 0x1014 (0x10 = Group d0, index 0x14 = 20).

To set V/f curve mode (C2.00) of EFC x610 frequency converter, use register address 0x2200 (0x22 = Group C2, index 0).

Access to a non-existing function code will be acknowledged with exception code 3 (see chapter "Modbus Function and Message Format" on page 290).

Frequency converter register address

Register	Address
Communication control register	0x7F00
Communication state register	0x7FA0
Additional status register	0x7FA1
STO safety status register	0x7FA2
Fault status register	0x7FB0
Communication frequency setting register	0x7F01
Torque setting register	0x7F02
Torque FWD limitation register	0x7F03
Torque REV limitation register	0x7F04
Speed limitation register	0x7F05

Tab. 12-48: Frequency converter register address

Communication control register (0x7F00)

The address of command word register for communication control is 0x7F00. This register is write-only. The frequency converter is controlled through writing data into the address. The definition of each bit is shown in table below:

bit	Value	Description
15...9	–	Reserved
8	1	Torque control active
	0	Inactive
7	1	Control word active
	0	Inactive
6	1	Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator)
	0	Inactive
5	1	Fault reset active
	0	Inactive
4	1	E-stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active (jogging direction determined by bit 2)
	0	Inactive
0	1	Run command active
	0	Inactive

Tab. 12-49: Communication control register (0x7F00)

If the communication frame check is successful (CRC valid), the frequency converter always accepts the content of the control word. All conflicts (e.g. run command and stop command active at the same time) are resolved by the application functionality (Run / Stop generator, jog control...). This assures that the frequency converter will always react in the same manner, independent of the run command source.

Communication state register (0x7FA0)

The frequency converter state can be monitored by reading the register. This register is read-only. The definition of each bit is shown in the table below:

bit	Value	Description
15 ... 8	–	Error code (equals to [E9.05])
7	1	Error
	0	No error
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-50: Communication state register (0x7FA0)

Additional status register (0x7FA1)

Additional status register is the extension of main status register(7FA0H), it stores other status information of frequency converter. This register is read-only. The definition of each bit is shown in the table below:

bit	Value	Description
15	1	Error
	0	No error
14	1	Warning
	0	No warning
13	-	Reserved
12	1	Sleep mode
	0	Normal
11	1	Coasting to stop
	0	Not coasting
10	1	Speed tracing
	0	Not tracing
9	1	0 speed
	0	Not 0 speed
8	1	DC braking
	0	Not DC braking
7	1	Converter OK
	0	Converter not OK
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-51: Additional status register (0x7FA1)

STO safety status register (0x7FA2)

bit	Value	Description
15...3	-	Reserved
2	1	StO-E
	0	Not in StO-E status
1	1	StO-r
	0	Not in StO-r status
0	1	StO-A
	0	Not in StO-A status

Tab. 12-52: STO safety status register (0x7FA2)

Fault status register (0x7FB0)

The fault status of frequency converter can be monitored by reading the register. This register is read-only.

bit	HEX	Description
bit 15 . . . bit 0	0	No error
	1	OC-1, overcurrent at constant speed
	2	OC-2, overcurrent during acceleration
	3	OC-3, overcurrent during deceleration
	4	OE-1, overvoltage at constant speed
	5	OE-2, overvoltage during acceleration
	6	OE-3, overvoltage during deceleration
	7	OE-4, overvoltage during stop
	8	UE-1, undervoltage during run
	9	SC, surge current or short circuit
	A	IPH.L, input phase loss
	B	OPH.L, output phase loss
	C	ESS-, soft start error
	14	OL-1, converter overload
	15	OH, converter over temperature
	17	FF, fan failure
	18	Pdr, pump dry
	19	CoL-, command value lost
	1A	StO-r, safe torque off request
	1B	StO-E, safe torque off error
	1E	OL-2, motor overload
	1F	Ot, motor over temperature
	20	t-Er, motor parameter tuning error
	21	AdE-, synchronous motor angle detection error
	23	SPE-, speed control loop error
	26	AibE, analog input broken wire detection
	27	EPS-, DC_IN power supply error
	28	dir1, forward running lock error
	29	dir2, reverse running lock error

bit	HEX	Description
bit 15 . . . bit 0	2A	E-St, terminal error signal
	2B	FFE-, firmware version mismatch
	2C	rS-, modbus communication error
	2D	E.Par, parameter settings invalid
	2E	U.Par, unknown parameter restore error
	30	idA-, internal communication error
	31	idP-, internal parameter error
	32	IDE-, converter internal error
	33	OCd-, extension card internal error
	34	Occ, extension card PDOs configuration error
	35	Fdi-, no valid process data
	36	PcE-, remote control communication error
	37	PbrE, parameter backup / restore error
	38	PrEF, parameter restore error after firmware update
	3C	ASF-, application firmware error
	3D	APE1, application error 1
	3E	APE2, application error 2
	3F	APE3, application error 3
	40	APE4, application error 4
	41	APE5, application error 5

Tab. 12-53: Fault status register (0x7FB0)

Communication frequency setting register (0x7F01)

The address of frequency setting register for communication control is 0x7F01. This register is for read and write. When 'First frequency setting source' [E0.00] = '20: Communication', the frequency converter can be set with writing data to this address.

Torque setting register (0x7F02)

The address of torque setting register is 0x7F02. This register is for read and write. When 'Torque reference channel' [C3.41] = '6: Communication', the torque reference channel can be set with writing data to this address.

Torque FWD limitation register (0x7F03)

The address of torque FWD limitation register is 0x7F03. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

Torque REV limitation register (0x7F04)

The address of torque REV limitation register is 0x7F04. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

Speed limitation register (0x7F05)

The address of speed limitation register is 0x7F05. This register is for read and write. When 'Speed limitation reference selection at torque control mode' [C3.48] = '4: Communication', the speed limitation reference can be set with writing data to this address.

Modbus Communication Example

One slave address is 01H. The frequency setting of the frequency converter has been set to 'Given by communication' and the RUN command source is set to 'Inputting commands by communication'. It is required for the motor connected to the frequency converter to run with 50 Hz (forward rotation). The operation can be achieved with function 0x10 (function 16) of the Modbus protocol. The messages of the requests from the master and responses from the slave are shown in table below:

- Example 1: Start 01# frequency converter for forward rotation at frequency of 50.00 Hz (represented by 5,000 internally)

	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x10	0x7F00	0x0002	0x04	0x0081 0x1388	0x8AE3
Response	0x01	0x10	0x7F00	0x0002	N/A	N/A	0x581C

- Example 2: Read the output frequency of 01# frequency converter and output velocity

	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x03	0x1000	0x0002	N/A	N/A	C0CB
Response	0x01	0x03	N/A	N/A	0x04	0x1388 0x05DC	0x7C54

- Example 3: Stop 01# frequency converter according to the stopping mode with the function code

	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x06	0x7F00	N/A	N/A	0x0088	0x9078
Response	0x01	0x06	0x7F00	N/A	N/A	0x0088	0x9078

Special Notes

1. The external computer can not write to function codes b0.11 'Parameter copy', U1.00 'Run monitoring display' and U1.10 'Stop monitoring display'.
2. b0.20 'User password' and b0.10 'Parameter initialization' do not support multiple write including single write in multiple write; Motor nameplate parameters and motor physical data should not be modified simultaneously; Multi-function digital input terminals (E1.00...E0.04) writing operation do not permit repeated non-zero value.
3. If the communication protocol is changed, baud rate, data frame and local address will be restored to factory default.
4. The read response of user password and manufacture password is '0000' in case of external computer reading.
5. The external computer can set, modify or cancel user password, the specific operation is same to the situation when 'Running command source' is from the operating panel.
6. The access to control registers and state registers is not limited by user password.

Communication Networking

Networking

The communication network is shown in figure below, with a PC, a PLC or an external computer as the master and all frequency converters as slaves, which are connected by shielded twisted pair cables. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω, 0.25 W.

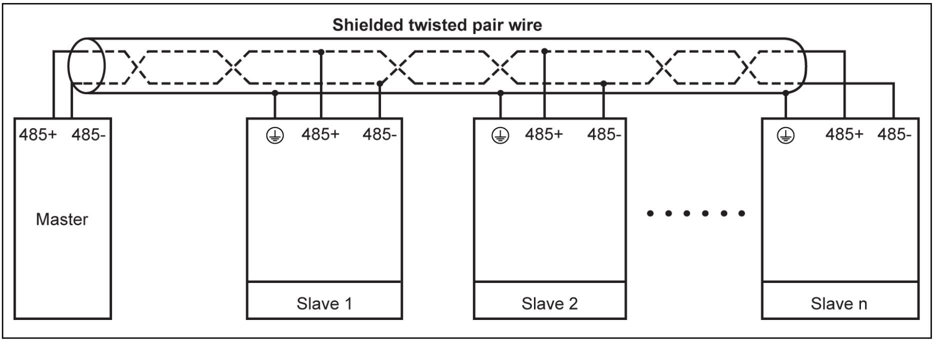


Fig. 12-105: Communication networking

- The maximum length of the communication cable is 300 m.
- The maximum length of the communication cable is 80 m if the number of slaves is less than 5.
- If the Modbus network cannot work successfully, check if a bias resistor has been installed for the master device and make sure that its resistance is not more than 1.5 kΩ.

⚠ WARNING

Cables may only be connected when the frequency converters are switched off!

Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- Modbus cable should be adequately away from power cables (minimum 30 cm).
- Avoid crossing of Modbus cables and power cables and use orthogonal crossing if crossing must be used.
- The shielding layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.

- In no circumstance should ground cables constitute a loop.

12.14.2 Communication Selection

This function is about the selection of the Communication Protocol.

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.00	Communication protocol	0: Modbus 1: Extension card	0	–	–	Stop

The standard product only supports Modbus communication protocol. To use other communication protocols, optional communication cards need to be ordered additionally and parameter E8.00 and other related parameters need to be set accordingly.

☞ For Multi-Ethernet extension card configurations, please refer to documentation R912006860.

12.14.3 Communication Error Reaction

This function defines the detection of the communication disruption and corresponding reaction.

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.01	Communication error detection time	0.0...60.0 s (0.0: Inactive)	0.0	s	0.1	Stop
E8.02	Communication error protection mode	0: Freewheeling stop 1: Keep running 2: Emergency stop	1	-	-	Stop
E8.03	Communication process data loss behavior	0: Decelerating stop 1: Freewheeling stop 2: Keep running 3: Keep running without warning	0	-	-	Stop

When [E8.01] = 0.0 s, the disruption detection function is inactive.

If the interval between the current and next communication commands exceeds the time defined in [E8.01] 'Communication error detection time', the frequency converter will reports a communication error code and act as defined in [E8.02] 'Communication error protection mode':

- **[E8.02] = 0: Freewheeling stop**

  The motor freewheels to stop after the communication timeout no matter the settings of parameter E0.50 'Stop mode'.

- **[E8.02] = 1: Keep running**

  The motor continues running at the setting frequency, and warning code 'C-dr' will be displayed on the operating panel.

- **[E8.02] = 2: Emergency stop**

  The motor decelerate to stop after the communication timeout no matter the settings of parameter E0.56 'Emergency stop action', the deceleration time is E0.57.

E8.03 determines the behavior of the frequency converter when the communication extension card process data lost:

- **[E8.03] = 0: Decelerating stop**

  The motor decelerates to stop according to the defined deceleration time when the communication extension card process data lost.

- **[E8.03] = 1: Freewheeling stop**

  The motor freewheels to stop after the communication extension card process data lost no matter the settings of parameter E0.50 'Stop mode'.

- **[E8.03] = 2: Keep running without warning**

The motor continues running at the setting frequency, and warning code 'Fdi' will be displayed on the operating panel.

- [E8.03] = 3: Keep running

  The motor continues running at the setting frequency, and no any warning on the operating panel.

12.14.4 Modbus Settings

Setting the Data Transmission Rate

Data transmission rate refers to the transmission rate of data between the external computer and the frequency converter.

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.10	Modbus baud rate	0: 1,200 bps 1: 2,400 bps 2: 4,800 bps 3: 9,600 bps 4: 19,200 bps 5: 38,400 bps	3	–	–	Stop

Setting the Data Format

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.11	Modbus data format	0: 1 start bit, 8 data bits, 1 stop bit, no parity 1: 1 start bit, 8 data bits, 1 stop bit, even parity 2: 1 start bit, 8 data bits, 1 stop bit, odd parity 3: 1 start bit, 8 data bits, 2 stop bits, no parity	0	–	–	Stop

☞ The data format of the converter must be the same as that of the master station. Otherwise, normal communication is impossible.

Setting the Local Address

In Modbus communication, the maximum number of frequency converters in the network is 247. Each frequency converter must have a unique local address.

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.12	Modbus local address	1...247	1	–	1	Stop

Setting Command Signal Type

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.13	Modbus level / edge sensitivity selection	0: Level sensitive 1: Edge sensitive	1	–	–	Stop

Setting range of E8.13:

E8.13 = 0: Level sensitive

The control word is not a real edge sensitive, master should manually reset the command.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is not reset
5. Master should set bit 5 = 0 firstly, then set bit 5 = 1, the error is reset

E8.13 = 1: Edge sensitive

The control command is reset automatically after the activation.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is not reset

Setting Modbus transmission mode

Code	Name	Setting range	Default	Unit	Step	Attri.
E8.14	Modbus transmission mode selection	0: RTU transmission 1: ASCII transmission mode	0	–	–	Stop
E8.15	Modbus ASCII inter-character timeout	1.0...5.0 s	1.0	s	0.1	Stop

E8.15 is used to set the maximum time delay allowed between 2 characters of a single ASCII frame.

12.15 E9: Error Log and Automatic Error Reset

12.15.1 Automatic Error Reset

Automatic error reset function can be used to ensure continuous running without human intervention in the case of occasional errors, such as over current and over voltage during start and running.

Related parameters

Code	Name	Setting range	Default	Unit	Step	Attri.
E9.00	Automatic error reset attempts	0..3	0	-	1	Stop
E9.01	Automatic error reset interval	0.1...60.0	10.0	s	0.1	Stop
E9.02	Automatic error reset attempts restart time	0...65535 0: disabled	0	s	1	Stop

Detailed description

Parameter E9.00 is used to set the allowed maximum times of attempts for automatic reset in case of fault.

When the fault auto reset time is set to 0, there is no auto fault reset function, only manual reset can be done.

Parameter E9.01 is used to set interval time between reset attempts.

Attention: for the hardware critical error SC (short circuit) the internal minimum error reset interval is always minimal 5.0s in cases there [E9.01] is smaller than this value.

Parameter [E9.02] can be used to reset the internal error rest attempts back to the value from [E9.00] in case there are no error events inside this restart time.

In the following case the number of reset attempts is reset to E9.00:

1. 1. The converter is stopped and restarted by a RUN command.
2. 2. The automatic fault reset sequence is interrupted by a power cycle.
3. 3. [E9.02] is set to a value different to 0 and there are no error reset events inside the interval given from this [E9.02] parameter value.

If the error is cleared successfully after some tries, the reset counter is not set back to [E9.00] It keeps its current value. Therefore, if another error happens later on, the number of possible reset attempts already has decreased.

List of errors with automatic error reset capability

Diagnostic Code	Diagnostic Code Name	Error Display	Hint
F5001	Overcurrent at constant speed	OC-1	
F5002	Overcurrent during acceleration	OC-2	

Diagnostic Code	Diagnostic Code Name	Error Display	Hint
F5003	Overcurrent during deceleration	OC-3	
F5004	Overvoltage at constant speed	OE-1	
F5005	Overvoltage during acceleration	OE-2	
F5006	Overvoltage during deceleration	OE-3	
F5007	Overvoltage during stop	OE-4	
F5008	Undervoltage during run	UE-1	
F5009	Surge current or short circuit	SC	
F5010	Input phase loss	IPH.L	* FW > 03V28
F5011	Output phase loss	OPH.L	* FW > 03V28
F5012	Soft start error	ESS-	
F5020	Converter overload	OL-1	
F5021	Converter over temperature	OH	
F5025	Command value lost	CoL-	* FW > 03V28
F5030	Motor overload	OL-2	
F5033	Synchronous motor angle detection error	AdE-	* FW > 03V28
F5901	Host communication timed out	FCd-	* FW >= 03V28 removed
F5902	Fieldbus process data configuration erroneous	FPC-	* FW >= 03V28 removed
F5903	RPDO Telegram Loss	FtL-	* FW >= 03V28 removed
F5904	Communication platform initialization failed	FIn-	* FW >= 03V28 removed
F5905	Fieldbus network configuration invalid	FnC-	* FW >= 03V28 removed
F5906	Communication platform critical error	FCE-	* FW >= 03V28 removed
F5907	Communication platform firmware corrupted	FnF-	* FW >= 03V28 removed

Tab. 12-54: List of errors with automatic error reset capability

12.15.2 Error Log

Error log record the error history and detailed error code.

Code	Name	Setting range	Default	Unit	Step	Attri.
E9.05	Last error type	–	–	–	–	Read
E9.06	Second last error type	–	–	–	–	Read
E9.07	Third last error type	–	–	–	–	Read
E9.10	Output frequency at last error	–	–	Hz	0.01	Read
E9.11	Setting frequency at last error	–	–	Hz	0.01	Read
E9.12	Output current at last error	–	–	A	0.1	Read
E9.13	Output voltage at last error	–	–	V	1	Read
E9.14	DC-bus voltage at last error	–	–	V	1	Read
E9.15	Power module temperature at last error	–	–	℃	1	Read
E9.50	Last warning type	–	–	–	–	Read
E9.51	Second last warning type	–	–	–	–	Read
E9.52	Third last warning type	–	–	–	–	Read
E9.97	Last error detail	00000...FFFFF	0	–	–	Read
E9.98	Second last error detail	00000...FFFFF	0	–	–	Read
E9.99	Third last error detail	00000...FFFFF	0	–	–	Read

Value range of E9.05...E9.07:

0: No error

1: OC-1, overcurrent at constant speed

2: OC-2, overcurrent during acceleration

3: OC-3, overcurrent during deceleration

4: OE-1, overvoltage at constant speed

5: OE-2, overvoltage during acceleration

6: OE-3, overvoltage during deceleration

8: UE-1, undervoltage during run

9: SC, surge current or short circuit

10: IPH.L, input phase loss

11: OPH.L, output phase loss

12: ESS-, soft start error

20: OL-1, converter overload

21: OH, converter over temperature

23: FF, fan failure

24: Pdr, pump dry

25: CoL-, command value lost

26: StO-r, STO request

27: StO-E, STO error

30: OL-2, motor overload

31: Ot, motor over temperature

32: t-Er, motor parameter tuning error

33: AdE-, synchronous motor angle detection error

34: EnCE-, encoder error

35: SPE-, speed control loop error

38: AibE, analog input broken wire detection

39: EPS-, DC_IN power supply error

40: dir1, forward running lock error

41: dir2, reverse running lock error

42: E-St, terminal error signal

43: FFE-, firmware version mismatch

44: rS-, Modbus communication error

45: E.Par, parameter settings invalid

46: U.Par, unknown parameter restore error

48: idA-, internal communication error

49: idP-, internal parameter error

50: idE-, converter internal error

51: OCd-, extension card internal error

52: OCc, extension card PDOs configuration error

54: PcE-, remote control communication error

55: PbrE, parameter backup / restore error

56: PrEF, parameter restore error after firmware update

60: ASF-, ASF system error

61: APE1, ASF customer error 1

62: APE2, ASF customer error 2

63: APE3, ASF customer error 3

64: APE4, ASF customer error 4

65: APE5, ASF customer error 5

70: ElbE, Encoder error

71: EPOE, Encoder error

72: R-SC, Encoder error

73: OS-E, Encoder error

901: FCd-, Host communication timed out

902: FPC-, Fieldbus process data configuration erroneous

903: FtL-, RPDO Telegram Loss

904: FIn-, Communication platform initialization failed

905: FnC-, Fieldbus network configuration invalid

906: FCE-, Communication platform critical error

907: FnF-, Communication platform firmware corrupted

908: Fdi-, Fieldbus data Invalid

For detailed information about above errors, please see chapter 13.4 "Error Code" on page 470.

Value range of E9.50...E9.52:

Diagnostic code	Description	Display	S-0-0390 contents
6	Pump leakage	PLE	0x000E5006
7	Overvoltage during stop	OE-4	0x000E5007
31	Motor over temperature	Ot	0x000E5031
42	Terminal Error Signal	E-St	0x000E5042
403	Communication disconnection	C-dr	0x000E5403
408	Analog input broken wire detection	Aib-	0x000E5408
409	Fan maintenance period expired	FLE	0x000E5409
410	Communication data exceeds value range	OCi	0x000E5410
411	Under Temperature warning	UH-A	0x000E5411
420	ASF customer warning 1	APF1	0x000E5420
421	ASF customer warning 2	APF2	0x000E5421
422	ASF customer warning 3	APF3	0x000E5422
423	ASF customer warning 4	APF4	0x000E5423
424	ASF customer warning 5	APF5	0x000E5424
430	UnSupported Device Configuration	USdc	0x000E5430
440	Speed limited by maximum Voltage	Sli-	0x000E5440
900	Invalid State Transition	iSt	0x000E5900
903	RPDO Telegram Loss	FtL	0x000E5903
908	Option card process data invalid	Fdi	0x000E5908

Tab. 12-55: List of errors with automatic error reset capability

12.16 F0: ASF Basic Settings

12.16.1 ASF Status

ASF function description

xFCx610 supply the function of ASF (Application Specific Firmware), the frequency converter can load different ASF (such as "Water supply", "Tension control" , etc.) based on different applications. This can realize flexible and fast requirement from user.

This function introduce the relevant information of ASF. For detailed information about ASF function and operation, please refer to each ASF Instruction Manual.

ASF Parameter

The range of ASF parameter is F1.00...F5.99, each parameter and its group numbers are defined by ASF instance.

The table below lists the ASF parameters loaded by frequency converter.

Code	Name	Setting range	Default*	Unit	Step	Attri.
F0.01	ASF version	–	0.00	-	-	Read
F0.02	ASF identifier	0x0000 ... 0x0FFF	0x0000	-	-	Read
F0.03	ASF API required version**	–	0.00	-	-	Read
F0.06	ASF trial time left	0...65,535 s	0	-	1	Read
F0.07	ASF API version	–	***	-	-	Read
F0.10	ASF status	0x0000H... 0xFFFFH	0x0000	-	-	Read

- *: The default value depends on the specific ASF function.
- **: API: Application Program Interface.
- ***: The value depends on firmware version of the frequency converter.

Each bit of F0.10 defines the status information of current ASF.

Bit	Definition
15..14	Reserved
13	Error-Stack overflow
12	Error-Runtime timeout
11	Reserved
10	Error-API incompatible
9	Error-Invalid

Bit	Definition
8	Error-Trial time expired
7...3	Reserved
2	ASF authenticated
1	API compatible
0	ASF activated

Tab. 12-56: ASF status bit definition

When the frequency converter loaded an effective and certified ASF, the value of F0.10 is 0x0007.

ASF Management

Download ASF

The ASF can be managed by engineering software tool "ConverterWorks" or "IndraWorks Ds (14V14 or newer)" via USB (serial) connection only.

Open the menu of ASF management on ConverterWorks before loading the ASF, a dialog box is shown as below:

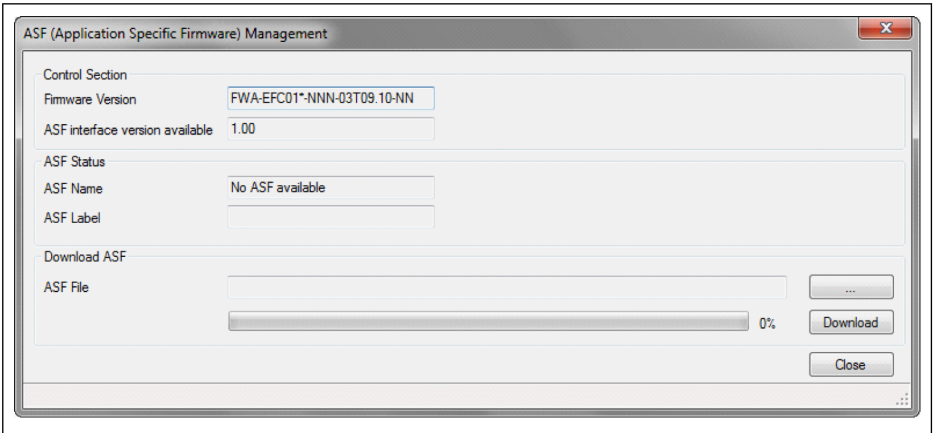


Fig. 12-106: ASF management menu

The first column's information on above figure depends on the frequency converter connected to PC.

Choose the target file in "Download ASF" area, then click "Download".

During the download process, "FUPd-" will be displayed on the LED panel of frequency converter.

After download is completed, the display window will show as follows.

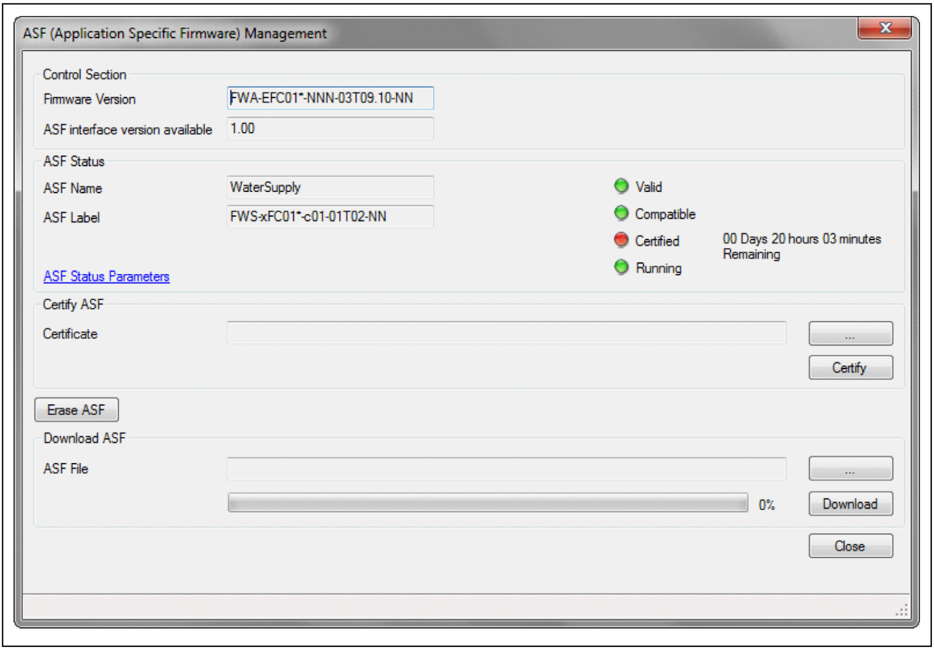


Fig. 12-107: ASF management window

Certify ASF

Choose the target file in "Certify ASF" area, then click "Certify".

When the indicator light on the certified item changes from red to green, it means that the certification is successful.

Erase ASF

Click "Erase ASF" in "ASF Management" window to delete the ASF files from the frequency converter.

ASF Diagnosis

ASF system error

Error code	Display	Description
F8060	ASF-	ASF error

Tab. 12-57: The information of ASF system error

ASF running platform detects the ASF objects and triggers the fault when there have problems. Specific fault causes can query the parameter F0.10 bit fault information.

ASF warning and error

Defined by specific ASF, see each ASF's Instruction Manual for detailed information.

12.16.2 ASF Command Values

This part is about the parameters used by ASF platform and extension card interface.

Code	Name	Setting range	Default*	Unit	Step	Attri.
F0.20	ASF command 1	–	0	-	-	Read
F0.21	ASF command 2	–	0	-	-	Read
F0.22	ASF command 3	–	0	-	-	Read
F0.23	ASF command 4	–	0	-	-	Read
F0.24	ASF command 5	–	0	-	-	Read
F0.25	ASF command 6	–	0	-	-	Read
F0.26	ASF command 7	–	0	-	-	Read
F0.27	ASF command 8	–	0	-	-	Read

For detailed information about the definition and operation, please refer to the Instruction Manual for extension card and specific ASF.

12.17 H0: Extension Card General Settings

12.17.1 Status and Control Words

Extension communication card control word

[H0.00] is the content of the control word that the converter always accepts.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.00	Control word	0x00000...0x0FFFF	0x00000	-	1	Run

For details on control word, see the table below:

bit	Value	Description
15...10	–	Reserved
9	1	Torque control active
	0	Inactive
8	1	Freewheeling stop
	0	Inactive
7	1	Control word active
	0	Inactive
6	1	Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator)
	0	Inactive
5	1	Fault reset active
	0	Inactive
4	1	E-stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active (jogging direction determined by bit 2)
	0	Inactive
0	1	Run command active
	0	Inactive

Tab. 12-58: Control word

Status word

[H0.01] will indicate the converter status.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.01	Status word	-	0x00000	-	1	Read

For details on status word, see the table below:

bit	Value	Description
15 ... 8	–	Error code (equals to [E9.05])
7	1	Error
	0	No error
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-59: Status word

Extended status word

Extended status word is the extension of main status word, it stores other status information of frequency converter.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.02	Extended status word	-	0x00000	-	1	Read

The definition of each bit is shown in the table below:

bit	Value	Description
15...1	–	Reserved
14	1	Warning
	0	No warning
13...3	–	Reserved
2	1	Converter OK
	0	Converter not OK
1	1	Sleep mode
	0	Normal

bit	Value	Description
0	1	24 V mode
	0	Normal mode

Tab. 12-60: Extended status word

STO safety status word

STO safety status word is used to monitor STO function state.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.03	STO safety status word	-	0x00000	-	1	Read

The definition of each bit is shown in the table below:

bit	Value	Description
15...3	–	Reserved
2	1	STO-E
	0	Normal
1	1	STO-r
	0	Normal
0	1	STO-A
	0	Normal

Tab. 12-61: Extended status word

Frequency command

When first or second frequency setting source is '20: Communication', the frequency command value can be set with parameter H0.10.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.10	Frequency command	0.00...655.35	0.00	Hz	0.01	Run

Frequency command is absolute frequency reference, setting value 0.00...655.35 representing 0.00...655.35 Hz.

Torque control reference from fieldbus

H0.12 is used to set torque reference value when [C3.41] = '6: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...655.35 representing 0.0...6553.5% rated torque.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.12	Torque control reference from fieldbus	0.0...6553.5	0.0	-	0.1	Run
C3.41	Torque reference channel	6: Communication (Modbus 0x7F02/ Fieldbus extension card H0.12)	0	-	-	Stop
E8.00	Communication protocol	1: Extension card	0	-	-	Stop

FWD torque limitation reference from fieldbus

H0.14 is used to set FWD torque limitation reference value when [C3.47] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...6553.5 representing 0.00...6553.5% rated torque.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.14	FWD torque limitation reference from fieldbus	0.0...6553.5	0.0	%	0.1	Run
C3.47	Torque limitation reference selection at speed control mode	4: Communication (Torque FWD limitation register: Modbus 0x7F03/ Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/ Fieldbus extension card H0.15)	0	-	-	Stop
E8.00	Communication protocol	1: Extension card	0	-	-	Stop

REV torque limitation reference from fieldbus

H0.15 is used to set REV torque limitation reference value when [C3.47] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...6553.5 representing 0.00...6553.5% rated torque.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.15	REV torque limitation reference from fieldbus	0.0...6553.5	0.0	%	0.1	Run
C3.47	Torque limitation reference selection at speed control mode	4: Communication (Torque FWD limitation register: Modbus 0x7F03/ Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/ Fieldbus extension card H0.15)	0	-	-	Stop
E8.00	Communication protocol	1: Extension card	0	-	-	Stop

Speed limitation at torque control mode from fieldbus

H0.16 is used to set Speed limitation at torque control mode when [C3.48] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.00...655.35 representing 0.00...655.35Hz.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.16	Speed limitation at torque control mode from fieldbus	0.00...655.35	0.00	-	0.01	Run
C3.48	Speed limitation reference selection at torque control mode	4: Communication (Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16)	0	-	-	Stop
E8.00	Communication protocol	1: Extension card	0	-	-	Stop

Fieldbus voltage command

H0.50 is used to set V/f separation output voltage when [C2.08] = '20: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.00...100.00 representing 0.00...100.00% rated voltage.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.50	Fieldbus voltage command	0.00...100.00 %	0.00	%	0.01	Run
C2.08	V/f separation output voltage source selection	20: Communication (Modbus 0x7F0B/ Fieldbus extension card H0.50)	22	-	-	Stop
E8.00	Communication protocol	1: Extension card	0	-	-	Stop

12.17.2 Extension Card Identification

This part is about the information that be transferred from option card to frequency converter for user checking after the communication between frequency converter and option card established.

Extension card interface version

H0.18 and H0.19 are read only parameters and will display the interface version of the option card used in which slot.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.18	Opt 1 active interface version	-	-	-	0.01	Read
H0.19	Opt 2 active interface version	-	-	-	0.01	Read

Extension card type

H0.20 and H0.30 are read only parameters and will represent which type of card is connected in which slot.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.20	Extension card 1 type	0: None 1: PROFIBUS card 2: CANopen card 3: MEP (Multi-Ethernet)	-	-	0.01	Read
H0.30	Extension card 2 type	7: Encoder card 8: I/O card 9: Relay card 10: IO plus card	-	-	0.01	Read

Extension card firmware version

H0.23 and H0.33 are read only parameters and will display the firmware version of the option card used in which slot.

Code	Name	Setting range	Default	Unit	Step	Attri.
H0.23	Extension card 1 firmware version	-	-	-	0.01	Read
H0.33	Extension card 2 firmware version	-	-	-	0.01	Read

12.18 H1: PROFIBUS Settings

12.18.1 PROFIBUS Basic Settings

This function is used to set parameter or read parameters when use PROFIBUS communication extension card.

Code	Name	Setting range	Default	Unit	Step	Attri.
H1.00	PROFIBUS local address	0...126	1	-	1	Stop
H1.01	Present baud rate	0: None 1: 9.6 kbps 2: 19.2 kbps 3: 45.45 kbps 4: 93.75 kbps 5: 187.5 kbps 6: 500 kbps 7: 1,500 kbps 8: 3,000 kbps 9: 6,000 kbps 10: 12,000 kbps	-	-	-	Read
H1.02	Present telegram type	1: PPO1 2: PPO2 3: PPO3 4: PPO4 5: PPO5 6: PPO6 7: PPO7 8: PPO8	-	-	-	Read

- H1.00 'PROFIBUS local address' is unique station address definition and needs to be set as equal to master configuration.
- H1.01 'Present baud rate' will display auto-detected baud rate.
- H1.02 'Present telegram type' indicates telegram type selected for communication network.
- Both H1.01 and H1.02 will be automatically checked after communication between master and frequency converter established successfully.

12.18.2 PROFIBUS Card LED

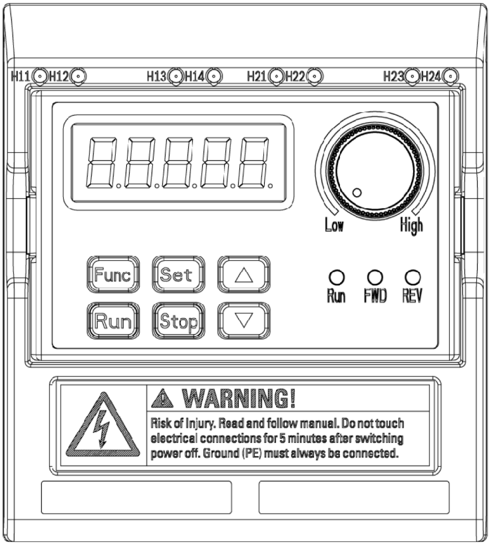


Fig. 12-108: PROFIBUS card LED

LED	Color	Function	Status	Description
H11/H21①	Green	PROFIBUS card configuration status	Fast blinking 0.4 s per cycle	Data exchanging
			ON	Communication established PROFIBUS card successfully parameterized and configured => Everything OK
H12/H22①	Red	PROFIBUS card error indication	OFF	PROFIBUS card OK
			Slow Blinking 1 s per cycle	PROFIBUS card error

Tab. 12-62: PROFIBUS card LED

①:

- H11 and H12 are available when the PROFIBUS card is installed on the left card slot
- H21 and H22 are available when the PROFIBUS card is installed on the right card slot

12.18.3 PROFIBUS Output PZD Setting

This function defines the configuration of output PZD word which received by frequency converter.

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Unit</th><th>Step</th><th>Attri.</th></tr>
<tr><td>H1.10</td><td>Output PZD 1</td><td rowspan="10">0: Not used
1: Control word
2: Frequency command
3: Empty PZD
4: ASF command 1
5: ASF command 2
6: ASF command 3
7: ASF command 4
8: ASF command 5
9: ASF command 6
10: ASF command 7
11: ASF command 8
12: Torque command
13: Forward torque limit
14: Reverse torque limit
15: Speed limit in torque mode
16: DO1/relay1 output values (see parameter E2.20)
17: AO1 value in percentage (see parameter E2.28)
18: EDO values (see parameter H8.23)
19: EAO value in percentage (see parameter H8.28)
20: Relay card output values (see parameter H9.10)
21: V/f separation voltage command in percentage (see parameter H0.50)</td><td>1</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.11</td><td>Output PZD 2</td><td>2</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.12</td><td>Output PZD 3</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.13</td><td>Output PZD 4</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.14</td><td>Output PZD 5</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.15</td><td>Output PZD 6</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.16</td><td>Output PZD 7</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.17</td><td>Output PZD 8</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.18</td><td>Output PZD 9</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
<tr><td>H1.19</td><td>Output PZD 10</td><td>0</td><td>-</td><td>-</td><td>Stop</td></tr>
</table>

Output PZD 1...Output PZD 10 are the process data containers for data transferring from PROFIBUS master to slave.

12.18.4 Input PZD Setting

This function defines the configuration of input PZD word which sent by frequency converter.

Code	Name	Setting range	Default	Unit	Step	Attri.
H1.30	Input PZD 1	0: Not used 1: Status word 2: Extended status word 3: Empty PZD 100: d0.00 (Output frequency) 101...199: d0.01...d0.99 (Monitoring values)	1	-	-	Stop
H1.31	Input PZD 2		100	-	-	Stop
H1.32	Input PZD 3		0	-	-	Stop
H1.33	Input PZD 4		0	-	-	Stop
H1.34	Input PZD 5		0	-	-	Stop
H1.35	Input PZD 6		0	-	-	Stop
H1.36	Input PZD 7		0	-	-	Stop
H1.37	Input PZD 8		0	-	-	Stop
H1.38	Input PZD 9		0	-	-	Stop
H1.39	Input PZD 10		0	-	-	Stop

Input PZD 1...Input PZD 10 are the process data containers for data transferring from PROFIBUS slave to master.

12.18.5 PROFIBUS Protocol

Protocol Description

PROFIBUS is an open serial communication standard, which enables data exchange among various automation control devices. PROFIBUS mainly includes three types: PROFIBUS-FMS (Fieldbus Message Specifications), PROFIBUS-DP (Distributed Peripheral Equipment) and PROFIBUS-PA (Process Automation). Frequency Converter EFC x610 supports PROFIBUS-DP Protocol.

PROFIBUS is widely used in various industries such as manufacturing automation and process automation, building, transportation, electric power, etc. Through PROFIBUS, automation equipments from different manufacturers can be easily connected into the same network for data exchange. The frame structure of data information in PROFIBUS network is shown in table below.

Protocol frame (header)	User data (control message/status message)	Protocol frame (end)

Tab. 12-63: PROFIBUS frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100...1,200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller, which is able to select the nodes responsive to commands from the master.

PROFIBUS protocol is described in details in standard EN 50170.

PROFIBUS Function

The PROFIBUS DP communication network is able to realize the following functions:

- Sending control commands to the frequency converter (such as start, stop, jog, etc.).
- Sending messages (e.g. setting frequency) to the frequency converter.
- Reading operating status message from the frequency converter (such as run, rotation direction, rotation speed, error message, etc.).
- Reading or modifying frequency converter parameters.
- Resetting the frequency converter in case of error.

Requirements for PROFIBUS Link Cable

Cables used in PROFIBUS are shielded twisted pair cables. The shielding is able to improve electromagnetic compatibility (EMC) ability. Unshielded twisted pair cable may be used if there is less electromagnetic interference (EMI). Impedance of the cable should be within 100...200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥ 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

Cable data	Type A	Type B
Impedance	135...165 Ω (f = 3...20 MHz)	100...130 Ω (f > 100 kHz)
Capacity	< 30 pF/m	< 60 pF/m
Resistance	≤ 110 Ω/km	≤ 110 Ω/km
Conductor cross section	≥ 0.34 (22 AWG)	≥ 0.22 (24 AWG)

Tab. 12-64: Type of PROFIBUS cable

☞ Standard Siemens PROFIBUS cable is (MLFB) 6XV1830-0EH10 (Type A), and connector is 6ES7972-0BA12-0XA0.

Relationship between Communication Rate and Cables

Relationship between communication rate and cable length is described in table below.

Baud rate	Maximum length for each cable in [m] (Type A)	Maximum length for each cable in [m] (Type B)
9.6...93.75 kbps	1,000	1,000
187.5 kbps	1000	600
500 kbps	400	200
1.5 Mbps	200	200
3...12 Mbps	100	100

Tab. 12-65: Relationship between communication rate and cable length

EMC Measures

The following EMC measures needs to be taken in order to improve the stability of PROFIBUS communication network:

- The shielding layer of the communication cables must be well grounded at all stations; a large area is required for the connection of the shielding layer to obtain a low impedance.
- A certain wiring distance (≥ 20 cm) must be kept between the communication cables and the power cables.
- Communication cables and power cables must be orthogonal in case of crossing.
- All stations in the network must be grounded to the same grounding network.

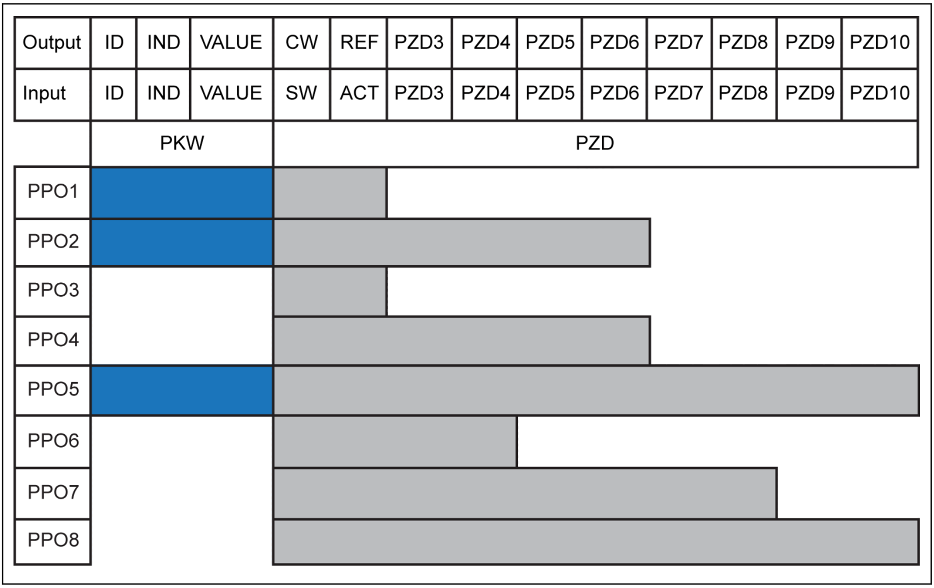
Periodical Data Communication

PPO telegram type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). Frequency Converter EFC x610 supports 8 PPO telegram types shown in figure below. PPO message is divided into two data areas in terms of transmission data contents:

Parameter area (PKW area): read or write a parameter of a slave.

Process data area (PZD area): including control word and set frequency, etc. (data flow from master to slave), or status word, actual output frequency and other status monitoring values of slave (data flow from slave to master). For detailed descriptions of PKW parameter area and PZD process data area, please refer to descriptions below.



Output Master output
Input Master input
ID Parameter identifier
IND Parameter index mark
VALUE Parameter value
CW Control word
SW Status word
REF Reference / Setting frequency
ACT Actual output frequency

Fig. 12-109: PPO telegram type

PKW parameter area

PKW parameter area description

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a parameter of a frequency converter, but only one parameter can be read or modified each time. When master sends request and slave responds, bit definition for each specific word in PKW area is shown in the tables below. If a frequency converter fails to execute PKW area request command, an error code will be returned to the master in VALUE_low. Refer to tab. 12-68 "PKW area error codes" on page 343 for details.

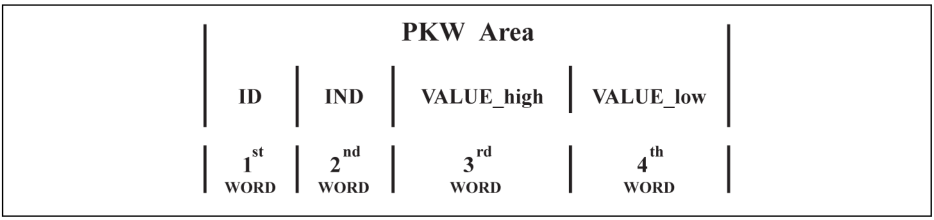


Fig. 12-110: PKW area data format

Request data frame in PKW area

Word	Identifier	bit	Value	Description
1st	ID	15...8	00H	Reserved
		7...0	00H	No request
			01H	Read
			02H	Write
2nd	IND	15...8	xxH	Group No. for parameter
		7...0	xxH	Index No. of function code within the group
3rd	VALUE_high	15...0	00H	Reserved
4th	VALUE_low	15...0	xxxxH	For a read request: Not used For a write request: Parameter value

Tab. 12-66: Request data frame in PKW area_from master to slave

Response data frame in PKW area

Word	Identifier	bit	Value	Description
1st	ID	15...8	00H	Reserved
		7...0	00H	No request
			01H	Successful read
			02H	Successful write
			07H	Error
2nd	IND	15...8	xxH	Group No. for parameter
		7...0	xxH	Index No. of function code within the group
3rd	VALUE_high	15...0	00H	Reserved
4th	VALUE_low	15...0	xxxxH	For a successful request: Parameter value Read or write error: Error code For no request situation: 0

Tab. 12-67: Response data frame in PKW area_from slave to master

Error message after execution failure in PKW area

Error code	Meaning	Reason
1	Password locked	User password is locked
2	Invalid command code	Command codes (bit 7...bit 0 of ID) are not 0, 1 or 2.
3	Invalid parameter address	Invalid function group or index number of the function group, or insufficient access/rights
4	Invalid parameter value	Data to write out of range
5	Forbid write in running mode	Frequency converter is running
6	Parameter read-only	Parameter are read-only, can not be written
7	Invalid operation	Function code does not support write or multiple write via external computer

Tab. 12-68: PKW area error codes

Example of parameter operation in PKW area

Example description

In applications, the master and the frequency converters communicate with messages in PPO structure. Among the 8 PPOs stated in fig. 12-109 "PPO telegram type" on page 341, PPO1, PPO2 and PPO5 apply both PKW area and PZD area. In following examples, PKW area data frames are taken from complete PPO message to describe its request and response data frames.

The following examples are all based on Frequency Converter EFC 5610 and PROFIBUS card.

Example 1

Reading value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group, then request and response data frames in PKW area are shown in table below:

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x0001	0x301A	0x0000	0x0000
Response data frame of PKW area	0x0001	0x301A	0x0000	0x0032

Tab. 12-69: Example 1_request and response data frames of PKW area

Example 2

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0x0064, then request and response data frames in PKW area are shown in table below:

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x0002	0x301A	0x0000	0x0064
Response data frame of PKW area	0x0002	0x301A	0x0000	0x0064

Tab. 12-70: Example 2_request and response data frames of PKW area

Example 3

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0xFFFF, then request and response data frames in PKW area are shown in table below:

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x0002	0x301A	0x0000	0xFFFF
Response data frame of PKW area	0x0007	0x301A	0x0000	0x0064

Tab. 12-71: Example 3_request and response data frames of PKW area

PZD process data area

PZD process data area description

The data in PZD process data area can be configured freely for periodical data exchange between the master and slaves. The request telegram type for sending message from master to slaves is decided by H1.30...H1.39; the request telegram type for returning message response from slaves to the master is decided by H1.30...H1.39 (number of PZD is decided by PPO telegram type). See parameters in group H1 chapter "H1: PROFIBUS card parameters" on page 614.

For details on control word, status word and extended status word see the tables below:

bit	Value	Description
15...10	–	Reserved
9	1	Torque control active
	0	Inactive
8	1	Freewheeling stop
	0	Inactive
7	1	Control word active
	0	Inactive
6	1	Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator)
	0	Inactive
5	1	Fault reset active
	0	Inactive
4	1	E-stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active (jogging direction determined by bit 2)
	0	Inactive
0	1	Run command active
	0	Inactive

Tab. 12-72: Control word

bit	Value	Description
15 ... 8	–	Error code (equals to [E9.05])
7	1	Error
	0	No error
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-73: Status word

bit	Value	Description
15...1	–	Reserved
0	1	24 V mode
	0	Normal mode

Tab. 12-74: Extended status word

For details on parameter addresses, see chapter 12.14.1 "Modbus Protocol" on page 288.

Examples for operation of PZD process data area

Example 1

The master communicates with the slave via PPO4, see fig. 12-109 "PPO telegram type" on page 341.

If we need to start frequency converter for forward rotation at 50.00 Hz (0×1388). When the parameters in group H1 are kept as defaults, complete PPO request and response messages are shown in table below.

<table>
<tr><th></th><th>PZD1</th><th>PZD2</th><th>PZD3</th><th>PZD4</th><th>PZD5</th><th>PZD6</th></tr>
<tr><td rowspan="2">PPO request message</td><td>CW</td><td>REF</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td></tr>
<tr><td>0x0081</td><td>0x1388</td></tr>
<tr><td rowspan="2">PPO response message</td><td>SW</td><td>ACT</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td></tr>
<tr><td>0xxx02</td><td>0x1388</td></tr>
</table>

Tab. 12-75: Example 1 for PZD process data area_request and response messages of PPO

The higher byte of the status word is the latest error code (0x00 means no error).

Example 2

When the frequency converter forward runs at 50 Hz, to stop the frequency converter as parameter settings, please refer to example 1.

<table>
<tr><th></th><th>PZD1</th><th>PZD2</th><th>PZD3</th><th>PZD4</th><th>PZD5</th><th>PZD6</th></tr>
<tr><td rowspan="2">PPO request message</td><td>CW</td><td>REF</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td></tr>
<tr><td>0x0088</td><td>0x1388</td></tr>
<tr><td rowspan="2">PPO response message</td><td>SW</td><td>ACT</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td><td rowspan="2">0x0000</td></tr>
<tr><td>0xxx00</td><td>0x0000</td></tr>
</table>

Tab. 12-76: Example 2 for PZD process data area_request and response messages of PPO

Communication parameter configuration

Communication related parameter settings

Parameter	Name	Parameter settings
E0.00	First frequency setting source	20: Communication
E0.01	First run command source	2: Communication
E0.02	Second frequency setting source	20: Communication
E0.03	Second run command source	2: Communication
E8.00	Communication protocol	1: Extension card
E8.03	Communication process data loss behavior	Depends on parameter setting①
H0.12	Torque control reference from fieldbus	6: Communication
H0.14	FWD torque limitation reference from field-bus	4: Communication
H0.15	REV torque limitation reference from fieldbus	4: Communication
H0.16	Speed limitation at torque control mode from fieldbus	4: Communication
H1.00	PROFIBUS local address	Depends on parameter setting①
H1.01	Present baud rate	(Read only)
H1.02	Present telegram type	

Parameter	Name	Parameter settings
H1.10	Output PZD 1	Depends on parameter setting①
H1.11	Output PZD 2	
H1.12	Output PZD 3	
H1.13	Output PZD 4	
H1.14	Output PZD 5	
H1.15	Output PZD 6	
H1.16	Output PZD 7	
H1.17	Output PZD 8	
H1.18	Output PZD 9	
H1.19	Output PZD 10	
H1.30	Input PZD 1	
H1.31	Input PZD 2	
H1.32	Input PZD 3	
H1.33	Input PZD 4	
H1.34	Input PZD 5	
H1.35	Input PZD 6	
H1.36	Input PZD 7	
H1.37	Input PZD 8	
H1.38	Input PZD 9	
H1.39	Input PZD 10	

Tab. 12-77: PROFIBUS-DP communication parameters

①: See chapter "H1: PROFIBUS card parameters" on page 614 for details.

In the operation controlled by communication, if the frequency converter is stopped by the **Stop** key on the operating panel, the frequency converter stops responding to the control commands by communication. To enable the control by communication, re-power the frequency converter or send **Stop** command to the frequency converter by communication.

Parameter configuration of master

For master related parameter configuration, refer to descriptions for master. The address configured for slave in the master should be consistent with the parameter address configured for the slave. Communication baud rate and PPO telegram type are determined by the master.

GSD file

Users may log on the website of the company at www.boschrexroth.com to download or contact sales personnel to obtain the GSD file BRFC0112.GSD. For installation and PROFIBUS system configuration method, please refer to respective instructions of system configuration software.

☞ The GSD file adapts to the PROFIBUS master which supports GSD revision 2 or above.

12.19 H2: CANopen Card Parameters

12.19.1 General Introduction

CANopen is a high-level communication protocol which is based on CAN (Controller Area Network) bus. As one of fieldbus commonly used in the industrial control field, CANopen can realize the interconnection of multiple industrial devices. CANopen adopts Open Systems Interconnection (OSI) model and implements media access control and physical signal transmission on basis of CAN technology. Its design is based on three sub-protocols, i.e. DS102 CAN physical layer for industrial applications, DS 301 CANopen communication profile for industrial systems and DSP 402 device profile for drives and motion control. CANopen operates in master-slave structure or distributed control structure which is based on peer-to-peer communication. Up to 127 slave nodes can be supported. CANopen card of the slave node is powered from frequency converter, and all slave nodes are connected to the same bus. CANopen defines corresponding configuration files for devices in specific classes. For other devices, a specific class must be defined to ensure the compatibility with CANopen system.

12.19.2 LED Status Introduction

The CiA-303-3 provides a standardized way for state indication of a CANopen device. There is an error LED and a run LED. The run LED is green and indicates the CANopen state. The error LED is red and shows errors of the physical layer.

LED	State	Color	Description
ERROR LED	No error	Off	The device is in working condition.
	Warning limit reached	Single flash	At least one of the error counters of the CAN controller has reached or exceeded the warning limit. (CAN Passive Error)
	Error control event	Double flash	A guard event (NMT slave or NMT master) or a Heartbeat event has occurred.
	Bus off	Red light on	The CAN controller is bus-off.

LED	State	Color	Description
RUN LED	OFF	Off	The CANopen controller is in “OFF” state.
	NMT stopped	Single flash	The device is in NMT STOPPED state.
	NMT pre-operational	Blinking green	The device is in NMT PRE-OPERATIONAL state.
	NMT operational	Green light on	The device is in NMT OPERATIONAL state.

Tab. 12-78: Description of various LED states

12.19.3 Converter Configuration

Overview

Communication with the frequency converter in CANopen is achieved via Service Data Objects (SDOs), Process Data Objects (PDOs) and Network Management (NMT).

Users can download the EDS file through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose “Frequency converter -> EFC 3610 (or EFC 5610)” from the navigation bar on left side of the operation interface.
3. Choose “Download area” tab from right side of the interface.
4. Click on “EDS_XFCX610.ZIP” to download the EDS file.

COB-Identifiers

Each communication object has a unique identity (COB-ID) comprising the function code and the node ID (node address) shown as follows.

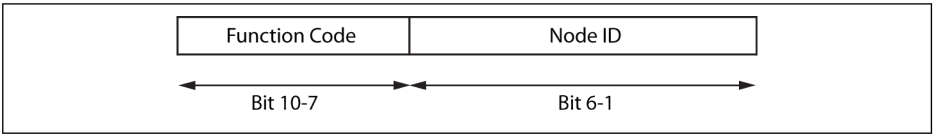


Fig. 12-111: COB-ID

Object Dictionary

The object dictionary is essentially a grouping of objects accessible via the network in an ordered predefined fashion. Each object within the object dictionary is addressed using a 16-bit index and an 8-bit sub-index. The object dictionary contains collection of all the data items which have an influence on the behaviour of the application objects, the communication objects and the state machine used on this device.

Index range (Hex)	Object group
1000h...1FFFh	Communication profile
2000h...5FFFh	Vendor specific objects
6000h...9FFFh	Standard device profiles

Tab. 12-79: CANopen object groups

The table below gives an overview of the objects prescribed for CANopen:

Object	Index	Name
General objects	1000h	Device type
	1001h	Error register
	1002h	Manufacturer status register
	1008h	Manufacturer device name
	1009h	Manufacturer hardware version
	100Ah	Manufacturer software version
	1010h	Store parameter field
	1011h	Restore default parameters
	1018h	Identity object
Error control protocol	100Ch	Guard time
	100Dh	Life time factor
	1014h	COB-ID EMCY
	1015h	Inhibit time emergency
	1016h	Heartbeat consumer entries
	1017h	Producer heartbeat time
	1029h	Error behaviour
SDO	1200h	Server SDO parameter 1

Object	Index	Name
PDO objects	1400h	Receive PDO communication parameter 1
	1401h	Receive PDO communication parameter 2
	1402h	Receive PDO communication parameter 3
	1403h	Receive PDO communication parameter 4
	1600h	Receive PDO mapping parameter 1
	1601h	Receive PDO mapping parameter 2
	1602h	Receive PDO mapping parameter 3
	1603h	Receive PDO mapping parameter 4
	1800h	Transmit PDO communication parameter 1
	1801h	Transmit PDO communication parameter 2
	1802h	Transmit PDO communication parameter 3
	1803h	Transmit PDO communication parameter 4
	1A00h	Transmit PDO mapping parameter 1
	1A01h	Transmit PDO mapping parameter 2
	1A02h	Transmit PDO mapping parameter 3
	1A03h	Transmit PDO mapping parameter 4
Manufacturer specific objects	2000h...3000h	Function code mapping
	4000h...5FFFh	Reserved for future enhancements
Device profiles	6000h...9FFFh	Used for CANopen drive profile CiA-402

Tab. 12-80: Object dictionary

For CANopen drive profile CiA-402 velocity mode, the following objects are supported:

Device profile segment	603Fh	Error code
	6040h	Control word
	6041h	Status word
	6042h	Target velocity
	6043h	Velocity demand
	6044h	Velocity actual value
	6046h	Velocity min max amount
	6048h	Velocity acceleration
	6049h	Velocity deceleration
	604Dh	Pole number (needed for conversion velocity vs. output frequency)
	6060h	Modes of operation
	6061h	Modes of operation display

Tab. 12-81: CANopen drive profile CiA-402 velocity mode objects

Let H.L be the High and Low byte, respectively of the numerical representation of a function code, where H is the simple decimal interpretation of the hexadecimal encoding of the function class.

Example: Frequency converter class “d” is encoded by 0x10. The simple decimal interpretation of “0x10” then is “10”. (Hint: this simple trick closes the unused gap in frequency converter class encoding between 0x0A and 0x0F in order to get all frequency converters mapped into CANopen index manufacturer parameters ranged between 0x2000 and 0x5FFF.)

Then the index of the corresponding “Manufacturer specific objects” is: I = 0x2000 + H x 100 + L.

Function code Yx.z, where Y ϵ {b,d,C,E,U,F,H}, x ϵ {0...9}, z ϵ {0...99}

That means:

Function code → H.L range (DEC) → FC index (DEC) → CAN index (HEX)

bx.z → {00...09}.{0...99} → {0000...0999} → {0x2000...0x23E7}

dx.z → {10...19}.{0...99} → {1000...1999} → {0x23E8...0x27CF}

Cx.z → {20...29}.{0...99} → {2000...2999} → {0x27D0...0x2BB7}

Ex.z → {30...39}.{0...99} → {3000...3999} → {0x2BB8...0x2F9F}

Ux.z → {40...49}.{0...99} → {4000...4999} → {0x2FA0...0x3387}

Fx.z → {50...59}.{0...99} → {5000...5999} → {0x3388...0x376F}

Hx.z → {60...69}.{0...99} → {6000...6999} → {0x3770...0x3B57}

Manufacturer specific objects (2000h...3FFFh)

All function codes (16 bit) can be reached through the manufacturer specific objects. The structure of the manufacturer specific objects is as follows:

Sub-index	Description
1	Access to data (parameter set 0)
2...8	Reserved (parameter set 1...7)
9	Reserved (parameter set 1...7)
10	Index of the list pointer
11	List element to which the element 10 points (only in case of parameters in the list)
12...18	Reserved (for parameter sets)
21	Parameter name
22...28	Reserved (for parameter sets)
31	Parameter attribute
32...38	Reserved (for parameter sets)
41	Parameter unit
41...48	Reserved (for parameter sets)
51	Minimum value of the parameter

Sub-index	Description
52...58	Reserved (for parameter sets)
61	Maximum value of the parameter
62...68	Reserved (for parameter sets)
71	Maximum length of the parameters in the list
72...78	Reserved (for parameter sets)
81	Actual length of the parameter in the list
82...88	Reserved (for parameter sets)

Tab. 12-82: Manufacturer specific objects

As evident from the table, with the help of the sub-index, besides the date (sub-index 1), even other information (minimum value, maximum value ...) of the function codes can be read out.

List access

The complete list of a list parameter can be read or written via the access to the operating date of the parameter.

To access individual elements in the list, there is an option to set a list index (sub-index 10), and then to access the respective list element of the list index via sub-index 11 (up to sub-index 18). For every access via sub-index 11 (up to sub-index 18), the list index is incremented by one element. With this, in case of multiple access to sub-index 11 (up to sub-index 18), a related section of a list is processed.

The list index is reset to the first element if one of the actions listed below occurs:

- Change in the parameter
- Abort of the connection

Therefore the list index should be set for each list element access which does not start from the first element.

If the length of the list has to be changed, this can be corrected by changing the actual length of the list parameter (sub-indices 81...88). The maximum list length can be read out using the sub-indices 71...78.

The parameter value is stored if writing to the last element occurs.

In case of failure of the control voltage, the changes are discarded.

Process Data Objects (PDO)

PDOs represent real-time process data with high priority. It is only possible if node is in “operational” state.

The CANopen option card features four sets of predefined PDOs:

- The first set of PDOs is automatically enabled when CiA-402 drive profile is active and it is fixed (static) mapping:
  - One received PDO (RPDO1), is used to control (Control word) the drive.
  - One transmitted PDO (TPDO1), is used to monitor (Status word) the drive.

☞

- The TPDO1 with transmission type of 255 shall only be triggered when the mapped drive status word is changing (event), other mapped objects shall not cause a PDO transmission.
- The TPDO1 with transmission type of 0 shall be transmitted after the occurrence of the SYNC but acyclic (not periodically), i.e. only if the drive status word is changed (event) before the occurrence of SYNC.

- The second set of PDOs (PDO2 for CiA-402 drive profile) includes: The second set of PDOs is initially disabled and the user has to enable it. The default mapping configuration is for supporting CiA-402 velocity mode.
  - One received PDO (RPDO2), is used to control the drive (Control word and velocity reference). In addition, it can be configured to include two additional objects/parameters. Control word and velocity reference can also be replaced with any two other objects which have write access rights via PDO.
  - One transmitted PDO (TPDO2), is used to monitor the drive (Status word and velocity actual value). In addition, it can be configured to include two additional objects which have read access via PDO. Status word and velocity actual value can also be replaced with any two other objects which have read access rights via PDO.
- The third set of PDOs (PDO3 for Rexroth drive profile) includes: The default mapping configuration enables the drive to be commanded by frequency input and Rexroth drive control word.
  - One received PDO (RPDO3), is used to control the drive (Control word and frequency command). In addition, it can be configured to include two additional objects/parameters. Control word and frequency command can also be replaced with any two other objects which have write access rights via PDO.
  - One transmitted PDO (TPDO3), is used to monitor the drive (Status word and actual output frequency). In addition, it can be configured to include two additional objects which have read access via PDO. Status word and actual output frequency can also be replaced with any two other objects which have read access rights via PDO.

- The fourth set of PDOs are initially disabled and no default mapping configuration is done. And the PDO information is freely deployed by the user.

- For TPDO2 with transmission type of 255 no internal profile specific event is defined for triggering PDO transmission. So for this transmission type of 255/254 (asynchronous) only event timer will trigger PDO transmission.
- PDO2 does not support transmission type of 0 (synchronous acyclic).

Process Data Objects (PDO) Configuration

The following configuration shall be executed.

- PDO1 mapping is static and hence it cannot be changed.
- The default PDO mapping configuration is shown as below for Rexroth drive profile.

RPDO No.	Mapping object index	Mapping object name	Comment
1	0x6040	Control word	Controls the CiA-402 state machine
2	0x6040 0x6042	Control word Target velocity (vl)	Controls the state machine and the nominal speed (vl)
3	0x3770 0x377A	Drive control word Frequency command	Controls the drive system state machine and setting frequency
4	0x0000	-	-
TPDO No.	**Mapping object index**	**Mapping object name**	**Comment**
1	0x6041	Status word	Shows the drive status
2	0x6041 0x6044	Status word vl control effort	Shows status and the current speed (vl)
3	0x3771 0x23EA	Drive status word Output frequency	Shows the drive status and the current output frequency
4	0x0000	-	-

Tab. 12-83: PDO communication parameter structure for CiA-402 profile

Index	Sub	Name	Default value
0x1400	0	Number of entries	5
	1	COB-ID used by PDO	0x80000200 + Node-ID**
	2	Transmission type	255
	3	Inhibit time (not implemented)	0
	4	Reserved	-
	5	Event timer	0
0x1600	0	Number of mapped objects	1
	1	Control word	0x60400010

Tab. 12-84: RPDO1

**: When CiA-402 is enabled, the RPDO1 is enabled, so COB-ID gets changed to 0x80000200 + Node-ID. RPDO1 is disabled in Rexroth Profile. If enabled then it’s erroneous.

Index	Sub	Name	Default value
0x1401	0	Number of entries	5
	1	COB-ID used by PDO	0x80000300 + Node-ID
	2	Transmission type	255
	3	Inhibit time (not implemented)	0
	4	Reserved	-
	5	Event timer	0
0x1601	0	Number of mapped objects	2
	1	Control word	0x60400010
	2	Target velocity (vl)	0x60420010

Tab. 12-85: RPDO2

Index	Sub	Name	Default value
0x1402	0	Number of entries	5
	1	COB-ID used by PDO	0x00000400 + Node-ID
	2	Transmission type	255
	3	Inhibit time (not implemented)	0
	4	Reserved	-
	5	Event timer	0
0x1602	0	Number of mapped objects	2
	1	Drive control word	0x37700010
	2	Frequency command	0x377A0010

Tab. 12-86: RPDO3

Index	Sub	Name	Default value
0x1404	0	Number of entries	5
	1	COB-ID used by PDO	0x80000500 + Node-ID
	2	Transmission type	255
	3	Inhibit time (not implemented)	0
	4	Reserved	-
	5	Event timer	0
0x1604	0	Number of mapped objects	0
	1...4	-	0x00000000

Tab. 12-87: RPDO4

Index	Sub	Name	Default value
0x1800	0	Number of entries	5
	1	COB-ID used by PDO	0x00000180 + Node-ID**
	2	Transmission type	255
	3	Inhibit time	50 (100us)
	4	Reserved	-
	5	Event timer	100 (1ms)
0x1A00	0	Number of mapped objects	1
	1	Status word	0x60400010

Tab. 12-88: TPDO1

☞ **: When CiA-402 is enabled, the TPDO1 is enabled, so COB-ID gets changed to 0x00000180 + Node-ID. TPDO1 is disabled in Rexroth Profile. If enabled then it's erroneous.

Index	Sub	Name	Default value
0x1801	0	Number of entries	5
	1	COB-ID used by PDO	0x80000280 + Node-ID
	2	Transmission type	255
	3	Inhibit time	50 (100us)
	4	Reserved	-
	5	Event timer	100 (1ms)
0x1A01	0	Number of mapped objects	2
	1	Status word	0x60410010
	2	vl control effort	0x60440010

Tab. 12-89: TPDO2

Index	Sub	Name	Default value
0x1802	0	Number of entries	5
	1	COB-ID used by PDO	0x00000380 + Node-ID
	2	Transmission type	255
	3	Inhibit time	50 (100us)
	4	Reserved	-
	5	Event timer	100 (1ms)
0x1A02	0	Number of mapped objects	2
	1	Drive status word	0x37710010
	2	Output frequency	0x23EA0010

Tab. 12-90: TPDO3

Index	Sub	Name	Default value
0x1805	0	Number of entries	5
	1	COB-ID used by PDO	0x80000480 + Node-ID
	2	Transmission type	255
	3	Inhibit time	50 (100us)
	4	Reserved	-
	5	Event timer	100 (1ms)
0x1A05	0	Number of mapped objects	0
	1...4	-	0x00000000

Tab. 12-91: TPDO4

1. PDO mapping configuration is not supported in NMT operational state. PDO mapping has to be done in NMT pre-operation state only. If PDO configuration is done in operational state, then CANopen option card automatically enters into pre-operation state.
2. [b8.61]: Field bus option card producer list defines all those parameters which can be mapped to TPDO.
3. [b8.62]: Field bus option card consumer list defines all those parameters which can be mapped to RPDO.

Service Data Objects (SDO)

SDO telegrams are used for configuration and setup.

The SDO services listed below are supported:

- **Initiate SDO Download** for writing maximum 4 byte data in the VFC/EFC x610, also for initiating the writing of more than 4 byte data in the VFC/EFC x610 (the data length is determined during "Initiate" process).
- **Download SDO Segment** for transmitting a fragment with data in the VFC/EFC x610 Initiate SDO.
- **Upload** for transmitting maximum 4 byte data from VFC/EFC x610 to the master, also for initiating the transmission of more than 4 byte data from VFC/EFC x610 to the master (VFC/EFC x610 informs master the length of the response data).
- **Upload SDO Segment** for transmitting a fragment with data from the VFC/EFC x610 to the master.
- **Abort SDO Transfer** for reporting errors and to abort SDO accesses.

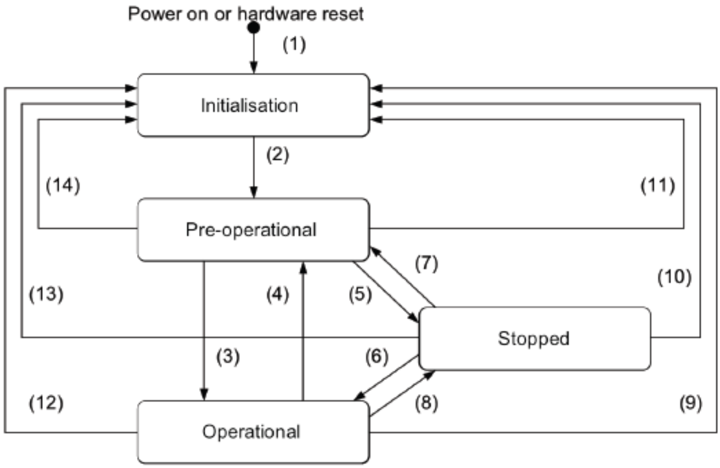
SDO abort code	Description
05040000h	SDO protocol timed out
05040001h	Client/server command specifier not valid or unknown
05040005h	Out of memory
06010001h	Attempt to read a write only object
06010002h	Attempt to write a read only object
06020000h	Object does not exist in the object dictionary
06040041h	Object cannot be mapped to the PDO
06040042h	The number and length of the objects to be mapped would exceed PDO length
06040043h	General parameter incompatibility reason
06060000h	Access failed due to an hardware error
06070010h	Data type does not match, length of service parameter does not match
06090011h	Sub-index does not exist
06090030h	Value range of parameter exceeded (only for write access)
06090031h	Value of parameter written too high
06090032h	Value of parameter written too low
060A0023h	No resources available
08000000h	General error
08000020h	Data cannot be transferred or stored to the application
08000022h	Data cannot be transferred or stored to the application because of the present device state
08000024h	No data available

Tab. 12-92: SDO abort codes

Network Management Objects (NMT)

NMT functions monitor the network stability and include synchronization, detection of faults and emergency message transmission.

The NMT state machine determines the behaviour of the communication function.



(1)	At Power on the NMT state initialisation is entered autonomously
(2)	NMT state Initialisation finished - enter NMT state Pre-operational automatically
(3)	NMT service start remote node indication or by local control
(4),(7)	NMT service enter pre-operational indication
(5),(8)	NMT service stop remote node indication
(6)	NMT service start remote node indication
(9),(10),(11)	NMT service reset node indication
(12),(13),(14)	NMT service reset communication indication

Fig. 12-112: NMT state diagram of CANopen device

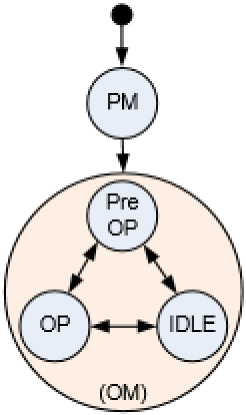


Fig. 12-113: Option card communication states and transitions

State	Description
PM	Parameterization mode (no exchange of process data)
Pre-OP	Pre-operation mode, however, no exchange of process data
OP	Operation mode, exchange of process data, process data is valid
IDLE	Operation mode, exchange of process data, process data is invalid

Tab. 12-93: Option card communication states description

- The communication status between option card and host system is transferred cyclically.
- The coupling between option card and NMT state machine is defined in the table below.

NMT – state	Option card state
Pre-OP / STOPPED	Pre-OP
OP	OP / IDLE IDLE state is entered on two cases: 1. Field-bus Data is Invalid (CAN is in ERROR PASSIVE, BUS OFF or INIT state and NMT is in OP state). 2. IDLE state is entered whenever the PDO configuration is invalid.

Tab. 12-94: Option card communication states description

Emergency Service (EMCY)

When an error occurs or is cleared, an EMCY telegram is transmitted. The EMCY telegram transports 8-byte data.

0	1	2	3	4	5	6	7
Error code		Error register	Manufacturer specific bytes				
Object: 0x603F This object provides the error code of the last error occurred in the drive device.		Object: 0x1001 The error register is a field of 8 bits, each for a certain error type. If an error occurs the bit has to be set.	[b6.91] Least 2 significant bytes		[b6.91] Least 3 significant bytes		
Error code = 0xFF00 (for all manufacturer specific) Error code -> CiA 301/402 specific error codes		Bit meaning 0: Generic error 1: Current 2: Voltage 3: Temperature 4: Communication error (overrun, error state) 5: Device profile specific 6: Reserved 7: Manufacturer specific	E.g. If [b6.91] = 0xF5001 Man_fact[3] = 0x01 Man_fact[4]= 0x50		Man_fact[5] = 0x01 Man_fact[6] = 0x50 Man_fact[7] = 0x0F		

Tab. 12-95: Error telegram

- Emergency telegram is triggered whenever a critical error is detected in either option card or error condition occurs in Host.
- EMCY Frame with error code 0x8120 is sent when CAN is in error passive state.
- EMCY Frame with error code 0x8140 is sent after CAN recovers from BUS-OFF error condition.
- Supported CiA-301 and CiA-402 error codes:

No Error	0x0000
Generic error	0x1000
Generic communication error	0x8100
CAN overrun	0x8110
CAN in passive error	0x8120
Heart beat or node guarding error	0x8130
Protocol error	0x8200
CAN recovered from bus-off	0x8140
Continuous over current (device output side)	0x2310

Continuous over current no.1	0x2311
2312h continuous over current no.2	0x2312
Continuous over current no.3	0x2313
DC link over-voltage	0x3210
Over-voltage no. 1	0x3211
Over-voltage no. 2	0x3212
DC link under-voltage	0x3220
Over-voltage no. 1	0x3211
Over-voltage no. 2	0x3212
DC link under-voltage	0x3220
Short circuit (device internal)	0x2250
Phase failure	0x3130
Load error	0x3230
Excess temperature drive	0x4310
Too low temperature drive	0x4320
Parameter error	0x6320
Any other manufacturer specific error	0xFF00
Any other manufacturer specific warning	0xFF01

Tab. 12-96: CiA-301 and CiA-402 error codes

0	1	2	3	4	5	6	7
Error code		Error register	Manufacturer Specific Bytes (last occurred error diagnostic code)				
0x0000		Object: 0x1001	[b6.91] Least 2 significant bytes		[b6.91] Least 3 significant bytes		

Tab. 12-97: Error-cleared telegram

Synchronisation Service (SYNC)

Overview

SYNC object is used to provide synchronous modes of communication of the CANopen slaves.

- PDO1 supports synchronous cyclic and synchronous acyclic modes.
- PDO2, PDO3 and PDO4 support only synchronous cyclic modes.

Error Control Services

The error control services are used to detect failures within a CAN-based network.

The CANopen option card supports the following error control protocols:

1. Heartbeat object
2. Node guarding object

- Either one of the error control protocol i.e. heartbeat or node guarding can be enabled at a time.
- Whenever failures are detected an error “FnC-” (Network Setup Error) is set and an EMCY telegram is sent.

Non-Volatile Storage

The following objects are implemented:

1. 0x1010: Store Parameter Field
2. 0x1011: Restore Default Parameter

☞

- Saving the contents of object (parameter) data value happens whenever it is written and the already saved data value is different. Saving of objects in EEPROM is handled.
- Only communication and device profile objects of CANopen option card parameters are restored to default values upon command to object 0x1011.
- Manufacturer specific parameter/objects are not restored to default values upon command to object 0x1011.
- The following CANopen option card parameters are not restored to default values upon command to object 0x1011:
  - [H2.00] – Node Address
  - [H2.01] – CAN Baudrate
  - [H2.02] – CANopen Device Profile Selection
  - [H2.98] – CANopen Termination Resistor Switch

Device Profile

Overview

1. Communication profile:

   The communication profile of xFC01 CANopen option card is based on:

   - Physical layer is as per CAN 2.0A standards.
   - The CANopen® specification CiA-301(Version: 4.2.0).

2. Function profile:

   The functional profile of xFC01 CANopen option card complies with:

   - "Device profile for drives and motion control" (DSP-402 V2.0, velocity mode).
   - Bosch Rexroth VFC/EFC x610 drive profile.

Profile Selection Option: For controlling the drive two profiles are provided. The parameter [H2.02] is defined for profile selection. The two profiles are:

0. Rexroth Drive Profile

1. CiA-402 Drive Profile

Rexroth Drive Profile

Rexroth Drive Profile: Set the parameter [H2.02] to 0 and activate Rexroth profile; the CANopen option card automatically disables RPDO1 and TPDO1.

Bit	Value	Description
15...8	-	Reserved
7	1	Active
	0	Control word inactive
6	1	Stop acceleration/deceleration active (stop the internal acc/dec ramp generator)
	0	Inactive
5	1	Fault reset active
	0	Inactive
4	1	E-stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active (jogging direction determined by bit 2)
	0	Inactive
0	1	Run command active
	0	Inactive

Tab. 12-98: VFC/EFC x610 drive control word

Bit	Value	Description
15...8	-	Fault code (equal to [E9.05])
7	1	Fault
	0	No fault
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration

Bit	Value	Description
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-99: VFC/EFC x610 drive status word

CiA-402 Drive Profile

Set the parameter [H2.02] to 1 and activate CiA-402 Drive Profile; the CANopen option card automatically enables RPDO1 and TPDO1.

After device profile selection option is changed to CiA-402 the CANopen master should send NMT reset application command.

Device control:

The device control function block controls all functions of the drive (drive function and power section). It is divided into:

- Device control of the state machine.
- Operation mode function.

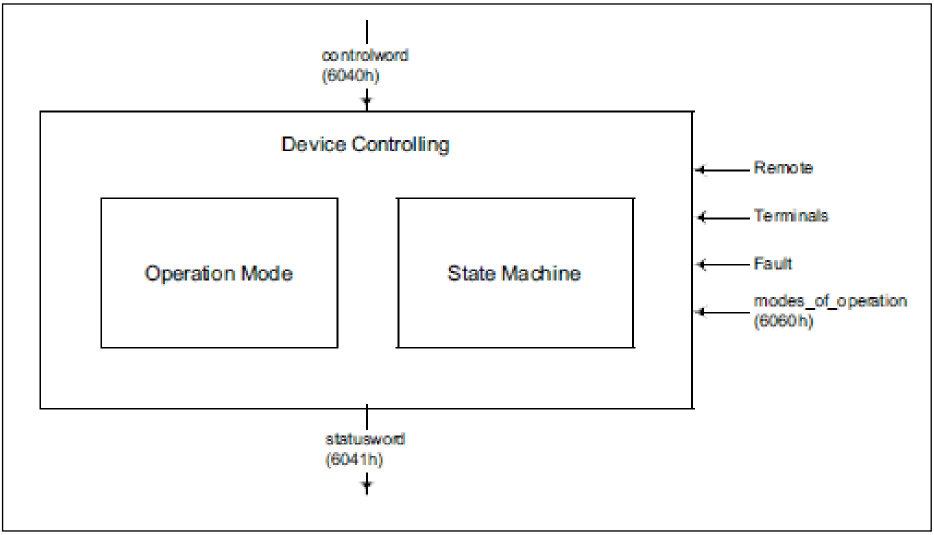


Fig. 12-114: Device control

The state of the drive can be controlled by the control word.

The state of the drive is shown in the status word.

Remote mode:

In remote mode the device is controlled directly from the CANopen network by PDO and SDO.

The state machine is controlled externally by the control word and external signals.

The write access to the control word is controlled by the optional hardware signal "Remote".

The state machine is also controlled by internal signals like faults and modes of operation.

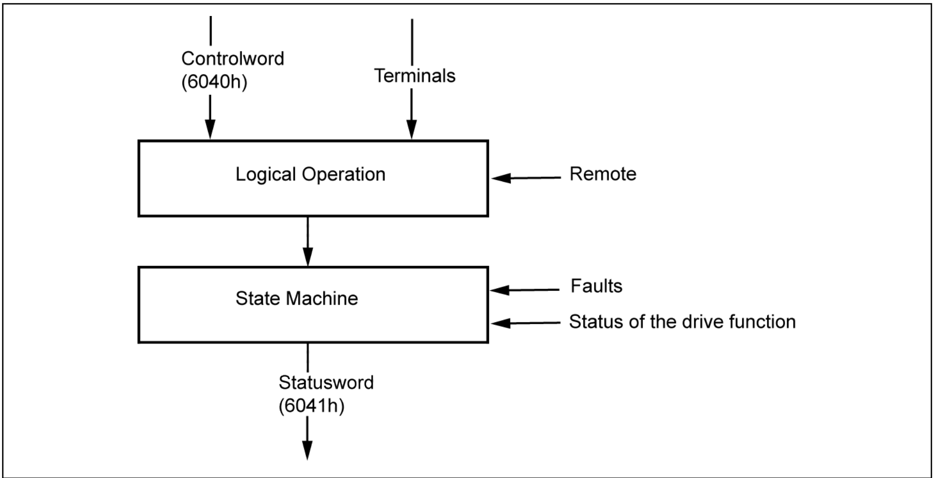


Fig. 12-115: Remote mode

From VFC/EFC x610 drive’s perspective, when the Run command source is from communication and the communication protocol is CANopen then remote mode is enabled. This remote mode is reflected in the status word: Remote Bit (set when active).

[E0.01]: First run command source

[E0.02]: Second run command source

[E8.00]: Communication protocol

CiA-402 State Machine:

The state machine describes the device status and the possible control sequence of the drive. A single state represents a special internal or external behaviour. The state of the drive also determines which commands are accepted. States may be changed using the control word and/or according to internal events. The current state can be read using the status word. The state machine describes the state machine of the device with respect to control of the power electronics as a result of user commands and internal drive faults.

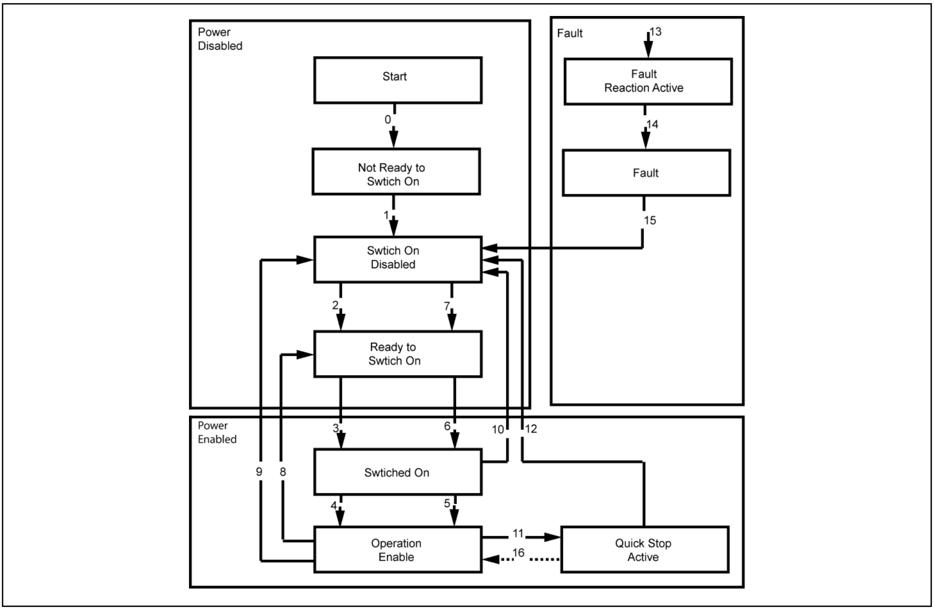


Fig. 12-116: CiA-402 state machine

Note:

- Some of the CiA-402 states cannot be directly mapped to drive's internal system state machine. More-over direct control of the drive's power section by option card is not feasible. The states defined in the CiA-402 state machine are simplified and mapped as follows.

CiA-402 state	Drive status
Not ready to switch on	Initialization phase
Switch on disabled / Ready to switch on / Switched on	Stop
Operation enable	Run
Quick stop active	Run -> Stop transition
Fault reaction active / Fault	When error is set

Tab. 12-100: The state mapping of CiA-402 state machine

- Quick stop object option code (0x605A) is not implemented.
- Transition 16 is not supported.
- Upon reception of Quick stop command the drive automatically transits (12) to "Switch On Disabled" state when the drive stops.
- Illegal state transition request is handled as follows:

  In order to control the drive, the state transitions have to be done in a proper sequence. If the requested state transition is not appropriate (as defined in the state chart) then it is termed as "Illegal transition".

When this occurs, suitable handling or indication will be given to the user/ master.

Examples:

-> Trying to directly move to “Operation Enabled” from “Switch On Disabled”.

-> Giving fault reset command in “Operation Enabled” state.

SDO Access:

If SDO is used to control the drive, then on occurrence of an illegal transition, the control word is rejected with abort code 0609 0030, “Invalid value for parameter”. The drive state is not affected.

PDO Access:

If RPDO is used to control the drive, then on occurrence of an illegal transition the drive state is not affected, but the following indication is given:

1. Warning is set and this is indicated on panel by displaying “ISt” (Invalid State Transition) and also in the CiA-Statusword warning bit (7) is set.
2. Emergency telegram is sent with error code 0x8200(protocol error).
3. The warning will be cleared only when the CANopen master gives a new valid state transition command(CiA-Controlword) either via SDO or PDO.

0	1	2	3	4	5	6	7
Error code Object: 0x603F		Error register Object: 0x1001	Manufacturer Specific Bytes				
0x8200 (Protocol error)		0x21	[b6.91] 0x5900		[b6.91] 0xE5900		

Tab. 12-101: CiA-Statusword warning bit

CiA-402 Controlword:

Object 6040h: Control word

The control word consists of bits for:

- The controlling of the state
- The controlling of operating modes
- Manufacturer specific options

Bit No.	Functionality	Description
0	Switch on	Active
1	Enable voltage	Active
2	Quick stop	Active
3	Enable operation	Active
4	Operation mode specific	Inactive (No need to consider on bit)
5	Operation mode specific	Inactive (No need to consider on bit)

Bit No.	Functionality	Description
6	Operation mode specific	Inactive (No need to consider on bit)
7	Fault reset	Active on Rising edge 0->1
8	Halt	Active
9	Reserved	Reserved (No need to consider on bit)
10	Reserved	Reserved (No need to consider on bit)
11	Manufacturer specific	Reserved (No need to consider on bit)
12	Manufacturer specific	Reserved (No need to consider on bit)
13	Manufacturer specific	Reserved (No need to consider on bit)
14	Manufacturer specific	Reserved (No need to consider on bit)
15	Manufacturer specific	Reserved (No need to consider on bit)

Tab. 12-102: Definition of control word bits

Device control commands are triggered by the following bit patterns in the control word:

Command	Bit of the control word					Transitions
	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	X	X	X	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset		X	X	X	X	15

Tab. 12-103: Device control commands

Halt-Bit (8): Drive stops when halt bit is set and enters “Switch on Disabled State”.

CiA-402 Statusword:

Object 6041h: status word

The status word indicates the current state of the drive. No bits are latched. The status word consists of bits for:

- The current state of the drive
- The operating state of the mode
- Manufacturer specific options

Bit No.	Functionality	Description
0	Ready to switch on	Active
1	Switched on	Active
2	Operation enabled	Active
3	Fault	Active
4	Voltage enabled	Active
5	Quick stop	Active
6	Switch on disabled	Active
7	Warning	Active
8	Manufacturer specific	Set to 0
9	Remote	Active
10	Target reached	Defined as drive transient* status
11	Internal limit active	Active
12	Operation mode specific	Set to 0
13	Operation mode specific	Set to 0
14	Manufacturer specific	Set to 0
15	Manufacturer specific	Set to 0

Tab. 12-104: Definition of status word bits

Value (Binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Tab. 12-105: Device state bits

Warning Bit (7):

Drive warnings are indicated on CiA-402 status word Bit-7. No emergency telegram is triggered for warning conditions detected from the Host. In case of warnings the Object 0x603F contains the warning code. If the warning is signaled from the Host then the corresponding error code object's (0x603F) data value is 0xFF01.

Target Reached Bit (10):

This bit detects whether drive is in transient* status or not. Target reached bit is set when the target velocity is reached and this is determined by checking the acceleration and deceleration status of the drive. An internal delay of 30ms is taken before validating and setting this bit in the CiA-Statusword. This is required because drive does not accelerate immediately after RUN command is issued. Approximately 8ms delay time is required for enabling the power-section and entering into RUN state.

Simple Velocity Mode:

Velocity mode is composed of the following sub-functions:

- Reference calculation
- Factor function, Reverse factor function
- Percentage function, Reverse percentage function
- Pole number function, Reverse pole number function
- Velocity limit function
- Velocity motor limit function
- Ramp function
- Ramp min function
- Closed open loop control function

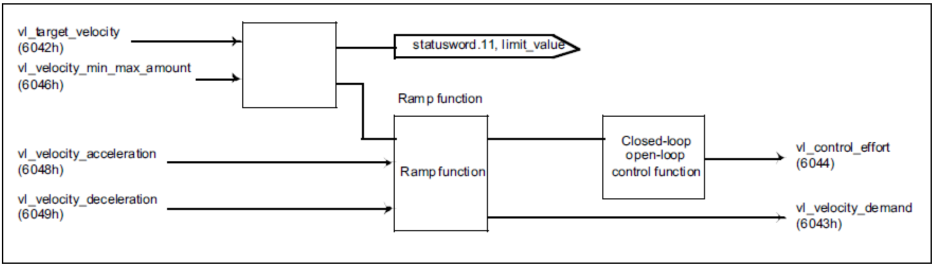


Fig. 12-117: Velocity mode with mandatory objects only

- **Rotation direction** is changed with positive and negative values of object 0x6042:

  Target velocity in RPM. The range of velocity command is from: -32768 RPM to +32767 RPM.

- In velocity mode: Acceleration is defined as: $\frac{\Delta\ Speed}{\Delta\ Time}$

  Whenever Delta speed or time changes, [E0.26] will be calculated and updated in the control board.

  $$[E0.26] = \frac{[E0.08] \times \Delta\ Time \times 120}{\Delta\ Speed \times Poles}$$

  Unit of acceleration is RPM/s.

- In velocity mode: Deceleration is defined as: $\frac{\Delta\ Speed}{\Delta\ Time}$.

  Whenever Delta speed or time changes, [E0.27] will be calculated and updated in the control board.

  $$[E0.27] = \frac{[E0.08] \times \Delta\ Time \times 120}{\Delta\ Speed \times Poles}$$

  [E0.08] -> Maximum output frequency

  Unit of deceleration is RPM/s.

Parameter dependency relation in CiA-402 velocity mode profile:

When CiA-402 drive profile is selected, a watch-list of parameters is prepared in the CANopen option card. So when these watch-list parameters are modified, then the associated dependent parameters are calculated and written back to Host (Control board) by CANopen option card automatically.

Main parameter (Watch list)	Associated dependent parameters and drive profile objects
[C1.11]: Motor Poles	1. [E0.26]: Acceleration Time 2. [E0.27]: Deceleration Time 3. [E0.10]: Output Frequency Low Limit* 4. [E0.09]: Output Frequency High Limit*
[E0.08]: Maximum Frequency	1. [E0.26]: Acceleration Time 2. [E0.27]: Deceleration Time 3. 0x6046: vl Velocity Min Max amount
[E0.09]: Output Frequency High Limit	0x6046-02: vl Velocity Max amount
[E0.10]: Output Frequency Low Limit	0x6046-01: vl Velocity Min amount
[E0.26]: Acceleration Time	Not writable when CiA-402 Profile is Active and NMT is in Operational State
[E0.27]: Deceleration Time	Not writable when CiA-402 Profile is Active and NMT is in Operational State

Tab. 12-106: List of dependent parameters

☞ *: The Low and High limits of frequency are calculated based on the velocity limits as defined in the object 0x6046 : vl Velocity Min Max amount

- When node is in NMT operational state, it is not possible to write parameters [E0.26] and [E0.27] directly by Converter Works/SDO (“Protected by others” error is thrown).
- When node is in NMT pre-operation state, it is possible to write parameters [E0.26] and [E0.27] directly by Converter Works/SDO; but the moment the NMT state transits from pre-operation to operation, the calculated acceleration/deceleration times based on the objects 0x6048 and 0x6049 are written back to [E0.26] and [E0.27].
- If motor poles [C1.11] or maximum frequency [E0.08] parameter is changed when node is in operational state then the dependent parameters are re-calculated and updated automatically.

Related Communication Parameters

Parameter	Name	Modify	Function	Value
E0.00	First frequency setting source	Stop	Setting frequency selection source	20: Communication
E0.01	First run command source	Stop	Run command selection source	2: Communication
E8.00	Communication protocol	Stop	Field bus protocol selection	0: Modbus* 1: Option card
E8.03	Communication process data loss behaviour	Stop	Selecting the drive behaviour when the CANopen node switches to Pre-Op during RUN	0: Decelerating stop 1: Freewheeling stop 2: Keep running
H0.00	Control word	Run	VFC/EFC x610 drive control word	-
H0.01	Status word	Read	VFC/EFC x610 Drive Status Word	-
H0.10	Frequency command	Run	Setting frequency	0...400 Hz (0...65535) Default: 0
H0.20	Option card 1 type	Read	Shows the option card type in slot 1 detected by frequency converter	0: Inactive* 1: PROFIBUS card 2: CANopen card 3: Multi-Ethernet card 8: I/O card 9: Relay card
H0.21	Option card1 hardware label	Read	-	-
H0.22	Option card1 firmware string	Read	-	-
H0.23	Option card 2 Type	Read	Shows the option card type detected in slot 2 by frequency converter	0: Inactive* 1: PROFIBUS card 2: CANopen card 3: Multi-Ethernet card 8: I/O card 9: Relay card

Parameter	Name	Modify	Function	Value
H0.24	Option card2 hardware label	Read	-	-
H0.25	Option card2 firmware string	Read	-	-

Tab. 12-107: Definition of status word bits

☞ * : Factory default

CANopen Option Card Parameters

Parameter	Mapped object in MO/CO/DPO	Name	Modify	Function	Value
H2.00	MO: 0x3838	CANopen address	Stop	Selects the address for CANopen Node	1...127 Default: 1
H2.01	MO: 0x3839	CAN baudrate	Stop	Sets the speed of CANopen communication	0...6 Default: 3 0: 10 kbits/s 1: 20 kbits/s 2: 50 kbits/s 3: 125 kbits/s 4: 250 kbits/s 5: 500 kbits/s 6: 1 Mbit/s
H2.02	MO: 0x383A	CANopen device profile selection	Stop	To switch between different drive profiles	0...1 Default: 0-> Rexroth Drive Profile 1-> CiA- 402 Drive Profile
H2.98	MO: 0x389A	CANopen termination resistor switch	Stop	Selects the state of the termination resistor	0:Disabled (Default) 1: Enabled

Tab. 12-108: CANopen option card parameters

☞ MO: Manufacturer Objects

12.20 H3: Multi-Ethernet Card Parameters

12.20.1 Introduction

About This Documentation

This documentation contains necessary data and information descriptions related to the Multi-Ethernet Platform (MEP) extension card, which is one of the fieldbus communication module accessories of EFC x610 series frequency converter.

As the name indicates, this extension card incoroporates multiple industrial Ethernet protocols listed as below.

- PROFINET IO
- EtherNet/IP
- SERCOS III
- EtherCAT
- Modbus/TCP

☞ This extension card fully supports the EFCx610 firmware the version 03V08 and above, while more industrial Ethernet protocols will be developed to be incorporated in the MEP extension card, please always check for the latest version of this manual for a most up-to-date reference.

Chapters 1 through 3 provide the general information of the MEP extension card, while chapters 5 through 9 contain detailed technical information relevant to different industrial Ethernet protocol. The common configuration, parameters and diagnosis are described in chapter 4, 10 and 11.

Engineering Tools

For using the MEP extension card, an engineering connection from laptop / PC to the EFC series frequency converter is necessary. Such a connection can be established with using following methods:

- Via Ethernet using IndraWorks Ds. In this case, the MEP can be browsed and the IP address can be set.
- Via USB using ConverterWorks or IndraWorks Ds. Plug the cable and connect.

The figure below shows an overview of ConverterWorks.

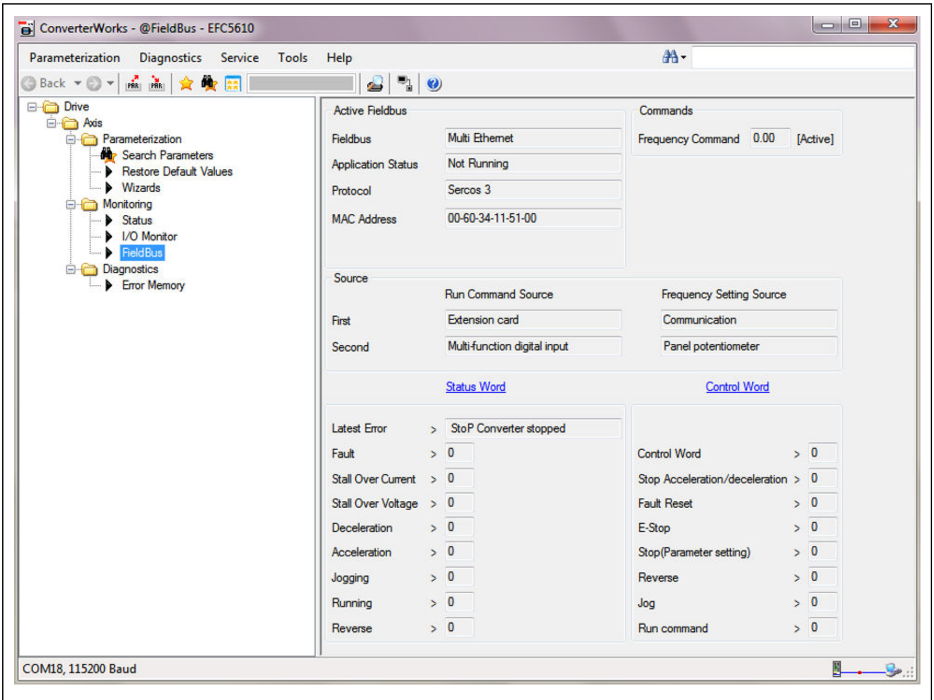


Fig. 12-118: Overview of ConverterWorks

Reference Documentations

Type	Typecode	Language	Material Number
Operating Instructions	DOK-RCON03-EFC-x610***-ITRS-ZH-P	Chinese	R912005853
	DOK-RCON03-EFC-x610***-ITRS-EN-P	English	R912005854
Quick Start Guide	DOK-RCON03-EFC-x610***-QURS-ZH-P	Chinese	R912005855
	DOK-RCON03-EFC-x610***-QURS-EN-P	English	R912005856
Instruction Manual (UL)	DOK-RCON01-REX*F*UL***-INRS-EN-P	English	R912004711
Extension Card Module Mounting Instructions	DOK-RCON0*-XFC-X610***-ASRS-EN-P	English	R912006261
	DOK-RCON0*-XFC-X610***-ASRS-ZH-P	Chinese	R912006262
Product Insert (I/O module)	DOK-RCON0*-XFC-X610***-ISRS-EN-P	English	R912006326
	DOK-RCON0*-XFC-X610***-ISRS-ZH-P	Chinese	R912006327
Safety Instructions	DOK-RCON**-SAFETY*****-SARS-BP-P	Portuguese	R911339218
	DOK-RCON**-SAFETY*****-SARS-DE-P	German	R911339363
	DOK-RCON**-SAFETY*****-SARS-EN-P	English	R911339362
	DOK-RCON**-SAFETY*****-SARS-ES-P	Spanish	R911339216
	DOK-RCON**-SAFETY*****-SARS-FR-P	French	R911339213
	DOK-RCON**-SAFETY*****-SARS-IT-P	Italian	R911339215
	DOK-RCON**-SAFETY*****-SARS-RU-P	Russian	R911339217
	DOK-RCON**-SAFETY*****-SARS-ZH-P	Chinese	R912004727
Product Insert (Multi-Ethernet Card)	DOK-RCON0*-XFCX610*MUL-ISRS-ZH-P	Chinese	R912006846
	DOK-RCON0*-XFCX610*MUL-ISRS-EN-P	English	R912006847

Tab. 12-109: Reference documentations

12.20.2 LEDs

Two slots are provided in the extension card module. On each slot, four dual-color LEDs are equipped for state indication if the MEP extension card is applied.

The network status (NS: H11/H21) and module status (MS: H12/H22) LEDs are red/green. The physical status of port 1 (P1: H13/H23) and port 2 (P2: H14/H24) are yellow/green.

The figure below shows an overview of LED indications on the extension card.

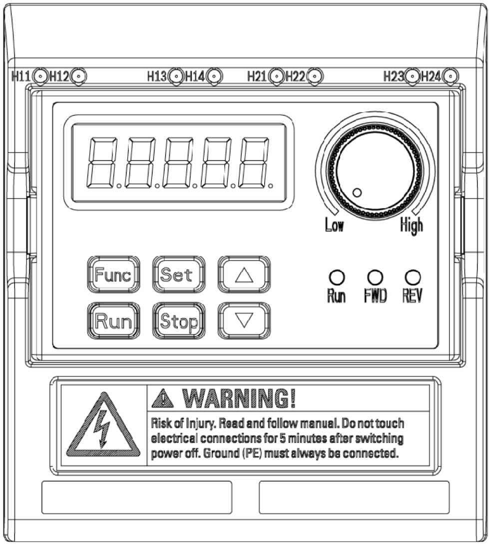


Fig. 12-119: Multi-Ethernet card LED

12.20.3 General Configuration

Protocol Selection

The parameter H3.40 is used to define the type of Industrial Ethernet protocol to be used with MEP card. And parameter H3.41 indicates which industrial Ethernet protocol is currently engaged. Once the request protocol is changed, a cycle power or a reboot is needed to activate the selected protocol.

Code	Name	Setting range
H3.40	MEP: Industrial Ethernet Protocol Request	S3: SERCOS III PN: PROFINET IO EI: Ethernet/IP EC: EtherCAT MB: Modbus/TCP
H3.41	MEP: Industrial Ethernet Protocol Active	Read-only

Tab. 12-110: Protocol selection parameters

The values of H3.40 and H3.41 are two characters representation that only accepts upper case letter. Figure 4-1 gives an example of PROFINET IO request.

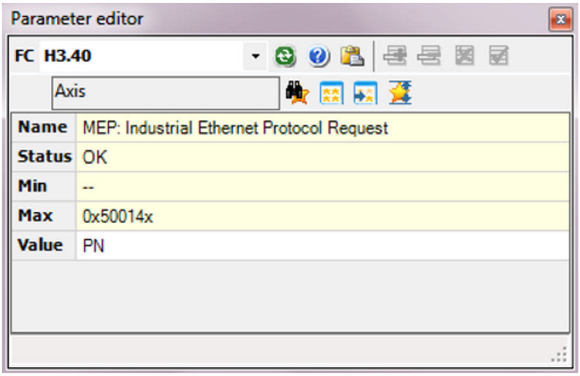


Fig. 12-120: Protocol request setting

Communication Channel Setting

The fieldbus communication channel should be configured according to the actual application when the MEP communication extension card is applied.

If the first control command and frequency setting are both transmitted via communication channel, parameters in table 4-2 should be set to open the first communication channel.

Code	Name	Value
E0.00	First frequency setting source	20: Communication
E0.01	First run command source	2: Communication

Tab. 12-111: First communication channel parameters

And if the second communication channel is used with the MEP extension card, the parameters in table 4-3 should be set to open the second communication channel.

Code	Name	Value
E0.02	Second frequency setting source	20: Communication
E0.03	Second run command source	2: Communication

Tab. 12-112: Second communication channel parameters

After configuration is completed for the communication channel, the parameter E8.00 should be set to redirect to the communication extension card.

Code	Name	Value
E8.00	Communication protocol	1: Extension card

Tab. 12-113: Communication selection parameter

Process Data Setting Range

The range of both output and input process data is listed in the table below. If the setting values exceed the range, "FPC-" error will be triggered.

The output process data list includes the cyclic data objects that can be transferred from controller to peripheral devices.

Code	Name
H0.00	Control word
H0.10	Frequency command
H0.40	Dummy PZD
F0.20	ASF command01
F0.21	ASF command02
F0.22	ASF command03
F0.23	ASF command04

Tab. 12-114: Output process data parameter list

And the input process data list includes the cyclic data objects that can be transferred from peripheral devices to controller. Normally, the monitoring data are collected by controller.

Code	Name	Code	Name
H0.01	Status word	d0.40	Digital input 1
H0.02	Extended status word	d0.43	I/O card digital input
d0.00	Output frequency	d0.45	DO1 output
d0.01	Actual speed	d0.47	I/O card EDO output
d0.02	Setting frequency	d0.50	Pulse input frequency
d0.03	Setting speed	d0.55	Pulse output frequency
d0.04	User-defined setting speed	d0.60	Relay output
d0.05	User-defined output speed	d0.62	I/O card relay output
d0.10	Output voltage	d0.63	Relay card output
d0.11	Output current	d0.70	PID reference engineering value
d0.12	Output power	d0.71	PID feedback engineering value
d0.13	DC-bus voltage	d0.80	ASF Display00
d0.16	Output torque	d0.81	ASF Display01
d0.17	Setting torque	d0.82	ASF Display02
d0.20	Power module temperature	d0.83	ASF Display03
d0.21	Actual carrier frequency	d0.84	ASF Display04
d0.22	Control stage running time	d0.85	ASF Display05
d0.23	Power stage running time	d0.86	ASF Display06
d0.30	AI1 input	d0.87	ASF Display07

Code	Name	Code	Name
d0.31	AI2 input	d0.88	ASF Display08
d0.33	I/O card EAI input	d0.89	ASF Display09
d0.35	AO1 output	d0.98	High resolution output current
d0.37	I/O card EAO output	H0.40	Dummy PZD

Tab. 12-115: Intput process data parameter list

☞ The parameter H0.40 can be used for filler in the output / input configurations.

Device Profile

The Rexroth device profile described below is used as common profile for the MEP extension card.

The following table is a general description of the H0.00 control words which are used to send commands from master to slave.

Bit	Value	Meaning
15...9	-	Reserved
8	1	Freewheeling stop
	0	Inactive
7	1	Control word active
	0	Inactive
6	1	Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator)
	0	Inactive
5	1	Fault reset active
	0	Inactive
4	1	E-stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active (jogging direction determined by bit 2)
	0	Inactive
0	1	Run command active
	0	Inactive

Tab. 12-116: Control word definition

- Bit 8 Freewheeling stop

Freewheeling stops that ignore the frequency converter stop mode setting. Only active start from frequency converter firmware version 03V12.

- Bit 6 Stop acceleration/deceleration active

The current acceleration/deceleration process will be paused when bit 6 = 1, and it will be recovered when bit 6 = 0.

- Bit 4 E-stop active

Freewheel stop will be triggered in conjunction with panel display error ‘E-St’ when bit 4 = 1.

- Bit 3 Stop according to parameter setting

The parameter E0.50 Stop Mode is referenced when bit 3 = 1.

- Bit 1 Jog active

Jog frequency and acceleration/deceleration time are set by the parameters E0.60, E0.61, and E0.62.

☞ The control bits (bit 6...0) in the control word are all edge sensitive. It is recommended to reset value 0x0080 at the time when the program starts to run initially.

The H0.01 status words are used to supply the real-time status information to master from slave.

Bit	Value	Meaning
15...8	-	Error code
7	1	Error
	0	No error
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in decelerating
3	1	Accelerating
	0	Not in accelerating
2	1	Jogging
	0	Not in jogging
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 12-117: Status word definition

- Bit 15...8 Error code

Please refer to chapter 13.4 of EFC x610 Operating Instructions for detailed error code description. The error code as referred in table 4-8 is the error occurring currently when the frequency converter is in error mode (i.e. bit 7 = 1); and the last error occurred when the frequency converter is in normal mode (i.e. bit 7 = 0).

Extended status word H0.02 supplies extended status information. See definition in table below.

Bit	Value	Meaning
15...1	-	Reserved
0	1	24V mode
	0	Normal mode

Tab. 12-118: Status information of H0.02

Parameters

Parameter Address

Each EFCx610 function code parameter XX.YY has a unique virtual address word. It's composed of two bytes that the low byte is the hex value of YY and the high-byte can be derived from XX using the following table.

Function Code Class	Numerical Representation (High-Byte)
b0...b9	0x00...0x09
d0...d9	0x10...0x19
C0...C9	0x20...0x29
E0...E9	0x30...0x39
U0...U9	0x40...0x49
F0...F9	0x50...0x59
H0...H9	0x60...0x69

Tab. 12-119: Parameter address

For instance, the virtual address word of E0.26 is 0x301A.

The function code parameter IDN addresses which used for SERCOS III parameter access are summarized in the table below.

Code Range*	IDN Range
b0.00...b0.99	P-0-1050.0.0 --- P-0-1050.0.99
d0.00...d0.99	P-0-1058.0.0 --- P-0-1058.0.99
C0.00...C0.99	P-0-1066.0.0 --- P-0-1066.0.99
C1.00...C1.99	P-0-1066.0.100 --- P-0-1066.0.199
C2.00...C2.99	P-0-1067.0.0 --- P-0-1067.0.99
C3.00...C3.99	P-0-1067.0.100 --- P-0-1067.0.199
E0.00...E0.99	P-0-1074.0.0 --- P-0-1074.0.99
E1.00...E1.99	P-0-1074.0.100 --- P-0-1074.0.199
E2.00...E2.99	P-0-1075.0.0 --- P-0-1075.0.99
E3.00...E3.99	P-0-1075.0.100 --- P-0-1075.0.199
E4.00...E4.99	P-0-1076.0.0 --- P-0-1076.0.99

Code Range*	IDN Range
E5.00...E5.99	P-0-1076.0.100 --- P-0-1076.0.199
E8.00...E8.99	P-0-1078.0.0 --- P-0-1078.0.99
E9.00...E9.99	P-0-1078.0.100 --- P-0-1078.0.199
U0.00...U0.99	P-0-1082.0.0 --- P-0-1082.0.99
U1.00...U1.99	P-0-1082.0.100 --- P-0-1082.0.199
F0.00...F0.99	P-0-1090.0.0 --- P-0-1090.0.99
F1.00...F1.99	P-0-1090.0.100 --- P-0-1090.0.199
F2.00...F2.99	P-0-1091.0.0 --- P-0-1091.0.99
F3.00...F3.99	P-0-1091.0.100 --- P-0-1091.0.199
F4.00...F4.99	P-0-1092.0.0 --- P-0-1092.0.99
F5.00...F5.99	P-0-1092.0.100 --- P-0-1092.0.199
H0.00...H0.99	P-0-1098.0.0 --- P-0-1098.0.99
H1.00...H1.99	P-0-1098.0.100 --- P-0-1098.0.199
H2.00...H2.99	P-0-1099.0.0 --- P-0-1099.0.99
H3.00...H3.99	P-0-1099.0.100 --- P-0-1099.0.199
H4.00...H4.99	P-0-1100.0.0 --- P-0-1100.0.99
H8.00...H8.99	P-0-1102.0.0 --- P-0-1102.0.99
H9.00...H9.99	P-0-1102.0.100 --- P-0-1102.0.199

Tab. 12-120: Parameter address

*: It is a summarized illustration. Some function code parameters are not available, either the related IDNs.

MEP Parameters

Terminology and Abbreviation

- Attri.: Parameter attribute
  - Run: Parameter setting can be modified when the converter is in run or stop state
  - Stop: Parameter setting can only be modified when the converter is in stop state
  - Read: Parameter setting is read-only and cannot be modified
- <MANU>: Depend on manufacturing
- -: Not available

Parameter List

Function Code	Parameter Name	Data Type	Factory Default	Attri.
H3.00	MEP: MAC Address Device	BYTE LIST	<MANU>	Read
H3.01	MEP: MAC Address Port 1	BYTE LIST	<MANU>	Read
H3.02	MEP: MAC Address Port 2	BYTE LIST	<MANU>	Read
H3.03	MEP: IP Address	BYTE LIST	192.168.0.1	Run
H3.04	MEP: Subnet Mask	BYTE LIST	255.255.255.0	Run
H3.05	MEP: Gateway Address	BYTE LIST	0.0.0.0	Run
H3.06	MEP: IP Options	DWORD	0	Run
H3.07	MEP: Local Hostname (SERCOS/IP, EtherNet/IP)	CHAR LIST	hostname	Run
H3.08	MEP: Application Type	CHAR LIST	Frequency Converter	Read
H3.10	MEP: Device ID (PROFINET)	WORD	0x2802	Read
H3.11	MEP: Order ID	CHAR LIST	<MANU>	Read
H3.12	MEP: Product Name	CHAR LIST	MEP	Read
H3.13	MEP: Serial Number	ULONG	<MANU>	Read
H3.14	MEP: Product Code (EtherNet/IP)	WORD	0x0024	Read
H3.18	MEP: Visual Status Indicators	ULONG	-	Read
H3.20	MEP: Station Name (PROFINET)	CHAR LIST	axis01	Stop
H3.21	MEP: Station Type (PROFINET)	CHAR LIST	Rexroth-Multi-Ethernet	Read
H3.22	MEP: Subdevice ID (PROFINET)	DWORD	0x011F2802	Read
H3.23	MEP: Device Address	WORD	1	Run

Function Code	Parameter Name	Data Type	Factory Default	Attri.
H3.24	MEP: Active Device Address (Topology)	WORD	0	Read
H3.25	MEP: IP address is remnant (PROFINET)	DWORD	0	Run
H3.26	MEP: EtherCAT List of Input Process Data (Master)	WORD LIST	0x0000, 0x0000	Read
H3.27	MEP: EtherCAT List of Output Process Data (Master)	WORD LIST	0x0000, 0x0000	Read
H3.28	MEP: Input Process Data Length (Master)	USHORT	0	Read
H3.29	MEP: Output Process Data Length (Master)	USHORT	0	Read
H3.30	MEP: List of Input Process Data	WORD LIST	0x6001, 0x1002	Stop
H3.31	MEP: List of Output Process Data	WORD LIST	0x6000, 0x600A	Stop
H3.32	MEP: Input Process Data Length (Slave)	USHORT	4	Read
H3.33	MEP: Output Process Data Length (Slave)	USHORT	4	Read
H3.34	MEP: Communication Platform State	DWORD	-	Read
H3.35	MEP: Communication Diagnosis Flags	DWORD	-	Read
H3.36	MEP: ComCycle Periods [ns]	ULONG	0,0,0	Read
H3.37	MEP: Communication Phase	USHORT	0	Read
H3.40	MEP: Industrial Ethernet Protocol Request	CHAR LIST	S3	Run
H3.41	MEP: Industrial Ethernet Protocol Active	CHAR LIST	S3	Read
H3.42	MEP: Industrial Ethernet Protocol Logicware	CHAR LIST	S3L	Read
H3.49	MEP: EtherCAT State	USHORT	1	Read
H3.51	MEP: Modbus/TCP Alternative TCP port	USHORT	0	Run
H3.63	MEP: List of external parameters	WORD	-	Read
H3.71	MEP: Subsystem identification parameter	CHAR LIST	<MANU>	Read
H3.96	MEP: FWA string	CHAR LIST	<MANU>	Read

Tab. 12-121: Parameter List

- H3.06 MEP: IP Options

  Bit 0: DHCP enabled (MEP receives IP address H3.03 from a DHCP server), other Bits unused.

- H3.18 MEP: Visual Status Indicators

  This parameter gives a data representation of the LED indications.

Bit	Name	Function
31...18	-	Reserved
17	Link P2	1 = Ethernet link present 0 = No Ethernet link
16	Link P1	

Bit	Name	Function
15...12	Network Status Red LED	15..5 = Reserved 4 = Steady On 3 = Blink 4 Hz 2 = Blink 2 Hz 1 = Blink 1 Hz 0 = Off
11...8	Network Status Green LED	
7...4	Module Status Red LED	
3...0	Module Status Green LED	

Tab. 12-122: Parameter H3.18

- H3.34 MEP: Communication Platform State

  This parameter describes the internal communication platform state.

Value	State	Description
0	NOP	Communication platform inactive
1	START	Running boot process
2	STARTERR	Error at boot process
3	SYSRDY	System up, preparing for configuration
4	CONFIG	System basic configuration done
5	CFGERR	Error at system basic configuration
6	COMCFG	Fieldbus selection done
7	COMCFGERR	Error at fieldbus selection
8	COMINIT	Ready for being connected by fieldbus master
9	COMINITERR	Error at fieldbus configuration
10	COMRDY	Preparing for cyclic communication
11	COMACTV	Cyclic communication active
12	COMERR	Error / Breakdown of cyclic communication
13	UPDATE	Update in progress

Tab. 12-123: Parameter H3.34

- H3.35 MEP: Communication Diagnosis Flags

  This parameter gives some detailed diagnosis on internal events. However, all diagnosis flags are assigned to some error codes and corresponding display messages.

Bit	Name	Description
31...28	-	Reserved
27	Host Watchdog	Internal communication to base system timed out.
26	FW CRC-Error	Communication Platform Firmware consistency check failed.
25...18	-	Reserved

Bit	Name	Description
17	FW CRC-OK	Communication Platform Firmware consistency check done and status is OK.
16...15	-	Reserved
14	PDC Invalid	Process Data Configuration contains unknown/unsupported parameters or exceeds maximum data length of 15 parameters for input and output data, each.
13	PDC Difference	Process Data Configuration of Communication Platform ([H3.30]/[H3.31]) and Process Data Configuration of Fieldbus Master are differing in data length.
12	Connection Timeout	An existing cyclic communication was terminated because of missing master telegrams.
11	Connection Closed	An existing cyclic communication was closed by the fieldbus master.
10	Connection Idle	Fieldbus master set process data status to “invalid”.
9	Connection Error	An existing cyclic communication got broken because of a communication problem.
8	Fieldbus Initiate Error	Error while starting fieldbus stack
7...6	-	Reserved
5	Identify Error	Invalid identification parameters
4	DHCP Error	DHCP request: No response from DHCP server.
3	MAC Address Error	Invalid MAC address
2	IP Initiate Error	Error while starting IP stack
1	IP Address Error	IP address already present at subnet
0	Link Error	No Ethernet link

Tab. 12-124: Parameter H3.35

- H3.36 MEP: ComCycle Periods [ns]

  This parameter consists of three values that define current communication cycle periods. All values are given in nanoseconds.

  – Value 1: Transmission Cycle On Bus

  – Value 2: Producer Cycle (Input Data Cycle)

  – Value 3: Consumer Cycle (Output Data Cycle)

Fault Management

The response of the frequency converter can be configured via parameter E8.03 when the process data are lost.

Code	Name	Setting range
E8.03	Communication process data loss behavior	0: Decelerating stop
		1: Freewheeling stop
		2: Keep running

Tab. 12-125: Parameter E8.03

12.20.4 PROFINET IO

Protocol Configuration

Device Name

A PROFINET IO device is addressed through the so-called device name. Each PROFINET IO device operating in the same network must have unique device name.

The device name can be assigned locally via: H3.20 MEP: Station Name (PROFINET), or through device naming by a configuration software tool.

IP Settings

All PROFINET IO devices follow the TCP/IP protocol, thus they need an IP address when operating on the Ethernet.

Table below gives an overview of all IP-related parameters.

Code	Name
H3.00	MEP: MAC Address Device
H3.01	MEP: MAC Address Port 1
H3.02	MEP: MAC Address Port 2
H3.03	MEP: IP Address
H3.04	MEP: Subnet Mask
H3.05	MEP: Gateway Address
H3.06	MEP: IP Options

Tab. 12-126: IP-related parameters

The parameter H3.06 can be set to enable the MEP in receiving IP address from a DHCP server, see chapter 10.2.2. In most cases, the IP address of IO devices are assigned by IO controller. If not assigned by the PNIO controller, user should manually set IP address, Subnet Mask, and Gateway Address.

It is recommended, either to use a static IP address at fieldbus project for engineering access via SERCOS/IP, which was already parameterized to the MEP or to ensure, that the IP address assigned dynamically by the PNIO controller at fieldbus startup is equal to the parameterized IP address at MEP. If static and dynamically assigned IP address differ, an engineering connection (SERCOS/IP) already established will be lost, when PNIO controller assigns new IP address.

System Configuration

GSD file

A GSD file which contains the setup information of IO device communication is required when configuring the PROFINET IO controller.

Users can download the GSD file through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose "Frequency converter -> EFC 3610 (or EFC 5610)" from the navigation bar on left-hand side of the operation interface.
3. Choose "Download area" tab from right-hand side of the interface.
4. Click on "DEVICE_DESCRIPTIONS_MULTI-ETHERNET_EFCX610_xxxx-xx-xx.ZIP" to download the ZIP file.
5. Extract the ZIP file and get the GSD file.

"xxxx-xx-xx" indicates the date.

The following is the instruction of installing the GSD file on the Simatic Manager software tool. It can be found in the hardware catalog.

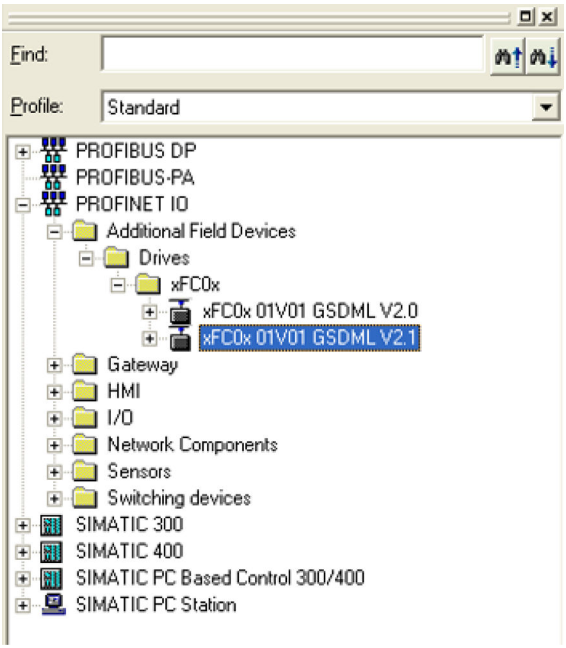


Fig. 12-121: Hardware catalog

Two GSDML schema versions are supported. For configuration tools, which don't support GSDML schema version 2.1, please use with version 2.0.

IO Device

In the configuration of project hardware, user can configure the EFC x610 as an IO device in the PROFINET IO system. The **Properties**window below shows the key information of the IO device.

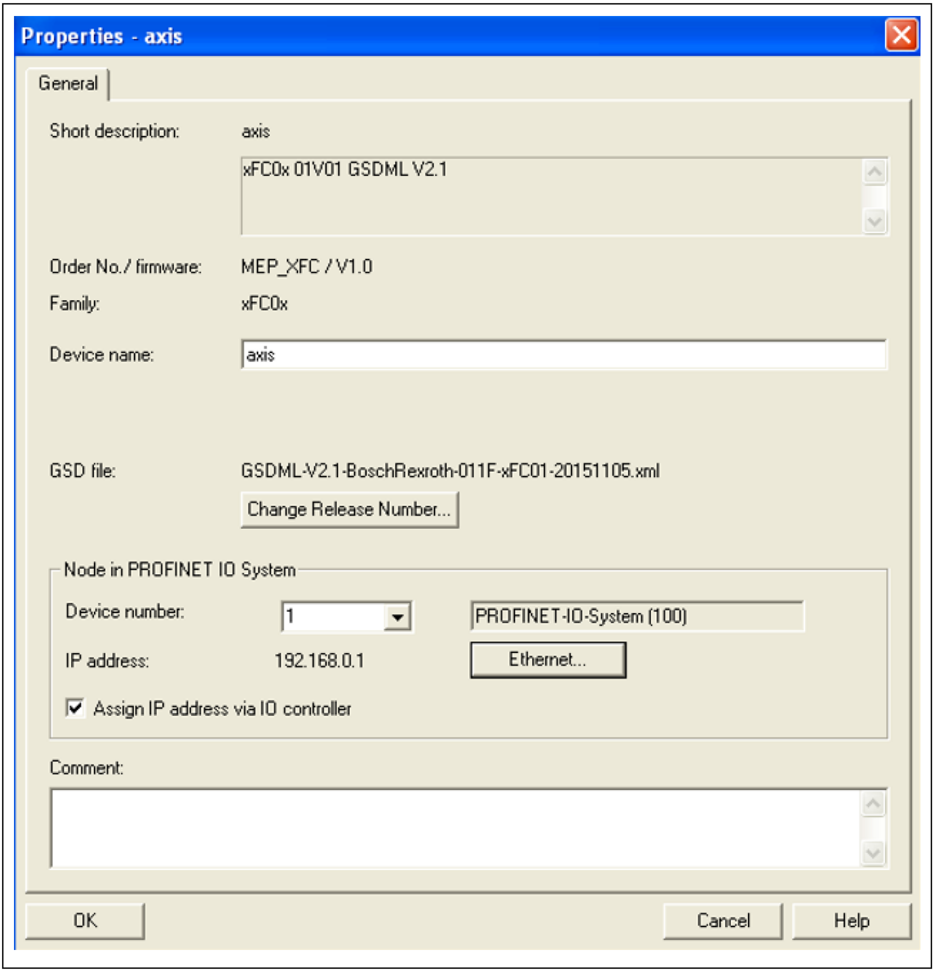


Fig. 12-122: IO device **Properties** window

The configured device name here must match the setting value of parameter H3.20 MEP: Station Name (PROFINET).

The IO modules should be configured here according to the acutal application. The figure below shows the two input and output words by default. User can freely configure the IO modules from 1 to 15 words.

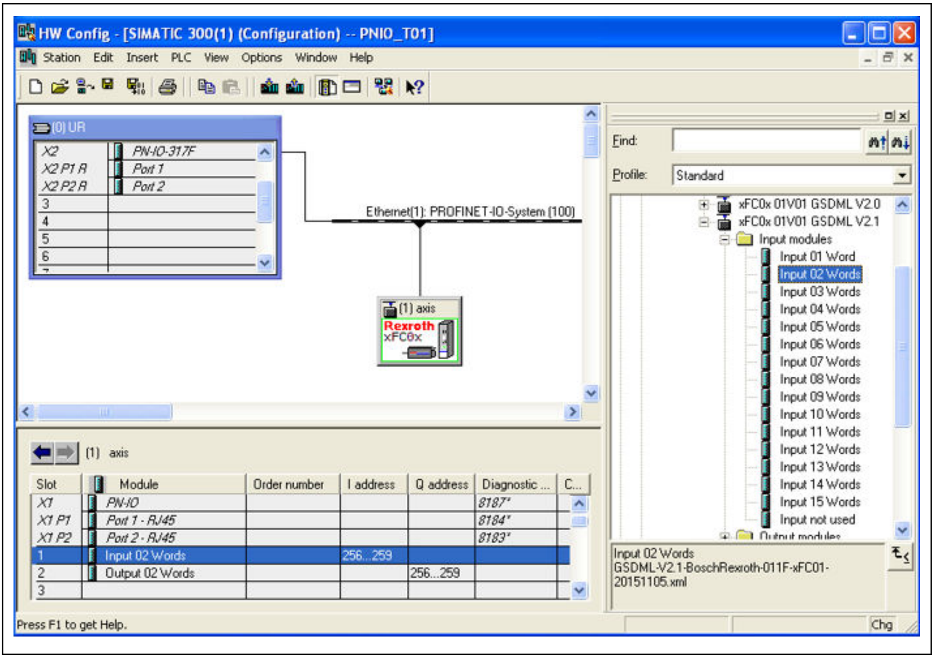


Fig. 12-123: Hardware configuration window

Topology

The MEP communication extension card integrates a Cut-Through-Switch that enables the possibility for connecting several MEP communication extension cards in a line topology as an alternative to the typical star topology.

Typically a mixed line and star topology connecting with an industrial Ethernet switch is applied in the field.

Process Data

The process data that are used for cyclic communication are configured via parameters H3.30 and H3.31.

The two parameters are list type that consist of parameter function codes. Figure below shows the default configurations.

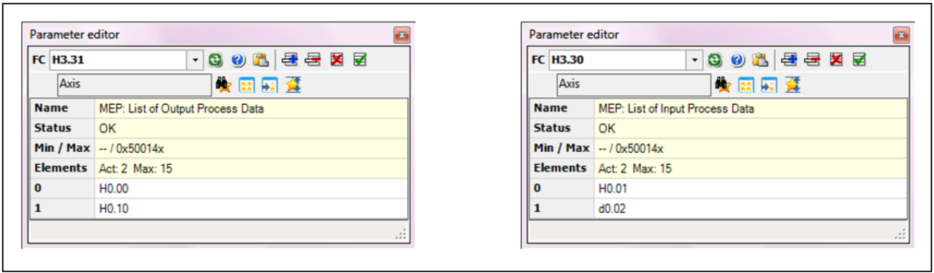


Fig. 12-124: Process data default configurations

Acyclic Communication

Principle

Acyclic communication is mainly used for parameter read/write accesses from controller, supervisor etc. The PROFINET service “read/write record” (RPC over UDP) is utilized to realize the object addressing.

With the SFB52 “RDREC” and SFB53 “WRREC”, a data record with the number INDEX can be read from or written to a PROFINET IO device module defined by ID. The key arguments ID and INDEX are described below.

When parameter write access on the two bytes type parameter, any values exceed 65,535 (0xFFFF) will be reduced automatically to a two bytes value. If the reduced two bytes value is in the valid range, then it will be accepted and without value exceed limits indication.

Module ID

The diagnostic address of the PROFINET IO device can be treated as the module ID when read/write record is called. It can be found in the hardware configuration of the software tool.

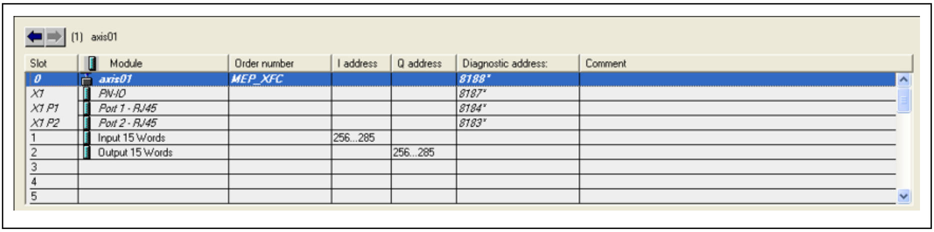


Fig. 12-125: Diagnostic address

Record Index

The record index corresponds exactly to the function code parameter to be accessed. The address of the function code parameter is composed of a higher byte representing the parameter group and a lower byte representing the sub-index in the group.

The parameter group map is shown as below.

Group	Index	Value	Example
b	0...9	0x00...0x09	b0: 0x00
d	0...9	0x10...0x19	d0: 0x10
C	0...9	0x20...0x29	C3: 0x23
E	0...9	0x30...0x39	E8: 0x38
U	0...9	0x40...0x49	U1: 0x41

Group	Index	Value	Example
F	0...9	0x50...0x59	F0: 0x50
H	0...9	0x60...0x69	H3: 0x63

Tab. 12-127: Parameter group mapping

An offset of 0x30 must be added on the parameter sub-index to form the record index. For example, the record index of E0.26 Acceleration Time is:

0x3000 + 0x1A + 0x30 = 0x304A

Example

A simple program fragment example that utilizes the mapped I/Q addresses is shown as below. The process data configuration is by defaults.

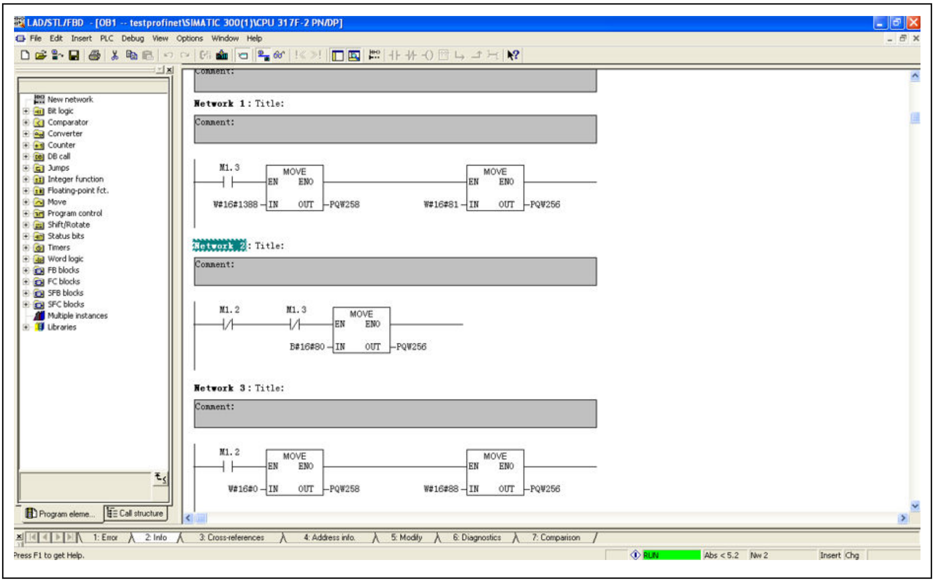


Fig. 12-126: Program example

12.20.5 EtherNet/IP

Protocol Configuration

The master communication address for EtherNet/IP is an IP address. It is set manually in the frequency converter side by using an engineering tool. The parameter H3.06 can be set to enable the MEP in receiving IP address from a DHCP server, see chapter 10.2.2.

Code	Name
H3.00	MEP: MAC Address Device
H3.01	MEP: MAC Address Port 1
H3.02	MEP: MAC Address Port 2
H3.03	MEP: IP Address
H3.04	MEP: Subnet Mask
H3.05	MEP: Gateway Address
H3.06	MEP: IP Options

Tab. 12-128: IP-related parameters

System Configuration

EDS File

An EDS file is provided with the EtherNet/IP application of MEP extension card.

Users can download the EDS file through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose “Frequency converter -> EFC 3610 (or EFC 5610)” from the navigation bar on left-hand side of the operation interface.
3. Choose “Download area” tab from right-hand side of the interface.
4. Click on “DEVICE_DESCRIPTIONS_MULTI-ETHERNET_EFCX610_xxxx-xx-xx.ZIP” to download the ZIP file.
5. Extract the ZIP file and get the EDS file.

"xxxx-xx-xx" indicates the date.

Generic Device

The MEP extension card is implemented as a ‘Generic Device’ when it is configured into the EtherNet/IP network. The EtherNet/IP object directory implemented contains the objects:

- Identity Object (0x01)
- Message Router Object (0x02)
- Ethernet Link Object (0xF6)
- TCP/IP Object (0xF5)
- Port Object (0xF4)
- Connection Manager Object (0x06)
- Assembly Object (0x04)

The cyclic communication is implemented via the "EtherNet/IP-I/O messaging" (Class 1). It can be configured up to 15 items in both data direction.

Topology

The star and line topology are both supported.

Process Data Configuration

The process data that are used for cyclic communication are configured on frequency converter via parameters H3.30 and H3.31.

The two parameters are list type that consist of parameter function codes. Figure below shows the default configurations.

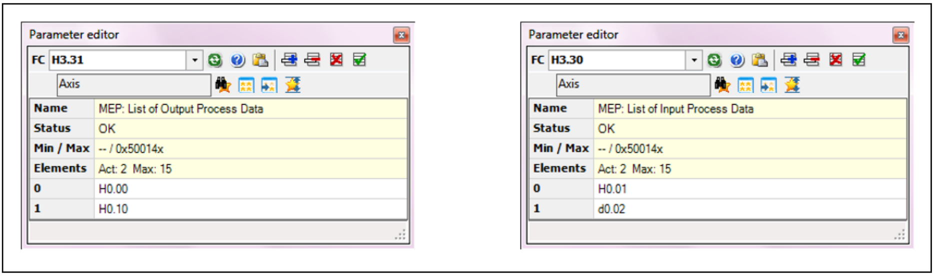


Fig. 12-127: Process data default configurations

☞ The set of allowed functions codes for input and output process data is contained at [b8.61] and [b8.62] respectively. Maximum supported input and output process data length is 30 bytes, each. Hence, as current supported process data function codes are all two bytes in data length, maximum number of configurable function codes is 15.

- Following the instructions of the EDS installation tool to import the file into the RSLogix. See the item in below picture.

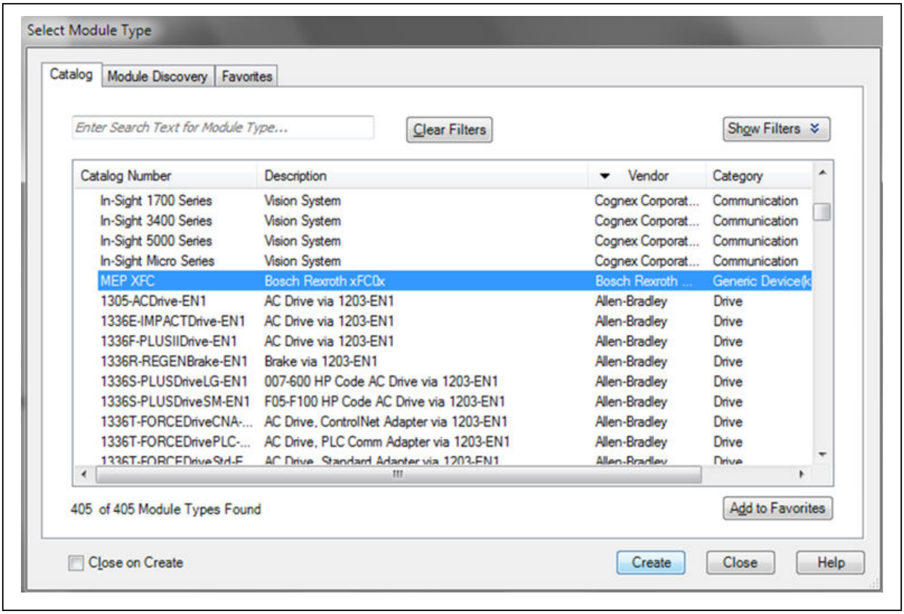


Fig. 12-128: Device catalog

- Select MEP XFC and click “Create”, then type **Name** and **IP Address** in the following interface.

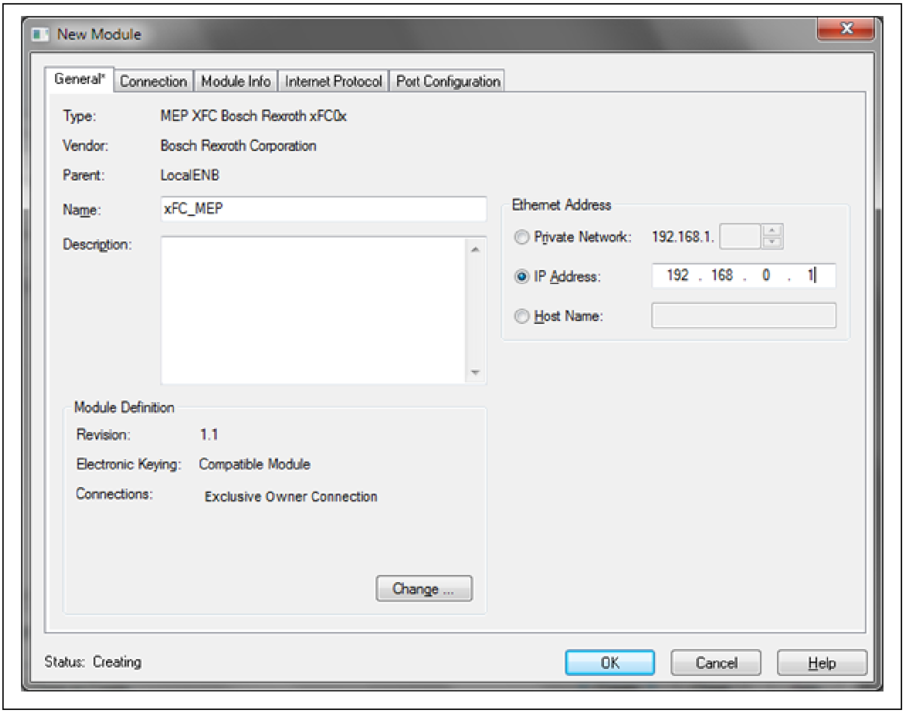


Fig. 12-129: MEP name and IP address

- The frequency converter was added to the project.

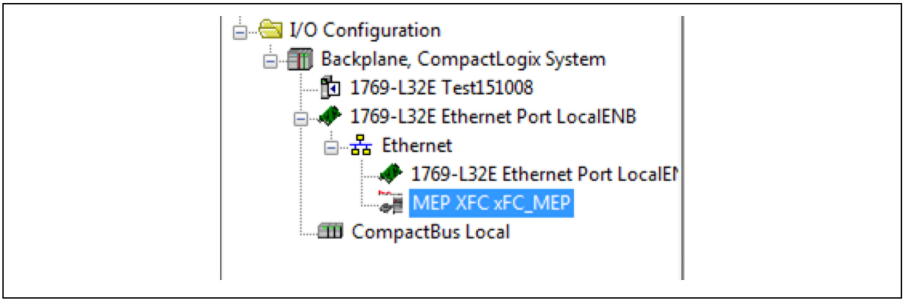


Fig. 12-130: Add frequency converter to project

- Download the project to RSLogix controller. The MEP monitor tag was added to the project.

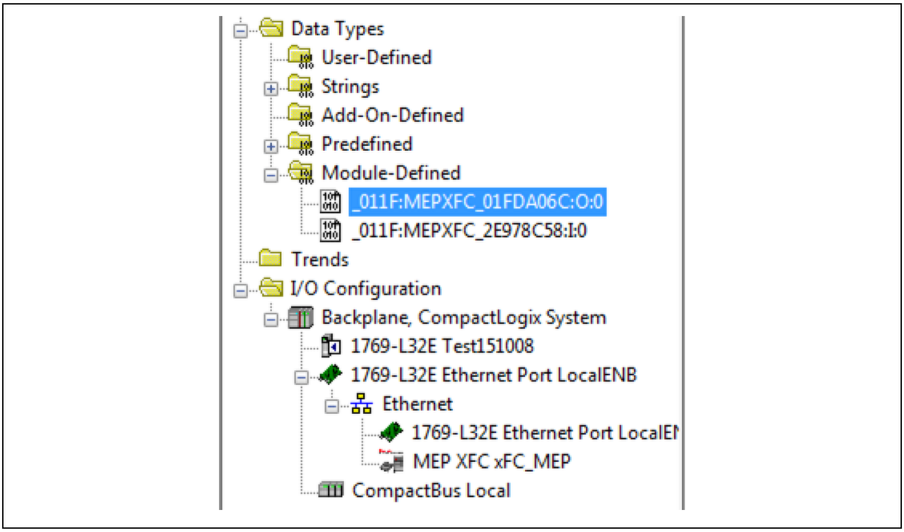


Fig. 12-131: MEP monitor tags

- Right-click then choose **Monitor Tags**. The interface is shown as below.

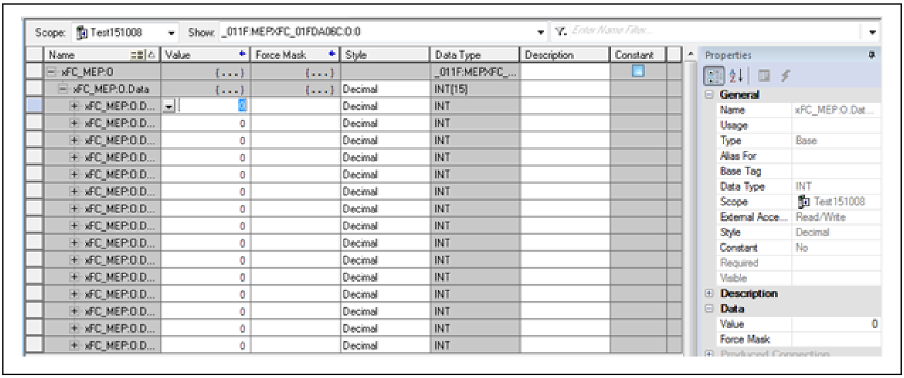


Fig. 12-132: MEP monitor tags 1

- Change the monitor tags xFC_MEP.O.0.data value to 129, the frequency converter will running.

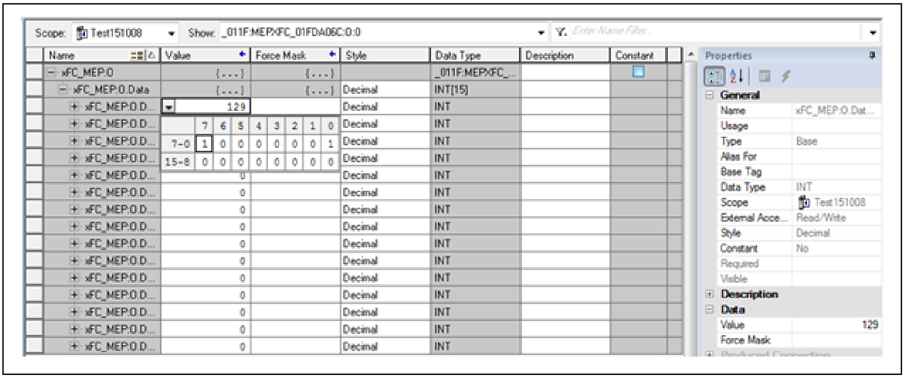


Fig. 12-133: Change the data value of monitor tags 1

- Change the monitor tags xFC_MEP.O.0.data value to 136, the frequency converter will stop.

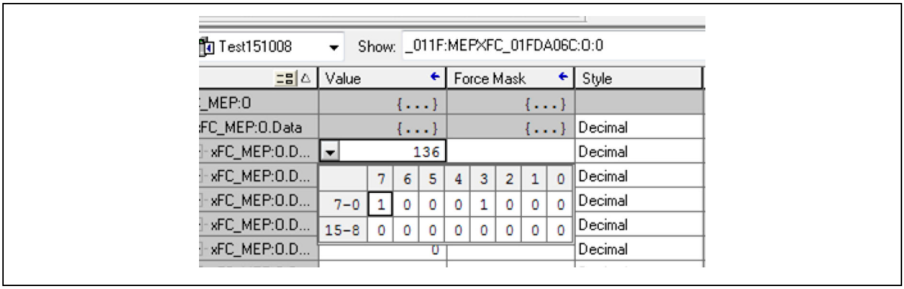


Fig. 12-134: Change the data value of monitor tags 2

Acyclic Communication

Message Parameters

To allow parameter for being set via Ethernet/IP interface, all function code parameters can be accessed, via a manufacturer-specific class object, with corresponding instances for each function code parameter. The function code parameters can be either addressed via an "Unconnected Explicit Message" (UCM) or via a "Connected Explicit Message" (Class 3).

In EtherNet/IP communication, the objects are addressed according to the following scheme: CLASS → INSTANCE → ATTRIBUTE.

Class: All parameters of the EFCx610 frequency converter are mapped to the manufacturer-specific classes 100 (0x64) + Subdevice index, i.e.: Subdevice 0 --> Class 100, Subdevice 1 --> Class 101 ... Subdevice 98 --> Class 198.

Instance: The instance number is identical to the numeric coding of the EFCx610 parameters.

Attribute: The attribute number is identical to the element number during access via function code parameters.

Message configuration below shows an example of parameter E0.26.

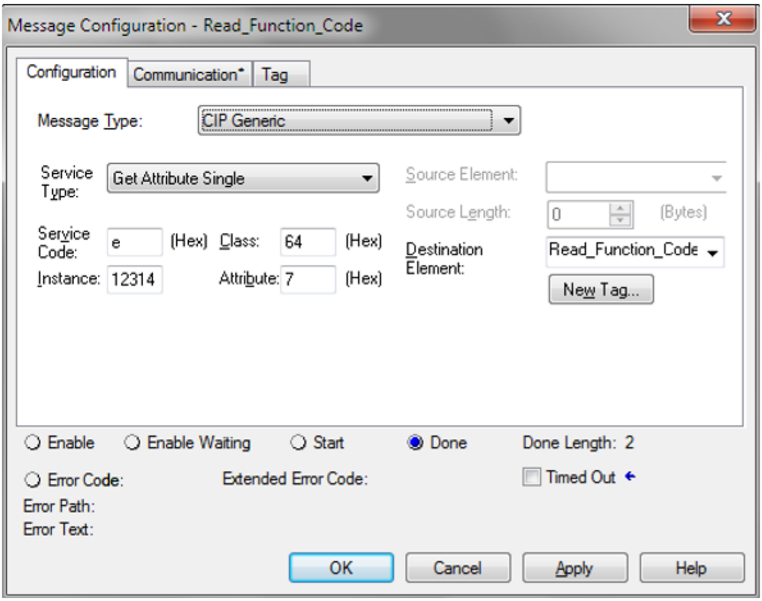


Fig. 12-135: Message configuration

Error Codes

If a manufacturer-specific error occurs during the parameter access, the supplementary error code provides pointers to the cause of the error. Excerpts of the main error codes are listed in the following table:

Error number (hex)	Meaning
0x03	Invalid parameter value • Value is less than minimum value • Value is greater than maximum value • Value is not correct • Invalid indirect addressing • Command execution not possible (invalid or wrong parameters)
0x0E	Parameter cannot be changed
0x0F	Parameter is password protected
0x10	Parameter is write-protected • Parameter currently write-protected • Parameter is write-protected, as configured cyclically in the MDT • Parameter write-protected on account of other settings (parameters, operation mode, ...) • Command execution is not possible now (e.g. command cannot be enabled in this phase)
0x13	Parameter transmitted for too short period
0x15	Parameter transmitted for too long period
0x1F	• Command is already active • Command interruption is not possible

Tab. 12-129: Error codes

☞ When parameter write access on the two bytes type parameter, any values exceeding 65,535 (0xFFFF) will be reduced automatically to a two bytes value. If the reduced two bytes value is in the valid range, then it will be accepted without sending value exceed limits indication.

Example

The following code fragment shows an example of explicit message: modifying frequency converter parameter E0.26.

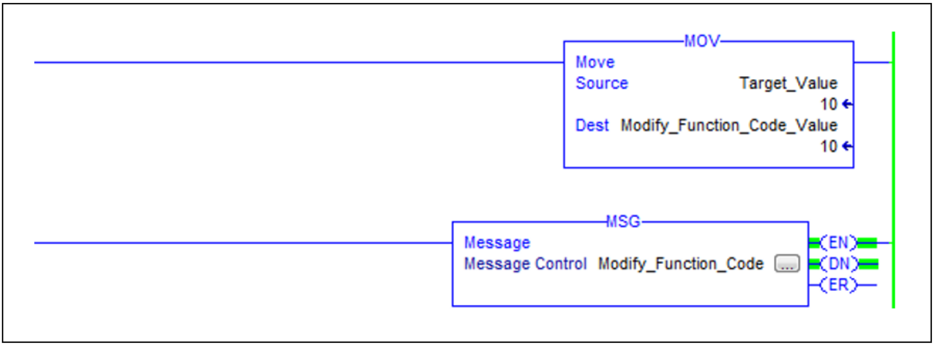


Fig. 12-136: Modify E0.26 to 1.0 s

The configuration of the message box:

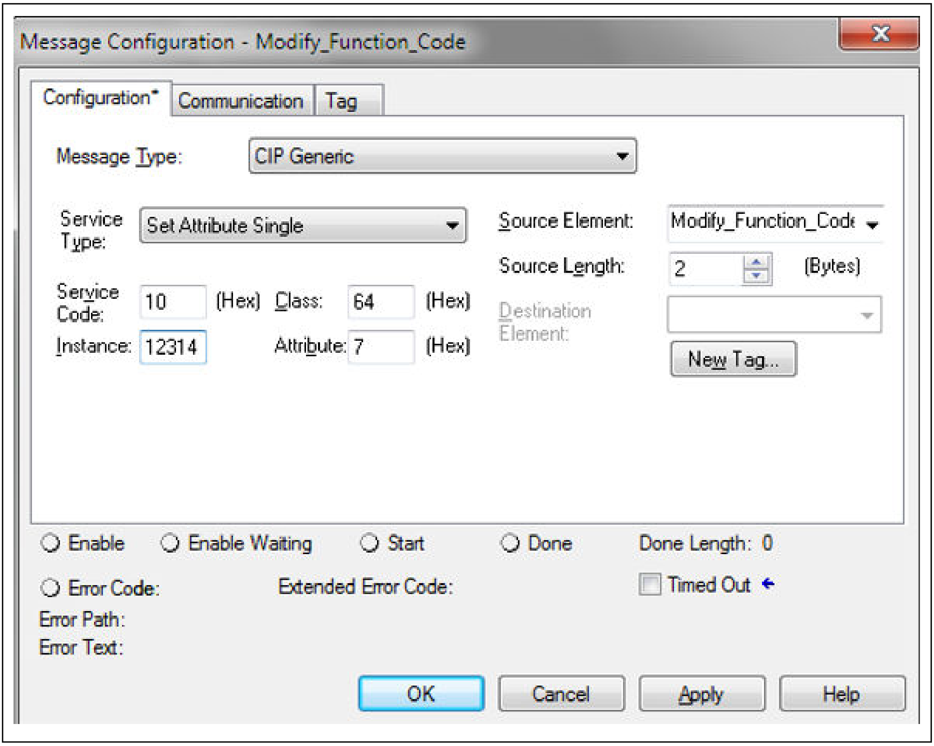


Fig. 12-137: Message box configuration

12.20.6 SERCOS III

Protocol Configuration

After the SERCOS III protocol is activated (H3.41 = S3), the unique device address in the SERCOS III network must be set via parameter H3.23.

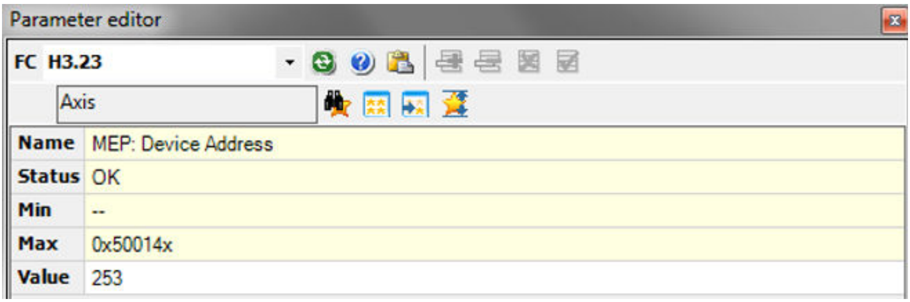


Fig. 12-138: Device address setting

Or the SERCOS address can be assigned within project from automatically calculated topology index. The resulted address reflects in parameter H3.24.

System Configuration

XML file

The SDDML and SPDML xml files are provided to add the EFCx610 to the device database of IndraWorks Ds Engineering.

The SPDML file (SERCOS Profile Description Markup Language) describes the parameters of a device, e.g. name, size of the parameter, attribute. This is needed for the configuration of the cyclic data. The SDDML file (SERCOS Device Description Markup Language) includes a reference to the SPDML file. When you install the SDDML file, the SPDML file is automatically also installed. Please install only the SDDML file.

Users can download the XML file through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose “Frequency converter -> EFC 3610 (or EFC 5610)” from the navigation bar on left-hand side of the operation interface.
3. Choose “Download area” tab from right-hand side of the interface.
4. Click on “DEVICE_DESCRIPTIONS_MULTI-ETHERNET_EFCX610_xxxx-xx-xx.ZIP” to download the ZIP file.
5. Extract the ZIP file and get the XML file.

☞ "xxxx-xx-xx" indicates the date.

After installation, you can find the device in device database as showing below.

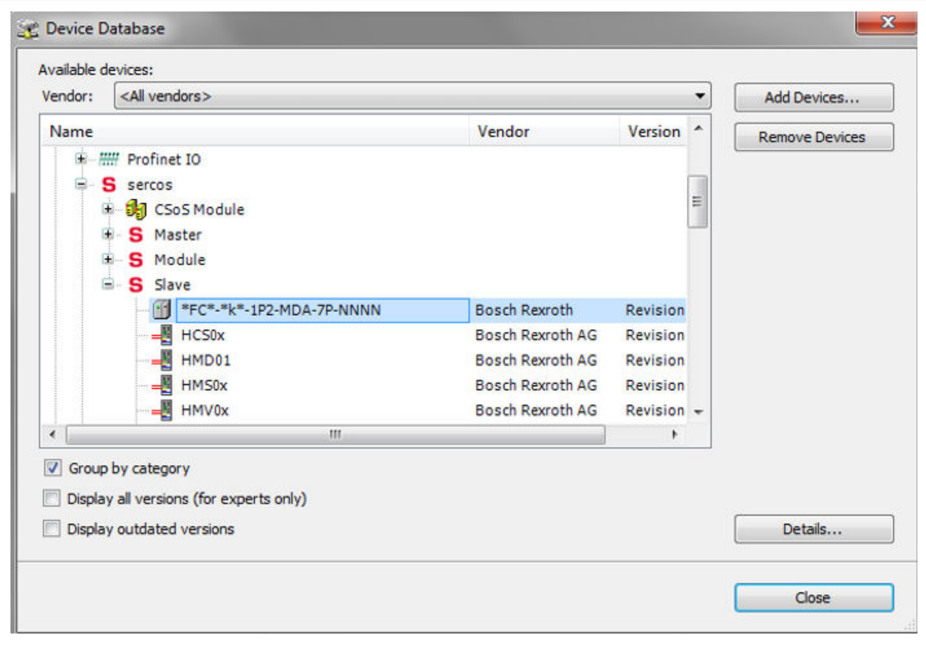


Fig. 12-139: Device database

Topology

Physical network topology shall be either a ring structure or a line structure.

Process Data

The process data configuration is transmitted from master during bus startup.

SERCOS III Control Word and Status Word

Bit No.	Value	Description
15	0	Drive OFF
	1	Drive ON
14	0	Drive disable
	1	Drive enable
13	0	Drive halt
	1	Drive restart
10...8	000	Primary operation mode①

Tab. 12-130: SERCOS III control word (S-0-0134)

Bit No.	Value	Description
15...14	00	Drive not ready
	01	Drive ready for main power on
	10	Drive ready and main power applied
	11	Drive enabled
13	0	No error
	1	Error
10...8	000	Primary operation mode②
4	0	Drive halt is not active
	1	Drive halt is active
3	0	Drive ignores the command values
	1	Drive follows the command values

Tab. 12-131: SERCOS III status word (S-0-0135)

☞ ① and ②: The drive modes of operation defined by S-0-0032 become active when the operation mode is selected via bits 10, 9 and 8 in the Drive control (S-0-0134). The activated operation mode is indicated by bits 10, 9 and 8 of the Drive status (S-0-0135).

For more information about "Primary operation mode", please refer to parameter S-0-0032. Currently, only the operation mode "Velocity control" (0x02) is supported.

Acyclic Communication

The MEP with SERCOS III supports two channels for object exchange: SERCOS service channel and SERCOS/IP.

When accessing frequency converter parameters via service channel, the function blocks IL_SIIISvcRead and IL_SIIISvcWrite shall be used.

☞ When parameter write access on the two bytes type parameter, any values exceeding 65,535 (0xFFFF) will be reduced automatically to a two bytes value. If the reduced two bytes value is in the valid range, then it will be accepted without sending value exceed limits indication.

Example

An example with XLC L65 is shown below.

- Creating project in IndraWorks Ds Engineering Suite 14V10, add XLC65 into the project and configure the interface of SERCOS master.

Compatibility mode must be matched with XLC / MLC firmware version!

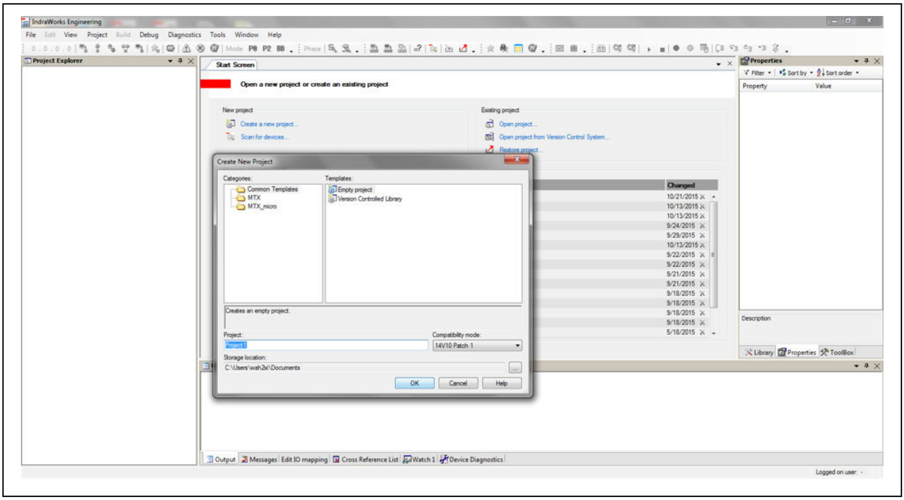


Fig. 12-140: Creating project in IndraWorks Ds_1

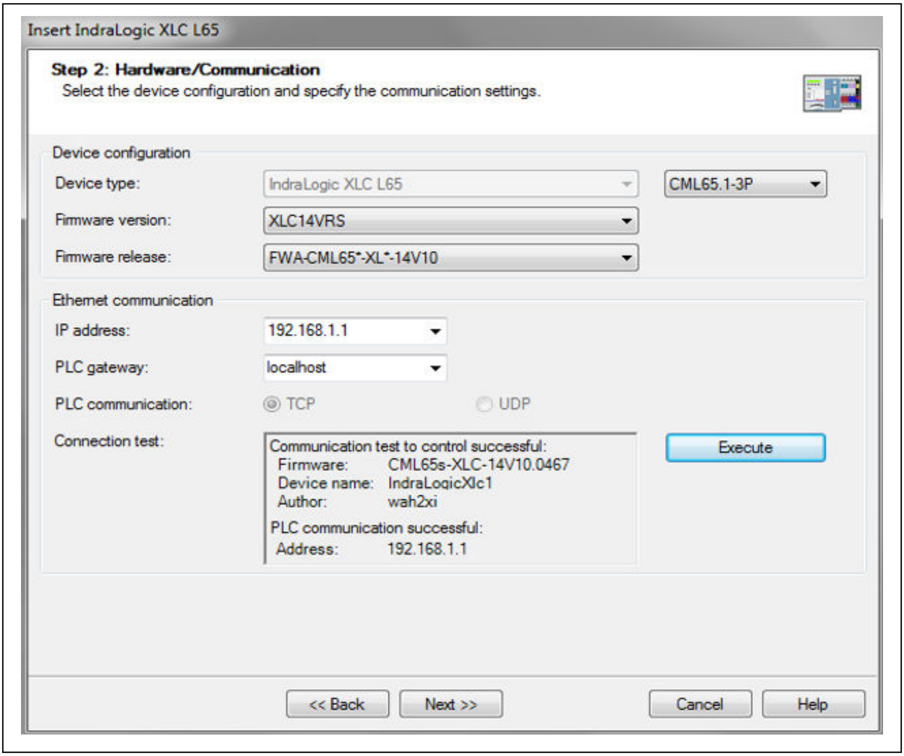


Fig. 12-141: Creating project in IndraWorks Ds_2

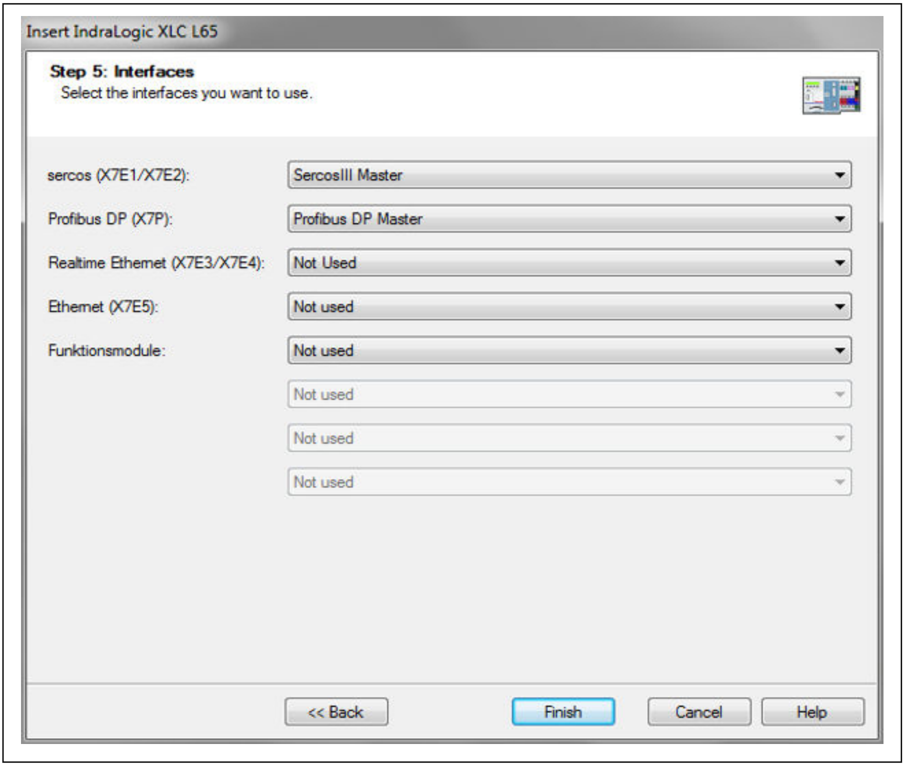


Fig. 12-142: Creating project in IndraWorks Ds_3

- In the “tools” menu, select “Device Database”, click “Add devices” for suitable XML file for EFC x610 converter, then drag the device from “Periphery” -> ”Sercos” into the “Sercos” of project explorer.

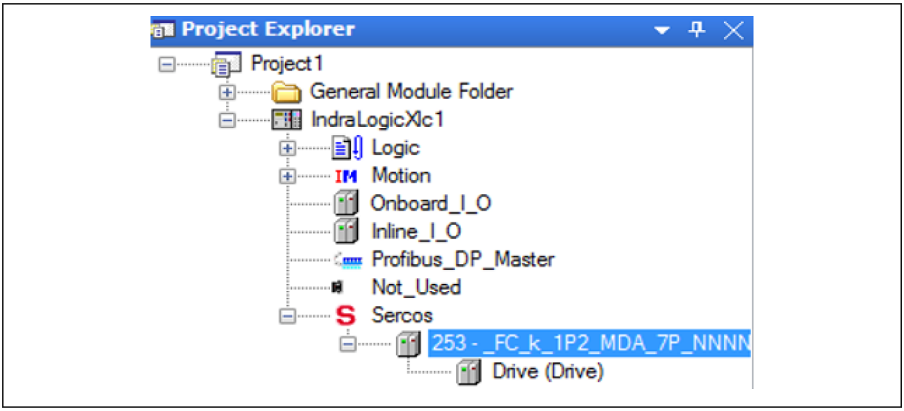


Fig. 12-143: Project Explorer window

- Double click on device name, modify the SERCOS address with values to be identical to that of EFCx610 MEP [H3.23].

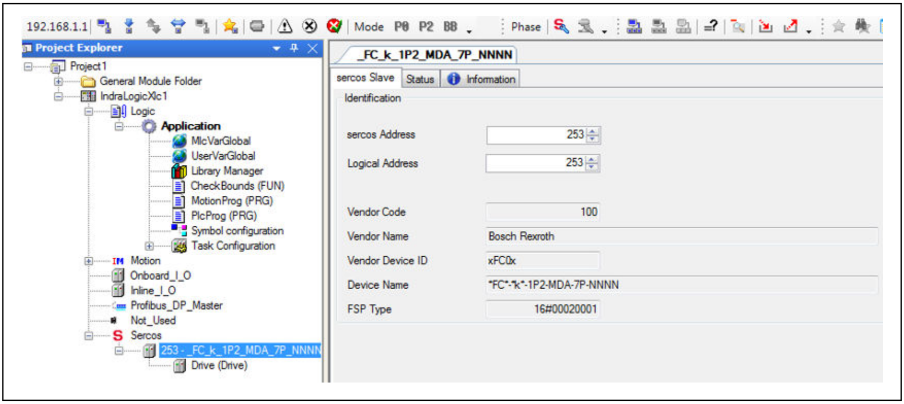


Fig. 12-144: Modify SERCOS address_1

The SERCOS address can also be modified through the following steps:

1. Right click on “Sercos” and select “Scan Bus Configuration”.

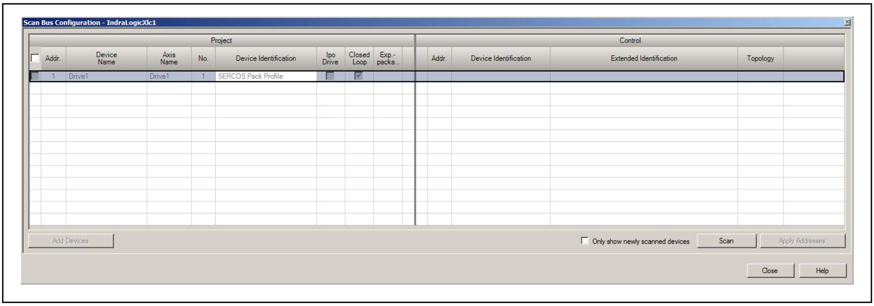


Fig. 12-145: Modify SERCOS address_2

2. Click "Scan" to scan the EFC device, then modify the address in the "Addr." column.

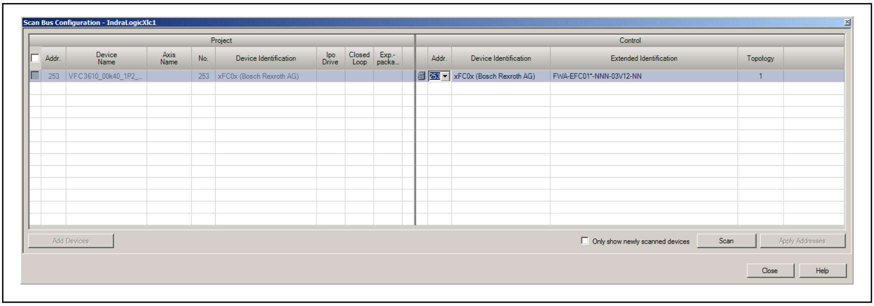


Fig. 12-146: Modify SERCOS address_2

3. Click "Apply Addresses".

☞ You can modify the SERCOS address of multiple devices at the same time.

After the address is modified, right click on “Sercos” and select “Sercos configuration”, make sure the “Status” is OK.

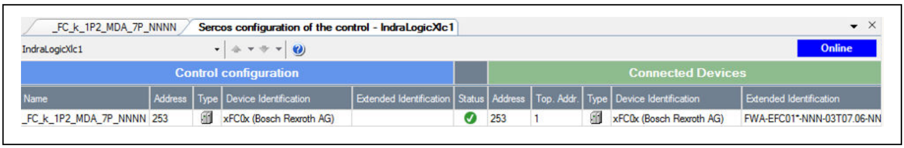


Fig. 12-147: Device status

- Double click on the “Drive”, click further into “General inputs and outputs”. Using “Add”, the parameters of producer can be added at left-hand side and parameters of consumer can be added at right-hand side.

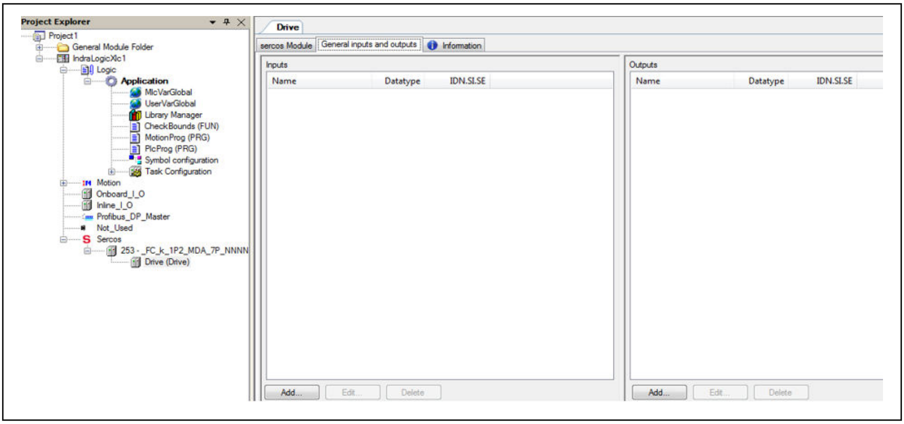


Fig. 12-148: Drive window

It is mandatory that S-0-0135 (Drive status) and P-0-1098.0.1 (Status word "H0.01") must be always added to the input list in sequential order, also S-0-0134 (Drive control) and P-0-1098.0.0 (Control word "H0.00") must be added to the output list sequentially*.

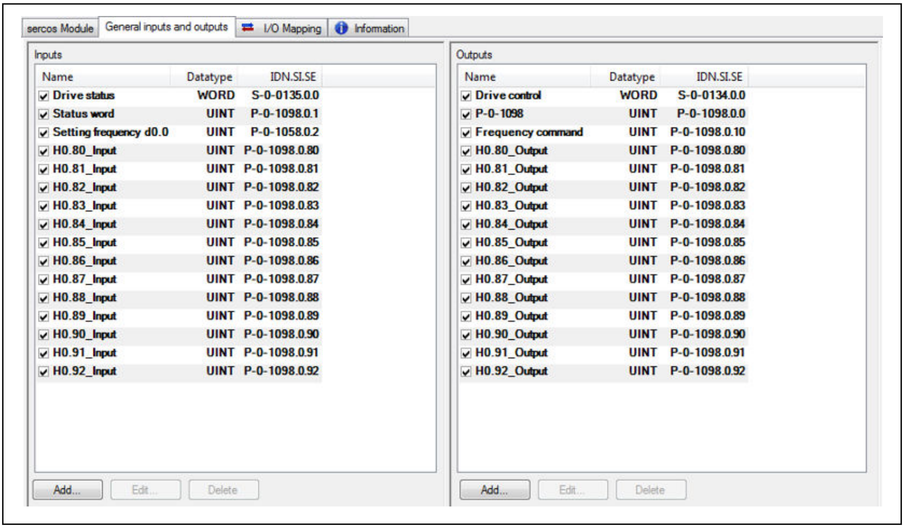


Fig. 12-149: General inputs and outputs

*: This only holds for MEP version 01V02. Starting from version 01V04, also velocity control profile is supported by MEP.

- In order to control the frequency converter and monitor on the status, Drive control, Control word, Drive status and Status word need to be mapped to PLC variable.

sercos Module | General inputs and outputs | I/O Mapping | Information

Channels

Variable	Mapping	Channel	Address	Type	Default Value	Unit	Description
Application.PlcProg.Drive_control		Drive control	~~%QW2~~	WORD			
Application.PlcProg.Control_word_UINT		P-0-1098	~~%QW4~~	UINT			
Application.PlcProg.Frequency_command_UINT		Frequency command	~~%QW6~~	UINT			
Application.PlcProg.Drive_status		Drive status	~~%IW2~~	WORD			
Application.PlcProg.Status_word_UINT		Status word	~~%IW4~~	UINT			
Application.PlcProg.Monitor_setting_freq		Setting frequency d0.02	~~%IW6~~	UINT			

Fig. 12-150: IO Mapping

- Run / Stop the frequency converter

Example:

```
(*Control word xFCx610*)
IF wCwEFC3610.xRun AND NOT wCwEFC3610.xEStop AND NOT wCwEFC3610.xErrorReset
AND NOT wSwEFC3610.byStatus.xFault_Bit7  THEN
wCwEFC3610.xRun    := TRUE;
        Drive_control:= 16#E000; // Drive ON, Drive enable and Drive restart
ELSE
        Drive_control:= 16#A000; //Drive ON, Drive disable and Drive restart
        wCwEFC3610.xRun    := FALSE;
END_IF

IF  wCwEFC3610.xJog  AND NOT wCwEFC3610.xRun AND NOT wCwEFC3610.xEStop AND
NOT wCwEFC3610.xErrorReset AND NOT wSwEFC3610.byStatus.xFault_Bit7 THEN
        wCwEFC3610.xJog    := TRUE;
        Drive_control:= 16#E000;
ELSE
        wCwEFC3610.xJog    := FALSE;
END_IF

wCwEFC3610.xControlActive       := TRUE;
        wControl.0 := wCwEFC3610.xRun;
        wControl.1 := wCwEFC3610.xJog;
        wControl.2 := wCwEFC3610.xReverse;
        wControl.3 := wCwEFC3610.xStop;
        wControl.4 := wCwEFC3610.xEStop;
        wControl.5 := wCwEFC3610.xErrorReset;
        wControl.6 := wCwEFC3610.xAccStop;
        wControl.7 := wCwEFC3610.xControlActive;
Frequency_command_UINT:=WORD_TO_UINT(wCwEFC3610.wSetValue);
        Control_word_UINT:= WORD_TO_UINT(wControl);
```

Fig. 12-151: Example code_1

- Read/Write acyclic data

```
Write 60(udiPar_Value_Dummy) to [E0.26]:
IF NOT Normal_Par_group_test_Write_finished THEN
        fbSIIISvcWrite.Execute:=TRUE;
        fbSIIISvcWrite.SercosAdr:=253;
        fbSIIISvcWrite.Element:=IL_OPDATA;
        fbSIIISvcWrite.Idn:=IL_SIIIElementsToIdn(IL_P_PARAM, 0, 1074, 0, 26);
        fbSIIISvcWrite.SizeofValue:=SIZEOF(udiPar_Value_Dummy);
        fbSIIISvcWrite.ValueAdr:=ADR(udiPar_Value_Dummy);
        fbSIIISvcWrite();
        IF fbSIIISvcWrite.Done THEN
                Normal_Par_group_test_Write_finished:= TRUE;
        END_IF
END_IF

Read [E0.26] to udiPar_Value_E7:
IF NOT Normal_Par_group_test_Read_finished THEN
        fbSIIISvcRead.Execute:=TRUE;
        fbSIIISvcRead.SercosAdr:=253;
        fbSIIISvcRead.Element:=IL_OPDATA;
        fbSIIISvcRead.Idn:=IL_SIIIElementsToIdn(IL_P_PARAM, 0, 1074, 0, 26);
        fbSIIISvcRead.SizeofValue:=SIZEOF(udiPar_Value_E7);
        fbSIIISvcRead.ValueAdr:=ADR(udiPar_Value_E7);
        fbSIIISvcRead();
        IF fbSIIISvcRead.Done THEN
                Normal_Par_group_test_Read_finished:= TRUE;|
        END_IF
END_IF
```

Fig. 12-152: Example code_2

12.20.7 EtherCAT

Protocol Configuration

For EtherCAT, the IP address configuration is done on master's side. From EtherCAT state PreOp, Ethernet over EtherCAT (EoE) is started and IndraWorks Ds can be used.

System Configuration

Configuration File

An EtherCAT master requires both, an EtherCAT Slave Information (ESI) and an Electronic Data Sheet (EDS) file in order to fully support an EtherCAT slave running CoE (CAN over EtherCAT). The former provides a slave device description for EtherCAT PLCs and some information for configuring the EtherCAT communication. The latter describes accessible CAN objects of the device.

Users can download the target files through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose "Frequency converter -> EFC 3610 (or EFC 5610)" from the navigation bar on left-hand side of the operation interface.
3. Choose "Download area" tab from right-hand side of the interface.
4. Click on "DEVICE_DESCRIPTIONS_MULTI-ETHERNET_EFCX610_xxxx-xx-xx.ZIP" to download the ZIP file.
5. Extract the ZIP file and get the target files.

"xxxx-xx-xx" indicates the date.

After putting the files into dedicated path, you can find the device showing below.

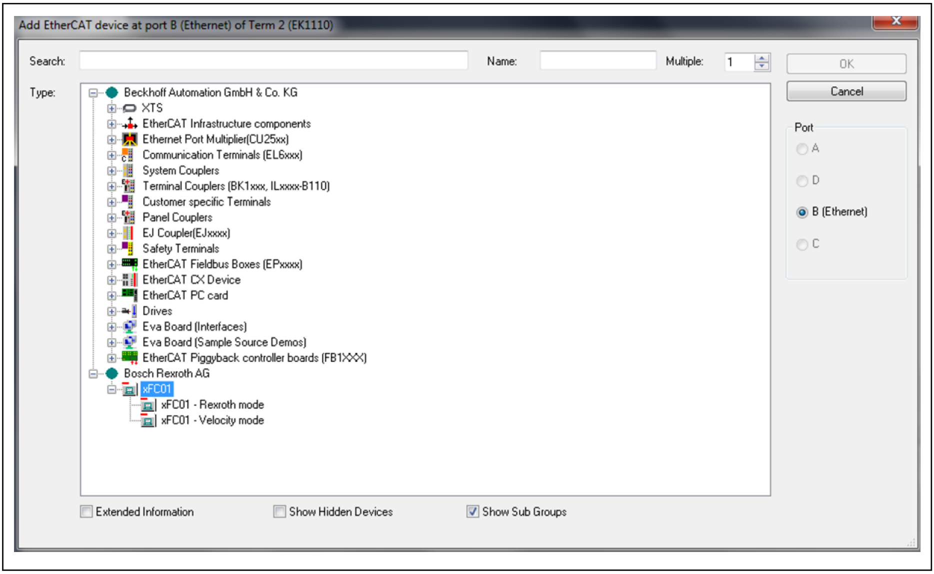


Fig. 12-153: Add EtherCAT device

Mode Selection

Beside the Rexroth profile mode described in chapter 4.4, the CiA 402 velocity profile mode is also supported by MEP card when the EtherCAT protocol is active. These two modes are selected by CAN object index [0x6060].

Mode	Value	Default Process Data Configuration
Rexroth mode	-128	Consumer {[H0.00], [H0.10]} Producer {[H0.01], [d0.02]}
CiA 402 velocity mode	2	Consumer {[0x6040], [0x6042]} Producer {[0x6041], [0x6044]}

Tab. 12-132: Mode selection

☞ A mode selection has to be carried out before cyclic data exchange can start. Failing to do so will make MEP deliver “invalid settings” when switching from PreOp to SafeOp. The user parameters can be configured freely. After changing a process data configuration, the first switch to SafeOp yields “unknown” error. A second attempt should succeed and no errors are thrown in case the process data configuration did not change.

Topology

The line topology is supported.

☞ When setting up an EtherCAT network with MEP cards, it should be ensured that

- Ethernet port 1 is used as Input ("IN")
- Ethernet port 2 is used as Output ("OUT")

Process Data

The process data can be configured by writing CAN object indexes to the following lists:

- Producer data list [0x1A15]
- Consumer data list [0x1615]

☞ Only the asynchronous transmission type “Free Run Mode” is supported.

Acyclic Communication

With supporting of CAN over Ethernet (CoE), all function code parameters of the EFC series frequency converter can be read, and if permitted can be written, directly by SDO.

Table below shows the CAN indexes corresponding to the function code parameters.

Function Code Range	CAN Index Range
b0.00...b9.99	0x2000...0x23E7
d0.00...d9.99	0x23E8...0x27CF
C0.00...C9.99	0x27D0...0x2BB7
E0.00...E9.99	0x27B8...0x2F9F
U0.00...U9.99	0x2FA0...0x3387

Function Code Range	CAN Index Range
F0.00 ...F9.99	0x3388...0x376F
H0.00...H9.99	0x3770...0x3B57

Tab. 12-133: CAN indexes corresponding to the function code parameters

When parameter write access on the two bytes type parameter, any values exceed 65,535 (0xFFFF) will be reduced automatically to a two bytes value. If the reduced two bytes value is in the valid range, then it will be accepted and without value exceed limits indication.

12.20.8 Modbus/TCP

Protocol Configuration

For Modbus/TCP, three IP addresses need to be set via parameters:

- IP address H3.03
- Subnet mask H3.04
- Gateway address H3.05

A Modbus/TCP client can connect to default TCP port 502. Additionally, a user can specify another port by writing a port number to parameter H3.51. However, only one client connection is accepted by the MEP card.

System Configuration

The process data configuration is setting via the parameters H3.30 and H3.31, respectively for the input and output.

The following Modbus/TCP transactions are supported by the MEP card:

Modbus Function Code	Transaction Name	Max. Value of N
3	Read N register words	16
6	Write one register word	-
16	Write N register words	16
23	Read / write N register words	16 / 16
43 (sub-function code 14)	Read Device Identification	-

Tab. 12-134: Modbus / TCP transactions

Besides accessing parameters by their function code virtual address, there are some special register addresses, that can be used, e.g. for reading/writing the complete process data image. The following table gives an overview:

Register Address	Contents
0x7F00	Control word H0.00
0x7F01	Frequency command value H0.10
0x7FA0	Status word H0.01
0x7FE0	Input Process Data Image as specified by H3.30
0x7FF0	Output Process Data Image as specified by H3.31

Tab. 12-135: Overview of special register addresses

☞

1. When a Modbus/TCP client established a new connection to the MEP card, output process data status initially is set invalid at the MEP. The output data status changes to valid, as soon as all parameters at output process data list are written at least once. The output data status then remains valid, until the TCP connection is closed or terminated.
2. Special Register Addresses mentioned above, only can be used without any offset. Example: It is not allowed to use address 0x7FF2 for accessing second output process data item.

Exception Codes

With Modbus/TCP, in error cases, the MEP card returns Exception Codes at the Modbus response telegram. The Exception Codes are listed in the following table:

Exception Code	Name	Meaning/Possible Causes
1	Illegal function	Unknown Function Code, transaction contained a Modbus Function Code not supported by the MEP card.
2	Illegal data address	• Access to unknown address • Error occurred while Function Code 43 transaction
3	Illegal data value	• Invalid read/write length value at Modbus transaction • Malformed request telegram • Invalid object ID at Function Code 43 transaction
4	Server device failure	Read / Write access failed

Tab. 12-136: Exception codes

12.20.9 Diagnosis

Warning Code

Panel display	Description	Cause	Countermeasures
Fdi	Fieldbus process data invalid	• Cyclic communication had been established, but was stopped because of an error. • Cyclic communication is running, but fieldbus master has set data status invalid.	• Check fieldbus master status, if the controller is in stop mode Fdi warning will appear also. • Check Ethernet cable and switches. • At the PLC, set application status and/or process data status valid.

Tab. 12-137: Warning code

Error Code

Panel display	Description	Cause	Countermeasures
Fin-	Initialization failed	• Parametrization of MEP has errors. MEP could not start up completely. • H3.03 IP Address and H3.05 Gateway Address are not matching.	• Check H3.62 List of Invalid Parameters and rewrite invalid parameters with valid values. • Write a consistent set of H3.03 IP Address, H3.04 Subnet Mask and H3.05 Gateway Address. If no gateway is needed, set H3.05 to 0.0.0.0.
FnC-	Network set-up error	• Parametrized IP address already present in network. • No DHCP response from DHCP server. • Fieldbus parametrization at MEP erroneous.	• Change H3.03 IP Address to a valid IP address in the subnet. • Check if the DHCP server is up and running. • Check the installed GSD file if it is right.
FPC-	Process data configuration mismatch	Parametrized process data configuration between MEP and fieldbus master are differing in length. Check H3.28/H3.29 and H3.32/H3.33 to have a comparison.	Correct process data configuration either at MEP (H3.30/H3.31) or at master. Before correcting the process data configuration at MEP side, the active connection between master and MEP should be disabled. And after correction, set up the connection to reset this fault.
Fdi-	Fieldbus process data invalid	Telegram losses or error occurs when frequency converter is in running mode.	• Check the master status and cable connection. • Check the switch status if any. • Check shielding and laying of cables if EMC problems. • Reduce Ethernet traffic, built up separate network for fieldbus communication if bus load is too high.
OCd-	MEP extension card error	• Two fieldbus extension cards are installed simultaneously. • Internal communication was disturbed.	• Keep only one fieldbus extension card in the slots. • Check the installation of MEP card and try to reset the error.
FCd-	Internal communication watchdog error	Internal communication is timed out.	Reset the error, if the problem persists, H3.38 Input Data Timeout could be increased.

Panel display	Description	Cause	Countermeasures
FnF-	Subsystem corrupted	Firmware file corrupted	Update the MEP firmware. If the problem persists, exchange the MEP hardware.
FCE-	Internal error	Fatal error or exception	Reboot the frequency converter. If the problem persists, exchange the MEP hardware.

Tab. 12-138: Error code

12.21 H7: Encoder Card Parameters

12.21.1 ABZ Encoder Card Parameters

Parameter

Code	Name	Setting range	Min.	Default	Attri.
H7.01	Encoder direction	0: Forward 1: Reverse	1	0	◆

Parameter H7.01 is used to change the phase sequence, if the encoder phases are reversely connected.

The value of parameter H7.01 will automatically updated after rotation auto tuning if the parameter value of H7.20 is correctly setting before rotation auto tuning.

Code	Name	Setting range	Min.	Default	Attri.
H7.05	Encoder wiring break detection level	0.0 (No protection) 0.1...1,000.0 rpm	0.1 rpm	0.0 rpm	◆
H7.06	Encoder wiring break detection time	0.1...10.0 s	0.1 s	1.0 s	◆

If measured speed is smaller than encoder wiring break detection level [H7.05] and the duration is more than encoder wiring break detection time [H7.06], wiring break error "EIbE" is detected.

This function can be disabled by setting [H7.05] = 0.0.

Code	Name	Setting range	Min.	Default	Attri.
H7.07	Encoder phase order error detection time	0.0 (No protection) 0.1...100.0 s	0.1 s	1.0 s	◆

If measured speed direction is different from running direction and the duration is more than encoder phase order error detection time [H7.07], phase order error "EPOE" is detected.

This function can be disabled by setting [H7.07] = 0.0.

Code	Name	Setting range	Min.	Default	Attri.
H7.20	Pulses per revolution of encoder	1...20,000	1	1,024	◆

Parameter H7.20 is used to set the number of pulses per revolution of the ABZ encoder.

Please correctly set this parameter under vector control with encoder before running.

Diagnosis

Error code	Display	Description	Possible reason	Solution
70	ElbE	Encoder input broken wire error	1. Encoder connection problem 2. Encoder error	1. Check encoder connection cable 2. Replace encoder
71	EPOE	Encoder phase order error	1. Wrong wiring between encoder and encoder card 2. Improper parameter setting of encoder	1. Check wiring 2. Set parameters related to encoder properly

Tab. 12-139:

12.21.2 Resolver Card Parameters

Parameter

Code	Name	Setting range	Min.	Default	Attri.
H7.01	Encoder direction	0: Forward 1: Reverse	1	0	◆

Parameter H7.01 is used to change the phase sequence, if the encoder phases are reversely connected.

Code	Name	Setting range	Min.	Default	Attri.
H7.05	Encoder wiring break detection level	0.0 (No protection) 0.1...1,000.0 rpm	0.1 rpm	0.0 rpm	◆
H7.06	Encoder wiring break detection time	0.1...10.0 s	0.1 s	1.0 s	◆

If measured speed is smaller than encoder wiring break detection level [H7.05] and keeps for more than encoder wiring break detection time [H7.06], wiring break error "ElbE" is detected.

This function can be disabled by setting [H7.05] = 0.0.

Code	Name	Setting range	Min.	Default	Attri.
H7.07	Encoder phase order error detection time	0.0 (No protection) 0.1...100.0 s	0.1 s	1.0 s	◆

If measured speed direction is different from running direction and keeps for more than encoder phase order error detection time [H7.07], phase order error "EPOE" is detected.

This function can be disabled by setting [H7.07] = 0.0.

Code	Name	Setting range	Min.	Default	Attri.
H7.31	Resolver poles	2...32	1	2	◆

Parameter H7.31 is used to set the poles of resolver.

Please correctly set this parameter before power on.

For synchronous motor, resolver card supports resolver with two poles or with the same poles as motor. For asynchronous motor, resolver card supports resolver with any poles.

Diagnosis

LED Flash State

LED	LED state	Meaning
H11 / H21	Always on	Resolver card power on
H13 / H23 and H14 / H24	Always on	Broken wire error
H13 / H23	On	Resolver input signal amplitude is wrong
H14 / H24	On	Resolver input signal phase is wrong

Tab. 12-140:

Error Code

Error code	Display	Description	Possible reason	Solution
70	ElbE	Resolver input broken wire error	1. Resolver connection problem 2. Resolver error	1. Check resolver connection cable 2. Replace resolver
71	EPOE	Resolver phase order error	1. Wrong wiring between resolver and resolver card 2. Improper parameter setting of resolver	1. Check wiring 2. Set parameters related to resolver properly

Error code	Display	Description	Possible reason	Solution
72	RDOS	Signal amplitude error	1. Wrong wiring 2. Resolver type not matching / resolver error 3. Interference	1. Check DB9 pin mapping / connection 2. Check resolver
73	RLOT	Signal phase error	1. Wrong wiring 2. Resolver type not matching / resolver error 3. Interference	1. Check DB9 pin mapping / connection 2. Check resolver

Tab. 12-141:

12.22 H8: IO&IO Plus Card Parameters

12.22.1 IO & IO Plus Card Analog Input Configuration

This function is implemented to configure the external analog input EAI1 and EAI2, which is provided in IO and IO plus extension card.

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.05	EAI1 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V 5: -10...10 V	0	–	–	Stop
H8.06	EAI1 input polarity setting	0: Polarity inactive 1: Polarity active without direction control 2: Polarity active with direction con-trol	1	–	–	Stop
H8.07	EAI1 dead zone filter value	0.0...30.0 %	0.0	%	0.1	Run
H8.09	EAI1 filter time	0.000...2.000	0.100	s	0.001	Run
H8.10	EAI1 gain	0.00...10.00	1.00	-	0.01	Run
H8.15	EAI1 curve minimum	-120.0 %...[H8.17]	0.0	%	0.1	Run
H8.16	EAI1 curve minimum value	-[E0.09]...[E0.09] Hz	0.00	Hz	0.01	Run
H8.17	EAI1 curve maximum	[H8.15]...120.0 %	100.0	%	0.1	Run
H8.18	EAI1 curve maximum value	-[E0.09]...[E0.09] Hz	50.00	Hz	0.01	Run
H8.30	EAI2 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V 5: -10...10 V	0	–	–	Stop

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.31	EAI2 input polarity setting	0: Polarity inactive 1: Polarity active without direction control 2: Polarity active with direction control	1	–	–	Stop
H8.32	EAI2 filter time	0.000...2.000	0.100	s	0.001	Run
H8.33	EAI2 gain	0.00...10.00	1.00	-	0.01	Run
H8.34	EAI2 curve minimum	-120.0 %...[H8.36]	0.0	%	0.1	Run
H8.35	EAI2 curve minimum value	-[E0.09]...[E0.09]	0.00	Hz	0.01	Run
H8.36	EAI2 curve maximum	[H8.34]...120.0 %	100.0	%	0.1	Run
H8.37	EAI2 curve maximum value	-[E0.09]...[E0.09]	50.00	Hz	0.01	Run
H8.38	EAI2 dead zone filter value	0.0...30.0 %	0.0	%	0.1	Run

Except for an additional option of '-10...10 V', EAI1 / EAI2 is the same as AI1 and AI2.

In order to use '-10...10 V', set [H8.05] (or [H8.30])= '-10...10 V' firstly.

Unlike other analog inputs, EAI1 / EAI2 will not have multiple curve selection. There are dedicated curves defined for EAI1 and EAI2. Parameters H8.15...H8.18 defines EAI1 curve, parameters H8.34...H8.37 defines EAI2 curve. Both the curve functionalities are similar, hence all the below descriptions mentioned are applicable to both curves.

H8.06 'EAI1 input polarity setting' (or H8.31 'EAI2 input polarity setting') defines how the input polarity information can be used for operation.

- **[H8.06] / [H8.31] = 0: Polarity inactive**

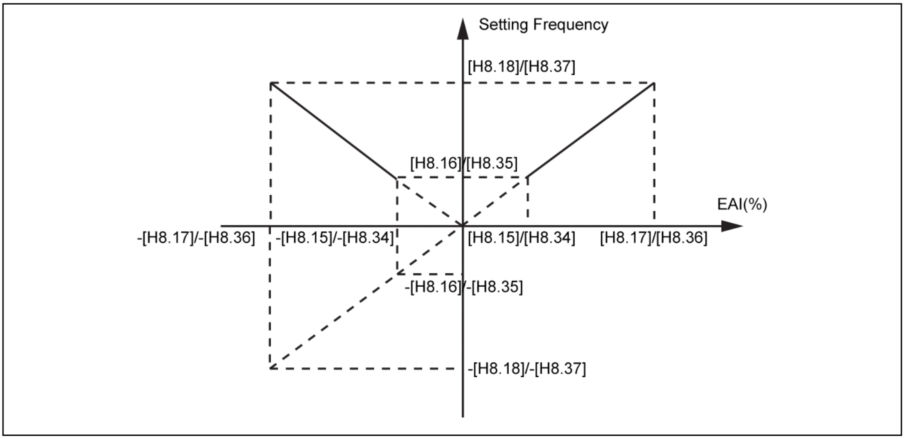


Fig. 12-154: Polarity inactive

- Setting frequency will be always positive irrespective of H8.16 / H8.18 parameter setting.
- Direction control is not active in this mode, which means even if negative frequency command is generated it will result in FWD direction only.
- When frequency source combination is used, the setting frequency from EAI will be only positive, and can be used in the addition and subtraction operation.

- **[H8.06] / [H8.31] = 1: Polarity active without direction control**

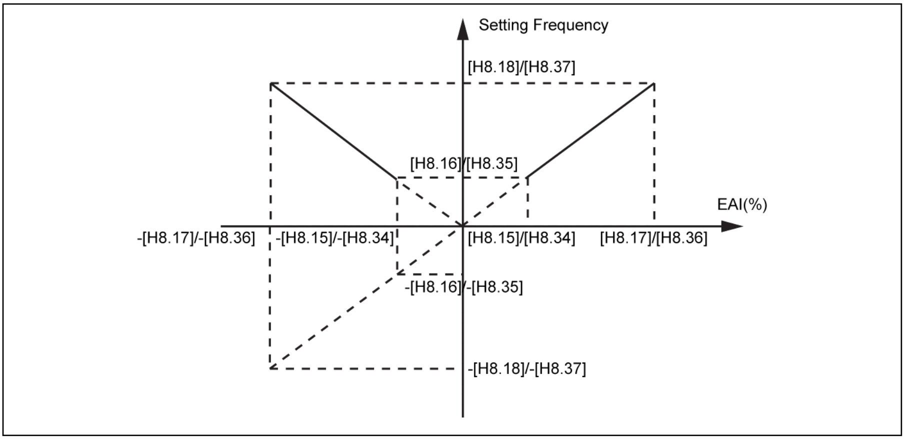


Fig. 12-155: Polarity active without direction control

- When frequency source combination is NOT used, the setting frequency will still be positive value even with negative EAI1 / EAI2 input, like the absolute value, and rotation direction will not be influenced by negative EAI1 / EAI2 input.

– When frequency source combination is used, the setting frequency from EAI1 / EAI2 can be positive / negative, and be used in the addition and subtraction operation.

- **[H8.06] / [H8.31] = 2: Polarity active with direction control**

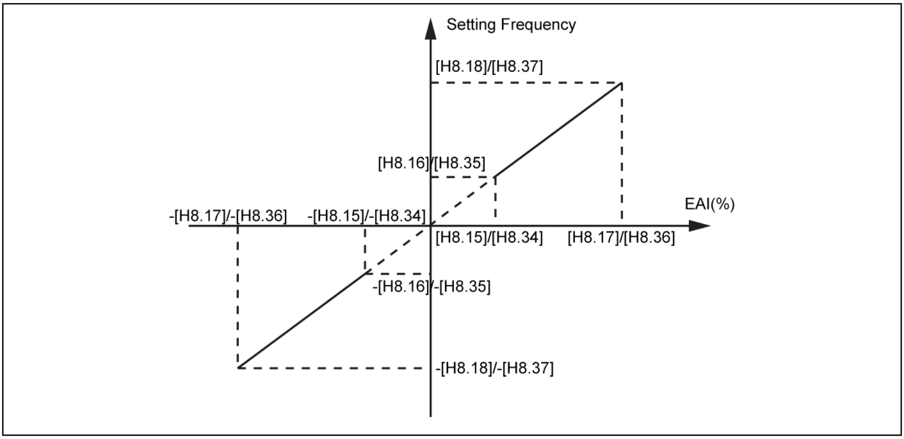


Fig. 12-156: Polarity active with direction control

– Direction control is active in this mode, which means negative frequency command will result in REV direction and positive frequency command will result in FWD direction.

– Frequency source combination operation cannot be enabled. As direction control from EAI is active.

– EAI1 / EAI2 as direction control has a higher priority than actual panel and terminal setting. For example, the terminal control is giving a FWD signal, but during the running process, the EAI1 / EAI2 's input is becoming negative, then the final direction would be changed to negative. If the command is from panel, then U1.00 will be inactive if polarity is used to control the direction. And the priorities of all other existing direction command sources (Ex: Simple PLC, Multi-Speed Control) if it is higher than panel and terminal setting then it remains higher than priority of EAI1 / EAI2 direction command also.

Example for EAI1, when H8.05 = 5:

1. H8.06 = 0, H8.15 = -100.0, H8.16 = 0.0, H8.17 = 100.0, H8.18 = 50.0

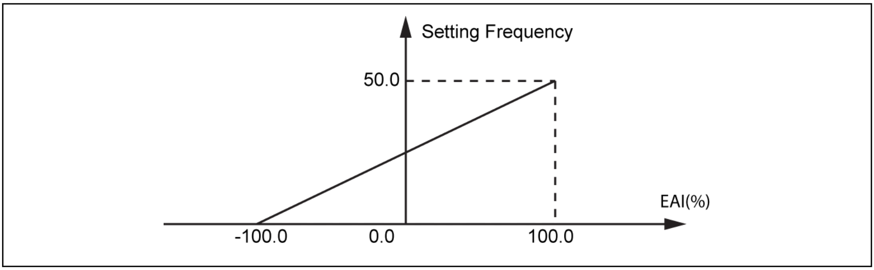


Fig. 12-157: EAI1 example 1

2. H8.06 = 1, H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

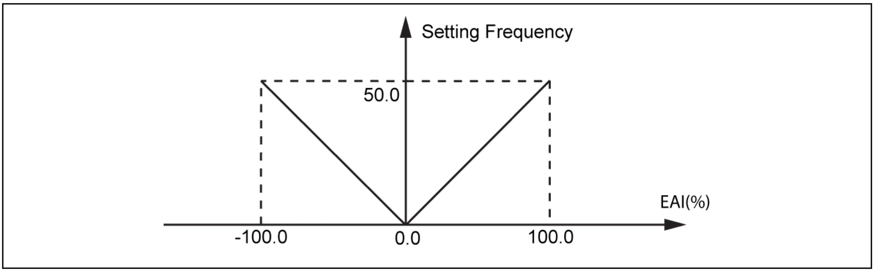


Fig. 12-158: EAI1 example 2

3. H8.06 = 2, H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

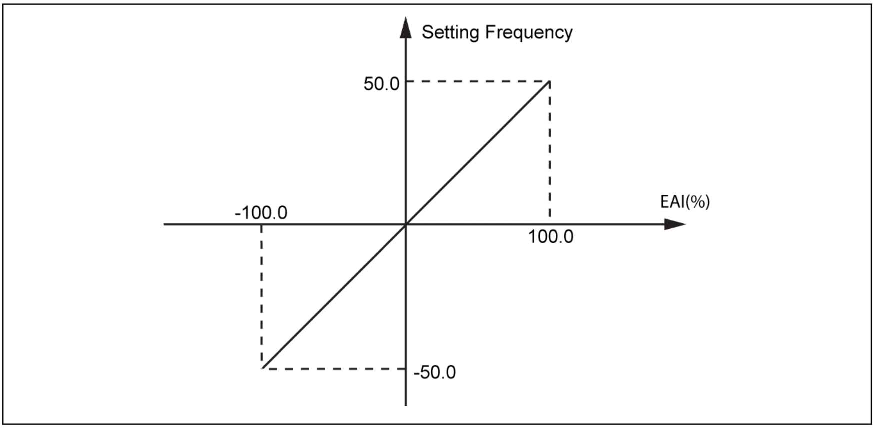


Fig. 12-159: EAI1 example 3

Frequency setting source combination with polarity of EAI1 / EAI2

- When H8.06 / H8.31 'EAI input polarity setting' is set to '0' or '1', and frequency source combination is selected, then the negative value of EAI1 / EAI2 will be treated normally.

  E.g: 5 V from AI1 and -2 V from EAI1, then the combination result will be 7 V with subtraction operation, and 3V with addition operation.

- When frequency source combination function is selected (either addition or subtraction), the H8.06 / H8.31 'EAI input polarity setting' will be limited to '1' or '0', and the combination result will always be limited to 0.00...[E0.09] Hz. When frequency combination is selected (addition / subtraction), then if polarity with direction control is already enabled (H8.06 / H8.31 = 2) 'PrSE' will be displayed.

When [H8.05] = '5: -10...10 V' and [H8.06] / [H8.31] = '2: Polarity active with direction control', the priority of direction command from EAI1 / EAI2 is

- higher than the direction command from communication or digital inputs
- lower than the direction command from simple PLC or Multi-Speed

---

Dead zone filter for external analog input -10 ...+10 V

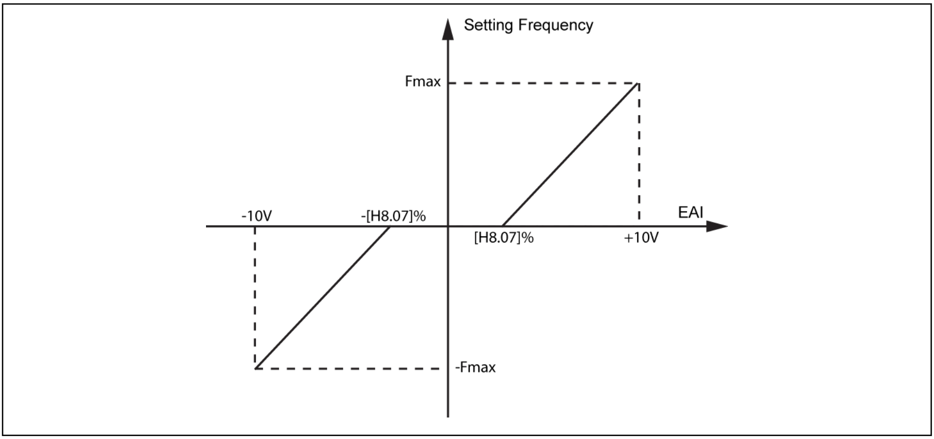


Fig. 12-160: Dead zone filter for external analog input

If [H8.05] / [H8.30] = 5, parameter H8.07 / H8.38 can be used to define the forward and reverse rotation dead zone of the motor, i.e. the range for treating input signals as zero, as shown in the above figure. For example, if [H8.07] / [H8.38] = 10.0 % when [H8.05] / [H8.30] = 5, analog input signals within the range of -1...1 V will be treated as zero, 1...10 V corresponds to 0 Hz to maximum frequency, -1...-10 V corresponds to 0 Hz to minus maximum frequency. The dead zone range is -1...+1 V in this case.

Dead zone filter will be active only for -10...+10 V mode when polarity control for that channel is enabled. i.e., when H8.05 / H8.30 = 5 and H8.06 / H8.31 = 1 or 2. And when dead zone filter is active, curve mode configurations will be inactive.

IO & IO plus card analog input status are monitored by parameter d0.33 'I/O card EAI1 input' or d0.34 'I/O card EAI2 input'.

12.22.2 IO & IO Plus Card Analog output Configuration

The EAO analog output terminal may output voltage or current signals based on some system variables with adjustable gain setting.

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.25	EAO output mode	0: 0...10 V 1: 0...20 mA 2: -10...10 V (only for IO plus card)	0	–	–	Run
H8.26	EAO output selection	0: Output frequency 1: Set frequency 2: Output current 4: Output voltage 5: Output power 6: AI1 analog input 7: AI2 analog input 8: EAI1 analog input 9: EAI2 analog input 11: Motor temperature sensor power 12: Parameter setting from communication 13: Setting torque 14: Output torque	0	–	–	Run
H8.27	EAO gain	0.00...10.00	1.00	–	0.01	Run
H8.28	EAO value in percentage from extension card fieldbus communication	0.00...100.00%	0.00	%	0.01	Stop
H8.39	EAO curve minimum	-100.0 %...[H8.41]	0.0	%	0.1	Run
H8.40	EAO curve minimum value	-100.0...100.0 %	0.00	%	0.01	Run
H8.41	EAO curve maximum	[H8.39]...100.0 %	100.0	%	0.1	Run
H8.42	EAO curve maximum value	-100.0...100.0 %	100.0	%	0.1	Run

Analog Output Configuration step:

- **Step 1: Set EAO output mode**

  H8.25 is for AO1 output mode selection, when IO plus card is connected, then H8.25 can be set to ‘2: -10 V...+10 V’ mode. Depending upon the configuration of H8.26, EAO will be in '-10 V...+10 V' range.

  For example: If H8.26 = 0 (output frequency), then

  0...50 Hz (FWD): 0...+10 V

0...50 Hz (REV): 0...-10 V

- **Step 2: Select EAO output signal**

Setting range of H8.26:

H8.26 = 0: Output frequency	Represents the actual output frequency between 0.00...[E0.08] Hz.
H8.26 = 1: Setting frequency	Represents the setting frequency between 0.00...[E0.08] Hz.
H8.26 = 2: Output current	Represents the 0...2 x [rated current].
H8.26 = 4: Output voltage	Represents 0...1.2 x [rated voltage], which is defined by parameter E2.40.
H8.26 = 5: Output power	Represents 0...1.2 x [rated power].
H8.26 = 6: AI1 Analog input	Represents AI1 input value.
H8.26 = 7: AI2 Analog input	Represents AI2 input value.
H8.26 = 8: EAI1 analog input	Represents EAI1 analog input value from IO or I/O plus card.
H8.26 = 9: EAI2 analog input	Represents EAI2 analog input value from I/O plus card.
H8.26 = 11: Motor temperature sensor power supply	Provides current source for motor temperature sensor, see chapter 12.3.7 "Motor Thermal Sensor Selection" on page 166.
H8.26 = 12: Parameter setting from communication	• For modbus mode, the output is defined by register 0x7F07, the value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value). • For other fieldbus mode, the output is defined by parameter H8.28.
H8.26 = 13: Setting torque	Represents range of setting torque selected using C3.42 and C3.43.
H8.26 = 14: Output torque	Represents range of output torque selected using C3.42 and C3.43.

- **Step 3: Set AO1 filter time and output curve**

EAO curve for H8.25 = 0 & 1:

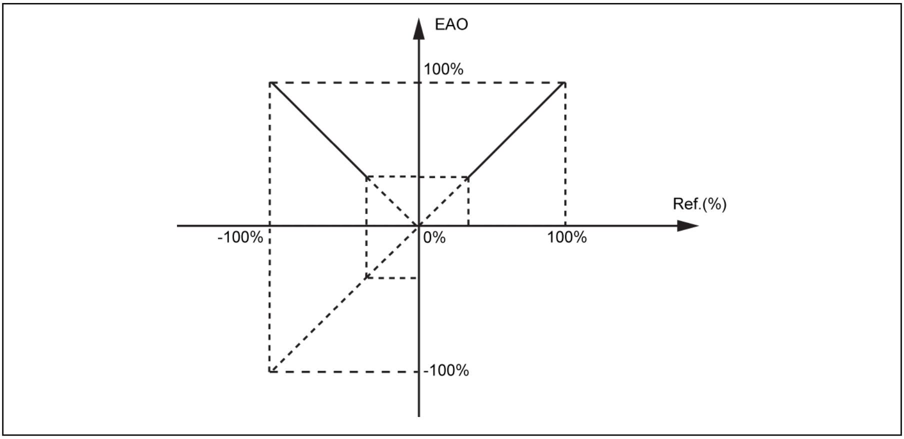


Fig. 12-161: EAO curve 1

EAO curve for H8.25 = 2:

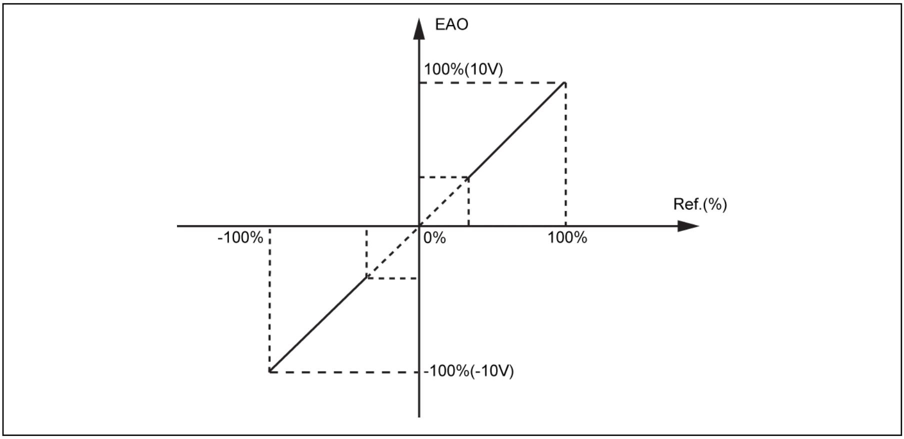


Fig. 12-162: EAO curve 2

- EAO analog output status is monitored by parameter d0.37 'I/O card EAO output'.
- Since mode 2 for H8.25 is valid only for IO plus card, when back-up is done with H8.25 = 2 and if restore is done with IO card, then 'E.par' would be displayed since mode 2 is not applicable for IO card.

12.22.3 IO & IO Plus Card Digital Input Configuration

This function defines 5 multi-function digital inputs with PNP and NPN wiring.

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.00	EX1 input	1...51	0	–	–	Stop
H8.01	EX2 input		0	–	–	Stop
H8.02	EX3 input		0	–	–	Stop
H8.03	EX4 input		0	–	–	Stop
H8.04	EX5 input		0	–	–	Stop

Setting range of H8.00...H8.04:

- 0: Inactive

  No function assigned.
- 1: Multi-speed control input 1
- 2: Multi-speed control input 2
- 3: Multi-speed control input 3
- 4: Multi-speed control input 4

  16 multi-speeds are available by combination of 4 terminals, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.
- 10: Acceleration / deceleration time 1 activation
- 11: Acceleration / deceleration time 2 activation
- 12: Acceleration / deceleration time 3 activation

  Used to switch between 8 groups of acceleration / deceleration time, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.
- 15: Freewheeling stop activation

  'Freewheeling stop activation' generates a stop command and forces the frequency converter to freewheel to stop regardless of the stopping mode configured by E0.50.
- 16: Stop DC-braking activation

  This function is used when stopping mode is set with [E0.50] = '0: Decelerating stop', details see chapter 12.8.9 "Stop Mode Configuration" on page 216.
- 20: Frequency Up command
- 21: Frequency Down command
- 22: Up / Down command reset

  Used to change the output frequency, details see chapter 12.9.3 "Digital Input Frequency Change Function" on page 239.
- 23: Torque / speed control switch

  Used to switch between torque control mode and speed control mode. If the defined switch is open, speed control mode is selected; If the defined switch is closed, torque control mode is selected.

- **25: 3-wire control**

  Used for the 3-wire control mode, details see chapter 12.9.2 "2- and 3-Wire Control" on page 234.
- **26: Simple PLC stop**
- **27: Simple PLC pause**

  Used for the simple PLC to stop and pause a PLC cycle, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.
- **30: Second frequency setting source activation**

  Used for switching to the second frequency setting source, details see chapter 12.8.1 "Frequency Setting Source" on page 197.
- **31: Second run command source activation**

  Used for switching to the second run command source, details see chapter 12.8.2 "Run Command Source" on page 202.
- **32: Error signal N.O. contact input**
- **33: Error signal N.C. contact input**

  Used for receive error signal from external sources. The frequency converter stops once an external error signal is active and the error code 'E-St' will be displayed on the operating panel if one X1...X5 or EX1...EX5 input is defined as either 'Error signal N.O. contact input' or 'Error signal N.C. contact input'.
  - **32: Error signal N.O. contact input**
    - If the defined switch is closed, the external error signal is active.
    - If the defined switch is open, the external error signal is inactive.
  - **33: Error signal N.C. contact input**
    - If the defined switch is open, the external error signal is active.
    - If the defined switch is closed, the external error signal is inactive.

    The converter will stop when the external error signal is active, and the stop mode is defined by E0.56 'Emergency stop action', please see chapter 12.8.9 "Stop Mode Configuration" on page 216 for the detailed information.

    Example:

    Set [E1.00] = '32: Error signal N.O. contact input' **or**

    Set [E1.01] = '33: Error signal N.C. contact input'

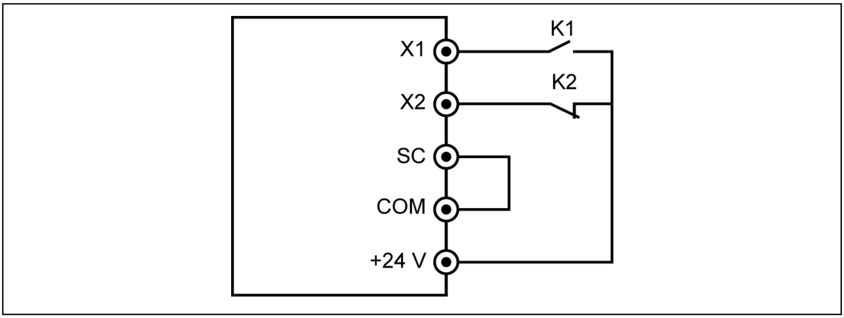


Fig. 12-163: Error signal 1

The frequency converter stops and indicates error code 'E-St' if K1 is closed.

Or the frequency converter stops and indicates error code 'E-St' if K2 is open.

- **34: Error reset**

  Used for error reset operation. The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset signal' is edge sensitive.

- **35: Forward running (FWD)**
- **36: Reverse running (REV)**

  Used for Run / Stop command control, details see chapter 12.8.2 "Run Command Source" on page 202.

- **37: Forward jog**
- **38: Reverse jog**

  See chapter 12.8.13 "Jog Function" on page 223.

- **39: Counter input**
- **40: Counter reset**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.

- **41: PID deactivation**

  See chapter 12.12 "E4: PID Control" on page 276.

- **46: User parameter set selection**

  Used to switch between two sets of parameters, details see chapter 12.1.4 "Parameter Set Switch" on page 123.

- **48: Motor overheating error N.O. contact input**
- **49: Motor overheating error N.C. contact input**

  Used for receive motor overheating error signal from external sources. The frequency converter stops once an external motor overheating error signal is active and the error code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating error N.O. contact input' or 'Motor overheating error N.C. contact input'.

- **48: Motor overheating error N.O. contact input**
  - If the defined switch is closed, the motor overheating error signal is active.
  - If the defined switch is open, the motor overheating error signal is inactive.
- **49: Motor overheating error N.C. contact input**
  - If the defined switch is open, the motor overheating error signal is active.
  - If the defined switch is closed, the motor overheating error signal is inactive.

  Example:

  Set [E1.00] = '48: Motor overheating error N.O. contact input' **or**

  Set [E1.01] = '49: Motor overheating error N.C. contact input'

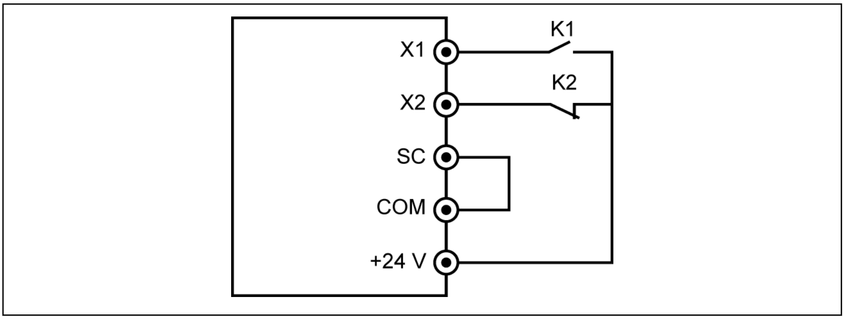


Fig. 12-164: Error signal 2

The frequency converter stops and indicates error code 'Ot' if K1 is closed.

Or the frequency converter stops and indicates error code 'Ot' if K2 is open.

- **50: Motor overheating warning N.O. contact input**
- **51: Motor overheating warning N.C. contact input**

Used for receive motor overheating warning signal from external sources. Warning code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating warning N.O. contact input' or 'Motor overheating warning N.C. contact input'.

- **50: Motor overheating warning N.O. contact input**
  - If the defined switch is closed, the motor overheating warning signal is active.
  - If the defined switch is open, the motor overheating warning signal is inactive.

- 51: Motor overheating warning N.C. contact input
  - If the defined switch is open, the motor overheating warning signal is active.
  - If the defined switch is closed, the motor overheating warning signal is inactive.

  Example:

  Set [E1.00] = '50: Motor overheating warning N.O. contact input' **or**

  Set [E1.01] = '51: Motor overheating warning N.C. contact input'

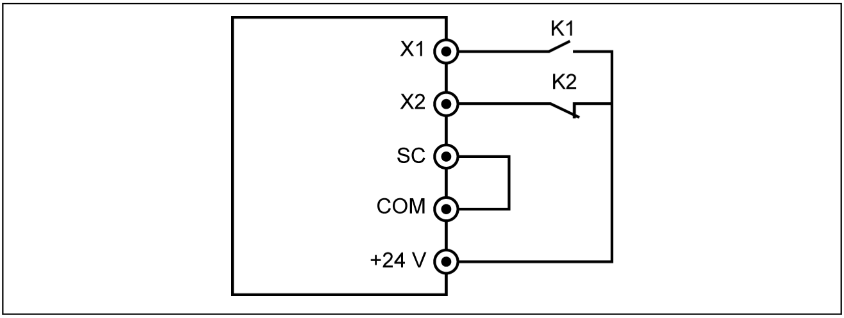


Fig. 12-165: Error signal 2

The frequency indicates warning code 'Ot' if K1 is closed.

Or the frequency converter indicates warning code 'Ot' if K2 is open.

I/O card digital input status is monitored by parameter d0.43 'I/O card digital input'.

12.22.4 IO & IO Plus Card Digital Output Configuration

This function defines the IO and IO plus extension card open collector output for system state monitoring.

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.20	EDO1 output selection	0...25	1	–	–	Stop
H8.22	EDO2 output selection		1	–	–	Stop
H8.23	Extended digital output value from extension card fieldbus communication	Bit0: EDO1 (IO / IO plus card) Bit1: EDO2 (IO plus card) Bit8: Erelay (IO card)	0	–	–	Stop

Setting range of H8.20, H8.22:

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 210 and chapter 12.8.9 "Stop Mode Configuration" on page 216.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.

☞ There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 258.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 258.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.
- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 146.
- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 163.
- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 229 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.
- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.
- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.
- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.
- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 276.
- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.
- **21: Parameter setting from communication**

  For modbus mode,

  – The output of EDO1 is defined by bit0 of register 0x7F09. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.

  – The output of EDO2 is defined by bit1 of register 0x7F09. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.

  For other fieldbus mode,

  – The output of EDO1 is defined by bit0 of H8.23. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.

- The output of EDO2 is defined by bit1 of H8.23. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.

☞

- Digital output status is monitored by parameter d0.47 'I/O card EDO1 output' and d0.48 'I/O card EDO2 output'.
- EDO2 is only for IO plus card.

12.22.5 IO Card Relay Output Configuration

This function defines the IO extension card extended relay output for system state monitoring.

Code	Name	Setting range	Default	Unit	Step	Attri.
H8.21	Extended relay output selection	0...25	1	–	–	Stop
H8.23	Extended digital output value from extension card fieldbus communication	Bit0: EDO1 (IO / IO plus card) Bit1: EDO2 (IO plus card) Bit8: Erelay (IO card)	0	–	–	Stop

Setting range of H8.21:

- 0: Converter ready

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- 1: Converter running

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- 2: Converter DC-braking

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 210 and chapter 12.8.9 "Stop Mode Configuration" on page 216.

- 3: Converter running at zero speed

  The output is active when the frequency converter is running at zero speed.

☞ There is no output for this selection during dead zone time of rotation direction change.

- 4: Speed arrival

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 258.

- 5: Frequency level detection signal (FDT1)
- 6: Frequency level detection signal (FDT2)

  See chapter 12.10.5 "Frequency Detection Function" on page 258.

- 7: Simple PLC stage complete
- 8: Simple PLC cycle complete

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- 10: Converter undervoltage

The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 146.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 163.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 229 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 276.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**

  – For modbus mode, the output extended relay is defined by bit8 of register 0x7F09. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.

  – For other fieldbus mode, the output of extended relay is defined by bit8 of H8.23. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

The output is inactive when the frequency converter without error / warning.

IO card relay output status is monitored by parameter d0.60 'Relay output'.

12.22.6 I/O & I/O plus card diagnosis

This function is used to perform the self-test function of I/O & I/O plus card.

Code	Name	Setting range	Default	Unit	Step	Attri.	Device
H8.87	I/O card output channel diagnosis	0: Inactive 1: EAO diagnosis 2: EDO diagnosis ERO diagnosis/EDO2 diagonis All output diagnosis	0	-	-	Stop	xFCx610

Setting range of H8.87:

- 0: Inactive

  The test is complete. All outputs are restored to default settings.
- 1: EAO diagnosis

  The analog output of I/O & I/O plus card outputs 10 V.
- 2: EDO diagnosis

  For I/O card, the open collector output of I/O card will have "Logic 1(High)" output state.

  For I/O plus card, the open collector output 1 of I/O plus card will have "Logic 1(High)" output state.
- 3: ERO diagnosis/EDO2 diagnosis

  For I/O card, the relay output of I/O card is closed.

  For I/O plus card, the open collector output 2 of I/O plus card will have "Logic 1(High)" output state.
- 4: All output diagnosis

  EAO, ERO, EDO are all tested with the above methods.

12.23 H9: Relay Card Parameters

12.23.1 Relay Card Output Configuration

This function defines the 4 relays output in relay extension card for system state monitoring.

Code	Name	Setting range	Default	Unit	Step	Attri.
H9.00	Extended relay 1 output selection	0...25	0	–	–	Stop
H9.01	Extended relay 2 output selection		0	–	–	Stop
H9.02	Extended relay 3 output selection		0	–	–	Stop
H9.03	Extended relay 4 output selection		0	–	–	Stop
H9.10	Relay output setting value	Relay1 is defined by bit0, when bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed Relay2 is defined by bit1, when bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed Relay3 is defined by bit2, when bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed Relay4 is defined by bit3, when bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed	0	–	–	Run
H9.97	Relay card output channel diagnosis	0: Inactive 1: Relay1 diagnosis 2: Relay2 diagnosis 3: Relay3 diagnosis 4: Relay4 diagnosis 5: All output diagnosis	0	–	–	Stop

Setting range of H9.00...H9.03:

- 0: Converter ready

After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- 1: Converter running

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- 2: Converter DC-braking

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 210 and chapter 12.8.9 "Stop Mode Configuration" on page 216.

- 3: Converter running at zero speed

  The output is active when the frequency converter is running at zero speed.

☞ There is no output for this selection during dead zone time of rotation direction change.

- 4: Speed arrival

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 258.

- 5: Frequency level detection signal (FDT1)
- 6: Frequency level detection signal (FDT2)

  See chapter 12.10.5 "Frequency Detection Function" on page 258.

- 7: Simple PLC stage complete
- 8: Simple PLC cycle complete

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 262.

- 10: Converter undervoltage

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- 11: Converter overload pre-warning

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 146.

- 12: Motor overload pre-warning

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 163.

- 13: Converter stop by external error

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 229 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.
- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.
- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 260.
- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 276.
- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.
- **21: Parameter setting from communication**

  For modbus mode,
  - The output of parameter H9.00 is defined by bit0 of register 0x7F0A. When bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed.
  - The output of parameter H9.01 is defined by bit1 of register 0x7F0A. When bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed.
  - The output of parameter H9.02 is defined by bit2 of register 0x7F0A. When bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed.
  - The output of parameter H9.03 is defined by bit3 of register 0x7F0A. When bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed.

  For other fieldbus mode, the output is defined by parameter H9.10.
- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.

H9.97 is used to perform the self-test function of relay card:

H9.97 = 0: Inactive	All relays are restored to default settings.
H9.97 = 1: Relay1 diagnosis	Relay1 is closed.
H9.97 = 2: Relay2 diagnosis	Relay2 is closed.
H9.97 = 3: Relay3 diagnosis	Relay3 is closed.

H9.97 = 4: Relay4 diagnosis	Relay4 is closed.
H9.97 = 5: All output diagnosis	All relays are closed.

12.24 U0: General Panel Parameters

This function contains the basic panel parameters.

Code	Name	Setting range	Default	Unit	Step	Attri.
U0.00	Direction control by panel	0: Forward 1: Reverse	0	–	–	Run
U0.01	Stop button control	0: Active only for panel control 1: Valid for all control methods	1	–	–	Run
U0.99	Panel firmware version	0.00...655.35	–	–	0.01	Read

Direction control via operation panel

The actual direction is controlled by the configuration of parameter [U0.00] 'Direction control by panel' and [E0.17] 'Direction control', see chapter 12.8.5 "Direction Control" on page 206.

Stop command via panel <Stop> button

U0.01 'Stop button control' is used to define the function of <Stop> button on the operating panel:

- 0: Stop command is active only for panel control
- 1: Stop command is Valid for all control methods

Panel board FW version

The Panel board FW version U0.99 is a number of the format **vv.rr**

- **vv** firmware version number
- **rr** firmware release number

Example: 2.03

This parameter is usable outside engineering tool to get FW version info over the panel or field bus.

12.25 U1: LED Panel Parameters

This function contains the LED panel parameters.

Code	Name	Setting range	Default	Unit	Step	Attri.
U1.00	Run monitoring display	0…99	0	–	–	Run
U1.10	Stop monitoring display		2	–	–	Run

Setting range of U1.00, U1.10:

0: Output frequency; 1: Actual speed

2: Setting frequency; 3: Setting speed

4: User-defined setting speed; 5: User-defined actual speed

9: V/f separation setting voltage; 10: Output voltage; 11: Output current

12: Output power; 13: DC-bus voltage

14: Energy saving counter kWh; 15: Energy saving counter MWh

16: Output torque; 17: Setting torque

20: Power module temperature; 21: Actual carrier frequency

23: Power stage running time; 30: AI1 input

31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input

35: AO1 output; 37: I/O card EAO output

40: Digital input 1; 43: I/O card digital input

45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output

50: Pulse input frequency; 55: Pulse output frequency

60: Relay output; 62: I/O card relay output

63: Relay card output; 70: PID reference engineering value

71: PID feedback engineering value; 80: ASF Display00

81: ASF Display01; 82: ASF Display02

83: ASF Display03; 84: ASF Display04

85: ASF Display05; 86: ASF Display06

87: ASF Display07; 88: ASF Display08; 89: ASF Display09

98: High resolution output current; 99: Firmware version

12.26 U2: LCD Panel Parameters

This function contains the LCD panel parameters.

Code	Name	Setting range	Default	Unit	Step	Attri.
U2.01	Backlight mode setting	0: Energy saving 1: Always on	1	–	–	Run
U2.02	Panel lock setting	0: Unlock 1: Lock	0	–	–	Run
U2.03	Remote / Local setting	0: Remote 1: Local	0	–	–	Stop
U2.04	Language selection	0: English 1: Chinese 2: Germany 3: French 4: Russian 5: Spanish 6: Portugal 7: Italian 8: Korean	0	–	–	Stop
U2.09	Permanent monitoring	0...99	0	–	–	Run
U2.10	Run monitoring items 1		0	–	–	Run
U2.20	Stop monitoring items 1		0	–	–	Run
U2.11	Run monitoring items 2	0...100	2	–	–	Run
U2.12	Run monitoring items 3		11	–	–	Run
U2.13	Run monitoring items 4		13	–	–	Run
U2.14	Run monitoring items 5		16	–	–	Run
U2.15	Run monitoring items 6		17	–	–	Run
U2.21	Stop monitoring items 2		2	–	–	Run
U2.22	Stop monitoring items 3		11	–	–	Run
U2.23	Stop monitoring items 4		13	–	–	Run
U2.24	Stop monitoring items 5		16	–	–	Run
U2.25	Stop monitoring items 6		17	–	–	Run

Setting range of U2.09...U2.25:

0: Actual output frequency; 1: Actual speed

2: Setting frequency; 3: Setting speed

4: User-defined setting speed; 5: User-defined output speed

9: V/f separation setting voltage; 10: Output voltage; 11: Output current

12: Output power; 13: DC-bus voltage

14: Energy saving counter kWh; 15: Energy saving counter MWh

16: Output torque; 17: Setting torque

20: Power module temperature; 21: Actual carrier frequency

23: Power stage running time; 30: AI1 input

31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input

35: AO1 output; 37: I/O card EAO output

40: Digital input 1; 43: I/O card digital input

45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output

50: Pulse input frequency; 55: Pulse output frequency

60: Relay output; 62: I/O card relay output

63: Relay card output; 70: PID reference engineering value

71: PID feedback engineering value; 80: ASF Display00

81: ASF Display01; 82: ASF Display02

83: ASF Display03; 84: ASF Display04

85: ASF Display05; 86: ASF Display06

87: ASF Display07; 88: ASF Display08

89: ASF Display09; 98: High resolution output current

99: Firmware version; 100: Inactive

13 Diagnosis

13.1 Display of LED Characters

Character	A	b	C	d	E	F	H	i	L
Display									
Character	n	O	o	P	r	S	t	U	–
Display									–

Tab. 13-1: Display of LED characters

13.2 Status Code

Code	Description
P.oFF	Displayed only at power down / drop in stop state
tUnE	Motor parameter tuning
88888	Power on during start state
PSLP	PID sleeping
StO-A	Safe torque off enabled
PAr1	Parameter Set change from Set2 to Set1
PAr2	Parameter Set change from Set1 to Set2
S.Err	Parameter change blocked
PrSE	Parameter setting contradiction, parameter password protected

13.3 Warning Code

Code	Description
PLE	Pump leakage
OE-4	Overvoltage during stop
Ot	Motor over temperature
E-St	Terminal Error Signal
C-dr	Communication disconnection
Aib-	Analog input broken wire detection
FLE	Fan maintenance period expired
OCi	Communication data exceeds value range
UH-A	Under Temperature warning
APF1	ASF customer warning 1
APF2	ASF customer warning 2
APF3	ASF customer warning 3
APF4	ASF customer warning 4

Code	Description
APF5	ASF customer warning 5
USdc	UnSupported Device Configuration
Sli-	Speed limited by maximum Voltage
iSt	Invalid State Transition
FtL	RPDO Telegram Loss
Fdi	Option card process data invalid

13.4 Error Code

13.4.1 Error 1 (OC-1), Error 2 (OC-2), Error 3 (OC-3): Overcurrent

Possible reason	Solution
The motor has been damaged due to overheating or the motor insulation is damaged	Check the insulation resistance. If it is damaged, replace the motor
Magnetic contactor (MC) on the output side of the drive has turned on or off	Set up the operation sequence so that the MC is not tripped while the drive is outputting current
Drive fails to operate properly due to interference	Review the possible solutions provided for handling interference, check the section on handling interference and the control circuit lines, main circuit lines, and ground wiring
One of the motor cables has shorted out or there is a grounding problem	• Check the motor cables, remove the short circuit and power the drive back up • Check the resistance between the motor cables and the ground terminal, replace damaged cables
The control mode and motor do not match	Check which control mode the drive is set to (C0.00) • For SM, set C0.00 = 1, 2 • For ASM, set C0.00 = 0, 1, 2
Excessively short acceleration/deceleration time	Increase acceleration time (E0.26)/deceleration time (E0.27)
Excessive start-up frequency	Reduce start frequency (E0.36)
Excessive load rotation inertia or impact	Increase acceleration time (E0.26), reduce sudden load change
Running command active while motor is coasting	Restart after motor stop or start with speed capture (E0.35)
Wrong setting of user-defined V/f curve parameters	Adjust setting of user-defined V/f curve parameters
Wrong motor parameters setting	• Check motor nameplate parameters • Motor parameters retuning
Excessive torque boost	Reduce torque boost setting (C2.21, C2.22)
Phase-phase or line-to-ground short circuit	Check if phase-phase or line-to-ground short circuit, if short circuit exists, then the transistor is damaged, please contact service
Excessive overexcitation braking factor	Reduce [E0.55]
Load change in run mode	Reduce occurrence and scale of change

Possible reason	Solution
Low mains voltage	Check input power supply
The motor cable is too long	● Decrease the carrier frequency (C0.05) ● Use a frequency converter with larger power

13.4.2 Error 4 (OE-1), Error 5 (OE-2), Error 6 (OE-3): Overvoltage

Possible reason	Solution
Surge voltage from power supply	Check input power supply
Motor to earth short circuit causes DC-bus capacitors overcharged	Check motor connection
Direct start during motor running	Restart after motor stop or start with speed capture (E0.35)
Excessively short acceleration time	Increase acceleration time (E0.26) or use S-curve (E0.25, E0.28, E0.29)
Wrong setting of speed tracing parameters	Adjust setting of speed tracing parameters(E0.42, E0.43)
Encoder cable is disconnected or wiring is wrong	Check the wring of encoder
Deceleration time is too short	Increase deceleration time(E0.27); Add braking resistor

13.4.3 Error 8 (UE-1): Undervoltage during Run

Possible reason	Solution
Power failure during running	● Check if the main circuit drive input power is disconnected or wired incorrectly ● Check if one of the drive input power wiring terminals is loose ● Check the voltage from the drive input power ● Check if the power has been interrupted
The soft start relay or contactor is damaged	Cycle power on and power off the drive and see if the fault reoccurs, if the problem continues, replace either the control board or the converter. For instructions on replacing the control board, please contact service.

13.4.4 Error 9 (SC): Surge Current or Short Circuit

Possible reason	Solution
Multiple motors are driven by one frequency converter in V/f mode	Increase capacity of frequency converter or decrease number of motors
Surge current	Increase the acceleration time (E0.26), reduce the overexcitation braking factor (E0.55)
Drive fails to operate properly due to interference	Review the list of possible solutions provided for controlling interference, review the section on handling interference and check the control circuit lines, main circuit lines, and ground wiring.

13.4.5 Error 10 (IPH.L): Input Phase Loss

Possible reason	Solution
Abnormal, omitted or broken connections of frequency converter power supply	Check power supply connections, remove omitted or broken connections
Broken fuse	Check fuse
Imbalance in the three phases of input power supply	Check if the imbalance situation exceeds converter withstand capability
Main circuit capacitor deterioration	Contact with service

13.4.6 Error 11 (OPH.L): Output Phase Loss

Possible reason	Solution
Abnormal, omitted or broken connections of frequency converter outputs	Check the connections of frequency converter outputs, remove omitted or broken connections
Imbalance in the three phases of outputs	Check if the transistor is damaged

13.4.7 Error 12 (ESS-): Soft Start Error

Possible reason	Solution
Power failure	Check the input power supply
Input phase loss occurs during start-up (3 phase)	Remove the input phase loss

13.4.8 Error 20 (OL-1): Converter Overload

Possible reason	Solution
Long time overload	Reduce overload time, reduce load
Wrong settings of V/f curve parameters	Adjust settings of V/f curve parameters

Possible reason	Solution
Overload happens at lower speed	• Reduce load at lower speed • Reduce the carrier frequency (C0.05) • Use a frequency converter with larger power
Excessive load, excessive short Acc. / Dec. time or cycle	• Adjust load, acceleration/deceleration time or cycle • Use a frequency converter with larger power
Low mains voltage	Check input power supply
Excessive torque compensation	Reduce torque compensation setting (C2.21, C2.22)
Excessive overexcitation braking factor	Reduce [E0.55]
Input phase loss	Check the power supply for phase loss
Acceleration/deceleration or cycle times are too short	Increase the settings for acceleration/deceleration or cycle times
The capacity of frequency converter is too small	Replace the frequency converter with a larger model
Wrong setting of speed tracing parameters	Adjust setting of speed tracing parameters(E0.42, E0.43)
Temperature is too high	• Check if the environment temperature is too high • Check if the fan is work normally

13.4.9 Error 21 (OH): Converter over Temperature

Possible reason	Solution
Frequency converter (heat sink) temperature is higher than max. allowable temperature Max. allowable temperature: • 0.4...90kW: 95 °C • 110...160kW: 100 °C	• Check the temperature surrounding the drive – Improve the air circulation within the enclosure panel – Install a fan or air conditioner to cool the surrounding area – Remove anything near the drive that might be producing excessive heat • Load is too heavy – Reduce load if necessary – Reduce carrier frequency (C0.05) • Temperature detection circuit error, contact with service

13.4.10 Error 23 (FF): Fan Failure

Possible reason	Solution
Fan defect	● Check if the fan is blocked Clear the fan or replace it ● Fan control circuit error Replace the circuit board or converter, contact with service

13.4.11 Error 24 (Pdr): Pump Dry

Possible reason	Solution
PID feedback is excessively low while converter is running at output frequency high limit	● Check if the feedback signal is valid ● If the PID control is used for controlling a water pump, check if the pump is running without water

13.4.12 Error 25 (CoL-): Command Value Lost

Possible reason	Solution
Panel potentiometer frequency setting command value lost	● Check if the panel is installed stably Reinstall the panel ● Check if the extended line for the panel is broken Replace the extended line for the panel ● The panel is broken Contact with service

13.4.13 Error 26 (StO-r): STO request

Possible reason	Solution
STO function is activated correctly in running mode, after re-energized input channels and reset the device, the device goes to normal state	Check the signal of STO input terminal

13.4.14 Error 27 (StO-E): STO error

Possible reason	Solution
STO function is activated incorrectly, it happens if one channel is energized but the other is deenergized	Check the signal of STO input terminal

13.4.15 Error 30 (OL-2): Motor Overload

Possible reason	Solution
Motor locked	Prevent motor lock
Normal motor runs long time with large load at low speed	● Increase frequency converter output frequency ● Reduce load ● Use variable frequency motor or set zero speed load (C1.76) to a higher value ● Set correct motor thermal model protection time constant (C1.74)
Low mains voltage	Check input power supply
Wrong settings of V/f curve related parameters	Adjust settings of V/f curve related parameters
Excessive sudden load change	Check load
Wrong input of rated motor current	Correct rated motor current in (C1.07)
Multiple motors are driven by one frequency converter	Connect only one motor to the frequency converter
Excessive overexcitation braking factor	Reduce [E0.55]
Wrong motor protection parameter settings	Adjust settings of C1.74, C1.75 and C1.76 according to actual motor situations
Output current imbalance due to input phase loss	Check if input phase loss

13.4.16 Error 31 (Ot): Motor over Temperature

Possible reason	Solution
Excessive load or bad cooling	● Check load ● Provide a better cooling condition
Temperature sensor defect	Check the motor temperature sensor feedback signal
Wrong motor protection parameter settings	Different motor with different maximum temperature, set motor protection parameters according to actual protection circuits (C1.72, C1.73, C1.74)

13.4.17 Error 32 (t-Er): Motor Parameter Tuning Error

Possible reason	Solution
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Wrong setting of motor parameters	Correct motor parameters setting according to motor nameplate
No connection of converter and motor	Check motor cable connections

13.4.18 Error 33 (AdE-): Motor Angle Detection Error

Possible reason	Solution
Internal error occurs during synchronous motor angle detection	● Check the motor wiring ● Check if output phase loss ● Check if the motor is blocked ● The converter can not receive the encoder signal – Check the encoder card – Check the wiring between the converter and encoder – Check the encoder

13.4.19 Error 34 (EnCE-): Encoder Connection Error

Possible reason	Solution
Wiring break or phase order error	● Check if the wring of encoder is reliable ● Check encoder wring break detection parameter(H7.05 and H7.06) ● Check encoder direction setting(H7.01) ● Check encoder phase order error detection time(H7.07)
Number of resolver poles and motor poles does not match	● Check resolver poles(H7.31) ● Check motor poles(C1.11)
The final calculated speed from encoder inclusive pole numbers exceeds the allowed range	● Check resolver poles(H7.31) ● Check pulses per revolution of encoder(H7.20)
The speed status of the encoder processing is invalid	● Check the grounding ● Check if the cable with the shields grounded at two ends ● Check if the wring of encoder is reliable ● Change encoder card
The angle status of the encoder processing is invalid	

13.4.20 Error 35 (SPE-): Speed Control Loop Error

Possible reason	Solution
The speed loop difference is outside [C3.26] over a time of [C3.25]	• Set appropriate C3.25 and C3.26 according to actual working condition • Check motor nameplate parameters(C1 group) • Check if the torque limitation level is too low • Motor control loop parameters error – Motor parameter tuning – Set relevant C3 group parameters according to actual working condition

13.4.21 Error 38 (AibE): Analog Input Broken Wire Detection

Possible reason	Solution
Analog input wire is disconnected	• Check the setting of analog input broken wire protection E1.61 • The converter not receive analog input signal – Check the wiring of AI1, AI2, EAI1 and EAI2 – Check analog input signal source – Analog input port broken, replace the control board or converter, contact with service

13.4.22 Error 39 (EPS-): DC_IN Power Supply Error

Possible reason	Solution
DC_IN power supply voltage is out of range 20...28 V	• Check the voltage supply on DC_IN terminal and make sure the voltage is within the range of 20...28 V • Control board detection circuit of 24V is broken, replace the control board or converter, contact with service

13.4.23 Error 40 (dir1): Forward Running Lock Error

Possible reason	Solution
Direction control [E0.17] = '1: Forward only' Direction command is reverse	Correct the parameter setting

13.4.24 Error 41 (dir2): Reverse Running Lock Error

Possible reason	Solution
Direction control [E0.17] = '2: Reverse only' Direction command is forward	Correct the parameter setting

13.4.25 Error 42 (E-St): Terminal Error Signal

Possible reason	Solution
External error caused by input signals via external terminals	Check external terminals input signal
Wrong wiring / setting of multi-function external terminals	Ensure the right external signals have been connected correctly to the right multi-function external terminals which are assigned for external error input ([E1.00]...[E1.04] = 32, 33)
Converter stop caused by E-Stop active command via Modbus communication	Check the stop command via Modbus communication (0X0088: stop according to parameter setting; 0X0090: E-stop active). If converter receives 0X0090 , E-St will be displayed

13.4.26 Error 43 (FFE-): Firmware Version Mismatch

Possible reason	Solution
Operating panel may be placed to the frequency converter with older/newer firmware	Use the panel that firmware is compatible with the converter firmware
Extension card may be installed to the frequency converter with older/newer firmware	Update firmware of the extension card or converter
Converter firmware is not support the used extension card	Update the converter firmware

13.4.27 Error 44 (rS-): Modbus Communication Error

Possible reason	Solution
Modbus communication disconnection	● Check communication error detection parameters E8.01 and E8.02 ● Check the device communication wiring ● Check status of communication target

13.4.28 Error 45 (E.Par): Parameter Settings Invalid

Possible reason	Solution
Parameter settings are invalid after firmware update or extension card removed or parameter copy	1. Check parameter group '-EP-' and modify the parameter values appeared in '-EP-' 2. Initialize all parameters

13.4.29 Error 46 (U.Par): Unknown Parameter Restore Error

Possible reason	Solution
If one or more parameters in the backup were not found in the device, they will be skipped during parameter restore	Check the differences between the different firmware versions

13.4.30 Error 48 (idA-): Internal Communication Error

Possible reason	Solution
Internal error caused by communication	• Check if there is interference – Check the ground wiring – Check if there is strong interference source around the device • Converter internal circuit board connection is loosen due to vibration • Contact with service

13.4.31 Error 49 (idP-): Internal Parameter Error

Possible reason	Solution
Internal error caused by parameter handling	• Hint to check fan, Fan total running time(C0.51) exceeds 30000 hours – Check the Fan works normally or not – Update to latest version firmware and set C0.53=1 • Check if there is interference – Check the ground wiring – Check if there is strong interference source around the device • Contact with service

13.4.32 Error 50 (idE-): Converter Internal Error

Possible reason	Solution
Internal error occurs	• If E9.05=50, E9.97=53/54, then external analog input mode is not match with the parameter setting Check E1.35, E1.40, H8.05 and H8.30 setting • If E9.05=50, E9.97=0xA0, then firmware version of the control board is incompatible with the power board Update the control board and power board to the same firmware version • If E9.05=50, E9.97=6/35, then MCU is in protection mode – Check the ground wiring – Check if there is strong interference source around the device • If E9.05=50, E9.97=52, then power control board power source failure – Check the ground wiring – Check if there is strong interference source around the device – Power control board error, replace power control board or converter, contact with service • Contact with service

13.4.33 Error 51 (OCd-): Extension Card Internal Error

Possible reason	Solution
Extension card was successfully detected by the device at startup, but the communication failed afterwards	• Check if there is interference – Check the ground wiring – Check if there is strong interference source around the device • Check if the extension card is installed reliably • Contact with service

13.4.34 Error 52 (OCc): Extension Card PDOs Configuration Error

Possible reason	Solution
Internal communication error between communication card and converter control board	• Update firmware version • Contact with service

13.4.35 Error 54 (PcE-): Remote Control Communication Error

Possible reason	Solution
Error if communication to IndraWorks Ds/ConverterWorks is lost during remote control	• Check communication status between frequency converter and IndraWorks Ds/ConverterWorks • Contact with service

13.4.36 Error 55 (PbrE): Parameter Backup / Restore Error

Possible reason	Solution
Error occurs during parameter backup/restore process	• Parameter backup/restore process is interrupted Restart backup/restore process • Converter firmware version which is back up is incompatible with the version which is restored

13.4.37 Error 56 (PrEF): Parameter Restore Error after Firmware Update

Possible reason	Solution
Error occurs if parameter settings cannot be restored after firmware update	Parameters recover failed after firmware update from low version to high version Reset the error, set customer parameters again after initialization

13.4.38 Error 60 (ASF-): Application Firmware Error

Possible reason	Solution
The application firmware was not loaded correctly or trail use is over	• Currently converter firmware is not support this application firmware – Reload the application firmware version which is supported by the converter – Update the converter firmware to the version which support this application firmware • The application firmware is not certificated Certificate this application firmware

13.4.39 Error 61...65 (APE1...APE5): Application Error

Possible reason	Solution
Application error	Error which can be thrown by the application, description in application manual

13.4.40 Error 70 (EIBE): encoder input broken wire error

Possible reason	Solution
Error caused by Encoder card	See instruction manual of Encoder card

13.4.41 Error 71 (EPOE): encoder phase order error

Possible reason	Solution
Error caused by Encoder card	See instruction manual of Encoder card

13.4.42 Error 72 (RDOS): signal amplitude error

Possible reason	Solution
Error caused by Encoder card	See instruction manual of Encoder card

13.4.43 Error 73 (RLOT): signal phase error

Possible reason	Solution
Error caused by Encoder card	See instruction manual of Encoder card

13.4.44 Error 901 (FCd-): host communication timed out

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.45 Error 902 (FPC-): fieldbus process data configuration erroneous

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.46 Error 903 (FtL-): RPDO telegram loss

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.47 Error 904 (FIn-): Communication platform initialization failed

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.48 Error 905 (FnC-): fieldbus network configuration invalid

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.49 Error 906 (FCE-): communication platform critical error

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.50 Error 907 (FnF-): communication platform firmware corrupted

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.4.51 Error 908 (Fdi-): fieldbus data Invalid

Possible reason	Solution
Error caused by FieldBus card	See instruction manual of FieldBus card

13.5 Error Handling

13.5.1 Restarting after Power Loss

Code	Name	Setting range	Default	Min.	Attri.
E0.45	Power loss restart mode	0: Inactive 1: Active for panel control 2: Active for digital input control	0	–	Stop
E0.46	Power loss restart delay	0.0...10.0 s	1.0	0.1	Stop

[E0.45] decides the restart behavior after power loss:

If option 1 is selected, then converter will run automatically when AC power resumes, if the run command source is set to 'panel'.

If option 2 is selected, then converter will run automatically when AC power resumes, if the run command source is set to 'multi-function digital input'.

The power loss restart procedure will be performed after [E0.46] 'Power loss restart delay'.

☞

- If the frequency converter was running in 3-wire mode before power loss, the restart of the frequency converter is decided by the status of this 3-wire terminal after power on.
- If the power loss was caused by power supply interference, an error code 'UE-1' will be displayed on the operating panel in undervoltage situation, and the frequency converter will not restart automatically after power on even E0.45 is 'Active'.
- If the run command is from communication, the frequency converter ONLY restarts after sending a stop command first and then sending a run command by communication.
- When E0.45 select "1" or "2", if the power supply of frequency converter and the error "UE-1" recover within the time of [E9.01], the frequency converter will restart; if the error "UE-1" always exists during the time of [E9.01], the frequency converter will not restart.

13.5.2 Automatic Error Reset

Automatic error reset function is used to ensure continuous running without human intervention in the case of occasional errors, such as overcurrent or overvoltage at start or in the run mode. This function can be activated by setting [E9.00] ≠ 0.

When an error occurs, the frequency converter stops the output and the related error code is displayed at the same time. The system remains in idle mode for delay time [E9.01]. Then the error will automatically be reset and a run command will be generated to restart the frequency converter. This sequence will be performed [E9.00] times. If the error still exists, the frequency converter remains in idle mode and no longer performs automatic restart attempts. In this case, a manual error reset is required to resume the operation.

Automatic error reset is valid for the following errors: OC-1, OC-2, OC-3, OE-1, OE-2, OE-3, OE-4, OL-1, OL-2, UE-1*****, E-St, OH and UH.

Code	Name	Setting range	Default	Min.	Attri.
E9.00	Automatic error reset attempts	0…3 (0: Inactive)	0	–	Stop
E9.01	Automatic error reset interval	0.1…60.0 s	10.0	0.1	Stop
E9.02	Automatic error reset attempts restart time	0…65,535	0	1	Stop

Parameter E9.02 can be used to reset the internal error rest attempts back to the value from [E9.00] in case there are no error events inside this restart time. The number of reset attempts is reset to [E9.00] when E9.02 is set to a value different to 0 and there are no error reset events inside the interval given from the value of parameter E9.02.

☞ *****:

1. If [E9.00] ≠ 0 and [E0.45] = 0, every time error ‘UE-1’ resets, the remaining times of automatic reset would decrease.
2. If [E9.00] ≠ 0 and [E0.45] ≠ 0, then reset time of error "UE-1" is without limitation.
3. If [E9.00] = 0 and [E0.45] ≠ 0, then reset time of error "UE-1" is without limitation.

13.5.3 Error Reset by Digital Input

The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset signal' is edge sensitive.

Code	Name	Setting range	Default	Min.	Attri.
E1.00	X1 input	34: Error reset	0	–	Stop
E1.01	X2 input		0	–	Stop
E1.02	X3 input		0	–	Stop
E1.03	X4 input		0	–	Stop
E1.04	X5 input		0	–	Stop
H8.00	EX1 input		0	–	Stop
H8.01	EX2 input		0	–	Stop
H8.02	EX3 input		0	–	Stop
H8.03	EX4 input		0	–	Stop
H8.04	EX5 input		0	–	Stop

Set the respective parameter of any digital input as '34: Error reset signal'. For wiring diagram, please refer to chapter "Digital input NPN / PNP wiring" on page 75.

14 Safety Technology

14.1 Overview

14.1.1 Background

In the case of a standard drive, the axis / spindle / roll is moved according to the command values of the control unit. In this case, incorrect drive motion can be caused by operating errors, incorrect installation in the system, defects in parts or materials, failures in the system, etc. Incorrect drive motion - even if the errors only occur for a short time and occasionally - can endanger persons staying in the danger zone of the drive motion. You therefore have to take measures that limit the effects of errors on the drive motion to a minimum. The residual risk of danger to persons is then considerably reduced.

The integrated Rexroth safety technology provides the user the facilities, on the control unit and drive side, for realizing functions of personal and machine protection with a minimum of planning and installation work required.

14.1.2 Comparison with Conventional Safety Technology

A drive and control system with integrated safety technology differs from systems with conventional safety technology by the fact that the safety functions are directly integrated in the intelligent drives in the form hardware and software. This increases the functionality in all operation modes with a maximum of safety (short reaction times).

The power contactor between controller and motor required for the conventional safety technology is not included in drive and control systems with the integrated safety technology.

☞ The integrated safety technology is not intended to replace conventional safety equipment, such as EMERGENCY STOP monitoring devices and safety door monitors.

Using the integrated safety technology increases the available personnel and machine safety, because the total reaction time of the system in the case of an error event, for example, is considerably reduced with regard to comparable systems with conventional safety technology. The safety signals are transmitted with conventional wiring.

Integrated safety technology is characterized by the following features:

- Complies with valid standards
- Increased system performance
- Reduced system costs
- Easy understanding of complex subjects
- Improved diagnostics
- Simplified certification
- Easy commissioning
- Independent of control units

14.1.3 Safe Torque Off (STO) Function Introduction

The normative definition of STO function is in §4.2.2.2 of the IEC 61800-5-2 (on the 2016 version):

"Power, that can cause rotation (or motion in the case of a linear motor), is not applied to the motor. The PDS (SR) (Power Drive System with safety-related functions) will not provide energy to the motor which can generate torque (or force in the case of a linear motor)."

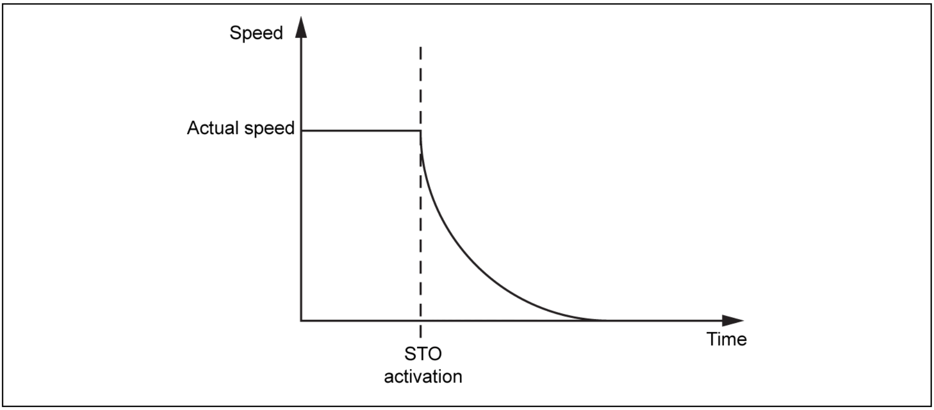


Fig. 14-1: STO function

The STO may be used where power removal is required to prevent an unexpected start. With this function, the energy supply to the motor can be safely interrupted. The drive in this case cannot generate any torque / force and, as a consequence, it cannot generate any dangerous movements.

The safety function corresponds to stop category 0 according to IEC 60204-1.

14.1.4 Safety Notes

⚠ DANGER

Lethal injury and / or property damage caused by unintended axis motion!

If external force influences are to be expected with the safety function "Safe Torque Off", e.g. in case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. a mechanical brake or a weight compensation.

⚠ DANGER

High electrical voltage! Danger to life, risk of injury due to electric shock!

The STO function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive system from the main supply.

⚠ WARNING

Injury and / or property damage caused by deviation from standstill position!

Even if the control unit has been safely locked, momentary axis motion, depending on the number of poles of the motor, can be triggered, when two errors are occurring simultaneously in the power section with the voltage DC bus being active:

- Breakdown of a power semiconductor and
- Breakdown of another semiconductor

In this case, two of six semiconductors are affected in such a way that the motor shaft is aligning.

⚠ CAUTION

Risk of injury and material damage due to improper operation!

It is not recommended to stop the drive using the STO function. If a running drive is stopped with STO, the drive will trip and stop by coasting. If this is not acceptable, the drive and machinery must be stopped using the appropriate stopping mode before using STO.

14.1.5 Standard Relevant to Safety Function

EFC 5610 frequency converter is comply with the following relevant safety standards:

Standard	Description
IEC 61508 2010-4	Functional safety of electrical/electronic/programmable electronic safety-related systems
ISO 13849-1 2015	Safety of machinery-safety-related parts of control systems-Part 1: General principles for design
ISO 13849-2 2012	Safety of machinery-safety-related parts of control systems-Part 2: Validation
IEC 62061 2015	Safety of machinery-Functional safety of electrical, electronic and programmable electronic control systems
IEC 61800-5-2 2016	Adjustable speed power drive systems- Part 5-2: safety requirements-Functional
IEC 60204-1 2016	Safety of machinery- Electrical equipment of machines

Tab. 14-1: STO relevant safety standards

14.2 Installation

14.2.1 Terminal Definition

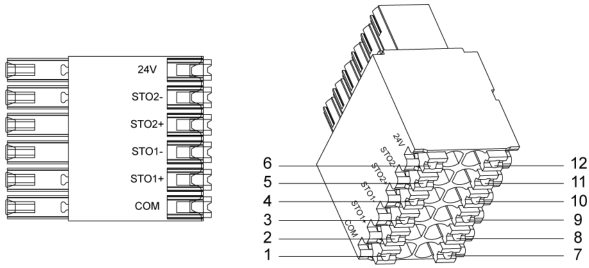


Fig. 14-2: STO terminals

Connection	Signal name	Function
1 / 7	COM	COM is the reference of +24 V
2 / 8	STO1+	Input channel 1
3 / 9	STO1-	The reference of Input channel 1
4 / 10	STO2+	Input channel 2
5 / 11	STO2-	The reference of Input channel 2
6 / 12	+24 V	Power supply

Tab. 14-2: Terminal definition

The 12-pin socket has two rows of connectors which are bridged for easy wiring.

14.2.2 Cable Definition

Cable type	Cross-section		Ferrule length	Stripped length
	mm^2	AWG	mm	mm
Shielded cable, wire-end ferrule w/ plastic collar	1.00	18	12	15
	0.75	18	12	14
	0.50	20	10	12
	0.34	22	8	10
	0.25	24	8	10
	0.14	24	8	10

Tab. 14-3: Cable definition for STO terminal

14.2.3 Application

There are several connection cases for using the STO function of EFC 5610, each have a different security level.

Case 1: Dual-channel Wiring with External Power Supply (Mode 1)

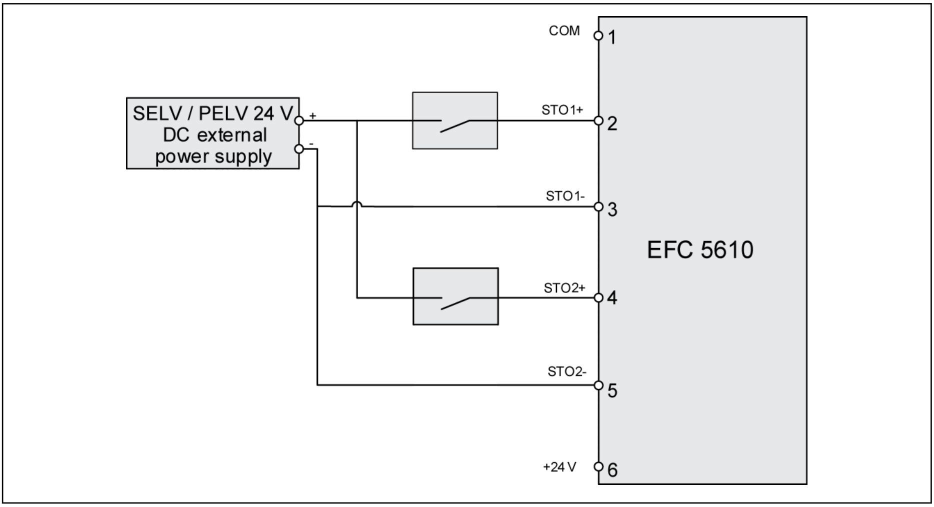


Fig. 14-3: Dual-channel wiring with external power supply (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

Case 2: Dual-channel Wiring with External Power Supply (Mode 2)

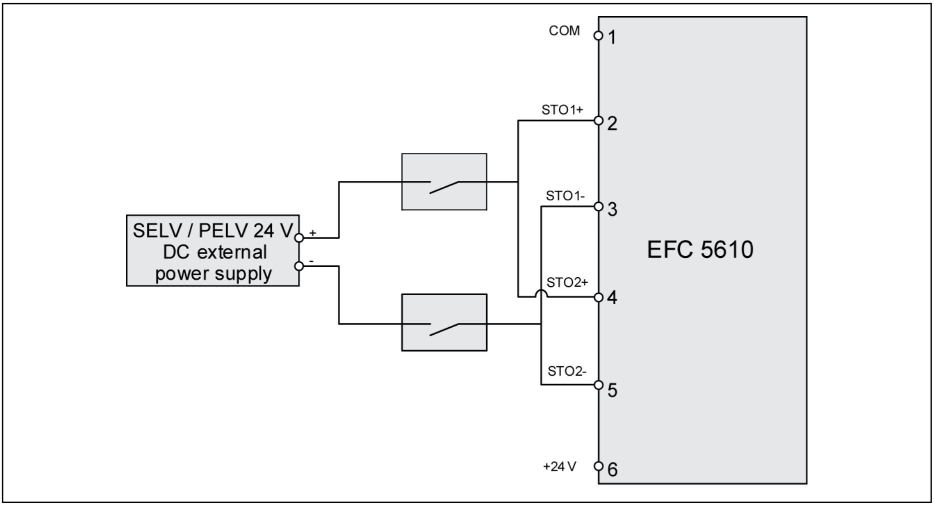


Fig. 14-4: Dual-channel wiring with external power supply (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

Case 3: Dual-channel Wiring with Safety SPS

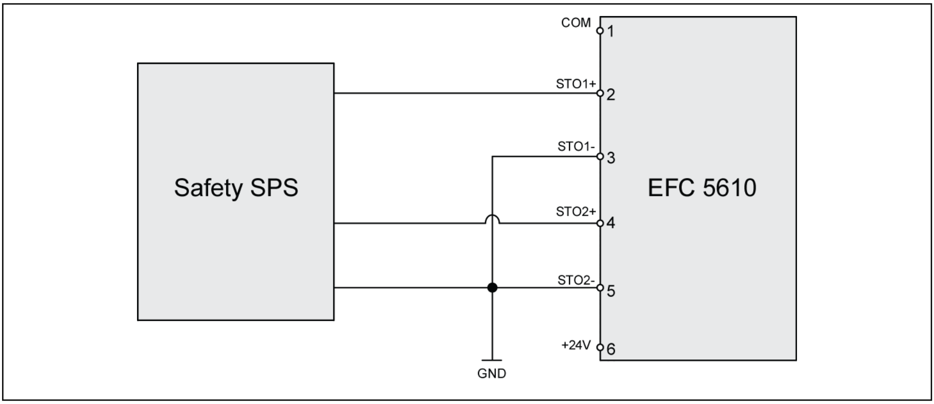


Fig. 14-5: Dual-channel wiring with safety SPS (SIL 3, Cat 4 / PLe)

Case 4: Dual-channel Wiring to IndraDrive with Safety SPS

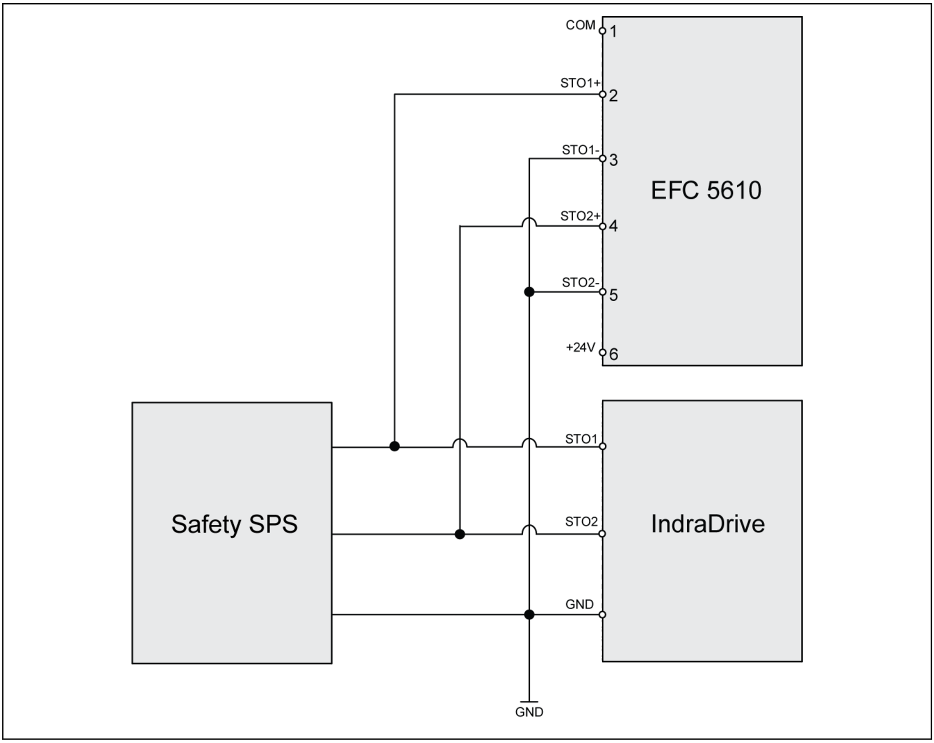


Fig. 14-6: Dual-channel wiring to Indradrive with safety SPS (SIL 3, Cat 4 / PLe)

Case 5: Dual-channel Wiring to IndraDrive without Safety SPS

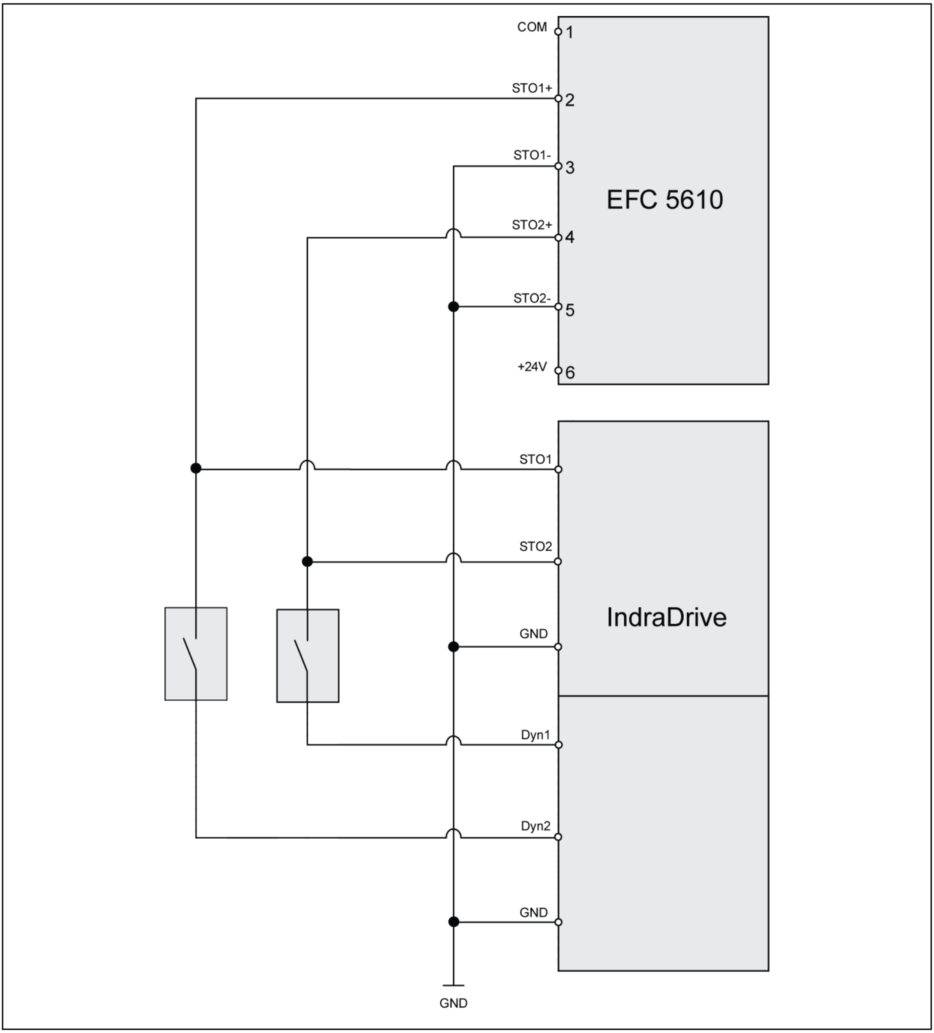


Fig. 14-7: Dual-channel wiring to IndraDrive without safety SPS (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

Case 6: Four-channel Wiring with External Power Supply

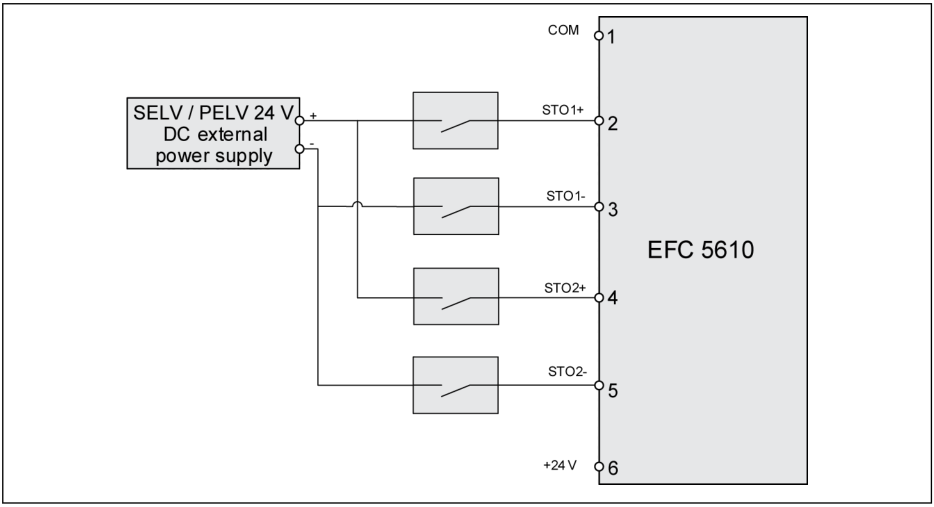


Fig. 14-8: Four-channel wiring with external power supply (SIL 3, Cat 4 / PLe)

Case 7: Paralleled Connection Type

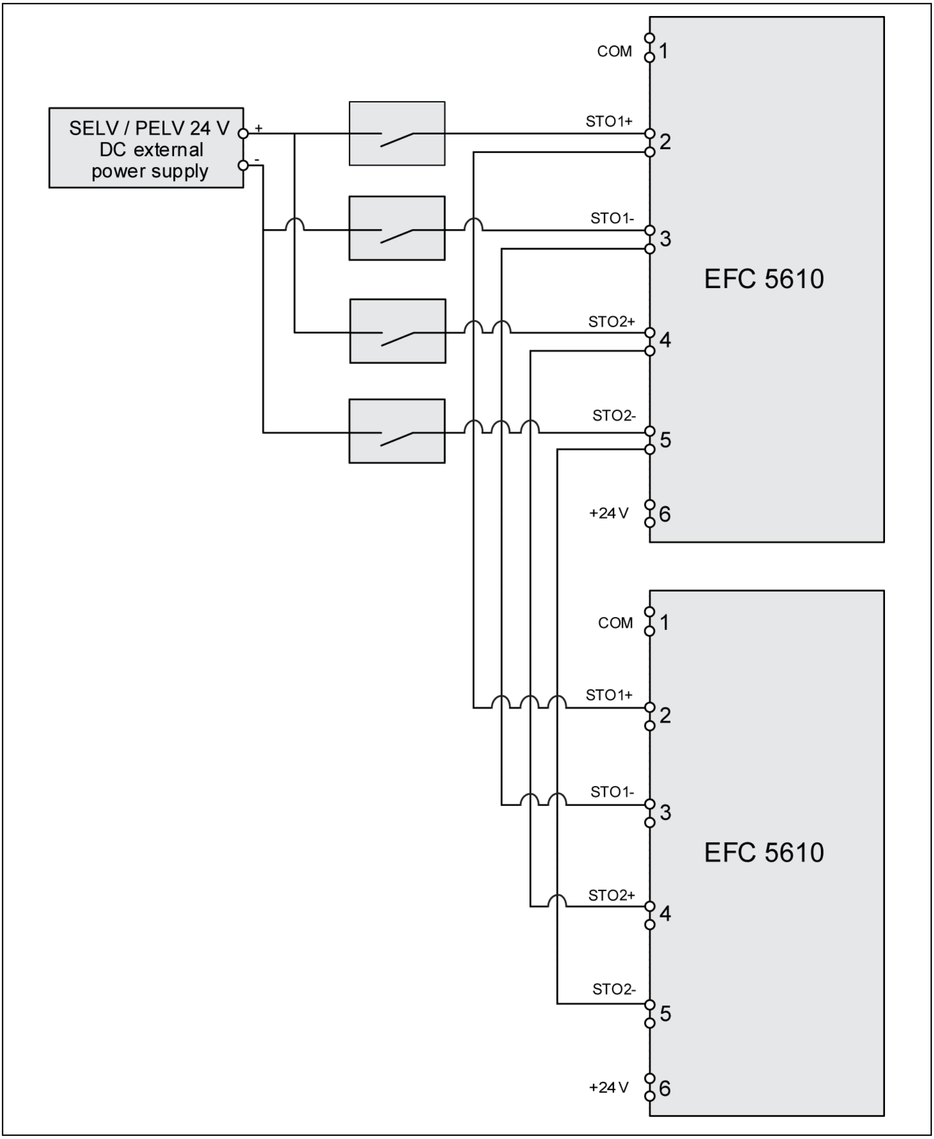


Fig. 14-9: Paralleled connection type (SIL 3, Cat 4 / PLe)

- To protect the drive against malfunction by dirt or moisture, it has to be mounted in a IP 54 cabinet.
- The +24 V DC external power supply has to meet SELV / PELV-requirements.
- The required supply current of maximum 15 mA for each circuit and the required voltage is +24 V DC + / - 10%.
- The paralleled connection type would decrease the total system safety fraction.

⚠ CAUTION

As the internal 24 V power supply is not SELV / PELV, it must not be used to supply the STO function, but only to disable STO!

14.2.4 STO Cable Connection

For the models of 110K and above, STO cable must be connected according to the following steps.

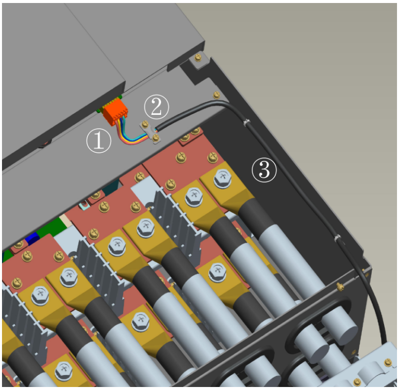


Fig. 14-10: STO Cable Connection 1

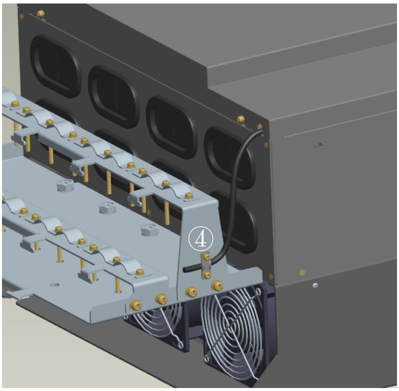


Fig. 14-11: STO Cable Connection 2

1. Connect STO cable to frequency converter with the STO terminal connector.
2. Fix STO cable on the metal plate with the clamp and make sure that the shielding layer reliable contact with the clamp.
3. Fix STO cable at the side panel.
4. Thread out the STO cable from the bottom of frequency converter and fix it to the side of shielding connector.

For more information about shielding connector, please see chapter 15.12 "Shielding Connector" on page 556.

14.2.5 Safety Function Disable

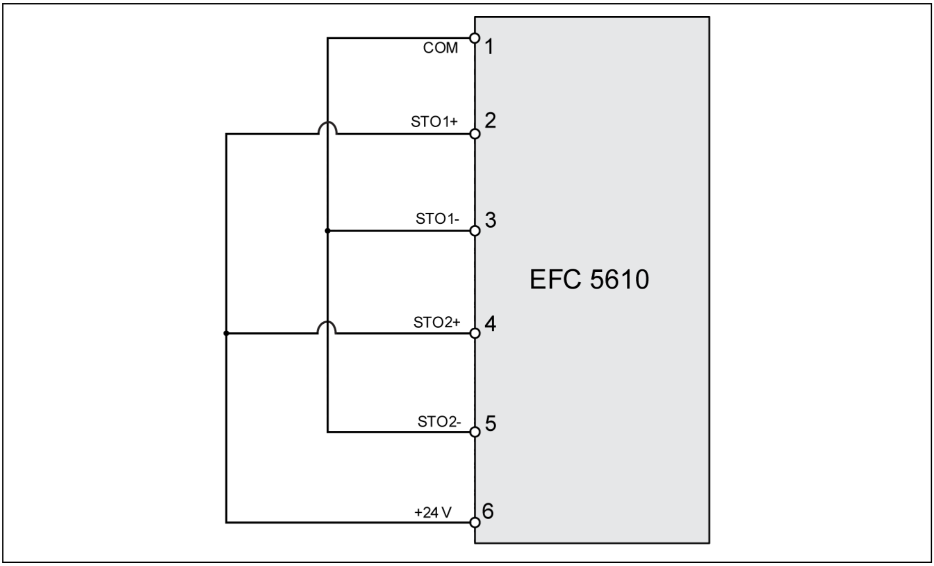


Fig. 14-12: Safety function disable

⚠ CAUTION

This is the default wiring of the device. STO is disabled in delivery state.

14.2.6 Input Channel Parameter

Input signal	Unit	Min	Typ.	Max
Allowed input voltage	V	-3	-	30
Logical 0 (Low)	V	-3	-	5
Logical 1 (High)	V	15	-	30
Input current	mA	2	-	15
Impedance	kΩ	-	3.8	-
Filtering time①	ms	-	3	-
Response time②	ms	-	< 20	-
Allowable switching time delay between channels	s	-	1	-

Tab. 14-4: Input channel parameter

①: Filtering time (shown as "t_p" in figure below) refers to the width of the low level pulse input to STO channel. In actual application, when the input pulse width is less than or equal to 3 ms, there is no influence to the operation and device.

②: Response time indicates the time interval from the power-off time of any STO input channel to the stop time of device output.

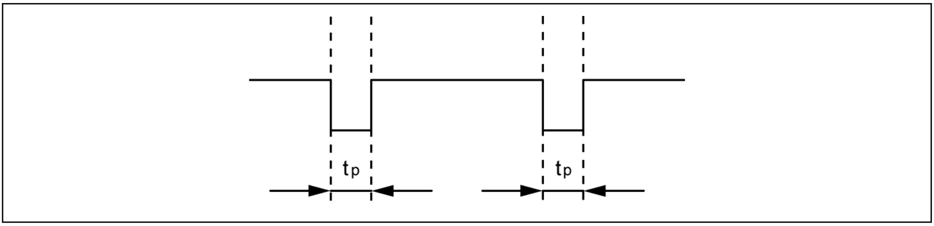


Fig. 14-13: Filtering time

14.3 Commission

Always test the operation and reaction of the STO function before commissioning.

⚠ WARNING **Dangerous movements! Danger to life, risk of injury, serious injury or property damage!**

Do not commission the installation without having it checked by a qualified person!

Before an installation with integrated safety technology is commissioned for the first time, the installation must be checked and approved in documented form by a qualified person.

Check the danger zone!

- Before commissioning, make sure that nobody is staying in the danger zone.
- Check the danger zone and secure it against access by persons (e.g., put up warning signs, install barriers or the like). Observe the applicable laws and local regulations.

14.4 STO Function Diagnosis and Status Indication

The normal state is that the device run normally and the STO function is in standby stage, if either of the input channels or both are de-energized, the STO function is activated and the device will go to safe state, at this state, the device shuts off the power semiconductor and disables start-up, no rotary field to generate any torque at the motor.

Indication	STO event	Description	Input channel logic	
			Channel 1	Channel 2
StO-A	STO alarm	STO function is activated correctly in stop mode, after re-energized input channels, the device goes to normal state.	0	0
StO-r	STO request	STO function is activated correctly in running mode, after re-energized input channels and reset the device, the device goes to normal state.	0	0
StO-E	STO error	STO function is activated incorrectly, it happens if one channel is energized but the other is de-energized.	1	0
			0	1

Tab. 14-5: STO function diagnosis and status indication

Parameter H0.03 is used to monitor the state of STO function, it is 'Read' only.

Code	Name	Setting range	Default	Min.	Attri.
H0.03	STO safety status word	bit 0: STO-A bit 1: STO-r bit 2: STO-E bit 3...15: Reserved	00000	–	Read

- Hardware damage of the channel may also cause “StO-E” error.
- The safety integrity level would decrease if only one input channel is used, please use two input channels.

14.5 Technical Data

14.5.1 Data Related to Safety Standards

Standard	Parameter	Value
IEC 61508 2010-04 IEC 61800-5-2 2016	SIL	3
	PFH	< 1 FIT
	Type	B
	PTI (Proof Test Interval)	20 years
	MT (Mission Time)	20 years
ISO 13849-1 2015	PL	e
	Category	4
	MTTFd	3.1E5 years
IEC 62061 2015	SIL CL	3

Tab. 14-6: Safety standard information

- The PFH only amounts to 2 % of the complete safety chain. The PFH < $2*10^{-9}$ 1/h (2 % SIL3).
- "Mission Time" and "Proof Test Interval":
  - The "Mission Time" of all components used must be observed and complied with. After the "Mission Time" of a component has elapsed, the component must be discarded or replaced. It is not allowed to continue operating the component!
  - After the component was discarded ("Mission Time" has elapsed), it must be ensured that it cannot be reused (e.g., by disabling it).
  - There is no specified "Proof Test Interval" for the drive system. Therefore, the "Mission Time" cannot be reset by a "Proof Test Interval".
- The safety function operates in High Demand Mode, where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year.

14.6 Maintenance

For preventive maintenance, the STO function must be activated once a year. The main power supply of the device must be turned off and then on again before this preventive maintenance. Active the STO function and confirm the operation and reaction of the STO function is normal.

14.7 Abbreviations

Abbreviation	Reference	Description
Category	ISO 13849-1	Classification of the safety-related parts of a control system
FIT	-	Failure In Time: 1E-9 hours
MTTFd	ISO 13849-1	Mean Time To dangerous Failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFH	IEC 61508	Probability of Dangerous Failures per Hour
PL	ISO 13849-1	Performance Level: Corresponds SIL, Levels a-e
PTI	IEC 61508	Proof Test Interval
SIL	IEC 61508	Safety Integrity Level
SIL CL	IEC 62061	Safety Integrity Level Claim Limit
STO	IEC 61800-5-2	Safe Torque Off

Tab. 14-7: Abbreviations

☞ Detailed description about each abbreviation, please refer to the content of corresponding standard.

15 Accessories

15.1 Optional Accessories

Optional accessory	Type	Descriptions
Operating panel:		
- LED panel	FPCC02.1-EANN-7P-NNNN	–
- LCD panel	FPCC02.1-EANN-LP-NNNN	–
- Dust cover	FPCC02.1-EANN-NN-NNNN	–
Panel mounting plate	FEAM02.1-EA-NN-NNNN	Cabinet mounting
Communication cable for cabinet control	FRKS0002/002,0	2 m
	FRKS0002/003,0	3 m
	FRKS0002/005,0	5 m
Extension card module	FEAE02.1-EA-NNNN	–
I/O module:		
- I/O card	FEAE04.1-IO1-NNNN	–
- Relay card	FEAE04.1-IO2-NNNN	–
- I/O plus card	FEAE04.1-IO3-NNNN	–
Communication module:		
- PROFIBUS card	FEAE03.1-PB-NNNN	–
- CANopen card	FEAE03.1-CO-NNNN	–
- Multi-Ethernet card	FEAE03.1-ET-NNNN	–
- Encoder card	FEAE04.1-EN1-NNNN	–
	FEAE04.1-EN2-NNNN	–
- Brake chopper	FEAE07.1-EA1-NNNN	–
	FEAE07.1-EA2-NNNN	–
Brake Chopper	FEAE07.1-EA1-NNNN	–
	FEAE07.1-EA2-NNNN	–
Plug-in connector for control section	FEAE05.1-B2-NNNN	For control terminals
External mains EMC filter	FCAF01.1A-A□□□-E-□□□□-□-0□-NNNN	See Appendix II
External brake resistor	FCAR01.1W□□□□-N□□□R0-□-0□-NNNN	See Appendix II

Optional accessory	Type	Descriptions
Shielding connector	FEAM03.2-001-NN-NNNN	For **B, C, D** housing
	FEAM03.2-002-NN-NNNN	For **E, F, G** housing
	FEAM03.2-003-NN-NNNN	For **H** housing
	FEAM03.2-004-NN-NNNN	For **I, J** housing
	FEAM03.2-005-NN-NNNN	For **K** housing
	FEAM03.2-006-NN-NNNN	For **L** housing

Tab. 15-1: Optional accessories

☞ For definition of model and type in the following sub-chapters, see chapter 19.2 "Appendix II: Type Coding" on page 573.

15.2 Operating Panel

For details on operating panel, see chapter 10 "Operating Panel and Dust Cover" on page 105.

15.3 Panel Mounting Plate

15.3.1 Function Description

With the operating panel mounted at the control cabinet, the user can operate and control the frequency converter from the outside of the control cabinet conveniently. To realize this function, the user needs order the panel mounting plate and its accessories additionally.

15.3.2 Recommended Opening Dimensions at Control Cabinet

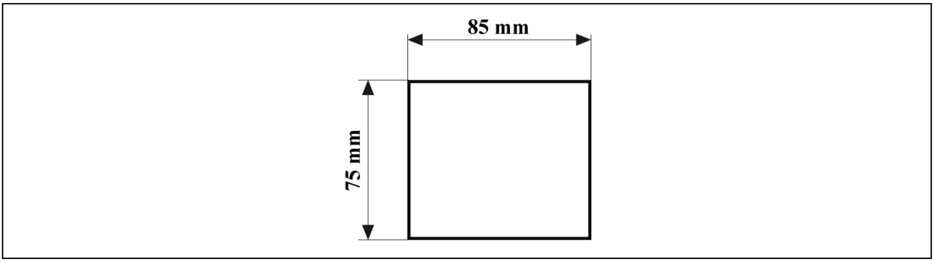


Fig. 15-1: Recommended opening dimensions at control cabinet

15.3.3 Mounting the Plate and the Operating Panel

Step 1

Push the mounting plate into the opening at the control cabinet:

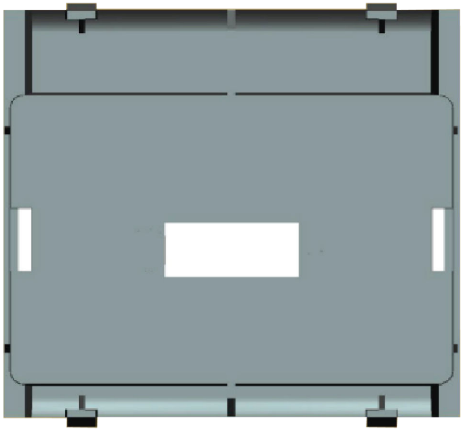


Fig. 15-2: Push the mounting plate into the opening (back view)

Step 2

Fix the mounting plate with a metal bar and 2 M4x8 screws:

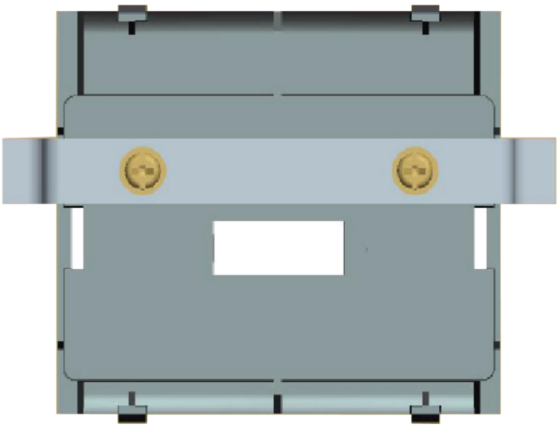


Fig. 15-3: Fix the mounting plate (back view)

Step 3

Push the operating panel in the direction perpendicular to the mounting plate:

Fig. 15-4: Mount the operating panel (front view)

Step 4

Connect the operating panel to the frequency converter with the connection cable and fix the cable connector on the mounting plate with 2 M3x10 screws:

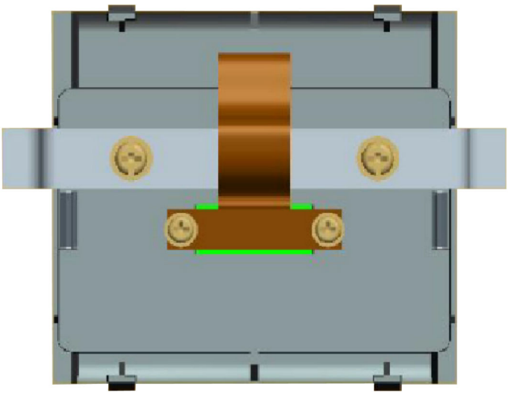


Fig. 15-5: Connect and fix the cable (back view)

15.4 Communication Cable for Control Cabinet

2 m long cable FRKS0002/002,0, 3 m long cable FRKS0002/003,0 or 5 m long cable FRKS0002/005,0 can be used for the connection of the operating panel.

15.5 Extension Card Module

15.5.1 Dimensions of Extension Card Module

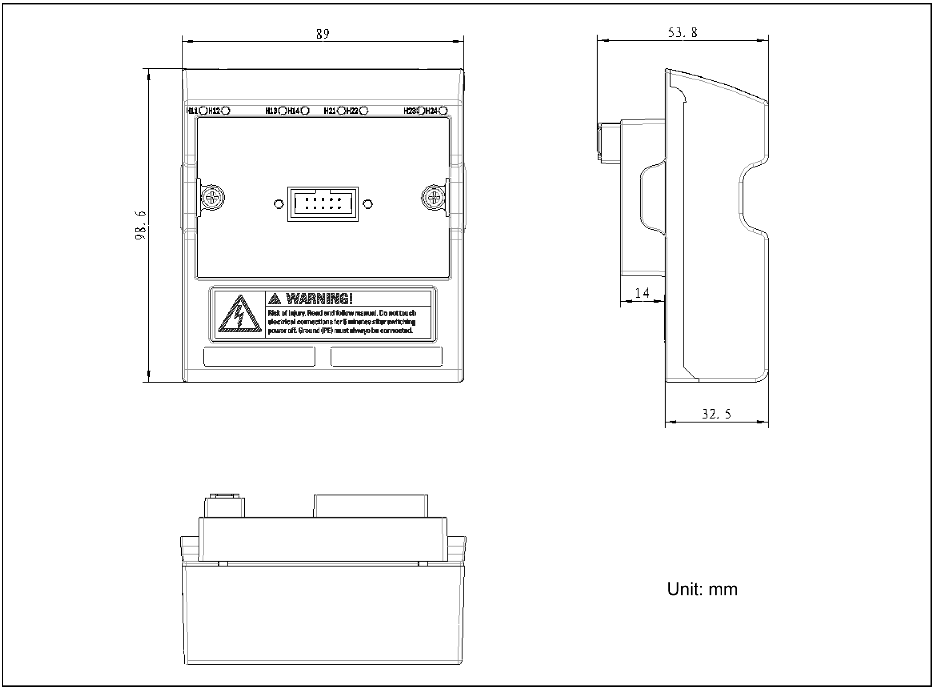


Fig. 15-6: Dimensions of Extension Card Module

15.5.2 Extension Card Module Mounting

NOTICE

Please make sure the power supply has been switched off before mounting the extension card module onto the frequency converter.

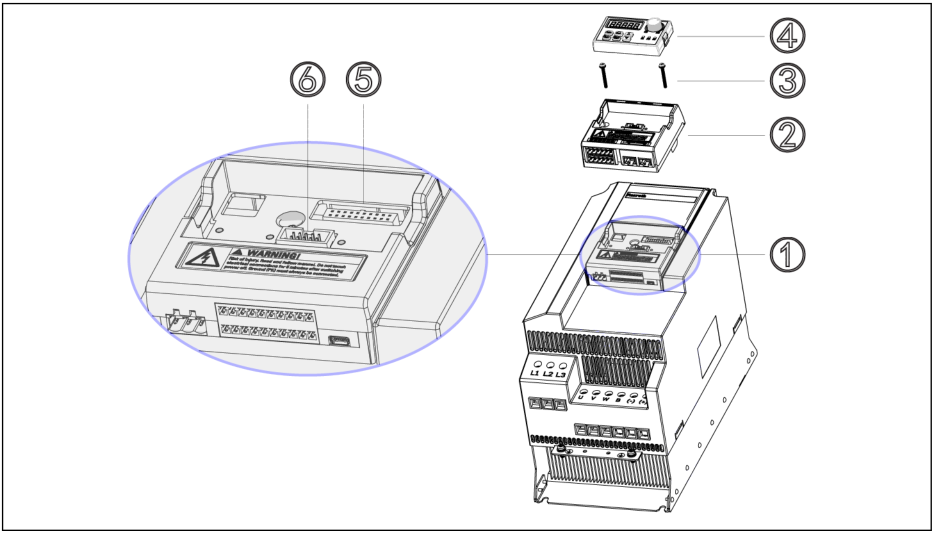


Fig. 15-7: Extension card module mounting

1. Remove operating panel ④ from Control & Terminal module ①.
2. Mount extension card module with extension cards ② into Control & Terminal module ①.
3. Tighten two screws ③ to fix carrier for option modules ② in Control & Terminal module ①.
4. Push operating panel ④ into carrier for option modules ②.

⑤: Control & Terminal module connector

⑥: Connector for operating panel

15.5.3 Extension Module Mounting

⚠ CAUTION Risk of device damage!

Do not mount the extension card when frequency converter is powered on, otherwise it will cause damage to the extension card.

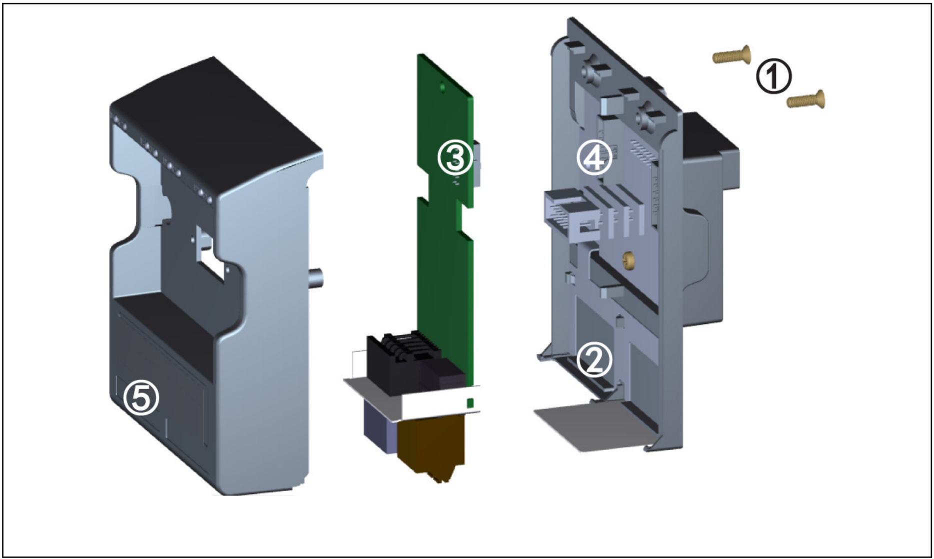


Fig. 15-8: Extension module mounting

1. Remove 2-M3 screws ① on back of the extension card module.
2. Remove the front cover of the extension card module.
3. Insert one extension card into the card slot with the metal plate beside the extension card terminals placed in ②.
4. Push the extension card to achieve a stable connection of connector ③ (on the back side of the extension card) with connector ④ (on the extension card module).
5. Mount the front cover of the extension card module.
6. Tighten 2-M3 screws ① of the extension card module.
7. Attach an appropriate terminal label on the label indentation ⑤ located at the lower section of the front cover. Terminal labels for various extension cards are delivered together with each extension card.

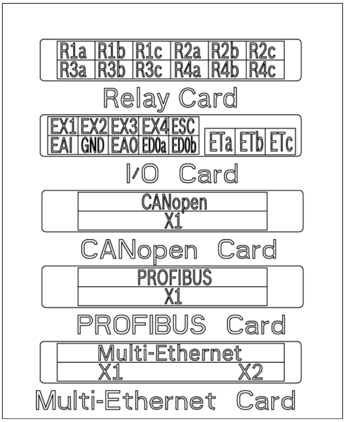


Fig. 15-9: Terminal labels of extension cards

☞

- Maximum two extension cards can be mounted in one extension card module.
- Extension cards in the two card slots CANNOT be the same.
- ONLY ONE type of communication card can be mounted in one extension card module.

15.6 I/O Module

15.6.1 I/O Card

I/O CardTerminals Label

Fig. 15-10: I/O card terminals label

I/O Card Terminals Descriptions

Terminal	Signal requirement	Description
EX1... EX4	Multi-function digital inputs: 24 VDC, 8 mA / 12 VDC, 4 mA with opto-electric couplers	See parameter group H8
ESC	–	Isolation optocouplers shared connection

Terminal	Signal requirement	Description
EAI	Voltage input range: -10...10 V* Voltage input impedance: > 20 kΩ Resolution: 1/1,000 Current input range: 0/4...20 mA Current input impedance: < 500 Ω Resolution: 1/1,000	The power supply is +5 V and +10 V from the frequency converter See parameter group H8
GND	–	Analog terminals shared connection, isolated from ESC
EAO	Voltage output range: 0...10 V Voltage output load impedance: > 2 kΩ Current output range: 0...20 mA Current output load impedance: < 500 Ω	See parameter group H8
EDOa, EDOb	Open collector output: Max. 30 VDC, 50 mA	See parameter group H8 ESC is reference
ETa, ETc	Rated capacity of relay outputs: 250 VAC, 3 A; 30 VDC, 3 A	See parameter group H8 ETb is the relay outputs shared connection
ETb		

* For -10 V input, external power supply must be provided. A frequency converter ONLY provides +5 V and +10 V.

I/O Card Terminals Wiring

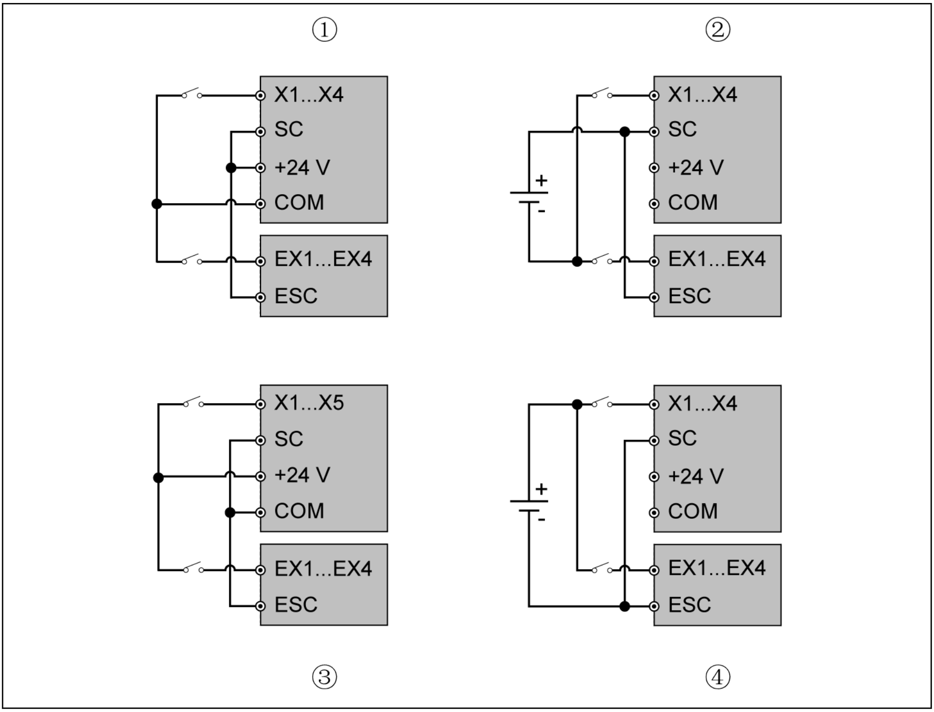


Fig. 15-11: I/O card terminals wiring

①: NPN with internal power supply

②: NPN with external power supply

③: PNP with internal power supply

④: PNP with external power supply

- X1...X5, SC, +24 V, COM are control terminals of the frequency converter
- EX1...EX4, ESC are control terminals of the I/O card.

15.6.2 Relay Card

Relay Card Terminals Label

R1a	R1b	R1c	R2a	R2b	R2c
R3a	R3b	R3c	R4a	R4b	R4c

Fig. 15-12: Relay card terminals label

Relay Card Terminals Descriptions

Terminal	Signal requirement	Description
R1a, R1c, R1b R2a, R2c, R2b R3a, R3c, R3b R4a, R4c, R4b	Rated capacity: 250 VAC, 3 A 30 VDC, 3 A	See Group H9 R1b, R2b, R3b, R4b are relay outputs shared connections

Details on Relay Card Terminals wiring , seechapter "Relay output terminals" on page 78

15.6.3 I/O Plus Card

Terminals Mapping

EX1	ESC	EX2	EX3	ESC	EX4	EX5	EDO1a	EDO1b
EAI1	GND	EAI2	GND	TSI	GND	EAO	EDO2a	EDO2b

Fig. 15-13: Terminals Mapping

Terminals Description

Terminal	Signal function	Description
EX1...EX5	Multi-function digital inputs: 24 VDC, 8 mA / 12 VDC, 4 mA with optocouplers isolation	See parameter group H8
ESC	-	Isolation optocouplers shared connection

Terminal	Signal function	Description
EAI1 / EAI2	Analog voltage / current inputs Voltage input range: -10...10 V * Input impedance: > 20 kΩ Resolution: 1/1,000 Current input range: 0/4...20 mA Input impedance: < 500 Ω Resolution: 1/1,000	The power supply is +5 V and +10 V from the frequency converter See parameter group H8
TSI	Supported sensor types: KTY 84/130, PT100, PT1000, TDK G1551_8320 (NTC)	GND is reference
GND	-	Analog terminals shared connection, isolated from ESC
EAO	Analog voltage / current outputs Voltage output range: -10...10 V Output load impedance: > 500 Ω Current output range: 0...20 mA Output load impedance: < 500 Ω	See parameter group H8
EDO1a, EDO1b, EDO2a, EDO2b	Open collector output: Max. 30 VDC, 500 mA	See parameter group H8

* For -10 V input, external power supply must be provided. A frequency converter ONLY provides +5 V and +10 V

Wiring

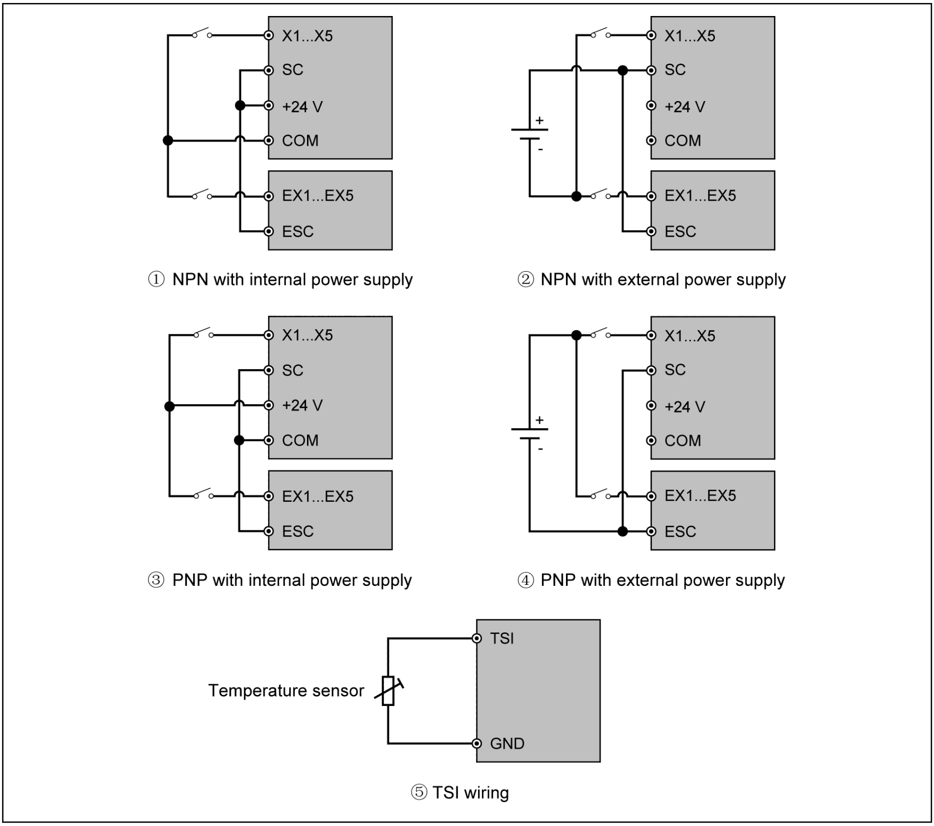


Fig. 15-14: I/O Plus Card Wiring

X1...X5, SC, +24V, and COM are control terminals of frequency converter.

EX1...EX4, ESC are control terminals of I/O Plus Card.

15.7 Communication Module

15.7.1 PROFIBUS

PROFIBUS Interface

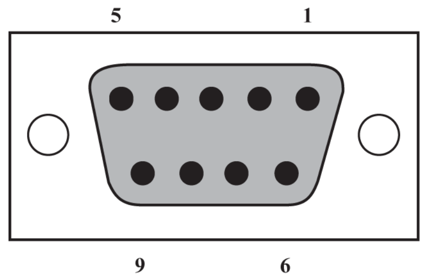


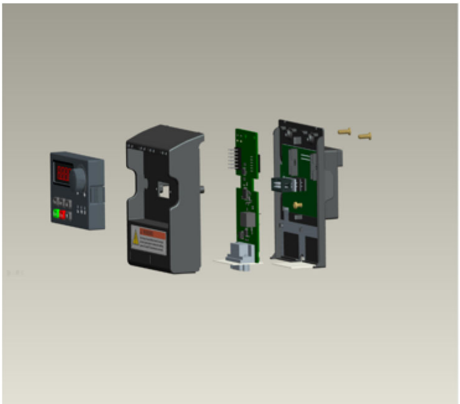
Fig. 15-15: PROFIBUS DB9 interface

Pin	Terminal sign	Terminal name	Function description
1	NC	–	Reserved
2	NC	–	Reserved
3	PROFIBUS_B	PROFIBUS terminal_B	PROFIBUS data cable B
4	RTS	Request for signal sending	–
5	GND	Power-	–
6	Vcc	Power+	–
7	NC	–	Reserved
8	PROFIBUS_A	PROFIBUS terminal_A	PROFIBUS data cable A
9	NC	–	Reserved

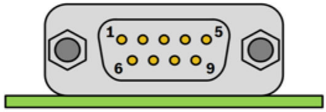
Tab. 15-2: Pin definition of PROFIBUS DB9 interface

15.7.2 CANopen Card

Interface Introduction



Pins of the DB9 connectors



Connector Pin Description

Pin #	Signal	Description
1	---	Reserved
2	CAN_L	CAN_L Bus line (dominant low)
3	CAN_V-	External bus power GND
4	---	Reserved
5	Earth	CAN cable shield
6	CAN_V-	External bus power GND
7	CAN_H	CAN_H Bus line (dominant high)
8	---	Reserved
9	---	Reserved
10	Earth	CAN cable shield

Fig. 15-16: Interface data

Cable and Connection

Please select CANopen cable type in accordance with the following instructions.

Baudrate	Max. cable length	Resistance [mΩ/m]	Cable cross section [mm^2/AWG]	Termination resistor
1,000 kbps	25m	<70	0.25...0.34 / AWG23...AWG22	120 Ω
500 kbps	100 m	< 60	0.34...0.6 / AWG22...AWG20	
250 kbps	250 m	< 40	0.5...0.6 / AWG20	
125 kbps	500 m			
50 kbps	1,000 m	< 26	0.75...0.8 / AWG18	
20 kbps	1,000 m			
10 kbps	1,000 m			

Tab. 15-3: Cable data

It is not suitable to connect frequency converter with “flat cable” and other unscreened cable types. With regards to the connection of the cable screen, it is recommended to connect to the ground at both ends of the cable at every CANopen slave node. Low impedance ground connection of high frequency screen is very important. This can be achieved by connecting to the ground with a cable clamp or a conductive cable device, such as converter shielding kit.

15.7.3 Multi-Ethernet Card

Multi-Ethernet Interface

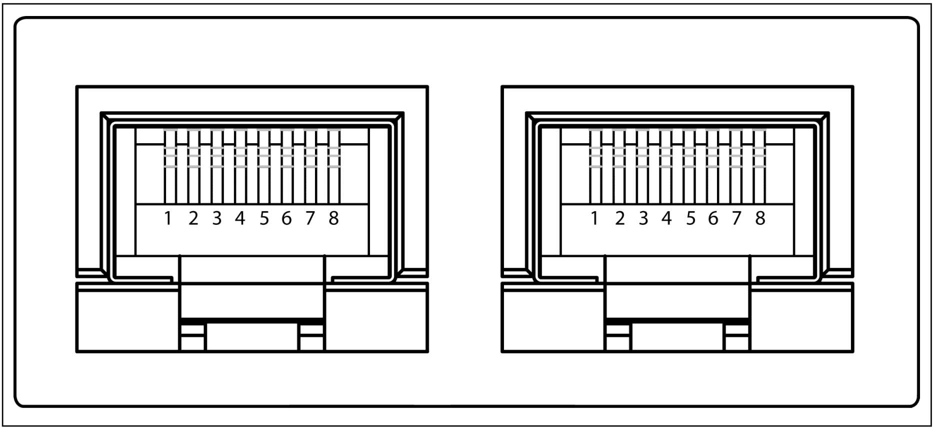


Fig. 15-17: Multi-Ethernet RJ45 interface

Pin	Terminal sign	Function description
1	RX+	Data receiving terminal (+)
2	RX-	Data receiving terminal (-)
3	TX+	Data transmission terminal (+)
4	NC	Not used
5	NC	Not used
6	TX-	Data transmission terminal (-)
7	NC	Not used
8	NC	Not used

Tab. 15-4: Pin definition of Multi-Ethernet RJ45 interface

Hardware Installation

Hardware Description

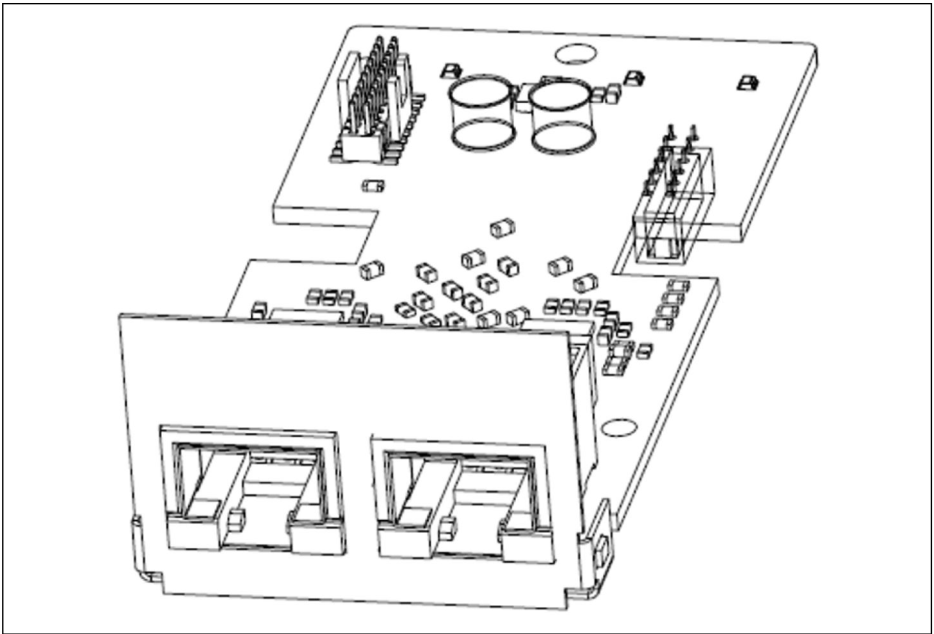


Fig. 15-18: Hardware illustration

The MEP extension card is provided with two shielded female RJ45 connectors.

Installing the Card in Frequency Converter

The MEP extension card must be installed in combination with the extension card module in the EFCx610 frequency converter. For details, please refer to Extension Card Module Mounting Instructions.

⚠ CAUTION

The MEP extension card does not support hot plug.

Cables

At least CAT 5e standard Ethernet cable is required for data transmission. The shielded cables are recommended for the use in industrial environments.

The transmission rate is fixed at 100 Mbps.

Power Supply

Please make sure the power of main circuit is supplied during commissioning and firmware updating. Once the AC power loss and the DC_IN terminal is connected (refer to chapter 8.3.2 "Control Terminals" of EFC x610 Operating Instructions), frequency converter goes to the 24 V mode.

In 24 V mode, the ability to start and keep running the fieldbus network without AC power supply is supported. However, 24 V mode is not applicable for parametrization of EFC x610.

The features of 24 V mode are concluded as below:

- 24 V mode is available since the firmware of EFC 03V18 and MEP 01V06.
- 24 V mode condition can be detected by reading extended status word H0.02.
- Power on the frequency converter at least once to enable 24 V mode, usually at commissioning or hardware changing.
- Firmware update, default parameter loading, parameter backup and parameter restore are not supported in 24 V mode.
- The parameters of power control board are not accessible (refer to the table in chapter 8.3.2 "Control Terminals" of EFC x610 Operating Instructions), and all the parameters are not writable in 24 V mode.

15.8 Encoder Card Module

15.8.1 ABZ Encoder Card

Start

ABZ (HTL / TTL) encoder card is one standard extension card for Rexroth frequency converter series of EFC 5610. This ABZ (HTL / TTL) encoder card has to be used with extension card module together.

Technical Data

Encoder power supply	5 V ± 5 % (200 mA), 12 V ± 5 % (150 mA)
Maximum input pulse frequency	300 kHz
Pulse input voltage	5...24 V
Connector type	Quick connectors
Pulse output	1:1 push-pull output

Tab. 15-5:

Extension Card Mounting

⚠ CAUTION **Risk of device damage!**

Do not mount the extension card when frequency converter is powered on, otherwise it will cause damage to the extension card.

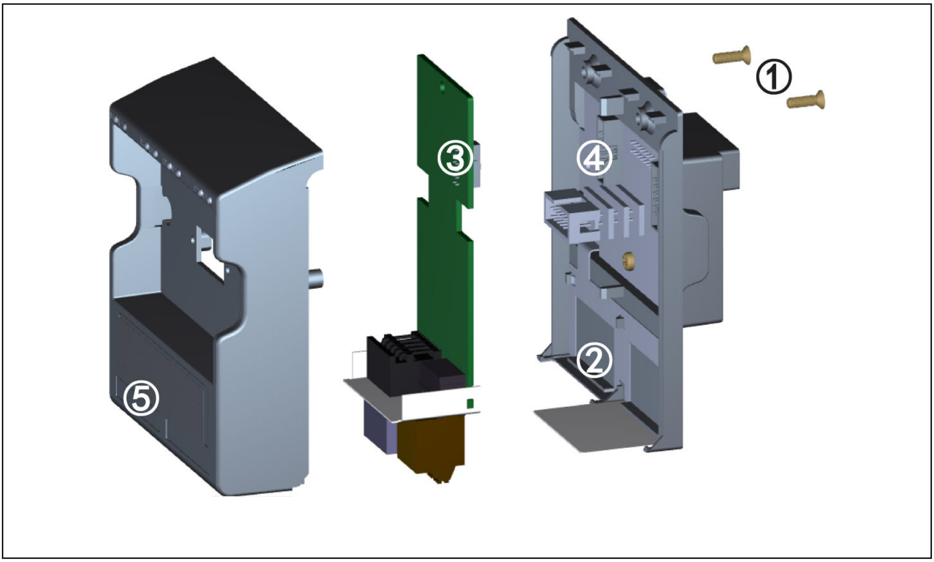


Fig. 15-19:

1. Remove 2-M3 screws ① on back of the extension card module.
2. Remove the front cover of the extension card module.
3. Insert one extension card into the card slot with the metal plate beside the extension card terminals placed in ②.
4. Push the extension card to achieve a stable connection of connector ③ (on the back side of the extension card) with connector ④ (on the extension card module).
5. Mount the front cover of the extension card module.
6. Tighten 2-M3 screws ① of the extension card module.
7. Attach an appropriate terminal label on the label indentation ⑤ located at the lower section of the front cover.

Terminals Mapping

A+	A-	B+	B-	Z+
PE	E5V	ECOM	E12V	Z-

OA	OB	OZ
GND	IN24V	PE

Fig. 15-20:

Terminals Description

Interface	Terminal	Signal function	Description	Signal requirement
Encoder interface	E5V	Encoder power supply 5V	ECOM is reference	Max. output current: 200 mA
	E12V	Encoder power supply 12V		Max. output current: 150 mA
	ECOM	Shared connection of encoder power supply	Isolated from GND	-
	A+	Encoder output signal A+	ECOM is reference	Input voltage range: 5...24 V Max. input pulse frequency: 300 kHz
	A-	Encoder output signal A-		
	B+	Encoder output signal B+		
	B-	Encoder output signal B-		
	Z+	Encoder output signal Z+		
	Z-	Encoder output signal Z-		
	PE	Shielding connection	Connected with grounding terminals on heatsink internally	-
Pulse output interface	OA	Pulse output A	GND is reference (External 24V power supply has to be supplied to terminal IN24V)	Output pulse voltage: 24 V Max. output current: 50 mA
	OB	Pulse output B		
	OZ	Pulse output Z		
	IN24V	External power supply	External 24V (± 5 %) power supply (not from the frequency converter) input to OA, OB and OZ	-
	GND	Shared connection of pulse output	Isolated from ECOM	-
	PE	Shielding connection	Connected with grounding terminals on heatsink internally	-

Tab. 15-6:

Wiring

Differential Pulse Input Wiring

Encoder power supply		Reference
Source option	Voltage	
Internal	5 V	Wiring 1
	12 V	Wiring 2
External	5...24 V	Wiring 3

Tab. 15-7:

1. Please make sure that the power supply has been switched off before wiring.
2. Please check the required voltage of encoder before power on, higher voltage than required will damage the encoder.
3. Using shielded twisted-pair cable as encoder signal cable.
4. Twisted-pair strictly in accordance with the differential pairs on the wiring.
5. Encoder cable shield should be connected to the PE terminal of encoder card.
6. Encoder cable and motor power cable have to be routed separately from each other.

Wiring 1

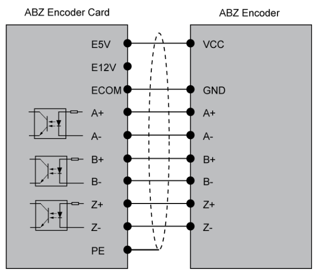


Fig. 15-21:

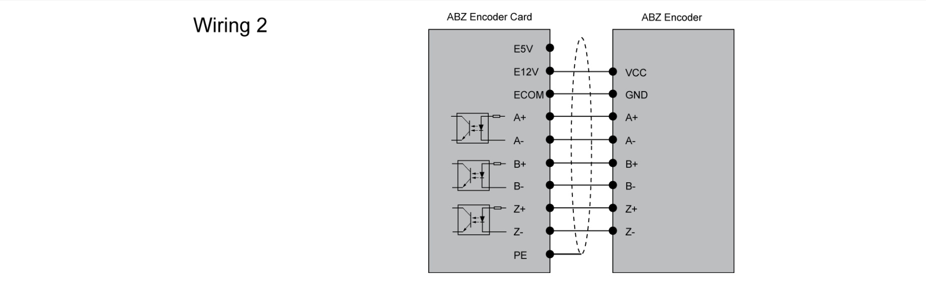


Fig. 15-22:

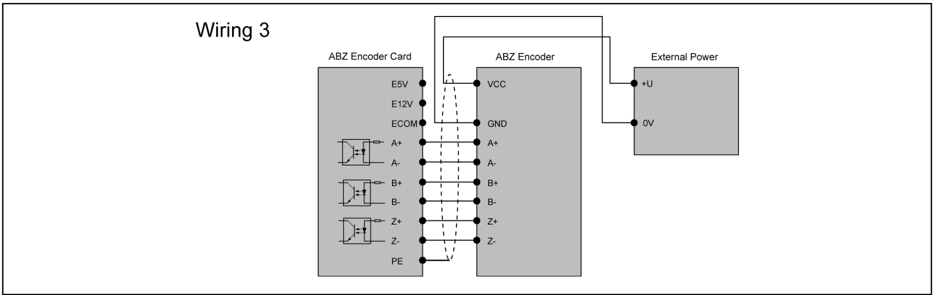


Fig. 15-23:

OC Pulse Input Wiring

Encoder power supply		Interface	Reference
Source option	Voltage		
Internal	5 V	NPN OC	Wiring 4
	5 V	PNP OC	Wiring 5
	12 V	NPN OC	Wiring 6
	12 V	PNP OC	Wiring 7
External	5...24 V	NPN OC	Wiring 8
	5...24 V	PNP OC	Wiring 9

Tab. 15-8:

☞

1. Please make sure that the power supply has been switched off before wiring.
2. Please check the required voltage of encoder before power on, higher voltage than required will damage the encoder.
3. Using shielded twisted-pair cable as encoder signal cable.
4. Each input channel (A, B, Z) should use a separated twisted-pair cable. The unused wires should be connected to ECOM.
5. Encoder cable shield should be connected to the PE terminal of encoder card.
6. Encoder cable and motor power cable have to be routed separately from each other.
7. Due to the electrical characteristics of the collector, the rising edge of the signal changes slowly. Signal transmission distance of this kind of encoder is usually less than 50m. For applications where the cable length is greater than 50m, it is recommended to use the differential output encoder, rather than the collector output encoder.

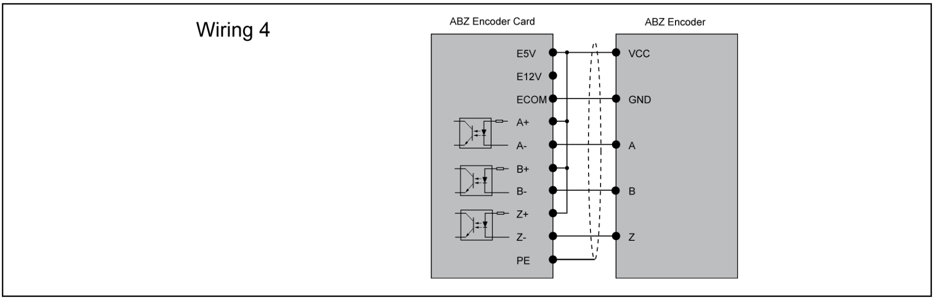


Fig. 15-24:

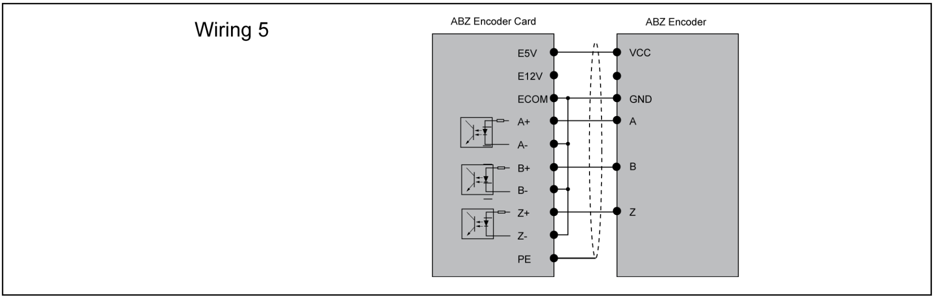


Fig. 15-25:

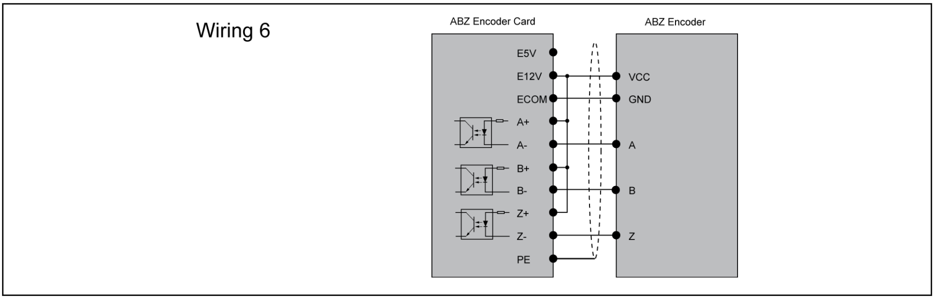


Fig. 15-26:

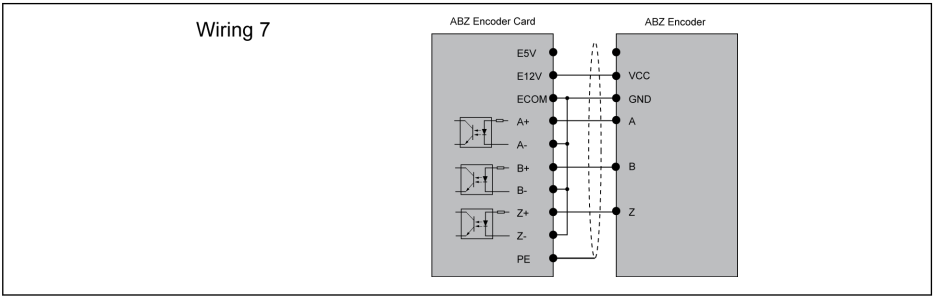


Fig. 15-27:

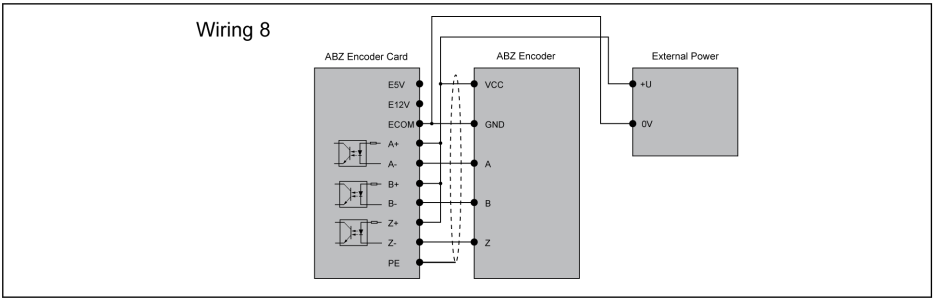


Fig. 15-28:

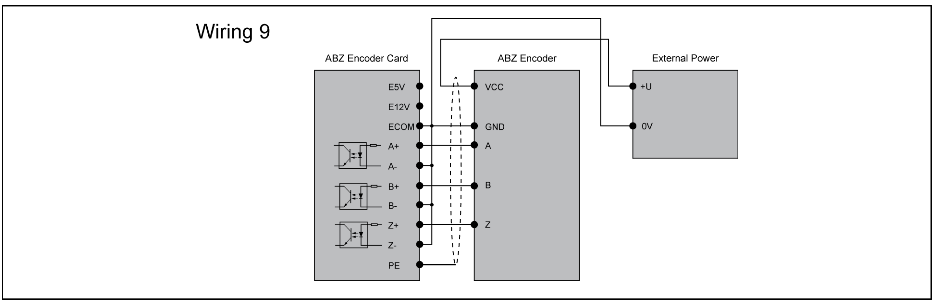


Fig. 15-29:

Push-pull Pulse Output Wiring

Encoder power supply		Output	Reference
Source option	Voltage		
External	24 V	Pull up	Wiring 10
External	24 V	Pull down	Wiring 11

Tab. 15-9:

1. Please make sure that the power supply has been switched off before wiring.
2. Please check input pulse voltage of PLC before power on.
3. Using shielded twisted-pair cable as output signal cable.
4. Signal cable shield should be connected to the PE terminal of encoder card.

Wiring 10

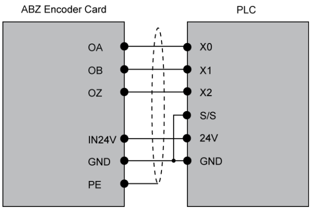


Fig. 15-30:

Wiring 11

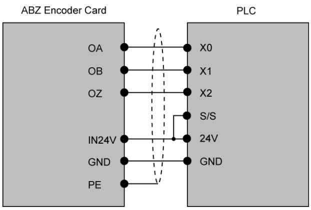


Fig. 15-31:

Cable Length

Cable length (m)	Cable cross	
	AWG	mm^2

10	≤ 24	≥ 0.205
20		
30		
40		
50		
60		
70	≤ 23	≥ 0.258
80		
90	≤ 22	≥ 0.326
100		

Tab. 15-10:

Type Code

Typecode	Description
FEAE04.1-EN1-NNNN	EFC 5610 ABZ (HTL / TTL) encoder card
FEAE02.1-EA-NNNN	EFC 5610 extension card module

Tab. 15-11:

15.8.2 Resolver Card

Start

Resolver card is one standard extension card for Rexroth frequency converter series of EFC 5610. This resolver card has to be used with extension card module together.

Technical Data

Resolver power supply	Voltage	5 Vrms
	Frequency	10 kHz
Resolver card input signal	Voltage	1.7...2.8 Vrms
	Frequency	10 kHz
Connector type		DB9 (Female)
Transformation ratio		0.35...0.55

Tab. 15-12:

Terminals Mapping

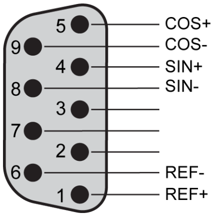


Fig. 15-32:

Terminals Description

Pin number	Terminal	Signal function
Pin 1	REF+	Resolver excitation +
Pin 6	REF-	Resolver excitation -
Pin 4	SIN+	Resolver feedback SIN+
Pin 8	SIN-	Resolver feedback SIN-
Pin 5	COS+	Resolver feedback COS+
Pin 9	COS-	Resolver feedback COS-

Tab. 15-13:

Wiring

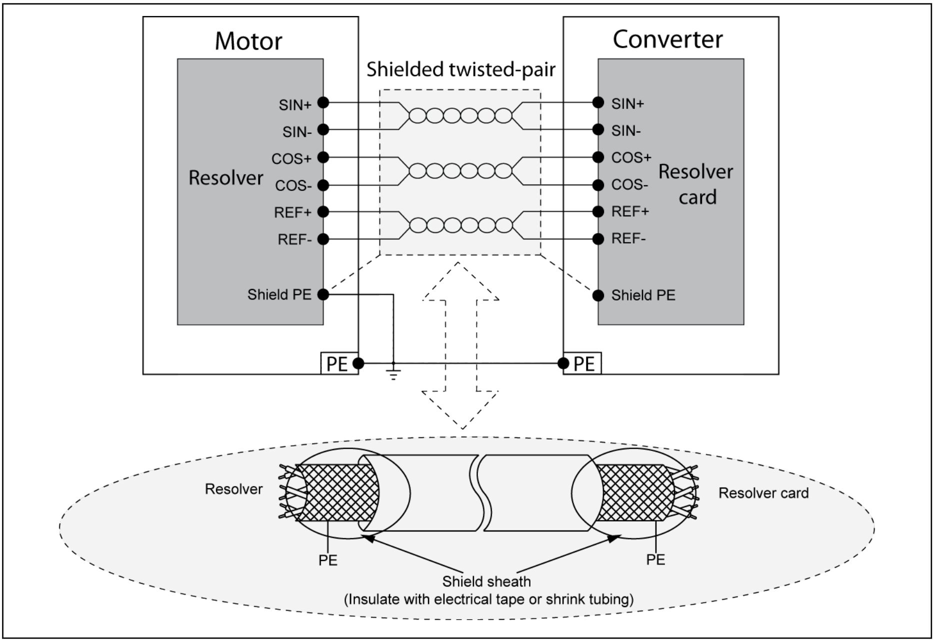


Fig. 15-33:

☞ Connect the wire according to the diagram above strictly and ensure:

1. The power supply of frequency converter has been switched off before wiring.
2. Motor and frequency converter must grounded.
3. Using shielded twisted-pair cable. Twisted-pair strictly in accordance with the differential pairs on the wiring.
4. Resolver cable and motor power cable have to be routed separately from each other.
5. The maximum length of the resolver cable is 50 m.
6. The PE terminal of the resolver card is connected to the metal shell of the DB9 interface.

Type Code

Typecode	Description
FEAE04.1-EN2-NNNN	EFC 5610 resolver card
FEAE02.1-EA-NNNN	EFC 5610 extension card module

Tab. 15-14:

15.9 Plug-in Connector for Control Section

For details on plug-in connector FEAE05.1-B2-NNNN, see fig. 8-9 "Control circuit terminals" on page 72.

15.10 External Mains EMC Filter

15.10.1 External Mains EMC Filter Type

EFC x610 model	External mains EMC filter type
0K40-1P2	FCAF01.1A-A050-E-0010-N-03-NNNN (0010-N-03)
0K75-1P2	
1K50-1P2	FCAF01.1A-A050-E-0020-N-03-NNNN (0020-N-03)
2K20-1P2	FCAF01.1A-A050-E-0025-N-03-NNNN (0025-N-03)
0K40-3P2	FCAF01.1A-A050-E-0025-A-05-NNNN (0025-A-05)
0K75-3P2	
1K50-3P2	
2K20-3P2	
3K00-3P2	FCAF01.1A-A050-E-0036-A-05-NNNN (0036-A-05)
4K00-3P2	
5K50-3P2	FCAF01.1A-A050-E-0066-A-05-NNNN (0066-A-05)
7K50-3P2	
11K0-3P2	FCAF01.1A-A050-E-0090-A-05-NNNN (0090-A-05)
0K40-3P4	FCAF01.1A-A050-E-0025-A-05-NNNN (0025-A-05)
0K75-3P4	
1K50-3P4	
2K20-3P4	
3K00-3P4	
4K00-3P4	
5K50-3P4	FCAF01.1A-A050-E-0036-A-05-NNNN (0036-A-05)
7K50-3P4	
11K0-3P4	FCAF01.1A-A050-E-0050-A-05-NNNN (0050-A-05)
15K0-3P4	
18K5-3P4	FCAF01.1A-A050-E-0066-A-05-NNNN (0066-A-05)
22K0-3P4	FCAF01.1A-A050-E-0090-A-05-NNNN (0090-A-05)
30K0-3P4	FCAF01.1A-A100-E-0120-A-05-NNNN (0120-A-05)
37K0-3P4	
45K0-3P4	FCAF01.1A-A100-E-0250-N-05-NNNN (0250-N-05)
55K0-3P4	

EFC x610 model	External mains EMC filter type
75K0-3P4	FCAF01.1A-A100-E-0320-N-05-NNNN (0320-N-05)
90K0-3P4	
110K-3P4	FCAF01.1A-A100-E-0400-N-05-NNNN (0400-N-05)
132K-3P4	
160K-3P4	

Tab. 15-15: External mains EMC filter type

- Only mount the external mains EMC filter FCAF vertically. Keep at least 80 mm above the top and below the bottom of the external mains EMC filter free from mounted parts.
- For EMC performance with the external mains EMC filter, see chapter 6.2.3 "Maximum Length of Motor Cables" on page 34.

15.10.2 Technical Data

Dimensions

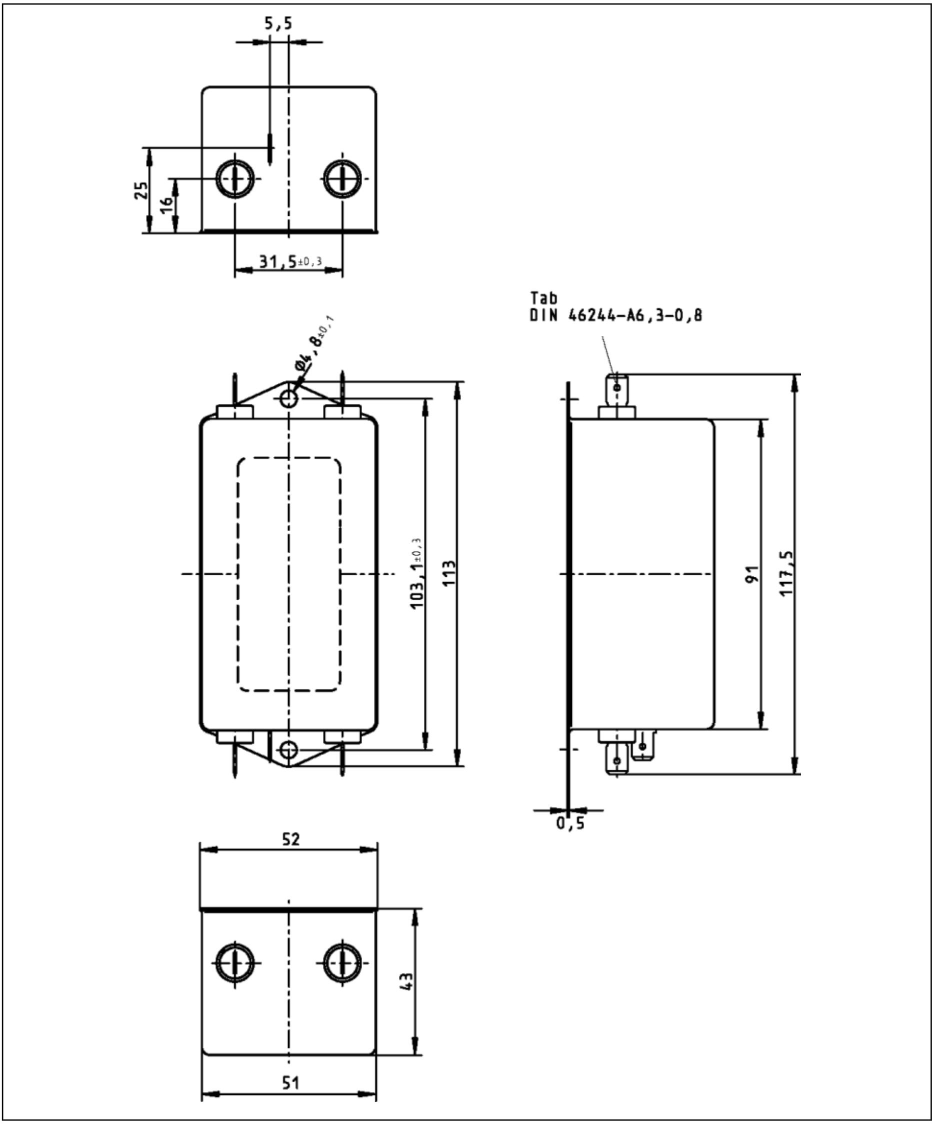


Fig. 15-34: 0010-N-03

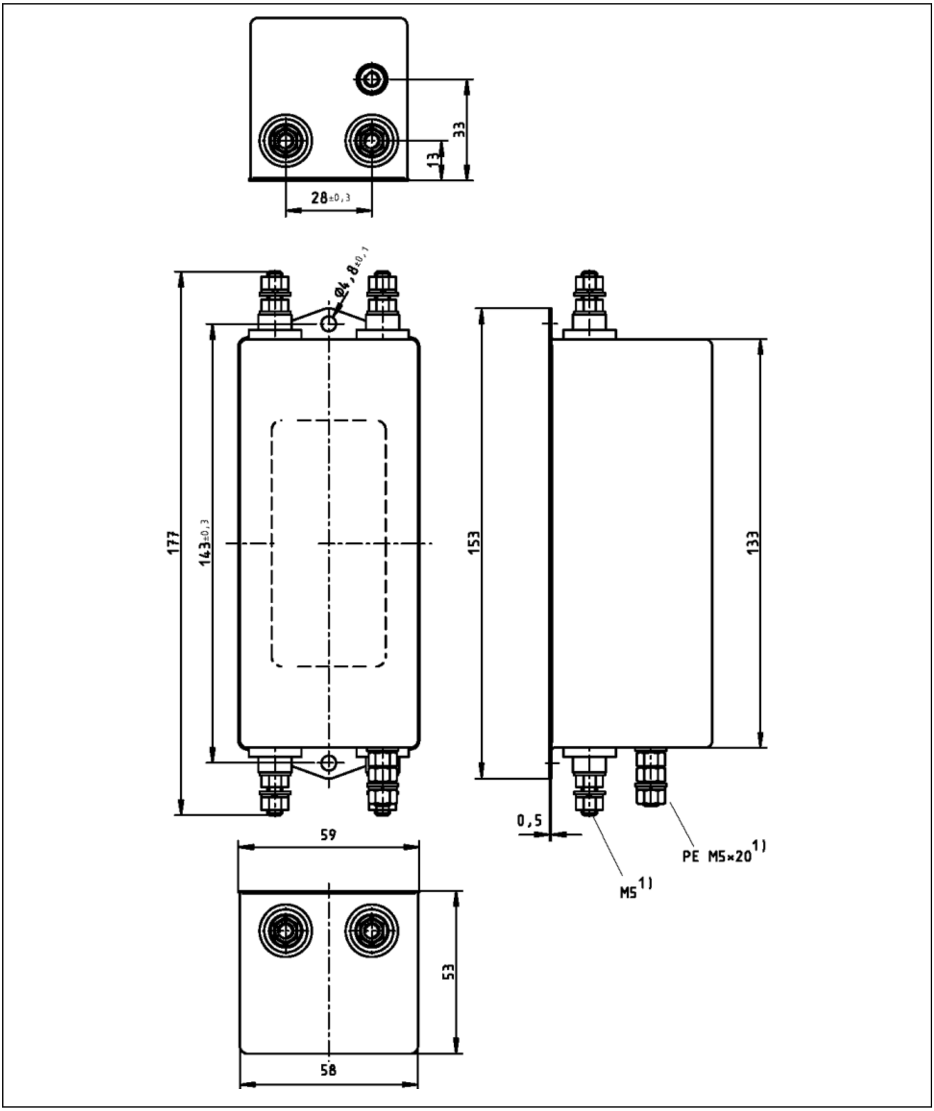


Fig. 15-35: 0020-N-03, 0025-N-03

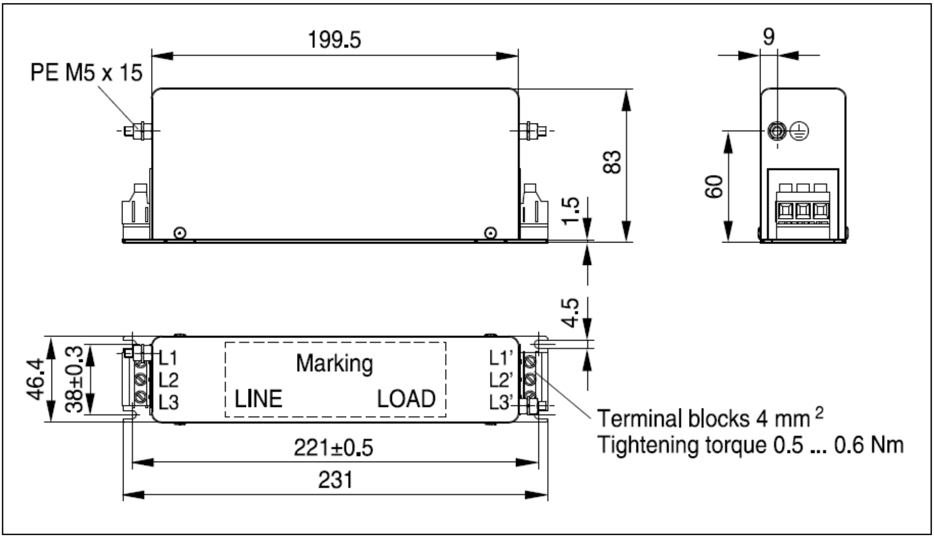


Fig. 15-36: 0025-A-05

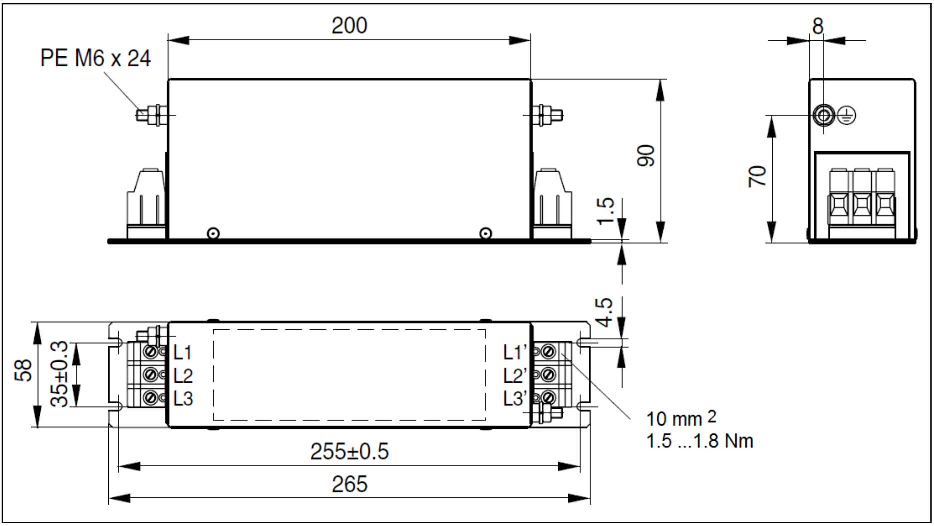


Fig. 15-37: 0036-A-05, 0050-A-05

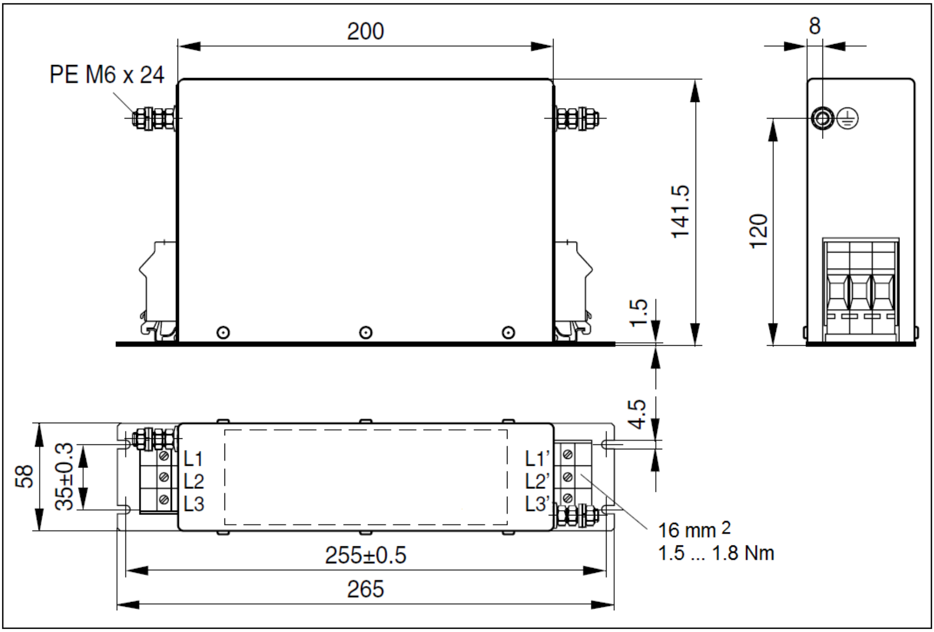


Fig. 15-38: 0066-A-05

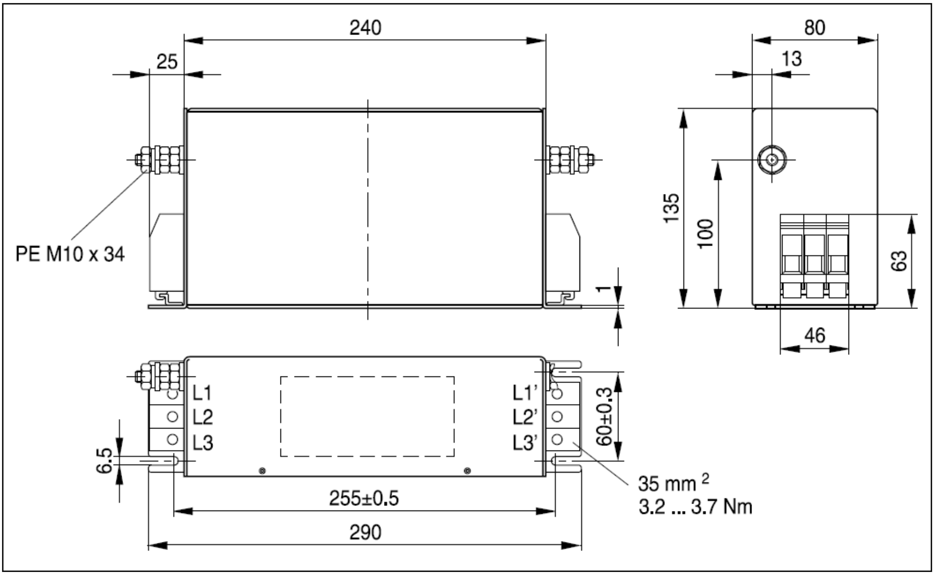


Fig. 15-39: 0090-A-05

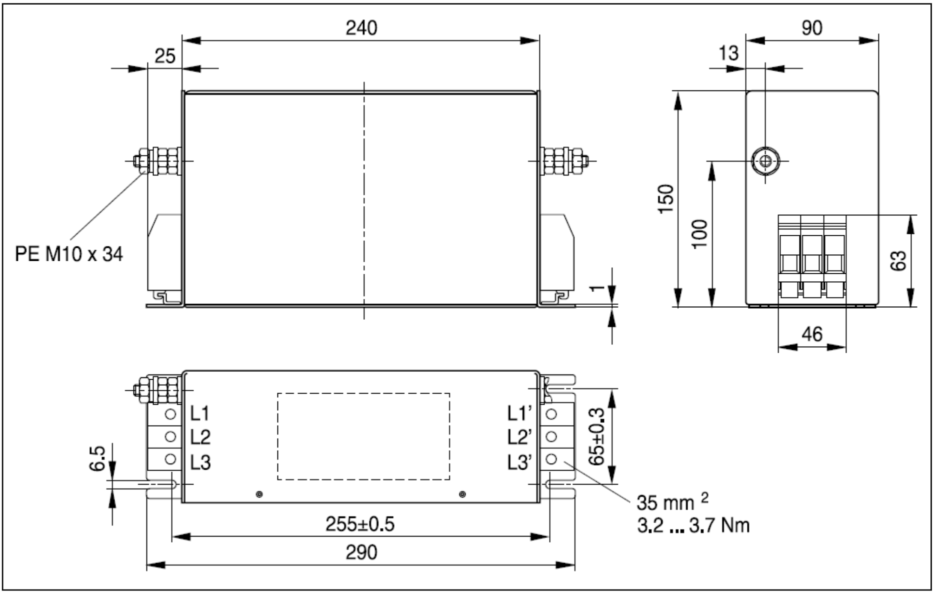


Fig. 15-40: 0120-A-05

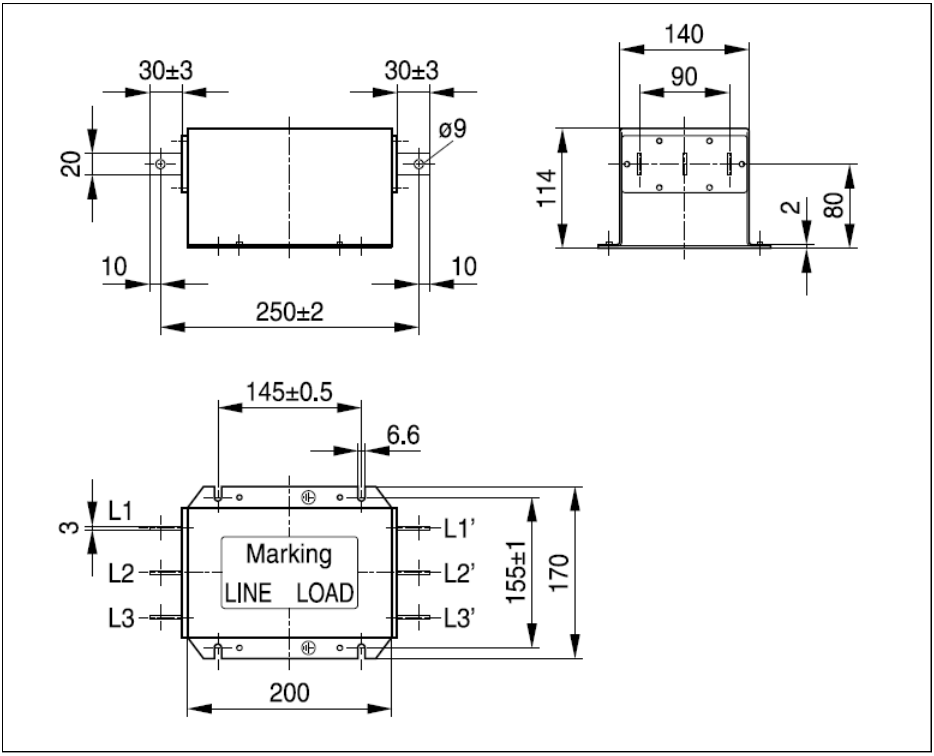


Fig. 15-41: 0250-N-05

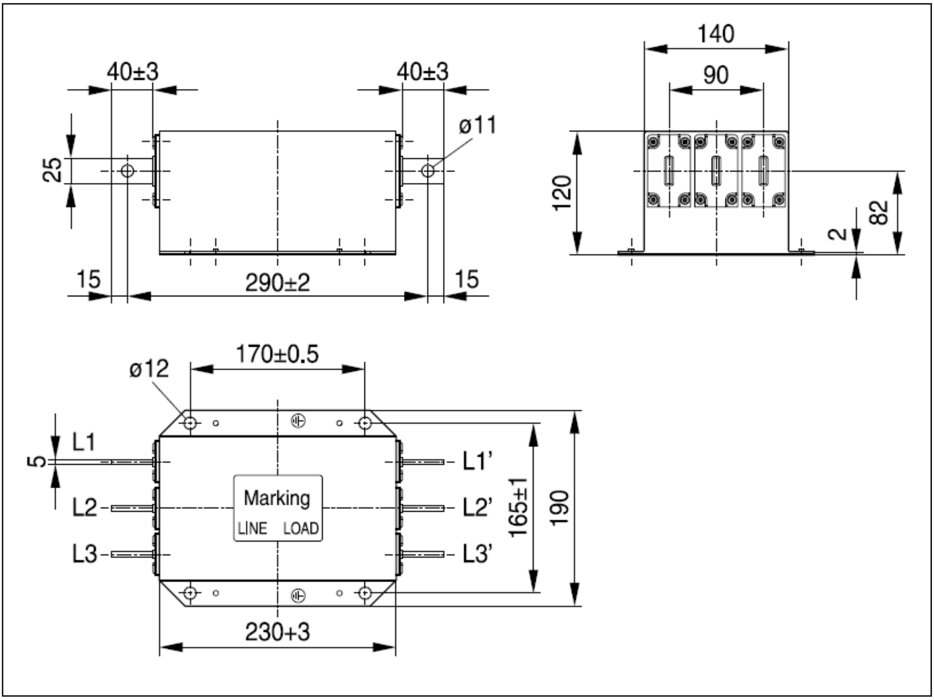


Fig. 15-42: 0320-N-05, 0400-N-05

Electric data

Electric data of EMC filter for 1P 200 VAC models

☞ When using EMC filters in **mains grounded via outer conductor**, use an isolating transformer between mains and EMC filter.

Description	Symbol	Unit	0010-N-03	0020-N-03	0025-N-03
Degree of protection according to IEC 60529	–	–	IP 20		
Listing according to UL standard (UL)	–	–	UL 1283		
Listing according to CSA standard (UL)	–	–	C22.2 No.8		
Mass (weight)	m	kg	0.42	0.86	0.87
Mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	200...240		
Mains voltage at Corner- grounded-Delta mains	U_{LN}	V	Not allowed		
Mains voltage at IT mains	U_{LN}	V	Not allowed		
Tolerance U_{LN} (UL)	–	–	-10...+10 %		
Input frequency (UL)	f_{LN}	Hz	50...60		
Nominal current	I_{L_cont}	A	10	20	25
Calculation of leakage current	I_{leak}	mA	< 0.5	< 3.5	< 3.5
Required wire size according to IEC 60364-5-52; at I_{L_cont}	A_{LN}	mm^2	2	3.5	5.3
Required wire size according to UL 508 A (internal wiring); at I_{L_cont} (UL)	A_{LN}	AWG	14	12	10

Tab. 15-16: 1P 200 VAC electric data

Electric data of EMC filter for 3P 200 VAC / 3P 380 VAC models

Description	Symbol	Unit	0025-A-05	0036-A-05	0050-A-05	0066-A-05	0090-A-05
Degree of protection according to IEC 60529	–	–	IP 20				
Listing according to UL standard (UL)	–	–	UL 1283				
Listing according to CSA standard (UL)	–	–	C22.2 No.8				
Mass (weight)	m	kg	1.1	1.75	1.75	2.70	4.20
Mains voltage three-phase at TN-S, TN-C, TT mains	U_{LN}	V	380...480				
Mains voltage three-phase at Corner- grounded-Delta mains	U_{LN}	V	Not allowed				
Mains voltage three-phase at IT mains	U_{LN}	V	Not allowed				
Tolerance U_{LN} (UL)	–	–	-15...+10 %				
Input frequency (UL)	f_{LN}	Hz	50...60				
Nominal current	I_{L_cont}	A	25	36	50	66	90
Calculation of leakage current	I_{leak}	mA	4.7	4.7	4.7	4.7	5
Required wire size according to IEC 60364-5-52; at I_{L_cont}	A_{LN}	mm^2	4	10	10	16	35
Required wire size according to UL 508 A (internal wiring); at I_{L_cont} (UL)	A_{LN}	AWG	10	6	6	6 (2)	1

Tab. 15-17: 3P 200 / 3P 380 VAC electric data

Description	Symbol	Unit	0120-A-05	0250-N-05	0320-N-05	0400-N-05
Degree of protection according to IEC 60529	–	–	IP 20			
Listing according to UL standard (UL)	–	–	UL 1283			
Listing according to CSA standard (UL)	–	–	C22.2 No.8			
Mass (weight)	m	kg	4.90	5.00	7.20	7.50
Mains voltage three-phase at TN-S, TN-C, TT mains	U_{LN}	V	380...480			

Description	Symbol	Unit	0120-A-05	0250-N-05	0320-N-05	0400-N-05
Mains voltage three-phase at Corner-grounded-Delta mains	U_{LN}	V	Not allowed			
Mains voltage three-phase at IT mains	U_{LN}	V	Not allowed			
Tolerance U_{LN} (UL)	–	–	-15...+10 %			
Input frequency (UL)	f_{LN}	Hz	50...60			
Nominal current	I_{L_cont}	A	120	250	320	400
Calculation of leakage current	I_{leak}	mA	5	14	14	14
Required wire size according to IEC 60364-5-52; at I_{L_cont}	A_{LN}	mm^2	35	70	120	185.0 / 95.0*2
Required wire size according to UL 508 A (internal wiring); at I_{L_cont} (UL)	A_{LN}	AWG	1	4 / 0	350 kcmil	500 kcmil

Tab. 15-18: 3P 200 / 3P 380 VAC electric data

15.11 External Brake Resistor

15.11.1 Braking Ratio

Brake resistors with different power ratings are available to dissipate braking energy when the frequency converter is in generator mode.

The tables below list the optimal combination of frequency converter, brake resistor and the number of components required to operate one frequency converter with respect to a given moderating ratio OT.

$$OT = \frac{Tb}{Tc} * 100\%$$

OT (On Time percentage) Braking ratio
Tb Braking time
Tc Engineering cycle time in application

Fig. 15-43: Braking ratio

15.11.2 Brake Resistor Type for Braking Ratio of 10 %

The recommended brake chopper and brake resistor listed below are for braking voltage 750 V, ED = 10 % and braking torque is 100%.

Converter model		Brake resistor					Brake chopper	
		Type	Spec-ifica-tion	Nu mb er	Max. brak-ing ON time [s]	Max. brak-ing en-ergy [KWs]	Type	Number
1P 200 VAC	0K40	FCAR01.1W0060-N400R0-B-03-NNNN	400Ω /60W	1	12	7.142 4	-	-
	0K75	FCAR01.1W0100-N190R0-B-03-NNNN	190Ω / 100 W	1	12	11.90 4	-	-
	1K50	FCAR01.1W0200-N095R0-B-03-NNNN	95Ω/ 200 W	1	12	23.80 8	-	-
	2K20	FCAR01.1W0300-N065R0-B-03-NNNN	65Ω/ 300 W	1	12	35.71 2	-	-
3P 200 VAC	0K40	FCAR01.1W0100-N190R0-B-03-NNNN	190Ω / 100 W	1	12	11.90 4	-	-
	0K75	FCAR01.1W0200-N095R0-B-03-NNNN	95Ω/ 200 W	1	12	23.80 8	-	-
	1K50	FCAR01.1W0300-N065R0-B-03-NNNN	65Ω/ 300 W	1	12	35.71 2	-	-
	2K20	FCAR01.1W0500-N065R0-B-03-NNNN	65Ω/ 500 W	1	12	59.52	-	-
	3K00	FCAR01.1W1K56-N040R0-A-05-NNNN	40Ω/ 1,56 0W	1	12	224.6 4	-	-
	4K00	FCAR01.1W1K56-N040R0-A-05-NNNN	40Ω/ 1,56 0W	1	12	224.6 4	-	-

3P 200 VAC	5K00	FCAR01.1W4K00-N016R0-A-05-NNNN	16Ω /4, 000 W	1	12	422.4	-	-
	7K50	FCAR01.1W4K00-N016R0-A-05-NNNN	16Ω /4, 000 W	1	12	422.4	-	-
	11K0	FCAR01.1W6K50-N010R0-A-05-NNNN	10Ω/ 6,50 0W	1	12	686.4	-	-
3P 380 VAC	0K40	FCAR01.1W0080-N750R0-B-05-NNNN	750Ω /80W	1	12	9.523 2	-	-
	0K75	FCAR01.1W0080-N750R0-B-05-NNNN	750Ω /80W	1	12	9.523 2	-	-
	1K50	FCAR01.1W0260-N400R0-B-05-NNNN	400Ω / 260 W	1	12	30.95 04	-	-
	2K50	FCAR01.1W0260-N250R0-B-05-NNNN	250Ω / 260 W	1	12	30.95 04	-	-
	3K00	FCAR01.1W0390-N150R0-B-05-NNNN	150Ω / 390 W	1	12	46.42 56	-	-
	4K00	FCAR01.1W0390-N150R0-B-05-NNNN	150Ω / 390 W	1	12	112.3 2	-	-
	5K50	FCAR01.1W0780-N075R0-A-05-NNNN	75Ω/ 780 W	1	12	112.3 2	-	-
	7K50	FCAR01.1W0780-N075R0-A-05-NNNN	75Ω/ 780 W	1	12	112.3 2	-	-

3P 380 VAC	11K0	FCAR01.1W1K56-N040R0-A-05-NNNN	40Ω/ 1,560W	1	12	224.64	-	-
	15K0	FCAR01.1W1K56-N040R0-A-05-NNNN	40Ω/ 1,560W	1	12	224.64	-	-
	18K5	FCAR01.1W04K8-N032R0-A-05-NNNN	32Ω/ 4,800W	1	12	506.88	-	-
	22K0	FCAR01.1W3K50-N018R9-A-05-NNNN	18.9 Ω/ 3,500W	1	12	369.6	-	-
	30K0	FCAR01.1W4K00-N016R0-A-05-NNNN	16Ω/ 4,000W	1	10	352	FEAE07.1-EA1- NNNN	1
	37K0	FCAR01.1W4K00-N016R0-A-05-NNNN	16Ω/ 4,000W	1	10	352	FEAE07.1-EA1- NNNN	1
	45K0	FCAR01.1W6K50-N010R0-A-05-NNNN	10Ω/ 6,500W	1	10	572	FEAE07.1-EA1- NNNN	1
	55K0	FCAR01.1W6K50-N010R0-A-05-NNNN	10 Ω/ 6,500 W	2	10	572	FEAE07.1-EA1- NNNN	1
	75K0	FCAR01.1W10K0-N006R0-A-05-NNNN	6Ω/ 10,000W	2	10	880	FEAE07.1-EA1- NNNN	1
	90K0	FCAR01.1W10K0-N006R0-A-05-NNNN	6Ω/ 10,000W	3	10	880	FEAE07.1-EA1- NNNN	1
	110K0	FCAR01.1W12K0-N008R0-A-05-NNNN	8Ω/ 12,000W	2	10	2112	FEAE07.1-EA1- NNNN	2
	132K0	FCAR01.1W12K0-N008R0-A-05-NNNN	8Ω/ 12,000W	2	10	2112	FEAE07.1-EA2- NNNN	2
	160K0	FCAR01.1W12K0-N008R0-A-05-NNNN	8Ω/ 12,000W	2	10	2112	FEAE07.1-EA2- NNNN	2

Tab. 15-19: Brake resistor type for braking ratio of 10 %

☞ Models 30K0 and up require an external brake chopper module, see documentation R912007235 for details.

15.11.3 Brake Resistor Type for Braking Ratio of 20 %

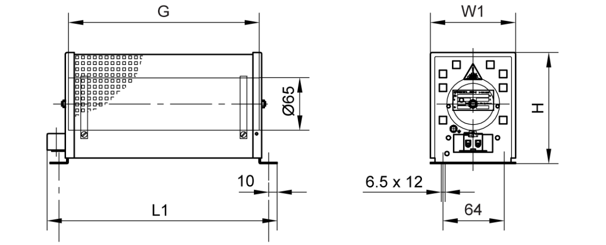
The recommended brake chopper and brake resistor listed below are for braking voltage 750 V, ED = 20 % and braking torque is 100%.

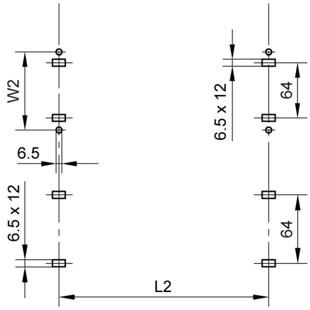
Converter model		Brake resistor				
		Type	Specifica-tion	Num-ber	Max. braking ON time [s]	Max. braking energy [KWs]
1P 200 VAC	0K40	FCAR01.1W0100-N400R0-B-03-NNNN	400 Ω / 100 W	1	12	8.64
	0K75	FCAR01.1W0200-N190R0-B-03-NNNN	190 Ω / 200 W	1	12	17.28
	1K50	FCAR01.1W0400-N095R0-B-03-NNNN	95 Ω / 400 W	1	12	34.56
	2K20	FCAR01.1W0500-N065R0-B-03-NNNN	65 Ω / 500 W	1	12	43.20
3P 200 VAC	0K40	FCAR01.1W0200-N190R0-B-03-NNNN	190 Ω / 200 W	1	12	17.28
	0K75	FCAR01.1W0400-N095R0-B-03-NNNN	95 Ω / 400 W	1	12	34.56
	1K50	FCAR01.1W0780-N075R0-A-05-NNNN	75 Ω /780 W	1	12	77.88
	2K20	FCAR01.1W1K56-N070R0-A-05-NNNN	70 Ω / 1,560 W	1	12	155.75
	3K00	FCAR01.1W1K56-N040R0-A-05-NNNN	40 Ω / 1,560 W	1	12	155.75
	4K00	FCAR01.1W1K56-N040R0-A-05-NNNN	40 Ω / 1,560 W	1	12	155.75
	5K50	FCAR01.1W4K00-N016R0-A-05-NNNN	16 Ω / 4,000 W	1	12	268.80
	7K50	FCAR01.1W4K00-N016R0-A-05-NNNN	16 Ω / 4,000 W	1	12	268.80
	11K0	FCAR01.1W6K50-N010R0-A-05-NNNN	10 Ω / 6,500 W	1	12	436.80

Converter model		Brake resistor				
		Type	Specification	Number	Max. braking ON time [s]	Max. braking energy [KWs]
3P 380 VAC	0K40	FCAR01.1W0150-N750R0-B-05-NNNN	750 Ω / 150 W	1	12	12.96
	0K75	FCAR01.1W0150-N750R0-B-05-NNNN	750 Ω / 150 W	1	12	12.96
	1K50	FCAR01.1W0520-N350R0-A-05-NNNN	350 Ω / 520 W	1	12	51.92
	2K20	FCAR01.1W0520-N230R0-A-05-NNNN	230 Ω / 520 W	1	12	51.92
	3K00	FCAR01.1W0780-N140R0-A-05-NNNN	140 Ω / 780 W	1	12	77.88
	4K00	FCAR01.1W0780-N140R0-A-05-NNNN	140 Ω / 780 W	1	12	77.88
	5K50	FCAR01.1W1K56-N070R0-A-05-NNNN	70 Ω / 1,560 W	1	12	155.75
	7K50	FCAR01.1W1K56-N070R0-A-05-NNNN	70 Ω / 1,560 W	1	12	155.75
	11K0	FCAR01.1W02K0-N047R0-A-05-NNNN	47 Ω / 2,000 W	1	12	199.68
	15K0	FCAR01.1W03K0-N034R0-A-05-NNNN	34 Ω / 3,000 W	1	12	201.60
	18K5	FCAR01.1W10K0-N028R0-A-05-NNNN	28 Ω / 10,000 W	1	12	672.00
	22K0	FCAR01.1W10K0-N028R0-A-05-NNNN	28 Ω / 10,000 W	1	12	672.00

Tab. 15-20: Brake resistor type for braking ratio of 20 %

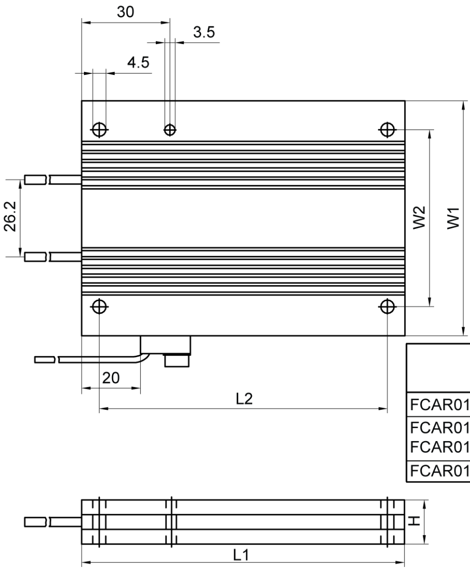
15.11.4 Brake Resistor Dimensions

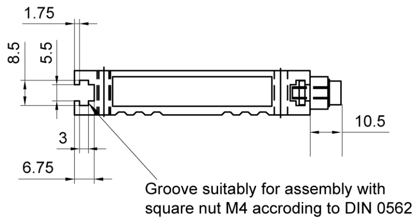




Type	Dimensions [mm]						Weight
	L1	L2	W1	W2	H	G	[kg]
FCAR01.1W0520-N350R0-A-05-NNNN FCAR01.1W0520-N230R0-A-05-NNNN	450	430	92	80	120	400	2.2
FCAR01.1W0780-N075R0-A-05-NNNN FCAR01.1W0780-N140R0-A-05-NNNN	550	530	92	80	120	500	2.7
FCAR01.1W1K56-N040R0-A-05-NNNN FCAR01.1W1K56-N070R0-A-05-NNNN	550	526	185	80	120	500	5.1
FCAR01.1W02K0-N047R0-A-05-NNNN	650	630	92	80	120	600	3.3

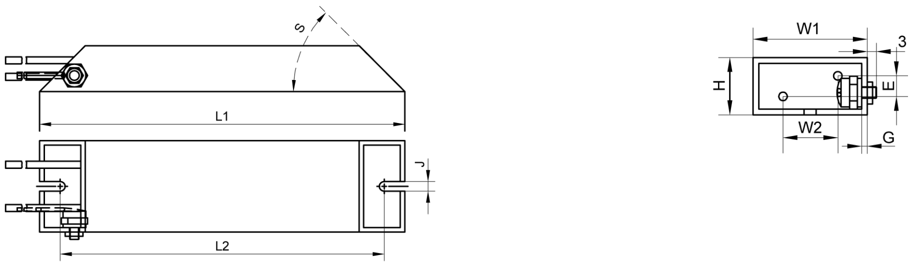
Fig. 15-44: Brake resistor dimensions_1





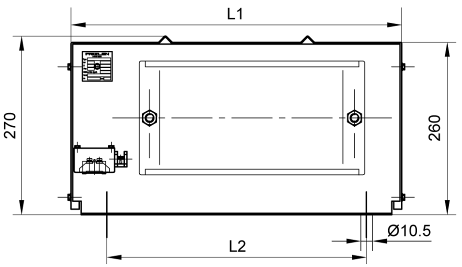
Type	Dimensions [mm]					Weight
	L1	L2	W1	W2	H	[kg]
FCAR01.1W0300-N065R0-B-03-NNNN	320	308				0.85
FCAR01.1W0390-N150R0-B-05-NNNN FCAR01.1W0400-N095R0-A-03-NNNN	420	408	80	60	15	1.10
FCAR01.1W0050-N065R0-B-03-NNNN	520	508				1.35

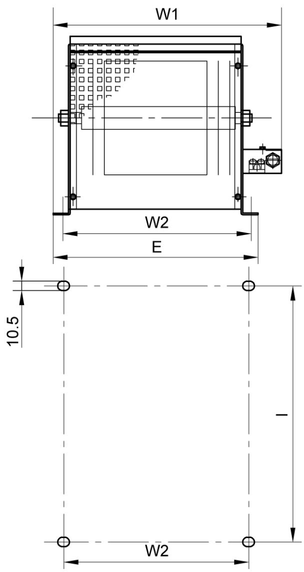
Fig. 15-45: Brake resistor dimensions_2



Type	Dimensions [mm]									Weight
	L1	L2	W1	W2	H	E	G	J	S	[g]
FCAR01.1W0060-N400R0-B-03-NNNN	150	132								215
FCAR01.1W0080-N750R0-B-05-NNNN FCAR01.1W0100-N190R0-B-03-NNNN FCAR01.1W0100-N400R0-B-03-NNNN	210	192	40	18.2	20	6.2	2	4.3	45	300
FCAR01.1W0150-N750R0-B-05-NNNN	300	282								430
FCAR01.1W0200-N095R0-B-03-NNNN FCAR01.1W0200-N190R0-B-03-NNNN FCAR01.1W0200-N195R0-B-03-NNNN	265	246	60	28.8	30	10.8	3	5.3	60	950
FCAR01.1W0260-N400R0-B-05-NNNN FCAR01.1W0260-N250R0-B-05-NNNN	335	316								1,200

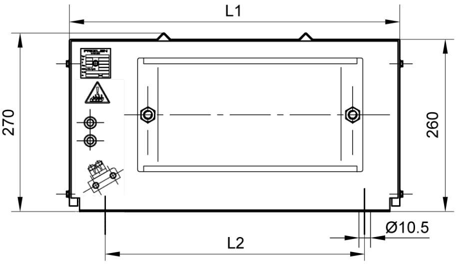
Fig. 15-46: Brake resistor dimensions_3

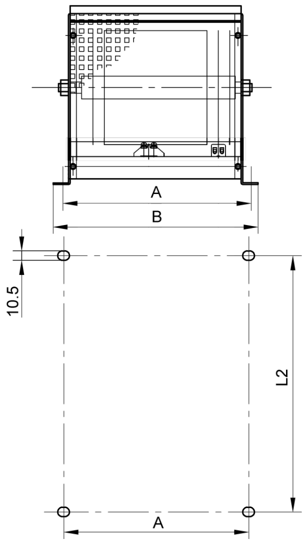




Type	Dimensions [mm]					Weight
	L1	L2	W1	W2	E	[kg]
FCAR01.1W03K0-N034R0-A-05-NNNN			330	270	295	9.5
FCAR01.1W04K8-N032R0-A-05-NNNN			430	370	395	13.0
FCAR01.1W10K0-N028R0-A-05-NNNN	490	380	630	570	595	22.0
FCAR01.1W3K50-N018R9-A-05-NNNN			355	270	295	8.5
FCAR01.1W4K00-N016R0-A-05-NNNN			355	270	295	8.5
FCAR01.1W6K50-N010R0-A-05-NNNN			455	370	395	12.0

Fig. 15-47: Brake resistor dimensions_4





Type	Dimensions [mm]				Weight
	L1	L2	A	B	[kg]
FCAR01.1W10K0-N006R0-A-05-NNNN`	490	380	570	595	22.0

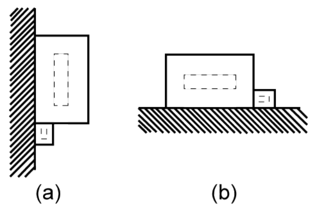
Fig. 15-48: Brake resistor dimensions_5

15.11.5 Installation of Brake Resistor

The given typical power values are valid for 100% duty cycle factor (DCF) (continuous dissipation) under the following conditions:

- Temperature rise of 200 K at the surface of fixed resistor enclosures (degree of protection > IP00)
- Temperature rise of 300 K at the surface of fixed resistor elements (degree of protection IP00)
- Unhindered access of cooling air
- Unhindered diverting of warmed up air (mind a minimum separation distance of approx. 200 mm to neighbouring components / walls and of approx. 300 mm to components above / ceiling)

The allowable mounting directions are shown as below:



(a) On vertical surfaces, terminals at the bottom
(b) On horizontal surfaces

Fig. 15-49: Mounting direction of brake resistor

15.12 Shielding Connector

The shielding layer of shielded cables must be reliably connected to the shielding terminals of the frequency converter. Accessories (connector and screws) for shielded cable connection are available for the connection convenience.

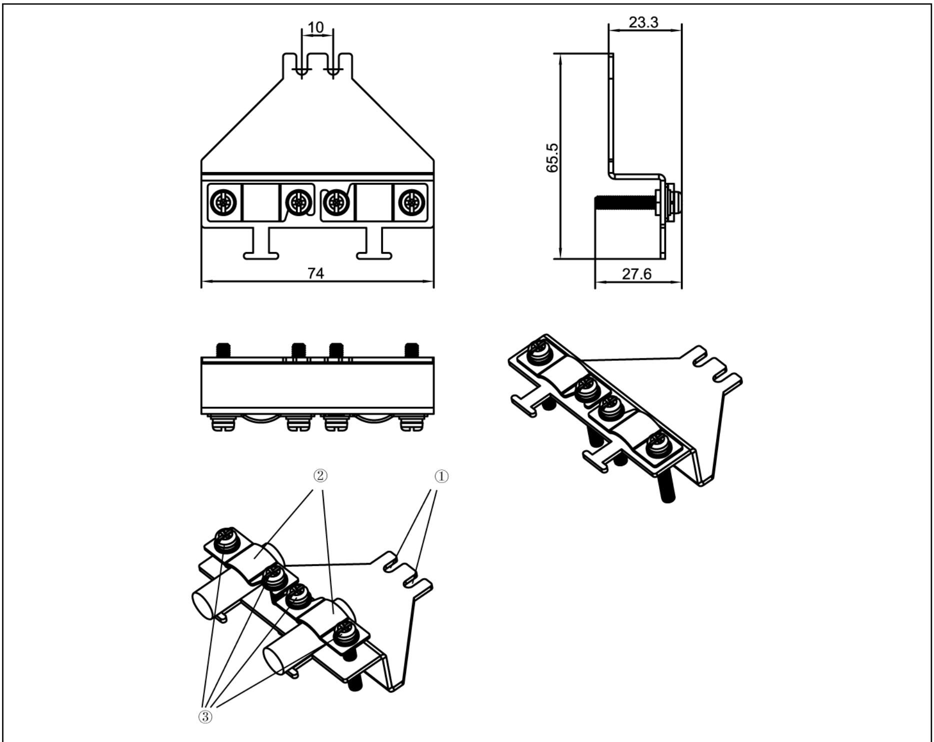


Fig. 15-50: Shielded cable connection with accessories for **B, C, D** housing (FEAM03.2-001-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the two screw holes inside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

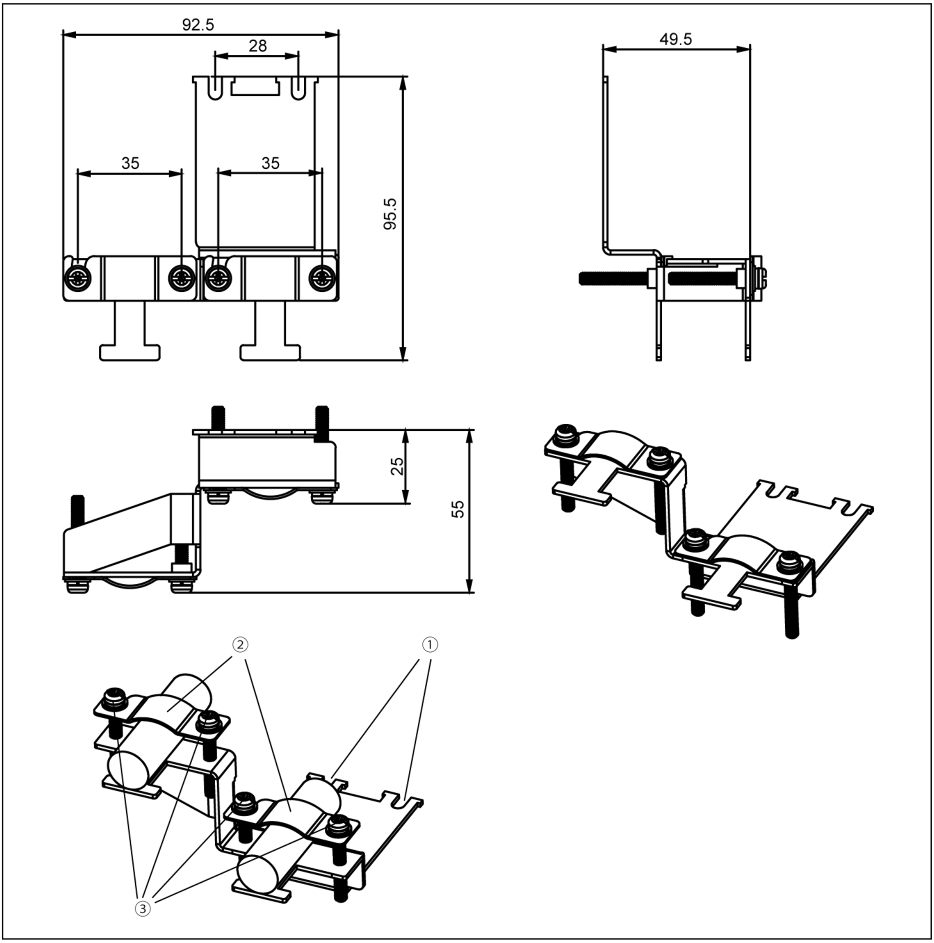


Fig. 15-51: Shielded cable connection with accessories for **E, F, G** housing (FEAM03.2-002-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the two screw holes inside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

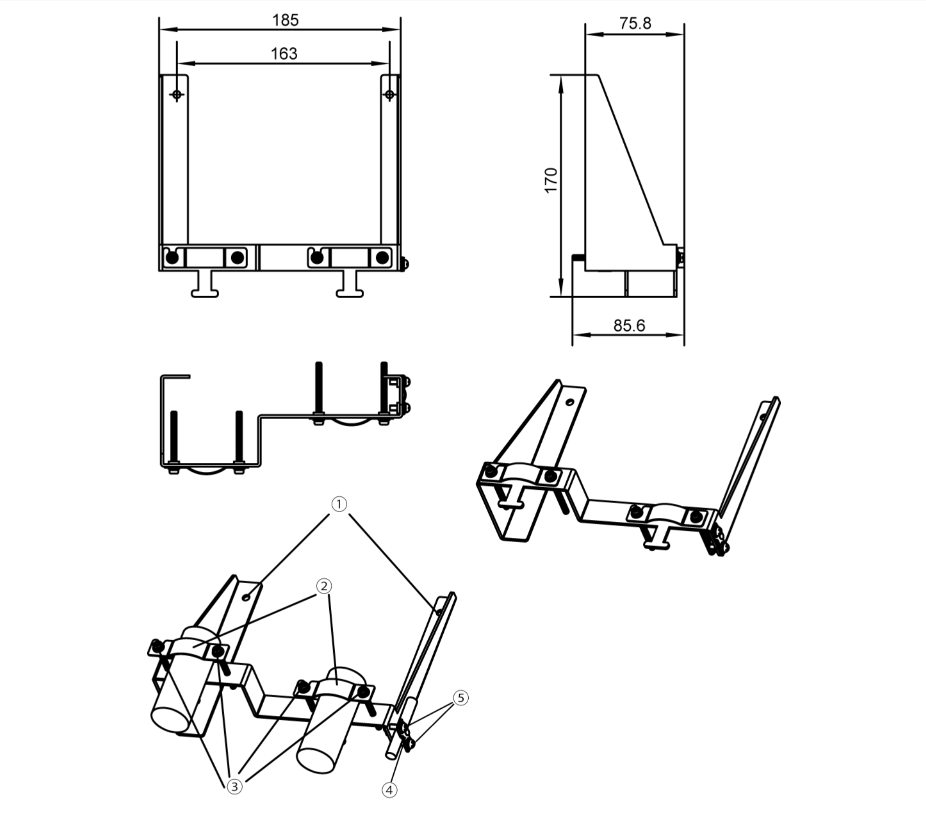


Fig. 15-52: Shielded cable connection with accessories for **H** housing (FEAM03.2-003-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

Step 4 (Optional): Insert the STO cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

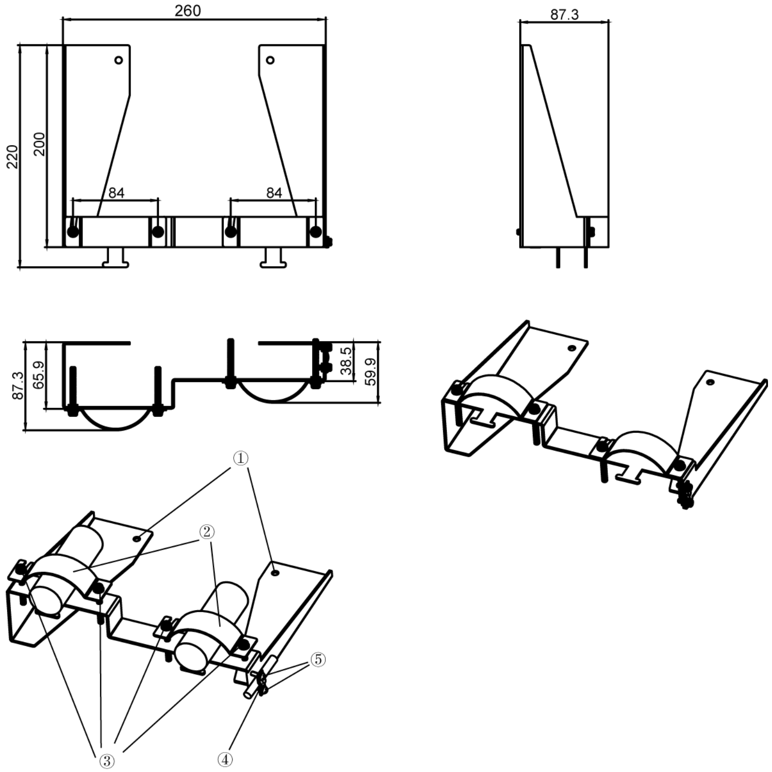


Fig. 15-53: Shielded cable connection with accessories for **I, J** housing (FEAM03.2-004-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

Step 4 (Optional): Insert the STO cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

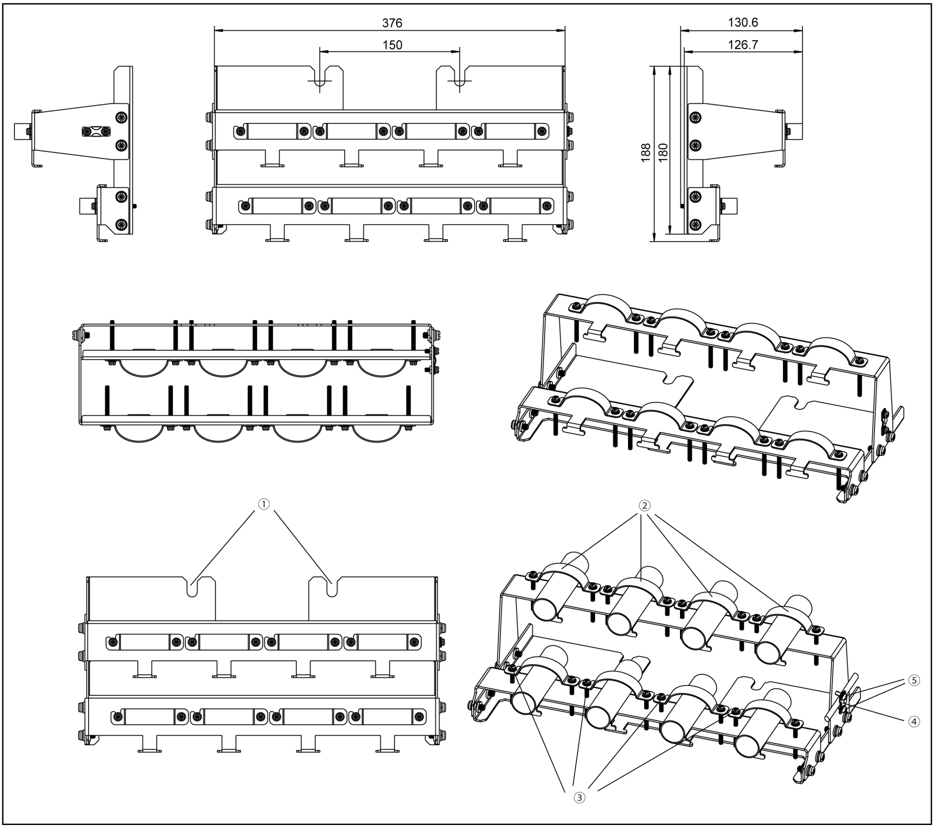


Fig. 15-54: Shielded cable connection with accessories for K housing (FEAM03.2-005-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

☞ When double cables are used, put double cables in one clamp.

Step 3: Tighten sixteen screws of the accessories.

Step 4 (Optional): Fix the STO cable to the side of shielding connector.

Step 5 (Optional): Tighten two screws of the accessories.

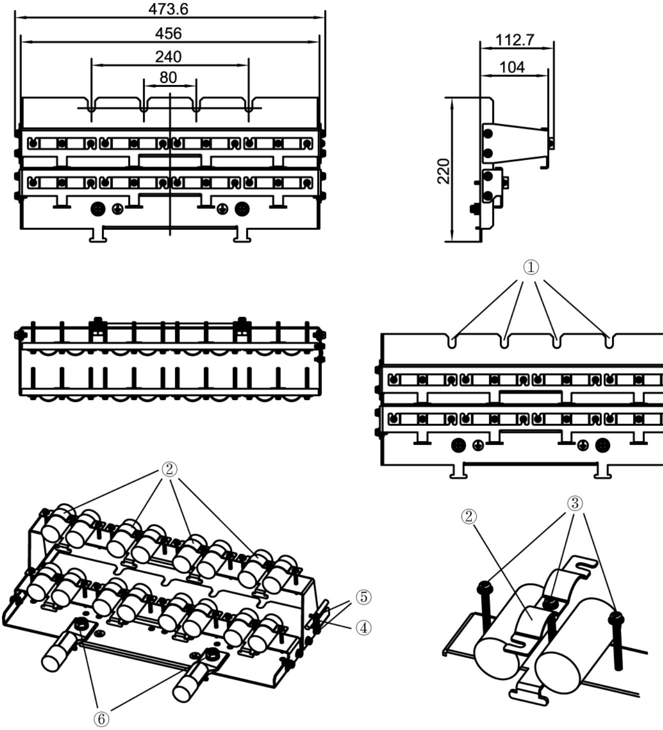


Fig. 15-55: Shielded cable connection with accessories for **L** housing (FEAM03.2-006-NN-NNNN)

Connection steps

Step 1: Place holes ① of the connector on the four screw holes at the bottom of frequency converter and tighten four screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten twenty-four screws of the accessories.

Step 4 (Optional): Fix the STO cable to the side of shielding connector.

Step 5 (Optional): Tighten two screws of the accessories.

Step 6: Connect the grounding cable to component ⑥.

16 Maintenance

16.1 Safety Instructions

⚠ WARNING

High electric voltage! Risk of death or severe bodily injury by electric shock!

- Only those trained and qualified to work with or on electric equipment are permitted to operate, maintain and repair this equipment.
- Do not operate electric equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electric parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage. Ensure that the mains voltage is not reconnected.
- In the frequency converters, capacitors are used in the DC bus as energy stores. Energy stores maintain their energy even when the supply voltage has been cut off. Frequency converters have been dimensioned in such a way that after the supply voltage was cut off, the voltage value falls below 50 V within a discharging time of a maximum of 5 minutes.

16.2 Daily Inspection

Please conduct daily inspection as indicated in the table below in order to prolong the life cycle of frequency converters.

Inspection category	Inspection item	Inspection criteria	Inspection result
Ambient conditions	Temperature	-10...55 ℃ (no frost or condensation)	
	Relative humidity	≤ 90 % (no condensation)	
	Dust, water and leakage	No heavy dust or sign of leakage (visual inspection)	
	Gas	No harmful, flammable gas or strange smell	
	Sound	No strange sound	
	Panel display	No error code	
	Others	No direct sunlight, no oil or corrosive substances around	
Converter	Status	Running stably, the outlet temperature is normal	
	Fan	No blockage or contamination	
	Terminal, screw	Wiring is correct, screw fastening without loosening	
Motor	Sound, vibration	No strange sound, no abnormal vibration	
	Temperature, color	No abnormal temperature and discoloration	

Tab. 16-1: Daily inspection list

16.3 Periodic Inspection

In addition to daily inspection, periodic inspection of frequency converters is also necessary. The inspection cycle should be less than 6 months. For operation details, please see table below:

Inspection category	Inspection item	Inspection criteria	Solution
Power supply	Voltage	Specified in nameplate	1P: 200...240 VAC (-10 % / +10 %) 3P: 380...480 VAC (-15 % / +10 %)
Power cable	Power cable	No color change or damage	Replace cable
Signal line	Signal line		Replace signal line
Terminal connection	Crimp terminal and cable / line	No loose connection	Tighten crimp and terminal screw
	Crimp terminal and terminal block		
Frequency converter	Visual appearance	No deformation	Contact with service
	Fan	No color change or deformation	Replace fan
		No blockage or contamination	Eliminate blockage and clean fan
	Cooling system (radiator, inlet, outlet)	No blockage or foreign matters	Eliminate blockage and clear foreign matters
	Printed circuit board	No dust or oil contamination No discoloration or deformation	Clean printed circuit board
	Electrolytic capacitor	No leakage, color change, crack or expansion with safety valve shut down	Replace capacitor (must be operated by service engineers)
	IGBT module	no dust, cotton or oil around the module Module without discoloration, bulge or crack	Clear foreign matters or replace module
Accessories	Connection	No loose connection	Tighten terminal screw
	Cable	No color change or damage	Replace cable

Tab. 16-2: Periodic inspection list

16.4 Expired replacement

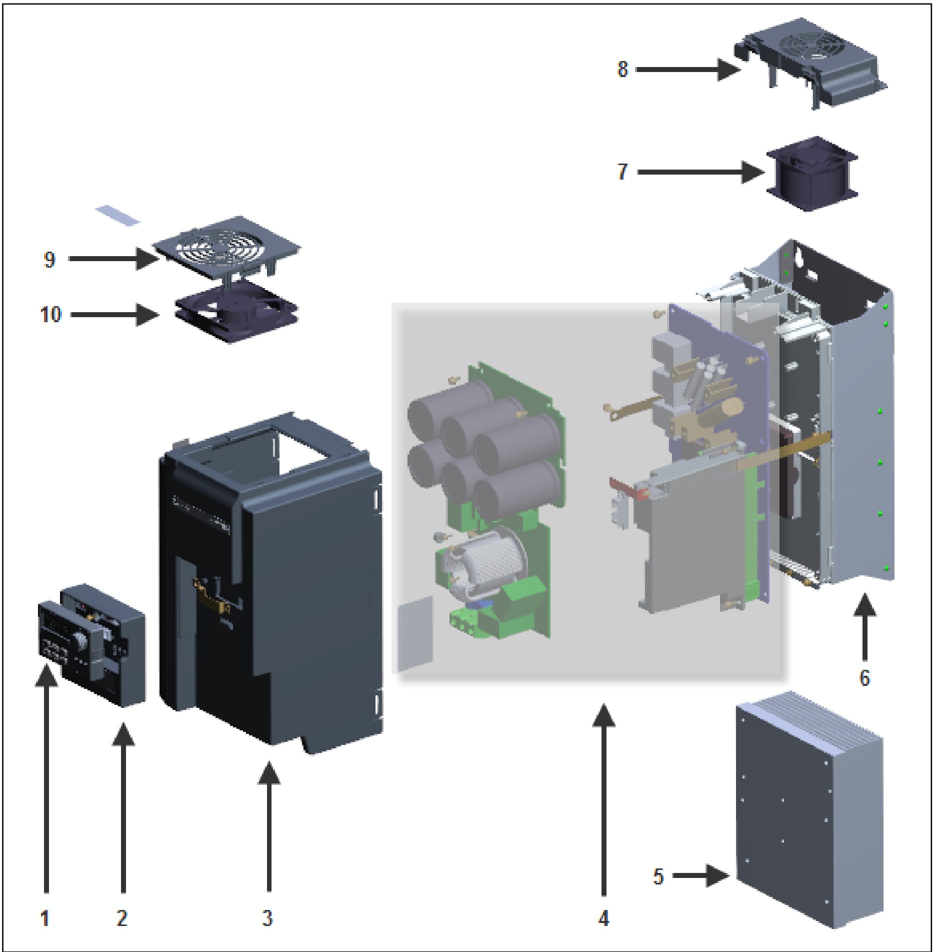
All electronic devices or equipment has certain service life, extended use will cause damage or change properties of devices, and even cause personal injury and property damage. Therefore, it is necessary to replace the device in time.

Item	Replacement criteria
Fan	Replace the cooling fan that running time exceed thirty thousand hours

Tab. 16-3: Device replacement

16.5 Removable Components Maintenance

16.5.1 Construction Overview



1	Operating panel	6	Heat sink mounting plate
2	I/O interface adapter	7	Back fan / Fan for heat sink
3	Housing / Frame	8	Back fan cover
4	Internal components	9	Front fan cover
5	Heat sink / Radiator	10	Front fan / Fan for internal components

Fig. 16-1: Construction overview

☞ Do not disassemble the converter components by yourself, otherwise it may cause damage to the components or converter. If necessary, please contact technical support.

16.5.2 Disassembly of the Operating Panel

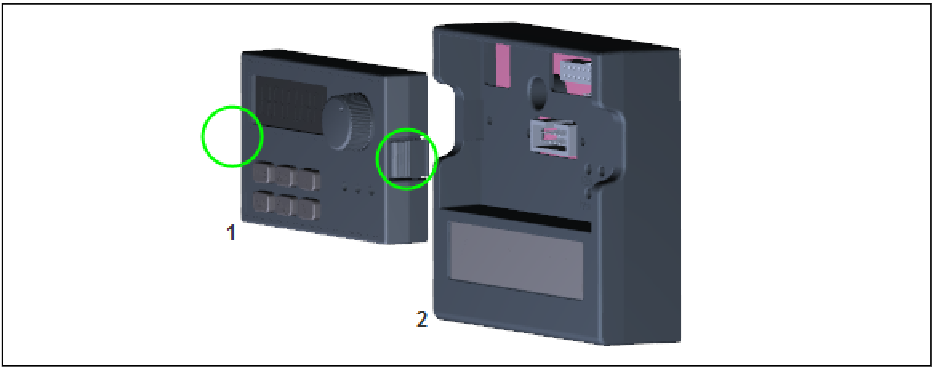


Fig. 16-2: Disassembly of operating panel

- Step 1: Press two buckles as circles indicating in the above figure
- Step 2: Hold component 1 and pull it out horizontally from component 2

16.5.3 Disassembly of Fans

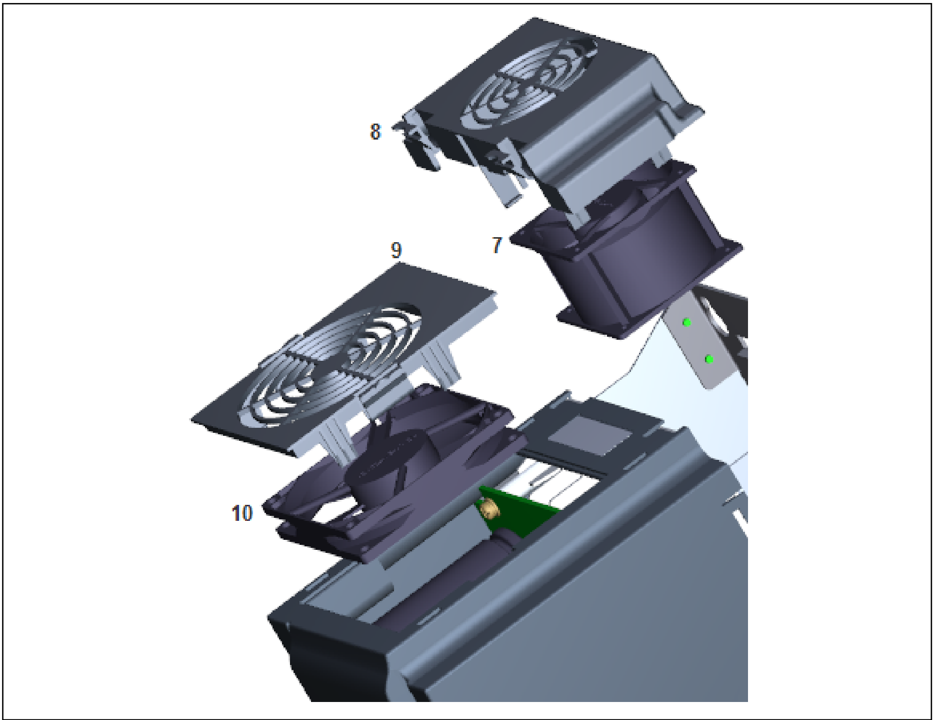


Fig. 16-3: Disassembly of fan

- Step 1: Press the buckle(s) on component 8 or 9 in the above figure
- Step 2: Hold component 8 or 9 and lift it up
- Step 3: Pull out component 7 or 10 slowly
- Step 4: Disconnect the cable connector of component 7 or 10

17 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	+49 9352 40 5060
Fax:	+49 9352 18 4941
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

18 Environmental protection and disposal

18.1 Environmental protection

Production processes

The products are manufactured in energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substances

Our products do not contain any hazardous substances which may be released in case of appropriate use. Normally, our products will not have any negative influences on the environment.

Significant components

Significant components of our products are:

Electronic devices
· Steel
· Aluminum
· Copper
· Plastics
· Electronic components

Motors
· Steel / Stainless steel
· Aluminum
· Copper
· Brass
· Magnetic materials
· Elektronic components

18.2 Disposal

Return of products

Our products can be returned to us for disposal free of charge. However, this requires that the products be free from oil, grease or other dirt.

Furthermore, the products returned for disposal may not contain any undue foreign material or foreign components.

Deliver the products "free domicile" to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Straße 2
97816 Lohr am Main, Germany

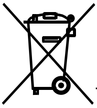
Packaging

Packaging materials consist of cardboard, wood and polystyrene They can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.



The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

End users in the EU are legally bound to return used batteries and accumulators. Outside the validity of the EU Directive 2006/66/EC, the particularly applicable regulations must be followed.

Batteries and accumulators can contain hazardous substances which can harm the environment or people's health when improperly stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products must be properly disposed of according to the country-specific collection systems.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual assemblies.

Metals contained in electric and electronic assemblies can also be recycled by means of special separation processes.

Plastic parts of the products may contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the applicable legal provisions.

19 Appendix

19.1 Appendix I: Abbreviations

- EFC x610: Frequency Converter EFC 3610 or EFC 5610
- FPCC: Operating panel
- FEAM: Panel mounting plate
- FRKS: Communication cable for control cabinet
- FEAE: Accessories, electric
  - Extension card module
  - I/O module
  - Communication module
  - Plug-in connector for control section
  - Brake chopper module
- FCAF: External mains EMC filter
- FCAR: External brake resistor
- FEAM: Shielding connector

19.2 Appendix II: Type Coding

19.2.1 Frequency Converter Type Coding

Type short description	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	E	F	C	3	6	1	0	-	0	K	4	0	-	1	P	2	-	M	D	A	-	7	P	-	N	N	N	N	N	-	N	N	N	N						

Product
EFC........................= EFC

Motor control
Enhanced V/Hz control........= 3
Standard Vector control SVC........................= 5

Design control section
Flex-Control with Standard I/O..........................= 6
Technology-Control with advanced I/O..................= 8

Product line
01..= 0
02..= 1

Configuration Control Section
Standard..= 0

Power(normal duty)
E.g. 400W..= 0K40

Phases
Single phase...= 1P
Three phase...= 3P

Mains connection voltage
200V (AC 200...240V+/-10%)...= 2
400V (AC 380...480V-15%/+10%)................................= 4

Communication interface
ModBus...= M

EMC filter
Industrial area, class C3...= D

Degree of protection
IP 20...= A
IP 20 Cold Plate...= B
IP 20 Wall through mounting...= C

Display
7-segment display with potentiometer..= 7P
Standard LCD display with potentiometer......................................= LP
None(with dust cover)..= NN

Specific firmware variant
Sytronix functionality FcP(max. 400Hz output)..............................= C10NN,FCPNN
Sytronix functionality SVP(max. 400Hz output).............................= C11NN,SVPNN
Sytronix functionality DRn(max. 400Hz output).............................= C14NN,DRnNN
Sytronix functionality EPn(max. 400Hz output)..............................= C15NN,EPnNN
None(max. 400Hz output)...= NNNNN
Bosch Plochingen(max. 400Hz output)....................................= 00001
Export version (max. 1000Hz output instead of 400 Hz output)= 00002

Other design
None..= NNNN
Safe Torque off...= L1NN
With DC-Terminal..= A001
3 Phase Current Sensor...= 3CNN

Fig. 19-1: Frequency converter type coding

19.2.2 Operating Panel Type Coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Example:	F	P	C	C	0	2	.	1	-	E	A	N	N	-	7	P	-	N	N	N	N

Product
FPCC....................= FPCC

Line
02..= 02

Design
1...= 1

Version
EFC...= E
VFC...= V

Degree of protection
IP 20..= A

Customer design
None..= NN

Display
7-segment display with potentiometer......................= 7P
Standard LCD display with potentiometer...............= LP
None (with dust cover)...= NN

Other design
None...= NNNN

Fig. 19-2: Operating panel type coding

19.2.3 Panel Mounting Plate Type Coding

Short text column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Example:	F	E	A	M	0	2	.	1	-	E	A	-	N	N	-	N	N	N	N

Product
VFC / EFC accessories......= FEAM

Design
LED panel mounting plate................= 02

Series
1...= 1

Version
EFC (middle gray RAL 7046)...........................= E
VFC (RAL 9011)..= V

Degree of protection
IP 20...= A

Customer design
None..= NN

Other design
None..= NNNN

Fig. 19-3: Panel mounting plate type coding

19.2.4 Communication Cable for Control Cabinet Type Coding

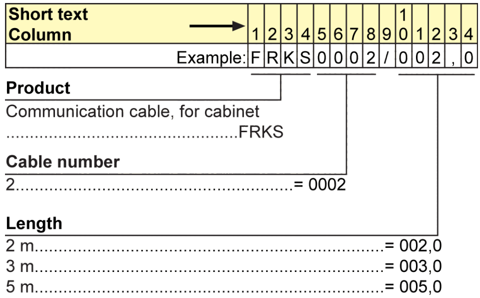


Fig. 19-4: Communication cable for control cabinet type coding

19.2.5 Extension Accessories Type Coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6
Example:	F	E	A	E	0	2	.	1	-	E	A	-	N	N	N	N

Product
Accessory, electric..= FEAE

Variant
Extension card module..........= 02

Line
1..= 1

Version
EFC..= E
VFC..= V

Degrees of protection
IP 20..= A

Other design
None...= NNNN
Left slot is integrated with Multi-Ethernet (ET) card and right slot is reserved................= ETNN
Left slot is integrated with Multi-Ethernet (ET) card and right slot is integrated with I/O (IO1)..= ETI1
Left slot is integrated with Profibus (PB) Card and right slot is integrated with I/O (IO1)..= PBI1
Left slot is integrated with I/O (IO1) card and Right slot is reserved..............................= I1NN

Note:

		Slot 1								
		NN	IO1	IO2	IO3	EN1	EN2	CO	PB	ET
Slot 2	NN	Y	Y	Y	Y	Y	Y	Y	Y	Y
	IO1	Y	N	Y	N	Y	Y	Y	Y	Y
	IO2	Y	Y	N	Y	Y	Y	Y	Y	Y
	IO3	Y	N	Y	N	Y	Y	Y	Y	Y
	EN1	Y	Y	Y	Y	N	N	Y	Y	Y
	EN2	Y	Y	Y	Y	N	N	Y	Y	Y
	CO	Y	Y	Y	Y	Y	Y	N	N	N
	PB	Y	Y	Y	Y	Y	Y	N	N	N
	ET	Y	Y	Y	Y	Y	Y	N	N	N

Fig. 19-5: Extension card module type coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7
Example:	F	E	A	E	0	4	.	1	-	I	O	1	-	N	N	N	N

Product

Accessory, electric..= FEAE

Variant

I/O module.............................= 04

Line

1...= 1

Version

I/O interface 1 (I/O card).........................= IO1
- 4 digital inputs (24 VDC)
- 2 digital outputs (24 VDC / 50 mA)
- 1 releay output
- 1 analog input
- 1 analog output

I/O interface 2 (Relay card)....................= IO2
- 4 relay outputs

I/O interface 3 (I/O plus card).................= IO3
- 2 analog inputs (-10…10V, 0…10V)
- 1 temperature sensor input (with internal powersupply, 1 pin usage)
- 1 analoge output (-10…10V)
- 1 digital output with 500mA
- 5 digital input (normal speed)

HTL/TTL Encoder card......................... = EN1
Resolver Encoder card..........................= EN2

Other design

None...= NNNN

Fig. 19-6: I/O module type coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6
Example:	F	E	A	E	0	3	.	1	-	P	B	-	N	N	N	N

Product

Accessory, electric..= FEAE

Variant

Communication module..........= 03

Line

1...= 1

Version

PROFIBUS...= PB
CANopen .... = CO
Multi-Ethernet .... = ET

Other design

None...= NNNN

Fig. 19-7: Communication module type coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Example:	F	E	A	E	0	5	.	1	-	B	2	-	N	N	N	N

Product
Accessory, electric..= FEAE

Variant
Plug-in connector
Control section......................= 05

Line
1...= 1

Version
EFC & VFC..= B

Design
For EFC & VFC...= 2
2 x socket strip 11pol + 1 x socket strip 3pol

Other design
None..= NNNN

Fig. 19-8: Plug-in connector for control section type coding

19.2.6 External Mains EMC Filter Type Coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Example:	F	C	A	F	0	1	.	1	A	-	A	0	5	0	-	E	-	0	0	2	5	-	A	-	0	5	-	N	N	N	N

Product
EMC filter........= FCAF

Line
1....................................... 01

Design
1..= 1

EMC area
C3 per DIN EN 61800-3...............= A
C1 per DIN EN 61800-3...............= B

Application range
Axis, 30 m ....= A030
Axis, 50 m ....= A050
Axis, 100 m ....= A100

Supply system
Only for feeding devices.......................................= E

Nominal current
E.g., 25 A...= 0025

Degrees of protection
IP20...= A
IP00...= N

Mains connecting voltage
1 x AC 200...240 V -10...+10 %, 50/60 Hz...= 03
3 x AC 380...480 V -15...+10 %, 50/60 Hz...= 05

Other design
None...= NNNN

Fig. 19-9: External mains EMC filter type coding

19.2.7 External Brake Resistor Type Coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30
Example:	F	C	A	R	0	1	.	1	W	1	K	5	6	-	N	0	7	0	R	0	-	A	-	0	5	-	N	N	N	N

Product
Brake resistor.........= FCAR

Line
01..= 01

Design
1..= 1

Cooling
Air cooling...= W

Rated power
E.g., 1.56 kW...= 1K56

Additional option
None...= N

Resistance
E.g., 70 Ω...= 070R0

Degrees of protection
IP 20 ....= A
IP 40 ....= B

DC-bus nominal voltage
320 VDC..= 03
560 VDC..= 05

Other design
None...= NNNN

Fig. 19-10: External brake resistor type coding

19.2.8 Shielding Connector Type Coding

Short text Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Example:	F	E	A	M	0	3	.	2	-	0	0	1	-	N	N	-	N	N	N	N

Product
Accessory, mechanical
..............................= FEAM

Variant
Shielding connector...............= 03

Line
1...= 1
2...= 2

Application
For 0K40...4K00 models.........................= 001
For 5K00...22K0 models.........................= 002
For 30K0...37K0 models.........................= 003
For 45K0...90K0 models.........................= 004
For 110K...132K models.........................= 005
For 160K...185K models.........................= 006

Other properties
None...= NN

Other design
None...= NNNN

Fig. 19-11: Shielding connector type coding

19.3 Appendix III: Parameter List

19.3.1 Terminology and Abbreviation in Parameter List

- **Code:** Function / parameter code, written in bx.xx, Cx.xx, Ex.xx, Hx.xx, Ux.xx, dx.xx
- **Name:** Parameter name
- **Default:** Factory default
- **Min.:** Minimum setting step
- **Attri.:** Parameter attribute
  - **Run:** Parameter setting can be modified when the converter is in run or stop status.
  - **Stop:** Parameter setting can only be modified when the converter is in stop status.
  - **Read:** Parameter setting is read-only and cannot be modified.
- **DOM:** Depends on model
- **[bx.xx], [Cx.xx], [Ex.xx], [Hx.xx], [Ux.xx], [dx.xx]:** Function / parameter values

19.3.2 Group b: System Parameters

b0: Basic system parameters

Code	Name	Setting range	Default	Min.	Attri.
b0.00	Access authority setting	0: Basic parameters 1: Standard parameters 2: Advanced parameters 3: Start-up parameters 4: Modified parameters	0	–	Run
b0.09	Parameter initialization setting	1: Base device and non fieldbus options 2: Fieldbus options 3: Base device, non fieldbus and fieldbus options	1	–	Stop
b0.10	Parameter initialization	0: Inactive 1: Restore to default settings 2: Clear error and warning record	0	–	Stop
b0.11	Parameter copy	0: Inactive 1: Backup parameters to panel 2: Restore parameters from panel	0	–	Stop
b0.12	Parameter set selection	0: Parameter set 1 active 1: Parameter set 2 active	0	–	Stop
b0.20	User password	0…65,535	0	1	Run
b0.21	Manufacturer password	0…65,535	0	1	Run
b0.22	Device frequency mode①	0: Low frequency mode 1: High frequency mode	1	–	Stop

①: This parameter applies only to 1 KHz model.

19.3.3 Group C: Power Parameters

C0: Power control parameters

Code	Name	Setting range	Default	Min.	Attri.
C0.00	Control mode (EFC 5610 only)	0: V/f control 1: Sensorless vector control 2: Vector control with encoder	0	–	Stop
C0.01	Normal / Heavy duty setting①	0: ND (Normal duty) 1: HD (Heavy duty)	1	–	Stop
C0.05	Carrier frequency	0K40...22K0: 1...15 kHz 30K0...160K: 1...12 kHz	0K40...4K00: 6k 5K50...22K0 (HD): 6k 5K50...22K0 (ND): 4k 30K0...90K0: 4k 110K...160K: 2k	1	Run
C0.06	Carrier frequency automatic adjustment	0: Inactive 1: Active 2: Fixed carrier frequency	1	–	Stop
C0.07	PWM mode	0: SVPWM 1: SVPWM with overmodulation 2: DPWM 3: DPWM with overmodulation	DOM	–	Run
C0.08	DPWM switchover frequency upper limit	8.00...400.00 Hz	12.00	0.01	Run
C0.10	Automatic voltage stabilization	0: Always active 1: Always inactive 2: Inactive only during deceleration	0	1	Stop
C0.11	Automatic voltage stabilization reference voltage	1P 200 VAC: 180...264 V	220	1	Stop
		3P 200 VAC: 180...264 V			
		3P 380 VAC: 323...528 V	380		

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Min.</th><th>Attri.</th></tr>
<tr><td rowspan="3">C0.15</td><td rowspan="3">Brake chopper start voltage②</td><td>1P 200 VAC: 300...390 V</td><td rowspan="2">385</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 300...390 V</td></tr>
<tr><td>3P 380 VAC: 600...785 V</td><td>770</td></tr>
<tr><td>C0.16</td><td>Brake chopper duty cycle②</td><td>1...100 %</td><td>100</td><td>1</td><td>Stop</td></tr>
<tr><td>C0.23</td><td>Overvoltage suppression adjustment gain</td><td>0.00...10.00</td><td>1.00</td><td>0.01</td><td>Run</td></tr>
<tr><td rowspan="3">C0.24</td><td rowspan="3">Stall overvoltage hysteresis voltage</td><td rowspan="3">0...100 V</td><td>1P 200 VAC: 30</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 30</td></tr>
<tr><td>3P 380 VAC: 50</td></tr>
<tr><td>C0.25</td><td>Overvoltage prevention mode</td><td>0...4</td><td>3</td><td>–</td><td>Stop</td></tr>
<tr><td rowspan="3">C0.26</td><td rowspan="3">Stall overvoltage prevention level</td><td>1P 200 VAC: 300...390 V</td><td rowspan="2">385</td><td rowspan="3">1</td><td rowspan="3">Stop</td></tr>
<tr><td>3P 200 VAC: 300...390 V</td></tr>
<tr><td>3P 380 VAC: 600...785 V</td><td>770</td></tr>
<tr><td>C0.27</td><td>Stall overcurrent prevention level③</td><td>20.0 %...[C2.42]</td><td>150.0</td><td>0.1</td><td>Stop</td></tr>
<tr><td>C0.28</td><td>Phase loss protection mode</td><td>0...3</td><td>3</td><td>–</td><td>Run</td></tr>
<tr><td>C0.29</td><td>Converter overload pre-warning level</td><td>20.0...200.0 %</td><td>110.0</td><td>0.1</td><td>Stop</td></tr>
<tr><td>C0.30</td><td>Converter overload pre-warning delay</td><td>0.0...20.0 s</td><td>2.0</td><td>0.1</td><td>Stop</td></tr>
<tr><td>C0.40</td><td>Power loss ride-through mode</td><td>0: Inactive
1: Output disabled
2: Regain kinetic energy
3: Regain kinetic energy, decelerate to stop</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>C0.41</td><td>Power loss ride-through recovery delay</td><td>0.10...30.00 s</td><td>0.50</td><td>0.01</td><td>Stop</td></tr>
</table>

Code	Name	Setting range	Default	Min.	Attri.
C0.42	Power loss ride-through action voltage	1P 200 VAC: 216...366 V	240	1	Stop
		3P 200 VAC: 216...366 V			
		3P 380 VAC: 406...739 V	440		
C0.43	Power loss ride-through recovery voltage	1P 200 VAC: 223...373 V	250	1	Stop
		3P 200 VAC: 223...373 V			
		3P 380 VAC: 413...746 V	450		
C0.44	Power loss ride-through deceleration to stop time	0.1...6,000.0 s	5.0	0.1	Stop
C0.50	Fan control	0: Automatically controlled 1: Always on 2: On when converter run	0	–	Run
C0.51	Fan total running time	0...65,535 h	0	1	Read
C0.52	Fan maintenance time	0...65,535 h (0: Inactive)	0	1	Stop
C0.53	Fan total running time reset	0: Inactive 1: Active Reset to '0' after action is executed	0	–	Run

①: this parameter is only available with 3P 380 VAC models of 5K50 and above.

②: the parameters are only available with models of 22K0 and below.

③: percentage of frequency converter rated current.

Setting range of C0.25:

0: Both disabled

1: Stall overvoltage protection enabled, resistor braking disabled

2: Stall overvoltage protection disabled, resistor braking enabled

3: Stall overvoltage protection enabled, resistor braking enabled

4: Reciprocating load mode

Setting range of C0.28:

0: Both input and output phase loss protection active

1: Only input phase loss protection active

2: Only output phase loss protection active

3: Both input and output phase loss protection inactive

C1: Motor and system parameters

Code	Name	Setting range	Default	Min.	Attri.
C1.00	Motor type	0: Asynchronous motor 1: Synchronous motor (only for EFC 5610)	0	–	Stop
C1.01	Motor parameter tuning	0: Inactive 1: Static auto-tuning 2: Rotational auto-tuning①	0	–	Stop
C1.02	Expert mode	0: Standard mode 1: Expert mode	0	–	Stop
C1.05	Motor rated power	0.1...1,000.0 kW	DOM	0.1	Stop
C1.06	Motor rated voltage	0...480 V	DOM	1	Stop
C1.07	Motor rated current	0.01...655.00 A (0.4...37 kW)	DOM	0.01	Stop
		0.1...6550.0 A (45 kW and above)		0.1	
C1.08	Motor rated frequency	5.00...400.00 Hz	50.00	0.01	Stop
C1.09	Motor rated speed	1...60,000 rpm	DOM	1	Stop
C1.10	Motor rated power factor	0.00...0.99②	0.00	0.01	Stop
C1.11	Motor poles①	2...256	4	1	Stop
C1.12	Motor rated slip frequency	0.00...60.00 Hz	DOM	0.01	Stop
C1.13	Motor inertia mantissa①	1...5,000	DOM	1	Stop
C1.14	Motor inertia exponent①	0...7	DOM	1	Stop
C1.15	Torque constant	0.01...200.00 mH	DOM	0.01	Stop
C1.16	Back emf voltage constant	0.0...6550.0 V/1000 min^{-1}	0.0	0.1	Read
C1.17	Motor rated torque	0.0...6553.5 N.m	DOM	0.1	Read
C1.20	Motor no-load current	0.00...[C1.07] A (0.4...37 kW)	DOM	0.01	Stop
		0.0...[C1.07] A (45 kW and above)		0.1	
C1.21	Stator resistance	0.00...50.00 Ω (0.4...37 kW)	DOM	0.01	Stop
		0.000...50.000 Ω (45 kW and above)		0.001	

Code	Name	Setting range	Default	Min.	Attri.
C1.22	Rotor resistance	0.00…50.00 Ω (0.4…37 kW)	DOM	0.01	Stop
		0.000…50.000 Ω (45 kW and above)		0.001	
C1.23	Leakage inductance	0.00…600.00 mH	DOM	0.01	Stop
C1.24	Mutual inductance	0.0…6,000.0 mH	DOM	0.1	Stop
C1.25	Rotor leakage inductance	0.00…600.00	DOM	0.01	Stop
C1.69	Motor thermal model protection setting	0: Inactive 1: Thermal model active 2: Current monitoring active	0	–	Stop
C1.70	Motor overload pre-warning level	100.0…250.0 %	100.0	0.1	Run
C1.71	Motor overload pre-warning delay	0.0…20.0 s	2.0	0.1	Run
C1.72	Motor thermal sensor type	0: KTY84/130; 2: PT100 3: PT1000; 4: TDK G1551_8320 (NTC)	0	–	Stop
C1.73	Motor thermal sensor protection level	0.0…10.0 V	2.0	0.1	Stop
C1.74	Motor thermal model protection time constant	0.0…400.0 min	DOM	0.1	Stop
C1.75	Low speed derating frequency	0.10…300.00 Hz	25.00	0.01	Run
C1.76	Zero speed load	25.0…100.0 %	25.0	0.1	Run

☞ ①: **ONLY** for EFC 5610, and motor load must be decoupled before rotational auto-tuning.

②: 0.00: Automatically identified; 0.01…0.99: Power factor setting.

C2: V/f control parameters

Code	Name	Setting range	Default	Min.	Attri.
C2.00	V/f curve mode	0: Linear 1: Square 2: User-defined 3: V/f separation	0	–	Stop
C2.01	V/f frequency 1	0.00...[C2.03] Hz	0.00	0.01	Stop
C2.02	V/f voltage 1①	0.0...120.0 %	0.0	0.1	Stop
C2.03	V/f frequency 2	[C2.01]...[C2.05] Hz	0.00	0.01	Stop
C2.04	V/f voltage 2①	0.0...120.0 %	0.0	0.1	Stop
C2.05	V/f frequency 3	[C2.03]...[E0.08] Hz	50.00	0.01	Stop
C2.06	V/f voltage 3①	0.0...120.0 %	100.0	0.1	Stop
C2.07	Slip compensation factor	0...200 %	0	1	Run
C2.08	V/f separation output voltage source selection	0: Panel potentiometer 1: Panel button setting 2: AI1 analog input 10: X5 pulse input 20: Communication (Modbus 0x7F0B/Fieldbus extension card H0.50) 22: Digital setting 23: Voltage PID control	22	–	Stop
C2.09	V/f separation output voltage digital setting	0.00...100.00 %	0.00	0.01	Run
C2.10	V/f separation output voltage acceleration time	0.0...6,000.0 s	0.0	0.1	Run
C2.11	V/f separation output voltage deceleration time	0.0...6,000.0 s	0.0	0.1	Run
C2.12	V/f separation stop mode selection	0: Voltage and frequency decelerates independently 1: Voltage decelerates to zero, then frequency decelerates to zero	0	–	Run
C2.13	V/f separation boost factor	0.00...100.00	0.00	0.01	Run
C2.20	0 Hz output mode	0: No output 1: Standard	1	1	Stop

Code	Name	Setting range	Default	Min.	Attri.
C2.21	Torque boost setting	0.0 %: Automatic boost 0.1...20.0 %: Manual boost	DOM	0.1	Run
C2.22	Automatic torque boost factor	0...320 %	50	1	Run
C2.23	Heavy load stabilization setting	0: Inactive 1: Active	1	–	Run
C2.24	Light load oscillation damping factor	0...5,000 %	300	1	Run
C2.25	Light load oscillation damping filter factor	10...2,000 %	30	1	Run
C2.40	Current limitation mode	0: Always inactive 1: Inactive at constant speed 2: Active at constant speed	2	–	Stop
C2.42	Current limitation level②	[C0.27]...250 %	150	1	Stop
C2.43	Current limitation proportional gain	0.000...10.000	DOM	0.001	Stop
C2.44	Current limitation integral time	0.001...10.000	DOM	0.001	Stop

①: percentage of motor rated voltage [C1.06].

②: percentage of frequency converter rated current.

C3: Vector control parameters

Code	Name	Setting range	Default	Min.	Attri.
C3.00	Speed loop proportional gain 1	0.00...655.35	DOM	0.01	Run
C3.01	Speed loop integral time 1	0.01...655.35 ms	DOM	0.01	Run
C3.02	Speed loop proportional gain 2	0.00...655.35	DOM	–	Run
C3.03	Speed loop integral time 2	0.00...655.35 ms	DOM	–	Run
C3.04	Speed observer harmonics damping factor	0.10...20.00	0.66	0.01	Stop
C3.05	Current loop proportional gain	0.1...1,000.0	DOM	0.1	Run
C3.06	Current loop integral time	0.01...655.35 ms	DOM	0.01	Run
C3.10	Speed loop switching frequency 1	0.00...[C3.11]	4.00	0.01	Stop
C3.11	Speed loop switching frequency 2	[C3.10]...[C1.08]	6.00	0.01	Stop
C3.20	Low speed torque limitation	1...200 %	100	1	Stop
C3.21	Encoder speed filter time	0...100.0	2.0	0.1	Stop
C3.22	Encoder commutation offset	0.0...360.0	360.0	0.1	Stop
C3.25	Speed monitor timeout	0.0...6553.5 s	5.0	0.1	Stop
C3.26	Speed monitor max. speed difference	0.00...655.35 Hz	10.00	0.01	Stop
C3.30	Maximum fieldweakening current factor for SM	1...95 %	75	1	Run
C3.38	Forward frequency limitation at torque control mode	0.00...[E0.09]	50.00	0.01	Run
C3.39	Reverse frequency limitation at torque control mode	0.00...[E0.09]	50.00	0.01	Run
C3.40	Torque control mode	0: Activated by digital inputs 1: Always active 2: Communication (Bit 8 of Modbus 0x7F00) (Bit 9 of extension card H0.00)	0	–	Stop

Code	Name	Setting range	Default	Min.	Attri.
C3.41	Torque reference channel	0: AI1 analog input 1: AI2 analog input 2: Panel potentiometer 3: EAI1 analog input 4: Pulse input via DI5 5: Parameter setting C3.46 6: Communication (Modbus 0x7F02/Fieldbus extension card H0.12) 7: EAI2 analog input	0	–	Stop
C3.42	Torque reference minimum value①	0.0 %...[C3.43]	0.0	0.1	Run
C3.43	Torque reference maximum value①	[C3.42]...200.0 %	150.0	0.1	Run
C3.44	Torque positive limit①	0.0...200.0 %	150.0	0.1	Run
C3.45	Torque negative limit①	0.0...200.0 %	150.0	0.1	Run
C3.46	Digital torque reference setting	0.0...200.0	150.0	0.1	Run
C3.47	Torque limitation reference selection at speed control mode	0: Parameter C3.44 and C3.45 1: AI1 (0.0...200.0 %) 2: AI2 (0.0...200.0 %) 3: EAI1 analog input 4: Communication (Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15) 5: EAI2 analog input	0	-	Stop

Code	Name	Setting range	Default	Min.	Attri.
C3.48	Speed limitation reference selection at torque control mode	0: Parameter C3.38 and C3.39 1: AI1 2: AI2 3: EAI1 analog input 4: Communication (Speed limitation register: Modbus 0x7F05/ Fieldbus extension card H0.16) 5: EAI2 analog input	0	-	Stop
C3.49	Torque command ramp	0.0...5.0 s	0.0	0.1	Stop
C3.50	Initial angle detection current	50...150 %②	80	1	Stop
C3.51	Initial angle detection mode	0: No detection 1: Detection when first power on 2: Detection at every running	2	–	Stop
C3.52	SVC regulation area lower frequency	0.00...600.00 Hz	DOM	0.01	Stop
C3.53	SVC regulation area upper frequency	0.00...600.00 Hz	DOM	0.01	Stop
C3.54	SVC dampfactor enhance upper frequency	DOM	DOM	0.01	Stop
C3.55	SVC dampfactor enhance coefficient	1...20	1	1	Stop

①: percentage of motor rated torque.

②: percentage of motor rated current.

☞ All parameters in Group C3 are ONLY for EFC 5610.

19.3.4 Group E: Function Control Parameters

E0: Set point and control parameters

Code	Name	Setting range	Default	Min.	Attri.
E0.00	First frequency setting source	0...21	0	–	Stop
E0.01	First run command source	0...2	0	–	Stop
E0.02	Second frequency setting source	0...21	2	–	Stop
E0.03	Second run command source	0...2	1	–	Stop
E0.04	Frequency setting source combination	0...6	0	–	Stop
E0.06	Digital setting frequency saving mode	0...4	0	–	Stop
E0.07	Digital setting frequency	0.00...[E0.09] Hz	50.00	0.01	Run
E0.08	Maximum output frequency	50.00...400.00 Hz	50.00	0.01	Stop
E0.09	Output frequency high limit	[E0.10]...[E0.08] Hz	50.00	0.01	Run
E0.10	Output frequency low limit	0.00...[E0.09] Hz	0.00	0.01	Run
E0.11	Reverse running frequency	0.00...[E0.09] Hz	0.00	0.01	Stop
E0.15	Low speed running setting	0: Run with 0.00 Hz 1: Run with low limit frequen-cy	0	–	Stop
E0.16	Low speed frequency hysteresis	0.00...[E0.10] Hz	0.00	0.01	Stop
E0.17	Direction control	0: Forward / Reverse 1: Forward only 2: Reverse only 3: Swap default direction	0	–	Stop
E0.18	Direction change dead time	0.0...60.0 s	1.0	0.1	Stop
E0.25	Acceleration / deceleration curve mode	0: Linear mode 1: S-curve	0	–	Stop
E0.26	Acceleration time	0.1...6,000.0 s	DOM	0.1	Run
E0.27	Deceleration time	0.1...6,000.0 s	DOM	0.1	Run
E0.28	S-curve starting phase factor	0.0...40.0 %	20.0	0.1	Stop
E0.29	S-curve stopping phase factor	0.0...40.0 %	20.0	0.1	Stop
E0.35	Start mode	0: Start directly 1: DC-braking before start 2: Start with speed tracing 3: Automatic start / stop ac-cording to setting frequency	0	–	Stop

Code	Name	Setting range	Default	Min.	Attri.
E0.36	Start frequency	0.00...50.00 Hz	0.05	0.01	Stop
E0.37	Start frequency holding time	0.0...20.0 s	0.0	0.1	Stop
E0.38	Start DC-braking time	0.0...20.0 s (0.0: Inactive)	0.0	0.1	Stop
E0.39	Start DC-braking current①	0.0...150.0 %	0.0	0.1	Stop
E0.41	Automatic start / stop frequency threshold	0.01...[E0.09] Hz	16.00	0.01	Stop
E0.42	Speed tracing voltage recovery ratio	0...20	10	1	Stop
E0.43	Speed tracing deceleration time	0.5...20.0 s	2.0	0.1	Stop
E0.45	Power loss restart mode	0: Inactive 1: Active for panel control 2: Active for digital input control	0	–	Stop
E0.46	Power loss restart delay	0.0...10.0 s	1.0	0.1	Stop
E0.47	Run command priority	0: High priority 1: Low priority	0	–	Stop
E0.50	Stop mode	0: Decelerating stop 1: Freewheeling stop 1 2: Freewheeling stop 2	0	–	Stop
E0.52	Stop DC-braking initial frequency	0.00...50.00 Hz	0.00	0.01	Stop
E0.53	Stop DC-braking time	0.0...20.0 s (0.0: Inactive)	0.0	0.1	Stop
E0.54	Stop DC-braking current①	0.0...150.0 %	0.0	0.1	Stop
E0.55	Overexcitation braking factor	1.00...2.00	1.10	0.01	Run
E0.56	Emergency stop action	0: Freewheeling stop 1: Decelerating stop	0	–	Stop
E0.57	Emergency stop deceleration time	0.1...6,000.0 s	5.0	0.1	Run
E0.60	Jog frequency	0.00...[E0.08] Hz	5.00	0.01	Run
E0.61	Jog acceleration time	0.1...6,000.0 s	5.0	0.1	Run
E0.62	Jog deceleration time	0.1...6,000.0 s	5.0	0.1	Run
E0.70	Skip frequency 1	0.00...[E0.09] Hz	0.00	0.01	Stop
E0.71	Skip frequency 2	0.00...[E0.09] Hz	0.00	0.01	Stop
E0.72	Skip frequency 3	0.00...[E0.09] Hz	0.00	0.01	Stop

Code	Name	Setting range	Default	Min.	Attri.
E0.73	Skip frequency range	0.00...30.00 Hz	0.00	0.01	Stop
E0.74	Skip window acceleration factor	1...100	1	1	Stop

①: percentage of frequency converter rated current.

Setting range of E0.00, E0.02:

0: Panel potentiometer

1: Panel button setting

2: AI1 analog input

3: AI2 analog input

4: EAI1 analog input

5: EAI2 analog input

10: X5 pulse input

11: Digital input Up / Down command

20: Communication

21: Multi-speed settings

Setting range of E0.01, E0.03:

0: Panel

1: Multi-function digital input

2: Communication

Setting range of E0.04:

0: No combination

1: First frequency setting + second frequency setting

2: First frequency setting - second frequency setting

3: First frequency setting x second frequency setting

4: Bigger one of 2 sources

5: Smaller one of 2 sources

6: Valid which channel is non-zero

Setting range of E0.06:

0: Not saved when powered off or stopped

1: Not saved when powered off; saved when stopped

2: Saved when powered off; not saved when stopped

3: Saved when powered off or stopped

4: Not saved when powered off; memorized when stopped

E1: Input terminal parameters

Code	Name	Setting range	Default	Min.	Attri.
E1.00	X1 input	0...51	35	–	Stop
E1.01	X2 input		36	–	Stop
E1.02	X3 input		0	–	Stop
E1.03	X4 input		0	–	Stop
E1.04	X5 input	0...51	0	–	Stop
E1.15	2-wire/3-wire control mode	0...4	0	–	Stop
E1.16	Digital input Up / Down change rate	0.10...100.00 Hz/s	1.00	0.01	Run
E1.17	Digital input Up / Down initial frequency	0.00...[E0.09] Hz	0.00	0.01	Run
E1.25	Pulse input maximum frequency	0.0...50.0 kHz	50.0	0.1	Run
E1.26	Pulse input filter time	0.000...2.000 s	0.100	0.001	Run
E1.35	AI1 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	2	–	Run
E1.40	AI2 input mode		1	–	Run
E1.38	AI1 gain	0.00...10.00	1.00	0.01	Run
E1.43	AI2 gain	0.00...10.00	1.00	0.01	Run
E1.60	Motor temperature sensor channel	0: Inactive 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: EAI2 analog input 5: TSI input (only for IO plus card)	0	–	Stop
E1.61	Broken wire protection	0: Inactive 1: Warning 2: Error	0	–	Stop
E1.68	Analog input curve setting	0...7	0	–	Run
E1.69	Analog input filter time	0.000...2.000 s	0.100	0.001	Run
E1.70	Input curve 1 minimum	0.0 %...[E1.72]	0.0	0.1	Run
E1.71	Input curve 1 minimum frequency	0.00...[E0.09] Hz	0.00	0.01	Run
E1.72	Input curve 1 maximum	[E1.70]...100.0 %	100.0	0.1	Run
E1.73	Input curve 1 maximum frequency	0.00...[E0.09] Hz	50.00	0.01	Run

Code	Name	Setting range	Default	Min.	Attri.
E1.75	Input curve 2 minimum	0.0 %...[E1.77]	0.0	0.1	Run
E1.76	Input curve 2 minimum frequency	0.00...[E0.09] Hz	0.00	0.01	Run
E1.77	Input curve 2 maximum	[E1.75]...100.0 %	100.0	0.1	Run
E1.78	Input curve 2 maximum frequency	0.00...[E0.09] Hz	50.00	0.01	Run

Setting range of E1.00...E1.04:

0: Inactive

1: Multi-speed control input 1

2: Multi-speed control input 2

3: Multi-speed control input 3

4: Multi-speed control input 4

10: Acceleration / deceleration time 1 activation

11: Acceleration / deceleration time 2 activation

12: Acceleration / deceleration time 3 activation

15: Freewheeling stop activation

16: Stop DC-braking activation

20: Frequency Up command

21: Frequency Down command

22: Up / Down command reset

23: Torque / speed control switch

25: 3-wire control

26: Simple PLC stop

27: Simple PLC pause

30: Second frequency setting source activation

31: Second run command source activation

32: Error signal N.O. contact input

33: Error signal N.C. contact input

34: Error reset

35: Forward running (FWD)

36: Reverse running (REV)

37: Forward jog

38: Reverse jog

39: Counter input

40: Counter reset

41: PID deactivation

46: User parameter set selection

47: Pulse input mode activation

48: Motor overheating error N.O. contact input

49: Motor overheating error N.C. contact input

50: Motor overheating warning N.O. contact input

51: Motor overheating warning N.C. contact input

Setting range of E1.15:

0: 2-wire forward / stop, reverse / stop

1: 2-wire forward / reverse, run / stop

2: 3-wire control mode 1

3: 3-wire control mode 2

4: 1-wire control

Setting range of E1.68:

0: AI1: curve1, AI2: curve1, pulse input: curve1

1: AI1: curve2, AI2: curve1, pulse input: curve1

2: AI1: curve1, AI2: curve2, pulse input: curve1

3: AI1: curve2, AI2: curve2, pulse input: curve1

4: AI1: curve1, AI2: curve1, pulse input: curve2

5: AI1: curve2, AI2: curve1, pulse input: curve2

6: AI1: curve1, AI2: curve2, pulse input: curve2

7: AI1: curve2, AI2: curve2, pulse input: curve2

E2: Output terminal parameters

Code	Name	Setting range	Default	Min.	Attri.
E2.01	DO1 output setting	0...25	1	–	Stop
E2.02	DO1 pulse output setting	0: Converter output frequency 1: Converter output voltage 2: Converter output current 3: Setting torque 4: Output torque	0	–	Stop
E2.03	Pulse output maximum frequency	0.1...32.0 kHz	32.0	0.1	Run
E2.15	Relay 1 output selection	0...25	1	–	Stop
E2.20	DO1/relay1 output values from extension card fieldbus communication	Bit0: 0 (open collector is opened); 1(open collector is closed) Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed)	0	–	Run
E2.25	AO1 output mode	0: 0...10 V 1: 0...20 mA 3: 2...10 V 4: 4...20 mA	0	–	Run
E2.26	AO1 output setting	0: Output frequency 1: Setting frequency 2: Output current 4: Output voltage 5: Output power 6: AI1 analog input 7: AI2 analog input 8: EAI1 analog input 9: EAI2 analog input 11: Motor temperature sensor power supply 12: Parameter setting from communication ② 13: Setting torque 14: Output torque	0	–	Run
E2.27	AO1 gain	0.00...10.00	1.00	0.01	Run

Code	Name	Setting range	Default	Min.	Attri.
E2.28	AO1 value in percentage from extension card fieldbus communication	0.00...100.00 %	0.00	0.01	Run
E2.40	Rated voltage	1P 200...240 VAC	220	1	Stop
		3P 200...240 VAC			
		3P 380...480 VAC	380		
E2.50	Output curve 1 minimum	0.0 %...[E2.52]	0.0	0.1	Run
E2.51	Output curve 1 minimum value	0.00...100.00 %	0.00	0.01	Run
E2.52	Output curve 1 maximum	[E2.50]...100.0 %	100.0	0.1	Run
E2.53	Output curve 1 maximum value	0.00...100.00 %	100.00	0.01	Run
E2.70	Frequency detection width	0.00...400.00 Hz	2.50	0.01	Run
E2.71	Frequency detection level FDT1	0.01...400.00 Hz	50.00	0.01	Run
E2.72	Frequency detection level FDT1 width	0.01...[E2.71] Hz	1.00	0.01	Run
E2.73	Frequency detection level FDT2	0.01...400.00 Hz	25.00	0.01	Run
E2.74	Frequency detection level FDT2 width	0.01...[E2.73] Hz	1.00	0.01	Run
E2.80	Counter middle value	0...[E2.81]	0	1	Run
E2.81	Counter target value	[E2.80]...9,999	0	1	Run

Setting range of E2.01, E2.15:

0: Converter ready

1: Converter running

2: Converter DC-braking

3: Converter running at zero speed

4: Speed arrival

5: Frequency level detection signal (FDT1)

6: Frequency level detection signal (FDT2)

7: Simple PLC stage complete

8: Simple PLC cycle complete

10: Converter undervoltage

11: Converter overload pre-warning

12: Motor overload pre-warning

13: Converter stop by external error

14: Converter error

15: Converter OK

16: Counter target value arrival

17: Counter middle value arrival

18: PID reference engineering value arrival

19: Pulse output mode enable (only available with DO1 output selection)

20: Torque control mode

21: Parameter setting from communication①

25: Converter error or warning

---

①:

- For parameter E2.01, the relationship between the output of '21: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 is '1', open collector is closed.
  - For other fieldbus mode, the output is defined by bit0 of parameter E2.20.
- For parameter E2.15, the relationship between the output of '21: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, when bit8 of register 0x7F08 is '0', Tb_Ta is opened; when bit8 is '1', Tb_Ta is closed.
  - For other fieldbus mode, the output is defined by bit8 of parameter E2.20.

②:

- For parameter E2.26, the relationship between the output of '12: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, the output is defined by register 0x7F06. The value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).
  - For other fieldbus mode, the output is defined by parameter E2.28.

E3: Multi-speed and simple PLC parameters

Code	Name	Setting range	Default	Min.	Attri.
E3.00	Simple PLC running mode	0: Inactive 1: Stop after selected cycle 2: Continuously cycling 3: Run last stage after selected cycle	0	–	Stop
E3.01	Simple PLC time multiplier	1...60	1	1	Stop
E3.02	Simple PLC cycle number	1...1,000	1	1	Stop
E3.10	Acceleration time 2	0.1...6,000.0 s	10.0	0.1	Run
E3.11	Deceleration time 2	0.1...6,000.0 s	10.0	0.1	Run
E3.12	Acceleration time 3	0.1...6,000.0 s	10.0	0.1	Run
E3.13	Deceleration time 3	0.1...6,000.0 s	10.0	0.1	Run
E3.14	Acceleration time 4	0.1...6,000.0 s	10.0	0.1	Run
E3.15	Deceleration time 4	0.1...6,000.0 s	10.0	0.1	Run
E3.16	Acceleration time 5	0.1...6,000.0 s	10.0	0.1	Run
E3.17	Deceleration time 5	0.1...6,000.0 s	10.0	0.1	Run
E3.18	Acceleration time 6	0.1...6,000.0 s	10.0	0.1	Run
E3.19	Deceleration time 6	0.1...6,000.0 s	10.0	0.1	Run
E3.20	Acceleration time 7	0.1...6,000.0 s	10.0	0.1	Run
E3.21	Deceleration time 7	0.1...6,000.0 s	10.0	0.1	Run
E3.22	Acceleration time 8	0.1...6,000.0 s	10.0	0.1	Run
E3.23	Deceleration time 8	0.1...6,000.0 s	10.0	0.1	Run
E3.40	Multi-speed frequency 1	0.00...[E0.09] Hz	0.00	0.01	Run
E3.41	Multi-speed frequency 2	0.00...[E0.09] Hz	0.00	0.01	Run
E3.42	Multi-speed frequency 3	0.00...[E0.09] Hz	0.00	0.01	Run
E3.43	Multi-speed frequency 4	0.00...[E0.09] Hz	0.00	0.01	Run
E3.44	Multi-speed frequency 5	0.00...[E0.09] Hz	0.00	0.01	Run
E3.45	Multi-speed frequency 6	0.00...[E0.09] Hz	0.00	0.01	Run
E3.46	Multi-speed frequency 7	0.00...[E0.09] Hz	0.00	0.01	Run
E3.47	Multi-speed frequency 8	0.00...[E0.09] Hz	0.00	0.01	Run
E3.48	Multi-speed frequency 9	0.00...[E0.09] Hz	0.00	0.01	Run
E3.49	Multi-speed frequency 10	0.00...[E0.09] Hz	0.00	0.01	Run
E3.50	Multi-speed frequency 11	0.00...[E0.09] Hz	0.00	0.01	Run
E3.51	Multi-speed frequency 12	0.00...[E0.09] Hz	0.00	0.01	Run
E3.52	Multi-speed frequency 13	0.00...[E0.09] Hz	0.00	0.01	Run
E3.53	Multi-speed frequency 14	0.00...[E0.09] Hz	0.00	0.01	Run

Code	Name	Setting range	Default	Min.	Attri.
E3.54	Multi-speed frequency 15	0.00...[E0.09] Hz	0.00	0.01	Run
E3.59	Stage 0 frequency source	0: Digital setting frequency 1: AI1 analog input 2: AI2 analog input 3: EAI1 analog input 4: X5 pulse input 5: Communication 6: Panel potentiometer 7: Digital input up/down command 8: EAI2 analog input	0	–	Stop
E3.60	Stage 0 action	011, 012, 013, 014, 015, 016 ,017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188	011	–	Stop
E3.62	Stage 1 action		011	–	Stop
E3.64	Stage 2 action		011	–	Stop
E3.66	Stage 3 action		011	–	Stop
E3.68	Stage 4 action		011	–	Stop
E3.70	Stage 5 action		011	–	Stop
E3.72	Stage 6 action		011	–	Stop
E3.74	Stage 7 action		011	–	Stop
E3.76	Stage 8 action		011	–	Stop
E3.78	Stage 9 action		011	–	Stop
E3.80	Stage 10 action		011	–	Stop
E3.82	Stage 11 action		011	–	Stop
E3.84	Stage 12 action		011	–	Stop
E3.86	Stage 13 action		011	–	Stop
E3.88	Stage 14 action		011	–	Stop
E3.90	Stage 15 action		011	–	Stop
E3.61	Stage 0 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.63	Stage 1 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.65	Stage 2 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.67	Stage 3 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.69	Stage 4 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.71	Stage 5 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.73	Stage 6 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.75	Stage 7 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.77	Stage 8 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.79	Stage 9 running time	0.0...6,000.0 s	20.0	0.1	Stop

Code	Name	Setting range	Default	Min.	Attri.
E3.81	Stage 10 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.83	Stage 11 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.85	Stage 12 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.87	Stage 13 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.89	Stage 14 running time	0.0...6,000.0 s	20.0	0.1	Stop
E3.91	Stage 15 running time	0.0...6,000.0 s	20.0	0.1	Stop

E4: PID control parameters

Code	Name	Setting range	Default	Min.	Attri.
E4.00	PID reference channel	0...10	0	–	Stop
E4.01	PID feedback channel	0: AI1 analog input 1: AI2 analog input 2: X5 pulse input 3: EAI1 analog input 4: Encoder card speed 5: EAI2 analog input	0	–	Stop
E4.02	PID reference / feedback factor	0.01...100.00	1.00	0.01	Run
E4.03	PID engineering analog reference	0.00...10.00	0.00	0.01	Run
E4.04	PID engineering speed reference	0...30,000 rpm	0	1	Run
E4.05	PID feedback polarity	0: Positive 1: Negative	0	–	Stop
E4.15	Proportional gain - P	0.000...60.000	1.500	0.001	Run
E4.16	Integral time - Ti	0.00...100.00 s (0.00: no integral)	1.50	0.01	Run
E4.17	Derivative time - Td	0.00...100.00 s (0.00: no derivative)	0.00	0.01	Run
E4.18	Sampling period - T	0.01...100.00 s	0.50	0.01	Run
E4.19	PID feed forward dynamic limit	0.00...100.00 %	10.00	0.01	Run
E4.20	PID feed forward limit offset	0.00...100.00 %	0.00	0.01	Run
E4.30	PID deadband	0.0...20.0 %	2.0	0.1	Run
E4.31	PID regulation mode	0, 1	0	–	Run
E4.32	PID engineering value detection width	0.01...100.00	1.00	0.01	Run
E4.33	PID feed forward settings	0: Inactive 1: Active	0	–	Stop

Setting range of E4.00:

0: Inactive

1: Panel potentiometer

2: Panel button

3: AI1 analog input

4: AI2 analog input

5: X5 pulse input

6: EAI1 analog input

7: Communication

8: Analog reference E4.03

9: Speed reference E4.04

10: EAI2 analog input

Setting range of E4.31:

0: Stop integral regulation when frequency arrives at upper / lower limit

1: Continue integral regulation when frequency arrives at upper / lower limit

E5: Extended function parameters

Code	Name	Setting range	Default	Min.	Attri.
E5.01	High resolution output current filter time	5...500 ms	40	1	Run
E5.02	User-defined speed scaling factor	0.01...100.00	1.00	0.01	Run
E5.05	Pump dry protection threshold	0.0 %...[E5.08]	30.0	0.1	Run
E5.06	Pump dry protection delay	0.0...300.0 s (0.0: Inactive)	0.0	0.1	Run
E5.07	Pump dry protection delay at start-up	0.0...300.0 s	30.0	0.1	Run
E5.08	Pump leakage protection threshold	0.0...100.0 %	50.0	0.1	Run
E5.09	Pump leakage protection delay	0.0...600.0 s (0.0: Inactive)	0.0	0.1	Run
E5.10	Pump leakage protection delay at start-up	0.0...600.0 s	60.0	0.1	Run
E5.15	Sleep level	0.00...[E0.09] Hz	0.00	0.01	Run
E5.16	Sleep delay	0.0...3,600.0 s	60.0	0.1	Run
E5.17	Sleep boost time	0.0...3,600.0 s	0.0	0.1	Run
E5.18	Sleep boost amplitude	0.0...100.0 %	0.0	0.1	Run
E5.19	Wake up level	0.0...100.0 %	0.0	0.1	Run
E5.20	Wake up delay	0.2...60.0 s	0.5	0.1	Run

E8: Standard communication parameters

Code	Name	Setting range	Default	Min.	Attri.
E8.00	Communication protocol	0: Modbus 1: Extension card	0	–	Stop
E8.01	Communication error detection time	0.0...60.0 s (0.0: Inactive)	0.0	0.1	Stop
E8.02	Communication error protection mode	0: Freewheeling stop 1: Keep running 2: Emergency stop	1	–	Stop
E8.03	Communication process data loss behavior	0: Decelerating stop 1: Freewheeling stop 2: Keep running 3: Keep running without warning	0	–	Stop
E8.10	Modbus baud rate	0: 1,200 bps; 1: 2,400 bps 2: 4,800 bps; 3: 9,600 bps 4: 19,200 bps; 5: 38,400 bps	3	–	Stop
E8.11	Modbus data format	0...3	0	–	Stop
E8.12	Modbus local address	1...247	1	1	Stop
E8.13	Modbus level / edge sensitivity selection	0: Level sensitive 1: Edge sensitive	1	–	Stop

Setting range of E8.11:

0: N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no parity)

1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even parity)

2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd parity)

3: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, no parity)

E9: Protection and error parameters

Code	Name	Setting range	Default	Min.	Attri.
E9.00	Automatic error reset attempts	0...3 (0: Inactive)	0	–	Stop
E9.01	Automatic error reset interval	0.1...60.0 s	10.0	0.1	Stop
E9.02	Automatic error reset attempts restart time	0...65,535	0	1	Stop
E9.05	Last error type	–	–	–	Read
E9.06	Second last error type	–	–	–	Read
E9.07	Third last error type	–	–	–	Read
E9.10	Output frequency at last error	–	–	0.01	Read
E9.11	Setting frequency at last error	–	–	0.01	Read
E9.12	Output current at last error	–	–	0.1	Read
E9.13	Output voltage at last error	–	–	1	Read
E9.14	DC-bus voltage at last error	–	–	1	Read
E9.15	Power module temperature at last error	–	–	1	Read
E9.50	Last warning type	-	0	-	Read
E9.51	Second last warning type	-	0	-	Read
E9.52	Third last warning type	-	0	-	Read
E9.97	Last error detail	00000...FFFFF	0	–	Read
E9.98	Second last error detail	00000...FFFFF	0	–	Read
E9.99	Third last error detail	00000...FFFFF	0	–	Read

Value range of E9.05...E9.07:

0: No error

1: OC-1, overcurrent at constant speed

2: OC-2, overcurrent during acceleration

3: OC-3, overcurrent during deceleration

4: OE-1, overvoltage at constant speed

5: OE-2, overvoltage during acceleration

6: OE-3, overvoltage during deceleration

7: OE-4, overvoltage during stop

8: UE-1, undervoltage during run

9: SC, surge current or short circuit

10: IPH.L, input phase loss

11: OPH.L, output phase loss

12: ESS-, soft start error

20: OL-1, converter overload
21: OH, converter over temperature
23: FF, fan failure
24: Pdr, pump dry
25: CoL-, command value lost
26: StO-r, STO request
27: StO-E, STO error
30: OL-2, motor overload
31: Ot, motor over temperature
32: t-Er, motor parameter tuning error
33: AdE-, synchronous motor angle detection error
35: SPE-, speed control loop error
38: AibE, analog input broken wire detection
39: EPS-, DC_IN power supply error
40: dir1, forward running lock error
41: dir2, reverse running lock error
42: E-St, terminal error signal
43: FFE-, firmware version mismatch
44: rS-, Modbus communication error
45: E.Par, parameter settings invalid
46: U.Par, unknown parameter restore error
48: idA-, internal communication error
49: idP-, internal parameter error
50: idE-, converter internal error
51: OCd-, extension card internal error
52: OCc, extension card PDOs configuration error
53: Fdi-, no valid process data
54: PcE-, remote control communication error
55: PbrE, parameter backup / restore error
56: PrEF, parameter restore error after firmware update
60: ASF-, application firmware error
61: APE1, application error 1
62: APE2, application error 2
63: APE3, application error 3
64: APE4, application error 4
65: APE5, application error 5

Value range of E9.50...E9.52:

0: No warning

6: PLE, pump leakage

7: OE-4, overvoltage during stop

31: Ot, motor over temperature

403: C-dr, communication disconnection

408: Aib-, analog input broken wire detection

409: FLE, fan maintenance period expired

410: OCi, communication data exceeds value range

411: UH-A, under Temperature warning

420: APF1, ASF customer warning 1

421: APF2, ASF customer warning 2

422: APF3, ASF customer warning 3

423: APF4, ASF customer warning 4

424: APF5, ASF customer warning 5

430: USdc, UnSupported Device Configuration

440: Sli-, speed limited by maximum Voltage

900: iSt, invalid State Transition

903: FtL, RPDO Telegram Loss

908: Fdi, option card process data invalid

19.3.5 Group F0: ASF Parameters

Code	Name	Setting range	Default	Min.	Attri.
F0.01	ASF version	–	–	–	Read
F0.02	ASF identifier	0x0001 ... 0x0FFF	–	–	Read
F0.03	ASF API required version	–	–	–	Read
F0.06	ASF trial time left	0...65,535 s	–	–	Read
F0.07	ASF API version	–	–	–	Read
F0.10	ASF status	0x0000H...0xFFFFH	–	1	Read
F0.20	ASF Command 1	–	0	–	Read
F0.21	ASF Command 2	–	0	–	Read
F0.22	ASF Command 3	–	0	–	Read
F0.23	ASF Command 4	–	0	–	Read
F0.24	ASF Command 5	–	0	–	Read
F0.25	ASF Command 6	–	0	–	Read
F0.26	ASF Command 7	–	0	–	Read
F0.27	ASF Command 8	–	0	–	Read

19.3.6 Group H: Extension Card Parameters

H0: Extension card general parameters

Code	Name	Setting range	Default	Min.	Attri.
H0.00	Control word	0x00000...0x0FFFF	0x00000	1	Run
H0.01	Status word	–	0x00000	1	Read
H0.02	Extended status word	–	0x00000	1	Read
H0.03	STO safety status word	bit 0: STO-A bit 1: STO-r bit 2: STO-E bit 3...15: Reserved	0x00000	–	Read
H0.10	Frequency command	0.00...655.35	0.00	0.01	Run
H0.12	Torque control reference from fieldbus	0.0...6553.5	0.0	0.1	Run
H0.14	FWD torque limitation reference from fieldbus	0.0...6553.5	0.0	0.1	Run
H0.15	REV torque limitation reference from fieldbus	0.0...6553.5	0.0	0.1	Run

Code	Name	Setting range	Default	Min.	Attri.
H0.16	Speed limitation at torque control mode from fieldbus	0.00...655.35	0.00	0.01	Run
H0.18	Opt 1 active interface version	–	–	0.01	Read
H0.19	Opt 2 active interface version	–	–	0.01	Read
H0.20	Extension card 1 type	0: None 1: PROFIBUS card 2: CANopen card 3: MEP (Multi-Ethernet) 7: Encoder card 8: I/O card 9: Relay card 10: IO plus card	0	–	Read
H0.30	Extension card 2 type		0	–	Read
H0.23	Extension card 1 firmware version	–	–	0.01	Read
H0.33	Extension card 2 firmware version	–	–	0.01	Read
H0.50	Fieldbus voltage command	0.00...100.00 %	0.00	0.01	Run

H1: PROFIBUS card parameters

Code	Name	Setting range	Default	Min.	Attri.
H1.00	PROFIBUS local address	0...126	1	1	Stop
H1.01	Present baud rate	0: None 1: 9.6 kbps 2: 19.2 kbps 3: 45.45 kbps 4: 93.75 kbps 5: 187.5 kbps 6: 500 kbps 7: 1,500 kbps 8: 3,000 kbps 9: 6,000 kbps 10: 12,000 kbps	–	–	Read

Code	Name	Setting range	Default	Min.	Attri.
H1.02	Present telegram type	1: PPO1 2: PPO2 3: PPO3 4: PPO4 5: PPO5 6: PPO6 7: PPO7 8: PPO8	–	–	Read

<table>
<tr><th>Code</th><th>Name</th><th>Setting range</th><th>Default</th><th>Min.</th><th>Attri.</th></tr>
<tr><td>H1.10</td><td>Output PZD 1①</td><td rowspan="10">0: Not used
1: Control word
2: Frequency command
3: Empty PZD
4: ASF command 1
5: ASF command 2
6: ASF command 3
7: ASF command 4
8: ASF command 5
9: ASF command 6
10: ASF command 7
11: ASF command 8
12: Torque command
13: Forward torque limit
14: Reverse torque limit
15: Speed limit in torque mode
16: DO1/relay1 output values (see parameter E2.20)
17: AO1 value in percentage (see parameter E2.28)
18: EDO values (see parameter H8.23)
19: EAO value in percentage (see parameter H8.28)
20: Relay card output values (see parameter H9.10)
21: V/f separation voltage command in percentage (see parameter H0.50)</td><td>1</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.11</td><td>Output PZD 2</td><td>2</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.12</td><td>Output PZD 3</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.13</td><td>Output PZD 4</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.14</td><td>Output PZD 5</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.15</td><td>Output PZD 6</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.16</td><td>Output PZD 7</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.17</td><td>Output PZD 8</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.18</td><td>Output PZD 9</td><td>0</td><td>–</td><td>Stop</td></tr>
<tr><td>H1.19</td><td>Output PZD 10</td><td>0</td><td>–</td><td>Stop</td></tr>
</table>

Code	Name	Setting range	Default	Min.	Attri.
H1.30	Input PZD 1②	0: Not used 1: Status word 2: Extended status word 3: Empty PZD 100: d0.00 (Output frequency) 101...199: d0.01...d0.99 (Monitoring values)	1	–	Stop
H1.31	Input PZD 2		100	–	Stop
H1.32	Input PZD 3		0	–	Stop
H1.33	Input PZD 4		0	–	Stop
H1.34	Input PZD 5		0	–	Stop
H1.35	Input PZD 6		0	–	Stop
H1.36	Input PZD 7		0	–	Stop
H1.37	Input PZD 8		0	–	Stop
H1.38	Input PZD 9		0	–	Stop
H1.39	Input PZD 10		0	–	Stop

☞ ①: Output PZD 1...Output PZD 10 are the process data containers for data transferring from PROFIBUS master to slave.

②: Input PZD 1...Input PZD 10 are the process data containers for data transferring from PROFIBUS slave to master.

H2: CANopen card parameters

Code	Name	Setting range	Default	Min.	Attri.
H2.00	CANopen address	1...127	1	-	Stop
H2.01	CAN baudrate	0: 10 kbits/s 1: 20 kbits/s 2: 50 kbits/s 3: 125 kbits/s 4: 250 kbits/s 5: 500 kbits/s 6: 1 Mbit/s	3	-	Stop
H2.02	CANopen device profile selection	0...1	0-> Rexroth Drive Profile 1-> CiA-402 Drive Profile	-	Stop
H2.98	CANopen termination resistor switch	0: Disabled 1: Enabled	0	-	Stop

H2.00 'CANopen address' is used to select the address for CANopen Node.

H2.01 'CAN baudrate' is used to set the speed of CANopen communication.

H2.02 'CANopen device profile selection' is used to switch between different drive profiles.

H2.98 'CANopen termination resistor switch' is used to select the state of the termination resistor.

H3: Multi-Ethernet card parameters

Code	Name	Setting range	Default	Min.	Attri.
H3.00	MEP: MAC Address Device	-	<MANU>	-	Read
H3.01	MEP: MAC Address Port1	-	<MANU>	-	Read
H3.02	MEP: MAC Address Port2	-	<MANU>	-	Read
H3.03	MEP: IP Address	-	192.168.0.1	-	Run
H3.04	MEP: Subnet Mask	-	255.255.255.0	-	Run
H3.05	MEP: Gateway Address	-	0.0.0.0	-	Run
H3.06	MEP: IP Options	-	0	-	Run
H3.07	MEP: Local Hostname (SERCOS/IP, Ethernet/IP)	-	hostname	-	Run
H3.08	MEP: Application Type	-	Frequency Converter	-	Read
H3.10	MEP: Device ID(PROFINET)	-	0x2802	-	Read
H3.11	MEP: Order ID	-	<MANU>	-	Read
H3.12	MEP: Product Name	-	MEP	-	Read
H3.13	MEP: Serial Number	-	<MANU>	-	Read
H3.14	MEP: Product Code (EtherNet/IP)	-	0x0024	-	Read
H3.18	MEP: Visual Status Indicators	-	-	-	Read
H3.20	MEP: Station Name (PROFINET)	-	axis01	-	Stop
H3.21	MEP: Station Type (PROFINET)	-	Rexroth-Multi-Ethernet	-	Read
H3.22	MEP: Subdevice ID (PROFINET)	-	0x011F2802	-	Read
H3.23	MEP: Device Address	-	1	-	Run
H3.24	MEP: Active Device Address (Topology)	-	0	-	Read
H3.25	MEP: IP address is remnant (PROFINET)	-	0	-	Run
H3.26	MEP: EtherCAT List of Input Process Data (Master)	-	0x0000,0x0000	-	Read

Code	Name	Setting range	Default	Min.	Attri.
H3.27	MEP: EtherCAT List of Output Process Data (Master)	-	0x0000,0x0000	-	Read
H3.28	MEP: Input Process Data Length (Master)	-	0	-	Read
H3.29	MEP: Output Process Data Length (Master)	-	0	-	Read
H3.30	MEP: List of Input Process Data	-	0x6001, 0x1002	-	Stop
H3.31	MEP: List of Output Process Data	-	0x6001, 0x600A	-	Stop
H3.32	MEP: Input Process Data Length (Slave)	-	4	-	Read
H3.33	MEP: Output Process Data Length (Slave)	-	4	-	Read
H3.34	MEP: Communication Platform State	-	-	-	Read
H3.35	MEP: Communication Diagnosis Flags	-	-	-	Read
H3.36	MEP: ComCycle Periods [ns]	-	0,0,0	-	Read
H3.37	MEP: Communication Phase	-	0	-	Read
H3.40	MEP: Industrial Ethernet Protocol Request	-	S3	-	Run
H3.41	MEP: Industrial Ethernet Protocol Active	-	S3	-	Read
H3.42	MEP: Industrail Ethernet Protocol Logicware	-	S3L	-	Read
H3.49	MEP: EtherCAT State	-	1	-	Read
H3.51	MEP: Modbus/TCP Alternative TCP port	-	0	-	Run
H3.63	MEP: List of external parameters	-	-	-	Read
H3.71	MEP: Subsystem identification parameter	-	<MANU>	-	Read
H3.96	MEP: FWA string	-	<MANU>	-	Read

H7: Encoder card parmaeters

Code	Name	Setting range	Default	Min.	Attri.
H7.01	Encoder direction	0: Forward 1: Reverse	0	-	Stop
H7.05	Encoder wiring break detection lev-el	0.0 (No protection) 0.1...1,000.0 rpm	0.0	-	Stop
H7.06	Encoder wiring break detection time	0.1...10.0 s	1.0	-	Stop
H7.07	Encoder phase order error detec-tion time	0.0 (No protection) 0.1...100.0 s	1.0	-	Stop
H7.20	Pulses per revolution of encoder	1...20,000	1024	-	Stop
H7.21	Sample point	0...50	0	-	Stop
H7.30	Resolver power supply	3.0...8.0 Vrms	7.0	-	Stop
H7.31	Resolver poles	2...32	1	-	Stop

H8: I/O card parameters

Code	Name	Setting range	Default	Min.	Attri.
H8.00	EX1 input	0...51	0	–	Stop
H8.01	EX2 input		0	–	Stop
H8.02	EX3 input		0	–	Stop
H8.03	EX4 input		0	–	Stop
H8.04	EX5 input		0	–	Stop
H8.05	EAI input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V 5: -10...10 V	0	–	Stop
H8.06	EAI1 input polarity setting	0...2	1	–	Stop
H8.07	EAI1 dead zone filter value	0.0...30.0 %	0.0	0.1	Run
H8.09	EAI1 filter time	0.000...2.000 s	0.100	0.001	Run
H8.10	EAI1 gain	0.00...10.00	1.00	0.01	Run
H8.15	EAI1 curve minimum	-120.0 %...[H8.17]	0.0	0.1	Run
H8.16	EAI1 curve minimum value	-[E0.09]...[E0.09] Hz	0.00	0.01	Run
H8.17	EAI1 curve maximum	[H8.15]...120.0 %	100.0	0.1	Run
H8.18	EAI1 curve maximum value	-[E0.09]...[E0.09] Hz	50.00	0.01	Run
H8.20	EDO1 output selection	0...25	1	–	Stop
H8.21	Extended relay output selection		1	–	Stop
H8.22	EDO2 output selection		1	–	Stop
H8.23	Extended digital output value from extension card fieldbus communication	Bit0: EDO1 (IO / IO plus card) Bit1: EDO2 (IO plus card) Bit8: Erelay (IO card)	0	–	Stop
H8.25	EAO output mode	0: 0...10 V 1: 0...20 mA	0	–	Run

Code	Name	Setting range	Default	Min.	Attri.
H8.26	EAO output selection	0: Output frequency 1: Set frequency 2: Output current 4: Output voltage 5: Output power 6: AI1 analog input 7: AI2 analog input 8: EAI1 analog input 9: EAI2 analog input 11: Motor temperature sensor power 12: Parameter setting from communication② 13: Setting torque 14: Output torque	0	–	Run
H8.27	EAO gain	0.00...10.00	1.00	0.01	Run
H8.28	EAO value in percentage from extension card fieldbus communication	0.00...100.00%	0.00	0.01	Stop
H8.30	EAI2 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V 5: -10...10 V	0	–	Stop
H8.31	EAI2 input polarity setting	0: Polarity inactive 1: Polarity active without direction control 2: Polarity active with direction control	1	–	Stop
H8.32	EAI2 filter time	0.000...2.000 s	0.100	0.001	Run
H8.33	EAI2 gain	0.00...10.00	1.00	0.01	Run
H8.34	EAI2 curve minimum	-120.0 %...[H8.36]	0.0	0.1	Run
H8.35	EAI2 curve minimum value	-[E0.09]...[E0.09]	0.00	0.01	Run
H8.36	EAI2 curve maximum	[H8.34]...120.0 %	100.0	0.1	Run
H8.37	EAI2 curve maximum value	-[E0.09]...[E0.09]	50.00	0.01	Run
H8.38	EAI2 dead zone filter value	0.0...30.0 %	0.0	0.1	Run

Code	Name	Setting range	Default	Min.	Attri.
H8.39	EAO curve minimum	-100.0 %...[H8.41]	0.0	0.1	Run
H8.40	EAO curve minimum value	-100.0...100.0 %	0.00	0.01	Run
H8.41	EAO curve maximum	[H8.39]...100.0 %	100.0	0.1	Run
H8.42	EAO curve maximum value	-100.0...100.0 %	100.0	0.1	Run
H8.87	I/O card output channel diagnosis	0: Inactive 1: EAO diagnosis 2: EDO diagnosis 3: ERO diagnosis/EDO2 diagnosis 4: All output diagnosis	1	–	Stop

Setting range of H8.00...H8.04:

0: No function assigned

1: Multi-speed control input 1

2: Multi-speed control input 2

3: Multi-speed control input 3

4: Multi-speed control input 4

10: Acceleration/deceleration time 1 activation

11: Acceleration/deceleration time 2 activation

12: Acceleration/deceleration time 3 activation

15: Freewheeling stop activation

16: Stop DC-braking activation

20: Frequency Up command

21: Frequency Down command

22: Up/Down command reset

23: Torque/Speed control switch

25: 3-wire control

26: Simple PLC stop

27: Simple PLC pause

30: Second frequency setting source activation

31: Second run command source activation

32: Error signal N.O. contact input

33: Error signal N.C. contact input

34: Error reset

35: Forward running (FWD)

36: Reverse running (REV)

37: Forward jog

38: Reverse jog

39: Counter input

40: Counter reset

41: PID deactivation

46: User parameter set selection

48: Motor overheating error N.O. contact input

49: Motor overheating error N.C. contact input

50: Motor overheating warning N.O. contact input

51: Motor overheating warning N.C. contact input

Setting range of H8.06:

0: Polarity inactive

1: Polarity active without direction control

2: Polarity active with direction control

Setting range of H8.20, H8.21:

0: Converter ready

1: Converter running

2: Converter DC-braking

3: Converter running at zero speed

4: Speed arrival

5: Frequency level detection signal (FDT1)

6: Frequency level detection signal (FDT2)

7: Simple PLC stage complete

8: Simple PLC cycle complete

10: Converter undervoltage

11: Converter overload pre-warning

12: Motor overload pre-warning

13: Converter stop by external error

14: Converter error

15: Converter OK

16: Counter target value arrival

17: Counter middle value arrival

18: PID reference engineering value arrival

20: Torque control mode

21: Parameter setting from communication[①]

25: Converter error or warning

①:

The relationship between the output of '21: Parameter setting from communication' and communication mode is as follow:

- For modbus mode,
  - The output of parameter H8.20 is defined by bit0 of register 0x7F09. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.
  - The output of parameter H8.21 is defined by bit8 of register 0x7F09. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.
  - The output of parameter H8.22 is defined by bit1 of register 0x7F09. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.
- For other fieldbus mode, the output is defined by parameter H8.23.

②:

The relationship between the output of '12: Parameter setting from communication' and communication mode is as follow:

- For modbus mode, the output is defined by register 0x7F07, the value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).
- For other fieldbus mode, the output is defined by parameter H8.28.

H9: Relay card parameters

Code	Name	Setting range	Default	Min.	Attri.
H9.00	Extended relay 1 output selection	0...25	0	–	Stop
H9.01	Extended relay 2 output selection		0	–	Stop
H9.02	Extended relay 3 output selection		0	–	Stop
H9.03	Extended relay 4 output selection		0	–	Stop

Code	Name	Setting range	Default	Min.	Attri.
H9.10	Relay output setting value	Relay1 is defined by bit0, when bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed Relay2 is defined by bit1, when bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed Relay3 is defined by bit2, when bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed Relay4 is defined by bit3, when bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed	0	–	Run
H9.97	Relay card output channel diagnosis	0: Inactive 1: Relay1 diagnosis 2: Relay2 diagnosis 3: Relay3 diagnosis 4: Relay4 diagnosis 5: All output diagnosis	0	–	Stop

Setting range of H9.00...H9.03:

0: Converter ready

1: Converter running

2: Converter DC-braking

3: Converter running at zero speed

4: Speed arrival

5: Frequency level detection signal (FDT1)

6: Frequency level detection signal (FDT2)

7: Simple PLC stage complete

8: Simple PLC cycle complete

10: Converter undervoltage

11: Converter overload pre-warning

12: Motor overload pre-warning

13: Converter stop by external error

14: Converter error

15: Converter OK

16: Counter target value arrival

17: Counter middle value arrival

18: PID reference engineering value arrival

20: Torque control mode

21: Parameter setting from communication①

25: Converter error or warning

---

①:

The relationship between output of '21: Parameter setting from communication' and communication mode is as follow:

- For modbus mode,
  - The output of parameter H9.00 is defined by bit0 of register 0x7F0A. When bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed.
  - The output of parameter H9.01 is defined by bit1 of register 0x7F0A. When bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed.
  - The output of parameter H9.02 is defined by bit2 of register 0x7F0A. When bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed.
  - The output of parameter H9.03 is defined by bit3 of register 0x7F0A. When bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed.
- For other fieldbus mode, the output is defined by parameter H9.10.

19.3.7 Group U: Panel Parameters

U0: General panel parameters

Code	Name	Setting range	Default	Min.	Attri.
U0.00	Direction control by panel	0: Forward; 1: Reverse	0	–	Run
U0.01	Stop button control	0: Active only for panel control 1: Valid for all control methods	1	–	Run
U0.99	Panel firmware version	00.00...99.99	–	0.01	Read

U1: LED panel parameters

Code	Name	Setting range	Default	Min.	Attri.
U1.00	Run monitoring display	0...99	0	–	Run
U1.10	Stop monitoring display		2	–	Run

0: Output frequency; 1: Actual speed
2: Setting frequency; 3: Setting speed
4: User-defined setting speed; 5: User-defined actual speed
9: V/f separation setting voltage; 10: Output voltage; 11: Output current
12: Output power; 13: DC-bus voltage
14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04
85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08; 89: ASF Display09
98: High resolution output current; 99: Firmware version

U2: LCD panel parameters

Code	Name	Setting range	Default	Min.	Attri.
U2.01	Backlight mode setting	0: Energy saving 1: Always on	1	–	Run
U2.02	Panel lock setting	0: Unlock 1: Lock	0	–	Run
U2.03	Remote / Local setting	0: Remote 1: Local	0	–	Stop
U2.04	Language selection	0: English 1: Chinese 2: Germany 3: French 4: Russian 5: Spanish 6: Portugal 7: Italian 8: Korean	0	–	Stop
U2.09	Permanent monitoring	0...99	0	–	Run
U2.10	Run monitoring items 1		0	–	Run
U2.20	Stop monitoring items 1		0	–	Run
U2.11	Run monitoring items 2	0...100	2	–	Run
U2.12	Run monitoring items 3		11	–	Run
U2.13	Run monitoring items 4		13	–	Run
U2.14	Run monitoring items 5		16	–	Run
U2.15	Run monitoring items 6		17	–	Run
U2.21	Stop monitoring items 2		2	–	Run
U2.22	Stop monitoring items 3		11	–	Run
U2.23	Stop monitoring items 4		13	–	Run
U2.24	Stop monitoring items 5		16	–	Run
U2.25	Stop monitoring items 6		17	–	Run

Setting range of U2.09...U2.25:

0: Actual output frequency; 1: Actual speed

2: Setting frequency; 3: Setting speed

4: User-defined setting speed; 5: User-defined output speed

9: V/f separation setting voltage; 10: Output voltage; 11: Output current

12: Output power; 13: DC-bus voltage

14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04
85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08
89: ASF Display09; 98: High resolution output current
99: Firmware version; 100: Inactive

19.3.8 Group d0: Monitoring Parameters

Code	Name	Minimum unit
d0.00	Output frequency	0.01 Hz
d0.01	Actual speed	1 rpm
d0.02	Setting frequency	0.01 Hz
d0.03	Setting speed	1 rpm
d0.04	User-defined setting speed	0.1
d0.05	User-defined output speed	0.1
d0.06	Encoder frequency	0.01
d0.07	Encoder speed	1
d0.09	V/f separation setting voltage	0.01 V
d0.10	Output voltage	1 V
d0.11	Output current	0.1 A
d0.12	Output power	0.1 kW
d0.13	DC-bus voltage	1 V
d0.14	Energy saving counter kWh	0.1 kWh
d0.15	Energy saving counter MWh	1 MWh
d0.16	Output torque	0.1 %
d0.17	Setting torque	0.1 %
d0.18	FWD speed limitation setting	0.01 rpm
d0.19	REV speed limitation setting	0.01 rpm
d0.20	Power module temperature	1 ℃
d0.21	Actual carrier frequency	1 kHz
d0.23	Power stage running time	1 h
d0.30	AI1 input	0.01 V / 0.01 mA
d0.31	AI2 input	0.01 V / 0.01 mA
d0.33	I/O card EAI1 input	0.01 V / 0.01 mA
d0.34	I/O card EAI2 input	0.01 V / 0.01 mA
d0.35	AO1 output	0.01 V / 0.01 mA
d0.37	I/O card EAO output	0.01 V / 0.01 mA
d0.40	Digital input 1	–
d0.43	I/O card digital input	–
d0.45	DO1 output	–
d0.47	I/O card EDO1 output	–
d0.48	I/O card EDO2 output	–
d0.50	Pulse input frequency	0.01 kHz
d0.55	Pulse output frequency	0.1 kHz
d0.60	Relay output	–

Code	Name	Minimum unit
d0.62	I/O card relay output	–
d0.63	Relay card output	–
d0.70	PID reference engineering value	0.1
d0.71	PID feedback engineering value	0.1
d0.80	ASF Display00	–
d0.81	ASF Display01	–
d0.82	ASF display02	–
d0.83	ASF display03	–
d0.84	ASF display04	–
d0.85	ASF display05	–
d0.86	ASF display06	–
d0.87	ASF display07	–
d0.88	ASF display08	–
d0.89	ASF display09	–
d0.98	High resolution output current	0.01 A
d0.99	Firmware version	0.01

☞ Parameters d0.16...d0.19 are only applicable to Vector Control mode.

19.3.9 Group d1: Enhanced Monitoring

This part is about enhanced monitoring parameters, which are not visible via Panel, but can be scoped in IndraWorks.

Code	Name	Minimum Unit	Attri.
d1.00	Phase current U [A]	0.1A	Read
d1.01	Phase current V [A]	0.1A	Read
d1.02	Phase current W [A]	0.1A	Read
d1.05	Current Id filtered Display	0.01A	Read
d1.06	Current Iq filtered Display	0.01A	Read
d1.10	Signed rotor frequency	0.1Hz	Read
d1.11	Rotor speed	1rpm	Read
d1.12	Signed encoder frequency	0.1Hz	Read
d1.15	High resolution output power	0.01kW	Read
d1.20	Encoder angle	0.01°	Read

19.4 Appendix IV: Certification

19.4.1 CE

Declaration of conformity

For Frequency Converters EFC x610 (0K40...160K), there are declarations of conformity which confirm that the devices comply with the applicable EN Standards and EC Directives. If required, you may ask our sales representative for the declarations of conformity.

EU directives	Standard
Low-Voltage Directive 2014/35/EU	EN 61800-5-1 (IEC 61800-5-1: 2007)
EMC Directive 2014/30/EU	EN 61800-3 (IEC 61800-3: 2004+A1: 2012)

Tab. 19-1: EU directives and standards

CE label

Fig. 19-12: CE label

High-voltage test

According to standard EN 61800-5-1, EFC x610 (0K40...160K) components are tested with high voltage.

19.4.2 UL

Frequency Converters EFC x610 (0K40...160K) are listed by UL "Underwriters Laboratories Inc.®". You can find the evidence of certification on the Internet under http://www.ul.com under “Certifications” by entering the file number or the “Company Name: Rexroth”.

UL listing

Fig. 19-13: UL listing

UL standard

UL 508C (0K40...18K5), UL 61800-5-1 (22K0...160K)

Company name

BOSCH REXROTH (XIAN) ELECTRIC DRIVES AND CONTROLS CO., LTD.

Category name

Power Conversion Equipment

File number

E328841

UL ratings

For using the components in the scope of UL, take the UL ratings of the individual component into account.

An appropriate fuse must be used, which rating shall be equal to or greater than the SCCR (0K40...37K0: 5,000 Arms; 45K0...90K0: 10,000 Arms; 110K...132K: 18,000 Arms; 160K: 30,000 Arms) of the power supply being used.

Wiring material UL

In the scope of UL, use only copper conductors rated 75 ℃ or above.

Requirements for United States / Canadian installations (UL/cUL):

Power cable use 75 °C or above copper wire. This equipment is capable of providing internal motor overload protection according to UL 508C.

For Canadian (cUL) installations the drive mains supply must be fitted with any external recommended suppressor with the following features:

- Surge-protective devices; device shall be a Listed Surge-protective device (Category code VZCA and VZCA7)
- Rated nominal voltage 480/277 VAC, 50/60 Hz, 3-phase
- Clamping voltage VPR = 2,000 V, IN = 3 kA min, MCOV = 508 VAC, SCCR = 5,000 A (0K40...37K0), 10,000 A (45K0...90K0), 18,000 A (110K...132K), 30,000 A (160K)
- Suitable for Type 2 SPD application
- Clamping shall be provided between phases and also between phase and ground

19.4.3 EAC

Frequency Converters EFC x610 (0K40...160K) have EAC certification. EAC marking is required for Custom Union, including Russia, Belarus and Kazakhstan.

EAC marking

Fig. 19-14: EAC marking

19.4.4 RCM

Frequency Converters EFC x610 (0K40...90K0) comply with the relevant ACMA standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997.These standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.

RCM label

Fig. 19-15: RCM label

RCM standard

EN 61800-3: 2004+A1: 2012, Adjustable speed electrical power drive systems - Part3: EMC requirements and specific test methods

ACMA supplier code

E1066

CAN, ABN or ARBN

ABN / IRDN 89003258384

Category

Frequency Converters EFC x610 (0K40...90K0) complies with the applicable requirements detailed in EN 61800-3: 2004+A1: 2012 (Category 3 limits) and is not intended to be used directly on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network, in which supplementary mitigation measures are required.

19.4.5 EU RoHS

The product meet the requirement of RoHS (Restriction on the use of certain Hazardous Substances) directive 2011/65/EU with the exemption per Annex of 2011/65/EU.

EU RoHS marking

Fig. 19-16: EU RoHS marking

19.4.6 REACH

Due to Art. 33 of EU-REACH (EC) No. 1907/2006, a REACH SVHC substance communication document is provided by following link:

www.boschrexroth.com/REACH

19.5 Third Party Licenses

19.5.1 STMicroelectronics

BY INSTALLING COPYING, DOWNLOADING, ACCESSING OR OTHERWISE USING THIS SOFTWARE PACKAGE OR ANY PART THEREOF (AND THE RELATED DOCUMENTATION) FROM STMICROELECTRONICS INTERNATIONAL N.V, SWISS BRANCH AND/OR ITS AFFILIATED COMPANIES (STMICROELECTRONICS), THE RECIPIENT, ON BEHALF OF HIMSELF OR HERSELF, OR ON BEHALF OF ANY ENTITY BY WHICH SUCH RECIPIENT IS EMPLOYED AND/OR ENGAGED AGREES TO BE BOUND BY THIS SOFTWARE PACKAGE LICENSE AGREEMENT.

Under STMicroelectronics' intellectual property rights and subject to applicable licensing terms for any third-party software incorporated in this software package and applicable Open Source Terms (as defined here below), the redistribution, reproduction and use in source and binary forms of the software package or any part thereof, with or without modification, are permitted provided that the following conditions are met:

1. Redistribution of source code (modified or not) must retain any copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form, except as embedded into microcontroller or microprocessor device manufactured by or for STMicroelectronics or a software update for such device, must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of STMicroelectronics nor the names of other contributors to this software package may be used to endorse or promote products derived from this software package or part thereof without specific written permission.
4. This software package or any part thereof, including modifications and/or derivative works of this software package, must be used and execute solely and exclusively on or in combination with a microcontroller or a microprocessor devices manufactured by or for STMicroelectronics.
5. No use, reproduction or redistribution of this software package partially or totally may be done in any manner that would subject this software package to any Open Source Terms (as defined below).
6. Some portion of the software package may contain software subject to Open Source Terms (as defined below) applicable for each such portion ("Open Source Software"), as further specified in the software package. Such Open Source Software is supplied under the applicable Open Source Terms and is not subject to the terms and conditions of license hereunder. "Open Source Terms" shall mean any open source license which requires as part of distribution of software that the source code of such software is distributed therewith or otherwise made available, or open source license that substantially complies with the Open Source definition specified at www.opensource.org and any other comparable open source license such as for example GNU General Public License (GPL), Eclipse Public License (EPL), Apache Software License, BSD license and MIT license.

7. This software package may also include third party software as expressly specified in the software package subject to specific license terms from such third parties. Such third party software is supplied under such specific license terms and is not subject to the terms and conditions of license hereunder. By installing copying, downloading, accessing or otherwise using this software package, the recipient agrees to be bound by such license terms with regard to such third party software.
8. STMicroelectronics has no obligation to provide any maintenance, support or updates for the software package.
9. The software package is and will remain the exclusive property of STMicroelectronics and its licensors. The recipient will not take any action that jeopardizes STMicroelectronics and its licensors' proprietary rights or acquire any rights in the software package, except the limited rights specified hereunder.
10. The recipient shall comply with all applicable laws and regulations affecting the use of the software package or any part thereof including any applicable export control law or regulation.
11. Redistribution and use of this software package partially or any part thereof other than as permitted under this license is void and will automatically terminate your rights under this license.

THIS SOFTWARE PACKAGE IS PROVIDED BY STMICROELECTRONICS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS, IMPLIED OR STATUTORY WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS ARE DISCLAIMED TO THE FULLEST EXTENT PERMITTED BY LAW. IN NO EVENT SHALL STMICROELECTRONICS OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE PACKAGE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

EXCEPT AS EXPRESSLY PERMITTED HEREUNDER AND SUBJECT TO THE APPLICABLE LICENSING TERMS FOR ANY THIRD-PARTY SOFTWARE INCORPORATED IN THE SOFTWARE PACKAGE AND OPEN SOURCE TERMS AS APPLICABLE, NO LICENSE OR OTHER RIGHTS, WHETHER EXPRESS OR IMPLIED, ARE GRANTED UNDER ANY PATENT OR OTHER INTELLECTUAL PROPERTY RIGHTS OF STMICROELECTRONICS OR ANY THIRD PARTY.

19.6 Appendix V: Parameter Change Record

19.6.1 Parameter changes---03V12 vs 03V08

Change type	Code	Name	Change description
New-added	C0.41	Power loss ride-through recovery delay	New-added parameters
	C0.42	Power loss ride-through action voltage	
	C0.43	Power loss ride-through recovery voltage	
	C0.44	Power loss ride-through deceleration to stop time	
	E9.97	Last detailed error type	
	E9.98	Second last detailed error type	
	E9.99	Third last detailed error type	
	F0.20	ASF Command 1	
	F0.21	ASF Command 2	
	F0.22	ASF Command 3	
	F0.23	ASF Command 4	
	d0.14	Energy saving counter kWh	
	d0.15	Energy saving counter MWh	

Change type	Code	Name	Change description
Modified	C0.40	Power loss ride-through mode	Added "3: Regain kinetic energy, decelerate to stop" to setting range
	C1.72	Motor thermal sensor type	Added "3: PT1000" to setting range
	H8.15	Input curve 0 minimum	Changed setting range to: "-120.0 %...[H8.17]" Changed default value to: "0.0"
	H8.16	Input curve 0 minimum frequency	Changed setting range to: "-[E0.09]...[E0.09] Hz"
	H8.17	Input curve 0 maximum	Changed setting range to: "[H8.15]...120.0 %"
	H8.18	Input curve 0 maximum frequency	Changed setting range to: "-[E0.09]...[E0.09] Hz" Changed default value to: "50.0"
	H8.87	I/O card output channel diagnosis	Changed parameter name to: "I/O card output channel diagnosis" Changed setting range to: 0: Inactive 1: EAO diagnosis; 2: EDO diagnosis 3: ERO diagnosis; 4: All output diagnosis
	H9.02	Extended relay 3 output selection	Changed attribute to: "Stop"
	H9.03	Extended relay 4 output selection	Changed attribute to: "Stop"
	H9.97	Relay card output channel diagnosis	Changed parameter name to: "Relay card output channel diagnosis" Changed setting range to: 0: Inactive; 1: Relay1 diagnosis 2: Relay2 diagnosis; 3: Relay3 diagnosis 4: Relay4 diagnosis; 5: All output diagnosis
	U1.00	Run monitoring display	Added "14: Energy saving counter kWh" and "15: Energy saving counter MWh" to setting range
	U1.10	Stop monitoring display	Added "14: Energy saving counter kWh" and "15: Energy saving counter MWh" to setting range
Deleted	None		

Tab. 19-2: Parameter changes between version 03V12 and 03V08

19.6.2 Parameter changes---03V20 vs 03V12

Change type	Code	Name	Change description
New-added	C0.10	Automatic voltage stabilization	New-added parameters
New-added	C0.24	Stall overvoltage hysteresis voltage	New-added parameters
New-added	C1.25	Rotor leakage inductance	New-added parameters
New-added	C2.20	0 Hz output mode	New-added parameters
New-added	C3.02	Speed loop proportional gain 2	New-added parameters
New-added	C3.03	Speed loop integral time 2	New-added parameters
New-added	C3.10	Speed loop switching frequency 1	New-added parameters
New-added	C3.11	Speed loop switching frequency 2	New-added parameters
New-added	C3.21	Encoder speed filter time	New-added parameters
New-added	C3.22	Communication encoder offset	New-added parameters
New-added	C3.25	Speed monitor timeout	New-added parameters
New-added	C3.26	Speed monitor max speed difference	New-added parameters
New-added	C3.38	Forward frequency limitation at torque control mode	New-added parameters
New-added	C3.39	Reverse frequency limitation at torque control mode	New-added parameters
New-added	C3.46	Digital torque reference setting	New-added parameters
New-added	C3.47	Torque limitation reference selection at speed control mode	New-added parameters
New-added	C3.48	Speed limitation reference selection at torque control mode	New-added parameters
New-added	d0.82...d0.89	ASF display 02...ASF display 09	New-added parameters
New-added	Group U2	LCD panel parameters	New-added parameters

Change type	Code	Name	Change description
Modified	b0.21	Manufacturer password	Changed attribute to: "Run"
	C0.00	Control mode	Added "2: FOC" to setting range
	C0.05	Carrier frequency	Changed setting range to: "0K40...22K0: 1...15 kHz 30K0...90K0: 1...12 kHz" Changed default value to: 0K40...4K00: 6k 5K50...22K0 (HD): 6k 5K50...22K0 (ND): 4k 30K0...90K0: 4k
	C1.69	Motor thermal model protection setting	Changed default value to: "0"
	C2.21	Torque boost setting	Changed default value to: "DOM"
	C3.00	Speed loop proportional gain 1	Changed parameter name to: "Speed loop proportional gain 1"
	C3.01	Speed loop integral time 1	Changed parameter name to: "Speed loop integral time 1"
	C3.40	Torque control mode	Added "2: Communication" to setting range
	C3.41	Torque reference channel	Added "4: Pulse input via DI5", "5: Parameter setting C3.46" and "6: Communication" to setting range
	E0.11	Reverse running frequency	Changed attribute to: "Stop"
	E0.37	Start frequency holding time	Changed default value to: "0.0"
	E0.55	Overexcitation braking factor	Changed setting range to: "1.00...2.00"
	E2.01	DO1 output setting	Added "25: Converter error or warning" to setting range
	E2.15	Relay1 output selection	
	H8.20	EDO output setting	
	H8.21	Extended relay output selection	
	H9.00...H 9.03	Extended relay 1 output selection...Extended relay 4 output selection	

Change type	Code	Name	Change description
Modified	E3.59	Stage 0 frequency source	Added "6: Panel potentiometer" and "7: Digital input up/down command" to setting range
	E4.01	PID feedback channel	Added "4: Encoder card speed" to setting range
	E9.05	Last error type	Added "35: SPE-, speed control loop error" to setting range
	E9.06	Second last error type	
	E9.07	Third last error type	
	U1.00	Run monitoring display	Added options 82...89 to setting range
	U1.10	Stop monitoring display	
Deleted	None		

Tab. 19-3: Parameter changes between version 03V20 and 03V12

19.6.3 Parameter changes---03V24 vs 03V20

Change type	Code	Name	Change description
New-added	C1.02	Expert mode	New-added parameters
	C2.08	V/f separation output voltage source selection	
	C2.09	V/f separation output voltage digital setting	
	C2.10	V/f separation output voltage acceleration time	
	C2.11	V/f separation output voltage deceleration time	
	C2.12	V/f separation stop mode selection	
	C2.13	V/f separation boost factor	
	E2.20	DO1/relay1 output values from extension card fieldbus communication	
	E2.28	AO1 value in percentage from extension card fieldbus communication	
	F0.20...F0.27	ASF Command 1...ASF Command 8	
	H0.12	Torque control reference from fieldbus	
	H0.14	FWD torque limitation reference from fieldbus	
	H0.15	REV torque limitation reference from fieldbus	
	H0.16	Speed limitaion at torque control mode from fieldbus	
	H0.50	Fieldbus voltage command	
	H8.07	EAI1 dead zone filter value	

Change type	Code	Name	Change description
New-added	H8.22	EDO2 output selection	New-added parameters
	H8.23	Extended digital output value from extension card fieldbus communication	
	H8.28	EAO value in percentage from extension card fieldbus communication	
	H8.30	EAI2 input mode	
	H8.31	EAI2 input polarity setting	
	H8.32	EAI2 filter time	
	H8.33	EAI2 gain	
	H8.34	EAI2 curve minimum	
	H8.35	EAI2 curve minimum value	
	H8.36	EAI2 curve maximum	
	H8.37	EAI2 curve maximum value	
	H8.38	EAI2 dead zone filter value	
	H8.39	EAO curve minimum	
	H8.40	EAO curve minimum value	
	H8.41	EAO curve maximum	
	H8.42	EAO curve maximum value	
	H9.10	Relay output setting value	
	d0.09	V/f separation setting voltage	
	d0.34	I/O card EAI2 input	
	d0.48	I/O card EDO2 output	

Change type	Code	Name	Change description
Modified	C0.05	Carrier frequency	Added the information of 132 kW
	C1.11	Motor poles	Changed setting range from "2...128" to "2...256"
	C1.72	Motor thermal sensor type	Added "4: TDK G1551_8320 (NTC)" to setting range
	C2.00	V/f curve mode	Added "3: V/f seperation" to setting range
	C3.38	Forward frequency limitation at torque control mode	Changed attribute to: "Run"
	C3.39	Reverse frequency limitation at torque control mode	
	C3.41	Torque reference channel	Changed setting range
	C3.47	Torque limitation reference selection at speed control mode	Changed setting range
	C3.48	Speed limitation reference selection at torque control mode	Changed setting range
	E0.00	First frequency setting source	Changed setting range
	E0.02	Second frequency setting source	Changed setting range
	E1.00...E1.04	X1 input...X5 input	Changed setting range
	E1.60	Motor temperature sensor channel	Changed setting range
	E2.01	DO1 output setting	Added "21: Parameter setting from communication" to setting range
	E2.02	DO1 pulse output setting	Added "3: Setting torque", " 4: Output torque" to setting range
	E2.15	Relay1 output selection	Added "21: Parameter setting from communication" to setting range

Change type	Code	Name	Change description
Modified	E2.26	AO1 output setting	Added "9: EAI2 analog input", " 12: Parameter setting from communication", "13: Setting torque", "14: Output torque" to setting range
	E3.59	Stage 0 frequency source	Changed setting range
	E4.01	PID feedback channel	Changed setting range
	E8.03	Communication process data loss behavior	Added "3: Keep running without warning" to setting range
	H1.10... H1.19	Output PZD 1...Output PZD 10	Changed setting range
	H8.00... H8.04	EX1 input...EX5 input	Added "48: Motor overheat detection" to setting range
	H8.05	EAI1 input mode	Changed parameter name to: "EAI1 input mode"
	H8.06	EAI1 input polarity setting	Changed parameter name to: "EAI1 input polarity setting"
	H8.09	EAI1 filter time	Changed parameter name to: "EAI1 filter time"
	H8.10	EAI1 gain	Changed parameter name to: "EAI1 gain"
	H8.15	EAI1 curve minimum	Changed parameter name to: "EAI1 curve minimum"
	H8.16	EAI1 curve minimum value	Changed parameter name to: "EAI1 curve minimum value"
	H8.17	EAI1 curve maximum	Changed parameter name to: "EAI1 curve maximum"
	H8.18	EAI1 curve maximum value	Changed parameter name to: "EAI1 curve maximum value"
	H8.20	EDO1 output selection	Added "21: Parameter setting from communication" to setting range
	H8.21	Extended relay output selection	
	H8.25	EAO output mode	Added "2: -10...10 V (only for IO plus card)" to setting range
	H8.26	EAO output selection	Added "9: EAI2 analog input", " 12: Parameter setting from communication", "13: Setting torque", "14: Output torque" to setting range
	H9.00... H9.03	Extended relay 1 output selection...Extended relay 4 output selection	Added "21: Parameter setting from communication" to setting range
	d0.33	I/O card EAI1 input	Changed parameter name to: "I/O card EAI1 input"
	d0.47	I/O card EDO1 output	Changed parameter name to: "I/O card EDO1 output"

Change type	Code	Name	Change description
Deleted	H8.08	EAI curve selection	Deleted parameter

Tab. 19-4: Parameter changes between version 03V24 and 03V20

19.6.4 Parameter changes---03V26 vs 03V24

Change type	Code	Name	Change description
New-added	C0.11	Automatic voltage stabilization reference voltage	New-added parameters
	C3.04	Speed observer harmonics damping factor	
	E0.42	Speed tracing voltage recovery ratio	
	E0.43	Speed tracing deceleration time	
	E0.56	Emergency stop action	
	E0.57	Emergency stop deceleration time	
	E9.02	Automatic error reset attempts restart time	
	H0.03	STO safety status word	
	d0.18	Opt 1 active interface version	
	d0.19	Opt 2 active interface version	

Change type	Code	Name	Change description
Modified	C0.06	Carrier frequency automatic adjustment	Added "2: Fixed carrier frequency" to setting range
	C0.50	Fan control	Added "2: On when converter run" to setting range
	C1.09	Motor rated speed	Changed setting range
	C1.12	Motor rated slip frequency	
	C1.15	Torque constant	
	C1.21	Stator resistance	
	C1.22	Rotor resistance	
	C2.08	V/f separation output voltage source selection	
	C3.22	Encoder commutation offset	Changed parameter name
	C3.48	Speed limitation reference selection at torque control mode	Changed item "0: Parameter C3.38 and C3.39" in setting range
	E0.04	Frequency setting source combination	Added items "3, 4, 5, 6" to setting range
	E0.06	Digital setting frequency saving mode	Added "4: Not saved when powered off; memorized when stopped" to setting range
	E8.02	Communication error protection mode	Added "2: Emergency stop" to setting range
	H8.26	EAO output selection	Changed item "0: Output frequency" in setting range
Deleted	None		

Tab. 19-5: Parameter changes between version 03V26 and 03V24

19.6.5 Parameter changes---03V34 vs 03V26

Change type	Code	Name	Change description
New-added	E9.50	Last warning type	New-added parameters
	E9.51	Second last warning type	
	E9.52	Third last warning type	
	E8.14	Modbus transmission mode selection	
	E8.15	Modbus ASCII inter-character timeout	
	C1.17	Motor rated torque	
	d0.38	IO plus card TSI input signal value	
	C0.23	Overvoltage suppression adjustment gain	
	C0.25	Overvoltage prevention mode	
	C3.49	Torque command ramp	
	C3.52	SVC regulation area lower frequency	
	C3.53	SVC regulation area upper frequency	
	C3.54	SVC damp factor enhance upper frequency	
	C3.55	SVC damp factor enhance coefficient	
	E0.47	Run command priority	
	C3.30	Maximum fieldweakening current factor for SM	

Change type	Code	Name	Change description
Modified	E2.25	AO1 output mode	Added "3: 2...10V","4: 4...20mA" to setting range
	b0.10	Parameter initialization	Changed option 2 to "Clear error and warning record"
	H0.02	Extended status word	Added bit 14: "1: warning; 0: No warning" Added bit 1: "1: sleep mode; 0: normal" Added bit 2: "1:Converter OK; 0: Converter not OK"
	C1.23	Leakage inductance	Changed setting range
	C1.24	Mutual inductance	
	C1.25	Rotor leakage inductance	
	C1.16	Back emf voltage constant	
	C2.24	Light load oscillation damping factor	Changed default value
	C2.25	Light load oscillation damping filter factor	
	C1.69	Motor thermal model protection setting	Added "2: current monitoring active" to setting range

Tab. 19-6: Parameter changes between version 03V34 and 03V26

Notes

rexroth
A Bosch Company

Bosch Rexroth (Xi'an) Electric Drives and Controls Co., Ltd.
No.3999, Shangji Road, Economic and Technological
Development Zone, 710021 Xi'an, P.R. China
Tel：+86 29 86555100
Tel(Sales)：+86 29 86555232
Tel(Aftersales)：400 887 6910
Emial：info.fc@boschrexroth.com.cn
Email(Aftersales)：service.fc@boschrexroth.com.cn
Website: www.boschrexroth.com.cn/fc

R912005854

DOK-RCON03-EFC-X610***-IT09-EN-P