

Force

- » Peak: 156 - 780 N
- » Continuous: 42 - 102 N

Maximum Velocity

- » Up to 8.5 m/s

Feedback

- » Built-in position sensor
- » 1V pk-pk sin/cos
- » 12 micron repeatability
- » Optionally with high resolution encoder

Range of motion

- » Strokes up to 1151 mm

Dimensions

- » W x H: 110 x 164 mm
- » Rod diameters: 25 mm

Applications

- » Packaging
- » Material Handling
- » Automated Assembly
- » Bio-medical

The OEM advantage

- » Easy integration
- » Flexible position control
- » High speed and acceleration
- » Clean, quiet operation
- » Low maintenance



The ServoTube Module with fully integrated bearing rail and position encoder offers unprecedented value in high performance applications. The ServoTube Module is a cost effective alternative to ballscrew and belt drive systems where high speed and flexibility are required.

Four models deliver a continuous force of 42~102 N (9~23lb) with peak forces of up to 780 N (175lb). Standard stroke lengths of 14~1151 mm are available.

The patented magnetic design of ServoTube generates 12 micron (0.47 mil) repeatability and 350 micron (14 mil) absolute accuracy, from a non-contact, integral position sensor. The standard ServoTube position encoder output is an industry standard 1V pk-pk sin/cos signal. For applications requiring higher levels of accuracy, the ServoTube Module is available with a fully integrated optical position encoder giving a resolution of 1 micron.

The non-contact nature of the direct linear drive results in life expectancy far above that for typical belt drive and ballscrew systems, with the added advantage of no deterioration in accuracy or repeatability over the entire life of the product.

The ServoTube Module is an ideal OEM solution for easy integration into pick-and-place gantry and general purpose material handling machines. The load is mounted directly to the forcer giving a very stable base. Servotube Modules can be easily integrated with each other or with other ServoTube products to create multi axis systems with minimal design effort.

The ServoTube has superior thermal efficiency, radiating heat uniformly. High duty cycles are possible without the need for forced-air or water cooling.

ELECTRICAL SPECIFICATIONS

| FORCER TYPE | 2504 | | 2506 | | 2508 | | 2510 | | units |
|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | S ⁽¹⁾ | P ⁽¹⁾ | S ⁽¹⁾ | P ⁽¹⁾ | S ⁽¹⁾ | P ⁽¹⁾ | S ⁽¹⁾ | P ⁽¹⁾ | |
| Peak force @ 25°C ambient for 1 sec | 312 | 156 | 468 | 234 | 624 | 312 | 780 | 390 | N |
| Peak current @ 25°C ambient for 1 sec | 20 | | | | | | | | Apk |
| With 25 x 25 x2.5cm heatsink plate | | | | | | | | | |
| Continuous stall force @ 25°C ambient ⁽²⁾ | 51.2 | | 69.5 | | 86.4 | | 102.4 | | N |
| Continuous stall current @ 25°C ambient | 2.31 | 4.62 | 2.10 | 4.20 | 1.96 | 3.92 | 1.86 | 3.72 | Arms |
| | 3.27 | 6.54 | 2.97 | 5.94 | 2.77 | 5.54 | 2.62 | 5.24 | Apk |
| Without heatsink plate | | | | | | | | | |
| Continuous stall force @ 25°C ambient ⁽²⁾ | 42.5 | | 59.5 | | 75.1 | | 90.0 | | N |
| Continuous stall current @ 25°C ambient | 1.92 | 3.84 | 1.80 | 3.60 | 1.70 | 3.40 | 1.63 | 3.26 | Arms |
| | 2.72 | 5.44 | 2.54 | 5.08 | 2.41 | 4.82 | 2.31 | 4.62 | Apk |
| Force constant (sine commutation) | 22.1 | 11.0 | 33.1 | 16.5 | 44.1 | 22.0 | 55.2 | 27.6 | N/Arms |
| | 15.6 | 7.8 | 23.4 | 11.7 | 31.2 | 15.6 | 39.0 | 19.5 | N/Apk |
| Back EMF constant (phase to phase) | 18.0 | 9.0 | 27.0 | 13.5 | 36.0 | 18.0 | 45.0 | 22.5 | Vpk/m/s |
| Fundamental forcer constant | 6.47 | | 7.92 | | 9.13 | | 10.24 | | N/√W |
| Eddy current loss | 9.51 | | 12.55 | | 15.58 | | 18.61 | | N/m/s |
| Resistance @ 25°C (phase to phase) | 6.02 | 1.50 | 9.02 | 2.25 | 12.03 | 3.01 | 15.04 | 3.76 | Ohm |
| Resistance @ 100°C (phase to phase) | 7.75 | 1.94 | 11.63 | 2.91 | 15.51 | 3.88 | 19.39 | 4.85 | Ohm |
| Inductance @ 1kHz (phase to phase) | 3.90 | 0.97 | 5.85 | 1.46 | 7.80 | 1.95 | 9.75 | 2.44 | mH |
| Electrical time constant | 0.65 | | | | | | | | ms |
| Maximum working voltage | 380 | | | | | | | | V d.c. |
| Pole pitch (one electrical cycle) | 51.2 | | | | | | | | mm |
| Peak acceleration ⁽³⁾ | 222 | 111 | 222 | 111 | 235 | 117 | 255 | 127 | m/s ² |
| Maximum speed ⁽⁴⁾ | 8.5 | 7.3 | 6.4 | 7.1 | 5.3 | 7.3 | 4.5 | 6.7 | m/s |

Notes: -

- ⁽¹⁾ S=series forcer phases, P=parallel forcer phases
⁽²⁾ Reduce continuous stall force to 89% at 40°C ambient
⁽³⁾ Based on a moving forcer with no payload
⁽⁴⁾ Based on a moving forcer with triangular move over maximum stroke and no payload

THERMAL SPECIFICATIONS

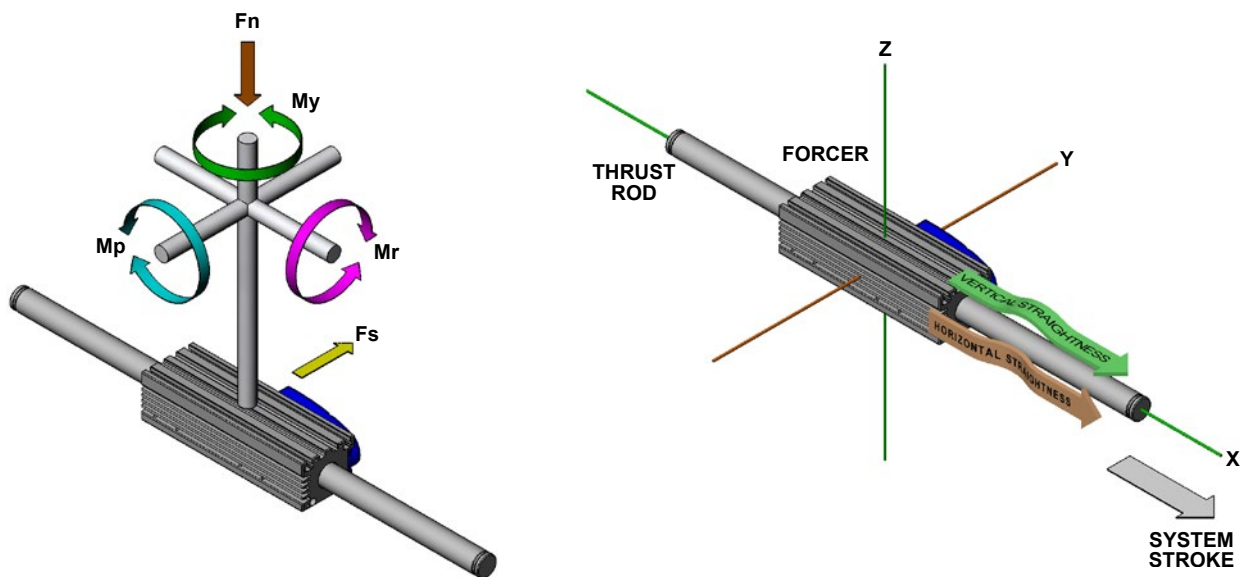
| FORCER TYPE | 2504 | 2506 | 2508 | 2510 | units |
|---|------|------|------|-------|---------|
| Maximum phase temperature | 100 | | | | °C |
| Thermal resistance $R_{th_{phase-housing}}$ | 0.41 | 0.27 | 0.20 | 0.16 | °C/Watt |
| With 25 x 25 x2.5cm heatsink plate | | | | | |
| Power dissipation @ 25°C ambient | 62.3 | 77.0 | 89.2 | 100.2 | Watt |
| Thermal resistance $R_{th_{housing-ambient}}$ | 0.79 | 0.69 | 0.64 | 0.59 | °C/Watt |
| Without heatsink plate | | | | | |
| Power dissipation @ 25°C ambient | 43.1 | 56.4 | 67.6 | 77.3 | Watt |
| Thermal resistance $R_{th_{housing-ambient}}$ | 1.33 | 1.06 | 0.91 | 0.81 | °C/Watt |
| Thermal time constant | 1188 | 1276 | 1377 | 1486 | s |

MECHANICAL SPECIFICATIONS

| FORCER TYPE | 2504 | 2506 | 2508 | 2510 | units |
|--|------|------|------|------|-------|
| Maximum stroke | 1151 | 1100 | 1049 | 998 | mm |
| Moving mass | 1.40 | 2.10 | 2.65 | 3.05 | kg |
| Maximum normal force, $F_n^{(1)(3)}$ | 1.05 | 2.11 | | | kN |
| Maximum side force, $F_s^{(1)}$ | | | | | |
| Maximum roll moment, $M_r^{(1)}$ | 17.8 | 35.6 | | | Nm |
| Maximum pitch moment, $M_p^{(1)}$ | 6.4 | 112 | 158 | 212 | Nm |
| Maximum yaw moment, $M_y^{(1)}$ | | | | | |
| Maximum normal force, $F_n^{(2)(3)}$ | 0.49 | 0.98 | | | kN |
| Maximum side force, $F_s^{(2)}$ | | | | | |
| Maximum roll moment, $M_r^{(2)}$ | 8.2 | 16.4 | | | Nm |
| Maximum pitch moment, $M_p^{(2)}$ | 2.9 | 52 | 73 | 98 | Nm |
| Maximum yaw moment, $M_y^{(2)}$ | | | | | |
| Constrained vertical straightness (flatness) | 60 | | | | µm/m |
| Constrained horizontal straightness | 80 | | | | µm/m |
| Unconstrained vertical straightness (flatness) | 100 | | | | µm/m |
| Unconstrained horizontal straightness | 80 | | | | µm/m |

Notes: -

- (1) For a bearing life expectancy of 10000 km with no other forces or moments
- (2) For a bearing life expectancy of 100000 km with no other forces or moments
- (3) Load in kg = force/9.81



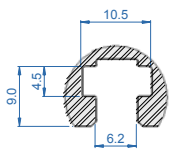
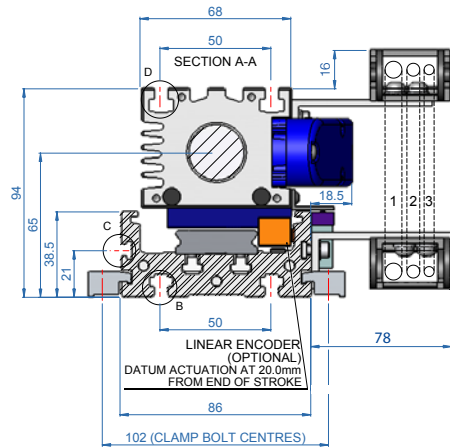
OUTLINE DRAWINGS

SM25

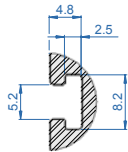
| FORCER | FORCER LENGTH (mm) | WITH BUFFERS (mm) |
|--------|--------------------|-------------------|
| 2504 | 160 | 164 |
| 2506 | 211 | 215 |
| 2508 | 262 | 266 |
| 2510 | 313 | 317 |

CABLES:

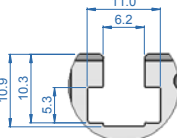
- Ø7.6 POWER CABLE
- Ø5.8 SENSOR CABLE
- Ø4.5 ENCODER CABLE (OPTIONAL)



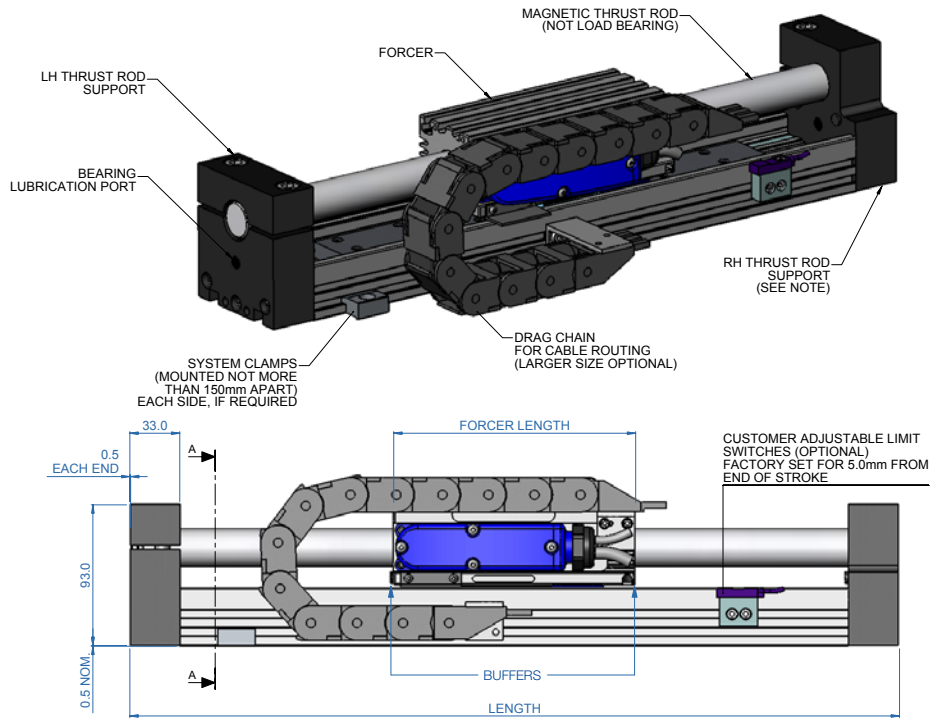
DETAIL B
SLOTS FOR M5 T-NUTS & M6 SQUARE / HEX. NUTS



DETAIL C
SLOTS FOR M4 SQUARE NUTS



DETAIL D
SLOTS FOR M5 T-NUTS & M6 SQUARE / HEX. NUTS



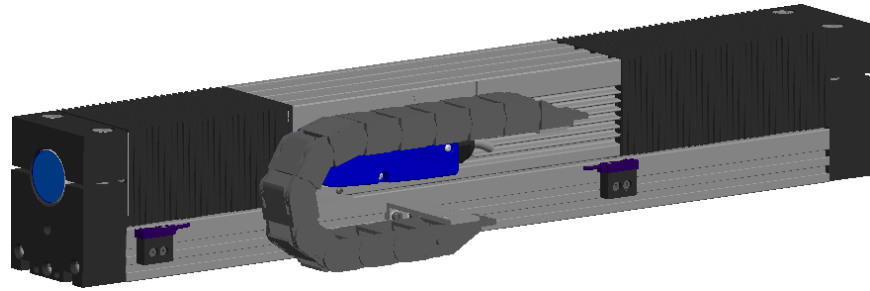
NOTE:
RH THRUST ROD SUPPORT SHOWN IS FOR 2504 MODULES ONLY. FOR ALL OTHER SIZES THIS SUPPORT WILL BE AS LH THRUST ROD SUPPORT.

| Length | Stroke | | | |
|--------|--------|------|------|------|
| | 2504 | 2506 | 2508 | 2510 |
| 253 | 23 | - | - | - |
| 278 | 48 | - | - | - |
| 304 | 74 | 23 | - | - |
| 330 | 100 | 49 | - | - |
| 355 | 125 | 74 | 23 | - |
| 381 | 151 | 100 | 49 | - |
| 406 | 176 | 125 | 74 | 23 |
| 432 | 202 | 151 | 100 | 49 |
| 458 | 228 | 177 | 126 | 75 |
| 483 | 253 | 202 | 151 | 100 |
| 509 | 279 | 228 | 177 | 126 |
| 535 | 305 | 254 | 203 | 152 |
| 560 | 330 | 279 | 228 | 177 |
| 586 | 356 | 305 | 254 | 203 |
| 612 | 382 | 331 | 280 | 229 |
| 637 | 407 | 356 | 305 | 254 |
| 663 | 433 | 382 | 331 | 280 |

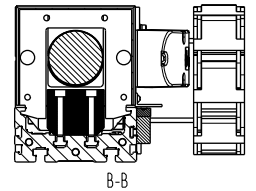
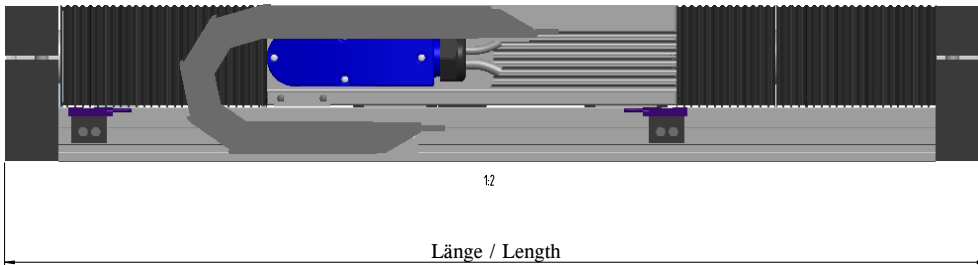
| Length | Stroke | | | |
|--------|--------|------|------|------|
| | 2504 | 2506 | 2508 | 2510 |
| 689 | 459 | 408 | 357 | 306 |
| 714 | 484 | 433 | 382 | 331 |
| 740 | 510 | 459 | 408 | 357 |
| 766 | 536 | 485 | 434 | 383 |
| 791 | 561 | 510 | 459 | 408 |
| 817 | 587 | 536 | 485 | 434 |
| 868 | 638 | 587 | 536 | 485 |
| 919 | 689 | 638 | 587 | 536 |
| 971 | 741 | 690 | 639 | 588 |
| 1022 | 792 | 741 | 690 | 639 |
| 1073 | 843 | 792 | 741 | 690 |
| 1125 | 895 | 844 | 793 | 742 |
| 1176 | 946 | 895 | 844 | 793 |
| 1227 | 997 | 946 | 895 | 844 |
| 1279 | 1049 | 998 | 947 | 896 |
| 1330 | 1100 | 1049 | 998 | 947 |
| 1381 | 1151 | 1100 | 1049 | 998 |

| Approximate module mass (kg) | | | |
|------------------------------|----------------------------|----------------------------|----------------------------|
| 2504 | 2506 | 2508 | 2510 |
| $(0.0108 \times L) + 3.35$ | $(0.0108 \times L) + 3.04$ | $(0.0108 \times L) + 3.58$ | $(0.0108 \times L) + 3.96$ |
| where L = Length in mm | | | |

Bellows SB25 (on request)



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| Length | Stroke | | | |
|--------|--------|------|------|------|
| | 2504 | 2506 | 2508 | 2510 |
| 253 | - | - | - | - |
| 278 | - | - | - | - |
| 304 | 14 | - | - | - |
| 330 | 40 | - | - | - |
| 355 | 65 | 14 | - | - |
| 381 | 91 | 40 | - | - |
| 406 | 114 | 65 | 14 | - |
| 432 | 134 | 91 | 40 | - |
| 458 | 148 | 115 | 66 | 15 |
| 483 | 165 | 134 | 91 | 40 |
| 509 | 183 | 148 | 115 | 66 |
| 535 | 197 | 166 | 135 | 91 |
| 560 | 214 | 183 | 148 | 115 |
| 586 | 230 | 197 | 166 | 135 |
| 612 | 248 | 215 | 184 | 149 |
| 637 | 265 | 230 | 197 | 166 |
| 663 | 297 | 248 | 215 | 184 |

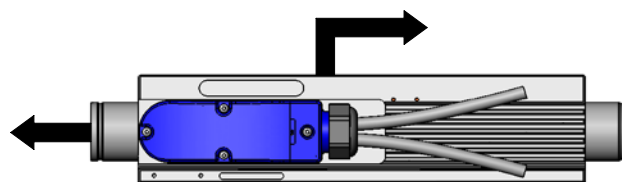
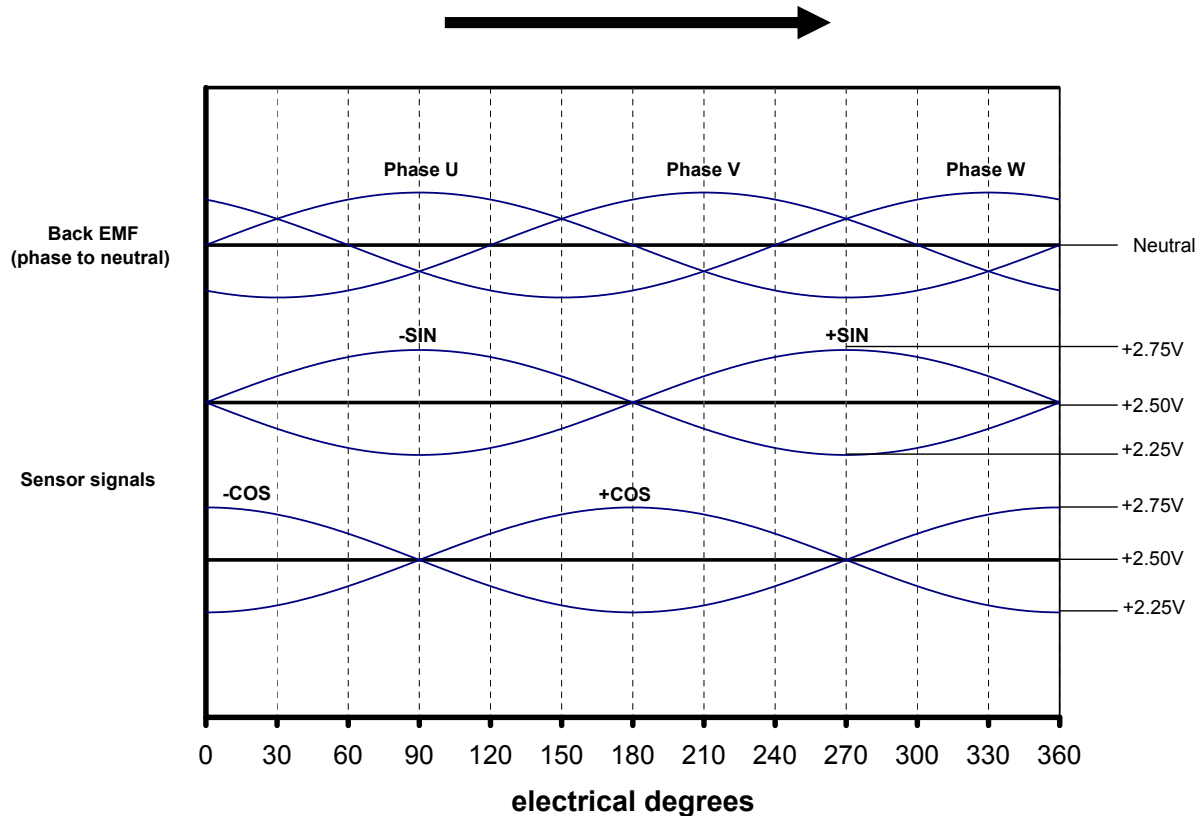
| Length | Stroke | | | |
|--------|--------|------|------|------|
| | 2504 | 2506 | 2508 | 2510 |
| 689 | 297 | 266 | 231 | 198 |
| 714 | 312 | 279 | 248 | 215 |
| 740 | 330 | 297 | 266 | 231 |
| 766 | 348 | 313 | 280 | 249 |
| 791 | 361 | 330 | 297 | 266 |
| 817 | 379 | 348 | 313 | 280 |
| 868 | 412 | 379 | 348 | 313 |
| 919 | 443 | 412 | 379 | 348 |
| 971 | 481 | 444 | 413 | 380 |
| 1022 | 512 | 481 | 444 | 413 |
| 1073 | 543 | 512 | 481 | 444 |
| 1125 | 577 | 544 | 513 | 478 |
| 1176 | 608 | 577 | 544 | 513 |
| 1227 | 643 | 608 | 577 | 544 |
| 1279 | 677 | 644 | 609 | 578 |
| 1330 | 708 | 677 | 644 | 609 |
| 1381 | 741 | 708 | 677 | 644 |

| Approximate module mass (kg) | | | |
|------------------------------|---------------------------|---------------------------|---------------------------|
| 2504 | 2506 | 2508 | 2510 |
| $(0.00885 \times L)+2.49$ | $(0.00885 \times L)+2.94$ | $(0.00885 \times L)+3.49$ | $(0.00885 \times L)+3.85$ |
| where L = Length in mm | | | |

FEEDBACK

The ServoTube Module is available with three feedback options with option S supplied as standard.

Option S feedback outputs analogue, differential sine and cosine signals for providing position feedback. Shown below are the relationships between forcer phase back EMF and position sensor outputs for one direction of motion (as shown by arrows). It should be noted that +SIN or -SIN is always in phase with forcer phase U. For the motion shown, -SIN is in phase with forcer phase U. For motion in the opposing direction +SIN is in phase with forcer phase U.



| OPTION S SPECIFICATION | Sx25 | units |
|--|----------|--------------------|
| Output signal period | 51.2 | mm |
| Signal amplitude (between +/- signals) | 1 | V _{pk-pk} |
| Output current | ± 10 | mA |
| Supply voltage | 5 ± 0.25 | V _{d.c.} |
| Supply current (output current=0) | 15 ± 5 | mA |
| Resolution ⁽¹⁾ | 12 | µm |
| Position repeatability ⁽²⁾ | ± 12 | µm |
| Absolute accuracy ⁽³⁾ | ± 350 | µm |

Notes: -

⁽¹⁾ Dependent on amplifier (indication with 12 bit resolution)

⁽²⁾ Dependent on amplifier. Under constant operating conditions. Self-heating of the forcer will cause expansion in the thrust rod during the initial warm up period. In high duty applications (corresponding to an internal forcer temperature of 80°C) a 1 metre thrust rod will expand typically by 250 µm.

⁽³⁾ Maximum error over 1 metre under constant operating conditions.

If improved positional accuracy is required, then in addition to option S, one external encoder option is available.

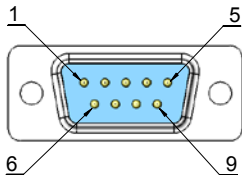
Option C uses the Renishaw RGH24X optical encoder. This option provides two channels, A and B, in phase quadrature (90° phase separated). A reference channel, Z, is also available that produces a single output at a position set by a reference mark.

| SPECIFICATION | OPTION C | units |
|---|------------|-------|
| Signal output | EIA RS422A | - |
| Supply voltage | 5 ± 0.25 | Vd.c. |
| Supply current (output current=0) | 120 | mA |
| Supply current (outputs terminated with 120R) | 195 | mA |
| Resolution | 1 | µm |
| Position repeatability ⁽¹⁾ | ± 1 | µm |
| Absolute accuracy ⁽²⁾ | ± 10 | µm |

Notes: -

⁽¹⁾ Dependent on amplifier. Under constant operating conditions.

⁽²⁾ Typical maximum error over 1 metre under constant operating conditions.



Connections are available via a 9-way D-sub male connector.

| FUNCTION | +5Vd.c. | 0V | A+ | A- | B+ | B- | Z+ | Z- | Screen |
|------------|---------|----|----|----|----|----|----|----|--------|
| PIN NUMBER | 5 | 1 | 2 | 6 | 4 | 8 | 3 | 7 | CASE |

FORCER OVER-TEMPERATURE SENSOR



It is strongly recommended that the forcer over-temperature sensor is connected to the drive amplifier or servo controller **at all times** in order to reduce the risk of damage to the forcer due to excessive temperatures.

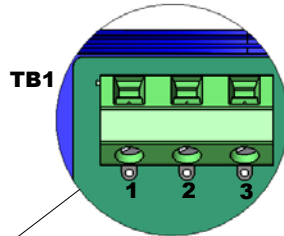
Protection is provided by three positive temperature coefficient (PTC) thermistors embedded in the forcer phases. As the forcer phase temperature approaches 100°C, the PTC thermistors exhibits a sharp increase in electrical resistance. This change in resistance can be detected by circuitry within the drive amplifier or servo controller and used to reduce or disable the output of the drive amplifier in order to protect the forcer.

| SPECIFICATION | VALUE | units |
|---|-----------|-------|
| Resistance in the temperature range -20°C to + 70°C | 60 to 750 | Ohms |
| Resistance at 85°C | ≤1650 | Ohms |
| Resistance at 95°C | ≥3990 | Ohms |
| Resistance at 105°C | ≥12000 | Ohms |
| Maximum continuous voltage | 30 | Vd.c. |

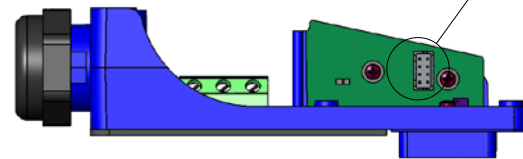
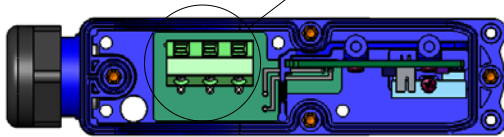
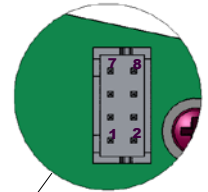
FORCER ELECTRICAL CONNECTIONS

Connections are made within the termination box.

| PIN NUMBER | FUNCTION |
|------------|--------------|
| 1 | Phase U |
| 2 | Phase V |
| 3 | Phase W |
| Chassis | Earth/Screen |



| PIN NUMBER | FUNCTION |
|------------|------------------|
| 1 | +SIN |
| 2 | -SIN |
| 3 | +COS |
| 4 | -COS |
| 5 | +5Vd.c. |
| 6 | 0V |
| 7 | +TH (Thermistor) |
| 8 | -TH (Thermistor) |



CABLE

The ServoTube Module has two separate cables providing connections for forcer power and position sensor. The cables are available in 3 metre, 5 metre and 10 metre lengths.

| SPECIFICATION | POWER | SENSOR |
|---|-----------------------------|------------------------------|
| Overall diameter (nominal) | 8.0mm | 5.8mm |
| Outer jacket material | PUR | PUR |
| Number of conductors | 4 | 4 x twisted pair |
| Size of conductors | 1.5mm ² (16 AWG) | 0.14mm ² (26 AWG) |
| Screened / Unscreened | Screened | Screened |
| Minimum bending radius - flexible routing | 42mm | 42mm |
| Operating temperature - flexible routing | -15°C to +80°C | -15°C to +80°C |
| Operating temperature - fixed routing | -30°C to +80°C | -30°C to +80°C |

CABLE TERMINATION

The ServoTube Module cable is available with three termination options. **Option F** has the wire ends stripped and solder tinned ready for termination. All other options are terminated with connectors that plug directly into the desired amplifier. The connections for all options are shown below: -

| SENSOR FUNCTION | D - (XTL-S) | N - (DME 230) | F - (Flying leads) |
|----------------------|------------------------------|--------------------------|--------------------|
| +SIN | 14 | 6 | Blue |
| -SIN | 13 | 7 | Red |
| +COS | 12 | 11 | White |
| -COS | 11 | 12 | Brown |
| +5Vd.c. | 4 | 10 | Yellow |
| 0V | 5 | 15 | Green |
| +TH (Thermistor) | 10 | 5 | Pink |
| -TH (Thermistor) | 15 | 15 | Grey |
| SCREEN | 1+ shell | Shell | SCREEN |
| Connector type | 15-way high density D | 15-way high density D | - |
| Amplifier connection | J8 | X6.2 | - |
| POWER FUNCTION | | | |
| Forcer phase U | 4 | U | Black <u>1</u> |
| Forcer phase V | 3 | V | Black <u>2</u> |
| Forcer phase W | 2 | W | Black <u>3</u> |
| Earth (forcer body) | 1 | PE | Green/Yellow |
| SCREEN | 1 | Shell | SCREEN |
| Connector type | 4-way 5mm pluggable terminal | 4-way pluggable terminal | - |
| Amplifier connection | J2 | X3 | - |

LIMITS

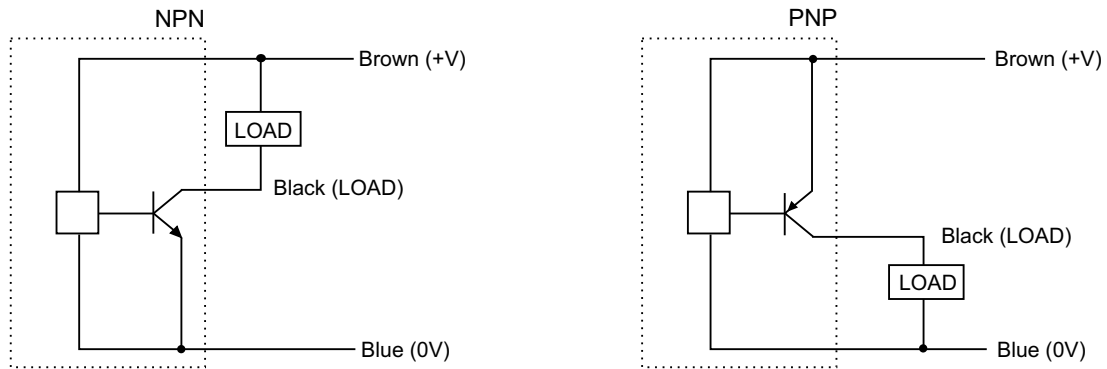


These limit switches are not intended as safety devices or as part of a system intended to ensure personal safety. When two switches are mounted in close proximity (as in the case of a left and right limit switch), a minimum of 30mm spacing between sense areas must be maintained.

If required, the ServoTube Module can be supplied with limit switches. There are two types available, NPN output and PNP output. Each output type is available with 2 metres of robotics cable. Each limit switch position is adjustable. Electrical connections are made via wire ends stripped and solder tinned ready for termination.

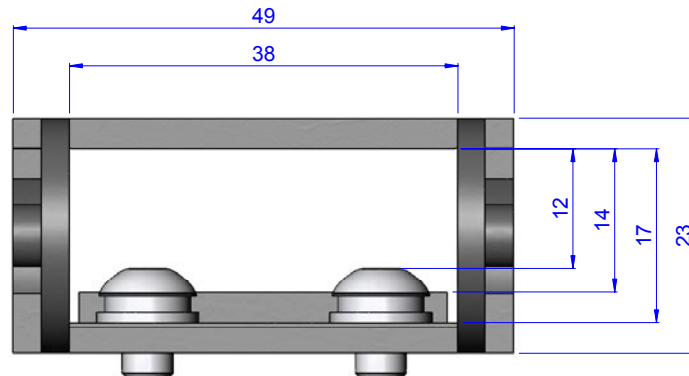
| SPECIFICATION | VALUE | | | |
|--------------------|---------|---------|---------|-------|
| | minimum | typical | maximum | units |
| Supply voltage | 10 | 24 | 30 | Vd.c. |
| Supply current | - | 15 | - | mA |
| Sink current | - | - | 100 | mA |
| "Closed" voltage | - | - | 1 | Vd.c. |
| Frequency response | - | - | 600 | Hz |

The output for all types can be either a normally closed (NC, opener) or normally open (NO, closer) open collector transistor. A red indicator shows the output status.



DRAG CHAIN

Size 15.3 is standard. Smaller drag chains on request.



ENVIRONMENT

The ServoTube Module is intended for use in an environment within the following conditions: -

| SPECIFICATION | VALUE |
|---------------------------------|------------------|
| Operating temperature | 0°C to +40°C |
| Storage temperature | -20°C to +70°C |
| Altitude (above mean sea level) | 1000m |
| Overvoltage category | II |
| Pollution degree | 2 |
| EMC | light industrial |

ORDER CODES

Module

