# iM Smart Sensor user manual

**HITECO**

HIGH TECHNOLOGY COMPONENTS

iM
Smart Sensor

# INDEX

## Meaning of the symbols

*GENERIC DANGER*    *It indicates a procedure, activity or action that, if not carried out correctly or complied with, can cause injuries to people.*

*WARNING!*    *It indicates a procedure, activity or action that, if not carried out correctly or complied with, can damage or destroy completely  the product.*

*INFORMATION*   *It indicates general information that must not be ignored.*

# 1     IM Smart Sensor components

IM Smart Sensor has been developed in two sizes, suitable for hiteco 3 axes spindles and 5 axes spindles. The main difference it's the sensor's body, that could be installed on the external casing of these two kind of electrospindles. Following a 3 axes iM Smart sensor with the axis orientation:
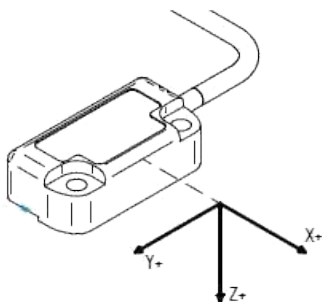


And next a 5 axes iM Smart sensor with its axis orientation:
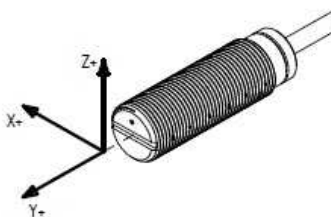


The 3 axes iM Smart Sensor is located on the front side of the spindle and connected inside the electrical box. The 5 axes sensor is located inside the shell and connected through signal cables of the spindle.
Due to rs485 protocol the iM Smart Sensor needs a proper serial bus converter (rs485 to usb) and a pc as user side interface.

## 2      Aim of this manual

This manual was written with the purpose to help all oem and final user that will utilize Hiteco iM Smart Sensor. It gives the standard procedures to install, connect and use iM Smart Sensor HMI properly with its maximum performances.

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# 3    Introduction to iM Smart Sensor

Hiteco iM Smart Sensor is a triaxial accelerometer with on-board temperature sensor that is capable of:

- measure the vibration level considering three axes
- measure the acceleration magnitude on three axes
- measure bearing temperatures of the spindle
- measure the speed of the spindle by a dedicated input channel
- change its output alarm state and signal if there is problems or harmful conditions for the spindle
- communicate via its rs485 modbus protocol to its HMI interface the real time datas acquired from its accelerometer unit

Due to its performances it could be used to monitor the spindle behaviour during time, ensuring better operability and good working conditions.

In the following table are highlighted the main features of iM Smart Sensor.

| | |
|---|---|
| Accelerometer type | **Triaxial** |
| Sensor type | **MEMS** |
| Maximum acceleration measured | **±16 g** |
| Bandwith | **1000 Hz** |
| Resolution | **0,125 g** |
| Operating temperature | **+5  to +85 °C** |
| Maximum tolerable pulse acceleration | **3000 g** |
| Connectivity | **Modbus protocol (RS485)** |
| Nominal power supply voltage | **24 Vdc** |
| Permissible power supply voltage range | **18-30 Vdc** |
| Nominal supply current | **40 mA @ 24 Vdc** |
| Temperature sensor range | **-40 to +125 °C** |
| Inspeed input impedance | **>100 kOhm** |
| Output alarm signal | **0 V (low) - 24 V or Vcc (high), 30 mA max output current, short circuit protected** |

The alarm terminal, available on iM Smart Sensor, stays normally at 24V and commutates low (to 0 V) if the vibration level is too high for safe operation of the spindle.

# 4      Hardware and software installation

The hardware installation is easy and quick, mainly resides in make appropriate connections for power supply and communication channels as explained in the next figures for the two types of spindles.

### 4.1 Three axis spindle with circular connection

In three axis spindle the iM Smart Sensor I/O and power supply pins are located in the signal connector.
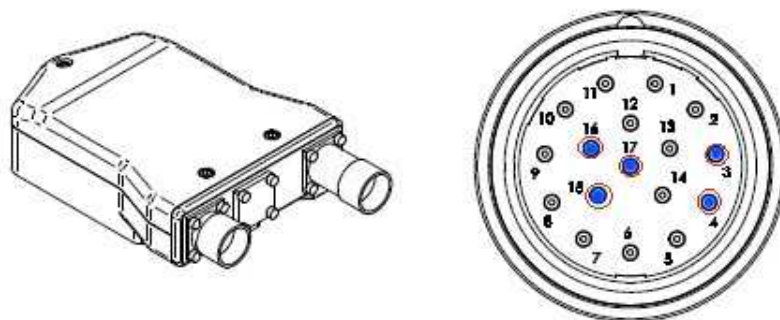


The pins are specified in the table below (they are also specified in the manual of the spindle):

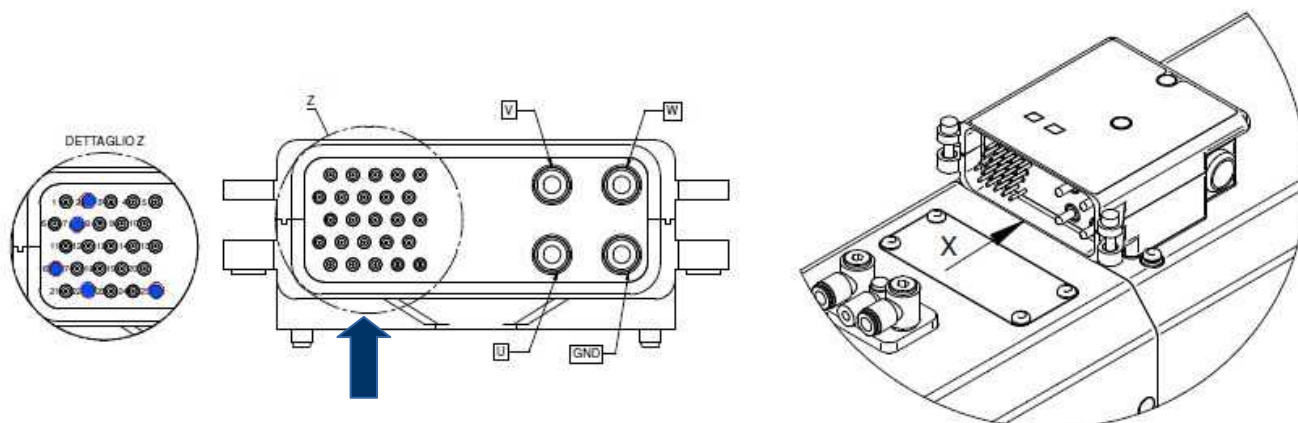| CIRCULAR CON. PIN | DESCRIZIONE / DESCRIPTION |
|---|---|
| P1 | OUTPUT ELETTROVENTOLA - OUTPUT ELECTROFAN |
| P2 | +24 Vcc - ALIM. ELETTROVENTOLA - SUPPLY ELECTROFAN |
| P3 | +24 Vcc - ALIM. S3 - SUPPLY S3 |
| P3 | +24 Vcc SVS - SUPPLY iM |
| P4 | 0 Vcc - ALIM. S3 - SUPPLY S3 |
| P4 | 0 Vcc SVS - 0 V SUPPLY iM |
|  | SCHERMO SVS - SVS SHIELD |
| P5 | OUTPUT S1 + S5 - UTENSILE AFFERRATO - TOOL LOCKED |
| P6 | OUTPUT S2 - UTENSILE SBLOCCATO - TOOL RELEASED |
| P7 | OUTPUT S3 - ROTAZIONE ALBERO - SHAFT ROTATION |
| P7 | INGRESSO VELOCITA' SVS - SVS INSPEED |
| P8 | 0 Vcc - ALIM. S1 - SUPPLY S1 |
| P8 | 0 Vcc - ALIM. S2 - SUPPLY S2 |
| P8 | 0 Vcc - ALIM. S5 - SUPPLY S5 |
| P9 | +24 Vcc - ALIM. S1 - SUPPLY S1 |
| P9 | +24 Vcc - ALIM. S2 - SUPPLY S2 |
| P10 | OUTPUT S1 (SERVICE) |
| P10 | +24 Vcc ALIM S5 |
| P11 | OUTPUT SONDA TERMICA - THERMAL ALLARM |
| P12 | 0 Vcc - ALIM. ELETTROVENTOLA - SUPPLY ELECTROFAN |
| P13 | +24 Vcc - SONDA TERMICA - THERMAL ALLARM |
| P13 | +24 Vcc - PULSANTE C.U. - T.C. BUTTON |
| P14 | OUTPUT - PULSANTE C.U. - T.C. BUTTON |
| P15 | IM RS485 RX D- - RS485 RX D- IM |
| P16 | IM RS485 TX D+ - RS485 TX D+ IM |
| P17 | ALLARME IM - IM ALARM |

 The rs485 channels and the iM alarm output signal are referred to the ground of the iM Smart Sensor power supply. So the sensor need the ground connection for communication channels and as reference to the output alarm signal.
If the sensor isn't grounded problems or malfunctions could occur.

## 4.2 Three axis spindle with plug and play connection

If the spindle is equipped with plug and play connection the pins are placed in the signal part of the  plug:



The pins are specified in the table below (they are also specified in the manual of the spindle):
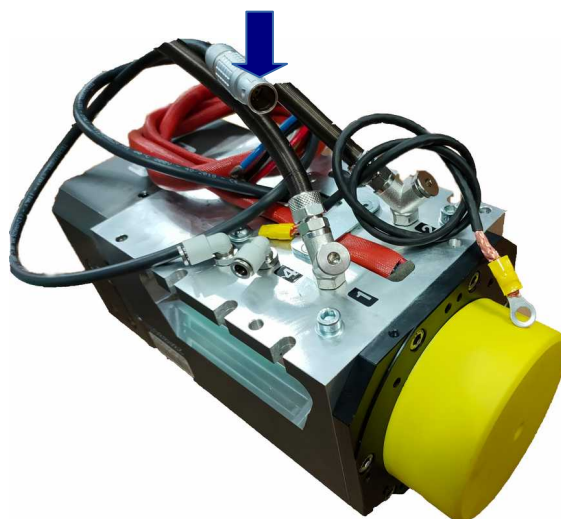
| PIN | DESCRIZIONE - DESCRIPTION |
|-----|---------------------------|
| 1 | Non collegato - Not connected |
| 2 | 0 Vcc S3 + IM (SVS) - GND S3 + IM (SVS) |
| 3 | 0 Vcc S2 - GND S2 |
| 4 | 0 Vcc S1 + S5 - GND S1 + S5 |
| 5 | 0 Vcc ALIM. ELETTROV. - GND ELECTROFAN |
| 6 | Non collegato - Not connected |
| 7 | +24 Vcc ALIM. S3 + IM (SVS) - SUPPLY S3 + IM (SVS) |
| 8 | +24 Vcc ALIM. S2 - SUPPLY S2 |
| 9 | +24 Vcc ALIM. S1 - SUPPLY S1 |
| 10 | +24 Vcc ALIM. ELETTROV. - SUPPLY ELECTROFAN |
| 11 | OUTPUT S1 (Service) + 24Vcc ALIM. S5 |
| 12 | OUTPUT S3 - ROTAZIONE ALBERO + INGR. VELOCITA' IM (SVS) - SHAFT ROTATION + INSPEED IM (SVS) |
| 13 | OUTPUT S2 - UTENSILE SBLOCCATO - TOOL RELEASED |
| 14 | OUTPUT S1 + S5 - UTENSILE BLOCCATO - TOOL LOCKED |
| 15 | OUTPUT ELETTROVENTOLA - OUTPUT ELECTROFAN |
| 16 | IM (SVS) D- (RS485 RX) |
| 17 | + 24 Vcc PULSANTE C.U. - T.C. BUTTON |
| 18 | OUTPUT PULSANTE C.U. T.C. BUTTON |
| 19 | +24 Vcc SONDA TERMICA - SUPPLY THERMOSWITCH |
| 20 | OUTPUT SONDA TERMICA - OUTPUT THERMOSWITCH |
| 21 | SCHERMO IM (SVS) - IM (SVS) SHIELD |
| 22 | IM (SVS) D+ (RS485 TX) |
| 23 | Non collegato - Not connected |
| 24 | Non collegato - Not connected |
| 25 | ALLARME IM (SVS) - IM (SVS) ALARM |

The rs485 channels and the im alarm output signal are referred to the ground of the iM Smart Sensor power supply. So the sensor need the ground connection for communication channels and as reference to the output alarm signal.

## 4.3 Five axis spindle with LEMO connector or free output cables

In five axis spindle the iM Smart Sensor I/O and power supply pins are located in the LEMO signal connector or in the signal cable (if the spindle is supplied with free output cables, not connectorized).

The LEMO signal connector constitutes the termination of the signal cable that came out from the spindle.

In the following table the iM Smart Sensor pins are represented.

| PIN | DESCRIZIONE/DESCRIPTION |
|---|---|
| 1 | +24 Vcc S1 S2 S5 |
| 2 | 0 Vcc (GND) S1 S2 S5 |
| 3 | OUTPUT S1 |
| 4 | - |
| 5 | - |
| 6 | OUTPUT S2 |
| 7 | +24 Vcc iM (SVS) e S3 |
| 8 | 0 Vcc (GND) iM (SVS) e S3 |
| 9 | OUTPUT S3 |
| 10 | iM (SVS) RS485 RX D- |
| 11 | iM (SVS) RS485 TX D+ |
| 12 | iM (SVS) ALARM |
| 13 | - |
| 14 | OUTPUT S5 |
| CASE | SHIELD iM (SVS) |

The rs485 channels and the im alarm output signal are referred to the ground of the iM Smart Sensor power supply. So the sensor need the ground connection for communication channels and as reference to the output alarm signal.
With the free output cables the next table explains the position (colors) for sensor's I/O.

| COLORE/COLOR | DESCRIZIONE/DESCRIPTION |
|---|---|
| BIANCO/WHITE | +24 Vcc S1 S2 S5 |
| VERDE/GREEN | 0 Vcc (GND) S1 S2 S5 |
| MARRONE/BROWN | OUTPUT S1 |
| N.C. | - |
| N.C. | - |
| VIOLA/VIOLET | OUTPUT S2 |
| BLU/BLUE | +24 Vcc iM (SVS) e S3 |
| NERO/BLACK | 0 Vcc (GND) iM (SVS) e S3 |
| ROSSO/RED | OUTPUT S3 |
| GRIGIO-ROSA/GREY-PINK | iM (SVS) RS485 RX D- |
| ROSSO-BLU/RED-BLUE | iM (SVS) RS485 TX D+ |
| GIALLO/YELLOW | iM (SVS) ALARM |
| N.C. | - |
| GRIGIO/GREY | OUTPUT S5 |
| SCHERMO/SHIELD | SCHERMO/SHIELD iM (SVS) |

If the rpm indication or communication is unstable connect the IM shield to the 0 Vcc GND cable.

🚫 Never connect alarm terminal to the ground of the machine because the sensor could be damaged.

🚫 Never connect +24 V supply to RX or TX terminals because the sensor could be damaged.

### 4.4 RS485 converter connections and power supply

The three wire rs485 bus (TX, RX and ground 0 Vcc) needs a rs485 to usb converter for exchange sensor's data with a pc or another display or communication device.
The image below explains how to connect these three wires came from the spindle to a third party converter (not supplied by Hiteco).



The sensor power supply is connected to the s3 sensor power supply and share the gnd wire with it in order to acquire the inspeed signal. **Even if the s3 sensor is not present in the spindle or is not utilized his wires/pin have to be power supplied to get iM Smart Sensor active**.
The power supply ratings are specified in the table at page 5.
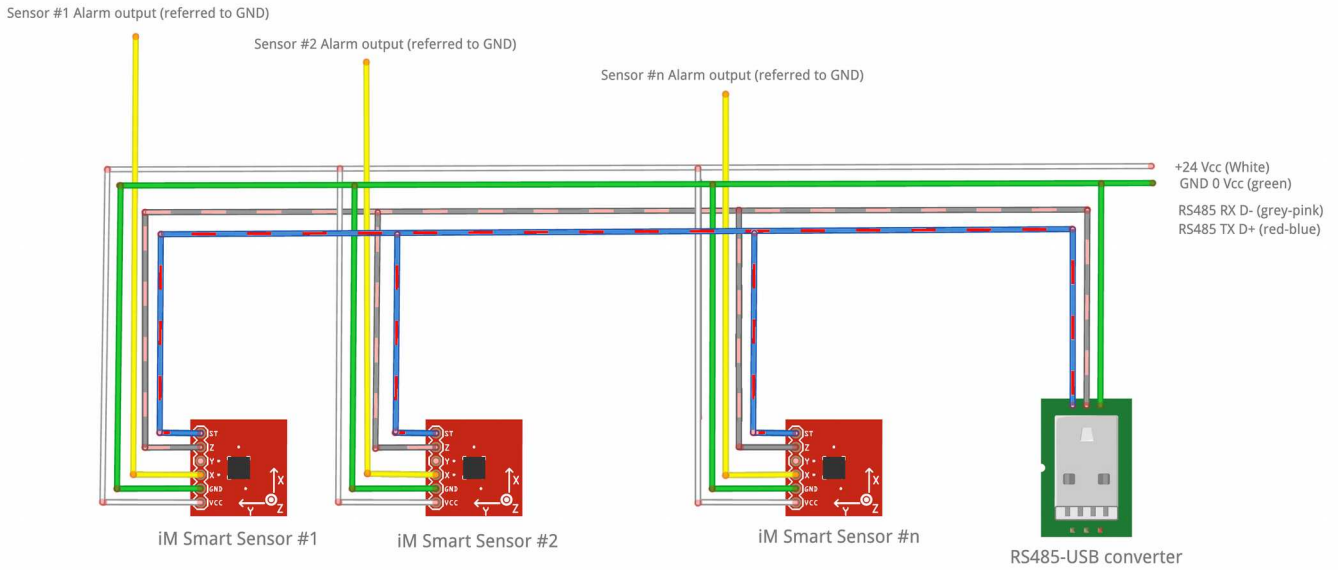
### 4.5 Multiple sensor connection

If more than one sensor has to be connected follow this procedure:

1. connect the first sensor to the rs485-usb converter and set the address (1) on the HMI interface
2. disconnect the first sensor and connect the second one and set its address (2) on the HMI interface
3. go on with all the sensor that has to be connected to the same modbus line
4. finally connect all the sensor in parallel on the rs485 bus and you can select them by the HMI interface.

The cable connection should be as depicted in the following scheme for:

1. RS485 bus connection
2. Power supply
3. Alarm output

Sensor #1 Alarm output (referred to GND)
Sensor #2 Alarm output (referred to GND)
Sensor #n Alarm output (referred to GND)

+24 Vcc (White)
GND 0 Vcc (green)

RS485 RX D- (grey-pink)
RS485 TX D+ (red-blue)

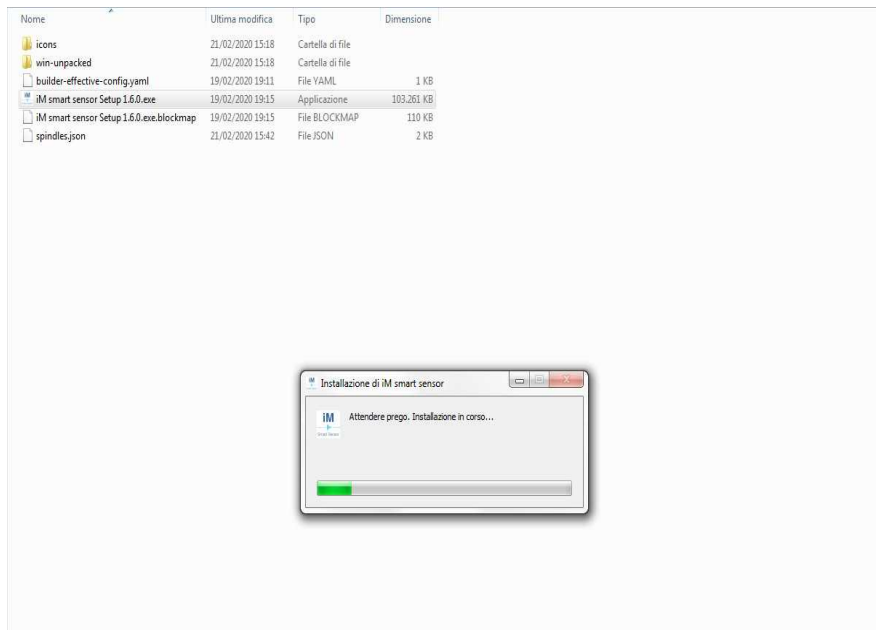iM Smart Sensor #1    iM Smart Sensor #2    iM Smart Sensor #n    RS485-USB converter
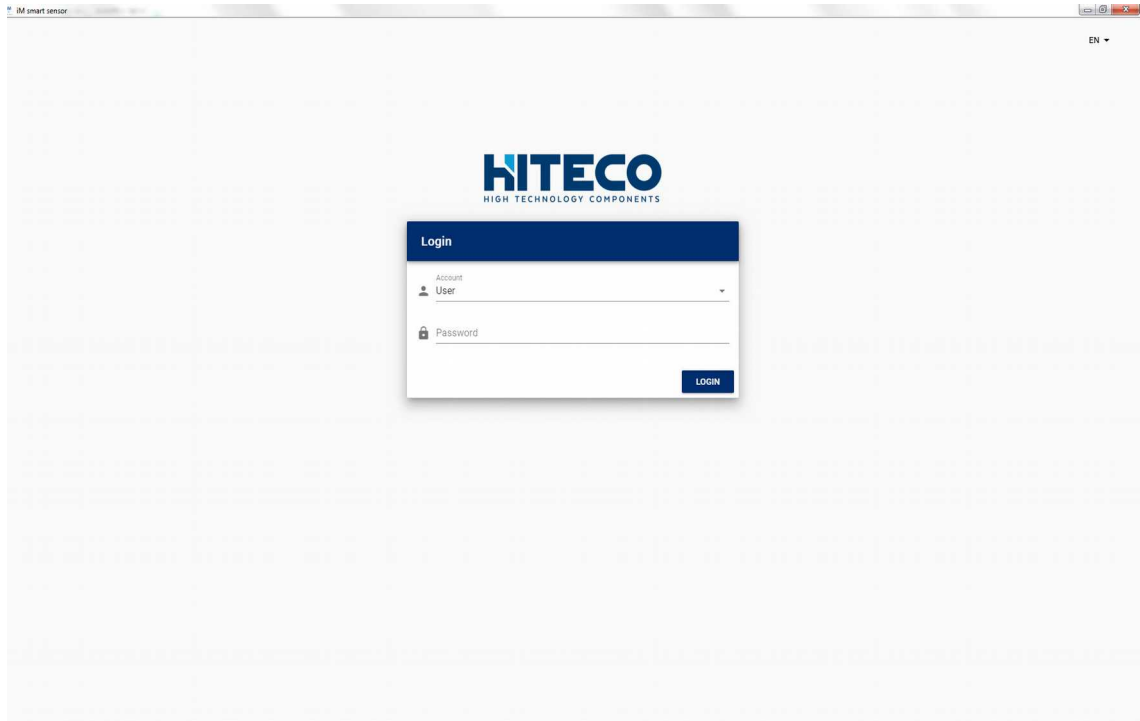
## 4.6 Software Setup

The system requirements for the iM Smart Sensor HMI are as follows:

Windows 7,8 and 10
ram 2 Gb
free disk space 400 Mb

The HMI can be installed on a windows based pc by its executable file "iM smart sensor Setup 1.x.y.exe" that is supplied by a usb key placed inside spindle box.

After a few seconds the first login screen pops up.



Now it's possible to follow the instructions at next chapter.

## 4.7 Communication problems

If the sensor doesn't communicate with the HMI, first switch off the sensor's power supply and then swap **RX** and **TX** wires on the Rs485-usb converter. So power on the sensor and try again to communicate with it.

The max communication speed of the port is 38400 baud. Communication speeds higher than 38400 baud arent' allowed. If the iM Smart Sensor doesn't communicate please try with different baudrate.

If the sensor doesn't communicate with HMI check the 24 V supply voltage.

# 5 iM Smart Sensor HMI startup and description

The iM Smart Sensor measure accelerations, speed and bearing temperatures and use its modbus protocol over rs485 line to communicate these datas to its HMI, that could be installed on a Windows based pc.

## 5.1 HMI and iM Smart Sensor startup

By starting the iM Smart Sensor HMI executable the login screen pops up with the access level panel
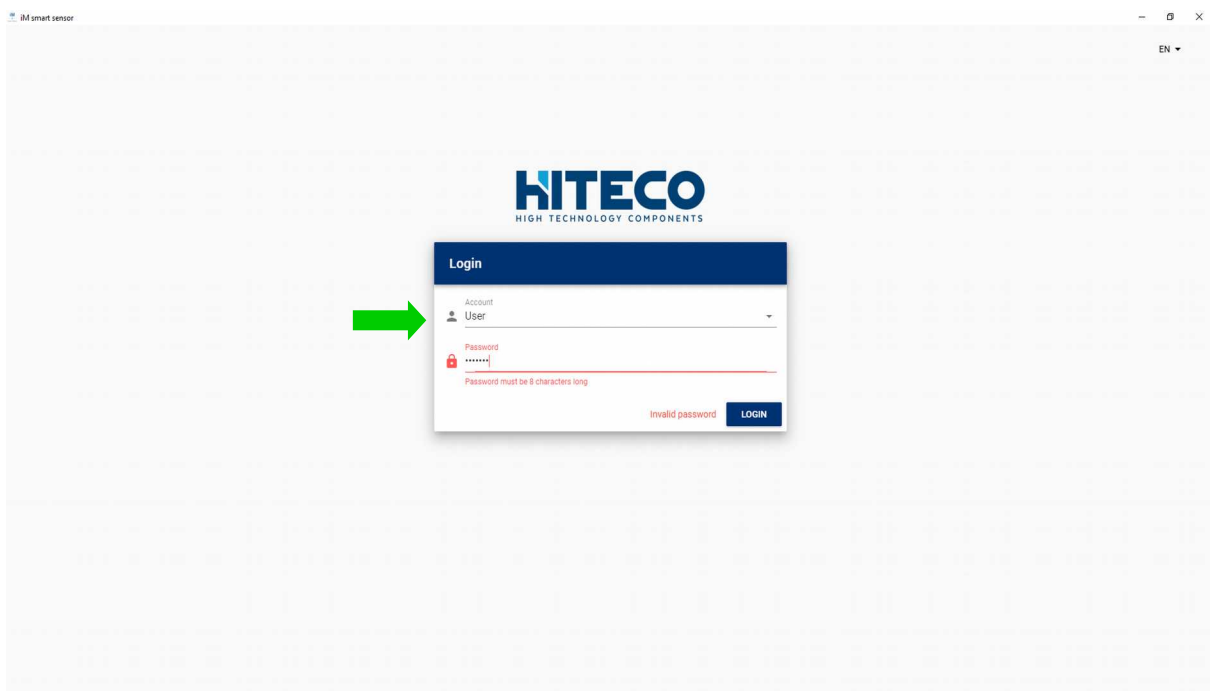


In the Account box it's possible to choose different level of access, such as:

- **User**, for final user that wants to monitor the working process and control if there's harmful events on the spindle;
- **OEM**, for machine assembler that enables the installation and configuration of iM Smart Sensor
- **Service**, which is intented for service HITECO personnel.

Every account type is enabled by its own password but for first User access the password has to be entered as a new password (next time will be requested the first time registered password).

## 5.2 User access

After the login screen the HMI will show the **Spindle status** box as showed in the next figure. In this window the iM Smart Sensor HMI shows:

A) The operation vibration level of the spindle represented by an updating hystogram and a peak vibration level bar. The first one shows if the vibration level of the spindle is normal, harmful or dangerous by a graphical scale respectively in grey color, orange color or red color.

B) Two boxes in the lower part of the screen for bearing temperature and actual spindle speed. They change from green color to red color if the temperature become dangerous for the spindle or, on the speed box, if the spindle stops (0 rpm condition).

C) Two boxes in the upper part of the screen for sensor identification and as general warning (that takes in or condition temperature and vibration level warnings)
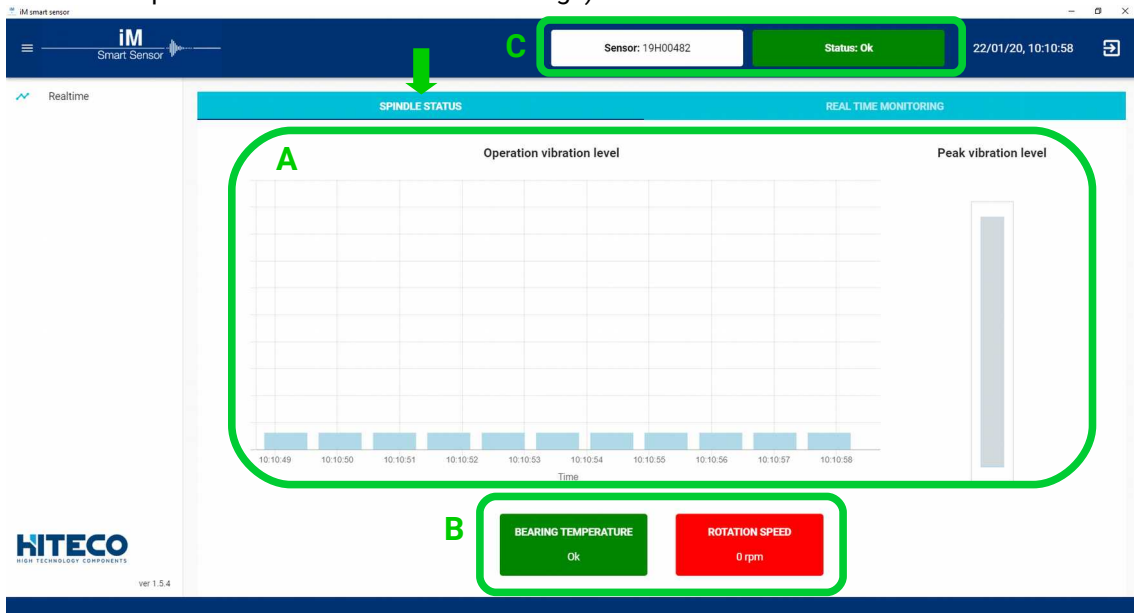


By clicking on the **Real time monitoring** tab the HMI shows, with an updated line graph, the actual values of:

1. Acceleration magnitude considering all three axis, in m/s$^2$;
2. Vibration calculated from integration of three axis accelerations, in mm/s;
3. Temperature of bearings, in °C;
4. Speed of spindle (if S3 or another compatible speed sensor is installed on the spindle), in Rpm.

There's also a green **Pause** button that is useful if the user wants to freeze a particular condition. The button turns to R**esume** to restart the graph.



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If the communication gets broken the HMI shows it by a dedicated icon in the upper right part of the window as showed in the next screeenshot
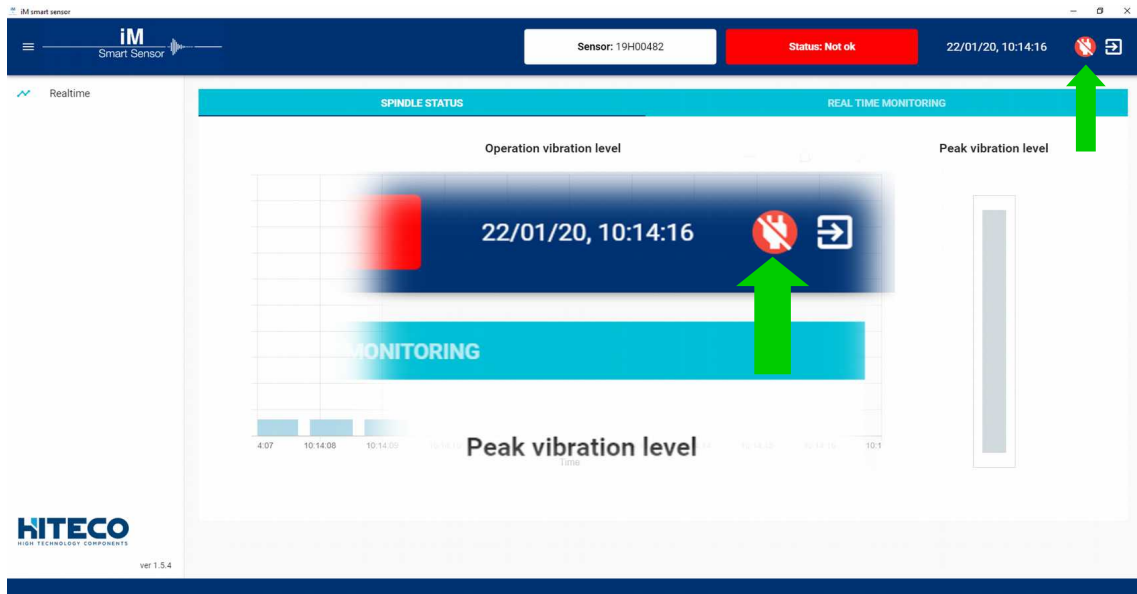


By applying increasing vibration level to iM Smart Sensor, the HMI shows that increase, in **spindle status** window, with higher and orange/red color bars. Also the **Status button** turns from green to red because the vibration level overcome the dangerous level.



The same vibration level increase is showed in the **Real time monitoring** tab by time varying magnitudes.
Even in this case an event of vibration level increase turns in red the **Status button** but here the HMI shows the values sampled by iM Smart Sensor.

By decreasing of vibration level the **Spindle status** shows decreasing bars with colors that turn from red to grey. Also the **Status button** turns from red to green, signalling that the spindle working conditions now are safe.



The same behaviour is showed in the Real time monitoring tab as showed in the next screenshot

## 5.3 OEM access

The OEM access allows to configure the iM Smart Sensor and its HMI in terms of:

- communication setup of one or more sensors;
- multiple iM Smart Sensor (and spindles) HMI handling;
- statistics of acquired datas;
- backup of acquired datas;
- firmware update.

In the login screen the OEM has to select its level in the **account box** and enter the password (supplied by HITECO).
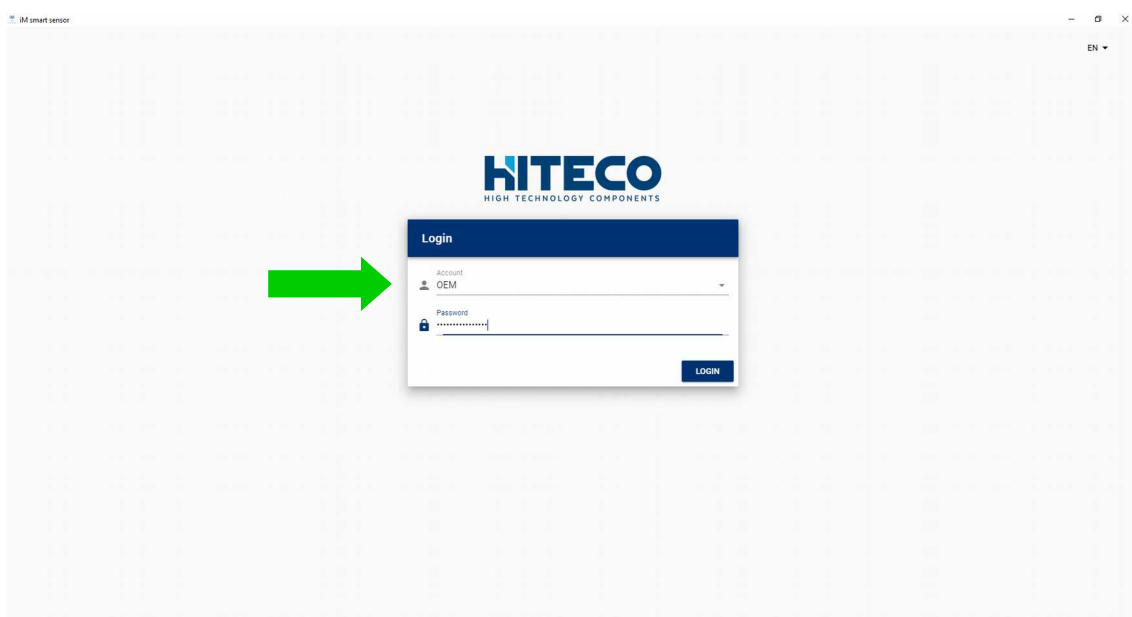
During first startup the main window of the iM Smart Sensor HMI could not shows any data because of a lack in communication settings.

To configure the communication between iM Smart Sensor and its HMI installed on a pc a gear button is placed in the upper right part of the screen



By clicking on it a new window pops up where it's possible to add to the HMI a new iM Smart Sensor.
On the "+" box the HMI adds a new sensor to its interface.
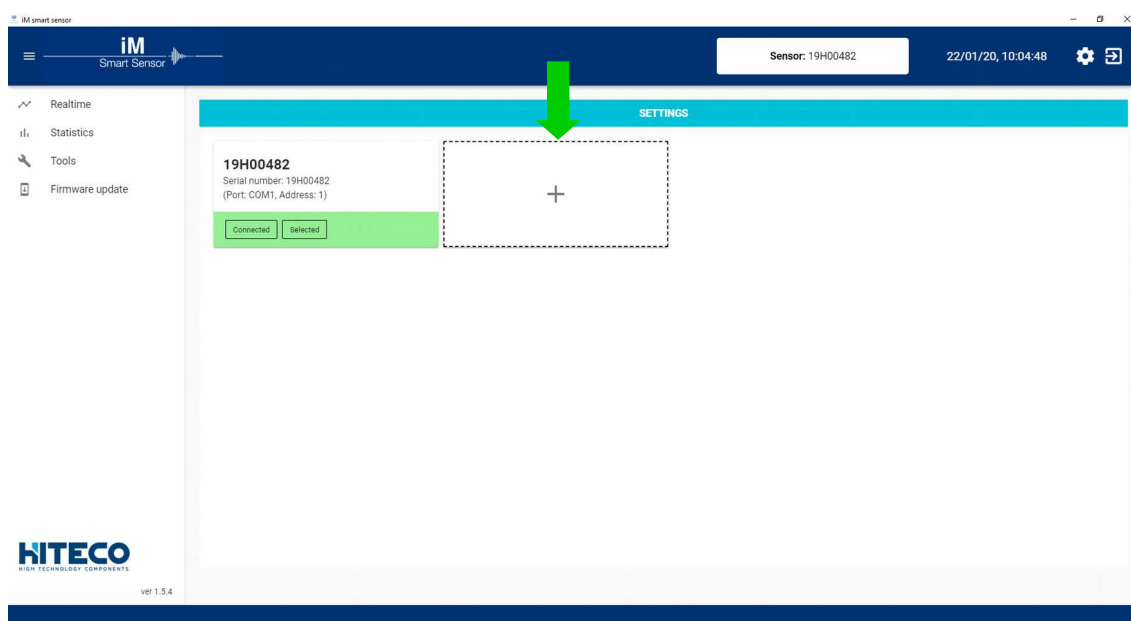


A new window pops out where it's possible to configure the communication settings of the sensor such as name of the sensor (as default the spindle serial number), Com port (defined by windows settings and type of rs485-usb converter) and address (as default set to 1). For multiple sensor installation it must be used the address 1 to communicate the first time with each sensor, before assigning the desired modbus address.
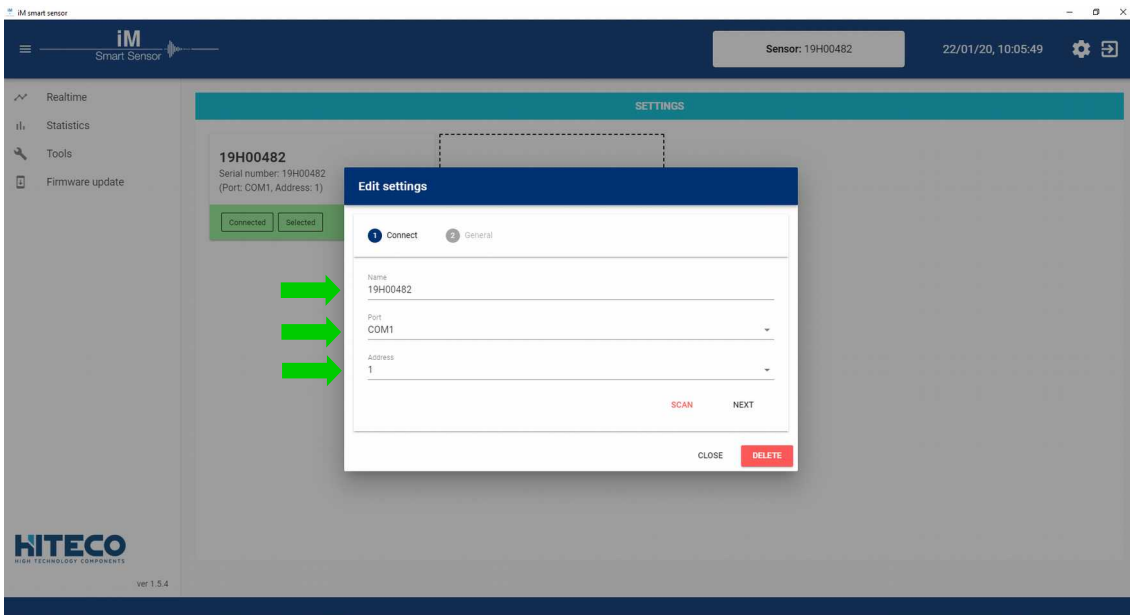
After the installation of the Rs485 to usb converter with its drivers on windows, it's possible to know the assigned com port by going in Windows control panel and look to the system tab, device manager. Here, after the rs485-usb converter ha been correctly installed, a new COM port will appear under the COM ports folder.
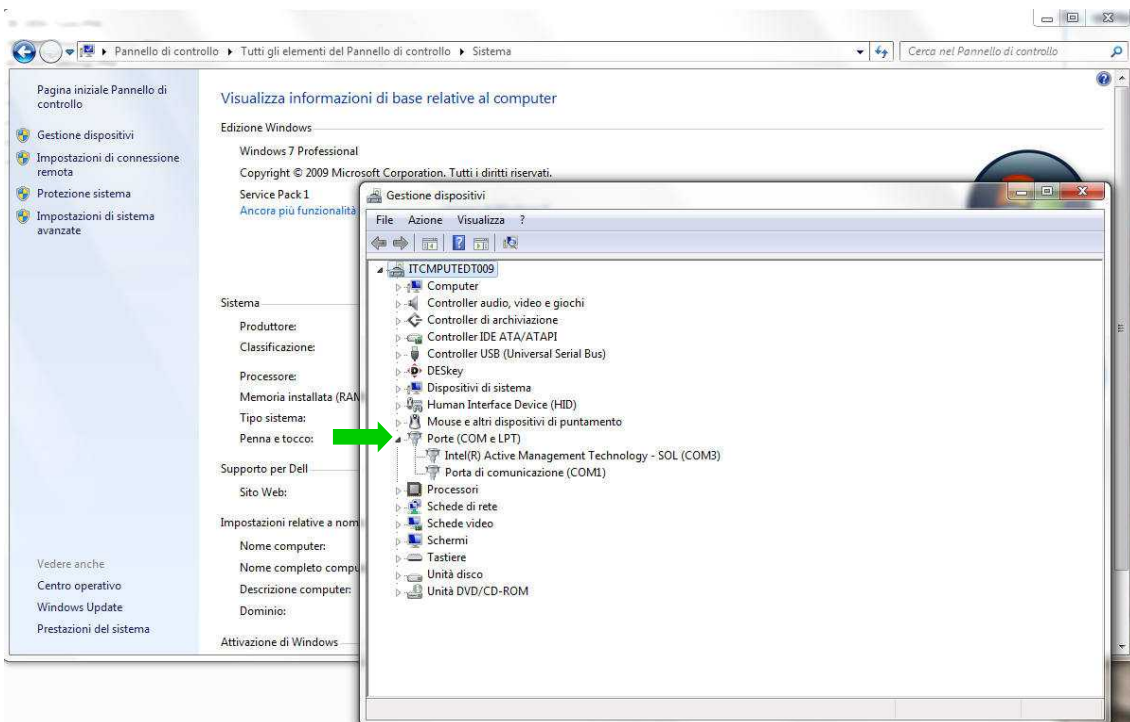


That com name must be used in the **Port** box of the HMI settings window. Now it's possible to click on **Scan** label to connect the sensor, and then close.
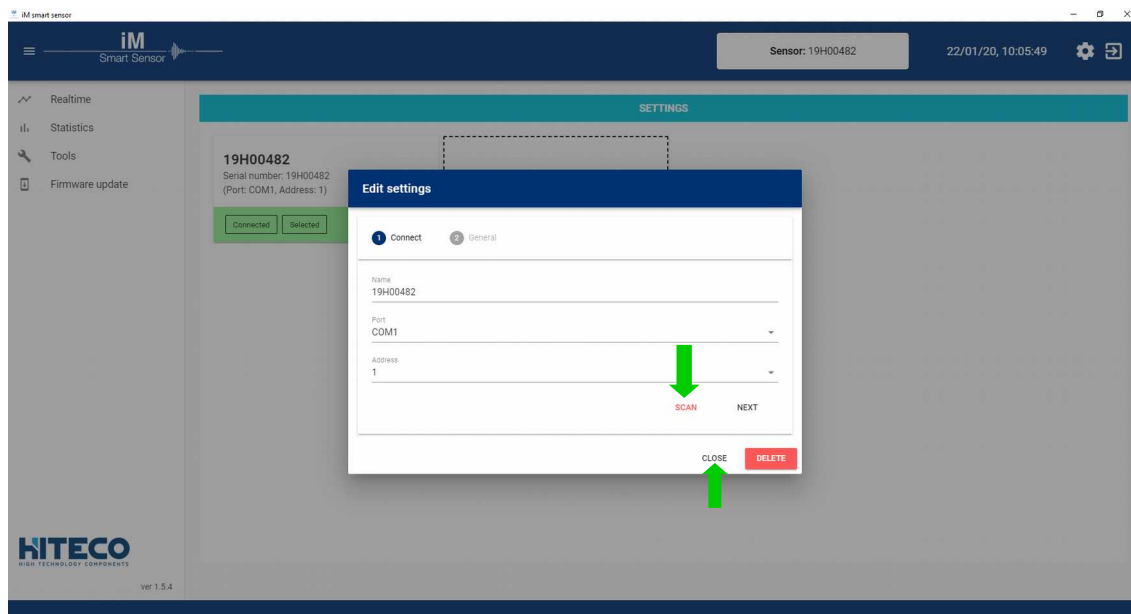
After the communication setup has been done the **Spindle status** window looks like the follows screenshot, with the acquired datas from sensor.



The datas showed are the same of the **user** access interface, see chapter 5.3 for further details.

With the **OEM** access level are also available other features (as well as **Realtime** feature) in the iM Smart Sensor HMI, such as:

1) **Statistics**, where the HMI shows the speed/time, vibrations/time and temperatures/time statistical datas;
2) **Tools**, where you can backup your iM Smart Sensor to an external file, and saved on a pc folder or sent to HITECO;
3) **Firmware update**, where it's possible to upgrade the iM Smart Sensor internal firmware.

By clicking on **Statistics** label the HMI shows 3 new labels that categorizes the available time-accumulated physical quantities measured by iM Smart Sensor (speed, vibration speed, temperature).

In **Speed/time** tab are reported the working times, subdivided in 10 speed range and with the partial accumulated times at damaging vibration level and dangerous vibration level.
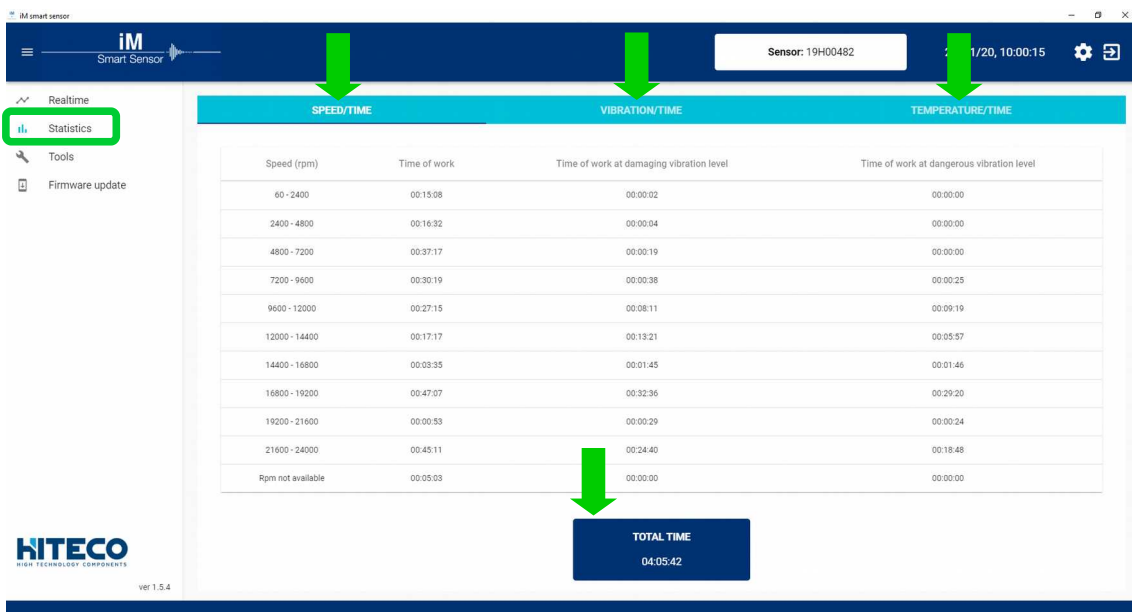


Also a total working time counter is present in the bottom of the screen.

In **Vibration/time** tab the HMI resumes, subdivided in 7 bands, in absolute times and percentage values the vibration level working hours. When the tab is selected an underline is activated under the label.
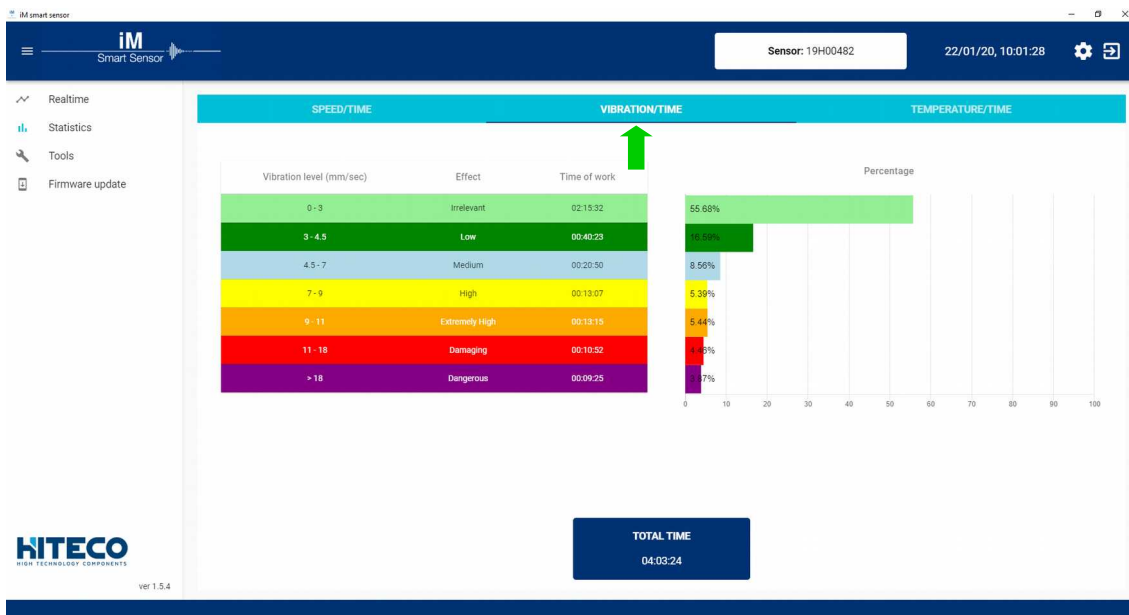
In **Temperature/time** tab 6 bands (that are populated with time measured bearing temperature) take in account the absolute and percentage accumulated work time at different temperatures.
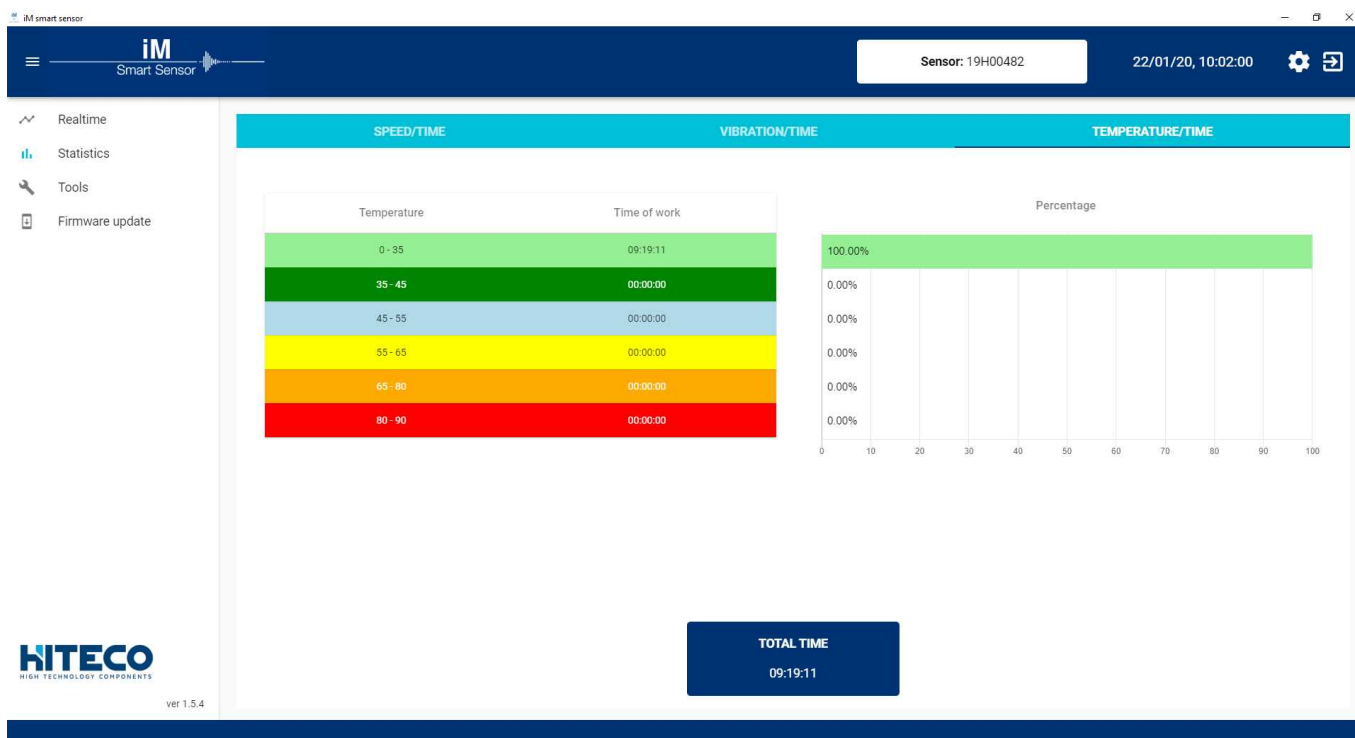


The **Tools** label can be used for backup iM Smart Sensor datas to an external file for storing it on a pc.
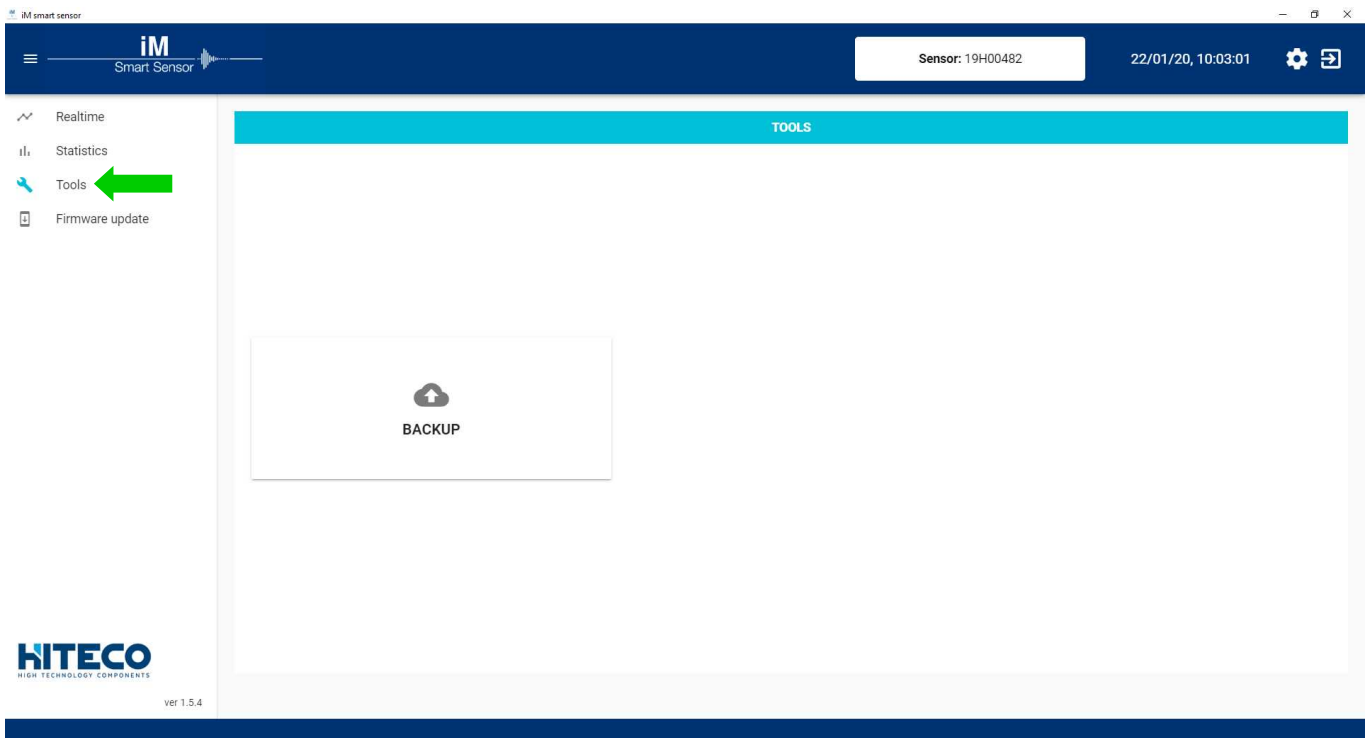
The **Firmware update** label allows to update the firmware on iM Smart Sensor by an appropriate file supplied by Hiteco.
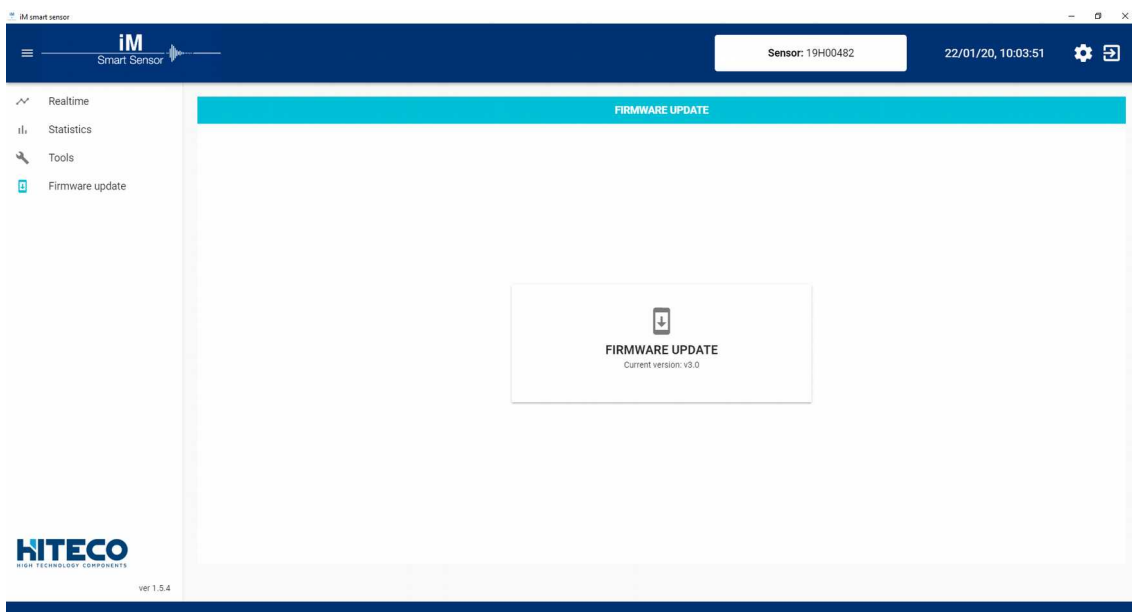


   

# 6 Troubleshooting

If the sensor doesn't communicate with the HMI, first switch off the sensor's power supply and then swap **RX** and **TX** wires on the Rs485-usb converter. So power on the sensor and try again to communicate with it.

The max communication speed of the port is 38400 baud. Communication speeds higher than 38400 baud arent' allowed. If the iM Smart Sensor doesn't communicate please try with different baudrate.

If the sensor doesn't communicate with HMI check the 24 V supply voltage.