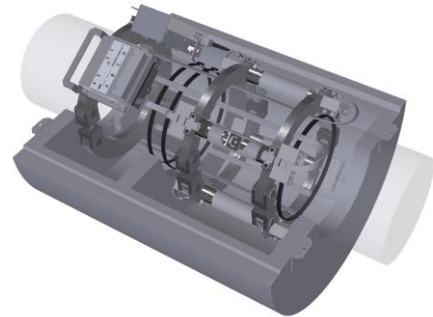


# VAF

INSTRUMENTS

## Technical Manual

Instructions for installation, operation and maintenance



# 674 TT-SENSE®

Valid for TT-Sense® serial numbers 18.2652 and higher

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# CONTENTS

1. PREFACE .....	2
1.1 General.....	2
1.2 Symbols.....	2
1.3 Copyright .....	2
2. SYSTEM DESCRIPTION .....	4
2.1 System description.....	4
2.2 System components .....	4
2.3 Principle of operation .....	4
3. TECHNICAL SPECIFICATION .....	7
3.1 Rotor .....	7
3.2 Stator .....	7
3.3 Specifications.....	7
4. SAFETY INSTRUCTIONS.....	8
4.1 Safety precautions .....	8
5. UNPACKING .....	8
6. INSTALLATION .....	9
6.1 TT-Sense® installation checklist.....	10
6.2 Mechanical installation.....	11
6.3 Electrical installation .....	20
6.4 Zero setting.....	23
6.5 Miscellaneous .....	25
7. OPERATING INSTRUCTIONS.....	27
8. MAINTENANCE .....	27
9. SERVICE AND REPAIR INSTRUCTIONS.....	27
10. TAKE OUT OF SERVICE .....	27
11. REMOVAL AND STORAGE OF EQUIPMENT .....	27
12. MALFUNCTION AND SEND FOR REPAIR.....	28
13. ENVIRONMENT .....	28
14. DISPOSAL .....	28
15. TROUBLE SHOOTING.....	29
16. CERTIFICATES.....	31
17. DRAWINGS.....	32
18. ABBREVIATIONS.....	43
19. PARTS LISTS.....	44
19.1 Rotor part.....	44
19.2 Available spare parts for stator and rotor part.....	44
19.3 Transport/mounting tools .....	46
19.4 Installation tools .....	46
20. WARRANTY CONDITIONS.....	47

# 1. PREFACE

## 1.1 GENERAL

This manual contains instructions for installation, operation and maintenance (IOM) of the TT Sense® optical thrust & torque sensor.

For IOM information of associated equipment supplied by VAF Instruments, refer to the separate manual supplied with those products.

This manual contains important information for the installer, the operator and for your maintenance department.



Never use the equipment outside its specifications or beyond common engineering practice nor use the equipment for other applications or make connections to other equipment than explicitly described in the order acknowledgement and/or technical manuals of VAF Instruments.



To ensure safe and correct installation and operation, read this manual completely before installing the equipment and starting operations.



The (micro) SD card should not be exposed to computer viruses, since this could contaminate the (micro) SD card. Contamination could disturb good working of the sensor.

For any additional information contact:

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Their addresses can be found on [www.vaf.nl](http://www.vaf.nl)

## 1.2 SYMBOLS

The following symbols are used to call attention to specific types of information.



A warning to use caution! In some instances, personal injury or damage to the torque sensor or control system may result if these instructions are not followed properly.



An explanation or information of interest.

## 1.3 COPYRIGHT

This technical manual is copyrighted with all rights reserved.

While every precaution has been taken in the preparation of this manual, no responsibility for errors or omissions is assumed. Neither is any liability assumed for damages resulting from the use of the information contained herein. Specifications can be changed without notice.



## 2. SYSTEM DESCRIPTION

### 2.1 SYSTEM DESCRIPTION

The TT-Sense® optical thrust & torque sensor is intended for the measurement of torque, shaft power and propeller thrust. The output can be used for power measurement, power consumption management, engine management and measurement of propeller efficiency and hull resistance.

### 2.2 SYSTEM COMPONENTS

The TT-Sense® optical thrust & torque sensor consists of three main components:

1. The optical sensors on the shaft (rotor)
2. The stator pedestal with coil and antenna
3. The electronic control box holding the data receiver, power supply and the data output.

The sensor is clamped onto the shaft by means of three rings. By tightening the bolts, the forces will be strong enough to create a stable connection between sensor and shaft. Two rings hold the measuring arms, which form the heart of the system. One arm holds a LED and the other one holds an optical detector, which is able to detect the movement of one ring in respect to the other. This movement is a measure for torque ( $\Delta y$  movement) and thrust ( $\Delta x$  movement) when the shaft properties are known. The analogue measuring data of the  $\Delta y$  and  $\Delta x$  movement is together with temperature and rpm data converted to digital data.

Power to the sensor is transmitted through an inductive coupling between stator and rotor coils. Information between rotor and stator is transmitted by 2.4 GHz wireless data communication. In the control box, the stator processes the raw measurement data into signals that can be send to a digital or analogue output.

### 2.3 PRINCIPLE OF OPERATION

When a shaft is subjected to torque ( $M$ ), sheer will occur in the shaft. As a result two points on the shaft will move in respect to each other. This movement  $\Delta y$  is a measure for the torque (fig 1). When an axial force is compressing the shaft, the length of the shaft will consequently decrease. This movement  $\Delta x$  is a measure for thrust ( $T$ ) induced by the propeller on the shaft (fig 1).

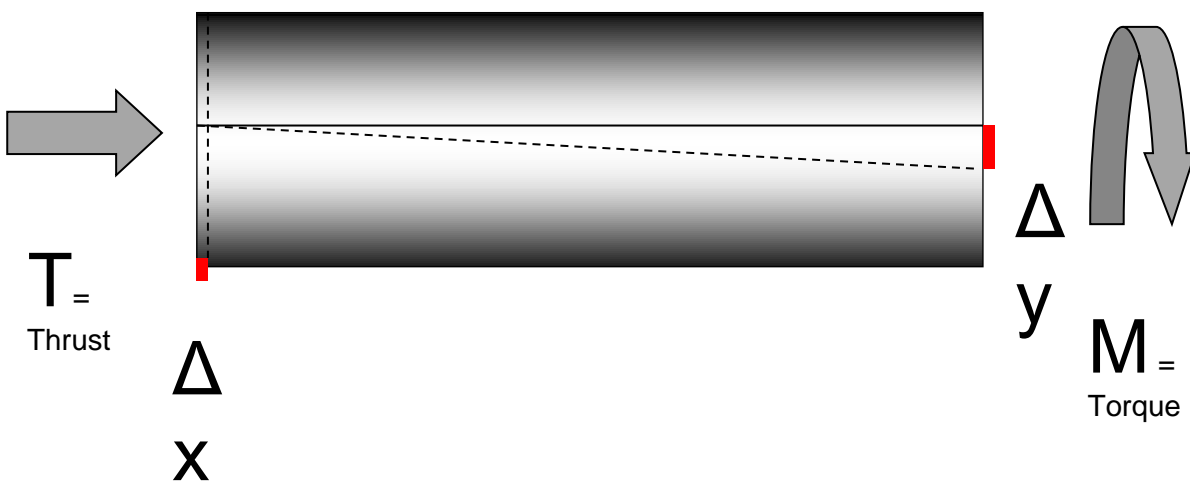


Figure1 Torque, Thrust and consequential  $\Delta y$  and  $\Delta x$  movement

The movement is measured by mounting two rings on the shaft (see fig. 2). On either ring an measuring arm is attached, partly overleaping each other. On one of the arms a light source is mounted, on the other a photo-electric sensor. This sensor will register any movement of the spot, induced by the movement of the rings. By knowing the distance between the rings and the dimensions of the shaft, the torque and thrust can be calculated.

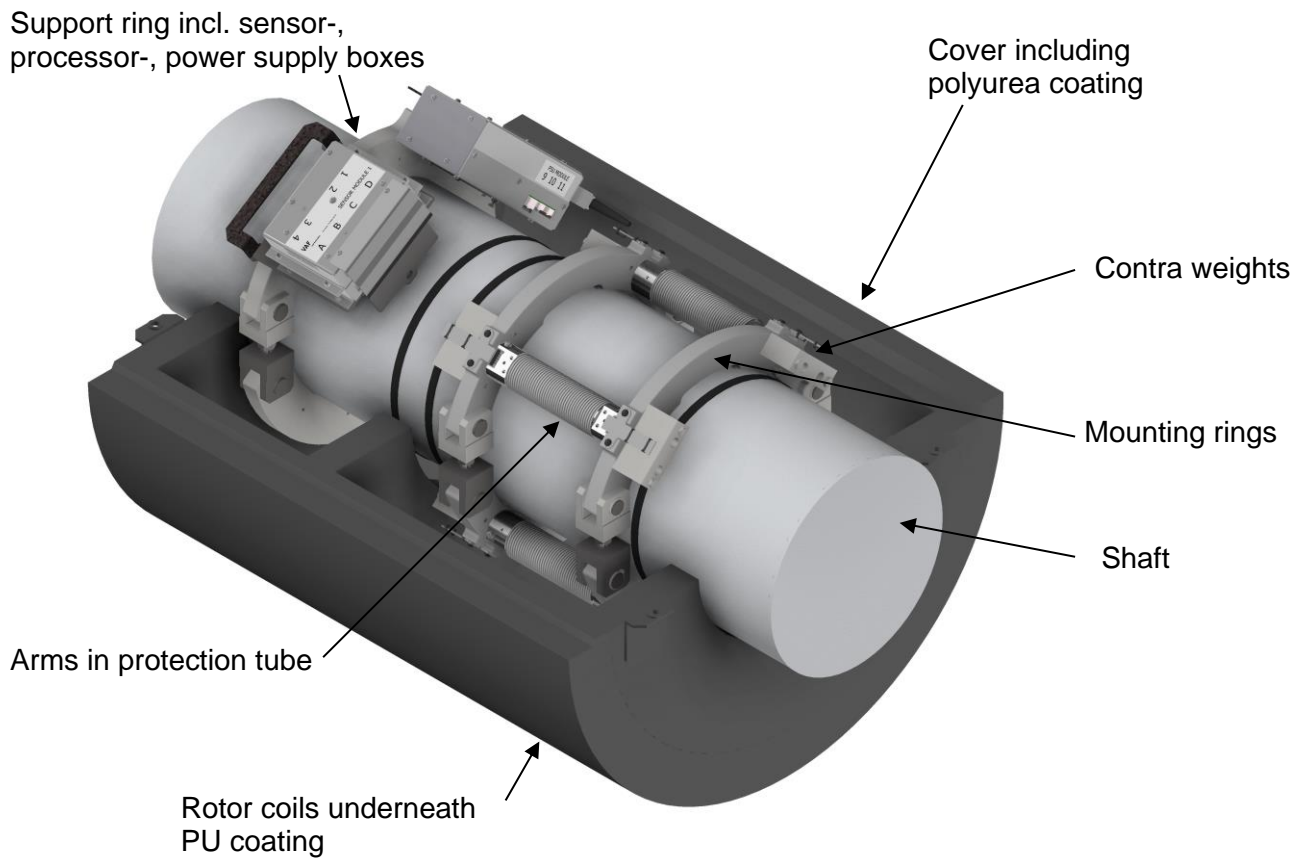


Figure 2 Assembly of mounting rings, contra weights, support ring, measuring arms and 1 cover part

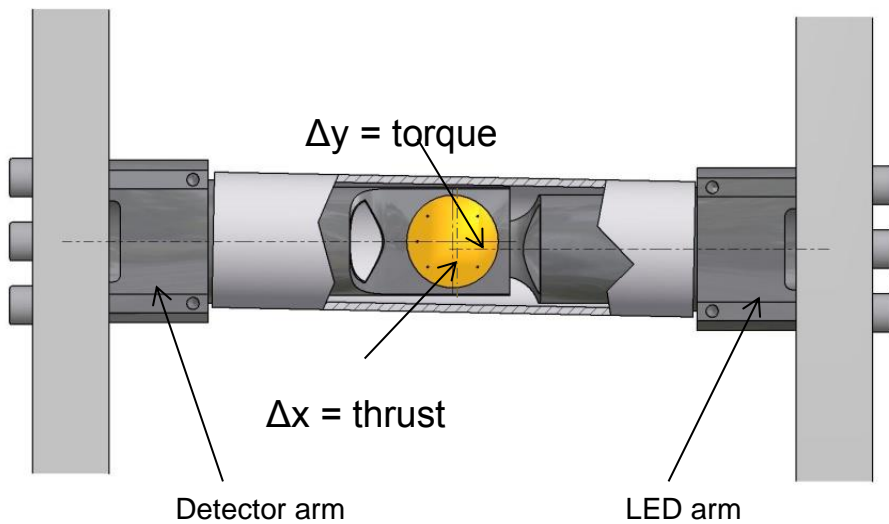


Figure 3 Two arms mounted onto the rings and  $\Delta x$  and  $\Delta y$  movement (exaggerated) of arm

The system is non-contacting, the measured value is constantly transmitted to the electronic stator control cabinet using 2.4 GHz wireless data communication, where further processing of the data will occur. The power supply is transferred to the rotor part by means of electromagnetic induction.

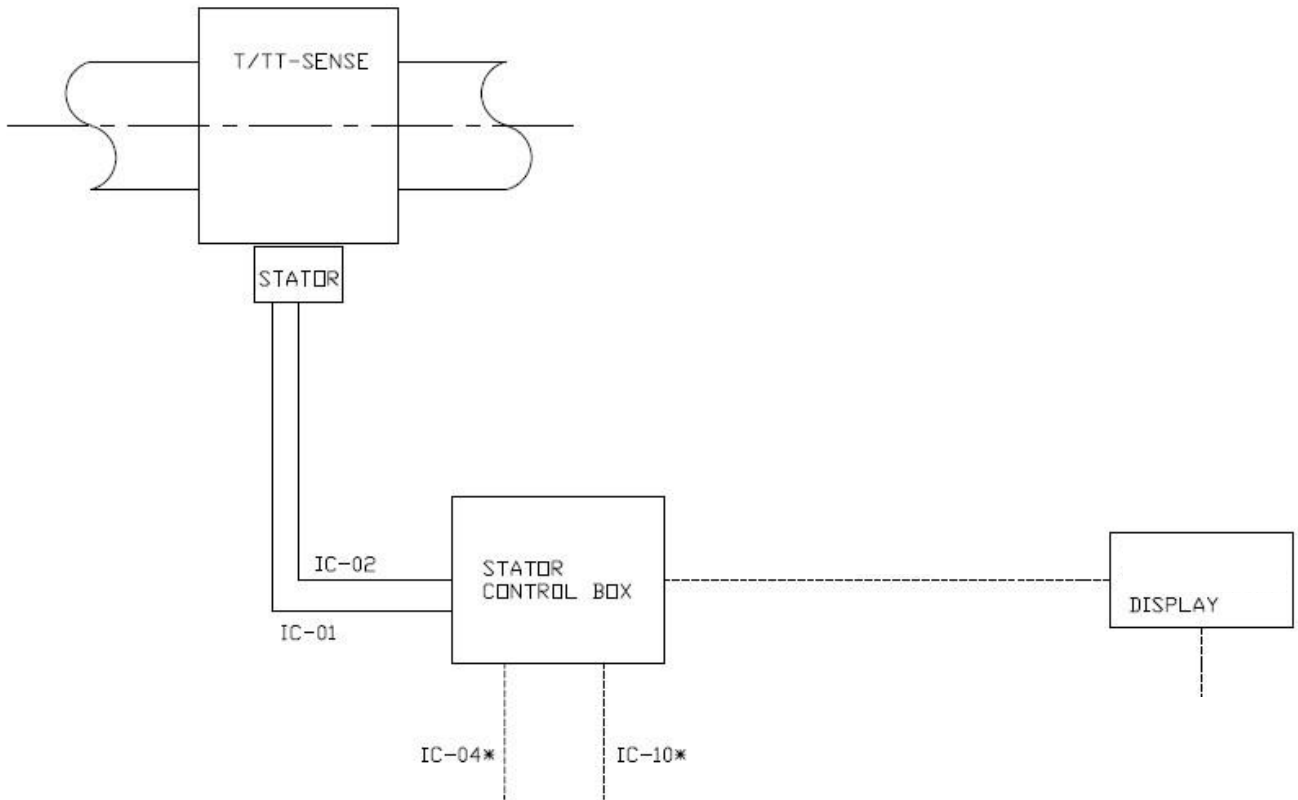


Figure 4 Schematic overview of TT-Sense® thrust & torque measurement system with display (optional)

For more detailed information on a TT-Sense® system including flowmeters and or speedlog/GPS input we like to refer to the specific Technical Installation Manual.

### 3. TECHNICAL SPECIFICATION

#### 3.1 ROTOR

Rotor input:

- Power supply 40 Watt through inductive coupling
- Wireless 2.4 GHz fully protected encrypted signal
- Master / slave mode

Rotor output through a 2.4 GHz wireless data communication:

- Thrust data
- Torque data
- RPM data
- Position sensors
- Temperature data (for internal calculation purpose only)
- Diagnostic information (internal use only)

#### 3.2 STATOR

Stator input:

- Supply 115 / 230 VAC  $\pm$  10%
- Wireless 2.4 GHz fully protected encrypted signal from rotor
- Calibration button
- SD card

Stator output:

<b>Output</b>	RS485	4-20 mA	SD Card	Ethernet
<b>Thrust</b>	X	Optional		X
<b>Torque</b>	X	Optional		X
<b>Speed</b>	X	Optional		X
<b>Shaft Power</b>	X	Optional		X
<b>Service/diagnostic</b>			X	
<b>Firmware update</b>			X	

Optionally a signal processing unit and/or a display could be connected to the system.

#### 3.3 SPECIFICATIONS

Measurement specifications:

- Thrust [kN] <1,0% FSD (depending on application)
- Torque [kNm] <0,25% FSD
- Power [kW] <0,25% FSD

Environmental data:

- Operating temperature 0 – 60°C
- Storage -20 – 70°C
- 1,5 x max. centrifugal force
- Vibrations as per classification society, 0-100 Hz @ 4,0 g
- EMC according EN 61000
- Protection degree stator control box IP65

#### Dimensions:

- Shaft diameters 200 to 1000 mm
- Length rotor 700 mm (please note that extra space is required for installation)
- Height rotor 150 to 165 mm
- Distance rotor / stator approx. 3 mm
- Stator coil bracket dimensions (BxHxD) 248x290x108 mm
- Stator control box (BxHxD) 407x360x119 mm

#### Mounting:

Clamp-on system with rings, to be installed by qualified personnel.

#### Materials:

Rings	: C45E
Arms	: C45E
Cover	: Poly Urea coated High Density foam
Protection tube	: Aluminium

## 4. SAFETY INSTRUCTIONS

### 4.1 SAFETY PRECAUTIONS

To ensure the safety of personnel and equipment:

- Always follow the safety and installation recommendations in this manual.
- Always use personal protective means when working with hot, aggressive and toxic process liquids.
- Always use insulated tools when working on electrical installations.
- Ensure that local safety regulations are met when installing and operating the equipment.
- All personnel who operate and service the equipment should read this manual completely and make themselves acquainted with the equipment before installing or operating the equipment.
- Do not work on TT-Sense<sup>®</sup> optical torque sensor while rotating.
- Disconnect power supply before opening cabinet or working on electronics.

## 5. UNPACKING

Let the instruments acclimatize in the location where they are going to be installed for at least one hour inside their shipment box. This is to avoid moisture buildup inside the instrument, or on the connectors and wires.

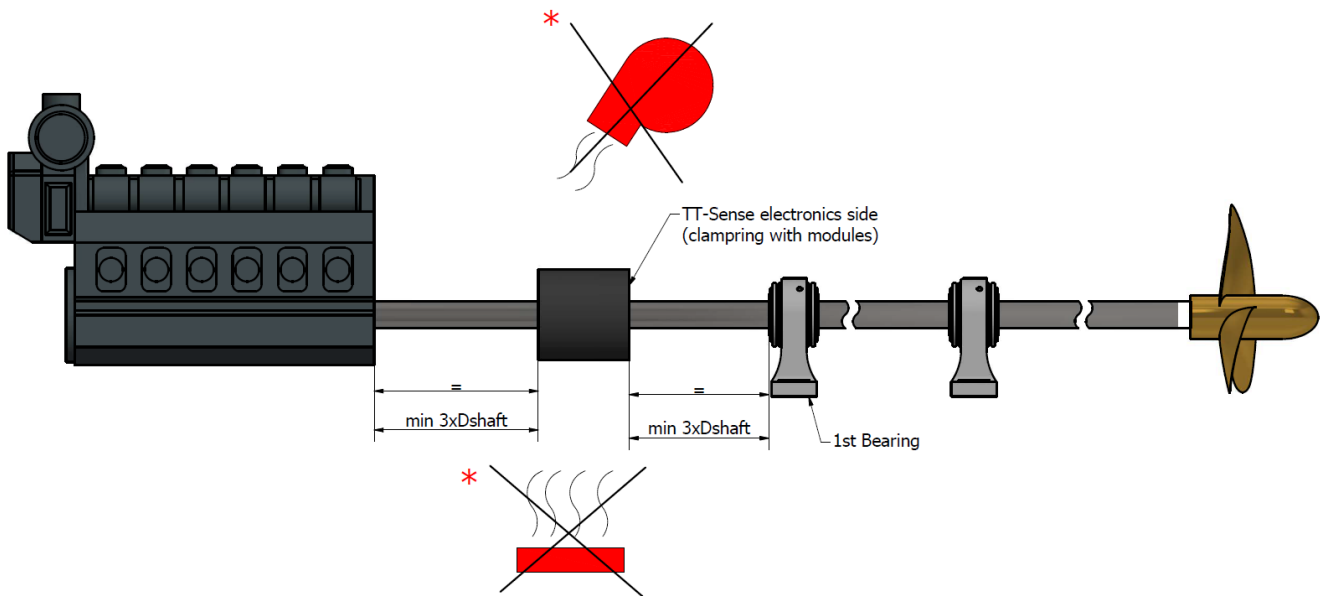
When the equipment is taken out of the box, please leave the transport locking materials for arms and between rings in place as long as possible to avoid any damage.

Dispose of the packing material should be done according to the laws of the country where the equipment is installed or according to the rules that are applicable on the vessel.

## 6. INSTALLATION



A TT-Sense® can only be installed by an authorized service engineer specially trained for TT-Sense® by VAF Instruments.

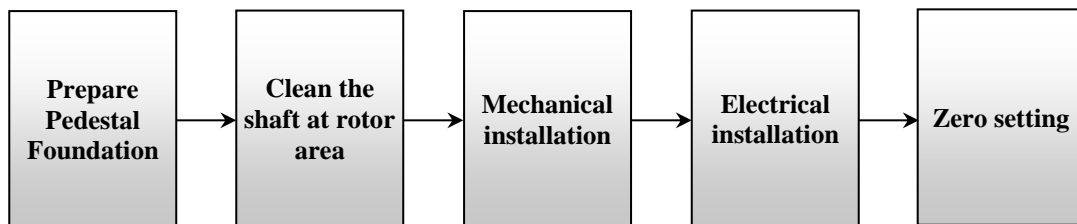


Heating and/or cooling sources like engines, generators, air conditioners, blowers, etc. close to the TT-Sense® equipment should be avoided. These sources can have an impact to the temperature householding of the TT-Sense® equipment. This can affect the accuracy of the measurement and send out data without the expected accuracy. Consult VAF Instruments B.V. if requirements cannot be met.

## 6.1 TT-SENSE® INSTALLATION CHECKLIST

Before starting up the installation of the TT-Sense® equipment please read this checklist to be aware of the chronological order for installation and commissioning of the TT-Sense® equipment.

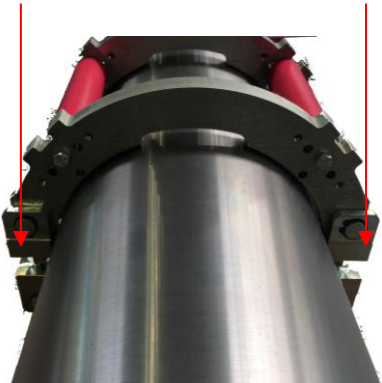
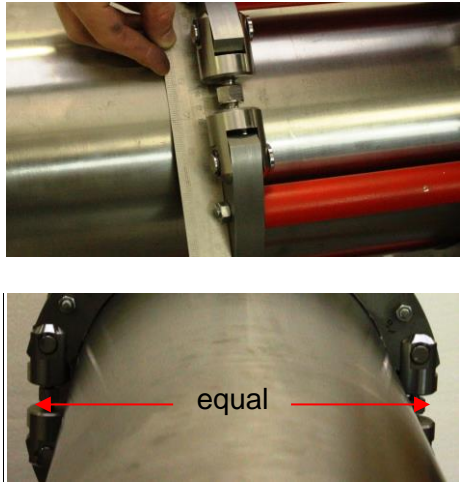
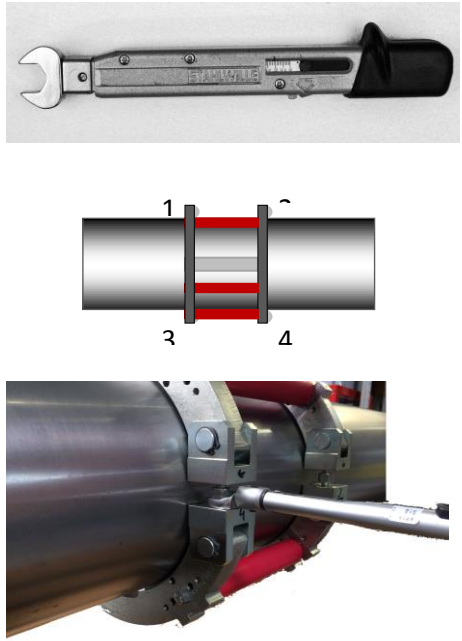
1. Please make sure that there is sufficient shaft length available. Sensor + length for installation require approx. 1250 mm.
2. Prepare the pedestal foundation and installation of the stator pedestal and stator coil  
Chapter 17 drawing 0815-1012, 0815-1013, 0815-1015, 0815-1212 and additional drawings for the stator pedestal (optional delivery) 0815-1008 and 0815-1014.
3. Clean the shaft at the location of the rotor parts  
Paragraph 6.2 Mechanical Installation
4. Follow and finish the mechanical installation instructions for the rotor part  
Paragraph 6.2 Mechanical Installation
5. Follow and finish the electrical installation instructions regarding cabling of the control box  
Paragraph 6.3 Electrical Installation
6. Start the ZERO SETTING procedure after fulfilling above installation instructions and after checking the integrity of external wiring.  
Paragraph 6.4 of this technical manual
7. The TT-Sense® system is ready for use


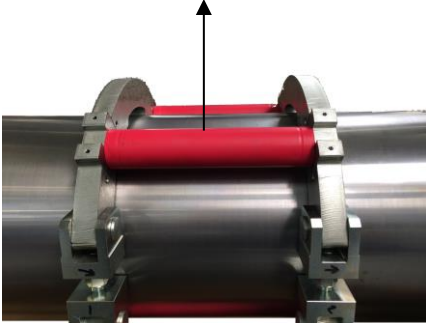

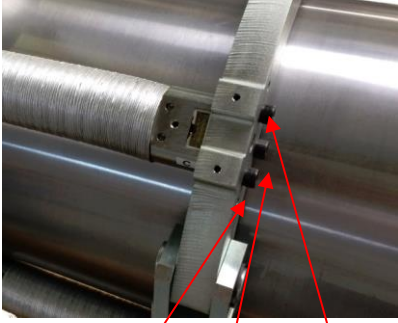



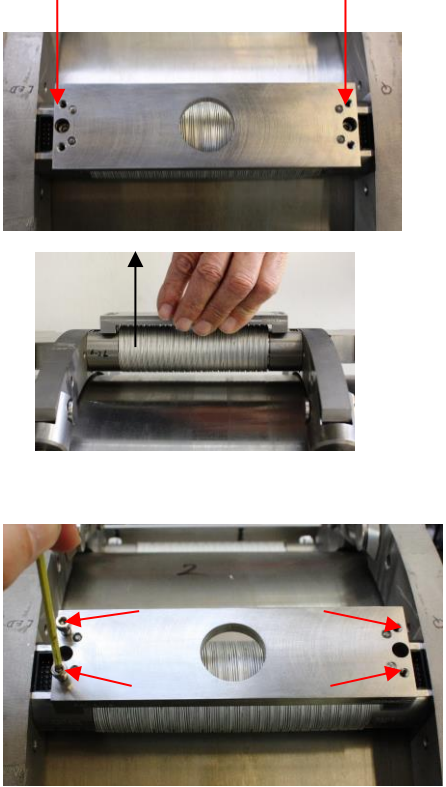
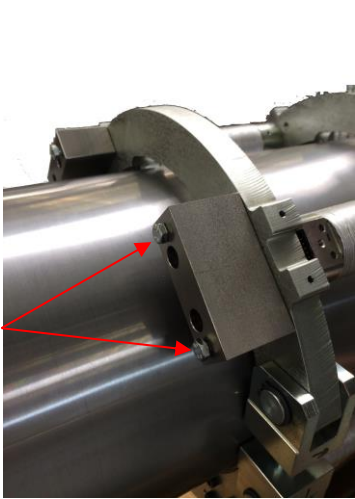
Direct after installation, the TT-Sense® might experience some mechanical settling, that could be noticed by a deviating measured value. There is no need to perform any actions, since the sensor will perform a zero-setting based on a self learning algorithm. This results in a stable and repeatable figure after approx. 2 weeks and 4 calls in port (in which the shaft is not rotating).

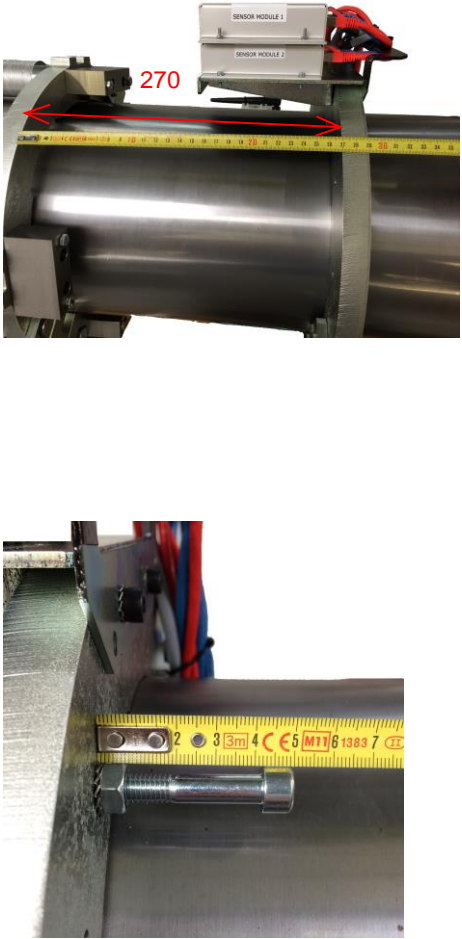
## 6.2 MECHANICAL INSTALLATION

<p><b>1</b></p>	<p><b>Clean shaft</b></p> <p>Clean the shaft thoroughly. Remove grease and rust particles from shaft. Finally clean the shaft with a degreasing detergent which is free from acid. E.g. white spirit, mineral spirit, mineral turpentine, etc.</p>	
<p><b>2</b></p>	<p><b>Friction parts and ring assembly</b></p> <p>Make sure that friction parts on mounting rings are clean. Contact between friction parts and shaft shall be metal to metal. (No grease, paint or dirt particles in between)</p> <p>If friction parts are dirty, clean them with a clean cloth. Remove grease with degreasing detergent. Use a medium free from acid, e.g. white spirit, mineral spirit, mineral turpentine, etc.</p> <p>Distance between the fork joints should be approx. 25 mm.</p>	
<p><b>3</b></p>	<p><b>Mounting rotor parts on the shaft</b></p> <p>Fix both rotor parts on the shaft by mounting the pins and the locking rings at the lower part.</p>	 <p>Pin                      Locking ring</p>

	<p>Position the ring assembly on to the shaft. Make sure that the rotor parts are positioned in such a way that the induction foil area at the cover is in line with the stator coil/pedestal.</p> <p>For an overview including relative positions of ring assembly, auxiliary ring and cover see drawing 0815-1015 in chapter 17 of this manual.</p> <p>Adjust the two rotor parts by tightening the four connecting bolts finger tight.</p>	<p>Connecting bolts - finger tight</p> 
<b>4 Alignment of rings</b>		
	<p>Make sure that mounting rings are mounted parallel to each other by using a ruler.</p> <p>Check gap between the fork joints. Gap should be equal on both sides.</p>	
<b>5 Fastening connecting bolts</b>		
	<p>Use a 5-50 Nm torque wrench together with open-ended spanner part.</p> <p>Tighten the M10 connecting bolts with the torque wrench (spanner size 17 mm) according schedule:</p> <p>10 Nm : 1-2-3-4  20 Nm: 4-3-2-1  30 Nm: 1-2-3-4  40 Nm: 4-3-2-1  45 Nm: 1-2-3-4  50 Nm: 4-3-2-1</p>	

<b>6</b>	<b>Final check connecting bolts on torque</b>	
	Make sure that all connecting bolts are on maximum torque (50 Nm)	
<b>7</b>	<b>Removing spacers</b>	
	<p>Loosen the nuts and remove the threaded rods by hand. Remove the spacers between the rings by hand. Make sure that they can be removed without clearance and without significant resistance.</p> <p>When the spacers are having significant resistance or significant clearance, the rings are not aligned properly. This can cause incorrect measurements because the sensor can be out of range. Correct alignment of the rings is crucial for accurate measurements.</p> <p> Important: Put spacers in supplied spare part box, as they are necessary for reinstallation.</p>	 <p>without clearance/resistance</p>
<b>8</b>	<b>Mounting the sensors</b>	
	<p>Make sure that the Detector side of the sensors is positioned at the side where the Rotor Auxiliary ring containing the electronic boxes will be mounted. The Detector side of the sensors is marked with character D on the mounting plate. (LED side is marked with L)</p> <p>Make sure that sensor 1, 2, 3 and 4 are mounted at the same radial position as the sensor boxes 1, 2, 3 and 4.</p> <p><u>Important:</u> The sensor should be able to easily slide between the rings. This should be done by hand only. When it is required to use tools, this is indicating the rotor is not correctly aligned. This will require re-alignment of the rings.</p> <p>Tighten the socket head screws with a torque wrench according schedule:</p> <p>5 Nm : 1-2-3 10 Nm: 1-2-3 14,5 Nm: 1-2-3</p>	 <p>D(detector-side)</p>  <p>2 1 3 Socket head screws</p>

9	Removing mounting plates	
	<p>Remove the mounting plates, which are located on top of the sensors by loosening the 2 socket head screws.</p> <p>Disconnect the mounting plates by hand.</p> <p>Please read next instruction when removing mounting plate by hand is difficult.</p> <p>If the mounting plate cannot be removed by hand easily, then insert the socket head screws in the holes to lift the mounting plate.</p> <p> Important: Mounting plate should be stored in spare parts box and is needed when sensor is removed and re-assembled. The mounting plate is dedicated for this specific sensor.</p>	
10	Mounting the contraweights	
	<p>Install the contra weight using the 2 hex bolts. Also install the other 7 contra weights.</p>	

11	Mounting the Rotor Auxiliary ring	
	<p>Place the Rotor Auxiliary ring containing the sensor boxes and additional electronic equipment at 270 mm distance from the mounting ring at the Detector side. (Drawing 0815-1030 and 0815-1033, chapter 17)            Make sure that sensor box 1 is at the same radial position as sensor 1. Sensor 2 is at the same radial position as sensor 2 etc.</p> <p>Use a 5-50 Nm torque wrench together with open-ended spanner part to tighten the M10 connecting bolts (spanner size 17 mm) according schedule:</p> <ul style="list-style-type: none"> <li>10 Nm bolt 1</li> <li>20 Nm bolt 1</li> <li>30 Nm bolt 1</li> <li>40 Nm bolt 1</li> <li>50 Nm bolt 1</li> </ul> <p>The bolt to prevent the cover from slipping on the axle should be installed with a length of 50 mm from the outside of the Auxiliary ring.</p>	

## 12 Cable connections from sensor box to sensor

Connect the cables from the sensor box to the sensor.



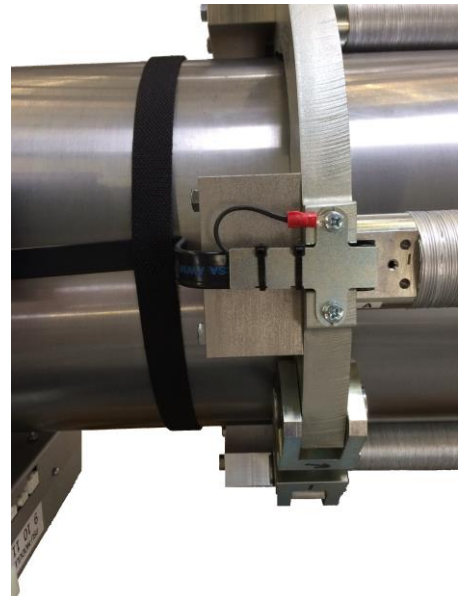
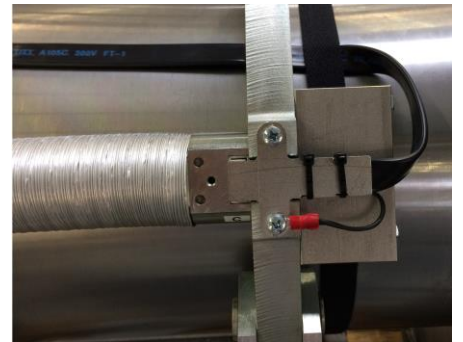
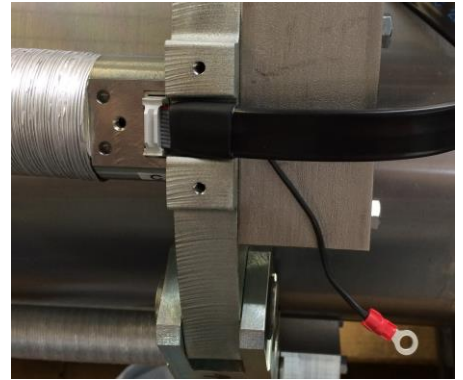
***Please note that the cables to the Led side will be guided under the mounting rings. The cables to the Detector side will not go under the mounting rings.***

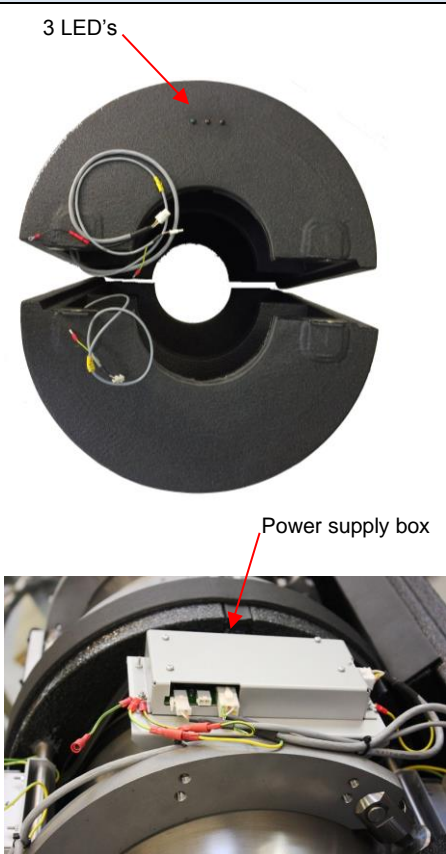
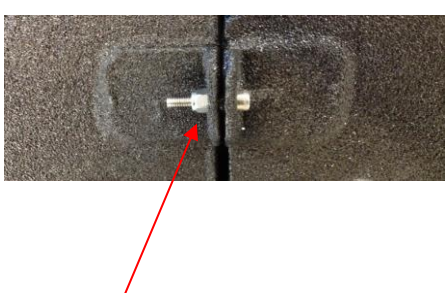
Mount the brackets on top of the connectors to secure them. Attach the cables to the brackets using 2 cables ties.

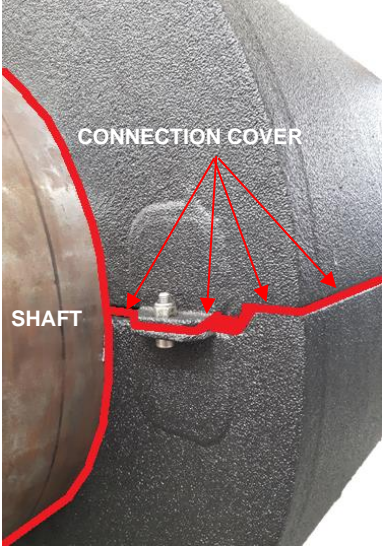
Secure the cables to the shaft using the velcro.



***Please be aware the velcro should be close to the contra weight as the cover will fit close to the contra weight. Also make sure the cables do not make contact with the contra weights to prevent damage.***



<p><b>13 Mounting the cover</b></p>	<p>Start mounting the cover part containing the 3 LED's.</p> <p>In order to be able to connect all the cables make sure that the cover part containing the 3 LED's (indication power supply) is mounted at the opposite side of the power supply box.</p> <p>Plug in the power supply cable (small connector) and the LED cable (large connector) at the power supply box.</p> <p>Connect the earth wires belonging to the power supply cable and LED cable to the earth wires at the side of the power supply box.</p>	 <p>3 LED's</p> <p>Power supply box</p>
<p><b>14 Closing the cover</b></p>	<p>First connect the power supply cable and earth wire to the power supply box again before mounting the second cover part .</p> <p>Make sure that the rubber seals attached to the cover are in the correct position and make sure that there is no gap between the shaft and the cover or both cover parts.</p> <p>Fix the 2 cover parts to each other. (4x M8 bolt, nut and washer)</p>	 <p>4x M8 bolt, nut &amp; washers</p>

15	Sealing the cover	
	<p>Apply the sealant at the point of contact between the shaft and the cover. Do this for both sides of the cover and all the way around. (See red marker line) Continue by applying sealant to the gap between the connection of the two covers. (See red marker line) Do this for all the way around and make sure that the sealant should seal the cover totally. No gaps should be left and the layer of sealant must be thick but never protrude the covers.</p> <p><b>Important remark:</b> Do not rotate the shaft when the sealant is not yet dried out.</p>	 <p data-bbox="1129 353 1377 383">CONNECTION COVER</p> <p data-bbox="1082 539 1153 568">SHAFT</p> <p data-bbox="1129 853 1310 882">■ = Sealant</p>

## 16 Position of stator pedestal/coil

The stator coil will be delivered together with a bracket and 5 meter antenna cable and power supply cable, which will be connected to the TT-Sense control box.

### Important:

Do not shorten or lengthen these cables!

Stator coil to be positioned in line with the cover side. Make sure that the coil is at the same side as the foil in the rotor cover. (Drawing 0815-1013, chapter 17)

***Delivery of stator pedestal is optional.***

Centre of coil should be positioned at 3 mm from the cover at the same vertical level as the centerline of the shaft.

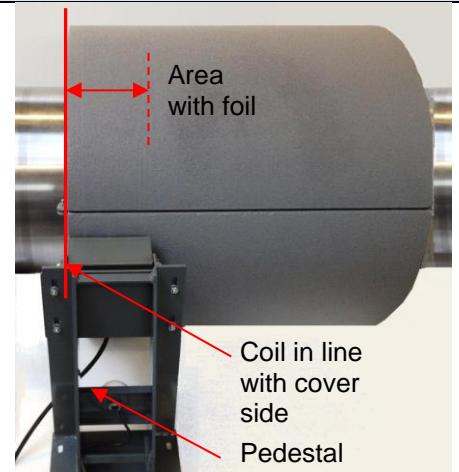
Loosen the bolts at the stator bracket and/or coil for fine-adjustment of the vertical position and clearance between coil and cover.

Use the 3 mm thick rubber mat to precisely adjust the clearance between coil and cover.

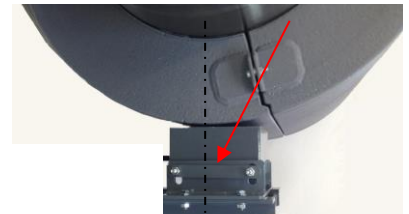
Alternatively the centre of coil could be positioned at 3 mm from the cover at the same horizontal level as the centerline of the shaft.

### Important:

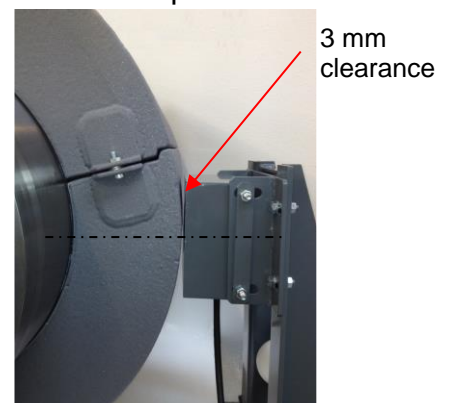
Centre of coil should always be above or below the horizontal centerline of the shaft.



Standard position 3 mm clearance



Alternative position

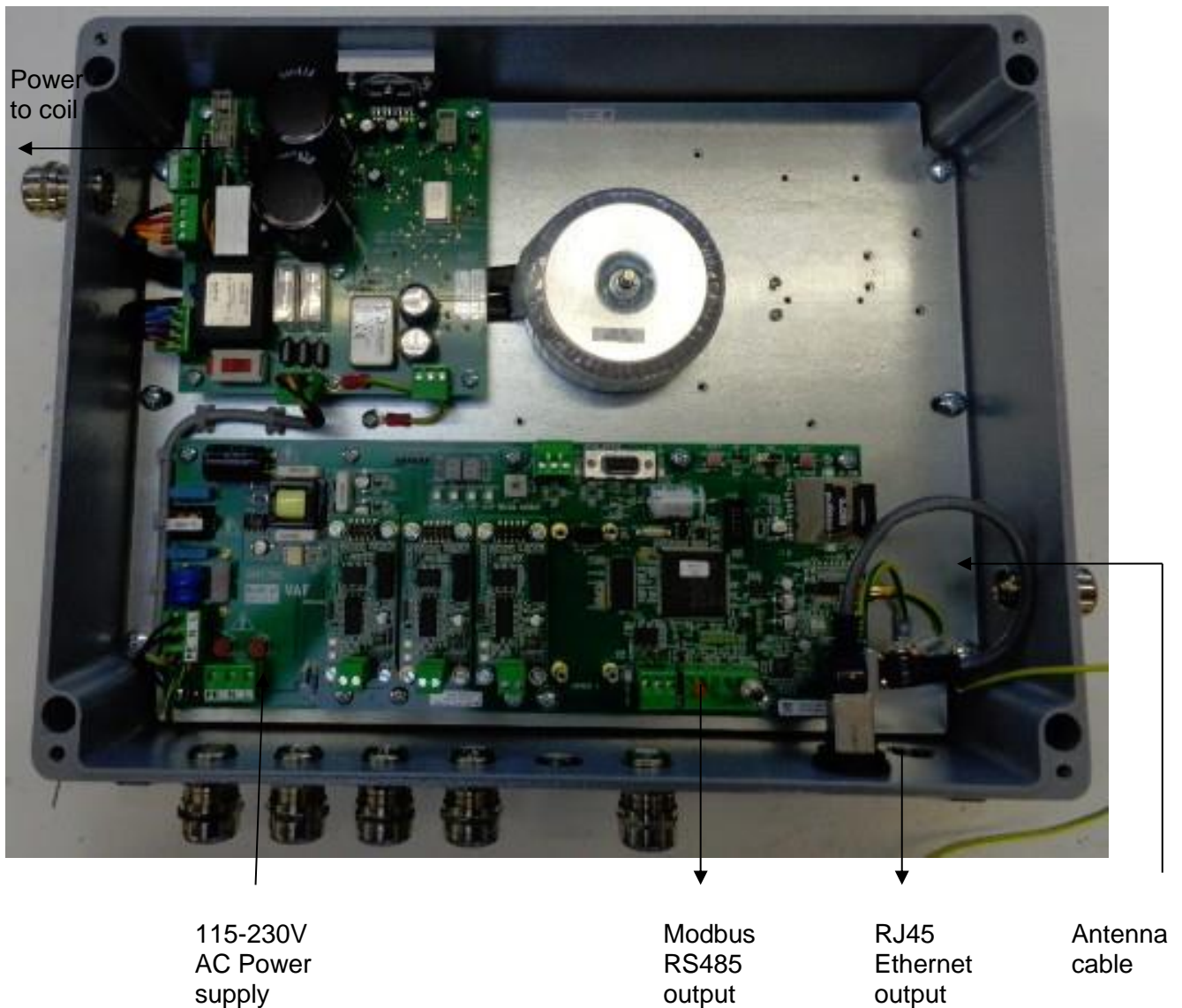


## 6.3 ELECTRICAL INSTALLATION

### Control box and cable connections

Ethernet cable to touch screen display, Modbus cable to SPU-3 signal processing unit or ship's monitoring system, power supply cable and power and antenna cable to stator coil should be connected to the control box as indicated in below picture and the electrical connection diagram on the next page.

For electrical connection diagrams of the total TT-Sense® system with optional touch screen display see paragraph 17 Drawings.



### **Important note:**

Please be aware that the control will have to be installed in the vicinity of the stator coil. Cable length from coil to control box is 5 m as a standard. Do not lengthen or shorten these cables. Make sure that all cables are according the cable specification.

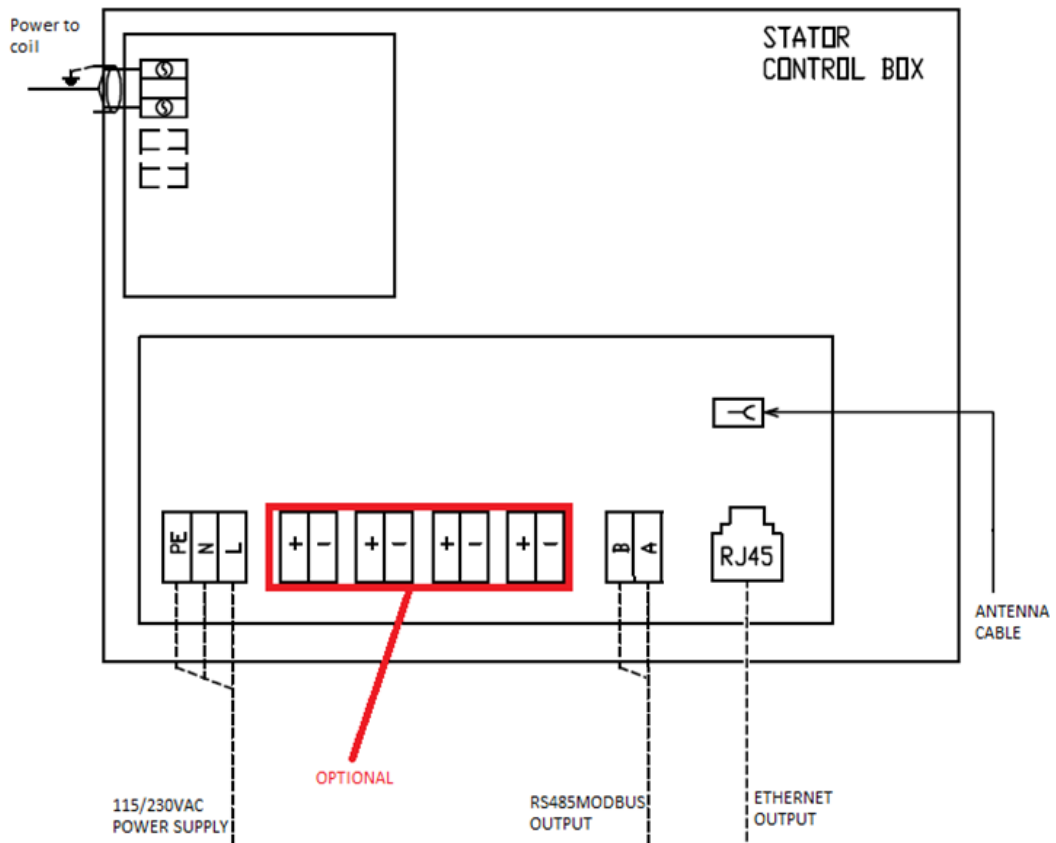


Figure 5 Connection diagram for power supply control box, power supply to stator coil, MODbus output, Ethernet output and antenna input

When the antenna cable is guided through the gland. Fix it to the PCB. When it is fixed, loosen it for 90°, so the antenna cable can rotate free. Then tighten the cable gland until the antenna cable is fixed in the cable gland. Next fix the antenna cable at the PCB again.

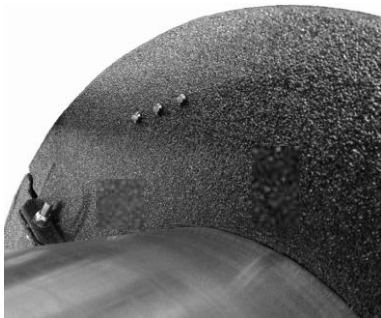
 **Important note:**

In case boardnet is 115 V  $\pm$  10% make sure that the voltage selector at the stator power supply PCB is set to 115 V before the control box is connected to its power supply.  
In case you select the wrong voltage the stator power supply will not work or the fuses at the PCB will be damaged.



115-230V  
Voltage  
Selector

If the control box is connected to the 115/230 V AC board net and the stator coil is connected to the control box, the 3 LED's at the cover side will indicate that power is available at the rotor part. Please continue with paragraph 6.4 ZERO SETTING. If power is not available please go to Chapter 15 – TROUBLE SHOOTING



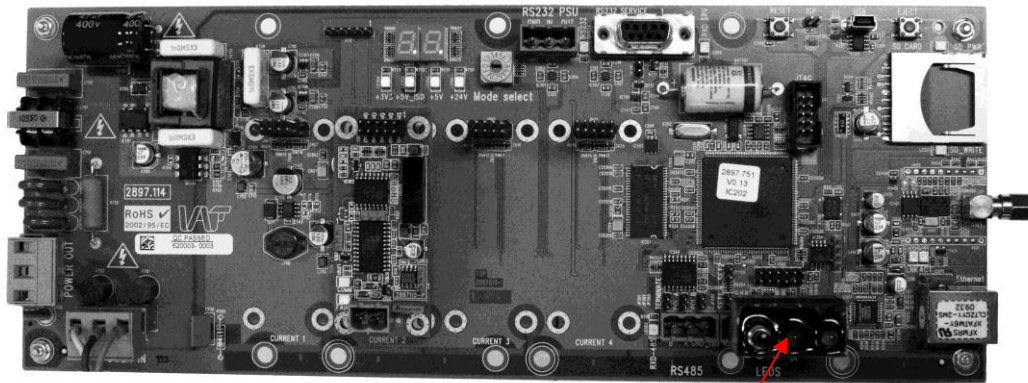
## 6.4 ZERO SETTING

Purpose of the zero torque setting procedure is to compensate for any torque or thrust left when the shaft is in rest situation.

Procedure:

1. Open the control box by removing 4 socket head cap screws.

On the bottom right hand side are two LED's and a push button located.



Push button and LED's

Figure 6 Push button and LED's for zero setting procedure

2. Press the push button until the green LED is on.  
After 10 seconds the green LED starts to flash.
3. Rotate the shaft two full rotations in any direction by means of the engines shaft turning device until the green LED stops flashing.  
When turning the shaft, make sure that the LED's at the cover stay indicating that power is available during the full rotation of the rotor. If not the diagnostic LED in the control box will display error 96 (see paragraph 15).
4. Do not stop or reverse direction during turning.  
The yellow LED starts to flash.
5. Rotate the shaft two full rotations in opposite direction until the yellow LED stops flashing and both LED's remain on continuously.  
Do not stop or reverse direction during turning.
6. Press the push button for a short period (approx. 1 sec.) to leave the 'zero setting mode'.  
Both LED's are off.
7. Close the cabinet  
System zero torque and thrust have been set. Still a small torque value can be indicated as due to friction a small amount of torque can be present.

In case both LED's flash alternating go to the 'Error procedure'.

If the zero setting procedure is completed the TT-Sense<sup>®</sup> torque measuring system is ready for use. If other VAF equipment is installed please proceed with the corresponding TIB.

Error procedure:

Make sure that the shaft is not stopped or is making a (short) reverse rotation.

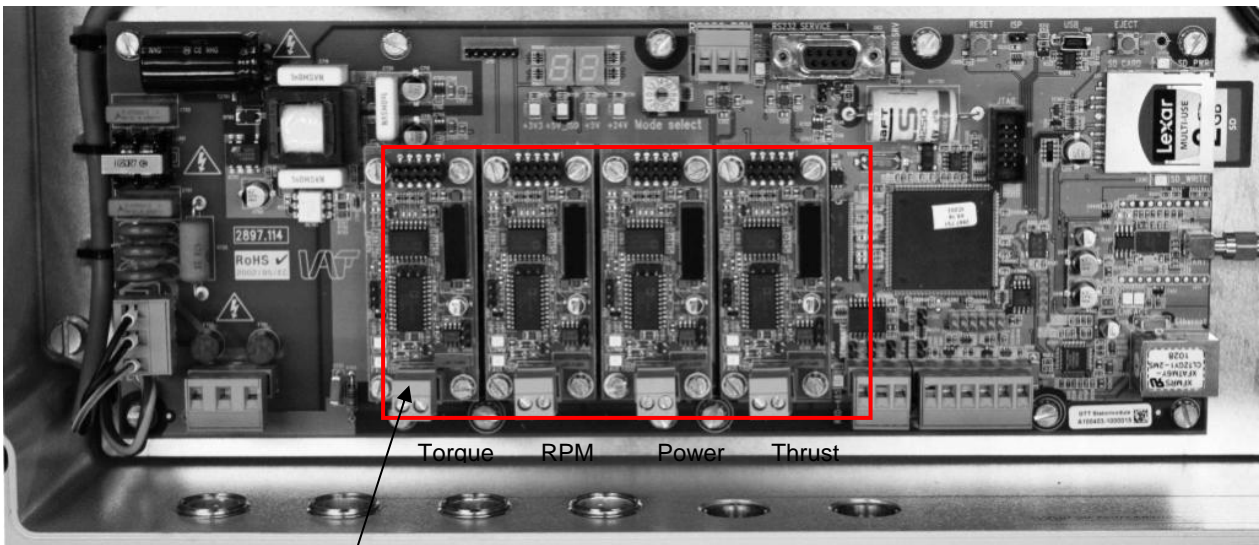
1. Press the push button to leave the 'zero setting mode'.
2. Repeat the procedure for zero setting.

Additional info:

- When the system is left in 'zero setting mode' it will automatically return in running mode after 15 minutes.

## 6.5 MISCELLANEOUS

### Optional isolated 4-20mA current output



4-20 mA outputs for torque, rpm, power and thrust

Figure 7 Control box print equipped with 4 modules for optional 4-20 mA current output

In case the control box is equipped with analog outputs the wiring of these outputs should be done according below connection diagram:

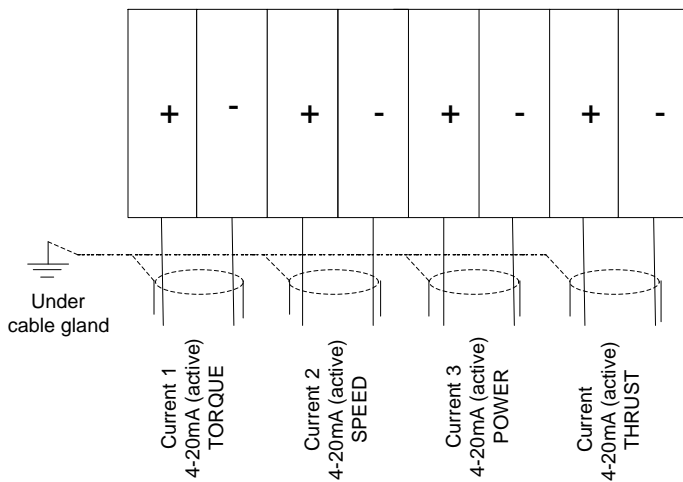


Figure 8 Connection diagram for optional isolated current output 4-20mA

The current outputs are corresponding to the required output range as provided by the customer. As a standard the output range is programmed by VAF Instruments as indicated below:

Analog output	Range	corresponds to
Current 1 / TORQUE	4-12 mA / 12-20 mA	under range (-) / upper range (+)
Current 2 / SPEED	4-20 mA	0 → Max
Current 3 / POWER	4-20 mA	0 → Max
Current 4 / THRUST	4-12 mA / 12-20 mA	under range (-) / upper range (+)

### **Specification for output and power supply cables**

Make sure that the cables you are using for power supply to the control box, MODbus digital output signal or the optional analog outputs, meet with the following specification:

Power supply 230VAC, single phase	Modbus, RS485 (from control box)	4-20mA analogue output signal (optional)	Ethernet, RJ45
3 x 1,5mm <sup>2</sup>	1 x 2 x 0,75 mm <sup>2</sup>	Torque: 1 x 2 x 0,75 mm <sup>2</sup> Speed: 1 x 2 x 0,75 mm <sup>2</sup> Power: 1 x 2 x 0,75 mm <sup>2</sup>	CAT5e, RJ45
Screened	Twisted pair, individually screened, braid shielded		Braid shielded



Make sure that output signal cables and high voltage cables are separated from each other. Use separate cable runs to avoid electromagnetically interference.

### **RS485 Modbus signal as input for AMS**

At the TT-Sense® control box there is one RS485 connection point for Modbus communication: Data A, Data B and Ground. In case the TT-Sense® thrust & torque sensor is supplied as stand-alone unit to be connected directly to the vessels Alarm & Monitoring System a communication protocol is used. The settings for Modbus communication according RS485 protocol are:

- Modbus: RTU
- Baudrate: 19200
- Data bits: 8
- Stop bits: 2
- Parity: None
- Function code: 3 (Holding registers)

The addresses are: Torque: 0+1, Speed: 2+3, Power: 4+5, Thrust 6+7

The read-out values have to be converted from two 16 bits integers to 32 bits float.

Be aware that the Modbus read-out values are presented as two 16 bits integers, which have to be converted to a 32-bits float. A 32 bits IEEE 754 floating point number is a mathematical formula that allows any real number with decimal points to be represented by 32 bits with an accuracy of seven digits. For more info please check the IEEE 754 standard for binary floating point arithmetic.

### **Ethernet connection as input for a display**

Connecting a monitor to the Ethernet connection makes it possible to see the data available in the control box. Contact VAF for optional displays.

The default IP address of the control box is 168.1.1.140

## 7. OPERATING INSTRUCTIONS

Make sure that power supply is connected to the sensor.

No other special actions are required for operation, as the output signals will be available now.



### **Important note:**

Please avoid direct contact of the TT-Sense® cover with spraying water or water jets to avoid water ingress.

## 8. MAINTENANCE

No regular maintenance of the torque sensor is required.

After special events i.e.; drydock, propeller shaft re-alignment, performing a zero setting of TT-Sense® might be required, see chapter 6.4

## 9. SERVICE AND REPAIR INSTRUCTIONS

Repair should be performed by VAF trained service engineers. After diagnosis of the raw data, the cause of a failure can be detected.

## 10. TAKE OUT OF SERVICE

Make sure that you take all necessary safety precautions with respect to electric shock, and make sure that the shaft and sensor are not able to start rotating.

Disconnect power supply of the control box (terminal L, N, PE of fig. 5) and if necessary disconnect cable between control box and coil. Remove the cover of the rotor, by unscrewing the bolts at both sides of the cover and unplug the connectors of the electronics. Install transport tools for both detecting arms and rings (see 19.4 Transport/mounting tools). Now you can loosen the four M10 connecting bolts (pos.12 at drawing 0815-1209), which allow you now to remove the complete sensor from the shaft.

## 11. REMOVAL AND STORAGE OF EQUIPMENT

To avoid damage to the equipment, rotor parts should be removed from the shaft in case a shaft is dismantled and removed from the shaft line for a maintenance or replacement job.

Make sure that you take all necessary safety precautions with respect to electric shock, and make sure that the shaft and sensor are not able to start rotating.

Disconnect power supply of the control box (terminal L, N, PE of fig. 5) and if necessary disconnect cable between control box and coil. Remove the cover of the rotor, by unscrewing the bolts at both sides of the cover and unplug the connectors of the electronics. Install transport tools for both detecting arms and rings (see 19.4 Transport/mounting tools). Now you can loosen the four M10 connecting bolts (pos.12 at drawing 0815-1209), which allow you now to remove the complete sensor from the shaft.

All parts should be stored in a cool and dry place.

## 12. MALFUNCTION AND SEND FOR REPAIR

If parts of the sensor fail, you might be asked to send the parts to VAF Instruments for investigation and / or repair. Please follow the instructions as will be supplied by your contact at the VAF service department.

## 13. ENVIRONMENT

The sensor is manufactured of normal construction steel and contains several electronic parts. During normal use all these parts can not cause any harm to the environment.

## 14. DISPOSAL

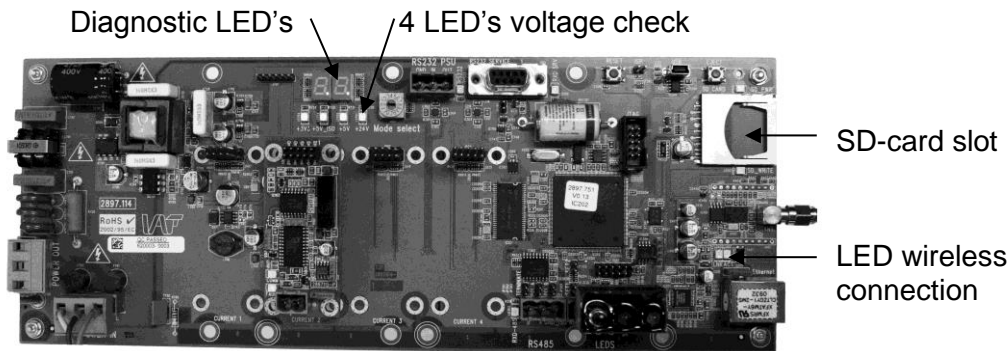
Laws and restrictions for disposal of equipment will be different in most countries. If in doubt or unable to dispose the equipment it can be send back to VAF Instruments. VAF Instruments will dispose the equipment in a correct way.

The TT-Sense<sup>®</sup> system has the following possible environmentally unfriendly components in minor quantities.

Rotor	Electronic components
Rotor	Poly Urea coated EPS cover
Stator	Electronic components

## 15. TROUBLE SHOOTING

Diagnostic LED's for diagnosis is available on the stator PCB in the control box.



Code diagnostic LED 11	Reading out SD card
Code diagnostic LED 12	SD Card locked
Code diagnostic LED 88	Initializing
Code diagnostic LED 91	Unable to write to SD card
Code diagnostic LED 96	No connection between rotor and stator
Code diagnostic LED uu	Updating firmware

Problem: No power available at the rotor part

Solution: Open the control box by removing 4 socket head cap screws and make sure that:

- 4 green LED's for supply voltage check (+3v, +5V\_ISO, +5V, +24V) are OK
- Fuses in control box are OK
- Check if clearance between coil and rotor part is not substantially larger than 3 mm.
- Voltage of power supply is OK. Check with multi tester if 115 to 230 V is available

Problem: No output data available

Solution Open the control box by removing 4 socket head cap screws and make sure that:

- The diagnostic LED's are not indicating an error message
- Green LED wireless connection is blinking

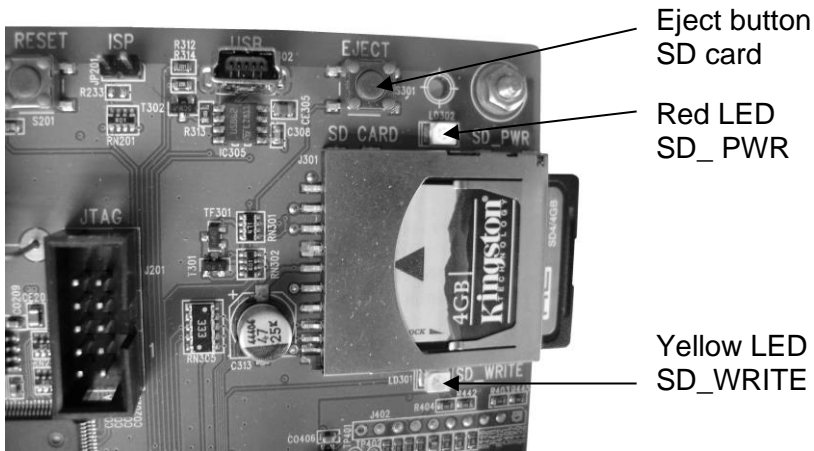
Problem: Output data is out of range

Solution Make sure that:

- Wrong zero setting. Please perform a zero setting according Chapter 6.4
- Young modulus (E) of shaft material is communicated correctly. As a standard the material properties of the frequently used C45 E shaft material is programmed.
- Output range of optional 4 to 20 mA current output is converted to the correct Torque, Speed, Power and Thrust values in case of analog current outputs. See paragraph 6.2 of this manual.
- TT-Sense<sup>®</sup> shaft speed indication is displaying the correct values. If the shaft speed output deviates, the power output value will indicate an equal deviation percentage.
- Compensator arms at rotor part are still in correct position. Check if cover, rings or protection tube are damaged or have moved.

## Removing SD card

Important: Strictly after approval of a VAF representative you are allowed to remove the SD card from the SD slot.



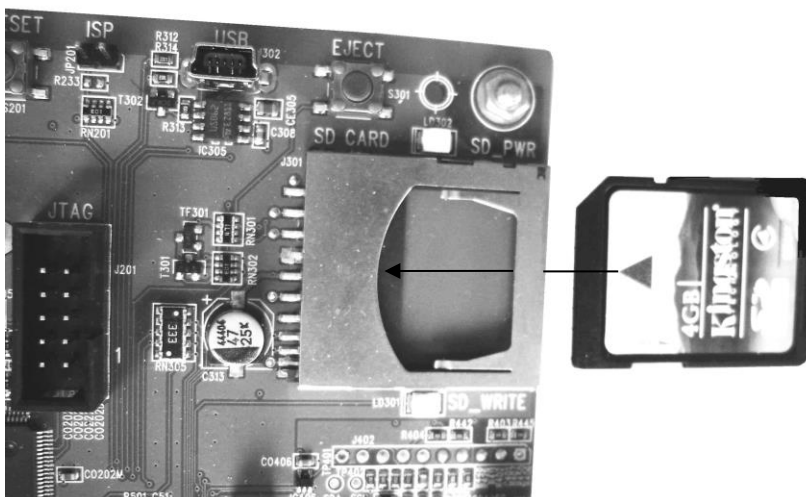
### Procedure

1. Open the control box by removing 4 socket head cap screws.
2. Push the eject button and wait until the LED's SD\_PWR and SD\_WRITE stop burning.
3. Push on the SD Card, it now will come out of the slot.

## SD card installation

### Procedure

1. Put the SD Card back into the slot until it is locked, see for correct position below picture.
2. When the SD Card is correctly installed, the LED SD\_WRITE flashes.
3. If all is correct, the control box can be closed.

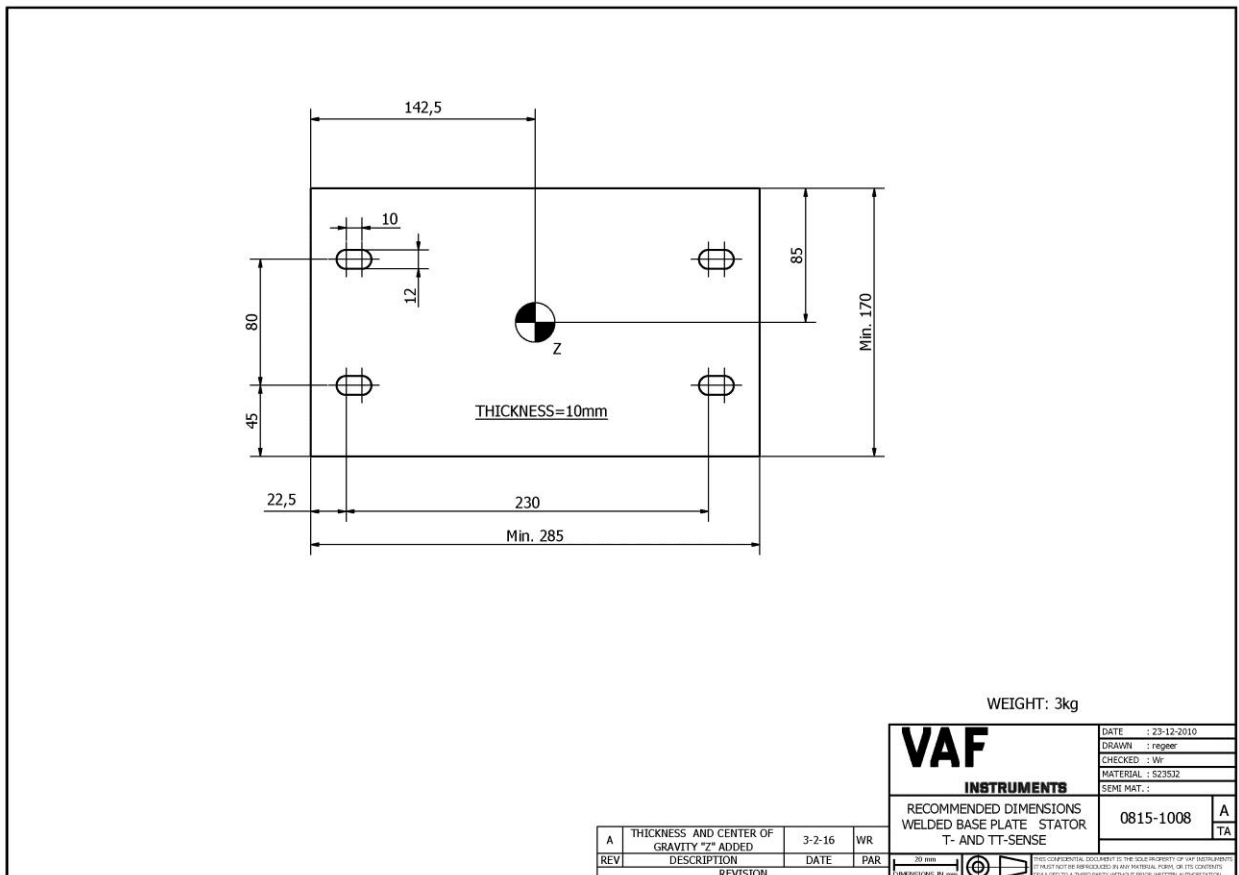


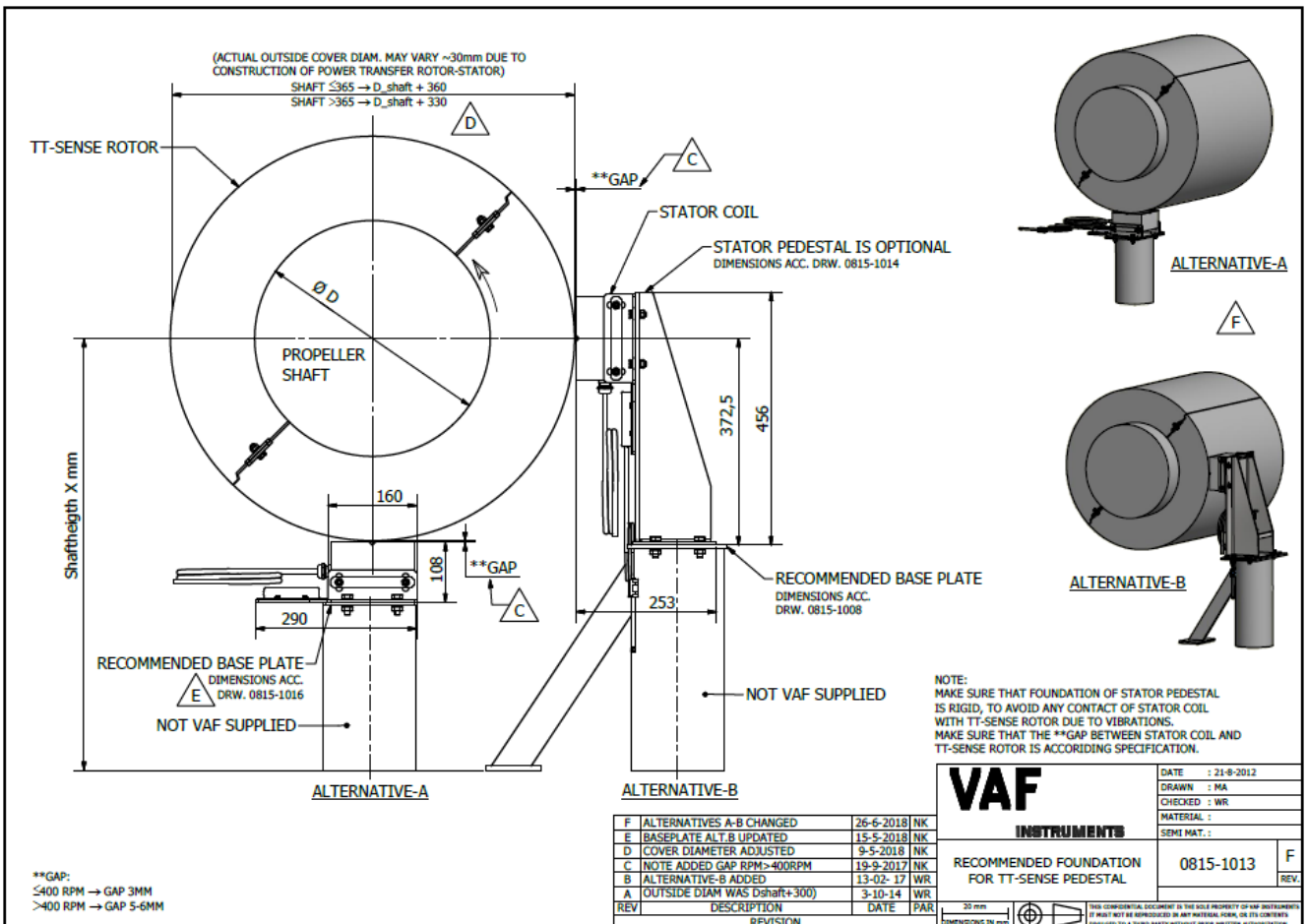
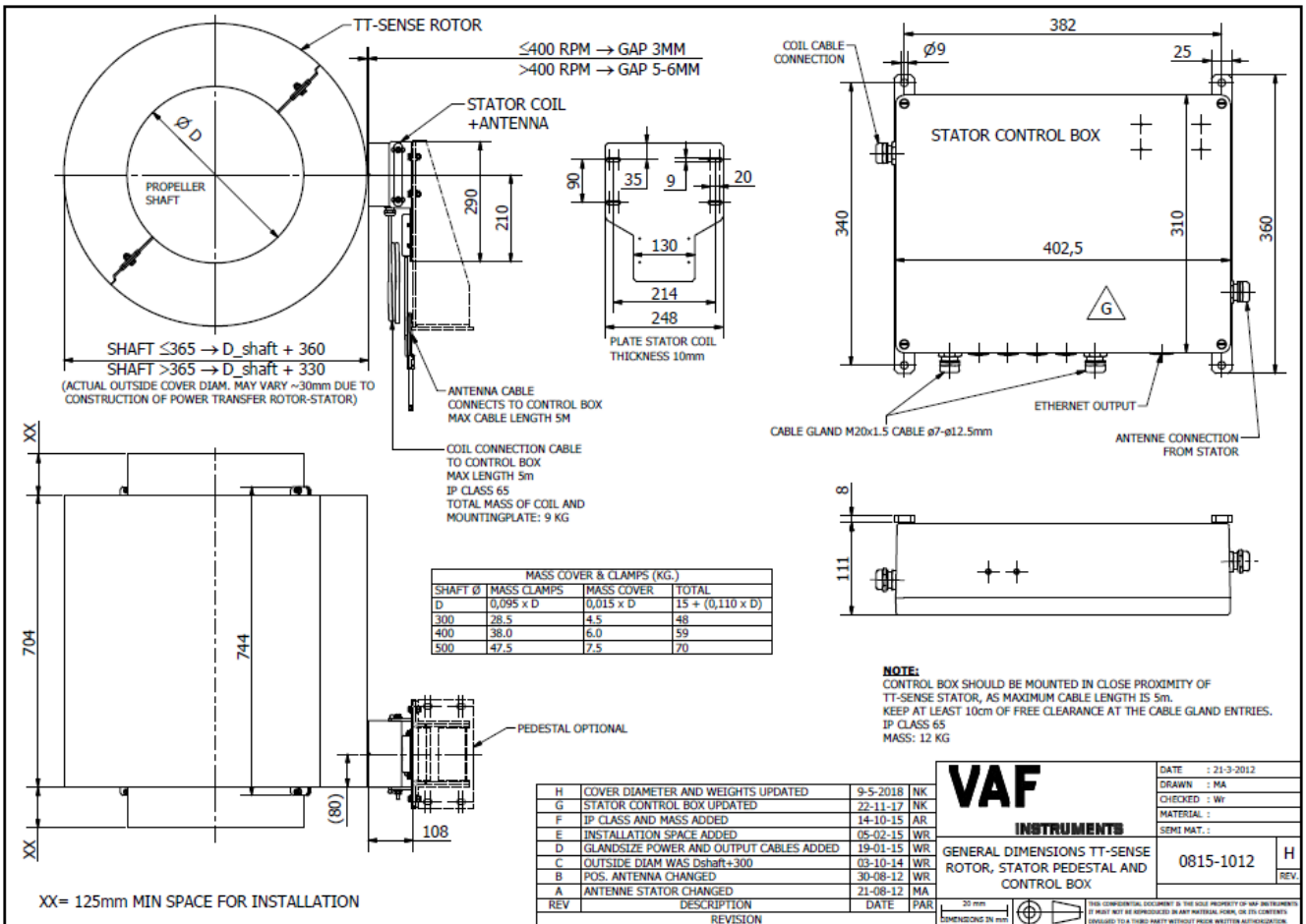
## 16. CERTIFICATES

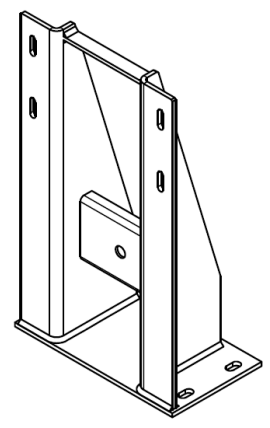
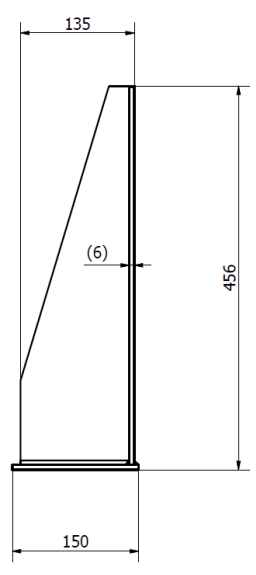
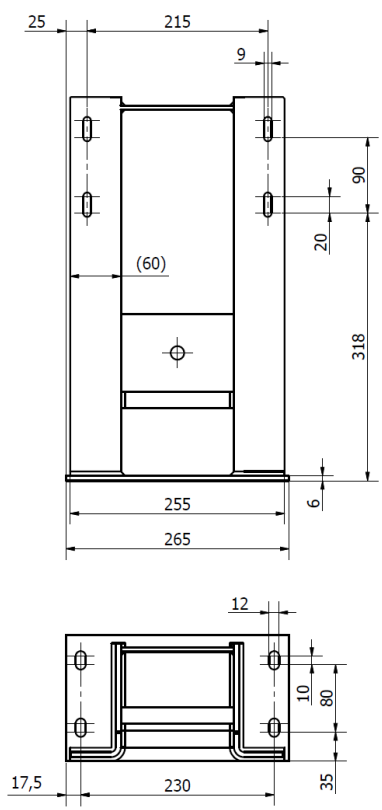
For a thrust and torque measuring system classification certificates are not required.

# 17. DRAWINGS

Description:	Drawing number:
RECOMMENDED DIM WELDED BASE PLATE	0815-1008
TT-SENSE DIMENSIONS	0815-1012
RECOMMENDED FOUNDATION FOR TT-SENSE PEDESTAL	0815-1013
DIM DRW STATOR PEDESTAL	0815-1014
RECOMMENDED DIMENSIONS WELDED BASE PLATE STATOR T-SENSE AND TT-SENSE	0815-1016
TT-SENSE min365 - ASSY + PARTSLIST CLAMP RINGS	0815-1028
TT-SENSE min365 - ASSY + PARTSLIST AUXILIARY RING	0815-1029
TT-SENSE min365 - RELATIVE ASSY OVERVIEW	0815-1030
TT-SENSE plus365 - ASSY + PARTSLIST CLAMP RINGS	0815-1031
TT-SENSE plus365 - ASSY + PARTSLIST AUXILIARY RING	0815-1032
TT-SENSE plus365 - RELATIVE ASSY OVERVIEW	0815-1033
PARTSLIST STATOR COIL AND ANTENNA	0815-1212
PARTSLIST CONTROL BOX TT-SENSE	0815-1217
INTERCONNECTION DIAGRAM	0815-2032
INTERCON. ROTOR TT-SENSE >365	0815-4012
INTERCON. ROTOR TT-SENSE <365	0815-4013
ASSY HSP TT-SENSE WITH RPM SENSOR	0815-8005

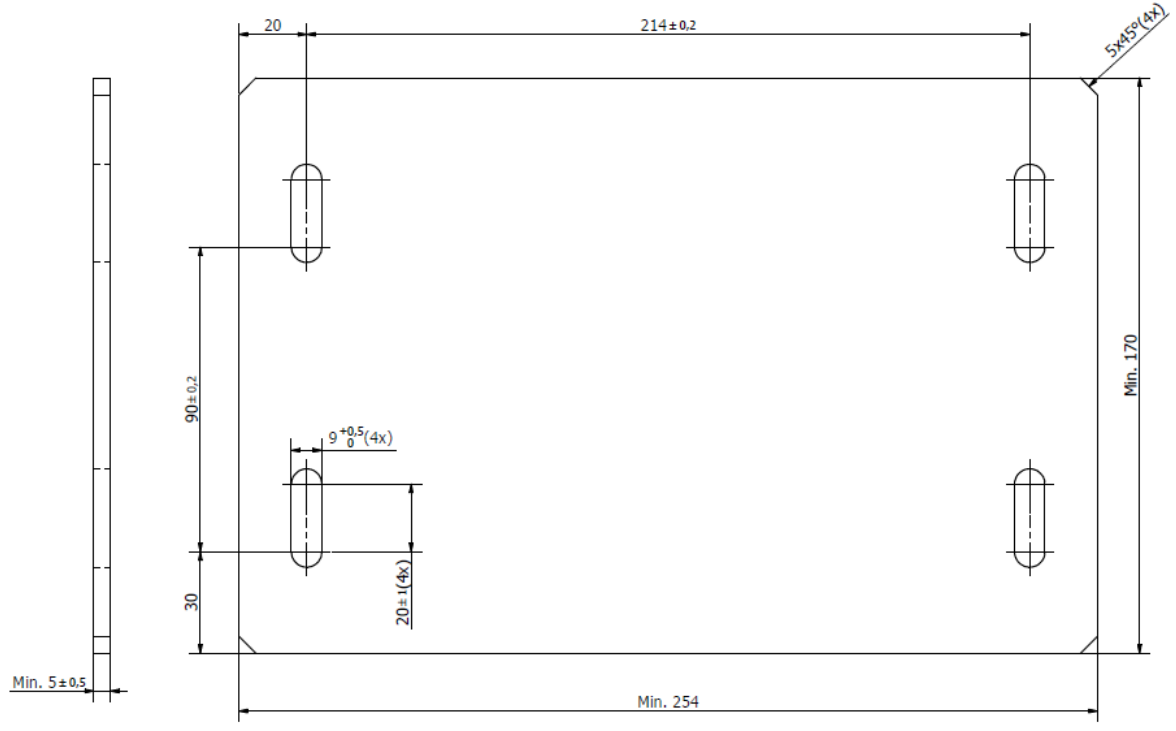






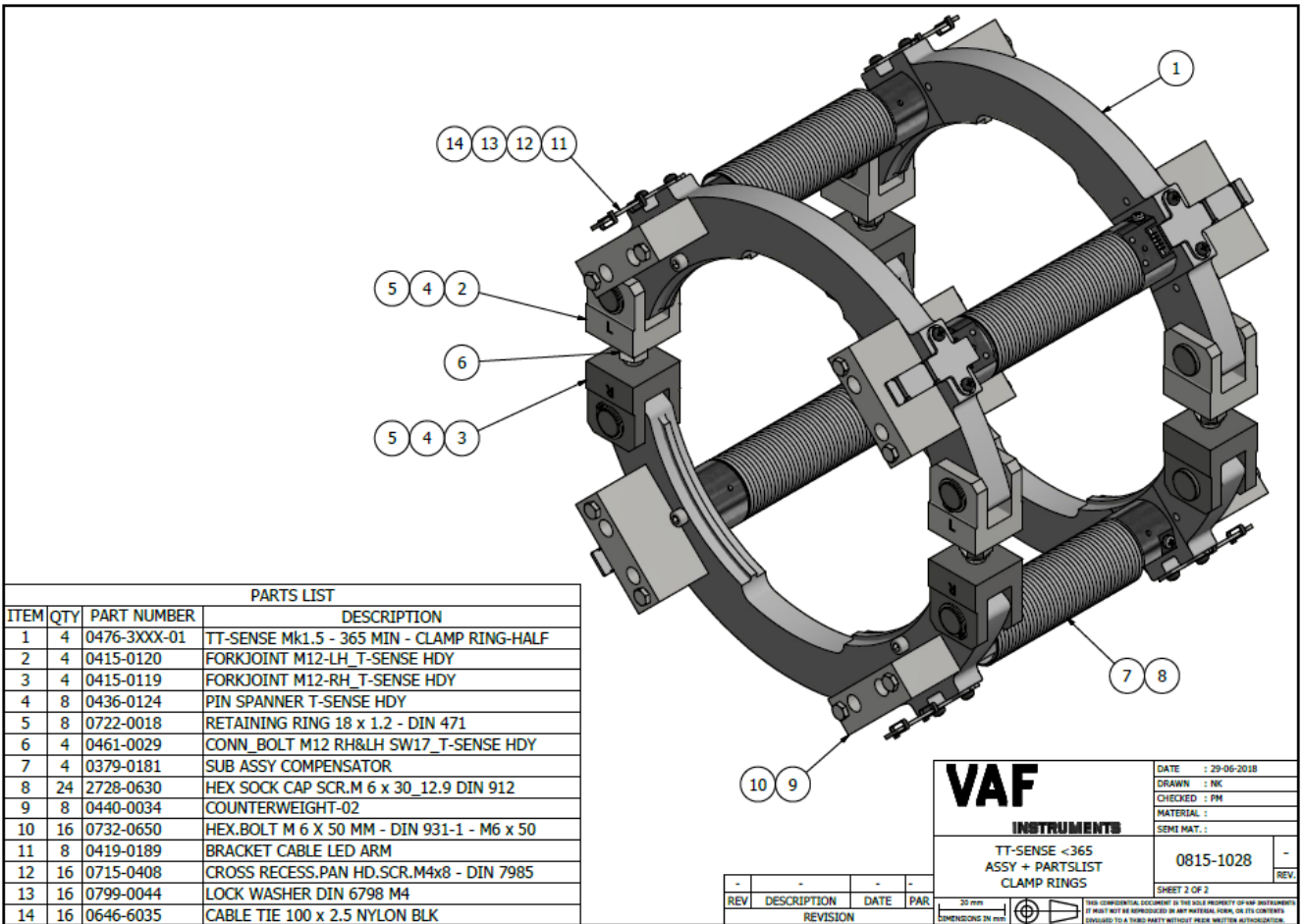
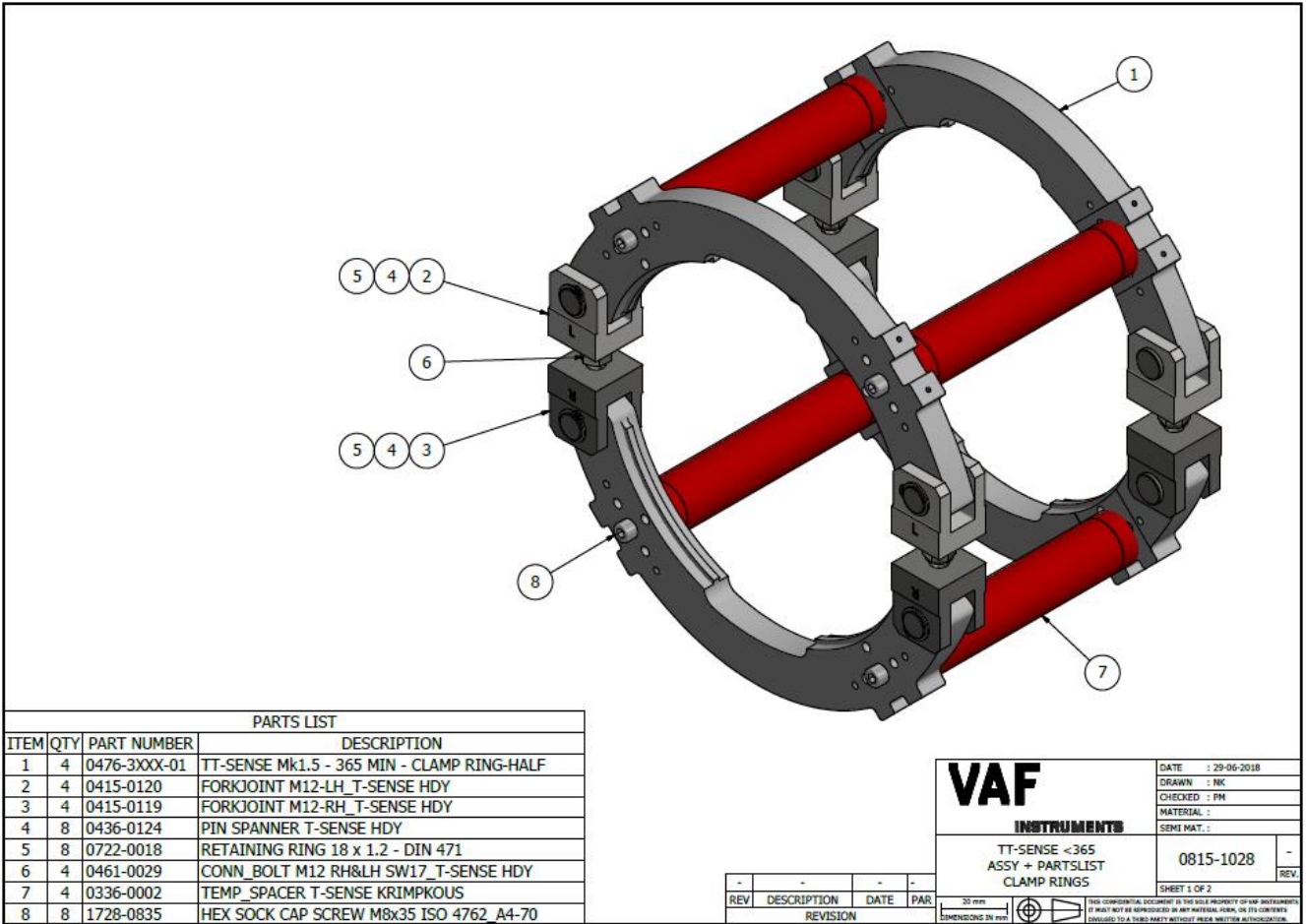
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		MATERIAL :
		SEMI MAT. :
		0815-1014
		REV.

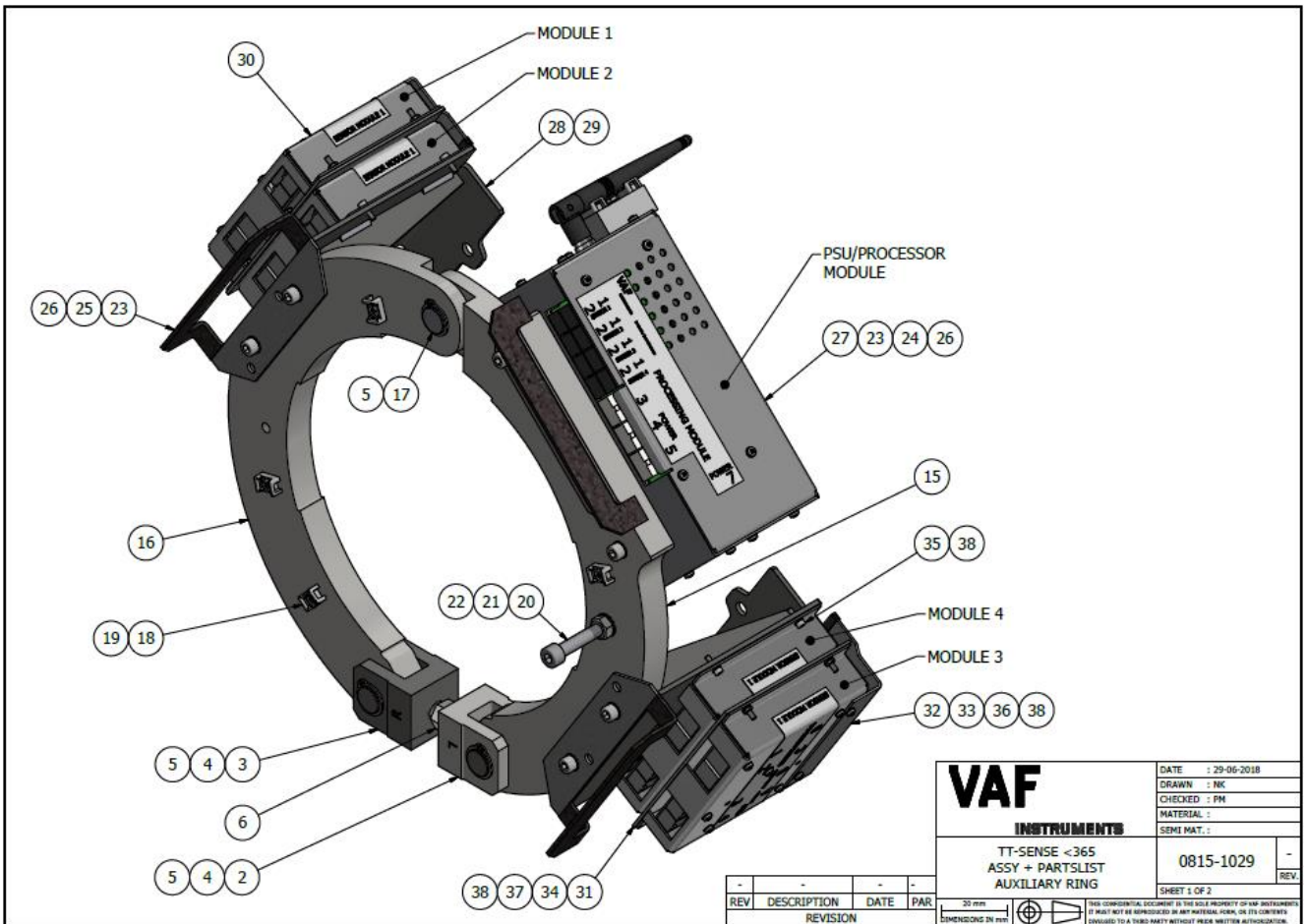
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	REVISION		



<b>VAF</b>		DATE : 19-03-13
INSTRUMENTS		DRAWN : FV
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		MATERIAL :
		SEMI MAT. :
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		A
		REV.

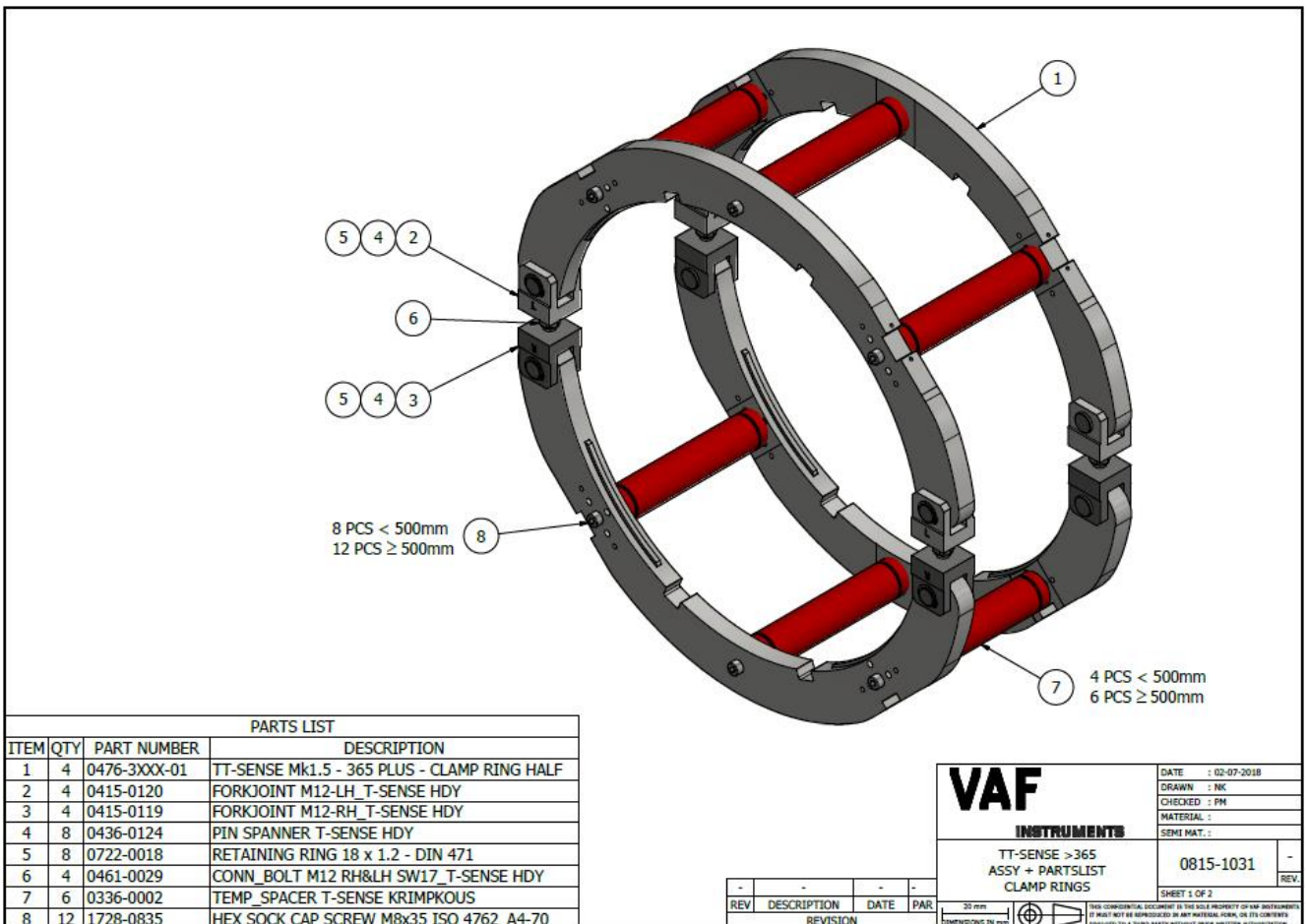
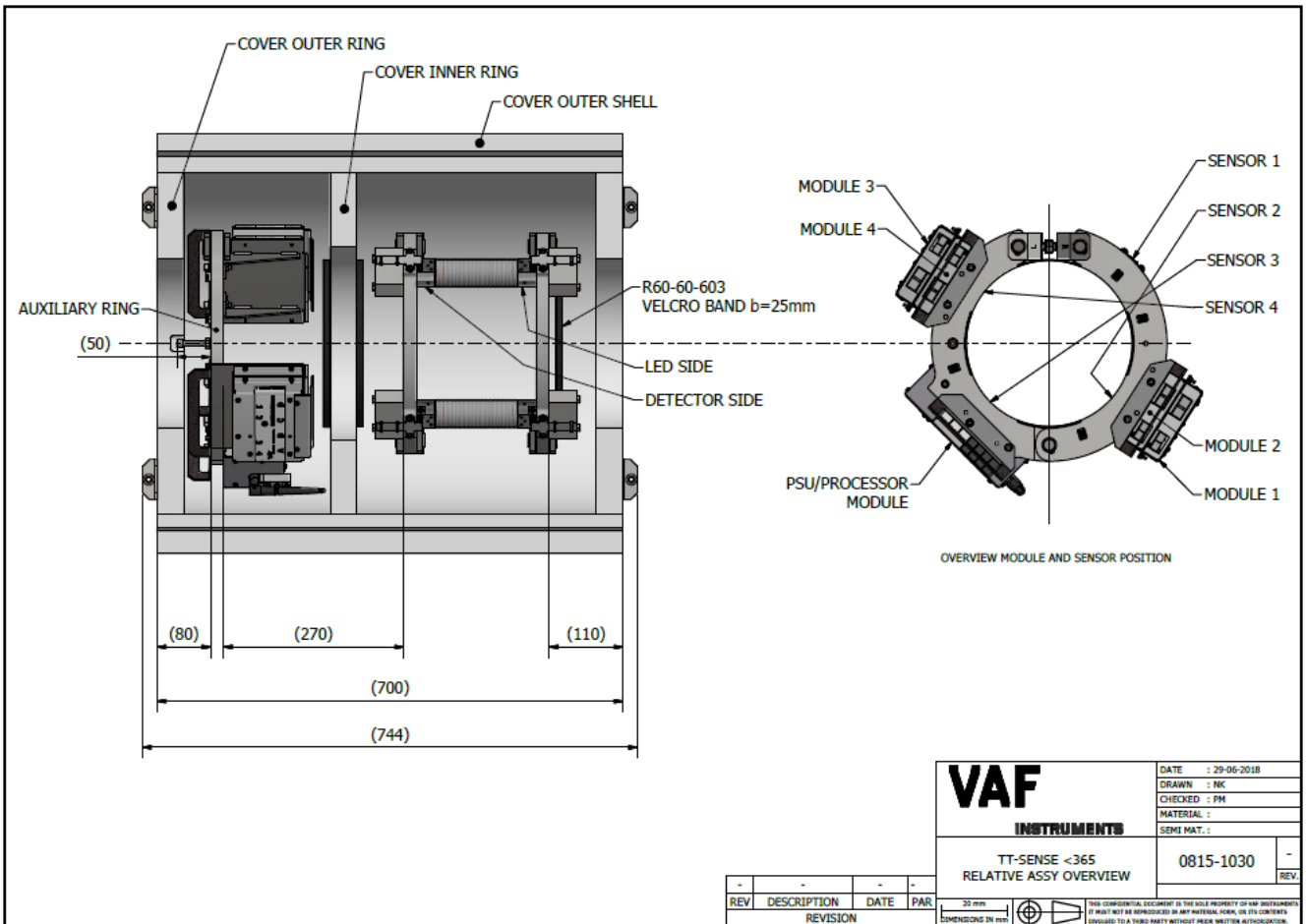
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REV	REVISION		

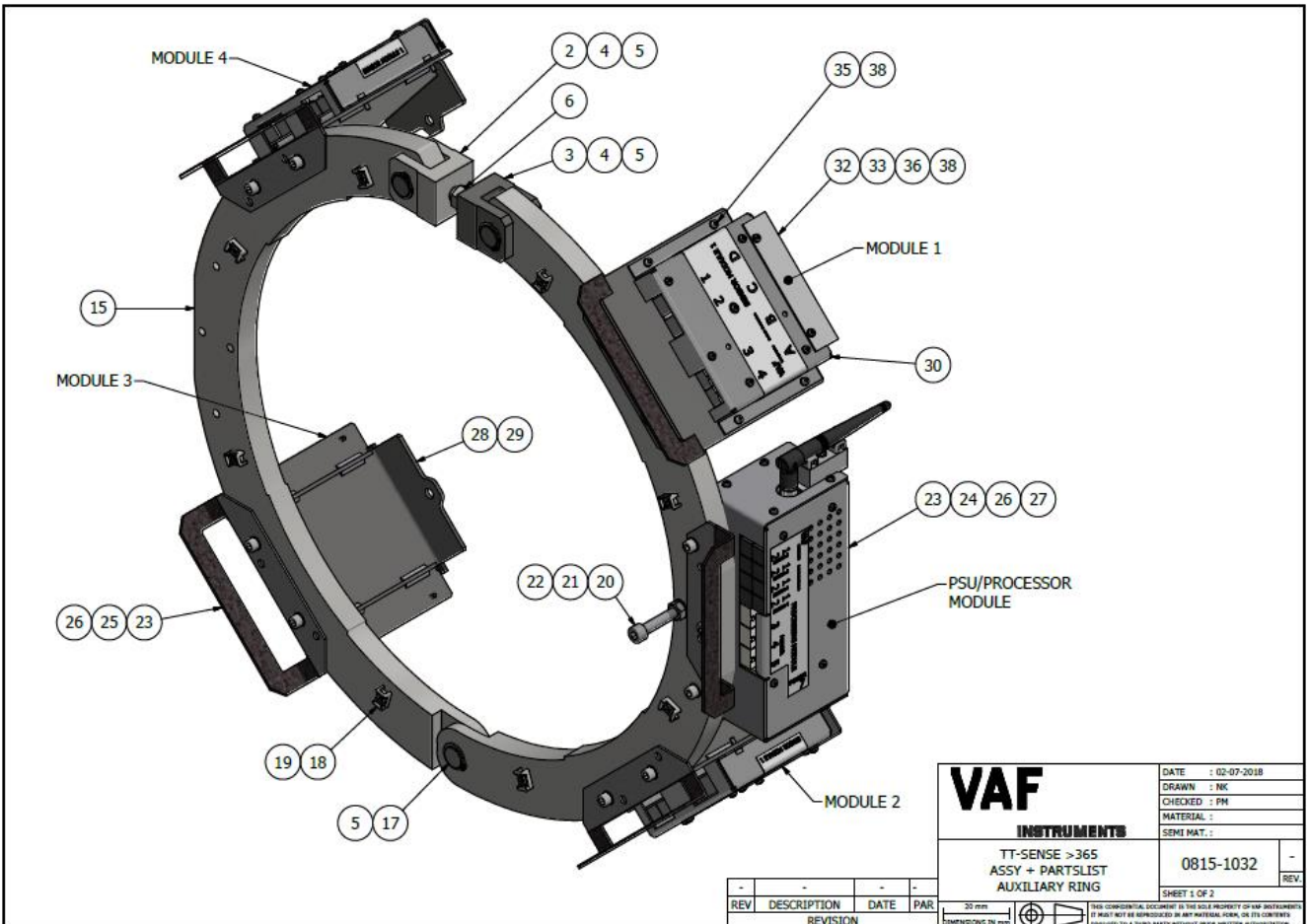
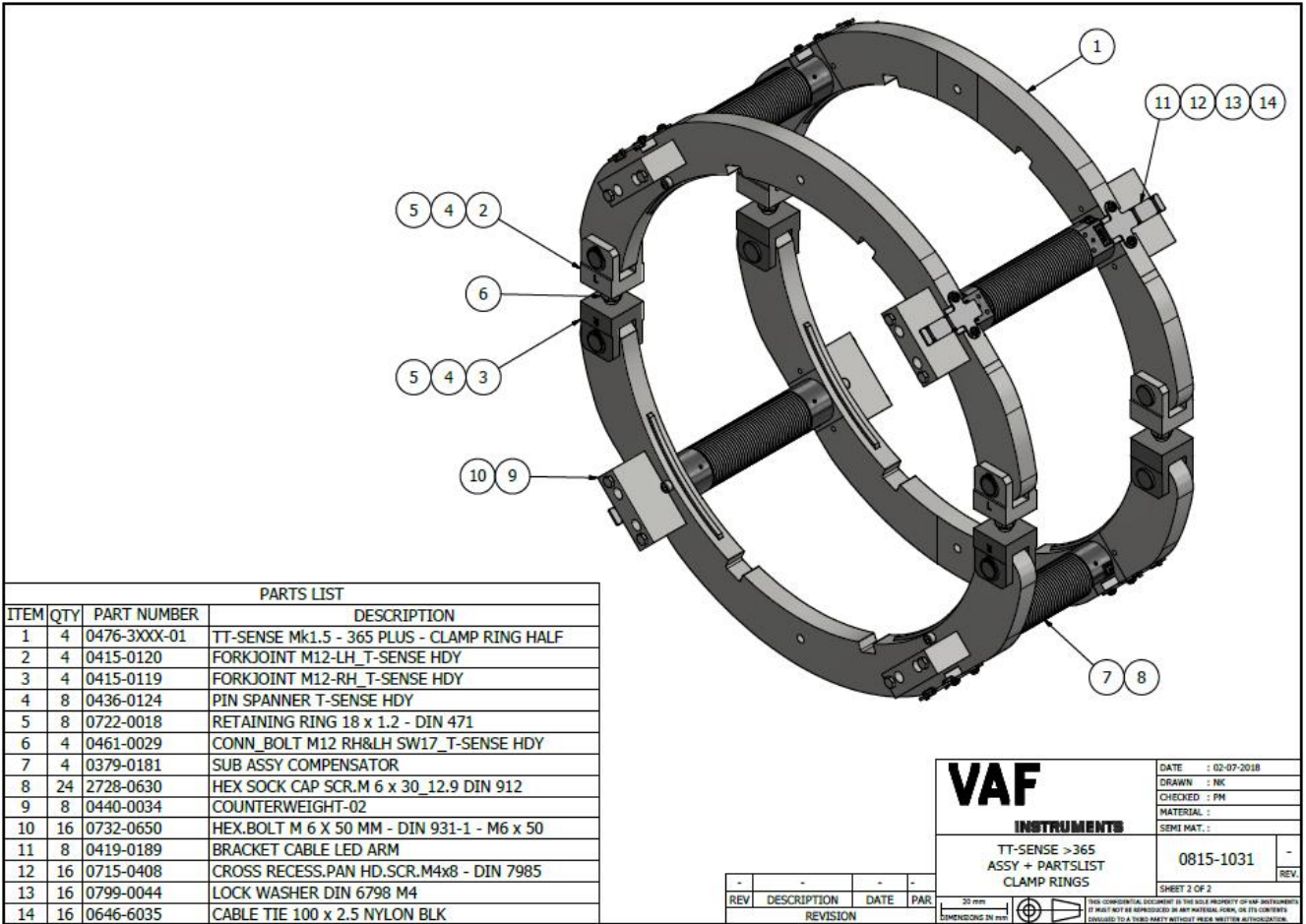


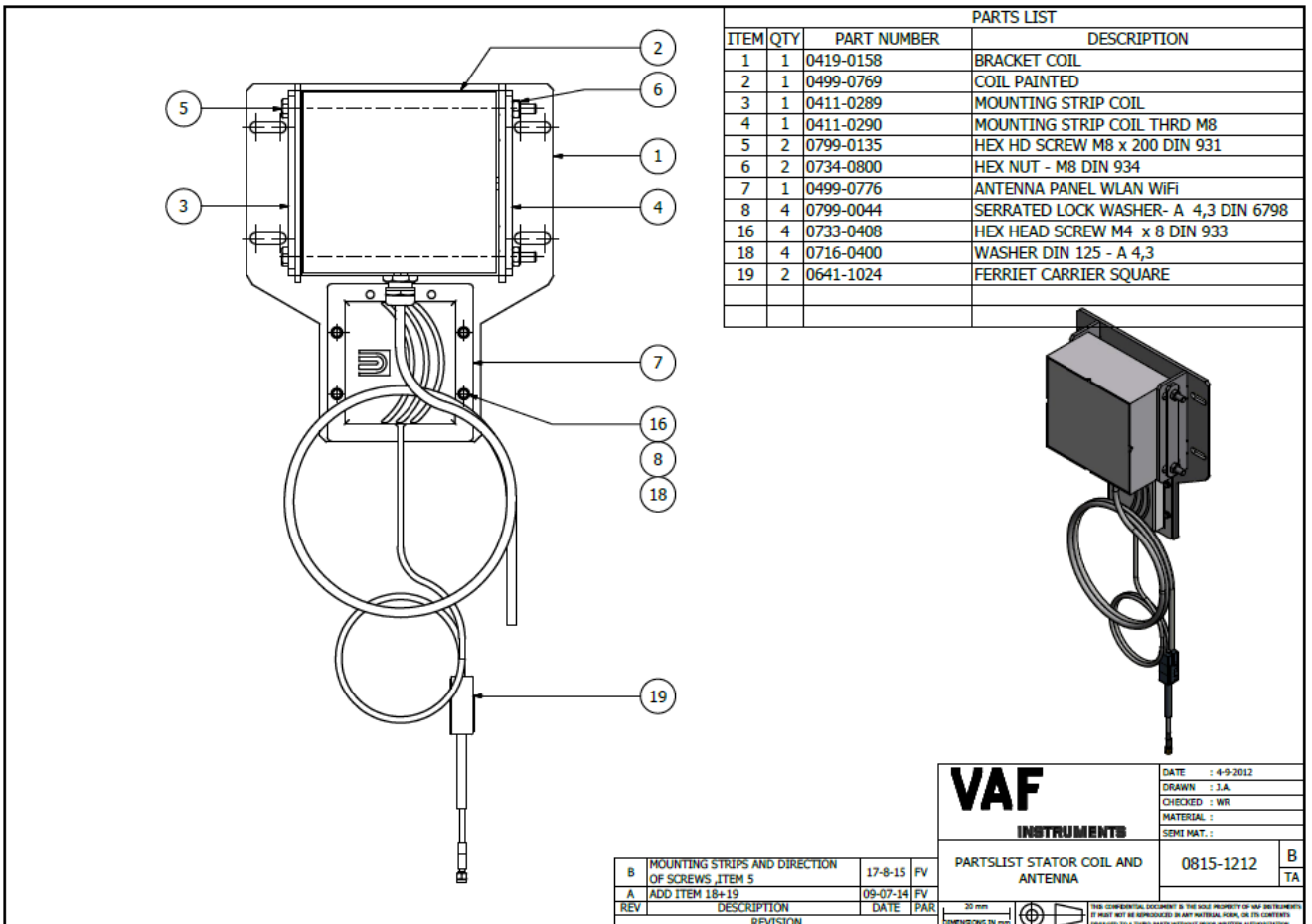
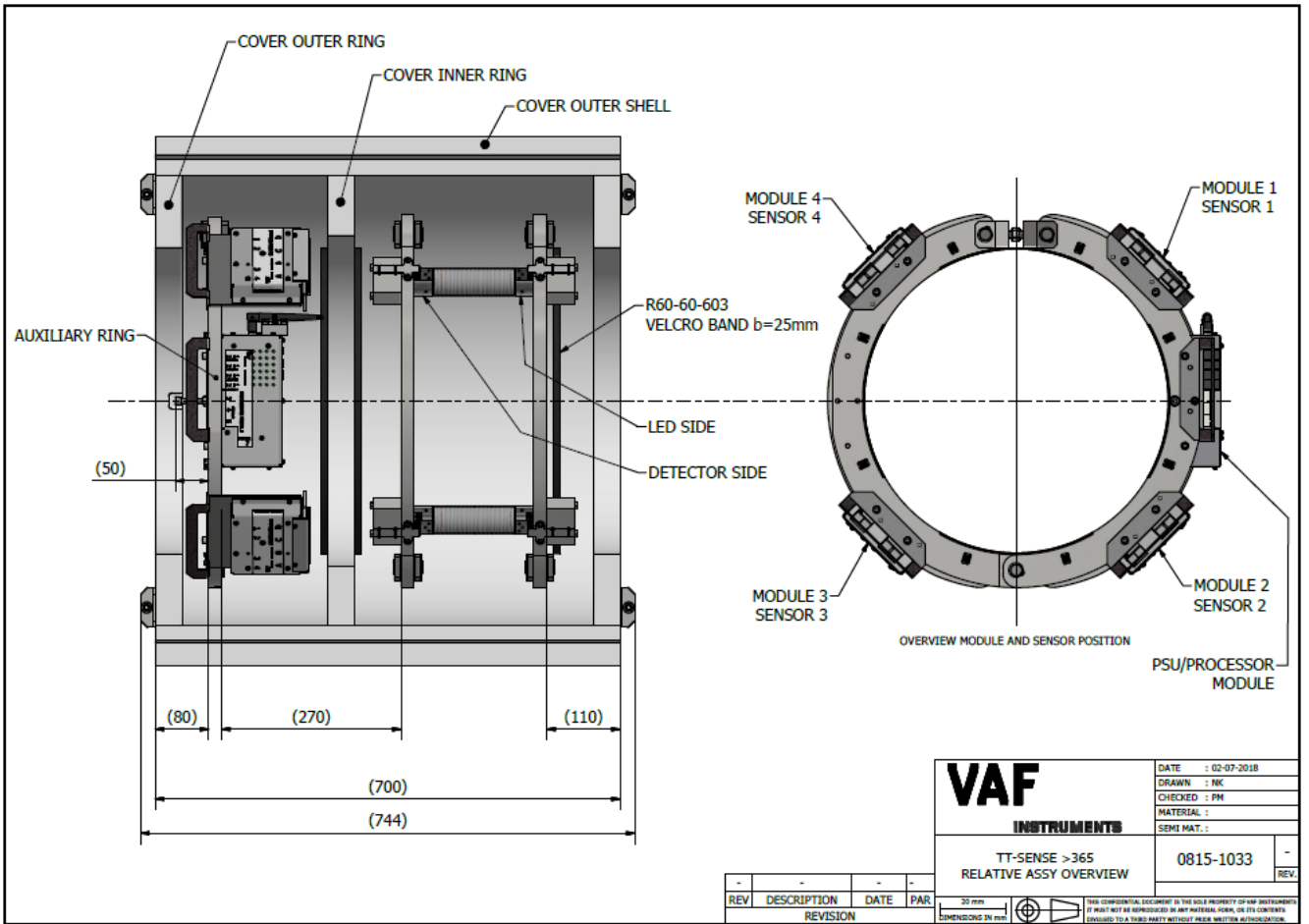


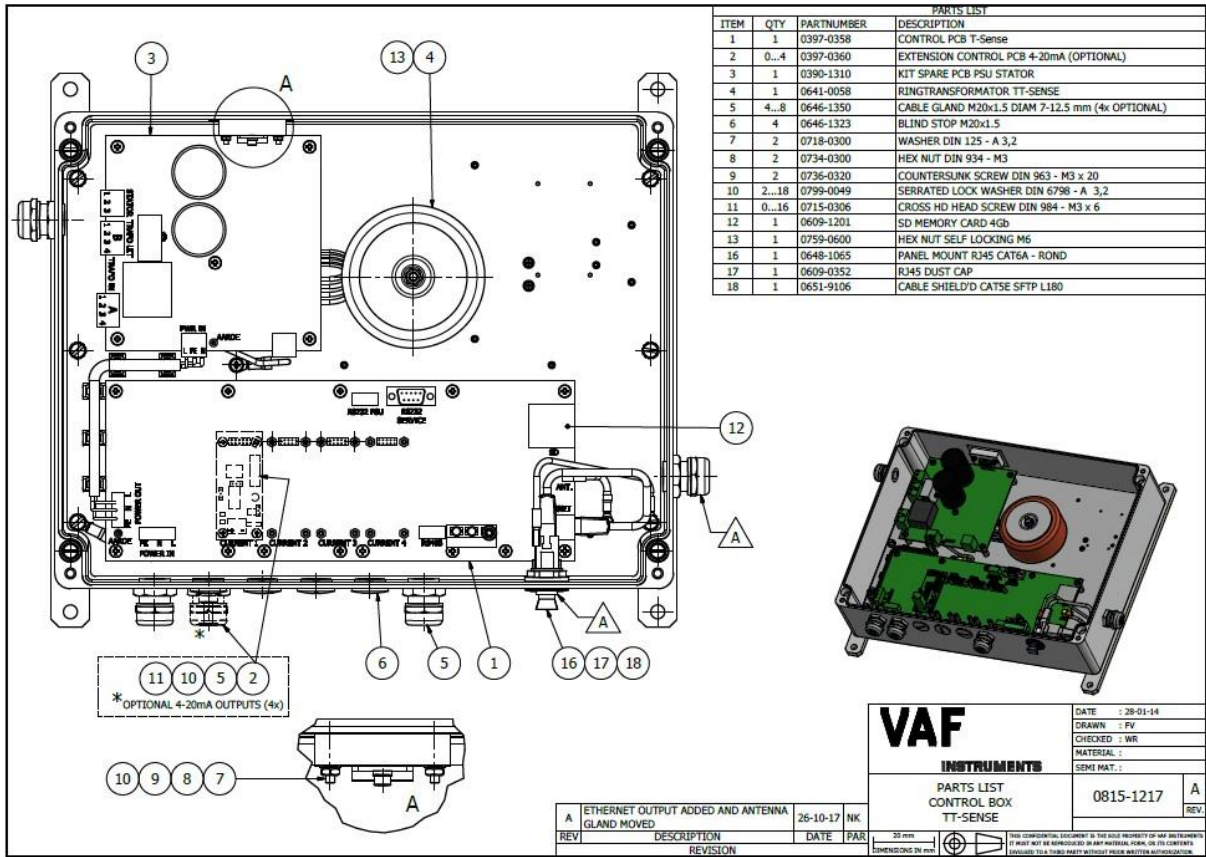
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3	1	0415-0119	FORKJOINT M12-RH_T-SENSE HDY
4	2	0436-0124	PIN SPANNER T-SENSE HDY
5	3	0722-0018	RETAINING RING 18 x 1.2 - DIN 471
6	1	0461-0029	CONN_BOLT M12 RH&LH SW17_T-SENSE HDY
15	1	0476-3XXX-03	TT-SENSE Mk1.5 - 365 MIN - AUXILIARY RING UPPER HALF
16	1	0476-3XXX-05	TT-SENSE Mk1.5 - 365 MIN - AUXILIARY RING LOWER HALF
17	1	0436-0126	PIVOT PIN TT HDY
18	4	0646-6034	CABLE TIE MOUNT TM2S8-C
19	4	0715-0410	CROSS RECESS.PAN HD.SCR. M4 x10 DIN7985
20	1	0728-0855	HEX SOCK CAP SCR.M 8 x 55 DIN 912
21	1	0799-0048	SERR.LOCK WASHER A8,4 DIN 6798 RVS A2
22	1	0734-0800	HEX NUT M8 DIN 934
23	3	0419-0186	BRACKET CABLE SUPPORT TT-SENSE
24	3	0728-0630	HEX SOCK CAP SCR.M 6 x 30 DIN 912
25	4	0728-0635	HEX SOCK CAP SCR.M 6 x 35 DIN 912
26	7	0799-0047	SERR.LOCK WASHER A6,4 DIN6798 RVS A2
27	1	0379-0411	DATA PROC MODULE TT-SENSE
28	2	0410-0385	SENSOR BRACKET TT_welded
29	4	0609-0333	PRESS NUT M6 Kh=1.8
30	4	0379-0186	ROTOR SENSOR MODULE-02
31	2	0410-0363	PLATE DUAL SENSOR MODULE
32	2	0410-0364	ANGLE BRACKET DUAL SENSOR MODULE
33	2	R60-60-602	RUBBER U-PROFIEL 3-1-5-5-2 - L=110
34	12	0736-0308	SL_CSK HD SCREW M 3 X 8 DIN 963
35	8	0728-0310	HEX SOCK CAP SCR.M 3 x 10 DIN 912
36	4	0715-0306	CROSS RECESS PAN HD SCREW M3x6 DIN 7985
37	8	0734-0300	HEX NUT M3 DIN934
38	20	0799-0049	SERR. LOCK WASHER DIN 6798 - A 3,2_ RVS

<b>VAF</b>		DATE : 29-05-2018
INSTRUMENTS		DRAWN : NK
TT-SENSE <365 ASSY + PARTSLIST AUXILIARY RING		CHECKED : PM
		MATERIAL :
		SEMI MAT. :
		0815-1029
		REV. -
		SHEET 2 OF 2



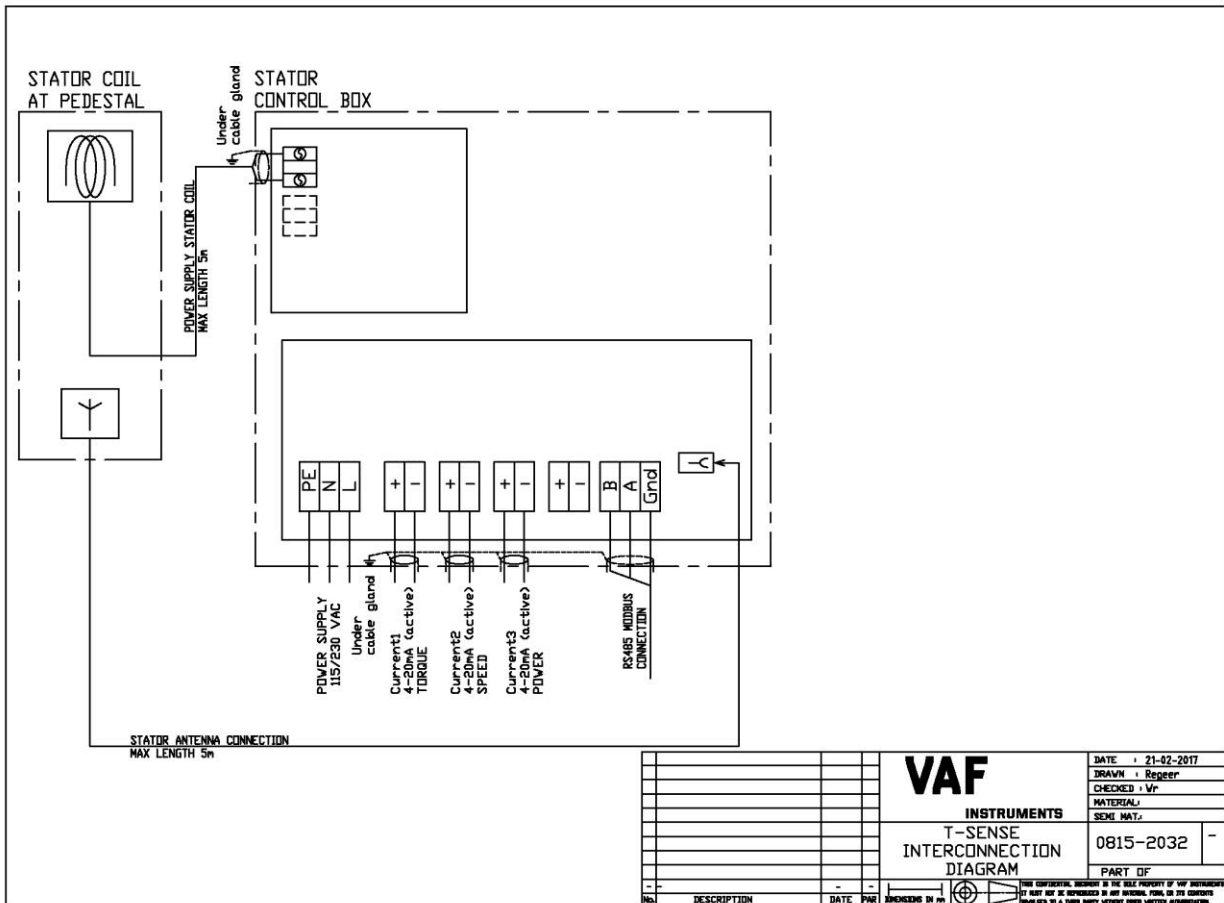






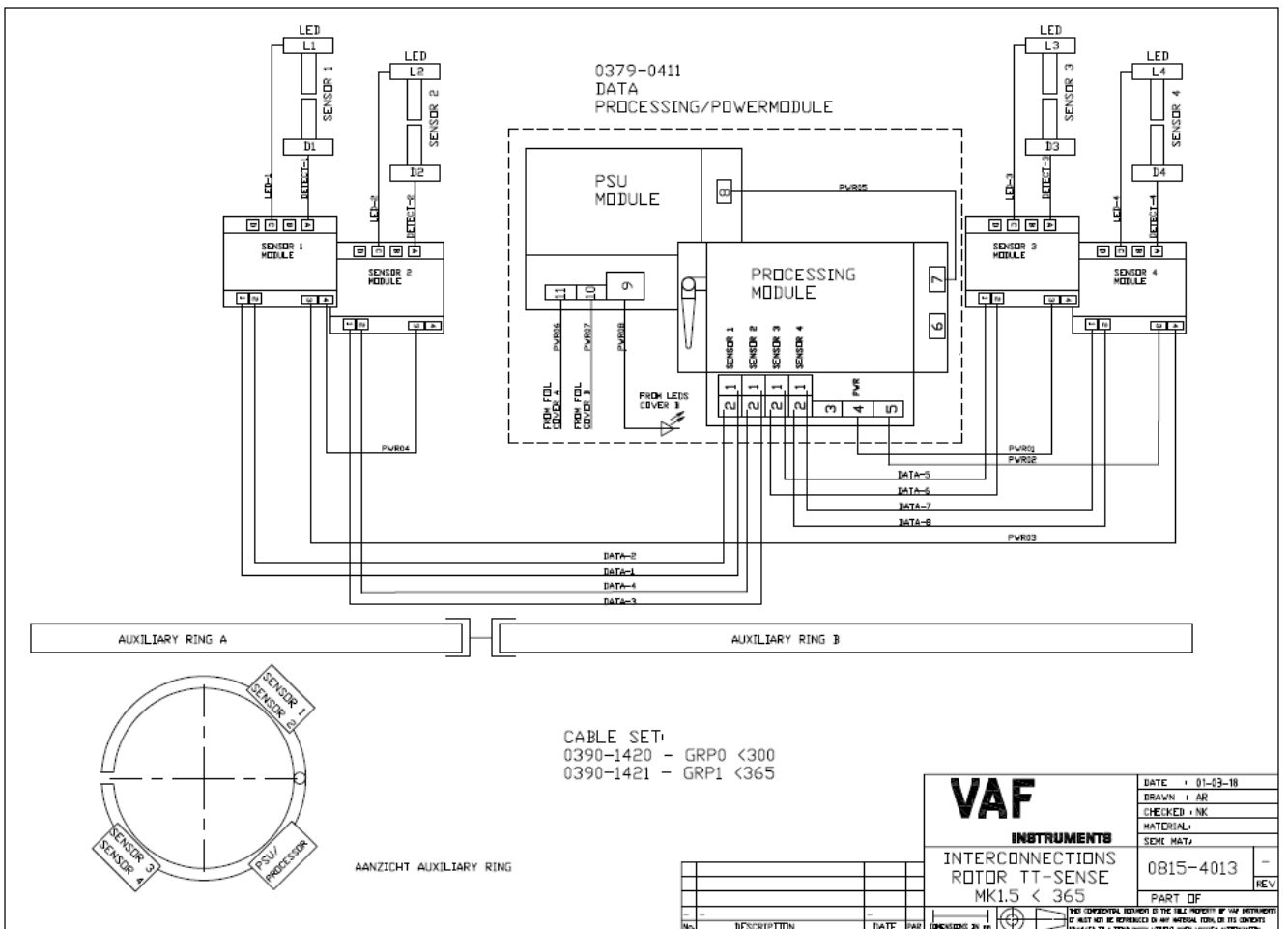
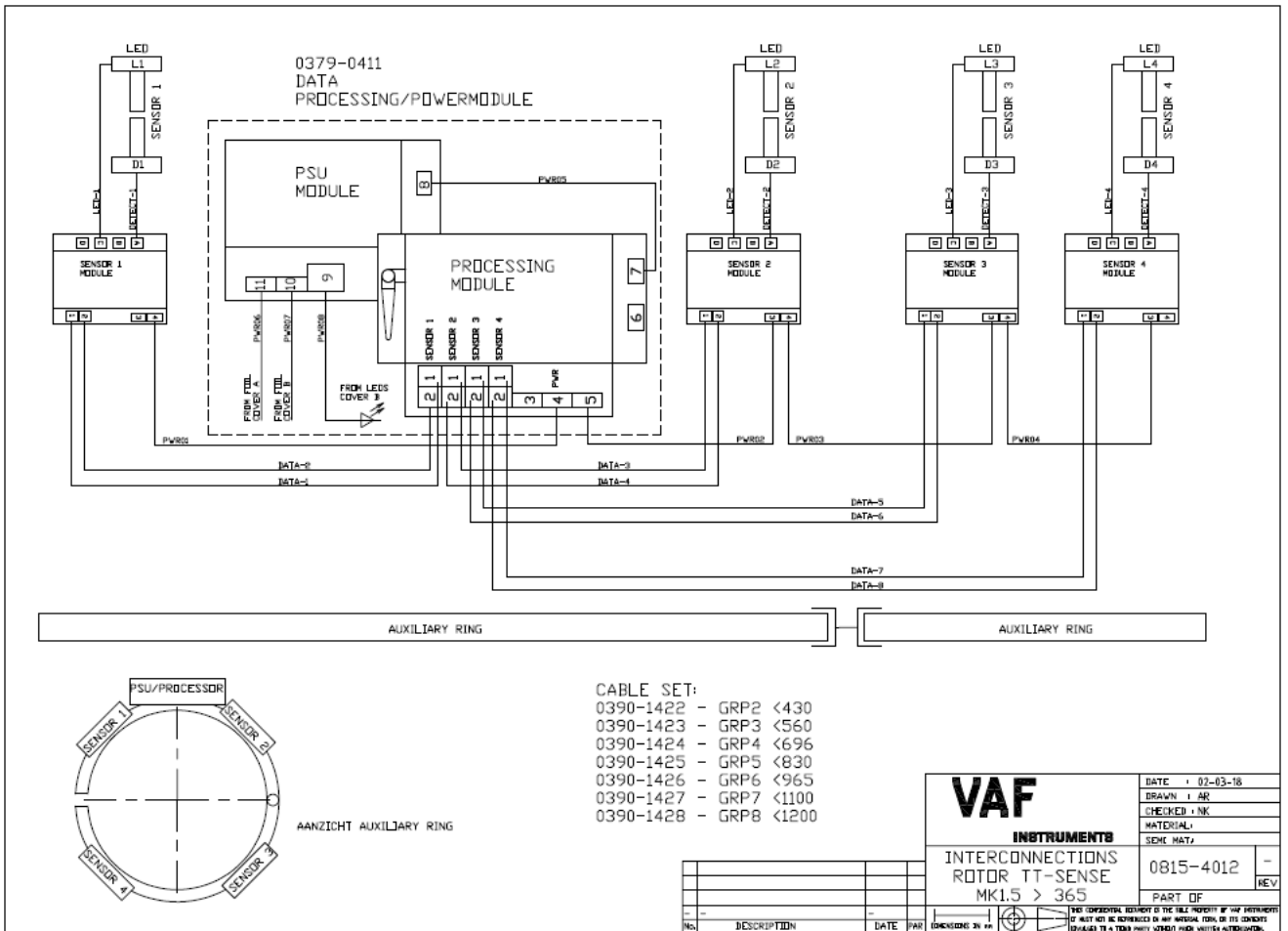
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		A
		REV.

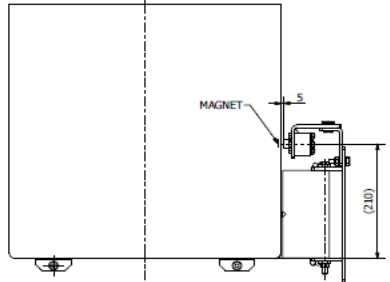
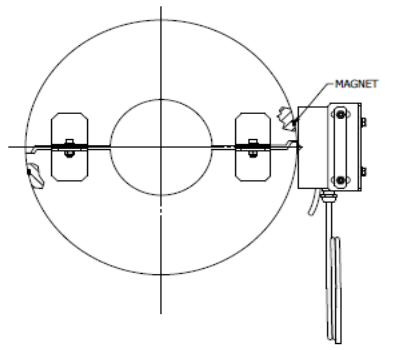
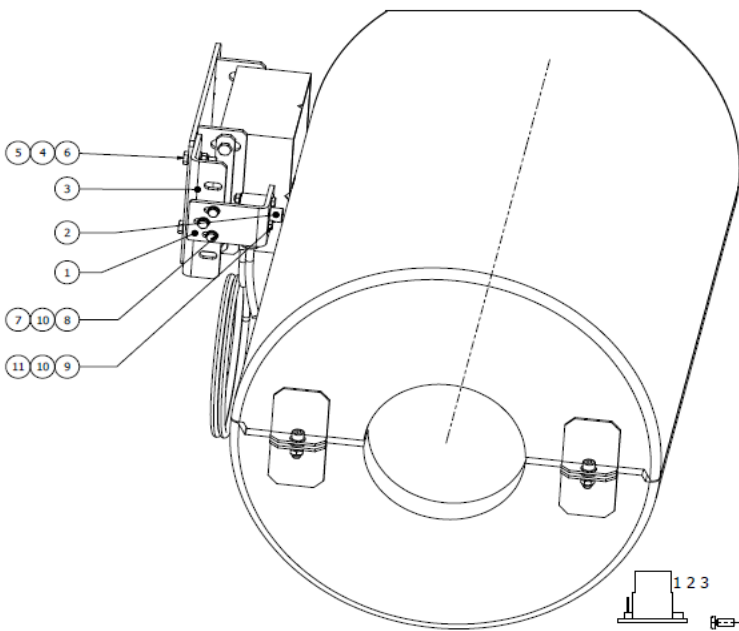
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REV	DESCRIPTION	DATE	PAR
	REVISION		



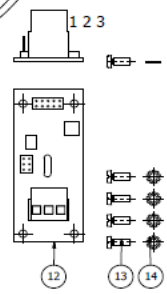
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INTERCONNECTION		MATERIAL :
DIAGRAM		SEMI MAT. :
		0815-2032
		PART OF

REV	DESCRIPTION	DATE	PAR





0390-1404 KIT RPM SENSOR HSP		
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2	1	0308-0070 ASSY RPM SENSOR T&TT-SENSE
3	1	0419-0182 BRACKET STATOR RPM T-SENSE HSP
4	4	1716-0800 WASHER A6,4 DIN125
5	2	0759-0800 HEX NUT SELF LOCKING M8 DIN 982
6	2	0733-0830 HEX HD BOLT M8x30 DIN 933
7	3	0716-0600 WASHER A 6,4 DIN 125
8	3	0733-0616 HEX HEAD BOLT M6x16 DIN 933
9	3	0732-0640 HEX HEAD BOLT M6x40 DIN 931-1
10	6	0799-0047 SERR. LOCK WASHER A 6,4 DIN 6798
11	3	0734-0600 HEX NUT M6 DIN 934
12	1	0397-1409 PCB RPM COUNTER T-SENSE
13	4	0708-0306 CH HD SCREW M3x6 DIN84
14	4	0799-0049 SERR. LOCK WASHER A3,2 DIN 6798



**VAF** DATE: 14-02-2017  
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 CHECKED: B&B  
 MATERIAL:  
 SERVO MNT:  
**ASSY HSP TT-SENSE WITH RPM SENSOR** 0815-8005  
 REF.

REV	DESCRIPTION	DATE	PAK

## 18. ABBREVIATIONS

ANSI	American National Standards Institute
AWG	American Wire Gauge
dia	Diameter
DIN	Deutsches Institut für Normung
DN	Diameter Nominal
EEPROM	Electrically Erasable Programmable Read-Only Memory
EPROM	Erasable Programmable Read-Only Memory
Hz	Hertz (Frequency)
IEC	International Electrotechnical Commission
IOM	Installation, Operation and Maintenance
JIS	Japanese Industrial Standard
Kg	Kilograms
LED	Light Emitting Diode
PAL	Programmable Array Logic
PT100	Temperature Sensor
RAM	Random Access Memory
RH	Relative Humidity
VAC	Volt Alternating Current
°C	Degrees Centigrade
Nm	Newton meter



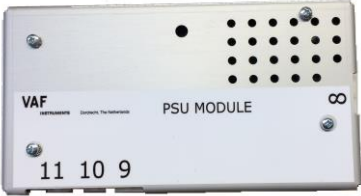

## 19. PARTS LISTS







### 19.1 ROTOR PART

For available rotor parts please see drawings of Chapter 17. Please be aware of the diameter of the shaft, depending of the situation.

### 19.2 AVAILABLE SPARE PARTS FOR STATOR AND ROTOR PART


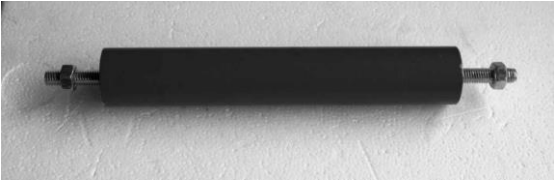
When ordering, specify the part number as mentioned below, as well as serial number of the TT-Sense® thrust & torque measurement system

Item	Part number	Qty.	Part name
	0390-1444 (PCB incl. Alu. box)	1	Sensor PCB (Rotor)
	0379-0189 (PCB incl. Alu. box)	1	Processing PCB (Rotor)
	0379-0191 (PCB incl. Alu. box)	1	PSU Rotor PCB (Rotor)
	0397-0358	1	Control PCB (Control box)

	0390-1407	1	Stator PCB (Control box) Including heat sink compound and insulation kit
	0390-1362	1	Assy Compensator arms TT-Sense including SD card to update stator control box settings.
<p><b>Only applicable if analogue output signals are available</b></p> 	0397-0360	1 to 4	4-20 mA Output control PCB
	0647-2019	2	Fuse at stator PCB, 1600 mA, 250 V slow
	0647-2020	1	Fuse at stator PCB, 2500 mA, 250 V slow
	0609-0351	1	Sealant

### 19.3 TRANSPORT/MOUNTING TOOLS

Be aware that these tools should be securely stored in the spare parts box. These tools are needed when the sensor is removed and re-assembled. The mounting plate is dedicated for this specific sensor.

		1	Mounting plate/ Connecting rod detector arms
		6	Temporary spacer TT- Sense

### 19.4 INSTALLATION TOOLS



Please note that following standard tools are needed for installation:

- Torque wrench (5-50 Nm) with rectangular open end fitting 17 mm
- Torque ratchet spanner (2-20 Nm) with 5 mm hex bit / set of allen keys
- Cir clip pliers for retaining rings
- Degreasing detergent, free from acid. E.g. white spirit, mineral spirit, mineral turpentine, etc.

## 20. WARRANTY CONDITIONS

1. Without prejudice to the restrictions stated hereinafter, the contractor guarantees both the soundness of the product delivered by him and the quality of the material used and/or delivered for it, insofar as this concerns faults in the product delivered which do not become apparent during inspection or transfer test, which the principal shall demonstrate to have arisen within 12 months from delivery in accordance with subarticle 1A exclusively or predominantly as a direct consequence of unsoundness of the construction used by the contractor or as a consequence of faulty finishing or the use of poor materials.
  - 1A. The product shall be deemed to have been delivered when it is ready for inspection (if inspection at the premises of the contractor has been agreed) and otherwise when it is ready for shipment.
2. Articles 1 and 1a shall equally apply to faults which do not become apparent during inspection or transfer test which are caused exclusively or predominantly by unsound assembly/installation by the contractor. If assembly/installation is carried out by the contractor, the guarantee period intended in article 1 shall last 12 months from the day on which assembly/installation is completed by the contractor, with the understanding that in this case the guarantee period shall end not later than 18 months after delivery in accordance with the terms of subarticle 1A.
3. Defects covered by the guarantee intended under articles 1, 1a and 2 shall be remedied by the contractor by repair or replacement of the faulty component either on or off the premises of the contractor, or by shipment of a replacement component, this remaining at the discretion of the contractor. Subarticle 3A shall equally apply if repair or replacement takes place at the site where the product has been assembled/installed. All costs accruing above the single obligation described in the first sentence, such as are not restricted to shipment costs, travelling and accommodation costs or disassembly or assembly costs insofar as they are not covered by the agreement, shall be paid by the principal.
  - 3A. If repair or replacement takes place at the site where the product has been assembled/installed, the principal shall ensure, at his own expense and risk, that:
    - a. the employees of the contractor shall be able to commence their work as soon as they have arrived at the erection site and continue to do so during normal working hours, and moreover, if the contractor deems it necessary, outside the normal working hours, with the proviso that the contractor informs the principal of this in good time;
    - b. suitable accommodation and/or all facilities required in accordance with government regulations, the agreement and common usage, shall be available for the employees of the contractor;
    - c. the access roads to the erection site shall be suitable for the transport required;
    - d. the allocated site shall be suitable for storage and assembly;
    - e. the necessary lockable storage sites for materials, tools and other goods shall be available;
    - f. the necessary and usual auxiliary workmen, auxiliary machines, auxiliary tools, materials and working materials (including process liquids, oils and greases, cleaning and other minor materials, gas, water, electricity, steam, compressed air, heating, lighting, etc.) and the measurement and testing equipment usual for in the business operations of the principal, shall be available at the correct place and at the disposal of the contractor at the correct time and without charge;
    - g. all necessary safety and precautionary measures shall have been taken and adhered to, and all measures shall have been taken and adhered to necessary to observe the applicable government regulations in the context of assembly/installation;
    - h. the products shipped shall be available at the correct site at the commencement of and during assembly.

4. Defects not covered by the guarantee are those which occur partially or wholly as a result of:
  - A. non-observance of the operation and maintenance instructions or other than foreseeable normal usage;
  - B. normal wear and tear;
  - C. assembly/installation by third parties, including the principal;
  - D. the application of any government regulation regarding the nature or quality of the material used;
  - E. materials or goods used in consultation with the principal;
  - F. materials or goods provided by the principal to the contractor for processing;
  - G. materials, goods, working methods and constructions insofar as are applied at the express instruction of the principal, and materials or goods supplied by or on behalf of the principal.
  - H. components obtained from third parties by the contractor insofar as that party has given no guarantee to the contractor.
5. If the principal fails to fulfil any obligation properly or on time ensuing from the agreement concluded between the principal and the contractor or any agreement connected to it, the contractor shall not be bound by any of these agreements to any guarantee regardless of how it is referred to. If, without previous written approval from the contractor, the principal commences disassembly, repair or other work on the product or allows it to be commenced, then every agreement with regard to guarantee shall be void
6. Claims regarding defects must be submitted in writing as quickly as possible and not later than 14 days after the discovery of such. All claims against the contractor regarding faults shall be void if this term is exceeded. Claims pertaining to the guarantee must be submitted within one year of the valid complaint on penalty of invalidity.
7. If the contractor replaces components/products under the terms of his guarantee obligations, the replaced components/products shall become the property of the contractor.
8. Unless otherwise agreed, a guarantee on repair or overhaul work carried out by the contractor or other services shall only be given on the correctness of the manner in which the commissioned work is carried out, this for a period of 6 months. This guarantee only covers the single obligation of the contractor to carry out the work concerned once again in the event of unsound work. In this case, subarticle 3A shall apply equally.
9. No guarantee shall be given regarded the inspection conducted, advice given and similar matters.
10. Alleged failure to comply with his guarantee commitments on the part of the contractor shall not absolve the principal from his obligations ensuing from any agreement concluded with the contractor.
11. No guarantee shall be given on products which form a part of, or on work and services on, goods older than 8 years.

Initial release off TT-Sense 1.5 (based on TIB-664 0418)

Revision 0319

Chapter 6.2 Step 1 and 2 cleaning instructions added

Chapter 17 Drawing 0815-1016 added

Chapter 19.3 Degreasing detergent added

Revision 0619

Chapter 6.2 Step 15 silicone sealant of covers added

Chapter 19.2 Spare part sealant added

Revision 0819

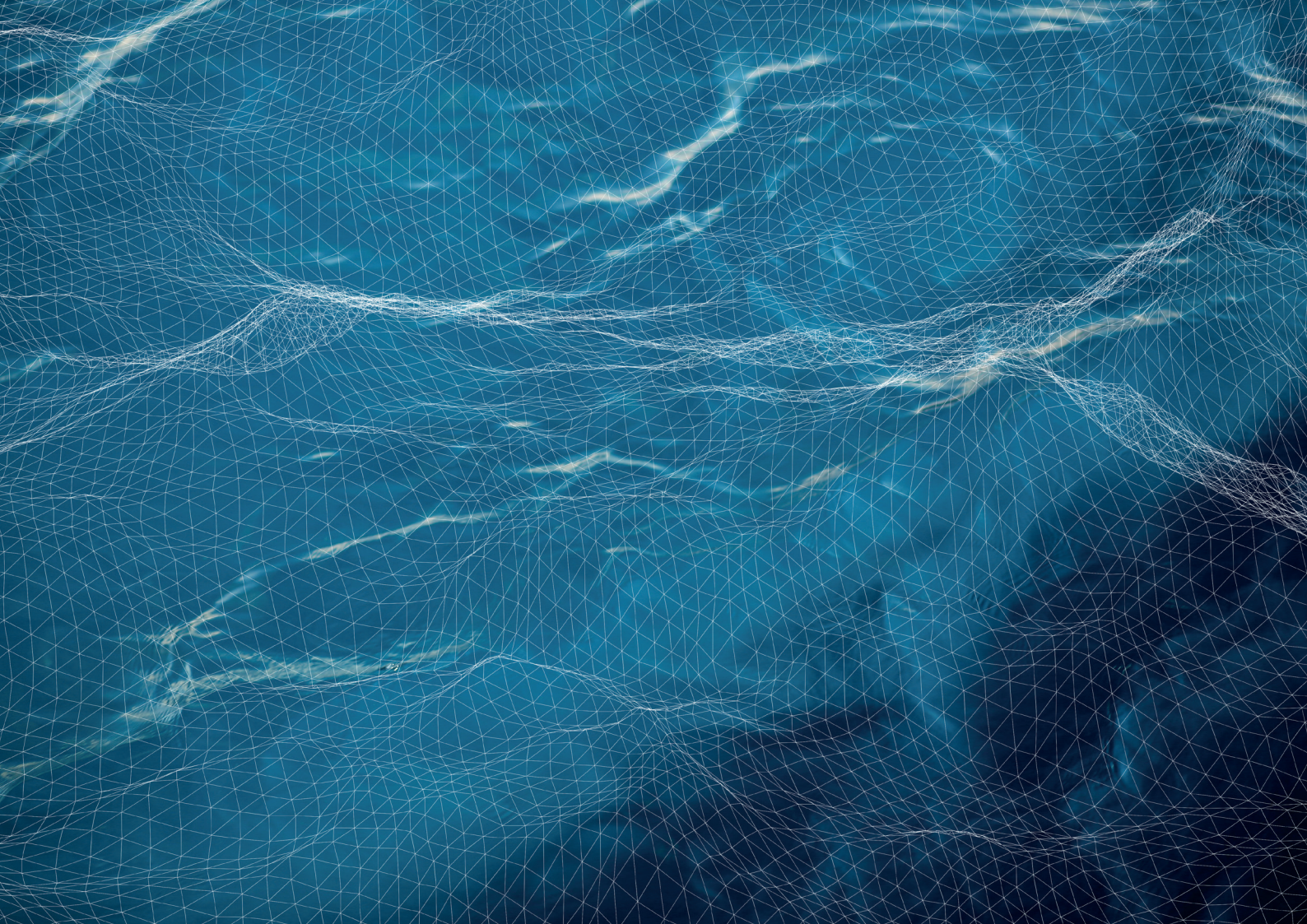
Chapter 17: drawing 0815-2035 replaced by 0815-2032

Revision 0220

Chapter 6: Note and drawing regarding heat and cooling sources added

Revision 0320

Chapter 8 adjusted



# VAF

## INSTRUMENTS

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