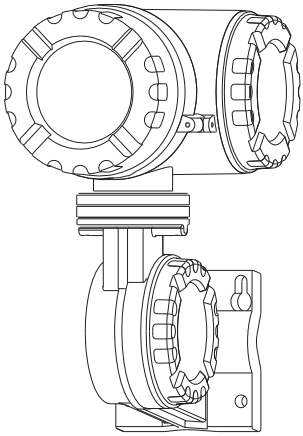
KA01070F/00/EN/15.15
71307019

Valid as of software version:
V02.04.zz

Brief Operating Instructions
Tank Side Monitor NRF590

Inventory Control



These Instructions are Brief Operating Instructions; they do not replace the Operating Instructions included in the scope of supply.

For detailed information, refer to the Operating Instructions and other documentation on the CD-ROM provided or visit "www.endress.com/deviceviewer".

Endress+Hauser
People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

The Tank Side Monitor NRF590 is a monitoring unit for use with the Endress+Hauser Micropilot M and Micropilot S-series radars and other HART compatible instruments. Mounted at the tank side, the NRF590 provides indication of measured data, allows configuration and supplies intrinsically safe (i.s.) power to the connected sensors on the tank. Various industry standard digital gauging communication protocols support integration into open architecture tank gauging and inventory systems.

1.2 Installation, commissioning and operation

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility.
- Personnel must absolutely and without fail read and understand this brief operating instruction before carrying out its instructions.
- The instrument may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this Manual and the supplied operating instruction are to be observed without fail.
- The installer has to make sure that the measuring system is correctly wired according to the wiring diagrams. The measuring system is to be grounded.
- Please observe all provisions valid for your country and pertaining to the opening and repairing of electrical devices.

1.3 Operational safety and process safety

- Alternative monitoring measures must be taken to ensure operational safety and process safety during confiugration, testing and maintenance work on the instrument.
- The instrument is safely built and tested according to state-of-the-art technology and has left the factory in perfect condition as regards technical safety. The applicable regulations and European standards have been taken into account.
- Pay particular attention to the technical data on the nameplate.
- If the instrument is to be installed in an explosion hazardous area, then the specifications in the certificate as well as all national and local regulations must be observed. The instrument is accompanied by separate "Ex documentation", which is an integral part of this Operating Instructions. The installation regulations, connection values and Safety Instructions listed in this Ex document must be observed. The documentation number of the related Safety Instructions is also indicated.

1.3.1 FCC-approval

This instrument complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This instrument may not cause harmful interference, and
2. this instrument must accept any interference received, including interference that may cause undesired operation.

Caution!

Changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

1.4 Return

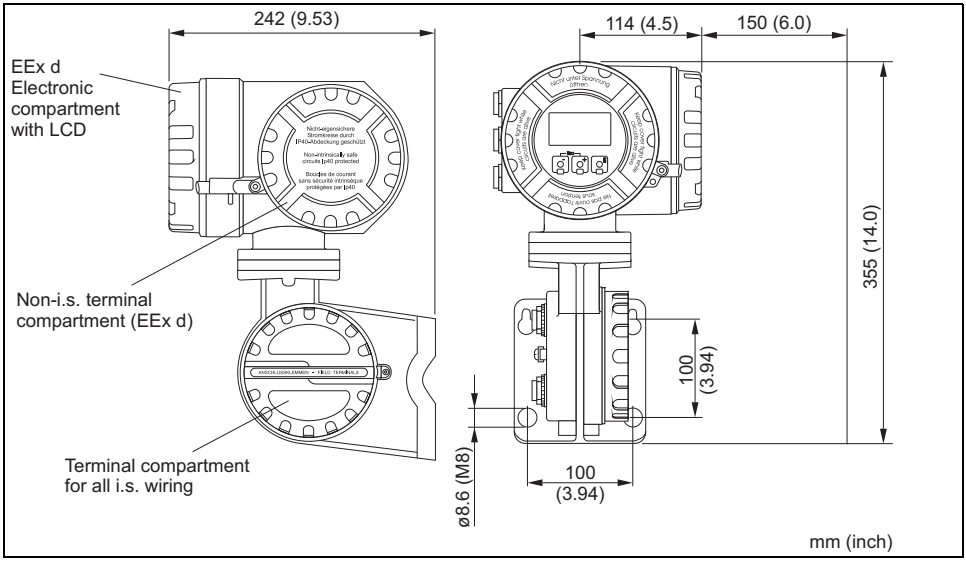
Follow the instructions on returning the instrument as outlined in the Operating Instructions on the CD-ROM provided.

1.5 Safety icons

Safety conventions	
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument.
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.
Explosion protection	
	**Instrument certified for use in explosion hazardous area** If the instrument has this symbol embossed on its name plate it can be installed in an explosion hazardous area.
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Instruments located in and wiring entering areas with the designation “explosion hazardous areas” must conform with the stated type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Instruments located in safe areas still require a certificate if their outputs run into explosion hazardous areas

2 Mounting

2.1 Design, dimensions



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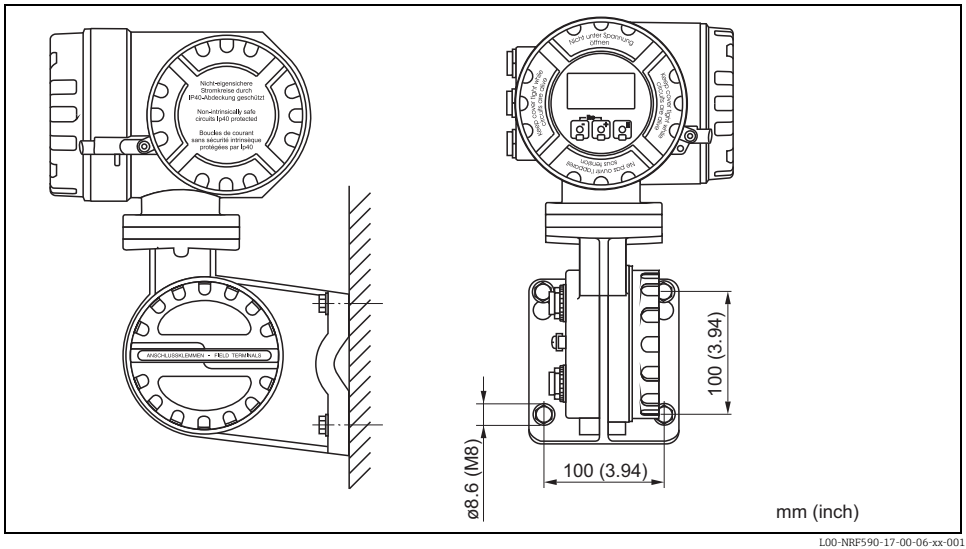
2.2 Installation variants

2.2.1 Mounting kit

You need the following tools:
- 3 mm (7/64") Allen wrench for loosening and tightening the locking screw.
- 4 mm (0.16 in) Allen wrench for turning the housing.

2.2.2 Wall mounting



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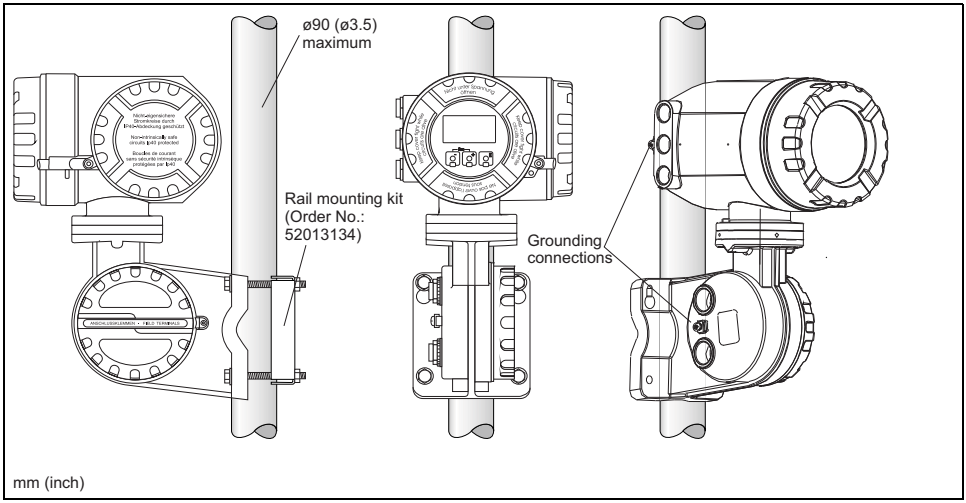
2.2.3 Mounting on vertical rail



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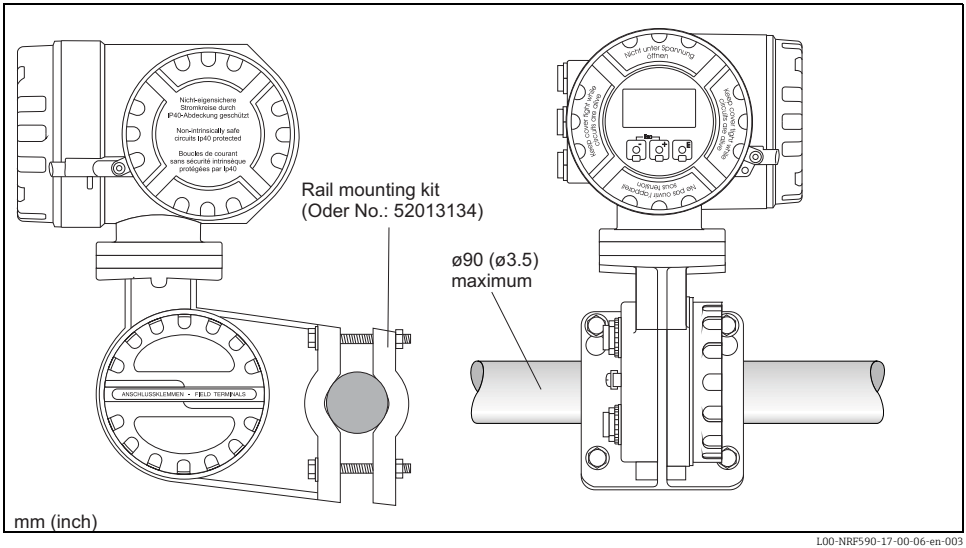
2.2.4 Mounting on horizontal rail



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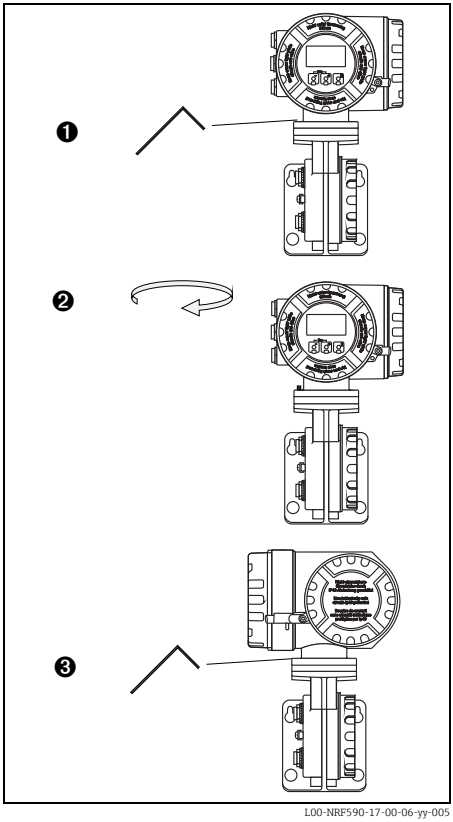
2.3 Turn housing

For easy access to the display or the terminal compartment, the upper part of the housing can be rotated into an arbitrary position. In order to do this, perform the following steps:

1. Loosen the alignment pin using a 4 mm (0.16 in) Allen key (approx. 5 turns).
2. Rotate the upper part of the housing to the desired position.
3. Tighten the pin securely.



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2.4 Rotating the display module

In order to facilitate operation and reading of the measuring value, the display module can be rotated in the following way:

⚠ Warning!
Danger from elctrical schock! Switch off power supply before opening the housing.

1. Using a 3 mm (7/64") Allen wrench, losen the safety pin for the display lid.
2. Unscrew the display lid.

   Note!
   If the display is difficult to unscrew, unplug one of the cables from the cable gland to allow air to enter the housing. Then, attempt once again to unscrew the display lid.

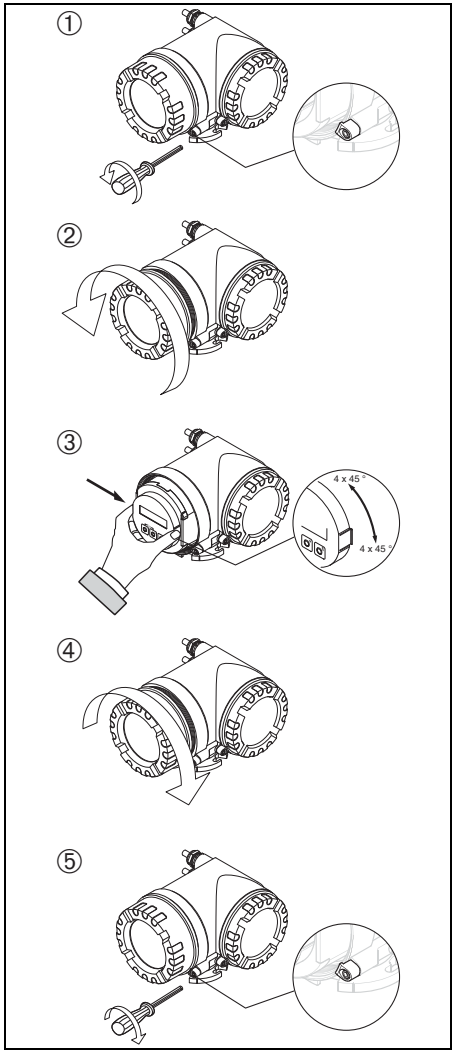
3. Push in the two flat areas on each side of the display module. Remove the Module from the holder, rotate it into the desired position and put it back onto the holder. Snap-in positions are located at an angle of 45° from each other.

   ⚠ Warning!
   The maximum angle of rotation is 180° in both directions (measured from the initial position).

4. Replace the display lid on the Tank Side Monitor housing.

   Note!
   Make sure to clean the threads of the lid to remove any dust or particles. Check that O-ring is in place and reapply anti-seize grease.

5. Adjust the safety pin so it is set over the display lid and tighten.



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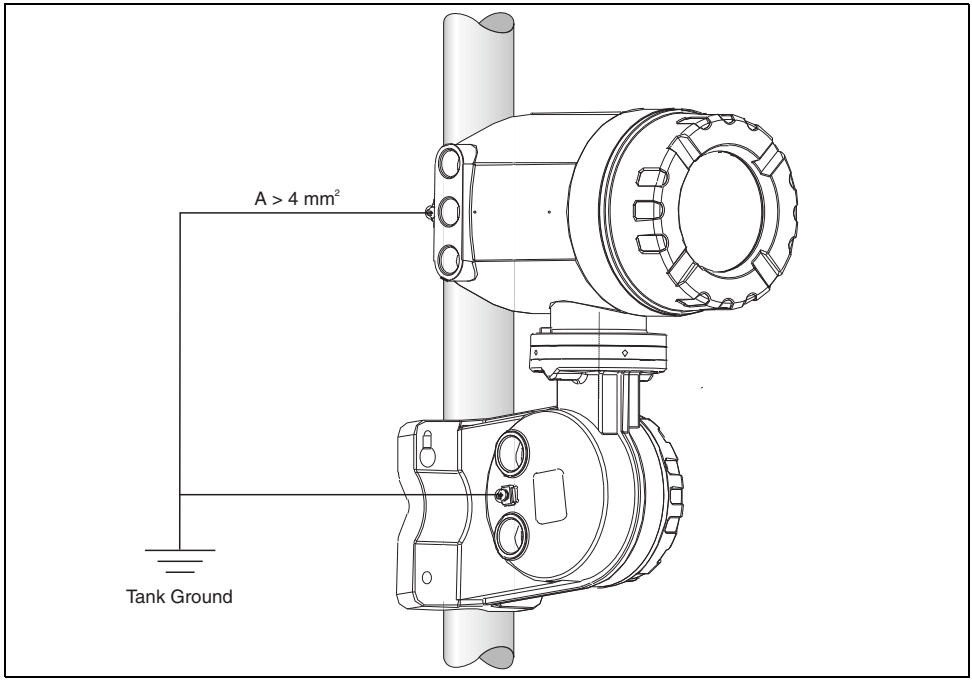
2.5 Grounding

The NRF590 must be grounded to the tank potential before communication and power connections are made. The connections ($A \geq 4mm^2$) from each outer ground plug of the NRF590 to the tank ground must be made before any other wiring connections are made. All grounding must be compliant with local and company regulations and checked before the equipment is commissioned.



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2.6 Post-installation check

After the Tank Side Monitor has been installed, perform the following checks:
- Is the measuring instrument damaged (visual check)?
- Have the mounting bolts been tightend securely?
- Are both grounding terminals connected to tank ground?

3 Wiring

3.1 Wiring the Non-IS (Ex d) connections

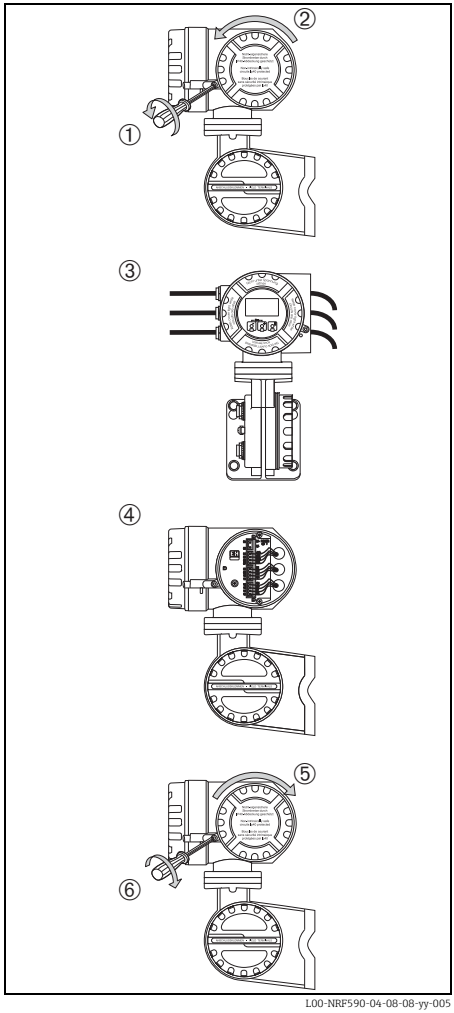
3.1.1 The procedure

Caution!
Before starting the wiring procedure, make sure that the supply voltage is switched off.

1. Using a 3mm (7/64") Allen wrench, losen the safety pin for the lid.
2. Unscrew the lid of the terminal compartment.
3. Push the power and signal cables through the appropriate cable glands.
4. Wire up according to the terminal assignment diagram.
5. Screw the lid of the terminal compartment securely back onto the transmitter housing.

   Note!
   Make sure to clean the threads of the lid to remove any dust or particles. Check that O-ring is in place and reapply anti-seize grease.

6. Adjust the safety pin so it is set over the display lid and tighten.



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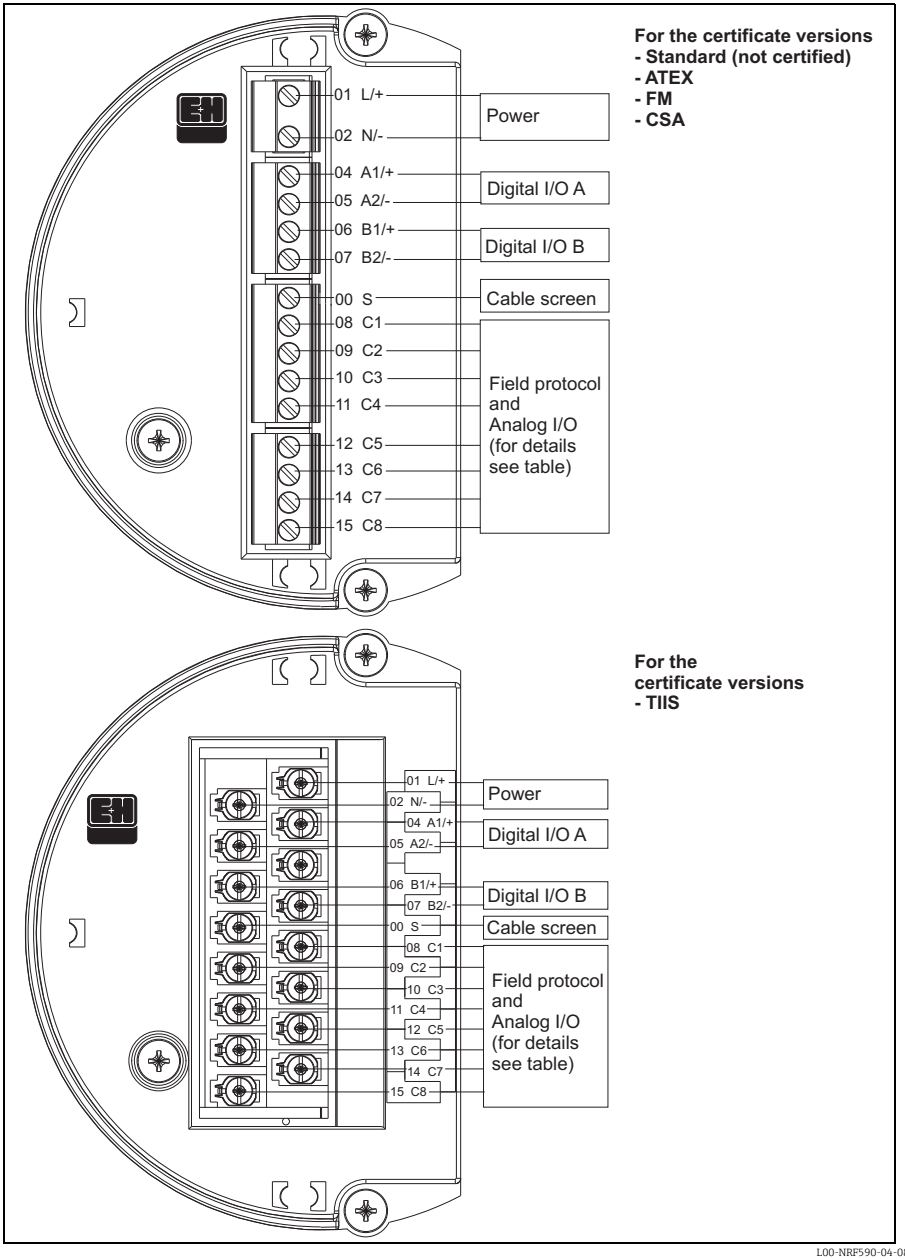
3.1.2 Terminal assignment of the field protocol/host side



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Terminal	01 L/+	02 N/-	04 A1/+	05 A2/-	06 B1/+	07 B2/-	00 S
	Power supply		Discrete I/O A +	Discrete I/O A -	Discrete I/O B +	Discrete I/O B -	Cable screen

	08 C1	09 C2	10 C3	11 C4	12 C5	13 C6	14 C7	15 C8
V1	4 to 20 mA output [1] #2	V1A	V1B	0 V	0 V	4 to 20 mA output #1 + HART	discrete output 1C	discrete output 2C
EIA-485 Modbus	not used [2]	485-B	485-A	0 V	0 V	4 to 20 mA output [3] + HART	4 to 20 mA input [3]	+ 24 V [1]
Whessoe WM550	4 to 20 mA output [1] #2	Loop 1-	Loop 1+	0 V	0 V	4 to 20 mA output #1 + HART	Loop 2-	Loop 2+
BPM	not used [2]	T	T	0 V	0 V	4 ..20 mA output + HART	4 to 20 mA input	+ 24 V [1]
Mark/Space	V+	Space	Mark	0 V (V-)	0 V	4 to 20 mA output + HART	4 to 20 mA input	+ 24 V [1]
L&J Tankway	Power	Encoder	Computer	Erde	0 V	4 to 20 mA output + HART	4 to 20 mA input	+ 24 V [1]
GPE	4 to 20 mA output [1] #2	Loop 1-	Loop 1+	0 V	0 V	4 to 20 mA output #1 + HART	not used	not used

1) In case an "Ex d" rated 4-wire level gauge version is used, the power supply can be obtained from these terminals (21V ±10%).

2) The internal voltage at this terminal is 0V, however, shielding and signal common should be connected to terminal 11 or 12.

3) option, s. pos. 20 of the product structure.

3.1.3 Connection of the field protocols

Sakura V1

The V1 protocol provides 2 wire communication allowing up to 10 instruments to operate on a loop. V1 connects to terminals 9-10.
Max. distance: 6000 m (19686 ft).

EIA-485 Modbus

The NRF590 protocol uses a shielded 3-wire EIA-485 hardware interface to communicate with the modbus master. EIA-485 is a high speed, differential communications network that allows up to 32 instruments to operate on one network.

- Using one shielded twisted pair of 18 AWG (0.75mm^2) wire, connect the EIA-485 at terminal 9 and 10.
- Termination of the EIA-485 bus at the NRF590 can be set in the operating menu (only enable on end instrument in a loop).
- Connect the 3rd wire from the control system signal common (0V) to terminal 11 or 12.
- Max distance: 1300 m (4265 ft).

Whessomatic WM550

The WM550 protocol provides 2 wire, current loop communication and allows up to 16 instruments per loop. For redundancy (safety function) two wire pairs are used. They always transmit the same values. The WM550-loops connect to terminals 9 - 10 and 14 - 15.
Max. distance: 7000 m (22967 ft).

BPM

The BPM protocol provides 2 wire communication allowing up to 10 instruments to operate on a loop. BPM connects to terminals 9-10.
Max. distance: 1000 m (3281 ft).

Mark / Space

For a NRF590 using the Mark/Space field communications option, the following additional wiring connections must be made:

- Run 2 twisted pairs (one power, one communication) of 18 AWG (0.75 mm^2) wire (Mark/Space wires) into the upper terminal compartment through one of the conduit entries along with the 48 Vdc power wiring.
- Connect the Mark line to terminal 10 and the Space line to terminal 9.
- Connect to power supply at terminals 8 and 11.

L&J Tankway

Including power and ground, L&J is a 4-wire system, allowing 50+ instruments to be connected on the communication bus. L&J connects to terminals 8 through 11.

GPE

The GPE protocol provides 2 wire current loop communication. GPE connects to terminal 9-10.

3.1.4 Grounding of the fieldbus screen

The screen of the fieldbus cable should be connected to ground at both ends. If this is not possible due to signal disruption by potential equalisation currents, it is advisable to connect the screen of the fieldbus cable to terminal "00 S" at the NRF590 and to ground at the other end. The "00S" terminal provides a 500V capacitor between the cable screen and tank ground potential.

3.1.5 Connection of the auxiliary energy

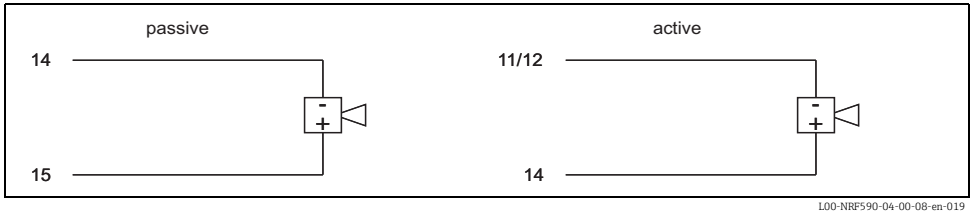
The Tank Side Monitor can be AC or DC supplied, depending on the installed power supply board. The AC supply needs to be connected to the terminals marked L/+ (Line) and N/- (Neutral), corresponding with the phase/line and neutral wire. DC supply can be connected to the same terminals, for which it is necessary to connect the positive (+) to the terminal marked (L/+), and the negative to the terminal marked (N/-).

Note!

When using the public power supply, install an easy accessible power switch in the proximity of the device. Mark the power switch as a disconnector for the device (IEC/EN 61010).

3.1.6 Connection of the non-i.s. 4 to 20 mA analogue input

Depending on the selected fieldbus communication board, a non-i.s. self-powered or loop powered analogue transmitter can be connected. The analogue signal for the loop powered transmitter can be connected to the terminals 14 (-) and 15 (+24 Vdc). The maximum supply current for the analogue transmitter is limited to 24 mA. The analog signal for a self powered transmitter should be connected to terminals 11 or 12 and 14.



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3.1.7 Connection of the non-i.s. 4 to 20mA analogue output

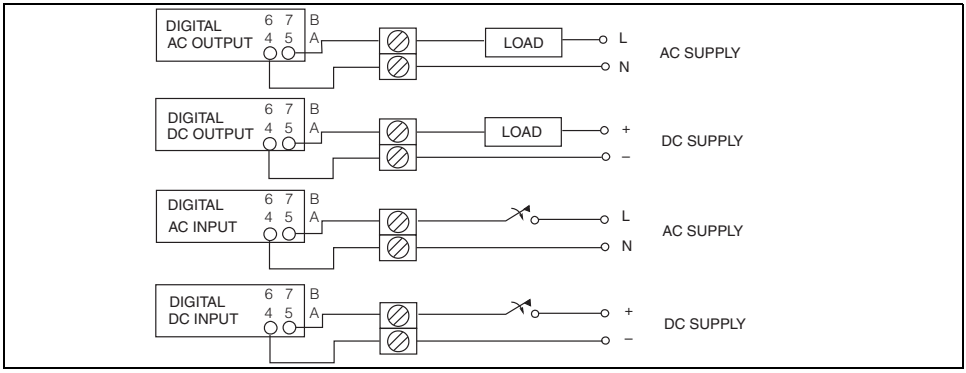
For all field communication boards except the Modbus Option without analog in/output, a non-i.s. 4 to 20mA output is available. Via Software settings, this analogue output can be connected to any parameter in the Tank Side Monitor. The analogue output is available between terminals 13 (+) and 12 (-). From SW 02.01.xx onwards, an additional HART signal is available at terminal 13.

3.1.8 Connection of the secondary non-i.s. 4 to 20 mA analogue output

For the V1, WM550 and GPE field protocol, a secondary analogue output is available at the terminals 8 (+) and 11 (0V). This output can also be used to power a FMR5xx radar.

3.1.9 Connection of the discrete in and output

The Tank Side Monitor can be equipped with up to 2 discrete I/O modules. These modules can be used for interfacing to non-i.s. discrete in- or outputs. Input and output voltage and current ranges depend on the type of selected module installed in the relevant I/O slot. Terminals 4 and 5 correspond to discrete I/O slot A, terminals 6 and 7 correspond to discrete I/O slot B. For details on available I/O modules see Operating Instruction BA00256F/00/EN on CD-ROM.



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Note! 250VAC is the maximum load that can be connected.

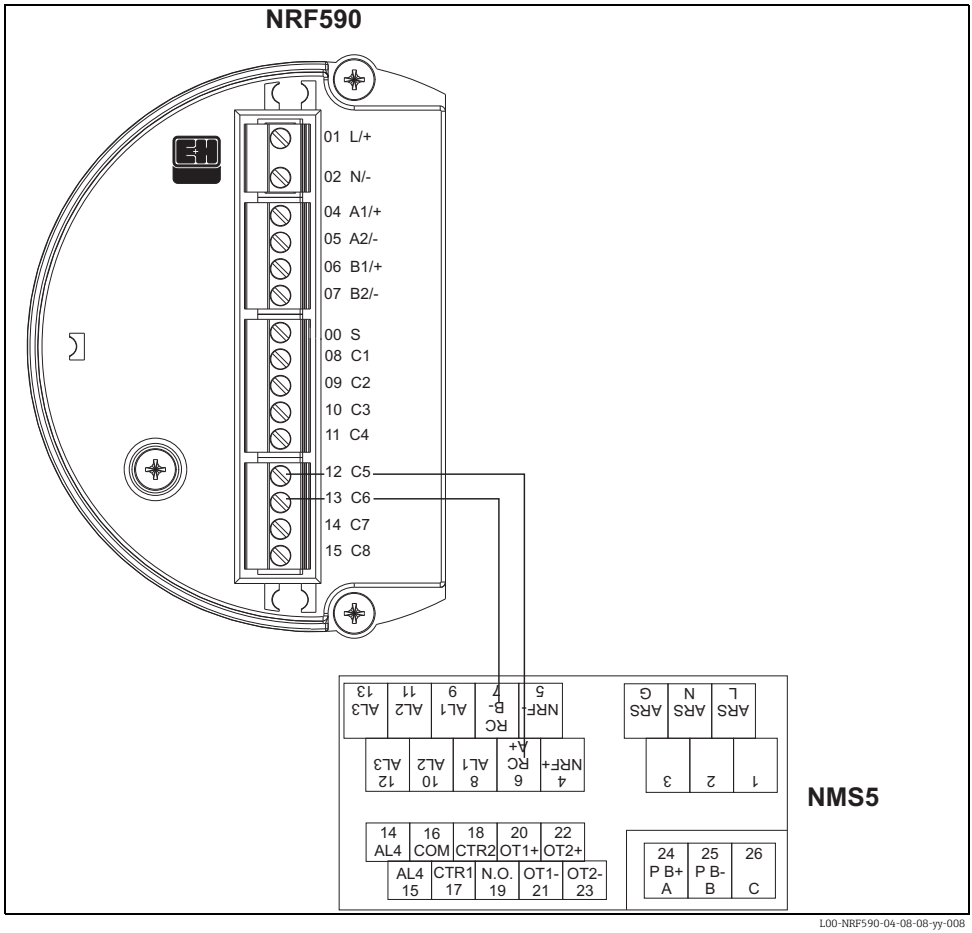
3.1.10 Connection of a Proservo NMS5 to the non-i.s. HART input

It is possible to connect Proservo NMS5 to the Tank Side Monitor NRF590 using the non-i.s. HART input available in the Exd terminal compartment.

Note!

- This is only possible if the NMS5 is equipped with a HART digital output (passive). The relevant order code must be: NMS5 - ***H********. ("H" meaning "HART passive").
- The Software Version must be: 04.24 or later.
- The Hardware Version must be: 4.00 or later.
- The Tank Side Monitor NRF590 software version must be V02.04 or later

The communication is "read only". This type of connection does not provide any parametrization or commanding capability from the Tank Side Monitor NRF590 to the Proservo NMS5.



Terminal at Tank Side Monitor NRF590	Terminal at Proservo NMS5
12 / C5	6 /RC / A+
16 / C6	7 / RC / B-

Note!

Optionally, a Prothermo NMT539 can be connected to the Proservo NMS5 at terminal 24 (+) and terminal 25 (-) (for reading temperature and water bottom).

The read-only parameters of the Proservo NMS5

Proservo NMS5		Tank Side Monitor NRF590	
Parameter name	**Parameter number**	**Parameter name**	**Parameter number (n: HART bus address)**
OperatinStatus	021	Op. Status	8n32
OperatingCommand	020	Op. Command	8n33
CustodyTransfer	271	Custody Mode	8n35
SoftwareVersion	029	Software Ver.	8n42
AccessCode	039	Access Code	8n31
DeviceStatus	036	Error Code	8n41
MatrixSelect	030	Matrix Select	8n45
New NMS Status	272	New NMS Status	8n36
WMTimeout	NA	W&M Timeout	8n46
Balancing	022	Balancing	8n34
MeasuredLevel	000	Displacer Pos	8n21
WaterBottom	014	Water Level	8n24
UpperDensity	005	Upper Density	8n23
LiquidTemperature	010	Liquid Temp	8n22
GasTemperature	013	Vapour Temp	8n26
SWVersion	275	Software Id	8n43
HWVersion	276	Hardware Id	8n44
LevelData	008	Liquid Level	8n27
BottomLevel	004	Bottom Level	8n25

Tank Side Monitor NRF590 settings

NRF590 settings to start communication with NMS5.

1. Go to the "Analog I/O" (7xxx) menu.
2. Go to "Analog Out" (73xx).
3. Go to the "HART Master" (735x) submenu.
4. Go to "Fixed current" (7351).
5. Set the fixed current to 26 mA (default setting).

3.2 Wiring the IS (Ex ia) connection

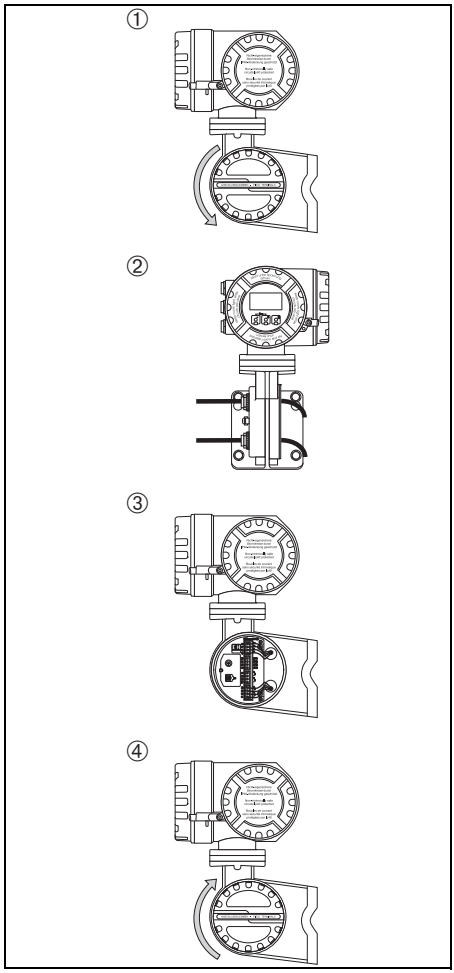
3.2.1 The procedure

Caution!
The diameter of the signal cable should allow tight closing of the cable glands. Example:
- Tank Side Monitor: M25x1.5
- Micropilot S: M20x1.5

→ suitable cable diameter: 10 to 13 mm (0.39 to 0.51in)

1. Unscrew the lid of the terminal compartment.
2. Push the signal cables through the appropriate cable glands.
3. Wire up according to the terminal assignment diagram (see following chapter).
4. Screw the lid of the terminal compartment securely back onto the transmitter housing.

   Note!
   Make sure to clean the threads of the lid to remove any dust or particles. Check that O-ring is in place and reapply anti-seize grease.



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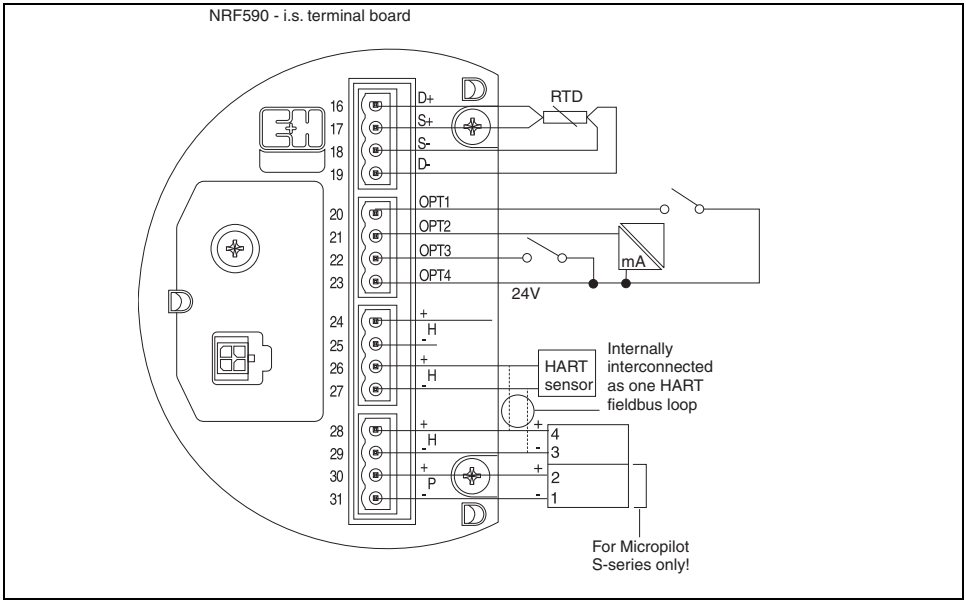
3.2.2 Terminal assignment



Terminal	Designation	Meaning	Terminal	Designation	Meaning
16	D+	+ RTD drive[1)]	24	H+	+HART Komm. [2)]
17	S+	+ RTD sense[1)]	25	H-	-HART Komm.[4)]
18	S-	- RTD sense[1)3)]	26	H+	+HART Komm.[2)]
19	D-	- RTD drive[3)4)]	27	H-	-HART Komm.[4)]
20	OPT1	Discrete Input 1	28	H+	+HART Komm.[2)]
21	OPT2	Analog Input 1 (4 to 20mA)	29	H-	-HART Komm.[4)]
22	OPT3	Discrete Input 2	30	P+	+ i.s. power for FMR S-series (terminal 2 of FMR) [3)]
23	OPT4	Option + 24V	31	P-	- i.s. power for FMR S-series (terminal 1 of FMR) [4)]

1) These terminals should be left unconnected if RTD has not been selected in feature 40 of the product structure.

2) These terminals share the same HART signal

3) For a 3-wire RTD, terminals 18 and 19 should be connected together.

4) These terminals share the same i.s. 0 V signal.

3.2.3 Connection of HART instruments

Tank sensors

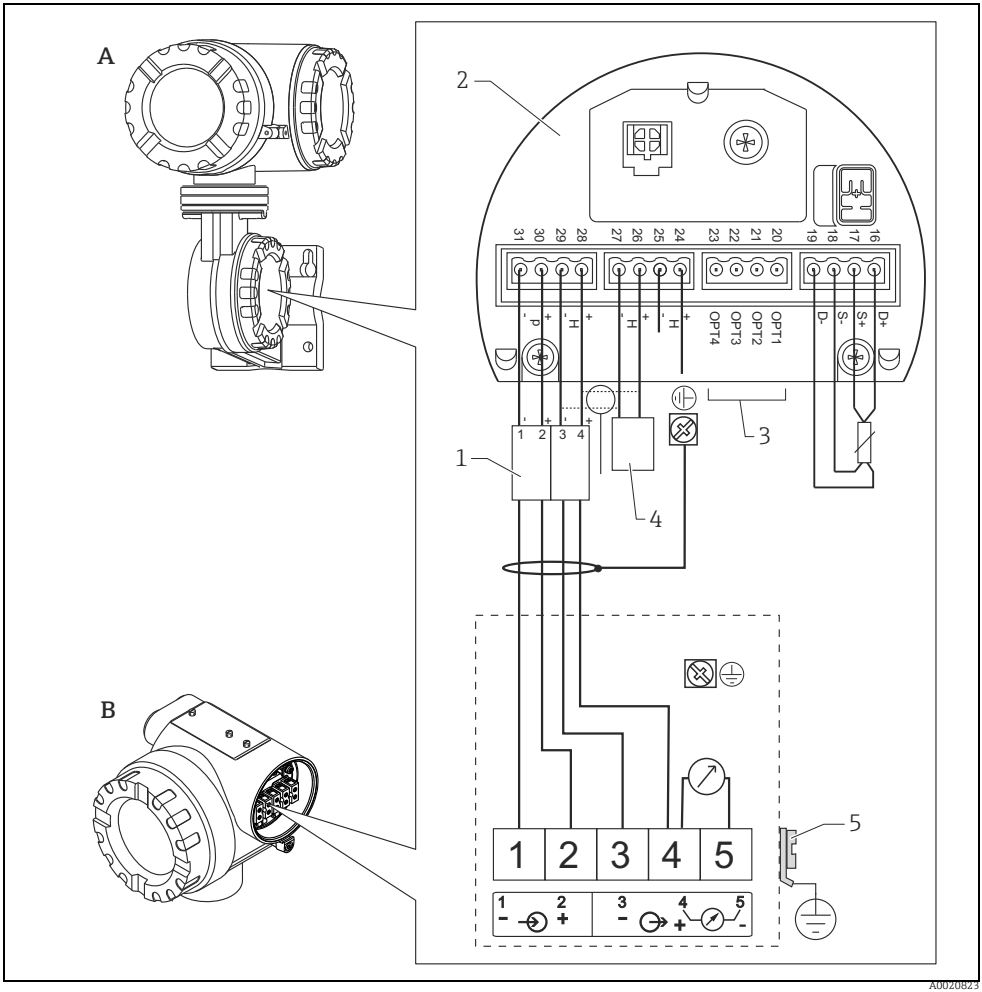
The Tank Side Monitor can interface to a maximum of 6 i.s. HART sensors. All HART sensors are connected to one HART multi-drop communication loop. In order to keep wiring simple, 3 interconnected terminal pairs are available. The terminal pairs are marked respectively H+ and H-.

Power supply for MicropilotS

For supplying extra i.s. power to the FMR S-series radar, additional power terminals are available, marked as P+ and P-. Although it is possible to use only 3 wires between the S-series radar and the NRF590, by combining the P- and H- wires, it is recommended to use a double pair of screened and twisted cable.

Grounding of the cable screen (for Micropilot S)

The screen of the cable connecting the Micropilot S to the Tank Side Monitor should be grounded at the Tank Side Monitor, **not** at the Micropilot S.

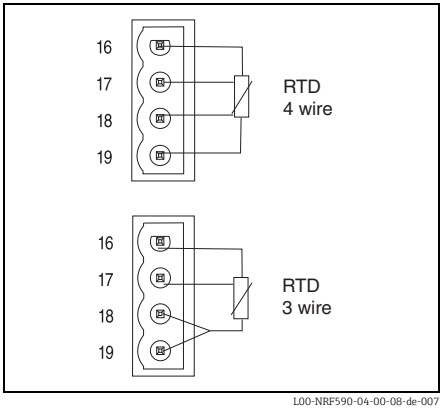


A Tank Side Monitor NRF590
B Micropilot S
1 Only for Micropilot S
2 Intrinsically safe terminal board
3 Grounding single sided on Tank Side Monitor NRF590
4 HART Sensor
5 PML (potential equalization line)

If there is no way to set a ground cable between NRF590 and Micropilot S it is possible to ground single side (grounding on side NRF590). In this case it's imperative to ground the shield (on Micropilot S side) via a ceramic capacitor with a maximum capacitance of 10 nF and a minimum insulating voltage of 1500 V.

The Micropilot S is - possibly in combination with other devices - connected to a tank side monitor in a hazardous area. In this case, it is recommended that you ground the cable screen centrally at the Tank Side Monitor and connect all devices to the same potential matching line (PML). If, for functional reasons, a capacitive coupling is required between local earth and screen (multiple grounding), ceramic condensers with a dielectric strength of min. 1500 Veff must be used, whereby the total capacitance of 10 nF must not be exceeded. Notes on grounding interconnected intrinsically safe devices are provided by the FISCO model.

Spot RTD



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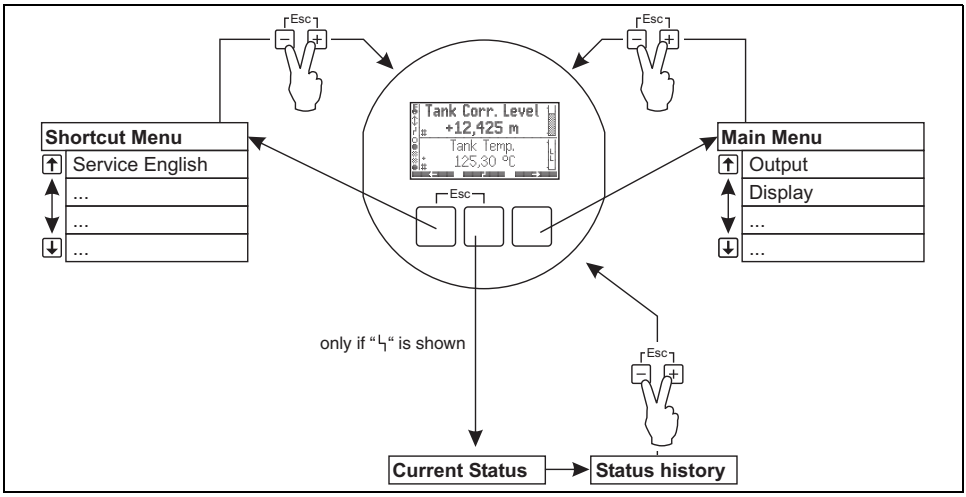
A spot RTD can be connected to the NRF590 if the option is installed. For 4-wire connection, the RTD must be connected to the 4 available terminals marked D+, S+, S- and D-. For 3-wire connection, the RTD should be connected to the same 4 terminals. The terminals D- and S- should be connected together directly at the NRF590 terminals.

Temperature setup should be performed after all external devices are connected to the NRF590.

4 Operation

4.1 Entering the menu

The navigation in the operating menu always starts from the main screen (measured value display). From there, the following three menus can be entered by the keys:



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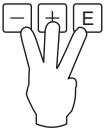
- **Shortcut menu**
  The shortcut menu allows to change the display language to "English", if any other language has been choosen by the customer. By activating the option "Service English", all parameters are displayed in english language. Using the "Quick exit" ("Quick Exit", see Chapter 4.2.1) twice, the system is reset to the language and the Software lock is activated.
- **Main menu**
  The main menu contains **all** readable and editable parameters of the Tank Side Monitor. The parameters are distributed among statical and dynamical submenus. Dynamical submenus adapt themselves to the current installation environment of the Tank Side Monitor. The main menu should be used if one wants to read or edit parameters which are not accessible via the shortcut menu.
- **Device Status**
  The "Device Status" comprises the most important parameters describing the current state of the Tank Side Monitor (error indication, alarm states etc.). Functions only, if a status is active (indicated by the error symbol on the display).

4.2 Key assignment

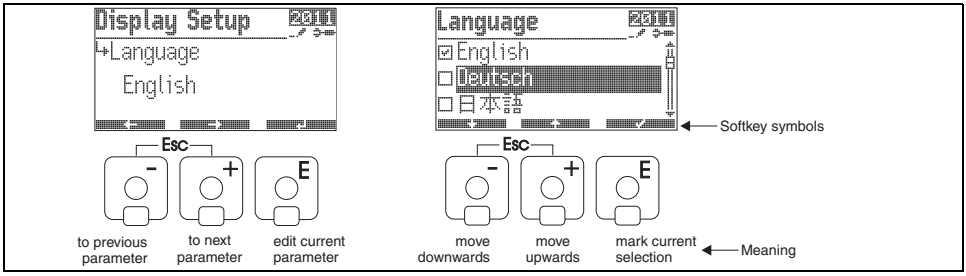
4.2.1 Function of the key

Key(s)	Meaning
	**Escape** Escape from the current editing opration. If the currently edited value has not been stored , then the parameter will retain its original value.
	**Display contrast** Opens the menu for the setting of the display contrast.
	
	**In the operating menu: Quick Exit** Return to the measured value display. **In the measured value display: Software-locking** Sets "Access Code" = 0 (instrument locked) Sets "Service English" = off (display language as selected by the user).

Softkeys

Except for the aforementioned key combinations, the keys operate as softkeys, i.e. their meaning varies depending on the current position within the operating menu. The meaning is indicated by softkey symbols in the bottom line of the display.

Example



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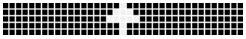
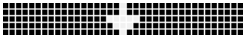
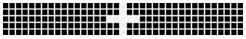
List of the softkey symbols

Softkey symbol	Meaning
	Move to the previous parameter in the list.
	Move to the next parameter in the list.
	Return to the group selection.
	Enter the current parameter for editing.
	Move the selection in a list up to the previous one.
	Move the selection in a list down to the next one.
	– Select the currently highlighted option. – "Yes" for yes/no questions.
	– Unselect the current option. – "No" for yes/no questions.
	Increment a numerical or alphanumerical value by one.
	Decrement a numerical or alphanumerical value by one.
	Display device status.

4.2.2 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

Symbol	Meaning
Status of the Tank Side Monitor	
	**W&M locking** is displayed, if the W&M parameters of the Tank Side Monitor have been locked by the hardware locking switch.
	**Communication** is displayed if the Tank Side Monitor is currently communicating on the Fieldbus.
	**Error** is displayed if the Tank Side Monitor detects an error.
Status of the displayed measuring values	
	**W&M status** is displayed, if the suitability for custody transfer measurement of the measured value can currently not be ensured (e.g. if the W&M locking of the respective sensor is not ensured).
Status of the discrete inputs and outputs	
	**Active** is displayed if the respective discrete input or output currently is in the "active" state.
	**Inactive** is displayed, if the respective discrete input or output currently is in the "inactive" state.
	**"Value unknown" or "Not fitted"** is displayed ▪ if "discrete" has been disabled in the operating menu ▪ before the first value has been read ▪ if the optional module is not installed.
Access code	
	**User** is displayed, if the "user" access code ("100") has been entered.
	**Service** is displayed, if the "service" access code has been entered.
	**Diagnostic** is displayed, if the "diagnostic" access code has been entered.

Symbol	Meaning
Parameter type	
	**Read only** indicates a measured or calculated value.
	**Editable** indicates a configuration parameter.
	**W&M locked** indicates the current parameter is locked by the W&M switch.
	Cyclic update (flashing left of the parameter name) indicates that the parameter is cyclically updated
	**DD** These parameters are linked to an external HART instrument. There is no internal copy of these parameters and their value is not automatically scanned by the system. When one of these parameters is selected on the display it is immediatly read from the connected instrument and displayed, changes are written directly back to the instrument (which may reject these changes, depending on instrument configuration e.g. access code or local W&M lock activated).

5 Commissioning

5.1 Theoretical background

5.1.1 Function blocks and data flow

The internal architecture of the Tank Side Monitor is organized as function blocks. During commissioning one can link the outputs and inputs of different function blocks in order to define a data flow through the Tank Side Monitor.
Generally one can distinguish three parts of the data flow:

1. Data enter into the Tank Side Monitor via the input blocks. There is a block for each connected HART instrument (e.g. FMR, NMT, PMD). Depending on the instrument version, there are additional Analog (AI) and Digital (DI) Input blocks.
2. Data are processed in the "Tank" function block (tank calculations and corrections) and in the Alarm (AL) function blocks.
3. Data are output to
   - the display
   - the fieldbus via the fieldbus function blocks (e.g. MODBUS, ENRAF, ...)
   - the analog or digital outputs via the Analog (AO) and Digital (DO) output blocks.

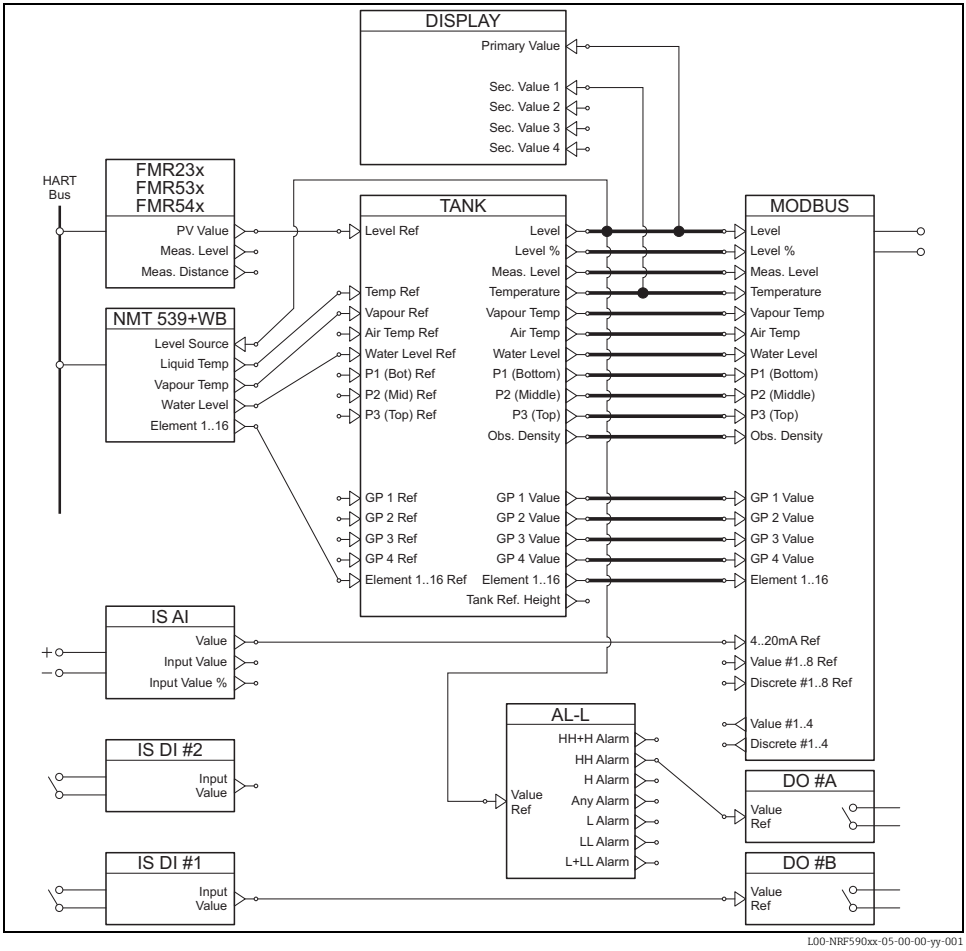
5.1.2 Linking sensors to function blocks

To commission the NRF590, it is necessary to connect all Tank HART sensor blocks to one of the internal function blocks, either the "tank functions" block or the "alarm function" block. The outputs of these function blocks can then be mapped to the display, the fieldbus function block and the AO or DO blocks.By default, these mappings are set to the most common default values. Some of these default mappings are unbreakable system links, others can be modified by the user.The linking is performed by reference parameters (marked by the ending "REF" in the parameter name). For each of these reference parameters the desired source can be selected from a list.

5.1.3 Linking Digital Inputs

An additional Digital Input can either be linked to the field protocol inputs or directly to an Digital output. This latter case is usually used for overspill protection.

5.1.4 Example of block linking



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The level value as given by the FMR level radar via the HART protocol is read into the "FMR" function block. The "FMR" function block sends the value to the "Tank" function block, to be stored in the "Level Ref" data point. From here, it is displayed in the primary display as well as communicated to the "Modbus" protocol function block, which maps the value to the adequate Modbus register. In parallel, the level value is sent to the "NMT" function block, from where it is sent to the NMT Prothermo gauge in order to assign the product level for the product temperature respectiveley the product vapour temperature.

Additionally, a digital input value is directly transferred from the Digital Input block (IS DI#1) to a Digital Output block (DO#B) as well as an analog value from the Analog Input Block (IS AI) to the MODBUS Block.
Furthermore, the level is evaluated in the Alarm block (AL-L). If the HH limit is overshot, an alarm signal will be transmitted via the Digital Output Block (DO #A)

5.1.5 Validation of Weight & Measure approved measurements

The weight & measure status is evaluated by the Tank Side Monitor on two stages:

- On a first stage, the measurement instrument value coming into the Tank Side Monitor is evaluated.
- On a second stage, the "Tank" function block is evaluated.

Status of a measurement instrument

The weight & measure status of a measurement instrument is o.k. if:
- the custody transfer switch (or the related software setting) of the instrument is closed.
- no alarm status is received from the measurement instrument.
- for the MicropilotS level radar: the custody transfer status is "active positive".
- for a RTD transmitter: the sensor's custody transfer switch is locked, the sensor position is defined and situated between the defined min and max alarm values.

Status of the "Tank" function block

The weight & measure status of the "Tank" function block is o.k. if:
- the custody transfer switch of the Tank Side Monitor is closed.
- the referenced measured value has a validated weight & measure status.
- additionally for the level measurement: no tank calculations (CTSh, HyTD, HTMS, HTG) are activated.

If any of these conditions are not met, then the "#" symbol is displayed along with the displayed "tank" function group value in the display.

The tank values are transmitted via the field protocol to the control room along with the current weight & measure status.

5.2 Configuration of the HART Interface

The NRF590 comes with two HART interfaces; the Ex i interface and the Ex d interface.[1)]

- On the **Ex i** side the Tank Side Monitor is always operating as **HART Master** polling the instruments connected. It can also temporarily operate as **HART Slave** in order to communicate with the ToF Tool.
- On the **Ex d** side the HART interfaced is controlled by the "Analog IO/AO" function group. The following modes can be selected:
  - **Enable**
    In this mode no HART signal is used on the Ex d side. There is only a 4 to 20 mA signal present at the analog output.
  - **HART slave**
    In this mode data can be transmitted from the analog output to a primary or secondary HART Master (e.g. ToF Tool).
  - **HART Master**
    In this mode the Tank Side Monitor can poll HART instruments which are connected to the Ex d HART bus.

For a specification of the modes see BA00256F/00/EN.

1) The Ex d HART bus is not available on a Modbus NRF590 with order code *4********* (without 4 to 20mA Input or Output).

5.3 Addressing of the HART instruments

If possible, the addresses of the HART instruments should be set before connection to the Tank Side Monitor.
The default block configurations require usage of the following addresses:

Tank calculation [1]	Addresses of the individual HART instruments				
	Level	Temperature [2]	Pressure 1 (bottom)	Pressure 2 (middle)	Pressure 3 (top)
level only	1	-	-	-	-
level + temp.	1	2	-	-	-
HTMS + P1	1	2	3	-	-
HTMS + P1,3	1	2	3	-	5
HTG P1	-	2	3	-	-
HTG P1,3	-	2	3	-	5
HTG P1,2	-	2	3	4	-
HTG P1,2,3	-	2	3	4	5

1) The types of tank calculations are described in BA00256F/00/EN.

2) If the RTD interface of the Tank Side Monitor is used for spot temperature measurement, no HART temperature sensor is required. In this case address "2" should remain unassigned.

Caution!
Do not connect a instrument with address "0"! Such a instrument has an active 4 to 20 mA output which may overload the HART bus, disrupting all HART communication.

Note!
The HART interface on the non-IS side of the Tank Side Monitor can be operated in different modes. If the "slave" mode has been selected, the HART loops on the IS an the non-IS sides will operate independently of each other. Therefore, it would be possible to use instruments with the same HART address on the IS and on the non-IS loop. In order to prevent confusion, we strongly recommend to avoid this kind of double usage of addresses.

5.4 Steps of the Commissioning Procedure

1. **Automatic check of the HART addresses of the connected instruments**[2)]
   After connection of the HART instruments, the Tank Side Monitor will check if all HART addresses are unique and unequal to "0". If this is not the case, then an alarm message will be displayed. In parallel, the actual HART addresses of the connected gauges can be checked in the "HART instruments"(8---) function group.
2. **Define the display values of the Tank Side Monitor**
   In the "Display"(2---) function group, the information to be displayed and their format (such as language, timing, scroll rate) is defined
   a. **Primary Value**
      The primary value will be continuously displayed in the upper part of the main display screen.
   b. **Secondary Values**
      Up to four secondary values will be displayed, which will be displayed cyclically in the lower part of the main display screen.
3. **Select the display units**
   The following unit presets are selectable in the "units preset"(2031) function:

Selection	Level	Pressure	Temperature	Density	Level Flow	Volume	Volume Flow
mm, bar, °C	mm	bar	°C	kg/m³	m/h	m³	m³/h
m, bar, °C	m	bar	°C	kg/m³	m/h	m³	m³/h
mm, PSI, °C	mm	PSI	°C	kg/m³	m/h	m³	m³/h
ft, PSI, °F	ft	PSI	°F	°API	ft/h	us gal	us gal/h
ft-in-16, PSI, °F	ft-in-16	PSI	°F	°API	ft/h	us gal	us gal/h
ft-in-8, PSI, °F	ft-in-8	PSI	°F	°API	ft/h	us gal	us gal/h

Note!
Only Tank values will be diesplayed in NRF590 units, values directly form HART instruments will be displayed in the HART instruments units.

2) In the Software Version SW 02.01, the HART buses on the IS and on the non-IS side are continuously monitored by the Tank Side Monitor. This means, that in contrast to SW 01.xx, an initial HART scanning of the bus has not to be performed. As soon as a new HART instrument is found, it is displayed with its HART communication address in the "HART instruments" (8---) group.

4. **Configure the connected HART instruments**
   After connecting all HART instruments to the HART multidrop line of the NRF590, these gauges can be configured via the NRF590 Tank Side Monitor display. In the "HART instruments"(8---) function group, all connected instruments are displayed with their respective HART address in brackets (e.g. FMR53x|01|).
   a. **Instruments known to the Tank Side Monitor**
      Endress+Hauser instruments "known" to the Tank Side Monitor will be represented by their product code, e.g. "FMR53x" for MicropilotS, "NMS" for Proservo, "NMTxxx" for the Prothermo line etc. If more than one instrument of a specific type is connected, each individual instrument will be represented in the Tank Side Monitor by a separate function block.
   b. **Instruments not known to the Tank Side Monitor**
      Instruments not known to the Tank Side Monitor will be presented as "generic HART instrument". For these, the universal HART commands and variables (such as communication address, TAG, message, PV, SV, etc.) are supported.

5. **Link the gauges to the tank functions**
   a. **Level and temperature functions**
      In the "Basic Configuration"(32--) function group, the connected HART instruments are linked to the Tank functions simply by choosing the appropriate references. For instance, a Micropilot S FMR53x level gauge will appear as a selectable choice in the "level reference"(3201) function, and by checking the box, the PV of this gauge will be taken by the Tank Side Monitor as the measured level. In the same manner, a connected Prothermo NMT53x average temperature transmitter can be chosen as "temperature reference"(3202) by checking its procuct code in the selection list.
   b. **Other typical Tank Gauging functions**
      For other typical Tank Gauging sensors, the appropriate links are found in either the "Extended Configuration"(33--) or the "Pressure Setup"(34--) function groups.
   c. **General Purpose Functions**
      Instruments which offer functionality not provided for in the standard function groups (e.g. pH meters) can be connected to the "General Purpose"(35--) functions. Here, the user can define a function name for the indication on the Tank Side Monitor display. The units of the instrument will not be processed in the tank function group. Instead, the values are transmitted directly to the output field protocols.[3)]

6. **Define the tank calculations and the tank corrections**
   In case any typical tank calculations (as the hydrostatic level measurement or the hybrid tank measurement) or tank corrections (as the "hydrostatic tank shell compensation" or the "correction of the thermal expansion") shall be performed, these functions can be easily set up in the "Calculations"(36--) function group. If any level corrections are defined in the calculation functions, then the corrected level is automatially sent to the "Host" system via the field protocol. Further Informations can be found in the BA257F - "Description of Instrument Functions" Manual.

3) For a list of values which can be transmitted by the individual protocols refer to the chapter "Technical Data".

7. **Define Alarm Functions**
   a. **Alarm type and limits**
      For all input variables, alarm limits can be defined. In the "Alarm"(5---) function group, the alarm type (level, temperature, various) and the alarm behaviour can be selected.
   b. **Alarm behaviour**
      To have the alarm disappear when the value is back in normal state, the "enabled" selection has to be made. To wait for alarm acknowledgement, the "latching" selection is appropriate. In both cases, the alarm limits have to be defined in the following steps. Either one or all values may be defined.
   c. **Extended alarm setup**
      In the extended alarm setup, additional default values (such as damping factor, hysteresis etc.) may be changed.
8. **Define Discrete Inputs and Outputs**
   In the "Discrete I/O"(6---) function group, both, the intrinsically safe (IS) in- and outputs as well as the explosion proof (non-IS) in- and outputs may be configured.
9. **Configure the field protocol**
   For each protocol listed below these parameters should be configured. Additional parameters may in some cases require changes from the default values, a description of these parameters can be found in the “Description of Instrument Function” (BA00257F/00/EN) and the protocol specific KA document.

   Sakura V1 (see KA00246F/00/EN)
   – **"Type"**(9211)
     defines the primary V1 communication type to be compatible with your control room system.
   – **"Id"**(9212)
     must be set to a unique number on this V1 loop.

   EIA-485 Modbus (see KA00245F/00/EN)
   – **"Id"**(9211)
     must be set to a unique number on this Modbus loop.
   – **"Baud Rate"**(9212) **and "Type"**(9213)
     must be the same as the control room system setting.
   – **Floating Values**
     – **"FP Mode"**(9214)
       must match the control room system floating point type.
     – **"V01 Map. Mode"**(9223)
       must be set to "Float Vals" if access to software V01 compatible register map is required.
     – **"Word Type"**(9221)
       must be configured to match the control room integer type.
   – **Integer Values**
     – **"Word Type"**(9221)
       must be configured to match the control room integer type.

– **"V01 Map. Mode"(9223)**
must be set to "Integer Vals." if access to software V01 compatible register map is required.
– **"0% value" and "100% value"**
must be configured to obtain correct integer values (see BA00256F/00/EN, Chapter "Configuring the Modbus Integer Scaling")

Whessoematic WM550 (see KA00247F/00/EN)

– **"Id"(9211)**
must be set to a unique number on both of the WM550 loops.
– **"Baud Rate"(9212)**
must match the control room equipment settings.
– **"Software Id"(9213)**
may need to be changed for some control room systems to enable the required functionality.
– If the second loop has a different baud rate, the **"Loop 2"(9231)** parameter must be set to "Different" and the **"Baud Rate (2)"(9232)** can be configured

BPM (see KA00248F/00/EN)

– **"Id length"(9211) and "Baud Rate"(9213)**
must be configured to match the control room settings.
– **"Id"(9212)**
must be set to a unique number on the BPM loop.
– **"TOI"(9214), "Device No [dn]"(9215) and "Dev. Type [dt]"(9216)**
must be configured to achieve the correct Enraf gauge emulation.

Mark/Space (see KA00249F/00/EN)

– **"Id"(9211)**
must be set to a unique number on both of the Mark/Space loops.
– **"Baud Rate"(9212), "Type"(9213) und "Data Mode"(9214)**
must match the control romm equipment settings.

GPE (see KA00251F/00/EN)

– **"ID"(9211)**
must be set to a unique number on both of the Mark/Space loops.
– **"Baud Rate"(9212), "Type"(9213) und "Loop Mode"(9214)**
must match the control room equipment settings.

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