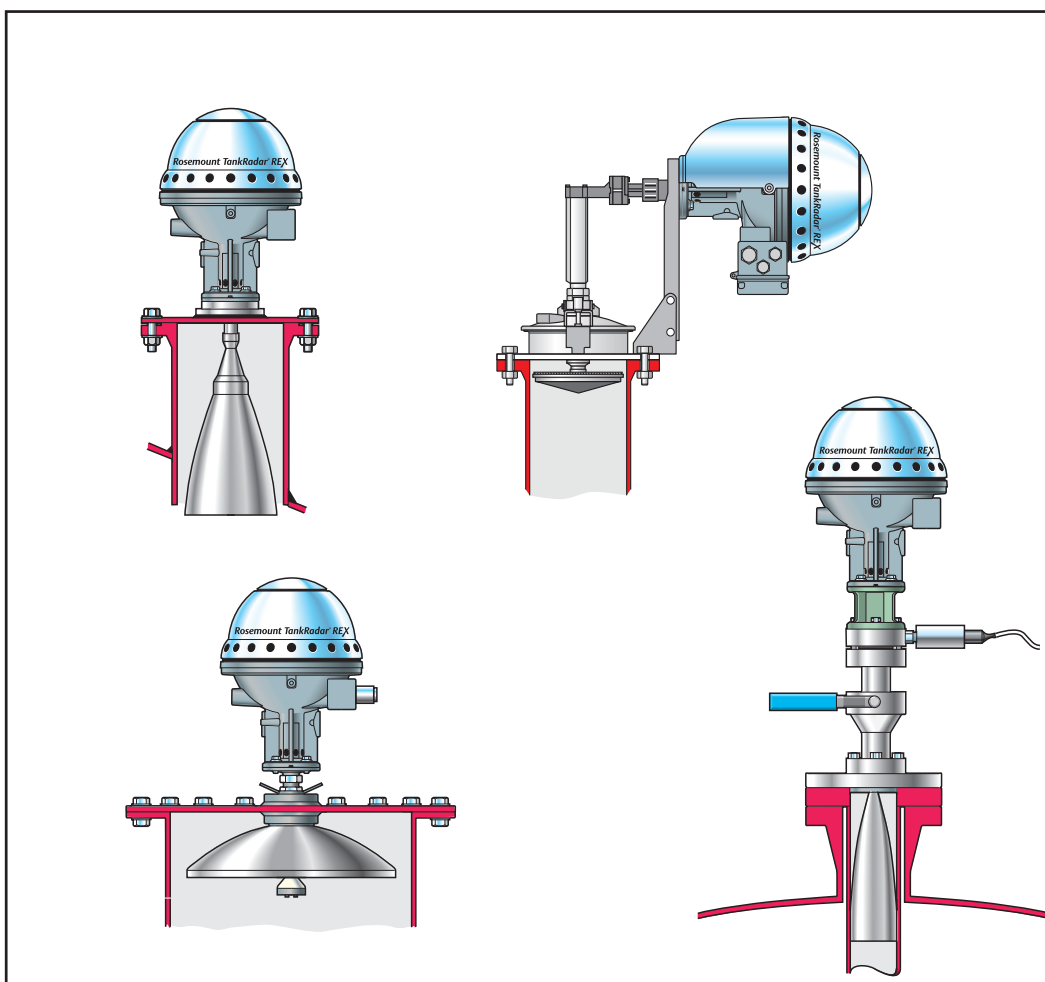


# TankRadar® REX

## Tank Gauging System

*Product Discontinued*





# *TankRadar<sup>®</sup> REX*

## **Service manual**

Second edition

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# Rosemount Tank Radar AB

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## Specific FCC Requirements (USA only)

Rosemount TankRadar Rex generates and uses radio frequency energy. If it is not installed and used properly, that is, in strict accordance with the manufacturer's instructions, it may violate FCC regulations on radio frequency emission.

Rosemount TankRadar Rex has been FCC certified under test conditions which assume a metallic tank. Installation on a non-metallic tank is not certified, and is not allowed.

The FCC certificate for Rosemount TankRadar Rex requires that the tank is closed as far as emitted radio energy is concerned. Tanks with open manholes, external-floating-roof tanks without still pipes etc. are not covered by the certificate.

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# 1. System Description

The TankRadar Rex System is a monitoring and control system for tank level gauging. The system can interface various sensors, such as temperature and pressure sensors, for complete inventory control.

There is a distributed intelligence in the various units of the system. The units continuously collect and process information. When a request for information is received an immediate response is sent with updated information. The units communicate with each other on a field bus, the TRL/2 Bus.

No part of the equipment is in actual contact with the product in the tank and the antenna is the only part of the gauge that is exposed to the tank atmosphere. The Radar Tank Gauge sends microwaves towards the surface of the product in the tank. The level is calculated based on the echo from the surface.

TankRadar Rex can measure the level of almost any product, including bitumen, crude oil, refined products, aggressive chemicals, LPG and LNG, etc. Using a suitable Tank Connection Unit, the TankRadar Rex System can gauge any type of tank

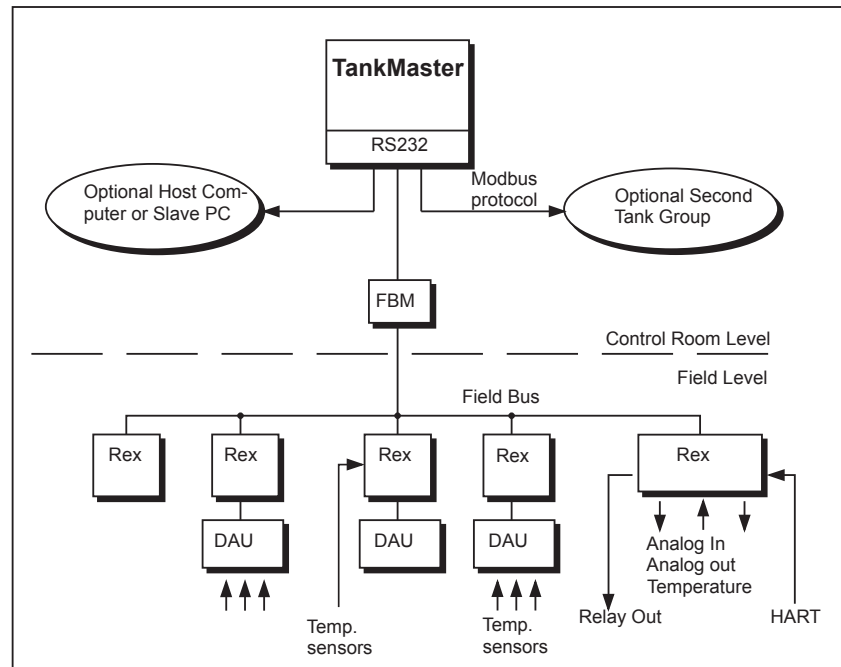


Figure 1-1. Example of a small TankRadar Rex System

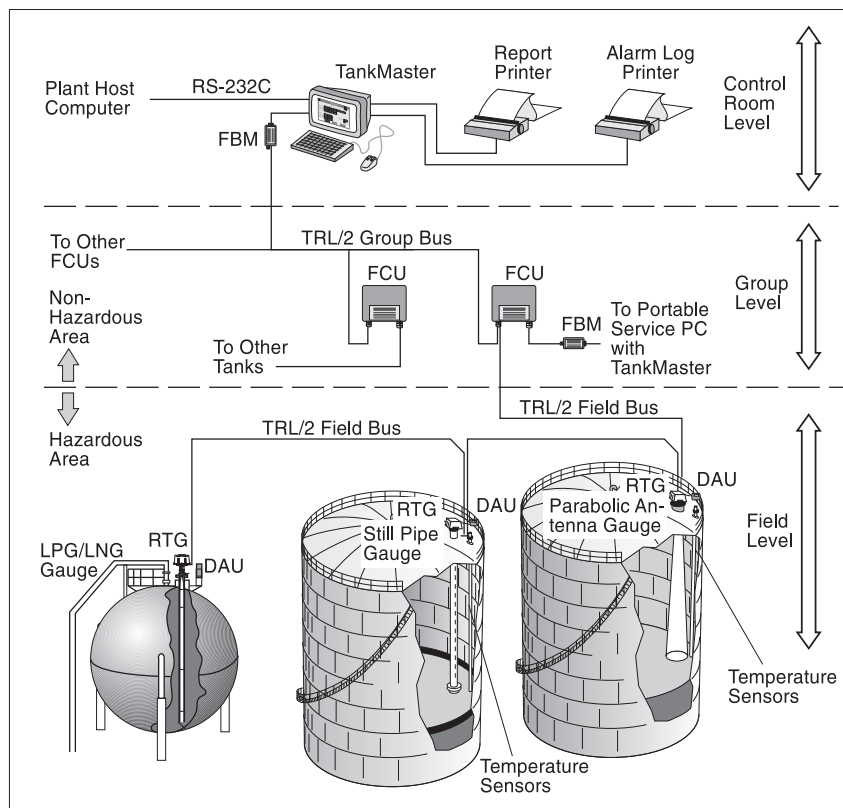


Figure 1-2 Example of a general configuration of a TankRadar Rex System

All the measured data is presented to the operator by TankMaster WinOpi, which in its complete version contains inventory functions. A plant host computer can be connected for further processing of data.

All Rosemount Tank Control supplied parts for tank top mounting weigh less than 25 kg (55 lb) (except for pressure flange etc. for the LPG/LNG Gauge). This makes it possible for one man to carry the various TankRadar parts to the tank top for installation.

Please read the **Technical Description** for a more detailed description of the Rosemount TankRadar Rex system.

The basic parts of the TankRadar Rex system are:

- The **Radar Tank Gauge, RTG**, is an intelligent explosion protected instrument for measuring the level of a product inside a tank. Four different Tank Connection Units can be attached in order to satisfy a variety of different applications.
- The **Data Acquisition Unit, DAU**, is a local readout/connection unit for use with the TankRadar Rex tank gauging system. The DAU is used for connection of temperature sensors when more inputs/outputs are required than is available in the Rex Gauge.
- The **Field Communication Unit, FCU**, acts as a gateway and data concentrator between the Group Bus and the Field Bus. Each FCU can have a total of 32 RTGs and 32 DAUs connected to it.
- The **Field Bus Modem, FBM**, acts as a converter between USB or RS-232C and the TRL/2 Bus. It is used for connecting a PC with TankMaster to the TRL/2 Bus.
- The **Remote Display Unit, RDU 40**, is a display unit for presenting calculated and measured data from the Rex gauge such as level, average temperature, volume, signal strength etc.
- The **TankMaster** is a software package for installation and configuration of level gauging equipment manufactured by Rosemount. The TankMaster program package provides powerful and easy-to-use tools for installation and configuration of level gauging devices.



## 2. Safety

TankRadar Rex equipment is often used in areas where flammable materials are handled and where an explosive atmosphere may be present. To protect both the plant and the staff, precautions must be taken to ensure that this atmosphere cannot be ignited. These areas are called hazardous areas and equipment within these areas are explosion protected.

A number of different explosion protection techniques have been developed over the years. Intrinsic safety and explosion proof (or flame proof) safety are two techniques.

### 2.1 Intrinsic safety

Intrinsic safety, IS, is based on the principle of restricting electrical energy available in hazardous-area circuits such that any sparks or hot surfaces, that may occur as a result of up to two electrical faults in components, are too weak to cause ignition. Intrinsic safety is the only technique accepted for Zone 0 (high risk) hazardous areas. It is also safe for personnel and allows equipment to be maintained without the need for a gas-free certificate.

The basic principles of intrinsic safety are:

- All flammable materials are grouped according to the energy needed to ignite them.
- Equipment located in hazardous areas are classified according to the maximum surface temperature that it can produce and this must be safe with the flammable gases that may be present.
- Hazardous areas are classified according to the probability that an explosive atmosphere is present, and this dictates whether or not a particular explosion protection technique may be used.

**IMPORTANT!**

**For trouble shooting and repair work of components in or in connection to intrinsically safe equipment, strict observance of the following rules is necessary:**

- **Disconnect the power supply to the Radar Tank Gauges and Field Communication Units.**
- **Use a certified battery operated instrument only.**
- **Use Rosemount original spare parts only. Replacement with non-original spare parts may jeopardize the intrinsic safety.**

## 2.2 Explosion Proof

Explosion proof enclosures can be used when an explosion can be allowed as long as it does not spread outside the enclosure. The enclosure must be strong enough to withstand the pressure and must have narrow gaps to allow the pressure to escape without igniting the atmosphere outside the equipment.

**IMPORTANT!**

**Any substitution to non-recognized parts may impair intrinsic safety.**

**The explosion-proof (flame-proof) enclosures of the Radar Tank Gauge and the Data Acquisition Unit must not be opened while the units are powered.**

## **3. Device Description**

### **3.1 Rex RTG**

#### **3.1.1 Overview**

The Radar Tank Gauge Rex, RTG Rex, is an autonomous distance measuring device. The distance and level calculations are continuously carried out in the Radar Tank Gauge. Upon request from a master the RTG can send the level information, status and other information on the Field Bus.

All Rex gauges consist of two main parts; the Transmitter Head (TH) and a Tank Connection Unit. A number of different Tank Connection Units (Antennas) can be attached in order to satisfy a variety of different applications.

There are different types of Radar Tank Gauges:

- The **Horn Antenna Gauge RTG 3920**, for fixed roof installation without still pipe.
- The **Parabolic Antenna Gauge RTG 3930**, for demanding environments without still pipe.
- The **Still Pipe Gauge RTG 3950**, for measuring in still pipes.
- The **LPG/LNG Gauge RTG 3960**, for liquid gas, LPG and LNG.

All antenna types use the same kind of Transmitter Head Electronics.

### 3.1.2 Antenna types

#### The Horn Antenna Gauge, RTG 3920

The Horn Antenna Gauge is designed for an 8 in. antenna to be used in small size openings on tanks with fixed roofs.

The RTG 3920 is designed for measurement of a variety of oil products and chemicals. However, for bitumen/asphalt and similar products the Parabolic antenna is recommended.

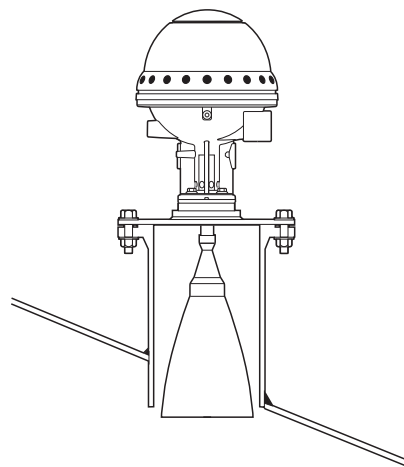


Figure 3-1. RTG 3920

#### The Parabolic Antenna Gauge, RTG 3930

The Parabolic Antenna Gauge RTG 3930 measures level of all types of liquids, from light products to bitumen/asphalt. The gauge is designed for mounting on tanks with fixed roofs and has custody transfer accuracy.

The design of the parabolic antenna provides extreme tolerance against sticky and condensing products. The narrow beam of this antenna makes it very suitable in narrow tanks with internal structures.

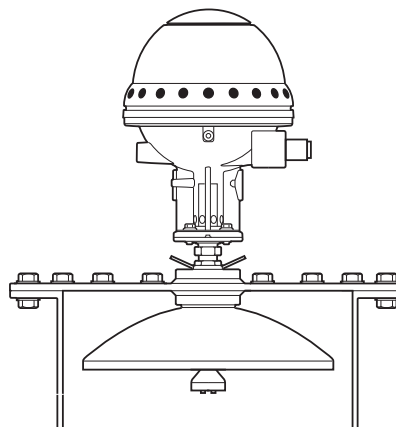


Figure 3-2. RTG 3930



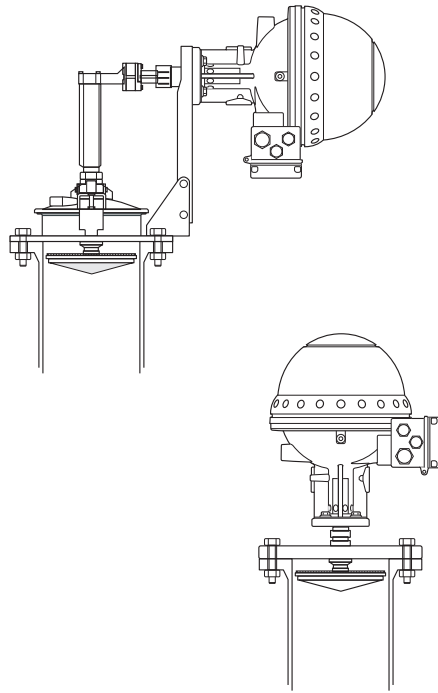
### **The Still Pipe Gauge, RTG 3950**

The Still Pipe Gauge is used on tanks with still pipes and with all products suited for still pipes.

The gauge uses a low-loss radar propagation mode which virtually eliminates the influence of the still pipe condition. Measurements is made with highest accuracy even when the pipe is old, rusty and covered with deposits.

The Still Pipe Gauge fits 5", 6", 8", 10" and 12" pipes. It can be mounted on an existing still pipe and there is no need to take the tank out of operation during installation.

There are two versions of RTG 3950: fixed and inclined. The inclined version has a hinged hatch, enabling full pipe size product sampling or verification hand-dips.



*Figure 3-3. RTG 3950*

### LPN/LNG Gauge, RTG 3960

The RTG 3960 is designed for level measurement in LPG and LNG tanks. A 4 in. still pipe is used as a wave guide for the measurement. It prevents a wavy or boiling surface from disturbing the measurement. Radar signals are transmitted inside the pipe towards the surface.

The pressure sealing is a quartz window approved for use in pressure vessels. As option the gauge can also be equipped with a fire-proof block valve and a vapor space pressure sensor.

The LPG/LNG Gauge is available in three different versions, a 150 PSI version, a 300 PSI version and a 600 PSI version.

The reference pin function enables verification of measurement without opening the tank. There is a reference pin at the top of the still pipe and a calibration ring at the bottom. By setting the gauge into "test mode" it measures against the reference pin and the calibration ring and compares with the actual distances stored during the transmitter configuration.

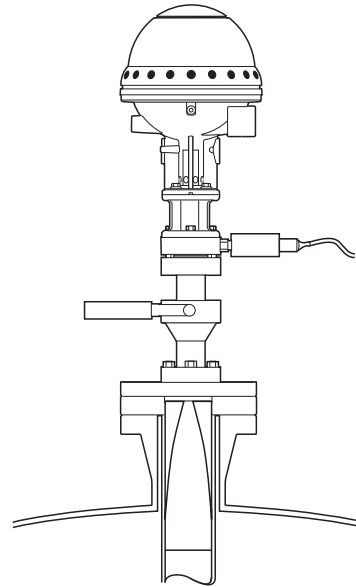


Figure 3-4. RTG 3960

### 3.1.3 Measurement principle

By using **FMCW** (Frequency Modulated Continuous Wave) method, Rex transmits a microwave signal with a continuously varying frequency towards the liquid surface. When the reflected signal returns to the antenna, it is mixed with the outgoing signal.

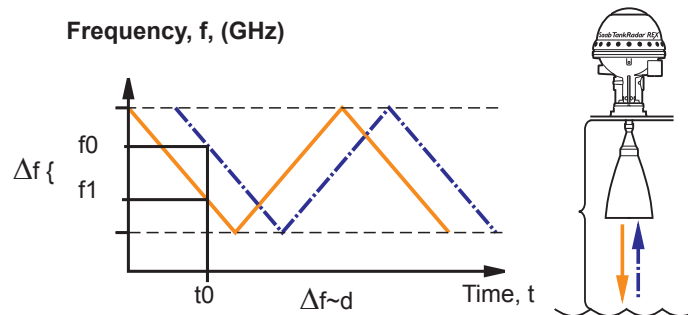


Figure 3-5. The FMCW method: The distance ( $d$ ) is calculated by measuring the frequency difference ( $\Delta f$ ) between the transmitted frequency ( $f_1$ ) and the reflected frequency ( $f_0$ ).

Since the transmitter continuously changes the frequency of the transmitted signal, there will be a difference in frequency between the transmitted and the reflected signals.

The gauge mixes the two signals, resulting in a low frequency signal which is proportional to the distance to the liquid surface. This signal can be measured very accurately allowing fast, reliable and accurate level measurements.

Rex uses an optimum microwave frequency, which reduces sensitivity to vapor, foam and contamination of the antenna, and keeps the radar beam narrow in order to minimize influence from walls and disturbing objects.

#### Fast Fourier Transformation - FFT

Rex uses **FFT**, which is a well established signal processing technique, to obtain a frequency spectrum of all echoes in the tank. From this frequency spectrum the surface level is extracted. In combination with **Rosemount's Echofixer**, FFT allows measurements in tanks with agitators, mixers and other disturbing objects.

#### Echofixer

Rosemount's Echofixer provides a technique to adapt measurements to various situations, by using information from previous measurements.

### Fast High Accuracy Signal Technique - FFAST™

To further improve measurement accuracy, Rex can utilize the benefits of Rosemount's Fast High Accuracy Signal Technique™

### Multiple Echo Tracking - MET™

Multiple Echo Tracking is another advanced feature, which provides increased resolution in tanks with disturbing objects. MET facilitates the separation of disturbances from the actual product surface echo.

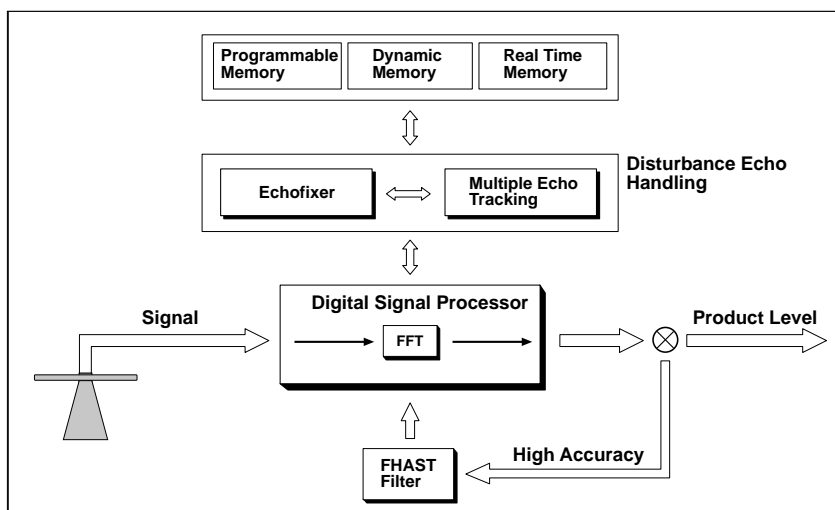


Figure 3-6. Signal processing schedule

### 3.1.4 Transmitter Head Electronics

The electronics is mounted in an exchangeable unit in the explosion proof Transmitter Head. A high measurement accuracy is achieved by using digital reference circuitry, and by controlling the internal temperature by an internal heater.

The 3900 transmitter head can be used on all types of Rex antennas.

A metrological seal is available to prevent unauthorized changes of database settings.

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*Note!* Some of the electronic cards shown below are optional and may not be installed in your transmitter

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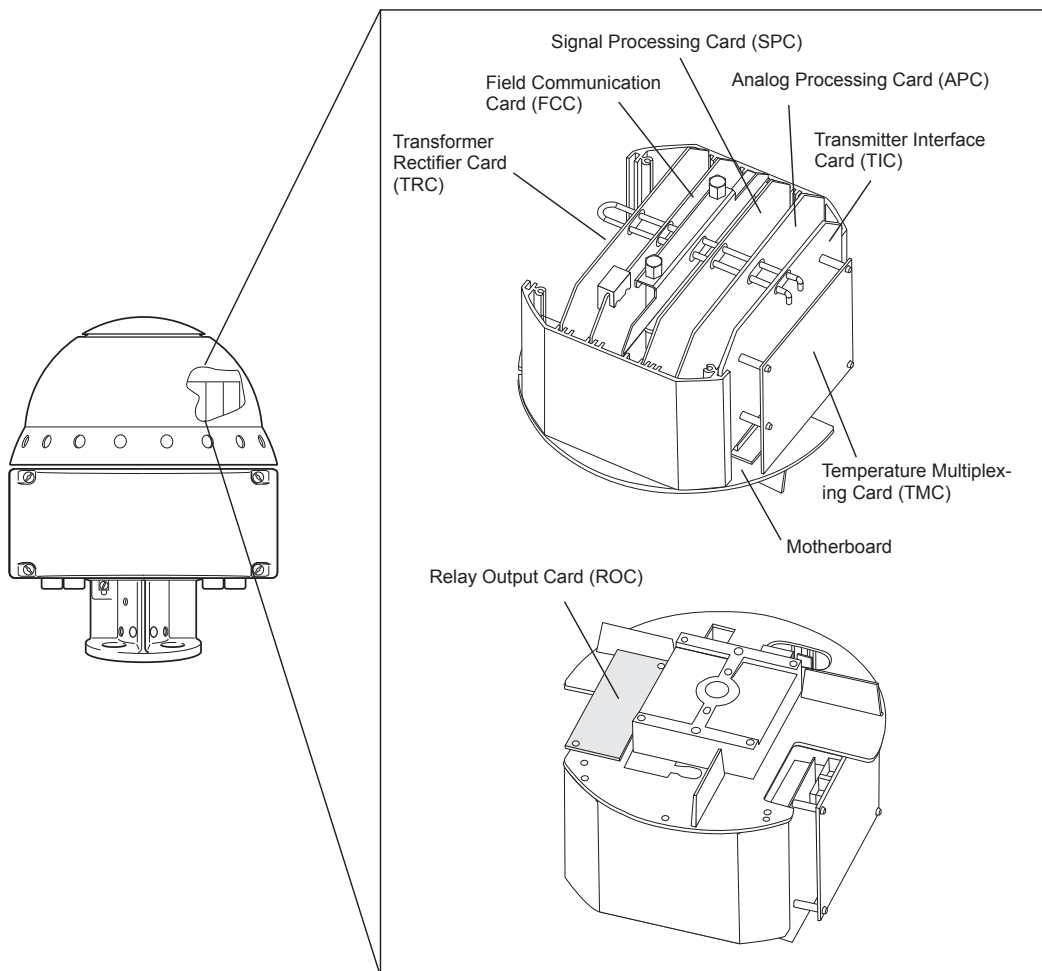


Figure 3-7. Rex Transmitter Head Electronics

### **Signal Processing Card (SPC)**

The SPC is mainly a digital processor card for advanced signal and communication processing as well as handling of auxiliary functions.

### **Analog Processing Card (APC)**

The APC is used for filtering and multiplexing of analog input signals. By keeping the analog circuitry on a separate card a high Signal to Noise Ratio is achieved.

### **Field Communication Card (FCC)**

The FCC handles communication with external devices. There are different versions of the FCC card allowing you to use various types of communication protocols and even emulate other types of gauges.

### **Relay Output Card (ROC), optional**

The Relay Output Card (ROC) contains two relays. It allows controlling external devices such as valves, pumps, heating coils etc.

### **Transmitter Interface Card (TIC, optional)**

The Transmitter Interface Card (TIC) is required for intrinsically safe auxiliary inputs. The TIC includes:

- Two supply barriers and two input/return barriers for 4-20 mA current loops.
- One supply barrier for a DAU or a local display unit.
- One signal barrier for communication with the DAU or local display unit.
- Signal/supply connection for optional TMC.

### **Temperature Multiplexer Card (TMC), optional**

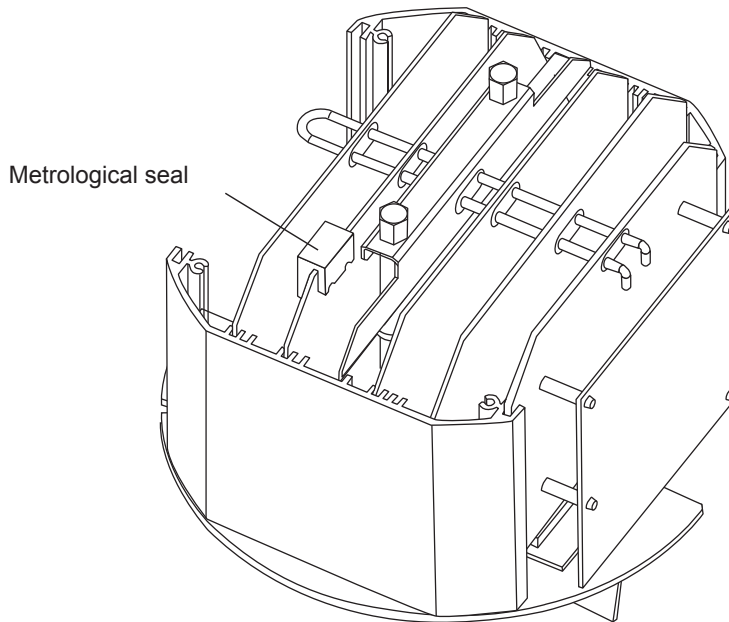
The Temperature Multiplexer Card (TMC) is an optional add-on board which is mounted on the back of TIC. TMC is used to connect up to 6 temperature sensors. Both spot and average sensors are supported.

### 3.1.5 Write protection (Metrological Seal)

Part of the memory space in the Electronic Unit is of EEPROM type (Electrically Erasable Programmable Read Only Memory). Program and database updates are possible to perform over the Field Bus without opening the Safety Enclosure.

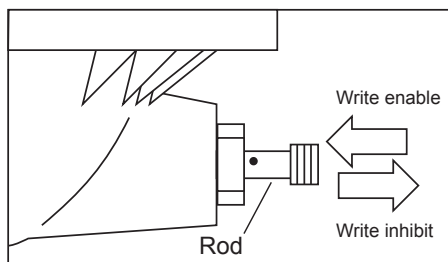
A switch on the FCC board can be used to prevent unauthorized changes in the RTG database. The switch can be sealed in the write-inhibit position by using a special plastic cover.

For further information see 4.1.7



*Figure 3-8. Metrological seal*

As an option Rex can be equipped with the TRL/2 Metrological Seal, consisting of a connection rod that activates the write protection switch.



*Figure 3-9. Optional version of Metrological Seal.*

### 3.1.6 Internal calculations

TankRadar Rex is designed to make inventory calculations directly in the gauge to be used by a DCS system, or give precise inputs for tank calculations in another computer. The gauge can receive and process signals from analog and digital pressure transmitters, water bottom sensors etc. All measured data are transmitted on the field bus and can be further processed in the control room by the TankMaster PC software or by the plants host computer/DCS system. Due to the high processing capacity, inventory calculations can be made by the signal processor in the gauge without any separate field computer.

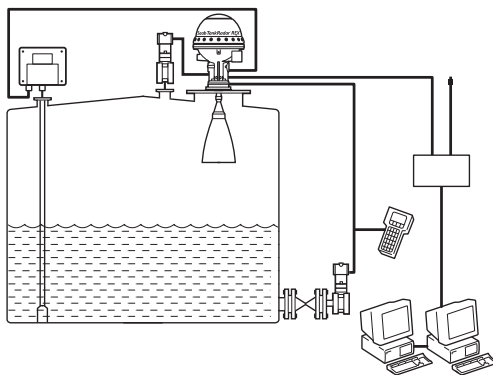


Figure 3-10. Hybrid tank gauging combines radar and pressure measurement to get density and mass information online.

#### The gauge calculates:

- Total observed volume using the tank strapping table
- Mass (if pressure sensor connected)
- Observed density (if pressure sensor connected)
- Level (corrected for thermal tank wall expansion)
- Temperature
- Oil/Water interface level

Strapping table data downloaded from the Rosemount TankMaster PC software are resident in the gauge.

All data is calculated according to updated API and ISO standards. The temperature calculations include API algorithms to handle elements close to the bottom.

The level value is software corrected for changes in tank reference height.

Both metric and USA/UK units are supported.



### 3.1.7 Inputs and Outputs

#### Inputs

The gauge has:

- up to 6 temperature inputs directly into the gauge.
- up to 14 temperature inputs to each gauge via separate Data Acquisition Unit.
- two 18 bits high accuracy analog inputs for e.g. pressure transmitters or water bottom sensors. The gauge can act as a single HART master using one analog input to interface intrinsically safe digital HART inputs from up to 3 HART based sensors.

#### Technical Data, Analog inputs

Accuracy	±20 µA
Input range	4-20 mA
Update range	0.5 Hz
Low alarm level	< 3.8 mA, configurable
High alarm level	> 20.7 mA, configurable
U <sub>max</sub> from TIC	25.2 V
I <sub>max</sub> from TIC	96 mA
P <sub>max</sub> from TIC	0.6 W
Available voltage	13.7 V (at 20 mA)

#### Outputs

The gauge has:

- two relay outputs (non-intrinsically safe) to be used for level, temperature or other alarms (250 VAC, 4 A). The relays are approved for overfill safety by TÜV and have function feedback. Operation is selectable as “normally open” or “normally closed”.
- one optional non-intrinsically safe Analog output. The Analog output replaces the second Relay output.

#### Technical Data, Relay outputs

Contact rating (resistive load)	250 V, 4A
Contact life	100 000 op

### Technical Data, Analog output

Type	Analog 4-20 mA current loop, passive or active output (external or internal loop supply)
Galvanic isolation	>1500 V RMS or DC
Range	4-20 mA
Alarm level	3.8 mA, 22 mA, "freeze current", Binary High or Binary Low; software selectable
Resolution	0.5 mA (0.003%)
Linearity	± 0.01%
Temperature drift	± 50 ppm/C°
Output impedance	>10 MW
Voltage compliance	7-30 V
External loop resistance	<700 W (passive output with 24 V external supply). <300 W (active output).

### 3.1.8 Database Registers

#### Holding Register

The **Holding registers** store various transmitter parameters used to control the measurement performance.

The database is stored in the non volatile EEPROM memory. It contains tank constants and data controlling the RTG performance. These data is used by the Application Software in order to calculate product level and other values of interest. Since the RTG measures the distance from the RTG to the product surface, the dimensions of the tank are needed in order to calculate the actual product level. The information needed to transform the measured distance into level values is stored in the database registers.

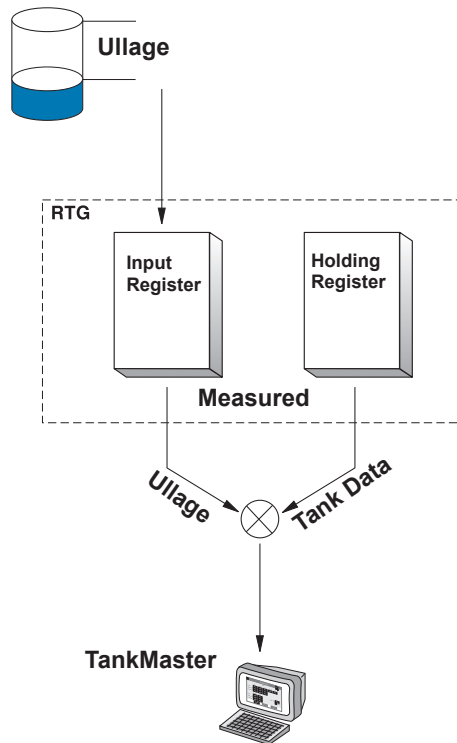


Figure 3-11. Using information from the database the measured ullage is converted to tank level.

The database contains other values than tank dimensions as well. Several registers are used for controlling the RTG gauging process. For example, there are registers which specify the measurement range, and registers which determine the lowest amplitude to be considered as a valid radar echo.

## Input Register

Measured data is continuously stored in the **Input registers** of DAUs, RTGs and FCUs. By viewing the contents of device input registers you can check that the device works properly.

The following summary lists some frequently referred database registers:

### Correction values

Unit ID                      Every RTG, DAU and FCU has a unique Unit ID which is used to identify the unit when installing a Rex system.

### System configuration

RTG address                The assigned Modbus slave address for the RTG. Default value: 246.

DAU address                The assigned Modbus slave address for the associated DAU. Default value: 247.

FCU address                The assigned Modbus slave address for the associated FCU. Default value: 245.

Tank Connection Length, TCL                The electrical distance from the Transmitter Head Electronics to the RTG Reference Point (the electrical distance is not equal to the physical distance). The TCL value is different for different gauge types/antennas. When configuring a Rex transmitter in TankMaster WinSetup you can choose between predefined or user-defined antennas (see TankMaster WinSetup Reference Manual). For a user-defined antenna TCL must be manually entered. For predefined antennas TCL is automatically set.

### Tank Dimensions

Tank Reference Height (R)                The Tank Reference Height (R) is the distance between the Tank Reference Point and the Zero Level (Dipping Datum Point) at the bottom of the tank.

RTG Reference Distance (G)                The RTG Reference Distance (G) is the distance between the Tank Reference Point and the RTG Reference Point. The RTG Reference Point is located at the top surface of the customer's flange or manhole cover on which the gauge is mounted as illustrated in Figure 3-12. For Still Pipe Gauges the RTG Reference point is located at the hand-dip mark on the Still Pipe Gauge Stand. G is positive if the Tank Reference Point is located above the RTG Ref Point. Otherwise G is negative.

Minimum level distance (C)	<p>The Minimum Level Distance (C) is defined as the distance between the Zero Level (Dipping Datum Point) and Minimum Level of the product surface (tank bottom). By specifying a C-distance, the measuring range can be extended to the bottom of the tank. If <math>C &gt; 0</math>, negative level values will be displayed when the product surface is below the Zero Level. Select the <b>Show negative level values as zero</b> check box if you want levels below the Zero Level to be displayed as Level=0.</p> <p>If you set the C-distance =0, measurements below the Zero Level will not be approved, i.e. the RTG will report an invalid level.</p>
Calibration Distance	<p>Calibration Distance is used for calibration of the RTG.</p>
Hold Off Distance (UFM)	<p>The Hold Off Distance (also referred to as Upper Filter Margin) defines how close to the RTG Reference Point measurements are accepted. Normally this parameter should not be changed. The Hold Off Distance may be increased, if for example, there are disturbing echoes from the tank nozzle.</p>

### 3.1.9 Tank Geometry

The following parameters are used for tank geometry configuration of a Rex transmitter:

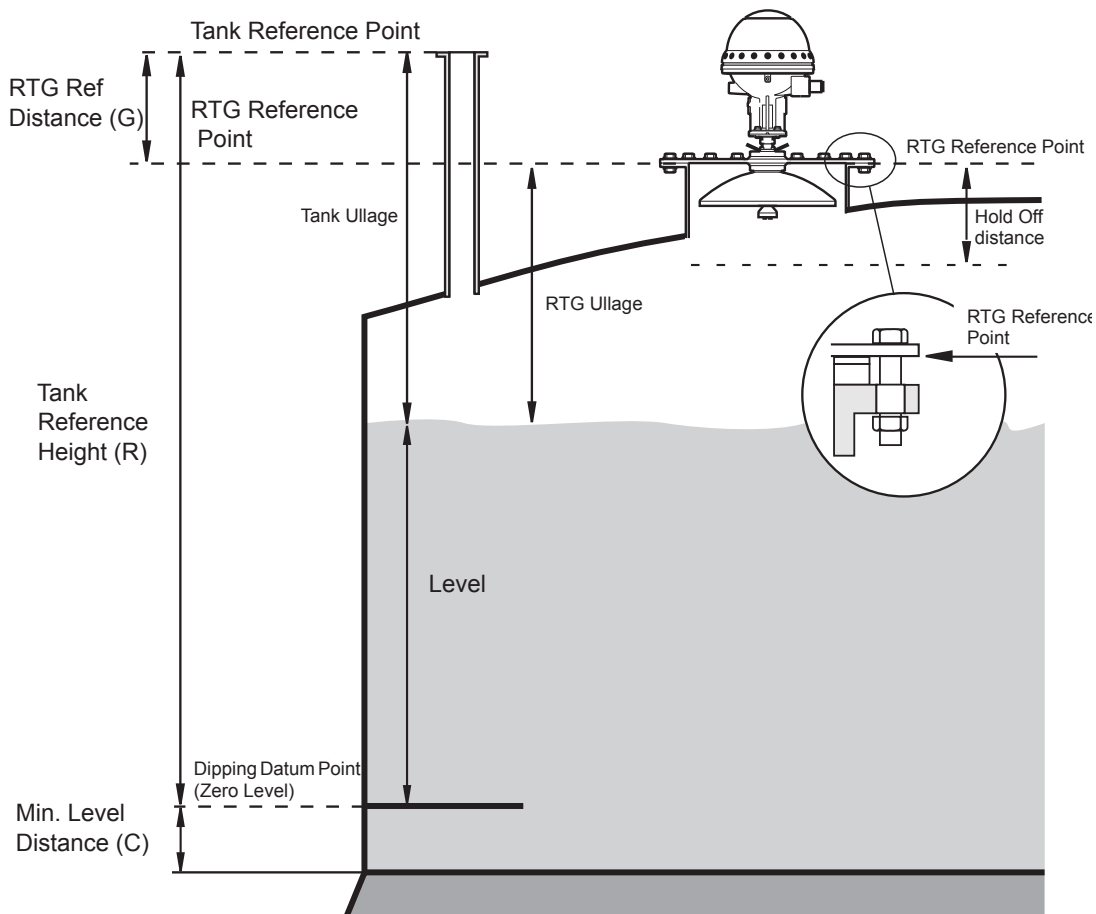


Figure 3-12. Tank geometry

See chapter 3.1.8 for information on the various tank geometry parameters. See also the **TankMaster WinSetup Reference Manual** for information on how to configure a Rex level gauge.

### **3.1.10 Software Description**

The Rex transmitter contains software which controls measurement, communication etc. Each program can be changed by either replacing an EEPROM or by downloading through the TRL/2 bus. Both programs must be changed simultaneously. The EEPROM contains both the Boot and the Application programs.

The transmitter software performs actions as:

- Internal initialization
- Communication handling
- Implementing measurement features
- Internal checks

For further information, see Chapter 4.1.5.

### 3.2 Field Communication Unit (FCU)

The Field Communication Unit, FCU acts as a master of communications on the Field Bus and as a slave on the Group Bus. The FCU is an intelligent data concentrator that continuously collects input data from a group of Radar Tank Gauges and Data Acquisition Units and stores it in a buffer memory.

The heart of the FCU is a microprocessor with RAM and EEPROM for data and program storage.

The FCU is delivered in an IP-65 weather protected, wall-mounted box of the same type as for the Data Acquisition Unit. See Figure 3-13.

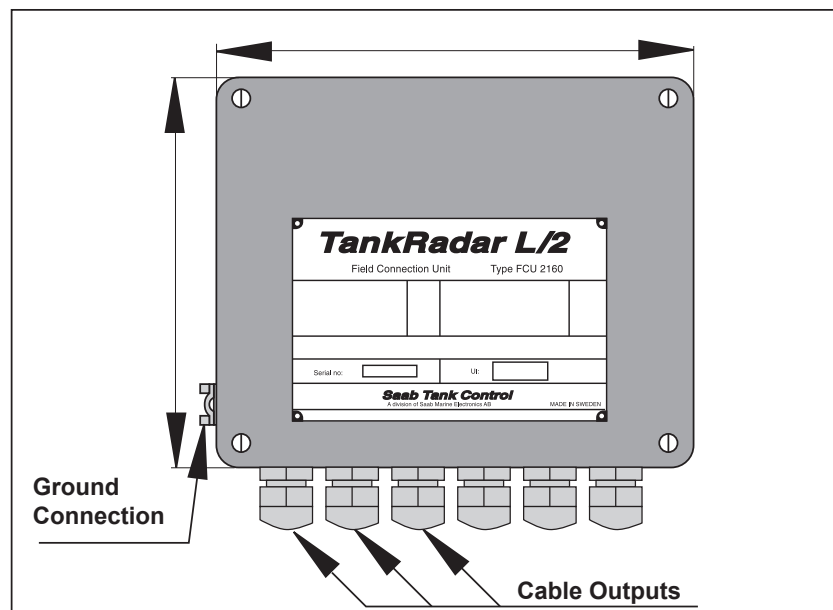


Figure 3-13. Field Communication Unit FCU 2160

---

**Note!** No explosion protection is provided so the Field Communication Unit must be installed in a non-hazardous area.

---



### 3.2.1 Field Bus and Group Bus Communication

The Field Communication Unit has six communication ports, X1 to X6. The standard configuration is six **TCM interface boards** with four TRL/2 Field Bus (FB) ports and two TRL/2 Group Bus (GB) ports. As an alternative, the FCM boards at the Group and Field Bus ports can be replaced with **FCI boards** for RS-485 communication. The FCU communication ports can be configured according to the following table:

X1	X2	X3	X4	X5	X6
FB	FB	FB	FB	GB	GB
FB	FB	FB	GB	GB	GB
FB	FB	GB	GB	GB	GB

The Field Communication Unit has six communication ports for the Field bus and Group bus communication. The Group Bus ports can be used independently of each other. For example, one Group Bus can be connected to a PC with OPI software, and at the same time another Group Bus may be connected to a plant host computer.

There are four Field Bus ports each of which can connect up to eight units. A unit may consist of a Rex gauge, or a Rex gauge connected to a DAU.

If the number of cables to a Field Communication Unit is higher than the capacity of the connectors then standard Junction Boxes (fitted for use in the environment in question) can be used to split the connections.

There is a steel plate to shield the bus ports from the rest of the electronics in the FCU.

### 3.2.2 Input and Database Registers

The input register is a dynamic register which holds the values that the FCU receives over the TRL/2 bus from connected slave units (RTGs, DAUs). Level, temperature and other measured data is stored in the input register, and are sent to the master on request.

The database contains information on program version, communication protocol values, slave configuration, memory configuration etc. It is divided into one write protected and one unprotected part. See Chapter 4.1.7 on how to remove the write protection.

### 3.2.3 Software

The FCU software controls the collection of data from the units connected to the Field Bus, and handles the distribution of data to the TankMaster PC on the Group Bus.

The Group Bus Process and the Field Bus Process work as interfaces to the serial communication control, SCC. The EEPROM switch is used by the program to determine if it is allowed to write to the EEPROM. The watch dog has to be gritted at least every tenth second or else a reset is performed. Direct Memory Access (DMA) channels in the FCU microprocessor are used to write to the SCC.

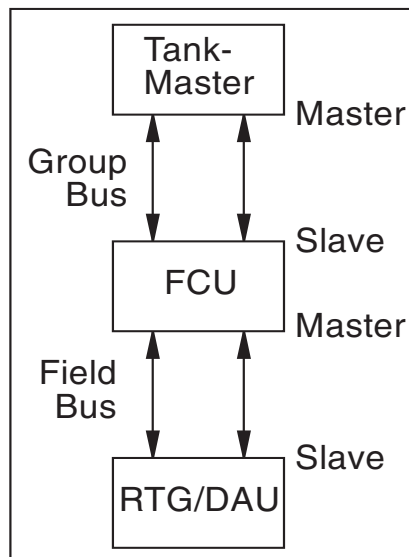


Figure 3-14. Group and Field bus communication

When the Group Bus Process receives a query from the master on the Group Bus, it will translate the query into the MODBUS format if necessary. The query is processed, translated back to the original format and the response is sent back to the master. The processing of the query could be done in the Field Communication Unit or it could request further processing in the slave units (RTGs and DAUs) connected to the Field Communication Unit.

The Field Bus Process scans the slave units as a master. The result of the queries is stored in the standard data registers. It could also get queries from the Group Bus, via the Special Command Process, to be sent out on the Field Bus. The results of those queries are stored in the Special Data Buffer.

### 3.2.4 Redundancy

In order to reduce the risk of communication failure between the TankMaster and the units connected to the TRL/2 field bus, two FCUs can be connected to run in parallel. If one FCU fails, the other one automatically takes over without any action from the operator. The FCUs are connected with an extra cable allowing them to communicate. The inactive FCU constantly checks if the connected FCU is active. If the active FCU fails, it signals to the backup FCU to take over. Then the backup FCU immediately switches to an active state.

### **3.2.5 Connection to a PC**

The FCU can be connected to the PC either directly via a TRL/2 Group Bus or via the RS-232C interface.

The RS-232C connection can be made with 3 wires from the PC to the Field Communication Unit. The cross sectional area must be at least 0.25 mm<sup>2</sup> (AWG 24 or similar). The maximum length of the RS-232C connection is 15 m.

The TRL/2 bus requires a twisted and shielded pair cable with a cross sectional area of min. 0.50 mm<sup>2</sup> (AWG 20 or similar).

### 3.3 Data Acquisition Unit (DAU)

#### 3.3.1 Overview

The Data Acquisition Unit, DAU, is a complement to the Radar Tank Gauge.

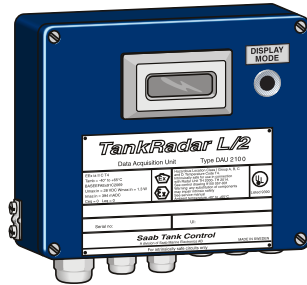


Figure 3-15. The DAU.

The DAU is equipped with an interface for temperature measurement.

#### 3.3.2 Data Acquisition Unit (DAU)

The DAU is intrinsically safe and is connected to the Radar Tank Gauge on the same tank. It receives its power supply and communicates via the Barrier Unit Card in the Radar Tank Gauge.

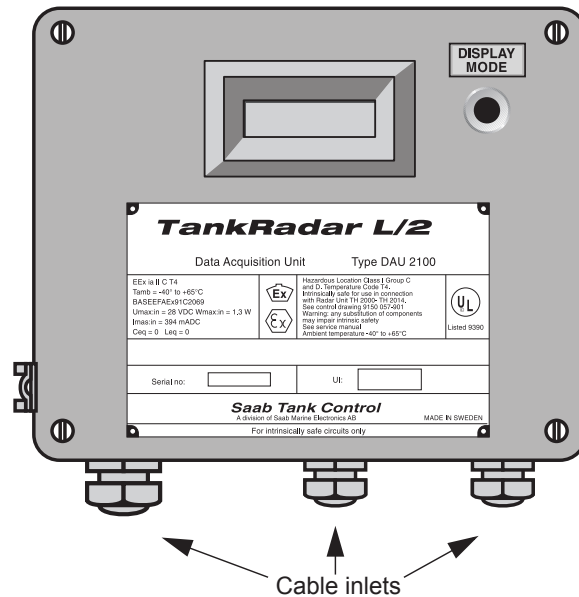


Figure 3-16. DAU

### 3.3.3 Electronics

The DAU's main circuit board is called DMB, DAU Minimum Board.

In Figure 3-17 the block diagram of the DAU is shown.

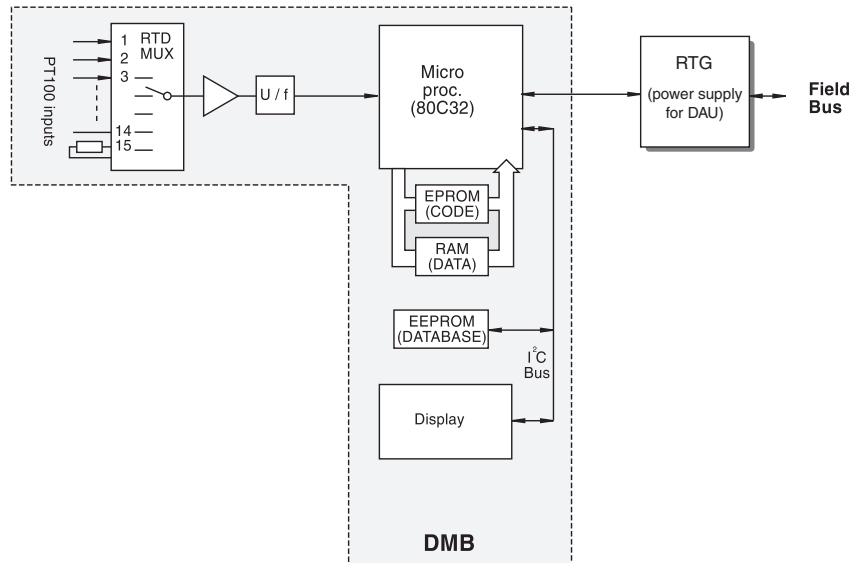


Figure 3-17. Block diagram of the Data Acquisition Unit.

### 3.3.4 Temperature Measurement

#### Temperature sensors

Measuring the product temperature is necessary for correct inventory calculations. Up to 14 temperature sensors can be connected to each Data Acquisition Unit. The temperature elements are placed in a tube which is anchored to the bottom of the tank. Either Pt 100 (spot element) or Cu90 (average sensor) temperature sensors can be used. By using the Pt100 spot sensors, a profile of the temperature at various tank levels is obtained, as well as the average temperature of the liquid. The Cu90 sensors measures the average temperature measured from the tank bottom to the product surface.

#### Reference resistors

There are two reference resistors connected which are used to calibrate the voltage to frequency converter (VCF) feeding the DAU's microprocessor with data from the temperature sensors. The internal 100 W precision reference resistor is connected to channel 0 of the RTD multiplexer. The external reference resistor is connected to channel 15. In some cases there is a third reference resistor connected to the first free temperature sensor input. Using this sensor enables the accuracy to be increased even more.

#### Database

The DAU's database contains several registers for temperature measurements. Temperature range and sensor type may need to be checked before operation. The ratio between the two reference resistances is measured, and the tolerance of the deviation from the nominal value is also stored in the database.

### 3.3.5 RTD Multiplexer

There is an RTD multiplexer for the multiplexing of signals from the Resistance Temperature Detectors (RTDs). See Figure 3-18. Channel 0 is connected to a 100 W precision reference resistor (0.01% accuracy) located on the DMB.

Channel 15 is also connected to an external reference resistor. It is connected to positions 43-45 on the X21 terminal, see chapter 10.5. Depending on which temperature range that has been selected, one out of three reference resistors must be chosen and connected. See also the list "Spare Parts" on page 7-1.

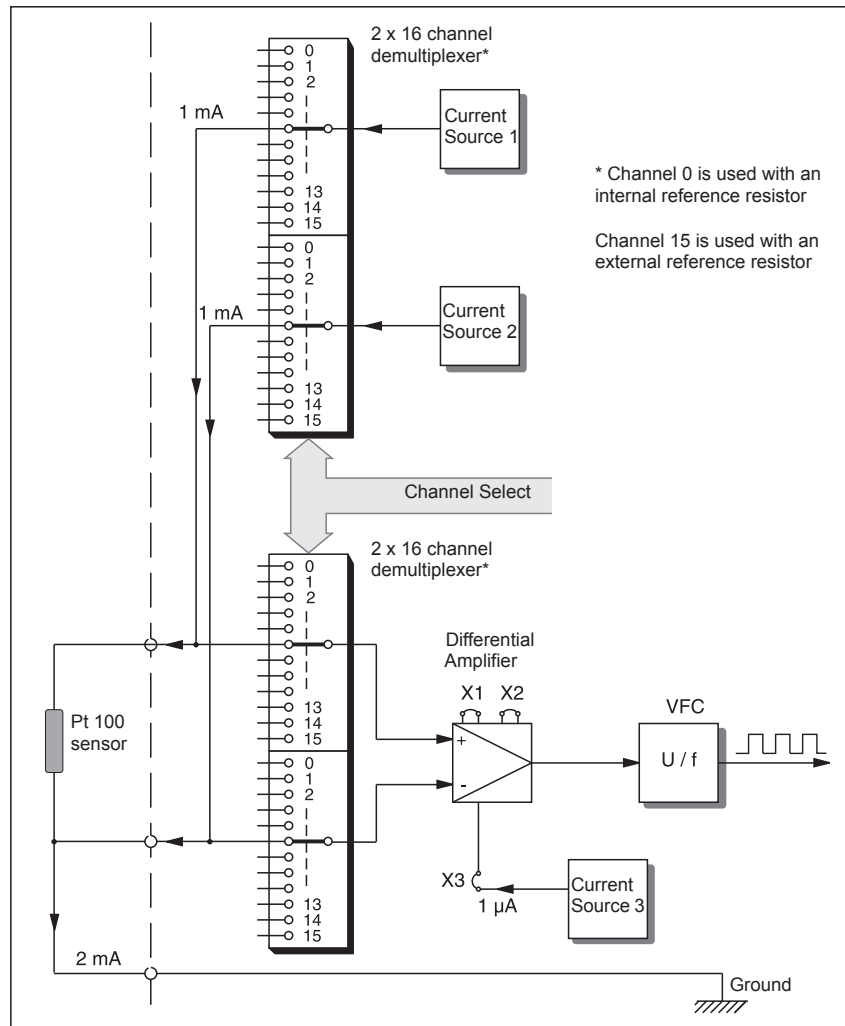


Figure 3-18. RTD Multiplexer

### 3.3.6 DAU Software

The software in the DAU operates in the context shown in Figure 3-19.

The software is made up of various modules called tasks. The tasks are running with the following priorities:

- Task 1: Timer
- Task 2: External communication
- Task 3: Internal communication
- Task 4: Commands decoding and handling
- Task 5: Background tasks

The TIMER task is running at the highest priority so that the communication cannot interfere with the measuring of a sensor.

The DAU controls the installed hardware based on the information stored in the database, and sends error reports if requested data is not available due to hardware failure.

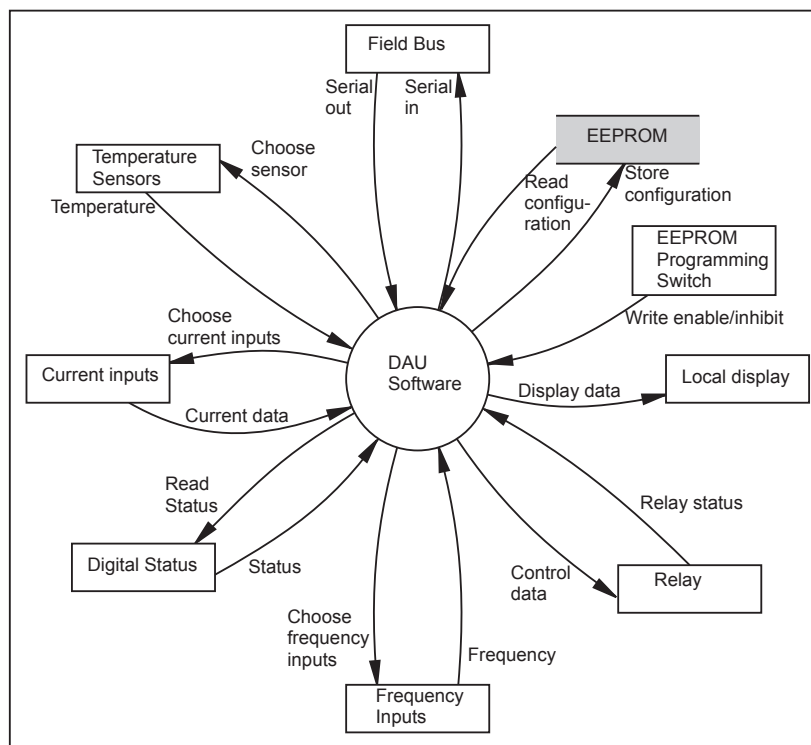


Figure 3-19. The DAU software handles several processes



### 3.3.7 Database Registers

The DAU's database is stored in a nonvolatile memory (it will retain its contents even if the power is turned off), a serial EEPROM. The database is copied to a part of RAM that acts as a Shadow RAM in order to increase performance when accessing the database. The database contains tank specific values like the height of the temperature sensors.

At start up the software determines whether it was a power on or a reset from the Watchdog. At power on it tests the checksum of the program stored in the EPROM, and runs a test of the entire RAM. If any faults are found, these are flagged in status registers. Then the checksum in the database is tested. If it is OK, the data base is loaded into the shadow RAM. If it is not OK, this is indicated in status registers, and a default database is restored in the EEPROM and RAM.

The program will also conduct memory tests during the usual chores. The RAM test is run approximately every 20:th second. The EPROM and EEPROM tests are run at intervals of 80 minutes separated by 40 minutes. It takes two consecutive errors to be detected before the error is signaled to the bus-master.

### 3.3.8 Local Display

The DAU is equipped with an LCD-display as a Local Readout function. The display shows the level of the associated RTG, values measured by the DAU itself and error codes.

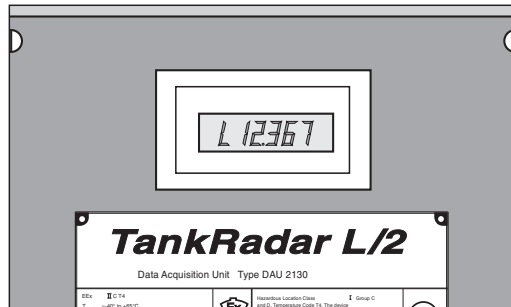


Figure 3-20. DAU LCD-display

### 3.3.9 Level value pick-up

There are several DAU functions which require level data from the associated RTG:

- The optional DAU local display can show tank level measured by the associated RTG.
- In order to calculate a correct product temperature, it is necessary to exclude the temperature sensors above the product surface from the calculations.

The DAU constantly listens to the communication that takes place on the TRL/2 Field Bus. The DAU is able to detect a query for level data to its associated RTG.

The following process takes place when a master sends a query for a level value to an RTG connected to the TRL/2 bus:

- 1 The Field Communication Unit (FCU) acting as a **master** on the TRL/2 Field Bus, sends a query for level data to the RTG.
- 2 The RTG and its associated DAU detect the query for level data.
- 3 The RTG, acting as a slave, replies with the current level value.
- 4 The associated DAU picks up the level value that is sent by the associated RTG to the FCU.

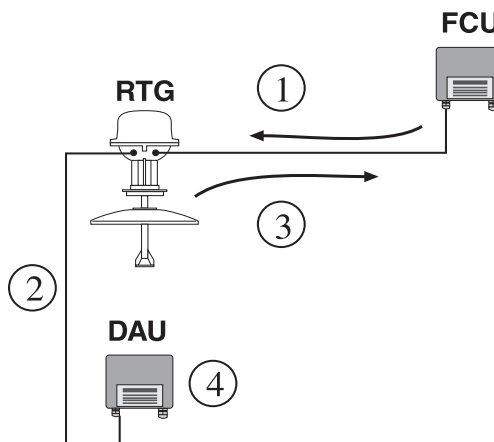


Figure 3-21. DAU level pick up

**Note!**

A prerequisite for the DAU to correctly pick-up level data from the associated RTG is that the address of the RTG is known by the DAU.

### 3.3.10 Automatic test of temperature references

The reference resistors are automatically tested by calculating the ratio between the temperature references,

$$\frac{Hi_{ref}}{Lo_{ref}}$$

This value is put into Input register 10. The ratio is compared with a nominal value which depends on the selected temperature range. The tolerance of the value is set in Database registers 307-310.

## 3.4 Remote Display Unit 40 (RDU 40)

The RDU 40 is a display unit for use with Rosemount TankRadar Rex and Rosemount TankRadar Pro. The display functions are controlled by the software of the connected TankRadar gauge.

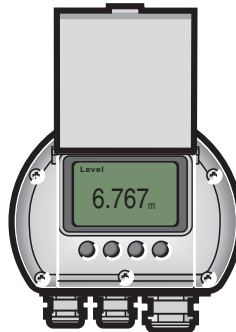


Figure 3-22. RDU 40 can be configured to show various measurement variables such as Level, Temperature, Volume etc.

For installation instructions see section “RDU 40” on page 4-69.

The RDU40 is used for monitoring measured data. To configure a TankRadar Rex gauge use the *TankMaster Winsetup* configuration software.

Configuration and installation of the RDU40 is described in the **Display Unit RDU 40, User’s Guide (Ref. no. 308010EN)**.

---

**Note!**

Check that the Rex Software version is 1.D2 or later, and that the RDU 40 Software version is 1.B1 or later.

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## 4. Service

### 4.1 Rex RTG

#### 4.1.1 How to initiate an echo search

There are several ways that an echo search can be initiated:

- Switch power supply off and on. A search is automatically performed.
- Restart the RTG:
  - 1 Select the transmitter icon in the *TankMaster WinSetup* workspace window.
  - 2 Click the right mouse button and choose the **Restart** option or-  
from the **Service** menu choose Devices/Restart.

#### What happens after a power on?

- 1 An internal check of software version and memory status is done.
- 2 The communication is enabled.
- 3 The sweep generation is started. A “dummy” sweep is generated until the sweep is linear (warm-up mode).
- 4 The level gauging starts with a search through the tank to find the level of the product.
- 5 When the level is found, the normal gauging procedure starts.

#### What happens during a search?

A microwave signal is sent towards the product surface with a continuously varying frequency. The reflected signal is mixed with the outgoing signal, resulting in a low-frequency signal which is proportional to the distance to the liquid surface. By using a signal processing technique based on Fast Fourier Transformation (FFT), a frequency spectrum of all echoes in the tank is obtained. From this spectrum the surface level is extracted with high accuracy.

#### 4.1.2 Viewing and Editing database registers

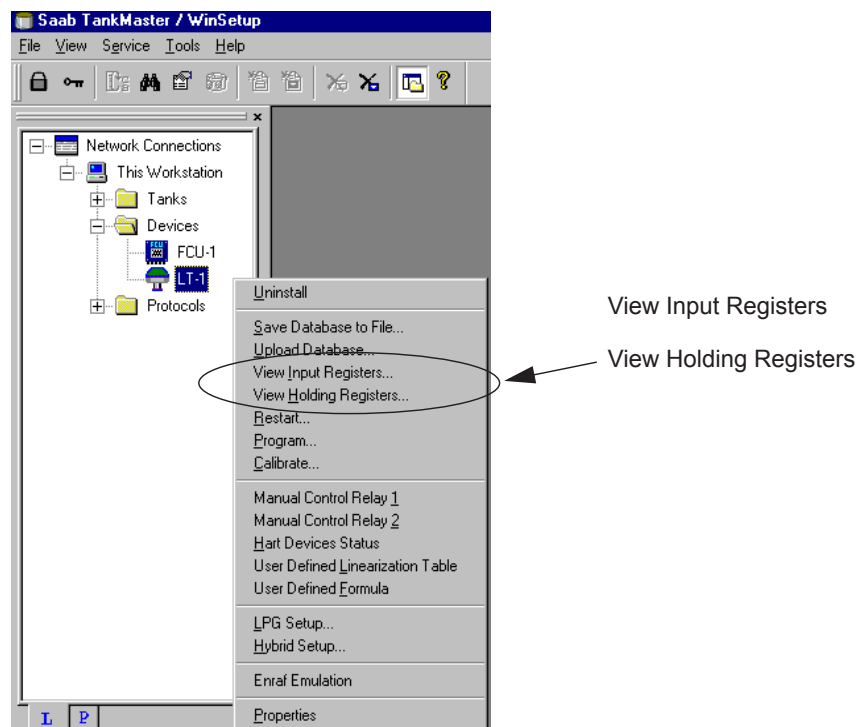
Measured data is continuously stored in the **Input registers** of DAUs, RTGs and FCUs. By viewing the contents of device input registers you can check that the device works properly.

The **Holding registers** store various transmitter parameters used to control the measurement performance.

Most **Holding registers** can be edited by simply typing a new value in the appropriate **Value** input field. Some holding registers (marked grey in the Value input column) can be edited in a separate window. In this case you can choose from a list of options or you can change separate data bits.

#### To view/edit input or holding registers of a certain device:

- 1 Select the desired device icon in the *TankMaster WinSetup* workspace window and click the right mouse button and choose the **View Input/Holding Registers** option.



For further information on viewing and editing database registers, see **TankMaster WinSetup Reference Manual**. See also the Rex Input/Holding Register Descriptions.

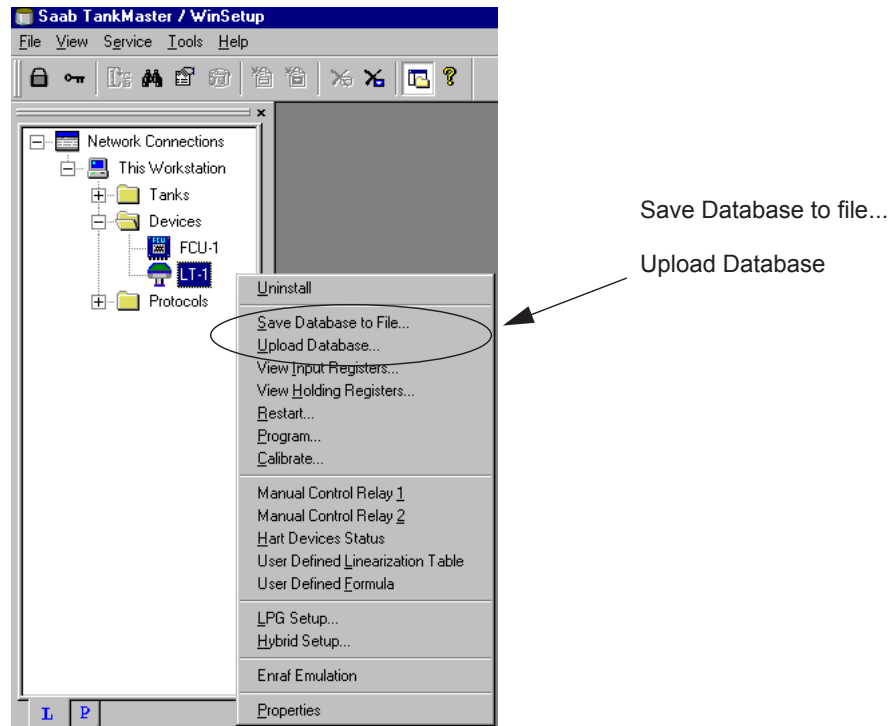
### 4.1.3 Loading and Saving a device database

Each device (RTG, DAU and FCU) is equipped with a database of parameters used by the Application Software to control the performance of the device. *TankMaster WinSetup* offers the option to load a new database to replace the current one. This can be useful if, for example, you want to try out new database settings and then want to reload the original database.

The **Save Database to File** function in the TankMaster WinSetup is used to store the registers from FCUs, RTGs and DAUs. The main use of the **Save Database to file** function is for service purposes. The registers can be stored into files on the hard disk of the PC or to a diskette.

#### To load/save database registers:

- 1 Select the desired device icon in the *TankMaster WinSetup* workspace window and choose the Upload **database/Save Database to File** option.



For further information on how to loading and saving database registers, see **TankMaster WinSetup Reference Manual**.

#### 4.1.4 Loading the default database

The **Default Database** is the original factory setting for the RTG Database.

*TankMaster WinSetup* offers the option to load the **Default Database**. This can be useful if, for example, you want to try new database settings and then want to reload the original factory setting, or when the tank conditions have been altered. If error messages appear or other problems occur concerning the Database a troubleshooting is recommended before loading the **Default Database**.

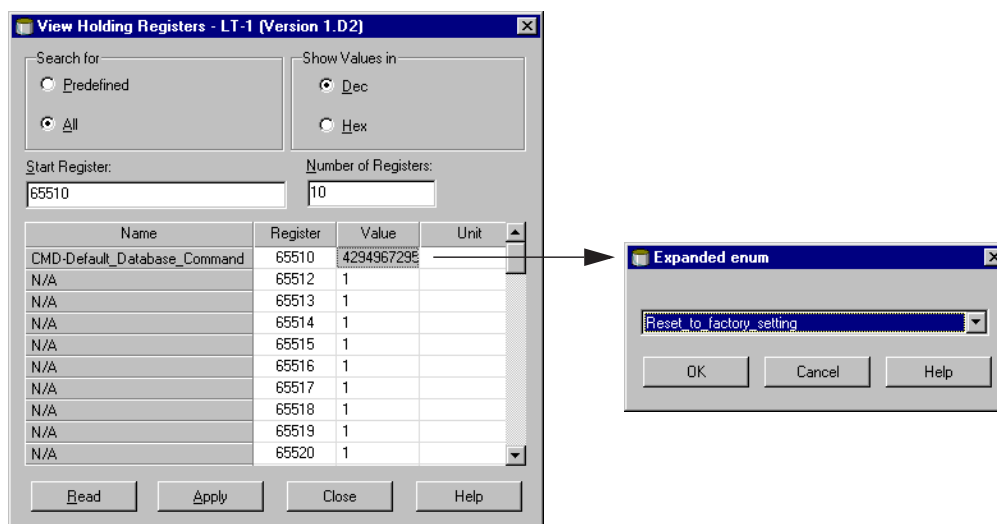
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*Note!*                    *The device address remains unaltered when the default database is loaded.*

---

#### To load the default database:

- 1 Select the desired device icon in the *TankMaster WinSetup* workspace window.
- 2 Click the right mouse button and choose the **View Holding Register** option.
- 3 Choose the **All** option and type 65510 in the **Start Register** input field. Type the desired number of registers to be displayed in the Number of Registers field and click the **Read** button.



- 4 Double click in the **Value** input field.
- 5 Select **Reset\_to\_factory\_setting** from the list of options
- 6 Click the **Apply** button.



### 4.1.5 Installing new Transmitter Software

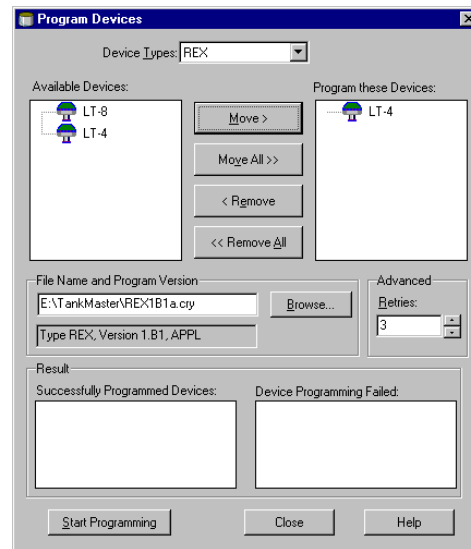
The transmitter software is stored in flash EEPROM. The software consists of **boot** software and **application** software. They are both placed in the same EEPROM.

There are two different methods to install new Transmitter Software:

- Downloading
- Changing the EEPROM

#### To download new Transmitter Software:

- 1 Select the **Devices** folder in the *Workspace* window or a single device in the *Devices* folder.
- 2 From the **Service** menu choose **Devices/Program All**  
- or -  
click the right mouse button and choose the **Devices/Program All** option. For single devices choose the **Program** option.

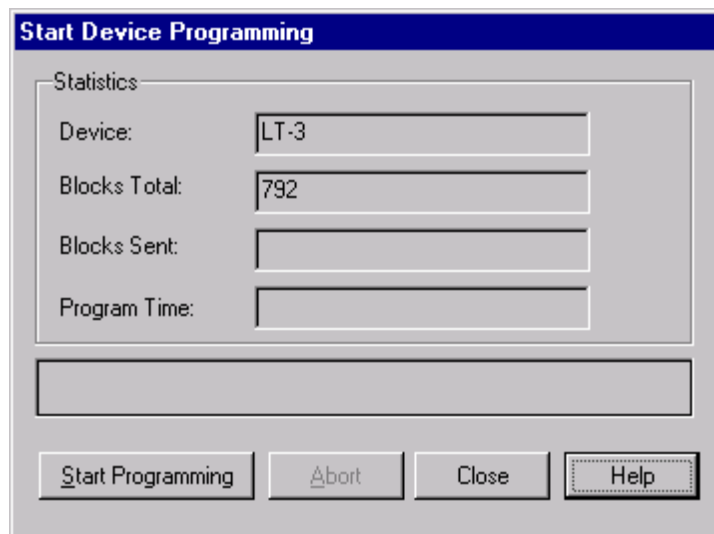


- 3 Select the desired device to be programmed from the **Available Devices** pane and click the **Move** button. Repeat for all devices to be programmed. If a single device was selected in the workspace window, no devices are available in the **Available Devices** pane. In this case the device appears automatically in the **Program these Devices** pane.

Use the **Remove** button if you want to change the list of devices to be programmed.

- 4 Click the **Browse** button and locate the flash program file. Use xxx**B**.cry file for **Boot Software** and xxx**A**.cry file for **Application Software**. Always start by downloading the Boot Software.
- 5 Click the **Start Programming** button.

*Response:* the Start Device Programming window is opened.



- 6 Make sure the devices are properly prepared for reprogramming and click the **Start Programming** button to activate the programming process.

*Response:* the programming is started.

*Comment:* It may take up to 2 minutes to download a flash program.

A maximum of 25 RTGs can be programmed for one FCU. If more RTGs are connected the programming must be performed in two steps. When programming is performed via a FCU only one Group Bus port may be used. The FCU must be restarted prior to the programming of the RTGs.

- 7 Update the TankMaster installation by copying the Rex \*.ini-files for TankMaster that correspond to the new Rex software version to the folder where TankMaster is installed. For example:

The **Rex.ini** file is copied to the \*/Saab/Server folder. The other \*.ini-files, for example **Rex\_1E4.ini**, are copied to the \*/Saab/Shared folder.

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*Note!* When new application software has been downloaded, the actual program version does not correspond to the text on the label on top of the EEPROM.

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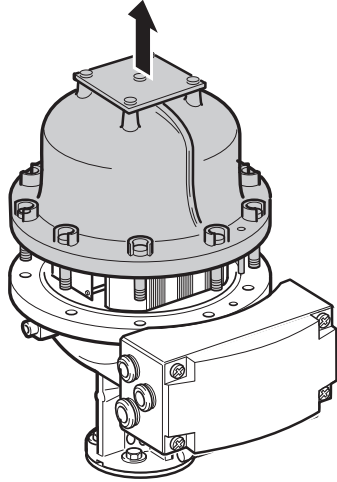
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**Changing EEPROM:**

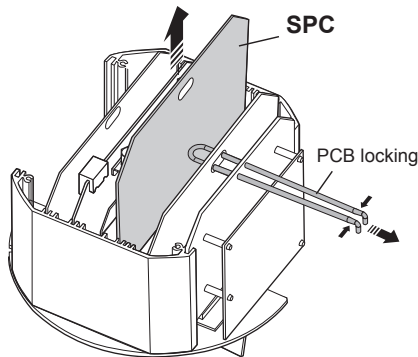
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*Note!*                    *Make sure that power is turned off*

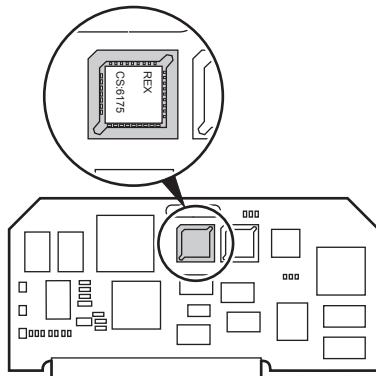
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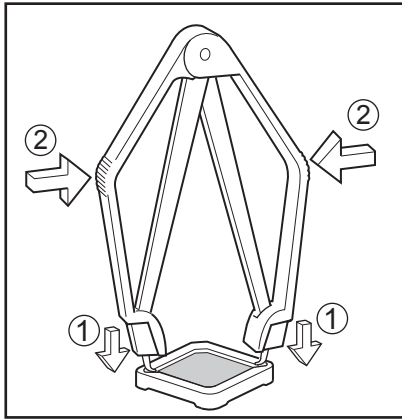
- 1 Check if there is any screw that is sealed. Contact Rosemount Tank Gauging before breaking the seal if warranty is still valid. Completely remove the seal so that it does not damage the threads. Loosen the screws and remove the cover.



- 2 Remove the PCB locking from the THE and remove the SPC board.

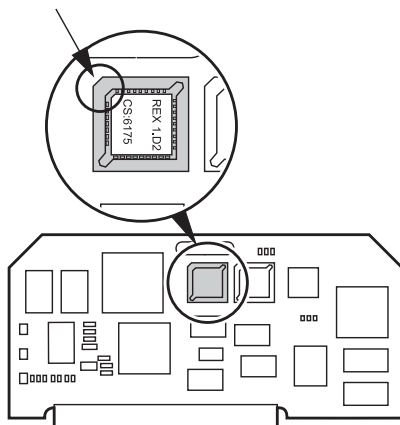


- 3 The EEPROM is located on the SPC board and mounted in a socket.



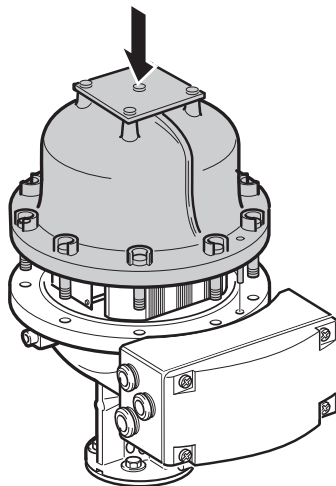
- 4 Remove the old EEPROM by using the IC Extractor tool. Do not use a screwdriver or similar tools.

Cut off corner



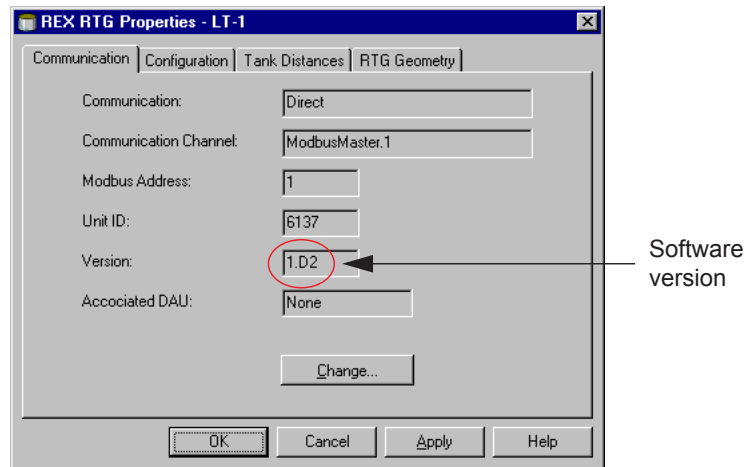
- 5 Place the new EEPROM into the socket. Make sure that the cut off corner is placed in the right position.

**Note!** Make sure that necessary precautions are taken in order to prevent electrostatic discharge from damaging the EEPROM.



- 6 Replace the SPC board, PCB locking and cover. Check that contact surfaces on the transmitter housing and cover are clean. Tighten the screws. Turn power on.

- 7 Check the Software version in TankMaster WinSetup:
  - 1 Select the desired device icon in the workspace window.
  - 2 Click the right mouse button and choose the **Properties** option.
- 8 Choose the Communication tab. Now the transmitter software version is displayed in the Version field.



---

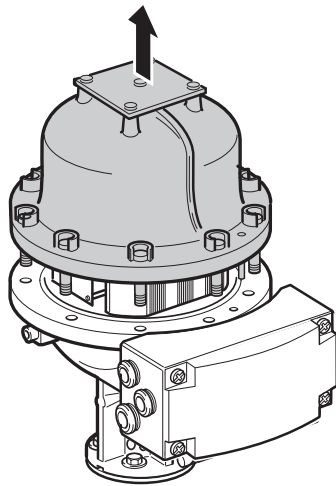
*Note!* Check that the Software version on the label of the EEPROM correspond to the version displayed in TankMaster.

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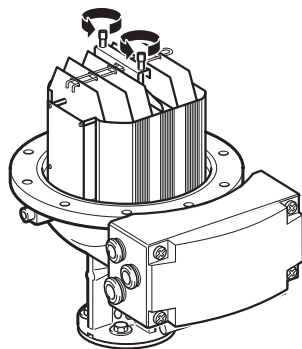
### 4.1.6 Exchanging the Transmitter Head Electronics

*Note!* Make sure that power is turned off

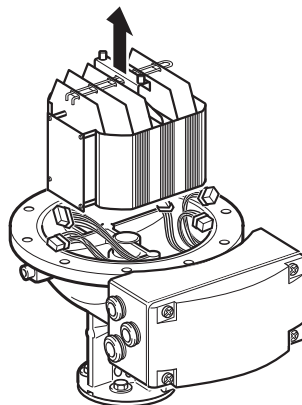
#### Removing the THE



- 1 Check if there is any screw that is sealed. Contact Rosemount Tank Gauging before breaking the seal if warranty is still valid. Completely remove the seal so that it does not damage the threads. Loosen the screws and remove the cover.



- 2 Loosen the two screws which hold the electronic unit.



- 3 Carefully lift the Electronic Unit. Remove the cable connectors. Handle the Electronic Unit carefully. Be especially careful with the PTFE plug at the center of the bottom of the Electronic Unit.

## Replacing the THE

- 1 Connect the cables to the THE. See Figure 4-1 below. Press firmly so that the connectors lock into place.

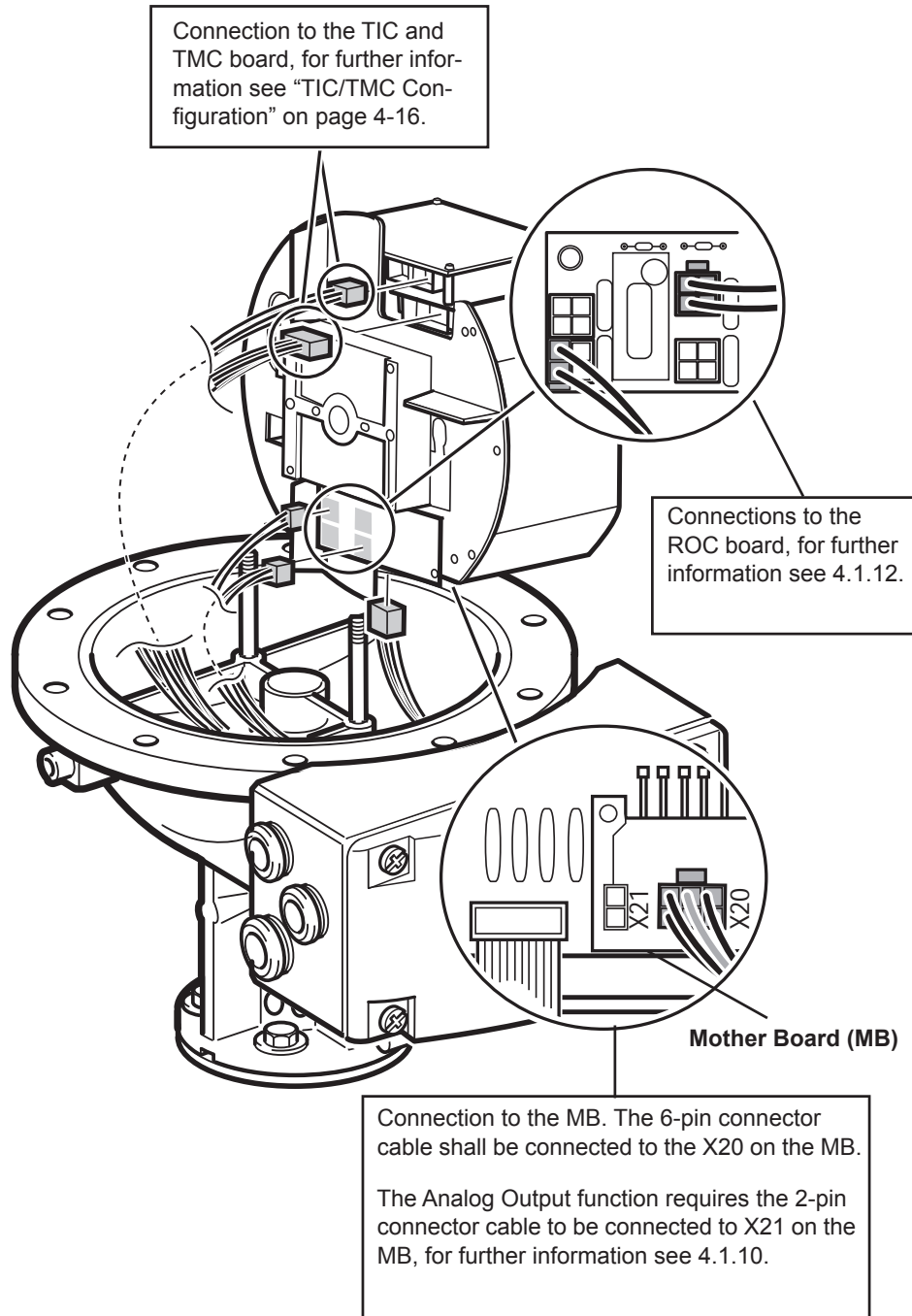
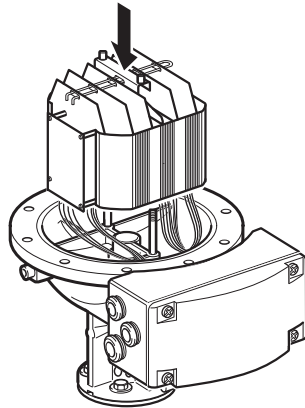
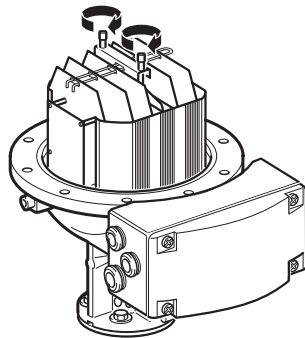


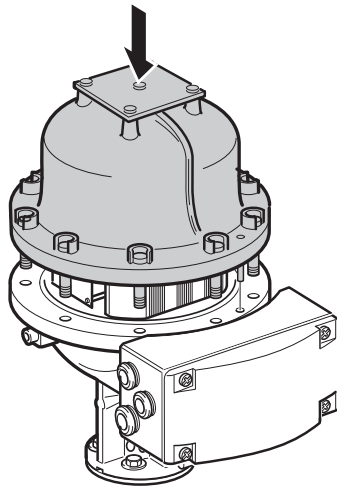
Figure 4-1. Transmitter Head Electronic connections.



- 2 Make sure that the PTFE plugs are clean. Lower the THE. Make sure that the cables are not stuck between the THE and the base of the enclosure. The THE must rest firmly on the base so that there is no gap for the microwaves to bridge.



- 3 Tighten screws on the bar to secure the THE.



- 4 Replace the cover. Check that contact surfaces on the transmitter housing and cover are clean. Tighten the screws.

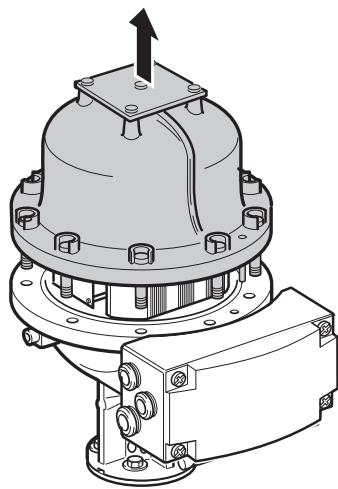


### 4.1.7 Write protection (Metrological Seal)

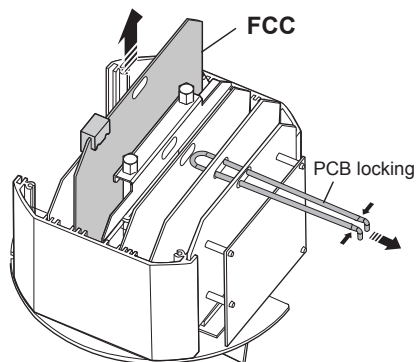
A switch on the FCC board can be used to prevent unauthorized changes in the RTG database. The switch can be sealed in the write-inhibit position by using a special plastic cover.

If there are problems writing to the database EEPROM, then check the setting of the Metrological Seal.

#### How to write protect the EEPROM

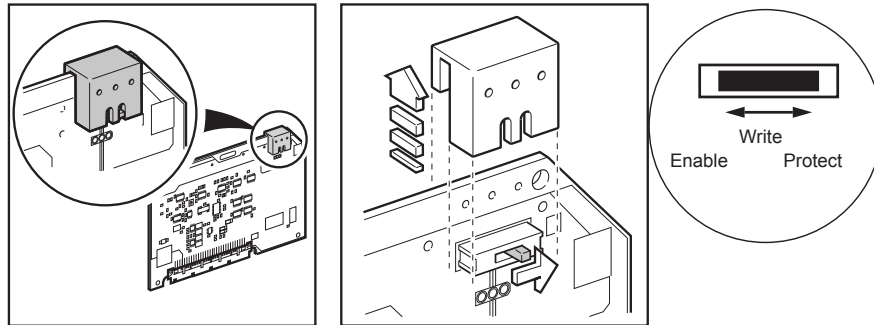


- 1 Check if there is any screw that is sealed. Contact Rosemount Tank Gauging before breaking the seal if warranty is still valid. Completely remove the seal so that it does not damage the threads. Loosen the screws and remove the cover.

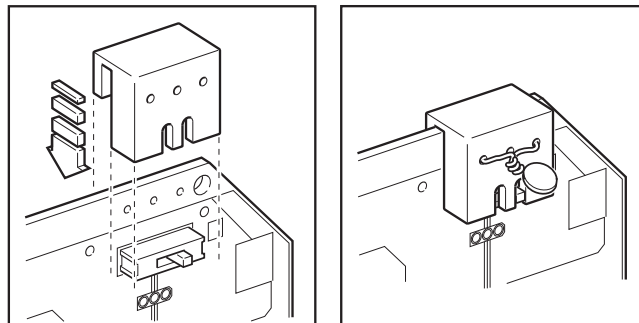


- 2 Remove the PCB locking from the Transmitter Head and remove the FCC board with the metrological seal.

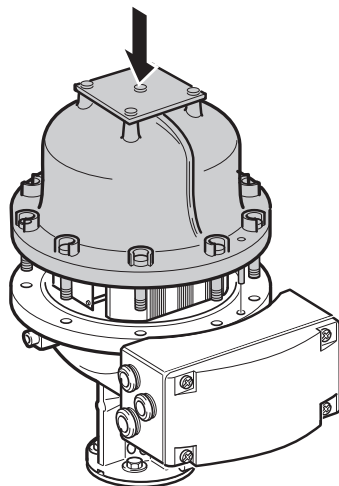
- 3 Remove the plastic cover and turn the switch to the right.



- 4 Replace the plastic cover and seal the switch in the write protect position.



- 5 Replace the FCC board and the PCB locking. Check that contact surfaces on the transmitter housing and cover are clean. Replace the cover and tighten the screws.



#### 4.1.8 Temperature measurement

The Rex transmitter can be connected to 1-3 single spot temperature elements, or to 1-6 multiple spot common return or average elements if the *Temperature Multiplexer Card (TMC)* is installed.

Max 6 sensors can be connected to the transmitter (sensor number 1 must have the lowest tank position etc.). The sensors must be of the same type (average or spot).

The TMC board must be configured in accordance with the type of sensor that is used, see .

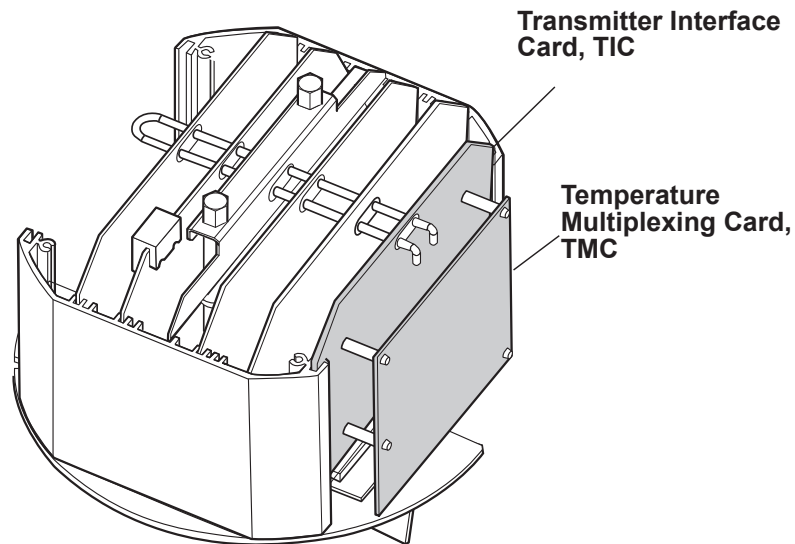


Figure 4-2. Transmitter Interface Card (TIC) and Temperature Multiplexing Card (TMC)

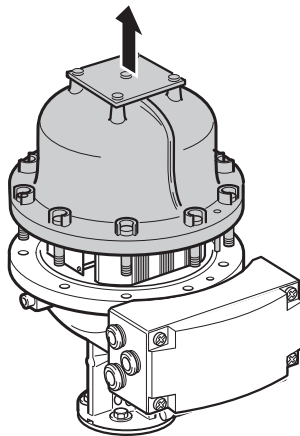
## TIC/TMC Configuration

The TMC board is configured depending on what type of sensor that is used. The jumpers are installed at factory and do normally not need to be changed. If you need to change TMC board configuration, for example if other sensor types than originally specified will be used, do the following:

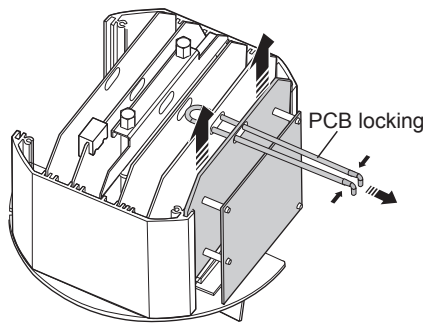
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*Note!*                    *Make sure that power is turned off.*

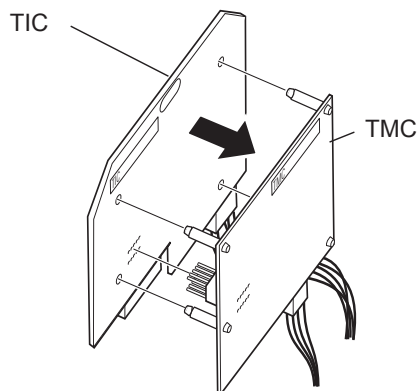
---



- 1 Check if there is any screw that is sealed. Contact Rosemount Tank Gauging before breaking the seal if warranty is still valid. Completely remove the seal so that it does not damage the threads. Loosen the screws and remove the cover.



- 2 Remove the PCB locking from the transmitter head and remove the TIC/TMC board.



- 3 Carefully separate the TMC from the TIC board.

- 4 Set jumpers on the TMC board to **one** of the following alternatives:

**1-6 multiple spot or average elements**

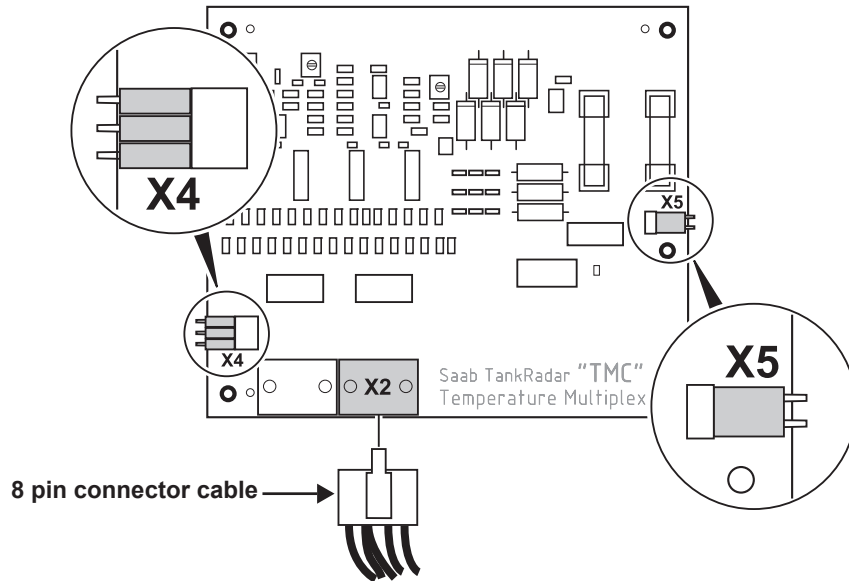


Figure 4-3. TMC board configured for 1-6 multiple spot or average elements

- Set **three** jumpers in socket X4 and **one** jumper in socket X5.
- Connect the 8-pin connector cable to the X2 connector on the TMC board.
- Check that the Temperature sensors are properly connected to X12, see the **Tankadar REX Installation Manual**.

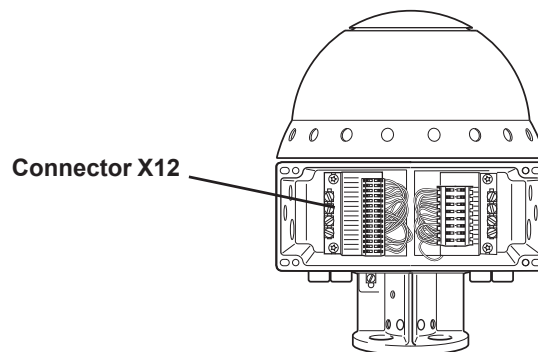


Figure 4-4. Connector X12

### 1-3 spot elements

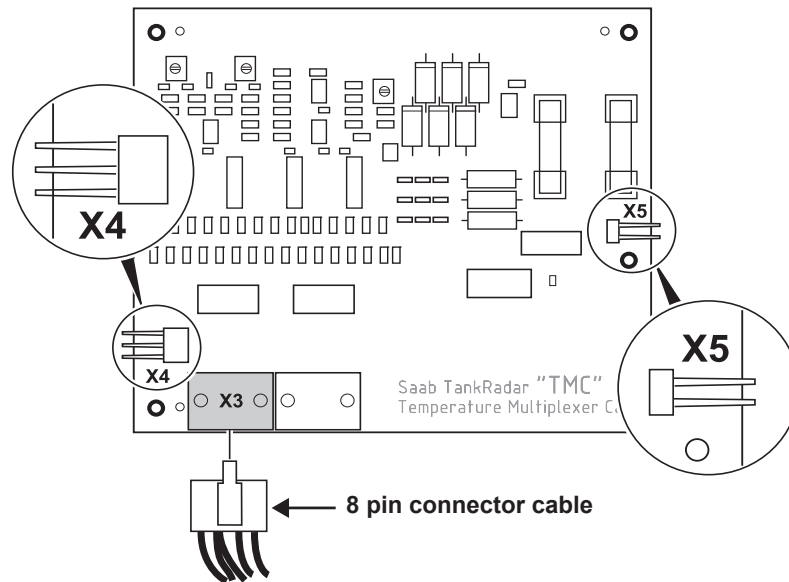


Figure 4-5. TMC board configured for 1-3 spot elements

- **No jumpers in socket X4 and X5!**
- Connect the 8-pin connector cable to the X3 connector on the TMC board.
- Check that the Temperature sensors are properly connected to X12, see the **TankRadar REX Installation Manual**.

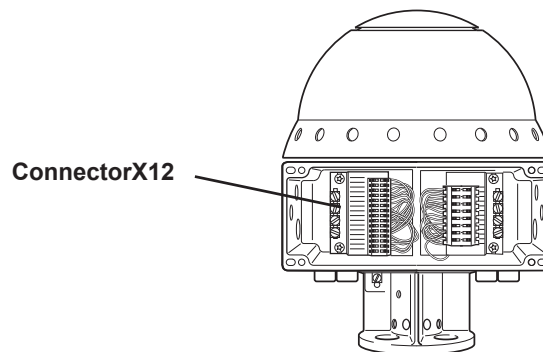
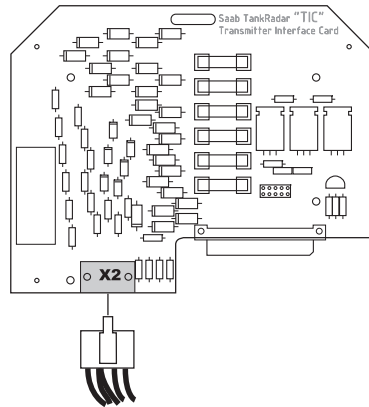
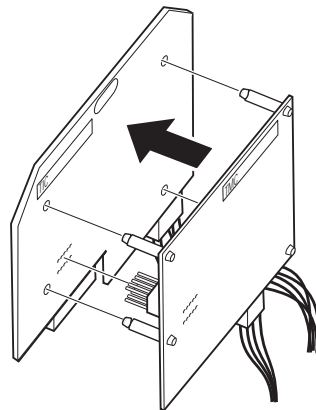


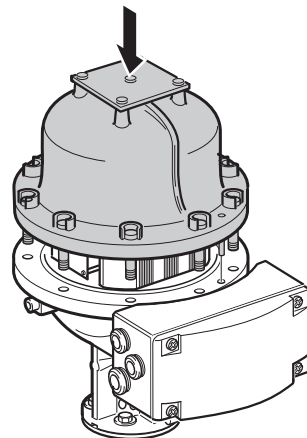
Figure 4-6. Connector X12



- 5 Make sure the 10-pin connector is connected to socket X2 on the TIC board.



- 6 Carefully attach the TMC on the back of the TIC.



- 7 Replace the TIC/TMC board and the PCB locking. Check that contact surfaces on the transmitter housing and cover are clean. Replace the cover and tighten the screws.

## Temperature sensor configuration

By using TankMaster WinSetup you can configure the transmitter by specifying sensor type, sensor range and sensor positions. See **WinSetup Reference Manual** for further information on how to configure the temperature sensors.

Following options are available in TankMaster WinSetup:

- **Spot DIN PT100** - for Spot and Multiple Spot sensors.
- **Avg. CU90** - for Average Temperature sensors.
- **User Defined** - The characteristics are specified by a mathematical formula or a linearization table (see WinSetup menu option Service>Devices>User Defined Linearization Table/Formula)

## Troubleshooting

If the temperature values are incorrect or are not shown check the following:

- TankMaster WinSetup; click the right mouse button on the Rex icon and choose **Properties>Configuration>Temp Input**. Check that the Enable/Disable check box is selected. Check the sensor position.
- The Device Error and Device Warning status in **Input Register 2**.
- The Temperature sensor status in **Input Register 27**.
- The Temperature sensor status in **Input Registers 4460, 4466, 4472 etc**. Double click the Status field for detailed information.
- The temperature values in **Input Registers 4462, 4468, 4474 etc**.
- The Sensor resistance values in **Input Registers 4464, 4470, 4476 etc**.
- Jumper settings and cable connections, see "TIC/TMC Configuration" on page 4-16.
- FCU Slave Database configuration (see WinSetup Reference Manual): check that the right number of temperature sensors are given. Also check that Interval 2 is set to 10.

See chapter 4.3.2 for information on how to check the temperature sensors.

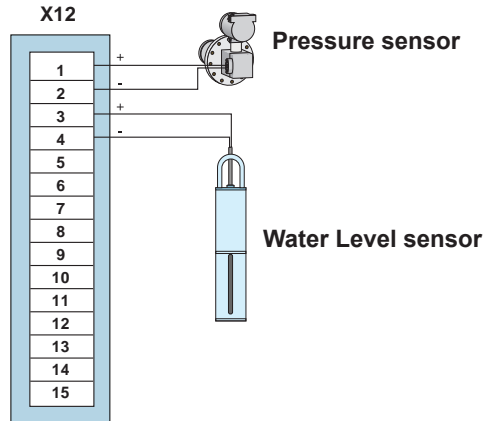
For a general overview of status and configuration check Holding Registers 3300-3542.



### 4.1.9 Analog inputs

Rex supports two high precision 4-20 mA analog inputs. Using the analog inputs requires that the transmitter is equipped with the *Transmitter Interface Card (TIC)*.

Analog Input 1 may be used to connect up to 3 HART Slaves (requires Multi FCC card). See 4.1.11.



*Figure 4-7. Connection of analog input instruments to the Rex Junction Box.*

The Analog Inputs are identified automatically by the software. The TIC board must be detected before this function is enabled.

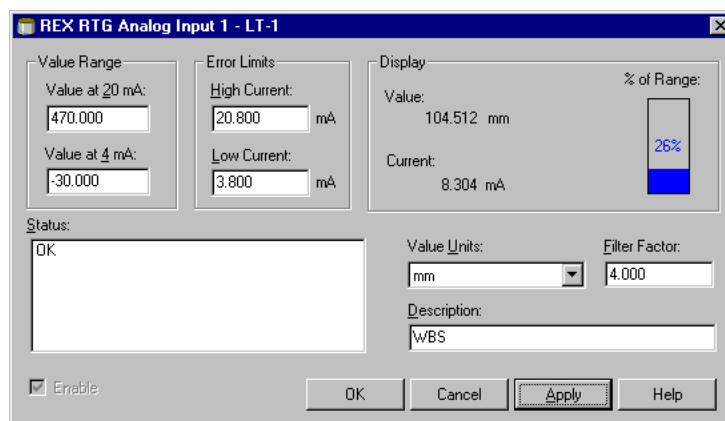
Analog inputs are connected to socket X12 for intrinsically safe connections in the Rex Junction Box. For further information on how to connect analog inputs see the **TankRadar Rex Installation Manual**.

*Note!* *Analog inputs can only be enabled at factory.*

## Software configuration - Analog inputs

To configure the analog input signals, do the following:

- 1 Select the desired Rex transmitter icon in the *TankMaster WinSetup* workspace.
- 2 Click the right mouse button and choose the **Properties** option, select the **Configuration** tab and click the appropriate **Analog Input** button.



- 3 Set the following parameters:

**HART slaves** - up to three HART slaves can be connected to Analog 1 using address 1-3, see the **TankRadar REX Installation Manual**. In this case the current is set to 4 mA.

In Analog Current mode only one HART slave is allowed. In this case address 0 must be used.

**Value range** - enter the lower and upper limits corresponding to the 4 mA and 20 mA input currents, respectively.

**Error limits** - defines the lower and upper limits of the input current. Outside this range an error will be indicated. Set the lower error limit to 3-4 mA and the upper error limit to 20-24 mA corresponding to the error limits of connected instruments. If for an example an instrument sets the output current in alarm mode to 3.8 mA, you should set the lower error limit to 3.8 or higher.

**Value unit** - choose a suitable measurement unit. You can choose between various units to indicate pressure, product level and current.

**Filter factor** - set a value between 1 and 200 to suppress spurious fluctuations in the analog input signal. Default value is 4.

For information on Analog Input configuration see also the **WinSetup Reference Manual**.

---

**Status information**

If the input values are incorrect or are not shown in TankMaster check the following:

- Analog Input Configuration, see “Software configuration - Analog inputs” on page 4-22.
- Device Error and Device Warning status in Input register 2.
- Analog Input Status (connection status, calibration mode, above/under limit etc.) and the Analog Input Value in Input registers 4420-4434.
- Analog Input Value Unit, Filter Factor, Lower/Upper range, High/Low current limit, Calibration method etc. in Holding registers 3200-3270.
- FCU configuration: check the number of Analog Inputs in the FCU Slave Database.

---

#### 4.1.10 Analog outputs

---

*Note!*            *The Multi Field Communication Card, version 9150072-673 or later is required.*

---

Rex supports one analog output signal.

The analog output replaces the second relay output. In this case the Relay 2 cabling is disconnected from the Relay Output Card (ROC) and connected to the MotherBoard.

The FCC board must be configured for Analog Output. Jumper settings are required depending on if the Current Loop Output is active (internal loop supply) or passive (external loop supply).

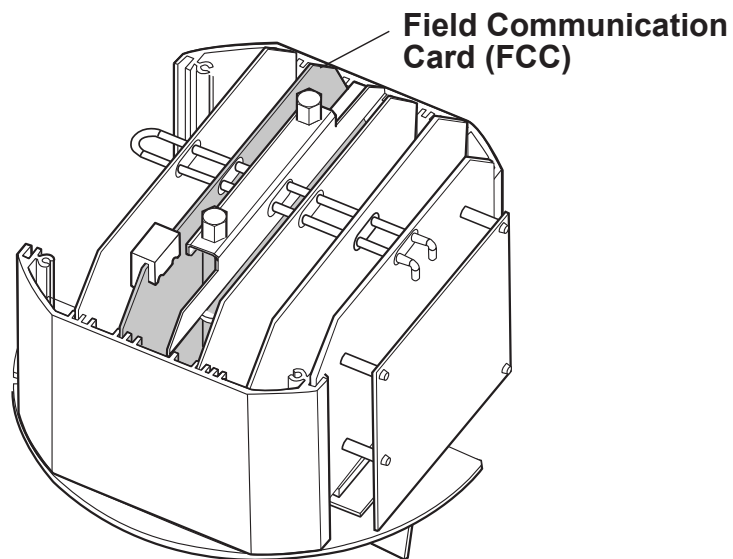


Figure 4-8. Field Communication Card (FCC)

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### FCC Configuration of Analog Output

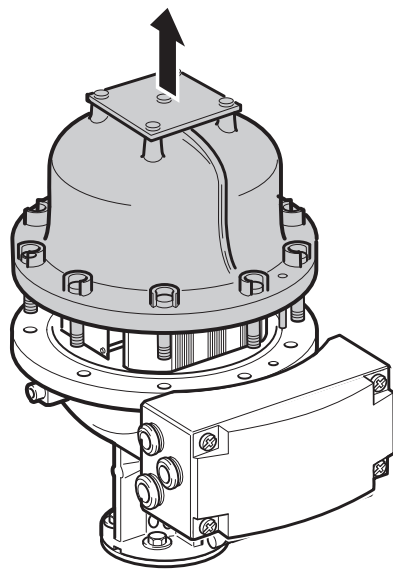
In order to use the Analog Output function the cabling must be disconnected from the ROC board and connected to the Mother Board.

Jumper settings on the FCC are needed in order to configure the card for Current Loop Output active (internal loop supply) or passive (external loop supply).

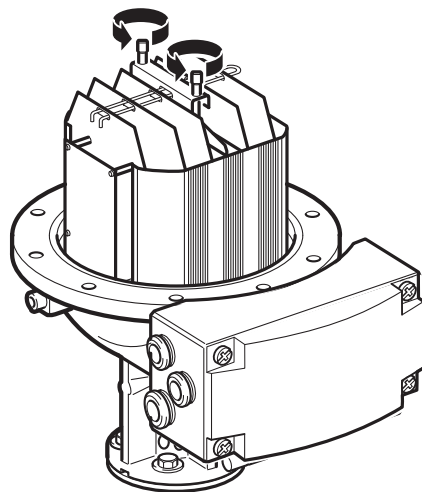
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*Note!*                      *Make sure that power is turned off before opening the cover.*

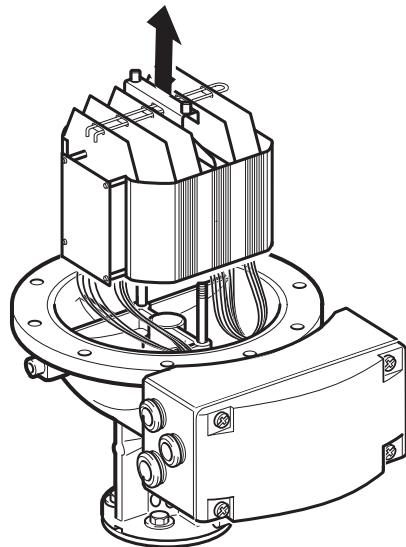
---



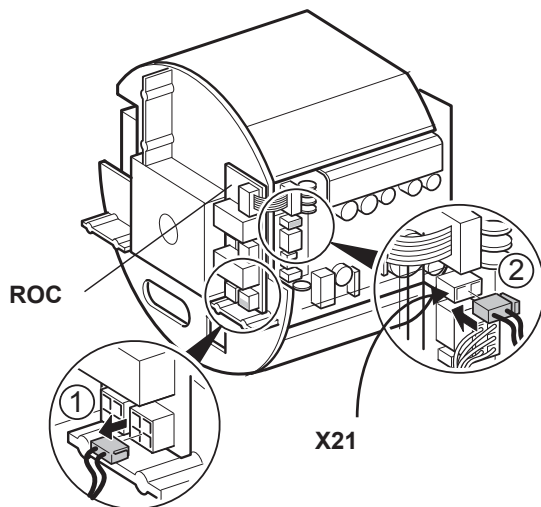
- 1** Check if there is any screw that is sealed. Contact Rosemount Tank Gauging before breaking the seal if warranty is still valid. Completely remove the seal so that it does not damage the threads. Loosen the screws and remove the cover.



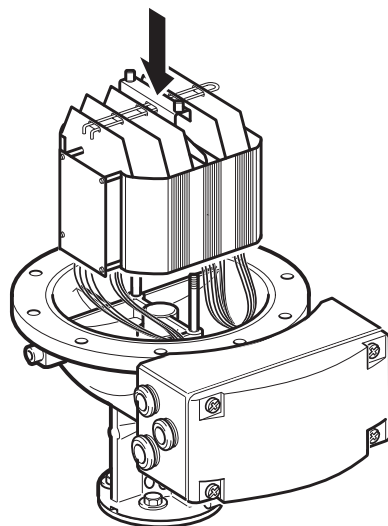
- 2** Loosen the two screws which hold the Electronic Unit.



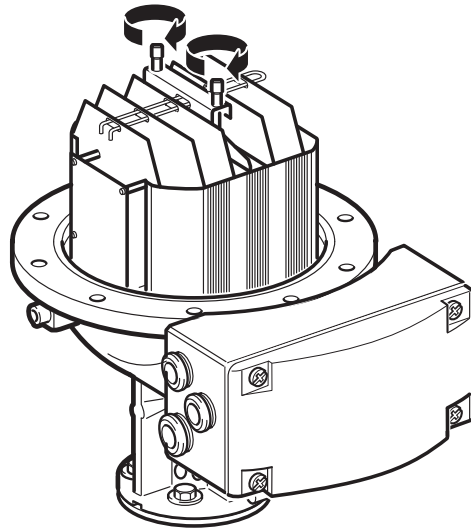
- 3 Carefully lift the Electronic Unit. Handle the Electronic Unit carefully. Be especially careful with the PTFE plug at the center of the bottom of the Electronic Unit.



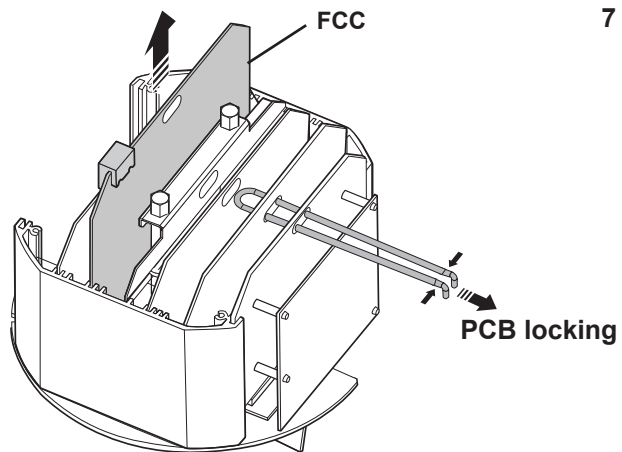
- 4 1) Remove the 2-pin connector from the ROC board.  
2) Plug the 2-pin connector cable into the X21-connection on the Motherboard.



- 5 Make sure that the PTFE plugs are clean. Lower the Electronic Unit. Check that the cables are not stuck between the Electronic Unit and the base of the enclosure. The Electronic Unit must rest firmly on the base so that there is no gap for the microwaves to bridge.



- 6** Tighten the two screws which hold the Electronic Unit.



- 7** Remove the PCB locking from the Electronic Unit and remove the FCC board.

- 8 Check that the Multi FCC card 9150072-673 is used.

Set the jumpers according to Figure 4-9 below for **current loop active** or **passive**.

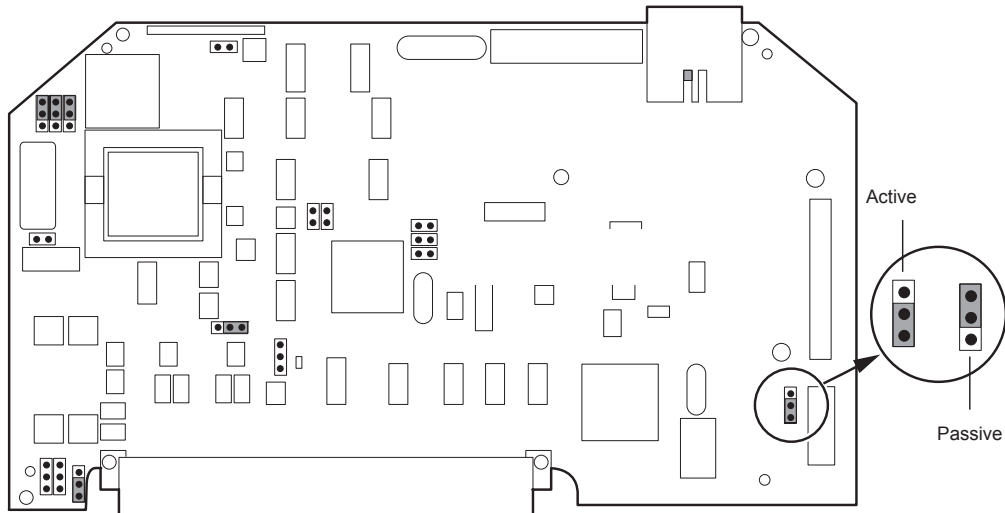
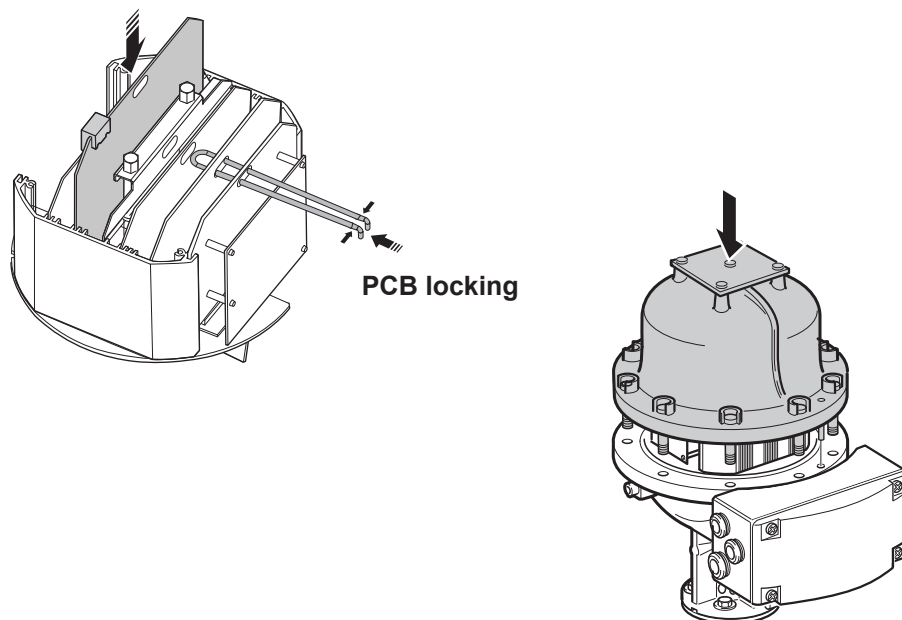


Figure 4-9. Current Loop Output settings.

- 9 Replace the FCC board and PCB locking. Check that contact surfaces on the transmitter housing and cover are clean. Replace the cover and tighten the screws.





### Software configuration - Analog outputs

You can choose various sources for the Analog Output. The **Upper Range value** for the analog output signal is 20mA and the **Lower Range value** is 4 mA.

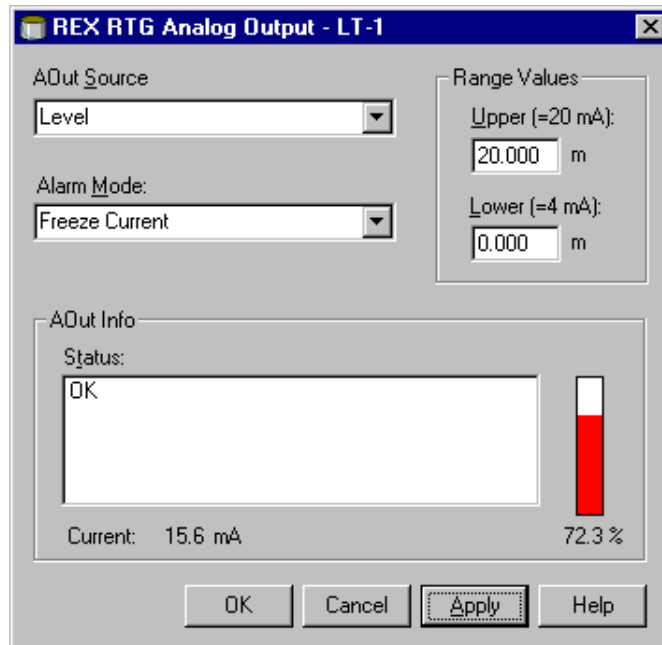
The following Analog Output sources (measuring variables) are available:

- 1 **Level, Ullage, Level Rate, Amplitude, Volume and Observed density** (the Upper and Lower range can be changed in the Range Values input field).
- 2 **RTG AvgLiqTemp, RF Head Temp, DAU AvgLiqTemp, Gas-Pressure, Liquid pressure, Gas Temp, LiquidTemp and Free Water Level** (the Upper and Lower range values can be changed in Holding Registers 2144 and 2146).

There are five different alarm modes available, for further information see "Alarm mode settings" on page 4-31.

#### To configure the Analog Output signal do the following:

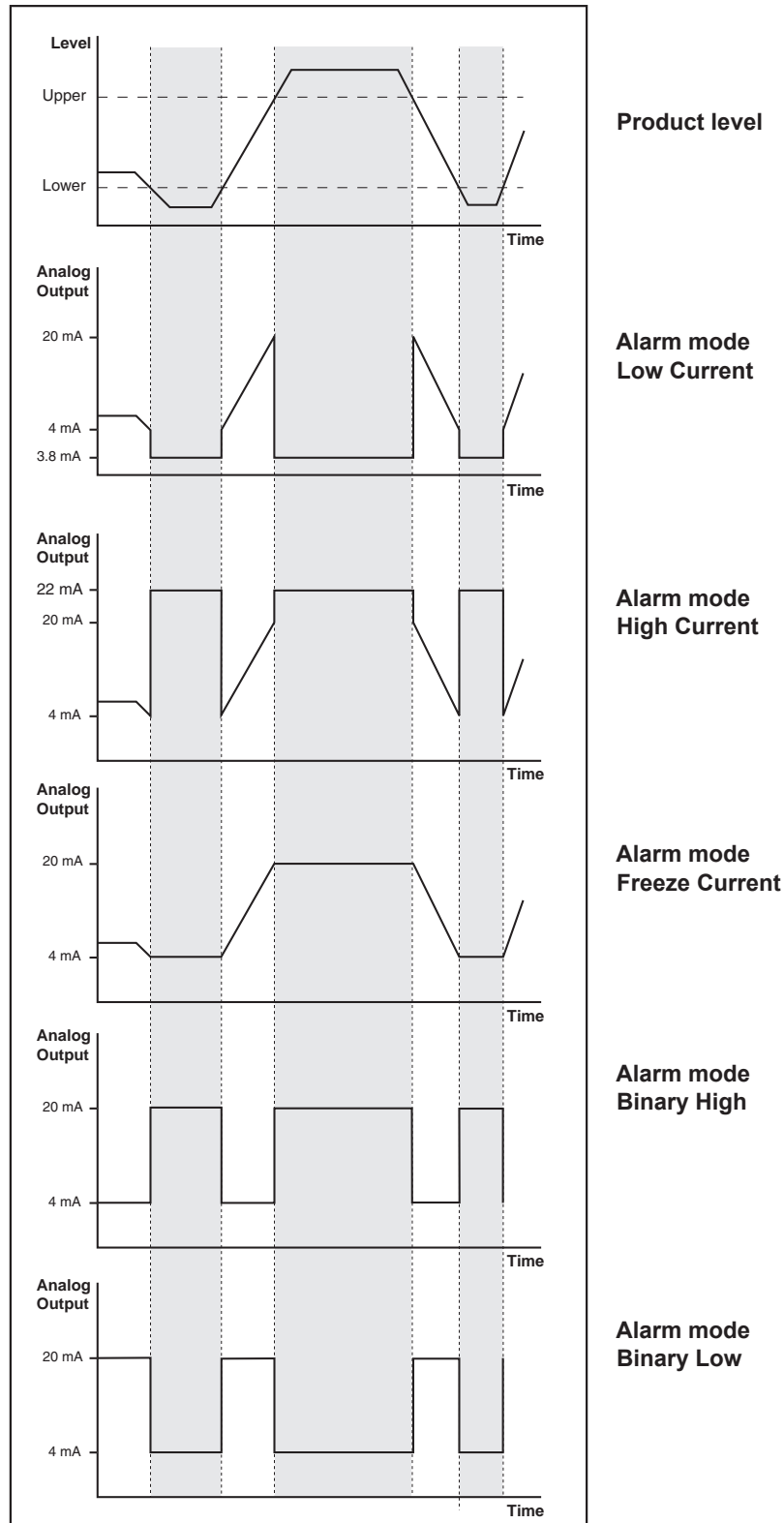
- 1 Select the desired device icon in the *WinSetup* workspace window.
- 2 Click the right mouse button, choose the **Properties** option and select the **Configuration** tab.
- 3 Click the **Analog Output** button.



- 4 Choose a measuring variable in the **AOut Source** list.

Set the Upper and Lower Range for the analog output signal in the Range Values input field. For measuring variables that can not be edited in the Range Value input field, set the Upper and Lower values in Holding Registers 2144 and 2146. For further information on how to edit Holding Registers, see "To view/edit input or holding registers of a certain device:" on page 4-2.

### Alarm mode settings



Analog Output current as a function of product level for different alarm mode settings. The shaded area indicates analog output in alarm mode.

Following alarm modes are supported in Rex:

**Table 4-1: Alarm Modes**

<b>Alarm Mode</b>	<b>Current Output</b>
Low Alarm	3.8 mA
High Alarm	22.2 mA
Freeze	The current that was output the last valid measurement
Binary Low	20 mA for valid measurements, 4 mA output when in Alarm Mode
Binary High	4 mA for valid measurements, 20 mA output when in Alarm Mode

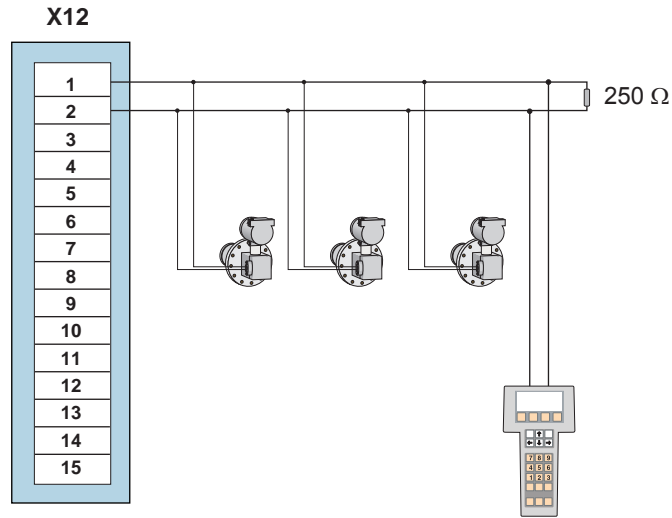
The Analog Output goes into alarm when:

- The measurement value goes outside the approved range.
- Measurements are invalid.
- An error is detected in the gauge.

For an overview on the Analog output signal status, see Holding Register 2000-2146. See also **WinSetup Reference Manual** for further information on how to configure the analog output.

### 4.1.11 HART Input

Hart Slaves are connected to Analog input 1. Connection to HART devices requires a Multi Field Communication Card equipped with optional HART modem.



*Figure 4-10. Connection of HART slaves.*

A maximum of 3 Hart slaves can be connected to the Rex gauge in multidrop configuration.

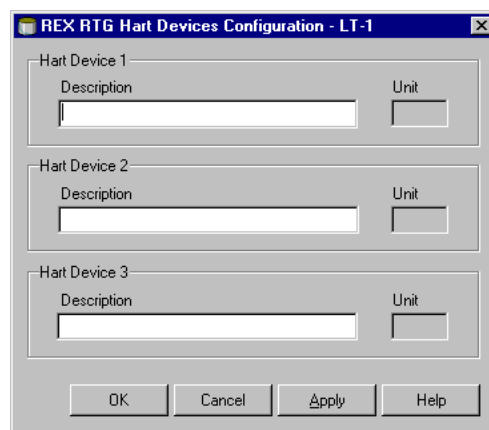
If only one HART slave is connected, and the short address = 0, current mode is supported.

With three HART slaves connected, short address 1-3 must be used and the slave current is parked at 4 mA.

The 250 Ω resistance is needed for HART-communication only.

### Software configuration - HART devices

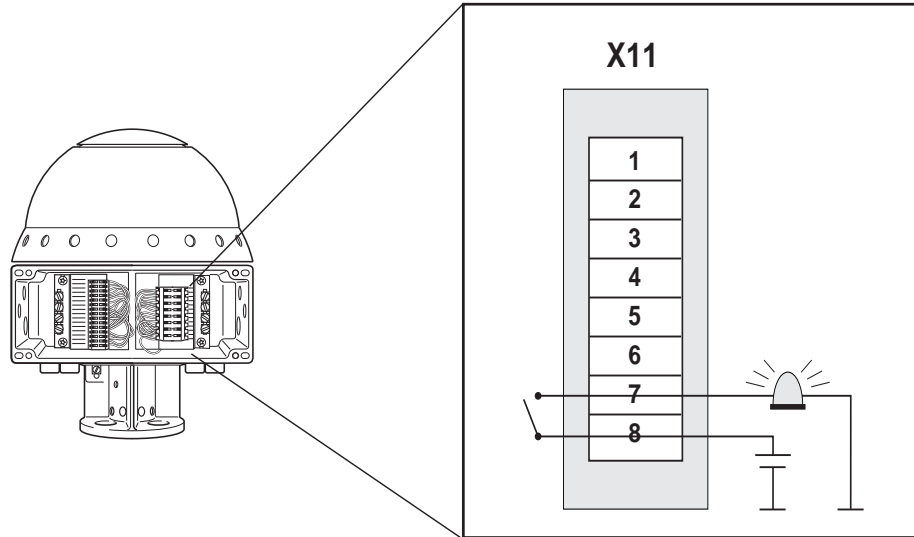
- 1 Select the desired Rex device icon in the WinSetup workspace window.
- 2 Click the right mouse button and choose the **Properties** option.
- 3 Select the **Configuration** tab.
- 4 Click the HART devices button and “configure” the HART slaves. This window is used only to add a description about the connected HART slaves.



For further information on how to configure the HART slaves, see **WinSetup Reference Manual**.

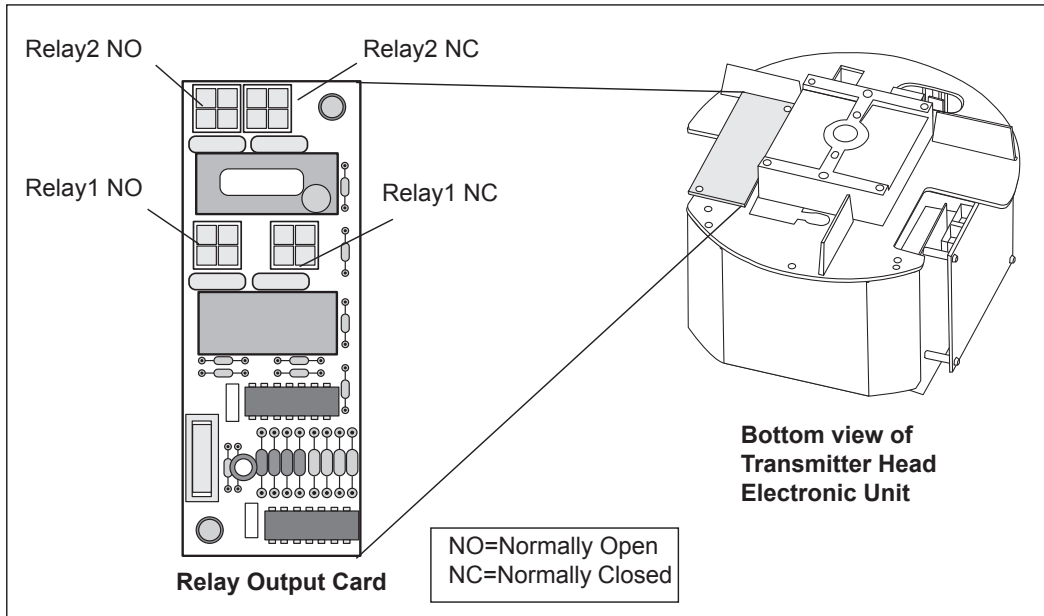
**4.1.12 Relay Output**

You can use two relay ports if the optional Relay Output Card (ROC) is installed. Different transmitter variables can be chosen to trigger the relay to change state.



*Figure 4-11. Connecting the relay ports.*

The relay outputs can be configured as Normally Open (NO) or Normally Closed (NC) depending on the selected connector on the ROC board. There is also a contact used for internal function monitoring.



*Figure 4-12. The relays can be configured as Normally Open or Normally Closed.*

Normally Open/Closed refers to the contact position when a relay is deenergized. This is also referred to as the Alarm state. The terminology can be summarized as follows:

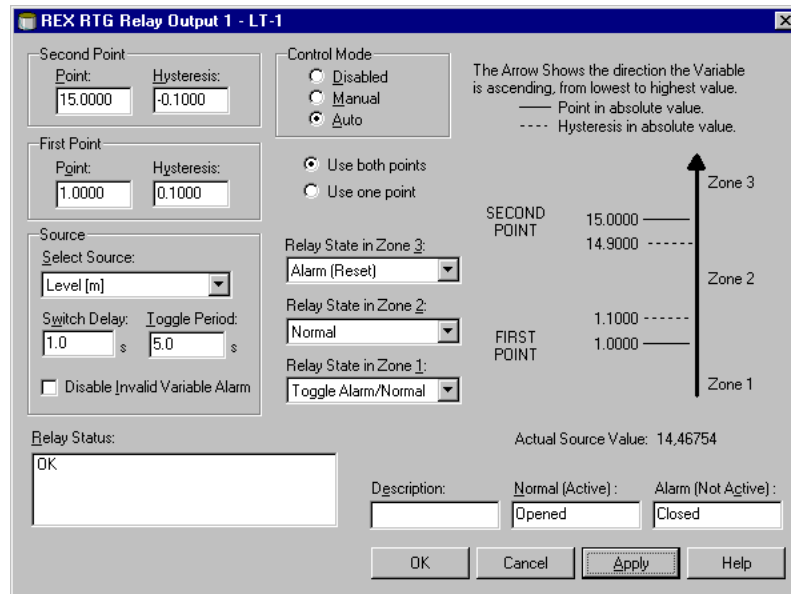
Normally Closed		Normally Open	
Closed	Open	Open	Closed
Deenergized	Energized	Deenergized	Energized
Not active	Active	Not active	Active
Alarm (reset)	Normal	Alarm (reset)	Normal



### Software configuration - Relay Outputs

- 1 Select the desired device icon in the WinSetup workspace window.
- 2 Click the right mouse button, choose the **Properties** option and select the **Configuration** tab.
- 3 Click the **Relay Output** button to configure the Relays.

*Response:* The Rex RTG Relay Output window opens.



- 4 Set the following parameters:

#### Using first/both points

To define three relay zones select **“Use Both Points”**.

To define only two relay zones select **“Use Only First Point”**.

#### First and second set points

The first and second set points define the transitions between Zone 1, 2 and 3. You can set different relay states in each of these zones.

#### Hysteresis

When the source variable passes a set point, the relay switches from one state to the other. If a hysteresis zone is specified, the relay remains in the new state even if the source signal returns back to a value within the previous zone. How far it will remain in the new state is defined by the value given in the hysteresis input field.

### Relay states.

- Alarm In this state the relay is deenergized.
- Normal In this state the relay is energized.
- Toggle The relay switches periodically between Normal and Alarm.

### Select source

Specifies the transmitter variable that triggers the switching of the relay.

### Switch Delay

This is the time delay until the relay switches into alarm state, i.e. the amount of time it takes for a relay to respond to an alarm. You can use this to prevent the relay from being activated due to temporary variations of the source signal.

### Toggle Period

When the relay is in Toggle state it switches between On and Off at a rate defined by the Toggle Period.

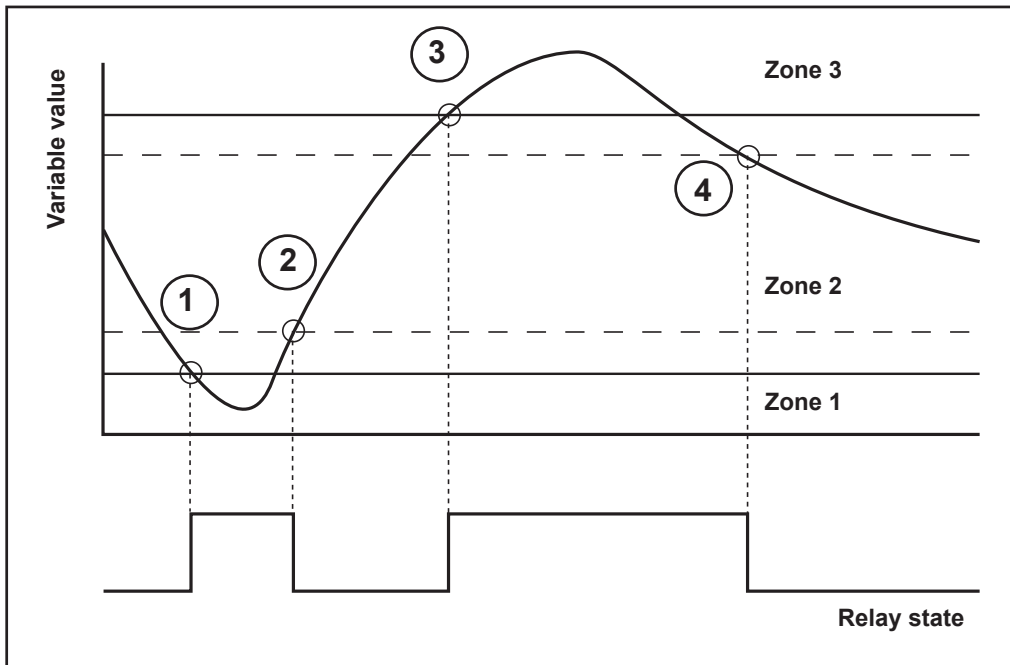
### Control Mode

- Manual The relay can be manually controlled by choosing the **Manual Control Relay** option from the Service/Devices menu.
- Auto The relay state is controlled by the transmitter variable specified in the Select Source field.
- Disabled The relay function is turned off.

**Relay Functions**

You can use one or two set points for relays connected to the Rex transmitter. Consequently, there are two or three zones in which different relay states can be specified. For each zone you can set any of the three available relay states Normal, Alarm, or Toggle.

For each set point you can specify a hysteresis zone which will prevent the relay from switching back to its previous state, as long as the source variable is changed only small amounts around a certain set point. The principle of relay set points and hysteresis zones is shown in the figure below. Note that in this case only two states are used:

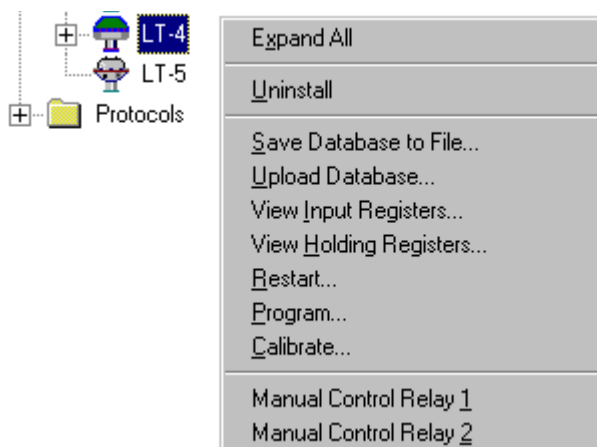


- 1 The source value passes set point one, and the relay state is changed according to the definition for Zone 1.
- 2 The relay state is changed back to the Zone 2 state when the source value passes the set point as given by the hysteresis value.
- 3 The source value passes set point two and the relay state is changed according to the definition for Zone 3.
- 4 The relay switches back to the Zone 2 relay state when the source value passes set point two as given by the corresponding hysteresis value.

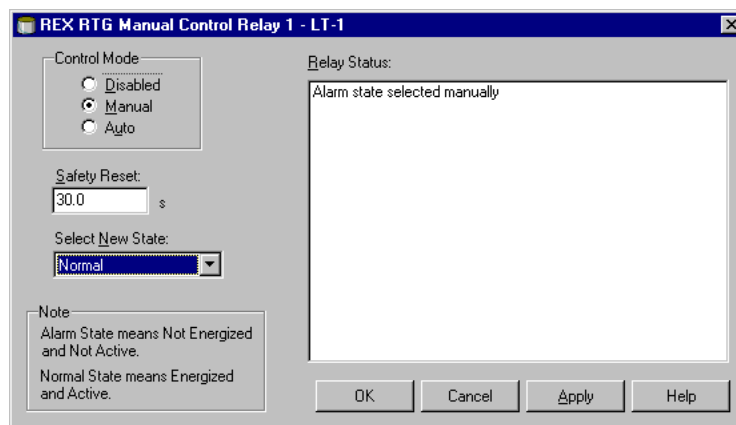
## Manual relay control

To manually switch between different relay states do the following:

- 1 Select a Rex gauge in the workspace window.



- 2 Click the right mouse button and choose the **Manual Control Relay** option  
- or -  
from the **Service** menu choose **Devices/Manual Control Relay**.



- 3 Choose Manual in the **Control Mode** field and click the Switch Mode button.
- 4 Choose a new relay state from the **Select New State** list and click the **Apply** or the **OK** button.

For further information on how to configure the Relay Output, see **WinSetup Reference Manual**.

## 4.2 FCU

### 4.2.1 Default database loading

The default database can be loaded by moving the jumpers on terminals X14 and X15. The position of X14 and X15 on the FCU board is shown in Figure 4-13.

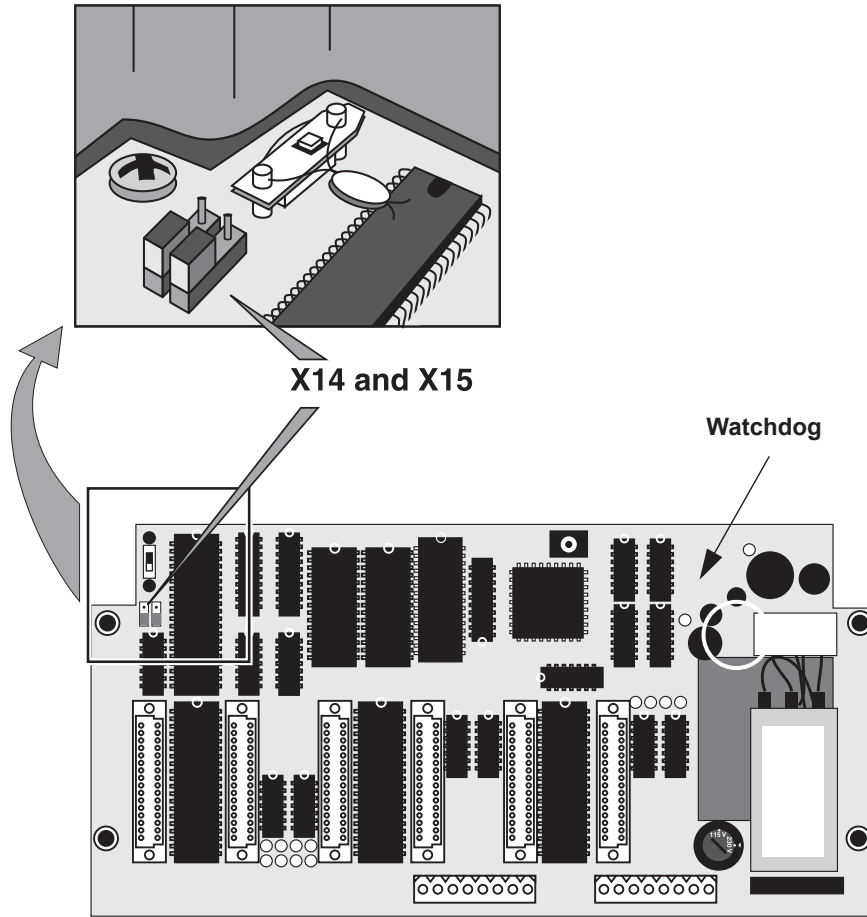
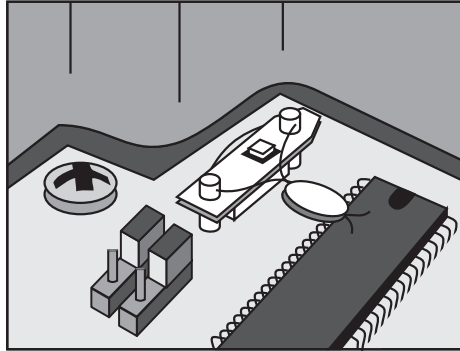


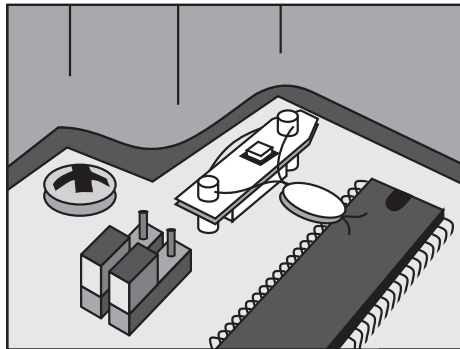
Figure 4-13. Terminals X14 and X15 on the FCU board

**To load the default FCU database:**

- 1 Disconnect power.
- 2 Move jumpers on socket 14 and 15 to the "upper" position.



- 3 Connect power.
- 4 Wait until watchdog lights up, see Figure 4-13.
- 5 Disconnect power.
- 6 Replace jumpers to the "lower" position.



- 7 Connect power.

### 4.2.2 Group and Field Bus Ports

Inside the FCU box there are two terminals, X10 and X11, which are used for RS-232C Group Bus communication, see Figure 4-14.

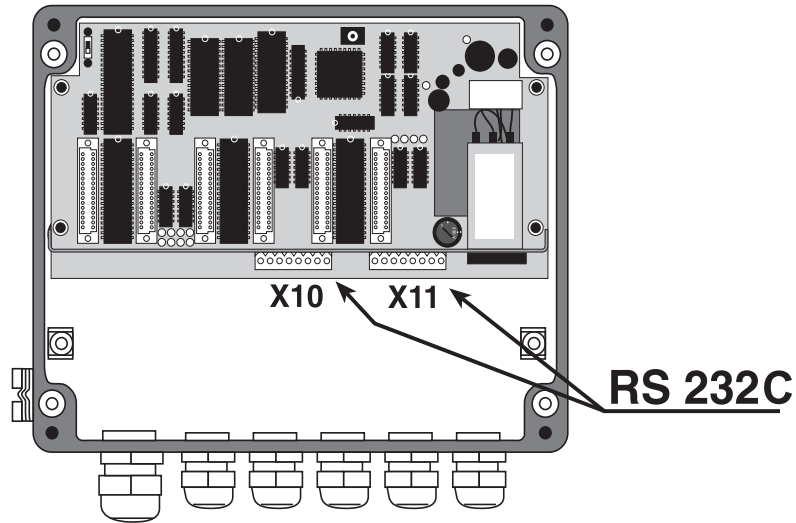


Figure 4-14. RS 232 ports

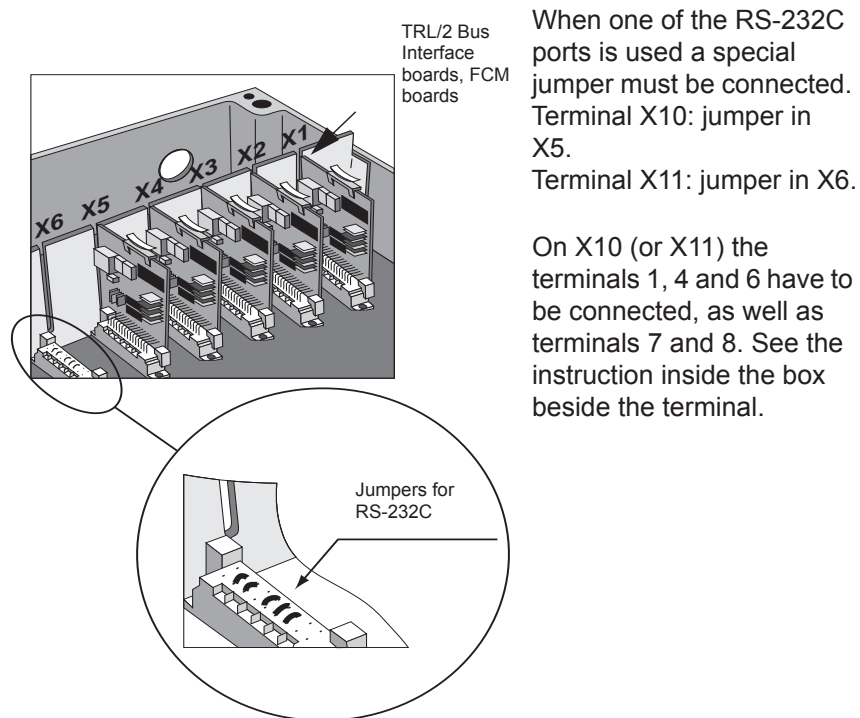


Figure 4-15. Connect a jumper to the X5 or X6 terminal when a RS-232 terminal is used.

### 4.2.3 Power Supply

Power supply can be selected as either 115 V or 230 V with a switch. See Figure 4-16. If the switch is set to 115 V, the box on the label of the FCU must be marked.

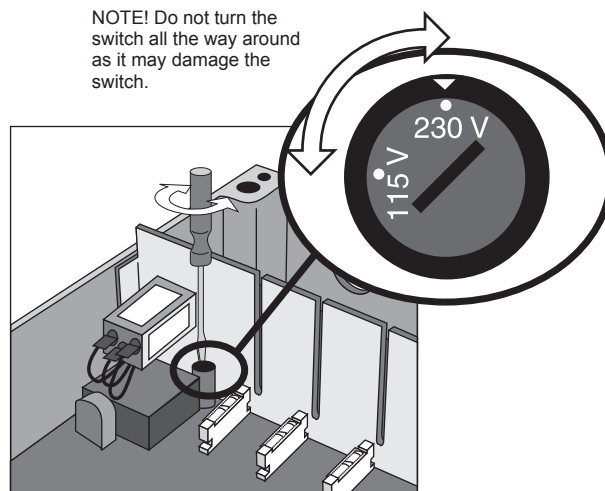


Figure 4-16. Selection of voltage for power supply on FCU.

### 4.2.4 Fuses

There are two 100 mA fuses inside the FCU box. See Figure 4-17.

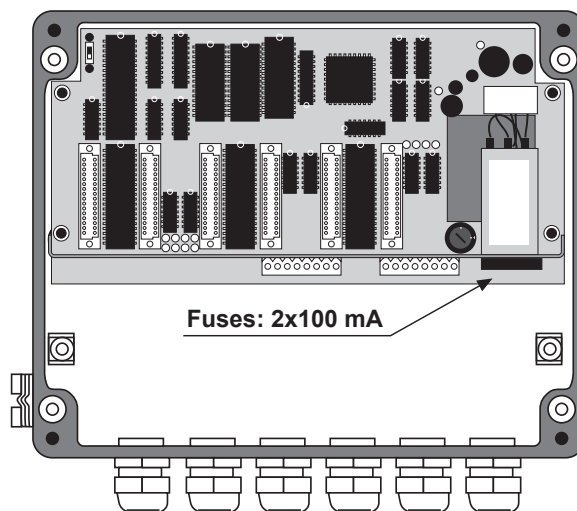


Figure 4-17. Location of the two 100 mA fuses inside the FCU box.



#### 4.2.5 Write protection and Reset

There is a write protection switch in the FCU which is used to prevent unauthorized changes to the data in the EPROM. The switch can be locked in the write inhibit position by securing a locking plate with a wire through the clevis pins, see Figure 4-18.

The reset switch can be used to restart the CPU of the FCU. The database in the EPROM remains unchanged by a reset. If the watch dog LED was lit before the reset, it is switched off by the reset.

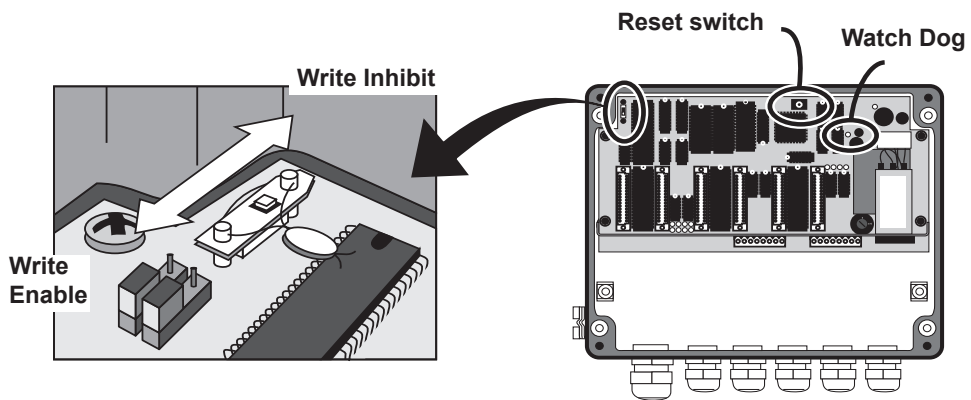


Figure 4-18. Write protection and reset switches in the FCU.

### 4.2.6 Electronics

The main board of the Field Communication Unit is the FCP-board (Field Communication Processor). See Figure 4-19 and Figure 4-21.

There are a number of LEDs on the FCP board. There are green LEDs for incoming signals and yellow LEDs for outgoing signals. There is a red LED indicating watch dog time out and CPU reset. When the watchdog LED is lit, it indicates that the CPU has been reset due to a watchdog time-out and not a dip in the supply voltage. There is a green LED to indicate that there is power on the FCU.

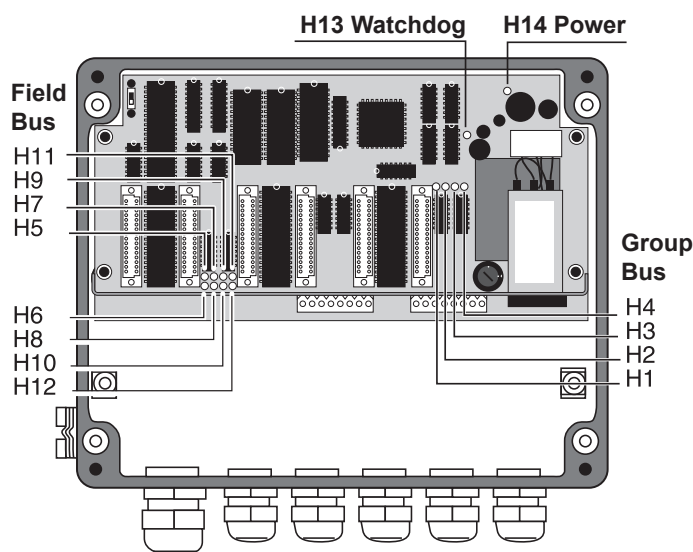
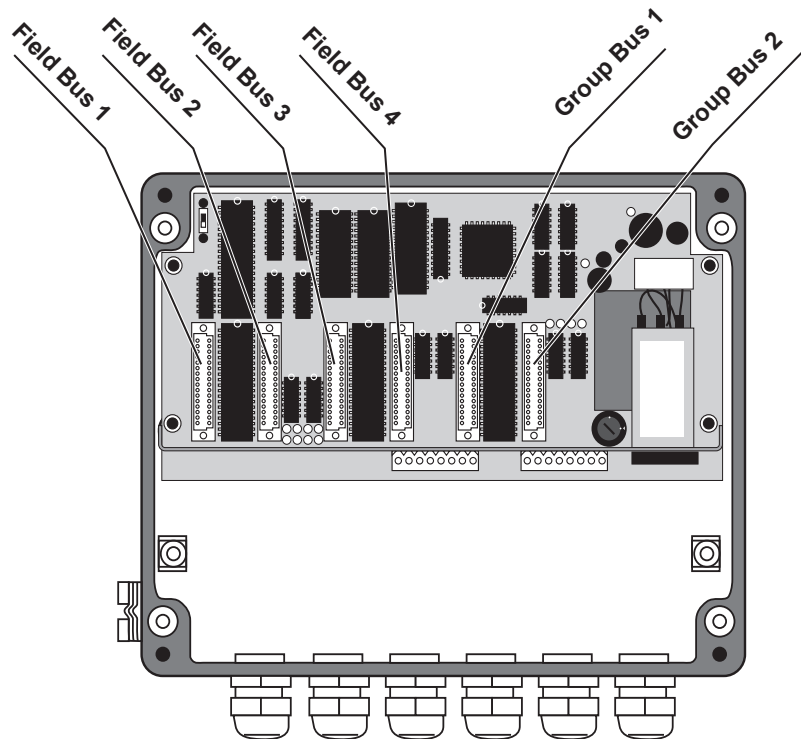


Figure 4-19. LEDs on the FCP board in the FCU

Table 4-2: Summary of LED indications

Serial communication port	Group Bus 1		Group Bus 2		Field Bus 1		Field Bus 2		Field Bus 3		Field Bus 4	
Green LED Serial data received	H1		H3		H5		H7		H9		H11	
Yellow LED Serial Data transmitted		H2		H4		H6		H8		H10		H12
Red LED Watchdog time out/CPU reset	H13											
Green LED Power on	H14											

The location of the Field bus and Group bus connections are shown in Figure 4-20.



*Figure 4-20. The location of Field and Group bus connections on the FCP board.*

The microprocessor of the FCU is the 80C188. It contains a DMA controller (Direct Memory Access) which allows the processor to process other information while the DMA controls data between the RAM memory and the serial ports.

There is RAM (Random Access Memory) of 32 KB for the data buffer. The data buffer is used to store the information from the slave units. The EPROM is used to store the program. When exchanging the EPROM it is strongly recommended that the FCP board is removed from the FCU box for better access of the memory chip.

The EEPROM is used to store database registers and can be remotely reprogrammed (if the write protection switch is in the write enable position).

There are three dual channel Serial Communication Controllers (SCC) that control the six serial communication ports for Group Bus and Field Bus communication.

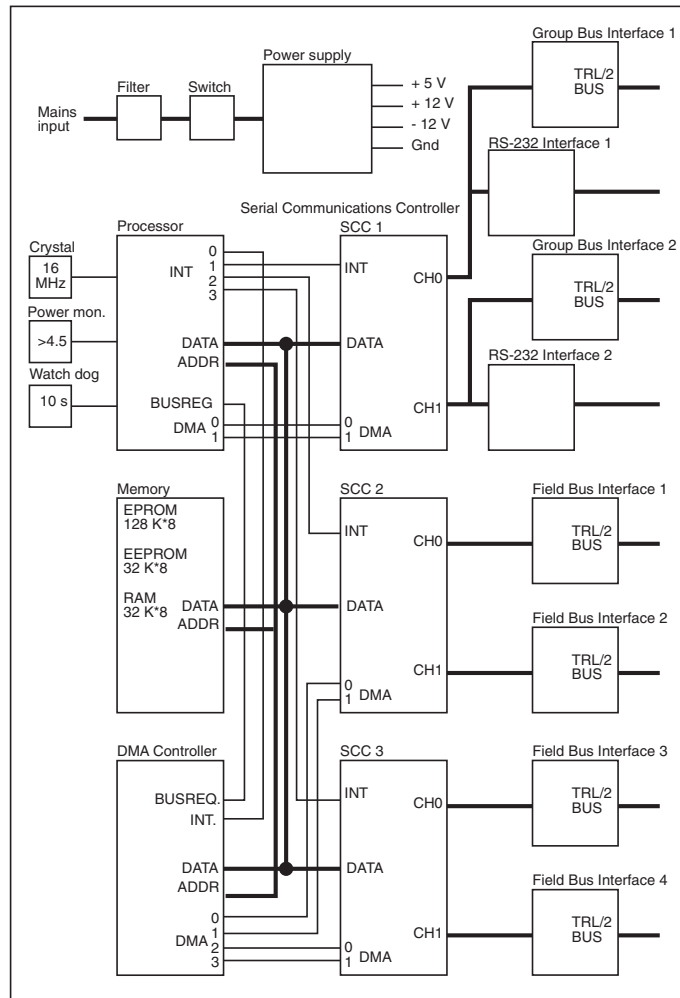


Figure 4-21. FCU block diagram

#### 4.2.7 Redundancy (option)

##### Introduction

In order to reduce the risk of communication failure between the *TankMaster* and the units connected to the TRL/2 field bus, two FCUs can be connected to run in parallel. If one FCU fails, the other one automatically takes over without any action from the operator. The FCUs are connected with an extra cable allowing them to communicate. The inactive FCU constantly checks if the connected FCU is active. If the active FCU fails, it becomes inactive, and signals to the backup FCU to take over. Then the backup FCU immediately switches to an active state.

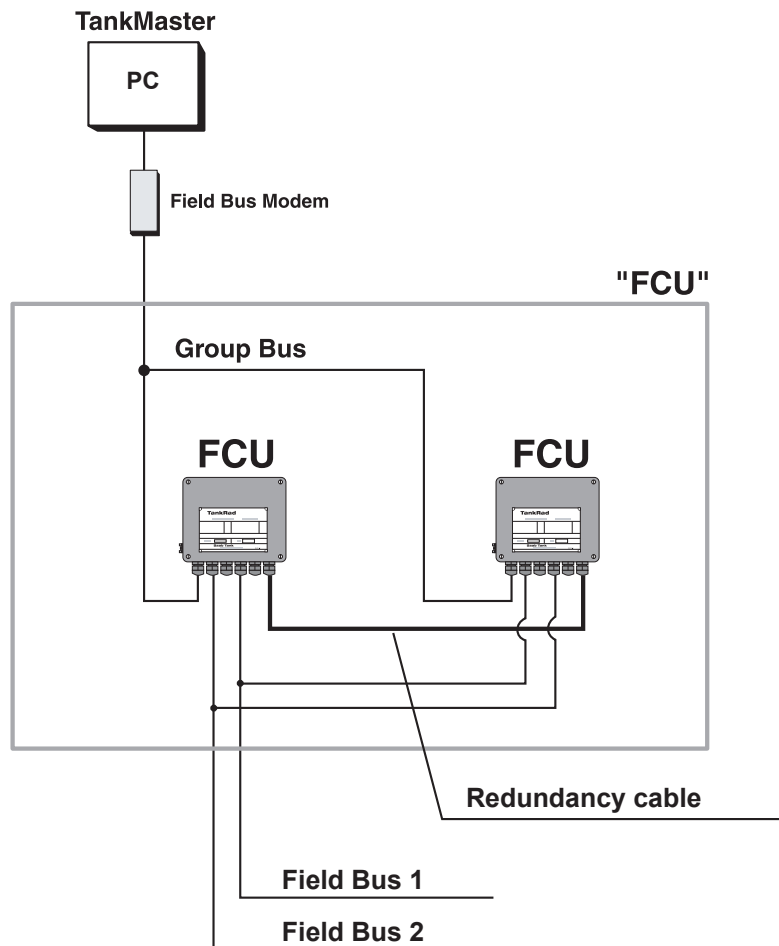


Figure 4-22. Parallel Field Communication Units connected to the TRL/2 bus.

### Hardware installation

- Connect the special three-wire cable between the RS-232 ports of the FCUs. The cable shall be connected to the RS-232 port 2 contact.

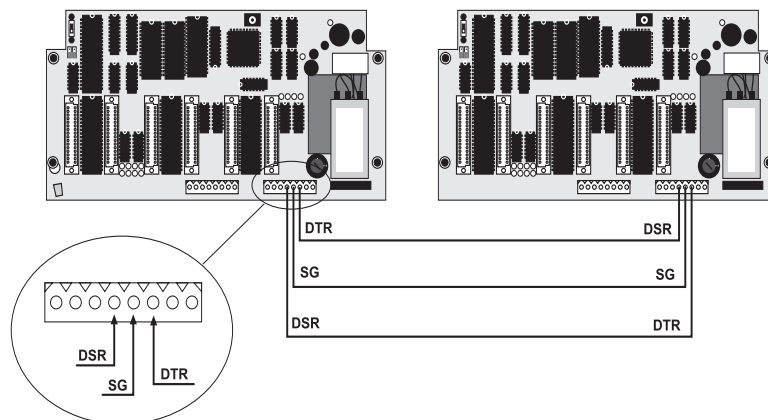


Figure 4-23. Connecting the RS-232 ports.

- If a TRL/2 bus is connected to GB2, use an FCM board with special jumper.

**Note!**

The old version of the standard FCM board can not be used at port 1 when redundant FCUs are used.

- If an RS-232 bus is connected to GB2: use separate communication lines from the workstation to the “primary” and “backup” FCU, respectively.

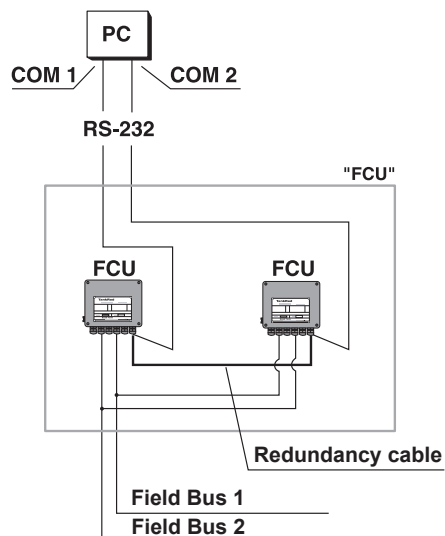


Figure 4-24. Using an RS-232 Group Bus connection.

---

**Software configuration**

---

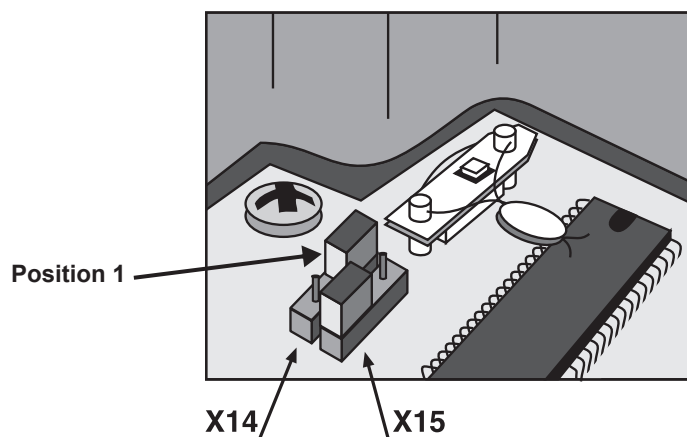
*Note!* For further information on how to configure/install the FCU see *TankMaster WinSetup Reference Manual*.

---

- 1 Power down both FCUs.
- 2 Power up one of the FCUs.
- 3 Select the **Devices** folder in the *TankMaster WinSetup* workspace window, click the right mouse button and choose the **Install New** option.
- 4 Choose device type FCU, specify a name in the **Tag** input field and click the **Next** button to continue.
- 5 Select a communication channel.
- 6 Set the FCU address:
  - 1 In the *FCU Communication* window click the **Change Address on Device** button.
  - 2 Enter the **Unit ID** and the **Modbus Address** and click the **OK** button.
  - 3 In the *FCU Communication* window click the **Verify Communication** button to make sure that communication is established.
  - 4 Click the **Next** button to continue.
- 7 In the *FCU Configuration* window choose the **Redundant, Primary mode** option to set the operation mode.
- 8 Click the **Next** button to open the *FCU Slave Database* window. Configure the FCU.
- 9 Click the **Next** button to open the *Summary* window and then the **Finish** button to finish the FCU installation.

*Comment:* The standard mode of operation is "normal". There is no difference in operation between the FCU designated "primary" and "backup", respectively. The reason for having different names is only to be able to distinguish between the redundant FCUs.
- 10 Check that holding register 831=7 (only memory tests).
- 11 Power down the FCU.

- 12 Power up the second FCU.
- 13 Set the second FCU address. It is important that both FCUs are using the same address.
  - 1 Select the FCU icon in the WinSetup workspace window, click the right mouse button and choose the **Properties** option.
  - 2 Select the **Communication tab** and click the **Change** button.
  - 3 Enter the **Unit ID** and the **Modbus Address** and click the **OK** button.
  - 4 Click the **Verify Communication** button to make sure that communication is established.
  - 5 Click the **OK** button to continue.
- 14 Select the **Configuration** tab and choose the **Redundant, Backup mode** option to set the operation mode.
- 15 Check that holding register 831=7.
- 16 Power down the FCU.
- 17 Move switch X14 to position 1 on both FCUs.



- 18 Power up the "primary" FCU first, and then the "backup" FCU.

*Comment: Now the "primary" FCU, which was powered up first, becomes active.*
- 19 Check that **TankMaster** reads data from the active FCU. Select the FCU icon, click the right mouse button and choose the **Properties** option and check that the Unit ID corresponds to the active FCU.



- 20 Check the diagnostics Input Register (Input Register 30689) to verify that the "primary" FCU is active. This is indicated by status bit 12=0. (If the "backup" FCU is active status bit 12=1).
- 21 Power down the active FCU.  
  
*Comment: The "backup" FCU switches from inactive to active.*
- 22 Make sure that the backup FCU is active. This is indicated by status bit 12=1 (see step 20).
- 23 Power down both FCUs, and then power up the FCUs again starting with the "primary" FCU as described in step 18.
- 24 Select the **FCU Slave Database tab** from the Properties menu, and configure the FCU pair like you would configure a single non redundant FCU. Both FCUs will receive the same data. Switch between the FCUs to make sure that the same data was stored in both FCUs.

For further information on FCU Installation Procedure see **WinSetup Reference Manual**.

## 4.3 DAU

### 4.3.1 Setting the temperature measurement range

Do the following to set the measuring range of the temperature sensors:

- 1 Connect the **reference resistor** corresponding to the desired measurement range to channel 15.

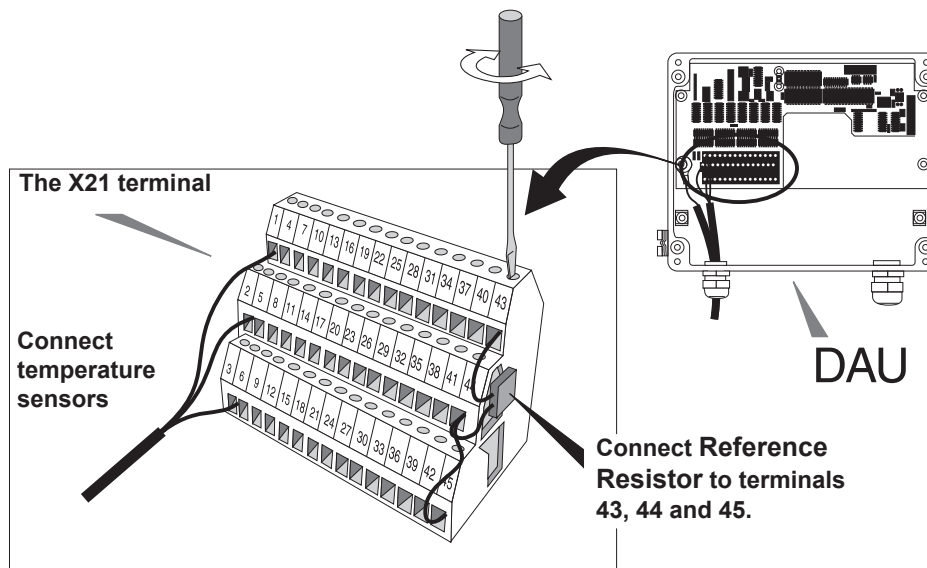


Figure 4-25. Reference Resistor

- 2 Set the **jumper X1, X2 and X3** on the DAU's circuit board in the correct positions for the desired measurement range. The jumpers are set according to Table 4-3. See also Figure 4-26. The default setting is from  $-50^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  for the Pt 100 sensor.

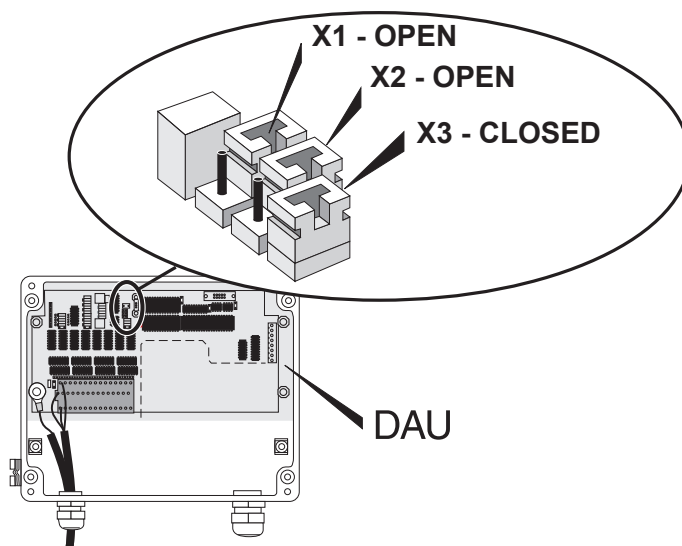


Figure 4-26. Jumper settings for temperature range  $-50$  to  $125^{\circ}\text{C}$

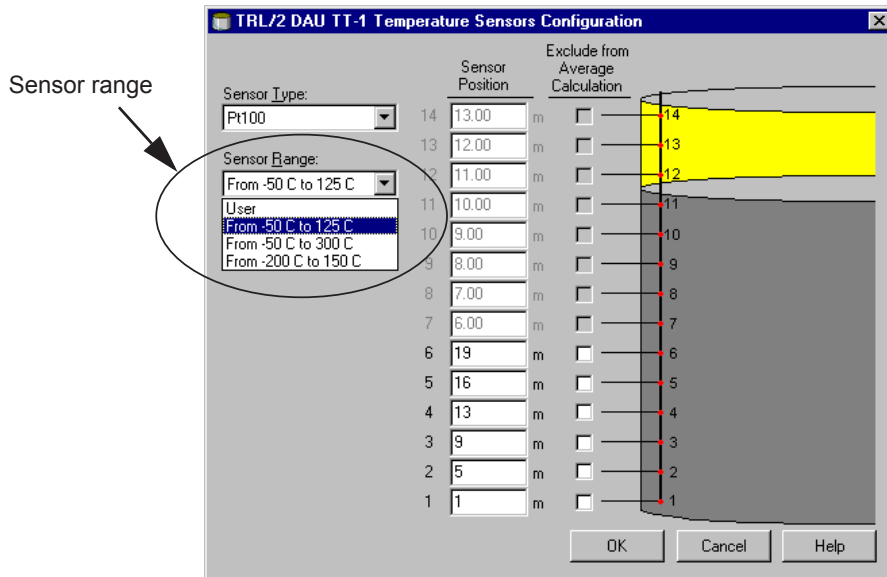
Table 4-3: Temperature Range

Temperature Range Pt 100 / Cu 90	X1	X2	X3	Reference Resistor ( $\Omega$ )
-50 - +125 °C	OPEN	OPEN	CLOSED	138.50
-50 - +300 °C	CLOSED	CLOSED	CLOSED	175.84
-200 - +150 °C	CLOSED	CLOSED	OPEN	24.90

- 3 Set the **database register** that specifies the temperature range to the value that corresponds to the jumper settings.

In TankMaster WinSetup:

In the *DAU configuration window* click the **Configure** button next to the **Number of Temperature Sensors** field.



*Note!*

See spare parts list for part number of reference resistors.

### 4.3.2 Checking the Resistance Temperature Detectors

Pt100 sensors (spot measurement) are connected with three wires each. The Cu90 sensors (average measurement) are connected with a common ground.

The sensors can be checked by measuring their resistance and the surrounding temperature. Then check in the tables below. If the temperature derived from the table does not correspond to the actual temperature, then the sensor needs to be replaced.

See tables and connection diagrams below. See also Installation drawings on page 8-1 for connection of the temperature sensors.

#### Pt100

°C	Ω	°C	Ω
-50	80.25	+80	130.89
-40	84.21	+90	134.70
-30	88.17	+100	138.50
-20	92.13	+110	142.28
-10	96.07	+120	146.06
0	100.00	+130	149.82
+10	103.90	+140	153.57
+20	107.79	+150	157.32
+25	109.73	+160	161.04
+30	111.67	+170	164.76
+40	115.54	+180	168.47
+50	119.40	+190	172.16
+60	123.24	+200	175.84
+70	127.07		

#### Cu90

°C	Ω	°C	Ω
-50	71.43	+80	120.95
-40	75.24	+90	124.76
-30	79.05	+100	128.57
-20	82.86	+110	132.38
-10	86.67	+120	136.19
0	90.48	+130	140.00
+10	94.29	+140	143.81
+20	98.10	+150	147.62
+25	100.00	+160	151.42
+30	101.91	+170	155.23
+40	105.72	+180	159.04
+50	109.53	+190	162.85
+60	113.33	+200	166.66
+70	117.14		

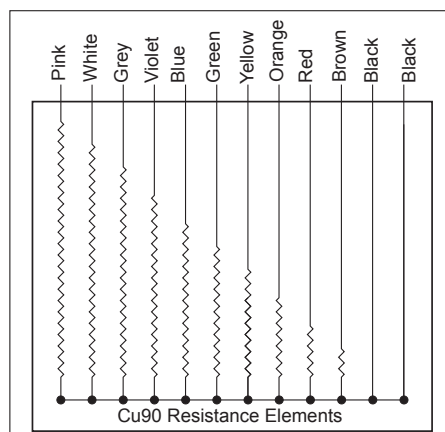
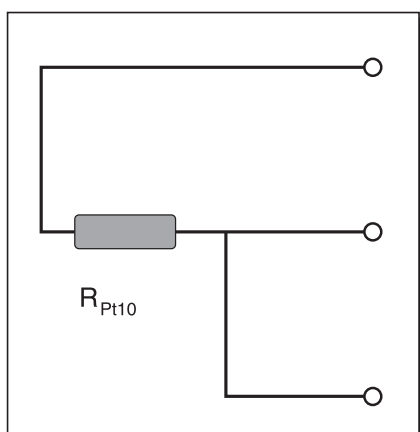


Figure 4-27. Pt 100 and Cu90 temperature

### 4.3.3 Exchanging the External Reference Resistor

The external reference resistor must be changed if a different temperature measurement range will be used, see 4.3.1. Also, if the local display shows a reference resistor calibration error, it may be necessary to replace it. The reference resistor is connected to channel 15 of the multiplexer.

The reference resistance values corresponding to different temperature ranges and sensors are given in the table below.

Resistance ( $\Omega$ )	Temperature range ( $^{\circ}\text{C}$ )
138.50	-50 - +125
175.84	-50 - 300
24.90	-200 - +150

Figure 4-28 illustrates how to connect the external reference resistor to the X21 terminal.

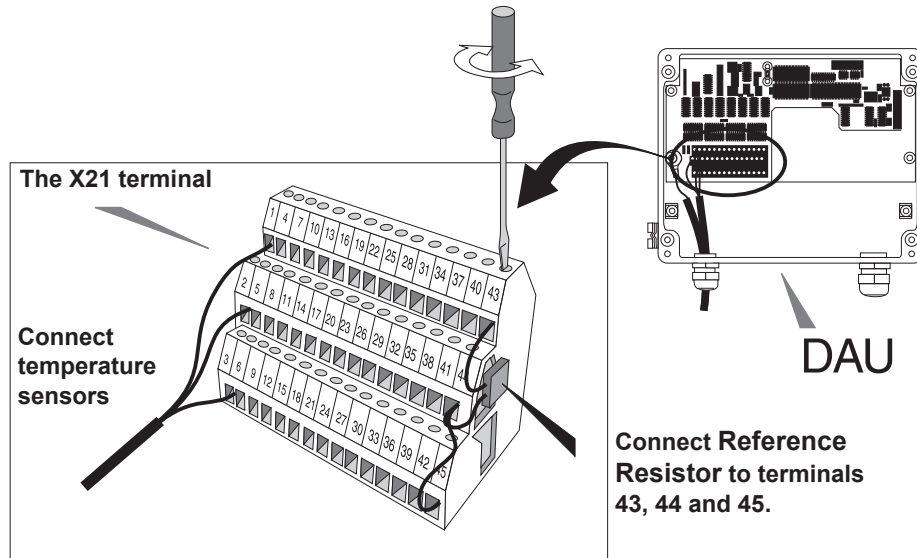


Figure 4-28. Connection of reference resistor

#### Automatic test of reference resistors

The internal reference resistor is placed on the Motherboard. The ratio between the high and low temperature references is calculated as a test of the reference resistors. This value is compared with a value given for the current temperature range. The ratio is allowed to deviate a certain amount from the nominal value. The tolerated deviation can be viewed in holding registers 307-310.

#### 4.3.4 Suppressing error indication...

... when associated RTG is not present.

Normally a DAU receives queries from the bus master (FCU), and picks up level data from the associated RTG. However, there may be situations when a DAU is installed without bus master and/or RTG. In this case error codes indicating external serial communication error will be shown on the DAU display. These error codes can be suppressed by setting DAU holding register 313 to the appropriate value:

Database value	Action
0	Normal operation
1	No bus master present
2	No associated RTG
3	No associated bus master or RTG

#### 4.3.5 DAU Reset

The DAU can be reset by switching power off and on with an external switch. Another way is to open the box and remove connector X20 on the DMB. When replacing the connector the power-LED will light up for a short period of time during start up. The (optional) display shows the **Unit Id** during start up.

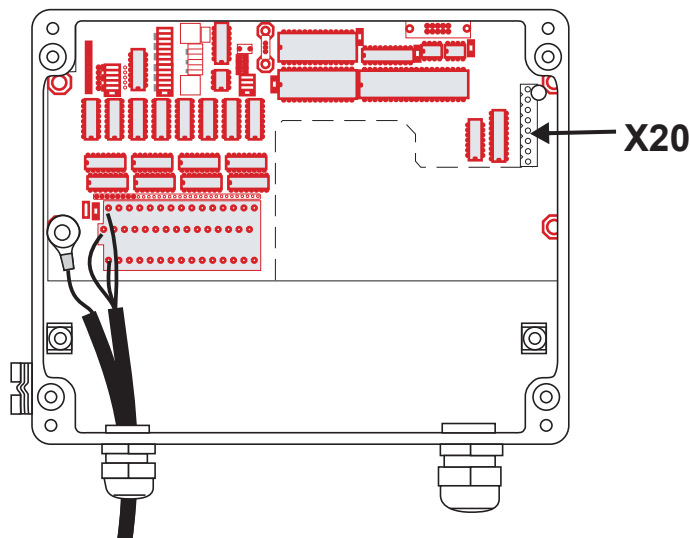


Figure 4-29. Connection X20

### 4.3.6 Write Protection

There is a write protection switch to prevent unauthorized changes in the EEPROM. The switch can be sealed in the write inhibit position using a wire through the clevis pins. See Figure 4-30.

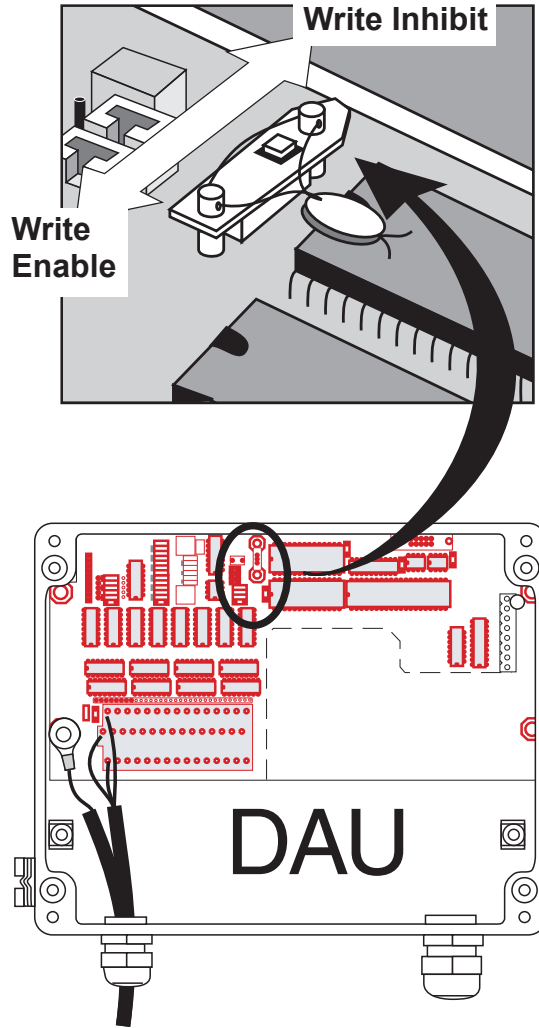


Figure 4-30. Write protection switch

### 4.3.7 Default database reload

- 1 Disconnect the DAU power supply.
- 2 Remove the program EEPROM from the socket, see Figure 4-31.

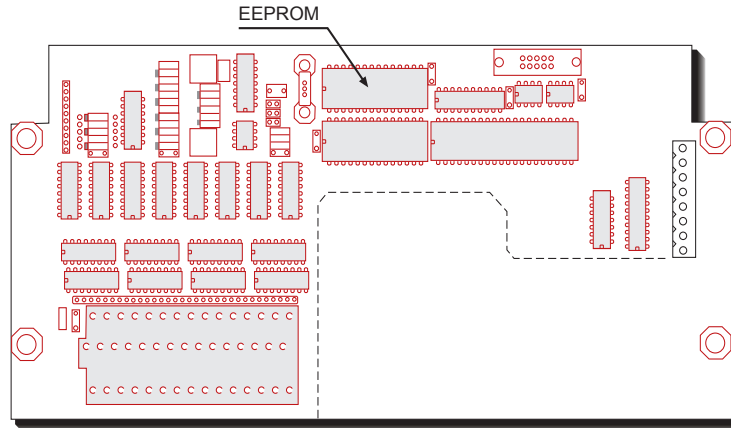


Figure 4-31. Database loader

- 3 Insert the DB-loader EEPROM into the EEPROM socket.
- 4 Power up and wait for about 30 seconds. When the database loading is finished, all segments on the local display light up:



*Comment: flashing display segments indicate that the database loading failed.*

- 5 Disconnect the power supply.
- 6 Remove the DB-loader and reinsert the program EEPROM.
- 7 Power up.
- 8 Configure the DAU.



### 4.3.8 Local Display modes

The display has three different display modes. These modes can be changed in two ways:

- Press the push button and wait for at least one second.
- Set database register 300. The default setting is 0, which allows you to change the display mode with the push button. By setting register 300 to 1, display mode 1 is selected and by setting it to 2 display mode 2 is selected. Reset the DAU to make the change valid (see section 4.3.5).

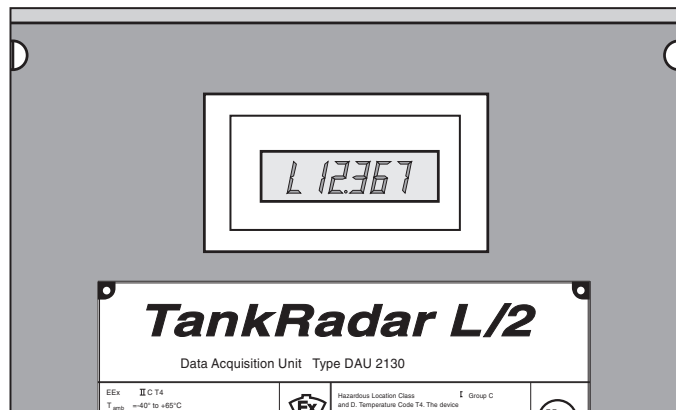


Figure 4-32. DAU LCD Display

### Error indication

There are two alternatives to indicate an error:

- Alt. 1: the corresponding value is flashing on the screen
- Alt. 2: a blinking "Err"














### Display mode 0:

The following values are shown. Only the values for which the DAU has been configured, are shown. The sequence is repeated continuously.

	<p>Level.</p>	<p>L for metric: decimal, colons for feet: inches: inches/17.</p>
	<p>Average temperature.</p>	<p>C for Celsius or F for Fahrenheit.</p>
	<p>One current input channel.</p>	<p>The specific channel is selected in the database.</p>
	<p>Digital input values.</p>	<p>The digital input values are shown high when the connected device is open (not grounding = 1). They are shown low when it is closed (grounding = 0). Each vertical segment corresponds to an input.</p>
	<p>Relay output control.</p>	<p>The lower segment is shown when the relay is in its normal position (inactivated). The upper section is shown when the relay is in its activated position. If the relay feedback does not match relay control this will be shown with a "-" sign like this:</p>
<p>If there is an error:</p>	<p>System status</p>	<p>See Chapter Troubleshooting for more information.</p>

**Display mode 1:**

The following sequence is shown when the display is in mode 1.

	Level	See display mode 0 for explanation.
	Temperature sensor 1.	
	If the sensor is below the surface.	
	The temperature value of sensor 1.	
	Temperature sensor 2.	
	The temperature value of sensor 2.	
	Pressure sensor 1.	
	The pressure value of sensor 1.	
	Pressure sensor 2.	
	The pressure value of sensor 2.	
	Digital input values.	See display mode 0 for explanation.
	Relay output control.	See display mode 0 for explanation.
If there is an error: 	System status.	See Chapter Troubleshooting for more information.

### Display mode 2:

This mode locks the display on the value which is on display at the moment. The value is still sampled at its usual rate (approximately every 15 seconds for a temperature sensor).

Press the button and hold it down. Release the button when the value before the desired value is displayed. For example, if temperature value C5 is to be displayed, then release the button when the display is showing the value of temperature C4.

You can set this display mode remotely via database register 300. The default reading is level. If you want to remotely change the display to other variables in display mode 2, please contact Emerson Process Management/Rosemount Tank Gauging for instructions.

### 4.3.9 Local Display Error codes

The type of errors displayed on the local display can be divided into the following groups.

- System
- External serial communication
- Internal serial communication
- Temperature measuring error

**System Errors** indicate that there is an error in one of the memory circuits.

**External serial communication** error means that communication with master or RTG is lost.

**Internal serial communication** error may indicate that there is an internal bus failure.

**Temperature measuring** error may indicate that there is a defect temperature sensor or a calibration error.

#### 4.3.10 Time-out settings

##### Master communication time-out

The master communication time-out specifies the elapsed time without contact before communication with the master is considered to be lost. This value is stored in database **register 188**. The default value is set to 20 s.

---

*Note!*                      *The database value is given in number of "ticks" 255. One tick is equal to 278  $\mu$ s, and 255 ticks is equal to 71 ms. Thus the value stored in database register 188 must be multiplied with 71 ms in order to obtain the time-out value in number of seconds.*

---

##### RTG Communication time-out

The RTG communication time-out is stored in database **register 249**. The default value is set to 60 seconds. This is the value which specifies the time interval without contact before communication with the RTG is considered to be lost.

## 4.4 FBM

The Field Bus Modem acts as a converter between USB or RS-232C and the TRL/2 Bus. The TRL/2 protocol is used for communication with Rosemount Tank Gauging equipment.

The Field Bus Modem may also be used to connect foreign units to the Field Bus.

Connecting a PC with the TankMaster software to the TRL/2 bus requires a Field Bus Modem model 2180.

### 4.4.1 Power Supply

Use adapter 90-264 V ac/9 V dc 1.5 A for RS232 communication.

DO NOT use external power supply when the modem is connected to the USB port. The USB interface itself supports power to the FBM2180 modem.

### 4.4.2 Operation - front panel

The FBM 2180 front LEDs show information on power supply, communication status and communication interface.

The Termination switch is used if there are extremely short cables between the transmitter and the modem.

The Gain switch is set to Lo by default. This setting is sufficient in most cases. The Hi Gain setting may be used if cable dimensions are insufficient resulting in a heavily damped communication signal.

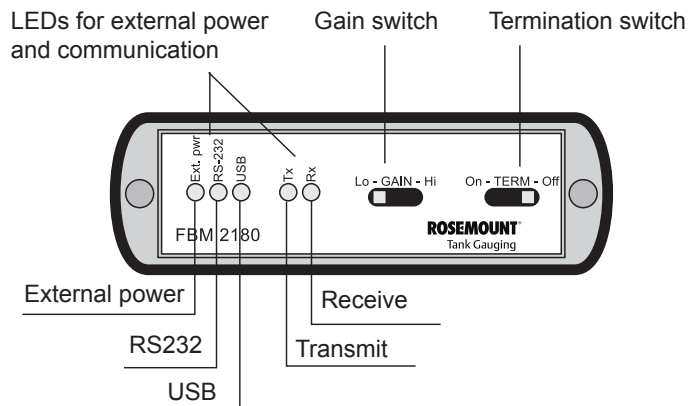


Figure 4-33. The Field Bus Modem

#### 4.4.3 FBM instead of FCU for small systems

In a small system with a maximum of 16 units (RTGs or DAUs), the Field Bus Modem can be used instead of an FCU. The Field Bus Modem can then be connected directly between the TankMaster PC (master) and the RTGs and the DAUs.

The Field Bus Modem is contained in a small box and must not be used in a hazardous area.

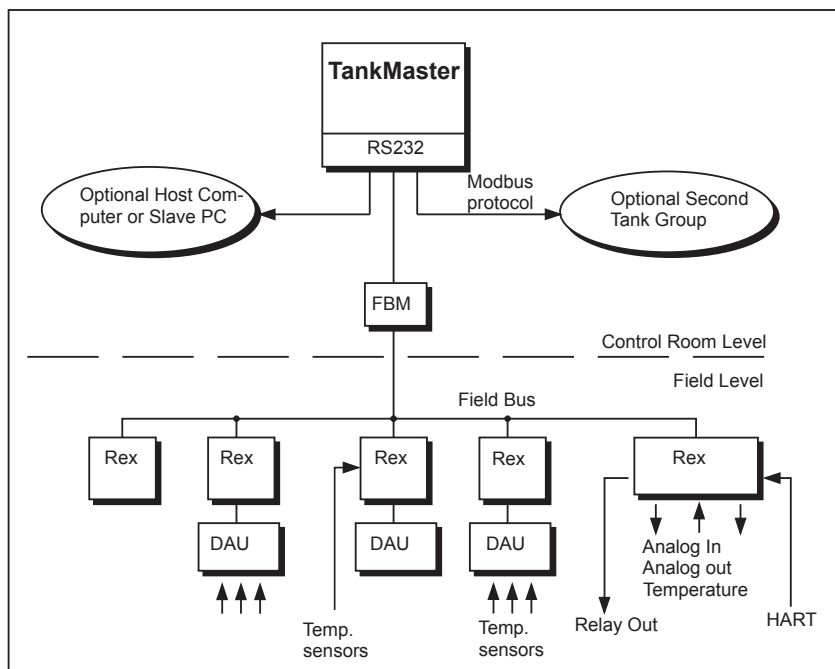


Figure 4-34. Example of a small TankRadar Rex System

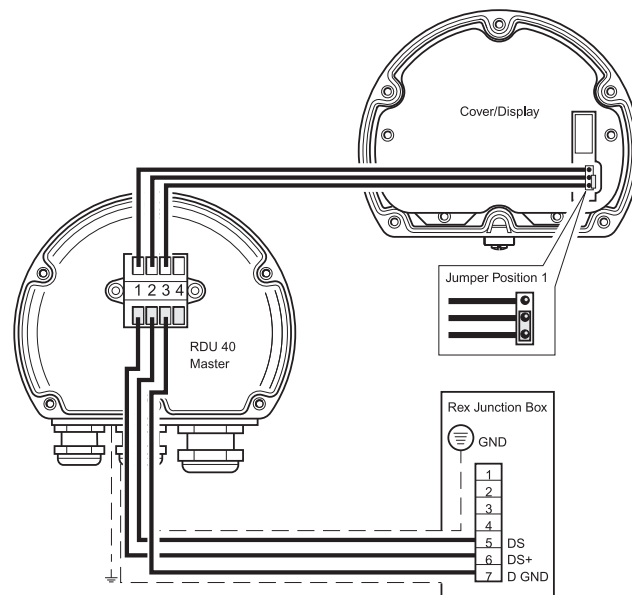


## 4.5 RDU 40

### 4.5.1 Installation

To access the upper screw of the RDU 40 cover remove the rubber plug. Unscrew and remove all six screws. Remove the cover and take care of the locking device for the weather protection hatch.

The RDU 40 shall be connected to the TankRadar Rex junction box for cable connections.



*Figure 4-35. Installation of RDU 40 master and slave*

Any of the three cable glands may be used to take the cable into the RDU40:

2xM20 - Cable diameter: 7 mm - 14 mm

1xM25 - Cable diameter: 9 mm - 18 mm.

External adapters 1/2 NPT and 3/4 NPT are optional.

Connect the RDU 40 to the X12 terminal in the Rex junction box as illustrated in Figure 4-35.

In order to allow proper operation and to fulfil EMC requirements, the cable between the RDU 40 and the Rex junction box should meet the following requirements:

- Shielded cable. Minimum 3 wires. The shield shall be circular connected inside the cable gland of the RDU 40 and connected to ground in the Rex junction box.
- All wires must have at least 0.25 mm individual insulation.
- Maximum total length of 100 m, both master and slave included.
- Minimum AWG 20 or 0.5 mm<sup>2</sup> for each wire.

The RDU 40-chassis shall be grounded locally to the tank. Use minimum 4 mm<sup>2</sup> or AWG 11 wire. Additional protective ground connection to the power distribution central or the Rex junction box is not recommended except where required according to national code of practice. A ground loop with circulating current may occur.

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*Note!* It is not possible to use an RDU40 and a DAU simultaneously.

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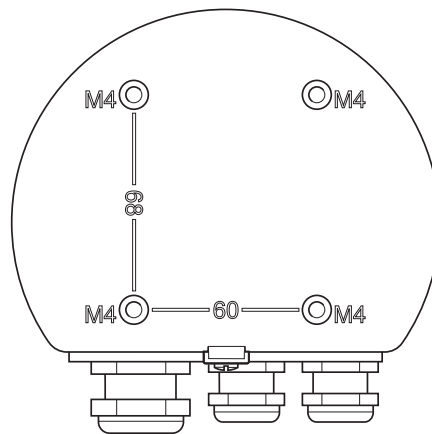


Figure 4-36. Back of RDU40.

If a cable with two shields is used, one shield shall be connected to ground in the Rex junction box and the other shall be circular connected inside the cable gland of the RDU 40.

Check the gasket and put the locking device for the weather protection hatch in position when remounting the RDU-cover. Tighten all six screws firmly.

Mount the RDU 40 with the four M4 screws. Distances between the screws are 60 mm and 68 mm according to the back of the RDU 40.

See the **RDU 40 User's Guide, Ref. no. 308010E**, for further information on RDU 40 installation.

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#### **4.5.2 Two RDU 40 connected to the same Rex**

If two RDU 40 are connected to the same Rex, one of them has to be configured as “slave” while the other is “master”. The slave cannot be configured or controlled individually but follows the master. Only the LCD-contrast can be individually controlled on the slave RDU 40.

To make an RDU 40 work as a slave it is necessary to move the jumper at the RDU 40 cover to position 2 (see Figure 4-35).

#### **4.5.3 Data items**

24 items are available, dependent of how the Rex gauge is equipped:

- Level
- Ullage
- Level rate
- Signal strength
- Volume
- Average temperature
- Temperature spot 1-6
- Analog input 1-2
- Vapor pressure
- Observed density
- Free water level
- Hart slave 1-3
- Relay 1-2



## 5. Calibration

### 5.1 Introduction

Normally a minor adjustment of the Calibration Distance is needed in order to achieve agreement between measured and actual product level. (For TRL/2 transmitters the Tank Connection Length (TCL) is adjusted). A small offset can for example result from deviations between the actual tank height and the value stored in the transmitter database, or from differences between various RTG microwave units and antennas.

The calibration should be performed once at the final commissioning, and does not need to be repeated unless tank conditions are altered.

You can choose to manually adjust the Calibration Distance, or you can use the Calibrate function in **WinSetup** for automatic adjustment.

### 5.2 Manually adjusting the Calibration Distance

The Calibration Distance can be manually adjusted in order to compensate for differences between different RTG microwave units and different antennas. For TRL/2 2900 transmitters the corresponding adjustment is done by changing the TCL parameter. (For Rex transmitters the TCL is never adjusted except when non-standard antennas are used).

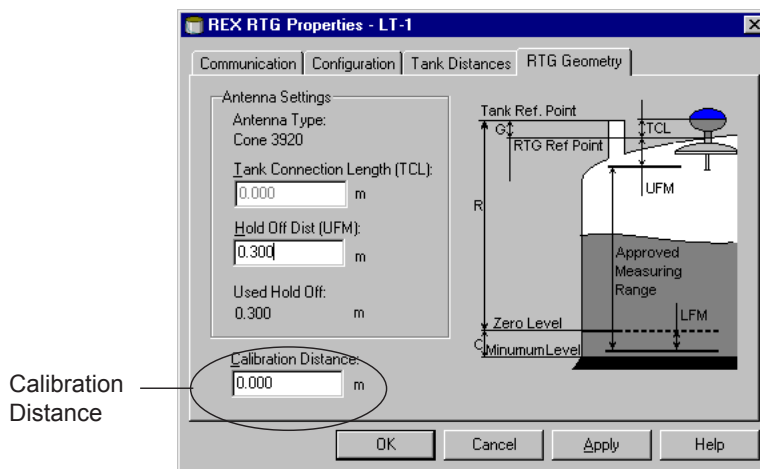
If there is a deviation between hand dipped and measured levels, you may calculate a new Calibration Distance value according to the formula:

$$\text{New Calibration Distance} = \text{Old Calibration Distance} + \Delta L$$

where  $\Delta L$  = observed level (hand dip) - transmitter level reading.  
The same formula applies for TRL/2 transmitters if the Calibration Distance is changed to the TCL parameter.

To change the Calibration Distance value stored in the transmitter database:

- 1 Start the TankMaster WinSetup program.
- 2 Select the transmitter icon in the WinSetup workspace.
- 3 Click the right mouse-button and choose the **Properties** option.
- 4 Select the **RTG Geometry** tab.



- 5 Type the Calibration Distance value in the corresponding input field and click the **OK** button.

## 5.3 Using the WinSetup Calibrate function

The Calibration function is a tool to adjust the RTG in order to minimize the offset between actual (hand dipped) product levels and the corresponding values measured by the transmitter. By using the Calibrate function you can optimize measurement performance over the whole measurement range from the top to the bottom of the tank.

The Calibration function calculates a new Calibration Distance based on fitting a straight line to the deviations between hand dipped levels and levels measured by the transmitter.

For the 3950 still pipe gauge the calibration function is specially suitable since a minor adjustment of the Scale Factor is often necessary. The radar propagation velocity is dependent on the inner diameter of the still pipe, and the Scale Factor parameter is used to adjust the transmitter to take this effect into account. Since the average diameter is often difficult to determine accurately a calibration is often needed.

### Procedure

The adjustment process includes the following steps:

- 1 Recording the hand dipped ullage values and the corresponding RTG level values.
- 2 Entering the hand dipped levels and the RTG level values into WinSetup.
- 3 Inspect the resulting calibration graph and, if necessary, exclude measurement points which should not be used in the adjustment calculation.

### 5.3.1 Required information

Make sure that the following information is available when you intend to use the **RTG Adjustment** function in TankMaster WinSetup:

- A list of hand dipped ullage values.
- A list of RTG level values corresponding to the hand dipped ullage/level values.

### 5.3.2 Hand dipping

#### Staff

Only one person should perform the manual ullage measurements in order to guarantee good repeatability between measurements.

#### Hand dip tape

Use only one tape for the calibration. The tape should be made of steel and calibrated by an approved testing institute. It must also be free from bends and kinks.

The thermal expansion factor and calibration temperature shall also be provided.

#### Manual dip hatch

A dip hatch should be available close to the level gauge. If the dip hatch is far away from the level gauge, differences in roof movements may result in large errors.

#### Procedure

Follow these instructions when you make hand dip measurements:

- hand dip until you obtain three consecutive readings within 1 mm
- correct the tape according to the calibration record
- note the hand dipped ullage and the RTG level reading simultaneously.

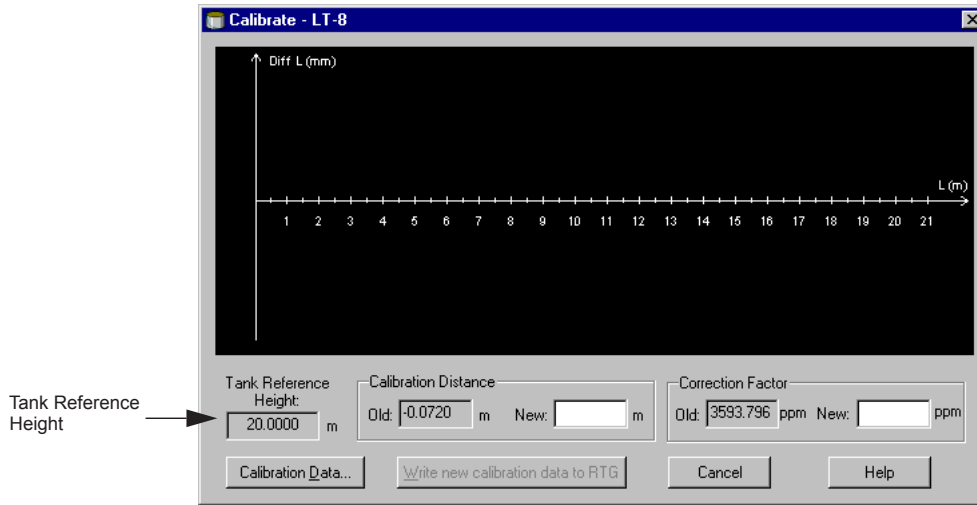
#### Do not calibrate when

- the tank is emptying or filling
- agitators are running
- when there are windy conditions
- when there is foam on the surface.



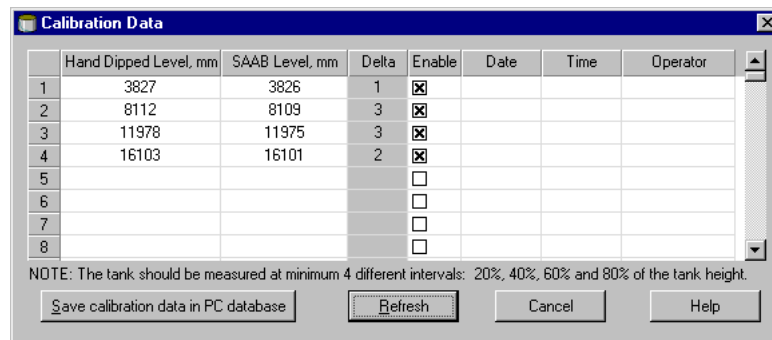
### 5.3.3 Entering calibration data

- 1 Select the transmitter to be calibrated in the workspace window and choose **Calibrate** from the **Service/Devices** menu,  
- or -  
click the right mouse button and choose **Calibrate**.



Before any data is entered, the *Calibrate* window is empty. Make sure that the **Tank Reference Height**, displayed in the lower left corner, is correct. To adjust the Tank Reference Height, select the transmitter icon in the WinSetup workspace, click the right mouse button and choose the **Properties/Tank Distances** option.

- 2 Click the **Calibration Data** button.



- 3 Enter hand dipped level values and the corresponding levels measured by the transmitter. It is recommended that the hand dipped levels are based on the average value of three consecutive measurements within 1 mm. For further information see 5.3.2 “Hand dipping”.

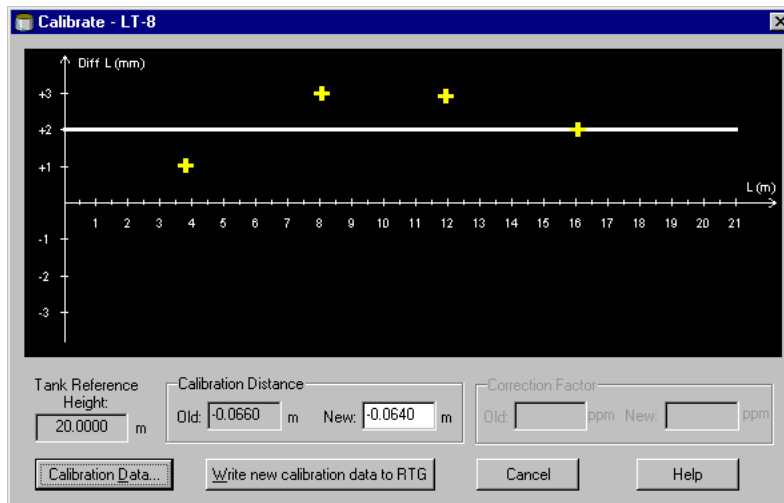
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*Note!*                      *Measurement unit mm is used in the Calibration Data window.*

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- 4 Click the **Refresh** button. Now WinSetup calculates the deviations between hand dipped and measured levels.

Click the **Save Calibration Data in PC Database** button in order to save the entered values and return to the *Calibration* window.



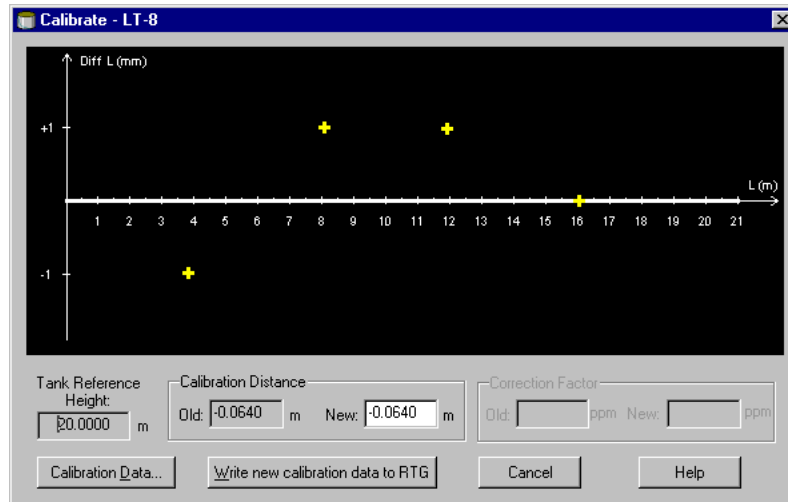
- 5 The *Calibration* window displays a straight line fitted through measurement points representing the difference between hand dipped level values, and values measured by the RTG. For still pipe antennas a sloping line is displayed, otherwise the line is horizontal. The slope is due to the linear impact from the still pipe on the microwave velocity of propagation.

Check that the line fits well to the measurement points. If a point deviates significantly from the line, it can be excluded from the calculations by opening the *Calibration Data* window (click the **Calibration Data** button) and deselecting the corresponding check box in the **Enable** column.

- 6 Click the **Write new calibration data to RTG** button in order to save the current calibration data.

*Note!* By clicking the **Write new calibration data to RTG** button, the Rosemount Level values in the Calibration Data window are recalculated and the old Calibration Data is replaced.

Now you can check the calibration result by opening the *Calibration* window again:



Note that all measured values are adjusted according to the calculated Calibration Distance. In the *Calibration Data* window you can also see that the level values measured by the transmitter are adjusted. Of course, the hand dipped levels are unaltered.

	Hand Dipped Level, mm	SAAB Level, mm	Delta	Enable	Date	Time	Operator
1	3827	3828	-1	<input checked="" type="checkbox"/>			
2	8112	8111	1	<input checked="" type="checkbox"/>			
3	11978	11977	1	<input checked="" type="checkbox"/>			
4	16103	16103	0	<input checked="" type="checkbox"/>			
5				<input type="checkbox"/>			
6				<input type="checkbox"/>			
7				<input type="checkbox"/>			
8				<input type="checkbox"/>			

NOTE: The tank should be measured at minimum 4 different intervals: 20%, 40%, 60% and 80% of the tank height.

Buttons: Save calibration data in PC database, Refresh, Cancel, Help



## 6. Troubleshooting

<b>SYMPTOM</b>	<b>CAUSE</b>	<b>ACTION</b>
<b>No contact with RTG</b>	Faulty TRL/2 bus connection.	Check TRL/2 bus wires.
	Incorrect address or Unit ID.	Check and correct address and Unit ID in TankMaster.
	Analyze communication.	Check LEDs in FCU (if a FCU is included).
	Field Bus connected to wrong communication port on the PC.	Check address of unit and check communication port for correlation.
	Incorrect or faulty cable connection between PC and FBM.	Check that all signals of the RS 232 are connected according to installation drawing.
	Unit connected to wrong field bus port of the FCU (if an FCU is included).	Check that unit is connected to the correct field bus port on the FCU.
	Group Bus connected to wrong communication port on the PC (if an FCU is included).	Check dress of unit and check communication port for correlation.
	Faulty FCM card (if an FCU is included).	Exchange FCM cards to identify the faulty card.
	Faulty Field Bus Modem, FBM.	Replace FBM.
<b>No contact with DAU</b>	Same as above.	Check the items above.
	No contact with associated RTG.	Check the items above.
	Incorrect configuration of RTG.	Check the RTG configuration in TankMaster.
	Incorrect power supply from RTG	Check power supply by measuring the voltage between pins 6 and 7 on DAU connector. The voltage should be about 5.5 V. Check Barrier board in Electronic Unit in RTG.
<b>Not possible to write to DAU or FCU</b>	No contact with unit	Check unit according to the previous page
	Write protection switch in wrong position	Put switch in write enable position

SYMPTOM	CAUSE	ACTION
Not possible to write to RTG	Metrological Seal in Write inhibit position.	Put switch in write enable position.
Temperature measurement incorrect	Temperature sensor incorrectly connected.	Measure resistance on temperature sensor wires. Check connection of temperature sensors to terminal: Lowest sensor to lowest number on terminal.
	Temperature sensor with ground failure.	Measure resistance between signal wire and ground, must be > 5 MΩ.
	Short circuited temperature sensor.	Measure resistance.
	Measured value outside the measuring range.	Check correspondence between measuring range and type of sensor. Check jumpers for temperature range in DAU.
	Faulty configuration.	Check configured measuring range. Check configured number of temperature elements. Check the configured position of the temperature elements.
Incorrect reading of level	Wrong average value but individual values correct.	Check the position of the temperature elements. Check the level of the product in the tank.
	Incorrect database constants.	Check tank distances in the RTG configuration. Hand dip to verify the level.
	RTG locked on disturbing echo.	Initiate new echo search. Look for objects in the tank creating disturbing echoes.
	Metrological Seal in write inhibit position.	Put switch in write enable position.


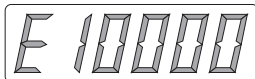







<b>SYMPTOM</b>	<b>CAUSE</b>	<b>ACTION</b>
	Echo amplitude below noise threshold.	Check signal amplitude. Check for foam on product surface. Check inclination of RTG, see "Installation Manual". Clean antenna. Check for waves on product surface.
	Still Pipe Gauge: Amplitude of approximately 20 000 mV or more.	Disturbing echo may be present. Restart the RTG. Check if level is near empty tank. Check the still pipe (drawings).
	Parabolic or Cone Antenna Gauge: Disturbing echo with strength above the noise threshold	Check amplitude of echo. Should be 1000-3000 mV. Restart the RTG.
	Varying amplitudes	Check that the surface of the product is calm (no mixer).
	Mechanically incorrect installation	Check installation drawings and Installation Manual.
Downloading of program to RTG impossible	Faulty communication.	Check the communication to the RTG in question.
	Wrong file used for programming.	Check that correct diskette is used. Check that correct disk drive is used. Check that correct file is used with name TH<date>.cry
ComFail occurs	TankMaster configuration incorrect.	Check configuration.
	Power supply to FBM insufficient.	Connect external power supply.
	Incorrect cables used.	Use a single twisted shielded pair of wires.
	Field Communication Unit faulty.	Check LEDs on the field bus ports and the group bus ports.
	Bad connection of cables.	Check connection of cables.
	Short cables between FBM and PC.	Check termination switch, see 4.4.2.
	Cable dimensions are insufficient	Check gain switch, see 4.4.2.
	No contact with RTG	See previous pages.

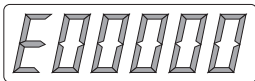








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<b>SYMPTOM</b>	<b>CAUSE</b>	<b>ACTION</b>
Current input reading incorrect	Connected device faulty.	Check device.
	Power supply faulty.	Connect a resistance and check the measured value. Measure current. If there is more than one current input then the power supply is multiplexed. There is no continuous current in that case.
	Incorrect correspondence between current and displayed value	Check scaling configuration of inputs.

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DAU Display	CAUSE	ACTION
	System: 0 - No detected error	No action required
	System: 1 - EEPROM (program) error	Restart the DAU. Exchange the EEPROM.
	System: 2 - EEPROM (database) error	Restart the DAU. Exchange PCB: DMB for Slave DAU or DXB for Independent DAU.
	System: 4 - RAM error	Restart the DAU. Exchange PCB: DMB for Slave DAU or DXB for Independent DAU.
	System: 3, 5, 6 or 7 - combinations of errors above. Codes added together.	See the items above.
	External serial communication error: 0 - No detected error	No action required.
	External serial communication: 1 - Communication with master lost	Restart the DAU. See items under “ <b>No contact with RTG or DAU</b> ”.
	External serial communication error: 2 - Communication with RTG lost	Restart the DAU. See items under “ <b>No contact with RTG or DAU</b> ”.
	External serial communication error: 3 - Combination of the errors above	See the items above.

DAU Display	CAUSE	ACTION
	Internal serial communication error: 0 - No detected error	No action required.
	Internal serial communication error: 1- Error detected	Restart the DAU. Exchange PCB: DMB for Slave DAU or DXB for Independent DAU.
	Internal serial communication error: 3 - Internal bus failure.	Restart the DAU. Exchange PCB: DMB for Slave DAU or DXB for Independent DAU.
	Temperature measuring error: 0 - No detected error	No action required.
	Temperature measuring error: 1- Error in at least one sensor	Watch display in mode 1 (if display is included) for blinking value of the faulty sensor.
	Temperature measuring error: 2 - Calibration error Reference signals out of range	Exchange the precision reference resistance. If problem persists, then exchange PCB: DMB for Slave DAU or DXB for Independent DAU.
	Temperature measuring error: 3 - Average error Not any functioning non-blocked sensor is within the product.	Check if product level is below the lowest functioning non-blocked sensor. Check that DAU receives a level from the associated RTG.
	Current input error (p for pressure): 0 - No detected error	No action required.
	Current input error (p for pressure): 1- Error in at least one sensor	See items under "Current input reading incorrect".

DAU Display	CAUSE	ACTION
	<p>Current input error (p for pressure): 2 - Internal calibration error</p>	<p>Exchange PCB: DMB for Slave DAU or DXB for Independent DAU.</p>
	<p>Current input error (p for pressure): 3 - Old value in at least one value. Same cause as 1 above.</p>	<p>See items under “Current input reading incorrect”.</p>
	<p>Output error (Independent DAU) Relay feedback does not match relay control.</p>	<p>Exchange relay card, DRM.</p>



## 7. Spare Parts

### **Radar Tank Gauge**

Transmitter Interface Card, TIC	9150072-551
Temperature Multiplexing Card, TMC	9150072-561
Relay Output Card, ROC	9150072-591

### **Data Acquisition Unit, DAU**

DAU - DMB board	9240002-512
Display board	9240002-541

#### **Precision Reference Resistors**

Hi Reference Adapter 1 138.50 $\Omega$ for temperature range -50 to 125 °C	9240003-721
Hi Reference Adapter 2 175.84 $\Omega$ for temperature range -50 to 300 °C	9240003-722
Hi Reference Adapter 3 24.90 $\Omega$ for temperature range -200 to 150 °C	9240003-723

### **Field Communication Unit, FCU**

FCU - PC board	9240002-574
FCM board	9240002-701

### **Field Bus Modem, FCBM**

FBM 2171	9240002-633
FBM cable	6853442-682
FBM DC power supply	6853496-240

### **Fuses**

Fuse THE (5 pcs.)	0980240-013
Fuse FCU (5 pcs.)	6853472-017
Fuse FBM	6853389-084



## 8. List of Drawings

### **Mechanical Installation**

Horn Antenna Gauge RTG 3920	9150 072-980
Parabolic Antenna Gauge RTG 3930	9150 072-981
Parabolic Antenna Gauge RTG 3930 (P440)	9150 072-982
Welding of T38-W	9240 003-944
Flange Ball T30	9240 003-947
RTG 3935/EES	9150 072-983
Still-pipe Array Antenna RTG 3950 fixed	9150 070-941
Still-pipe Array Antenna RTG 3950 inclined	9150 070-943
LPG/LNG Gauge 3960	9150 072-986
Reference pin to still pipe	9150 072-922
Reflector kit LPG still pipe	9150 071-651
Reflector kit LPG still pipe (Alt. B)	9150 072-924
Reflector kit LPG still pipe (Alt. A)	9150 072-925
Recommended still pipes for Rosemount Radar	9240 003-987
Installation Drawing FBM 2180 sheet 3 DIN-rail	9150 070-972
Installation Drawing FBM 2180 sheet 4 wall mounting	9150 070-972
Dimensional drawing FCU 2160	9240 002-914
Mechanical Installation Sun Shelter	9240 003-930
Dimensional drawing DAU 2100	9240 002-913

### **Electrical Installation**

RTG (DAU-AIN, Relay)	9150 072-913
RTG (AIN-Temp, Relay)	9150 072-914
RTG/JBi (DAU-AIN, Relay)	9150 072-911
RTG/JBi (AIN-Temp, Relay)	9150 072-912
Power - TRL/2 Bus Connection RTG (W11/X11)	9150 072-930
Relay 1+2 connection RTG (W11/X11)	9150 072-932
Relay 1 connection RTG (W11/X11)	9150 072-933
Analog Output Connection RTG (W11/X11)	9150 072-934

RDU/DAU and Analog Input RTG (W12/X12)	9150 072-940
Temp sensor connection RTG (W12/X12)	9150 072-941
WBS + temperature connection RTG (W12/X12)	9150 072-943
Installation Drawing FBM 2180 sheet 2 USB	9150 070-972
PC-FBM 2180-JB/RTG	9240 002-968
PC-FBM 2180-FCU	9240 002-959
FCU 2160	9240 002-914
PC-FCU-RS232	9240 002-905
FCU in PU2	9240 002-931
PC-FCU-RS485	9240 002-936
PC-RS232/485-FCU	9240 003-931
FCU-PS12-LABKO 2000	9240 003-933
PC-Fibre Modem-FCU	9240 007-987
Redundant FCU connection	9240 007-988
PC-Host-FCU	9240 007-989
DU620-FCU	9244 000-904
DAU-Cu90	9240 002-909
DAU-Pt100 3-wire	9240 002-910
DAU - Pt100 with common returns	9240 003-912
DAU - Pt100 3-wire - WBSi w/RTD	9240 003-940
DAU - Pt100 3-wire -WBSi w.out/RTD	9240 003-941



## 9. Technical Data

### 9.1 RTG 3900

The following specification is valid for RTG 3900 standard version:

Ambient operating temperature	-40 °C to +70 °C (-40 °F to +158 °F).
Hazardous locations certifications	II 1/2G Ex d IIB Ga/Gb T6 ( $T_{amb}$ = -40 °C to +70 °C) according to ATEX directive (EN 50014, EN 50018, EN 50020, EN 50284 Europe).  Class 1, Div I, Groups C and D according to UL 1203, UL 913, UL 508 (USA).  Ex d IIB Ga/Gb T6 ( $T_{amb}$ = -40°C to +70 °C) according to IECEx.
Instrument accuracy	RTG 3900 ± 0.5 mm ± (5/256 in.) RTG 3900 L ± 3 mm ± (1/8 in.).
Power Supply	100-240 VAC, 50-60 Hz, average 15 W (max. 80 W at gauge power up in temper- atures below freezing point) 34-70 VAC (option) 20-28 VDC, max 30 W (option) 48-99 VDC (option)
Field Bus	1) TRL/2 Bus (FSK, half duplex, two wires, galvanically isolated, 4800 Baud, Modbus based). 2) RS485 (Modbus based)

## 9.2 RTG 3920

Instrument accuracy	RTG 3900 ± 0.5 mm ± (5/256 in.) RTG 3900 L ± 3 mm ± (1/8 in.)
Operating temperature in tank	Max. +230 °C (+445 °F)
Ambient temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Measuring range	0.8 to 20 m (2.6 to 65 ft) below flange Can be extended to 0.3 to 30 m (1 to 100 ft) below flange with reduced accuracy.
Pressure	-0.2 to 2 bar (-2.9 to 29 psig)
Material exposed to tank atmosphere	Antenna: Acid proof steel type EN 1.4436 (AISI 316) Sealing: PTFE O-ring: FPM (Viton™)
Total weight	Approximately 20 kg (44 lbs) excl. flange
Mounting flange	8-in. ANSI B 16.5 150 lbs/DN 200 PN 10 DIN 2632/SS2032

**9.3 RTG 3930**

Instrument accuracy	RTG 3900 $\pm 0.5 \text{ mm} \pm (5/256 \text{ in.})$ RTG 3900 L $\pm 3 \text{ mm} \pm (1/8 \text{ in.})$
Operating temperature in tank	Max. +230 °C (+445 °F)
Ambient temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Measuring range	0.8 to 40 m (2.6 to 130 ft) below flange
Pressure	Clamped: -0.2 to 0.2 bar (-2.9 to 2.9 psig) Welded: -0.2 to 10 bar (-2.9 to 145 psig)
Material exposed to tank atmosphere	Antenna: Acid proof steel type EN 1.4436 (AISI 316) Sealing: PTFE O-ring: FPM (Viton™)
Total weight	Appr. 25 kg (55 lbs) excluding flange
Manway size	Minimum 20 in.

## 9.4 RTG 3950

Instrument accuracy	RTG $\pm 0.5$ mm + (5/256 in.) RTG 3950 L $\pm 3$ mm $\pm$ (1/8 in.)
Operating temperature in tank	-40 °C to +120 °C (-40 °F to +248 °F)
Ambient temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Measuring range	0.8 to 40 m (2.6 to 130 ft) from antenna end.
Pressure (two versions available)	Fixed version: -0.2 to 2 bar (-2.9 to 29 psig) at 20°C Inclined version: 5 to 8 in. pipes, -0.2 to 0.5 bar (-2.9 to 7.2 psig). 10 and 12 in. pipes, -0.2 to 0.25 bar (-2.9 to 3.6 psig)
Material exposed to tank atmosphere	Antenna: Polyphenylensulfid (PPS) Sealing: PTFE O-ring: Fluorosilicone Flange: Acid Proof Steel EN 1.4404 (AISI 316L)
Total weight	21.5-32 kg for fixed version and 28.5-41.5 kg for inclined version, depending on dimension
Still-pipe dimensions	5-, 6-, 8-, 10- or 12 in.

**9.5 RTG 3960**

Instrument accuracy	RTG 3900 $\pm 0.5 \text{ mm} \pm (5/256 \text{ in.})$ RTG 3900 L $\pm 3 \text{ mm} \pm (1/8 \text{ in.})$
Operating temperature at ball valve	-55 °C to 90 °C (-67 °F to 194 °F)
Operating temperature in tank	-170 °C to 90 °C (-274 °F to 194 °F)
Ambient temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Measuring range	0.5 m to 60 m (1.6 ft to 200 ft) from cone end.
Maximum pressure	Up to 25 bar (365 psig)
Pressure sensor (option)	Druck PTX 621
Material exposed to tank atmosphere	Antenna: Acid proof steel type EN 1.4436 (AISI 316) Sealing: Quartz
Total weight	6 in. 150 lbs-appr. 38 kg (84 lbs) 6 in. 300 lbs-appr. 48 kg (106 lbs)
Still-pipe dimensions	4 in. Sch 10 or 100 mm inner diameter.

## 9.6 FCU 2160

Ambient operating temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Power Supply	115 or 230 VAC, +10% to -15%, 50-60 Hz, max. 10 W
Group bus interface	TRL/2 Bus, RS-232 or RS-485, Modbus based protocol
Field bus interface	TRL/2 Bus. Max 8 units on one port
Explosion protection	None
Number of tanks per FCU	Max 32 (max 8 per field bus is recommended)

**9.7 DAU 2100**

Ambient operating temperature	-40 °C to 65 °C (-40 °F to 149 °F)
Sensor elements	Pt 100 single or multispot
Number of sensor elements	Max. 14 per DAU
Temperature measuring range	Range 1: -50 °C to 125 °C (-58 °F to 257 °F) Range 2: -50 °C to 300 °C (-58 °F to 572 °F) Range 3: -200 °C to +150 °C (-330 °F to 302 °F)
Explosion protection	II 1G Ex ia IIB T4 Ga (ATEX) and Class 1, Div I, Groups C and D (UL913 USA).
Power Supply	Intrinsically safe supply from Radar Tank Gauge.
Field bus	Intrinsically safe local line from Radar Tank Gauge.

## 9.8 RDU 40

Ambient temperature	-20 °C to +70 °C (-4 °F to +158 °F)
Hazardous locations certifications	II 2 G Ex ib IIC T4 Gb
FM	Class I Div I Group A, B, C, D
Max cable length	100 m (328 ft) (total length if two units are connected to the same gauge)
Cable requirement	3-wire, shielded instrument cable Min 0.5 mm <sup>2</sup> (AWG 20) Max 2.5 mm <sup>2</sup> (AWG 14) Max Ø14 mm (0.55 inch) Min insulation thickness for each wire 0.25 mm (0.00985 inch)
Material housing	Die cast aluminium
Dimensions	150 x 120 x 70 mm (6 x 4 x 3 inch)
Weight	1.2 kg (2.6 lbs)
Ingress protection	IP 66 & 67



**9.9 FBM 2180**

Power supply (for RS-232)	DC 7-12 V, 50 mA
Cable to Host PC	RS-232: 3 m (10 ft) USB: 3 m (10 ft)
Explosion protection	None
Field bus over-voltage protection	Galvanic insulation, and transient suppressors
Field interface	TRL/2
Computer/Host interface	RS-232 or USB
LED indicators	External power, host connection, TRL/2 transmit and receive



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