Technical Description

Saab TankRadar® REX

High Precision Inventory Tank Gauging System

SAAB ROSEMOUNT
Tank Control

Contents

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Technical data is subject to change without prior notice. Saab Marine Electronics AB accepts no responsibility for any errors that may appear in this description.

Available technical documentation for Saab TankRadar Rex:

- Technical Description
- Installation Manual
- TankMaster WinSetup User's Guide
- TankMaster WinOpi User's Guide
- Commissioning Manual
- Commissioning Checklist
- Installation Drawings
- Service Manual

The Technical Description includes technical data on the various parts of the TankRadar Rex system.

The Installation Manual is used for planning and performing the installation.

The Commissioning Manual & Commissioning Checklist include information on how to commission the Saab TankRadar Rex System. They are used together with the TankMaster WinSetup User's Guide.

The TankMaster WinSetup User's Guide describes how to start-up the system using the WinSetup software on a personal computer. TankMaster is the Human Machine Interface (HMI) software for TankRadar Rex. It includes the WinSetup and WinOpi software modules.

The TankMaster WinOpi User's Guide describes the inventory and display functions included in the optional TankMaster WinOpi software.

The Service Manual is used for service and trouble shooting

Abbreviations used in this document:

APC	Analog Processing Card
API	American Petroleum Institute
DAU	Data Acquisition Unit
DCS	Digital Control System.
EEPROM	Electrically Erasable Programmable Read Only Memory
FBM	Field Bus Modem
FCC	Field Communication Card
FCU	Field Communication Unit
FMCW	Frequency Modulated Continuous Wave
FSK	Frequency Shift Keyed
HMI	Human Machine Interface
IS	Intrinsically Safe
ISO	International Standard Organization
JB	Junction Box
LCD	Liquid Crystal Display
OIML	International Organization of Legal Metrology
PC	Personal Computer
PCB	Printed Circuit Board
PROM	Programmable Read Only Memory
PTB	Physikalisch Technische Bundesanstalt
PTFE	Polytetrafluoroethylene. A polymer also marketed as Teflon®.
RDU	Remote Display Unit
RF-head	A device for emitting and receiving microwaves.
ROC	Relay Output Card
RTD	Resistance Temperature Detectors
RTG	Radar Tank Gauge
SCADA	Supervisory Control and Data Acuisisition System
SPC	Signal Processing Card
TH	Transmitter Head
THE	Transmitter Head Electronics
TIC	Transmitter Interface Card
TM	TankMaster
TMC	Transmitter Multiplexer Card
TRC	Transformer Rectifier Card
TRL	Saab TankRadar L (First generation)
TÜV	Technischer Übervachungs-Verein
VAC	Volts Alternating Current
VDC	Volts Direct Current

Saab TankRadar Rex – the industry standard tank gauging system

Saab TankRadar Rex is a state-of-the art inventory and custody transfer radar tank gauging system for storage tanks . It fulfills the highest requirements on performance and safety. The development of Saab TankRadar Rex is based on 25 years experience in radar level gauging. More than 50 000 radar gauges have been delivered by Saab Rosemount.

Features

- Excellent reliability (gauge MTBF is 65 years).
- Highest accuracy with custody transfer approvals, including OIML certificate.
- Drip-off antennas according to API.
- Antennas for all types of tanks.
- Proven performance and installations at all major oil companies.
- Patented method for accurate measuring in still-pipes.
- Overfill protection certified by TÜV for high environmental safety.
- Gauge emulation for cost-effective installation in systems supplied by other vendors.
- All functions for complete tank farm monitoring available in one system.
- OPC compatible HMI software.
- Worldwide service and support.

Applications

Bulk liquid storage tanks at:

- Refineries
- Independent tank terminals
- Marketing terminals
- Pipeline terminals
- Petrochemical industry
- Liquefied gas terminals
- Aviation fuel depots

The extensive range of TankRadar Rex RTG 3900 Series level gauges fits all types of tanks, fixed or floating roofs, pressurized or non-pressurized. The Saab TankRadar Rex system measures the entire storage tank site.

Summary of functions & system overview

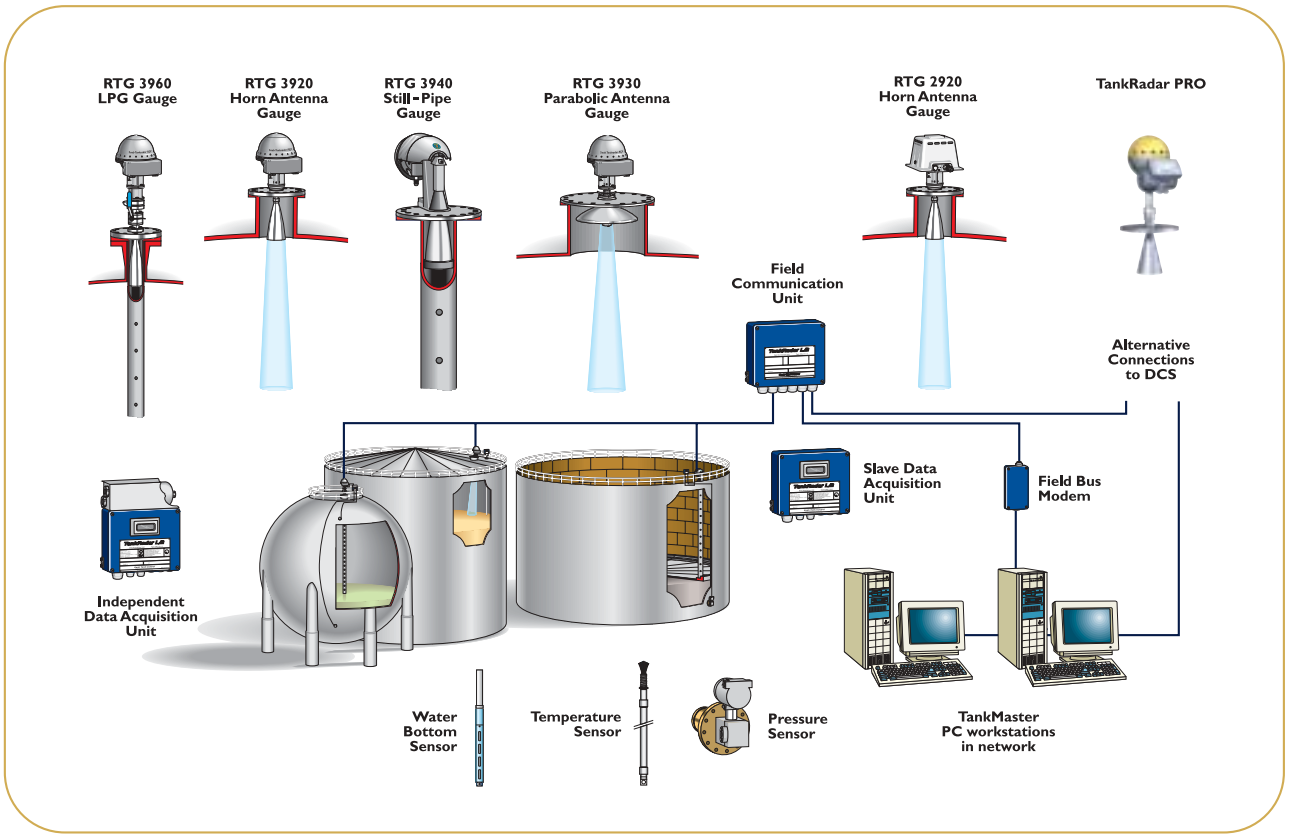
TankRadar Rex system measures and calculates tank data for:

- Inventory calculations
- Custody transfer
- Oil movement
- Loss control
- Operational & blending control
- Leak detection and overfill protection

The system is configured with the functions as required by the user. Available functions are:

- Level, temperature, and water interface level measurement.
- Vapor pressure and hydrostatic pressure measurement.
- Gross volume, mass and observed density calculations in the gauge.
- Net volume calculations according to API (with the TankMaster software package).
- Complete inventory, hybrid and custody transfer functions (with the TankMaster software package).
- Profibus DP, Tiway and proprietary TRL/2 bus communication.
- Emulation of other field buses for cost efficient installation in older systems delivered by other vendors.
- Built-in multiple temperature inputs, analog inputs/outputs, HART inputs for pressure transmitters and relay outputs in radar-gauge.
- Local field display.

TankRadar Rex system overview.



Measured values are communicated on a field bus or directly to a PC. In larger systems there are Field Communication Units (FCU:s) that collect data from separate field buses. In this way both stand-alone gauges and large systems with several hundred gauges are economical and have an excellent performance.
The Saab TankRadar Rex system is configured and operated using the OPC compatible TankMaster software package. Its a user-friendly Human Machine Interface (HMI) software that gives the operator a good overview and quick access to any measured values. The software also provides a wide range of inventory and custody transfer functions such as net standard volumes according to API standards, reporting, alarms, graphics, trends etc.
A whole range of plant host computer systems, DCS or SCADA systems can be connected to the Saab TankRadar Rex system for display of measured and calculated values. Protocols for communication with major suppliers of plant host computers have been developed and certified.
TankMaster Rex gauges can also be incorporated in other tank gauging manufacturers' systems using the emulation features.
The TankRadar Rex system can include various integrated equipment, such as:

- Multi-spot temperature sensors.
- Water Interface measurement sensors integrated with temperature sensors.
- Vapor pressure transmitters.
- Hydrostatic pressure transmitters.
- TankMaster PC workstations in network.
- Radio link between TankMaster PC workstation and Field Communication Unit.
- Local data display on the Data Acquisition Units or on the Remote Display Units.

Installation and commissioning of the TankRadar Rex System

The Saab TankRadar Rex system is easily installed by the customer or the customer's contractor. No special tools are required and all parts can be carried onto the tank roof.
Normally existing field cabling is used.
There are clear instructions in the Installation Manual and installation drawings. Installation can be done with the tanks in operation, except for pressurized tanks such as LPG tanks.
Commissioning is normally done by a trained engineer from our local representative, or in some cases by the customer.
The TankMaster WinSetup PC software is used to configure the system.

Rex gauges are installed using existing nozzles and manways.

Radar level gauging

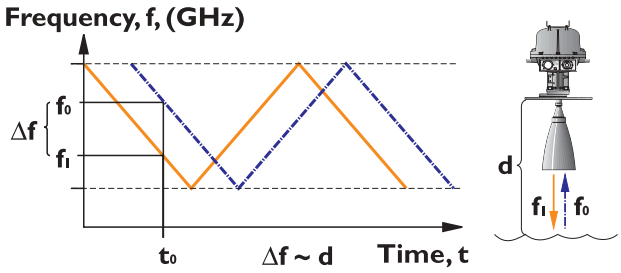
Saab TankRadar Rex gauges provide outstanding reliability using non-contact radar measurement with no moving parts and only the antenna inside the tank atmosphere.
For radar level measurement, there are mainly two modulation techniques:

- Pulse method. Measures the time it takes for a pulse to travel to the surface and back. Pulse radar level gauges are mainly available for lower accuracy applications.
- Frequency Modulated Continuous Wave, FMCW. This method is used by high performance radar level gauges.

The FMCW method

The radar gauge transmits microwaves towards the surface of the liquid. The microwave signal has a continuously varying frequency around 10 GHz. When the signal has travelled down to the liquid surface and back to the antenna, it is mixed with the signal that is being transmitted at that moment. The frequency of the transmitted signal has changed slightly during the time it takes for the echo signal to travel down to the surface and back again. When mixing the transmitted and the received signal the result is a signal with a low frequency proportional to the distance to the surface. This signal provides a measured value with high accuracy. The method is called the FMCW-method (Frequency Modulated Continuous Wave).

This gauge is still operating and gauging accurately despite the heavy contamination. The parabolic antenna has for several months been exposed to blown bitumen heated to over 220° C (430° F).



The FMCW-method is based on a radar sweep with varying frequency.

Accuracy enhancement

To enhance accuracy further, TankRadar Rex has some built-in unique features:

Temperature control

TankRadar Rex gauges are designed to operate in all climates. The gauge is continuously controlling the temperature of the electronics and keeps it constant. This is one of the reasons for the high accuracy and the 65 years of mean time between failure (MTBF) for the gauge.

Digital reference

A radar gauge needs an internal reference to make the radar sweep absolutely linear. Each deviation from the linearity produces a corresponding inaccuracy. To achieve highest precision, Saab TankRadar Rex uses a digital crystal oscillator. This gives the most stable reference that is available with today's technology.

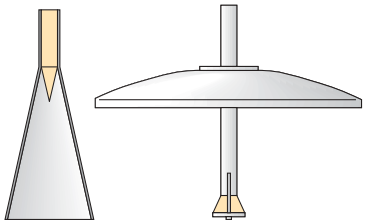
Drip-off means no condensation

If the antenna has an inclined polished PTFE-surface (Teflon®) where the microwaves are emitted, it will be less susceptible to condensed water or product. The drops of condensation will not coat the active part of the antenna. In this way the radar signal will be less weakened resulting in higher accuracy and better reliability.

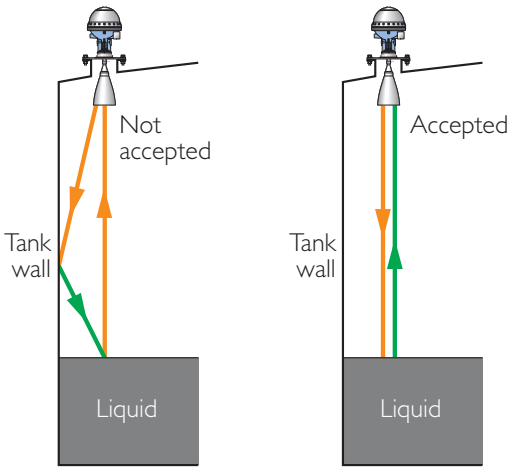
Measurement close to tank wall

A standard manway (or flange) is normally 0.3-1 m (1-3 feet) from the tank wall. Both the Saab RTG 3920 Horn Antenna Gauge and the RTG 3930 Parabolic Antenna Gauge are specially designed to be mounted close to the wall.

The RTG 3920 Horn Antenna Gauge radar signal is polarized so that the direct reflection from the liquid surface is the only detectable reflection. Any wall disturbance will be blanked out. The RTG 3930 Parabolic Antenna has a narrow radar beam due to the large 20-inch antenna diameter resulting in a small and uncritical wall echo.



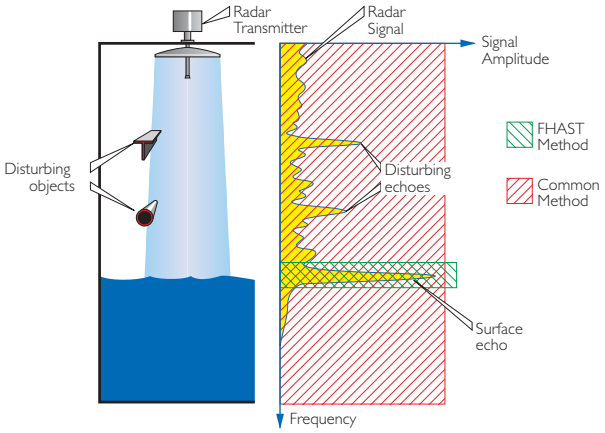
Antenna design with no horizontal surfaces according to the American Petroleum Institute Standard (API ch. 3.1B).



Gauges emitting microwaves with circular polarization can be installed closer to the tank wall.

Saab's patented method for detecting the surface echo

TankRadar Rex uses a patented method for detecting the surface echo. The measured signal passes through a digital filter. First, one filter removes any echoes smaller than a threshold value. Then a narrow filter "window" is placed around the frequency corresponding to the surface echo. The remaining frequency is compared with the frequency calculated in the previous radar sweep, resulting in a very accurate measurement. This method uses the calculating power of the processor very efficiently and focuses on accuracy as well as fast and reliable results.



The FHAST™ filter limits the region around the liquid surface to be analyzed, resulting in a much more efficient signal processing.

No risk to be exposed to the micro-waves from the TankRadar Rex antenna

There are no health hazards from the Saab TankRadar microwave output. As the emitted power from each transmitter is very low, there is no health hazard even when you are very close to the antenna. A few figures will illustrate this:
most international standards state that a power density of up to 1 mW / cm^2 is considered safe for continuous human exposure. The power density close to the antenna is 0.001 mW / cm^2, and further down in the tank it is much lower. The transmitted microwave power is less than 1 mW. As a comparison, the normal sunshine a person is exposed to a sunny day corresponds to a power density of 100-150 mW / cm^2.

Lightning Protection

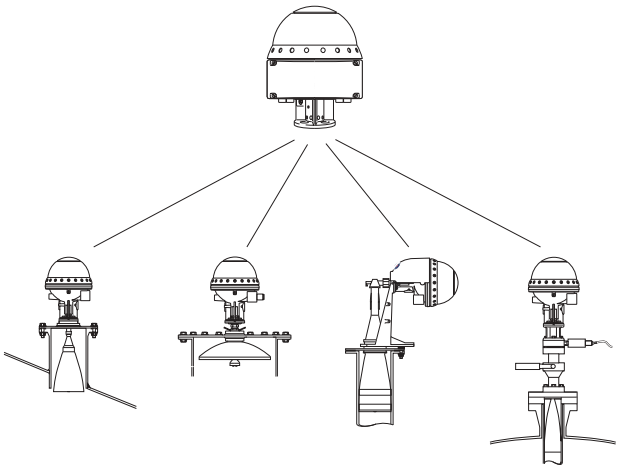
Lightning strikes can induce very high voltages in tank farm field cables. The TankRadar Rex system has been designed to minimize the risk of lightning damage to the equipment.

- Every node of the system is galvanically isolated on both the mains supply and the TRL / 2 bus.
- Standard protection components and filters able to handle fast transients are applied.
- Multiple varistors (fast transient protection) and gas tube arrestors (surge protection) inside the gauge protect the electronics from over-voltages. Since any sparking will occur inside the flameproof enclosure, the tank is also protected from expolsion hazard.
- Mains supply is protected by fuses.

Radar Tank Gauges

There are five types of RTG 3900 Series Radar Tank Gauges to fit any storage tank:

- **Horn Antenna Gauge, RTG 3920**, for fixed roof installation without still pipe.
- **Parabolic Antenna Gauge, RTG 3930**, for installation without still pipe, for general use and in demanding environments.
- **Still Pipe Gauge, RTG 3940**, for measurement in existing still pipes.
- **Still Pipe Gauge, RTG 3945**, for measuring in still pipes in pressurized tanks (other than liquefied gas tanks).
- **LPG/LNG Gauge, RTG 3960**, for liquiefied gas, LPG and LNG.



The RTG 3900 Transmitter Head with different antennas.

The Radar Tank Gauge (RTG) measures the distance to the surface of the product in the tank. Using tank distances stored locally in the memory of the gauge, it calculates the level of the liquid's surface. The level is communicated on the digital TRL/2 field bus to the Field Communication Units and to the PC workstations or other host computers.

Transmitter Head

The radar gauges are built up by the Transmitter Head (TH) and the antenna. The same Transmitter Head is used on all types of Rex tank gauges minimizing spare parts requirements. It is freely interchangeable between different gauges, regardless of antenna type. The Transmitter Head weight is only 8 kg (18 lbs).
The enclosure of the Transmitter Head is a rugged air and watertight protection against salt spray atmosphere in coastal areas.

Transmitter Head with optional junction box for deliveries according to CENELEC standards.

Transmitter Head Electronics

The Transmitter Head Electronics (THE) is a separate unit located inside the safety enclosure of the Transmitter Head. It is easily exchangeable and not in contact with the tank atmosphere. The THE includes the microwave unit, circuit boards for signal processing, data communication, power supply and transient protection.

The unit contains no analog reference lines that can cause drift by age or temperature changes. It uses a digitally synthesized feedback channel from the microwave unit as a reference for the measurement. The Rex gauge requires no recalibration, not even after the THE has been exchanged.

Following circuit boards are included in the THE:

Signal Processing Card (SPC)
The SPC card includes a high performance signal processor plus memories for tank specific data set via remote programming.

Analog Processing Card (APC)
The APC card is used for filtering and multiplexing of analog input signals. Keeping the analog circuitry on a separate card improves measuring accuracy by giving a high signal to noise ratio.

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

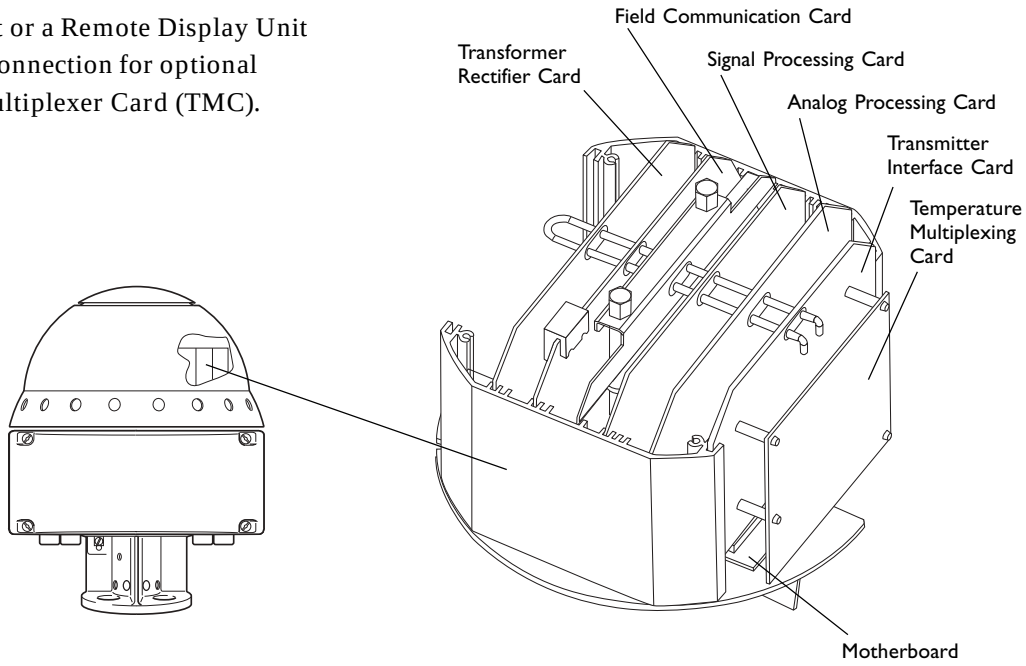
- Two supply zener barriers and two return barriers for 4-20 mA current loops.
- One supply zener barrier for a Slave Data Acquisition Unit or a Remote Display Unit
- Signal / supply connection for optional Temperature Multiplexer Card (TMC).

Temperature Multiplexer Card - TMC
The Temperature Multiplexer Card (TMC) is used to connect up to 6 temperature sensors directly to the RTG.

Relay Output Card – ROC
The Relay Output Card (ROC) includes two relays. It allows controlling external devices such as valves, pumps, heating coils, overfill protection according to TÜV etc.

Field Communication Card – FCC
The FCC card handles communication with external devices. There are different versions of the FCC card allowing the use of various types of communication protocols and also emulation of gauges from other vendors.

Metrological Seal (option)
An optional metrological seal in the Transmitter Head prevents unauthorized changes in the database. The metrological seal is a requirement from fiscal authorities in some countries



RTG 3900 Transmitter Head Electronics.

Technical Data for the Transmitter Head	
Instrument accuracy:	±0.5 mm ± (5/256 in.) [The instrument accuracy is given as a 2σ value. This means that approximately 97% of the measured values are within the 0.5 mm tolerance.]
Maximum instrument deviation:	±0.8 mm (1/32 in.)
Ambient operating temperature:	-40°C to +70°C (-40°F to +158°F)
Hazardous locations certifications:	EEx d[ia] IIB T6 (EN50014, EN50018 and EN50020 Europe) and Class 1, Div 1, Groups C and D (UL1203, UL913 USA). See also the list on page 43 "*Approvals for Installation in Hazardous Areas*."
Ingress protection:	IP 66 & 67
Housing Material:	Anodized Aluminium
Power Supply:	100-240 VAC, 50-60 Hz, average 15 W (max. 80 W at gauge power up in temperatures below freezing point) 34-70 VAC (option) 48-99 VDC (option)
Analog outputs:	One output 4-20 mA passive or active (non-intrinsically safe)
Analog inputs:	alt 1) One or two 4-20 mA alt 2) One 4-20 mA standard plus one 4-20 mA superimposed with HART (the RTG is HART master).
Relay outputs:	Max 2 relays, only 1 output available if analog outputs are included. See also under "Field bus (options)" and "Other vendor's communication protocols" below.
Field bus (standard):	TRL/2 Bus (FSK, half duplex, two wires, galvanically isolated, 4800 Baud, Modbus based)
Field bus (options):	1) Profibus® DP 2) Tiway® *(Only one relay available, analog out not available)*
Other vendor's communication protocols:	1) Enraf® *(Requires special Field Bus Modem EBM* 2) Varec® *(Only one relay available, analog output not available)* 3) L&J® *(Only one relay available, analog output not available)* 4) Whessoe *(Only one relay available, analog output not available)* *5) GPE®* *(Only one relay available, analog output not available)*
Temperature inputs:	Up to 6 Pt 100 Resistance Temperature Detector (RTD) inputs with common return or 3 RTD inputs with individual wiring, directly in TH. Up to 14 RTD inputs via separate Data Acquisition Unit, see page 24
Field data display:	In separate DAU (page24) or RDU (page 27).

Cable Connections to the Transmitter Head
The Transmitter Head is either delivered with an integrated junction box (JBi) for cable connections, or with two cable outlets only. The JBi includes two connection terminals; one for power, field bus and relays, and one for intrinsically safe connections from temperature, pressure and water bottom sensors, Data Acquisition Unit, Remote Display Unit etc.

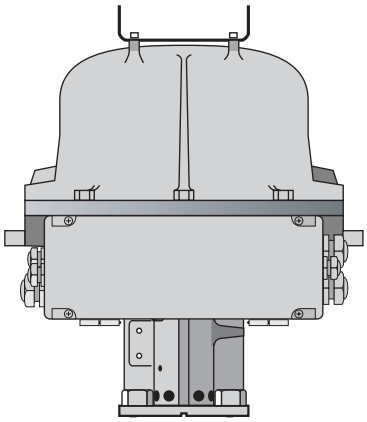
If the JBi is **not** included, the gauge is delivered with two separate cable outlets as follows:

For power and field bus:
Number of wires: 8
Length: 2.5 m (8 ft)
[Optional cable length 20 m (50 ft)]

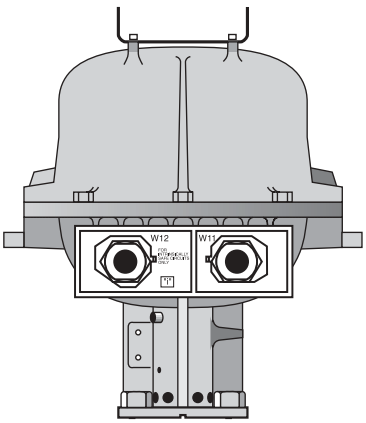
For IS connections such as e.g. temperature:
Number of wires: 8 or 15
Length: 2.5 m (8 ft)
[Optional cable length is 20 m (50 ft)]

The TH version with cables and no JBi is always delivered with shipments to the USA (UL certification). The field bus uses a 2-core twisted and shielded standard instrument cable for distances up to 4 km (2.5 miles).

For more details about installation, see separate installation manual and installation drawings.

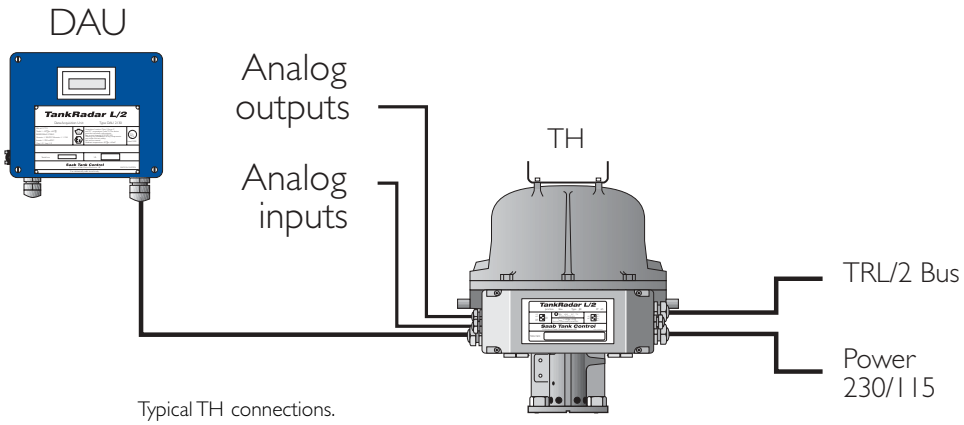


Transmitter Head with JBi.



Transmitter Head with cable outlets and no JBi.

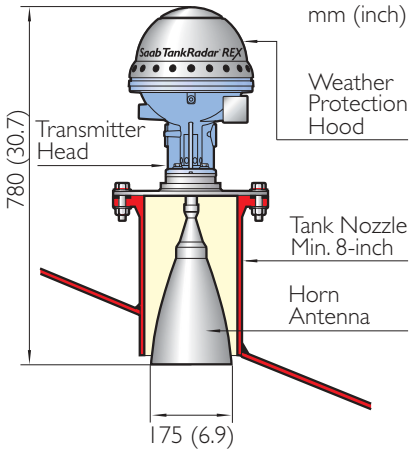
Technical data for integrated junction box (JBi)	
For data on available separate junction boxes, see page 31.	
Hazardous locations certifications:	Increased safety according to EExe IIB T4. There is one EExe side for power and bus cables (W11 wire terminal), and one EExi side for intrinsically safe connections (W12 wire terminal).
Ingress Protection:	IP65.
Material:	Cast aluminium coated with grey polyester
Temperature range:	-40° C to +70° C (-40° F to +158° F)
Cable inlets EExe side (W11):	Standard: 2 pcs M25, 1 pc M20 Option: 2 pcs ¾-in. with NPT thread and 1 pc ½-in. with NPT thread.
Wire terminals EExe side (W11):	8 terminals. (For power and Field Bus)
Cable inlets EExi side IS cabling (W12):	Standard: 1 pc M25, 2 pcs M20 Option: 1 pc ¾-in. with NPT thread, 2 pcs ½-in. with NPT thread.
Wire terminals EExi side (W12):	15 terminals. (For intrinsically safe cables, e.g. to a slave DAU, temp sensors etc.)
Cable glands:	All cable glands must be of EExe type. Each cable inlet is, as standard, sealed with an Ex approved metal blind plug at delivery.



Typical TH connections.

Horn Antenna Gauge RTG 3920

The Horn Antenna Gauge is designed for easy mounting on 200 mm (8-inch) or larger nozzles on tanks with fixed roofs. The RTG 3920 gauge measures on a variety of oil products and chemicals except for asphalt and similar products where the Parabolic Antenna Gauge RTG 3930 is recommended.
The Horn Antenna Gauge is delivered with a flange for straight mounting or one for inclined mounting. The inclined flange is used when the gauge is mounted close to the tank wall and highest accuracy is required. Otherwise the straight flange can be used.
The entire horn antenna is inside the tank and has almost the same temperature as the tank atmosphere preventing condensation on the inside of the antenna.
Installation is normally made without taking the tank out of operation.



RTG 3930 Horn Antenna Gauge

Technical Data for RTG 3920	
See also technical data for the Transmitter Head.	
Instrument accuracy (2σ value):	± 0.5 mm (5/256 inch)
Maximum instrument deviation:	± 0.8 mm (1/32 inch).
Operating temperature in tank:	Max. +230° C (+445° F).
Measuring range (standard):	0.85 to 20 m (2.8 to 65 ft) below flange.
Measuring range (option):	0.3 to 30 m (1 to 98 ft) below flange with reduced accuracy.
Pressure:	-0.2 to 2 bar (-2.9 to 30 psig).
Total weight:	Appr. 20 kg (44 lbs).
Material exposed to tank atmosphere:	Antenna: Acid proof steel type EN 1.4436 (AISI 316). Sealing: PTFE (Teflon®). O-ring: FPM (Viton®).
Antenna dimension:	175 mm (7 in.).
Nozzle diameter:	Minimum 200 mm (8 in.).
Mounting flange:	8-in. ANSI B 16.5 150 lbs/DN 200 PN 10 DIN 2632/SS2032 Monting flange can be horizontal or 4° inclined for mounting close to tank wall. (Other flanges available on request.)
Field data display:	In separate DAU (page 24) or RDU (page 27).

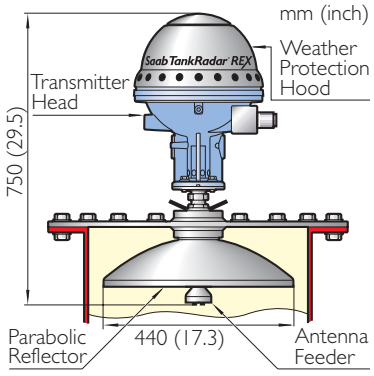
Parabolic Antenna Gauge RTG 3930

The RTG 3930 gauge is designed for mounting on tanks with fixed roofs. It measures levels of products ranging from clean products to very difficult ones like bitumen / asphalt. The design of the parabolic antenna gives extreme tolerance against sticky and condensing products.

The large antenna diameter provides high antenna gain and a high signal to noise ratio. The Parabolic Antenna Gauge can be mounted on existing manhole covers. The standard parabolic reflector has a diameter of 440 mm (17 inch) and it fits onto, for example, a 20 inch manway. For easy access in extremely dirty applications, the gauge can be mounted on a manhole cover with hinges.

The Parabolic Antenna Gauge can also be used on tanks with floating roofs. The RTG is then mounted at the tank top and measures the distance down to a target plate on the floating roof.

Installation is normally made without taking the tank out of operation.

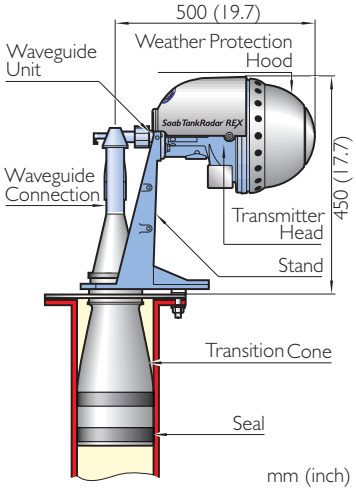


RTG 3930 Parabolic Antenna Gauge

Technical Data for RTG 3930	
See also technical data for the Transmitter Head.	
Instrument accuracy (2σ value):	± 0.5 mm (5/256 inch).
Maximum instrument deviation:	± 0.8 mm (1/32 inch).
Operating temperature in tank:	Max. +230°C (+450°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).
Total weight:	Appr. 25 kg (55 lbs).
Material exposed to tank atmosphere:	Antenna: Acid proof steel type EN 1.4436 (AISI 316). Sealing: PTFE (Teflon®). O-ring: FPM (Viton®).
Antenna dimension:	440 mm (17 inch).
Manway size:	Min. 20-in.
Tank connection:	Gauge is clamped or welded in a 96 mm (3.78 inch) diameter hole in manway cover, see installation manual.
Field data display:	In separate DAU (page 24) or RDU (page 27).

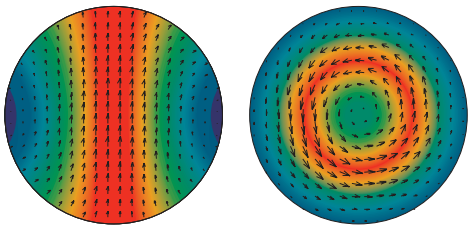
Still-Pipe Gauge RTG 3940

The Still-Pipe Gauge RTG 3940 is used on tanks with still-pipes and with all products suitable for still-pipes such as crude oil, gasoline etc. It transmits radar waves from a cone shaped antenna towards the liquid surface inside the pipe. The still-pipe can be mounted in a tank with an external or internal floating roof or on a fixed roof tank.
To get custody transfer accuracy the gauge uses a unique patented Low Loss Mode to transmit the radar waves in the center of the pipe. This virtually eliminates degradation of the accuracy due to rust and product deposits inside the pipe. The Low Loss Mode accuracy has been tested by custody transfer authorities in rusty and deposit coated still-pipes.
The Still-Pipe Gauge can be mounted on existing still-pipes. Standard antenna cones and flanges are available for 5-, 6-, 8-, 10- and 12-inch pipes.The flanges are made with or without pressure sealing.
The Waveguide Connection can be removed for taking product samples or for hand dipping through a Ø110 mm (4.33 inch) opening.
Installation is normally made without taking the tank out of operation.



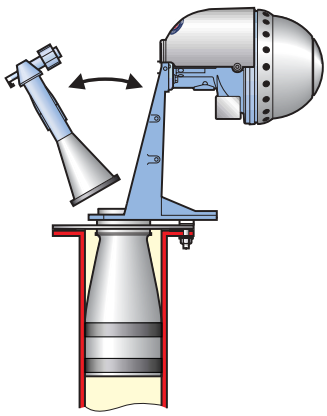
RTG 3940 Still-Pipe Gauge

Pipe seen from above



H_{11} is the normal radar mode of a circular waveguide.

Saab Low Loss Mode. Very low losses from rust or deposits.



Removable Wave-Guide Unit allows hand dips and sampling.

Still-Pipe Gauge RTG 3945

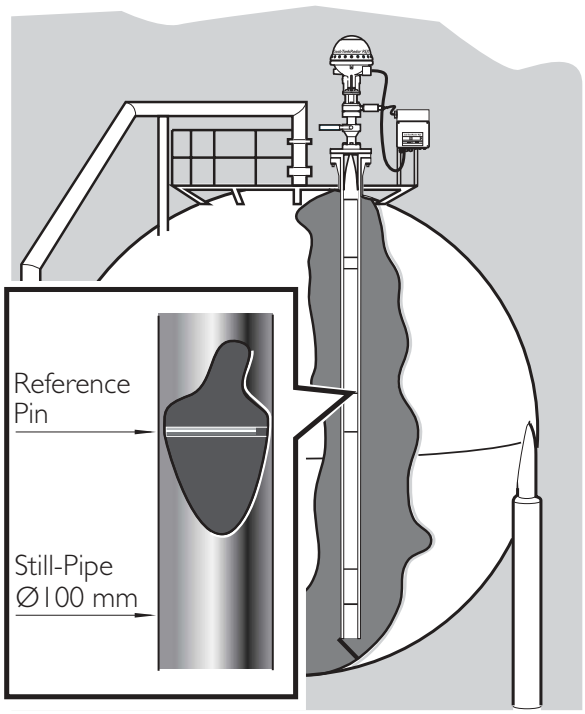
The RTG 3945 gauge meets the German PTB requirements for installation in zone 0 (PTB Zone 0). The RTG 3945 gauge can also be used generally on pressurized tanks with still-pipes as well as in cavern applications with long measuring distances.

If required, the gauge can be removed to open the tank, if the tank is depressurized.
The RTG 3945 gauge is available with the same antenna cone sizes as RTG 3940.

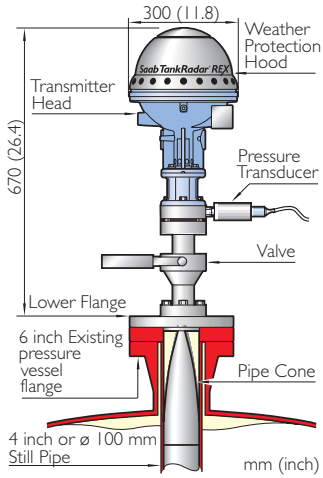
Technical Data for RTG 3940	
See also technical data for the Transmitter Head.	
Instrument accuracy (2σ value):	± 0.5 mm (5/256 inch).
Maximum instrument deviation:	± 0.8 mm (1/32 inch).
Operating temperature in tank:	Max. +230° C (+445° F).
Measuring range:	0 to 40 m from cone end (0 to 130 ft).
Pressure (two versions available):	1) Atmospheric 2)-0.2 to 0.5 bar (-2.9 to 7.3 psig)
Total weight:	Appr. 20 kg (44 lbs)
Material exposed to tank atmosphere:	Antenna: Acid proof steel type EN 1.4436 (AISI 316), Aluminium. Sealing: PTFE (Teflon®). O-ring: FPM (Viton®).
Still-pipe dimensions:	5-, 6-, 8-, 10- or 12-inch.
Field data display:	In separate DAU (page 24) or RDU (page 27).
Technical Data for RTG 3945	
For all other data see "Technical data for RTG 3940" above.	
Measuring range:	0 to 40 m (0 to 130 ft) from cone end. 0 to 200 m (0 to 650 ft) from cone end, with reduced accuracy.
Pressure:	-0.2 to 2 bar (-2.9 to 30 psig) with standard flange. Up to 10 bar (145 psig) with optional pressure flange.
Material exposed to tank atmosphere:	Antenna: Acid proof steel type EN 1.4436 (AISI 316). Sealing: PTFE (Teflon®). O-ring: FPM (Viton®) or PFPM (Kalrez ®).

LPG/LNG Gauge RTG 3960

The RTG 3960 gauge is designed for level measurement of liquefied gas in LPG or LNG tanks. A still-pipe enables the gauge to have a sufficiently strong echo even under surface boiling conditions. The radar signals are transmitted inside the still pipe. The pressure sealing is a quartz / ceramic window approved for use in pressure vessels. As an option the gauge is equipped with a fire-proof ball valve and a vapor space pressure sensor. The pressure sensor is required for highest accuracy.
The installation flange of the LPG / LNG Gauge is available in three different versions; 6-in. 150 psi, 6-in. 300 psi or 6-in. 600 psi.
A patented reference device function enables measurement verification with the tank in operation. A reference pin mounted in a still-pipe hole, and a deflection plate with a reflection ring at the lower pipe end provides measured distance values which are compared with stored positions. Installation is made with the pressurized tank taken out of operation.



The reference pin mounted inside the 4-inch still-pipe and a bottom reflection ring enable the measurement to be checked during operation.



Technical Data for RTG 3960	
Instrument accuracy (2σ value):	± 0.5 mm (5/256 inch).
Maximum instrument deviation:	± 0.8 mm (1/32 inch).
Operating temperature in tank:	-66° C to 90°C (-87° F to 194° F). Version for LNG -162 °C (-260 °F) available.
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). (Note! Flanges may have higher pressure rating than 25 bar, but maximum tank pressure is still 25 bar.)
Pressure rating:	PN 10 bar/150 psi. PN 20 bar/300 psi. PN 40 bar/600 psi.
Pressure sensor (option):	Druck PTX 110.
Flange:	6-in.
Still-pipe dimension alternatives:	4-in. sch. 10 or sch 40 100 mm (99 mm inner diameter).
Total weight:	38 kg (84 lbs) for 6-in. 150 psi. 48 kg (106 lbs) for 6-in. 300 psi. 68 kg (150 lbs) for 6 in. 600 psi.
Material exposed to tank atmosphere:	Antenna: Acid proof steel type EN 1.4436 (AISI 316). Sealing: Quartz.
Ball valve sealing kit (option):	20 bar or 70 bar (290 psi or 1015 psi), the higher pressure for 600 psi flange only.
Field data display:	In separate DAU (page 24) or RDU (page 27).

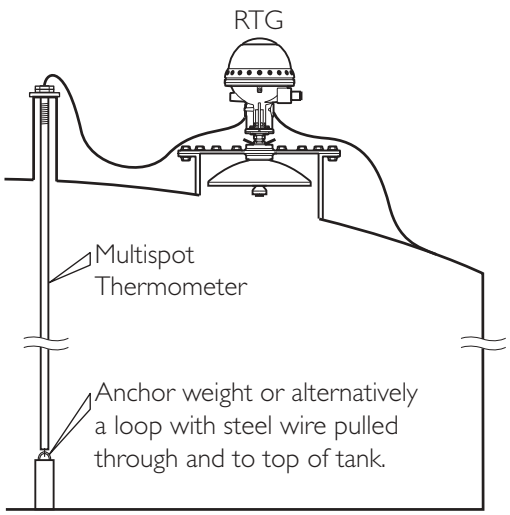
Temperature measurement

Product temperature is an important parameter for accurate custody transfer and inventory measurement in liquid bulk storage tanks. High quality Multiple Spot Thermometers (MST) can be included in the Rex system delivery as an essential part.
The Multiple Spot Thermometer (MST) measures the temperature with a number of Pt 100 spot elements placed at different heights to provide a tank temperature profile and an average temperature. Only the elements that are fully immersed are used to determine the product temperature. The spot elements are placed in a flexible gas tight protection tube made from convoluted stainless steel. A flange can be attached to a top fitting and the tube can be anchored to the bottom.

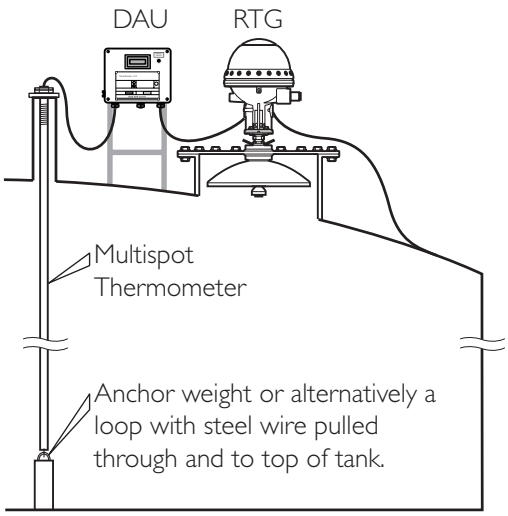
API chapter 7 recommends minimum one element per 10 feet (3 m) tank height for custody transfer applications.
The Multiple Spot Thermometer is easy to install, even if the tank is in service. In pressurized tanks the MST can be installed in a closed thermowell so that it can be removed for service or inspection while the tank is in operation. For LPG tanks single spot temperatures sensors in thermowells are used.
Temperature sensors can be connected in two ways to the RTG:

- Directly into the RTG with common return connection (up to six temperature elements)
- Via the DAU (up to 14 temperature elements)

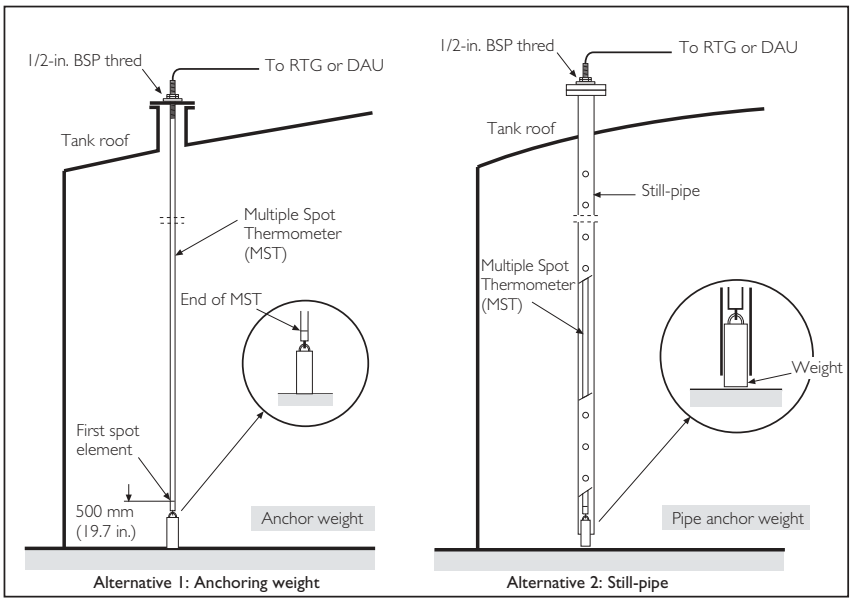
A water bottom sensor can be integrated in the MST, se page 34.



Up to 6 temperature elements can be connected directly to the radar gauge.



When the number of temperature elements is above 6 they are connected via a Data Acquisition Unit. Maximum 14 temperature elements can be connected.



Technical Data for Multispot Thermometer	
Elements type:	Pt 100 spot elements according to EN 60751
Accuracy:	
1/6 DIN class B (std):	±0.25° C (0.45° F)
1/10 DIN class B (option):	±0.17° C (0.31° F)
	-40° C to 40° C (-40° F to 104° F)
Overall temp range (standard):	-50° C to 120° C (-58° F to 248° F)
Overall temp range (optional):	-20° C to 250° C (-4° F to 482° F)
Number of elements:	6 elements per MST as standard. Max. 14 elements for each MST
Overall length:	0.95-70 m (3.1-230 ft)
Sheath diameter:	¾-in. (standard), 1-in. (option)
Tank connection:	1/2-in. BSP thread, length 250 mm (9.8 in.)
Top fitting:	Steel pipe ½-in. BSP thread, length 305 mm (12-in.)
Tank opening:	Min. Ø 2-in. (50.8 mm)
Outer Material:	Stainless steel, AISI 316
Flange (option):	¾-in. or 1-in.
Lead wire length:	3 m (9.8 ft). longer wires optional
No of wires:	3 independent wires per element or 1 wire per element plus 2 common return wires
Bottom weight:	2-12 kg (4.4-26 lbs)
Connection to Rex system:	Max. 14 elements via DAU, or max 6 elements with common return directly to Rex Gauge (max. 3 elements with independent wires)
Designed according to:	IEC 751 and ATEX Directive 94/9/EC

Technical Data for Single Spot Temperature Sensor – LPG tanks	
Element type:	Pt100 1/6 DIN or optional 1/10 DIN 3 wire
Temperature range (standard):	-50° C to 260° C (-58° F to 500° F)
Sheath:	8 mm (0.31 in.) outer diameter
Sheath material:	Stainless steel AISI 316TI
Mounting thread:	½-in. BSP thread
Length (standard):	160 mm (6.30 in.)
Thermowell:	12 mm (0.5-in.) outer diameter.
Thermowell material:	Stainless steel AISI 316TI
Designed according to:	IEC 751 and ATEX Directive 94/9/EC

Data Acquisition Units

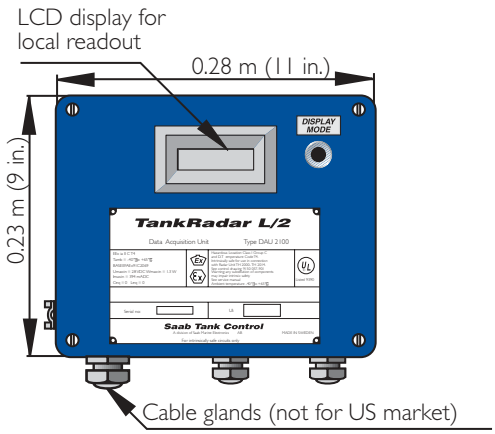
The Data Acquisition Unit (DAU) is used together with an associated Radar Tank Gauge for local readout and for connection of temperature sensors, pressure transmitters, on / off switches etc when more inputs / outputs are required than is available in the RTG.

There are two versions of the Data Acquisition Unit, the Slave DAU and the Independent DAU.

Slave Data Acquisition Unit DAU 2100

A Multiple Spot Thermometer (MST) with up to 14 temperature elements can be connected to the Slave DAU. The unit is powered from, and communicates through the Radar Tank Gauge to which it is connected. The Slave DAU is intrinsically safe using zener barriers on the Transmitter Interface Card (TIC) in the Radar Tank Gauge.
The weatherproof box houses a printed circuit board with a cable terminal for connection of the temperature sensors, as well as the power and communication cable. Cable inlet cable glands are located at the bottom of the box.

The Slave Data Acquisition Unit with Local Readout Display mounted at the foot of a tank.



DAU 2100 Slave Data Acquisition Unit.

Independent Data Acquisition Unit DAU 2130

Also to the Independent DAU a Multiple Spot Thermometer with up to 14 temperature elements can be connected. In addition the unit has four 4-20 mA inputs, eight digital inputs and four relay outputs.

The Independent Data Acquisition Unit is used for connecting temperature sensors, various pressure sensors, as well as other types of sensors, such as water interface sensors in case they are not directly connected to the RTG. The Independent DAU can also be equipped with four relays for controlling other equipment.

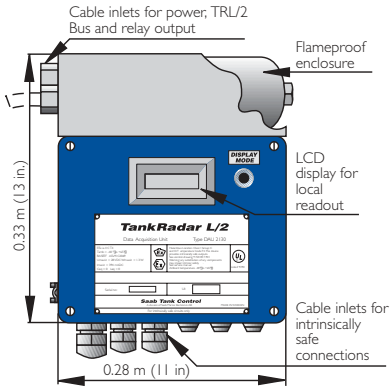
The Independent DAU has its own power supply and communicates directly on the TRL / 2 Bus.

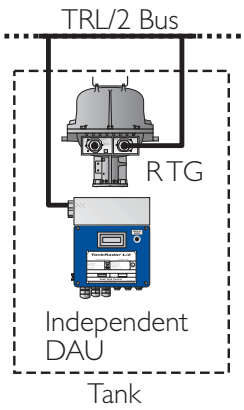
Part of the Independent DAU is intrinsically safe, part of it is explosion proof. The non-intrinsically safe circuits are placed in a flameproof enclosure where the power, communication and relay cables are connected. The intrinsically safe sensors are connected at the bottom of the weatherproof box.

Local Readout

Both types of DAU:s can be equipped with a Readout Display showing level, temperature and other measured values. With the DAU placed at the foot of the tank, these values can be viewed at the tank without having to climb to the tank top.

If required, the DAU can also be placed at the tank top.





DAU 2130 connection to TRL/2 Bus.

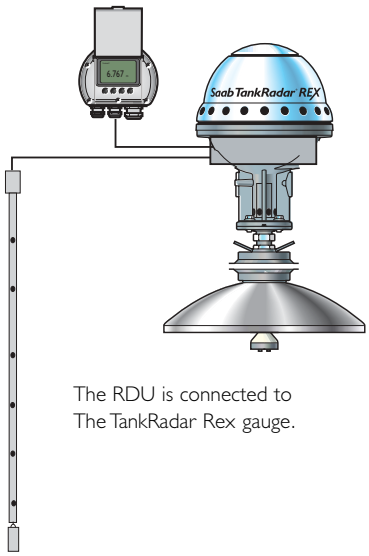
Technical Data For Both Types of DAU:s	
Ambient operating temperature:	-40° C to 70° C (-40° F to+158° F)
Number of sensor elements:	Max. 14 per DAU
Temperature ranges:	Range 1: -50° C to 125° C (-58° F to 257° F) Range 2: -50° C to 300° C (-58° F to 572° F) Range 3: -200° C to +150° C (-330° F to 302° F)
Temperature resolution:	0.1° C (0.18° F)
Accuracy (excl. sensor):	±0.2° C (±0.36° F) [for -20° C to 100° C (-4° F to 212° F)] ±0.5° C (±0.9° F) [for other ranges]
Sensor elements:	Pt 100 single or multispot.
Display (optional):	LCD with 6 digits,
Available data on display:	Level, Ullage, Spot temperature, Average temperature, Level rate, Signal strength.
Ingress protection:	IP 66 & 67.
Technical Data for Slave DAU 2100	
Explosion protection:	EEx ia IIC T4 (EN50020 Europe) and Class 1, Div 1, Groups C and D (UL913 USA). See also the list on page 43. *Approvals for Installation in Hazardous Areas*.
Power Supply:	Intrinsically safe supply from Radar Tank Gauge
Field bus:	Intrinsically safe local line from Radar Tank Gauge
Technical Data for Independent DAU 2130	
Explosion protection:	EEx d[ia] IIB T4 (EN50014, EN50018 and EN50020 Europe) Class 1, Div 1, Groups C and D (UL1203, UL913 USA). See also the list in page 43. "*Approvals for Installation in Hazardous Areas*."
Power Supply:	115 or 230 VAC, +10% to -15%, 50-60 Hz, max. 10 W Field bus. TRL/2 Bus
Analog inputs:	4-20 mA. Intrinsically safe. Max. 4. Multiplexed (only one is powered at a time)
Status and frequency inputs:	Max. 8. Intrinsically safe
Relay outputs (option):	Max. 4
Relay contact rating:	250 VAC / 5A (resistive load)

Remote Display Unit RDU 40

The Remote Display Unit (RDU 40) is a robust display unit for outdoor use in hazardous area. If the number of temperature elements per tank is 6 or less, the RDU 40 is the most cost-effective solution for field display. In this case the temperature elements can be connected directly to the TankRadar gauge (RTG) without using a Data Acquisition Unit (DAU). The display functions are software controlled by the connected TankRadar gauge. It is easy to work with via the 4-key display keyboard. Each screen view can display 7 text lines with 16 characters per line.

The RDU 40 is connected by a 3-wire cable up to 100 m (330 ft) from the RTG. Up to two units can be connected to one TankRadar Rex gauge. It displays calculated data, such as level, average temperature, volume, signal strength, etc. The data can be displayed in lists or as single values in very easily readable 25 mm (1 inch) solid fonts. The operator can set up a user-defined window where the most useful information is presented. This window will be shown as the default view. The RDU 40 can view up to six spot temperature elements connected to a TankRadar Rex gauge.

The rugged design of the RDU 40 makes it withstand many years of outdoor use under harsh environmental conditions.



The RDU is connected to The TankRadar Rex gauge.

Technical Data for RDU 40		
View/Software:	Available data:	Level, Ullage, Spot temperature , Average temperature, Volume, Level rate, Signal strength,
Electrical:	Display type:	Graphic LCD display 128 x 64 pixels
	Ambient temperature:	-20°C to 55 °C (-4°F to 130 °F)
	Hazardous locations certifications:	Cenelec Ex ib IIC T4
		FM: Class 1 Div 1 Group A, B, C, D
	Max cable length:	100 m (330 ft) (total length if two units are connected to the same gauge)
Mechanical:	Material housing:	Die cast aluminium
	Dimensions (width x height x depth):	150 x 120 x 70 mm (6 x 4 x 3 inch)
	Weight:	1.2 kg (2.6 lbs)
	Cable entry:	2 x M20, 1x M25
	Optional:	½ inch NPT and ¾ inch NPT by external adapters
	Ingress protection:	IP 66 & 67

Field Communication Unit FCU 2160

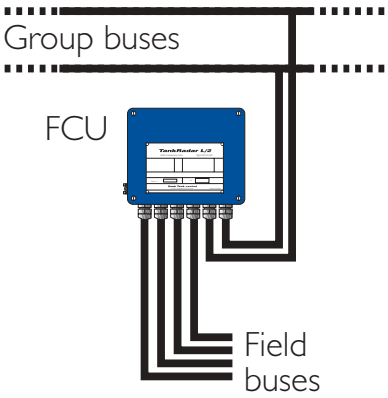
The Field Communication Unit (FCU) is a data concentrator that continuously polls data from field devices such as Radar Tank Gauges, Data Acquisition Units and Remote Display Units and stores them in a buffer memory. Whenever a request for data is received, the FCU can immediately send data from a group of tanks from the updated buffer memory. The FCU acts as a slave on the group bus and as a master on the field bus. The unit has six communication ports. The ports can be individually configured as either group bus ports or as field bus ports according to one of the alternatives below:

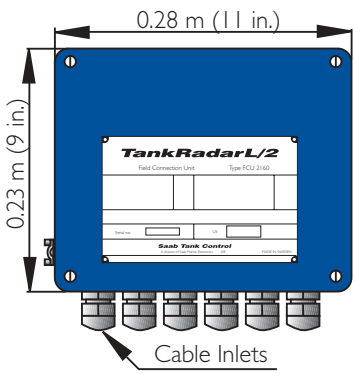
Alternative	No. of field bus ports	No. of group bus ports
1	4	2
2	3	3
3	2	4

An interface board can be connected for each communication port. These boards can be either FCM boards for the TRL / 2 Bus or FCI boards for RS-485 communication. Two group bus ports can also be configured as RS-232 by connecting a jumper connector instead of an FCM or FCI board. As standard the Field Communication Unit is delivered with six FCM boards and two RS-232 jumper connectors.

Each RTG and each Independent DAU has an individual address on the field bus. Slave DAU:s and RDU:s use the same address as the RTG they are connected to and do not have separate addresses.

Two FCU:s can be connected in parallel with one unit operational and one working as “hot” redundant backup for the other. The units are software monitored and the backup unit is automatically triggered and activated in case of primary unit failure. See page 41 for more information.





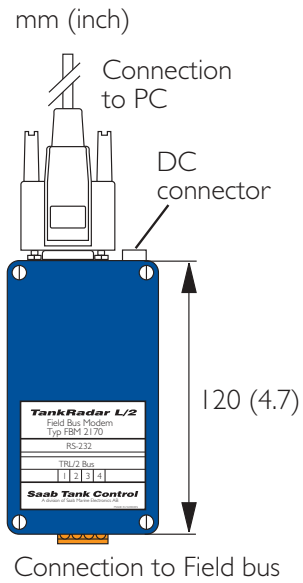
FCU 2160 Field Communication Unit.

Technical Data for FCU 2160		
Explosion protection:	None	
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.	
Ingress protection:	IP 65.	
Communication:	Field bus ports:	TRL/2 Bus, modified Modbus protocol.
	Total number of RTG:s and Independent DAU:s per field bus port:	Max 8.
	Group bus ports:	TRL/2 Bus, RS 232 or RS 485, Modbus based protocol.
	Group bus baud rate:	Programmable up to 19 200 Baud.
	Host communication via group bus ports:	Various protocols available, see page 32.
Number of tanks per FCU:	With RTG:s and Slave DAU:s or RDU:s:	Max 32 (max 8 per field bus).
	With RTG:s and Independent DAU:s:	Max 16 (max 4 per field bus).

The FCU works as a data concentrator for a group of tanks ensuring fast data communication from the tanks to the control room.

Field Bus Modem, FBM 2171

The Field Bus Modem (FBM) converts the signal from RS-232 to the TRL / 2 Bus. It is used to connect a PC with the TankMaster HMI software to the TRL / 2 Bus. The Field Bus Modem is delivered with the cable for connection to the PC. The Field Bus Modem has its own power supply through an AC / DC converter.



FBM 2170 Field Bus Modem.

Technical Data for FBM 2171	
Explosion protection:	None
Power supply:	From AC/DC converter supplied by Saab Rosemount Tank Control (6-15 V, 10 mA).
Cable to PC:	3 m (10 ft) included in delivery.
Field bus over voltage protection:	Galvanic insulation, transient protection, suppressors and fuses.

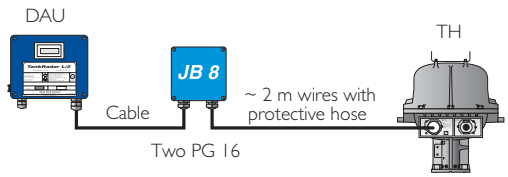
Junction Boxes

As optional equipment a series of junction boxes can be delivered with the TankRadar Rex system. They are used to connect the various system units. (The junction box integrated in the Transmitter Head is described on page 15.)

Note: Other junction boxes are available for the US market.

Junction Box JB 8 for connection of RTG to Slave DAU

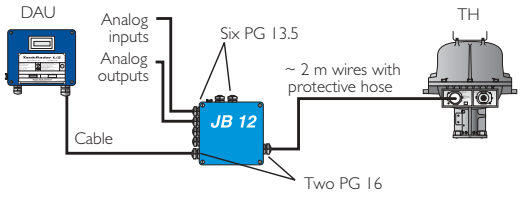
Junction Box JB 8 should only be used for intrinsically safe connections. It can be used when a Slave DAU or an RDU 40 is located more than 2 m away from the RTG. It contains eight terminals and two openings with PG 16 glands cable diameter 11-15 mm.



Junction box JB 8.

Junction Box JB 12 for connection of RTG to Slave DAU

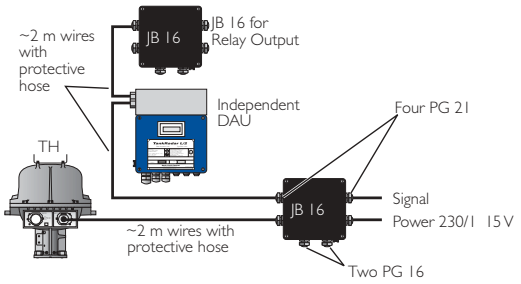
Junction Box JB 12 should only be used for intrinsically safe connections. It includes 12 wire terminals, various openings for glands from PG 13.5-PG 16. Six glands PG 13.5 for cable diameters 11-15 mm are included.



Junction box JB 12.

Junction Box JB 16 for connection to RTG and Independent DAU

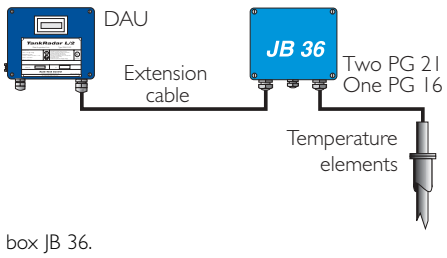
Junction Box JB 16 is an EEx "e" approved junction box. It can be used to connect power and TRL / 2 Bus to the RTG and the Independent DAU. It includes 16 terminals, a flexible hose for the cabling to the RTG or Independent DAU, a mounting plate and various openings for glands for PG16-21. Four glands are included for cable diameters 8-18 mm.
Note: EEx "e" is not an approved protection on all markets.



Junction box JB 16.

Junction Box JB 36 for connection of temperature sensors

Junction Box JB 36 can be used for the intrinsically safe connection of up to 14 temperature sensors to a Data Acquisition Unit (12 if 3-wire connection is used). The DAU may also be placed on top of the temperature sensors.



Junction box JB 36.

Connection to other systems

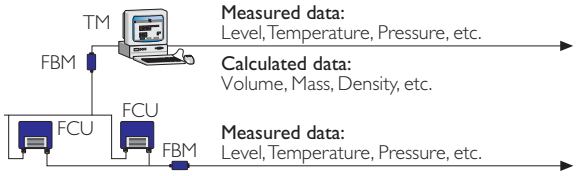
The Saab TankRadar Rex system can be connected to all major suppliers of DCS, SCADA systems, plant host computers or terminal automation systems. The connnection can be made in two ways:

- To a TankMaster PC workstation.
- Directly to a Field Communication Unit.

The advantage of connecting to a TankMaster workstation is that not only the measured values, but also the values calculated by the TankMaster can be communicated.

Examples of available protocols is given below. Certified test reports are available for most of the protocols.

If you require a protocol which is not included in the list, contact Saab Rosemount as new protocols are developed on a regular basis.



The host computer can be connected either to a TankMaster(TM) PC or directly to the FCU.

Communication protocols (examples only, more are available)

Vendor	Unit	Rex Unit	Interface
Allen-Bradley®	PLC-5	TankMaster	RS-232 Data Highway Plus
Allen Bradley®	PLC-5 (CSI)	OPI	RS-232/485 Modbus
Allen Bradley®	PLC-5 (Wonderware)	OPI	RS-232/485 Modbus
Bailey®	B90	FCU	RS-232/485 Modbus
CSI®	Allan Bradley 1771 Basic Module	OPI	RS-232 Modbus
DEC®	Not hardware dependent	OPI	Ethernet Decmessage Q
E+H®	MDP -11-1/F	TankMaster	RS-232 Modbus
ENRAF®	CIU	OPI	RS-232 Modbus
ENRAF®	Microlect	FCU+PC	RS-232 Enraf
ENRAF®	MODCIU	FCU	RS-232 Modbus
ENRAF®	MSU PC-ENTIS	OPI	RS-232 EF_CIU protocol
Fisher Controls®	CL6921 (Provox)	FCU	RS-232 Modbus
Foxboro®	I/A Gateway (MDG)	FCU	RS-232/485 Modbus
Foxboro®	I/A Gateway (MDG)	OPI	RS-232/485 Modbus
Honeywell®	PLCG,APM-SI or CLM	FCU	RS-232/485 Modbus
Honeywell®	APM-SI	OPI	Ethernet
Honeywell®	S-9000	OPI	RS-232/485 Modbus
IBM®	IBM9121	OPI	SDLC
Rosemount®	RS 3	FCU	RS-232/485 Modbus
Siemens®	S5	FCU	RS-232 Modbus
Vega®	Vegacom 556	OPI	RS-232
Yokogawa®	Centum-XL EFGW	FCU	RS-232/485 Modbus
Yokogawa®	Centum-CS	FCU	RS-232/485 Modbus

(OPI is the previous generation HMI software.)

Tank inventory, density & hybrid calculations

The TankRadar Rex gauge, with its high capacity signal processor is designed to make basic inventory calculations directly in the gauge, or give precise inputs for complete tank calculations in another computer. The gauge can receive and process signals from analog and digital pressure transmitters, water bottom sensors etc. Time consuming manual density measurements can be avoided. 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.

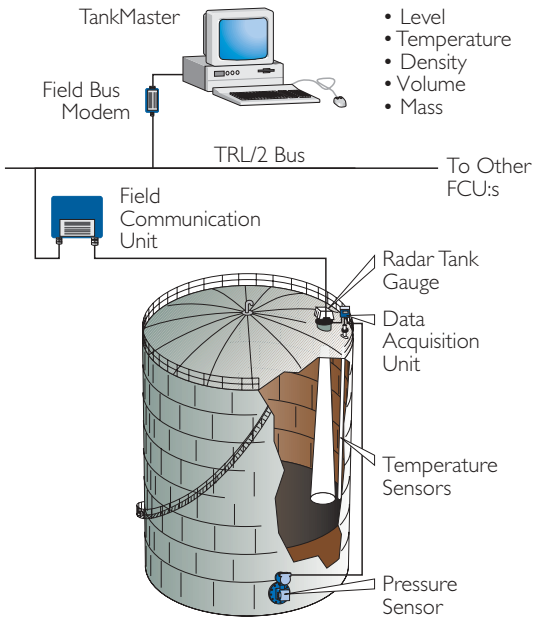
Density measurement with pressure transmitters
When the RTG is connected with a pressure transmitter near the bottom of the tank, the density of the product can be calculated and presented on-line. The accuracy of the density calculation largely depends on the accuracy of the pressure transmitter. Saab TankRadar Rex can interface to any pressure transmitter with a standard output of 4-20 mA or HART. The 4-20 mA signal is converted from analog to digital form in the RTG.

The standard pressure transmitter supplied with the TankRadar Rex system for in-liquid mounting is Rosemount 3051.

The gauge calculates (or receives inputs for) the following data:

- Gross volume using the tank strapping table (100 strapping points).
- Mass (if pressure sensor connected)
- Observed density (if pressure sensor connected)
- Level (corrected for thermal tank wall expansion)
- Temperature
- Oil / Water interface level.
- 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.

If net volume calculations with very high accuracy using up to 2000 strapping points are required, the TankMaster PC software package is to be used, see page 34. Normally less than 100 points per tank are necessary for 1 liter accuracy. TankMaster is using quadratic interpolation for spheres and horizontal cylinders, which increases volume accuracy and reduces number of strapping points.



By complementing the level measurement with temperature and pressure measurement, the density of the product in the tank can be continuously calculated and provided on-line.

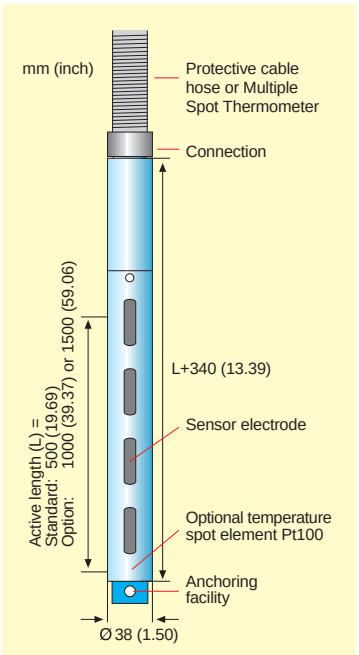
Water interface measurement

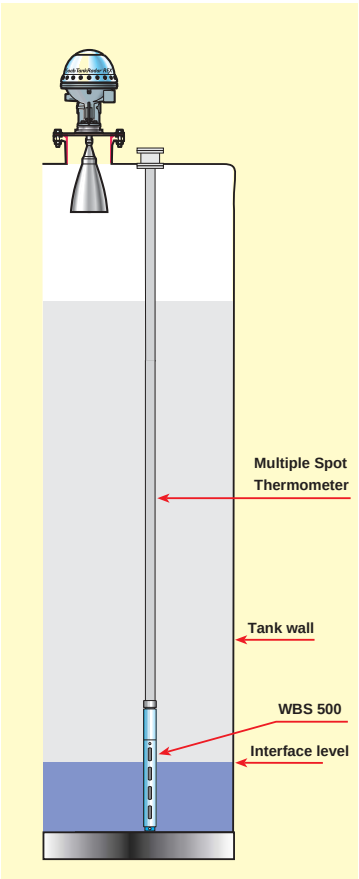
The capacitive Water Bottom Sensor WBS 500 continuously measures free water level below the oil surface and provides input for on-line net inventory. The sensor is integrated with the Multiple Spot Thermometer. WBS 500 outputs a 4-20 mA signal, which is connected directly to an RTG, or to an Independent DAU. There is a Pt100 temperature sensor inside the probe at the bottom, allowing measurements at low levels. The WBS 500 is detachable for repair.

The WBS 500 Water Interface Sensor measures the level of the interface in most types of tanks but is not recommended for use in crude oil.

Technical Data for WBS 500	
Hazardous locations certifications:	EEx ia IIB T5 (EN 50014, EN 50020)
Accuracy:	2 mm (0.08 in.)
Repeatability:	±0.5 mm (0.02 in.)
Product temperature:	0° C to 60° C (32° F to 380° F)
Storage temperature:	-40° C to 90° C (-40° F to 194° F)
Max. pressure:	5 bar (73 psig)
Active length:	Standard: 500 mm (20 in.) Option: 300-1500 mm (12-60 in.)
Cabling:	Shielded pair. Min. 0.75 mm^2
Material exposed to tank atmosphere:	Acid proof steel type 316, PTFE (Teflon®), FEP, Viton®

A typical application
The WBS 500 is installed together with a MST to be hung from the top of the tank. The vertical position is chosen according to the actual bottom water range. The WBS 500 should be anchored to the tank bottom to ensure a fixed position in case of turbulence.





TankMaster HMI software

TankMaster is a powerful Windows-based Human Machine Interface (HMI) for complete tank inventory management. It provides configuration, service and set up, inventory and custody transfer functions for TankRadar Rex systems. All calculations are based on current API and ISO standards. TankMaster follows the OPC standard and can communicate with Microsoft® programs and OPC compatible systems like Intellution's iFIX® and Wonderware's InTouch®. TankMaster is developed and supported by Saab Rosemount Tank Control. TankMaster has two main software modules:

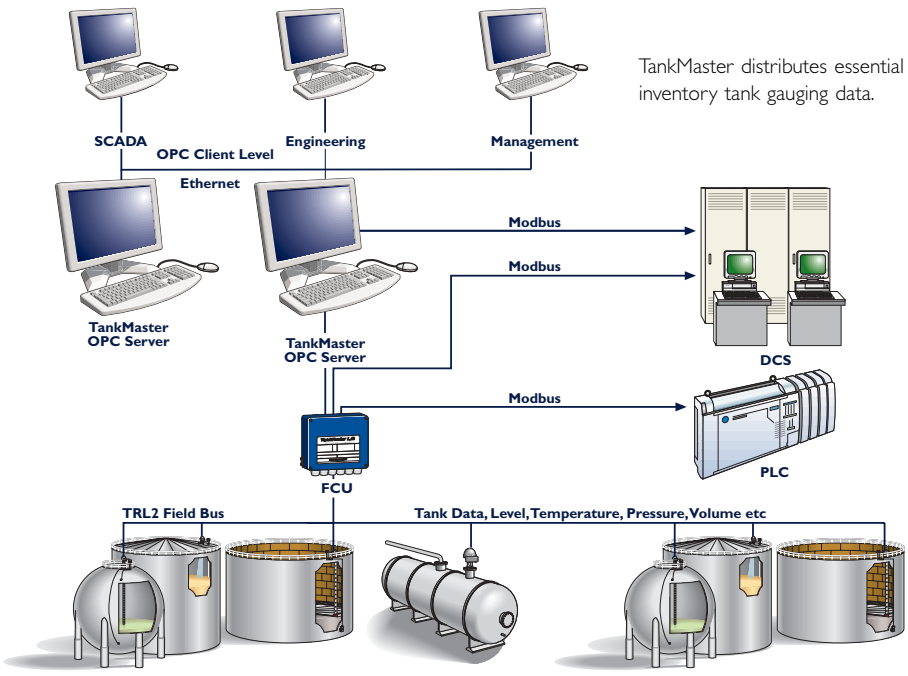
- WinSetup is the software package used for configuration of the total Rex system.
- WinOpi is a complete inventory software package.

The WinSetup package is included with all TankRadar Rex deliveries as a set-up and configuration tool. Other functions are options depending on which package is used.
Available main functions in TankMaster include the following:

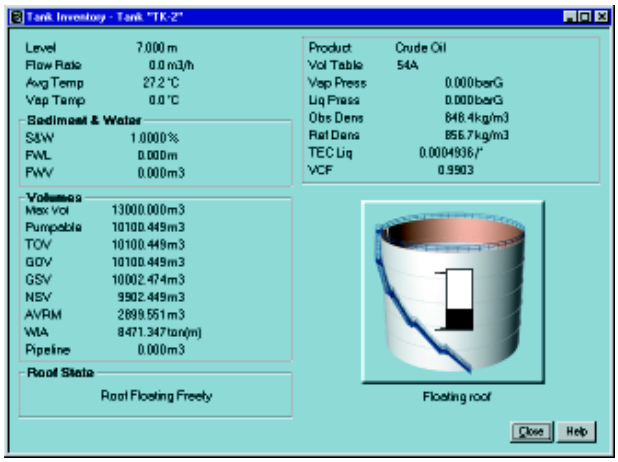
Interactive configuration and installation with set-up wizard

Inventory and custody transfer functions

- Real time tank gauging data such as level, temperature, water interface level and pressure.
- Real time, gross and net volume inventory calculations based on API and ISO.
- Hybrid tank gauging with pressure inputs giving data for density and mass calculation.
- Metrologically sealed data.
- API calculator.



TankMaster distributes essential inventory tank gauging data.



TankMaster gives the most important inventory data for a specific tank in one easy-to-read window.

Networking and interfacing

- OPC server with browser for easy interface with other plant computer systems.
- Full network capabilities.
- SCADA / DCS communication via MODBUS.
- SCADA / DCS communication via OPC.
- Integration with other tank gauging systems by taking in and displaying data from other vendors' gauges.

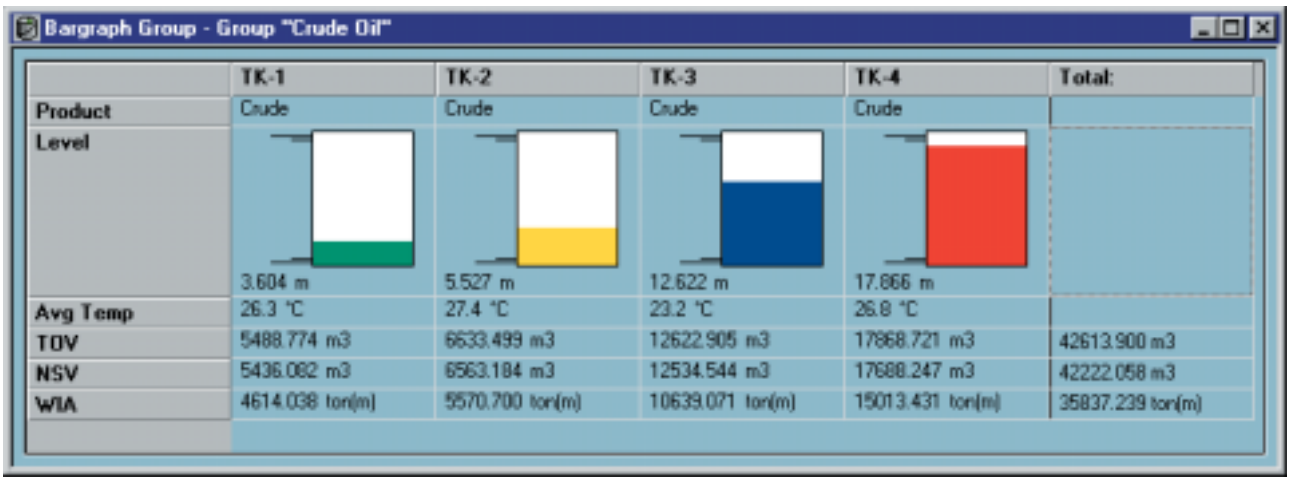
Reports and data sampling

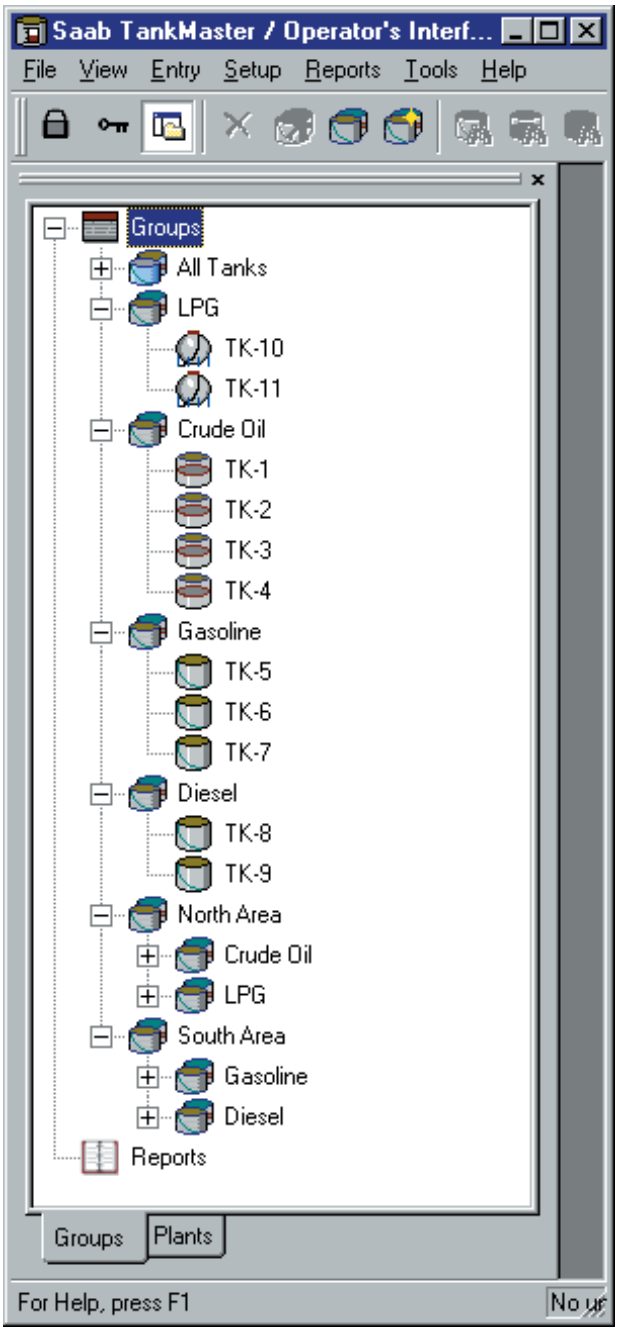
- Batch report for internal and external transfers.
- Customized Reports to Microsoft Office programs.
- Automatic reports.
- Reports via e-mail.
- Audit log for events.
- Historical data sampling.

Alarms

- Reliable alarm handling of measured values with high, high-high, low and low-low level alarms.
- Alarms to mobile phones.
- Alarms via e-mail.
- Leakage alarms based on net volume.

You can easily organize the tanks in e.g. geographical or product groups, with associated sub-groups. For example you can choose to see the actual tank gauging and inventory data in a bargraph group, giving a quick overview of tank farm activity.





The "tank farm explorer" makes it easy to navigate in TankMaster. Just like in "Windows explorer" it is possible to expand and minimize fields and get direct group and tank access by double-clicking the specific group or tank icon.

Others

- User manager with different access levels for personnel.
- Customized views with graphic plant layouts.
- Easy translation to other languages than English.
- Advanced group configuration in geographical or product groups etc.
- Compatibility with Saab's earlier platform OPI which can easily be replaced by TankMaster.

PC Requirements

Required operating system:
Windows 2000, NT 4.0 SP5 or later. Distributed COM (DCOM), which is used for network computing.

Required hardware (PC):
Windows 2000 / NT approved PC. 350 MHz Intel or compatible. 128 MB RAM. 4 GB disk drive (TankMaster requires approx. 200 MB).
Graphics card 1024*768 pixels, 65536 colors.

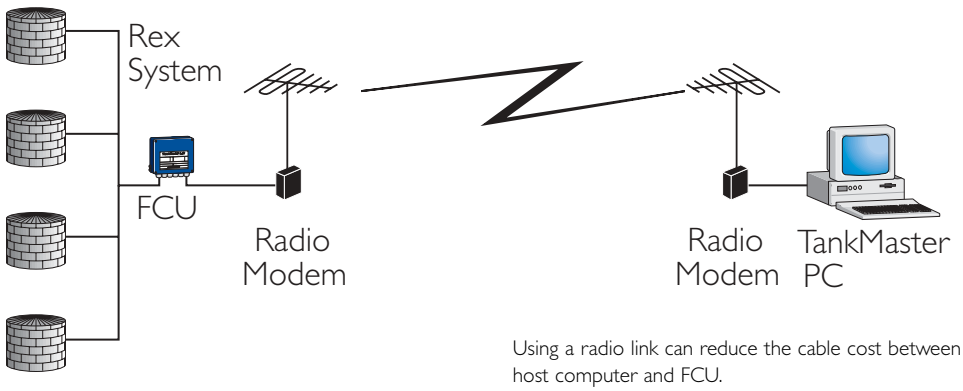
Required hardware (network server PC):
1-2 Network clients – same / better performance on the server than on the client PC.
3 or more Network clients – 500 MHz Intel or compatible, 256 MB RAM on the server PC.

For further information a separate TankMaster brochure is avaialble.

Radio Link

It is possible to use a high speed UHF Radio Link instead of cable between the control room and the Field Communication Unit (FCU). The link consists of two small size UHF radio modems that are connected to the serial RS-232 port on the TankMaster PC and to the group bus port of an FCU. The Radio Link is completely transparent and works just like a cable connection. A Host Computer can also be connected using the same method.

Depending on the antennas and the surrounding topography the range is up to five kilometers (three miles). Longer distances can be covered by using directional antennas.



Using a radio link can reduce the cable cost between host computer and FCU.

Technical Data for Radio Link		
Anntenna:	Arrangement for 450 MHz	
Frequency range:	405 - 470 MHz,	
Basic tuning range:	2 MHz	
Channel separation:	25 kHz	
Number of channels:	16	
Transmitter:	RF Power:	500 mW / 50Ω
	Deviation:	±2,5 kHz
	Adjacent channel power:	< 200 nW
Spurious radiation:	Meets ETSI 300-113	
Receiver Sensitivity:	< - 108 dBm	
Radio Modem:	Ambient temperature:	-25°C to + 55 °C (-13° F to 131 °F)
	Size:	11 x 65 x 26 mm (0.43 x 2.6 x 1.0 inch)
	Weight:	260 g (0.6 lbs)
	Power supply:	12 VDC at 500 mA max
Approvals:	Sweden, Finland, Denmark, U.K., Switzerland, Hong Kong, FCC approval pending	

Saab TankRadar Rex System Configurations

The Saab TankRadar Rex System can be applied to a single tank or to large and very complex systems. All system configurations are based on the same basic parts.

The TRL/2 Bus - A fast and reliable data bus

In the descriptions below the TRL / 2 Bus is divided into two parts:

- Group bus
- Field bus.

Both buses work in the same way with the same technical specifications. However, the Group Bus is defined as the TRL / 2 Bus between the TankMaster / host computer and the FCU:s, while the field buses connect the DAU:s, RDU:s and the RTG:s with the FCU:s.

TankMaster communicates on the TRL / 2 Bus via a Field Bus Modem. The Field Bus Modem translates the signals from RS-232 to TRL / 2 Bus and vice versa.

The TRL / 2 Bus was developed to minimize the updating times as well as to provide a robust and reliable field bus for transferring the measured values from the tanks to the control room.

The recommended maximum total number of RTG:s plus IDAU:s on one field bus is 8 (The maximum number of RTG:s plus IDAU:s per FCU:s is 32). This means for example that for tanks with RTG:s and SDAU:s (or RDU:s) there should be max 8 tanks per field bus. Each Field Communication Unit continuously collects data from up to four TRL / 2 field buses and stores the values in a buffer memory. When a query reaches the Field Communication Unit from the TankMaster or from a plant host computer on the group bus, it can quickly send data directly from the database.

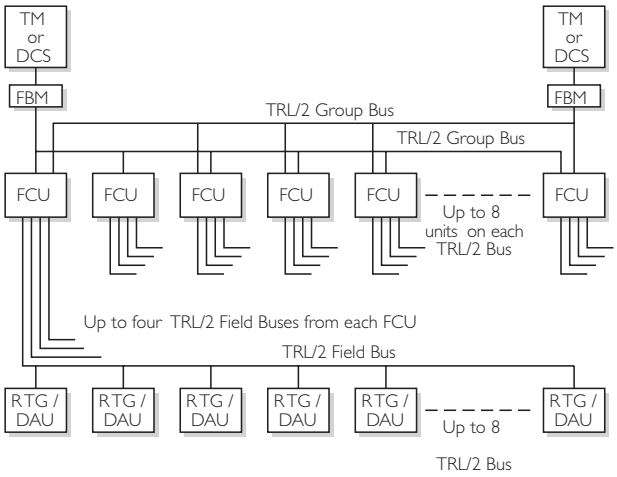


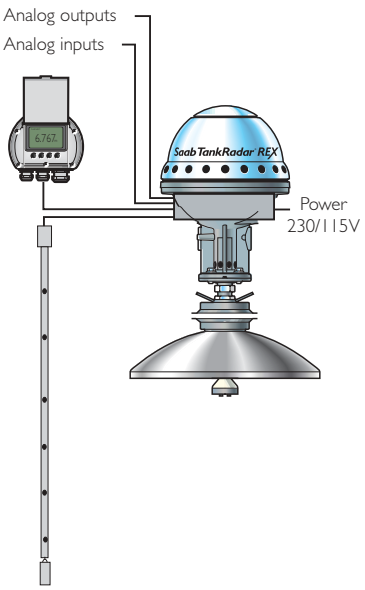
Figure showing how the TRL/2 Bus is used in the TankRadar Rex system.

Technical Data for TRL/2 field bus	
Number of units:	Max 8 units are recommended on one TRL/2 Bus. (Each RTG and each IDAU corresponds to one unit.)
Cable:	Twisted and shielded pair
Cable area:	Min 0.50 mm^2 AWG 20
Cable length:	Max 4 km (2.5 miles)
Modulation type:	FSK (frequency shift keyed), half duplex

Stand-Alone Application

A stand-alone Radar Tank Gauge can be used to measure on a single tank. The measured level is output on the field bus or as an analog 4-20 mA signal. The RTG can also include 4-20 mA inputs or temperature inputs.

A Slave Data Acquisition Unit or an RDU can be connected to the stand-alone gauge.



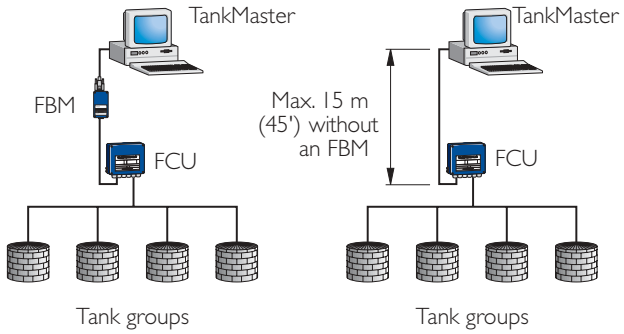
In a stand-alone configuration the analog output can be used to connect an analog display. If connecting a Slave Data Acquisition Unit or the RDU 40, all measured values can be displayed.

Systems with a TankMaster Work Station

The TankMaster PC can be connected via RS-232 directly (without a Field Bus Modem) to one Field Communication Unit if the FCU is placed close to the PC. If more than one FCU is used, FBM:s or RS 485 communication is required.

Normally the Field Bus Modem, FBM, is connected to the TankMaster PC. The FBM is then connected to the FCU and uses the TRL / 2 Bus. The FCU does not need to be close to the TankMaster PC in this case.

Both communication ports of the TankMaster can be used to connect TRL / 2 group buses.

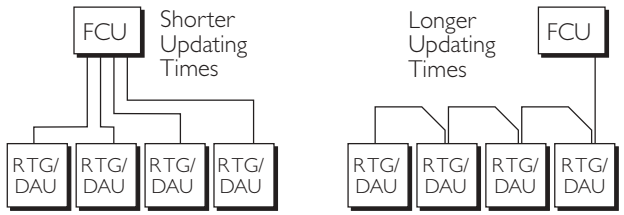


The connection between TankMaster and FCU.

Connecting the Field Communication Unit FCU 2160

The FCU is very flexible. There are six communication ports on the FCU. Normally four of these ports are used for field buses. However, it can have up to four group bus ports.
The FCU can handle up to 32 RTG:s and 32 DAU:s (or RDU:s). Each field bus could connect up to 16 units (RTG:s and / or Independent DAU:s. One RTG with one Slave DAU or RDU is considered as one unit). However in order to ensure robust data communication **maximum 8 units** are recommended per field bus.

To increase the updating speed of the FCU, the number of connected RTG:s and DAU:s should be approximately the same on each field bus connected to one FCU.



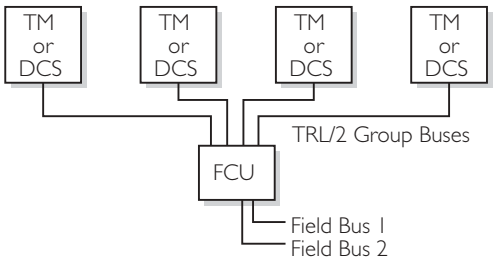
The updating times are improved if the units are evenly spread out on the field buses of the FCU.

Redundant connection of Field Communication Units

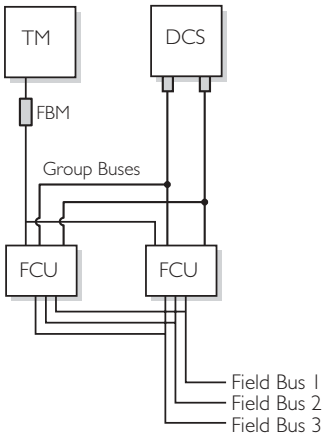
The Field Communication Units can be connected in parallel to provide automatic redundancy in the Saab TankRadar Rex system.

Redundancy can be made in different ways:

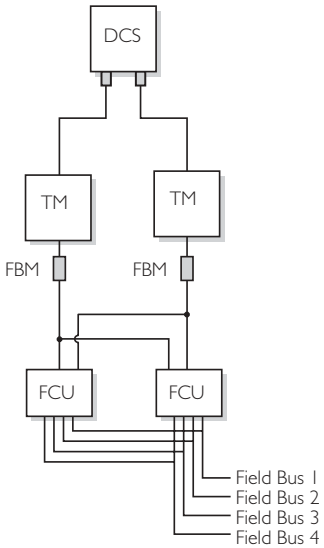
- The FCU can connect up to four group buses with different masters asking the FCU for data. A system can for example have two TankMaster PC:s connected via two different group buses.
- Using two FCU:s provides redundancy on both FCU and host computer level. With two FCU:s connected in parallel to the field buses, one of the FCU:s will be configured as the primary FCU and will be in an active state. The other FCU will be in a back-up state. The backup FCU listens to the communication on the field bus. If the communication on the field bus ceases for a certain delay time, the backup FCU will take over and communication will be resumed. A message is sent to the TankMaster (or DCS) that the primary FCU has failed and that the backup FCU has taken over the communication.
- A complete redundancy from control room to RTG:s and DAU:s is achieved by using double FCU:s as well as double TankMaster work stations.



There can be up to four connections to TankMaster (TM) or DCS units on the Group Bus ports of the FCU.



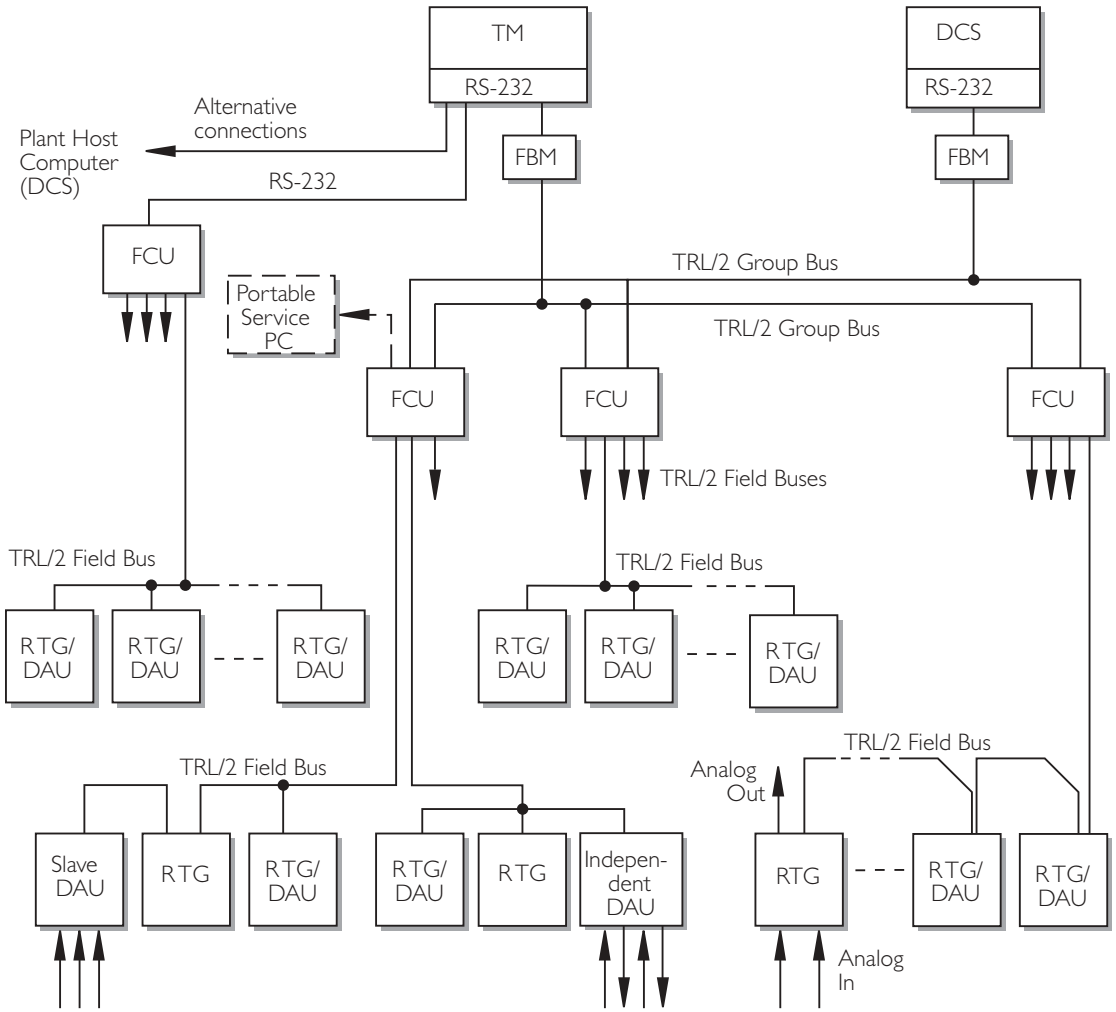
By using double FCU:s, the FCU:s can be made redundant as well.



Two FCU:s and two TankMaster work stations provide a high degree of redundancy.

Example of a General System

The figure below shows an example of a general Saab TankRadar Rex system.



Certificates

The list below includes the certificates and approvals of the Saab TankRadar Rex system at the time of the printing of this description. Please note that the list does not give any detailed information on each certificate or approval. There may be restrictions in them, for example, a certificate may be valid for only parts of the Saab TankRadar Rex system. Saab Rosemount Tank Control should be contacted if you require more information on any of the certificates.

Accuracy approvals / Legal metrological certificates

- OIML R85 (E) International
- BEV, Austria
- Belgium Metrological Inspection, BMS, Belgium
- China Metrological Institute, China
- Physikalisch Technische Bundesanstalt, PTB, Germany
- Ministry of Civil Supplies, W & M, India
- Nederland Meet Institute Ijkwesen, NMI, The Netherlands
- SIM, France, pending
- GUM, Poland
- BRML, Romania
- GOSStandart, Russia
- Statens Provningsanstalt, SP, Sweden
- SIRIM, Malaysia
- Thai Excise and Customs, Thailand
- GOSStandart, Ukraine

In addition to the accuracy approvals listed above, many countries are presently in the process to define custody transfer requirements.

Approvals for installation in hazardous areas

- BASEEFA / CENELEC, Europe
- Underwriters Laboratory, UL, USA
- C-UL, Canada
- JIS, Japan, part of approval pending
- TÜV, Austria
- PTB, Germany (Zone 0 approval)
- GOSStandart, Russia
- GOSStandart, Ukraine
- Department of Explosives, India

Emission Approvals

The listed approvals below deal with how much radiated power that is sent out from the radar gauge. In most countries there are no formulated requirements on equipment like a radar gauge, due to the very low output power and the fact that it is normally installed in a metallic tank. Saab TankRadar has been tested in accordance with CISPR-22 and CISPR-16.The certificates listed below are exceptions for specific countries:

- Bundes Ministerium für Post und Telekommunikationen, BMPT, Germany
- Federal Communications Commission, FCC, USA
- Post und Telegraf Direktion, Austria
- Department of Trade and Industry / Radio Communication Agency DTI / RCA, United Kingdom

Miscellaneous Approvals

- CE Mark, European Community
- TÜV Overfilling Protection, Germany
- TÜV Pressure Approval, Germany
- TÜV Firesafe Approval, Germany

In addition to the list above, there are a number of certificates or approvals for optional equipment which can be delivered by Saab Rosemount Tank Control. Junction boxes, pressure transducers, water interface sensors, etc. have approvals in the name of their manufacturers. Copies of these can be requested from Saab Rosemount Tank Control.

Vapor Influence on Radar Measurement

For a few specific products there can be a measurable influence on the level accuracy, if the composition of the vapor varies between no vapor and fully saturated vapor condition. However, there is no noticeable influence, if the vapor variation is small.
For these specific products it is in many cases sufficient that the pressure and temperature is measured. The software in the Radar Tank Gauge then automatically corrects for the influence from the vapor. This is for example performed when measuring in LPG tanks.
Gases that are known to affect the transmission of radar waves are:

- Propylene oxide
- Etylether
- Propylether
- Acetaldehyde
- Propionaldehyde
- Isobutyraldehyde
- Acetone
- 2-Butanone
- Methanol

One gas that dampens (or attenuates) the radar signal is ammonia. In applications where ammonia is involved, Saab Rosemount Tank Control should always be contacted for evaluation of the application.

Patents

This product is protected by the following patents:

Australia	578279, 623980, 616357, 600679, others pending
Belgium	0167505, 0457801, 0419636, 0324731, others pending
Brazil	PI 8501945, PI 8502625, others pending
Canada	1294357, others pending
China, PRC	85103379.2, 85104668.1
Croatia	Patents pending
Denmark	160374, 161261, 0457801, 0419636, others pending
Finland	73836, 80961, others pending
France	0167505, 0457801, 0419636, 0324731, others pending
Germany	0167505, 69008514.108, P69005245.6-08, P3688141.408, others pending
India	164742, 164799
Italy	0457801, 0419636, 0324731, others pending
Japan	1734107, others pending
Kuwait	Patents pending
Mexico	158252, 158486
Norway	166345, 172911, others pending
Saudi Arabia	Patents pending
Slovenia	Patents pending
South Korea	36650, 72075, others pending
Spain	0542528, 0543730, 0457801, 0419636, others pending
Sweden	8402247-4, 8402960-2, 8900424-6, 8901260-3, 8504317-2, others pending
The Netherlands	0167505, 0457801, 0419636, 0324731, others pending
USA	4641139, 4665403, 5136299, 5070730, 4933915, others pending
United Kingdom	0167505, 0457801, 0419636, 0324731, others pending
Venezuela	47537, 47606

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