TECHNICAL DESCRIPTION

The New Generation

Saab TankRadar™

Saab TankRadar MaC

COMBITECH GROUP

Saab Marine Electronics

Third edition

Saab Marine Electronics AB

Abbreviations and Denominations:

LCB - Backup Display
LCI - Interface Board
LCM - Processor Memory Board
LCS - Signal Board
LI - Transmitter Interface
LP - Power Block
LU - Level Unit
MUX - Multiplexer Unit
PRS - Portable Readout System
PRU - Portable Readout Unit
RTD - Resistance Temperature Detectors
TAC - Cone Antenna Transmitter
TAP - Parabolic Antenna Transmitter
TDU - Tank Display Units. Console mounted bargraph instrument.
TE - Electronic Box
TEB - Electronic Board
TEL - Local Display
SS - Substation
TX - Transmitter
WS - Work Station

Contents

Third edition, March 1996

A Tough System for Rough Conditions

Saab TankRadar G3 has been developed by Saab Marine Electronics using all the knowledge and experience gained from more than 20 years of experience from radar tank gauging.

This Saab TankRadar is the third generation of marine tank gauges. The first generation, the SUM 21, was released in 1976 and was installed on 283 ships of which 95 % are still sailing. The second generation of Saab TankRadar was released in 1985 and more than 600 systems have been sold so far. About 50% of the tankers built today, are equipped with Saab TankRadar.

Saab TankRadar MaC is the most complete cargo control system available today. The integrated system is easy to use and with fast and accurate information, you control your cargo with complete confidence. From one or more Work Stations you control your pumps and valves using a convenient light pen directly on the monitor's screen. With the close integration of the Saab TankRadar G3 system for monitoring and the MaC system for control, information is always updated, reliable and accurate.

All marine Saab TankRadar transmitters are intrinsically safe, providing a number of benefits for the operator. There is a high degree of safety built into the system. Since it is impossible for electrical faults to cause an

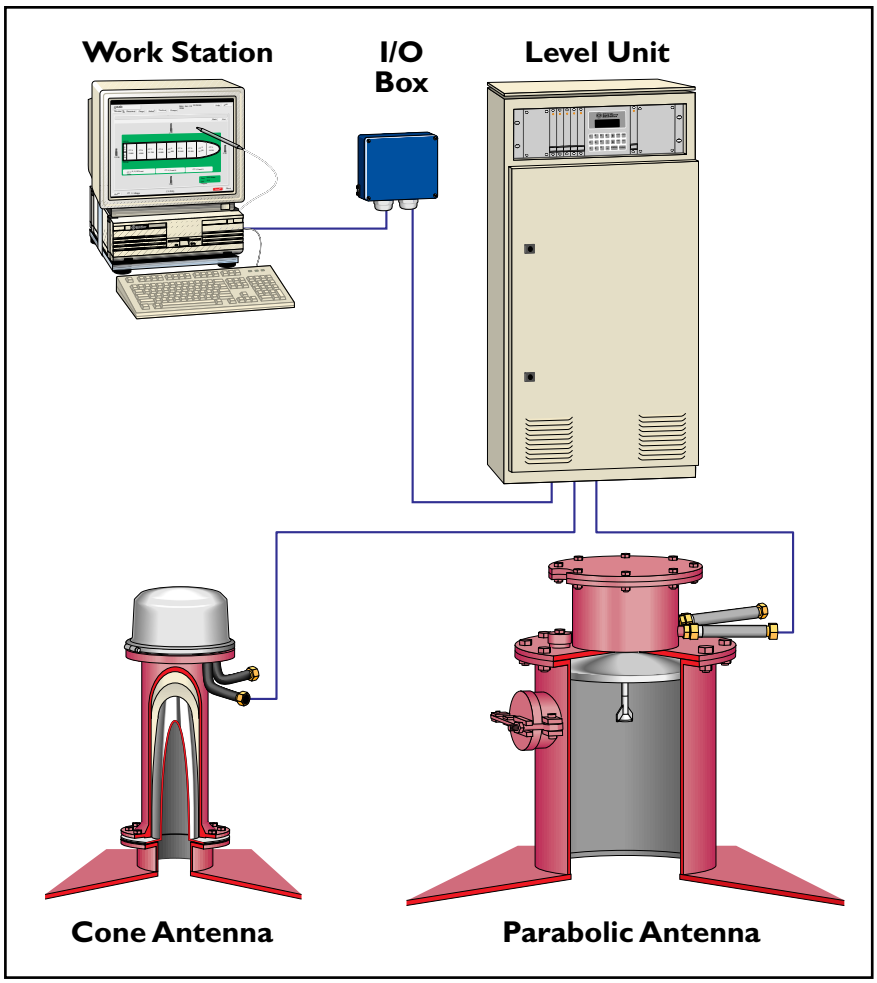
Product tanker with Saab Cargo Control System at the inlet to Gothenburg.

igniting spark, the equipment can be serviced at any time, even though the ship is in operation.

Saab TankRadar G3 is made up mainly by the following parts:

- The Transmitters
- The Level Unit
- The Work Station.

These units are shown in the figure below.



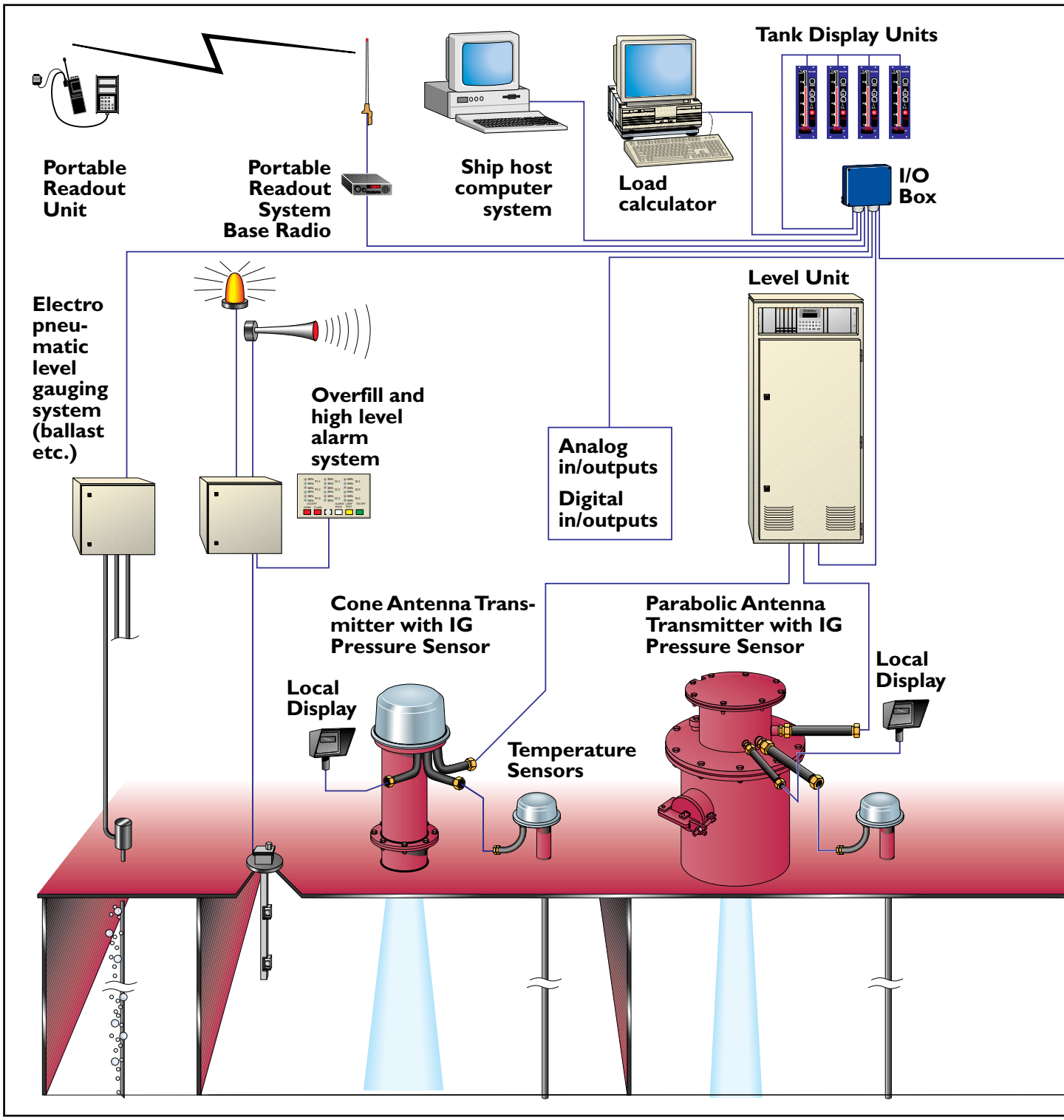
The main parts of the Saab TankRadar G3 system

Saab TankRadar G3 is also the main part of the Saab Cargo Control System which includes the following optional features:

- Cargo control functions with Saab TankRadar MaC
- Ballast level gauging and draft gauging
- Overfill and high level alarm system
- Load calculation

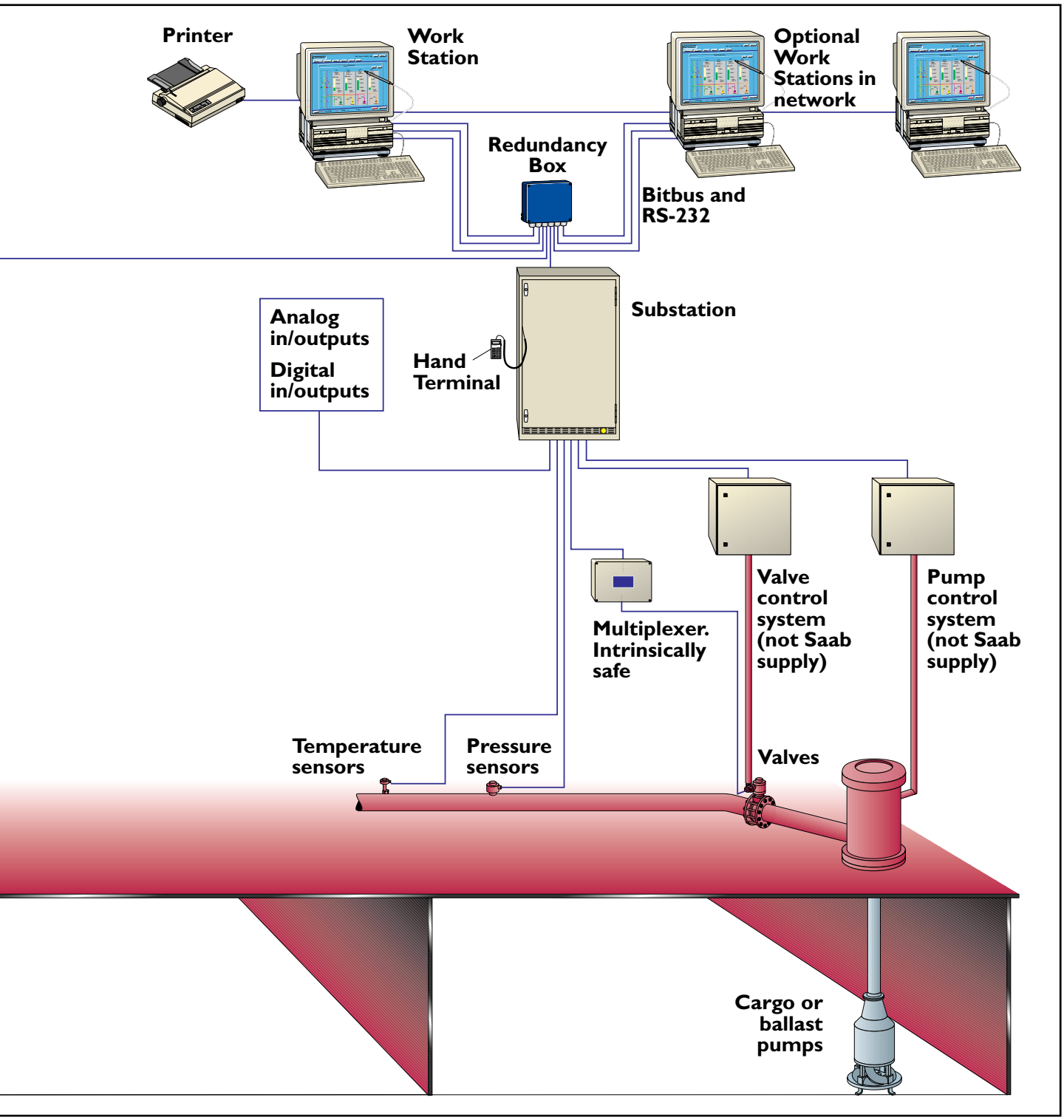
Work Station

The **Work Station** is used by the operator for monitoring of tank ullages, temperatures, inert gas pressures and all the other data that is handled by the Saab TankRadar G3. The Work Station does the alarm handling of the measured values. The Work Station communicates with other systems, such as load calculators and electro-pneumatic level gauging systems (for ballast etc.) and supervises the Transmitter and Level Unit computers.



This illustration shows the complete Saab Cargo Control System including the following systems:

- *Cargo **monitoring** functions with Saab TankRadar G3*
- *Cargo **control** functions with Saab TankRadar MaC*
- *Electropneumatic level gauging with the LevelDatic system for ballast tanks, other miscellaneous tanks and draft gauging.*
- *Overfill and High Level Alarm with Omicron System*
- *Load calculation with Kockumation's LoadMaster*


Printer
Work Station
Optional Work Stations in network
Redundancy Box
Bitbus and RS-232
Substation
Analog in/outputs
Digital in/outputs
Hand Terminal
Multiplexer. Intrinsically safe
Valve control system (not Saab supply)
Pump control system (not Saab supply)
Temperature sensors
Pressure sensors
Valves
Cargo or ballast pumps

Level Unit

The **Level Unit** contains terminals for the intrinsically safe connection of the Transmitters. It contains the electronics used for processing the signals from the Transmitters, for calculating tank parameters, such as trim/list corrected ullage, and for communicating with the Work Station.

Transmitters

The **Transmitters** measure the distance to the product surface using a continuous radar signal. The Transmitters have an Electronic Box for generating and processing the radar signal.

There are two types of Transmitters, one standard type with a high performance Parabolic Antenna and another with a Cone Antenna.

Optional equipment for each tank, such as temperature sensors, inert gas pressure sensor or the Local Display, is connected to a wire terminal inside the Transmitter Housing. The inert gas pressure sensor is placed inside the Transmitter Housing. The Local Display can display ullage, average temperature and inert gas pressure of the tanks.

Meets the Strictest Requirements on Electrical Safety

When connecting equipment in hazardous areas, certain requirements must be fulfilled to provide protection against explosion . There are requirements both for the equipment in the hazardous area on deck and for the associated equipment in non-hazardous area.

The Saab TankRadar G3 system is intrinsically safe and meets the requirements of all the major classification societies. The Transmitters and deck units connected to them, have the following safety approval code:

- EEx ia IIC T4 according to EN50014 and EN 50020 (European Norm)

All other optional equipment such as Portable Readout System, separate high level alarm system, supplied by Saab Marine Electronics, placed in hazardous areas, is also intrinsically safe and meets the requirements of all the major classification societies.

With intrinsically safe equipment, no electrical fault can cause igniting sparks or such heat as to cause a flame or an explosion. Zener diodes and current limiting resistors are used in the Level Unit to restrict the maximum voltages and currents into the Transmitters.

The safety certificate for Saab TankRadar G3

Radar Principle and its Advantages

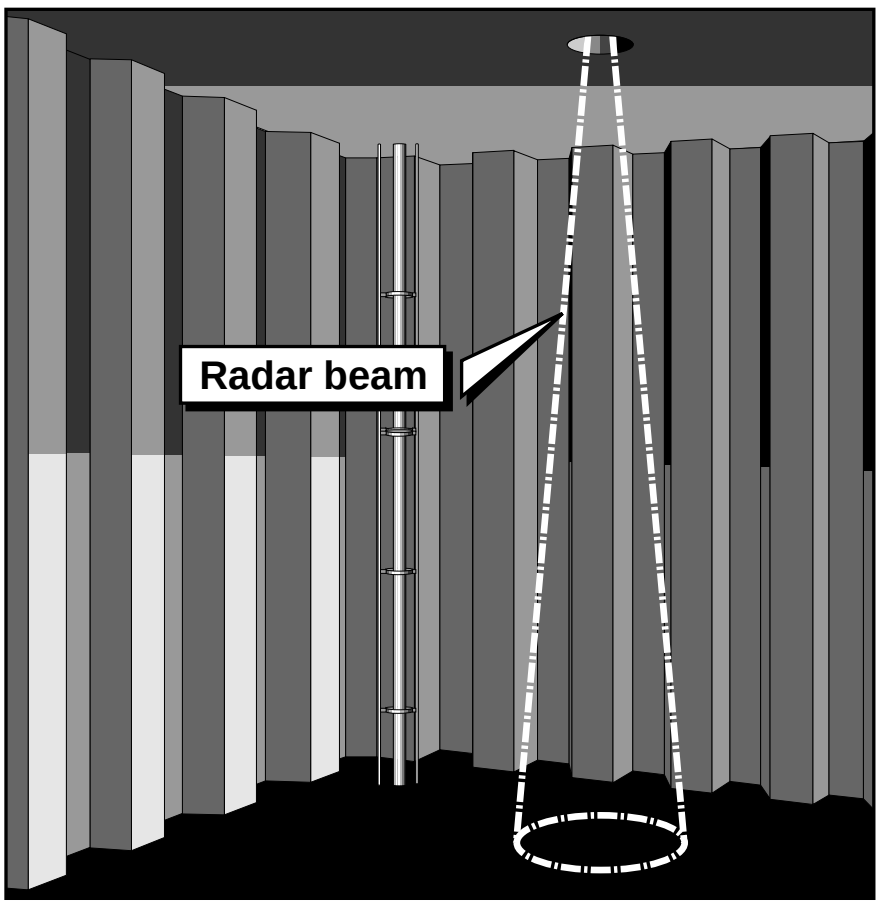
The main advantages for using radar for tank gauging are:

- Radar waves never get stuck.
- Radar waves are not affected by the atmosphere above the product in the tank.
- The only part located within the tank is the antenna.
- No moving parts - High reliability.
- High accuracy
- On the Saab TankRadar systems, the Electronic Box can easily be changed with closed tank conditions.

These advantages mean a lot on a tanker. An extremely high reliability is a prerequisite on a tanker since an extra day in harbor due to a faulty tank gauging system costs a lot. The Saab TankRadar systems have a long record of providing reliable tank gauging to our customers.

With the high level of environmental consideration of the tanker crews today, the level gauging system must provide accurate and reliable measurement at all times. Since there are no moving parts in Saab TankRadar G3, the tanks can be confidently topped up.

With more than 20 years of research and experience in radar tank gauging, Saab Marine Electronics have developed the Saab TankRadar G3 Transmitters with narrow radar beams for easy location of the Transmitters on deck.



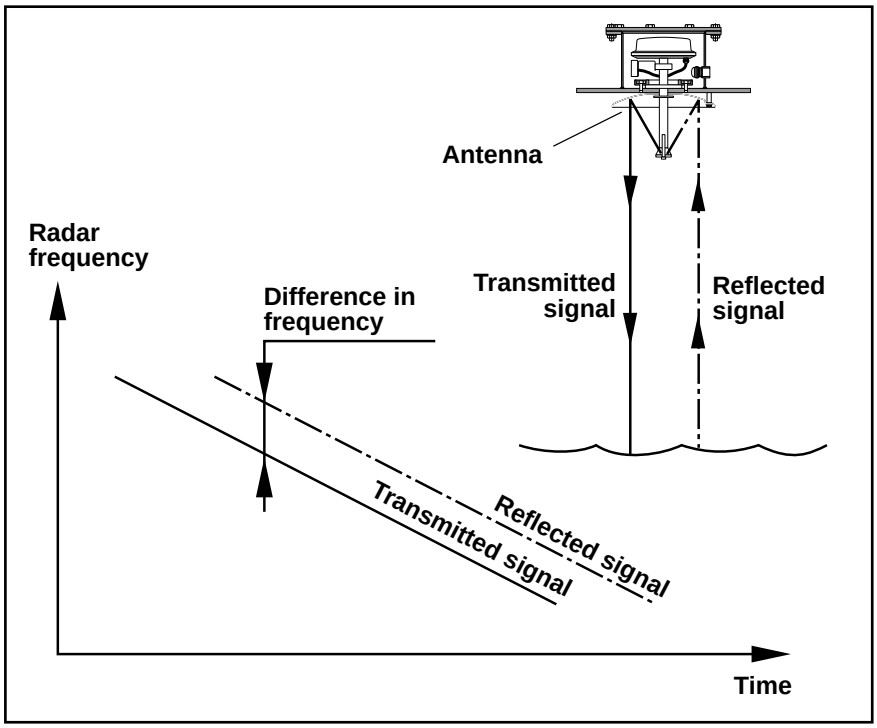
The radar beam inside a tank.

Non-Contact Gauging with Radar

The Transmitter emits radar waves towards the surface of the product. The reflected signal is received and processed in the Electronic Box. The signal is then sent to the Level Unit for further processing and calculation of the ullage.

The frequency of the transmitted signal decreases over a time period. The incoming signal is compared with the outgoing signal. The difference between these two signals is a low-frequency-signal. Its frequency is directly proportional to the distance from the Transmitter to the surface of the product. This is called the FMCW-method (Frequency Modulated Continuous Wave).

Saab TankRadar uses its own advanced patented method to detect the surface echo and measure the distance to the surface accurately. The signal is filtered in a digitally controlled analog filter. First, a filter removes any echoes smaller than a threshold value. Then a narrow filter is applied around the frequency corresponding to the surface echo. The remaining frequency is compared with the one calculated in the previous sweep, resulting in a very accurate signal with a frequency of only a few hertz. With this method it is possible to achieve a very high accuracy. It uses the calculating power very efficiently, focusing on reliable and fast results.



The radar principle. The difference in frequency between the transmitted signal and the reflected signal is directly proportional to the ullage.

"What happens if I'm hit by the radar beam?"

We sometimes get this question from our customers. There are no health hazards in handling the Saab TankRadar transmitters when they are powered. As the emitted power from each transmitter is so low, there is no health hazard even when you are very close to the antenna. Some data below illustrates this.

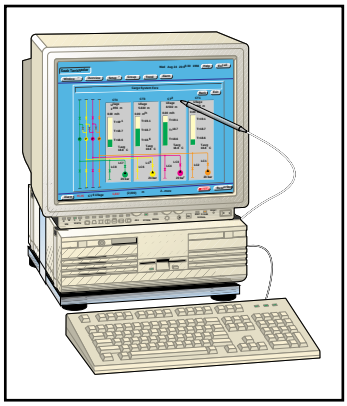
Most international standards state that a power density of up to 1 mW/cm^2 is considered safe for continuous exposure.

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 it might be interesting to know that in sunshine you are exposed to a power density of 100-150 mW/cm^2.

This photo shows the Parabolic Antenna from inside the tank. It is perfectly safe to enter the tank while the Saab TankRadar equipment is in operation. It is also safe to handle the transmitters while they are in operation, since the transmitted power is so low.

The Work Station - Easy to Learn and Easy to Use



The Work Station, is the main presentation unit in Saab TankRadar G3. The main functions of the Work Station are:

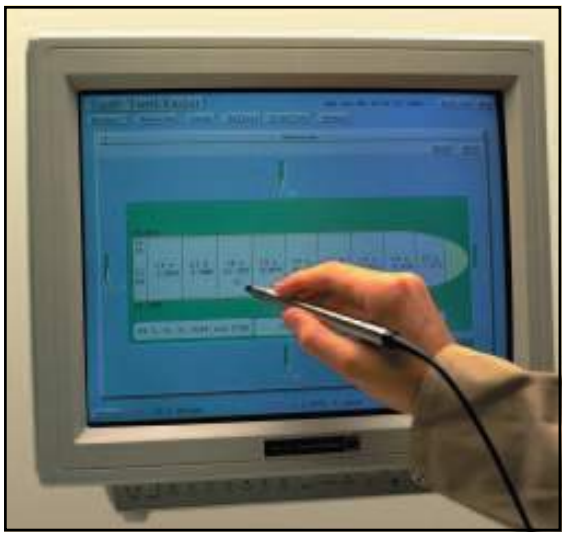
- Operator display and interaction.
- Handling of alarm and failures.
- Storage of measured values.
- Configuration of system and logging
- Calculation using measured values
- Digital outputs for system failure relay and common alarm.

The Work Station has been made to be easy to understand and to use. The presentation is made with full graphics on a personal computer. There is an easy access to the normally used monitoring pictures and alarm functions. There is an on-line Help-function, providing direct access to on-screen help texts from the Operating Manual.

The Work Station is delivered with a light pen as standard. With the light pen, the operator just points directly on the monitor screen to activate various functions. The Work Station can also be operated with a mouse or a track ball. For input of, for example alarm limits and text messages, a keyboard is included as standard.

The Work Station can communicate with other systems, such as a load calculator or a ship host computer system.

The Work Station is also used for onboard-configuration of the Transmitters, the Level Unit and the Work Station itself. It regularly runs supervision and logging of system performance.



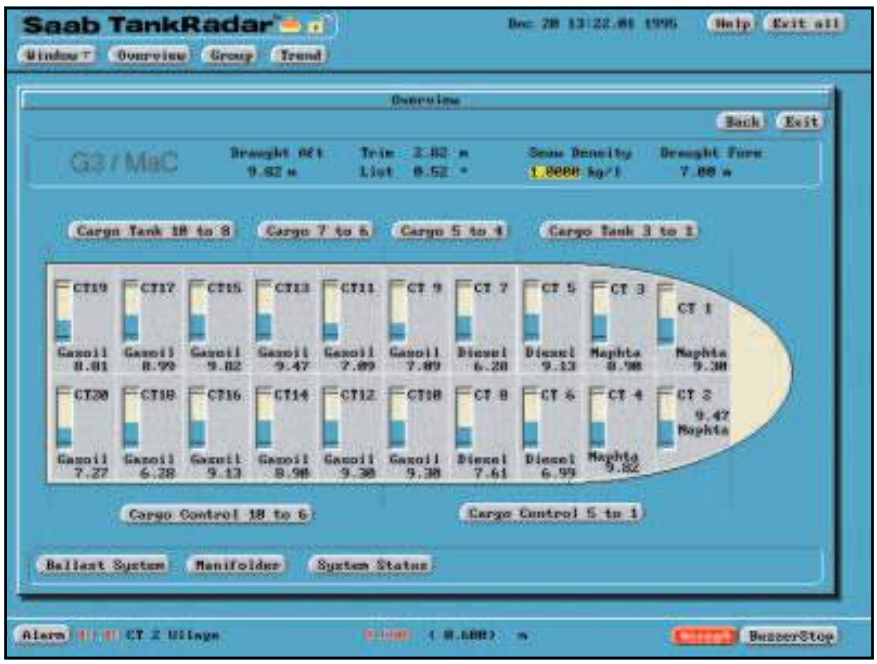
You operate the Work Station using the Light Pen.

The Work Station-software runs under the real-time operating system QNX. As an option, a number of Work Stations can be connected in a network to provide several operator consoles on the ship.

Initial configuration and new software are downloaded from the Work Station to the various units in Saab TankRadar G3.

The following optional features are available:

- Trim/list correction of ullage to a separate ullage plug or to the center of gravity in the tank.
- Trim/list corrected ballast levels.
- Draft measurement.
- Communication with external units.
- Calculation of volume and weight of the tank contents.
- Analog inputs and outputs
- Digital inputs and outputs.
- Printer reports



An example of how the measured data can be presented on the Work Station.

I/O Box - Connects Level Unit and Other Equipment to a Work Station

The I/O Box is used to connect various equipment and sensors as well as the Level Unit to the Work Station.

The I/O Box is made up of a motherboard with power supply, relays and connectors for seven Interface Boards. The I/O Box provides galvanic isolation between the Work Station and other equipment. When required it also provides interface conversion, for example from RS-232 to RS-485.

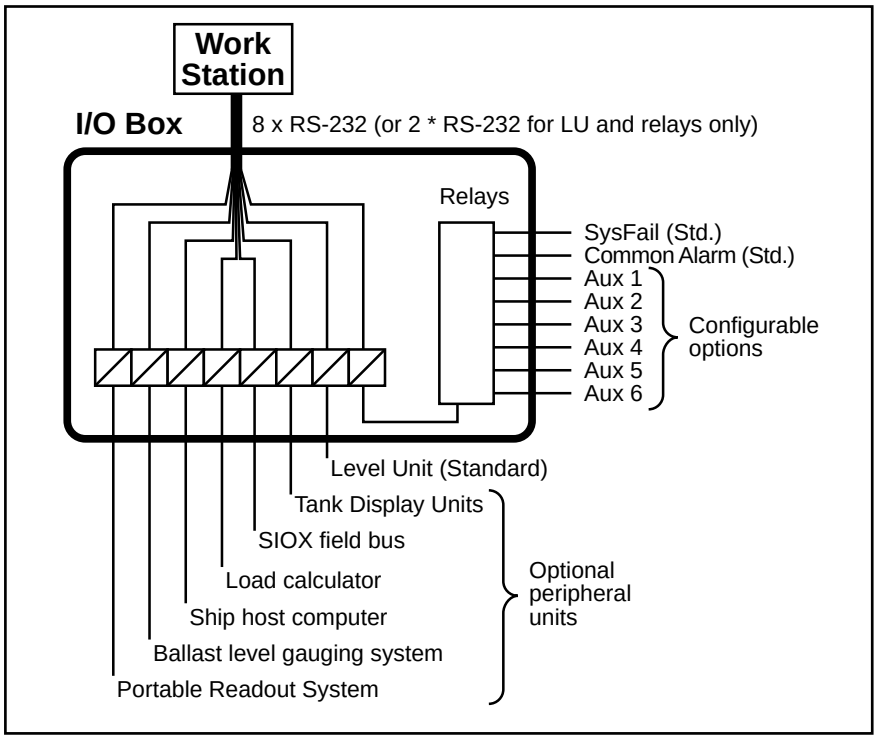
The I/O Box can be connected either to an 8-channel serial interface board in the Work Station or to the Com1 and Com2 ports (for connection of Level Unit and relays only). One of these channels is used for relay output control. The other seven channels are wired to seven Interface Board connectors on the motherboard. Of these seven channels, one is dedicated for connection of the Level Unit.

Eight relays in the I/O Box are controlled by one of the channels. One of them is a system failure relay controlled by a watchdog circuit. The other seven relays can be used for alarms or for general output signals.

The Interface Boards are used for connecting equipment such as host computer, load calculator, ballast level gauging systems, Saab Tank Display Units and Saab Portable Readout System.

The I/O Box also contains relays for alarms and general output signals.

A wide range of analog and digital inputs and outputs can be connected to the Work Station via the I/O Box. Distributed I/O modules are connected to the I/O Box via a field bus interface (SIOX).



The I/O Box with its possible connections.

The Level Unit - Rugged Design - Easy to Install

The Level Unit is a cabinet containing modules for the connection of the Transmitters, the electronics for signal processing, communication, power supply, and a Backup Display with a keyboard.

The Level Unit is made up of the following parts:

- Calculation Unit
- One or two Transmitter Interfaces (depending on the size of the system)
- Power Block

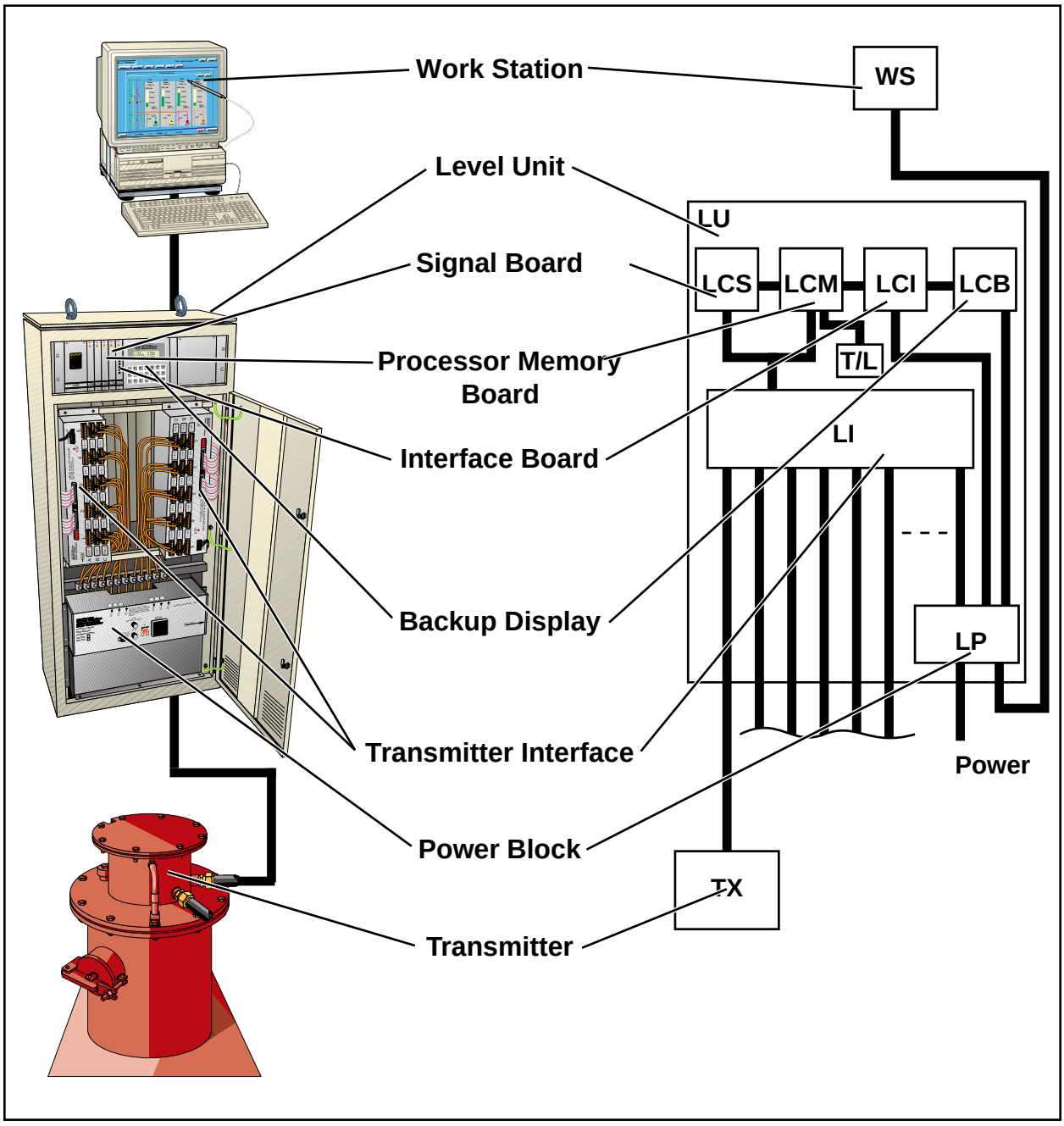
The cables from the Transmitters enter the cabinet through the bottom of the Level Unit. The entire cabinet has been verified to provide the required EMC-protection (electromagnetic compatibility).

Up to 30 Transmitters can be connected to one Level Unit. An additional Slave Level Unit is included for systems with 31 to 60 Transmitters. The Slave Level Unit contains a Power Block and one or two Transmitter Interfaces. The Slave Level Unit does not have a Calculation Unit. The signals from the Transmitters connected to it, are processed by the Calculation Unit in the master Level Unit.

The Level Unit shown with closed as well as opened door.

Information Flow within the Level Unit

The signals from the Transmitter enter the Level Unit into a Transmitter Interface where they pass the zener barriers and go on to the Signal Board. The components on the Signal Board amplify and process the signals. The signals are converted to digital form by the Signal Board and are sent to the Processor Memory Board, where the signals are digitally processed. The Interface Board communicates data between the Work Station and the Processor Memory Board.



Information flow within the Level Unit.

Calculation Unit

The Calculation Unit, with its printed circuit boards in a card cage, is placed in the top part of the Level Unit. The Calculation Unit contains the Signal Board, Processor Memory Board and Interface Board. There is also a power supply for the Calculation Unit.

Signal Board

The Signal Board contains analog filters and an A/D converter for the analog signal from the Transmitters.

Processor Memory Board

The Processor Memory Board processes the A/D converted signals from the Signal Board and calculates ullages, temperatures and IG pressures for all tanks. The Processor Memory Board contains a processor, flash memory, database memory, etc. It has inputs for ground failure alarm from the Transmitter Interface. Each Processor Memory board can handle up to 60 Transmitters.

Interface Board

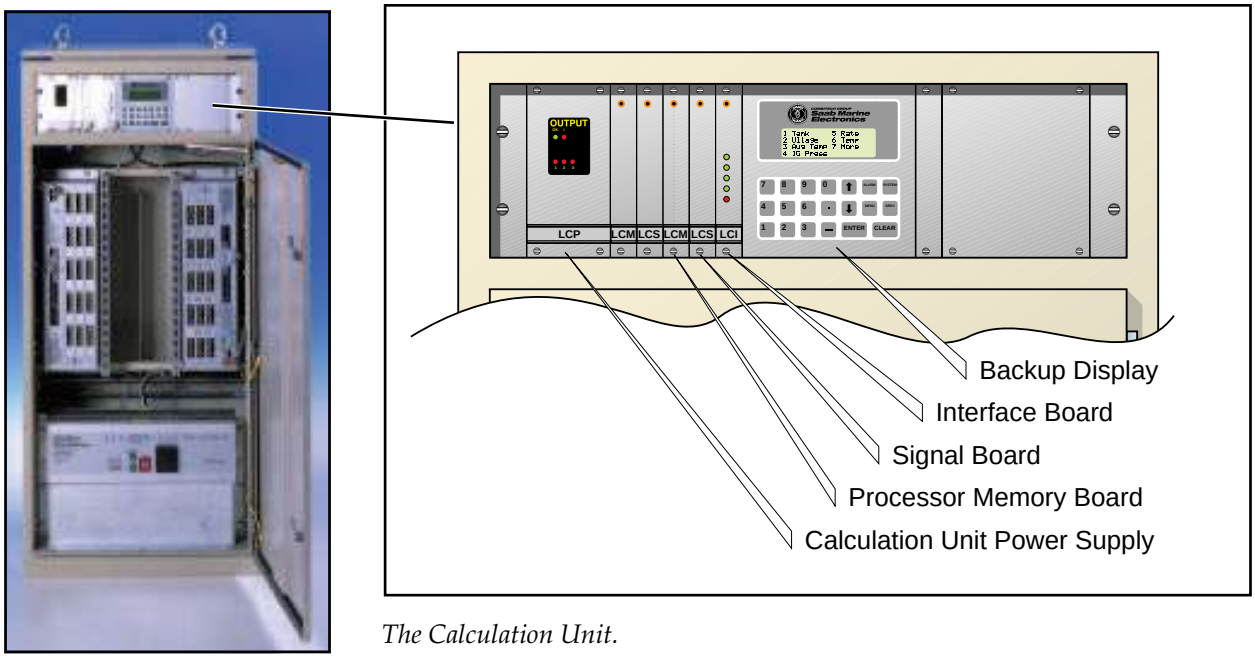
The Interface Board works as an interface between the Processor Memory Board and the Work Station. It also supports the Backup Display with its keyboard.

Trim/List Unit

As standard, a unit for measuring trim and list angles is integrated in the Level Unit cabinet. The trim and list angles are used to support the radar echo detection process that finds the true ullage.

Trim and list values are also used when the ullage needs to be corrected to a separate ullage plug or to a tank's center of gravity. In these cases we recommend one of the following methods:

- on-line draft input for calculation of trim and list values.
- calculated trim and list values from the load calculator.
- values from the Trim/List Unit.



The Calculation Unit.

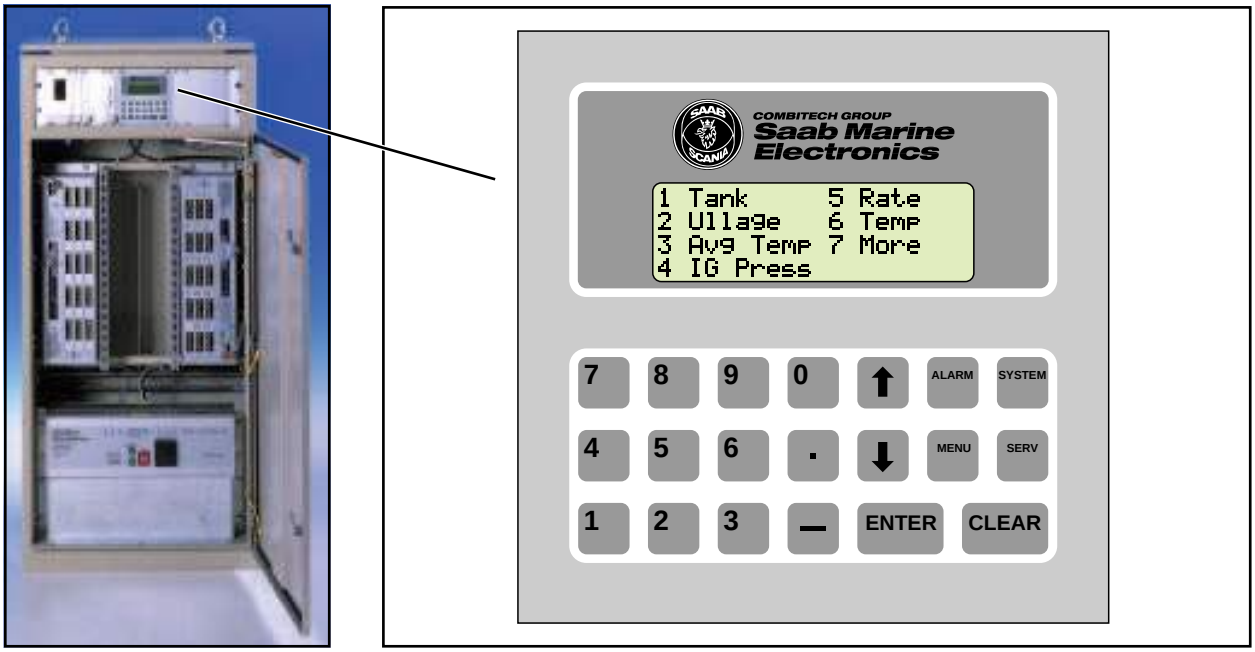
Backup Display

The Backup Display is located in the Calculation Unit in the top part of the Level Unit cabinet. The Backup Display serves only as a backup for the Work Station, for displaying the measured values and contents of the memory registers in the Transmitters, Processor Memory Board and the Interface Board.

As all the operations are normally done on the Work Station, the Backup Display is normally not used by the crew onboard during operation.

The display has 4 lines with 20 characters on each line. There are 20 keys for controlling the display.

The display can show each tank with its tank name and relevant tank values. The display can also show other status in the Level Unit. Alarms are not shown on the Backup Display since the Work Station does the alarm handling.



The Backup Display.

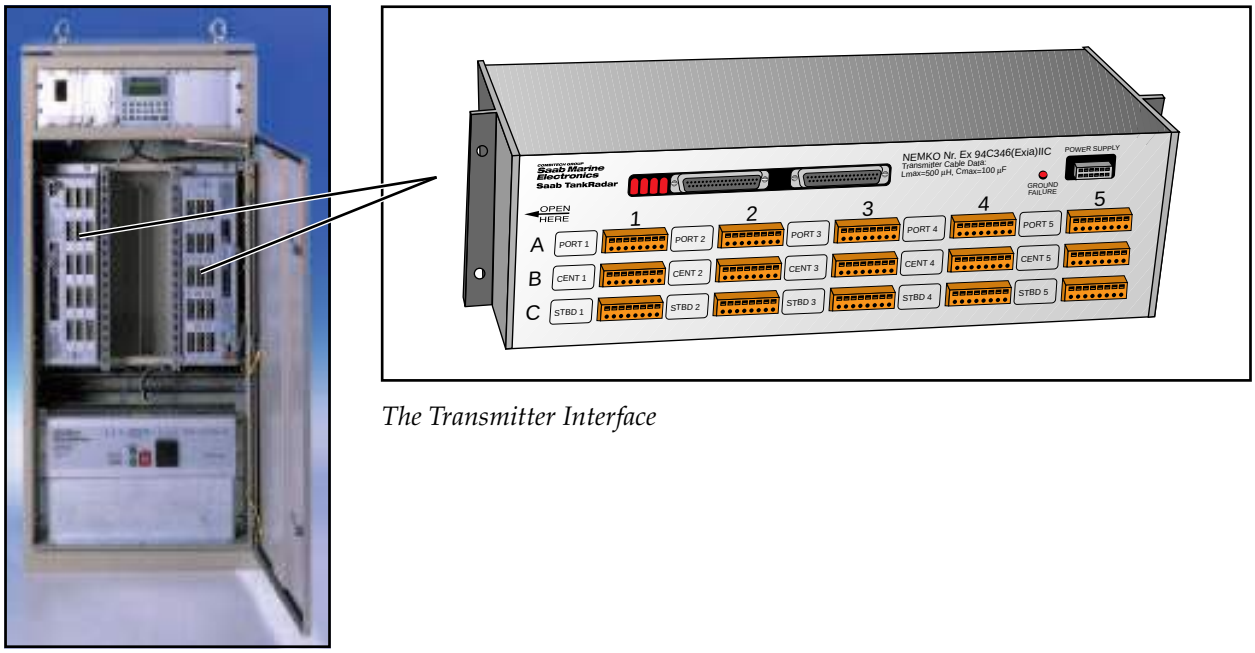
Transmitter Interface

The cables from the Transmitters are connected to the Transmitter Interfaces in the Level Unit. A Transmitter Interface contains multiplexers and zener barriers for the intrinsically safe connection of the Transmitters. The Transmitters are connected with individual jackable terminals for easy installation and service.

The Transmitter Interfaces multiplex the communication between the Signal Board and the Transmitters. The Transmitter Interfaces supply the Transmitters with intrinsically safe power.

Each Transmitter Interface can connect 5, 10 or 15 Transmitters. There can be one or two Transmitter Interfaces in each Level Unit. For systems with from 31 to 60 Transmitters, an additional Slave Level Unit is required. One Transmitter Interface is connected to the Calculation Unit at the top of the Level Unit, while the other Transmitter Interfaces are connected in serial with a flat cable between each one. The intrinsically safe parts of the Transmitter Interfaces receive power from the Power Block at the bottom of the Level Unit via separate cables. The non-intrinsically safe parts receive the power from the Calculation Unit power supply.

The Transmitter Interface is made up of two types of printed circuit boards, the Analog/Digital/Power Board and the Zener Barrier Board.



The Transmitter Interface

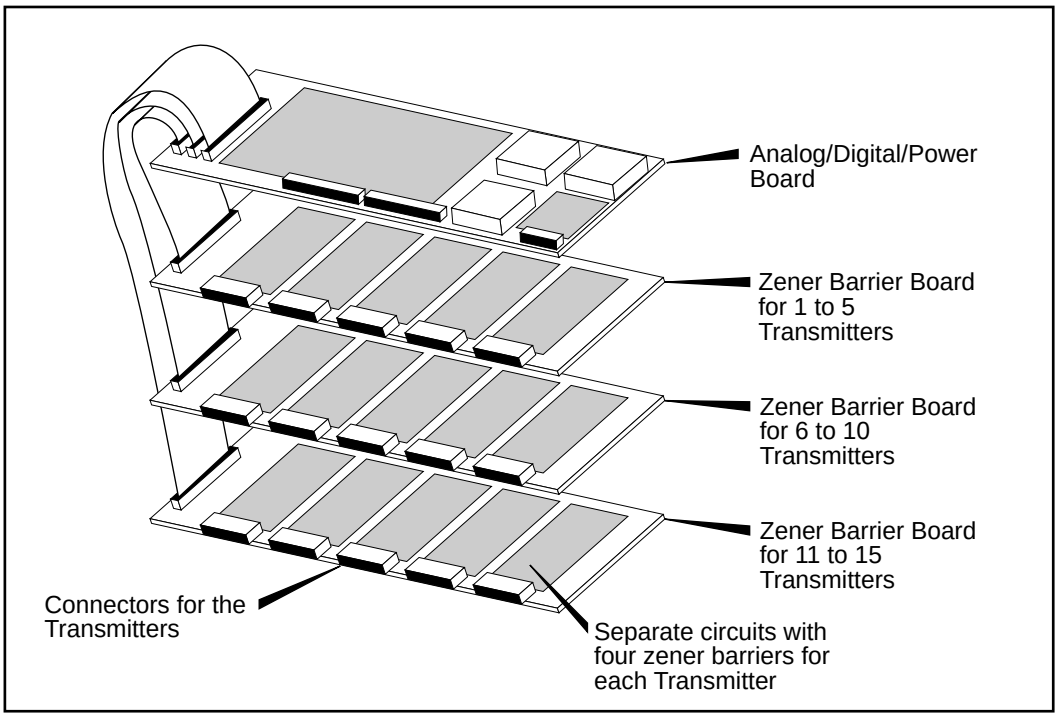
The Analog/Digital/Power Board

The Analog/Digital/Power Board;

- relays the analog signal from the Transmitter to the Signal Board,
- relays the digital signals between the Transmitter and the Processor Memory Board and
- stabilizes the intrinsically safe power supply and checks for ground failure.

The Zener Barrier Board

The Zener Barrier Board has five separate circuits for the intrinsically safe connection of five Transmitters. There can be up to three Zener Barrier Boards in one Transmitter Interface. The Zener Barrier Boards are connected to the Analog/Digital/Power Board with flat cables. The Transmitters are connected to the Zener Barrier Board with jackable connectors with eight conductors, from four twisted pair cables. Each of the five separate circuits on the Zener Barrier Board contain four zener barriers.



The Transmitter Interface boards

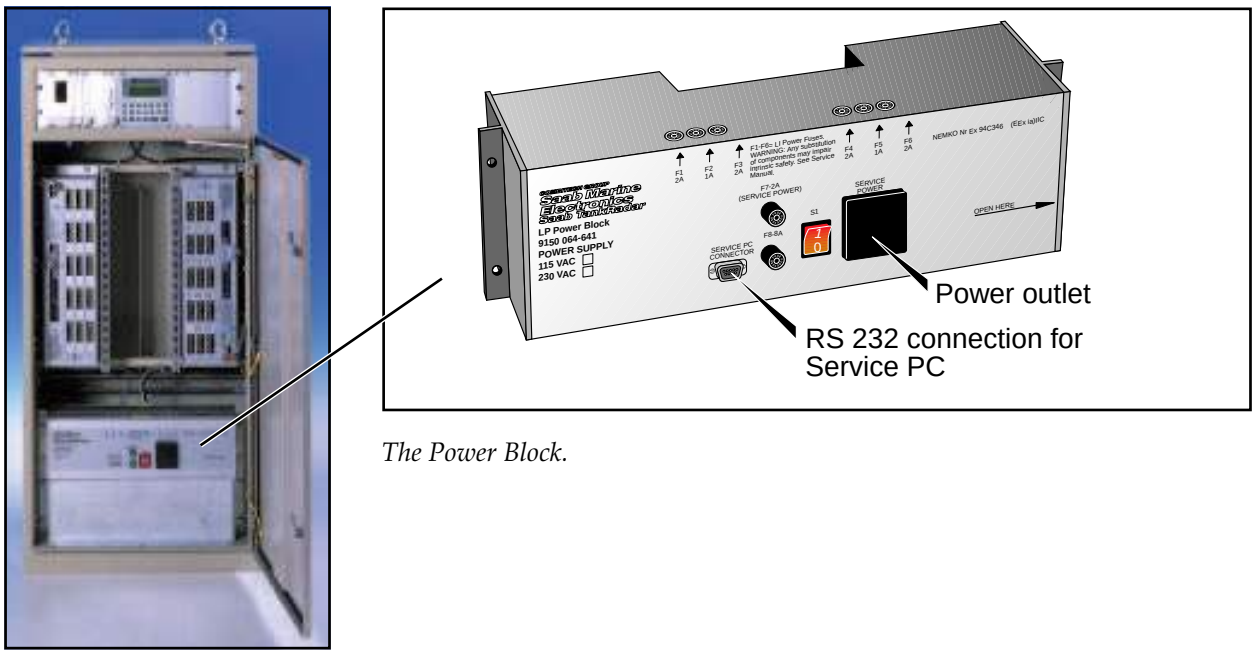
Power Block

The Power Block contains filters for the supply voltage, to ensure that the strictest EMC requirements are met.

The Power Block can be set for supply voltages of either 115 or 230 VAC.

There are five relays in the Power Block. Three of these relays are used for cargo tank IG pressure alarm, power loss and system failure. Two relays can be controlled from the Work Station. These relays are normally not used when a Work Station and an I/O Box are included, since the relays in the I/O Box are used instead. The I/O Box relays are controlled by the Work Station.

There is an RS-232 connector and a power outlet located in the Power Block for connecting a service PC to the Level Unit.



The Power Block.

The Transmitter - Two Types to Cover all Applications

There are two types of transmitters with different antennas available with Saab TankRadar G3:

- Parabolic Antenna Transmitter
- Cone Antenna Transmitter.

The Parabolic Antenna Transmitter, which is the standard version, is used on all types of tanks. Due to its large antenna diameter, the radar beam from the Parabolic Antenna is very narrow. This makes it easy to find a good location so that the radar beam can pass unobstructed in complicated tanks with a lot of internal structures, as well as in deep and/or narrow tanks. In these cases a smaller antenna with a wider radar beam will find disturbing echoes or will not receive a strong enough echo from the surface of the liquid.

The Cone Antenna Transmitter can be used on more shallow tanks and in special cases when a small socket is required due to limited space between longitudinals or frames on deck.

The Transmitters are prepared for inert gas pressure measurement, local readout, and connection, from deck, of up to five RTD sensors (Resistance Temperature Detectors). Three of these can be used for optional Pt100 temperature sensors in a tank mounted thermowell. The other two analog sensors can be used for additional Pt100 sensors, for example from heaters.

The Parabolic Antenna Transmitter.

When cargo tank temperature measurement is included the Temperature Connection Box (connecting up to three Pt100 sensors) is located on top of the thermowell and connected via a cable to the Transmitter. The Temperature Connection Box may be deck mounted or pump mounted.

There is a wire terminal within the Transmitter Housing used for connection of the optional sensors, the Local Display and the cables to the Level Unit.

The electronics for the Transmitter are intrinsically safe and are placed in the Electronic Box. The main parts of the Electronic Box are the Microwave Module and the Electronic Board. The same type of Electronic Box is used for both types of Transmitters.

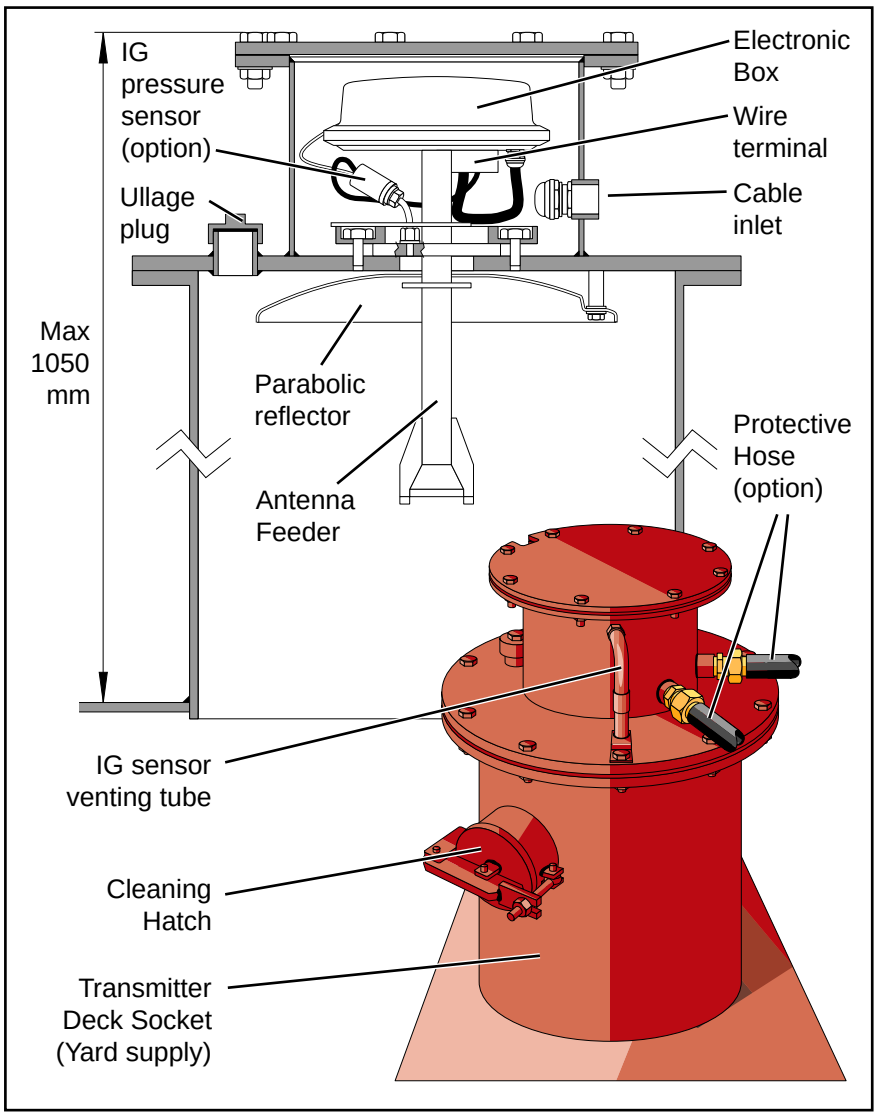
The Parabolic Antenna and Cone Antenna Transmitters with optional protection hoses mounted.

Parabolic Antenna Transmitter

The Transmitter is placed on a socket. The only part of the Transmitter within the tank is the antenna consisting of a stainless steel parabolic reflector and antenna feeder. Adjustment of the direction of the antenna beam can be done within ± 2°. The optional inert gas pressure sensor is placed within the Transmitter Housing.

The microwave aperture on the Parabolic Antenna Transmitter can be cleaned under closed tank conditions using a brush that is entered via a check valve in the cleaning hatch on the socket. The cleaning hatch is included as standard with the Parabolic Antenna Transmitter.

There is an Ø 1,5" ullage plug for hand dipping and for taking samples. When the ullage cap is removed, there is a clear reference point that can be used for hand dipping. Equipment for collecting samples up to 1.5" standard size, under closed tank conditions, can be connected to the threaded connection.

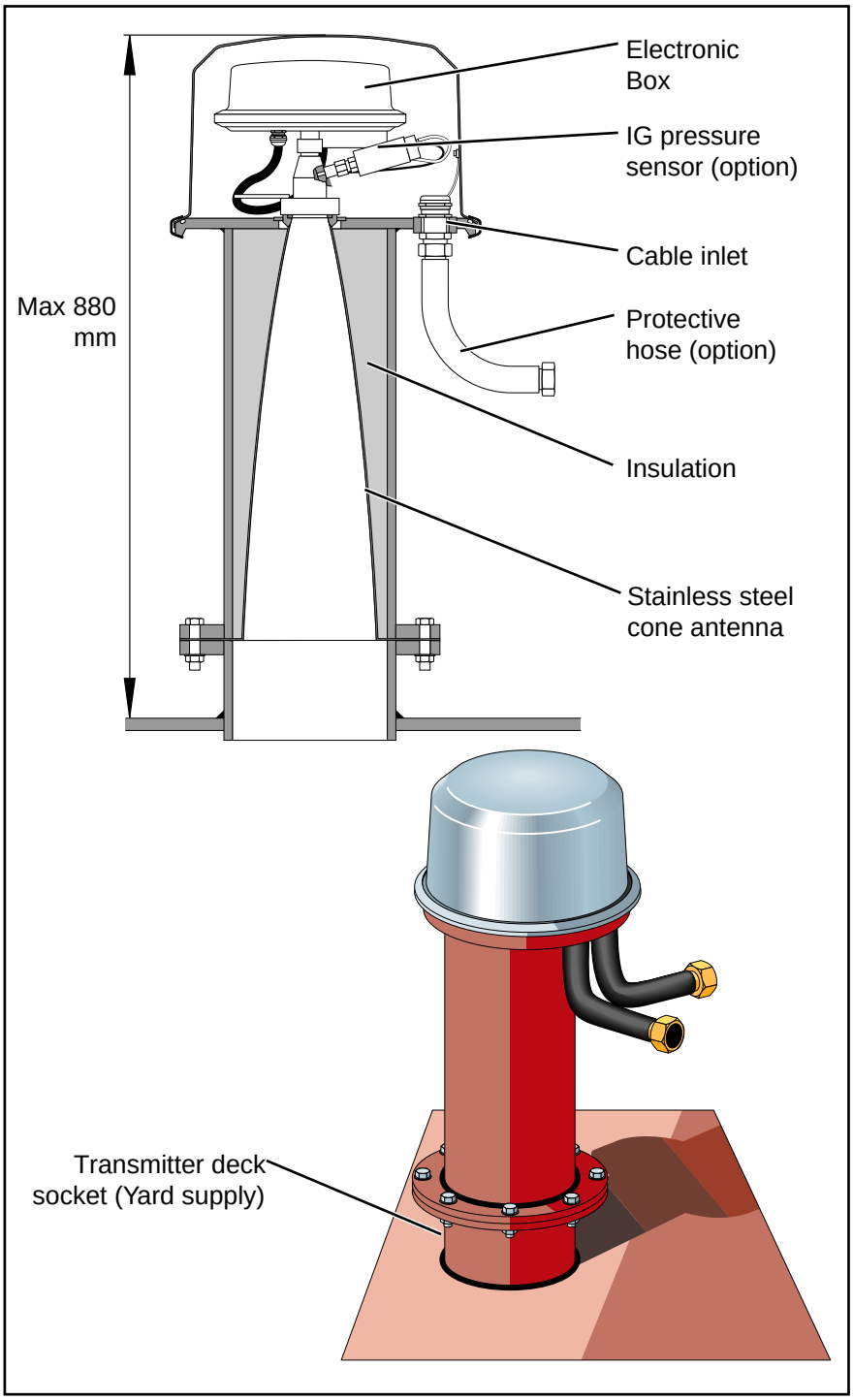


The Parabolic Antenna Transmitter

Cone Antenna Transmitter

The Cone Antenna Transmitter is mounted on a socket with a DN200-flange. With this small flange, the Cone Antenna Transmitter can be placed on a deck where there are many closely spaced frames or longitudinals.

The Cone Antenna Transmitter can be used on more shallow tanks. A cleaning facility is available so that the Cone Antenna Transmitter can be inspected and cleaned from above.



The Cone Antenna Transmitter

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Easy Installation of Saab TankRadar G3

Saab TankRadar G3 is very convenient to install. The Transmitters are placed on the deck according to a few requirements stated in the Installation Manual. The main requirement for the Transmitter is that the radar beam should be unobstructed.

The Level Unit can be placed anywhere in safe area indoor on board. It is bolted or welded to a bulkhead or to the floor.

The Work Station can be placed on the bridge, in the cargo control room or wherever the cargo is monitored and controlled. There can be a number of Work Stations placed in various locations on board. They are then connected in a network.

There is only one cable from each Transmitter to the Level Unit, as the temperature sensors and the inert gas pressure sensors are connected to the Transmitter. There is one communication cable between the Level Unit and the Work Station.

Associated systems, such as load calculator and electro-pneumatic level gauging systems, are connected to the Work Station via the I/O Box.

The Parabolic Antenna Transmitter installed on deck before painting.

A Flexible System to Meet our Customers' Requirements

Saab TankRadar G3 is a complete system for tank gauging. As standard, Saab TankRadar G3 provides ullage, level rate, Hi, Hi.Hi, Lo and Lo.Lo alarms.

The measured data is presented on one or more Work Stations with color monitors, as well as on the Backup Display. The data can also be presented on deck, at each tank on a small display, the optional Local Display.

Optional Equipment for Many Purposes

There are numerous options that can be added to Saab TankRadar G3 such as:

- Temperature measurement with calculation of average temperature.
- Inert gas pressure measurement with instant alarm indication.
- Cargo control with Saab TankRadar MaC.
- Local Displays on deck.
- Tank Display Units (Console mounted bargraph instrument)
- Portable Readout System for reading measured values anywhere onboard.
- Serial communication with load calculators.
- Serial communication with electro-pneumatic ballast and draft measurement.
- Serial communication with other host computers.
- Printers for alarm logs and for other reports.
- Volume calculation*.
- Weight calculation*.

  * Normally received from an on-line load calculator.
- Analog and digital inputs and outputs.
- Flexible protective hose with or without flange for cables from Transmitter to deck pipe conduit.
- Ballast-, HFO-, DO- etc. level gauging as well as draft gauging (electropneumatic).
- A totally independent high level and/or overfill alarm system. See also note below.

See pages 6 and 7 for an illustration of some of the optional equipment.

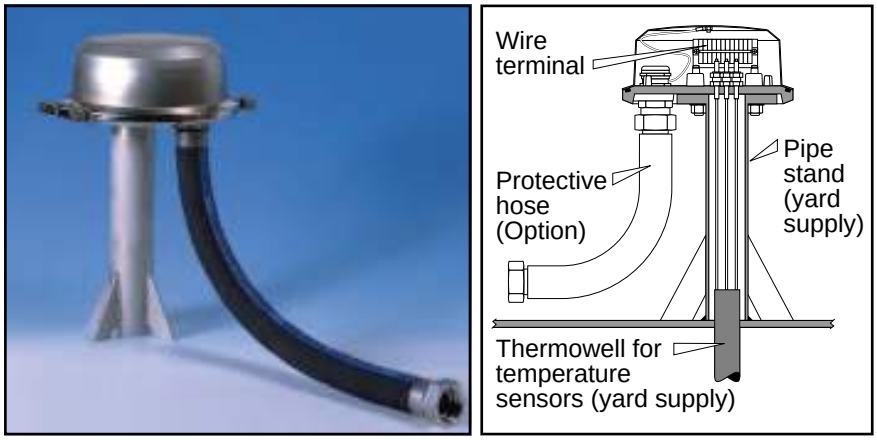
Many other options and optional equipment are available with the Saab TankRadar system. Contact your local agent for more information.

Note: *Saab TankRadar G3 fulfills the USCG requirements CFR46, §39,20,7 a to c High Level Alarm (95%) as integrated with the cargo gauging system.*

Temperature Measurement (Option)

Up to three Pt100 type temperature sensors can be used for each tank with three or optionally four wire connection. They are connected in the Temperature Connection Box. The temperature is measured and sent to the Level Unit with the same interval as the ullage.

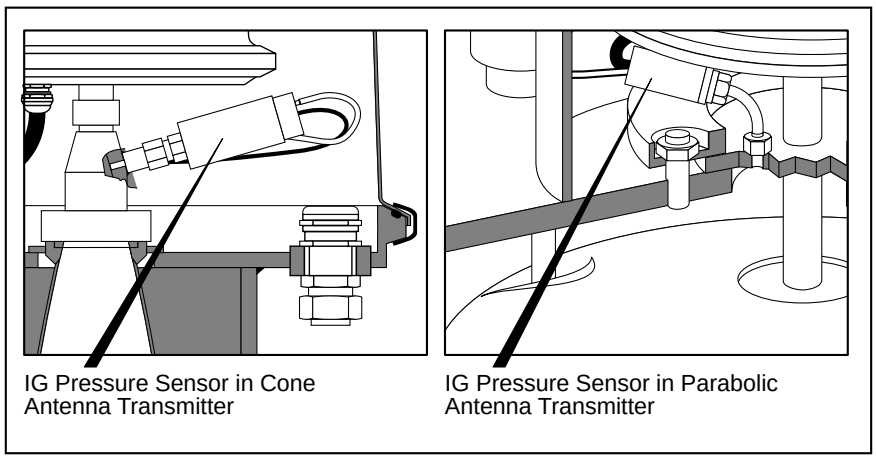
The Temperature Connection Box can be mounted on deck, as in the figure below. Another version of it can be mounted onto a cargo pump with the thermowell mounted into the tank along the pump pipes.



The deck mounted Temperature Connection Box.

Inert Gas Pressure Measurement (Option)

The inert gas pressure can be measured with a sensor integrated in the Transmitter Housing. It is connected on a wire terminal inside the Transmitter Housing. The inert gas pressure is measured and sent to the Level Unit with the same interval as the ullage. Normal high and low pressure alarm handling is done in the Work Station. However, there is also a direct alarm handling in the Transmitter itself, for handling extreme situations very quickly. This type of alarm is immediately sent to the Work Station for instant display. It can be used for example for leak alarm detection.



The inert gas pressure sensor inside the Transmitter Housing.

Local Display (Option)

The Local Display is a display that can be mounted on deck, close to a valve of the tank to which its Transmitter is connected. It has a display with six characters. The Local Display is intrinsically safe and is mounted separately on deck up to 20 m away from the Transmitter to which it is connected. The Local Display can display the tank's ullage. It can also be set to automatic toggling between ullage, average temperature and inert gas pressure. It can also show alarms. The Local Display has been made so that it can be bolted, clamped or welded to any suitable structure on deck.

The Local Display.

Portable Readout System (Option)

Saab Marine's Portable Readout System allows the crew on deck to have continuous overview of the ullages in the tanks during loading and discharging. The system is made up of mainly two parts, the portable unit and the base radio.

The Portable Readout Unit has a display and a keyboard and is connected to a walkie-talkie. The walkie-talkie is used for both talking and digital communication.

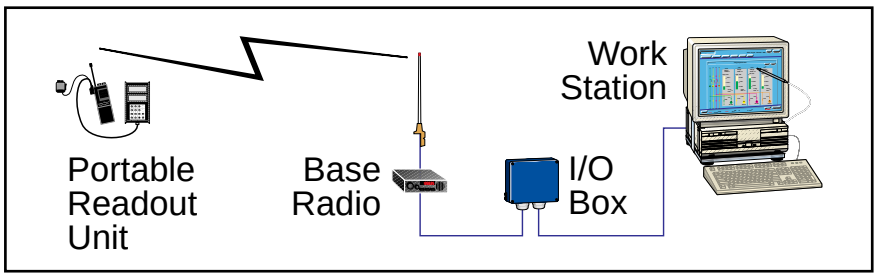
The Portable Readout Unit displays ullage, temperature, inert gas pressure and alarms in alphanumeric characters on two displays. Alarms are indicated with a buzzer, and the concerned tank name is shown on the display.

The information is automatically updated to the Portable Readout Unit from the Work Station.

As the Portable Readout Unit is intrinsically safe it can be used anywhere onboard. The Portable Readout Unit is completely sealed and contained in a leather case with a shoulder strap.

The Work Station communicates with the Portable Readout Unit via a base radio connected to a PRS Interface Card in the I/O Box. The base radio and its antenna must be mounted in a non-hazardous area.

Saab's Portable Readout System. The Portable Readout Unit together with the walkie-talkie is shown to the left. The base radio with its antenna is shown to the right.



The Portable Readout System is connected to the Work Station via the I/O Box.

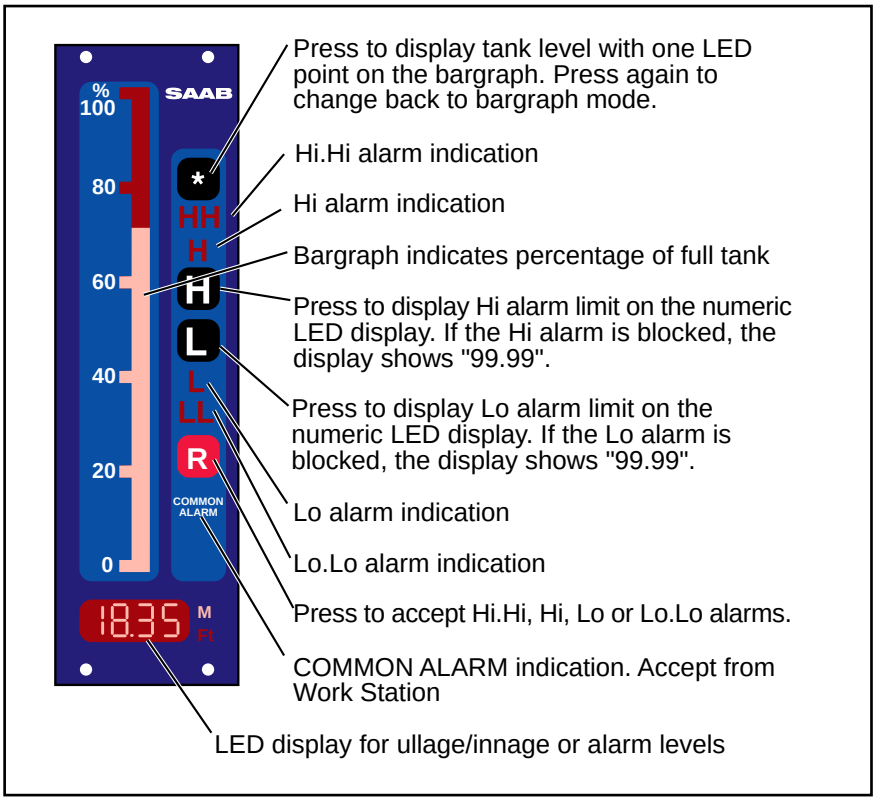
Tank Display Unit (Option)

One Tank Display Unit for each tank installed in a common panel gives a clear view of tank contents (ullage or innage). The standard Tank Display Unit has a four digit numeric display and a bargraph of light emitting diodes (LEDs) indicating tank filling as a percentage of the tank height. The display also indicates alarm levels (Hi, Hi.Hi, Lo and Lo.Lo alarms). Values can be displayed in either metric or imperial units, which is preset at delivery.

The standard Tank Display Unit can also be adapted for temperature, ballast or draft indications.

The Tank Display Units are powered by a separate power supply unit. Up to 30 Tank Display Units can be supplied by one power supply unit.

There is an optional thumbwheel that can be used together with a single Tank Display Unit. The thumb wheel is used to select the tank to be displayed at the moment.



These illustrations show the Tank Display Unit for ullage presentation.

Printer (Option)

A printer can be supplied with the Saab TankRadar system for printing reports and logs of alarms and warnings.

Alarm logs are useful when you want to keep track of when alarms or warnings occurred as well as when they went out of alarm. The printer prints one row for each alarm or warning, describing it with date, time, if it went into or out of alarm, name of parameter that caused the alarm, value, alarm limit and unit of measurement.

Reports can also be created and printed. You can easily modify the reports for your own needs. These reports can either be printed at your command or they can be set to be printed automatically at certain intervals, for example each week or month.

The printer is of the matrix type. This type of printer is suitable for printing alarm logs since it can print one row at a time on continuous paper.

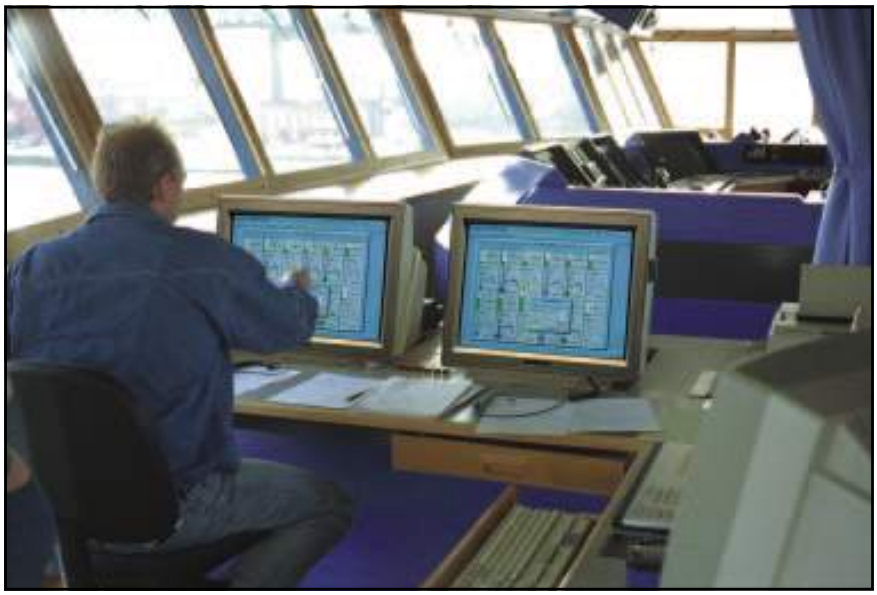
Saab TankRadar MaC

Saab TankRadar MaC is the third generation cargo control system from Saab Marine Electronics. The two previous generations of cargo control systems were the Saab TCS (Tanker Control System) and the Saab MaC/501.

Saab TankRadar MaC is a further refinement of the previous Saab MaC/501 system. It takes full advantage of the new opportunities with Saab TankRadar G3.

It is unique with its complete integration of monitoring and control functions. This gives the operator immediate response on any actions and all the measured values are instantly displayed.

With its advanced man-machine interface, it gives the operator complete overview and control. The operator can discharge and load a number of tanks at a time, as well as topping up tanks quickly and with full confidence.



The photo shows two Saab TankRadar MaC Work Stations placed on the bridge.

Work Station

The same type of PC is used as Work Station for both Saab TankRadar MaC and Saab TankRadar G3.

A large 21" color monitor is included as standard on the MaC Work Station. The large screen provides ample space for the mimic in the control windows of the Work Station software.

The design of the operator's interface in the MaC Work Station software is very similar to that of Saab TankRadar G3. In this way the operator can comfortably switch between monitoring and control windows. The Light Pen is used for Saab TankRadar MaC as well. Experience has shown this to be the easiest to use and most powerful and reliable tool for interacting with the system.

The control windows of the Work Station software contain mimic diagrams showing tanks, pumps, valves, sensors etc. A standardized set of graphic symbols and layouts are used to make the windows as clear and

user-friendly as possible. Following these standards, each of the control windows are specially made according to the requirements of each customer.

A number of Work Stations can be placed in a network at various locations onboard. By connecting the optional Redundancy Box, a redundancy can be obtained, allowing one of the master Work Stations to fail. This function is described in more detail below.

A board for the Bitbus communication to the Substation is included in the master Work Station (in both master Work Stations if the redundancy option is included).

Control Functions

Pumps, valves and other equipment are controlled by pressing the symbol using the Light Pen. An indication shows that the symbol is selected. A small control window is opened close to the symbol, allowing the operator to give commands such as open/close, start/stop or percentage settings. Control commands can be issued from any Work Station in a network.

In order to minimize the risk of handling errors, all control commands are clearly shown and are easily understood by the operator.

Feedback signals from sensors on pumps and valves can be monitored and alarms issued if actual values differ from setpoint values.

Extensive self test functions are included in the system to alert the operator if anything is abnormal in the system.

Example of a mimic window with symbols for control functions.

Substation

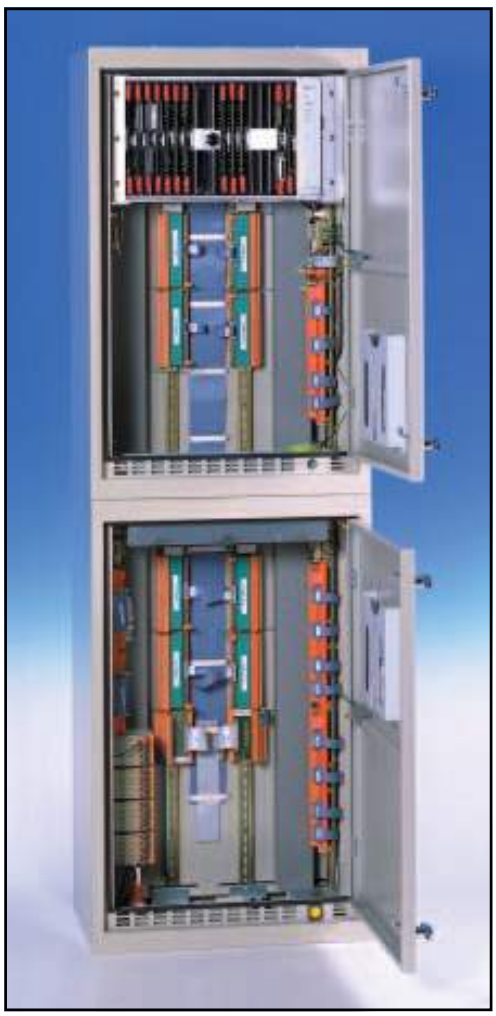
The Substation contains electronics and wire terminals for input signals as well as control signals. The main function of the Substation is to handle the signals between the Work Station and the connected control equipment.

Signals from various devices, such as valve positions, pressures and temperatures, are sent to the Substation where they are processed and sent to the Work Station for presentation. When the operator orders actions from a Work Station, these orders are sent to a Substation. From the Substation, control signals are sent to the corresponding equipment, such as on/off switches, pumps and valves.

All communication between the Work Station and the Substation is transmitted over the high speed Bitbus data link.

Each Substation handles input/output signals to and from:

- Valves and pumps (actuators and feedbacks).
- Temperature and pressure sensors
- On/off switches.
- Other types of sensors and equipment (refer to Technical Specifications).



The Substation with an extended cabinet.

4-20 mA feedback signals from sensors in hazardous areas pass through conventional zener barriers. Potentiometer or digital signals pass through the Multiplexer Unit, MUX, which can handle up to 15 intrinsically safe signals.

Multiplexer Unit, MUX.

Input/Output

I/O channels to the Substation are routed via wire terminals in the cabinet to dedicated circuit boards.

A number of different types of circuit boards for various purposes can be installed in the Substation.

Input boards:

ADC - analog/digital converter (used together with the analog boards).

AIX - analog input multiplexer board for the analog/digital converter (ADC). One or more AIX boards are interfaced to a single ADC board.

CIN - receives up to 30 channels 4 to 20 mA inputs.

DIX - receives up to 56 channels of digital inputs 0/24 V.

Output boards:

AOUT - up to 16 analog output channels;
voltage output ±10 V max 5 mA,
current output 0 to 20 mA or 4 to 20 mA.

DOX - up to 64 digital output channels: 30 V, 0.1 A. With optional relay terminal 250 V, 1A.

Substation Cabinet

The Substation's electronics and terminals are placed in a cabinet. A card cage at the top of the cabinet houses the circuit boards for data processing and communications.

The wire terminals are placed in the lower part of the cabinet. There is space for the cabling for the input and output signals. A door gives easy access to the interior of the cabinet.

For larger systems, the cabinet can be extended to accommodate more wire terminals and cables.

Substation Hand Terminal

A hand terminal with an alphanumeric display and keyboard is included with the Substation. It can be used to test the system or, if there is any failure, be used as a backup to control the Substation manually.

The following functions are available in the hand terminal:

- Reading of parameter values.
- Output of control signals.
- Test functions.

Hand Terminal for Substation

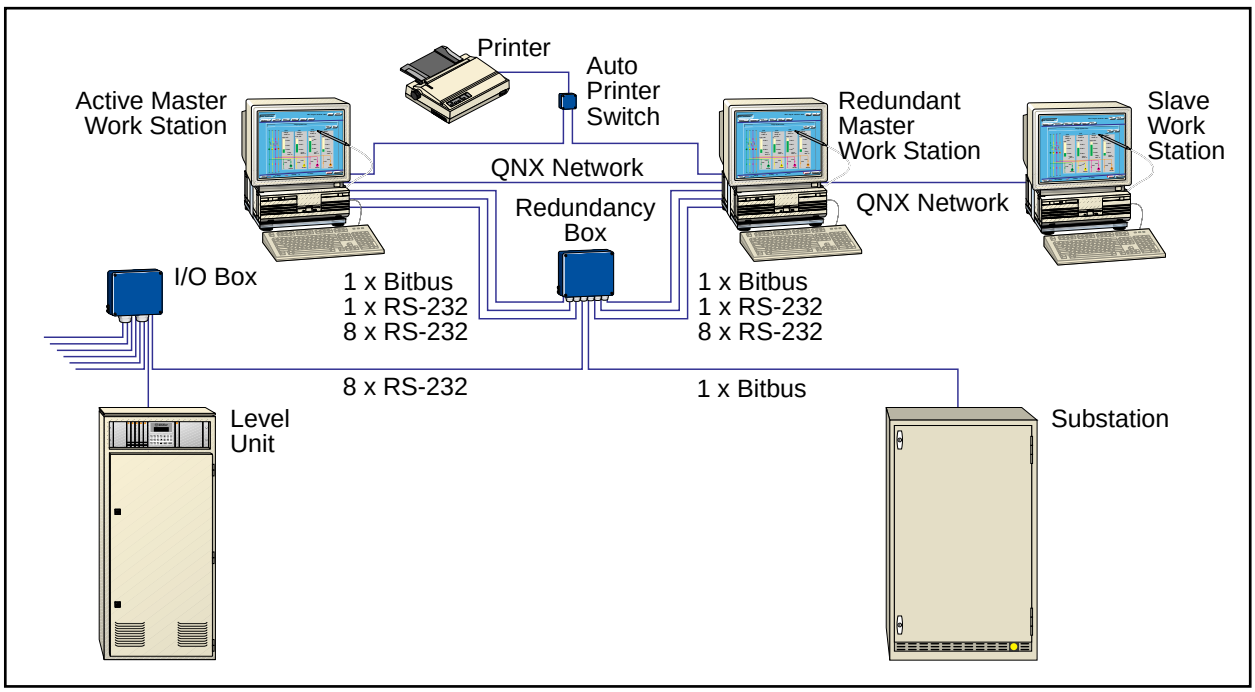
Work Station Redundancy (Option)

When two or more Work Stations are connected in a network, two of them can be configured as masters and be connected to the Redundancy Box. If the active master Work Station fails, the redundant master will automatically detect this and take over control of the system.

The redundant master Work Station monitors the QNX network, and when it notices that the active master Work Station has failed, it takes over control. In order to become the active master it has to restart its software. It takes approximately one minute after the active master Work Station fails, until the redundant master Work Station has taken over as active master.

The Redundancy Box switches the signal to the active master. The active master has exclusive control over the Redundancy Box. Only one of the master Work Stations is active at any one time.

The redundant master Work Station works like any slave Work Station until it detects that the active master has failed.



A Saab TankRadar MaC system with redundant Work Stations. If the Master Work Station fails, the redundant master Work Station takes over and becomes active master.

Technical Specification

Transmitter

Instrument accuracy	± 3 mm
Operational accuracy	± 5 mm
Resolution	1 mm
Operating temperature	-40 to +80 °C (-40 to +176 °F)
Maximum temperature of product	+120 °C (+248 °F) standard. Optional isolation of the Transmitters for bitumen tankers
Product range	Crude, products, chemicals, bitumen, molten sulphur etc.
Analog inputs	Five inputs for either 3-wire or 4-wire Pt100 sensors, scalable range One input for inert gas pressure sensor.
Explosion protection	Intrinsically safe: • EEx ia IIC T4 according to EN 50020 (European Norm) • Accepted by USCG and ABS

Parabolic Antenna Transmitter

Measuring range	0-60 m
Ullage reference plug	Inner diameter 1.5″
Socket (Yard supply)	Height 800 mm
Flange	DN500 (Outer tube diameter 532 mm)
Antenna diameter	390 mm
Beam width	2.7° (3-dB beam width from antenna axis)
Free space requirement	5.0° (angle from antenna axis)
Material facing tank atmosphere	Stainless steel SS2343, PTFE (Teflon), Coated steel SS1312. Other materials optional
Weight	80 kg (deck socket excluded)

Cone Antenna Transmitter

Measuring range	0-14 m
Socket (Yard supply)	Height 120 mm
Flange	DN200 (Flange outer diameter 340 mm, pipe outer diameter 219 mm)
Beam width	6.2° (3-dB beam width from antenna axis)
Free space requirement	12.7° (angle from antenna axis)
Material facing tank atmosphere	Stainless steel SS2343 and PTFE (Teflon). Other materials optional
Weight	45 kg (deck socket excluded)

Level Unit

Number of transmitters	Max 30 for one Level Unit Max 60 with an additional Slave Level Unit
Dimensions	550 x 1200 x 300 mm (Width x Height x Depth)
Weight	68 kg
Power supply	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Power consumption	Max 250 VA for standard LU with 30 Transmitters connected. Recommended fuse: 10 A, 250 V
Alarm relays	Five relays, rated 250 VAC, 2 A (system failure, pressure alarm, power failure and two spares)
Intrinsic safety	Associated apparatus for non-hazardous location: [EEx ia] IIC T4 (provides intrinsic safety for equipment in hazardous location)
Cables from each transmitter	2 x 4 twisted wire cable with common shield Area 0.50-1.50 mm^2 (max length: - with 0.50 mm^2 = 200 m - with 0.75 mm^2 = 325 m - with 1.00 mm^2 = 480 m - with 1.25 mm^2 = 520 m - with 1.50 mm^2 = 670 m) Yard supply
Operating temperature	0 to +55 °C (32 to 131 °F)
Connection to Work Station	RS-485 (two wire with half duplex) via I/O Box Max distance 400 m Cable type: twisted pair with common shield
Connection to Service PC	RS-232
Trim/List Unit	
Inclinometer range	±5°
Inclinometer accuracy	±0.08°

Work Station

Computer	Type approved PC
Monitor Saab TankRadar G3	17" monitor
Monitor Saab TankRadar MaC	21" monitor
Operating System	QNX
Power supply	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Power consumption	Max 300 VA
Connection of associated equipment	Via the I/O Box
Dimensions	
PC, Monitor, mounting plate	415 x 545 x 425 mm
Keyboard	470 x 40 x 195 mm (Width x Height x Depth)
Weight	35 kg

I/O Box

Serial communication interfaces	Up to seven galvanically isolated RS-232 (max 15 m) or RS-485 (max 400 m) of which one is dedicated for LU communication.
Communication Protocol	Saab Master/Slave Protocol.
Relays	System failure, common alarm and up to six configurable relays for alarms or general output signals Rated 250 VAC, 8 A
Analog/digital inputs/outputs	Field bus interface for distributed I/O modules
Connection to Work Station	RS-232, max 15 m. Cable supplied by Saab Marine Electronics
Power supply	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Power consumption	Max 15 VA
Dimensions	280 x 230 x 110 mm (Width x Height x Depth)
Weight	5 kg

Redundancy Box (Optional)

Connection to Work Station	RS-232 and Bitbus, max 3 m. Cable supplied by Saab Marine Electronics
Power supply	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Power consumption	Max 15 VA
Dimensions	280 x 230 x 110 mm (Width x Height x Depth)
Weight	5 kg

Temperature Measurement (Optional)

Operational accuracy, standard 3 wire	± 0.2 °C excluding sensor accuracy for temperature range 0 °C to +100 °C (+32 to + 212 °F)
Sensor accuracy, standard	± 0.3 °C + 0.005 ΔT for Pt100 Class B sensor (ex. ±0.3 °C at 0 °C and ±0.55 °C at +50 °C)
Optional for custody transfer	± 0.15 °C excluding sensor accuracy for temperature range 0 °C to +100 °C. 4-wire connection in Transmitter. Class $\frac{1}{3}$B sensor recommended
Temperature range	Whole or part of -50 °C to +250 °C (-58 to +482 °F)

Inert Gas Pressure Measurement (Optional)

Operational accuracy	± 5 mBar excluding sensor accuracy
Sensor accuracy, standard	± 2 % of full scale for operating environment
Pressure range	± 500 mBar. Extended range ±800 mBar available

Local Display (Optional)

Resolution	1 mm, 0.1 °C, 1 mBar
Operating temperature	-40 °C to +80 °C (-40 to +176 °F)
Distance to Transmitter	Max 20 m
Explosion protection	Intrinsically safe, EEx ia IIC T4
Dimensions	120 x 195 x 126 mm (Width x Height x Depth)
Weight	6 kg
Material	Stainless steel

Tank Display Unit (Optional)

Resolution	50 LEDs in bargraph represent full tank height. Numeric display shows ullage in cm.
Operating Temperature	0-55 °C (+32 to +131 °F)
Dimensions, TDU	48 x 168 x 200 mm (Width x Height x Depth)
Signal cables	RS-485, 3 twisted pairs with common shield. Area: 0.5-1.5 mm^2
From TDU Power Supply to TDU:	2 x 1.5 mm^2 (max 10 TDU/cable pair)
Weight, TDU	0.7 kg

TDU Power Supply Unit

Dimensions	285 x 325 x 100 mm (Width x Height x Depth)
Weight	10 kg
Power Supply for 1 - 30 Units	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Power consumption	Max 100 VA

Portable Readout System (Optional)

Portable Readout Unit

Intrinsic safety	According to CENELEC (Europe) and FM (USA)
Resolution	
Ullage/innage	0.01 m
Temperature	0.1 °C
IG Pressure	1 mBar
Power requirements	2-4 mA, 7-15 V (supplied from walkie-talkie)
Dimensions	120 x 190 x 45 including leather case (Width x Height x Depth)
Weight	0,6 kg (including leather case)
Operating temperature	-20 to +50 °C (-4 to +122 °F)
Storage temperature	-55 to +60 °C (-67 to +140 °F)

Available Standard Frequencies

VHF	157.525, 157.550, 157.575 MHz
UHF	457.525, 457.550, 457.575 MHz

Walkie-Talkie

Type	Motorola MX1000 (from 1996 Motorola MT2100) or Sabre (Safety Class 1)

Base Radio

Type	Motorola Mobius 900 or Motorola Max-Trac 50

Printer (Optional)

Dimensions	430 x 120 x 310 (Width x Height x Depth)
Weight	5.2 kg
Power supply	115 VAC +10 to -15%, 47-63 Hz or 230 VAC +10 to -15%, 47-63 Hz
Connection	Parallel port on Work Station

Substation for Saab TankRadar MaC Cargo Control System (Optional)

Cabinet

Dimensions	600 x 950 x 415 mm (Width x Height x Depth)
Weight	110 kg
Power supply	110 VAC +10 to -15%, 50-60 Hz or 230 VAC +10 to -15%, 50-60 Hz or 24 VDC
Power consumption	300 VA, max
Ambient operating temperature	0 to 55 °C (+32 to +131 °F)

Extension cabinet

Dimensions	600 x 950 x 415 mm (Width x Height x Depth)
Weight	100 kg

Substation Input channels

Resistance Temperature Detectors (RTD)	
Type	Pt100 according to DIN or JIS standards
RTDs and Thermo Couple Elements	Connects to current input via signal conditioner/current transmitter
Current Transmitters	
Current range	4 to 20 mA (0 to 20 mA)
Input resistance	50 Ω, max
Accuracy	± 1% of full range
Potentiometers	
Total resistance	1 kΩ, min
Accuracy	Limited by potentiometer linearity
Digital Inputs (voltage-free contacts)	
Supply	24 V
Load current	2 mA

Intrinsically Safe Inputs (multiplexors)

Type	I.S. RTD-MUX (15 Pt100 elements)
Range	-50 to +100 °C (-58 to +212 °F)
Accuracy	+/-1 °C
Approval	SP (EEx ia) IIC
Type	I.S. Pot-Mux (15 Potentiometers)
Range	1 to 10 kΩ
Approval	SP, (EEx ia) IIC
Size of Multiplexor Unit (MUX)	420 x 128 x 300 mm (Width x Height x Depth)
Weight	10 kg
Cables (from MUX to SS):	Eight cores plus one per Multiplexor Unit. Core area: min. 0.2 mm^2 (AWG 24)

Outputs

Analog	
Current	0 to 20 mA or 4 to 20 mA
Accuracy	±0.5% of full scale
Voltage	-10 to +10 V
Accuracy	± 0.2% of full scale
Digital	
Transistor output (open collector)	30 V, 100 mA, max
Relay contacts	
Nominal	250 V, 2 A, max

Hand Terminal

Display	Liquid Crystal Display (LCD), 2 lines, 32 characters, 5 x 7 dot matrix
Power supply	+5 V, +0.25 V (from Substation)
Operating temperature	0 to 50 °C
Case material	ABS plastic
Dimensions	82 x 156 x 35 mm (Width x Height x Depth)
Weight	300 g

Note: *Due to constant development, specifications may be subject to change without prior notification. All specifications in this publication are based on functions and features that can be included on demand. For a specific description of included functions and features, please refer to the technical data stated in the quotation in response to your inquiry for quotation, or in the order acknowledgment.*

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