RADius

Technical Description

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1. INTRODUCTION

1.1 About this manual

The purpose of this manual is to describe the technical principles applied in the design of the RADius 1000 system.

This manual is organised into the following chapters:

Chapter 1 **Introduction** - A brief overview of this manual with references and abbreviations.

Chapter 2 Deals with Health, Environment and Safety issues.

Chapter 3 Contains the technical description.

In this manual the following notations are used:

WARNING! **Used when it is necessary to warn personnel that a risk of injury or death exists if care is not exercised.**

Caution! ***Used to warn the reader that a risk of damage to the equipment exists if care is not exercised.***

Note! *Used to draw the reader's attention to a comment or some important information.*

1.2 References

[1] *RADius 1000 User's Manual*
[2] *RADius 1000 Installation Manual*

1.3 Definitions, abbreviations and acronyms

1.3.1 Definitions

Interrogator	The actual radar module measuring distance and bearing to one or more transponders. Mounted on the DP vessel.
Transponder	The radar reflector. Mounted on the remote object/vessel.

1.3.2 Abbreviations and acronyms

AC	Alternating Current
CU	Controller Unit
DP	Dynamic Positioning
DGPS	Differential Global Positioning System
FM-CW	Frequency Modulated Continuous Wave
GPS	Global Positioning System
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
IU	Interrogator Unit
LAN	Local Area Network
MRU	Motion Reference Unit
PPS	Pulse-Per-Second
PU	Processing Unit
RADius	
TID	Transponder Identity
VDU	Video Display Unit
VGA	Video Graphic Adapter
WEEE	Waste Electrical and Electronic Equipment

2. HEALTH, ENVIRONMENT AND SAFETY

Operation or troubleshooting of RADius equipment will not imply any risk for high voltages, explosions or exposure to gas. The RADius 1000 complies with IEC 60950/EN60950 standards regarding product safety (low voltage) and IEC 60945/EN60945 standards on electromagnetic compatibility (immunity/radiation) and vibration.

WARNING! **The RADius 500 contains a lithium battery inside the equipment housing. The battery is completely covered by the transponder housing and is watertight. Unless severe damage is made to the housing there is no risk of explosion or fire.**

To avoid possible fire, explosion, leakage or burn hazard do not open the sealed unit. Do not attempt to recharge, disassemble, heat above +75° C/167 F or incinerate.

Caution! ***The RADius 500 battery cannot be recharged and an attempt to do so could result in a hazard. (Battery terminals are not accessible unless the cover is destroyed or removed).***

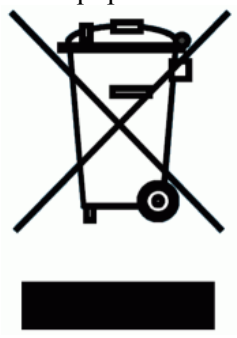
Note! RF Exposure: The RADius must be mounted with a separation distance of at least 20 cm from any humans.

Disposal

All RADius electrical and electronic components have to be disposed separately from the municipal waste stream via designated collection facilities appointed by the government or local authorities. The correct disposal and separate collection of your old appliance will help preventing potential negative consequences for the environment and human health. It is a precondition for reuse and recycling of used electrical and electronic equipment. For more detailed information about disposal of your old appliance, please contact your local authorities or waste disposal service.

Until further notice is given regarding reuse, disassembly or disposal, the equipment at end-of-life, could be returned to Kongsberg Seatex AS if there is no local WEEE collection.

The equipment is marked with the following pictogram.



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3. TECHNICAL DESCRIPTION

3.1 The product

RADius (patent pending) represents a completely new way of utilising radar principles in short range and direction monitoring. RADius is mainly meant to be used in operations where increased safety is crucial. The system could typically be used to control or assist automatic dynamic positioning (DP) of a vessel.

The RADius system is designed to operate close by structures and other vessels. The use of identifiable transponders minimizes the risk of tracking false radar echoes.

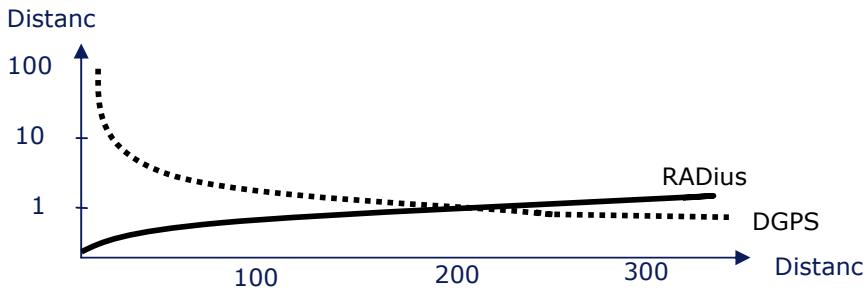

Figure 1 Illustration of position accuracy as a function of distance

As shown in ***Figure 1***, DGPS and RADius have complementary characteristics when closing up to large structures. The DGPS systems will suffer from limited view of the sky, resulting in degraded GPS availability. This can be crucial when the GPS constellation is at its minimum and the most important satellite disappears behind the structure. The RADius system increases its performance as it moves closer to the transponders located on the structure.

Figure 2 A typical scenario where a vessel operates close to a high structure

Innovative technology
The implementation is fully solid state and based on measuring reflected signals from a number of transponders who represent targets in the nearby area. Each reflected signal is mixed with a unique ID in order to separate different transponders from each other. Advanced signal processing allows simultaneous and continuous measurements from up to five transponders. RADius is designed for multiple vessels utilizing the same transponders simultaneously.

Advanced principles
One or more Interrogator Units are located at the manoeuvring vessel and one or more transponders are attached to different points at the remote object. Signal processing will effectively remove possible interference with other transmitting devices in the same frequency band. Application software makes configuration and monitoring of the RADius operation easy and effective. Interfaces to remote systems are provided through serial lines.

RADius is designed to fill the need specified by IMO for DP Class 2 vessels.

Operational features
RADius is capable of detecting and measuring the distance to transponders within the range of up to 1000 metres. The angle between the Interrogator and each transponder is determined by the use of interferometric methods. RADius is delivered with an easy-to-use graphical user interface.

3.2 Design principles

The RADius product is a high precision reference and tracking system, utilising low power FM-CW radar principles. The system may include a number of Interrogators and transponders. The Interrogator is used to read the individual distance and direction to a number of transponders by means of microwaves.

The Interrogator includes a transmitter unit, a receiver unit and a pre-processor unit. The Interrogator communicates with the Processing Unit through an Ethernet link

Each transponder includes antennas, a side band oscillator and a voltage source. The transponder generates sub-carriers at individual frequencies for identification. The RADius 500 low power transponder is powered by a battery. The RADius 600 high gain transponder is permanently connected to 6 VDC.

3.2.1 Distance and bearing determination

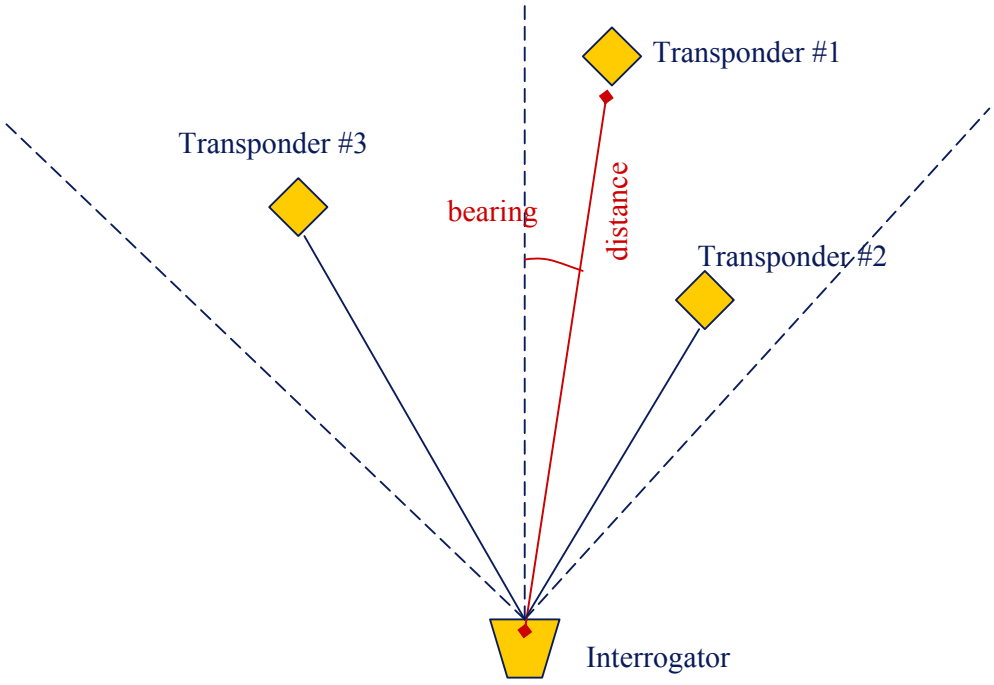

Figure 3 Relative distance and bearing

The RADius Interrogator measures distance and bearing to the transponders. It can operate on one transponder alone or up to five simultaneously. The ability to track several transponders simultaneously increases the integrity capability and the robustness of the system.

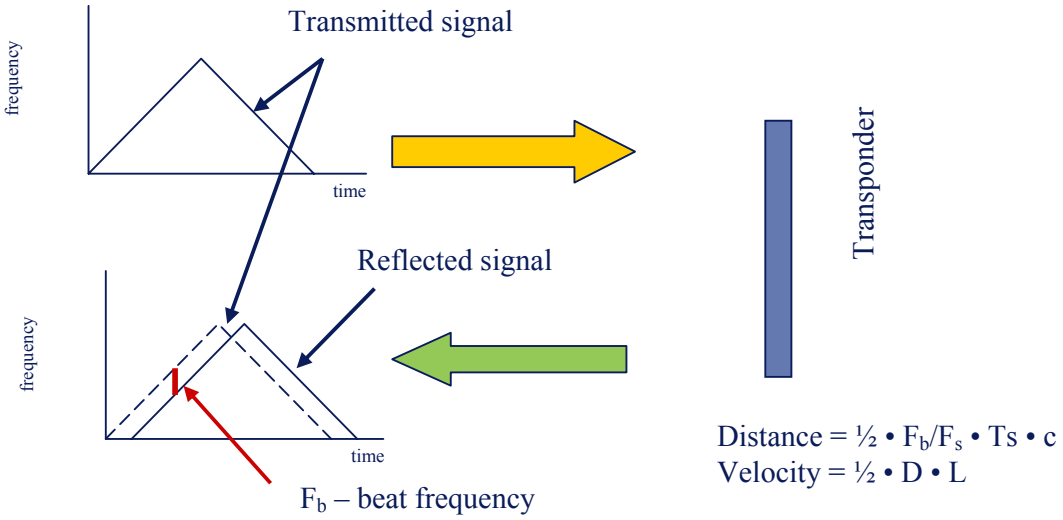

Figure 4 RADius principle

RADius measures range based on the FM-CW radar principles. It sweeps the frequency transmitted and mixes the transmitted signal with the received signal. The transmitted signal has changed frequency during the flight time of the received signal and it is the difference between the transmitted frequency and the received frequency that is measured. This frequency difference is proportional to twice the distance to the transponder.

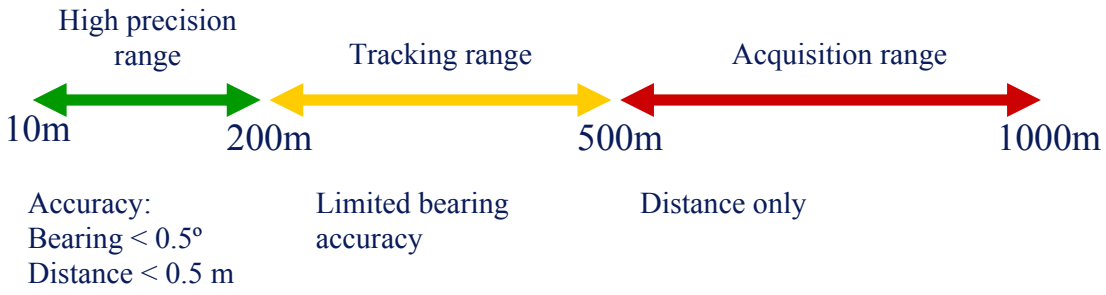

Figure 5 RADius operation modes

The RADius characteristics are determined from the measuring principles. This leads to different performance at different ranges. The accuracy is best at close range. Between 10 - 200 metres is optimal accuracy is acquired. Between 200 - 500 metres distance and bearing is measured but the accuracy is degraded due to the nature of angle measurements. Beyond 500 metres, the system acquires the transponders but only with range measurements. These can be used to verify the functionality of the system (typically prior to entering 500-metre safety zone).

3.3 System components

The RADius 1000 system comprises two main parts, which are physically separated. These are:

- Interrogator Unit
- Controller Unit/Processing Unit (CU)

In addition there are:

- One or more transponders
- VDU
- Power cables
- Signal and power cables between the Processing Unit and the Interrogator Unit
- Documentation

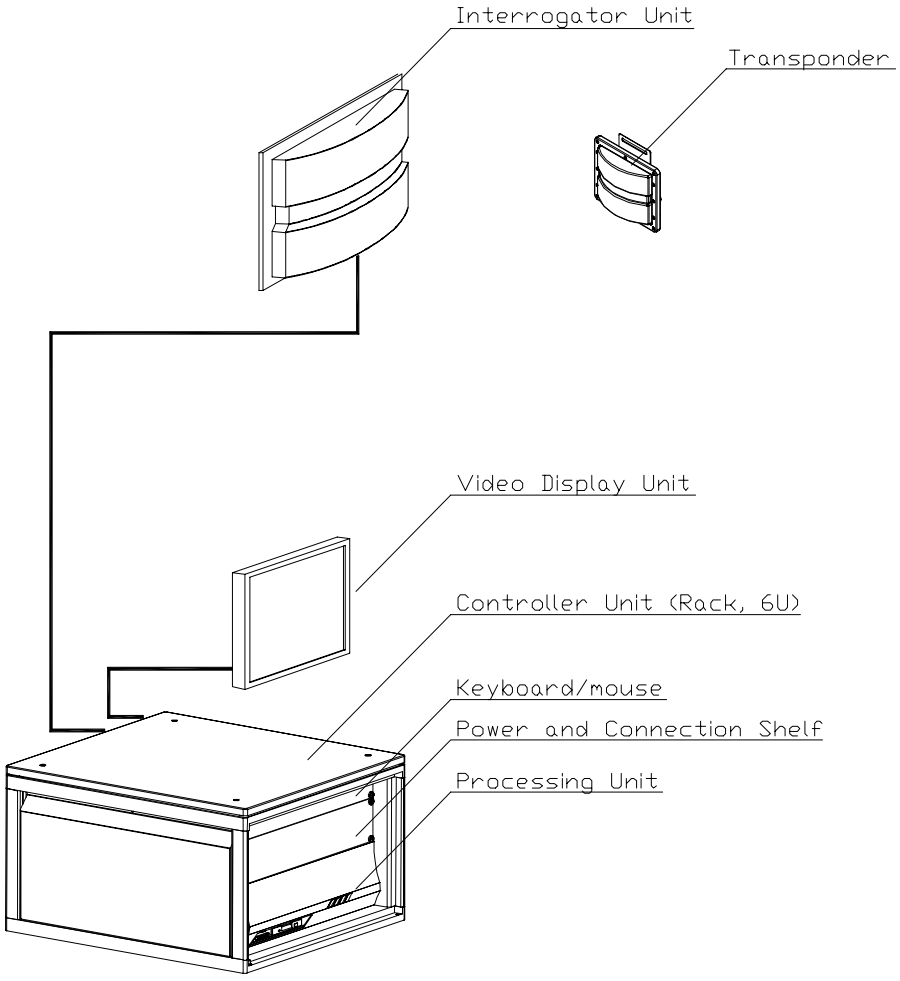

Figure 6 RADius 1000 system

3.3.1 Interrogator Unit

The Interrogator is a sealed unit which consists of a transmitter, a receiver and pre-processing modules. The power is supplied from the power/connection shelf in the CU. The ON/OFF switch is located on the right-hand side on the power/connection shelf, rear view.

The Interrogator is only to be opened by qualified Kongsberg Seatex personnel.

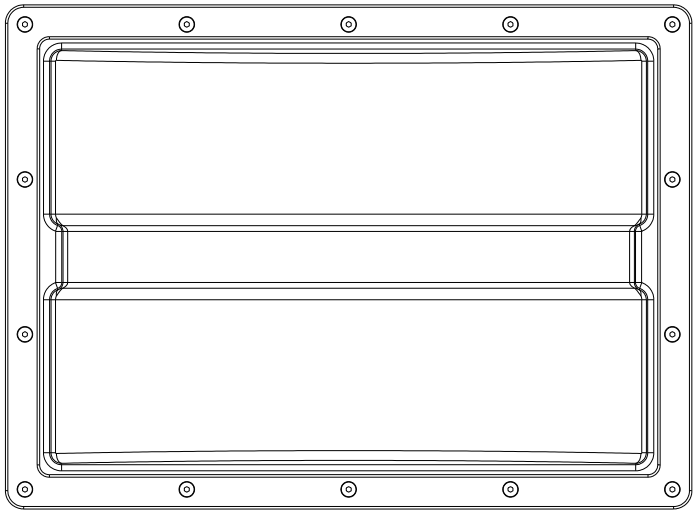

Figure 7 Interrogator front view

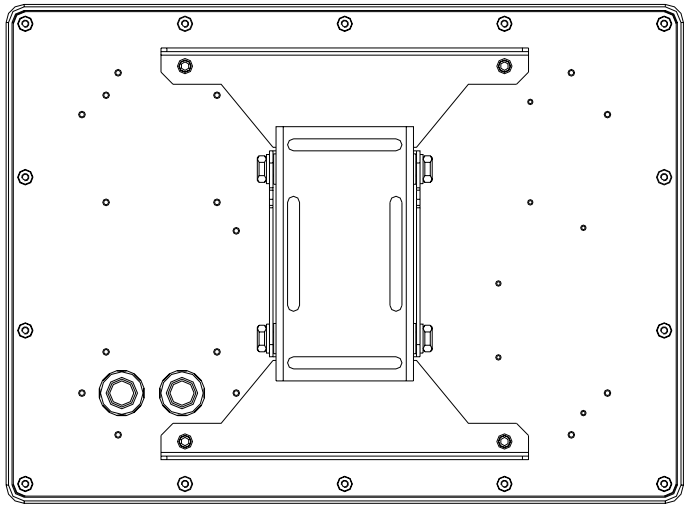

Figure 8 Interrogator rear view

3.3.2 Controller Unit

The Controller Unit is installed on the bridge, in the instrument room or a similar location. It comprises the components described in the chapters below:

- Processing Unit (3U)
- Power/connection shelf (2U)
- Keyboard/mouse (1U)

3.3.2.1 Processing Unit

The Processing Unit is designed to fit standard 19-inch racks. It comprises the following main parts:

- Hard disk
- 3.5-inch floppy disk
- Serial and analog I/O boards
- Computer main board
- 110/230V AC power supply

The front panel includes the following items:

- ON/OFF switch
- A 3.5-inch floppy disk for software installation and upgrade
- Four status indicator lights
- RS-232 serial port (COM1) for service purposes only

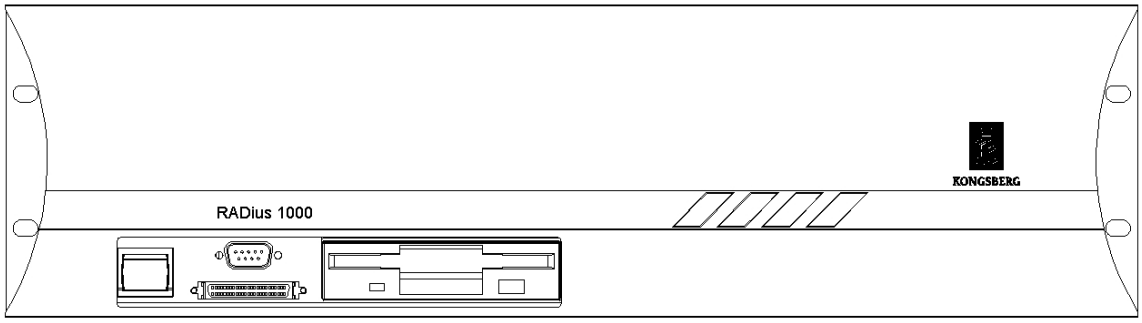

Figure 9 Front panel of the Processing Unit

The rear panel of the Processing Unit contains communication interface ports for interfacing to external systems.

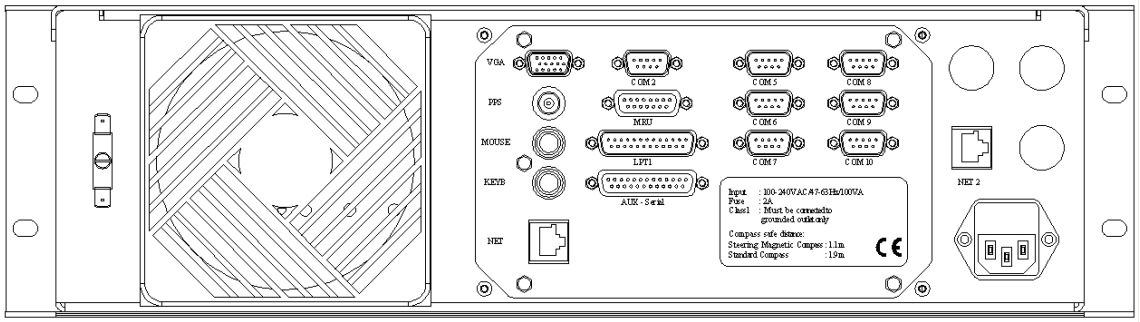

Figure 10 Rear panel of the Processing Unit

Description of the connectors:

Connectors	Type	Connected to
VGA	Video Graphic Adapter	Display
PPS	1 pulse-per-second	N/A
MOUSE		Mouse/trackball
KEYB		Keyboard
NET	Ethernet	Interrogator interface
NET2	Ethernet	External equipment interface
MRU	RS-422	N/A
LPT1	Parallel port	N/A
AUX - Serial	Analogue output channels and additional serial lines (com13 to com16)	N/A
COM 5	RS-232 or 422 (default 232)	User configurable output
COM 6	RS-232 or 422 (default 232)	User configurable output
COM 7	RS-232 or 422 (default 422)	User configurable output
COM 8	RS-232 or 422 (default 422)	User configurable output
COM 9	RS-232 or 422 (default 422)	User configurable output
COM 10	RS-232 or 422 (default 422)	User configurable output
100/240VAC	Power	Input of 85 to 135 and 180 to 265V AC

3.3.2.2 Power/connection shelf

The Power/connection shelf is designed to fit standard 19-inch racks, and is providing power and network interface to one or more Interrogators. It comprises the following parts:

- Ethernet switch
- ON/OFF switch with integrated fuse
- 110/230V AC power supply for Interrogators
- 110/230V AC power supply for Ethernet switch
- Power and LAN terminals for Interrogators

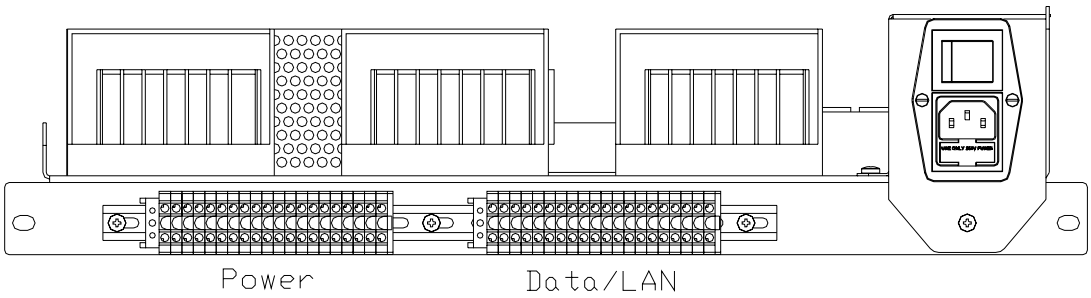

Figure 11 Rear view of the power/connection shelf

3.3.2.3 Keyboard/mouse

A 1U keyboard with integrated trackball is installed in the rack. The keyboard is the system's primary input device.

3.3.3 Transponder

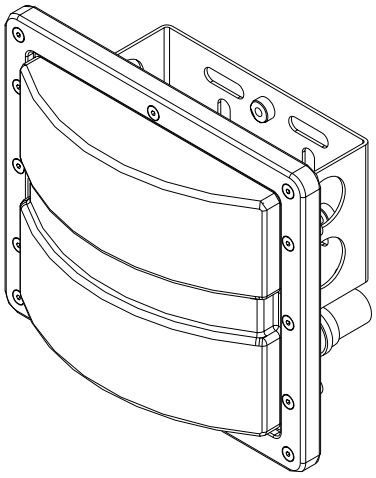

Figure 12 RADius transponder

The transponder is the actual reflector. It receives the signal from the Interrogator, mixes the input signal with its own identity frequency and reflects the signal back.

The transponder is supplied as a sealed unit, configured with an ID. It does not need any user interaction to be configured.

The transponder ID (TID) is derived from the actual transponder identification frequency which ranges from 1.5 MHz to 3.0 MHz. TID then ranges from 150 to 300.

Two different transponder types are available; see detailed description in the chapters below. One RADius 500 transponder is supplied with the RADius 1000 system. This is primarily meant to be used as a reference transponder for system calibration and check of the IU and PU during the system installation and commissioning. It can also be placed at a suitable location of user choice, thus making the system autonomous. The supplied transponder is always set to TID 150.

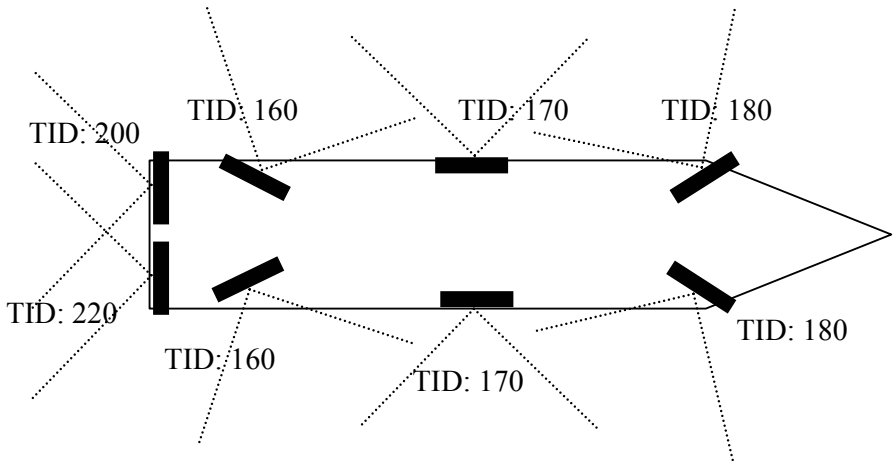

Figure 13 Recommended transponder placement on a production vessel

For more information on transponder placement, refer to the installation manual.

3.3.3.1 RADius 600 High Gain Transponder

The RADius 600 transponders are typically installed on platforms or other floating installations.

- High precision range of 200 metres.
- Operating sector: 90 degrees horizontally and vertically.

3.3.3.2 RADius 500 Low Power Transponder

The RADius 500 transponders are easily relocated as there is no cable connection.

- High precision range of 100 metres.
- Operating sector: 90 degrees horizontally and vertically.
- Powered by an internal 3.6 VDC battery. Estimated battery life is one year. Rental units are available when battery replacement is required.
- ON/OFF switching by removing the connector cover and inserting the activate connector. The transponder is powered ON when the connector is inserted.

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