



KONGSBERG

# RADius

## Short-Range Relative Positioning



**Product Paper**

**Patented technology**

Patent No.:

US 7,315,274 B2

Date of patent:

Jan. 1, 2008

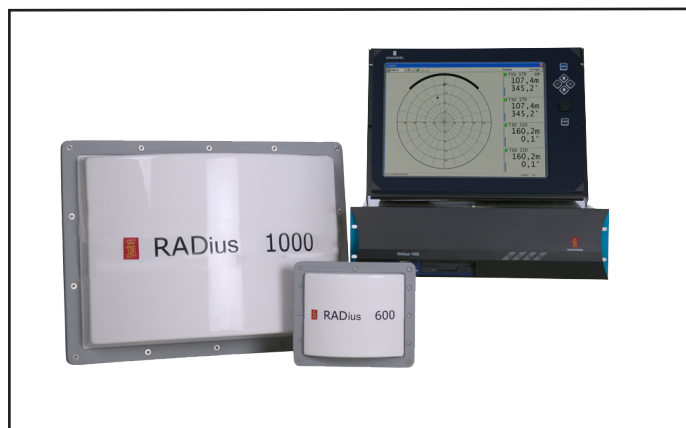
## The RADius positioning system

RADius is developed for applications in need of a robust and reliable relative positioning system. Many applications can benefit from RADius in operations, as there are different types of retroreflective transponders, and different types of installation of the sensor heads, (Interrogators).

### RADius system elements

RADius consists of one or several interrogators typically located on a moving vessel and one or several transponders that are deployed on the target the vessel will approach. The RADius system measures the distance and bearing between the interrogators on the moving vessel and the transponders.

All deployed transponders at the target has unique identities, thus multiple transponders can be utilised for integrity and high availability.



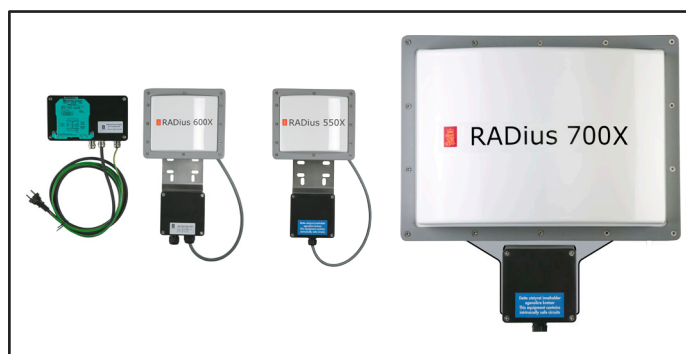
*RADius components*

### RADius Interrogator

Several interrogators can be easily deployed on suitable places on the outside of the vessel. Each contains antenna elements - with an horizontal and vertical opening angle of 90°, a receiver, a transmitter and a signal processing front end.

### RADius transponder

Transponders are deployed on vessels or installations that a vessel with an interrogator approaches. Transponders are either battery operated (over 1 year operation) or connected to a power source from the installation or vessel. Opening angle from transponders are 90° vertically and horizontally. ATEX certified transponders (intrinsically safe) are also available.



*ATEX-certified transponders*

### RADius workstation

The RADius workstation is a module rack containing a processing unit with RADius software, a graphical user interface and serial interface lines to for example the DP or other possible users.

## RADius applications

Many different applications can benefit from the robust and easy deployable RADius system. DP-operated vessels are often required to have redundancy in their positioning sensor when performing different types of operations. Due to the wide opening angles, RADius contribute to secure “close-by” operations in all weather conditions.

Typical users of RADius are

- Anchor Handling Tug Supply vessels
- Offshore Support Vessels / MPSV

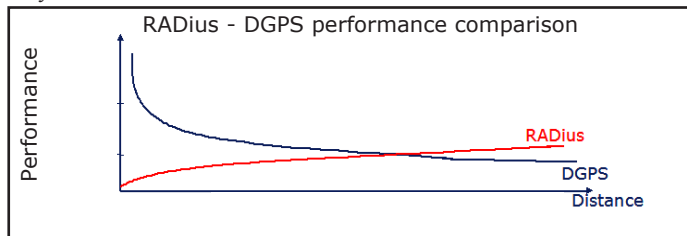




# RADius operational advantages

## Complementary to other positioning solutions

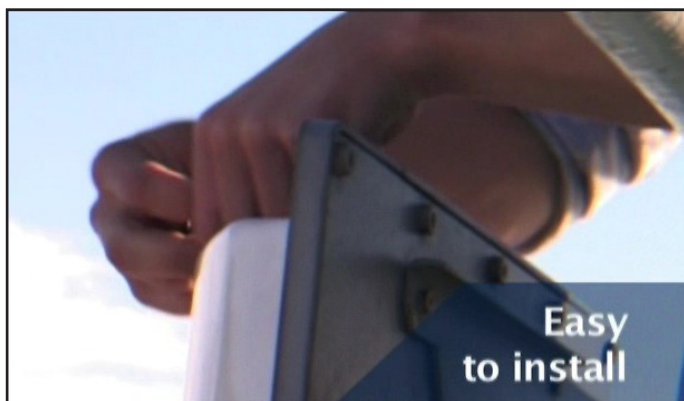
Due to for example shadowing from installations offshore, GNSS solutions can experience challenges in positioning accuracy when a vessel perform close-by operations. RADius is designed to give higher accuracy



The figure illustrates RADius' performance down to sub-meter accuracy when moving closer to the target.

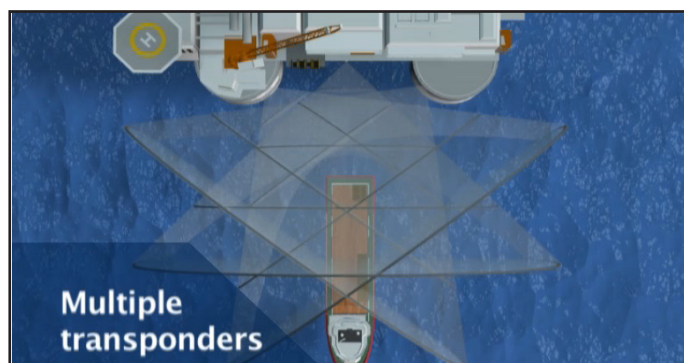
## Easy to deploy and operate

Several interrogators can be deployed on suitable places on the vessel, dependent on what type of vessel construction and what kind of operations that are to be performed. Due to the light weight of both the transponders and interrogator, deployment of the system is easy. The robustness of the system allow the interrogators to be mounted independable of each other, this is to avoid dead angles and to obtain up to 360° coverage.



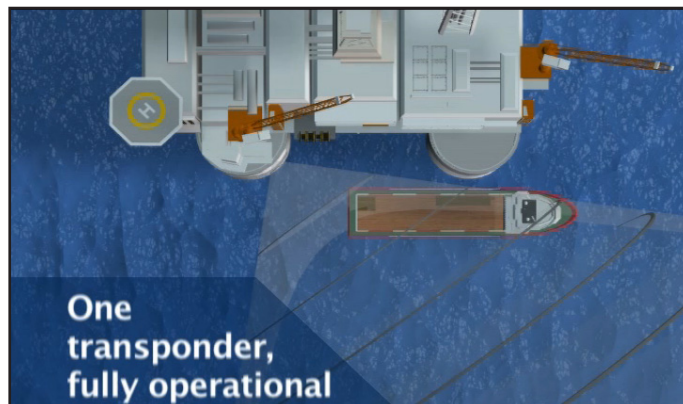
## Multiple transponder capacity

RADius can track up to five transponders simultaneously, increasing robustness, reliability and integrity.



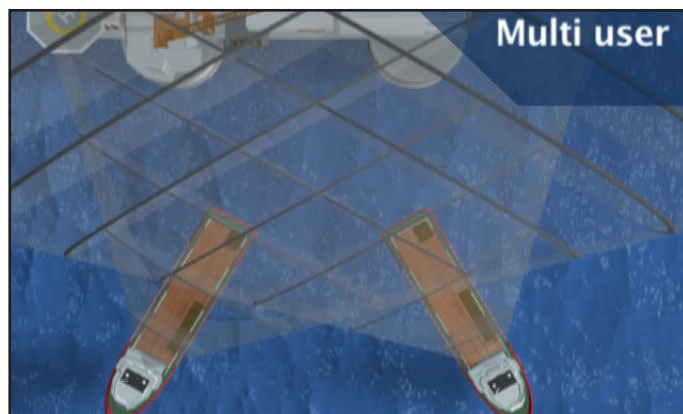
## Fully operational with one transponder

Up to five transponders can be tracked by each interrogator simultaneously, however, RADius operates also with only one transponder available.



## Multi user capacity

The system allows for multi user operability, which means that several vessels can utilise the same transponders simultaneously.



## Solid state - no moving parts

The RADius system is a "solid state" system. There are no motors, stabilized platforms or other moving parts within the system. Hence, the maintenance cost of the system is low.

## Weather robustness

The RADius system is operating in a 5.5 - 5.6 GHz frequency band, and is not affected by any weather conditions. RADius is also available for extreme cold conditions down to -40 °C (-40 °F)

## Wide opening angles

RADius has a vertical and horizontal opening angle of 90°. This secure stable operations in close by operations where the difference in mounted transponder and interrogator can be considerable. Due to this it is not necessary to tilt the interrogator in any direction to obtain signal.

## High precision position reference and tracking system.

RADius is developed for applications in need for a robust and reliable relative positioning system. Many applications can benefit from RADius in operations, as there are different types of retroreflective transponders, and different types of installation of the sensor heads, (Interrogators).

### Innovative technology

The implementation is fully solid state and based on measurement of reflected radar signals from a number of passive transponders in the nearby area. Each reflected signal is mixed with a unique ID to separate different targets from each other. Advanced signal processing allows simultaneous and continuous measurements to any practical number of transponders. RADius is designed for multiple users leveraging the same transponders simultaneously.

### Multiple sensor heads

RADius can be deployed as an omni directional system utilising four sensor heads, which can be placed on suitable locations on the vessel dependent on the construction and operation. This provides full 360° signal acquisition as well as avoidance of blind angles as there will be a sensor head at a receiving angle to transponders at all times, regardless of the vessels relative position to the RADius transponder.

Signal processing will effectively remove possible interference with other transmitting devices in the same frequency band. Accurate Doppler measurements allow for rapid and reliable determination of relative velocities between the maneuvering vessel and transponders.

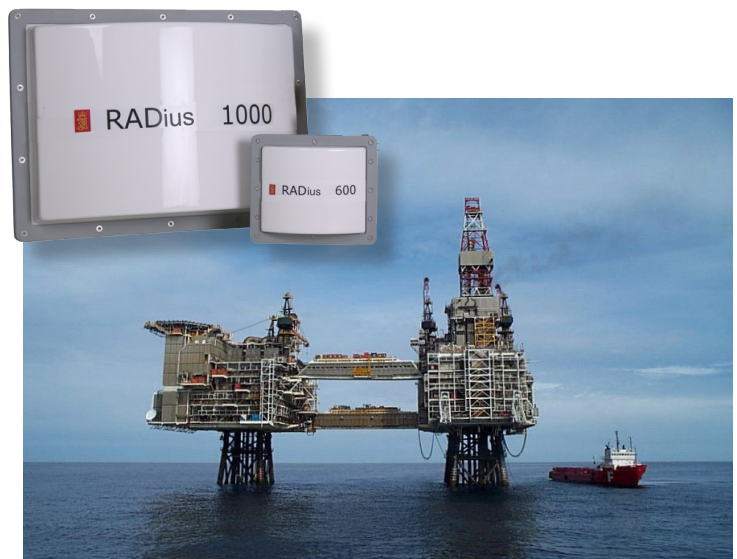
Application software makes configuration and monitoring of the RADius operation easy and effective, and interfaces to remote systems like Dynamic Position may either be serial lines or Ethernet based. RADius is designed to fill the need specified by IMO for DP Class 2 vessels.

### Operational features

RADius is capable of detecting and measuring accurate range and bearing to any transponder within the range of up to 550 metres. (Dependant on the targets transponders) The direction from the interrogator to each transponder is accurately determined by the use of interferometric methods. Due to use of open standards, deployment of the operator interface is very flexible.

### Wide opening angles

RADius has a vertical and horizontal opening angle of 90°. This



secure stable operations in close by operations where the difference in mounted transponder and interrogator can be considerable. Due to this there is not necessary to tilt the sensor head in any direction to obtain signal.

### A variety of transponders

Retroreflective transponders are mounted on the target that are to be approached. A variety of transponders are available suitable for any operation that demands an robust and reliable relative positioning solution.

### Features

- Multiple sensor heads
- Measuring and output of range and bearing
- Wide opening angles secure close-by operations
- No moving parts
- Multi user feasibility
- Multiple transponder capability
- Operates in all weather conditions, also extreme cold
- Complementary to existing GNSS reference system
- Designed to meet all IMO DP Class requirements
- Both battery and fixed power operated transponders
- Operates in license free radio band
- ATEX certified transponders
- Easy to deploy and adapt

## System Components

### • RADius 1000 - Interrogator

The interrogator is mounted on the outside of the vessel. It contains antenna elements, a transmitter and a signal processing front end.

### • RADius Workstation

The workstation contains RADius Processing unit, a graphical user interface and serial interface. The System is delivered in a 6U 19" rack with keyboard, video display unit and power / connection module.

### • RADius 600 and 700 transponder

There are both high-gain and low power (battery operated) transponders available.

### • RADius 550X, 600X and 700X transponder

ATEX certified intrinsically safe transponders in low-power (battery operated) and high gain versions.

### • User Terminal Application Software



## Technical Specifications

### Measurements

- DP range  
(Dependent on transponder type)
- Range accuracy \*
- Angle accuracy \*
- Update frequency rate
- Latency

up to 550 m

0.25 m (1  $\sigma$ )

0.25° (1  $\sigma$ )

5 Hz

< 0.5 sec

### Opening angle

vertical

± 45°

horizontal

± 45°

### Operational

Frequency band

5.51 - 5.61 Ghz

### Environmental

#### RADius 1000 Processing Unit

Enclosure material:

Aluminium

Enclosure protection:

IP-30

Operating temperature range:

-15 to +55°C/5 to 131 F

Operating humidity:

20 to 80% relative

Storage temperature range:

-20 to +60°C/-4 to 140 F

Storage humidity:

Less than 55%

Vibration test according to:

IEC/EN 60945

#### RADius 1000 Interrogator Unit

Enclosure material:

Anodised aluminium - rear

Enclosure material:

Plastic - front cover

Enclosure protection:

IP-66

Operating temperature range:

-30 to +55°C/-22 to 131 F

Operating humidity (max.):

100%

Storage temperature range:

-25 to +70°C/-13 to 158 F

Storage humidity (max.):

60%

Vibration testing according to:

EN 60945

### Physical Dimensions

#### Interrogator:

• Height x Width x Depth:

412 x 562 x 184 mm

• Weight:

7.0 kg

• Protection

IP 66

#### RADius Workstation:

• Height x Width x Depth:

300 x 500 x 150 mm

• Weight:

15 kg

### Power

#### Interrogator

Input Voltage

110/220 V AC

Power consumption

160 W

#### RADius Transponders:

See dedicated datasheets

#### ATEX certified Transponders:

See dedicated datasheets

### Interfaces

• 6 x RS422/232 (isolated)

Proprietary NMEA 0183

• Ethernet

TCP/IP

Output formats:

PSXRAD (multiple targets)

FanBeam MDL

\* All accuracy specifications are based on real-life tests conducted in the North Sea under various conditions. Operation on other locations under different conditions may produce different results.







KONGSBERG

# RADius 550X

## ATEX certified RADius transponder

The RADius 550X transponder is a part of the short-distance relative positioning system RADius, developed for use in applications where the need for a robust and highly accurate relative positioning system is crucial.

The RADius 550X Low Power Transponder is an intrinsically safe product (category 2) suitable to be installed in hazardous locations where there may be an explosive mixture of flammable gases belonging to gas groups IIB and/or IIA. The transponder can be used in hazardous zones 1 and 2. Temperature class is T4.

The RADius 550X is powered from an encapsulated battery with an integral current limiting resistor and has no wired connection to other equipment.

### Unique ID

The transponders are coded with unique ID's ensuring reliable identification and tracking in cluttered environments. Several interrogators can approach the same transponders, ensuring multi-user capabilities. Up to five transponders can be tracked simultaneously by the interrogator. The transponder is suited with dip-switches for easy setting of transponder ID.



## Technical specifications

### Range \*)

Operational Range	550 metres
DP range	350 metres

### Opening angle

vertical	± 45°
horizontal	± 45°

### Physical properties

WxHxD:	220x400x147 mm
Weight without clamps:	3.6 kg
Weight with clamps:	3.8 kg

### Colour:

Electronic part:	White front/grey rear
Connection/Battery box (GRP):	Black

### Battery module data

Type:	Primary cell, D-size, IEC 60086-1 type E
Open loop battery voltage:	Max 3.7 VDC
Capacity:	19 Ah (one cell)
Expected lifetime:	2 years
Short circuit current for battery module:	Maximum 9.6 mA
Current consumption for the low power transponder:	Approximately 1 mA

### Environmental data

Humidity Operational:	10 - 100 % RH
Humidity Storage: (Recommended)	20 - 70 % RH

### Ingress protection

Transponder electronic unit:	IP 66
Connection/battery box:	IP 66

### Temperature range

Operational:	- 25 °C to + 60 °C
Storage: (Recommended)	+0 °C to + 40 °C

Electromagnetic compatibility:	Compliant to IEC 60945 ed 4
--------------------------------	-----------------------------

\*)

- Possible to acquire the signal, typically range only, within the "Operational Range - > 550 meters" (in order to verify that your reference system is available).
- At a certain range, the system will track both range and bearing with a large probability. However, the bearing will have limited accuracy.
- At the "DP Range - > 350 meters", the system will be fully operational both in range and bearing.



KONGSBERG

# RADius 600

## High Gain Long Range Transponder

The RADius 600 High Gain long-range transponder is a part of the short-distance relative positioning system RADius for use in applications where the need for a robust and highly accurate relative positioning system is crucial. The system comprises an interrogator - typically installed on a vessel - operating in the GHz maritime band and transponders that are typically deployed on the target.

The RADius 600 is an fixed power transponder and has an effective operational range of 1000 meters.

### Unique ID

The transponders are coded with unique ID's ensuring reliable identification and tracking in cluttered environments.



Several interrogators can approach the same transponders, ensuring multi-user capabilities. Up to five transponders can be tracked simultaneously by the interrogator. Operating sector of the unit is 90° horizontally and vertically.

## Technical specifications

### Range \*)

Operational range: up to 1000 m  
DP Range: < 550 m.

### Opening angle

Vertical:  $\pm 45^\circ$   
Horizontal:  $\pm 45^\circ$

### Physical properties

**RADius 600 Transponder**  
WxHxD: 220x228x72 mm  
Weight: 1.4 kg  
Colour: White front/grey rear

### Transponder power supply dimensions

WxHxD: 126x226x90 mm  
Weight: 2.5 kg  
Colour: Grey

### Power

**RADius 600 Transponder**  
Voltage: Supplied from Transponder Power Supply  
Power consumption: 700 mW (max.)

### Environmental data

#### RADius 600 Transponder

Enclosure material: Anodised aluminium - rear  
Enclosure material: Plastic - front cover  
Enclosure protection: IP-66  
Operating temperature range: 30 to +55°C/-22 to 131 F  
Operating humidity (max.): 100%  
Storage temperature range: -25 to +70°C/-13 to 158 F  
Storage humidity (max.): 60%

#### RADius Transponder Power Supply

Enclosure material: Aluminium  
Enclosure protection: IP-66  
Operating temperature range: -15 to +55°C/5 to 131 F  
Operating humidity (max.): 100%  
Storage temperature range: -25 to +70°C/-13 to 158 F  
Storage humidity (max.): 60%

Electromagnetic compatibility: Compliant to IEC 60945 ed 4

\*)

- Possible to acquire the signal, typically range only, within the "Operational Range - > 1000 meters" (in order to verify that your reference system is available).
- At a certain range, the system will track both range and bearing with a large probability. However, the bearing will have limited accuracy.
- At the "DP Range - > 550 meters", the system will be fully operational both in range and bearing.



KONGSBERG

# RADius 600X

## ATEX certified RADius transponder.

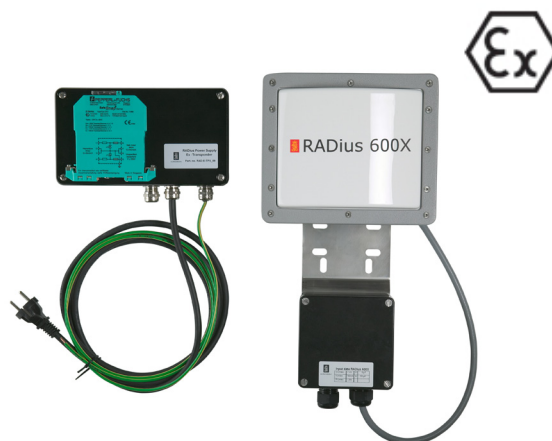
The RADius 600X transponder is a part of the short-distance relative positioning system RADius, developed for use in applications where the need for a robust and highly accurate relative positioning system is crucial.

The RADius 600X High Gain Transponder is an intrinsically safe product (category 2) suitable to be installed in hazardous locations where there may be an explosive mixture of flammable gases belonging to gas groups IIB and/or IIA. The transponder can be used in hazardous zones 1 and 2. Temperature class is T4.

RADius 600X is powered from a power supply located in a safe (non-hazardous) location and a zener barrier is used to limit the delivered energy to the hazardous location to a safe level. The barrier - located in a safe area - will prevent any hazardous voltage or excessive current from reaching the hazardous zone.

### Unique ID

The transponders are coded with unique ID's ensuring reliable identification and tracking in



cluttered environments. Several interrogators can approach the same transponders, ensuring multi-user capabilities. Up to five transponders can be tracked simultaneously by the interrogator.

The transponder is ATEX approved with certificate number DNV-2005-ATEX-0040

## Technical specifications

### Range\*)

Operational range: up to 1000 m  
DP Range: < 550 m

### Opening angle

Vertical / Horizontal:  $\pm 45^\circ / \pm 45^\circ$

### Physical properties

WxHxD: 220x400x147 mm

Weight without clamps: 3.3 kg

Weight with clamps: 3.5 kg

### Colour:

Electronic part: White front/grey rear

Connection/Battery box (GRP): Black

### Transponder power supply dimensions

WxHxD: 12.5x110x115 mm

Weight: 0.2 kg

Colour: Grey or black

### Environmental data

Humidity Operational: 20 - 100 % RH

Humidity Storage: (Recommended) 20 - 70 % RH

### Ingress protection

Transponder electronic unit: IP 66

Connection box: IP 66

### Temperature range

Operational:  $-25^\circ\text{C}$  to  $+60^\circ\text{C}$

Storage: (Recommended)  $+5^\circ\text{C}$  to  $+40^\circ\text{C}$

Electromagnetic compatibility: Compliant to IEC 60945 ed 4

### Transponder Power Supply

Enclosure material: Aluminium

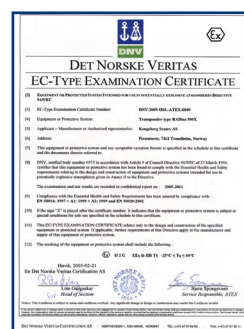
Enclosure protection: IP 65

Operating temperature range:  $-15^\circ\text{C}$  to  $+55^\circ\text{C}$

Nominal current power consumption for high-gain transponder: 100 - 125 mA  
Operating humidity (max): 100%  
Storing temperature range:  $-25^\circ\text{C}$  to  $+70^\circ\text{C}$   
Storage humidity (max): 60%  
Electromagnetic compatibility: Compliant to IEC 60945 ed 4  
**Zener barrier**  
Humidity  
Humidity Operational: 10 - 95 % RH  
Humidity Storage: 20 - 70 % RH  
Ingress protection: IP 20  
**Temperature range**  
Operational:  $-20^\circ\text{C}$  to  $+60^\circ\text{C}$   
Storage (recommended):  $+5^\circ\text{C}$  to  $+40^\circ\text{C}$

\*)

- Possible to acquire the signal, typically range only, within the "Operational Range - > 1000 meters" (in order to verify that your reference system is available).
- At a certain range, the system will track both range and bearing with a large probability. However, the bearing will have limited accuracy.
- At the "DP Range - > 550 meters", the system will be fully operational both in range and bearing.





## Long Range Battery Operated Transponder

The RADius 700 long-range transponder is a part of the short-distance relative positioning system RADius for use in applications where the need for a robust and highly accurate relative positioning system is crucial. The system comprises an interrogator - typically installed on a vessel - operating in the GHz maritime band and transponders that are typically deployed on the target. RADius 700 has an operating range of up to 1000 meters.

### Unique ID

The transponders are coded with unique ID's ensuring reliable identification and tracking in cluttered environments. Several interrogators can approach the same transponders, ensuring multi-user capabilities. Up to five transponders can be tracked simultaneously by the interrogator. The transponder is suited with dip-switches for easy setting of transponder ID.

### Easy to deploy and operate

The RADius 700 transponder is easily deployed as the unit is running on internal batteries, thus, no cable connection is necessary. The replaceable internal



Lithium battery has an estimated life time of three years.

ON/OFF switching is easily done by inserting/removing the activate connector on the back of the transponder.

Operating sector of the unit is 90° horizontally and vertically.

## Technical specifications

### Range \*)

Operational range	up to 1000 m
DP range	< 550 m

### Opening angle

vertical	± 45°
horizontal	± 45°

### Physical properties

HxWxD:	412 x 562 x 184 mm
Weight:	6.0 kg

### Colour:

Electronic part:	White front/grey rear
------------------	-----------------------

### Environmental data

Humidity Operational:	20 - 100 % RH
Humidity Storage: (Recommended)	20 - 70 % RH

### Ingress protection

Transponder electronic unit:	IP 66
------------------------------	-------

### Temperature range

Operational:	- 25 °C to + 60 °C
Storage: (Recommended)	+5 °C to + 40 °C

### Electromagnetic compatibility:

Compliant to IEC 60945 ed 4

### Transponder Power Supply Replaceable battery pack

Battery type:	Lithium
Battery lifetime	3 years

\*)

- Possible to acquire the signal, typically range only, within the "Operational Range - > 1000 meters" (in order to verify that your reference system is available).
- At a certain range, the system will track both range and bearing with a large probability. However, the bearing will have limited accuracy.
- At the "DP Range - >550 meters", the system will be fully operational both in range and bearing.

# RADius 700X



KONGSBERG

## ATEX Certified Long Range Battery Operated Transponder



The RADius 700X long-range transponder is a part of the short-distance relative positioning system RADius for use in applications where the need for a robust and highly accurate relative positioning system is crucial. The system comprises an interrogator - typically installed on a vessel - operating in the GHz maritime band and transponders that are typically deployed on the target. RADius 700X has an operating range of up to 1000 meters.

The RADius 700X Long Range Transponder is an intrinsically safe product (category 2) suitable to be installed in hazardous locations where there may be an explosive mixture of flammable gases belonging to gas groups IIB and/or IIA. The transponder can be used in hazardous zones 1 and 2. Temperature class is T4.

The RADius 700X is powered from an encapsulated battery with an integral current limiting resistor and has no wired connection to other equipment.



### Unique ID

The transponders are coded with unique ID's ensuring reliable identification and tracking in cluttered environments. Several interrogators can approach the same transponders, ensuring multi-user capabilities. Up to five transponders can be tracked simultaneously by the interrogator. The transponder is suited with dip-switches for easy setting of transponder ID.

## Technical specifications

### Range \*)

Operational range	up to 1000 m
DP range	< 550 m

### Opening angle

vertical	± 45°
horizontal	± 45°

### Physical properties

H x W x D:	564 x 560 x 214 mm
Weight:	7.4 kg
Colour:	
Electronic part:	White front/grey rear

### Battery module data

Type:	Primary cell, D-size, IEC 60086-1 type E
Open loop battery voltage:	Max 3.7 VDC
Capacity:	19 Ah (one cell)
Expected lifetime:	1,5 year
Short circuit current for battery module:	Maximum 9.6 mA
Current consumption for the low power transponder:	Approximately 1 mA

### Environmental data

Humidity Operational:	20 - 100 % RH
Humidity Storage: (Recommended)	20 - 70 % RH

### Ingress protection

Transponder electronic unit:	IP 66
------------------------------	-------

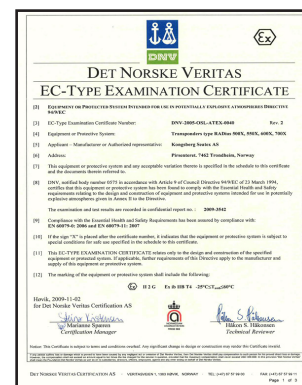
### Temperature range

Operational:	- 25 °C to + 60 °C
Storage: (Recommended)	+5 °C to + 40 °C

Electromagnetic compatibility:	Compliant to IEC 60945 ed 4
--------------------------------	-----------------------------

\*)







- Possible to acquire the signal, typically range only, within the "Operational Range - > 1000 meters" (in order to verify that your reference system is available).
- At a certain range, the system will track both range and bearing with a large probability. However, the bearing will have limited accuracy.
- At the "DP Range - > 550 meters", the system will be fully operational both in range and bearing.



# RADIUS Transponder Line, November 2009



KONGSBERG

	DP Range	Opening angles (vertical & horizontal)	Power	Battery Lifetime	# of Batteries	Atex Certified	Size (W x H x D)	Weight
RADIUS 550 X 	350 m	± 45°	Battery	2 years	1	✓	220x400x147 mm	3,8 kg
RADIUS 600 	<550	± 45°	Fixed				220x228x72 mm	1,4 kg
RADIUS 600 X 	<550	± 45°	Fixed			✓	220x228x72 mm	1,4 kg
RADIUS 610 S 	<550	± 45°	Fixed				H:620 mm Ø:150 mm	3,7 kg
RADIUS 700 	<550	± 45°	Battery	3 years	2		412x562x184 mm	6,0 kg
RADIUS 700 X 	<550	± 45°	Battery	1,5 years	1	✓	412x562x184 mm	7,4 kg



**Patented technology**

Patent No.: US 7,315,274 B2  
Date of patent: Jan. 1, 2008

PRODUCT PAPER RADIUS AUG 2010 HLA  
KONGSBERG SEATEX AS  
Pirsenteret N-7462 Trondheim  
Norway  
Telephone +47 73 54 55 00  
Telefax +47 73 51 50 20  
km.seatex@kongsberg.com  
[www.km.kongsberg.com/seatex](http://www.km.kongsberg.com/seatex)



KONGSBERG