



# ***WaveRadar® REX***

## **Operating Manual Issue K**

From WaveRadar serial Number 49318



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## Document Change Summary

<u>Issue</u>	<u>Issue date</u>	<u>Reason for change</u>
A	04/2000	Initial issue for WaveRadar REX.
B	09/2000	Specification change
C	06/2003	Introduction of RDU40 and 24vDC power supply
D	11/2003	Introduction of Baseefa03ATEX information and Underwriters Laboratory (UL) standard
E	05/2006	Introduction of FBM 2180 and additional updates
F	12/2006	Introduction of WaveRadar REX (second generation) with microwave module and other hardware improvements
G	03/2007	Change of Saab name to Rosemount. Correction to text
H	04/2009	New installation and fault finding sections
J	09/2009	Change to maintenance instructions and minor Correction to text
K	03/2014	Change to assembly instructions, access to electronics Introduction of new mounting frame GR-1

### Notes:

1. A vertical black line at the side of any text indicates either an amendment or the introduction of new text, picture or sketch to this version of this manual.
2. RS Aqua Ltd. provides exclusive global sales and service support for WaveRadar and WaveRadar REX systems.

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## 1. INTRODUCTION

### 1.1 General

WaveRadar REX is the latest version of the WaveRadar series first introduced in 1994. It is a non-invasive stable system for the measurement of waves, sea level and air-gap in the offshore environment. The device is manufactured by Rosemount Tank Radar AB of Gothenburg, Sweden, an Emerson Process Management company. It is a derivative of their Rosemount TankRadar series, many thousands of which are used throughout the world for monitoring levels in storage tanks.



## 1.2 Features

The downward looking sensor uses a microwave radar technique to measure the distance to the sea surface. It continuously collects and processes information and outputs distance measurement on to a data bus. Output values can be stored and displayed to industry standards on a remote PC or may be interfaced to multi-parameter environmental monitoring systems.

The microwave signals are very low in power and present no safety hazard.

WaveRadar REX is available in the following versions:

WaveRadar REX Type M	Digital and analogue output, mains power
WaveRadar REX Type D	Digital and analogue output, DC power

Both versions are hazardous zone BASEEFA03ATEX EEx certified.

The WaveRadar REX package comprises a radar electronics module enclosed in a flameproof (explosion proof) housing, an integral antenna with parabolic reflector and a field bus modem. The DC version operating range is from 20 to 28 volts. WaveRadar REX D units with a s/n prior to 38587 require a 48 – 100 volt source. An external module is used to convert a 24 volt source supply to 48 volts.

The WaveRadar REX is intended for external mounting on offshore or coastal structures such that the antenna has a clear downward view of the sea surface within at least a 10° angle conical beam.

The WaveRadar REX is shipped in a plywood pallet case. The wood packing used meets the requirements of the International Standard for Phytosanitary Measures of ISPM-15 and bears the International Plant Protection Convention (IPPC) mark on the pallet case, showing that the material has been subjected to an approved measure.

## 1.3 Assumptions about the user

In writing this manual it has been assumed that the user has some prior knowledge of computer operating systems and RS232/USB serial communications. It has also been assumed that the user will have some experience with instrumentation and data analysis.



## 2 SPECIFICATION

<b>Performance</b>	Sensor measuring range Accuracy  Maximum deviation Beam width	3 – 65 metres to surface Range <50m = +/-6mm Range >50m = +/-12mm Range <50m = +/-1mm 10 degrees included angle
<b>Radar transmission</b>	Transmitter frequency Effective radiated power Antenna type	9.7 to 10.3GHz (linear sweep) <0.5mW Parant (parabolic) reflector
<b>Radar measurement</b>	Measuring frequency	10Hz
<b>Data output</b>	Data bus  Connector cabling Output data rate  Digital - from FBM Type Protocol Analogue output Range Resolution Refreshing rate Connector cabling	Digital two wire FSK field bus, binary data output. Eex "e" (non intrinsically safe) 2 to 10Hz (4Hz default). Factory selectable RS232 at 4800 baud 8 data bits, no parity, one stop bit Half duplex 1 x Current loop 4 – 20mA 16 bits 4Hz (default) Eex "e" (non intrinsically safe)
<b>Power supply</b>	Mains voltage (type M)  Radar power rating Current consumption DC voltage (type D) Radar power rating Current consumption	100 to 240V AC (auto detects 110 and 220 VAC) 50 – 60Hz 80 watts maximum 1.6A max: operating <1A 20 to 28V DC +10% -15% 30 watts maximum 1.6A max: operating <550mA
<b>Mechanical</b>	Overall dimensions Weight Measurement datum Materials (external)	635(h) x 440(w) x 440(d)mm 26kg Upper surface of TRL/2 adapter Stainless steel 316 grade Anodised aluminium alloy ss4253 PTFE (Teflon)
<b>Environmental</b>	Operating and storage temp Environmental sealing	-40°C to +70°C IP67
<b>CE Conformity</b>	Approval number	0575
<b>BASEEFA03ATEX certification</b>	Radar unit type no. Certification no. Code	TH2015 – RTG3930 Baseefa03ATEX0071X Ex II 1/2G EEx d IIB T6 (T <sub>amb</sub> = -40°C to +70°C)
<b>Shipping case</b>	Dimensions Weight (gross) Materials	600 x 800 x 600mm 45kg – standard supply Plywood to IPPC standard

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### 3. GETTING STARTED

#### 3.1 Unpacking

WaveRadar REX (WRRex) is shipped in a plywood pallet case in modular form. Please refer to WRRex Assembly Diagram, WP2001M001 to help identify components. The primary task is to check the scope of supply which should be:

- Transmitter head (THE) with integrated junction box (fitted with cable glands) and waveguide housing. (Note: UL version excludes junction box, see 4.2.7)
- Weather protection cover (fitted to transmitter head)
- Waveguide with 2 x grub screws (already fitted into waveguide housing)
- Spring sleeve seal (already fitted into waveguide housing)
- Mounting flange plate fitted with T30 flange ball (fitted with 2 x “O” rings on lower face and large “O” ring under rim of flange ball), securing nut/locking ring with locking hex head grub screw.
- Antenna feeder with washer ball, stop washer, finger nut, tab washer and lock nut
- TRL/2 adapter, 4 x M10 bolts and 4 x M10 washers
- Parabolic reflector with 5 x M5 socket cap screws and Allen key
- Field bus modem (FBM 2180) with 1 x 3m RS232 cable, ac/dc power supply adapter with 4 x removable socket connectors and 2 x DIN rail mounting clips
- Documentation pack comprising:
  - Operating manual and WaveRadar set-up report
  - Manufacturer’s certificate of conformance
  - Delivery test certificate
  - IP67 certificate
  - Radio Communications Agency (UK) exemption notice
  - BASEEFA03ATEX certification
  - EC declaration of conformity – EMC directive
  - Special safety instruction

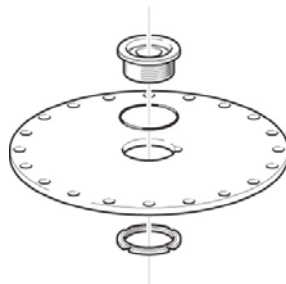


## 3.2 Assembly

### Tools Required

Allen (hex) keys: 4mm, 5mm, 6mm,  
Ring spanners: 10mm, 17mm, 19mm  
Adjustable spanner: 42mm opening  
Flathead screwdriver: 8mm  
Crosshead screwdriver: 6mm  
Terminal screwdriver  
“C” spanner (if required to fit flange ball into mounting plate)

The T30 flange ball will be fitted to the mounting flange plate. If not, follow the instructions below:



Fit the large ‘O’ ring to the groove under the rim of the T30 flange ball and insert the flange ball into the central hole of the mounting flange plate. Make sure that the locating pin fits into the recess on the plate. Fit and tighten the securing nut and lock in place with the Allen screw.

Fit the two “O” rings (black and red) into the grooves on the lower surface of the flange ball.

Note that depending on your installation, it may be necessary at this point to fit the mounting flange plate to the WaveRadar mounting frame (ensure the two ‘O’ rings on the lower face of the flange ball are facing the water) and secure with M10 bolts, insulation bushes, plain washer and nuts.

Fit the antenna feeder to the mounting plate, ensuring that the upper shoulder of the antenna feeder meets the lower side of the flange ball that has the two “O” rings.



Fit in this order over the top of the antenna feeder: stop washer, washer ball (ensuring the recessed section is lowermost) and finger nut.



Stop washer  
fitted over  
antenna  
feeder



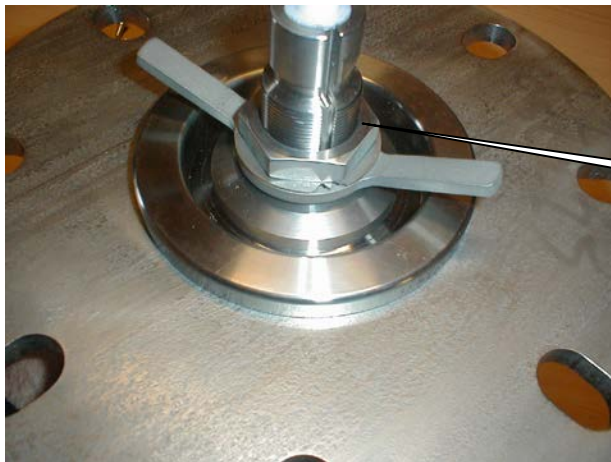
Washer Ball  
fitted over  
Stop Washer  
(not shown)



Finger nut  
screwed down  
to retain  
washer ball



Tab washer

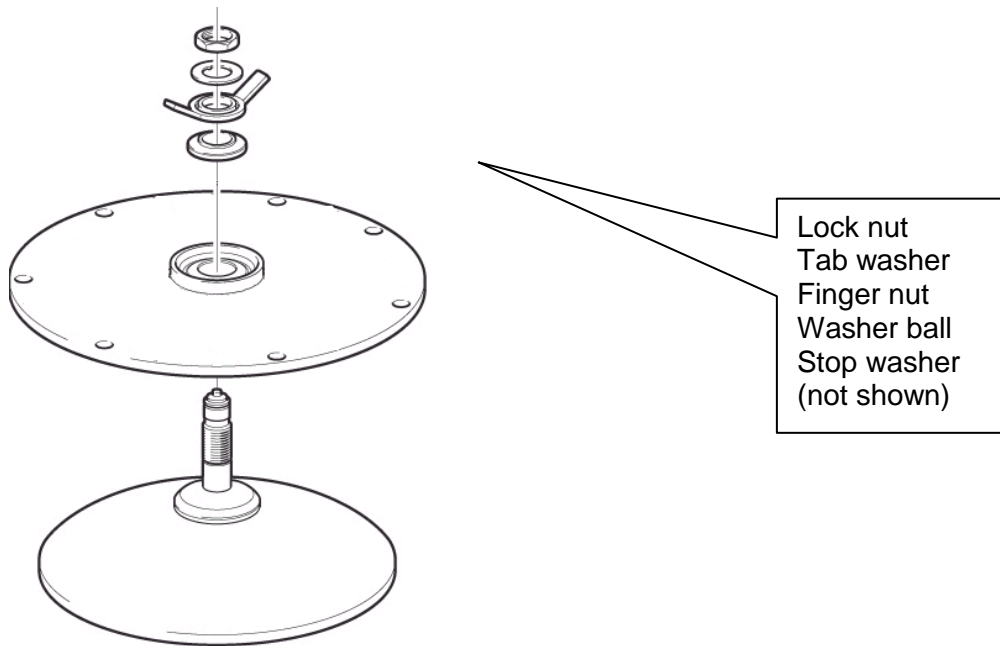


Lock nut



TRL/2  
Adapter fitted  
to antenna  
feeder





Check that the antenna and washer ball are central to the 3 x inscribed rings in the top recess of the flange ball. Tighten the finger nut. Fit the tab washer and lock nut, tighten the lock nut. Bend the tab of the tab washer against the flat of the lock nut to lock the complete assembly.

Fit the parabolic reflector to the antenna feeder and secure using the five M5 socket cap screws.

Place the TRL/2 adapter on top of the antenna feeder, engaging the locating key with the key way of the antenna feeder and fully screw the adapter nut onto the antenna feeder. Check that the antenna and adapter are vertical and fully tighten adapter nut. There should be no movement of the TRL/2 adapter and the adapter should be fully fitted to the antenna feeder.



*Note. In the top recess of the flange ball, three rings are marked as an aid to positioning the antenna and adapter in a vertical attitude.*



Check that the two guide pins on the TRL/2 adapter are aligned (as shown by the direction of the arrow) pointing outwards from the mounting frame or platform.



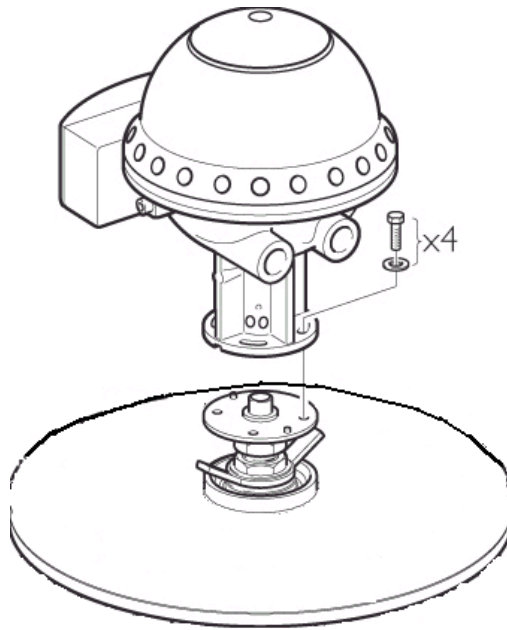
*Note. The two guide pins on the TRL/2 adapter assist in positioning the antenna in the correct orientation with regard to the microwave footprint on the sea surface. The footprint is slightly elliptical and the guide pins alignment ensures that the smallest axis is presented to the side of the platform.*

The waveguide and stainless steel spring sleeve seal will be fitted to the waveguide housing. If not, follow the instructions below:

Mount the waveguide unit into the waveguide housing at the base of the transmitter head. The waveguide unit has two screws fitted at one end. This end goes into the housing. Check that the side flutes engage the location pins fitted to the side of the waveguide housing.

Fit the stainless steel spring sleeve seal with the tab located in the slot on the transmitter head flange. Fit the two grub screws ensuring that they engage in the dimples in the waveguide and tighten them.





Before fitting the waveguide housing to the TRL/2 adapter, lightly grease the flange face then engage the guide pins into the holes on the base of the waveguide housing. Fit 4 x M10 bolts and washers and tighten.

Remove the weather protection cover. Check that the gauge is vertical (by placing a level on the flat plate that is fitted to the top of the transmitter housing). If not level, loosen the finger nut, adjust the transmitter, and then tighten the finger nut.

*Note. In the top recess of the flange ball, three rings are marked as an aid to positioning the antenna and adapter in a vertical attitude.*

Tighten the lock nut and secure by folding the tab washer over the nut. Replace the weather cover.

### 3.3 Voltage supplies

#### **Cautions**

- ***Do not connect the power without first checking the supply voltage is within the limits defined in Section 2 Specification***
- ***Do not open the transmitter head without permission from RS Aqua Ltd. or the warranty may be invalidated***
- ***Do not connect power with the flameproof housing of the transmitter head removed***

The identification plate fitted to the transmitter head will display the power supply required.

The mains version is auto sensing for a supply voltage between 100 to 240 volts AC.

Within this range the specifications are:

100 -120 VAC, 50 – 60 Hz, max. 80 W.

200 – 240 VAC, 50 – 60 Hz, max. 80 W.

The DC version operating range is from 20 to 28 volts.

WaveRadar REX D units with a s/n prior to 38587 require a 48 – 100 volt source. An external module is used to convert a 24 volt source supply to 48 volts.

This module is described in Annex A.

For lightning protection, the power supply input and measurement signals are fully galvanic separated from the field cabling. Additionally there are filters and internal fuses for peaks and disturbances also multiple varistors to protect from over voltages.

### 3.4 System description

#### 3.4.1 Sensor

The transmitter head consists of a flameproof anodised cast aluminium alloy enclosure with an integral junction box. A weather protection cover is fitted to protect it from direct solar heating.



The enclosure contains the radar electronic unit (THE) that includes the microwave module and cards for distributed power supplies, microprocessors, signal processing and field bus communication. The electronics unit incorporates two high capacity processors, each dedicated to a specific function within the overall operation of the radar and a Dual Port Memory (DPM) module that acts as the interface between both processors.

A digital reference ensures linearity of the radar sweep and internal temperature control prevents signal drift. The dedicated measurement processor enables powerful microwave signal processing, control of the measurement cycle and calculations of range data. The communications processor, assembles the output data string, controls the data bus and its output timing and all other internal and external communications to the radar.

The internally generated radar signal is guided out of the base of the enclosure through a PTFE plug pressed into the housing. The radar signals pass through a waveguide in the base of the transmitter head to the antenna assembly which consists of an antenna feeder and a parabolic reflector dish. Between the antenna and the transmitter head is a TRL/2 adapter. The upper surface of the TRL/2 adapter, where it bolts to the transmitter head, is the measurement datum. (See Section 4)

Electrical connections between the housing and the integral junction box are via flameproof feedthroughs. The junction box, designed for safety EEx d[ia] IIB T6 classification, contains two separate chambers with DIN rail mounted terminal blocks. X11 is for power supply, output data bus and analogue connections. X12 (when fitted) is for intrinsically safe circuits.

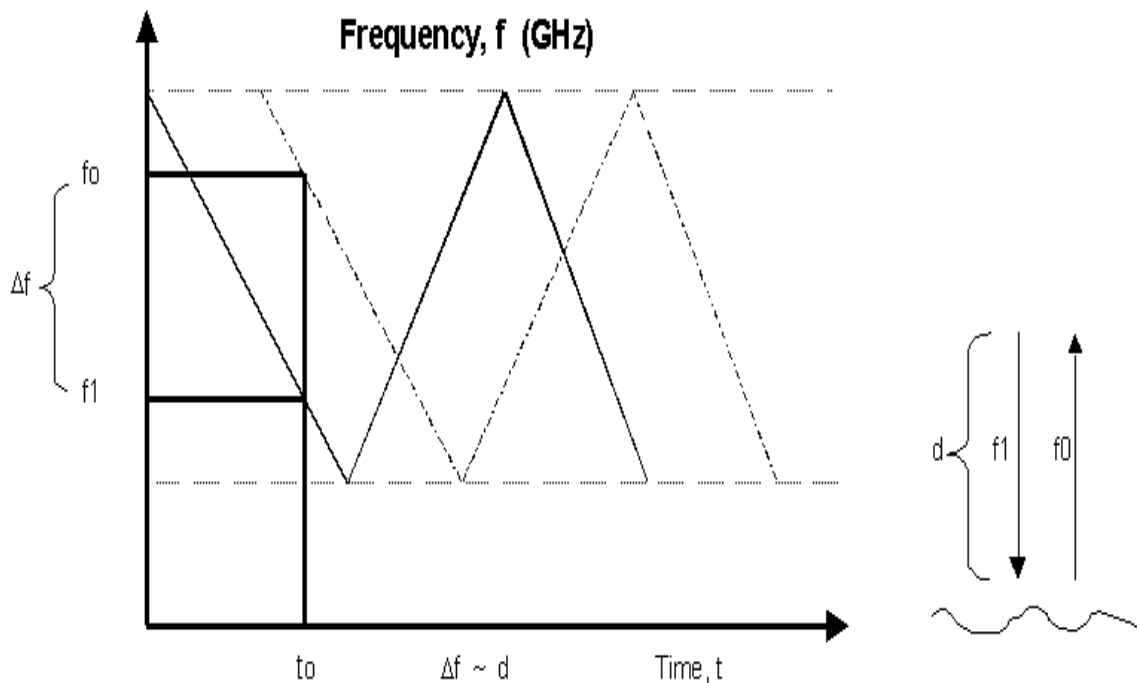
Pre s/n 38587 WaveRadar REX type D units required a small external DC/DC module intended to be located in a safe area.

### 3.4.2 Measurement method

The WaveRadar REX uses an optimum microwave frequency which keeps the radar beam narrow to reduce influence from adjacent disturbing objects.

The transmitted frequency is a continuously varying signal (Frequency Modulated Continuous Wave - FMCW). The transmitted signal changes frequency during the time taken for the reflected signal to return. The reflected signal from the sea surface is compared with the transmitted frequency value, the difference between frequencies being proportional to the distance from the sensor to the sea surface. This frequency difference is converted to a distance measurement. The radar firmware also uses advanced digital filtering and FFT calculations to counter disturbances and maintain measurement accuracy.

During the measurement cycle of 10 Hz, a number of measurements are collected and at the end of the cycle an average distance value produced. At the end of a measurement cycle the distance value is inserted into a serial data string and output onto a data bus at intervals of 250ms (4Hz) as standard.



### 3.4.3 Data communications

#### 3.4.3.1 Serial link

Digital communication with the sensor is over a two wire serial data field bus developed by Rosemount. Frequency shift keying (FSK) is used and the bus terminations are galvanically isolated and protected against noise transients and over voltage. This ensures reliable communications over long distances even in electrically noisy conditions.

A field bus modem (FBM 2171 or 2180) is provided to interface the FSK signals to the PC end of the bus cable. The FBM is a small interface box that is intended to be located in a safe area near the host computer. The FBM is connected to the PC via a RS232 cable.

The FBM is supplied with an AC/DC converter to power it from any mains power supply (115 – 240v) for use with RS232 configuration.



Field Bus Modem 2171

The FBM 2180 modem has five LEDs to indicate power on and communication functions. There are front panel switches to set gain and termination if required.

***The FBM is fitted with a USB output, this is not recommended for use with software used for wave/metocean data functions.***

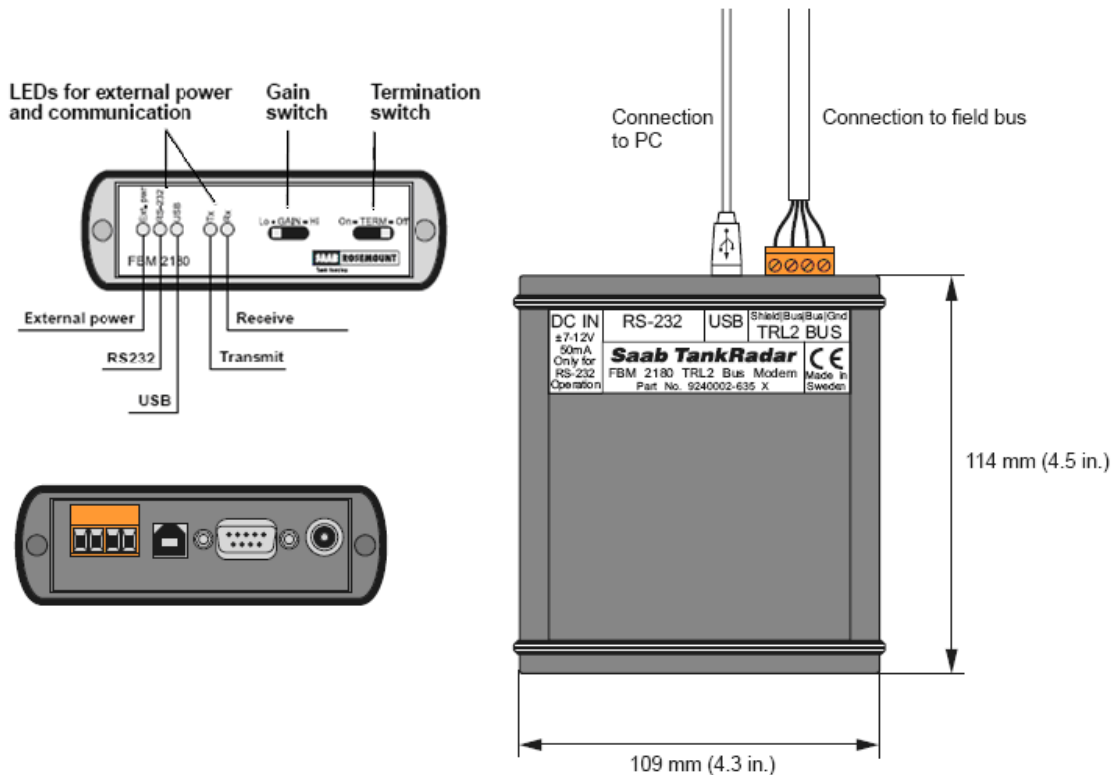


Field Bus Modem 2180

The Termination switch is set to OFF by default. It should be set to ON when there are extremely short cables between the WaveRadar and the FBM.

The Gain switch is set to low by default. The Hi Gain setting may be used if cable dimensions (small conductor size) result in a reduced length message string (communications signal).

A mechanical mounting kit is supplied with the modem to enable fitting of the FBM to a DIN rail.



FBM 2180 Field Bus Modem.

Serial port settings for all FBM types are:

<b>Speed</b>	4800 baud
<b>Byte format</b>	8 data bits no parity 1 stop bit
<b>Handshakes</b>	RTS is used for Tx/Rx control On (+ve) to send commands Off (-ve) to receive data

N.B. For RS232 a full 7 conductor cable is required (see 4.2.5)

### 3.4.3.2 Serial protocol

Messages from the WaveRadar REX consist of fixed length strings of binary values which are sent over a half-duplex link. Output messages will utilise the data link for approximately 20 ms every 250 ms and are repeated every 250 ms (4Hz). Any message sent to the radar will be interpreted as a query and the continuous output of data on the bus will cease. The communications processor will wait for a command message. If no message is received within 60 seconds the data output string will recommence. If within this period a further query is sent to the radar, the 60 second period will then recommence from that query. A sample HEX message string of 17 bytes from the WaveRadar REX is shown below.

F6 04 0C 00 01 02 47 80 70 00 00 01 92 29 8F 17 B6

Where:-

Byte F6 is the RTG address (default)

Byte 04 is the command code (default)

Byte 0C is a byte counter. Number of data bytes in message excluding address, command and check sum bytes.

Byte 00 01 02 47 comprise a measured range value in 1/10mm steps (MS byte to LS byte). Where 00 01 02 47 Hex = 66119mm or 6.6119m

Byte 80 and 70 is the sensor status Ss1 and Ss2 (see description below)

Byte 00 and 00 are reserved – No value.

Byte 01 and 92 are signal strength value (for test use)

Byte 29 and 8F is (for test use)

Byte 17 is the check sum high byte

Byte B6 is the check sum low byte

The CRC checksum is a 2 byte sequence used at the end of each command and data message. It is based on the CRC-16 sequence as defined by Modbus protocol.

#### **Note**

***The digital output data message streamed from the 2180 FBM consists of 17 bytes, however, due to field bus loading and resonant frequency, occasionally an 18 byte message (an extra null/space character) may be output.***

***It strongly recommended that host metocean software be capable of recognising a mixed 17/18 byte message (using the address code of F604 as the fixed length string identifier) to ensure that the host metocean software does not hang up or treat the message as corrupt.***

### 3.4.3.3 WaveRadar status indicator

The fields 'Ss1' and 'Ss2' provides information on both the operation of the sensor and a quality assessment on the validity of the measurement produced. It is strongly recommended that software used for metocean functions displays or store this status word.

**In the event of any permanent or regular change of the status word from normal, please contact RS Aqua Ltd.**



The sensor status 'Ss1' and 'Ss2' are bit fields where the normal status is 8000H or 8070H. When the most significant bit is set the measurement value is valid. As long as the MSB is set the value is OK. If other bits of the status are set they have the following meaning shown in the small example list below;

Bit no	HEX	Meaning: If the bit is set
1	0001	Running in Boot software
2	0002	Device warning: Radar detected something that should be checked.
3	0004	Reserved
4	0008	Device error: Serious internal error detected. This bit may only be cleared after a radar reset (this is a copy of bit 7)
5 – 7	0010 - 0070	Reserved
8	0080	Device error: Serious internal error detected. This may only be cleared after a radar reset.
9 – 15	0100 - 4000	Reserved
16	8000	Valid level

### 3.5 Analogue Output

The WaveRadar Rex has a single 4-20mA analogue output that is directly proportional to the range.

The output is internally powered with 16bit resolution and an update rate of 4 Hz.

### 3.5 Configuration

Every unit is configured by Rosemount Tank Radar AB to a set of default values which are contained within the control registers of the electronic module and suit the majority of applications. The principle variables are:

Item	Factory setting
Range	65 metres
Measurement cycle	10 Hz
Output data rate	4 Hz
Operating mode	Auto-start
Analogue output	Enabled
Analogue refreshing rate	4 Hz

These items can be re-configured by RS Aqua Ltd. prior to delivery.

### 3.6 Testing

Every WaveRadar REX unit is thoroughly tested and calibrated by Rosemount Tank Radar AB before shipment. A functional check is also carried out by RS Aqua Ltd. before supply to the user.

It is difficult for the user to perform meaningful testing without installing the WaveRadar REX in its correct working environment. This is a result of the difficulties

in obtaining a clear beam footprint at sufficient range and the possible introduction of spurious echoes from surrounding workshop structures.

## 4. INSTALLATION

### 4.1 Mechanical

The microwave beam from the centre of the antenna is a 10° wide cone and the installation must be selected to allow an unobstructed beam of at least 10°. Greater than 10° is preferable. As an example a unit installed 30 metres above the sea surface will require an unobstructed footprint of at least 5.25 metres diameter.

***The footprint is slightly elliptical and during assembly of the WaveRadar REX the guide pins alignment ensures that the smallest axis is presented to the side of the platform (see page 3-6).***

Height of the sensor mounting should be chosen with regard to the maximum peak to trough wave height (plus tidal excursion) expected under extreme conditions. This must lie within the sensor's measurement range of 3 to 65 metres (zero point is the upper surface of the TRL/2 adapter, the measurement datum) to the sea surface. A mounting height of 20 to 30 metres above mean sea level is normally ideal. A level within this range identified as either the Mean Sea Level or the Lowest Astronomical Tide Level is nominated as the DATUM LEVEL and the determined height from this level to the radar TRL/2 adapter is known as the 'Wave Sensor Elevation'.

#### ***Optional Mounting Frames***

WaveRadar is normally installed by extending the sensor over the side of the platform or structure. A mounting frame (DS-1), as illustrated in the following images and in drawing figure 3A, is available from RS Aqua Ltd for this application.



*Image courtesy of Fugro Structural Monitoring*

It is designed to fit within a gap in the platform handrails, projecting outwards to offer the WaveRadar an unobstructed beam to the sea surface. It can be vertically rotated for ease of deployment and recovery. When in the deployment position it provides a barrier across the gap in the handrails.

This application is particularly suitable for temporary/semi permanent installations.



*Image courtesy of Areva T&D/Vestas Controls*

Alternatively a WaveRadar mounting frame may be fitted to the platform guardrail, removing the requirement to cut the rail or weld existing frames to the platform deck and extending the sensor over the side of the platform or structure. A mounting frame (GR-1), as illustrated in the following image and in drawing figure 3B, is available from RS Aqua Ltd for this application.



*Image courtesy of Semco Maritime*

### ***Through Deck Mounting***

An alternative method of mounting the WaveRadar is to install it through the decking of the host platform/structure, aligned vertically to the water. The technique used is to remove a section of the decking/grating, cut an opening to suit the mounting flange plate and assemble the WaveRadar REX around the section. Details of the mounting flange plate are shown in drawing figure 2. The flange is made from stainless steel and it is recommended that insulating bushes are fitted to the mounting bolts to prevent electrolytic corrosion of the carbon steel decking.

***It is strongly recommended that a grill or grating is used with this method and not a solid metal plate. Use of a solid metal plate may result in the introduction of spurious echoes.***

## **4.2 Electrical**

### ***4.2.1 Safety warning***

- ***WaveRadar REX is BASEEFA03ATEX approved for use in hazardous areas. Installation must be carried out in accordance with Special Safety Instruction, Fourth Edition, Feb 2008 (see Documentation Pack).***
- ***Do not open the flameproof housing while power is connected***
- ***Do not replace any parts with non-approved spares***

### ***4.2.2 Power supply***

Check WaveRadar REX for correct input voltage limits before connecting power. Refer to 3.3 for details. Pre s/n 38587 WaveRadar REX type D units required a small external DC/DC module intended to be located in a safe area.

### ***4.2.3 Cabling***

#### ***4.2.3.1 General***

- Power and signals to be run in separate cables
- Cables and glands must be approved for use in hazardous areas as appropriate.

#### ***4.2.3.2 Cables***

Cable conductor sizes must be selected to avoid excessive voltage drop over long distances. The following table gives an indication of voltage drop resulting from various combinations of cable length and conductor size at the maximum power consumption of 80W (mains version). Combinations marked \* should be avoided. For the WaveRadar type D (DC version) the input voltage must be balanced against conductor size and cable length to give a voltage within the range specified.

Cable length	110VAC		230VAC		24VDC	
	0.75mm <sup>2</sup> (AWG18)	1.5mm <sup>2</sup> (AWG16)	0.75mm <sup>2</sup> (AWG18)	1.5mm <sup>2</sup> (AWG16)	1.5mm <sup>2</sup> (AWG16)	2.5mm <sup>2</sup> (AWG14)
100m	4V	2V	1.6V	0.8V	4V	2V
200m	9V*	4V	3.2V*	1.6V		4V
400m		8.0V*	8.0V*	4.0V		

The field bus cable is to be a single twisted preferably shielded pair of conductors, polarity independent. The recommended cable length for specific conductor sizes are:

#### Digital signal cable

Connection	Max length	No. of wires	Type	Min. core size
RS232	30m	7	Screened	0.25mm <sup>2</sup>
FSK bus	3000m	2	Screened	0.5 mm <sup>2</sup> (AWG 20)
FSK bus	4000m	2	Screened twisted pair	0.75mm <sup>2</sup> (AWG 18)

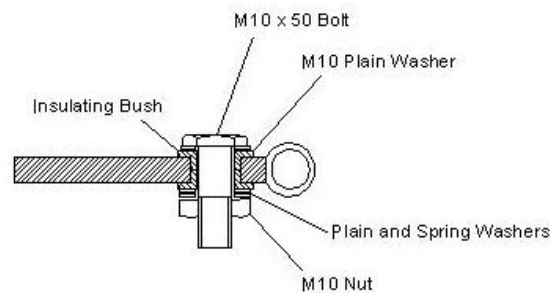
#### Analogue output cable

Connection	Max length	No. of wires	Type	Min. core size
Analogue output	1000 m	2	Screened	0.5mm <sup>2</sup> (AWG 20)

#### 4.2.3.3 Earthing

To be in accordance with local regulations. Ground connection terminals are fitted to the transmitter head and the integral junction box.

To assist in preventing circulating earth paths it is recommended that insulating bushes (Pt # WP2001-038-001C, available from RS Aqua Ltd) be fitted to the securing bolts of the Mounting Flange Plate when installing the WaveRadar to its Mounting Frame / grill etc. See drawing below.



#### **4.2.3.4 Integrated junction box**

The integrated junction box on WaveRadar REX has two separate chambers with DIN rail mounted klippon terminal blocks. The right hand chamber X11 (non intrinsically safe) is for power supply, data bus and analogue output connections. The left hand chamber X12 is for the connection of intrinsically safe circuits. The junction box has one M25 and two M20 cable gland inlets for intrinsic circuit cabling and for the non-intrinsic cabling circuits, one M20 and two M25 inlets. Appropriate cable glands are fitted to the junction box. Annex B gives further details on the glands and cable inlets.



#### **4.2.4 DC to DC Converter module (Pre s/n 38587)**

Prior to s/n 38587, an external DC/DC module was supplied with D versions. This was a small self contained module intended to be located in a safe area. The converter was configured to produce a 48v DC output from a 24v DC input.

Fully enclosed in a black coated aluminium case, that acts as a heat sink and RFI shield, the module corresponds to class 1 safety and installation specifications.

#### **4.2.5 Field bus modem (FBM)**

***The FBM is not protected for use in hazardous areas or outdoor environments. It is intended for indoor use in a safe area close to the host computer.***

Version type changed from 2170 to 2171 in 2003 (see below) and then to type 2180 early in 2006. Carefully check to establish which version is being used.

The field bus modem has fitted connectors for the FSK bus (Klippon BL4/SL4) and RS232 connection (9 way D type). A three metre long RS232 cable is provided for connection to the host computer. The FBM 2180 is also fitted with a USB connector.

The FSK bus connections are not polarity sensitive and may be connected either way round. Wiring connections for all types of FBM are shown in drawing figure 4.

##### **FBM type 2170**

Power for the FBM is supplied by the PC DTR line, provided the supply voltage is sufficient. Some PCs, particularly small portables, do not provide sufficient voltage. A miniature jack connector allows connection of an external DC power supply (6 to 12V, 150mA, polarity connections: outer +ve, inner -ve). It is recommended that if this facility is required, a dedicated Rosemount power supply is used. Incorrect voltage or polarity will damage the FBM.

##### **FBM type 2171**

Power for the FBM type 2171 is supplied by an external DC power supply (6 to 12V, 150mA, polarity connections: outer +ve, inner -ve). It is recommended that the provided, dedicated Rosemount power supply be used. Incorrect voltage or polarity will damage the FBM.

##### **FBM type 2180**

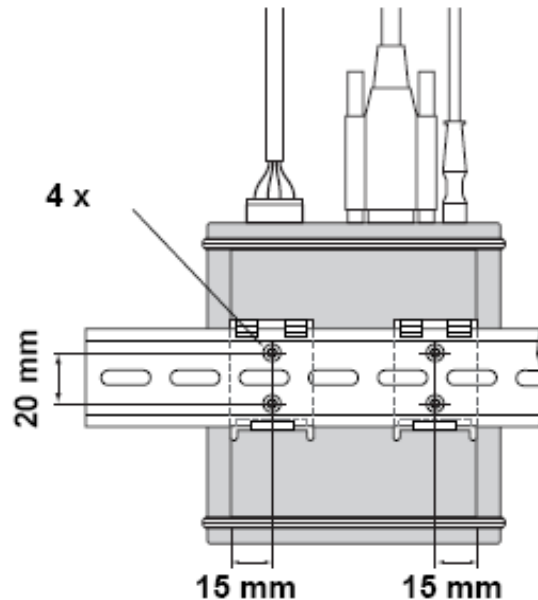
***The FBM is fitted with a USB output. This is not recommended for use with software used for wave/metocean data functions and, for this reason, no USB cable is supplied with the FBM kit. Using a USB connection will produce an unstable output and unwanted gaps in the data stream (due to the USB/windows packet assembly transmissions). The RS232 output is completely stable.***

Front panel LEDs provide indications of power on, communication configuration and Tx or Rx transmissions. Additional switches provide gain and termination selection. Power for the RS232 configuration is supplied by an external DC power supply (7 to 12V, 50mA, polarity connections: outer +ve, inner -ve). It is recommended that the supplied dedicated Rosemount power supply be used. Incorrect voltage or polarity will damage the FBM. Additionally, connecting a USB cable and an external power supply to the FBM at the same time will result in damage to the FBM.



The FBM type 2180 is designed to be mounted on a DIN-rail 35 EN50022.

Securing screws and 2 x DIN mounting clips are included with the FBM. There are 4 x pre-drilled holes on the base of the housing for securing the mounting clips.



#### **4.2.6 Remote Display Unit (RDU40)**

The RDU40 is a cable connected, remote display unit for use with the WaveRadar REX. The display functions are software controlled and power for the display operation is supplied by the connected WaveRadar REX. Only WaveRadar REX units with firmware versions 1D2 and later are able to operate the RDU40.

When configured for a WaveRadar REX at the factory the RDU40 will show the range measured by the WaveRadar. The four soft keys have limited functions and the default setting is the View mode.

#### **4.2.7 Underwriters Laboratory (UL) standard**

Installation of a WaveRadar REX under the Underwriters Laboratory (UL) configuration necessitates the replacement of the integrated junction box. The Non-intrinsically (W11) and Intrinsically safe (W12) circuit outputs exit as single wires through lead seals in the transmitter head. The wires are protected by conduit hoses and must be terminated in two customer-supplied junction boxes. Annex D gives further details on the wire identification and protective conduit hose kits.

## 5. OPERATION

WaveRadar REX produces distance measurements between the upper surface of the TRL/2 adapter and the sea surface, over a range of 65 metres. The first 3 metres from the TRL/2 adapter constitute an invalid zone where all measurements are disregarded. The valid measurement range is therefore between 3 and 65 metres. The measurement output to the data bus is a resultant average of several distance measurements taken during the measurement cycle period and refers to the footprint area covered by the microwave beam.

On first applying power to the WaveRadar REX, the unit carries out start up and initialisation procedures where the control registers configure the radar to its operating parameters. On completion it enters the first measuring cycle. On completion of this cycle, all distance measurements that have been recorded in an array are summed and the average distance measurement value is passed via the Dual Port Memory to the communications processor and the analogue card. A measuring cycle is carried out every 10 Hz as standard.

The communications processor assembles the output serial data string message that contains the average distance measurement, status information on the radar unit and other data gathered since the last output data string and this is transmitted on the bus. Serial data messages are in binary form and are continuous while the WaveRadar REX is powered.

The analogue output from the current loop card is continuously refreshed at the 4 Hz rate until the WaveRadar REX is stopped.

The digital data output will continue until stopped by a message from the host computer or when power is disconnected from the WaveRadar REX.

If any message is sent to the radar it will be interpreted as a query and the continuous output of data on the bus will cease. The communications processor will wait for a command message. If no message is received within 60 seconds the data output string will recommence. If within this period a further query is sent to the radar, the 60 second period will then recommence from that query.

The WaveRadar REX sensor does not perform any analysis of wave data. This must be carried out by software in the host computer.

A suitable software package, WaveView, can be provided by RS Aqua Ltd. It has functions for data acquisition, processing, display, logging and output to a remote PC. Alternatives, some with emphasis towards specific applications e.g. Air-Gap studies, are available from other sources.

## 6. MAINTENANCE AND CALIBRATION

### 6.1 Routine maintenance

WaveRadar REX is rugged and reliable with no moving parts. Therefore regular maintenance is not required. However, due to the harsh offshore environment in which the unit is normally used the following routine maintenance and inspection is recommended.

Frequency	Item
<b>Monthly</b> (or whenever reasonably possible)	<p>Hose / wipe down sensor unit with fresh water</p> <p>Check the following items for damage, corrosion, and security</p> <ul style="list-style-type: none"> <li>• Weather protection cover</li> <li>• Flameproof housing, junction box and TRL/2 adapter</li> <li>• Antenna feeder with washer ball, finger nut and lock nut</li> <li>• Antenna dish</li> <li>• Mountings</li> <li>• Cable glands</li> <li>• Cables</li> </ul>
<b>Annually (or biannually)</b>	<p>Remove transmitter housing from TRL/2 adapter and check waveguide for:</p> <p>a) Corrosion to waveguide unit. Replace if corroded.</p> <p>b) Ensure waveguide and the end of the antenna fitted to the TRL/2 adapter are clear of foreign matter or crystal growth. Remove as necessary.</p> <p>Note – For WaveRadar units installed very close to the water (less than 10m) there may be an increased likelihood that the wave guide may be blocked by corrosion.</p>

### 6.2 Calibration

Every WaveRadar REX is calibrated by Rosemount in a special calibration facility. Due to the design and construction of the electronic and microwave unit, the WaveRadar REX calibration is extremely stable and periodic re-calibration is not required.

## 6.3 Replacing fuses

### WaveRadar REX

There is one 1.6 Amp fuse in a fuse holder in the Transformer Rectifier Card (TRC) module of the WaveRadar REX M electronics unit. There is one 3.15 Amp fuse in a fuse holder in the TRC module of the WaveRadar REX D electronics unit.

To gain access to electronics unit the top half of the transmitter housing must be removed as in 6.4 for access.

### FBM 2170

There are two 0.05 Amp fuses on the circuit board of the field bus modem. Remove the lid for access.

The FBM types 2171 and 2180 do not have any internal fuses.

## 6.4 Opening flameproof transmitter housing

Before opening the flameproof transmitter head housing, contact RS Aqua Ltd. to obtain authority or the warranty may be invalidated.

***Do not open the flameproof housing when power is connected. Danger from:***

- ***Hazardous area***
- ***Electrocution***

***Important - Only open the housing in a clean dry indoor environment***

Unscrew (single captive M8 Allen screw) and remove the weather protection cover. Remove the 10 x M8 Allen screws and lift off the top half of the transmitter housing.

## 6.5 Removal of “THE” electronics unit

***If the electronics unit needs to be removed, it must be removed and replaced as a complete module.***

- Remove the top half of the transmitter housing as per 6.4.



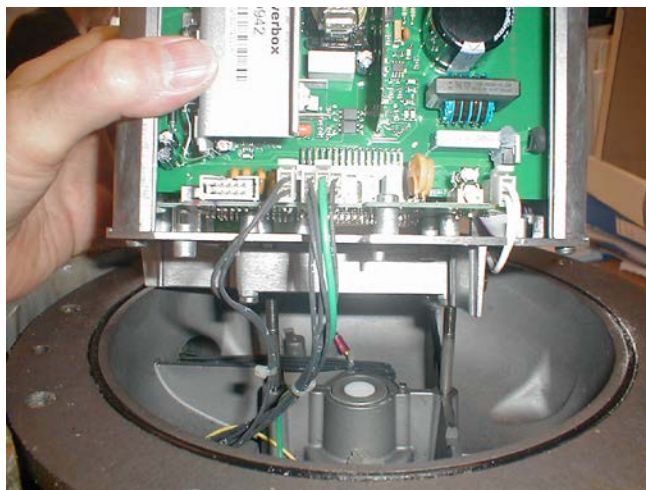
- Note the orientation of the “THE” assembly. Loosen the two captive M6 bolts on the bar of the electronics carriage assembly (between the circuit boards).

- Disconnect the two connectors to the TRC module.
- Lift the carriage assembly off the locating studs and disconnect the cable connector underneath the assembly.
- Be especially careful not to damage the central PTFE plug.



## 6.6 Replacement of “THE” electronics unit

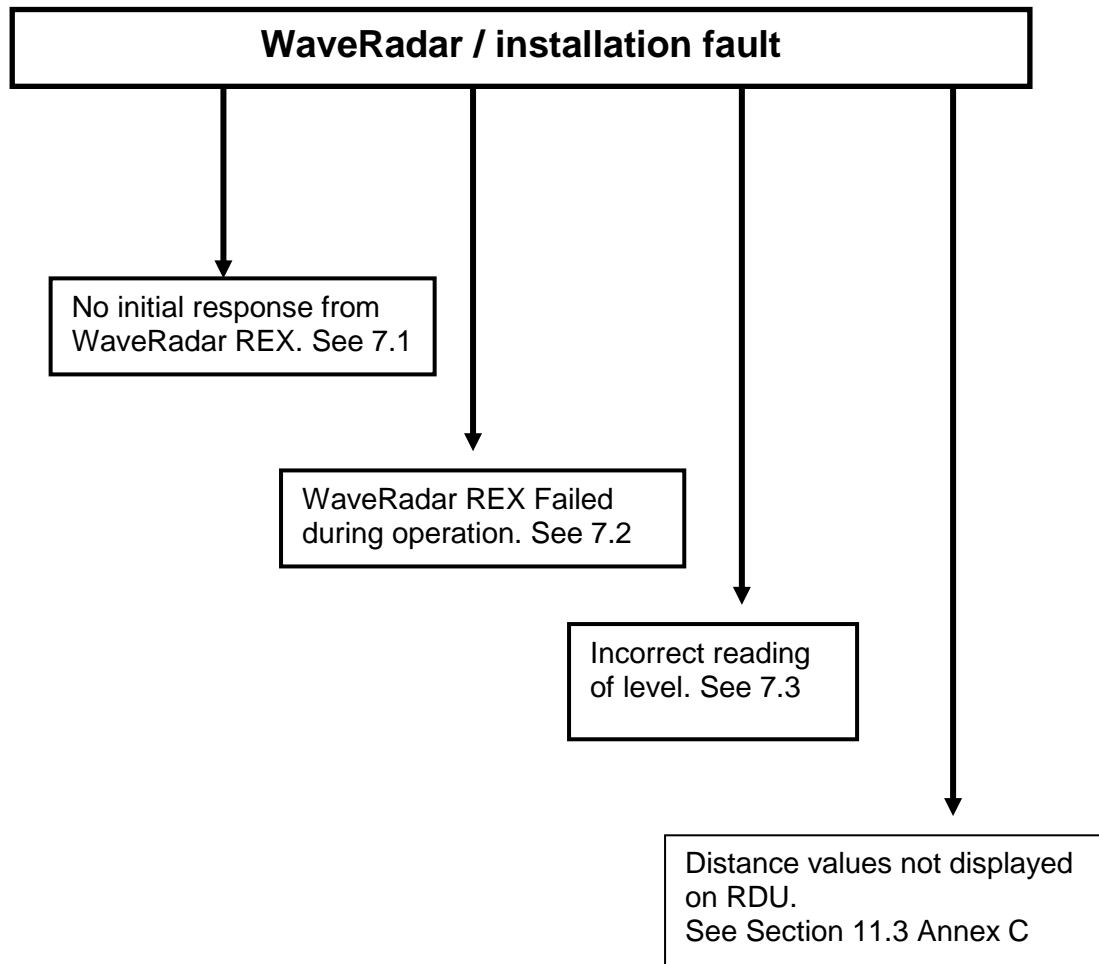
- Connect the cable connector underneath the assembly.
- Ensure that there is no foreign matter between the central PTFE plug and connector.
- Lower the electronics carriage assembly onto the locating studs, carefully ensuring that cables are not trapped and that the unit fits firmly on its base.



- Connect the two connectors to the TRC module
- Tighten the two captive M6 bolts
- When replacing the top half of the housing, ensure that the surfaces are clean, the “O” ring is undamaged and seated correctly.
- Ensure all 10 x Allen screws are tightened evenly.

## 7. FAULT FINDING

This section on fault finding is divided into three subsections each of which contains symptom identification and check actions. These are followed by a corrective action section.



**If a fault persists after following the fault finding checks and actions, please contact RS Aqua Ltd for advice.**

## **7.1 NO INITIAL RESPONSE FROM WAVERADAR REX**

### **7.1.1 Symptoms: Both digital and analogue outputs fail to produce data**

- Check:*
- 1) Power supply to Wave Radar
  - 2) Cable wires to junction box.
  - 3) Internal power fuse fitted to the “THE” of the radar unit.

### **7.1.2 Symptoms: No digital output but analogue output is working**

- Check:*
- 1) That the RS232 cable has full standard wiring connections.
  - 2) That the FBM is connected to correct comport on PC (2180 FBM RS232 LED).
  - 3) The external power supply to FBM (2180 FBM power LED).
  - 4) The data bus wiring. Use screened twisted pair for FSK bus and correct wire core size for cable length.
  - 5) The data bus wiring is connected to correct terminals (3 and 4) of Wave Radar junction box and to terminal block (2 and 3) of FBM.
  - 6) Ensure that the host software is not trying to communicate with the Wave Radar or generate stray characters on the bus. This will stop data output on the bus and activate the 60 second period before output recommences.

### **7.1.3 Symptoms: Digital message length is reduced (input data errors reported by host software)**

- Check:*
- 1) The data bus wiring. Only use screened twisted pair for FSK bus and correct wire core size for cable length.
  - 2) The 2180 FBM Terminal switch (TERM) is set to ON position (if installation has a very short length of field bus cable).
  - 3) The 2180 FBM Gain switch (GAIN), set to Hi (if communication signal is heavily damped producing a serial output message of different lengths [byte sizes] due to small or undersize cable core).
  - 4) If using the 2170/2171 FBM, load the field bus by connecting a 100 ohm resistor between the two bus wires at the FBM connector.

## **7.2 WAVERADAR REX FAILED DURING OPERATION**

### **7.2.1 Symptoms: Both digital and analogue output failed**

- Check:*
- 1) The power supply to WaveRadar
  - 2) The cable wires to junction box
  - 3) The internal power fuse fitted to the “THE” of the radar unit

### **7.2.2 Symptoms: Digital output has failed with analogue output still working**

- Check:*
- 1) The 2180 FBM, to confirm power and RS232 LEDs are illuminated
  - 2) The 2180 FBM, to confirm the TX LED is flashing.
  - 3) The data bus wiring is connected to correct terminals (3 and 4) of WaveRadar junction box and to terminal block (2 and 3) of FBM.
  - 4) That the RS232 cable between the FBM and the PC is connected.
  - 5) The host software is operating correctly / has not frozen.

## 7.3 INCORRECT READING OF LEVEL

### 7.3.1 Symptoms: *Flat topping of data, gaps in data, static data, incorrect level*

Possible causes:

- Intermittent or unusual measurements
- WaveRadar locked on a disturbing or spurious echo
- Corrupted data message or message length changed

*Check:*

- 1) The correct orientation of microwave footprint and whether the WaveRadar is vertical.
- 2) The horizontal attitude of mounting frame.
- 3) Inspect the antenna and waveguide for correct fitting and no foreign matter in waveguide.
- 4) The installation against instruction in the manual.
- 5) For objects in radar beam creating disturbing echoes and for a clear downward view of surface.
- 6) For a change to WaveRadar STATUS word and note if distance measurement values have static value.
- 7) The digital output message length for any changes.

## 7.4 CORRECTIVE ACTIONS

### 7.4.1 Corrective actions – Installation

- 1) Adjust mounting frame, attitude and orientation of WaveRadar.
- 2) Re-site WaveRadar (contact RS Aqua Ltd for advice).
- 3) Initiate new echo search by switching radar unit power off/on.

### 7.4.2 Corrective actions – FBM / Host software

- 1) For a short length message of less than 17 bytes:
  - a) 2180 FBM, set the terminal switch to GAIN.
  - b) 2170/2171 FBM, load the field bus by connecting a 100 ohm resistor between the two bus wires at the FBM connector.
- 2) For a long message length of 18 bytes or more:  
The 2180 FBM only, set the Terminal switch (TERM) to ON.
- 3) Amend host software to recognise a 17/18 byte message.

#### **Note**

***The digital output data message streamed from the 2180 FBM consists of 17 bytes and is the same format as all earlier FBMs. However, due to field bus loading and resonant frequency, occasionally an 18 byte message (an extra null/space character) may be output.***

***It strongly recommended that host metocean software be capable of recognising a mixed 17/18 byte message (perhaps using the address code of F604 as the fixed length string identifier) to ensure that the host metocean software does not hang up or treat the message as corrupt.***

### 7.4.3 Corrective actions – WaveRadar status word

WaveRadar Status word change. Note changed value. Initiate restart procedure by switching radar unit power off/on.

#### **Note**

***If the status word remains at a non normal value, please contact RS Aqua Ltd..***



## 8. CRC GENERATION

The CRC-16 error check sequence is implemented as follows:

The message (data bits only, disregarding start, stop and parity bits) is considered as one continuous binary number, of which the MSB is transmitted first. The message is pre-multiplied by  $x^{16}$  (shifted left 16 steps), then divided by  $x^{16}+x^{15}+x^2+1$  expressed as a binary number (11000000000000101). The integer quotient digits are ignored and the 16 bit remainder (initialised to all ones at the start to avoid the case of all zeroes being an accepted message), is appended to the message (MSB first) as the two CRC check bytes. The resulting message including CRC, when divided by the same polynomial at the receiver, will give a zero remainder if no errors have occurred. The receiving unit re-calculates the CRC and compares it to the transmitted CRC. All mathematics are performed using modulo 2 (no carry).

Example of a function:

Name of function: CRC\_CALC

Input

BUF – Pointer to message buffer.

BYTE\_NUM – Number of bytes in message (exclusive CRC bytes)

/*declarations*/	
BUF_IDX word	
IDX byte,	
FLAG byte,	
CRC word;	
/*code*/	
CRC=65535;	/*Init*/
BUF_IDX=0;	/*Pointer in message*/
do while BYTE_NUM>0;	
CRC=CRC xor BUF(BUF_IDX);	/*Update CRC*/
Do IDX=0 to 7;	
FLAG=CRC AND 1;	/*Save shift flag*/
CRC=shr(CRC, 1);	/*Shift one bit right*/
if FLAG then	/*If flag is one*/
CRC=CRC xor 0A001H;	/*Update CRC register*/
End;	
BYTE_NUM=BYTE_NUM-1;	
BUF_IDX=BUF_IDX+1;	
end;	
Return CRC;	

### Example of adding CRC-16 word to the message:

You have a message with the length LENGTH in your application

/*declarations*/	
LENGTH BYTE;	/*Length of message, inclusive of CRC bytes*/
MESSAGE(LENGTH)BYTE;	/*message buffer*/
CRC word;	
/*code*/	
CRC=CRC_CALC(MESSAGE. LENGTH-2);	
MESSAGE(LENGTH-2)=LOBYTE(CRC);	/*Intel l.o. to CRC h.o.*/
MESSAGE(LENGTH-1)=HIBYTE(CRC);	/*Intel h.o. to CRC l.o.*/

Note: The CRC\_CALC function can also swap l.o. and h.o. of CRC word before returning but such code will be less efficient than the above example.

## **9. GUARANTEE**

WaveRadar REX is guaranteed by Rosemount Tank Radar AB through RS Aqua Ltd. against any defect resulting from faulty design, materials or workmanship for a period of 18 months after ex-factory delivery.

Rosemount Tank Radar AB reserves the right to decide whether a guarantee repair shall be carried out at the installation site or at Rosemount Tank Radar AB premises or by RS Aqua Ltd. Travelling expenses and travelling time in connection with guarantee visits are not included in the guarantee cover.

Further terms and conditions of this guarantee shall be in accordance with United Nations Economic Commission for Europe, General Conditions for the supply of Plant and Machinery for export 188/53.

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## 10. DRAWINGS

### ***Fig 1. Assembly diagram***

Drawing number: WP2001M001    Version: 2 – January 2012

### ***Fig 2. Dimensions and mounting details***

Drawing number: WP2001M002    Version: 3 – January 2012

### ***Fig 3A. Frame installation (DS-1)***

Drawing number: WP2001M003-1    Version: 3 – January 2012

### ***Fig 3B. Frame installation (GR-1)***

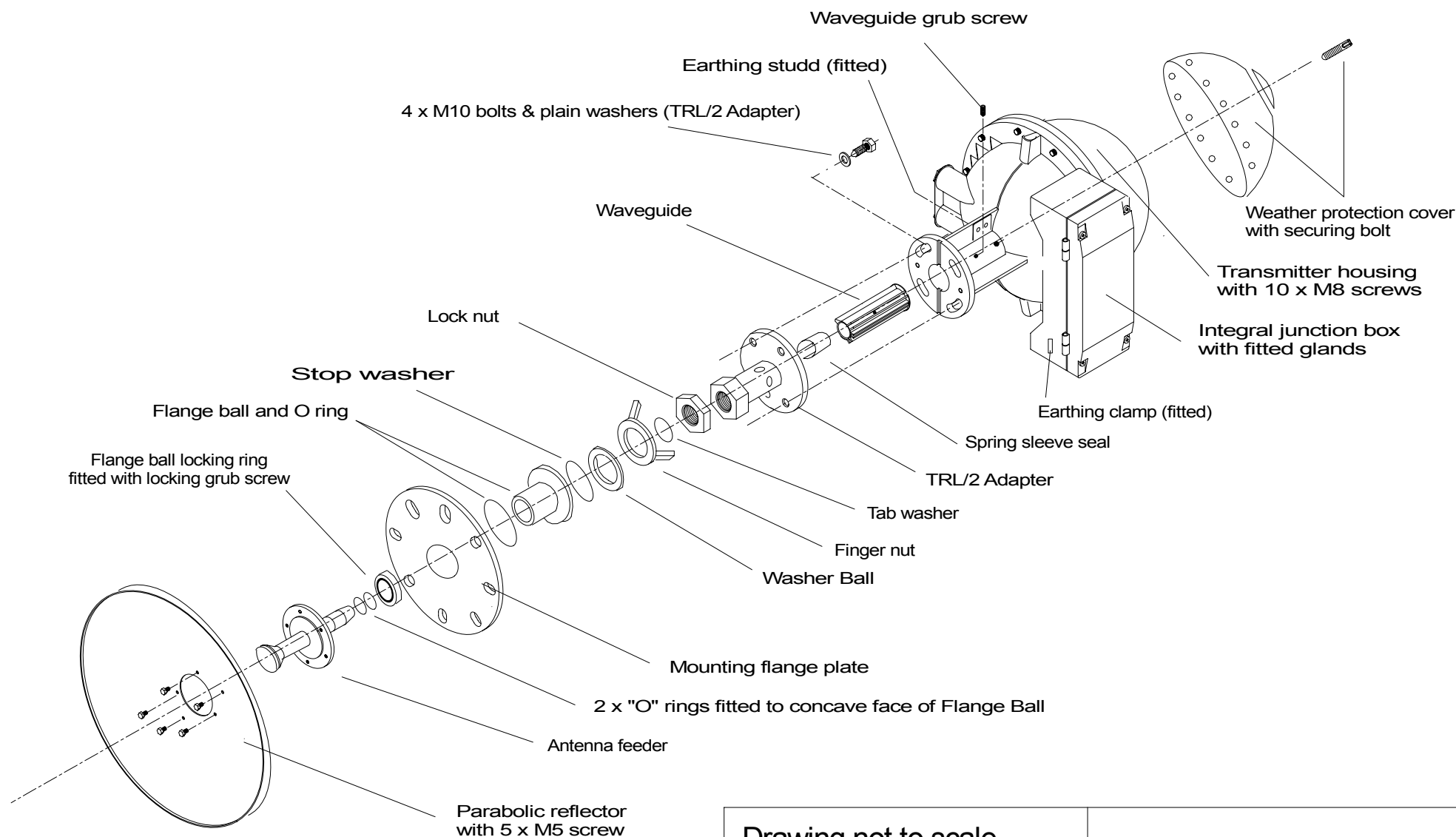
Drawing number: WP2001M003-2    Version: 1 – January 2012

### ***Fig 4A. Wiring details***

Drawing number: WP2001M006    Version: 2 – January 2009

### ***Fig 4B. Wiring details***

Drawing number WP2001M007    Version: 2- January 21012



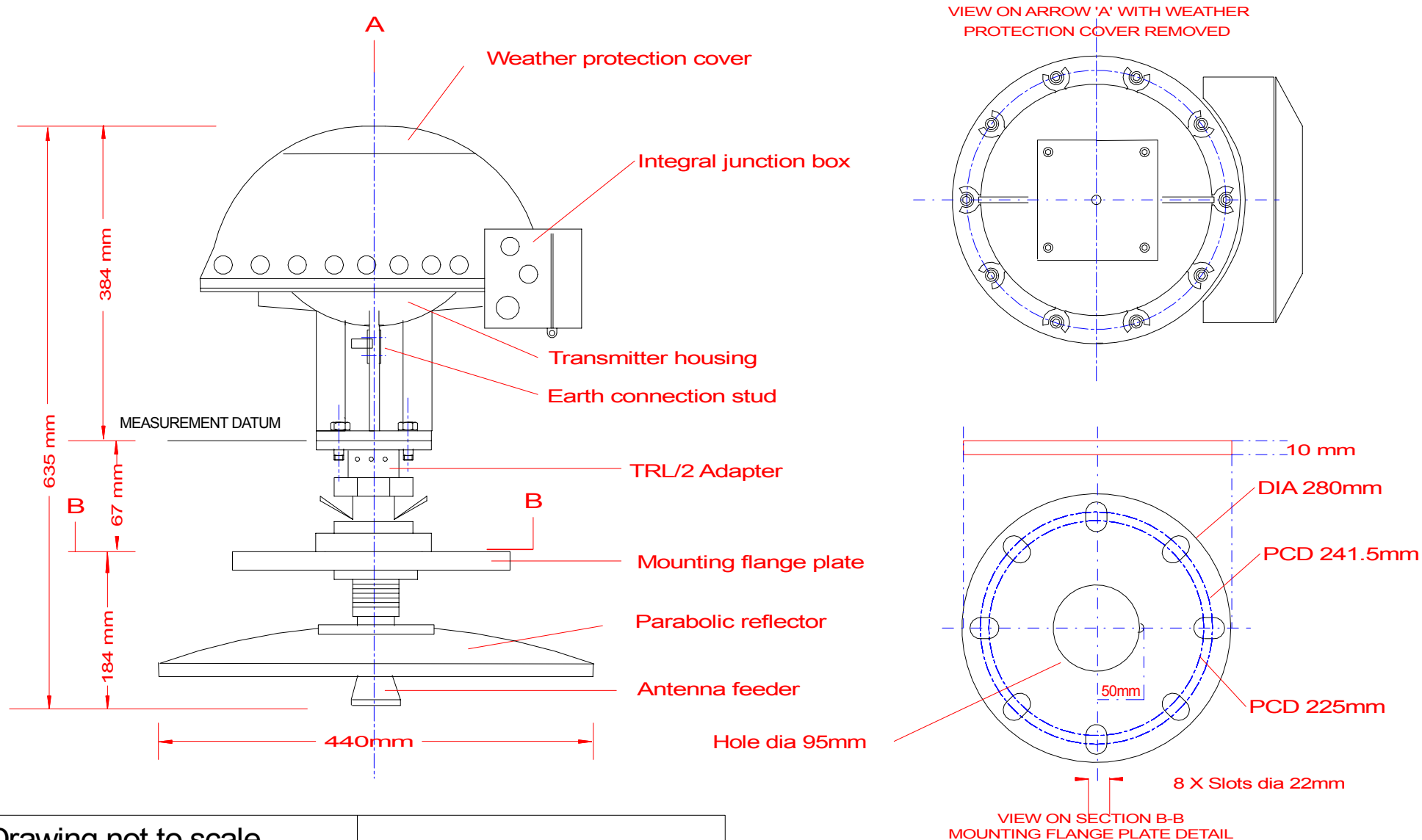
Drawing not to scale

Equipment: WaveRadar REX

Assembly Diagram - Figure 1

Version :  
02 - January 2012

Drawing. No.  
VP2001M001



Drawing not to scale



Units 4 - 6, Hurst Barns,  
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Hampshire. GU34 3PL. UK

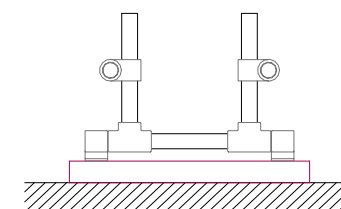
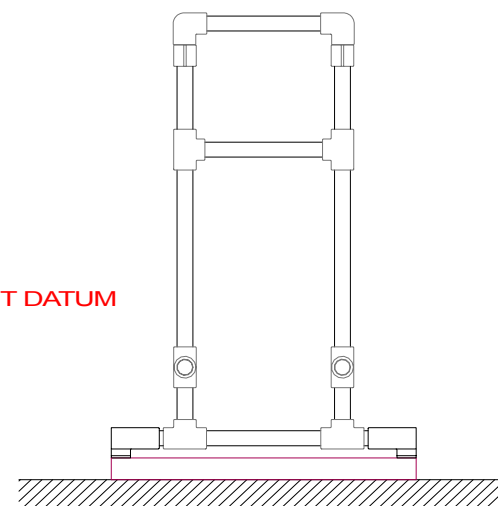
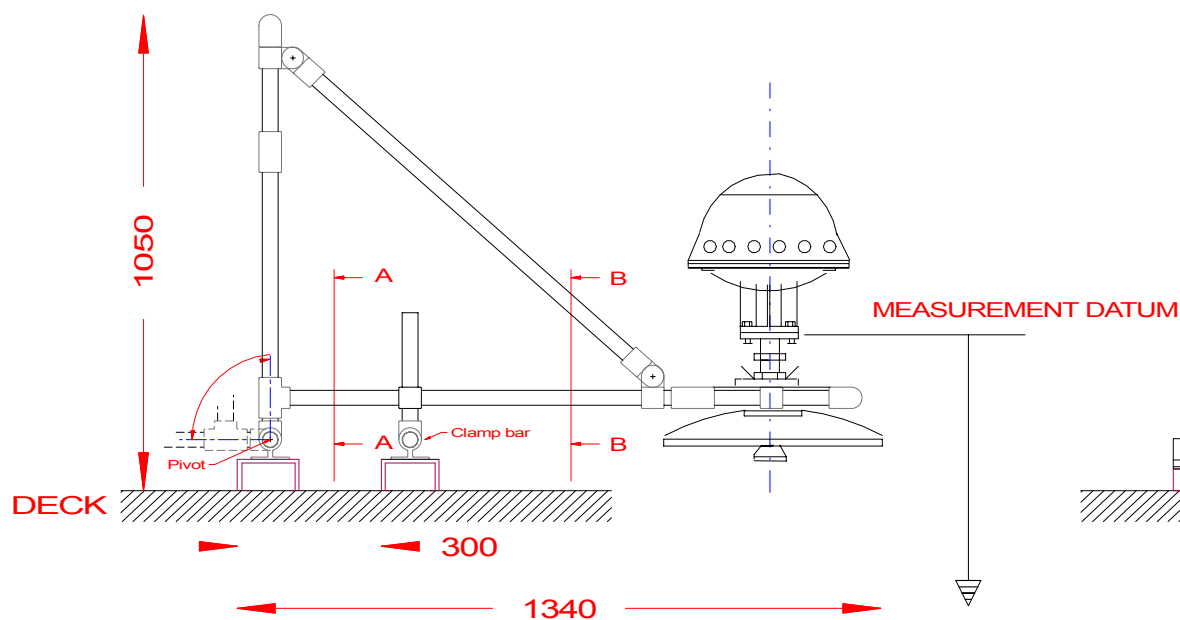
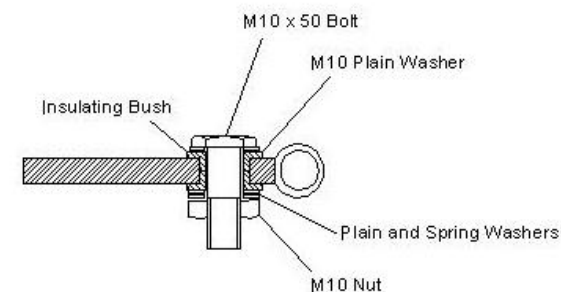
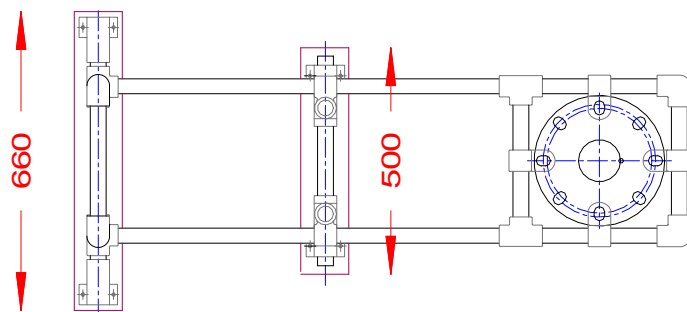
Tel: +44 (0)1730 828222 Fax: +44 (0)1730 828128  
Email: info@rsaqua.co.uk Web: www.rsaqua.co.uk

Equipment: WaveRadar REX

Dimensions / Mounting Details - Figure 2

Version :  
03 - January 2012

Drawing. No.  
WP2001M002



SECTION A - A

VIEW ON B - B

Dimensions are in millimeters (mm)

Drawing not to scale



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Tel: +44 (0)1730 828222 Fax: +44 (0)1730 828128  
Email: info@rsaqua.co.uk Web: www.rsaqua.co.uk

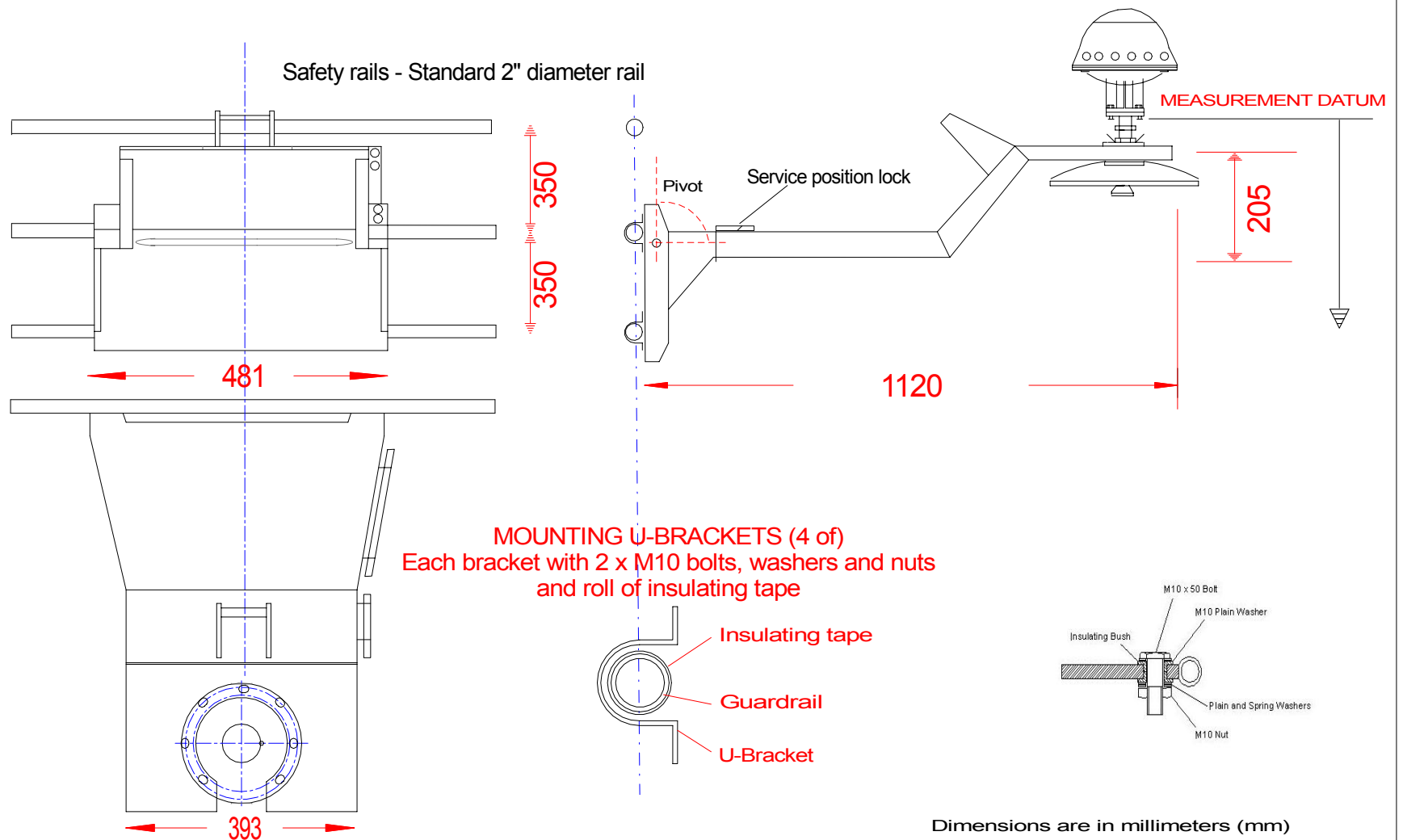
Equipment: WaveRadar REX

Frame Installation (DS-1) - Figure 3A

Version :  
03 - January 2012

Drawing. No.  
WP2001M003-1





Dimensions are in millimeters (mm)  
Material: Stainless steel 316 - A4 , 3mm sheet  
plate. Weight is 32 Kg.

Drawing not to scale



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Hampshire. GU34 3PL. UK

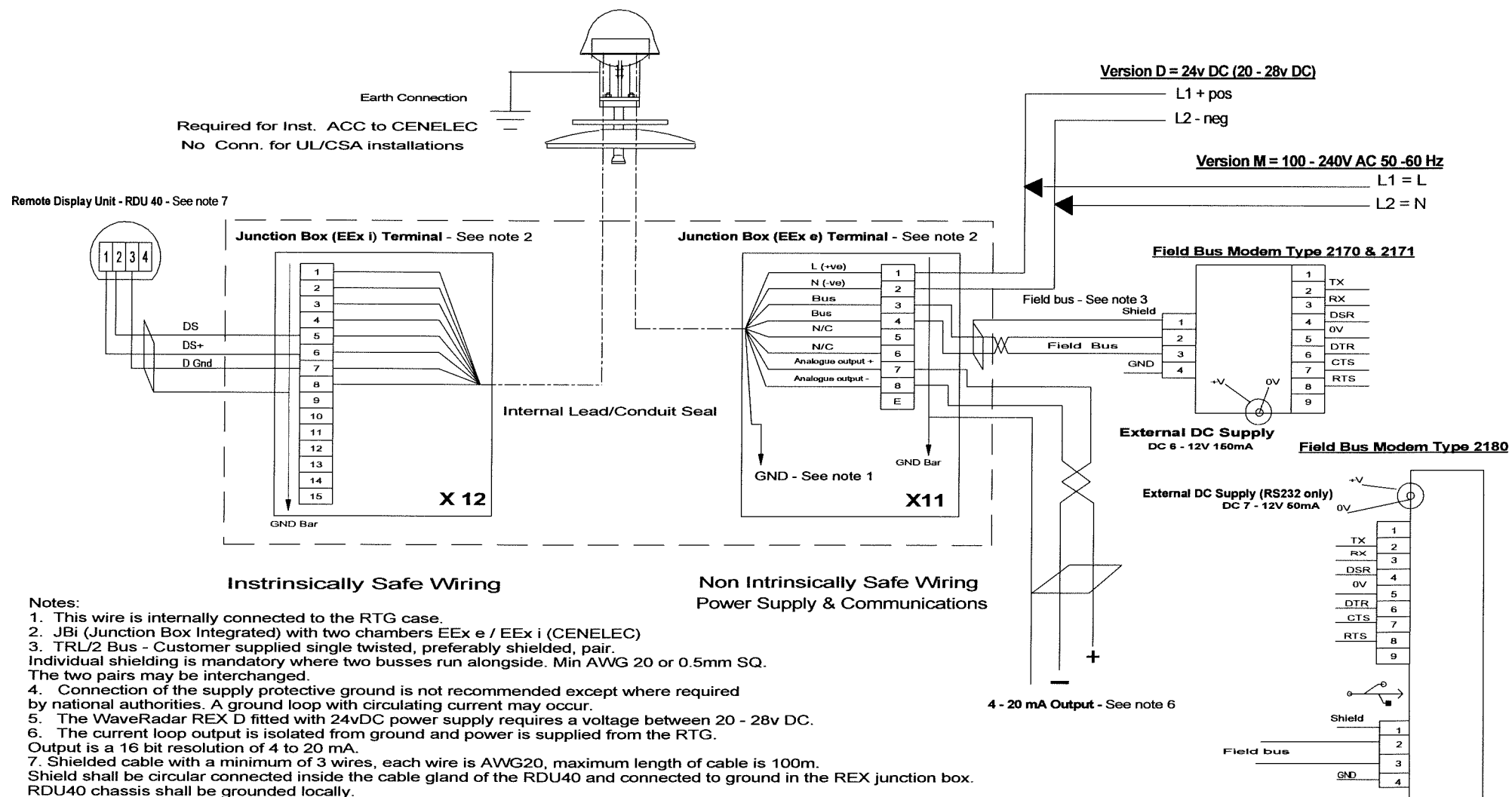
Tel: +44 (0)1730 828222 Fax: +44 (0)1730 828128  
Email: info@rsaqua.co.uk Web: www.rsaqua.co.uk

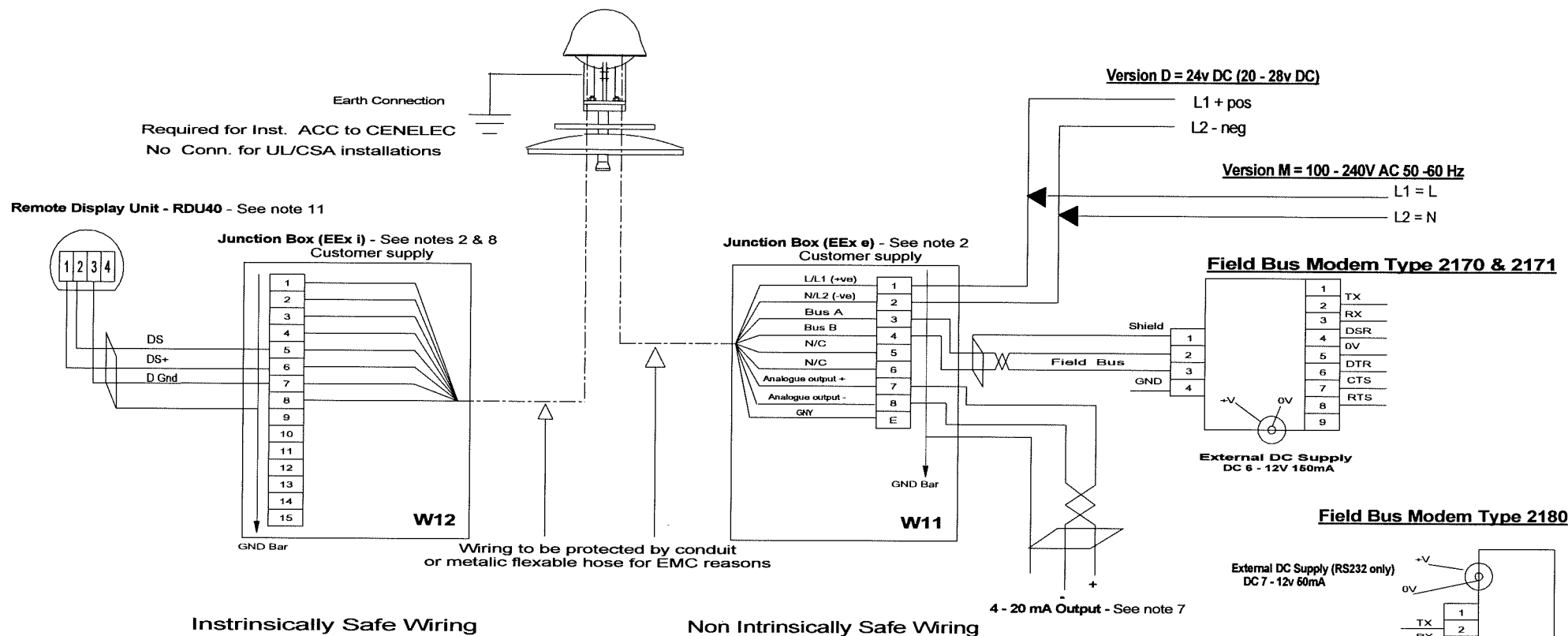
**Equipment: WaveRadar REX**

**Frame Installation (GR-1) - Figure 3B**

Version :  
**01 - January 2012**

Drawing. No.  
**VP2001M003-2**





#### Notes:

1. Make sure a continuous electric path exists from the cable shield to WaveRadar unit chassis. Shorter cables may be specified for performance reasons. See WaveRadar manual.
2. W12 is optional and may contain up to 15 wires connected to six separate intrinsically safe circuits. Separation between different IS circuits must be maintained in junctions boxes.
3. TR/L2 Bus - Customer supplied single twisted, preferably shielded, pair. Individual shielding is mandatory where two busses run alongside. Min AWG 20 or 0.5mm SQ. The two pairs may be interchanged.
4. The intrinsically safe wiring must be in accordance with the National Electrical Code ANSI/NFPA 70, NEC Artical 504 and ANSI/ISA RP12.6. In Canada the installation must be in accordance with the Canadian Electrical Code, CEC part 1.
5. The ground of the radar unit must be connected to earth ground of the AC feeder supply circuit. The resistance between the ground lug and the earth ground must be less than 1 ohm.
6. The radar unit must not be powered by or connected to equipment that uses or generates more than 250vRMS with respect to earth.
7. The current loop output is isolated from ground and power is supplied from the radar unit. Output is a 16 bit resolution of 4 to 20mA.
8. The outputs at W12 are intrinsically safe for use in Class 1, Zone 1, Group IIB; Class 1, Division 1, Groups C & D Hazardous Locations.
9. Intrinsically safe apparatus must be simple apparatus or be third party approved such that:  $V_{oc} \leq V_{max}$ ,  $I_{sc} \leq I_{max}$ ,  $C_a \leq C_i + C_{cable}$  and  $L_a \geq L_i + L_{cable}$ .
10. For  $C_{cable}$  and  $L_{cable}$ , if the capacitance per foot is not known, then the following values shall be used.  $C_{cable} = 60pF/foot$  and  $L_{cable} = 0.2uH/foot$ .
11. Shielded cable with a minimum of 3 wires, each wire is AWG20, maximum length of cable is 100m. Shield shall be circular connected inside the gland of the RDU40 and connected to ground.

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## **11. ANNEXES**

- 11.1 Annex A**      *DC to DC Converter module*
- 11.2 Annex B**      *Power, data and RDU40 cabling*
- 11.3 Annex C**      *Remote Display Unit RDU40*
- 11.4 Annex D**      *Underwriters Laboratory (UL) standard*

## 11.1 Annex A DC to DC Converter module

This text applies only in respect of WaveRadar REX D units with a s/n prior to 38587.

The DC/DC module supplied with WaveRadar REX type D is a small self contained module that is intended to be located in a safe area. The converter module is configured to produce a 48v DC output from a 24v DC input. The single output is configured from a series output, with negative sense at the load and the inhibit function disabled. This configuration is pre wired in the accompanying DIN H15 connector to the module.

Fully enclosed in a black coated aluminium case, that acts as a heat sink and RFI shield, the module corresponds to class 1 safety and installation specifications and meets EN60950, UL 1950, IEC 950 and EN 41003. It is recommended that the output from the module shall be a SELV circuit, ( i.e. a circuit separated from mains by at least basic insulation, that is so designed and protected that under normal and single fault conditions, the voltage between any two conductors and between any conductor and earth does not exceed 60 volts DC).

The module has a neon indicator to show when output is functional.

### Specification

Input voltage	16 – 36 volts DC 24 volts nominal
Output voltage	48 volts DC nominal
Output current	2.2 Amps nominal
Max output power	105 Watt
Configuration	Single output from series connection
Connector	DIN H15 female
Safety equipment specification for class 1	EN 60950, VDE 0805, EN 41003, UL 1950
Module installation requirement regulation	IEC 950 SELV circuit
Environmental	Fully enclosed case that acts as heat and RFI shield. With connector fitted sealed to IP 30.
Temperature range (start up and operational)	-10 to 50 deg C
Temperature range (operational)	-10 to 80 deg C
Dimensions	164 x 111 x 20 mm
Weight	0.48 Kg

## 11.2 Annex B Power, data and RDU40 cabling

### Cable specifications

The following are specifications for cables and gland components that may be supplied by RS Aqua Ltd. that in most cases provide the optimum input voltage balanced against conductor size and cable length to give a voltage within the range specified for the different versions of the WaveRadar REX.

#### Power cable:

ESI two-core 1.5sq mm (Armoured). PVC / SWA / PVC BLACK  
Or  
BS 5467 2.5 sq mm (Armoured). PVC / SWA / PVC BLACK

#### Data cable:

BS 5308 part 2, type 1, one twisted pair 0.5 sq. mm. PVC / SCREEN / PVC / SWA /PVC.

#### Remote Display Unit - RDU40:

BS5308 Part 2 three core 0.5 sq.mm. PVC / screened / PVC / SWA / PVC Blue  
Or  
BS5308 Part 2 four core 0.5 sq.mm. PVC / screened / PVC / SWA / PVC Blue  
Or  
IEC 228, IEC 227 core size 0.5 sq mm.

### Gland and adapter specifications

The WaveRadar REX integrated junction box is supplied with fitted glands. These glands are:

KEMA M20 x 1.5

KEMA M25 x 1.5.

Approval categories: 99ATEX 6971X II2G1D EEx e II /LDA20

IECEX – KEM 07.0014x

Temperature range 60deg C - + 105 deg C.

*Glands available from RS Aqua Ltd. are:*

Hawk JB gland - M20 501/453 size OS

Hawk reducer M25 to M20 Exd 25M-20F,1 with lock nut M25

Hawk washer M25 Hawk SLG WSH B 25M-1, FBR

Environmental IP66

Approval categories EEx dIIC, EEx e II

Plugs are also available from RS Aqua Ltd. These plugs replace unwanted/unused glands.

Lapp Group - M20 and M25.

Approval categories: BExU03ATEX 1011

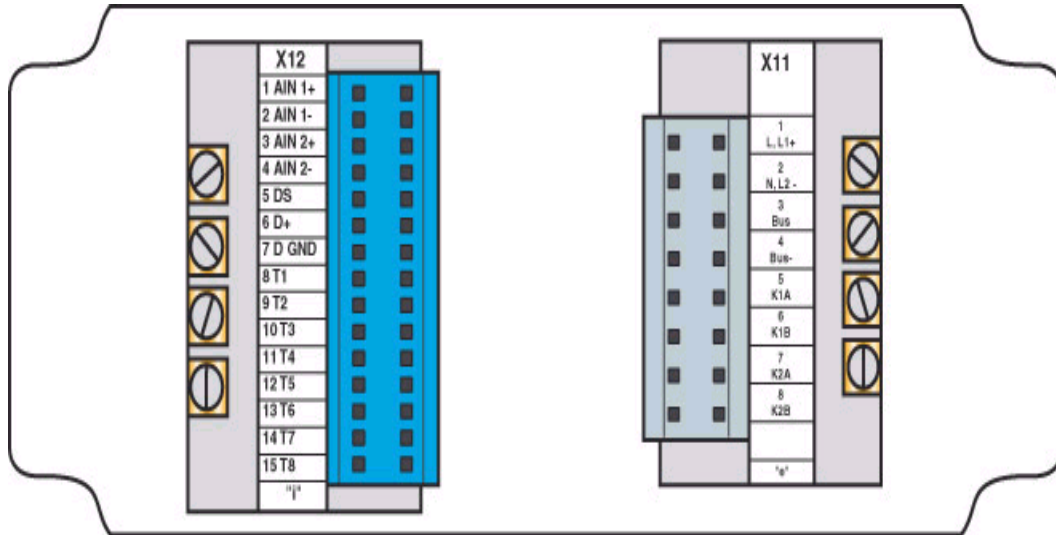
II2G1D EEx e II

Environmental IP66/IP68

## Integrated Junction box - cable inlets

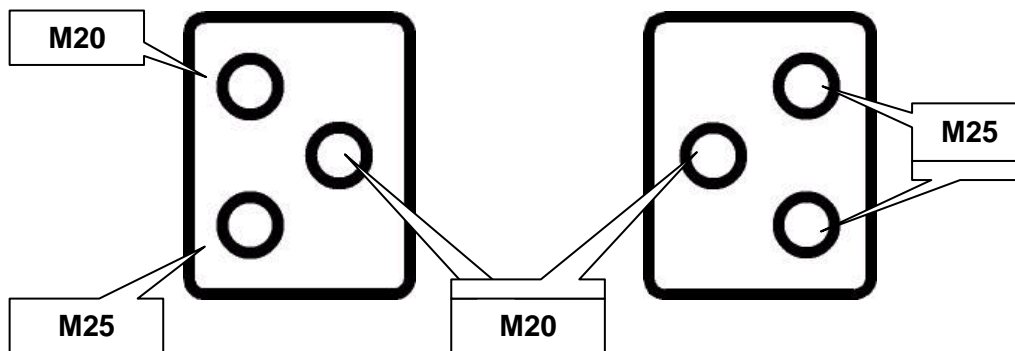
Connector X12

Connector X11

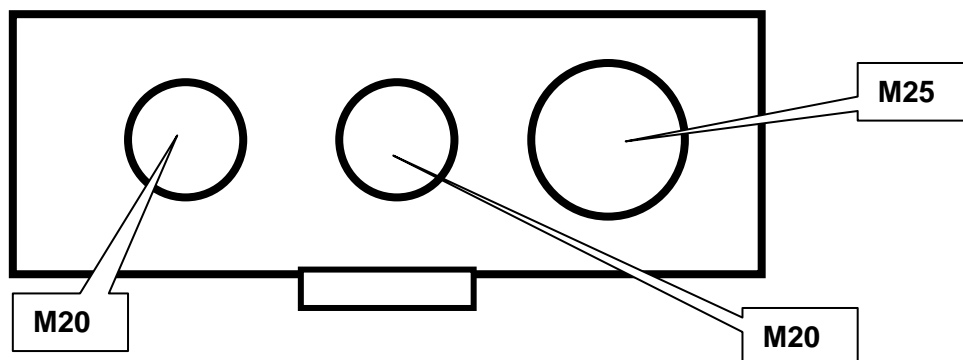


*Cable inlet EEx i*

*Cable inlet EEx e (power I/P, data O/P)*



## Remote Display Unit (RDU40) cable inlets – EEx-i





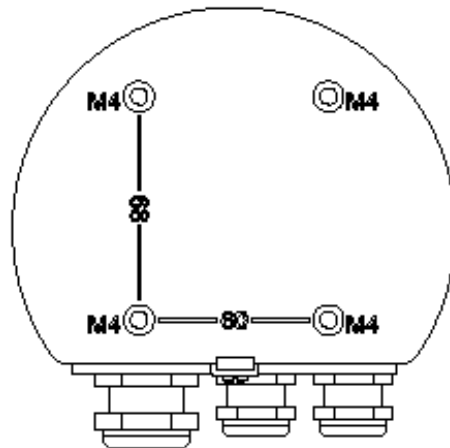
### 11.3 Annex C Remote Display Unit RDU40

#### **Technical data**

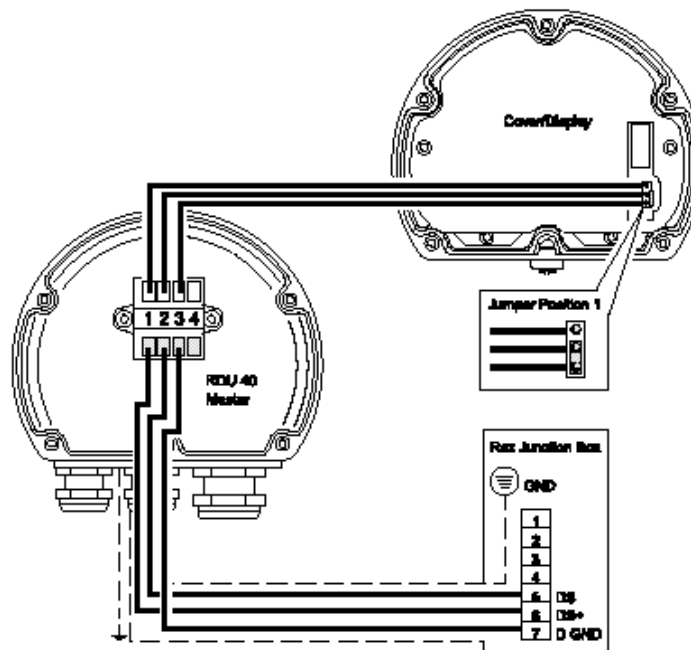
Ambient temperature	-40°C to +70°C
Ex Class	Cenelec: Ex ib IIC T4 FM: Class 1, Group A, B, C, D Division 1 Hazardous location.
ATEX	Sira 00 ATEX 2062
CE	To EN50 014 and EN50 020 CE0600 €112G
Maximum cable length	100m (328 ft) – Total length if two units are connected to the same WR Gauge.
Cable requirement	3 wire, shielded instrument cable Min 0.5mm" (AWG 20) Max 2.5mm" (AWG 14) Max ↓14 mm (0.55 inch) Min insulation thickness for each wire 0.25mm (0.00985 inch)
Material housing	Diecast aluminium
Dimensions	150 x 120 x 70 mm (6 x 4 x 3 inch)
Weight	1.2 kg (2.6 lbs)
Protection class	IP67. NMEA 4.



Mount the RDU with the four M4 screws. Distances between the screws are 60mm and 68mm and are shown on the diagram below.



If two RDU40 are to be connected to the same REX one of the RDU40 units must be the “slave” while the other is the “master”. The slave unit will follow the master and only the LCD contrast may be individually controlled at the slave unit. To make the RDU40 work as a slave the jumper connection must be moved to position 2.



## **Operation**

The RDU40 is factory set to display the View mode presenting the default display. The four soft keys have limited functions. The LCD contrast can be increased by simultaneously pressing the two buttons on the right hand side to adjust from minimum to maximum LCD contrast.

Approximately 30 seconds after power is applied to the WaveRadar REX the RDU40 display will show the measured range and status.

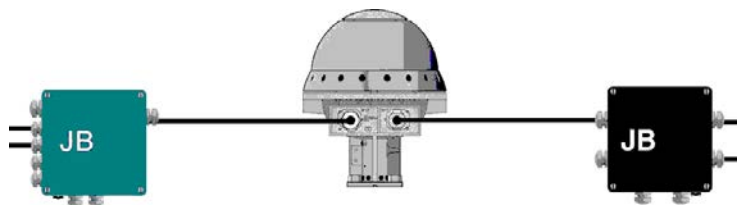
## **Fault finding**

<b>Symptom</b>	<b>Cause</b>	<b>Action</b>
No display	No power from the WaveRadar	<ol style="list-style-type: none"> <li>1. Ensure WaveRadar is operating.</li> <li>2. Check wires are connected correctly to the X12 JB on the WaveRadar REX.</li> </ol>
The RDU flashes a checked pattern	<ol style="list-style-type: none"> <li>1. Wiring to RDU from WaveRadar REX incorrect</li> <li>2. The WaveRadar REX is operating in boot mode.</li> <li>3. RDU has been connected to the WaveRadar while the WaveRadar is running.</li> </ol>	<p>Check</p> <ol style="list-style-type: none"> <li>1. Wiring connections to the RDU. Wiring is the correct type and size.</li> <li>2. Restart WaveRadar</li> <li>3. Restart WaveRadar</li> </ol>
The RDU shows nothing but four black rectangles at the bottom of the display	Incorrect slave/master mode	<ol style="list-style-type: none"> <li>1. Ensure that jumper is fitted to the master position (position 1) on the back of the RDU PCB.</li> </ol>

## 11.4 Annex D Underwriters Laboratory (UL) standard

### **Technical data**

Hazardous Location	Class 1, Division 1, Group C or D Class 1, Zone 1, Group IIB. Ex d [ia] IIB T6
UL Listed	939U
FCC ID	K8CREXX
Ambient temperature	-40°C to +70°C
Environmental protection	IP67
Reference	Special Safety Instruction, Chapter 4. System control drawing for hazardous location installation, Number 9150072-966
Customer supplied items	Flexible hose conduit to local regulations, 1m length (two per REX unit) and hose terminations/adapters to fit cable exit port of electronic housing. The port threads are ¾" NPT. Junction boxes (two per REX unit) certified for use in a hazardous area.



For the UL configured WaveRadar REX, the integrated junction box is removed and the wires for the Non Intrinsically Safe (W11) and the Intrinsically Safe (W12) circuits exit through a lead seal in the transmitter head. The permanently attached wires are of 1.5m in length and flexible hose conduit is required for each outlet to provide protection for the wires and fitting to a junction box. The permanently attached wires must be suitably terminated in customer supplied junction boxes that must be certified for use in a hazardous area.

The W12 output is optional and may contain up to 15 wires connected to six separate intrinsically safe circuits. Wires are clearly numbered and identified both on the plate attached to the outlet and on the System Control Drawing in chapter 4 of the Special Safety Instruction.

**W12 Intrinsically safe wire ID's**

**W11 Non Intrinsically Safe wire ID's**

Wire Number	Circuit Identity		Wire Number	Circuit Identity
1	AIN 1+:		1	MAINS L/L1 +
2	AIN 1 -:		2	MAINS L/L2 -
3	AIN +2:		3	BUS A
4	AIN -2:		4	BUS B
5	DS (RDU40)		5	K1 A
6	D + (RDU40)		6	K1 B
7	D GND (RDU40)		7	K2 A (Analogue o/p +)
8	T1		8	K2 B (Analogue o/p -)
9	T2		9	PROT EARTH
10	T3			
11	T4			
12	T5			
13	T6			
14	T7			
15	T8			

The wiring details for the WaveRadar REX are shown on drawing WP2001M007 attached to this annex.

## 11.4 Annex E ESAAASD standard

### *Technical data*

Hazardous Location	Class 1, Division 1, Group C or D Class 1, Zone 1, Group IIB. Ex d [ia] IIB T6
UL Listed	939U
FCC ID	K8CREXX
Ambient temperature	-40°C to +70°C
Environmental protection	IP67
Reference	Special Safety Instruction, Chapter 4. System control drawing for hazardous location installation, Number 9150072-966
Customer supplied items	Flexible hose conduit to local regulations, 1m length (two per REX unit) and hose terminations/adapters to fit cable exit port of electronic housing. The port threads are 3/4" NPT. Junction boxes (two per REX unit) certified for use in a hazardous area.

For the UL configured WaveRadar REX, the integrated junction box is removed and the wires for the Non Intrinsically Safe (W11) and the Intrinsically Safe (W12) circuits exit through a lead seal in the transmitter head. The permanently attached wires are of 1.5m in length and flexible hose conduit is required for each outlet to provide protection for the wires and fitting to a junction box. The permanently attached wires must be suitably terminated in customer supplied junction boxes that must be certified for use in a hazardous area.

The W12 output is optional and may contain up to 15 wires connected to six separate intrinsically safe circuits. Wires are clearly numbered and identified both on the plate attached to the outlet and on the System Control Drawing in chapter 4 of the Special Safety Instruction.