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CMR-1141

RADASCAN MINI RESPONDER TECHNICAL DESCRIPTION

Contents

1. INTRODUCTION

The RadaScan Mini Responder is an active radar responder designed for use with the RadaScan range of position sensors operating in the band 9.2GHz to 9.3GHz. The RadaScan sensor measures range and bearing to the active Responder for use with Dynamic Positioning (DP) systems on Marine Vessels. The Responder receives the microwave signal from the RadaScan sensor with a vertically polarized patch array, amplifies and modulates the signal before re-transmitting it with a horizontally polarized patch array. Figure 1.1 below shows an external view of the Responder.

1.1 Figure 1.1, External View

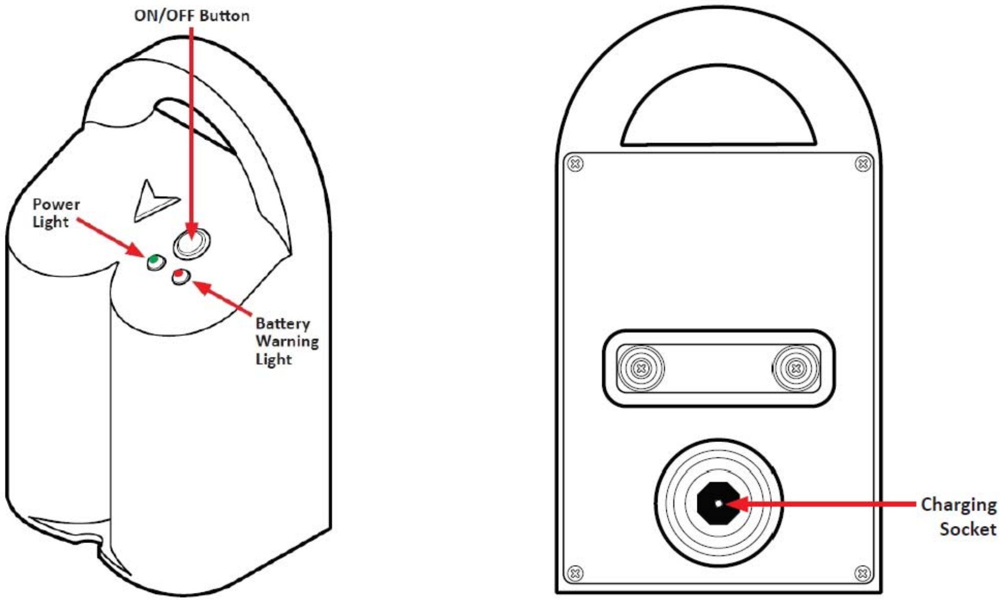
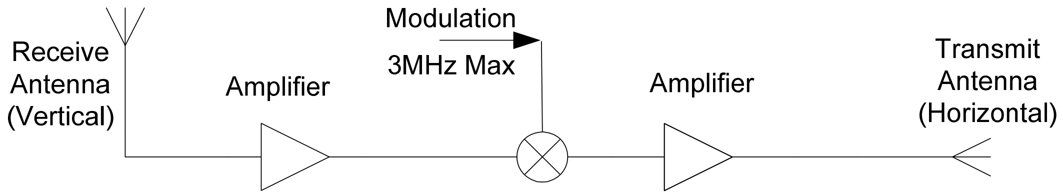


Figure 1.2 below illustrates the function of the Responder.

1.2 Figure 1.2, Functional Block Diagram of the Mini Responder



There is a more detailed Block Diagram in Figure 3.1 later.

The RadaScan sensor is a Frequency Modulated Continuous Wave (FMCW) Radar so the Responder operates in CW mode, returning an amplified version of the received signal back to the sensor; the Responder doesn't contain an RF source of its own.

Power for the Responder is obtained from batteries with both re-chargeable and primary cell options being available.

There are two main versions of the Responder: 180° and 360°. The 360° version is simply made from the 180° version with additional RF board on the back.

The Responder is compact at just 260mm high and light weighing less than 4kg for the 180° version.

2. PERFORMANCE PROPERTIES

2.1 Power Consumption

The total power consumption of the 180° Responder is typically 140mW, nominally from a 4V source and a drain of 35mA.

The total power consumption of the 360° Responder is typically 240mW, nominally from a 4V source and a drain of 60mA.

2.2 Operating Frequency

The Nominal operating frequency band (peak gain) is 9.2 to 9.3GHz.

2.3 Amplifier Gain

The total gain through the amplifier and modulation chain is 30dB.
This is made of 40dB amplifier gain and 10dB loss through the modulator.

2.4 Antenna Gain

The Antenna gain measurements are summarised in report CMR-1163.
The peak transmit antenna gain is 11.9dBi.
The peak Receive antenna gain is 12.25dBi.

2.5 Maximum Transmitted Power

The maximum transmitted power is 4dBm.

The maximum power is output when the last amplifier in the chain saturates. All of the RF amplifiers are made using Eudyna FHX35LG low noise FETs. These have a specified saturated output power of around 16dBm with a drain current of 15mA. The Mini Responder uses drain currents of 3mA to conserve battery life and this gives a measured saturated output power of 4dBm.

2.6 Maximum Transmitted EIRP

The maximum transmitted EIRP is 15.9dBm.

This is from a maximum output power of 4dBm and a transmit antenna gain of 11.9dBi.

2.7 Effective Radar Cross Section

The effective Radar Cross Section of the Responder between $2m^2$ and $6m^2$.

Note that the Responder is cross-polar so to standard co-polar systems the Radar Cross Section would appear as much less and a maximum of $1.3m^2$, equivalent to a 13cm corner reflector.

2.8 Frequency Response

Normalised to the peak gain, the table below illustrates the gain response with frequency.

Frequency GHz	8	8.5	9.3	9.4	10	10.5
Normalised Gain (dB)	-33	-15	0	-3	-28	-36

2.9 Modulation

The maximum modulation frequency is 3MHz.

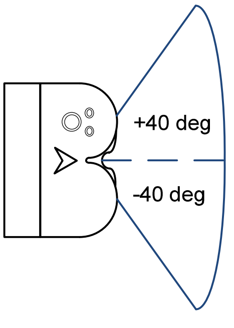
The modulation scheme is Single Sideband with offset frequencies between 3MHz and 1.75MHz. The Single Sideband modulation is Phase Shift Keyed at a rate of 62.5kHz to give the Responder a 16 bit ID.

2.10 Azimuth Radiation Patterns

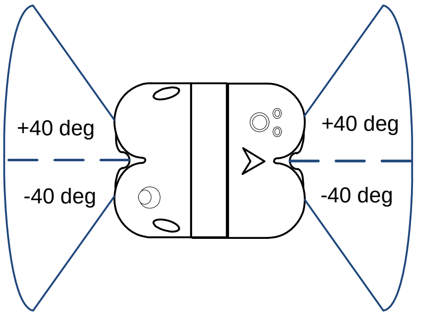
The Antenna gain measurements are summarised in report CMR-1163.

The Azimuth 10dB beam width is 80° for both the 180° and 360° versions as illustrated in Figure 2.10.1 below.

2.10.1 Figure 2.10.1, Azimuth Beam Patterns



180° Version



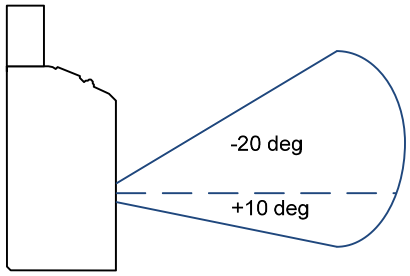
360° Version

2.11 Elevation Radiation Pattern

The Antenna gain measurements are summarised in report CMR-1163.

The Elevation 10dB beam width is 31° (20° up and 10° down) for both the 180° and 360° versions as illustrated in Figure 2.11.1 below.

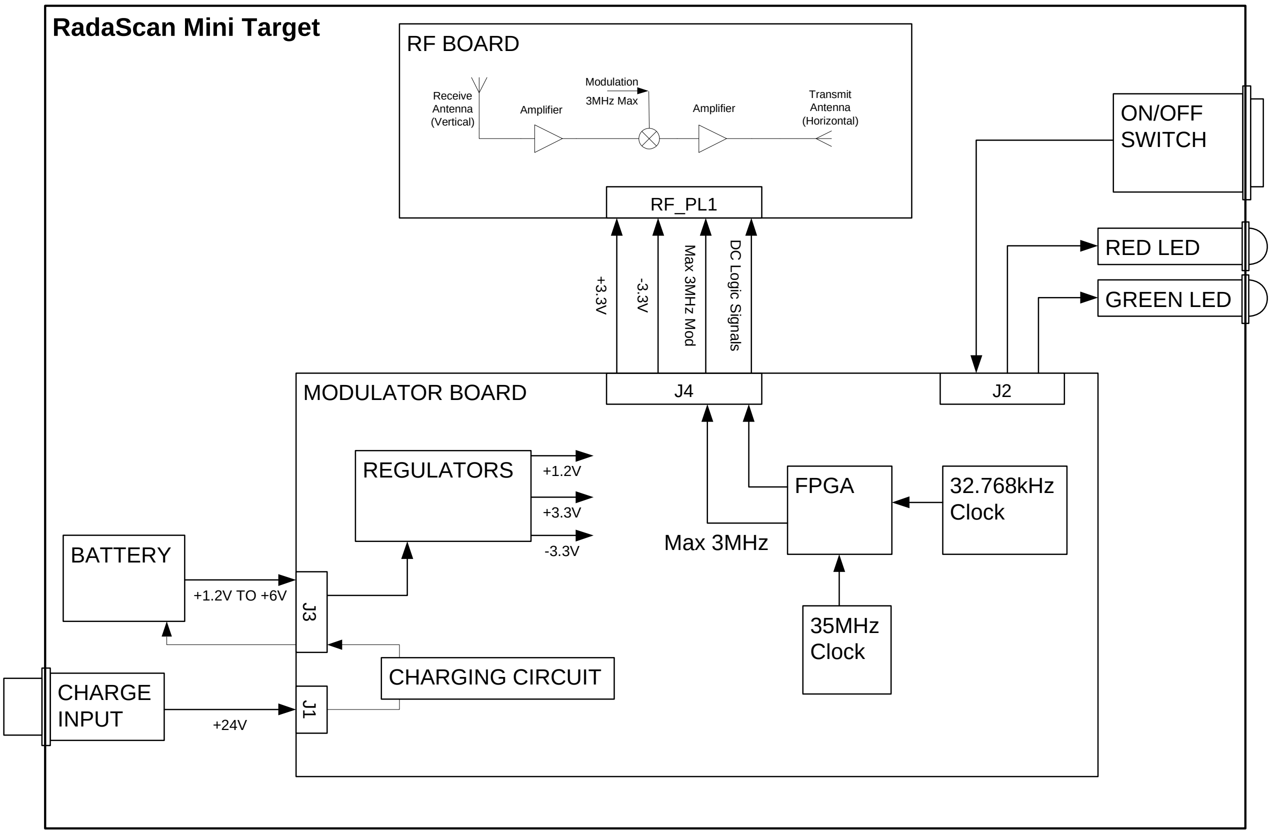
2.11.1 Figure 2.11.1, Elevation Beam Pattern



3. SYSTEM BLOCK DIAGRAM

Figure 3.1 below shows a System Block Diagram for the Mini RadaScan Responder.

3.1 Figure 3.1, RadaScan Mini Responder System Block Diagram



There are 2 electronic PCBs: the RF Board and the Modulator Board. The battery supply is connected to the Modulator board which has the voltage regulation circuitry. The charger input is nominally +24V and is connected to the battery via charging electronics on the Modulator board. Two clocks drive an FPGA which is used to generate the modulation signals with a maximum frequency of 3MHz to the RF board. The FPGA monitors for correct operation and battery status, controlling 2 LEDs to indicate operational status to the user. The front of the Responder is a radome allowing the reception and transmission of the microwave signals to the RF board.

4. TUNE UP PROCEDURE

The Mini Responder RF board is built and tested with select on test attenuation to limit the range of effective RCS. The test procedure is defined in CMR-1142 which specifies the measurement of the RF board Effective Radar Cross Section and select on test attenuation.