Information to Support Radio Approval of the SAT-401 IsatM2M Terminal

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Amendment Record				
Issue	Description	Date	Implemented By	Approved By
1	Initial Issue	9/4/2013	O Hilton	P Spear
2	Transmit frequency stability and typical Rx sensitivity added to section 2.4. Section 2.5 added to cover FCC radiation hazard analysis. Section 2.6 added to describe mechanical variants.	18/10/13	O Hilton	P Spear

[This document complies fully with the Design Inputs referenced within]

CONTENTS

ABBREVIATIONS

EMC	Electromagnetic Compatibility
FCC	Federal Communications Commission
GPS	Global Positioning System
MES	Mobile Earth Station
MET	Mobile Earth Terminal
PCBA	Printed Circuit Board Assembly
SDM	System Definition Manual

1 INTRODUCTION

The purpose of this document is to provide technical data for the SAT-401 INMARSAT IsatM2M Terminal to support applications for Radio Approvals.

The SAT-401 INMARSAT IsatM2M Terminal is compliant with the Radio Approvals listed in Table 1.

Category	Standard	Comment	Compliance
Radio Performance (Inmarsat INMARSAT-D IsatM2M Approval)	INMARSAT-D SDM	Provides protection of the spectrum allocated to terrestrial/space radios comms so as to avoid harmful interference. The standard specifies three conformance requirements: Unwanted out-of-band emissions, Unwanted in-band emissions and Control & Monitoring functions.	Compliant
Radio Performance (RTTE/CE certification)	EN 301-426	Provides protection of the spectrum allocated to terrestrial/space radios comms so as to avoid harmful interference. The standard specifies three conformance requirements: Unwanted out-of-band emissions, Unwanted in-band emissions and Control & Monitoring functions.	Compliant
Radio Performance (FCC certification)	25.202(f)	Required for equipment used in radio communications in the US. The standard specifies limits for close-to-carrier emissions.	Compliant
	25.216	Required for equipment used in radio communications in the US. The standard specifies limits for Emissions from Mobile Earth Stations for Protection of Aeronautical Radio-navigation-Satellite Service.	Compliant
EMC Performance (RTTE/CE certification)	EN 301-489-1	Defines the common technical requirements for radio equipment. The standard specifies limits for emissions and immunity.	Compliant
	EN 301-489-20	Defines the specific requirements for low date rate MES operating within the 1.5/1.6GHz bands.	Compliant

Table 1: Radio Approvals

2 THE SAT-401 INMARSAT ISATM2M TERMINAL

2.1 Overview

The SAT-401 INMARSAT IsatM2M Terminal consists of a modem PCBA and patch antenna mounted within a PC/ABS enclosure. Refer to Figure 1 to Figure 6.

Figure 1: External View of a SAT-401 Terminal

The SAT-401 modem PCBA contains all of the active circuitry and is enclosed by two shielding cans. The shielding cans are made from a metallised plastic that provides the required level of RF shielding for the module.

The patch antenna parts are mounted in a stack on top of the modem PCBA. The stack is held together with the 4 fixing screws that secure the stack in place in the enclosure.

Figure 2: Underside view

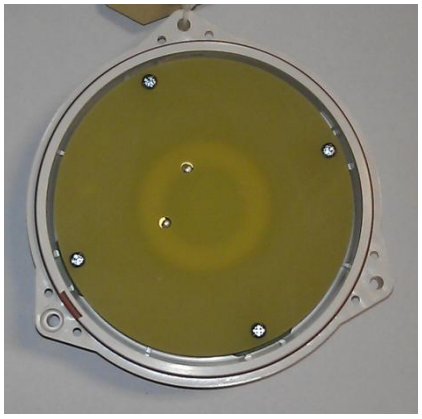


Figure 3: Top view with radome removed

Figure 4: Modem PCBA and antenna stack removed from enclosure

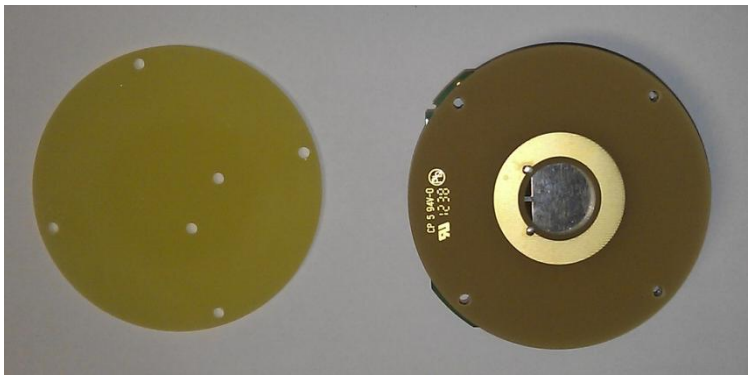


Figure 5: Modem and antenna parts removed from enclosure

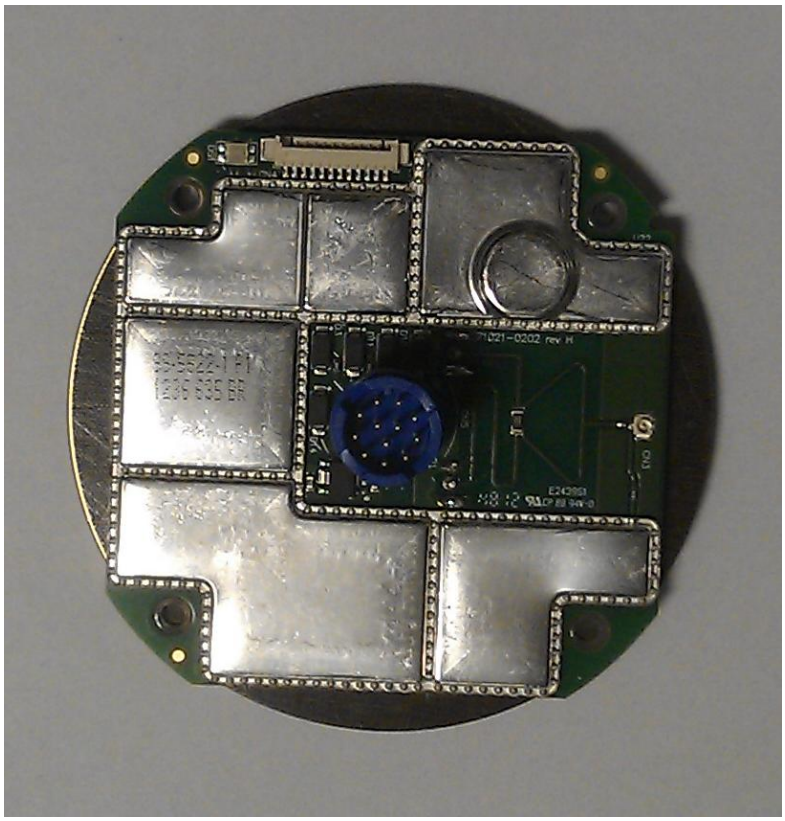


Figure 6: Base view of modem and antenna stack showing modem PCBA and shielding can

2.2 Signal Path Description

The distribution of circuitry within the Terminal is shown in Figure 7 and described below.

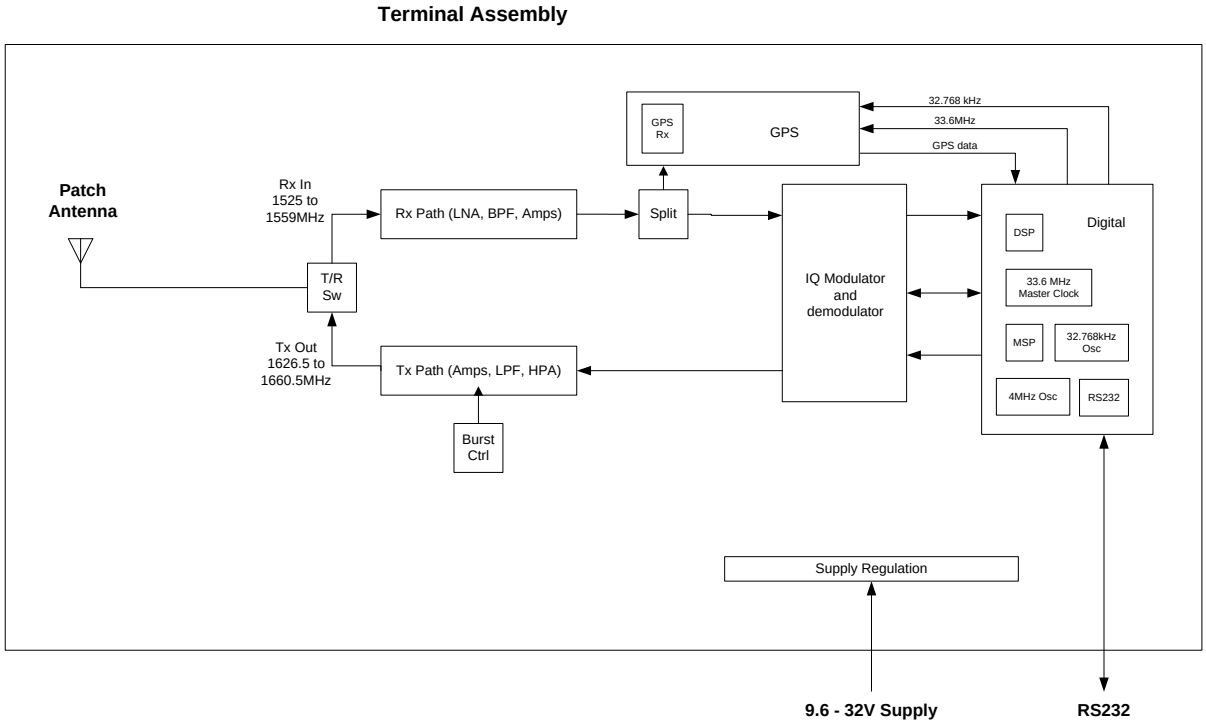


Figure 7: Functional Block Diagram

The SAT-401 has the following features:

- Digital section –includes MSP, DSP, clock sources.
- IQ modulator – creates the modulated L-band transmit signal.
- Burst Control – provides control of transmit output power.
- Split – routes a signal off to the GPS module.
- IQ demodulator – translates received signals to baseband for digitisation.
- Supply Regulation – regulates a range of voltages from the 9.6 – 32V external supply.
- Transmit path –amplifies and filters the L-band transmit signal from the Modem board before passing it to the Patch for radiation.
- Receive path – amplifies and filters L-band signals received by the patch before passing them to the Modem board for down conversion and demodulation.

The antenna is an omni-directional patch element that is mounted above a ground plane.

2.3 Location of Main Functional Elements

The locations of the main functional elements of the SAT-401 modem PCBA are shown in Figure 8 below. Note – the screening cans have not been fitted in order to show the components beneath.

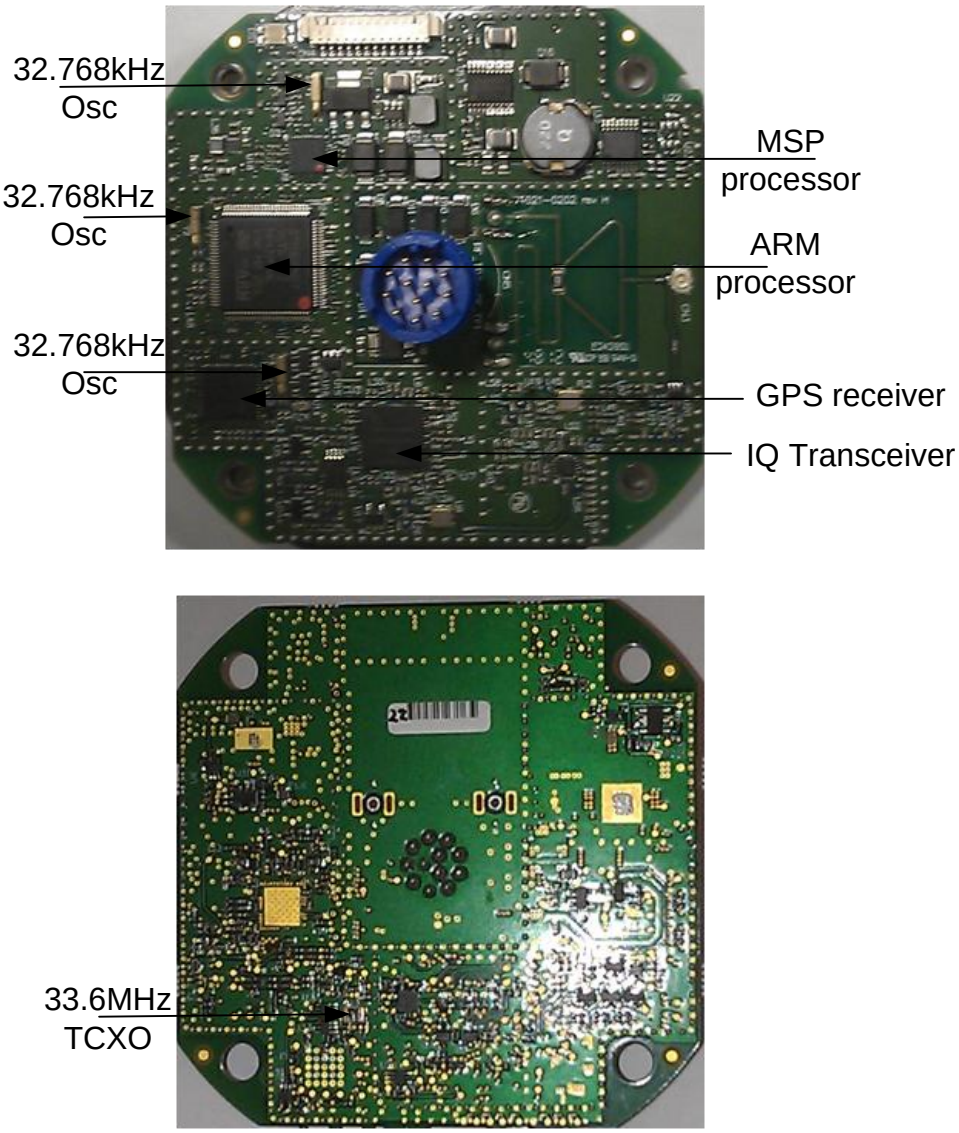


Figure 8: Location of Key Parts on Bottom Side of Modem Board

2.4 Performance at Air Interface

2.4.1 Transmit Path Performance

The Transmit Path's performance is summarised in Table 2.

Parameter	Specification	Comment
Transmit Frequency (MHz)	1626.5 to 1660.5	
Antenna Polarization	Right Hand Circular	
Signal Format	2-ary FSK, 256Hz tone spacing	
Data Rate (symbols/sec)	128	Maximum.
Channel Bandwidth (kHz)	2.5	
Antenna Gain (dBiC)	+6.0	At Zenith.
EIRP (dBW)	+7.0	Max at zenith.
Beam Width (degrees)	90	Half Power.
Phase Noise (dBc/Hz)	≤ –23 at 10Hz ≤ –51 at 100Hz ≤ –60 at 1kHz ≤ –60 at 5kHz ≤ –90 at 100kHz	
Spurious Emissions Outside Bands of Operation	EN301-426 and FCC CFR 25.216 (Carrier-On) EN 301-426 (Carrier-Off).	
Harmonic Emissions	EN 301-426	
Spurious Emissions Within Bands of Operation	EN 301-426 and FCC CFR 25.202(f) (Carrier-On) EN 301-426 (Carrier-Off).	
Transmit frequency stability	±0.1 ppm	Transmit frequency error is less than 150Hz at 1.6GHz

Table 2: Transmit Performance

2.4.2 Receive Path Performance

The Receive Path's performance is summarised in Table 3.

Parameter	Specification	Comment
Receive Frequency (MHz)	1525 to 1559	
Antenna Polarisation	Right Hand Circular	
Signal Format	32-ary FSK, 20Hz tone spacing	
Data Rate (symbols/sec)	4	
Channel Bandwidth (kHz)	2.5	
Antenna Gain (dBiC)	+6.0	Typical at Zenith.
Receive sensitivity	-154 dBm typical	

Table 3: Receive Performance

2.5 Radiation Hazard Analysis

This analysis summarizes the power flux density levels for the SAT-401 MET. The calculations in this exhibit follow the methodology outlined in OET Bulletin No. 65 (Edition 97-01 August 1997) "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," and Supplement C (Edition 01-01 June 2001) entitled "Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions."

The following table summarizes the relevant antenna and MET characteristics.

Manf.	MET Type	Antenna Type	Antenna Size	Antenna Peak Gain (dBi)
Honeywell Global Tracking	SAT-401	Patch	0.11m	6.0

The MET type has a peak EIRP of less than 9 dBW. The power flux density calculations in this exhibit are based on this peak value for a transmitting frequency at 1.6 GHz. At this frequency, the maximum permissible exposure ("MPE") levels in the FCC's guidelines are as follows:

Occupational/controlled	5 mW/cm^2 averaged over 6 minutes
General population/uncontrolled	1 mW/cm^2 averaged over 30 minutes

While most of applications for this MET will be located in areas that fall within the FCC's definition of "Occupational/controlled," there may be some applications where the MET operates in areas where the general public may be present. Those persons falling within the former category will be made fully aware of the potential for exposure through warning signs, labels, operating instructions and/or training. Those METs that are not fixed at any particular location fall under the Commission's definition of "mobile" (not "portable") transmitting devices because they are designed to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of a user or nearby persons.

The power flux density levels around the MET type can be calculated as follows:

$$S = EIRP/4\pi R^2 = 1.58\ mW/cm^2 \text{ (at 20 cm)}$$

However, as indicated in OET Bulletin 65, the FCC's exposure guidelines are averaged over certain periods of time. Because the transmissions from the MET is "burst" in nature, they are not always on and therefore the power flux density levels can be averaged over time. While typical MET will transmit bursts only a few times per day, a worst case scenario could result from the following:

Maximum length of each transmission burst = 8 seconds

Transmission time slot = 10 seconds

The MET references its timing from the received traffic channel to which it must tune and decode the frame header before a transmission is allowed in the following 30 second frame. The Inmarsat-D (IsatM2M mode) system limits the maximum number of transmissions to 4 in any 2 consecutive 30 second frames. As a result:

Maximum transmit/total time ratio = 4*8/60 = 0.533

Using this factor and the above calculated power flux density level yields a power flux density as follows:

Max power flux density = 1.58 * 0.533 = 0.842 mW/cm^2 (at 20 cm)

As indicated above, this level is within the most restrictive MPE requirements for general population/uncontrolled environments.

2.6 Mechanical Variants

There are 3 mechanical variants of the SAT-401 series of products:

- SAT-401 (Standard base entry connector variant)
- SAT-401E (Side entry cable variant)
- SAT-401C (Base entry cable variant)

The only differences between these variants are the physical connection method to the product. The modem and antenna parts are exactly the same.

The standard SAT-401 has a base entry connector which is soldered directly to the modem PCBA (see central connector in Figure 9).

The SAT-401E has a side entry cable that mates with the modem PCBA via the edge connector (see Figure 9).

The SAT-401C has a base entry cable that mates with the modem PCBA via the edge connector (see Figure 9).

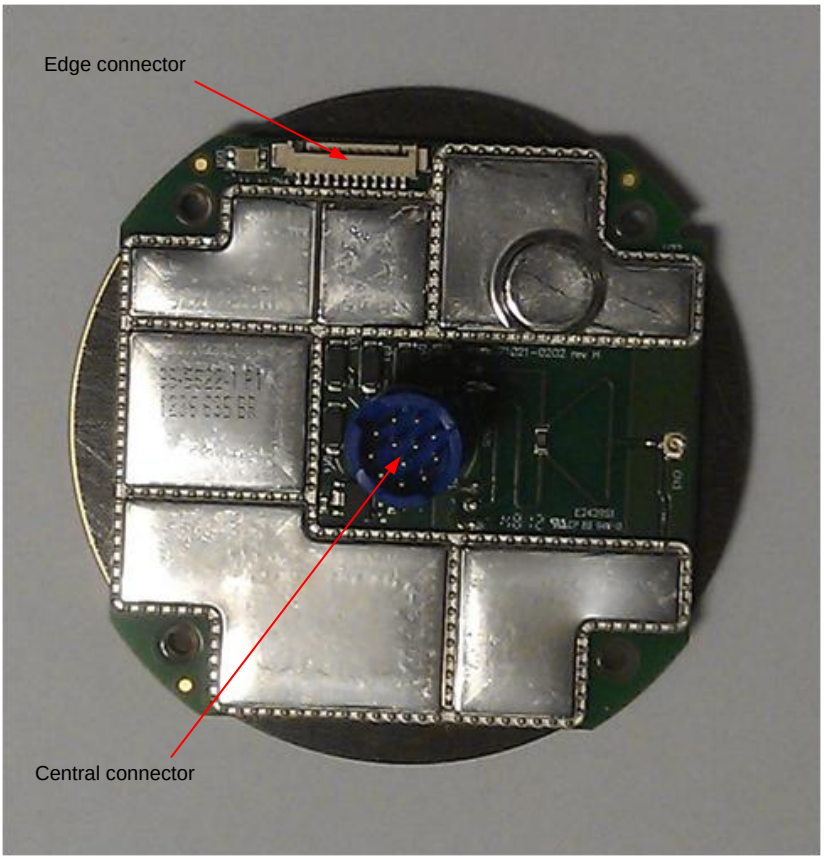
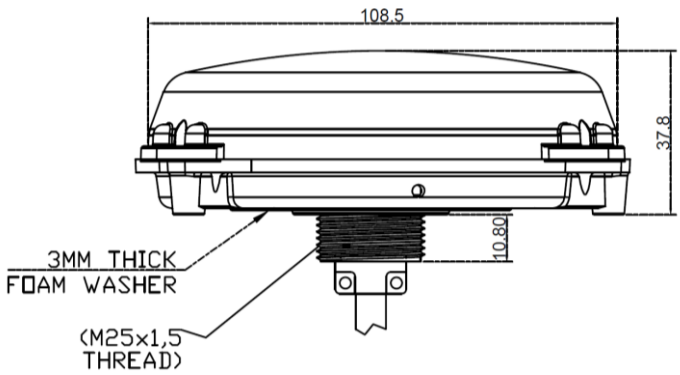
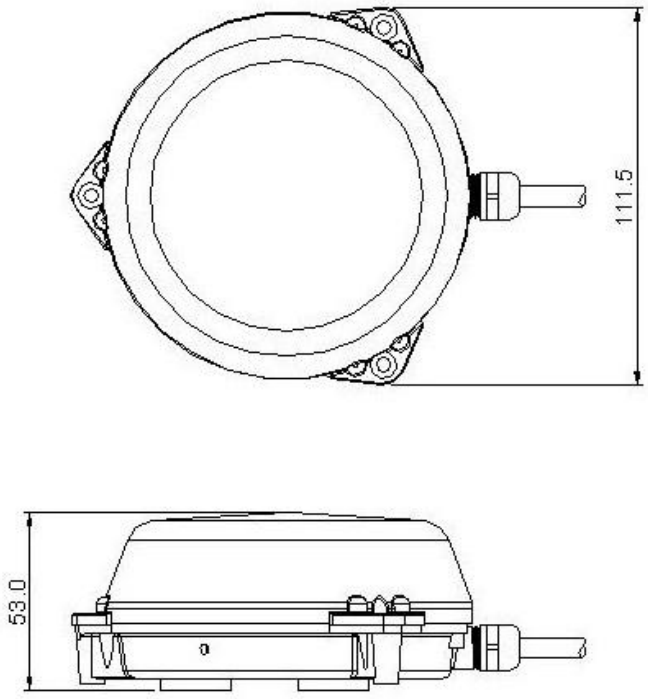


Figure 9: Modem PCBA connectors

SAT-401



SAT-401C



SAT-401E

Figure 10: SAT-401 Mechanical Variants