ORBCOMM®

CONNECTING THE WORLD'S ASSETS

OGi Modem Hardware Guide

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PREFACE

Purpose

This document provides an overview of the hardware characteristics and specifications for the OGi modem[1].

Errata Sheet

Refer to the Customer Support website for updates or for an Errata Sheet that might be available after the release of this document. Always check the website for the most current documentation.

Notation

An OEM Integrator is an ORBCOMM customer who purchases an OGi modem for integration into their own enclosure. To become an OEM Integrator certain commercial criteria must be met. Contact your Account Executive for further details.

Hardware components and hardware stickers in this document might not be exactly as shown and are subject to change without notice.

In this document, the term *modem* often refers to a modem plus an antenna.

CAUTION: This safety symbol warns of possible hazards to personnel, equipment, or both. It includes hazards that will or can cause personal injury, property damage, or death if the hazard is not avoided.

Note: A note indicates information with no potential hazard. A note indicates points of interest or provides supplementary information about a feature or task.

Numbered lists indicate a series of steps required to complete a task or function.

Bulleted lists highlight information where order or sequence is not crucial.

Reference

The content of the following documents might be useful in conjunction with this guide. These documents are available from the downloads section at support.skywave.com or from the ORBCOMM Developer Toolkit (ODT), which is also available from the website.

[T402] OG Interface Developer Guide

[T403] AT Interface Developer Guide

[1] In this document, the term *modem* often refers to a modem plus an antenna.

1 OVERVIEW

The OGi modem[1] is an L-Band mobile device and provides either an AT interface or an OG interface for command and control. Hardware using an AT interface operates on the IsatData Pro gateway while hardware using an OG interface operates on the ORBCOMM gateway. Regardless of which gateway is used, the OGi modem operates over Inmarsat satellites. ORBCOMM's turn-key OEM solutions are intended for early integration into M2M applications.

An OGi modem contains a satellite transceiver and a GNSS receiver, and requires a specific passive antenna. The modem accepts commands and returns responses via a serial interface.

The modem is suitable for both fixed and mobile applications such as:

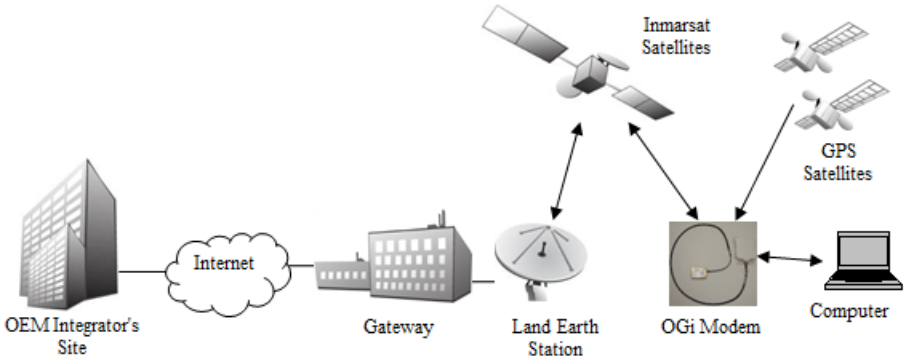
- Transportation and Distribution
- Fleet management and security
- Asset tracking, monitoring and control
- SCADA - oil and gas and electricity distribution

1.1 Overview of the Messaging System

The OGi modems are designed to communicate with Inmarsat satellites, with data accessible from both the IsatData Pro and ORBCOMM gateways. This is referred to as the ORBCOMM IsatData network. The network is designed for low latency two-way communication to mobile or fixed assets over very wide areas.

The OGi modem communicates with application processors through an AT interface (compatible with the IsatData Pro gateway protocol); or through an OG interface (compatible with the OG XML gateway protocol). In both interfaces the OGi modem communicates over-the-air with Inmarsat satellites.

Figure 1: ORBCOMM IsatData Pro Network



The ORBCOMM IsatData Pro provides the following key features and benefits:

- Polling of modem status and location
- Transmission of messages to and from a serial port on the modem
- Two-way communication for messaging to and from the modem for near real-time control
- Up to 6,399 bytes from-mobile messages
- Up to 10,000 bytes to-mobile messages

[1] In this document, the term *modem* often refers to a modem plus an antenna.

- Broadcast messages
- Fully acknowledged service (excludes broadcast messages)
- Global service (non-polar)

1.2 OGi Modem

The OGi modem provides easy integration and the highest level of EMI/EMC shielding that reduces integration risk when the modem is co-located with other electronics.

Figure 2: OGi Modem

1.2.1 Remote Antennas

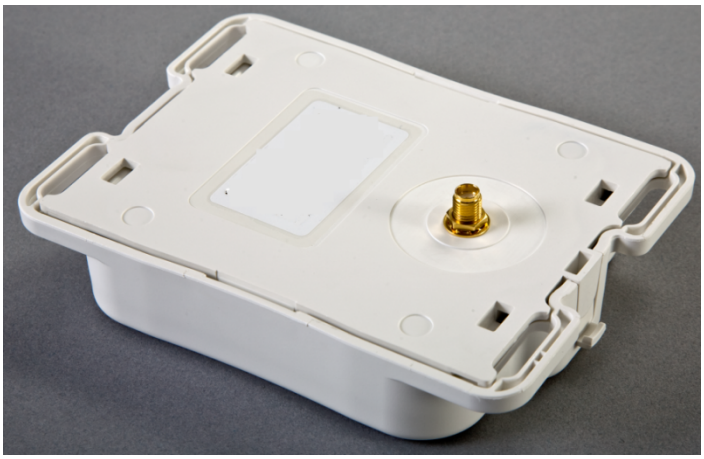
Two passive antenna types are available: a standard antenna (Figure 3) and a low elevation antenna (Figure 3). The standard antenna has an elevation angle of 20 to 90° and the low elevation antenna has an elevation angle of -15 to 90°. The OEM Integrator is responsible for providing a specific RF cable to connect the antenna to the modem.

Both the standard and low elevation antennas are:

- Available with a side or bottom connector (Figure 4)
- Sealed for operating in outdoor environments
- Provide four mounting tabs for installation
- Available with an SMA connector
- Available packaged or unpackaged

Figure 3: Antennas

Figure 4: Antenna Bottom Mount (standard antenna shown)



1.2.2 Unpackaged Antennas

Both antenna types, standard and low elevation, are also available in an unpackaged form. Both feature an IPX connector for connection to the modem and four mounting holes for installation.

Figure 5: Unpackaged Standard Antenna

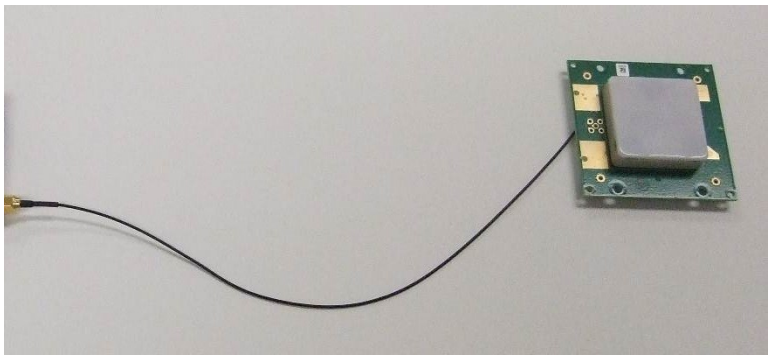
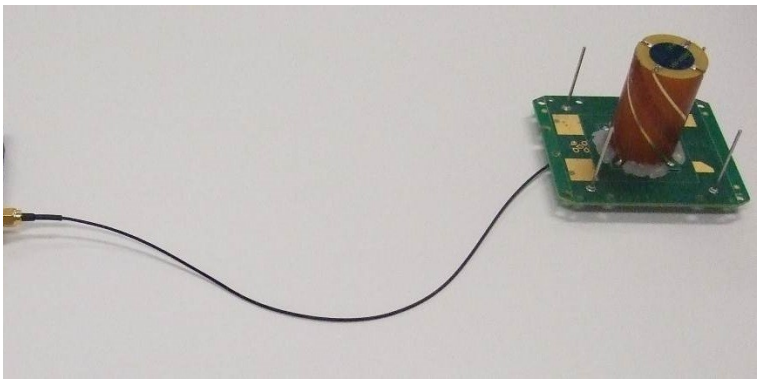


Figure 6: Unpackaged Low Elevation Antenna



1.3 Key Features and Benefits

The OGi modem offers the following key features and benefits:

- Designed to be incorporated into an OEM Integrator's solution
- Built-in GNSS receiver to provide position, speed and heading information
- Broad operational temperature range
- IsatData Pro message payload and latency capabilities

1.4 Operating Modes

1.4.1 Satellite Modem

For the most part, the modem operates independently from the host application. The modem operating modes are described in Table 1.

Table 1: Satellite Modem Operating Modes

Operating Mode	Description
Transmit Mode	In transmit mode the modem is transmitting a signal to the gateway.
Receive Mode	In receive mode the modem is attempting or actively listening to the satellite (listening on the bulletin board channel or on a traffic channel).
Sleep Mode	In this mode the modem turns itself off between wake-up intervals. Both the device and the gateway track the wake-up interval. Consequently, when a device is in sleep mode it does not miss incoming messages. If a modem has a message to send, it automatically exits sleep mode without waiting for the next wake-up interval.
Idle Mode	With IsatData Pro, a modem only receives messages in one of the 10 half second sub-frames. Idle mode is when the modem turns off its receiver waiting for its next assigned sub-frame. The modem automatically enters idle mode on its own, independent of the application.

1.4.2 GNSS Receiver

The GNSS receiver is a module peripheral that is either on or off.

2 COMPLIANCE

These certifications and test results are available to OEM Integrators for use as a baseline for the certification approval of their enclosure.

However, the OEM Integrator is responsible for ensuring that their final enclosure complies with all local regulatory requirements, and electrical and safety codes wherever the enclosures are sold or used. As the OEM Integrator's enclosure contains the OEM Integrator's power supply and possibly other circuitry that affects the modem, the OEM Integrator must obtain Inmarsat Type Approval, and most likely need to perform additional testing or repeat some of the tests listed below.

Inmarsat Type Approval

Industry Canada RSS-170

- IC ID: 11881A-OGI100

FCC 47 CRF Part 25

- FCC ID: XGS-OGI100

CE Mark

- EN 301 426

RoHS

- Restriction of Hazardous Substances (RoHS)[1]

OEM Integrators should place a label on their final product to indicate that the OGi module is pre-certified and sates: "contained FCC ID: XGS-OGI100; IC: 11881A-OGI100".

EU Declaration of Conformity

Hereby, ORBCOMM Inc. declares that the radio equipment types listed in this document comply with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available from http://www2.orbcomm.com/eudoc.

[1]European Union's (EU) Directive 2002/95/EEC "Restriction of Hazardous Substances" (RoHS) in Electronic and Electrical Equipment.

3 SPECIFICATIONS

3.1 Connector

The table below describes the mating connector.

Parameter	Value
Connector	Mini PCI express, 0.8 mm pitch, 52 pin connectors with 26 per side, with a minimum of 30 micro inches of gold plating on the contacts. Several heights are available from multiple vendors.

3.1.1 Pin Designations

Figure 7 and Figure 8 show the pin number designations.

Figure 7: Modem Connector Pinout - Top View of Modem (odd numbers)

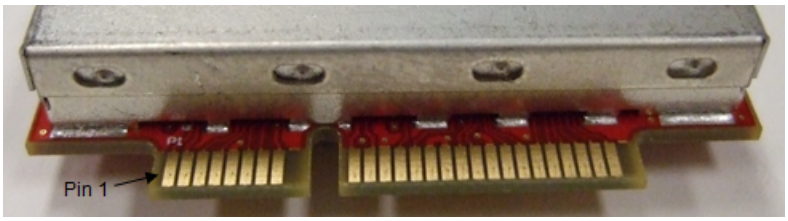
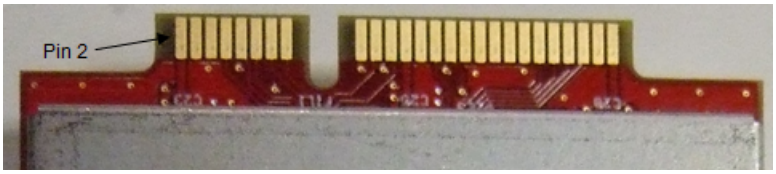


Figure 8: Modem Connector Pinout - Bottom View of Modem (even numbers)



3.1.2 Pin Descriptions

Table 2 contains the modem pin assignments.

Table 2: Modem Electrical Pin Assignment

Pin	Name	I/O	Voltage	Description
1	Reserved	-	-	Do no connect
2	MAIN_POWER	I	5.0 - 15.0 VDC	Input voltages
3	Reserved	-	-	Do no connect
4	GND	-	-	Ground
5	MASTER_RX	I	-	3.3 V logic levels
6	Reserved	-	-	Do no connect

Pin	Name	I/O	Voltage	Description
7	MASTER_TX	O	-	3.3 V logic levels
8	GPIO	-	-	Refer to section 3.1.4
9	GND	-	-	Ground
10	GPIO	-	-	Refer to section 3.1.4
11	DEBUG_RX	I	-	3.3 V logic levels
12	GPIO	-	-	Refer to section 3.1.4
13	DEBUG_TX	O	-	3.3 V logic levels
14	GPIO	-	-	Refer to section 3.1.4
15	MASTER_RESET	I	-	High impedance, active low internal 10 kΩ pull-up
16	Reserved	-	-	Do no connect
17	Reserved	-	-	Do no connect
18	GND	-	-	Ground
19	MODEM_WAKEUP	I	-	Input to wake up the modem. Active high.
20	Reserved	-	-	Do no connect
21	GND	-	-	Ground
22, 23	Reserved	-	-	Do no connect
24	MAIN_POWER	I	5.0 - 15.0 VDC	Input voltages
25	Reserved	-	-	Do not connect
26	GND	-	-	Ground
27	GND	-	-	Ground
28	Reserved	-	-	Do not connect
29	GND	-	-	Ground
30	1PPS	O	-	3.3 V logic levels
31...33	Reserved	-	-	Do not connect
34	GND	-	-	Ground
35	GND	-	-	Ground
36...39	Reserved	-	-	Do not connect
40	GND	-	-	
41...49	Reserved	-	-	Do not connect
50	GND	-	-	Ground
51	Reserved	-	-	Do not connect
52	MAIN_POWER	I	5.0 - 15.0 VDC	Input voltages

3.1.3 MODEM_WAKEUP

When MODEM_WAKEUP is de-asserted, the modem lowers some clocks and disables communication to the host. AT/OG interface commands no longer function. Prior to communicating with the modem, the host must ensure that the MODEM_WAKEUP signal is asserted. After the MODEM_WAKEUP is asserted for at least 1 ms, the host can send AT/OG commands to the modem. When the AT/OG command is accepted and the result code delivered from the modem, the host de-asserts the MODEM_WAKEUP signal at any time.

For low power design, it is highly recommended that the design use the MODEM_WAKEUP signal to reduce power consumption by allowing the modem to go to sleep.

3.1.4 General Purpose I/O

The modem outputs different status on pins 8, 10, 12 and 14 depending on the configured default operating user interface (i.e., using OG mode or AT mode per Section 1.1), to maintain the highest level of compatibility with the OG2 modem and IDP modem.

PCI Signal Pin	Modem	
	OG I/F	AT I/F
8	Spare	
10	GPS Power On	Message Indicator
12	1 PPS Indicator (200 mS/pulse)	External Reset
14	Satellite-in-view	Spare

3.2 RF Connectors

Parameter	Value
Modem RF Connector	MMCX, female (jack) connector
Unpackaged Antenna RF Connector	IPEX (U.FI) SMT receptacle
Packaged/Remote Antenna RF Connector	SMA female

3.3 RF Connection Specifications

The table below lists the specification for the RF present on the RF connector.

Parameter	Minimum	Typical	Maximum	Units
RF Output	30.5	31.5	32.5	dBm

3.4 Power

The modem has various power pins as shown in Table 2. Power input must always be present on all power pins.

Parameter	Minimum	Maximum	Units
MAIN_POWER	5	15	VDC

3.4.1 Average Power Consumption

When the modem is on, its default and steady state is idle unless it is receiving, transmitting or acquiring a GPS fix.

Pulling the MODEM_WAKEUP pin to a low voltage allows the modem to enter low power sleep when idle.

Table 3 shows power averages, at room temperature (22°C), taken from startup to registration, for three MAIN_POWER voltage.

Table 3: Typical Power Consumption (current)

Parameter	Current		
	@ 5 VDC (mA)	@ 8 VDC (mA)	@ 12 VDC (mA)
Low power sleep	2	1.5	1
Idle	23	15	12
GPS acquisition	150	100	70
Satellite communications receive	170	110	80
Satellite communications transmit	2000	1050	750

3.4.2 Maximum Transmit Current

The maximum transmit current over temperature is shown below.

Parameter	Current		
	@ 5 VDC (A)	@ 8 VDC (A)	@ 12 VDC (A)
Room	2.6	1.5	1.0
-40°C	2.9	1.7	1.4
-85°C	2.5	1.4	0.95

3.4.3 Inrush Current

The modem's inrush specifications for MAIN_POWER are shown in the tables below.

	Typical Inrush Current on MAIN_POWER at 5 V		
	Amplitude (mA)	Period (µs)	Charge (µC)
Power up	500	4000	3000
GPS Power up	150	500	50
Receive Power up	200	160	100
Transmit Power up	3000	3700	3000

The table below shows typical inrush current on MAIN_POWER at 12 V.

	Typical Inrush Current on MAIN_POWER at 12 V		
	Amplitude (mA)	Period (µs)	Charge (µC)
Power up	700	3000	400
GPS Power up	80	350	50
Receive Power up	90	200	60
Transmit Power up	900	3000	1100

3.5 Typical Current Consumption to Registration

The modem's current consumption to registration for MAIN_POWER are shown below.

MAIN_POWER	Avg. Current (mA)	Max. Current (A)	Avg. Power (mW)	Total Coulombs	Time (s)
5 V	170	2.6	850	14	90
8 V	100	1.2	800	9	90
12 V	75	0.74	900	7	90

3.6 Serial Interface

The serial defaults to the following settings: 9600 bit/s (8 data, no parity, 1 stop bit) with debug default of 115,200 bit/s (8 data, no parity, 1 stop bit).

The master and debug ports are configurable. Voltages for these ports are 3.3 VDC CMOS logic levels.

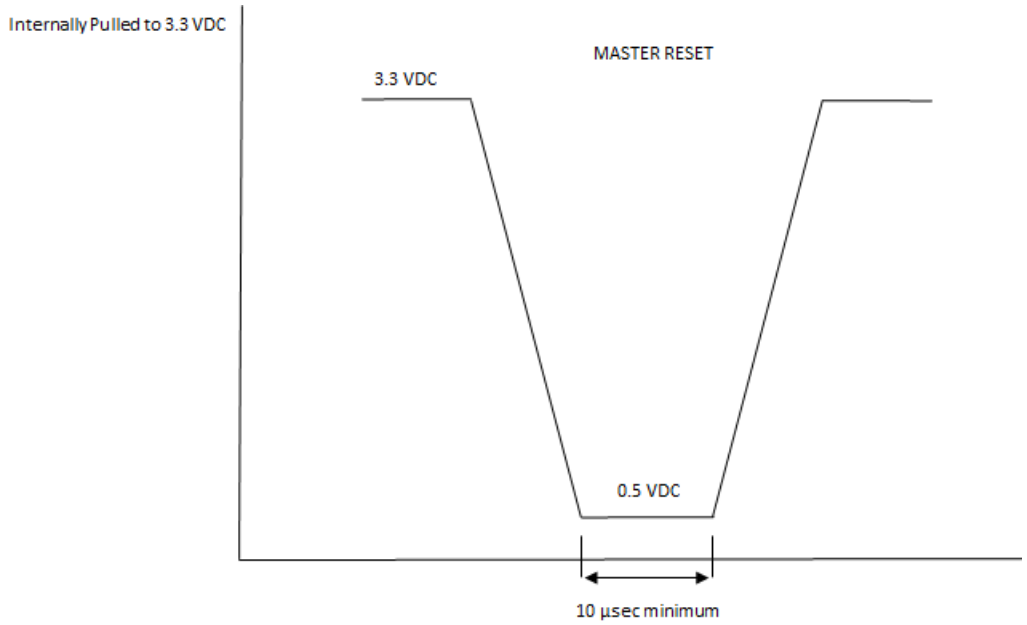
Parameter	Minimum	Typical	Maximum	Units
DEBUG_RX input	2.7	3.3	3.6	VDC
MASTER_RX input	2.7	3.3	3.6	VDC
DEBUG_TX output	2.7	3.3	3.6	VDC
MASTER_TX output	2.7	3.3	3.6	VDC

3.7 Master Reset

The MASTER_RESET resets the modem to its default startup state. The MASTER_RESET pin is open drain and has an internal 10 kΩ pull-up.

Parameter	Min. Low Threshold	Maximum	Units
MASTER_RESET pulled high	2.46	3.6	V
MASTER_RESET low	-	0.5	V
MASTER_RESET	-	<500	µA

Figure 9: Master Reset - Minimum Duration of External Reset Signal



3.8 Frequency

The table below lists the modem's operating frequencies.

Parameter	Value
Receive frequency band (to-mobile)	1518 to 1559 MHz, channel bandwidth 5 kHz; 1518 to 1525 MHz, channel bandwidth 5 kHz
Transmit frequency band (from-mobile)	1626.5 to 1660.5 MHz, channel bandwidth 2 kHz; 1668 to 1675 MHz, channel bandwidth 2 kHz
GNSS Band	GPS L1; GLONASS L1; BeiDou B1

3.9 Antenna Specifications

The antenna is available in two types: standard and low elevation.

3.9.1 Standard Antenna

Parameter	Value
Elevation angle	> 20 degrees elevation
Maximum transmit passive antenna gain	4.5 dBic

3.9.2 Low Elevation Antenna

Parameter	Value
Elevation angle	-15 degrees elevation
Maximum transmit passive antenna gain	2.5 dBic

3.9.3 EIRP

3.9.3.1 Minimum Tx EIRP

Omnidirectional antenna patterns vary with azimuth. The EIRP specifications here are expressed as the 10th percentile EIRP over all azimuths at the required elevation. Measurements over all azimuths at that elevation are ordered and the worst 10 percent are ignored. The device must meet the requirement for the minimum EIRP using the remaining 90% of the measurements.

At all frequencies in the transmit band from 1626.5 to 1660.5 MHz, the 10th percentile Tx EIRP of the transceiver measured over all azimuths at 20° elevation must be -5.3 dBW or more. In the band 1668-1675 MHz, the 10th percentile Tx EIRP of the transceiver measured over all azimuths at 20° elevation must be -6.2 dBW or more.

At all frequencies in the transmit band from 1626.5 to 1660.5 MHz or 1668 to 1675 MHz, with a low elevation antenna the 10th percentile Tx EIRP of the transceiver measured over all azimuths at -5°elevation must be -4.1 dBW or more.

3.9.3.2 Maximum EIRP

The maximum EIRP of the modem with the low profile antenna, in any direction and at any frequency, must not exceed 7.0 dBW.

3.9.3.3 EIRP Stability

The modem must maintain EIRP stability of 1 dB or better over the course of any transmission of 1 second or less.

3.10 Satellite Transmitting Power

The maximum transmitting power (EIRP) for the satellite is 7 dBW (OGi modem + antenna).

3.11 Multi-GNSS

Table 4: Multi-GNSS Typical Specifications

Parameter	GPS	GPS / GLONASS	GPS / BeiDou
Time to First Fix[1]			
Cold Start	30 s	27 s	28 s
Hot Start	1 s	1 s	1 s
Sensitivity			
Tracking	-163 dBm	-164 dBm	-162 dBm
Hot Start	-156 dBm	-156 dBm	-156 dBm
Cold Start	-147 dBm	-147 dBm	-147 dBm
Accuracy			
Horizontal Position (CEP)[2]	-	2.5/2.0 m	-

[1] All satellites at -130 dBm.

[2] CEP, 50%, 24 hours static, -130 dBm, >6 SVs

Parameter	GPS	GPS / GLONASS	GPS / BeiDou
Velocity	-	0.05 m/s	-
Heading	-	0.3 degrees	-

3.11.1 1PPS Signal

The 1PPS signal is available in the modem. It outputs a pulse per second by default, provided a valid GPS signal is Present. If the GPS signal is blocked, the 1PPS stops.

By default the GPS is only on when requested by the application or the network. For constant time updates, the GPS must be on at all times. Timing information of the 1PPS signal is on the rising edge.

3.12 Mechanical Properties

3.12.1 OGi Modem

Parameter	Value
Mass	20 g

3.12.2 Packaged Antenna - Standard

Parameter	Value
Mass (excludes cable, side entry version)	360 g
Enclosure Material	Lexan EXL 9330

3.12.3 Packaged Antenna - Low Elevation

Parameter	Value
Mass (excludes cable, side entry version)	367 g
Enclosure Material	Lexan EXL 9330

3.12.4 Unpackaged Antenna - Standard

Parameter	Value
Mass	92 g
UV Resistance	No inherent UV stability

3.12.5 Unpackaged Antenna - Low Elevation

Parameter	Value
Mass	68 g
UV Resistance	No inherent UV stability

3.13 Physical Dimensions

All dimensions are shown in millimeters (mm).

3.13.1 OGi Modem

Figure 10: Top View Dimensions (mm)

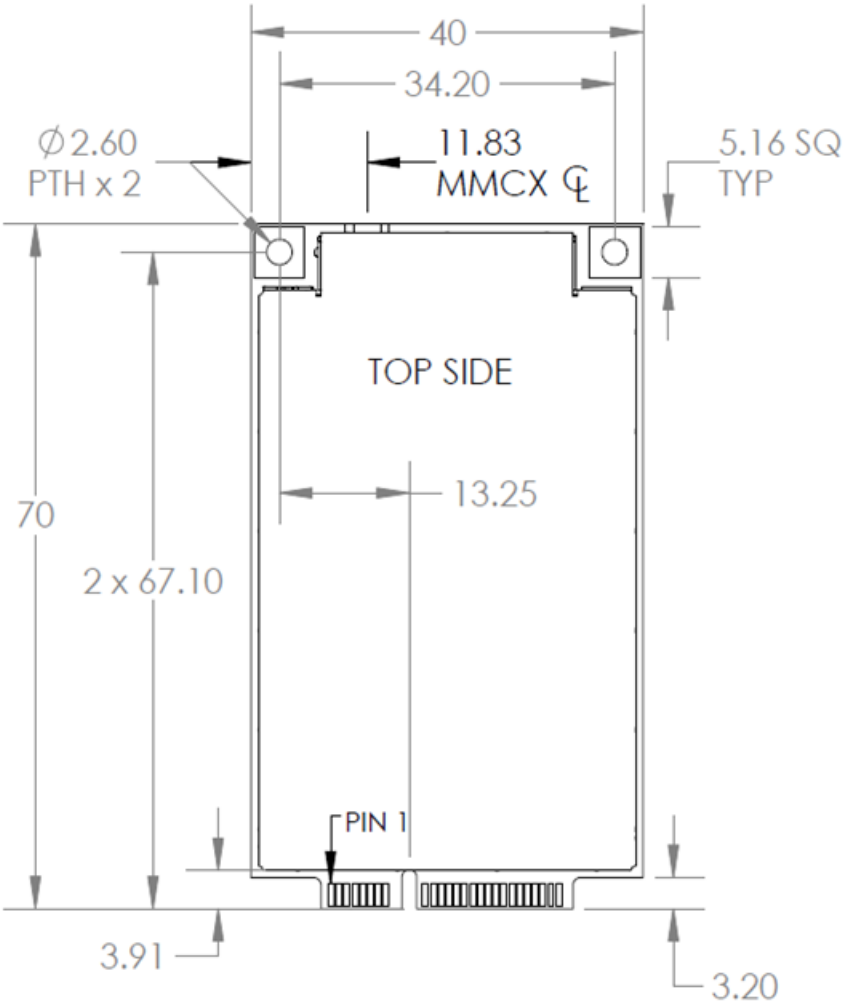


Figure 11: Side View (mm)

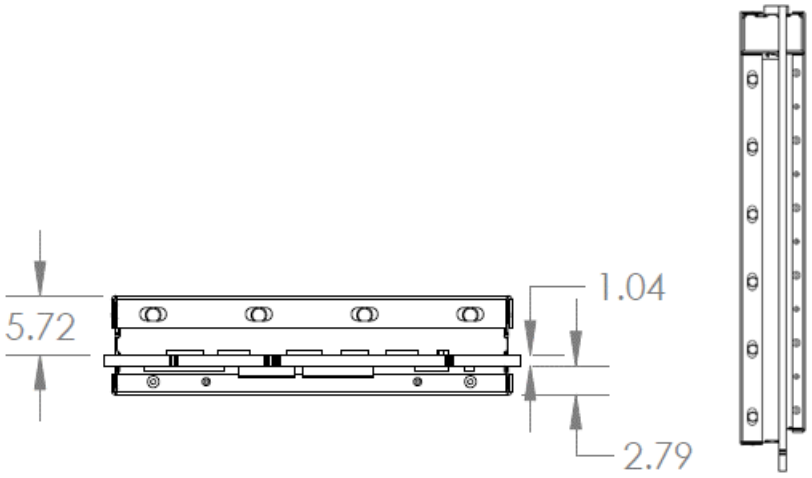
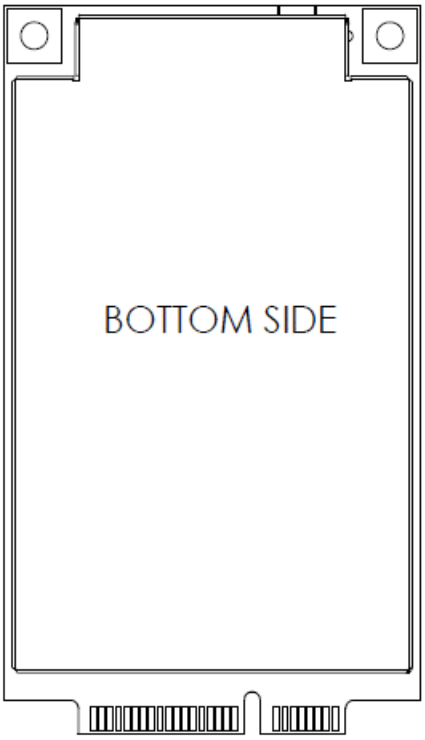


Figure 12: Bottom View



3.13.2 Packaged Antenna - Standard

Figure 13: Packaged Antenna (Standard and Low Elevation) - Bottom View (mm)

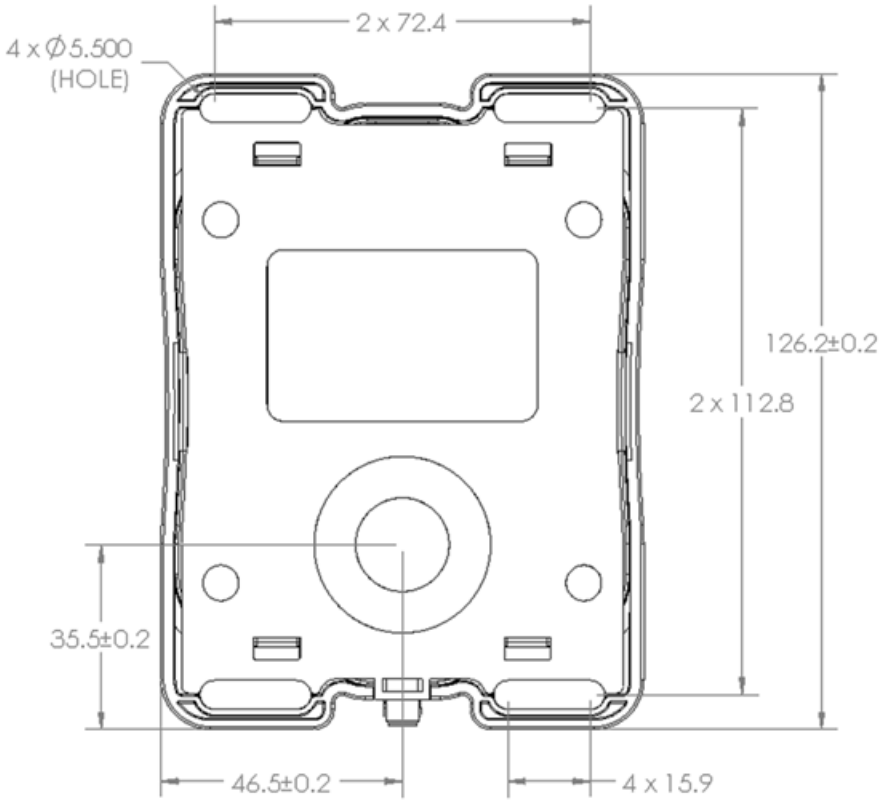


Figure 14: Packaged Standard Antenna Height Dimensions (mm)

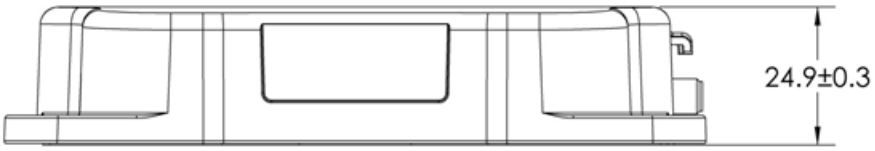


Figure 15: Packaged Low Elevation Antenna height Dimensions (mm)

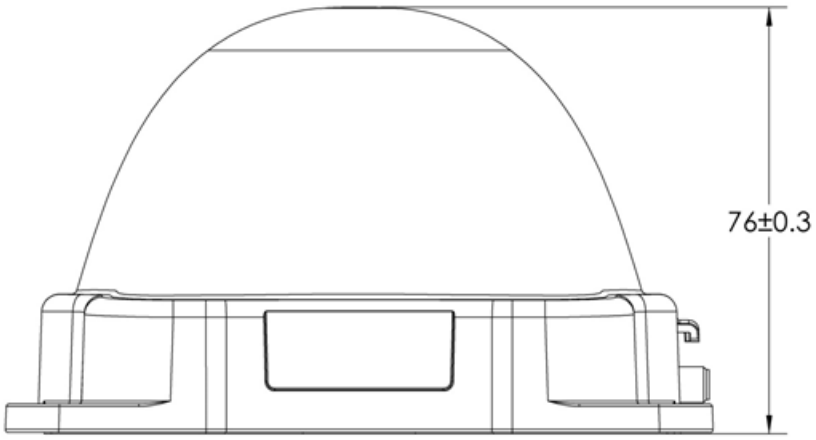


Figure 16: Standard Unpackaged Antenna - Top View (mm)

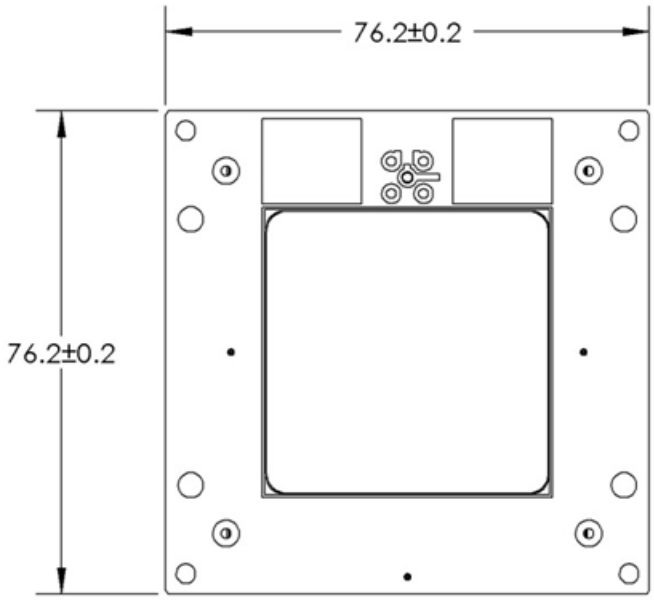


Figure 17: Standard Unpackaged Antenna - Side View (mm)

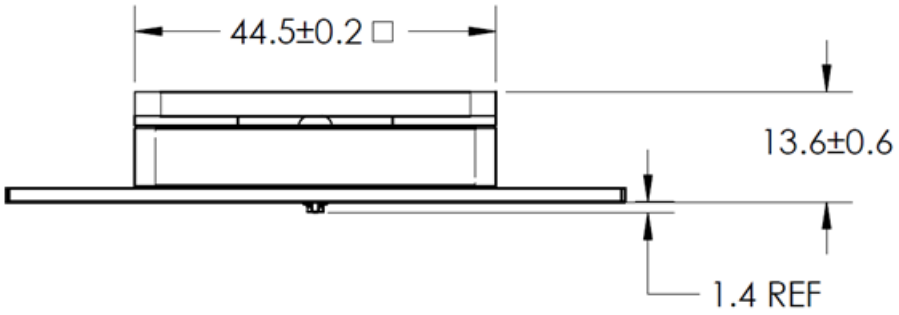


Figure 18: Unpackaged Antenna (Standard and Low Elevation) - Bottom View (mm)

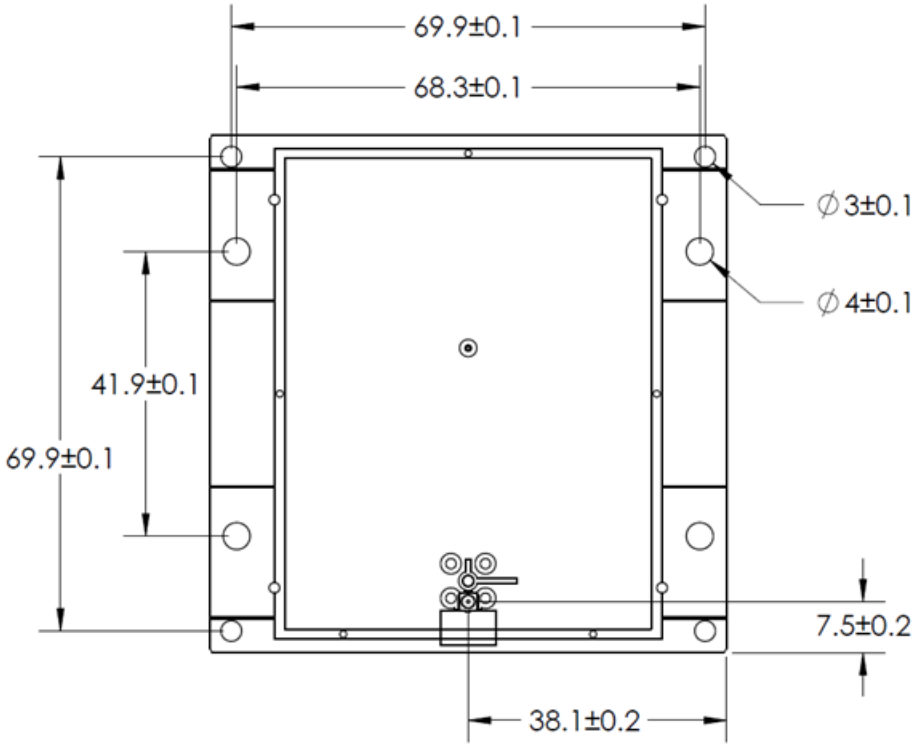


Figure 19: Unpackaged Antenna (Low Elevation) - Top View (mm)

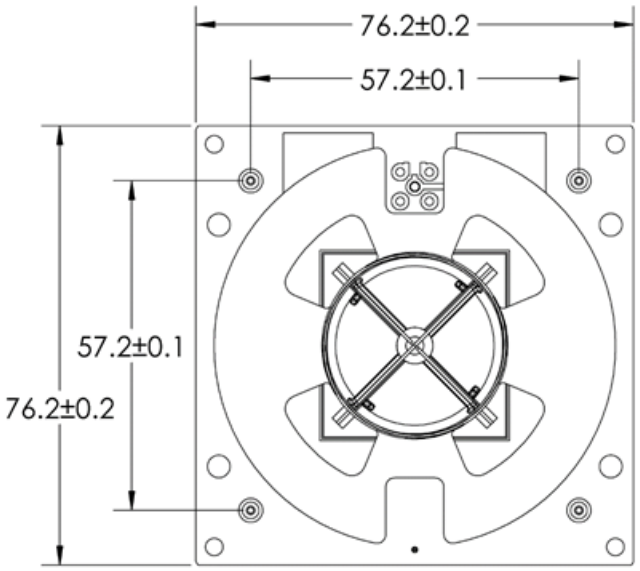
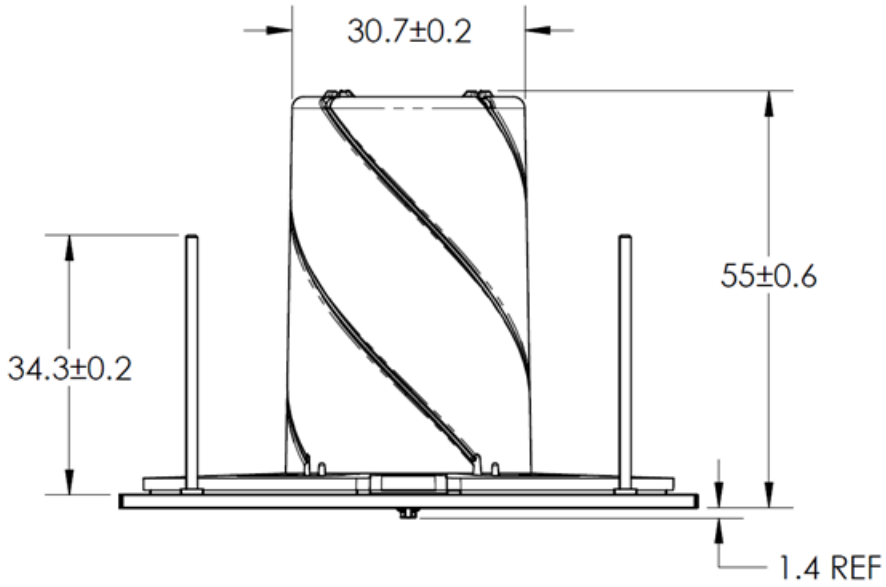


Figure 20: Unpackaged Antenna (Low Elevation) - Side View (mm)



3.14 Environmental

References to SAE J1455 (section 4.1.3.1) refer to the 2006 version.

Temperature

Parameter	Value
Operating temperature range	-40°C to +85°C -40°C to +85°C
Storage temperature	-40°C to +85°C -40°C to +85°C

Modem

Parameter	Value
Vibration	The modem meets all its specifications during exposure to random vehicular vibration levels per SAE J1455, section 4.10.4.2 and MIL-STD-810G, section 514.6, fig 514.6C-1.
Mechanical Shock	The modem meets all its specifications after exposure to positive and negative saw tooth shock pulses with peaks of 20G and durations of 11 ms as specified in MIL-STD-810G, section 516.6, Procedure I, section 2.3.2c, 3/axis/(positive and negative direction).

Packaged Antenna

The antenna is an IP67 enclosure that contains no user serviceable parts.

Parameter	Value
Humidity	The packaged antenna meets all its specifications during exposure to 90% relative humidity at +85°C, per the test methodology of SAE J1455, section 4.2.3.
Vibration	The packaged antenna meets all its specifications during exposure to random vehicular vibration levels per SAE J1455, section 4.9.4.2 and MIL-STD-810G, section 514.6, fig 514.6C-1.
Mechanical Shock	The packaged antenna meets all its specifications after exposure to positive and negative saw tooth shock pulses with peaks of 20G and durations of 11 ms as specified in MIL-STD-810G, section 516.6, Procedure I, section 2.3.2c, 3/axis/(positive and negative direction).
Altitude	The packaged antenna meets all of its specifications after a non-operating 12.2 km altitude test as detailed in SAE J1455, section 4.9.3, except with an ambient temperature of -40°C.
Thermal Shock	The packaged antenna meets all of its specifications after a thermal shock test as detailed in SAE J1455, section 4.1.3.2.
Salt Spray Atmosphere	The packaged antenna meets all of its specifications after a salt spray test as detailed in SAE J1455, section 4.3.3.1.
Immersion	The packaged antenna meets all of its specifications after a 6 hour alternating hot/cold salt water immersion test as detailed in SAE J1455, section 4.3.3.2. The remote antenna meets all of its specifications after a 30 minute, 1 m depth fresh water immersion test as detailed in IEC 60529, section 14.2.7.

Parameter	Value
Exposure to Chemicals and Oils	The packaged antenna meets all of its specifications after a light to moderate splash test as detailed in SAE J1455 section 4.4.3.2, for the following chemicals: Window Washer Solvent Gasoline Diesel Fuel Fuel Additives Alcohol Anti-Freeze Water Mixture Degreasers Soap and Detergents Steam Waxes Kerosene Freon Spray Paint Paint Strippers Ether Dust Control Agents (magnesium chloride) Moisture Control Agents (calcium chloride) Ammonia Aluminum brightener (acid wash)
Steam Cleaning and Pressure Washing	The packaged antenna meets all of its specifications after a steam cleaning and pressure wash test as detailed in SAE J1455, section 4.5.3.
Fungus	The packaged antenna meets all of its specifications after a fungus test as detailed in SAE J1455, section 4.6.3.
Dust and Sand Bombardment	The packaged antenna meets all of its specifications after a dust and sand bombardment test as detailed in SAE J1455 section 4.7.3. The remote antenna meets the acceptance conditions of IEC 60529 section 13.6.2 after a dust and sand bombardment test as detailed in IEC 60529 section 13.4. The RF connector at the end of the remote antenna cable intended to be mated with the enclosed modem board was not subjected to dust and sand bombardment during the tests.
Drop Test	The packaged antenna meets all its specifications after a handling drop test as specified in SAE J1455 section 4.11.3.1.
Flammability	UL94, IEC 60707, 60695-11-10 and 60695-11-20.

Unpackaged Antenna

The unpackaged antenna met the following specifications when mounted to a rigid structure. Note that the rigidity and strength of the mounting structure must be considered to maintain or comply with these specifications.

Parameter	Value
Vibration	The unpackaged antenna meets all its specifications during exposure to random vehicular vibration levels per SAE J1455, section 4.9.4.2 and MIL-STD-810G, section 514.6, fig 514.6C-1.
Mechanical Shock	The unpackaged antenna meets all its specifications after exposure to positive and negative saw tooth shock pulses with peaks of 20G and durations of 11 ms as specified in MIL-STD-810G, section 516.6, Procedure I, section 2.3.2c, 3/axis/(positive and negative direction).
Altitude	The unpackaged antenna meets all of its specifications after a non-operating 12.2 km altitude test as detailed in SAE J1455, section 4.9.3, except with an ambient temperature of -40°C.
Thermal Shock	The unpackaged antenna meets all of its specifications after a thermal shock test as detailed in SAE J1455, section 4.1.3.2.

3.15 Mobile Identification Number

Each modem has a mobile ID used to register it on the network. The mobile ID is a 15-digit alphanumeric identifier in the format NNNNNNNNSKYXXXX.

Figure 21 shows the location of the sticker.

Figure 21: Mobile ID Location

4 INTEGRATION GUIDELINES

This section contains a number of guidelines to assist the OEM Integrator in building their enclosure. It must be recognized that this section provides guidelines only and each OEM Integrator must use their own discretion to finish the integration approach that works for them.

4.1 Regulatory Guidelines

The OEM Integrator must recognize the importance of regulatory requirements for their integrated design. These requirements can have a major impact on the product design functioning and schedule. Further, as the regulatory requirements can be quite complex, ORBCOMM recommends that OEM Integrators always seek the advice of a regulatory expert prior to starting integration. This advice allows the OEM Integrator to properly plan and schedule design and test requirements.

When the regulatory tests are defined, it is also important to identify authorized test labs that are qualified to perform the required tests. Prior to a design, critical tests should be identified. It is recommended that the OEM Integrator pretest any high risk critical specifications early in the design stage.

4.2 Compliance

Refer to section 2 for compliance information.

4.2.1 Reference Power Supply

The internal power supply operates between 5.0 and 15.0 VDC, referred to as the modem power input port.

4.2.2 Review Process

The OGi modem integration can be challenging as the modem is a sensitive receiver that has stringent emission specifications.

To help minimize integration risk, it is recommended that the OEM Integrator consult with ORBCOMM and review the mechanical integration prior to starting a detailed design.

4.3 Installation Provisions

A reliable installation for the OEM Product is critical. ORBCOMM recommends that the OEM Integrator consider the following important mounting guidelines when designing their OEM Product.

- Installation into brackets, mounting holes or alternatives that allow the OEM product to be mounted securely to an asset.
- Consideration for cable ingress into the OEM Product to ensure minimum cable length and to prevent water from leaking into the OEM Product.

4.4 EMI/EMC Guidelines

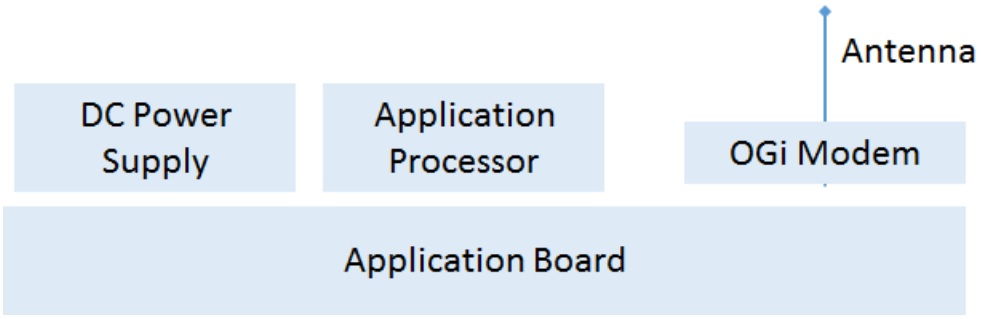
The modem and antenna form a highly sensitive receiver that can receive very weak satellite or GNSS signals. The highly sensitive receiver can also pick up noise or other interference. Components such as processors and support circuitry should be shielded with good quality shielding. It is also recommended that RF coupling/bypass capacitors

be added to the power supply rail, as close as possible to the modem's power pin. Digital interface devices should be shielded, and care must be taken to ensure the digital interface cable does not run close to the antenna.

4.5 Typical Integration

The modem is intended to be used in a larger system. The system must provide adequate power (low noise and relatively high current) and must possess an electrical signaling mechanism compatible with the modem. Ensure that the custom designed circuit board does not create undesirable signals that can impact the performance of the modem. An external antenna is required to complete the modem design.

Figure 22: Typical OEM Integration Modem Design



4.5.1 Application Board Integration

Consider the following when integrating the application board.

Source Mini PCI/E Connector

The modem uses a specific Mini-PCI/E connector that has 52 pins with a pitch of 0.8 mm. ORBCOMM recommends the following part numbers when designing an application board.

Manufacturer	Connector Model
Molex	48338-0065 (tall, suitable for components underneath)
TE Connectivity	1775838-2
FCI	10123908-xxxLF

Mechanical Plan

It is recommended that you do not place any application board components (e.g., SMT passive components) under the modem. This prevents mechanical strain on the connector and any risk of electrical shorting.

You must have secure and vibration resistant mounting at the screw holes. Lock washers are recommended. Refer to section 3.12 for dimensions.

Noise Mitigation

The OGi receiver is sensitive to noise. One strategy is to eliminate noise in the time domain. It is best if you have the minimum circuitry active during satellite receives. This requires that you have separate power rails, one for the processor and one for the modem, to power down potentially noisy circuitry. Overall, the best way to avoid potential receiver spurs is to offset application and receiver processes in time.

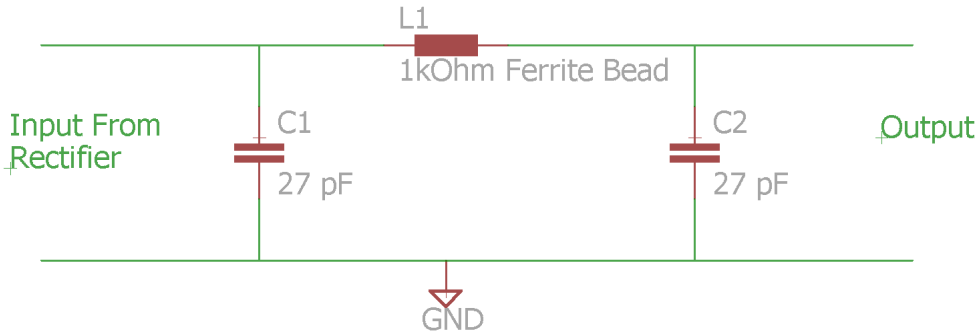
You can also eliminate noise in the frequency domain. To do so, use RF decoupling capacitors and ferrite beads to isolate noisy digital circuits.

Recommended Parts	
Decoupling Capacitors	27pF 0402 package or 33pF 0603 package
Ferrite Beads	Use high impedance ferrite beads on both power rails and noisy digital circuits

Remember to include 0R resistors and unpopulated decoupling caps on power rails and key signals.

Power supplies are often noisy, and should also be filtered to mitigate noise. Figure 23 shows an example of how the parts mentioned above can be used to filter power supply noise.

Figure 23: Recommended Pi Filter for Main Power Supply - for small current



Power Supply Design

Depending on the application, you might have stringent power consumption limitations for application board design. The following tools are helpful to optimize power consumption and monitor application activity.

- Current Data Logger - This tool allows developers to measure and log power consumption for application boards. It can also aid in the development of a total system power budget. This tool is available from the Customer Support website.
  - Download the CurrentDataLogger.zip file to your computer and unzip the file.
  - Detailed instructions about how to use the tool are included in the zip file.
  - The following are components required to run the tool:

    - Agilent IOLibSuite (CurrentDataLogger\Agilent34410Driver)

    - Agilent IVI-COM (CurrentDataLogger\Agilent34410Driver\[64|32]bit\driver_ivicom_ivic_matlab_Agilent34410...)

    - Visa Shared Components (CurrentDataLogger\Agilent34410Driver\[64|32]bit\VisaSharedComponent.)

    - Run Setup.exe (CurrentDataLogger\)

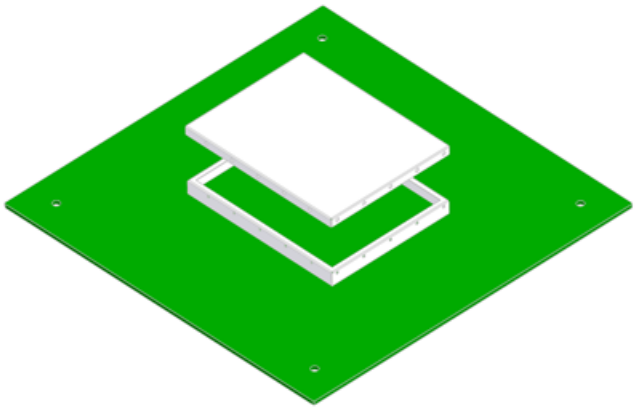
- USB Multimeter - This tool aids developers with measurements and is paired with CurrentDataLogger through the above Agilent Plugins. It is available from http://www.keysight.com/en/pd-2270273-pn-34461A/digital-multimeter-6-digit-34401a-replacement-truevolt-dmm?nid=-536902435.1058513&cc=CA&lc=eng

Application Board PCB Layout

Consider the following when planning the overall PCB layout for application boards using the OGi modem:

- Application boards must have room for shields.

Figure 24: Example of PCB Level Shielding



- The entire board must have a continuous ground (split grounds are not recommended).
- Avoid power planes that cover the entire board, traces are recommended.
- Avoid surface routing on the processor to the memory bus.

4.5.2 Antenna Cable Guidelines

The OEM Integrator is responsible for designing a custom-made RF cable to connect antenna and modem. The following recommendations provide some guidelines for RF cable selection:

Application	Cable Type	Connector	Max. Total Loss at 1.6 GHz	Cable Example
Packaged/Remote Antenna cable	RF Coaxial 50 Ω	MMCX male/SMA male	1.5 dB	LMR195
Unpackaged Antenna Cable	RF Coaxial 50 Ω	MMCX male/IPEX plug male	0.5 dB	-

4.5.2.1 General Guidelines for Antenna Positioning

Antenna placement is important. When positioning the antenna consider EMI performance of the integrated product and visibility to the sky.

Depending on the EMI performance of the integration product, the satellite antenna may need to be placed a distance away from the integrated product.

The antenna must be positioned such that it has a good view of the sky and there is no metal/circuit board nearby to interfere with or block the antenna.

4.5.2.2 Remote Antenna Configuration

It is recommended that any remote antenna (packaged or unpackaged) be placed no more than a 1.5 dB loss away from an OGi board level shielded modem. This recommendation also applies for OGi overshielded modems.

Figure 25: OGi Overshielded with Remote Standard Antenna

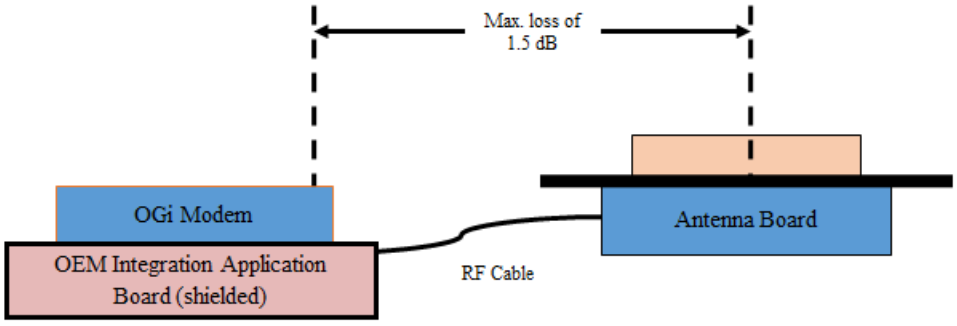
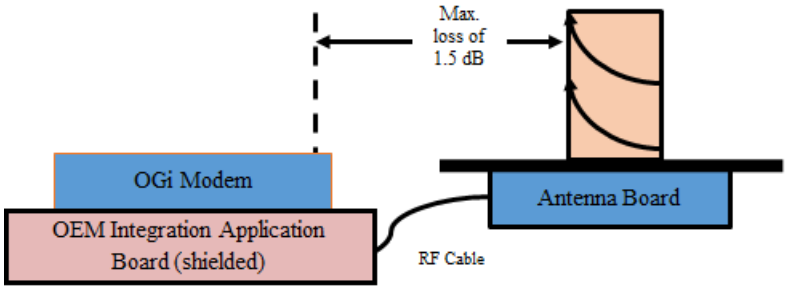


Figure 26: OGi Modem with Remote Low Elevation Antenna



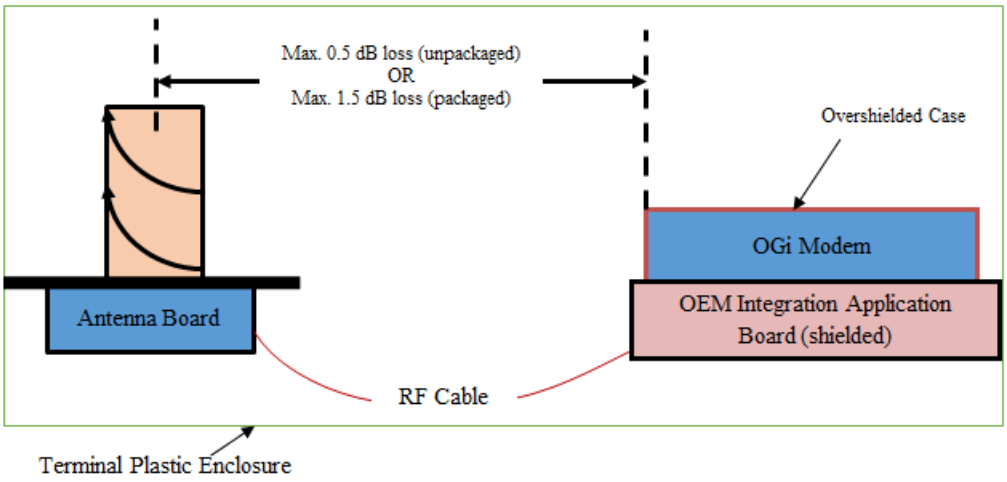
4.5.2.3 In-Housing Antenna Design Configuration

Special consideration is required when placing the remote antenna into the same housing as other components such as the OGi modem, application board or circuit boards. The following examples provide some guidance.

- OGi modem is mounted on an OEM Integration application board

  If the OGi modem is mounted to an OEM Integration application board, the separation between the OGi modem and the antenna can be no more than the values indicated in the figures below.

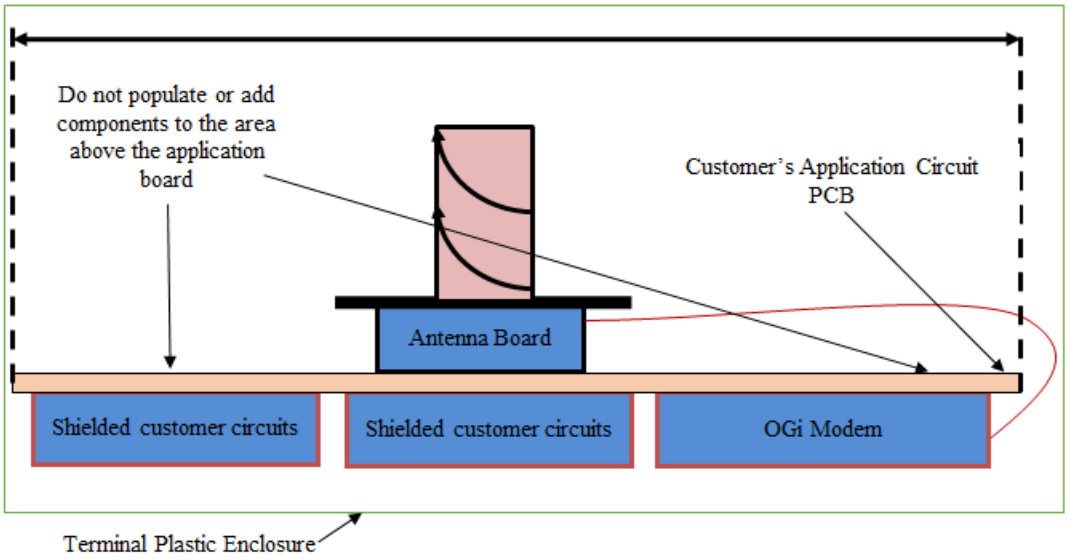
Figure 27: OGi Modem and Customer's Application Board



- OGi Modem is mounted on a large application board

  To avoid the highly sensitive antenna picking up noise from the OGi modem or a customer's circuit, the antenna can be configured and mounted to the bottom of a customer's large application circuit board.

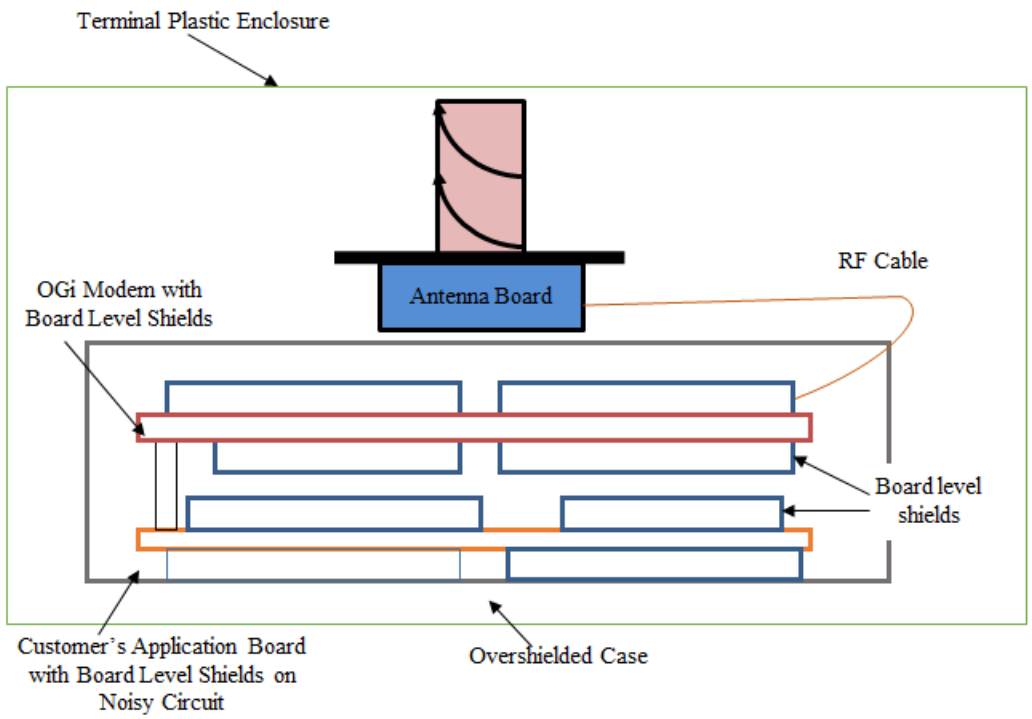
Figure 28: OGi Modem on a Larger Application Board



- OGi modem board and the customer's application board are installed into a customer designed overshielded case.

  With good overshielding to shield both the application board and the OGi modem board, it is possible to place the antenna much closer. For this configuration it is recommended that there not be any holes in the case.

Figure 29: OGi Modem (overshielded) with an Application Board and Antenna on Top



4.5.3 Host Shielding

In a typical integration, the modem is controlled by a microcontroller.

The microcontroller and supporting circuitry, such as memory, high speed data/address bus, clock references and power supply sources are normally noisy and could potentially affect the highly sensitive satellite or GPS receiver performance if the antenna is placed too close to the circuitry.

The following guidelines are provided when building a microcontroller board that interfaces with the modem.

- Microcontroller and circuitry should be fully shielded.
- Digital interfaces such as serial ports, USBs and I2C along with their tracks should be shielded.
- Avoid running any digital interface connector and cable close to the antenna. Do not route any metal or cable above the ground plane of the antenna board or above the antenna.

4.5.4 Decoupling

The following are recommendations for the power supply and digital lines to reduce emissions that could be picked up by the modem.

- RF decoupling/bypass capacitors (22pF 0403 or 33pF 0603 typical) should be added as close as possible to the modem's power pin on the power supply rail of the processor and high speed digital circuitry.
- RF decoupling/bypass capacitors should be added on the interface power rails.

4.6 Maximum Current

It is recommended that the power supply be designed with a margin to supply the maximum current required by the modem. Refer to sections 3.4.1 and 3.4.2 for maximum current and inrush current requirements when designing a power supply.

4.7 Enclosure Design

The modem is not designed for outdoor environments. Consequently, the enclosure typically requires a robust environmentally sealed enclosure that can house the modem.

The following guidelines are recommended for the enclosure design.

- An IP67 rating[1] or better for outdoor use.
- Use enclosure materials that are transparent to L-Band (1-2 GHz) radio signals.
- Lexan Resin EXL 9330 is a common recommended enclosure material, but there are many other suitable materials.
- The unpackaged standard antenna is supplied with a dielectric cap, a piece of plastic over the ceramic patch antenna that helps to negate the effects of different enclosure materials on the performance of the antenna. With the dielectric cap, the standard unpackaged antenna can be placed as close as desired to the adjacent enclosure material.
- The unpackaged low elevation antenna is less sensitive to enclosure material selection and does not require a dielectric cap.
- Do not use metallic paint or tinting that may be conductive.

4.7.1 Sticker Guidelines

The sticker on the modem includes its mobile ID. If the modem is placed inside of an enclosure that is not intended to be opened, an exterior label must be affixed to the enclosure, in a visible location.

When integrating the modem into an enclosure, you must do one of the following:

- Provide visibility of the modem through a window.
- Provide an easy way to get to the modem when an access panel or door is removed.
- Place a sticker on the outside of the final enclosure that contains the following information:
  - A copy of the ORBCOMM logo
  - Text that indicates the enclosure contains a transmitter
  - The mobile ID
  - A list of all valid certifications (for example, ETSI, Industry Canada, etc.)

With this information accessible from the exterior of the enclosure, installers can readily identify the required information.

4.7.2 Mating Connector Guidelines

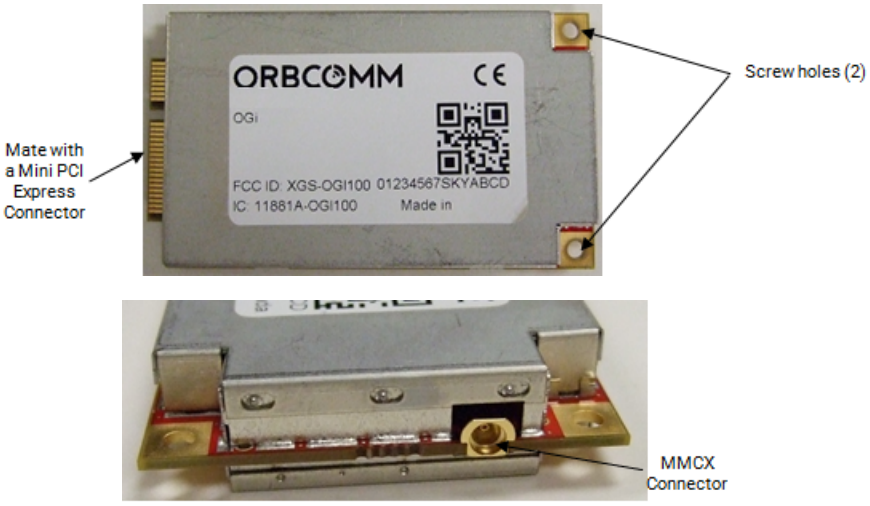
Refer to section 3.1 for connector guidelines.

[1] IEC 60529

4.8 Modem Mounting Guidelines

As shown in Figure 30 the modem has a hole in each corner of the enclosure sized for M2.5 hardware to secure the modem to an application board or other environmental enclosure surface.

Figure 30: Modem Mounting Holes



The modem inserts into the connector at an angle, and is held in place with screws and standoffs that match the connector height. The standoffs and screws generally interface to a ground connection on the host board. Mounting screws should be properly tightened to 0.80 N-m (7 pound-inches) of torque or as per the specifications of the connector manufacturer.

4.9 Unpackaged Antenna Mounting Guidelines

As shown in Figure 31 the unpackaged antenna has a set of four holes sized for M3.5 hardware to secure the antenna to an environmental enclosure surface. A second set of holes at the corner of the board can be used for mounting with #4 hardware, but the holes are tight fitting and tolerances need to be considered, so the larger hole set for mounting is recommended.

Figure 31: Unpackaged Antenna Mounting Holes

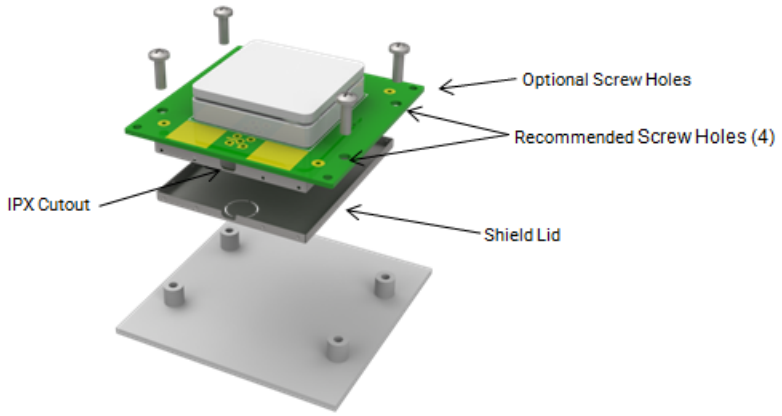


Figure 31 illustrates the recommended mounting for the unpackaged antenna to an enclosure. Follow these steps for installation:

1. Slide the IPX connector of the cable through the cutout in the shield fence and connect to the mating IPX connector on the antenna. The cable should swivel freely when properly engaged.
2. Install the shield lid onto the shield fence. Press firmly around the perimeter to ensure the lid is fully engaged.
3. Secure the antenna using four M3.5 screws and washers. Apply the appropriate torque for the chosen screw size and adjoining material.
4. Connect the free end of the cable, either an IPX connector or SMA connector, to the IDP modem. For SMA connectors, apply torque of 0.5 N-m.

CAUTION: Enclosure design should ensure that the IPX cable cannot chafe against the shield fence or the lid.

4.10 Test Process

Following is a list of suggested tools to assist with debugging the design and allowing you to scan for interference sources in the 1518-1610 MHz range:

- To detect spurs: MiniCircuits LNA: ZX60-33LN+: http://www.minicircuits.com/pdfs/ZX60-33LN+.pdf
- EMC-101A Probe Set: http://www.magneticsciences.com/EMCProbes.html
- SMA-Adapter: http://www.magneticsciences.com/EMCProbes.html
- Generic 3GHz spectrum analyzer (Benchtop version recommended)

5 FIELD INSTALLATION

The following section contains the recommended installation guidelines for field installing the OEM Product. It is recommended that the OEM Integrator include these in the installation guidelines for end users.

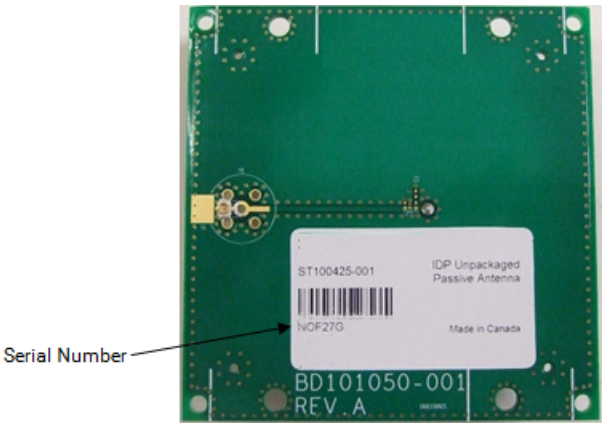
5.1 Mobile Identification and Serial Number

The mobile ID is located on the OGi modem. To facilitate installation the mobile ID should be visible on the OEM Product.

The packaged antenna serial number is located on the side as shown in Figure 32. The unpackaged antenna serial number is located on the bottom shield as shown in Figure 33.

Figure 32: Packaged Antenna Serial Number Sticker Location

Figure 33: Unpackaged Antenna Serial Number Sticker Location



5.2 Follow OEM Product Mounting Guidelines

The OEM Integrator should provide installation procedures for their OEM Product.

Each OEM Product has its own unique mounting requirements. The OEM Integrator should consider the following important mounting guidelines for their OEM Product.

CAUTION: It is very important for installers to install the modem in a safe and secure way to avoid danger or damage to persons or property.

6 ANTENNA INSTALLATION

The following section contains the recommended installation guidelines for installing the antenna. It is recommended that the OEM Integrator include these in the installation guidelines for end users.

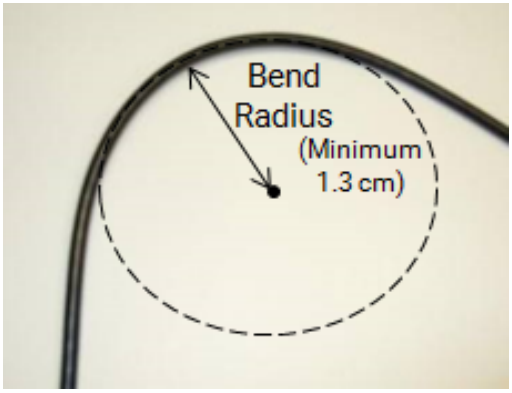
6.1 Antenna Mounting Guidelines

CAUTION: Mount the antenna at least 25 cm away from humans.

The following guidelines for mounting the remote antenna also apply to an OEM Product that includes the unpackaged antenna where applicable.

- For fixed installations ensure that the antenna is pointing toward the equator, facing south if in the Northern Hemisphere and facing north if in the Southern Hemisphere, and its line of sight to the sky (satellite) is clear of obstructions.
- For a mobile installation, mount the antenna at the highest point on the vehicle or vessel where it has a clear view of the sky (satellite) in all directions.
- Do not mount the antenna near metal objects. The antenna can communicate with the satellite through fiberglass, but not through metal. Metal causes interference if it is above the antenna and within 10.2 cm from the top of the antenna. Respect the 20° or -15° elevation angle requirement with metallic object. Ensure that the antenna is at least 1.3 cm higher than the metallic surface in cases where it must be mounted next to a vertical metallic surface.
- Ensure that any paint above the antenna is non-metallic and non-metallic flake, if the installation is under fiberglass or composite wind fairings.
- Mount the antenna on a surface that does not exceed the antenna's maximum operating temperature. Locating the antenna where temperatures exceed the recommended range might compromise performance.
- Do not mount the antenna close to an exhaust pipe due to the excessive heat and the potential for the exhaust pipe causing satellite blockage.
- Do not mount the antenna close to air horns or any tractor roof hardware (for example, emergency lights) that could interfere with satellite communications.
- Mount the antenna on the driver's side of the vehicle, if possible, when there is a possibility of strikes by overhanging tree branches.
- Do not drill any holes before checking that you have room for the bend radius of the low loss coax cable. For reliable operation, do not go below a bend radius of 1.3 cm. Measure the bend radius of the cable as shown in Figure 34.

Figure 34: Antenna Cable Bend Radius



- Mount on a surface that is free from dirt, grime, water and grease to avoid damaging the mounting surface or the vehicle's paint.
- Mount so that the cable end faces the rear of the vehicle.

6.2 Mount a Remote Antenna

Two mounting options are available for the remote packaged satellite antennas: screw mount or silicone mount. OEM Integrators, who have included an unpackaged antenna within their product, should apply any packaged antenna restrictions mentioned in this section, to the mounting of their own product.

6.2.1 Screw Mount

If mounting a remote antenna the following tools and materials are required:

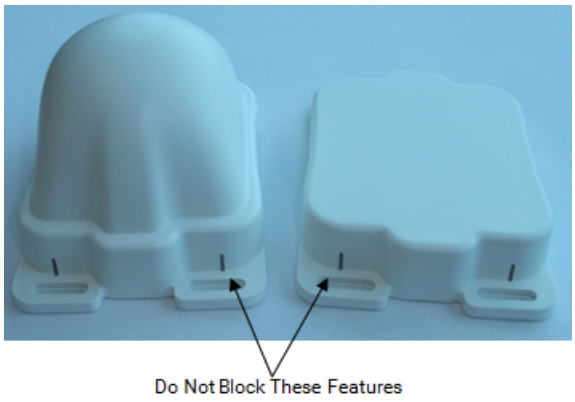
- Drill
- M4 hardware
- Outdoor waterproof adhesive sealant (silicone)

To mount the antenna, follow the steps below.

1. Find a location for the remote antenna following the guidelines provided in section 6.1.
2. Use the mounting template (APPENDIX B) or the antenna as a template, to mark the location of the mounting holes.
3. Drill the mounting holes using the drill.
4. Apply waterproof sealing compound, such as RTV silicone, around the drill holes so water does not seep into the asset.

   CAUTION: Adhesive or silicone cannot block the air vent features shown in Figure 35.

Figure 35: Air Vent Feature



5. Secure the antenna in place with self-tapping screws or machine screws and nuts depending on access to the mounting surface. The remote antenna might also be mounted using adhesive or a high strength outdoor grade silicone when mounting holes are not an option in the mounting surface

   Note: The recommended torque specification is approximately finger tight plus a 45 degree rotation using an 8 mm wrench.

   CAUTION: Cable management and connector strain relief MUST be incorporated in the installation. Secure the cable no more than 15 cm from the enclosure and at regular intervals along its length as part of the installation to prevent cable wear and eliminate strain on the terminal connector. Damage to the connector interface or cable might otherwise result leading to hardware failure.

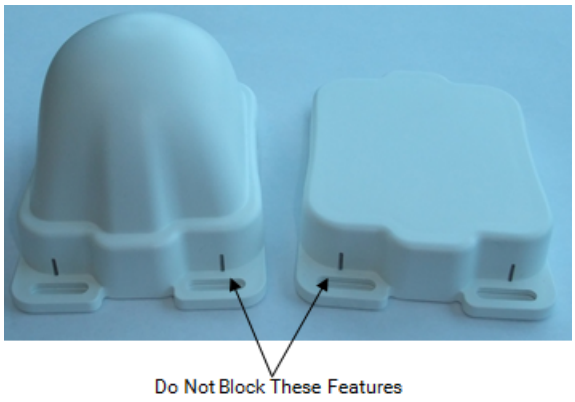
6.2.2 Adhesive Mount

The remote antenna might also be mounted using adhesive or a high strength outdoor grade silicone when mounting holes are not an option in the mounting surface.

Refer to the adhesive manufacturer's recommendations for application temperature, application conditions, compatible bonding materials, and minimum curing times when working with an adhesive. Failure to follow the manufacturer's guidelines could result in the remote antenna separating from the mounting surface.

CAUTION: Adhesive or silicone cannot block the air vent features shown in Figure 36.

Figure 36: Air Vent Feature



6.2.2.1 Silicone Side Connector Mount

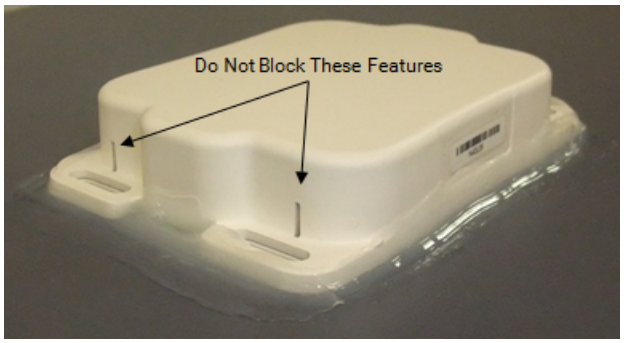
The following tools and materials are required if mounting a side cabled remote antenna with silicone.

- Outdoor rated silicone adhesive sealant (GE RTV 108)
- Isopropyl alcohol or an equivalent

To mount the antenna:

1. Find a location for the remote antenna following the guidelines provided in section 6.1.
2. Clean the asset surface with isopropyl alcohol or an equivalent product that does not leave a residue.
3. Apply silicone around the hole in the asset and to the bottom surface of the remote antenna and position onto the assets surface.
4. Apply a generous bead of silicone around the entire perimeter of the remote antenna enclosure. The two vertical slots shown in Figure 37 are vent features and must not be filled with silicone.

Figure 37: Apply Silicone to Remote Antenna



5. Place some weight on the remote antenna while the silicone cures.

   CAUTION: Cable management and connector strain relief MUST be incorporated in the installation. Secure the cable no more than 15 cm from the antenna enclosure and at regular intervals along its length as part of the installation to prevent cable wear and eliminate strain on the terminal connector. Damage to the terminal connector interface or cable might otherwise result leading to hardware failure.

6.2.2.2 Silicone Bottom Connector Mount

The following tools and materials are required if mounting a bottom cabled remote antenna with silicone.

- Outdoor rated silicone adhesive sealant (GE RTV 108)
- 5/16” or 8 mm wrench
- Drill
- 12 to 19 mm drill bit for a straight SMA cable connector
- 29 mm minimum drill bit (hole saw) for right angle SMA cable connector
- Isopropyl alcohol or an equivalent

To mount the antenna:

1. Find a location for the remote antenna following the guidelines provided in section 6.1.
2. Drill a 12 to 19 mm hole in the asset surface Figure 38) when using a straight SMA cable connector. For a right angle SMA cable connector, drill a minimum hole diameter of 29 mm.

   Refer to the note in step 7 if the right angle hole is considered too large.

Figure 38: Drill Mounting Hole

3. Clean the asset surface with isopropyl alcohol or an equivalent product that does not leave a residue.
4. Insert the cable through the hole, from inside the asset, and thread the cable connector onto the antenna. Torque the connector finger tight plus a 45 degree rotation using an 8 mm wrench.

Figure 39: Attach Cable to Antenna

5. Apply silicone around the hole in the asset and to the bottom surface of the remote antenna.

Figure 40: Apply Silicone to Hole in Asset

6. Lower the remote antenna onto the mounting surface.

   The straight SMA cable connector can be lowered straight down onto the mounting surface.

The right angle SMA cable connector, not shown, must be pivoted down onto the mounting surface to fit the right angle cable and connector through a larger clearance hole. Additional care is required with this installation to ensure the right angle cable and connector does not smear the silicone around the clearance hole when attempting to pivot the antenna into position.

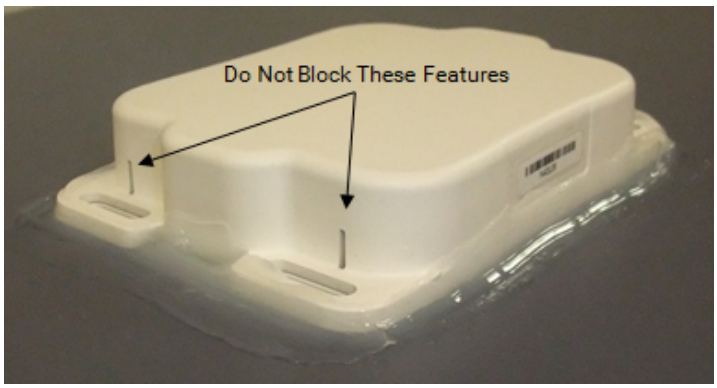
7. Apply a generous bead of silicone around the entire perimeter of the remote antenna enclosure. The two vertical slots shown in Figure 37 are vent features and must not be filled with silicone.

   Note: If the large clearance hole required for the right angle SMA cable connector is considered too large, you have the option to use a smaller clearance hole in the mounting surface and install the cable from inside the asset after the antenna has been adhered with silicone.

   In this case, first confirm there is enough room from inside the asset to thread the SMA cable connector by hand and clearance for the wrench to apply the final torque.

   Also note that the silicone used to mount the antenna must be fully cured before the cable can be installed from the inside otherwise the seal and mounting are compromised.

Figure 41: Apply Silicone to Terminal



8. Place some weight on the remote antenna while the silicone cures.

   CAUTION: Cable management and connector strain relief MUST be incorporated in the installation. Secure the cable no more than 15 cm from the antenna enclosure and at regular intervals along its length as part of the installation to prevent cable wear and eliminate strain on the terminal connector. Damage to the terminal connector interface or cable might otherwise result leading to hardware failure.

APPENDIX A ORDER PART NUMBERS

Packaged Antennas	**Part Number**
Standard (side mount SMA connector, no cable)	ST100368-NSA ST100368-NSB
Standard (bottom mount SMA connector, no cable)	ST100368-NSB
Low Elevation (side mount SMA connector, no cable)	ST100369-NSA
Low Elevation (bottom mount SMA connector, no cable)	ST100369-NSB
Unpackaged Antennas	**Part Number**
Standard (passive antenna)	ST100425-001
Low Elevation (passive antenna)	ST100426-001
Contact your Account Executive for additional products and ordering codes	

APPENDIX B REMOTE ANTENNA TEMPLATE

CAUTION: Before drilling check the template against actual hardware for dimensional accuracy. If it is not correct, DO NOT USE THIS TEMPLATE.

CAUTION: Cable management and connector strain relief MUST be incorporated in the installation. Secure the cable no more than 15 cm from the antenna enclosure and at regular intervals along its length as part of the installation to prevent cable wear and eliminate strain on the connector. Damage to the connector interface or cable may otherwise result leading to hardware failure.