ORBCOMM™

CONNECTING THE WORLD'S ASSETS

ST 6000

Hardware Guide

T407, Version 0.10 BETA

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LEGAL NOTICE

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PREFACE

Purpose

This document provides an overview of the hardware characteristics and specifications for the 20-pin ST 6000.

Notation

An OEM Integrator is an ORBCOMM customer who purchases an ST 6000 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.

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 may be useful in conjunction with this guide. These documents are available from the ORBCOMM Developer Toolkit (hereafter referred to as the Toolkit) or customer support.

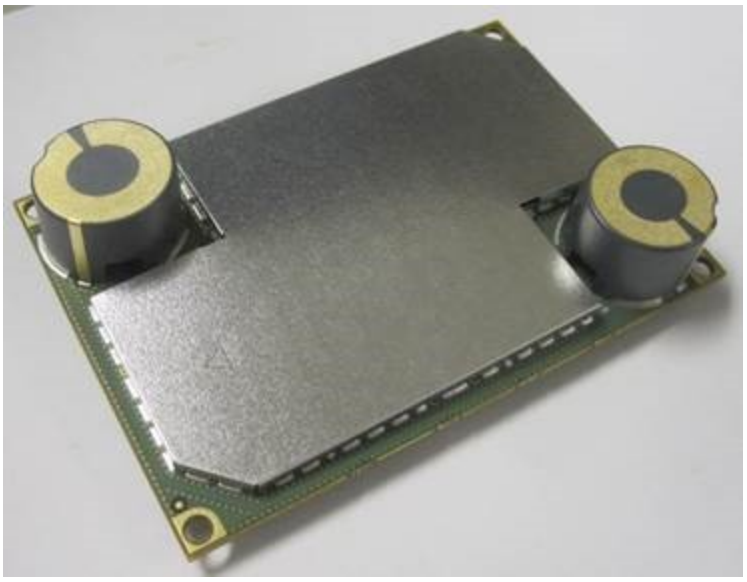
[T404]	LSF Developer Guide for FW v3.x
[T405]	IsatData Pro Service API Reference for FW v3.x

1 OVERVIEW

The ST 6000 provides a high performance, low latency, two-way communication solution that uses the IsatData Pro network.

The device consists of a Lua application controller, integral antennas, a satellite modem for communicating with the satellite, an integral GNSS subsystem, several input/output feeds capable of monitoring and controlling external sensors and devices, and dedicated serial ports (two RS-232 ports and an RS-485). Solution Providers (SPs) must create a custom power supply for their particular application.

Figure 1: ST 6000



The ST 6000 is suitable for both industrial and fixed applications, and it can work as a standalone data-messaging device, with built-in I/O data collection and processing capabilities. Feature-rich software tools make programming easy and shorten the design and testing time.

1.1 Key Features and Benefits

The ST 6000 has the following key features and benefits:

- Designed to be incorporated into a custom solution
- Built-in GNSS receiver to calculate position, speed, and heading that uses the satellite antenna
- Broad operational temperature range
- IsatData Pro message payload and latency capabilities

2 COMPLIANCE

Certification is pending for all the items below.

CE Mark Norms

- EN 301 426
- EN 301 489-20; EN 301 489-1
- EN 60950
- IEC 62311

FCC Regulations

- FCC ID: XGS-ST6000
- 47 CFR 25
- 47 CFR 15
- OET 65

Industry Canada Regulations

- IC ID: 11881A-ST6000
- ICES-003
- RSS-170
- RSS-102

Note: Integrators who integrate ST6000 OEM module into their final products should follow FCC and IC labeling rules to indicate the final product "CONTAINS FCC ID: XGS-ST6000 and IC ID: 1181A-ST6000" on product label. In some cases, If the regulation is applied, Integrators may need to get their own FCC ID and IC ID for the final product.

Anatel

Anatel certification and test results are available to Solution Providers for use as a baseline for the certification approval of their ST 6000 enclosure.

In all cases, the SP is responsible for ensuring that their final ST 6000 enclosure complies with all local regulatory, electrical and safety codes. As the ST 6000 enclosure contains the SP's power supply and possibly other circuitry that affects the ST 6000, likely additional testing or a repeat of some of the tests listed below may be required.

Inmarsat Type Approval

RoHS 2

- Restriction of Hazardous Substances (RoHS) 2 [1]

[1]European Union's (EU) Directive 2011/65/EU "Restriction of Hazardous Substances" (RoHS) 2 in Electronic and Electrical Equipment.

3 SPECIFICATIONS

3.1 Connectors

3.1.1 ST 6000 Connector Details

See Table 1 for ST 6000 connector details.

Table 1: Connector Details

Parameter	
Manufacturer Part Number	Samtec SFC-110-T2-L-D-A-K-TR
Connector	Rectangular, shrouded female socket, SMT
Temperature Rating	-55°C to +125°C
Insulator Material	Black Liquid Crystal Polymer
Contact Material	Phosphor Bronze
Configuration	2 x 10, SMT connector
Contact Rating	3.1 A per pin

3.1.2 Mating Connector Details

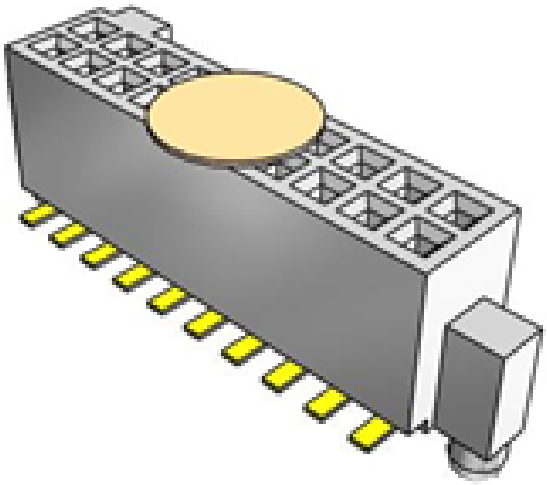
The ST 6000 requires a mating connector (not included), see Table 2.

Table 2: Mating Connector Details

Parameter	
Manufacturer Part Number	Samtec TFC-110-32-L-D
Connector	Rectangular, shrouded male header, SMT
Temperature Rating	-55°C to +125°C
Insulator Material	Black Liquid Crystal Polymer
Device Material	Phosphor Bronze
Contact Rating	3.1 A per pin

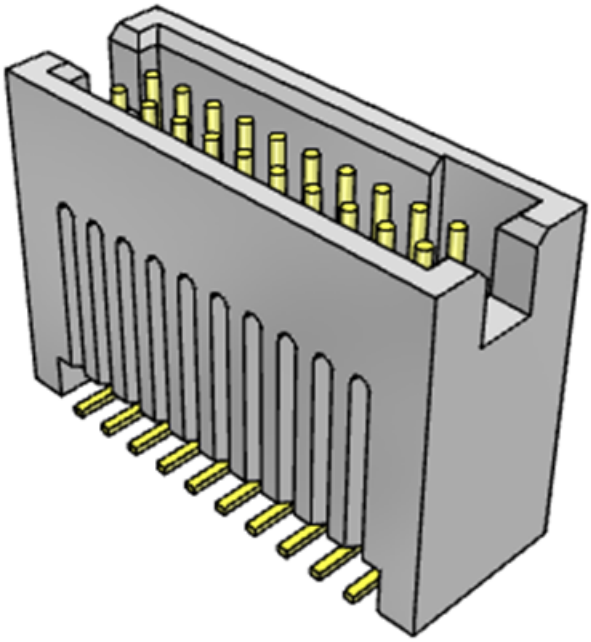
3.1.3 ST 6000 Connector

Figure 2: ST 6000 Connector



3.1.4 Mating Connector

Figure 3: Mating Connector



3.1.5 Connector Electrical Pin Assignment

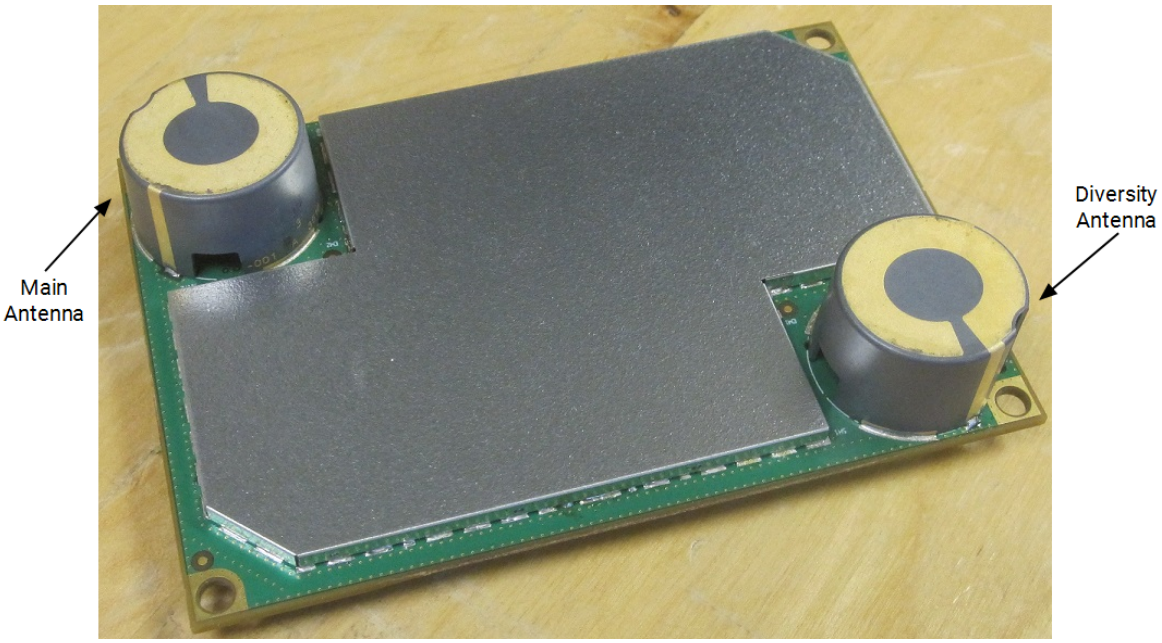
Table 3: Electrical Pin Assignment (ST 6000)

PIN	Functionality	Description
1	GND	The negative terminal of the external power supply must be connected to this pin.
2	VIN	This pin is used to provide input power directly to the power amplifier circuitry. Regulated power must be applied to this pin whenever the device drives the TX_PWR EN line high and may be removed when the TX_PWR EN line is low. Alternatively, power may be applied to this pin continuously.
3	VAUX	This is the input power pin for the RF and baseband processors. Regulated power must be applied to this pin continuously to keep the device alive.
4	TX PWR EN	This is the control signal to apply power to the VIN pin. Power must be applied to VIN whenever this signal is high. If not used (VIN powered continuously), this pin should be left unconnected.
5	RS-485/J1708 TX	3.3 V transmit data connection to the external RS-485 transceiver. This signal can also be connected to a J1708 network when the external transceiver is configured for J1708 operation.
6	AUX TX	This pin is 3.3 V compatible TTL signal to be connected to the receive input of the external serial port. May be used for logging and debugging.
7	RS-485/J1708 RX	3.3 V receive data connection from the external RS-485 transceiver. This signal can also be connected to a J1708 network when the external transceiver is configured for J1708 operation.
8	AUX RX	This pin is 3.3 V compatible TTL signal to be connected to the transmit output of the external serial port. May be used for logging and debugging.
9	Console TX	3.3V compatible TTL transmit output from the modem console port to be connected to the receive input of the external serial port.
10	OUT1	This pin is a 3.3 V TTL compatible connection for Output channel 5.
11	Console RX	This pin is 3.3 V compatible TTL receive input to the modem console port to be connected to the transmit output of the external serial port.
12	OUT2	This pin is a 3.3 V TTL compatible connection for Output channel 6.
13	I/O_1	This pin is 3.3V TTL compatible connection for Input / Output channel 1
14	I/O_3	This pin is 3.3V TTL compatible connection for Input / Output channel 3
15	I/O_2	This pin is 3.3V TTL compatible connection for Input / Output channel 2
16	I/O_4	This pin is 3.3V TTL compatible connection for Input / Output channel 4
17	1 PPS	This pin is 3.3V TTL compatible 1 pulse per second output generated by the internal GNSS module.
18	Console Valid	This pin is 3.3V TTL compatible active high input that indicates if valid RS-232 levels are present on the external console receiver input.
19	AUX Valid	This pin is 3.3V TTL compatible active high input that indicates if valid RS-232 levels are present on the external auxiliary receiver input.
20	Reset Out~	N/A

3.2 Antenna

The ST 6000 supports two standard onboard antennas: Main and Diversity. Refer to [T406] for general antenna specifications.

Figure 4: Onboard Antennas



3.3 Power

3.3.1 Input Power

The ST 6000 has two power input pins (VAUX and VIN), and can be powered from either a single or dual external DC power source.

VAUX supplies power to the ST 6000 baseband and RF processors. Regulated power must be applied to this pin continuously to keep the device alive and synchronized with the satellite network.

VIN is the input power pin for the RF power amplifier circuitry. Regulated power must be applied to this pin whenever the device drives the TX_PWR EN line high and may be removed when the TX_PWR EN line is low. Alternatively, power may be applied to this pin continuously and TX_PWR_EN ignored.

Note: Input power protection is not provided on the ST 6000.

Table 4: Input Power

Parameter	Values
VAUX voltage	3.5 to 5.8 VDC (6 V Max)
VAUX Ripple	50 mV p-p (max)
VAUX Current	600 mA (max)
VIN Voltage	5.8 VDC ± 3%
VIN Ripple	50 mV p-p (max)
VIN Current	1.6 A (max)
TX_PWR EN Asserted to VIN Stable	10 ms (max)
Reverse Polarity Protection	None
Over Voltage Protection	None
Over Current Protection	None
ESD Protection	Protection to ±30 kV contact discharge on all signals connected to the 20 pin interface header, except for the power pins.

3.3.2 Power Consumption

Typical power consumption values at VIN and VAUX=5.8 V and at room temperature (23°C)

Table 5: ST 6000 Power Consumption

Scenario	-40°C		RT		+85°C	
	VIN	VAUX	VIN	VAUX	VIN	VAUX
Shutdown	10 nA	7.93 µA	10 nA	11 µA	10 nA	32.1 µA
Sleep	10 nA	108 µA	10 nA	129 µA	10 nA	211 µA
Power On	18.2 µA	23 mA	20.2 µA	24 mA	22.4 µA	26 mA
RFIC On	18.2 µA	37 mA	19.5 µA	38 mA	22.1 µA	40 ma
RFIC + GPS On	18.2 µA	84 mA	19.3 µA	83 mA	21.9 µA	84 mA
Tx On	0.83 A	275 mA	0.85 A	273 mA	0.81 A	274 mA

3.3.3 Inrush Current

Inrush current transients occur when the ST 6000:

- First powers on
- Wakes up
- Applies power to the RF transmit circuitry

These transients are of very short duration and low energy but can have high peak currents. The power supply must be capable of handling these inrush currents without dipping below the minimum input voltage of the respective power rails. Typical inrush currents are listed in the following table.

Table 6: Inrush Current

Scenario[1]	-40°C		RT		+85°C	
	VIN	VAUX	VIN	VAUX	VIN	VAUX
Power Application	-	1.71 A (<343µs)	-	1.9 A (<263µs)	-	1.6 A (<263µs)
RFIC On	-	1.4 A (<333µs)	-	2 A (<243µs)	-	1.7 A (<253µs)
GPS On	-	1 A (<243µs)	-	1 A (<173µs)	-	1 A (<212µs)
Tx Activation (with main antenna)	1.5 A (<1ms)	0.7 A (<262µs)	1.7 A (<1ms)	0.6 A (<105µs)	0.85 A (<1ms)	0.35 A (<425µs)

3.4 Input/Output

The ST 6000 I/Os are each independently operable and configurable in one of the following modes:

- Analog input
- Digital input
- Digital output – push pull

The ST 6000 is equipped with various I/O ports. Refer to the pin number descriptions in section 3.1.5 for an explanation of each I/O signal. To connect these ports to an external device you may need to use a suitable translator depending on what the signal is connected to.

The I/O electrical characteristics of this interface are shown in Table 7 and Table 8 shows the analog characteristics.

Table 7: I/O Electrical Characteristics

Parameter	Min.	Typ.	Max.	Units
Input high voltage threshold	2.31	-	-	V
Input low voltage threshold	-	-	1.155	V
Output high voltage threshold	2.8	-	-	V
Output low voltage threshold	-	-	0.5	V
Output high voltage, high drive strength	-	-	-8	mA
Output high voltage, low drive strength	-	-	-2	mA
Output low voltage, high drive strength	-	-	9	mA
Output low voltage, low drive strength	-	-	2	mA

OUT1 and OUT2 are dedicated push-pull outputs only. These outputs may be used to drive off board circuitry capable of driving high current loads.

[1]All VIN and VAUX measurements were performed at 5.8 V.

Table 8: Analog Input Characteristics

Parameter	Min.	Typ.	Max.	Units
Input resistance	-	2	5	kΩ
Input capacitance	-	4	5	pF
Normal input range	0	-	3.3	V
Resolution (12 bits)	-	0.8	-	mV
Full scale error	-	-	5.4	LSB

3.4.1 Input Bandwidth

When used as a digital or analog input, the bandwidth of the I/O circuitry is 1 kHz or more.

Note: This does not imply that the software must have a sample rate greater than 1 Hz.

3.4.2 Output Bandwidth

When used as a digital output the I/O circuitry has a bandwidth exceeding 100Hz.

Note: This does not imply that the software must have the capability of generating high rate pulse trains at frequencies > 10 Hz.

3.5 Serial Interfaces

The ST 6000 is equipped with various serial ports. To connect these ports to a standard RS-232 serial device such as a computer for example, you must use a 3.3 V TTL/CMOS to RS-232 translator device.

The electrical characteristics (Table 9) of the interface are:

Table 9: Electrical Characteristics

Parameter	Min.	Typical	Max.	Units
Rx input high voltage threshold	2.31			V
Rx input low voltage threshold			1.155	V
Tx output high voltage threshold	2.8			V
Tx output low voltage threshold		-	0.5	V

3.5.1 Console/Auxiliary (RS-232) Interface

The ST 6000 is equipped with an RS-232 console and an auxiliary TTL level serial port. The auxiliary port is primarily intended for debug output or software upgrade downloads. The console and auxiliary serial port is connected directly to the UART of the microcontroller and therefore communicates via CMOS level RS-232 style signaling (0-3.3 V, non-inverted).

The console and auxiliary serial interfaces to the ST 6000 are asynchronous with 1 start bit, 8 data bits, no parity, 1 stop bit; the default rate is 9600 bps, while the maximum rate is 115.2 kbps. The interfaces are 3.3 V TTL compatible.

3.5.2 RS-485/J1708 Interface

The ST 6000 has a dedicated TTL level serial port for interfacing to an RS-485/J1708 interface as an accessory bus and for SCADA interfacing. The ST 6000 does not incorporate a driver and termination resistor. The RS-485 serial port is connected directly to the UART of the microcontroller and therefore communicates via 3.3 V CMOS levels.

3.6 Accelerometer/GNSS/Temperature Sensor

The ST 6000 supports an accelerometer, a multi-GNSS module, and a temperature sensor. Refer to [T406] for details.

3.7 RF Specifications

3.7.1 Frequency

Parameter	Value
Receive	
Frequency Band	1525 to 1559 MHz
Modulation	OQPSK
Symbol Rate	3000 symbols/seconds
Polarization	RHCP
Transmit	
Frequency Band	1626.5 to 1660.5 MHz
Modulation	OQPSK
Symbol Rate	900 symbols/seconds (maximum)
Polarization	RHCP
Typical Output Power	1.5W

WARNING: Please keep the device minimum 20cm away from human body

3.7.2 Antenna

Parameter	Value
Maximum EIRP	7 dBW
Elevation Angle	0 to 90 degrees
Maximum transmit antenna gain	3.9 dBic

3.8 GNSS

The manufacturer's specifications are given in the table below.

Table 10: Multi-GNSS Specifications

Parameter	GPS	GLONASS	BeiDou	GPS/GLONASS	GPS/BeiDou
Time to First Fix[1]					
Cold Start	29 s	30 s	36 s	26 s	27 s
Hot Start	1 s	1 s	1 s	1 s	1 s
Sensitivity					
Tracking	-166 dBm	-166 dBm	-160 dBm	-167 dBm	-165 dBm
Hot Start	-156 dBm	-155 dBm	-155 dBm	-156 dBm	-156 dBm
Cold Start	-148 dBm	-145 dBm	-138 dBm	-148 dBm	-148 dBm
Accuracy					
Horizontal Position (CEP) [2]	2.5/2.0 m	4.0 m	3.0 m	2.5/2.0 m	2.5/2.0 m
Velocity	0.05 m/s	0.1 m/s	0.1 m/s	0.05 m/s	0.05 m/s
Heading	0.3 degrees	0.4 degrees	-	0.3 degrees	0.3 degrees

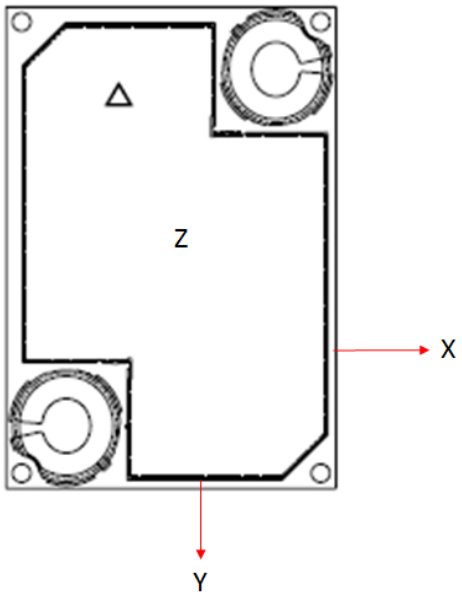
3.9 Accelerometer

The device has an internal 3D accelerometer to detect motion in any axis. Figure 5 shows the positive axes for the accelerometer.

[1]All satellites at -130 dBm

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

Figure 5: Accelerometer Axis



The accelerometer is very important for low power devices when it is critical to save power while stationary and quickly detect when motion starts. In powered devices where low power is not critical, GPS can be polled to detect motion. However, for low power applications frequent GPS fixes can dominate the power budget. To reduce power budget effects of GPS fixes, an accelerometer can be used to trigger a GPS fix to detect if motion occurred.

The accelerometer thresholds to detect motion vary depending on the environment. In order to avoid, false motion detects, extensive testing is required to ensure that adequate acceleration magnitude thresholds and time durations are used. Refer to [T405] for further details about the accelerometer.

Table 11: Accelerometer Specifications

Parameter	Condition	Min.	Typical	Max.	Units
Resolution	2 g	-	3.91	-	mG
Tracking	software selectable	-	±2	-	g
		-	±4	-	g
		-	±8	-	g
		-	±16	-	g
Bandwidth Filtering	Selectable via digital interface	8	-	1000	Hz
Sensitivity	2 g	-	256	-	LSB/g
	4 g	-	128	-	LSB/g
	8 g	-	64	-	LSB/g
	16 g	-	32	-	LSB/g

If using the accelerometer, mount the device in one of the configurations shown in [T405].

3.10 Mechanical

3.10.1 Dimensions

Figure 6: ST 6000 Top View

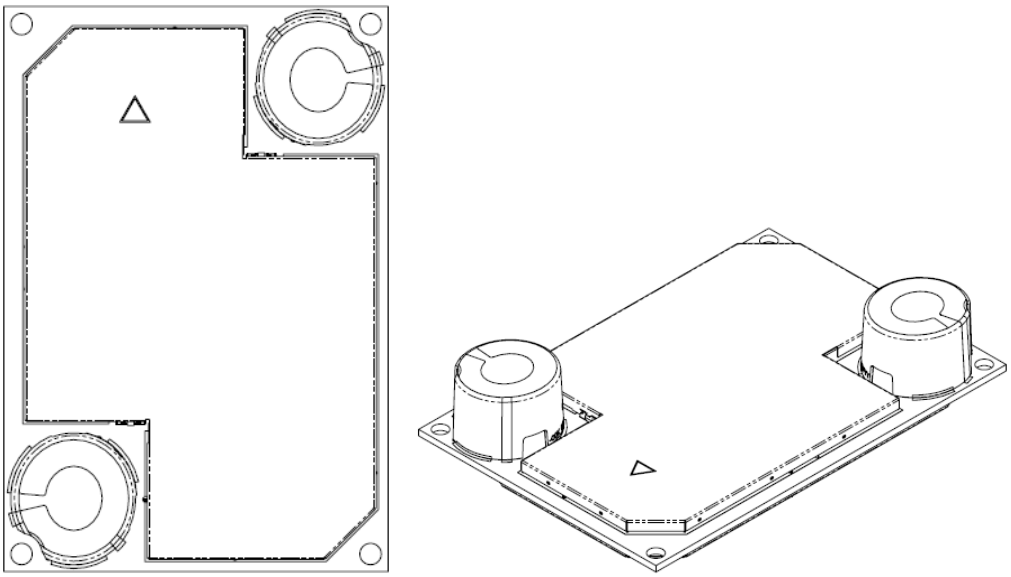


Figure 7: ST 6000 Side View Dimensions (in.)

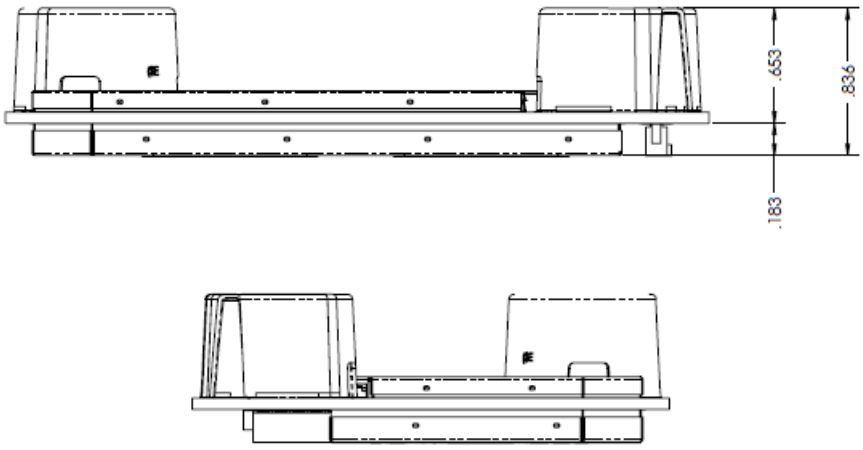
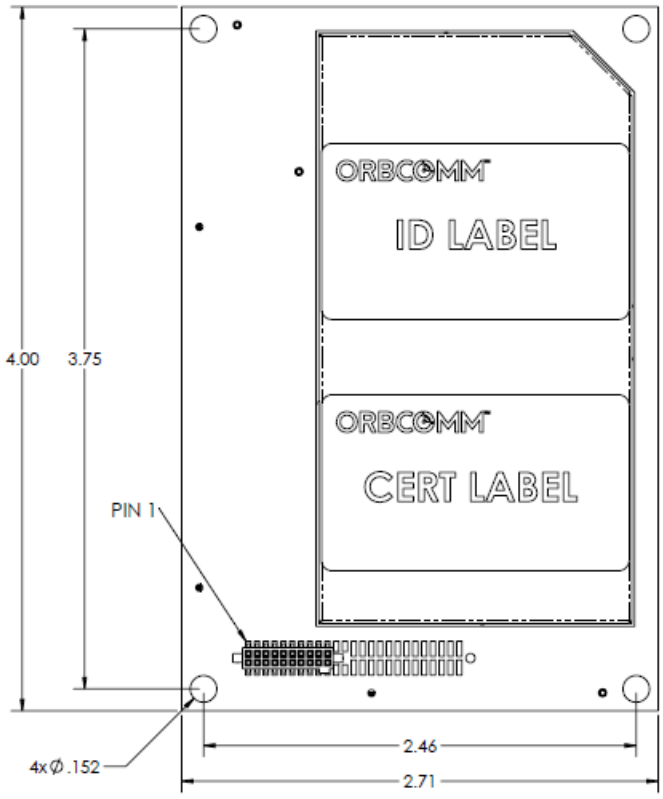


Figure 8: ST 6000 Bottom View Dimensions (in.)



3.10.2 Mass and UV Resistance

Parameter	Value
ST 6000 mass	59.4 g
UV resistance	TBD

3.11 LED

The ST 6000 has a white visual indicator that is controlled by the software. It is a power indicator during initial power on, otherwise it is off.

3.12 Nonvolatile Storage

The device has nonvolatile flash memory, which is shared by both the device firmware and user services.

Parameter	Value
Nonvolatile Onboard Flash Storage	4 MB
Write-Erase Cycles (per operating life)	100 000

3.13 Environmental

3.13.1 Temperature

Parameter	Value
Operating Temperature	-40° to +85°C
Storage Temperature	-40° to +85°C

3.13.2 Environmental

Parameter	Description
Vibration	The ST 6000 meets all its specifications during exposure to random vehicular vibration levels per SAE J1455, section 4.9.4.2 figures 6, 7, and 8, and MIL-STD-810G, section 514.6, figure 514.6C-1.
Mechanical Shock	The ST 6000 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.
Altitude	The ST 6000 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 ST 6000 meets all of its specifications after a thermal shock test as detailed in SAE J1455, section 4.1.3.2.
ESD	The ST 6000 meets all its specifications after exposure of the ST 6000 to 2 kV ESD contact discharge per IEC 60945 and IEC 61000-4-2, level 3. All the connections on the connectors, except for the VIN and VAUX power rails, are ESD protected to ±30 kV contact discharge according to IEC 61000-4-2 far exceeding level 4.

4 INTEGRATION GUIDELINES

This section contains a number of guidelines to assist the Solution Provider (SP) in building their ST 6000 enclosure. It must be recognized that this section provides guidelines only and each SP must use their own discretion to finalize the integration approach that works for them.

4.1 Enclosure Design

The ST 6000 is not designed for outdoor environments. Consequently, the ST 6000 requires a robust environmentally sealed enclosure that can house the ST 6000.

The following guidelines are recommended for the enclosure design.

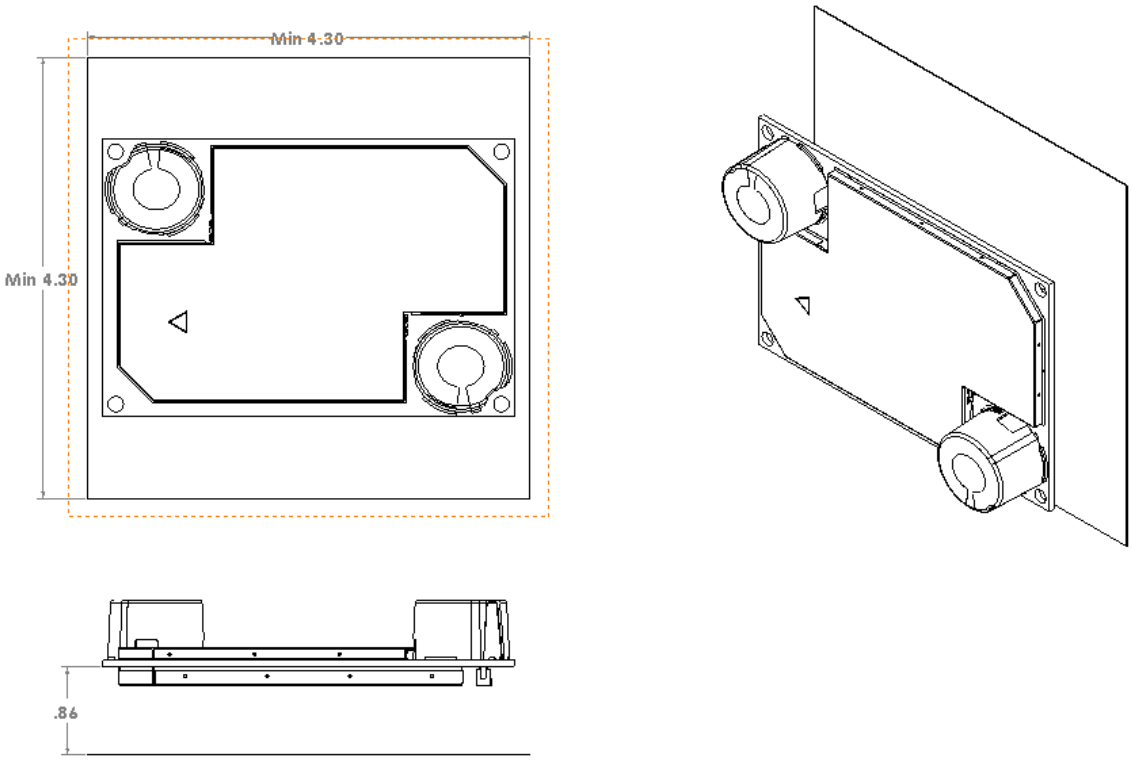
- An IP67 rating or better for outdoor use.
- Use enclosure materials that are transparent to L-Band (1-2 GHz) radio signals.
- Two recommended enclosure materials are:
    - Xenoy® Resin 5220U. This plastic material offers good chemical and UV resistance and great impact resistance even at low temperatures.
    - Lexan EXL 9330.

4.2 Ground Plane Requirements

A metal plate is required under the antenna board. The optimal recommended separation between the metal plate and the modem card is 0.86”. This can be reduced to 0.5” with some moderate impact on low elevation gain.

If the ST 6000 is installed on a metal surface larger than the metal plate size indicated in Figure 9, then no metal plate is needed as long as the surface-to-antenna distance is the same as shown in Figure 9.

Figure 9: Ground Plane Requirements (in.)



4.3 Labeling

The mobile ID on the ST 6000 is the network identification number. It is recommended that the SP place a copy of the mobile ID on the exterior of the enclosure housing the device. With the mobile ID on the enclosure, installers can readily identify the network identification number.