ORBCOMM®

CONNECTING THE WORLD'S ASSETS

ST 9100
Hardware Guide

T413, Version **1.0**
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TABLE OF CONTENTS

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LIST OF FIGURES

LIST OF TABLES

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PREFACE

Purpose

This document is as an overview of the hardware characteristics and specifications for the ST 9100.

Note: This is a Beta Trial document. Information in this document is subject to change.

Notation

A terminal consists of a transceiver unit plus antennas.

Hardware components and hardware labels 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 might be useful in conjunction with this guide. These documents are available from Customer Support or from the ORBCOMM Developer Toolkit.

Document titles and numbers are subject to change without notice.

[N210]	IsatData Pro Gateway Web Service 2 User Guide
[N206]	MTWS Cellular Protocol
[T404]	LSF Developer Guide FW v4.x
[T405]	IsatData Pro Service API Ref FW v4.x
[T414]	ST 9100 Installation Guide

Battery Safety Warnings

CAUTION: Do not short circuit or expose the battery to temperatures above the maximum rated temperature.

CAUTION: Always follow local disposal guidelines to properly dispose of the Lithium-ion battery and the device.

CAUTION: Store in a cool, well ventilated area. Elevated temperatures can result in shortened battery life.

CAUTION: DO NOT replace the battery. Changing the battery without ORBCOMM's permission could violate regulatory conformity.

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CAUTION: DO NOT throw the internal battery or the device into fire.

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1 PRODUCT OVERVIEW

The ST 9100 is a flexible, robust, and programmable dual mode satellite-cellular terminal. It is ideal for remotely monitoring and controlling fixed and portable assets in industries as diverse as transportation, oil and gas, utilities, maritime and more. The versatile, environmentally sealed ST 9100 is ideal for rugged environments in the world's most remote areas.

The ST 9100 (Figure 1) is a satellite-cellular terminal. Features include the following:

- An IsatData Pro satellite-cellular transceiver for communicating with the network
  - Part number ST9100-D01 for use in the Americas
  - Part number ST9100-C01 for use outside of the Americas
- An integral multi-GNSS subsystem
- Four (4) general purpose I/Os
- Two (2) dedicated outputs
- Four (4) digital inputs
- Four (4) 0-5 V analog ports
- Two (2) 4-20 mA ports
- Two RS-232 ports
- RS-485 port
- Two (2) CAN Bus ports
- 1-Wire interface
- 3-Axis accelerometer
- Bluetooth connectivity
- Multiple SIM support
- Cellular module
- Internal backup battery
- Satellite antenna (p/n ST901065-AFA standard antenna, ST901066-AFA low elevation antenna)
- Cellular antenna - LTE/3G/2G fallback (p/n ST101066-001)
- Terminal shroud (optional- p/n ST101014-001)

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Figure 1: ST 9100 Satellite-Cellular Transceiver

The transceiver's built-in programmability allows it to work as a standalone data-messaging transceiver, with built-in I/O data collection and processing capabilities. Feature-rich software tools make programming easy and shorten the design and testing time. The transceiver can also be configured with terminal apps. Terminal apps are configurable device-level applications that include specific feature sets that are implemented by ORBCOMM. Contact Customer Support or your Account Manager for further details.

1.1 Overview of the Messaging System

The IsatData Pro satellite messaging system is designed to support the management of mobile or fixed assets located around the world. An asset fitted with one of ORBCOMM's satellite based mobile terminals can have their status and locations monitored and send large messages.

The network provides the following key features and benefits:

- Polling of terminal status and location
- Scheduled reporting of terminal status and location
- Transmission of text messages to and from a serial port on the transceiver
- Two-way communication for messaging to and from the asset for near real-time control
- Up to 6,399 bytes from-mobile messages
- Up to 10,000 bytes to-mobile messages
- Default acknowledged messages
- Global service

Service is provided to end users by Solution Providers (SPs) who use the IsatData Pro network to offer particular applications and/or services to their clients. The SPs link their application services to the satellite terminals by connecting to the IsatData Pro gateway. This acts as the communications hub of the system, routing traffic to and from the terminals and the various service providers.

The terminal can be configured to route cellular messages through the same IsatData Pro Gateway that supplies satellite messages. This is shown as Option 1 in the System Diagram. Option 2 represents a terminal configured to route cellular messages directly to a customer or Solution Provider proprietary cell server. In this case the connection to ORBCOMM's IsatData Pro Gateway supplies satellite messages. Refer to [T404, N206, and N210] for more information about configuring the terminal's cellular messaging transport.

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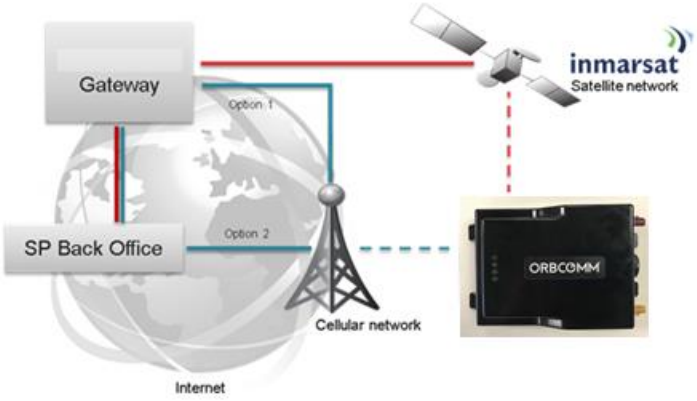
Figure 2: System Architecture



The satellite-cellular terminal is based on Lua software and is supported by a suite of IsatData Pro tools, enabling SPs a programmable platform they can tailor to their specific applications.

1.2 Terminal

Note: Hardware components may not be exactly as shown in this document. A terminal consists of a transceiver unit plus antennas.

Transceivers with a standard antenna operate on the IsatData Pro network at an elevation angle of 20° to 90° and -5° to 90° for transceivers with low elevation antennas. The transceivers are self-contained, compact, and provide low power consumption.

A cellular module is available to operate over the cellular network

The transceiver's built-in programmability allows it to work as a stand-alone with built-in I/O data collection and processing capabilities. Terminals are suitable for the AVL market.

Feature-rich software tools make application design easy and shorten the design and testing time. ORBCOMM also provides consulting services to SPs to help program the transceiver and get customer applications running quickly.

1.3 Transceiver Components

CAUTION: Do not rely solely on the terminal for emergency (SOS) calls.

In addition to the features mentioned earlier, the transceiver has the following benefits:

- Designed to be used as a standalone or incorporated into an SP solution
- Built-in dual-GNSS receiver to calculate position, speed, and heading
- Quick and easy installation reduces labor time and costs
- Installed firmware
- Flexible custom application design (Lua Services Framework)
- Wide operational temperature range
- Satellite plus cellular modem integration
- Discrete I/O ports to interface with a wide range of after-market accessories
- Rugged construction

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1.3.1 Transceiver Unit

Each transceiver is a self-contained unit, including a satellite/cellular modem, a multi-GNSS module, programmable microcontroller, and multiple discrete and analog I/Os (input/output) capable of monitoring and controlling external sensors and devices. Ideal for mobile applications, it is also suitable for fixed installations.

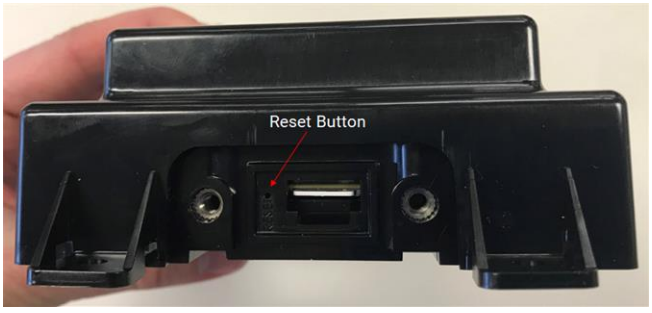
Arranging the transceiver unit's connectors (Figure 3) at one end of the unit simplifies installation. Sturdy flanges on the side make mounting quick and easy.

Figure 3: Connector Position

An anti-tamper SIM door on the back side of the transceiver (Figure 4) provides easy access to the SIM card holder and reset button.

Figure 4: SIM Access Door

Figure 5: Reset Button



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1.3.2 Satellite Antenna

The satellite-cellular tranceivers's satellite antenna is waterproof and designed to operate in extreme environments. It has four mounting flanges for installation.

The satellite antenna connects to the transceiver using a 5 m (16 foot) cable terminated with a curry yellow colored FAKRA RF connector.

The satellite-cellular transceiver is available with either the standard satellite antenna (Figure 6) or the low elevation satellite antenna (Figure 7).

Figure 6: Standard Satellite Antenna

Figure 7: Low Elevation Satellite Antenna

1.3.3 Cellular Antenna

The ST 9100 cellular antenna is an LTE antenna with a burgundy colored FAKRA connector.

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Figure 8: Cellular Antenna

1.3.4 Terminal Shroud

Use the optional terminal shroud if mounting the transceiver outdoors.

Figure 9: Terminal Shroud

1.3.5 ST 9100 Cables and Connectors

The following are available for the ST 9100:

- A 5-meter blunt cut cable (p/n ST101062-002). Refer to [T414] for details.
- An IP67 Field Installable Connector (p/n ST101096). Refer to [T414] for details.
- A development cable (p/n ST101084-001). Refer to APPENDIX A for details.

CAUTION: An external 5 A slow blow fuse must be added in series with the external voltage wire (Table 3).

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2 SPECIFICATIONS

2.1 Temperature

Parameter	Value
Operating Temperature Range	-20° to +75°C (-4°F to +167°F)
Storage Temperature Range	-20° to +60°C (-4°F to +140°F)

2.1.1 Internal Backup Battery Temperature

Table 1 defines the internal backup battery's temperature specifications.

Table 1: Transceiver with Internal Backup Battery Temperature Specifications

Parameter	Value
Charge Temperature Range	0°C to +45°C (32°F to +113°F)
Discharge Temperature Range	-20°C to +75°C (-4°F to +167°F)
Storage Range	
≤ 1 month	-20°C to +45°C (-4°F to +113°F)
≤ 3 months	-20°C to +35°C (-4°F to +95°F)
≤ 1 year	0°C to +30°C (32°F to +86°F)
Ideal for long-term storage	10°C to +25°C (60±25% R.H.), (50°F to +77°F)

2.2 Electrical

2.2.1 Input Range

CAUTION: An external 5 A slow blow fuse must be added in series with the external voltage wire (Table 3).

Parameter	Value
Power Supply Voltage	9 to 32 V DC

2.2.2 Power Consumption

Typical values with a transceiver input voltage of 12 VDC.

Table 2: Transceiver Input Currents

Mode of Operation	Condition	25°C (77°F)	-40°C (-40°F)	85°C (185°F)	Unit
Sleep	Externally powered	212	203	500.98	µA
Charger	ON	297	N/A	N/A	mA
SatCom Tx	Burst current	733.87	720.77	728.13	mA

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Mode of Operation	Condition	25°C (77°F)	-40°C (-40°F)	85°C (185°F)	Unit
SatCom Rx	Burst current for Rx frequency. 1540045000 1000 2 (C/No=42dBHz)	76.70	25.77	80.13	mA
GPS	Cold fix current during uBlox on command	32.60	38.37	36.59	mA
TOBY Rx (Idle)	measure Rx level in 129 channels for 1000 ms intervals	91.52	101.36	102.3	mA
	measure Rx level in LTE FDD5 for 1000 ms	88.97	92.31	104	mA
	measure Rx level in LTE FDD 12 for 1000 ms	89.17	91.10	156.92	mA
TOBY Tx max	2G-850 TX in channel=189, PCL=0 (max power), Seq=5, Mod=1(GMSK), Interval=5000 ms	403.99	375.03	473.8	mA
	2G-900 TX in channel=37, PCL=0 (max power), Seq=5, Mod=1(GMSK), Interval=5000 ms	777.52	614.95	900	mA
	2G-1900 TX in channel=698, PCL=0 (max power), Seq=5, Mod=1(GMSK), Interval=5000 ms	504.42	510.73	525.17	mA
	4G FDD band 5, 850MHz, TX in channel=120525, power=24 dBm, Internal=5000 ms	224.88	202.20	236.68	mA
	4G FDD band 2, 1900MHz, TX in channel=118900, power=24 dBm, Internal=5000 ms	270.94	288.16	282.63	mA

2.2.3 Load Dump Protection

Active load dump protection is provided on the power pins. The cut-off is >34 V and automatic reset of the load dump occurs when the input voltage is <34 V.

2.2.4 Inrush Currents

Typical inrush currents: 12 volts and 25°C (77°F).

Quantity	Value
Peak in-rush current	4.12 A
In-rush pulse duration	138 µS

2.2.5 Reverse Voltage Input

Parameter	Voltage
Reverse Polarity Protection	-40 V DC (maximum)

2.2.6 SIM Cards

The transceiver offers two embedded (not field replaceable) and one removable SIM card. The specifications for the SIM cards are the same.

Parameter	Value
SIM Voltage	1.8 V or 3 V standard SIM cards
Card Detection	Switch connected to cellular module

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2.3 Connectors

Transceiver 24 position mating connector	Chogori Technology Company
Satellite Antenna	IMS Connector Systems 3400.SMBA.2K10.089 (RG58/LMR-195 sized cable) FAKRA - K-curry yellow
Cellular Antenna	IMS Connector Systems 3400.SMBA.2D10.029 9RG174 sized cable) FAKRA - D-bordeaux

2.3.1 Connector Pin Assignment

Table 3 maps to the layout shown in Figure 10.

Figure 10: Transceiver View of Connector

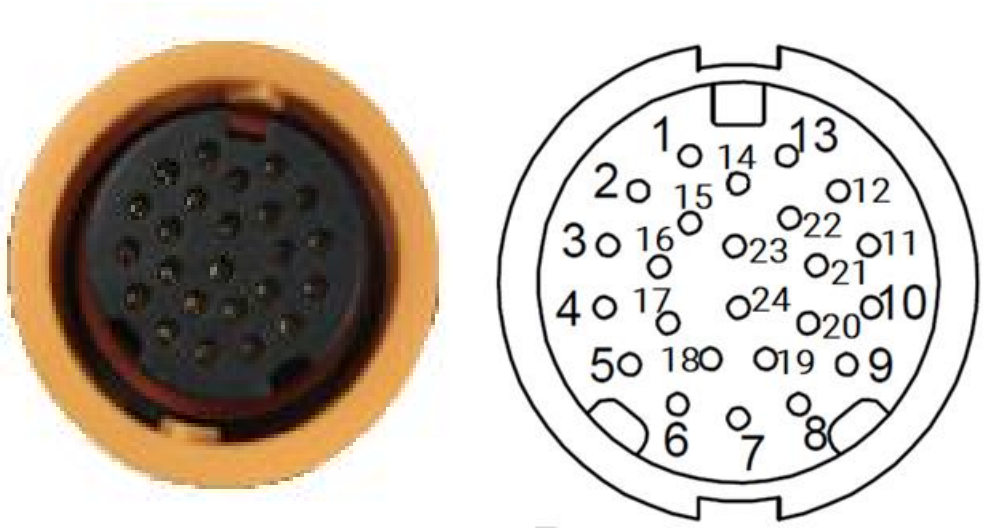

Table 3: Electrical Pin Assignment

Note: CAN0 is available for BETA trials.

PIN	Function	Type	Description
1	RS485_A	I/O	Half duplex RS485 driver output or receiver input (complementary to RS485_B)
2	Digital_IN4 / 0-5 V_IN4	I	Digital input or 0-5 V
3	Digital_IN3 / 0-5 V_IN3	I	Digital input or 0-5 V
4	I/O_4	I/O	Multifunction GPIO, push-pull, analog input, current limited current sink and ignition load
5	I/O_2	I/O	Multifunction GPIO, push-pull, analog input and current sink
6	Ground	PWR	External supply ground return
7	External Voltage	PWR	External 9-32 VDC supply

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PIN	Function	Type	Description
8	Output_6	O	Open drain output
9	1Wire Com	PWR	1-WIRE return path
10	Console_RS232_TX	O	±15 kV ESD protected, RS-232 level (nominally ±5.5 V) transmitter outputs
11	AUX_RS232_RX	I	TTL/CMOS level receiver outputs
12	CAN1_H	I/O	High level CAN BUS line
13	CAN1_L	I/O	Low level CAN BUS line
14	CAN0_L	I/O	Low level CAN BUS line
15	RS485_B	I/O	Half duplex RS485 driver output or receiver input (complementary to RS485_A)
16	Digital/Analog_IN1 / 0-5 V_IN1 / P1_4-20 mA+	I	Digital input or 0-5 V analog input or 4-20 mA
17	I/O_3	I/O	Multifunction GPIO, push-pull, analog input and current sink
18	I/O_1	I/O	Multifunction GPIO, push-pull, analog input and current sink
19	Output_5	O	Open drain output
20	1Wire_DATA	I/O	Input/output driver for 1-Wire Line
21	Console_RS232_RX	I	TTL/CMOS level receiver outputs
22	AUX_RS232_TX	O	±15 kV ESD protected, RS-232 level (nominally ±5.5 V) transmitter outputs
23	CAN0_H	I/O	High level CAN BUS line
24	Digital/Analog_IN2 / 0-5 V_IN2 / P2_4-20 mA+	I	Digital input or 0-5 V analog input or 4-20 mA

2.4 I/O Interface

2.4.1 Standard General Purpose I/Os

The transceiver supports four configurable general purpose I/Os (GPIO I/O_1 to I/O_4):

- Digital input with weak (1 MΩ) pull-down
- Digital input with 20-50 K pull-down
- Digital input with 20-50 K pull-up
- Analog input
- Digital output – push-pull
- Digital output – open drain switch-to-ground
- Disabled

On certain vehicles, I/O_1 can be used to monitor ignition. The voltage on the I/O pin may not drop low enough to present a logic zero to the host processor when the ignition is turned off. In such a case I/O_1 can be configured to switch in a 4 kOhm load to draw the voltage below the logic zero threshold level of the host processor ensuring a logic zero. The other I/O ports should not be used for ignition monitoring. Refer to section 2.4.1.1

I/O_4 provides dedicated overcurrent/short circuit protection circuitry when operated in the open drain, switch-to-ground mode. The other I/Os do not have this circuitry therefore I/O_4 is recommended for applications requiring overcurrent/short circuit protection.

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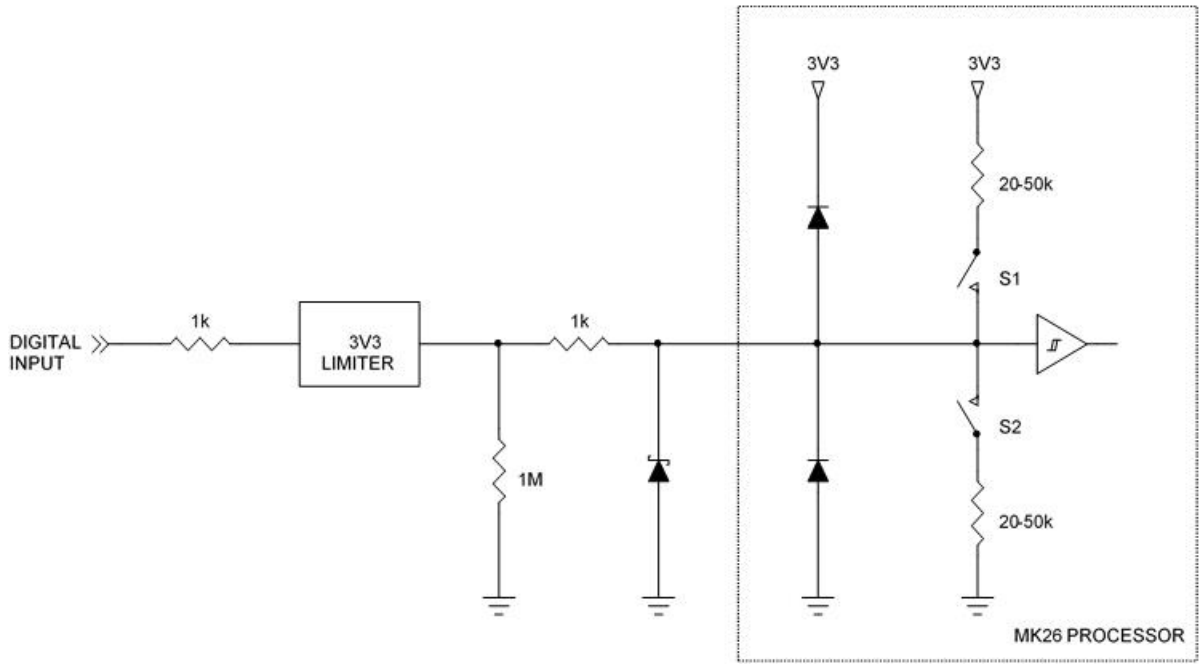
Simplified block diagrams of the I/O when configured as digital inputs, digital outputs, and analog inputs are shown in the figures below (Figure 11, Figure 12, and Figure 13).

The transceiver also supports two dedicated outputs (Output_5 and Output_6). More information on these outputs can be found in section 2.3.1.

2.4.1.1 Digital Input

Figure 11 shows a schematic of the I/O when configured as a digital input.

Figure 11: Digital Input



Input Type	S1	S2
With weak pull-down	Open	Open
With pull-down	Open	Closed
With pull-up	Closed	Open

The input specifications are provided in the table below.

Parameter	Min.	Typical	Max.	Units
Input low range	-10	-	1.05	V
Input high range	1.95	-	150	V
Input current with weak pull-down (weak 1 MΩ pull-down still in place); V_{in} = 3.0 V	-	4.5	-	µA

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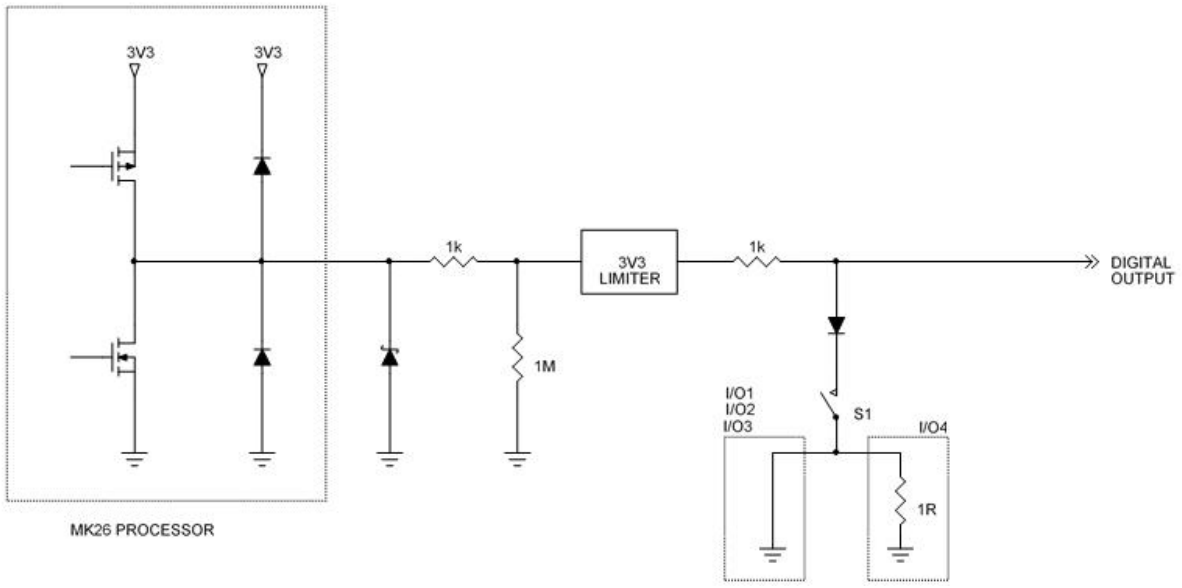
Parameter	Min.	Typical	Max.	Units
Input source current with pull-up (V_{in} = 0.0 V)	-	75	-	µA
Input sink current with pull-down (V_{in} = 3 to 150 V)	-	81	-	µA
Input bandwidth	1	-	-	kHz

2.4.1.2 Digital Output

Figure 12 shows a schematic of the I/O when configured as a digital output.

Figure 12: Digital Output



Push-pull	S1 = Open
Open drain	S1 = Closed (Low Impedance) S1 = Open (High Impedance)

2.4.1.2.1 Push-pull

In the push-pull configuration the output is driven directly from the microprocessor.

Parameter	Min.	Typical	Max.	Units
Output high voltage - open circuit	2.65	3.0	3.15	V
Output high voltage (sourcing 25 µA)	2.50	-	-	V
Output low voltage (sinking 25 µA)	-	-	0.05	V
Output bandwidth	100	-	-	Hz

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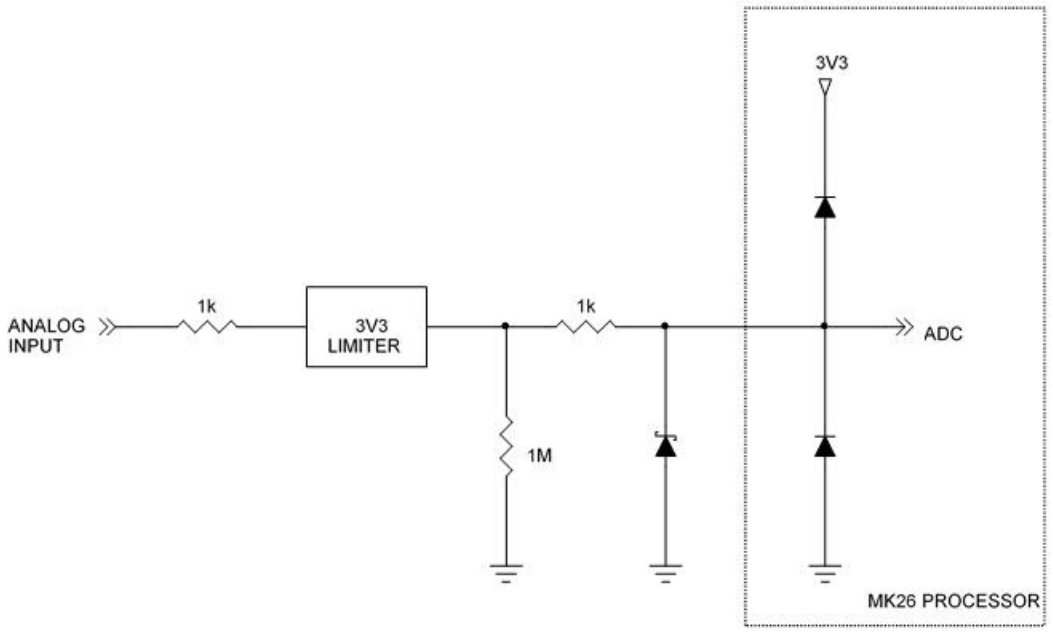
2.4.1.2.2 Switch to Ground

Parameter	Min.	Typical	Max.	Units
Sink current (do not exceed)	-	-	250	mA
Output voltage (sinking 250 mA) I/O_1 to I/O_3 I/O_4	 - -	 1.15 1.40	 1.35 1.60	 V V
Absolute limits (high impedance)	-10	-	150	V
Output bandwidth	100	-	-	Hz

2.4.1.3 Analog Input

Figure 13 shows a schematic of the I/O when configured as an analog input.

Figure 13: Analog Input



Parameter	Min.	Typical	Max.	Units
Input impedance	-	1	-	MΩ
Minimum measurement voltage	-	0	-	V
Maximum measurement voltage	2.75	3.0	-	V
Normal input range	-	-	3	V
Resolution (12 bits)	-	0.7	-	mV
Proportional measurement error	-	-	3	%
INL error	-	-	2	LSB
Absolute limits	-10	-	150	V

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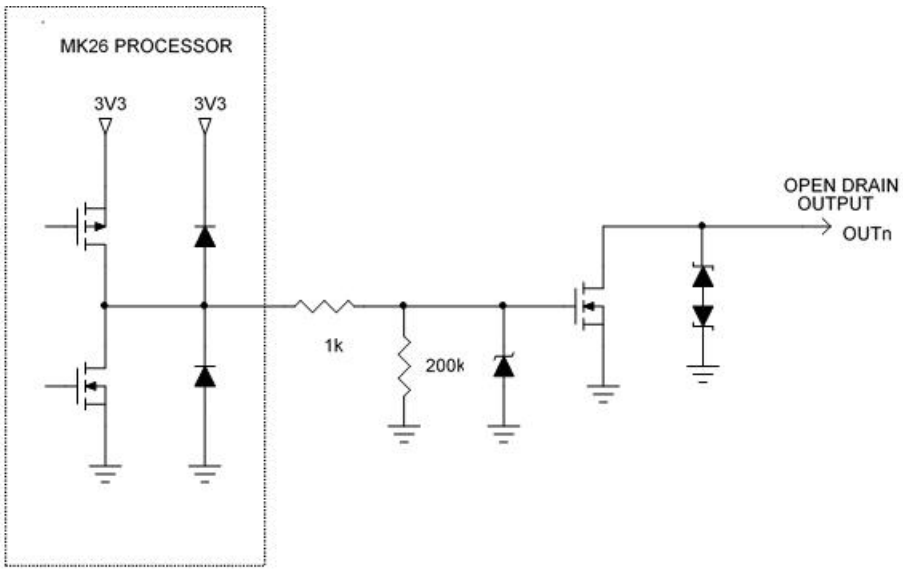
2.4.2 Dedicated Outputs

The transceiver provides two open drain outputs (output_5 and output_6) that can be used to turn on various devices such as relays, lights or audible alarms. These outputs are capable of sinking current only. Both outputs are controlled from the host processor. The outputs are not protected against over current conditions and you must ensure that the maximum current capability of the internal switch is not exceeded. Both outputs include ESD protection. You must also ensure that the voltage applied to the output pin does not exceed the maximum value as shown in the table below.

Figure 14: Open Drain Outputs



Parameter	Max.	Units
Sink Current	250	mA
Applied Voltage	40	V
Internal switch power dissipation	691	mW
Voltage output (sink current = 250 mA)	2.76 (minimum 48 mV)	V

2.4.3 Multi-purpose Ports

In addition to the standard I/Os, the transceiver provides the following multi-function ports.

- Four (4) digital input only ports.
- Four (4) 0-5 V analog input only ports.
- Two (2) 4-20 mA inputs.

Four pins on the interface connector are independently configured to provide the following combinations:

- Four (4) digital inputs or,
- Four (4) 0-5 V analog inputs or,
- Two (2) 4-20 mA inputs or,
- Two (2) digital inputs and two 0-5 V analog inputs or,

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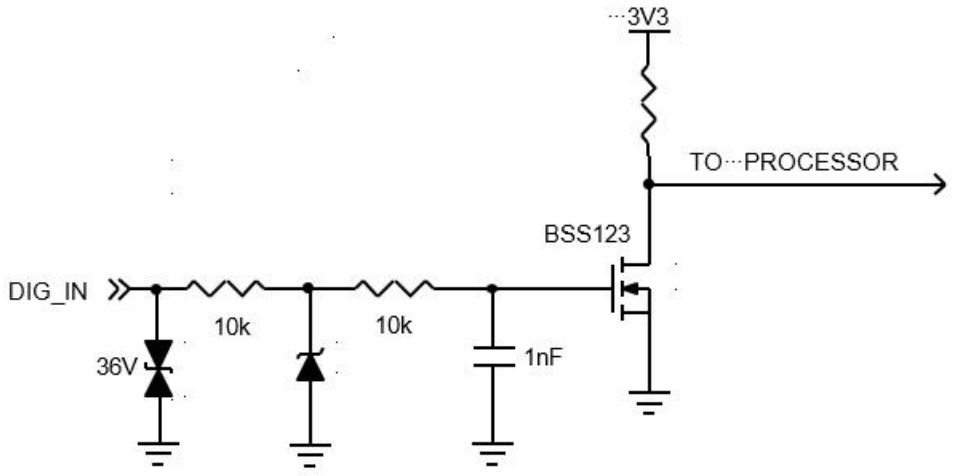
- Two (2) digital inputs and one 4-20 mA input or,
- Two (2) 0-5 V analog inputs and one 4-20mA input.

2.4.3.1 Input Only Ports

Four ports (PINs 2, 3, 16, and 24) can be configured as dedicated inputs. Each input is ESD protected by a 36 V transient voltage suppressor that clamps the input transient at 58 V. A 15 V Zener ensures the FET maximum gate voltage of 20 V is not exceeded.

Figure 15: Dedicated Inputs



Parameter	Min.	Max.	Processor	Units
Digital Input				
Typical Input high voltage (Zener starts conducting at ±14.49 V)	1.6	14	0	V
Maximum input high voltage	-	32	0	V
Input low voltage	0	1.4	3.3	V
Input frequency	1	10	-	Hz
ESD				
TVS breakdown voltage	40	44.2	-	V
TVS clamp voltage	-	58.1	-	V

2.4.3.2 Analog Inputs (0-5 V)

Four ports (PINs 2, 3, 16, and 24) can be configured as dedicated 0-5 V analog inputs. 0-5 V applied to the ports is converted to 0-3.3 V to be compatible with the ADC voltage range of the host processor.

Parameter	Min.	Max.	Units
Analog Input			
Input voltage range	0	5	V

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Parameter	Min.	Max.	Units
Maximum input high voltage	-	32	V
ESD			
TVS breakdown voltage	40	44.2	V
TVS clamp voltage	-	58.1	V

2.4.3.3 Inputs 4-20 mA

The ST9100 can monitor two 4-20 mA sensors. Two ports (PINs 16 and 24) can be configured as two dedicated 4-20 mA receivers.

Parameter	Min.	Max.	Units
Current Loop			
Operating current range	4	20	mA
Load voltage at 4 mA	0.396	0.404	V
Load voltage at 20 mA	1.98	2.02	V
Load resistance	99	101	Ω
Loop voltage (supplied by users externally)	10	32	V
Maximum input high voltage	-	32	-
ESD			
TVS breakdown voltage	40	44.2	V
TVS clamp voltage	-	58.1	V

2.5 Serial Interfaces

Transceivers have the following interfaces:

- 2 x CAN Bus
- 1 x RS-485/J1708
- 2 x RS-232
- 1 x 1-Wire

2.5.1 CAN Bus

Note: CAN0 is available for BETA trials.

The transceiver provides two CAN Bus interfaces for sending and receiving frames.

The transceiver incorporates a controller area network interface with signaling rates up to 1 Mbps.

Note: You must provide a termination resistor externally to the transceiver.

Parameter	Min.	Typical	Max.	Units
Input Common Mode Voltage	-7	-	12	V
Differential Input Threshold	-6	-	6	V
Peak to Peak Output Common Mode Voltage	-	1	-	V

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Parameter	Min.	Typical	Max.	Units
Differential Output Voltage (dominant)	1.2	-	3	V
Differential Output Voltage (recessive) No Load	-0.5	-	0.05	V
CANH or CANL	-36	-	36	V
ESD Protection				
Human Body Model[1]	-	±16	-	kV
Contact Discharge Model	-	±30	-	kV

2.5.2 RS-485/J1708

The transceiver provides a half-duplex RS-485 or J1708 interface as an accessory bus and for SCADA interfacing with signaling rates up to 250 kbps.

Note: You must provide a termination resistor externally to the transceiver when required.

The electrical characteristics of the interface are:

Parameter	Min.	Typical	Max.	Units
Input Common Mode Voltage	-8	-	12.5	V
Differential Input Threshold	-200	-	200	mV
Output Common Mode Voltage	-	1.8	3	V
Differential Drive Output, 54 Ω load	1.5	2.3	-	V
ESD Protection				
Human Body Model	-	±16	-	kV
Contact Discharge Model	-	±30	-	kV

2.5.3 RS-232 (Console and Auxiliary)

The two RS-232 interfaces default to the following settings: 9600 bit/s, 1 start, 8 data, 1 stop bit, and no parity. The baud rate is configurable up to 115,200 bps.

The electrical characteristics of the interface are:

Parameter	Min.	Typical	Max.	Units
Rx Input Low Threshold for DTE Connected	-	-	-2.7	V
Rx Input High Threshold for DTE Connected	2.7	-	-	V
Rx Threshold for DTE Disconnected	-0.3	-	0.3	V
Serial Rx Input Low Threshold	0.6	-	-	V
Serial Rx Input High Threshold	-	-	2.4	V
Rx Input Voltage Range	-25	-	25	V
Serial Tx Low Output (3 kΩ load)	-	-	-3.7	V
Serial Tx High Output (3 kΩ load)	3.7	-	-	V

[1]All electrical interfaces operate normally after being subjected to 8 kV ESD contact discharge per IEC 60945 and IEC 61000-4-2 human body model, level 3.

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Parameter	Min.	Typical	Max.	Units
ESD Protection				
Human Body Model	-	±15	-	kV
Contact Discharge Model	-	±8	-	kV

2.5.4 1-Wire

The 1-Wire interface allows connection to downstream 1-Wire devices connected on a bus, or to a single button reader. Relative to any attached 1-Wire device, the transceiver behaves as the master. The 1-Wire driver supports 3 or 5 V devices on the bus.

At standard speed, the 1-Wire supports up to 39 devices over a 61-meter (200 feet) CAT5 cable. In overdrive, the usable expected distance is reduced to ≤ 15 meters (≤ 50 feet) with a maximum node count of 9.

The electrical characteristics of the interface are:

Parameter	Min.	Typical	Max.	Units
1-Wire Input High Voltage	3	-	-	V
1-Wire Input Low Voltage	-	-	1	V
1-Wire Output Low Voltage (IOL - 8 mA sink current)	-	-	0.2	V
1-Wire ESD Protection Diode and Resistors				
Avalanche Voltage	7.4	-	11.05	V
Trigger Voltage	-	10	11	V
Holding Voltage (IOL - 8 mA sink current)	5.5	-	-	V
Holding Current	11	-	-	mA
Continuous Diode Current	-	-	80	mA

2.6 RF Specifications

2.6.1 Satellite (Standard) Antenna

Parameter	Value
Maximum EIRP	7 dBW
Elevation Angle	20° to 90° degrees
Maximum transmit antenna gain	4.5 dBic
Rx Operating Frequency	1518-1559 MHz
Tx Operating Frequency	1626.5-1660.5 MHz, 1668-1675 MHz

2.6.2 Satellite (Low Elevation) Antenna

Parameter	Value
Maximum EIRP	5 dBW
Elevation Angle	-5° to 90° degrees
Maximum transmit antenna gain	2.5 dBic

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Parameter	Value
Rx Operating Frequency	1518-1559 MHz
Tx Operating Frequency	1626.5-1660.5 MHz, 1668-1675 MHz

2.6.3 Cellular Antenna

Parameter	Value
Network Coverage	Global: Cat 4 LTE (B1, B3, B5, B7, B8, B28), UMTS (850, 900, 1900, 2100), Quad-band GSM Americas: Cat 1 LTE (B2, B4, B5, B12), UMTS (850, 900, 1900, 2100), Quad-band GSM
Frequency	700/824/960/1710/1880/2170/2600/2700 MHz
Impedance	50 Ω
VSWR	2.0:1
Gain	2.5 dB
Maximum EIRP	700-2700 MHz

2.6.3.1 Cellular Antenna Electrical

Frequency (MHz)	Return Loss (dB)	VSWR	Efficiency (%)	GAIN (dB)
700	-10.62	1.85	46.03	1.45
824	-22.27	1.16	36.48	0.6
960	-14.25	1.48	56.75	1.25
1710	-19.03	1.25	44.98	2.18
1880	-21.14	1.21	66.68	4.74
2170	-10.93	1.78	34.04	1.06
2600	-22.79	1.16	49.32	3.89
2700	-26.19	1.10	60.12	4.45

2.7 Satellite Transmitting Power

The maximum transmitting power (EIRP) for the IsatData Pro satellite is 7 dBW.

2.8 GNSS Module

The transceiver allows concurrent reception of up to three (3) GNSS channels.

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

Table 4: Multi-GNSS Specifications

Parameter	GPS	GLONASS	BeiDou	Galileo
Time to First Fix				
Cold Start	29 s	30 s	34 s	45 s
Warn Start	2s	2 s	3 s	7 s

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Parameter	GPS	GLONASS	BeiDou	Galileo
Hot Start	1 s	1 s	1 s	1 s
Sensitivity				
Tracking	-162 dBm	-166 dBm	-160 dBm	-159 dBm
Hot Start	-157 dBm	-156 dBm	-155 dBm	-151 dBm
Cold Start	-148 dBm	-145 dBm	-143 dBm	-138 dBm
Accuracy				
Horizontal Position	2.5 m	4.0 m	3.0 m	TBD
Velocity	0.05 m/s			
Heading	0.3 degrees			

2.9 Internal Backup Battery

The internal backup battery provides autonomous battery charging to the transceiver and operates directly from the external supply over the 9-32 VDC input range. The internal backup battery contains a protection card to ensure that the pack does not get damaged due to a short circuit, over discharge or an over-charge condition.

If the battery voltage is below the minimum set voltage, the charger turns off.

Table 5: Internal Backup Battery

Parameter	Value
Battery Chemistry	Lithium Ion
Back-up Period	48 hours
Rated Capacity	2000 mAh
Charge (capacity) Retention	90% (after 28 days at 25 ±5°C (77 ±9°F)
Battery Cut-off	7 V
Nominal Pack Voltage	7.2 V (2 x cells in series)
Minimum Discharge Voltage	5 V
Charging Voltage	8.4 V
Peak Output Current	6 A

Refer to section 1.0.1 for internal backup battery temperature ranges.

2.10 Memory

Parameter	Value
PSRAM	8 MB
Flash	16 MB

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2.11 Environmental

Parameter	Description
Vibration	The terminal meets all its specifications during exposure to random vehicular vibration levels per SAE J1455, section 4.10.4.2 figures 6, 7, and 8, and MIL-STD-810H, section 514.8, figure 514.8C-1.
Mechanical Shock	The terminal meets all its specifications after exposure to positive and negative saw tooth shock pulses with peaks of 20 G and durations of 11 ms as specified in MIL-STD-810H, section 516.8, Procedure I, section 2.3.2c.
Thermal Shock	The terminal meets all of its specifications after a thermal shock test as detailed in SAE J1455, section 4.1.3.2
Drop Test	The terminal meets all its specifications after a handling drop test as specified in SAE J1455, section 4.11.3.1.
ESD (Enclosure)	All electrical interfaces operate normally after being subjected to 6 kV ESD contact discharge per IEC 60945 and IEC 61000-4-2 human body model, level 3.
Altitude	The terminal meets all specifications after a nonoperating 12.2 km (7.5 miles) altitude test as detailed in SAE J1455, section 4.9.3, except with an ambient temperature of -40°C (-40°F).
Humidity	The terminal meets all its specifications during exposure to 90% relative humidity at +85°C (185°F), per the test methodology of SAE J1455, section 4.2.3 (3 x 8-hour humidity cycle per figure 4a)
Ingress Protection	IP67 – The terminal meets all of its specifications after immersion and dust tests as detailed in IEC 60529, sections 13.1, 13.4, 14.1, 14.2.7 and 14.3 (with and without optional terminal shroud)

2.12 Sensors

2.12.1 Temperature Sensor

Parameter	Value
Range	-40 to +85°C (-40 to +185°F)
Accuracy (typical)	±4°C (±7.2°F)

2.12.2 Accelerometer

The transceiver has a 3D accelerometer to detect motion in any axis.

In low power applications, frequent GPS fixes can dominate the power budget. To reduce the power budget effects of GPS fixes, the accelerometer can be used to detect if motion has occurred.

The accelerometer thresholds to detect advanced features such as driver behavior monitoring vary depending on the environment. To avoid false detects, extensive testing is required to ensure that adequate acceleration magnitude thresholds and time durations are used.

Parameter	Condition	Min.	Typ.	Max.	Units
Resolution	-	-	16	-	bit
Acceleration Range	software selectable	-	+2	-	g
		-	+4	-	g
		-	+8	-	g
		-	+16	-	g

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Parameter	Condition	Min.	Typ.	Max.	Units
Output Data Rate (ODR)	selectable via digital interface	12.5	-	1600 [1]	Hz
Sensitivity	2 g	-	16384	-	LSB/g
	4 g	-	8192	-	LSB/g
	8 g	-	4096	-	LSB/g
	16 g	-	2048	-	LSB/g
Sensitivity Temperature Drift	3 V supply	-	±0.02	-	%/K
Zero-g Offset	Ta = 25°C (77°F)	-	±40	-	mg
Zero-g Offset Temperature Drift	3 V supply	-	±1	-	mg/K
Wake up Time	from low power or suspended modes	-	0.8	-	ms
Start up Time	power on reset	-	3.2	3.8	ms

2.13 Cellular Module - LTE

2.13.1 Transceivers Operating in the Americas

Transceivers (p/n ST9100-D01), operating in North or South America, have the following characteristics.

Type	u-blox Toby R200 series
LTE Module	LTE bands: 2, 4, 5, 12 UMTS bands: 850, 900, 1900, 2100 MHz GSM 850/900/1800/1900 MHz
Output Power	LTE power Class 3 (23dBm) UMTS/HSDPA/HSUPA power Class 3 (24dBm) GSM/GPRS Power Class: *Class 4 (33 dBm) for GSM/E-GSM band *Class 1 (30 dBm) for DCSPCS band EDGE(8-PSK) Power Class: *Class E2 (27 dBm) for GSM/E-GSM band *Class E2 (26 dBm) for DCS/PCS band
Input Power	Peak currents of 1.5 A typical, 1.9 A maximum. Module supply peak current consumption: peak of current consumption through the VCC pins during a GSM 1-slot Tx burst at maximum Tx power, with a matched antenna
Data Transfer	LTE Category 1: up to 10.3Mb/s DL, 5.2 Mb/s UL HSDPA category 8: up to 7.2 Mb/s DL, HSUPA category 6: up to 5.76 Mb/s UL GPRS multi-slot class 33, CS1-CS4, up to 107 kb/s DL, up to 85.6 kb/s UL EDGE multi-slot class 33, MCS1-MCS9, up to 296 kb/s DL, up to 236.8 kb/s UL
Antenna Detect	Output DC current pulse: 9 µA typical Output DC current pulse time length: typical 330 µs

2.13.2 Transceivers Operating Outside of the Americas

Transceivers (p/n ST9100-C01), operating outside of North or South America, have the following characteristics.

[1] The software supports a maximum ODR of 400 Hz.

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Type	u-blox Toby L280 series
LTE Module	LTE bands: 1, 3, 5, 7, 8, 28 UMTS bands: 850, 900, 1900, 2100 MHz GSM 850/900/1800/1900 MHz
Output Power	LTE power Class 3 (23dBm) UMTS/HSDPA/HSUPA power Class 3 (24dBm) GSM/GPRS Power Class: *Class 4 (33 dBm) for GSM/E-GSM band *Class 1 (30 dBm) for DCSPCS band EDGE(8-PSK) Power Class: *Class E2 (27 dBm) for GSM/E-GSM band *Class E2 (26 dBm) for DCS/PCS band
Input Power	Peak currents of 1.9 A typical, 2.5 A maximum. Module supply peak current consumption: peak of current consumption through the VCC pins during a GSM 1-slot Tx burst at maximum Tx power, with a matched antenna
Data Transfer	LTE Category 4: up to 150Mb/s DL, 50 Mb/s UL HSDPA category 24: up to 42 Mb/s DL, HSUPA category 6: up to 5.6 Mb/s UL GPRS multi-slot class 12, CS1-CS4, up to 85.6 kb/s DL/UL EDGE multi-slot class 12, MCS1-MCS9, up to 236.8 kb/s DL/UL
Antenna Detect	Output DC current pulse: 21 µA typical Output DC current pulse time length: typical 3.6 ms

2.14 Bluetooth Module

Not available for beta trials.

2.15 LED

The transceiver has four visible LEDs (2.15) to indicate status.

Figure 16: LED Location

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Table 6: LED Operation

	Sensor	Indicates whether the transceiver is receiving sensor data, or if paired with a sensor.
	Cellular	Indicates cellular communications status.
	Satellite	Indicates satellite communications status.
	Power	Indicates that the transceiver has external power.

2.16 Mechanical

2.16.1 ST 9100

Parameter	Value
Mass	465 g (16 oz)
Enclosure Material	Lexan plastic

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Figure 17: ST 9100 Top View Dimensions

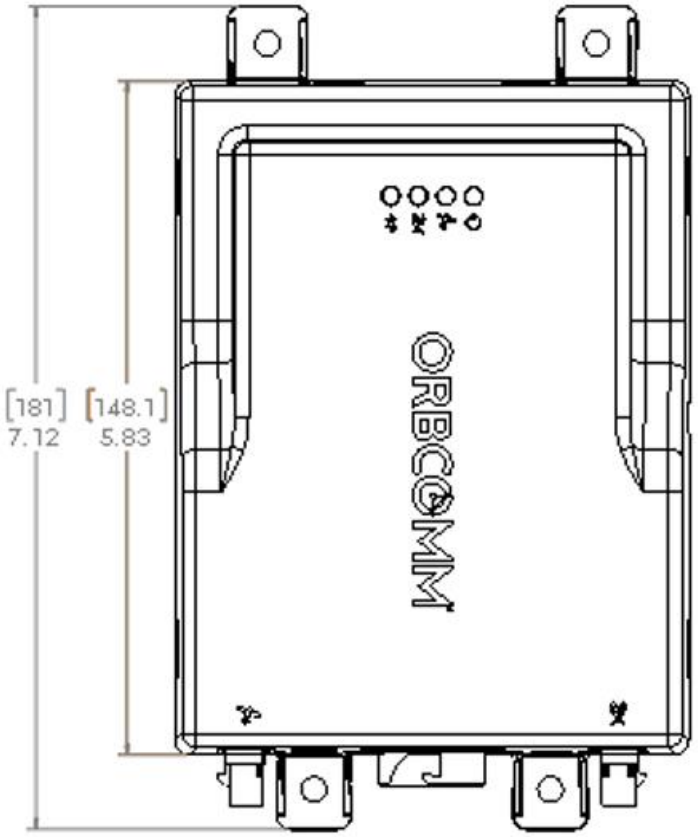
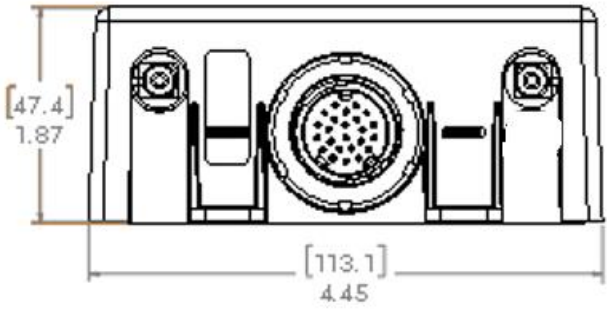


Figure 18: ST 9100 Side Connector View Dimensions



2.16.2 Cellular Antenna

Parameter	Value
Mass	55 g (2 oz..)

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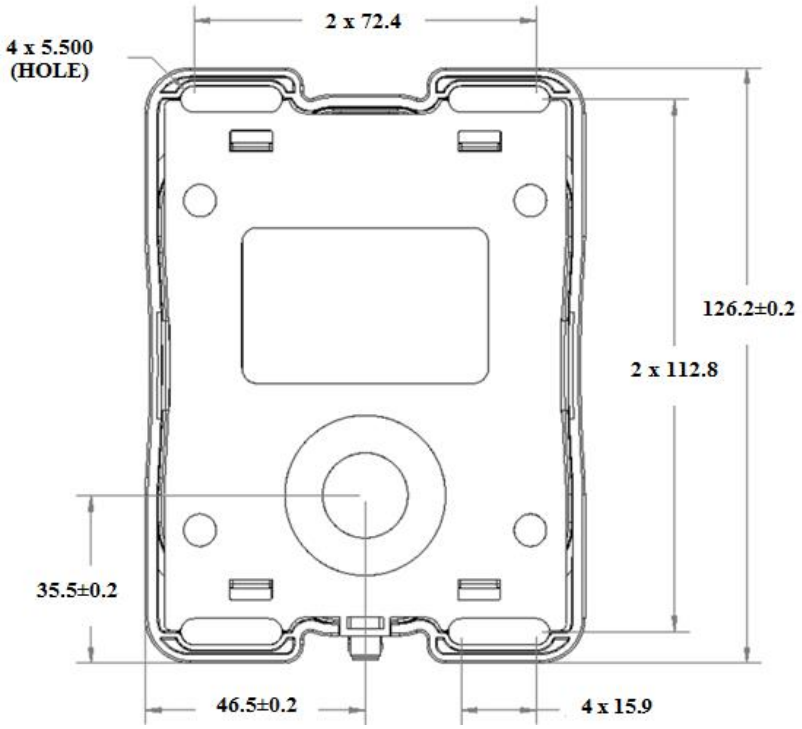
Parameter	Value
Dimensions	129.5 x 22.8 x 7 mm (5 in. x 0.9 x 0.27 in.)
Cable length	3 m (10 ft.)
Mounting	FAKRA straight plug connector
Operating Temperature	-40°C to 85°C (-40°F to 185°F)

2.16.3 Satellite Antenna

Figure 19: Satellite Antenna (standard and low elevation) - Bottom View (mm)



2.16.3.1 Standard Antenna

Parameter	Value
Mass	Side entry with 5 m (16 ft.) cable: 360 g (13 oz.)
Enclosure Material	Lexan EXL
Color Code	8T9D076 (white)
Sealing Gasket Material	Santoprene®

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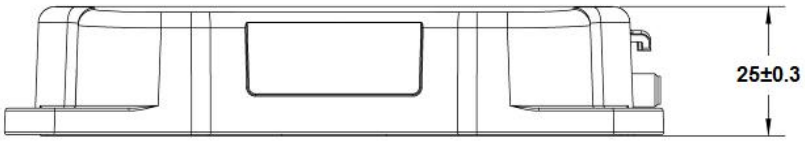
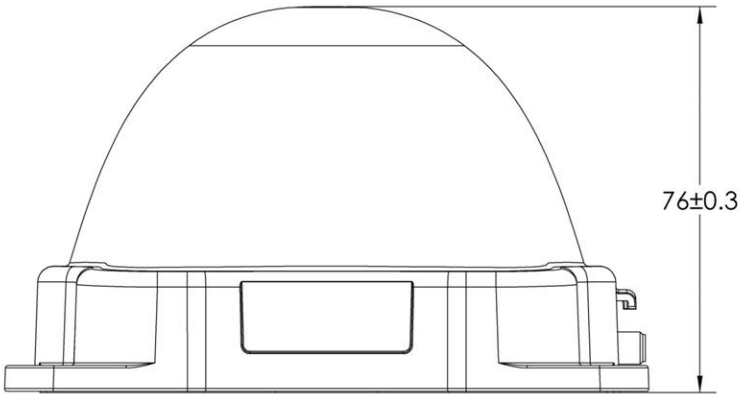
Figure 20: Standard Antenna Height Dimensions (mm)



2.16.3.2 Low Elevation Antenna

Parameter	Value
Mass	Side entry with 5 m (16 ft.) cable: 365 g (13 oz.)
Enclosure Material	Lexan EXL
Color Code	8T9D076 (white)
Sealing Gasket Material	Santoprene®

Figure 21: Low Elevation Antenna Height Dimensions (mm)



2.16.3.3 Terminal Shroud

Parameter	Value
Mass	150 g (2 oz.)
Enclosure Material	Lexan EXL
Color Code	8T9D076 (white)

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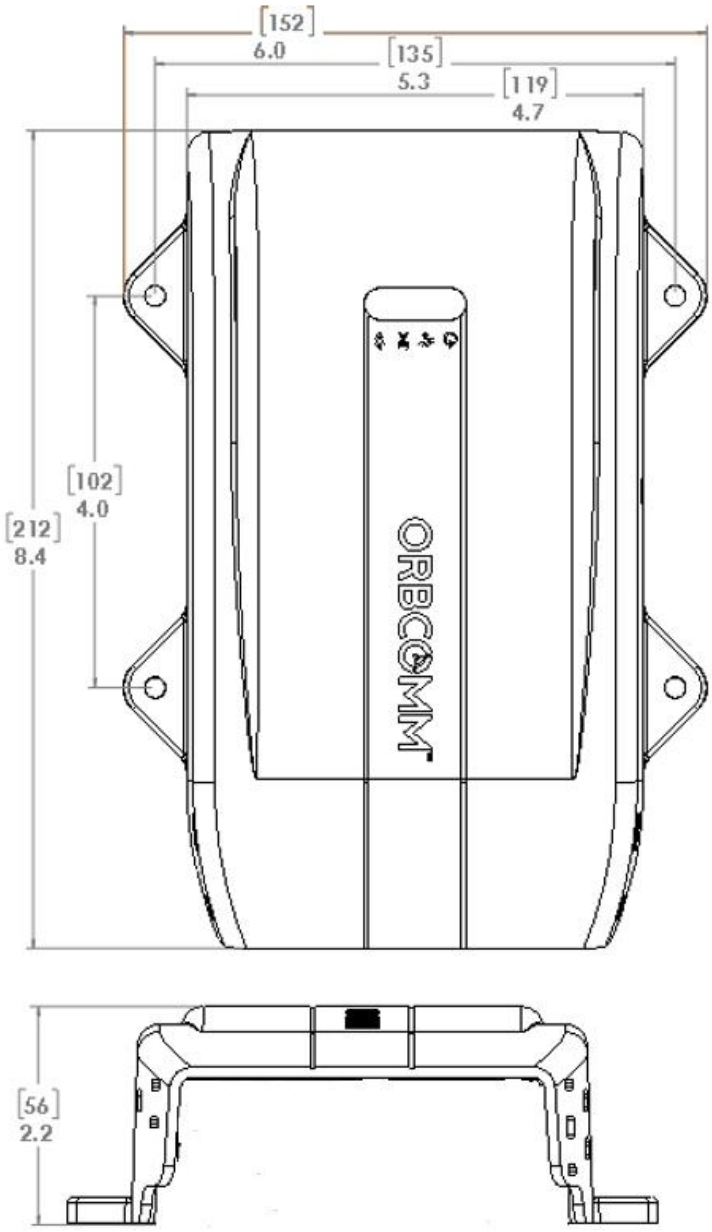
Figure 22: Terminal Shroud Dimensions



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3 COMPLIANCE & CERTIFICATION

Inmarsat Type Approval

Industry Canada

- ICES-003
- RSS-170, Issue 2, Spectrum Management and Telecommunications Policy, Radio Standard
- RSS-102, radiation safety per Safety Code 6 (compliance shown by computation)
- IC ID: 11881A-ST9100; 11881A-UNNB30; 8595A-TOBYL280 or 8595A-1EHM44NN

FCC

- CFR 47 Part 25, CFR 47 Part 15
- CONTAINS FCC ID: XGS-ST9100; XGS-UNNB30; XPYTOBYL280 or XPY1EHM44NN

Ingress Protection

- Cellular antenna: IP65
- Satellite antenna: IP67
- Transceiver unit: IP67

RoHS

Restriction of Hazardous Substances (RoHS) [1]

UN

- UN 38.3 Transportation Compliance

Other Certificate

- IEC60945; Anatel, ACMA, ICASA,

PTCRB

EU RED 2014/53/EU

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.

Warning

- The minimum 20cm separation distance from the device is required for RF exposure safety for all persons.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:(1)This device may not cause interference.(2)This device must accept any interference, including interference that may cause undesired operation of the device.
- L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
  1) L'appareil ne doit pas produire de brouillage;
  2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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

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APPENDIX A DEVELOPMENT CABLE

The development cable is p/n ST101084-001.

Figure 23: Development Cable

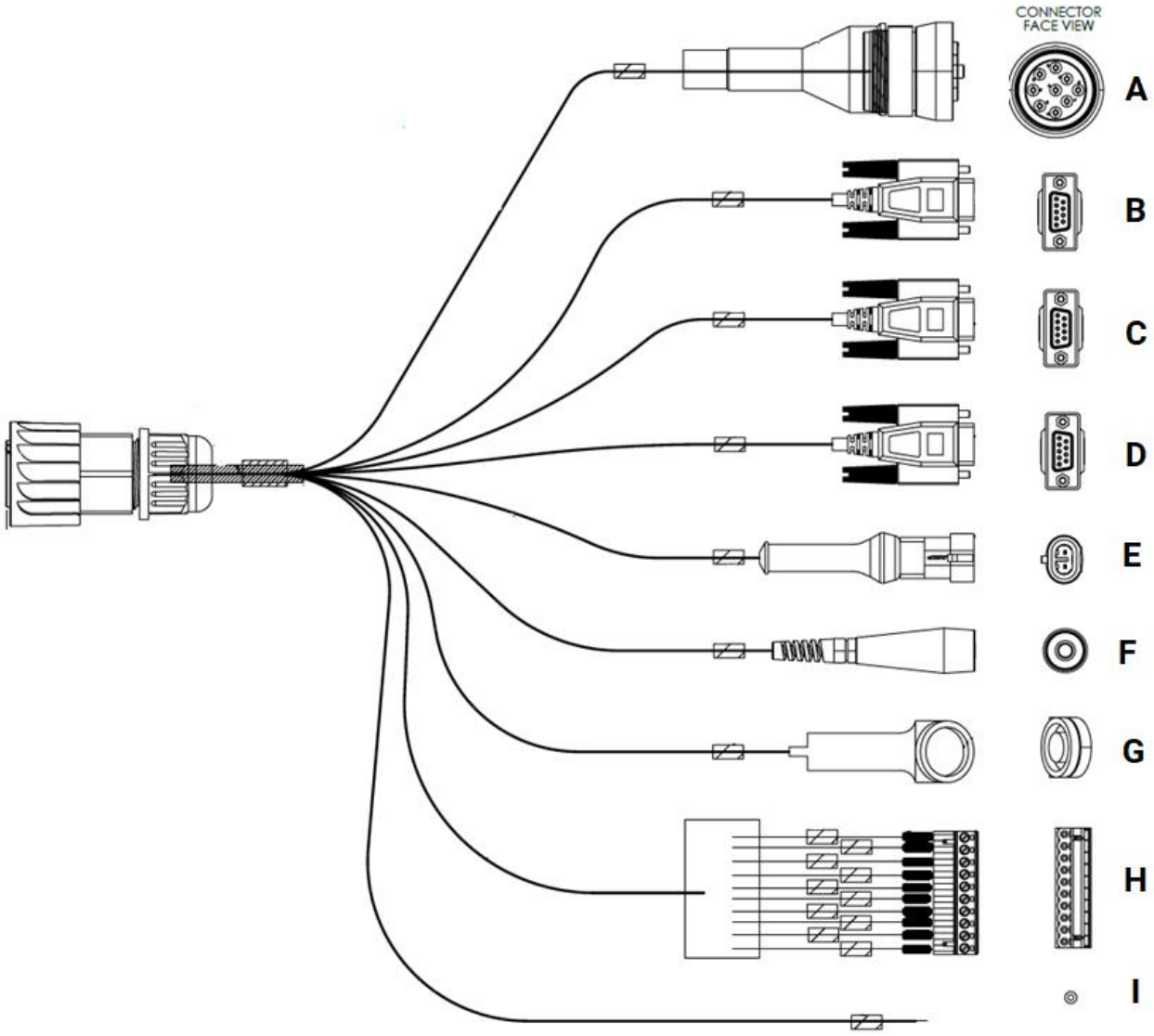

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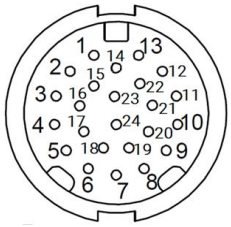
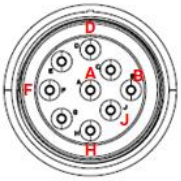
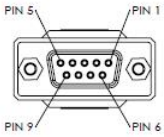
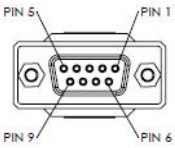
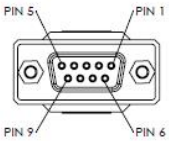
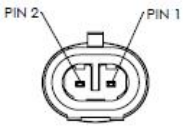
Table 7: Development Cable Connectors

Transceiver Connector	End A	End B	End C	End D	End E
					
PIN 9 - 1Wire Com					
PIN 10 - RS232 TX		PIN 2			
PIN 21 - RS232 RX		PIN 3			
PIN 22 - AUX RS232 TX			PIN 2		
PIN 13 - CAN 1 Low	PIN D				
PIN 14 - CAN 0 Low	PIN J				
PIN 1 - RS485 A				PIN 1	
PIN 24 - Dig IN 2					
PIN 16 - Dig IN 1					
PIN 4 - I/O_4					
PIN 5 - I/O_2					
PIN 6 _ Ground	PIN A and PIN E	PIN 5	PIN 5	PIN 5	PIN 2
PIN 7 - VEXT	PIN B				PIN 1
PIN 8 - Out 6					
PIN 18 - I/O_1					
PIN 17 - I/O_3					
PIN 3 - Dig IN 3					
PIN 15 - RS485 B				PIN 2	
PIN 23 - CAN 0 High	PIN H				
PIN 12 - CAN 1 High	PIN C				
PIN 11 - AUX RS232 RX			PIN 3		
PIN 20 - 1Wire Data					
PIN 19 - Out 5					
PIN 2 - Dig IN 4					

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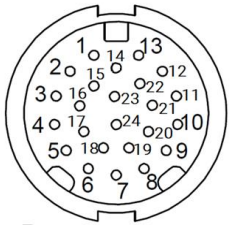
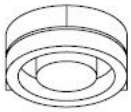
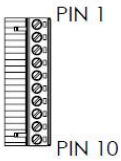
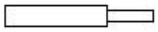
Transceiver Connector	End F	End G	End H	End I
				
PIN 9 - 1Wire Com		1Wire Common		
PIN 10 - RS232 TX				
PIN 21 - RS232 RX				
PIN 22 - AUX RS232 TX				
PIN 13 - CAN 1 Low				
PIN 14 - CAN 0 Low				
PIN 1 - RS485 A				
PIN 24 - Dig IN 2			PIN 8	
PIN 16 - Dig IN 1			PIN 7	
PIN 4 - I/O_4			PIN 4	
PIN 5 - I/O_2	Input 1			
PIN 6 _ Ground	Ground		PIN 2	
PIN 7 - VEXT			PIN 1	
PIN 8 - Out 6			PIN 6	
PIN 18 - I/O_1				I/O_1
PIN 17 - I/O_3			PIN 3	
PIN 3 - Dig IN 3			PIN 9	
PIN 15 - RS485 B				
PIN 23 - CAN 0 High				
PIN 12 - CAN 1 High				
PIN 11 - AUX RS232 RX				
PIN 20 - 1Wire Data		1Wire Data		
PIN 19 - Out 5			PIN 5	
PIN 2 - Dig IN 4			PIN 10	

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