Resolute User Manual

GNSS RECEIVER - AUTONOMOUS, LOW POWER, TELEMETERED

Version 2.5

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Shipped From

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About Us:

Alert Geomatics is the Geomatics arm of Xeos Technologies Inc., a telemetry, monitoring and tracking company founded in 2004.

Version History

Version No.	Firmware Ver.	Date	Description
1.1	1.1.4147	Nov 2017	RTK Details Added
1.3	1.1.4641	July 2018	Tunnel Details Added, New Firmware Features added
1.4	1.1.4769	Sept 2018	ASCII External Sensor Recording Added
1.5	1.1.4769	Jan 2019	Improved manual graphics
2.0	1.1.5205	Jan 2019	File Stream Buffering, XBD
2.1	1.1.5222	March 2019	Real Time Streaming: RTCM over cell
2.2	1.1.5504	June 2019	Ethernet functionality added
2.3	1.1.6048	Nov 2019	
2.4	1.1.6272	Feb 2020	Memory Management functionality added
2.5	1.1.6702	Oct 2020	Hardware version upgrade

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Overview

The Resolute GNSS Receiver is an autonomous low power GNSS receiver with L1/L2 GPS and GLONASS tracking abilities. Optionally, other satellite constellations and frequencies may be added. The Resolute is powered by a flexible GNSS modem capable of RTK or Standalone data collection.

The Resolute records GNSS data in the **Septentrio Binary Format (SBF)**. Any blocks listed in the SBF Reference Guide can be recorded at a configurable rate. Optional telemetry includes an Iridium 9523 modem for both RUDICS and SBD, a cellular modem or 900 MHz Radio. The Resolute is housed in a rugged enclosure and includes redundant SD cards capable of logging outputs from external sensors.

Device Configurations

The Resolute is a flexible and powerful platform that comes in many different configurations. It is important to realize that this manual may cover subjects that do not apply to your specific device. Separate permission files are required for specific Resolute features, such as raw measurements, Base station corrections, or some signals such as Galileo. Contact sales or support for further clarification on which units contain which features. For a quick implementation guide for your specific unit, please refer to the quick start guide.

Reference

The Reference Receiver is a GNSS receiver capable of recording raw GNSS measurements along with standalone PVT (Position, Velocity, Time) data and many other SBF blocks. It is designed to operate without any real-time corrections and can record data for post processing.

Polar

Similar to the Reference receiver, the Polar Resolute includes an Iridium 9523 modem for RUDICS and SBD telemetry. The Polar Resolute also includes self-governing heaters for operation in extreme cold, along with an IP67 enclosure.

RTK PIN Base -RTK Base Receiver

The RTK Base station is a correction generator for RTK measurements. Equipped with a 900MHz radio or a connection to the internet, a single base station properly configured can broadcast a correction service to one or more RTK Rovers. An RTK Base roughly measures an initial base position and then measures deviations from this position to generate corrections. The Base operates on the assumption that the Base antenna is **not** moving.

RTK PIN Rover -RTK Rover Receiver

The RTK Rover is the measurement and data collection sensor. Depending on the data filter length (at receiver) and response time necessary, it is capable of measuring deviations on centimeter or millimeter levels, when properly serviced with corrections. The RTK Rover should be mounted to the desired landmark of whose movement is to be measured.

NorthStar

The NorthStar is a correction repeater and communications unit that has two primary functionalities relating to RTK receivers. First, it can be a correction relay unit to overcome geographical issues such as distance and topography between the RTK Base and RTK Rover.

Secondly, can also be utilized as a collection point for RTK Rover data. In this second functionality, the NorthStar can be attached to a server or doghouse computer and relay 30-second averaged positions from any RTK Rovers in the radio network. While the theory of operation is similar to the Resolute, the NorthStar is covered in a separate manual found at:

https://manuals.alertgeo.com/Northstar

Device Preparation

Making the Connection
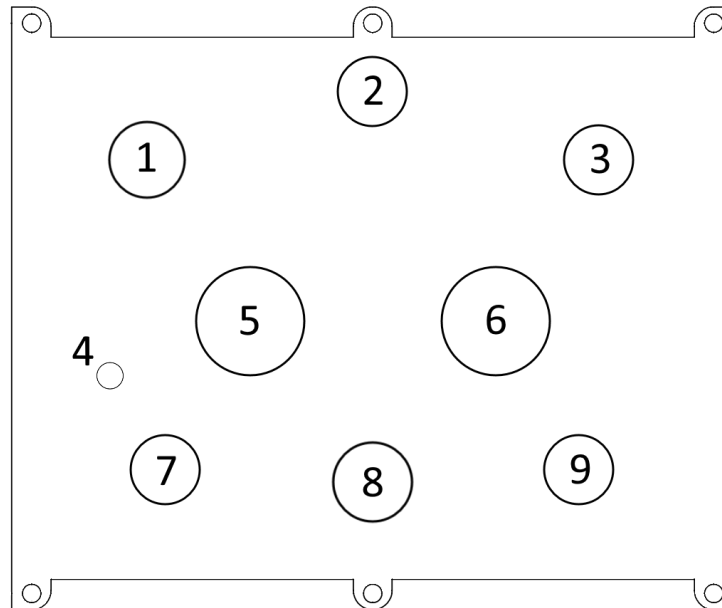
No.	Name	Function
1	USB-Mini	Provides access for configuration of device for deployment via PC
2	Test Button	Used as a test to check if the device is working properly and should turn all the LEDs on. It also initiates the device's connection to its peripheral devices. Hold the button to reset the device.
3	Radio TNC	Connection to Radio antenna via TNC connector
4	2 BA Ground Stud	Grounding connection for lightning and surge protection
5	Serial/SDI-12/SW LOAD	Connection to peripheral device via Serial/SDI-12, Serial output and/or Switched power for peripheral device (14-Pin Female)
6	Power/ENET/CBUS	Connection to power supply, ethernet and CBUS connection (10-Pin Female)
7	Iridium TNC	Connection to Iridium antenna via TNC connector
8	GNSS Type N	Connection to GNSS antenna via Type N connector
9	Cellular TNC	Connection to Cellular antenna via TNC connector

The front panel of the Resolute has up to 7 connectors, depending on the configuration to connect to various antennas.

The USB (USB Mini) is used as a diagnostic I/O port for the device. Alternatively, Serial 1 on the 14-pin circular Souriau connector can be used as a diagnostic port. The user can set various settings on the device through this port, as well as receive diagnostic output. It is also where the device will accept firmware upgrades.

The Type N connector on the panel is supplied to attach to one of the many supported GNSS antennae. Depending on what modems (iridium, cellular or radio) you have installed, there may also be TNC connectors for the various telemetry options as indicated on the label.

The 10-pin circular Souriau connector contains the power connections. The 14-pin circular Souriau connector contains the serial port connections.

Below are the pinouts for the two connectors:

Circular Connector, 14-Pin Female

Pin	Function
A	TXD1-RS
B	N/C, PPS*
C	SDI-12 BUS
D	RXD1-RS
E	CTS+RS
F	GND
H	PWR-SW3
J	RTS1+RS
K	GND
L	RTS8+RS
M	PWR-SW4
N	TXD8-RS
P	RXD8-RS
R	CTS8+RS
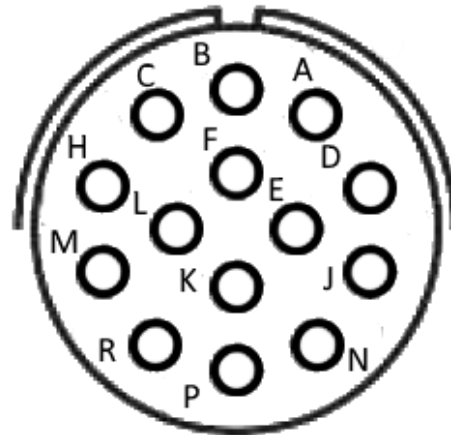
*Note PPS is optionally connected. Must be requested from the factory at time of purchase.

Circular Connector, 10-Pin Female

Pin	Function
A	VBAT
B	GND
C	ETH RD-
D	ETH RD+
E	ETH TD-
F	ETH TD+
G	GND
H	CAN-H
J	CAN-L
K	GND
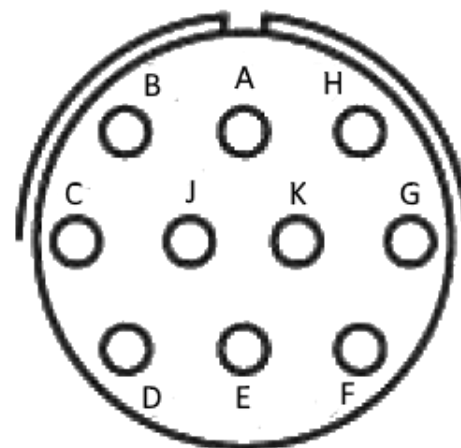
The power leads on the 10-Pin connector (A and B) are connected to the red (+) and black (-) flying leads on the supplied cable. They require a DC power supply of **11V (minimum) to 28V (maximum).** For Resolute units with Cellular or Iridium telemetry a 3A supply is required.

Removable Door: SD cards Access and SIM Installation

The Resolute has a removable door that allows access to the SD cards that are shipped with your Resolute along with access to the SIM slots for optional Cell and Iridium Telemetry. Using a 3/32 Allen key, the four captive fasteners pictured below can be unscrewed from the main housing. Opening the door will automatically unmount the cards to protect the stored data. **No data will be written while the door is removed.**

Door fasteners in their unscrewed configuration. The door is free and able to be removed.

The image below shows the various components of the Resolute unit that can be viewed when the door is open.

No.	Name	Function
1	Clock Battery	Used to maintain the internal clock of the Resolute
2	Iridium SIM Holder	SIM Cards mandatory for use with Iridium are inserted here
3	SD Card Holder	PCB holding both the MicroSD cards is stored here
4	Cell Micro SIM	Module for holding a cellular Micro SIM card is installed here
5	Radio	Radio module is mounted at this point (if applicable)

Retrieving SD Cards

The two SD cards are of the microSD form factor and are mounted on a single removable cartridge on the left side of the Resolute box. To remove the SD cartridge, grasp the edges and pull in the direction of the opening of the enclosure. When replacing the SD cartridge, note that the orientation of the cartridge does not matter as long as the cartridge is fully seated in its slot.

⚠ **It is recommended to only use SLC industrial rated microSD cards. For firmware versions equal to or greater than 1.4641, any capacity microSD is compatible. If using an earlier firmware version, there is a storage capacity requirement of 4GB**
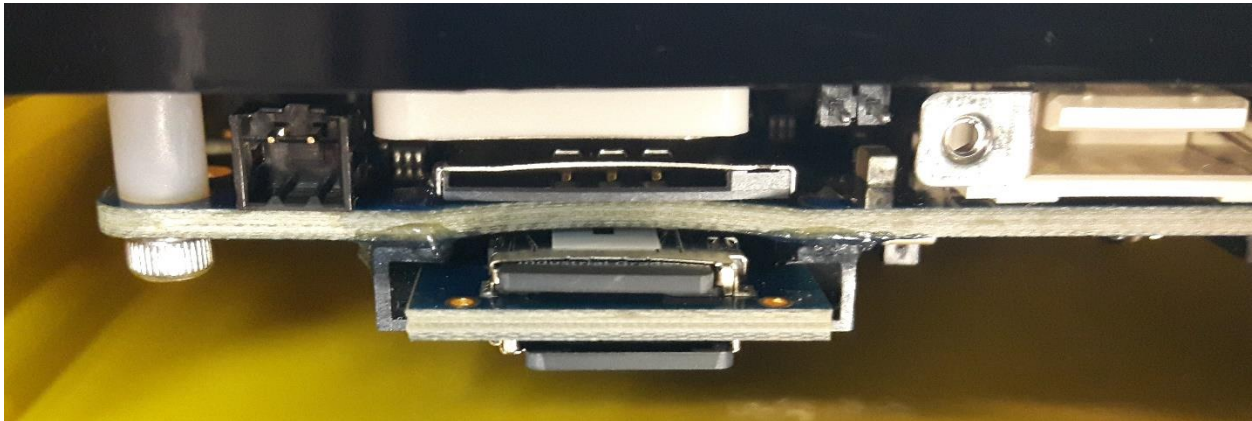
The SD cartridge fully mounted on the PCB chassis.

When the cartridge is removed, labelling of the SD cards can be read from the two holders with one holder on either side of the cartridge. SD 1 is recording GNSS data. SD 2 records unit diagnostics.

If the SD cards are placed in the incorrect SD holders, the data will become mixed (diagnostic and GNSS data on the same card). This has no effect on the performance of the unit but may cause GNSS data to be removed from the card sooner than desired; read about the memory management later in this section for more information.

The SD holders are of the push type. Simply push the SD card further into the holder to remove the SD. The card will pop free upon releasing the card from the push. Push again to mount.
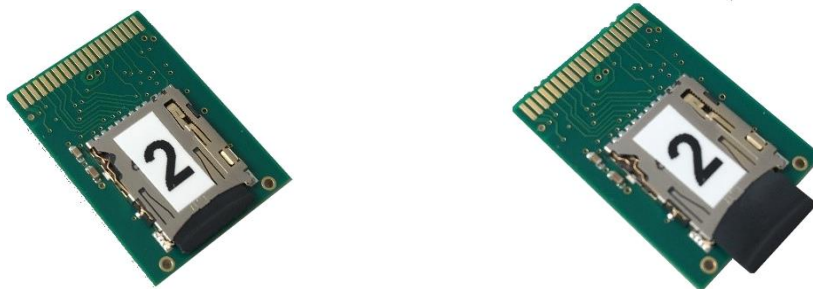
SD 2 Mounted on Left, Push Ejected on Right

To resume recording after accessing the SD cards, mount the cards on the cartridge, then return the cartridge to the PCB chassis and close the door. Upon closing the door, recording will resume. Check that the SD LED is green to ensure both cards were mounted properly. Screw in the fasteners to ensure the door is retained by the enclosure.

Installing the Iridium SIM

If your unit comes equipped with an Iridium modem, it requires a SIM to operate. Iridium SIMs can be purchased through the parent company, Xeos Technologies, an Iridium Value Added Reseller. If only using SBDs, a register only SIM is required. If using RUDICS, your SIM will need to be activated for RUDICS use. **Before inserting or removing the Iridium SIM, verify no power applied to the unit.** To access the Iridium SIM slot, open the SD card door of the Resolute. Using a 3/32 Allen key, the four captive fasteners pictured below should be unscrewed from the main housing.

The Iridium SIM slot is immediately above the SD Cards. The contact plates of the SIM card must face the SD cards. Insert the SIM by pushing the SIM in place. A fully installed SIM is flushed with the SIM holder. For people with large fingers it may be easier to insert or remove the SIM if the SD cartridge is removed first.
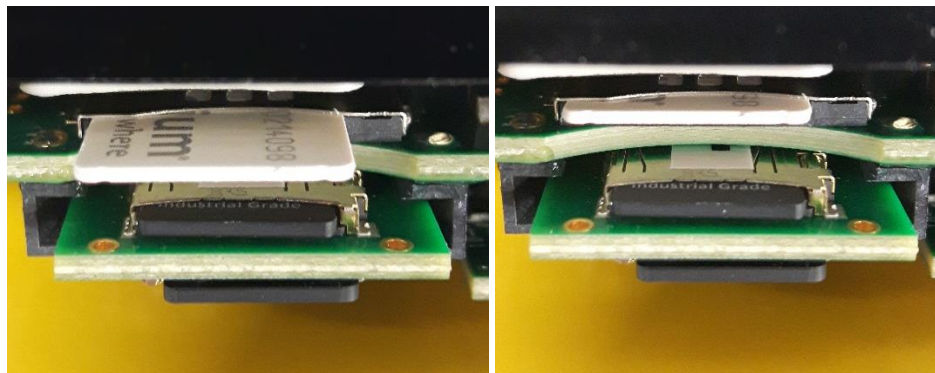
Iridium SIM Ejected (Correct Orientation) on Left, Seated on Right

Installing the Cell microSIM

If your unit comes equipped with a cell modem, it requires a micro SIM to operate. Cell SIMS can be purchased from your local cellular carrier. The default modem standard of the Resolute is GSM. If you wish to use a CDMA carrier, this must be specified at purchase time. The Resolute also requires an APN (Access Point Name) to be configured to connect to your carrier's network. See the Configuring the Cell Modem Section for more information.
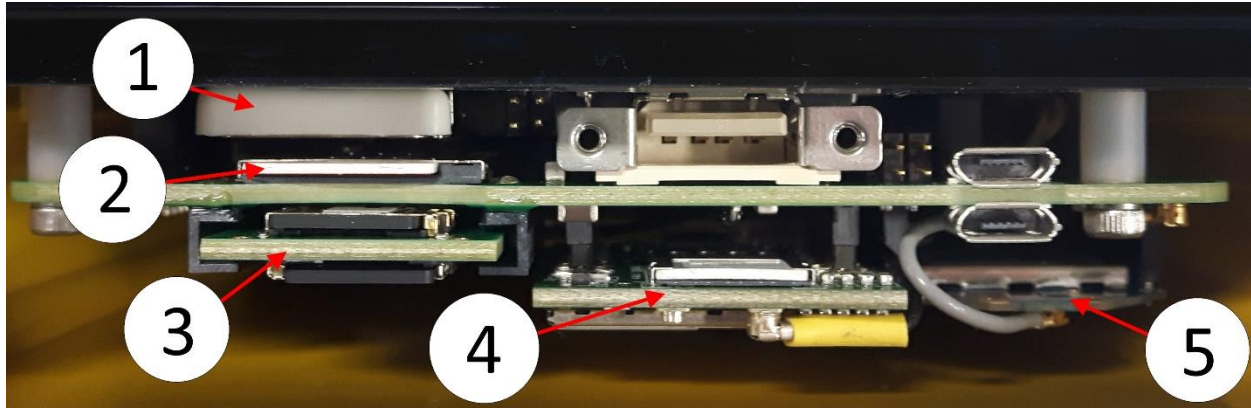
Cell SIM Inserted on Cell modem (4)

Installing Power to the Unit

The Resolute requires power supply capable of sourcing three amp surge currents at 12 V. this can be reduced to one amp if no Iridium or Cellular modem is present. The power cable supplied has a red ring that matches the red ring of the power connector on the box. Appendix G outlines average power consumption requirements for various configurations of the Resolute.

The majority of units in the field will be powered by battery and solar panel. It is recommended to utilize a charge controller for your battery equipped with a low voltage disconnect. This will increase the lifespan of your battery.

It is also important to ground the Resolute for lightning and surge protection. The ground stud is located to the left of the serial connector and is pictured below. The thread of the grounding stud is 2 BA

2 BA Threaded Ground Stud

Test Button and LED Behavior

Test Button Operation

The test button operation is controlled by variable length button presses. Additional confirmation feedback to these button presses is provided by the response of the LEDs. A summary table is provided at the bottom of this subsection.

To turn on the lights, press the test button (roughly one second press). This will light up the LEDs for the next 15 minutes. This is useful for confirming the unit is working and communicating with the network.

Holding the test button longer than three seconds resets the unit. After three seconds of holding the test button, the LED's will begin to flash yellow to confirm releasing will reset the unit.

Holding the test button longer than 10 seconds will, in the case of a Base Station, reset the static Base position and the unit. The GNSS LED flashing blue confirms this hold period. For an RTK Rover, the GNSS LED will still flash blue, but the unit will only reset. A 10 second button press, on a Rover will not reset the Base the Rover is communication with over radio. This operation must be done at the base.

Holding the button for 20s cancels all the above operations and the LEDs turn off. It is safe to release the button at that point if you did not wish to reset the unit or the base position.

Press Length	Unit Response	LED indication
~1s - 3s	LEDs On	LEDs On
3s - 10s	Software Reset	Flashing Yellow LEDs
10s - 20s	Base Position Reset (Base Only) and Software Reset	GNSS LED flashing blue
20s +	Cancel Above Responses	Off

LED Behavior

Confirming the correct operation of the unit is an important step in installing the unit. The LEDs on the unit are designed to assist in this confirmation. The LEDS are automatically on after power up for 15 minutes to assist with installation. LEDS can be reactivated with a quick 1s button push at any point. The below table indicates the meanings of the LEDs.

Power LED	
Behaviour	Meaning
Red	Reverse voltage applied
Green	Unit is powered
No LED	Unit is not powered

SD LED	
Behaviour	Meaning
Red	SD Cards unmounted / **Safe to remove**
Yellow	1 SD card mounted. Not safe to remove
Flashing Yellow	1 SD card mounted, and writing to card. Not safe to remove
Green	2 SD cards mounting. Not safe to remove
Flashing Green	2 SD cards mounted, writing to cards. Not safe to remove

GNSS LED	
Behaviour	Meaning
Red	GNSS receiver on, no valid positions received in last 30s, < 4 SV tracked
Yellow	Last position received is valid (non RTK), Tracking at least 4 satellites
Blue	Last position received RTK Float
Green	Last position received RTK Fixed
No LED	GNSS is not powered

Iridium LED	
Behaviour	Meaning
Red	Modem on
Green	RUDICS Tunnel confirmed connected to XeosOnline
Flashing Green	SBD successfully sent to gateway
No LED	Iridium modem is not Powered

Cellular LED	
Behaviour	Meaning
Red	Modem on
Green	Cell is registered to Network
No LED	Cell is not powered

Radio LED	
Behaviour	Meaning
Red	On
Yellow	Sending correction (RTK Base), receiving correction (RTK Rover)
Green	A Rover is registered (RTK Base), registered to Base (RTK Rover)
No LED	Radio is not powered

Ethernet LED	
Behaviour	Meaning
Red	Ethernet is enabled
No LED	Ethernet is disabled

Installing a Resolute

When installing a Resolute it is important to choose the installation site thoughtfully. It should be noted that there are differences when installing Rovers, Bases, and Reference receivers which will be highlighted in the following sub sections.

RTK Radio Network Design

Before leaving the office, if your unit includes a radio for broadcasting or receiving corrections, best practice is to determine the radio network for your device. Consider any already installed units that you want to avoid disturbing or include in your network. See the example radio network drawings in the Appendix E in addition to the RTK Radio Network Design section for more information. It is easiest to configure the radios in the office before leaving, but configuration is possible to do in the field. Record the radio channel numbers of various units for future reference.

Easiest installation order is generally from Base to NorthStars (if utilized) to Rovers as this allows the installer to confirm corrections are being received at the Rovers before concluding install.

Installing the GNSS Antenna

The GNSS Antenna is the measuring point of the Resolute. Installing the antenna in ideal conditions will increase the performance of your units. The antenna should ideally be installed with a 180 degree uninterrupted view of the sky. If this is not possible, maximizing the volume of the sky in view is advantageous. Keep in mind the majority of GNSS satellites do not pass directly overhead, but travel closely to the horizon. The GNSS antenna will perform better if metallic objects and other reflective surfaces are not in the immediate vicinity. This means the antenna should be mounted one meter off the ground or other surface if possible. It should also be above surrounding buildings if possible.

For RTK Rovers and Reference stations, GNSS antenna should be monumented to the desired landmark to be measured. This means that the antenna should be attached in such a way that if the landmark moves the antenna will be moved by the same amount. Keep in mind of the thermal expansion when mounting the antenna to the landmark, especially for fine deformation monitoring.

If an RTK Base is being installed, the antenna should be monumented to a piece of land that is not moving. Bedrock if available is great for this. Any movement of the Base antenna will present itself as movement of the Rovers in the data.

A-03-058 GNSS Antenna Mount

See Appendix C for specific GNSS antenna mount installation instructions if you purchased an antenna and mount from Alert Geomatics.

Installing the Radio Antenna

If your unit is equipped and configured to send information over radio, installing a radio antenna is necessary. The radio antennas come in two flavors, Yagi and Omni antennas. Yagi antennas are directional antennas and are best used when communicating with only one other radio. Omni antennas are omni-directional antennas and are best used when a radio must communicate with multiple devices.

Both Yagi and Omni radio antennas work on a line of sight basis, with a range up to seven kilometers (4.3 miles) in ideal conditions. Mounting a radio antenna higher in general will allow the radio antenna to transmit over more obstacles in the path between radios. If line of sight is not possible between radios, NorthStars are perfect for relaying corrections over or around obstacles and are not inhibited by the GNSS antenna mounting requirements.

Rovers equipped with radios only need Yagi antennas. Install the Yagi on a pole, or other high point in a horizontal orientation, and point the Yagi to the nearest source of corrections. Poles are advantageous for mounting as they allow 360 degrees of orientation. The smallest element

of the antenna is the "front" of the antenna when orientating. The antenna comes equipped with mounting hardware.

Bases can be equipped with Yagi or Omni antennas depending if they are broadcasting to a single endpoint, or multiple end points. If multiple end points for the corrections from the base are needed, an Omni antenna must be used. If installing a Yagi, point the Yagi to the desired endpoint for the corrections. If installing an Omni, mount in a vertical orientation, on a mast or other high point. The antenna comes equipped with mounting hardware.

Installing the Cell Antenna

If your unit comes equipped with a cellular modem, install the cellular whip antenna in a vertical orientation. While a cell antenna does not have the additional stringent requirements of the other antennas, a cell antenna should not be contained in a metal box.

Installing the Iridium Antenna

If your unit comes equipped with an Iridium modem, the Iridium antenna needs to be installed. This antenna should be installed with as clear a view of the entire sky as possible.

Similar to GNSS satellites, Iridium satellites travel closer to the horizon than over top of your location. There are a limited number of satellites in the sky, so to maintain the best possible connection, the larger the continuous volume of the sky the antenna can see the better.

The Iridium antenna can cause interference with the GNSS receiver so should be placed a minimum of 1 meter away from the GNSS antenna; 10 meters of distance is ideal.

Installing RF Cables

Connecting the RF cables to the antennas involves transitioning the cables through a weather protective enclosure for the Resolute and the power system. This can be done, depending on the environment, through a downspout on the enclosure, or through polyphasers in the wall of the enclosure (not supplied).

If using polyphasers, the polyphaser in line with the GNSS antenna must allow +15V DC Pass-through, as the GNSS antenna is active. RF cables supplied by Alert Geomatics are marked with a part number and color code. The color code matches the ring around the connector on the panel to allow for easy tracing of cables. For an assembly diagram of the various RF cable configurations see Appendix D.

Setting the Base Position (Base Stations Only)

Setting the Base position tells the unit that the Base is configured in its final location. **This MUST be done for all RTK Base units** and should be done after installing the GNSS antenna at the base site and powering the unit. To automatically find the Base press the test button for 10 seconds until the GNSS LED starts to flash blue. Release the button and the unit will reset along with wiping the previously stored base position. The GNSS modem will start up and calculate a new Base position that will be stored to survive power resets. Automatically setting the Base position

will allow the RTK Rovers attached to the Base to make relative measurements from this position. The unit will store this information through power resets.

Device Theory of Operation

The Resolute at its heart is an embedded peripheral control unit. All enabled peripherals, including the GNSS are controlled by a scheduler, which can be controlled by the user. Each peripheral has three separate timer settings using the scheduler: *duration*, *interval* and *offset*. Duration is the length of time the peripheral is on. Interval describes how often the device comes on. Offset offsets the interval by the specified amount of time. Using these three parameters, the timing of powering the peripherals can be controlled. A peripheral can be set to always on by setting the duration to 0.

GNSS Receiver Theory of Operation

The GNSS receiver operates on the scheduler like all other peripherals. The GNSS outputs configurable Septentrio Binary Format (SBF) blocks at a configurable rate. The Resolute can subdivide these outputted blocks into four file 'streams'. Individual streams are recorded to their own files, and have the ability to record SBD blocks at different rates across streams. The files produced from steams are individually configurable in length.

SD Cards Theory of Operation

Data written to the SD cards is initially written to circular buffers in SRAM as of firmware version 5200. SRAM buffering allows for higher data recording rates, and greater data verification. Data is assigned a buffer based on the configuration of the data streams, with Stream 1 and 3 writing to card 1, and Stream 2 and 4 writing to card 2.

> ⚠️ **If you wish to upgrade to firmware version 5200+ from a lower version number, please verify you have SRAM installed on your unit by contacting Alert Geomatics.**

An SRAM buffers will empty its contents to its respective SD card when the buffer reaches 70 % full. While the file is being written to, the file is 'open' on the device, this makes it important to notify the device when you are shutting it down.

Proper shut down etiquette is to either send the device a **$resetnow** command or to hold the test button for 3+ seconds. Failure to do so will cause the file to be left open. Open files are partially recoverable on a computer provided they are not written over. Files are written to the SD card use a naming convention with an ASCII representation of BASE-36 characters with the following name format:

SSFYYMDH.sbf

SS	Two-character representation of device serial number
F	Stream Source (1-4, D (Diagnostics))
YY	Two-character representation of year
M	Month of year
D	Day of Month

H	Hour of Day

Example: **2T10FATC.sbf**

Serial #	2T = 101
Stream	1 = 1
Year	0F = 15 (2015)
Month	A = 10 (October)
Day	T = 29
Hour	C = 12

The GNSS SBF files follow the format outlined in the **Septentrio SBF Reference Guide**. SBF files can be converted to Rinex or

https://manuals.alertgeo.com/RxTools/

Data recorded to the SD card is by default managed by a "memory management" task. Data is recorded until the memory management task detects the card is 90% full, at this point the oldest 10% of data will be deleted. This task can be turned off on a per card basis. Read about this in the SD Memory management Section of the manual.

Tunnel Theory of Operation

If your unit is equipped with a Cellular modem or Iridium modem and a data or RUDICS plan, your unit is capable of remotely connecting to the Xeos Tunnel. The Tunnel is useful for configuring your unit remotely and retrieving data and diagnostics from the SD card remotely. It is also useful for diagnosing potential issues on units deployed in the field.
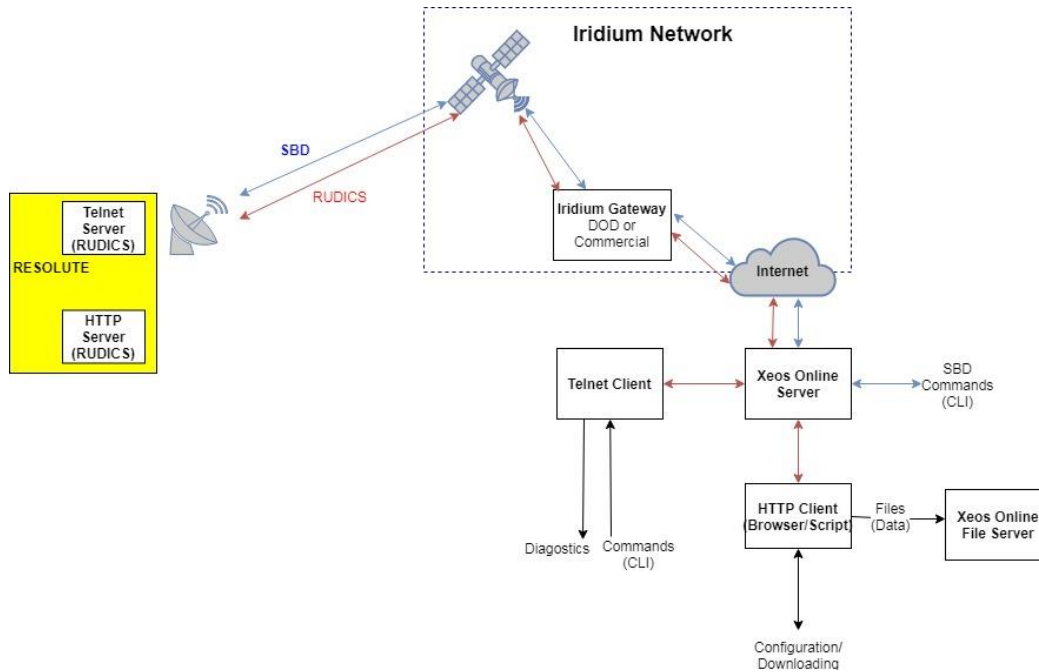
Iridium Tunnel and SBD Network Diagram

Upon reaching its start time, the tunnel will power on the configured modem and will attempt to open a two way connection to XeosOnline (XO). The tunnel confirms two way operation to XO via a heartbeat message known as a "keep alive". A keep alive is a small data packet sent from the unit to the XO server every 15 seconds and acknowledged by the server. This "keep alive" message manages the connection between the unit and XO irrespective of any sockets being opened by the user or a script. If two packets are unacknowledged in a row, the unit closes the connection and tries to reestablish it.

Keep alive data packets include SOH information about the receiver, including voltage and temperature conditions. Keep alive data packets are also the best way to verify the tunnel is connected when your unit is in a remote location. If keep alives are coming in to the Message Log of the unit every 15 seconds, the tunnel is connected.

ID	Device ⇕	Date Processed ▼	SBD Date ⇕	Direction	
♥ 6774609	155	Mar 18 2018 08:18:59.543 PM	Mar 18 2018 08:18:59.538 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774608	155	Mar 18 2018 08:18:44.249 PM	Mar 18 2018 08:18:44.244 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774607	155	Mar 18 2018 08:18:32.101 PM	Mar 18 2018 08:18:32.094 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774606	155	Mar 18 2018 08:17:57.445 PM	Mar 18 2018 08:17:57.441 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774605	155	Mar 18 2018 08:17:54.296 PM	Mar 18 2018 08:17:54.292 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774604	155	Mar 18 2018 08:17:42.138 PM	Mar 18 2018 08:17:42.133 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774603	155	Mar 18 2018 08:17:23.701 PM	Mar 18 2018 08:17:23.696 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774602	155	Mar 18 2018 08:17:08.844 PM	Mar 18 2018 08:17:08.839 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774601	155	Mar 18 2018 08:16:56.696 PM	Mar 18 2018 08:16:56.692 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774600	155	Mar 18 2018 08:16:41.399 PM	Mar 18 2018 08:16:41.395 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774599	155	Mar 18 2018 08:16:24.419 PM	Mar 18 2018 08:16:24.415 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774598	155	Mar 18 2018 08:16:09.568 PM	Mar 18 2018 08:16:09.563 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774597	155	Mar 18 2018 08:15:54.269 PM	Mar 18 2018 08:15:54.263 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774596	155	Mar 18 2018 08:15:39.033 PM	Mar 18 2018 08:15:39.027 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774594	155	Mar 18 2018 08:15:24.184 PM	Mar 18 2018 08:15:24.176 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774593	155	Mar 18 2018 08:15:13.511 PM	Mar 18 2018 08:15:13.507 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774592	155	Mar 18 2018 08:14:56.645 PM	Mar 18 2018 08:14:56.638 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774591	155	Mar 18 2018 08:14:40.446 PM	Mar 18 2018 08:14:40.441 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774590	155	Mar 18 2018 08:14:25.151 PM	Mar 18 2018 08:14:25.146 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774589	155	Mar 18 2018 08:14:09.401 PM	Mar 18 2018 08:14:09.396 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774588	155	Mar 18 2018 08:13:56.347 PM	Mar 18 2018 08:13:56.342 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774587	155	Mar 18 2018 08:13:42.402 PM	Mar 18 2018 08:13:42.397 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774586	155	Mar 18 2018 08:13:23.225 PM	Mar 18 2018 08:13:23.220 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774585	155	Mar 18 2018 08:13:11.078 PM	Mar 18 2018 08:13:11.073 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH
♥ 6774584	155	Mar 18 2018 08:12:58.926 PM	Mar 18 2018 08:12:58.921 PM	Incoming	Data Source: RUDICS, Message Type: Resolute SOH

Iridium Keep Alives in the XeosOnline Message Tab

Tunnel connections over cellular are normally stable (in good cellular coverage). Tunnel connections over Iridium RUDICS will have interruptions under normal operation. The maximum data transfer rate of Iridium RUDICS is 17 KB/min.

The user of the remote device can interact with the device through a number of interface (sockets) into the tunnel. These include an embedded HTTP (Web) Server, automatic download scripts and a Telnet Server. It is possible to open only one socket of the tunnel at a time. Multiple open connections to the tunnel will result in the tunnel disconnecting. The tunnel will reconnect after disconnecting provided the tunnel end time is not met. See Appendix I for information on setting up Iridium Service.

SBD: Theory of Operation

SBDs are a low cost, low power method of communicating remotely with your unit if you have an Iridium modem installed. They are the Iridium equivalent of a text message (SMS). The Resolute schedules SBD message checks using the scheduler. At a scheduled interval, the unit will check for messages at the Iridium gateway. SBDs cannot be sent at the same time as RUDICS tunnels are scheduled. If an SBD message check is scheduled during a tunnel connection, it will be executed upon the tunnel reaching its end time. Any messages sent by the user between the last message check and the next message check will wait at the Iridium gateway for the unit to check in. The unit requires an unlock code in order for any message sent to the unit to issue a command to prevent undesired command and control. Unlock codes are sent out to the

provisioned addresses of the modem on startup and each SBD after. Unlock codes are automatically included by SBDs generated by XeosOnline.

XBD: Theory of Operation

XBDs is Alert Geomatics cellular answer to the Iridium SBD. XBD utilizes the IP connection of the cell modem to send short, low data remotely with your unit if you have a cellular modem installed. XBDs have the advantage over SMS of having responses logged on our server for later analysis or graphing. XBDs can also be sent to the unit from any country in the world without an international texting plan, just using a local data plan. The Resolute schedules XBD message checks using the scheduler. At a scheduled interval, the unit will check for messages at the Xeos Online server. XBDs cannot be sent at the same time as a tunnel is scheduled. If an XBD message check is scheduled during a tunnel connection, it will be executed upon the tunnel reaching its end time. Any messages sent by the user between then last message check and the next message check will wait on the Xeos Online server for the unit to check in. The unit requires an unlock code in order for any message sent to the unit to issue a command to prevent undesired command and control. Unlock codes are sent out to the provisioned addresses of the modem on startup and each XBD after. Unlock codes are automatically included by XBDs generated by XeosOnline.

Device Configuration

All of the settings on the Resolute can be configured either by connecting one of the diagnostic ports to a serial port terminal, the USB port, or by sending configuration commands from a remote location over the Iridium Satellite Network or Cellular SMS (telemetry options needed). If configuring the unit locally, USB is recommended.

USB Diagnostic Port

All the settings on the Resolute can be configured by connecting the USB diagnostic port to a USB port on your computer.

To connect to the USB diagnostic port, if using a Windows PC, you may need to download a driver for the STM32 USB chip contained in the unit. The driver can be found here:

http://www.st.com/en/development-tools/stsw-stm32102.html

⚠️ **Windows 10 Users: The Windows 7 and 8 drivers are functional for Windows 10, but will not auto install. Download the drivers and install the dpinst_amd64.exe file located at:**

C:\Program Files (x86)\STMicroelectronics\Software\Virtual comport driver\Win7\dpinst_amd64.exe
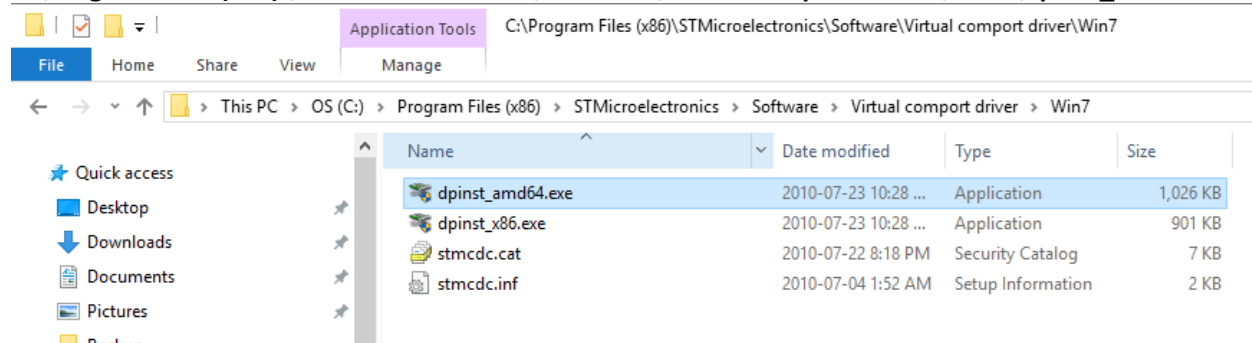
Modern Linux and Mac operating systems already support the driver.

After downloading and installing the driver, connect the supplied USB mini cable between the Resolute and your computer. Your computer will assign the Resolute a COM port number (Windows only) that will show up under ports in the Windows Device Manager. If the device is not recognized, check the driver the device is implementing.

To communicate with the Resolute, you will need a serial port terminal program. **Alert Geomatics recommends STerm, a Windows only product**. A free alternative for Linux and Mac is PuTTY. STerm and related configuration files can be downloaded here:

https://manuals.alertgeo.com/STerm

Port Settings - USB	
Baud Rate	Any

Data Bits	8
Parity	None
Stop Bits	1
Flow Control	Disabled

Using STerm and Sending Commands
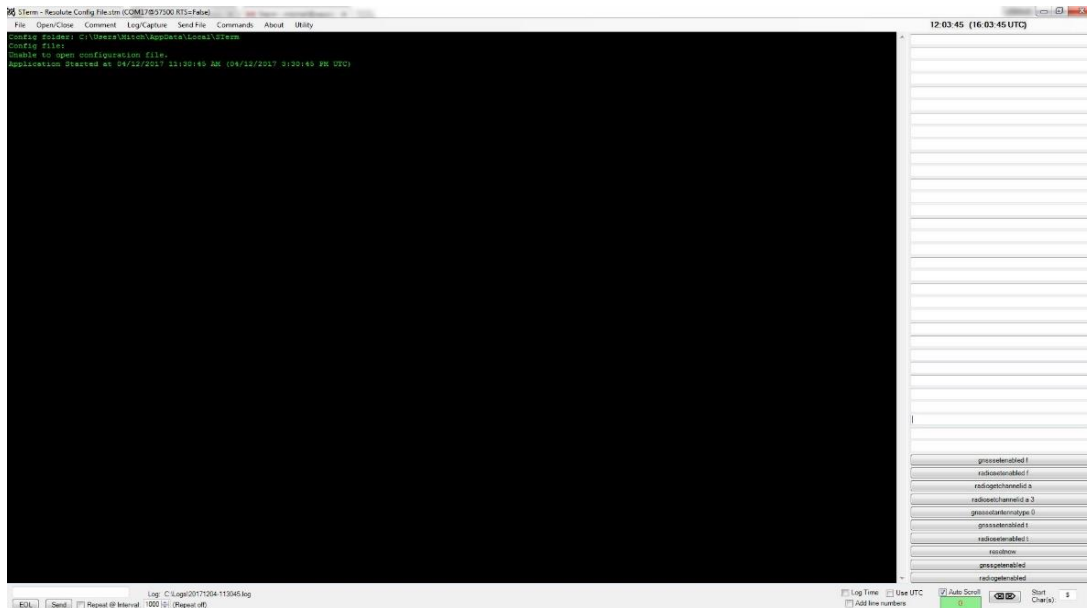
An STerm Window

STerm is the officially supported serial port terminal program of Alert Geomatics.

Sterm can load configuration files to allow the commands for Alert Geomatics products to appear as buttons on the right side of the window. This can be done through the FILE>OPEN menu and opening the Resolute Config File.stm file. This is available to download here:

https://manuals.alertgeo.com/STerm

To open a connection to your device, power it on by applying 12V power using the supplied power cable and a DC power source. The LED should flash on power up. Wait for the computer to recognize the device driver. Select the COM port of your device from the Serial Port Settings menu in the bottom right corner of the screen. Click the open port button and you should now be connected to the unit. The buttons that appear on the right side of the window can be clicked and will send commands to your unit.
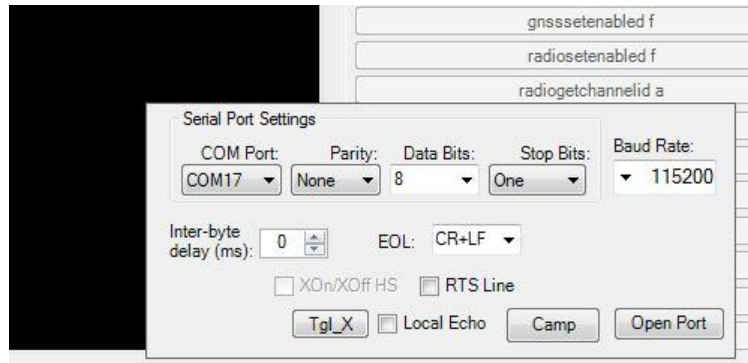
STerm Serial Port Settings Menu

The buttons on the right side of the window can be edited to change the input variable you are sending to the device. This is done by hovering over the right side of the button and then clicking the green edit button. Type your changes into the button then move your mouse away to end the edit.

The Edit icon of the command buttons

When connecting to a device, the diagnostics can flow too quickly to read, especially when not familiar with the output. To confirm commands are correctly received by the unit, it is recommended to disable the Radios and GNSS, which are the primary diagnostic generating peripherals in the unit. This can be done with the top buttons on the right of the Resolute Sterm config file **$RadioSetEnabled f** and **$GnssSetEnabled f** commands**.** If the radio or GNSS does not disable within 30 seconds (the diagnostics should almost completely stop), reset the unit. Resetting the unit may cause you to have to replug in the USB connector depending on your version of Windows. You will also have to reopen the COM port.

After disabling the peripherals, send the desired commands and wait for the unit to reply. Reenable the radio **$RadioSetEnabled t,** GNSS **$GnssSetEnabled t** and reset the unit with the **$resetnow** command. Your unit is ready for operation.

Configuration Commands

Timer Methodology

The timers on the device are powered by an onboard battery backed up by a real time clock (RTC). The RTC is updated from GNSS time to compensate for drift. The RTC continues to tick while the device is powered off and operates in the UTC timeframe.

It is possible to shift to the GPS/GNSS time scale (i.e. discount leapseconds) by utilizing the command **"$gnsssetusegnsstime t"**.

All peripherals are controlled by four separate timer settings: *enabled*, *duration*, *interval* and *offset*. Enabled controls if the peripheral is active or scheduled. Duration is the length of time the

peripheral is on. Interval is the how often the device comes on. Offset offsets the interval by the specified amount of time.

Peripherals can be enabled or disabled using **"$(function)SetEnabled T/F"**. For example, the following setting will enable the GNSS module:

$GnssSetEnabled T

When adjusting the timing settings, the time input can take form of seconds (by default, if no units are entered), minutes, hours or days. For example, 3 hours would be entered as "3h". The command for timing settings accepts "m" as minutes, "h" as hours and "d" as days. The timer input can only be input with one unit. If you wish the duration to be infinite (always on), simply set the duration time to "0".

The next start and end time of various peripherals and tasks can be queried using the **$schedule** command. If a task or peripheral is not on the schedule, it is not enabled. If the schedule command does not return any output, all peripherals and tasks are off.

GNSS Configuration

The GNSS module can be enabled or disabled using **"$GNSSSetEnabled T/F"**. To enable the GNSS module use:

$GnssSetEnabled T

The status of the GNSS module can be queried using **$GnssGetEnabled.**

The GNSS antenna type can be configured in firmware using "**$GnssSetAntennaType [type]**". This command configures the Antenna Reference Point (ARP) and other settings needed for accurate GNSS measurements. Type is a number corresponding to an antenna index. Common antennas supplied with the Resolute have the following numbers for this command:

0: Talisman TW3870/2 (default)

1: Septentrio PolaNt-x MF.

If your antenna is not on the above list, please consult Appendix B for the complete list. The example below would configure the receiver correctly for the Talisman TW3872:

$GnssSetAntennaType *0*

⚠️ **Some antennas require a different voltage supply than others**. The standard antenna voltage supply is 3.3V. This can be increased to 5V using the "**$GnssSet5vAnt t**" command. Consult the data sheet of your antenna for more information. The voltage supply can be reverted to 3.3V by sending a "**$GnssSet5vAnt f**" command. The status of the antenna voltage supply can be requested with the "**$GnssGet5Ant**" command.

GNSS's *duration* parameter specifies the length of time the GNSS peripheral is on. This timer can range from 30 seconds to always on (infinite). To change this timer, issue the following command:

$$\text{\textbf{\$GnssSetDuration} \textit{[time]}}$$

The variable time is length of the timer. For example, to turn on a unit for a duration of 3 hours, you would enter the following command:

$GnssSetDuration 3h

GNSS's *interval* timer is the length of time between the on periods of the GNSS (start of one period to start of next). This timer can range from 30 seconds to multiple days. To change this timer, issue the following command:

$GnssSetInterval *[time]*

The variable time is the length of the timer. To turn on the unit for an interval of 1 day, issue the following command:

$GnssSetInterval 1d

GNSS's *offset* timer is the length of time the interval timer is offset between the GNSS peripheral on periods (start of one period to start of next). This timer can range from 30 seconds to multiple days. To change this timer, issue the following command:

$GnssSetOffset *[time]*

The variable time is the length of the timer. For example, to offset the start-up of the peripheral on a daily interval to 13:20 UTC time would be entered as follows:

$GnssSetOffset 800m

Working Example:

A Resolute on a long term remote deployment in Alaska monitoring fault lines is required to record data for 20 minutes every two hours for plate subsidence. For this application the GNSS duration would be set to 20m while the interval would be set to 2h. To implement this the following commands would be sent:

$GnssSetEnabled T

$GnssSetDuration 20m

$GnssSetInterval 2h

Configuration of the GNSS signals, blocks and report rates can be done through the HTTP Server of the device. This can be accessed through the XeosOnline tunnel. This configuration is covered in the HTTP client operation section of the manual.

Alternatively, command line messages can be sent to configure unit signals and messages enabled. For Iridium SBD, these are best formed on XeosOnline using the 'admin' option (user must be an admin level user to see the button on the top bar).

To configure and send the command to a unit, click on the two-directional arrow button under the Admin page next to the particular unit to open the Resolute Configuration window.
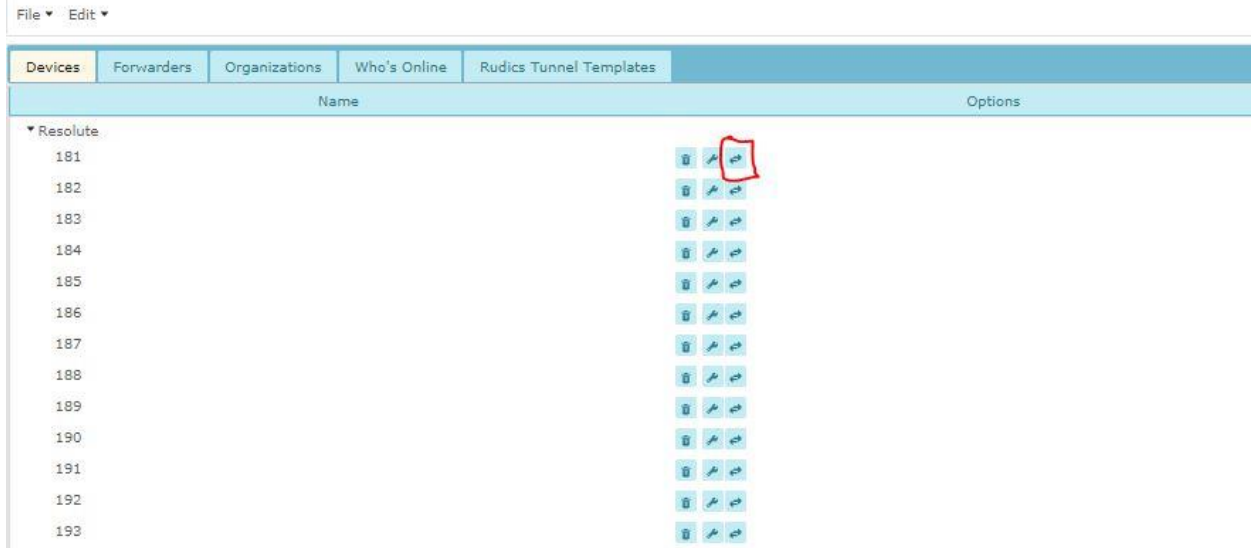
To configure the signals that are to be tracked, this command would be sent: **$gnssSetSignalTracking [signals (HEX)].** This can be formed and sent by clicking on the 'GNSS Signal Tracking' tab, and checking the signals you would like to track. The command can be sent directly to the unit through this window using the 'send' button.
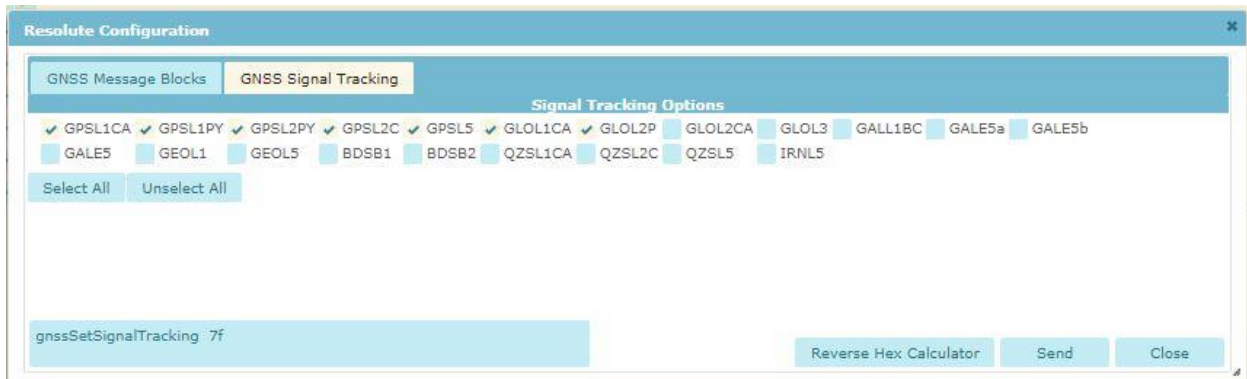
The current settings can be recovered by using the 'reverse hex calculator' button on the bottom of this window and by entering the hex bitmap in the text box from the **$gnssGetSignalTracking** command. Clicking on 'update' option under the calculator will check the boxes of the signals that are currently tracked.

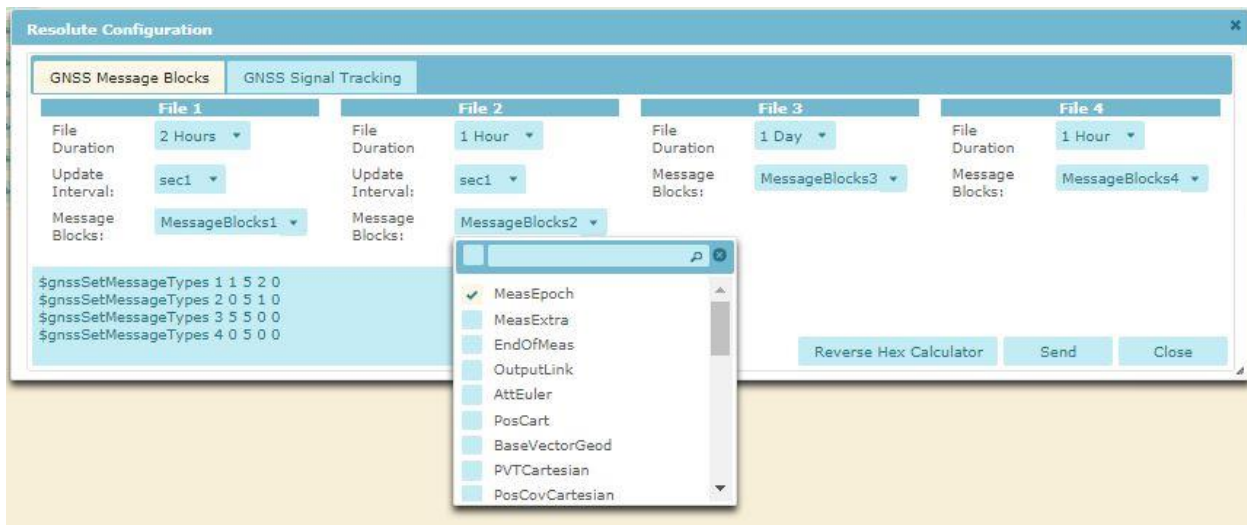Like the configuration of signals, the messages and intervals can also be configured under the 'GNSS Message Blocks' tab in the Resolute Configuration window. The command used for configuring the recording of messages is **$gnssSetMessageTypes [stream] [duration] [update interval] [Bitmap A] [Bitmap B].** Stream is for file streams 1 through 4. File streams 1 and 2 have a configurable update interval while 3 and 4 are recorded only when the details of the block have changed, or a new file has opened. Duration specifies the duration for which the GNSS data is recorded.

File Duration and Update Interval, as shown in the Resolute Configuration window below, are indices corresponding to the values you either provide in the calculator or you enter those manually in the window. File stream 1 and file stream 2 could be recorded at different update intervals. Accordingly, file streams 1 and 3 are recorded to SD1 and file streams 2 and 4 are recorded to SD2. Bitmap A and B are configurations used to choose message types of interest. You can either choose message types from the drop-down menu given under each file, as shown in the image below, or by using the reverse hex calculator. By selecting values in the calculator or drop-down menus, the message to send to the unit is formed.

> **Note: When using the calculator, messages to configure all four streams are sent, verify the settings for each stream!**

Like configuring signals, the reverse calculator can be used, and clicking the send button sends the message. The current GNSS message block values can be retrieved using the **$gnssgetMessageTypes** command.

For an example, "$gnssSetMessageTypes 1 1 5 2 0" would record only "MeasExtra" message blocks in file 1 for 2 hours with an update interval of 1 second. Conversion of the chosen *File Duration*, U*pdate Interval* and *Message Blocks* from the drop-down menus to their respective codes is done internally by Xeos Online.

Collecting RINEX Data

The Resolute does not naturally record in RINEX (Receiver Independent Exchange) format, but native SBF files can be converted to RINEX. To log the SBF equivalent of RINEX observation files, enable the "MeasEpoch" SBF message in stream 1 or 2. To log the equivalent of the Navigation RINEX files, log the GPSNav or GloNav, or respective Nav SBF block for the satellite constellations enabled in stream 3 or 4 of the Resolute. RINEX conversion can be accomplished using either sbf2rin, or Septentrio's SBF Converter.

If you wish to populate the RINEX header, enable the ReceiverSetup SBF block [more information can be found in the "SBF Reference Guide"]. This block must be concatenated onto the observation file before converting with SBF converter, Alert Geomatics has tools to handle the concatenation available. The details of the RINEX header can be filled out with the following **set** commands. **Get** commands are also available

Command	Variables	Description
$gnsssetantennatype	See Appendix B	Set the antenna reference point, also used for RINEX header
$ gnssSetAntennaOffsets	20 characters [E-Offset] [N-Offset] [U-offset]	Set the antenna offset for RINEX header
$gnssSetAntennaSerialnumber	20 characters	Set the antenna offset for RINEX header
$gnssSetAntennaSetupId	20 characters	Set the antenna setup ID for RINEX header
$gnssSetMarkerName	20 characters	Set the marker name for RINEX header
$gnssSetMarkerNumber	20 characters	Set the marker number for RINEX header
$gnssSetMarkerType	20 characters	Set the marker type for RINEX header
$gnssSetObserverName	20 characters	Set the observer name for RINEX header
$gnssSetObserverAgency	20 characters	Set the observer agency for RINEX header
$gnssSetObserverComment	20 characters	Set the obersever comment for RINEX header

Configuring Base Station Correction Output

The Resolute can, for units enabled with Base Station Permissions, send RTCM corrections and data out of various modems and ports. The majority of base station users, will use the Base station corrections over the built in Radio. This is the default correction output method. However

this corrections can also be output over the Serial 2 port, as well as streamed over a cellular tunnel connection to a port on Xeos Online (Beta Feature).

To configure the output of the RTCM corrections a bitmap parameter must be set. The command for this is **$rtcmsetoutputbitmap [value].** Valid values are**:**

1: Radio (Default)
2: Serial 2
4: Cell Tunnel Streaming (Beta)

To set the RTCM output to Serial 2 send the command
<div align="center">

$rtcmsetoutputbitmap 2
</div>

⚠️   **Note: A unit restart is advised after updating the output bitmap.**

The RTCM output bitmap can be verified with the **$rtcmgetoutputbitmap** command.

Recording External Sensors

The Resolute can be configured to record external data over some of the interfaces present. If you wish to record a sensor with an interface not mentioned here, please contact Alert Geomatics.

Recording and Requesting ASCII Strings

The Resolute can record requested ASCII strings of data in the SBF ASCIIIN Data Format over the SERIAL 2 port as of version 1.4769. This data format is compatible with RXConverter for conversion back to ASCII. To enable this feature use the command **"$AESSetEnabled t"** The status of this feature can be confirmed with **"$AESGetEnabled".** AES represents ASCII External Sensor.

To request the ASCII string from the device, the Resolute can issue an AES command using a string value. This can be done with the **"$AESSetCommandString [string]"**command. The resolute Serial 2 port must also be set to the same baud rate as the sensor. This can be accomplished using the **"Serial2SetBaud [baudrate]"** command.

The interval of the command can be controlled with the **"$AESSetInterval [interval]"** and **"$AESSetOffset [offset]"** commands, where interval and offset are entered in seconds (s), minutes (m) or hours (h). The interval command controls the repeat interval of the command, while the offset controls the timing of the command relative to the interval. The next scheduled ASCII request timing can be viewed through the **"$schedule"** command.

After the sensor sends the command request, the Resolute will wait for a specific amount of time for a response from the external sensor before timing out.

Recording Binary Data

The Resolute can record binary data from other sensors. Contact Alert Geomatics for more details.

SD Memory Management

The data produced by the Resolute is written to two microSD cards. As the data generated by the Resolute fills the card, files will automatically be deleted by a memory management task. The task measures the size of the files on the SD cards. If an SD card is over 90 % full, the task deletes the oldest dated files until the SD card is less than 80 % full. This continues in perpetuity. This task is enabled by default, but can be enabled disabled with **$SdSetMemoryManagement [T/F].** For instance to completely disable the setting send the command:

<div align="center">

$SdSetMemoryManagement F

</div>

If Memory Management is disabled and the memory cards are full, no new data will be written to the SD Cards. If the task is enabled, the task can be assigned specific cards to operate on, on a per card basis. This is configurable with the **$MemoryManagementSetDisks [1/2/3]** command where 1 corresponds to only operating on SD 1, 2 corresponds to only operating on SD 2 and 3 (the default setting) corresponds to operating on both SD cards. For example to only manage the memory on SD 2, and keep SD 1 data indefinitely the following command would be sent.

> ⚠️ **Before firmware 6272, the memory management task could be enabled or disabled with $SDSetdeleteoldest [T/F]. This command does not exists in 6272 or later.**

The lifespan of the files on the card before they are deleted depends heavily on the settings of the unit. If only a small amount of GNSS data is being recorded, for instance 1 Hz PVT/PNT data, the files will be present for months. If raw GNSS data is being recorded at 5 Hz, the data may be present for merely weeks.

While it is not necessary for operation, it is possible to re-format the SD cards. This can be done using the **"$formatSD [identifier] [filesystem]"** command, where the identifier is either "**1**" for card 1, or "**2**" for card 2. Filesystem is either "**1**" for Fat32 or "**2**" for exFat. exFat must be used for card sizes over 32GB. To format card 1 as Fat32, the following command would be issued:

<div align="center">

$formatSD 1 1

</div>

If operating the Resolute off of a low voltage disconnect (LVD), the power interruptions can result in the corruption of the SD cards. To protect the cards, the Resolute can be configured to unmount at a set voltage, before the low voltage disconnect cuts power to the device. The unit can be configured to remount the cards at a higher voltage. The feature must first be enabled with the **"$setshutdownvoltageenabled t"**. The lower shutdown voltage must be set with the **"setshutdownvoltage [voltage]"** command. The default shutdown voltage is 11.5 V and should

be set higher than the disconnect voltage of the LVD. The restart voltage must be set with the **"setrestartvoltage [voltage]"** command. This should be set a few hundred millivolts above the shutdown voltage. The default restart voltage is 11.7 V. The three commands required to configure the shutdown voltage are shown for a shutdown voltage of 10.5 V and a restart voltage of 10.8V.

<div align="center">

$SetShutdownVoltageEnabled t

$SetShutdownVoltage 10.5

$SetRestartVoltage 10.8

</div>

RTK Radio Network Design

The Resolute RTK units contain an embedded radio peripheral for sending and receiving RTK corrections. The radio peripheral included with RTK and NorthStar units operate on a channel basis, with 8 possible channels (0-7). For a simple single-Base-single-Rover network, all the radios should operate on the same channel to receive the corrections. The default channel from the factory for this is channel 3. The Base broadcasts corrections to the Rover, and the Rover receives the corrections. For this configuration, the use of Yagi antennas is recommended.
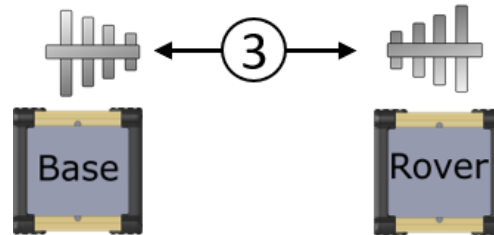
An example of a Single-Base-Single-Rover network.

A step up from this network is the Single-Base-Multiple-Rover network. For this to work, the Base needs to be equipped with an Omni antenna to allow strong radio signal in all directions. This is the only change required as the base broadcasts. All Rovers should be configured on the same channel as the Base.
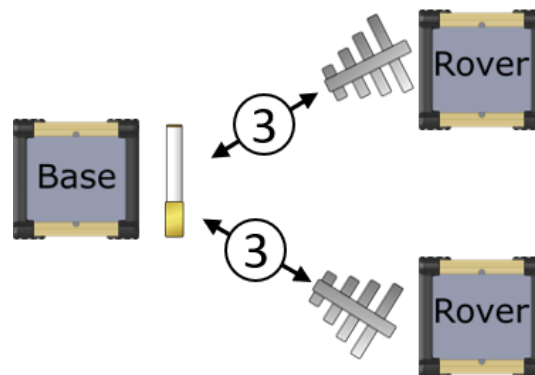
An example of a Single-Base-Multiple-Rover configuration.

If the Base radio does not have line of sight to all Rovers required for your application, additional NorthStar Repeater(s) can be added into the Network. The NorthStar Repeater is equipped with two radios which are identified as Radio A and Radio B.

Radio A receives the corrections broadcasted from the Base, in this configuration it operates as a Rover and should be configured to the same channel as the Base, in this case the default channel 3. Radio B rebroadcasts the corrections like a Base. Because this radio is a second broadcasting radio on the same network it must be on a different channel to the Base it is receiving corrections from. The factory default for Radio B is channel 5. Any Rovers that require the NorthStar for line of sight to receive corrections should be on the same channel as the NorthStar Radio B.

In the configuration where a base is only broadcasting to a single NorthStar, the Base would need to be equipped with a Yagi antenna pointed at the NorthStar. NorthStar Radio A would be equipped with a Yagi Antenna pointed at the Base, while NorthStar Radio B would be equipped with an Omni Antenna to broadcast to multiple Rovers.
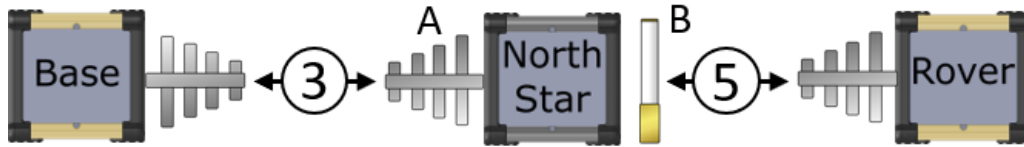
An example of a single NorthStar network (only one Rover shown).

It is possible to add multiple NorthStars in sequence for a long baseline connection to an RTK Rover. To add an additional NorthStar to the network mentioned above, radio A would be configured to channel 5. Radio B could be configured to channel 2 (There are many options here if the channel is free). Rovers attached to this NorthStar would be configured to channel 2. For the best performance, it is ideal to have Rovers connected to the Base as directly as possible. Each NorthStar added in series adds roughly ½ second of delay in the corrections. Additionally, baseline length can also degrade the RTK results resulting in an additional +/- 1mm error per kilometer of baseline. To reach multiple NorthStars, the Base requires an Omni Antenna.
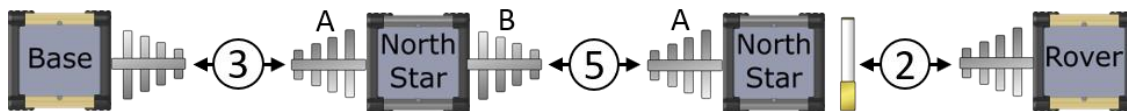
An example of a chained NorthStar network.

Multiple-Base-Multiple-Rover setups are the best way to collect the most accurate results possible.

⚠️**Bases cannot be configured on the same network; separate channels are required.**

Multiple Bases reduce baselines and transmission delays. Bases or NorthStar Radio Bs cannot transmit on the same channel, when they are within communication distance of one another. **This means up to seven kilometers (4.3 miles) line of sight.** Rovers should be configured to receive from the Base closest to them, within line of sight. The maximum number of units linked to one Base or NorthStar is 28.

 The best practice when setting up a large RTK network is to draw a radio network map. Examples of such a map can be found in the Appendix E. The map in Appendix E is also a good example of possible configurations.
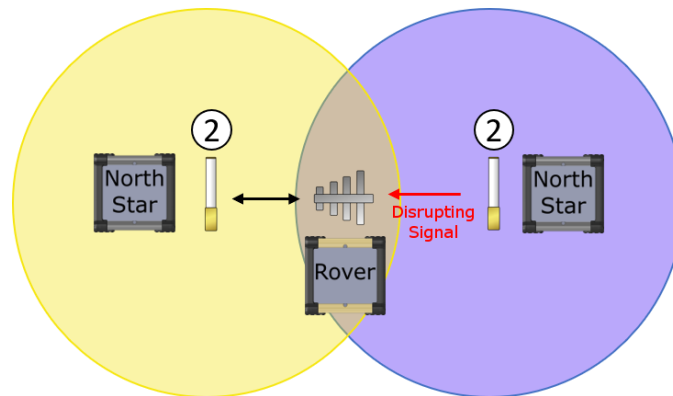
Avoid overlapping base coverage boundaries.

Radio Configuration

The radios as configured from the factory will work for a single Base, multiple Rover RTK network. If a NorthStar Repeater was included in your order, the Rovers will be configured to receive from a single NorthStar. Multiple NorthStar Repeaters in series will require reconfiguration of the Rovers.

To configure the radio channel on a Resolute use the command:

$RadioSetChannelid [identifier] [channel]

The identifier for a Resolute is always "**A**" and is not case sensitive. The 'channel' is a value between and inclusive of **0** and **7**.

To configure the radio to broadcast or receive on channel 7 the following command would be sent.

$RadioSetChannelid A 7

Configuring the Cell Modem

If a cell modem is installed in your unit, it needs a micro SIM from a local carrier to operate. See details in Installing the Cell Micro Sim. The cell modem also requires setting the APN (Access Point Name) specific to the plan you procured from your local carrier. This can be set with **$cellsetAPN [APN]** . For instance for Bell data plans in Canada, the APN is

$cellsetAPN pda.bell.ca

The device should be reset after updating the APN. It is also a good idea to enable and disable SMS or Data features depending on the plan and your intended usage. The Tunnel and XBD require a Data plan.

⚠️ **Note: SMS is currently only functional for North American phone numbers.**

The remainder of cell configuration is covered in the "Embedded Telemetry Data Transfer: IP Tunnel Configuration" and "SBD and SMS and XBD Configuration" sections ahead.

Embedded Telemetry Data Transfer: IP Tunnel Configuration

Data transfer is accomplished with the embedded telemetry (Cell or Iridium) over an IP tunnel which is simply referred to as the tunnel throughout the rest of the document. The tunnel grants access to the embedded servers on the device and manages the connection to the Xeos Online server. Tunnel timers are useful if you have either a Cellular or Iridium modem. The Resolute needs to be configured with which modem should be prioritized for connections to the tunnel. The priority list can be changed with the "**$TunnelSetModem [priority] [modem]**" command. Priority 0 is the highest priority while 3 is the lowest. Most users will only Modems have the following corresponding numbers for this command: 2: Cellular, 3: Iridium. To prioritize the cell modem before the Iridium modem the following commands would be entered:

$TunnelSetModem 0 2
$TunnelSetModem 1 3

Tunnel timers operate the same as the GNSS timers, with enabled, *duration*, *interval* and *offset*. The commands are as follows:

$TunnelSetEnabled *[T/F]*
$TunnelSetDuration *[time]*
$TunnelSetInterval *[time]*
$TunnelSetOffset *[time]*

Working Example:
A polar unit records data continuously and only needs up to one hour of Iridium RUDICS time to transmit the collected data daily. The operators of this station need the previous 24 hours of data to arrive at 1 PM. To configure the unit for this situation a duration 1h, an interval of 24h and an offset of 12h is desired. The following commands would be sent to the unit:

$TunnelSetEnabled T
$TunnelSetDuration 1h
$TunnelSetInterval 24h
$TunnelSetOffset 12h

SBD and SMS and XBD Configuration

If your unit is equipped with cellular and/or Iridium modems, it is possible to use SBD (Iridium) and/or SMS (cellular) to interrogate or configure the unit.

SBD, XBD and SMS can be configured individually using the interval and offset timer commands. **SBD and XBD duration timer is 3 minutes and is NOT configurable** . The commands to configure the timers are below and operate on the same principals outlined in detail in the GNSS section:

$SmsSetInterval *[time]*
$SmsSetOffset *[time]*
$SbdSetInterval *[time]*
$SbdSetOffset *[time]*
$XBDSetInterval *[time]*
$XBDSetOffset *[time]*

SBD, XBD and SMS capable units will send a power up message when the unit first turns on. This is useful for confirming when deploying in the field, and notifying users of remote stations of unexpected power loss. SBD, XBD and SMS cannot occur simultaneously to their respective tunnels. If an SBD or SMS is scheduled during a tunnel session, a flag is set and the SBD or SMS will occur at the conclusion of the tunnel.

Ethernet Configuration

The Ethernet port of the Resolute can be enabled using the **$EthernetSetEnabled T** command. The Ethernet port is disabled by default. The IP Address of the Resolute can be configured using the **$EthernetSetIP [xxx xxx xxx xxx]** command. Note that spaces are used instead of periods and no brackets are required.

⚠️ **Note: The Resolute MUST be reset in order for any changes to Ethernet settings (including enabling) to take effect.**

Other Ethernet settings are listed below:

Command	Description	Example
$ethernetGetEnabled	Returns the status of the ethernet peripheral	ethernetGetEnabled
$ethernetSetEnabled y/n	Enables or disables the ethernet peripheral	ethernetSetEnabled y
$ethernetGetIP	Returns the current ethernet IP address of the Resolute	ethernetGetIP
$ethernetSetIP 111 111 111 111	Sets the 4 bytes of the ethernet IP.	ethernetSetIP 192 1 168 2
$ethernetGetNetMask	Returns the configured ethernet netmask of the Resolute	ethernetGetNetMask

$ethernetSetNetMask 111 111 111 111	Sets the configured ethernet netmask (space delimited)	ethernetSetNetMask 255 255 255 0
$ethernetGetMac	Returns the set mac address of the Resolute (default: aa bb cc dd aa bb)	ethernetGetMac
$ethernetSetMac aa bb cc dd ee ff gg	Sets the mac address	ethernetSetMac F1 3A 83 3C 6F BF
$ethernetGetGateway	Returns the set Gateway IP of the Resolute	ethernetGetGateway

The Gateway address is set according to the IP address automatically and cannot be set manually.

Ethernet Latency Configuration

In situations where the Ethernet port of the Resolute is connected to high latency telemetry (BGAN, Some Ethernet Radios, etc) A higher data rate may be achieved by implementing the **$IPSetHighLatency [T/F]** command. This setting enabled more packets to be sent without acks when transferring data. The default setting is disabled. To enable send the **$IPSetHighLatency T** command and reset the device.

⚠️ **Note: Enabling this setting on a low latency connection will result in slower performance.**

Switch Power Configuration

The Resolute has two switch Power pins, for powering external device with 12V power. These pins can be configured on a one time basis, or via the scheduler.

To enable the switch on a one time basis the command **$pwrsetswitch [1/2] [T/F],** enabled the switch until the switch is turned off or the device power reset.

To enabled the switch power via the scheduler, send the command **$Pwr1Setenabled [T/F]** or **$Pwr2Setenabled [T/F]** depending on the switch. After enabling the switch on the scheduler the duration, interval and offset can be set via **$Pwr1Setduration [duration], $Pwr1Setinterval [interval], $Pwr1Setoffset [offset]** commands. For switch 2 use **$Pwr2...** . To leave the switch always on, even after restarts, set the duration to 0:

<p align="center">$Pwr1Setduration 0</p>

Using the Tunnel: Connecting to the embedded servers and operation

The tunnel can open sockets to both the HTTP and Telnet servers on the device. Only one socket per server can be connected. See Appendix I for information on setting up Iridium Service.

Scripts that are used for downloading data use the HTTP socket and must be disabled by Alert Geomatics to allow other use of the HTTP socket.

Contact Alert Geomatics for more information about connecting to the embedded servers over the tunnel, your IP must be cleared to access your device.

Accessing the HTTP Server

Over Ethernet, the HTTP server can be accessed on port 80 by typing the set IP into a connected computer using any standard web browser. Contact Alert Geomatics about connecting to the HTTP client through the tunnel.

Operating the HTTP Client
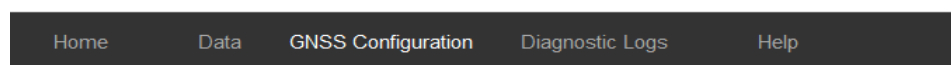
The http client can be navigated with the top menu on the accessed HTTP page. **Wait for the pages to load fully (spinning wheel disappears) before loading another page or starting another operation.**

To change which signals are tracked by the unit, access the "**GNSS CONFIGURATION>SIGNAL TRACKING**" page. Click on the check boxes corresponding to the signals and click save to send the new configuration to the unit.

To change which SBF blocks are recorded, click on the "**GNSS CONFIGURATION>MESSAGE TYPES**" page of the HTTP tunnel. Recording is done in streams. The first two streams are recorded at configurable record rates and the other two are recorded on change. Click on the check boxes corresponding to the blocks you wish to record under the streams you wish to record and click save to send the new configuration to the unit.

To download files manually click on the "**DATA**" tab on the HTTP page. Choose the files you want to download, one at a time, then wait for the downloads to finish before clicking on the next file.

You cannot queue downloads by clicking multiple files. The tunnel will disconnect. Do not cancel a partial download as this function is not built into the Resolute**.**

Automatic File Retrieval (Auto-Downloader)

If you wish to retrieve files from the embedded HTTP server on a consistent basis it is possible to run a script to download all new files on the unit either through the Tunnel to the Xeos Server or over the local Ethernet connection to the device operating the script. The script will automatically start downloading files for the duration of the connection. Contact Alert Geomatics for further details. **This is especially recommended for retrieving files over Iridium**. This script acts as your one HTTP socket connection. Alert Geomatics must enable and disable the script at this time when operating over the Tunnel.

Connecting to the Telnet Server

Over Ethernet, the Telnet server can be accessed on port 23 using the set IP on freely available programs such as Putty. Contact Alert Geomatics about connecting to the Telnet client through the tunnel.

Operating the Telnet Client

After connecting your client to the Telnet server, you may send any command you would normally send over the diagnostic port following the $command format. The unit response will print out on the screen. If you wish to turn on all diagnostics, send the following command to let them stream:

$telnetsetdiagnostics t

To close the connection, close your telnet client otherwise the connection will time out after 3 minutes.

Sending XBDs and SBDs Using XeosOnline

After logging in to XeosOnline, click on "**FILE>SEND**"**.** A new window will pop up in your browser. The left area will have a list of all the units in your XeosOnline organization in the form of the Serial Number or other identification name followed by an (IMEI). IMEI's are identifying numbers of Iridium and Cellular modems.

⚠️ **Each unit has a default method of sending messages. When both Iridium and Cell modems are present, Iridium is the default. Contact support to change this setting.**

Select which units you want to send XBDs or SBDs to (X/SBDs), by moving them into the right hand selected column. **TIP: You can send X/SBDs to multiple units at once.** Type out the commands you wish to send to your unit in the commands column at the bottom of the window. Include the $ ahead of the commands, leave white space or return carriages after commands. Click send to distribute the X/SBDs to correct gateway. When the unit receives the command(s) it will respond to the command(s) via SBD. Only single line responses are sent via X/SBD. Any

command that responds in a multiline list will not reply. Both Outgoing and incoming messages can be viewed in the messages tab on XeosOnline.

Send Message

Targets

#4 (300234010846630)	102 (300234061234102)
103 (300234061234103)	
104 (300234061234104)	→
105 (300234061234105)	→I
106 (200234061234106)	
107 (300234169999107)	←
108 (300125060052070)	I←
109 (30043406123 4109)	
110 (300234061234110)	
112 (300125060155400)	

Commands

$gnssgetenabled

Saved templates... ▼   Save   Save As   Delete   Send

XeosOnline Send Message Window

XeosOnline Status of Health

If a Cell or an Iridium modem is connected to XeosOnline, the Resolute will naturally output status of health (SOH) messages. These can be downloaded (CSV or Excel formats) and viewed in either tabular or graphical formats in the Status of Health tab. Status of Health variables currently include, Battery Voltage, Temperature, Space Vehicle (tracked), Disk Percent Full (1 and 2).

Confirming Device Operation

Confirm Power to the Unit

After plugging in the power connector, the unit will flash all of its LEDs. Confirm the power LED is green. If red, reverse the voltage supplied to the unit.

Confirming SD Cards Mounted

Shortly after start up the processor, will try to mount the SD cards, and the LED should change from Red to Green. If the LED is red or yellow check that the cartridge and SDs are correctly mounted.

Confirming GNSS Receiver Operation

60 to 90 seconds after start-up, the GNSS receiver will power on and restore its configured settings. The GNSS LED will initially be red after configuring the GNSS receiver. The receiver will begin tracking satellites when the first valid position fix comes in (i.e. tracking 4 satellite or more) and the LED will turn yellow.

Confirming RTK Radio Operation (Base)

60 to 90 seconds after start-up the GNSS modem will power on and configure. The GNSS LED will initially be red. If it does not have a Base position stored, the GNSS receiver will use the first valid position it receives as the base position. If this is the first time the unit has been at this location resetting the Base is advised to ensure the Base position is correct. Do not rely on the unit not having a Base position. After getting a Base position the GNSS will reset and start up. When the GNSS receiver get valid positions to generate corrections the GNSS LED will go change to yellow. The Base GNSS LED stays yellow during normal operation.

After the GNSS LED turns yellow, the Radio LED should change to yellow to indicate the corrections are being sent over the radio. If a Rover is active in the field and configured correctly, the radio LED should go green.

Confirming RTK Radio Operation (Rover)

30 to 60 seconds after start-up the radio should power on red. The radio will take a minute or two to configure. After which if the antenna is correctly pointed to a corrections source, the radio LED should go yellow.

60 to 90 seconds after the unit changing to yellow, the radio should confirm registration with the Base, at which point it will go green. This confirms two-way communication with the Base or NorthStar.

60 to 90 seconds after start-up the GNSS receiver will power on and configure. The GNSS LED will initially be red after configuring the GNSS receiver, the receiver will begin tracking satellites, when the first valid position fix comes in the LED will turn yellow. If the radio is receiving good

quality corrections and the receiver has received the ephemeris (<5 minutes), the radio will attempt to fix ambiguities and enter float RTK mode. If the receiver enters float RTK mode, the GNSS LED will turn blue. After this if the GNSS antenna is well placed the ambiguities will usually fix in under 5 minutes. This results in the GNSS going green and optimal performance.

Confirming Cell Operation

If your unit is equipped with a Cell modem, there are multiple configuration options. Startup behavior will depend on which options are enabled. If XBD is enabled your unit will send an SBD on start up. If SMS is enabled the unit will send an SMS on start up. After successfully sending an XBD/SMS, the Cell LED will flash green for 10s. This indicated that the message has been successfully sent. To test the tunnel connection wait for the tunnel to start or change the tunnel schedule to a time closer to the present. After the start time pass the unit will attempt to connect to Xeos Online. If the connection is successful, the Cell LED will turn solid green.

⚠️ **Note: Testing SMS only confirms the SMS portion of the connection. The data portion of the connection if being used should be tested either with XBD or the tunnel.**

Confirming Iridium Operation

If your unit is equipped with Iridium, it will send an SBD on start up. After successfully sending this SBD, the Iridium LED will flash green for 10s. This indicates that the SBD has successfully made it to the Iridium gateway. To confirm RUDICS operation schedule the tunnel to start at the time desired. The modem will dial up a RUDICS connection at this time. If the unit is able to connect to XeosOnline with modem Iridium LED will stay solid green. Any time the modem is powered on but has not yet successfully connected the tunnel or sent an SBD the Iridium LED will be Red.

XeosOnline

Contact Alert Geomatics to set up an organization in XeosOnline. XeosOnline can be used to view the state of the units Tunnel Connection, Status of Health and for easily sending and receiving SBD messages to units configured with the correct modems. Contact Alert Geomatics for more information.

Upgrading Firmware

Connect to the Resolute with a USB or Serial cable and start STERM. Open a connection at 115200 baud.

Disable the GNSS functionality and if your unit has a 900 Mhz radio installed, the radio.

Send the following commands to turn off GNSS and Radio respectively:

$gnsssetenabled f

$radiosetenabled f

```
2018-02-28 16:08:14 - GNSS On Interval Enabled: FALSE
2018-02-28 16:08:29 - Radio On Interval Enabled: FALSE
```

On the top menu bar, navigate to *Send File* and click on *Send Bootload Image*.
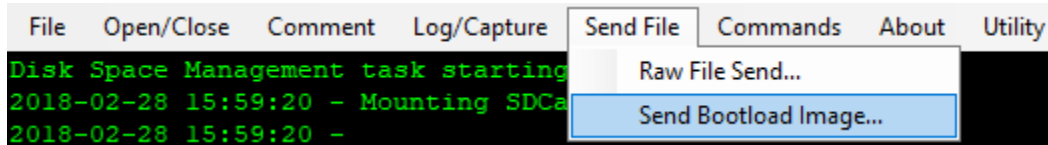
The *Firmware Image Send* window will open and you will need to select the new version of firmware by clicking the … and opening the .bin file. Once the *Sent* number matches the *Size* number, the upload is complete.
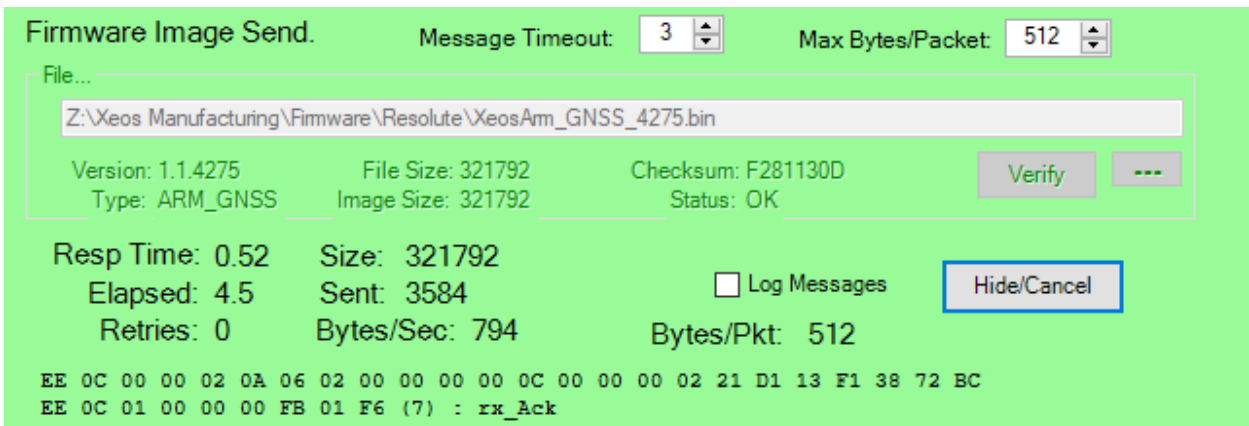
Reset the unit by sending the following command and wait for the unit to restart.

$resetnow

```
2018-02-28 16:19:02 - RESETTING - COMMANDED
2018-02-28 16:19:03 - Un-Mounting SDCard 1
2018-02-28 16:19:03 - Un-Mounting SDCard 2
```

Check the firmware version to confirm the installation was successful by entering the $ver command and comparing it to the number on the .bin file that was uploaded:

$ver

```
2018-02-28 16:20:34 - Ver: 1.1.4275  Boot: 1.1.4097
```

If the new version wasn't properly uploaded resend the image.

To view all the firmware images on the Resolute, use the $i**mglst** command.

```
2018-02-28 16:21:44 - Sctr Errs     DateTime      Size  Type   Version  Pri/Count
2018-02-28 16:21:44 -    2    0   1519833755   320512 x3000  1.01.04262  1/011
2018-02-28 16:21:44 -   81    0   1519834264   321792 x3000  1.01.04275  1/015
```

Delete the old firmware using $imgdelete command. In this example, firmware version 4275 was uploaded so 4262 must be the old firmware. Enter $**imgdelete** followed by the version number omitting the zeroes and replacing periods with a space. For this example, the following command would be sent to delete the old firmware:

$imgdelete 1 1 4262

⚠️ **Do not delete the current version of firmware.**

Re-enable the GNSS functionality with the following command:

$gnsssetenabled t

If a 900 Mhz radio is installed on your unit (Resolute-PIN) re-enabled the radio as well with the following command:

$radiosetenabled t

⚠️ **Units without 900 MHz radio's installed can experience issues if the functionality is enabled. If you have a Resolute Polar or Reference do not enabled the radio functionality.**

If your unit is equipped with a cellular or iridium tunnel it is likely possible to update your firmware remotely. Contact Alert Geomatics for details.

Appendix A: Command Index

Command	Variables	Description	Sample
$resetnow	N/A	Resets the unit	$resetnow
$schedule	N/A	Returns schedule of all enabled peripherals	$schedule
$ver	N/A	Returns the firmware version loaded	$ver
$getserialnumber	N/A	Returns the device serial nubmer	$getserialnumber
$GnssSet5vAnt	T,F	T (true) sets the antenna voltage to 5V, F(false) the default, sets the antenna voltage to 3.3V	$GnssSet5vAnt T
$Gnssget5vAnt	N/A	Returns the antenna voltage	$Gnssget5vAnt
$gnsssetenabled	T,F	T (true) enables the GNSS, F (false) disables the GNSS	$gnsssetenabled t
$gnssgetenabled	N/A	Returns the enabled state of the GNSS	$gnssgetenabled
$gnsssetduration	s,m,h,d	Set the duration of the GNSS receiver (0 for always on)	$gnsssetduration 1h
$gnssgetduration	N/A	Returns the duration of the GNSS receiver	$gnssgetduration
$gnsssetinterval	s,m,h,d	Set the interval of the GNSS receiver	$gnsssetinterval 1d
$gnssgetinterval	N/A	Returns the interval of the GNSS receiver	$gnssgetinterval
$gnsssetoffset	s,m,h,d	Set the interval of the GNSS receiver	$gnsssetoffset 12h
$gnssgetoffset	N/A	Returns the offset of the GNSS receiver	$gnssgetoffset
$gnsssetusegnsstime	T,F	T (true) enables GNSS time (no leap seconds), F (false) disabled	$gnsssetusegnsstime t
$gnssgetusegnsstime	N/A	Returns if GNSS time is enabled	$gnssgetusegnsstime
$tunnelsetenabled	T,F	T (true) enables the tunnel, F (false) disables	$tunnelsetenabled t

		the tunnel	
$tunnelgetenabled	N/A	Returns the enabled state of the tunnel	$tunnelgetenabled
$tunnelsetmodem	[0-3],[2-3]	Sets the priority of multiple cell and iridium modems	$tunnelsetmodem 0 3
$tunnelsetduration	s,m,h,d	Set the duration of the tunnel connection	$tunnelsetduration 600s
$tunnelgetduration	N/A	Returns the duration of the tunnel connection	$tunnelgetduration
$tunnelsetinterval	s,m,h,d	Set the interval of the tunnel	$tunnelsetinterval 1h
$tunnelgetinterval	N/A	Returns the interval of the tunnel	$tunnelgetinterval
$tunnelsetoffset	s,m,h,d	Set the interval of the tunnel	$tunnelsetoffset 20m
$tunnelgetoffset	N/A	Returns the offset of the tunnel	$tunnelgetoffset
$irdsetdod	T,F	T (true) enables DISA gateway, F (false) disables DISA gateway	$irdsetdod t
$irdgetdod	N/A	Returns enabled state of DISA gateway	$irdgetdod
$sbdsetenabled	T,F	T (true) enables SBD, F (false) disables SBD	$sbdsetenabled t
$sbdgetenabled	N/A	Returns the enabled state of SBD message checks	$sbdgetenabled
$sbdsetinterval	s,m,h,d	Set the interval of SBD message checks	$sbdsetinterval 4h
$sbdgetinterval	N/A	Returns the interval of the SBD message checks	$sbdgetinterval
$sbdsetoffset	s,m,h,d	Set the interval of the SBD message checks	$sbdsetoffset 0
$sbdgetoffset	N/A	Returns the offset of the SBD message checks	$sbdgetoffset
$radiogetenabled	N/A	Returns the enabled state of the radio	$radiogetenabled
$radiosetchannelid A	0,1,2,3,4,5,6,7	Sets the radio channel	$radiosetchannelid A 1
$radiogetchannelid A	N/A	Returns the radio channel	$radiogetchannelid A
$gnsssetantennatype	See	Set the antenna	$gnsssetantennatype 0

	Appendix B	reference point, also used for RINEX header	
$gnssgetantennatype	N/A	Returns the set antenna	$gnssgetantennatype
$ gnssSetAntennaOffsets	20 characters [E-Offset] [N-Offset] [U-offset]	Set the antenna offset for RINEX header	$ gnssSetAntennaOffsets 0 0 0
$gnssGetAntennaOffsets	N/A	Get the antenna offset for RINEX header	$gnssGetAntennaOffsets
$gnssSetAntennaSerialnumber	20 characters	Set the antenna offset for RINEX header	$gnssSetAntennaSerialnumber 9999
$gnssGetAntennaSerialNumber	N/A	Get the antenna offset for RINEX header	$gnssGetAntennaSerialNumber
$gnssSetAntennaSetupId	20 characters	Set the antenna setup ID for RINEX header	$gnssSetAntennaSetupId id
$gnssGetAntennaSetupId	N/A	Get the antenna setup ID for RINEX header	$gnssGetAntennaSetupId
$gnssSetMarkerName	20 characters	Set the marker name for RINEX header	$gnssSetMarkerName name
$gnssGetMarkerName	N/A	Get the marker name for RINEX header	$gnssGetMarkerName
$gnssSetMarkerNumber	20 characters	Set the marker number for RINEX header	$gnssSetMarkerNumber number
$gnssgetMarkerNumber	N/A	Get the marker number for RINEX header	$gnssgetMarkerNumber
$gnssSetMarkerType	20 characters	Set the marker type for RINEX header	$gnssSetMarkerType marker info
$gnssGetMarkerType	N/A	Get the marker type for RINEX header	$gnssGetMarkerType
$gnssSetObserverName	20 characters	Set the observer name for RINEX header	$gnssSetObserverName UNAVCO
$gnssGetObserverName	N/A	Get the observer name for RINEX header	$gnssGetObserverName
$gnssSetObserverAgency	20 characters	Set the observer agency for RINEX header	$gnssSetObserverAgency UNAVCO
$gnssGetObserverAgency	N/A	Get the observer agency for RINEX header	$gnssGetObserverAgency
$gnssSetObserverComment	20 characters	Set the obersever comment for RINEX header	$gnssSetObserverComment Res FW 4162

$gnssGetObserverComment	N/A	Get the obersever comment for RINEX header	$gnssGetObserverComment
$gnssSetMessageTypes	[stream] [duration] [update interval] [Bitmap A] [Bitmap B]	GNSS message configuration bitmaps	$gnssSetMessageTypes 1 0 2 1 0
$gnssgetMessageTypes	N/A	Returns enabled message types bitmap	$gnssgetMessageTypes
$gnssSetSignalTracking	[signals (HEX)]	GNSS signal tracking configuration bitmaps	$gnssSetSignalTracking 1f
$gnssSetSignalTracking	N/A	Returns tracked signals bitmap	$gnssSetSignalTracking
$SDSetMemoryManagement	T,F	Enable/Disable "delete" function	$sdSetMemoryManagement F
$MemoryManagementSetDisks	1,2,3	Enable delete on SD1 Enable delete on SD2 Enable delete on both disks	$memoryManagementSetDisks 2
$formatSD	[card (1,2)] [format(1, 2)]	Format an SD card	$formatSD 2 1
$SetShutdownVoltageEnabled	T/F	Set if cards are unmounted at a specific voltage	$SetShutdownVoltageEnabled T
$GetShutdownVoltageEnabled	N/A	Get if cards are unmounted at a specific voltage	$GetShutdownVoltageEnabled
$SetShutdownVoltage	[Voltage]	Set the level at which cards are unmounted	$SetShutdownVoltage 11.5
$GetShutdownVoltage	N/A	Get the level at which cards are unmounted	$GetShutdownVoltage
$SetRestartVoltage	[Voltage]	Set the level at which cards are remounted	$SetRestartVoltage 11.8
$GetRestartVoltage	N/A	Get the level at which cards are remounted	$GetRestartVoltage
$AESSetEnabled	T/F	Set ASCII External Sensor Logging enabled	$AESSetEnabled T
$AESGetEnabled	N/A	Get ASCII External Sensor Logging enabled	$AESGetEnabled

$AESSetDuration	[Duration]	Set ASCII External Sensor Logging timeout duration	$AESSetDuration 1m
$AESGetDuration	N/A	Get ASCII External Sensor Logging timeout duration	$AESGetDuration
$AESSetInterval	[Interval]	Set ASCII External Sensor Logging interval	$AESSetInterval 1h
$AESGetInterval	N/A	Get ASCII External Sensor Logging interval	$AESGetInterval
$AESSetOffset	[Offset]	Set ASCII External Sensor Logging Offset	$AESSetOffset 15m
$AESGetOffset	N/A	Get ASCII External Sensor Logging Offset	$AESGetOffset
$AESSetCommandString	[string]	Set ASCII External Sensor Logging Request String	$AESSetCommandString 0R0
$AESGetCommandStri ng	N/A	Get ASCII External Sensor Logging Command String	$AESGetCommandString
$Serial2SetBaud	[baud]	Set Serial 2 Baud Rate	$Serial2SetBaud 19200
$Serial2GetBaud	N/A	Get Serial 2 Baud Rate	$Serial2GetBaud

Appendix B: Antenna Type Index

0: TWI3870+GP
1: SEPPOLANT_X_MF
2: 3S-02-TSADM
3: 3S-02-TSATE
4: ACC123CGNSSA_XN
5: ACC2G1215A_XT_1
6: ACC3G1215A_XT_1
7: ACC42G1215A_XT1
8: ACC4G1215A_XT_1
9: ACC53G1215A_XT1
10: ACC53GO1215AXT1
11: ACC72CGNSSA
12: ACC72GNSSA_XT_1
13: ACCG3ANT_3AT1
14: ACCG3ANT_42AT1
15: ACCG3ANT_52AT1
16: ACCG5ANT_123CAN
17: ACCG5ANT_2AT1
18: ACCG5ANT_3AT1
19: ACCG5ANT_42AT1
20: ACCG8ANT-CHOKES
21: ACCG8ANT_3A4TB1
22: ACCG8ANT_3A4_M1
23: ACCG8ANT_52A4T1
24: ACCG8ANT_52A4TC
25: ACC_G5ANT_52AT1
26: ACC_G5ANT_72AT1
27: AERAT1675_120
28: AERAT1675_120 SPKE
29: AERAT1675_180
30: AERAT1675_182
31: AERAT1675_200
32: AERAT1675_200 SPKE
33: AERAT1675_29
34: AERAT1675_300
35: AERAT1675_300 SPKE
36: AERAT1675_304
37: AERAT1675_32
38: AERAT1675_382
39: AERAT1675_39
40: AERAT1675_504
41: AERAT1675_80
42: AERAT1675_81
43: AERAT2775_150
44: AERAT2775_159
45: AERAT2775_159 SPKE
46: AERAT2775_160
47: AERAT2775_270
48: AERAT2775_382

49: AERAT2775_41
50: AERAT2775_42
51: AERAT2775_42+CR
52: AERAT2775_43
53: AERAT2775_43   SPKE
54: AERAT2775_443
55: AERAT2775_443 SPKE
56: AERAT2775_62
57: AERAT3075_460
58: AOA7490582.2
59: AOAD/M_B
60: AOAD/M_R
61: AOAD/M_T
62: AOAD/M_TA_NGS
63: AOARASCAL
64: APSAPS-3
65: APSAPS-3L
66: APSAPS-NR2
67: APS_APS-3
68: APS_APS-3   SCIT
69: ASH110454
70: ASH111660
71: ASH111661
72: ASH700228A
73: ASH700228B
74: ASH700228C
75: ASH700228D
76: ASH700228E
77: ASH700699.L1
78: ASH700700.A
79: ASH700700.B
80: ASH700700.C
81: ASH700718A
82: ASH700718B
83: ASH700829.2   SNOW
84: ASH700829.3   SNOW
85: ASH700829.A   SNOW
86: ASH700829.A1   SNOW
87: ASH700936A_M
88: ASH700936A_M   SNOW
89: ASH700936B_M
90: ASH700936B_M   SNOW
91: ASH700936C_M
92: ASH700936C_M   SNOW
93: ASH700936D_M
94: ASH700936D_M   SCIS
95: ASH700936D_M   SNOW
96: ASH700936E
97: ASH700936E   SNOW

98: ASH700936E_C
99: ASH700936E_C   SNOW
100: ASH700936F_C
101: ASH701008.01B
102: ASH701023.A
103: ASH701073.1
104: ASH701073.3
105: ASH701933A_M
106: ASH701933A_M   SNOW
107: ASH701933B_M
108: ASH701933B_M   SNOW
109: ASH701933C_M
110: ASH701933C_M   SCIS
111: ASH701933C_M   SCIT
112: ASH701933C_M   SNOW
113: ASH701941.1
114: ASH701941.2
115: ASH701941.A
116: ASH701941.B
117: ASH701941.B   SCIS
118: ASH701945B_M
119: ASH701945B_M   SCIS
120: ASH701945B_M   SCIT
121: ASH701945B_M   SNOW
122: ASH701945C_M
123: ASH701945C_M   OLGA
124: ASH701945C_M   PFAN
125: ASH701945C_M   SCIS
126: ASH701945C_M   SCIT
127: ASH701945C_M   SNOW
128: ASH701945D_M
129: ASH701945D_M   SCIS
130: ASH701945D_M   SCIT
131: ASH701945D_M   SNOW
132: ASH701945E_M
133: ASH701945E_M   SCIS
134: ASH701945E_M   SCIT
135: ASH701945E_M   SNOW
136: ASH701945G_M
137: ASH701945G_M   SCIS
138: ASH701945G_M   SCIT
139: ASH701945G_M   SNOW
140: ASH701946.2
141: ASH701946.2   SNOW
142: ASH701946.3
143: ASH701946.3   SNOW
144: ASH701975.01A
145: ASH701975.01AGP
146: ASH701975.01B

147: ASH701975.01BGP
148: ASH802129
149: ASH802147_A
150: ASH_LOCUS
151: AYIHY-BGLRB06RT
152: CHANV3
153: CHATK2
154: CHATKO
155: CHCA220GR
156: CHCA300GNSS
157: CHCC220GR   CHCD
158: CHCC220GR
159: CHCX900B
160: CHCX900R
161: CHCX900S-OPUS
162: CHCX90D-OPUS
163: CHCX91+S
164: CHCX91B
165: CHCX91R
166: CNTT300
167: CNVC-NAV286
168: DGR_QEDGE
169: FOIA30
170: GDCGS1HX-BS601
171: GMXZENITH10
172: GMXZENITH20
173: GMXZENITH25
174: GMXZENITH25PRO
175: GUTGPSL1L2A
176: HEMA21
177: HEMA325
178: HEMA42
179: HEMA45
180: HEMA52_WB
181: HEMS320
182: HGGCYH8321   HGGC
183: HGGCYH8321
184: HITV30
185: HITV60
186: HRZK2007224V3.0
187: HXCCA7607A
188: HXCCG7601A   HXCG
189: HXCCG7601A
190: HXCCG7602A   HXCG
191: HXCCG7602A
192: HXCCGX601A   HXCS
193: HXCCGX601A
194: HXCCSX601A
195: HXCGG486A   HXCS
196: HXCGG486A
197: HXCGS488A
198: ITT3750323
199: ITT3750323   SCIS

200: JAVGISMORE
201: JAVGRANT_G3
202: JAVGRANT_G3+GP JVGR
203: JAVGRANT_G3+GP
204: JAVGRANT_G3TJ
205: JAVGRANT_G3TJ+G JVGR
206: JAVGRANT_G3TJ+G
207: JAVGRANT_G5T
208: JAVGRANT_G5T+GP JVGR
209: JAVGRANT_G5T+GP
210: JAVRINGANT_DM JVDM
211: JAVRINGANT_DM
212: JAVRINGANT_DM SCIS
213: JAVRINGANT_DM SCIT
214: JAVRINGANT_G5T JAVC
215: JAVRINGANT_G5T
216: JAVTRIANT_A
217: JAVTRIUMPH_1M
218: JAVTRIUMPH_1MR
219: JAVTRIUMPH_2A
220: JAVTRIUMPH_LSA
221: JAVTRIUMPH_VS
222: JAV_GRANT-G3T
223: JAV_GRANT-G3T+G JVGR
224: JAV_GRANT-G3T+G
225: JAV_RINGANT_G3T JAVC
226: JAV_RINGANT_G3T
227: JAV_TRIUMPH-1
228: JAV_TRIUMPH-1R
229: JNSCHOKERING_DM
230: JNSCR_C146-22-1
231: JNSCR_C146-22-1 SCIS
232: JNSMARANT_GGD
233: JPLD/M_R
234: JPLD/M_RA_SOP
235: JPSLEGANT_E
236: JPSMARANT_GGD
237: JPSODYSSEY_I
238: JPSREGANT_DD_E
239: JPSREGANT_DD_E1
240: JPSREGANT_DD_E2
241: JPSREGANT_SD_E
242: JPSREGANT_SD_E1
243: JPSREGANT_SD_E2
244: KOLK9_T
245: LEIAR10
246: LEIAR20   LEIM
247: LEIAR20
248: LEIAR25   LEIT
249: LEIAR25
250: LEIAR25   SCIS
251: LEIAR25   SCIT
252: LEIAR25.R3   LEIT

253: LEIAR25.R3
254: LEIAR25.R3   SCIS
255: LEIAR25.R3   SCIT
256: LEIAR25.R4   LEIT
257: LEIAR25.R4
258: LEIAR25.R4   SCIS
259: LEIAR25.R4   SCIT
260: LEIAS05
261: LEIAS10
262: LEIAT202+GP
263: LEIAT202-GP
264: LEIAT302+GP
265: LEIAT302-GP
266: LEIAT303   LEIC
267: LEIAT303
268: LEIAT502
269: LEIAT503   LEIC
270: LEIAT503
271: LEIAT504   LEIS
272: LEIAT504
273: LEIAT504   OLGA
274: LEIAT504   SCIS
275: LEIAT504GG   LEIS
276: LEIAT504GG
277: LEIAT504GG   SCIS
278: LEIAT504GG   SCIT
279: LEIATX1230
280: LEIATX1230+GNSS
281: LEIATX1230GG
282: LEIAX1202
283: LEIAX1202A
284: LEIAX1202GG
285: LEIAX1203+GNSS
286: LEIGG02PLUS
287: LEIGG03
288: LEIGS08
289: LEIGS08PLUS
290: LEIGS09
291: LEIGS12
292: LEIGS14
293: LEIGS15
294: LEIICG60
295: LEIMNA950GG
296: LEISR299_INT
297: LEISR399_INT
298: LEISR399_INTA
299: MAC4647942   MMAC
300: MAC4647942
301: MAG105645
302: MAG111406
303: MAG990596
304: MPL1230
305: MPL1370W

306: MPLL1/L2_SURV
307: MPL_WAAS_2224NW
308: MPL_WAAS_2225NW
309: NAVAN2004T
310: NAVAN2008T
311: NAVANT3001A
312: NAVANT3001B
313: NAVRT3010S
314: NAVSF2040G
315: NAVSF3040
316: NAV_ANT3001BR   SPKE
317: NAV_ANT3001R
318: NAX3G+C
319: NGSD/M+GP60
320: NOV501
321: NOV501+CR
322: NOV502
323: NOV502+CR
324: NOV503+CR
325: NOV503+CR   SPKE
326: NOV512
327: NOV531
328: NOV531+CR
329: NOV533   RADM
330: NOV533+CR   NOVC
331: NOV600
332: NOV701GGL
333: NOV701GG_1.03
334: NOV702
335: NOV702GG
336: NOV702GGL_1.01
337: NOV702GG_1.02
338: NOV702GG_1.03
339: NOV702L_1.01
340: NOV702L_1.03
341: NOV702_2.02
342: NOV702_3.00
343: NOV703GGG.R2
344: NOV750.R4
345: NOV750.R4   NOVS
346: NOV750.R4   SCIS
347: NOV750.R4   SCIT
348: NOV750.R5   NOVS
349: NOV_WAAS_600
350: RNG80971.00
351: SEN67157514
352: SEN67157514+CR
353: SEN67157549
354: SEN67157549+CR
355: SEN67157596
356: SEN67157596+CR
357: SEPCHOKE_MC
358: SEPCHOKE_MC   SPKE

359: SEPPOLANT_X_MF
360: SEPPOLANT_X_SF
361: SEP_POLANT+
362: SEP_POLANT+_GG
363: SLGSL600_V1
364: SMICR3B
365: SMICR3B   SPKE
366: SOK502
367: SOK600
368: SOK702
369: SOKA110
370: SOKA120
371: SOKGRX1
372: SOKGRX1+10
373: SOKGRX2
374: SOKGRX2+10
375: SOKGSX2
376: SOKGSX2+10
377: SOKSTRATUS
378: SOK_GSR2700IS
379: SOK_GSR2700ISX
380: SOK_LOCUS
381: SOK_RADIAN_IS
382: SPP39105.90
383: SPP571212238+GP
384: SPP571908273+CR
385: SPP571908273+CR SPKE
386: SPP67410_42
387: SPP67410_44
388: SPP67410_46
389: SPP68410_10
390: SPP89823_10
391: SPP91564_00
392: SPP91564_1
393: SPP91564_2
394: STH82VHX-BS601A
395: STHCR3-G3
396: STHCR3-G3   STHC
397: STHS82HX-BS601A
398: STHS82_7224V3.0
399: STHS86HX-BS611A
400: STHS86_7224V3.1
401: STXG5ANT_72AT1
402: STXS8BS603A
403: STXS8PX003A
404: STXS9+X001A
405: STXS9BS604A
406: STXS9PX001A
407: STXS9SA7224V3.0
408: THA800961+REC
409: THA800961+RTK
410: THA800961RECUHF
411: THA800961RTKUHF

412: THANAP002
413: TIAPENG2100B
414: TIAPENG2100R
415: TIAPENG3100R1
416: TIAPENG3100R2
417: TIASMT888-3GV3
418: TOP700779A
419: TOP72110
420: TPSCR.G3
421: TPSCR.G3   SCIS
422: TPSCR.G3   SCIT
423: TPSCR.G3   TPSH
424: TPSCR.G5
425: TPSCR.G5   SCIS
426: TPSCR.G5   SCIT
427: TPSCR.G5   TPSH
428: TPSCR3_GGD   CONE
429: TPSCR3_GGD
430: TPSCR3_GGD   OLGA
431: TPSCR3_GGD   PFAN
432: TPSCR4   CONE
433: TPSCR4
434: TPSG3_A1
435: TPSG3_A1   TPSD
436: TPSGR3
437: TPSGR5
438: TPSHIPER_GD
439: TPSHIPER_GGD
440: TPSHIPER_II
441: TPSHIPER_II+10
442: TPSHIPER_LITE
443: TPSHIPER_PLUS
444: TPSHIPER_SR
445: TPSHIPER_SR+10
446: TPSHIPER_V
447: TPSHIPER_V+10
448: TPSHIPER_XT
449: TPSLEGANT
450: TPSLEGANT2
451: TPSLEGANT3_UHF
452: TPSLEGANT_G
453: TPSMAPANT_B
454: TPSMG_A2
455: TPSODYSSEY_I
456: TPSPG_A1
457: TPSPG_A1   TPSD
458: TPSPG_A1+GP
459: TPSPG_A1_6
460: TPSPG_A1_6+GP
461: TPSPG_A2
462: TPSPG_A5
463: TPSPG_F1
464: TPSPG_F1+GP

465: TPSPG_S1
466: TPSPG_S1+GP
467: TPSPN.A5
468: TPSPN.A5   SCIS
469: TPSPN.A5   SCIT
470: TPSPN.A5   TPSH
471: TPS_CR.3   SCIS
472: TPS_CR4+RD   SCIS
473: TPS_MC.A5
474: TRM14177.00
475: TRM14532.00
476: TRM14532.10
477: TRM22020.00+GP
478: TRM22020.00-GP
479: TRM22020.02   TCWD
480: TRM23903.00
481: TRM27947.00+GP
482: TRM27947.00-GP
483: TRM29659.00
484: TRM29659.00   OLGA
485: TRM29659.00   SCIS
486: TRM29659.00   SCIT
487: TRM29659.00   SNOW
488: TRM29659.00   TCWD
489: TRM29659.00   UNAV
490: TRM33429.00+GP

491: TRM33429.00-GP
492: TRM33429.20+GP
493: TRM33429.20+GP TCWD
494: TRM33429.20+GP UNAV
495: TRM36569.00+GP
496: TRM39105.00
497: TRM41249.00
498: TRM41249.00   SCIT
499: TRM41249.00   TZGD
500: TRM41249USCG   SCIT
501: TRM44830.00
502: TRM4800
503: TRM49700.00
504: TRM53406.00
505: TRM55970.00
506: TRM55971.00
507: TRM55971.00   SCIT
508: TRM55971.00   TZGD
509: TRM57970.00
510: TRM57971.00
511: TRM57971.00   SCIT
512: TRM5800
513: TRM59800.00
514: TRM59800.00   SCIS
515: TRM59800.00   SCIT
516: TRM59800.80

517: TRM59800.80   SCIS
518: TRM59800.80   SCIT
519: TRM59900.00
520: TRM59900.00   SCIS
521: TRM65212.00
522: TRM77970.00
523: TRM77971.00
524: TRM77971.00   SCIT
525: TRMA3_L1
526: TRMR10
527: TRMR4-2
528: TRMR4-3
529: TRMR6
530: TRMR6-2
531: TRMR6-3
532: TRMR6-4   NONE
533: TRMR8   NONE
534: TRMR8-4   NONE
535: TRMR8_GNSS   NONE
536: TRMR8_GNSS3   NONE
537: TRMSPS985   NONE
538: TWI3870+GP   NONE
539: UNIUA35   NONE
540: Unknown

Appendix C: GNSS Antenna Mount Diagram

Talisman Mount Diagram

A-03-058

Tighten Nut to Attach Antenna

TNC Connector

Lock Nuts Together

Use Included Washers

5/8-11 Rod

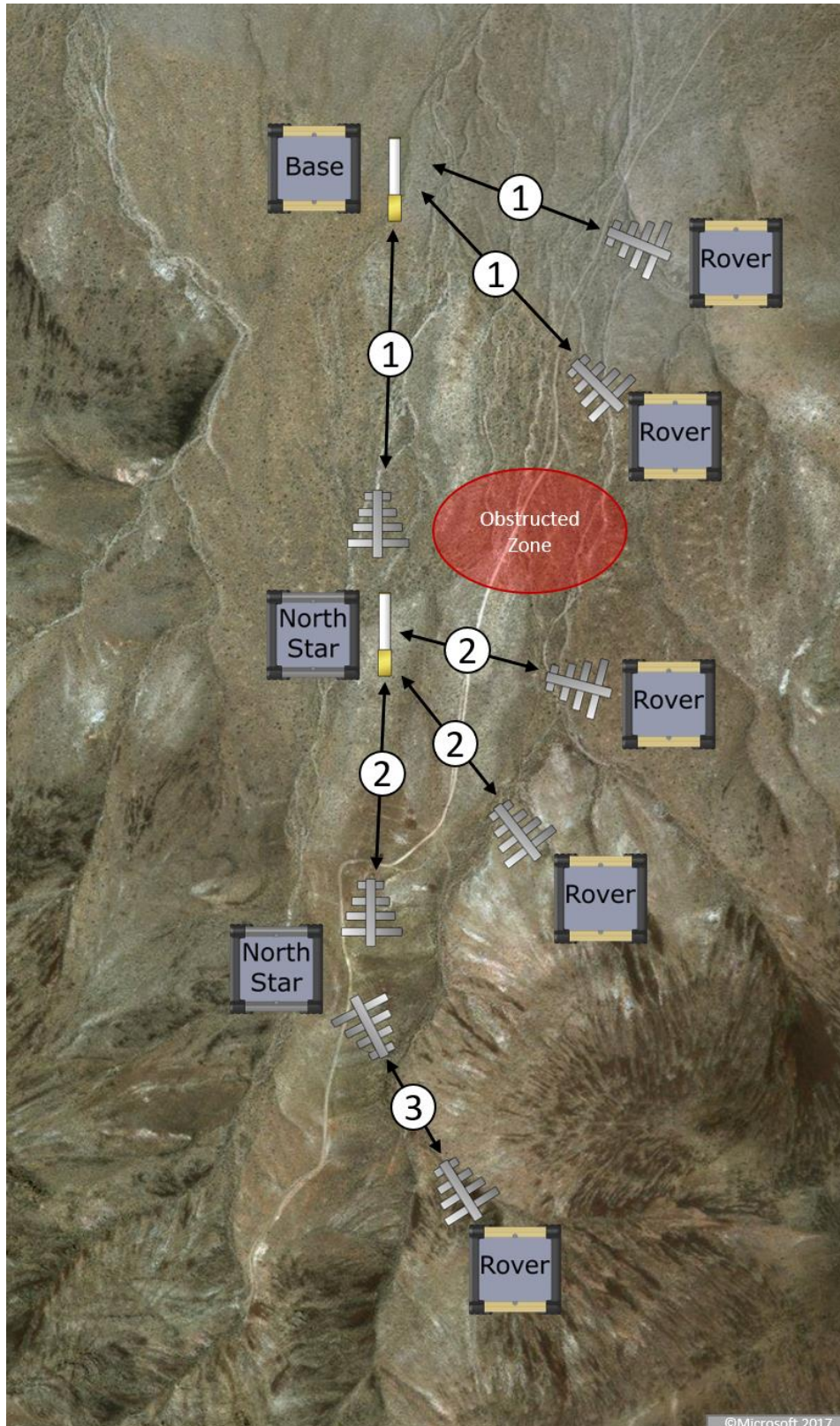| UNLESS OTHERWISE SPECIFIED:	Physical Properties	TITLE:						
DIMENSIONS ARE IN INCHES TOLERANCES:		Tallysman 3872 Antenna Mount Assembly A-03-058						
ONE PLACE DECIMAL ±0.05 TWO PLACE DECIMAL ±0.005 THREE PLACE DECIMAL ±0.001								
PROPRIETARY AND CONFIDENTIAL		SIZE	A	Rev	001	SCALE	Sheet	1 of 1
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF XEOS TECHNOLOGIES. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF XEOS TECHNOLOGIES IS PROHIBITED								

Appendix D: RF Cable Installation Diagrams
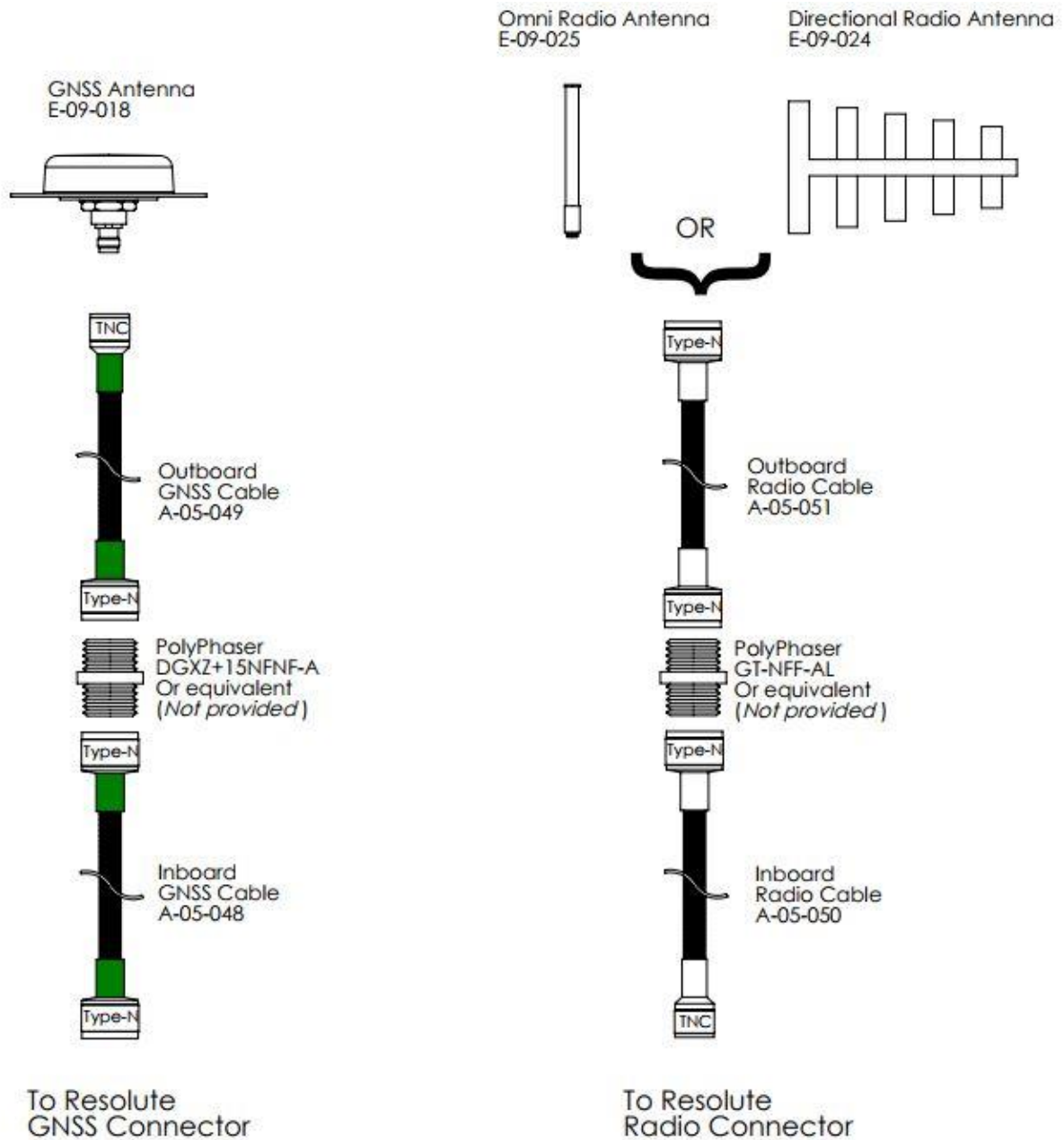
Appendix E: Example RTK Network Map

Appendix F: Mechanical Specifications
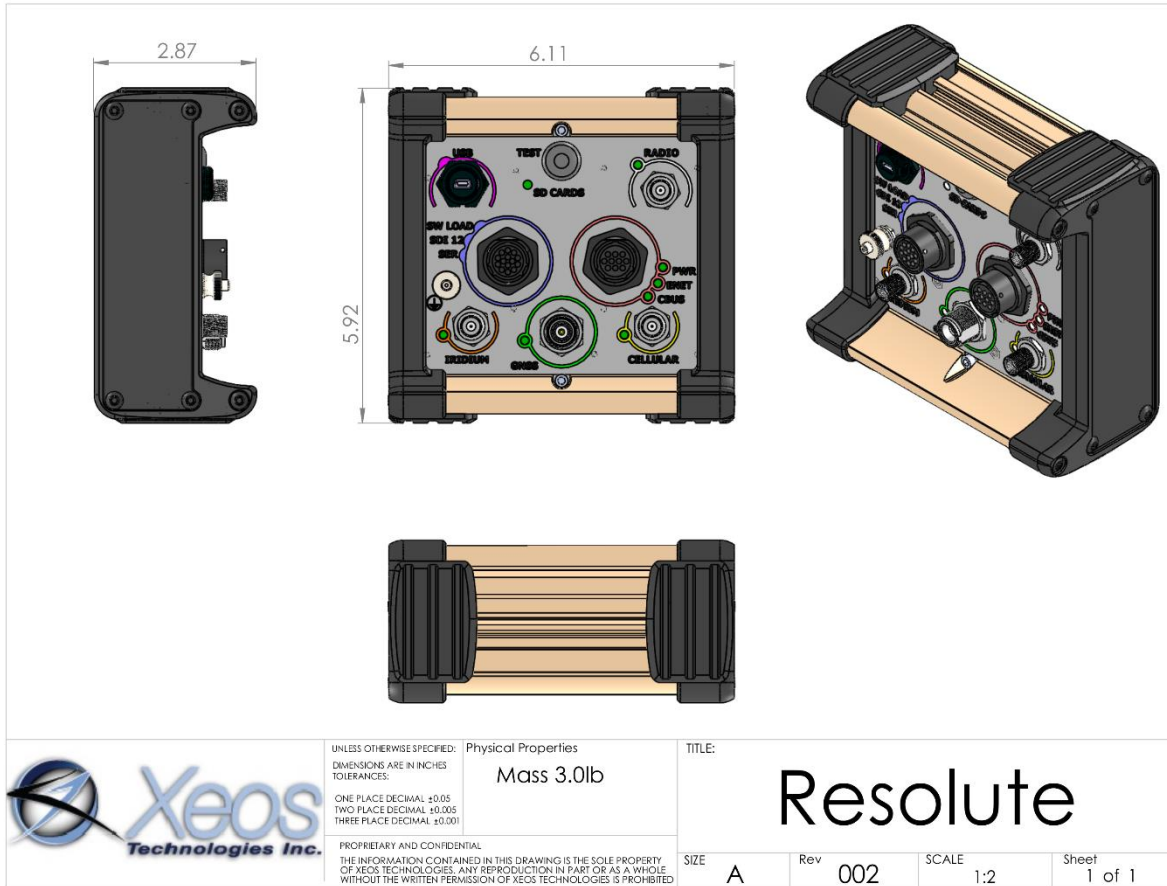
Appendix G: Power Requirements

The following section specifies power requirements for various configurations of the resolute with various use cases of duty cycling peripherals. Measurements can fluctuate as receivers and modems use varying power depending on the rate of transmitting, tracking settings and other factors.

Continuous RTK (Resolute Pin):
Peripherals: Radio (Average Continuous), GNSS (GPS L1,L2, GLONASS L1,L2), TW3872 Antenna
Power Requirement: 1.4W

Reference Receiver
Peripherals: GNSS (GPS L1), TW3872 Antenna (Average Continuous)
Power Requirement: 1 W
Peripherals: GNSS (GPS L1 L2), TW3872 Antenna (Average Continuous)
Power Requirement: 1.25 W
Peripherals: GNSS (GPS, GLONASS, L1, L2), TW3872 Antenna (Average Continuous)
Power Requirement: 1.3 W
Peripherals: GNSS (All Signals), Nominal Antenna (Average Continuous)
Power Requirement: 1.5 W

Add Power for Configurable Length Peripherals

IRIDIUM RUDICS (Average Continuous)
Iridium RUDICS Minimum Connection (Tunnel Connected, No Data)
Power Requirement: 1.85W
Iridium RUDICS Data Transfer
Power Requirement: 3.8W

IRIDIUM SBD
SBD Message Check (Average Power, per check, Average check 36 seconds)
Power Requirement: 0.5W (36 seconds)

Appendix H: RxTools Download

Download the RxTools software and manual from https://manuals.alertgeo.com/RxTools/
RX Tools contains the SBF Converter to convert SBF blocks to ASCII or RINEX. SBF Block info can be found in the SBF Reference Guide also in the link above.

Appendix I: Iridium Service

If your Resolute comes equipped with a 9523 Iridium Transceiver which makes use of the Iridium satellite system's RUDICS and Short Burst Data services.

SBD service is a global, two-way, real-time, email-based data delivery service that has a maximum outbound (from unit) message size of 340 bytes and a maximum inbound (to unit) message size of 270 bytes.

Resolute end users/integrators must set up an approved data delivery account with their preferred service provider. Xeos, the parent company of Alert Geomatics is an Iridium VAR and can provide Iridium service if you wish. Using our web form is a quick and easy way to setup service. It can be found at www.xeostech.com and selecting Iridium Service from the Product menu.

Setting up service requires the International Mobile Equipment Identity (IMEI) number. Each 9523 modem has a unique IMEI number that must be registered with the preferred service provider. Xeos will make these numbers available as product is delivered.

Each IMEI number is capable of being associated with up to five (5) unique email addresses. This may vary between service providers. When registering your IMEI number, please provide the service provider with the temporary Xeos testing account email address. This account is:

xeosbeaconb@gmail.com

Setting up this email address allows for better technical support during the initial learning period for the product. Once service is activated, please notify the technical support team.

While any email application can be used to send and receive messages to the Resolute XeosOnline is the easiest way to manage and monitor the Resolute The messages contain a lot of information and XeosOnline presents the information in a "readable" format and displays it on street level maps.

If you wish to use a RUDICS tunnel, please contact Xeos for assistance in setting up and managing a RUDICS tunnel if you do not already have one established.

Warranty, Support and Limited Liability

Xeos Technologies Inc. warranties the Resolute to be free of defects in material or manufacturing for a period of one year following delivery. Liability is limited to repair or replacement of the defective part and will be done free of charge.

LIMITED WARRANTY: Xeos Technologies Inc. warrants that the product will perform substantially in accordance with the accompanying written materials for a period of one year from the date of receipt.

CUSTOMER REMEDIES: Xeos Technologies Inc. entire liability and your exclusive remedy shall be at Xeos Technologies Inc. option, either (a) return of the price paid or (b) repair or replacement of the product that does not meet Xeos Technologies Inc. Limited Warranty and that is returned to Xeos Technologies Inc. with a copy of your receipt. This Limited Warranty is void if failure of the product has resulted from accident, abuse, or misapplication. Any replacement product will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer.

NO OTHER WARRANTIES: Xeos Technologies Inc. disclaims all other warranties, either express or implied, including but not limited to implied warranties of merchantability and fitness for a purpose, with respect to the product or the accompanying written materials. This limited warranty gives you specific legal rights. You may have others, which vary from state to state.

NO LIABILITY FOR CONSEQUENTIAL DAMAGES: In no event shall Xeos Technologies Inc. or its suppliers be liable for any damages whatsoever (including, without limitation, damages for loss of equipment, for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use of or inability to use this Xeos Technologies Inc. product, even if Xeos Technologies Inc. has been advised of the possibility of such damages.