9602-LP

USER GUIDE Rev. E

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9602-LP

User Guide

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REVISION HISTORY

Revision	Date	Description
1.4.6	04/05/2021	Initial version
A	03/28/2022	Formal release; updated to new template
B	03/07/2023	- Updated Section 2.1 External DC Power Input. Changed default to higher voltage setting. - Added 9602-LP-BTI
C	03/19/2024	Formal release of 9602-LP (removed BTI)
C.1	02/23/2026	Corrected arrows on GPS and Iridium antenna connector information. Replaced spec drawing. Updated to new template
D	03/04/2026	Formal release
D.1	04/20/2026	Updated spec drawing
E	04/20/2026	Formal release

REFERENCE DOCUMENTS

Please email support@naltec.com for the latest revisions of the below Naltec documents.

Reference	Title	Version
[1]	AT Commands for 9602-LP	A

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GLOSSARY

AES ..... Advanced Encryption Standard

BIS ..... Bureau of Industry and Security

C/A..... Coarse/Acquisition

CE ..... Conformité Européenne

CEP ..... Circular error probability

CMOS..... Complementary Metal–Oxide–Semiconductor

COCOM..... Coordinating Committee for Multilateral Export Controls

DAV ..... Data After Voice

DC..... Direct Current

DGPS ..... Differential Global Positioning System

DISA ..... Defense Information Systems Agency

DoD..... Department of Defense

DSN..... Defense Switch Network

DTE ..... Data Terminal Equipment

EAR ..... Export Administration Regulations

EGNOS ..... European Geostationary Navigation Overlay Service

EMI..... Electromagnetic

EMSS..... Enhanced Mobile Satellite Services

ETSI ..... European Telecommunications Standards Institute

FCC..... Federal Communications Commission

FDMA ..... Frequency-Division Multiple Access

GAGAN..... GPS-Aided GEO Augmented Navigation

GND ..... Ground

GPS ..... Global Positioning System

GUI..... Graphical user interface

ID ..... Static Identifier

I/O..... Input/Output

ISP ..... Internet Service Provider

ISU ..... Iridium Subscriber Units

LAN ..... Local Area Network

LED ..... Light Emitting Diode

Li-ion ..... Lithium-ion

LNA ..... Low-Noise Amplifier

LP..... Low Power

MSAS..... Multi-functional Satellite Augmentation System

NIPRNet ..... Non-classified Internet Protocol (IP) Router Network

NMEA ..... National Marine Electronics Association

NOC ..... Network Operation Center

OFAC ..... Office of Foreign Asset Controls

PDA ..... Personal digital assistant

PMS..... PECOS message structure

PPP ..... Point-to-Point Protocol

PSTN ..... Public Switched Telephone Network

PWR ..... Power

RF ..... Radio Frequency

RHCP ..... Right-Handed Circular Polarization

RUDICS ..... Router-based Unrestricted Digital Internetworking Connectivity Solution

SBAS ..... Satellite-Based Augmentation System

SBD ..... Short Burst Data

SMA..... SubMiniature version A

SMS..... Short Message Service

SMSC ..... Short Message Service Center

TDD ..... Time-Division Duplex

TDMA ..... Time-Division Multiple Access

TTL ..... Transistor–Transistor Logic

VSWR ..... Voltage Standing Wave Ratio

WAAS ..... Wide Area Augmentation System

INTRODUCTION

This user guide describes the operational features, configuration settings, and electrical and mechanical interfaces of the 9602-LP mountable tracker and 9602-LP-BTI mountable tracker.

9602-LP is a low size, weight, and power (SWaP) microcontroller for operation. It can be attached to high-value, untethered, or non-powered assets and also be used to track environmentally demanding platforms such as helicopters, high-altitude ballons, ground vehicles, and remote unattended sensors.

With the exception of smaller form-factor and wide input voltage range, model 9602-LP is functionally compatible with the 9601-DGS-LP.

9602-LP comprises an Iridium 9602 transceiver module; a built-in, 50-channel Global Positioning System (GPS) receiver; and low-power microcontrollers. 9602-LP allows only Short Burst Data (SBD) connectivity to the Iridium satellite network and does not support voice, circuit-switched data, or Short Message Service (SMS).

It can transmit messages in NAL Technologies' (Naltec) defined formats compatible with models 9601-DGS and 9601-DGS-LP. 9602-LP can also transmit in PECOS Message Structure (PMS). The PMS complies with the Blue Force Tracking Data Format Specification. 9602-LP supports 256-bit AES encryption algorithm.

Naltec can enable 9602-LP to utilize the Department of Defense (DoD) Enhanced Mobile Satellite Services (EMSS) gateway when requested by an authorized user.

IMPORTANT: EMSS-enabled 9602-LP must first be provisioned (signed up for airtime) with EMSS SBD Service before testing or field use. Accessing the DoD EMSS gateway is not authorized until 9602-LP is provisioned. Unauthorized attempts to access the DoD EMSS gateway result in immediate disabling of the offending device, which must then be returned to Naltec for repair. See https://sbd.pac.disa.mil for more information regarding EMSS service provisioning. **NOTE**: This is a U.S. Government Information System website and can only be accessed by authorized users with a valid certificate.

When a Data Terminal Equipment (DTE) is connected to 9602-LP with SatTerm software installed (or any terminal emulator software), the DTE can be used to set up the operating parameters of the 9602-LP via a serial connection. A DTE can be a desktop computer, a laptop computer, or a tablet.

DEVICE DESCRIPTION

Front Panel

9602-LP has 5 status LEDs that provide a quick visual check to ensure proper operations. These include a power indicator, Iridium signal strength, GPS availability, SBD transmission status, and 'Emergency Mode' alert.

Figure 1: 9602-LP front panel

During 'Normal Tracking' mode, the LEDs provide the following information:

- ***Power***: Lights up when power is applied to 9602-LP and power-on button is pressed.
- ***GPS***: Stays solid when there is a valid GPS position fix; blinks when there is 2-D fix or when using dead reckoning; and stays off when unable to obtain a position fix. Watch closely for the LED because it can briefly stay on.
- ***Iridium***: Stays solid when the Iridium signal strength is between 3–5 bars; blinks when the Iridium signal strength is between 1–2 bars; and stays off when the Iridium signal strength is at 0 bars. Because the Iridium modem is on over a short period during a location report, this LED lights up very briefly and you might need to watch closely to see it.
- ***Status***: When first entering 'Tracking' mode, the LED does not light up. This LED stays solid if the last SBD transmission had a valid GPS fix and successfully received it by the gateway; blinks if the last SBD transmission was unsuccessfully sent or did not have a valid GPS fix, but one was sent since the unit was turned on; and stays off if no SBD transmission with a valid GPS fix was sent to the gateway.
- ***Emergency***: Lights up when the 'Emergency' button is pressed or the Input S0 is activated.

For more information, see the LED Settings section.

Back Panel

The back of 9602-LP contains a mini DB-15 connector, a silver connector for the GPS antenna, and a gold connector for the Iridium antenna. More information about these antenna connectors can be found in the GPS Antenna Connector and Iridium Antenna Connector sections, respectively.

Figure 2: 9602-LP back panel

MINI DB-15 CONNECTOR

The multi-interface connector on model 9602-LP is a standard male 15-pin miniature D-sub type (DB-15) connector. It comprises 4 interfaces with the pin assignments shown in the table below:

1) External DC power input
2) 3-wire RS232 serial data interface
3) TTL/CMOS I/Os
4) Reserved RS232 serial data interface

Table 1: Pin Assignments for the 9602-LP Multi-Interface Connector

Pin #	Signal	Description	Interface
1	EXT_PWR	External power input (+3.6 VDC to +5.3 VDC)	DC Power (+)
2	EXT_GND	External power input (GND)	DC Power (GND)
3	Tx1	RS232 Input	RS232 Data
4	Rx1	RS232 Output	RS232 Data
5	Signal_GND	Signal Ground, 0 V signal reference and return	RS232 GND
6	EMERGENCY	External TTL/CMOS Input S0	0–5 V TTL

Table 1: Pin Assignments for the 9602-LP Multi-Interface Connector

Pin #	Signal	Description	Interface
7	TTL	TTL/CMOS Output 0	0–5 V TTL
8	TTL	TTL/CMOS Output 1	0–5 V TTL
9	EXT_PWR	External power input (+6.0 VDC to +32.0 VDC)	DC Power (+)
10	Rx2	Reserved	RS232 Data
11	Tx2	Reserved	RS232 Data
12	TEST	External TTL/CMOS Input S1	0–5 V TTL
13	TTL	External TTL/CMOS Input S3	0–5 V TTL
14	TTL	External TTL/CMOS Input S2	0–5 V TTL
15	TTL	TTL/CMOS Output 2	0–5 V TTL

External DC Power Input

The DC power interface contains 2 DC power inputs and a ground input as summarized in the table above. 9602-LP accepts either +3.6 VDC to +5.3 VDC input through pin #1 or +6.0 VDC to +32 VDC input through pin #9.

9602-LP is shipped with hardware set for +6.0 VDC to +32 VDC input. It can be changed to +3.6 VDC to +5.3 VDC input through an internal jumper—power must be disconnected before jumper reset.

To set the voltage input range, remove the modem's top plate to find the jumper. With 9602-LP held in the position shown in **Figure 3** (DB15 connector to the left), 9602-LP is set for:

- 3.6 VDC to +5.3 VDC when the red jumper is on the middle and top pins,
- +6.0 VDC to +32 VDC when the jumper is on the middle and bottom pins.

Each pin is also labeled with 5 V and 32 V to the left of the top and bottom pins, respectively. The power applied to the pin on the multi-interface connector must match the setting of the jumper for the unit to power up properly.

For example, if +5.0 VDC ±0.5 V is applied to pin 1, then the jumper must be in the +5V DC position. If +6.5 VDC to +32 VDC is applied to pin 2, the jumper must be in the +6.5 VDC to +32 VDC position.

NOTE: Do NOT apply voltage higher than 5.3 VDC on pin 1 (or accidentally swap voltage between pins 1 and 9). 9602-LP will be damaged beyond repair with warranty voided if this were to occur.

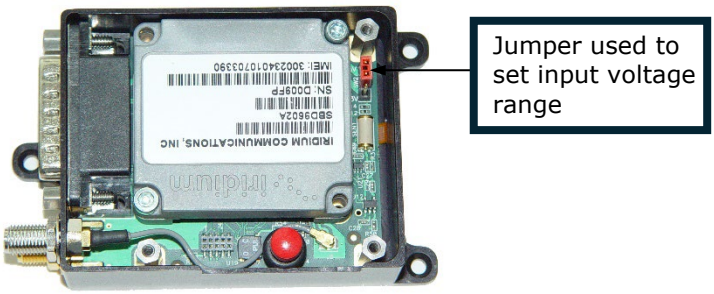

Figure 3: Power input setting for 9602-LP

IMPORTANT: You can remove 9602-LP's top plate to set the jumper but not for repair or services. The warranty is voided if the 9602-LP is disassembled for any reason other than to set the jumper.

The cables that supply power to 9602-LP should be as short as possible to prevent significant voltage drop, which can cause the 9602-LP to malfunction during an SBD session. Model HRC-24-12 (see below) is a data/power cable assembly designed to work with the 9602-LP tracker.

The HRC-24-12 has a three-foot RS-232 cable for connection onto a computer and 3 wires for DC power inputs to a 9602-LP. Model HRC-24-12 is available on the Naltec website at https://naltec.com/products/data-cables-kits/.

Figure 4: Model HRC-24-12 data/power cable assembly

A power reset by 9602-LP during an SBD transmission indicates the DC power source is unable to sustain voltage above 3.0 VDC at peak current demand. Plots of the DC power requirement for the 9602-LP are in the Power Consumption section.

RS232 Serial Data Interface

9602-LP supports a 3-wire serial interface to a host DTE through the multi-interface connector. The serial comprises a transmit (Tx) line on pin 3, a receive (Rx) line on pin 4, and a signal GND on pin 5, as described in **Table 1**.

Baud Rate

9602-LP does not support autobaud; the default baud rate is factory set at 19.2 Kbps. The baud rate can be reconfigured with the +IPR command ranging from 4.8 Kbps to 115.2 Kbps.

Serial Port

The serial port allows a connected DTE to configure 9602-LP using Naltec's defined AT commands and any terminal emulator software. Find these AT commands in the manual "AT Commands for Model 9602-LP" [1]. Instead of trying to memorize the various functions of AT commands, it is easier to use the SatTerm graphical user interface (GUI) software to configure 9602-LP.

TTL/CMOS Inputs/Outputs

9602-LP has 4 TTL/CMOS inputs and 3 TTL/CMOS outputs. All I/Os are brought out to the multi-interface connector (min DB-15 connector). Use SatTerm to configure these I/Os under the I/O tab of the *Configuration Settings* window, as shown in **Figure 5**.

The 4 CMOS/TTL inputs, denoted as S0 through S3, have internal pull-ups, which allow the inputs to float as high. Configure the inputs as emergency, test, or general input with a trigger on a rising and/or falling edge. The trigger activates the special functionality of the input type.

The input types include:

1) *Emergency* configured inputs enable the 'Emergency Tracking' mode when triggered.
2) *Test* configured inputs enable the 'Test Tracking' mode.
3) *General* configured inputs queue the transmission of an Input Report (see Appendix C in "AT Commands for Model 9602-LP" [1]).

Regardless of the type or trigger configuration, the value of the input is included in any version 5 GPS report sent. By default, S0 is configured as an emergency input triggered by a falling edge, and S1 is configured as a test input triggered by a falling edge.

S0 is shared with the onboard Emergency button (see **Figure 6**). This means both the guarded 'Emergency' button on 9602-LP and S0 can be used to activate 'Emergency Tracking'.

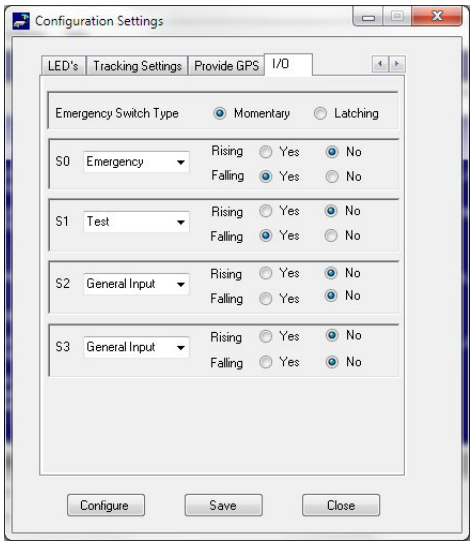

Figure 5: Configuration settings: I/O

EMERGENCY BUTTON

Under the default configuration, you can trigger 'Emergency Tracking' at any time with a quick press and release of the Emergency button (momentary switch). Once enabled, holding the emergency button longer than 3 seconds takes 9602-LP out of 'Emergency Tracking'.

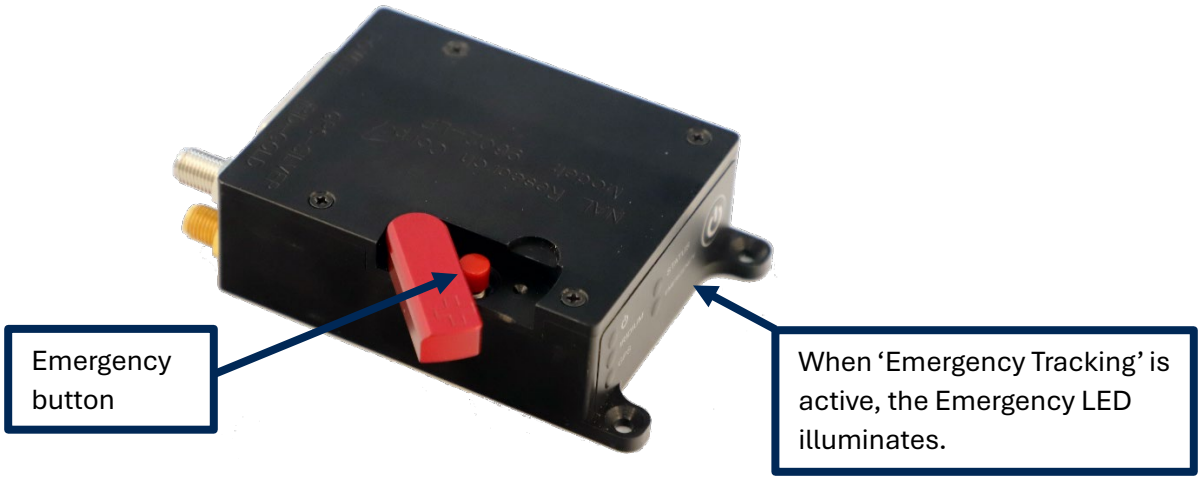

Figure 6: Activate 'Emergency Tracking'

The Emergency trigger can be further customized using the AT command ^EST. This command specifies the type of emergency switch as either *momentary* (default) or *latching* (similar to the toggle switch on the 9601-DGS-LP).

The *momentary* switch type functions as described above. When set to *latching*, 'Emergency Tracking' is enabled only when the trigger is active. For example, setting the emergency trigger to the falling edge and the switch type to *latching* causes 'Emergency Tracking' to enable when the input level is pulled from high to low, and then it disables when the input level returns to high.

The AT command ^PR controls input value reporting. When ^PR is enabled and a pin changes, an unsolicited response, ^PV, is sent on the serial port, indicating the values of the input pins. Setting the outputs is controlled by the AT command ^Pn. Outputs can also be set by remote update. For detailed information regarding I/Os, refer to the manual "AT Commands for Model 9602-LP" [1].

CONFIGURATION SETTINGS

Modes of Operation

When powered on, 9602-LP can be in either Command Mode or Tracking Mode.

COMMAND MODE

In Command Mode, AT commands can be entered to configure the 9602-LP's operating profiles, or it can be operated as a 9602-G (standard SBD-modem with GPS). As a reminder, developers are encouraged to use SatTerm GUI software to set up 9602-LP instead of using AT commands.

TRACKING MODE

When in Tracking Mode, 9602-LP automatically transmits GPS reports as defined by parameters in the *active operating profile* (see description below). There are 3 types of Tracking Modes: Normal, Emergency, and Test.

9602-LP is factory-set for AT^START0 to turn on in Command Mode and can be reset to turn on in Tracking Mode with the AT^START1 command. After 9602-LP is turned on, use the AT^TRK command to switch from Command to Tracking Mode; switch from Tracking back to Command Mode with the +++ escape sequence. **Figure 7** describes 9602-LP operating modes.

There are 3 types of operating profiles:

- ***Active***: The set of parameters currently in use by 9602-LP.
- ***User-defined***: There are 2 of these operating profiles available: 0 and 1. Each *user-defined* operating profile can be edited and saved at any time through the AT command &Wn.
- ***Factory-default***: This profile is stored permanently on 9602-LP's memory and cannot be changed by the user. Profiles 0 and 1 are initially set as the *factory default* profile.

When turned on and as a default, 9602-LP loads *user-defined* operating profile 0 into the active operating profile. However, either one of the two *user-defined* operating profiles can be designated as the active operating profile when turned on through the use of the AT&Yn command.

When turned on, the *factory-default* operating profile can be loaded (soft reset) into the *active* operating profile using the AT&Fn command. The *active* operating profile reverts back to the *user-defined* operating profile designated under the AT&Yn command at power reset.

Similarly, the *active* operating profile can be soft reset with either of the two *user-defined* operating profiles during power up with the ATZn command. Again, the *active* operating profile reverts back to the *user-defined* operating profile designated under the AT&Yn command at power reset.

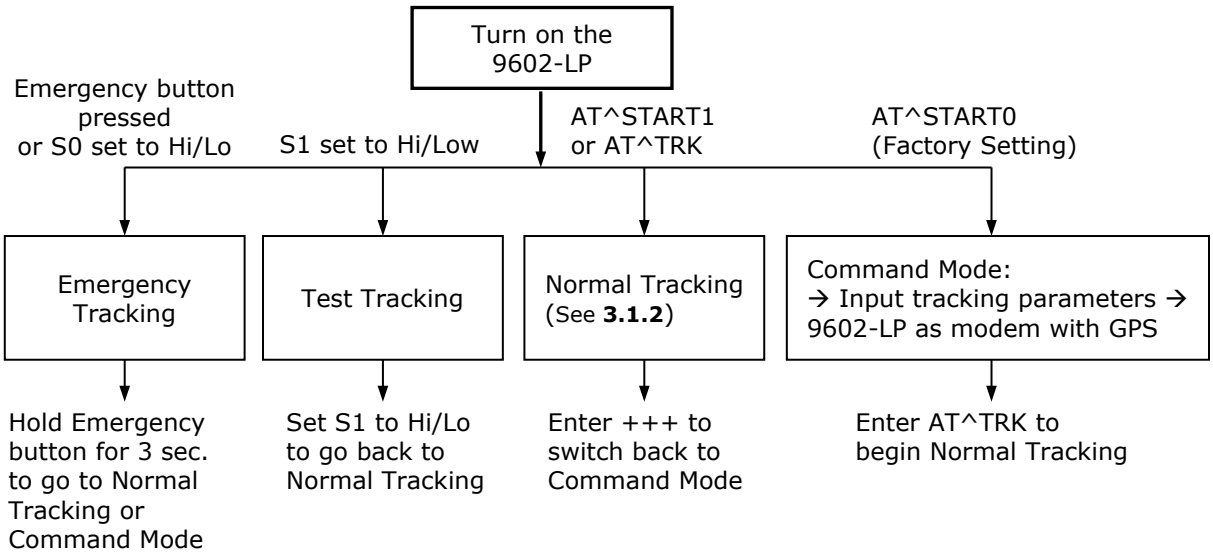

Figure 7: 9602-LP operating modes

Normal Tracking Mode

Normal Tracking is the mode when 9602-LP is configured to turn on with the AT^START1 command or after transitioning from Command to Tracking Mode with the AT^TRK command.

Normal Tracking provides a wide range of unique settings, as each setting can be tailored to meet specific applications. For example, 9602-LP can be preprogrammed to transmit reports at fixed intervals or when triggered by the internal motion sensor, Emergency switch, or by external devices.

The “Callable (No)” option is implemented when lowest power consumption is required because of limited battery capacity, or “Same Place Skip Reports” is chosen so that 9602-LP does not repeatedly send the same location information back to a command center.

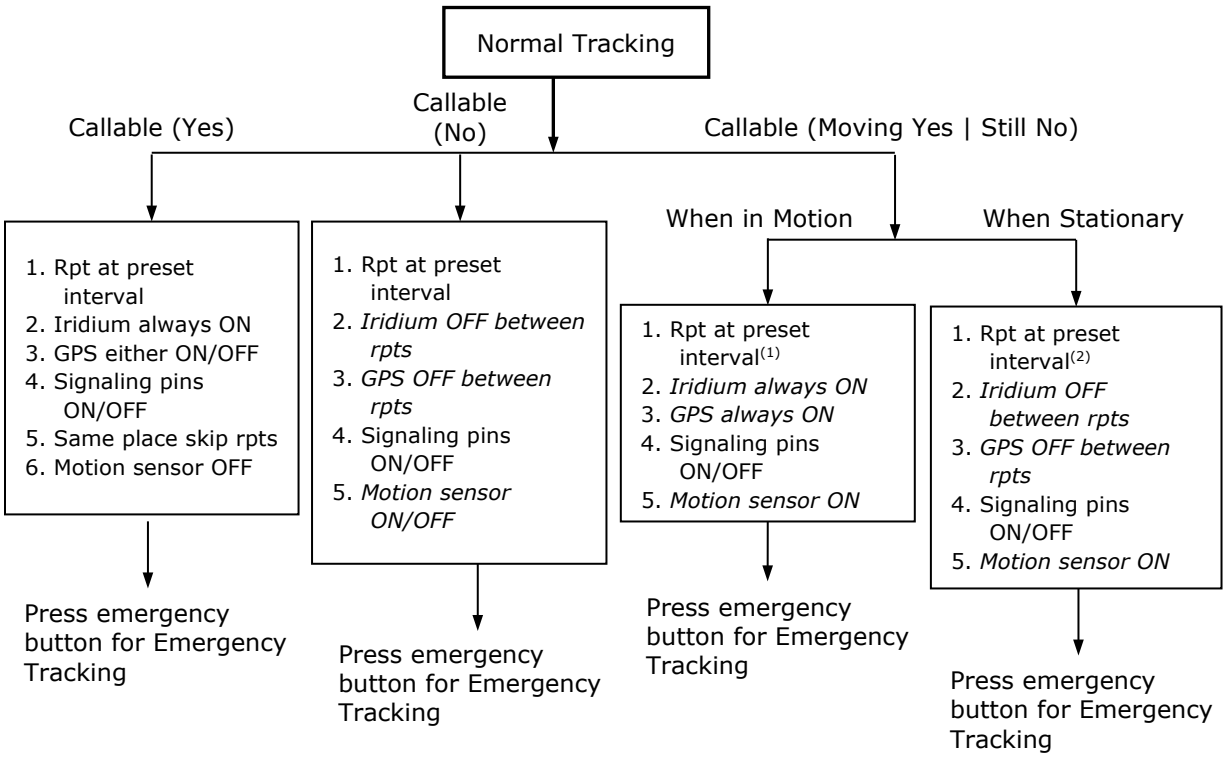

Figure 8: Normal Tracking Mode: Settings

Settings that control report intervals:

1) The interval is determined by setting Time Between Reports Awake (**AT^TBRA**).
2) The interval is determined by setting Time Between Reports (**AT^TBR**).

During Normal Tracking and when "Callable" is set to "Yes", 9602-LP automatically transmits GPS reports at a preset interval ranging from continuous to one report every 7 days. The Iridium RF board is ON in between reports, allowing the 9602-LP's operating profile to be reconfigured remotely in real-time. Because the Iridium RF board is ON at all times, 9602-LP consumes the most power in between reports (approx. 110 mA at 5 VDC).

The GPS receiver can be left either ON or OFF in between reports to reduce power by approx. 40 mA at 5 VDC. Any of the 4 input pins (S0 through S3) on the multi-interface connector can be selected to trigger immediate transmission of GPS report(s) when a rising edge or a falling edge of a TTL/CMOS input signal is detected.

Once the last GPS report is sent, 9602-LP goes back to Normal Tracking. The "Same Place Skip Reports" option prevents GPS reports from being transmitted if 9602-LP does not move outside a defined radius. When you select the "Callable (Yes)" option in the SatTerm Configuration Settings window, the motion sensor signal is ignored by the tracker (see below).

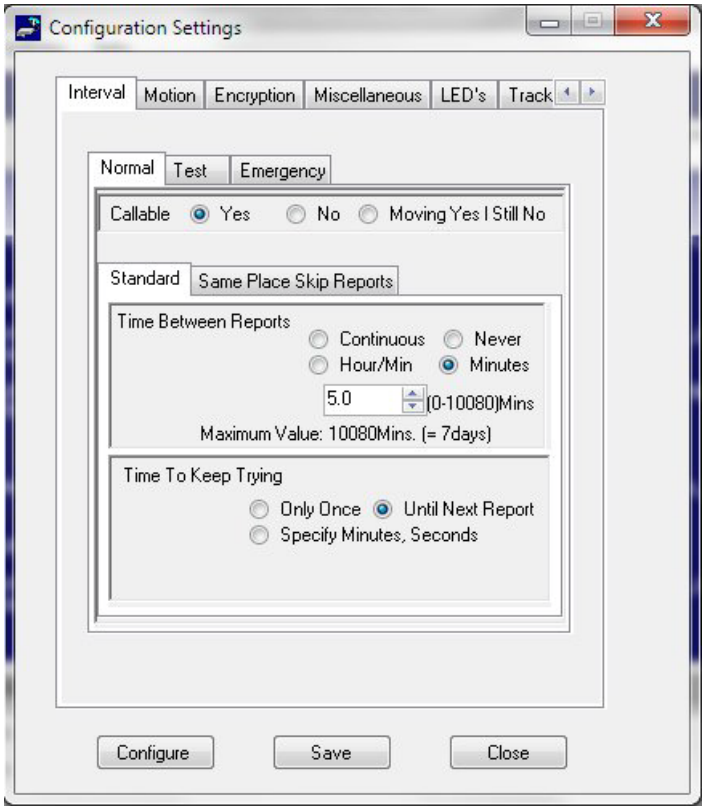

Figure 9: Normal Tracking "Callable (Yes)" option

During Normal Tracking and "Callable" set to "No", 9602-LP automatically transmits GPS reports at a preset interval ranging from continuous to one report every 7 days. All 9602-LP internal circuits are turned OFF in between reports, including the GPS receiver, GPS antenna's LNA, Iridium RF board, DC-DC converters, and serial interfaces. The only active components are the microcontroller and motion sensor.

9602-LP draws the lowest current in between reports of around 60 µA at 5 VDC. The device will not respond to any entered commands, including the +++. The +++ command works only while 9602-LP is waiting for GPS acquisition or is transmitting a report.

An updated operating profile sent to 9602-LP from a command center remains at the Iridium gateway until 9602-LP wakes up and retrieves it. Any of the 4 input pins (S0 through S3) on the multi-interface connector (DB-15 connector) can be selected to trigger immediate transmission of GPS report(s) when a rising edge or a falling edge of a TTL/CMOS input signal is detected. Once the last GPS report is sent, 9602-LP goes back to Normal Tracking.

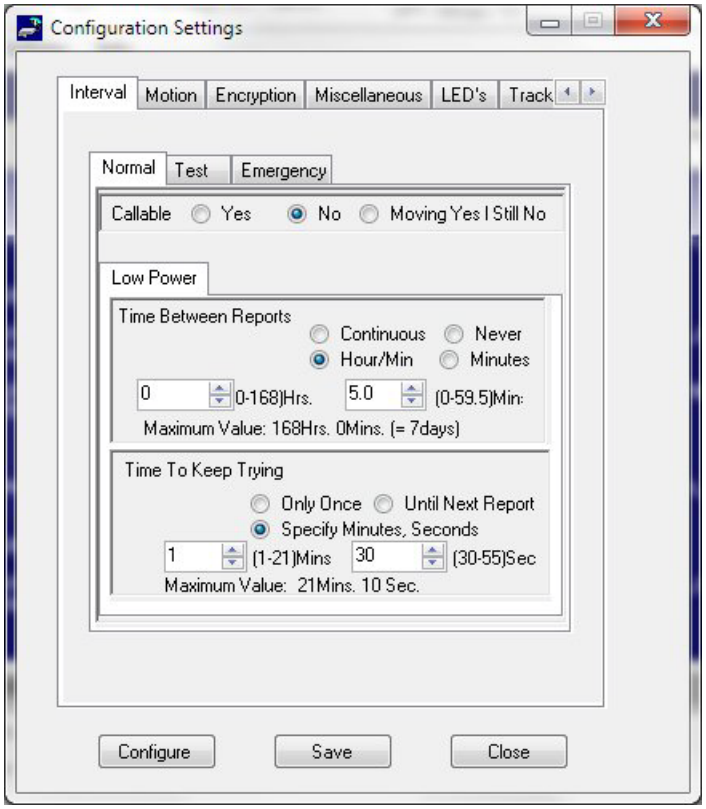

Figure 10: Normal Tracking "Callable (No)" option

When you select the *"Callable (No)"* option (see above) and select the *Awake on Motion* option (see **Figure 11**), 9602-LP can be triggered by an internal motion sensor to send a GPS report. 9602-LP has a built-in motion sensor that works regardless of how it is mounted or aligned.

9602-LP is sensitive both to tilt (static acceleration) and vibration (dynamic acceleration). When in motion, the sensor produces continuous on-off contact closures (a series of TTL-level logic or pulse train) as it chatters open and closed. The signal level is fed directly into the 9602-LP micro-controller. When at rest, it normally settles in a closed state.

Three parameters must be provided when choosing the *Awake on Motion* option:

1) ***Minutes of Motion Before Waking***: A user-defined duration within which valid motion must exist before 9602-LP sends a GPS report. For example, a car must experience continuous motion for 3 minutes before a GPS report is sent. Otherwise, a slight bump by a person or by a gust of wind might initiate a report. The duration of *Minutes of Motion Before Waking* is divided into one-minute blocks.
2) ***Sensitivity***: Defined as the number of motion sensor on-off contact closures 9602-LP must detect in each of the one-minute blocks for motion within that block to be considered valid motion. All contiguous one-minute blocks must have valid motion before a GPS report is sent. Any time a block has an invalid motion, the *Minutes of Motion Before Waking* timer is reset and the motion detection process starts over again.

3) ***Motion Sensor Wait***: After valid motion is detected and a successful GPS report is sent, 9602-LP goes back to sleep with all circuits OFF. It ignores the motion sensor input signal for *Motion Sensor Wait* minutes. All other parameters and I/O pins are still observed.

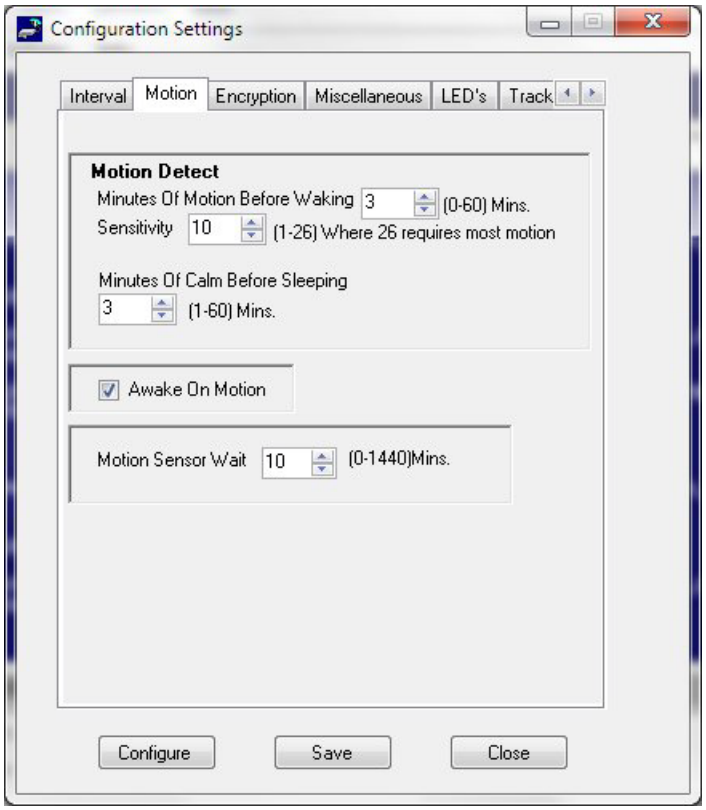

Figure 11: Normal Tracking "Awake on Motion"

The third Normal Tracking option is "Callable (Moving Yes | Still No)." This is a hybrid between the "Callable (Yes)" and "Callable (No)" configurations.

When in motion, 9602-LP uses a set of "Callable (Yes)" parameters to send GPS reports; when not in motion, it uses a set of "Callable (No)" parameters to send GPS reports. This allows flexibility to define different sets of parameters for different operating conditions. For example, a stationary vehicle may need to send position report only once a day. However, when in motion, a higher reporting frequency is required.

The setup parameters for "Callable (Moving Yes | Still No)" and *Not in Motion or Low Power* are shown in **Figure 12**. These parameters are similar to the standard "Callable (No)" option, except there is no *Awake on Motion* option. 9602-LP uses *Minutes of Motion Before Waking* and *Sensitivity* to determine if valid motion is observed by applying the same approach described previously. Once valid motion is determined, 9602-LP switches to "Callable (Moving Yes | Still No)" and "in motion" mode.

The setup parameters for "Callable (Moving Yes | Still No)" and *In Motion or Motion* are similar to the "Callable (Yes)" option, except the motion sensor is active. 9602-LP uses *Minutes of Motion Before*

Waking and *Sensitivity* to determine if valid motion is observed by applying the same approach described above. If valid motion is not detected before the *Minutes of Calm Before Sleeping* expires, it switches back to "Not in Motion or Low Power" mode.

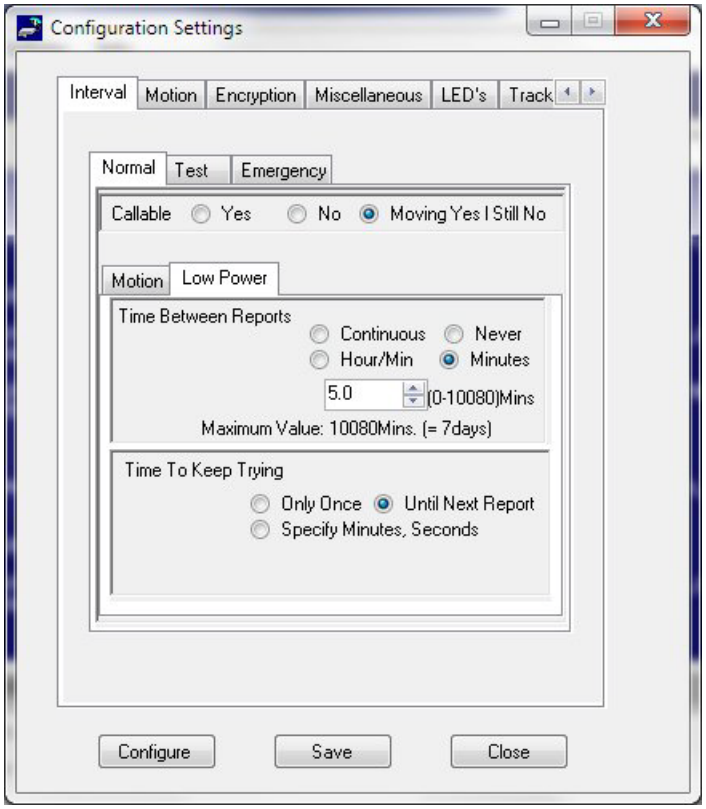

Figure 12: Normal Tracking "Callable (Moving Yes | Still No)" option

Emergency and Test Tracking Modes

Emergency Tracking can be triggered by the Emergency button (see **Figure 6**) or by input pin S0. Test Tracking can be triggered by input pin S1.

Emergency Tracking and Test Tracking operate similarly to Normal Tracking in that they have individually configurable reporting parameters. While in Emergency Tracking, 9602-LP does not respond to the +++ escape sequence, and at least one "report send attempt" must be completed before transitioning back to Normal Tracking.

The Emergency GPS reports have a special data bit activated to alert the recipient of the message type. 9602-LP allows GPS reports to be saved on its nonvolatile memory when an Iridium satellite is not available.

Encryption Setting

You can send GPS reports in AES 256-bit encrypted format. Use the SatTerm *Change Encryption Settings* window, to change the Crypto Officer Password, enable or disable the encryption, and set or change the encryption or decryption key.

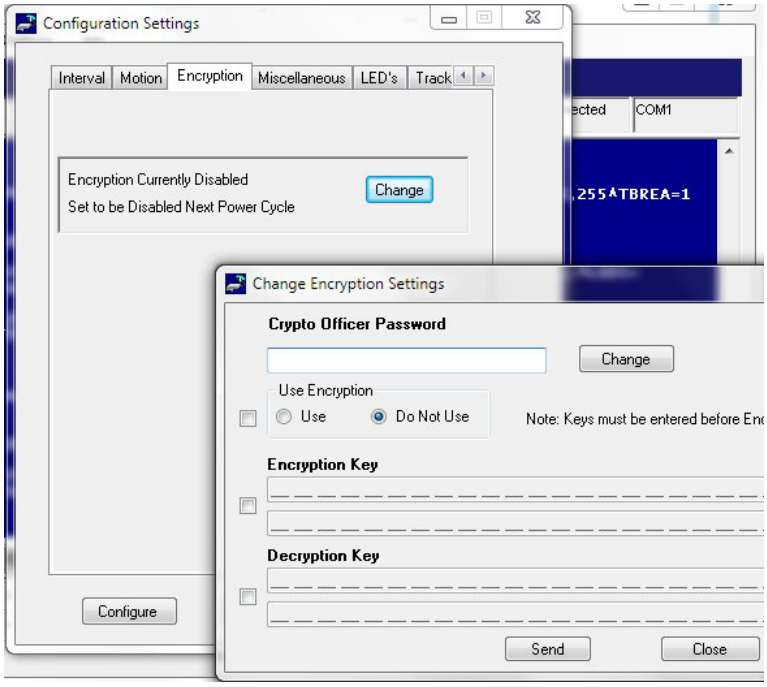

Figure 13: Change encryption settings: AES-256 bit encryption

A factory-default Crypto Officer Password is initially set and saved into 9602-LP and must be changed before you set or configure encryption properties. To change the default password:

1) Click 'Change' to open the *Change Crypto Officer Password* window.
2) Complete the form. The default password is displayed as the *Old Password*.
3) Press 'Send'.

Once the default password is changed, set the encryption and decryption keys in order to use encryption for the first time.

1) In the *Change Encryption Settings* window, select 'Use Encryption' checkbox > 'Use'.
2) Press the 'Encryption Key' checkbox and enter the key 2 times.
3) Select the Decryption Key checkbox and enter the key 2 times.
4) Click 'Send'. The message 'Update Made' is displayed.

After the default Crypto Officer Password is changed and the encryption and decryption keys are set, encryption properties can be modified via the *Change Encryption Settings* window using the current Crypto Officer Password.

Miscellaneous Settings

The *Miscellaneous* tab has 4 settings:

1) **Remote Update Password**: Set the required password when a remote update to the current *active* operating profile is made from a command center while 9602-LP is in the field. The <password> entered must be 8 characters in length and all printable characters are allowed. The factory-set password is 12345678, and there is no requirement to change it.
2) ***Identifier in Reports****:* Enter a unique static identifier of up to 50 characters (platform identifier of 9602-LP) and add it to the GPS report.
3) ***Startup Information****:* Display or hide the startup text.
4) ***Initial Power State***: 9602-LP has a single power on/off button. With the correct internal voltage jumper setting, 9602-LP is defaulted to turn on automatically when DC power is first applied to either pin 1 or pin 9 on the multi-interface connector. It can be turned off/on again by momentarily holding down and releasing the power button. Using AT command ^IPS, 9602-LP can also be set to turn on by pressing the power button when DC power is first applied to pin 1 or pine 9. If the device is sleeping in between reporting cycles, pressing the power button turns 9602-LP on for 10 seconds. During this time, you can exit Tracking mode by sending +++.

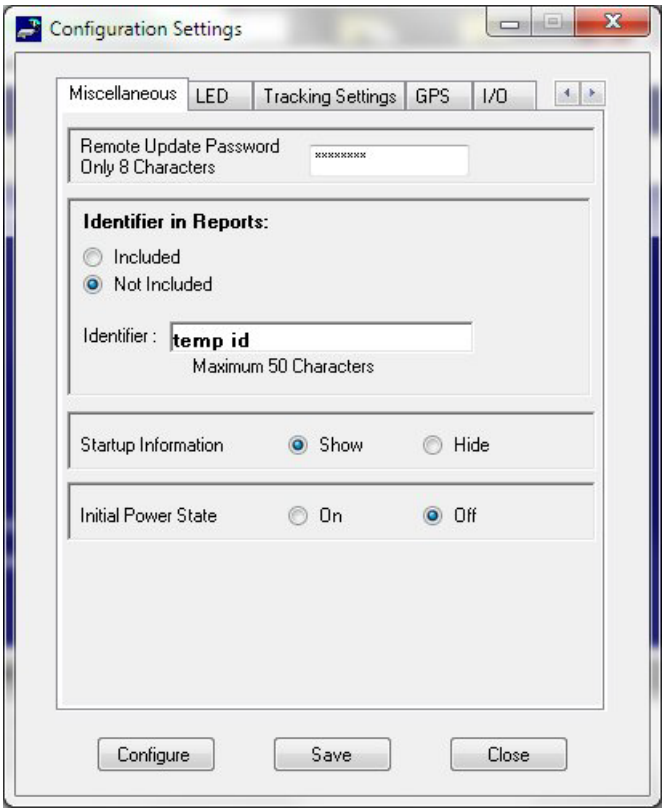

Figure 14: Configuration Settings window: Miscellaneous

LED Settings

During Command Mode or while operating 9602-LP as a 9602-G modem, the LEDs display information in the same manner as in Normal Tracking mode.

In addition, when first entering Command Mode, the Status LED does not light up. If the last SBD session does not have an error, the LED stays solid. An error occurs when a transmitted SBD message is not being acknowledged by the gateway or if a message received from the gateway contains an error(s). The LED blinks only after 9602-LP is turned on with the last SBD session having an error but the next SBD session is error-free.

See the Front Panel section for information on the LED patterns during normal operations.

Figure 15: LED Status

For applications where prolonging battery life is essential, the LEDs can be turned OFF using the ^LEDS AT command or using the SatTerm LED's tab, as shown in **Figure 16**. 9602-LP is shipped with all LEDs set to ON.

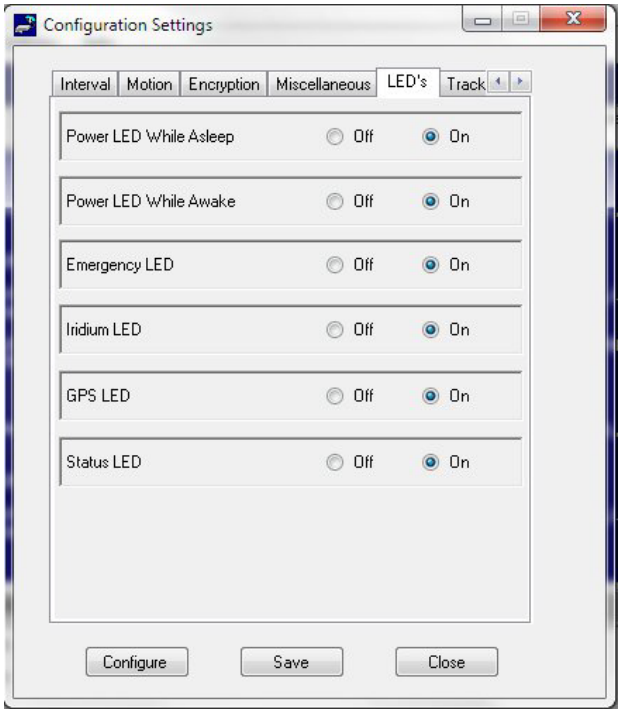

Figure 16. Configuration Settings window: LED's

Tracking Settings

The *Tracking Settings* tab contains the following:

1) ***Emergency Report Flood***: Sets how many GPS reports are sent out continuously when first entering Emergency Tracking. After <n> GPS reports are sent, the preprogrammed reporting interval takes effect.
2) ***Remote Message Format***: Sets format of messages sent to the command center.
3) ***GPS Always ON***: Forces the GPS receiver to stay on in between reports, allowing hot-start each time 9602-LP wakes up.
4) ***Start-Up Mode***: Sets the 9602-LP power-up mode.
5) ***Data Log Tracking***: Allows GPS reports to be saved on its nonvolatile memory. When memory is full, the oldest reports are overwritten. SatTerm can be used to retrieve all position reports at a later time through the multi-interface serial port.
6) ***Block Invalid Reports***: When this setting is enabled and a tracking mode is selected, reports with invalid GPS fix are not sent.
7) ***Test Report Flood***: Sets how many GPS reports are sent out continuously when first entering Test Tracking. After <n> GPS reports have been sent, the preprogrammed reporting interval takes effect.

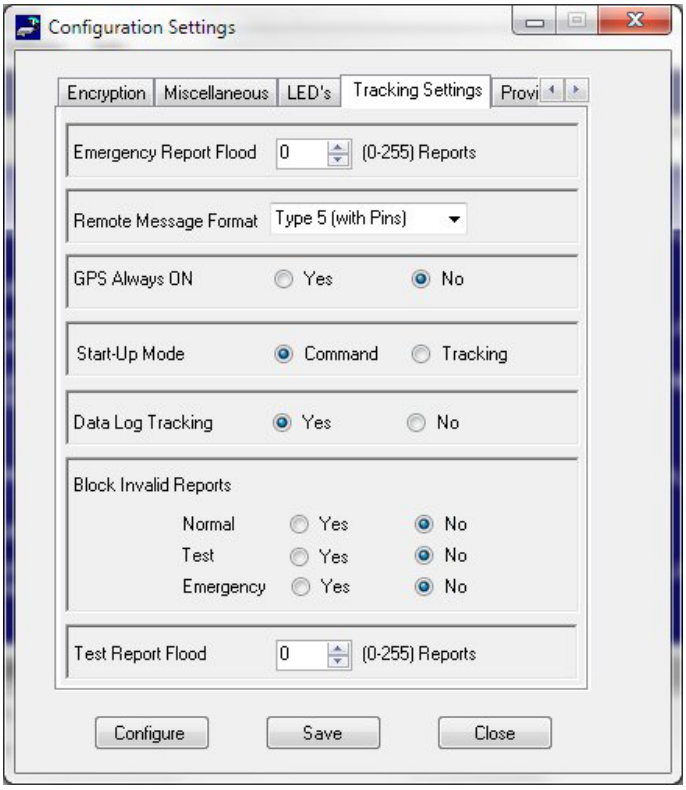

Figure 17: Configuration Settings Window: Tracking Options

GPS Settings

From the *Configuration Setting* window, the *GPS* option allows you to obtain GPS information from the 9602-LP serial port while the unit is in Command or Tracking mode (similar to the command ^PG). Both GPS NMEA formats and updating (streaming) rate can be defined.

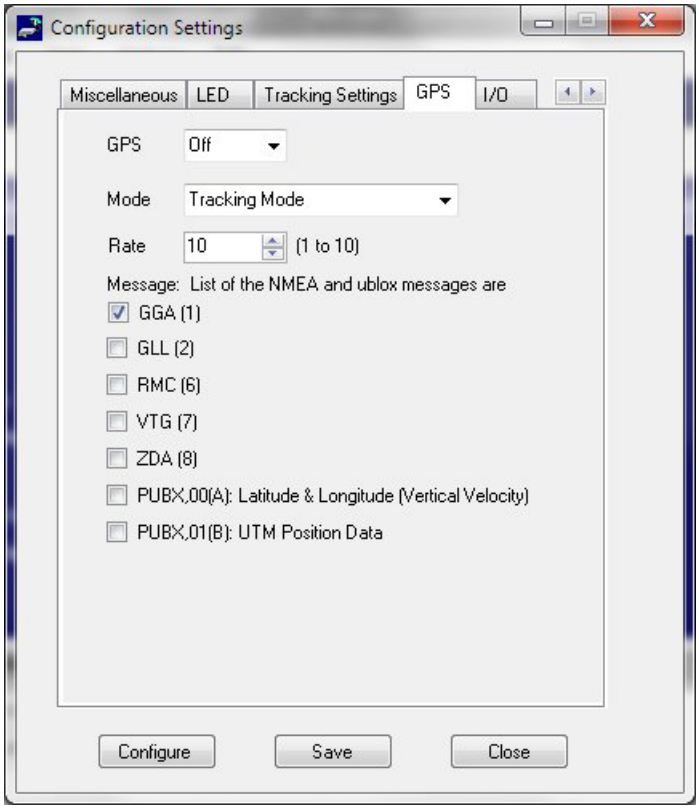

Figure 18: Configuration Setting Window: GPS Options

MOTION SENSOR

9602-LP has a built-in omnidirectional sensor that can reliably detect motion and functions regardless of how 9602-LP is mounted or aligned. It is sensitive to both tilt (static acceleration) and vibration (dynamic acceleration).

The sensor produces a series of TTL-level logic or pulse train. The signal level is fed directly into 9602-LP's microcontroller to wake the device out of sleep mode when activity is sensed and to transmit location report.

The 9602-LP motion sensor can be enabled or disabled through the AT command (^MSA). When enabled, the motion sensor has a user-defined time-out to prevent false alarm and is the duration in which 9602-LP must remain in motion before the signal level is asserted to the microcontroller.

Additional motion sensor settings can be found in the AT manual. The motion sensor draws approximately 4 µA at 4 VDC power input, regardless of whether it is software-enabled or not.

GPS ANTENNA CONNECTOR

9602-LP tracker uses a silver SubMiniature Version A (SMA) female connector for the GPS antenna. Any active antenna accepting a bias voltage of 3 VDC is appropriate. However, the Low-Noise Amplifier (LNA) gain should not exceed 30 dB.

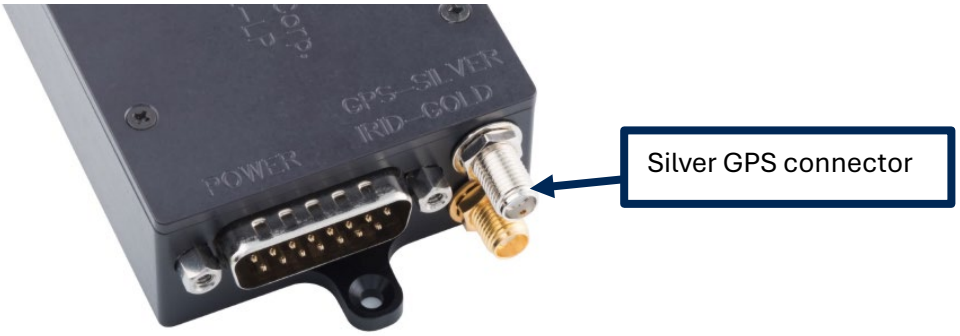

Figure 19: SMA female 50-ohm antenna connector (GPS)

Naltec offers a magnetic mount GPS antenna as well as dual Iridium/GPS antennas for use with 9602-LP. For cost-effective applications where low size, weight, and power (SWaP-C) solutions are required, Naltec highly recommends model SAF7352-IG, as shown in **Figure 22**.

Figure 20: Model SAF7352-IG antenna

Below is important information about using the GPS antenna connector with 9602-LP:

1) DO NOT CONNECT OR DISCONNECT THE GPS ANTENNA WHEN 9602-LP IS TURNED ON.
2) The internal GPS receiver calibrates the noise-floor when turned on. Connecting the GPS antenna after power-up can result in prolonged acquisition time and possibly damage the receiver.
3) To test GPS signal reacquisition, physically block the signal to the antenna rather than disconnect and reconnect the antenna.
4) Never feed external supply voltage into the active GPS antenna.
5) Always use the bias voltage supplied by 9602-LP via the SMA antenna connector to power an active GPS antenna.
6) Feeding voltage to the GPS antenna other than the provided bias voltage will damage 9602-LP.

IRIDIUM ANTENNA CONNECTOR

9602-LP uses a single SMA female 50-ohm antenna connector for both Iridium signal transmission and reception. The mating SMA male connectors are readily available from many RF hardware vendors/suppliers. Cable and connector losses between 9602-LP and the antenna are critical and must be kept to less than 2 dB at the operating frequency of 1616 to 1626.5 MHz.

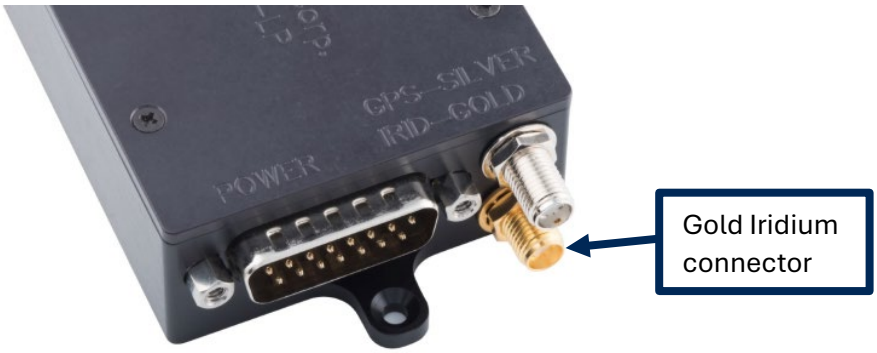

Figure 21: SMA female 50-ohm antenna connector (Iridium)

Naltec offers several types of antennas for use with 9602-LP, including the fixed mast, mobile magnetic/permanent mount, and portable auxiliary. For cost-effective applications where low size, weight, and power (SWaP-C) solutions are required, Naltec highly recommends model SYN7391-C.

Figure 22: Model SYN7391-C antenna

If a custom-designed antenna is required, it must meet the specifications shown below.

Table 2: Recommended Iridium Antenna's Design Specifications

Parameter	Value
Measurement Frequency Range	1616 to 1626.5 MHz
Return Loss (Minimum)	9.5 dB
Gain	0.0 dBic (weighted average minimum)
VSWR	1.5:1
Minimum 'Horizon' Gain	–2.0 dBic (82° conic average)

Table 2: Recommended Iridium Antenna's Design Specifications

Parameter	**Value**
Nominal Impedance	50 Ohms
Polarization	Right-handed circular (RHCP)
Basic Pattern	Omni directional and hemispherical

POWER CONSUMPTION

This section provides insight into the 9602-LP electrical power profile; however, it does not describe every situation and permutation possible. It should be used as a starting point for continuing your own development design. The actual usage profile can vary for a number of reasons:

1) Poor visibility of the sky where clear line of sight is not available between 9602-LP and a satellite.
2) The higher the antenna Voltage Standing Wave Ratio (VSWR), the higher the current consumed.
3) Manufacturing variation from device to device.

9602-LP power consumption can be divided into distinct operating segments: 1) power up, 2) standby, 3) sleep between reports, 4) GPS acquisition, and 5) SBD report transmission. When turned on in Command Mode, typical in-rush current of approx. 3 A–4 A over a few milliseconds is mainly due to the current drawn by 9602-LP.

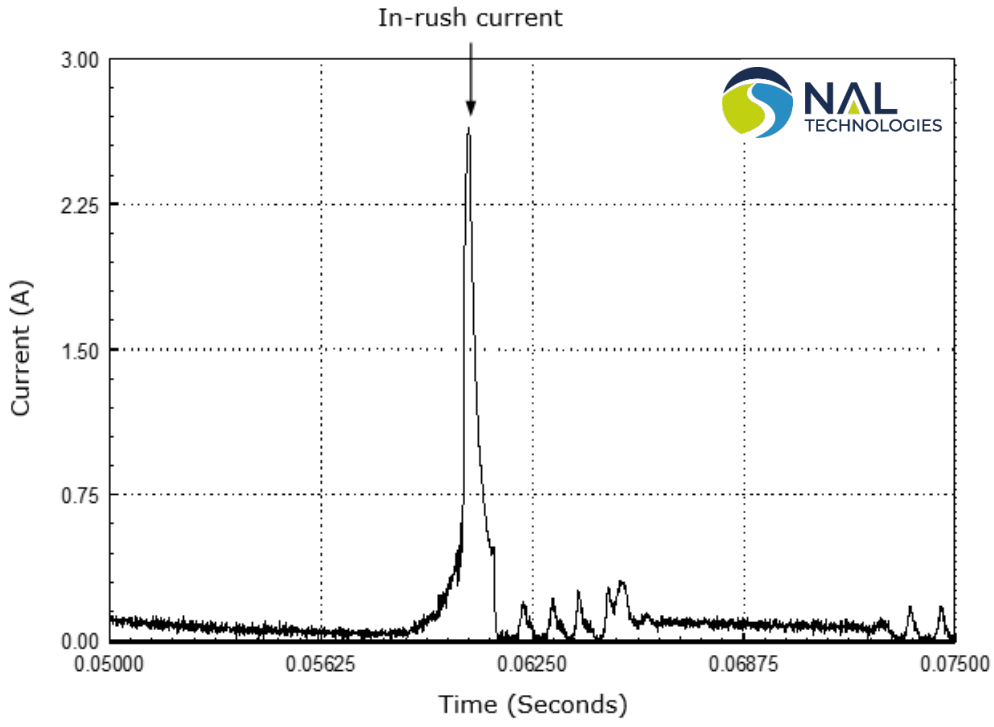

Figure 23: In-rush current spike during power-up: Command mode (5 VDC input)

At standby in Command Mode, current is measured when all circuits are on. The average current drawn during standby with 3.6 VDC–5 VDC input and 6 VDC–32 VDC are shown in **Figure 24** and **Figure 25**, respectively.

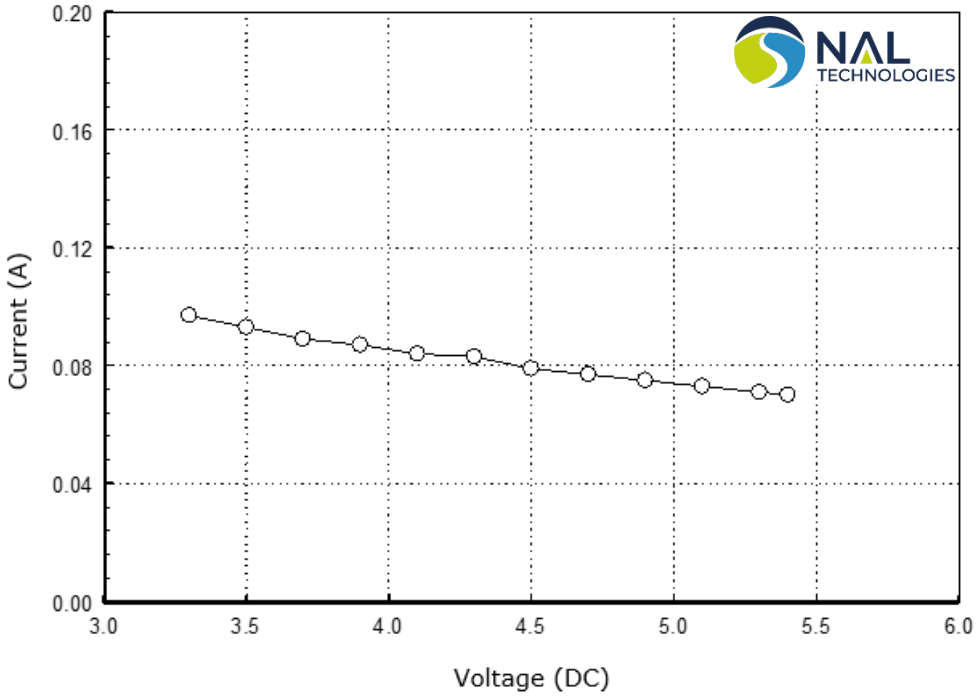

Figure 24: Average current during standby (3.5 VDC to 5 VDC input)

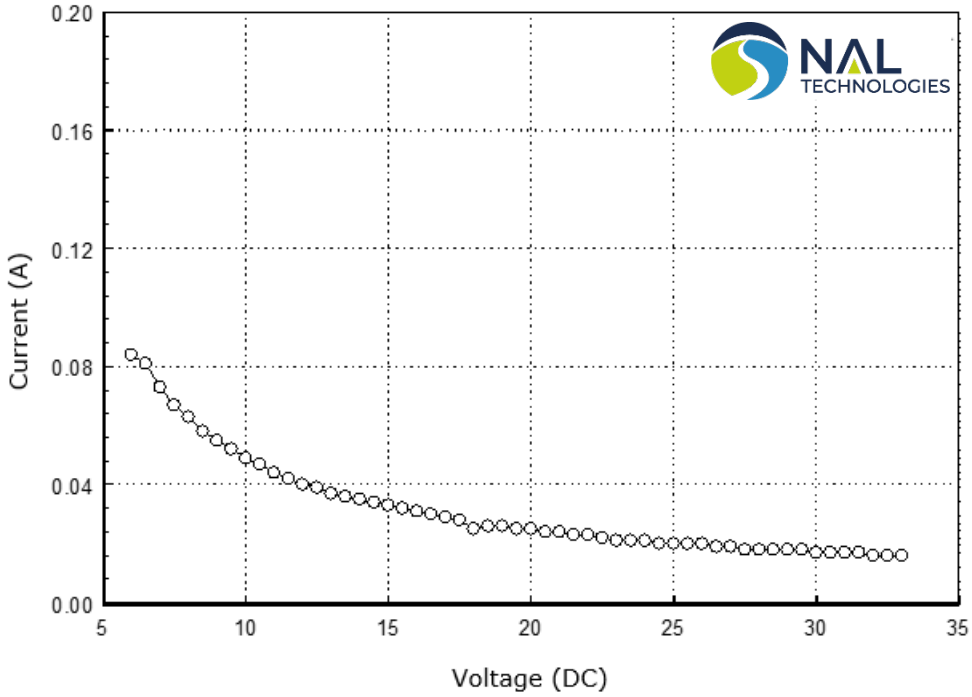

Figure 25: Average current during standby (6 VDC to 32 VDC input)

Figure 26 shows the average power consumption by 9602-LP at standby in command mode for the entire voltage range.

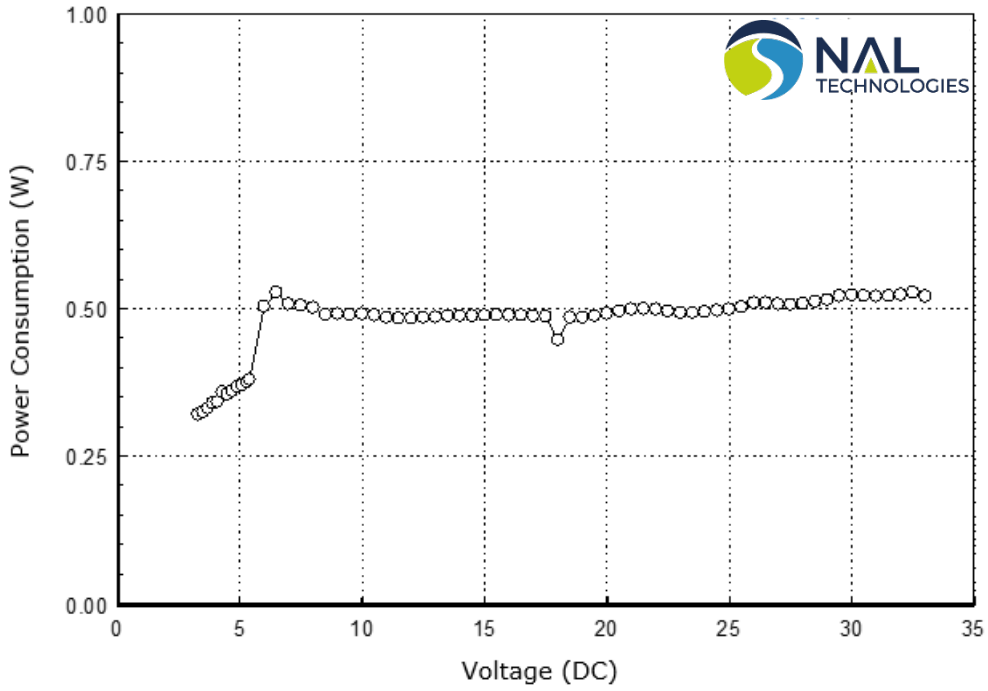

Figure 26: Average power consumption during standby (3.5 VDC to 32 VDC input)

In tracking mode, 9602-LP goes through 3 power consumption segments:

1) The sleep (in between reports) segment
2) GPS acquisition segment
3) SBD transmission segment

Figure 27 shows different stages of current drawn by 9602 when in tracking mode. During the sleep segment, 9602-LP goes into power-saving mode by shutting down all its internal circuits.

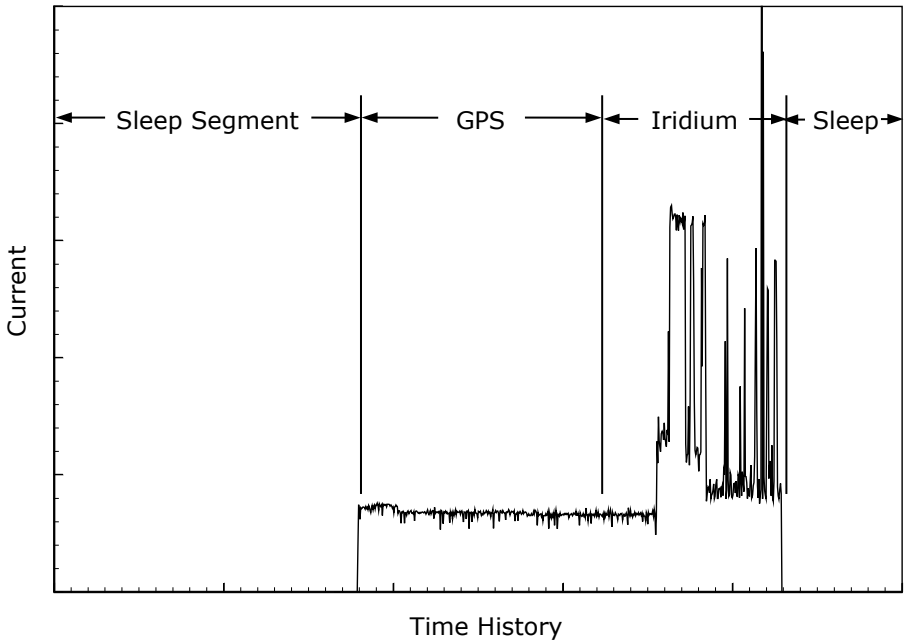

Figure 27: Stages of current drawn: Tracking mode

The average current drawn by 9602-LP during sleep with 3.6 VDC–5 VDC input is shown in **Figure 28**.

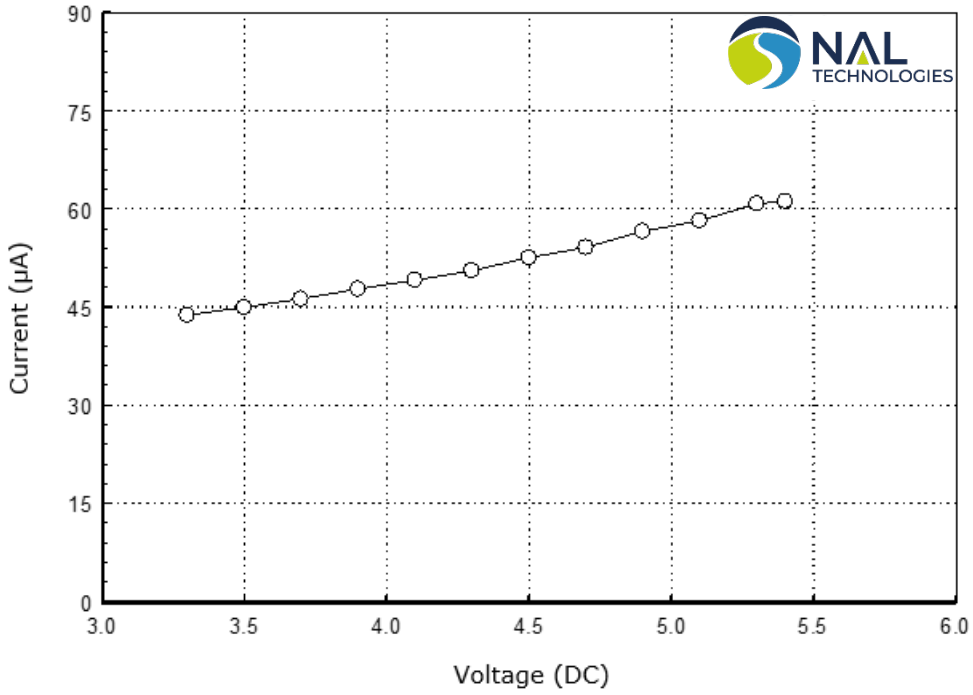

Figure 28: Average current during sleep (3.5 VDC to 5 VDC) input

The average current drawn by 9602-LP during sleep with 6 VDC–32 VDC is shown in **Figure 29**. Due to limitations of our signal analyzer, current drawn for voltages above 15 VDC in the µA range could not be measured. The dashed line results from curve fitting (cubic spline) of the data.

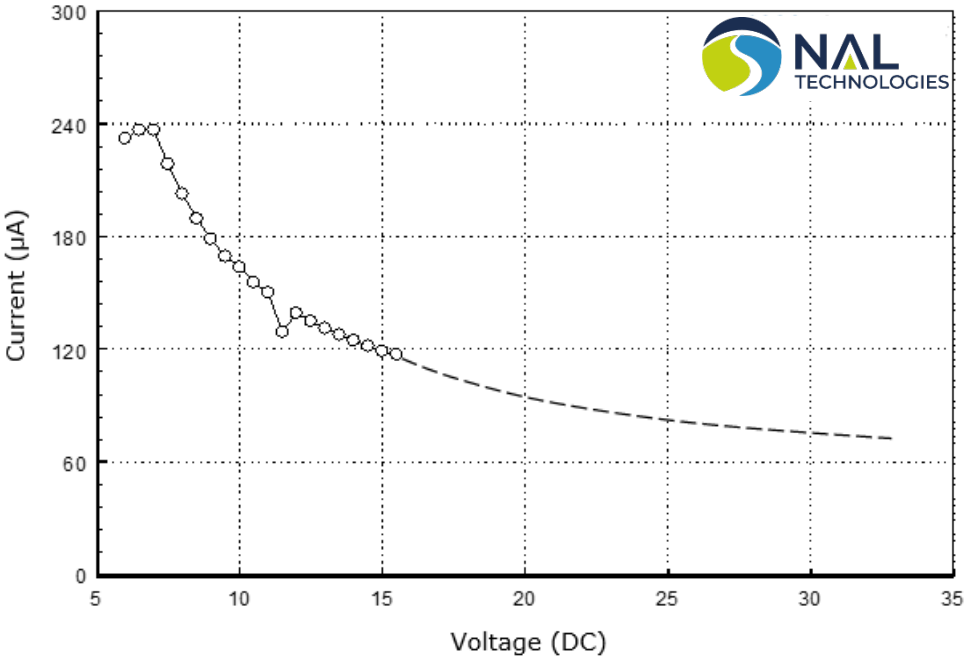

Figure 29: Average current during sleep (6 VDC to 32 VDC input)

Figure 30 shows 9602-LP's average power consumption during sleep for the entire voltage range.

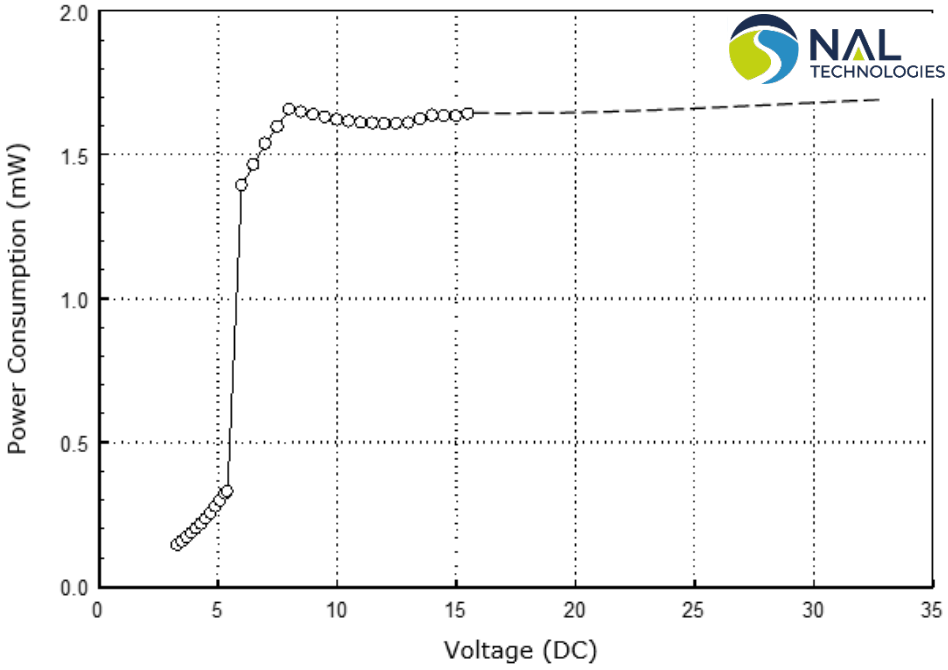

Figure 30: Average power consumption during sleep (3.5 VDC to 32 VDC input)

During the GPS acquisition segment, the average current drawn by 9602-LP with 3.6 VDC–5 VDC input and 6 VDC–32 VDC are shown in **Figure 31** and **Figure 32**, respectively. The GPS acquisition time can range from 1 second (hot starts) to 28 seconds (cold starts).

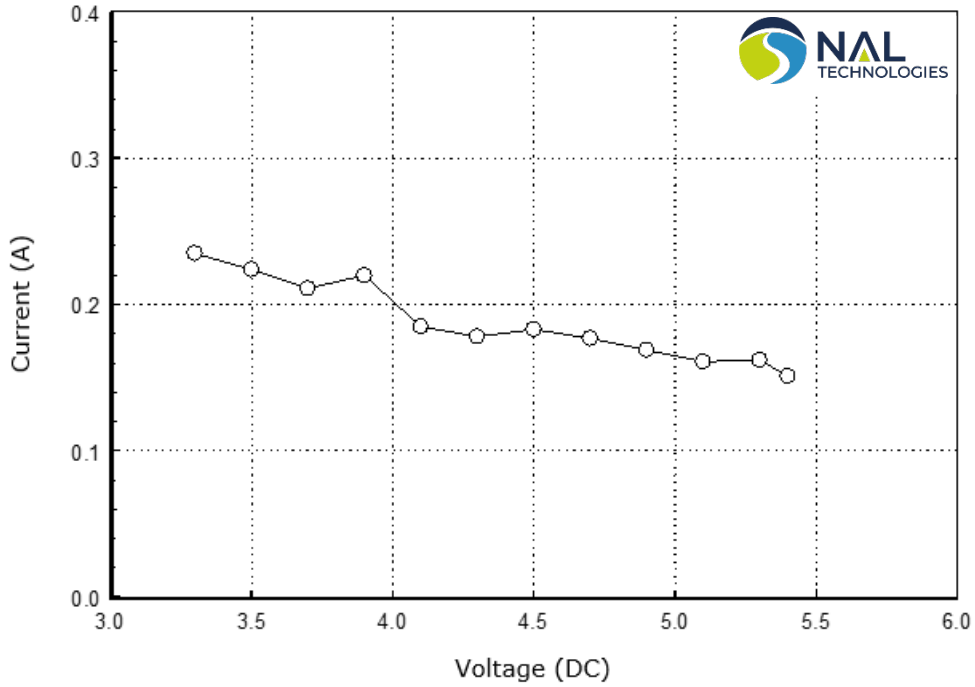

Figure 31: Average current during GPS acquisition (3 VDC to 5 VDC input)

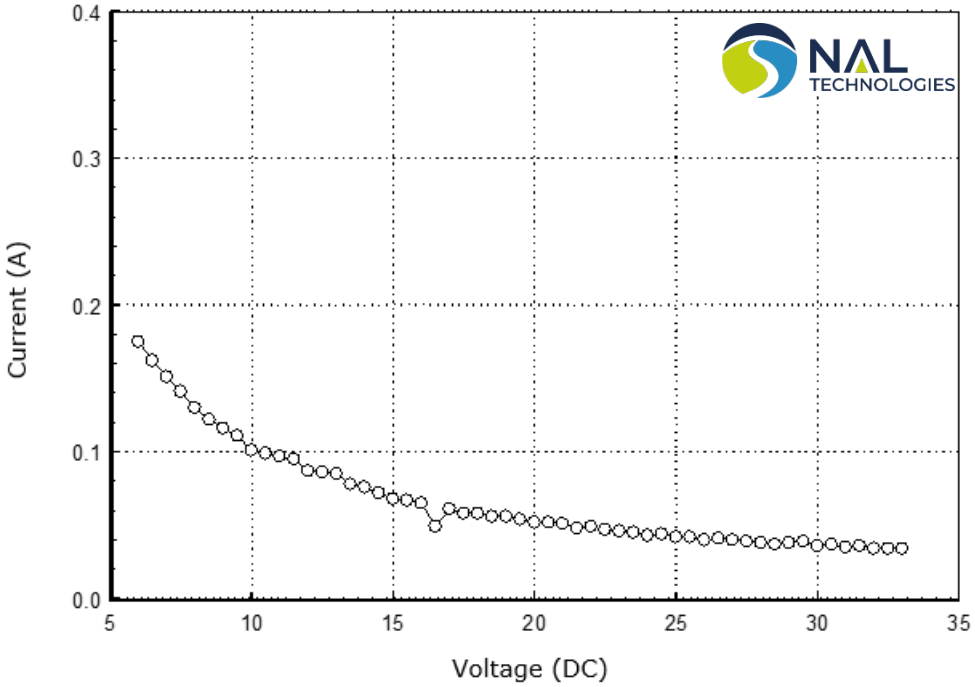

Figure 32: Average current during GPS acquisition (6 VDC to 32 VDC input)

Figure 33 shows 9602-LP's average power consumption during GPS acquisition for the entire voltage range.

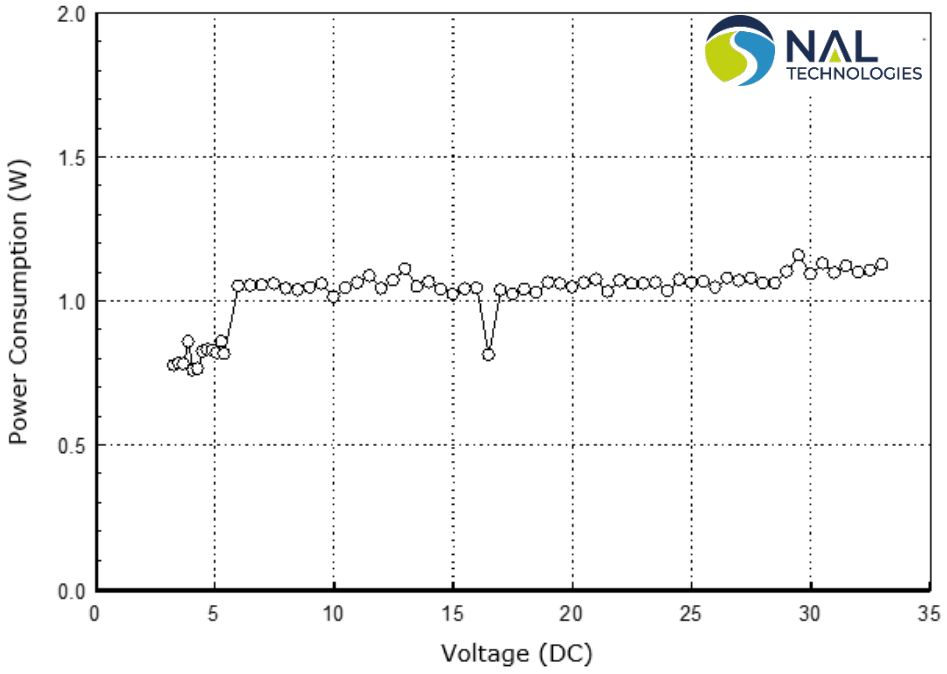

Figure 33: Average power consumption during GPS acquisition (3.5 VDC to 32 VDC input)

During the SBD transmission segment, the average current drawn by 9602-LP with 3.6 VDC–5 VDC input and 6 VDC–32 VDC are shown in **Figure 34** and **Figure 35**, respectively.

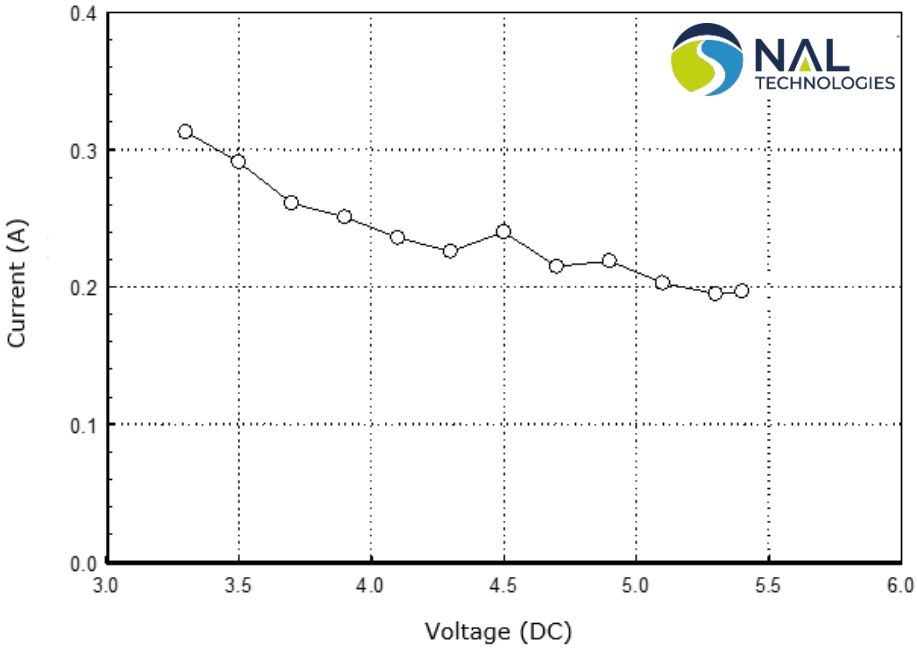

Figure 34: Average current during SBD (3 VDC to 6 VDC input)

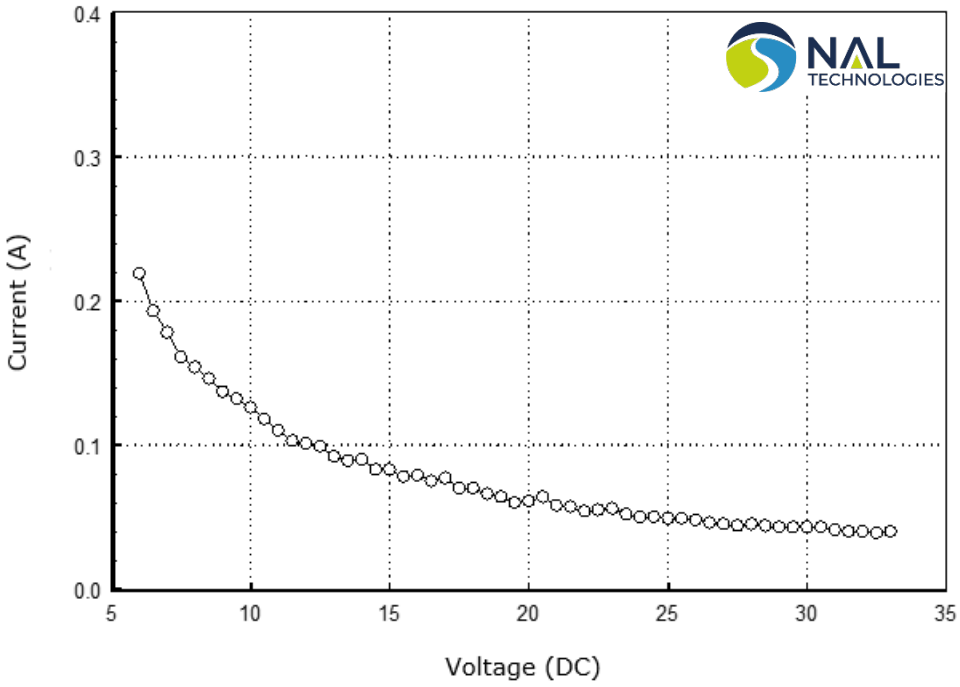

Figure 35: Average current during SBD (6 VDC to 32 VDC input)

Figure 36 shows 9602-LP's average power consumption during SBD transmission on for the entire voltage range.

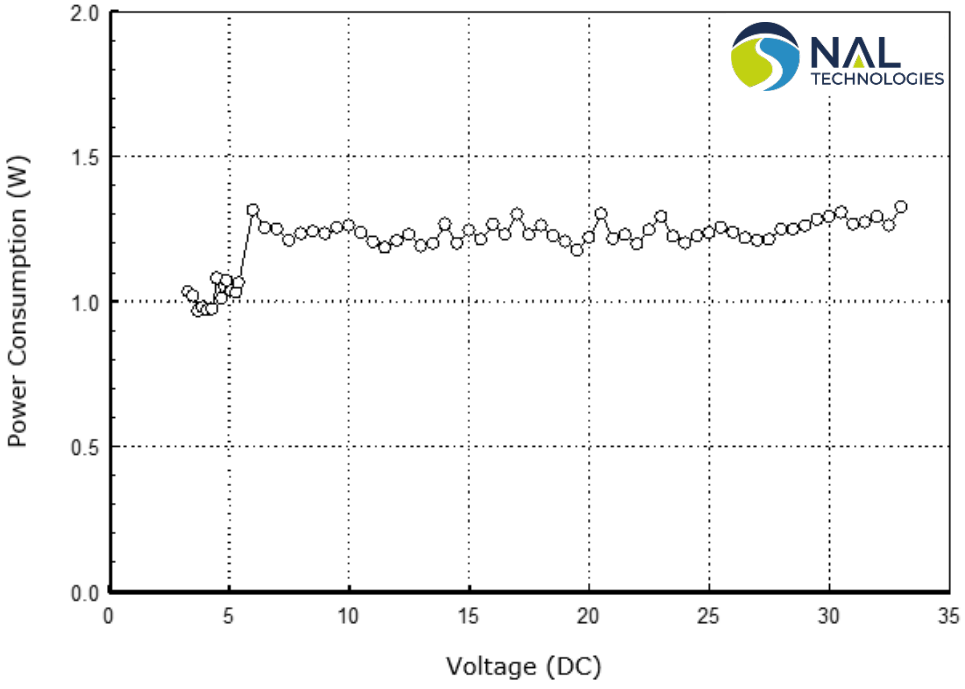

Figure 36: Average power consumption during SBD transmission (3.5 VDC to 32 VDC input)

All the plots above show that 9602-LP is more efficient (consumes less power) when it operates in the 3.6 VDC to 5.3 VDC input range, especially in between reports. The actual current profiles may vary for a number of reasons; optimize your setup to attain the lowest possible power consumption.

Some setup parameters to be carefully observed include:

1) Have a clear view of the sky for both the GPS and Iridium antennas—poor visibility of the sky is when a clear line-of-sight is not available between 9602-LP and the satellites.
2) Keep the Iridium antenna's VSWR low—the higher the antenna VSWR, the higher the current consumed by 9602-LP.
3) Keep the antenna cables' loss to less than 3 dB—the higher the antenna cable loss, the higher the current consumed by 9602-LP.
4) Select active GPS antennas with low-power consumption LNAs—a GPS antenna LNA with 30 dB gain is sufficient.
5) Keep the power cable between 9602-LP and the power source as short as possible.

LIST OF KNOWN ISSUES

There are currently no known issues.

TECHNICAL SUPPORT

Naltec is committed to providing the highest level of service and support. If you have any questions or concerns, please feel free to contact us using the information at the bottom of this page. For self-help, please visit https://naltec.com/support-resources/.

Thank you for choosing Naltec!

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Support@Naltec.com | www.Naltec.com

APPENDIX A: STANDARD COMPLIANCE

The 9602 transceiver is designed to meet the regulatory requirements for approval by FCC, Canada, and CE, assuming an antenna with a gain of approx. 3 dBi and adequate shielding. The 9602 transceiver is tested to the regulatory and technical certifications shown below.

Table 3: Standards Compliance

Regulatory Approvals	Radio Tests	EMC Tests	Mechanical/ Electrical Tests
CE	ETSI EN 301 441 V1.1.1 (2000-05)	ETSI EN 301 489-1 V1.8.1 (2008-04) ETSI EN 301 489-20 V1.2.1 (2002-11)	EN60950–1:2006 Part 1
FCC	FCC CFR47 Parts 2, 15, and 25	EN61000-4-2: 1995/A2: 2001 Part 4.2 EN61000-4-3: 2002 Part 4.3 EN61000-4-4: 2004 EN61000-4-6: 1996/A1: 2001 Part 4.6 EN55022: 2006	
Industry Canada	Industry Canada RSS170 Issue 1, Rev 1, November 6, 1999		

APPENDIX B: EXPORT COMPLIANCE

9602-LP is controlled by the export laws and regulations of the United States of America (U.S.). It is the policy of Naltec to fully comply with all U.S. export and economic sanction laws and regulations. The export of Naltec products, services, hardware, software, and technology must be made only in accordance with the laws, regulations, and licensing requirements of the U.S. government. Naltec customers must also comply with these laws and regulations. Failure to comply can result in the imposition of fines and penalties, the loss of export privileges, and termination of your contractual agreements with Naltec.

The export and re-export of Naltec products and services are subject to regulation by the Export Administration Regulations (15 CFR 730-744), as administered by the U.S. Department of Commerce, Bureau of Industry and Security ("BIS"). See: https://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear for further information on BIS and the Export Administration Regulations (EAR). Additional export restrictions are administered by the U.S. Department of the Treasury's Office of Foreign Asset Controls ("OFAC"). See: http://www.ustreas.gov/ofac for further information on OFAC and its requirements.

APPENDIX C: DESIGN SPECIFICATIONS

Mechanical Specifications

Dimensions:	2.73” L x 2.17” W x 0.94” D (69 mm x 55 mm x 24 mm)
Weight:	4.8 oz. (136 g)
Enclosure:	Hard anodized aluminum/EMI shielding Waterproof version of the enclosure is available (Model 9602-BTI)
Multi-Interface Connector:	15-Pin D-Sub
Iridium Antenna:	SMA female
GPS Antenna:	SMA female
OFF/ON Switch:	Push Button
Emergency Switch:	Guarded Button and/or External via Multi-Interface Connector
Status LED Displays:	Power, GPS, Iridium, SBD status and Emergency

Iridium RF Specifications

Operating Frequency:	1616 to 1626.5 MHz
Duplexing Method:	TDD
Input/Output Impedance:	50 Ω
Multiplexing Method:	TDMA/FDMA

Iridium Radio Characteristics

Average Power during a Transmit Slot (Max):	1.6W
Receiver Sensitivity at 50 (Typical):	–117 dBm
Maximum Cable Loss Permitted:	2 dB
Link Margin–Downlink:	13 dB
Link Margin–Uplink:	7dB

Electrical Specifications

Input Voltage Range:	+3.6 VDC to +5.3 VDC or +6.0 VDC to +32 VDC
Main Input Voltage Ripple:	< 40 mV peak-to-peak
Transmit Current (Average):	200 mA @ 5 VDC
Transmit Current (Peak):	1.5 A @ 5 VDC
Receive Current (Average):	45 mA @ 5 VDC
Receive Current (Peak):	195 mA @ 5 VDC
Message Transfer Power (Average):	<= 1.0W @ 5 VDC
Current in Between Reports:	Less than 65 µA @ 5 VDC
Power Input Type:	DC power or Li-ion battery

NOTE: The DC power requirement was measured at the 9602-LP multi-interface connector and not at the DC power supply. Take into account voltage drop across the power supply cable to ensure adequate current provided to 9602-LP during SBD sessions. If input voltage does not stay above 3.0 VDC during surge or high current demand, 9602-LP will reset itself.

NOTE: The average current drawn during transmission may vary depending on the field-of-view between the 9602-LP antenna and the Iridium satellite, the type of Iridium antenna used, and the cable loss.

Environmental Specifications

Operating Temperature Range:	–40°F to +185°F (–40°C to +85°C)
Operating Humidity Range:	≤ 75% RH
Storage Temperature Range:	–40°F to +185°F (–40°C to +85°C)
Storage Humidity Range:	≤ 93% RH

NOTE: Operating temperature range based on a duty-cycled usage model with the stand-alone 9602 transceiver sending one SBD message per hour and is otherwise turned off during the hour.

Data I/O Specifications

Short-Burst Data Mobile-Originated:	340 bytes per message
Short-Burst Data Mobile-Terminated:	270 bytes per message
Hardware Interface:	3-Wire RS232
Software Interface:	AT commands

Related Hardware

Antennas:	SYN7391 Series, SAF2040 Series, SAF5340 Series, SAF5350 Series, SAF4070-IG, SAF7352-IG and SAF5270-G
AC Power Adapter:	LA-3098 (100–240VAC, 47–60Hz input)
Car Adapter:	LA-7021 (12VDC car battery input)
Power Cable:	HRC-24-12, HRC-24-12A

APPENDIX D: GPS PERFORMANCE DATA

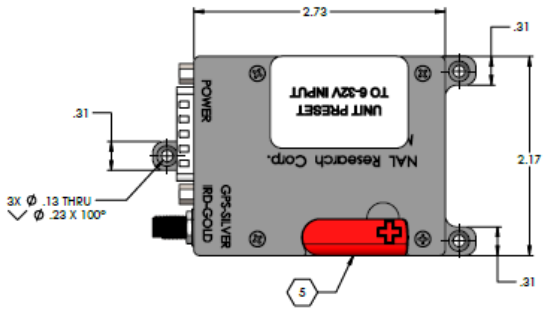
Type of GPS Receiver:	NEO-6Q from u-blox AG
Receiver Type:	L1 frequency C/A code 50-Channel SBAS: WAAS, EGNOS, MSAS, GAGAN
Update Rate:	5 Hz
Accuracy:	Position: 8.2 feet (2.5 meters) CEP Position DGPS/SBAS: 6.6 feet (2.0 meters) CEP
Acquisition (typical):	Hot starts: 1 second Aided starts: 1 second Warm starts: 28 seconds Cold starts: 28 seconds
Sensitivity:	Tracking: –160 dBm Reacquisition: –160 dBm Cold starts: –147 dBm
Operational Limits:	COCOM restrictions apply Altitude: 164,000 feet (50,000 meters) Velocity: 1,640 feet/sec (500 m/sec) One of the limits may be exceeded but not both

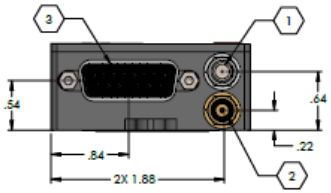
As long as power is provided to 9602-LP, the GPS receiver stores ephemeris data in its memory before turning off (sleeping between reports). The ephemeris data is valid up to 2 hours and can be used in future startup to improve time-to-first fix. Unlike 9601-DGS-LP, 9602-LP does not need an extra backup battery to retain ephemeris data.

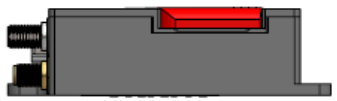
NOTES:

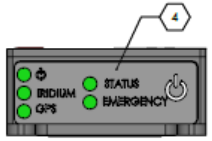
1. GPS ANTENNA PORT SMA FEMALE (SILVER)
2. IRIDIUM ANTENNA PORT SMA FEMALE (GOLD)
3. DATA / POWER PORT DB15 MALE
4. LED STATUS / POWER PANEL
5. EMERGENCY SWITCH COVER

REVISION SYMBOL: X				
ZONE	REV.	DESCRIPTION	DATE	CHANGED BY
	F	ECN-HW-0061	03/19/24	RLB

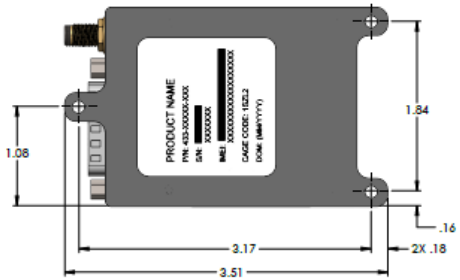








DB15 PIN	SIGNAL
1	VIN 5V
2	GND
3	RS232 TX(INPUT)
4	RS232 RX (OUTPUT)
5	GND
6	PIC16 PGC/EMER SW
7	TLL OUT 1
8	TLL OUT2
9	VIN 6-32V
10	SPARE
11	SPARE
12	TLL IN 1
13	TLL IN2
14	TLL IN 3
15	TLL OUT 3



		UNLESS OTHERWISE SPECIFIED INTERPRET DIMENSIONS AND TOLERANCES IN ACCORDANCE WITH ASME Y 14.5 2018. INTERPRET DRAWING IN ACCORDANCE WITH ASME Y14.100.	UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS PROPERTY. DO NOT DISCLOSE TO OR DUPLICATE FOR OTHERS WITHOUT EXPRESS WRITTEN CONSENT.	NAL TECHNOLOGIES
			TOLERANCES	APPROVALS DATE	DESCRIPTION: PRODUCT SPECIFICATION, 9602-LP
NONE	9602-LP		FRACTIONAL ± 1/4" ANGULAR ± 0.5 ONE PLACE DECIMAL ± .03 TWO PLACE DECIMAL ± .012 THREE PLACE DECIMAL ± .005	ENGINEER M.TIWARI 3/18/2004	
NEXT ASSY	PROJECT			CHECKED R. BAUGHMAN 3/19/2004	SIZE C | CAGE CODE 1SZL2 | DWG. NO. 433-92750-001-SPEC | REV F
APPLICATION		THIRD ANGLE PROJECTION	DO NOT SCALE DRAWING	APPROVED R. BAUGHMAN 3/19/2004	SCALE: 5:4 | SHEET 1 OF 1