

# ST100

## USER MANUAL



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# TABLE OF CONTENTS

|                                                                               |           |
|-------------------------------------------------------------------------------|-----------|
| <b>LIST OF TABLES .....</b>                                                   | <b>V</b>  |
| <b>LIST OF FIGURES .....</b>                                                  | <b>V</b>  |
| <b>1. INTRODUCTION .....</b>                                                  | <b>1</b>  |
| 1.1. PURPOSE .....                                                            | 1         |
| 1.2. APPLICABLE DOCUMENTS .....                                               | 1         |
| 1.2.1. Globalstar Documents .....                                             | 1         |
| 1.2.2. External References .....                                              | 1         |
| 1.3. DESCRIPTION .....                                                        | 1         |
| 1.4. CERTIFICATIONS .....                                                     | 2         |
| <b>2. APPLICATION .....</b>                                                   | <b>3</b>  |
| 2.1. THEORY OF OPERATION FOR GLOBALSTAR COMMERCIAL IoT.....                   | 3         |
| 2.2. ST100 FUNCTIONAL STATES .....                                            | 5         |
| 2.2.1. Pre-operational states.....                                            | 5         |
| 2.2.1.1. Configuration mode.....                                              | 5         |
| 2.2.1.2. Staged for activation mode .....                                     | 5         |
| 2.2.1.3. Activating mode.....                                                 | 5         |
| 2.2.1.3.1. Activation mode - line powered, alternative forced activation..... | 6         |
| 2.2.2. Operational states.....                                                | 6         |
| 2.2.2.1. Normal operation.....                                                | 6         |
| 2.2.2.2. Low battery operation.....                                           | 6         |
| 2.2.2.3. Extreme low battery suspend .....                                    | 6         |
| 2.2.3. End of life.....                                                       | 7         |
| 2.3. BLOCK DIAGRAM .....                                                      | 7         |
| 2.4. HANDLING OF ELECTROSTATIC SENSITIVE DEVICES .....                        | 8         |
| 2.5. WIRING .....                                                             | 8         |
| 2.6. NOISE SOURCES.....                                                       | 8         |
| 2.7. NORDIC PROCESSOR UNUSED PINS.....                                        | 8         |
| 2.8. OBSTRUCTIONS.....                                                        | 8         |
| 2.9. PCB ANTENNA.....                                                         | 8         |
| 2.10. EXTERNAL CONNECTIONS.....                                               | 9         |
| 2.10.1. External Antenna Option.....                                          | 9         |
| 2.10.2. Battery.....                                                          | 9         |
| 2.10.3. Solar Panel .....                                                     | 10        |
| 2.10.4. 14 Pin Connector.....                                                 | 11        |
| 2.11. POWER PERFORMANCE CHARACTERISTICS.....                                  | 12        |
| 2.12. ACCELEROMETER .....                                                     | 13        |
| 2.12.1. Factory Hardware Configuration.....                                   | 13        |
| 2.12.1.1. Proprietary Motion Activated Track .....                            | 13        |
| 2.12.2. Custom Hardware Configuration.....                                    | 13        |
| <b>3. GENERAL SPECIFICATIONS.....</b>                                         | <b>14</b> |

|                                                   |           |
|---------------------------------------------------|-----------|
| <b>4. APPLICATION PROGRAMMING INTERFACE .....</b> | <b>15</b> |
| 4.1. ASCII COMMAND LIST AND FORMAT .....          | 17        |
| 4.1.1. ASCII Format.....                          | 17        |
| 4.1.1.1. “?” .....                                | 17        |
| 4.1.1.2. “abort” .....                            | 17        |
| 4.1.1.3. “auth” .....                             | 18        |
| 4.1.1.4. “bursts” .....                           | 18        |
| 4.1.1.5. “ctrack” .....                           | 18        |
| 4.1.1.6. “data” .....                             | 18        |
| 4.1.1.7. “dldump” .....                           | 19        |
| 4.1.1.8. “esn” .....                              | 19        |
| 4.1.1.9. “fgd” .....                              | 19        |
| 4.1.1.10. “firmware” .....                        | 19        |
| 4.1.1.11. “gadgdata” .....                        | 20        |
| 4.1.1.12. “gdvlife” .....                         | 20        |
| 4.1.1.13. “ggeoframe” .....                       | 20        |
| 4.1.1.14. “ghwdetail” .....                       | 20        |
| 4.1.1.15. “glbatrate” .....                       | 21        |
| 4.1.1.16. “glgps” .....                           | 21        |
| 4.1.1.17. “gopmode” .....                         | 21        |
| 4.1.1.18. “gpspgdump” .....                       | 22        |
| 4.1.1.19. “gpssnap” .....                         | 22        |
| 4.1.1.20. “gpstdump” .....                        | 22        |
| 4.1.1.21. “gtrackst” .....                        | 23        |
| 4.1.1.22. “guid” .....                            | 23        |
| 4.1.1.23. “hardware” .....                        | 23        |
| 4.1.1.24. “hwversion” .....                       | 23        |
| 4.1.1.25. “peek” .....                            | 24        |
| 4.1.1.26. “qreset” .....                          | 24        |
| 4.1.1.27. “raw” .....                             | 24        |
| 4.1.1.28. “reboot” .....                          | 24        |
| 4.1.1.29. “runpost” .....                         | 25        |
| 4.1.1.30. “setup” .....                           | 25        |
| 4.1.1.31. “sgactskip” .....                       | 26        |
| 4.1.1.32. “sgadprfx” .....                        | 26        |
| 4.1.1.33. “sgbattemp” .....                       | 26        |
| 4.1.1.34. “sgblepar” .....                        | 27        |
| 4.1.1.35. “sghltint” .....                        | 28        |
| 4.1.1.36. “sglogpar” .....                        | 28        |
| 4.1.1.37. “sgvltlmts” .....                       | 29        |
| 4.1.1.38. “slbatrate” .....                       | 29        |
| 4.1.1.39. “track” .....                           | 29        |
| 4.1.1.40. “vbatt” .....                           | 29        |
| 4.2. BINARY SERIAL PACKET COMMANDS .....          | 30        |
| 4.2.1. Serial Packet Format.....                  | 30        |

|                                                                                       |    |
|---------------------------------------------------------------------------------------|----|
| 4.2.2. Serial Packet Command List .....                                               | 30 |
| 4.2.2.1. Send Data (0x00) .....                                                       | 31 |
| 4.2.2.2. Query Electronic Serial Number (ESN) (0x01) .....                            | 31 |
| 4.2.2.3. Abort Transmission (0x03) .....                                              | 31 |
| 4.2.2.4. Query Bursts Remaining (0x04) .....                                          | 32 |
| 4.2.2.5. Query Firmware Version (0x05) .....                                          | 32 |
| 4.2.2.6. Setup (0x06) .....                                                           | 32 |
| 4.2.2.7. Query Setup (0x07) .....                                                     | 33 |
| 4.2.2.8. Query Hardware Version (0x09) .....                                          | 34 |
| 4.2.2.9. Set GPS Timeout command .....                                                | 35 |
| 4.2.2.10. Get GPS Timeout query .....                                                 | 35 |
| 4.2.2.11. "SPOT GEN3 emulation" .....                                                 | 35 |
| 4.2.2.12. Special consideration for "Byte 7" in the next several commands .....       | 36 |
| 4.2.2.13. "Proprietary Track" command .....                                           | 36 |
| 4.2.2.14. "Proprietary Motion Activated Track" command .....                          | 38 |
| 4.2.2.15. "Update Proprietary Track Data" command .....                               | 39 |
| 4.2.2.16. "Cancel Proprietary Track/Proprietary Motion Activated Track" command ..... | 40 |
| 4.2.2.17. "Proprietary Track Status" query .....                                      | 41 |
| 4.2.2.18. "Tracking Statistics" query .....                                           | 42 |
| 4.2.2.19. "GPS Statistics" query .....                                                | 43 |
| 4.2.2.20. "Transmitter Statistics" query .....                                        | 44 |
| 4.2.2.21. "Set Accelerometer On/Off" Command .....                                    | 44 |
| 4.2.2.22. Accelerometer On/Off Query .....                                            | 45 |
| 4.2.2.23. "Send Redundant Burst with GPS" command .....                               | 45 |
| 4.2.2.24. "Query Location" command .....                                              | 47 |
| 4.2.2.25. "Set Lifetime" command .....                                                | 48 |
| 4.2.2.26. "Query Lifetime Status" command .....                                       | 49 |
| 4.2.2.27. "Set Minimum Track Rate" command .....                                      | 49 |
| 4.2.2.28. "Query Minimum Track Rate" .....                                            | 50 |
| 4.2.2.29. "Suspend/Unsuspend" command .....                                           | 51 |
| 4.2.2.30. Suspended State query .....                                                 | 51 |
| 4.2.2.31. "Set Low Battery Rate" command .....                                        | 52 |
| 4.2.2.32. "Query Low Battery Rate" .....                                              | 52 |
| 4.2.2.33. "Turn On GPS" command .....                                                 | 53 |
| 4.2.2.34. "Turn Off GPS" command .....                                                | 53 |
| 4.2.2.35. "Turn On GPS Pass-through" command .....                                    | 54 |
| 4.2.2.36. "Turn Off GPS Pass-through" command .....                                   | 55 |
| 4.3. ST100 BOARD SELF-TEST COMMAND .....                                              | 56 |
| 4.4. HEALTH STATUS MESSAGING .....                                                    | 57 |
| 4.5. BOOTLOADING. FIELD UPDATE OF DEVICE FIRMWARE .....                               | 58 |
| 4.5.1. Nordic Nrf52832 Firmware Update Via Bootloader ("Buttonless" DFU) .....        | 58 |
| 4.5.2. On Ax50324 Firmware Update Via Serial Bootloader .....                         | 58 |
| 4.5.2.1. 0x60 "Enter Bootloader Command" .....                                        | 58 |
| 4.5.2.2. 0x61 "Flash One Line" .....                                                  | 59 |
| 4.5.2.3. 0x62 "Enter Application" .....                                               | 60 |

|                                                                                   |           |
|-----------------------------------------------------------------------------------|-----------|
| 4.5.2.4. 0x63 “Status Query” .....                                                | 61        |
| 4.5.3. JTAG Programming Kit .....                                                 | 62        |
| 4.5.4. Nordic low-level load via JTAG.....                                        | 62        |
| 4.5.5. On AX50324 Low-Level Load Via AXSEM Proprietary Programming Interface..... | 62        |
| 4.6. EXAMPLE CRC CALCULATION ROUTINES FOR SERIAL PACKETS .....                    | 62        |
| 4.7. 24-BIT LOCATION FORMAT .....                                                 | 65        |
| 4.7.1. Calculating Latitude .....                                                 | 65        |
| 4.7.2. Calculating Longitude .....                                                | 65        |
| 4.8. FLASH MEMORY MAP .....                                                       | 66        |
| <b>5. TEST MODES.....</b>                                                         | <b>69</b> |
| 5.1. HARDWIRED METHOD .....                                                       | 69        |
| 5.2. SOFT COMMAND METHOD.....                                                     | 70        |
| 5.2.1. Step 1: Enable the regulatory test modes. ....                             | 70        |
| 5.2.2. Step 2: Set the channel that you wish to perform the test on. ....         | 70        |
| 5.2.3. Step 3: Start the desired mode. ....                                       | 70        |
| 5.2.4. Step 4: Disable the test commands. ....                                    | 71        |
| 5.2.5. Step 5: Restore the desired setup.....                                     | 71        |
| <b>6. ANTENNA TUNING GUIDANCE .....</b>                                           | <b>72</b> |
| 6.1. POWER REQUIREMENTS FOR AN EXTERNAL ANTENNA TO MAINTAIN SPECIFIED EIRP.....   | 72        |
| 6.2. GPS / SATELLITE ANTENNA TUNING.....                                          | 73        |
| 6.3. BLUETOOTH ANTENNA TUNING .....                                               | 78        |
| <b>7. GLOBALSTAR CERTIFICATION PROCESS FOR CUSTOMER PRODUCTS.....</b>             | <b>79</b> |
| <b>8. GENERAL WARNINGS .....</b>                                                  | <b>80</b> |
| <b>9. REGULATORY .....</b>                                                        | <b>81</b> |
| <b>10. ACRONYM LIST .....</b>                                                     | <b>84</b> |

## LIST OF TABLES

---

|                                                             |    |
|-------------------------------------------------------------|----|
| Table 1 - Nominal Battery Characteristics.....              | 10 |
| Table 2 - Nominal Solar Panel Characteristics .....         | 10 |
| Table 3 - 14 pin Connector (Molex 5034801400) .....         | 11 |
| Table 4 - LP503035, 3.7V, 500mAh, Li-Polymer Battery.....   | 12 |
| Table 5 - LP552535, 3.7V, 420mAh, Li-Polymer Battery.....   | 12 |
| Table 6 - DTP401525, 3.7V, 110mAh, Li-Polymer Battery ..... | 12 |
| Table 7 - Operating Conditions.....                         | 14 |
| Table 8 - Operating Modes & Standby Currents.....           | 38 |
| Table 9 - ST100 Test Modes .....                            | 69 |
| Table 10 - ST100 Channels.....                              | 69 |
| Table 11 - External Antenna Power Requirements.....         | 72 |

## LIST OF FIGURES

---

|                                            |    |
|--------------------------------------------|----|
| Figure 1 - Board Physical Dimensions.....  | 2  |
| Figure 2 - LEO Constellation .....         | 3  |
| Figure 3 - Simplex Messaging .....         | 3  |
| Figure 4 - ST100 Block Diagram.....        | 7  |
| Figure 5 - ST100 External Connections..... | 9  |
| Figure 6 - Serial Packet Format.....       | 30 |
| Figure 7 - Nordic Memory Map.....          | 66 |
| Figure 8 - Flash Layout Diagram.....       | 68 |

# 1. INTRODUCTION

## 1.1. PURPOSE

This document describes the physical, electrical, and functional characteristics of the ST100 satellite transmitter module with Bluetooth Low Energy. The information contained in this document is intended to provide the VAR/Integrator with the necessary technical information required to configure and use the module in a custom application.

This document is intended to be used by engineers and technical management and assumes a general knowledge of basic engineering practices by the user. **NOTE:** Globalstar is only responsible for ensuring that the ST100 Module meets the published manufacturing specifications described herein.

## 1.2. APPLICABLE DOCUMENTS

### 1.2.1. GLOBALSTAR DOCUMENTS

GS-07-1248 - REMOTE TELEMETRY SERVICE FREQUENCY PLAN FOR SIMPLEX TRANSMITTERS

GS-07-1247 - REMOTE TELEMETRY SERVICE SIMPLEX ANTENNA SPECIFICATION AND TEST PROCEDURE

GS-02-0795 - REMOTE SIMPLEX TELEMETRY SYSTEM DESCRIPTION AND APPLICATION NOTE

GS-09-3102 - GLOBALSTAR EQUIPMENT EVALUATION APPLICATION FOR REMOTE TRANSMITTER UNIT

8545-0195-01 - ST100 APP USER GUIDE

8545-0196-01 - GLOBALSTAR ST100 PRODUCT SUBMISSION GUIDE

8545-0197-01 - ST100 QUICK START GUIDE (QSG)

### 1.2.2. EXTERNAL REFERENCES

Wikipedia article on Intel Hex format: [https://en.wikipedia.org/wiki/Intel\\_HEX](https://en.wikipedia.org/wiki/Intel_HEX)

NMEA-0183 rev. 3.0 Specification

FCC Guidance for Use of Radio Modules KDB 996369 D03 & D04

- Nordic Programmer (Segger):  
<https://www.digikey.com/product-detail/en/segger-microcontroller-systems/8-08-00-J-LINK-BASE/899-1004-ND/2175882>
- ASIC Programmer (On Semi):  
<https://www.digikey.com/product-detail/en/on-semiconductor/AXDBG-2-GEVK/AXDBG-2-GEVK-ND/5820231>

## 1.3. DESCRIPTION

The ST100 board is a simplex Satellite transmitter designed to send small packets of user defined data to a network of low earth orbiting (LEO) satellites using the Globalstar commercial IoT network. The received data is then forwarded to a user defined network interface that may be in the form of an FTP host or HTTP host where the user will interpret the data for further processing. The ST100 board must be powered by a battery, or line-powered by a DC source. The ST100 Board features a solar charging circuit that allows battery charging from an attached solar panel. The unit will not power from a solar panel alone, without a battery. The ST100 board contains a satellite transmitter, GPS receiver, motion sensor, Bluetooth Low Energy transceiver, solar charger, and printed circuit antennas for each of the radio subsystems. The ST100 board has u.FL connectors on the outputs of the Bluetooth transceiver and GPS receiver / satellite transmitter, which give the user the option to use external antennas.

The ST100 board also has the option for the user to use an external serial port.

Under VAR setup and configuration, and normal use by the end user, communication with the device is via a Bluetooth Low Energy (BLE) GATT/Modem interface with a mixture of ASCII and binary command/query protocols. The ST100 PCB weighs ~6.2g (with shield, no battery, no solar panel), with the dimensions shown below:

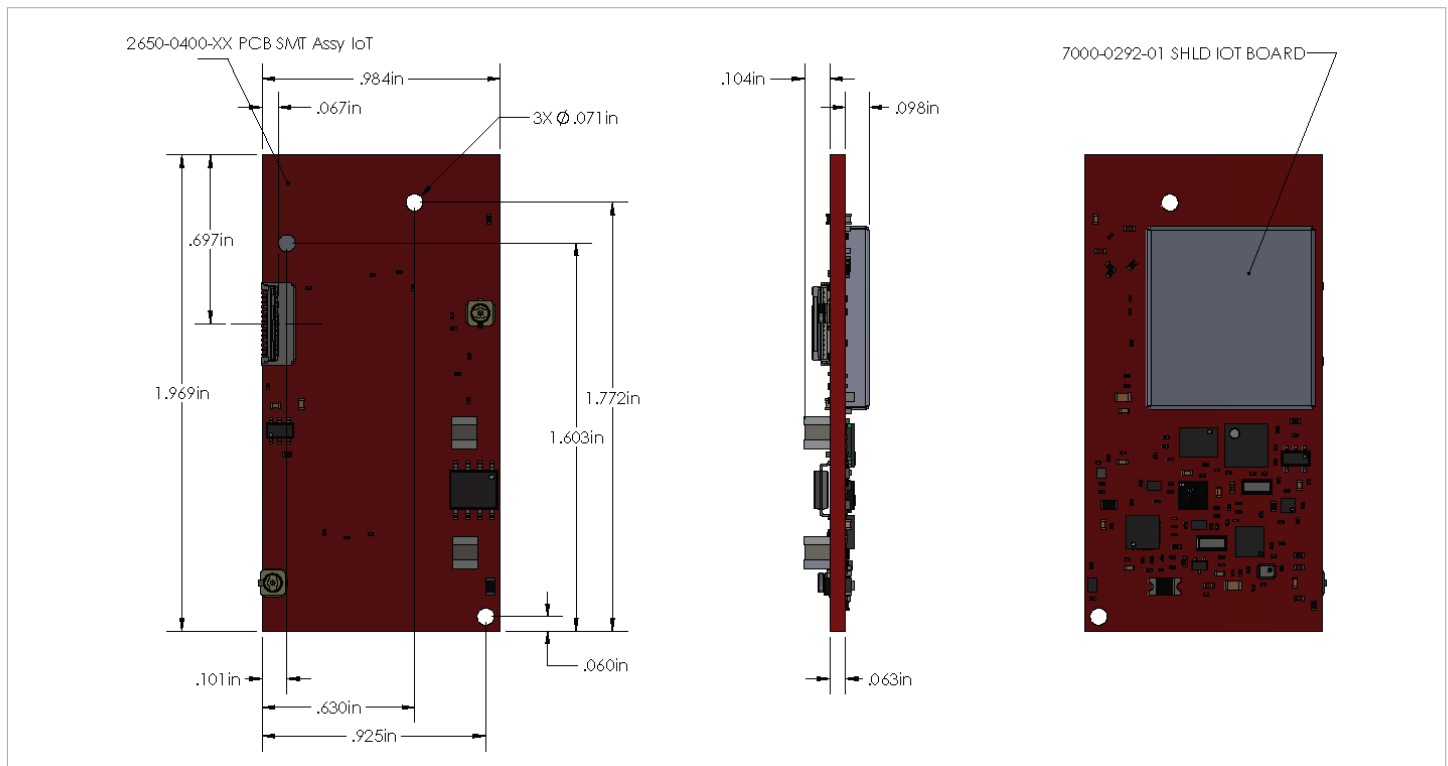


FIGURE 1 - BOARD PHYSICAL DIMENSIONS

## 1.4. CERTIFICATIONS

Our products comply with WEEE and RoHS. The ST100 has the following certifications:

- Bluetooth LE
- FCC
- ISED
- CE RED

## 2. APPLICATION

### 2.1. THEORY OF OPERATION FOR GLOBALSTAR COMMERCIAL IoT

The ST100 Board operates on the Globalstar LEO satellite network. LEO (Low Earth Orbit) means that there are a number of satellites in low earth orbit that constantly orbit the planet and can communicate with Globalstar devices that are within range of its current position.



FIGURE 2 - LEO CONSTELLATION

Because the satellite position is constantly changing, commercial IoT devices on the ground will transmit (with no knowledge of any of the satellites locations) and the transmission may be received by one or more satellites. These satellites will then relay the message to the nearest satellite gateway (Figure 3). Once received by the satellite gateway, the simplex message will be delivered to the simplex gateway where redundant messages are discarded and the data from the message is sent to the OEM via the Internet.

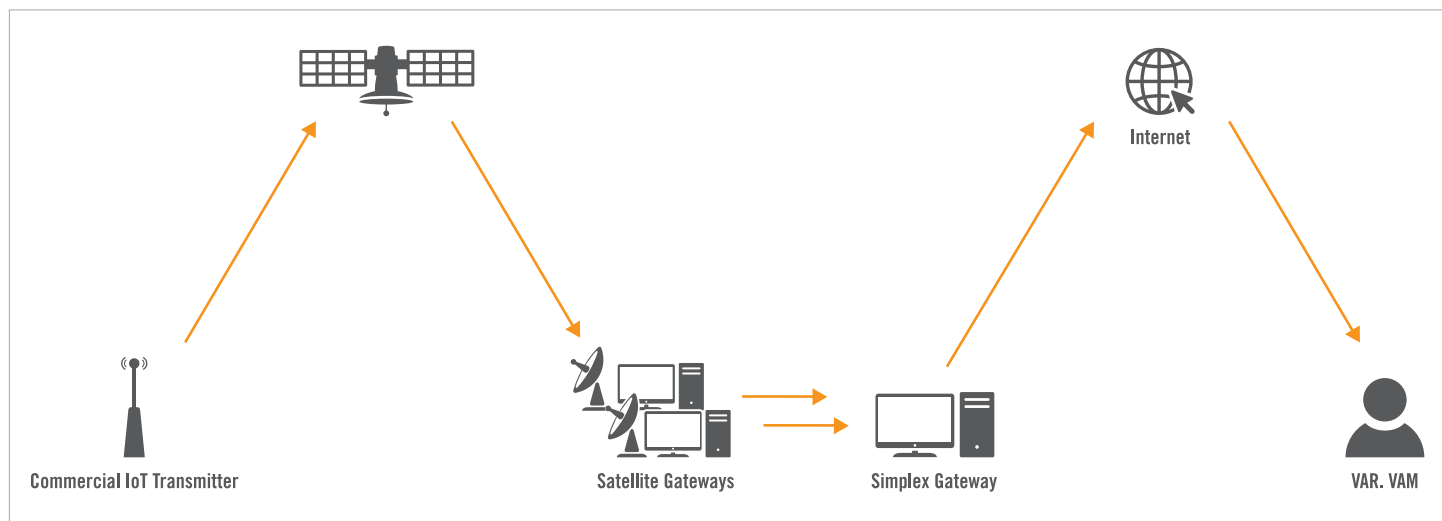


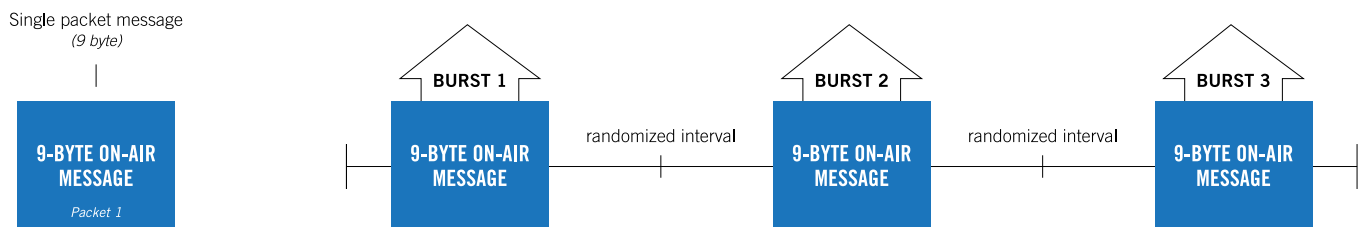
FIGURE 3 - SIMPLEX MESSAGING

Messages are composed of 1 or more 9-byte payloads. The user application may send a message via the Bluetooth Low Energy interface to the ST100 board from 1 to 144 bytes in length. The ST100 board will break the message into 9 byte packets. A 144 byte message would be divided into 16 packets.

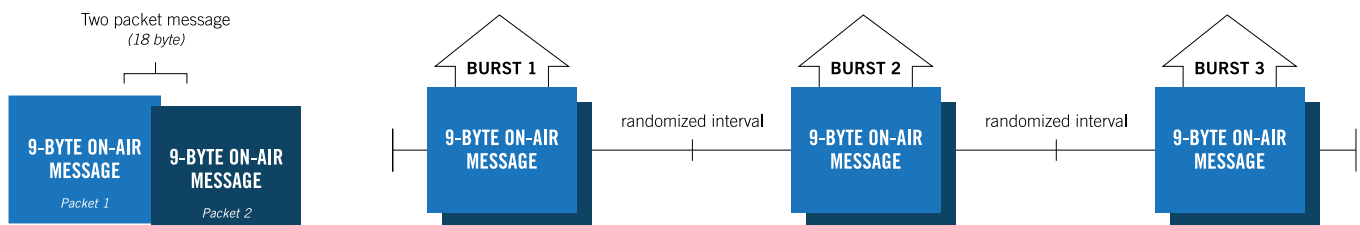


There are brief periods of time where there is no satellite in range of the commercial IoT transmitters due to obstructions and/ or satellite coverage geometry. Since a commercial IoT device has no way of knowing if a transmitted message has been successfully received, the ST100 Board is designed to send multiple (redundant) transmissions for each message sent over the Globalstar network.

The default value for the number of redundant transmissions per message is 3. This means that each message sent to the ST100 Board will normally be transmitted 3 times. Each transmission will contain the exact same data payload. The redundant transmissions of each message will be sent on a randomized interval with a configurable maximum and minimum duration. The default re-transmission configuration occurs between 5 to 10 minutes apart for each even randomized distribution. The transmission sequence for a single-packet message using the default setting of 3 redundant transmissions is shown below.



The transmission sequence for a two-packet message using the default setting of 3 redundant transmissions is shown below.



For normal conditions where the transmitter has an open view of the sky, this will result in a better than 99% chance that the message will be received.

## 2.2. ST100 FUNCTIONAL STATES

Over the ST100's lifetime, it transitions through the following states.

### 2.2.1. PRE-OPERATIONAL STATES

Note that these states are conceptual, rather than hard “states” that the device can be commanded to be in directly. They are defined by events that have occurred prior to the device becoming fully operational.

#### 2.2.1.1. Configuration mode

This describes the state in which the unit leaves the factory. No operational profile and no lifetime have been programmed into it. The unit's solar panel has not been uncovered and the battery has not been allowed to charge. The VAR transitions the unit to be staged for activation mode by setting a lifetime and a profile into the unit, as described in the section below.

#### 2.2.1.2. Staged for activation mode

The device is considered to be in staged for activation mode when the following things have been programmed.

- Device lifetime in months.
- A reporting profile: This is set using the “track” command. (See section on ASCII commands). The track command takes arguments for the reporting interval in minutes, and the values of the user programmable bytes (bytes 0, 7, and 8) of the on-air message.
- Optional: GPS fix timeout. The unit comes from the factory with a GPS fix timeout of 4 minutes. Note, this is the MAXIMUM time it will attempt to obtain a GPS fix before giving up for that report cycle. If a fix is obtained in less time (about 40 seconds is typical with a good view of the sky) the unit will de-power the GPS as soon as a fix is obtained. Leaving this value at the factory default of 4 minutes is strongly recommended for GPS reliability.
- Optional: A low battery report rate. This is the report rate the ST100 drops to when the battery voltage is below 3.6 volts. The unit is shipped from the factory with this value set to 24 hours (one transmission per day). If the VAR desires a different value here, it may be set via the “slbrate” command.
  - Note, the low battery rate MUST be greater than the normal rate. If, for example, the VAR intends to set the normal reporting rate to 24 hours (via the “track” command) he must first set the low battery rate to greater than 24 hours, and then issue the track command. While not required, it is recommended that the low battery rate be a multiple of the normal track rate. For example, a common configuration is to set the track rate to 6 hours and the low battery rate to 24 hours (4 times the track rate).

#### 2.2.1.3. Activating mode

The unit enters this mode when it detects that the unit is apparently in sunlight and the battery is charging, defined as a positive current flow into the battery for 5 consecutive minutes.

**NOTE: A minimum amount of sunlight may be required for the solar panel to begin charging the battery, in order to enter the activating mode. If sunlight is not available (cloudy day), the device can be commanded to enter the activating mode.**

Once charging of the battery is detected, the unit will attempt to obtain a GPS fix. If the fix is not obtained within the GPS timeout, the unit will sleep for 5 minutes and try again. This cycle will continue until a fix is successfully obtained. This cycle will “pause” if the battery level drops below 3.4 volts and resume after it has had some time to charge.

**NOTE:** If charging for 5 consecutive minutes is detected, the likelihood is extremely high that the unit is outside, and the GPS fix will be obtained on the first attempt. The retry cycle is an edge case exception in operation.

Once the unit obtains a GPS fix, it calculates its expiration date, based on the lifetime previously programmed, and enters operational mode.

#### **2.2.1.3.1. Activation mode - line powered, alternative forced activation**

For line powered units, the battery charging detection portion for this process can be skipped by issuing the “sgactskip” command during setup. If this command is issued, the GPS fix step below will commence when line power is applied. If you are unable to activate the ST100 (due to low sunlight conditions) bypass the activation algorithm to instantly activate the unit using the following steps: Note, this does not mean that the unit will start transmitting even if the battery is low. It will still stick to its power & temperature mode behaviors.

1. Login, connect to the device, and access the Diagnostics screen to enter commands (Full instructions on how to access the screen can be found in Section 4).
2. Skip the activation:
  - Send command “sgactskip 1 1”
3. Reboot the BLE processor:
  - Send command “reboot”
4. Verify the ST100 is in the Activated mode:
  - Send command “gopmode”

### **2.2.2. OPERATIONAL STATES**

These are the states the unit may be in after finishing “activating mode” described above.

#### **2.2.2.1. Normal operation**

The unit is in normal operation executing its track profile any time the battery voltage is above 3.6 volts.

#### **2.2.2.2. Low battery operation**

The unit will execute a track profile, but at the reduced “low battery” rate, when the battery voltage is below 3.6 volts but above 3.4 volts.

#### **2.2.2.3. Extreme low battery suspend**

When the battery voltage is below 3.4 volts, the unit will completely suspend operation, entering a “hibernate” state to allow the battery to charge.

### 2.2.3. END OF LIFE

When the unit auto activates, it calculates an end date based on its programmed lifetime. For example, if the lifetime is 3 years (36 months) and it activates on October 24, 2020, the expiration date will be October 24, 2023.

Each time the unit obtains a GPS fix, it checks the calendar date. If the date is past the expiration date (in this example, October 25, 2023) it immediately drops out of track mode and enters end of life mode.

Once the unit has entered end of life mode, it will respond to simple queries, such as a query for its version number or tracking state (which will be “none”), but it will NAK any command that might cause it to transmit over the Globalstar network, such as commands to put it back into a track mode or to send a custom message.

## 2.3. BLOCK DIAGRAM

The ST100 is configured at the factory to cutoff charging at temperatures below -30°C and above 85°C. These cutoff points are configurable via the “sgbatttemp” command over a range of -30°C to 85°C. **It is imperative that these temperatures match those recommended for the battery or a fire hazard could result!**

The battery fully charged voltage cutoff is 4.08 volts.

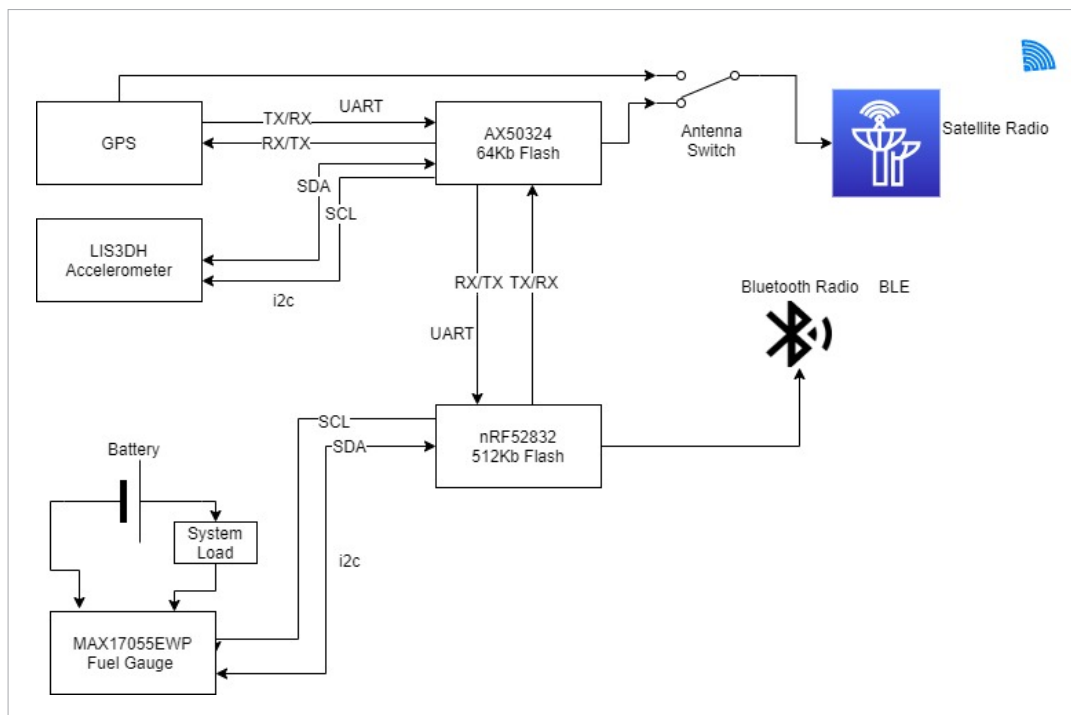


FIGURE 4 - ST100 BLOCK DIAGRAM

## 2.4. HANDLING OF ELECTROSTATIC SENSITIVE DEVICES

Some components on the ST100 PCB are sensitive to electrostatic discharge (ESD). The following general guidelines can help reduce damage due to ESD.

1. Use a grounding bracelet if possible, to minimize charge build-up on personnel.
2. Handle the ST100 PCB by the long edges without touching components or printed circuit paths. The long edges measure approximately 2" (50.8mm). The short edges measure approximately 1" (25.4mm). **NOTE:** There are ESD sensitive devices located closer to the short edges than the long edges.
3. Store the ST100 PCB in static sensitive packaging whenever possible.

**NOTE:** Failure to adhere to ESD guidelines will void the product warranty.

## 2.5. WIRING

If the ST100 will be line-powered, proper installation and field wiring practices are important to follow. Users and installers should familiarize themselves with the requirements of all applicable codes, laws, and standards.

## 2.6. NOISE SOURCES

Electrical noise is an important consideration in any installation of the ST100. When possible, sufficient physical separation should be maintained between electrical noise sources and the ST100.

## 2.7. NORDIC PROCESSOR UNUSED PINS

Due to its sensitivity to IR light, the Nordic processor is covered with opaque, light-blocking epoxy.

Tests have shown that if unused pins on the Nordic processor are set as input without internal pulldowns enabled, the epoxy will cause higher current draw in low power mode.

It is strongly advised to not leave unused Nordic pins at high impedance (input without internal pulldown).

## 2.8. OBSTRUCTIONS

If the internal ST100 Bluetooth and/or GPS/Satellite antennas are used, care should be taken as to what is placed above, below, and around the short edges of the PCB. The short edges are where the ST100 internal antennas are located. For best performance, the ST100 should have an unobstructed view of the sky, either outdoors or in a glass-enclosed area such as a vehicle dashboard.

## 2.9. PCB ANTENNA

**REGULATORY NOTE:** The ST100 was certified with its Satellite and Bluetooth PCB Trace antennas. Use of any external antenna will require additional regulatory testing.

## 2.10. EXTERNAL CONNECTIONS

The picture (below) depicts the PCB external interfaces.

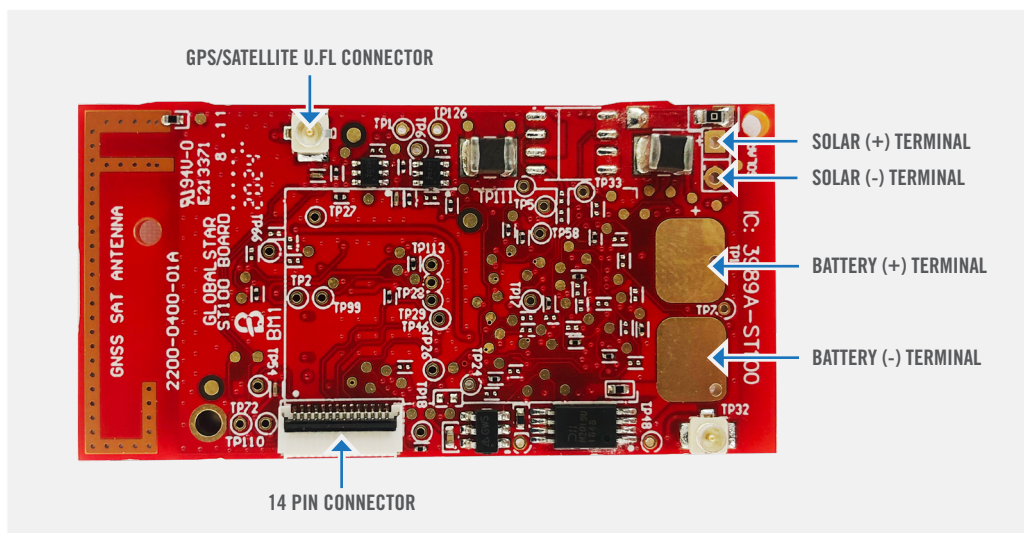


FIGURE 5 - ST100 EXTERNAL CONNECTIONS

### 2.10.1. EXTERNAL ANTENNA OPTION

The ST100 has provisions where an external antenna can be used on either the Bluetooth and/or the GPS/Satellite antennas. If an external antenna is used, care should be taken when connecting the external antenna to the u.FL connector - Hirose part # U.FL-R-SMT(10) on the ST100 PCB. If this option is desired, Globalstar needs to know before boards are ordered.

### 2.10.2. BATTERY

The ST100 has terminals on the PCB where a battery can be soldered to. The user / installer should carefully note the location of the positive and negative terminals marked on the PCB and solder the battery accordingly. It will be up to the user / installer to verify the power requirements (see Table 7 - Operating Conditions). **NOTE:** RoHS-compliant and lead-free solder must be used in order to maintain the RoHS-compliance of the ST100.

The ST100 can be powered in the following configurations:

1. Line powering with a 3.4V to 5.5VDC source to the battery terminals. The source must meet the requirements specified (see Table 7 - Operating Conditions).
2. Connecting a battery to the battery terminals and connecting a 0.75V to 5VDC source to the solar terminals. The source on the solar terminals must meet the requirements specified (see Table 7 - Operating Conditions).

**TABLE 1 - NOMINAL BATTERY CHARACTERISTICS**

| MANUFACTURER / PART #                          | DESCRIPTION              | PROTECTION CIRCUIT INCLUDED | IEC62133 APPROVALS | DIMENSIONS                   | NOTES                                                                                       |
|------------------------------------------------|--------------------------|-----------------------------|--------------------|------------------------------|---------------------------------------------------------------------------------------------|
| PK Cell part # LP503035                        | 3.7V, 500mAh, Li-Polymer | Yes                         | Yes                | 35 x 30 x 5mm<br>+/- 0.1mm   | Battery is normally stocked with a connector attached, but can be ordered without connector |
| PK Cell part # LP552535                        | 3.7V, 420mAh, Li-Polymer | Yes                         | No                 | 35 x 25 x 5.5mm<br>+/- 0.1mm | Battery is normally stocked with a connector attached, but can be ordered without connector |
| Data Power Technology Limited part # DTP401525 | 3.7V, 110mAh, Li-Polymer | Yes                         | No                 | 25 x 15 x 4mm<br>+/- 0.1mm   | Battery will only work down to 0°C                                                          |

**Notes:**

1. This list is not a complete list of acceptable batteries. These are batteries that Globalstar has identified and tested as acceptable.
2. The VAR/installer should review the pairing of solar panel/battery and determine if the solar panel is adequate for use with the selected battery.
3. If a battery is used, it will be the responsibility of the VAR/installer to verify the relevant battery approvals/certifications for where the end-product will be used (i.e. IEC62133 approval).
4. Due to the solar charger chip's 100mA max input current, the max recommended battery size is 500mAh.

**2.10.3. SOLAR PANEL**

The ST100 has terminals on the PCB where a solar panel can be soldered to. The user/installer should carefully note the location of the positive and negative terminals marked on the PCB and solder the solar panel accordingly. It will be up to the user/installer to verify the solar power requirements (see Table 7 - Operating Conditions: Power Requirements).

**NOTE:** RoHS-compliant and lead-free solder must be used in order to maintain the RoHS-compliance of the ST100.

**TABLE 2 - NOMINAL SOLAR PANEL CHARACTERISTICS**

| MANUFACTURER / PART #             | DESCRIPTION                   | VOC<br>(open-circuit voltage) | VMPP<br>(max power point) | ISC<br>(short-circuit current) | TYPICAL FULL-SUN CURRENT AVAILABLE FOR CHARGING THE BATTERY (Note 3) | DIMENSIONS         |
|-----------------------------------|-------------------------------|-------------------------------|---------------------------|--------------------------------|----------------------------------------------------------------------|--------------------|
| PowerFilm part # 2.4V 94x73mm BSC | 2-cell, 2.4V, 288mW           | 3.6V                          | 2.4V                      | 140mA                          | 50-60mA                                                              | 94 x 73 x 0.8 mm   |
| PowerFilm part # SP2.4-37         | 4-cell, 2.4V, 54mW            | 3.6V                          | 2.4V                      | 30mA                           | 7-11mA                                                               | 50 x 36.5 x 0.8 mm |
| PowerFilm part # SP2.4-37         | 5-cell, 2.4V, 67.5mW          | 4.5V                          | 3V                        | 30mA                           | 10-14mA                                                              | 60 x 36.5 x 0.8 mm |
| IXYS part # SM111K06L             | High Efficiency, 3.35V, 156mW | 4.15V                         | 3.35V                     | 46.7mA                         | 20-30mA                                                              | 42 x 21 x 2 mm     |
| IXYS part # SM451K08L             | High Efficiency, 4.46V, 370mW | 5.53V                         | 4.46V                     | 187mA                          | 70-75mA                                                              | 89 x 55 x 2 mm     |

## Notes:

1. This list is not a complete list of acceptable solar panels. These are panels that Globalstar has identified and tested as acceptable.
2. The VAR/installer should review the pairing of solar panel / battery and determine if the solar panel is adequate for use with the selected battery.
3. This value is based on the efficiency of the solar charger chip, which is typically 80-85%.
4. The solar panel should be chosen for outdoor use, if the end-application will be mostly outdoors.
5. For the 140mAh solar panel, under ideal conditions, it would take ~ 10 hours to recharge a fully discharged 500mAh battery (listed in the Power Performance Characteristics tables).

## 2.10.4. 14 PIN CONNECTOR

The ST100 is equipped with a 14 pin connector to provide access to serial connection, ASIC programming and Bluetooth processor programming using external breakout/debug tools.

**TABLE 3 - 14 PIN CONNECTOR (MOLEX 5034801400)**

| PIN # | FUNCTION                                     | SIGNAL NAME    | DESCRIPTION                          | NOTES                                                       |
|-------|----------------------------------------------|----------------|--------------------------------------|-------------------------------------------------------------|
| 1     | Bluetooth processor programming through JTAG | 3V0            | 3V supply                            | The 3V supply is only meant to power loads less than 20mA.  |
| 2     |                                              | SWDIO          | Bluetooth processor programming line |                                                             |
| 3     |                                              | GND            | PCB Ground                           |                                                             |
| 4     |                                              | SWDCLK         | Bluetooth processor programming line |                                                             |
| 5     | ASIC Programming                             | GND            | PCB Ground                           |                                                             |
| 6     |                                              | SAT_DBG_DATA   | ASIC programming line                |                                                             |
| 7     |                                              | SAT_DBG_CLK    | ASIC programming line                |                                                             |
| 8     |                                              | SAT_DBG_EN     | ASIC programming line                |                                                             |
| 9     |                                              | SAT_RST_N      | ASIC reset                           |                                                             |
| 10    | Serial connection                            | EXT_TX_CONN    | External Serial Port Transmit        | This is the Receive signal on the Bluetooth processor.      |
| 11    |                                              | EXT_RTS_CONN   | External Serial Port Request to Send | This is a GPIO signal connected to the Bluetooth processor. |
| 12    | Bluetooth processor programming through JTAG | MCU/BLE_#RESET | Bluetooth processor reset            |                                                             |
| 13    | Serial connection                            | EXT_CTS_CONN   | External Serial Port Clear to Send   | This is a GPIO signal connected to the Bluetooth processor. |
| 14    |                                              | EXT_RX_CONN    | External Serial Port Receive         | This is the Transmit signal on the Bluetooth processor.     |

**NOTE:**

1. The mating cable for Molex 5034801400 is Molex part # 0152660153, or equivalent.
2. The max voltage level on all pins is 3.3V.
3. It is possible to share the UART with two different entities. First, make sure that no UART communication is planned from the Nordic to the ASIC then, un-initialize the UART from the ASIC Tx & Rx Pins. Following this, reinitialize the UART to the external connector Tx & Rx Pins. It is highly recommended to keep it to Nordic-ASIC configuration by default and at any time that it is not in use.

## 2.11. POWER PERFORMANCE CHARACTERISTICS

The ST100 battery performance heavily depends on the amount of GPS and Satellite Transmitter usage. Below are some examples of battery performance for select battery sizes and track modes.

**TABLE 4 - LP503035, 3.7V, 500MAH, LI-POLYMER BATTERY**

| TEST MODE              | EXPECTED BATTERY LIFE<br>(without charging the battery) |
|------------------------|---------------------------------------------------------|
| 30 minute track mode   | 8.5 days (tested)                                       |
| 60 minute track mode   | 16.5 days (tested)                                      |
| 240 minute track mode  | 49 days                                                 |
| 360 minute track mode  | 67 days (tested)                                        |
| 720 minute track mode  | 100 days                                                |
| 1440 minute track mode | 140 days                                                |

**TABLE 5 - LP552535, 3.7V, 420MAH, LI-POLYMER BATTERY**

| TEST MODE              | EXPECTED BATTERY LIFE<br>(without charging the battery) |
|------------------------|---------------------------------------------------------|
| 30 minute track mode   | 5.5 days (tested)                                       |
| 60 minute track mode   | 10.5 days                                               |
| 240 minute track mode  | 34 days                                                 |
| 720 minute track mode  | 72 days                                                 |
| 1440 minute track mode | 100 days                                                |

**TABLE 6 - DTP401525, 3.7V, 110MAH, LI-POLYMER BATTERY**

| TEST MODE              | EXPECTED BATTERY LIFE<br>(without charging the battery) |
|------------------------|---------------------------------------------------------|
| 30 minute track mode   | 1.5 days                                                |
| 60 minute track mode   | 3 days                                                  |
| 240 minute track mode  | 10 days                                                 |
| 720 minute track mode  | 19 days                                                 |
| 1440 minute track mode | 28 days                                                 |

**NOTE:** 50mW (minimum) is required to recharge a discharged battery

**NOTE:** The data gathered above represents messages with a size of 1 data packet.

## 2.12. ACCELEROMETER

### 2.12.1. FACTORY HARDWARE CONFIGURATION

The ST100 is shipped from the factory with the Accelerometer connected to the ASIC processor.

Rather than issue the normal “track” command, during configuration, the VAR may issue the binary command “Proprietary Motion Activated Track”. This will cause the ASIC to use the accelerometer for motion detection.

Custom Nordic firmware written by the VAR using the Globalstar ST100 SDK may also be used to invoke this special track mode. All interface to the ASIC processor from such custom code is via the binary serial packed commands described in section 4.2.

#### 2.12.1.1. Proprietary Motion Activated Track

In this mode, the ST100 uses the same proprietary motion detection algorithm as the SPOT branded SPOT Gen3, SPOT Gen4, SPOT Trace, and SPOTX products. Track reporting is suspended when the accelerometer indicates that the device is not moving and operates when the accelerometer indicates that the device is moving. This is the mode that is the default mode on the SPOT branded products listed here. (These products do not offer non-suspending track, which is the most common mode used in the ST100).

### 2.12.2. CUSTOM HARDWARE CONFIGURATION

The ST100 can be ordered with the I2C lines and interrupt lines of the accelerometer routed to the Nordic processor. With this special order, the customer is expected to write custom code using the ST100 SDK to implement whatever algorithm he chooses on the accelerometer.

- In this configuration, the Nordic processor has direct control of the accelerometer.
- The accelerometer is an ST Micro LIS3DH. The user must program and access it directly.
- Data sheets and programming guides for the accelerometer are available at:  
<https://www.st.com/en/mems-and-sensors/lis3dh.html>

Note, however that the ASIC has control over the accelerometer’s power. The custom code written by the VAR using the SDK must turn the accelerometer on and off using the “Turn Accelerometer On/Off” command (see section 4.2. BINARY SERIAL PACKET COMMANDS, page 30).

### 3. GENERAL SPECIFICATIONS

**TABLE 7 - OPERATING CONDITIONS**

|                                                          |                                                                                                                       |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>COMPONENT TEMPERATURE RANGE (WITHOUT BATTERY)</b>     | -30 to +85°C (Note 1)                                                                                                 |
| <b>BOARD FUNCTIONAL TEMPERATURE RANGE</b>                | -30 to +85°C                                                                                                          |
| <b>BOARD STORAGE TEMPERATURE RANGE (WITHOUT BATTERY)</b> | -40 to +85°C                                                                                                          |
| <b>BATTERY CHARGING TEMPERATURE RANGE</b>                | -30 to +85°C (Note 2)                                                                                                 |
| <b>POWER REQUIREMENTS (BATTERY INPUT)</b>                | 3.4 to 5.5VDC (Notes 3, 4, 5)<br>Standby current: 30-40uA                                                             |
| <b>POWER REQUIREMENTS (LINE POWER)</b>                   | 3.4 to 5.5 VDC: 500mA                                                                                                 |
| <b>INPUT PROTECTION (BATTERY INPUT)</b>                  | PTC resettable fuse<br>Hold current<br>-30°C: 1.5A, 20°C: 1.1A, 70°C: 0.65A, 85°C: 0.52A                              |
| <b>POWER REQUIREMENTS (SOLAR INPUT)</b>                  | 0.75 to 5VDC (Notes 6, 7, 8)<br>Minimum power required: 50mW<br>Maximum power: 510mW                                  |
| <b>EXTERNAL SERIAL PORT PARAMETERS</b>                   | 3V (Note 9)                                                                                                           |
| <b>BATTERY CURRENT DRAIN</b>                             | Standby current: 30-40uA<br>GPS on current: 50-60mA<br>Transmitter on current: 500mA max<br>(at 3.7V battery voltage) |
| <b>SATELLITE RF OUTPUT</b>                               | 24.5dBm (Note 10)<br>Frequency configurable to 1611.25MHz,<br>1616.25MHz, or 1618.75MHz                               |
| <b>GPS/SATELLITE ANTENNA GAIN</b>                        | +1.06 dBi                                                                                                             |
| <b>BLUETOOTH LOW ENERGY (BLE)</b>                        | 0dBm TX power - 69dBm RX sensitivity                                                                                  |
| <b>BLUETOOTH ANTENNA GAIN</b>                            | -1.09 dBi                                                                                                             |

**Notes:**

1. The -30 to +85°C temperature range is for the ST100 components and doesn't include the battery or solar panel.
2. The functional and battery charging temperature ranges are configurable parameters.
3. The power source on the battery input should be able to supply 500mA pulse current (at 3.7V) for 1.5 seconds. If the end-application expects to have 16 packet messages, the supply should be able to provide this pulse current up to 16 times in succession.
4. If a battery is used, the VAR/installer should verify the battery's performance at the application's lowest expected ambient temperature before proceeding with the selected battery. User MUST set charge/discharge limits according to the battery manufacturer's Safety Data Sheets (SDS). See command sgbattemp description for details.
5. The ST100 has the option to install a battery protection circuit. The VAR/installer will need to inform Globalstar before ordering PCBs if this feature is desired.
6. Both the 0.75V and 50mW requirements must be met on the solar input for charging a depleted battery.
7. The maximum current the solar charger chip on the ST100 board will accept is about 100mA, regardless of solar panel size.
8. If connecting a 5V source to the solar input, the source must be current limited to 100mA.
9. The external serial port consists of 4 GPIO pins connected to the ST100 Bluetooth processor.
10. The 24.5dBm is the conducted power going into the antenna.

## 4. APPLICATION PROGRAMMING INTERFACE

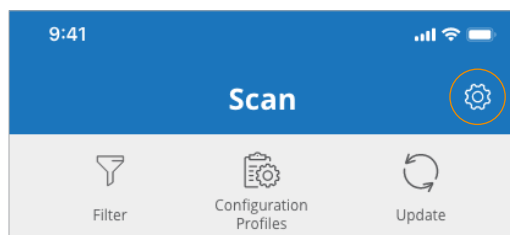
The ST100 Board provides a Bluetooth Low Energy (BLE) GATT/Modem interface for controlling the operation of the device. Commands are used to send information over the commercial IoT network, operate the GPS engine, and monitor the internal operation of the device. The following types of commands are provided by the ST100 Interface:

- Simple ASCII Text commands for basic operation.
- Legacy binary commands, primarily emulating the interface of the STINGR product

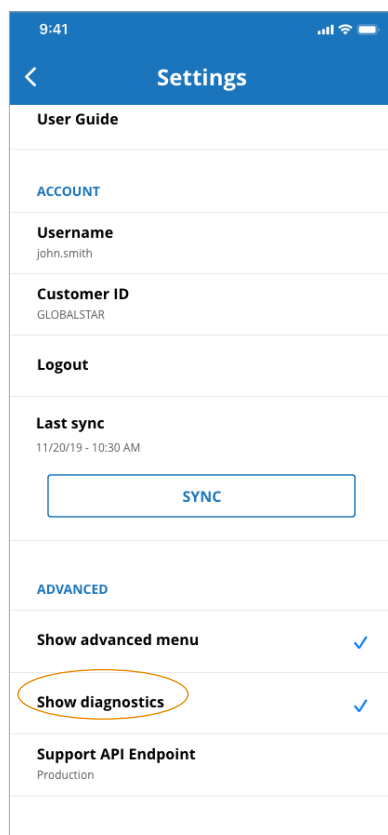
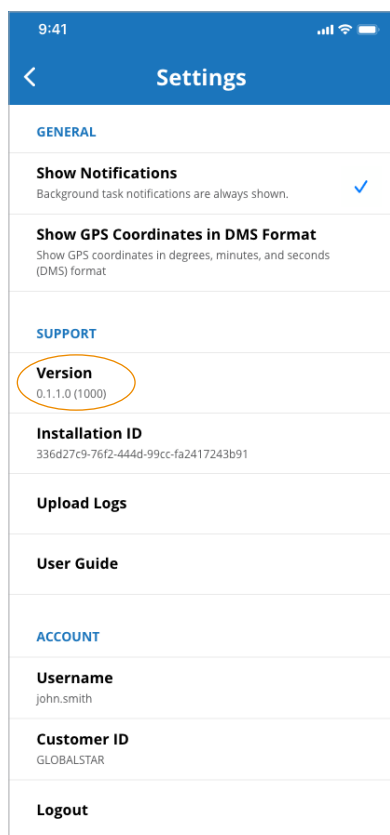
Commands can be entered using the Diagnostics screen in the Globalstar ST100 app.

### Enabling Diagnostics Screen

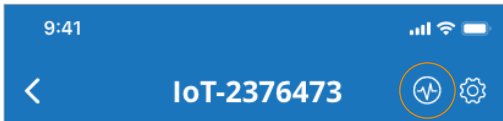
1. Login to the app and click the Settings icon in the top right corner.



2. On the Settings screen tap "Version" 10 times.
3. Select "Show Diagnostics" on the "ADVANCED" menu.



4. Connect to the device.
5. Press the Diagnostic Menu icon.



6. Enter commands.



## 4.1. ASCII COMMAND LIST AND FORMAT

The ST100 Board accepts a set of ASCII commands to query the board for status, and to cause it to perform various commands. Commands take the form of a “keyword” and a variable number of arguments, in the same form of command line arguments in a Windows or Linux command prompt window.

### 4.1.1. ASCII FORMAT

**Command** <arg1> <arg2> <arg3> ... <argn> <CR>

Where the “CR” is an ASCII Carriage Return or Enter (Decimal value of 13).

#### 4.1.1.1. “?”

Print a list of commands.

Command: ?

Arguments: None

Example: ?

Example response:

Commands List:

|           |           |           |
|-----------|-----------|-----------|
| abort     | glbtrate  | reboot    |
| auth      | glgps     | runpost   |
| bursts    | gopmode   | setup     |
| ctrack    | gpspgdump | sgactskip |
| data      | gpssnap   | sgadprfx  |
| dldump    | gpstdump  | sgbattemp |
| esn       | gtrackst  | sgblepar  |
| fgd       | guid      | sghtint   |
| firmware  | hardware  | sglogpar  |
| gadgdata  | hwversion | sgvltlmts |
| gdvlife   | qpeek     | slbtrate  |
| ggeoframe | qreset    | track     |
| ghwdetail | raw       | vbatt     |

#### 4.1.1.2. “abort”

Aborts a redundant burst in progress. **NOTE:** Does not cancel a running tracking session.

Command: abort

Arguments: None

Example: abort

Example response: Message Aborted

#### 4.1.1.3. “auth”

Unlocks privileged commands.

Command: auth  
 Arguments: A 32 bit unlocking key in Hexadecimal  
 Example: auth 11764BA3  
 Example response: Auth success!

The following commands require a unique authorization key to be issued via this command before they will be recognized: “raw”

The commands requiring “auth” are unlocked for 30 seconds after sending the auth command. Sending the commands multiple times (e. g. “raw”) DOES NOT “bump out” the 30 second timer. However, once the user has kicked the ST100 board into binary passthrough mode, the “auth” will expire concurrently with the binary passthrough expiry.

For instructions on how to generate the authorization key, contact Globalstar.

#### 4.1.1.4. “bursts”

Returns the remaining bursts for a message in progress.

Command: bursts  
 Arguments: None  
 Example: bursts  
 Example response: 2 remaining

#### 4.1.1.5. “ctrack”

Cancel the current ongoing track session on ST100.

Command: ctrack  
 Arguments: None  
 Example: ctrack  
 Example response: ctrack: ACK received  
 ctrack: NACK received

#### 4.1.1.6. “data”

Sends raw data via the commercial IoT modem. The example shown here would send that hex string and would require two 9 byte simplex packets.

Command: data  
 Arguments: a hexadecimal string  
 Example: data 112233445566778899aabbccddeeff  
 Example response: Data sent

**NOTE:** If the hex string is too long, a NAK response will be provided.

#### 4.1.1.7. “dldump”

Dump the 2 pages of diagnostic logs in bytes.

Command: dldump

Arguments: None

Example: dldump

Example response: Hex bytes will be TX over the BLE interface for about 30 sec.

**NOTE:** Total data should be 8192 hex bytes.

#### 4.1.1.8. “esn”

Prints the unit ESN in the form “0-123456”.

Command: esn

Arguments: None

Example: esn

Example response: esn: 0-123456

#### 4.1.1.9. “fgd”

Get the current values of important fuel gauge registers.

Command: fgd

Arguments: None

Example: fgd

Example response:

|              |                    |
|--------------|--------------------|
| Current:     | ffffc5c0           |
| Avg Current: | 0                  |
| Vcell:       | -14912             |
| TTF:         | -1 (Time to Full)  |
| TTE:         | -1 (Time To Empty) |

#### 4.1.1.10. “firmware”

Returns the Aggregate board firmware version, and individual processor firmware versions.

Command: firmware

Arguments: None

Example: firmware

Example response: Firmware version: 1.0.0 (010000-010000)

#### 4.1.1.11. “gadgdata”

Get the Modem processor (ASIC) diagnostic data. Returns the data in bytes.

Command: gadgdata

Arguments: None

Example: gadgdata

Example response: Bytes of ASIC diagnostic data will be transmitted over BLE.

**NOTE:** ASIC documentation contains details of the diagnostic data.

#### 4.1.1.12. “gdvlife”

Get the programmed device lifetime.

Command: gdvlife

Arguments: None

Example: gdvlife

Example response: Lifetime Months: 01, End Month: 07, End Day: 19, End Year: 14, Alive/Dead: FF

##### **Alive/Dead Flag definition:**

0xFF: Device is operational/ alive

0x00: Device is dead/end of life

#### 4.1.1.13. “ggeoframe”

Get the most recent GPS timestamp acquired by the Modem processor.

Command: ggeoframe

Arguments: None

Example: ggeoframe

Example response: Size: 4 Value: 1595867014

**NOTE:** Using this command at high frequency or with a low tracking interval may cause GPS data logging inconsistencies.

#### 4.1.1.14. “ghwdetail”

Get the HW details of the ST100 board.

Command: ghwdetail

Arguments: None

Example: ghwdetail

Example response: Product Type: 0, HW Revision: 1

#### 4.1.1.15. “glbtrate”

Get the low battery transmission rate of ST100.

Command: glbtrate  
 Arguments: None  
 Example: glbtrate  
 Example response: Low battery rate is 0005

#### 4.1.1.16. “glgps”

Get latest GPS frame from the Nordic processor.

Command: glgps  
 Arguments: None  
 Example: glgps  
 Example response: Last GPS frame: 000000000000000000000000

#### 4.1.1.17. “gopmode”

Get the ST100 current operational mode information.

Command: gopmode  
 Arguments: None  
 Example: gopmode  
 Example response: Current Operation mode: Staged for activation mode  
 Current Power Mode is Unknown mode  
 Current Temperature mode: Unknown

#### NOTE:

Possible modes:

Operation Mode:

1. Staged for activation mode
2. Staged for activation waiting for GPS mode
3. Activated GPS acquired mode

Power Mode:

1. Normal Mode
2. Low Current Mode
3. Hibernation Mode
4. Normal Battery Charging Mode
5. Normal Battery Full Mode

## 6. Unknown Mode

Temperature Mode:

1. Nominal
2. Temperature High
3. Temperature Low
4. Unknown Mode

**NOTE:** Unknown Mode is typical for the first 3 to 4 minutes following device activation.

### 4.1.1.18. “gpspgdump”

Get one of GPS data using the BLE interface in bytes.

Normal Battery Charging Mode

Command: `gpspgdump`  
 Arguments: starting address of the page: Can be acquired using the `gpssnap` command  
 Example: `gpspgdump 54000`  
 Example response: Bytes will be transmitted over the BLE interface.  
 4096 bytes of GPS data will be transmitted

### 4.1.1.19. “gpssnap”

Get the Snapshot of GPS section in the flash. Returns the non-empty pages of the GPS section.

Command: `gpssnap`  
 Arguments: None  
 Example: `gpssnap`  
 Example response: Non-Empty start addresses: 0x54000 0x55000

**NOTE:** You can utilize these start addresses with the `gpspgdump` command.

### 4.1.1.20. “gpstdump”

Get GPS frames from the flash in certain timestamp range.

Command: `gpstdump`  
 Arguments: Timestamp enable flag: Always set this to 1  
 Timestamp 1: Start time in UNIX 10 digit format  
 Timestamp 2: End time in UNIX 10 digit format  
 Example: `gpstdump 1 1595869702 1595879702`  
 Example response: GPS frames are transmitted over the BLE interface.  
 Only the GPS frames that are within the timestamp range will be transmitted.

#### 4.1.1.21. “gtrackst”

Get current tracking details.

|                   |                                                                            |
|-------------------|----------------------------------------------------------------------------|
| Command:          | gtrackst                                                                   |
| Arguments:        | None                                                                       |
| Example:          | gtrackst                                                                   |
| Example response: | Suspend State: 00, Track Type:30, Tracking Interval: 0005, Payload: 000000 |

#### 4.1.1.22. “guid”

Get UID of ST100.

|                   |                 |
|-------------------|-----------------|
| Command:          | guid            |
| Arguments:        | None            |
| Example:          | guid            |
| Example response: | UID: 4294967294 |

**NOTE:** The UID is the unique identifier for the ST100 device.

#### 4.1.1.23. “hardware”

Returns the ST100 Board hardware version.

|                   |                            |
|-------------------|----------------------------|
| Command:          | hardware                   |
| Arguments:        | None                       |
| Example:          | hardware                   |
| Example response: | Hardware Version: 1.0.0-F0 |

#### 4.1.1.24. “hwversion”

Get the ASIC (Modem Processor) hardware version.

|                   |              |
|-------------------|--------------|
| Command:          | hwversion    |
| Arguments:        | None         |
| Example:          | hwversion    |
| Example response: | hwversion: 1 |

#### 4.1.1.25. “qpeek”

Peek the queue (user messages) to see the snapshot of contents.

Command: qpeek  
 Arguments: None  
 Example: qpeek  
 Example response: qpeek: aa:08:00:11:22:33

**NOTE:** Full message is not transmitted in the qpeek snapshot. Only first 6 bytes are provided for all the elements in the queues.

#### 4.1.1.26. “qreset”

Reset the queue and start fresh.

Command: qreset  
 Arguments: None  
 Example: qreset  
 Example response: Queue reset complete

#### 4.1.1.27. “raw”

Send raw binary command to the ASIC.

Command: raw  
 Arguments: A hex string command to send to the ASIC (See “Binary Serial Packet Commands” section).  
 CRC is omitted, and is generated and appended by the Nordic firmware as it sends the command to the ASIC.  
 Example1: raw AA0501  
 Example1 response: Response: AA090100123456  
 Example2 (invalid): raw AA0577  
 Example2 response: Response: RAW: command passthrough fail

This allows any command in the “Binary Serial Packet Commands” section to be sent to the ASIC. It is this command that implements the simplest form of the “STINGR with Bluetooth” function of the ST100 tag.

The response is the Hex string returned as an acknowledgement from the ASIC. The example above is an ESN query.

#### 4.1.1.28. “reboot”

Reboot the Nordic processor.

Command: reboot  
 Arguments: None  
 Example: reboot

#### 4.1.1.29. “runpost”

Run power on self-test (POST) for both the Nordic & Modem Processor.

Command: runpost

Arguments: None

Example: runpost

Example response: Post Passed. flags value 32

**NOTE:** If POST fails, the response will be: POST Failed w/ the flags value

#### 4.1.1.30. “setup”

Command: setup

Arguments: <default channel> <Number of TX Tries> <Minimum time between tries>  
<Maximum time between tries>

Example: setup 0 3 60 120

Example response: Setup: Channel: 0 Bursts: 3 Min Interval: 60 Max Interval: 120

**NOTE:** Factory default settings are: “setup 0 3 60 120”

Sending the command with no arguments returns the current settings. If sent with arguments, the response is the same, confirming the settings.

All arguments must be present. If any are missing, or any are out of range, the command will return a fail message and reason.

The Channel Field: May contain 0 – 2 corresponding to simplex Return Link channels A – C respectively. Note that this will affect the channel for the next raw transmission. Subsequent GPS fixes will steer the active channel to the appropriate one based on GPS location.

The correct Globalstar Simplex channel is dictated by RAS (Radio Astronomy Site) avoidance and by a “geofrequency” channel map. Whenever the ST100 board obtains a fix, it sets the channel based on these criteria. If a user uses the product to send “raw” simplex messages without obtaining a fix, it is up to the user to be aware of where the device is and adhere to this channel map. For example, Send Data (AA00) does not check for a GPS reading before transmitting data while Send Redundant Burst with GPS (AA33) does. If AA00 is being used, the location should be checked regularly based on the movement of the device before the data is sent to ensure the right channel is used. See document GS-07-1248 - REMOTE TELEMETRY SERVICE FREQUENCY PLAN FOR SIMPLEX TRANSMITTERS to determine how to calculate the channel map.

The number of TX Tries field: Number of tries in the burst. Valid range is 1 – 5. If the number of TX Tries field is set to 1, the message will have 0 retry messages.

Minimum time between tries: Based on a value from a legacy simplex transmitter (the original Globalstar STU), this is a number of “5 second ticks”. E. g. 60 = 5 minutes (5 \* 5 seconds = 300 seconds). Minimum value = 1 (5 seconds) Maximum Value = 60 (5 minutes).

Maximum time between tries: Also, expressed in number of “5 second ticks”. Minimum value = value of minimum time + 1. Maximum value = 120 (600 seconds).

The wait between each “try” will be an evenly distributed pseudo-random amount of time between the minimum and maximum value expressed above. Resolution of the pseudo-random timing for this device is 1.5 seconds.

#### 4.1.1.31. "sgactskip"

Bypass or reinstate the activation algorithm of ST100. Mostly used for line powered devices.

Command: sgactskip

Arguments: Set/Get flag: "0" gets the current skip activation state  
 "1" sets the current skip activation state

Skip activation state: Only valid when set/get flags is set to "1"

Example1: sgactskip 0

Example1 response: Current skip activation state: 0

Example2: sgactskip 1 1

Example2 response: Wrote skip activation flag to flash

#### 4.1.1.32. "sgadprfx"

Set or get the BLE advertising prefix of ST100.

Command: sgadprfx

Arguments: Set/Get flag: "0" gets the prefix and "1" sets the prefix Advertising

Prefix: Only valid when the set/get flag is set to "1"

Example1: sgadprfx 0

Example1 response: Adv prefix: gst

Example2: sgadprfx 1 gst

Example2 response: Wrote adv prefix

**NOTE:** The advertising prefix must be of 3 bytes length. If it is not 3, then "Length error argv[2]" will be returned.

#### 4.1.1.33. "sgbattemp"

Set or Get battery temperature configuration values.

Command: sgbattemp

Arguments: Set/Get flag: "0" gets the battery temperature config parameters  
 "1" sets the Battery temperature config parameters

Charging temp low: Only valid when Set/Get flag is set to "1".  
 Low threshold for charging temperature. Min Value

Charging temp high: Only valid when Set/Get flag is set to "1".  
 High threshold for charging temperature

Discharging temp low: Only valid when Set/Get flag is set to "1".  
 Low threshold for discharging temperature.

Discharging temp high: Only valid when Set/Get flag is set to "1".  
 High threshold for discharging temperature

Example1: sgbattemp 0

Example1 response: Temp Charge Low:-30  
Temp Charge High:85  
Temp Discharge Low:-30  
Temp Discharge High:85

Example2: sgbattemp 1 15 40 0 60

Example2 response: Battery cutoff temperatures set

**NOTE:** Absolute range for charging: -30C to 85C  
Absolute range for discharging: -30C to 85C

#### 4.1.1.34. "sgblepar"

Set or Get BLE configuration parameters.

Command: sgblepar

Arguments: Set/Get flag: "0" gets the BLE config parameters  
"1" sets the BLE config parameters

Advertising interval: Only valid when Set/Get flag is set to "1". Advertising rate possible values:

adv\_rate\_250ms = 0  
adv\_rate\_500ms = 1  
adv\_rate\_750ms = 2  
adv\_rate\_1000ms = 3  
adv\_rate\_1250ms = 4  
adv\_rate\_1500ms = 5  
adv\_rate\_1750ms = 6  
adv\_rate\_2000ms = 7

Transmit Power: Only valid when Set/Get flag is set to "1".

Transmit power possible values (in dBm):

-8  
-4  
0  
3  
4

Example1: sgblepar 0

Example1 response: Adv Interval: 7 TX power: 0

Example2: sgblepar 1 1 4

Example2 response: BLE parameters updated. Adv Interval: 1 TX power: 4

#### 4.1.1.35. "sghltint"

Health Check read or set message interval.

Command: sghltint

Arguments: Set/Get flag: "0" gets the current interval

"1" sets the interval

Interval: Number of days between messages, integer between 1 and 30

Example1: sghltint 0

Example1 response: Health check interval: %u, Next time to transmit: %u

Example2: sghltint 1 25

Example2 response: Successfully set the health check interval

#### 4.1.1.36. "sglogpar"

Lists the current logging parameters.

Command: sglogpar

Arguments: Set/Get flag: "0" gets the logging parameters

"1" sets the logging parameters

Logging Mode: Only valid when set/get flag is set to "1".

Possible logging modes: 0 -> reduced mode

1-> basic mode

2-> verbose mode

Logging Overflow: Only valid when set/get flag is set to "1".

Possible overflow modes: 0 -> Overflow disabled

1-> Overflow enabled

Example1: sglogpar 0

Example1 response: Logging Mode: 1

Logging Overflow status: 1

Example2: sglogpar 1 1 1

Example2 response: Logging Mode: 1

Logging Overflow status: 1

Wrote logging parameters to flash (When set/get flag is set to "1")

#### 4.1.1.37. “sgvltlmts”

Set the low battery voltage threshold of the ST100.

Command: sgvltlmts

Arguments: Set/Get flag: “0” gets the logging parameters  
“1” sets the logging parameters

Example: sgvltlmts 0

Example response: Low battery threshold: 3.60, Hibernation threshold: 3.40

#### 4.1.1.38. “slbatrate”

Set the low battery transmission rate of ST100.

Command: slbatrate

Arguments: Tracking rate: 2 bytes

Example: slbatrate 00 05

Example response: Low battery rate set successfully

**NOTE:** 00 05 corresponds to 5 minutes. 00 3C corresponds to 1 hour.

#### 4.1.1.39. “track”

Start a new track session on ST100.

Command: track

Arguments: Tracking Interval: 2 bytes  
User defined bytes: 3 bytes (payload)

Example: track 00 05 AA BB CC

Example response: Track: ACK received but suspended

**NOTE:** 00 05 corresponds to 5 minutes. 00 3C corresponds to 1 hour.

**NOTE:** A payload is required, else the response will be: “track : Invalid no of arguments”

#### 4.1.1.40. “vbatt”

Read the current average battery voltage in human readable format.

Command: vbatt

Arguments: None

Example: vbatt

Example response: Vbatt: 3.948282

## 4.2. BINARY SERIAL PACKET COMMANDS

These commands represent the Legacy Globalstar format.

These commands are accessible on an individual basis by issuing them as the argument to the “raw” ASCII command.

**NOTE:** When using the “raw” command to send individual messages, the CRC is not sent by the user. The Nordic processor firmware calculates and appends the correct CRC to the message going to the ASIC processor.

### 4.2.1. SERIAL PACKET FORMAT

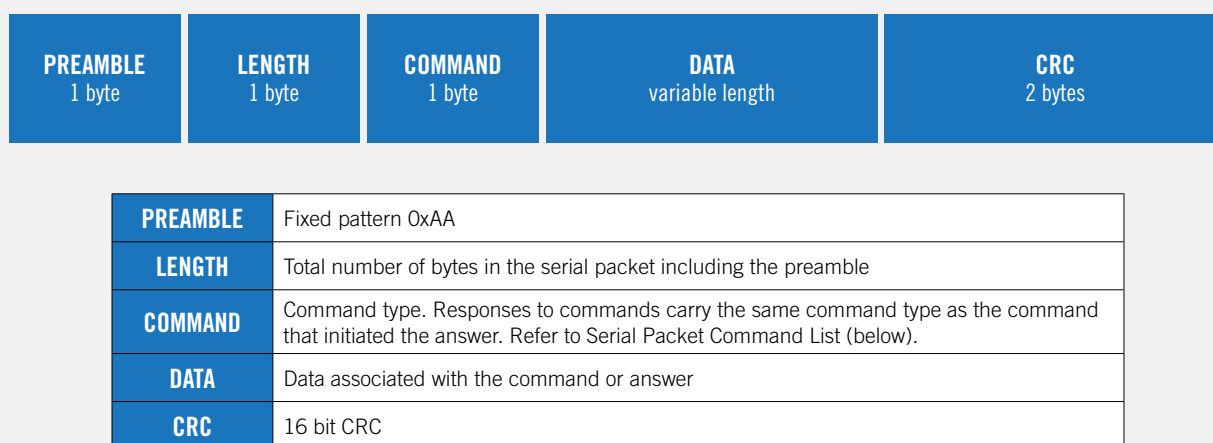


FIGURE 6 - SERIAL PACKET FORMAT

### 4.2.2. SERIAL PACKET COMMAND LIST

For all serial packet commands as described below:

- AA is the **Preamble**.
- NN is the **Length**.
- XX is an unspecified byte value.
- **CLSB** is the least significant **CRC** byte.
- **CMSB** is the most significant **CRC** byte.
- **CLSB** and **CMSB** are omitted when using the RAW command. **Length** must still be specified to include them, however.
- If an improperly formatted command is received, the ST100 BOARD will return a NAK response:  
AA 05 FF A1 CB

#### 4.2.2.1. Send Data (0x00)

The Send Data command requests the ST100 board to send from 1 to 144 data bytes over the Globalstar Simplex network. 0x00

| LEADER | LEN | CMD | PAYLOAD 1 | PAYLOAD 2 | PAYLOAD 3 | .. | PAYLOAD N | CRC1 | CRC2 |
|--------|-----|-----|-----------|-----------|-----------|----|-----------|------|------|
| AA     | NN  | 00  | XX        | XX        | XX        | XX | XX        | CLSB | CMSB |

Example Command: AA 0E 00 **01 02 03 04 05 06 07 08 09** BE E8

Response: AA 05 00 D9 C4

The example above commands the ST100 Board to send 9 bytes of **user defined data** over the Globalstar Simplex network. If the ST100 Board receives a properly formatted Send Data command, it returns an acknowledge response as shown above. If the command is not properly formatted, it will return the NAK response AA 05 FF A1 CB.

#### 4.2.2.2. Query Electronic Serial Number (ESN) (0x01)

The Electronic Serial Number command requests the ST100 board to respond with the units Electronic Serial Number (ESN). 0x01

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 01  | 50   | D5   |

Command: AA 05 01 50 D5

| LEADER | LEN | CMD | ESN |    |    |    | CRC1 | CRC2 |
|--------|-----|-----|-----|----|----|----|------|------|
| AA     | 09  | 01  | XX  | XX | XX | XX | 86   | 7A   |

Example Response: AA 09 01 **00 23 18 60** 86 7A

Where the ESN returned is 2300000.

#### 4.2.2.3. Abort Transmission (0x03)

The Abort Transmission command requests the ST100 BOARD to abort the current message transmit sequence over the Globalstar Simplex network. This command aborts a redundant burst transmission. It DOES NOT abort track mode.

0x03

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 03  | 42   | F6   |

Command: AA 05 03 42 F6

Response: AA 05 03 42 F6

#### 4.2.2.4. Query Bursts Remaining (0x04)

The Query Bursts Remaining command requests the ST100 BOARD to return the current number of bursts remaining the current message transmit sequence over the Globalstar commercial IoT network.

0x04

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 04  | FD   | 82   |

Command: AA 05 04 FD 82

Response:

| LEADER | LEN | 04 | COUNT | CRC1 | CRC2 |
|--------|-----|----|-------|------|------|
| AA     | 05  | 04 | XX    | CC   | CC   |

Example Response: AA 06 04 00 F4 33

Where the bursts remaining returned is: 0

#### 4.2.2.5. Query Firmware Version (0x05)

The Query Firmware Version command requests the ST100 BOARD to return the current firmware version.

0x05

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 05  | 74   | 93   |

Command: AA 05 05 74 93

Response:

| LEADER | LEN | 4 | FW MAJOR | FW MINOR | FW BUILD | CRC1 | CRC2 |
|--------|-----|---|----------|----------|----------|------|------|
| AA     | 8   | 5 | XX       | XX       | XX       | CC   | CC   |

Example Response: AA 08 05 01 07 04 E0 6A

Where the firmware version returned is: 1.7.4

#### 4.2.2.6. Setup (0x06)

The Setup command requests the ST100 BOARD to use the specified setup parameters. These are stored in non-volatile memory.

Command: 0x06

| HEADER | LEN | 04 | RESERVED |    |    |    | RF CHANNEL | # OF BURSTS | INTERVAL MIN | INTERVAL MAX | RESERVED | CRC1 | CRC2 |
|--------|-----|----|----------|----|----|----|------------|-------------|--------------|--------------|----------|------|------|
| AA     | 0E  | 06 | XX       | XX | XX | XX | XX         | XX          | XX           | XX           | XX       | CC   | CC   |

Where:

- RF channel : Valid values are: 0 = Channel A, 1 = Channel B, 2 = Channel C
- # of bursts: Valid values are: 0x01 thru 0x05 (1 to 5 bursts)
- Minimum Burst Interval: Units of 5 seconds. Valid values are: 0x01 thru 0x3C (5 to 300 seconds)
- Maximum Burst Interval: Units of 5 seconds. Valid values are: 0x02 thru 0x78 (10 to 600 seconds)

Example Command: AA 0E 06 00 00 00 00 **00 03 18 30** 00 CE 9C

Where the setup information is:

- RF channel : 00 Channel A
- # of bursts: 03 3 bursts per message
- Minimum Burst Interval: 18  $0x18 = 24, 24 \times 5 = 120$  seconds
- Maximum Burst Interval: 30  $0x30 = 48, 48 \times 5 = 240$  seconds

#### 4.2.2.7. Query Setup (0x07)

The Query Setup command requests the ST100 BOARD to return the current setup parameters.

0x07

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 07  | 66   | B0   |

Command: AA 05 07 66 B0

| HEADER | LEN | CMD | RESERVED |    |    |    | RF CHANNEL | # OF BURSTS | INTERVAL MIN | INTERVAL MAX | RESERVED | CRC1 | CRC2 |
|--------|-----|-----|----------|----|----|----|------------|-------------|--------------|--------------|----------|------|------|
| AA     | 0E  | 07  | XX       | XX | XX | XX | <b>XX</b>  | <b>XX</b>   | <b>XX</b>    | <b>XX</b>    | XX       | 18   | 59   |

Where:

- RF channel : Valid values are: 0 = Channel A, 1 = Channel B, 2 = Channel C
- # of bursts: Valid values are: 0x01 thru 0x05 (1 to 5 bursts)
- Minimum Burst Interval: Units of 5 seconds. Valid values are: 0x01 thru 0x3C (5 to 300 seconds)
- Maximum Burst Interval: Units of 5 seconds. Valid values are: 0x02 thru 0x78 (10 to 600 seconds)

Example Response: AA 0E 07 00 23 18 60 **00 03 18 30** 00 5D 60

Where the setup information returned is:

- RF channel : 00 Channel A
- # of bursts: 03 3 bursts per message
- Minimum Burst Interval: 18  $0x18 = 24, 24 \times 5 = 120$  seconds
- Maximum Burst Interval: 30  $0x30 = 48, 48 \times 5 = 240$  seconds

#### 4.2.2.8. Query Hardware Version (0x09)

The Query Hardware Version command requests the ST100 BOARD to return the current hardware version information. 0x09

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 09  | 18   | 59   |

Command: AA 05 09 18 59

| HEADER | LEN | CMD | DEVICE CODE |    | SILICON REV | CPU REV | RADIO REV | CRC1 | CRC2 |
|--------|-----|-----|-------------|----|-------------|---------|-----------|------|------|
| AA     | 0A  | 09  | 00          | 01 | XX          | XX      | XX        | CC   | CC   |

Where:

- Device Code : Always 1 for ST100 BOARD
- Silicon Revision: Simplex Silicon revision
- CPU Revision: Simplex CPU revision
- Radio Revision: Simplex Radio revision

Example Response: AA 0A 09 00 01 8F 62 62 F7 58

Where the revision information returned is:

- Device Code: 01
- Silicon Revision: 8F
- Revision: 62
- Radio Revision: 62

#### 4.2.2.9. Set GPS Timeout command

This command sets the GPS timeout - the maximum time the unit will attempt to obtain a GPS fix before giving up.

##### SET GPS TIMEOUT COMMAND FORMAT

| BYTE | BITS   | PARAMETER         | DESCRIPTION                                                                                                                      |
|------|--------|-------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader            | Always a value of 0xAA                                                                                                           |
| 1    | 0 - 7  | Length            | 0x07                                                                                                                             |
| 2    | 0 - 7  | Command Code      | 0x23 = Set GPS timeout                                                                                                           |
| 3-4  | 0 - 15 | GPS timeout value | GPS timeout value in seconds. Must be between 60 and 300 seconds (1 to 5 minutes).<br>Factory default is 4 minutes (240 seconds) |
| 5-6  | 0 - 15 | CRC               |                                                                                                                                  |

Example response: AA 05 23 [CRC] [CRC]

#### 4.2.2.10. Get GPS Timeout query

##### GET GPS TIMEOUT QUERY FORMAT

| BYTE | BITS   | PARAMETER         | DESCRIPTION              |
|------|--------|-------------------|--------------------------|
| 0    | 0 - 7  | Leader            | Always a value of 0xAA   |
| 1    | 0 - 7  | Length            | 0x5                      |
| 2    | 0 - 7  | Command Code      | 0x24 = GPS Timeout Query |
| 3-4  | 0 - 15 | GPS timeout value |                          |

##### GET GPS TIMEOUT QUERY RESPONSE

| BYTE | BITS   | PARAMETER         | DESCRIPTION                  |
|------|--------|-------------------|------------------------------|
| 0    | 0 - 7  | Leader            | Always a value of 0xAA       |
| 1    | 0 - 7  | Length            | 0x07                         |
| 2    | 0 - 7  | Command Code      | 0x24 = GPS Timeout Query     |
| 3-4  | 0 - 15 | GPS timeout value | GPS timeout value in seconds |
| 5-6  | 0 - 15 | CRC               |                              |

#### 4.2.2.11. "SPOT GEN3 emulation.

The ST100 board has the ability to emulate the tracking and messaging modes of a SPOT GEN3 device for particular applications.

#### 4.2.2.12. Special consideration for “Byte 7” in the next several commands.

The following commands cause the ST100 to transmit either a single burst message, or to enter track mode or to modify a track mode, wherein bytes 1,2,3,4,5 and 6 of the over the air message contain the latitude and longitude location data. The user may set bytes 0, 7, and 8 (and subsequent packets in the case of the “Send Redundant Burst with GPS” (0x33) command) to any value of his choosing with a special exception for “byte 7”. The commands for which this rule applies are:

0x30 - Proprietary Track

0x33 - Send Redundant Burst with GPS

0x34 - Proprietary Motion Activated Track

In any of the above modes, if the user specifies a value for “Byte 7” with the most significant 4 bits all ones ( $(\text{byte } 7 \gg 4) \& 0xF0 = 0xF0$ ) the following special behavior is activated:

The 4 most significant bits of byte 7 become status flags with the meanings as follows:

0x10 = RESERVED

0x20 = Low Battery (Tracking rate reduced to low battery rate)

0x40 = GPS location invalid

0x80 = GPS location of low confidence

#### 4.2.2.13. “Proprietary Track” command

This command allows the initiation of a periodic track message with user defined data prepended and appended to the latitude and longitude fields. A periodic 9-byte custom track message, transmitted nominally at the interval specified, will result.

The behavior of this mode differs somewhat from the same mode’s behavior in the STINGR product. In the ST100 board implementation, if the interval is set to 30 minutes or greater, a redundant burst transmission will be initiated at each interval, with the number of attempts and the timing between the attempts as specified in the “setup” command. If the interval is less than 30 minutes, a single transmission will be sent per interval.

If the interval is 40 minutes or greater, the ST100 board will randomize the start of each burst by  $\pm 10$  minutes around the nominal. For example, if a track mode with an interval of 1 hour is started at 12:00, the next burst position report will begin randomly between 12:50 and 1:10, the one after that will begin between 1:50 and 2:10, etc.

While in Proprietary Track mode with an interval of 30 minutes or less, the GPS will retain its clock and ephemeris data in order to perform a “hot” GPS fix. This will increase the sleep current by roughly 50uA in such a track mode.

If the unit is already in a track mode, and this command is sent, it will be NAK’d. To change the track rate, the “Cancel Proprietary Track” command must be sent, and a new track command then issued.

| OPERATING MODE                                 | STANDBY CURRENT  |
|------------------------------------------------|------------------|
| Proprietary Tracking $\leq$ 30 minute interval | GPS Standby Mode |
| Proprietary Tracking $>$ 30 minute interval    | Standby Mode     |

### PROPRIETARY TRACK COMMAND FORMAT

| BYTE | BITS   | PARAMETER    | DESCRIPTION                                                                                                                                                                                |
|------|--------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA                                                                                                                                                                     |
| 1    | 0 - 7  | Length       | 0x0A (10 decimal)                                                                                                                                                                          |
| 2    | 0 - 7  | Command Code | 0x30 = Initiate proprietary track                                                                                                                                                          |
| 3-4  | 0 - 15 | Interval     | Interval in minutes between the track points. 2 to 65535 minutes. (A setting of 2 actually results in a 2.5 minute interval, any other value results in an interval of that many minutes). |
| 5    | 0 - 7  | Byte 0 value | The value to transmit as byte 0                                                                                                                                                            |
| 6    | 0 - 7  | Byte 7 value | The value to transmit as byte 7                                                                                                                                                            |
| 7    | 0 - 7  | Byte 8 value | The value to transmit as byte 8                                                                                                                                                            |
| 8-9  | 0 - 15 | CRC          |                                                                                                                                                                                            |

Example Command: AA 0A 30 **00 0A** AA BB CC 90 84

Where:

- **Period :** **0x000A (10 minute intervals)**
- Payload Byte 0: 0xAA
- Payload Byte 7: 0xBB
- Payload Byte 8: 0xCC

### INITIATE PROPRIETARY TRACK RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION              |
|------|--------|--------------|--------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA   |
| 1    | 0 - 7  | Length       | 0x5                      |
| 2    | 0 - 7  | Command Code | 0x30 = ACK or 0xFF = NAK |
| 3-4  | 0 - 15 | CRC          |                          |

Example Response: AA 05 30 5A F5

Example Payload: 0xAA**2B4856BFF032**BBCC

Where: **2B4856** is the 24-bit latitude 30.433051586151 (North)  
**BFF032** is the 24-bit longitude -90.086817741394 (West)

See section 4.6: "24 bit location format" for documentation of the encoding/decoding of Globalstar on-air location data.

#### 4.2.2.14. “Proprietary Motion Activated Track” command

This command allows the initiation of a periodic track with user defined data prepended and appended to the latitude and longitude fields. A periodic 9-byte custom track message, transmitted nominally at the interval specified, will result. In this mode, tracking will suspend when the accelerometer detects that the device is not moving, and then resume when it detects that the device is moving again.

The behavior of this mode differs somewhat from the same mode’s behavior in the STINGR product. In the ST100 board implementation, if the interval is set to 30 minutes or greater, a redundant burst transmission will be initiated at each interval, with the number of attempts and the timing between the attempts as specified in the “setup” command. While in Proprietary Track mode with an interval of 30 minutes or less, the GPS will retain its clock and ephemeris data in order to perform a “hot” GPS fix. This will increase the GPS standby current to the “GPS Standby Mode” value in Table 7. For tracking intervals greater than 30 minutes, the GPS will be powered off in between transmissions and the sleep current will be the “Standby Mode” value in Table 7.

If the interval is 40 minutes or greater, the ST100 board will randomize the start of each burst by +/- 10 minutes around the nominal. For example, if a track mode with an interval of 1 hour is started at 12:00, the next burst position report will begin randomly between 12:50 and 1:10, the one after that will begin between 1:50 and 2:10, etc.

If the unit is already in a track mode, and this command is sent, it will be NAK’d. To change the track rate, the “Cancel Proprietary Track” command must be sent, and a new track command then issued.

While in Motion Activated Track mode, the accelerometer sub-system will remain powered during the standby periods in between transmissions and the accelerometer standby current will be the “Standby mode supply current w/Accelerometer” value in Table 7. The following table summarizes the standby mode supply current for different modes.

**TABLE 8 - OPERATING MODES & STANDBY CURRENTS**

| OPERATING MODE                                  | STANDBY CURRENT                                                |
|-------------------------------------------------|----------------------------------------------------------------|
| Continuous Tracking <= 30 minute interval       | GPS Standby Mode + Standby mode supply current w/Accelerometer |
| Continuous Tracking > 30 minute interval        | Standby mode supply current w/Accelerometer                    |
| Motion Activated Tracking <= 30 minute interval | GPS Standby Mode + Standby mode supply current w/Accelerometer |
| Motion Activated Tracking > 30 minute interval  | Standby mode supply current w/Accelerometer                    |

**PROPRIETARY MOTION ACTIVATED TRACK COMMAND FORMAT**

| BYTE | BITS   | PARAMETER    | DESCRIPTION                                                                                                                                                                                |
|------|--------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA                                                                                                                                                                     |
| 1    | 0 - 7  | Length       | 0x0A (10 decimal)                                                                                                                                                                          |
| 2    | 0 - 7  | Command Code | 0x34 = Initiate proprietary motion activated track                                                                                                                                         |
| 3-4  | 0 - 15 | Interval     | Interval in minutes between the track points. 2 to 65535 minutes. (A setting of 2 actually results in a 2.5 minute interval, any other value results in an interval of that many minutes). |
| 5    | 0 - 7  | Byte 0 value | The value to transmit as byte 0                                                                                                                                                            |
| 6    | 0 - 7  | Byte 7 value | The value to transmit as byte 7                                                                                                                                                            |
| 7    | 0 - 7  | Byte 8 value | The value to transmit as byte 8                                                                                                                                                            |
| 8    | 0 - 15 | CRC          |                                                                                                                                                                                            |

Example Command: AA 0A 34 **00 0A** AA BB CC 3C 94

Where:

- **Period :** **0x000A (10 minute intervals)**
- Payload Byte 0: 0xAA
- Payload Byte 7: 0xBB
- Payload Byte 8: 0xCC

#### INITIATE PROPRIETARY TRACK RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION              |
|------|--------|--------------|--------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA   |
| 1    | 0 - 7  | Length       | 0x5                      |
| 2    | 0 - 7  | Command Code | 0x30 = ACK or 0xFF = NAK |
| 3-4  | 0 - 15 | CRC          |                          |

Example Response: AA 05 30 5A F5

Example Payload: 0xAA**2B4856BFF032**BBCC

Where: **2B4856** is the 24-bit latitude 30.433051586151 (North)  
**BFF032** is the 24-bit longitude -90.086817741394 (West)

See section 4.6: “24 bit location format” for documentation of the encoding/decoding of Globalstar on-air location data.

#### 4.2.2.15. “Update Proprietary Track Data” command

This command is used to change the user programmable data in a proprietary track message. If a proprietary track session is not in progress, it is ACK'd but will do nothing.

#### UPDATE PROPRIETARY TRACK DATA COMMAND FORMAT

| BYTE | BITS   | PARAMETER    | DESCRIPTION                      |
|------|--------|--------------|----------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA           |
| 1    | 0 - 7  | Length       | 0x08                             |
| 2    | 0 - 7  | Command Code | 0x31 = Update proprietary track. |
| 3    | 0 - 7  | Byte 0 value | The value to transmit as byte 0  |
| 4    | 0 - 7  | Byte 7 value | The value to transmit as byte 7  |
| 5    | 0 - 7  | Byte 8 value | The value to transmit as byte 8  |
| 6-7  | 0 - 15 | CRC          |                                  |

Example Command: AA 08 31 AA BB CC 21 FA

Where:

- Payload Byte 0: 0xAA
- Payload Byte 7: 0xBB
- Payload Byte 8: 0xCC

#### UPDATE PROPRIETARY TRACK DATA RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION              |
|------|--------|--------------|--------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA   |
| 1    | 0 - 7  | Length       | 0x5                      |
| 2    | 0 - 7  | Command Code | 0x31 = ACK or 0xFF = NAK |
| 3-4  | 0 - 15 | CRC          |                          |

Example Response: AA 05 31 D3 E4

#### 4.2.2.16. "Cancel Proprietary Track/Proprietary Motion Activated Track" command

This command is used to terminate a Proprietary Track or Proprietary Motion Activated Track session.

#### CANCEL PROPRIETARY TRACK COMMAND FORMAT

| BYTE | BITS   | PARAMETER    | DESCRIPTION                     |
|------|--------|--------------|---------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA          |
| 1    | 0 - 7  | Length       | 0x5                             |
| 2    | 0 - 7  | Command Code | 0x32 = cancel proprietary track |
| 3-4  | 0 - 15 | CRC          |                                 |

| LEADER | LEN | CMD | CRC1 | CRC2 |
|--------|-----|-----|------|------|
| AA     | 05  | 32  | 48   | D6   |

Example Command: AA 05 32 48 D6

#### 4.2.2.17. “Proprietary Track Status” query

##### PROPRIETARY TRACK STATUS QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION                           |
|------|--------|--------------|---------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA                |
| 1    | 0 - 7  | Length       | 0x5                                   |
| 2    | 0 - 7  | Command Code | 0x38 = Proprietary Track Status Query |
| 3-4  | 0 - 15 | CRC          |                                       |

##### PROPRIETARY TRACK STATUS QUERY RESPONSE

| BYTE  | BITS   | PARAMETER             | DESCRIPTION                                                                                |
|-------|--------|-----------------------|--------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader                | Always a value of 0xAA                                                                     |
| 1     | 0 - 7  | Length                | 0x0C                                                                                       |
| 2     | 0 - 7  | Command Code          | 0x38 = Proprietary Track Status Query                                                      |
| 3     | 0 - 7  | Suspend / Power State | 0x00 = Fully suspended<br>0x01 = Low battery / Partial<br>Suspend 0x02 = Fully unsuspended |
| 4     | 0 - 7  | Specific track mode   | 0x30 = Proprietary Track<br>0x34 = Motion activated proprietary track                      |
| 5-6   | 0 - 15 | Track interval        | Value of interval in minutes                                                               |
| 7     | 0 - 7  | Byte 0 value          | The value being transmitted as byte 0.                                                     |
| 8     | 0 - 7  | Byte 7 value          | The value being transmitted as byte 7. (See note below)                                    |
| 9     | 0 - 7  | Byte 8 value          | The value being transmitted as byte 8.                                                     |
| 10-11 | 0 - 15 | CRC                   |                                                                                            |

**NOTE:** If the upper nibble of the Byte 7 value is 0xF, in other words if the “Byte 7 value & 0xF0 = 0xF0, the upper nibble of byte 7 is being populated with ST100 Status flags (See status flags section)

**NOTE 2:** If the device is NOT in track mode, bytes 4 - 9 will all be populated with 0's.

Example response: AA 0C 38 02 30 00 3C 03 F7 45 <crc- lo> <crc- hi>

02 = Fully unsuspended

30 = Proprietary Track Mode

00 3C = 60 minute interval

03 = Value of Byte 0

F7 = lower nibble of Byte 7 will be a value of 7, upper nibble populated with status flags

45 = Byte 8 value of 0x45

#### 4.2.2.18. "Tracking Statistics" query

##### TRACKING STATISTICS QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION                      |
|------|--------|--------------|----------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA           |
| 1    | 0 - 7  | Length       | 0x5                              |
| 2    | 0 - 7  | Command Code | 0x39 = Tracking Statistics Query |
| 3-4  | 0 - 15 | CRC          |                                  |

##### TRACKING STATISTICS RESPONSE

| BYTE  | BITS   | PARAMETER                                         | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|--------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader                                            | Always a value of 0xAA                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1     | 0 - 7  | Length                                            | 0x13                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2     | 0 - 7  | Command Code                                      | 0x39 = Tracking Statistics Query                                                                                                                                                                                                                                                                                                                                                                                                |
| 3     | 0 - 7  | Reset Flag                                        | 0x00 = Device has not reset since the last time this query was issued<br>0x01 = Device has reset since the last time this query was issued                                                                                                                                                                                                                                                                                      |
| 4     | 0 - 7  | Suspended state                                   | 0x00 = Tracking is fully suspended<br>0x01 = Tracking is partially suspended (operating at low battery rate)<br>0x02 = Tracking is running at normal schedule                                                                                                                                                                                                                                                                   |
| 5     | 0 - 7  | Resolution of next field                          | 0x00 = Next field represents a value in seconds<br>0x01 = Next field represents a value in minutes<br>(This allows the next field to express a much wider range of values while still only 2 bytes in size.)                                                                                                                                                                                                                    |
| 6-7   | 0 - 15 | Time remaining in current interval                | The time remaining until the next GPS fix and location report cycle. Resolution, minutes or seconds, is shown in the previous field.                                                                                                                                                                                                                                                                                            |
| 8     | 0 - 7  | Track burst tries remaining                       | If a burst track message is in progress, this is the number of attempts left in the burst                                                                                                                                                                                                                                                                                                                                       |
| 9-10  | 0 - 15 | Time to next transmission in burst                | Time, in seconds, until the next attempt in the burst, if a burst is not currently running, will be zero.                                                                                                                                                                                                                                                                                                                       |
| 11    | 0 - 7  | Number of attempts remaining in interleaved burst | If an interleaved burst is running, the number of attempts remaining in the burst is shown here. If no interleaved message is running, this field will read 0.                                                                                                                                                                                                                                                                  |
| 12-13 | 0 - 15 | Time to next interleaved burst                    | If an interleaved burst is running, this is the number of seconds until the next burst attempt. If no interleaved burst is running, this field is zero.                                                                                                                                                                                                                                                                         |
| 14    | 0 - 7  | Number of packets in interleaved burst message    | The number of packets in the interleaved burst message.<br><b>NOTE:</b> As a "quirky feature" this value does not clear when the burst finishes, and if no interleaved burst is running, this will show the number of packets that were in the last interleaved burst that ran. It can be determined if a burst is currently running by examining bytes 11, and 12-13. They will be non-zero if an interleaved burst is running |
| 15-16 | 0 - 15 | Total messages in mode                            | This holds the total messages transmitted since the track mode began. It will be a total of the scheduled track messages and the interleaved messages.                                                                                                                                                                                                                                                                          |
| 17-18 | 0 - 15 | CRC                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                 |

#### 4.2.2.19. “GPS Statistics” query

##### GPS STATISTICS QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION                 |
|------|--------|--------------|-----------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA      |
| 1    | 0 - 7  | Length       | 0x5                         |
| 2    | 0 - 7  | Command Code | 0x3A = GPS Statistics Query |
| 3-4  | 0 - 15 | CRC          |                             |

##### GPS STATISTICS RESPONSE

| BYTE  | BITS   | PARAMETER             | DESCRIPTION                                                                                                                                                                                                                                                                                  |
|-------|--------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader                | Always a value of 0xAA                                                                                                                                                                                                                                                                       |
| 1     | 0 - 7  | Length                | 0x15                                                                                                                                                                                                                                                                                         |
| 2     | 0 - 7  | Command Code          | 0x3A = GPS Statistics Query                                                                                                                                                                                                                                                                  |
| 3     | 0 - 7  | Reset Flag            | 0x00 = Device has not reset since the last time this query was issued<br>0x01 = Device has reset since the last time this query was issued                                                                                                                                                   |
| 4-5   | 0 - 15 | Grand total fixes     | Number of fixes attempted since the last reset                                                                                                                                                                                                                                               |
| 6-7   | 0 - 15 | Total fix fails       | Total number of times a fix could not be obtained within the fix timeout since the last reset.                                                                                                                                                                                               |
| 8-9   | 0 - 15 | Mean fix time         | Average time to obtain a fix over the last 16 fixes in seconds                                                                                                                                                                                                                               |
| 10-11 | 0 - 15 | Last fix time         | Time to obtain the last fix in seconds                                                                                                                                                                                                                                                       |
| 12-13 | 0 - 15 | Fix timeout           | Set fix timeout in seconds                                                                                                                                                                                                                                                                   |
| 14    | 0 - 7  | GPS Active flag       | 0 = GPS Not active<br>1 = GPS Active                                                                                                                                                                                                                                                         |
| 15-16 | 0 - 15 | Fix timeout remaining | Time remaining until the fix times out. If the GPS system is not running, will be zero                                                                                                                                                                                                       |
| 17    | 0 - 7  | Fix quality level     | 0 = no fix<br>1 = 2D fix<br>2 = 3D fix<br>3 = 3D fix and Globalstar “fix confidence” level reached.<br><br><b>NOTE:</b> Since the GPS subsystem is switched off as soon as the Globalstar Fix Confidence level is reached in normal operation, it will be rare to catch a “3” in this field. |
| 18    | 0 - 7  | Total sats.           | Total GPS satellites with a sufficient signal level to be useful, in view.                                                                                                                                                                                                                   |
| 19-20 | 0 - 15 | CRC                   |                                                                                                                                                                                                                                                                                              |

#### 4.2.2.20. “Transmitter Statistics” query.

##### TRANSMITTER STATISTICS QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION                         |
|------|--------|--------------|-------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA              |
| 1    | 0 - 7  | Length       | 0x5                                 |
| 2    | 0 - 7  | Command Code | 0x3B = Transmitter Statistics Query |
| 3-4  | 0 - 15 | CRC          |                                     |

##### TRANSMITTER STATISTICS RESPONSE

| BYTE  | BITS   | PARAMETER                 | DESCRIPTION                                                                                                                                                                                                                                                                                                                                    |
|-------|--------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader                    | Always a value of 0xAA                                                                                                                                                                                                                                                                                                                         |
| 1     | 0 - 7  | Length                    | 0x0C                                                                                                                                                                                                                                                                                                                                           |
| 2     | 0 - 7  | Command Code              | 0x3B = Transmitter Statistics Query                                                                                                                                                                                                                                                                                                            |
| 3     | 0 - 7  | Reset Flag                | 0x00 = Device has not reset since the last time this query was issued<br>0x01 = Device has reset since the last time this query was issued                                                                                                                                                                                                     |
| 4-5   | 0 - 15 | Total messages in mode    | Total messages transmitted in the current track mode, including interleaved messages.                                                                                                                                                                                                                                                          |
| 6-7   | 0 - 15 | Total Packets Transmitted | Total packets transmitted since the last reset. Rolls over at 65,535                                                                                                                                                                                                                                                                           |
| 8-9   | 0 - 15 | Total TX failures         | Total times the transmitter attempted to lock the PLL so it could transmit and the PLL would not lock<br>Any number here other than zero is a serious indication of a problem.<br>(It's possible the PLL might not lock in extreme high or low temperature conditions, but generally speaking, anything other than zero here is probably bad.) |
| 10-11 | 0 - 15 | CRC                       |                                                                                                                                                                                                                                                                                                                                                |

#### 4.2.2.21. “Set Accelerometer On/Off” Command.

This command is intended to be used ONLY in units where the hardware has been configured to connect the accelerometer to the Nordic processor. If a Motion Activated Track is running, that command will be NAK'd.

##### SET ACCELEROMETER ON/OFF COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                     |
|------|--------|--------------|---------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA          |
| 1    | 0 - 7  | Length       | 0x06                            |
| 2    | 0 - 7  | Command Code | 0x86 = Set Accelerometer On Off |
| 3    | 0 - 7  | On or off    | 0x00 = Off<br>0x01 = On         |
| 4-5  | 0 - 15 | CRC          |                                 |

#### 4.2.2.22. Accelerometer On/Off Query.

This command is intended to be used ONLY in units where the hardware has been configured to connect the accelerometer to the Nordic processor. If a Motion Activated Track is running, that command will be NAK'd.

##### SET ACCELEROMETER ON/OFF COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                       |
|------|--------|--------------|-----------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA            |
| 1    | 0 - 7  | Length       | 0x05                              |
| 2    | 0 - 7  | Command Code | 0x87 = Accelerometer On/Off Query |
| 3-4  | 0 - 15 | CRC          |                                   |

##### SET ACCELEROMETER ON/OFF COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                       |
|------|--------|--------------|-----------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA            |
| 1    | 0 - 7  | Length       | 0x06                              |
| 2    | 0 - 7  | Command Code | 0x87 = Accelerometer On/Off Query |
| 3    | 0 - 7  | On or off    | 0x00 = Off<br>0x01 = On           |
| 4-5  | 0 - 15 | CRC          |                                   |

#### 4.2.2.23. "Send Redundant Burst with GPS" command

This command is used to initiate a redundant burst message (as setup in STX configuration). Bytes 1 – 6 of the first packet of the message shall contain latitude and longitude in standard Globalstar 24-bit format. Since each on-air message must be a multiple of 9 bytes, the message will contain up to 16 9-byte packets depending on the size of the payload.

##### SET ACCELEROMETER ON/OFF COMMAND

| BYTE  | BITS   | PARAMETER       | DESCRIPTION                                                                                                                                                                             |
|-------|--------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader          | Always a value of 0xAA                                                                                                                                                                  |
| 1     | 0 - 7  | Length          | Variable 0x08 – 0x90 (144 bytes)                                                                                                                                                        |
| 2     | 0 - 7  | Command Code    | 0x33 = Send Redundant Burst with GPS.                                                                                                                                                   |
| 3     | 0 - 7  | Byte 0 value    | The value to transmit as byte 0 of first packet                                                                                                                                         |
| 4     | 0 - 7  | Byte 7 value    | The value to transmit as byte 7 of first packet                                                                                                                                         |
| 5     |        | Byte 8 value    | The value to transmit as byte 8 of first packet                                                                                                                                         |
| 6 - n |        | Additional data | Up to 135 additional bytes of data (16 9 byte packets). Maximum value of n = 141. If this number is not divisible by 9, the end of the final packet of the message will be zero padded. |
| n+1-  | 0 - 15 | CRC             |                                                                                                                                                                                         |

Example Command: AA 08 33 AA BB CC 57 C3

Where:

- Payload Byte 0: 0xAA
- Payload Byte 7: 0xBB
- Payload Byte 8: 0xCC

Example Command: AA 11 33 01 02 03 04 05 06 07 08 09 0A 0B 0C C6 8E

Where:

- Payload Byte 0: 0x01
- Payload Byte 7: 0x02
- Payload Byte 8: 0x03
- Payload Byte 9: 0x04
- Payload Byte 10: 0x05
- Payload Byte 11: 0x06
- Payload Byte 12: 0x07
- Payload Byte 13: 0x08
- Payload Byte 14: 0x09
- Payload Byte 15: 0x0A
- Payload Byte 16: 0x0B
- Payload Byte 17: 0x0C

#### SEND REDUNDANT BURST WITH GPS RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION              |
|------|--------|--------------|--------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA   |
| 1    | 0 - 7  | Length       | 5                        |
| 2    | 0 - 7  | Command Code | 0x33 = ACK or 0xFF = NAK |
| 3-4  | 0 - 15 | CRC          |                          |

Example Response: AA 05 33 C1 C7

Example Payload: 0x01**2B485DBFF02E**02030405060708090A0B0C

Where: **2B485D** is the 24-bit latitude 30.433126688004 (North)  
**BFF02E** is the 24-bit longitude -90.086903572083 (West)

See section 4.6: “24 bit location format” for documentation of the encoding/decoding of Globalstar on-air location data.

#### 4.2.2.24. “Query Location” command

This command returns the GPS coordinates and timestamp of the most recent fix obtained by the device (which might be as “old” as the track interval time). It returns zeros if no fix has been obtained since reset, or the last fix attempt failed. See section on 24-bit location format for a description of the latitude and longitude encoding.

##### QUERY LOCATION COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                   |
|------|--------|--------------|-------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA        |
| 1    | 0 - 7  | Length       | 0x05                          |
| 2    | 0 - 7  | Command Code | 0x25 = Query Location command |
| 3-4  | 0 - 15 | CRC          |                               |

This response is sent to response to a “Query Location” command.

The timestamp fields represent the exact second the fix being reported was obtained.

##### QUERY LOCATION RESPONSE

| BYTE  | BITS   | PARAMETER    | DESCRIPTION                                                                                                                                              |
|-------|--------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0 - 7  | Leader       | Always a value of 0xAA                                                                                                                                   |
| 1     | 0 - 7  | Length       | 0x11                                                                                                                                                     |
| 2     | 0 - 7  | Command Code | 0x25 = Query Location command                                                                                                                            |
| 3     |        | Month        | Value of 1 - 12                                                                                                                                          |
| 4     |        | Day          | Value of 1 – 31                                                                                                                                          |
| 5     |        | Year         | Year minus 2000. Example, 2020 is reported as 20.                                                                                                        |
| 6     |        | Hour         | 0 – 23 GMT                                                                                                                                               |
| 7     |        | Minute       | 0 - 59                                                                                                                                                   |
| 8     |        | Second       | 0 - 59                                                                                                                                                   |
| 9-11  | 0 - 23 | Latitude     | 24-Bit Signed Integer encoded Latitude. 180 degrees of latitude coded in signed binary. Byte 3 is MSB. Positive Latitude corresponds to North Latitudes. |
| 12-14 | 0 - 23 | Longitude    | 24-Bit Signed Integer encoded Longitude. 360 degrees of longitude in signed binary. Byte 6 is MSB. Positive longitude corresponds to East longitudes.    |
| 15-16 | 0 - 15 | CRC          | Will contain the response CRC                                                                                                                            |

Command: AA 05 25 76 B2

Response: AA 0C 25 2B 48 5B BF F0 2B 00 2E A1

Latitude = 0x2B485B (30.4331), Longitude = 0xBFF02B (-90.0870)

#### 4.2.2.25. “Set Lifetime” command

This command sets the lifetime of the device. Upon getting its first GPS fix after the “set lifetime” command is issued, the device will calculate an end of life date based on the value sent in this command.

##### SET LIFETIME COMMAND

| BYTE | BITS   | PARAMETER                         | DESCRIPTION                                                                                                                                      |
|------|--------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader                            | Always a value of 0xAA                                                                                                                           |
| 1    | 0 - 7  | Length                            | 0x06                                                                                                                                             |
| 2    | 0 - 7  | Command Code                      | 0x70 = Set Lifetime Command                                                                                                                      |
| 3    | 0 - 7  | Time to live, expressed in Months | Valid values are the entire span of the byte minus 1. 0 to 254 months. See description below for how the end date is calculated and interpreted. |
| 4-5  | 0 - 15 | CRC                               |                                                                                                                                                  |

This response is sent in response to a “Set Lifetime” command.

| BYTE | BITS   | PARAMETER    | DESCRIPTION                   |
|------|--------|--------------|-------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA        |
| 1    | 0 - 7  | Length       | 0x05                          |
| 2    | 0 - 7  | Command Code | 0x70 = “Set Lifetime”         |
| 3-4  | 0 - 15 | CRC          | Will contain the response CRC |

The first time the unit gets a GPS fix after this command is issued, an end date will be calculated.

The factory default lifetime is 1 month. If this command is never issued, the unit will expire 1 month after getting its first GPS fix. Until it has gotten that first fix and calculated its expiration date, any command that would cause it to transmit without first obtaining a GPS fix will be NAK'd.

A value of 0 is a special case and will cause “today” to be the end date. The device lifetime will expire, and it will cease to operate at midnight GMT on the day that it gets its first fix after this command is issued.

If the value is nonzero, the first time the unit gets a GPS fix after this command is issued it will calculate an end date, its final date of operation, that is on this day of the month, that many months hence.

If the “expiration month” has fewer days than the day it got its fix (e.g. it got its first fix on the 31st of the month and the expiration month has 30 days) the last day of the expiration month will be its last day of operation.

Once the unit has “expired”, it will not engage its satellite transmitter, and any command that would result in one or more satellite transmissions will be NAK'd. It will drop out of track mode if in track mode. Simple query commands (e. g. querying for its ESN or firmware versions) will still work.

Examples:

- Lifetime is set for 12 months and unit gets its first fix after setting the lifetime on Jan. 21, 2020: Last day of operation will be Jan 21, 2021. Beginning Jan. 22, 2021, the unit will be shutdown.
- Lifetime is set for 18 months and unit gets its first fix after setting the lifetime on Mar. 31, 2020: Last day of operation will be Sep. 30, 2021. Beginning Oct. 1, 2021, unit will be shut down.

- Lifetime is set for 1 month (or never set) and unit gets its first fix: Last day of operation will be the same day next month. If it gets a fix on the 31st of the month, and the following month has fewer than 31, days, last day of operation will be the last day of next month.

#### 4.2.2.26. “Query Lifetime Status” command

This command is used to query the lifetime status of the unit.

##### QUERY LIFETIME STATUS COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                    |
|------|--------|--------------|--------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA         |
| 1    | 0 - 7  | Length       | 0x05                           |
| 2    | 0 - 7  | Command Code | 0x71 = “Query Lifetime Status” |
| 3-4  | 0 - 15 | CRC          | Will contain the CRC           |

##### QUERY LIFETIME STATUS RESPONSE

| BYTE | BITS   | PARAMETER           | DESCRIPTION                                                                                                                                                                                                                                                               |
|------|--------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader              | Always a value of 0xAA                                                                                                                                                                                                                                                    |
| 1    | 0 - 7  | Length              | 0x0A (10 decimal)                                                                                                                                                                                                                                                         |
| 2    | 0 - 7  | Command Code        | 0x71 = Query Lifetime Status                                                                                                                                                                                                                                              |
| 3    | 0 - 7  | Programmed lifetime | The number of months for which the device was originally programmed.                                                                                                                                                                                                      |
| 4    | 0 - 7  | End Month           | Contains the month of the expiration date. If this field contains 0xFF, this indicates that the unit has not obtained a fix since the lifetime was set, and the end date has not yet been calculated. (Possible values 1 – 12 decimal).                                   |
| 5    | 0 - 7  | End Day             | Day of the month of the expiration date. If this field contains 0xFF, this indicates that the unit has not obtained a fix since the lifetime was set, and the end date has not yet been calculated. (Possible values, 1 – 31 decimal).                                    |
| 6    | 0 - 7  | End year            | The year of the device expiration. Expressed as years since 2000. E. g. 2021 is represented by “21” (decimal). If this field contains 0xFF, this indicates that the unit has not obtained a fix since the lifetime was set, and the end date has not yet been calculated. |
| 7    | 0 - 7  | Alive or Dead       | A non-zero value (typically 0xFF) indicates the device is operational. A value of 0 indicates the device has expired.                                                                                                                                                     |
| 8-9  | 0 - 15 | CRC                 | Will contain the response CRC                                                                                                                                                                                                                                             |

#### 4.2.2.27. “Set Minimum Track Rate” command

This command sets the minimum track rate that is allowed to be set with a Proprietary Track (0x30) or Motion Activated Proprietary Track (0x34).

The minimum track that can be set in any case with one of the above commands is “2” which is interpreted as 2.5 minutes (all other values that may be sent are interpreted as the actual number of minutes).

This command will not be NAK'd for values < 2 but setting this “minimum” value to less than 2 shall simply enforce the absolute minimum of 2.

The factory value for this shall be “0”.

### SET MINIMUM TRACK RATE COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                           |
|------|--------|--------------|---------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA                |
| 1    | 0 - 7  | Length       | 0x07                                  |
| 2    | 0 - 7  | Command Code | 0x84 = Set minimum track rate command |
| 3-4  | 0 - 15 | Rate         | Rate in minutes, MSB first            |
| 5-6  | 0 - 15 | CRC          |                                       |

Response: **AA 05 84 <CRC>**

**NOTE:** If a track mode (0x30, 0x34, or 0x35) is already active, this command will be NAK'd if a value of greater than the track already running is sent.

The purpose of this command is to allow a VAR to limit the minimum track interval that a customer might set so as to not over-discharge the battery and solar charging system chosen for the particular application.

#### 4.2.2.28. "Query Minimum Track Rate"

### QUERY MINIMUM TRACK RATE

| BYTE | BITS   | PARAMETER    | DESCRIPTION                       |
|------|--------|--------------|-----------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA            |
| 1    | 0 - 7  | Length       | 0x05                              |
| 2    | 0 - 7  | Command Code | 0x85 = "Query minimum track rate" |
| 3-4  | 0 - 15 | CRC          | Will contain the CRC              |

### QUERY MINIMUM TRACK RATE RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION                     |
|------|--------|--------------|---------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA          |
| 1    | 0 - 7  | Length       | 0x07                            |
| 2    | 0 - 7  | Command Code | 0x85 = Query minimum track rate |
| 3-4  | 0 - 15 | Rate         | Rate in minutes, MSB first      |
| 5-6  | 0 - 15 | CRC          |                                 |

#### 4.2.2.29. “Suspend/Unsuspend” command

The purpose of this command is to suspend tracking due to battery low, as well as to suspend tracking when the unit is in the “waiting to activate” state. If this command is issued with an argument for “full suspend” when the unit is not in track, and then a “proprietary track” command is issued while in that suspended state, this condition shall be defined as “waiting to activate” state, and the unit will begin tracking when this command is received with the “unsuspend” or “partial suspend” argument.

The Nordic processor uses this command to transition from “battery very low”, “battery low” and “battery OK” states.

#### SUSPEND/UNSUSPEND COMMAND

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                                                                                                                                 |
|------|--------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                                                                                                                                      |
| 1    | 0 - 7  | Length        | 0x06                                                                                                                                                                        |
| 2    | 0 - 7  | Command Code  | 0x80 = Suspend / Unsuspend                                                                                                                                                  |
| 3-4  | 0 - 7  | Mode argument | 0x00 = Full Suspend stop tracking messages completely<br>0x01 = Partial suspend reduce tracking rate to low battery rate<br>0x02 = Unsuspend. Track at normal tracking rate |
| 5-6  | 0 - 15 | CRC           |                                                                                                                                                                             |

Response: **AA 05 80 <CRC>**

#### 4.2.2.30. Suspended State query

#### SUSPENDED STATE QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION                  |
|------|--------|--------------|------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA       |
| 1    | 0 - 7  | Length       | 0x05                         |
| 2    | 0 - 7  | Command Code | 0x81 = Suspended state query |
| 3-4  | 0 - 15 | CRC          | Will contain the CRC         |

#### SUSPENDED STATE QUERY RESPONSE

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                                                                                                                                 |
|------|--------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                                                                                                                                      |
| 1    | 0 - 7  | Length        | 0x06                                                                                                                                                                        |
| 2    | 0 - 7  | Command Code  | 0x81 = Suspended state query                                                                                                                                                |
| 3-4  | 0 - 7  | Mode argument | 0x00 = Full Suspend stop tracking messages completely<br>0x01 = Partial suspend reduce tracking rate to low battery rate<br>0x02 = Unsuspend. Track at normal tracking rate |
| 5-6  | 0 - 15 | CRC           |                                                                                                                                                                             |

#### 4.2.2.31. “Set Low Battery Rate” command

This command sets the rate to drop to in a low battery condition.

If a track mode (by 0x30, 0x34, or 0x35) is already running, this command will be NAK'd if the rate is less than the already running rate.

Sending a 0x30, 0x34, or 0x35 command with a rate greater than the rate specified by this command will cause those commands to be NAK'd.

##### SET LOW BATTERY RATE COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION                               |
|------|--------|--------------|-------------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA                    |
| 1    | 0 - 7  | Length       | 0x07                                      |
| 2    | 0 - 7  | Command Code | 0x82 = Set low battery track rate command |
| 3-4  | 0 - 15 | Rate         | Rate in minutes, MSB first                |
| 5-6  | 0 - 15 | CRC          |                                           |

Response: **AA 05 82 <CRC>**

#### 4.2.2.32. “Query Low Battery Rate”

##### QUERY LOW BATTERY RATE

| BYTE | BITS   | PARAMETER    | DESCRIPTION                     |
|------|--------|--------------|---------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA          |
| 1    | 0 - 7  | Length       | 0x05                            |
| 2    | 0 - 7  | Command Code | 0x83 = Query battery track rate |
| 3-4  | 0 - 15 | CRC          |                                 |

##### QUERY LOW BATTERY RATE RESPONSE

| BYTE | BITS   | PARAMETER    | DESCRIPTION                         |
|------|--------|--------------|-------------------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA              |
| 1    | 0 - 7  | Length       | 0x07                                |
| 2    | 0 - 7  | Command Code | 0x83 = Query low battery track rate |
| 3-4  | 0 - 15 | Rate         | Rate in minutes, MSB first          |
| 5-6  | 0 - 15 | CRC          |                                     |

#### 4.2.2.33. “Turn On GPS” command

This command will turn on the GPS engine and once a fix is obtained, the location will be available in memory for later querying. Use the “Query GPS Statistics” command to monitor the progress of the GPS engine. Once a fix is indicated, use the “Turn Off GPS” command to power down the GPS engine.

##### TURN ON GPS

| BYTE | BITS   | PARAMETER        | DESCRIPTION            |
|------|--------|------------------|------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA |
| 1    | 0 - 7  | Length           | 0x06                   |
| 2    | 0 - 7  | Command Code     | 0xFD                   |
| 3    | 0 - 7  | Sub Command Code | 0x21 (Turn On GPS)     |
| 4-5  | 0 - 15 | CRC              |                        |

Command: **AA 06 FD 21 6F A8**

Response: **AA 05 FD B3 E8**

#### 4.2.2.34. “Turn Off GPS” command

This command will turn off the GPS engine.

##### TURN OFF GPS

| BYTE | BITS   | PARAMETER        | DESCRIPTION            |
|------|--------|------------------|------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA |
| 1    | 0 - 7  | Length           | 0x06                   |
| 2    | 0 - 7  | Command Code     | 0xFD                   |
| 3    | 0 - 7  | Sub Command Code | 0x22 (Turn Off GPS)    |
| 4-5  | 0 - 15 | CRC              |                        |

Command: **AA 06 FD 22 F4 9A**

Response: **AA 05 FD B3 E8**

#### 4.2.2.35. “Turn On GPS Pass-through” command

This command will turn on the GPS engine and will output the NMEA messages from the GPS engine over the Bluetooth GATT connection. The NMEA messages conform to NMEA-0183 rev. 3.0. The NMEA messages are in hex format and may need to be converted to ASCII for readability. The following NMEA messages are output at a one second update rate:

- GPRMC
- GNRMC
- GPGGA
- GNGGA
- GPGSA
- GNGSA
- GPGSV
- GPGLL
- GNGLL

**NOTE:** Depending on GPS engine configuration and status of the fix, all message types shown here may or may not be present. For example, the ST100 board is shipped with its GPS engine configured to obtain location using both GPS and GLONASS constellations. This results in several messages types (for example, GNGGA and GNGSA) to have an “N” as the second character, indicating that the data within those messages was calculated from “aNy” satellite constellation. Calculation from GPS only would result in a “P” in that position (for “gPs”).

#### TURN ON GPS PASS-THROUGH

| BYTE | BITS   | PARAMETER        | DESCRIPTION                     |
|------|--------|------------------|---------------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA          |
| 1    | 0 - 7  | Length           | 0x06                            |
| 2    | 0 - 7  | Command Code     | 0xFD                            |
| 3    | 0 - 7  | Sub Command Code | 0x00 (Turn On GPS Pass-through) |
| 4-5  | 0 - 15 | CRC              |                                 |

Command: **AA 06 FD 00 E4 98**

Response: **AA 05 FD B3 E8**

Example NMEA messages:

\$GNRMC,204738.00,A,3028.62674,N,09003.83218,W,0.132,,100420,,,A\*73

\$GNVTG,,T,,M,0.132,N,0.244,K,A\*3F

\$GNGGA,204738.00,3028.62674,N,09003.83218,W,1,06,1.59,11.0,M,-27.3,M,,\*48

\$GNGSA,A,3,17,30,07,06,03,,,,,,,,,2.83,1.59,2.34\*1A

\$GNGSA,A,3,79,,,,,,,,,2.83,1.59,2.34\*13

\$GPGSV,3,1,09,01,31,046,20,03,13,101,27,06,22,200,32,07,24,163,23\*74

\$GPGSV,3,2,09,11,05,046,,13,16,263,25,15,01,287,,17,62,305,18\*76

\$GPGSV,3,3,09,30,54,184,36\*4A

\$GNGLL,3028.62674,N,09003.83218,W,204738.00,A,A\*6D

#### 4.2.2.36. “Turn Off GPS Pass-through” command

This command will turn off the GPS engine and will cease of the NMEA messages from the GPS engine to the serial port.

##### TURN OFF GPS PASS-THROUGH

| BYTE | BITS   | PARAMETER        | DESCRIPTION                      |
|------|--------|------------------|----------------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA           |
| 1    | 0 - 7  | Length           | 0x06                             |
| 2    | 0 - 7  | Command Code     | 0xFD                             |
| 3    | 0 - 7  | Sub Command Code | 0x20 (Turn Off GPS Pass-through) |
| 4-5  | 0 - 15 | CRC              |                                  |

Command: **AA 06 FD 20 E6 B9**

Response: **AA 05 FD B3 E8**

### 4.3. ST100 BOARD SELF-TEST COMMAND

This command is used to initiate an internal self-test of the ST100 BOARD. When this command is received by the ST100 board, there will be a 2 - 5 second delay before the response is returned (self-test in progress).

Note that as a binary command to the ASIC, this is specifically a self-test of the ASIC. The following operations are tested:

- A test transmission is sent, testing the transmitter and oscillator operation from end to end.
- The GPS is powered up and checked that it is generating correctly formatted and readable NMEA messages. As the “view of the sky” cannot be known, only communication to the GPS is tested, not signal strengths.
- The I2C link to the Accelerometer is tested for proper communication to the accelerometer.
- **NOTE:** If the custom hardware configuration is ordered wherein the accelerometer is connected to the Nordic processor rather than to the ASIC processor, this portion of the self-test will indicate a fail.

#### SELF-TEST COMMAND

| BYTE | BITS   | PARAMETER        | DESCRIPTION              |
|------|--------|------------------|--------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA   |
| 1    | 0 - 7  | Length           | 0x06                     |
| 2    | 0 - 7  | Command Code     | 0xFD                     |
| 3    | 0 - 7  | Sub Command Code | 0x0E (Perform Self Test) |
| 4-5  | 0 - 15 | CRC              |                          |

Example Command: AA 06 FD 0E 9A 71

#### TRANSMITTER SELF-TEST RESPONSE

| BYTE | BITS   | PARAMETER        | DESCRIPTION                                                                                                                                                                                            |
|------|--------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader           | Always a value of 0xAA                                                                                                                                                                                 |
| 1    | 0 - 7  | Length           | 0x07                                                                                                                                                                                                   |
| 2    | 0 - 7  | Command Code     | 0xFD                                                                                                                                                                                                   |
| 3    | 0 - 7  | Sub Command Code | 0x0E (Perform Self-Test)                                                                                                                                                                               |
| 4    | 0 - 7  | Result Code      | The following bit flags indicate a pass or fail of each subsystem.<br>0x01 = Transmitter (0 = failed 1 = passed)<br>0x02 = GPS (0 = failed 1 = passed)<br>0x04 = Accelerometer (0 = failed 1 = passed) |
| 5-6  | 0 - 15 | CRC              |                                                                                                                                                                                                        |

## 4.4. HEALTH STATUS MESSAGING

The Health Status Message reports the current settings and condition of the device. The message generation interval is configurable from 1-30 days, with a default interval of 30 days. One message per month is generated at no charge, shorter intervals are charged according to the device plan.

**NOTE:** One message per month minimum, cannot be set to zero.

The device health check message length is 2 packets (18 bytes).

**HEALTH CHECK MESSAGE PACKET 1**

| BYTE | BITS | PARAMETER                    | DESCRIPTION                                                                                                                                                                                                                                               |
|------|------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 2    | Type 3 Message Category      | Bit (1:0) = 3 Non Standard Message Type                                                                                                                                                                                                                   |
|      | 6    | Message Subtype              | Bit (7:2) = 31 = 0x1F - OTA Health Check Message                                                                                                                                                                                                          |
| 1    | 4    | Number of Bursts per Message | Bits (3:0) = Number of Bursts/Transmissions. Range is 1 to 5 Transmissions. Number of bursts per message the device will attempt.                                                                                                                         |
|      | 1    | Battery Condition            | Bit 4: 0 = Battery OK; 1 = Battery LOW. Set to 1 if not full, not normal, or not charging.                                                                                                                                                                |
|      | 1    | GPS Subsystem Fault          | Bit 5: 0 = GPS system OK; 1 = Fault. Set to 1 if a GPS hardware error is detected.                                                                                                                                                                        |
|      | 1    | Transmitter Subsystem Fault  | Bit 6: 0 = Transmitter OK; 1 = Fault. Set to 1 if an ASIC hardware error is detected.                                                                                                                                                                     |
|      | 1    | Line Powered                 | Bit 7: Reserved. Not used in the ST100.                                                                                                                                                                                                                   |
| 2-4  | 24   | FW Version                   | Byte 2: Major FW , Byte 3: Minor FW, Byte 4: Patch FW Version.                                                                                                                                                                                            |
| 5    | 8    | Number of GPS Fails          | Unsigned binary count of failed GPS attempts since last Diagnostics Message. It shall be cleared after Diagnostics Message is sent. MSB first.                                                                                                            |
| 6-7  | 16   | Number of Transmissions      | Number of transmissions since last Diagnostics Message. It shall be cleared after Diagnostics Message is sent. MSB first. Can also be used to determine a percentage of transmissions that are succeeding based on how many have been received to the BO. |
| 8    | 8    | Mean GPS Fix Time            | Mean time to get a GPS Fix since last health check message was sent. Cleared each time the health check is sent.                                                                                                                                          |

**HEALTH CHECK MESSAGE PACKET 2**

| BYTE | BITS | PARAMETER                         | DESCRIPTION                                                             |
|------|------|-----------------------------------|-------------------------------------------------------------------------|
| 0-1  | 16   | Bluetooth Sensor Connection Count | Not used in the ST100.                                                  |
| 2    | 1    | Board Reset                       | 0 - Board not reset since last HSM; 1 - Board was reset since last HSM. |
|      | 7    |                                   | Reserved.                                                               |
| 3-4  | 16   | Device Metadata                   | Reserved for configuration details of future products.                  |
| 5-8  | 32   | Reserved                          | Reserved.                                                               |

## 4.5. BOOTLOADING. FIELD UPDATE OF DEVICE FIRMWARE

The following are typical firmware update times using the “ST100 Configuration App” tool (available in the Google Play and Apple Store):

### Android App:

|         |         |
|---------|---------|
| Nordic: | 2 mins  |
| ASIC:   | 15 mins |

### iOS App:

|         |         |
|---------|---------|
| Nordic: | 2 mins  |
| ASIC:   | 15 mins |

### 4.5.1. NORDIC NRF52832 FIRMWARE UPDATE VIA BOOTLOADER (“BUTTONLESS” DFU)

The Nordic Bluetooth Low Energy application is written to support the Nordic Buttonless DFU (Device Firmware update) bootloader. The Nordic DFU app for Android or IOS can be used to update the firmware.

It is essential that any custom firmware written by an OEM or VAR include the DFU library, provided with the Globalstar ST100 SDK, to support this functionality.

### 4.5.2. ON AX50324 FIRMWARE UPDATE VIA SERIAL BOOTLOADER

The AX50324 mixed signal ASIC is updated over the Bluetooth Low Energy (BLE) GATT/Modem interface, using binary commands in the same format described in section 4.2.

Globalstar provides an Android and IOS app that encapsulates the functionality of the Nordic DFU app and adds a loader that utilizes the protocols below to flash applications into the AX50324 processor. This app can be used to update either processor on an ST100 board.

The binary commands relevant to bootloading the AX50324 ASIC are outlined here:

#### 4.5.2.1. 0x60 “Enter Bootloader Command”

This command causes the application to jump into the bootloader.

#### JUMP TO BOOTLOADER

| BYTE | BITS   | PARAMETER    | DESCRIPTION            |
|------|--------|--------------|------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA |
| 1    | 0 - 7  | Length       | 0x05                   |
| 2    | 0 - 7  | Command Code | 0x60                   |
| 3-4  | 0 - 15 | CRC          |                        |

Jump to bootloader response:

If you issue this command from the application, the response will be a simple echo of the command, and then the ASIC processor will reset and come back up in the bootloader. You must delay for about one second to allow the bootloader to begin running before issuing the next command.

If this command is issued when already in the bootloader, it causes a commitment to re-load an application. In other words, if you issue this command in the application, but not again, you can issue “0x62” (see below) to jump right back into the application. However, if you issue 0x60 in the application, and then again in the bootloader, you have committed to load a new application, A response of length 6 will be returned with a condition code as follows:

#### JUMP TO BOOTLOADER RESPONSE

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|--------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1    | 0 - 7  | Length        | 0x06                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2    | 0 - 7  | Command       | 0x60                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3    | 0 - 7  | Response Code | 0xFF = Bootloader is running and application area is blank or not completely loaded.<br>0x03 = Bootloader is running and new executable code has been loaded during this execution of the bootloader, bootloader is ready to jump to application if commanded.<br>0x02 = Bootloader is running but application code that existed when the bootloader started is still in place. However, having issued this command again, you have now committed to re-load the application. |
| 4-5  | 0 - 15 | CRC           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

#### 4.5.2.2. 0x61 “Flash One Line”

This command is used to flash one line from an Intel HEX format file into the program memory of the processor. As the table below illustrates, there is roughly a 1 to 1 correspondence between fields within the Intel Hex Record line, and fields within this message. The ASCII represented HEX values within the Intel Hex file are represented as binary numbers in this binary record.

The Wikipedia article on the Intel Hex format may be the best reference available for concise description of the Intel Hex format: [https://en.wikipedia.org/wiki/Intel\\_HEX](https://en.wikipedia.org/wiki/Intel_HEX)

#### FLASH ONE LINE MESSAGE

| BYTE    | BITS     | PARAMETER        | DESCRIPTION                                                                                                                                                                                                                                      |
|---------|----------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0       | 0 - 7    | Leader           | Always a value of 0xAA                                                                                                                                                                                                                           |
| 1       | 0 - 7    | Length           | Length contains the length of this entire binary message, including CRC (as in all other message of this protocol). It will be “byte count” (byte 4 value, below) +10                                                                            |
| 2       | 0 - 7    | Command          | 0x61                                                                                                                                                                                                                                             |
| 3       | 0 - 7    | Processor Number | Must be 0 for the ST100 Board ASIC                                                                                                                                                                                                               |
| 4       | 0 - 7    | Byte Count       | The “byte count” field (the first 2-digit hex number) of the Intel Hex Record line goes here (as a binary value).                                                                                                                                |
| 5-6     | 0 - 15   | Address          | The start address of this hex record. (The 2 bytes represented by the 4 hex characters of the Intel Hex Record line goes here as a binary value.)                                                                                                |
| 7       | 0 - 7    | Record Type      | The “Record Type” field of the Intel Hex record                                                                                                                                                                                                  |
| 8-n     | variable | Data             | The data fields of the Intel Hex record. Number of bytes in this portion will be equal to the value in byte 4 (byte count) Note, the “checksum” field of the HEX record is omitted as its function is provided by the CRC field of this message. |
| n+1-n+2 | 0 - 15   | CRC              |                                                                                                                                                                                                                                                  |

There are some special behaviors of the bootloader when receiving this message type to be aware of:

- The first “0x61” type command the bootloader receives after it is entered causes it to erase the existing application and write the data in the “0x61” message to the specified address in flash. As a result of the page-by-page erase taking some time, the ACK of the first message may take up to 2 seconds to return. ACK’s of subsequent “0x61” messages will return almost immediately, as the bootloader is simply writing the subsequent data to the already-erased flash. If the bootloader is entered and no “0x61” bootloader may be exited and the application re-run. Once a “0x61” message is sent, the user has committed to load the complete application before jumping out of the bootloader.
- The “end of file” marker in every Intel Hex file looks like this: “:00000001FF”. This marker encodes an address of 0, a byte count of 0, a “record type” of 0x01 (End of File), (and a checksum of 0xFF). When the end of the Intel Hex file is reached, this marker must be encoded by the user application into a “0x61” message via the format in the table above and sent to the device. When the bootloader encounters this marker, it verifies the validity of the application, calculates a CRC/Signature for the application, and sets its internal flags to indicate that the application is valid and OK to jump to. As this check and calculation takes some time, the transmission of this marker will result in the ACK taking up to 2 seconds to return and the loading application must be accepting of that delay.

Response to the Flash One Line message:

#### FLASH ONE LINE MESSAGE RESPONSE

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|--------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1    | 0 - 7  | Length        | 0x06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2    | 0 - 7  | Command       | 0x61                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3    | 0 - 7  | Response Code | <p>Response codes with the MSB set are “NAKs” or “fails” and indicate that the bootloader didn’t do anything with the record. Codes without the MSB set are various success codes, indicating that the message was acted on as expected.</p> <p>0x01 = OK but not done loading. (Returned for each line loaded until End of File is received.)</p> <p>0x00 = OK and done. (This is the response to End of File when loaded code has passed acceptance tests.</p> <p>0xF0 = Address outside of application memory range. (In the ST100 board, this code is also returned if “processor number” is not 0.)</p> <p>0xFF = Message format error or unknown error.</p> |
| 4-5  | 0 - 15 | CRC           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

#### 4.5.2.3. 0x62 “Enter Application”

#### ENTER APPLICATION COMMAND

| BYTE | BITS   | PARAMETER    | DESCRIPTION            |
|------|--------|--------------|------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA |
| 1    | 0 - 7  | Length       | 0x05                   |
| 2    | 0 - 7  | Command Code | 0x62                   |
| 3-4  | 0 - 15 | CRC          |                        |

Enter application response:

#### ENTER APPLICATION RESPONSE

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------|--------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1    | 0 - 7  | Length        | 0x06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2    | 0 - 7  | Command       | 0x62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 3    | 0 - 7  | Response Code | <p>0x00 = OK booting application</p> <p>0xF0 = CRC/Signature failed. If this is received, the bootloader “believed” it had a valid application loaded but a re-check of the CRC/Signature failed. (This should be quite rare and indicates a significant glitch occurred during the loading process, or the device has bad flash memory.)</p> <p>0xFF = Other error. Usually returned because the application flash area is blank, or an incomplete application is loaded. This will occur if the “0x61” command is used to load some of the file, but the “End of File” marker was never seen.</p> <p>If either 0xFF or 0xF0 are received, the user should attempt to load the application again.</p> |
| 4-5  | 0 - 15 | CRC           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

#### 4.5.2.4. 0x63 “Status Query”

A query to determine if the bootloader is running, or the application is running. Response code will be 0x00 if the application is running, and 0x05 if the bootloader is running.

#### BOOTLOADER/APPLICATION STATUS QUERY

| BYTE | BITS   | PARAMETER    | DESCRIPTION            |
|------|--------|--------------|------------------------|
| 0    | 0 - 7  | Leader       | Always a value of 0xAA |
| 1    | 0 - 7  | Length       | 0x05                   |
| 2    | 0 - 7  | Command Code | 0x63                   |
| 3-4  | 0 - 15 | CRC          |                        |

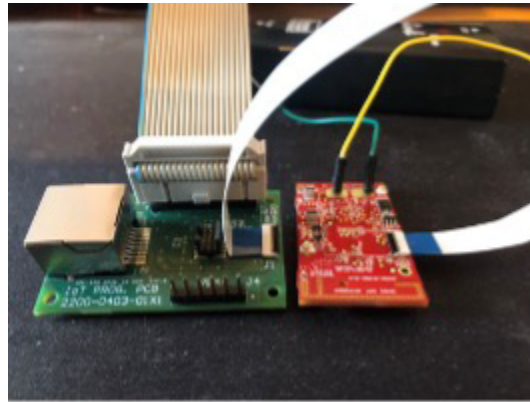
#### ENTER APPLICATION RESPONSE

| BYTE | BITS   | PARAMETER     | DESCRIPTION                                                        |
|------|--------|---------------|--------------------------------------------------------------------|
| 0    | 0 - 7  | Leader        | Always a value of 0xAA                                             |
| 1    | 0 - 7  | Length        | 0x06                                                               |
| 2    | 0 - 7  | Command       | 0x63                                                               |
| 3    | 0 - 7  | Response Code | <p>0x00 = Application running</p> <p>0x05 = Bootloader running</p> |
| 4-5  | 0 - 15 | CRC           |                                                                    |

### 4.5.3. JTAG PROGRAMMING KIT

Globalstar offers as an accessory a JTAG programming kit. This kit contains a custom JTAG programming board and all necessary cables to connect between a ST100 board and a JTAG programming unit (such as the Segger Programmer). The programming kit allows a user to program the ST100's Nordic processor at a low level without the bootloader. Reference Globalstar document 8545-0223-01 ST100 Manual Upgrade Procedure for details. It is most strongly recommended that if this method is used, that a combined image, with application and bootloader merged, be loaded so that the device remains field-upgradable later.

Globalstar part number: 2300-0403-01



A JTAG programmer may be connected by a standard JTAG connector to the JTAG input of this breakout board.

### 4.5.4. NORDIC LOW-LEVEL LOAD VIA JTAG

Using the breakout board above, the Nordic can be programmed and debugged through a compatible JTAG programmer. Globalstar recommends Segger Studio as the development and debugging environment for this processor. The Nordic processor can also be programmed via Nordic's NRF Go Studio application.

### 4.5.5. ON AX50324 LOW-LEVEL LOAD VIA AXSEM PROPRIETARY PROGRAMMING INTERFACE.

The AX50324 processor is programmed via an AXSEM proprietary programming board and the Axldb proprietary Axsem debugger. These devices are available from ON Semiconductor: <https://www.onsemi.com/support/evaluation-board/axdbg-2-gevk>

## 4.6. EXAMPLE CRC CALCULATION ROUTINES FOR SERIAL PACKETS

**NOTE:** When using the “raw” command to send individual messages, the CRC is OMITTED. The Nordic processor firmware calculates and appends the correct CRC to the message going to the ASIC processor.

The following example is written in the C programming language where:

int = 32 bits, short = 16 bits, char = 8 bits

```

unsigned short crc16_lsb(unsigned char *pData, int length)
{
    unsigned char i; unsigned short data, crc;

    crc = 0xFFFF;

    if (length == 0) return 0;

    do
    {
        data = (unsigned int)0x00FF & *pData++; crc = crc ^ data;

        for (i = 8; i > 0; i--)
        {
            if (crc & 0x0001) crc = (crc >> 1) ^ 0x8408; else crc >>= 1;
        }
    }while (--length);

    crc = ~crc;

    return (crc);
}

```

**USAGE:**            **calculate the CRC for a message and update the message CRC**

```

unsigned short crc = crc16_lsb(msg, msg [1]- 2); msg
[msg [1]- 2] = (unsigned char) (crc&0xFF); msg [msg [1]-
1] = (unsigned char) (crc>>8);

```

The following example is written in the Java programming language:

```
char crc16_lsb(byte pData[], int length)
{
    int pData_i = 0; char s1,s2; byte i;
    char data, crc;

    crc = (char) 0xFFFF; if (length == 0) return 0;
    do
    {
        data = (char)((char)0x00FF & pData[pData_i++]); crc = (char)(crc ^ data); for (i = 8; i > 0; i--)
        {
            if ((crc & 0x0001) != 0) crc = (char)((crc >> 1) ^ 0x8408);
            else

                crc >>= 1;

        }
    }while (--length != 0);

    crc = (char)~crc;

    return (crc);
}
```

**USAGE:**      **calculate the CRC for a message and update the message CRC**

```
msg[]; int len; char crc = crc16_lsb(msg,len- 2);
msg[len- 2] = (byte)((short)crc & (short)0xff); msg[len-
1] =
(byte)((short)crc >> 8);
```

## 4.7. 24-BIT LOCATION FORMAT

The 24-bit format used for latitude and longitude encodes 180 degrees of LATITUDE as a 24-bit (3-byte) signed integer and 360 degrees of LONGITUDE as a 24-bit (3-byte) signed integer.

### 4.7.1. CALCULATING LATITUDE

Latitude may be calculated by converting the 3 encoded latitude bytes represented in hexadecimal to a decimal number and multiplying this decimal integer by the DEGREES\_PER\_COUNT\_LAT conversion factor.

$$\text{DEGREES\_PER\_COUNT\_LAT} = 90.0 / 223$$

Since the latitude is signed and can range from -90 to 90 degrees, if the above result is greater than or equal to 90 degrees, 180 must be subtracted from the result.

Negative Latitude corresponds to Latitude in the SOUTHERN Hemisphere. Positive Latitude corresponds to Latitude in the NORTHERN Hemisphere.

Latitude Calculation Example:

24-bit latitude: 0x2AB69C (Hexadecimal)

This number converted to decimal (base 10) is: 2,799,260.

$$2,799,260 * (90.0 / 223) = 30.032802$$

Since this result is less than 90 degrees, no subtraction is necessary.

$$30.032802 \text{ degrees} = 30.032802 \text{ degrees NORTH}$$

### 4.7.2. CALCULATING LONGITUDE

The longitude may be calculated by converting the 3 encoded longitude bytes represented in hexadecimal to a decimal number. This decimal integer is multiplied by the DEGREES\_PER\_COUNT\_LONG conversion factor.

$$\text{DEGREES\_PER\_COUNT\_LONG} = 180.0 / 223$$

If the above result is greater than or equal to 180 degrees, 360 must be subtracted from the result since the longitude is signed and can range from -180 to 180 degrees.

Negative Longitude corresponds to Longitude in the WESTERN Hemisphere.

Positive Longitude corresponds to Longitude in the EASTERN Hemisphere.

Longitude Calculation Example:

24-bit longitude: 0xBFF46B (Hexadecimal)

This number converted to decimal (base 10) is: 12,579,947.

$$12,579,947 * (180.0 / 223) = 269.936378$$

Since this result is greater than 180 degrees, subtract 360 degrees from the result to create the correct signed representation.

$$69.936378 \text{ degrees} - 360 \text{ degrees} = -90.063622 \text{ degrees} = 90.063622 \text{ degrees WEST}$$

## 4.8. FLASH MEMORY MAP

Below is the memory map of a Nordic nRF52832 from its data sheet.

| USAGE                               | MEMORY RANGE NRF52832<br>(S132 V6.1.X) | MEMORY RANGE NRF52840<br>(S140 V6.1.X) | MEMORY RANGE NRF52810<br>(S112 V6.1.X) |
|-------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| Bootloader settings                 | 0x0007 F000 - 0x0008 0000 (4 kB)       | 0x000F F000 - 0x0010 0000 (4 kB)       | 0x0002 F000 - 0x0003 0000 (4 kB)       |
| MBR parameter storage               | 0x0007 E000 - 0x0007 F000 (4 kB)       | 0x000F E000 - 0x000F F000 (4 kB)       | 0x0002 E000 - 0x0002 F000 (4 kB)       |
| Bootloader                          | 0x0007 8000 - 0x0007 E000 (24 kB)      | 0x000F 8000 - 0x000F E000 (24 kB)      | 0x0002 8000 - 0x0002 E000 (24 kB)      |
| Application area (incl. free space) | 0x0002 6000 - 0x0007 8000 (328 kB)     | 0x0002 6000 - 0x000F 8000 (840 kB)     | 0x0001 9000 - 0x0002 8000 (60 kB)      |
| SoftDevice                          | 0x0000 1000 - 0x0002 6000 (148 kB)     | 0x0000 1000 - 0x0002 6000 (148 kB)     | 0x0000 1000 - 0x0001 9000 (96 kB)      |
| Master Boot Record (MBR)            | 0x0000 0000 - 0x0000 1000 (4 kB)       | 0x0000 0000 - 0x0000 1000 (4 kB)       | 0x0000 0000 - 0x0000 1000 (4 kB)       |

FIGURE 7 - NORDIC MEMORY MAP

- The sections marked in red are fixed and cannot be used to store application specific data. The section marked in green can be used to store application data.
- The total available space for application is 328kB (code + data)
- Total memory consumption calculation for Globalstar IoT board

- **Location Logging:**
  1. **Size of each data element:** 12 Bytes (3 for Lat, 3 for Long , 4 for Timestamp & 2 bytes padding)
  2. **Total number of data elements:** 8.4 (years) \* 365 (days) \* 4 (Tx per day) = 12276 datapoints
  3. **Total space needed for GPS section:** 147456 Bytes
  4. **Location log section start address:** 0x00054000
  5. **Location log section end address:** 0x00077FFF
  6. **Percentage Used:** 0%
- **Estimate for Application Code size:** As of now the application size stands at 98560 Bytes. We assume that it will grow to approximately double. So, the allocation will be considered to be 180kB to **NOTE:** This is an assumption
  1. **Current size of application:** 135215 Bytes
  2. **Total size of application:** ?176128? Bytes
  3. **Application section start address:** 0x00026000
  4. **Application section end address:** 0x00050FFF
  5. **Percentage Used:** 76.77%
- **Debug Logging:** This section is allocated to the left over of the application part in the flash space. Total section that would be left is 80kB. This is assumed to be used for debug logging but, can be used elsewhere if need be
  1. **Total size of debug log section:** 8192 Bytes
  2. **Debug log section start address:** 0x00052000
  3. **Debug log section end address:** 0x00053FFF
  4. **Percentage Used:** 0%
- **Config Page:** This section contains the config data for ST100
  1. **Total size of debug log section:** 4096 Bytes
  2. **Debug log section start address:** 0x00051000
  3. **Debug log section end address:** 0x00052FFF
  4. **Percentage Used:** 100%
- Flash Layout Diagram:
- All the above flash details are diagrammatically expressed in the flash layout diagram below.



FIGURE 8 - FLASH LAYOUT DIAGRAM

**NOTE:** A custom Nordic application could change or eliminate the logging sections and relocate the config page if desired to create additional code space.

## 5. TEST MODES

### 5.1. HARDWIRED METHOD

The ST100 Board provides several test modes intended to aid in manufacturing testing and certification testing. All test modes are activated by grounding selective pins on the ST100 BOARD prior to applying power. Once power is applied, the ST100 Board will sample the states of the pins and based on the states of the pins, the ST100 BOARD will enter the selected test mode. For normal operation these pins must be left floating or in a high (logic 1) state.

A typical implementation is to rig small switches to these pins so that turning the switch on connects the pins to ground. Such a “rigged” board is then sent to the regulatory test house with instructions on how to set the switches to enable each mode. The switches should be set to select the desired mode, then power applied, then measurements taken. Power should be switched off before selecting another mode.

In the table below, the **TEST1**, **TEST2**, **RX** and **RTS** pins come up on the board as follows.

**TEST1** – On Test Point 28 and edge connector pin 7.

**TEST2** – On Test Point 29 and edge connector pin 6.

**RX** – On Test Point 46

**RTS** – On Test Point 15

The following tables define the different test modes available in the ST100 Board.

**TABLE 9 - ST100 TEST MODES**

| TEST1 | TEST2 | MODE                                                                                                                                                                                                                                                                                                                  |
|-------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0     | <b>Mod Mode</b> (continuous transmission) - A test packet is continuously transmitted until power is removed from the board. The test packet shall comply with the Air Interface Packet format with a user information equal to the hex stream 0x80AAFOFOAAFOFOFO where the most significant bit is transmitted first |
| 0     | 1     | <b>Test Packet</b> - The test packet shall comply with the Air Interface Packet format with a user information equal to the hex stream 0x80AAFOFOAAFOFOFO where the most significant bit is transmitted first                                                                                                         |
| 1     | 0     | <b>CW mode</b> - An un-modulated carrier is continuously transmitted.                                                                                                                                                                                                                                                 |
| 1     | 1     | Normal Operation                                                                                                                                                                                                                                                                                                      |

The channels are selected via the Rx and RTS pins as follows.

**TABLE 10 - ST100 CHANNELS**

| RX | RTS | CHANNEL                                                                                                                                                        |
|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0  | 0   | B                                                                                                                                                              |
| 0  | 1   | C                                                                                                                                                              |
| 1  | 0   | Reserved                                                                                                                                                       |
| 1  | 1   | Channel specified in the flash setup. To specify channel A, it must be the default channel specified in the flash setup. See <b>Setup</b> command for details. |

## 5.2. SOFT COMMAND METHOD

**WARNING:** The **only** way to stop Mod Mode and CW Mode is to power cycle the unit. To perform the tests listed in this section the battery must be disconnected, and the battery terminals be connected to a power supply supplying between 3.4 and 5.5VDC, capable of delivering 500mA. Mod Mode and CW mode are terminated by switching off the power supply.

The smartphone configuration application in “advanced” mode is used to issue the following commands.

### 5.2.1. STEP 1: ENABLE THE REGULATORY TEST MODES.

These modes are disabled by default from the factory, to prevent them from being accidentally activated on a unit in the field. Using the configuration application in “advanced” mode:

- Tap the “auth” button
- Send the command: “raw aa0676d4”
- Watch for the ACK, which should be “aa0576” and 2 bytes of CRC

### 5.2.2. STEP 2: SET THE CHANNEL THAT YOU WISH TO PERFORM THE TEST ON.

Use the “setup” command for this. Using the configuration application in “advanced” mode:

- Tap the “auth” button.
- Send the command: “setup <ch> 2 60 120”
- Where “<ch> =
  - 0 = Channel A
  - 1 = Channel B
  - 2 = Channel C

### 5.2.3. STEP 3: START THE DESIRED MODE.

Using the configuration application in “advanced” mode:

Tap the “auth” button.

- For CW Mode, send the command: “raw aa06fc01”
- For Mod Mode, send the command: “raw aa06fc03”
- To send a single test packet, send the command: “raw aa06fc02”
- When entering each of the commands above, you should see an ACK: “aa05fc” and 2 bytes of CRC

Repeat steps 2 and 3 for the tests you want to perform on each channel.

#### 5.2.4. STEP 4: DISABLE THE TEST COMMANDS.

After turning the power off following the last test, use the configuration application in “advanced” mode to do the following:

- Tap the “auth” button.
- Send the command: “raw aa067600”
- Watch for the ACK, which should be “aa0576” and 2 bytes of CRC

#### 5.2.5. STEP 5: RESTORE THE DESIRED SETUP.

Using the configuration application in “advanced” mode:

- Tap the “auth” button.
- For CW Mode, send the command: “raw aa06fc01”
- Tap the “auth” button.
- Send the command: “setup <ch> <transmit attempts> <min time between attempts> <max time between attempts>”
- **NOTE:** Factory default settings are: “setup 0 3 60 120”

## 6. ANTENNA TUNING GUIDANCE

### 6.1. POWER REQUIREMENTS FOR AN EXTERNAL ANTENNA TO MAINTAIN SPECIFIED EIRP

Globalstar has used complex computer simulations to establish the required link budget for Simplex devices. Globalstar link budget calculations are used for diagnostic purposes and to establish the workable EIRP spec, referenced below.

Due to movement of the satellites, the ability to serve users from diversity links, the internetworking of rake receivers, it is not possible to make meaningful static link budget calculations. Link budget analyses are useful for trend analysis and for comparing various system design changes. However, they cannot be used to determine absolute performance.

The link budget varies as a function of satellite elevation angle and azimuth angle from the user to the satellite. It depends on both the user's specific location and the specific location of the satellite. There are multiple satellites in view, each with a different azimuth and elevation from the user, and each satellite is often communicating with multiple gateways. Every one of these parameters are changing minute by minute.

There are two levels of Globalstar approval available for VAM products, Globalstar Registered<sup>2</sup> and Globalstar Certified<sup>3</sup>. The transmitted signal EIRP must satisfy the requirements in the table below from the minimum elevation angle of 25° to a maximum elevation angle of 90°:

**TABLE 11 - EXTERNAL ANTENNA POWER REQUIREMENTS**

|               | EIRP (dBm) <sup>1</sup> | SPECIFICATION                                                                                                               | GLOBALSTAR REGISTERED <sup>2</sup> | GLOBALSTAR CERTIFIED <sup>3</sup> |
|---------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------|-----------------------------------|
| Minimum Limit | 16 <sup>[1]</sup> dBm   | meet at least the Minimum Limit for at least 85% of all azimuth directions, at each elevation (25°, 40°, 65°, 90°)          | N/A                                | Compliance required               |
| Average       | 19 dBm                  | meet at least the Average Gain requirement for each frequency, when averaged over all azimuth directions and all elevations | N/A                                | Required                          |
| Maximum Limit | 23 dBm                  | be at or below the Maximum Limit over 100% of all azimuth directions, at each elevation (25°, 40°, 65°, 90°)                | Required                           | Required                          |

Notes:

1. The low EIRP setting value corresponds to the 25° elevation angle at which point the Globalstar gateway is required to pick up the transmitted ST100 signals. Link closure is not required until the satellites are at the minimum elevation angle specified by Globalstar.
2. **Globalstar Registered** - Globalstar Registered Products have been evaluated and have been approved for use on the Globalstar network but may not achieve the message success rates shown on the online Globalstar Simplex coverage map.
3. **Globalstar Certified** – Globalstar Certified Products are evaluated and tested to ensure that their performance meets Globalstar's certification performance specifications. Certified Products, when transmitting according to the 30-minute certification benchmark messaging profile, with a clear view of the sky and no local interference, will provide the message success rates advertised on the online Simplex Coverage map (<http://www.Globalstar.com>).

The VAM must consider the complete gain of the antenna system to be compliant with the specified EIRP limit. Conducted power from the ST-100 is set to 24.5 dBm. Although there is some degree of adjustment available via software, the VAM should use this as the starting point.

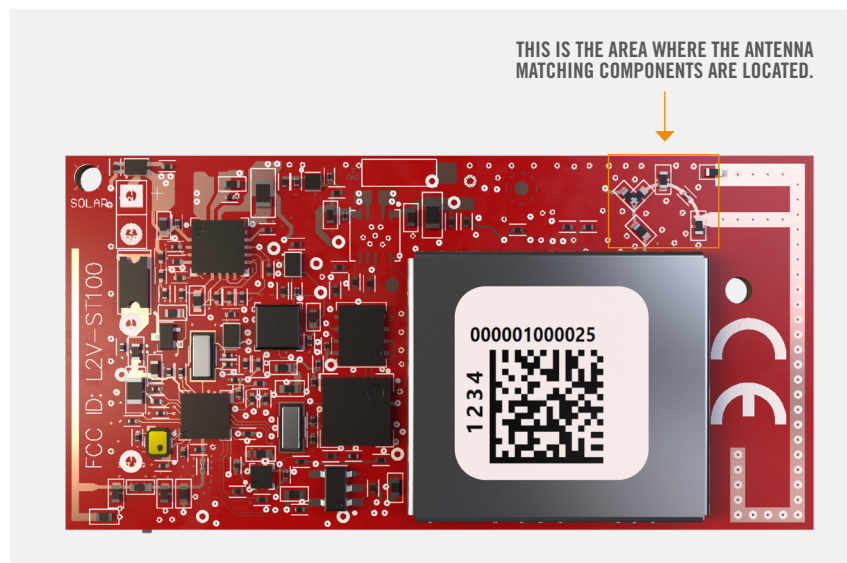
Final radiated power must not exceed 23dBm. This means that as designed the unit must operate such that conducted-power + line-loss + antenna-gain meets the criteria in the above table.

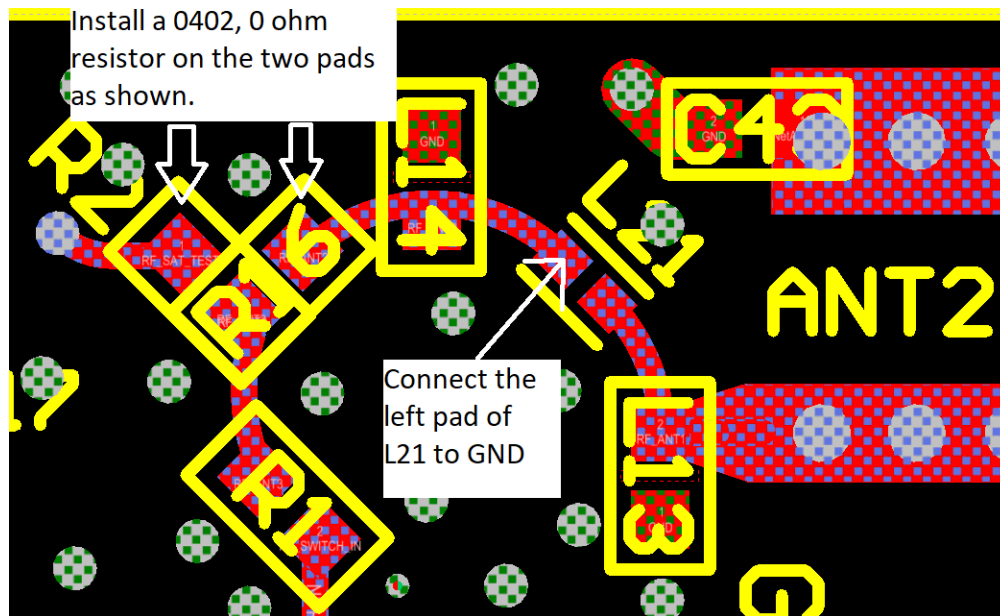
<sup>[1]</sup> The low EIRP setting value corresponds to 25 deg elevation angle at which point the GWA is required to pick up the STU signals. Link closure is not required until the satellites are at the minimum elevation angle specified by Globalstar.

## 6.2. GPS / SATELLITE ANTENNA TUNING

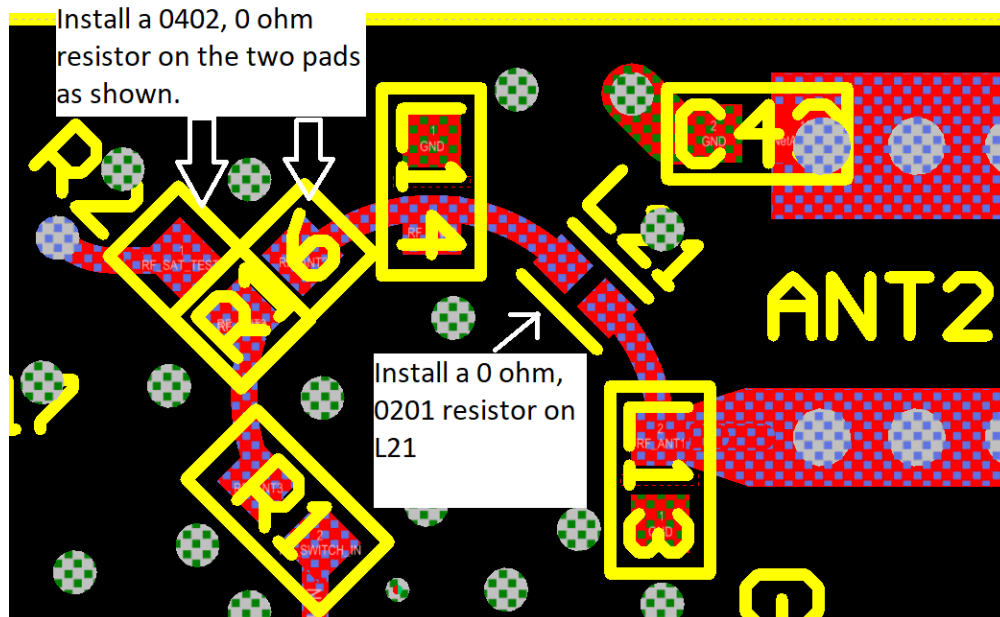
If the VAR wants to tune the internal GPS / satellite antenna on the PCB for a specific enclosure / environment, the following should be used as guidance.

1. An appropriate vector network analyzer (VNA) should be used to measure return loss (S11) of the antenna. The VNA output should be 50 ohms, and the frequency range should go up to about 3MHz but can be higher if the VNA allows. A two port VNA is not necessary but can be used (only one port measurements will be done for antenna tuning). The VNA should have the Port Extensions feature, which will allow for more accurate antenna tuning. In this manual, the TR5048 VNA from Copper Mountain Technologies is used.
2. Two ST100 boards will be used for the antenna tuning: one board will be used as a calibration board, and the other board will be used for tuning the GPS / satellite antenna.
3. The ST100 board should be placed in the plastics/enclosure where it will be used, and in an orientation that best represents the end-application. When tuning the antenna, try not to have metallic surfaces nearby. Placing a cardboard box under the ST100 is one way to move the antenna away from the surface it's resting on.
4. Both ST100 boards will have hardware modifications (swapping resistors, etc.) done to it during the tuning process. This procedure assumes that the user has some experience with soldering surface mount components (0201 inductors, resistors).
5. On both PCBs, make sure there are no components installed on R2, R16, L13, and L14.
6. On the calibration ST100 PCB, install a 0 ohm, 0402 resistor as shown below, and connect the left pad of L21 to GND, as shown. **NOTE:** Some solder mask can be scraped away on the GND plane to access GND.

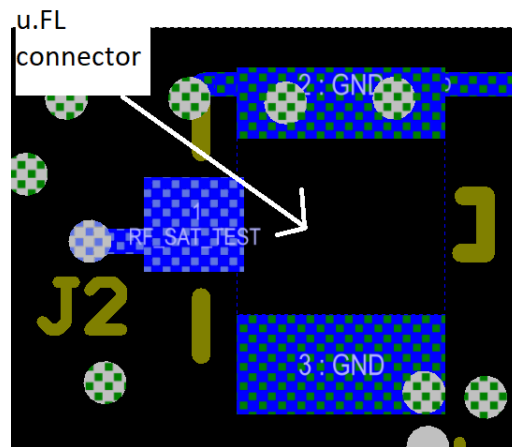




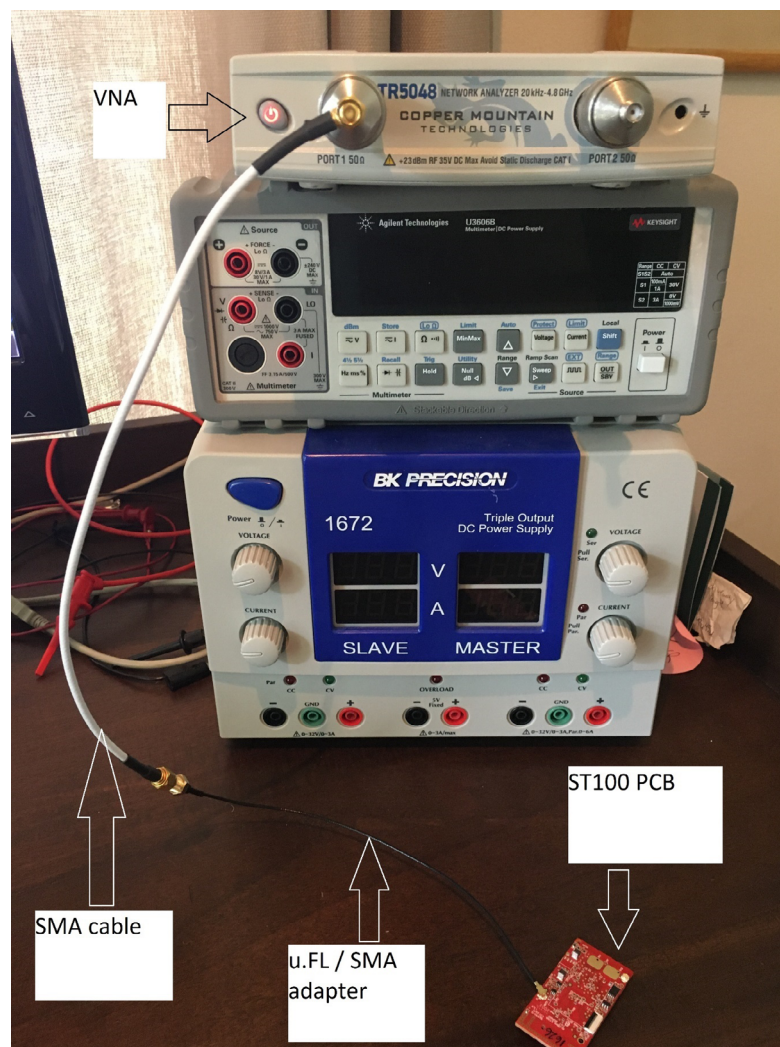
7. On the other board (ST100 antenna tuning board), install a 0 ohm, 0402 resistor as shown below, and install a 0 ohm, 0201 resistor onto L21.



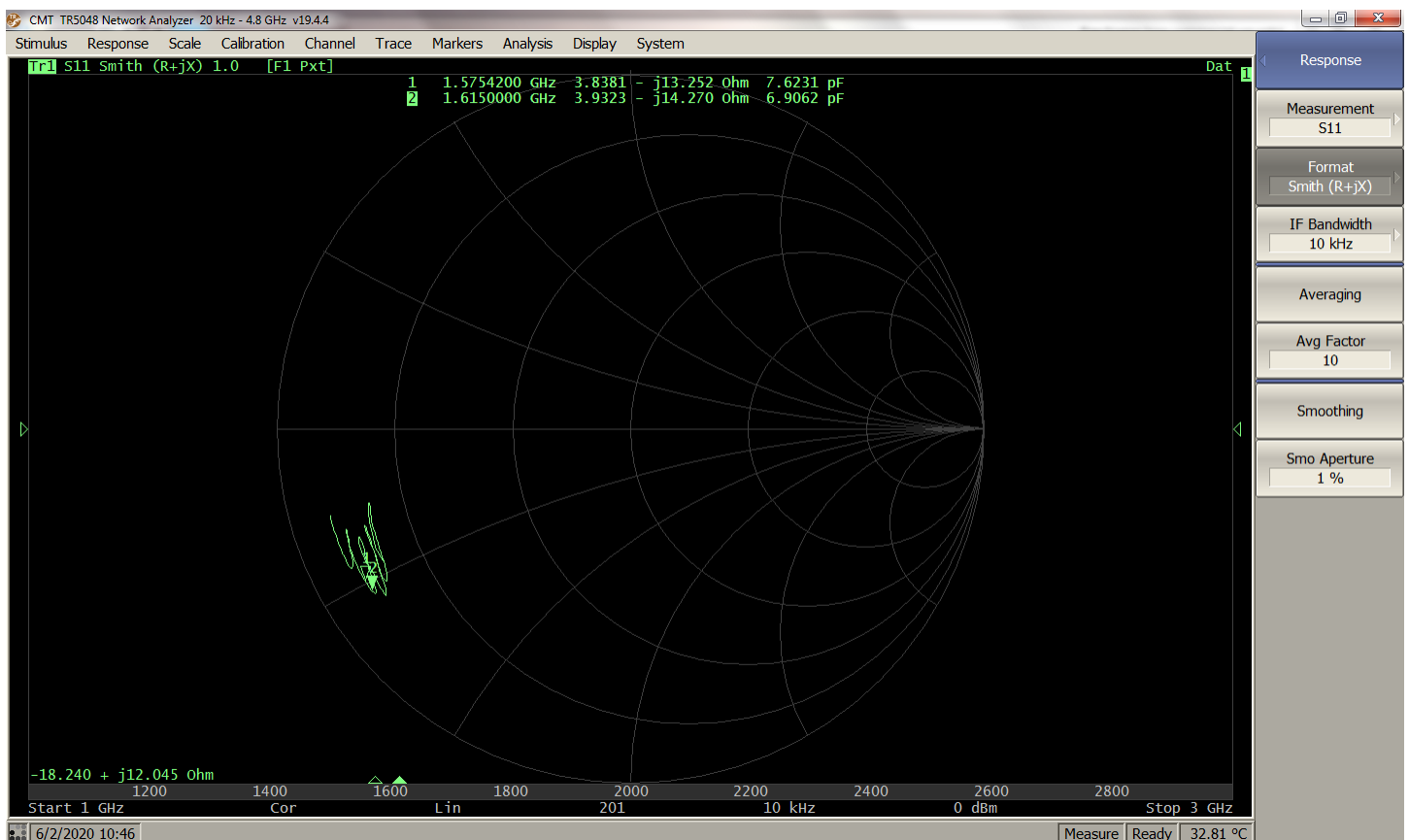
8. For both PCBs, if a u.FL connector is not installed on J2 (bottom side of PCB), there will need to be an RF cable (i.e. semi-rigid RF coax pigtail) soldered to the board so that the VNA RF signal can be connected to the semi-rigid RF coax pigtail.



9. On the calibration PCB, connect a u.FL / SMA adapter to the J2 u.FL connector. If J2 is not installed, ensure the semirigid RF coax is soldered onto the PCB.



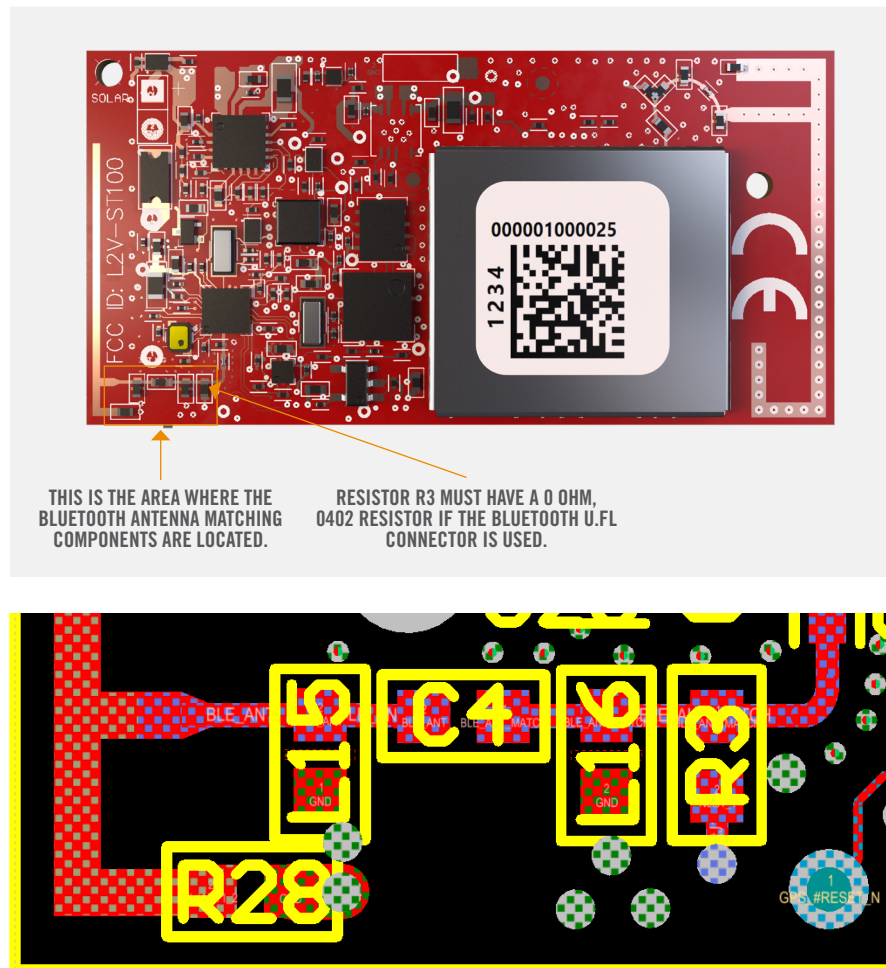
10. Turn on the VNA, set the start frequency to 1GHz, end frequency to 3GHz, the measurement bandwidth as low as possible (10kHz should be ok), the measurement is set to S11, the system impedance = 50 ohms, the format for the S11 response is Smith Chart, and the RF power of the VNA is on. Add markers in the S11 response at 1615MHz and 1575.42MHz
11. Ensure the calibration kit you are using for the VNA is selected in the VNA software (and all the settings for the calibration kit have been verified).
12. Ensure a RF coax cable (i.e. SMA cable) is connected to port 1 of the VNA and connect the other end of the SMA cable to the calibration kit.
13. In the VNA software, perform a one-port calibration using the VNA calibration kit. You should do open, short, and load.
14. Once the calibration is done, connect the SMA cable from the VNA port 1 to the u.FL / SMA adapter that is connected to the ST100 calibration PCB (if J2 is not installed, connect the RF coax cable to the semi-rigid RF coax soldered to the PCB)
15. In the VNA software, find the Port Extensions feature. Turn on Port Extensions, then perform a short circuit calibration. In the VNA software, the 1575.42MHz and 1615MHz markers should be located on the far left side of the Smith Chart, something similar as shown below.



16. Remove the u.FL / SMA adapter cable from the ST100 calibration board and connect it to the other ST100 board for antenna tuning (**NOTE:** the other ST100 board will require a semi-rigid RF coax if J2 is not installed).
17. Once the u.FL/SMA adapter is connected to the other ST100 PCB, record the impedances of the 1575.42MHz and 1615MHz markers. This is the initial antenna impedance without tuning. You can also take a photo to have as a reference for later.
18. When tuning a RF network, the goal is to get the impedance on the Smith Chart to move as close as possible to the center of the Smith Chart circle. This is the 50 ohm point ( $50 + j0$ ). Another good rule of thumb is to have a minimum of -10dB return loss ( $S_{11}$ ) for all orientations of the antenna.
19. Once the initial impedances have been recorded, use a Smith Chart simulation tool to determine which components (i.e. shunt inductor or series capacitor) should be added to move the impedance as close as possible to the Smith Chart center point. (**NOTE:** Iowa Hills Smith Chart is a free tool that can be downloaded.)
20. The values from the simulation may not be exact, so you may have to experimentally solder the simulation values onto the ST100 PCB, and check on the VNA if these values are getting the impedance closer to the center point.  
**NOTE:** L21, L14, and L13 are the matching components that can be used. L13 can be used, but past experience shows to start with using L21, and then L14. The components that Globalstar has used in the past have been Murata LQP03TN inductors and Murata GJM15, 0402 HiQ, tight tolerance capacitors.
21. Once both 1575.42MHz and 1615MHz impedances are close to the center point and you have -10dB return loss for both frequencies in all end-application orientations, the tuning can be stopped. Record the final tuning values.
22. Remove the 0402, 0 ohm resistor that was installed in step 7, and install a 0 ohm, 0402 on R16. The ST100 board with a tuned antenna is now ready to be tested outdoors.

### 6.3. BLUETOOTH ANTENNA TUNING

1. The Bluetooth antenna may not need tuning (it will depend if the Bluetooth range is acceptable as is), but the process is the same as tuning the GPS/Satellite antenna, with the exception the frequency markers in the VNA will be changed to 2.402GHz, 2.44GHz, and 2.48GHz.
2. The matching components for the Bluetooth antenna are located in the area shown below.



## 7. GLOBALSTAR CERTIFICATION PROCESS FOR CUSTOMER PRODUCTS



Before a customer's end product can be used on the Globalstar network, it must receive a Globalstar Product Certification. The certification process ensures that the customer's product meets Globalstar's internal system standards and has received the applicable regulatory approvals for the countries it will be operating in.

Typical certification process flow:

- Customer designs their product using the ST100 module.
  - **NOTE:** Over the Air (OTA) testing strongly recommended during design phase to catch performance bugs before submission for certification.
- Customer notifies their Globalstar Regional Sales Manager (RSM) that they want to start the Globalstar certification process.
- Customer completes ST100 Product Submission Form and Equipment Details Form
  - The application provides the list of items needed for certification and the product's configuration.
- Globalstar will require 2 - 3 units for antenna tuning/tuning verification and OTA testing at Globalstar.
  - Potential issues are highlighted/corrective actions made.
- Customer obtains all applicable regulatory approvals for end product. .

**NOTE:** Typical reasons for delays in the certification process include:

- Problems found during Antenna tuning:
  - No housing submitted with circuit.
  - Housing submitted is missing pieces, not in the final shape or uses materials other than what will be used in final version of housing.
- Problems found, especially during OTA testing.
- Lack of required documentation.
- Regulatory certificate issues.

## 8. GENERAL WARNINGS

---

**Warning – Modifications:** Changes or modifications to the ST100 not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**Warning – Battery:** User must set charge/discharge limits according to the battery manufacturer's Safety Data Sheets (SDS) for safety concerns.

**Warning – Blasting Area:** To avoid interference with blasting operations, turn your ST100 off when in a "Blasting Area" or in areas posted "Turn off two-way radio." Obey all signs and instructions.

**Warning – Potential Explosive Atmosphere:** Turn off the ST100 or any product with the ST100 installed when in any area with a potentially explosive atmosphere and obey all signs and instructions. (End products specifically designed to work in Explosive Atmospheres are to follow their certification guidelines.)

**Warning – Pacemakers:** The Health Industry Manufacturers Association recommends that a minimum separation of six (6") inches be maintained between the ST100 and a pacemaker to avoid potential interference with the pacemaker.

**Warning – Hearing Aids:** Some digital wireless devices may interfere with some hearing aids. In order to prevent such interference, you may want to consult the manufacturer of your hearing aid.

**Warning – Specific Absorption Rate (SAR):**

**FCC / Canada:** The ST100 has been shown to be compliant to localized Specific Absorption Rate (SAR) for uncontrolled environment/ general exposure limits specified in ANSI/IEEE STD C95.1-1992 and has been tested in accordance with measurement procedure specified in IEEE 1528-2013 and IEC 62209-2:2010 using a separation distance of 20 cm.

**European Union (CE RED):** The ST100 has been shown to be compliant for localized specific absorption rate (SAR) for uncontrolled environment / general exposure limits specified in ANSI/IEEE Std. C95.1-1999 and has been tested in accordance with the measurement procedures specified in EN50566:2017 and EN62209-2:2010 using a separation distance of 20 cm.

**NOTE:** If concerned about RF exposure during use, place the ST100 away from your body. The RF exposure level drops off dramatically with distance from the ST100 antenna.

## 9. REGULATORY

### Radio Astronomy Site Avoidance

The ST100 complies with FCC CFR25.213. The customer end-product must comply with the requirements for Radio Astronomy avoidance. See Globalstar document GS-07-1248 REMOTE TELEMETRY SERVICE FREQUENCY PLAN FOR SIMPLEX TRANSMITTERS for more details

### Regulatory Notices

The ST100 Board has received Federal Communications Commission authorization under FCC Rules Part 25 and Part 15C as a modular transmitter. Final installation must be in compliance with 25.213 (see 6.1 above). The installation and operating configurations of this transmitter must satisfy MPE categorical Exclusion Requirements of 2.1091. The antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

The ST100 modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The only antennas authorized to be used with the ST100 module are the module PCB trace antennas. If any other antennas are used, then additional regulatory testing will be required.

**NOTE:** Any additional host device the module is integrated into will require regulatory testing and certification (C2PC for FCC and C4PC for ISSED).

The ST100 BOARD module has been labeled with its own FCC and Industry Canada (IC) ID numbers, and if the FCC/IC ID numbers are not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module:

Contains Transmitter Module FCC ID: L2V-ST100 IC: 3989AST100

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The VAR's user's manual shall include the following statements:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment OFF and ON, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

WARNING: Changes or modifications not expressly approved by Globalstar may render the device non-compliant to FCC and other regulatory body standards for operation and may void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme NMB-003.

Hereby, Globalstar declares that this ST100 BOARD is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU. The declaration of conformity may be consulted at [www.Globalstar.com/Regulatory](http://www.Globalstar.com/Regulatory).

NOTICE: This equipment complies with FCC, IC and CE RF Exposure Limits. A minimum of 20 centimeters (8 inches) separation between the device and the user and all other persons should be maintained.

AVIS: Cet équipement est conforme aux RSS-102 Limites d'exposition RF. Un minimum de 20 centimètres (8 pouces) entre l'appareil et l'utilisateur et toutes les autres personnes devrait être maintenue.

Transmit Frequencies: 1611.25 Mhz - 1618.75 Mhz (4 Channels) Max Power Out: 25.82 dBm EIRP

FCC ID: L2V-ST100

CAN ICES-3(B)/NMB-3B

IC: 3989A-ST100



Complies with FCC standards.

FOR HOME OR OFFICE USE

The ST100 BOARD has been so constructed that the product complies with the requirement of Article 10(2) as it can be operated in at least one Member State as examined and the product is compliant with Article 10(10) as it has no restrictions on being put into service in all of the EU except Ireland. The ST100 BOARD cannot be marketed in Ireland.



~~IE~~ **Not to be Marketed in Ireland**

Anatel Certification stamp for operation in Brazil:

TBD

|            |                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------|
| Portuguese | Produto não acabado, de uso interno, cuja integração em outros equipamentos pode requerer nova certificação.           |
| English    | Unfinished product, for internal use, the integration of which into other equipment may require further certification. |

## 10. ACRONYM LIST

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|                |                                                         |
|----------------|---------------------------------------------------------|
| <b>ACK</b>     | Acknowledgement                                         |
| <b>APP</b>     | Application                                             |
| <b>ASCII</b>   | American Standard Code for Information Interchange      |
| <b>ASIC</b>    | Application-Specific Integrated Circuit                 |
| <b>BLE</b>     | Bluetooth Low Energy                                    |
| <b>C</b>       | Celsius                                                 |
| <b>CE RED</b>  | Conformité Européene Radio Equipment Directive (Europe) |
| <b>CPU</b>     | Central Processing Unit                                 |
| <b>CRC</b>     | Cyclic Redundancy Check                                 |
| <b>dBm</b>     | Decibel-Milliwatts                                      |
| <b>DC</b>      | Direct Current                                          |
| <b>DFU</b>     | Device Firmware Update                                  |
| <b>EIRP</b>    | Effective, or Equivalent, Isotropically Radiated Power  |
| <b>ESD</b>     | Electrostatic Discharge                                 |
| <b>ESN</b>     | Electronic Serial Number                                |
| <b>F</b>       | Fahrenheit                                              |
| <b>FCC</b>     | Federal Communications Commission                       |
| <b>FTP</b>     | File Transfer Protocol                                  |
| <b>GATT</b>    | Generic Attribute Profile                               |
| <b>GLONASS</b> | Global Navigation Satellite System                      |
| <b>GND</b>     | Ground                                                  |
| <b>GPIO</b>    | General-Purpose Input/Output                            |
| <b>GPS</b>     | Global Positioning System                               |
| <b>HTTP</b>    | Hypertext Transfer Protocol                             |
| <b>HW</b>      | Hardware                                                |
| <b>I2C</b>     | Inter-Integrated Circuit                                |
| <b>IC</b>      | Industry Canada                                         |
| <b>iOS</b>     | iPhone Operating System                                 |
| <b>ISED</b>    | Innovation, Science and Economic Development (Canada)   |
| <b>JTAG</b>    | Joint Test Action Group                                 |
| <b>LEO</b>     | Low Earth Orbiting                                      |
| <b>mA</b>      | Milliamps                                               |
| <b>mAh</b>     | Milliamp Hour                                           |

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|             |                                                  |
|-------------|--------------------------------------------------|
| <b>MBR</b>  | Master Boot Record                               |
| <b>mm</b>   | millimeter                                       |
| <b>mW</b>   | milliwatt                                        |
| <b>N/A</b>  | Not Applicable                                   |
| <b>NAK</b>  | Negative-Acknowledgement                         |
| <b>NMEA</b> | National Marine Electronics Association          |
| <b>OEM</b>  | Original Equipment Manufacturer                  |
| <b>OTA</b>  | Over the Air                                     |
| <b>PCB</b>  | Printed Circuit Board                            |
| <b>PLL</b>  | Phase-Locked Loop                                |
| <b>POST</b> | Power-On Self-Test                               |
| <b>RF</b>   | Radio Frequency                                  |
| <b>RoHS</b> | Restriction of Hazardous Substances              |
| <b>RTU</b>  | Remote Transmitter Unit                          |
| <b>RX</b>   | Receive                                          |
| <b>SAR</b>  | Specific Absorption Rate                         |
| <b>SCL</b>  | Serial Clock                                     |
| <b>SDA</b>  | Serial Data                                      |
| <b>SDK</b>  | Software Development Kit                         |
| <b>SMA</b>  | Sub-Miniature Version A                          |
| <b>STU</b>  | Satellite Transmitter Unit                       |
| <b>TX</b>   | Transmit                                         |
| <b>UART</b> | Universal Asynchronous Receiver/Transmitter      |
| <b>V</b>    | Volts                                            |
| <b>VAM</b>  | Value Added Manufacturer                         |
| <b>VAR</b>  | Value Added Reseller                             |
| <b>VDC</b>  | Voltage Direct Current                           |
| <b>VNA</b>  | Vector Network Analyzer                          |
| <b>WEEE</b> | Waste Electrical & Electronic Equipment (Europe) |

