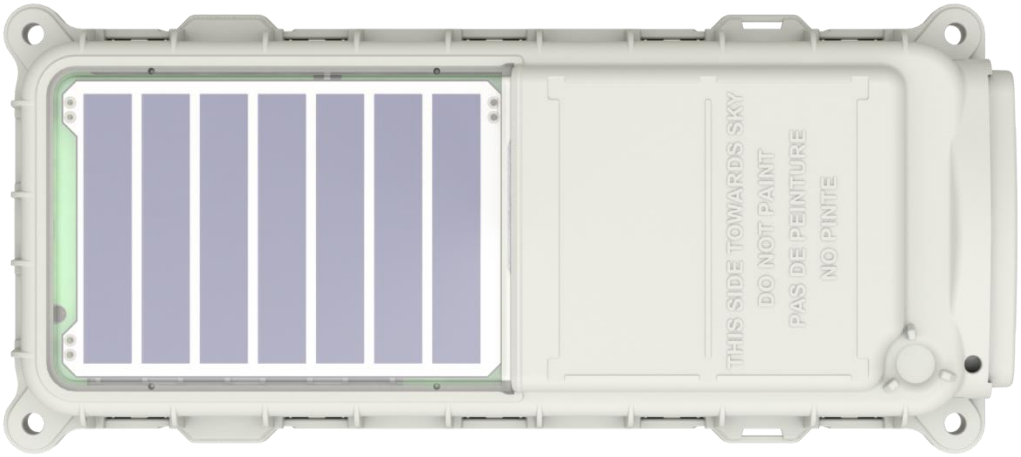


# SmartOne Solar™

# User Manual

## Distribution Statements:



Globalstar Inc.
300 Holiday Square Blvd.
Covington, LA 70433

This guide is based on the production version of the Globalstar SmartOne Solar™. Software changes may have occurred after this printing.

Globalstar reserves the right to make changes in technical and product specifications without prior notice.



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| **1.0.1** | 10/17/2017 | M. Pergola | Added Safe Use Conditions section |
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# Document Approval History

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| **1.0** | Sales | | |
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| **1.0** | Software and App | | |
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| **1.0** | Quality | | |
| | | | |

# Related Documents

| Doc Rev | Title | Name | Date |
|---|---|---|---|
| | | | |

# Table of Contents

# 1. SmartOne Basics

## Overview

The Globalstar SmartOne series of products are designed to track the positions of trailers, cargo containers, heavy construction equipment, generators, boats/barges and any other mobile assets.

NOTE: Throughout the rest of this manual, the term SmartOne will refer to the SmartOne Solar™ product unless explicitly referred to otherwise.

The SmartOne processes GPS satellite signals to obtain its position in terms of longitude & latitude and transmits this information over Globalstar's Satellite Network. In addition to position information, the SmartOne transmits other message types that include battery status, input alarm status and diagnostic information. The SmartOne is configured using a computer & configuration cable or over Bluetooth® interface. The configuration parameters allow the SmartOne unit to communicate messages at certain times and/or under certain conditions.

The SmartOne has two dry contact inputs, to manage run time of engines and/or other alarm inputs, and one serial port for passive and smart sensors. The SmartOne incorporates a built-in solar panel that charges the internal batteries to provide 8+ years of maintenance-free operation.

## Modes of Operation

The SmartOne can be configured to operate in three different Modes:

- Standard Messaging Mode
- Reduced Messaging Mode
- Theft Alert Mode.

### Standard Messaging

In Standard Messaging Mode, the SmartOne reports its position at regular time intervals that are programmed during the configuration process. Standard Messaging Mode can also be configured to utilize the SmartOne's internal motion/vibration sensor. If enabled, the SmartOne will transmit its position at independently configured regular time intervals when the device is In Motion.

Location messages can be programmed to be constant (Message Interval) or the device may be configured to use up to 12 different delays in sequence (Message-Time(s) of Day). Message Interval can be programmed in one minute intervals from 35 minutes up to 45 days.

- **Example of Message Interval**: The SmartOne is configured to report once every 24 hours when not In Motion and every two hours when In Motion. If the SmartOne went into motion at any time of day the Message Interval while In Motion would be every two hours beginning when the SmartOne started moving.
- **Example of Message-Time(s) of Day**: The SmartOne is configured with a message time of day of 9:00 AM, a second message time of day of 12:00 noon, a third message time of day of 8:00 PM and once per hour when In Motion. The SmartOne would transmit three messages a day at the same configured times every day. If the SmartOne went In Motion it would transmit its location message every hour.
- **Usage Example**: A Company is required to report the GPS locations of their hazardous chemical containers twice a day. Based on this requirement, the Company has two options: set a message

interval of every 12 hours, the 12 hour internal begins when the device is powered up or when the configure message times of day are 12:00 noon and 12:00 midnight.

## Reduced Messaging

Reduced Messaging Mode reduces the cost associated with transmitting messages over Globalstar's satellite network by sending messages at a minimal message interval when the asset is in a defined area and transmits at a higher message interval when the asset is changing locations. These message intervals are set as part of the configuration process based on the concept that repeated reporting information of the same location, when an asset has not moved from its defined area, is redundant and doesn't provide addition usable information about its current location.

By comparing current and prior position information, the SmartOne determines if its location is changing. The definable area in which the device should remain in Reduced Messaging Mode is called the Change of Location Area and it is a square. When the SmartOne goes outside of the square, its location is considered to be changing or relocating.

**Usage Example**: *A fleet operator owns 1,000 trailers. When the trailer(s) are sitting at a depot they want a location message once a day. They also want a message notification within one hour when a trailer has left a depot. Lastly, they want a location message every three hours when a trailer is moving between depots. Based on this requirement, the fleet operator will need to set the Change of Location Area (size of the depots where the trailers will visit), the message interval while the trailers are inside the Change of Location Area (one per day), the interval at which the SmartOne will check its location while in a State of Vibration and inside the Change of Location Area(one per hour), set the number of messages when the trailer leaves the Change of Location Area (one Change of Location Area Alert Message) and the message interval while the trailers are in transit between depots (every three hours).*

## Theft Recovery

When the SmartOne is configured to operate in the Theft Recovery Mode, it differentiates between authorized and unauthorized movement of an asset. While the power to the SmartOne is turned off, all movement of the asset is considered authorized. When power is turned on, the SmartOne obtains a position from GPS satellites. The position is used to set the center of the defined Change of Location Area in Theft Alert Mode. While in the Change of Location Area, the SmartOne obtains position fixes at an interval set during configuration. If the SmartOne remains within the Change of Location Area, all movement is considered to be authorized.

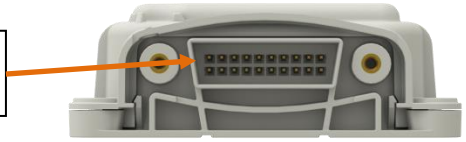
Once the SmartOne's position is outside of the Change of Location Area, it alerts the SmartOne to an unauthorized movement and immediately sends a location message (Change of Location Alert Message). The SmartOne continues to send location messages at a message interval set during the configuration process until the power is turned off or the battery is dead.

**Usage Example**: *A construction company is working on a job site for one year and wants to ensure that their generators and other heavy equipment on site aren't stolen. The company wants to check the location of their equipment 12 times a day, every 2 hours, to confirm the asset hasn't been stolen, but only wants a transmitted location message once per day. Based on this requirement, the construction company will need to set the Change of Location Area (size of the job site), the message interval while inside the Change of Location Area (one per day), the interval at which the SmartOne will check its location while in a State of Vibration and within the Change of Location Area (every two hours) and the message interval if the asset is outside the Change of Location Area (stolen).*

# Inputs

The SmartOne has a 20-pin connector that provides ground, two dry contact inputs and serial communication lines.

SmartOne with connector cover off showing 20-pin connector



The SmartOne allows sending Input Status Changed Messages for both Input 1 and Input 2. The Inputs must be asserted for at least five seconds in order to be acknowledged.

> **Usage Example**: *A construction company needs to document, per their contract, when they begin their work day and when they end their work day. Based on this requirement, the SmartOne would be connected to the ignition switch and configured to send a transmission with location when the input changes state.*

The SmartOne also allows the user to define the Message Interval while the Inputs are in an Undesired State, either Opened or Closed.

> **Usage Example**: *A company has remote containers at job sites and would like to know if a door is ajar. If a door is left ajar the company would like a notification every two hours. Based on this requirement, the SmartOne would be connected to an open door sensor with the Undesired Input State Message enabled and set as Opened with a Message Interval of two hours.*

**Note: The SmartOne uses a five minute "hysteresis" window to prevent sending false alarms. This means that only one status change message can be sent during any five minute time window. Any subsequent status changes will be detected but not reported. Multiple status changes during any five minute window will result in the transmission of incorrect trigger bits.**

The SmartOne has the ability to send an Accumulate/Count Message at a regular configurable interval and/or based on configurable multiples of accumulated hours and/or number of counted events or hours of vibration.

> **Usage Example 1**: *A construction company needs weekly engine run times for their heavy equipment to manage their maintenance scheduling. Based on this requirement, the company would schedule a weekly Accumulate/Count Message.*
>
> **Usage Example 2**: *A construction company wants to insure that no equipment is ever operated beyond 400 hours without maintenance. Based on this requirement, the company would schedule an Accumulate/Count Message for every 400 hours of use.*

The SmartOne has the ability to send both the Status Change and Undesired State messages based on vibration.

# Serial Commands

The SmartOne uses the I/O port for unit configuration as well as interface to remote passive and smart sensors. Two commands are provided in the unit interface to support smart sensors. External sensors or instruments, that can format and communicate with the SmartOne, can send user data through the SmartOne by using these two commands.

The SmartOne connects to smart sensors via the SmartOne Serial Cable. The SmartOne Serial Cable is sold as an accessory.

# Bluetooth Interface

The SmartOne uses its built-in Bluetooth interface to advertise itself and for programming configuration settings.

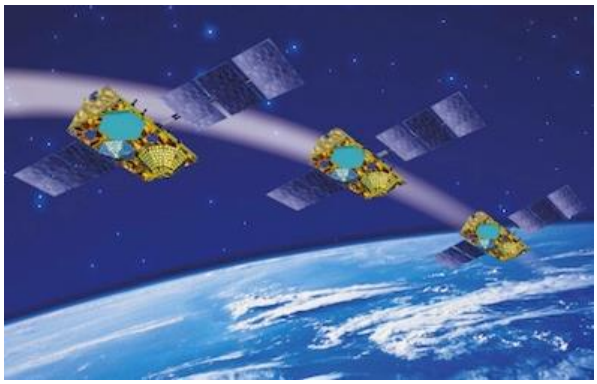
# Satellite Communications

The SmartOne communicates with both the GPS satellite network and the Globalstar Satellite Network. All GPS locations are pulled from the GPS network and all transmissions are sent via the Globalstar Satellite Network.


The SmartOne has the unique ability to check its GPS coordinates at a programmable rate while it is inside of the Change of Location Area without actually sending a message over the Globalstar Satellite Network.

For a Location Message, the SmartOne will wake up at a scheduled interval or time of day and begin to acquire a GPS fix. Once it receives its GPS fix, the SmartOne will transmit its location to the Globalstar Satellite Network.

# Globalstar Satellite Network



The network consists of 32 Low Earth Orbiting (LEO) satellites that are constantly orbiting the earth and complete their orbits in less than two hours. Because of this, the SmartOne will be in contact with at least one of the satellites during each scheduled transmission. In LEO communication networks, the satellites are constantly changing their positions in the sky relative to the transmitter on earth. This minimized the shading effects seen in geostationary satellite systems where the mobile device must be pointed toward a specific direction in the sky. Geostationary satellites also orbit at a much higher altitude and move along the equator.

Messages are transmitted from the SmartOne via the Globalstar Satellite Network using an uplink-only connection (one-way data transmission) and received by a Globalstar Ground Station. The messages are then sent via an HTTP or FTP server to the internet and received by the VAR or end customer's back office application and converted into actionable data.

The SmartOne will send each message three times to insure that the message has been received by the Globalstar Satellite Constellation. Once Globalstar receives the message, any remaining duplicate messages are ignored and discarded (VAR or end user account is only charged for one transmission).

# 2. Getting Started

## The SmartOne Device

### Batteries

The SmartOne is powered by, and comes with, four installed Nickel Metal Hydride(NiMH) batteries. The battery compartment is not accessible for the user and, in fact, the batteries are not replaceable. Since the unit is designed for the solar panels to recharge the batteries, the user never needs to worry about replacing the batteries. The SmartOne will provide 8+ years of maintenance-free operation.

### Turning On and Off

The SmartOne ships with a magnetic switch that will shut down the unit if installed. To turn the SmartOne unit on, remove the magnet and it will begin monitoring the asset.

NOTE: If the asset is going to be stored indoors for extended periods of time, the SmartOne should be shut down by installing the magnet to avoid draining the batteries.


### Commisioning

Before installing the SmartOne unit, record the serial number and identify the asset to which it will be mounted. Since the serial number is etched on the mounting surface of the SmartOne unit, it is not visible after installation.

### Installation

The SmartOne unit must be mounted on the asset with a clear view of the sun and sky. The device requires a flat surface area of 17.78 cm x 8.26 cm (7” x 3.25”). The ideal configuration is facing up on a flat horizontal surface.

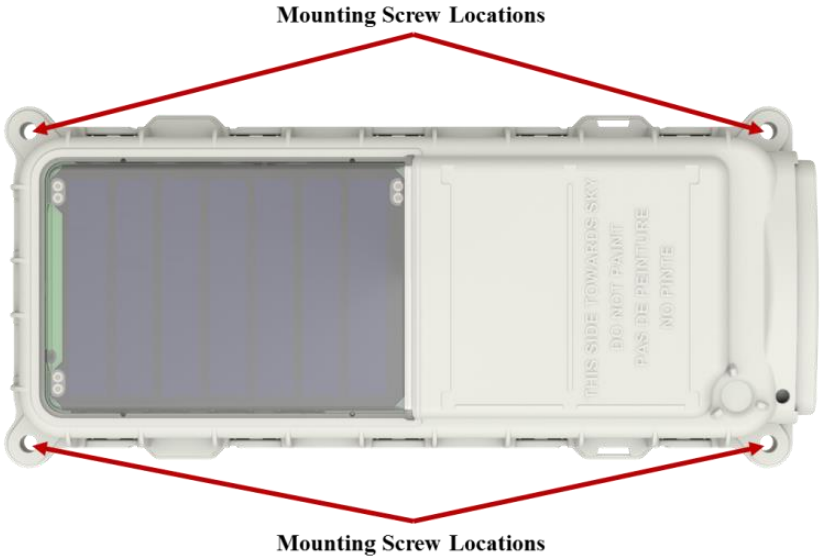
The SmartOne unit can also be mounted on a flat vertical surface but this may reduce the communication reliability, decrease the maximum sustainable messaging rate, and may reduce the GPS location accuracy.

# Mounting methods

The SmartOne can be mounted using different methods depending on the mounting surface or user preference.

## Direct bolt or screw installation

It is strongly recommended to bolt the SmartOne unit to the asset using the provided mounting holes. Four #6 machine screws (Pan head recommended) of the appropriate length are required. The unit can also be mounted using self-tapping screws adapted to the mounting substrate.




**NOTES:**

- Do not use chamfered (flat head) screws as this may damage the housing.
- Do not over-tighten the mounting screws: DO NOT exceed 1.2 N.m (10 in.lb) torque
- It is recommended to use 316 grade stainless steel fasteners for longevity.

## Adhesive pad installation

If drilling holes into the asset is not practical, the SmartOne may be installed using the adhesive gasket. To ensure proper strength for mounting, the following recommendations must be followed; failure to follow proper procedure could lead to the SmartOne becoming detached from the asset in the field.

The ambient temperature must be above 10 °C and the asset must be protected from rain before and during installation.

The mounting surface must be smooth and in good condition and be thoroughly cleaned using the following procedure: use water and soap first to remove any dirt and residues from the mounting surface and let dry. Wipe the mounting area and the bottom surface of the SmartOne with a solvent impregnated clean cloth (such as Isopropyl Alcohol) and let air dry.

Peel one side of the adhesive gasket and install it to the bottom of the unit, ensuring the outer edges are aligned properly.

Peel the other side of the adhesive gasket and place the SmartOne onto the asset. Apply at 80lb (350N) of force to the unit for a minimum of three seconds to achieve full bonding strength.

## Optional Metal Bracket installation

The optional metal mounting bracket is used to firmly secure the device to the asset. It has four screws that attach the SmartOne Solar device to the asset. This allows the SmartOne Solar to be mounted such that the antennas have direct view of the sky with mounting flexibility. The SmartOne Solar attaches to the metal mounting bracket using four Phillips-head screws.

# Programming Overview

The SmartOne comes ready to use with a factory configuration loaded in the device. The factory configuration is: Standard Messaging without Motion and Interval Messaging of 12 hours. These configuration settings may be changed using the SmartOne Configuration Software, the USB Configuration Cable and a (Windows)PC or via its Bluetooth interface provided the correct Bluetooth dongle has been installed on the PC.

## Inputs

The SmartOne has two inputs that can be accessed by using the SmartOne External Input Cable. The , SmartOne External Input Cable is sold as an accessory to the device.

## Installation of Configuration Software

The SmartOne Configuration Software can be downloaded from the Globalstar website at http://var.globalstar.com. You must first login to your VAR account using your username and password. The Configuration Software is located in the Software Downloads section and is supported by Windows 7, Windows Vista, Windows XP Service Pack 2, Windows 2000 and Windows 98.

## Installation of Windows USB Driver

In order to properly connect to the SmartOne unit using the USB Configuration Cable, the required USB device driver must be installed on the PC running the Windows Operating System. In particular, the device driver for using the USB Configuration Cable is supplied by Prolific (`PL2303_Prolific_DriverInstaller_v1.18.0B.zip` ) and may be downloaded at the following link:
http://www.prolific.com.tw/US/ShowProduct.aspx?p_id=225&pcid=41.

Download the ZIP file, unpack it, then run the DriverInstaller executable. It should seamlessly install the correct USB device driver for use with the SmartOne USB Configuration Cable.

## Connecting Devices

The SmartOne connects to a PC using a USB Configuration Cable. Since the Windows Operating System needs to install the driver for the SmartOne USB Configuration Cable, first connect the cable to the PC, then to the SmartOne unit. The USB Configuration Cable plugs into the SmartOne when the connector cover is removed. The SmartOne Configuration Software may be used without being connected to devices to prepare configurations, but must be connected to a device using the USB Configuration Cable to program it. Once the Program button has been depressed the USB Configuration Cable should not be disconnected, if already connected, from the device and/or the computer.

### BLUETOOTH INTERFACE INSTRUCTIONS

# 3. Messages

The SmartOne produces on-air messages conforming to the Globalstar specified format. See Appendix G through J for detailed examples of various message decoding.

The data being communicated to the end user is contained entirely in the 72 bit (9 byte) field.

This section will describe the use of the 9 byte user information segment for communicating the range of information that the SmartOne is able to convey to the user.

**Note: User information is also referred to as the Message Payload.**

## Global Message Type

Bits 0 and 1 in the first byte of the user data defines the Global Message Type; there are four total global types. Types 0 and 3 are applicable to the function and features of the SmartOne, Type 1 and 2 are user defined message types.

- **Type 0** - Standard Message: All of the various message types that contain Latitude and Longitude data that are transmitted by the SmartOne will be of this type.
- **Type 1** - Truncated Message: This message type provides for up to 2 bytes plus 6 bits of user data to be appended to the status byte and GPS location information.
- **Type 2** - Raw Message: This message type provides for up to 8 bytes plus 6 bits of user data.
- **Type 3** - Non Standard Message: This is the message type that covers the category “none of the above”. The SmartOne will use this message type for messages that do not contain Latitude and Longitude data. Smart One message types which fall into this category include Accumulate/Count messages, Diagnostic messages, Contact Service Provider messages and Low Battery messages.

## Type 0 Message Class

### Message Format

The table below displays the format of all standard messages. Specific variants of the message will be shown individually in the following subsections.

| Byte # | Variable | Bits | Description |
|---|---|---|---|
| 0 | Type Field | 2 | Bit (1:0) = 0 - Message Type: Described above. |
| 0 | Battery State | 1 | Bit (2) 0 = Good battery. 1 = Replace battery. |
| 0 | GPS Data Valid | 1 | Bit (3) 0 = GPS Data valid in this message.<br>1 = GPS failed in this message cycle, ignore Latitude and Longitude fields. |
| 0 | Missed Input State Change | 2 | Bit (4) = Missed Input 1. A value of 1 in this bit means that an input state change of Input 1 was missed due to the transmission of a higher priority message.<br>Bit (5) = Missed Input 2. A value of 1 in this bit means that an input state change of Input 2 was missed due to the transmission of a higher priority message. |
| 0 | GPS Fail Counter | 2 | Bit (7:6) = GPS fail counter. Counts up to a maximum value of 3 upon GPS failure. |
| **Byte #** | **Variable** | **Bits** | **Description** |
| 1,2,3,4, | Latitude/Longitude | 48 | Byte 1 = Latitude MSByte |

| | | | |
|---|---|---|---|
| 5,6 | | | Byte 2 = Latitude<br>Byte 3 = Latitude LSByte<br>Byte 4 = Longitude MSByte<br>Byte 5 = Longitude<br>Byte 6 = Longitude LSByte<br><br>360 degrees of Longitude coded in signed binary with 3 bytes and 180 degrees of Latitude coded in signed binary with 3 bytes.<br>Positive Longitudes correspond to East Longitudes<br>Positive Latitudes correspond to North Latitudes<br><br>See Appendix G for an Lat/Long decoding example |
| 7 | Input Status | 4 | These bits reflect the state of the Inputs and indicate which one, if any, triggered an Input Status Changed message.<br>Bit 0: Input 1 change: 0 = Did not trigger message, 1 = Triggered message.<br>Bit 1: Input 1 state: 0 = Closed, 1 = Open<br>Bit 2: Input 2 change: 0 = Did not trigger message, 1 = Triggered message<br>Bit 3: Input 2 state: 0 = Closed, 1 = Open |
| 7 | Message Sub-Type | 4 | Bits (7:4) message sub-type code. See subtypes below:<br>Value is **0** in the location message.<br>Value is **1** in the Device Turned On message.<br>Value is **2** in the Change of Location Area alert message.<br>Value is **3** in the Input Status Changed message.<br>Value is **4** in the Undesired Input State message.<br>Value is **5** in the Re-Centering message. |
| 8 | RESERVED | 3 | Bits (2:0) RESERVED in SmartOne |
| 8 | Vibration Triggered Message | 1 | Bit (3) – Value 1 = This message is being sent because Transmit on Change of Vibration State is selected and the vibration just changed state, or Undesired Vibration State is selected and the vibration is in the undesired state.<br>Value 0 = This message is being transmitted for a reason other than the above reasons. |
| 8 | Vibration Bit. | 1 | Bit (4) – Value 1 = Unit is in a state of vibration.<br>Value 0 = Unit is not in a state of vibration. |
| 8 | 2D | 1 | Bit (5) – Value 1 = GPS data reported is from a 2D fix. (Only 3 satellites were used in the fix.)<br>Value 0 = GPS data reported is from a 3D fix. |
| 8 | Motion | 1 | Bit (6) – Value 1 = Device was In-Motion when the message was transmitted.<br>Value 0 = Device was At-Rest when the message was transmitted. |
| 8 | Fix Confidence Bit. | 1 | Bit (7) 1=Reduced confidence in GPS fix accuracy, 0=High confidence in GPS fix accuracy, |

## Location Message

This is the message that is transmitted on an interval. When this message is received, it indicates that the transmission is due to a scheduled interval at either the At Rest rate or In Motion rate. Whether the device is At Rest or In Motion can be determined by the Motion bit (Byte 8, bit 6).

The Location Message Subtype field of this message, contained in byte 7; bits 4-7 have a value of zero 0.

## Device Turned On Message

This is the message transmitted at power on.

The Standard Message Subtype field of this message, contained in byte 7; bits 4-7, has a value of 1.

## Change of Location Area Alert Message

This is the message transmitted when the SmartOne detects that it has left its Change of Location Area.

The Standard Message Subtype field of this message, contained in byte 7; bits 4-7, has a value of 2.

## Input Status Changed Message

This is the message that will be transmitted upon the change of state of the inputs if it is enabled and as selected by the user:

- Input 1 open, Input 1 closed, or Input 1 both(open or closed)
- Input 2 open, Input 2 closed, or Input 2 both(open or closed)

The Standard Message Subtype field of this message, contained in byte 7; bits 4-7, has a value of 3.

The Input Status Value of byte 7; bits 0-3 in the message indicates which input changed state to trigger the message and also reports the states of both inputs.

## Undesired Input State Message

This is the message that is transmitted when the user has selected an undesired input state to cause a different report rate. When this Mode is enabled, the user defined Undesired Input State report rate supersedes the At Rest and In Motion report rates when the Input(s) is (are) in an undesired state.

The Standard Message Subtype field of this message, contained in byte 7; bits 4-7, has a value of 4.

The Input Status portion of byte 7; bits 0-3 in the message indicate which Input(s) are in the undesired state and triggering the Undesired Input State report rate.

## Re-Center Message

The Re-Center message is transmitted when Reduced Messaging Mode is selected and the SmartOne re-centers (automatically sets a new Change of Location Area).

The Standard Message Subtype field of this message, contained in byte 7; bits 4-7, has a value of 5.

# Type 1 Message Class

## Truncated Message Type – Single Packet

This message type provides for up to 2 bytes plus 6 bits of user data to be appended to the status byte and GPS location information. The input and status bits data of the standard message are replaced with user data from the configuration port. The Truncated message will follow the following on-air format:

| Variable | Bits | Description |
|---|---|---|
| Status Byte | 8 | Bit (1:0) = 1 Truncated message type<br>Bit (7:2) = Submask data from Truncated user data |
| Latitude/Longitude | 48 | Byte 1 = Latitude MSByte<br>Byte 2 = Latitude<br>Byte 3 = Latitude LSByte<br>Byte 4 = Longitude MSByte<br>Byte 5 = Longitude<br>Byte 6 = Longitude LSByte<br><br>360 degrees of longitude coded in signed binary with 3 bytes and 180 degrees of latitude coded in signed binary with 3 bytes<br><br>Positive longitude corresponds to East longitudes<br>Positive Latitude corresponds to North latitudes<br><br>See Appendix G for an Lat/Long decoding example |
| User Data | 16 | Byte 1 = User data byte 1<br>Byte 2 = User data byte 2 |

## Truncated Message Type – Multiple Packet Version

The Globalstar simplex messaging protocol provides for single and multiple packet messaging. In the event that the user application requests a user data length exceeding 9 bytes, the SmartOne (running firmware version 2.1 or later) will automatically “packetize” the message, that is, transmit it as multiple 9 byte packets. The ground station appliqué will reverse the process, “de-packetizing” the message back into a single (“long”) message. From the user application point of view, this eliminates the 9 byte limitation allowing the user to compose longer messages transparently. They are presented to the user by the Globalstar back office as complete messages of a length longer than 9 bytes. The SmartOne supports user-defined messages (Class 1 and 2) of up to 54 bytes.

This message type provides for up to 47 bytes plus 6 bits of user data to be appended to the status byte and GPS location information. The input and status bits data of the standard message are replaced with user data from the configuration port.

NOTE: Total message length will be a minimum of 9 bytes in length, and a maximum of 54 bytes in length, and the length sent to the user will always be divisible by 9.

The Truncated message will follow the following on-air format:

| Variable | Bits | Description |
|---|---|---|
| Status Byte | 8 | Bit (1:0) = 1 = Truncated message type<br>Bit (7:2) = submask data from Truncated user data |
| Latitude/Longitude | 48 | Byte1 = Latitude MSByte<br>Byte 2 = Latitude<br>Byte 3 = Latitude LSByte<br>Byte 4 = Longitude MSByte<br>Byte 5 = Longitude<br>Byte 6 = Longitude LSByte<br><br>360 degrees of longitude coded in signed binary with 3 bytes and 180 degrees of latitude coded in signed binary with 3 bytes<br><br>Positive longitude corresponds to East longitudes<br>Positive Latitude corresponds to North latitudes<br><br>See Appendix G for an Lat/Long decoding example |
| User Data | Variable | Byte 1 = User data byte 1<br>Byte 2 = User data byte 2<br>Byte 3 = User data byte 3<br>……<br>……<br>……<br>Byte 47 = User data byte 47 |

# Type 2 Message Class

## Raw Message Type – Single Packet Version

Message type 2 shall be a Raw Payload message. This message type provides for up to 8 bytes plus 6 bits of user data. This mode is provided to enable the user to directly send a single data burst through the network. The only bits not accessible to the user are the message type bits needed by the receiving data processor to delineate message type associated to the transmit ID. User data less than the full payload will be zero padded as necessary.

The Raw Payload message Single Packet version will follow the following on-air format:

| Variable | Bits | Description |
|---|---|---|
| Status Byte | 8 | Bit (1:0) = 2 = Raw message type<br>Bit (7:2) = submask data from Raw Payload user data |
| User Data | Variable | Byte 1 = User data byte 1<br>Byte 2 = User data byte 2<br>Byte 3 = User data byte 3<br>Byte 4 = User data byte 4<br>Byte 5 = User data byte 5<br>Byte 6 = User data byte 6<br>Byte 7 = User data byte 7<br>Byte 8 = User data byte 8 |

## Raw Message Type – Multiple Packet Version

The Globalstar simplex messaging protocol provides for single and multiple packet messaging. In the event that the user application requests a user data length exceeding 9 bytes, the SmartOne will automatically “packetize” the message, that is, transmit it as multiple 9 byte packets. The ground station appliqué will reverse the process, “de-packetizing” the message back into a single (“long”) message. From the user application point of view, this eliminates the 9 byte limitation allowing the user to compose longer messages transparently. They are presented to the user by the Globalstar back office as complete messages of a length longer than 9 bytes. The SmartOne supports user-defined messages (Class 1 and 2) of up to 54 bytes.

Message type 2 shall be a Raw Payload message. This message type provides for up to 53 bytes plus 6 bits of user data. This mode is provided to enable the user to directly send a single data burst through the network. The only bits not accessible to the user are the message type bits needed by the receiving data processor to delineate message type associated to the transmit ID. User data less than the full payload will be zero padded as necessary. Note: Total message length will be a minimum of 9 bytes in length, and a maximum of 54 bytes in length, and the length sent to the user will always be divisible by 9.

The Raw Payload message Multiple Packet version will follow the following on-air format:

| Variable | Bits | Description |
|---|---|---|
| Status Byte | 8 | Bit (1:0) = 2 = Raw message type<br>Bit (7:2) = submask data from Raw Payload user data |
| User Data | Variable | Byte 1 = User data byte 1<br>Byte 2 = User data byte 2<br>Byte 3 = User data byte 3<br>…..<br>…..<br>Byte 53 = User data byte 53 |

# Type 3 Message Class

The SmartOne will use the Type 3 message class for the following message types:

- Diagnostic Message – Subtype 21.
- Replace Battery Message – Subtype 22. ←Solar product does not require this message
- Contact Service Provider Message – Subtype 23.

## Diagnostic Message

The Diagnostic Message includes battery status, GPS average acquisition time, GPS fails and number of transmissions since the last Diagnostic Message.

Appendix I has an example of a decoded Diagnostic Message.

The format and fields of the SmartOne Diagnostic Message is shown in table 8 below.

| Byte # | Variable | Bits | Description |
|---|---|---|---|
| 0 | Type Field | 2 | Bit (1:0) = 3 Non Standard message type: |
| 0 | Subtype | 6 | Bit (7:2) = 21 for Diagnostic Message.<br>Bit (7:2) = 22 for Replace Battery Message.<br>Bit (7:2) = 23 Contact Service Provider Message.. |
| 1 | Number of Transmissions per Burst. | 4 | Bits(3:0) = Number of Transmissions (1 to 15 Transmissions) |
| 1 | Battery Condition | 1 | Bit 4: 0 = Good battery. 1 = Replace Battery |
| 1 | GPS Subsystem Fault | 1 | Bit 5: 0 = GPS system OK. 1 = Fault |
| 1 | Transmitter Subsystem Fault | 1 | Bit 6: 0 = Transmitter OK. 1 = Fault. |
| 1 | Scheduler Subsystem Fault | 1 | Bit 7: 0 = OK. 1 = Fault |
| 2 | Min Interval | 8 | Minimum Interval between transmission attempts (5 second resolution) Default is 300 seconds |
| 3 | Max Interval | 8 | Maximum Interval between transmission attempts. Default is 600 seconds |
| 4 | GPS Mean Search Time | 8 | Unsigned binary count in seconds for mean GPS search to acquire |
| 5,6 | # GPS Fails | 16 | Unsigned binary count of failed GPS attempts since last Diagnostic Message |
| 7,8 | # Transmissions | 16 | # of transmissions since last Diagnostic message |

## Contact Service Provider Message

The SmartOne will send a Contact Service Provider message when an internal fault is detected. The SmartOne will send one such message upon the detection of an internal fault. It will then attempt to

continue to operate normally. The SmartOne will not send another Contact Service Provider message unless the fault is determined to have cleared, and then determined to have come back again.

## Accumulate/Count Message

The Accumulate/Count message is used to report the accumulation of time that an input is in a specified state as defined by the user, the accumulation of time that the device is in a State of Vibration, and/or the total transitions of the Inputs, as configured by the user. The message is transmitted either at a pre-set interval, at a point where any of the accumulation or count registers reach multiples as programmed by the user, just before rollover of any count/accumulate register, or all of the above.

Appendix J has an example of a decoded Accumulate/Count message.

| Byte # | Variable | Bits | Description |
|---|---|---|---|
| 0 | Type Field | 2 | Bit (1:0) = 3 Non Standard message type: |
| 0 | Subtype | 6 | Bit (7:2) = 24 Accumulate/Count message.. |
| 1, 2 | Accumulated Input 1 | 16 | Accumulated time that Input 1 has been in its undesired state with a resolution of 10 minutes. For example: 1 hour would be represented as a value of 6, 2 hours as a value of 12, etc. This resolution results in a rollover rate of a total time accumulation of approximately 1.25 years. (OxFFFF means that Input 1 Accumulate has been turned off) |
| 3, 4 | Accumulated Input 2 | 16 | Accumulated time that Input 2 has been in its undesired state with a resolution of 10 minutes. For example: 1 hour would be represented as a value of 6, 2 hours as a value of 12, etc. This resolution results in a rollover rate of a total time accumulation of approximately 1.25 years. (OxFFFF means that Input 2 Accumulate has been turned off) |
| 5, 6 | Accumulated Vibration | 16 | Accumulated time that the SmartOne has been in a State of Vibration with a resolution of 10 minutes. For example: 1 hour would be represented as a value of 6, 2 hours as a value of 12, etc. This resolution results in a rollover rate of a total time accumulation of approximately 1.25 years. (OxFFFF means that Accumulated Vibration has been turned off) |
| 7 | Input 1 Count | 8 | The total number of openings or closings of input 1 as selected by the user. (OxFF means that Input 1 Accumulate has been turned off) |
| 8 | Input 2 Count | 8 | The total number of openings or closings of input 2 as selected by the user. (OxFF means that Input 2 Accumulate has been turned off) |

# Messaging Priority

## Prioritization of Periodic Standard Message Report Rates

The SmartOne supports several rates at which it will send a Periodic standard message. Periodic versus Scheduled standard message rates are mutually exclusive. This is the priority of the different rates at which the SmartOne will send a standard message (Highest is listed first):

- Rate specified by Undesired Input State.
- Rate specified for when the SmartOne is inside its Change of Location Area.

- Rate specified for when device is In Motion. (Note, when inside the Change of Location Area, this rate affects sampling, but not reporting, as indicated by a higher priority for inside Change of Location Area.)
- Rate specified for when the device is At Rest.

## Message Priorities

It is possible that message types may collide. Whenever feasible, the SmartOne will examine its known schedule and reschedule lower priority messages to occur after higher priority ones. If there is not enough time in the known schedule for all scheduled messages to be transmitted in a reasonable time, or there is insufficient memory to queue them, the lowest priority message(s) could be dropped. In any case, unscheduled messages (for example, Input Status Changed) shall cancel pending messages of lower priority and not cancel pending messages of higher priority. The following list shows the priority of message types, with the highest priority being listed first.

- Contact Service Provider
- User Defined Raw message. *
- User Defined Truncated message. *
- Change of Location Area
- Replace Battery ←Solar product does not require this message
- Undesired Input State
- Re-Center
- Diagnostics
- Accumulate/Count
- Input Status Changed
- Device Turned On
- Normal Location (In-Motion or At-Rest).

***Note: The two user defined message types actually have equal priority. Either one will cancel the other one. If, for example, the user interface commands the device to send a Truncated message, and then, before it has time to obtain a fix and send the message, the user commands a Raw message, the Raw message will be sent.**

# 4. Serial Commands

The SmartOne uses the I/O port for unit configuration as well as interface to remote passive and smart sensors. Two commands are provided in the unit interface to support smart sensors. External sensors that can format and communicate to the SmartOne can send user data through the SmartOne by using these two commands.

This section describes the serial interface between the SmartOne and a computer or other programming device. SmartOne will respond to any command that contains fields with invalid values with a NAK response (command field set to 0xFF).

## Describe Bluetooth Interface in this Section

## Serial Packet Format (commands and answers)

Communication to the SmartOne will follow the following specific format:

| Preamble | Length | Cmd | Data | CRC |
|---|---|---|---|---|
| 1 byte | 1 byte | 1 byte | Variable length 0 – 54 bytes | 2 bytes |

*Total length range permitted: 5 bytes (Data field length 0) to 59 bytes (Data field length 54).*

## Serial Packet Fields

The different fields are defined as:

| Preamble | Fixed Pattern 0xAA |
|---|---|
| Length | Total number of bytes in the serial packet including the preamble |
| Cmd | Command type (See table below). Responses to commands carry the same command type as the command that initiated the answer |
| Data | Data associated with the command or answer |
| CRC Low | Least significant byte of the 16-bit CRC |
| CRC High | Most significant byte of the 16-bit CRC |

# CRC Algorithm

The Security Field is a 16-bit CRC of all of the previous fields including the preamble, length, and command bytes. The remainder is initialized to all 1's (0xFFFF) and the CRC is inverted before being sent. Following is a sample C routine that implements the algorithm using the reversed technique:

```
WORD crc16_lsb(BYTE *pData, WORD length)
{
    BYTE i;
    WORD data, crc;
    crc = 0xFFFF;
    if (length == 0)
        return 0;

    do
    {
        data = (WORD)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);
}
```

As an example, for a type (0x01) “Get ID” message made up of the following bytes: **AA 05 01**

The following 2 byte CRC would be calculated: **D5 50**

The complete message sent by the host to the SmartOne is: **AA 05 01 50 D5**

# Serial Packet Types

| Cmd | Description/Usage/ Comment | Command Data Bytes | Acknowledge Data Bytes |
|---|---|---|---|
| 0x01 | User requests the SmartOne to reply with integral ESN (Electronic Serial Number). This is the ID used by Globalstar to identify the unit | None | Four data bytes, which contain the unit ID as an unsigned integer. The MSByte is sent first. Only the 27 LSbits are non-zero |
| 0x26 | Send Truncated Message | See Truncated Message section below | None |
| 0x27 | Send Raw Message | See Raw Message section below | None |

# Send Truncated Message (serial message type 0x26)

The SmartOne will perform a GPS location and append user data passed to the unit via the Truncated Message command 0x26.

47 bytes plus 6 bits of user data may be sent with the standard GPS location information in a messaging burst. Two bits are set in the on-air message by the SmartOne informing the recipient that the message is the Truncated type.

The following table defines the message structure of the "data" portion of the command used to send a Truncated message.

Communication to the SmartOne will follow the following specific format:

| Byte | Bit | Parameter | Description | Default Value |
|---|---|---|---|---|
| 0 | 7.2 | Submask Bits | User data bits. Bits 1:0 are reserved and will be masked by SmartOne | 0x00 |
| Variable | | User Data | Supports a maximum of 47 total bytes in this field. User application (smart sensor) should transmit only as many bytes as needed (don't pad the message) in order to keep on air packets to a minimum | |

**Example 1 - Sending a "Truncated" User Message**

The host sends:

**AA 08 26 10 22 33 <CRC-low> <CRC-High>**

The SmartOne would respond:

**AA 05 26 <CRC-Low> <CRC-High>**

What would go out over the air is:

**11 Lat-3 Lat-2 Lat-1 Lon-3 Lon-2 Lon-1 22 33**

**Note: All on air messages are padded to a multiple of 9 bytes. This is the reason for the trailing zeros in this example.**

**Note: The least two significant bits of the first byte are always "01" for a trunc message, the remaining 6 bits make up the top 6 bits of the first byte sent in the serial command, in this example 000100xx (with the "xx" representing the two bits that the SmartOne forces to "01").**

The 22 and the 33 that the user sent are appended after the 6 bytes of latitude and longitude.

**Example 2 - Using a Longer Message**

The host sends:

**AA 0D 26 10 22 33 44 55 66 77 88 <CRC-low> <CRC-High>**

**Note: The length field: 0D – 0D is the number 13 in hexadecimal, the length of the total serial command.**

The SmartOne would respond:

**AA 05 26 <CRC-Low> <CRC-High>**

What would go out over the air is:

**11 Lat-3 Lat-2 Lat-1 Lon-3 Lon-2 Lon-1 22 33 44 55 66 77 88 00 00 00 00**

# Send Raw Message (serial message type 0x27)

The SmartOne will send raw user data using the Raw Payload command 0x27.

53 bytes plus 6 bits of user data may be sent. Two bits are set in the on-air message by the SmartOne informing the recipient that the message is Raw.

The following table defines the message structure used to send a Raw message.

| Byte | Bit | Parameter | Description | Default Value |
|---|---|---|---|---|
| 0 | 7.2 | Submask Bits | User data bits. Bits 1:0 are reserved and will be masked by SmartOne | 0x00 |
| Variable | | User Data | Any user data<br>Supports a maximum of 53 total bytes in this field. User application (smart sensor) should transmit only as many bytes as needed (don't pad the message) in order to keep on air packets to a minimum | |

**Example 1 - Sending a Raw User Message:**

The Host sends:

**AA 0E 27 10 22 33 44 55 66 77 88 99 <CRC-low> <CRC-high>**

The SmartOne Responds:

**AA 05 27 <CRC-low> <CRC-high>**

What actually goes out over the air is:

**12 22 33 44 55 66 77 88 99**

**Note: The least two significant bits of the first byte are always "10" for a raw message (a HEX or decimal value of "2", the remaining 6 bits make up the top 6 bits of the first byte sent in the serial command, in this example 000100xx (with the "xx" representing the two bits that the SmartOne forces to "10").**

**Example 2 - Using a Longer Message:**

The Host sends:

AA 21 27 10 22 33 44 55 66 77 88 99 AA BB CC DD EE FF 11 22 33 44 55 66 77 88 99 AA 44 56 78 <CRC-low> <CRC-high>

**Note: The length field, the command contains a total of 33 bytes. The length is 21 Hexadecimal, which is equal to 33 decimal.**

The SmartOne Responds:

**AA 05 27 <CRC-low> <CRC-high>**

What actually goes out over the air is:

**12 22 33 44 55 66 77 88 99 AA BB CC DD EE FF 11 22 33 44 55 66 77 88 99 AA 44 56 78 00 00 00 00 00 00 00 00**

**Note: All on air messages are padded to a multiple of 9 bytes. This is the reason for the trailing zeros in this example.**

A simple ACK or NAK from the SmartOne Device to the host (smart sensor):

ACKs.

**AA 05 26 <crc crc>** (for the Truncated message)

**AA 05 27 <crc crc>** (for the Raw message)

NAK:

**AA 05 FF <crc crc>** (NAK).

**Note: As the SmartOne operates, some debugging traces come out of the serial port. Those traces should simply be ignored. Once the handshake line is pulled low, the unit is in "command mode" and debugging traces will stop.**

**Note: User commands will ALWAYS be responded to immediately with either an acknowledgement or a NAK (as shown in the examples above). Once an acknowledgement (or NAK) is received, the host should simply ignore the serial port until the next time it sends a command.**

**Note: The most common reasons for a NAK are incorrect CRC, incorrect length field, or incorrect command field (i.e. not 0x26 or 0x27 for trunc and raw respectively).**

# The Handshake Line

The handshake line should be pulled low before sending each serial message. The recommended use of the handshake line is:

1) Pull handshake low.
2) Wait 2-3 milliseconds.
3) Send command
4) Receive response.
5) Raise handshake high.

# 5. Connecting Serial Devices to the SmartOne

The SmartOne accepts a serial connection at 3 volt levels (Max), at 9600 baud. The relevant pins are TX, RX, Handshake and ground. The SmartOne can connect with devices that contain an asynchronous UART at 3 volt levels. (High State: 2.7-3 Volts, Low State: 0 Volts. Please contact Globalstar Support for more information).

**CAUTION: *NEVER* attempt to connect the SmartOne directly to the pins on a computer's RS232 or USB port. The voltages in RS232/USB are too high and can damage the SmartOne.**

Any deviations from the above guidelines will violate all RMA requirements and prevent any no-cost replacement.

**Note: See Appendix K for information on the External Input Cables for the SmartOne.**

# Appendix A - Glossary of Terms

## A

***Accelerometer*** – A sensor used for detecting and measuring vibration.

***Accumulate Hours*** – The activity time accumulated in the Inputs of the device while the Input is in the user defined state.

***Activation –*** The activation of an ESN (electronic serial number) on the Globalstar satellite network. The process consists of programming a start and an end date for the use of the ESN and the payment of certain fees to Globalstar. Sometimes referred to as “provisioning.”

***At Rest –*** A tracker is considered to be at rest when the comparison of a new GPS reading to a previous GPS reading indicates that the tracker has not changed location by more than a specified minimum distance. The specified minimum time and the specified minimum distance are both configuration parameters.

## C

***Configuration –*** The collection of variables that control the operating performance of a device.

***Configure (configuring) –*** Programming (setting) the variables that control the operation performance of a tracker.

***Count Events*** – The accumulated number of state changes in the Inputs of the device.

## D

***Delay To Start*** – Specific delay in time following the programming of the device to commence operation.

***Desired State*** – The state of the Input in normal condition defined by the user.

## E

***ESN*** – Electronic Serial Number is a unique number assigned to each SmartOne device. The ESN Network is used by Globalstar Simplex to identify messages from the devices in the field.

## F

***Failed GPS reading –*** A GPS reading could not be processed from available GPS satellite signals.

***FW Ver*** – Firmware version is the existing software loaded in the device main processor

## G

***GPS*** – The GPS (Global Positioning System) is a "constellation" of 24 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location.

***GPS reading –*** The longitude, latitude, time, and date information obtained from processing the signals from the GPS satellites.

## I

***In Motion –*** The unit is considered to be In Motion when there is a State of Vibration – and – when a comparison of a new GPS reading to a previous GPS reading indicates the device has changed location by at least a specified minimum distance (100 meters by default).

***Inaccurate GPS reading –*** The longitude and latitude information obtained from processing the signals from the GPS satellites when a tracker cannot observe an adequate number of satellites; the GPS signals were jammed by electronic interference; the GPS signals were reflected from objects creating multi-path conditions; or weather conditions distorted the GPS signals. An inaccurate GPS reading may have longitude and latitude errors of a mile or more.

***Input*** – A digital channel in the device that allows the detection of switch stage changes. The inputs are dry contact inputs, ON/OFF.

## M

***Message –*** A collection of information that is transmitted in a group over the satellite network.

***Message Interval*** – The indicates the amount of time specified by the user between Location Messages. The SmartOne transmits a Location Message once the Message Interval has elapsed. The internal clock on the device is reset to the interval time after each transmission. The SmartOne is in low power consumption Mode during the interval to preserve battery life.

***Message Time(s) of Day*** – The specific time of day in military format for the SmartOne to transmit Location Messages. The SmartOne is in low power consumption Mode between the specific times of day to preserve battery life.

***Message Transmission –*** The indicates the process of sending a message over the satellite network. The process includes sending a message multiple times to improve the transmission success rate.

## N

***Number of message repeats –*** The number of times a message is sent in a message transmission with the same Unique Message Number(UMN). The number of message repeats is configurable during the tracker set up process. Globalstar only counts repeated messages as one message if it is received three times or less. If the same message is received more than three times, Globalstar may count the message as more than one message for billing purposes

## S

***Self Test –*** An internal unit test that is performed by the processor, checking for the proper operation of unit functions.

***State of Lacking Vibration –*** The motion sensor is indicating a cease of vibration when the number of vibration pulses per minute is lower than the Level of Sensitivity for Vibration Sensor number for the time required to determine if a State of Vibration has ceased.

## T

***Time to be in a State of Lacking Vibration –*** A configurable parameter that sets the period of time vibration has to be absent to determine if a State of Vibration has ceased.

***Time to be in a State of Vibration*** – A configurable parameter that sets the period of time used to determine if a State of Vibration exists.

## U

***Undesired State Message*** – The SmartOne sends this message at a user defined interval while any of its Inputs are in the undesired state selected by the user, either closed or opened.

# Appendix B - Technical Support

We suggest VARs reference our online content at our Globalstar VAR Support Website http://var.globalstar.com/ prior to contacting our VAR Support. The content located there should address most activation/provisioning inquiries and minor frequently asked questions concerning business account management functions. Please create an account by accessing this site and clicking on:

***Sign Up for Access Here***

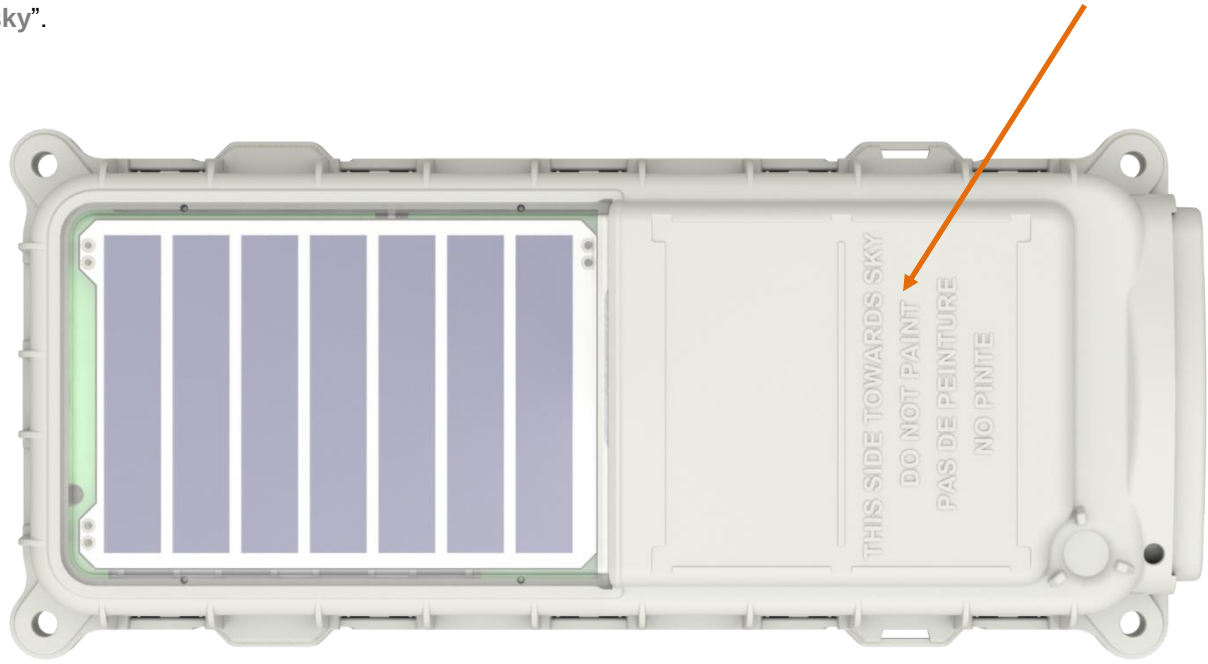
For all other support issues, please contact Globalstar, Inc. at our corporate headquarters:

- Email: varsupport@globalstar.com.
- Phone: +1 (985) 335-1590
- Address: Globalstar, Inc.
  300 Holiday Square Blvd.
  Covington, LA 70433

# Appendix C - RF Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE: The SmartOne antennas are located in the unit under the embossed words: "**This side towards sky**".




RAPPORT D'EXPOSITION DE RAYONNEMENT DE LA FCC RF Cet equipment est conforme aux limites d'exposition de rayonnement de la FCC RF determinees pour un environnement non controle. Cet equipment devrait etre installe et actionne avec une distance minimum de 20 cm entre le radiature et votre corps.

# Appendix D - Regulatory Notices

## FCC/IC Notices

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. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note:

This equipment has been tested and found to comply with the limits for a Class A 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.

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

CAN ICES-3 (A)/NMB-3(A) – This Class A Digital Apparatus Complies with Canadian ICES-003.

Cet Appareil numerique de la classe (A) est conforme a la norme NMB-003 du Canada.

## CE Notices

**DECLARATION OF CONFORMITY FOR EUROPEAN CUSTOMERS**

Hereby, Globalstar declares that this SmartOne Solar 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.

SmartOne Solar™ Transmit Frequencies: 1611.25 Mhz - 1618.75 Mhz (4 Channels)

SmartOne Solar™ Max Power Out: 23.46 dBm EIRP

The SmartOne Solar 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 SmartOne Solar cannot be marketed in Ireland.

CE

IE Not to be Marketed in the Republic of Ireland

# Hazardous Locations Safe Use Conditions

## Certification and Ratings

This device is certified Intrinsically Safe to the following levels:

II 1 G, Ex ia IIC T4 Ga

-40°C<$T_{amb}$<+65°C IP68, IP69K

Class I: Division 1|Groups A-D T4

US: Class I: Zone 0|AEx ia IIC T4 Ga

CAN: Class I: Zone 0|Ex ia IIC T4 Ga

The device can be installed and operated safely in hazardous locations covered by the above ratings provided the following safety instructions and warnings are followed.

## External Electrical Connections

WARNING: The external connector is not intended for use in hazardous locations.

Electrical rating: Um=250Vrms for non-intrinsically safe sources connected in non-hazardous locations.

While it may be possible to connect certain equipment in a safe manner, a field evaluation must be carried out by the relevant authority and installations certified on a case-by-case basis.

## Static Electricity Warning

WARNING: the housing of this product is made of non-conductive material that may build an ignition-capable electrostatic charge under certain conditions. Do not touch, wipe, or clean the unit in hazardous environments. Installation and maintenance should only be performed when the environment has been confirmed to be safe.

## Metal Protection Bracket Installation

WARNING: The measured capacitance of the worst case unearthed protection bracket was determined to be 124.6 pF as measured per clause 26.14 of IEC 60079-0: 2011. It is the installer's responsibility to determine safe use conditions when installing in a hazardous location where proper grounding of the bracket is not guaranteed or the bracket is purposefully insulated.

In most cases, the bracket should be grounded to the asset by maintaining metal-to-metal contact between the bracket and the mounting surface. A separate grounding wire connected to the provided location on the bracket may also be used.

The bracket may be painted or powder-coated provided the maximum coating thickness is less than 0.2mm.

# Appendix E – General Warnings

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

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

**Warning – Potential Explosive Atmosphere:** Do not use SmartOne Solar when in any area with a potentially explosive atmosphere and obey all signs and instructions.

**Warning – Driving:** Always follow safe driving practices and local rules and regulations regarding the use of wireless devices while driving. Do not drive when programming or servicing the SmartOne Solar.

**Warning - Installation and Service:** Allow only authorized personnel to install or service the SmartOne Solar and accessories. Faulty installation or service can be dangerous and can invalidate the warranty.

**Warning - Pacemakers:** The Health Industry Manufacturers Association(HIMA USA) recommends that a minimum separation of six (6”) inches be maintained between the SmartOne Solar and a pacemaker to avoid potential interference with the pacemaker.

**Warning – External Power:** When connecting external power to the SmartOne Solar, make sure that the supply voltage to the unit is at the rated voltage(See Appendix K). If the supply voltage to the SmartOne Solar is not at the rated voltage, the unit may not operate correctly and damage to the unit may occur. Also, it will void the warranty if an invalid voltage is supplied via external input and the SmartOne Solar is damaged.

**Warning – Tightening Cover Screws:** Upon replacing the Configuration Cable Cover, tighten the screws according to specification(Section 2 of this manual); otherwise the unit may no longer retain its water-tight capability.

# Appendix F – Specifications & Standards

| Specifications | |
|---|---|
| Dimensions | H·W·D(metric): 8.26 cm x 17.78 cm x 2.87 cm |
| | H·W·D(English): 3.25” x 7” x 1.125” |
| Weight | 385 grams; with optional bracket 1150 grams |
| | 13.5 oz.; with optional bracket 40.57 oz. |
| Operating/Storage Temperature Range | -40°C to 85°C (-40°F to 185°F) |
| | NOTES:<br>While functional in the specified Operating Temperature Range, usage of the SmartOne Solar™ above 60°C may cause RF signal degradation and decreased battery lifetime of the unit.<br>The unit is certified Intrinsically Safe for hazardous environments over the temperature range -40° to +65°C (-40°F to 149°F). |
| Line Power | 5 VDC or 8-22 VDC Regulator Cable |
| Battery Type | Built-in Nickel Metal Hydride rechargeable |

| Standards | | |
|---|---|---|
| Waterproof | IP69K | Ingress Protection (Dust & Waterproofing) |
| Military Standards | MIL-STD-810G | Immersion (Method 512.5)<br>Impact resistance (Method 516.7)<br>Salt Fog (Method 509.5)<br>Acidic Atmosphere (Method 518.2)<br>Humidity<br>Vibration (Figure 514.7) |

# Appendix G – Latitude/Longitude Decoding

**Example Message = 0x002B5372BFF12F0A02**

| | 0x 00 | 2B | 53 | 72 | BF | F1 | 2F | 0A | 02 |
|---|---|---|---|---|---|---|---|---|---|
| **Signed integer (MSB..LSB)** | | Lat2 | Lat1 | Lat0 | Long2 | Long1 | Long0 | | |

## Calculating Latitude

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

**Degree_per_count_lat =$(90.0/2^{23})$**

**Hex Lat = 0X2B5372 ; Conversion to Decimal = 2,839,410**

**Latitude = Decimal Lat bytes * Degree_per_count_lat**
**= 2,839,410 * $(90.0/2^{23})$**
**= 30.463564 degrees NORTH**

Note: If greater than 90 degrees, 180 must be subtracted from result

## Calculating Longitude

Negative Longitude corresponds to Longitude in the WESTERN Hemisphere.
Positive Longitude corresponds to Longitude in the EASTERN Hemisphere.

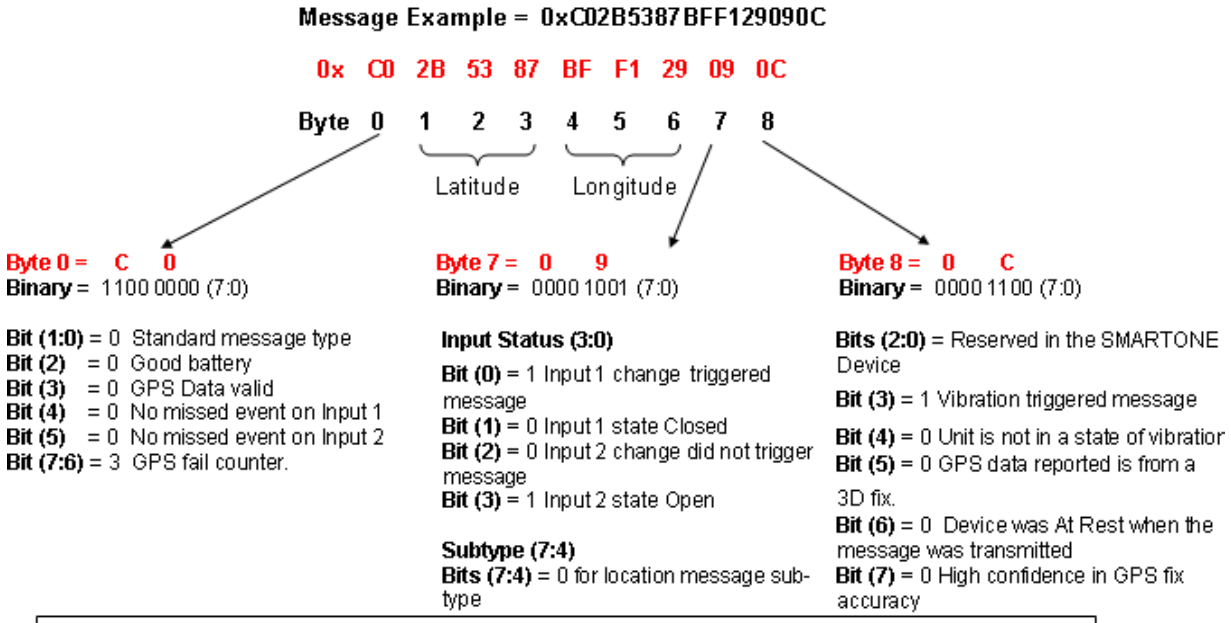
**Degree_per_count_long =$(180.0/2^{23})$**

**Hex Long = 0XBFF12F ; Conversion to Decimal = 12,579,119**

**Longitude = Decimal Long bytes * Degree_per_count_long**
**= 12,579,119 * $(180.0/2^{23})$**
**= 269.918611**

Note: If greater than 180 degrees, 360 must be subtracted from result.Therefore, **269.918611 degrees – 360 degrees**
**= -90.081388 degrees**
**= 90.081388 degrees WEST**

# Appendix H – Standard Message Decoding




**Note:** The following 5 messages have the same message format as the Location Message. The only difference is the sub-type value of Byte 7.

| Sub-type Value | Message |
|---|---|
| =1 | Device Turned On |
| =2 | Change of Location alert |
| =3 | Input Status Changed |
| =4 | Undesired Input State |
| =5 | Re-center |

# Appendix I - Diagnostic Message Decoding

**Message Example = 0x 57033C784F00000009**

| | 0x | 57 | 03 | 3C | 78 | 4F | 00 | 00 | 00 | 09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Byte** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | |

**Byte 0 = 5 7**
**Binary =** 0101 0111 (7:0)
**Bits (1:0)** = 3 Non Standard message type
**Bits (7:2)** = 21 for Diagnostic Message

**Byte 1 = 0 3**
**Binary =** 0000 0011 (7:0)
**Bits(3:0)** = 3 Number of Transmissions
**Bit (4)** = 0 Good battery
**Bit (5) =** 0 GPS system OK
**Bit (6) =** 0 Transmitter OK
**Bit (7) =** 0 Scheduler Subsystem OK

**Byte 2 = 3 C**
**Decimal =** 60
Minimum Interval between transmission attempts
( 5 second resolution, 300)

**Byte 3 = 7 8**
**Decimal =** 120
Maximum Interval between transmission attempts.
( 5 second resolution, 600)

**Byte 4 = 4 F**
**Decimal =** 79
Unsigned binary count in seconds for mean GPS search to acquire

**Byte 5 & 6 = 00 00**
**Decimal =** 0
Unsigned binary count of failed GPS attempts since last Diagnostic Message

**Byte 7 & 8 = 00 09**
**Decimal =** 9
# of transmissions since last Diagnostic message

**Note:** The following 2 messages have the same message format as the Diagnostic Message. The only difference is the value of Bits(7:2) of Byte 0

| Bits (7:2) Value | Message |
|---|---|
| =22 | Replace Battery |
| =23 | Contact Service Provider |

# Appendix J - Accumulate/Count Message Decoding

**Message Example = 0x63FFFFFFFFFFF7DFF**

| | 0x | 63 | FF | FF | FF | FF | FF | FF | 7D | FF |
|---|---|---|---|---|---|---|---|---|---|---|
| **Byte** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | |

**Byte 0 = 6 3**
**Binary =** 0110 0011 (7:0)
**Bits (1:0)** = 3 Non Standard message type
**Bits (7:2)** = 24 for Accumulate/Count Message

**Byte 1 & 2 = FFFF**
Accumulated time that Input 1 has been in its undesired state with a resolution of 10 minutes.
**OxFFFF** means that Input 1 Accumulate has been turned off

**Byte 3 & 4 = FFFF**
OxFFFF means that Input 2 Accumulate has been turned off

**Byte 5 & 6 = FFFF**
Accumulated time that the SMARTONE has been in a State of Vibration with a resolution of 10 minutes.
**OxFFFF** means that accumulate time of vibration been turned off

**Byte 7 = 7D**
Decimal = 125
The total number of openings or closings of Input 1

**Byte 8 = FF**
**OxFF** means that Input 2 Accumulate count has been turned off

# Appendix K - External Input Cable

## INSTRUCTIONS AND WIRING DIAGRAM FOR EXTERNAL INPUT CABLE (PN# 2030-0265-04)

INSTRUCTIONS

1. This cable is designed to work with the SmartOne Solar product only. Do not use with any other SmartOne product.
2. This cable is designed to work with 3V logic only. Do not use with 5V logic devices.
3. Be certain that unused wires do not short to each other.
4. All ground wires are common; therefore, any ground can be used with any function.

| Connector PIN # | Color | Function |
|---|---|---|
| 2 | Green | Ground |
| 3 | Brown | Setup (Handshake from Serial Device) |
| 4 | Red | RX (connect to Serial Device TX) |
| 5 | Orange | TX (connect to Serial Device RX) |
| 8 | Light Blue | Dry Contact 2 |
| 9 | White | Dry Contact 1 |
| 11 | Yellow | Soft Power Down (Normally Open) |
| 12 | Blue | Ground |
| 19 | Violet | Line Power + (positive) |
| 20 | Gray | Line Power – (negative) |

# Appendix L – Solar Powered Limitations

## Storage (Shelf Life)

The rechargeable NiMH batteries may be considered operational for up to 8 months with the device powered off while in storage without sunlight.

## Typical Usage Life

Battery life is dependent on several factors:

- View of the sky
- How often the device is transmitting
- Requesting GPS fixes
- Temperature
- Sleep Current

Typically, the SmartOne batteries will have a lifetime battery life of 8 years when sending up to 140 In-Motion/Exception Reports or Location Messages per day.

## Usage in the Absence of Sunlight

The rechargeable NiMH batteries should last up to 6 months with a clear view of the sky in the absence of sunlight under any of the following mutually exclusive conditions:

1) Two Location Messages/day
2) Two nine-byte raw messages/day
3) Two GPS fixes/day