STINGR Users Manual

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1 Introduction

1.1 Purpose

This document describes the physical, electrical, and functional characteristics of the STINGR satellite transmitter module. The information contained in this document is intended to provide the end user with the necessary technical information required to 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.

1.2 Applicable Documents

1.3 Description

The STINGR 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 simplex satellite 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 STINGR is a satellite transmitter radio module which contains a satellite transmitter, GPS receiver, motion sensor, and a dual band patch antenna. The STINGR is a surface mount module designed to attach to a user defined host PCB which must provide power and communications with a host processor which will control the operation of the STINGR. All electrical connections are provided via the castellated pads on the perimeter of the PCB.

The STINGR is a small, low-profile device with the dimensions shown below.
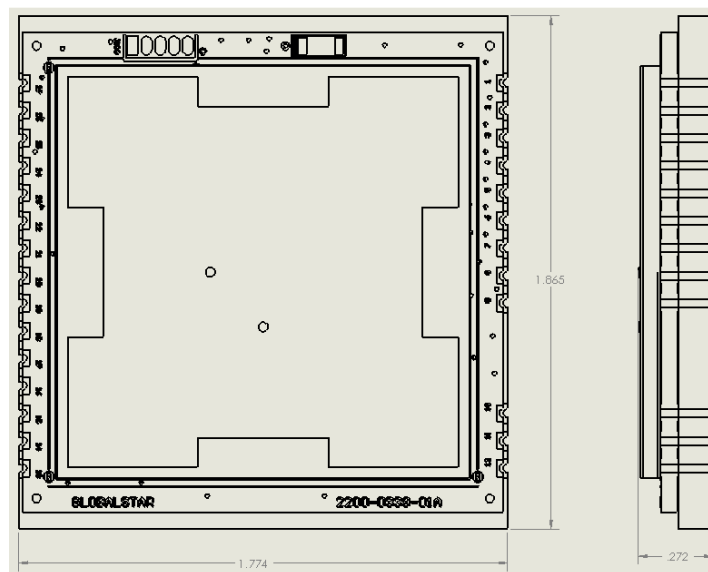
Figure 1 **(dimensions in inches)**

2   Application

2.1   Theory of Operation

The STINGR 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

Since the satellite position is constantly changing, simplex 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 as shown below. 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.
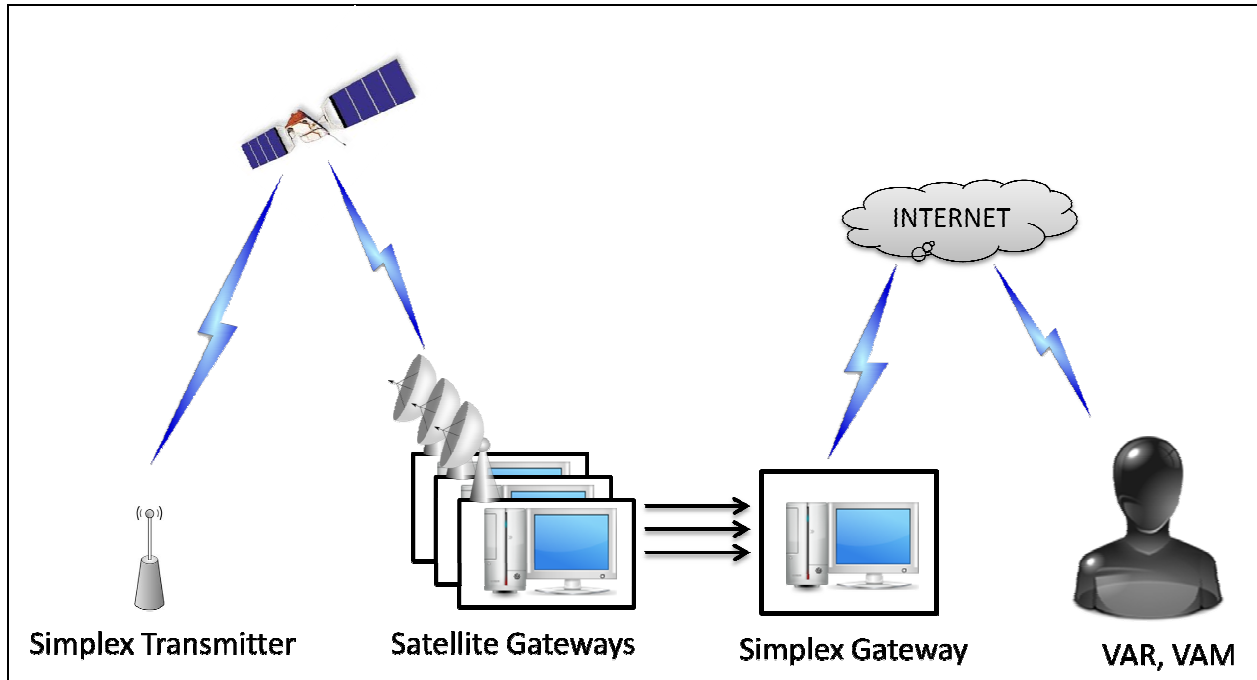
Figure 3 Simplex Messaging

Messages are composed of 1 or more 9-byte payloads. The STINGR can only transmit 9-byte on-air messages, so user payloads greater than 9 bytes will require multiple on-air packets to be transmitted for each user payload.
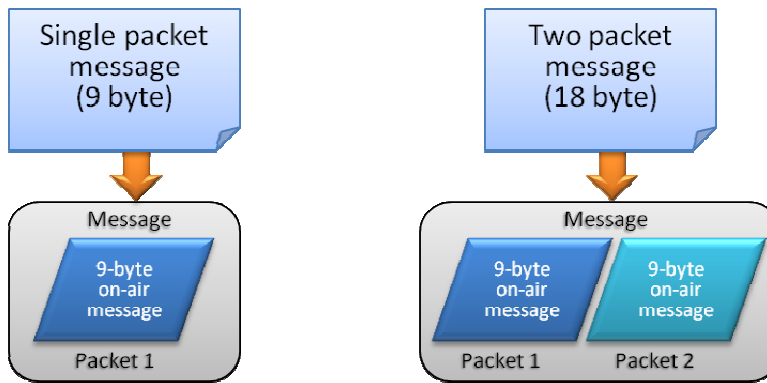
There are brief periods of time where there is no satellite in range of the simplex transmitters due to obstructions and/or satellite coverage geometry. Since a simplex device has no way of knowing if a transmitted message has been successfully received, the STINGR device is designed to send multiple (redundant) transmissions for each message being 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 STINGR will 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 5-minute nominal interval.

The transmission sequence for a single-packet message using the default setting of 3 redundant transmissions is shown below.
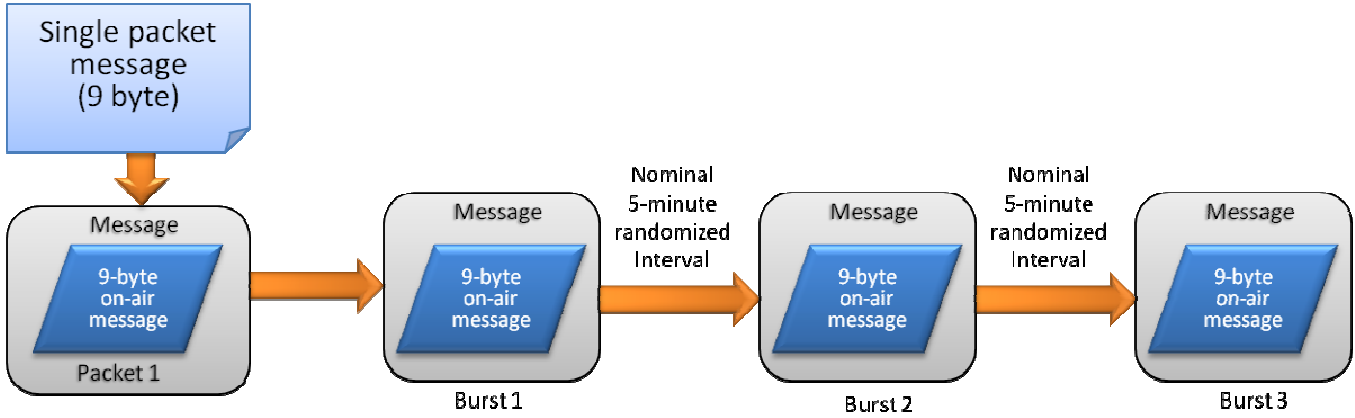
The transmission sequence for a two-packet message using the default setting of 3 redundant transmissions is shown below.
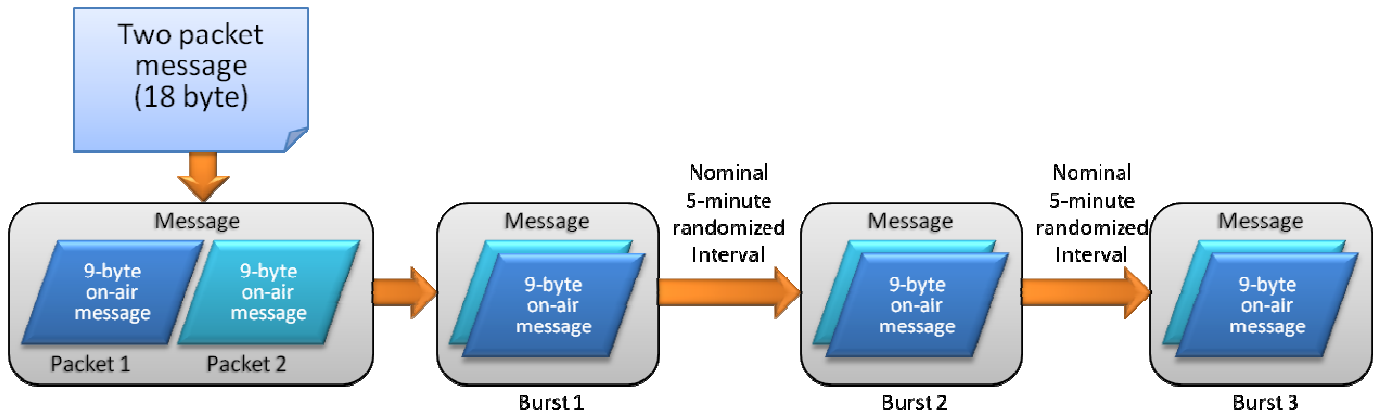
For normal conditions where the transmitter has an open view of the sky, this will result in a better than 99% chance that the message will be received.

2.2   Block Diagram

The basic elements of a design utilizing the STINGR simplex transmitter are shown below.
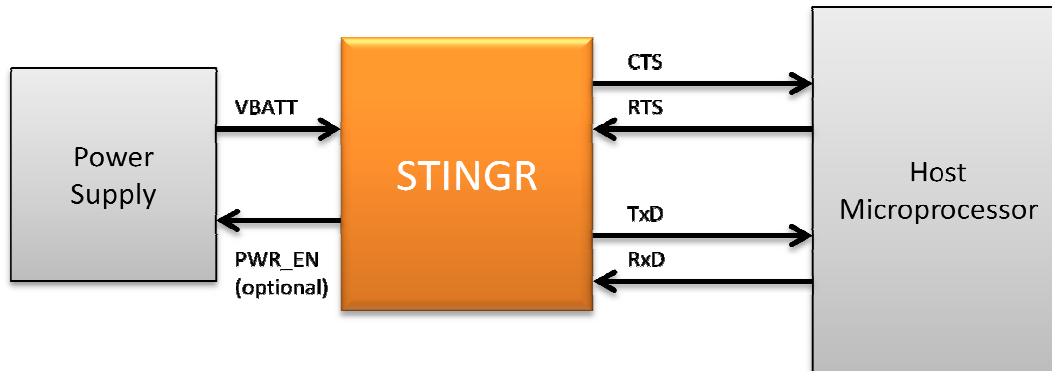
Figure 4

The STINGR provides a single power supply input. Normally, this will be a high-current battery which can provide the required transmit current during RF transmissions. The STINGR has internal regulators which provide separate power for the digital, RF and GPS circuitry. This provides the capability to leave the STINGR in a low power consumption state when the transmitter RF section and the GPS section is idle. The internal RF power supply is a high power supply which is only required while the STINGR is transmitting a data packet. Internal cirucuitry turns this supply off except during active transmissions in order to minimize the power consumption of the STINGR. Since the transmission duty cycle is very low, this supply will be turned off the majority of the time and only active during the transmission of a packet. Due to the random nature of the burst transmissions, and open collector output (PWR_EN) is provided by the STINGR which can directly control an external high current supply for VBATT (VBATT can NOT be turned off between bursts when sending a multi-packet message). This will ensure that the RF power supply high current mode is enabled for the minimum amount of time to complete each transmission. It may also be monitored by the host to determine when each burst has been completed without the need to query the STINGR via the serial host interface.

3   Physical Charactersistics
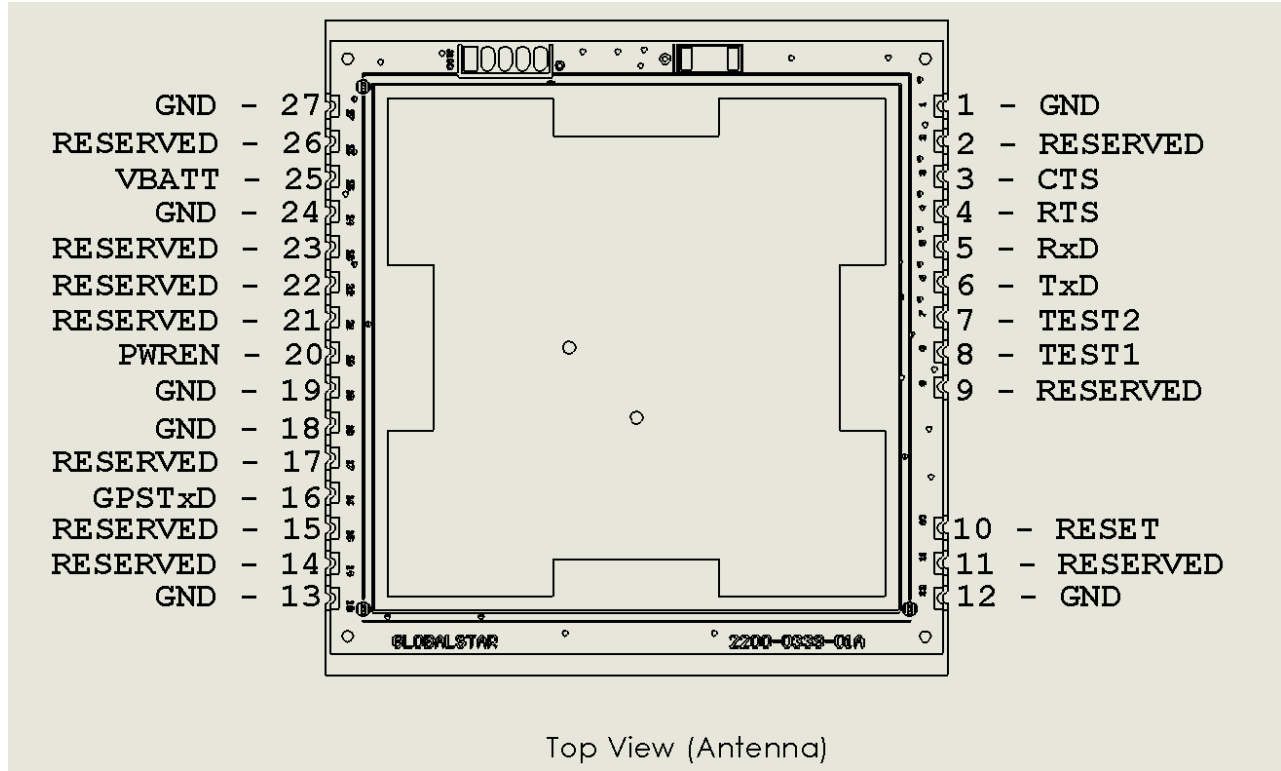
Figure 5   Top View
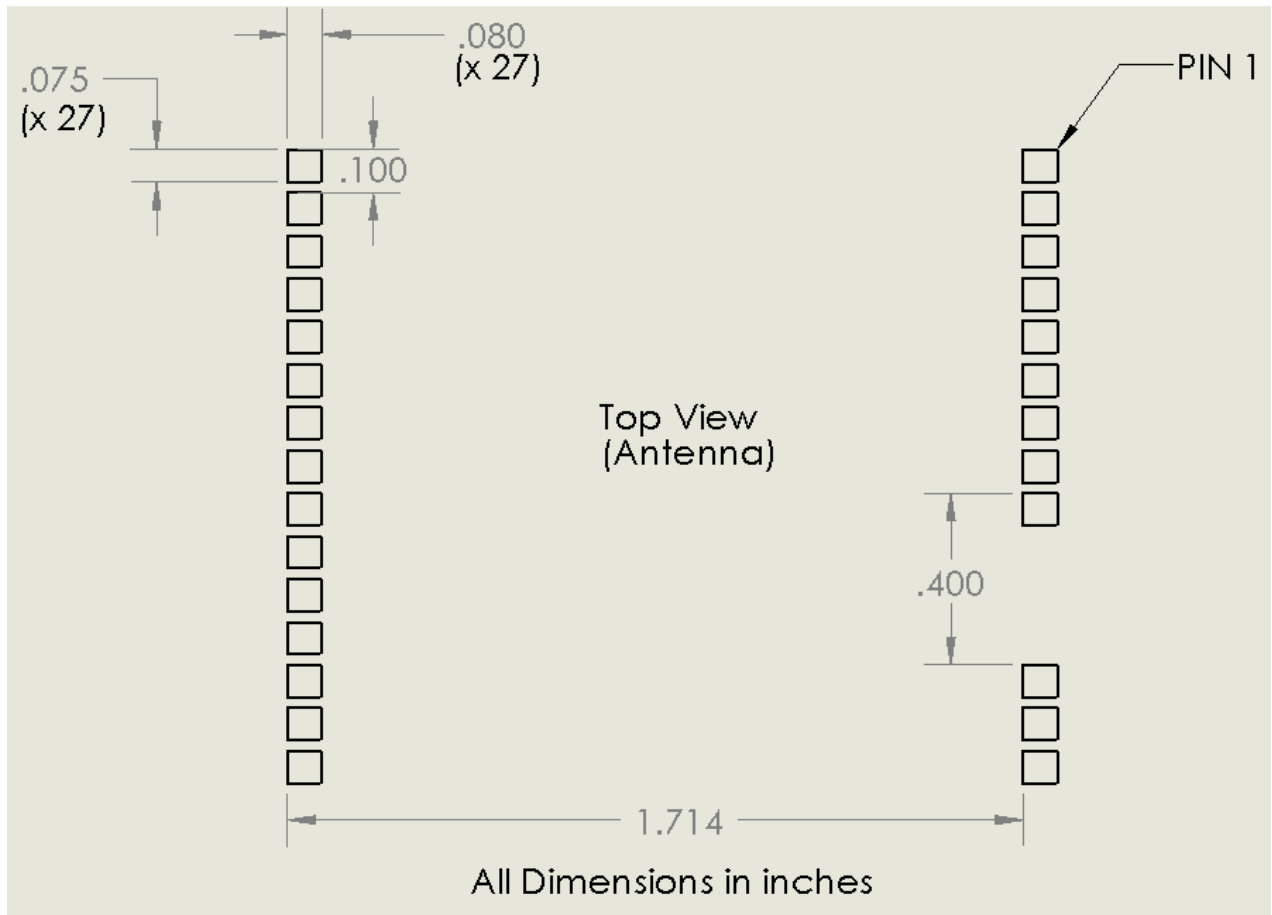
Figure 6 Recommended PCB footprint layout

PIN	NAME	TYPE	Description
1	GND	Ground	
2	RESERVED	RESERVED	Do NOT connect
3	CTS	Output	3.0V Open Collector, weak internal pull-up, may be pulled up to 5V max external
4	RTS	Input	3.0V (5V tolerant), weak internal pull-up
5	RxD	Input	3.0V (5V tolerant), weak internal pull-up
6	TxD	Output	3.0V Open Collector, weak internal pull-up, may be pulled up to 5V max external
7	Test2	Input	**Internal pull-up, ground or use open collector output, no external voltage to be applied**
8	Test1	Input	**Internal pull-up, ground or use open collector output, no external voltage to be applied**
9	RESERVED	RESERVED	Do NOT connect
10	RESET	Input	**Only drive with open collector, no external voltage to be applied**
11	RESERVED	RESERVED	Do NOT connect
12	GND	Ground	
13	GND	Ground	
14	RESERVED	RESERVED	Do NOT connect
15	RESERVED	RESERVED	Do NOT connect
16	GPSTxD	Output	5V tolerant, weak internal pull-up, may be pulled up to 5V max external
17	RESERVED	RESERVED	Do NOT connect
18	GND	Ground	
19	GND	Ground	
20	PWR_EN	Output	Open collector output to control VRF supply
21	RESERVED	RESERVED	Do NOT connect
22	RESERVED	RESERVED	Do NOT connect
23	RESERVED	RESERVED	Do NOT connect
24	GND	Ground	
25	VBATT	Power In	3.0 to 5.5 Volts, 400 mA max load @ 3.7V
26	RESERVED	RESERVED	Do NOT connect
27	GND	Ground	

Operating Temperature Range	**-40 to +85°C**
VBATT Power Supply Operational Range	**3.0 to 5.5 Volts**

ABSOLUTE MAXIMUM RATINGS

VBATT	**6.0 Volts**
Voltage onTxD,RxD,RTS,CTS	**5.0 Volts**

Operating Modes

Sleep Mode	VBATT is applied, no transmissions are pending, no serial activity
Active Mode	The STINGR is active and responding to the serial port but is not transmitting
Standby Mode	The STINGR is inactive between transmissions but is not transmitting

Transmit Mode	The unit is transmitting an RF packet

Parameter	Test Conditions	Min	Typ	Max	Unit
Transmit mode supply current	-40-85º C, VBATT=3.7 volts	425	450	500	mA
Active mode supply current	25º C, VBATT = 3.7 volts		2.3	2.5	mA
Standby mode supply current	25º C, VBATT = 3.7 volts		12	50	uA
Sleep mode supply current	25º C, Vcc = 3.7 volts		8	40	uA

4 Reference Design

The reference design presented below illustrates a basic implementation using the STINGR module in conjunction with a primary battery, USB interface, and test mode switches.

Since the battery is located on the same board as the STINGR, no decoupling capacitor is required on the VBATT input, however, if there are battery leads, lengthy power distribution, or noise sources present, a suitable decoupling capacitor might be appropriate. A ceramic XR7 10uF capacitor is usually a good choice.

Switch S1 can be used to initate test modes of operation without using the USB serial interface using the settings shown in Table 6.1. Select the desired test mode and depress S3 (reset) to execute the selected test mode.

When interfacing to a host processor, replace the USB serial interface with a 3.0 volt serial interface.

The USB interface is powered by the USB bus, however, due to the high peak current requirements of the STINGR during transmissions, the STINGR is powered by the battery.

4.1   Schematic
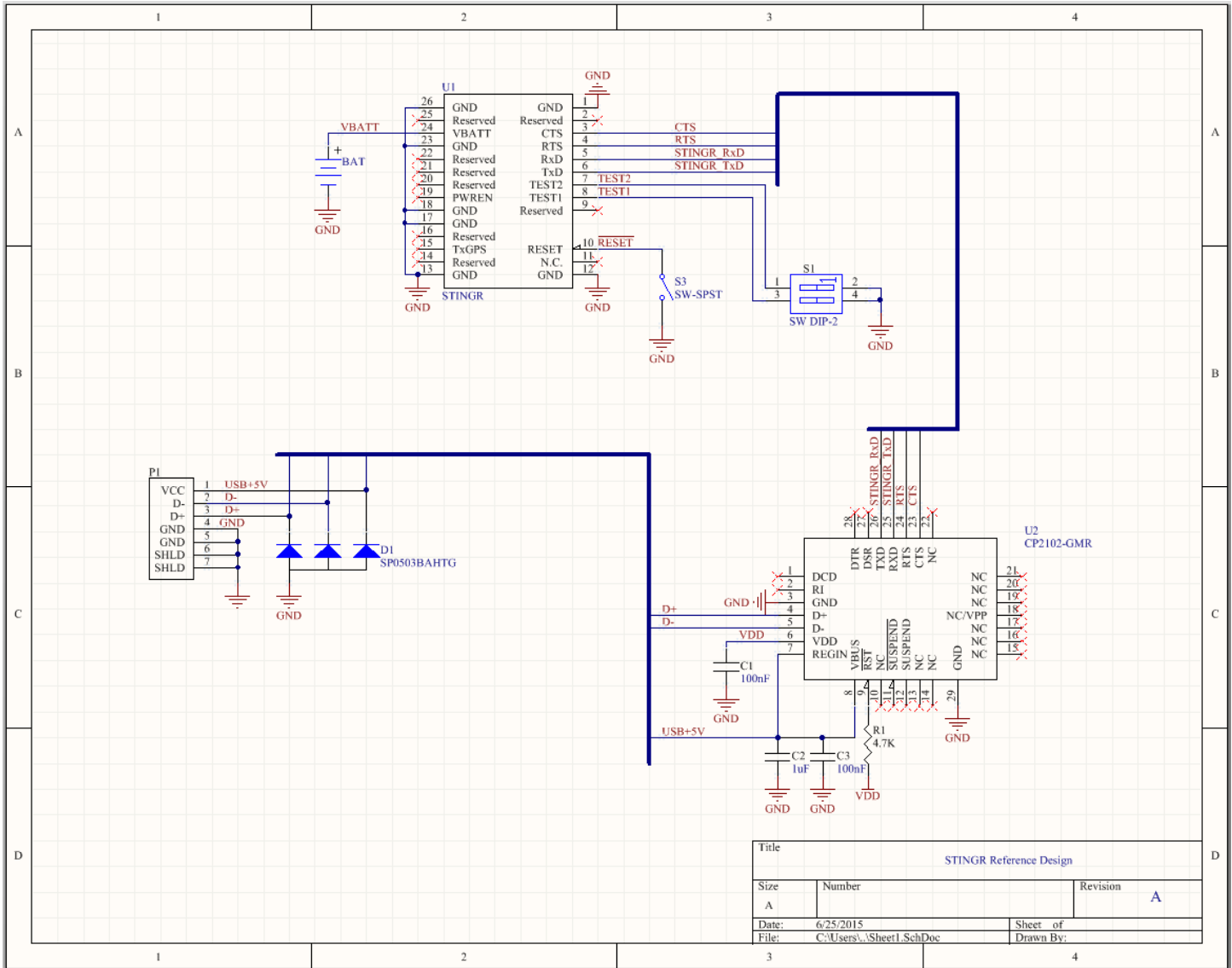
4.2 PCB
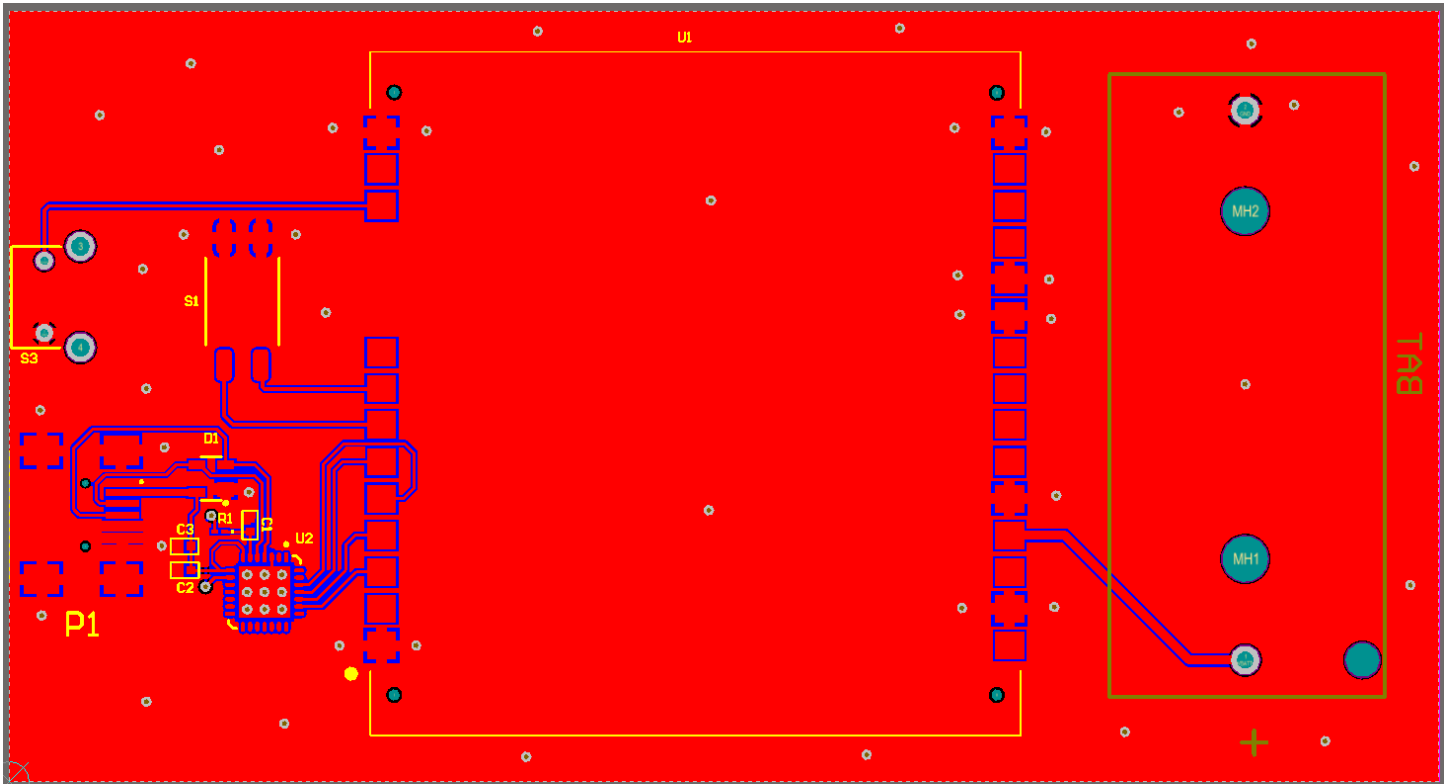
4.3 BOM

Manufacturer Part Number	Designator	Description	Manufacturer	Quantity
BC2/3AE	BAT	Multicell Battery	MPD	1
GRM155R71A104KA01D	C1, C3	CAP 0402 CER 100NF 10V X7R +/-10%	MURATAELEC	2
04026D105KAT2A	C2	CAP 0402 CER 100NF 10V X7R +/-10%	AVXCORP	1
SP0503BAHTG	D1	3 channel ESD protection diode array	Little Fuse	1
897-43-005-00-100001	P1	CONN HDR USB-MINI-D	Mill-Max	1
ERJ-2GEJ104X	R1	RES 0402 TKF 100K 5% 1/16W	Panasonic Electronic Components	1
KAJ02LGGT	S1	DIP Switch, 2 Position, SPST	E-Switch	1
MJTP1117	S3	Single-Pole, Single-Throw Switch	Apem Inc.	1
2350-0339-01	U1	STINGR	Globalstar, Inc.	1
CP2102-GMR	U2	USB-Serial Interface	Silicon Labs	1

5   Application Programming Interface

5.1   Serial Port

A half-duplex (0-3.0V) TTL asynchronous serial port (UART) is the primary interface to the user equipment. The serial port operates with the serial parameters of 9600bps, 8 data bits, no parity, 1 stop bit.

The RX data input and the RTS inputs are 5V tolerant. The TX data and CTS outputs are 0-3.0V TTL.

RS232 input levels are not supported. RS232 data must be converted to TTL before being sent to the unit.

Each command from the DTE to the STINGR is sent in a serial packet. Upon receiving the command, the modem answers to the DTE and, if applicable, executes the command.

In order to wake the STINGR from sleep mode and to indicate the end of the serial packet, each serial packet must be framed by activating RTS before the first byte of the command and deactivating RTS after the last byte of the command.

STINGR pins

RTS

< 25 ms

< 125 ms

CTS

RxD   Command   TxD

TxD   Response   RxD

Host pins
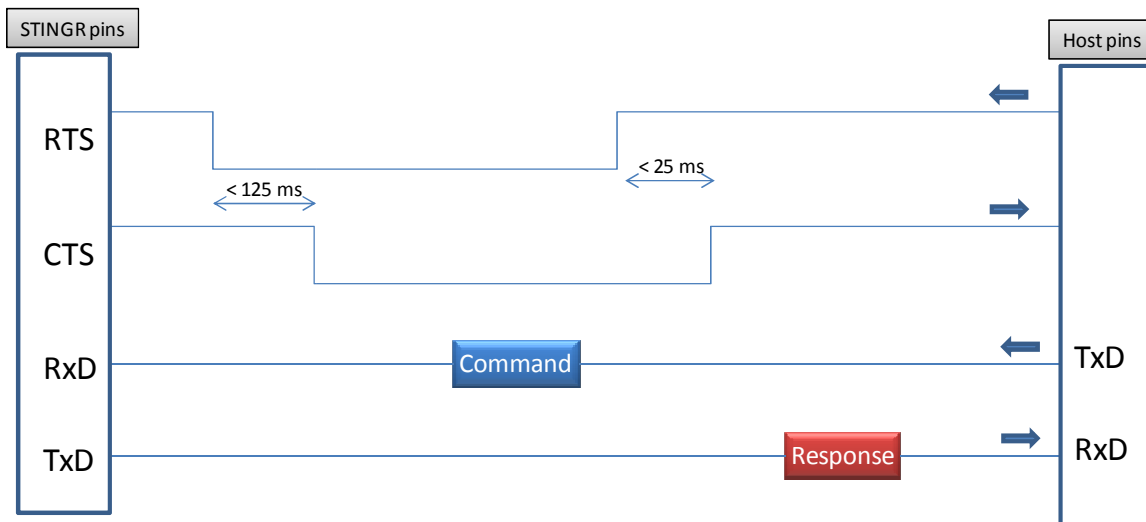
1. Lower RTS
2. Wait for CTS to go low
3. Send Command to STINGR
4. Raise RTS
5. STINGR raises CTS
6. STINGR sends response

5.2   Serial Packet Mode

This mode is the legacy mode of operation as implemented in the STX2 and STX3 which consists of binary data packets.

5.2.1   Serial Packet Format

| Preamble (1 byte) Always 0xAA | Length (1 bytes) | Command (1 bytes) | Data (variable length) | CRC (2 bytes) |

Preamble	Fixed pattern 0xAA
Length	Total number of bytes in the serial packet including the preamble
Command	Command type (See Table 5 Serial Packet Type). Responses to commands carry the same command type as the command that initiated the answer
Data	Data associated with the command or answer
CRC	16 bit CRC

Figure 7 Serial Packet Format

5.2.2   STX3 Legacy Serial Packet Commands

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
- If an improperly formatted command is received, the STINGR will return a NAK response:

AA 05 FF A1 CB

5.2.2.1   Send Data (0x00)

The Send Data command requests the STINGR 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 STINGR to send 9 bytes of **user defined data** over the Globalstar Simplex network. If the STINGR 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.

5.2.2.2   Query Electronic Serial Number (ESN) (0x01)

The Electronic Serial Number command requests the STINGR 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

Response:

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.

5.2.2.3   Abort Transmission (0x03)

The Abort Transmission command requests the STINGR to abort the current message transmit sequence over the Globalstar Simplex network.

0x03

Leader	len	Cmd	CRC1	CRC2
AA	05	03	42	F6

Command: AA 05 03 42 F6

Response: AA 05 03 42 F6

5.2.2.4   Query Bursts Remaining (0x04)

The Query Bursts Remaining command requests the STINGR to return the current number of bursts remaining the current message transmit sequence over the Globalstar Simplex network.

0x04

Leader	len	cmd	CRC1	CRC2
AA	05	04	FD	82

Command: AA 06 04 00 F4 33

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**

5.2.2.5   Query Firmware Version (0x05)

The Query Firmware Version command requests the STINGR 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	CRC1	CRC2
AA	7	5	**XX**	**XX**	CC	CC

Example Response: AA 07 05 **01 07** E0 6A

Where the firmware version returned is: **1.7**

5.2.2.6   Setup (0x06)

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

0x06
Command:

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, 3 = Channel D
- # of bursts: Valid values are: 0x01 thru x14 (1 to 20 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 x 5 = 120 seconds
- Maximum Burst Interval: 30   0x30 = 48, 48 x 5 = 240 seconds

5.2.2.7   Query Setup (0x07)

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

0x07

Leader	len	cmd	CRC1	CRC2
AA	05	07	66	B0

Command: AA 05 07 66 B0

Response:

Leader	len	cmd	RESERVED				RF channel	# of Bursts	Interval Min	Interval Max	RESERVED	CRC1	CRC2
AA	0E	07	XX	XX	XX	XX	**XX**	**XX**	**XX**	**XX**	XX	18	59

Where:

- RF channel :   Valid values are: 0 = Channel A, 1 = Channel B, 2 = Channel C, 3 = Channel D
- # of bursts: Valid values are: 0x01 thru x14 (1 to 20 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 x 5 = 120 seconds
- Maximum Burst Interval: 30   0x30 = 48, 48 x 5 = 240 seconds

5.2.2.8   Query Hardware Version (0x09)

The Query Hardware Version command requests the STINGR to return the current hardware version information.

0x09

Leader	len	Cmd	CRC1	CRC2
AA	05	09	18	59

Command: AA 05 09 18 59

Response:

Leader	len	04	Device Code		Board Rev	CPU Rev	Radio Rev	CRC1	CRC2
AA	0A	09	00	01	XX	XX	XX	CC	CC

Where:

- Device Code :   STINGR hardware revision
- Board Revision: STINGR hardware revision
- CPU Revision: STINGR CPU revision
- Radio Revision: STINGR radio revision

Example Response: AA 0A 09 00 01 **00 8E 62** E5 5E

Where the revision information returned is:

- Board Revision: 00
- CPU Revision: 8E
- Radio Revision: 62

5.2.3   STINGR Serial Packet Commands

5.2.3.1   "Initiate proprietary 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.

Initiate proprietary track command format

Byte	Bits	Parameter	Description
0	0 – 7	Leader	Always a value of 0xAA.
1	0 – 7	Length	0x0A (decimal 10)
2	0 – 7	Command Code.	0x30 = Initiate proprietary track.
3 -4	0 - 15	Interval	Interval in minutes between the track points. MIN and MAX allowed TBD.
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	

Leader	len	Cmd	Interval (MSB)	Interval (LSB)	Byte 0	Byte 7	Byte 8	CRC1	CRC2
AA	0A	30	00	05	AA	BB	CC	18	59

Example Command: AA 0A 30 **00 05 AA BB CC** 69 36

Where:

- Period :   0x0005 (5 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	5
2	0 - 7	Command Code.	0x30 = ACK or 0xFF = NAK
3 -4	0 - 15	CRC	

Example Response: AA 05 30 5A F5

5.2.3.2 *"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	

Leader	Len	Cmd	Byte 0	Byte 7	Byte 8	CRC1	CRC2
AA	08	31	**AA**	**BB**	**CC**	18	59

Example Command: AA 08 31 **BB CC DD** AC 99

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	5
2	0 - 7	Command Code.	0x31 = ACK or 0xFF = NAK
3 -4	0 - 15	CRC	

Example Response: AA 05 31 D3 E4

5.2.3.3 *"Cancel Proprietary Track" command*

This command is used to terminate a proprietary track session.

Cancel Proprietary Track command format

Byte	Bits	Parameter	Description
0	0 - 7	Leader	Always a value of 0xAA.
1	0 - 7	Length	0x05
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

Cancel Proprietary Track response

Byte	Bits	Parameter	Description
0	0 - 7	Leader	Always a value of 0xAA.
1	0 - 7	Length	5
2	0 - 7	Command Code.	0x32 = ACK or 0xFF = NAK
3 -4	0 - 15	CRC	

Example Response: AA 05 32 48 D6

5.2.3.4 "Send Redundant Burst with GPS" command

This command is used to initiate a redundant bursted 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.

Send Redundant Burst with GPS command format

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	0 - 7	Byte 8 value	The value to transmit as byte 8 of first packet
6 - n		Additional data	Up to 135 additional bytes of data (15 9 byte packets). Maximum value of n = 141. If this number is not divisable by 9, the end of the final packet of the message will be zero padded.
n+1-n+2	0 - 15	CRC	

Leader	Len	Cmd	Byte 0	Byte 7	Byte 8	CRC1	CRC2
AA	08	33	**AA**	**BB**	**CC**	57	C3

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** 57 C3

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

5.2.4 STINGR Serial Test Commands

5.3 "Transmitter Test" command

This command is used to initiate a transmitter test in one of three modes.

Transmitter test command format

Byte	Bits	Parameter	Description
0	0 - 7	Leader	Always a value of 0xAA.
1	0 - 7	Length	0x06
2	0 - 7	Command Code.	0xFC = Transmitter test.
3	0 - 7	Test mode	The following test modes may be selected: 0x01 = CW Mode 0x02 = Transmit single test packet. 0x03 = Mod mode. Transmit a continuous signal modulated with a bit pattern.
4 – 5	0 - 15	CRC	

Leader	Len	Cmd	Test Mode	CRC1	CRC2
AA	06	FC	02	2E	A2

Example Command: AA 06 FC 02 2E A2

Where:

- Test Mode: 0x02 = Single Test Packet

Table 50: Transmitter test response format.

Byte	Bits	Parameter	Description
0	0 - 7	Leader	Always a value of 0xAA.
1	0 - 7	Length	0x05
2	0 - 7	ACK or NAK	0xFC for success, 0xFF for incorrectly formatted command. A value for the test mode other than 0x01, 0x02, or 0x03 will generate a NAK.
3 - 4	0 - 15	CRC	

Example Response: AA 05 FC 3A F9

5.4   Example CRC calculation routines for serial packets

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

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

```c
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**

```
byte 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);
```

6   Test Modes

The STINGR provides several test modes intended to aid in manufacturing testing and certification testing.

All test modes are activated by grounding selective pins on the STINGR prior to applying power. Once power is applied, the STINGR will sample the states of the pins and based on the states of the pins, the STINGR will enter the selected test mode. For normal operation these pins must be left floating or in a high (logic 1) state.

The following tables define the different test modes available in the STINGR.

TEST1	TEST2	Mode
0	0	**Mod Mode** (continuous transmission) - A test packet is continuously transmitted. The test packet shall comply with the Air Interface Packet format with a user information equal to the hex stream 0x80AAF0F0F0AAF0F0F0 where the most significant bit is transmitted first
0	1	**Test Packet** - The test packet shall comply with the Air Interface Packet format with a user information equal to the hex stream 0x80AAF0F0F0AAF0F0F0 where the most significant bit is transmitted first
1	0	**CW mode** - An un-modulated carrier is continuously transmitted.
1	1	Normal Operation

Table 6.1

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

RX	RTS	Channel
0	0	B
0	1	C
1	0	D
1	1	Channel specified in the flash setup. To specify channel A, it must be the default channel specified in the flash setup. See **Setup** command for details.

<div align="center">Table 6.2</div>

7   REGULATORY APPROVAL

The STINGR module has received regulatory approvals for modular devices in the United States and Canada. Modular device approval allows the end user to place the STINGR module inside a finished product and not require regulatory testing for an intentional radiator (RF transmitter), provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user's authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance. The integrator is still responsible for testing the end product for any additional compliance requirements required with this module installed (digital device emission, PC peripheral requirements, etc.) in the specific country that the end device will be marketed. For more information on regulatory compliance, refer to the specific country radio regulations in the following sections.

7.1   Radio Astronomy Site Avoidance

The end user device must comply with the requirements for Radio Astronomy Site avoidance as specified by the Globalstar National Science Foundation agreement of 2001. It must be compliant with CFR25.213.

7.2   Regulatory Notices

The STINGR has received Federal Communications Commission authorization under FCC Rules Part 25 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 STINGR 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-STGR IC: 3989A-STGR
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 user's manual should 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.

This device will operate in accordance to the standards set forth by the CE Mark Directives and standards R&TTE: (TBR41 v1.1.1 May 2000, EN 301 441), RFI: (EN61000-4-3:1996 + A1:1998 + A2:2000), ESD: (EN61000-4-2: 1995 + A1:1998)

NOTICE: This equipment complies with the FCC 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.

FCC ID: L2V-STGR
ICES-003/(A/B)
IC:3989A-STGR

CE   R&TTE: TBR41

FC   Complies with FCC standards.
      FOR HOME OR OFFICE USE