GPS Engine Board

Operational Manual

REB-2100

RoyalTek

Table of contests

Electrical characteristics

General

Sensitivity -135 dBm
Channels 12 channels
L1 1575.42 MHz.
C A code 1.023MHz chip rate.

Accuracy

Satellites number average 7.7
Satellites number >= 4 99.87%
Satellites number >= 3 100%
Position accuracy 25m CEP without SA
Velocity accuracy 0.1 meters / second without SA
Time accuracy 1 microsecond synchronized to GPS time.

DGPS Accuracy

Position 1 to 5 m, typical
Velocity 0.05 meters / second, typical

Datum

WGS-84.
Position update rate 1 Hz

Acquisition rate

Snap star 2 sec., average
Hot start 8 sec., average
Warm start 45 sec., average
Cold start 60 sec., average at 25 C
Reacquisition 0.1 sec., average

Dynamic conditions

Altitude 18000 meters (60000 feet) max.
Velocity 515 meters / second max.
Jerk 20 meters / second^3, max.
Acceleration 4 g., max.

Power

It shall use the following power
DC 3.3V ± 10 %
Supply current 170mA, typical at 3.3V
Backup power +2.5V to +3.1V
Backup current 10uA, typical

Differential Input

Built in WAAS and USCG DGPS
Beacon Processor
External Serial RTCM 104 (Type 1, 5, 9)

Softwart interface

NMEA V2.2 Protocol

It is the RS-232 interface 9600 bps, 8 bit data, 1 stop bit and no parity. It supports the following NMEA-0183 messages GGA, GLL, GSA, GSV, RMC and VTG.

NMEA Output Messages

The Engine board outputs the following messages as shown in Table 1

Table 1 ***NMEA-0183 Output Messages***

NMEA Record	Description
GGA	Global positioning system fixed data
GLL	Geographic position – latitude / longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

GGA Global Positioning System Fixed Data

Table 2 contains the values of the following example $GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,0000*18

Table 2 ***GGA Data Format***

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 2-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoid Separation		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
CR LF			End of message termination

Table 2-1 ***Position Fix Indicator***

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

GLL Geographic Position – Latitude/Longitude

Table 3 contains the values of the following example $GPGLL, 3723.2475, N, 12158.3416, W, 161229.487, A*2C

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Table 3 ***GLL Data Format***

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header

Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.ss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
CR LF			End of message termination

GSA GNSS DOP and Active Satellites

Table 4 contains the values of the following example $GPGSA, A, 3, 07, 02, 26, 27, 09, 04, 15, , , , , , 1.8,1.0,1.5*33

Table 4 ***GSA Data Format***

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
Satellite Used[1]	07		Sv on Channel 1
Satellite Used[1]	02		Sv on Channel 2
….			….
Satellite Used[1]			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
CR LF			End of message termination

1. Satellite used in solution.

Table 4-1 ***Mode 1***

Value	Description
1	Fix not available
2	2D
3	3D

Table 4-2 ***Mode 2***

Value	Description
M	Manual forced to operate in 2D or 3D mode
A	Automatic allowed to automatically switch 2D/3D

GSV GNSS Satellites in View

Table 5 contains the values of the following example $GPGSV, 2, 1, 07, 07, 79, 048, 42, 02, 51, 062, 43, 26, 36, 256, 42, 27, 27, 138, 42*71$GPGSV, 2, 2, 07, 09, 23, 313, 42, 04, 19, 159, 41, 15, 12, 041, 42*41

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Table 5 ***GGA Data Format***

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages[1]	2		Range 1 to 3
Messages Number[1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 32)
Elevation	79	degrees	Channel 1(Maximum 90)
Azimuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking

….			….
Satellite ID	27		Channel 4(Range 1 to 32)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
CR LF			End of message termination

2. Depending on the number of satellites tracked multiple messages of GSV data may be required.

RMC Recommended Minimum Specific GNSS Data

Table 6 contains the values of the following example $GPRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13, 309.62, 120598, ,*10

Table 6 ***GGA Data Format***

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		ddmmyy
Magnetic Variation		degrees	E=east or W=west
Checksum	*10		
CR LF			End of message termination

VTG Course Over Ground and Ground Speed

Table 7 contains the values of the following example $GPVTG, 309.62, T, , M, 0.13, N, 0.2, K*6E

Table 7 ***VTG Data Format***

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course	309.62	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Checksum	*6E		
CR LF			End of message termination

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SiRF Proprietary NMEA Input Messages
NMEA input messages allow you to control the Evaluation Unit in NMEA protocol mode. The Evaluation Unit may be put into NMEA mode by sending the SiRF Binary protocol message " Switch To NMEA Protocol – Message I.D.129 " on page 17 using a user program or using SiRFdemo.exe and selecting Switch to NMEA Protocol from the Action menu. If the receiver is in SiRF Binary mode, all the NMEA input messages are ignored. Once the receiver is put into NMEA mode, the following messages may be used to command the module.

Transport Message

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR><LF>[4]

1. Message Identifier consists of three numeric characters . Input messages begin at MID 100.
2. Message specific data. Refer to a specific message section for <data>…<data> definition
3. CKSUM is a two-hex character checksum as defined in the NMEA specification . Use of checksums is required on all input messages.
4. Each message is terminated by using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D 0A. Because \r\n are not printable ASCII characters , they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

Note – All fields in all proprietary NMEA messages are required, none are exceptional. All NMEA messages are comma delimited

SIRF NMEA Input Messages

Message	Message Identifier (MID)	Description
Set Serial Port	100	Set PORT A Parameters and protocol
Navigation Initialization	101	Parameters required for start using X/Y/Z
Set DGPS Port	102	Set PORT B parameters for DGPS input
Query / Rate Control	103	Query standard NMEA message and/or set output rate
LLA Navigation Initialization	104	Parameters required for start using Lat/Lon/Alt1
Development Data On/Off	105	Development Data messages On/Off

Input coordinates must be WGS84.
Set Serial Port
This command message is used to set the protocol (SiRF Binary or NMEA) and/or the communication parameters (baud , data bits, stop bits, parity). Generally, this command is used to switch the module back to SiRF Binary protocol mode where a more extensive command message set is available. When a valid message is received , the parameters are stored in battery-backed SRAM and then the Evaluation Unit restarts using the saved parameters.

Table 8 contains the input values for the following example Switch to SIRF Binary protocol at 9600,8,N,1
$PSRF100,0,9600,8,1,0*0C

Table 8 ***Set Serial Port Data Format***

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF Binary, 1=NMEA
Baud	9600		4800,9600,19200,38400
Data Bits	8		8,7[1]
Stop Bits	1		0,1
Parity	0		0=None ,1=Odd,2=Even
Checksum	*0C		
<CR><LF>			End of message termination

1. SiRF protocol is only valid for 8data bits, 1 stop bit, and no parity.

LLA Navigation Initialization

This command is used to initialize the module for a warm start, which provide current position (in X, Y, Z coordinates), clock offset , and time .This enables the Evaluation Unit to search for the correct satellite signals at the correct signal parameters . Correct initialization parameters enable the Evaluation Unit to acquire signals quickly.

Table 9 contains the input values for the following example Switch to SiRF Binary protocol at 9600,8,N,1 $PSRF 101,-2686700,-4304200, 3851624, 95000, 497260, 921, 12, 3*22

Table 9 ***Navigation Initialization Data Format***

Name	Example	Units	Description
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	Meters	X coordinate position
ECEF Y	-4304200	Meters	Y coordinate position
ECEF Z	3851624	Meters	Z coordinate position
CLK Offset	95000	Hz	Clock Offset of the Evaluation Unit[1]
Time Of Week	497260	seconds	GPS Time OF Week
Week No	921		GPS Week Number
Channel Count	12		Range 1 to 12
Reset Cfh	3		See Table 10
Checksum	*22		
<CR><LF>			End of message termination

Use 0 for last saved value if available . If this is unavailable, a default value of 96,000 will be used…

Table 10 ***Reset Configuration***

Hex	Description
0x01	Data Valid – Warm /Hot Starts=1
0x02	Clear Ephemeris – Warm Start=1
0x04	Clear Memory – Cold Start =1

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Set DGPS Port

This command is used to control Serial Port B which is an input – only serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. The default communication parameters for PORT B are 9600 baud, 8 data bits, stop bit, and no parity. If a DGPS received , the parameters are stored in battery – backed SRAM and then the receiver restarts using the saved parameters.

Table 11 contains the input values for the following example Set DGPS Port to be 9600,8,N,1. $PSRF 102,9600,8,1,0*3C

Table 11 ***Set DGPS Port Data Format***

Name	Example	Units	Description
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800,9600,19200,38400
Data Bits	8		8,7
Stop Bits	1		0,1
Parity	0		0==None, 1=Odd, 2=Even
Checksum	*3C		
<CR><LF>			End of message termination

Query/Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, RMC, and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Table 12 Query/Rate Control Data Format(See example 1.)

1.Quety the GGA message with checksum enabled
$PSRF103,00,01,00,01*25

2.Enable VTG message for a 1 Hz constant output with checksum enabled
$PSRF103,05,00,01,01*20

3.Disable VTG message
$PSRF103,05,00,00,01*21

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Table 12 ***Query/Rate Control Data Format(See example 1.)***

Name	Example	Units	Description
Message ID	$PSRF103		PSRF102 protocol header
Message	00		See Table 13
Mode	01		0=Set Rate, 1=Query
Rate	00	seconds	Output – off=0,max=255
Cksum Enable	01		0=Disable Checksum, 1=Enable Checksum
Checksum	*25		
<CR><LF>			End of message termination

Table 13 ***Messages***

Value	Description
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG

LLA Navigation Initialization

This command is used to initialize the module for a warm start , by providing current position(in latitude, longitude, and altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters . Correct initialization parameters enable the receiver to acquire signals quickly.

Table 14 contains the input values for the following example: Start using known position and time $PSRF104, 37.3875111, -121.97232, 0, 95000, 237759, 922, 12, 3*3A

Table 14 ***LLA Navigation Initialization Data Format***

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	Degrees	Latitude position (Range 90 to –90)
Lon	-121.97232	Degrees	Longitude position (Range 180 to –180)
Alt	0	Meters	Altitude position
CLK Offset	95000	Hz	Clock Offset of the Evaluation Unit[1]
Time Of Week	237759	Seconds	GPS Time Of Week
Week No	922		GPS Week Number
Channel Count	12		Range 1 to 12
Reset Cfg	3		See Table 15
Checksum	*3A		
<CR><LF>			End of message termination

Use 0 for last saved value if available. If this is unavailable, a default value of 96,000 will be used.

Table 15 ***Reset Configuration***

Hex	Description
0x01	Data Valid – Warm /Hot Starts=1
0x02	Clear Ephemeris – Warm Start=1
0x04	Clear Memory – Cold Start =1

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Development Data On/Off
Use this command to enable development data information if you can not get the commands accepted. Invalid commands generate debug information that enables the user to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum of parameter out of specified range.

Table 16 contains the input values for the following examples

1. Debug On
   $PSRF 105,1*3E
2. 2.Debug Off
   $PSRF 105,1*3F

Table 16 ***Development Data On/Off Data Format***

Name	Example	Units	Description
Message ID	$PSRF105		PSRF105 protocol header
Debug	1		0=Off , 1= On
Checksum	*3E		
<CR><LF>			End of message termination

Calculating Checksums for NMEA Input
The Checksum is the 8-bit exclusive OR of all the characters after $ and before *. (Not including $ and *)

Softwart interface

SiRF Binary Protocol

The serial communication protocol is designed to include

● Reliable transport of messages
● Ease of implementation
● Efficient implementation
● Independence from payload

Protocol Layers Transport Message

Start Sequence	Payload Length	Payload	Message Checksum	End Sequence
0xA0[1] 0xA2	Two-bytes (15-bits)	Up to 2^{10-1} (<1023)	Two-bytes (15-bits)	0xB0, 0xB3

0xYY denotes a hexadecimal byte value. 0xA0 equals 160.

Transport

The transport layer of the protocol encapsulates a GPS message in two start characters and two stop characters. The values are chosen to be easily identifiable and such that they are unlikely to occur frequently in the data. In addition, the transport layer prefixes the message with a two-byte (15- bit)message length and a two-byte(15-bit) choice of a 15-bit values for length and check sum are designed such that both message length and check sum can not alias with either the stop of start code.

Message Validation

The validation layer is of part of the transport, but operates independently. The byte count refers to the payload byte length. Likewise, the check sum is a sum on the payload.

Message Length

The message length is transmitted high order byte first followed by the low byte.

High Byte	Low Byte
<0x3F>	Any value

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Even though the protocol has a maximum length of (2^{15-1}) bytes practical considerations require the SiRF GPS module implementation to limit this value to a smaller number. Likewise, the SiRF receiving programs (e.g., SiRF demo) may limit the actual size to something less than this maximum..

Payload Data
The payload data follows the message length. It contains the number of bytes specified by the message length. The payload data may contain any 8-bit value. Where multi-byte values are in the payload data neither the alignment nor the byte order are defined as part of the transport although SiRF payloads will use the big-endian order.

Checksum
The check sum is transmitted high order byte first followed byte the low byte. This is the so-called big- endian order

High Byte	Low Byte
<0x3F	Any value

The check sum is 15-bit checksum of the bytes in the payload data .The following pseudo code defines the algorithm used. Let message to be the array of bytes to be sent by the transport. Let msgLen be the number of bytes in the message array to be transmitted .

```
Index = first
checkSum = 0
while index < msgLen
checkSum = checkSum +message[index]
checkSum = checkSum AND(210-1)
```

Input Messages for SiRF Binary Protocol

Note – All input messages are sent in BINARY format

Table 17 *SiRF Messages – Input Message List*

Hex	ASCII	Name
0 x 80	128	Initialize Data Source
0 x 81	129	Switch to NMEA Protocol
0 x 82	130	Set Almanac
0 x 84	132	Software Version
0 x 88	136	Mode Control
0 x 89	137	DOP Mask Control
0 x 8A	138	DFPS Control
0 x 8B	139	Elevation Mask
0 x 8C	140	Power Mask
0 x 8D	141	Editing Residual
0 x 8E	142	Steady-State Detection
0 x 8F	143	Static Navigation
0 x 90	144	Clock Status
0 x 91	145	Set DGPS Serial Port
0 x 92	146	Almanac
0 x 93	147	Ephemeris

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Initialize Data Source-Message I.D. 128

Table 18 contains the input values for the following example Warm start the receiver with the following initialization data ECEF WYZ (-2686727 m,-4304282 m,3851642 m),Clock Offset (75,000 Hz),Time of Week(86,400 s),Week Number(924),Week Number(924),and Channels(12). Raw track data Debug data enabled.

Example A0A20019-Start Sequence and Payload Length
80FFD700F9FFBE5266003AC57A000124F80083S600039C0C33-
Payload 0A91B0B3-Message Checksum and End Sequence

Table 18 ***Initialize Data Source***

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		80		ASCII 128
ECEF X	4		FFD700F9	meters	
ECEF Y	4		FFBE5266	meters	
ECEF Z	4		003AC57A	meters	
Clock Offset	4		000124F8	Hz	
Time of Week	4	*100	0083D600	seconds	
Week Number	2		039C		
Channels	1		0C		Range 1-12
Reset Config.	1		33		See Table 10

Payload Length 25 bytes

Table 19 ***Initialize Data Source***

Bit	Description
0	Data valid flag-set warm/hot start
1	Clear ephemeris-set warm start
2	Clear memory-set cold start
3	Reserved (must be 0)
4	Enable raw track data (YES-1,NO=0)
5	Enable raw track data(TES=1,NO=0)
6	Reserved(must be 0)
7	Reserved (must be 0)

Note - If Raw Track Data is ENABLED then the resulting messages are message I.D. 0x05(ASCII 5-Raw Track Data), message I.D. 0x08(ASCII 8-50 BPS data), and message I.D. 0x90 (ASCII 144 Clock Status). All messages are sent at 1 Hz.

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Switch To NMEA Protocol – Message I.D. 129

Table 20 contains the input values for the following example

Request the following NMEA data at 9600 baud
GGA – ON at 1 sec , GLL – 1sec , GSA – ON at 1 sec
GSV – ON at 1 sec , RMC – 1 sec , VTG – 1 sec

Example A0A20018 – Start Sequence and Payload Length
81020101000105010501000100010001000100010001000112C0 – Payload
0164B0B3 – Message Checksum and End Sequence

Table 20 *Switch To NMEA Protocol*

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		81		ASCII 129
Mode	1		02		
GGA Message1	1		01	1/s	See Appendix D for format
Checksum2	1		01		
GLL Message	1		00	1/s	See Appendix D for format
Checksum	1		01		
BSA Message	1		05	1/s	See Appendix D for format
Checksum	1		01		
GSV Message	1		05	1/s	See Appendix D for format
Checksum	1		01		
RMC Message	1		00	1/s	See Appendix D for format
Checksum	1		01		
VTG Message	1		00	1/s	See Appendix D for format
Checksum	1		01		
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Baud Rate	1		12C0		38400,19200,9600,4800,2400

Payload Length 24bytes

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1. A value of 0x00 implies NOT to send message, otherwise data is sent at 1 message every X seconds requested (i.e., to request a message to be sent every 5 seconds, request the message using a value of 0x05.)Maximum rate is 1/255s.
2. A value of 0x00implies the checksum is NOT calculated OR transmitted with the message (not recommended) .A value of 0x01 will have a checksum calculated and transmitted as part of the message (recommended).

Set Almanac- Message I.D. 130

This command enables the user to upload an almanac to the Evaluation Unit

Note – This feature is not documented in this manual. For information on implementation contact SiRF Technology Inc.

Software Version – Message I.D. 132

Table 21 contains the input values for the following example Poll the software version

Example A0A20002 – Start Sequence and Payload Length
8400 – Payload
0084B0B3 – Message Checksum and End Sequence

Table 21 *Software Version*

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		84		ASCII 132
TBD	1		00		

Payload Length 2 bytes

Mode control – Message I.D .136

Table 22 contains the input values for the following example: 3D Mode = Always , Alt Constraining = Yes , Degraded Mode – clock then direction , TBD = 1 , DR Mode = Yes , Altitude = 0, Alt Hold Mode = Auto, Alt Source = Last Computed , Coast Time Out = 20, Degraded Time Out = 5, DR Time Out = 2, Track Smoothing = Yes

Example A0A2000W – Start Sequence and Payload Length
8801010101010100000002140501 – Payload
00A9B0B3 – Message Checksum and End Sequence

Table 22 ***Mode Control***

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		88		ASCII 136
3D Mode	1		01		1 (always true=1)
Alt Constraint	1		01		YES = 1,NO = 0
Degraded Mode	1		01		See Table C-7
TBD	1		01		Reserved
DR Mode	1		01		YES = 1,NO = 0
Altitude	2		0000	Meters	Range –1,000 to 10,000
Alt Hold Mode	1		00		Auto = 0,Always=1,Disable=2
Alt Source	1		02		Last Computed=0,Fixed to=1
Coast Time Out	1		14	Seconds	0 to 120
Degraded Time Out	1		05	Seconds	0 to 120
Dr Time Out	1		01	Seconds	0 to 120
Track Smoothing	1		01		YES = 1,NO = 0

Payload Length 14 bytes

Table 23 ***Degraded Mode Byte Value***

Byte Value	Description
0	Use Direction then Clock Hold
1	Use Clock then Direction Hold
2	Direction(Curb)Hold Only
3	Clock(Time)Hold Only
4	Disable Degraded Modes

DOP Mask Control – Message I.D. 137

Table 24 contains the input values for the following example

Auto Pdop/Hdop, Gdop = 8(default),Pdop=8,Hdop=8

Example A0A20005 – Start Sequence and Payload Length

8900080808 – Payload

00A1B0B3 – Message Checksum and End Sequence

Table 24 ***DOP Mask Control***

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		88		ASCII 137
DOP Selection	1		00		See Table C-9
GDOP Value	1		08		Range 1 to 50
PDOP Value	1		08		Range 1 to 50
HDOP Value	1		08		Range 1 to 50

Payload Length 5 bytes

Table 25 ***DOP Selection***

Byte Value	Description
0	Auto PDOP/HDOP
1	PDOP
2	HDOP
3	GDOP
4	Do Not Use

DFPS Control – Message I.D.138

Table 26 contains the input values for the following example:

Set DGPS to exclusive with a time out of 30 seconds.

Example:A0A20003 – Start Sequence and Payload Length

8A011E – Payload

00A9B0B3 – Message Checksum and End Sequence

Table 26 ***DGPS Control***

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8A		ASCII 138
DGPS Selection	1		01		See Table 18
DGPS Time Out	1		1E	Seconds	Range 1 to 120

Payload Length 3 bytes

Table 27 ***DGPS Selection***

Byte Value	Description
0	Auto
1	Exclusive
2	Never
3	Mixed (not recommended)

Elevation Mask – Message I.D.139

Table 28 contains the input values for the following example:

Set Navigation Mask to 15.5 degrees (Tracking Mask is defaulted to 5 degrees).

Example: A0A20005 – Start Sequence and Payload Length

8B0032009B – Payload

0269B0B3 – Message Checksum and End Sequence

Table 28 ***Elevation Mask***

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8B		ASCII 139
Tracking Mask	2	*10	0032	degrees	Not currently used
Navigation Mask	2	*10	009B	degrees	Range –20.0 to 90.0

Payload Length 5 bytes

Power Mask – Message I.D.140

Table 29 contains the input values for the following example:

Navigation mask to 33dBHz (tracking default value of 28)

Example: A0A20003 – Start Sequence and Payload Length

8C1C21 – Payload

00C9B0B3 – Message Checksum and End Sequence

Table 29 ***Power Mask***

Name	Bytes	Binary(Hex) Scale	Example	Units	Description
Message ID	1		8C		ASCII 140
Tracking Mask	1		1C	dBHz	Not currently implemented
Navigation Mask	1		21	dBHz	Range –28 to 50

Payload Length 3 bytes

Editing Residual – Message I.D.141

Note – Not implemented currently

Steady State Detection – Message I.D.142

Table 30 contains the input values for the following example:

Set Stead State Threshold to 1.5 m/sec^2

Example A0A20002 – Start Sequence and Payload Length

8E0F – Payload

009DB0B3 – Message Checksum and End Sequence

Table 30 ***Steady Detection***

Name	Bytes	Binary(Hex) Scale	Example	Units	Description
Message ID	1		8E		ASCII 142
Threshold	1		0F	M /sec2	Range 0 to 20

Payload 2 bytes

Static Navigation – Message I.D.144

Table 31 *Steady State Detection*

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		90		ASCII 144
TBD	1		00		Reserved

Payload Length 2 bytes

Set DGPS Serial Port – Message I.D 145

Table 32 contains the input values for the following example
Set DGPS Serial port to 9600.n,8,1.
Example A0A20009-Start Sequence and Payload Length
910000258008010000 – Payload
013FB0B3 – Message Checksum and End Sequence

Table 32 *Set DGPS Serial Port*

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		91		ASCII 145
Baud	4		00002580		38400,19200,9600,4800,2400,1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0,Odd=1,Even=2
Pad	1		00		Reserved

Payload Length 9 bytes

Almanac – Message I.D.146

Table 33 contains the input values for the following example
Poll for the Almanac.
Example A0A20002 – Start Sequence and Payload Length
9200 – Payload
0092B0B3 – Message Checksum and End Sequence

Table 33 *Almanac*

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		92		ASCII 146
TBD	1		00		Reserved

Payload Length 2 bytes

Ephemeris Message I.D.147

Table 34 contains the input values for the following example

Poll for *Ephemeris* Data for all satellites.

Example A0A20003 – Start Sequence and Payload Length

930000 – Payload

0092B0B3 – Message Checksum and End Sequence

Table 34 ***Almanac***

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		93		ASCII 147
Sv I.D.1	1		00		Range 0 to 32
TBD	1		00		Reserved

Payload Length 3 bytes

A value of 0 requests all available ephemeris records, otherwise the ephemeris of the Sv I.D. is requested.

Switch To SiRF Protocol

Note – To switch to SiRF protocol you must send a SiRF NMEA message to revert to SiRF binary mode. (See page 9, " NMEA Input Messages " for more information)

Output Messages for SiRF Binary Protocol

Note – All output messages are received in BINARY format. SiRF demo interprets the binary data and saves if to the log file in ASCII format.

Table 35 ***lists the message list for the SiRF output messages***

Hex	ASCII	Name	Description
0x02	2	Measured Navigation Data	Position, velocity, and time
0x04	4	Measured Tracking Data	Signal to noise information
0x05	5	Raw Track Data	Measurement information
0x06	6	SW version	Receiver software
0x07	7	Clock Status	
0x08	8	50 BPS Subframe Date	Standard ICD format
0x09	9	Throughput	CPU load
0x0B	11	Command Acknowledgment	Successful request
0x0C	12	Command N Acknowledgment	Unsuccessful request
0X0D	13	Visible List	
0x0E	14	Almanac Data	
0x0F	15	Ephemeris Data	
0xFF	255	Development Data	Various data messages

Measure Navigation Data Out – Message I.D.2

Output Rate 1 Hz

Table 36 lists the binary and ASCII message data format for the measured navigation data

Example A0A20029 – Start Sequence and Payload Length

02FFD6F78CFFBE869E003AC00400030104A00036B039780E3

0612190E160F04000000000000 – Payload

09BBB0B3 – Message Checksum, and End Sequence

Table 36 ***Measured Navigation Data Out – Binary & ASCII Message Data Format***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		02			2
X – position	4		FFD6F78C	M		-2689140
Y – position	4		FFBE536E	M		-4304018
Z – position	4		003AC004	M		3850244
X – velocity	2	*8	00	M/s	Vx/8	0
Y – velocity	2	*8	03	M/s	Vy/8	0.375
Z – velocity	2	*8	01	M/s	/8	0.125
Mode 1	1		04	Bitmap1		4
DOP2	1	*5	A		/5	2.0
Mode 2	1		00	Bitmap3		0
GPS Week	2		036B			875
GPS TOW	4	*100	039780E3	seconds	/100	602605.79
SVs in Fix	1		06			6
CH 1	1		12			18
CH 2	1		19			25
CH 3	1		0E			14
CH 4	1		16			22
CH 5	1		0F			15
CH 6	1		04			4
CH 7	1		00			0
CH 8	1		00			0
CH 9	1		00			0
CH 10	1		00			0
CH 11	1		00			0
CH 12	1		00			0

Payload Length 41 bytes

1. For further information , go to *Table 28*
2. Dilution of precision (DOP) field contains value of PDOP when Position is obtained using 3D solution and HDOP in all other cases.
3. For further information , go to *Table 28*

Note – Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (i.e., decimal Xvel = binary Xvel /8).

Table 37 ***Mode 1***

Mode 1		Description
Hex	ASCII	
0x00	0	No Navigation Solution
0x01	1	1 Satellite Solution
0x02	2	2 Satellite Solution
0x03	3	3 Satellite Solution (2D)
0x04	4	>=4 Satellite Solution (3D)
0x05	5	2D Point Solution(Krause)
0x06	6	3D Point Solution(Krause)
0x07	7	Dead Reckoning (Time Out)

Table 38 ***Mode 2***

Mode 2		Description
Hex	ASCII	
0x00	0	DR Sensor Data
0x01	1	Validated / Unvalidated
0x02	2	Dead Reckoning (Time Out)
0x03	3	Output Edited by UI
0x04	4	Reserved
0x05	5	Reserved
0x06	6	Reserved
0x07	7	Reserved

Measured Tracker Data Out – Message I.D.4

Output Rate 1 Hz

Table 39 lists the binary and ASCII message data format for the measured tracker data.

Example A0A200BC – Start Sequence and Payload Length
04036C0000937F0C0EAB46003F1A1E1D1D191D1A1A1D1F1D59423
F1A1A…. – Payload ****B0B3 – Message Checksum and End Sequence

Table 39 ***Measured Tracker Data Out***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		04	None		4
GPS Week	2		036C			876
GPS TOW	4	S*100	0000937F	S	S/100	37759
Channels	1		0C			12
1st Sv ID	1		0E			14
Azimuth	1	Az*[2/3]	AB	Degree	/[2/3]	256.5
Elev.	1	EI*2	46	Degree	/2	35
State	2		003F	Bitmap1		63
C/NO 1	1		1A			26
C/NO 2	1		1E			30
C/NO 3	1		1D			29
C/NO 4	1		1D			29
C/NO 5	1		19			25
C/NO 6	1		1D			29
C/NO 7	1		1A			26
C/NO 8	1		1A			26
C/NO 9	1		1D			29
C/NO 10	1		1F			31
2nd Sv ID	1		1D			29
Azimuth	1	Az*[2/3]	59	Degree	/[2/3]	89
Elev.	1	EI*2	42	Degree	/2	66
State	2		3F	Bitmap1		63
C/NO 1	1		1A			26
C/NO 2	1		1A			63
…..						

Payload Length 188 bytes

For further information, go to *Table 40*.

Note – Message length is fixed to 188 bytes with non tracking channels reporting zero values

Table 41 ***Trk. to NAV Struct. Trk._status Field Definition***

Field Definition	Hex Value	Description
ACQ_SUCCESS	0x0001	Set if acq/reacq if done successfully
DELTA_CARPHASE_VALID	0x0002	Integrated carrier phase is valid
BIT_SYNC_DONE	0x0004	Bit sync completed flag
SUBFRAME_SYNC_DONE	0x0008	Subframe sync has been done
CARRIER_PULLIN_DONE	0x0010	Carrier pull in done
CODE_LOCKED	0x0020	Code locked
ACQ_FAILED	0x0040	Failed to acquire S/V
GOT_EPHEMERIS	0x0080	Ephemeris data available

Note – When a channel is fully locked and all data is valid , the status shown is 0xBF

Raw Tracker Data Out – Message I.D.5

Output Rate 1 Hz

Table 41 lists the binary and ASCII message data format for the raw tracker data .

Example A0A20033 – Start Sequence and Payload Length

05000000070013003F00EA1BD4000D039200009783000DF45E000105B5FF90F5C200002428272723272424272905000000070013003F – Payload

0B2DB0B3 – Message Checksum and End Sequence

Table 41 ***Raw Tracker Data Out***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		05			5
Channel	4		00000007			7
SVID	2		0013			19
State	2		003F	Bitmap1		63
Bits	4		00EA1BD4	Bit		15342548
Ms	2		000D	Ms		13
Chips	2		0392	Chip		914
Code Phase	4	2^{-16}	00009783	Chip	$/2^{-16}$	38787
Carrier Doppler	4	2^{-10}	000DF45E	Rad/2ms	$/2^{-10}$	914526
Time Tag	4		000105B5	Ms		66997
Delta Carrier	4	2^{-10}	FF90F5C2	Cycles	$/2^{-10}$	-7277118
Search Count	2		0000			0
C/NO 1	1		24	dBHz		36
C/NO 2	1		28	dBHz		40
C/NO 3	1		27	dBHz		39
C/NO 4	1		27	dBHz		39
C/NO 5	1		23	dBHz		35
C/NO 6	1		27	dBHz		39
C/NO 7	1		24	dBHz		36
C/NO 8	1		24	dBHz		36
C/NO 9	1		27	dBHz		39
C/NO 10	1		29	dBHz		41
Power Bad Cnt	1		05			5
Phase Bad Cnt	1		00000007			7
Delta Car Int	2		0013	Ms		19
Correl Int	2		003F			63

Payload Length 51 bytes per satellite tracked (up to 12)
For further information ,go to *Table 40*

Response Software Version String – Message I.D.6
Output Rate Response to polling message
Example A0A20015 – Start Sequence and Payload Length
0606312E322E30444B495431313920534D0000000000-Payload
0382B0B3 – Message Checksum and End Sequence

Table 42 ***Software Tracker Data Out***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		06			6
Character	20		1			2

Payload Length 21 bytes
1.06312E322E30444B495431313920534D0000000000
2.1.2.0Dkit119SM

Note – Convert to symbol to assemble message (i.e., 0x4E is 'N'). These are low priority task and are not necessarily output at constant intervals.

Response Clock Status Data – Message I.D.7

Output Rate 1Hz or response to polling message
Example A0A20014 – Start Sequence and Payload Length
0703BD021549240822317923DAEF – Payload
0598B0B3 – Message Checksum and End Sequence

Table 43 ***Clock Status Data Message***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		07			7
GPS Week	2		03BD			957
GPS TOW	4	*100	02154924	S	/100	349494.12
Svs	1		08			8
Clock Drift	4		2231	Hz		74289
Clock Bias	4		7923	ns		128743715
Estimated GPS Time	4		DAEF	ms		349493999

Payload Length 20 bytes

50BPS Data – Message I.D.8
Output Rate As available (12.5 minute download time)
Example A0A2002B – Start Sequence and Payload Length
08******** - Payload
****B0B3 – Message Checksum and End Sequence

Table 44 ***Clock Status Data Message***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		08			8
Channel	1					
Sv ID	1					
Word [10]	40					

Payload Length 43 bytes per subframe (6subframes per page, 25 pages Almanac)

Note – Data is logged in ICD format (available from www.navcen.uscg.mail)

CPU Throughput – Message I.D.9
Output Rate 1 Hz
Example A0A20009 – Start Sequence and Payload Length
09003B0011001601E5 – Payload
0151B0B3 – Message Checksum and End Sequence

Softwart interface

Table 45 ***CPU Throughput***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		09			9
SegStatMax	2	*186	003B	ms	/186	.3172
SegStatLat	2	*186	0011	ms	/186	.0914
AveTrkTime	2	*186	0016	ms	/186	.1183
Last MS	2		01E5	ms		485

Payload Length 9 bytes

Command Acknowledgment – Message I.D.11
Output Rate Response to successful input message
This is successful almanac (message ID 0x92)request example

A0A20002 – Start Sequence and Payload Length
0B92 – Payload
009DB0B3 – Message Checksum and End Sequence

Table 46 ***Command Acknowledgment***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0B			11
Ack.I.D.	1		92			146

Payload Length 2 bytes

Command N Acknowledgment – Message I.D. 12

Output Rate Response to rejected Input message

This is unsuccessful almanac (message ID 0x92) request example

A0A20002 – Start Sequence and Payload Length
0C92 – Payload
009EB0B3 – Message Checksum and End Sequence

Table 47 ***Command N Acknowledgment***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0C			12
N Ack. I.D	1		92			146

Payload Length 2 bytes

Visible List – Message I.D.13

Output Rate Updated approximately every 2minutes

Note – This is a variable length message. Only the number of visible satellites are reported(as define by visible Svs in Table C-32), Maximum is 12 satellites

Example A0A2002A – Start Sequence and Payload Length
0D08070029003809013300 2C******************* - Payload
****B0B3 – Message Checksum and End Sequence

Table 48 ***Visible List***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0D			13
Visible Svs	1		08			8
CH 1 –Sv I.D	1		07			7
CH 1 –Sv Azimuth	2		0029	Degrees		41
CH 1 –Sv Elevation	2		0038	Degrees		56
CH 2 –Sv I.D	1		09			9
CH 2 –Sv Azimuth	2		0133	Degrees		307
CH 2 –Sv Elevation	2		002C	Degrees		44
……						

Payload Length 62 bytes(maximum)

Almanac Data – Message I.D.14
Output Rate Response to poll
Example A0A203A1 – Start Sequence and Payload Length
0E01************* - Payload
****B0B3 – Message checksum and End Sequence

Table 49 ***Visible List***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0E			14
Sv I.D.(1)	1		01			1
Almanac Data[14][2]	28					
….						
Sv I.D.(32)	1		20			32
Almanac Data[14][2]	28					

Payload Length 929 bytes(maximum)

Set Ephemeris – Message I.D.254
This command enables the user to upload an ephemeris to the Evaluation unit.

Note – This feature is not documented in this manual . For information on implementation contact SiRF Technology Inc.

Softwart interface

Development Data – Message I.D.255
Output Rate Receiver generated
Example A0A2**** - Start Sequence and Payload Length
FF************* - Payload
****B0B3 – Message Checksum and End Sequence

Table 50 ***Visible List***

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example

Message ID	1		FF			255

Payload Length Variable

Note – Messages are output to give the user information of receiver activity. Convert to symbol to assemble message (i.e., 0x4E is 'N') these are low priority task and are not necessarily output at constant intervals.

Hardware interface

Digital Interface connector type
12 pin header (180°) , 1.27 mm in *Table 51*

Table 51

Pin NO	Signal Name	I/O	Description	Characteristics
1	VCC_3	I	+3.3V DC Power Input	DC +3.3V ± 10%.
2	TXA	O	NMEA Output 9600bps, 8 data bits, no parity, 1 stop bit	TTL Level Voh ≥ 2.4V Vo1 ≤ 0.4V
3	RXA		**Reserved**	
4	GND	G	Ground	
5	GPIOA		**Reserved**	
6	TXB		**Reserved**	
7	RXB	I	RTCM 104 differential GPS input.	TTL Level Voh ≥ 2.4V Vo1 ≤ 0.4V
8	TIMEMARK	O	1PPS Time Mark Output.	TTL Level Voh ≥ 2.4V Vo1 ≤ 0.4V
9	RESET	I	Reset Input, Active Low	Voh>VCC_3 -1.5V Vol<0.3V
10	VANT	O	**Reserved**	DC +3.3V ± 10%.
11	VBAT	I	User Supply +2.5~3.1V DC Power Input*	DC + 2.5 ~ 3.1V Current ≤ 10uA
12	BOOTSET		Reserved	

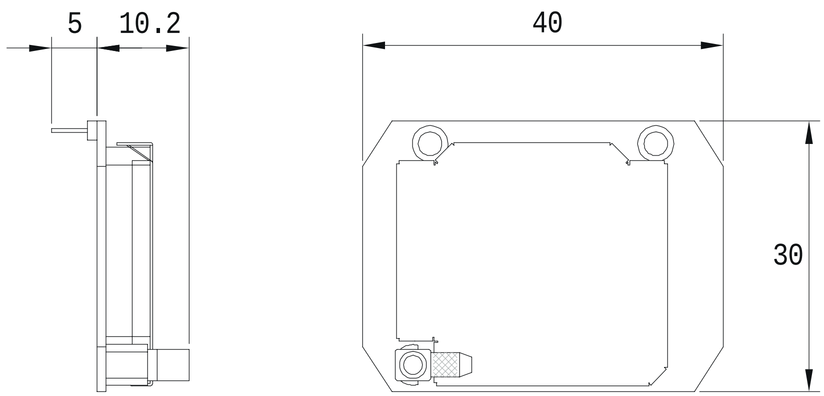
Physical characteristics

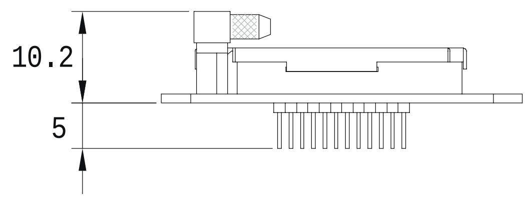
Mechanical requirement
Length 40mm ±0.2mm
Width 33mm ±0.2mm

Temperature characteristics

REB-2100
a. Storage temperature: -10 ~ +85 .
b. Operating temperature: 0 ~ +70 .

Mechanical Dimension





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