REB-12R Series

Operational Manual

Version 1.5
2002/4/25

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Prepared by

RoyalTek Company LTD.

RoyalTek REB-12R series Operational Manual

Introduction

REB-12R is the first generation of RoyalTek GPS Receiver. It consists of SiRF Star I technology and RoyalTek proprietary navigation algorithm that providing you more stable navigation data. REB-12R contains series of different combination of 20 pins header, RF connector, protocol and so on. Please refer to the section, **serial number definition**, for more information.

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Product Features

Õ OEM product development is fully supported through applications engineering and WEB technique forum.

Õ 12 parallel channels

Õ 0.1 second re-acquisition time.

Õ Enhanced algorithm for navigation stability.

Õ NMEA-0183 compliant protocol/custom protocol.

Õ Excellent sensitive for urban canyon and foliage environments.

Õ Single satellite positioning.

Õ Dual multi path rejection.

Product applications

Õ Automotive applications

Õ Personal positioning and navigation

Õ Marine navigation

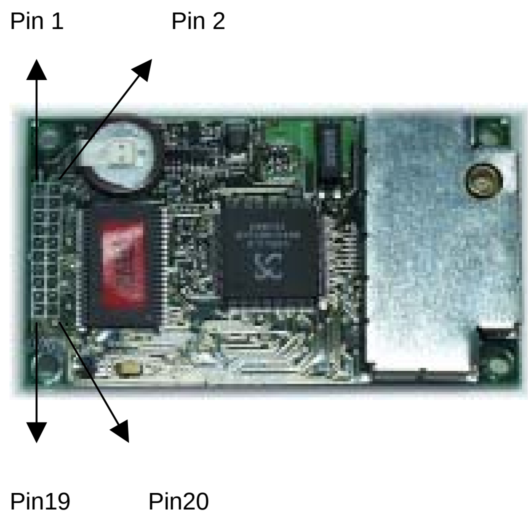
Õ Timing application

Technique description

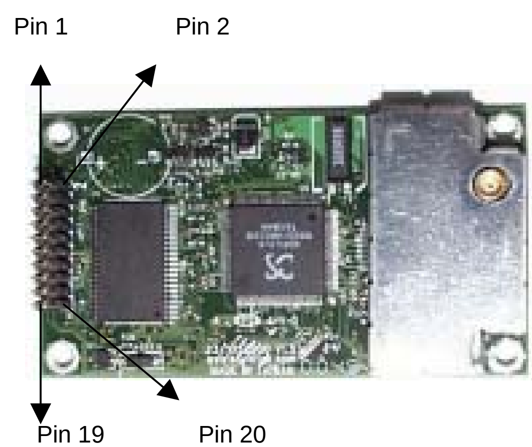
Pictures of REB-12R series

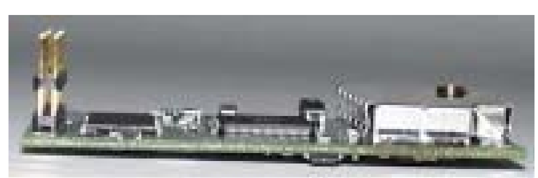
REB-12R

The following is the example picture of REB-12R with short-down 20 pins header and straight-up MCX connector

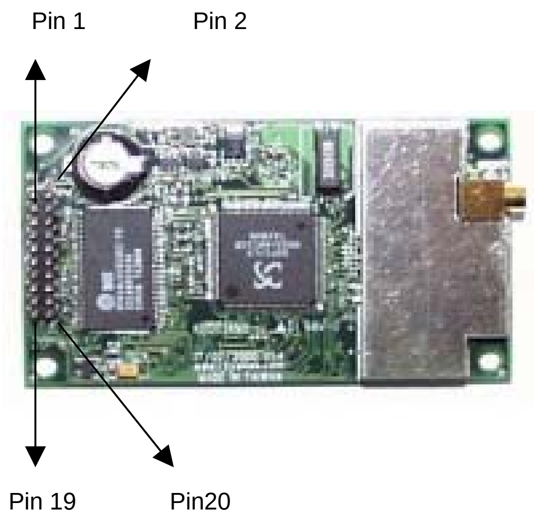


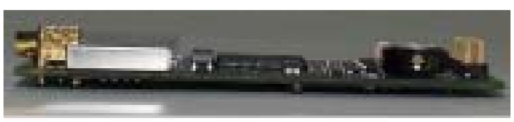
The picture of REB-12R with short-down 20 pins header and straight-up MCX connector





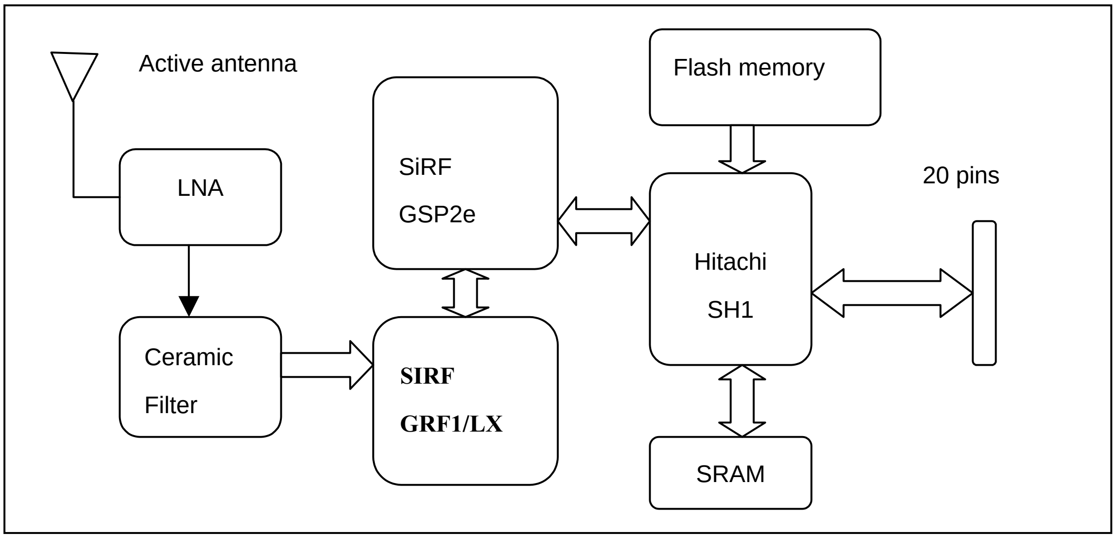
The picture of REB-12R with short-up 20 pins header and right-angle-up MCX connector





REB-12R Series Block diagram

The block diagram is described as follows.



Technique specifications

The specification list of REB-12R series

Operational Characteristics.

12 Channels

L1, 1575.42MHz.

C / A code, 1.023MHz chip rate.

Snap start:2second, average

Hot start 8second, average

Warm start 38second, average

Cold start 48second, average

Reacquisition:0.1 second, average

Navigation update rate Once per second.

Datum: WGS-84.

Accuracy.

Position accuracy 10m 90% without SA

Velocity accuracy:0.1 meters/second without SA

DGPS Accuracy.

Position:1 to 5 m, typical

Velocity: 0.05 meters/second, typical

Dynamics.

Altitude 18000 meters (60000 feet) Max.

Velocity 515 meters / second Max.

Acceleration 4 g. , Max.

Power Requirements.

Regulated power for the REB-12R series is required. The input voltage shall be 5.0V ± 5%. The full run (without trickle power) maximum current is less than 180mA.

Weight. 19.3g

Environment.

Temperature.

Operating temperature -40 ~ +85 Degree (Celsius).

Storage temperature: -40 ~ +85 Degree (Celsius).

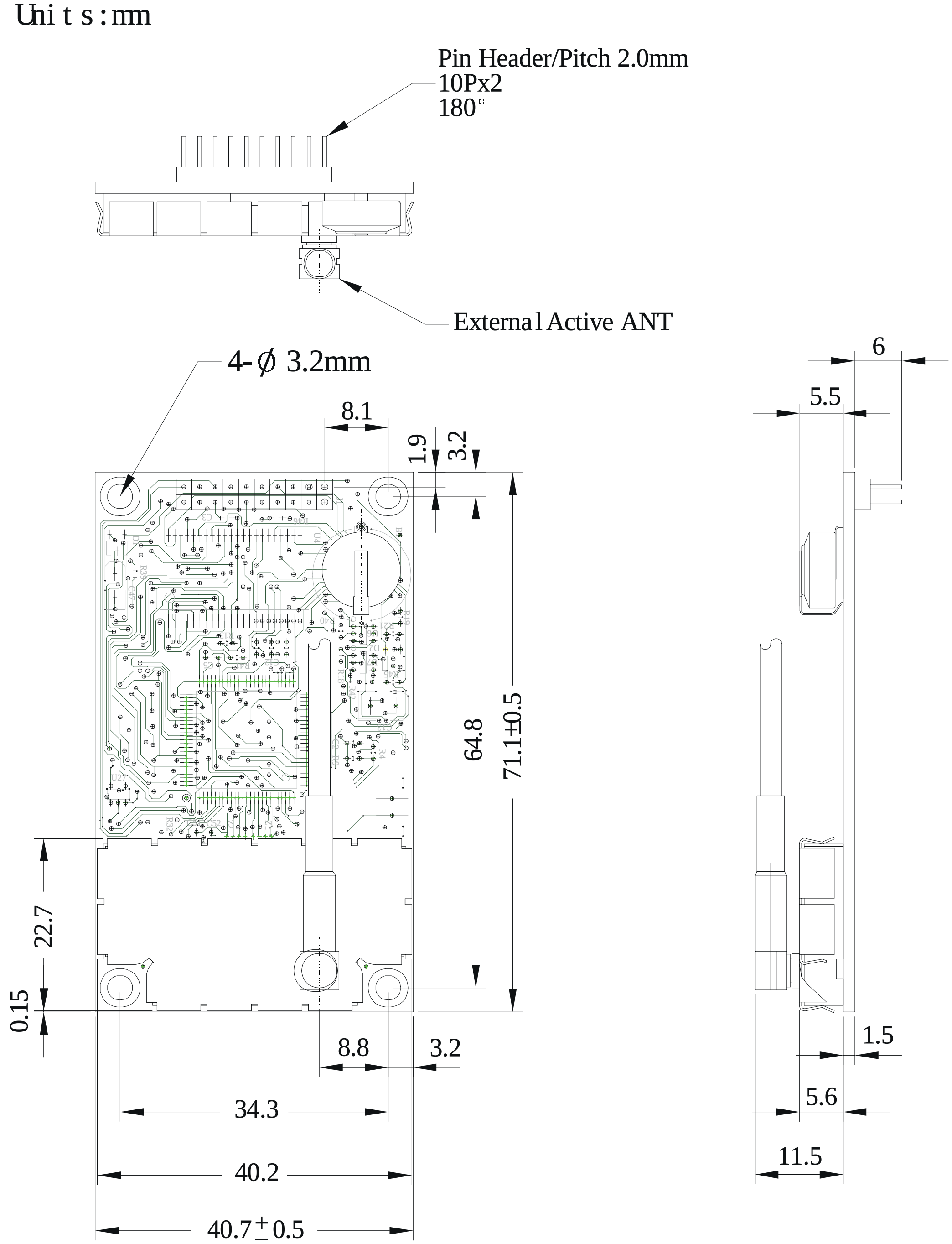
Humidity. ȝ 95% noncondensing

Serial number definition

LXHA/ LXHS	Power	Trickle Power	RF Connector	20pin I/O	Backup battery	Signal level of serial data I/O	Ant. Power	Memory Type	Software	Extension Cable	Antenna
1	2	3	4	5	6	7	8	9	10	11	12
1: LXHA 2: LXHS	3: 3.3V 5: 5V	0: Disable 1: Enable	1: MCX straight-angle-up 2: MCX straight-angle-down 3: MCX right-angle-up 4: MCX right-angle-down 5: SMA straight-angle-up 6: SMA straight-angle-down 7: SMA right-angle-up 8: SMA right-angle-down	1: short-down 2: short-up 3: long-up 4: long-down 5: short right-up 6:short right-down 7: long right-up 8:long right-down	0: None 1:Super CAP 2: Li-Ion battery.	1: TTL 2: RS-232	1: external 3: 3.3V 5: 5V	1:Flash memory 2: Mask ROM	0: Customize 1: RMC 9600 2: GGA ,GLL, GSA, GSV, RMC, VTG, 9600 3: GGA, GSA, GSV, RMC 4800 4.GGA, GSA,RMC 4800 5. GGA, VTC 4800 6. SIRF Binary , 19200	0: None 1: MCX(R/A) to BNC 2: MCX(R/A) to HRS 3: MCX(R/A) to SMA	0: None 1: MCX 2: BNC 3: GT5 4: SMA

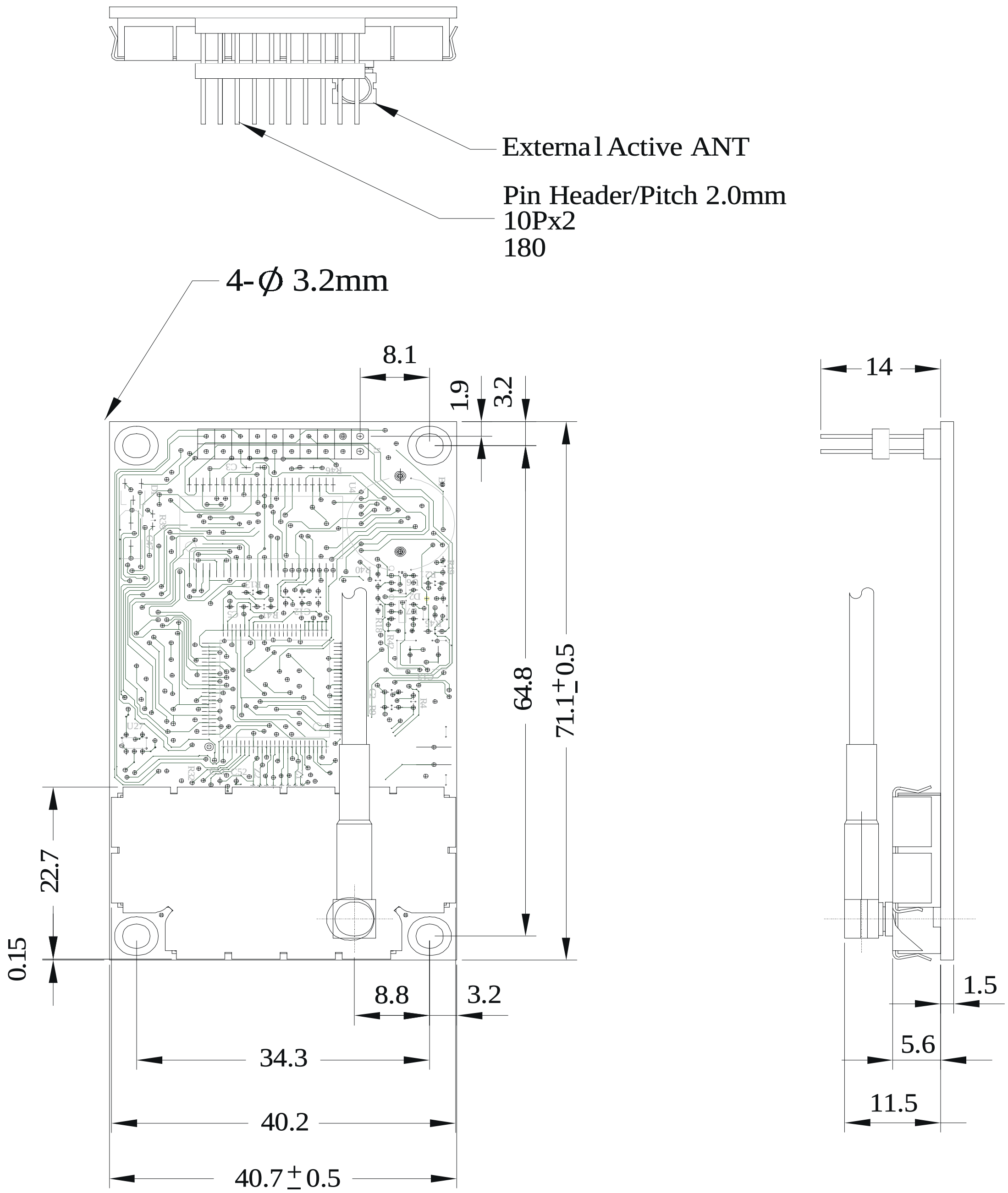
Mechanical Layout.

REB-12R with short-down 20 pins header and straight-up MCX connector.

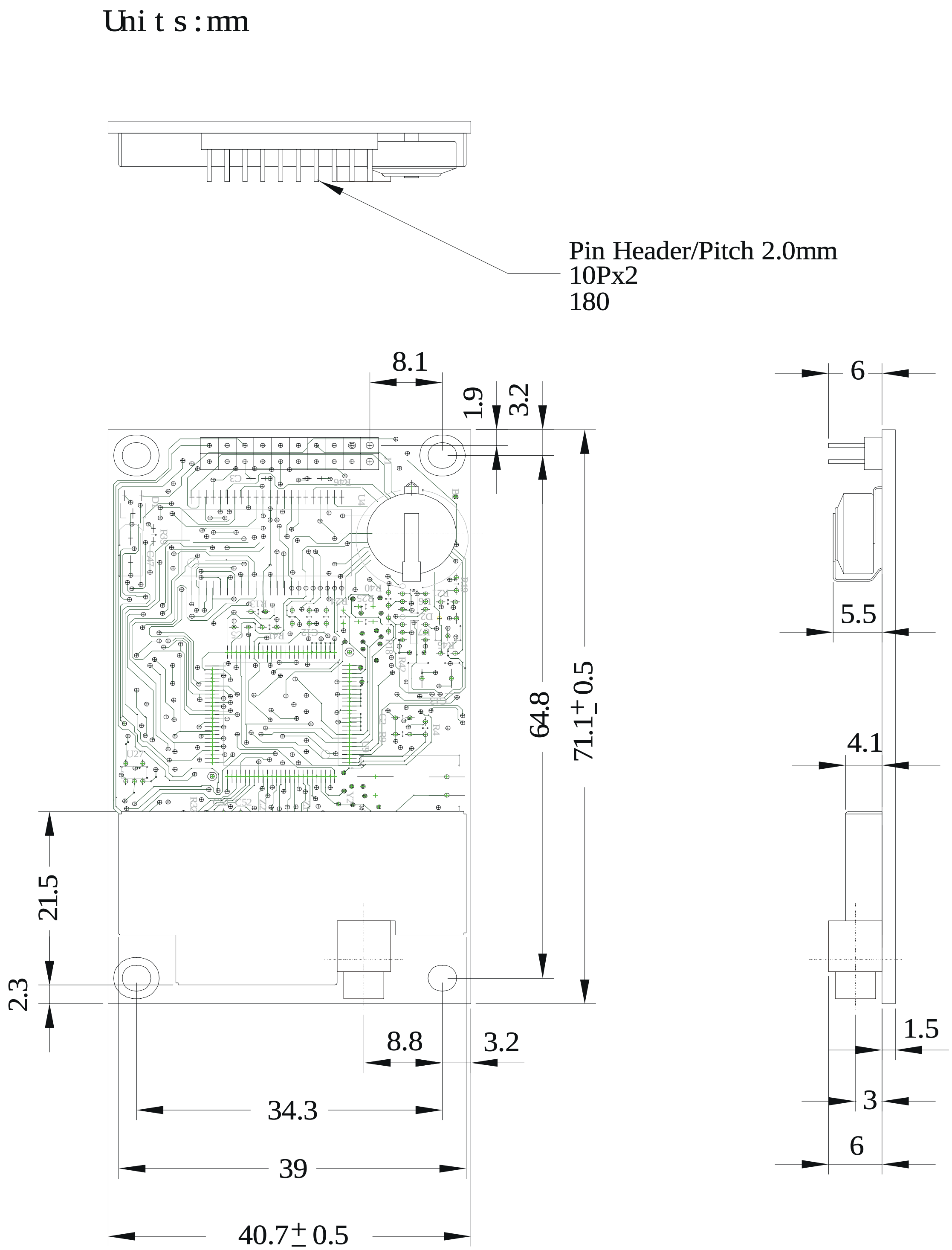


REB-12R with long-up 20 pins header and straight-up MCX connector.

Unit s : mm



REB-12R with short-up 20 pins header and right-angle-up MCX RF connector



Hardware interface

For LXHA type.

Pin NO	Signal Name	I/O	Description	Characteristics
1	VANT	I	Antenna DC Voltage	Depending on the user requirement..
2	VCC_5	I	+5V DC Power Input	DC +5V ± 10%.
3	VBAT	I	User Supply +3.3V DC Power Input*	DC +3.3V ± 10%. Current ≤ 10mA
4	RESERVED		Reserved	DC +3V ± 10%
5	RESET	I	Reserved. Please leave it floating.	
6	RESERVED	-	Reserved	
7	SELECT	-	Boot selection. Please do not connect it to high. Please leave it open or ground.	
8	RESERVED	-	Reserved	
9	RESERVED	-	Reserved	
10	GND	G	Ground	
11	TXA	O	NMEA Output 9600bps, 8 data bits, no parity, 1 stop bit	Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA
12	RAX	I	Serial Data Input A	VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
13	GND	G	Ground	
14	TXB	O	Serial Data Output B	Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA
15	RXB	I	RTCM 104 differential GPS input.	VCC*0.7 ≤ Vih ≤ VCC+0.3V -0.3V ≤ Vil ≤ VCC*0.2V
16	GND	G	Ground	
17	RESERVED	-	Reserved	
18	GND	G	Ground	
19	TIMEMARK	O	1PPS Time Mark Output.	Voh ≥ VCC-0.4V, Vo1 ≤ 0.4V, Ioh = 4mA Io1 = 4mA Pulse duration 100ms. Time reference is at the pulse negative edge. Measurements are aligned to GPS second, ± 1 microsecond.
20	RESERVED	-	Reserved	

VCC_5 DC Power Input

This is the main power supply for the GPS Engine board. Use a regulated 5V supply (± 5%) capable of supplying 180mA.

VANT

DC voltage for an active antenna. This voltage is not required for operation with a passive antenna.

VCC_3 DC Power Input

RoyalTek also provides the 3.3 V version GPS receiver. This is the main power supply for the Engine board. Use a regulated 3.3V supply (± 5%).

GND

GND provides the ground for the Engine board. Connect all grounds.

Serial Data:RXA, RXB, TXA, and TXB

The GPS Engine board supports two full duplicated serial channels. All four connections are at TTL levels, and all support variable baud rates. A TTL to RS232 conversion is necessary to directly communicate with a PC serial port.

RXA

This is the main receiving channel and is used to receive software commands to the Engine board from user written software.

RXB

This is the auxiliary receive channel and is used to input differential corrections to the Engine board to DGPS navigation.

TXA

This is the main transmit channel and is used to output navigation and measurement data to user written software.

TXB

Reserved.

RESET

It is reserved. Please leave it open. If you want to use this pin, please contact our sales sales@royaltek.com.

TIMEMARK

This pin provides one pulse per second output from the engine board which is synchronized to within one microsecond of GPS time. The output is a TTL negative level signal with negative logic.

VBAT

This is the battery backup supply that powers the SRAM and RTC when main power is removed. Without an external backup battery or on board battery, engine board will execute a cold start after every turn on. To achieve the faster start-up offered by a hot or warm start, either a backup battery must be connected or battery installed on board.

For LXHS type.

Pin NO	Signal Name	I/O	Description	Characteristics
1	VANT	I	Antenna DC Voltage	Depending on the user requirement..
2	VCC_5	I	+5V DC Power Input	DC +5V ± 10%.
3	VBAT	I	User Supply +3.3V DC Power Input*	DC +3.3V ± 10%. Current ≤ 10mA
4	VCC_3		Reserved	DC +3V ± 10%
5	RESET	I	Reserved. Please leave it open.	
6	GPIO1	I/O	SH-1 PB15 (Note1,2)	For output: Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA For input: VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
7	GPIO2	I/O	SH-1 PA11(Note1,2)	For output: Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA For input: VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
8	GPIO3	I/O	SH-1 PA10(Note1,2)	For output: Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA For input: VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
9	GPIO4	I/O	SH-1 PA14(Note1,2)	For output: Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA For input: VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
10	GND	G	Ground	
11	TXA	O	NMEA Output 9600bps, 8 data bits, no parity, 1 stop bit	Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA
12	RAX	I	Serial Data Input A	VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
13	GND	G	Ground	
14	TXB	O	Serial Data Output B	Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA
15	RXB	I	RTCM 104 differential GPS input.	VCC*0.7 ≤ Vih ≤ VCC+0.3V -0.3V ≤ Vil ≤ VCC*0.2V
16	GND	G	Ground	
17	GPIO5	I/O-	SH-1 PA15(Note1,3)	For output: Voh ≥ VCC-0.5, Vo1 ≤ 0.4V, Ioh = -200uA Io1 = 1.6mA For input: VCC*0.7 ≤ Vih ≤ VCC+0.3V, -0.3V ≤ Vil ≤ VCC*0.2V
18	GND	G	Ground	
19	TIMEMARK	O	1PPS Time Mark	Voh ≥ VCC-0.4V, Vo1 ≤ 0.4V, Ioh = 4mA

			Output.	Io1 = 4mA Pulse duration 100ms. Time reference is at the pulse negative edge. Measurements are aligned to GPS second, ± 1 microsecond.
20	RESERVED	-	Reserved	

Note 1). Software dependent functions.

2) Pulled high on board

3) Pulled low on board. This pin can be as firmware upload selection pin. To upload new firmware, tie this pin high and cycle the power.

VCC_5 DC Power Input

This is the main power supply for the GPS Engine board. Use a regulated 5V supply (± 5%) capable of supplying 180mA.

VANT

DC voltage for an active antenna. This voltage is not required for operation with a passive antenna.

VCC_3 DC Power Input

RoyalTek also provides the 3.3 V version GPS receiver. This is the main power supply for the Engine board. Use a regulated 3.3V supply (± 5%).

GND

GND provides the ground for the Engine board. Connect all grounds.

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The GPS Engine board supports two full duplicated serial channels. All four connections are at TTL levels, and all support variable baud rates. A TTL to RS232 conversion is necessary to directly communicate with a PC serial port.

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RXB

This is the auxiliary receive channel and is used to input differential corrections to the Engine board to DGPS navigation.

TXA

This is the main transmit channel and is used to output navigation and measurement data to user written software.

TXB

Reserved.

RESET

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TIMEMARK

This pin provides one pulse per second output from the engine board which is synchronized to within one microsecond of GPS time. The output is a TTL negative level signal with negative logic.

VBAT

This is the battery backup supply that powers the SRAM and RTC when main power is removed. Without an external backup battery or on board battery, engine board will execute a cold start after every turn on. To achieve the faster start-up offered by a hot or warm start, either a backup battery must be connected or battery installed on board.

Active antenna.

GSP Antenna

Characteristics	Specification
Center frequency	1575.42 ± 1.023MHz
Bandwidth	2MHz Min.
Gain at Zenith	2.0 dBi Min.
Gain at 10° elevation	-4.0 dBi Min.
Polarization	R.H.C.P
Axial Ratio	4.0dB Max.

5V Filter/LNA:

Characteristics	Specification
Center frequency (fo)	1575.42 ± 1.023MHz
Gain	28dB Min.
Noise Figure	2.0dB Max.
Out band attenuation	2dB Min. fo ± 20MHz 12dB Min. fo ± 50MHz 22dB Min. fo ± 100MHz
Output V.S.W.R.	2.0 dB max.
Voltage	5.0 ± 0.5V
Current	12mA Max.

3.3V Filter/LNA:

Characteristics	Specification
Center frequency (fo)	1575.42 ± 1.023MHz
Gain	26dB Min.
Noise Figure	2.0dB Max.
Out band attenuation	2dB Min. fo ± 20MHz 12dB Min. fo ± 50MHz 22dB Min. fo ± 100MHz
Output V.S.W.R.	2.0 dB max.
Voltage	3.3 ± 0.3V
Current	12mA Max.

Absolute maximum ratings

Parameter	Symbol	Unit	Min. Value	Max. Value
Supply voltage	VCC_5	V	-0.3	6
RTC power	VBAT	V	-0.3	3.6

Ordering information

For the complete pricing and delivery information, please contact:

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Fax: 886-3-3560900

Http://www.royaltek.com

e-mail: sales@royaltek.com

Software 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		
ӵ CR ɼ ӵ LF ɼ			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

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		
ӵ CR ɼ ӵ LF ɼ			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	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
….			….
Satellite Used			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		
ӵ CR ɼ ӵ LF ɼ			End of message termination

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

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		
ӵ CR ӷ ӵ LF ӷ			End of message termination

[1]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 *RMC* 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	309.62	degrees	True

Ground			
Date	120598		ddmmyy
Magnetic Variation		degrees	E=east or W=west
Checksum	*10		
ӵ CR ӷ ӵ LF ӷ			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		
ӵ CR ӷ ӵ LF ӷ			End of message termination

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 manual. 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

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

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

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. Debug Off $PSRF 105,0*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 *)

SiRF Binary Protocol

The serial communication protocol is designed to include:

ŏ Reliable transport of messages

ŏ Ease of implementation

ŏ Efficient implementation

ŏ 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
<0x7F>	Any value

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

format

High Byte	Low Byte
<0x7F	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(2^{15}-1)

Input Messages for SiRF Binary Protocol

Note – All input messages are sent in BINARY

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
0x 85	133	DGPS Source Control
0x 86	134	Set Main Serial Port
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
0 x 95	149	Set Ephemeris
0 x 96	150	Switch Operating Mode
0 x 97	151	Set Trickle Power Parameters
0 x 98	152	Navigation Parameters (Poll)
0 x B6	182	Set UART Configuration

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

80FFD700F9FFBE5266003AC57A000124 F80083S600039C0C33- 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 19

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.

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 – 0sec , GSA – ON at 5 sec GSV – ON at 5 sec , RMC – 0 sec , VTG – 0 sec

Example:

A0A20018 – Start Sequence and Payload Length

81020101000105010501000100010001000100010 001000112C0 – Payload

016AB0B3 – Message Checksum and End Sequence

Table 20 Switch To NMEA Protocol

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		81		ASCII 129
Mode	1		02		
GGA Message[1]	1		01	1/s	
Checksum[2]	1		01		
GLL Message	1		00	1/s	
Checksum	1		01		
GSA Message	1		05	1/s	
Checksum	1		01		
GSV Message	1		05	1/s	
Checksum	1		01		
RMC Message	1		00	1/s	
Checksum	1		01		
VTG Message	1		00	1/s	
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

(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 0x00 implies 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

DGPS Source – Message I.D. 133

This command allows the user to select the source for DGPS corrections. Options available are:

External RTCM Data (any serial port)

WAAS (subject to WAAS satellite availability)

Internal DGPS beacon receiver

Example 1: Set the DGPS source to External RTCM Data

A0A200007—Start Sequence and Payload Length

85020000000000—Payload

0087B0B3—Checksum and End Sequence

Table B-6 DGPS Source Selection (Example 1)

Name	**Bytes**	**Binary(Hex)**		**Units**	**Description**
		Scale	Example		
Message ID	1		85		Message identifier
DGPS Source	1		00		See Table B-8. DGPS Source Selections
Internal Beacon	4		00000000	Hz	See Table B-9. Internal Beacon Search setting.
Internal Beacon Bit Rate	1		0	BPS	See Table B-9. Internal Beacon Search setting.

Payload: 7Bytes.

Example2: Set the DGPS source to Internal DGPS Beacon Receiver

Search Frequency 310000, Bit Rate 200

A0A200007—Start Sequence and Payload Length

85030004BAF0C802—Payload

02FEB0B3—Checksum and End Sequence

Table B-7 DGPS Source Selection (Example 2)

Name	**Bytes**	**Binary(Hex)**		**Units**	**Description**
		Scale	Example		
Message ID	1		85		Message identifier
DGPS Source	1		03		See Table B-8. DGPS Source Selections
Internal Beacon	4		0004BAF0	Hz	See Table B-9. Internal Beacon Search setting.
Internal Beacon Bit Rate	1		C8	BPS	See Table B-9. Internal Beacon Search setting.

Payload: 7Bytes.

Table B- 8 DGPS Source Selections

DGPS Source	**Hex**	**Decimal**	**Description**
None	00	0	DGPS corrections will not be used (even if available).
WAAS	01	1	Uses WAAS Satellite (subject to availability).
External RTCM Data	02	2	External RTCM input source (i.e., Coast Guard Beacon).
Internal DGPS Beacon Receiver	03	3	Internal DGPS beacon receiver.

Table B- 9 Internal Beacon Search Settings

Search Type	Frequency	Bit Rate	Description
Auto Scan	0	0	Auto scanning of all frequencies and bit rates are performed.
Full Frequency Scan	0	Non zero	Auto scanning of all frequencies and specified bit rate are performed.
Full Bit Rate Scan	Non Zero	0	Auto scanning of all bit rates and specified frequency are performed.
Specific Search	Non Zero	Non Zero	Only the specified frequency and bit rate search are performed.

Set Main Serial Port-Message I.D. 134

Table B-10 contains the input values for the following example:

Set Main Serial port to 9600,n,8,1.

Example:

A0A20009—Start Sequence and Payload Length

860000258008010000—Payload

0134B0B3—Message Checksum and End Sequence

Table B- 10 Set Main Serial Port

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		86		Message identifier
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

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

8801010101010000000002140501 – 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)		Units	Description
		Scale	Example		
Message ID	1		88		ASCII 137
DOP Selection	1		00		See Table 25
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

DGPS 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 27
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)		Units	Description
		Scale	Example		
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)		Units	Description
		Scale	Example		
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) Scale	Example	Units	Description
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) Scale	Example	Units	Description
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)

Switch Operating Modes - Message I.D.

150

Table 35 contains the input values for the following example:

Sets the receiver to track a single satellite on all channels.

Example:

A0A20007—Start Sequence and Payload Length

961E510006001E—Payload

0129B0B3—Message Checksum and End Sequence

Table 35 Switch Operating Mode I.D. 150

Name	Bytes	Binary(Hex) Scale	Example	Units	Description
Message ID	1		96		ASCII 150
Mode	2		1E51		1E51=test, 0=nomal
SvID	2		0006		Satellite to Track
Period	2		001E	seconds	Duration of Track

Payload length: 7 bytes

Set Trickle Power Parameters - Message I.D. 151

Table 36 contains the input values for the following example: Sets the receiver into low power Modes. Example: Set receiver into Trickle Power at 1 hz update and 200 ms On Time.

A0A20009—Start Sequence and Payload Length

97000000C8000000C8—Payload

0227B0B3—Message Checksum and End Sequence

Table 36 Set Trickle Power Parameters I.D. 151

Name	Bytes	Binary(Hex) Scale	Example	Units	Description
Message ID	1		97		ASCII 151
Push To FixMode	2		0000		ON=1, OFF=0
Duty Cycle	2	*10	00C8	%	% Time on
Milli Seconds On Time	4		000000C8	ms	Range 200 ~ 500 ms

Payload Length: 9bytes.

Computation of Duty Cycle and On Time.

The Duty Cycle is the desired time to be spent tracking.The On Time is the duration of each tracking period (range is 200 - 900 ms). To calculate the TricklePower update rate as a function of Duty cycle and On Time, use the following formula:

Off Time = (On Time - (Duty Cycle * On Time)) / Duty Cycle

Update rate = Off Time + On Time

Note – On Time inputs of > 900 ms will default to 1000 ms

Following are some examples of selections:

Table 37 Example of selections for Trickle Power Mode of Operation

Mode	On Time (ms)	Duty Cycle (%)	Update rate (1/Hz)
Continuous	1000	100	1
Trickle Power	200	20	1
Trickle Power	200	10	2
Trickle Power	300	10	3
Trickle power	500	5	10

See Table 38 for supported/unsupported settings.

Table 38 Trickle Power Mode Settings

On Time (ms)	Update Rate (second)							
	1	2	3	4	5	6	7	8
200	Y	Y	N	N	N	N	N	N
300	Y	Y	Y	Y	Y	Y	N	N
400	Y	Y	Y	Y	Y	Y	Y	Y
500	Y	Y	Y	Y	Y	Y	Y	Y
600	Y	Y	Y	Y	Y	Y	Y	Y
700	Y	Y	Y	Y	Y	Y	Y	Y
800	Y	Y	Y	Y	Y	Y	Y	Y
900	Y	Y	Y	Y	Y	Y	Y	Y

Y = Yes (Mode supported)

N = No (Mode NOT supported)

Push-to-Fix

In this mode the receiver will turn on every 30 minutes to perform a system update consisting of a RTC calibration and satellite ephemeris data collection if required (i.e., a new satellite has become visible) as well as all software tasks to support SnapStart in the event of an NMI. Ephemeris collection time in general this takes 18 to 30 seconds. If ephemeris data is not required then the system will re-calibrate and shut down. In either case, the amount of time the receiver remains off will be in proportion to how long it stayed on:

Off period = (On Period*(1-Duty Cycle) / Duty Cycle)

Off Period is limited to 30 minutes. The duty cycle will not be less than approximately On Period/1800, or about 1%. Push-to-Fix keeps the ephemeris for all visible satellites up to date so position/velocity fixes can generally be computed within SnapStart times (when requested by the user) on the order of 3 seconds.

Poll Navigation Parameters - Message I.D. 152

Table C-20 contains the input values for the following example:

Example: Poll receiver for current navigation parameters.

A0A20002—Start Sequence and Payload Length

9800—Payload

0098B0B3—Message Checksum and End Sequence

Table 39 Poll Receiver for Navigation Parameters

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		98		ASCII 152
Reserved	1		00		

Payload length: 2 bytes

Set UART Configuration - Message I.D. 182

This command configures the Evaluation Receiver for data I/O with unique protocols at specified communication parameters. All four ports are configured at the same time.

Example: Set the receiver to the following configuration:

Table B- 32 Example Configuration Settings

Serial Port	Protocol	Baud Rate	Parity	Data Bits	Stop Bits
UART0	SiRF Binary	19200	N	8	1
UART1	NMEA	4800	N	8	1
UART2	RTCM-DGPS	9600	N	8	1
UART3	No I/O	0	0	0	0

A0A20031—Start Sequence and Payload Length

B600000000004B000801000000010101000012C0080100000002030300002580080

1000000030505000000000000000000—Payload

02ABB0B3—Checksum and End Sequence

Table B- 33 Set UART Configuration Message Definition

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		B6		ASCII 152, Message Identification
Serial Port Number	1		00		Fixed setting(See Table B-34. Serial Port setting)
Input protocol	1		00		See Table B-35, Protocol setting
Output protocol	1		00		See Table B-35, Protocol setting
Baud Rate	4		00004B00		1200, 2400, 4800, 9600, 19200, and 38400.
Data bits	1		08		Number of data bits (7 or 8)
Stop bits	1		01		Number of stop bits (0 or 1)
Parity bits	1		00		None(0), Odd(1), Even(2)
TBD	1		00		Reserved
TBD	1		00		Reserved
Serial Port Number	1		01		Fixed setting(See Table B-34. Serial Port setting)
Input protocol	1		01		See Table B-35, Protocol setting
Output protocol	1		00		See Table B-35, Protocol setting
Baud Rate	4		000012C0		1200, 2400, 4800, 9600, 19200, and 38400.
Data bits	1		08		Number of data bits (7 or 8)
Stop bits	1		01		Number of stop bits (0 or 1)
Parity bits	1		00		None(0), Odd(1), Even(2)
TBD	1		00		Reserved
TBD	1		00		Reserved
Serial Port Number	1		02		Fixed setting(See Table B-34. Serial Port setting)
Input protocol	1		03		See Table B-35, Protocol setting
Output protocol	1		03		See Table B-35, Protocol setting
Baud Rate	4		00002580		1200, 2400, 4800, 9600, 19200, and 38400.
Data bits	1		08		Number of data bits (7 or 8)
Stop bits	1		01		Number of stop bits (0 or 1)
Parity bits	1		00		None(0), Odd(1), Even(2)
TBD	1		00		Reserved

TBD	1		00		Reserved
Serial Port Number	1		03		Fixed setting(See Table B-34. Serial Port setting)
Input protocol	1		05		See Table B-35, Protocol setting
Output protocol	1		05		See Table B-35, Protocol setting
Baud Rate	4		00000000		1200, 2400, 4800, 9600, 19200, and 38400.
Data bits	1		08		Number of data bits (7 or 8)
Stop bits	1		01		Number of stop bits (0 or 1)
Parity bits	1		00		None(0), Odd(1), Even(2)
TBD	1		00		Reserved
TBD	1		00		Reserved

Payload length: 49 Bytes

The message to set the UART configuration is a series of four data blocks of 12 bytes for each port setting as shown in Table B-33. This message is designed that each block is fixed to a serial port as shown in Table B-34 and must be maintained for correct port configuration. To maintain the current port settings, send an 0xFF in place of the Serial Port Number and the remaining values in the data block are ignored (i.e., current settings are maintained).

Table B- 34 Serial Port Settings

Serial Port	Serial Port Number(Hex)	Serial Port Number(Decimal)
UART 0 (CPU SCIO 0)	00	0
UART 1 (CPU SCIO 1)	01	1
UART 2 (GSP Port A)	02	2
UART 3 (GSP Port B)	03	3
ALL Ports	FF	255

The multiple port functionality currently supports only SiRF implemented data I/O (SiRF binary and NMEA) as well as RTCM DGPS corrections for input only. Additional protocols have been set aside for user definition and implementation as shown in Table B-35.

Table B- 35 Protocol Settings

Protocol	Hex	Decimal	Description
SiRF Binary	00	0	
NMEA	01	1	
ASCII	02	2	ASCII output; user defined.
RTCM–DGPS	03	3	
User1	04	4	User defined.
User2	06	6	User defined.
User3	07	7	User defined.
User4	08	8	User defined.
No I/O	05	5	Serial port is shut off (must be reactivated by other active port).

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 40 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	Auto Output
0x0E	14	Almanac Data	Response to Poll
0x0F	15	Ephemeris Data	Response to Poll
0x12	18	OkToSend	CPU ON / OFF (Trickle Power)
0x13	19	Navigation Parameters	Response to Poll
0xFF	255	Development Data	Various data messages

1. SiRFtest is production testing software tool.

Measure Navigation Data Out – Message I.D.2

Output Rate: 1 Hz

Table 41 lists the binary and ASCII message data format for the measured navigation data

Example:

A0A20029 – Start Sequence and Payload Length

02FFD6F78CFFBE869E003AC004000301 04A00036B039780E3 0612190E160F04000000000000 – Payload

09BBB0B3 – Message Checksum, and End Sequence

Table 41 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
DOP[2]	1	*5	A		/5	2.0
Mode[3]	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 42*

[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 43*

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 42 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 43 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 44 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 44 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	El*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	El*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 45*.

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

Table 45 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 46 lists the binary and ASCII message data format for the raw tracker data .

Example:

A0A20033 – Start Sequence and Payload Length

05000000070013003F00EA1BD4000D03
9200009783000DF45E000105B5FF90F5
C200002428272723272424272905000000
0070013003F – Payload

0B2DB0B3 – Message Checksum and

End Sequence

Table 46 Raw Tracker Data Out

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	ASCII(Decimal) Scale	ASCII(Decimal) Example
Message ID	1		05			5
Channel	4		00000007			7
SVID	2		0013			19
State	2		003F	Bitmap[1]		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[2]	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 Loss Count	1		05			5
Phase Loss Count	1		00000007			7
Integration Interval	2		0013	Ms		19
Track Loop Iteration	2		003F			63

Payload Length:51 bytes per satellite tracked (up to 12)

1.For further information,go to Table 45

2.Multiply by $(1000 \div 4\pi) \div 2^{16}$ to convert to Hz.

The meaning of I.D.5 is described as following table

Message ID:	Each SiRF binary message is defined based on the ID.
Channel:	Receiver channel where data was measured (range 1-12).
SVID:	PRN number of the satellite on current channel.
State:	Current channel tracking state (see Table 45)
Bit Number:	Number of GPS bits transmitted since Sat-Sun midnight (in Greenwich) at a 50 bps rate.
Millisecond Number:	Number of milliseconds of elapsed time since the last received bit(20 ms between bits)
Chip Number:	Current C/A code symbol being transmitted (range 0 to 1023 chips;1023 chips=1 ms).
Code Phase:	Fractional chip of the C/A code symbol at the time of sampling(scaled by 2^{-16} ,=1/65536)
Carrier Doppler:	The current value of the carrier frequency as maintained by the tracking loops.
Receiver Time Tag:	This is the count of the millisecond interrupts from the start of the receiver (power on) until the measurement sample is taken. The ms interrupts are generated by the receiver clock.
Delta Carrier Phase:	The difference between the carrier phase(current) and the carrier phase(previous). Units are in carrier cycles with the LSB= 0.00185 carrier cycles. The delta time for the accumulation must be known.

	Note –Carrier phase measurements are not necessarily in sync with code phase measurement for each measurement epoch.
Search Count:	This is the number of times the tracking software has completed full satellite signal searche.s
C/No:	Ten measurements of carrier to noise ratio(C/No) values in dBHZ at input to the receiver.Each value represents 100 ms of tracker data and its sampling time is not necessarily in sync with the code phase measurement.
Power Loss Count:	The number of times the power detectors fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).
Phase Loss Count:	The number of time the phase lock fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).
Integration Interval:	The time in ms for carrier phase accumulation . This is the time difference (as calculated by the user clock) between the Carrier Phase(current) and the Carrier Phase(previous).
Track Loop Iteration:	The tracking Loops are run at 2 ms and 10 ms intervals. Extrapolation values for each interval is 1 ms and 5 ms for range computations.

Calculation of Pseudo-Range Measurements

The pseudo-range measurement in meters can be determined from the raw track data by solving the following equation:

Pseudo-range (PR) = {Received Tine (RT) – Transmit Time (TT)} * C

where C = speed of light

The following variables from the raw track data are required for each satellite:

Bit Number (BN) – 50 bits per second

Millisecond Number (MSN)

Chip Number (CN)

Code Phase (CP)

Receiver Time Tag (RTTag)

Delta Carrier Phase (DCP)

The following steps are taken to get the psr data and carrier data for each measurement epoch.

1. Computation of initial Receiver Time(RT) in seconds. Note-Where the initial arbitrary value chosen at start up to make the PR reasonable (i.e.,set equal to TT+70ms) and then incriminated by one second for each measurement epoch.
2. Computation of Transmit Time (TT) in seconds.
3. Calculate Pseudo-range at a common receiver time of the first channel of the measurement data set. Note-All channel measurements are NOT taken at the same time. Therefore, all ranges must be extrapolated to a common measurement epoch. For simplicity, the first channel of each measurement set is used as the reference to which all other measurements are extrapolated.
4. Extrapolate the pseudo-range based on the correlation interval to improve precision.
5. Compute the delta range.

If the accumulation time of the Dalta Carrier Phase is 1000 ms then the measurement is valid and can be added to the previous Delta Carrier Phase to get Accumulated Carrier Phase data. If the accumulation time of the Delta Carrier Phase is not equal to 1000 ms then the measurement is not valid and the accumulation time must be restarted to get Accumulated Carrier Phase data.

Response :Software Version String – Message I.D.6

Output Rate:Response to polling message

Example:

A0A20015 – Start Sequence and Payload Length

0606312E322E30444B495431313920534 D0000000000-Payload

0382B0B3 – Message Checksum and End Sequence

Table 47 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

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 48 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 49 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

Table 50 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 51 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 52 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 53), Maximum is 12 satellites

Example:A0A2002A – Start Sequence and Payload Length

0D080700290038090133002C******************* - Payload

****B0B3 – Message Checksum and End Sequence

Table 53 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 54 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)

OkToSend - Message I.D. 18

Output Rate: Trickle Power CPU on/off indicator

Example:

A0A20002—Start Sequence and Payload Length

1200—Payload

0012B0B3—Message Checksum and End Sequence

Table B- 50 Almanac Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		12			18
Send indicator[1]	1		00			00

Payload Length: 2 bytes

1. 0 implies that CPU is about to go OFF, OkToSend==NO, 1 implies CPU has just come ON, OkToSend==YES

Navigation Parameters (Response to Poll) – Message I.D. 19

Output Rate:1 Response to Poll

Example:

A0A20018—Start Sequence and Payload Length

130100000000011E3C0104001E004B1E00000500016400C8—Payload

022DB0B3—Message Checksum and End Sequence

Table B- 51 Navigation Parameters

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		13			19
Reserved	4		00000000			
Altitude Hold Mode	1		00			0
Altitude Hold Source	1		00			0
Altitude Input Source	2		0000	meters		0
Degraded Mode[1]	1		01			1
Degraded Timeout	1		1E	seconds		30
DR Timeout	1		3C	seconds		60
Track Smooth Mode	1		01			1
Static Navigation	1					
3SV Least Squares	1					
Reserved	4					
DOP MASK Mode[2]	1		04			4
Navigation Elevation Mask	2					
Navigation Power Mask	1					
Reserved	4					
DGPS Source	1					
DGPS Mode[3]	1		00			0
DGPS Timeout	1		1E	seconds		30
Reserved	4					
LP Push-to-Fix	1					
LP On-Time	4					
LP Interval	4					

LP User Tasks Enabled	1					
LP User Task Interval	4					
LP Power Cycling Enabled	1					
LP Max. Acq. Search Time	4					
LP Max. Off Time	4					
Reserved	4					
Reserved	4					

Payload Length: 65 bytes

1. See Table 22.
2. See Table 24.
3. See Table 26.

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.

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 55 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.