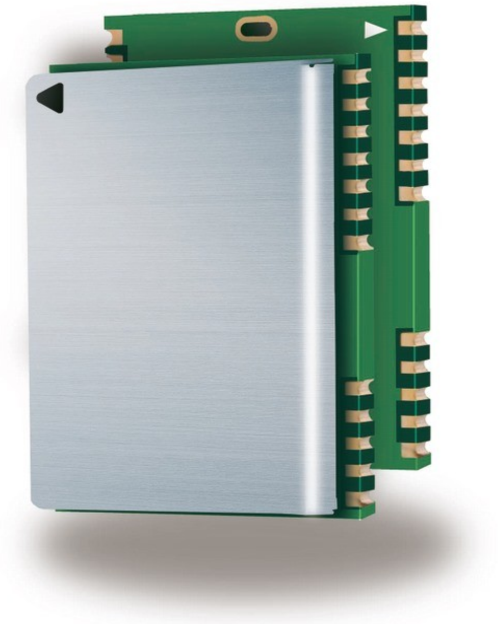
L20

Quectel GPS Engine



GPS Protocol Specification

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0. Revision History

Revision	Date	Author	Description of change
1.0	2010-12-24	Ree ZHANG	Initial
2.0	2013-02-01	Ada LI	1. Added Message ID 125, 136, 195. 2. Modified Message ID 103,104.

1. Introduction

L20, GPS ROM-based module, enables fast acquisition and tracking with the latest SiRF starIV technology. This module provides outstanding GPS performance in a compact form factor and low power consumption. The module supports location, navigation and industrial applications including autonomous GPS C/A, SBAS (WAAS, EGNOS or QZSS), and A-GPS (CGEE function).

This document provides the software information of L20. L20 supports NMEA 0183 standard V3.01 with backward compatibility.

1.1 Reference

Table 1: Reference

SN	Document name	Remark
[1]	L20_Hardware_Design	Hardware design document of L20 module
[2]	L20_EVB_User_Guide	L20 EVB user guide

1.2 Terms and Abbreviations

Table 2: Terms and Abbreviations

Abbreviation	Description
GGA	Global positioning system fix data
GLL	Geographic Position – Latitude/Longitude
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
NMEA	National Marine Electronics Association
OSP	One Socket Protocol
PDOP	Position Dilution of Precision
RMC	Recommended Minimum Specific GNSS Data
SBAS	Satellite-based Augmentation System
QZSS	Quasi-Zenith Satellite System
VDOP	Vertical Dilution of Precision
VTG	Course over Ground and Ground Speed
ZDA	Time and Date

2. NMEA Output/Input Messages

2.1. NMEA Message Structure

L20 supports NMEA 0183 standard V3.01 with backward compatibility. The structure of the NMEA protocol message is given as below:

Table 3: Structure of NMEA message

Field	Length (bytes)	Description
$	1	Each NMEA message starts with '$'
Talker ID	1~2	'GP' for a GPS receiver 'P' for proprietary message
NMEA message ID	3	NMEA message ID
Data Field	Variable, depend on the NMEA message type	Data fields, delimited by comma ','
*	1	End character of data field
Checksum	2	A hexadecimal number calculated by exclusive OR of all characters between '$' and '*'
<CR><LF>	2	Each NMEA message ends with 'CR' and 'LF'

2.2. NMEA Output Message

The default output message of L20 has the following four sentences: RMC, GGA, GSA and GSV[1]. The other NMEA sentences can be chosen to output by sending relevant commands.

*[1].*Output once every five position fix for ***GSV***.

2.2.1 RMC

RMC, Recommended Minimum Specific GNSS Data, is the essential GPS data including position, velocity, course and time. The output depends on the datum selected currently. The default datum is WGS84.

Example: **$GPRMC,083557.942,A,3109.8883,N,12123.4479,E,0.35,133.35,250910,,,A*6E<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
GPRMC		Message ID

UTC time	083557.942	Time in format 'hhmmss.sss'
Fix status	A	'V' = invalid 'A' = Valid
Latitude	3109.8883	Latitude in format 'ddmm.mmmm' (degree and minutes)
N/S Indicator	N	'N' = North 'S' = South
Longitude	12123.4479	Longitude in format 'dddmm.mmmm' (degree and minutes)
E/W Indicator	E	'E' = East 'W' = West
SOG	0.35	Speed over ground in knots
COG	133.35	Course over ground in degree
Date	250910	Date in format 'DDMMYY'
Magnetic variation		Magnetic variation in degree, not being output
E/W		Magnetic variation E/W indicator, not being output
Positioning mode	A	'N' =output data not valid 'A' = Autonomous 'D' = DGPS 'E'=DR 'R'=Coarse Position[1]
*		End character of data field
Checksum	6E	Hexadecimal checksum
<CR><LF>		End of message

[1]. Position was calculated based on the SVs (satellites in view) which have their states derived from almanac parameters, as opposed to ephemeris.

2.2.2. VTG

VTG, course over ground and ground speed.

Example:
$GPVTG,230.02,T,,M,0.30,N,0.6,K,A*0B<CR><LF>

Field	Example	Description
$		Each NMEA message starts with '$'
GPVTG		Message ID
COG(T)	230.02	Course over ground (true) in degree
T	T	Fixed field, true
COG(M)		Course over ground (magnetic), not being output
M	M	Fixed field, magnetic
Speed	0.30	Horizontal Speed over ground in knots

N	N	Fixed field, knots
Speed	0.6	Horizontal Speed over ground in km/h
K	K	Fixed field, km/h
Positioning mode	A	'N' =output data not valid 'A' = Autonomous 'D' = DGPS 'E'=DR 'R'=Coarse Position
*		End character of data field
Checksum	0B	Hexadecimal checksum
<CR><LF>		End of message

2.2.3. GGA

GGA, global positioning system fix data, is the essential fix data which provides 3D location and accuracy data.

Example: **$GPGGA,083056.000,3109.8726,N,12123.4353,E,1,05,2.4,42.5,M,8.0,M,,0000*5E<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
GPGGA		Message ID
UTC time	083056.0000	Time in format 'hhmmss.sss'
Latitude	3109.8726	Latitude in format 'ddmm.mmmm' (degree and minutes)
N/S Indicator	N	'N' = North 'S' = South
Longitude	12123.4353	Longitude in format 'dddmm.mmmm' (degree and minutes)
E/W Indicator	E	'E' = East 'W' = West
Fix status	1	'0' = Fix not available or invalid '1' = GPS fix (SPS) '2' = DGPS fix '3-5'= Not supported '6'= Dead Reckoning Mode, fix valid
Number of SV	05	Number of satellites being used (0 ~ 12)
HDOP	2.4	Horizontal dilution of precision
MSL Altitude	42.5	Altitude in meters according to WGS84 ellipsoid
M	M	Fixed field, meter
GeoID separation	8.0	Geoid-to-ellipsoid separation.

		Ellipsoid altitude = MSL Altitude +GeoID Separation
M	M	Fixed field, meter
DGPS age		Age of DGPS data in second, null when DGPS is not used
Diff.Ref.station ID	0000	DGPS station ID
*		End character of data field
Checksum	5E	Hexadecimal checksum
<CR><LF>		End of message

2.2.4. GSA

GSA, GNSS DOP and Active Satellites, provides details on the fix, including the numbers of the satellites being used and the DOP. At most the first 12 satellite IDs are output.

Example: **$GPGSA,A,3,28,17,08,04,23,,,,,,,9.1,6.1,6.8*33<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
GPGSA		Message ID
Mode 1	A	Auto selection of 2D or 3D fix 'M' = Manual, forced to operate in 2D or 3D mode 'A' = 2D Automatic, Allowed to automatically switch 2D/3D mode
mode 2	3	'1' = No fix '2' = 2D fix '3' = 3D fix
Satellite Used[1]	28	Satellite used on channel 1
Satellite Used	17	Satellite used on channel 2
Satellite Used	08	Satellite used on channel 3
Satellite Used	04	Satellite used on channel 4
Satellite Used	23	Satellite used on channel 5
Satellite Used	..	Satellite used on channel 6
Satellite Used	..	Satellite used on channel 7
Satellite Used	..	Satellite used on channel 8
Satellite Used	..	Satellite used on channel 9
Satellite Used	..	Satellite used on channel 10
Satellite Used	..	Satellite used on channel 11
Satellite Used	..	Satellite used on channel 12
PDOP[2]	9.1	Position dilution of precision
HDOP	6.1	Horizontal dilution of precision

VDOP	6.8	Vertical dilution of precision
*		End character of data field
Checksum	33	Hexadecimal checksum
<CR><LF>		End of message

[1]. Satellite used in solution.

[2]. Maximum DOP value reported is 50. When 50 is reported, the actual DOP may be much larger.

2.2.5. GSV

GSV, GNSS Satellites in View, shows data about the satellites that might be found based on its viewing mask and almanac data. It also shows current ability to track this data. One GSV sentence can only provide data for up to 4 satellites, so 3 sentences might be required for the full information. Since GSV includes satellites that are not used as part of the solution, GSV sentence contains more satellites than GGA does.

Example:
$GPGSV,3,1,10,28,80,286,24,17,44,317,26,08,22,215,24,04,22,240,09*76<CR><LF>
$GPGSV,3,2,10,07,05,188,22,27,04,317,18,20,51,095,,11,45,043,*7B<CR><LF>
$GPGSV,3,3,10,32,36,070,,19,07,088,*74<CR><LF>

Field	**Example**	**Description**
$		Each NMEA message starts with '$'
GPGSV		Message ID
Number of Message	3	Number of messages, total number of GPGSV messages being output (1 ~ 3)
Sequence number	1	Sequence number of this entry (1 ~ 3)
Satellites in View	10	Total satellites in view
Satellite ID 1	28	Satellite ID
Elevation 1	80	Elevation in degree (0 ~ 90)
Azimuth 1	286	Azimuth in degree (0 ~ 359)
SNR 1	24	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
Satellite ID 2	17	Satellite ID
Elevation 2	44	Elevation in degree (0 ~ 90)
Azimuth 2	317	Azimuth in degree (0 ~ 359)
SNR 2	26	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
Satellite ID 3	08	Satellite ID
Elevation 3	22	Elevation in degree (0 ~ 90)
Azimuth 3	215	Azimuth in degree (0 ~ 359)
SNR 3	24	Signal to noise ration in dBHz (0 ~ 99), null

		when not tracking
Satellite ID 4	04	Satellite ID
Elevation 4	22	Elevation in degree (0 ~ 90)
Azimuth 4	240	Azimuth in degree (0 ~ 359)
SNR 4	09	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
*		End character of data field
Checksum	76	Hexadecimal checksum
<CR><LF>		End of message

2.2.6. GLL

GLL, Geographic Latitude and Longitude, contains position information, time of fix position and status. The output of this message is dependent on the currently selected datum. The default datum is WGS84.

Example: **$GPGLL,3109.8874,N,12123.4484,E,083558.944,A,A*54 <CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
GPGLL		Message ID
Latitude	3109.8874	Latitude in format 'ddmm.mmmm' (degree and minutes)
N/S Indicator	N	'N' = North 'S' = South
Longitude	12123.4484	Longitude in format 'dddmm.mmmm' (degree and minutes)
E/W Indicator	E	'E' = East 'W' = West
UTC time	083558.944	Time in format 'hhmmss.sss'
Data valid	A	'V' = invalid 'A' = Valid
Positioning mode	A	'N' =output data not valid 'A' = Autonomous 'D' = DGPS 'E'=DR 'R'=Coarse Position
*		End character of data field
Checksum	54	Hexadecimal checksum
<CR><LF>		End of message

2.2.7. ZDA

ZDA mainly shows the time and date. This message is included only with systems which support a time-mark output pulse identified as “1PPS”. Outputs the time associated with the current 1PPS pulse. Each message is output within a few hundred ms after the 1PPS pulse output and tells the time of the pulse that just occurred.

Example: **$GPZDA,090932.000,25,09,2010,,*5A<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with ‘$’
GPZDA		Message ID
UTC time	090932.000	Time in format ‘hhmmss.sss’
Day	25	Day in format ‘dd’
Month	09	Month in format ‘mm’
Year	2010	Year in format ‘yyyy’
Local zone hours		Local zone hours, not supported, empty
Local zone minutes		Local zone minutes, not supported, empty
*		End character of data field
Checksum	5A	Hexadecimal checksum
<CR><LF>		End of message

2.3. SIRF Proprietary NMEA Input Messages

2.3.1. Message ID 100: Set Serial Port

This command message is used to set the protocol (SiRF binary or NMEA) and/or the communication parameters (Baud rate, data bits, stop bits, and 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 the receiver resumes its work with the saved parameters after a reset. Now，switch to SiRF Binary protocol at 9600,8,1,0.

Example: **$PSRF100,0,9600,8,1,0*0C<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with ‘$’
PSRF		SIRF proprietary message
Message ID	100	100
Protocol	0	0=SiRF binary 1=NMEA

Band Rate	9600	4800 - default setting 9600 19200 38400 57600 115200
DataBits	8	8 only
StopBits	1	1 only
Parity	0	0=None only
*		End character of data field
Checksum	0C	
<CR> <LF>		End of message

2.3.2. Message ID 101: Navigation Initialization

This command can be used to restart the receiver, specify the type of restart. Optionally, it may also initialize position (in X, Y, Z ECEF coordinates), clock drift, GPS Time of Week and GPS Week Number. This action enables the receiver to search for the correct satellite signals with accurate parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

The following command warm start the module with initialization data: ECEF XYZ(-2686727 m, -4304282 m, 3851642 m), Clock Offset (75,000 Hz), Time of Week (86,400 sec), Week Number (924), and Channels (12).

Example: **$PSRF101,-2686727,-4304282,3851642,75000,86400,1311,12,2*20 <CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
PSRF		SIRF proprietary message
Message ID	101	101
ECEF X	-2686727	X coordinate position in meter
ECEF Y	-4304282	Y coordinate position in meter
ECEF Z	3851642	Z coordinate position in meter
Clk drift	75000	Clock Offset of the Evaluation Unit[1]
TimeOfWeek	86400	GPS Time of Week
WeekNo	1311	GPS Week Number
ChannelCount	12	Range 1 to 12
ResetCfg	2	'1'='Hot Start' '2'='Warm Start' '4'='Cold Start'
*		End character of data field

Checksum	20	
<CR> <LF>		End of message

[1].Use 0 for last saved value is available; otherwise, a default value 96250 will be used.

2.3.3. Message ID 103: Set Rate Control

This command is only used to control the output of standard NMEA messages GGA, GLL, GSA, GSV, RMC, and VTG. It also controls the ZDA message in software that supports it. 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 access when the message is applied.

Example: **$PSRF103,00,00,02,01*26<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
PSRF		SIRF proprietary message
Message ID	103	103
Msg	00	Message to control. '0'='GGA' '1'='GLL' '2'='GSA' '3'='GSV' '4'='RMC' '5'='VTG'
Mode	00	'0 '=' Set Rate' '1 '='Query one time' '6 '='5HZ Navigation On' '7 '='5HZ Navigation Off'
Rate	02	Output Rate, 0 = Off 1-255 = seconds between messages
CksumEnable	01	'0'='Disable Checksum' '1'='Enable Checksum'
*		End character of data field
Checksum	26	
<CR> <LF>		End of message

2.3.4. Message ID 104: LLA Navigation Initialization

This command is used to make a restart of the receiver, specify the restart type. Optionally, it may also initialize position (in latitude, longitude, and altitude), clock drift, GPS Time of Week and

GPS Week Number. This action enables the receiver to search for the correct satellite signals with accurate parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

Example: **$PSRF104,-26.86727,-43.04282,0,96000,86400,1311,12,2*27<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
PSRF		SIRF proprietary message
Message ID	104	104
Lat	-26.86727	Latitude + = North (Range 90 to -90)
Lon	-43.04282	Longitude + = East (Range 180 to -180)
Alt	0	Altitude position
Clk drift	96000	Clock Offset of the Evaluation Unit[1]
Time Of Week	86400	GPS Time Of Week
WeekNo	1311	Extended GPS Week Number
ChannelCount	12	Range 1 to 12
ResetCfg	2	'1'='Hot Start' '2'='Warm Start' '4'='Cold Start' '8'='Factory Reset'
*		End character of data field
Checksum	27	
<CR> <LF>		End of message

[1]. Use 0 for last saved value is available. Otherwise, a default value of 96,250 (96000) Hz will be used.

2.3.5. Message ID 125: Poll Software Version String

This message polls the version string when in NMEA mode. The response is PSRF195. If a customer version string is defined, this request will generate two PSRF195, one with the SW Version String, and the second one with the customer-specific version string.

Example: **$PSRF125*21<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
PSRF		SIRF proprietary message
Message ID	125	125
*		End character of data field
Checksum	21	
<CR> <LF>		End of message

2.4. SIRF Proprietary NMEA Output Messages

2.4.1. Message ID 195: Response to Poll Software Version String

This message is the response to the Poll SW version message (PSRF125).

Example: **$PSRF195, GSD4e_4.1.2-P1 R+ 11/15/2011 319*67<CR><LF>**		
Field	**Example**	**Description**
$		Each NMEA message starts with '$'
PSRF		SIRF proprietary message
Message ID	195	195
Version String	GSD4e_4.1.2-P1 R+ 11/15/2011 319	
*		End character of data field
Checksum	67	
<CR> <LF>		End of message

3. SiRF Binary Protocol Specification

3.1. Protocol Layers

SiRF Binary protocol is the standard interface protocol used by the products of SiRF star family. This serial communication protocol is designed to provide:

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

3.1.1 Transport Message

Table 4: Generic Packet Format

Start Sequence	Payload Length	PAYLOAD	Checksum	End Sequence
0xA0[1], 0xA2	2 Bytes (15 bits)	Up to (210 – 1) Bytes	2 Bytes(15 bits)	0xB0, 0xB3

[1].Characters preceded by "0x" denotes a hexadecimal value. 0xA0 equals 160.

3.1.2. 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 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) checksum. The values of the start and stop characters and the choice of a 15-bit value for length and checksum ensure message length and checksum cannot alias with either the stop or start code.

3.1.3. Message Validation

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

3.1.3. Payload Length

The payload length is transmitted with high order byte first and followed by the low byte.

Table 5: Payload Length

High Byte	Low Byte
< 0x7F	Any value

Although the protocol has a maximum length of (215-1) bytes, practical considerations require the SiRF® GPS module implementation to limit this value to a smaller number. The receiving programs (e.g., μ-center) may limit the actual size to something less than this maximum.

3.1.4 Payload Data

The payload data follows the payload length. It contains the number of bytes specified by the payload 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® Binary payloads will use the big-endian order.

3.1.5 Checksum

The checksum is transmitted high order byte first followed by the low byte. This is the so-called big-endian order.

Table 6: Checksum

High Byte	Low Byte
< 0x7F	Any value

The checksum is 15-bit checksum of the bytes in the payload data. The following pseudo code defines the algorithm used.

Enable message to be the array of bytes which will 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 $(2^{15}-1)$
checkSum = checkSum AND $(2^{15}-1)$.

3.2. Input Messages

3.2.1. Message ID 128: Initialize Data Source

This message is used to warm start the GPS module .Warm start the receiver with the following initialization data: ECEF XYZ (-2686727 m, -4304282 m, 3851642 m), Clock Offset (75,000 Hz), Time of Week (86,400 s), Week Number (924), and Channels (12). Raw track data enabled, Debug data enabled.

Example: **A0A2001980FFD700F9FFBE5266003AC57A000124F80083D600039C0C320A90B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0019	25 bytes
Message ID	80	Decimal 128
ECEF X	FFD700F9	X coordinate position
ECEF Y	FFBE5266	Y coordinate position
ECEF Z	003AC57A	Z coordinate position
Clock drift	000124F8	
Time of Week	0083D600	GPS Time Of Week (/100 in scale)
Week Number	039C	Extended week number (0 - no limit)
Channels	0C	Range 1 to 12
Reset Configuration Bit Map	32	'30'='Hot Start' '32'='Warm Start' '34'='Cold Start' '38'='Factory Reset'
Checksum	0A90	
B0B3		End Sequence

Note:
Every reset mode starts up with different ECEF coordinates, clock drift, time of week, week number and channels.

3.2.2. Message ID 129: Switch to NMEA Protocol

This message enables to switch a serial port from binary to NMEA protocol and sets message output rates and bit rate on the port. Request the following NMEA data at 9600 bits per second:
GGA – ON at 1 sec, GLL – OFF, GSA – ON at 1sec,
GSV – ON at 5 sec, RMC – Off, VTG-OFF, ZDA-OFF.

Example: **A0A200188102010100010101050100010001000100000001000012C00164B0B3**

Field	Example(HEX)	Description
A0A2		Start Sequence
Payload Length	0018	24 bytes
Message ID	81	Decimal 129
Mode	02	00= Enable NMEA debug messages 01= Disable NMEA debug messages 02= Do not change last-set value for NMEA debug messages
GGA Message[1]	01	Refer to the NMEA Protocol Reference Manual for format
Checksum[2]	01	Send checksum with GGA message
GLL Message	00	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
GSA Message	01	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
GSV Message	05	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
RMC Message	00	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
VTG Message	00	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
MSS Message	00	Output rate for MSS message
Checksum	01	
EPE Message	00	
Checksum	00	
ZDA Message	00	Refer to the NMEA Protocol Reference Manual for format
Checksum	01	
Unused Field	00	
Unused Field	00	
Bit Rate	12C0	4800, 9600, 19200, 38400 and 57600
Checksum	0164	
B0B3		End Sequence

[1]. A value of 0x00 implies not to send the message. Otherwise, data is sent at 1 message every X seconds requested (e.g., to request a message to be sent every 5 seconds, request the message using a value of 0x05). The maximum rate is 1/255 sec.

[2]. A value of 0x00 implies the checksum is not transmitted with the message (not recommended). A value of 0x01 has a checksum calculated and transmitted as part of the

message (recommended).

3.2.3 Message ID 132: Poll Software Version

This message enables to obtain software version information.

Example: **A0A2000284000084B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0002	2 bytes
Message ID	84	Decimal 132
Control	00	
Checksum	0084	
B0B3		End Sequence

3.2.4. Message ID 133: DGPS Source

It allows the user to select the source for Differential GPS (DGPS) corrections. Options available are:

Satellite Based Augmentation System (SBAS) – subject to SBAS satellite availability

Internal DGPS beacon receiver (supported only on specific GPS receiver hardware)

Example: **A0A20007850100000000000086B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0007	7 bytes
Message ID	85	Decimal 133
DGPS Source	01	0= None, DGPS corrections are not used (even if available) 1= SBAS, uses SBAS satellite (subject to availability) 3= Internal DGPS Beacon Receiver, Internal DGPS beacon receiver 4= User Software, corrections provided using a module interface routine in a custom user application
Internal Beacon Frequency	00000000	Not used
Internal Beacon Bit Rate	00	Not used

Checksum	0086	
B0B3		End Sequence

3.2.5. Message ID 136: Mode Control

Set up the navigation operations. It controls use of fewer than four satellites, and enables or disables the track smoothing and navigation features. Using fewer than four satellites results in what is commonly called a '2-D' fix. Four or more satellites allow a '3-D' fix.

Example: **A0A2000E880000001000000000000000000000098B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	000E	14bytes
Message ID	88	Decimal 136
Reserved	0000	Reserved
Reserved	00	Reserved
Position Calc Mode	10	'04'= 5 Hz Navigation enabled '08'= SBAS Ranging enabled '10'= Fast time Sync
Reserved	00	Reserved
Altitude	0000	User-specified altitude for Altitude Hold Mode, range -1000 to 10,000
Alt Hold Mode	00	'00'=Automatically determine best available altitude to use '02'= Always use user-input altitude '04'= Do not use altitude hold – Forces all fixes to be 3-D fixes
Alt Hold Source	00	'00'= Use last computed altitude '01' = Use user-input altitude
Reserved	00	Reserved
Reserved	00	Reserved
Reserved	00	Reserved
Measurement and Track Smoothing	00	Bit Field Description 0 Track Smoothing, 1 = enable 1 Measurements, 0 = Raw, 1 = smoothed 2 Software Tracking Loops 0 = enable [4:3] Channel Usage[1] 0 0 Acq & Nav: Full 0 1 Acq: Limited, Nav: Full 1 0 Acq: Full, Nav: Limited

		1 1 Acq & Nav: Limited [7:5] Reserved
Checksum	0098	
B0B3		End Sequence

[1]. Channel Usage provides a means to control power used during acquisition (Acq) and tracking (Nav). Full uses all resources available and the most power. Limited uses less power and restricts usage to the minimum necessary to find satellites.

3.2.6. Message ID 138: DGPS Control

The message enables to control how the receiver uses differential GPS (DGPS) corrections. As follow, it's the example that setting DGPS to exclusive with a time out of 30 seconds.

Example: **A0A200038A011E00A9B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0003	3 bytes
Message ID	8A	Decimal 138
DGPS Selection	01	00=Auto, use corrections when available 01= Exclusive, include in navigation solution only SVs with corrections 02= Never Use, ignore corrections
DGPS Time Out	1E	Range 0 to 255
Checksum	00A9	
B0B3		End Sequence

Note :
DGPS Timeout interpretation varies with DGPS correction source. For an internal beacon receiver, a value of 0 means infinite timeout (use corrections until another one is available). A value of 1 to 255 means use the corrections for a maximum of this many seconds.

3.2.7. Message ID 146: Poll Almanac

The message enables to Poll for the almanac.

Example: **A0A2000292000092B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0002	2 bytes
Message ID	92	Decimal 146

Control	00	Not used
Checksum	0092	
B0B3		End Sequence

3.2.8. Message ID 147: Poll Ephemeris

The message enables to Poll for Ephemeris Data for all satellites.

Example: A0A200039300000092B0B3		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0003	3 bytes
Message ID	93	Decimal 147
Sv ID[1]	00	Range 0 to 32
Control	00	Not used
Checksum	0092	
B0B3		End Sequence

[1]. A value of zero requests all available ephemeris records. This results in a maximum of twelve output messages. A value of 1 through 32 requests only the ephemeris of that SV.

3.2.9. Message ID 170: Set SBAS Parameters

This message allows the user to set the SBAS parameters. Then, we can set WAAS Regional Search Mode in the following format.

Example: A0A20006AA020001027A0129B0B3		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0006	6 bytes
Message ID	AA	Decimal 170
Select Regional Search Mode	02	00=Auto Mode 02= WAAS Mode
SBAS Mode	00	00= Testing 01= Integrity
Flag Bits	01	If Bit 0 = 1, user-specified timeout from Message ID 138 is used. If Bit 0 = 0, timeout specified by the SBAS satellite is used (this is usually 18 seconds). If Bit 3 = 1, the SBAS PRN specified in the SBAS PRN field is used. If Bit 3 = 0, the system

		searches for any SBAS PRN.
region[1]	02	Used to assign a PRN to a defined region. 0 means this feature is not being updated by this message. 2-5 designates one of the defined regions/systems.
regionPRN	7A	When region field is non-zero, this field specifies the PRN to assign to the region designated in region field.
Checksum	0129	
B0B3		End Sequence

[1].Region designations are only supported in a GSW3 version to be designated. Current releases only allow auto mode and PRN in the SBAS field, and do not recognize region and region PRN fields.

3.3. Output Message

3.3.1. Message ID 2: Measure Navigation Data Out

The output message, the rate of which is 1 Hz, measure navigation data.

Example:
A0A2002902FFD6F78CFFBE536E003AC004000000030001040A00036B039780E3 0612190E160F0400000000000009BBB0B3

Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0029	41 bytes
Message ID	02	Decimal 2
ECEF X	FFD6F78C	X coordinate position
ECEF Y	FFBE536E	Y coordinate position
ECEF Z	003AC004	Z coordinate position
X-velocity	0000	velocity in meter per second
Y-velocity	0003	velocity in meter per second
Z-velocity	0001	velocity in meter per second
Mode	04	'0-2'=' PMODE' '3'=' TPMODE' '4-5'='ALTMODE' '6'='DOP-MASK' '7'='DGPS'
HDOP[1]	0A	Horizontal dilution of precision
Mode	00	Bit Mapped byte information
GPS Week[2]	036B	

GPS TOW	039780E3	GPS time of week 602605.79
SVs ID	06	Satellite in Fix
CH 1 PRN[3]	12	18
CH 2 PRN	19	25
CH 3 PRN	0E	14
CH 4 PRN	16	22
CH 5 PRN	0F	15
CH 6 PRN	04	4
CH 7 PRN	00	0
CH 8 PRN	00	0
CH 9 PRN	00	0
CH 10 PRN	00	0
CH 11 PRN	00	0
CH 12 PRN	00	0
Checksum	09BB	0
B0B3		End Sequence

[1]. HDOP value reported has a maximum value of 50.

[2]. GPS week reports only the ten LSBs of the actual week number.

[3]. PRN values are reported only for satellites used in the navigation solution.

3.3.2. Message ID 4: Measured Tracker Data Out

The output message, the rate of which is 1 Hz, turns measured tracker data out.

Example:

A0A200BC040242032367E00C03959C00BF1B1B1B1B1B1A1A1A1A1A17AE5F00BF1C1
C1C1C1C1C1C1C1B1B138B5600AD161616161616161616150DC84700BD1A1A1A1A1A1
A1919191907D00A00AD10100F0F0F0F0F0F0F062EA5000000000000000000000000101
6630000000000000000000000001F513500000000000000000000000019D3320000000000000
00000000000186A1C00000000000000000000000015261A0000000000000000000000000000
000000000000000000000000001349B0B3

Field	Example(HEX)	Description
A0A2		Start Sequence
Payload Length	00BC	188 bytes
Message ID	04	Decimal 4
GPS Week[1]	0242	876
GPS TOW	032367E0	GPS time of week
Channels	0C	12
1st SVid	03	Satellite in Fix
Azimuth	95	Azimuth in degree (0 ~ 359)
Elev	9C	Elevation in degree (0 ~ 90)

State	00BF	State values for each channel
C/N0 1	1B	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 2	1B	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 3	1B	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 4	1B	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 5	1B	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 6	1A	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 7	1A	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 8	1A	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 9	1A	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
C/N0 10	1A	Signal to noise ration in dBHz (0 ~ 99), null when not tracking
2nd SVid	17	
Azimuth	AE	
Elev	5F	
State	00BF	
C/N0 1	1C	
C/N0 2	1C	
…		
SVid, Azimuth, Elevation, State, and C/N0 1-10 values are repeated for each of the 12 channels		
Checksum	1349	
B0B3		End Sequence

[1]. ***GPS week number is reported modulo 1024 (ten LSBs only).***

3.3.3. Message ID 7: Response: Clock Status Data

This message is output as part of each navigation solutions. It provides the actual time of the measurement (in GPS time), and gives the computed clock bias and drift information calculated by the navigation software. It is unique to control this message. This message will be enabled or disabled according to the condition that navigation library messages are enabled or disabled. It is also enabled by default whenever a system reset occurs.

Output Rate: 1 Hz or response to polling message

Example: **A0A200140703BD0215492408000122310000472814D4DAEF0598B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0014	20 bytes
Message ID	07	Decimal 7
Extended GPS Week	03BD	957
GPS TOW	02154924	GPS time of week
SVs	08	Satellite in Fix
Clock Drift	00012231	Clock Offset of the Evaluation Unit
Clock Bias	00004728	
Estimated GPS Time	14D4DAEF	
Checksum	0598	
B0B3		End Sequence

3.3.4. Message ID 9: CPU Throughput

The output message, with the rate 1 Hz, shows CPU throughput data.

Example: **A0A2000909003B0011001601E50151B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0009	9 bytes
Message ID	09	Decimal 9
SegStatMax	003B	
SegStatLat	0011	
AveTrkTime	0016	
Last Millisecond	01E5	
Checksum	0151	
B0B3		End Sequence

3.3.5. Message ID 10: Error ID Data

Output Rate: As errors occur

Message ID 10 messages have a different format from other messages. Rather than one fixed format, there are several formats, each designated by an error ID. However, there is also standard format which is indicated in the following table.

Field	**Description**
A0A2	Start Sequence

Payload Length	
Message ID	Decimal 10
Error ID	Sub-message type
Count	Count of number of 4-byte values that follow
Data[n]	Actual data for the message, n is equal to Count
Checksum	
B0B3	End Sequence

3.3.6. Message ID 11: Command Acknowledgment

This message is sent in response to messages accepted by the receiver. If the message being acknowledged requests data from the receiver, the data will be sent first, then this acknowledgment.

Output Rate: Response to successful input message

A successful almanac request (Message ID 0x92) example is given as below:

Example: **A0A200020B92009DB0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0002	2 bytes
Message ID	0B	Decimal 11
ACK ID	92	Message ID 146
Checksum	009D	
B0B3		End Sequence

3.3.7. Message ID 12: Command Negative Acknowledgment

This message is sent when an input command to the receiver is rejected. Possible reasons are: the input message failed checksum, contained an argument that was out of the acceptable range, or the receiver was unable to comply with the message for some technical reason.

Output Rate: Response to rejected input message

An unsuccessful almanac request (Message ID 0x92) example is indicated as below:

Example: **A0A200020C92009EB0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence

Payload Length	0002	2 bytes
Message ID	0C	Decimal 12
ACK ID	92	Message ID 146
Checksum	009E	
B0B3		End Sequence

3.3.8. Message ID 41: Geodetic Navigation Data

The output message shows geodetic navigation data. The feature of output Rate: Every measurement cycle (full power / continuous: 1 Hz).

Example: **A0A2005B290000020406421F620EC007DA0919020F138800441044129353934853AB774000** **01403000010E215005E17F500000000000000007C7000000F90000000000002DA0FE36000** **00000001C0C050000000000000000000000000510000DF7B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	005B	91 bytes
Message ID	29	decimal 41
Nav Valid	0000	0x0000 = valid navigation
NAV Type	0204	Bits 2 – 0 : GPS position fix type 000 = no navigation fix 001 = 1-SV KF solution 010 = 2-SV KF solution 011 = 3-SV KF solution 100 = 4 or more SV KF solution 101 = 2-D least-squares solution 110 = 3-D least-squares solution 111 = DR solution (see bits 8, 14-15) Bit 3 : TricklePower in use Bits 5 – 4 : altitude hold status 00 = no altitude hold applied 01 = holding of altitude from KF 10 = holding of altitude from user input 11 = always hold altitude (from user input) Bit 6 ON : DOP limits exceeded Bit 7 ON : DGPS corrections applied 1 = sensor DR 0 = velocity DR2 if Bits 0 – 2 = 111; else check Bits 14-15 for DR error status Bit 9 ON : navigation solution overdetermined1

		Bit 10 ON : velocity DR2 timeout exceeded Bit 11 ON : fix has been edited by MI functions Bit 12 ON : invalid velocity Bit 13 ON : altitude hold disabled 00 = GPS-only navigation 01 = DR calibration from GPS 10 = DR sensor error 11 = DR in test
Extended Week Number	0642	GPS week number; week 0 started January 6 1980. This value is extended beyond the 10-bit value reported by the SVs.
TOW	1F620EC0	GPS time of week in seconds x 10^3
UTC Year	07DA	UTC time and date. Seconds reported as integer milliseconds only
UTC Month	09	00BF
UTC Day	19	1B
UTC Hour	02	1B
UTC Minute	0F	1B
UTC Second	1388	1B
Satellite ID List	00441044	Bit map of SVs used in solution. Bit 0 = SV 1, Bit 31 = SV 32. A bit set ON means the corresponding SV was used in the solution
Latitude	12935393	In degrees (+ = North) x 10^7
Longitude	485AB774	In degrees (+ = East) x 10^7
Altitude from Ellipsoid	00001403	In meters x 10^2
Altitude from MSL	000010E2	In meters x 10^2
Map Datum	15	See footnote
Speed Over Ground (SOG)	005E	In m/s x 10^2
Course Over Ground (COG, True)	17F5	In degrees clockwise from true north x 10^2
Magnetic Variation	0000	Not implemented
Climb Rate	0000	In m/s x 10^2
Heading Rate	0000	deg/s x 10^2
Estimated Horizontal Position Error	000007C7	EHPE in meters x 10^2
Estimated Vertical Position Error	000000F9	EVPE in meters x 10^2
Estimated Time Error	00000000	ETE in seconds x 10^2
Estimated Horizontal Velocity Error	0000	EHVE in m/s x 10^2

Clock Bias	2DA0FE36	In m x 10^2
Clock Bias Error	00000000	In meters x 10^2
Clock Drift	001C0C05	In m/s x 10^2
Clock Drift Error	00000000	In m/s x 10^2
Distance[1]	00000000	Distance traveled since reset in meters
Distance error[2]	0000	In meters
Heading Error	0000	In degrees x 10^2
Number of SVs in Fix	05	Count of SVs indicated by SV ID list
HDOP	10	Horizontal Dilution of Precision x 5 (0.2 resolution)
AdditionalModeInfo	00	Additional mode information: Bit 0: Map matching mode for Map Matching only 0 = Map matching feedback input is disabled 1 = Map matching feedback input is enabled Bit 1: Map matching feedback received for Map Matching only 0 = Map matching feedback was not received 1 = Map matching feedback was received Bit 2: Map matching in use for Map Matching only 0 = Map matching feedback was not used to calculate position 1 = Map matching feedback was used to calculate position Bit 7: DR direction 0 = Forward 1 = Reserve
Checksum	0D57	
B0B3		End Sequence

Note:

[1] and [2]: At present, the two parameters are not supported.

3.3.9. Message ID 50: SBAS Parameters

This message can be used to output SBAS operating parameter information including SBAS PRN, mode, timeout, timeout source, and SBAS health status.

Output Rate: Every measurement cycle (full power / continuous: 1Hz)

Example: **A0A2000D327A00120800000000000000000C6B0B3**

Field	Example(HEX)	Description
A0A2		Start Sequence
Payload Length	000D	13 bytes
Message ID	32	Decimal 50
SBAS PRN	7A	0 = Auto mod SBAS PRN 120-138 = Exclusive (set by user)
SBAS Mode	00	0 = Testing 1 = Integrity
DGPS Timeout	12	Range 0-255 seconds. 0 returns to default timeout.1-255 is value set by user.
Flag bits	08	Bit 0: Timeout; 0 = Default 1 = User Bit 1: Health; 0 = SBAS is healthy 1 = SBAS reported unhealthy and can't be used Bit 2: Correction; 0 = Corrections are being received and used 1 = Corrections are not being used because: the SBAS is unhealthy, they have not yet been received, or SBAS is currently disabled in the receiver Bit 3: SBAS PRN; 0 = Default 1 = User Note: Bits 1 and 2 are only implemented in GSW3 and GSWLT3, versions 3.3 and later
Spare	0000000000000000	These bytes are currently unused and should be ignored.
Checksum	00C6	
B0B3		End Sequence

3.3.10. Message ID 52: 1 PPS Time

Output time associated with current 1 PPS pulse. Each message is output within a few hundred ms after the 1 PPS pulse is output and tells the time of the pulse that just occurred. The Message ID 52 reports the UTC time of the 1 PPS pulse when it has a current status message from the satellites. If it does not have a valid status message, it reports time in GPS time, and so indicates by means of the status field.

Output Rate: 1 Hz (Synchronized to PPS)

Example: **A0A200133415122A0E0A07D3000D000000050700000000190B0B3**		
Field	**Example(HEX)**	**Description**
A0A2		Start Sequence
Payload Length	0013	19 bytes
Message ID	34	Decimal 52

Hour	15	21
Minute	12	18
Second	2A	42
Day	0E	15
Month	0A	10
Year	07D3	2003
UTCOffsetInt[1]	000D	13
UTCOffsetFrac[1]	00000005	$0.000000005*10^9$ in scale
Status	07	0= When set, bit indicates that time is valid 1= When set, bit indicates that UTC time is reported in this message. Otherwise, GPS time 2= When set, bit indicates that UTC to GPS time information is current, (i.e., IONO/UTC time is less than 2 weeks old) 3-7= Reserved
Reserved	00000000	00000000
Checksum	0190	
B0B3		End Sequence

[1]. Difference between UTC and GPS time, integer, and fractional parts. GPS time = UTC time + UTCOffsetInt + UTCOffsetFrac x 10^{-9}**.**

Note:

Only when a specific patch is loaded from the external EEPROM, the function mentioned will be enabled. Furthermore, the new version of firmware, ROM 2.0, will be released by SIRF in the second quarter, 2011. The new one will support the pin definition mentioned above.

4. Default Settings

Table 7: Default Settings

Item	Default
NMEA port baud rate	4800bps
OSP port baud rate	115200bps
Datum	WGS84
Rate of position fixing	1Hz
SBAS enable	Disable
NMEA output rate message	Output once every one position fix for RMC, GGA, GSA, Output once every five position fix for GSV

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