SPK ELECTRONICS CO., LTD.

Data Sheet / SPK-GGSM-072

Easy to Use,

Compact,

High Performance,

GNSS

Smart Antenna Module

RoHS
Compliant

Version 1.1

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1 Introduction

1.1 Overview

SPK-GGSM-072 is a thin, compact, low-power, ultra-high performance, easy to use GNSS smart antenna module designed with u-blox's latest 7th generation single chip.

This feature rich GPS module not only shortens the design efforts but also provides powerful functions. The compact design allows fast adoption and high yield production.

The power control feature is very convenient to turn on/off power just via GPIO control pin. It's especially useful to turn off power as the GPS function is not needed in the host applications.

SPK- GGSM-072 supports either GPS/QZSS or GLONASS. It default works with GPS and QZSS.

1.2 Main Features

Not only handheld but also any other GPS applications can share the following major features of SPK-GGSM-072.

- Easy adoption with best performance
- Built-in 18.2x18.2x4 (mm) patch antenna [Option of 18x18x4 (mm) patch available]
- Backup power input for faster position fix
- USB/UART-TTL interface support
- Minimum RF and EMI efforts, excellent EMI protection
- Time pulse support option for timing application
- Fully implementation of ultra-high performance u-blox7 single chip architecture
- High tracking sensitivity of -162 dBm/-148dBm acquisition (GPS)
- Low power consumption of 40mA for average tracking
- Hardware power saving control pin option allowing power on/off GPS via GPIO
- Windows location sensor support
- OMA SUPL compliant A-GPS support
- GNSS support : either GPS/QZSS (default) or GLONASS
- Up to 10Hz update rate (default 1Hz)
- SBAS (WAAS, EGNOS, MSAS) support

1.3 Receiver Specifications

Features	Specifications[1]
GPS/QZSS receiver type	56-channel u-blox 7 engine GPS & QZSS:L1 C/A,1575.42MHz, GLONASS:L1OF,1598.0625~1605.375MHz SBAS: WAAS, EGNOS, MSAS, L1 frequency, C/A code
Horizontal Position Accuracy	Autonomous:2.5m (GPS), 4m (GLONASS) SBAS: 2.0m (GPS) (CEP, 50%, 24hr static, -130dBm, 6+ SVs)
Velocity Accuracy	<0.1 m/s (speed) <0.5° (heading) (50%@30m/s)
Accuracy of Time pulse Signal	RMS: 30ns (GPS), 50ns (GLONASS) 99%: 60ns (GPS), 100ns (GLONASS)
TTFF (Time to First Fix) (50%, -130dBm, autonomous)	Hot Start: 1sec (GPS), 1sec (GLONASS) Warm Start: 28sec (GPS), 25sec (GLONASS) Cold Start: 29sec (GPS), 30 sec (GLONASS)
Sensitivity dBm (Autonomous)	Acquisition: -148 (GPS), -140 (GLONASS) Tracking: -162 (GPS), -158 (GLONASS)
Measurement data output	NMEA output protocol: Ver. 2.3 (compatible to 3.0) UART baud rate: 9600 bps, (N-8-1) Datum: WGS-84 Default: GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, GPTXT
Navigation. Update Rate	Default 1Hz, Max. 10Hz by enabling command
Max. Altitude	< 50,000 m
Max. Velocity	< 1,852 km/hr or 515m/s
SBAS Support	WAAS, EGNOS, MSAS
Dynamics	< 4g
Power consumption	40 mA / average tracking (9 SVs) 13.5uA / backup power (module disabled)
Power supply	3.1 ~ 5.5 V (TTL); 4.75~5.25V (USB)
Dimension	20 (W) x 20 (L) x 6.5 (H) (mm) with default antenna 20 (W) x 20 (L) x 6.76 (H) (mm) with optional antenna
Operating temperature	-40℃ ~ +85℃
Storage temperature	-40℃ ~ +85℃

[1]Note: Data is from chip vendor.

1.4 Protocols

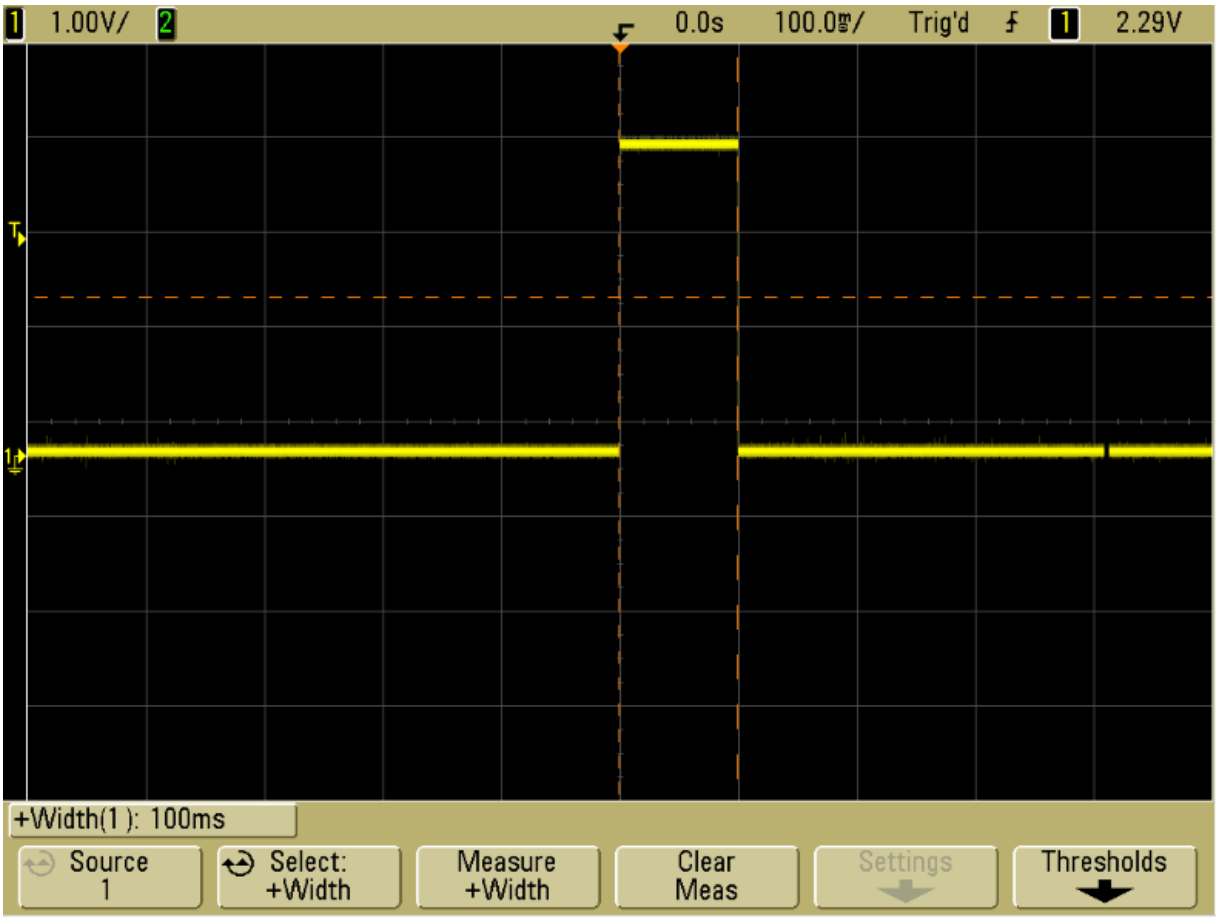
The NMEA protocol is supported via serial UART (RX/TX) or USB (DM/DP) I/O port. The default supported protocol is NMEA protocol.

1. Serial communication channel – UART
    i. No parity, 8-data bit, 1-stop bit (N-8-1)
    ii. 9600 bps.
2. NMEA 0183 Version 2.3 ASCII output
    i. Default GPGGA, GPGSA, GPGSV, GPGLL, GPRMC, GPVTG and GPTXT

1.5 1PPS

The GPS 1PPS is a time pulse delivered at the top of each GPS second with accuracy of 30ns (RMS) or 60ns (99%). This signal allows devices all over the world to be accurately synchronized to a common time base.

SPK-GGSM-072A/S SPK-GGSM-072U provides 1PPS on pin 6 of the 6-pin wire to board connector. The default pulse width is 100ms as shown below.



Leap second – Due to the synchronization between atomic clocks and earth rotation, there is leap second adjustments every a few years. Such kind of adjustment would be calibrated before chip release. There might be multiple leap second adjustments after chip release. The chip will adjust such kind of leap seconds after it acquires accurate clock and leap second information.

To know if leap second has been calibrated, one can send following binary command to query.

B5 62 01 20 00 00 21 64

The chip will return binary message similar to following two.

B5 62 01 20 10 00 80 09 47 07 87 6A 06 00 22 07 0F 03 0C 00 00 00 46 50
B5 62 01 20 10 00 60 DB 56 07 AC 5F FF FF 22 07 10 07 09 00 00 00 18 45

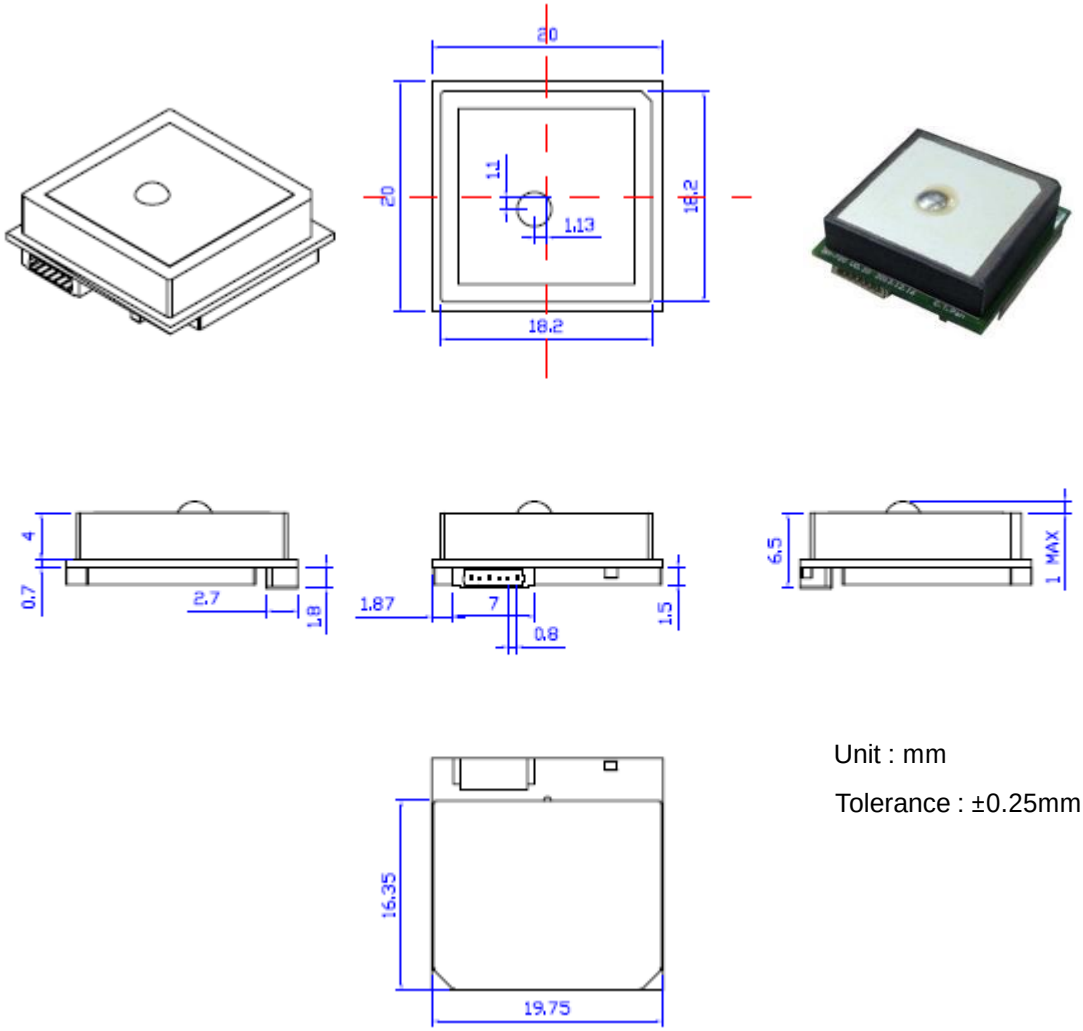
Check the value of byte 18 which is marked in red, if the value is 07, the GPS time is correct. Otherwise (e.g. 3, 1, 0), the GPS time is still not correct.

2 Hardware Interface

2.1 Module Dimension

SPK-GGSM-072 is 20 mm (W) x 20 mm (L) x 6.5 mm (H) with 18.2x18.2x4 (mm) patch antenna. [Antenna option of dimension 18x18x4.26 (mm) is available]

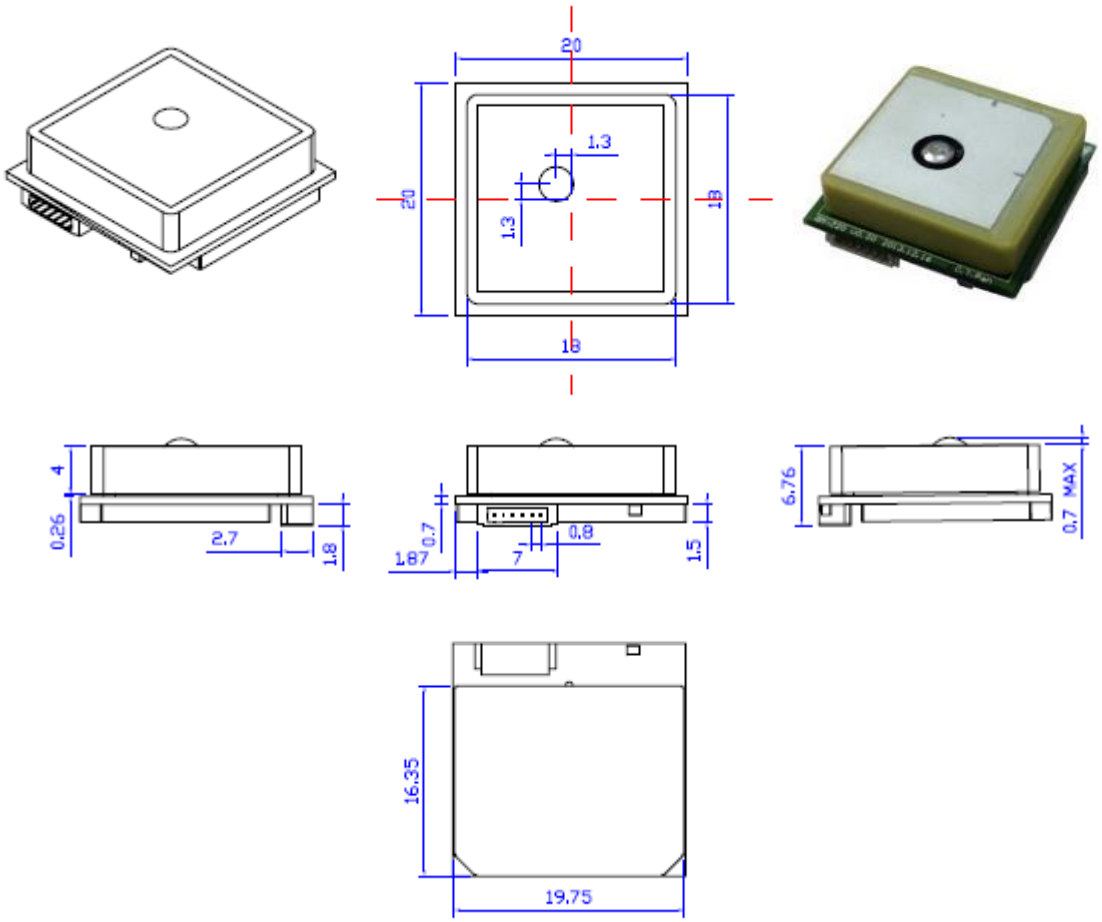
Mechanical Data – 20 x 20 x 6.5 (mm) (with default 18.2x18.2x4 patch antenna)



Unit : mm

Tolerance : ±0.25mm

Mechanical Data – 20 x 20 x 6.76 (mm) (with optional 18x18x4.26 patch antenna)

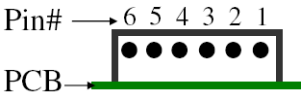


Application

There is an additional pad at the right of the 6-pin header. This pad is reserved for reducing potential electromagnetic noise. For that case, a shielded ground cable would be suggested to connect to motherboard depending on the noise condition.

2.2 Pin Assignment

6-pin Interface, pitch 0.8mm



SPK-GGSM-072A/U

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TXD/D+	TTL level serial data output (from GPS) / USB positive	Output / I/O
4	RXD/D-	TTL level serial data input (to GPS) /	Input /

		USB negative	I/O
5	V_BAT	Backup power	Input
6	1PPS	Time Pulse Per Second	Output

SPK-GGSM-072B/V

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TXD/D+	TTL level serial data output (from GPS) / USB positive	Output / I/O
4	RXD/D-	TTL level serial data input (to GPS) / USB negative	Input / I/O
5	V_BAT	Backup power	Input
6	PWR_CTRL	Power control; floating or high : ON Low: OFF	Input

SPK-GGSM-072N

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TXD	TTL level serial data output (from GPS)	Output
4	RXD	TTL level serial data input (to GPS)	Input
5	1PPS	Time Pulse Per Second	Output
6	V_BAT	Backup power	Input

Power Saving

SPK-GGSM-072B/V supports the power saving mechanism. To control the power of SPK-GGSM-072B/V, connect the **PWR_CTRL** pin to a GPIO pin of a micro-processor. To cut off the power of SPK-GGSM-072B/V (VCC is always connected to power source), just pull the PWR_CTRL pin low (in this case, SPK-GGSM-072B/V only keeps power of RTC and RAM). During normal run, pull it high or leave it floating (in this case, SPK-GGSM-072B/V is fully powered).

3 Software Interface

SPK-GGSM-072 supports both NMEA text messages and UBX binary messages. For the UBX binary messages, please refer to u-blox Receiver Description Protocol Spec. In this section, the NMEA output messages are discussed.

3.1 NMEA Output Messages

To distinguish GLONASS fix from GPS fix, new talker ID (GL) is used.

- Talker ID is 'GP' if worked in GPS mode
- Talker ID is 'GL' if worked in GLONASS mode

The NMEA-0183 Output Messages are shown as below:

NMEA Record	Descriptions
GPGGA	Global positioning system fixed data: time, position, fixed type
GPGLL	Geographic position: latitude, longitude, UTC time of position fix and status
GPGSA	GPS receiver operating mode, active satellites, and DOP values
GPGSV	GNSS satellites in view: ID number, elevation, azimuth, and SNR values
GPRMC	Recommended minimum specific GNSS data: time, date, position, course, speed
GPVTG	Course over ground and ground speed
GPTXT	u-blox message

The SPK-GGSM-072 adopts interface protocol of National Marine Electronics Association's NMEA-0183 Version 2.3 interface specification. SPK-GGSM-072 supports 7 types of NMEA sentences (GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, and GPTXT).

The default output sentences are GPGGA, GPGSA, GPGSV, GPRMC, GPVTG and GPGLL. The default UART communication parameters are 9600 bps, 8 data bits, 1 stop bit, and no parity. Other baud rate and related configurations could be requested based on MOQ.

GPS message examples:

$GPRMC,065500.00,A,2447.65027,N,12100.78318,E,15.869,189.32,051109,,,D*57

$GPVTG,189.32,T,,M,15.869,N,29.405,K,D*30

$GPGGA,065500.00,2447.65027,N,12100.78318,E,2,12,0.91,69.8,M,16.3,M,,*65

$GPGSA,A,3,20,02,23,13,50,42,04,11,17,28,32,08,1.53,0.91,1.22*0D

$GPGSV,4,1,13,02,10,252,26,04,39,268,40,08,09,197,41,11,17,058,32*7B

$GPGSV,4,2,13,13,06,144,23,17,50,345,43,20,45,056,44,23,11,109,37*72

$GPGSV,4,3,13,27,02,301,,28,73,194,39,32,20,043,38,42,54,140,34*7B

$GPGSV,4,4,13,50,51,133,33*4B

$GPGLL,2447.65027,N,12100.78318,E,065500.00,A,D*6E

$GPTXT,01,01,02,u-blox ag - www.u-blox.com*50

GLONASS message examples:

$GLRMC,031809.00,V,,,,,,,050913,,,N*6C

$GLVTG,,,,,,,,,N*2C

$GLGGA,031809.00,,,,,0,04,1.76,,,,,,*4D

$GLGSA,A,1,81,79,77,82,,,,,,,,,4.23,1.76,3.84*1B

$GLGSV,2,1,06,77,26,149,33,78,79,127,,79,39,336,32,81,59,299,35*6F

$GLGSV,2,2,06,82,23,242,33,88,33,020,*6E

$GLGLL,,,,,031809.00,V,N*55

$GLRMC,031810.00,A,2446.42259,N,12100.44836,E,0.265,,050913,,,A*6B

$GLVTG,,T,,M,0.265,N,0.491,K,A*32

$GLGGA,031810.00,2446.42259,N,12100.44836,E,1,05,1.29,133.2,M,16.3,M,,*40

$GLGSA,A,3,81,79,88,77,82,,,,,,,,3.50,1.29,3.26*18

$GLGSV,2,1,06,77,26,149,34,78,79,127,26,79,39,336,33,81,59,299,35*6D

$GLGSV,2,2,06,82,23,242,33,88,33,020,28*64

$GLGLL,2446.42259,N,12100.44836,E,031810.00,A,A*7D

3.2 GPGGA - Global Positioning System Fix Data

- Example

  $GPGGA,065500.00,2447.65027,N,12100.78318,E,2,12,0.91,69.8,M,16.3,M,,*65

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGGA		GGA protocol header
UTC Time	065500.00		hhmmss.ss hh: hour, mm: minute, ss: second
Latitude	2447.65027		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.78318		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Position Fix Indicator	2		0: Fix not available or invalid, 1: GPS SPS Mode, fix valid, 2: Differential GPS, SPS Mode, fix valid, 3~5: Not supported, 6: Dead Reckoning Mode, fix valid

Satellites Used	12		Number of satellites used in positioning calculation (0 to 12)
HDOP	0.91		Horizontal Dilution of Precision
MSL Altitude	69.8	meters	
Unit	M		Meters
Geoidal separation	16.3	meters	
Units	M		Meters
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			
checksum	*65		
<CR><LF>			End of sentence

3.3 GPGLL - Geographic Position - Latitude / Longitude

- Example

  $GPGLL,2447.65027,N,12100.78318,E,065500.00,A,D*6E

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGLL		GLL protocol header
Latitude	2447.65027		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.78318		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
UTC Time	065500.00		hhmmss.ss hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Mode Indicator	D		A: Autonomous, D: DGPS, E: DR
checksum	*6E		
<CR><LF>			End of sentence

3.4 GPGSA - GNSS DOP and Active Satellites

- Example

  $GPGSA,A,3,20,02,23,13,50,42,04,11,17,28,32,08,1.53,0.91,1.22*0D

- Explanation

Contents	Example	Explanation
Message ID	$GPGSA	GSA protocol header
Mode 1	A	M: Manual—forced to operate in 2D or 3D mode A: 2D Automatic—allowed to automatically switch 2D/3D
Mode 2	3	1: Fix not available 2: 2D (<= 4 Satellites used) 3: 3D (>= 4 Satellites used)
Satellite used in solution	20	Satellite on Channel 1
Satellite used in solution	02	Satellite on Channel 2
…		Display of quantity used (12 max) If less than 12 SVs are used for navigation, the remaining fields are left

		empty. If more than 12 SVs are used for navigation, only the IDs of the first 12 are output.
PDOP	1.53	Position Dilution of Precision
HDOP	0.91	Horizontal Dilution of Precision
VDOP	1.22	Vertical Dilution of Precision
checksum	*0D	
<CR><LF>		End of sentence

3.5 GPGSV - GNSS Satellites in View

- Example

  $GPGSV,4,1,13,02,10,252,26,04,39,268,40,08,09,197,41,11,17,058,32*7B

  $GPGSV,4,2,13,13,06,144,23,17,50,345,43,20,45,056,44,23,11,109,37*72

  $GPGSV,4,3,13,27,02,301,,28,73,194,39,32,20,043,38,42,54,140,34*7B

  $GPGSV,4,4,13,50,51,133,33*4B

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGSV		GSV protocol header
Number of messages	4		Range 1 to 4
Message number	1		Range 1 to 4
Satellites in view	13		Number of satellites visible from receiver
Satellite ID number	02		Channel 2 (Range 1 to 64) The satellite ID numbers are in the range of 1 to 32 for GPS satellites, and 33 to 64 for SBAS satellites (ID=120-PRN; e.g. SV ID 33 is SBAS PRN 120, 34 is SBAS PRN 121, and so on)
Elevation	10	degrees	Elevation angle of satellite as seen from receiver channel 1 (00 to 90)
Azimuth	252	degrees	Satellite azimuth as seen from receiver channel 1 (000 to 359)
SNR (C/No)	26	dBHz	Received signal level C/No from receiver channel 1 (00 to 99, null when not tracking)
…			
Satellite ID number	11		Channel 4 (Range 1 to 32)
Elevation	17	degrees	Elevation angle of satellite as seen from receiver channel 4 (00 to 90)
Azimuth	058	degrees	Satellite azimuth as seen from receiver channel 4 (000 to 359)
SNR (C/No)	32	dBHz	Received signal level C/No from receiver channel 4 (00 to 99, null when not tracking)
checksum	*71		
<CR><LF>			End of sentence

3.6 GPRMC - Recommended Minimum Specific GNSS Data

- Example

  $GPRMC,065500.00,A,2447.65027,N,12100.78318,E,15.869,189.32,051109,,,D*57

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPRMC		RMC protocol header
UTC Time	065500.00		hhmmss.ss

			hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Latitude	2447.65027		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.78318		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Speed over ground	15.869	knots	Receiver's speed
Course over ground	189.32	degrees	Receiver's direction of travel Moving clockwise starting at due north
Date	051109		ddmmyy dd: Day, mm: Month, yy: Year
Magnetic variation		degrees	This receiver does not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.
Mode Indicator	D		A: Autonomous M: Manual D: DGPS S: Simulation E: Dead Reckoning N: Data Invalid
checksum	*57		
<CR><LF>			End of sentence

3.7 GPVTG - Course over Ground and Ground Speed

- Example

  $GPVTG,189.32,T,,M,15.869,N,29.405,K,D*30

Explanation

Contents	Example	Unit	Explanation
Message ID	$GPVTG		VTG protocol header
Course over ground	189.32	degrees	Receiver's direction of travel Moving clockwise starting at due north (geodetic WGS84 directions)
Reference	T		True
Course over ground		degrees	Receiver's direction of travel
Reference	M		Magnetic
Speed over ground	15.869	knots	Measured horizontal speed
Unit	N		Knots
Speed over ground	29.405	km/hr	Measured horizontal speed
Unit	K		km/hr
Mode Indicator	D		A: Autonomous, D: DGPS, E: DR
checksum	*30		
<CR><LF>			End of sentence

3.8 GPTXT – Text Transmission

- Example

  $GPTXT,01,01,02,u-blox ag - www.u-blox.com*50

Explanation

Contents	Example	Unit	Explanation
Message ID	$GPTXT		TXT protocol header
Number of messages	01		Total number of messages in this transmission, 01..99

Message number	01		Message number in this transmission, range 01..xx
Message type	02		Text identifier, u-blox GPS receivers specify the type of the message with this number. 00: Error 01: Warning 02: Notice 07: User
Text	u-blox ag - www.u-blox.com		Any ASCII text
Checksum	*50		Checksum
<CR><LF>			End of sentence

3.9 GNSS Switching Commands

Switches between different GNSS systems could be done by u-blox binary commands described below.

Switch to GLONASS

B5 62 06 3E 24 00 00 00 16 04 00 04 FF 00 00 00 00 01 01 01 03 00 00 00 00 01 05 00 03 00 00 00 00 01 06 08 FF 00 01 00 00 01 A4 0D

Switch to GPS+QZSS+SBAS

B5 62 06 3E 24 00 00 00 16 04 00 04 FF 00 01 00 00 01 01 01 03 00 01 00 00 01 05 00 03 00 01 00 00 01 06 08 FF 00 00 00 00 01 A6 45

Responses

ACK (Success): B5 62 05 01 02 00 06 3E 4C 75

NAK (Failure): B5 62 05 00 02 00 06 3E 4B 70

Please note that

- Hexadecimal values under each command are binary data.
  - E.g. B5 is one byte. It should NOT be sent as two characters.
- Each command is followed by either an ACK or a NAK response.
  - ACK response: the command has been successfully executed
  - NAK response: the command is not valid and is not accepted
- It takes some time (from a few to tens of seconds) before switches to alternating satellite system taking effect.
  - Typically, the longer it runs, the longer it takes to switch.

4 Evaluation Information

4.1 Overview

It's easy to connect the 6-pin I/O connector for checking the performance or doing power saving control.

Additional USB cable from SPK for checking performance on PC is available for order.

- For TTL version, the USB cable is built-with Prolific USB Bridge.
- For USB version, the chip built-in USB is used.

4.2 Tips in Designing

The GPS signal is pretty low, less than -130 dBm, which is easily interfered by the EMI of application circuit, and its central frequency, 1.575 GHz might be shifted due to the housing material of host.

Interference checking

1. Check the signal reception status of GPS module standalone with GPS viewer tool.
2. Compare it when it is placed at the planned location on the application board.
3. Please find better location or adjust the application to reduce the interference if it

Antenna working frequency checking

1. Compare the GPS sensitivity with and without host's housing.
2. If the GPS signal is degraded significantly, the GPS antenna needs to fine tune to match the housing material to achieve the optimum central frequency and field pattern.
3. Please note that there is MOQ request for antenna customization.

4.3 Ordering Information

SPK-GGSM-072X (X=A,B etc.)

Where X=	A/N	B	U	V
TTL	Y	Y	-	-
USB	-	-	Y	Y
PPS	Y	-	Y	-
Power Control		Y		Y

5 Electrical and Environmental Data

Electrical Data

Power Supply (VDC)	3.1 ~ 5.5 V (TTL); 4.75~5.25V (USB)
Power Consumption (w/o antenna)	36 mA / average tracking (9 SVs) 13.5uA / backup power (module disabled)
Backup power	1.5 ~ 3.5V
USB I/O (V)	V_{IH}: 2 ~ VCC, V_{IL}: 0 ~ 0.8 V_{OH}: >= 2.8, V_{OL}<= 0.3
Digital I/O (V)	V_{IH}: 0.7*VCC ~ VCC+0.5 V_{IL}: 0 ~ 0.2*VCC V_{OH}: >= VCC-0.4, V_{OL}<= 0.4
Protocols	NMEA (default)

Environmental Data

Operating temperature	-40 ~ 85℃
Storage temperature	-40 ~ 85℃
Vibration	5Hz to 500Hz, 5g
Shock	Half sine 30g/11ms
RoHS compliant	Yes