Data Sheet

GlobalTop Technology Inc.

Fox1
GPS Standalone Module
Data Sheet

Revision: V02

GlobalTop Technology Inc.

The Fox1 is a 4th generation stand-alone GPS module with lightning fast TTFF, ultra high sensitivity (-165dBm), low power consumption in a small form factor (16*16*4.7mm) , and can support extra device via I2C bus

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Specification

Customer Name	
Model No.	**Fox-1**
GPS Firmware Version	TBD
Product type	Module type: Smart GPS GPS Chipset: MT3339 Dimension: 16 x 16x 4.8mm Supports I2C interface
Remarks	
Signature by Customer	

Approved by	Checked by	Issued by
Jason Yu	Jason Yu & Steve Chen	Max Ni

Version History

Title:	GlobalTop Fox-1 Datasheet		
Subtitle:	GPS Module		
Doc Type:	Datasheet		
Revision	**Date**	**Author**	**Description**
V01	2013-8-21	Max.Ni	Preliminary
V02	2014-01-15	Max.Ni	Figure and text font changes

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1. Functional Description

1.1 Overview

Fox-1 utilizes MediaTek new generation GPS/GNSS Chipset –MT3339 achieving the industry's highest level of sensitivity (-165dBm) and instant Time-to-First Fix (TTFF) with lowest power consumption while retaining precise GPS positioning even under poor reception and high velocity conditions.

The Fox-1 receiver module comes with a patch on top (POT) antenna. While having antenna of its own, the module can also be attached with external antenna. As it comes with **automatic antenna switching function**, when external antenna attached the embedded smart feature namely "Antenna Advisor" will notify the host system indicating the selected Antenna status–Internal Antenna Usage, External Antenna connection or Short Circuit Condition.

Fox-1 is low in power consumption (acquisition 31mA, tracking 26mA) suitable for power sensitive devices especially portable applications. Fox-1 supports MEMS sensors (E-compass, Accelerometer, Pressure sensor, etc.) via I2C interface. To Fox-1 users, GlobalTop provides customization firmware for supporting different MEMS sensors.

Up to 12 multi-tone active interference canceller (ISSCC2011 awarded), allowing customer to have more flexibility in system design. The module supports up to 210 PRN channels with 66 search channels and 22 simultaneous tracking channels. Fox-2 supports various location and navigation applications, including autonomous GPS, SBAS ranging (WAAS, EGNOS, MSAS and GAGAN*), QZSS and AGPS.

Note: SBAS can only be enabled when update rate is equal or less than to 5Hz.

*GAGAN will later be supported.

Application:

- ✓ Handheld Device
- ✓ Tablet PC/PLB/MID
- ✓ M2M application
- ✓ Asset management
- ✓ Surveillance
- ✓ Tracking Device/Pet Tracking /Vehicle Tracking
- ✓ Balloon
- ✓ Sport
- ✓ Video Recorder
- ✓ Logger

1.2 Highlights and Features

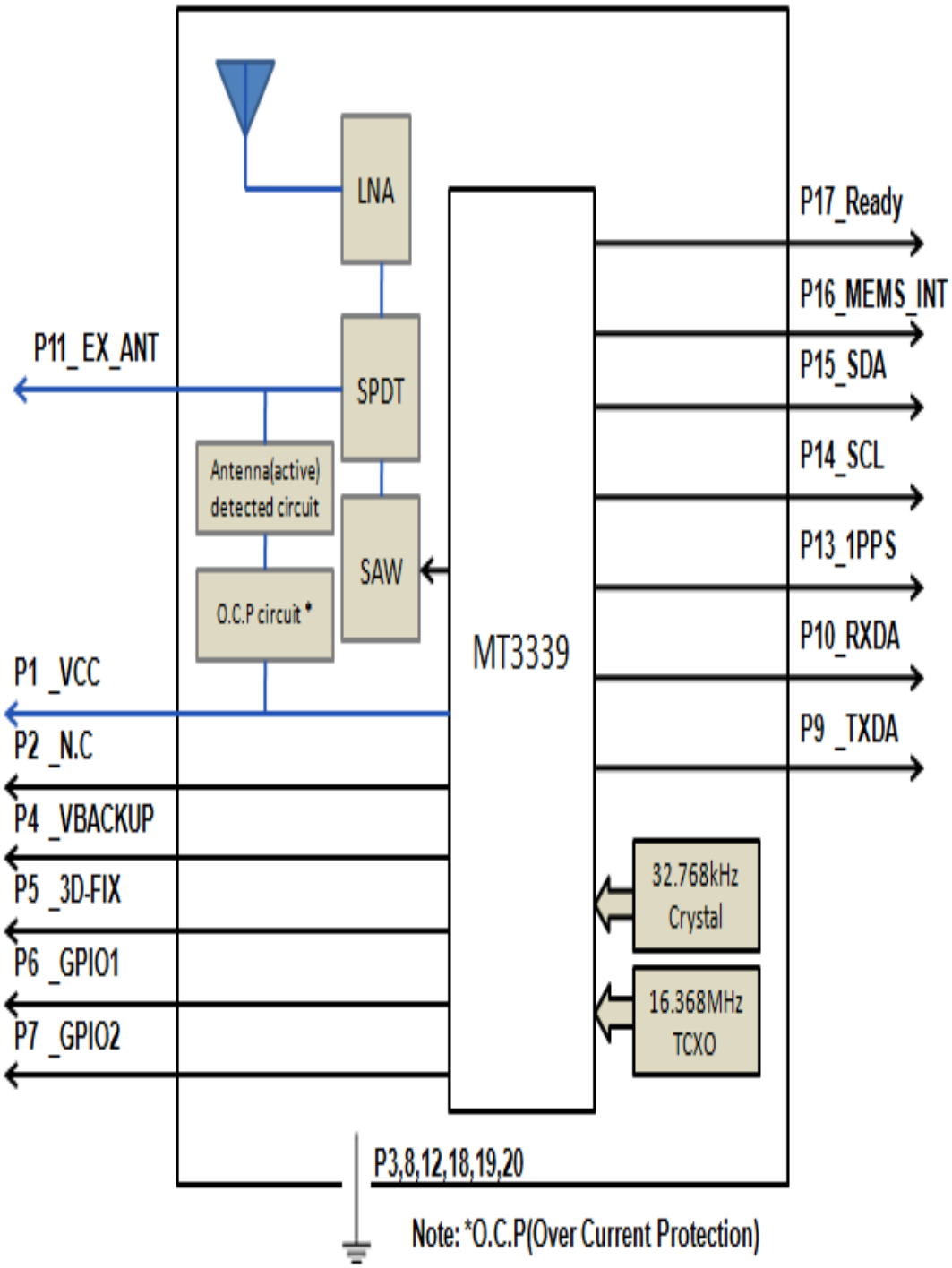
- Built-in 15X15X2.5mm ceramic patch antenna
- Ultra-High Sensitivity: -165dBm (w/o patch antenna), up to 45dB C/N of SVs in open sky reception.
- High Update Rate: up to 5Hz(notes 1)
- 12 multi-tone active interference canceller(note2) [ISSCC 2011 Award -Section 26.5] (http://isscc.org/doc/2011/isscc2011.advanceprogrambooklet_abstracts.pdf)
- High 1-PPS timing accuracy for Timing Applications (±10ns RMS jitter)
- AGPS Support for Fast TTFF (EPO™ Enable 7 days/14 days)
- EASY™(note2): Self-Generated Orbit Prediction for instant positioning fix
- AlwaysLocate™(note 2) Intelligent Algorithm (Advance Power Periodic Mode) for power saving
- LOCUS (Embedded Logger Function) (note3)
- Automatic antenna switching function
- Antenna Advisor function
- Short circuit protection on External Antenna connection
- GlobalTop Firmware Customization Services
- Power Consumption (@3.3V) with MEMS sensor used via I2C:
  - Acquisition: 31mA Typical
  - Tracking: 26mA Typical
- E911, RoHS, REACH compliant

Note1: SBAS can only be enabled when update rate is less than or equal to 5Hz.

Note2: Some features need special firmware or command programmed by customer, please refer to G-top "GPS command List"

Note3: Please refer to "GlobalTop LOCUS Library User Manual"

1.3 System Block Diagram



System block diagram

1.4 Multi-tone active interference canceller

Navigation system often integrated with variant applications that are not limited to Wi-Fi, GSM/GPRS, 3G/4G, Bluetooth. Such system, as often seen, generates RF harmonics which would influence the GPS reception and performance. The embedded multi-tone active interference canceller (MTAIC) is capable of rejecting unwanted RF harmonics of the nearby on-board active components. MTAIC improves the capacity of GPS reception leaving hardware integration engineering without the need of hardware changes. Fox-1 cancels up to 12 independent channels continuous interference wave.

1.5 1PPS

Fox-1 generates a_pulse_per_second signal (1 PPS). It is an electrical signal which precisely indicates the start of a second with the accuracy of ±10ns RMS.

In general, 1 PPS signals are used to provide precise timekeeping and time measurement to the system. It is commonly used for timekeeping in computers which may involve with the NTP protocol.

Fox-1 generates highly accurate 1PPS based timing method to synchronize GPS positioning time after obtained 3D-Fix. 1PPS output at power on is available through firmware customization service.

1.6 AGPS Support for Fast TTFF (EPO™)

The AGPS (EPO in flash™) supply the predicated Extended Prediction Orbit data to speed TTFF. Users can download the EPO data to GPS engine from the FTP server via internet or wireless network. The GPS engine of the module will use the EPO data to assist position calculation when the navigation information from satellites is not enough as is the case of weak signal. For more details on EPO, visit our website.

1.7 EASY™

Embedded Assist System (EASY™) is embedded within the receiver module to assist for quick positioning when not enough information is received from the satellites. With EASY™ technology, the GPS engine is able to calculate and predict up to 3 days single ephemeris automatically when power on. It then saves the predicted information onto the memory. So the GPS engine can use this information for positioning later if no enough information received from the satellites. This function will be helpful for TTFF improvement to allow positioning even under weak signal condition such dense urban. Backup power (VBACKUP) is required for this feature.

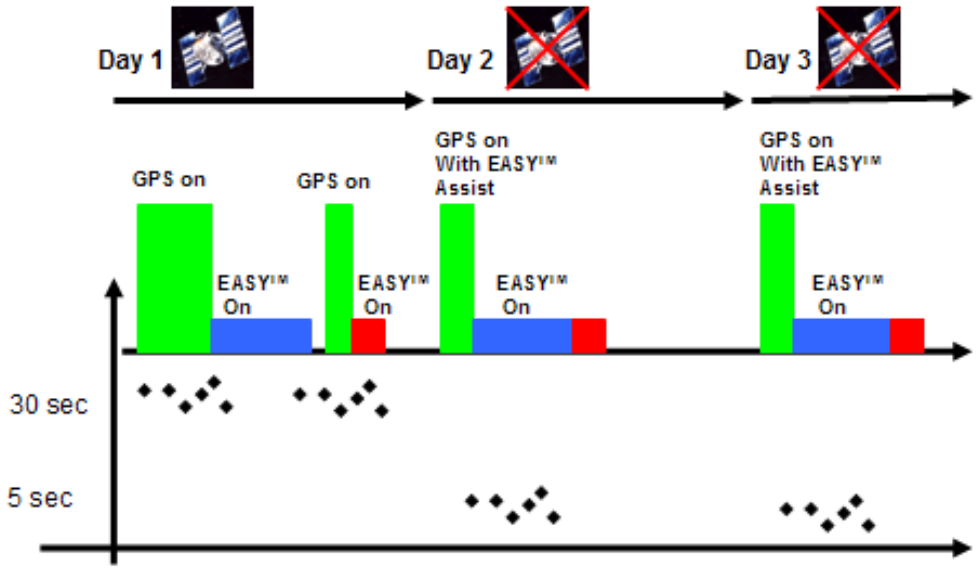


Figure 1.12-1 EASY System operation

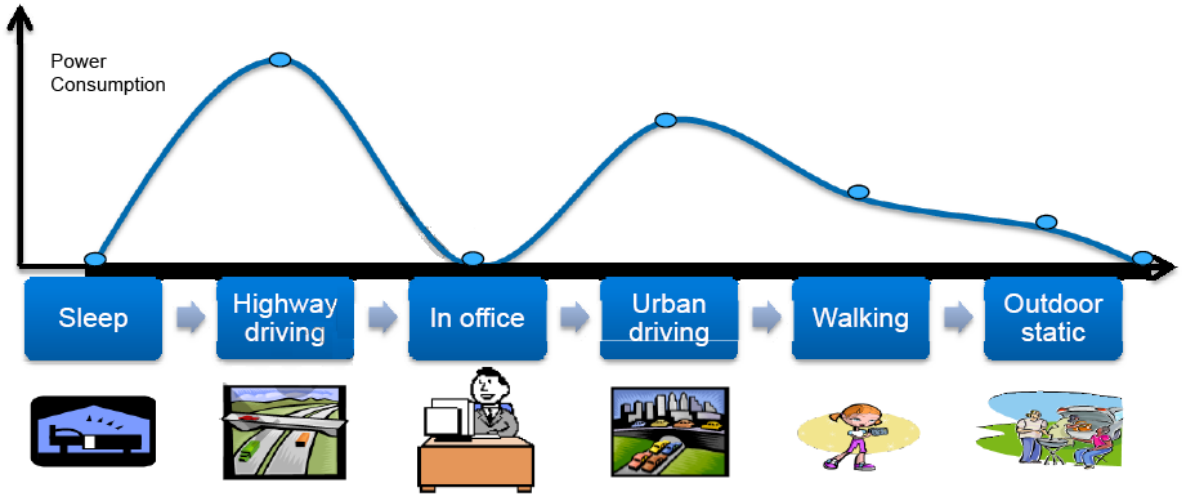
Figure 1.12-1 show that when GPS device obtained the satellite information from GPS satellites, the GPS engine automatically pre-calculates to predict orbits for 3 extended days.

1.8.4 AlwaysLocate™

Fox-1 uses AlwaysLocate™(Advance Power Periodic Mode) modes to achieve power saving by adaptively adjust the on/off time to achieve balance between positioning accuracy and power consumption according to the environmental and motion conditions to achieve best power conservation. PMTK225 command is used to configure the receiver module for the function.

The following figure gives some insight on power saving under different use cases when AlwaysLocate™ mode is enabled. For command detail, please contact our sales staff at

sales@gtop-tech.com.



1.9 LOCUS

When LOCUS (Embedded Logger Function) feature is enabled, the receiver module becomes a logger capable device. It does not need a host or external flash to log GPS data, such as data format: UTC, latitude, longitude, valid, checksum. The maximum constant log duration can be up to 2 days under AlwaysLocate™ condition.

2.0 Antenna Advisor

“Antenna Advisor” is a brand new antenna system available exclusively for Fox-1. It is designed to detect and notify antenna status using software (through proprietary protocol on **Chapter 3.2**).

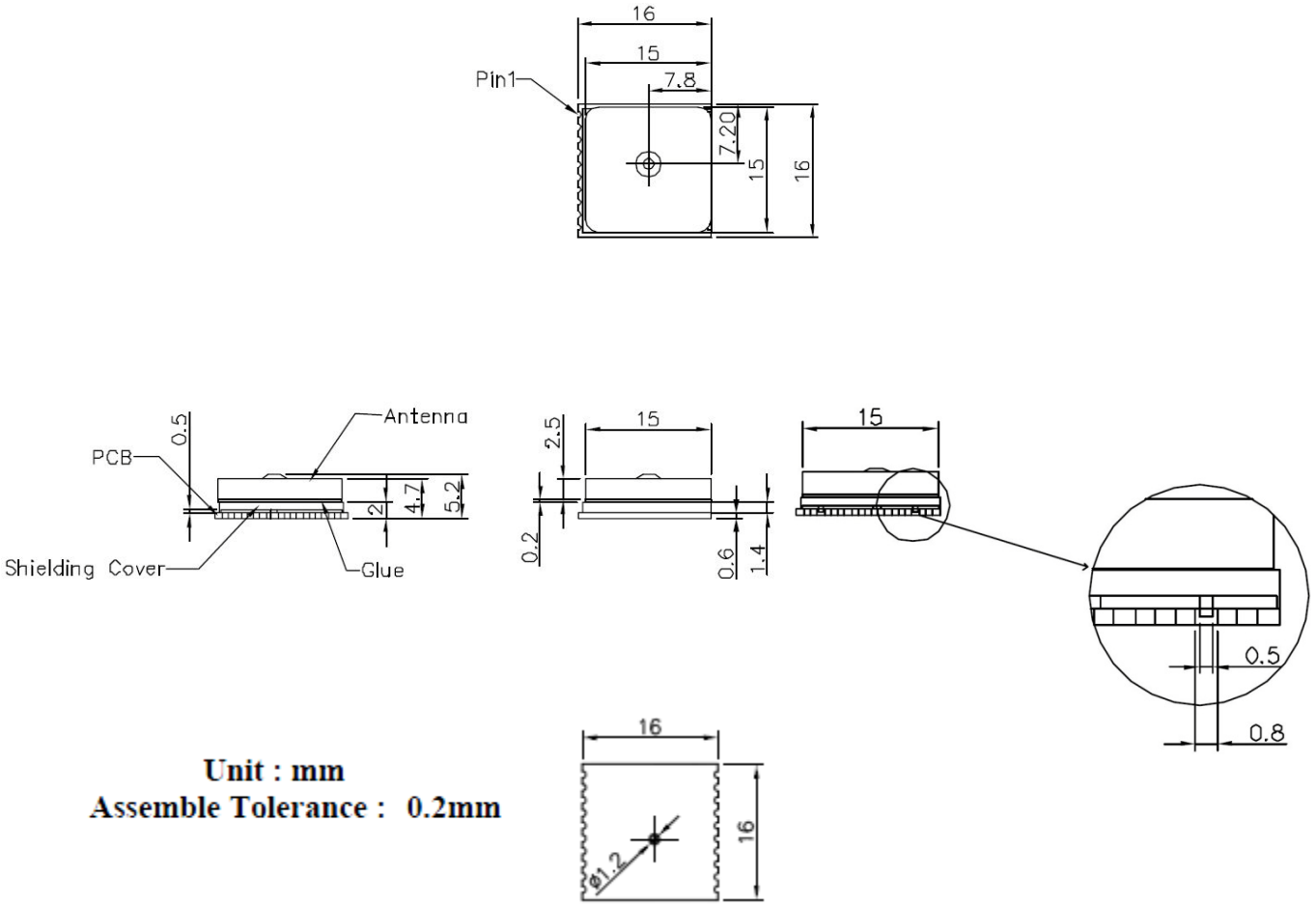
Antenna Advisor can detect and notify the following:

- Active Antenna Shorted
- Using Internal Antenna
- Using Active Antenna

2. Specifications

2.1 Mechanical Dimension

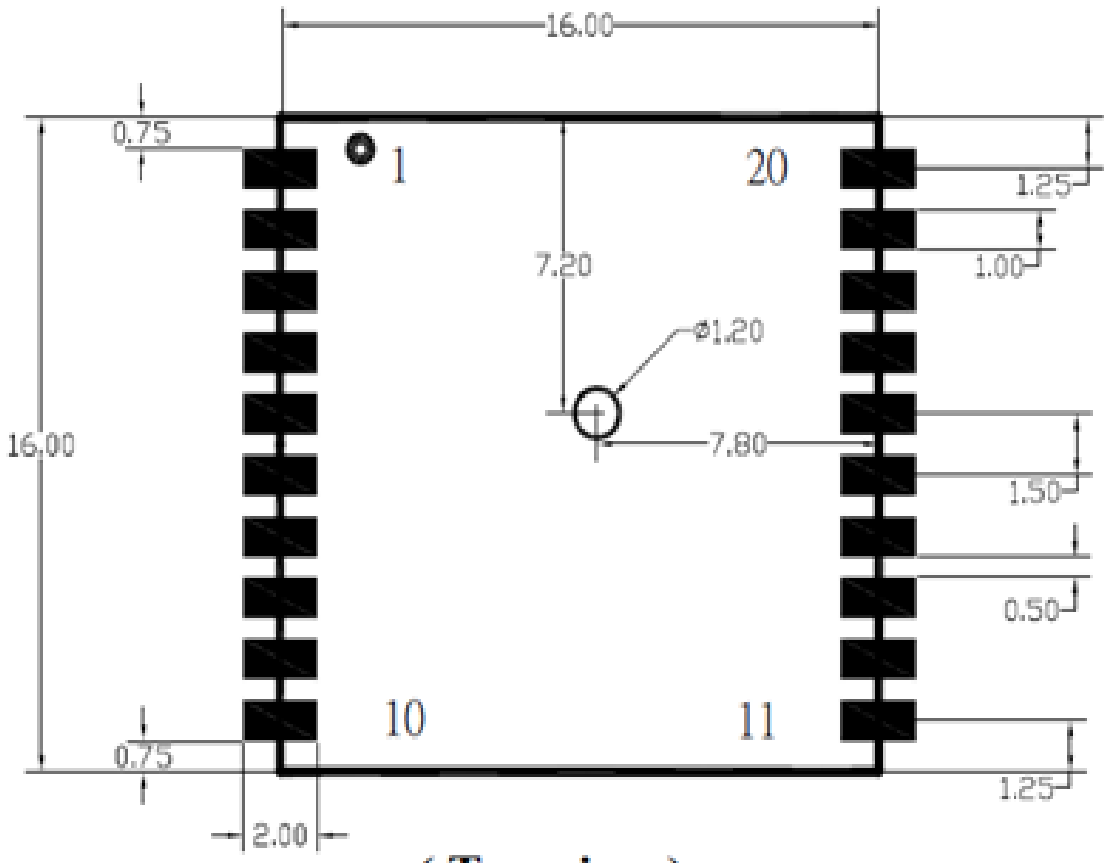
Dimension: (Unit: mm, Tolerance: +/- 0.2mm)



2.2 Recommended PCB pad Layout

(Unit: mm, Tolerance: 0.1mm)

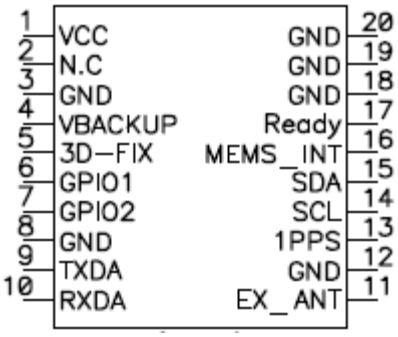
Fox-1 PCB Pad



(Top view)

(Unit : mm, Tolerance : 0.1mm)

2.3 Pin Configuration



(Top view)

2.4 Pin Assignment

(Note: pin 6, 7, 16, 17 are GPIO type from GPS module which can be defined by customer)

Pin	Name	I/O	Description & Note
1	VCC	PI	Main DC power input
2	N.C	I	No connection
3	GND	P	Ground
4	VBACKUP	PI	Backup power input for RTC & navigation data keep
5	3D_FIX	O	3D-Fix Indicator
6	GPIO1	I/O	General-Purpose Input/Output
7	GPIO2	I/O	Reserved pin
8	GND	P	Ground
9	TXDA	O	Serial Data Output A for NMEA output (TTL)
10	RXDA	I	Serial Data Input A for Firmware update (TTL)
11	EX_ANT	I	External Antenna Signal Input
12	GND	P	Ground
13	1PPS	O	1PPS Time Mark Output 2.8V CMOS Level
14	SCL	I/O	I2C - Serial Clock Line
15	SDA	I/O	I2C- Serial Data Line
16	MEMS _INT	I	Interrupt input
17	Ready	O	General-Purpose Input / Output
18	GND	P	Ground
19	GND	P	Ground
20	GND	P	Ground

2.5 Description of I/O Pin

VCC (Pin1)

The main DC power supply of the module, the voltage should be kept between from 3.0V to 4.3V **(Typical: 3.3V)**. **The Vcc ripple must be controlled under 50mV$_{pp}$**

N.C (Pin2)

keep floating or Pull high.

GND (Pin3, Pin6, Pin12, Pin18, Pin19, Pin20)

Ground

VBACKUP (Pin4)

This connects to the backup power of the GPS module. Power source (such as battery) connected to this pin will help the GPS chipset in keeping its internal RTC running when the main power source is turned off. The voltage should be kept between 2.0V~4.3V. Typical 3.0V.

IF VBACKUP power were not reserved, the GPS module will perform a lengthy cold start each time it is powered on as previous satellite information is not retained and needs to be re-transmitted.

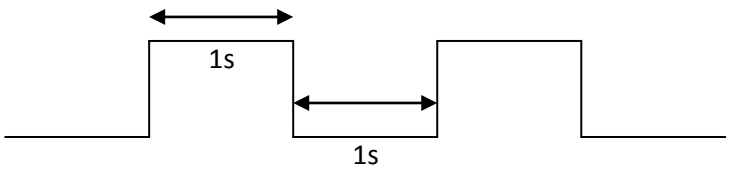
If not used, leave this pin floating.

3D-FIX (Pin5)

The 3D-FIX is assigned as a fix flag output. The timing behavior of this pin can be configured via custom firmware service for different applications (Example: waking up host MCU).

If not used, leave this pin floating.

- Before 2D Fix
  The pin should continuously output one-second high-level with one-second low-level signal.

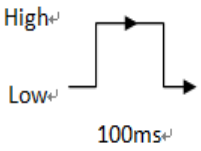


- After 2D or 3D Fix
  The pin should continuously output low-level signal.

  Low _____

GPIO1(Pin6)

Fox-1 constantly detects this pin for a pulse signal. When current Magnetic deviation exceeds pre-set threshold setting of E-Compass, within 200ms, Fox-1 will send out a pulse with duration of 100ms.



GPIO2(Pin7)

This is a reserved Pin

TX (Pin9)

This is the UART transmitter of the module. It outputs the GPS information for application.

RX (Pin10)

This is the UART receiver of the module. It is used to receive software commands and firmware update.

EX_ANT (Pin11)

DC power from VCC and provide for external active antenna (Recommendation: 3.3V).

When a 4mA or higher current is detected, the detecting circuit will acknowledge the external antenna connection.
In the event of short circuit occurring at external antenna, the module will limit the current drawn to a safe level.
Limited to 25mA @3.0v
Limited to 28mA @3.3v
Limited to 31mA @3.6v

1PPS (Pin13)

This pin provides one pulse-per-second output from the module and synchronizes to GPS time.

Keep floating if not used.

SCL (Pin14)

I2C bus_ Serial Clock Line, follow I2C specification and can support 100 kHz and 400 kHz speed.

SDA (Pin15)

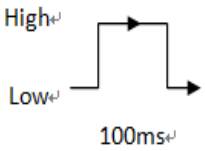
I2C bus_ Serial Data Line, follow I2C specification and can support 100 kHz and 400 kHz speed.

MEMS_INT (Pin16)

This is a reserved pin. No used.

Ready (Pin17)

When pin11_ACC_INT is trigged, Fox-1 will wake-up, within 200ms, Fox-2 will send out a pulse with duration of 100ms.



2.6 Specification

	Description
GPS Solution	MTK MT3339
Frequency	L1, 1575.42MHz
Sensitivity[1]	Acquisition: -148dBm, Cold start Reacquisition: -163dBm, Hot start Tracking: -165dBm
Channel	66 channels
TTFF	Hot start: 1 second typical Warm start: 33 seconds typical Cold start: 35 seconds typical (No. of SVs>4, C/N>40dB, PDop<1.5)
Position Accuracy	Without aid:3.0m (50% CEP) DGPS(SBAS(WAAS,EGNOS,MSAS, GAGAN*)):2.5m (50% CEP)
Velocity Accuracy	Without aid : 0.1m/s DGPS(SBAS(WAAS,EGNOS,MSAS, GAGAN*)):0.05m/s
Timing Accuracy (1PPS Output)	± 10ns RMS
Altitude	Maximum 18,000m (60,000 feet)
Velocity	Maximum 515m/s (1000 knots)
Acceleration	Maximum 4G
Update Rate	1Hz (default), 2Hz, 5Hz
Baud Rate	115200 bps (default)
DGPS	SBAS (defult) [WAAS, EGNOS, MSAS,GAGAN*]
QZSS	Support (Ranging)
AGPS	Supported
Power Supply	VCC: 3.0V to 4.3V；VBACKUP: 2.0V to 4.3V
Current Consumption	31mA acquisition, 26mA tracking
Working Temperature	-40 °C to +85 °C
Dimension	16 x 16x 4.7mm, SMD
Weight	**4g**

**GAGAN will be supported.*

2.7 Absolute Maximum Ratings

The voltage applied for VCC should not exceed 4.3VDC.

	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	VCC	3.0	3.3	4.3	V
Backup battery Voltage	VBACKUP	2.0	3.0	4.3	V

2.8 Operating Conditions

	Condition	Min.	Typ.	Max.	Unit
Operation supply Ripple Voltage	—	—	—	50	**mVpp**
RX0 TTL H Level	VCC=3.0~4.3V	2.0	—	VCC	**V**
RX0 TTL L Level	VCC=3.0~4.3V	0	—	0.8	**V**
TX0 TTL H Level	VCC=3.0~4.3V	2.4	—	2.8	**V**
TX0 TTL L Level	VCC=3.0~4.3V	0	—	0.4	**V**
Current Consumption @ 3.3V, 1Hz Update Rate	Acquisition	—	31	—	**mA**
	Tracking	—	26	—	**mA**
Backup Power Consumption@ 3V	25°C	—	7	—	**uA**

2.9 GPS External Antenna Specification (Recommended)

It is important that the antenna gets a clear view of the sky and is positioned on a surface level to the horizon for best results. The following specification has to meet for the use reference design.

Characteristic	Specification
Polarization	Right-hand circular polarized
Frequency Received	1.57542GHz +/- 1.023MHz
Power Supply	3V to 3.6V
DC Current	4mA ~ 20mA at 3.3V
Total Gain	>+ 15dBi (Two-stage LNA)
Output VSWR	< 2.5
Impedance	50ohm
Noise Figure	< 1.5dB

2.10 Supported MEMS Sensors

Supported Sensors		
	Internal Sensor	**External Sensor**
Fox-1	*(not supported)*	1. LSM303D 2. LIS3DH 3. L3GD20* 4. LP331AP
Fox-2**	1. LSM303D or 2. LIS3DH	1. LSM303D 2. LIS3DH 3. L3GD20* 4. LP331AP

*It will be supported
**either internal or external sensor can be selected.

3. Protocols

3.1 NMEA Output Sentences

Table-1 lists each of the NMEA output sentences specifically developed and defined by MTK for use within MTK products

Table-1: NMEA Output Sentence	
Option	**Description**
GGA	Time, position and fix type data.
GSA	GPS receiver operating mode, active satellites used in the position solution and DOP values.
GSV	The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.
RMC	Time, date, position, course and speed data. The recommended minimum navigation information.
VTG	Course and speed information relative to the ground.
GLL	Geographic Position, Latitude / Longitude and time
ZDA	UTC, day, month, year, and local time zone

GGA—Global Positioning System Fixed Data. Time, Position and fix related data

Table-2 contains the values for the following example:

$GPGGA,064951.000,2307.1256,N,12016.4438,E,1,8,0.95,39.9,M,17.8,M,,*65

Table-2: GGA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGGA		GGA protocol header
UTC Time	064951.000		hhmmss.sss
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See **Table-3**
Satellites Used	8		Range 0 to 14
HDOP	0.95		Horizontal Dilution of Precision
MSL Altitude	39.9	meters	Antenna Altitude above/below mean-sea-level
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.8	meters	
Units	M	meters	Units of geoids separation
Age of Diff. Corr.		second	Null fields when DGPS is not used
Checksum	*65		
<CR> <LF>			End of message termination

Table-3: Position Fix Indicator	
Value	**Description**
0	Fix not available
1	GPS fix
2	Differential GPS fix

GSA—GNSS DOP and Active Satellites

Table-4 contains the values for the following example:

$GPGSA,A,3,29,21,26,15,18,09,06,10,,,,,2.32,0.95,2.11*00

Table-4: GSA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See **Table-5**
Mode 2	3		See **Table-6**
Satellite Used	29		SV on Channel 1
Satellite Used	21		SV on Channel 2
….	….	….	….
Satellite Used			SV on Channel 12
PDOP	2.32		Position Dilution of Precision
HDOP	0.95		Horizontal Dilution of Precision
VDOP	2.11		Vertical Dilution of Precision
Checksum	*00		
<CR> <LF>			End of message termination

Table-5: Mode 1	
Value	**Description**
M	Manual—forced to operate in 2D or 3D mode
A	2D Automatic—allowed to automatically switch 2D/3D

Table-6: Mode 2	
Value	**Description**
1	Fix not available
2	2D (＜4 SVs used)
3	3D (≧4 SVs used)

GSV—GNSS Satellites in View

Table-7 contains the values for the following example:

$GPGSV,3,1,09,29,36,029,42,21,46,314,43,26,44,020,43,15,21,321,39*7D

$GPGSV,3,2,09,18,26,314,40,09,57,170,44,06,20,229,37,10,26,084,37*77
$GPGSV,3,3,09,07,,,26*73

Table-7: GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages	3		Range 1 to 3 *(Depending on the number of satellites tracked, multiple messages of GSV data may be required.)*
Message Number1	1		Range 1 to 3
Satellites in View	09		
Satellite ID	29		Channel 1 (Range 1 to 32)
Elevation	36	degrees	Channel 1 (Maximum 90)
Azimuth	029	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, (null when not tracking)
….	….	….	….
Satellite ID	15		Channel 4 (Range 1 to 32)
Elevation	21	degrees	Channel 4 (Maximum 90)
Azimuth	321	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	39	dBHz	Range 0 to 99, (null when not tracking)
Checksum	*7D		
<CR> <LF>			End of message termination

RMC—Recommended Minimum Navigation Information

Table-8 contains the values for the following example:

$GPRMC,064951.000,A,2307.1256,N,12016.4438,E,0.03,165.48,260406,3.05,W,A*2C

Table-8: RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over Ground	0.03	knots	
Course over Ground	165.48	degrees	True
Date	260406		ddmmyy
Magnetic Variation	3.05, W	degrees	E=east or W=west (Needs GlobalTop Customization Service)
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination

VTG—Course and speed information relative to the ground

Table-9 contains the values for the following example**:**

$GPVTG,165.48,T,,M,0.03,N,0.06,K,A*37

Table-9: VTG Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPVTG		VTG protocol header
Course	165.48	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic (Needs GlobalTop Customization Service)
Speed	0.03	knots	Measured horizontal speed
Units	N		Knots
Speed	0.06	km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*06		
<CR> <LF>			End of message termination

GLL—Geographic Position, Latitude / Longitude and time

Table-10 contains the values for the following example**:**

$GPGLL, 2307.1256,N,12016.4438,E,064951.000,A

Table-10: GGA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGLL		GLL protocol header
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E=east or W=west
UTC Time	064951.000		hhmmss.sss
Status	A		Valid Data

ZDA—Date & Time

Table-11 contains the values for the following example**:**

$GPZDA, 064951.000,16,10,2013,08,00*60

,

Table-11: ZDA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPZDA		ZDA protocol header
UTC Time	064951.000		hhmmss.sss
Date	16,10,2013		dd,mm,yyy Day,Month,Year
Local Zone Hours	08		-13..13
Local Zone minutes	00		0..59
Check Sum	*60		

3.2 MEMS Sensor NMEA Output Sentences

3.2.1 GlobalTop proprietary messages

1. **HCHDG Heading**: Deviation and Variation

The HCHDG heading contains the values for the following example:

$HCHDG,101.1,,,,*43<CR><LF>

Table-1.1: HCHDG Heading

Name	Example	Unit	Description
Sentence ID	$HCHDG		
Heading	101.1	degree	Magnetic Sensor heading
Deviation		degree	Magnetic Deviation
Deviation Direction			Magnetic Deviation direction, E = Easterly, W = Westerly
Variation		degree	Magnetic Variation
Variation Direction			W Magnetic Variation direction, E = Easterly, W = Westerly
Checksum	43		
<CR><LF>			End of message termination

2. **PGSR Compass Measurement Report** : calibration and acceleration
The PGSR compass measurement report contains the values for the following example:

$PGSR,1,1,95,7,165,148,-37,210,31,0,2*14<CR><LF>

Table 1.2 PGSR Compass Measurement Report 1			
Name	**Example**	**Unit**	**Description**
Sentence ID	$PGSR,1,1		
Direction	95	degree	Magnetic direction: 0-360 degree, north: 0
Calibration Status	7		Auto-calibration status: 7:X,Y,Z complete 1 : X complete, 2 : Y complete, 4 : Z complete
Field Intensity	165		Magnetic field intensity: 0..4000 mgauss
Acceleration X	148		Acceleration X: -2000 mg to 2000 mg
Acceleration Y	-37		Acceleration Y: -2000 mg to 2000 mg
Acceleration Z	210		Acceleration Z: -2000 mg to 2000 mg
Temperature	31	Celsius	Module temperature in Celsius (°C)
Mounting Mode	0		Module Mounting Mode: 0..7, default 0
Current Calibration Data Status	2		Current calibration data status: none zero: valid 0:not valid
Checksum	1D		
<CR><LF>			End of message termination

3. **PGSR Pressure Measurement Report** : Pressure and Temperature output data
The PGSR pressure measurement report contains the values for the following example:

$PGSR,1,2,1003.5,81,29*22<CR><LF>

Table 1.3 PGSR Pressure Measurement Report 2			
Name	**Example**	**Unit**	**Description**
Sentence ID	$PGSR,1,2		
Pressure	1003.5	mbar	Operating pressure range: 260 ~ 1260 mbar
Altitude	81	meter	Relative altitude in meter
Temperature	29	Celsius	Module temperature in Celsius (°C)
Checksum	22		
<CR><LF>			End of message termination

4. **PGSR Turn Measurement Report** : Turn Angle output data

The PGSR turn measurement report contains the values for the following example:

$PGSR,1,4,60,65*32<CR><LF>

Table 1.4 PGSR Turn Measurement Report 4			
Name	**Example**	**Unit**	**Description**
Sentence ID	$PGSR,1,4		
Turn Threshold	60	deg	Command setup Turn Threshold
Turn Angle	65	deg	Current Turn Angle
Checksum	32		
<CR><LF>			End of message termination

5. **PGSR Man-Down Measurement Report:** Man-Down output data

The PGSR Man-Down measurement report contains the values for the following example:

$PGSR,1,5,0*0E<CR><LF>

Table 1.5 PGSR Turn Measurement Report 5			
Name	**Example**	**Unit**	**Description**
Sentence ID	$PGSR,1,5		
Mode	0		0:Free-Fall mode report 1:Static mode report 2:Tilt mode report
Checksum	0E		
<CR><LF>			End of message termination

3.2.2 Module Initialization

Send command 0 (Table 3) to initiate MEMS sensor setting. All the internal calibration status will be cleared and the calibration status is Null.

Send command 1 (Table 3) to perform sensor calibration in case when the module is near strong magnetic field and the output measurement becomes abnormal. As soon as this command is issued to the module, the calibration status field in Measurement Report 1 returns Null that is $PGSR,2,1,0. When calibration is completed, the calibration status field returns 7 (Table 1.2 –Report 1) that is $PGSR,2,1,7.

Notes:

The application software should provide interfaces to access command “$PGSC,2,1” to allow end user to calibrate the module when needed.

Table 3 Input Command Parameters			
Field Name	**Value**	**Description**	**Remark**
MID	2	Message ID	
Command	0..2	0: Coil reset to recover module from high magnetic field environment 1: Reset auto-calibration 2: Reset auto-calibration from GPIO1	2: reset when GPIO1 low
CheckSum			
<CR><LF>			

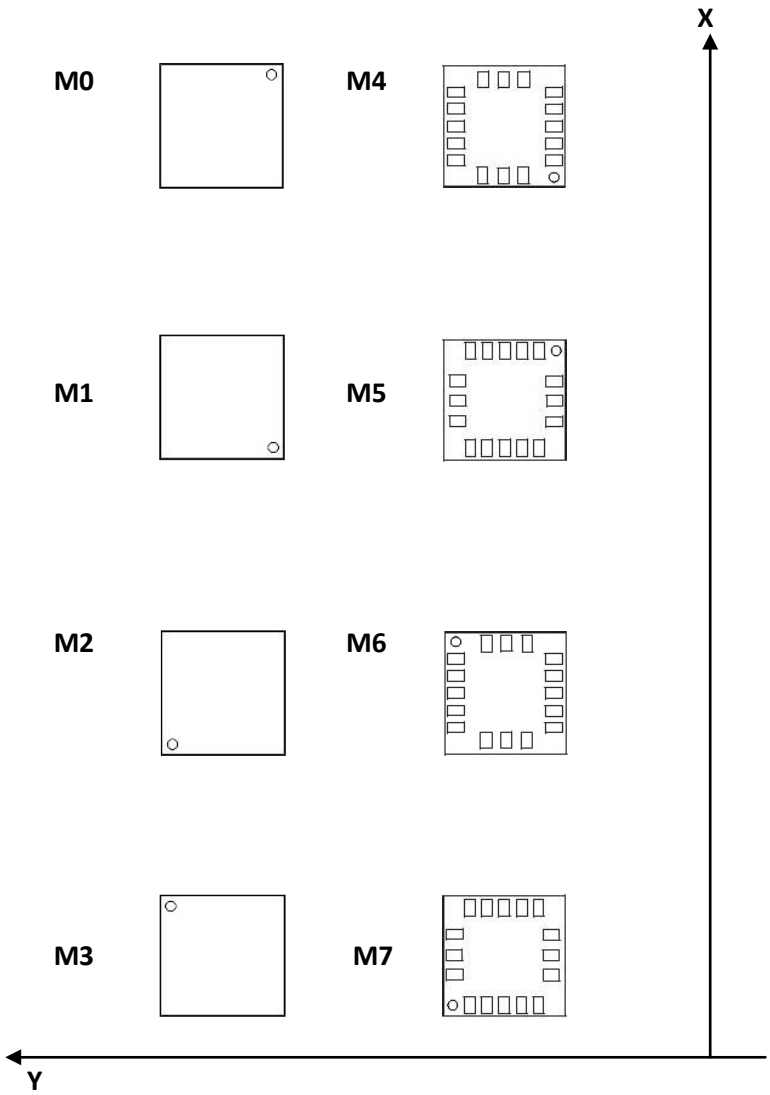
Table 4 Output Command Parameters			
Field Name	**Value**	**Description**	**Remark**
MID	2	Message ID	
Valid	0..1	1:command valid 0:command invalid	
Result	0, -1	0: success -1: command failed	
CheckSum			
<CR><LF>			

Table 5 Example		
Input	**Output**	**Description**
$PGSC,2,0*05	$PGSR,2,1,0*09	Reset Coil
$PGSC,2,1*04	$PGSR,2,1,0*09	Reset auto-calibration. Start to swing the module until calibration complete.

3.2.3 Configure the Sensor Mounting Orientation

Refer to figure bellow

Table 6 Input Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	3	Message ID	
Command	0..1	0: query mounting mode 1: set mounting mode	
Mode	0..7	sensor mounting mode	Default 0
CheckSum			
<CR><LF>			



Mounting Modes (Axis X: Heading Direction)

Table 7 Output Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	3	Message ID	
Valid	0..1	1: command valid 0: command invalid	
Result	0..7, -1	0..7: sensor mounting mode -1: command failed	
CheckSum			
<CR><LF>			

Table 8 Example		
Input	**Output**	**Description**
$PGSC,3,0,0*18	$PGSR,3,1,0*08	Query mounting mode
$PGSC,3,1,4*1D	$PGSR,3,1,4*0C	Set mounting mode to 4.
$PGSC,3,1,0*19	$PGSR,3,1,0*08	Set back to default mounting mode 0

3.2.3 Altitude Calibration for the Pressure Measurement Output

Table 18 Input Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	7	Message ID	
Command	0…2	0: Query Absolute Altitude Value 1: Set Absolute Altitude Value 2: Clear Absolute Altitude Value	
Altitude	-200…2000	Present absolute altitude for Calibration	unit : m
CheckSum			
<CR><LF>			

Table 19 Output Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	7	Message ID	
Valid	0..1	1: command valid 0: command invalid	
Altitude	-200…2000	Present absolute altitude for Calibration	unit : m
CheckSum			
<CR><LF>			

Table 20 Example		
Input	**Output**	**Description**
$PGSC,7,0,0*1C	$PGSR,7,1,30*3F	Query Absolute Altitude Value
$PGSC,7,1,30*2E	$PGSR,7,1,30*3F	Set Absolute Altitude Value
$PGSC,7,2,0*1E	$PGSR,7,1,0*0C	Clear Absolute Altitude Value

3.2.4 Configure Turn Interrupt

Table 21 Input Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	8	Message ID	
Command	0…2	0: Query turn interrupt threshold 1: Set the turn interrupt threshold 2: Clear turn interrupt threshold	
Angle	10…350	Turning angle	unit : degree
CheckSum			
<CR><LF>			

Table 22 Output Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	8	Message ID	
Valid	0..1	1: command valid 0: command invalid	
Angle	10…350	Turning angle	unit : degree
CheckSum			
<CR><LF>			

Table 23 Example		
Input	**Output**	**Description**
$PGSC,8,0,0*13	$PGSR,8,1,30*30	Query turn interrupt threshold
$PGSC,8,1,30*21	$PGSR,8,1,30*30	Set the turn interrupt threshold
$PGSC,8,2,0*11	$PGSR,8,1,0*03	Clear turn interrupt threshold

3.2.5 Configure Man-Down Notification

The following steps are the configure Man-Down notification procedure

Step1. Configure Man-Down parameters (Command 3), include mode 0~2

Then when events occurs, the module will send messages ($PGSR,1,5,x).

Step2. Setup interrupt mode (Command 1), select only one of the modes: mode 0~2.

Then when interrupt occurs, the module will send a message ($PGSR,1,5)

and send out a high signal with the duration of 100ms from Ready Pin.

Step3. Send Command 10 to enter Standby Mode, the module will enter Power Saving Mode.

When interrupt occurs, the module will wake-up and send a message ($PGSR,1,5)

and send out a high signal with the duration of 100ms from Ready Pin.

Note:

If the interrupt mode is set to Mode 1 or 2 (Table 24), and Duration is set to greater than 10 sec,

When the module enters power saving mode, and the interrupt occurs,

the module will wake up after sleeping 10 seconds, and observe the event to Duration are reached, then send a message ($PGSR,1,5) and send out a high signal with the duration of 100ms from Ready pin.

Table 24 Input Command Parameters

Field Name	Description	Value	Remark
MID	9	Message ID	
Command	0…3	0: Query Man-Down interrupt state 1: Enable Man-Down interrupt 2: Disable Man-Down interrupt 3: Config Man-Down parameters	3:only config parameters, no interrupt function
Mode	0…2, 9	0: Set Free-Fall mode 1: Set Static mode 2: Set Tilt mode 9:Query interrupt mode	9:only for command 0, Query used

Duration	0 -> 100..1300 1 -> 1..1800 2 -> 1..1800	0: Set Free-Fall interrupt duration 1: Set Static interrupt duration 2: Set Tilt interrupt duration	0->ms 1->sec 2->sec
Threshold	0…90	Set Tilt interrupt threshold	deg
CheckSum			
<CR><LF>			

Table 25 Output Command Parameters

Field Name	Description	Value	Remark
MID	9	Message ID	
Valid	0..1	1: command valid 0: command invalid	
Interrupt	0..1	1: Enable interrupt 0: Disable interrupt	
Mode	0…2	0: Free-Fall mode 1: Static mode 2: Tilt mode	
Duration	0 -> 100..1300 1 -> 5..1800 2 -> 3..1800	0: Set Free-Fall interrupt duration 1: Set Static interrupt duration 2: Set Tilt interrupt duration	0->ms 1->sec 2->sec
Threshold	0…90	Set Tilt interrupt threshold	deg
CheckSum			
<CR><LF>			

Table 26 Example		
Input	**Output**	**Description**
$PGSC,9,0,0,0*0E	$PGSR,9,1,1,0,100*02	Query Man-Down interrupt state
$PGSC,9,1,0,100*0E	$PGSR,9,1,1,0,100*02	Enable Free-fall interrupt
$PGSC,9,1,1,10*3F	$PGSR,9,1,1,1,10*33	Enable Static interrupt
$PGSC,9,1,2,10,45*11	$PGSR,9,1,1, 2,10,45*3D	Enable Tilt interrupt
$PGSC,9,2,0,0*0C	$PGSR,9,1,0*02	Disable Man-Down interrupt
$PGSC,9,0,9,0*07	$PGSR,9,1,1,0,100*02	Query interrupt mode
$PGSC,9,3,2,10,45*13	$PGSR,9,1,0, 3,10,45*3D	Config Tilt parameters without interrupt

3.2.5 Set Standby Mode

Table 27 Input Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	10	Message ID	
Command	0…1	0: Exit Standby mode 1: Enter Standby mode	
CheckSum			
<CR><LF>			

Table 28 Output Command Parameters			
Field Name	**Description**	**Value**	**Remark**
MID	10	Message ID	
Valid	0..1	1: command valid 0: command invalid	
Command	0…1	0: Exit Standby mode 1: Enter Standby mode	
CheckSum			
<CR><LF>			

Table 29 Example		
Input	**Output**	**Description**
$PGSC,10,0 *36	$PGSR,10,1,0*3A	Exit Standby mode
$PGSC,10,1*37	$PGSR,10,1,1*3B	Enter Standby mode

3.3 Antenna Status Protocol (Antenna Advisor)

The function is for external active antenna only.

PGTOP—Status of antenna

Table-12 contains the values for the following example**:**

$PGTOP,11,3 *6F

Table-12: PGACK Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$PGTOP		Protocol header
Command ID	11		Function Type
Reference	3		Value of antenna status

Example:

$PGTOP,11,value*checksum

Value: 1=>Active Antenna Shorted

2=>Using Internal Antenna

3=>Using Active Antenna

3.4 MTK NMEA Command Protocols

Packet Type:

103 PMTK_CMD_COLD_START

Packet Meaning:

Cold Start：Don't use Time, Position, Almanacs and Ephemeris data at re-start.

Example:

$PMTK103*30<CR><LF>

3.5 Firmware Customization Services

GlobalTop also offers flexible, value-adding GPS firmware customization services that maximize the overall system efficiencies and power consumptions. To find out the latest features like Binary Mode, One-Sentence Output, Geo-fencing and Last Position Retention, please visit our website at **www.gtop-tech.com**

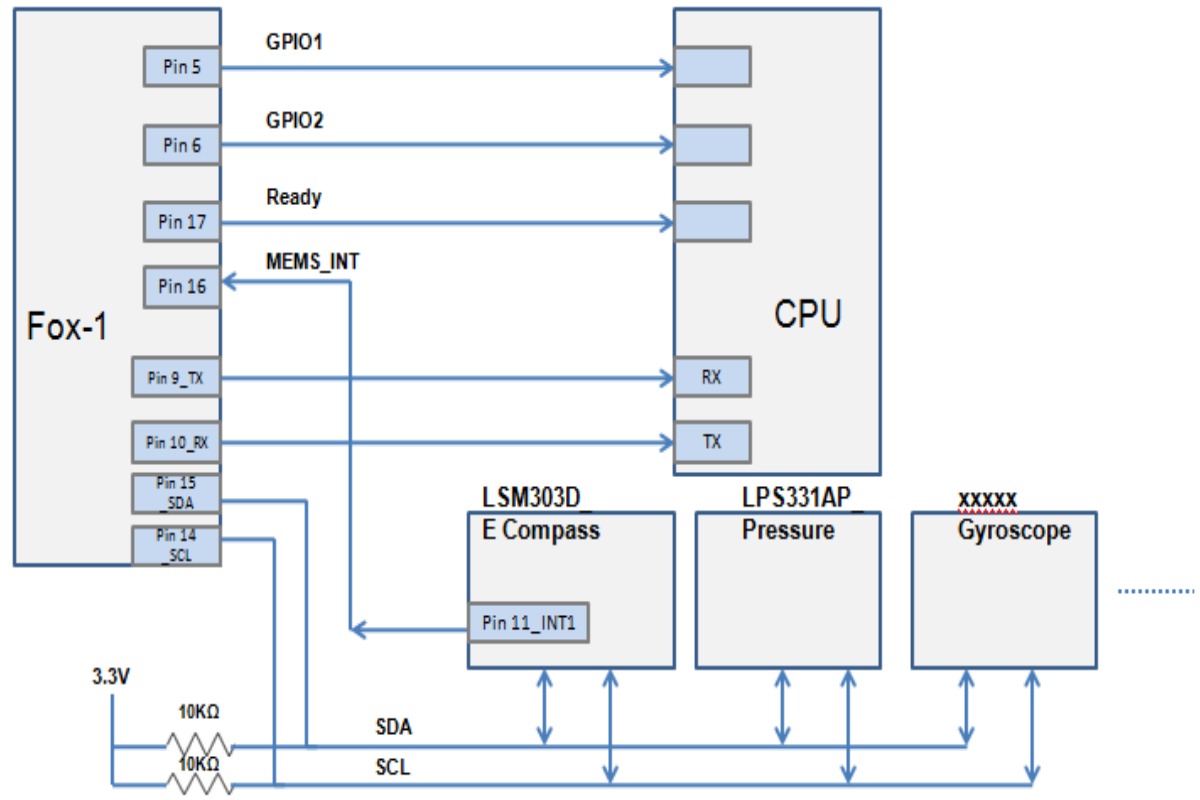
Note that not all firmware customization services listed below are supported for all products.

Please contact GlobalTop sales representatives or technical support for more details.

4. Reference Design

This section introduces the reference schematic design for best performance. Additional tips and cautions on design are well documented in the Application Note which is available upon request.

4.1 Reference Design Circuit



Note:

1. If you need more support and information on antenna implementation, please directly contact us at sales@gtop-tech.com for further services.

5. Packing and Handling

FOX-1, like any other SMD devices, is sensitive to moisture, electrostatic discharge, and temperature. By following the standards outlined in this document for GlobalTop module storage and handling, the chances of them being damaged during production set-up can be reduced. This section will walk you through the basics on how GlobalTop packages its modules to ensure they arrive at their destination without any damages and deterioration to performance quality. It includes cautionary notes for prior to the surface mount process.

⚠ **Please read the sections II to V carefully to avoid permanent damages due to moisture intake.**

⚠ **GPS receiver modules contain highly sensitive electronic circuits and are electronic sensitive devices. Improper handling without ESD protections may lead to permanent damages to the modules. Please read section VI for more details.**

5.1 Moisture Sensitivity

GlobalTop modules are moisture sensitive, and must be pre-baked before going through the solder reflow process. It is important to know that:

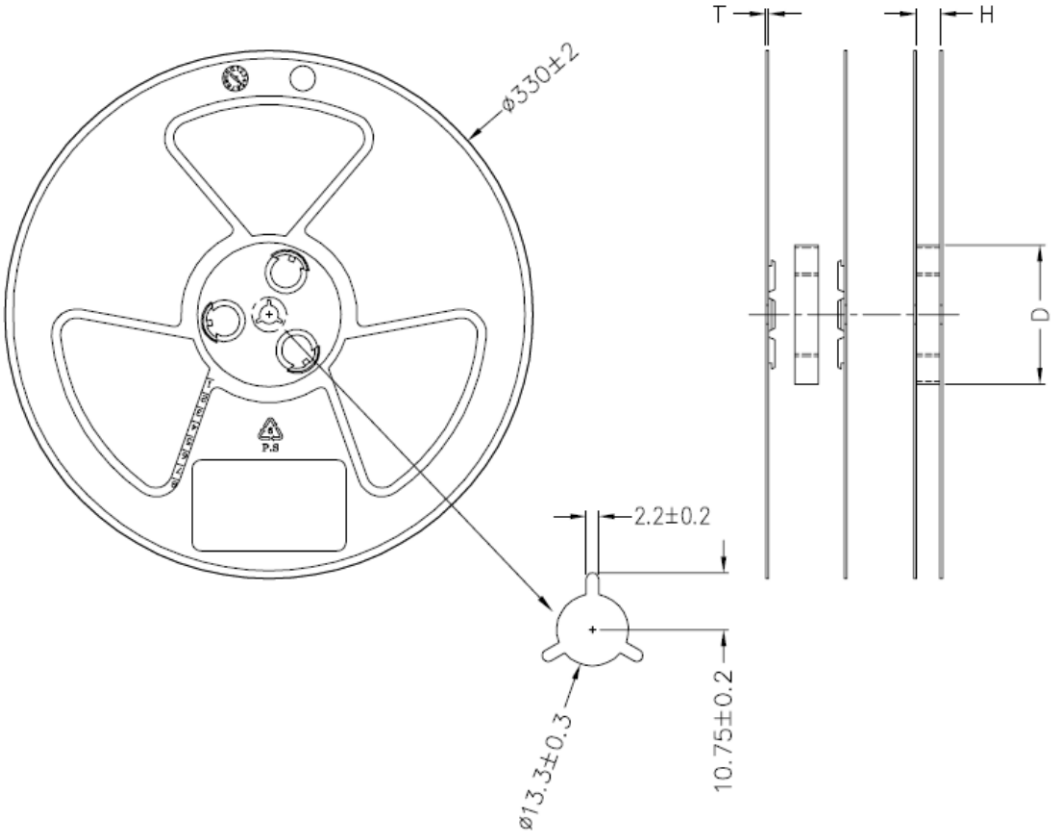
GlobalTop GPS modules must complete solder reflow process in 72 hours after pre-baking.

This maximum time is otherwise known as “Floor Life”

If the waiting time has exceeded 72 hours, it is possible for the module to suffer damages during the solder reflow process such as cracks and delamination of the SMD pads due to excess moisture pressure.

5.2 Tape Reel Packing Information

250pcs/Reel

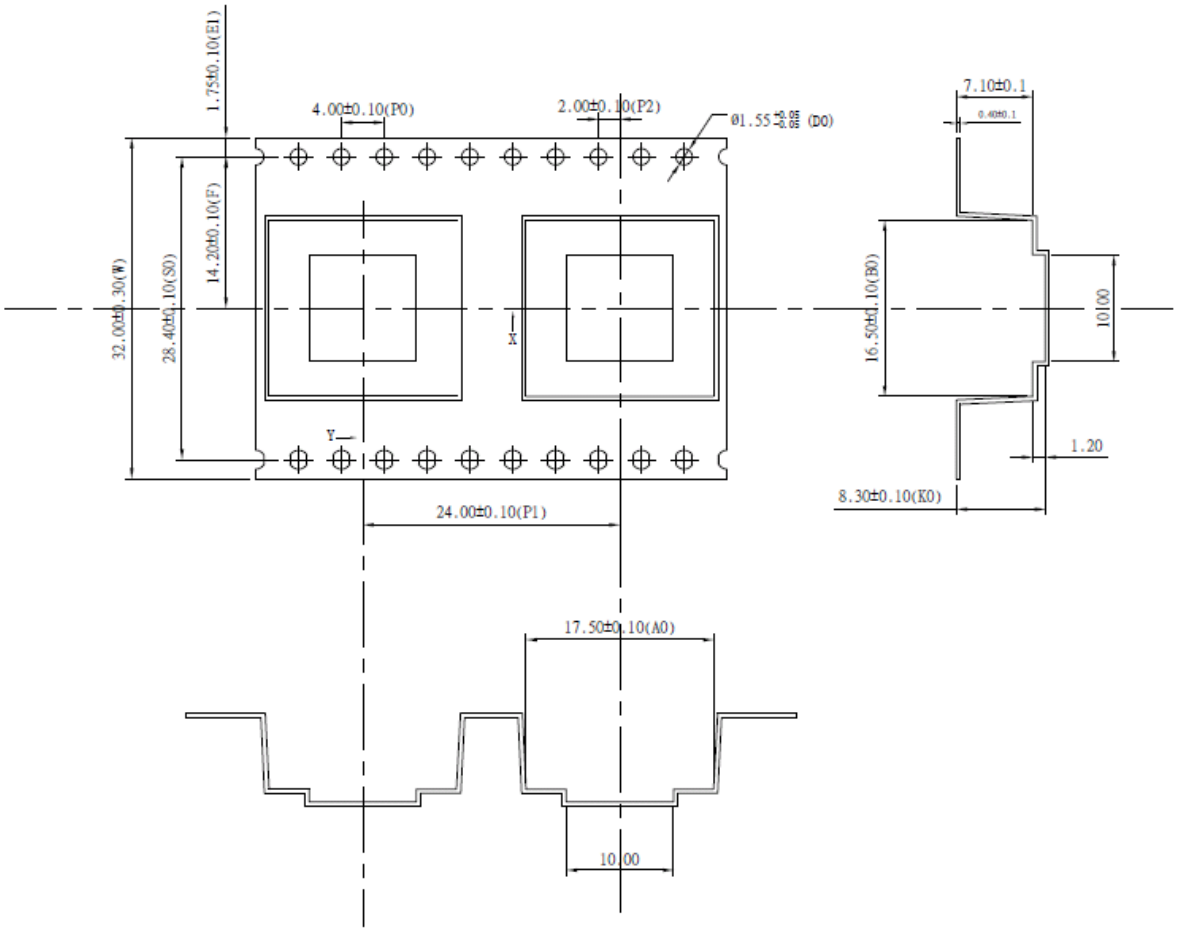


Spec: H: 32.5±1.5, T: 2.2±0.2, D: 99±1.5

Note: 13”Reel , Material : P.S

Unit: (mm)

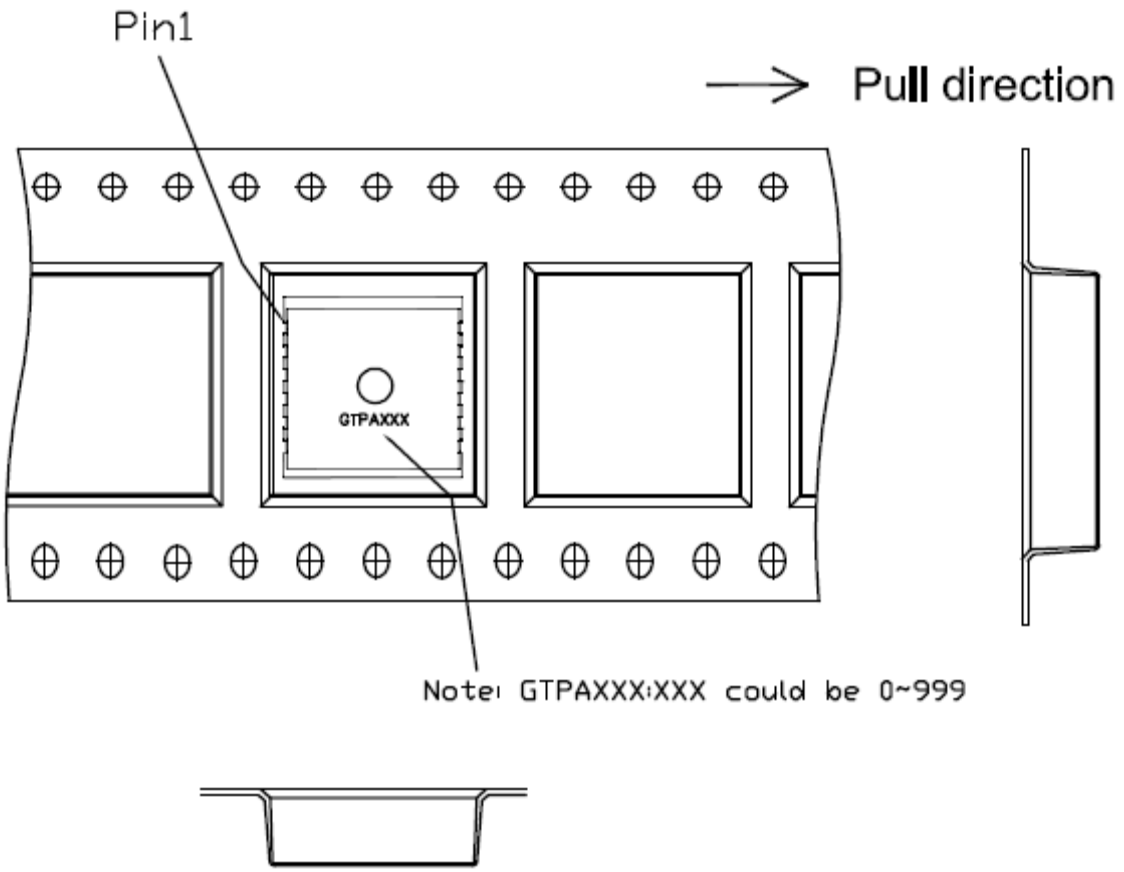
Figure 1: Reel Dimension



A0	17.5±0.10
B0	16.5±0.10
K0	8.3±0.10

Unit: (mm)

Figure 2: Tape Dimension



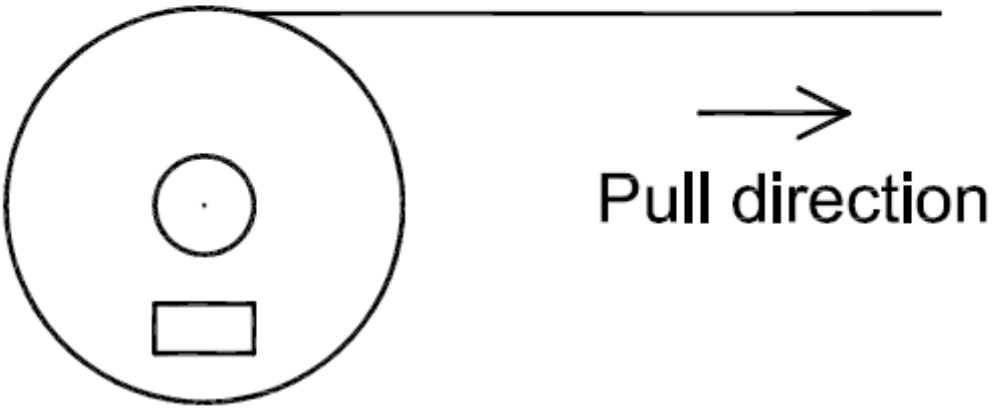
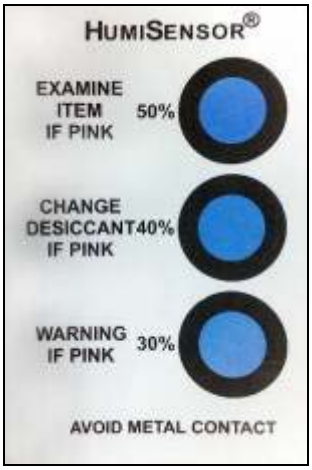


Figure 3: Tape Orientation

The moisture color coded card provides an insight to the relative humidity in percentage (RH). When the GPS modules are taken out, it should be around or lower than 30% RH level.

Outside each electrostatic bag is a caution label for moisture sensitive device.



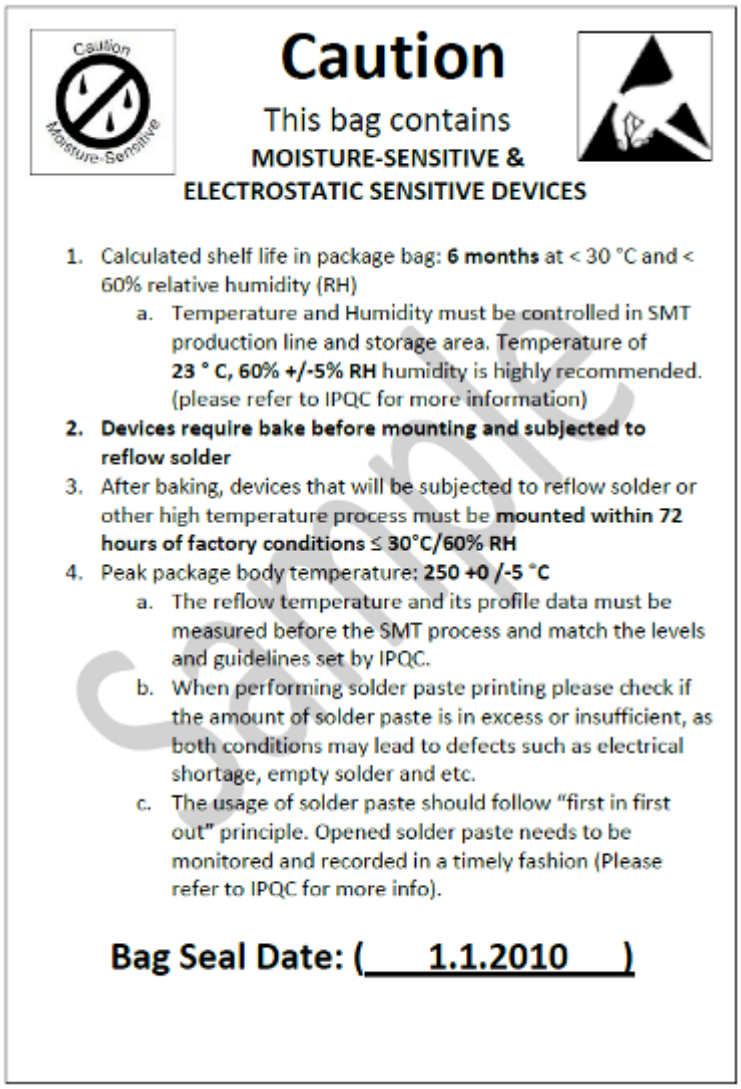


Figure 4: Example of moisture color coded card and caution label

5.3 Storage and Floor Life Guideline

Since GlobalTop modules must undergo solder-reflow process in 72 hours after it has gone through pre-baking procedure, therefore if it is not used by then, it is recommended to store the GPS modules in dry places such as dry cabinet.

The approximate shelf life for GlobalTop GPS modules packages is 6 months from the bag seal date, when store in a non-condensing storage environment (<30°C/60% RH)

⚠ **It is important to note that it is a required process for GlobalTop GPS modules to undergo pre-baking procedures, regardless of the storage condition.**

5.4 Drying

When GPS modules exposed to high temperature of solder reflow, the moisture vapor pressure inside the GPS modules increase greatly. In order to prevent internal delaminating, cracking of the device or the "popcorn" phenomenon, to undergo pre-baking procedure become necessary prior to any high temperature or solder reflow process.

The recommended baking time for GlobalTop GPS module is as follows:

- ✓ **60°C for 8 to 12 hours**

Once baked, the module's floor life will be "reset", and has additional 72 hours in normal factory condition to undergo solder reflow process.

⚠ **Please limit the number of times the GPS modules undergoes baking processes as repeated baking process has an effect of reducing the wetting effectiveness of the SMD pad contacts. This applies to all SMT devices.**

⚠ **Oxidation Risk: Baking SMD packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive, can result in solderability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solderability considerations. The cumulative bake time at a temperature greater than 90°C and up to 125°C shall not exceed 96 hours. Bake temperatures higher than 125°C are not allowed.**

5.5 ESD Handling

Please carefully follow the following precautions to prevent severe damage to GPS modules.

GlobalTop GPS modules are sensitive to electrostatic discharges, and thus are Electrostatic Sensitive Devices (ESD). Careful handling of the GPS modules particularly to its patch antenna (if included) and RF_IN pin. Please follow the standard ESD safety practices stated below:

- ✓ Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
- ✓ Before working with RF_IN pin, please make sure the GND is connected
- ✓ When working with RF_IN pin, do not contact any charged capacitors or materials that can easily develop or store charges such as patch antenna, coax cable, soldering iron.
- ✓ Please do not touch the mounted patch antenna to prevent electrostatic discharge from the RF input
- ✓ When soldering RF_IN pin, please make sure to use an ESD safe soldering iron tip.

6. Reflow Soldering Temperature Profile

The following reflow temperature profile was evaluated by GlobalTop and has been proven to be reliable qualitatively. Please contact us beforehand if you plan to solder this component using a deviated temperature profile as it may cause significant damage to our module and your device.

All the information in this sheet can only be used only for Pb-free manufacturing process.

6.1 SMT Reflow Soldering Temperature Profile
(Reference Only)

Average ramp-up rate (25 ~ 150°C): 3°C/sec. max.

Average ramp-up rate (270°C to peak): 3°C/sec. max.

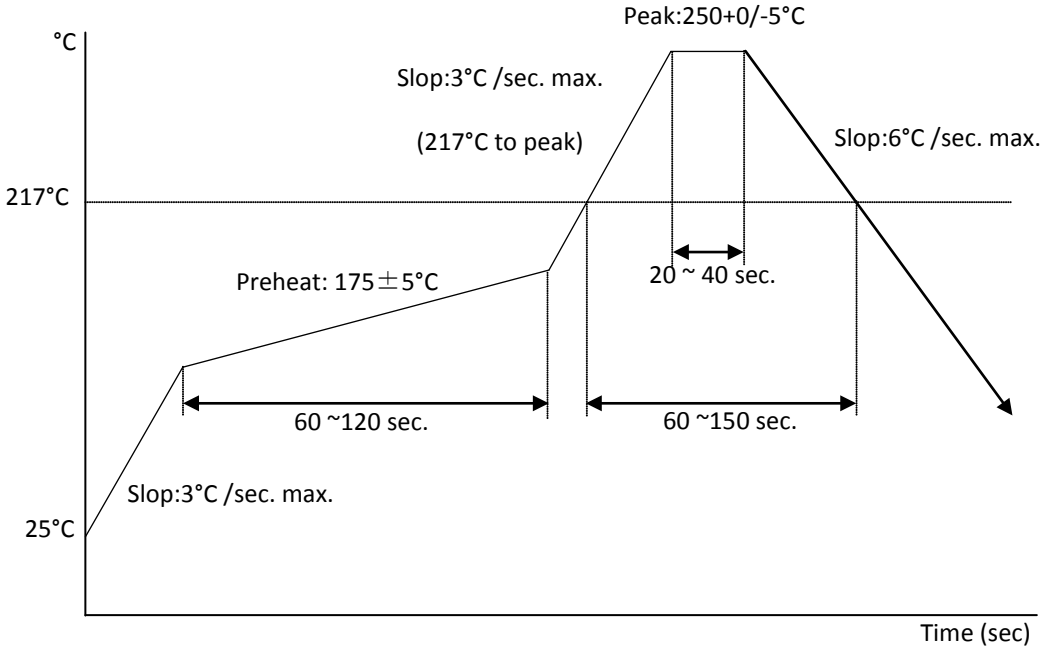
Preheat: 175 ± 25°C, 60 ~ 120 seconds

Temperature maintained above 217°C: 60~150 seconds

Peak temperature: 250 +0/-5°C, 20~40 seconds

Ramp-down rate: 6°C/sec. max.

Time 25°C to peak temperature: 8 minutes max.



	Details	Suggestions	Notes
1	Before proceeding with the reflow-soldering process, the GPS module must be pre-baked.	Pre-bake Time: 6 Hours @ 60°±5°C or 4 Hours @ 70°±5°C	**The maximum tolerated temperature for the tray is 100°C.** **After the pre-baking process, please make sure the temperature is sufficiently cooled down to 35°C or below in order to prevent any tray deformation.**
2	Because PCBA (along with the patch antenna) is highly endothermic during the reflow-soldering process. Extra care must be paid to the GPS module's solder joints if any signs of cold weld(ing) or false welding.	The parameters of the reflow temperature must be set accordingly to module's reflow-soldering temperature profile.	**Double check to see if the surrounding components around the GPS module are displaying symptoms of cold weld(ing) or false welding.**
3	Special attentions are needed for PCBA board during reflow-soldering to see if there are any symptoms of bending or deformation to the PCBA board, possibly due to the weight of the module. If so, this will cause concerns at the latter half of the production process.	A loading carrier fixture must be used with PCBA if the reflow soldering process is using rail conveyors for the production.	**If there is any bending or deformation to the PCBA board, this might causes the PCBA to collide into one another during the unloading process.**
4	Before the PCBA is undergoing a reflow-soldering process, the production operators must check with own eyes to see if there are positional offset to the module, because it will be difficult to readjust after the module has gone through reflow-soldering process.	The operators must check with own eyes and readjust the position before reflow-soldering process.	**If the operator is planning to readjust the module position, please do not touch the patch antenna while the module is hot in order to prevent rotational offset between the patch antenna and module**

Note: References to patch antenna is referred to GPS modules with integrated Patch-on-top antennas (PA/Gms Module Series), and may not be applicable to all GPS modules.

	Details	Suggestions	Notes
5	Before handling the PCBA, they must be cooled to 35°C or below after they have undergone a reflow-soldering process, in order to prevent positional shift which may occurred when the module is still hot.	1. One may use electric fans behind the reflow machine to cool them down. 2. Cooling the PCBA can prevent the module from shifting due to fluid effect.	**It is very easy to cause positional offset to the module and its patch antenna when handling the PCBA under high temperature.**
6	1. When separating the PCBA panel into individual pieces using the V-Cut process, special attentions are needed to ensure that there are sufficient gap between patch antennas. 2. If V-Cut process is not available and the pieces must be separated manually, please make sure the operators are not using excess force which may cause rotational offset to the patch antennas.	1. The blade and the patch antenna must have a distance gap greater than 0.6mm. 2. Do not use patch antenna as the leverage point when separating the panels by hand.	**1. Test must be performed first to determine if V-Cut process is going to be used. Ensure that there is enough space between the blade and the patch antenna so that they do not touch one another.** **2. An uneven amount of manual force applied to the separation will likely to cause positional shift in patch antenna and module.**
7	When separating panel into individual pieces during latter half of the production process, special attentions are needed to ensure the patch antennas do not come in contact with one another in order to prevent chipped corners or positional shifts.	Use tray to separate individual pieces.	**It is possible to chip corner and/or cause a shift in position if patch antennas come in contact with each other.**

Note: References to patch antenna is referred to GPS modules with integrated Patch-on-top antennas (PA/Gms Module Series), and may not be applicable to all GPS modules.

Other Cautionary Notes on Reflow-Soldering Process:

1. Module must be pre-baked **before** going through SMT solder reflow process.
2. The usage of solder paste should follow "First-in-First out" principle. Opened solder paste needs to be monitored and recorded in a timely manner (refer to IPQC standards for related documentation and examples).
3. Temperature and humidity must be controlled within SMT production line and storage area. Temperature of 23°C, 60±5% RH humidity is recommended. (please refer to IPQC standards for related documentation and examples)
4. When performing solder paste printing, please notice if the amount of solder paste is in excess or insufficient, as both conditions may lead to defects such as electrical shortage, empty solder and etc.
5. Make sure the vacuum mouthpiece is able to bear the weight of the GPS module to prevent positional shift during the loading process.
6. Before the PCBA is going through the reflow-soldering process, the operators should check with his/her own eyes to see if there are positional offset to the module.
7. The reflow temperature and its profile data must be measured before the SMT process and match the levels and guidelines set by IPQC.
8. If SMT protection line is running a double-sided process for PCBA, please process GPS module during the second pass only to avoid repeated reflow exposures of the GPS module. Please contact GlobalTop beforehand if you must process GPS module during the 1st pass of double-side process.

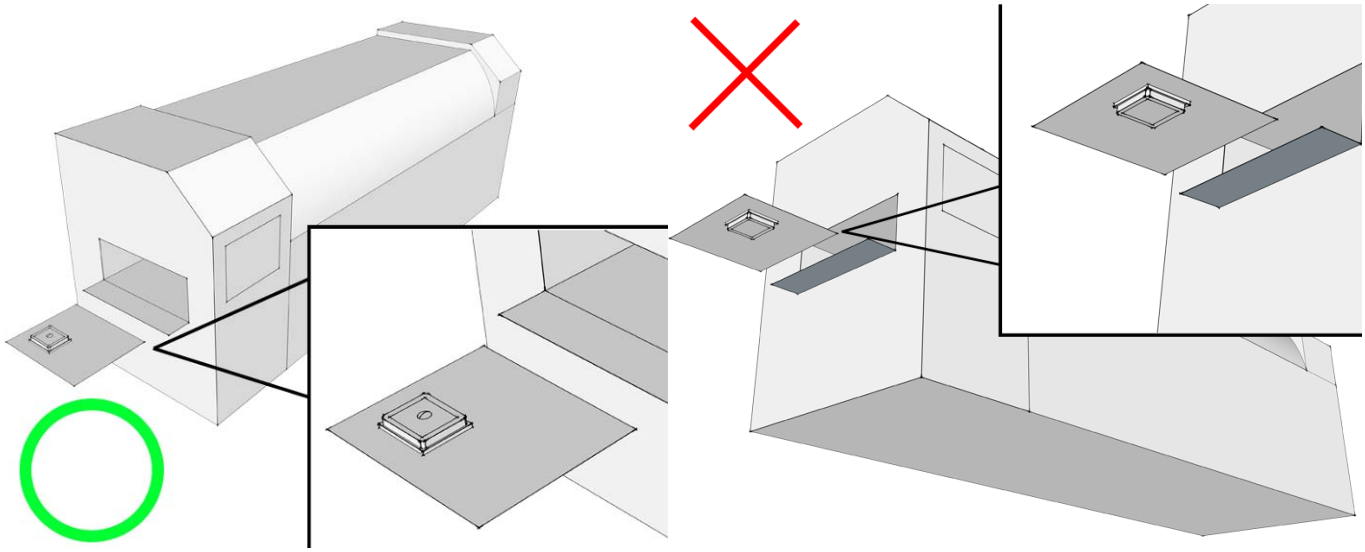


Figure 5: Place GPS module right-side up when running reflow-solder process, do not invert.

6.2 Manual Soldering

Soldering iron:

Heat temperature: under 380°C | Time: Under 3 sec.

Notes:

1. Please do not directly touch the soldering pads on the surface of the PCB board to prevent further oxidation
2. The solder paste must be defrosted to room temperature before use so it can return to its optimal working temperature. The time required for this procedure is unique and dependent on the properties of the solder paste used.
3. The steel plate must be properly assessed before and after use, so its measurement stays strictly within the specification set by SOP.
4. Please watch out for the spacing between soldering joint, as excess solder may cause electrical shortage
5. Please exercise with caution and do not use extensive amount of flux due to possible siphon effects on neighboring components, which may lead to electrical shortage.
6. Please do not use the heat gun for long periods of time when removing the shielding or inner components of the GPS module, as it is very likely to cause a shift to the inner components and will leads to electrical shortage.

7. Contact Information

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