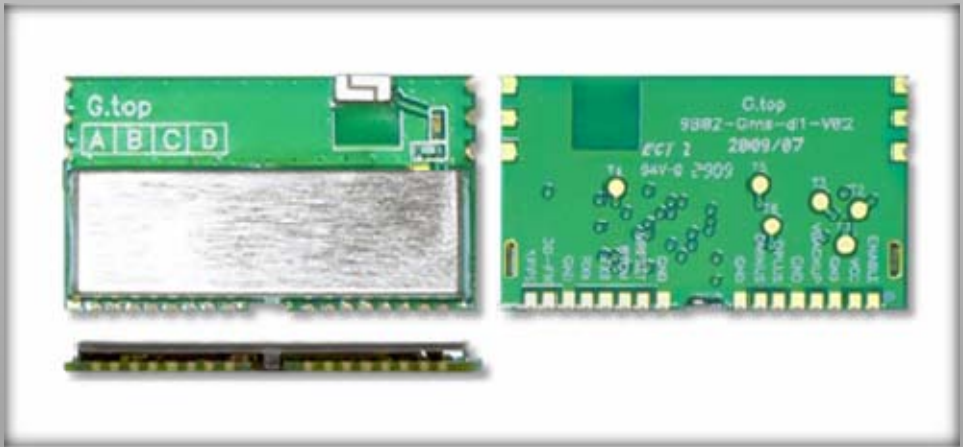
GlobalTop Technology Inc.

Gms-d1
GPS Antenna Module
Datasheet

Revision: V0F



The Gms-d1 is a stand-alone GPS antenna module with ultra-high sensitivity (-165dBm) in an ultra-slim form factor (24*14*2.1mm), while utilizing the latest in MediaTek GPS solution.

Datasheet

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Title	**GlobalTop Gms-d1 Datasheet**
Subtitle	**GPS Antenna Module**
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Doc Id	**GR9802-DS000F**

Revision	Date	Author	Description
V0A	2009-07-31	Frank	First Release
V0B	2009-09-10	Frank	Add Chapter 4 : Application Add Chapter 5: Layout Guide and Ground Plane
V0C	2009-09-16	Gavin	Add System Block Diagram Add Footprint (Top View) Typo Correction
V0D	2009-10-28	Delano	Add Reflow Thermal Profile
V0E	2010-01-28	Brian Wang	Add Accuracy and RTCM
V0F	2010-03-23	Eric Yeh	Add Packing and Handling Section, design application note

Table of Contents

1. Functional Description

1.1 Overview

The GlobalTop Gms-d1 is a high sensitivity, low power and ultra-slim GPS antenna module. Gms-d1 can support up to 66 channels of satellite searching. Even at high speed vehicle movement, Gms-d1 has special function to provide maximum update rate 10Hz to give customers more precise position fix and vehicle velocity. It delivers major advancements in GPS performances, accuracy, integration, power consumption and flexibility. It is designed to be suitable for embedded system integration and simplifies the design procedure by antenna module structure. Gms-d1 module is the best choice for integrating GPS function in to system design.

Application

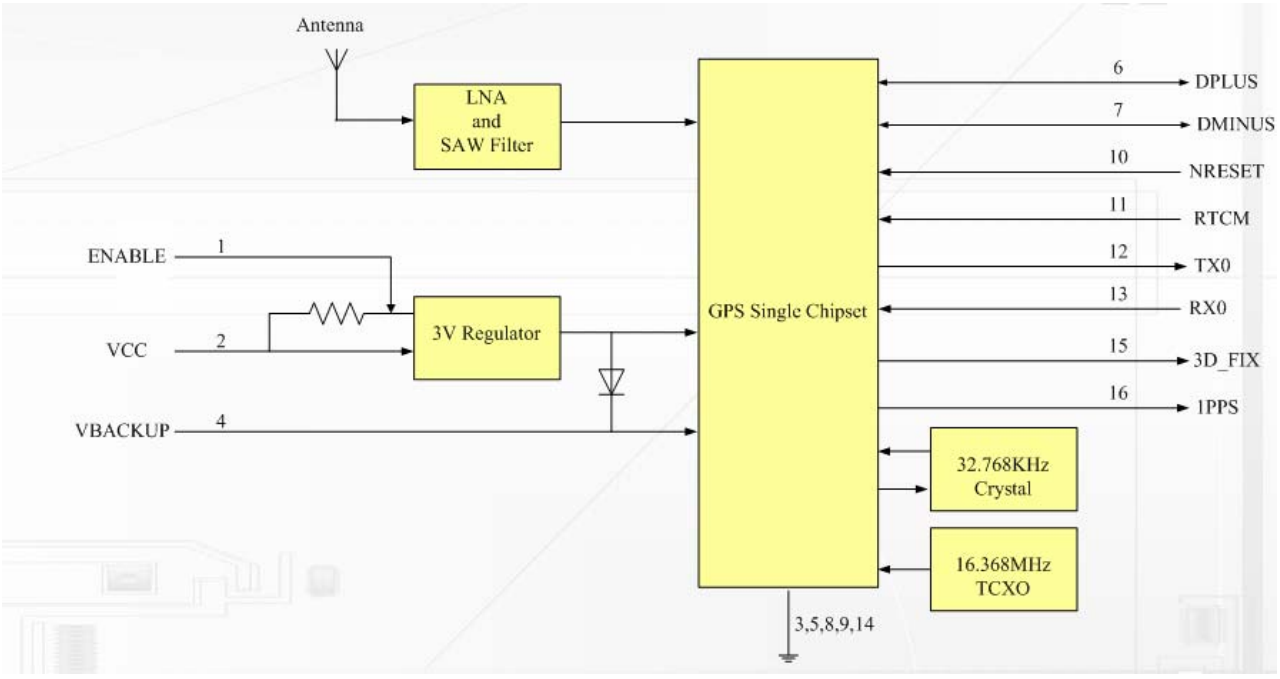
- Digital camera
- Personal tracker
- Bike computer
- Mobile phone
- PND

1.2 Highlights and Features

- Ultra-high sensitivity, -165dBm[1]
- L1 Frequency, C/A code, 66-channels satellite searching
- AGPS support for fast positioning (offline mode: EPO valid up to 14 days)
- DGPS(WAAS/EGNOS/MSAS/GAGAN) support
- Multi-path detection and compensation
- E-GSM-900 band rejection
- E911 compliance
- USB Interface support
- High update rate, up to 10Hz (configurable by firmware)
- Magnetic Variation function support (configurable by Gtop customized firmware)
- Low power consumption, 48mA acquisition, 37mA tracking
- Low shut-down current consumption, 15uA typical
- Ultra-slim form factor, 24*14*2.1mm
- RoHS compliant

[1] Reference to GPS chipset specification

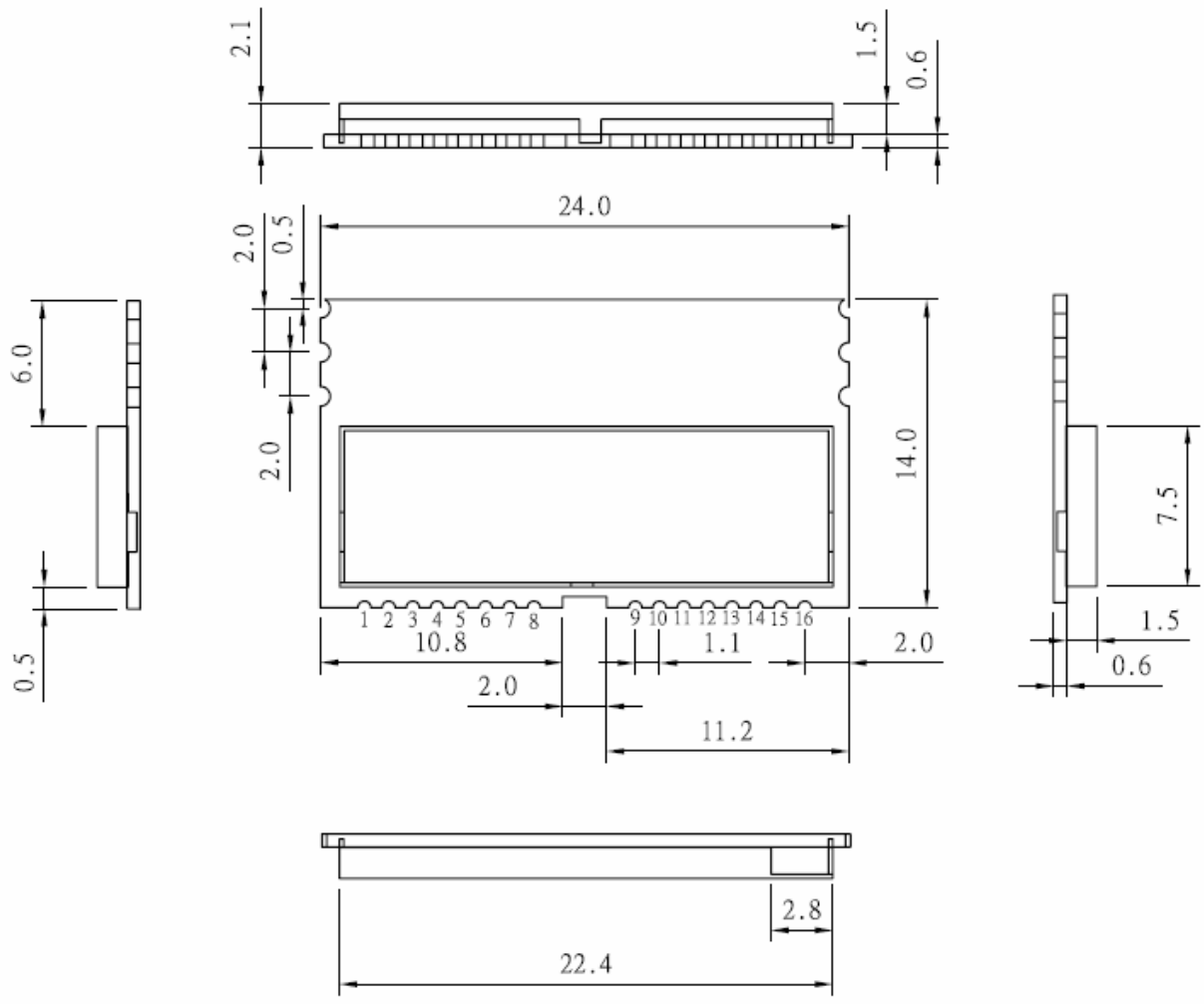
1.3 System Block Diagram



2. Specifications

Unit: mm

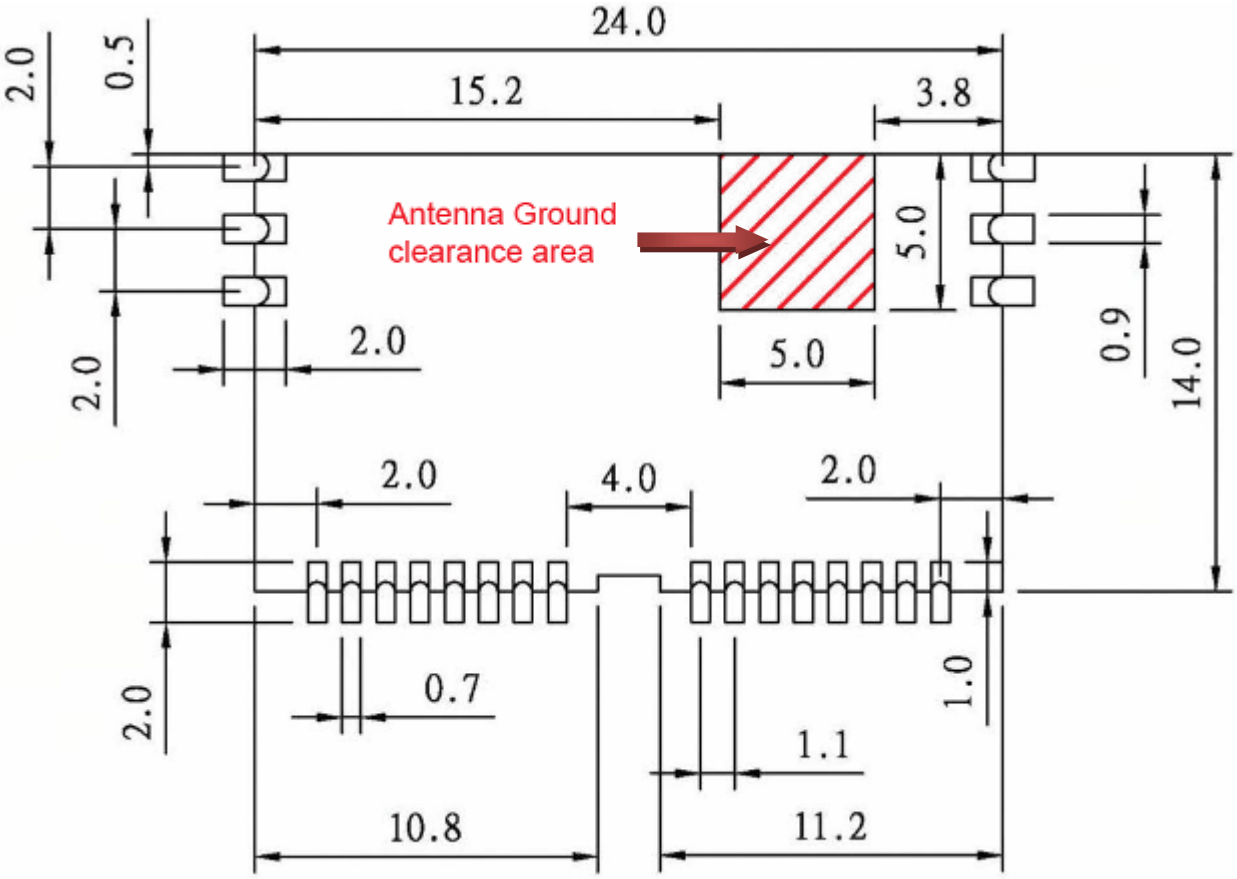
Mechanical



Top View

Unit: mm

Recommend PCB pad Layout (Top View)



Note:

1. Tolerance of recommended control pad: 0.7*2.0mm (±0.1mm)
2. Recommended Ground pad: 2.0*0.9mm (±0.1mm)
3. All traces of metallization such as copper circuits and pins must be removed in all PCB layers beneath antenna ground clearance area. Please see page 22 for more details.

2.1 Pin Assignment

Pin	Name	I/O	Description & Note
1	ENABLE	I	Keep open or pull high to Power ON
2	VCC	PI	Main DC power input
3	GND	P	Ground
4	VBACKUP	PI	Backup power input for RTC & navigation data keep
5	GND	P	Ground
6	DPLUS	I/O	USB port D+
7	DMINUS	I/O	USB port D-
8	GND	P	Ground
9	GND	P	Ground
10	NRESET	I	Reset Input, Low Active
11	RTCM	I	Serial Data Input for DGPS RTCM data streaming
12	TX0	O	Serial Data Output for NMEA output
13	RX0	I	Serial Data Input for Firmware update
14	GND	P	Ground
15	3D_FIX	O	3D-fix indicator
16	1PPS	O	1PPS Time Mark Output 2.8V CMOS Level

2.2 Description of I/O Pin

ENABLE, Pin1

Keep open or pull high to Power ON. Pull low to shutdown the module.

Enable (High): 1.6V<= V_{enable}<=VCC

Disable (Low): 0V<= V_{enable}<=0.3V

VCC, Pin2

The main DC power supply for the module. The voltage should be kept between from 3.3V to 5.5V. **The ripple must be controlled under 50mV_{pp} (Typical: 3.3V)**

GND, Pin3

Ground

VBACKUP, Pin4

This is the power for GPS chipset to keep RTC running when main power is removed. The voltage should be kept between 2.0V~4.0V, **Typical 3.0V**

To use the function related to VBACKUP, this pin must be connected to a power supply.

GND, Pin5

Ground

DPLUS, Pin6

USB Port DPLUS signal (Differential Signal +)

DMINUS, Pin7

USB Port DMINUS signal (Differential Signal －)

GND, Pin8

Ground

GND, Pin9

Ground

NRESET, Pin10

Low active , it causes the module to reset. If not used, keep floating

RTCM, Pin11

This pin receive DGPS data of RTCM protocol (TTL level) ,if not used keep floating

TX0, Pin12

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

RX0, Pin13

This is the UART receiver of the module. It is used to receive commands from system

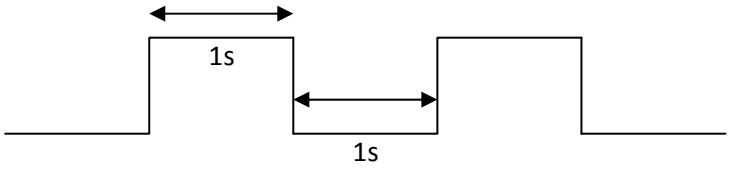
GND, Pin14

Ground

3D-FIX, Pin15

The 3D-FIX was assigned as fix flag output. If not used, keep 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

1PPS, Pin16

This pin provides one pulse-per-second output from the module, which is synchronized to GPS time. If not used, keep floating; default duration 100ms

2.3 Specification List

Parameter	Description
GPS Solution	MTK MT3329
Frequency	L1, 1575.42MHz
Sensitivity[1]	Acquisition -148dBm, cold start Reacquisition -160dBm Tracking -165dBm
Channel	66 channels
TTFF[1]	Hot start: 1 second typical Warm start: 33 seconds typical Cold start: 35 seconds typical
Position Accuracy	Without aid:3.0m 2D-RMS <3m CEP(50%) without SA(horizontal) DGPS(RTM,SBAS(WAAS,EGNOS,MSAS)):2.5m
Velocity Accuracy	Without aid : 0.1m/s DGPS(RTM,SBAS(WAAS,EGNOS,MSAS)):0.05m/s Without aid:0.1 m/s^2
Acceleration Accuracy	Without aid:0.1 m/s^2 DGPS(RTM,SBAS(WAAS,EGNOS,MSAS)):0.05m/s^2
Altitude	Maximum 18,000m (60,000 feet)
Velocity	Maximum 515m/s (1000 knots)
Acceleration	Maximum 4G
Update Rate	1Hz (default), maximum 10Hz
Baud Rate	9600 bps (default)
DGPS	RTCM protocol(configuable by firmware) or SBAS(defult) [WAAS, EGNOS, MSAS,GAGAN]
AGPS	Support
Power Supply	VCC：3.3V to 5.5V；VBACKUP：2.0V to 4.0V
Current Consumption	48mA acquisition, 37mA tracking Shut-down current consumption 15uA typical
Working Temperature	-40 ℃ to +85 ℃
Dimension	24x14x2.1 mm, SMD
Weight	1.2g

[1] Reference to GPS chipset specification

2.4 Absolute Maximum Ratings

The voltage applied for VCC should not exceed 6VDC;

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	VCC	–	3.3	5.5	**V**
Backup battery Voltage	VBACKUP	2.0	3.0	4.0	**V**

2.5 Operating Conditions

Parameter	Condition	Min.	Typ.	Max.	Unit
Operation supply Ripple Voltage	–	–	–	50	**mVpp**
RX0 TTL H Level	VCC=3.3V	2.1	–	VCC	**V**
RX0 TTL L Level	VCC=3.3V	0	–	0.9	**V**
TX0 TTL H Level	VCC=3.3V	2.1	–	2.8	**V**
TX0 TTL L Level	VCC=3.3V	0	–	0.8	**V**
RTCM TTL H Level	VCC=3.3V	2.1	–	VCC	**V**
USB D+	Standard	–	–	–	**V**
USB D-	Standard	–	–	–	**V**
RTCM TTL L Level	VCC=3.3V	0	–	0.9	**V**
Current Consumption @ 3.3V	Acquisition	43	48	53	**mA**
	Tracking	32	37	42	**mA**
Backup Power Consumption@ 3.0V	25℃	–	10	–	**uA**

3. Protocols

NMEA Output Sentence

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. Recommended Minimum Navigation Information.
VTG	Course and speed information relative to the ground.

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-sae-level
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.8	meters	
Units	M	meters	Units of geoid 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,,,A*55

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		degrees	E=east or W=west **(Need GlobalTop Customization Service)**
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*65		
<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 (Need 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

MTK NMEA Command Protocol

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>

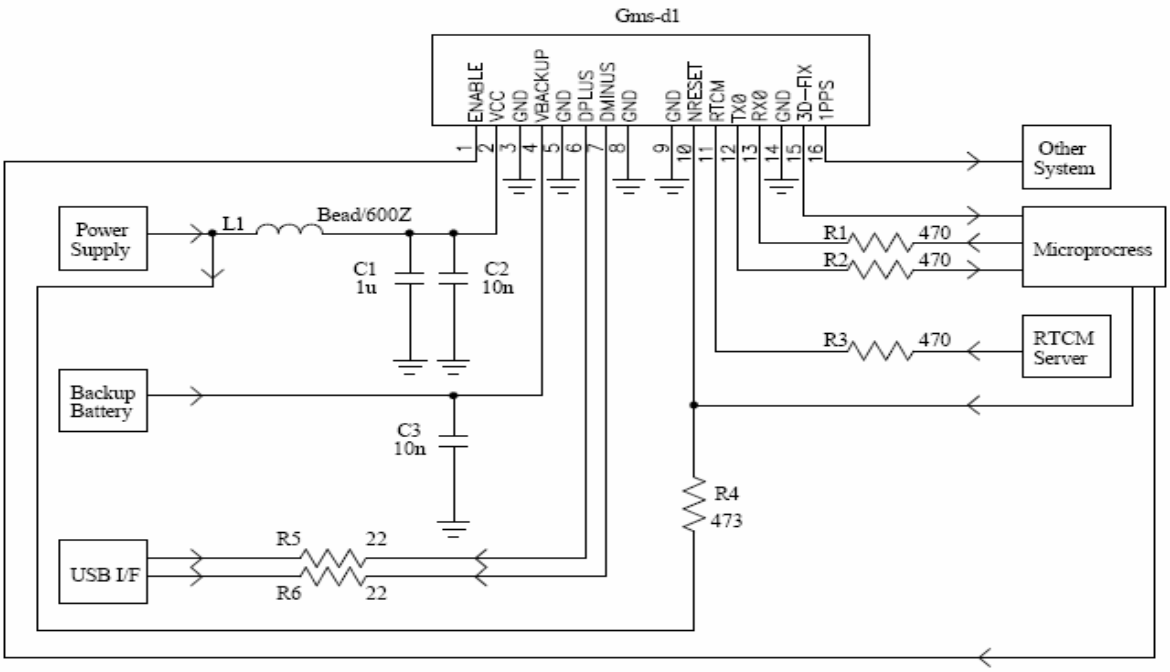
4. Application

4.1 Description

This document introduces the reference schematic and the ground plane design for the best performance.

It also shows the performance comparison table in different ground plane design. It can help customer to get better performance.

4.2 Reference Design Circuit



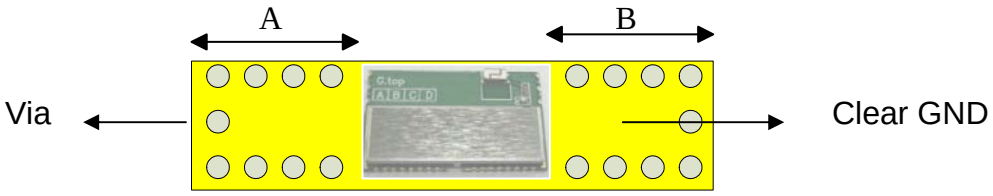
Notice:

1. Ferrite bead L1 was add for power noise reduction.
2. C1 and C2 decoupling capacitor should put near module.
   For C1, the value depends on system noise, range 1uF~100uF is reasonable.
3. Damping resistors R1, R2, R3, R5 and R6 should be fine-tuned for system application.

5. Layout Guide and Ground Plane

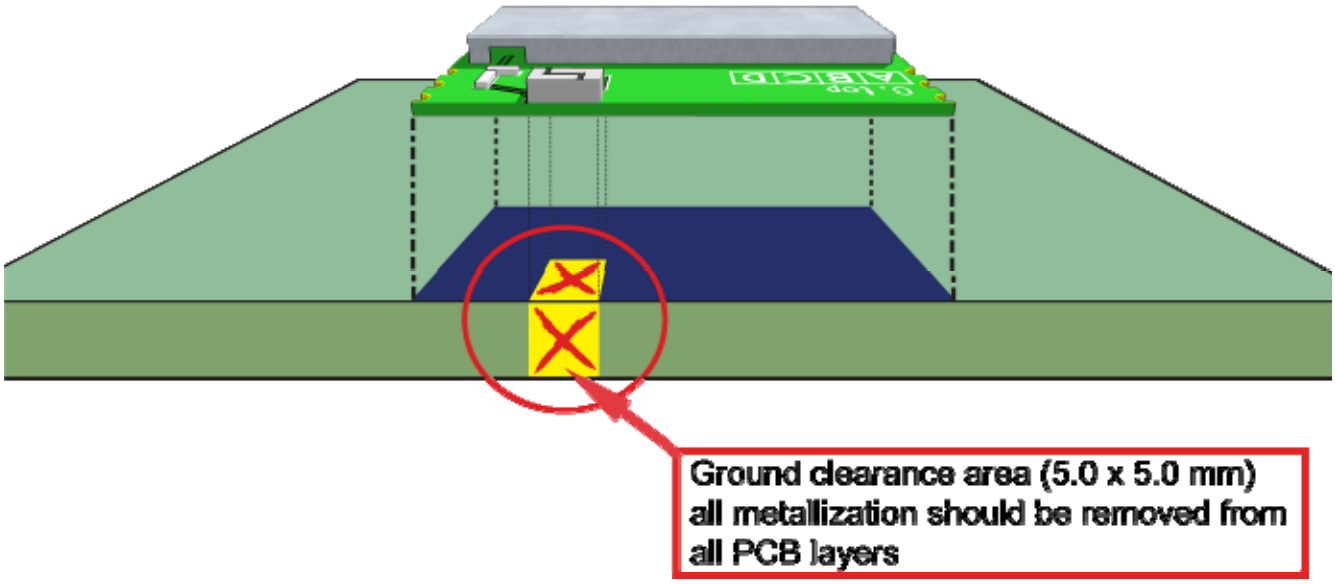
5.1 Basic Ground Plane

Be noted that the antenna module need a clear ground plan beside the GPS module as shown in A and B area. It will be better if place GND via through top and bottom layer.



A	B	Sensitivity(typical)
10 mm	10 mm	-158 dBm

When designing the PCB for Gms-d1, it is crucial that all metallization in all PCB layers beneath the antenna is removed. This antenna ground clearance area must contain ***no*** traces of metal and/or copper circuits in order for the GPS module to have a clear reception of GPS signals. Please refer to page 8 for recommended PCB pad layout.

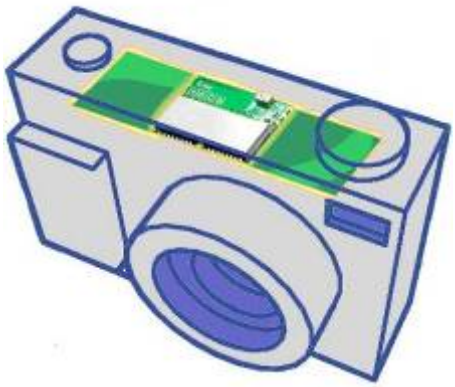


5.2 Performance Improvement from Ground Plane

In order to increase the sensitivity for the overall module, if the ground space A, B can be increased then the better sensitivity can be archive improvements as listed table as following.

A	B	Sensitivity(typical)
15 mm	10 mm	-159 dBm
15 mm	15 mm	-160 dBm
15 mm	20 mm	-161 dBm
20 mm	20 mm	-162 dBm
20 mm	25 mm	-163 dBm
25 mm	25 mm	-165 dBm

5.3 Suggested GPS Module Layout



6. Packing and Handling

GPS modules, like any other SMD devices, are sensitive to moisture, electrostatic discharge, and temperature. By following the standards outlined in this document for GlobalTop GPS module storage and handling, it is possible to reduce the chances of them being damaged during production set-up. This document will go through the basics on how GlobalTop packages its modules to ensure they arrive at their destination without any damages and deterioration to performance quality, as well as some cautionary notes before going through the surface mount process.

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

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

6.1 Moisture Sensitivity

GlobalTop GPS 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.

6.2 Packing

GlobalTop GPS modules are packed in such a way to ensure the product arrives to SMD factory floor without any damages.

GPS modules are placed individually on to the packaging tray. The trays will then be stacked and packaged together.

Included are:

1. Two packs of desiccant for moisture absorption
2. One moisture level color coded card for relative humidity percentage.

Each package is then placed inside an antistatic bag (or PE bag) that prevents the modules from being damaged by electrostatic discharge.

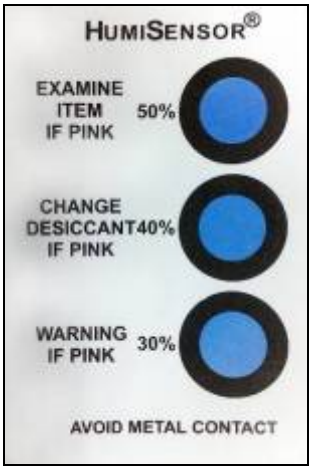
Figure 1: One pack of GPS modules

Each bag is then carefully placed inside two levels of cardboard carton boxes for maximum protection.

Figure 2: Box protection

The moisture color coded card provides an insight to the relative humidity 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.



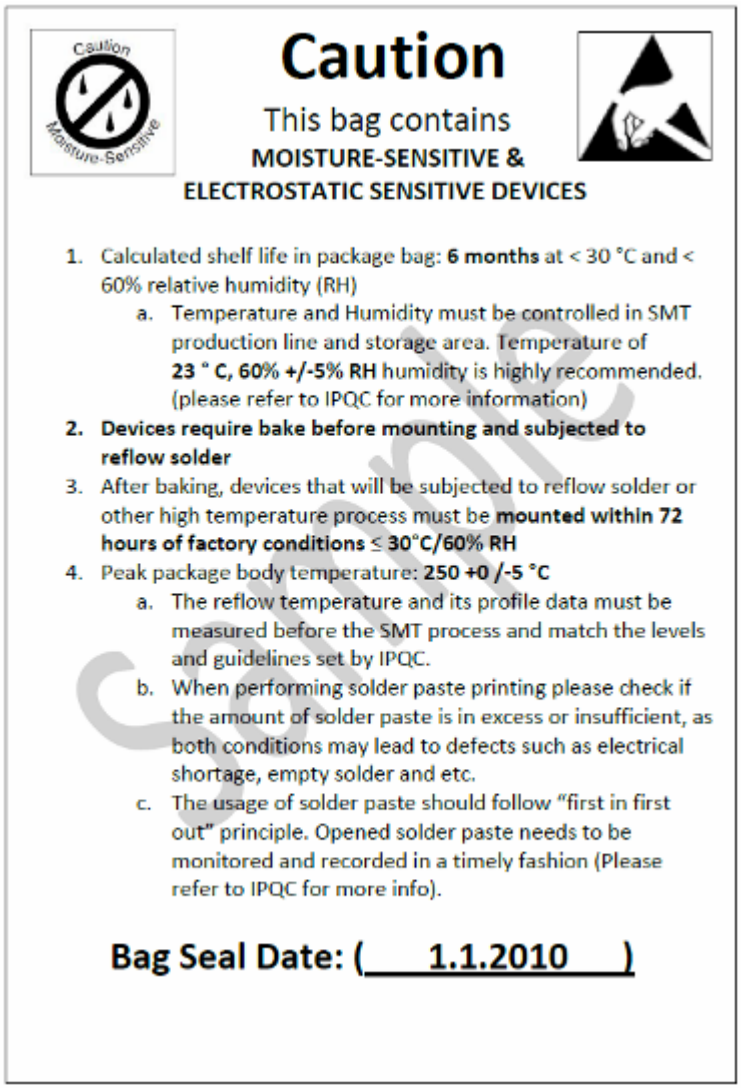


Figure 3: Example of moisture color coded card and caution label

6.3 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.**

6.4 Drying

Because the vapor pressures of moisture inside the GPS modules increase greatly when it is exposed to high temperature of solder reflow, in order to prevent internal delaminating, cracking of the devices, or the “popcorn” phenomenon, it is a **necessary requirement** for GlobalTop GPS module to undergo pre-baking procedure before any high temperature or solder reflow process.

The recommendation 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 now allowed.

6.5 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 and in particular to its patch antenna (if included) and RF_IN pin, must follow the standard ESD safety practices:

- ✓ 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 charges 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).

7. 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.

7.1 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.

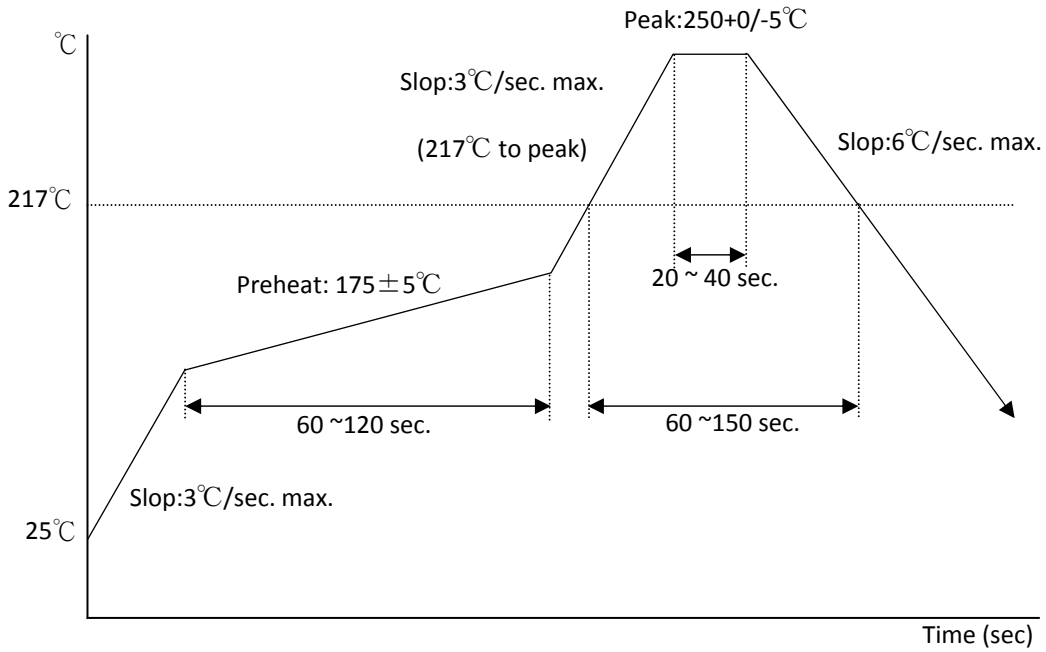
Preheat: 175 ± 25°C 、60 ~ 120 seconds

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.



Notes:

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 fashion (can refer to IPQC for related documentation and examples).
3. Temperature and humidity must be controlled in SMT production line and storage area. Temperature of 23°C, 60±5% RH humidity is recommended. (please refer to IPQC 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. The reflow temperature and its profile data must be measured before the SMT process and match the levels and guidelines set by IPQC.

7.2 Manual Soldering:

Soldering iron:

Bit 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, in order 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.

8. Contact

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