

APPROVAL SHEET

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MODULE NO	MG1613S
SPECIFICATION	MG1613S specification V2.2
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DATE	2011 年 9 月 19 日

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GPS Module MG1613S Specification

Version 2.2

2011/09

Revision history

Title		
Model No		
Document No		
Revision	Date	Description
Ver 1.0	2008.03	Original Draft
Ver 2.0	2011.05	Modified 1.1 overview 1.2 feature 2.1.1 General 2.2.1 DC power 4.1 Definition of Pin assignment
Ver 2.1	2011.08	Modified 2.2.1DC power
Ver 2.2	2011. 09	Modified 5.3 Tapes

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1. Introduction

1.1 Over view

MSB2312 GPS solution is a highly sensitivity, ultra compact single chip for GPS application. It includes RF receiver, a fully-featured baseband processor, a Flash memory and a power management unit. The RF receiver employs a single conversion digital low-IF architecture, the high level integration leaves only few off-chip matching and decoupling components really minimize the system cost. The baseband processor is controlled by adaptive signal processing and navigation firmware optimized for execution on low power microprocessor. Sophisticated adaptive control algorithms provide optimal signal acquisition/tracking strategy.

1.2 Feature

- GPS L1 C/A code
- High sensitivity of -161dBm in tracking & -144dBm in acquisition(cold start)
- RF receiver of noise figure at 2.0dB
- Build in power-on-reset and calibration circuits
- Assisted/Autonomous operation
- Fast TTFF in all modes (a typical outdoor)
 - ✓ hot-start in 1s,
 - ✓ warm-start in 32s
 - ✓ cold-start in 34s
 - ✓ Deep Indoor < 20s typical
- Up to 10,000,000 simultaneous search windows
- 80 acquisition & 20 tracking channels
- DGPS & SBAS (WAAS/EGNOS/MSAS) capable
- Support standard NMEA-0183 & Mstar binary protocol
- TCXO & RTC integrated

- Integrate a high-performance embedded CPU
- Integrate a 1MB NOR flash memory
- Frequency-locking between -40 °C ~ 125 °C
- Easy to integrate,
 - ✓ Flexible RF interface – compatible with various frequency plan
 - ✓ Dual UART data interface
 - ✓ I2C & SPI interface
 - ✓ Numerous GPIO
 - ✓ Wheel trick , PWM and ADC input
- Operate in 1.2V/3.1V (core/IO), integrate LDO
- Battery backed RAM & RTC and direct connection
- 0.18um CMOS for RF and 65nm Baseband

1.3 Start Now™ technology

- Mstar Start Now™ AGPS for GSM/3GPP & CDMA for extended ephemeris and fast TTFFs (mobile phone & tracker)
- Mstar Start Now™ MGAN™-LTE (long term ephemeris) for extended 5~7days ephemeris and fast TTFFs (PND & tracker/logger)
- Advanced power management for trickling and position-fix™ power management

1.4 Product Application

- ◆ PND
- ◆ Mobile Phone
- ◆ UMPC
- ◆ Tracker & Logger units
- ◆ MP3 GPS
- ◆ GPS Watch
- ◆ DSC GPS and related
- ◆ Marine & timing navigation

2. Technical Specifications

2.1 General Characteristics

2.1.1 General

Frequency	L1, 1575.42 MHz
C/A code	1.023 MHz chip rate
Acquisition Channel	80
Tracking Channel	20

2.1.2 Accuracy

Position	2m CEP
Velocity	0.1 m/s
Time	1PPS <20 ns resolution

2.1.3 Datum

WGS-84	Default WGS84
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2.1.4 Time To First Fix (TTFF)

Hot start	1sec., average
Warm start	32sec., average
Cold start	34sec., average

2.1.5 Sensitivity

Tracking Sensitivity	-161dBm, typical
Acquisition Sensitivity	-144dBm, typical for cold start

2.1.6 Dynamic condition

Altitude	18000m(Max)
Velocity	515m/s(Max)
Acceleration	4g
Jerk	1g/s

2.2 Electrical Characteristics

2.2.1 DC Power

Voltage	+3.3V ~ +5.0V DC
Supply current	Under 80mA @ 5.0V DC Typical
Backup Battery Power	+3.3V DC

2.2.2 Serial Port

Electrical Interface	Two full duplex serial communication
Baud rate	4.8K /9.6K (Default) /19.2K /38.4K /57.6K/115.2K
Navigation update rate	1Hz
Protocol Message	NMEA-0183 Ver 2.0

2.2.3 Antenna

Center Frequency	1575.42 +/-1.032MHz
Polarization	RHCP
Impedance	50 Ohm

2.3 Environmental Characteristics

Operating range	-40°C ~ +85°C
Storage range	-40°C ~ +150°C
Relative Humidity	5% ~ 80%

2.4 Physical Characteristics

Length	15.9 mm
Width	13.1 mm

3. Software Interface

3.1 NMEA V2.0 Protocol

Its output signal level is TTL: 9600bps (default), 8 bit data, 1 stop bit and no parity. It supports the following NMEA-0183

Messages: GGA, GLL, GSA, GSV, RMC and VTG.

NMEA Output Messages: the module board outputs the following messages as shown in Table

Table 1 NMEA-0183 Output Messages

NMEA Record	Description
GGA	Global positioning system fixed data
GLL	Geographic position – latitude / longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

3.1.1 GGA-Global Positioning System Fixed Data

Table 2 contains the values of the following example:

\$GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,
,0000*18

Table 2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		Dddmm.mmmm

E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 2-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoid Separation		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
<CR> <LF>			End of message termination

Table 2-1 Position Fix Indicator

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

3.1.2 GLL-Geographic Position –Latitude/Longitude

Table 3 contains the values of the following Example:

\$GPGLL, 3723.2475, N, 12158.3416, W, 161229.487, A*2C

Table 3 GLL Data Format

Name	Example	Units	Description
Message ID	\$GPGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south

Longitude	12158.3416		Dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.ss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
<CR> <LF>			End of message termination

3.1.3 GSA-GNSS DOP and Active Satellites

Table 4 contains the values of the following example:

\$GPGSA, A, 3, 07, 02, 26, 27, 09, 04, 15, , , , , 1.8,1.0,1.5*33

Table 4 GSA Data Format

Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
....		
Satellite Used			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
<CR> <LF>			End of message termination

Table 4-1 Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 4-2 Mode 2

Value	Description
M	Manual-forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

3.1.4 GSV-GNSS Satellites in View

Table 5 contains the values of the following example:

\$GPGSV, 2, 1, 07, 07, 79, 048, 42, 02, 51, 062, 43, 26, 36, 256, 42, 27, 27, 138, 42*71

\$GPGSV, 2, 2, 07, 09, 23, 313, 42, 04, 19, 159, 41, 15, 12, 041, 42*41

Table 5 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Number of Messages ¹	2		Range 1 to 3
Messages Number ¹	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 32)
Elevation	79	degrees	Channel 1(Maximum 90)
Azimuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
....		
Satellite ID	27		Channel 4(Range 1 to 32)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR> <LF>			End of message termination

¹ Depending on the number of satellites tracked multiple messages of GSV data may be required.

3.1.5 **RMC**-Recommended Minimum Specific GNSS Data

Table 6 contains the values of the following example:

\$GPRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13, 309.62, 120598, , *10

Table 6 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		ddmmyy
Magnetic Variation		degrees	E=east or W=west
Checksum	*10		
<CR> <LF>			End of message termination

3.1.6 **VTG**-Course Over Ground and Ground Speed

Table 7 contains the values of the following example:

\$GPVTG, 309.62, T, , M, 0.13, N, 0.2, K*6E

Table 7 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course	309.62	degrees	Measured heading

Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Checksum	*6E		
<CR> <LF>			End of message termination

3.2 MStar NMEA Command

<1>Cold Start Command
\$PMST02,58*39

<2>Warm Start Command
\$PMST02,48*38

<3>Hot Start Command
\$PMST02,0*04

4. Hardware interface

4.1 Definition of Pin assignment

Pin	Signal Name	I/O	Description	Characteristics
1	RF_IN	I	GPS Signal Input	3.0V active antenna DC power output
2	GND	G	Ground	
3	GND	G	Ground	
4	GND	G	Ground	
5	V_BAT	I	RTC Power	+2.5V~+5.0V
6	GND	G	Ground	
7	NC			
8	GND	G	Ground	
9	GND	G	Ground	
10	GND	G	Ground	
11	VCC	I	DC Supply Voltage Input	+3.3V~+5V
12	GND	G	Ground	
13	RESET	I		This input is low active.
14	GND	G	Ground	
15	GND	G	Ground	
16	NC			
17	GND	G	Ground	
18	GPIO	I/O	General Purpose Input Output	
19	GND	G	Ground	
20	1PPS	O	1 Pulse Per Second	
21	GND	G	Ground	
22	GND	G	Ground	
23	GND	G	Ground	
24	GND	G	Ground	
25	TIMESYNC	I		
26	GND	G	Ground	

27	WAKE UP	I		
28	GND	G	Ground	
29	GND	G	Ground	
30	TX1	O	Serial port	$V_{OH} \geq V_{CC} - 0.1$ $V_{OL} \leq 0.1V$
31	RX1	I	Serial port	$V_{IH} \geq 2.5V$ $V_{IL} \leq 0.8V$
32	RX0 /I2C_SCL	I	Serial port /I2C serial clock	$V_{IH} \geq 2.5V$ $V_{IL} \leq 0.8V$
33	GND	G	Ground	
34	TX0 /I2C_SDA	O	Serial port /I2C serial data	$V_{OH} \geq V_{CC} - 0.1$ $V_{OL} \leq 0.1V$
35	GND	G	Ground	
36	GND	G	Ground	

VCC

3.3V ~ 5V is acceptable operation range of main power supply. The DC power ripple is required for less than 50mVpp.

GND

Bigger ground planes and more ground vias around the module ground pins is important to minimize the interference.

RESET

On module power up, this signal should remain low until power stable.

This input is low active.

TIMESYNC

In case of Conventional Autonomous Mode, This pin should be pull down (4.7K~10.0KΩ)

WAKE UP

This pin is not available now. This Wake Up pin should be pull down (4.7K~10.0KΩ).

1PPS

GPS Additional Function (1 Pulse Per Second)

RX0

This is the auxiliary receiving channel and is used to input differential corrections to the board to enable DGPS navigation.

TX0

For user's application (not currently used).

RX1

This is the main receiver channel and is used to receive software commands to the board from debug software or from user written software.

TX1

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

RF_IN

The GPS module input is optimized to connect to a 50 ohm antenna. The minimized noise figure is achieved by -10dB input return loss. Well controlled antenna impedance (as close to 50ohm as possible) remains the stable system sensitivity. Do not try to match the GPS module to 50ohm for lower return loss which might induce the noise figure increased.

The impedance of RF traces between GPS module, π matching network, and antenna has to be controlled in 50ohm +/-10%. More and tight ground vias surround the RF traces is benefit to isolate interference out.

V_BAT

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

2.5V ~ 5V is acceptable operation range of main power supply. The DC power ripple is required for less than 50mVpp.

GPIO

User can use this I/O pin for special function. For example, on/off LED

4.2 Electrical specification

Absolute Maximum ratings

Parameter	Symbol	Condition	Min	Max	Units
Power supply voltage	VCC		-0.5	5.5	V
Backup battery Voltage	V_BAT		-0.5	5.5	V
Human Body Model ESD capability	V _{ESD_HBM}			2000	V
Machine Model ESD capability	V _{ESD_MM}			75	V
Storage temerature	Tstg		-40	150	°C

4.3 Operating Conditions

All specifications are at an ambient temperature of 25°C

Parameter	Symbol	conditions	Min	Typ	Max	Units
Power supply voltage	VCC		3.3		5.0	V
VCC Supply current	I _{cc} Acquisition	VCC=3.3V		55		mA
		VCC=5.0V		47		
	I _{cc} Tracking	VCC=3.3V		45		mA
		VCC=5.0V		41		
	I _{cc} Standby	VCC=3.3V V _{pen} =0V		35		uA
Backup battery Voltage	V_BAT		2.5		5.0	V
Backup battery current	I _{bat}	V_BAT=3.3V VCC=0V		16.5		uA
Input return loss	R _{Lin}	RF_IN		10		dB
Power Gain	S ₂₁			12		dB
Operating temperature	T _{opt}		-40		85	°C

5. Product handling

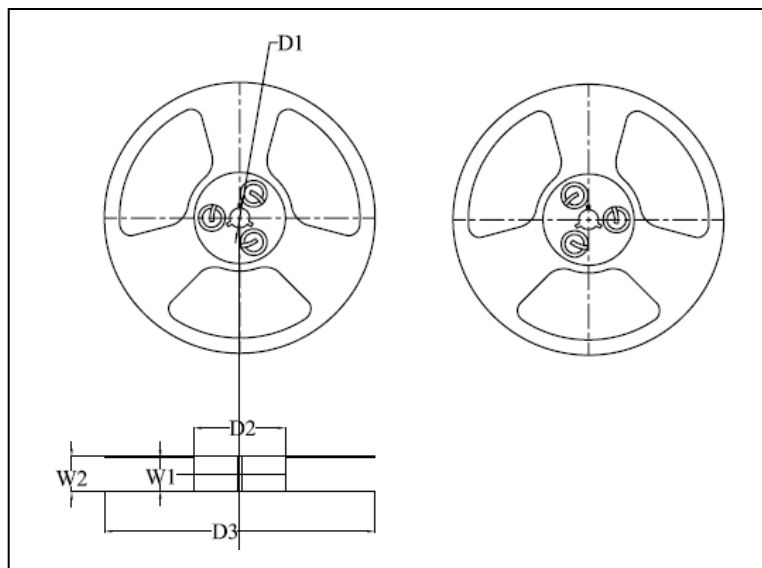
5.1 Packaging

Modules are delivered as hermetically, tape reel in order to enable efficient production.



5.2 Reels

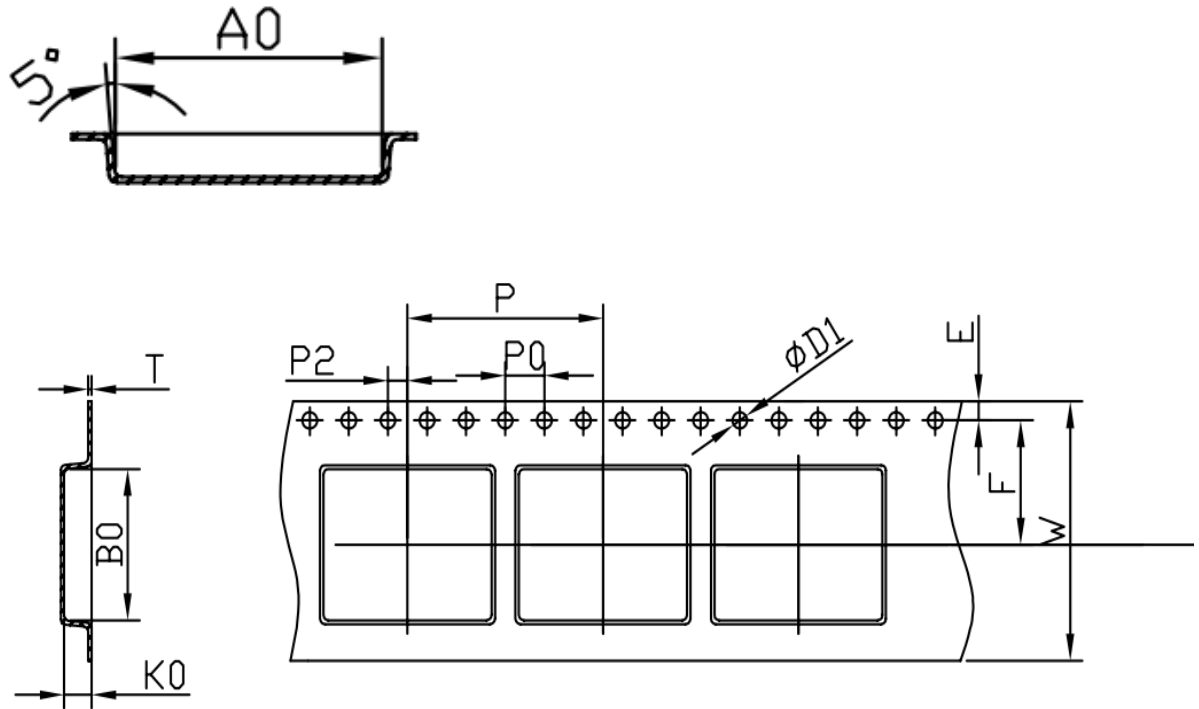
Modules are deliverable in quantities of 1000pcs on a reel. The dimensions of the reel are shown as below.



代号	尺寸 (mm)
A	2.4± 0.20
B	2.2± 0.20
D ₁	13± 0.20
D ₂	100+1/-0
D ₃	330± 0.50
W ₁	24.0+1/-0
W ₂	28.8± 1.00

5.3 Tapes

The dimensions and orientations of the tapes for MG1613S modules are specified below picture.



代号	尺寸(mm)
W	24.00± 0.2
F	11.50± 0.10
E	1.75± 0.10
ØD1	2.00± 0.10
P	20.00± 0.10
P ₀	4.00± 0.10
P ₂	2.00± 0.10
A ₀	17.20± 0.10
B ₀	14.00± 0.10
K ₀	2.80± 0.10
T	0.35± 0.05

5.4 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling

precautions required. Modules are rated at MSL level 4

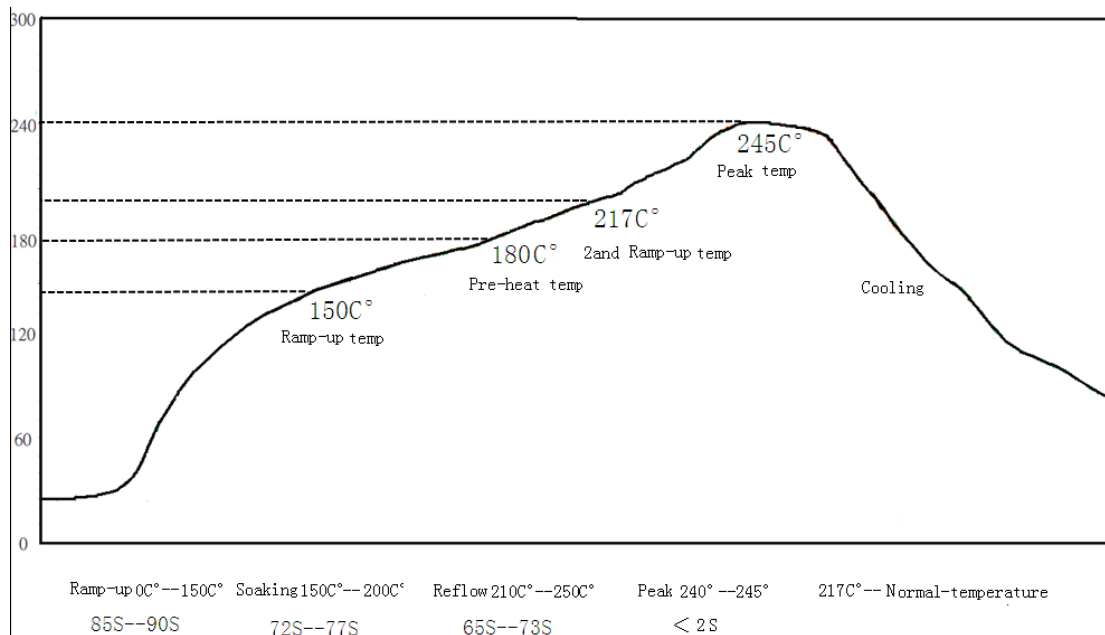
⦿ For MSL standard see IPC/JEDEC J-STD-020, that can be download from www.jedec.org

5.5 Shipment

MG1613S modules are delivered on Tape-and-Reels in a hermetically sealed package to prevent moisture intake and protect against electrostatic discharge. For protection from physical damage.

5.6 Reflow soldering

Recommand the reflow profile show as below.



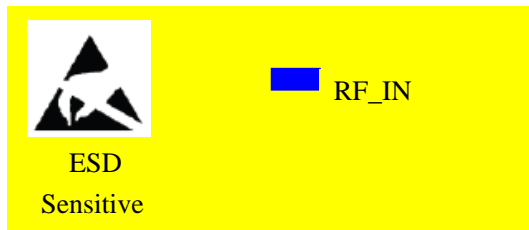
5.7 ESD handling

The modules are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Care must be exercised when handling path antennas, due to the risk of electrostatic charges.

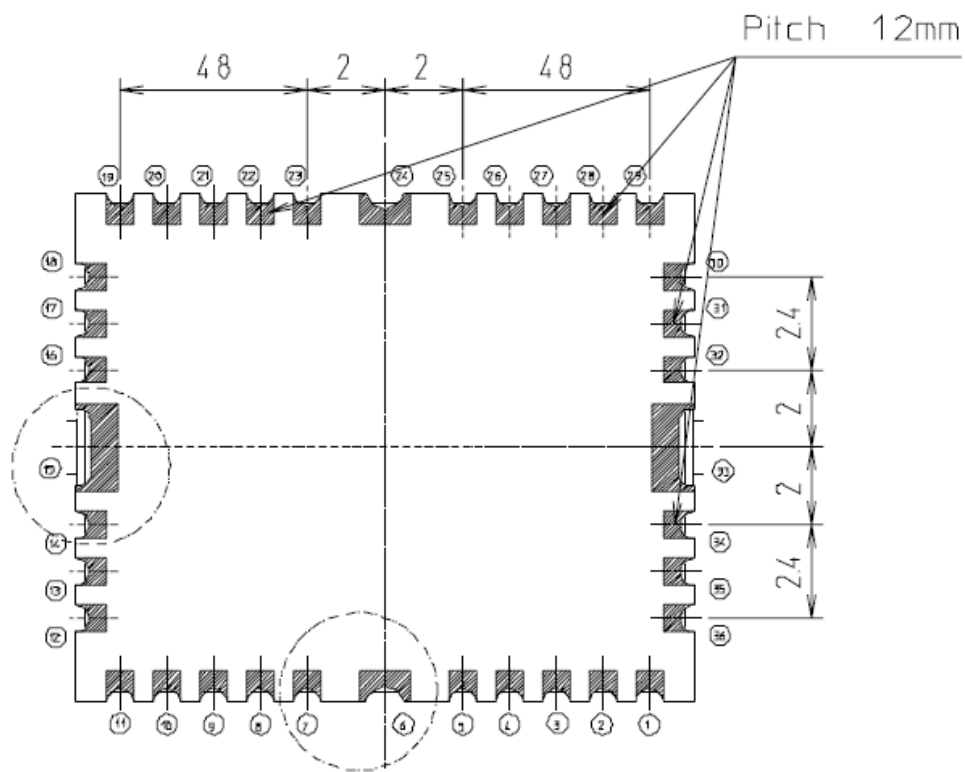


For ESD safety, the following measures should be taken into account Whenever handling the modules:

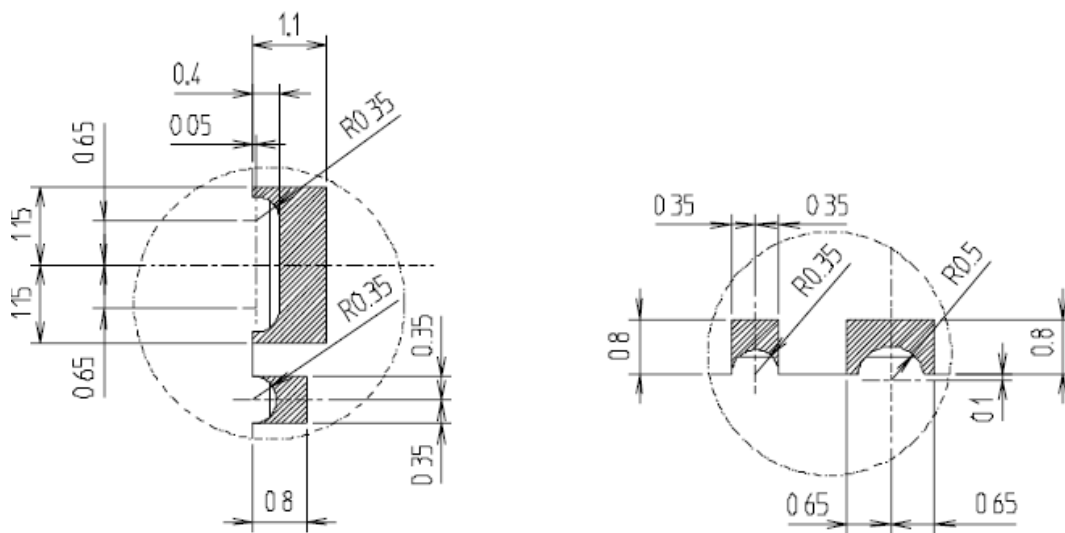
- ⦿ Connect ground of the device before solder an antenna patch.
- ⦿ To prevent electrostatic discharge through the RF_IN do not Touch the mounted patch antenna.
- ⦿ When solder RF connectors and patch antennas to the Module's RF_IN pin, make sure to use an ESD safe soldering iron.



Appendix A. Foot-print & Outline drawing

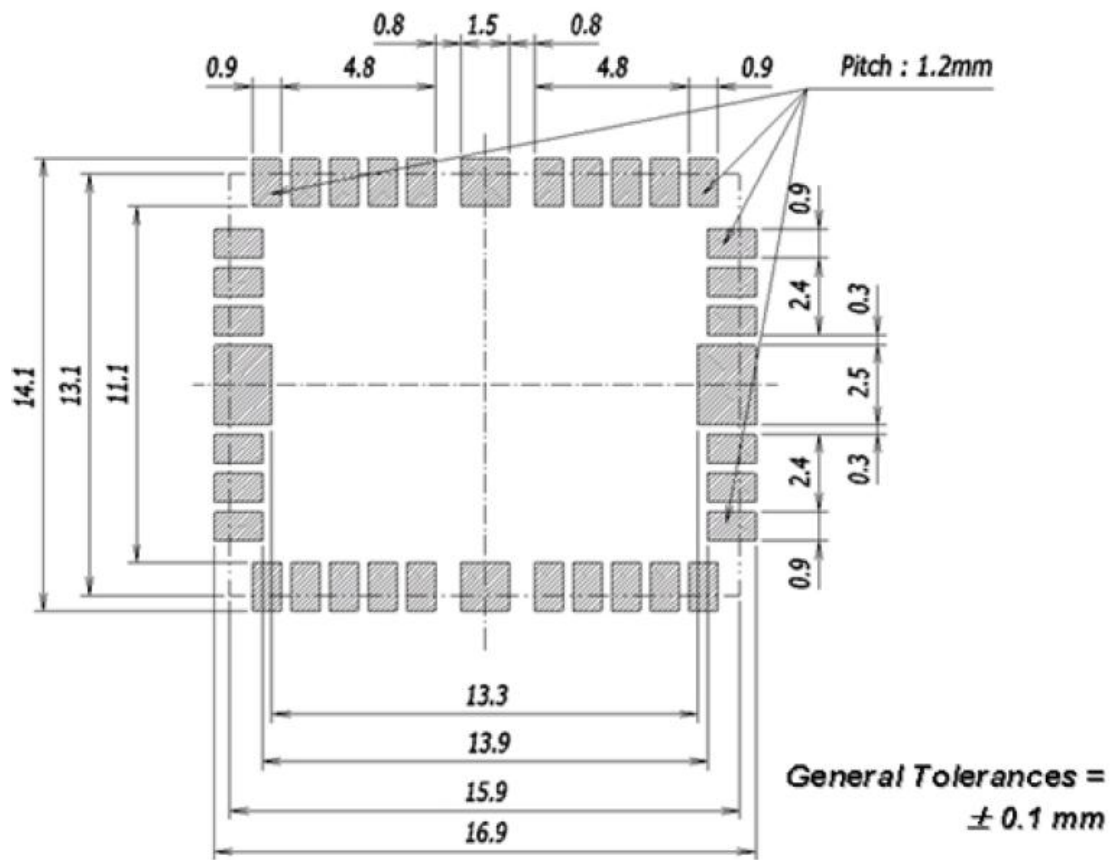


Bottom View



* General tolerances = ± 0.2
Unit : mm

Appendix B. Recommend PCB Footprint



Appendix C. Marking Information

①	②	③
MG	1613	S
④	1120	

①	MG	Product type		S	Chipset
②	1613	Module Size	④	1120	Date Code