LOCOSYS

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MC-1612 Hardware Design Guide

Version 1.0

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1 General Rules for Design-in

In order to obtain good GPS performances, there are some rules which require attentions for using MC-1612 GPS module.

2 Circuit Design

2.1 Power supply VCC

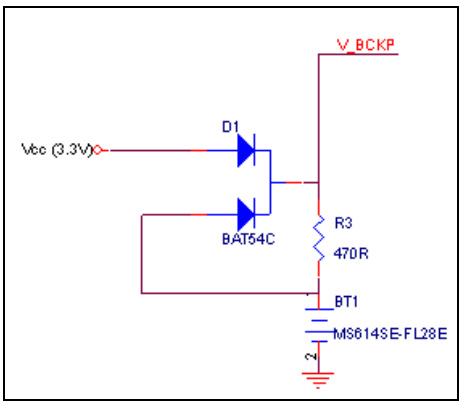
It is necessary to provide a clean and stable power supply for our GPS module in order to obtain good performances. Unstable power source may have a significant negative impact on the GPS performance. To achieve this, the Vcc ripple must be controlled under 50mVpp. In addition, there are also some suggestions for main power circuit design:

(1). Add a ferrite bead, power choke or low pass filter for power noise reduction
(2). linear regulator is better than switch DC/DC power supplier in ripple
(3). Use enough decoupling capacitors beside VCC for stable voltage.

2.2 V_BCKP backup battery

Backup power is used for keeping RTC running and navigation data after the main power was turn off. For a short term VCC off, with backup power, the GPS module can have a faster TTFF, Time to First Fix, or hot start when next power on.

It is recommended to connect the module V_BCKP to a sustained power source (ex: Li-Ion rechargeable coin battery, super cap) for backup power. See figure for reference.



Using Coin Battery for GPS module

Note: 1. The V_BCKP pin must be supplied power to make the module function-able.
2. The sequence of V_BCKP and VCC power supply must comply with the following conditions:

- V_BCKP priority than VCC power is supplied.
- V_BCKP and VCC's power is supplied at the same time.

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2.3 UART (RX/TX) –Serial Interface

(1). UART is the default interface (TTL level) that has the baud rate ranging from 4800 bps to 115200bps.

(2). Placing damping resistor on the RX and TX of the GPS module could limit the interference from host MCU or high speed digital logics. Fine tuning the damping resistor is required to suppress interference efficient. The damping resistor would be a chock coil as well.

(3). Please leave RX open if it is not used as there is an internal pull-up to VCC.

(4). Please don't connect diode(s) to RX/TX as it will decrease signal driving capability which might adversely affect RX/TX signal level (ex. no data output).

(5). If RS232 logic-level is needed for any particular application, and then the level shifter is necessary.

(6). If USB logic-level is needed for any particular application and then the USB bridge is necessary.

2.4 GND-Ground

Make sure all GND pins of module are connected to a good ground plane.

2.5 Antenna Compliance Design

GPS antenna is a receiving device to acquire weak GPS signal from sky. Popular solution would be ceramic patch antenna because of its small form factor with low cost. There are two types of antennas, passive and active.

Passive antenna is with solely antenna itself such as patch antenna and chip antenna.
An external antenna is a stand long device integrates with LNA, patch antenna and cable to have high gain and good performance.
Antenna can be chosen according to radiation efficiency, radiation pattern, gain, bandwidth, form factor and cost. Make sure the ground plane is sufficient for the antenna to operate with good enough performance

The recommended antenna specification is given in following table.

Antenna Type	**Specification**	
Passive antenna	GPS frequency:	1575.42±2 MHz
	VSWR:	<2 (Typ.)
	Polarization:	RHCP or Linear
	Gain:	>0 dBi
Active antenna	GPS frequency:	1575.42±2 MHz
	VSWR:	<2 (Typ.)

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	Polarization:	RHCP or Linear
	Noise figure:	<1.5dB (Typ.)
	Gain (antenna):	>-2dBi
	Gain (embedded LNA):	28dB (Typ.)
	Total Gain:	>20dBi(Typ.)

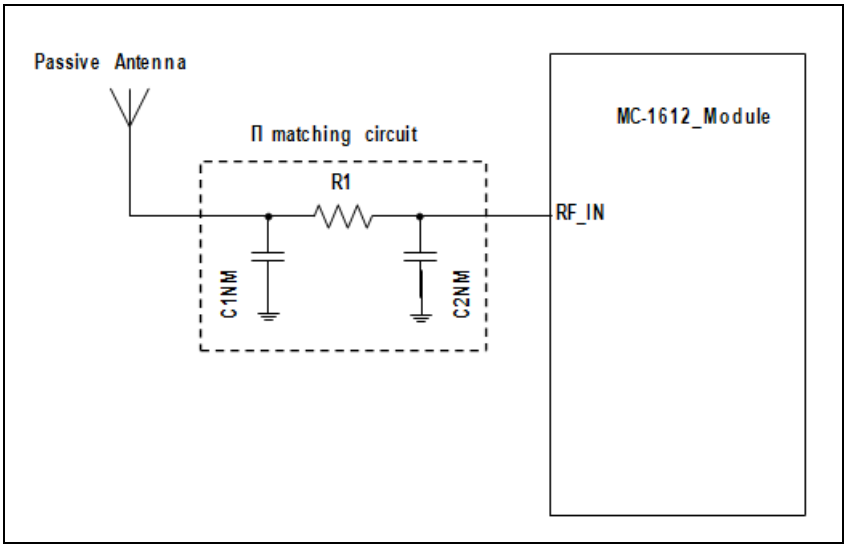
Design patch antenna with GPS module.

(1). Generally speaking, a 50Ω Patch antenna will work good with GPS module just connect the RF_IN with a 50Ω impedance trace.

(2). Pleases keep the patch antenna far away noise source such as switch power supplier and high speed digital logics.

(3). The 50Ω trace should keep as short as possible to reduce the chance to receive the noise from air and PCB. A simple direct line is recommended.

(4). If need, a matching circuit could be place between patch antenna and GPS module as following. The match circuit should be discussed with module and patch antenna maker by case.



Select an external antennal architecture with GPS module.

For an external antenna, it needs a DC power to have it work properly.

A typical method is to feed a DC into the RF trace and the external antenna can extract the DC from RF trace. Thus we can use the RF trace to transport both RF signal and DC volt.

We use a RF chock coil to couple the DC to RF trace to perform the mentioned method.

In LOCOSYS, we applied 2 types of architectures in our MC-1612 module.

Customer select the module carefully while applying the design with an external antenna.

Type I: The power supply needs to be externally provided and is connected directly to the external antenna via chock coil or 27nH inductor as following figure.

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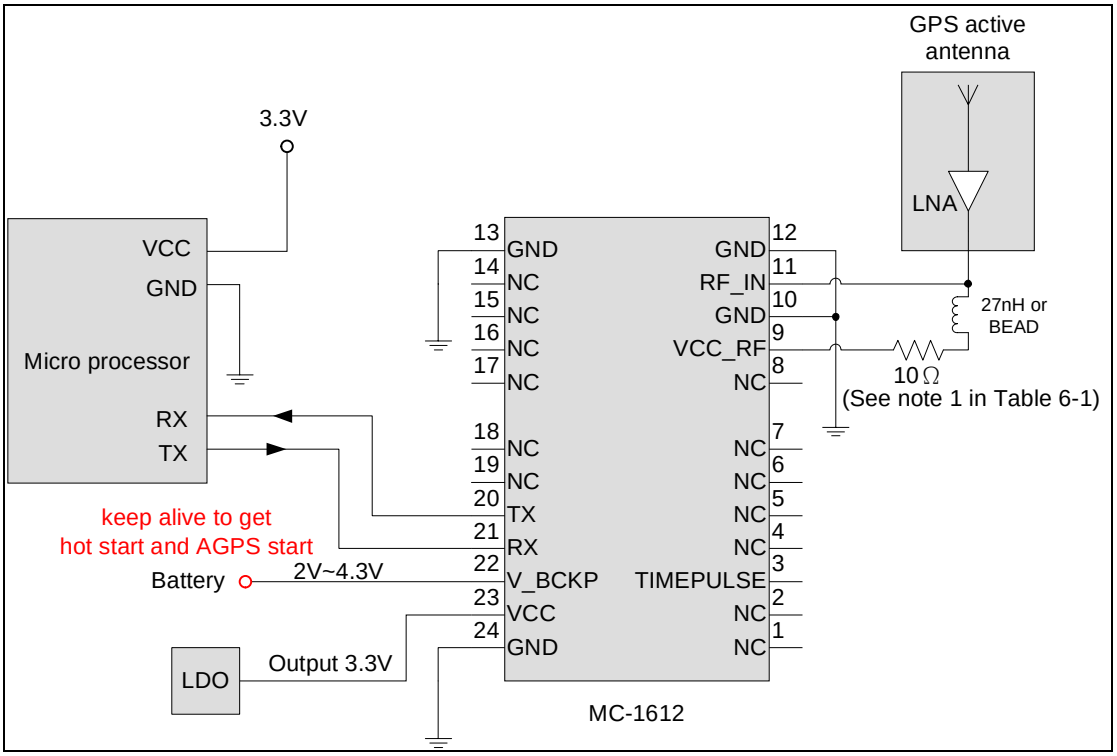

Type II: The power supply comes from an individual 3.3V via an antenna supervise circuit to monitor the status of DC current and limit the supplied current (over current protection) as following figure.

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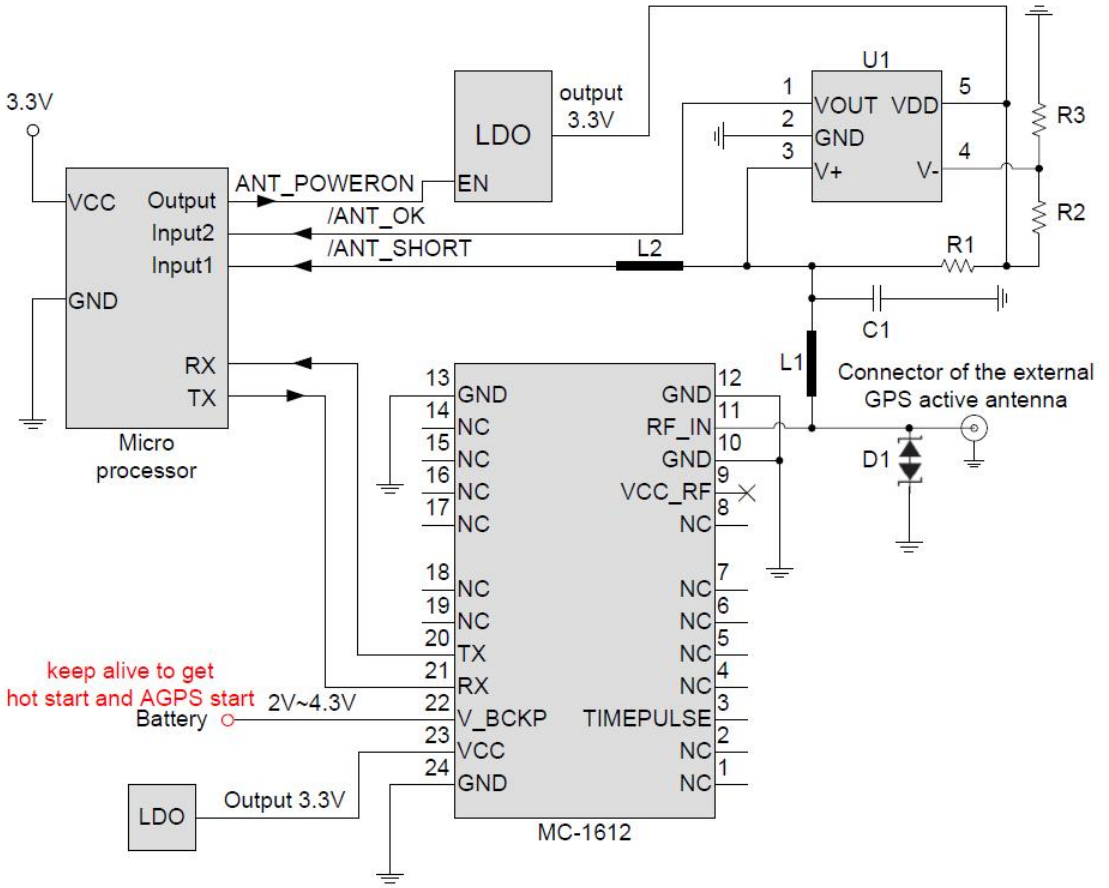

Logic table			
/ANT_SHORT	/ANT_OK	Status of the external GPS active antenna	Description
LOW	X	Short	Antenna is short.
HIGH	LOW	OK	Antenna is properly connected.
HIGH	HIHG	Open	Antenna is not connected

Reference BOM			
Part	Spec/value	Vendor	Remark
C1	18pF±5%, size 0402/0603		
D1	SUC0402-240E0R05P-LF	SFI	Input capacitance ≦ 0.5pF
L1	BEAD, 300R, size 0603 PBY16080T-301Y-N	YAGEO	Must use 0603 size or larger
L2	BEAD, 300R, size 0402/0603		
R1	10R±5%, size 0603		Must use 0603 size or larger
R2	1K±5%, size 0402/0603		
R3	100K±5%, size 0402/0603		
U1	MCP6001T-IOT	Microchip	
	SGM8541XN5/TR	SG Micro	

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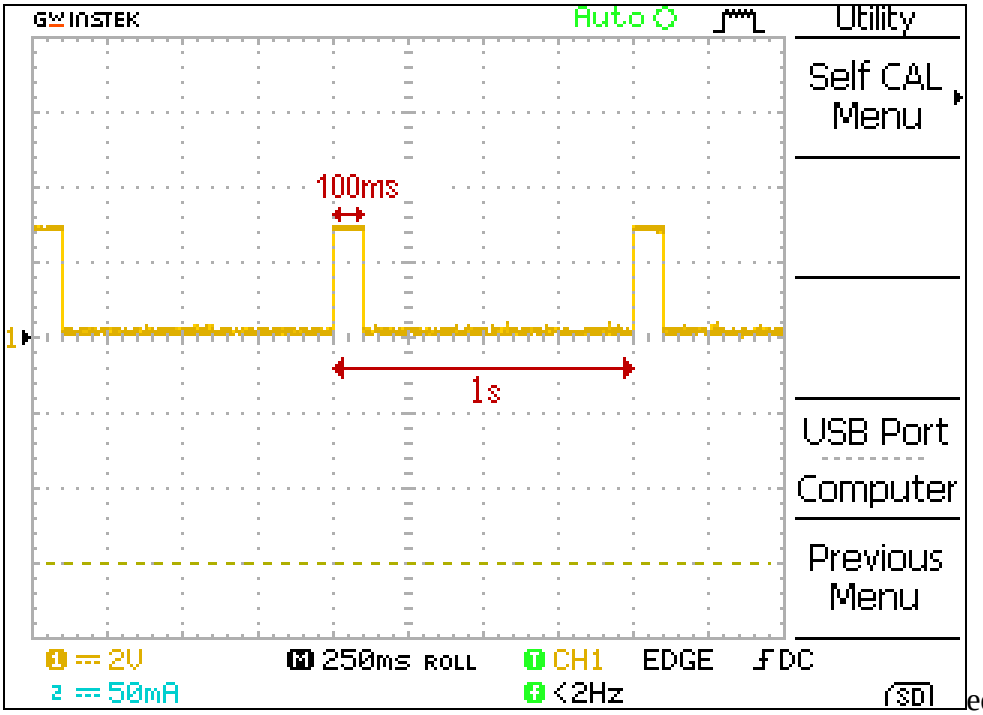
2.6 1PPS

1PPS signal is an output pulse signal used for timing application, its electronic characteristic are list below:



1PPS signal and its pulse width with 100ms duration

Low Voltage level: 0~0.4V
High Voltage level: 2.8~3.1V
Duration: 100ms (Firmware customization for duration is available)
Period: 1s

LOCOSYS provides following 1pps signal output mode for customer selections

- Standard GPS module will output the 1pps after the module is 3D_FIX.
- Free run 1PPS output after 3D_FIX
- GPS module will output the 1pps after the module is 2D_FIX.
- A customize firmware also could set the 1PPS plus out as soon as power-on disregard to 3D_Fix or not.

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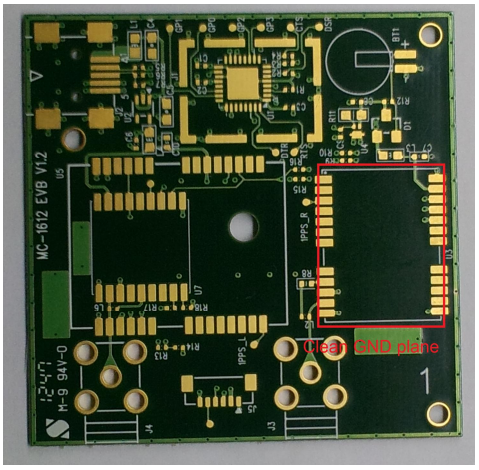
3 Layout Guideline

3.1 Layout underneath the GPS module

GPS signal is very weak signal level around -160dBm~130dBm. Any noise or harmonic will decrease the quality of GPS. In modern GPS product, it almost includes LCD, MCU, High Speed digital and RF system (BT, Wi-Fi, DVB-T…). In order to minimize the influence of mentioned noise to GPS module, please customer don't place any trace underneath the GPS module. In other word, give GPS module a clean GND plane is very important.



GPS on a clean GND plane

3.2 Module Placement

Place the decoupling capacitors close to GPS module

Place the damping resistors close to GPS module

Do not place:

GPS module close to high-speed digital processing circuitry

GPS module close to high-current switching power circuitry

GPS module close to clock sources circuitry

3.3 Trace

(1). The USB differential signals should be trace close and equal-length for minimum radiation and noise immunity.

(2). Please have the RF traces had the character impendence of 50 ohm for good impedance matching.

(3). Any right angle turn in trace routing should be accomplished with two 135 degree turn or an arc turn

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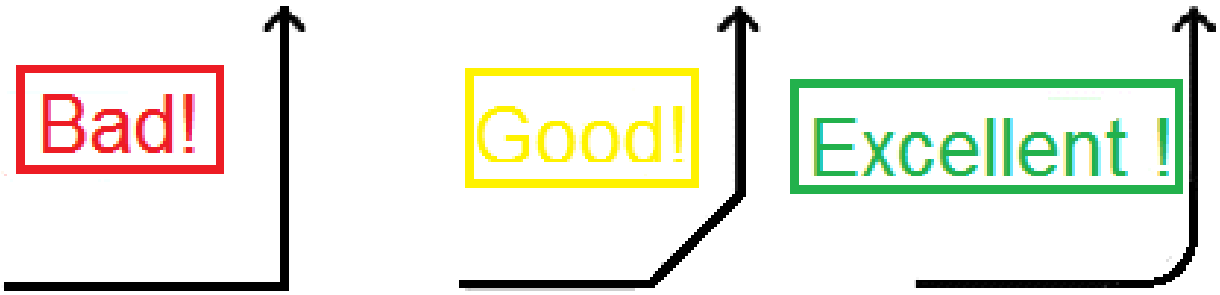
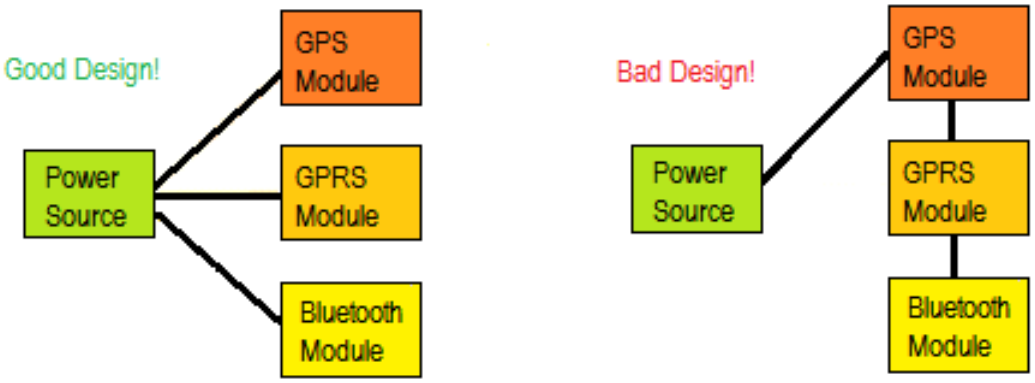


It is better to have independent trace of power source for any device



3.4 Ground Segmentation

The separation of ground between GPS module and the rest of the system is recommended to avoid system interference. If this is not possible, it is best to follow these typical rules: segmentation of ground between digital and analogue system, high current and low current system, and different radiation systems in general (such as GPS and GPRS).

One way to segment the ground is to place digital and noise component at one corner of the board, while placing analog and quiet components at the opposite corner of the board. Make sure there is no crossing of microstrip or current between the two component sets and grounds of each sets are contacted in one point only.

Another way to do this is the place the two different sets at different layers of the board, while the ground of each layer is contacted in one point only (preferable at border of the board).

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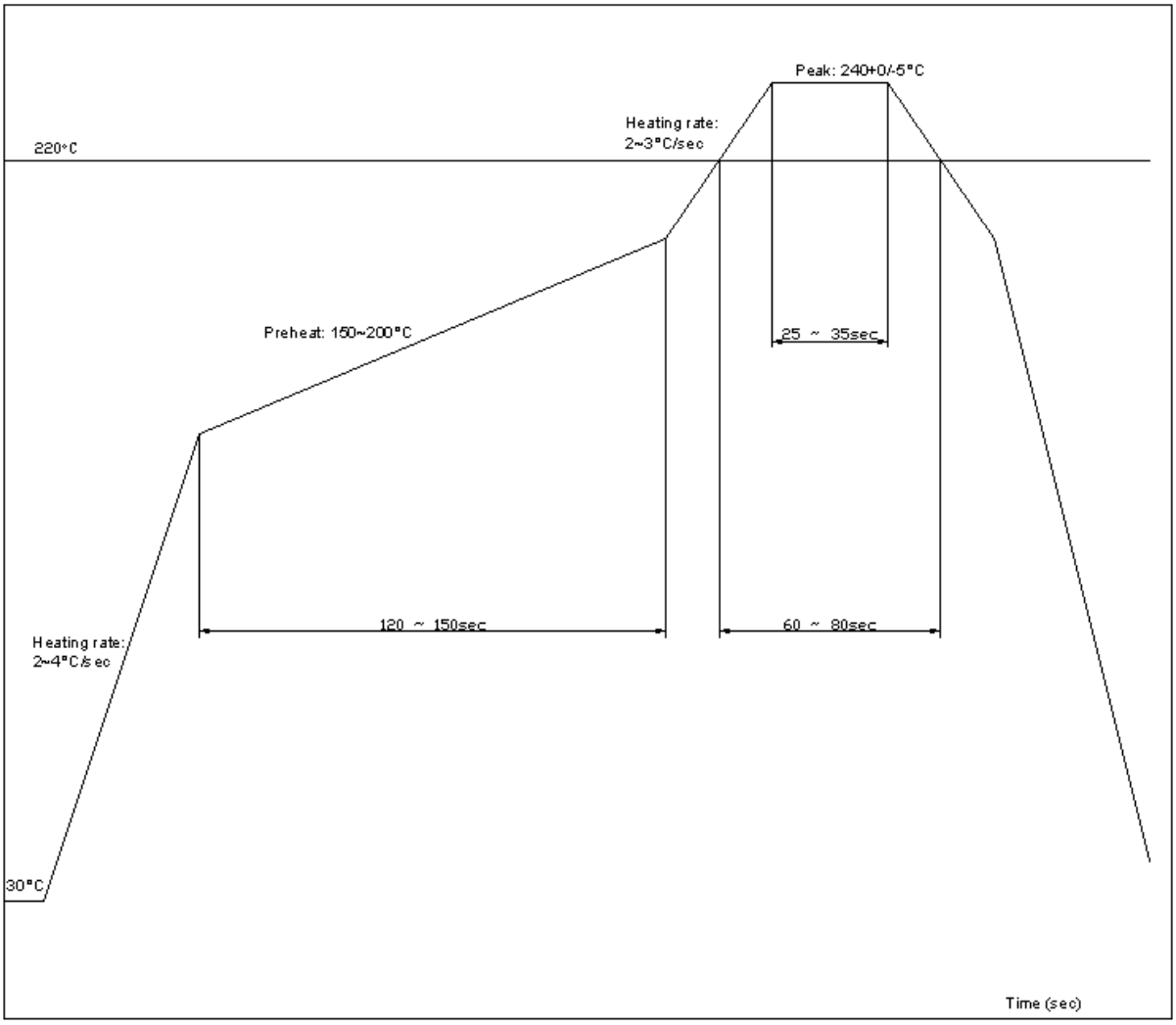
4 Thermal Profile for MC-1612 Modules

All the information in this sheet should be used only for Pb-free certification.



Lead –Free Solder Paste (Sn 96.5-Ag 3.0-Cu 0.5) Cycle Interval: 300sec

4.1 SMT Solder Mask:

Please use the dimension of PCB pad as reference and shrink the size by 0.1 to 0.2 mm and use that as layout for paste mask. (For PCB pad layout, please see "Recommended land pattern dimensions" in MC-1612 GPS module datasheet)

4.2 Manual Soldering:

Soldering iron: Bit Temperature: Under 380°C Time: Under 3 second.