AKMU5J GPS Module

Data Sheet(v1.1)

AscenKorea
The Special Group in GNSS

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1. Funtional Description

1.1 Overview

The AscenKorea AKMU5J module utilizes MediaTek GPS MT3329 solution that supports up to 66 channels of satellite searching with -165dBm sensitivity and 10Hz maximum update rate for precise GPS signal processing under low receptive, high velocity conditions.

AKMU5J comes with built-in, fully programmable GPS Jammer Detect & Report System called "**Anti-JACK™**". The alarm indicator can output jammer status using UART TX output in customized NEMA string or via hardware pin voltage output once the jammer signal detected exceeds the specified level.

Anti-JACK™ is adaptable to various environments via the 2 levels of sensitivity which can be easily set through software command, and can be switched on/off as needed. An additional power saving mode for Anti-JACK™ is also available that automatically reduces power consumption used for GPS jammer detection when the GPS signal reception is above acceptable range.

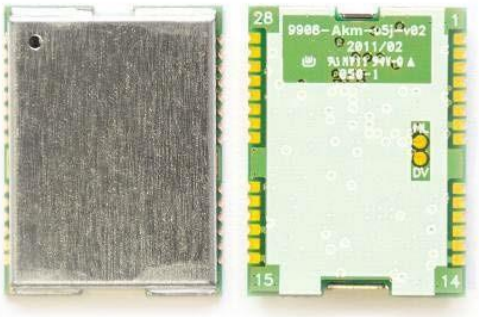
AKMU5J also features an antenna system called "Antenna Advisor" that helps with detecting and notifying different antenna statuses, including active antenna connection, antenna open circuit and antenna short circuit. Antenna short circuit protection is also available to safe-guard the module from being damaged due to DC short circuit between antenna and GND.

It is very easy to implement "Antenna Advisor" function by mounting a single additional resistor. (see application note or reference circuit)

The major advancement in jammer detection and hassle-free antenna detection/protection in a popular SMD form factor coupled with flexible GPS firmware customization makes this GPS module an ideal solution for fleet management and critical asset security.

Application:

- ✓ Asset management
- ✓ Security industry
- ✓ Surveillance



1.2 Highlights and Features

a. GPS Receiver System:

- "Antenna Advisor " - Active and Passive Antenna support with the following features and only a single additional resistor is required:
  - Active and Passive Antenna Detection & Notification
  - Open Circuit Detection & Notification
  - Short Circuit Protection & Notification
- Ultra-High Sensitivity: -165dBm(Typical)
- High Update Rate: up to 10Hz
- DGPS (WAAS/EGNOS/MSAS/GAGAN) Support [Note 1]
- AGPS Support for Fast TTFF
- Magnetic Variation Support (Configurable by Customized Firmware)
- 1-PPS Support for Timing Applications
- E911, RoHS, REACH compliant
- Power Consumption:
  - Acquisition: 33 mA Typical
  - Tracking: 26 mA Typical

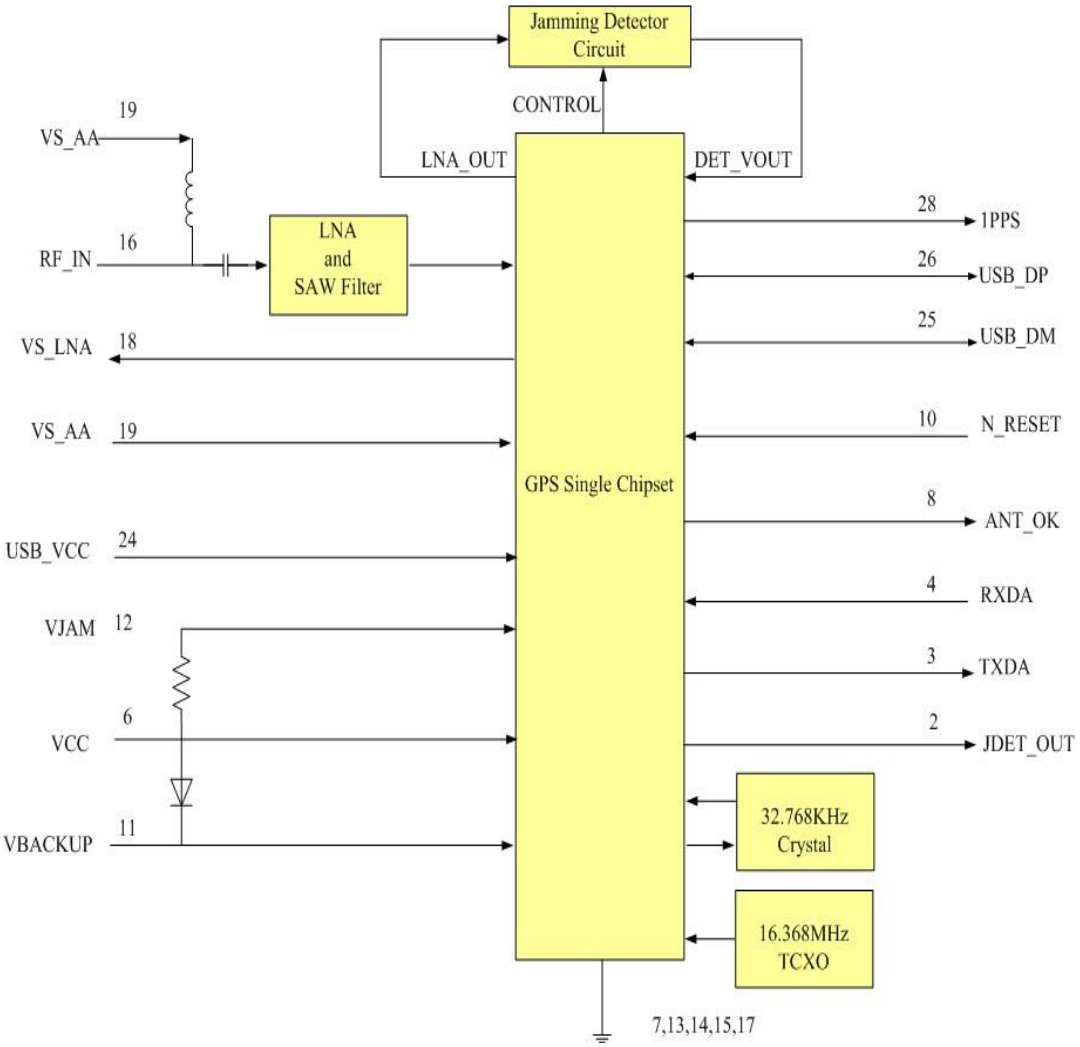
Note 1: SBAS can only be enabled when update rate is less than or equal to 5Hz.

b. Anti-**JACK**™ (Anti-**J**amming **A**ssessment **C**ommand feedbac**K**) System (GPS Jammer Detect & Report)

- Jamming Sensitivity:

  -50dBm (High sensitivity) & -40dBm(Low Sensitivity)@1575.42MHz
- Auto Jamming Sensitivity Adjustment Based on Antenna Type (Active vs. Passive)
- Customized NMEA and Hardware Pin Voltage Output Notification
- Power Saving Mode for Jammer Detection
- Power Consumption:
  - operating: 16 mA Typical

1.3 System Block Diagram



1.4 Antenna Advisor

"Antenna Advisor" is a brand new antenna system available exclusively for Gmmu5j. It is designed to detect and notify antenna status using both hardware (through pin voltage level output) and software (through proprietary protocol).

Antenna Advisor can detect and notify the following:

- Active Antenna Connected
- Active Antenna Short
- Active Antenna Open (Not Connected), or Passive Antenna Connected (Antenna Advisor cannot differentiate these two)

In addition, Antenna Advisor can protect the module against short from (external) active antenna by limiting the current drawn to a safe level. This is automatically activated whenever the system detects a load larger than 30mA at RF_IN pin.

To implement Antenna Advisor, please go through the Pin requirements (Pin 8, Pin 16, Pin 18, Pin 19) on **Chapter 2.5** and **Chapter 2.9**, software protocol readout on **Chapter 3.2**, and most importantly, the antenna reference circuit design on **Chapter 4**.

1.5 Anti-JACK™ (GPS Jammer Detect & Report)

Anti-JACK™ (Anti-Jamming Assessment Command Feedback) is a revolutionary GPS Jammer Detect & Report system available exclusively to Gmmu5j. It is designed to detect and notify jamming noise status using both hardware (through pin voltage level output) and software (through proprietary protocol).

By connecting this warning output to GSM/GPRS modem[1] or anti-theft system such as engine disable mechanism and siren, this system can effectively double the protection of your vehicles or assets in addition to GSM jamming protection[1].

Anti-JACK™ can also auto detect antenna type to deduce the level of jamming sensitivity, as well as supply several control command for host CPU to program the report and detect model under different conditions. Also a power saving mode is implemented that reduces power consumption of jammer detection when GPS signal reception is acceptable. It is a very flexible solution for users who wish to design GPS jamming signal detection for various applications.

To implement Anti-JACK™, please go through the Pin requirements (Pin 2, Pin 12) on **Chapter 2.5**, software protocol readout on **Chapter 3.4 to 3.6**, and the reference circuit design on **Chapter 4**.

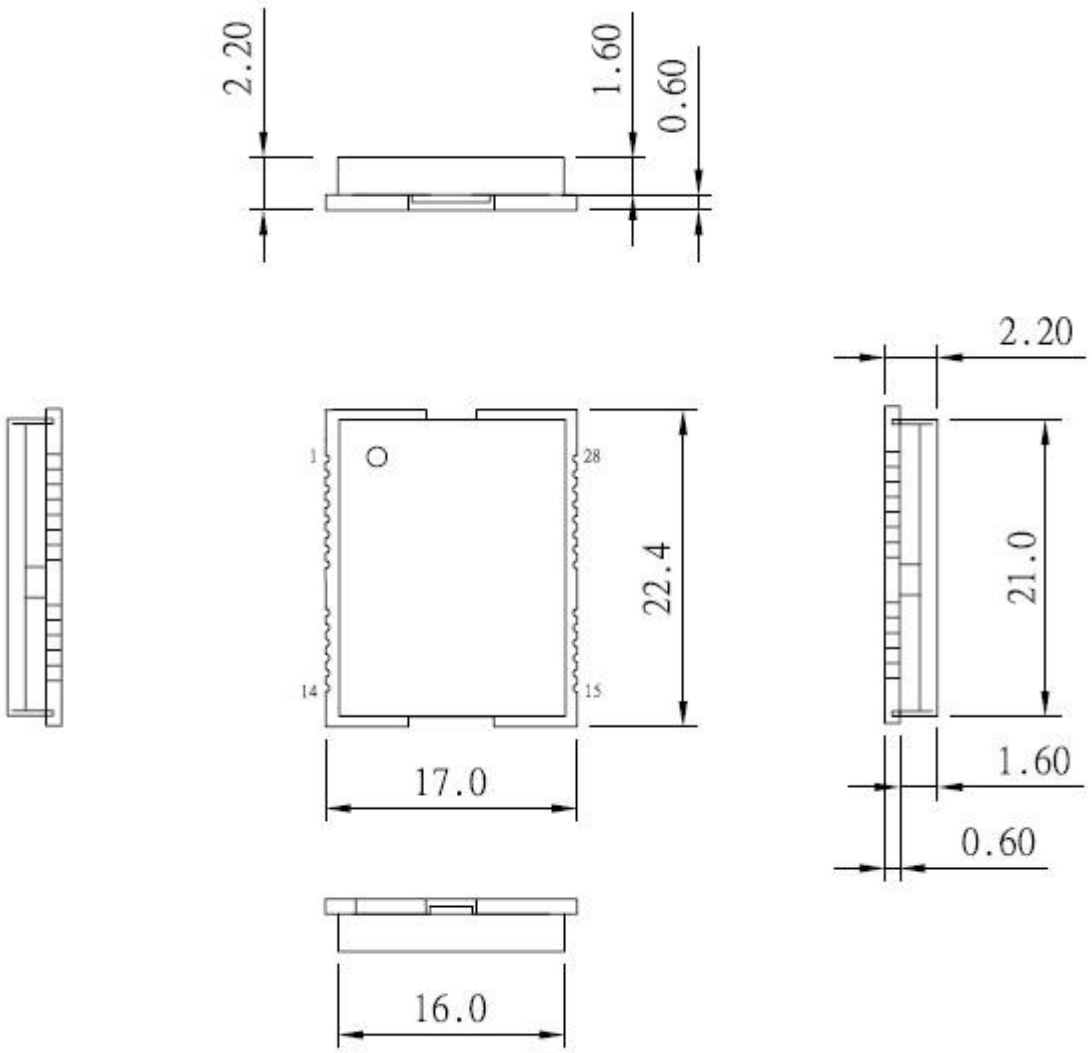
Notes:

[1]Not Included in Gmmu5j

2. Specifications

2.1 Mechanical Dimension

(Unit: mm, Tolerance: 0.2 mm)

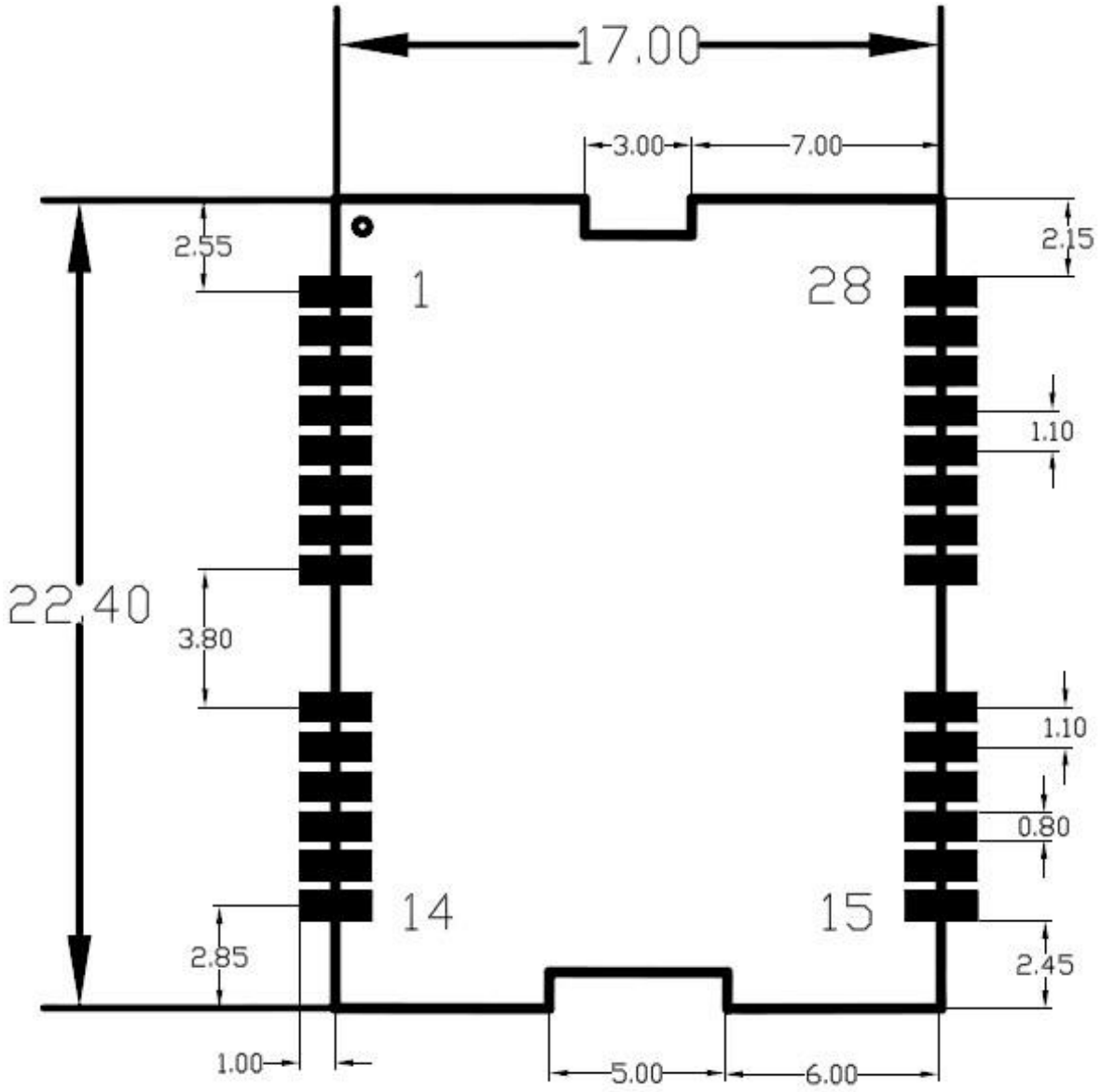


(Unit : mm, Tolerance : 0.2mm)

(Top view)

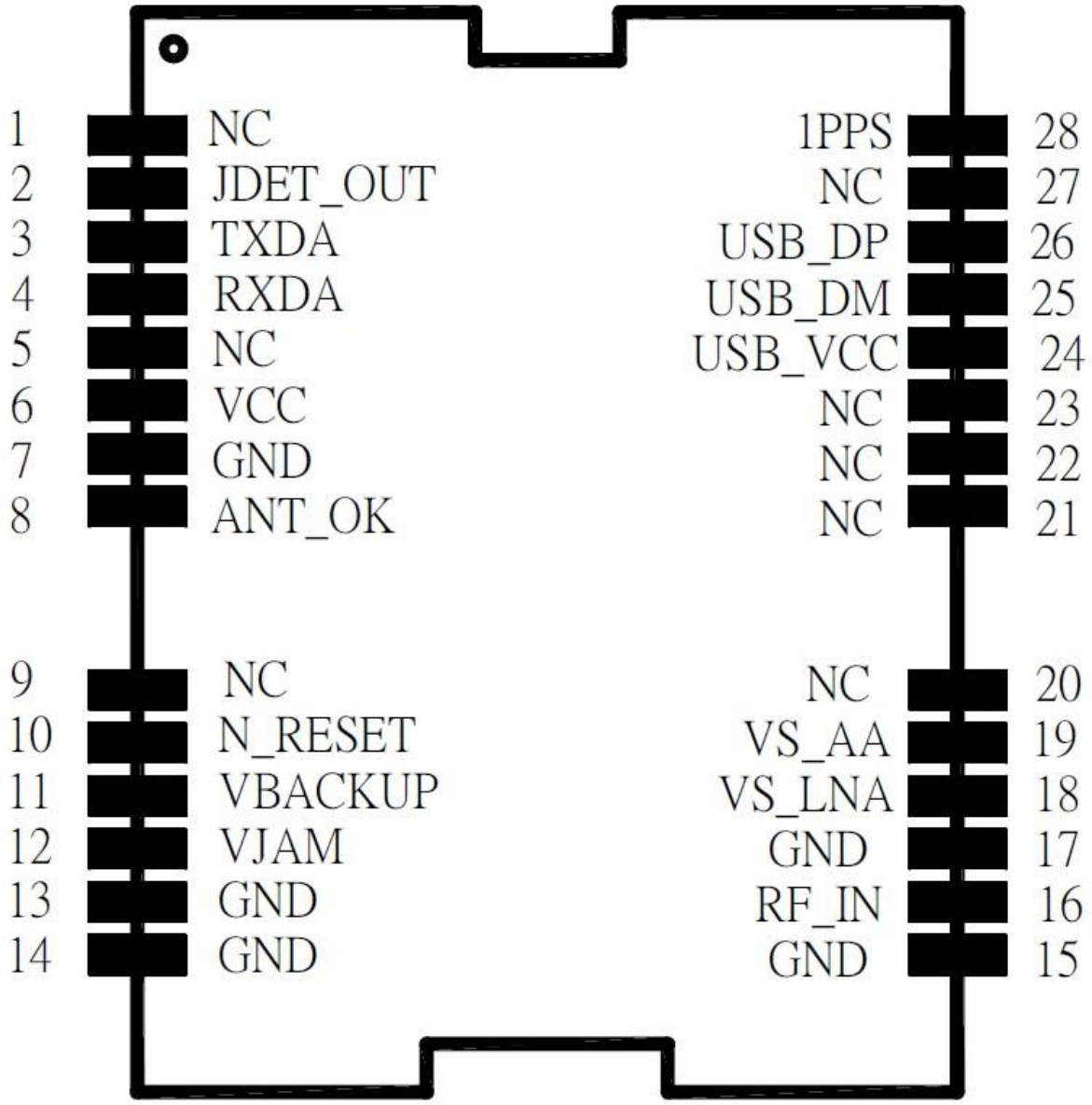
2.2 Recommended PCB pad Layout

(Unit: mm, Tolerance: 0.2mm)



(Top view)

2.3 Pin Configuration



(Top view)

2.4 Pin Assignment

Pin	Name	I/O	Description & Note
1	NC	-	NC
2	JDET_OUT	O	Jamming detecting status out
3	TXDA	O	Serial Data Output for NMEA output (TTL)
4	RXDA	I	Serial Data Input for Firmware update (TTL)
5	NC	-	NC
6	VCC	PI	Main DC power input
7	GND	P	Ground
8	ANT_OK	O	Antenna status indicator
9	NC	-	NC
10	N_RESET	I	Reset Input, Low Active
11	VBACKUP	PI	Backup power input for RTC & navigation data keep
12	VJAM	-	NC
13	GND	P	Ground
14	GND	P	Ground
15	GND	P	Ground
16	RF_IN	I	Antenna Signal Input
17	GND	P	Ground
18	VS_LNA	PO	Output Voltage for Active Antenna
19	VS_AA	I	Active Antenna Voltage & Active Antenna detect
20	NC	-	NC
21	NC	-	NC
22	NC	-	NC
23	NC	-	NC
24	USB_VCC	PI	USB DC power input
25	USB_DM	I/O	USB port D-
26	USB_DP	I/O	USB port D+
27	NC	-	NC
28	1PPS	O	1PPS Time Mark Output 2.8V CMOS Level

Red Font: Pins used in Anti-JACK™ system for jammer detect and report

Blue Font: Pins used as a part of Antenna Advisor System

2.5 Description of I/O Pin

NC, Pin1

This pin is NC pin. It is not connected.

JDET_OUT, Pin2

Indicate the status of jamming signal detected. A “High” level indicates a jamming signal has been detected nearby the module, and a “Low” level indicates no jamming signal has been detected.

TXDA, Pin3

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

RXDA, Pin4

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

NC, Pin5

This pin is NC pin. It is not connected.

VCC, Pin6

The main DC power supply for the module. The voltage should be kept between from 3V to 3.6V. The ripple must be limited under 50mVpp (Typical: 3.3V).

GND, Pin7

Ground

ANT_OK, Pin8

The pin is used for antenna type detection (passive or active) as a part of the antenna advisor system. If not used, keep open.

ANT_OK function: The pin will output low or high voltage level to help differentiate the type of antenna connected at Pin16 (RF-In), providing that the proper Antenna Advisor circuit is used.

- If it outputs at low level, then Pin 16 is connected to passive antenna or is open circuit (bias<3mA).
- If it outputs at high level, then Pin 16 is connected to active antenna (3mA<bias<30mA) or is short to ground (bias>30mA).

  (To distinguish active or short status, please see Pin18 description)

NC, Pin9

This pin is NC pin. It is not connected.

N_RESET, Pin10

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

VBACKUP, Pin11

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 removed. The voltage should be kept between 2.0V~4.3V, Typical 3.0V.

IF VBACKUP power was not reserved, the GPS module will perform a lengthy cold start every time it is powered-on because previous satellite information is not retained and needs to be retransmitted.

If not used, keep open or ground.

VJAM, Pin12

This pin is a NC pin. It is not connected.

GND, Pin13, Pin14, Pin 15

Ground

RF_IN, Pin16

This is the GPS RF signal input pin, which can be connected to a passive antenna or an active antenna.

When using a passive antenna, please connect the antenna directly to this pin.

When using an active antenna, it is typical for the RF_IN pin to supply the necessary voltage to power the active antenna by routing power from Pin 19 VS_AA. Please see **Pin 19 VS_AA** and **Chapter 4** for more information on implementing active antenna.

- The active antenna current will be limited to < 30mA, for information on recommended active antenna specification, please refer to **Chapter 2.10**.

GND, Pin17

Ground

VS_LNA, Pin18 (for active antenna use only)

This pin provides the internal DC power source output for active antenna.

To enable Antenna Advisor, it is necessary to connect this pin to Pin 19 VS_AA with an additional 10ohm resistor.

Leave VS_LNA open if a passive antenna or an active antenna DC power source is used. **VS_AA, Pin19 (for active antenna use only)**

This pin takes in DC power source and route it to RF_IN to power the active antenna. It is also used as the active antenna detection of the module.

When using an active antenna, please connect this pin to an external DC power source (Range 3.0V to 3.6V, 3mA < current < 30mA), or add a 10 ohm resistor between Pin18 VS_LNA and Pin19 VS_AA to power it internally.

If the RF circuit is closed (as indicated by Pin 8), the output level of this pin is an indication on the status of antenna connected to Pin 16 RF_IN as active (3mA < bias < 30mA) or short (bias > 30mA). See **Chapter 2.8: Antenna Status** for more details on the output level and their corresponding definition.

To enable Antenna Advisor, it is necessary to connect this pin to Pin 18 VS_LNA with an additional 10ohm resistor.

Leave VS_AA open if a passive antenna is used.

NC, Pin20, 21, 22, 23

These are NC pins, they are not connected.

USB_VCC, Pin24

This pin is connected to an external DC power source that enables the USB function of the module. The voltage should be kept between 3V to 3.6V. The ripple must be controlled under 50mVpp.

If not used, keep open or ground.

USB_DM, Pin25

USB Port D- signal (USB_VCC supplied), if not used, keep open.

USB_DP, Pin26

USB Port D+ signal (if USB_VCC supplied), if not used, keep open.

NC, Pin27

This pin is NC pin. It is not connected.

1PPS, Pin28

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

Keep floating if not used. Default duration is 100ms.

2.6 Specification List

GPS Receiver System Specification	
GPS Chipset	MTK MT3329
Frequency	L1, 1575.42MHz
Sensitivity[1]	Acquisition ： -148dBm, cold start Reacquisition ： -160dBm Tracking ： -165dBm
Channel	66 channels
TTFF[1]	Hot start : 1 sec (Typical) Warm start: 33 sec (Typical) Cold start : 35 sec (Typical)
Position Accuracy	Without aid: 3.0m 2D-RMS DGPS (SBAS [WAAS,EGNOS,MSAS]): 2.5m 2D-RMS
Velocity Accuracy	Without aid: 0.1m/s DGPS (SBAS [WAAS,EGNOS,MSAS,GAGAN]): 0.05m/s Without aid: 0.1 m/s^2
Acceleration Accuracy	Without aid:0.1 m/s^2 DGPS (SBAS [WAAS,EGNOS,MSAS]):0.05m/s^2
Timing Accuracy(1PPS Output)	100 ns RMS
Altitude	Maximum 18,000m (60,000 feet)
Velocity	Maximum 515m/s (1000 knots)
Acceleration	Maximum 4G

[1] Reference to GPS chipset specification

Update Rate	1Hz (default), maximum 10Hz
Baud Rate	9600 bps (default)
DGPS	SBAS (default) [WAAS, EGNOS,MSAS,GAGAN](≤5Hz update rate)
AGPS	Support
Power Supply	VCC: 3V to 3.6V / VBACKUP: 2.0V to 4.3V
Current Consumption	33 mA acquisition, 26 mA tracking

Anti-JACK™ (GPS Jammer Detection and Report) Specification	
Jamming Sensitivity	-50dBm (High sensitivity) & -40dBm (Low Sensitivity)
Jamming Detection	Built-in high gain and band selection device for detection
Power Supply	VCC: 3V to 3.6V
Current Consumption	16 mA (operating)

Common Specifications	
Working Temperature	-40 °C to +85 °C
Vibration Condition Tested	Frequency range: 10Hz ~ 55Hz Magnitude: 0 ~ 7G Test period: 1 min/cycle, 120 cycles, 3 axis (X,Y,Z)
Dimension	22.4 x 17 x 2.2 mm, SMD
Weight	2g

2.7 Absolute Maximum Ratings

The voltage applied for VCC should not exceed 4VDC.

	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	VCC	3.0	3.3	3.6	V
Backup battery Voltage	VBACKUP	2.0	3.0	4.3	V
USB Supply Voltage	USB_VCC	3.0	3.3	3.6	V

2.8 Operating Conditions

	Condition	Min.	Typ.	Max.	Unit
Operation supply Ripple Voltage	□	□	□	50	**mVpp**
RX0 TTL H Level	VCC=3.3V	2.0	□	VCC	**V**
RX0 TTL L Level	VCC=3.3V	0	□	0.8	**V**
TX0 TTL H Level	VCC=3.3V	2.4	□	2.8	**V**
TX0 TTL L Level	VCC=3.3V	0	□	0.4	**V**
USB D+	Standard	□	□	□	**V**
USB D-	Standard	□	□	□	**V**
Backup Power Consumption@ 3V	25°C		7		**uA**

2.9 Antenna Status (Antenna Advisor)

Pin 8 (ANT_OK) and Pin 19 (VS_AA) are hardware indicators on Antenna Status. Their output states and corresponding definition are described in the table below.

Pin	Active Antenna Connected (bias<30mA)	Active Antenna Short (bias>30mA)	Active Antenna Open *or* Passive Antenna Connected (bias<3mA)
Pin 8 (ANT_OK)	High Level	High Level	Low Level
Pin 19 (VS_AA)	High Level	Low Level	Not Applicable

Please also see Chapter 3.2 for software readout for antenna status on UART.

2.10 Jamming Detection Status

Please also see Chapter 3.3 for software read out for Jamming status on UART.

2.11 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	3mA < IDC < 30mA at 3.3V
Total Gain	+ 25dBi
Output VSWR	< 2.5
Impedance	50ohm
Noise Figure	< 1.5dB

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. Recommended Minimum Navigation Information.
VTG	Course and speed information relative to the ground.
GLL	Geographic Position, Latitude/Longitude

Table-2 lists each of the custom NMEA output sentences specifically developed and defined by MTK for use within MTK products

Table-2: Custom NMEA Output Sentence	
Option	**Description**
PGACK	The status of antenna, auto switch sensitivity function, and "**AntiJACK**": Jammed Detect & Report function.

3.2 Definition of standard NMEA Output Sentences

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

Table-3 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-3: GGA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGGA		GGA protocol header
UTC Time	064951.00		hhmmss.ss
Latitude	2307.12562		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.44382		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See **Table-4**
Satellites Used	8		Range 0 to 14
HDOP	0.95		Horizontal Dilution of Precision
MSL Altitude	39.9	meters	Antenna Altitude above/below mean-sealevel
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
Checksum	*65		
<CR> <LF>			End of message termination

Table-4 Position Fix indicator

Table-4: Position Fix Indicator	
Value	**Description**
0	Fix not available
1	GPS fix
2	Differential GPS fix

GSA—GNSS DOP and Active Satellites

Table-5 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-5: GSA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See **Table-6**
Mode 2	3		See **Table-7**
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-6: Mode 1	
Value	**Description**
M	Manual—forced to operate in 2D or 3D mode
A	2D Automatic—allowed to automatically switch 2D/3D

Table-7: Mode 2	
Value	**Description**
1	Fix not available
2	2D (□4 SVs used)
3	3D (≧4 SVs used)

GSV—GNSS Satellites in View

Table-8 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-8: 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-9 contains the values for the following example□

$GPRMC,064951.00,A,2307.12562,N,12016.44382,E,0.034, ,260406,,,A*55

Table-9: RMC Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPRMC		RMC protocol header
UTC Time	064951.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2307.12562		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.44382		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over Ground	0.034	knots	
Course over Ground			Null
Date	260406		ddmmyy
Magnetic Variation		degrees	Null
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*55		
<CR> <LF>			End of message termination

VTG—Course and speed information relative to the ground

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

$GPVTG,,T,,M,0.034,N,0.06,K,A*37

Table-10: VTG Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPVTG		VTG protocol header
Course			Null
Reference	T		True
Course		degrees	Null
Reference	M		
Speed	0.034	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	*37		
<CR> <LF>			End of message termination

GLL—Geographic Position, Latitude/Longitude

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

$GPGLL,2305.91626,N,12017.06438,E,051817.00,A,A*61

Table-11: VTG Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2305.91626		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12017.06438		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
UTC Time	064951.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*61		
<CR> <LF>			End of message termination

3.3 MTK NMEA Command Protocols

The complete MTK NMEA Command list document is available by request. Contact Ascenkorea for more details.

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>

3.4 Antenna and GPS Jammer Status Report Protocol (Antenna Advisor and Anti-JACK™)

Table-12: PGACK 100 Data Format

Name	Value	Description
Message ID	$PGACK	PGACK protocol header
Command ID	100	The id of command for status
Parameter 1	1, 2, or 3	Antenna connecting status: 1. Active Antenna Short 2. Passive Antenna Connected or Active Antenna Open 3. Active (external) antenna active (see 3.3.1)
Parameter 2	0, 1, or 2	Jamming sensitivity setting status: 0. Jamming detect function is disabled 1. Current setting is "High Sensitivity" for jamming detector. 2. Current setting is "Low Sensitivity" for jamming detector.
Parameter 3	0 or 1	Value of jamming status: 0. No jammer detected. 1. Jammer detected.
Checksum	*checksum	
<CR> <LF>		End of message termination

Example:

$PGACK,100,2,1,1*5D<CR><LF>

Parameter 1: 2=>Passive Antenna Connected or Active Antenna Open

Parameter 2: 1=> the current setting is “High Sensitivity” for jamming detector.

Parameter 3: 1=> Jammer detected

Checksum: 5D

3.4.1 Status of antenna with auto switch sensitivity

The function is to report antenna connecting status detected by advisor circuit which is already built-in the module. The Jammer sensitivity will be changed according to the antenna connecting status.

(If command mode 3 was programmed, the Jamming sensitivity will be set to high sensitivity. See 3.4.1)

3.5 Anti-JACK: GPS Jammer Detection Mode Selection Protocol

Anti-JACK™ offers four flexible GPS jammer detect modes that users can select via UART RX depending on their applications.

Example:

$PGCMD, 23, Mode*checksum<CR><LF>

Mode 0 : $PGCMD, 23, 0*6C<CR><LF> Mode 1 : $PGCMD, 23, 1*6D<CR><LF>
Mode 2 : $PGCMD, 23, 2*6E<CR><LF> Mode 3 : $PGCMD, 23, 3*6F<CR><LF>

Table-13: Command mode Format

Mode	Jammer Detector disabled	Power Saving Mode	SW UART Protocol Output	HW JDET_OUT (Pin 2) Output	AJSS[1]	Description
0	✓					Disable Jammer Detect function
1			✓	✓	✓	Jammed Detect & Report on UART (see 3.3) and Pin 2 Voltage Output (see 2.4), AJSS is enabled.
2		✓	✓	✓	✓	Power Saving Mode active in Jammer Detect
3 (default)		✓	✓	✓		AJSS is not active, set to high sensitivity.

1 AJSS = Auto Jamming Sensitivity Setting

AJSS: Auto Jamming Sensitivity Setting

AJSS will automatically adjust the sensitivity of jammer detection based on the following:

- The auto sensitivity switch will set to “low sensitivity” if an active antenna was connected.
- The auto sensitivity switch will set to “high sensitivity” if a passive antenna is connected to **RF_IN** (**Pin16**).

- If GPS Jammer Detect Mode 3 (default) is selected, the sensitivity will be always at high sensitivity

When you finished selecting GPS Jammer Detection Mode with the appropriate command, you will receive an ACK after the command is processed. Please refer to **Table-14** for the detail of ACK packet.

Table-14 contains the values for the following example**:**

$PGACK 23,Mode*checksum<CR><LF>

Table-14: PGACK 23 Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$PGACK		PGACK protocol header
Command ID	23		The id of command
Mode	3		The mode of Jammer function setting
Checksum	*6C		
<CR> <LF>			End of message termination

Example:

$PGACK,23,3*6C<CR> <LF>

3.6 Anti-JACK: GPS Jammer Detection Test Program

A simple GPS test tool is available for Gmmu5j which allows the testing of various jammer detection and control commands with statues report, including firmware version, NMEA output and CNR. This test tool is for Windows OS based PC and is available for download from AscenKorea website at http://www.ascen korea.com

3.7 Firmware Customization Services

AscenKorea also offers flexible, value-adding GPS firmware customization services that maximizes the over system efficiencies and power consumptions. Latest functions like Binary Mode, 1-Sentence Output, Geo-fencing and Last Position Retention, please see our website at **www.ascenkorea.com** under Products / GPS Modules / Software Services for more details.

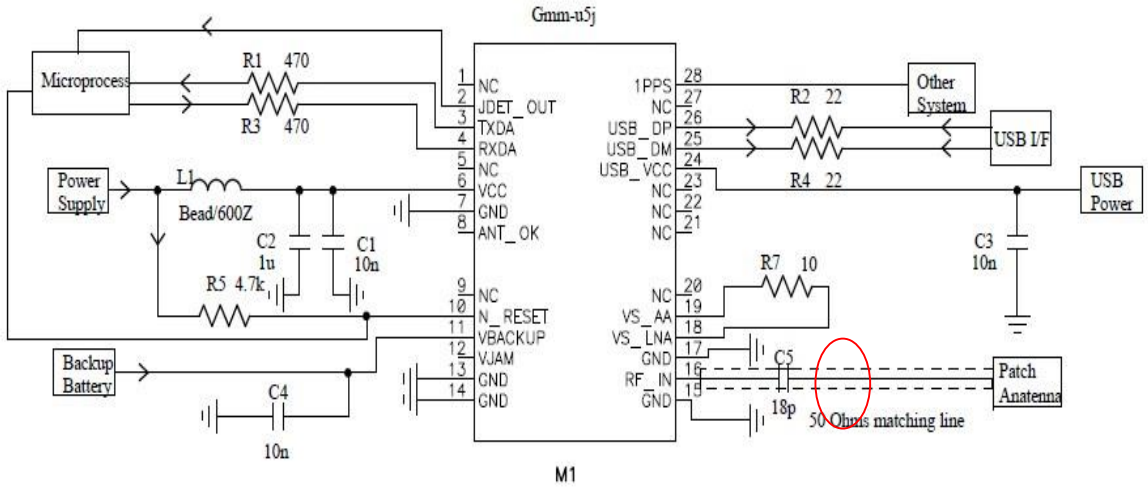
Note: Not all firmware customization services listed below are supported by Gmmu5j. Please contact AscenKorea Sales or Technical Support for more details.

4. Rererence Design

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

4.1 Patch (Passive) Antenna

When using a passive antenna, please connect the antenna directly to Pin16, RF_IN.

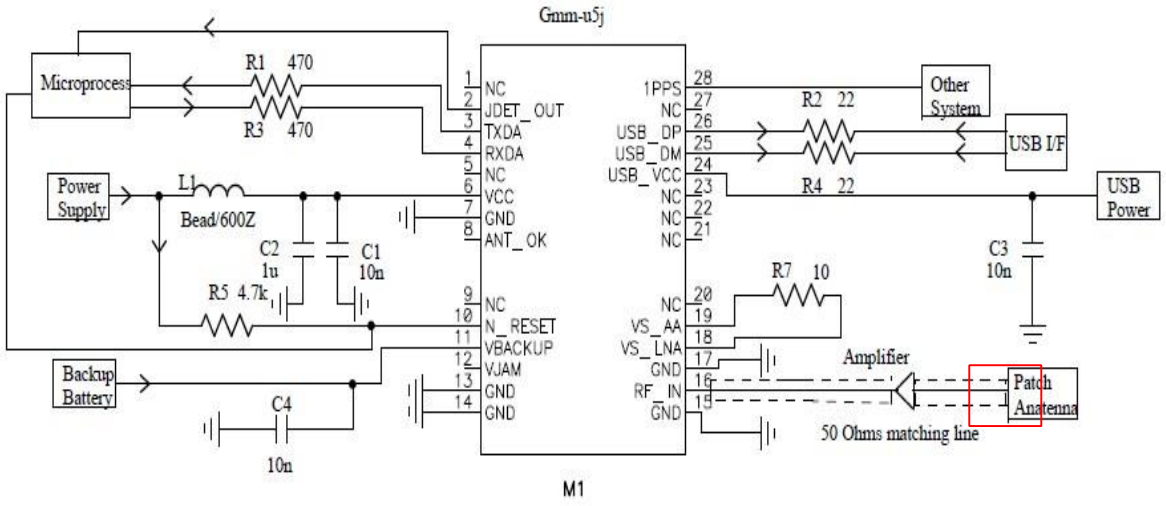


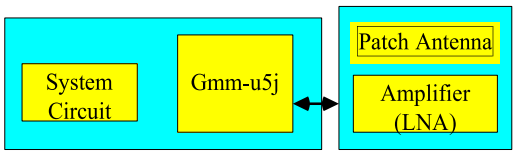
Note:

1. The maximum Jammer detection distance: 2m or less (jamming detector @ high sensitivity)
2. It is not recommended to set jamming detector @ low sensitivity setting using patch antenna
3. If you need more support and information on antenna implementation, please directly contact us at sales@ascen.co.kr for further services.
4. Ferrite bead L1 is added for power noise reduction.
5. C5 coupling capacitor should be put near the Antenna.
6. C1, C2, C3 and C4 decoupling capacitor should be put near the module.
   For C2, the value chosen depends on the amount of system noise, the range from 1uF to 100uF is reasonable.
7. Damping resistors R1, R2, R3, R4 and R5 could be modified based on system application.
8. An additional resistor R7 (10ohm) is used to connect Pin 19 VS_LNA with Pin 18 VS_AA, which also enables “Antenna Advisor” mechanism.

4.2 Patch (Passive) Antenna (additional stage LNA)

Adding a LNA between Patch Antenna and RF_IN pin will increase jamming detection distance. When using a passive antenna, please connect the antenna directly to Pin16, RF_IN.





Reference System Block Diagram

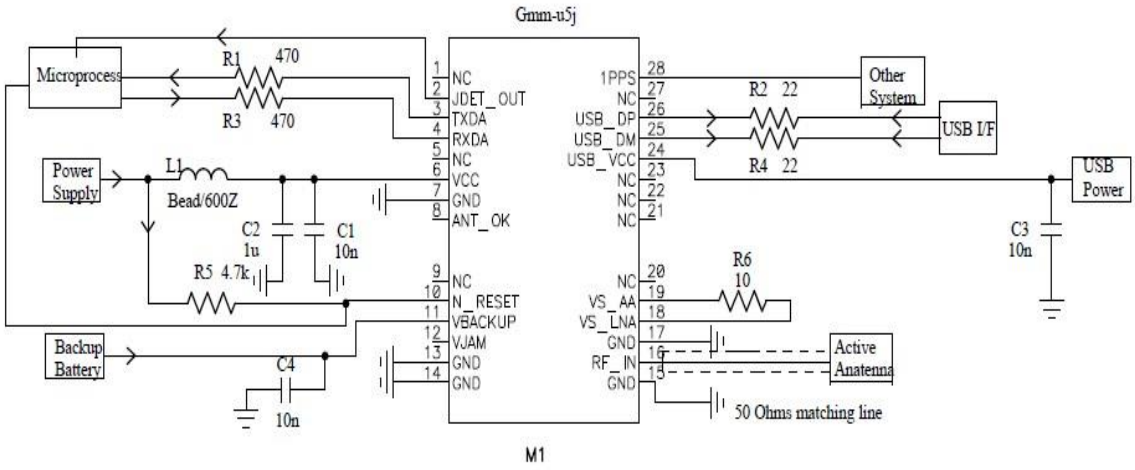
Note:

1. Addition Amplifier (LNA: Gain <20dB, NF <2dB) between RF_IN pin and Passive (Patch) Antenna will increase GPS jammer detection distance >5m(High Sensitivity). Recommended Component: JRC NJG1107HB3 and Patch 25x25x4mm (Gain 1.7dBi)
2. Patch Antenna + LNA must be placed directly before Gmmu5j RF-end (RF_IN). This is to prevent the accidental detection of internal system interference. Additional spacing >5mm is required between the antenna and RF_IN pin.
3. Patch Antenna + LNA must not be placed at the opposite side of PCB from Gmmu5j 4. Power supply for LNA will be directly provided by RF_IN pin. The voltage range is 3V~3.6V.
5. If you need more support and information on antenna implementation, please directly contact us at sales@ascen.co.kr for further services.
6. Ferrite bead L1 is added for power noise reduction.
7. C5 coupling capacitor should be put near the Antenna.
8. C1, C2, C3, and C4 decoupling capacitor should be put near the module. For C2, the value chosen depends on the amount of system noise, the range from 1uF to 100uF is reasonable.
9. Damping resistors R1, R2, R3, R4 and R5 could be modified based on system application.
10. An additional resistor R7 (10ohm) is used to connect Pin 19 VS_LNA with Pin 18 VS_AA, which also enables “Antenna Advisor” mechanism.

4.3 Active Antenna with Antenna Advisor

When using an active antenna, a supply voltage is typically required to drive the internal LNA located inside the active antenna. For majority of the active antenna, the power will be sent on the same coaxial cable used for GPS signal reception through the RF_IN Pin (Pin 16). For Gmmu5j, this power source is inputted from Pin 19 VS_AA, which is designed to route the power to RF_IN Pin.

To power the active antenna through module's own power supply, please add an additional 10 ohm resistor between Pin18 VS_LNA and Pin19 VS_AA, which also enables the Antenna Advisor function such as open and short circuit detection and protection.

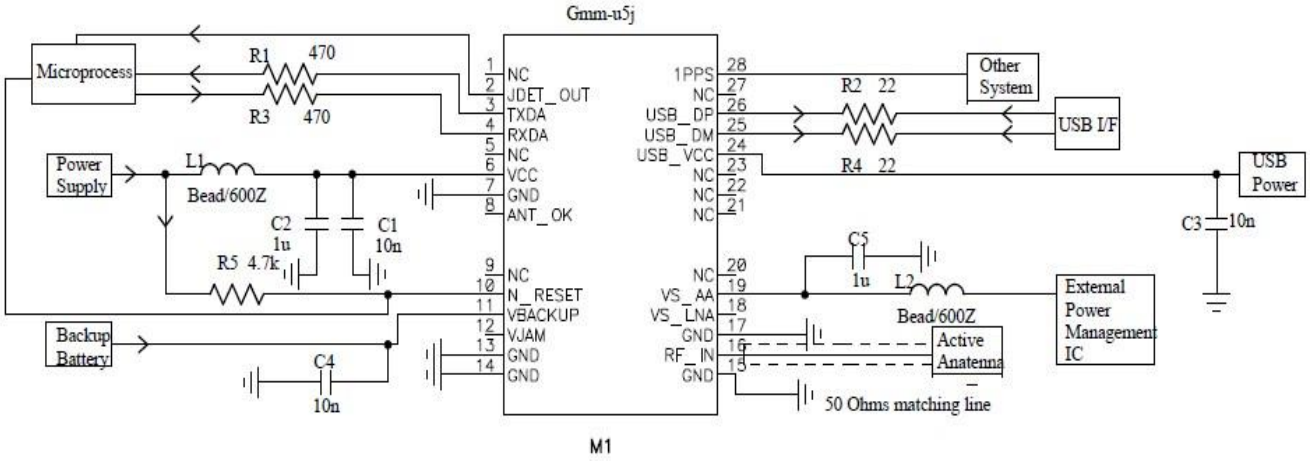


Note:

1. Please refer to Chapter 4.6 for maximum GPS jammer detection distance.
2. If you need more support and information on antenna implementation, please directly contact us at sales@ascen.co.kr for further services.
3. Ferrite bead L1 is added for power noise reduction.
4. C1, C2, C3 and C4 decoupling capacitor should be put near the module.
   For C2, the value chosen depends on the amount of system noise, the range from 1uF to 100uF is reasonable.
5. Damping resistors R1, R2, R3, R4, and R5 could be modified based on system application.
6. An additional resistor R6 (10ohm) is used to connect Pin 19 VS_LNA with Pin 18 VS_AA, which also enables "Antenna Advisor" mechanism.

4.4 Active Antenna with External Power Management IC

The reference design is for those who want to use a power management IC to perform external antenna status detection by defining their own behavior. The power IC should supply power to Pin 19 VS_AA (Range 3.0V to 3.6V, 3mA < current < 30mA), which will be routed to Pin 16 RF_IN internally, and this in turn will supply the power to the active antenna. (There is an internal inductor between VS_AA and RF_IN).



Note:

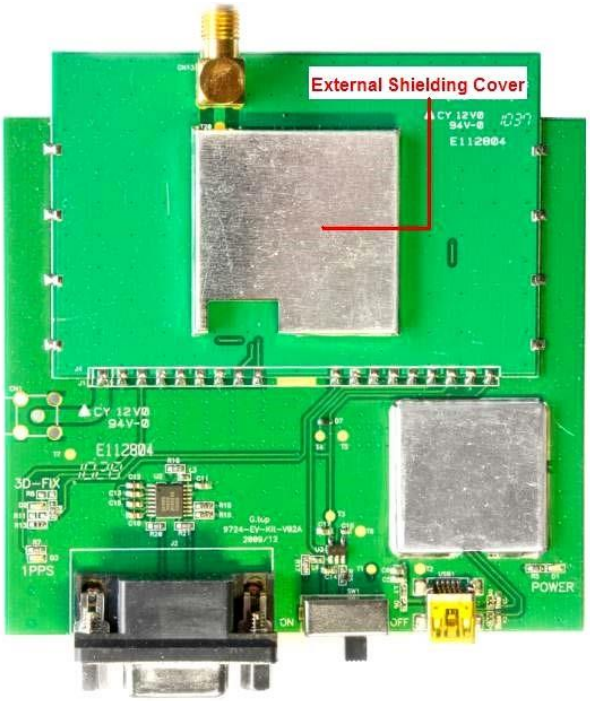
1. Please refer to Chapter 4.6 for maximum GPS jammer detection distance.
2. If you need more support and information on antenna implementation, please directly contact us at sales@ascen.co.kr for further services.
3. Ferrite bead L1 and L2 are added for power noise reduction.
4. C1, C2, C3, C4 and C5 decoupling capacitor should be put near the module.
   For C2 and C5 the value chosen depends on the amount of system noise, the range from 1uF to 100uF is reasonable.
5. Damping resistors R1, R2, R3, R4 and R5 could be modified based on system application.
6. “Antenna Advisor” mechanism will be not operational when using this design.

4.5 Extra Shielding Cover to Isolate Unwanted Noise

To obtain the best result for **Anti-JACK™** GPS Jammer Detection, it is highly recommended that an extra external shielding cover is used to isolate system interference from Gmmu5j to prevent the likelihood of a false alarm.

The recommend external shielding cover size should be > 30x25mm.

External Shielding cover on Gmmu5j Module:



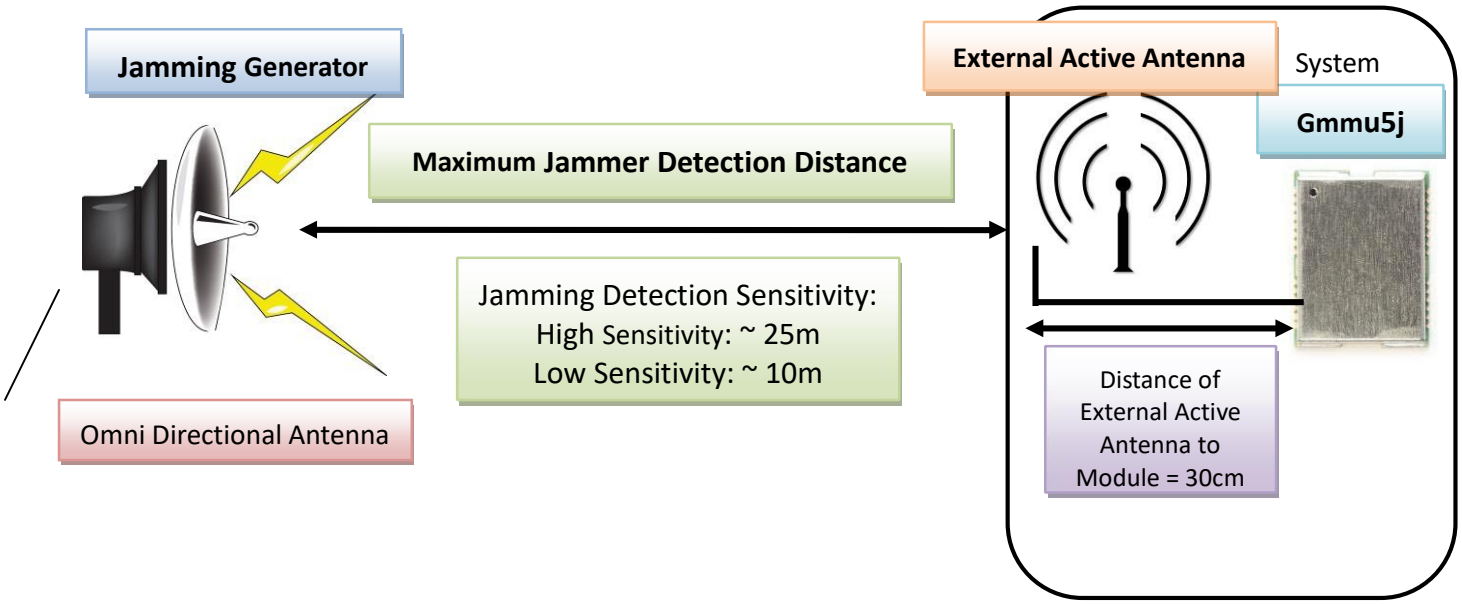
4.6 Test Environment for GPS Jammer Detection

Below is a simple system diagram on the reference setup used by AscenKorea Lab when testing for the effectiveness of Anti-JACK™GPS Jammer Detection.

Test Condition:

1. Jamming Generator Output Power Level: -10dBm
   Sweep BW: 26MHz
   Center Frequency: 1575MHz

2. Active (External) Antenna : Patch 25x25x4mm, LNA (Gain=25dB,NF<1.5dB)



5. 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 AscenKorea 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 AscenKorea 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.**

5.1 Moisture Sensitivity

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

AscenKorea 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 Packing

AscenKorea 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.

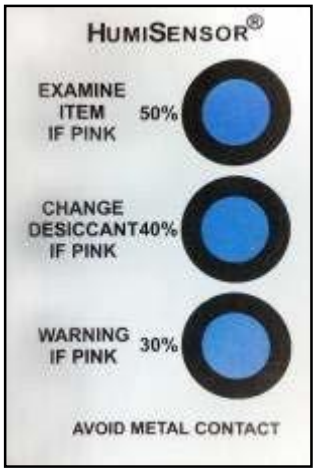
Figure 1: One pack of GPS modules

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.



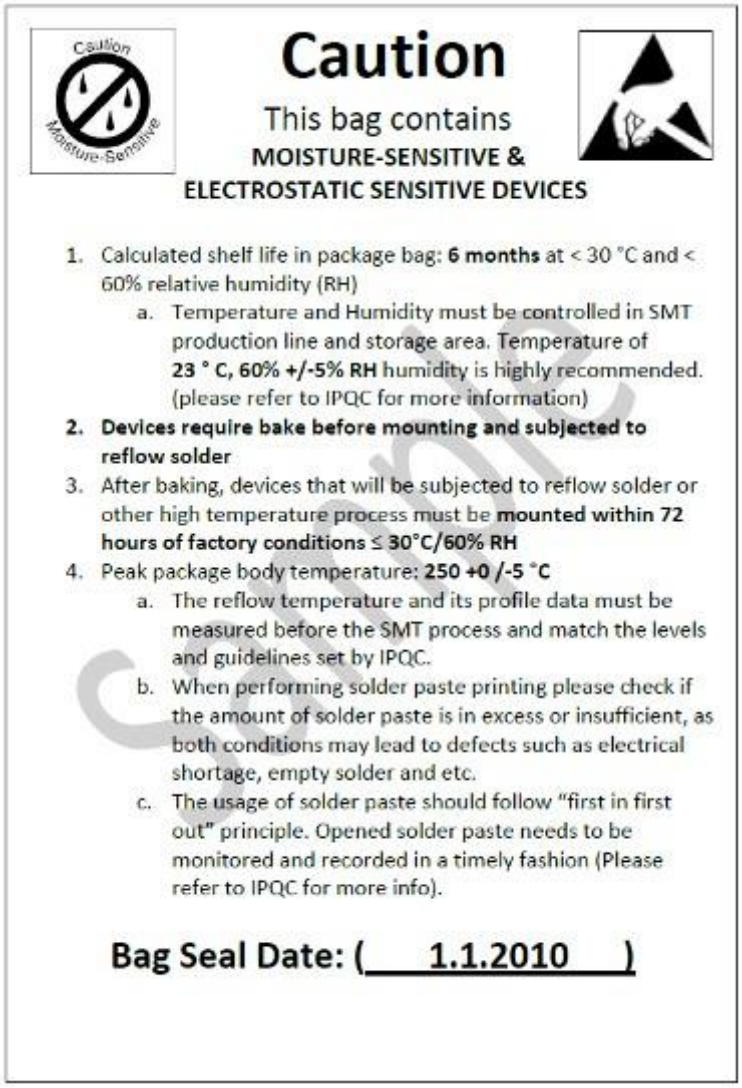


Figure 3: Example of moisture color coded card and caution label

5.3 Storage and Floor Life Guideline

Since AscenKorea 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 AscenKorea 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 AscenKorea GPS modules to undergo pre-baking procedures, regardless of the storage condition.**

5.4 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 AscenKorea GPS module to undergo pre-baking procedure before any high temperature or solder reflow process.

The recommendation baking time for AscenKorea 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 solder ability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solder ability 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.**

5.5 ESD Handling

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

AscenKorea 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).

6. Reflow Soldering Temperature Profile

The following reflow temperature profile was evaluated by AscenKorea 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.

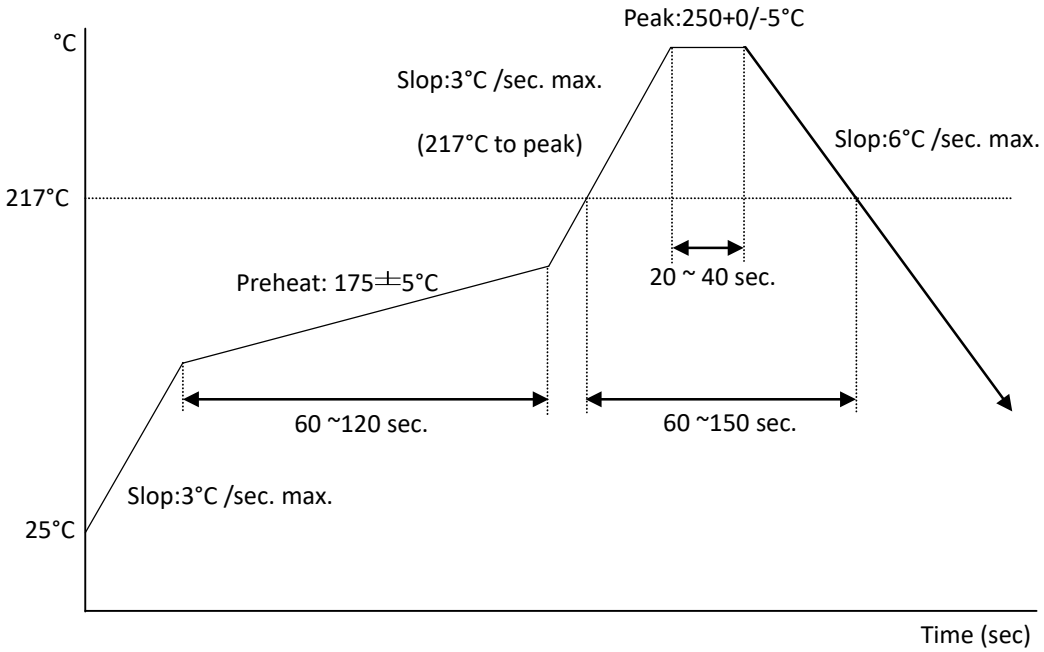
Preheat: 175 ± 25°C, 60 ~ 120 seconds

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.



6.2 Cautions on Reflow Soldering Process

	Details	Suggestions	Notes
1	Before proceeding with the reflowsoldering 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 joint to see if there are any signs of cold weld(ing) or false welding.	The parameters of the reflow temperature must be set accordingly to module's reflowsoldering 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, possibility 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 going through the reflow-soldering process, the production operators must check by eyesight 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 by eyesight 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 gone through the reflow-soldering process, in order to prevent positional shift that might occur when the module is still hot.	1. Can 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 there are sufficient gap between patch antennas so the patch antennas are not in contact with one another. 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. There must be enough space to ensure the blade and patch antenna 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 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. 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 by eyesight 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 AscenKorea beforehand if you must process GPS module during the 1st pass of double-side process.

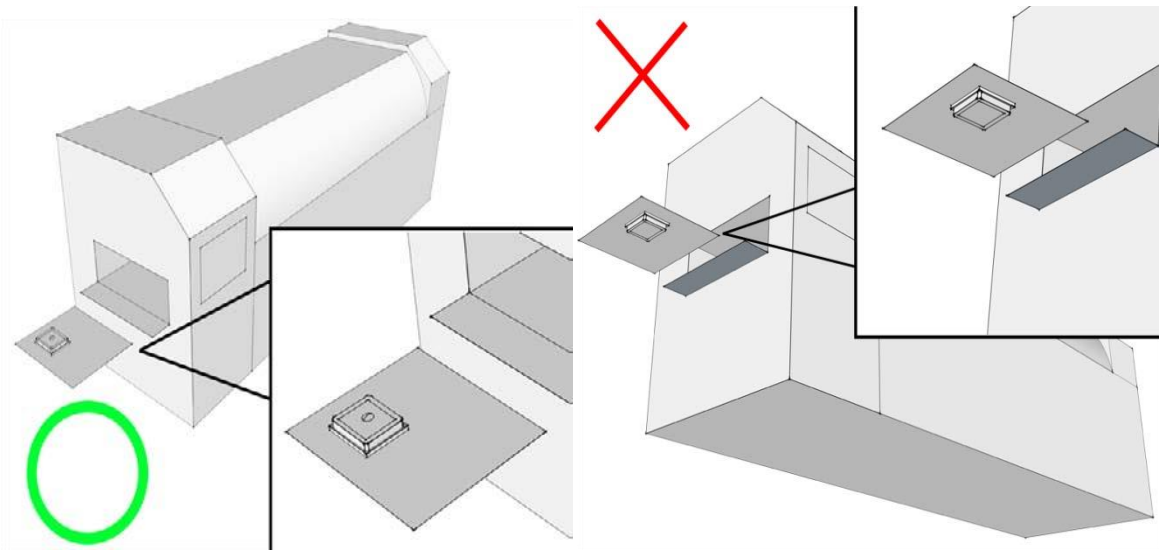


Figure 6.2: Place GPS module right-side up when running reflow-solder process, do not invert.

9. Module must be pre-baked **before** going through SMT solder reflow process.

10. 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).

11. 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)

12. 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.

13. The reflow temperature and its profile data must be measured before the SMT process and match the levels and guidelines set by IPQC.

6.3 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.