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# G7A

# Hardware User Guide

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## Notice

This document provides guide for users to use G7A.

This document is intended for system engineers (SEs), development engineers, and test engineers.

THIS GUIDE PROVIDES INSTRUCTIONS FOR CUSTOMERS TO DESIGN THEIR APPLICATIONS. PLEASE FOLLOW THE RULES AND PARAMETERS IN THIS GUIDE TO DESIGN AND COMMISSION. NEOWAY WILL NOT TAKE ANY RESPONSIBILITY OF BODILY HURT OR ASSET LOSS CAUSED BY IMPROPER OPERATIONS.

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# About This Document

## Scope

This document is applicable to G7A series.

It defines the features, indicators, and test standards of the G7A module and provides reference for the hardware design of each interface.

## Audience

This document is intended for system engineers (SEs), development engineers, and test engineers.

## Change History

| Issue | Date | Change | Changed By |
|---|---|---|---|
| 1.0 | 2019-02 | Initial draft | Zhuo Jianzheng |
| 1.1 | 2019-07 | • Deleted I2C<br>• Updated the bottom dimensions | Gong Hualiang |
| 1.2 | 2019-08 | • Revised the values of channel quality<br>• Reversed the label figures | Gong Hualiang |

## Conventions

| Symbol | Indication |
|---|---|
|  | This warning symbol means danger. You are in a situation that could cause fatal device damage or even bodily damage. |
|  | Means reader be careful. In this situation, you might perform an action that could result in module or product damages. |
|  | Means note or tips for readers to use the module |

# Related Documents

*Neoway_G7A_Datasheet*

*Neoway_G7A_Product_Specifications*

*Neoway_G2/G7A_Receiver_Command_Mannual*

*Neoway_GNSS_EVK_User_Guide*

# 1 About G7A

G7A is a GNSS module that supports BDS B1, GPS L1, and GLONASS L1. It adopts a unified chipset integrating baseband and RF and its dimensions are 10.6 mm x 9.7 mm x 2.2 mm. It is an optimal navigation solution to demands for high sensitivity, low power consumption, and low cost in different navigation devices

## 1.1 Overview

G7A series including the following variants and band configurations.

Table 1-1 Versions and bands

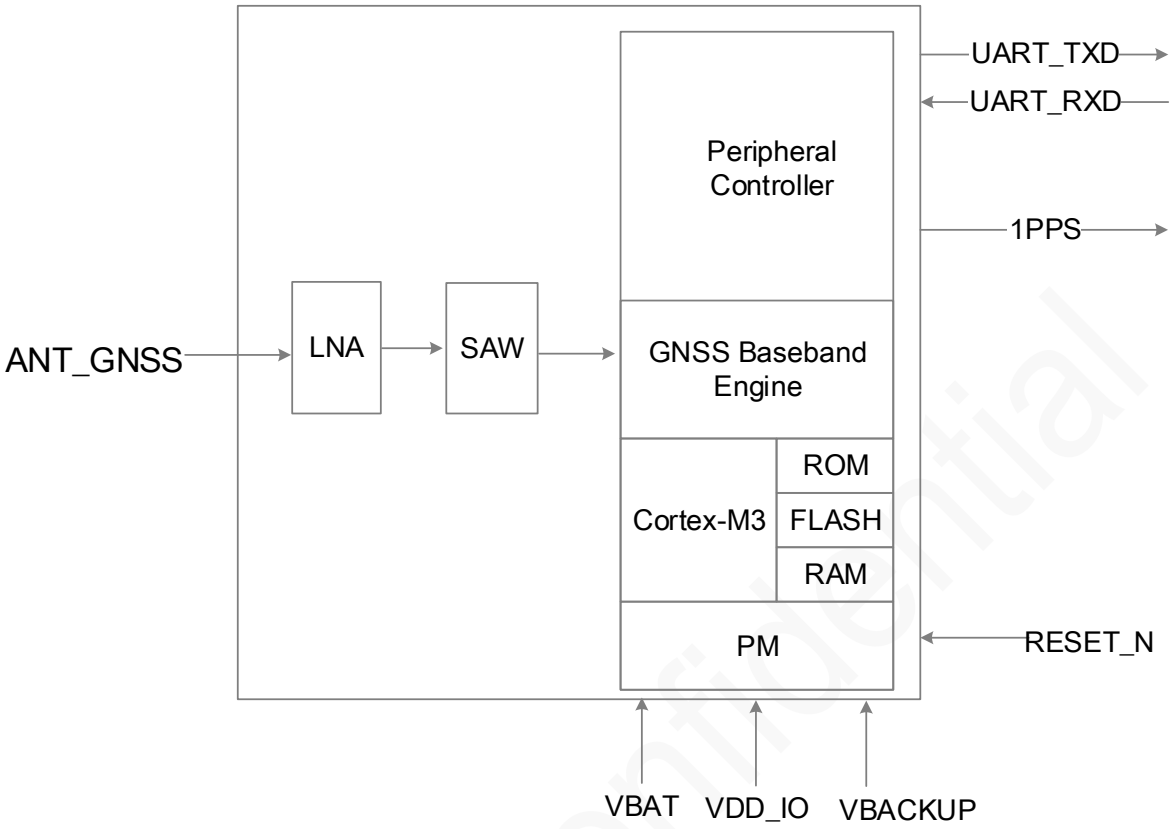
| Module | Variants | GPS | BDS | GLONASS | Support GAGAN |
|---|---|---|---|---|---|
| G7A | G7A-B1 | √ | √ | | |
| | G7A-D1 | √ | | √ | √ |

## 1.2 Block Diagram

G7A consists of the following functional units:

- GNSS baseband
- RF front end components
- RTC
- Peripheral interfaces

Figure 1-1 Block diagram




## 1.3 Specifications

| Parameter | Description | Min. | Typ. | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Positioning precision (open air) | Horizontal | | <3 | | m | |
| | Elevation | | <4.5 | | m | |
| Speed precision | | | <0.1 | | m/s | |
| Channel quantity | Capturing | | 32 | | | |
| | Tracking | | 32 | | | |
| TTFF (@-130dBm) | Cold start | | <32 | | s | |
| | Hot start | | 1 | | s | |
| | Recapture | | 1 | | s | |
| Sensitivity | Cold start | | -148 | | dBm | |
| | Hot start | | -156 | | dBm | |
| | Recapture | | -160 | | dBm | |
| | Tracking | | -162 | | dBm | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Baud rate | | 4800 | 9600 | 256000 | bps | 9600bps by default |
| Update frequency | | | 1 | 10 | Hz | 1Hz by default |
| Operating voltage | VBAT | 2.7 | 3.3 | 3.6 | V | |
| | VDD_IO | 2.7 | 3.3 | 3.6 | V | |
| | VBACKUP | 1.4 | 3.3/3.0 | 3.6 | V | |
| Current (@instrument) | Capturing | | 30 | | mA | 3.3 V |
| | Tracking | | 28 | | mA | 3.3 V |
| | Idle | | 10 | | μA | 3.3 V |
| Certification and Approvals | RoHS, CE | | | | | |

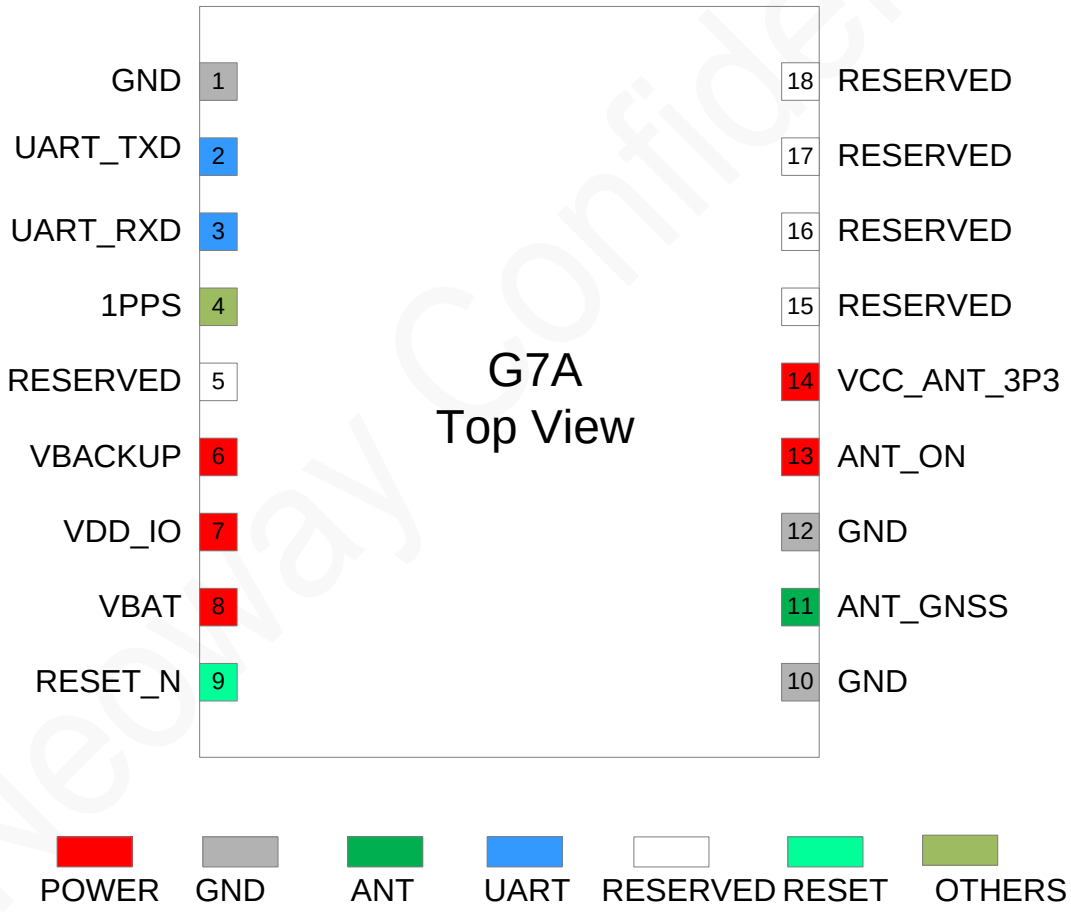
# 2 Pad Layout and Pin Definition

There are 18 pins on G7A and their pads are in LCC package.

## 2.1 Pad Layout

错误!未找到引用源。 shows the pad layout of G7A.

Figure 2-1 G7A pin definition (top view)



# 2.2 Pin Definition

Table 2-1 lists the IO types

Table 2-1 IO types

| IO types | | |
|---|---|---|
| B | Digital input/output, COMS logic level | |
| DO | Digital output, COMS logic level | |
| DI | Digital input, COMS logic level | |
| PO | Power output | |
| PI | Power input | |
| AO | Analog output | |
| AI | Analog input | |
| **DC feature description** | | |
| P1 | Power type of digital IO interface | 3.3V:<br>$V_{IH}$=2.4V~3.6V,<br>$V_{IL}$= -0.3V~0.6V<br>$V_{OH}$=2.9V~3.3V,<br>$V_{OL}$=0V~0.4V |

Table 2-2 Pin definition

| Signal | Pin | I/O | Function | DC Feature | Remarks |
|---|---|---|---|---|---|
| **Power** | | | | | |
| VBAT | 8 | PI | Main power supply | 2.7V~3.6V (Typ:3.3V) | Supply a maximum current of 100 mA |
| VDD_IO | 7 | PI | IO power input | 2.7V~3.6V (Typ:3.3V) | Supply power for digital IO. Connect it to VBAT |
| VBACKUP | 6 | PI | Backup power supply input | 1.4V~3.6V (Typ:3.3/3.0V)<br>$I_{norm}$=10μA | Supply power to RTC and backup RAM. Leave it floating if not used. |
| VCC_ANT_3P3 | 14 | PO | Power supply for external RF component | Same as that of VBAT | Leave it floating if not used |
| GND | 1, 10, 12 | | | | Ensure that all GND pins are grounded. |
| Control interface | | | | | |
| RESET_N | 9 | DI | Reset the module | P1 | Low level triggered |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Leave it floating if not used. |
| **RF** | | | | | |
| ANT_GNSS | 11 | AI | RF signal input | | See chapter 4. |
| **UART** | | | | | |
| UART_TXD | 2 | DO | Data transmitting | P1 | Used for data transmission.<br>Leave it floating if not used. |
| UART_RXD | 3 | DI | Data receiving | P1 | |
| **Others** | | | | | |
| ANT_ON | 13 | DO | Switch external LNA or antenna | 3.3V output | Output low level in idle mode<br>Leave it floating if not used |
| 1PPS | 4 | DO | Pulse per second | P1 | Pulled up by default.<br>Leave it floating if not used. |
| RESERVED | 5, 15, 16, 17, 18 | | Reserved pins | | Leave them floating if not used. |

# 3 Application Interfaces

G7A provides power supply interface, UART interface, I2C interface, and 1PPS interface.

This chapter describes how to use each interface and the design precautions.

## 3.1 Power Supply

| Signal | Pin | I/O | Function | Remarks |
|---|---|---|---|---|
| VBAT | 8 | PI | Main power supply | 2.7 V to 3.6 V (Typ:3.3 V) |
| VDD_IO | 7 | PI | IO power input | 2.7 V to 3.6 V (Typ:3.3 V) |
| VBACKUP | 6 | PI | Backup power supply | 1.4 V to 3.6 V (Typ:3.3/3.0 V)<br>Supply power to RTC and backup RAM.<br>Leave it floating if not used. |
| VCC_ANT_3P3 | 14 | PO | Power supply for external RF component | Same as that of VBAT |
| GND | 1, 10, 12 | | | Ensure that all GND pins are grounded. |

### 3.1.1 VBAT

VBAT is the power supply input pin of the module. Its input voltage ranges from 2.7 V to 3.6V and the typical value is 3.3 V. In addition to baseband, it supplies power to RF component. The performance of the VBAT power supply is a critical path to module's performance and stability.

To ensure the optimal performance of the module, use low-noise LDO specifically for RF to supply power.

### 3.1.2 VDD_IO

VDD_IO is the power supply for digital IO of the module. It is recommended to connect it to VBAT in your applications.

### 3.1.3 VBACKUP

VBACKUP is the backup power supply of the module. It is used to supply power to RTC and backup RAM after VBAT is shut down so that the module can save key ephemeris data and almanac for hot start, warm start, and ephemeris computation.

The input voltage of the backup power supply ranges from 1.4 V to 3.6 V. The recommended value is 3.3/3.0V. It can be connected to a button battery or capacitor.

### 3.1.4 Work Modes

G7A supports the following two work modes:

- Positioning mode

  In positioning mode, the capturing engine is enabled all the time and it will automatically switch to tracking status to decrease operating current after finding valid location information, all ephemeris and data.

- Idle mode

  The module enters idle mode after VBAT is shut down. Only RTC backup part works normally. The power and clocks of all other functions are shut down.
  After VBAT is supplied power, the module enters positioning mode.
  To support hot start and warm start, VBCKUP must be able to supply power after VBAT is shut down.
  To position quickly, keep the power supply of the VBACKUP.

Table 3-1 lists the power status, clock status, and current in different modes.

Table 3-1 Power status, clock status, and current in different work modes

| Work Mode | VBAT | VBACKUP | Main Clock | RTC Clock | Current |
|---|---|---|---|---|---|
| Positioning | ON | ON | ON | ON | $I_{VBAT} + I_{VDD\_IO}30\text{mA}$ @multi-mode |
| Idle | OFF | ON | OFF | ON | $I_{VBACKUP} = 20uA$ |

## 3.1 RESET_N

RESET_N is triggered by negative pulse that exceeds 160 ms. This pin is pulled up internally and its typical high-level voltage is 3.3 V. Leave this pin floating if you do not use it.

If you use an IO system other than 3.3 V, it is recommended to add a triode to separate it. Refer to the following designs. To reset the module through high level, refer to Figure 3-2.

Figure 3-1 Reset controlled by button

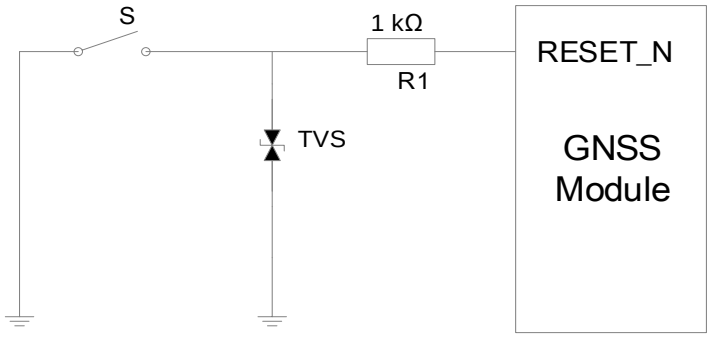



Figure 3-2 Reset circuit with triode separating

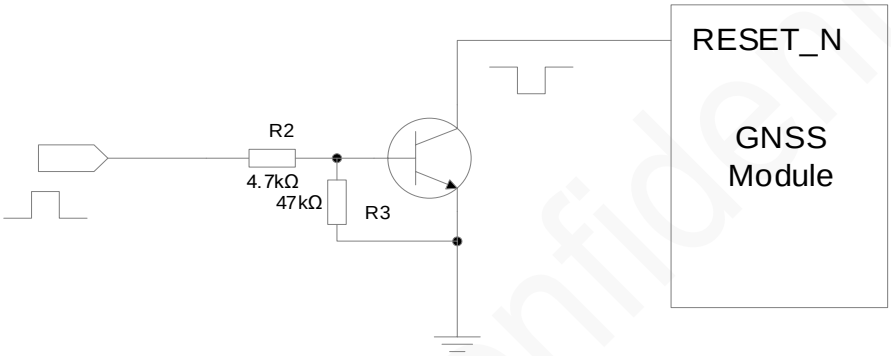
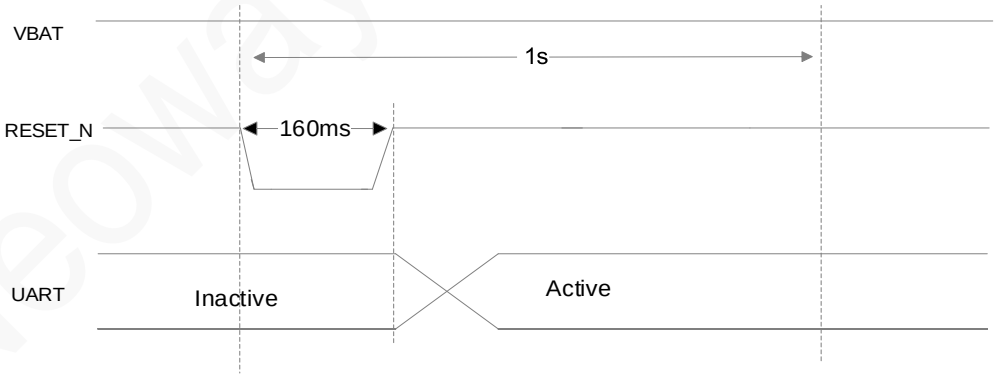



Figure 3-3 shows the reset timing of G7.

Figure 3-3 Reset timing of G7A



## 3.2 UART

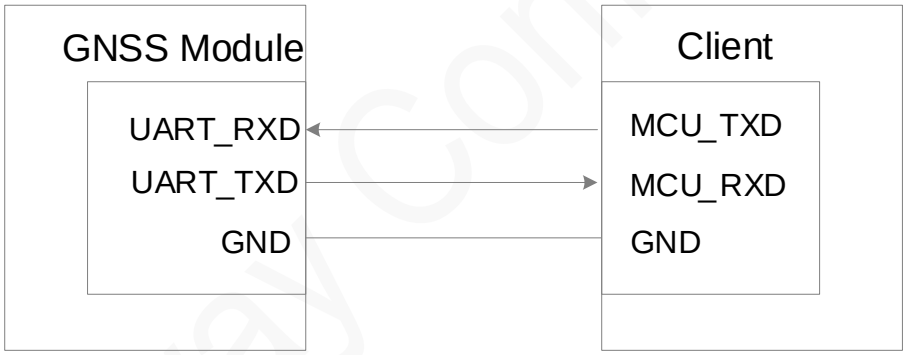
| Signal | Pin | I/O | Function | Remarks |
|---|---|---|---|---|
| UART_TXD | 2 | DO | Data transmitting | |
| UART_RXD | 3 | DI | Data receiving | |

UART outputs NMEA data at UTC second boundary. The MCU can switch the work mode, set baud rate, and select UART through AT commands. The module supports baud rate ranging from 4800bps to 2560400 bps. The default baud rate is 9600bps. Data format: 1 start bit, 8 data bits, 1 stop bit, no checksum bit.

For more information, see *Neoway_G2/G7A_Receiver_Commands_Manual*.

Figure 3-4 shows the connection of the UART interface. If the logic level of UART and MCU does not match, add a level shifter.

Figure 3-4 UART connection

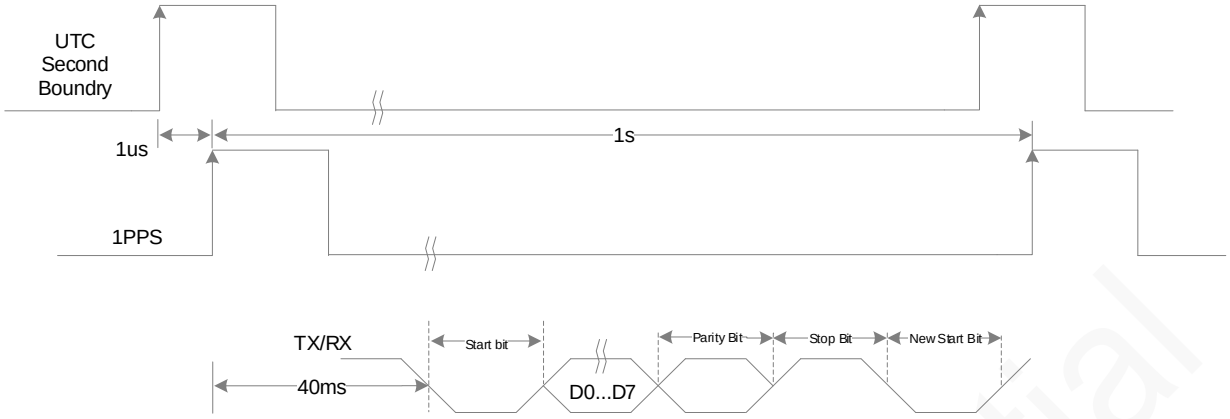



## 3.3 1PPS

1PPS signal is output several seconds after the module fixes position.

Figure 3-5 shows the timing of 1PPS signal.

Figure 3-5 1PPS timing




## 3.4 ANT_ON

In positioning mode, ANT_ON outputs 3.3 V. It is used to switch the external LNA or antenna.

In sleep or standby mode, it outputs low level. For details about the reference design, see 4.2.

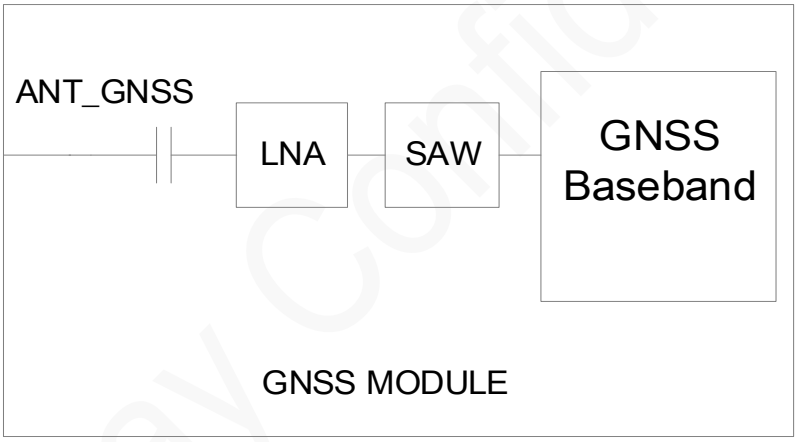
# 4 Antenna Interface

G7A provides one antenna interface for GNSS. This chapter describes how to control the impedance in design and provides reference deisgns with antenna and recommended antenna specifications.

## 4.1 Impedance Control

ANT_GNSS is the GNSS RF interface of G7A, which requires a characteristic impedance of 50 Ω. Figure 4-1 shows the structure inside G7A.

Figure 4-1 Internal circuit




Control the impedance of the traces between the pins and antenna to ensure the RF performance. An impedance matching circuit, such as L network, T network, and pi network is mandatory in between. Pi network is recommended.

Figure 4-2 L network

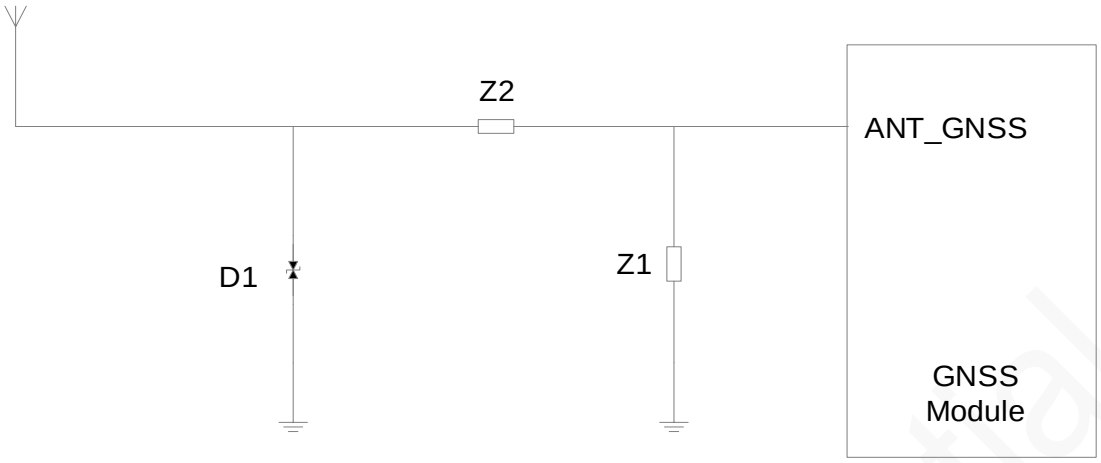



Figure 4-3 T network

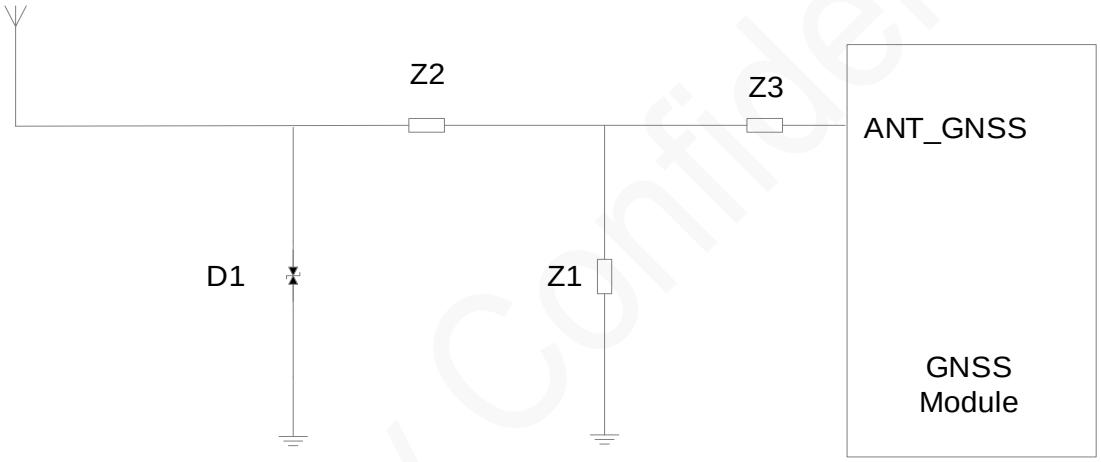
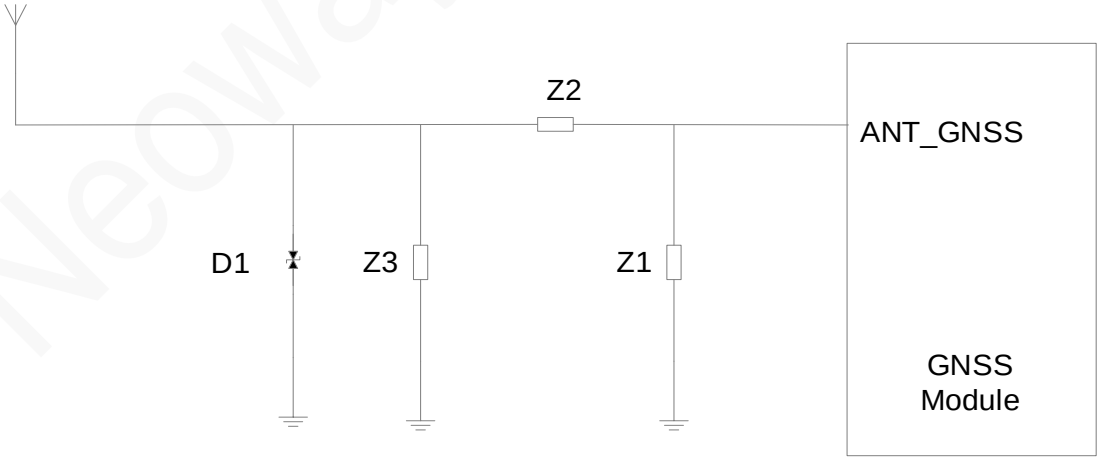



Figure 4-4 Pi network



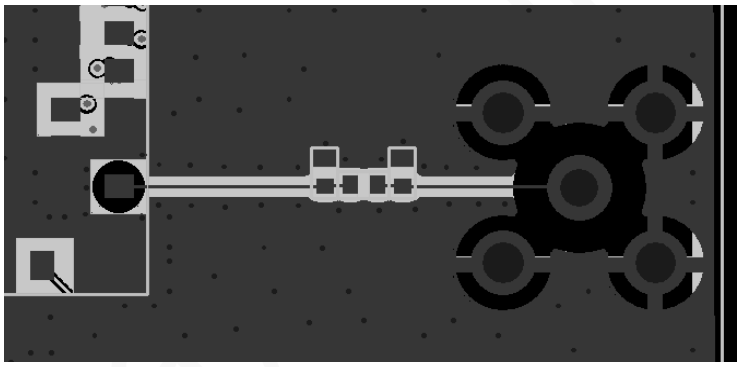

Schematic Design Guidelines:

- Element components in the above figures are capacitors, inductors, and 0 Ω resistors. Place these RLC components as close to the antenna interface as possible.
- Add an ESD protector if the antenna might generate static electricity. The protector can be a TVS diode with a junction capacitance of lower than 0.5 pF. Ensure that the reverse breakdown voltage of the TVS is greater than 10 V (above 15 V is recommended).
- G7A embeds an LNA, and no external LNA is required if a passive GNSS antenna is used.

PCB Layout Guidelines:

- Lay copper foil around RF connector. Dig as many ground holes as possible on the copper to ensure lowest grounding impedance.
- The trace between G7A and the antenna connector, should be as short as possible. Control the trace impedance to 50 Ω.
- If customers adopt SMA connector, big RF solder pad might result in great parasitic capacitance, which will affect the antenna performance. Remove the copper on the first and second layers under the RF solder pad.

Figure 4-5 Recommended RF PCB design



- On the PCB, keep the RF signals and components far away from digital circuits, power supplies, transformers, great inductors, the clock circuit, etc.

## 4.2 Reference Design of Active GNSS Antenna

After the antenna receives GNSS satellite signals, the LNA amplifies the signals and then transmits them to the ANT_GNSS through feeder and PCB traces. Figure 4-6 and Figure 4-7 shows reference designs of active GNSS antenna.

Figure 4-6 Reference design of active antenna (with control)

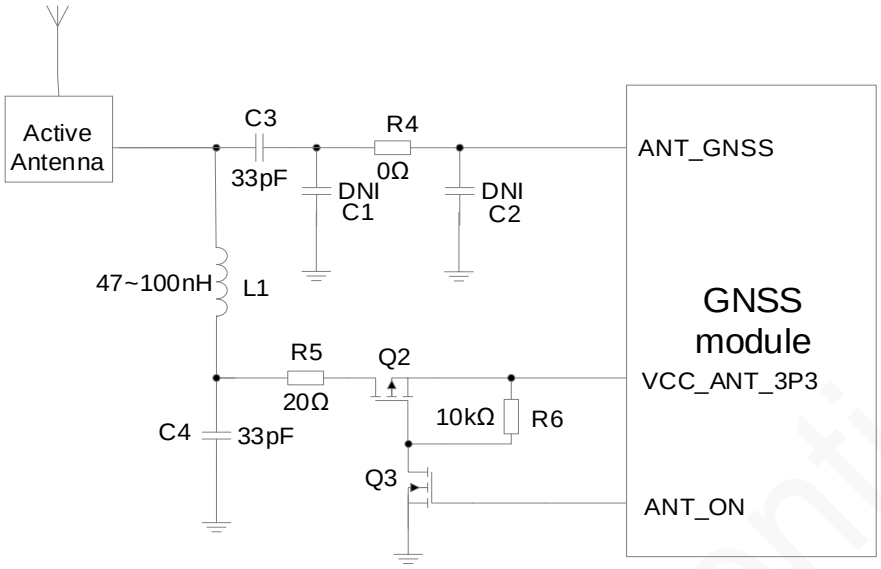
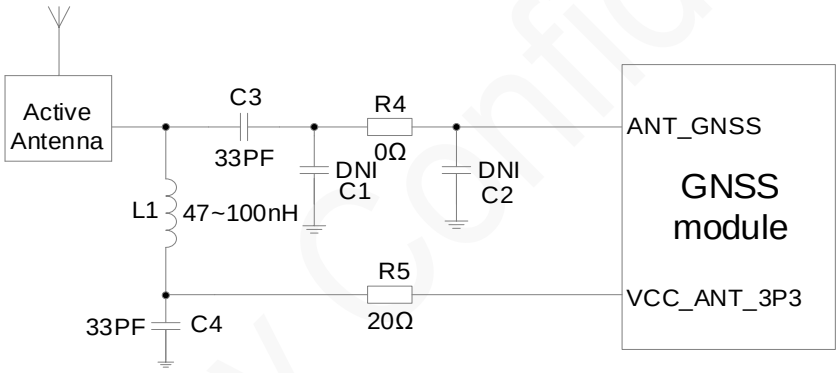



Figure 4-7 Reference design of active antenna (without control)




Schematic Design Guidelines:

- For matching circuit design between GNSS interface and antenna, refer to design guidelines in 4.1.
- If there is a requirement for power consumption in the application, connect an active antenna with control.

  In position fix mode, ANT_ON outputs high level, Q2 and Q3 are switched on simultaneously, and VCC_ANT_3P3 supplies power for the active antenna.
  In sleep or standby mode, ANT_ON outputs low level, Q2 and Q3 are switched off, and the power for active antenna is shut down.
  This design will help reduce the power consumption of G7A.

PCB Layout Guidelines:

- For guidelines of PCB layout between GNSS interface and antenna, refer to layout guidelines in 4.1.

- 50Ω impedance is required for the feeder and PCB traces and the traces should be as short as possible. The power supply of the active antenna is fed by the 47 to 100 nH inductor through the signal traces.
- Keep GNSS antenna circuit far away from the communications antenna circuits on PCB. Otherwise, these two parts will jam each other, lowing the RF performance.

## 4.3 Recommended Antenna

Table 4-1 Recommended antenna for G7A

| Antenna Type | Parameter | Value | Remarks |
|---|---|---|---|
| Passive antenna | Frequency | GPS:1575.42 MHz<br>BDS:1561.098 MHz<br>GLONASS:1602.5625 MHz | The frequency of the antenna matches the version of the module. |
| | Bandwidth | >5 MHz | |
| | Polarity | RHCP | |
| | SWR | <1.5 | |
| | Gain | ≥2 dBi | |
| | Efficiency | ≥40% | |
| Active antenna | Dimensions | 15.0×15.0×4.0 mm | |
| | Frequency | GPS:1575.42 MHz<br>BDS:1561.098 MHz<br>GLONASS:1602.0 MHz | The frequency of the antenna matches the version of the module. |
| | Bandwidth | >6 MHz | |
| | Polarity | RHCP | |
| | SWR | <1.5 | |
| | Gain (LNA embedded) | 20±2 dB | |
| | Gain | ≥2 dBi | |
| | Efficiency | ≥40% | |
| | Noise factor | <1.5 dB | |
| | Operating voltage | 3.0±0.3 V | |

# 5 Electrical Feature and Reliability

This chapter describes the electrical features and reliability of G7A.

## 5.1 Electrical Features

To ensure that G7A functions properly, operate it in recommended operationg conditions.

Table 5-1 Extreme operating voltage

| Parameter | Description | Minimum Value | Maximum Value | Unit |
|---|---|---|---|---|
| VBAT | Power supply | -0.3 | 4.5 | V |
| VDD_IO | Power supply | -0.3 | 4.5 | V |
| VBACKUP | Backup power supply | -0.3 | 4.5 | V |
| VIO | IO voltage | -0.3 | 4.5 | V |

If the input voltage is lower than the minimum value, the module might fail to start. If the voltage exceeds the high threshold or there is a voltage burst during the startup, the module might be damaged permanently.

Table 5-2 Recommended operating voltage

| Parameter | Minimum Value | Typical Value | Maximum Value | Unit |
|---|---|---|---|---|
| VBAT | 2.7 | 3.3 | 3.6 | V |
| VDD_IO | 2.7 | 3.3 | 3.6 | V |
| VBACKUP | 1.4 | 3.3/3.0 | 3.6 | V |

Table 5-3 Current features

| State | | Current | Unit |
|---|---|---|---|
| Continuous position fix | Multi-mode | 30 | mA |
| | Single-mode | 28 | mA |
| Idle | | 10 | μA |

## 5.2 Temperature

Table 5-4 Temperature feature

| Module Status | Minimum Value | Typical Value | Maximum Value |
|---|---|---|---|
| Operating | -40°C | 25 °C | 85°C |
| Storage | -45°C | / | 125°C |

If the module works in an environment where the temperature exceeds the thresholds of the operating temperature range, some of its RF performance indicators might be worse but it can still work properly.

## 5.3 ESD Protection

Humidity: 45%  Temperature: 25 °C

Table 5-5 ESD feature

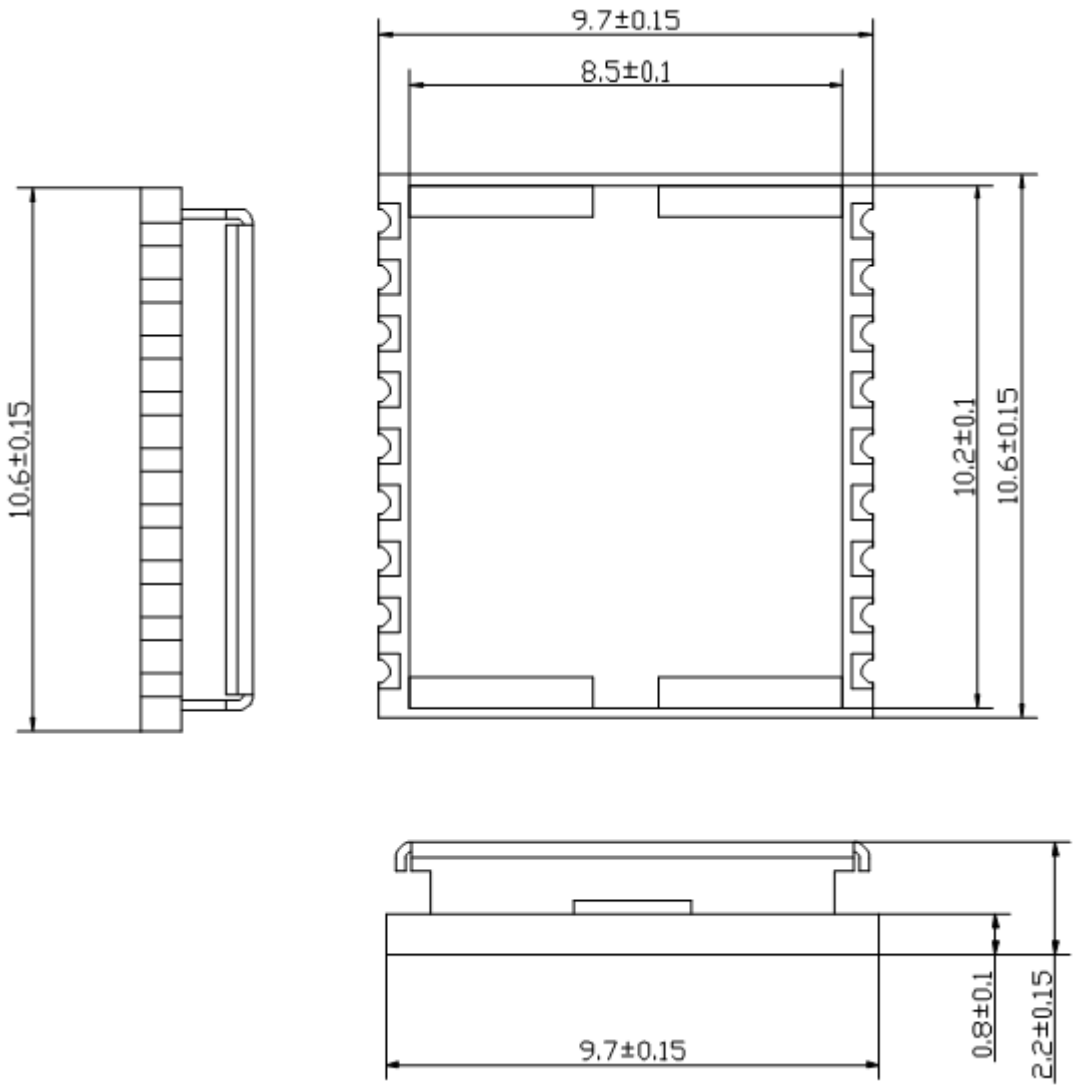
| Testing Point | Contact Discharge | Air Discharge |
|---|---|---|
| VBAT | ±8 kV | ±15 kV |
| GND | ±8 kV | ±15 kV |
| ANT | ±8 kV | ±15 kV |
| Cover | ±8 kV | ±15 kV |
| UART | ±4 kV | ±8 kV |
| Others | ±4 kV | ±8 kV |

# 6 Mechanical Features

This chapter describes the mechanical features of G7A.

## 6.1 Dimensions

Figure 6-1 G7Adimensions (Unit: mm)



## 6.2 Label

Figure 6-2 and Figure 6-3 shows the label of G7A.

Figure 6-2 G7A-B1 label

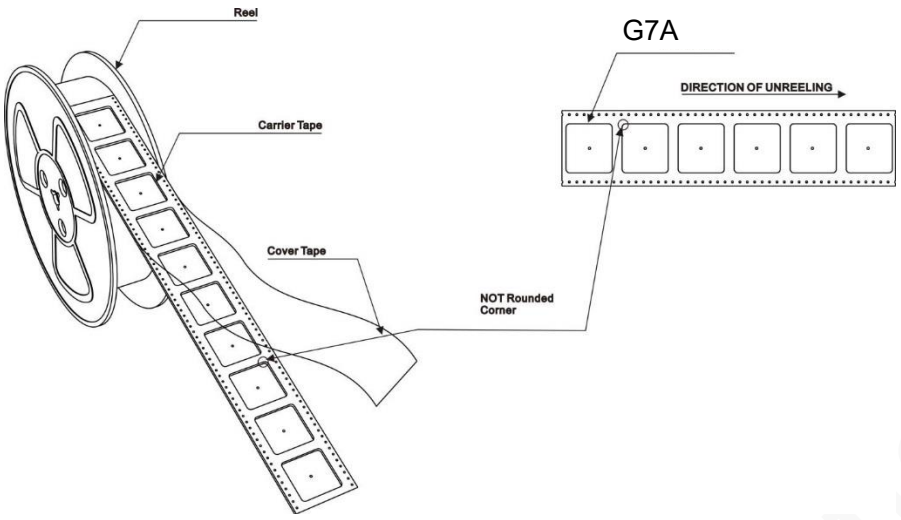

Figure 6-3 G7A-D1 label


## 6.3 Packaging

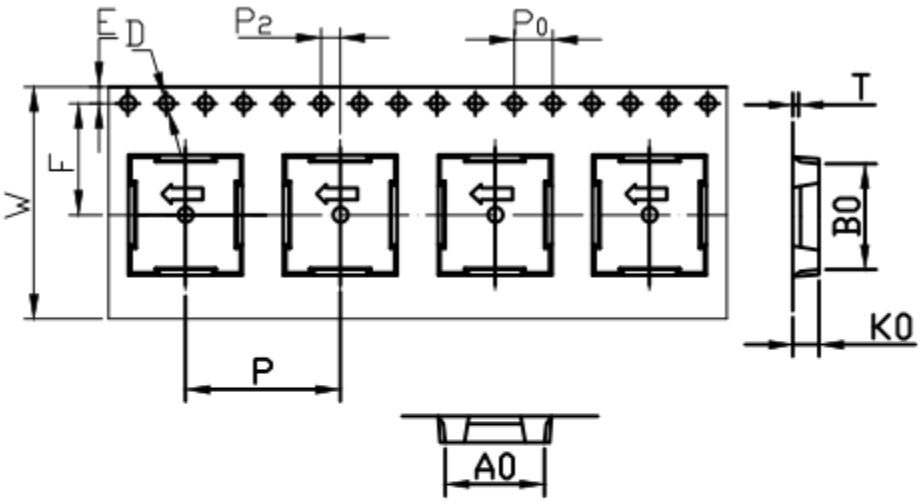
G7A modules are packed in sealed bags on delivery to guarantee a long shelf life. Follow the same package of the modules again in case of opened for any reasons.

### 6.3.1 Tape & Reel Packaging

G7A in mass production are shipped in the following package.

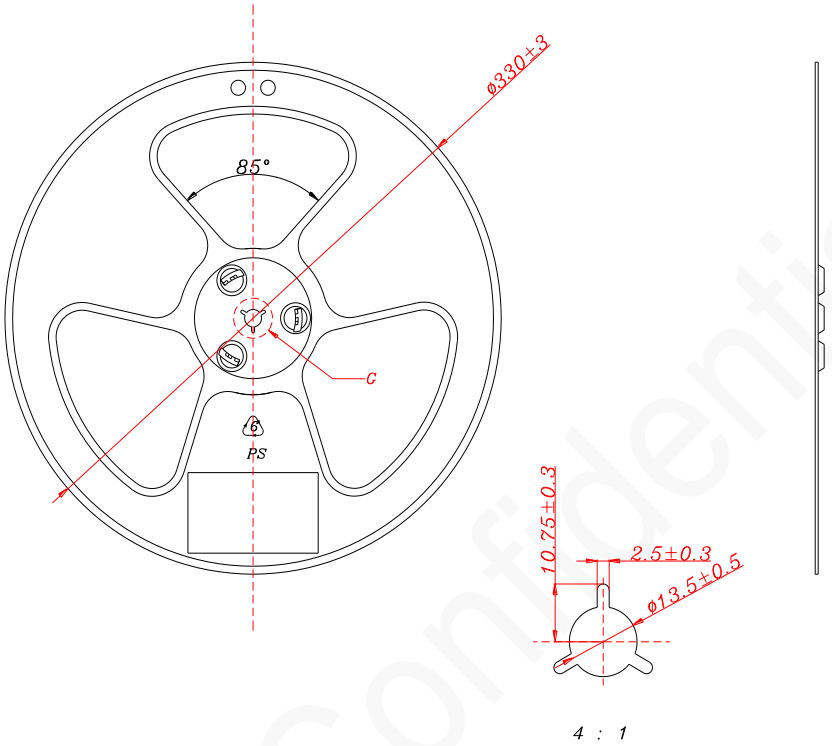



Tape




| ITEM | W | A0 | B0 | K0 | K1 | P | F | E | D | D1 | P0 | P2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIM | 24.0 +0.30 -0.10 | 10.1 +0.10 -0.10 | 11.0 +0.10 -0.10 | 2.7 +0.10 -0.10 | 0.00 +0.10 -0.10 | 16.0 +0.10 -0.10 | 11.5 +0.10 -0.10 | 1.75 +0.10 -0.10 | 1.50 +0.10 -0.00 | 0.00 +0.25 -0.00 | 4.00 +0.10 -0.10 | 2.00 +0.10 -0.10 |

Reel




## 6.3.2 Mositure-Sensitive

G7A is a level 3 moisture-sensitive electronic elements, in compliance with IPC/JEDEC J-STD-020 standard.

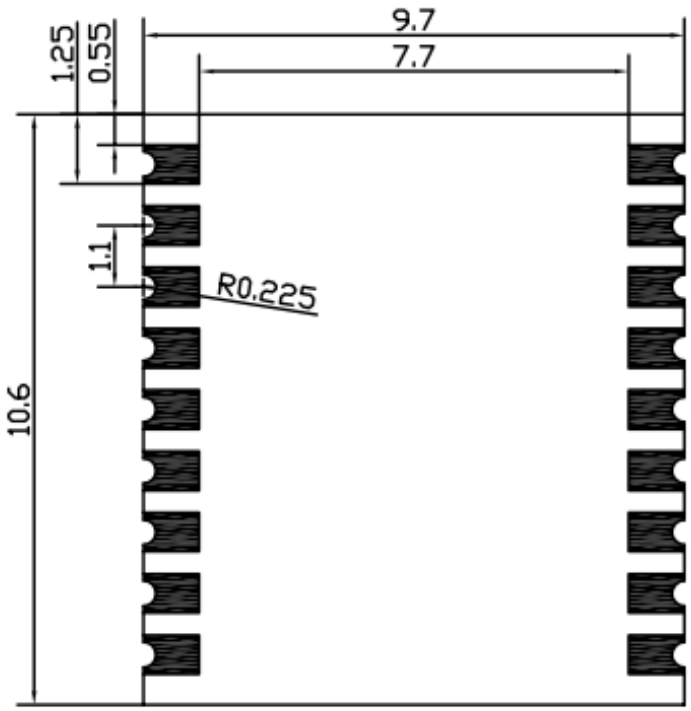
If the module is exposed to air for more than 48 hours at conditions not worse than 30°C/60% RH, bake it at a temperature higher than 90 degree for more than 12 hours before SMT.Or, if the indication card shows humidity greater than 20%, the baking procedure is also required.Do not bake modules with the package tray directly.

# 7 Application Design and SMT

G7A is introduced in LCC package. This chapter provides G7A foot print, recommended PCB design and SMT information to guide users how to mount the module onto application PCB board.

## 7.1 G7A Foot Print

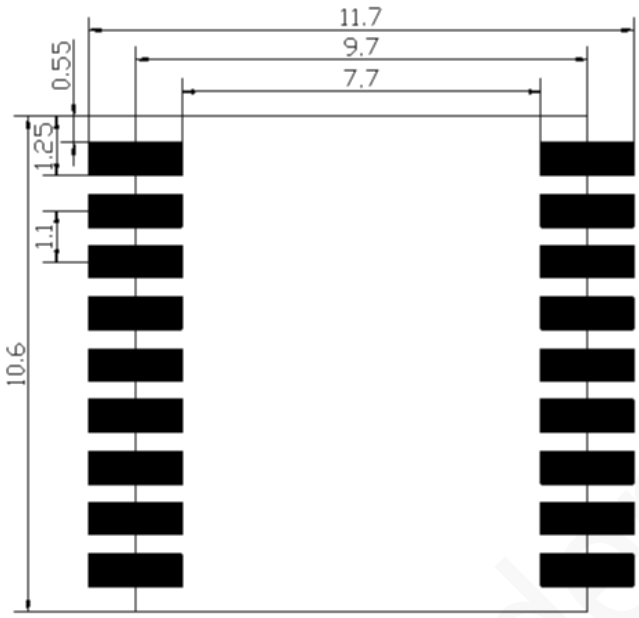
Figure 7-1 G7A foot print (bottom view)




## 7.2 Recommended Footprint

错误!未找到引用源。 shows the recommended application PCB footprint. (Unit: mm)

Figure 7-2 Recommended PCB footprint (top view)




## 7.3 Stencil

The recommended stencil thickness is at least 0.15 mm to 0.20 mm.

## 7.4 Solder Paste

Do not use a kind of solder paste different from our module technique.

- The melting temperature of solder paste with lead is 35°C lower than that of solder paste without lead. It is easy to cause faulty joints for LCC inside the module after second reflow soldering.
- When using only solder pastes with lead, please ensure that the reflow temperature is kept at 220°C for more than 45 seconds and the peak temperature reaches 240°C.

## 7.5 Reflow Profile

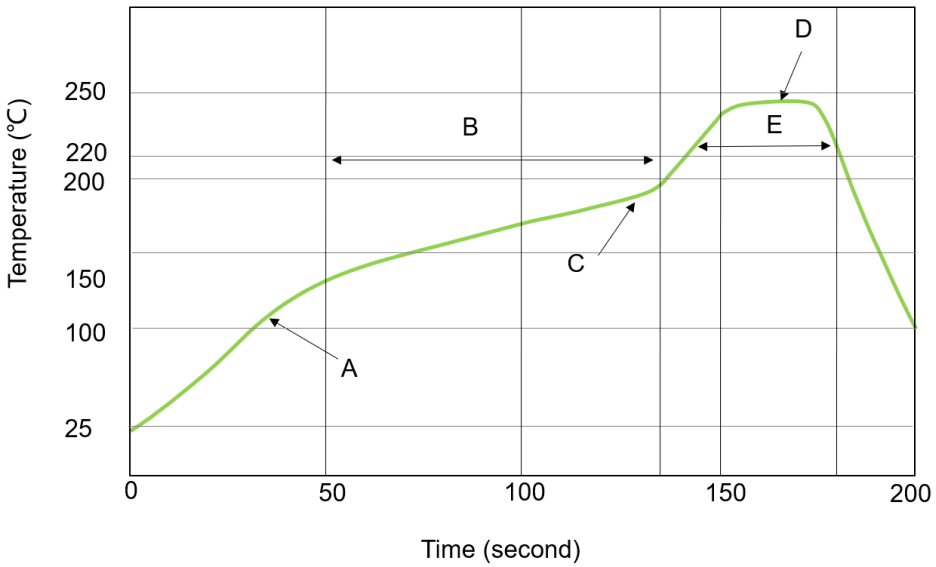
G7A is compatible with industrial standard reflow profile for lead-free SMT process.

The reflow profile is process dependent, so the following recommendation is just a start point guideline:

- Only one flow is supported.

- Quality of the solder joint depends on the solder paste volume. Minimum of 0.12 mm to 0.15 stencil thickness is recommended.
- Use bigger aperture size of the stencil than actual pad size.
- Use a low-residue, no-clean type solder paste.

Figure 7-3 Temperature curve




X: Time (s) Y: Temperature (°C)

Technical parameters:

- Ramp up rate: 1 to 4°C/sec
- Ramp down rate: -3 to-1°C/sec
- Soaking zone: 150-180°C for 60-100 seconds
- Reflow zone: >220°C for 40-90 seconds
- Peak temperature: 235-245°C

Neoway will not provide warranty for heat-responsive element abnormalities caused by improper temperature control.

For information about cautions in G7A storage and mounting, refer to *Neoway Module Reflow Manufacturing Recommendations*.

To maintain and manually desolder it, use heat guns with great opening, adjust the temperature to 245 degrees (depending on the type of the solder paste), and heat the module till the solder paste is melt. Use tweezers to remove the module. Do not shake the module in high temperature while removing it. Otherwise, the components inside the module might be misplaced.

# 8 Safety Recommendations

Ensure that this product is used in compliant with the requirements of the country and the environment. Please read the following safety recommendations to avoid body hurts or damages of product or work place:

- Do not use this product at any places with a risk of fire or explosion such as gasoline stations, oil refineries, etc
- Do not use this product in environments such as hospital or airplane where it might interfere with other electronic equipment.

Please follow the requirements below in application design:

- Do not disassemble the module without permission from Neoway. Otherwise, we are entitled to refuse to provide further warranty.
- Please design your application correctly by referring to the HW design guide document and our review feedback on your PCB design.
- Please avoid touch the pins of the module directly in case of damages caused by ESD.

# A Abbreviation

| Abbr | Full Name |
|---|---|
| AGPS | Assisted GPS |
| CEP | Circular Error Probable |
| DGPS | Differential GPS |
| EASY | Embedded Assist System |
| EGNOS | European Geostationary Navigation Overlay Service |
| EPO | Extended Prediction Orbit |
| EMI | Electro Magnetic Interference |
| ESD | Electronic Static Discharge |
| GPS | Global Positioning System |
| GNSS | Global Navigation Satellite System |
| GGA | GPS Fix Data |
| GLONASS | Global Navigation Satellite System |
| GSV | GNSS Satellites in View |
| I/O | Input/output |
| LNA | Low Noise Amplifier |
| MSAS | Multi-Functional Satellite Augmentation System |
| NMEA | National Marine Electronics Association |
| PPS | Pulse Per Second |
| PRN | Pseudo Random Noise Code |
| QZSS | Quasi-Zenith Satellite System |
| RHCP | Right Hand Circular Polarization |
| RMC | Recommended Minimum Specific GNSS Data |
| SBAS | Satellite-based Augmentation System |
| SAW | Surface Acoustic Wave |
| TTFF | Time To First Fix |
| UART | Universal Asynchronous Receiver & Transmitter |