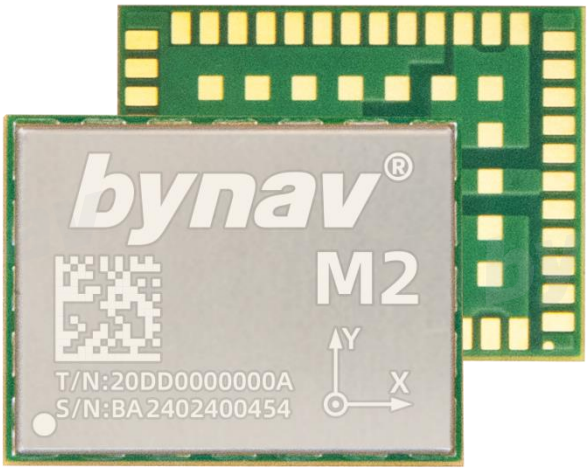
# M20D High-Precision Positioning & Heading Module

USER MANUAL




**Description**

This document applys to M20D high-precision positioning&heading module.

No.: UG073 Ver.: V2.0 Date: 2025.4.28

# CONTENTS


**CONTENTS** ..... **1**

**1 Feature** ..... **1**

1.1 Brief Introduction ..... 1

1.2 Performance ..... 1

1.3 Supported Protocol ..... 3

**2 System Architecture** ..... **4**

**3 Pin Definition** ..... **5**

3.1 Pin Assignment ..... 5

3.2 Pin Description ..... 6

**4 Electrical Specification** ..... **10**

4.1 Absolute Maximum Ratings ..... 10

4.2 Recommended Operating Condition ..... 10

**5 Communication Interface** ..... **12**

5.1 UART ..... 12

5.2 SPI ..... 12

5.3 CAN ..... 12

5.4 RMII ..... 12

5.5 Default Interface Setting ..... 12

**6 Application Guide** ..... **14**

6.1 Antenna Input ..... 14

6.1.1 RF Circuit Design ..... 14

6.1.2 Antenna Power Supply ..... 18

6.1.3 Recommended Active Antenna Specification ..... 18

6.2 Power Supply Design ..... 19

6.3 Minimal Design ..... 20

6.4 UART Interface ..... 22

6.5 SPI Interface ..... 23

6.6 RMII Interface ..... 23

6.7 Reset Interface ..... 24

6.8 Trouble Shooting ..... 25

6.9 PCB Layout ..... 25

6.10 Thermal Management ..... 26

6.11 Electromagnetic Interference (EMI) Precaution ..... 26

**7 Manufacturing** ..... **28**

7.1 Assembly and Welding ..... 28
7.1.1 SMD Device Requirement ..... 28
7.1.2 Humidity Sensitivity Level ..... 29
7.1.3 Baking ..... 29
7.1.4 Preheating Phase ..... 30
7.1.5 Storage ..... 30
7.1.6 Workshop Lifetime and Temperature-Humidity Control ..... 30
7.1.7 Requirement for Production of Stencil ..... 31
7.1.8 Automatic Placement ..... 31
7.1.9 Reflow Soldering ..... 31
7.1.10 SMT Furnace Recommendation ..... 33
7.2 ESD Protection ..... 33
**8 Mechanical Specification ..... 35**
**9 Labeling And Ordering Information ..... 36**
9.1 Product Label ..... 36
9.1.1 T/N Code ..... 36
9.1.2 S/N Code ..... 36
9.2 Ordering Number ..... 37
**10 Package ..... 38**
**Appendix A Record of Revision of Documents ..... 40**

# 1 Feature

## 1.1 Brief Introduction

The M20D high-precision positioning and heading module is based on Bynav Technology's new generation 22nm process high-performance automotive-grade GNSS SoC, Alice. It is equipped with the high-precision measurement engine and navigation engine, it supports high-performance RTK solution, anti-interference and dual-antenna heading. It can effectively handle challenging environments such as satellite signal interference and loss, providing continuous, real-time and reliable position and heading results with high precision. It can be applied in fields such as unmanned aerial vehicles, agricultural machines, intelligent robots.

**Built-in high-precision GNSS measurement and positioning engine**

Bynav REAL (Ransac Enhanced Advanced Location) GNSS positioning engine with built-in integrity monitoring and partial ambiguity resolution algorithms is adopted, which improves the fault tolerance and fix-solution success rate in urban environments with multipath and interference.

**Built-in adaptive anti-interference algorithm**

To deal with the demand for anti-jamming in complex electronic environment, signal preprocessing and adaptive interference suppression with high quantization bits are carried out for common interference such as vehicle-mounted anti-tracking devices and radar/airport signal towers, which greatly improves the usability and integrity of high-precision positioning in vehicle scenarios.

Technical features:

- 22nm process GNSS SoC, Alice
- Full-constellation and multi-frequency GNSS (1500 channels)
- Supports NRTK/PPP/PPP-RTK
- Anti-jamming and anti-deception*
- AEC-Q104

## 1.2 Performance

**Table 1-1 Performance Indicators**

| Indicator | Index |
|---|---|

| | |
|---|---|
| GNSS Band[1] | BDS B1I, B2I, B1C*, B2b (PPP)*<br>GPS L1 C/A, L1C*, L2<br>GLONASS G1, G2<br>Galileo E1, E5b<br>QZSS L1C*, L2, L1 C/A |
| Number of Channels | 1500 |
| Re-acquisition Time | ≤1s |
| Measurement Accuracy | Carrier Phase ≤1mm (RMS)<br>Pseudorange≤ 0.1m (RMS) |
| GNSS Observation Transfer Rate | 10Hz |
| GNSS RTK Positioning Data | 10Hz |
| Single Point Positioning Accuracy | Horizontal[2, 3]: 1.5m (RMS)<br>Vertical[2, 3]: 2.5m (RMS) |
| RTK Accuracy | Horizontal[2, 3]: 1.0cm+1ppm (RMS)<br>Vertical[2, 3]: 1.5cm+1ppm (RMS) |
| Heading Accuracy | 0.2°/1m baseline (RMS) |
| Timing Accuracy[3] | ≤20ns (RMS) |
| Velocity Accuracy[4] | 0.03m/s (RMS) |
| Initialization Time | Cold start: 30s [6]<br>Hot start: 5s [7] |
| RTK Initialization Time[2] | 5s (Typical value) |
| RTK Solution Delay | 50ms (Typical value) |
| Anti-jamming* | 65dBc (signal-to-noise ratio)<br>Multitone interference with 6 or more pulses.<br>Narrowband interference whose bandwidth is not less than 10% of the signal bandwidth.<br>Fast sweep interference. |
| L-Band | $10^{-5}$ (Error rate) |
| Power Consumption[5] | 530mW |
| Weight | 1.75g (Typical value) |
| Size | 16.0x21.0x2.6mm (Typical value) |

* Support in special firmware.

Note 1: The signal of B1C, B2b, L1C, SBAS is supported in special firmware.

Note 2: Typical value.Performance will be affected by GNSS status,satellites' location,baseline length,multipath and other interference.

Note 3: -130dBm and more than 12 satellites are available.

Note 4: Open sky without any obstruction,99%@static.

Note 5: Typical value. Power consumption of antenna and peripherals is not included.

Note 6: Typical value. The duration from power-up to the first output of a valid single-point solution after clearing the ephemeris/almanac/approximate position and time information.
Note 7: Typical value. The duration from power-up to the first output of a valid single-point solution, given that the receiver has stored valid ephemeris/almanac/approximate position and reasonably accurate time (error less than 5 minutes). The special firmware can support 2s hot start, and the firmware can't support network port.

## 1.3 Supported Protocol

| Protocol | I/O | Format |
|---|---|---|
| RTCM 3.3 | Input/Output | Binary |
| NMEA 4.11/4.10/4.0/2.3/2.1 | Input/Output | ASCII |
| BYNAY[1] | Input/Output | ASCII, Binary |

Note1: See UG017_ Interface Protocol for details

# 2 System Architecture

The architecture diagram of M20D high-precision positioning & heading module as shown below.

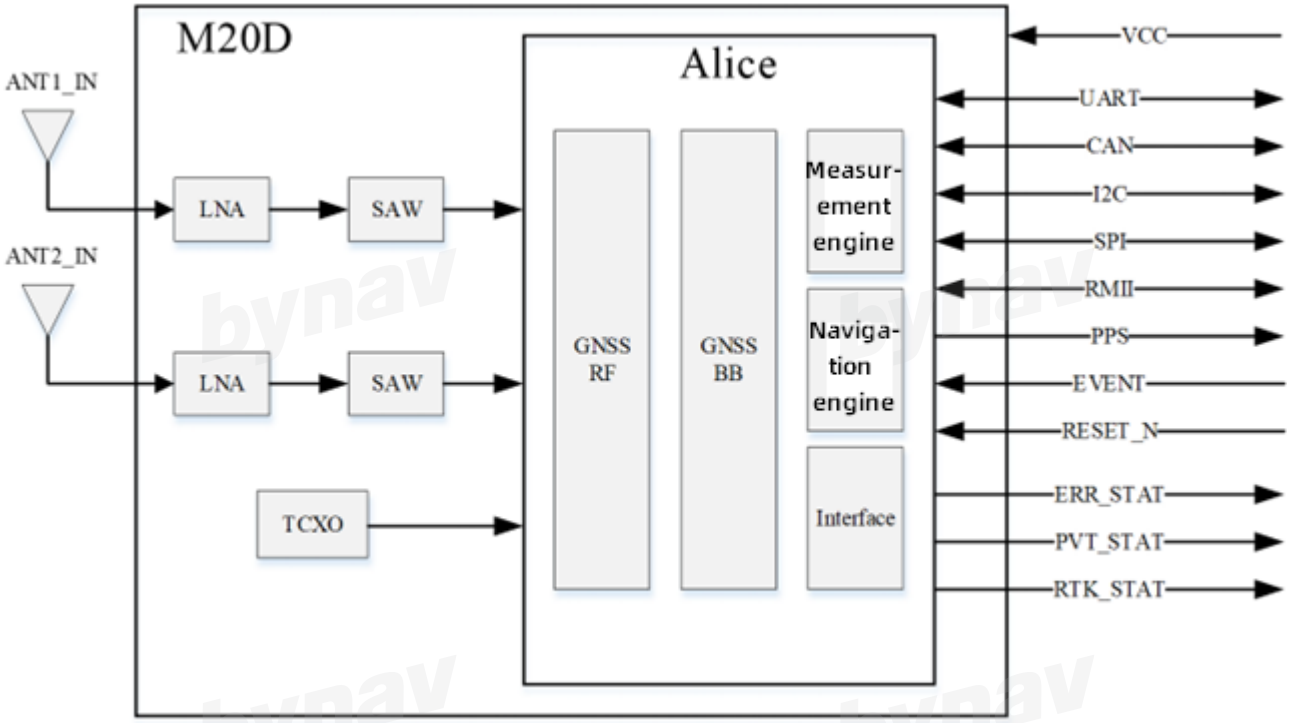
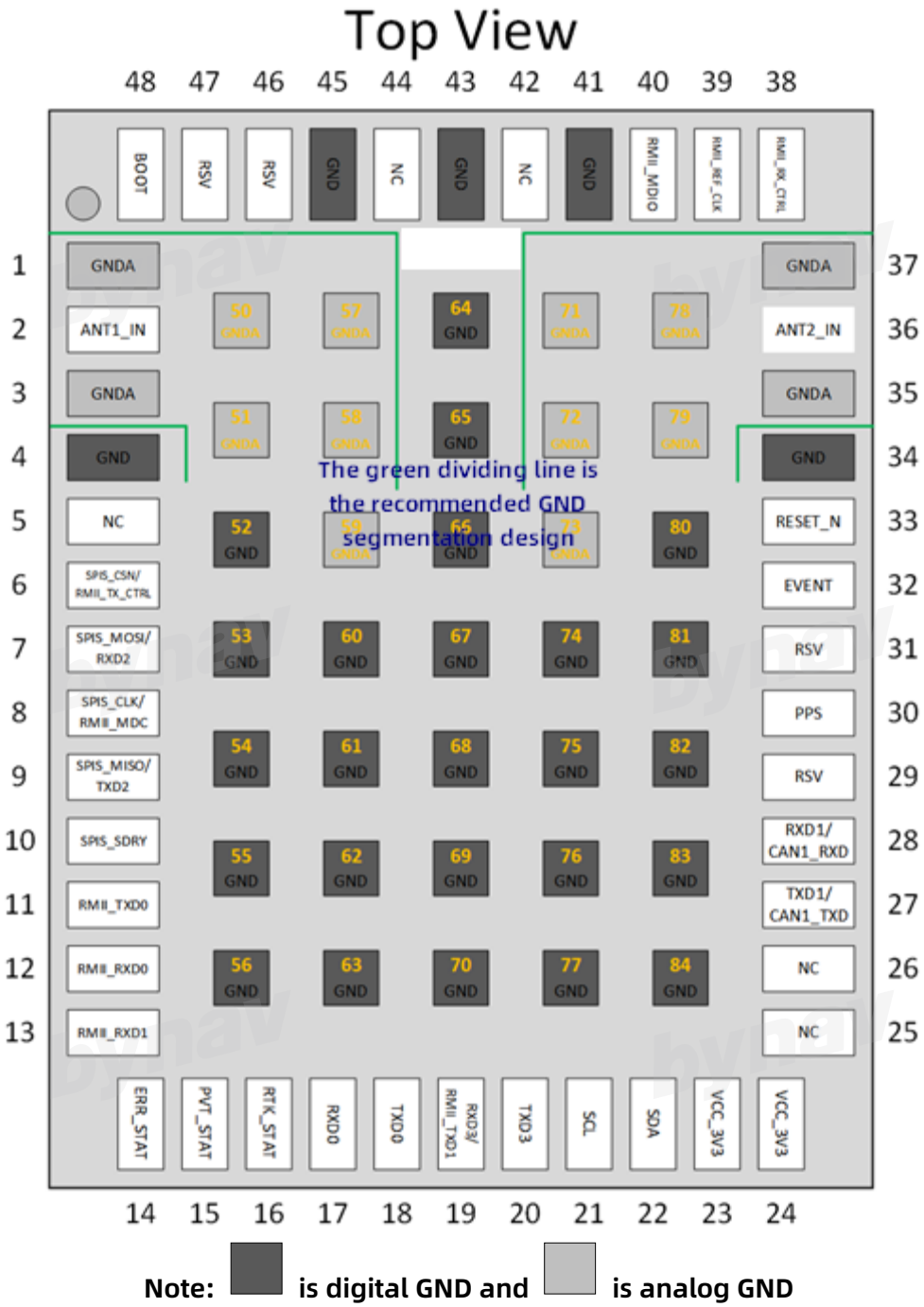



**Figure 2-1 Architecture Diagram**

# 3 Pin Definition

## 3.1 Pin Assignment




**Note:** ■ **is digital GND and** ■ **is analog GND**

**Figure 3-1 Pin Assignment**

## 3.2 Pin Description

**Table 3-1 Pin Description**

| No. | Name | I/O | Description | Connection when not in use |
|---|---|---|---|---|
| 1 | GNDA | - | Analog ground | GNDA |
| 2 | ANT1_IN | I | RF signal input (Main Antenna) | Floating |
| 3 | GNDA | - | Analog ground | GNDA |
| 4 | GND | - | Digital grounding | GND |
| 5 | NC | - | Internal unconnection | Floating |
| 6 | SPIS_CSN0/RMII_TX_CTRL | I/O | Slave SPI chip selection input and control signal of RMII data sending; It can be switched by software configuration | Floating |
| 7 | SPIS_MOSI/RXD2 | I | Slave SPI data input and serial port 2 receiveing; It can be switched by software configuration | Floating |
| 8 | SPIS_CLK/RMII_MDC | I/O | Slave SPI clock and RMII Management Data Clock; It can be switched by software configuration | Floating |
| 9 | SPIS_MISO/TXD2 | O | Slave SPI data output and serial port 2 sending; It can be switched by software configuration | |
| 10 | SPIS_SDRY | O | Slave SPI interrupt output | Floating |
| 11 | RMII_TXD0 | O | RMII data sending 0 | Floating |
| 12 | RMII_RXD0 | I | RMII data receiving 0 | Floating |
| 13 | RMII_RXD1 | I | RMII data receiving 1 | |

| | | | | |
|---|---|---|---|---|
| 14 | ERR_STAT | O | Abnormal indication, active high. Outputs high when the module system self-check fails; outputs low when self-check passes. | Floating |
| 15 | PVT_STAT | O | PVT positioning indication, active high. Outputs high when the module is capable of positioning; outputs low when not positioning. | Floating |
| 16 | RTK_STAT | O | RTK positioning indication. Outputs low during RTK fix-solution; Flashes when differential data is accepted, outputs high during other positioning states or when not positioning. | Floating |
| 17 | RXD0 | I | Serial port 0 receiving | Floating |
| 18 | TXD0 | O | Serial port 0 sending | Floating |
| 19 | RXD3/RMII_TXD1 | I | Serial port 3 receiving and RMII data transmit 1; It can be switched by software configuration | Floating |
| 20 | TXD3 | O | Serial port 3 sending | Floating |
| 21 | SCL | I/O | I2C clock | Floating |
| 22 | SDA | I/O | I2C data | Floating |
| 23 | VCC | POWER | Power supply (+3.3V) | +3.3V |
| 24 | VCC | POWER | | +3.3V |
| 25 | NC | - | Internal unconnection | Floating |
| 26 | NC | - | | Floating |
| 27 | TXD1/CAN1_TXD | O | Serial port 1 sending and CAN1 sending; It can be switched by software configuration | Floating |

| | | | | |
|---|---|---|---|---|
| 28 | RXD1/CAN1_RXD | I | Serial port 1 receiving and CAN1 receiving; It can be switched by software configuration | Floating |
| 29 | RSV | - | Recommend adding a test point; do not connect to ground, power or external peripheral I/O. | Floating |
| 30 | PPS | O | Second pulse, it supports software configuration | Floating |
| 31 | RSV | - | Recommend adding a test point; do not connect to ground, power, or external peripheral I/O. | Floating |
| 32 | EVENT | I | Event input signal, it supports software configuration | Floating |
| 33 | RESET_N | I | System reset, active low, it has pulled up by internal 4.7k Ω resistance | Floating |
| 34 | GND | - | Digital grounding | GND |
| 35 | GNDA | - | Analog ground | GNDA |
| 36 | ANT2_IN | I | GNSS antenna signal input (auxiliary antenna) | Floating |
| 37 | GNDA | - | Analog ground | GNDA |
| 38 | RMII_RX_CTRL | I | RMII data receives control signal | Floating |
| 39 | RMII_REF_CLK | I | RMII 50MHz reference clock input | Floating |
| 40 | RMII_MDIO | I/O | Data management input and output | Floating |
| 41 | GND | - | Digital grounding | GND |
| 42 | NC | - | Internal unconnection | Floating |
| 43 | GND | - | Digital grounding | GND |

| | | | | |
|---|---|---|---|---|
| 44 | NC | - | Internal unconnection | Floating |
| 45 | GND | - | Digital grounding | GND |
| 46 | RSV | - | Reserved. Floating is required | Floating |
| 47 | RSV | - | Reserved. Floating is required | Floating |
| 48 | BOOT[1] | I | The internal program update enabling pin, and has pulled down by internal 1kΩ resistance | Floating |
| 50-51<br>57-59<br>71-73<br>78-79 | GNDA[2] | - | Analog ground | GNDA |
| 52-56<br>60-70<br>74-77<br>80-84 | GND | - | Digital grounding | GND |

Note 1: The BOOT signal inside the module has a fixed voltage level and does not require external pull-up or pull-down processing during normal use. It is only used for re-burning the firmware after a module malfunction. See section 6.8 for details.

Note 2: In the module application schematic design, both GNDA and GND should be directly connected to GND, and the size of the GNDA connection area should be controlled.

Note 3: The voltage level of control and communication signals is 3.3V LVTTL.

Note 4: The direction refers to the module definition.

Note 5: The SPI interface is not supported by default and requires a firmware upgrade for support.

Note 6: Leave unused pins floating.

# 4 Electrical Specification

## 4.1 Absolute Maximum Ratings

**Table 4-1 Absolute Maximum Ratings**

| Parameter | Name | Condition | Min. | Max. | Unit |
|---|---|---|---|---|---|
| Power Supply Voltage<br>VCC Ramp Voltage | VCC | | -0.3<br>120 | 3.6 | V<br>μs/V |
| Input Pin Voltage | $V_{in}$ | VCC≤3.1V<br>VCC>3.1V | -0.3<br>-0.3 | VCC + 0.5<br>3.6 | V<br>V |
| Input Power of RF_IN | $P_{RFIN}$ | 50Ω impedance | | 10 | dBm |
| Human Body Model | ESD_HBM | | | ±2 | kV |
| Charging Device Model | ESD_CDM | | | ±500 | V |

## 4.2 Recommended Operating Condition

**Table 4-2 Recommended Operating Conditions**

| Parameter | Name | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Main Power Supply | VCC_3V3 | The actual values should be within maximum and minimum voltage ranges | 3.0 | 3.3 | 3.6 | V |
| Peak Current Input | $I_{Peak}$ | VCC = 3.3 V | - | - | 300 | mA |
| Low Level Input Voltage | $V_{IL}$ | | -0.3 | | 0.7 | V |
| High Level Input Voltage | $V_{IH}$ | | 1.7 | | 3.6 | V |
| Low Level Output Voltage | $V_{OL}$ | | | | 0.7 | V |
| High Level Output Voltage | $V_{OH}$ | | 1.7 | | | V |
| Low Level Output Current | $I_{OL}$ | | 10 | | | mA |
| High Level Output Current | $I_{OH}$ | | 10 | | | mA |
| Externa RF Gainl | $P_{RFIN}$ | | 17 | 30 | | dB |
| RF Noise Factor | NF | | | | 4 | dB |
| Junction Temperature | Tj | | -40 | | 125 | ℃ |
| Storage Temperature | $T_{storage}$ | | -40 | | 105 | ℃ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Operating Temperature[1] | $T_{operation}$ | | -40 | 25 | 85 | ℃ |

Note1: Optional maximum temperature is 105℃.

# 5 Communication Interface

## 5.1 UART

The UART interface supports baud rate configuration but does not support hardware flow control. There are three UART interfaces available: UART0, UART1, UART2 and UART3.

**Table 5-1 UART Parameter**

| Name | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| Ru | Baud rate | 9600 | 921600 | bit/s |
| △Tx | Tx baud rate accuracy | -1% | +1% | - |
| △Rx | Rx baud rate tolerance | -2.5% | +2.5% | - |

## 5.2 SPI

The M20D module can support one SPI slave interface by configured via software. The maximum SPI clock frequency is 10 MHz.

## 5.3 CAN

The M20D module can support one CAN/CANFD interface by configured via software. It supports the rate of 500k~2Mbps.

## 5.4 RMII

The M20D module can support one RMII ethernet interface by configured via software.

## 5.5 Default Interface Setting

The default configuration for the external communication interfaces is as follows:

**Table 5-2 Default Interface Configuration**

| Interface | Configuration |
|---|---|
| UART0 output<br>UART1 output<br>UART2 output<br>UART3 output | Up to 921600 baud, 8 bits, no parity bit, 1 stop bit.<br>NMEA messages, BYNAV protocol, RTCM protocol supported. |

| | |
|---|---|
| UART0 input<br>UART1 input<br>UART2 input<br>UART3 input | Up to 921600 baud, 8 bits, no parity bit, 1 stop bit.<br>BYNAV commands, RTCM protocol supported. |
| RMII output | Maximum rate of 100Mbps. NMEA messages, BYNAV protocol, RTCM protocol supported. |
| RMII input | Maximum rate of 100Mbps. BYNAV commands, RTCM protocol supported. |

# 6 Application Guide

## 6.1 Antenna Input

The M20D module provides 2 sets of antenna interfaces, currently supporting active antennas. These interfaces are used for receiving GNSS satellite signals to achieve satellite timing, positioning and heading.

The input of the RF signal on the PCB must satisfy a 50-ohm impedance and adhere to a Coplanar waveguide planar transmission line structure, as shown below. It is recommended to use ≥4 layers design.

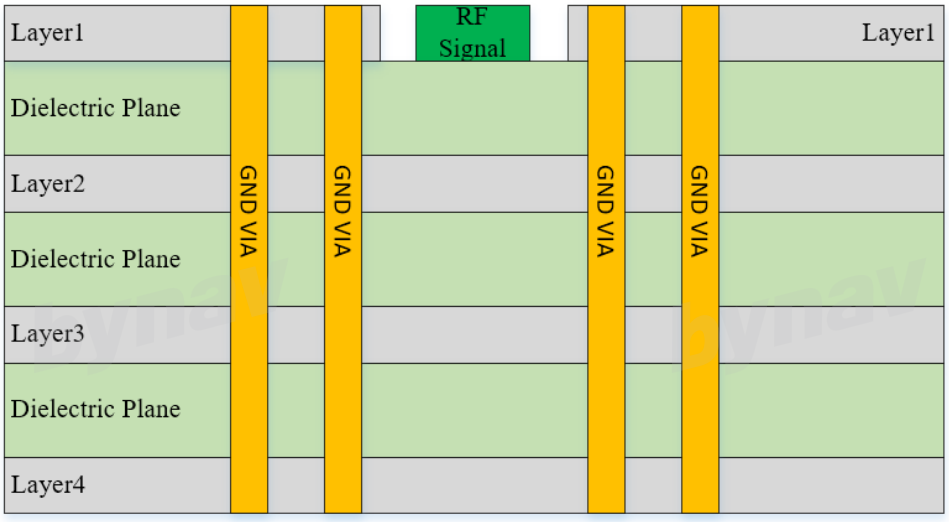



**Figure 6-1 Coplanar Waveguide Planar Transmission Line Structure Diagram**

### 6.1.1 RF Circuit Design

The RF (RFIN) interface of the M20D module has an impedance requirement of 50Ω. The internal structure of the module for GNSS RF is illustrated in the following diagram:

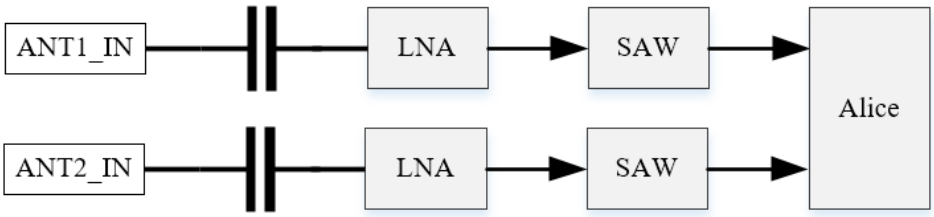



**Figure 6-2 Internal Structure of RF Fore-end**

The trace between the RF input interface of the M20D module and the RF coaxial connector also needs to be controlled within the impedance range. To ensure RF performance, a conservative

design approach is to add a matching network in the RF circuits. The matching network is typically categorized into three types: L-type, T-type and π-type which is recommended, the matching network should be place near the module.

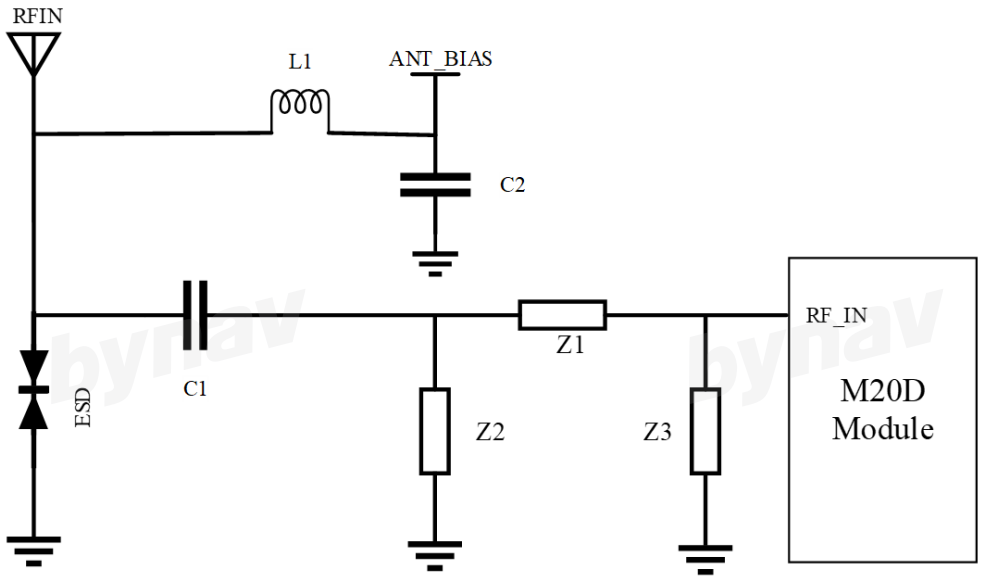



**Figure 6-3 Diagram of π Type Matching Network**

Design considerations for schematic:

- The components in the RF matching circuits are capacitors and inductors which should be placed near the antenna port. By default, there is a resistor of 0Ω on Z1 and no component on Z2 and Z3.
- If electrostatic discharge is a concern on the antenna, it is recommended to add ESD protection. A TVS (Transient Voltage Suppression) diode with ultra-low junction capacitance (Cj) can be used. It is recommended to use a ESD diode with a junction capacitance ≤0.5 pF.
- Please refer to the diagram below for the power feed design. Both inductor L and capacitor C are essential and cannot be omitted, as they form a low-pass filter with a cutoff frequency calculated as 1/2πsqrt(LC). It is recommended that the cutoff frequency be less than 5MHz. Additionally, when laying out the LC circuit, it should be placed close to the RF trace, and the RF trace stub should be kept as short as possible.

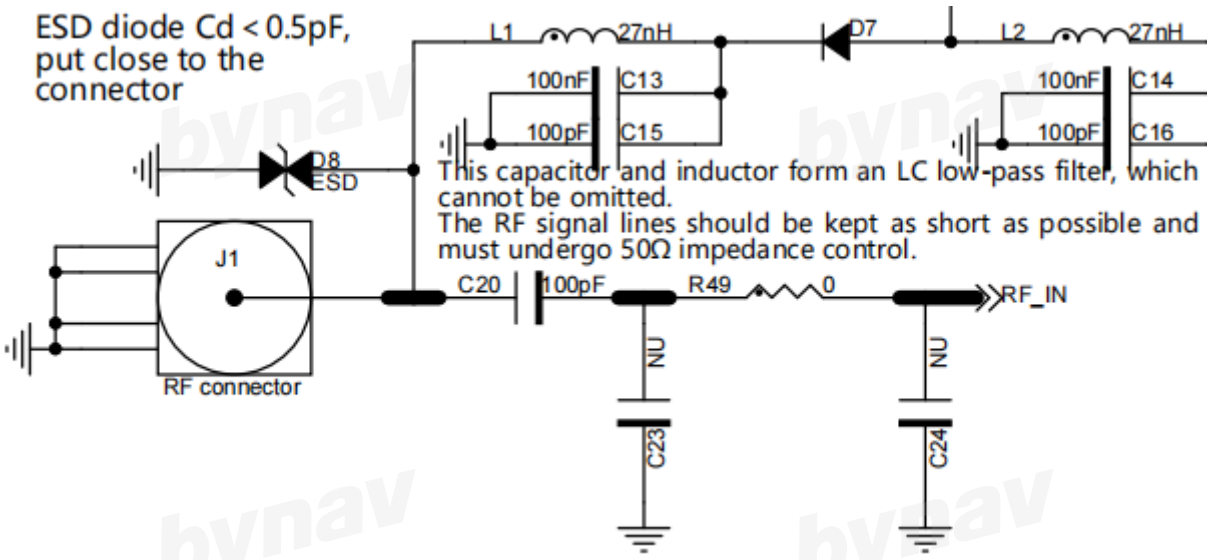



**Figure 6-4 Diagram of RF**

PCB design considerations:

- The RF traces should be surrounded by grounded copper planes. Ground planes should have multiple GND vias to ensure a low ground impedance. Insufficient GND vias can increase the loop area of the RF signal reference ground, so an adequate GND vias should be placed around the RF traces. The reference ground plane for the RF signal line should be continuous. Adding some grounding vias around the signal line and the reference ground can help improving RF performance. The distance between the grounding vias and the signal line should be at least twice the distance of the primary reference copper.
- The PCB traces between the module and RF lines should be as short as possible with the impedance of no more than 50Ω. An impedance simulation tool should be used to accurately control the RF signal line to 50Ω impedance.
- The GND pins adjacent to the RF pins should not use thermal relief pads and must have full contact with the ground.
- The reserved π-type matching circuit should be placed close to the RF input for convenient debugging during PCB layout.
- There can't be right angles in RF trace, which will lead to discontinuity of impedance and reflect of the signal, so the receiving efficiency of the antenna will reduce. The arc line can be adopted as shown below when you need to turn a corner.

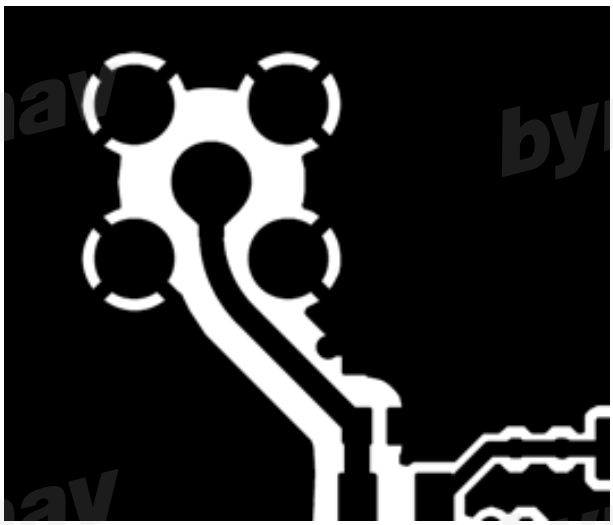


**Figure 6-5 RF Signal Curved Traces**

- RF traces should not have branches or splits. Improper placement of reserved matching circuits on the RF traces can cause splits in the RF signal path, leading to impedance discontinuity.
- Do not take other signal lines in the projection area on the back of the RF trace and make sure you lay a complete GND as a reference layer for the RF trace; The RF back trace will split the reference layer, resulting in impedance discontinuity and signal reflection will also occur, if the back trace is a high-speed digital signal line, the noise of the digital signal will be coupled to the RF signal.
- The relevant parameters of RF trace impedance are PCB dielectric constant, PCB thickness, RF trace width, the width of RF trace to the same layer GND and the stacked structure of PCB.
- To reduce the possibility of antenna performance degrading due to larger RF pads if a SMA connector is used, both the first and second layers under the module RF pad are recommended to be hollowed out as shown in the figure below.

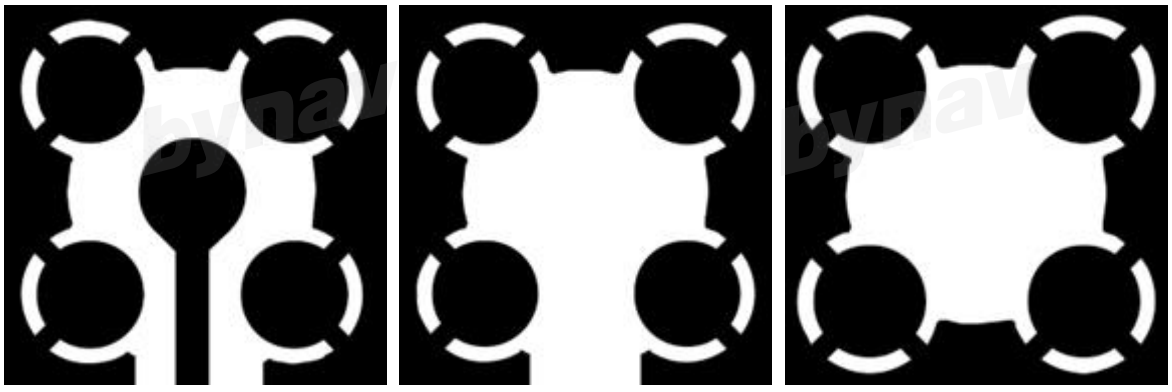


**Figure 6-6 PCB Design Reference for RF**

- The layout of RF signals and RF-related components in the module should be positioned away from strong sources of interference such as digital circuits, USB interface, SIM card interface, camera module, SD card, monitor interface, switch-mode power supplies, power transformers,

power inductors or clocks.

### 6.1.2 Antenna Power Supply

The M20 module does not provide VCC_RF. The feeding circuit can be designed as followed diagram when external active antenna is used.

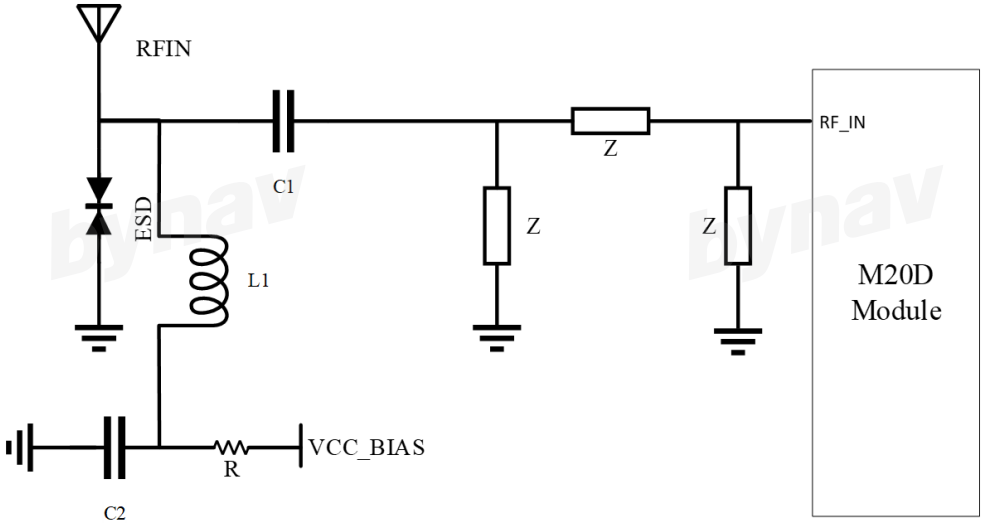



**Figure 6-7 Reference Design for Active Antenna Feeding**

The C1 capacitor is used to block the DC signal from the feed; The L1 inductor is used to eliminate the risk of the RF signal leaking into the VCC_RF; When the active antenna is shorted to GND, R is used to protect the module, and the fuse or resistance can be used also. The voltage drop introduced by resistance should be noticed when resistance is used.

It is strongly recommended that users add various protection circuits (PTC, varistor, TVS, etc.) to enhance protection against lightning strikes and surges.

### 6.1.3 Recommended Active Antenna Specification

**Table 6-1 Recommended Active Antenna Specification**

| | |
|---|---|
| **Frequency Range** | GPS: L1, L2<br>BDS: B1, B2<br>GLONASS: L1, L2<br>GALILEO: E1, E5b<br>QZSS: L1, L2<br>SBAS: L1 |
| **Impedance** | 50 Ω |
| **Polarization** | Right-handed circular polarization (RHCP) |

| | |
|---|---|
| **Standing-wave Ratio** | < 1.5 |
| **Gain**[1] | 17~50 dB |
| **Noise Factor** | <1.5 dB |
| **Shaft Ratio** | ≤2 dB |
| **Phase Center Bias** | <±2 mm |
| **Horizontal Coverage** | 360° |

Note1: The total gian from antenna to module should meet the requirement of external RF gain.

## 6.2 Power Supply Design

The design and layout of the power supply circuit are very important aspects of the entire product design, as the rationality of the power supply design affects the overall performance of the product.

The M20D module internally uses a single power input, VCC_3V3, as the main power input. The input voltage range for VCC_3V3 is 3.0 V to 3.6 V, with a recommended value of 3.3 V and a ripple of less than 50mVpp. It supplies power to the internal baseband and RF devices of the module. The performance of the power supply, such as load capacity, ripple, noise, and power supply rejection ratio, directly affects the performance and stability of the module. The recommended power supply design is shown in the diagram below.

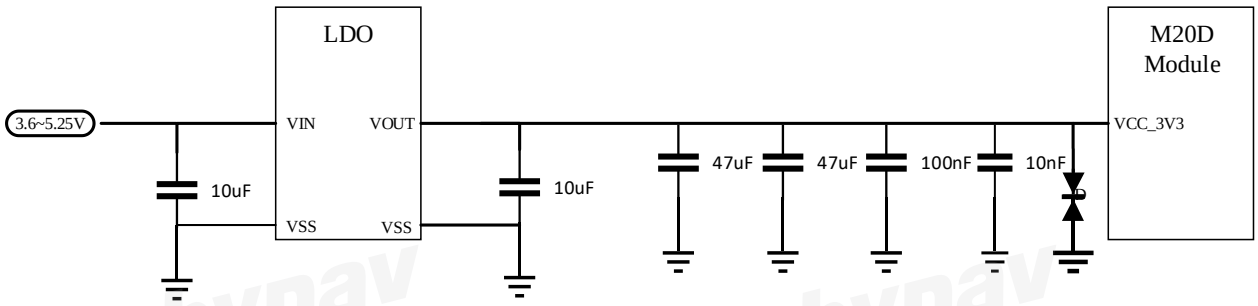



**Figure 6-8 Recommended Power Supply Design**

To ensure optimal performance of the module, a low-noise 3.3V LDO specifically designed for RF should be used. It is recommended to select a low-noise linear regulator with an output noise voltage ≤50μV $_{RMS}$, a power supply rejection ratio ≥60dB@1kHz, and an output current ≥600mA.

- Low ESR multilayer ceramic capacitors are recommended, with a voltage rating greater than 1.5 times the main power supply voltage.
- D is an ESD protection device. If ESD protection is needed, the position of D should be as close

to the module's power interface as possible.

- Place bypass capacitors close to the module to filter out high-frequency interference from the power supply.
- Be sure to evaluate the power consumption and heat dissipation of the LDO.

## 6.3 Minimal Design

The diagram of minimal design is shown below, UART1 is used to connect to a host device, UART3 is optional and can be used to receive RTCM data.

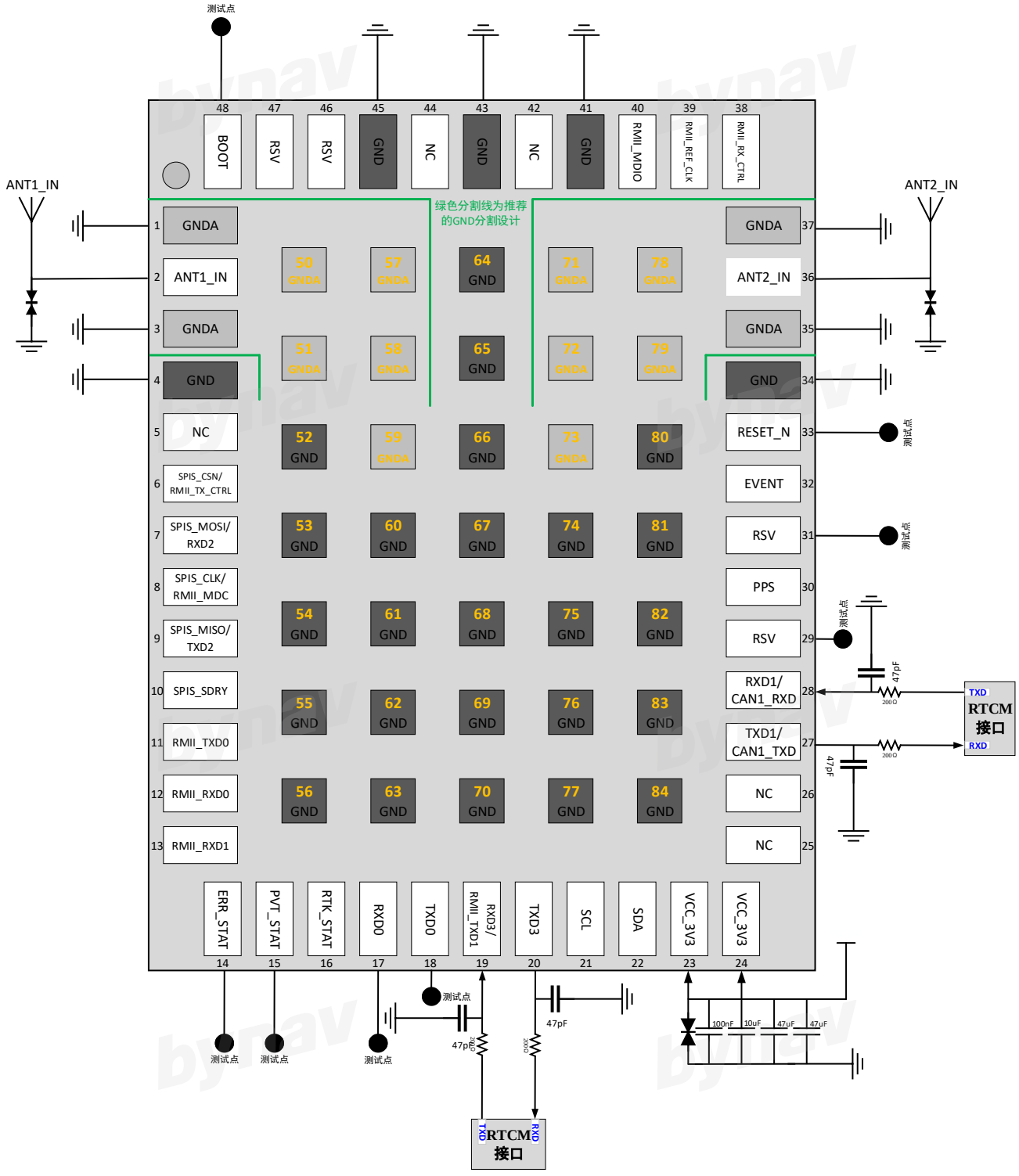



**Figure 6-9 Minimal Design**

Please follow the tips below in design:

- VCC should be connected to power supply of 3.3V.
- The central GND pad at the bottom of the module should be well-grounded.
- The recommended value of serial resistance is 200Ω.

## 6.4 UART Interface

M20D provides 4 sets of UART, please refer to 5.1 for configuration details:

**Table 6-2 UART**

| Function | Pin Name | I/O (The I/O direction is defined for the module) | Level |
|---|---|---|---|
| RXD0 | RXD0 | I | 3.3V LVTTL |
| TXD0 | TXD0 | O | 3.3V LVTTL |
| RXD1 | RXD1/CAN1_RXD | I | 3.3V LVTTL |
| TXD1 | TXD1/CAN1_TXD | O | 3.3V LVTTL |
| RXD2 | SPIS_MOSI/RXD2 | I | 3.3V LVTTL |
| TXD2 | SPIS_MISO/TXD2 | O | 3.3V LVTTL |
| RXD3 | RXD3/RMII_TXD1 | I | 3.3V LVTTL |
| TXD3 | TXD3 | O | 3.3V LVTTL |

UART interface application information as shown below:

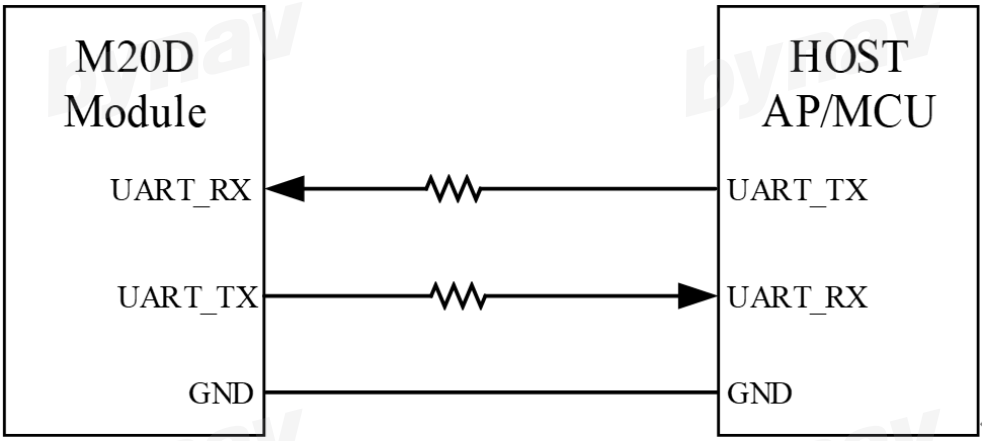



**Figure 6-10 Recommended UART Design**

Pay attention to the following When it comes to the schematic:

- Mind the correspondence between signal connections.
- If the voltage level of the HOST device is different from that of the M20D module, a level conversion design is required.
- The name of RX or TX for M2 module and HOST device in the diagram should be based on the respective device's transmit and receive directions.
- The recommended resistance value of serial resistance is 200Ω

Pay attention to the following when it comes to layout design:

- Avoid areas that may introduce static electricity.
- The serial resistance should be placed near the module.

## 6.5 SPI Interface

M20D modules can provide a set of slave SPI interface, reference chapter 5.2 for configuration details.

**Table 6-3 Slave SPI**

| Function | Pin Name | I/O | Level |
|---|---|---|---|
| SPIS_MISO | SPIS_MISO/TXD2 | O | 3V3_LVTTL |
| SPIS_MOSI | SPI_MOSI/RXD2 | I | 3V3_LVTTL |
| SPIS_CSN | SPIS_CSN/RMII_TX_CTRL | I | 3V3_LVTTL |
| SPIS_CLK | SPIS_CLK/RMII_MDC | I | 3V3_LVTTL |

SPI interface application information as shown below, the recommended resistance value of serial resistance is 200Ω:

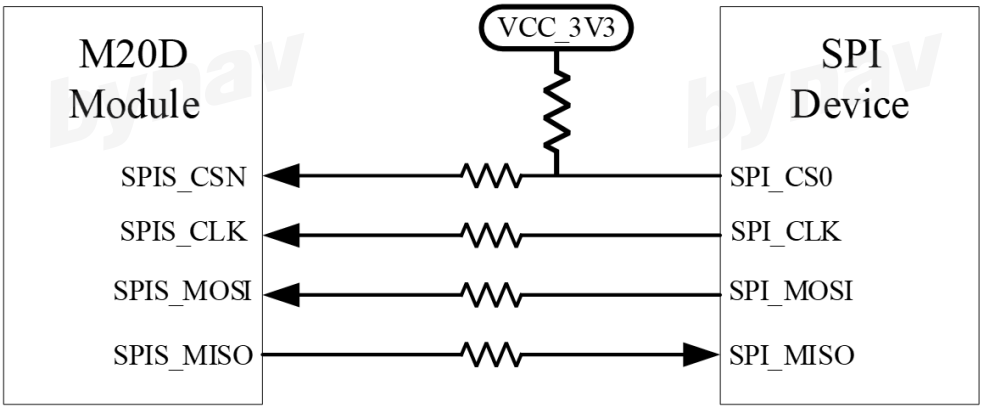



**Figure 6-11 Recommended SPI Interface Design**

## 6.6 RMII Interface

M20D modules can provide a set of RMII interface, reference chapter 5.4 for configuration details.

**Table 6-4 RMII**

| Function | Pin Name | I/O | Level |
|---|---|---|---|
| RMII_MDC | SPIS_CLK/RMII_MDC | O | 3.3V LVTTL |
| RMII_MDIO | RMII_MDIO | I/O | 3.3V LVTTL |
| RMII_REF_CLK | RMII_REF_CLK | I | 3.3V LVTTL |
| RMII_RX_CTRL | RMII_RX_CTRL | I | 3.3V LVTTL |

| | | | |
|---|---|---|---|
| RMII_RXD0 | RMII_RXD0 | I | 3.3V LVTTL |
| RMII_RXD1 | RMII_RXD1 | I | 3.3V LVTTL |
| RMII_TX_CTRL | SPIS_CSN/RMII_TX_CTRL | O | 3.3V LVTTL |
| RMII_TXD0 | RMII_TXD0 | O | 3.3V LVTTL |
| RMII_TXD1 | RXD3/RMII_TXD1 | O | 3.3V LVTTL |

RMII interface application information as shown below, the recommended resistance value of serial resistance is 200Ω:

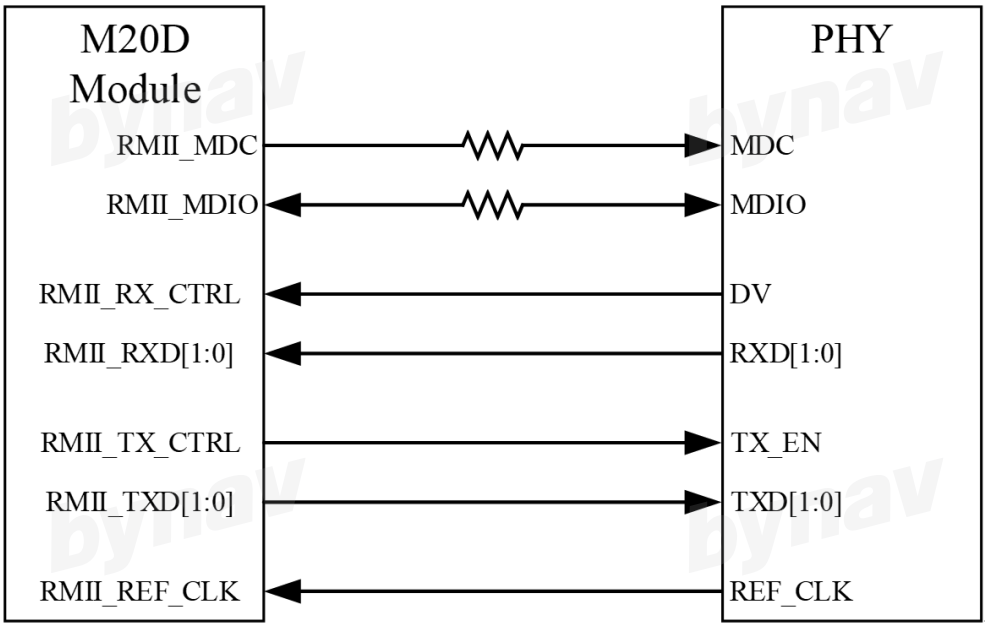



**Figure 6-12 Recommended RMII Interface Design**

## 6.7 Reset Interface

The module has a hardware reset pin, RESET_N, which is active low. The RESET_N pin is internally connected to the module's main power supply VCC through a 4.7kΩ pull-up resistor.

There is no need to add an external pull-up circuit to this pin, as it may conflict with the internal pull-up resistor, potentially causing unnecessary current consumption or circuit malfunctions.

It is recommended that the RESET pin be connected to HOST for control. When powering up the module, a POR is required, with the reset low-level duration being > 50ms when the power is applied.

After the module is powered on, a reset can be performed by pulling the RESET_N pin low for at least 2ms and then pulling it high.

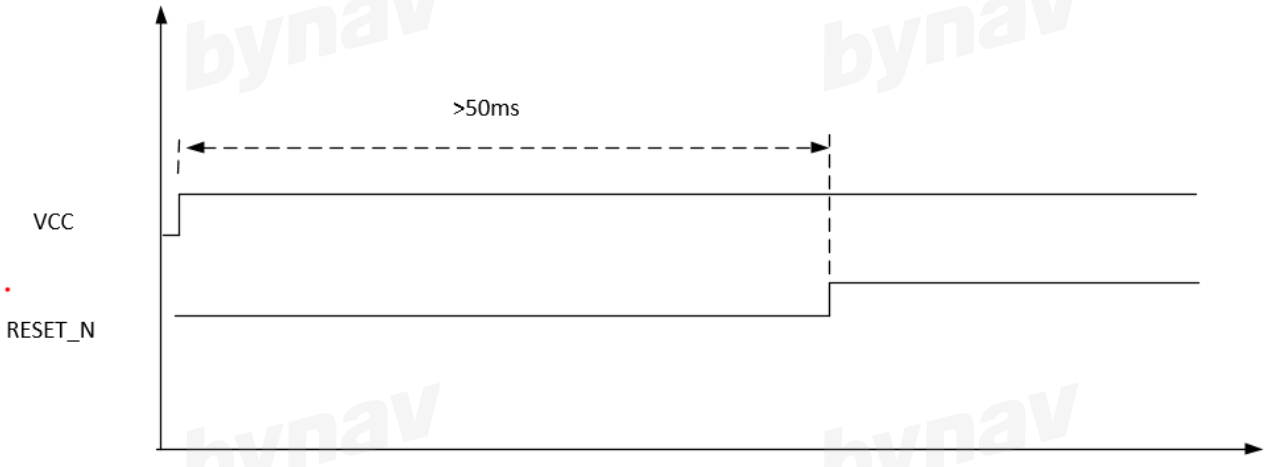



**Figure 6-13 RESET_N Signal Logic**

## 6.8 Trouble Shooting

In the event of an unexpected failure of the M20D module, it is recommended that the users bring out the following pins to a test point or connector to troubleshooting.

| Pin No. | Pin Name | Description |
|---|---|---|
| 14 | ERR_STAT | Debugging interface for test mode. |
| 15 | PVT_STAT | Debugging interface for test mode. |
| 17 | RXD0 | UART0 input |
| 18 | TXD0 | UART0 output |
| 29 | RSV | Debugging interface for test mode. |
| 31 | RSV | Debugging interface for test mode. |
| 33 | RESET_N | System reset, active low, it has pulled up by internal 4.7kΩ resistance |
| 48 | BOOT | The internal program update enabling pin, and has pulled down by internal 1kΩ resistance |

## 6.9 PCB Layout

Here are some key points summarized for power supply design:

- Bypass capacitors should be placed near the module's power supply pins to filter out high-frequency noise signals from the power supply.
- For the main power supply loop of the module, PCB trace width should be sufficient to safely pass a current of 600mA or more, and there should not be any significant voltage drop in the loop.

The PCB trace width should be at least 0.5mm to ensure a complete ground plane in the power supply section.

- The GNSS RF circuit is noise-sensitive and should be located far away from source of noise or strong interference such as audio circuits, RF circuits and DC-DC power supplies.

## 6.10 Thermal Management

The thermal design of the M20D module refers to a series of design measures taken to ensure stable operation of the module under various environmental temperatures. The primary goal of thermal design is to manage the internal heat of the module, preventing critical components from overheating while ensuring a reasonable temperature distribution throughout the module, thereby avoiding reliability issues caused by thermal stress.

- Optimization of heat dissipation paths: The design should consider effectively conducting the heat generated inside the module to external cooling systems.
- PCB layout: The PCB layout should keep sensitive areas away from heat-generating regions.
- Thermal isolation: For high-power or heat-generating components, the module needs to be separated or kept at a distance from these components to reduce heat transfer.
- Environmental testing: After design completion, thermal cycling tests and extreme temperature performance tests are required to ensure stable performance within the expected operating temperature range.

## 6.11 Electromagnetic Interference (EMI) Precaution

Any signal line longer than 3mm can act as an antenna, and RF signals from the surrounding environment can be coupled into the GNSS receiver module through these lines as noise, affecting GNSS positioning performance.

EMI issues must be considered in receiver design. GNSS modules are susceptible to interference from nearby RF sources of any type because the power level of GNSS signals is very low compared to other wireless communication systems such as LTE, GSM, WCDMA, WiFi, Bluetooth. Out-of-band interference can enter the GNSS receiver module through the GNSS antenna or unshielded traces, degrading GNSS positioning performance. Out-of-band interference can be effectively mitigated by adding SAW filters at the RF front end. Additionally, in the design of GNSS receiver products, it is important to consider keeping GNSS antennas and modules away from high-power transmitting wireless communication systems and their antennas.

Strong interference may also generate intermodulation signals falling in the GNSS frequency band, further impacting module performance.

In-band interference refers to signals with frequencies very close to the GNSS frequency. This type of interference is usually caused by harmonics of signals from displays, buses or clocks. Optimization measures for in-band interference include:

- Keep the connection to GND reliable in the design.
- Shielding RF lines from signal lines.
- Optimizing layout, keeping GNSS modules and antennas away from noise sources.
- Adding filters to interference sources, for example, the low-pass filters at digital signal output ports or band-pass filters at RF signal output ports such as LTE, GSM, WCDMA, WiFi, Bluetooth.

# 7 Manufacturing

## 7.1 Assembly and Welding

The M20D module is a precision device that uses LGA packaging. To ensure good surface mount soldering, it is recommended to use reflow soldering to avoid issues such as solder voids and short circuits. It is not recommended to solder the module using a hot air gun, as the uneven and high temperature from the hot air gun can severely damage the module's functionality and performance.

### 7.1.1 SMD Device Requirement

#### 7.1.1.1 Placement Machine

- Feeder: supports Tape reel and Tray
- Vision system: optical alignment.
- Nozzle diameter: select based on the size of the module (16.00mm×21.00mm, typical value) to ensure stability during module placement.

**Note: It is recommended to choose a nozzle diameter that is not less than 40% of the shorter side length of the module. For example, if the module size is 16.0mm × 21.0mm, it is recommended to select a nozzle with a diameter of 8mm or above (appropriate nozzle selection may vary depending on the equipment).**

#### 7.1.1.2 Welding Requirement

- The module requires a reflow soldering equipment with at least ten temperature zones.
- For lead-free process reflow soldering, the measured peak temperature at the solder pad on the bottom of the module component should reach 238°C. The recommended highest temperature with the reflow fixture should be between 240°C and 246°C. If the temperature is higher than 217°C, the reflow time should be extended by 10 seconds to prevent cold solder joints.
- If the thickness of the carrier PCB for the module is less than 1.0mm, it is recommended to make a reflow fixture or a carrier tray to prevent PCB warpage at high temperatures, which could affect the coplanarity of solder joints.
- Regarding the treatment of the bottom pad surface, it is recommended to use an immersion-gold process equivalent to the module pad, and electroplated nickel/gold or chemical nickel/gold plating is recommended also. It is not recommended to use a tin-spraying surface treatment

method.

- It is recommended to use no-clean solder paste, eliminating the need for post-solder cleaning.

The following are recommended to be followed for soldering:

- Solder pastes type and composition: OM338 SAC405/Nr.143714 (Cookson Electronics)
- Alloy: Sn95.5/Ag4/Cu0.5 (95.5% Tin/4% Silver/0.5% Copper)
- Solder pastes melting point: 217℃
- Stencil thickness: 0.20mm.

### 7.1.2 Humidity Sensitivity Level

The M20D module is moisture-sensitive, according to IPC/JEDEC J-STD-033 standards, the M20D module has a Moisture Sensitivity Level (MSL) of 3. Before using the module, it is necessary to confirm the integrity of the packaging. After opening the package, check the status of the humidity indicator card inside the vacuum packaging. If the 5% indicator circle has turned pink and 10% indicator circle is no longer blue on the humidity indicator card as shown in the image below are observed, the module needs to undergo baking before use.

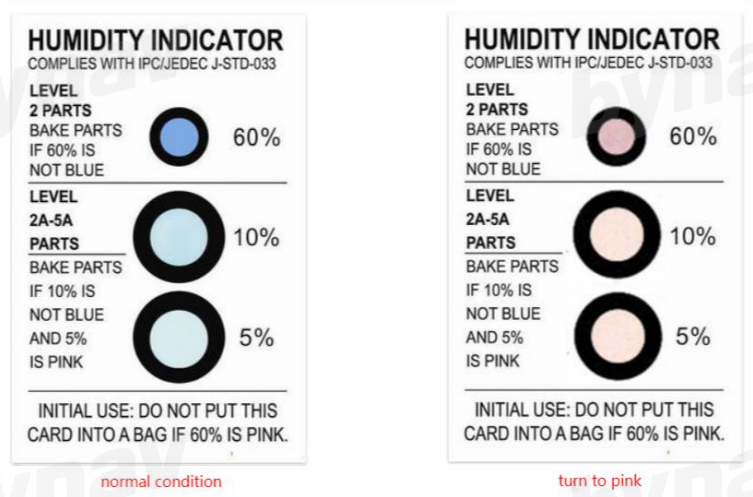



**Figure 7-1 Three-point Humidity Indicator Card**

### 7.1.3 Baking

Before soldering the module, refer to the humidity indicator card. If baking is required, follow these conditions:

- For reel-packaged materials, the recommended baking temperature is 55±5℃ for 48 hours.
- After baking, it is recommended to complete soldering within 24 hours. If this is not possible, re-vacuum seal the modules or store them in a dry box with a humidity level below 10%.

### 7.1.4 Preheating Phase

The initial heating process evaporates residual moisture from the module. Note that the preheating phase cannot replace the previous baking process. The preheating temperature requirements are as follows:

- Temperature rise rate: Maximum 3℃/s. If the preheating temperature rises too quickly, it may cause excessive component shift.
- Time: 60~120 seconds. Insufficient preheating may result in large solder balls, while excessive preheating can lead to more solder splashes and solder balls.
- End temperature: 150~200℃. If the temperature is too low, the solder paste may not melt in areas with high thermal mass.

### 7.1.5 Storage

Recommended storage conditions: Temperature 23℃±5℃, with a relative humidity of 35%~60%.

Shelf life: Under sealed vacuum packaging conditions, with a temperature not exceeding 40℃ and humidity below 90% RH, the shelf life is 12 months from the production date.

Expiration date: Under sealed vacuum packaging conditions, with a temperature not exceeding 40℃ and humidity below 90% RH, the expiration date is 24 months from the production date.

### 7.1.6 Workshop Lifetime and Temperature-Humidity Control

For products with a moisture sensitivity level of 3, the workshop lifetime is 168 hours (see note below). In a workshop environment with a temperature of 23℃±5℃ and relative humidity below 60%, the module needs to undergo reflow soldering or other high-temperature operations within 168 hours after unsealing. Otherwise, the module should be stored in an environment with a relative humidity below 10% (e.g., in a dry cabinet) to maintain product dryness.

Notes:

- This is only applicable if the low-humidity workshop environment complies with the IPC/JEDEC J-STD-033 standard. If users are unsure whether the workshop's temperature and humidity meet the conditions, or if the relative humidity exceeds 60%, complete the reflow process within 24 hours after unsealing, and avoid unsealing too many modules in advance.
- To prevent and reduce soldering defects such as bubbling or delamination caused by moisture absorption, strict control is required, and it is not recommended to expose the modules to the air for an extended period after unsealing the vacuum packaging.

- If there is any leakage in the sealed vacuum packaging, if the packaging was opened without following the moisture sensitivity control requirements, if the materials are bulk-packed, or if the valid shelf life exceeds one year, pre-baking is required before the modules are mounted or repaired. Pre-bake the modules at 120℃±5℃ for 24 hours to prevent moisture absorption.
- Before baking, remove the modules from the packaging and place the bare modules on heat-resistant tools (do not bake directly with plastic trays or reels). Solder the baked modules within 24 hours after baking or store them in a dry box. Pay attention to ESD protection when handling modules and wear anti-static gloves.
- After baking, when mounting the bare modules, the pick-and-place machine requires a tray. The methods are as follows: Method 1: Use a dedicated tray of matching size, place the modules in the tray, and then mount them. Method 2: If no dedicated tray is available, use the black anti-static carrier tape that was used for packaging the modules, cut several strips of the same length, and arrange them neatly on the tray of the pick-and-place machine to serve as a simple tray.

### 7.1.7 Requirement for Production of Stencil

To ensure sufficient solder and reliable soldering of the M20D module in LGA packaging, it is recommended to locally increase the thickness of the stencil (Step-up) at the module positions. The stencil should be thickened on the front side (printing side). It is advised to have a stencil thickness of 0.20mm in the module area. However, this thickness can be adjusted based on the actual measured thickness of the solder paste (≤0.20mm) and verified through validation using the conditions and empirical values of the SMT (Surface Mount Technology) factory.

### 7.1.8 Automatic Placement

To ensure the production quality, it is important to select suitable nozzles for the process. The nozzles must be positioned at the center of gravity of the module during suction. The mounting speed should be set to medium speed to prevent instability during movement. The image recognition detection should have a pass rate of 100%. After mounting the module on the PCB, align the module pins with the center of the solder paste for proper alignment.

### 7.1.9 Reflow Soldering

It is recommended to establish a furnace temperature profile based on actual board or oven temperature plate testing. The temperature plate should be connected to thermocouple temperature test points located at the center solder pad and pin positions on the bottom of the module to ensure that the module pins reach the required soldering temperature. The recommended furnace temperature profile for lead-free SMT reflow soldering as shown below:

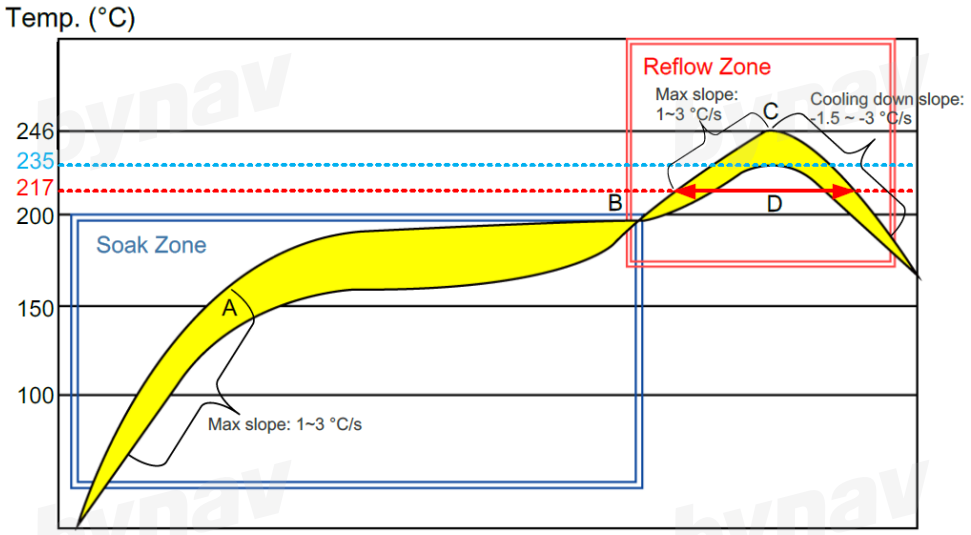



**Figure 7-2 Recommended Furnace Temperature Profile of Assembly**

**Table 7-1 Control Requirements of Recommended Furnace Temperature Test**

| Requirement | Recommended Value |
|---|---|
| Soak Zone | |
| Max Temperature Ramp Slope | 1~3°C/s |
| Constant Temperature Time (Time Between A and B: 150°C~200°C) | 70~120s |
| Reflow Zone | |
| Max Temperature Ramp Slope | 1~3°C/s |
| Reflux Time (D: Period Exceeding 217°C) | 40~70s |
| Max Temperature | 235°C~246°C |
| Cooling Slope | -1.5~-3°C/s |
| Reflux times | |
| Max Number of Reflow | 3 |

Note 1: Reflow oven temperature: The actual soldering temperature can be affected by various external factors, such as whether a reflow fixture is used, the solder paste, the size and thickness of the PCB, the heat resistance requirements of the components, and the board design. If the recommended parameters from our company cannot be achieved, please consult our technical team promptly; otherwise, it may result in module damage.

Note 2: Reflow fixture: For PCBs with a thickness less than 1.0mm, it is recommended to use a reflow fixture for support or high Tg materials to prevent warping during heating, which could cause PCB deformation and impact the module's soldering quality.

Note 3: Cooling: Controlled cooling rates can prevent negative effects on soldering (e.g., brittle solder joints) and reduce mechanical stress within the product. Controlled cooling helps achieve a shiny solder surface, fine crystalline grains, and low contact angles, and avoids rapid cooling changes that can cause shield cover warping.

Note 4: Visual inspection: After module soldering, inspect the soldering quality using X-ray and optical magnification methods. Follow the relevant IPC-A-610F standards. The inspection is divided into three classes, and customers can choose the appropriate soldering level based on the product's application environment and scenarios. For automotive

applications, Class 3 standards are recommended.
Note 5: In principle, we do not recommend using leaded solder paste that differs from our module's process for the following reasons: The melting point of leaded solder paste is 34℃ lower than that of lead-free solder, resulting in lower temperature settings in reflow profiles and shorter process times. This can cause BGA components in the module to be in a semi-molten state during the second reflow, leading to cold solder joints. If leaded processes must be used, ensure that the reflow temperature stays above 220℃ for over 45 seconds, with a peak temperature reaching 240℃.
Note 6: During the module SMT process, it is recommended to perform only one reflow operation, with the module being reflowed in the final pass. Dual reflow operations, where the module side is reflowed first and then the opposite side is reflowed, are not recommended. During the second reflow, the module may experience issues such as cold solder joints or even detachment due to its own weight. If dual reflow is necessary, the above risks must be evaluated, and the use of reflow fixtures is advised.

### 7.1.10 SMT Furnace Recommendation

Because the module contains BGA chips, SMD resistor, SMD capacitor and other SMD componets and is also connected to PCB with solder which also melts at high temperature. If the furnace temperature is too high, the solder inside the module will also completely melt, at this time, if the module encounters large vibration, such as excessive vibration of the conveyor belt in the reflow furnace or the bumper, the BGA components and other devices inside the module are easy to shift or fake soldering. Therefore，please pay attention to:

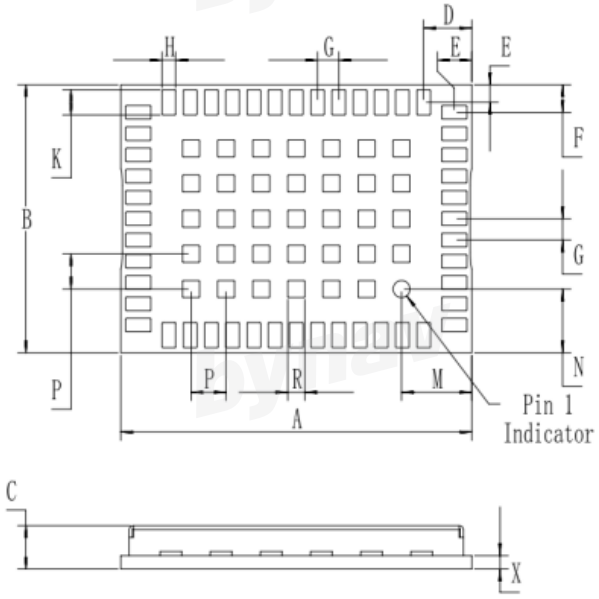
- Please adopt active solder paste from brands such as Alpha.
- The module must be mounted using SMT machine, it is not recommended to place it by hand or weld it by hand.
- It is recommended to perform reflow soldering only once, which can improve the yield of the product.
- Please strictly control the pressure and speed in surface mounting.
- It is necessary to use a reflow furnace with more than 10 temperature zones and strictly control the furnace temperature curve.
- Keep the module still in the furnace. To ensure smooth furnace passing, the furnace with tracks (chains) should be used if it is possible and don’t use the barbed wire in furnace passing.
- When the furnace temperature curve is not suitable, for example, the furnace temperature is too high, and solder of carrier board melt well, but the module defect rate is high due to componets drifts and short circuit after BGA melting again. Later, the furnace temperature curve is adjusted, so both the welding quality of the carrier board and the board-level reliability of the module were improved.

## 7.2 ESD Protection

The M20D module is an electrostatic sensitive (ESD), and ESD protection should be taken into

consideration when packaging, handling or assembling the module.

# 8 Mechanical Specification




| Symbol | Min. (mm) | Typ. (mm) | Max. (mm) |
|---|---|---|---|
| A | 20.80 | 21.00 | 21.20 |
| B | 15.90 | 16.00 | 16.10 |
| C | 2.40 | 2.60 | 2.80 |
| D | 2.78 | 2.88 | 2.98 |
| E | 1.00 | 1.10 | 1.20 |
| F | 1.55 | 1.65 | 1.75 |
| G | 1.17 | 1.27 | 1.37 |
| H | 0.71 | 0.81 | 0.91 |
| K | 1.30 | 1.40 | 1.50 |
| M | 4.10 | 4.20 | 4.30 |
| N | 3.70 | 3.80 | 3.90 |
| P | 2.00 | 2.10 | 2.20 |
| R | 0.92 | 1.02 | 1.12 |
| X | 0.70 | 0.80 | 0.90 |

**Figure 8-1 Mechanical Size**

# 9 Labeling And Ordering Information

## 9.1 Product Label

The label of M20D module is as follows:

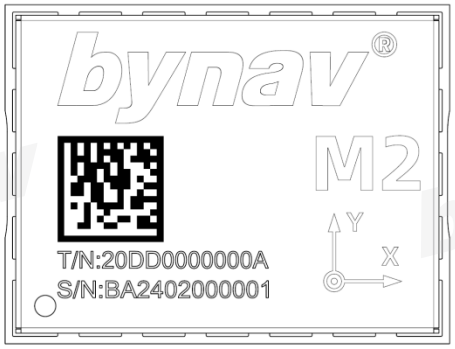



**Figure 9-1 Module Label**

### 9.1.1 T/N Code

The M20D product number is shown below includes information such as the product ID and internal product features.

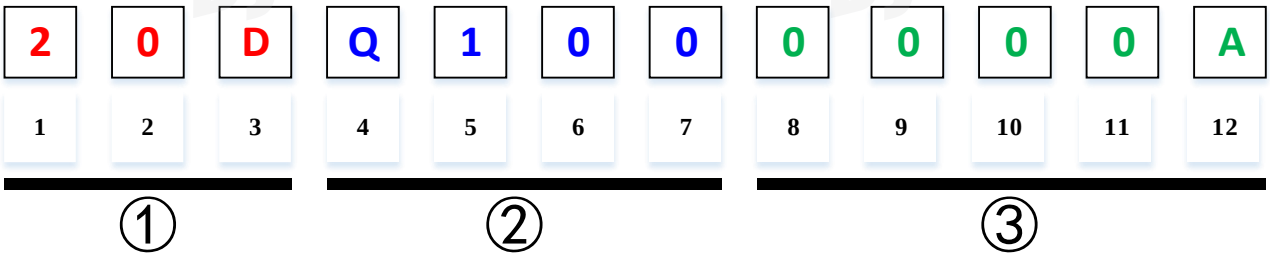



**Figure 9-2 T/N Label**

① is the product ID:

1~3rd code: M20D/M21D, 20D means module M20D.

② and ③ are internal product features.

### 9.1.2 S/N Code

The S/N code represents the module's Serial Number. As shown in the figure below, the serial number mainly includes additional module information for internal use.

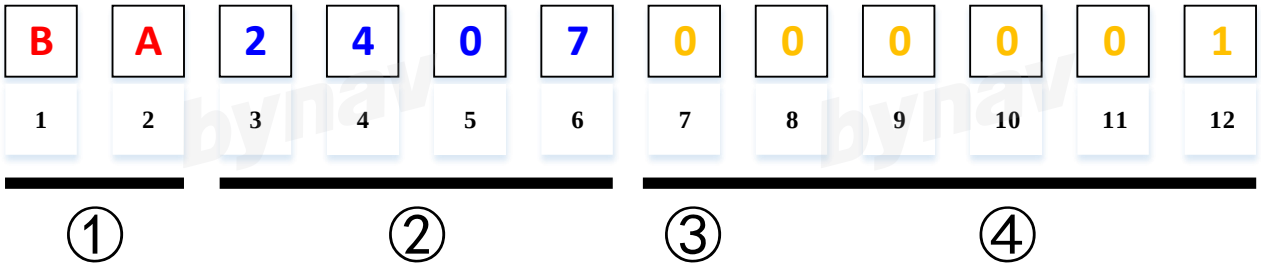



**Figure 9-3 S/N Label**

① is the hardware type.

② is the date of manufacture.

③④ is production serial number.

## 9.2 Ordering Number

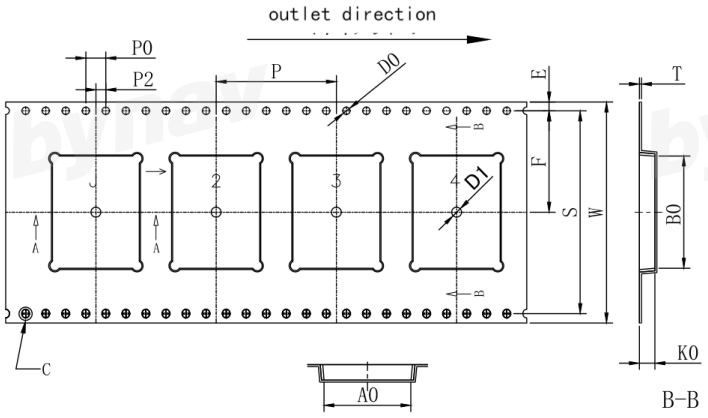
**Table 9-1 Ordering Number**

| Product Name | Ordering Number | Description |
|---|---|---|
| M20D | M20D | Multi-frequency, RTK, 85℃ |
| | M20D A | Multi-frequency, RTK, 105℃, automotive grade |

# 10 Package

The M20D module is packaged in vacuum-sealed aluminum foil anti-static bags using tape and reel packaging, with desiccants and a humidity indicator card included. When soldering the module using the reflow process, please strictly follow the IPC-7350 standard for module handling.

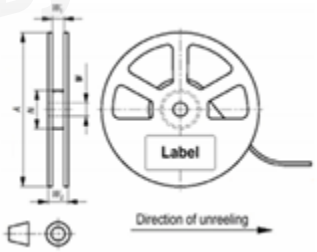
The tape and reel packaging for the M20D module is shown as follows:




| | |
|---|---|
| Po | 4.00±0.10 |
| 10Po | 40.0±0.20 |
| W | 44.00±0.30 |
| P | 24.0±0.10 |
| Ao | 17.35±0.10 |
| BO | 22.35±0.10 |
| KO | 3.10±0.10 |
| T | 0.40±0.05 |

**Figure 10-1 Carrier Tape Information**

The M20D module uses a standard Type C Reel, as shown below:

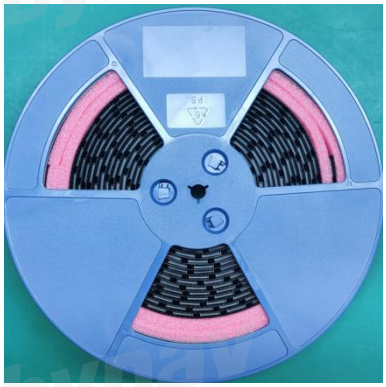



| A | N | N1 | N2 | M |
|---|---|---|---|---|
| 330 | 100 +/-1 | 44.3(-0/+0.3) | 44.9+/-0.3 | #13 (-0.2/+0.5) |

Unit: mm
Qty per roll: 250 pcs
Length: 12.48 m

**Figure 10-2 Reel Information**

The outer packaging for the M20D module is as follows:



**Reel**

**Vacuum Packaging**

Internal Box Packaging

External Box Packaging

**Figure 10 3 External Packaging Information**

# Appendix A Record of Revision of Documents

| Ver. | Creation/Revision Contents | Release Date |
|---|---|---|
| V1.0 | Initial version | 2023.04.08 |
| V1.1 | Added hardware architecture<br>Updated interface signal definitions | 2023.05.16 |
| V1.2 | Added minimum design requirements | 2023.09.13 |
| V1.3 | Added module certification icons | 2024.05.08 |
| V1.4 | Modified the format throughout the document | 2024.05.13 |
| V1.5 | Updated module laser engraving image and physical image | 2024.07.05 |
| V1.6 | Updated system architecture diagram<br>Modified the electrical parameters table<br>Updated application illustrations in the communication interface section<br>Revised status descriptions in the functional safety section<br>Updated application illustrations in the antenna input section and added design requirements for antenna power supply<br>Removed certain physical specifications for the active antenna<br>Updated power supply constraints<br>Updated thermal design requirements<br>Updated product label illustrations and information<br>Corrected some erroneous or ambiguous descriptions<br>Revised the reset section description<br>Added a new section on troubleshooting and handling<br>Added supplementary explanation on the number of reflow soldering cycles<br>Updated the description of module baking<br>Added information on module outer packaging | 2024.07.22 |
| V1.7 | Updated mechanical size | 2024.12.09 |
| V1.8 | Updated RESET interface description | 2024.12.30 |

| | | |
|---|---|---|
| V1.9 | Updated the hot start and cold stard parameter in chapter 1.2<br>Updated the ramp voltage parameter in chapter 4.1 Absolute Maximum Ratings<br>Updated the recommended power supply design, power supply rejection ratio, minimal design<br>Updated functional pin description<br>Added the note of pin definition | 2025.02.28 |
| V2.0 | Modify the pull-down time for POR reset on the RESET_N pin<br>Add the diagram of logic for the reset pin in power-up timing | 2025-04-28 |

**Disclaimer**

This manual provides information about the products of Hunan Bynav Technology Co., Ltd. (hereinafter referred to as Bynav Technology). The manual does not transfer any rights or licenses under the patents, copyrights, trademarks, ownership, etc. of the company or any third party in any form, implied or implied. Except for the responsibilities stated in the sales terms and agreements of the product, our company shall not assume any other responsibilities. At the same time, Bynav Technology does not make any express or implied warranties regarding the sales and use of its products, including but not limited to the suitability and marketability for specific purposes of the products, or any liability for infringement of intellectual property rights such as copyrights, copyrights, and patents. Our company is exempt from liability for any problems arising from not following the manual requirements for connection or operation. If necessary, Bynav Technology may modify product specifications and descriptions without prior notice.

For certain design defects or inadequacies that may exist in our company's products, once discovered, improvements will be made and product version iterations may occur, which may result in differences between the product and the published specifications. If customers require, we can provide the latest product specifications.

All rights reserved © 2013-2025, Hunan Bynav Technology Co., Ltd.

**Bynav Technology**
Building 12, Phase 1, Zhongdian Software Park,
No.39 Jianshan Road, High-tech Zone, Changsha,
Hunan 410205, China

Tel.: 0731-85058117
Email: en@bynav.com
FAE: support@bynav.com

www.bynav.com