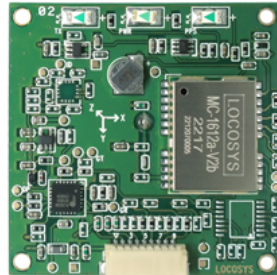


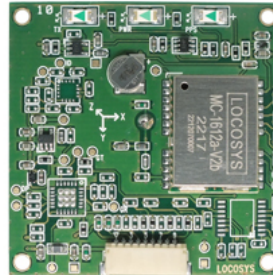
| Product Name | Description | Version |
|--------------|--|---------|
| LC20030-Vx | Dual-frequency multi-constellation GNSS smart antenna, USB | 0.2 |
| LC20031-Vx | Dual-frequency multi-constellation GNSS smart antenna, TTL | |
| LC20032-Vx | Dual-frequency multi-constellation GNSS smart antenna, RS232 | |



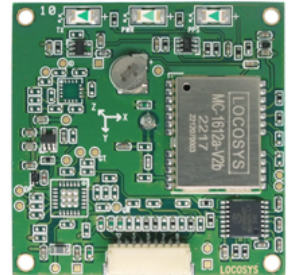
Antenna side



LC20030-Vx



LC20031-Vx



LC20032-Vx

1 Introduction

LC2003x-Vx series products are high-performance dual-band GNSS smart antenna modules, including an embedded antenna and GNSS receiver circuits, designed for a broad spectrum of OEM system applications. The GNSS smart antenna will acquire both L1 and L5 signals at a time while providing the better standalone position accuracy. It can provide you with fast Time-To-First-Fix, superior sensitivity and low power consumption. Its far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

2 Features

- Concurrent reception of L1 and L5 band signals
- Support GPS, GLONASS, BEIDOU, GALILEO, QZSS and IRNSS (NavIC)
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN) and QZSS SLAS
- Support 135-channel GNSS
- Fast TTFF at low signal level
- Free hybrid ephemeris prediction to achieve faster cold start
- Smart jammer detection and suppression
- Build-in micro battery to reserve system data for rapid satellite acquisition
- LED indicator for GNSS fix or not

3 Application

- Personal positioning and navigation
- Automotive navigation and fleet management
- Marine navigation

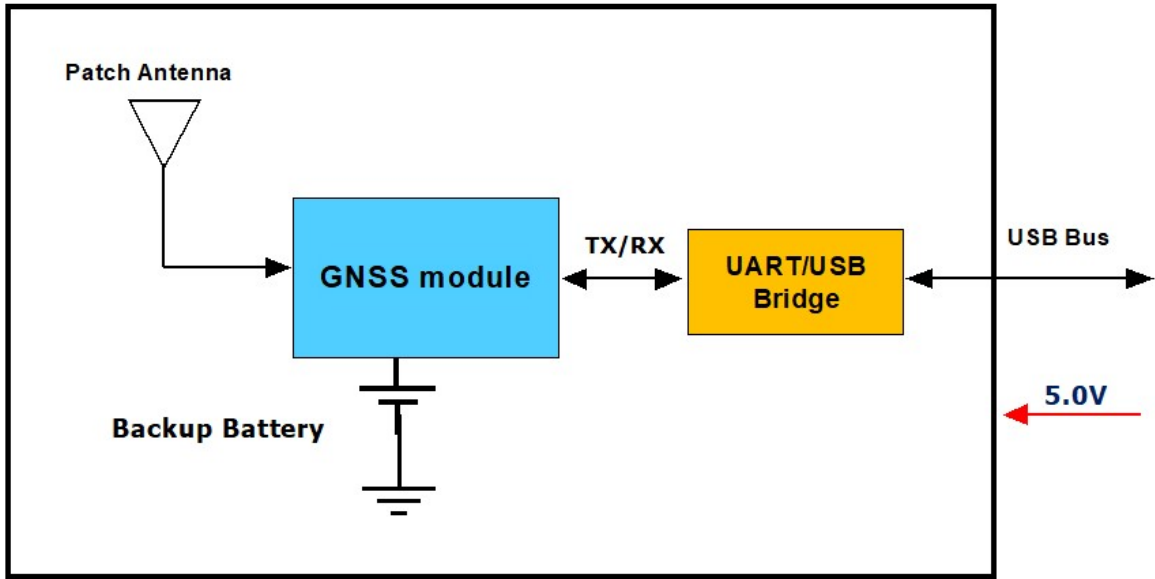


Fig 3-1 System block diagram of LC20030-Vx

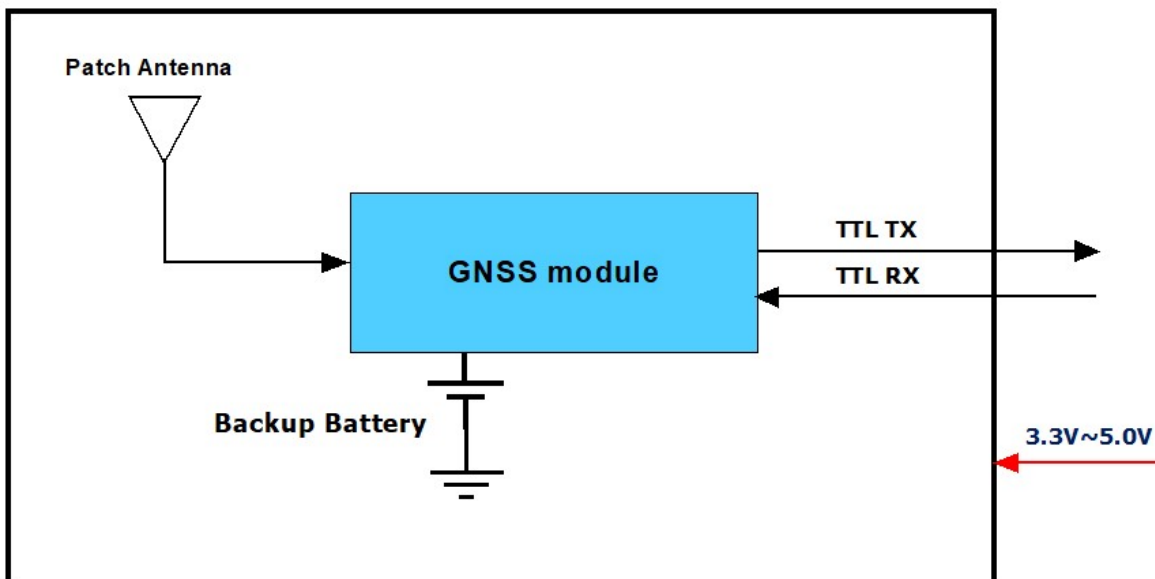


Fig 3-2 System block diagram of LC20031-Vx

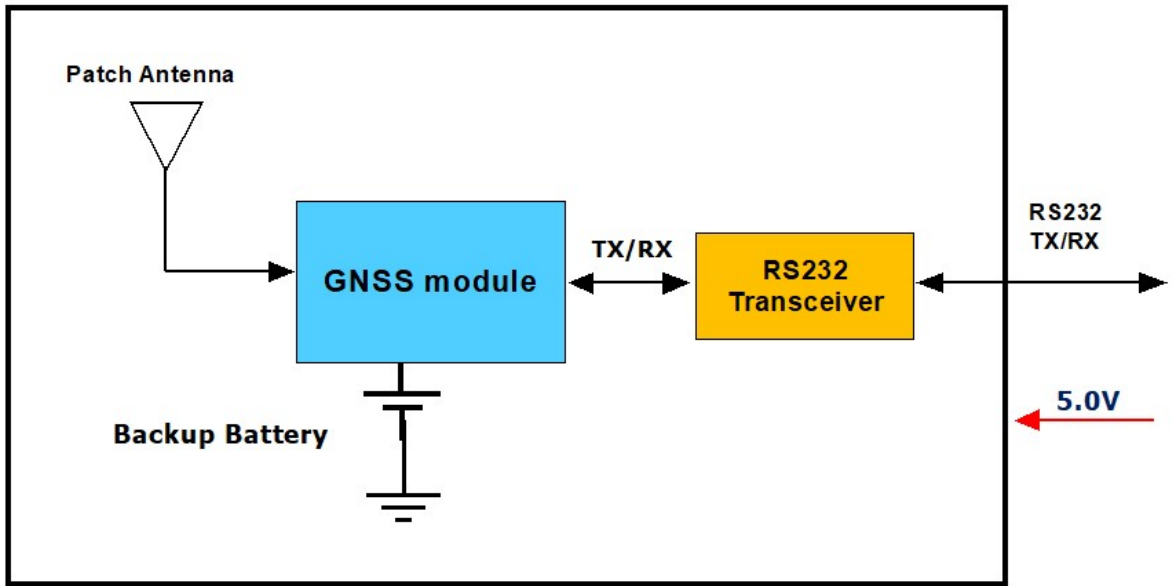


Fig 3-3 System block diagram of LC20032-Vx

4 GNSS receiver

| | | |
|-------------------|--|--|
| Frequency | LC20030-V2 LC20031-V2 LC20032-V2 | GPS/QZSS: L1 C/A, L5C GLONASS: L1OF BEIDOU: B1I, B2a GALILEO: E1, E5a |
| | LC20030-V3 LC20031-V3 LC20032-V3 | GPS/QZSS: L1 C/A GLONASS: L1OF BEIDOU: B1I GALILEO: E1 IRNSS L5 |
| Channels | Support 135 channels | |
| Update rate | 1Hz default, up to 10Hz | |
| Acquisition Time | Hot start (Open Sky) | 2s (typical) |
| | Cold Start (Open Sky) | 28s (typical) without AGPS |
| Position Accuracy | LC20030-V2 LC20031-V2 LC20032-V2 | Autonomous: 1.5m (CEP) |
| | LC20030-V3 LC20031-V3 LC20032-V3 | Autonomous: 2.5m (CEP) |
| Datum | WGS-84 (default) | |
| Max. Altitude | < 18,000 m | |
| Max. Velocity | < 500 m/s | |
| Protocol Support | NMEA 0183 ver. 4.1 | 115200 bps , 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG, GST |

5 Software interface

5.1 NMEA output message

Table 5.1-1 NMEA output message

| NMEA record | Description |
|-------------|--|
| GGA | Global positioning system fixed data |
| GLL | Geographic position - latitude/longitude |
| GSA | GNSS DOP and active satellites |
| GSV | GNSS satellites in view |
| RMC | Recommended minimum specific GNSS data |
| VTG | Course over ground and ground speed |
| GST | Estimated error in position solution |

- **GGA--- Global Positioning System Fixed Data**

Table 5.1-2 contains the values for the following example:

\$GNGGA,091250.000,2503.71250,N,12138.74514,E,1,32,0.55,119.0,M,17.2,M,,*7E

Table 5.1-2 GGA Data Format

| Name | Example | Units | Description |
|------------------------|-------------|--------|--|
| Message ID | \$GNGGA | | GGA protocol header |
| UTC Time | 091250.000 | | hhmmss.sss |
| Latitude | 2503.71250 | | ddmm.mmmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.74514 | | dddmm.mmmmm |
| E/W Indicator | E | | E=east or W=west |
| Position Fix Indicator | 1 | | See Table 5.1-3 |
| Satellites Used | 32 | | Number of satellites in view |
| HDOP | 0.55 | | Horizontal Dilution of Precision (meters) |
| MSL Altitude | 119.0 | meters | Antenna Altitude above/below mean-sea-level (geoid) (in meters) |
| Units | M | meters | Units of antenna altitude, meters |
| Geoidal Separation | 17.2 | meters | |
| Units | M | meters | Units of geoidal separation, meters |
| Age of diff. GNSS data | | second | Null fields when DGPS is not used |
| Diff. Ref. Station ID | | | Differential reference station ID, 0000-1023 |
| Checksum | *7E | | Checksum |
| <CR> <LF> | | | End of message termination |

Table 5.1-3 Position Fix Indicators

| Value | Description |
|-------|-----------------------|
| 0 | No position fix |
| 1 | Autonomous GNSS fix |
| 2 | Differential GNSS fix |

- **GLL--- Geographic Position – Latitude/Longitude**

Table 5.1-4 contains the values for the following example:

\$GNGLL,2503.71193,N,12138.74582,E,094450.000,A,A*47

Table 5.1-4 GLL Data Format

| Name | Example | Units | Description |
|---------------|-------------|-------|---|
| Message ID | \$GNGLL | | GLL protocol header |
| Latitude | 2503.71193 | | ddmm.mmmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.74582 | | dddmm.mmmmm |
| E/W indicator | E | | E=east or W=west |
| UTC Time | 094450.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Mode | A | | N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix E = Estimated/Dead reckoning fix |
| Checksum | *47 | | |
| <CR> <LF> | | | End of message termination |

- **GSA---GNSS DOP and Active Satellites**

Table 5.1-5 contains the values for the following example:

\$GNGSA,A,3,11,195,194,199,08,07,01,27,16,09,23,,1.19,0.64,1.00,1*3F

\$GNGSA,A,3,87,81,76,,,,,,,,,1.19,0.64,1.00,2*0F

\$GNGSA,A,3,,,,,,,,,,,,,1.19,0.64,1.00,3*09

\$GNGSA,A,3,34,24,12,07,11,10,08,38,25,09,13,16,1.19,0.64,1.00,4*02

Table 5.1-5 GSA Data Format

| Name | Example | Units | Description |
|----------------------|---------|-------|---------------------|
| Message ID | \$GNGSA | | GSA protocol header |
| Mode 1 | A | | See Table 5.1-6 |
| Mode 2 | 3 | | See Table 5.1-7 |
| ID of satellite used | 11 | | SV on Channel 1 |

| | | | |
|----------------------|------|--|----------------------------------|
| ID of satellite used | 195 | | SV on Channel 2 |
| | | | |
| ID of satellite used | | | SV on Channel 12 |
| PDOP | 1.19 | | Position Dilution of Precision |
| HDOP | 0.64 | | Horizontal Dilution of Precision |
| VDOP | 1.00 | | Vertical Dilution of Precision |
| GNSS system ID | 4 | | See Table 5.1-8 |
| Checksum | *3F | | |
| <CR> <LF> | | | End of message termination |

Table 5.1-6 Mode 1

| Value | Description |
|-------|---|
| M | Manually set to operate in 2D or 3D mode |
| A | Automatically switching between 2D or 3D mode |

Table 5.1-7 Mode 2

| Value | Description |
|-------|-----------------|
| 1 | No position fix |
| 2 | 2D fix |
| 3 | 3D fix |

Table 5.1-8 GNSS system ID

| Value | Description |
|-------|-------------|
| 1 | GPS |
| 2 | GLONASS |
| 3 | GALILEO |
| 4 | BEIDOU |
| 6 | IRNSS |

● GSV---GNSS Satellites in View

Table 5.1-9 contains the values for the following example:

```
$GPGSV,3,1,09,8,71,268,47,27,63,18,49,11,44,191,46,4,41,237,46,1*54
$GPGSV,3,2,09,16,38,42,42,9,32,279,39,26,22,70,38,31,15,131,36,1*56
$GPGSV,3,3,09,7,15,320,40,1*6B
$GPGSV,1,1,04,8,71,268,50,27,63,18,49,9,32,279,43,26,22,70,42,8*6C
$GLGSV,2,1,05,82,63,47,47,83,56,182,36,80,47,9,42,79,33,85,45,1*71
$GLGSV,2,2,05,81,15,27,37,1*71
$GAGSV,1,1,04,08,48,300,43,03,47,025,45,13,36,309,42,05,06,061,34,7*79
$GAGSV,1,1,04,08,48,300,43,03,47,025,47,13,36,309,43,05,06,061,33,1*7B
$GBGSV,5,1,17,12,80,182,47,24,64,5,51,7,58,355,44,3,57,205,45,1*7C
```

\$GBGSV,5,2,17,1,54,141,44,34,52,211,49,9,48,230,45,10,47,316,42,1*79
 \$GBGSV,5,3,17,26,44,100,47,16,39,207,43,4,38,117,41,2,37,240,41,1*77
 \$GBGSV,5,4,17,39,37,210,43,6,36,198,41,38,27,173,41,25,18,317,42,1*4E
 \$GBGSV,5,5,17,35,16,39,40,1*7F
 \$GBGSV,1,1,02,24,64,5,50,26,44,100,43,4*77

Table 5.1-9 GSV Data Format

| Name | Example | Units | Description |
|--------------------------|---------|---------|--|
| Message ID | \$GPGSV | | GSV protocol header. GP=GPS/QZSS, GL=GLONSS, GA=GALILEO, GB=BEIDOU, GI=IRNSS. |
| Total number of messages | 3 | | Range 1 to 9 |
| Message number | 1 | | Range 1 to 9 |
| Satellites in view | 09 | | |
| Satellite ID | 8 | | Channel 1 |
| Elevation | 71 | degrees | Channel 1 (Range 00 to 90) |
| Azimuth | 268 | degrees | Channel 1 (Range 000 to 359) |
| SNR (C/No) | 47 | dB-Hz | Channel 1 (Range 00 to 99, null when not tracking) |
| | | | |
| Satellite ID | 4 | | Channel 4 (Range 01 to 196) |
| Elevation | 41 | degrees | Channel 4 (Range 00 to 90) |
| Azimuth | 237 | degrees | Channel 4 (Range 000 to 359) |
| SNR (C/No) | 46 | dB-Hz | Channel 4 (Range 00 to 99, null when not tracking) |
| Signal ID | 1 | | GPS/QZSS: L1 C/A=1, L5Q=8 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=4 IRNSS: L6=1 |
| Checksum | *54 | | |
| <CR> <LF> | | | End of message termination |

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

Table 5.1-10 contains the values for the following example:

\$GNRMC,070143.000,A,2503.71317,N,12138.74533,E,0.002,70.50,130220,,A,V*01

Table 5.1-10 RMC Data Format

| Name | Example | Units | Description |
|------------|------------|-------|---------------------|
| Message ID | \$GNRMC | | RMC protocol header |
| UTC Time | 070143.000 | | hhmmss.sss |

| | | | |
|-------------------------------|-------------|---------|---|
| Status | A | | A=data valid or V=data not valid |
| Latitude | 2503.7117 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12138.74533 | | dddmm.mmmmm |
| E/W Indicator | E | | E=east or W=west |
| Speed over ground | 0.002 | knots | True |
| Course over ground | 70.50 | degrees | |
| Date | 130220 | | ddmmyy |
| Magnetic variation | | degrees | |
| Variation sense | | | E=east or W=west |
| Mode | A | | N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix E = Estimated/Dead reckoning fix |
| Navigational status indicator | V | | S = Safe C = Caution U = Unsafe V = Void |
| Checksum | *01 | | |
| <CR> <LF> | | | End of message termination |

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

Table 5.1-11 contains the values for the following example:

\$GNVTG,0.00,T,,M,0.003,N,0.006,K,A*26

Table 5.1-11 VTG Data Format

| Name | Example | Units | Description |
|--------------------|---------|---------|--|
| Message ID | \$GPVTG | | VTG protocol header |
| Course over ground | 0.00 | degrees | Measured heading |
| Reference | T | | True |
| Course over ground | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed over ground | 0.003 | knots | Measured speed |
| Units | N | | Knots |
| Speed over ground | 0.006 | km/hr | Measured speed |
| Units | K | | Kilometer per hour |
| Mode | A | | N = No position fix A = Autonomous GNSS fix |

| | | | |
|-----------|-----|--|---|
| | | | D = Differential GNSS fix E = Estimated/Dead reckoning fix |
| Checksum | *26 | | |
| <CR> <LF> | | | End of message termination |

● **GST---Estimated error in position solution**

Table 5.1-12 contains the values for the following example:

\$GNGST,075707.000,2.9,1.8,1.5,113.3,1.6,1.8,5.9*7F

Table 5.1-12 GST Data Format

| Name | Example | Units | Description |
|------------|------------|---------|--|
| Message ID | \$GNGST | | GST protocol header |
| UTC Time | 075707.000 | | hhmmss.sss |
| RangeRMS | 2.9 | meters | RMS value of the standard deviation of the ranges |
| stdMajor | 1.8 | meters | Standard deviation of semi-major axis of error ellipse |
| stdMinor | 1.5 | meters | Standard deviation of semi-minor axis of error ellipse |
| Orient | 113.3 | degrees | Orientation of semi-major axis of error ellipse |
| stdLat | 1.6 | meters | Standard deviation of latitude error |
| stdLong | 1.8 | meters | Standard deviation of longitude error |
| stdAlt | 5.9 | meters | Standard deviation of altitude error |
| Checksum | *7F | | |
| <CR> <LF> | | | End of message termination |

5.2 Proprietary command

The commonly used commands are in the following.

5.2.1 ID: 004

[Description]

Hot Start. Use the available data in the NVRAM.

[Data Field]

\$PAIR004*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR004*3E\r\n

Response:

\$PAIR001,004,0*3F\r\n ==> Success

5.2.2 ID: 005

[Description]

Warm Start. Not using Ephemeris data at the start.

[Data Field]

\$PAIR005*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR005*3F\r\n

Response:

\$PAIR001,005,0*3E\r\n ==> Success

5.2.3 ID: 006

[Description]

Cold Start. Not using the Position, Almanac and Ephemeris data at the start.

[Data Field]

\$PAIR006*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

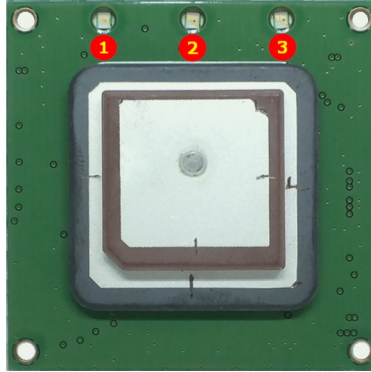
Send:

\$PAIR006*3C\r\n

Response:

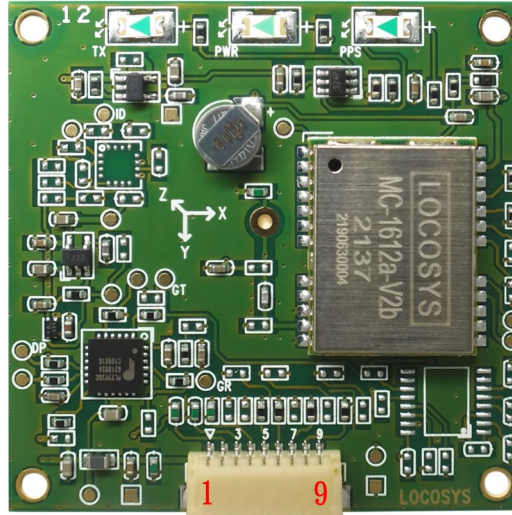
\$PAIR001,006,0*3D\r\n ==> Success

6 LED indicator



| LED | Color | Descriptions |
|-----|-------|-----------------|
| 1 | Blue | PPS Indicator |
| 2 | Red | Power Indicator |
| 3 | Green | TX Indicator |

7 Pin assignment and descriptions



- **LC20030-Vx**

| Pin # | Name | Type | Description |
|-------|------------|------|---|
| 1 | VCC | P | DC supply input. |
| 2 | USB_DM | | USB D- |
| 3 | USB_DP | | USB D+ |
| 4 | TIMEPULSE* | O | PPS, default 100ms pulse/sec when 3D fix is available |
| 5 | NC | | No connection |
| 6 | NC | | No connection |
| 7 | NC | | No connection |
| 8 | NC | | No connection |
| 9 | GND | P | Ground |

Note: The Timepulse(PPS) signal also connect to DCD(Data Carrier Detect) pin.

● **LC20031-Vx**

| Pin # | Name | Type | Description |
|-------|-----------|------|---|
| 1 | VCC | I | DC supply input. |
| 2 | RXD | I | UART, asynchronous input, TTL level |
| 3 | TXD | O | UART, asynchronous output, TTL level |
| 4 | TIMEPULSE | O | PPS, default 100ms pulse/sec when 3D fix is available |
| 5 | NC | | No connection |
| 6 | NC | | No connection |
| 7 | NC | | No connection |
| 8 | NC | | No connection |
| 9 | GND | P | Ground |

● **LC20032-Vx**

| Pin # | Name | Type | Description |
|-------|-----------|------|---|
| 1 | VCC | I | DC supply input. |
| 2 | RXD | I | UART, asynchronous input, RS232 level |
| 3 | TXD | O | UART, asynchronous output, RS232 level |
| 4 | TIMEPULSE | O | PPS, default 100ms pulse/sec when 3D fix is available |
| 5 | NC | | No connection |
| 6 | NC | | No connection |
| 7 | NC | | No connection |
| 8 | NC | | No connection |
| 9 | GND | P | Ground |

8 DC & Temperature characteristics

8.1 DC Electrical characteristics

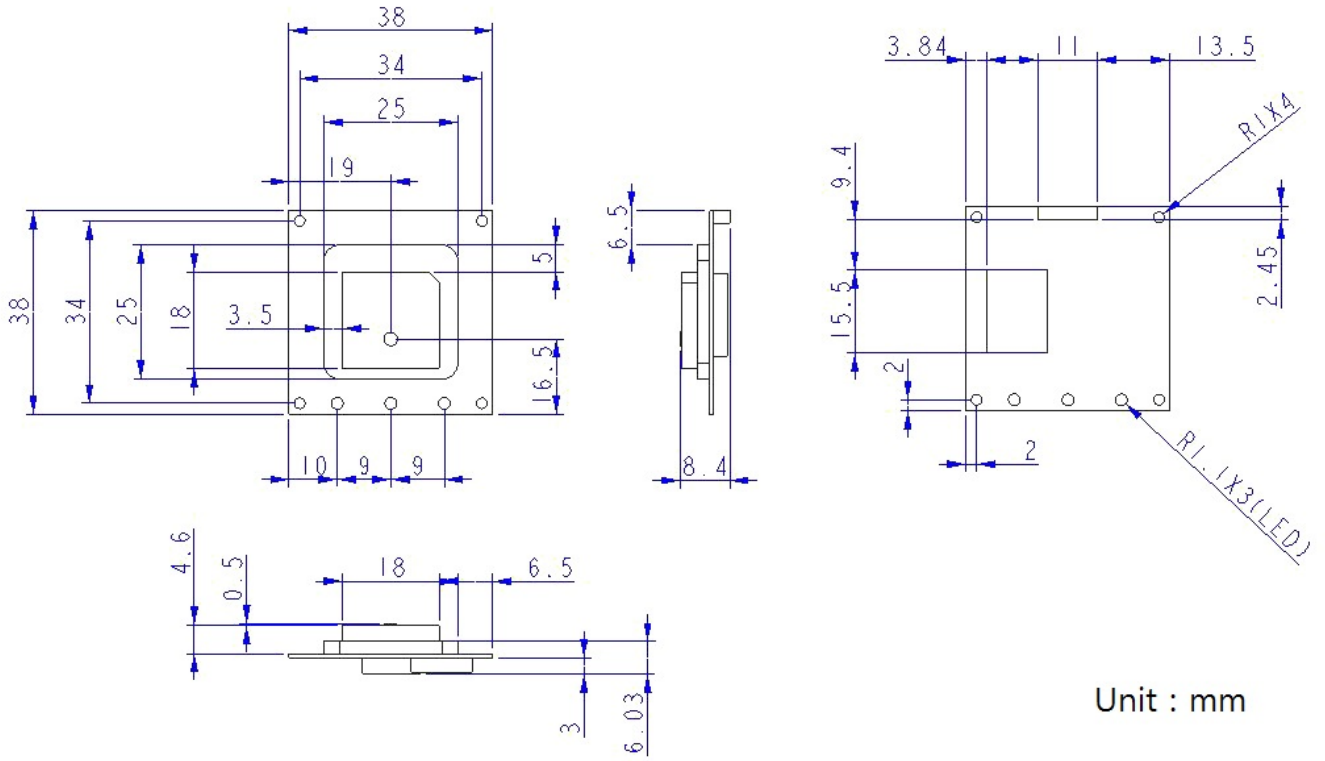
| Parameter | Symbol | Product | Min. | Typ. | Max. | Units |
|------------------------------|-----------------|------------|---------|------|---------|-------|
| Input voltage | VCC | LC20030-Vx | 4.75 | 5.0 | 5.25 | V |
| | | LC20031-Vx | 3.30 | 3.3 | 5.25 | |
| | | LC20032-Vx | 4.75 | 5.0 | 5.25 | |
| Input current ⁽¹⁾ | Icc | LC20030-V2 | | 73 | | mA |
| | | LC20031-V2 | | 64 | | |
| | | LC20032-V2 | | 67 | | |
| | | LC20030-V3 | | 54 | | |
| | | LC20031-V3 | | 42 | | |
| | | LC20032-V3 | | 43 | | |
| High Level Input Voltage | V _{IH} | LC20031-Vx | 0.7*VCC | | VCC | V |
| Low Level Input Voltage | V _{IL} | LC20031-Vx | 0 | | 0.2*VCC | V |
| High Level Output Voltage | V _{OH} | LC20031-Vx | VCC-0.4 | | | V |
| Low Level Output Voltage | V _{OL} | LC20031-Vx | | | 0.4 | V |
| High Level Output Current | I _{OH} | LC20031-Vx | | 4 | | mA |
| Low Level Output Current | I _{OL} | LC20031-Vx | | 4 | | mA |

Note 1: Measured when position fix (1Hz) is available, the function of self-generated ephemeris prediction is inactive.

8.2 Temperature characteristics

| Parameter | Symbol | Product | Min. | Typ. | Max. | Units |
|-----------------------|--------|------------|------|------|------|-------|
| Operating Temperature | Topr | LC20030-Vx | -20 | - | 60 | °C |
| | | LC20031-Vx | | | | |
| | | LC20032-Vx | | | | |
| Storage Temperature | Tstg | LC20030-Vx | -20 | 25 | 60 | °C |
| | | LC20031-Vx | | | | |
| | | LC20032-Vx | | | | |

9 Mechanical specification

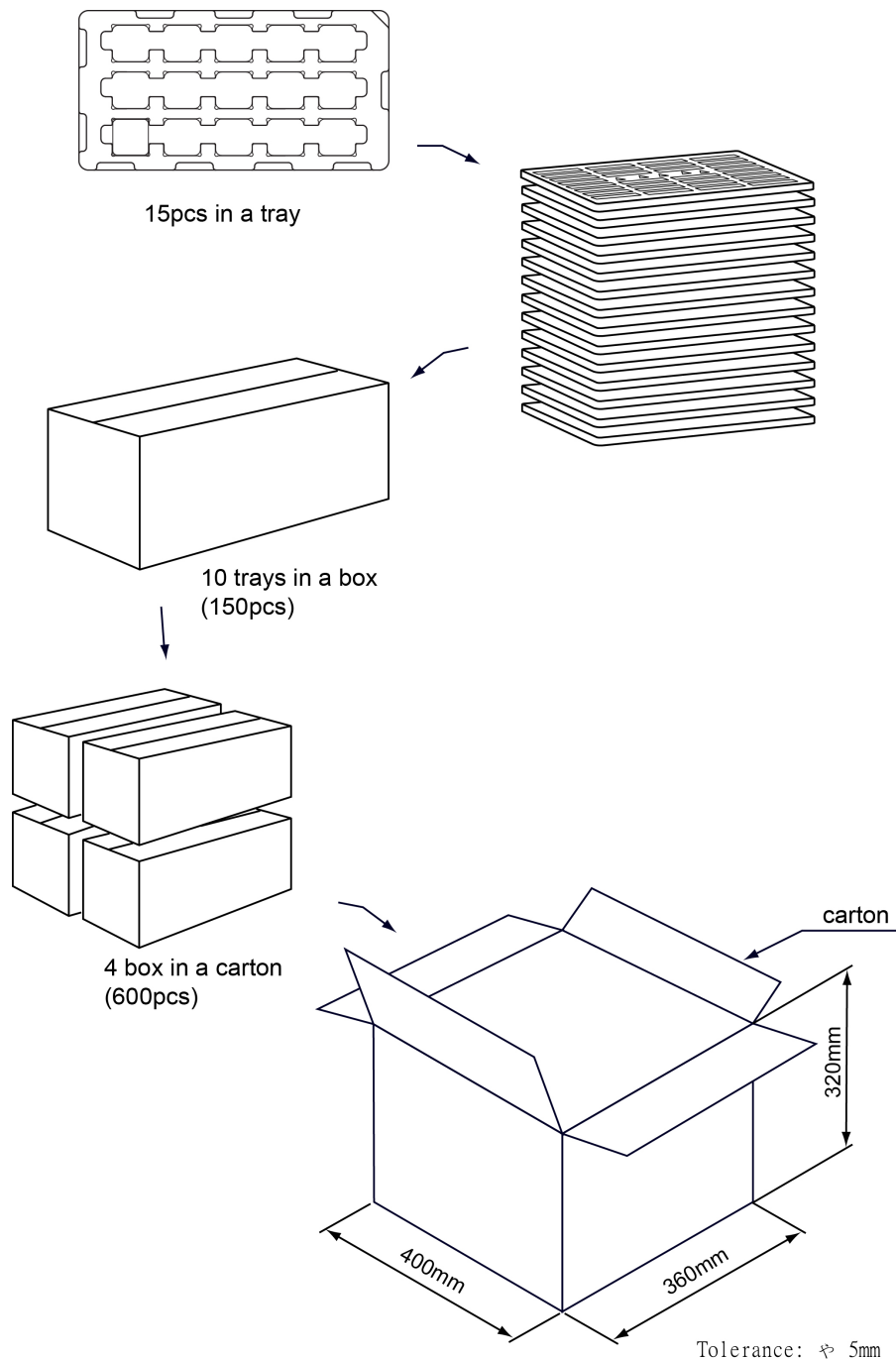


10 Product handling

10.1 ESD precaution

GNSS modules are electrostatic sensitive devices. Handling the modules without proper ESD protection may result in severe damage to them. ESD protection must be implemented throughout the processing, handling and even when the modules are being returned for repair.

10.2 Packaging



10.3 Storage

We recommend storing the smart antenna module in a dry place, such as moisture-proof cabinet. The shelf life of the module package is about 6 months from the packaging date when it is stored in a non-condensing storage environment (<30°C/60% RH).

11 Ordering information

| Product name | Description | Remark |
|--------------|--|--|
| LC20030-V2 | Dual-frequency multi-constellation GNSS smart antenna, USB | GPS/QZSS: L1 C/A, L5C GLONASS: L1OF BEIDOU: B1I, B2a GALILEO: E1, E5a |
| LC20031-V2 | Dual-frequency multi-constellation GNSS smart antenna, TTL | |
| LC20032-V2 | Dual-frequency multi-constellation GNSS smart antenna, RS232 | |
| LC20030-V3 | Dual-frequency multi-constellation GNSS smart antenna, USB | GPS/QZSS: L1 C/A GLONASS: L1OF BEIDOU: B1I GALILEO: E1 IRNSS: L5 |
| LC20031-V3 | Dual-frequency multi-constellation GNSS smart antenna, TTL | |
| LC20032-V3 | Dual-frequency multi-constellation GNSS smart antenna, RS232 | |

Document change list

Revision 0.1

- Draft release on Apr 29, 2022.

Revision 0.2 (May 11, 2022)

- Revised the mechanical specification in section 9.
- Added Section 10.2.