

| Product name | Description                                  | Version |
|--------------|----------------------------------------------|---------|
| ST-1612-DB   | Datasheet of ST-1612-DB multiple GNSS module | 1.3     |



## 1 Introduction

The LOCOSYS ST-1612-DB Dead Reckoning (DR) module is the perfect solution for automotive application. The ST-1612-DB is embedded 3D accelerometer, 3D gyroscope Micro-Electro-Mechanical Systems (MEMS) sensor, equipped with DR software, and powered by STMicroelectronics Teseo III. With adverse GNSS conditions in urban canyons, tunnels, or parking garages where DR boosts the accuracy, and the software fills the gaps. It supports three dimensional DR. This module can simultaneously acquire and track multiple satellite constellations that include GPS, BeiDou, GALILEO and QZSS. It features high sensitivity, low power and ultra small form factor, and provide you the superior performance.

## 2 Features

- STMicroelectronics Teseo III high sensitivity solution
- Support GPS, BeiDou, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- 48 tracking channels and 2 fast acquisition channels
- Fast TTFF at low signal level
- Built-in Dead Reckoning (DR) software
- Built-in MEMS sensor (3-axis Gyroscope and 3-axis Accelerometer)
- Support Odometer (wheel-tick pulse) input
- Support Forward / Reverse Direction (FWD) input
- Support sensors data feed through the UART port
- Support CAN Bus ( ISO 15765-4 )
- Small form factor 16 x 12.2 x 2.2 mm
- SMD type, RoHS compliant

### 3 System Block Diagram

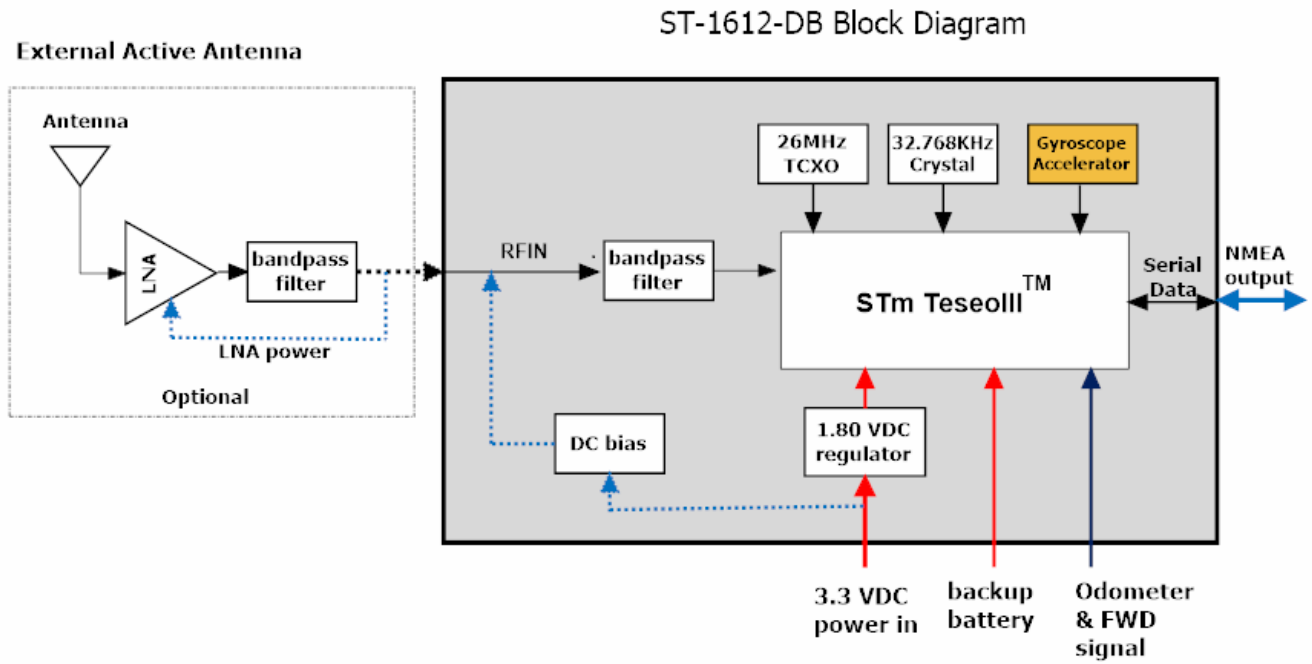


Fig 3-1 System block diagram.

## 4 GNSS receiver

### 4.1 GNSS receiver

|                   |                                                                               |                                                                                                                     |
|-------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Chip              | STA8090FGB series                                                             |                                                                                                                     |
| Frequency         | GPS, GALILEO, QZSS: L1 1575.42MHz, C/A code<br>BeiDou: B1 1561.098MHz, C code |                                                                                                                     |
| Channels          | Support 48 channels                                                           |                                                                                                                     |
| Update rate       | 1Hz default                                                                   |                                                                                                                     |
| Sensitivity       | Tracking <sup>(1)</sup>                                                       | -163dBm                                                                                                             |
|                   | Cold start <sup>(2)</sup>                                                     | -147dBm                                                                                                             |
| Acquisition Time  | Cold Start (Open Sky)                                                         | 36s (typical)                                                                                                       |
|                   | Hot start (Open Sky)                                                          | 1s (typical)                                                                                                        |
| Position Accuracy | Autonomous                                                                    | 1.8m CEP                                                                                                            |
|                   | SBAS                                                                          | 1.5m (depends on accuracy of correction data)                                                                       |
| Max. Altitude     | < 18,000 m                                                                    |                                                                                                                     |
| Max. Velocity     | < 515 m/s                                                                     |                                                                                                                     |
| Protocol Support  | NMEA 0183 ver 3.01                                                            | 115200 bps <sup>(3)</sup> , 8 data bits, no parity, 1 stop bits (default)<br>1Hz: GGA, GLL, GSA, GSV, RMC, VTG, ZDA |

Note1: For signal tracking sensitivity. With a good external LNA (Noise figure <=1.0dB, Gain>=13dB).

Note2: With a good external LNA (Noise figure <=1.0dB, Gain>=13dB).

Note3: Both baud rate and output message rate are configurable to be factory default.

### 4.2 MEMS Sensor

The ST-1612-DB receiver support Dead Reckoning (DR) function, it composed by a 3-axis Gyroscope and 3-axis Accelerometer. To provide optimal solution it needs to calibrate sensor parameters. The sensor parameters are initialized to default values allowing system to start up when no other better information is available, if system is started for the first time in an unknown vehicle gyroscope dedicated maneuvers are required and algorithms able to estimate these parameters.

### 4.3 Sensor Data Input

The receiver needs two more sensor input, odometer and forward/reverse direction signal.

There are three methods to feed datum to receiver as below descriptions.

- (1) Feed through vehicle Odometer (wheel-tick pulse) input.
- (2) Feed through the UART port; please contact LOCOSYS for more details.
- (3) Feed through CAN Bus (ISO 15765-4).

## 5 Pin assignment and descriptions

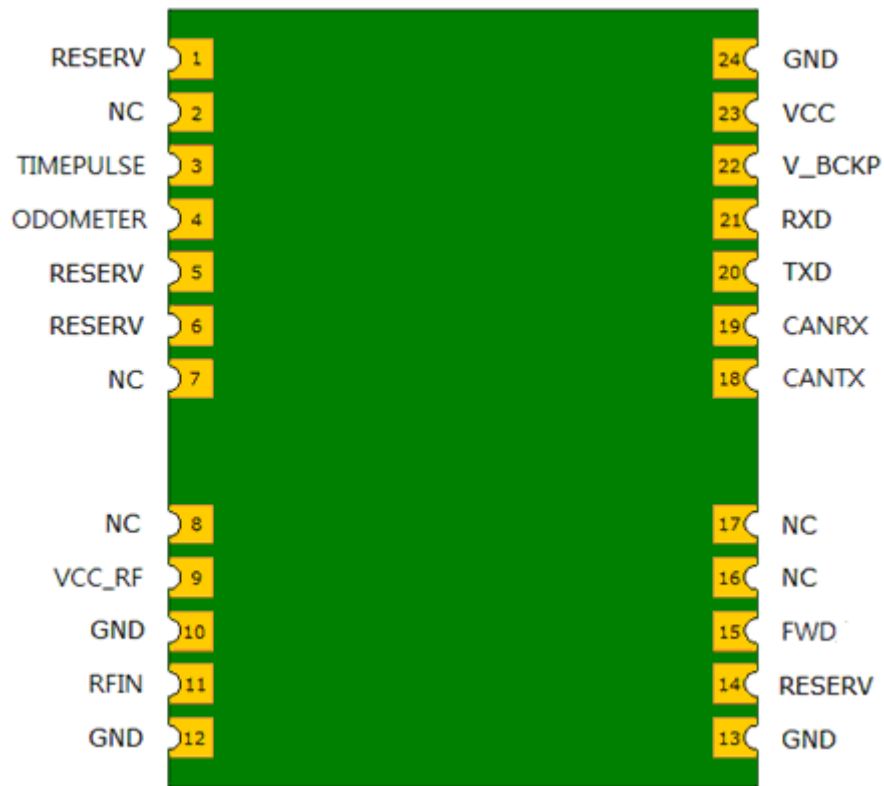


Table 5-1 Pin descriptions

| Pin # | Name      | Type | Description                                 | Note |
|-------|-----------|------|---------------------------------------------|------|
| 1     | RESERV    |      | Reserved, keep floating                     |      |
| 2     | NC        |      | Not connected                               |      |
| 3     | TIMEPULSE | O    | Time pulse (1PPS, default 500 ms pulse/sec) |      |
| 4     | ODOMETER  | I    | Odometer wheel-tick input                   | 2    |
| 5     | RESERV    |      | Reserved, keep floating                     |      |
| 6     | RESERV    |      | Reserved, keep floating                     |      |
| 7     | NC        |      | Not connected                               |      |
| 8     | NC        |      | Not connected                               |      |
| 9     | VCC_RF    | O    | Output voltage for active antenna           | 1    |
| 10    | GND       | P    | Ground                                      |      |
| 11    | RFIN      | I    | GNSS RF signal input                        |      |
| 12    | GND       | P    | Ground                                      |      |
| 13    | GND       | P    | Ground                                      |      |
| 14    | RESERV    |      | Reserved, keep floating                     |      |

|    |        |   |                                          |   |
|----|--------|---|------------------------------------------|---|
| 15 | FWD    | I | Forward/Reverse signal input             | 2 |
| 16 | NC     |   | Not connected                            |   |
| 17 | NC     |   | Not connected                            |   |
| 18 | CANTX  | O | CAN bus transmit data output             | 3 |
| 19 | CANRX  | I | CAN bus receive data input               | 3 |
| 20 | TXD    | O | UART, asynchronous output (Default NMEA) |   |
| 21 | RXD    | I | UART, asynchronous input                 |   |
| 22 | V_BCKP | P | Backup battery supply voltage            |   |
| 23 | VCC    | P | DC supply voltage                        | 4 |
| 24 | GND    | P | Ground                                   |   |

Note1: The VCC\_RF pin short-circuit protection is built-in the module.

Note2: Pin4 and Pin15 need external level shift circuits to meet DC electrical characteristics.

Note3: Need an external CAN Bus Transceiver (Maxim MAX3051, STM L9616D...etc) and vehicle CAN Bus protocol.

Note4: The module is operated in fully functions, if customer want to turn module off for power saving reason, please add a PMOS or LDO(with enable pin) to control the module on or off.

## 6 DC & Temperature characteristics

### 6.1 Absolute maximum ratings

| Parameter                    | Symbol | Ratings  | Units |
|------------------------------|--------|----------|-------|
| Input Voltage                | VCC    | 3.6      | V     |
| Input Backup Battery Voltage | V_BCKP | 3.6      | V     |
| Operating Temperature Range  | Topr   | -40 ~ 85 | °C    |
| Storage Temperature Range    | Tstg   | -40 ~ 85 | °C    |

### 6.2 DC Electrical characteristics

| Parameter                    | Symbol           | Conditions                                                            | Min. | Typ.                    | Max. | Units          |
|------------------------------|------------------|-----------------------------------------------------------------------|------|-------------------------|------|----------------|
| Input Voltage                | VCC              |                                                                       | 3.0  | 3.3                     | 3.6  | V              |
| Input Backup Battery Voltage | V_BCKP           |                                                                       | 1.8  |                         | 3.6  | V              |
| VCC_RF Output Voltage        | VCC_RF           |                                                                       |      | VCC                     |      | V              |
| Supply Current               | I <sub>ss</sub>  | VCC = 3.3V,<br>w/o active antenna,<br>Peak<br>Acquisition<br>Tracking |      | 71<br>75 <sup>(1)</sup> | 284  | mA<br>mA<br>mA |
| Backup Battery Current       | I <sub>bat</sub> | VCC = 0V                                                              |      | 10                      |      | uA             |
| VCC_RF Output Current        | I <sub>out</sub> | VIN = 3.3V                                                            |      |                         | 25   | mA             |
| High Level Input Voltage     | V <sub>IH</sub>  |                                                                       | 2.0  |                         | 3.6  | V              |
| Low Level Input Voltage      | V <sub>IL</sub>  |                                                                       | -0.3 |                         | 0.8  | V              |
| High Level Output Voltage    | V <sub>OH</sub>  |                                                                       | 2.6  |                         |      | V              |
| Low Level Output Voltage     | V <sub>OL</sub>  |                                                                       |      |                         | 0.4  | V              |

Note: Measured when position fix (1Hz) is available and input voltage is 3.3V with UART interface.

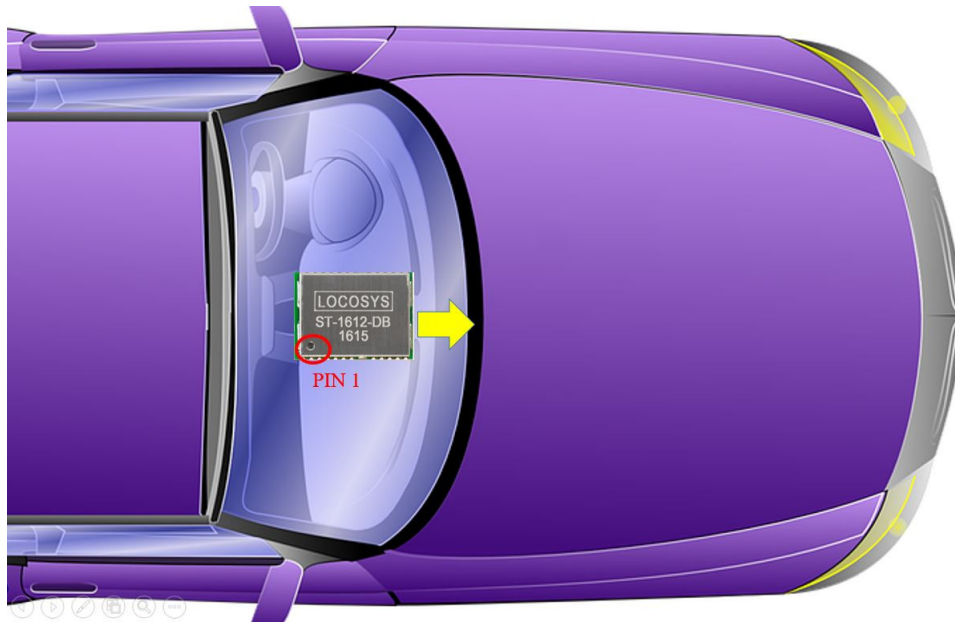
### 6.3 Temperature characteristics

| Parameter             | Symbol | Min. | Typ. | Max. | Units |
|-----------------------|--------|------|------|------|-------|
| Operating Temperature | Topr   | -40  | -    | 85   | °C    |
| Storage Temperature   | Tstg   | -40  | 25   | 85   | °C    |

## 7 Mechanical specification

### 7.1 Recommended Mounting

Please refer to the following figure to mount ST-1612-DB on vehicle. The module should be securely mounted to a stable part of the vehicle.



**Note1: ST-1612-DB module MUST mount horizontally on vehicle (when the vehicle is on a level surface) and toward the front of vehicle. (Default is standard installation method)**

**Note2: If the module is not mounted as the above figure, please consult LOCOSYS in advance.**



## 8 Software interface

### 8.1 NMEA output message

Table 8.1-1 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      |
| ZDA         | UTC, day, month and year.                |

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

Table 8.1-2 contains the values for the following example:

\$GNGGA,013654.000,2503.71447,N,12138.74593,E,1,16,0.7,130.00,M,15.3,M,,\*72

Table 8.1- 2 GGA Data Format

| Name                   | Example     | Units  | Description                                          |
|------------------------|-------------|--------|------------------------------------------------------|
| Message ID             | \$GNGGA     |        | GGA protocol header                                  |
| UTC Time               | 013654.000  |        | hhmmss.sss                                           |
| Latitude               | 2503.71447  |        | ddmm.mmmmm                                           |
| N/S indicator          | N           |        | Latitude Direction: North or South                   |
| Longitude              | 12138.74593 |        | dddmm.mmmmm                                          |
| E/W Indicator          | E           |        | Longitude Direction: East or West                    |
| Position Fix Indicator | 1           |        | See Table 8.1-3                                      |
| Satellites Used        | 16          |        | Satellites in use                                    |
| HDOP                   | 0.7         |        | Horizontal Dilution of Precision,max:99.0            |
| MSL Altitude           | 130.00      | meters | Height above mean sea level                          |
| Units                  | M           | meters | Reference Unit for Altitude (“M” = meters)           |
| Geoidal Separation     | 15.3        | meters | Geoidal Separation measure in “M” = meters           |
| Units                  | M           | meters | Reference Unit for Geoidal Separation (“M” = meters) |
| DGPS Age               |             |        | Not supported                                        |
| DGPS Reference         |             |        | Not supported                                        |
| Checksum               | *72         |        |                                                      |
| <CR> <LF>              |             |        | End of message termination                           |

Table 8.1-3 Position Fix Indicators

| Value | Description                     |
|-------|---------------------------------|
| 0     | Fix not available or invalid    |
| 1     | GNSS fix valid                  |
| 2     | Differential GNSS fix valid     |
| 3-5   | Not supported                   |
| 6     | Estimated (Dead Reckoning) Mode |

### ● GLL--- Geographic Position – Latitude/Longitude

Table 8.1-4 contains the values for the following example:

\$GNGLL,2503.71447,N,12138.74593,E,013654.000,A,A\*42

Table 8.1-4 GLL Data Format

| Name          | Example     | Units | Description                                                                                      |
|---------------|-------------|-------|--------------------------------------------------------------------------------------------------|
| Message ID    | \$GNGLL     |       | GLL protocol header                                                                              |
| Latitude      | 2503.71447  |       | ddmm.mmmmm                                                                                       |
| N/S indicator | N           |       | Latitude Direction: North or South                                                               |
| Longitude     | 12138.74593 |       | dddmm.mmmmm                                                                                      |
| E/W indicator | E           |       | Longitude Direction: East or West                                                                |
| UTC Time      | 013654.000  |       | hhmmss.sss                                                                                       |
| Status        | A           |       | Validity of Data; A=data valid or V=data invalid                                                 |
| Mode          | A           |       | A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning) Mode, N=Data invalid, |
| Checksum      | *42         |       |                                                                                                  |
| <CR> <LF>     |             |       | End of message termination                                                                       |

### ● GSA---GNSS DOP and Active Satellites

Table 8.1-5 contains the values for the following example:

\$GNGSA,A,3,25,26,22,10,16,32,14,29,31,,1.1,0.6,0.9\*2B

\$GNGSA,A,3,193,,,,,,,,,1.1,0.6,0.9\*18

\$GNGSA,A,3,324,312,309,,,,,,,,,1.1,0.6,0.9\*1C

\$GNGSA,A,3,141,143,142,144,146,147,145,149,150,,1.1,0.6,0.9\*1E

Table 8.1-5 GSA Data Format

| Name       | Example | Units | Description         |
|------------|---------|-------|---------------------|
| Message ID | \$GNGSA |       | GSA protocol header |
| Mode 1     | A       |       | See Table 8.1-6     |
| Mode 2     | 3       |       | See Table 8.1-7     |

|                      |     |  |                                            |
|----------------------|-----|--|--------------------------------------------|
| ID of satellite used | 25  |  | Sv on Channel 1                            |
| ID of satellite used | 26  |  | Sv on Channel 2                            |
| ....                 |     |  | ....                                       |
| ID of satellite used |     |  | Sv on Channel 12                           |
| PDOP                 | 1.1 |  | Position Dilution of Precision,max:99.0    |
| HDOP                 | 0.6 |  | Horizontal Dilution of Precision, max:99.0 |
| VDOP                 | 0.9 |  | Vertical Dilution of Precision, max:99.0   |
| Checksum             | *2B |  |                                            |
| <CR> <LF>            |     |  | End of message termination                 |

Table 8.1-6 Mode 1

| Value | Description                                      |
|-------|--------------------------------------------------|
| M     | Manual: forced to operate in 2D or 3D mode       |
| A     | Automatic: allowed to automatically switch 2D/3D |

Table 8.1-7 Mode 2

| Value | Description      |
|-------|------------------|
| 1     | No Fix available |
| 2     | 2D               |
| 3     | 3D               |

## ● GSV---GNSS Satellites in View

Table 8.1-8 contains the values for the following example:

```
$GNGSV,7,1,26,14,76,112,42,26,69,286,45,149,67,249,38,309,63,224,41*64
$GNGSV,7,2,26,147,60,338,42,143,58,205,39,141,55,140,38,146,54,191,39*61
$GNGSV,7,3,26,31,51,017,47,32,49,137,42,157,49,024,,150,48,296,36*63
$GNGSV,7,4,26,324,49,307,40,16,46,243,44,144,39,117,36,142,38,240,32*5A
$GNGSV,7,5,26,29,30,060,44,193,25,177,39,22,25,278,41,312,20,140,31*62
$GNGSV,7,6,26,03,18,297,,145,15,256,29,148,13,168,,27,11,192,*65
$GNGSV,7,7,26,25,09,042,37,50,51,134,35,,,,,,,,*6E
```

Table 8.1-8 GSV Data Format

| Name                                  | Example | Units | Description                        |
|---------------------------------------|---------|-------|------------------------------------|
| Message ID                            | \$GNGSV |       | GSV protocol header                |
| Total number of messages <sup>1</sup> | 7       |       | Range 1 to 8                       |
| Message number <sup>1</sup>           | 1       |       | Range 1 to 8                       |
| Satellites in view                    | 26      |       | Total Number of Satellites in view |
| Satellite ID                          | 14      |       | Channel 1 (Range 01 to 330)        |

|              |     |         |                                                    |
|--------------|-----|---------|----------------------------------------------------|
| Elevation    | 76  | degrees | Channel 1 (Range 00 to 90)                         |
| Azimuth      | 112 | degrees | Channel 1 (Range 000 to 359)                       |
| SNR (C/No)   | 42  | dB-Hz   | Channel 1 (Range 00 to 99, null when not tracking) |
| .....        |     |         | .....                                              |
| Satellite ID | 309 |         | Channel 4 (Range 01 to 330)                        |
| Elevation    | 63  | degrees | Channel 4 (Range 00 to 90)                         |
| Azimuth      | 224 | degrees | Channel 4 (Range 000 to 359)                       |
| SNR (C/No)   | 41  | dB-Hz   | Channel 4 (Range 00 to 99, null when not tracking) |
| Checksum     | *64 |         |                                                    |
| <CR> <LF>    |     |         | End of message termination                         |

Note1: Depending on the number of satellites tracked multiple messages of GSV data may be required.

Note2: GPS ID: 01~32, SBAS ID: 33~51, QZSS ID: 183~197, BeiDou ID: 141~172, GALILEO:301~330

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

Table 8.1-9 contains the values for the following example:

\$GNRMC,015924.000,A,2503.71417,N,12138.74623,E,0.1,0.0,230217,,D\*77

Table 8.1-9 RMC Data Format

| Name               | Example     | Units   | Description                                                                                        |
|--------------------|-------------|---------|----------------------------------------------------------------------------------------------------|
| Message ID         | \$GNRMC     |         | RMC protocol header                                                                                |
| UTC Time           | 015924.000  |         | hhmmss.sss                                                                                         |
| Status             | A           |         | A=data valid or V=data invalid                                                                     |
| Latitude           | 2503.71417  |         | ddmm.mmmmm                                                                                         |
| N/S Indicator      | N           |         | Latitude Direction: North or South                                                                 |
| Longitude          | 12138.74623 |         | dddmm.mmmmm                                                                                        |
| E/W Indicator      | E           |         | Longitude Direction: East or West                                                                  |
| Speed over ground  | 0.1         | knots   | Speed over ground in knots                                                                         |
| Course over ground | 0.0         | degrees |                                                                                                    |
| Date               | 230217      |         | ddmmyy                                                                                             |
| Magnetic variation |             | degrees |                                                                                                    |
| Variation sense    |             |         | Magnetic Variation Direction: East or West                                                         |
| Mode               | D           |         | A = Autonomous mode, D = Differential mode,<br>E = Estimated (Dead Reckoning) mode, N=Data invalid |
| Checksum           | *77         |         |                                                                                                    |
| <CR> <LF>          |             |         | End of message termination                                                                         |

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

Table 8.1-10 contains the values for the following example:

\$GNVTG,0.0,T,,M,0.1,N,0.1,K,D\*16

Table 8.1-10 VTG Data Format

| Name               | Example | Units   | Description                                                                       |
|--------------------|---------|---------|-----------------------------------------------------------------------------------|
| Message ID         | \$GNVTG |         | VTG protocol header                                                               |
| Course over ground | 0.0     | degrees | Reference to “true” earth poles                                                   |
| Reference          | T       |         | Indicates “terrestrial”                                                           |
| Course over ground |         | degrees | Reference to “magnetic” earth poles                                               |
| Reference          | M       |         | Indicates “Magnetic”                                                              |
| Speed over ground  | 0.1     | knots   | Speed over ground in knots                                                        |
| Units              | N       |         | Indicates “Knots”                                                                 |
| Speed over ground  | 0.1     | km/h    | Speed over ground in kilometers per hour                                          |
| Units              | K       |         | Indicates “Kilometers per hour”                                                   |
| Mode               | D       |         | A = Autonomous mode, D = Differential mode,<br>E = Estimated (Dead Reckoning)mode |
| Checksum           | *16     |         |                                                                                   |
| <CR> <LF>          |         |         | End of message termination                                                        |

- **ZDA---UTC, day, month and year.**

Table 8.1-11 contains the values for the following example:

\$GNZDA,020849.00,23,02,2017,00,00\*78

Table 8.1-11 ZDA Data Format

| Name               | Example   | Units  | Description                                 |
|--------------------|-----------|--------|---------------------------------------------|
| Message ID         | \$GNZDA   |        | ZDA protocol header                         |
| Timestamp          | 020849.00 |        | hhmmss.ss                                   |
| Day                | 23        |        | Decimal, 2 digits Day of month (01 to 31)   |
| Month              | 02        |        | Decimal, 2 digits Month (01 to 12)          |
| Year               | 2017      |        | Decimal, 4 digits Year (1994 - ...)         |
| Local zone hour    | 00        | hour   | Local time zone offset from UTC (set to 00) |
| Local zone minutes | 00        | minute | Local time zone offset from UTC (set to 00) |
| Checksum           | *78       |        |                                             |
| <CR> <LF>          |           |        | End of message termination                  |

## 8.2 Proprietary input/output message

Table 8.2-1 The table below summarizes the set of proprietary command sets for the ST-1612-DB

| Software command         | Command descriptions                         |
|--------------------------|----------------------------------------------|
| \$PSTMCOLD<CR><LF>       | Perform a Cold start                         |
| \$PSTMWARM<CR><LF>       | Perform a Warm start                         |
| \$PSTMHOT<CR><LF>        | Perform a Hot start                          |
| \$PSTMSRR<CR><LF>        | System Reset                                 |
| \$PSTMRESTOREPAR<CR><LF> | Restore System Parameters (Factory Settings) |

### ● \$PSTMCOLD

Perform a COLD start.

Synopsis:

\$PSTMCOLD<Mask><CR><LF>

| Parameter | Format  | Description                                                                                                                                             |
|-----------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mask      | Integer | Optional param to invalidate time, position, ephemeris and almanac:<br>0x1-clear almanac<br>0x2-clear ephemeris<br>0x4-clear position<br>0x8-clear time |

Note: If Mask parameter is not used, default is 0xE (clear ephemeris, time and position).

Example:

\$PSTMCOLD,6

### ● \$PSTMWARM

Perform a WARM start.

Synopsis:

\$PSTMWARM<CR><LF>

Example:

\$PSTMWARM

### ● \$PSTMHOT

Perform a HOT start.

Synopsis:

\$PSTMHOT<CR><LF>

Example:

\$PSTMHOT

### ● \$PSTMSRR

Executes a system reset. The GNSS firmware is rebooted.

Synopsis:

\$PSTMSRR<CR><LF>

Example:

\$PSTMSRR

## ● **\$PSTMRESTOREPAR**

Restore the factory setting parameters. The configuration data block stored in NVM, if present, will be invalidated.

Any changed parameter will be lost.

Synopsis:

\$PSTMRESTOREPAR<CR><LF>

Example:

\$PSTMRESTOREPAR

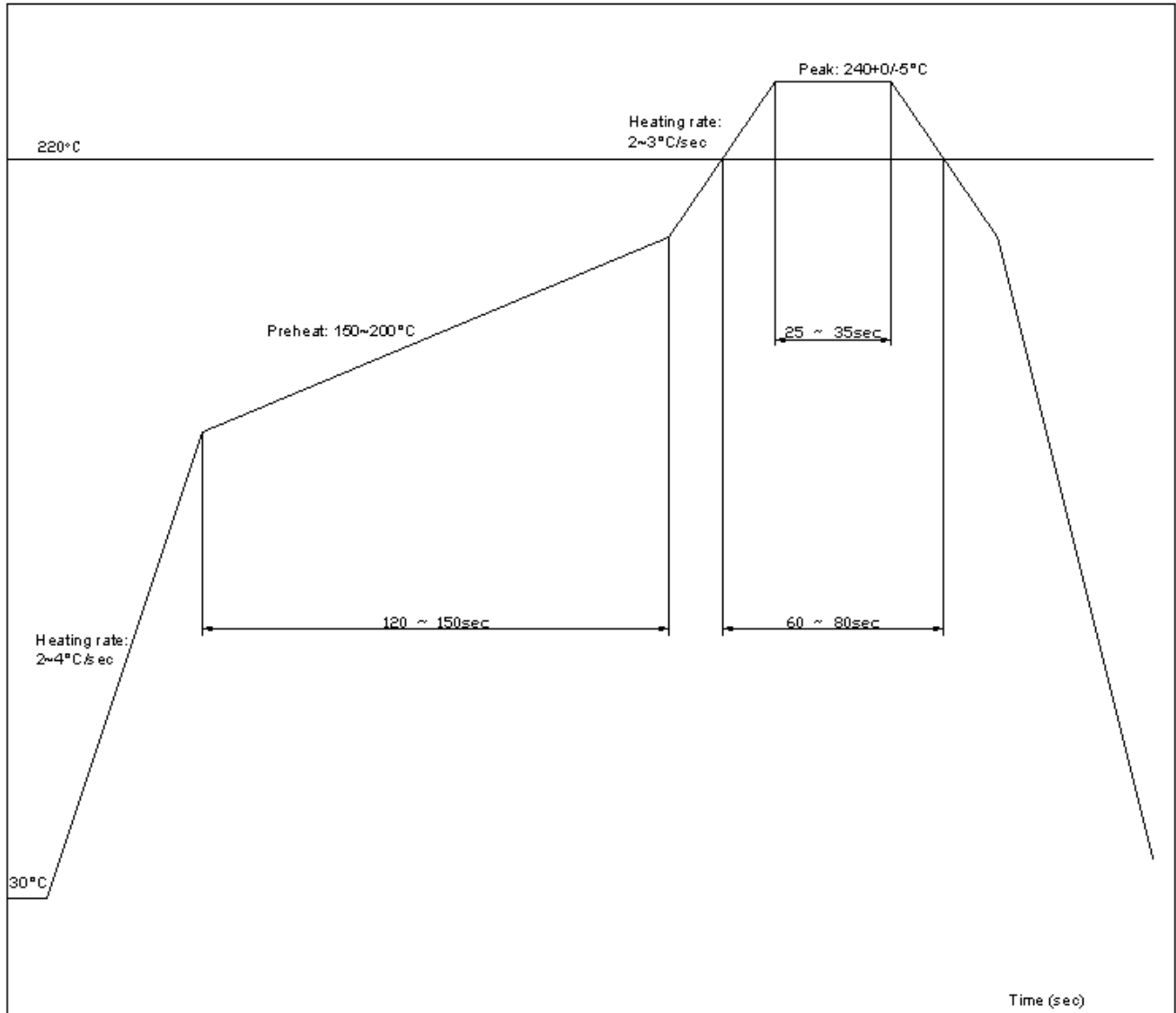
## 9 Ordering Information

| Model       | Interface                                  |
|-------------|--------------------------------------------|
| ST-1612-DBA | CAN Bus ( ISO 15765-4 ) 11bit , 250k Bit/s |
| ST-1612-DBB | CAN Bus ( ISO 15765-4 ) 11bit , 500k Bit/s |
| ST-1612-DBC | CAN Bus ( ISO 15765-4 ) 29bit , 250k Bit/s |
| ST-1612-DBD | CAN Bus ( ISO 15765-4 ) 29bit , 500k Bit/s |
| ST-1612-DBE | CAN Bus ( ISO 15765-4 ) 11bit , 125k Bit/s |
| ST-1612-DBO | Odometer signal input                      |
| ST-1612-DBU | Sensor data over UART input                |

## 10 Recommended soldering reflow profile

The module belongs to RoHS device. The maximum of reflow temperature, real on top of PCB, is not over 240 Celsius.

### Lead-free Processes

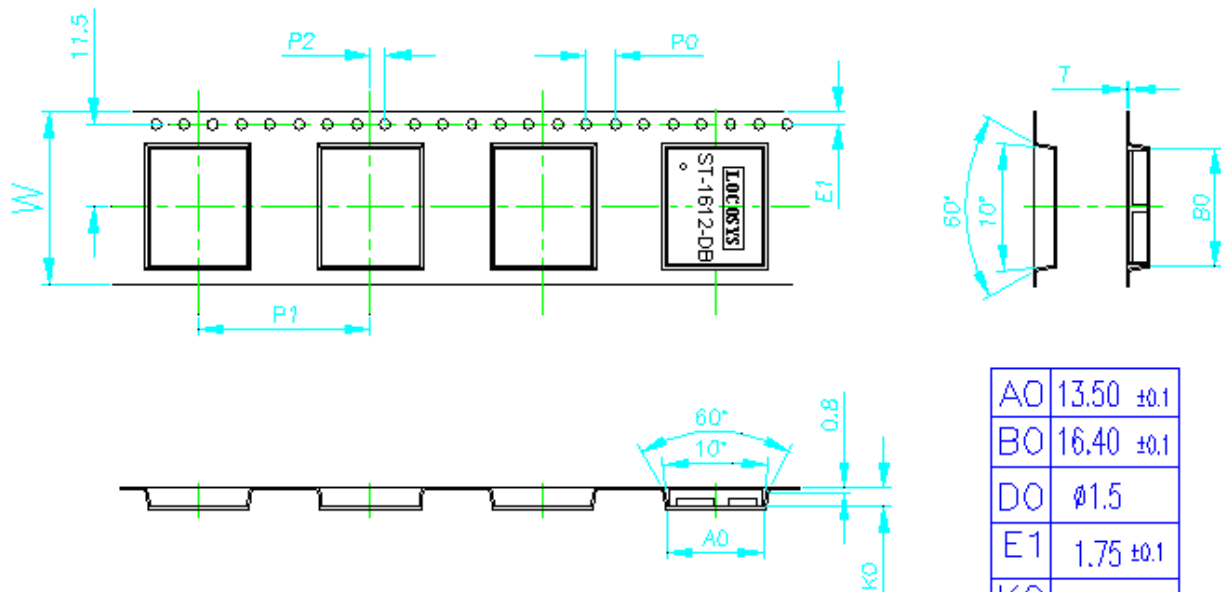


Lead -Free Solder Paste (Sn 96.5-Ag 3.0-Cu 0.5)

Cycle Interval: 300 sec

Note: The ST-1612-DB module should be soldered on the topside in the soldering process to prevent from falling down.

## 11 Reel Packing information



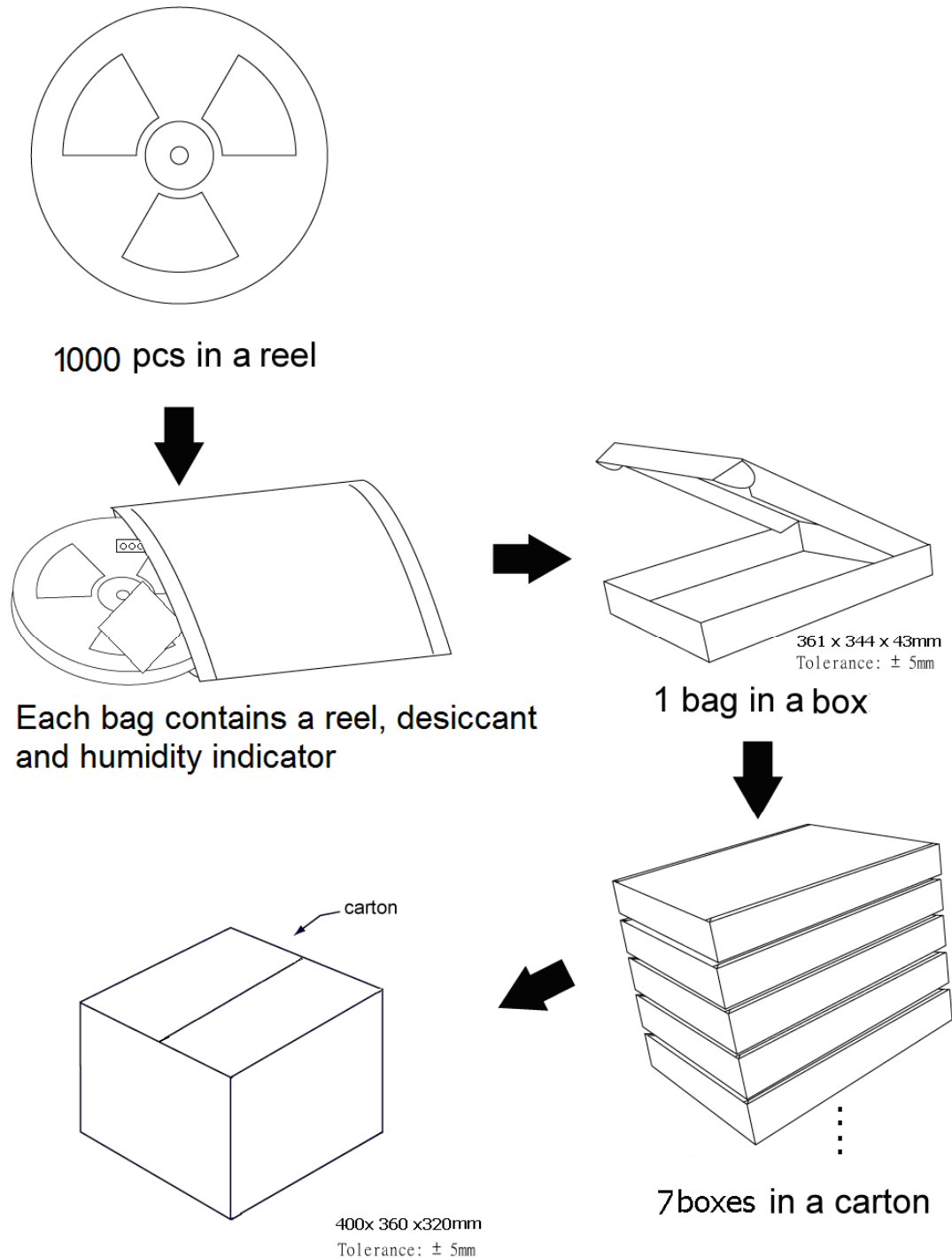
|    |            |
|----|------------|
| A0 | 13.50 ±0.1 |
| B0 | 16.40 ±0.1 |
| D0 | ∅1.5       |
| E1 | 1.75 ±0.1  |
| K0 | 2.70 ±0.1  |
| P0 | 4.0 ±0.1   |
| P1 | 24.00 ±0.1 |
| P2 | 2.0 ±0.10  |
| T  | 0.3 ±0.10  |
| W  | 24.0 ±0.30 |

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$
2. Camber not to exceed 1mm in 100mm
3. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
4. K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier .
5. pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
6. Component load per 13" reel: 1000 pcs
7. Packing length per 22" reel: 75 M

## 12 Packing and Handling

GNSS modules, like any other SMD devices, are sensitive to moisture, electrostatic discharge, and temperature. By following the description sketched in the document for LOCOSYS GNSS module storage and handling, it is possible to reduce the chances of them being damaged during production.

### 12.1 Packing



## 12.2 Moisture Sensitivity

The module belongs to moisture sensitive device (IPC/JEDEC J-STD-020C Level III). If it is not used by then, we strong recommended storing the GNSS modules in dry places such as dry cabinet. The approximate shelf life for LOCOSYS GNSS modules packages is 6 months from the bag seal date, when store in a non-condensing storage environment (<30°C/60% RH)

## 12.3 ESD Handling



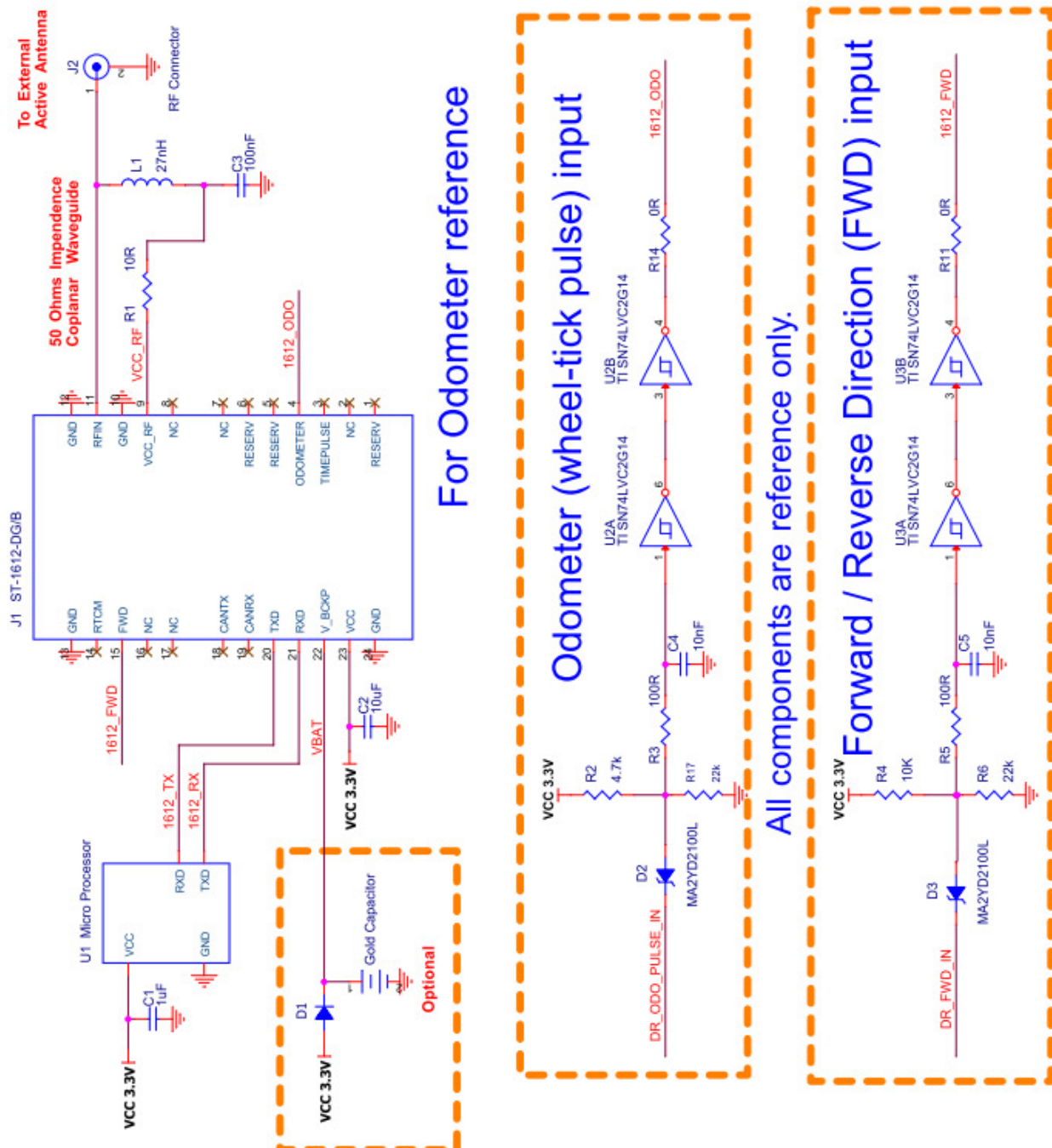
**Please carefully follow the following precautions to prevent severe damage to GNSS modules.**

LOCOSYS GNSS modules are sensitive to electrostatic discharges, and thus are Electrostatic Sensitive Devices (ESD). Careful handling of the GNSS modules and in particular RFIN pin must follow the standard ESD safety protections:

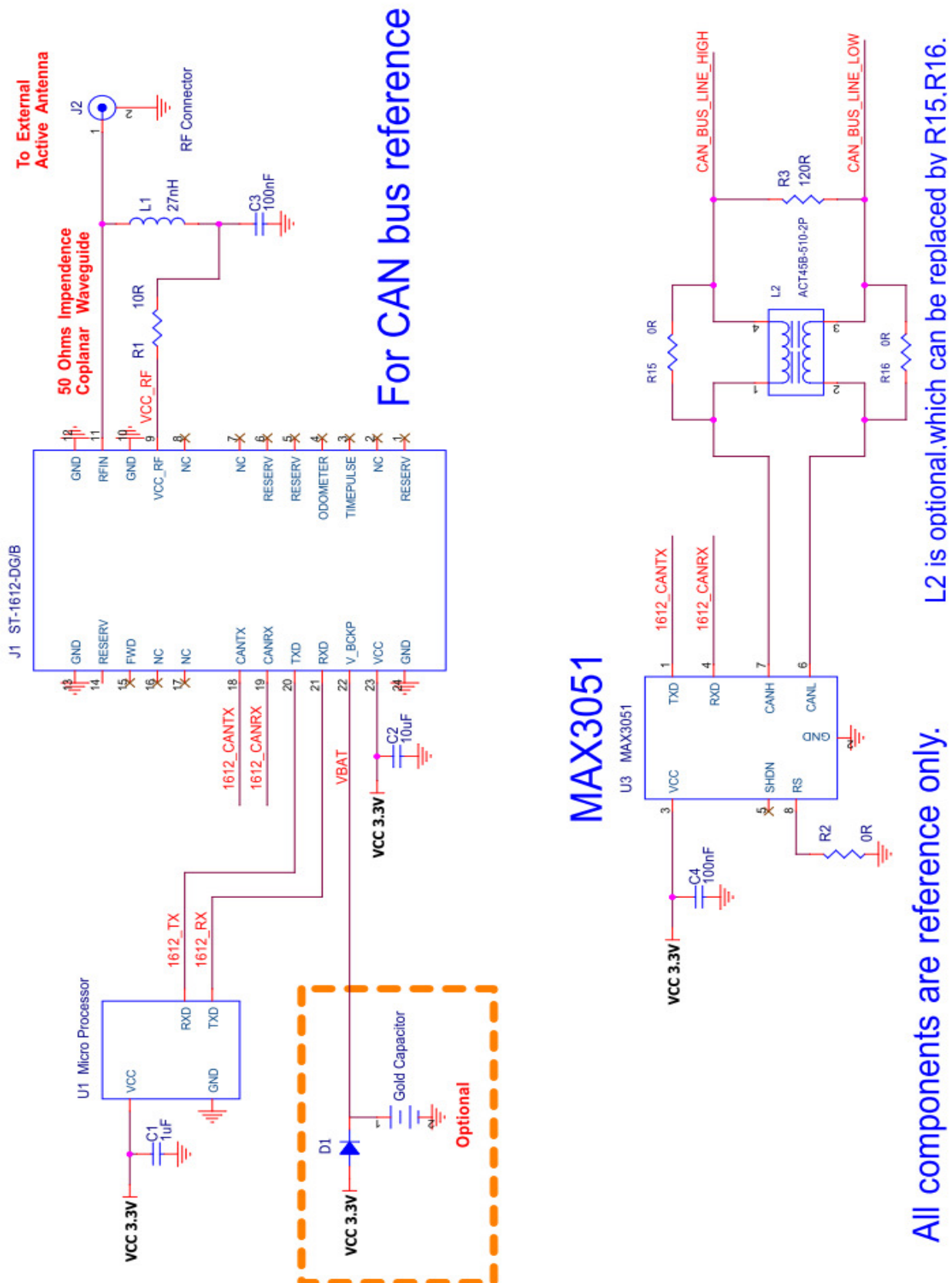
- Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
- Before working with RFIN pin, please make sure the GND is connected.
- When working with RFIN pin, do not contact any charges capacitors or materials that can easily develop or store charges such as patch antenna, coax cable, soldering iron.
- When soldering RFIN pin, please make sure to use an ESD safe soldering iron (tip).

## 13 Reference Circuit

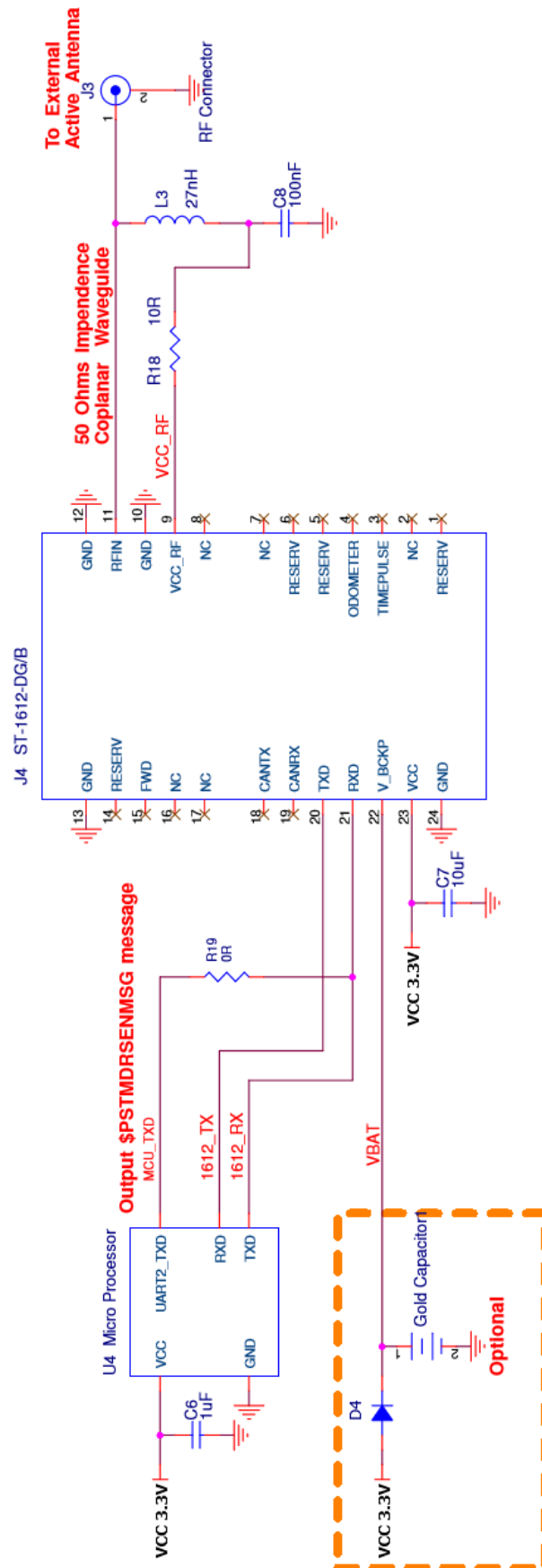
### 13.1 For Odometer (wheel-tick pulse) and Forward / Reverse Direction (FWD) input reference



## 13.2 For CAN Bus Reference



### 13.3 For UART input Reference



For UART reference

All components are reference only.

## Document change list

### Revision 1.0

- First release on Feb. 20, 2017.

### Revision 1.1 (April 10, 2017)

- Changed reference circuit in section 13.2 on page 21.

### Revision 1.2 (June 22, 2017)

- Added note 4 in section 5 on page 5.
- Added reference circuit in section 13.3 on page 22.

### Revision 1.3 (July 26, 2017)

- Added Hot Start time in section 4 on page 3.