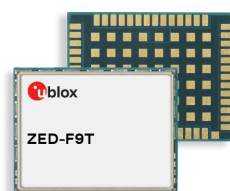


# ZED-F9T-10B

**High accuracy timing module**  
**Professional grade**

Data sheet



## **Abstract**

This data sheet describes the ZED-F9T timing module with multi-band GNSS receiver and nanosecond-level timing accuracy. ZED-F9T meets the most stringent 5G timing requirements, is ideal for global deployment due to GPS, BeiDou, Galileo, and GLONASS reception, and is unaffected by ionospheric errors. The module provides differential timing mode for highly accurate local timing and built-in security for highest robustness against malicious attacks.

# Document information

|                               |                             |             |
|-------------------------------|-----------------------------|-------------|
| <b>Title</b>                  | <b>ZED-F9T-10B</b>          |             |
| <b>Subtitle</b>               | High accuracy timing module |             |
| <b>Document type</b>          | Data sheet                  |             |
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| <b>Product status</b>                | <b>Corresponding content status</b> |  |
|--------------------------------------|-------------------------------------|--|
| <b>Functional Sample</b>             | Draft                               | For functional testing. Revised and supplementary data will be published later.        |
| <b>In development / prototype</b>    | Objective specification             | Target values. Revised and supplementary data will be published later.                 |
| <b>Engineering sample</b>            | Advance information                 | Data based on early testing. Revised and supplementary data will be published later.   |
| <b>Initial production</b>            | Early production information        | Data from product verification. Revised and supplementary data may be published later. |
| <b>Mass production / End of life</b> | Production information              | Document contains the final product specification.                                     |

This document applies to the following products:

| <b>Product name</b> | <b>Type number</b> | <b>FW version</b> | <b>IN/PCN reference</b> | <b>Product status</b> |
|---------------------|--------------------|-------------------|-------------------------|-----------------------|
| ZED-F9T             | ZED-F9T-10B-01     | TIM 2.20          | UBX-21050800            | Mass production       |

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# 1 Functional description

## 1.1 Overview

The ZED-F9T-10B is a multi-band GNSS module offering 5 ns (1-sigma) timing accuracy with unparalleled low power consumption.

The ZED-F9T-10B incorporates the u-blox F9 multi-band platform in a small surface-mount device with a form factor of 22 x 17 mm.

## 1.2 Performance

| Parameter                                  | Specification                                    |          |
|--|--|----------|
| Receiver type                              | Multi-band GNSS receiver for timing applications |          |
| Accuracy of time pulse signal <sup>1</sup> | Absolute timing mode                             | 5 ns     |
|  | Differential timing mode <sup>2</sup>            | 2.5 ns   |
| Frequency of time pulse signal             | 0.25 Hz to 25 MHz (configurable)                 |          |
| Time pulse jitter                          | ±4 ns  |          |
| Time-mark resolution                       | 8 ns   |          |
| Operational limits <sup>3</sup>            | Dynamics   | ≤ 4 g    |
|  | Altitude   | 80,000 m |
|  | Velocity   | 500 m/s  |
| Velocity accuracy <sup>4</sup>             | 0.05 m/s   |          |
| Dynamic heading accuracy <sup>4</sup>      | 0.3 deg  |          |

**Table 1: ZED-F9T-10B specifications**

| GNSS                                    |                          | GPS+GLO+GAL+BDS | GPS+BDS+GAL | GPS+GAL | GPS+GLO | GPS+BDS | GPS   |
|---|--------------------------|-----------------|-------------|---------|---------|---------|-------|
| Acquisition <sup>5</sup>                | Cold start               | 24 s            | 25 s        | 29 s    | 26 s    | 28 s    | 29 s  |
|   | Hot start                | 2 s             | 2 s         | 2 s     | 2 s     | 2 s     | 2 s   |
|   | Aided start <sup>6</sup> | 2 s             | 2 s         | 2 s     | 2 s     | 2 s     | 2 s   |
| Max navigation update rate <sup>7</sup> |                          | 8 Hz            | 10 Hz       | 15 Hz   | 15 Hz   | 12 Hz   | 20 Hz |

**Table 2: ZED-F9T-10B performance in different GNSS modes**

| GNSS                     |                         | GPS+GLO+GAL+BDS | GPS+BDS+GAL | GPS+GAL   | GPS+GLO   | GPS+BDS   | GPS       |
|--------------------------|-------------------------|-----------------|-------------|-----------|-----------|-----------|-----------|
| Horizontal pos. accuracy | Standalone <sup>8</sup> | 1.5 m CEP       | 1.5 m CEP   | 1.5 m CEP | 1.5 m CEP | 1.5 m CEP | 1.5 m CEP |

**Table 3: ZED-F9T-10B position accuracy in different GNSS modes**

<sup>1</sup> 1-sigma, fixed position mode, depends on temperature, atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry

<sup>2</sup> Demonstrated with 20 km baseline

<sup>3</sup> Assuming Airborne 4 g platform

<sup>4</sup> 50% at 30 m/s for dynamic operation

<sup>5</sup> Commanded starts. All satellites at -130 dBm. Measured at room temperature. Dual band operation

<sup>6</sup> Dependent on the speed and latency of the aiding data connection, commanded starts

<sup>7</sup> 95% In PVT navigation mode, assumes secondary navigation output disabled (default)

<sup>8</sup> Depends on atmospheric conditions, GNSS antenna, multipath conditions, satellite visibility, and geometry



In order to achieve the best absolute timing accuracy, measure the propagation delay of the entire signal path from the antenna to the receiver's time pulse output, and then compensate for this delay using the CFG-TP configuration items.

| GNSS                     | GPS+GLO+GAL+BDS   |          |
|--------------------------|-------------------|----------|
| Sensitivity <sup>9</sup> | Tracking and nav. | -167 dBm |
|                          | Reacquisition     | -160 dBm |
|                          | Cold start        | -148 dBm |
|                          | Hot start         | -157 dBm |

Table 4: ZED-F9T-10B sensitivity

## 1.3 Supported GNSS constellations

The ZED-F9T-10B GNSS module is a concurrent GNSS receiver that can receive and track multiple GNSS systems. Owing to the multi-band RF front-end architecture, all four major GNSS constellations (GPS, Galileo, GLONASS and BeiDou) plus NavIC, SBAS and QZSS satellites can be received concurrently. If low power consumption is a key factor, then the receiver can be configured for a subset of GNSS constellations.

The ZED-F9T-10B can receive the NavIC L5 satellite signals that share the same frequency with GPS L5 signals and can be configured to work on its own or in parallel with the other GNSS constellations.

The QZSS system shares the same frequency bands with GPS and can only be processed in conjunction with GPS.

To benefit from multi-band signal reception, dedicated hardware preparation must be made during the design-in phase. See the Integration manual [1] for u-blox design recommendations.

The ZED-F9T-10B supports the GNSS and their signals as shown in Table 5.

| GPS / QZSS           | GLONASS                                     | Galileo               | BeiDou                                   | NavIC                 |
|----------------------|---|-----------------------|--|-----------------------|
| L1C/A (1575.420 MHz) | L1OF (1602 MHz + k*562.5 kHz, k = -7,...,6) | E1-B/C (1575.420 MHz) | B1I (1561.098 MHz)<br>B1C (1575.420 MHz) | -                     |
| L5 (1176.450 MHz)    | -   | E5a (1176.450 MHz)    | B2a (1176.450 MHz)                       | SPS-L5 (1176.450 MHz) |

Table 5: Supported GNSS signals on ZED-F9T-10B


The ZED-F9T-10B can use the u-blox AssistNow™ Online service which provides GNSS assistance information.

## 1.4 Supported GNSS augmentation systems

### 1.4.1 Quasi-Zenith Satellite System (QZSS)

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that provides positioning services for the Pacific region covering Japan and Australia. The ZED-F9T-10B is able to receive and track QZSS L1 C/A and L5 signals concurrently with GPS signals, resulting in better availability especially under challenging signal conditions, e.g. in urban canyons.

<sup>9</sup> Demonstrated with a good external LNA. Measured at room temperature.

 QZSS can be enabled only if GPS operation is also configured.

### 1.4.2 Satellite-based augmentation system (SBAS)

The ZED-F9T-10B supports SBAS (including WAAS in the US, EGNOS in Europe, L1Sb(QZSS SBAS) in Japan and GAGAN in India) to deliver improved location accuracy within the regions covered. However, the additional inter-standard time calibration step used during SBAS reception results in degraded time accuracy overall.

 SBAS reception is disabled by default in ZED-F9T-10B.

### 1.4.3 Differential timing mode

To improve timing accuracy locally, the ZED-F9T-10B can be used in differential timing mode, in which correction data is sent to neighboring ZED-F9T-10B timing receivers via a communication network.

In differential timing mode the ZED-F9T-10B can operate either as a reference station generating the following RTCM 3.3 messages, or as a corrected station using the following RTCM 3.3 messages:

| Message type | Description  |
|--------------|--|
| RTCM 1005    | Stationary RTK reference station ARP                                       |
| RTCM 1077    | GPS MSM7   |
| RTCM 1087    | GLONASS MSM7   |
| RTCM 1097    | Galileo MSM7   |
| RTCM 1127    | BeiDou MSM7  |
| RTCM 1230    | GLONASS code-phase biases  |
| RTCM 4072.1  | Additional reference station information (u-blox proprietary RTCM Message) |


**Table 6: Supported RTCM 3.3 messages**

## 1.5 Broadcast navigation data and satellite signal measurements

The ZED-F9T-10B can output all the GNSS broadcast data upon reception from tracked satellites. This includes all the supported GNSS signals as well as the QZSS and SBAS augmentation services. The UBX-RXM-SFRBX message provides this information, see the Interface description [2] for the UBX-RXM-SFRBX message specification. The receiver can provide satellite signal information in a form compatible with the Radio Resource LCS Protocol (RRLP) [3].

### 1.5.1 Carrier-phase measurements

The ZED-F9T-10B modules provide raw carrier-phase data for all supported signals, along with pseudorange, Doppler and measurement quality information. The data contained in the UBX-RXM-RAWX message follows the conventions of a multi-GNSS RINEX 3 observation file. For the UBX-RXM-RAWX message specification, see Interface description [2].

 Raw measurement data are available once the receiver has established data bit synchronization and time-of-week.

## 1.6 Supported protocols

The ZED-F9T-10B supports the following protocols:

| Protocol | Type                                     |
|----------|--|
| UBX      | Input/output, binary, u-blox proprietary |

| Protocol                                     | Type                 |
|--|----------------------|
| NMEA 4.11 (default), 4.10, 4.0, 2.3, and 2.1 | Input/output, ASCII  |
| RTCM 3.3                                     | Input/output, binary |

**Table 7: Supported protocols**

For specification of the protocols, see the Interface description [\[2\]](#).

## 2 System description

### 2.1 Block diagram

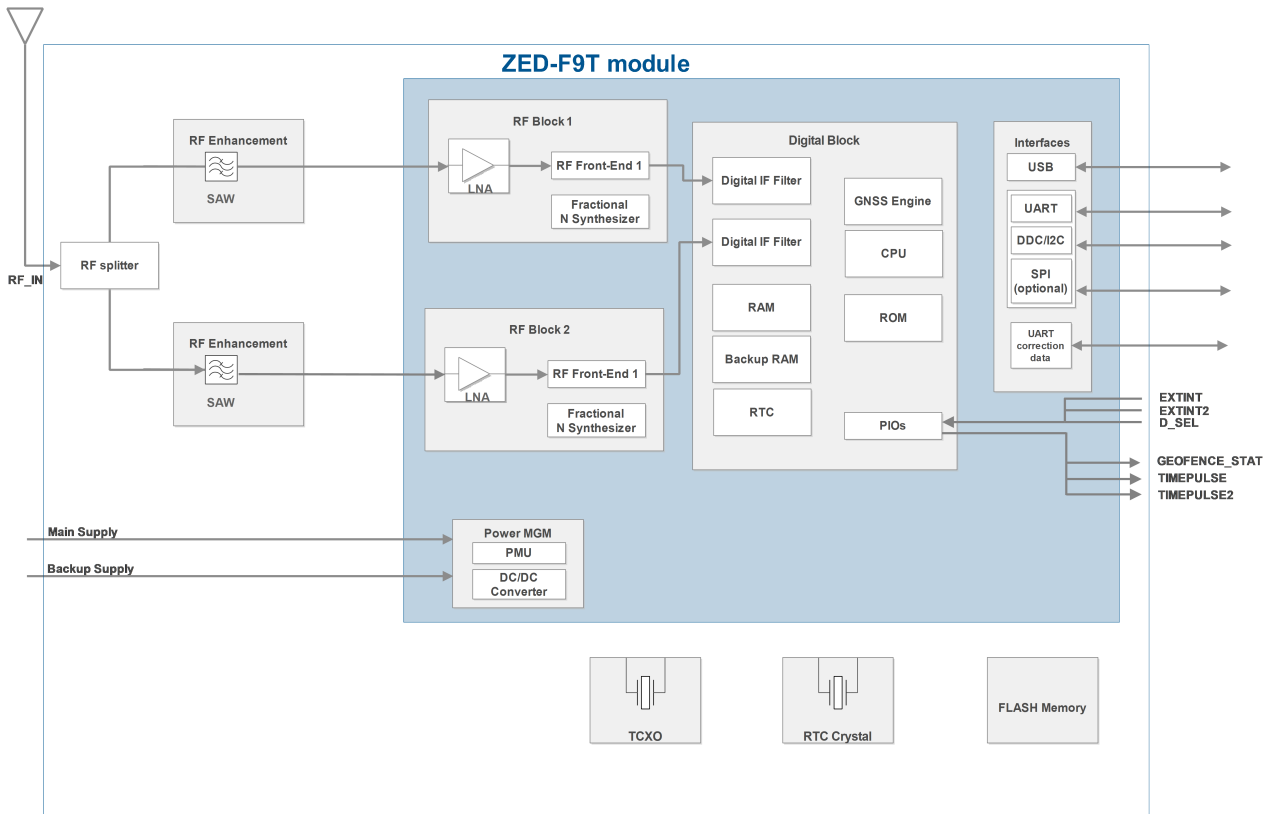


Figure 1: ZED-F9T-10B block diagram



An active antenna is mandatory with the ZED-F9T-10B. For more information, see the Integration manual [1].



## 3 Pin definition

### 3.1 Pin assignment

The pin assignment of the ZED-F9T-10B module is shown in [Figure 2](#). The defined configuration of the PIOs is listed in [Table 8](#).

For detailed information on pin functions and characteristics, see the Integration manual [1].



The ZED-F9T-10B is an LGA package with the I/O on the outside edge and central ground pads.

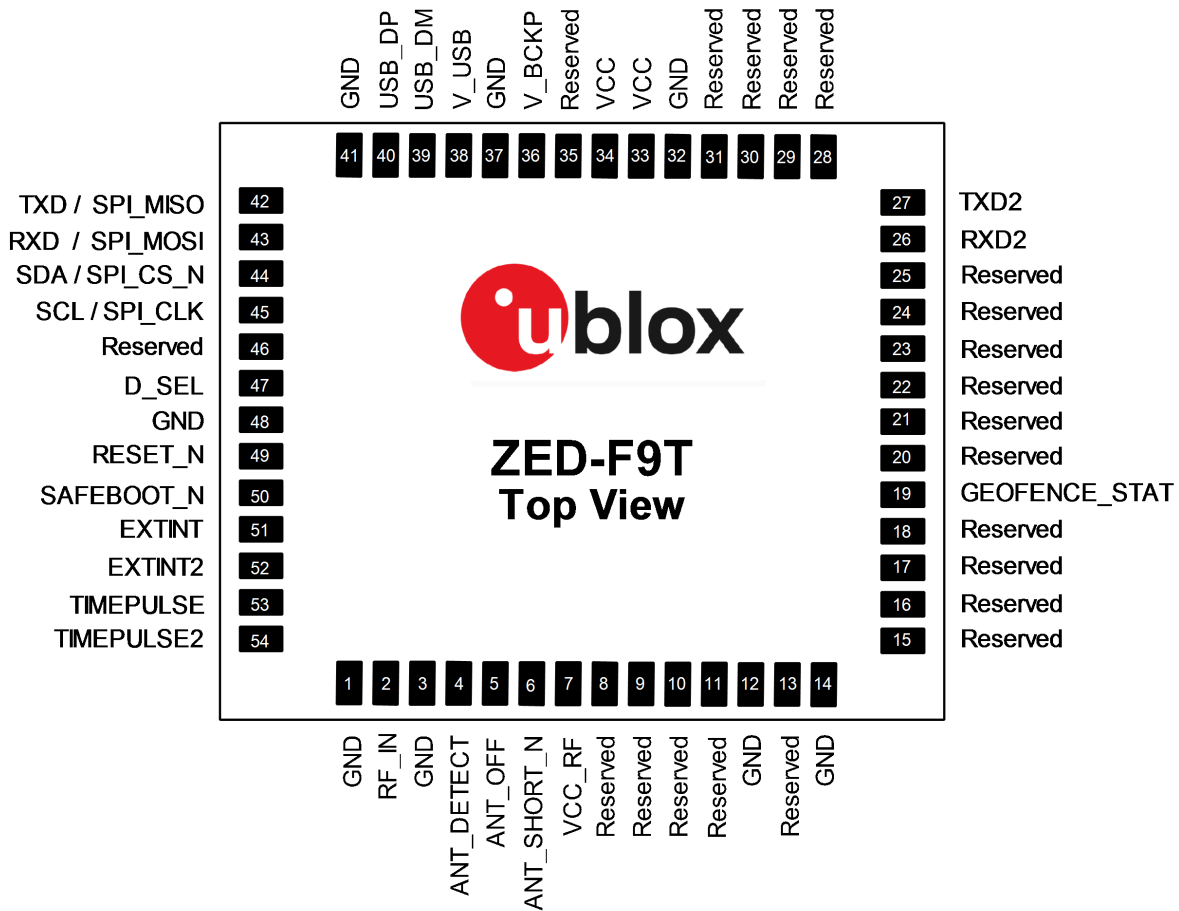


Figure 2: ZED-F9T-10B pin assignment

| Pin no. | Name        | I/O | Description                                      |
|---------|-------------|-----|--|
| 1       | GND         | -   | Ground   |
| 2       | RF_IN       | I   | RF input   |
| 3       | GND         | -   | Ground   |
| 4       | ANT_DETECT  | I   | Active antenna detect - default active high      |
| 5       | ANT_OFF     | O   | External LNA disable - default active high       |
| 6       | ANT_SHORT_N | I   | Active antenna short detect - default active low |
| 7       | VCC_RF      | O   | Voltage for external LNA                         |
| 8       | Reserved    | -   | Reserved   |

| Pin no. | Name           | I/O | Description  |
|---------|----------------|-----|--|
| 9       | Reserved       | -   | Reserved   |
| 10      | Reserved       | -   | Reserved   |
| 11      | Reserved       | -   | Reserved   |
| 12      | GND            | -   | Ground   |
| 13      | Reserved       | -   | Reserved   |
| 14      | GND            | -   | Ground   |
| 15      | Reserved       | -   | Reserved   |
| 16      | Reserved       | -   | Reserved   |
| 17      | Reserved       | -   | Reserved   |
| 18      | Reserved       | -   | Reserved   |
| 19      | GEOFENCE_STAT  | O   | Geofence status, user defined  |
| 20      | Reserved       | -   | Reserved   |
| 21      | Reserved       | -   | Reserved   |
| 22      | Reserved       | -   | Reserved   |
| 23      | Reserved       | -   | Reserved   |
| 24      | Reserved       | -   | Reserved   |
| 25      | Reserved       | -   | Reserved   |
| 26      | RXD2           | I   | Correction UART input  |
| 27      | TXD2           | O   | Correction UART output   |
| 28      | Reserved       | -   | Reserved   |
| 29      | Reserved       | -   | Reserved   |
| 30      | Reserved       | -   | Reserved   |
| 31      | Reserved       | -   | Reserved   |
| 32      | GND            | -   | Ground   |
| 33      | VCC            | I   | Voltage supply   |
| 34      | VCC            | I   | Voltage supply   |
| 35      | Reserved       | -   | Reserved   |
| 36      | V_BCKP         | I   | Backup supply voltage  |
| 37      | GND            | -   | Ground   |
| 38      | V_USB          | I   | USB supply   |
| 39      | USB_DM         | I/O | USB data   |
| 40      | USB_DP         | I/O | USB data   |
| 41      | GND            | -   | Ground   |
| 42      | TXD / SPI_MISO | O   | Host UART output if D_SEL = 1 (or open). SPI_MISO if D_SEL = 0           |
| 43      | RXD / SPI_MOSI | I   | Host UART input if D_SEL = 1 (or open). SPI_MOSI if D_SEL = 0            |
| 44      | SDA / SPI_CS_N | I/O | I2C Data if D_SEL = 1 (or open). SPI Chip Select if D_SEL = 0            |
| 45      | SCL / SPI_CLK  | I/O | I2C Clock if D_SEL = 1 (or open). SPI Clock if D_SEL = 0                 |
| 46      | Reserved       | -   | Reserved   |
| 47      | D_SEL          | I   | Interface select for pins 42-45  |
| 48      | GND            | -   | Ground   |
| 49      | RESET_N        | I   | RESET_N  |
| 50      | SAFEBOOT_N     | I   | SAFEBOOT_N (for future service, updates and reconfiguration, leave OPEN) |
| 51      | EXTINT         | I   | External interrupt pin   |
| 52      | EXTINT2        | I   | External interrupt pin 2   |

| Pin no. | Name       | I/O | Description  |
|---------|------------|-----|--------------|
| 53      | TIMEPULSE  | O   | Time pulse   |
| 54      | TIMEPULSE2 | O   | Time pulse 2 |

**Table 8: ZED-F9T-10B pin assignment**

## 4 Electrical specification

**CAUTION** Operating the device above one or more of the limiting values may cause permanent damage to the device. The values provided in this chapter are stress ratings. Extended exposure to the values outside the limits may effect the device reliability.

Where application information is given, it is advisory only and does not form part of the specification.

### 4.1 Absolute maximum ratings

| Parameter                            | Symbol            | Condition                                   | Min  | Max           | Units |
|--------------------------------------|-------------------|---|------|---------------|-------|
| Power supply voltage                 | VCC               |   | -0.5 | 3.6           | V     |
| Voltage ramp on VCC <sup>10</sup>    |                   |   | 20   | 8000          | µs/V  |
| Backup battery voltage               | V_BCKP            |   | -0.5 | 3.6           | V     |
| Voltage ramp on V_BCKP <sup>10</sup> |                   |   | 20   |               | µs/V  |
| Input pin voltage                    | V <sub>in</sub>   | VCC ≤ 3.1 V                                 | -0.5 | VCC + 0.5     | V     |
|                                      |                   | VCC > 3.1 V                                 | -0.5 | 3.6           | V     |
| VCC_RF output current                | ICC_RF            |   |      | 300           | mA    |
| Supply voltage USB                   | V_USB             |   | -0.5 | 3.6           | V     |
| USB signals                          | USB_DM,<br>USB_DP |   | -0.5 | V_USB + 0.5 V |       |
| Input power at RF_IN                 | Pr <sub>fin</sub> | source impedance =<br>50 Ω, continuous wave |      | 10            | dBm   |
| Storage temperature                  | T <sub>stg</sub>  |   | -40  | +85           | °C    |

**Table 9: Absolute maximum ratings**

**CAUTION** Risk of equipment damage. This product is not protected against overvoltage or reversed voltages. Use appropriate protection diodes to avoid voltage spikes exceeding the specified boundaries damaging the equipment.

### 4.2 Operating conditions

The values for the following operating conditions have been specified at 25°C ambient temperature. Extreme operating temperatures can significantly impact the specified values. If an application operates near the min or max temperature limits, ensure the specified values are not exceeded.

| Parameter                               | Symbol          | Min       | Typical | Max | Units | Condition                  |
|---|-----------------|-----------|---------|-----|-------|----------------------------|
| Power supply voltage                    | VCC             | 2.7       | 3.0     | 3.6 | V     |                            |
| Backup battery voltage                  | V_BCKP          | 1.65      |         | 3.6 | V     |                            |
| Backup battery current <sup>11</sup>    | I_BCKP          |           | 45      |     | µA    | V_BCKP = 3 V,<br>VCC = 0 V |
| SW backup current                       | I_SWBCKP        |           | 1.4     |     | mA    |                            |
| Input pin voltage range                 | V <sub>in</sub> | 0         |         | VCC | V     |                            |
| Digital IO pin low level input voltage  | V <sub>il</sub> |           |         | 0.4 | V     |                            |
| Digital IO pin high level input voltage | V <sub>ih</sub> | 0.8 * VCC |         |     | V     |                            |

<sup>10</sup> Exceeding the ramp speed may permanently damage the device

<sup>11</sup> To measure the I\_BCKP the receiver should first be switched on, i.e. VCC and V\_BCKP is available. Then set VCC to 0 V while the V\_BCKP remains available. Afterward measure the current consumption at the V\_BCKP.

| Parameter   | Symbol            | Min       | Typical   | Max | Units | Condition  |
|---|-------------------|-----------|-----------|-----|-------|--|
| Digital IO pin low level output voltage<br>TIMEPULSE        | V <sub>ol</sub>   |           |           | 0.4 | V     | I <sub>ol</sub> = 2 mA<br>I <sub>ol</sub> = 4 mA |
| Digital IO pin high level output voltage<br>TIMEPULSE       | V <sub>oh</sub>   | VCC - 0.4 |           |     | V     | I <sub>oh</sub> = 2 mA<br>I <sub>oh</sub> = 4 mA |
| DC current through any digital I/O pin<br>(except supplies) | I <sub>pin</sub>  |           |           | 5   | mA    |  |
| VCC_RF voltage  | VCC_RF            |           | VCC - 0.1 |     | V     |  |
| VCC_RF output current                                       | ICC_RF            |           |           | 50  | mA    |  |
| Receiver chain noise figure <sup>12</sup>                   | NF <sub>tot</sub> |           | 9.5       |     | dB    |  |
| External gain (at RF_IN)                                    | Ext_gain          | 17        |           | 50  | dB    |  |
| Operating temperature                                       | Topr              | -40       | +25       | +85 | °C    |  |

**Table 10: Operating conditions**

Operation beyond the specified operating conditions can affect the device reliability.

### 4.3 Indicative power requirements

**Table 11** provides examples of typical current requirements when using a cold start command. The given values are total system supply current for a possible application including RF and baseband sections.

The actual power requirements vary depending on the FW version used, external circuitry, number of satellites tracked, signal strength, type and time of start, duration, and conditions of test.

| Symbol                         | Parameter    | Conditions  | GPS+GLO<br>+GAL+BDS | GPS | Unit |
|--------------------------------|--------------|-------------|---------------------|-----|------|
| I <sub>PEAK</sub>              | Peak current | Acquisition | 130                 | 120 | mA   |
| I <sub>VCC</sub> <sup>13</sup> | VCC current  | Acquisition | 90                  | 75  | mA   |
| I <sub>VCC</sub> <sup>13</sup> | VCC current  | Tracking    | 85                  | 68  | mA   |

**Table 11: Currents to calculate the indicative power requirements**

All values in **Table 11** are measured at 25 °C ambient temperature.

<sup>12</sup> Only valid for GPS

<sup>13</sup> Simulated GNSS signal

## 5 Communications interfaces

The ZED-F9T-10B has several communications interfaces, including UART, SPI, I2C and USB.

All the inputs have internal pull-up resistors in normal operation and can be left open if not used. All the PIOs are supplied by VCC, therefore all the voltage levels of the PIO pins are related to VCC supply voltage.

### 5.1 UART

The UART interfaces support configurable baud rates. See the Integration manual [1].

Hardware flow control is not supported.

The UART1 is enabled if D\_SEL pin of the module is left open or "high".

| Symbol        | Parameter              | Min   | Max    | Unit  |
|---------------|------------------------|-------|--------|-------|
| $R_U$         | Baud rate              | 9600  | 921600 | bit/s |
| $\Delta_{Tx}$ | Tx baud rate accuracy  | -1%   | +1%    | -     |
| $\Delta_{Rx}$ | Rx baud rate tolerance | -2.5% | +2.5%  | -     |

Table 12: ZED-F9T-10B UART specifications

### 5.2 SPI

The SPI interface is disabled by default. The SPI interface shares pins with UART and I2C and can be selected by setting D\_SEL = 0. The SPI interface can be operated in slave mode only. The maximum transfer rate using SPI is 125 kB/s and the maximum SPI clock frequency is 5.5 MHz.

The SPI timing parameters for slave operation are defined in Figure 3. Default SPI configuration is CPOL = 0 and CPHA = 0.

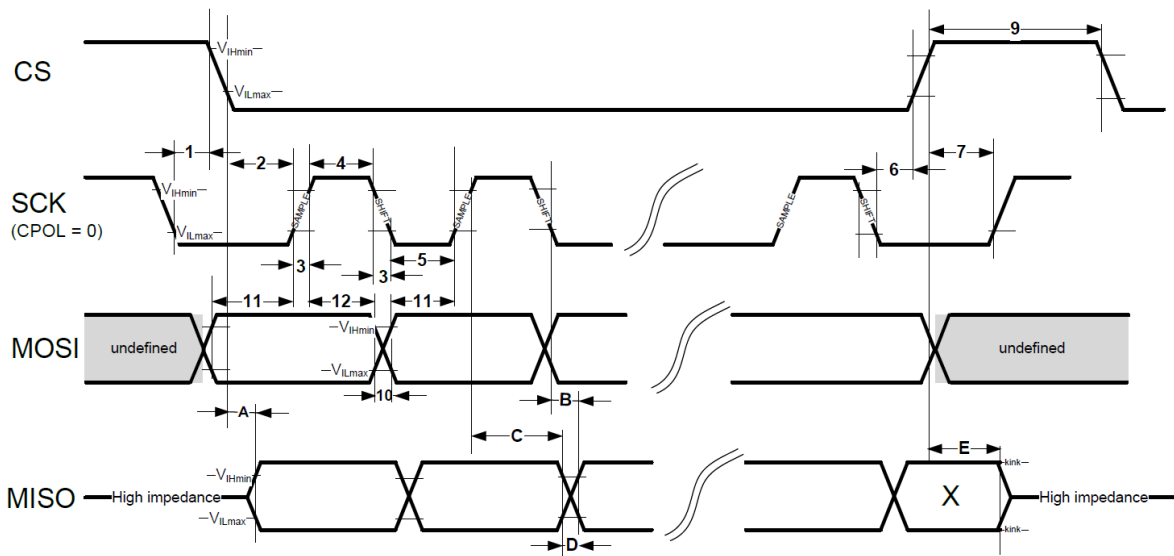


Figure 3: ZED-F9T-10B SPI specification mode 1: CPHA=0 SCK = 5.33 MHz

| Symbol | Parameter                     | Min | Max | Unit |
|--------|-------------------------------|-----|-----|------|
| 1      | CS deassertion hold time      | 23  | -   | ns   |
| 2      | Slave select time (CS to SCK) | 20  | -   | ns   |

| Symbol | Parameter                               | Min | Max | Unit |
|--------|---|-----|-----|------|
| 3      | SCK rise/fall time                      | -   | 7   | ns   |
| 4      | SCK high time                           | 24  | -   | ns   |
| 5      | SCK low time                            | 24  | -   | ns   |
| 6      | Slave deselect time (SCK falling to CS) | 30  | -   | ns   |
| 7      | Slave deselect time (CS to SCK)         | 30  | -   | ns   |
| 9      | CS high time                            | 32  | -   | ns   |
| 10     | MOSI transition time                    | -   | 7   | ns   |
| 11     | MOSI setup time                         | 16  | -   | ns   |
| 12     | MOSI hold time                          | 24  | -   | ns   |

**Table 13: SPI slave input timing parameters 1 - 12**

| Symbol | Parameter                                    | Min | Max | Unit |
|--------|--|-----|-----|------|
| A      | MISO data valid time (CS)                    | 12  | 40  | ns   |
| B      | MISO data valid time (SCK), weak driver mode | 15  | 40  | ns   |
| C      | MISO data hold time                          | 100 | 140 | ns   |
| D      | MISO rise/fall time, weak driver mode        | 0   | 5   | ns   |
| E      | MISO data disable lag time                   | 15  | 35  | ns   |

**Table 14: SPI slave timing parameters A - E, 2 pF load capacitance**

| Symbol | Parameter                                    | Min | Max | Unit |
|--------|--|-----|-----|------|
| A      | MISO data valid time (CS)                    | 16  | 55  | ns   |
| B      | MISO data valid time (SCK), weak driver mode | 20  | 55  | ns   |
| C      | MISO data hold time                          | 100 | 150 | ns   |
| D      | MISO rise/fall time, weak driver mode        | 3   | 20  | ns   |
| E      | MISO data disable lag time                   | 15  | 35  | ns   |

**Table 15: SPI slave timing parameters A - E, 20 pF load capacitance**

| Symbol | Parameter                                    | Min | Max | Unit |
|--------|--|-----|-----|------|
| A      | MISO data valid time (CS)                    | 26  | 85  | ns   |
| B      | MISO data valid time (SCK), weak driver mode | 30  | 85  | ns   |
| C      | MISO data hold time                          | 110 | 160 | ns   |
| D      | MISO rise/fall time, weak driver mode        | 13  | 45  | ns   |
| E      | MISO data disable lag time                   | 15  | 35  | ns   |

**Table 16: SPI slave timing parameters A - E, 60 pF load capacitance**

## 5.3 I2C

An I2C interface is available for communication with an external host CPU in I2C Fast-mode. Backwards compatibility with Standard-mode I2C bus operation is not supported. The interface can be operated only in slave mode with a maximum bit rate of 400 kbit/s. The interface can make use of clock stretching by holding the SCL line LOW to pause a transaction. In this case, the bit transfer rate is reduced. The maximum clock stretching time is 20 ms.

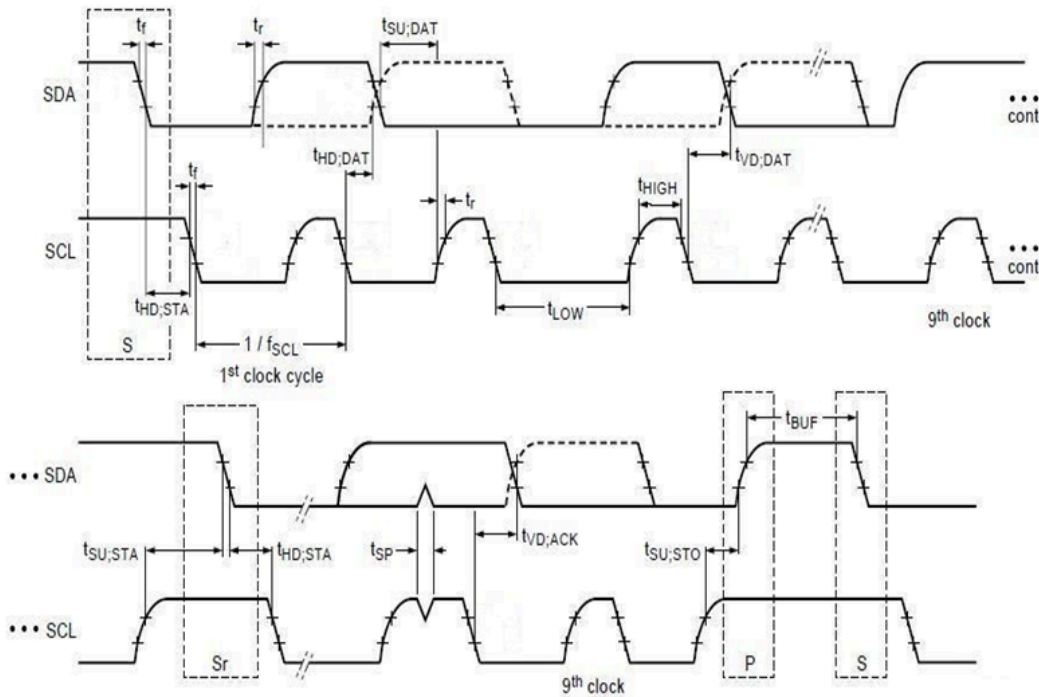


Figure 4: ZED-F9T-10B I2C slave specification

| Symbol       | Parameter  | I2C Fast-mode     |                     | Unit    |
|--------------|--|-------------------|---------------------|---------|
|              |  | Min               | Max                 |         |
| $f_{SCL}$    | SCL clock frequency                              | 0                 | 400                 | kHz     |
| $t_{HD,STA}$ | Hold time (repeated) START condition             | 0.6               | -                   | $\mu s$ |
| $t_{LOW}$    | Low period of the SCL clock                      | 1.3               | -                   | $\mu s$ |
| $t_{HIGH}$   | High period of the SCL clock                     | 0.6               | -                   | $\mu s$ |
| $t_{SU,STA}$ | Setup time for a repeated START condition        | 0.6               | -                   | $\mu s$ |
| $t_{HD,DAT}$ | Data hold time                                   | 0 <sup>14</sup>   | - <sup>15</sup>     | $\mu s$ |
| $t_{SU,DAT}$ | Data setup time                                  | 100 <sup>16</sup> | -                   | ns      |
| $t_r$        | Rise time of both SDA and SCL signals            | -                 | 300 (for C = 400pF) | ns      |
| $t_f$        | Fall time of both SDA and SCL signals            | -                 | 300 (for C = 400pF) | ns      |
| $t_{SU,STO}$ | Setup time for STOP condition                    | 0.6               | -                   | $\mu s$ |
| $t_{BUF}$    | Bus-free time between a STOP and START condition | 1.3               | -                   | $\mu s$ |
| $t_{VD,DAT}$ | Data valid time                                  | -                 | 0.9 <sup>15</sup>   | $\mu s$ |
| $t_{VD,ACK}$ | Data valid acknowledge time                      | -                 | 0.9 <sup>15</sup>   | $\mu s$ |
| $V_{nL}$     | Noise margin at the low level                    | 0.1 VCC           | -                   | V       |
| $V_{nH}$     | Noise margin at the high level                   | 0.2 VCC           | -                   | V       |


Table 17: ZED-F9T-10B I2C slave timings and specifications

<sup>14</sup> External device must provide a hold time of at least one transition time (max 300 ns) for the SDA signal (with respect to the min  $V_{ih}$  of the SCL signal) to bridge the undefined region of the falling edge of SCL.

<sup>15</sup> The maximum  $t_{HD,DAT}$  must be less than the maximum  $t_{VD,DAT}$  or  $t_{VD,ACK}$  with a maximum of 0.9  $\mu s$  by a transition time. This maximum must only be met if the device does not stretch the LOW period ( $t_{LOW}$ ) of the SCL signal. If the clock stretches the SCL, the data must be valid by the set-up time before it releases the clock.

<sup>16</sup> When the I2C slave is stretching the clock, the  $t_{SU,DAT}$  of the first bit of the next byte is 62.5 ns.



 The I2C interface is only available with the UART default mode. If the SPI interface is selected by using D\_SEL = 0, the I2C interface is not available.

## 5.4 USB


The USB 2.0 FS (full speed, 12 Mbit/s) interface can be used for host communication. Due to the hardware implementation, it may not be possible to certify the USB interface. The V\_USB pin supplies the USB interface.

## 5.5 Default interface settings

| Interface    | Settings   |
|--------------|--|
| UART1 output | 38400 baud, 8 bits, no parity bit, 1 stop bit.<br>NMEA protocol with <b>GGA, GLL, GSA, GSV, RMC, VTG, TXT, ZDA</b> messages are output by default. UBX and RTCM 3.3 protocols are enabled by default but no output messages are enabled by default.                |
| UART1 input  | 38400 baud, 8 bits, no parity bit, 1 stop bit.<br>UBX, NMEA and RTCM 3.3 input protocols are enabled by default.   |
| UART2 output | 38400 baud, 8 bits, no parity bit, 1 stop bit.<br>UBX protocol cannot be enabled.<br>RTCM 3.3 protocol is enabled by default but no output messages are enabled by default.<br>NMEA protocol is disabled by default.   |
| UART2 input  | 38400 baud, 8 bits, no parity bit, 1 stop bit.<br>UBX protocol cannot be enabled and will not receive UBX input messages.<br>RTCM 3.3 protocol is enabled by default.<br>NMEA protocol is disabled by default.   |
| USB          | Default messages activated as in UART1. Input/output protocols available as in UART1.  |
| I2C          | Available for communication in the Fast-mode with an external host CPU in slave mode only. Default messages activated as in UART1. Input/output protocols available as in UART1. Maximum bit rate 400 kb/s.  |
| SPI          | Allow communication to a host CPU, operated in slave mode only. Default messages activated as in UART1. Input/output protocols available as in UART1. SPI is not available unless D_SEL pin is set to low (see section D_SEL interface in Integration manual [1]). |

**Table 18: Default interface settings**

 Refer to the applicable Interface description [2] for information about further settings.

 By default, the ZED-F9T-10B outputs NMEA messages that include satellite data for all GNSS bands being received. This results in a high NMEA output load for each navigation period. Make sure the UART baud rate used is sufficient for the selected navigation rate and the number of GNSS signals being received.

## 6 Mechanical specification

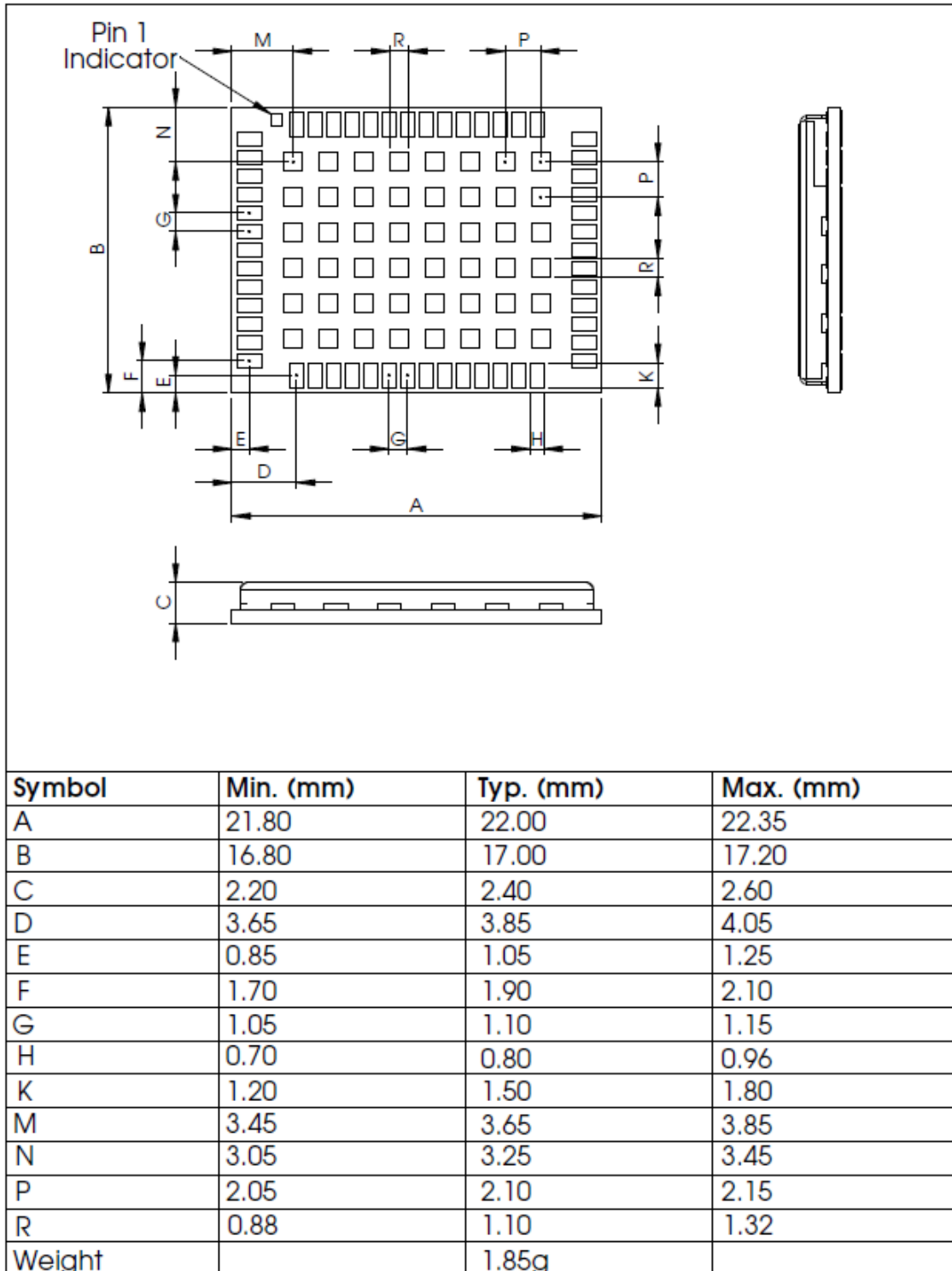


Figure 5: ZED-F9T-10B mechanical drawing

## 7 Reliability tests and approvals

ZED-F9T-10B modules are based on AEC-Q100 qualified GNSS chips.

Tests for product family qualifications comply with ISO 16750 "Road vehicles – environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

### 7.1 Approvals

ZED-F9T-10B complies with the essential requirements and other relevant provisions of the Radio Equipment Directive (RED) 2014/53/EU.

ZED-F9T-10B complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

The Declaration of Conformity (DoC) is available on the [u-blox website](#).

## 8 Labeling and ordering information

This section provides information about product labeling and ordering. For information about moisture sensitivity level (MSL), product handling and soldering see the Integration manual [1].

### 8.1 Product labeling

The labeling of the ZED-F9T-10B modules provides product information and revision information. For more information contact u-blox sales.

### 8.2 Explanation of product codes

Three product code formats are used in the ZED-F9T-10B labels. The **Product name** used in documentation such as this data sheet identifies all u-blox products, independent of packaging and quality grade. The **Ordering code** includes options and quality, while the **Type number** includes the hardware and firmware versions.

Table 19 below details these three formats.

| Format        | Structure      | Product code   |
|---------------|----------------|----------------|
| Product name  | PPP-TGV        | ZED-F9T        |
| Ordering code | PPP-TGV-NNQ    | ZED-F9T-10B    |
| Type number   | PPP-TGV-NNQ-XX | ZED-F9T-10B-01 |

**Table 19: Product code formats**

The parts of the product code are explained in Table 20.

| Code | Meaning                | Example  |
|------|------------------------|--|
| PPP  | Product family         | ZED  |
| TG   | Platform               | F9 = u-blox F9   |
| V    | Variant                | T = Timing   |
| NNQ  | Option / Quality grade | NN: Option [00...99]<br>Q: Grade, A = Automotive, B = Professional |
| XX   | Product detail         | Describes hardware and firmware versions                           |

**Table 20: Part identification code**

### 8.3 Ordering codes

| Ordering code | Product        | Remark |
|---------------|----------------|--------|
| ZED-F9T-10B   | u-blox ZED-F9T |        |

**Table 21: Product ordering codes**



Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website at: <https://www.u-blox.com/en/product-resources>.

## Related documents

- [1] ZED-F9T Integration manual, [UBX-21040375](#)
- [2] TIM 2.20 Interface description [UBX-21048598](#)
- [3] Radio Resource LCS Protocol (RRLP), (3GPP TS 44.031 version 11.0.0 Release 11)



For regular updates to u-blox documentation and to receive product change notifications please register on our homepage <https://www.u-blox.com>.

## Revision history

| Revision | Date        | Name      | Status / comments  |
|----------|-------------|-----------|--|
| R01      | 08-Aug-2020 | byou/dama | Objective specification  |
| R02      | 15-Dec-2020 | byou      | Objective specification<br>Minor text/typo fixes, Alt. limit change to 80km, QZSS sec. updated,USB certification info. added. NMEA ZDA mess. added to default list,AU office No. update.   |
| R03      | 16-Apr-2021 | byou      | Advance Information<br>FW ver. TIM2.11   |
| R04      | 15-Jun-2021 | rzuo      | Advance Information<br>FW ver. TIM2.13   |
| R05      | 28-Jun-2021 | byou      | Early production information   |
| R06      | 07-Jan-2022 | byou      | Early production information<br>FW version TIM2.20; section 1.2: navigation rates updated; section 1.3: NavIC L5 signal enabled; section 4.1: Abs. max. ratings updated; Related docs updated.   |
| R07      | 18-Apr-2023 | vema      | Updated I2C and SPI timing specifications in section Communications interfaces<br>Updated VCC_RF output current in table Absolute maximum ratings<br>Updated backup current in table Operating conditions<br>Added timepulse details in table Operating conditions |
| R08      | 01-Jun-2023 | vema      | Updated product status to mass production.   |

## Contact

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