RCB-F9T

u-blox RCB-F9T timing board

Data sheet

Abstract
This data sheet describes the RCB-F9T timing board, which provides an industry standard connector access to the ZED-F9T timing module and includes an SMB antenna connector and 8-pin connector for easy connectivity.

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This document applies to the following products:

Product name	Type number	Firmware version	PCN reference
RCB-F9T	RCB-F9T-1-01	TIM 2.20	

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1 Functional description

1.1 Overview

The RCB-F9T timing board enables multi-band GNSS timing in a compact form factor using the ZED-F9T, the u-blox F9 high accuracy timing module. The ZED-F9T module provides nanosecond-level timing accuracy in both standalone and differential timing modes.

In addition to the ZED-F9T module, the RCB-F9T timing board contains an SMB antenna connector and 5 V power supply circuitry for an external active multi-band GNSS antenna. The 8-pin, 2.0 mm pitch pin-header provides powering of the board, UART communications, and two independently configurable time pulse signals.

1.2 Performance

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

GNSS		GPS+GLO+GAL+BDS	GPS+BDS+GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Acquisition[5]	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[6]	2 s	2 s	2 s	2 s	2 s	2 s
Nav. update rate[7]		8 Hz	10 Hz	15 Hz	15 Hz	12 Hz	20 Hz

Table 1: RCB-F9T performance in different GNSS modes

GNSS		GPS+GLO+GAL+BDS	GPS+BDS+GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Horizontal pos. accuracy	Standalone[8]	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 2: RCB-F9T position accuracy in different GNSS modes

1 1-sigma, fixed position mode, depends on temperature, atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry
2 Demonstrated with 20 km baseline
3 Assuming Airborne 4 g platform
4 50% at 30 m/s for dynamic operation
5 Commanded starts. All satellites at -130 dBm. Measured at room temperature.
6 Dependent on the speed and latency of the aiding data connection, commanded starts
7 95% In PVT navigation mode, assumes secondary navigation output disabled (default)
8 Depends on atmospheric conditions, GNSS antenna, multipath conditions, satellite visibility, and geometry

☞ In order to achieve the best absolute timing accuracy, it is recommended to 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.

1.3 Supported GNSS constellations

The RCB-F9T timing board 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 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 RCB-F9T can receive the NavIC L5 satellite signals that share the same frequency with GPS L5 signals and can be configured to work singly or in parallel with the other GNSS constellations.

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

The RCB-F9T supports the GNSS and their signals as shown in Table 3.

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) B1C (1575.420 MHz)[9]	-
L5 (1176.450 MHz)	-	E5a (1176.450 MHz)	B2a (1176.450 MHz)	SPS-L5 (1176.450 MHz)

Table 3: Supported GNSS and signals on RCB-F9T

The RCB-F9T 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 RCB-F9T 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.

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

1.4.2 Satellite based augmentation system (SBAS)

The RCB-F9T supports SBAS (including WAAS in the US, EGNOS in Europe, MSAS 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 RCB-F9T.

1.4.3 Differential timing mode

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

[9] BeiDou B1I and B1C signals are not to be enabled concurrently

In differential timing mode the RCB-F9T 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 4: Supported RTCM 3.3 messages

1.5 Broadcast navigation data and satellite signal measurements

The RCB-F9T can output all the GNSS broadcast data upon reception from tracked satellites. This includes all the supported GNSS signals plus the augmentation services QZSS and SBAS. The UBX-RXM-SFRBX message is used for this information. The receiver also makes available the tracked satellite signal information, i.e. raw code phase and Doppler measurements, in a form aligned to the Radio Resource LCS Protocol (RRLP) [4]. For the UBX-RXM-SFRBX message specification, see the interface description [2].

1.5.1 Carrier-phase measurements

The RCB-F9T 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 RCB-F9T supports the following protocols:

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

Table 5: Supported protocols

For specification of the protocols, see the interface description [2].

2 System description

2.1 Block diagram

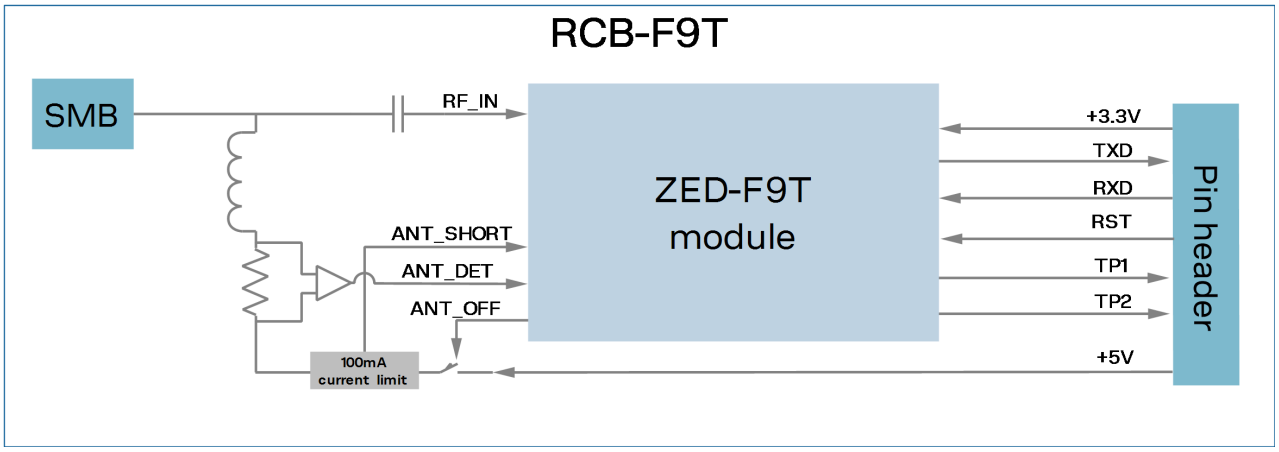

Figure 1: RCB-F9T block diagram

3 Pin definition

3.1 Pin assignment

The pin assignment of the RCB-F9T module is shown in Figure 2. The defined configuration of the PIOs is listed in Table 6.

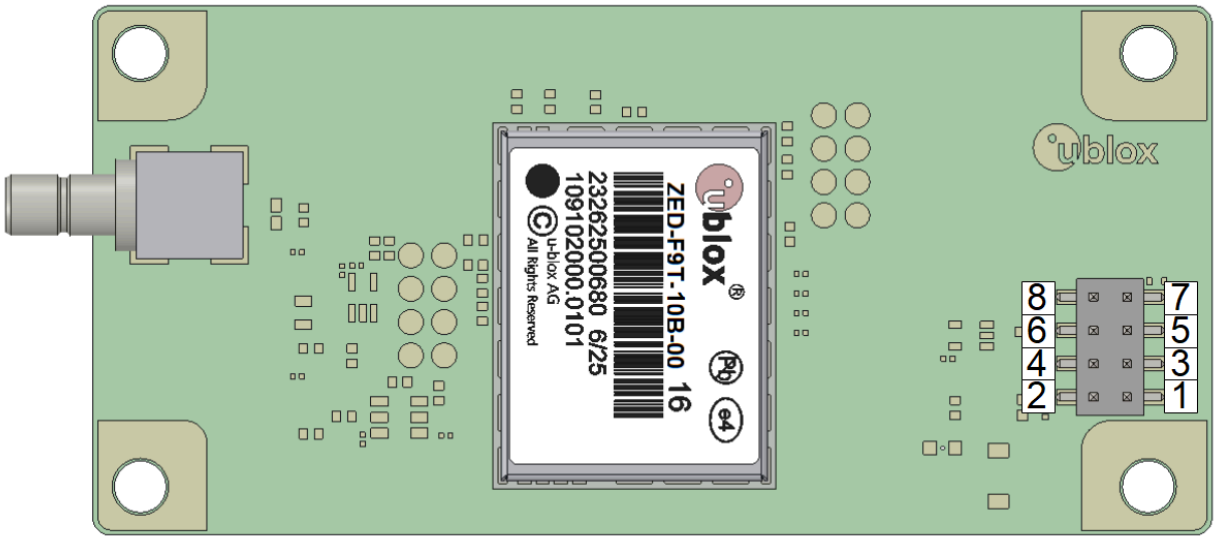

Figure 2: RCB-F9T pin assignment

Pin no.	Name	I/O	Description
1	VCC_ANT	I	Antenna power supply. 5.0 V max 100 mA
2	VCC	I	Operating voltage, 3.3 V
3	TXD	O	UART TXD, LVCMOS
4	RST	I	Hardware reset
5	RXD	I	UART RXD, LVCMOS
6	TP1	O	Time pulse1, LVCMOS
7	TP2	O	Time pulse2, LVCMOS
8	GND	-	Ground

Table 6: RCB-F9T pin assignment

See Figure 3 for a detailed view of the board measurements.

The labelling of the u-blox module in Figure 2 is for the illustration purpose only.

4 Electrical specification

The limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or at any other conditions above those given below is not implied. Exposure to limiting values for extended periods may affect 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
Antenna power supply voltage	VCC_ANT		-0.5	5.5	V
Input pin voltage	Vin	VCC ≤ 3.1	-0.5	VCC + 0.5	V
		VCC > 3.1 V	-0.5	3.6	V
Input power at ANT connector	Prfin	source impedance = 50 Ω, continuous wave		10	dBm
Storage temperature	Tstg		-40	+85	°C

Table 7: Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. Voltage spikes exceeding the power supply voltage specification, given in the table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

4.2 Operating conditions

All specifications are at an ambient temperature of 25 °C. Extreme operating temperatures can significantly impact the specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	Symbol	Min	Typical	Max	Units	Condition
Power supply voltage	VCC	2.7	3.0	3.6	V	
Power supply current	ICC		100		mA	3.3 V
External antenna power supply voltage	VCC_ANT	4.5	5.0	5.5	V	
External antenna current consumption[10]	ICC_ANT	18		100	mA	
Input pin voltage range	Vin	0		VCC	V	
Digital IO pin low level input voltage	Vil			0.4	V	
Digital IO pin high level input voltage	Vih	0.8 * VCC			V	
Digital IO pin low level output voltage	Vol			0.4	V	Iol = 2 mA
Digital IO pin high level output voltage	Voh	VCC – 0.4			V	Ioh = 2 mA
DC current through any digital I/O pin (except supplies)	Ipin			5	mA	
Receiver chain noise figure[11]	NFtot		9.5		dB	

10 If antenna current consumption is less than specified Min value, then attached antenna will not be detected.

11 Only valid for GPS

Parameter	Symbol	Min	Typical	Max	Units	Condition
External gain (at RF_IN)	Ext_gain	17		50	dB	
Operating temperature	Topr	-40	+25	+85	°C	

Table 8: Operating conditions

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

4.3 Indicative power requirements

Table 9 lists examples of the total system supply current including RF and baseband section for a possible application.

☞ Values in Table 9 are provided for customer information only, as an example of typical current requirements. The values are characterized on samples by using a cold start command. Actual power requirements can vary depending on 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 +GAL+BDS	GPS	Unit
I_{PEAK}	VCC peak current	Acquisition	130	120	mA
I_{VCC} [12]	VCC current	Acquisition	90	75	mA
I_{VCC} [12]	VCC current	Tracking	85	68	mA

Table 9: Currents to calculate the indicative power requirements

All values in Table 9 are measured at 25 °C ambient temperature.

☞ VCC_ANT current is depending on used active antenna current consumption. Maximum current is limited to 100 mA.

[12] Simulated signal

5 Communications interfaces

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 RCB-F9T has one UART interface which supports configurable baud rates. See the integration manual [1].

Hardware flow control is not supported.

Symbol	Parameter	Min	Max	Unit
R_u	Baud rate	9600	921600	bit/s

Table 10: RCB-F9T UART specifications

5.2 Default interface settings

Interface	Settings
UART Output	115200 baud, 8 bits, no parity bit, 1 stop bit. NMEA **GGA, GLL, GSA, GSV, RMC, VTG, TXT** (and no UBX) messages are output by default.
UART Input	115200 baud, 8 bits, no parity bit, 1 stop bit. UBX, NMEA and RTCM 3.3 messages are enabled by default.

Table 11: Default configurations

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

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

6 Mechanical specification

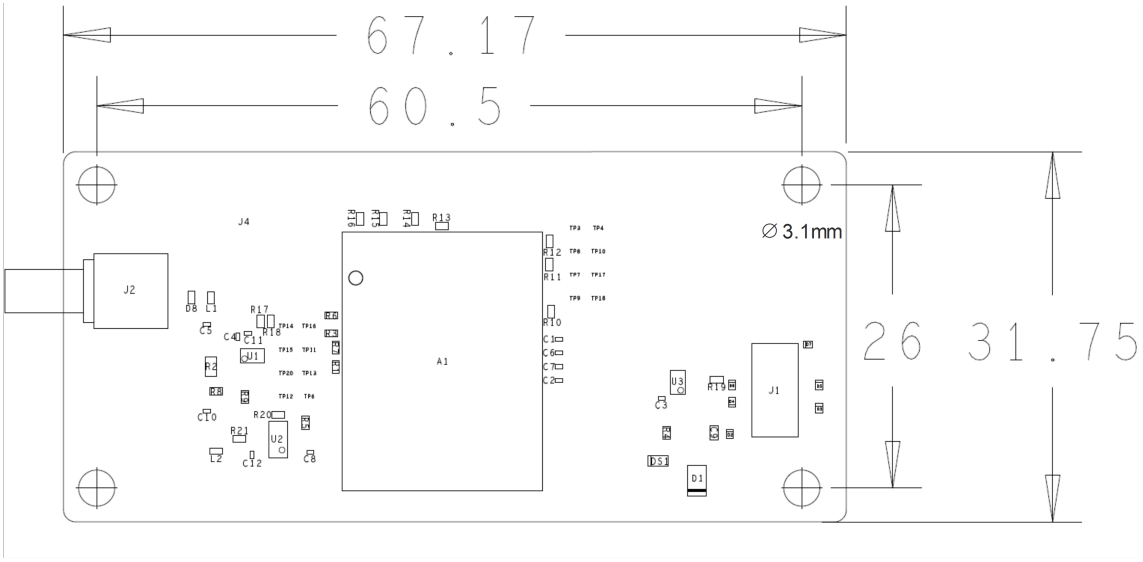

Figure 3: RCB-F9T mechanical drawing

For accurate mounting and antenna connector alignment information, see the u-blox Integration manual [1] for a detailed PCB view.

7 Reliability tests and approvals

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

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

7.1 Approvals

The RCB-F9T is designed to in compliance with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

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

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 RCB-F9T timing boards 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. The **Product name** is used in documentation such as this data sheet and 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 12 below details these three formats.

Format	Structure	Product code
Product name	PPP-TGV	RCB-F9T
Ordering code	PPP-TGV-N	RCB-F9T-1
Type number	PPP-TGV-N-XX	RCB-F9T-1-01

Table 12: Product code formats

The parts of the product code are explained in Table 13.

Code	Meaning	Example
PPP	Product family	RCB
TG	Platform	F9 = u-blox F9
V	Variant	T = Timing
N	Version	N: [0..9]
XX	Product detail	Describes hardware and firmware versions

Table 13: Part identification code

8.3 Ordering codes

Ordering code	Product	Remark
RCB-F9T-1	u-blox RCB-F9T	

Table 14: 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] RCB-F9T Integration manual, UBX-22004121
[2] TIM 2.20 Interface description UBX-21048598
[3] ZED-F9T Data sheet, UBX-20033635
[4] 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	28-Apr-2021	rzuo	Advance information
R02	25-Feb-2022	byou	Early production information FW version TIM2.20, sec. 1.3 Beidou B1C and NavIC SPS-L5 added

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