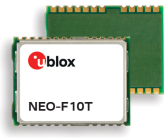
NEO-F10T

High precision timing GNSS module

Professional grade

Data sheet



Abstract

This data sheet describes the NEO-F10T module, a low-power receiver for high-performance timing applications.

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UBX-22022576 - R03
C1-Public

Document information

Title	**NEO-F10T**	
Subtitle	High precision timing GNSS module	
Document type	Data sheet	
Document number	UBX-22022576	
Revision and date	R03	20-Dec-2023
Disclosure restriction	C1-Public	

Product status	Corresponding content status	
Functional Sample	Draft	For functional testing. Revised and supplementary data will be published later.
In development / prototype	Objective specification	Target values. Revised and supplementary data will be published later.
Engineering sample	Advance information	Data based on early testing. Revised and supplementary data will be published later.
Initial production	Early production information	Data from product verification. Revised and supplementary data may be published later.
Mass production / End of life	Production information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	FW version	IN/PCN reference	Product status
NEO-F10T	NEO-F10T-00B-00	TIM 3.01	UBXDOC-963802114-12477	Initial production

Contents

1 Functional description

1.1 Overview

The NEO-F10T module features the u-blox F10 GNSS multi-band platform and provides nanosecond level timing accuracy with unparalleled low power consumption for L1 and L5 GNSS signals.

1.2 Performance

Parameter	Specification	Value
Receiver type		u-blox F10 receiver
Accuracy of time pulse signal[1]	1-sigma	10 ns
	1-sigma jitter removed	5 ns
Frequency of time pulse signal		Default 1PPS (0.25 Hz to 25 MHz configurable)
Time pulse jitter		±8 ns
Time-mark resolution		16 ns
Operational limits[2]	Dynamics	≤ 4 g
	Altitude	80,000 m
	Velocity	500 m/s
Velocity accuracy[3]		0.05 m/s
Dynamic heading accuracy[3]		0.3 deg

Table 1: NEO-F10T specifications

GNSS		GPS+GAL+BDS	GPS+GAL	GPS+BDS	GPS
Acquisition[4]	Cold start	27s	27s	28s	29s
	Hot start	2s	2s	2s	2s
	Aided start[5]	2s	2s	2s	2s

Table 2: NEO-F10T performance in different GNSS modes

GNSS		GPS+GAL+BDS	GPS+GAL	GPS+BDS	GPS
Horizontal pos. accuracy	Standalone[6]	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP
Max navigation update rate[7]		8 Hz	8 Hz	8 Hz	10 Hz

Table 3: NEO-F10T position accuracy in different GNSS modes

1 Fixed position mode, depends on temperature, atmospheric conditions, GNSS antenna, multipath conditions, satellite visibility and geometry

2 Assuming Airborne 4 g platform.

3 50% at 30 m/s for dynamic operation.

4 Commanded starts. All satellites at -130 dBm. Measured at room temperature.

5 Dependent on the speed and latency of the aiding data connection, commanded starts.

6 Depends on atmospheric conditions, GNSS antenna, multipath conditions, satellite visibility, and geometry.

7 95% In PVT navigation mode, assumes secondary navigation output disabled (default).

GNSS		GPS+GAL+BDS
Sensitivity[8]	Tracking and nav.	-167 dBm
	Reacquisition	-158 dBm
	Cold start	-148 dBm
	Hot start	-159 dBm

Table 4: NEO-F10T sensitivity in different GNSS modes

1.3 Supported GNSS constellations

NEO-F10T is a concurrent GNSS receiver that can receive and track multiple GNSS systems. The dual-band RF front-end architecture enables concurrent reception of multiple dual frequency GNSS constellations. The receiver can be configured for a subset of GNSS constellations to achieve lower power consumption.

The default configuration on NEO-F10T is concurrent reception of GPS, Galileo and BeiDou with QZSS and SBAS enabled.

The following GNSS and their signals are supported:

System	Signals
GPS / QZSS	L1C/A (1575.42 MHz), L5 (1176.450 MHz)
Galileo	E1-B/C (1575.42 MHz), E5a (1176.450 MHz)
GLONASS[9]	L1OF (1602 MHz + k*562.5 kHz, k = -7,..., 5, 6)
BeiDou	B1C (1575.42 MHz), B2a (1176.450 MHz)
NavIC	SPS-L5 (1176.450 MHz)

Table 5: Supported GNSS and signals on NEO-F10T

The following GNSS assistance services are supported:

Service	Support
AssistNow™ Online	GPS L1C/A, Galileo E1, QZSS L1C/A

Table 6: Supported Assisted GNSS (A-GNSS) services

The following augmentation systems are supported:

System	Support
SBAS[10]	EGNOS, GAGAN, MSAS and WAAS
QZSS	L1Sb (SBAS)

Table 7: Supported augmentation systems

The augmentation system QZSS can be enabled only if GPS operation is also enabled.

1.4 Supported protocols

NEO-F10T supports the following interface protocols:

8 Demonstrated with a good external LNA. Measured at room temperature.

9 GLONASS L1OF cannot be enabled together with L5 signals.

10 Ionospheric correction service is the only SBAS service supported by NEO-F10T

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

Table 8: Supported protocols

1.5 Firmware features

Feature	Description
Assisted GNSS	AssistNow Online
RAW data	Provides tracked satellite signal observables
Backup modes	Hardware backup mode and software standby mode
Galileo return link messages	Galileo search and rescue (SAR) return link messages (RLM) via Galileo satellite signal

Table 9: Firmware features

Feature	Description
Anti-jamming	RF interference and jamming detection and reporting
Anti-spoofing	Spoofing detection and reporting
Configuration lockdown	Receiver configuration can be locked by command
Secure boot	Only signed firmware images executed

Table 10: Security features

2 System description

2.1 Block diagram

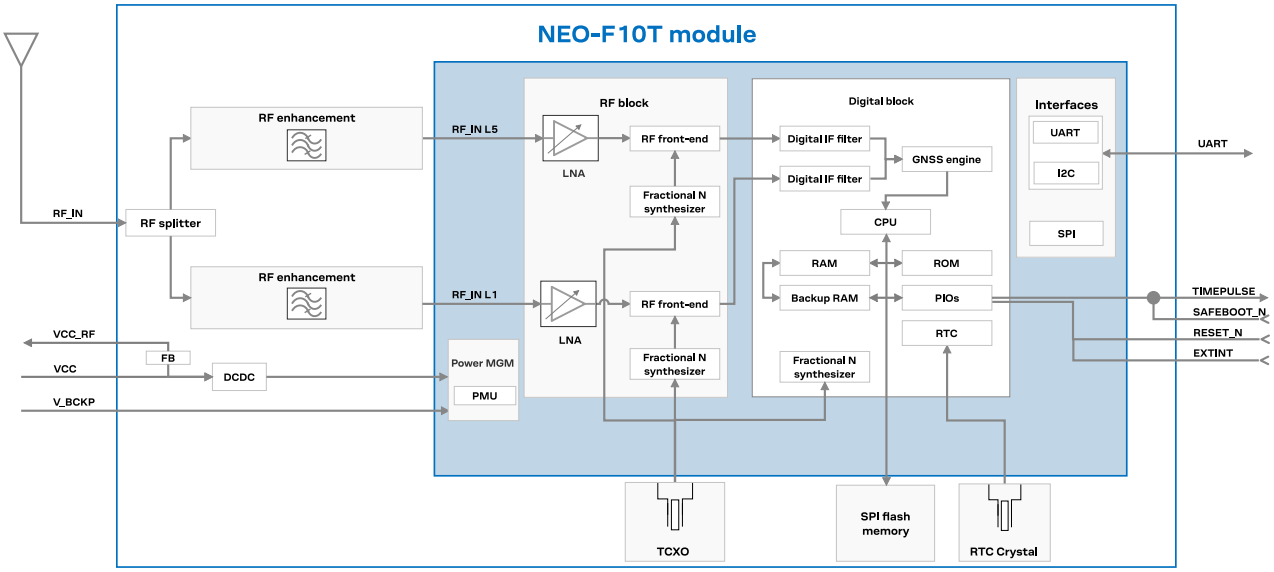

Figure 1: NEO-F10T block diagram

☞ An active antenna is recommended to use with the NEO-F10T. See the Integration manual [1]

3 Pin definition

3.1 Pin assignment

The pin assignment of the NEO-F10T module is shown in Figure 2. The defined configuration of the PIOs is listed in Table 11.

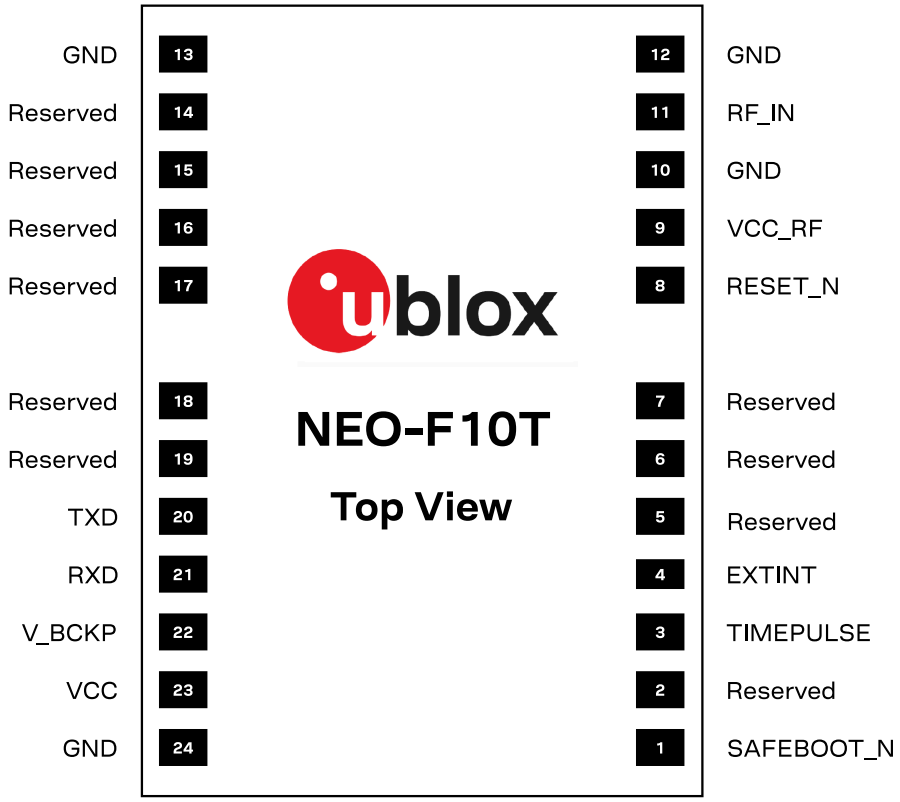

Figure 2: NEO-F10T pin assignment

Pin no.	Name	I/O	Description
1	SAFEBOOT_N	I	Safeboot mode (leave open)[11]
2	Reserved	-	Not connected
3	TIMEPULSE	O	Time pulse signal (1 PPS, Not to be pulled hi/low on start-up) [11]
4	EXTINT	I	External interrupt
5	Reserved	-	Not connected
6	Reserved	-	Not connected
7	Reserved	-	Not connected
8	RESET_N	I	RESET (active low)
9	VCC_RF	O	Output voltage RF section
10	GND	-	Ground
11	RF_IN	I	GNSS signal input
12	GND	-	Ground

[11] The receiver enters safeboot mode if SAFEBOOT_N pin is low at start up. The SAFEBOOT_N pin is internally connected to TIMEPULSE pin through a 1 kΩ series resistor.

Pin no.	Name	I/O	Description
13	GND	-	Ground
14	Reserved	-	Not connected
15	Reserved	-	Not connected
16	Reserved	-	Not connected
17	Reserved	-	Not connected
18	Reserved	-	Not connected
19	Reserved	-	Not connected
20	TXD	O	UART TX
21	RXD	I	UART RX
22	V_BCKP	I	Backup voltage supply
23	VCC	I	Supply voltage
24	GND	-	Ground

Table 11: NEO-F10T pin assignment

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

3.2 Pin state

Table 12 defines the state of the interface pins in different modes.

Pin no.	Function	Continuous mode	Software standby mode	Safe boot mode
21	RXD	Input pull-up	Input pull-up	Input pull-up
20	TXD	Output	Input pull-up	Output
1	SAFEBOOT_N [12]	Output	Input pull-down	High Z
3	TIMEPULSE	Output	Input pull-down	High Z
8	RESET_N	Input pull-up	Input pull-up	Input pull-up
4	EXTINT	Input pull-up	Input pull-up	Input pull-up

Table 12: Pins state

☞ In the reset mode (RESET_N = low), all interface pins are configured as input pull-ups.

☞ Do not drive pins in the hardware backup mode (VCC = 0 V).

[12] SAFEBOOT_N shares the same internal IC pin via a 1k series resistor with TIMEPULSE

4 Electrical specifications

4.1 Absolute maximum ratings

⚠ CAUTION. Risk of device damage. Exceeding the absolute maximum ratings may affect the lifetime and reliability of the device or permanently damage it. Do not exceed the absolute maximum ratings.

⚠ This product is not protected against overvoltage or reversed voltages. Use appropriate protection to avoid device damage from voltage spikes exceeding the specified boundaries.

Symbol	Parameter	Min	Max	Unit
VCC	Main supply voltage	-0.3	3.6	V
	Voltage ramp on VCC [13]	25	35000	µs/V
V_BCKP	Backup supply voltage	-0.3	3.6	V
V_PIO	Input voltage on RESET_N and digital pins.	-0.3	VCC + 0.3	V
I_PIO	Max source / sink current, digital pins [14]	-10	10	mA
ICC_RF	Max source current, VCC_RF		300	mA
P_{rfin}	RF input power on RF_IN [15]		+15	dBm
T_{amb}	Ambient temperature	-40	+85	°C
T_s	Storage temperature	-40	+85	°C

Table 13: Absolute maximum ratings

4.2 Operating conditions

Table 14 shows the general operating conditions. Table 15 shows the electrical parameters for digital I/O.

Symbol	Parameter	Min	Typical	Max	Unit
VCC	Main supply voltage	2.7	3.0	3.6	V
V_BCKP	Supply voltage, backup domain	1.65		3.6	V
VCC_{SWITCH}	VCC voltage threshold to switch an internal supply for the backup domain from VCC to V_BCKP		1.45		V
VCC_RF	VCC_RF output voltage		VCC - 0.1		V
ICC_RF	VCC_RF output current			300	mA
NF_{tot}	Receiver chain noise figure (L1/L5)		5.5/6.5		dB
Ext_gain [16]	External gain at RF_IN, normal gain mode (default)			40	dB
T_{opr}	Operating temperature	-40		+85	°C

Table 14: General operating conditions

Symbol	Parameter	Min	Typical	Max	Unit
I_{leak}	Leakage current input pins [17]		25		nA
V_{in}	Input pin voltage range	0		VCC	V

13 Exceeding the voltage ramp speed may permanently damage the device.

14 The SAFEBOOT_N pin has an internal 1 kΩ series resistor.

15 Test conditions: source impedance = 50 Ω, continuous wave.

16 The internal LNA gain is configurable.

17 V_{in} = VCC, at room temperature.

Symbol	Parameter	Min	Typical	Max	Unit
V_{il}	Low-level input voltage			0.63	V
V_{ih}	High-level input voltage	0.68 x VCC			V
V_{ol}	Low-level output voltage, Iout = -2 mA TIMEPULSE, I_{ol} = -4mA			0.4	V
V_{oh}	High-level output voltage, Iout = 2 mA TIMEPULSE, I_{oh} = 4mA	VCC - 0.4			V
$R_{pu, IO}$	Pull-up resistance, Digital IO	8	18	40	kΩ
$R_{pd, IO}$	Pull-down resistance, Digital IO	21	80	180	kΩ
$R_{pu, SAFEBOOT\_N}$	Pull-up resistance, SAFEBOOT_N [18]	6	17	72	kΩ
$R_{pu, RESET\_N}$	Pull-up resistance, RESET_N	7	10	13	kΩ

Table 15: Digital IO

4.3 Indicative power requirements

This section provides examples of typical current requirements. They are characterized on samples using a cold start command. The actual power requirements may vary depending on the firmware version used, the external circuitry, the number of satellites tracked, the signal strength, the type and time of start, duration, internal LNA gain mode, and the test conditions.

All values in Table 16 and Table 17 have been measured at 25 °C ambient temperature with the default configuration unless otherwise stated. SBAS and QZSS are active in all measurements.

Table 16 shows indicative current consumption for VCC with a 3.0 V supply.

Symbol (Parameter)	Conditions	GPS+GAL+BDS	GPS+GAL	GPS+BDS	GPS	Unit
I_{VCC} [19] (Current at VCC pin)	Acquisition [20]	20	19	19	15	mA
	Tracking (Continuous mode)	19	17	18	15	mA

Table 16: Typical currents for 3.0 V supply at VCC

☞ The inrush current can go up to 100 mA at startup. Ensure that the external power supply is able to deliver up to 100 mA.

Table 17 shows current consumption for backup modes.

Symbol	Parameter	Conditions	Typ.	Unit
I_{V_BCKP} [21]	Total current in hardware backup mode	V_BCKP = 3.0 V; VCC = 0 V	32	µA
I_{Vcc}	Total current in software standby mode	VCC = 3.0 V	45	µA

Table 17: Backup currents

☞ 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.

18 The SAFEBOOT_N pin has an additional 1 kΩ series resistor.

19 Simulated signals using power levels of -130 dBm.

20 Average current from start-up until the first fix.

21 I_{V_BCKP} current in normal operation (V_BCKP =3.0 V) is ~3 µA.

5 Communication interfaces

The receiver supports communication over UART only.

All the inputs have an internal pull-up resistor in normal operation and can be left open if not used. The voltage level at the PIO pins is related to the VCC supply voltage.

5.1 UART

The UART interface supports configurable baud rates. Hardware flow control is not supported. UART specifications are described in Table 18.

Symbol	Parameter	Min	Max	Unit
R_u	Baud rate	9600	921600	bit/s
Δ_{Tx}	Tx baud rate accuracy	-1%	+1%	-
Δ_{Rx}	Rx baud rate tolerance	-2.5%	+2.5%	-

Table 18: UART specifications

5.2 Default interface settings

Interface	Settings
UART	• 38400 baud[22], 8 bits, no parity bit, 1 stop bit. • Input messages: NMEA and UBX. • Output messages: NMEA GGA, GLL, GSA, GSV, RMC, VTG and TXT.

Table 19: Default interface settings

[22] 9600 baud in safe boot mode.

6 Mechanical specifications

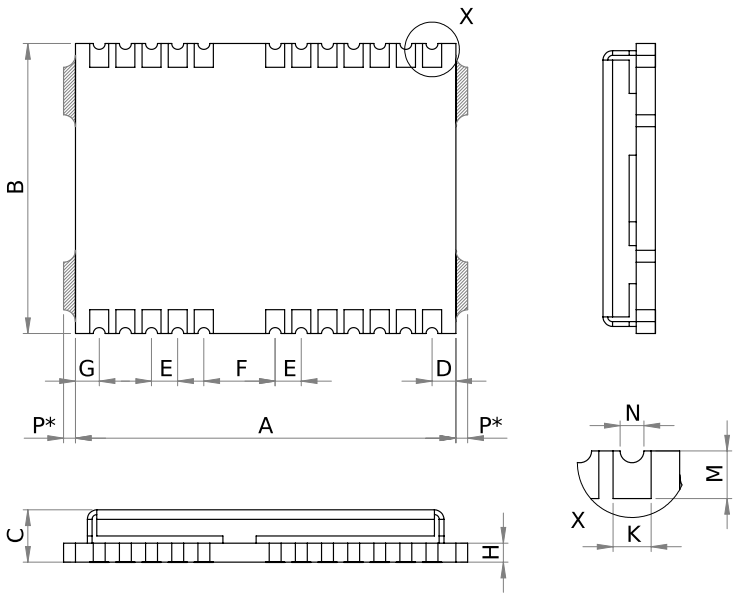

Figure 3: NEO-F10T mechanical drawing

Symbol	Min (mm)	Typical (mm)	Max (mm)	
A	15.9	16.0	16.1	
B	12.1	12.2	12.3	
C	2.2	2.4	2.6	
D	0.9	1.0	1.1	
E	1.0	1.1	1.2	
F	2.9	3.0	3.1	
G	0.9	1.0	1.1	
H	-	0.82	-	
K	0.7	0.8	0.9	
M	0.8	0.9	1.0	
N	0.4	0.5	0.6	
P*	0.0	-	0.5	The de-paneling residual tabs may be on either side (not both).
Weight		1.6 g		

Table 20: NEO-F10T mechanical dimensions

☞ The mechanical picture of the de-paneling residual tabs (P*) is an approximate representation, shape and position may vary.

☞ Component keep-out area must consider that the de-paneling residual tabs can be on either side (not both).

7 Approvals

The NEO-F10T is designed for the presumption of conformity with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

The NEO-F10T 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 at u-blox website within Support > File Category > Conformity and Certification.

8 Product handling

8.1 Moisture sensitivity level

The moisture sensitivity level (MSL) relates to the packaging and handling precautions required. NEO-F10T LCC (professional grade) package is rated at MSL level 4. For MSL standard, see IPC/JEDEC J-STD-020 [4].

9 Labeling and ordering information

This section provides information about product labeling and ordering.

9.1 Product labeling

The labeling of NEO-F10T package provides product information and revision information. For more information contact u-blox sales.

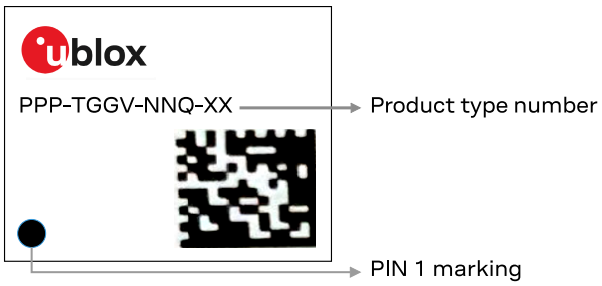

Figure 4: NEO-F10T label

The parts of the product code are explained in Table 21

Code	Meaning	Example
PPP	Product family	NEO
TGG	Platform	F10 = u-blox F10
V	Variant	T = Timing
NN	Option	00, 01, 02, ...
Q	Quality grade	A = Automotive, B = Professional
XX	Product detail	Describes hardware and firmware versions

Table 21: Part identification code

9.2 Explanation of product codes

Three product code formats are used in the product label. 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 22 describes the three different product code formats used in the NEO-F10T module.

Format	Structure	Product code
Product name	PPP-TGGV	NEO-F10T
Ordering code	PPP-TGGV-NNQ	NEO-F10T-00B
Type number	PPP-TGGV-NNQ-XX	NEO-F10T-00B-00

Table 22: Product code formats

9.3 Ordering codes

Ordering code	Product	Remark
NEO-F10T-00B	u-blox F10 GNSS timing Module, 24 pin LCC, professional grade	

Table 23: 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] NEO-F10T Integration manual, UBX-22018271
[2] u-blox F10 TIM3.01 Interface description, UBX-23003447
[3] u-blox Product packaging reference guide, UBX-14001652
[4] MSL standard IPC/JEDEC J-STD-020, www.jedec.org

☞ 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	Status / comments
R01	10-Oct-2022	Objective specification
R02	30-Mar-2023	Updated product status to engineering sample
R03	20-Dec-2023	Updated product status to initial production

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