NEO-F10N

Standard precision GNSS module
Professional grade

Integration manual

Abstract
This document describes the features and application of the u-blox NEO-F10N module, an L1/L5 dual-band GNSS receiver for meter-level accuracy in urban environment.

Document information

Title	**NEO-F10N**
Subtitle	Standard precision GNSS module
Document type	Integration manual
Document number	UBXDOC-963802114-12193
Revision and date	R02 07-Nov-2023
Disclosure restriction	C1-Public

This document applies to the following products:

Product name	Type number	FW version	IN/PCN reference	RN reference
NEO-F10N	NEO-F10N-00B-00	EXT SPG 6.00	UBXDOC-963802114-12320	UBXDOC-963802114-12318

Contents

1 System description

This document is an important source of information for all aspects of NEO-F10N software and hardware design. The purpose of this document is to provide guidelines for a successful integration of the receiver with the customer's end product.

1.1 Overview

The NEO-F10N module features the u-blox F10 GNSS multi-band platform and provides exceptional sensitivity and acquisition time with unparalleled low power consumption for L1 and L5 GNSS signals.

1.2 Architecture

The NEO-F10N receiver provides all the necessary RF and baseband processing to enable dual-band operation. The block diagram below shows the key functionality.

1.2.1 Block diagram
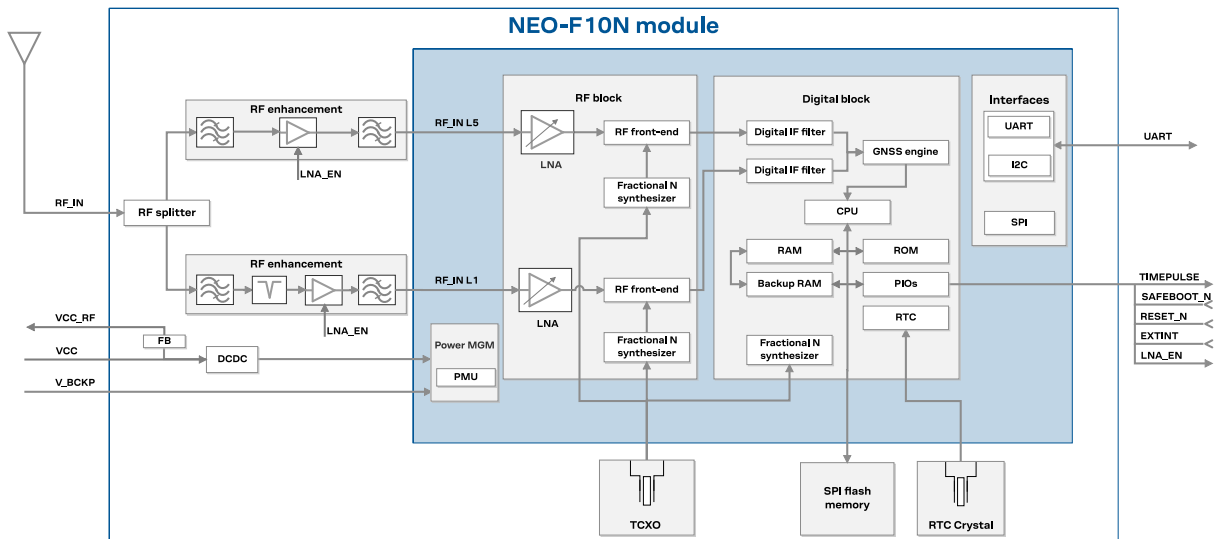
Figure 1: NEO-F10N block diagram

1.3 Pin definition

1.3.1 Pin assignment
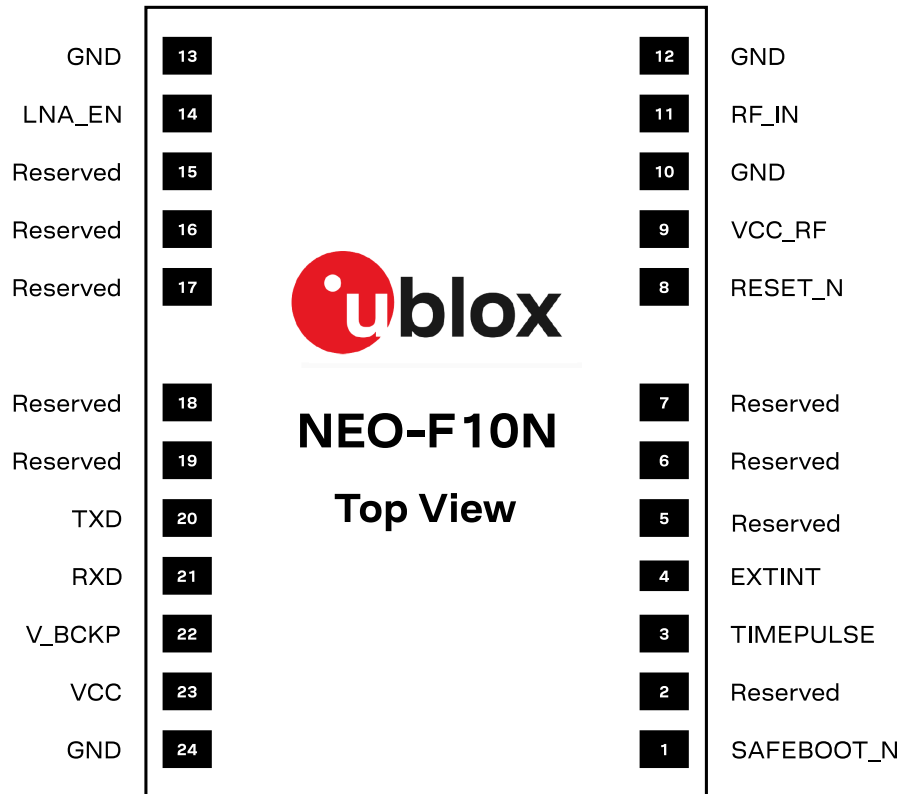
Figure 2: NEO-F10N pin assignment

Pin no.	Name	I/O	Description
1	SAFEBOOT_N	I	Safeboot mode (leave open)
2	Reserved	-	Not connected
3	TIMEPULSE	O	Time pulse signal (shared with SAFEBOOT_N pin)
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
13	GND	-	Ground
14	LNA_EN	O	On/Off internal LNAs and an optional external LNA or an active antenna
15	Reserved	-	Not connected

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[1] The receiver enters safeboot mode if this 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
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 1: NEO-F10N pin assignment

2 Receiver configuration

The configuration determines all aspects of the GNSS receiver operation and therefore, information in this section is essential for the successful integration of NEO-F10N.

NEO-F10N is configured using UBX configuration interface keys. The configuration database in the receiver's RAM holds the current configuration, which is used by the receiver at runtime. It is constructed at the receiver startup from several sources of configuration. For more information on receiver configuration, see the interface description [3].

The configuration can be stored in the RAM, battery-backed RAM (BBR), and flash memory. The permanence of the stored configuration and the actions to clear it in each memory are listed in Table 2.

Memory	Permanence of storage	Clearing actions
RAM	Settings remain effective until power-down	• Activating the RESET_N pin • A UBX-CFG-RST message excluding GNSS stop (resetMode 0x08) and GNSS start (resetMode 0x09) • Entering software standby mode
BBR	The receiver retains the settings stored as long as the backup power supply remains	• Activating the RESET_N pin • A UBX-CFG-RST message with reset mode set to a hardware reset (resetMode 0x00 and 0x04)
Flash	Permanent storage of the configuration settings	• A UBX-CFG-CFG message to erase the configuration on the flash layer

Table 2: Permanence of storage and clearing actions for each memory

It is recommended to apply runtime configuration on both RAM and BBR or flash memory layers. For more information about the UBX-CFG-RST message, refer to Forcing receiver reset.

⚠ **CAUTION** The configuration interface has changed from earlier u-blox positioning receivers. Users must adopt the configuration interface described in this document.

The configuration interface settings are stored in a database consisting of separate configuration items. An item is made up of a pair consisting of a key ID and a value. Related items are grouped together and identified under a common group name: CFG-GROUP-*; a convention used in u-center 2 and within this document. Within u-center 2, a configuration group is identified as "Group name" and the configuration item is identified as the "item name" in the "Device configuration" window.

The UBX messages available to change or poll the configurations are the UBX-CFG-VALSET, UBX-CFG-VALGET, and UBX-CFG-VALDEL messages. For more information about these messages and the configuration keys, see the configuration interface section in the Interface description [3].

2.1 Basic receiver configuration

This section summarizes the most commonly used, basic receiver configurations.

2.1.1 Basic hardware configuration

The NEO-F10N receiver is configured with the default settings during the module production. The receiver starts up and is fully operational as soon as proper power supply, communication interfaces and antenna signal from the host application device are connected.

2.1.2 Internal LNA mode configuration

u-blox 10 receivers support three modes for the internal low-noise amplifier (LNA): normal gain, low gain, and bypass mode. The NEO-F10N default is the normal mode. With a high-gain external active antenna, the low gain or the bypass mode shall be used to save power.

The internal LNA mode can be configured at run time in the flash, BBR and RAM memory using the configuration item CFG-HW-RF_LNA_MODE and applying a software reset by sending UBX-CFG-RST message. For more information, refer to Forcing receiver reset.

The default gain mode is pre-configured in the receiver and does not require configuration in production. The configuration strings for setting the internal LNA mode in the flash memory is given in Table 3.

Internal LNA mode	Configuration string
Normal gain	Default
Low gain	B5 62 06 8A 09 00 01 04 00 00 57 00 A3 20 01 B9 2F
Bypass	B5 62 06 8A 09 00 01 04 00 00 57 00 A3 20 02 BA 30

Table 3: Internal LNA mode configuration in the flash memory

Configuring the internal LNA mode in the flash memory:

1. Power up the system.
2. Test the communication interface by polling the UBX-MON-VER message.
3. Send the configuration string in Table 3.
4. Power the receiver off and on or send UBX-CFG-RST message (the reset type must be set to a hardware reset). The new internal LNA setting is applied at startup.
5. Verify that the configuration item is correctly set by polling CFG-HW-RF_LNA_MODE at RAM layer using the UBX-CFG-VALGET message.
6. The configuration is completed.

2.1.3 GNSS signal configuration

NEO-F10N supports reception of GPS, Galileo, BeiDou and QZSS L1/L5 dual-band signals plus NavIC L5 and SBAS L1. The default configuration is concurrent reception of GPS (L1C/A, L5), Galileo (E1-B/C, E5a) and BeiDou (B1C, B2a) with SBAS enabled.

Each GNSS constellation can be enabled or disabled independently except for QZSS, which is functional only with GPS. In addition to the configuration key for each constellation, there is a configuration key for each signal supported by the firmware. For constellations with dual-band support, it is not possible to disable one of the bands. Both bands must be enabled and disabled at once. Alternatively, the CFG-SIGNAL-* configuration group for that constellation can be enabled and disabled. For example, if CFG-SIGNAL-GPS_ENA is set to zero, the GPS constellation is disabled.

Unsupported combinations are rejected with a UBX-ACK-NAK message, and the warning "inv sig cfg" is sent via UBX-INF and NMEA-TXT messages (if enabled).

☞ Any change to the signal configuration items triggers a restart of the GNSS subsystem. During the restart, the host application should wait for message acknowledgement and a margin of 0.5 seconds prior to sending any further commands.

For more information on the CFG-SIGNAL-* configuration group, refer to the Interface description [3].

2.1.4 GPS L5 signal health status configuration

NEO-F10N supports both GPS L1 C/A and L5 signals. Broadcasting of Civil Navigation (CNAV) messages on the L5 signal began in April 2014. At the time of writing, GPS L5 signals remain pre-operational which are set unhealthy until sufficient monitoring capability is established.

To evaluate GPS L5 signals before they become fully operational, the receiver can be configured to ignore the GPS L5 health status by overriding it with the respective GPS L1 C/A signal status.

⚠ Do not use unhealthy, pre-operational GPS L5 signals for safety-of-life or other critical purposes. This is an operational issue concerning the satellites / space segment and not a limitation or specific configuration of u-blox products.

To ignore the GPS L5 signal health status and override it with the respective GPS L1 signal health status, send the configuration string given in Table 4. The configuration can be stored in RAM, battery-backed RAM (BBR), and flash layers. Stored in the RAM layer, the device returns the UBX-ACK-ACK message if the configuration is sent successfully and it is applied immediately without a configuration reset. To apply the configuration stored in the BBR and flash layers, send the UBX-CFG-RST message with resetMode 0x01.

To revert back to the default configuration, send the configuration string given in Table 5. The device returns the UBX-ACK-ACK message if the configuration is sent successfully and it is applied immediately without a reset in the RAM layer. To apply the configuration stored in the BBR and flash layers, send the UBX-CFG-RST message with resetMode 0x01.

⚠ Customers who choose to ignore the GPS L5 signal health status in their production system do so at their own risk and must be fully aware of the implications. The system should also include a mechanism to revert to the mode where the L5 signal health status is respected.

Configuration layer	Configuration string
RAM	B5 62 06 8A 09 00 01 01 00 00 01 00 32 10 01 DF F6
BBR	B5 62 06 8A 09 00 01 02 00 00 01 00 32 10 01 E0 FE
FLASH	B5 62 06 8A 09 00 01 04 00 00 01 00 32 10 01 E2 0E

Table 4: UBX binary string to override GPS L5 signal health status with GPS L1 health status

Configuration layer	Configuration string
RAM	B5 62 06 8A 09 00 01 01 00 00 01 00 32 10 00 DE F5
BBR	B5 62 06 8A 09 00 01 02 00 00 01 00 32 10 00 DF FD
FLASH	B5 62 06 8A 09 00 01 04 00 00 01 00 32 10 00 E1 0D

Table 5: UBX binary strings to revert the GPS L5 signal health status monitoring to default

2.1.5 Communication interface configuration

Several configuration groups allow configuring the operation mode of the communication interfaces. These include parameters for the data framing, transfer rate and enabled input/output protocols. See Communication interfaces and PIOs section for details. The configuration groups available for each interface are:

Interface	Configuration groups
UART	CFG-UART1-*, CFG-UART1INPROT-*, CFG-UART1OUTPROT-*

Table 6: Interface configuration

2.1.6 Message output configuration

The receiver supports two protocols for output messages: industry-standard NMEA and u-blox UBX. Any message type can be enabled or disabled individually and the output rate is configurable.

The message output rate is related to the frequency of an event. For example, the output message UBX-NAV-PVT (position, velocity, and time solution) is related to the navigation event, which generates a navigation epoch. In this case, the rate for each navigation epoch is defined by the configuration keys CFG-RATE-MEAS and CFG-RATE-NAV. For example, a value of 1000 ms in CFG-RATE-MEAS indicates that a measurement is done every second. If CFG-RATE-NAV is set to one (1), the solution is calculated for every measurement. This means that a navigation epoch is calculated every 1000 ms. If the rate is set to two (2), only the second measurement is used and the navigation epoch is calculated every two seconds. The same result is obtained if CFG-RATE-MEAS is set to 2000 ms, and CFG-RATE-NAV is set to one (1). Every 2000 ms a measurement is done, and in every measurement, a navigation epoch is calculated. However, this second option demands fewer resources and is the correct procedure when the navigation rate is changed. Setting a navigation rate value higher than one (1) is only needed when it is required that the raw measurement data is output at a higher rate than the navigation data.

The output rate for each message is defined in the CFG-MSGOUT-* configuration group. If the output rate of the message is set to one (1) on the UART interface, CFG-MSGOUT-UBX_NAV_PVT_UART1 = 1, the message is output for every navigation epoch. If the rate is set to two (2), the message is output for every other navigation epoch. If the rate is zero (0), then corresponding message is not output. As seen in this example, the rates of the output messages are individually configurable per communication interface.

Some messages, such as UBX-MON-VER, are non-periodic and are only output as an answer to a poll request.

The UBX-INF-* and NMEA-Standard-TXT information messages are non-periodic output messages that do not have a message rate configuration. Instead they can be enabled for each communication interface via the CFG-INFMSG-* configuration group.

☞ All message output is additionally subject to the protocol configuration of the communication interfaces. Messages of a given protocol are not output unless the protocol is enabled for output on the interface. See Communication interface configuration for details.

2.2 Navigation configuration

This section presents various configuration options related to the navigation engine. These options can be configured through CFG-NAVSPG-* configuration keys.

2.2.1 Dynamic platform

The dynamic platform model can be configured through the CFG-NAVSPG-DYNMODEL configuration item. For the supported dynamic platform models and their details, see Table 7 and Table 8.

Platform	Description
Portable	Applications with low acceleration, e.g. portable devices. Suitable for most situations.

Platform	Description
Stationary	Used in timing applications (antenna must be stationary) or other stationary applications. Velocity restricted to 0 m/s. Zero dynamics assumed.
Pedestrian	Applications with low acceleration and speed, e.g. how a pedestrian would move. Low acceleration assumed.
Automotive	Used for applications with equivalent dynamics to those of a passenger car. Low vertical acceleration assumed.
At sea	Recommended for applications at sea, with zero vertical velocity. Zero vertical velocity assumed. Sea level assumed.
Airborne <1g	Used for applications with a higher dynamic range and greater vertical acceleration than a passenger car. No 2D position fixes supported.
Airborne <2g	Recommended for typical airborne environments. No 2D position fixes supported.
Airborne <4g	Only recommended for extremely dynamic environments. No 2D position fixes supported.
Wrist	Only recommended for wrist-worn applications. Receiver will filter out arm motion.

Table 7: Dynamic platform models

Platform	Max altitude [m]	Max horizontal velocity [m/s]	Max vertical velocity [m/s]	Sanity check type	Max position deviation
Portable	12000	310	50	Altitude and velocity	Medium
Stationary	9000	10	6	Altitude and velocity	Small
Pedestrian	9000	30	20	Altitude and velocity	Small
Automotive	6000	100	15	Altitude and velocity	Medium
At sea	500	25	5	Altitude and velocity	Medium
Airborne <1g	80000	100	6400	Altitude	Large
Airborne <2g	80000	250	10000	Altitude	Large
Airborne <4g	80000	500	20000	Altitude	Large
Wrist	9000	30	20	Altitude and velocity	Medium

Table 8: Dynamic platform model details

Applying dynamic platform models designed for high acceleration systems (e.g. airborne <2g) can result in a higher standard deviation in the reported position.

If a sanity check against the limit of the dynamic platform model fails, the position solution becomes invalid. Table 8 shows the types of sanity checks which are applied for a particular dynamic platform model.

2.2.2 Navigation input filters

The navigation input filters in the CFG-NAVSPG-* configuration group control how the navigation engine handles the input data that comes from the satellite signal.

Configuration item	Description
CFG-NAVSPG-FIXMODE	By default, the receiver calculates a 3D position fix if possible but it reverts to 2D position if necessary (auto 2D/3D). The receiver can be configured to only calculate 2D (2D only) or 3D (3D only) positions.
CFG-NAVSPG-CONSTR_ALT, CFG-NAVSPG-CONSTR_ALTVAR	The fixed altitude is used if fixMode is set to 2D only. A variance greater than zero must also be supplied.
CFG-NAVSPG-INFIL_MINELEV	Minimum elevation of a satellite above the horizon to be used in the navigation solution. Low-elevation satellites may provide degraded accuracy, due to the long signal path through the atmosphere.
CFG-NAVSPG-INFIL_MINSVS, CFG-NAVSPG-INFIL_MAXSVS	Minimum and maximum number of satellites to use in the navigation solution. There is an absolute maximum limit of 32 satellites that can be used for navigation.

Configuration item	Description
CFG-NAVSPG-INFIL_NCNOTHRS, CFG-NAVSPG-INFIL_CNOTHRS	A navigation solution will only be attempted if there is at least the given number of satellites with signals at least as strong as the given threshold.

Table 9: Navigation input filter parameters

If the receiver has only three satellites for calculating a position, the navigation algorithm uses a constant altitude to compensate for the missing fourth satellite. This is called a 2D fix. The constant altitude value is taken from the last successful 3D fix using a minimum of four available satellites.

☞ u-blox receivers do not calculate any navigation solution with fewer than three satellites.

2.2.3 Navigation output filters

The result of a navigation solution is initially classified by the fix type (as detailed in the `fixType` field of the UBX-NAV-PVT message). This distinguishes between failures to obtain a fix ("No Fix") and cases where a fix has been achieved, which are further subdivided into specific types of fixes (for example, 2D, 3D).

Where a fix has been achieved, the fix is checked to determine whether it is valid or not. A fix is only valid if it passes the navigation output filters as defined in CFG-NAVSPG-OUTFIL. In particular, both PDOP and accuracy values must be below the respective limits.

☞ Important: Users are recommended to check the `gnssFixOK` flag in the UBX-NAV-PVT or the NMEA valid flag. Fixes not marked as valid should not be used.

UBX-NAV-STATUS message also reports whether a fix is valid in the `gpsFixOK` flag. These messages have only been retained for backwards compatibility and it is recommended to use the UBX-NAV-PVT message.

2.2.4 Odometer filters

2.2.4.1 Speed (3D) low-pass filter

The CFG-ODO-OUTLPVEL configuration item activates a speed (3D) low-pass filter. The output of the speed low-pass filter is available in the UBX-NAV-VELNED message (`speed` field). The filtering level can be set via the CFG-ODO-VELLPGAIN configuration item and must be between 0 (heavy low-pass filtering) and 255 (weak low-pass filtering).

☞ The internal filter gain is computed as a function of speed. Therefore, the level defines the nominal filtering level for speeds below 5 m/s, as defined in the CFG-ODO-VELLPGAIN configuration item.

2.2.4.2 Course over ground low-pass filter

The CFG-ODO-OUTLPCOG configuration item activates a course over ground low-pass filter when the speed is below 8 m/s. The output of the course over ground (also named heading of motion 2D) low-pass filter is available in the UBX-NAV-PVT message (`headMot` field), UBX-NAV-VELNED message (`heading` field), NMEA-RMC message (`cog` field), and NMEA-VTG message (`cogt` field). The filtering level can be set via the CFG-ODO-COGLPGAIN configuration item and must be between 0 (heavy low-pass filtering) and 255 (weak low-pass filtering).

☞ The filtering level defines the filter gain for speeds below 8 m/s, as defined in the CFG-ODO-COGLPGAIN configuration item. If the speed is 8 m/s or higher, no course over ground low-pass filtering is performed.

2.2.4.3 Low-speed course over ground filter

The CFG-ODO-USE_COG configuration item activates this feature and the CFG-ODO-COGMAXSPEED, CFG-ODO-COGMAXPOSACC configuration items are used to configure a low-speed course over ground filter (also named heading of motion 2D). This filter derives the course over ground from position at very low speed. The output of the low-speed course over ground filter is available in the UBX-NAV-PVT message (`headMot` field), UBX-NAV-VELNED message (`heading` field), NMEA-RMC message (`cog` field) and NMEA-VTG message (`cogt` field). If the low-speed course over ground filter is not configured, then the course over ground is computed as described in section Freezing the course over ground.

2.2.5 Static hold

The static hold mode allows the navigation algorithms to decrease the noise in the position output when the velocity is below a predefined "Static Hold Threshold" level. This reduces the position wander caused by environmental factors such as multi-path and improves position accuracy especially in stationary applications. By default, the static hold mode is disabled.

The CFG-MOT-GNSSSPEED_THRS configuration item defines the static hold speed threshold. If the speed drops below the defined "Static Hold Threshold", static hold mode is activated. Once static hold mode is active, the position output is kept static and the velocity is set to zero until there is evidence of movement again. Such evidence can be velocity, acceleration, changes of the valid flag (for example, position accuracy estimate exceeding the position accuracy mask, see also section Navigation output filters), position displacement, etc.

The CFG-MOT-GNSSDIST_THRS configuration item defines the static hold distance threshold. If the distance between the estimated position and the static hold position exceeds the defined threshold, the static hold mode is suspended or deactivated until there is evidence of no movement.
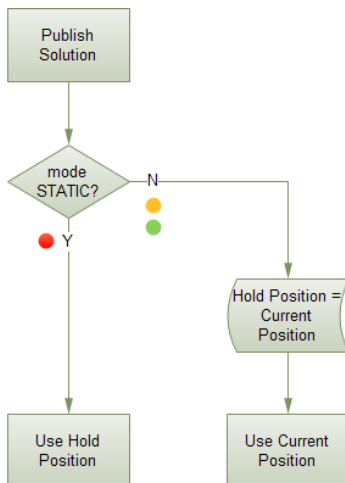

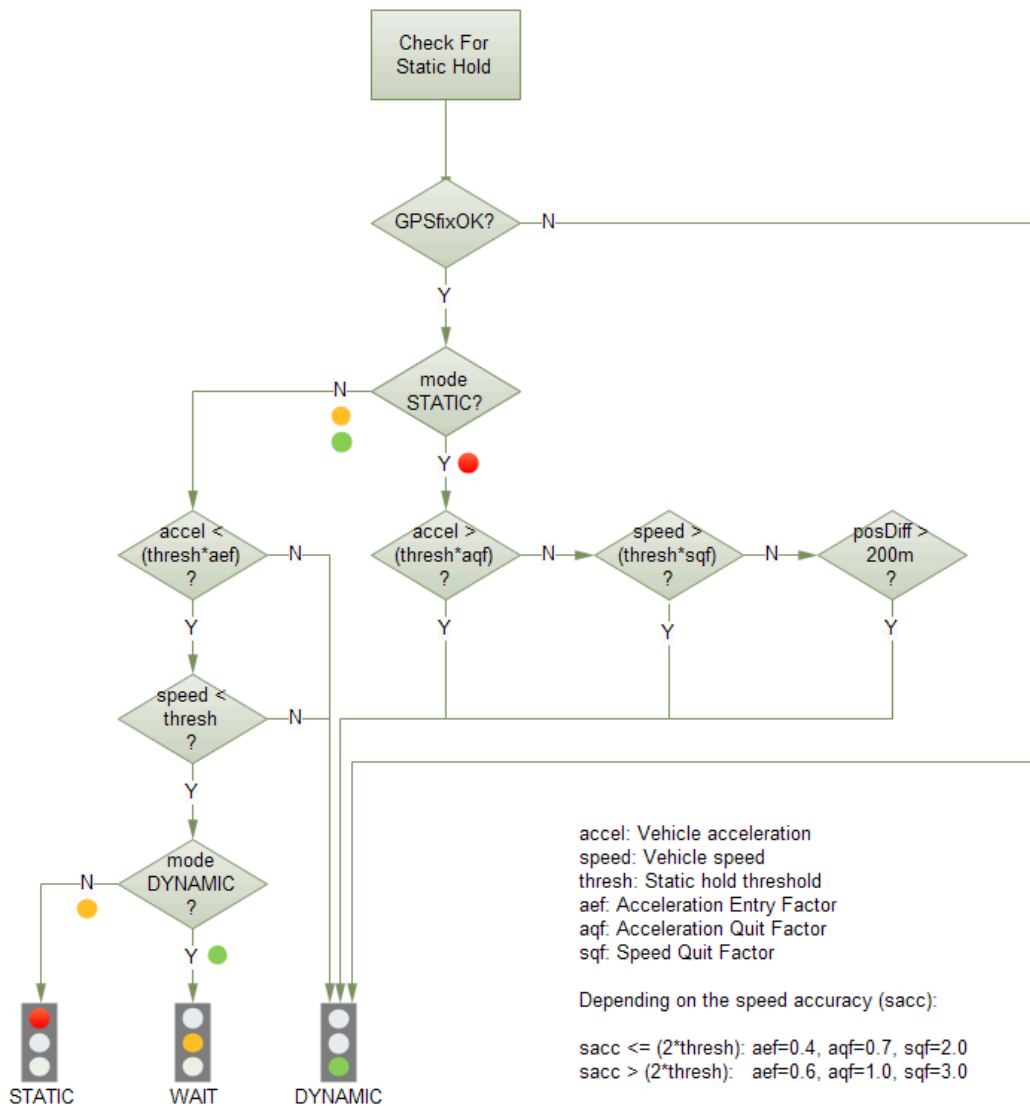**Figure 3: Position output in static hold mode**

Figure 4: Flowchart of static hold mode

2.2.6 Freezing the course over ground

If the low-speed course over ground filter is deactivated or inactive (see section Low-speed course over ground filter), the receiver derives the course over ground from the GNSS velocity information. If the velocity cannot be calculated with sufficient accuracy (for example, with bad signals) or if the absolute speed value is very low (under 0.1 m/s), the course over ground value becomes inaccurate too. In this case the course over ground value is frozen, that is, the previous value is kept and its accuracy degrades over time. These frozen values will not be output in the NMEA messages NMEA-RMC and NMEA-VTG unless the NMEA protocol is explicitly configured to do so (see NMEA protocol configuration in the applicable interface description [3]).
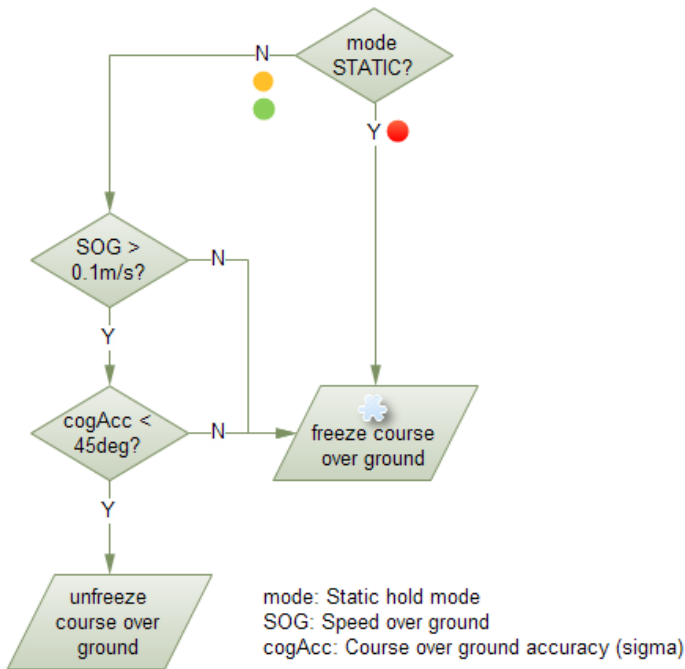
Figure 5: Flowchart of course over ground freezing

3 Receiver functionality

This chapter provides a description of the receiver's functionality.

3.1 Communication interfaces and PIOs

NEO-F10N supports communication over UART for communication with a host system. UBX and NMEA protocols can be enabled simultaneously with individual interface settings, e.g., for baud rate, message rates, and so on.

3.1.1 UART

NEO-F10N supports a Universal Asynchronous Receiver/Transmitter (UART) port consisting of an RX and a TX line. The UART can be used as a host interface which supports a configurable baud rate and protocol selection.

☞ Neither handshaking signals nor hardware flow control signals are supported.

The UART baud rate can be configured for selected speeds. Different rates than these speeds are not supported for transmission and reception.

☞ The UART RX interface will be disabled when more than 100 frame errors are detected during a one-second period. This can happen if the wrong baud rate is used or the UART RX pin is grounded. An error message appears when the UART RX interface is re-enabled at the end of the one-second period.

Baud rate	Data bits	Parity	Stop bits
4800	8	none	1
9600	8	none	1
19200	8	none	1
38400	8	none	1
57600	8	none	1
115200	8	none	1
230400	8	none	1
460800	8	none	1
921600	8	none	1

Table 10: Possible UART interface configurations

Allow a short time delay of typically 100 ms between sending a baud rate change message and providing input data at the new rate. Otherwise some input characters may be ignored or the port could be disabled until the interface is able to process the new baud rate.

☞ The default baud rate is 38400 baud. Using a lower baud rate may cause buffering problems.

If there is too much data for the interface's bandwidth, the output buffer will fill up. Once the buffer space is exceeded, new messages to be sent will be dropped. To prevent message loss, the baud rate and the number of enabled messages should be selected carefully.

3.1.2 PIOs

This section describes the PIOs supported by NEO-F10N. All PIO active voltage levels are related to the VCC supply voltage. All the inputs have internal pull-up resistors in normal operation and can be left open if unused.

☞ When assigning a different function to a PIO, ensure that the default function is disabled where applicable. For example, disable the I2C interface with the CFG-I2C-ENABLED configuration key if I2C pins are used for antenna supervisor functions.

3.1.2.1 RESET_N

NEO-F10N provides a RESET_N pin to reset the receiver. The RESET_N pin is input-only with an internal pull-up resistor to VCC and should be left open for normal operation. Driving RESET_N low for at least 1 ms will trigger a reset of the receiver. The RESET_N complies with the VCC level and can be actively driven high.

☞ Use RESET_N only in critical situations to recover the receiver. RESET_N resets the receiver and clears the BBR content including receiver configuration, real-time clock (RTC), and GNSS orbit data, triggering a cold start.

☞ No capacitor should be placed at RESET_N to GND, otherwise it could trigger a reset on every startup.

3.1.2.2 SAFEBOOT_N

The SAFEBOOT_N pin is for future service, updates and reconfiguration.

☞ The SAFEBOOT_N pin is internally connected to the TIMEPULSE pin through a 1 kΩ series resistor.

3.1.2.3 TIMEPULSE

The NEO-F10N features one time pulse output at the TIMEPULSE pin. This can only be configured in PIO4.

☞ The TIMEPULSE and SAFEBOOT_N functions share the same internal IC function. If this pin is low at receiver startup, the receiver will enter safeboot mode. However, in normal operation the pin outputs the time pulse signal. Make sure there is no load on this pin that could pull it low at startup.

3.1.2.4 LNA_EN

The LNA_EN signal can be used to turn on and off an optional external LNA and an active antenna supply to optimize the power consumption in the backup modes. The LNA and the active antenna supply are turned on when the LNA_EN signal is "high".

The LNA_EN signal is also used internally in NEO-F10N to control the integrated LNAs. The polarity cannot be changed.

3.1.2.5 EXTINT

NEO-F10N supports external interrupts at the EXTINT pin. The EXTINT pin has a fixed input voltage threshold with respect to VCC.

The EXTINT pin can also be configured for another functionality.

☞ EXTINT functionality is only available at the EXTINT pin.

3.2 Forcing receiver reset

GNSS receivers typically make a distinction between cold, warm, and hot start based on the type of valid information the receiver has during the restart.

- **Cold start:** in the cold start mode, the receiver has no information from the last position (e.g. time, velocity, frequency etc.) at startup. Therefore, the receiver must search the full time and frequency space, and all possible satellite numbers. If a satellite signal is found, it is tracked

to decode the ephemeris (18-36 seconds under strong signal conditions), while the other channels continue to search satellites. Once there is a sufficient number of satellites with valid ephemeris, the receiver can calculate position and velocity data. Other GNSS receiver manufacturers call this the Factory startup mode.

- **Warm start:** in the warm start mode, the receiver has approximate information for time, position, and coarse satellite position data (Almanac). In this mode, the receiver normally needs to download ephemeris after power-up before it can calculate position and velocity data. As the ephemeris data is usually outdated after 4 hours, the receiver typically starts with a warm start if it has been powered down for more than 4 hours. In this scenario, several augmentations are possible. See Multiple GNSS assistance.
- **Hot start:** in the hot start mode, the receiver has been powered down only for a short time (4 hours or less), so that its ephemeris is still valid. Since the receiver does not need to download ephemeris again, this is the fastest startup method.

Using the UBX-CFG-RST message, you can force the receiver to reset and clear data, in order to see the effects of maintaining/losing such data between restarts. For this purpose, use the `navBbrMask` field in the UBX-CFG-RST message to initiate hot, warm, and cold starts, or a combination of startup modes.

The reset type can also be specified. This is not related to GNSS, but to the way the software restarts the system.

- **Hardware reset** uses the on-chip watchdog to electrically reset the chip. This is an immediate asynchronous reset. No stop events are generated.
- **Controlled software reset** terminates all running processes in an orderly manner. Once the system is idle, restarts the receiver operation, reloads its configuration and starts to acquire and track GNSS satellites.
- **Controlled software reset (GNSS only)** only restarts the GNSS tasks, without reinitializing the full system or reloading any stored configuration.
- **Hardware reset (after shutdown)** uses the on-chip watchdog to reset the receiver after shutdown.
- **Controlled GNSS stop** stops all GNSS tasks. The receiver is not restarted, but stops any GNSS-related processing.
- **Controlled GNSS start** starts all GNSS tasks.

Table 11 below contains an overview of the different reset types and the data that is cleared.

Reset type	Clears RAM	Clears BBR	Clears Flash
0x00 - Hardware reset (immediately), 0x04 - Hardware reset (after shutdown)	Yes	Yes	No
0x01 - Controlled Software reset	Yes	No	No
0x02 - Controlled Software reset (GNSS only), 0x08 - Controlled GNSS stop, 0x09 - Controlled GNSS start	No	No	No
RESET_N pin	Yes	Yes	No

Table 11: Overview of the available reset types

3.3 Power management

u-blox receivers support different operating modes. These modes represent strategies of controlling the acquisition and tracking engines to achieve either the best possible performance or good performance with reduced power consumption.

3.3.1 Continuous mode

NEO-F10N uses dedicated signal processing engines optimized for signal acquisition and tracking. The acquisition engine actively searches for and acquires signals during cold starts or when insufficient signals are available during navigation. The tracking engine continuously tracks and downloads all the almanac data and acquires new signals as they become available during navigation. The tracking engine consumes less power than the acquisition engine.

The current consumption is lower when a valid position is obtained quickly after the start of the receiver navigation, the entire almanac has been downloaded, and the ephemeris for each satellite in view is valid. If these conditions are not met, the search for the available satellites takes more time and consumes more power.

3.3.2 Backup modes

A backup mode is an inactive state where the power consumption is reduced to a fraction of that in operating modes. The receiver maintains time information and navigation data to speed up the receiver restart after backup or standby mode.

The NEO-F10N supports two backup modes: hardware backup mode and software standby mode.

3.3.2.1 Hardware backup mode

The hardware backup mode allows entering a backup state and resuming operation by switching the main power supply on and off while maintaining a V_BCKP supply via, e.g. a battery.

V_BCKP must be supplied to maintain the backup domain (BBR and RTC) to allow better TTFF, accuracy, availability and power consumption at the next startup compared with a cold start. As VCC is not supplied, the PIOs cannot be driven by an external host processor. If driving of the PIOs cannot be avoided, buffers are required for isolating the PIOs.

3.3.2.2 Software standby mode

Software standby mode is entered using the UBX-RXM-PMREQ message. The VCC supply, which must be maintained during standby is switched internally to supply the battery-backed RAM (BBR), RTC, and PIO sections to save power.

Entering the software standby mode clears the RAM memory including the receiver configuration. To maintain the configuration, store it on RAM and BBR or flash layers. For more information on permanence of the stored configuration, refer to Receiver configuration.

The software standby mode can be set for a specific duration, or until the receiver is woken up by a signal at a wake-up source defined in UBX-RXM-PMREQ. The possible wake-up sources are the UART RX or EXTINT pins. Refer to the interface description [3] for more information on the UBX-RXM-PMREQ message. A system reset with the RESET_N signal also terminates the software standby mode, clears the BBR content and restarts the receiver.

As VCC is supplied, the PIOs can be driven by an external host processor. No buffers are required for isolating the PIOs, which reduces cost.

☞ V_BCKP should be left open if not used.

4 Hardware integration

This section explains how the receiver can be integrated into an application design.

4.1 Power supply

The NEO-F10N has the following power supply pins: VCC and V_BCKP.

A power supply at VCC must be present for normal operation. A supply at V_BCKP is optional. If present, it enables the hardware backup mode when the VCC supply is off.

Refer to the NEO-F10N Data sheet [1] for absolute maximum ratings, operating conditions, and power requirements.

4.1.1 VCC

VCC provides power to the core and RF domains. Consequently, it always needs to be supplied to start up the receiver or for operation in continuous mode. The VCC pin supplies power to the core via an internal DCDC converter for efficient power consumption. A filtered VCC supply is available on the VCC_RF module pin.

VCC also supplies all the digital IOs, clock, and the backup domain. The current drawn at VCC depends on the activity and loading of the PIOs and the main oscillator.

☞ Do not add series resistance greater than 0.2 Ω on the supply line to avoid voltage ripple due to the dynamic current conditions.

☞ The output voltage at the VCC_RF pin is derived from the VCC supply, and consequently not available if the VCC supply is removed.

4.1.2 V_BCKP

Power supply at V_BCKP is optional. If the power supply at VCC is interrupted, but the V_BCKP pin is supplied, the receiver enters the hardware backup mode. In this mode, the RTC time and the GNSS orbit data in the BBR are maintained. Valid time and GNSS orbit data at startup improves positioning performance by enabling hot starts, warm starts, and AssistNow Autonomous. This ensures faster TTFF when VCC is supplied again. To make these features available, connect an independent power supply to V_BCKP to ensure backup domain supply when VCC is not supplied.

Designs using an external battery as a power source at the V_BCKP pin must consider the battery capacity. The GNSS satellite ephemeris data is typically valid for up to 4 hours for hot starts, and up to a few days for warm starts and AssistNow (Offline and Autonomous).

☞ Avoid high resistance on the V_BCKP line. During the switch to V_BCKP supply, a short current adjustment peak may cause a high voltage drop at the pin.

☞ If the hardware backup mode is not used, leave the V_BCKP pin open.

4.2 RF front-end

GNSS receivers operate with very low signal levels, ranging from –130 dBm to approximately –167 dBm. This alone is a challenge for the GNSS application design. Out-of-band sources of interference such as GSM, CDMA, WCDMA, LTE, Wi-Fi, or Bluetooth wireless systems with a much higher signal level require additional specific measures. The goal of the RF front-end design is to receive the in-band signal with minimum loss and added noise while suppressing the out-of-band interference.

The NEO-F10N RF front-end is designed for highest immunity against RF interference and is suitable for designs with a cellular transmitter. The integrated RF circuit includes an L1, L5 dual-band diplexer SAW filter followed by a low-noise amplifier (LNA) and a second SAW filter stage at both GNSS bands. There is also an LTE B13 notch filter in front of the LNA at L1 band. The dual-band SAW–LNA–SAW circuit with built-in LTE Band 13 suppression efficiently rejects out-of-band blocking signals and amplifies the GNSS signal enhancing the sensitivity of the receiver. The RF input is matched to 50 Ω and includes a built-in DC block.

Refer to the Block diagram for an overview of the RF front-end.

4.2.1 Internal LNA modes

In addition to the L1 and L5 band LNAs integrated in the RF front-end circuit in NEO-F10N, there are internal LNAs in the u-blox F10 receiver.

The internal L1 and L5 band LNAs in the receiver have three operating modes: normal gain, low gain, and bypass mode.

- By default, the internal L1 and L5 band LNAs are configured for the normal-gain mode for optimized sensitivity. For designs with external gain above 25 dB, the low-gain or bypass mode must be used to maintain the dynamic range.
- The low-gain mode can be used up to 35 dB total external gain. There are also minor improvements in immunity and power consumption in the low-gain mode.
- The bypass mode can be used up to 45 dB external gain. There are further improvements in immunity and power consumption in the bypass mode.

The internal LNA mode can be configured at run time in the RAM, BBR and flash layers using the configuration item CFG-HW-RF_LNA_MODE and applying a reset. Once in production, the flash layer can be configured to automatically apply the configuration at every startup. For more information, refer to Internal LNA mode configuration .

For information on RF parameters, refer to the NEO-F10N data sheet [1] .

4.2.2 Out-of-band blocking immunity

Out-of-band RF interference may degrade the quality and availability of the navigation solution. Out-of-band immunity limit describes the maximum power allowed at the receiver RF input with no degradation in performance. Minor violation of the immunity limit may reduce C/N0 of the received signals but does not necessarily affect the overall receiver performance. However, a significant violation may reduce receiver sensitivity or cause a complete loss of signal reception. The severity of the interference depends on the repetition rate, frequency, signal level, modulation, and bandwidth of the signal.

A typical out-of-band immunity limit at the NEO-F10N RF input for the normal gain (default) mode is +13 dBm at 400–1070 MHz, 1280–1460 MHz, and 1710–3300 MHz. The immunity decreases closer to the GNSS in-band. The limit is defined at room temperature using a test signal with 64QAM modulation and 10 MHz bandwidth similar to an LTE signal.

☞ If the out-of-band immunity limit is exceeded, it is recommended to verify that the receiver performance is not affected or is at an acceptable level in the presence of interference.

4.2.3 Out-of-band interference

RF interference is typically first coupled into the antenna and subsequently conducted into the receiver input. Typical out-of-band interference sources include transmitting antennas of other

radio systems. Estimation of the RF interference level coupled into the receiver antenna is a starting point for RF front-end design.

For designs with other radio systems, the maximum power coupled into the antenna can be estimated from the maximum transmission power and the isolation between the antennas. Practical values for antenna isolation can range from 15–20 dB down to 6–10 dB for very small devices. RF interference may also couple from external sources such as nearby mobile devices or base stations.

☞ A simplified test board can be used to estimate the isolation between two antennas. The size of the board and the placement of the antennas must match the final design. Connect the RF cables to the antenna inputs and measure S21 over the frequency band of interest with a vector network analyzer (VNA).

RF interference from other parts of the design is more difficult to estimate. One option is to measure the interference level at the receiver input using a spectrum analyzer. Interference within the design is primarily a problem at the receiver in-band, where it cannot be addressed by filtering on the RF path. Outside the GNSS band, the required filtering is determined by the estimated interference level and the immunity of the receiver.

The maximum power coupled into the receiver RF input is compared against the immunity limit of the receiver defined in Out-of-band blocking immunity.

4.2.4 Antenna power supply

Figure 6 shows an active antenna supply network to connect the antenna supply to the RF signal line. The inductance L4 connects the antenna power supply to the RF signal line. The capacitance C14 filters out high-frequency interference from the power supply and the resistor R8 limits the short-circuit current.

The type and value of L4 is selected to have a resonance peak at GNSS frequencies. This provides a high series impedance above 500 Ω at GNSS L1 and L5 frequencies, creating an impedance mismatch with respect to the 50 Ω RF signal line. This minimizes the effect of the feed point on the RF signal line, and isolates the antenna supply from the RF signal line at GNSS frequencies. Both R8 and L4 must have sufficient current and power rating to withstand the short-circuit current. Example component values for the antenna supply network are given in Standard resistors, Standard capacitors, and Inductors.

The VCC_RF pin can be used to supply an active antenna. VCC_RF is a RF filtered supply voltage derived from the VCC supply. Refer to the data sheet[1] for the VCC_RF specification.

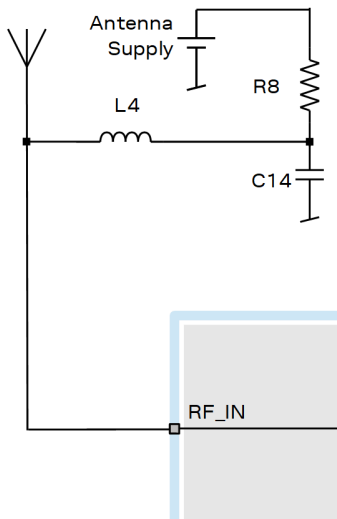The LNA_EN pin can be used to control the active antenna supply.

Figure 6: Antenna supply network

4.3 Layout

GNSS signals on the surface of the earth have a very low signal strength and are about 15 dB below the thermal noise floor. When integrating a GNSS receiver into a PCB, the placement of the components, as well as grounding, shielding, and interference from other digital devices are crucial issues that need to be considered very carefully.

An important factor in achieving high GNSS performance is the placement of the receiver with respect to other components on the PCB.

To minimize signal loss on the RF connection from the antenna to the receiver input and to avoid possible coupled interference, the connection to the antenna must be kept short while keeping some distance from the antenna to other electronic components.

The RF section should not be subject to noisy digital supply currents running through its GND plane. Make sure that critical RF circuits are clearly separated from any other digital circuits on the system board. To achieve this, position the receiver digital part towards the digital section of the system PCB and place the RF section and antenna as far away as possible from the other digital circuits on the board. Keep at least a 5 mm distance to any RF component and ensure proper grounding.

☞ For applications using cellular antennas, increase the distance between both antennas as much as possible.

Another very important factor in GNSS applications is the grounding concept. Ensure good ground reference to the host ground by increasing the number of GND vias. The GND vias will improve the GND reference between all the layers, and the pads will serve as thermal relief.

Any stubs at the ground planes must be avoided or ended with a via to the reference ground. Otherwise, they could pick up and propagate interference.

For the RF signal line, it is best to use the co-planar waveguide with ground on the second layer. All the RF parts need a solid GND plane underneath in order to achieve the targeted impedance in the RF signal line.

The length and geometry in the RF signal line must be carefully analyzed. The impedance of the RF signal line must be 50 Ω. Select the stack-up, copper, and dielectric properties of the PCB accordingly to fulfill this condition. The RF signal line should be as short as possible and the ground plane around should be filled with GND vias.

The RF trace must be shielded by vias to ground along the entire length of the trace and the NEO-F10N RF_IN pad should be surrounded by vias as shown in Figure 7.
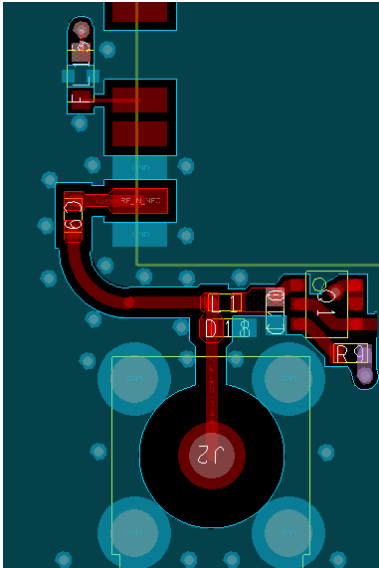

Figure 7: RF input trace

The RF_IN trace on the top layer should be referenced to a suitable ground layer.

The VCC pad for the NEO-F10N Standard precision GNSS module needs to have as low an impedance as possible with large vias to the lower power layer of the PCB. The VCC pad needs a large pad and the decoupling capacitor must be placed as close as possible. This is shown in Figure 8.
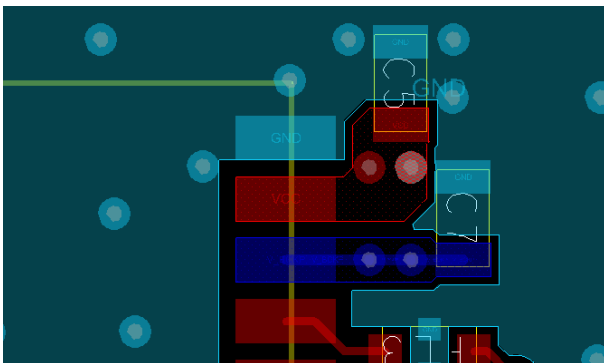

Figure 8: VCC pad

Be careful when placing the receiver in proximity to circuitry that can emit heat. Temperature-sensitive components inside the module, like TCXOs and crystals, are sensitive to sudden changes in ambient temperature which can adversely impact satellite signal tracking. Sources can include co-located power devices, cooling fans or thermal conduction via the PCB.

The GND planes can conduct heat to other elements, but they can act as heat dissipators as well. Increasing the number of GND vias helps to decrease sudden temperature changes.

⚠ High temperature drift and air vents can affect the GNSS performance. For best performance, avoid high temperature drift and air vents near the module.

4.3.1 Package footprint, copper and solder mask

The mechanical specification is available in the data sheet [1].

Figure 9 and Figure 10 describe the footprint and provide recommendations for the paste mask. Note that the copper and solder masks have the same size and position.

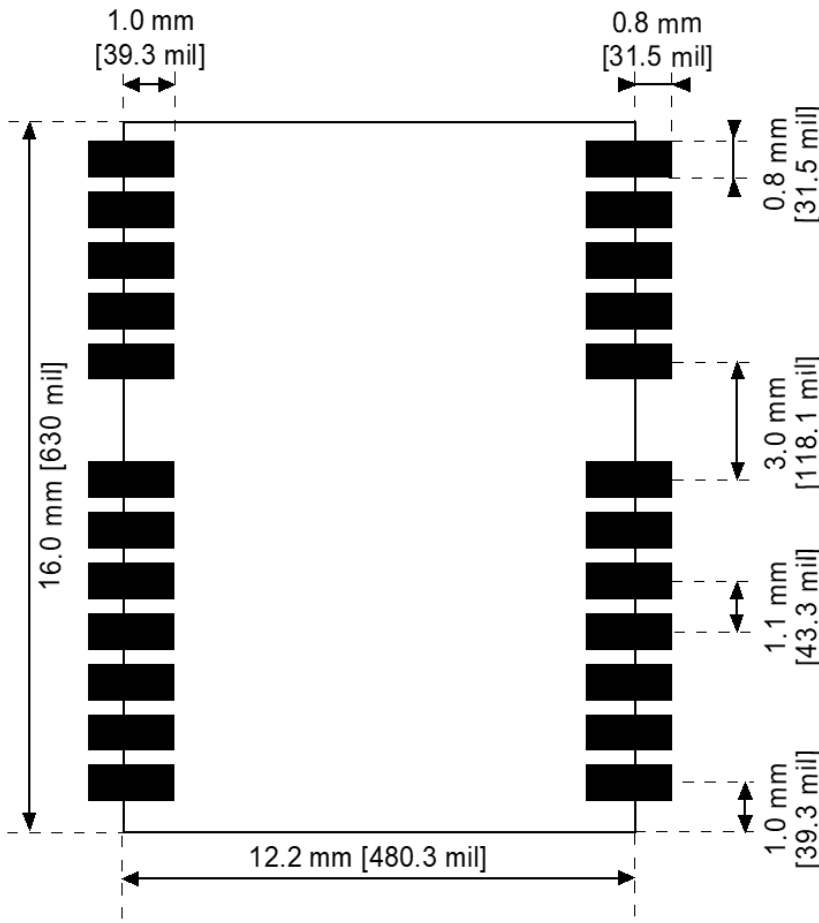**Figure 9: Recommended copper land and solder mask opening for NEO-F10N**

To improve the wetting of the half vias, reduce the amount of solder paste under the module and increase it outside of the module by defining the dimensions of the paste mask to form a T-shape (or equivalent) extending beyond the copper mask.
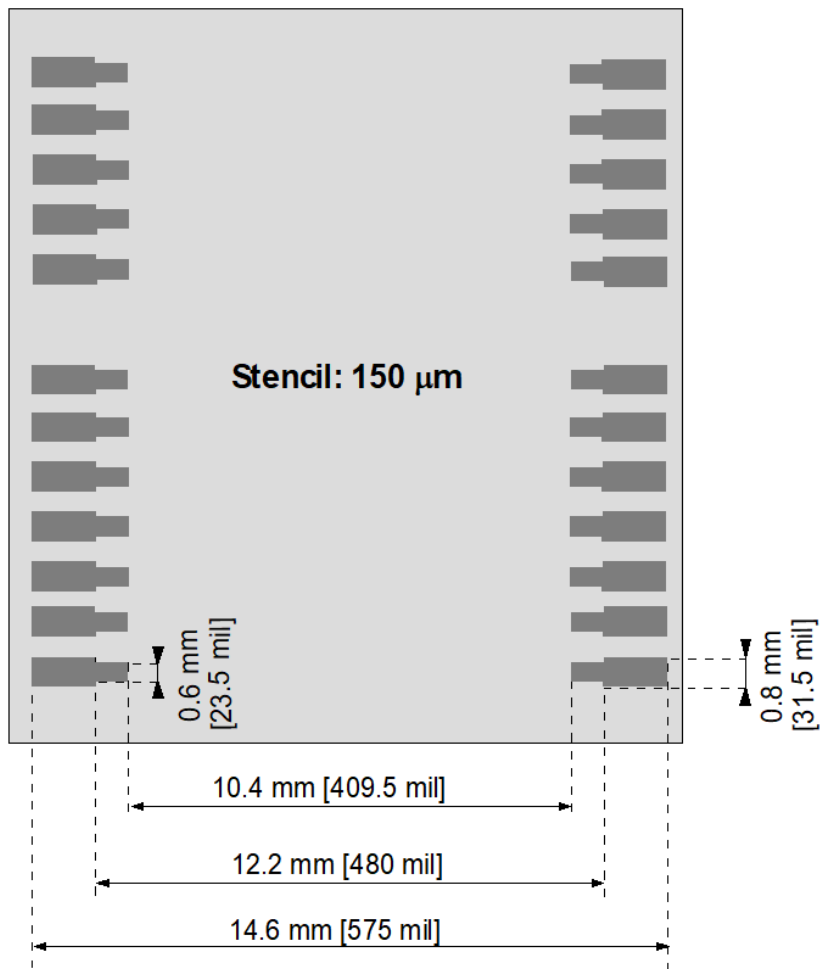
Recommended stencil thickness is 150 μm.

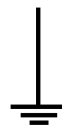**Figure 10: Recommended paste mask pattern for NEO-F10N**

5 Product handling
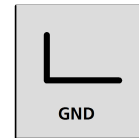
5.1 Safety

5.1.1 ESD precautions

⚠️ u-blox chips and modules contain highly sensitive electronic circuitry and are electrostatic sensitive devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the component!
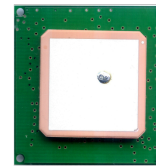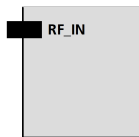
- Unless there is a galvanic coupling between the local GND (that is, the work desk) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.
- Before mounting an antenna patch, connect ground of the device.

Connect first to local GND

GND

- When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (for example, patch antenna ~10 pF, coax cable ~50-80 pF/m or soldering iron).

ESD Sensitive!

RF_IN

- To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in a non-ESD protected work area, implement proper ESD protection measures in the design.

- When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD-safe soldering iron (tip).

ESD safe only!

5.1.2 Safety precautions

The NEO-F10N modules must be supplied by an external limited power source in compliance with the clause 2.5 of the standard IEC 60950-1. In addition to external limited power source, only Separated or Safety Extra-Low Voltage (SELV) circuits are to be connected to the module including interfaces and antennas.

☞ For more information about SELV circuits see section 2.2 in Safety standard IEC 60950-1.

5.2 Packaging

The NEO-F10N modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down. For more information, see the u-blox packaging information reference [4].

5.2.1 Reels

NEO-F10N modules are deliverable in quantities of 250 pieces on a reel. They are shipped on reel type B, as specified in the u-blox Packaging information reference [4].

5.2.2 Tapes

Figure 11 shows the feed direction and illustrates the orientation of the components on the tape.
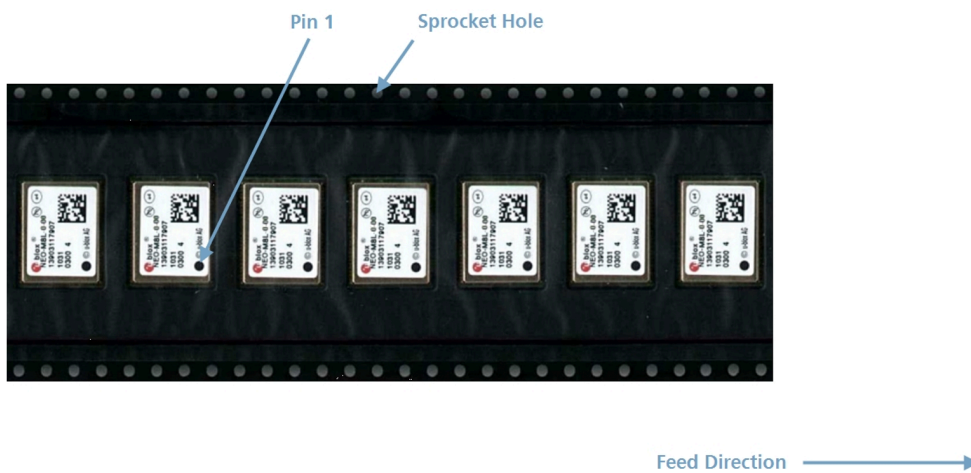

Figure 11: Orientation of the components on the tape

The feed direction into the pick and place pick-up is from the reel (located on the left of the figure) towards right, and the tape is fed to the right.

The dimensions of the tape are specified in Figure 12 (measurements in mm).
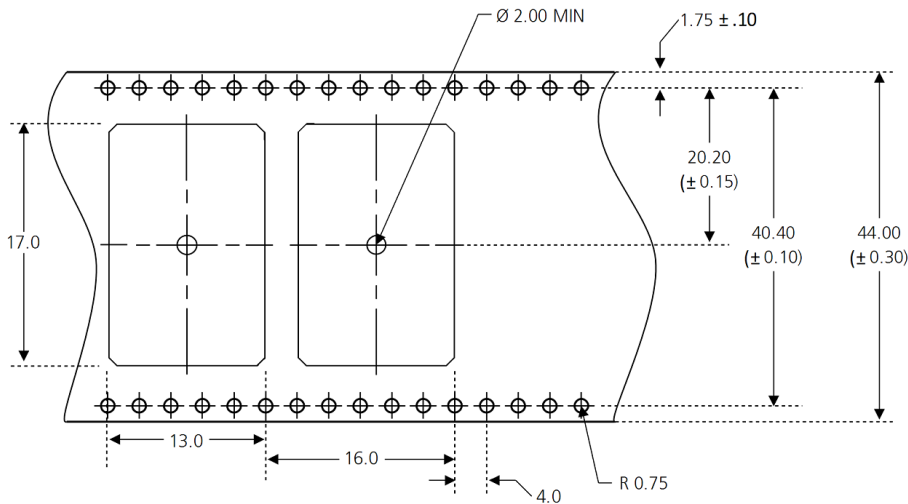
Figure 12: Tape dimensions (mm)

5.2.3 Moisture sensitivity level

The moisture sensitivity level (MSL) for NEO-F10N modules is specified in the table below.

Package	MSL level
LCC (professional grade)	4

Table 12: MSL level

For MSL standard see IPC/JEDEC J-STD-020, and J-STD-033 that can be downloaded from www.jedec.org. For more information regarding moisture sensitivity levels, labeling, storage and drying, see the u-blox packaging information reference [4].

5.2.4 Soldering

Reflow soldering procedures are described in the IPC/JEDEC J-STD-020 standard.

☞ When populating the modules, make sure that the pick and place machine is aligned to the copper pins of the module and not to the module edge.

Soldering paste

Use of "no clean" soldering paste is highly recommended, as it does not require cleaning after the soldering process. The paste in the example below meets these criteria.

- Soldering paste: OM338 SAC405 / Nr.143714 (Cookson Electronics)
- Alloy specification: Sn 95.5/ Ag 4/ Cu 0.5 (95.5% tin/ 4% silver/ 0.5% copper)
- Melting temperature: 217 °C
- Stencil: The exact geometry, distances, stencil thicknesses and solder paste volumes must be adapted to the customer's specific production processes.

Reflow soldering

A convection-type soldering oven is highly recommended over the infrared-type radiation oven. Convection-heated ovens allow precise control of the temperature, and all parts will heat up evenly, regardless of material properties, thickness of components and surface color.

As a reference, see "IPC-7530 Guidelines for temperature profiling for mass soldering (reflow and wave) processes", published in 2001.

Preheat phase

During the initial heating of component leads and balls, residual humidity will be dried out. Note that the preheat phase does not replace prior baking procedures.

- Temperature rise rate: max 3 °C/s. If the temperature rise is too rapid in the preheat phase, excessive slumping may be caused
- Time: 60 – 120 s. If the preheat is insufficient, rather large solder balls tend to be generated. Conversely, if performed excessively, fine balls and large balls will be generated in clusters
- End temperature: 150 – 200 °C. If the temperature is too low, non-melting tends to be caused in areas containing large heat capacity

Heating - reflow phase

The temperature rises above the liquidus temperature of 217 °C. Avoid a sudden rise in temperature as the slump of the paste could become worse.

- Limit time above 217 °C liquidus temperature: 40 – 60 s
- Peak reflow temperature: 245 °C

Cooling phase

A controlled cooling prevents negative metallurgical effects of the solder (solder becomes more brittle) and possible mechanical tensions in the products. Controlled cooling helps to achieve bright solder fillets with a good shape and low contact angle.

- Temperature fall rate: max 4 °C/s

☞   To avoid falling off, the modules should be placed on the topside of the board during soldering.

The final soldering temperature chosen at the factory depends on additional external factors such as the choice of soldering paste, size, thickness and properties of the base board, etc. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.
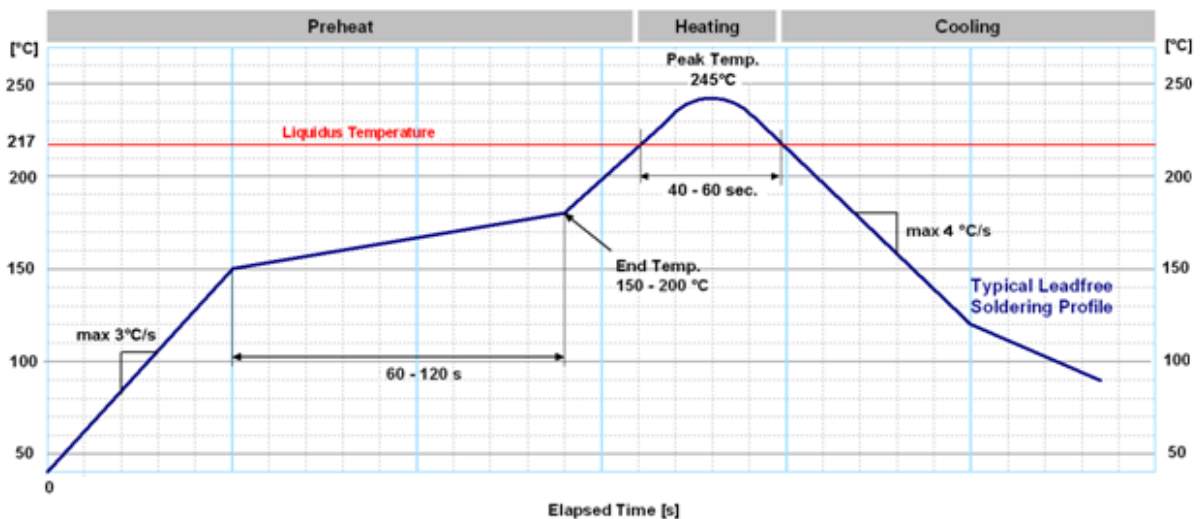

Figure 13: Soldering profile

☞   Modules must not be soldered with a damp heat process.

Optical inspection

After soldering the module, consider optical inspection.

Cleaning

☞ Do not clean with water, solvent, or ultrasonic cleaner:

- Cleaning with water will lead to capillary effects where water is absorbed into the gap between the baseboard and the module. The combination of residues of soldering flux and encapsulated water leads to short circuits or resistor-like interconnections between neighboring pads.
- Cleaning with alcohol or other organic solvents can result in soldering flux residues flowing underneath the module, into areas that are not accessible for post-cleaning inspections. The solvent will also damage the sticker and the printed text.
- Ultrasonic cleaning will permanently damage the module, in particular the quartz oscillators.

The best approach is to use a "no clean" soldering paste to eliminate the cleaning step after the soldering.

Repeated reflow soldering

☞ Repeated reflow soldering processes or soldering the module upside down are not recommended.

A board that is populated with components on both sides may require more than one reflow soldering cycle. In such a case, the process should ensure the module is only placed on the board submitted for a single final upright reflow cycle. A module placed on the underside of the board may detach during a reflow soldering cycle due to lack of adhesion.

The module can also tolerate an additional reflow cycle for rework purposes.

Wave soldering

Base boards with combined through-hole technology (THT) components and surface-mount technology (SMT) devices require wave soldering to solder the THT components. Only a single wave soldering process is encouraged for boards populated with modules.

Rework

We do not recommend using a hot air gun because it is an uncontrolled process and can damage the module.

⚠ Use of a hot air gun can lead to overheating and severely damage the module. Always avoid overheating the module.

After the module is removed, clean the pads before reapplying solder paste, placing and reflow soldering a new module.

⚠ Never attempt a rework on the module itself, e.g. by replacing individual components. Such actions will immediately void the warranty.

Conformal coating

Certain applications employ a conformal coating of the PCB using HumiSeal® or other related coating products. These materials affect the RF properties of the GNSS module

☞ Conformal coating of the module will void the warranty.

Casting

If casting is required, use viscose or another type of silicon pottant. The OEM is strongly advised to qualify such processes in combination with the module before implementing this in the production.

☞ Casting will void the warranty.

Grounding metal covers

Attempts to improve grounding by soldering ground cables, wick or other forms of metal strips directly onto the EMI covers is done at the customer's own risk. The numerous ground pins should be sufficient to provide optimum immunity to interferences and noise.

☞   u-blox makes no warranty for damages to the module caused by soldering metal cables or any other forms of metal strips directly onto the EMI covers.

Use of ultrasonic processes

Some components on the module are sensitive to ultrasonic waves. Use of any ultrasonic processes (cleaning, welding etc.) may cause damage to the receiver.

☞   u-blox offers no warranty against damages to the module caused by ultrasonic processes.

Appendix

A Migration

u-blox is committed to ensure that products in the same form factor are backwards compatible over several technology generations. This section describes important differences to consider when migrating from u-blox M8 to u-blox F10.

A.1 Hardware changes

Table 13 lists the key hardware-related changes between NEO-F10N and the NEO-M8 modules.

Feature	Change	Action needed / Remarks
Absolute maximum ratings	Maximum input voltage for PIOs is changed to VCC + 0.3 V in NEO-F10N.	HW change is required if main supply voltage source is not within the specified range.
VCC supply range	NEO-F10N: 2.7 V - 3.6 V NEO-M8M: 1.65 V - 3.6 V	HW change is required when migrating from a NEO-M8M design that uses less than 2.7 V VCC supply.
V_BCKP supply range	NEO-F10N: 1.65 V - 3.6 V NEO-8Q/M8N/Q/J/M: 1.4 V - 3.6 V	HW change is required when migrating from a NEO-8Q or NEO-M8 design that uses less than 1.65 V V_BCKP supply.
Backup current	NEO-F10N: I_BCKP = 31 µA NEO-8Q/M8N/Q/J/M: I_BCKP = 15 µA	The hardware backup current in NEO-F10N is higher than in NEO-8Q and NEO-M8 modules. Check that the backup battery capacity is still suitable for the target design/application requirements.
Power consumption	NEO-F10N peak current: 100 mA NEO-8Q/M8 peak current: 67 mA	In u-blox F10, the average current consumption of acquisition and tracking state is smaller than in u-blox 8/M8. However, in terms of peak current, I_VCC is slightly higher in u-blox F10 than in u-blox 8/M8. Ensure that the power supply is still able to provide clean and stable voltage with the higher current demand in NEO-F10N.
Pin-out	1:1 pin-out mapping with NEO-8Q/ M8N/Q/J/M modules.	NEO-M8M (pin 14) is reserved and NEO-F10N (pin 14) is LNA_EN. NEO-M8M designs can be updated to use pin 14 on NEO-F10N for external LNA and antenna control. VDD_USB (pin 7) name changed to Reserved in NEO-F10N since USB interface is not available.
Communication interfaces	Due to the hardware implementation, only UART interface is available on NEO-F10N.	Communication with host can only be done by UART interface.
Dual-band L1+L5 SAW-LNA-SAW RF front-end	NEO-F10N has two SAW filters and one LNA on the RF path for both L1 and L5 along with a Band 13 notch filter for L1, which allows the use of a passive antenna.	The Band 13 notch filter and the SAW filters used in NEO-F10N provide improved out-of-band immunity compared to NEO-8Q and NEO-M8 modules.
RF path	NEO-F10N supports dual-band L1/L5 GNSS signals. NEO-F10N noise figure: 3 dB for L1 and L5 NEO-8Q/M8 noise figure: 2 dB	Antenna supporting dual-band L1/L5 is required with NEO-F10N. Check that the RF path (antenna and filtering) is suitable for all of the GNSS signals in use.
RESET_N	NEO-F10N: clears RTC time and BBR contents (GNSS orbit data). NEO-8Q/M8: clears only RTC time.	TTFF after resetting NEO-F10N with the RESET_N pin is similar to performing a cold start. TTFF after resetting NEO-8Q/M8 modules is typically around 6 s in open-sky conditions.

Feature	Change	Action needed / Remarks
Digital IO	External IO isolation is required. The output current of the digital IOs is 2 mA compared to 4 mA in NEO-8Q and NEO-M8 modules, except for the TIMEPULSE pin, which still provides drive strength of 4 mA.	**Caution!** Risk of receiver damage. If the IO pins are not isolated, the GNSS receiver may get permanently damaged when high current is drawn from the IO pins. Use external IO isolation to avoid receiver damage. Do not drive IOs when VCC is not supplied. Removing the VCC supply does not isolate the module IO pins from the the host device IO pins. You may need to use additional external pull-up resistors to increase the drive strength of the digital IO output pin or adjust the load accordingly.

Table 13: NEO-F10N hardware features compared to NEO-8Q/M8 modules

A.2 Software changes

Table 14 presents a summary of the key software-related changes between u-blox F10 and u-blox M8.

Feature	Change	Action needed / Remarks
Signals		
Default GNSS configuration	NEO-F10N: Dual-band L1/L5 signals for GPS, Galileo, BeiDou B1C/B2a and SBAS. NEO-M8N/Q/M/J: Single-band L1 signals GPS, GLONASS, QZSS and SBAS.	Code change (optional) HW change (optional): requires antenna selection or antenna frequency tuning and any additional filtering in the previous NEO-M8 designs to support L5 frequency band.
GPS L5	New signal.	Code change (optional)
BeiDou B1C	New signal. BeiDou satellite IDs up to 63 supported.	Code change (optional)
BeiDou B2a	New signal. BeiDou satellite IDs up to 63 supported.	Code change (optional)
Galileo E5a	New signal.	Code change (optional)
GLONASS	GLONASS system is not supported.	Code change
SBAS	New SBAS PRN selection: 123, 126-129, 131, 133, 136-138.	Code change (optional)
QZSS L1S	SLAS corrections are now applied for navigation.	Code change (optional)
QZSS IMES	Not supported in current firmware.	Code change (optional)
NavIC SPS L5	New signal.	Code change (optional)
Protocols		
NMEA	Supports NMEA V4.11, V4.10, V4.0, V2.3, and V2.1. NMEA V4.11 is enabled by default. In u-blox F10, the NMEA GSV messages for zero signal C/No level are grouped separately as compared to u-blox M8. If the signal's C/No level is 0, the FW treats it as an unknown signal for not being able to track it and sets the "signal ID" to zero. The FW then creates separate GSV messages for grouping the untracked signals with zero C/No and other messages for grouping the tracked signals with non-zero C/No. In the untracked signals message group, the C/No field is blank (i.e. , ,). There is no configuration to revert this to the u-blox M8 format.	Code change (optional)
RTCM	Not supported in current firmware.	Code change
General		
Configuration concept	New configuration scheme using UBX-CFG-VALSET and UBX-CFG-VALGET messages.	Code change

Feature	Change	Action needed / Remarks
Navigation update rate	Navigation update rate up to 25 Hz for single GNSS and 10 Hz for multi-GNSS constellations.	Code change (optional)
Power save mode (PSM)	PSM is not supported. Hardware backup and software standby modes are supported.	Code change (optional)
Altitude limit	The maximum altitude limit increased to 80 000 m.	-
AssistNow	Simultaneous operation of AssistNow Online, Offline and Autonomous. New AssistNow Offline data download options are available. The time period can be limited to a resolution of days to reduce the data package size.	Code change (optional)
Geofencing	Not supported in current firmware.	Code change
Data logging	Not supported in current firmware.	Code change
Galileo return link message	Galileo search and rescue (SAR) return link message UBX-RXM-RLM.	Code change (optional)
RF spectrum view	New message. UBX-MON-SPAN shows in-band RF spectrum around the GNSS band. This can be used to identify potential in-band RF interference sources in the design.	Code change (optional)
Protection level	New feature. Real-time position accuracy estimate with 95% confidence level with the message UBX-NAV-PL.	Code change (optional)
Security		
Message integrity	New feature. Authentication of data output based on private/public key pair.	Code change (optional)
Unique chip identifier	A unique chip identifier output in boot screen and in the UBX-SEC-UNIQID message.	Code change (optional))
Configuration lock	New security feature that is enabled with CFG-SEC-CFG_LOCK message for locking the receiver configuration.	Code change (optional)

Table 14: NEO-F10N software features

For more information on supported features and messages in u-blox NEO-F10N receiver, refer to the firmware Release notes [2] and the Interface description [3] .

B Reference designs

The External components section provides the specification and recommendations for the external components that are shown in each reference design.

B.1 Typical design

Here are some key features for a NEO-F10N typical design:
• The internal RF front design in the NEO-F10N makes the module suitable for passive antenna designs where external gain is not required. It is importnat to use a good quality passive antenna to avoid performance degradation. Figure 14 shows a design using a dual band passive antenna with single feed.
• NEO-F10N has an internal SAW filter diplexer, two SAW filters and an LTE band 13 notch filter which provides high out-of-band immunity against RF interference from other sources.
• Applications that require maximum sensitivity can integrate an external LNA with very low noise figure (NF). The maximum external gain must not exceed 25 dB. The external LNA can be supplied with the VCC_RF output from NEO-F10N and controlled by the LNA_EN signal, switching off the LNA when entering hardware backup mode, and software standby mode.

- V_BCKP supply is optional. If present, the hardware backup mode is supported. This mode maintains the RTC time and GNSS orbit data in the battery-backed RAM memory if the main supply is switched off.
  If there is no backup supply, time aiding with the UBX-MGA-INI-TIME_UTC message (optionally with a timing signal at the EXTINT pin) and the GNSS orbit data from the AssistNow services or stored on the host controller can be used to reduce the TTFF.
- For an absolute minimum design, all the PIOs (RESET_N, EXTINT, TIMEPULSE, LNA_EN, and SAFEBOOT_N) can be left open.
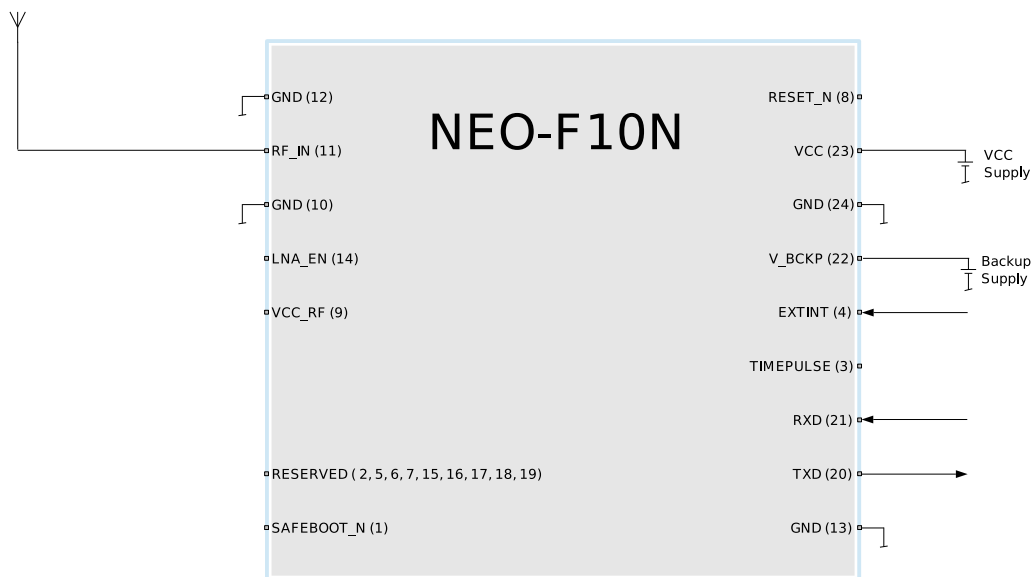

Figure 14: Typical design

B.2 Active antenna design

Here are some key features for a NEO-F10N design with an active antenna:

- Designs using active antennas must not exceed 25 dB gain. For antenna gain above 25 dB, the internal LNA mode can be changed to low-gain or bypass mode.
- The active antenna can be supplied either with the VCC_RF output from NEO-F10N as shown in Figure 16 or from an external supply as shown in Figure 15. In both figures the supply is controlled by the LNA_EN signal. The LNA_EN signal combined with the dual MOSFET switches on/off the antenna power supply when VCC supply is removed or during software standby mode, saving the antenna power consumption during the off periods.
- Designs using the VCC_RF output to supply the GNSS antenna require a current limiter circuitry in case of short circuit on the antenna side. Figure 16 shows the required components. The R17 resistor value defines the maximum current in case of antenna short circuit.

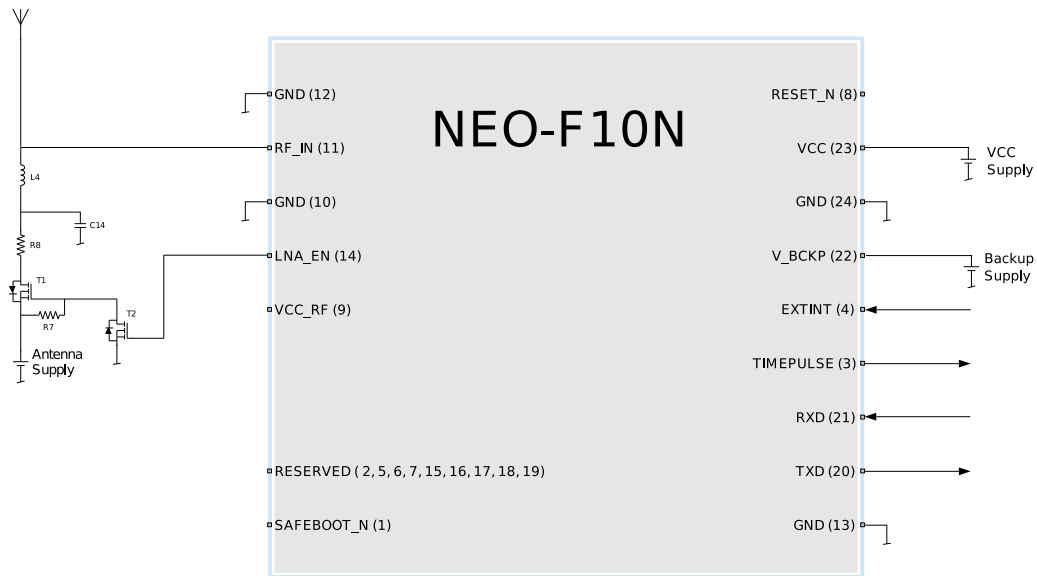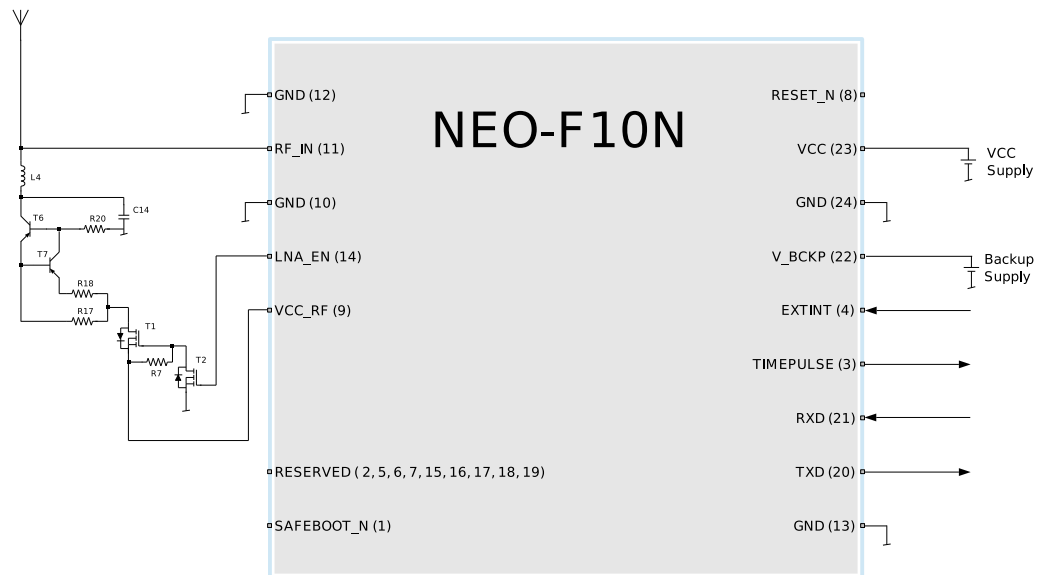**Figure 15: Design with active antenna controlled by LNA_EN signal**

Figure 16: Design with active antenna supplied by VCC_RF and controlled by LNA_EN signal

C External components

This section lists the recommended values for the external components in the reference designs.

C.1 Standard capacitors

Table 15 presents the recommended capacitor values for NEO-F10N.

Name	Use	Type / Value
C14	RF Bias-T capacitor	10 nF, 10%, 16 V, X7R

Table 15: Standard capacitors

C.2 Standard resistors

Table 16 presents the recommended resistor values for NEO-F10N.

Name	Use	Type / Value
R7	Pull-up resistor at antenna switch transistor	100 kΩ, 5%, 0.1 W
R8	Antenna supply current limiter/shunt resistor	10 Ω, 5%, 0.25 W
R17	Current limiter to supply antenna through VCC_RF	10 Ω, 5%, 0.1 W
R18	Current limiter to supply antenna through VCC_RF	220 Ω, 5%, 0.1 W
R20	Current limiter to supply antenna through VCC_RF	2.2 kΩ, 5%, 0.1 W

Table 16: Standard resistors

C.3 Inductors

Table 17 presents the recommended inductor values for NEO-F10N.

Name	Use	Type / Value	Recommended component
L4	RF Bias-T inductor	47 nH, 5%	Murata LQG15HS47NJ02
			Johanson Technology L-07W series
			Any other inductor with impedance > 500 Ω at GNSS L1 and L5 frequencies and current rating above 300 mA.

Table 17: Recommended inductors

C.4 Switch transistors for antenna supply

Table 18 presents the recommended switch transistors for NEO-F10N.

Name	Manufacturer	Order no.	Comments
T1, T2	Vishay	Si1016X-T1-GE3	p-channel, n-channel MOSFET
T6, T7	-	BC857C	BJT PNP transistor

Table 18: Recommended parts list for the antenna supply switch transistors

Related documents

[1] NEO-F10N Data sheet, UBX-23002117
[2] u-blox F10 SPG 6.00 Release notes, UBXDOC-963802114-12318
[3] u-blox F10 SPG 6.00 Interface description, UBX-23002975
[4] u-blox Packaging information reference, UBX-14001652

☞ 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	05-Sep-2023	Initial release.
R02	07-Nov-2023	Added sections: • GPS L5 signal health status configuration • LNA_EN Updated sections: • Block diagram • Pin assignment • Internal LNA modes • Migration

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