

NEO-M8N

u-blox GNSS module

Hardware Integration Manual

Abstract

This document describes the features and specifications of u-blox NEO-M8N module.



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Document Information

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Document status explanation

Objective Specification	Document contains target values. Revised and supplementary data will be published later.		
Advance Information	Document contains data based on early testing. Revised and supplementary data will be published later.		
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Production Information	Document contains the final product specification.		

This document applies to the following products:

Product name	Type number	ROM/FLASH version	PCN reference
NEO-M8N	NEO-M8N-0-10	FLASH SPG 3.01	N/A

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Preface

u-blox Technical Documentation

As part of our commitment to customer support, u-blox maintains an extensive volume of technical documentation for our products. In addition to our product-specific technical data sheets, the following manuals are available to assist u-blox customers in product design and development.

- **GPS Compendium:** This document, also known as the GPS book, provides a wealth of information regarding generic questions about GPS system functionalities and technology.
- **Receiver Description including Protocol Specification:** This document describes messages, configuration and functionalities of the NEO-M8N software releases and receivers.
- **Hardware Integration Manuals:** These manuals provide hardware design instructions and information on how to set up production and final product tests.
- **Application Notes:** These documents provide general design instructions and information that applies to all u-blox GNSS positioning modules.

How to use this Manual

This manual has a modular structure. It is not necessary to read it from beginning to end.

The following symbols highlight important information within the manual:



An index finger points out key information pertaining to module integration and performance.



A warning symbol indicates actions that could negatively influence or damage the module.

Questions

If you have any questions about NEO-M8N integration, please:

- Read this manual carefully.
- Contact our information service on the homepage <http://www.u-blox.com>.
- Read the questions and answers on our FAQ database on the homepage.

Technical Support

Worldwide Web

Our website (www.u-blox.com) is a rich pool of information. Product information, technical documents and helpful FAQ can be accessed 24h a day.

By E-mail

If you have technical problems or cannot find the required information in the provided documents, contact the closest Technical Support office. To ensure that we process your request as soon as possible, use our service pool email addresses rather than personal staff email addresses. Contact details are at the end of the document.

Helpful Information when Contacting Technical Support

When contacting Technical Support please have the following information ready:

- Receiver type (e.g. NEO-M8N-0-10), Datacode (e.g. 180200.1000) and firmware version (e.g. FLASH SPG 3.01)
- Receiver/module configuration
- Clear description of your question or the problem (may include a u-center logfile)
- A short description of the application
- Your complete contact details

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Advance Information

1 Hardware description

1.1 Overview

u-blox NEO-M8N is a standard precision GNSS module featuring the high performance u-blox M8 positioning engine. Available in the industry standard NEO form factor in leadless chip carrier (LCC) package, they are easy to integrate and combine exceptional positioning performance with highly flexible power, design, and connectivity options. SMT pads allow fully automated assembly with standard pick & place and reflow-soldering equipment for cost-efficient, high-volume production enabling short time-to-market.



For product features see the *NEO-M8N Data Sheet* [1].



To determine which u-blox product best meets your needs, see the product selector tables on the u-blox website www.u-blox.com.

1.2 Configuration

The configuration settings can be modified using UBX protocol configuration messages, see the *u-blox 8 / u-blox M8 Receiver Description including Protocol Specification* [2]. The modified settings remain effective until power-down or reset. If these settings have been stored in BBR (Battery Backed RAM), then the modified configuration will be retained, as long as the backup battery supply is not interrupted.

For NEO-M8N module, configuration can be saved permanently in SQL flash.

1.3 Connecting power

The u-blox NEO-M8N module has four power supply pins: **VCC**, **V_BCKP**, **VDD_USB**, and **VCC_RF**.

1.3.1 VCC: Main supply voltage

The **VCC** pin provides the main supply voltage. During operation, the current drawn by the module can vary by some orders of magnitude, especially if enabling low-power operation modes. For this reason, it is important that the supply circuitry be able to support the peak power for a short time (see the *NEO-M8N Data Sheet* [1] for specification).



When switching from backup mode to normal operation or at start-up, u-blox NEO-M8N modules must charge the internal capacitors in the core domain. In certain situations, this can result in a significant current draw. For low power applications using Power Save and backup modes, it is important that the power supply or low ESR capacitors at the module input can deliver this current/charge.

Use a proper GND concept. Do not use any resistors or coils in the power line.

1.3.2 V_BCKP: Backup supply voltage

If the module supply has a power failure, the **V_BCKP** pin supplies the real-time clock (RTC) and battery backed RAM (BBR). Use of valid time and the GNSS orbit data at start up will improve the GNSS performance, as with hot starts, warm starts, AssistNow Autonomous and AssistNow Offline. If no backup battery is connected, the module performs a cold start at power up.



Avoid high resistance on the **V_BCKP** line: During the switch from main supply to backup supply, a short current adjustment peak can cause high voltage drop on the pin with possible malfunctions.



If no backup supply voltage is available, connect the **V_BCKP** pin to **VCC**.



As long as power is supplied to the NEO-M8N module through the **VCC** pin, the backup battery is disconnected from the RTC and the BBR to avoid unnecessary battery drain (see Figure 1). In this case, **VCC** supplies power to the RTC and BBR.

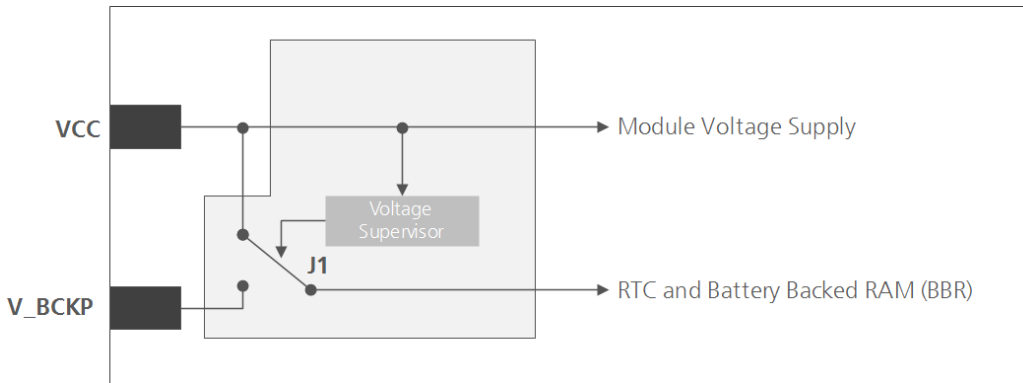


Figure 1: Backup battery and voltage (for exact pin orientation, see the *NEO-M8N Data Sheet [1]*)

Real-Time Clock (RTC)

The RTC is driven by a 32 kHz oscillator using an RTC crystal. If the main supply voltage fails, and a battery is connected to V_BCKP, parts of the receiver switch off, but the RTC still runs providing a timing reference for the receiver. This operating mode is called Hardware Backup Mode, which enables all relevant data to be saved in the backup RAM to allow a hot or warm start later

1.3.3 VDD_USB: USB interface power supply

VDD_USB supplies the USB interface. If the USB interface is not used, the VDD_USB pin must be connected to GND. For more information about correctly handling the VDD_USB pin, see section 1.4

1.3.4 VCC_RF: Output voltage RF

The VCC_RF pin can supply an active antenna or external LNA. For more information, see section 2.4

1.4 Interfaces

1.4.1 UART

The NEO-M8N positioning module includes a Universal Asynchronous Receiver Transmitter (UART) serial interface **RxD/TxD** supporting configurable baud rates. The baud rates supported are specified in the *NEO-M8N Data Sheet [1]*.

The signal output and input levels are 0 V to VCC. An interface based on RS232 standard levels (+/- 12 V) can be implemented using level shifters such as Maxim MAX3232. Hardware handshake signals and synchronous operation are not supported.



Designs must allow access to the UART pin for future service and reconfiguration.

1.4.2 USB

A USB version 2.0 FS (Full Speed, 12 Mb/s) compatible interface is available for communication as an alternative to the UART. The **USB_DP** integrates a pull-up resistor to signal a full-speed device to the host. The VDD_USB pin supplies the USB interface.

u-blox provides Microsoft® certified USB drivers for Windows Vista, Windows 7, Windows 8 and Windows 10 operating systems. These drivers are available at our website at www.u-blox.com

USB external components

The USB interface requires some external components to implement the physical characteristics required by the USB 2.0 specification. These external components are shown in Figure 2 and listed in Table 1. To comply with USB specifications, VBUS must be connected through an LDO (U1) to pin VDD_USB on the module.

In USB **self-powered** mode, the power supply (VCC) can be turned off and the digital block is not powered. In this case, since VBUS is still available, the USB host would still receive the signal indicating that the device is present and ready to communicate. This should be avoided by disabling the LDO (U1) using the enable signal

(EN) of the VCC-LDO or the output of a voltage supervisor. Depending on the characteristics of the LDO (U1) it is recommended to add a pull-down resistor (R11) at its output to ensure **VDD_USB** is not floating if the LDO (U1) is disabled or the USB cable is not connected i.e. VBUS is not supplied.



USB bus-powered mode is not supported.

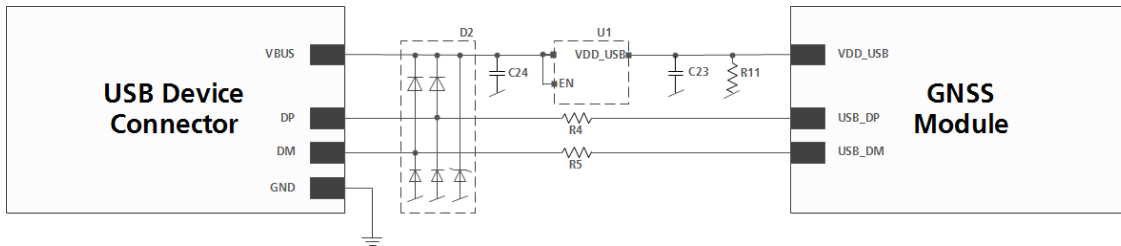


Figure 2: USB Interface

Name	Component	Function	Comments
U1	LDO	Regulates VBUS (4.4 ... 5.25 V) down to a voltage of 3.3 V.	Almost no current requirement (~1 mA) if the GNSS receiver is operated as a USB self-powered device.
C23, C24	Capacitors		Required according to the specification of LDO U1
D2	Protection diodes	Protect circuit from overvoltage / ESD when connecting.	Use low capacitance ESD protection such as ST Microelectronics USBLC6-2.
R4, R5	Serial termination resistors	Establish a full-speed driver impedance of 28...44 Ω	A value of 27 Ω is recommended.
R11	Resistor		100 k Ω is recommended for USB self-powered setup.

Table 1: Summary of USB external components

1.4.3 Display Data Channel (DDC)

An I²C compatible Display Data Channel (DDC) interface is available with u-blox M8 modules for serial communication with an external host CPU. The interface only supports operation in slave mode (master mode is not supported). The DDC protocol and electrical interface are fully compatible with the Fast-Mode of the I²C industry standard. DDC pins **SDA** and **SCL** have internal pull-up resistors.

For more information about the DDC implementation, see the *u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification* [2]. For bandwidth information, see the *NEO-M8N Data Sheet* [1]. For timing, parameters consult the *I²C-bus specification* [5].



The u-blox M8 DDC interface supports serial communication with u-blox cellular modules. See the specification of the applicable cellular module to confirm compatibility.

1.4.4 SPI

An SPI interface is available for communication to a host CPU.



SPI is not available in the default configuration, because its pins are shared with the UART and DDC interfaces. The SPI interface can be enabled by connecting D_SEL to ground. For speed and clock frequency, see the *NEO-M8N Data Sheet* [1].

1.4.5 TX Ready signal

The TX Ready signal indicates that the receiver has data to transmit. A listener can wait on the TX Ready signal instead of polling the DDC or SPI interfaces. The UBXC-FG-PRT message lets you configure the polarity and the number of bytes in the buffer before the TX Ready signal goes active. The TX Ready signal can be mapped to UART TXD (PIO 06). The TX Ready function is disabled by default.



The TX Ready functionality can be enabled and configured by AT commands sent to the u-blox cellular module supporting the feature. For more information, see the *GPS Implementation and Aiding Features in u-blox wireless modules* [6].

1.5 I/O pins

RESET_N: Reset input

Driving **RESET_N** low activates a hardware reset of the system. Use this pin only to reset the module. Do not use **RESET_N** to turn the module on and off, since the reset state increases power consumption. With u-blox 8 / M8 modules **RESET_N** is an input only.

1.5.1 EXTINT: External interrupt

EXTINT is an external interrupt pin with fixed input voltage thresholds with respect to **VCC** (see the *NEO-M8N Data Sheet* [1] for more information). It can be used for wake-up functions in Power Save Mode on all u-blox M8 modules and for aiding. Leave open if unused, function is disabled by default.

Pin Control

The pin control feature allows overriding the automatic active/inactive cycle of Power Save Mode. The state of the receiver can be controlled through the **EXTINT** pin. The receiver can also be forced OFF using **EXTINT** when Power Save Mode is not active.

Aiding

The **EXTINT** pin can be used to supply time or frequency aiding data to the receiver.

For time aiding, hardware time synchronization can be achieved by connecting an accurate time pulse to the **EXTINT** pin.

Frequency aiding can be implemented by connecting a periodic rectangular signal with a frequency up to 500 kHz and arbitrary duty cycle (low/high phase duration must not be shorter than 50 ns) to the **EXTINT** pin. Provide the applied frequency value to the receiver using UBX messages.

1.5.2 SAFEBOOT_N

If the **SAFEBOOT_N** pin is “low” at start up, the NEO-M8N module starts in Safe Boot Mode and does not begin GNSS operation. The Safe Boot Mode can be used to recover from situations where the Flash has become corrupted.



Designs must allow access to the **SAFEBOOT_N** function pin for future service and reconfiguration.

1.5.3 D_SEL: Interface select

The **D_SEL** pin selects the available interfaces. SPI cannot be used simultaneously with UART/DDC.

If open, UART and DDC are available. If pulled low, the SPI interface is available. See the *NEO-M8N Data Sheet* [1].

1.5.4 TIMEPULSE

A configurable time pulse signal is available with NEO-M8N module. By default, the time pulse signal is configured to one pulse per second. For more information, see the *u-blox 8 / u-blox M8 Receiver Description including Protocol Specification* [2]

1.5.5 ANT_ON: Active Antenna Control

In Power Save Mode, the system can turn on/off an optional external LNA using the ANT_ON signal in order to optimize power consumption. A pull-down resistor (10 kOhm) is required to ensure correct operation in backup mode of the ANT_ON signal.

"high" = Turn OFF antenna supply, "low" = Turn ON antenna supply

1.6 Electromagnetic interference on I/O lines

Any I/O signal line with a length greater than approximately 3 mm can act as an antenna and may pick up arbitrary RF signals transferring them as noise into the GNSS receiver. This specifically applies to unshielded lines, in which the corresponding GND layer is remote or missing entirely, and lines close to the edges of the printed circuit board.

If, for example, a cellular signal radiates into an unshielded high-impedance line, it is possible to generate noise in the order of volts and not only distort receiver operation but also damage it permanently.

On the other hand, noise generated at the I/O pins will emit from unshielded I/O lines. Receiver performance may be degraded when this noise is coupled into the GNSS antenna (see Figure 13).

To avoid interference by improperly shielded lines, it is recommended to use resistors (e.g. $R > 20 \Omega$), ferrite beads (e.g. BLM15HD102SN1) or inductors (e.g. LQG15HS47NJ02) on the I/O lines in series. These components should be chosen with care because they will affect also the signal rise times.

Figure 3 shows an example of EMI protection measures on the RX/TX line using a ferrite bead. More information can be found in section 4.3.

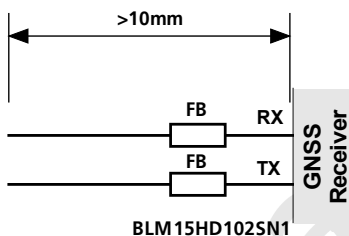


Figure 3: EMI Precautions

2 Design

2.1 Pin description

Function	PIN	No	I/O	Description	Remarks
Power	VCC	23		Supply Voltage	Provide clean and stable supply.
	GND	10,12,13, 24		Ground	Assure a good GND connection to all GND pins of the module, preferably with a large ground plane.
	V_BCKP	22		Backup Supply Voltage	It is recommended to connect a backup supply voltage to V_BCKP in order to enable warm and hot start features on the positioning modules. Otherwise, connect to VCC .
	VDD_USB	7		USB Power Supply	To use the USB interface, connect this pin to 3.0 – 3.6 V. If no USB serial port used connect to GND.
Antenna	RF_IN	11	I	GNSS signal input from antenna	The connection to the antenna has to be routed on the PCB. Use a controlled impedance of 50 Ω to connect RF_IN to the antenna or the antenna connector.
	VCC_RF	9	O	Output Voltage RF section	VCC_RF can be used to power an external active antenna.
UART	TxD	20	O	Serial Port/ SPI MISO	Communication interface, Can be programmed as TX Ready for DDC interface. If pin 2 low => SPI MISO.
	RxD	21	I	Serial Port / SPI MOSI	Serial input. Internal pull-up resistor to VCC . Leave open if not used. If pin 2 low => SPI MOSI.
USB	USB_DM	5	I/O	USB I/O line	USB bidirectional communication pin. Leave open if unused.
	USB_DP	6	I/O	USB I/O line	
System	TIMEPULSE	3	O	Timepulse Signal	Configurable Timepulse signal (one pulse per second by default). Leave open if not used.
	SAFEBOOT_N	1	I	Reserved	For future service, updates and reconfiguration, leave OPEN
	EXTINT	4	I	External Interrupt	External Interrupt Pin. Internal pull-up resistor to VCC . Leave open if not used. Function is disabled by default.
	RESERVED	15	-	Reserved	Leave open.
	SDA	18	I/O	DDC Data / SPI CS_N	DDC Data If pin 2 low => SPI chip select.
	SCL	19	I	DDC Clock / SPI SCK	DDC Clock. If pin 2 low => SPI clock.
	ANT_ON	14	O	ANT_ON	Antenna control can be used to turn on and off an optional external LNA.
	RESET_N	8	I	Reset input	Reset input
	D_SEL	2	I	selects the interface	Allow selecting UART/DDC or SPI open-> UART/DDC; low->SPI
	RESERVED	16,17	-	Reserved	Leave open.

Table 2: NEO-M8N Pinout

2.2 Minimal design

This is a minimal design for a NEO-M8N GNSS receiver.

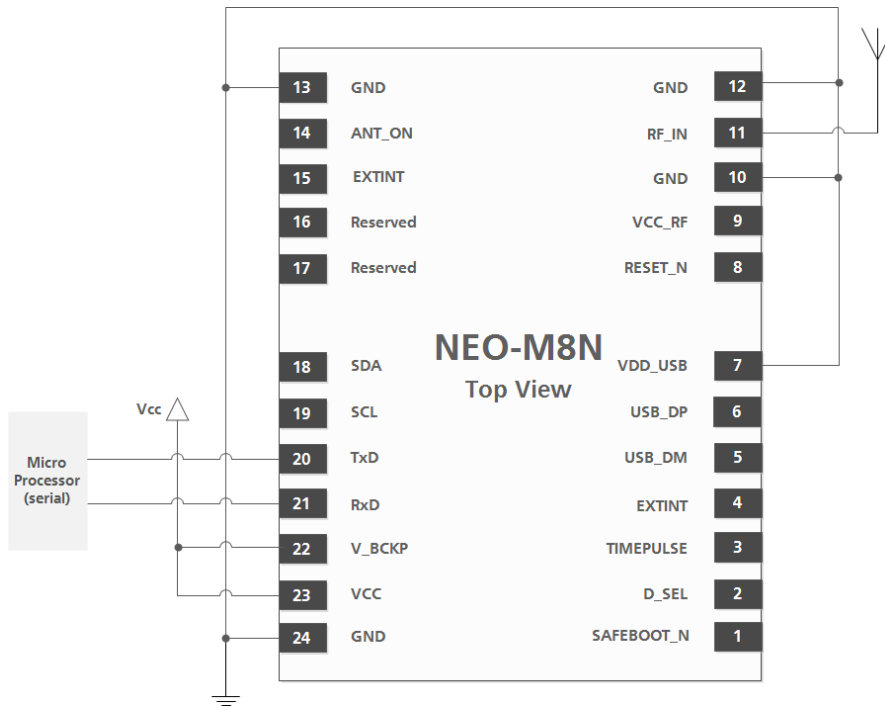


Figure 4: NEO-M8N passive antenna design

2.3 Layout: Footprint and paste mask

Figure 5 describes the footprint and provides recommendations for the paste mask for NEO-M8N LCC modules. These are recommendations only and not specifications. Note that the copper and solder masks have the same size and position.

To improve the wetting of the half vias, reduce the amount of solder paste under the module and increase the volume outside of the module by defining the dimensions of the paste mask to form a T-shape (or equivalent) extending beyond the copper mask. For the stencil thickness, see section 4.2.



Consider the paste mask outline when defining the minimal distance to the next component. The exact geometry, distances, stencil thicknesses and solder paste volumes must be adapted to the specific production processes (e.g. soldering) of the customer.

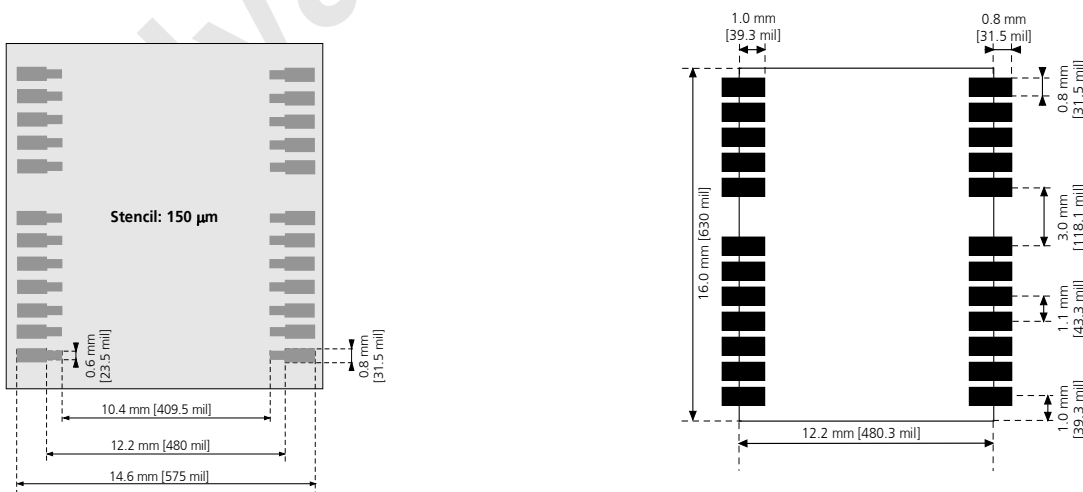


Figure 5: NEO-M8N footprint

NEO-M8N paste mask

2.4 Antenna

2.4.1 Antenna design with passive antenna

A design using a passive antenna requires more attention to the layout of the RF section. Typically, a passive antenna is located near electronic components; therefore, care should be taken to reduce electrical noise that may interfere with the antenna performance. Passive antennas do not require a DC bias voltage and can be directly connected to the RF input pin **RF_IN**. Sometimes, they may also need a passive matching network to match the impedance to 50 Ω .



Use an antenna that has sufficient bandwidth to receive all GNSS constellations. See Appendix.

Figure 6 shows a minimal setup for a design with a good GNSS patch antenna.

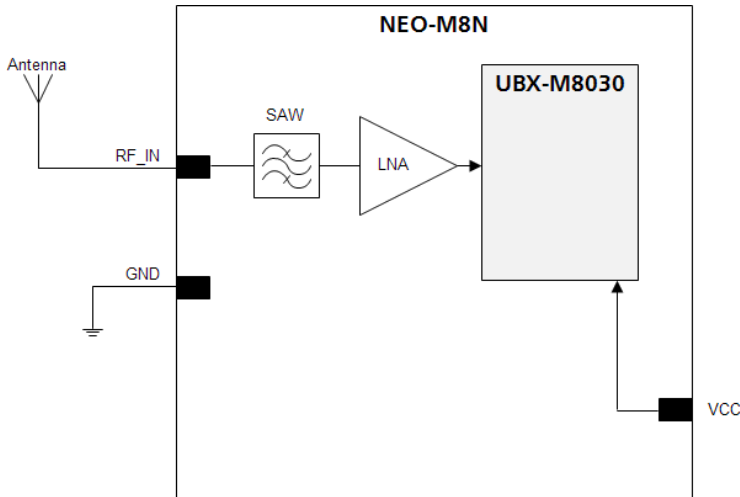


Figure 6: NEO-M8N passive antenna design (for exact pin orientation see the *NEO-M8N Data Sheet* [1])

2.4.2 Active antenna design

Active antennas have an integrated low-noise amplifier. Active antennas require a power supply that will contribute to the total GNSS system power consumption budget with additional 5 to 20 mA typically.

If the supply voltage of the NEO-M8N receiver matches the supply voltage of the antenna (e.g. 3.0 V), use the filtered supply voltage available at pin **VCC_RF** as shown in Figure 7.

Active antenna design using VCC_RF pin to supply the active antenna

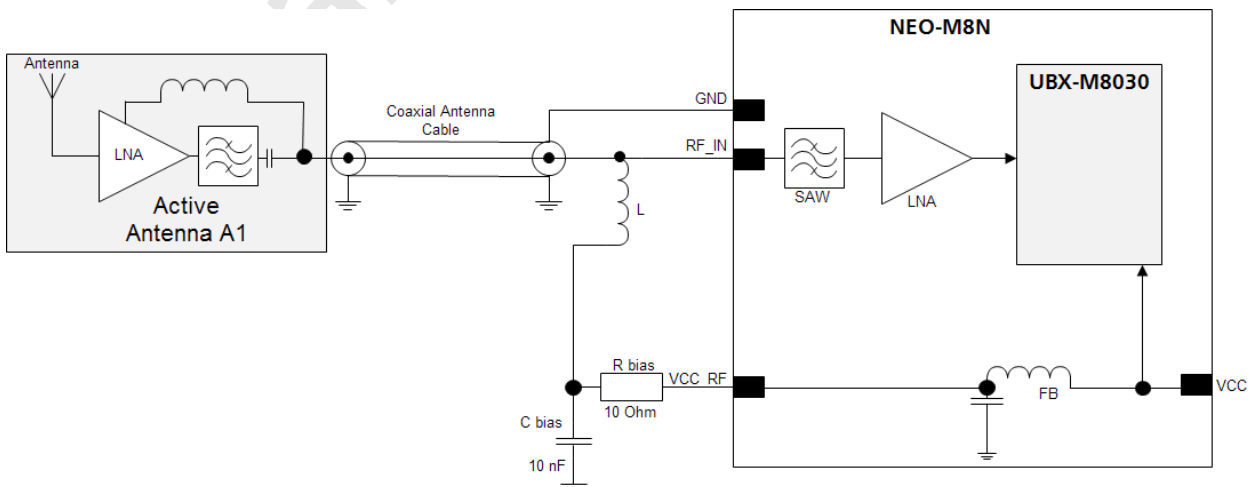


Figure 7: Active antenna design, external supply from **VCC_RF** (for exact pin orientation see the *NEO-M8N Data Sheet* [1])

In case the **VCC_RF** voltage does not match with the supply voltage of the active antenna, use a filtered external supply as shown in Figure 8.

Active antenna design powered from external supply

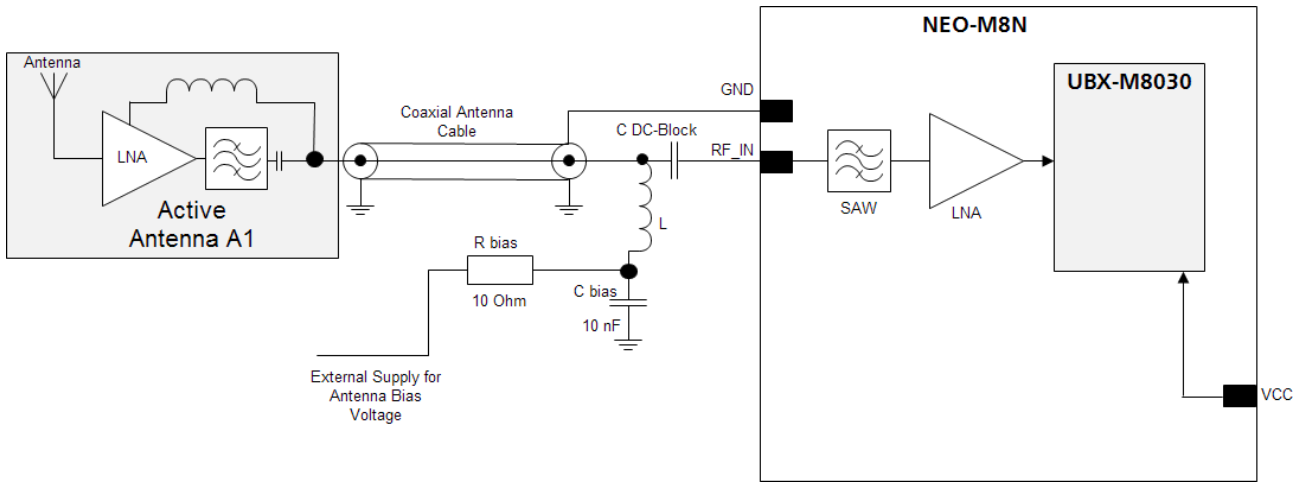


Figure 8: Active antenna design, direct external supply (for exact pin orientation see the *NEO-M8N Data Sheet* [1])



The circuit shown in Figure 8 works with all u-blox M8 modules, also with modules without **VCC_RF** output.

3 Migration to u-blox M8 modules

3.1 Migrating u-blox 7 designs to a u-blox M8 modules

u-blox is committed to ensuring that products in the same form factor are backwards compatible over several technology generations. Utmost care has been taken to ensure there is no negative impact on function or performance and to make u-blox M8 modules as fully compatible as possible with u-blox 7 modules. If using BeiDou, check the bandwidth of the external RF components and the antenna. For information about power consumption, see the *NEO-M8N Data Sheet* [1].

It is highly advisable that customers consider a design review with the u-blox support team to ensure the compatibility of key functionalities.

3.2 Hardware migration NEO-6 -> NEO-M8N

Pin	NEO-6		NEO-M8N		Remarks for Migration
	Pin Name	Typical Assignment	Pin Name	Typical Assignment	
1	SAFEBOOT_N	Leave open.	SAFEBOOT_N	Leave open.	No difference
2	SS_N	SPI Slave Select	D_SEL	selects the interface	-> Different functions, compatible only when not using SPI for communication.
3	TIMEPULSE 1	Timepulse 1 (1PPS)	TIMEPULSE 1	Timepulse 1 (1PPS)	No difference
4	EXTINT0	External Interrupt Pin	EXTINT0	External Interrupt Pin	No difference
5	USB_DM	USB Data	USB_DM	USB Data	No difference
6	USB_DP	USB Data	USB_DP	USB Data	No difference
7	VDD_USB	USB Supply	VDD_USB	USB Supply	No difference
8	RESERVED	Pin 8 and 9 must be connected together.	RESET_N	Reset input	If pin 8 is connected directly to pin 9, the RESET function is not available. If the RESET function shall be used, a 3k3 resistor from pin 8 to pin 9 in conjunction with an open drain buffer is required for u-blox 6. For NEO-M8N modules pin 8 can be connected to pin 9 or can be left open. Do not populate the 3k3 resistor. Behavior of RESET_N has changed; For u-blox 7 and M8, a RESET will erase the time information in the BBR, which has maintained in u-blox 6. Therefore, with u-blox 7 and M8 a RESET will not result in a hot start, etc.
9	VCC_RF	Can be used for active antenna or external LNA supply.	VCC_RF	Can be used for active antenna or external LNA supply.	No difference
10	GND	GND	GND	GND	No difference
11	RF_IN	GNSS signal input	RF_IN	GNSS signal input	No difference
12	GND	GND	GND	GND	No difference
13	GND	GND	GND	GND	No difference
14	MOSI/CFG_COM0	SPI MOSI / Configuration Pin. Leave open if not used.	ANT_ON	Used to turn on and off an optional external LNA	ANT_ON (Active Antenna Control) can be used to turn on and off an optional external LNA. -> Different functions, no SPI MOSI and configuration pins with NEO-M8N. If not used as default configuration, it must be set using software command! It is not possible to migrate from NEO-6 to NEO-M8N, if NEO-6 pin 14 is connected to GND. In this case, migrate to NEO-M8M!
15	MISO/CFG_COM1	SPI MISO / Configuration Pin. Leave open if not used.	RESERVED	Leave open.	

Pin	NEO-6		NEO-M8N		Remarks for Migration
	Pin Name	Typical Assignment	Pin Name	Typical Assignment	
16	CFG_GPS0/SCK	Power Mode Configuration Pin / SPI Clock. Leave open if not used.	RESERVED	Leave open.	
17	RESERVED	Leave open.	RESERVED	Leave open.	No difference
18	SDA	DDC Data	SDA	DDC Data / SPI CS_N	No difference for DDC. If pin 2 low = SPI chip select
19	SCL	DDC Clock	SCL	DDC Clock / SPI SCK	No difference for DDC. If pin 2 low = SPI clock
20	TxD	Serial Port	TxD	Serial Port / SPI MISO	No difference for UART. If pin 2 low = SPI MISO
21	RxD	Serial Port	RxD	Serial Port / SPI MOSI	No difference for UART. If pin 2 low = SPI MOSI
22	V_BCKP	Backup Supply Voltage	V_BCKP	Backup Supply Voltage	Check current in Data Sheet If on u-blox 6 module this was connected to GND, no problem to do the same in u-blox M8/8.
23	VCC	Supply voltage NEO-6Q/M/P/V/T: 2.7 – 3.6V	VCC	Supply voltage NEO-M8N: 2.7 – 3.6V	No difference
24	GND	GND	GND	GND	No difference

Table 3: Pin-out comparison NEO-6 vs. NEO-M8N

Make sure that the RF path (antenna and filtering) matches that of the GNSS constellations used.

3.3 Software migration



For an overall description of the module software operation, see the *u-blox 8 / u-blox M8 Receiver Description including Protocol Specification* [2]



For migration, see the *u-blox M8 FW3.01 Migration Guide* [7].

4 Product handling

4.1 Packaging, shipping, storage and moisture preconditioning

For information pertaining to reels and tapes, Moisture Sensitivity levels (MSL), shipment and storage information, as well as drying for preconditioning see the *NEO-M8N Data Sheet* [1].

Population of Modules



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

4.2 Soldering

Soldering paste

Use of “No Clean” soldering paste is highly recommended, as it does not require cleaning after the soldering process has taken place. The paste listed 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 Thickness:	see section 2.3

The final choice of the soldering paste depends on the approved manufacturing procedures.

The paste-mask geometry for applying soldering paste should meet the recommendations.



The quality of the solder joints on the connectors ('half vias') should meet the appropriate IPC specification.

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 the “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 this preheat phase will not replace prior baking procedures.

- Temperature rise rate: max. 3 °C/s. If the temperature rise is too rapid in the preheat phase it may cause excessive slumping.
- 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 avoids negative metallurgical effects (solder becomes more brittle) of the solder 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 u-blox M8 GNSS module should be placed on the topside of the motherboard during soldering.

The final soldering temperature chosen at the factory depends on additional external factors like 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.

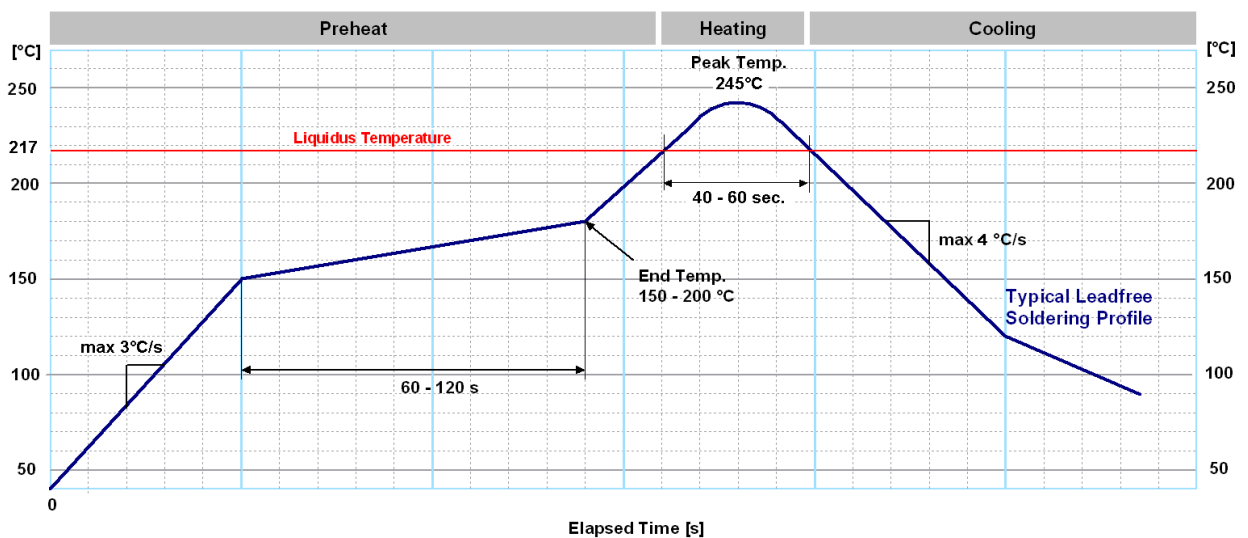


Figure 9: Recommended soldering profile



u-blox M8 modules **must not** be soldered with a damp heat process.

Optical inspection

After soldering the u-blox M8 module, consider an optical inspection step to check whether:

- The module is properly aligned and centered over the pads
- All pads are properly soldered
- No excess solder has created contacts to neighboring pads, or possibly to pad stacks and vias nearby

Cleaning

In general, cleaning the populated modules is strongly discouraged. Residues underneath the modules cannot be easily removed with a washing process.

- Cleaning with water will lead to capillary effects where water is absorbed in 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 flooding into the two housings, areas that are not accessible for post-wash inspections. The solvent will also damage the sticker and the ink-jet 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 and eliminate the cleaning step after the soldering.

Repeated reflow soldering

Only single reflow soldering processes are recommended for boards populated with u-blox M8 modules. u-blox M8 modules should not be submitted to two reflow cycles on a board populated with components on both sides in order to avoid upside down orientation during the second reflow cycle. In this case, the module should always be placed on that side of the board, which is submitted into the last reflow cycle. The reason for this (besides others) is the risk of the module falling off due to the significantly higher weight in relation to other components.

Two reflow cycles can be considered by excluding the above described upside down scenario and taking into account the rework conditions described in section Product handling.



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

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 u-blox M8 modules.

Hand soldering


Hand soldering is allowed. Use a soldering iron temperature setting equivalent to 350 °C. Place the module precisely on the pads. Start with a cross-diagonal fixture soldering (e.g. pins 1 and 15), and then continue from left to right.

Rework

The u-blox M8 module can be unsoldered from the baseboard using a hot air gun. When using a hot air gun for unsoldering the module, a maximum of one reflow cycle is allowed. In general, we do not recommend using a hot air gun because this is an uncontrolled process and might damage the module.

 **Attention: 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 placing and hand soldering a new module.

 **Never attempt a rework on the module itself, e.g. replacing individual components. Such actions immediately terminate the warranty.**

In addition to the two reflow cycles, manual rework on particular pins by using a soldering iron is allowed. Manual rework steps on the module can be done several times.

Conformal coating

Certain applications employ a conformal coating of the PCB using HumiSeal® or other related coating products. These materials affect the HF properties of the GNSS module and it is important to prevent them from flowing into the module. The RF shields do not provide 100% protection for the module from coating liquids with low viscosity; therefore, care is required in applying the coating.



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 u-blox M8 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 u-blox M8 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 u-blox M8 module are sensitive to Ultrasonic Waves. Use of any Ultrasonic Processes (cleaning, welding etc.) may cause damage to the GNSS Receiver.




u-blox offers no warranty against damages to the u-blox M8 module caused by any Ultrasonic Processes.

4.3 EOS/ESD/EMI precautions

When integrating GNSS positioning modules into wireless systems, careful consideration must be given to electromagnetic and voltage susceptibility issues. Wireless systems include components that can produce Electrical Overstress (EOS) and Electro-Magnetic Interference (EMI). CMOS devices are more sensitive to such influences because their failure mechanism is defined by the applied voltage, whereas bipolar semiconductors are more susceptible to thermal overstress. The following design guidelines are provided to help in designing robust yet cost effective solutions.

 **To avoid overstress damage during production or in the field it is essential to observe strict EOS/ESD/EMI handling and protection measures.**

 **To prevent overstress damage at the RF_IN of your receiver, never exceed the maximum input power (see the *NEO-M8N Data Sheet [1]*).**

Electrostatic discharge (ESD)

Electrostatic discharge (ESD) is the sudden and momentary electric current that flows between two objects at different electrical potentials caused by direct contact or induced by an electrostatic field. The term is usually used in the electronics and other industries to describe momentary unwanted currents that may cause damage to electronic equipment.



ESD handling precautions

ESD prevention is based on establishing an Electrostatic Protective Area (EPA). The EPA can be a small working station or a large manufacturing area. The main principle of an EPA is that there are no highly charging materials near ESD sensitive electronics, all conductive materials are grounded, workers are grounded, and charge build-up on ESD sensitive electronics is prevented. International standards are used to define typical EPA and can be obtained for example from International Electrotechnical Commission (IEC) or American National Standards Institute (ANSI).

GNSS positioning modules are sensitive to ESD and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver.

- Unless there is a galvanic coupling between the local GND (i.e. the work table) 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



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



Failure to observe these precautions can result in severe damage to the GNSS module!

ESD protection measures



GNSS positioning modules are sensitive to Electrostatic Discharge (ESD). Special precautions are required when handling.



For more robust designs, employ additional ESD protection measures. Using an LNA with appropriate ESD rating can provide enhanced GNSS performance with passive antennas and increases ESD protection.

Most defects caused by ESD can be prevented by following strict ESD protection rules for production and handling. When implementing passive antenna patches or external antenna connection points, then additional ESD measures can also avoid failures in the field as shown in Figure 10.

Small passive antennas (<2 dBic and performance critical)	Passive antennas (>2 dBic or performance sufficient)	Active antennas
<p>A</p> <p>LNA with appropriate ESD rating</p>	<p>B</p>	<p>C</p>

Figure 10: ESD Precautions



Protection measure A is preferred because it offers the best GNSS performance and best level of ESD protection.

Electrical Overstress (EOS)

Electrical Overstress (EOS) usually describes situations when the maximum input power exceeds the maximum specified ratings. EOS failure can happen if RF emitters are close to a GNSS receiver or its antenna. EOS causes damage to the chip structures. If the RF_IN is damaged by EOS, it is hard to determine whether the chip structures have been damaged by ESD or EOS.

EOS protection measures



For designs with GNSS positioning modules and wireless (e.g. GSM/GPRS) transceivers in close proximity, ensure sufficient isolation between the wireless and GNSS antennas. If wireless power output causes the specified maximum power input at the GNSS RF_IN to be exceeded, employ EOS protection measures to prevent overstress damage.

For robustness, EOS protection measures as shown in Figure 11 are recommended for designs combining wireless communication transceivers (e.g. GSM, GPRS) and GNSS in the same design or in close proximity.

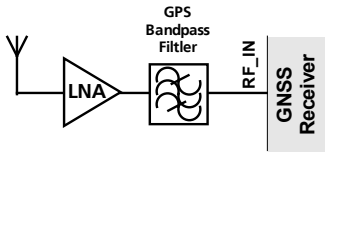
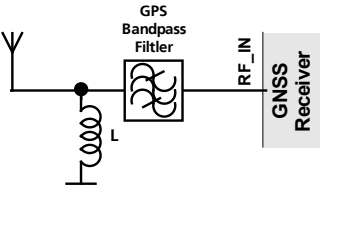
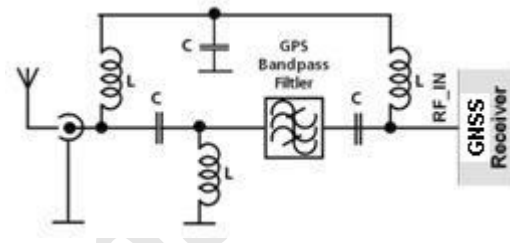
Small passive antennas (<2 dBic and performance critical)	Passive antennas (>2 dBic or performance sufficient)	Active antennas (without internal filter which need the module antenna supervisor circuits)
		
LNA with appropriate ESD rating and maximum input power	GNSS Band pass Filter: SAW or Ceramic with low insertion loss and appropriate ESD rating	

Figure 11: EOS and ESD Precautions

Electromagnetic interference (EMI)

Electromagnetic interference (EMI) is the addition or coupling of energy causing a spontaneous reset of the GNSS receiver or resulting in unstable performance. In addition to EMI degradation due to self-jamming (see section 1.5) any electronic device near the GNSS receiver can emit noise that can lead to EMI disturbances or damage.

The following elements are critical regarding EMI:

- Unshielded connectors (e.g. pin rows etc.)
- Weakly shielded lines on PCB (e.g. on top or bottom layer and especially at the border of a PCB)
- Weak GND concept (e.g. small and/or long ground line connections)

EMI protection measures are recommended when RF emitting devices are near the GNSS receiver. To minimize the effect of EMI a robust grounding concept is essential. To achieve electromagnetic robustness follow the standard EMI suppression techniques.

<http://www.murata.com/products/emc/knowhow/index.html>

<http://www.murata.com/products/emc/knowhow/pdf/4to5e.pdf>

Improved EMI protection can be achieved by inserting a resistor or better yet a ferrite bead or an inductor (see Table 5) into any unshielded PCB lines connected to the GNSS receiver. Place the resistor as close as possible to the GNSS receiver pin.

Alternatively, feed-thru capacitors with good GND connection can be used to protect e.g. the **VCC** supply pin against EMI. A selection of feed-thru capacitors are listed in Table 5.

4.4 Applications with cellular modules

GSM uses power levels up to 2 W (+33 dBm). Consult the *NEO-M8N Data Sheet* [1] for the absolute maximum power input at the GNSS receiver.



See the *GPS Implementation and Aiding Features in u-blox wireless modules* [6].

Isolation between GNSS and GSM antenna

In a handheld type design, an isolation of approximately 20 dB can be reached with careful placement of the antennas. If such isolation cannot be achieved, e.g. in the case of an integrated GSM/GNSS antenna, an additional input filter is needed on the GNSS side to block the high energy emitted by the GSM transmitter. Examples of these kinds of filters would be the SAW Filters from Epcos (B9444 or B7839) or Murata.

Increasing interference immunity

Interference signals come from in-band and out-band frequency sources.

In-band interference

With in-band interference, the signal frequency is very close to the GNSS constellation frequency used, e.g. GPS frequency of 1575 MHz (see *Figure 12*). Such interference signals are typically caused by harmonics from displays, micro-controller, bus systems, etc.

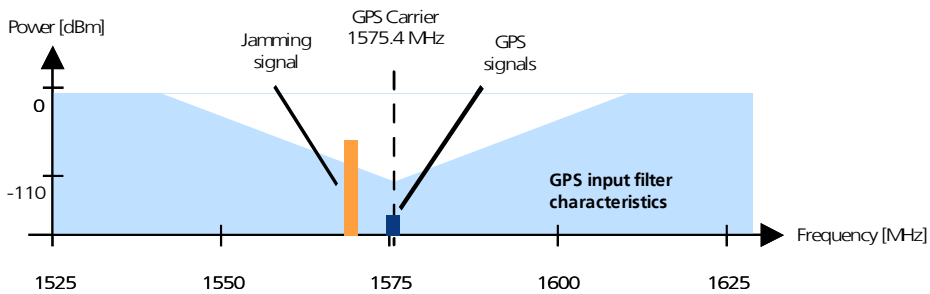


Figure 12: In-band interference signals

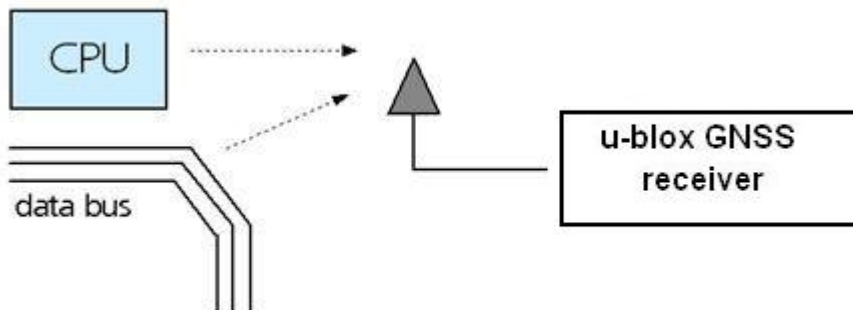


Figure 13: In-band interference sources

Measures against in-band interference include:

- Maintaining a good grounding concept in the design
- Shielding
- Layout optimization
- Filtering
- Placement of the GNSS antenna
- Adding a CDMA, GSM, WCDMA band pass filter before handset antenna

Out-band interference

Out-band interference is caused by signal frequencies that are different from the GNSS carrier (see *Figure 14*). The main sources are wireless communication systems such as GSM, CDMA, WCDMA, Wi-Fi, BT, etc.

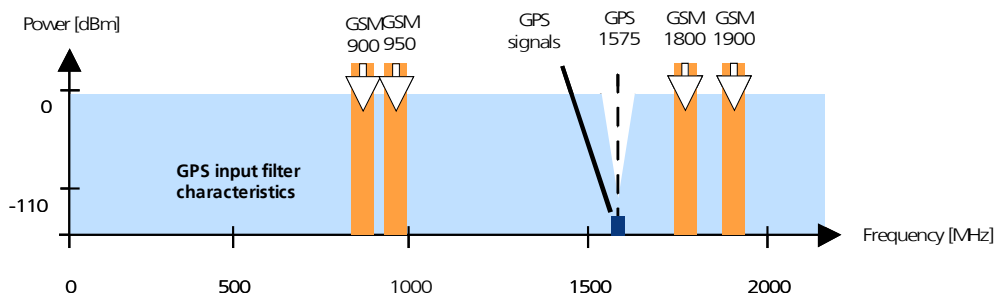


Figure 14: Out-band interference signals

Measures against out-band interference include maintaining a good grounding concept in the design and adding a SAW or band pass ceramic filter (as recommend in section 4) into the antenna input line to the GNSS receiver (see *Figure 15*).

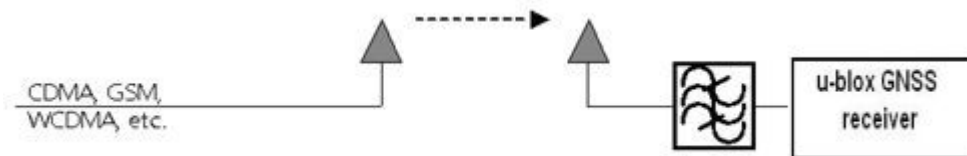


Figure 15: Measures against out-band interference



For design-in recommendations in combination to Cellular operation see Appendix



See the *GPS Implementation and Aiding Features in u-blox wireless modules* [6]

Appendix

A Glossary

Abbreviation	Definition
ANSI	American National Standards Institute
CDMA	Code Division Multiple Access
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EOS	Electrical Overstress
EPA	Electrostatic Protective Area
ESD	Electrostatic discharge
GLONASS	Russian satellite system
GND	Ground
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
IEC	International Electrotechnical Commission
PCB	Printed circuit board
QZSS	Quasi-Zenith Satellite System

Table 4: Explanation of abbreviations used

Recommended parts

Recommended parts are selected on data sheet basis only. Other components may also be used.

Part	Manufacturer	Part ID	Remarks	Parameters to consider
Diode Semiconductor	ON	ESD9R3.3ST5G	Standoff Voltage>3.3 V	Low Capacitance < 0.5 pF
		ESD9L3.3ST5G	Standoff Voltage>3.3 V	Standoff Voltage > Voltage for active antenna
		ESD9L5.0ST5G	Standoff Voltage>5 V	Low Inductance
SAW	TDK/ EPCOS	B8401: B39162-B8401-P810	GPS+GLONASS	High attenuation
	TDK/ EPCOS	B3913: B39162B3913U410	GPS+GLONASS+BeiDou	For automotive application
	TDK/ EPCOS	B4310: B39162B4310P810	GPS+GLONASS	Compliant to the AEC-Q200 standard
	ReyConns	NDF9169	GPS+ BeiDou	Low insertion loss, Only for mobile application
	muRata	SAFFB1G56KB0F0A	GPS+GLONASS+BeiDou	Low insertion loss, Only for mobile application
	muRata	SAFEA1G58KB0F00	GPS+GLONASS	Low insertion loss, only for mobile application
	muRata	SAFEA1G58KA0F00	GPS+GLONASS	High attenuation, only for mobile application
	muRata	SAFFB1G58KA0F0A	GPS+GLONASS	High attenuation, only for mobile application
	muRata	SAFFB1G58KB0F0A	GPS+GLONASS	Low insertion loss, Only for mobile application
	TAI-SAW	TA1573A	GPS+GLONASS	Low insertion loss
TAI-SAW	TA1343A	GPS+GLONASS+BeiDou	Low insertion loss	
TAI-SAW	TA0638A	GPS+GLONASS+BeiDou	Low insertion loss	
LNA	JRC	NJG1143UA2	LNA	Low noise figure, up to 15 dBm RF input power
	Avago	ALM-GN001	LNA	Low noise figure, with pre-LNA filter, concurrent GNSS
	Avago	ALM-GN002	LNA	Very low noise figure, with post-LNA filter, concurrent GNSS
Inductor	Murata	LQG15HS27NJ02	L, 27 nH	Impedance @ freq GPS > 500 Ω
Capacitor	Murata	GRM1555C1E470JZ01	C _{DC-block} , 47 pF	DC-block
	Murata	X7R 10N 10% 16V	C _{Bias} , 10nF	Bias-T
Ferrite	Murata	BLM15HD102SN1	FB	High IZI @ fGSM

Bead				
Feed thru Capacitor for Signal	Murata	NFL18SP157X1A3 NFA18SL307V1A45	Monolithic Type Array Type	For data signals, 34 pF load capacitance For data signals, 4 circuits in 1 package
Feed thru Capacitor	Murata	NFM18PC NFM21P....	0603 2A 0805 4A	Rs < 0.5 Ω
Resistor		10 Ω ± 10%, min 0.250 W	R _{bias}	
		560 Ω ± 5%	R2	
		100 kΩ ± 5%	R3, R4	

Table 5: Recommended parts

Recommended antennas

Manufacturer	Order No.	Comments
Hirschmann (www.hirschmann-car.com)	GLONASS 9 M	GPS+GLONASS active
Taoglas (www.taoglas.com)	AA.160.301111	36*36*4 mm, 3-5V 30mA active
Taoglas (www.taoglas.com)	AA.161.301111	36*36*3 mm, 1.8 to 5.5V / 10mA at 3V active
INPAQ (www.inpag.com.tw)	B3G02G-S3-01-A	2.7 to 3.9 V / 10 mA active
Amotech (www.amotech.co.kr)	B35-3556920-2J2	35x35x3 mm GPS+GLONASS passive
Amotech (www.amotech.co.kr)	A25-4102920-2J3	25x25x4 mm GPS+GLONASS passive
Amotech (www.amotech.co.kr)	A18-4135920-AMT04	18x18x4 mm GPS+GLONASS passive
Amotech (www.amotech.co.kr)	Amotech AGA363913-S0-A1	GPS+GLONASS+ BeiDou active
INPAQ (www.inpag.com.tw)	ACM4-5036-A1-CC-S	5.2 x 3.7 x 0.7 mm GPS+GLONASS passive

Additional antenna Manufacturer: Allis Communications, 2J, Tallysman Wireless

Table 6: Recommend antenna

Related documents

- [1] NEO-M8N Data Sheet, Docu. No. UBX-15031086
- [2] u-blox 8 / u-blox M8 Receiver Description including Protocol Specification (Public version), Docu. No. UBX-13003221
- [3] GPS Antenna Application Note, Docu. No. GPS-X-08014
- [4] GPS Compendium, Docu. No. GPS-X-02007
- [5] I²C-bus specification, Version 2.1, Jan 2000,
http://www.nxp.com/acrobat_download/literature/9398/39340011_21.pdf
- [6] GPS Implementation and Aiding Features in u-blox wireless modules, Docu. No. GSM.G1-CS-09007
- [7] u-blox M8 FW3.01 Migration Guide, Docu. No. UBX-15028330



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

Revision history

Revision	Date	Name	Status / Comments
R01	28-Jan-2016	jfur	Advance Information

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