

EVA-7M

u-blox 7 GNSS module

Hardware Integration Manual

Abstract

This document describes the hardware features and specifications of the cost effective EVA-7M GNSS module featuring the u-blox 7 positioning engine.

The EVA-7M module boasts the industry's smallest form factor and is a fully tested standalone solution that requires no host integration.

This module combines exceptional GNSS performance with highly flexible power, design, and serial communication options.



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| Objective Specification | Document contains target values. Revised and supplementary data will be published later. | | |
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This document applies to the following products:

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1 Hardware description

1.1 Overview

The EVA-7M standalone GNSS module features the reliable performance of the u-blox 7 positioning engine (receiving GPS, GLONASS, QZSS and SBAS signals). The EVA-7M delivers high sensitivity and minimal acquisition times in the ultra compact EVA form factor.

The EVA-7M is an ideal solution for cost and space-sensitive applications. It is easy to design-in, only requiring an external GNSS antenna in most applications. The layout of the EVA-7M is especially designed to ease the customer's design and limit near field interferences since RF and digital domains are kept separated.

EVA-7M uses a crystal oscillator for lower system costs. Like other u-blox GNSS modules, the EVA-7M uses components selected for functioning reliably in the field over the full operating temperature range.

The EVA-7M is easily integrated in manufacturing, thanks to its QFN-like package and low moisture sensitivity level. The modules are available in 500 pcs/reel, ideal for small production batches. The EVA-7M module combines a high level of integration capability with flexible connectivity options in a miniature package. This makes it perfectly suited for industrial and mass-market end products with strict size and cost requirements. The DDC (I2C compliant) interface provides connectivity and enables synergies with u-blox cellular modules.

The EVA-7M module is manufactured in ISO/TS 16949 certified sites and qualified as stipulated in the JESD47 standard.



For product features see the *EVA-7M 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.

2 Design-in

In order to obtain good performance with a GNSS receiver module, there are a number of points that require careful attention during the design-in. These include:

- Power Supply: Good performance requires a clean and stable power supply.
- Interfaces: Ensure correct wiring, rate and message setup on the module and your host system.
- Antenna interface: For optimal performance, seek short routing, matched impedance and no stubs.
- External LNA: With EVA-7M an additional external LNA is mandatory if a passive antenna is used to achieve the performance values as written in the *EVA-7M Data Sheet* [1].

2.1 Power management

2.1.1 Overview

The EVA-7M provides 4 supply pins: **VCC**, **VCC_IO**, **V_BCKP** and **V_USB**. They can be supplied independently or tied together to adapt various concepts, depending on the intended application. The different supply voltages are explained in the following subsections.

Figure 1 shows an example to supply the EVA-7M module when not using the USB interface. In this case, the **V_USB** pin is connected to ground.

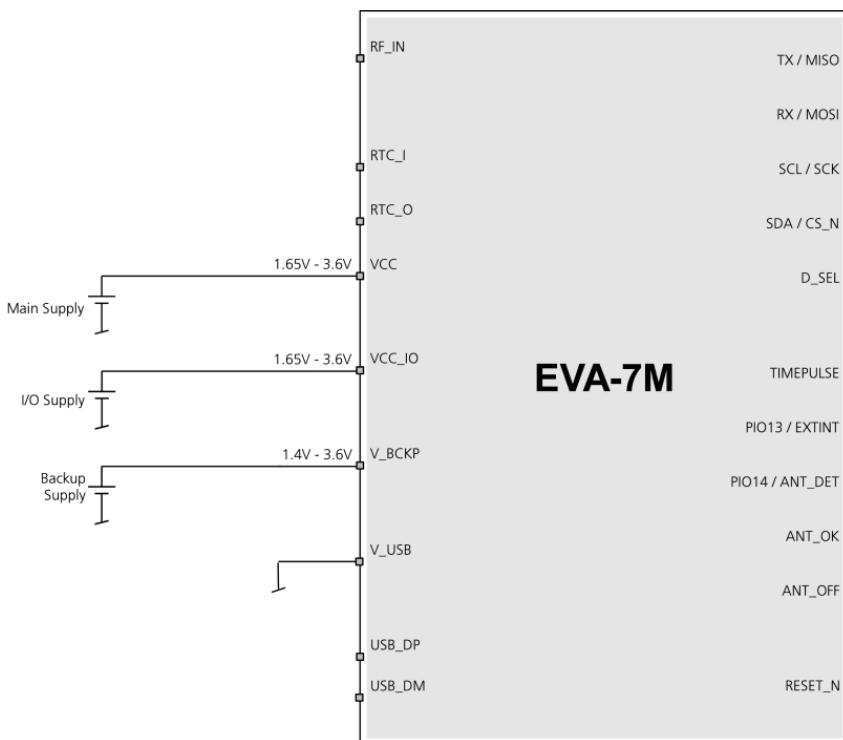



Figure 1: EVA-7M power supply example

2.1.1.1 Main supply voltage (VCC)

During operation, the EVA-7M module is supplied through the **VCC** pin. It makes use of an internal DC/DC converter for improved power efficiency. In a following step, built-in LDOs generate stabilized voltages for the Core and RF domains of the chip respectively. The current at **VCC** depends heavily on the current state of the system and is in general very dynamic.

 Do not add any series resistance ($< 0.2 \Omega$) to the **VCC** supply, as it will generate input voltage noise due to the dynamic current conditions.

2.1.1.2 I/O supply voltage (VCC_IO)


The digital I/Os of the EVA-7M can be supplied with a separate voltage from the host system connected to the **VCC_IO** pin of the module. The wide range of **VCC_IO** allows seamless interfacing to standard logic voltage levels. However, in most applications **VCC_IO** and **VCC** share the same voltage level and are tied together. **VCC_IO** supplies also the RTC and the backup RAM (BBR) during normal operation.


 **VCC_IO** must be supplied in order for the system to boot.

2.1.1.3 Backup power supply (V_BCKP)

In the event of a power failure at **VCC_IO**, the backup domain is supplied by **V_BCKP**.


 If no backup supply is available, connect **V_BCKP** to **VCC_IO**.

 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 the RTC frequency is derived from the main clock, the **V_BCKP** pin also supplies the clock domain if there is a power failure at **VCC_IO**, meaning that the **V_BCKP** current will also be higher. Ensure that the capacity of the backup battery chosen meets your requirements.

2.1.1.4 USB interface power supply

V_USB supplies I/Os of the USB interface. If the USB interface is being used, the system can be either self-powered, i.e. powered independently from the USB bus, or it can be bus-powered, i.e. powered through the USB connection. In bus-powered mode, the system supply voltages need to be generated from the USB supply voltage VBUS.

 If the USB interface is not used, the **V_USB** pin must be connected to GND.

2.1.2 Power management configuration

Depending on the application, the power supply schematic will differ. Some examples are shown in the following sections:

- Single supply voltage for **VCC** and **VCC_IO**, no backup supply see Appendix, Figure 12
- Separate supply voltages for **VCC**, **VCC_IO** and **V_BCKP** see Appendix, Figure 13
- Single supply voltage for **VCC** and **VCC_IO**, use of a backup supply see Appendix, Figure 15

 For description of the different operating modes see the *EVA-7M Data Sheet* [1].

2.2 Interfaces



The EVA-7M provides UART, SPI and DDC (I²C compatible) interfaces for communication with a host CPU. A USB interface is also available on dedicated pins (see section 2.2.4).

The UART, SPI and DDC pins are supplied by **VCC_IO** and operate at this voltage level.



Four dedicated pins can be configured as either 1 x UART and 1 x DDC or a single SPI interface selectable by **D_SEL** pin. Table 1 below provides the port mapping details.

| Pin 32 (D_SEL) = "high" (left open) | Pin 32 (D_SEL) = "Low" (connected to GND) |
|-------------------------------------|-------------------------------------------|
| UART TX | SPI MISO |
| UART RX | SPI MOSI |
| DDC SCL | SPI CLK |
| DDC SDA | SPI CS |

Table 1: Communication Interfaces overview

-  It is not possible to use the SPI interface simultaneously with the DDC or UART interface.
-  For debugging purposes, it is recommended to have a second interface e.g. USB available that is independent from the application and accessible via test-points.

For each interface, a dedicated pin can be defined to indicate that data is ready to be transmitted. 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 UBX-CFG-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 function is disabled by default.

-  The TX Ready functionality can be enabled and configured by proper AT commands sent to the involved u-blox wireless module supporting the feature. For more information see *GPS Implementation and Aiding Features in u-blox wireless modules* [5].
-  The TX Ready feature is supported on version LEON FW 7.xx and LISA-U2 01S and above.

2.2.1 UART interface

A UART interface is available for serial communication to a host CPU. The UART interface supports configurable data rates with the default at 9600 baud. Signal levels are related to the **VCC_IO** supply voltage. An interface based on RS232 standard levels (+/- 7 V) can be realized using level shifter ICs such as the Maxim MAX3232.



Hardware handshake signals and synchronous operation are not supported.

A signal change on the UART RX pin can also be used to wake up the receiver in Power Save Mode (see the *u-blox 7 Receiver Description including Protocol Specification* [2].).

2.2.2 Display Data Channel (DDC) Interface

An I²C compatible Display Data Channel (DDC) interface is available for serial communication with a host CPU.

The SCL and SDA pins have internal pull-up resistors sufficient for most applications. However, depending on the speed of the host and the load on the DDC lines additional external pull-up resistors might be necessary. For speed and clock frequency see the *EVA-7M Data Sheet* [1].

-  To make use of DDC interface the **D_SEL** pin has to be left open.
-  The EVA-7M DDC interface provides serial communication with u-blox wireless modules. See the specification of the applicable wireless module to confirm compatibility.

For more information about DDC implementation refer to the *u-blox 7 Receiver Description including Protocol Specification* [2].

2.2.3 SPI Interface

The SPI interface can be used to provide a serial communication with a host CPU. If the SPI interface is used, UART and DDC are deactivated, because they share the same pins.



To make use of the SPI interface, the **D_SEL** pin has to be connected to GND.



Connecting the **D_SEL** pin to GND will slightly increase the power consumption in Power Save Mode ON/OFF operation and SW backup mode because of its internal pull-up resistor.

2.2.4 USB interface

The USB interface of the EVA-7M supports the full-speed data rate of 12 Mbit/s. It is compatible to the USB 2.0 FS standard. The interface requires some external components in order to implement the physical characteristics required by the USB 2.0 specification. Figure 2 shows the interface pins and additional external components. In order to comply with USB specifications, VBUS must be connected through a LDO (U2) to pin **V_USB** of the EVA-7M. This ensures that the internal 1.5 k Ω pull-up resistor on **USB_DP** gets disconnected when the USB host shuts down VBUS.

Depending on the characteristics of the LDO (U2), for a self-powered design it is recommended to add a pull-down resistor (R8) at its output to ensure **V_USB** does not float if a USB cable is not connected, i.e. when VBUS is not present.

The interface can be used either in “self powered” or “bus powered” mode. The required mode can be configured using the UBX-CFG-USB message. Also, the vendor ID, vendor string, product ID and product string can be changed.

In order to get the 90 Ω differential impedance in between the **USB_DM** and **USB_DP** data line a 27 Ω series resistor (R1,R2) must be placed into each data line (**USB_DM** and **USB_DP**).

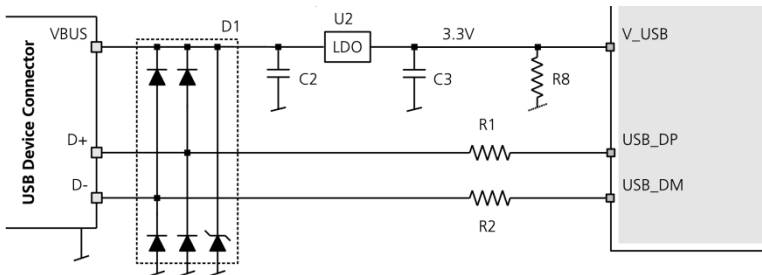


Figure 2: USB interface

| Name | Component | Function | Comments |
|--------|------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U2 | 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, but if bus-powered LDO (U2) must be able to deliver the maximum current of ~100 mA. |
| C2,C3 | Capacitors | | Required according to the specification of LDO U2 |
| D1 | Protection diodes | Protect circuit from overvoltage / ESD when connecting. | Use low capacitance ESD protection such as ST Microelectronics USBL6-2. |
| R1, R2 | Serial termination resistors | Establish a full-speed driver impedance of 28...44 Ω | A value of 27 Ω is recommended. |
| R8 | Resistor | Ensures defined signal at V_USB when VBUS is not connected / powered | 100k Ω is recommended for USB self-powered setup. For bus-powered setup R8 is not required. |

Table 2: Summary of USB external components

See Appendix A.5 and Appendix A.6 for reference schematics for self- and bus-powered operation.



If the USB interface is not used, connect **V_USB** to GND.

2.3 I/O Pins

All I/O pins make use of internal pull-ups. Thus, there is no need to connect unused pins to **VCC_IO**.

2.3.1 Time pulse

A configurable time pulse signal is available and configured by default to 1 pulse per second. For further information see the *u-blox 7 Receiver Description including Protocol Specification* [2].

2.3.2 External interrupt

EXTINT is an external interrupt pin with fixed input voltage thresholds with respect to **VCC_IO** (see the *EVA-7M Data Sheet* [1] for more information). It can be used for wake-up functions in Power Save Mode on all u-blox 7 modules and for aiding. Leave open if unused; its function is disabled by default. By default the external interrupt is disabled.

For further information see the *u-blox 7 Receiver Description including Protocol Specification* [2].



If the EXTINT is configured for on/off switching of the EVA-7M, the internal pull-up becomes disabled. Thus make sure the EXTINT input is always driven within the defined voltage level by the host.

2.3.3 Active antenna supervisor

EVA-7M supports active antenna supervisors. The antenna supervisor gives information about the status of the active antenna and will turn off the supply to the active antenna in case a short is detected or to optimize the power consumption when in Power Save Mode.

There is either a 2-pin or a 3-pin antenna supervisor. By default the 2-pin antenna supervisor is enabled.

2.3.3.1 2-pin antenna supervisor

The 2-pin antenna supervisor function, which is enabled by default, consists of the **ANT_OK** input and the **ANT_OFF** output pins.

| Function | I/O | Description | Remarks |
|----------|-----|----------------------------------------------------------------------------------------------------|-----------------------|
| ANT_OK | I | Antenna OK "high" = Antenna OK "low" = Antenna not OK | Default configuration |
| ANT_OFF | O | Control signal to turn on and off the antenna supply "high" = Antenna OFF "low" = Antenna ON | Default configuration |

Table 3: 2-pin antenna supervisor pins

The circuitry, as shown in Appendix A.7, (see Figure 18) provides antenna supply short circuit detection. It will prevent antenna operation via transistor T1 if a short circuit has been detected or if it is not required (e.g. in Power Save Mode).

The status of the active antenna can be checked by the UBX-MON-HW message. See the *u-blox 7 Receiver Description including Protocol Specification* [2].

Open drain buffers U4 and U7 (e.g. Fairchild NC7WZ07) are needed to shift the voltage levels. R3 is required as a passive pull-up to control T1 because U4 has an open drain output. R4 serves as a current limiter in the event of a short circuit.

2.3.3.2 3-pin antenna supervisor

The 3-pin antenna supervisor is comprised of the **ANT_DET** (active antenna detection), **ANT_SHORT_N** (short detection) and **ANT_OFF** (antenna on/off control) pins. This function must be activated by sending the following sequence to the EVA-7M receiver in production:

```
B5 62 06 41 0C 00 00 00 03 1F CD 1A 38 57 FF FF F6 FF DE 11
```



Applying this sequence results in a permanent change and cannot be reversed.

| Function | I/O | Description | Remarks |
|-------------|----------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| ANT_DET | I (pull-up) | Antenna detected "high" = Antenna detected "low" = Antenna not detected | Must be changed by Low Level Configuration, see section 2.3.3. |
| ANT_SHORT_N | I (pull-up) | Antenna not shorted "high" = antenna has no short "low" = antenna has a short | Must be changed by Low Level Configuration, see section 2.3.3.. |
| ANT_OFF | O | Control signal to turn on and off the antenna supply "high" = turn off antenna supply "low" = short to GND | Must be changed by Low Level Configuration, see section 2.3.3. |

Table 4: 3-pin Antenna supervisor pins

The external circuitry, as shown in Appendix A.8, (see Figure 19) provides detection of an active antenna connection status. If the active antenna is present, the DC supply current exceeds a preset threshold defined by R4, R5, and R6. It will shut down the antenna via transistor T1 if a short circuit has been detected via U7 or if it's not required (e.g. in Power Save Mode).

The status of the active antenna can be checked by the UBX-MON-HW message. See the *u-blox 7 Receiver Description including Protocol Specification* [2].

The open drain buffers U4, U7 and U8 (e.g. Fairchild NC7WZ07) are needed to shift the voltage levels. R3 is required as a passive pull-up to control T1 because U4 has an open drain output. R4 serves as a current limiter in the event of a short circuit.

2.3.4 Electromagnetic interference on I/O lines

Any I/O signal line (length > ~3 mm) may pick up high frequency signals and transfer this noise into the GNSS receiver. This specifically applies to unshielded lines, lines where the corresponding GND layer is remote or missing entirely, and lines close to the edges of the printed circuit board. If a GSM signal radiates into an unshielded high-impedance line, noise in the order of volts can be generated and possibly not only distort receiver operation but also damage it permanently.

In such case it is recommended to use feed-thru capacitors with good GND connection close to the GNSS receiver in order to filter such high-frequency noise. See Appendix B.12 for component recommendations. Alternatively, ferrite beads (see Appendix B.11) or resistors can be used. These work without GND connection but may adversely affect signal rise time.

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.

2.4 Real-Time Clock (RTC)

The use of the RTC is optional to maintain time in the event of power failure at **VCC_IO**. The RTC is required for hot start, warm start, AssistNow Autonomous, AssistNow Offline and in some Power Save Mode operations.

The time information can either be generated by connecting an external RTC crystal to the EVA-7M, by deriving the RTC from the internal crystal oscillator, by connecting an external 32.768 kHz signal to the RTC input, or by time aiding of the GNSS receiver at every startup.

2.4.1 RTC using a crystal

The easiest way to provide time information to the receiver is to connect an RTC crystal to the corresponding pins of the RTC oscillator, **RTC_I** and **RTC_O**. There is no need to add load capacitors to the crystal for frequency tuning, because they are already integrated in the chip. Using an RTC crystal will provide the lowest current consumption to **V_BCKP** in case of a power failure. On the other hand, it will increase the BOM costs and requires space for the RTC crystal.

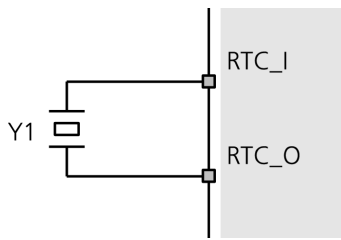


Figure 3: RTC crystal

2.4.2 RTC derived from the system clock

The EVA-7M can be configured in such way that the reference frequency for the RTC is internally derived from the 26 MHz crystal oscillator. For this feature **RTC_I** must be connected to ground and **RTC_O** left open. The capacity of the backup battery at **V_BCKP** must be dimensioned accordingly, taking into account the higher than normal current consumption at **V_BCKP** in the event of power failure at **VCC_IO**.

The single crystal feature can be configured by sending the following sequence to the receiver:

```
B5 62 06 41 0C 00 00 00 03 1F 47 F2 D7 AD FF FF FC FF 2B 3D
```



Applying this sequence results in a permanent change and cannot be reversed.

2.4.3 RTC using an external clock

Some applications can provide a suitable 32.768 kHz external reference to drive the EVA-7M RTC. The external reference can simply be connected to the **RTC_I** pin. Make sure that the 32.768 kHz reference signal is always turned on and the voltage at the **RTC_I** pin does not exceed 350 mVpp. The level (typ. 200 mVpp @ **RTC_I**) adjusting can be achieved with a resistive voltage divider followed by a DC blocking capacitor in the range of 1 nF to 10 nF. Also make sure the frequency versus temperature behavior of the external clock is within the recommended crystal specification shown in section B.1.

2.4.4 Time aiding

Time can also be sent by UBX message at every startup of the EVA-7M. This can be done to enable warm starts, AssistNow Autonomous and AssistNow Offline. This can be done when no RTC is maintained.

To enable hot starts correctly, the time information must be known accurately and thus the TimeMark feature has to be used.

For more information about time aiding or timemark see the *u-blox 7 Receiver Description including Protocol Specification* [2].



For information of this use case it is mandatory to contact u-blox support team.



For Power Save Mode operations where the RTC is needed, the time aiding cannot be used. This is because the host does not have any information about when the EVA-7M turns from OFF status to ON status during ON/OFF operation of Power Save Mode.

2.5 RF input

The EVA-7M RF-input is already matched to 50 Ohms and has an internal DC block. To achieve the performance values as written in the *EVA-7M Data Sheet* [1], an active antenna with a good LNA inside or the mandatory LNA in front of EVA-7M must have a noise figure below 1 dB.

The EVA-7M can receive GPS and GLONASS frequencies. However, because of differing center frequencies, the receiver has to be switched to GPS or GLONASS mode by using a UBX message. Concurrent reception of both GPS and GLONASS is not possible with the EVA-7M.

2.5.1 Active Antenna

In case an active antenna is used, just the active antenna supply circuit has to be added in front of EVA-7M RF-input, see Figure 15. In case the active antenna has to be supervised, either the 2-pin active antenna supervisor

circuit (see Figure 18) or the 3-pin active antenna supervisor circuit (see Figure 4), has to be added to the active antenna circuit. These active antenna supervisor circuits also make sure that the active antenna is turned off in Power Save Mode stages.

2.5.2 Passive Antenna

If a passive antenna is connected to the EVA-7M, it is mandatory to use an additional LNA in front of EVA-7M to achieve the performance values as written in the *EVA-7M Data Sheet* [1], see Appendix A. An LNA (U1) alone would make the EVA-7M more sensitive to out-band jammers, so an additional GNSS SAW filter (F1) has to be connected between the external LNA (U1) and the EVA-7M RF-input. If strong out-band jammers are close to the GNSS antenna (e.g. a GSM antenna), see section 2.5.3.

The LNA (U1) can be selected to deliver the performance needed by the application in terms of:

- Noise figure (sensitivity)
- Selectivity and linearity (Robustness against jamming)
- Robustness against RF power and ESD



The external LNA (U1) must be placed close to the passive antenna to get best performance.

The **ANT_OFF** pin can be used to turn off an external LNA. The **ANT_OFF** signal must be inverted for common LNAs which come with an enable pin which has to be "low" to turn off.

The function of the **ANT_OFF** pin can be inverted by sending the following sequence to the receiver:

```
B5 62 06 41 0C 00 00 00 03 1F 90 47 4F B1 FF FF EA FF 33 98
```



Note, that applying this sequence results in a permanent change and cannot be reversed.



A pull-down resistor (R7) is required to ensure correct operation of the **ANT_OFF** pin.

ESD discharge into the RF input cannot always be avoided during assembly and / or field use with this approach! To provide additional robustness an ESD protection diode, as listed in Appendix B.7, can be placed in front of the LNA to GND.

2.5.3 Improved Jamming Immunity

If strong out-band jammers are close to the GNSS antenna (e.g. a GSM antenna) GNSS performance can be degraded or the maximum input power of the EVA-7M RF-input can be exceeded. An additional SAW filter (F2) has to be put in front of the external LNA (U1), see Appendix A. If the external LNA can accept the maximum input power, the SAW filter between the passive antenna and external LNA (LNA1) might not be necessary. This results in a better noise figure than an additional SAW filter (F2) in front of the external LNA (U1).

If the EVA-7M is exposed to an interference environment it is recommended to use additional filtering. Improved interference immunity with good GNSS performance is achieved when using a SAW/LNA/SAW configuration between the antenna and the EVA-7M RF-input. The single-ended SAW filter (F2) can be placed in front of the LNA matching network to prevent receiver blocking due to strong interference, see Figure 5.

It should be noted that the insertion loss of SAW filter (F2) directly affects the system noise figure and hence the system performance. Choice of a component with low insertion loss is mandatory when a passive antenna is used with this set-up. An example schematic for an improved jamming immunity is shown in Appendix A.3 (see Figure 14).

2.6 RESET_N

The EVA-7M provides a **RESET_N** pin to reset the system. The **RESET_N** is an input-only with internal pull-up resistor. It must be at low level for at least 10 ms to make sure **RESET_N** is detected. It is used to reset the system. Leave **RESET_N** open for normal operation. The **RESET_N** complies with the **VCC_IO** level and can be actively driven high.



RESET_N should be only used in critical situations to recover the system. The Real-Time Clock (RTC) will also be reset and thus immediately afterwards the receiver cannot perform a Hot Start.



In reset state, the EVA-7M consumes a significant amount of current. It is therefore recommended to use **RESET_N** only as a reset signal and not as an enable/disable.

2.7 Design-in checklist

2.7.1 General considerations

Check power supply requirements and schematic:

- Is the power supply voltage within the specified range? See how to connect power in Section 2.1.
- For USB devices: Is the voltage **V_USB** voltage within the specified range? Do you have a Bus or Self powered setup?
- Compare the peak current consumption of EVA-7M with the specification of your power supply.
- GNSS receivers require a stable power supply. Avoid series resistance in your power supply line (the line to **VCC**) to minimize the voltage ripple on **VCC**.

Backup battery

- For achieving a minimal Time To First Fix (TTFF) after a power down (warm starts, hot starts), make sure to connect a backup battery to **V_BCKP**, and use an RTC. If not used, make sure **V_BCKP** is connected to **VCC_IO**.

Antenna/ RF input

- The total noise figure including external LNA (or the LNA in the active antenna) should be around 1 dB.
- With EVA-7M, an external LNA is mandatory if no active antenna is used to achieve the performance values as written in the *EVA-7M Data Sheet* [1].
- Make sure the antenna is not placed close to noisy parts of the circuitry and not facing noisy parts. (E.g. micro-controller, display, etc.)
- To optimize performance in environments with out-band jamming/interference sources, use an additional SAW filter.



For more information dealing with interference issues see the *GPS Antenna Application Note* [3].

Schematic

- Inner pins of the package must all be connected to GND.**

2.7.2 Schematic design-in for EVA-7M

For a minimal design with EVA-7M the following functions and pins need to be considered:

- Connect the power supply to **VCC**, **VCC_IO** and **V_BCKP**.
- **V_USB**: Connect the USB power supply to a LDO before feeding it to **V_USB** and **VCC** or connect it to GND if USB is not used.
- Ensure an optimal ground connection to all ground pins of the EVA-7M module
- Choose the required serial communication interface (UART, USB, SPI or DDC) and connect the appropriate pins to your application
- If you need hot or warm start in your application, connect a Backup Battery to **V_BCKP** and add RTC circuit.
- If antenna bias is required see Appendix A.4.

2.8 Pin description

| Name | I/O | Description | Remark |
|-----------------|-----|---------------------|-----------------------------------------------------|
| ANT_OFF | O | Antenna control | Leave open if not used. |
| ANT_OK | I | Antenna status | Leave open if not used. |
| D_SEL | I | Interface selector | See section 2.2. |
| GND | I | Ground | Outer ground pin |
| GND | I | Ground | Outer ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| GND | I | Ground | Inner ground pin |
| PIO13 / EXTINT | I | External interrupt | Leave open if not used. |
| PIO14 / ANT_DET | I | Antenna detection | Leave open if not used. |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| Reserved | I/O | Reserved | Do not connect. Must be left open! |
| RESET_N | I | System reset | See section 2.6. |
| RF_IN | I | RF Input | Add external LNA and SAW if no active antenna used. |
| RTC_O | O | RTC Output | Leave open if no RTC Crystal attached. |
| RTC_I | I | RTC Input | Connect to GND if no RTC Crystal attached. |
| RX / MOSI | I | Serial interface | See section 2.2. |
| SCL / SCK | I | Serial interface | See section 2.2. |
| SDA / CS_N | I/O | Serial interface | See section 2.2. |
| TIMEPULSE | O | Time pulse output | Leave open if not used. |
| TX / MISO | O | Serial interface | See section 2.2. |
| USB_DM | I/O | USB data | Leave open if not used. |
| USB_DP | I/O | USB data | Leave open if not used. |
| V_BCKP | I | Backup supply | See section 2.1. |
| VCC | I | Main supply | See section 2.1. |
| VCC_IO | I | I/O Supply | See section 2.1. |
| V_USB | I | USB Interface power | Connect to GND if not used. |

Table 5: EVA-7M pin description



For pin assignment see the *EVA-7M Data Sheet* [1].

2.9 Layout design-in checklist

Follow this checklist for the layout design to get an optimal GNSS performance.

Layout optimizations (Section 2.10)

- Is the EVA-7M placed according to the recommendation in section 2.10.3?
- Is the grounding concept optimal?
- Has the 50 Ohm line from antenna to EVA-7M (micro strip / coplanar waveguide) been kept as short as possible?
- Assure low serial resistance in **VCC** power supply line (choose a line width > 400 um).
- Keep power supply line as short as possible.
- Design a GND guard ring around the optional RTC crystal lines and GND below the RTC circuit.
- Add a ground plane underneath the GNSS module to reduce interference. This is especially important for the RF input line.
- For improved shielding, add as many vias as possible around the micro strip/coplanar waveguide, around the serial communication lines, underneath the GNSS module, etc.

Calculation of the micro strip for RF input

- The micro strip / coplanar waveguide must be 50 Ohms and be routed in a section of the PCB where minimal interference from noise sources can be expected. Make sure around the RF line is only GND as well as under the RF line.
- In case of a multi-layer PCB, use the thickness of the dielectric between the signal and the 1st GND layer (typically the 2nd layer) for the micro strip / coplanar waveguide calculation.
- If the distance between the micro strip and the adjacent GND area (on the same layer) does not exceed 5 times the track width of the micro strip, use the "Coplanar Waveguide" model in AppCad to calculate the micro strip and not the "micro strip" model.

2.10 Layout

This section provides important information for designing a reliable and sensitive GNSS system.

GNSS signals at the surface of the earth are about 15 dB below the thermal noise floor. Signal loss at the antenna and the RF connection must be minimized as much as possible. When defining a GNSS receiver layout, the placement of the antenna with respect to the receiver, as well as grounding, shielding and jamming from other digital devices are crucial issues and need to be considered very carefully.

2.10.1 Footprint

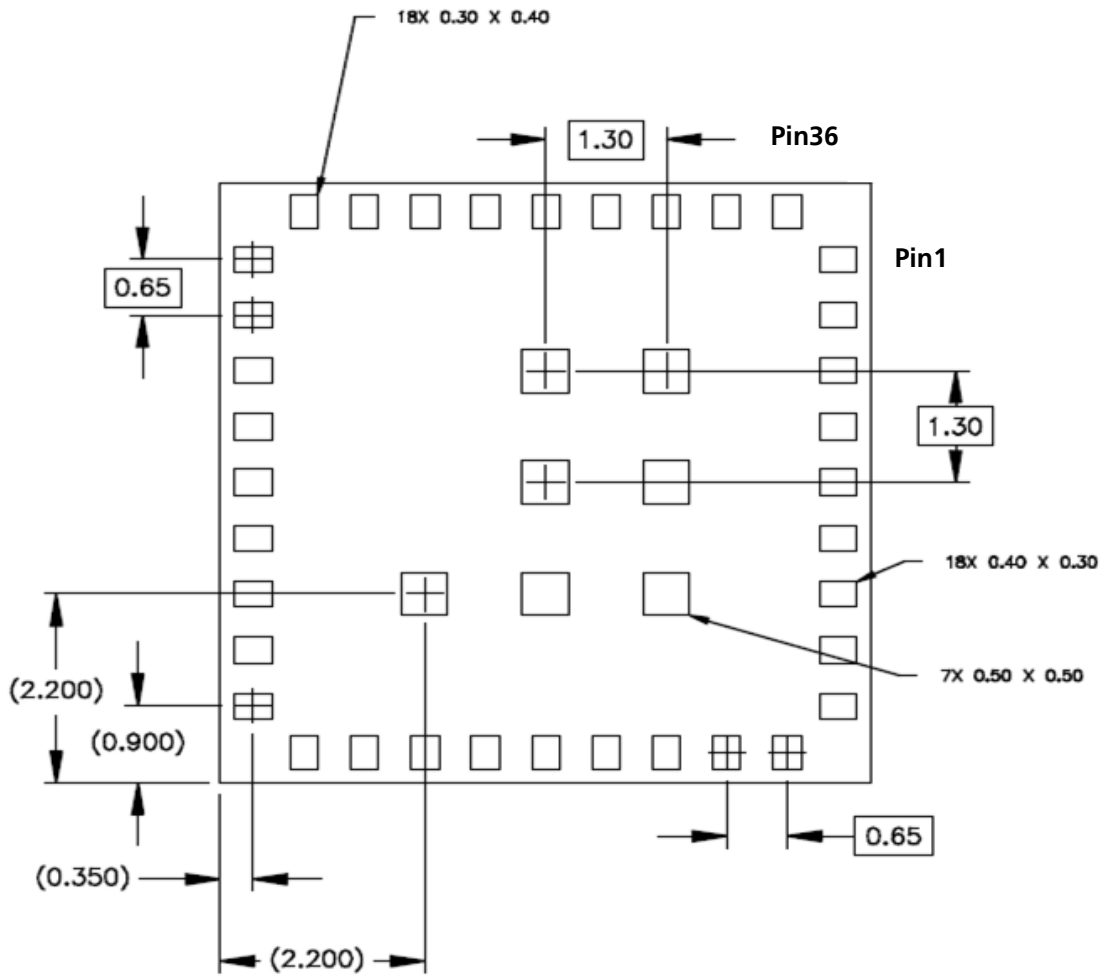




Figure 6: Recommended footprint (bottom view)

Units are in mm.

2.10.2 Paste mask

The paste mask shall be 50 µm smaller than the copper pads with a paste thickness of 100 µm.

-  The paste mask outline needs to be considered when defining the minimal distance to the next component.
-  These are recommendations only and not specifications. The exact geometry, distances, stencil thicknesses and solder paste volumes must be adapted to the specific production processes (e.g. soldering etc.) of the customer.

2.10.3 Placement

A very important factor in achieving maximum GNSS performance is the placement of the receiver on the PCB. The connection to the antenna must be as short as possible to avoid jamming into the very sensitive RF section.

Make sure that RF critical circuits are clearly separated from any other digital circuits on the system board. To achieve this, position the receiver digital part towards your digital section of the system PCB. Care must also be exercised with placing the receiver in proximity to circuitry that can emit heat. The RF part of the receiver is very sensitive to temperature and sudden changes can have an adverse impact on performance.

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


2.11 Migration considerations

EVA-7M modules are targeted to be the successor of AMY-6M. However, both modules make use of a different package. As a consequence a layout for AMY-6M cannot be directly migrated to EVA-7M and must be modified.

-  **EVA-7M modules are not pin-compatible to AMY-6M modules.**

2.11.1 C88-7M - Evaluating EVA-7M on existing NEO-xM sockets

The C88-7M GNSS application board is designed for easier evaluation and design-in of u-blox EVA-7M module in existing NEO based products. The C88-7M integrates the EVA-7M GNSS module into a NEO form factor adaptor board (i.e. with the same dimensions and pinout as the NEO-6M and NEO-7M). The C88-7M application board allows straightforward integration of the u-blox EVA-7M in customers' existing end products based on the u-blox NEO GNSS modules. It enables fast verification of the EVA-7M functionalities and performances before the design-in

-  Schematic of C88-7M is available upon request.

| NEO-6M | | C88-7M | | Remarks for Migration | |
|--------|-------------------|-------------------------------------------------------------------|-----------|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pin | Pin Name | Typical Assignment | Pin Name | | Typical Assignment |
| 1 | RESERVED | Leave open. | RESERVED | Leave open. | No difference |
| 2 | SS_N | SPI Slave Select | D_SEL | Leave open. If connected to GND SPI interface available on Pins 18-21. | Different functions. Only compatible if this pin is left open! |
| 3 | TIMEPULSE | Time pulse (1PPS) | TIMEPULSE | Time pulse (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 to pin 9 on C88-7M, the device always runs. With NEO-6Q, if Reset input is used, it implements the 3k3 resistor from pin 8 to pin 9. This also works with NEO-7N. If used with NEO-7N, do not populate the pull-up resistor. |
| 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 | GPS signal input | RF_IN | GPS signal input | For designs with a passive antenna directly connected to the RF_IN pin, an additional LNA in front of C88-7M is recommended in order to achieve the performance values shown in the <i>EVA-7M Data Sheet</i> [1]. The Noise Figure of the C88-7M is about 2 dB higher than NEO-6M. |
| 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. | RESERVED | Leave open. | Different functions. Only compatible if this pin is left open! |
| 15 | MISO/ CFG_COM1 | SPI MISO / Configuration pin. Leave open if not used. | RESERVED | Leave open. | Different functions. Only compatible if this pin is left open! |
| 16 | CFG_GPS0/ SCK | Power Mode Configuration pin / SPI Clock. Leave open if not used. | RESERVED | Leave open. | Different functions. Only compatible if this pin is left open! |
| 17 | RESERVED | Leave open. | RESERVED | Leave open. | No difference |
| 18 | SDA | DDC Data | SDA | DDC Data / SPI CS_N | No difference if pin 2 is left open. 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 | No difference |
| 23 | VCC | Supply voltage | VCC | Supply voltage | |
| 24 | GND | GND | GND | GND | No difference |

Table 6: Replacing NEO-6M by C88-7M


NEO-6M **cannot** be replaced by C88-7M if SPI interface or configuration pins (Pin 2, pin 14, pin 15 and pin 16) are used.



For the existing NEO-7M designs, C88-7M is one to one compatible with the exception of some performance difference.

For software migration, consult the *u-blox 7 Firmware Version 1.0 Release Note* [6] and the *u-blox 7 Receiver Description Including Protocol Specification* [2].

2.12 EOS/ESD/EMI precautions

When integrating GNSS receivers into wireless systems, careful consideration must be given to electromagnetic and voltage susceptibility issues. Wireless systems include components which can produce Electrostatic Discharge (ESD), 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 as specified in the *EVA-7M Data Sheet* [1].

2.12.1 Abbreviations

| 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 |
| 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 |

Table 7: Explanation of abbreviations used in this section

2.12.2 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.



2.12.3 ESD protection measures



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

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 as shown in Figure 5 can also avoid failures in the field.

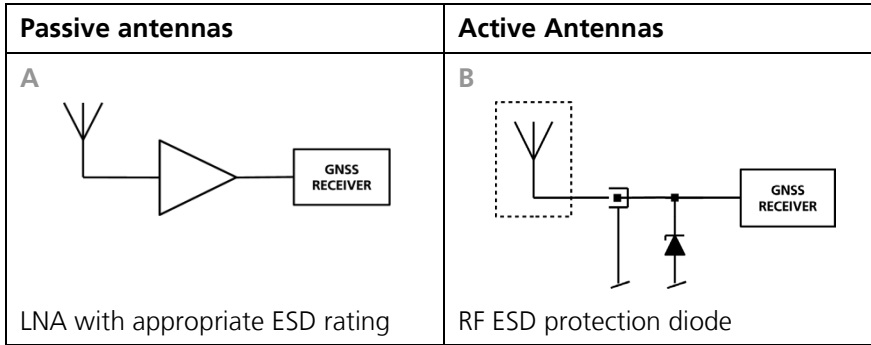


Figure 7: ESD Precautions

2.12.4 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's hard to determine whether the chip structures have been damaged by ESD or EOS.

2.12.5 EOS protection measures

EOS protection measures as shown in Figure 6 are recommended for any designs combining wireless communication transceivers (e.g. GSM, GPRS) and GNSS in the same design or in close proximity.

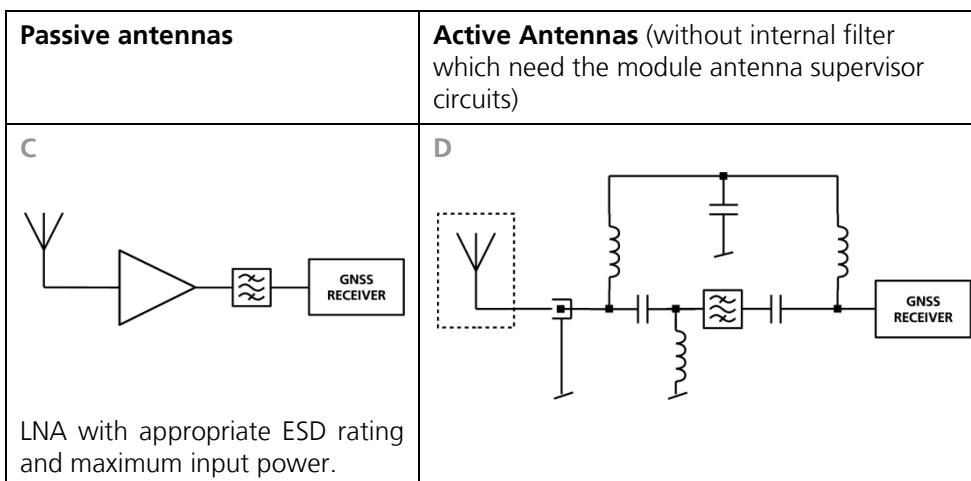


Figure 8: EOS and ESD Precautions

2.12.6 Applications with cellular modules

GSM uses power levels up to 2W (+33dBm). Make sure that absolute maximum input power level of GNSS receiver is not exceeded.

See the *GPS Implementation and Aiding Features in u-blox wireless modules* [5].

2.12.6.1 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 can't 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.

2.12.6.2 Increasing interference immunity

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

2.12.6.3 In-band interference

With in-band interference the signal frequency is very close to the GPS frequency of 1575 MHz (see Figure 7). Such interference signals are typically caused by harmonics from displays, micro-controller, bus systems, etc.

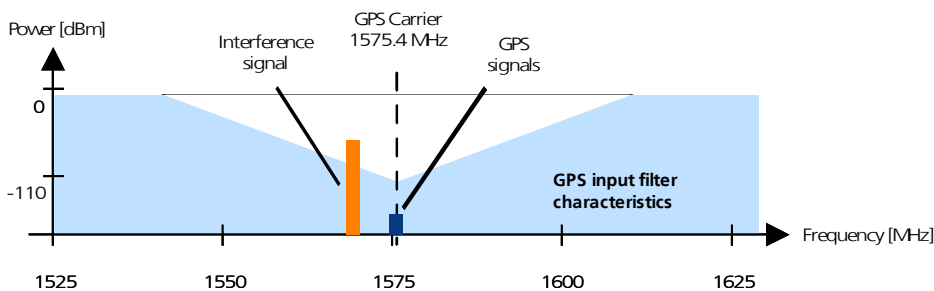


Figure 9: In-band interference signals

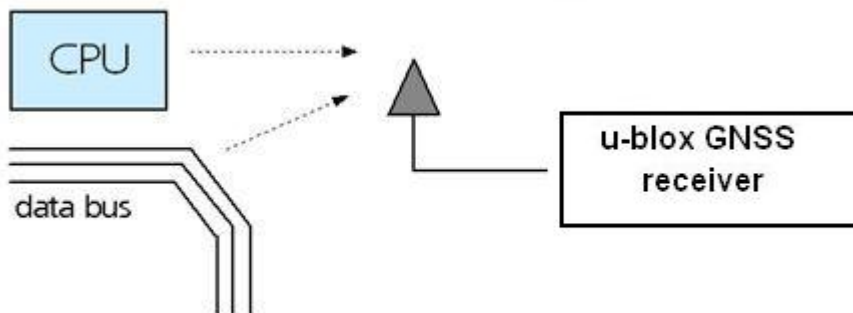


Figure 10: In-band interference sources

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 bandpass filter before handset antenna

2.12.6.4 Out-band interference

Out-band interference is caused by signal frequencies that are different from the GNSS carrier (see Figure 9). The main sources are wireless communication systems such as GSM, CDMA, WCDMA, WiFi, BT, etc.

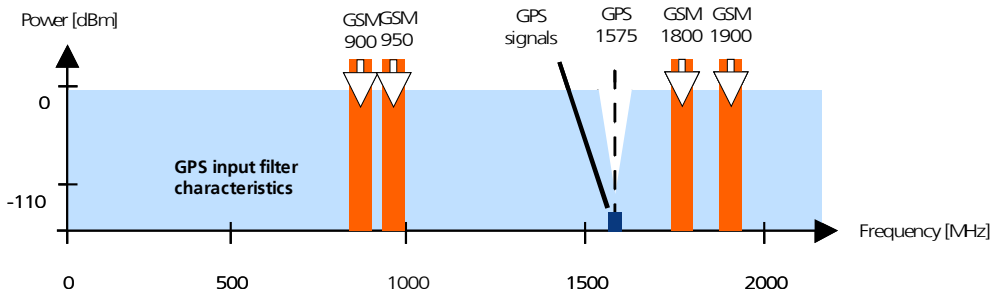


Figure 11: Out-band interference signals

Measures against out-band interference include maintaining a good grounding concept in the design and adding a SAW or bandpass ceramic filter (as recommend in section 2.12.5) into the antenna input line to the GNSS receiver (see Figure 10).



Figure 12: Measures against out-band interference

3 Product handling & soldering

3.1 Packaging, shipping, storage and moisture preconditioning

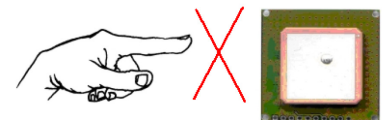
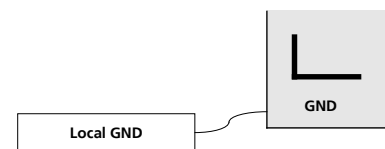
For information pertaining to reels and tapes, Moisture Sensitivity levels (MSD), shipment and storage information, as well as drying for preconditioning see the *EVA-7M Data Sheet* [1].

3.2 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 in the vicinity of 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 receivers 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 shall 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 the mounted patch antenna.
- 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 receiver!

3.3 Soldering

3.3.1 Soldering paste

Use of "No Clean" soldering paste is strongly recommended, as it does not require cleaning after the soldering process has taken place.

Stencil Thickness: 100 to 150 µm for base boards

The paste-mask geometry for applying soldering paste should meet the recommendations given in section 2.10.2.

3.3.2 Reflow soldering

| | | |
|--------------------------------------------------|------------------------------------|------------------|
| Preheat/ Soak Temperature min. | T_{smin} | 150°C |
| Preheat/ Soak Temperature max. | T_{smax} | 180°C |
| Preheat/ Soak Time from T_{smin} to T_{smax} | T_s (T_{smin} to T_{smax}) | < 90 seconds |
| Liquidus Temperature | T_L | 217°C |
| Time maintained above T_L | t_L | 40 to 60 seconds |
| Peak Package Body Temperature | T_p | 250°C |
| Ramp up rate (T_L to T_p) | | 3°C/ second max. |
| Time within +0°C...-5°C of T_p | | 30 seconds |
| Ramp down rate (T_p to T_L) | | 4°C/ second max. |

Table 8: Recommended conditions for reflow process

The peak temperature must not exceed 250°C. The time above 245°C must not exceed 30 seconds.



EVA-7M **must not** be soldered with a damp heat process.

3.3.3 Optical inspection

After soldering the EVA-7M module, consider an optical inspection step to check whether:

- The module is properly aligned and centered over the pads

3.3.4 Repeated reflow soldering

Only single reflow soldering processes are recommended for boards populated with EVA-7M modules.

3.3.5 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 EVA-7M.

3.3.6 Rework

Not recommended.

3.3.7 Conformal coating

Certain applications employ a conformal coating of the PCB using HumiSeal® or other related coating products.



Conformal Coating of the module will void the warranty.

3.3.8 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 EVA-7M module before implementing this in the production.



Casting will void the warranty.

3.3.9 Use of ultrasonic processes

Some components on the EVA-7M 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 EVA-7M module caused by any Ultrasonic Processes.

4 Product testing

4.1 Test parameters for OEM manufacturer

Because of the testing done by u-blox, it is obvious that an OEM manufacturer doesn't need to repeat firmware tests or measurements of the GNSS parameters/characteristics (e.g. TTFF) in their production test.

An OEM manufacturer should focus on:

- Overall sensitivity of the device (including antenna, if applicable)
- Communication to a host controller

4.2 System sensitivity test

The best way to test the sensitivity of a GNSS device is with the use of a Multi-GNSS generator. It assures reliable and constant signals at every measurement.

u-blox recommends the following Multi-GNSS generator:

- Spirent GSS6300
Spirent Communications Positioning Technology
www.positioningtechnology.co.uk



Figure 13: Multi-GNSS generator

4.2.1 Guidelines for sensitivity tests

1. Connect a Multi-GNSS generator to the OEM product.
2. Choose the power level in a way that the "Golden Device" would report a C/No ratio of 38-40 dBHz.
3. Power up the DUT (Device Under Test) and allow enough time for the acquisition.
4. Read the C/N0 value from the NMEA GSV or the UBX-NAV-SVINFO message (e.g. with u-center).
5. Compare the results to a "Golden Device" or a u-blox 7 Evaluation Kit.

4.2.2 'Go/No go' tests for integrated devices

The best test is to bring the device to an outdoor position **with excellent sky view** (HDOP < 3.0). Let the receiver acquire satellites and compare the signal strength with a "Golden Device".



As the electro-magnetic field of a redistribution antenna is not homogenous, indoor tests are in most cases not reliable. These kind of tests may be useful as a 'go/no go' test but not for sensitivity measurements.

Appendix

A Reference schematics

A.1 Cost optimized circuit

- Passive Antenna¹
- No RTC crystal
- No backup battery
- UART and DDC for communication to host

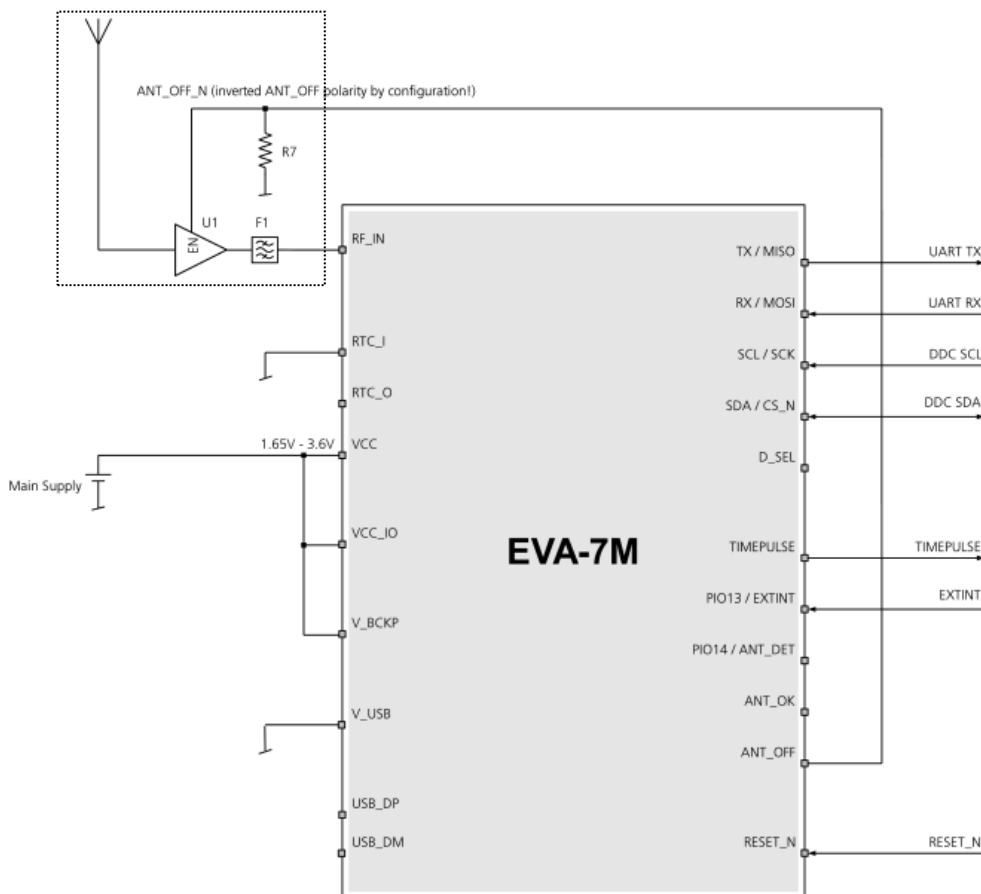


Figure 14: Cost optimized circuit

¹ To achieve the performance values as written in the *EVA-7M Data Sheet* [1] either use an active antenna or add an LNA+SAW between the passive antenna and RF_IN pin.

A.2 Best performance circuit with passive antenna

- External LNA
- RTC crystal
- Backup battery
- UART and DDC for communication to host

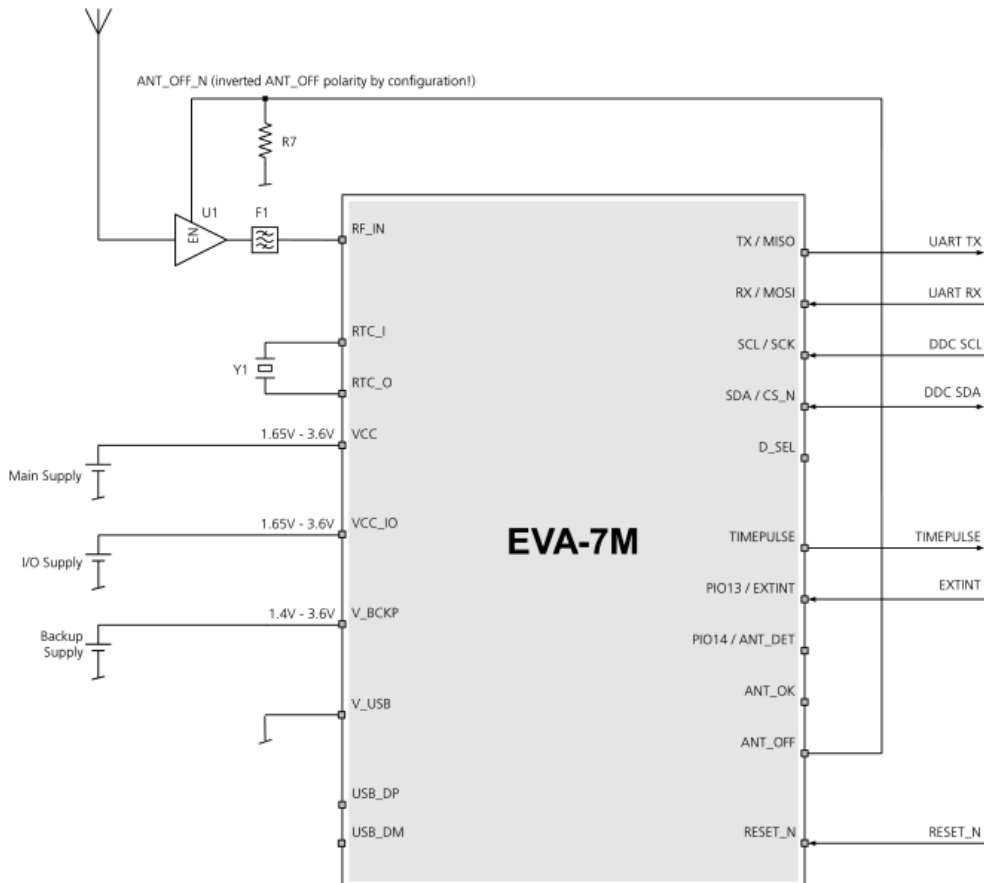


Figure 15: Best performance circuit

A.3 Improved jamming immunity with passive antenna

- External SAW filter – LNA – SAW filter
- RTC crystal
- Backup battery
- UART and DDC for communication to host

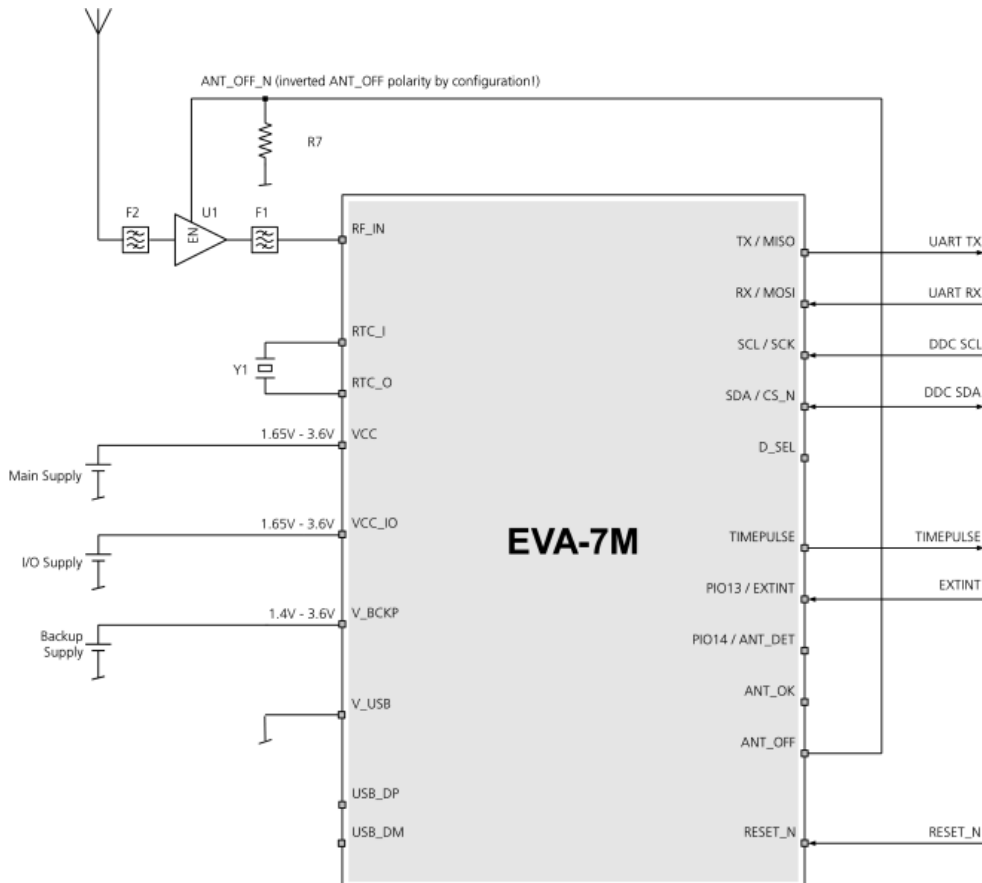


Figure 16: Standard circuit for an improved jamming immunity

A.4 Circuit using active antenna

- Active antenna
- RTC crystal
- Backup battery
- UART and DDC for communication to host

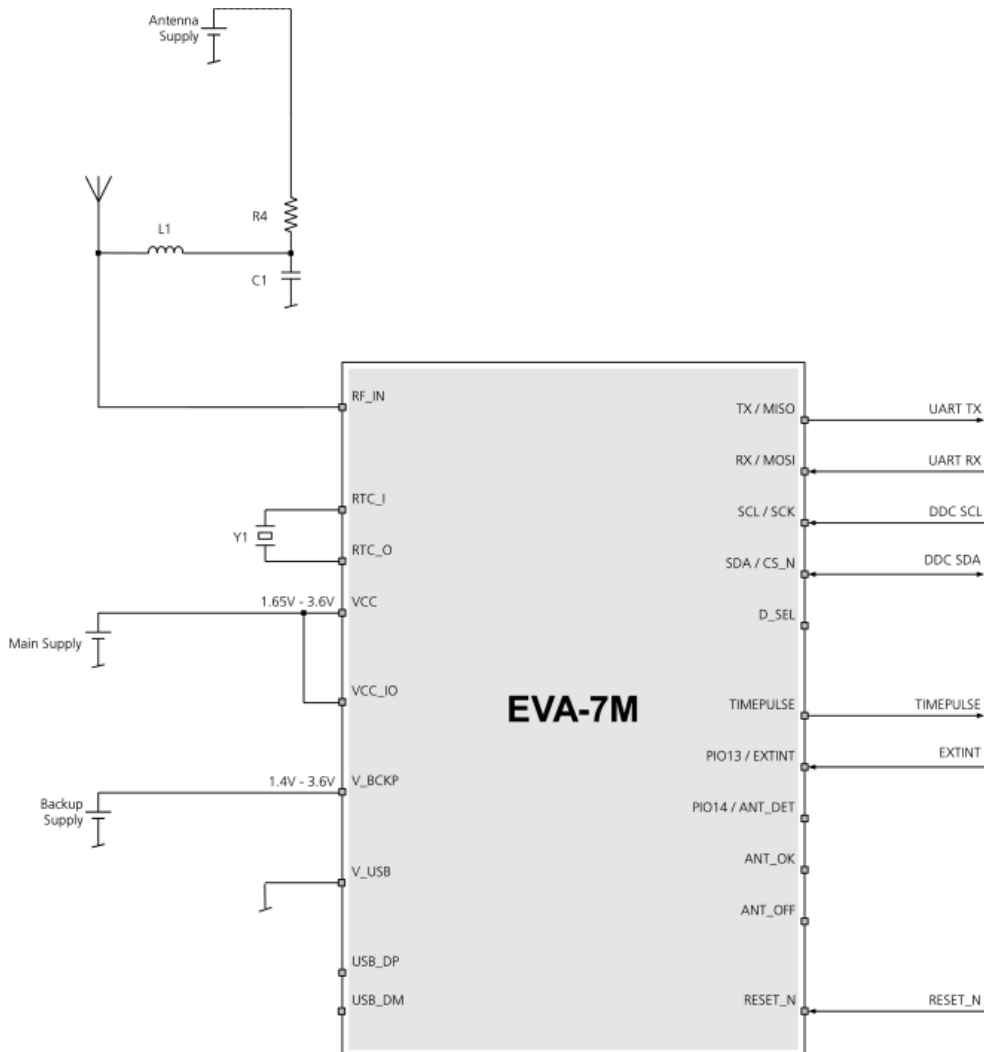


Figure 17: Standard circuit using active antenna

A.5 USB self-powered circuit with passive antenna

- External LNA
- RTC crystal
- Backup battery
- UART and DDC for communication to host
- USB interface

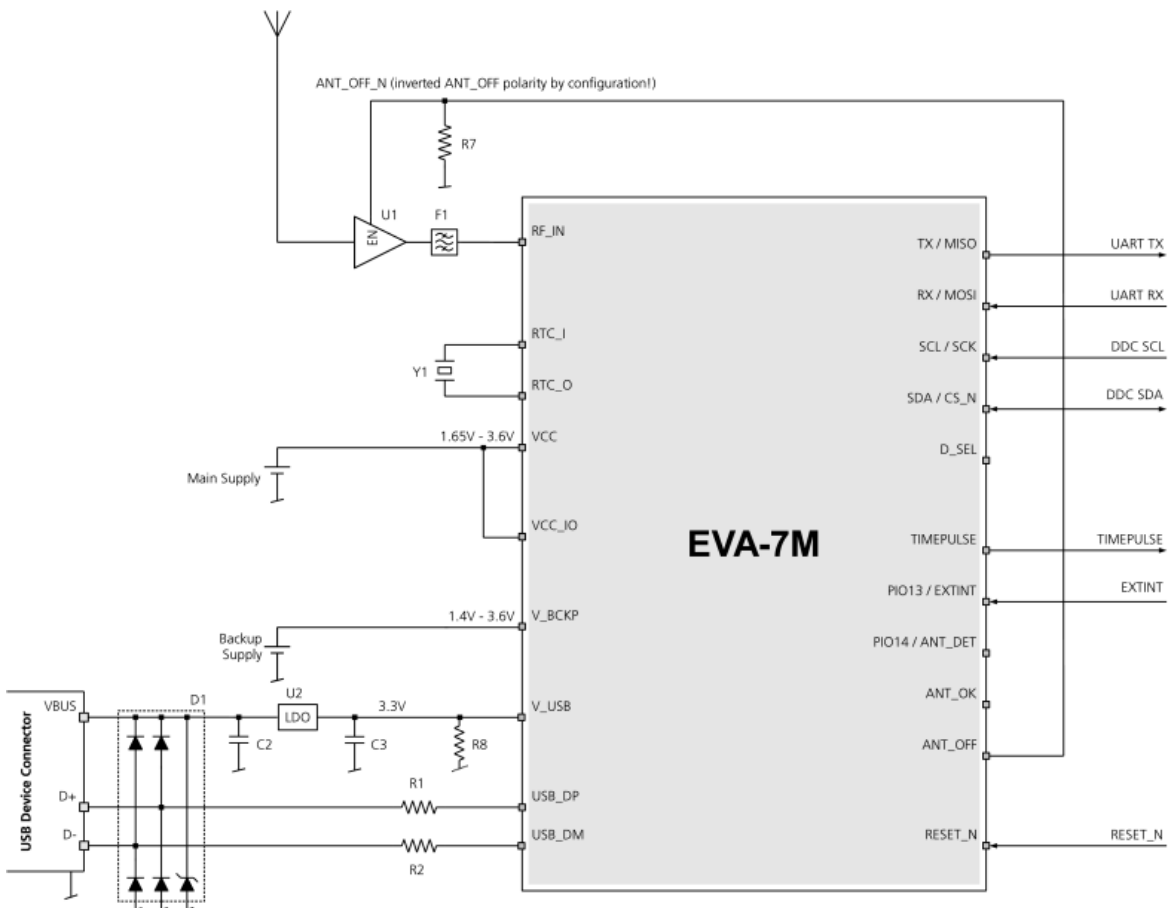


Figure 18: USB self-powered circuit

A.6 USB bus-powered circuit with passive antenna

- External LNA
- RTC crystal
- Backup battery
- SPI for communication to host
- USB interface

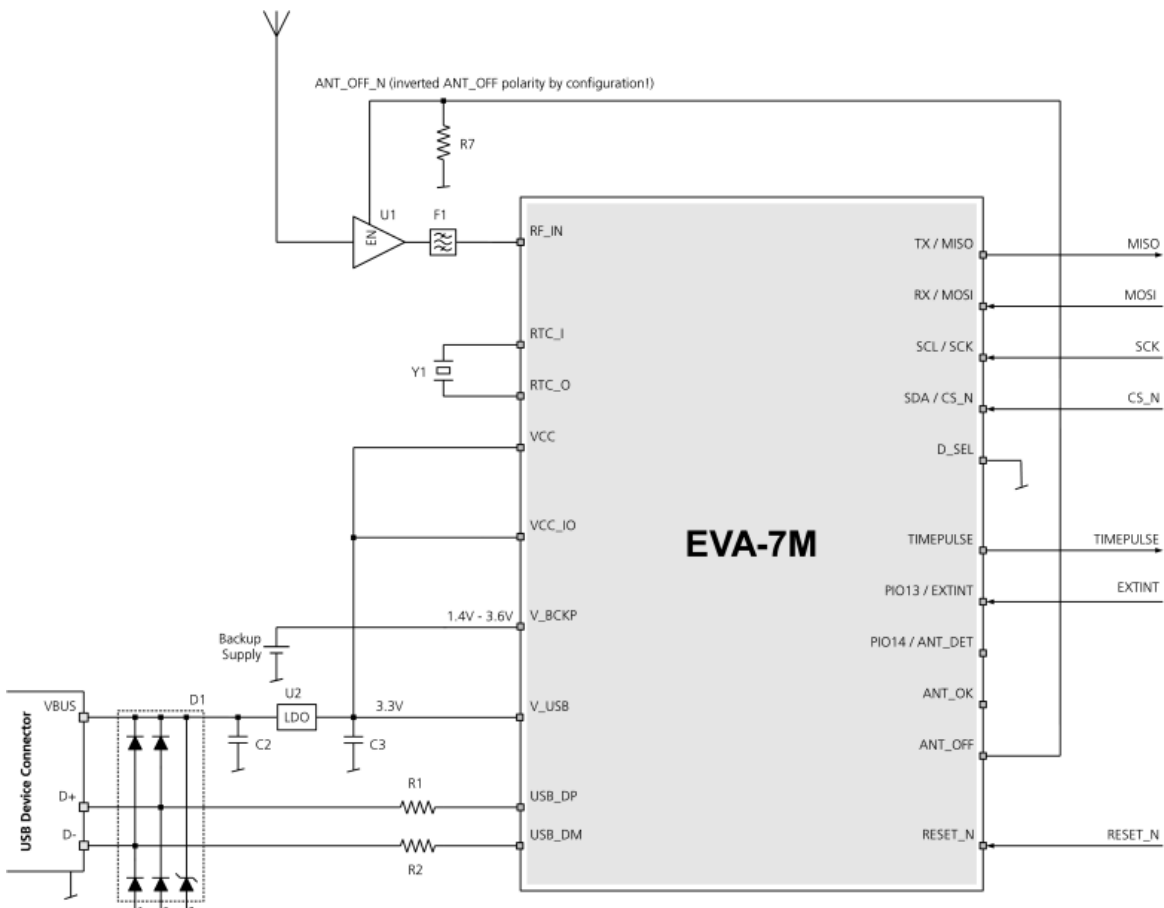


Figure 19: USB bus-powered circuit

A.7 Circuit using 2-pin antenna supervisor

- 2-pin antenna supervisor
- RTC crystal
- Backup battery
- UART and DDC for communication to host

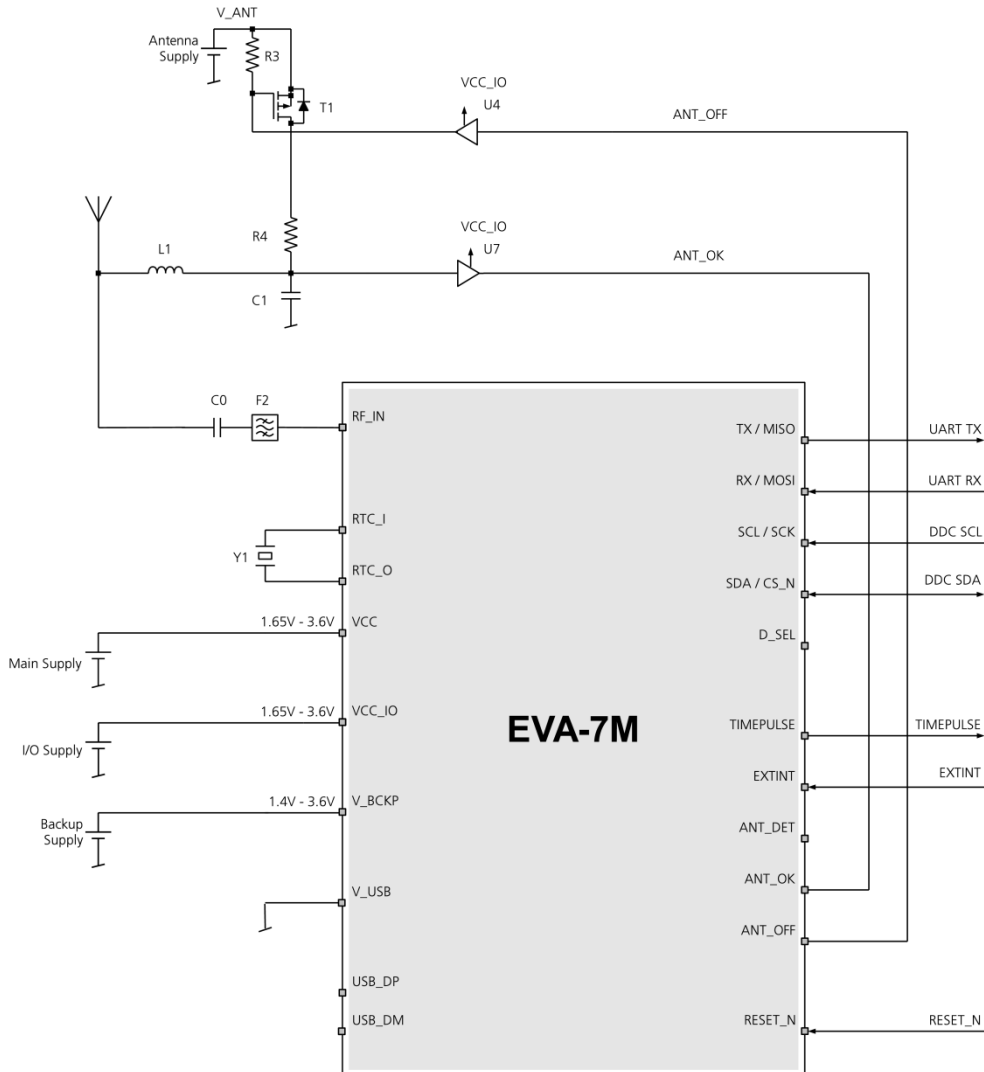


Figure 20: Circuit using 2-pin antenna supervisor

A.8 Circuit using 3-pin antenna supervisor

- 3-pin antenna supervisor
- RTC crystal
- Backup battery
- UART and DDC for communication to host

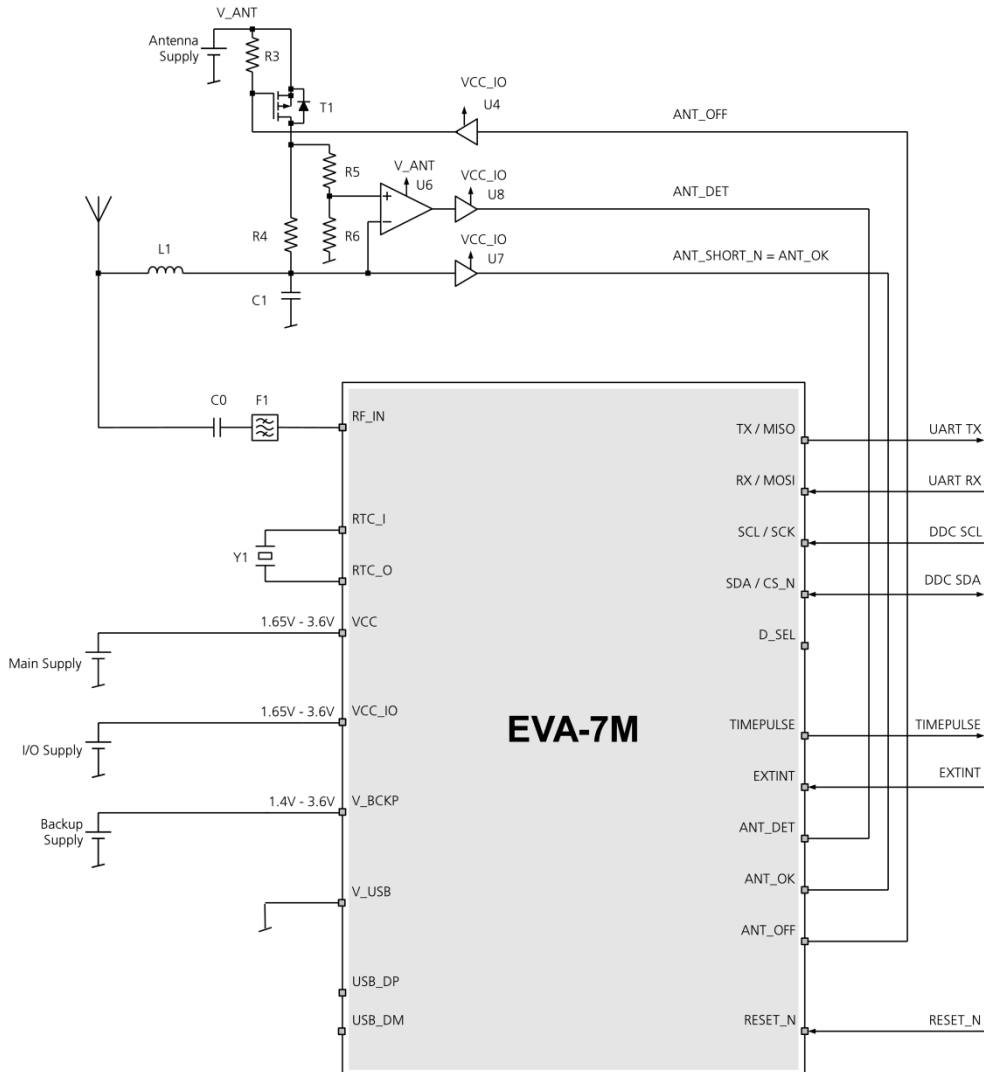







Figure 21: Circuit using 3-pin antenna supervisor

A.9 Design-in Recommendations in combination with cellular operation

| Product | | Receiver Chain | | | | | Cellular and GNSS Simultaneous operation | | | |
|---------|---------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------|----------------|---------------------|---|
| Family | Variant |  |  |  |  |  | Passive GNSS Antenna | | Active GNSS Antenna | |
| | | Antenna | SAW LNA | SAW | On-chip LNA | SAW | 2G cellular | 3G/4G cellular | 2G/3G/4G cellular | |
| MAX-6 | Any | | | | • | • | ✓ | | ✓ | ✓ |
| NEO-6 | Any | | | | • | • | ✓ | | ✓ | ✓ |
| LEA-6 | Any | | | | • | • | ✓ | | ✓ | ✓ |
| EVA-7 | M | | | | • | | ✓ | | ✓ | ✓ |
| MAX-7 | C | | | | • | | ✓ | | ✓ | ✓ |
| | W | | | | • | | ✓ | | ✓ | ✓ |
| | Q | | | | • | | ✓ | | ✓ | ✓ |
| NEO-7 | N | | • | | • | | ✓ | ✓ | ✓ | ✓ |
| | M | | | | • | | ✓ | | ✓ | ✓ |
| | P | | | • | • | | ✓ | ✓ | ✓ | ✓ |
| PAM-7 | Q | • | • | • | • | | ✓ | ✓ | ✓ | ✓ |

• = integrated

✓ = optimal performance

Table 9: Combinations of u-blox GNSS modules with different cellular technologies (2G/3G/4G)



See the *GPS Implementation and Aiding Features in u-blox wireless modules* [5].

B Component selection

This section provides information about components that are critical for the performance of the EVA-7M GNSS receiver module.

Recommended parts are selected on a data sheet basis only.

Temperature range specifications need only be as wide as required by a particular application. For the purpose of this document, specifications for industrial temperature range (-40 C ... +85 C) are provided.

B.1 External RTC (Y1)

| ID | Parameter | Value |
|----------|------------------------------------------|------------------|
| 1 | Frequency Specifications | |
| 1.1 | Oscillation mode | Fundamental Mode |
| 1.2 | Nominal frequency at 25 °C | 32.768 kHz |
| 1.3 | Frequency calibration tolerance at 25 °C | < ±100 ppm |
| 2 | Electrical specifications | |
| 2.1 | Load capacitance C_L | 7 pF |
| 2.2 | Equivalent series resistance R_s | < 100 k Ω |

Table 10: RTC crystal specifications

| Manufacturer | Order No. |
|---------------|----------------------------------------|
| Micro Crystal | CC7V-T1A 32.768 kHz 7.0 pF +/- 100 ppm |

Table 11: Recommend parts list for RTC crystal

B.2 RF band-pass filter (F1)

Depending on the application circuit, consult manufacturer datasheet for DC, ESD and RF power ratings!

| Manufacturer | Order No. | System supported | Comments |
|--------------|--------------------------|------------------|------------------------------------|
| TDK/ EPCOS | B8401: B39162-B8401-P810 | GPS+GLONASS | High attenuation |
| TDK/ EPCOS | B3913: B39162B3913U410 | GPS+GLONASS | For automotive application |
| TDK/ EPCOS | B9416: B39162B9416K610 | GPS | High input power |
| TDK/ EPCOS | B4310: B39162B4310P810 | GPS+GLONASS | Compliant to the AEC-Q200 standard |
| TDK/ EPCOS | B9482: B39162B9482P810 | GPS+GLONASS | Low insertion loss |
| muRata | SAFEA1G58KA0F00 | GPS+GLONASS | Only for mobile application |
| muRata | SAFFB1G58KA0F0A | GPS+GLONASS | Only for mobile application |
| Triquint | 856561 | GPS | Compliant to the AEC-Q200 standard |

Table 12: Recommend parts list for RF band-pass filter

B.3 External LNA protection filter (F2)

Depending on the application circuit, consult manufacturer datasheet for DC, ESD and RF power ratings!

| Manufacturer | Order No. | System supported | Comments |
|--------------|--------------------------|------------------|--------------------------------------------------|
| TDK/ EPCOS | B8401: B39162-B8401-P810 | GPS+GLONASS | High attenuation |
| TDK/ EPCOS | B3913: B39162B3913U410 | GPS+GLONASS | For automotive application |
| TDK/ EPCOS | B4310: B39162B4310P810 | GPS+GLONASS | Compliant to the AEC-Q200 standard |
| TDK/ EPCOS | B9850: B39162B9850P810 | GPS | Low insertion loss |
| TDK/ EPCOS | B8400: B39162B8400P810 | GPS | ESD protected and high input power |
| TDK/ EPCOS | B9416: B39162B9416K610 | GPS | High input power |
| TDK/ EPCOS | B9482: B39162B9482P810 | GPS+GLONASS | Low insertion loss |
| 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 |
| Triquint | B9850 | GPS | Compliant to the AEC-Q200 standard |
| CTS | CER0032A | GPS | Ceramic filter also offers robust ESD Protection |

Table 13: Recommended parts for the LNA protection filter

B.4 USB line protection (D1)

| Manufacturer | Order No. |
|---------------------|-----------|
| ST Microelectronics | USBLC6-2 |

Table 14: Recommend parts list for USB line protection

B.5 USB LDO (U2)

| Manufacturer | Order No. |
|------------------------|-----------------|
| Seiko Instruments Inc. | S-1206B33-I6T2G |

Table 15: Recommend parts list for USB LDO

B.6 External LNA (U1)

| ID | Parameter | Value |
|----------|------------------------------------------|---------|
| 1 | Gain and Noise Figure @ 1.575 GHz | |
| 1.1 | Gain | > 17 dB |
| 1.2 | Noise Figure | < 2 dB |

Table 16: External LNA specifications

| Manufacturer | Order No. | Comments |
|---------------------|-------------|------------------------------------------------------------------|
| Maxim | MAX2659ELT+ | Low noise figure, up to 10 dBm RF input power |
| JRC New Japan Radio | NJG1143UA2 | Low noise figure, up to 15 dBm RF input power |
| NXP | BGU8006 | Low noise figure, small size |
| Avago | ALM-1912 | Module, for GPS only, also including FBAR filter in front of LNA |
| Avago | MGA-231T6 | Up to 13 dBm RF input power |
| Avago | ALM-2712 | Module, for GPS only, FBAR filter-LNA filter FBAR |

Table 17: Recommend parts list for external LNA

B.7 RF ESD protection diode (D2)

| Manufacturer | Order No. |
|------------------|----------------|
| ON Semiconductor | ESD9R3.3ST5G |
| Infineon | ESD5V3U1U-02LS |

Table 18: Recommend parts list for RF ESD protection diode

B.8 Operational amplifier (U6)

| Manufacturer | Order No. |
|-------------------|-----------|
| Linear Technology | LT6000 |
| Linear Technology | LT6003 |

Table 19: Recommend parts list for Operational Amplifier

B.9 Open-drain buffer (U4, U7 and U8)

| Manufacturer | Order No. |
|--------------|------------|
| Fairchild | NC7WZ07P6X |

Table 20: Recommend parts list for open-drain buffer

B.10 Antenna supervisor switch transistor (T1)

| Manufacturer | Order No. |
|--------------|---------------------------|
| Vishay | Si1016X-T1-E3 (p-channel) |

Table 21: Recommend parts list for antenna supervisor switch transistor (p-channel MOSFET)

B.11 Ferrite beads (FB1)

| Manufacturer | Order No. | Comments |
|--------------|---------------|----------------------------|
| MuRata | BLM15HD102SN1 | High impedance @ 1.575 GHz |
| MuRata | BLM15HD182SN1 | High impedance @ 1.575 GHz |
| TDK | MMZ1005F121E | High impedance @ 1.575 GHz |
| TDK | MMZ1005A121E | High impedance @ 1.575 GHz |

Table 22: Recommend parts list for ferrite beads FB1

B.12 Feed-thru capacitors

| Manufacturer | Order No. | Comments |
|--------------|-----------------|-------------------------------------------|
| MuRata | NFL18SP157X1A3 | For data signals, 34 pF load capacitance |
| MuRata | NFA18SL307V1A45 | For data signals, 4 circuits in 1 package |
| MuRata | NFM18PC474R0J3 | For power supply < 2 A, size 0603 |
| MuRata | NFM21PC474R1C3 | For power supply < 4 A, size 0805 |

Table 23: Recommend parts list for feed thru capacitors

B.13 Inductor (L)

| Manufacturer | Order No. |
|---------------------|---------------|
| MuRata | LQG15H Series |
| MuRata | LQP15M Series |
| MuRata | LQW15A Series |
| Johanson Technology | L-07W Series |

Table 24: Recommend parts list for inductor

B.14 Standard capacitors

| Name | Use | Type / Value |
|------|------------------------------|---------------------------------------|
| C0 | RF-input DC block | COG 47P 5% 25V |
| C1 | Decoupling Capacitor | X7R 10N 10% 16V |
| C2 | Decoupling capacitor at VBUS | Depends on USB LDO (U2) specification |
| C3 | Decoupling capacitor at VBUS | Depends on USB LDO (U2) specification |

Table 25: Standard capacitors

B.15 Standard resistors

| Name | Use | Type / Value |
|------|------------------------------------------|--------------|
| R1 | USB data serial termination | 27R 5% 0.1W |
| R2 | USB data serial termination | 27R 5% 0.1W |
| R3 | Pull-up at antenna supervisor transistor | 100K 5% 0.1W |
| R4 | Antenna supervisor current limiter | 10R 5% 0.25W |
| R5 | Antenna supervisor voltage divider | 560R 5% 0.1W |
| R6 | Antenna supervisor voltage divider | 100K 5% 0.1W |
| R7 | Pull-up at LNA enable | 10K 5% 0.1W |
| R8 | Pull-down at V_USB | 100K 5% 0.1W |

Table 26: Standard resistors

Related documents

- [1] EVA-7M Data Sheet, Docu. No. UBX-13000581
- [2] u-blox 7 Receiver Description including Protocol Specification (Public version), Docu. No. GPS.G7-SW-12001
- [3] GPS Antenna Application Note, Docu. No. GPS-X-08014
- [4] GPS Compendium, Docu. No. GPS-X-02007
- [5] GPS Implementation and Aiding Features in u-blox wireless modules, Docu. No. GSM.G1-CS-09007
- [6] u-blox 7 Firmware Version 1.0 Release Note, Docu. No. GPS.G7-SW-12003



For regular updates to u-blox documentation and to receive product change notifications please register on our homepage.

Revision history

| Revision | Date | Name | Status / Comments |
|----------|-------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| R01 | 23-Jan-2014 | ffel | Objective Specification |
| R02 | 05-May-2014 | smos | Minor style revisions, reference corrections |
| R03 | 23-Jun-2014 | ffel | Advance Information, updated section 2.4.4, updated Appendix A.1, added Appendix A.9 (Design-in Recommendations in combination with cellular operation). |
| R04 | 28-Aug-2014 | mdur | Early Production Information, updated section 2.4.3, added section 2.11.1 (C88-7M - Evaluating EVA-7M on existing NEO-xM sockets). |
| R05 | 30-Jan-2015 | julu | Production Information |

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