LEA-M8S / LEA-M8T

u-blox M8 concurrent GNSS modules

Hardware Integration Manual

Abstract

This document describes the features and specifications of the cost effective and high-performance LEA-M8S and LEA-M8T modules, which feature the u-blox M8 concurrent GNSS engine with reception of GPS, GLONASS, BeiDou and QZSS signals.

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Document status explanation	
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:

Product name	Type number	ROM/FLASH version	PCN reference
LEA-M8S	LEA-M8S-0-01	ROM 2.01	UBX-15015253
LEA-M8T	LEA-M8T-0-01	ROM 2.01 / FLASH FW 2.30 TIMRAW 1.02	UBX-15012993

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Contents

1 Hardware description

1.1 Overview

LEA-M8S and LEA-M8T are standalone GNSS positioning modules featuring the high performance u-blox M8 positioning engine. 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 specific product features, see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2].

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

1.2 Configuration

The configuration settings can be modified using UBX protocol configuration messages, more information see the *u-blox M8 Receiver Description Including Protocol Specification* [3]. 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.

☞ The configuration can be saved permanently in flash of the LEA-M8T receiver.

1.3 Connecting power

The LEA-M8S and LEA-M8T positioning modules have up to three power supply pins: **VCC**, **V_BCKP** and **VDD_USB**.

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 is able to support the peak power for a short time (see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2] for detail specification).

☞ When switching from backup mode to normal operation or at start-up, the LEA-M8S and LEA-M8T 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, i.e. enables hot and warm starts. 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 the LEA-M8S / LEA-M8T module is supplied via the **VCC**, 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.
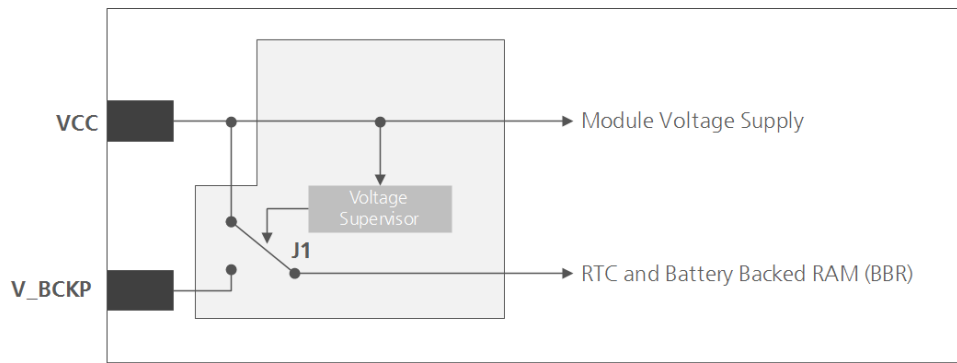
Figure 1: Backup battery and voltage (for exact pin orientation, see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2])

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 section

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

1.3.5 V_ANT: Antenna supply

The **V_ANT** pin is available to provide antenna bias voltage to supply an optional external active antenna. For more information, see section 2.4.

☞ If not used, connect the **V_ANT** pin to GND.

1.4 Interfaces

1.4.1 UART

The LEA-M8S and LEA-M8T positioning modules include a Universal Asynchronous Receiver Transmitter (UART) serial interface **RxD/TxD**, which supports configurable baud rates. The baud rates supported are specified in the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2]. 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.

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, and Windows 7 operating systems (also Windows 8 compatible). 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.

The USB device is **self-powered**, 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.
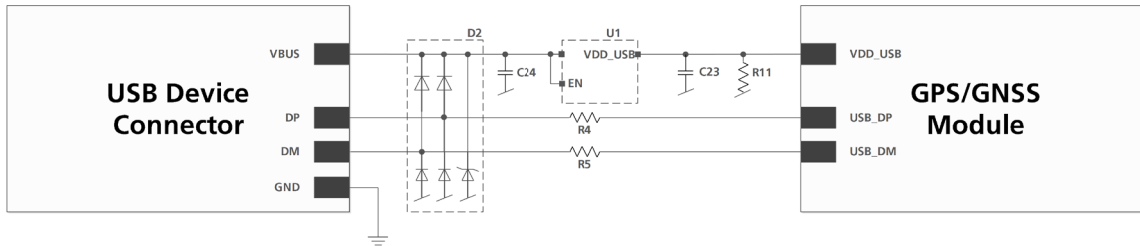
☞ USB **bus powered** is not supported.

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)
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 kΩ is recommended for USB self-powered setup. For bus-powered setup, R11 can be ignored.

Table 1: Summary of USB external components

1.4.3 Display Data Channel (DDC)

An I²C compatible Display Data Channel (DDC) interface is available 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 M8 Receiver Description Including Protocol Specification* [3]. For bandwidth information, see the *LEA-M8S Data Sheet* [1]. For timing parameters, consult the *I2C-bus specification* [8].

☞ 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 (LEA-M8T ONLY)

An SPI interface is available for communication to a host CPU with LEA-M8T module.

☞ 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/LEA-M8T Data Sheet* [2]

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 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 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 involved u-blox cellular module supporting the feature. For more information, see the *GPS Implementation and Aiding Features in u-blox wireless modules* [9].

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 LEA-M8S and LEA-M8T modules **RESET_N** is an input only.

☞ RESET_N should be used only 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.

EXTINT: External interrupt

EXTINT is an external interrupt pin with fixed input voltage thresholds with respect to VCC (see the *LEA-M8S Data Sheet* [1] or the *NEO/LEA-M8T Data Sheet* [2] 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.

SAFEBOOT_N

If the SAFEBOOT_N pin is "low" at start up, the u-blox M8 module starts in Safe Boot Mode and doesn't begin GNSS operation. The Safe Boot Mode can be used to recover from situations where the Flash has become corrupted.

D_SEL: Interface select (LEA-M8T ONLY)

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/LEA-M8T Data Sheet* [2].

Antenna Short circuit detection

The LEA-M8S and LEA-M8T modules include internal short circuit antenna detection. For more information, see section 2.4.

Antenna open circuit detection

The LEA-M8S and LEA-M8T modules provide antenna open circuit detection (OCD) functionality over the **AADET_N** pin.

AADET_N is an input pin used to report whether an external circuit has detected an external antenna or not. Low means an antenna has been detected (antenna consumes current), while high means no external antenna has been detected (no current drawn). This functionality is by default disabled. See section 2.4.2.

TIMEPULSE 1

A configurable time pulse signal is available with all u-blox M8 modules. By default, the time pulse signal is configured to 1 pulse per second. For more information, see the *u-blox M8 Receiver Description Including Protocol Specification* [3].

TIMEPULSE 2 (LEA-M8T only)

A configurable time pulse 2 signal is available on LEA-M8T module only. For more information see the *u-blox M8 Receiver Description Including Protocol Specification* [3].

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 19).

To avoid interference by improperly shielded lines, it is recommended to use resistors (e.g. R>20 Ω), 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.
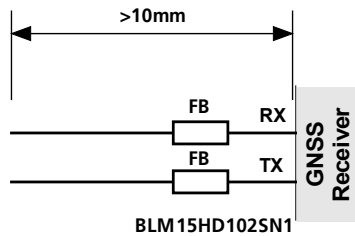

Figure 3: EMI Precautions

2 Design

2.1 Pin description

Function	PIN	No	I/O	Description	Remarks
Power	**VCC**	6	I	Supply Voltage	Provide clean and stable supply.
	GND	7, 13, 14, 15, 17	-	Ground	Assure a good **GND** connection to all **GND** pins of the module
	VCC_OUT	8	O	Output Voltage (VCC)	Leave open if not used.
	V_BCKP	11	I	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	24	I	USB Power Supply	To use the USB interface connect this pin to 3.0 – 3.6V. If no USB serial port used connect to GND.
Antenna	**RF_IN**	16	I	GNSS signal input from antenna	Use a controlled impedance transmission line of 50 Ω to connect to RF_IN.
	VCC_RF	18	O	Output Voltage RF section	Can be used to power external LNA or an external active antenna (**VCC_RF** connected to **V_ANT with 10 Ω**). The max power consumption of the antenna must not exceed the datasheet specification of the module. Leave open if not used.
	V_ANT	19	I	Antenna Bias voltage	Connect to **GND** (or leave open) if passive antenna is used. If an active antenna is used, add a 10 Ω resistor in front of **V_ANT** input to the Antenna Bias Voltage or **VCC_RF**
	EXTINT1/ AADET_N	20	I	Ext. Interrupt /Active Antenna Detect	Ext. Interrupt Pin. Int. pull-up resistor to VCC./ Input pin for optional antenna supervisor circuitry. Leave open if not used.
UART	**TxD** (LEA-M8S)	3	O	Serial Port	Communication interface can be programmed as TX Ready for DDC interface. Leave open if not used.
	TxD / SPI MISO (LEA-M8T)		O	TxD SPI MISO	Serial Port if D_SEL =1(or open) SPI MISO if D_SEL = 0
	RxD (LEA-M8S)	4	I	Serial Port	Serial port input with internal pull-up resistor to VCC. Leave open if not used. Do not use external pull up resistor.
	RxD /SPI MOSI (LEA-M8T)		I	RxD SPI MOSI	Serial Port if D_SEL =1(or open) SPI MOSI if D_SEL = 0
USB	**USB_DM**	25	I/O	USB I/O line	USB2.0 bidirectional communication pin. Leave open if unused. Implementations see section 1.4
	USB_DP	26	I/O	USB I/O line	
System	**RESET_N**	10	I	Hardware Reset (Active Low)	Leave open if not used. Do not drive high.
	TIMEPULSE 1	28	O	Timepulse 1	Configurable Timepulse signal (one pulse per second by default). Leave open if not used.
	SAFEBOOT_N / TIMEPULSE 2 (LEA-M8T)	12	I/O	Safeboot_N / Timepulse 2	Configurable Timepulse signal. Must not be held LO during start-up.
	SAFEBOOT_N (LEA-M8S)		I/O	Safeboot_N	Must not be held LO during start-up
	EXTINT0	27	I	Ext. Interrupt	Ext. Interrupt Pin. Int. pull-up resistor to **VCC**. Leave open if unused.
	SDA (LEA-M8S)	1	I/O	DDC Pins	DDC Data. Leave open if not used.
	SDA /SPI CS_N (LEA-M8T)		I/O	SDA SPI CS_N	DDC Data if D_SEL =1 (or open) SPI Chip Select if D_SEL = 0
	SCL (LEA-M8S)	2	I	DDC Pins	DDC Clock. Leave open if not used.
	SCL / SPI CLK (LEA-M8T)		I/O	SCL SPI CLK	DDC Clock if D_SEL =1 (or open) SPI Clock if D_SEL = 0
	D_SEL (LEA-M8T)	5	I	Interface Select	D_SEL = 0 -> SPI, D_SEL =1 (or open) -> DDC
	Reserved(LEA-M8S)		-	Reserved	Leave open
	Reserved	9, 21, 22, 23	-	Reserved	Leave open

Table 2: Pinout LEA-M8S / LEA-M8T

2.2 Minimal design

This is a minimal setup for a GNSS receiver with a LEA-M8S / LEA-M8T module:

- Passive antenna used
- No backup battery
- UART for communication
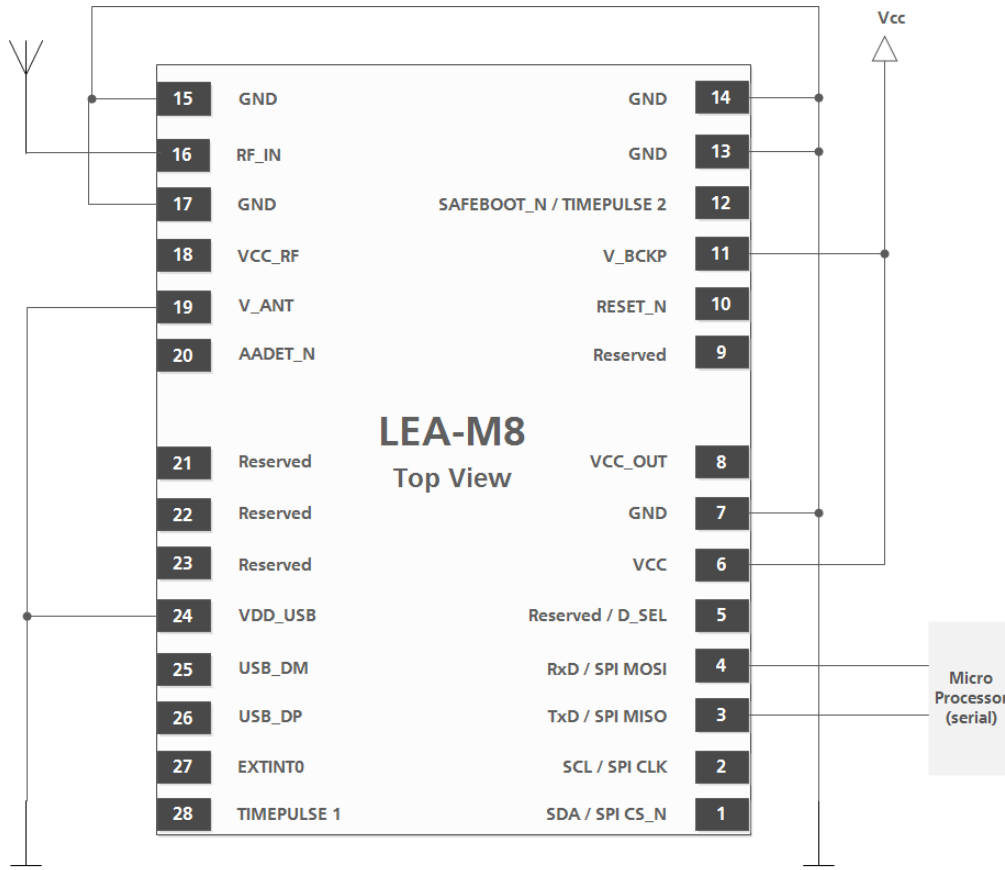
Figure 4: LEA-M8S / LEA-M8T passive antenna design

☞ For active antenna design, see section 2.4

2.3 Footprint and paste mask

Figure 5 describes the footprint and provides recommendations for the paste mask for the LEA-M8S and LEA-M8T 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 Figure 6.
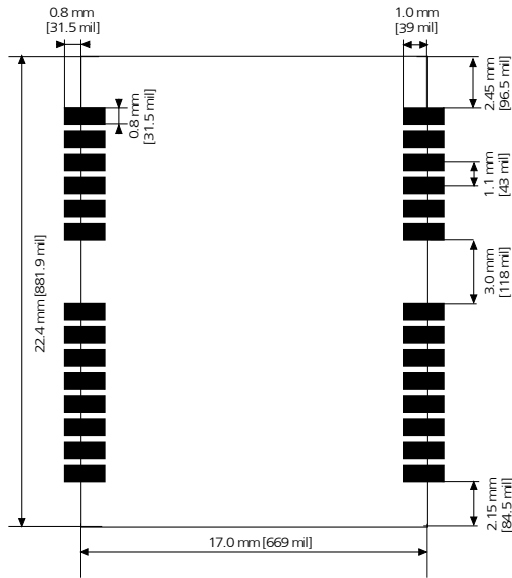
Figure 5: LEA-M8S / LEA-M8T footprint
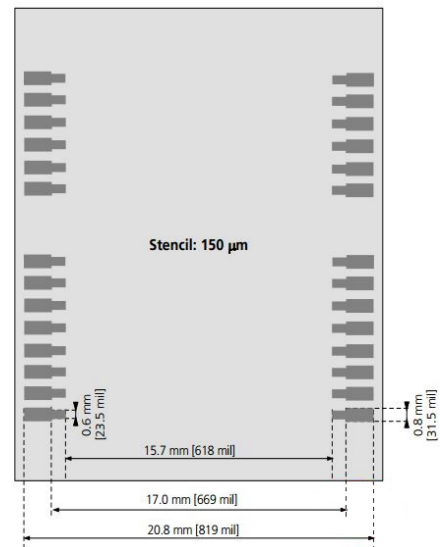
Figure 6: LEA-M8S / LEA-M8T paste mask

2.4 Antenna and Antenna supervision

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.

Minimal setup with a good patch antenna

Figure 7 shows a minimal setup for a design with a good GNSS patch antenna.
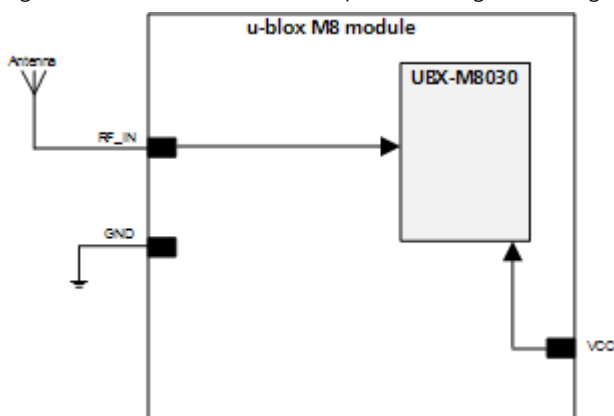
Figure 7: Module design with passive antenna (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2])

Setup for best performance with passive antenna

Figure 8 shows a design using an external LNA to increase the sensitivity for best performance with passive antenna.
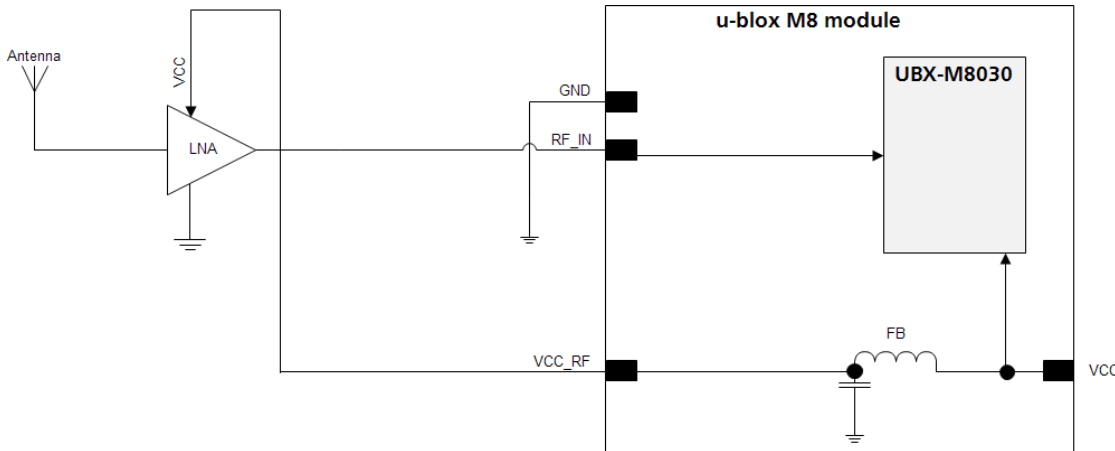
Figure 8: Module design with passive antenna and an external LNA (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2].)

The **VCC_RF** output can be used to supply the LNA with a filtered supply voltage.

☞ For recommended parts, see Appendix

☞ A standard GNSS LNA has enough bandwidth to amplify GPS / GLONASS and BeiDou signals.

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 customers do not want to make use of the internal antenna supervisor and the supply voltage of the LEA-M8S / LEA-M8T module matches the supply voltage of the antenna (e.g. 3.0 V), they can use the filtered supply voltage **VCC_RF** output to supply the antenna (See Figure 9). This design is used for modules in combination with active antenna.

In case of different supply voltage, use a filtered external supply, see Figure 10.

Active antenna design using VCC_RF pin to supply the active antenna
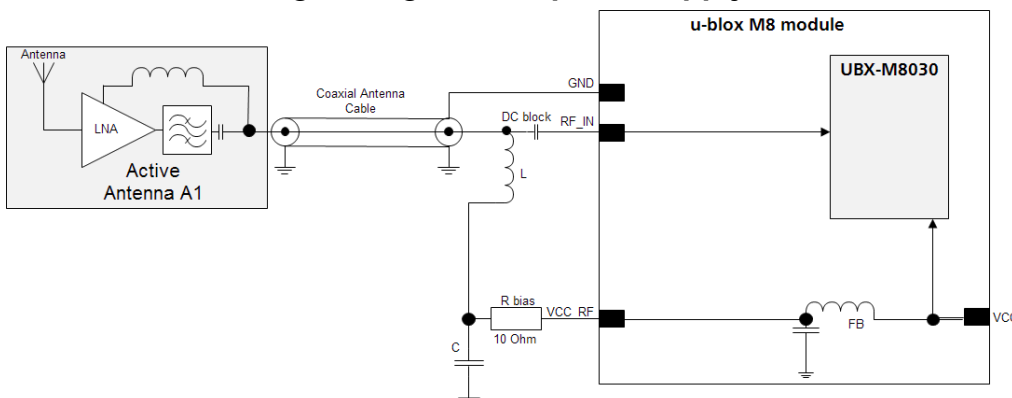
Figure 9: Active antenna design, external supply from VCC_RF (for exact pin orientation see the *LEA-M8S Data Sheet* [1])

Active antenna design powered from external supply

Figure 10 shows a design with direct externally powered active antenna.

This circuit has to be used if the active antenna has a different supply voltage than the VCC_RF (for example if a 5 V active antenna is used).
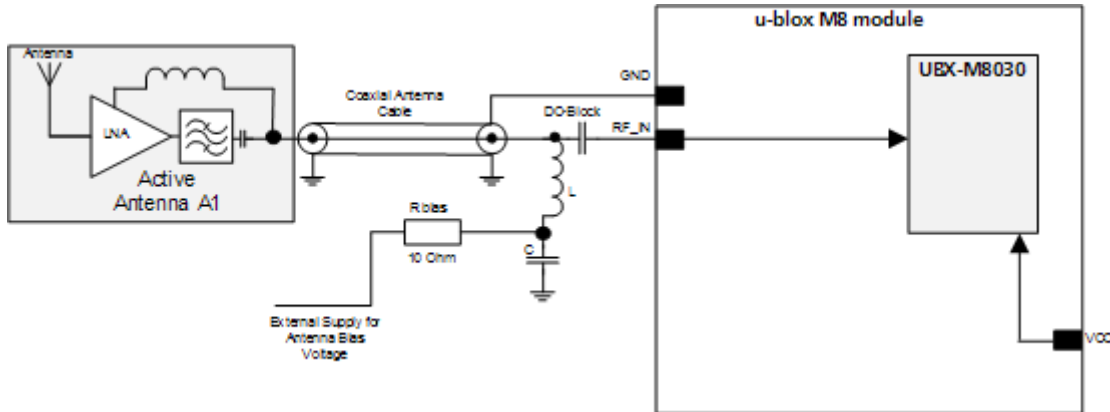
Figure 10: Active antenna design, direct external supply (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2])

☞   For recommended parts, see Appendix.

☞   In case **VCC_RF** voltage does not match with the antenna supply voltage, use a filtered external supply as shown in Figure 10.

Antenna design with active antenna using antenna supervisor

An active antenna supervisor provides the means to check the antenna for open and short circuits and to shut off the antenna supply if a short circuit is detected. The Antenna Supervisor is configured using serial port UBX binary protocol message. Once enabled, the active antenna supervisor produces status messages, reporting in NMEA and/or UBX binary protocol. These indicate the particular state of the antenna supervisor shown in the state diagram (see Figure 11).

The current active antenna status can be determined by polling the UBX-MON-HW monitor command. If an antenna is connected, the initial state after power-up is "Active Antenna OK."
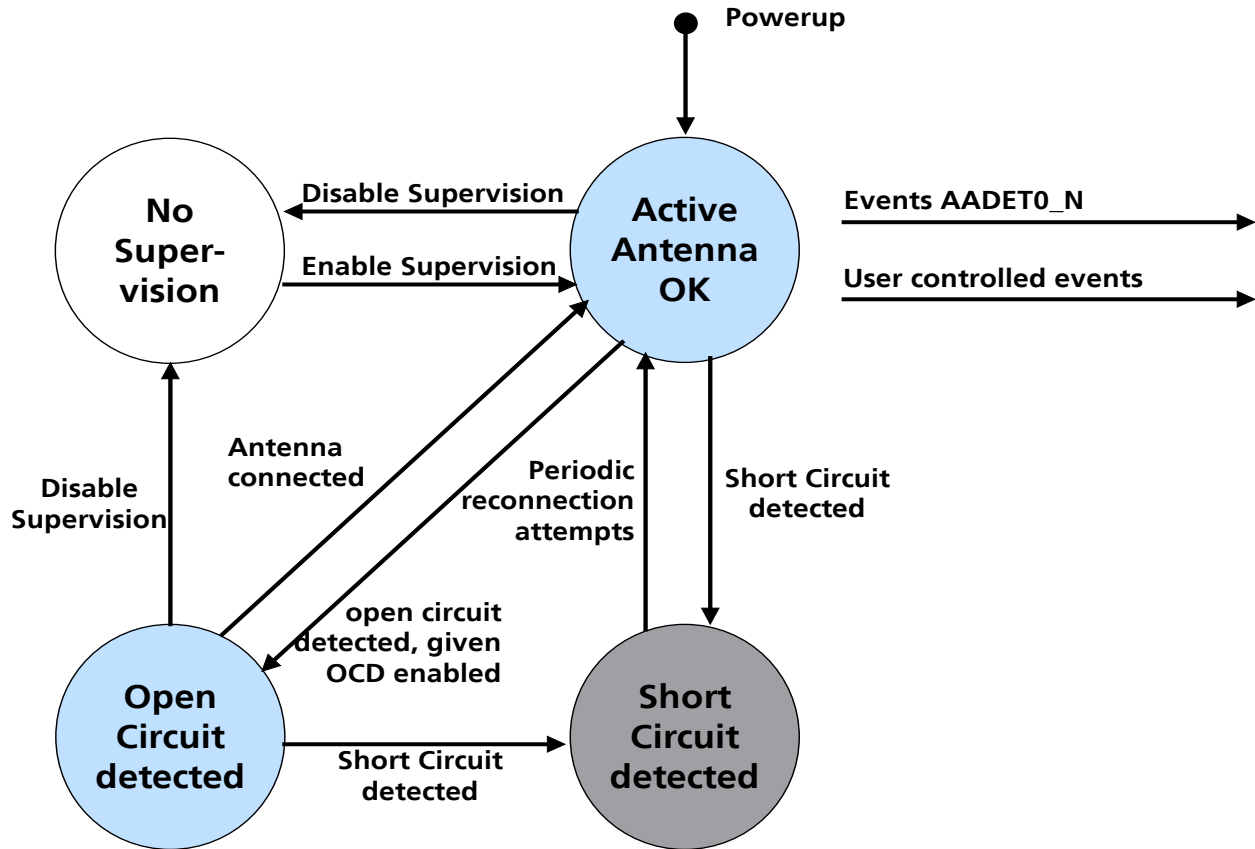
Figure 11: State diagram of active antenna supervisor

The module firmware supports an active antenna supervisor circuit, which is connected to the **AADET_N** pin. For an example of an open circuit detection circuit, see Figure 14. High on **AADET_N** means that an external antenna is not connected.

Status reporting

At startup, and on every change of the antenna supervisor configuration, the LEA-M8S and LEA-M8T modules will output an NMEA **($GPTXT)** or UBX (**INF-NOTICE**) message with the internal status of the antenna supervisor (disabled, short detection only, enabled).

Abbreviation	Description
AC	Antenna Control (e.g. the antenna will be switched on/ off controlled by the GNSS receiver)
SD	Short Circuit Detection Enabled
SR	Short Circuit Recovery Enabled
OD	Open Circuit Detection Enabled
PdoS	Power Down on short

Table 3: Active Antenna Supervisor Message on startup (UBX binary protocol)

☞ To activate the antenna supervisor use the UBX-CFG-ANT message. For further information, refer to the *u-blox M8 Receiver Description Including Protocol Specification* [3].

Similar to the antenna supervisor configuration, the status of the antenna supervisor will be reported in an NMEA (**$GPTXT**) or UBX (**INF-NOTICE**) message at start-up and on every change.

Message	Description
ANTSTATUS=DONTKNOW	Active antenna supervisor is not configured and deactivated.
ANTSTATUS=OK	Active antenna connected and powered
ANTSTATUS=SHORT	Antenna short
ANTSTATUS=OPEN	Antenna not connected or antenna defective

Table 4: Active antenna supervisor message on startup (NMEA protocol)

Module design with active antenna, short circuit protection / detection

If a suitably dimensioned R_BIAS series resistor is placed in front of the **V_ANT** pin, a short circuit can be detected in the antenna supply. The detection happens inside the u-blox M8 module, after which the antenna supply voltage will be immediately shut down. Afterwards, periodic attempts to re-establish antenna power are made by default.

An internal switch (under control of the receiver) can turn off the supply to the external antenna whenever it is not needed. This feature helps to reduce power consumption in power save mode.

☞ To configure the antenna supervisor use the UBX-CFG-ANT message. For further information, see the *u-blox M8 Receiver Description Including Protocol Specification* [3].

⚠ **Short circuits on the antenna input without limitation (R_BIAS) of the current can result in permanent damage to the receiver! Therefore, it is mandatory to implement an R_BIAS in all risk applications, such as situations where the antenna can be disconnected by the end-user or that have long antenna cables.**

☞ In case **VCC_RF** voltage does not match with the antenna supply voltage, use a filtered external supply as shown in Figure 13.

Supply from VCC_RF

Figure 12 shows an active antenna supplied from the LEA-M8S and LEA-M8T modules.

LEA-M8S and LEA-M8T modules includes a built in antenna bias supply for nominal 3V antennas enabled by linking the filtered **VCC_RF** supply output pin to the **V_ANT** antenna supply input pin with a 10 Ohm resistor in series. The module then controls the power supply to the antenna, applying power whenever the receiver is active and removing power during power-save idle times and if a short-circuit is detected. Short-circuit is detected if the voltage at the antenna supply falls close to zero and is indicated as an alarm in message MON-HW
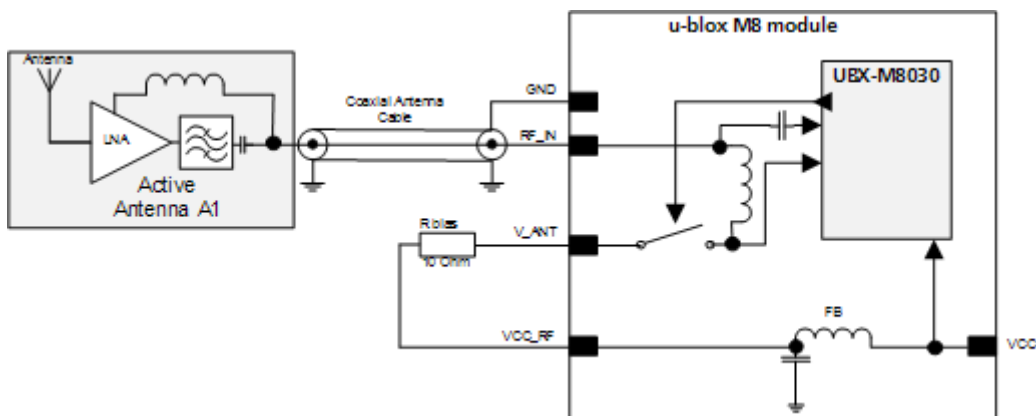
Figure 12: Module design with active antenna, internal supply from VCC_RF (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2].)

☞ For recommended parts, see Appendix.

External supply

Figure 13 shows an externally powered active antenna design.

Since the external bias voltage is fed into the most sensitive part of the receiver (i.e. the RF input), this supply should be free of noise. Usually, low frequency analog noise is less critical than digital noise of spurious frequencies with harmonics up to the GPS/QZSS band of 1.575 GHz, GLONASS band of 1.602 GHz and BeiDou band at 1.561 GHz. Therefore, it is not recommended to use digital supply nets to feed the **V_ANT** pin.
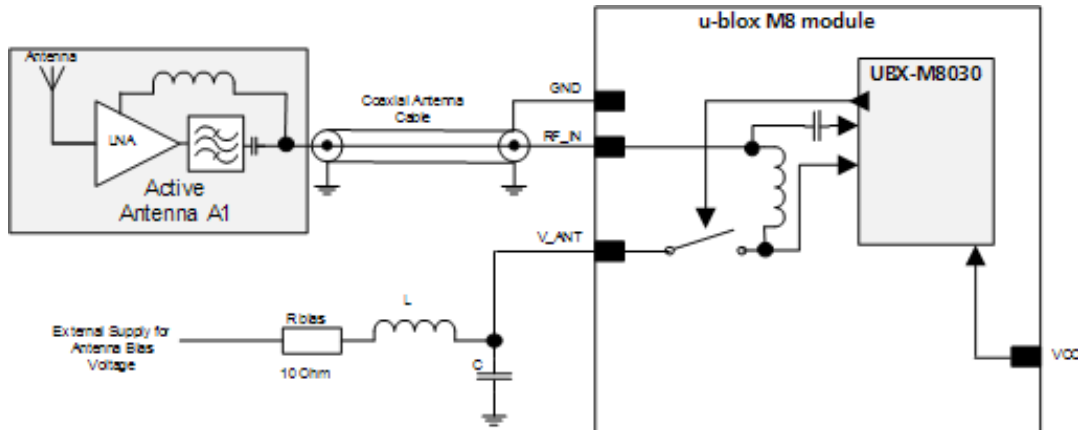
Figure 13: Module design with active antenna, external supply (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2])

Antenna supervision with open circuit detection (OCD)

Optionally the **AADET_N** pin may be reassigned to antenna supervision allowing an external circuit to indicate to the module that the antenna is open-circuit. This condition is then reported by the module in message MON-HW. Calculate the threshold current using Equation 1.
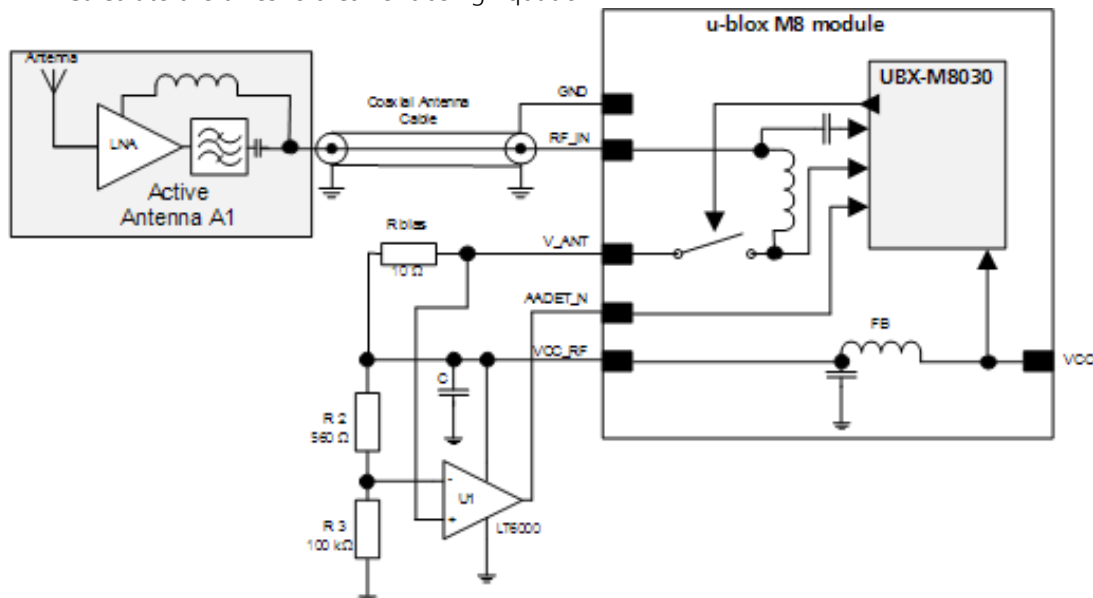
Figure 14: Schematic of open circuit detection (for exact pin orientation see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2].)

$$I = \frac{\left(\dfrac{R2}{R2+R3}\right)}{Rbias} \bullet Vcc\_RF$$

Equation 1: Calculation of threshold current for open circuit detection

☞   If the antenna supply voltage is not derived from **VCC_RF**, do not exceed the maximum voltage rating of **AADET_N**.

☞   For recommended parts, see Appendix

3 Migration to u-blox M8 modules

3.1 Migrating u-blox 6 designs to a u-blox M8 module

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 previous generations modules. If using BeiDou, check the bandwidth of the external RF components and the antenna. For information about power consumption, see the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2]. 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 LEA-6N -> LEA-M8S

	LEA-6N		LEA-M8S		
Pin	**Pin Name**	**Typical Assignment**	**Pin Name**	**Typical Assignment**	**Remarks for Migration**
1	SDA	DDC Data	SDA	DDC Data	No difference
2	SCL	DDC Clock	SCL	DDC Clock	No difference
3	TxD	Serial Port	TxD	Serial Port	No difference
4	RxD	Serial Port	RxD	Serial Port	No difference
5	NC	Not Connected	Reserved	Not Connected	No difference
6	VCC	Supply voltage	VCC	Supply voltage	No difference
7	GND	Ground (digital)	GND	Ground (digital)	No difference
8	VCC_OUT	Output voltage	VCC_OUT	Output voltage	No difference
9	NC	Not Connected	Reserved	Not Connected	No difference
10	RESET_N	External Reset	RESET_N	External Reset	No difference
11	V_BCKP	Backup voltage supply	V_BCKP	Backup voltage supply	If this was connected to GND on u-blox 6 module, OK to do the same on u-blox M8.
12	Safeboot_N	Do not drive low	Safeboot_N	Do not drive low	No difference
13	GND	Ground	GND	Ground	No difference
14	GND	Ground	GND	Ground	No difference
15	GND	Ground	GND	Ground	No difference
16	RF_IN	GNSS signal input	RF_IN	GNSS signal input	No difference
17	GND	Ground	GND	Ground	No difference
18	VCC_RF	Output Voltage RF section	VCC_RF	Output Voltage RF section	No difference
19	V_ANT	Antenna Bias voltage	V_ANT	Antenna Bias voltage	No difference
20	AADET_N	Active Antenna Detect	AADET_N	Active Antenna Detect	No difference
21	Reserved	Not Connected	Reserved	Not Connected	No difference
22	Reserved	Not Connected	Reserved	Not Connected	No difference
23	Reserved	Not Connected	Reserved	Not Connected	No difference
24	VDD_USB	USB Supply	VDD_USB	USB Supply	No difference
25	USB_DM	USB Data	USB_DM	USB Data	No difference
26	USB_DP	USB Data	USB_DP	USB Data	No difference
27	EXTINT0	External Interrupt Pin	EXTINT0	External Interrupt Pin	No difference
28	TIMEPULSE	Timepulse (1PPS)	TIMEPULSE	Timepulse (1PPS)	No difference

Table 5: Pin-out comparison LEA-6N vs. LEA-M8S

3.3 Hardware migration LEA-6T -> LEA-M8T

Pin	LEA-6T Pin Name	Typical Assignment	LEA-M8T Pin Name	Typical Assignment	Remarks for Migration
1	SDA	DDC Data	SDA	DDC Data	No difference
2	SCL	DDC Clock	SCL	DDC Clock	No difference
3	TxD	Serial Port	TxD	Serial Port	No difference
4	RxD	Serial Port	RxD	Serial Port	No difference
5	NC	Not Connected	**D_SEL**	**D_SEL =1(or open)**	**Do not drive low**
6	VCC	Supply voltage	VCC	Supply voltage	No difference
7	GND	Ground (digital)	GND	Ground (digital)	No difference
8	VCC_OUT	Output voltage	VCC_OUT	Output voltage	No difference
9	TIMEPULSE2	2nd Timepulse	**Not Connected**	**Reserved**	**Time Pulse 2 is now available on pin 12 (Safeboot_N / Time Pulse 2)**
10	RESET_N	External Reset	RESET_N	External Reset	No difference
11	V_BCKP	Backup voltage supply	V_BCKP	Backup voltage supply	If this was connected to GND on u-blox 6 module, OK to do the same on u-blox M8.
12	Safeboot_N	Safeboot_N	Safeboot_N/ TIMEPULSE2	Safeboot_N /Timepulse 2	Must not be held LO during start-up.
13	GND	Ground	GND	Ground	No difference
14	GND	Ground	GND	Ground	No difference
15	GND	Ground	GND	Ground	No difference
16	RF_IN	GNSS signal input	RF_IN	GNSS signal input	No difference
17	GND	Ground	GND	Ground	No difference
18	VCC_RF	Output Voltage RF section	VCC_RF	Output Voltage RF section	No difference
19	V_ANT	Antenna Bias voltage	V_ANT	Antenna Bias voltage	No difference
20	AADET_N	Active Antenna Detect	EXTINT1/AADET_N	External Interrupt Pin/ Active Antenna Detect	
21	Reserved	Not Connected	Reserved	Not Connected	No difference
22	Reserved	Not Connected	Reserved	Not Connected	No difference
23	Reserved	Not Connected	Reserved	Not Connected	No difference
24	VDD_USB	USB Supply	VDD_USB	USB Supply	No difference
25	USB_DM	USB Data	USB_DM	USB Data	No difference
26	USB_DP	USB Data	USB_DP	USB Data	No difference
27	EXTINT0	External Interrupt Pin	EXTINT0	External Interrupt Pin	No difference
28	TIMEPULSE1	Timepulse (1PPS)	TIMEPULSE1	Timepulse (1PPS)	No difference

Table 6: Pin-out comparison LEA-6T vs. LEA-M8T

3.4 Software migration

☞ For overall description of the module software operation, see the *u-blox M8 Receiver Description Including Protocol Specification* [3].

☞ All features requiring a flash on LEA-6N are not supported on LEA-M8S. (AssistNow offline / save config)

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 *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2].

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 strongly 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 Figure 6.

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 baseboard, etc. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.
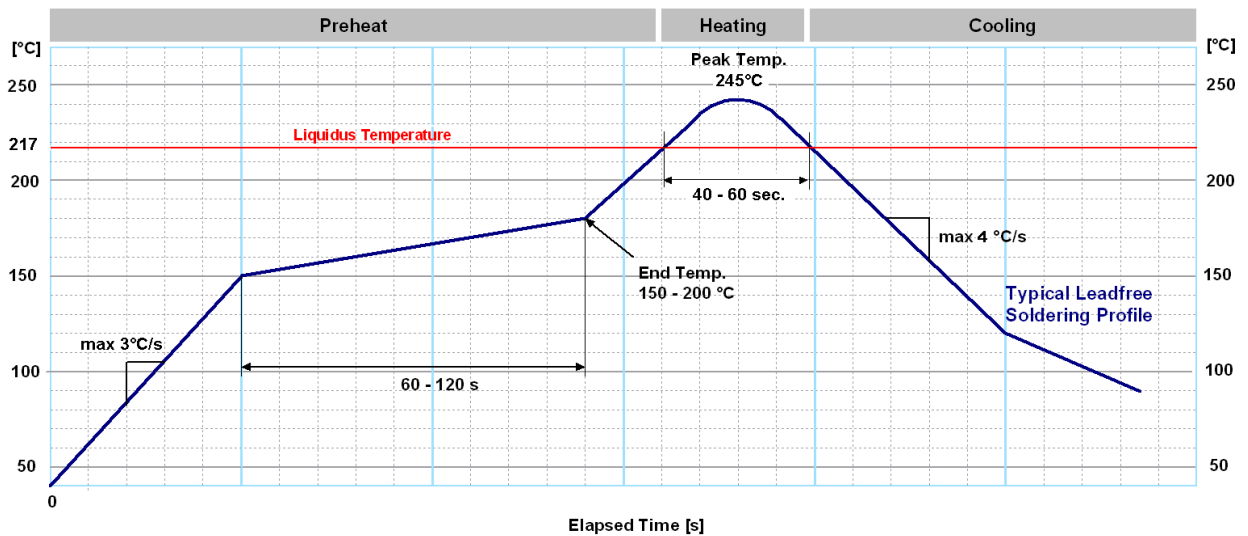

Figure 15: Recommended soldering profile

☞ 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 4.

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

Wave soldering

Baseboards 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 *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [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.

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

Connect first to local GND

GND

- When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (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 16.

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

Figure 16: 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 17, 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 17: 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 7) 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 7.

4.4 Applications with cellular modules

GSM uses power levels up to 2 W (+33 dBm). Consult the *LEA-M8S Data Sheet* [1] and the *NEO/LEA-M8T Data Sheet* [2] for the absolute maximum power input at the GNSS receiver.

☞ See the *GPS Implementation and Aiding Features in u-blox wireless modules* [9].

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 18). Such interference signals are typically caused by harmonics from displays, micro-controller, bus systems, etc.
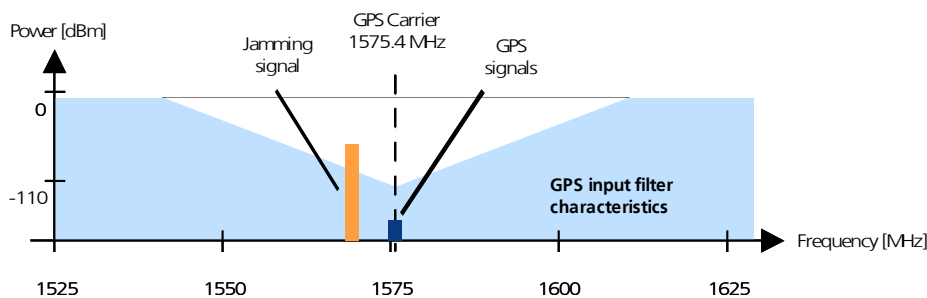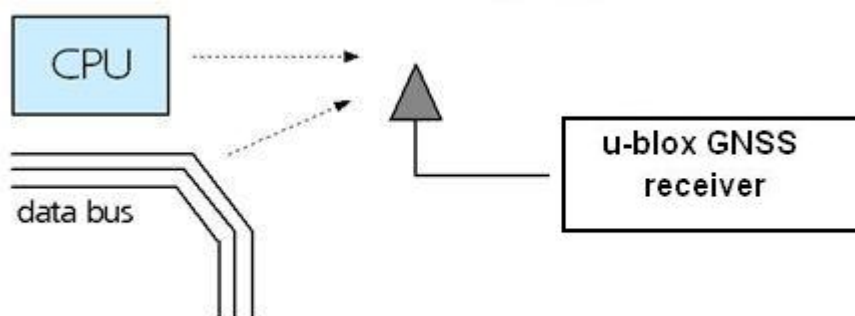

Figure 18: In-band interference signals

Figure 19: 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 20). The main sources are wireless communication systems such as GSM, CDMA, WCDMA, Wi-Fi, BT, etc.
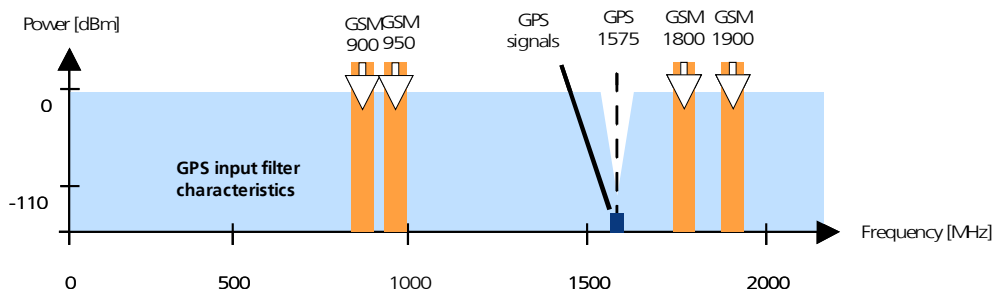

Figure 20: Out-band interference signals

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 21).
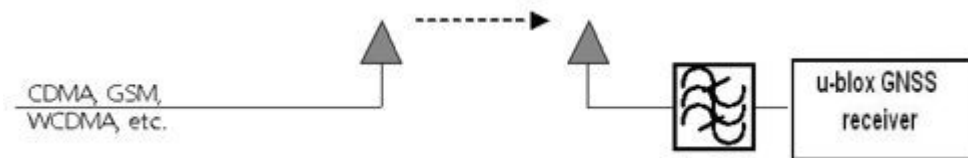

Figure 21: Measures against in-band interference

Appendix

Recommended parts

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

	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 GNSS > 500 Ω
Capacitor	Murata	GRM1555C1E470JZ01	C, 47 pF	DC-block
Ferrite Bead	Murata	BLM15HD102SN1	FB	High IZI @ fGSM
Feed thru Capacitor for Signal	Murata	NFL18SP157X1A3	Monolithic Type	For data signals, 34 pF load capacitance
		NFA18SL307V1A45	Array Type	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 7: 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.inpaq.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.inpaq.com.tw)	ACM4-5036-A1-CC-S	5.2 x 3.7 x 0.7 mm GPS+GLONASS passive
Additional antenna Manufacturer: Allis Communications, Tallysman Wireless		

Table 8: Recommend antenna

A.1 Design-in recommendations in combination with cellular operation

Product		Receiver Chain					Cellular and GNSS Simultaneous operation			
							Passive GNSS Antenna		Active GNSS Antenna	
Family	Variant	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				•		✓		✓	✓
MAX-7	W				•		✓		✓	✓
MAX-7	Q				•		✓		✓	✓
NEO-7	N		•		•		✓	✓	✓	✓
NEO-7	M				•		✓		✓	✓
NEO-7	P			•	•		✓	✓	✓	✓
EVA-M8	M				•				✓	✓
MAX-M8	C				•		✓		✓	✓
MAX-M8	W				•		✓		✓	✓
MAX-M8	Q				•		✓		✓	✓
NEO-M8	N		•		•		✓	✓	✓	✓
NEO-M8	M				•		✓		✓	✓
NEO-M8	Q		•		•		✓	✓	✓	✓
NEO-M8	T		•		•		✓	✓	✓	✓
LEA-M8	S			•	•		✓	✓	✓	✓
LEA-M8	T			•	•		✓	✓	✓	✓
PAM-7	Q	•	•	•	•		✓	✓	✓	✓
CAM-M8	C	•	•		•		✓	✓	✓	✓
CAM-M8	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* [9].

Related documents

[1]   LEA-M8S Data Sheet, Docu. No. UBX-14001841

[2]   NEO/LEA-M8T Data Sheet Docu. No. UBX-14006196

[3]   u-blox M8 Receiver Description Including Protocol Specification (Public version), Docu. No. UBX-13003221

[4]   GNSS Firmware 2.01 for u-blox M8 Release Note, Docu. No. UBX-13004697

[5]   GPS Antenna Application Note, Docu. No. GPS-X-08014

[6]   UBX-M8030 Data Sheet, Docu. No. UBX-13001634

[7]   GPS Compendium, Docu. No. GPS-X-02007

[8]   I2C-bus specification, Version 2.1, Jan 2000,
        http://www.nxp.com/acrobat_download/literature/9398/39340011_21.pdf

[9]   GPS Implementation and Aiding Features in u-blox wireless modules, Docu. No. GSM.G1-CS-09007

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

Revision history

Revision	Date	Name	Status / Comments
R01	29-Jan-2014	jfur	Objective Specification
R02	2-Jul-2014	jfur	Advance Information. Updated Table 8 (added Amotech GPS+GLONASS+ BeiDou active antenna); added Table 9: Combinations of u-blox GNSS modules with different cellular technologies (2G/3G/4G).
R03	02-Sep-2014	julu	Early Production Information
R04	28-Oct-2014	jfur	Added LEA-M8T variant, updated EXTINT1/AADET_N (Pin 20) in Table 2, added SAFEBOOT_N pin description in Figure 4, Table 2, Table 5 and Table 6.
R05	07-Jan-2015	julu	Production Information
R06	20-Apr-2015	amil/jfur	Updated Section 1.3 (power), updated Table 7 (Recommended parts) and Table 9, LEA-M8T PCN FW TIMRAW 1.02
R07	02-Jun-2015	julu	Updated section 1.5 (added Electromagnetic interference on I/O lines).
R08	21-Oct-2015	julu	Updated product type number to LEA-M8S-0-01 and added relevant PCN reference

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