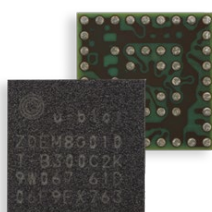




# ZOE-M8 series

Ultra-small u-blox M8 SiP modules  
Hardware Integration Manual



## Abstract

This document describes the hardware features and specifications of the u-blox ZOE-M8G and ZOE-M8Q GNSS SiP (System in Package) modules.

# Document Information

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<b>Initial Production</b>	Early Production Information	Data from product verification. Revised and supplementary data may be published later.
<b>Mass Production / End of Life</b>	Production Information	Document contains the final product specification.

## European Union regulatory compliance

ZOE-M8G and ZOE-M8Q SiPs comply with all relevant requirements for RED 2014/53/EU. The ZOE-M8G/Q Declaration of Conformity (DoC) is available at [www.u-blox.com](http://www.u-blox.com) under Support > Product resources > Conformity Declaration.

This document applies to the following products:

<b>Product name</b>	<b>Type number</b>	<b>ROM/FLASH version</b>	<b>PCN reference</b>
ZOE-M8G	ZOE-M8G-0-10	ROM SPG 3.01 / Flash FW SPG 3.01	N/A
ZOE-M8Q	ZOE-M8Q-0-10	ROM SPG 3.01 / Flash FW SPG 3.01	N/A

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# 1 Hardware description

## 1.1 Overview

u-blox ZOE-M8 standard precision GNSS SiP (System in Package) modules feature the high performance u-blox M8 GNSS engine. ZOE-M8's ultra-miniature form factor integrates a complete GNSS receiver including SAW filter, LNA and TCXO.

The ZOE-M8 SiPs are targeted for applications that require a small size without compromising the performance. For RF optimization, the ZOE-M8 SiPs integrate a front-end SAW filter and an additional front-end LNA for increased jamming immunity and easier antenna integration. A passive antenna can be used to provide a highly integrated system solution with a minimal eBOM.

The ZOE-M8 SiPs can be easily integrated in manufacturing thanks to the advanced S-LGA (Soldered Land Grid Array) packaging technology, which enables easier and more reliable soldering processes compared to a normal LGA (Land Grid Array) package.

-  For product features, see the *ZOE-M8 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](http://www.u-blox.com).

## 2 Design-in

In order to obtain good performance with ZOE-M8 GNSS receiver SiPs, there are a number of issues requiring 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 SiP and your host system.
- **Antenna interface:** For optimal performance, seek short routing, matched impedance and no stubs.

### 2.1 Power management


The ZOE-M8G is a 1.8 V variant, while the ZOE-M8Q is a 3.0 V variant and has an option to make use of the built-in DC/DC converter to reduce the power consumption.

The ZOE-M8 GNSS SiPs provide two supply pins: **VCC** and **V\_BCKP**. They can be supplied independently or tied together depending on the intended application.

Additionally, ZOE-M8Q has the option to make use of a built-in DC/DC converter and thus comes with two additional supply pins, **V\_CORE** and **V\_DCDC\_OUT**. The supply voltages are explained in the following subsections.

#### 2.1.1 Main supply voltage (VCC)



During operation, the ZOE-M8 GNSS SiPs are supplied through the **VCC** pin. 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 ( $< 0.1 \Omega$ ) to the **VCC** supply, as it will generate input voltage noise due to the dynamic current conditions.

The digital I/Os of the ZOE-M8 GNSS SiPs are also referred and supplied to the **VCC** voltage.

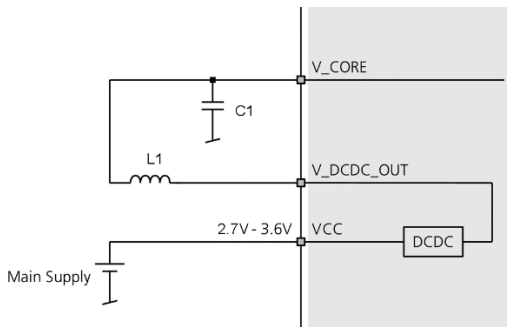
#### 2.1.2 V\_CORE (only on ZOE-M8Q)

**V\_CORE** draws the main current of the ZOE-M8Q. The current at **V\_CORE** depends heavily on the current system state and in general exhibits very dynamic behavior. It can be supplied either by main supply or with the built-in DC/DC converter, see section 2.1.3.

-  Do not add any series resistance greater than  $0.1 \Omega$  to the **V\_CORE** supply as it will generate input voltage noise due to the dynamic current conditions.
-  If a DC/DC converter is not used, supply **V\_CORE** with the same supply as used for the **VCC**.

#### 2.1.3 DC/DC converter (only on ZOE-M8Q)

ZOE-M8Q comes with a built-in DC/DC converter to supply **V\_CORE**, thus enabling significant power savings. For more information, see the *ZOE-M8 Data Sheet* [1]. It requires an external inductor (L1) and capacitor (C1). For the recommended inductor and capacitor, see Appendix A.4 and Appendix A.9.



**Figure 1 : Circuit for DC/DC converter with ZOE-M8Q**

The DC/DC converter block provides an energy conversion efficiency of up to 85%. The actual value depends on the current drawn and which external inductor (L1) and capacitor (C1) are used.

To enable the DC/DC converter there are two options.

**Option 1:** In production, send a one-time command to the ZOE-M8Q, which enables the DC/DC converter permanently in ZOE-M8Q's internal OTP memory. The command to be sent is "B5 62 06 41 0C 00 00 00 03 1F C5 90 E1 9F FF FF FE FF 45 79" and will be acknowledged (UBX-ACK). After doing a reset, it can be verified by checking the UBX-MON-LLC message.

Ensure a stable **VCC** supply when sending the command to enable the DC/DC converter.

**Option 2:** Alternatively, if no SQI flash is used, the DC/DC converter can be enabled by defining the SQI flash pins as shown in Table 1.

Pin #	Name	State	Remarks
D1	SQI_D0	<b>open</b>	Must be left open!
C1	SQI_D1	<b>GND</b>	Must be connected to GND!
E3	SQI_D2	<b>GND</b>	Must be connected to GND!
F3	SQI_D3	<b>Open</b>	Must be left open!
E1	SQI_CLK	<b>GND</b>	Must be connected to GND!
D3	SQI_CS_N	<b>GND</b>	Must be connected to GND!

**Table 1: Enable DC/DC converter**

If the SQI flash pins are used to enable the DC/DC converter, ensure that the SQI flash pins are exactly set as mentioned in Table 1, otherwise it can cause malfunction of the ZOE-M8Q.

### 2.1.4 Backup power supply (V\_BCKP)

In the case of a power failure at main supply **VCC**, the backup domain and optional RTC oscillator are supplied by **V\_BCKP**. Providing a **V\_BCKP** supply maintains the time (RTC) and the GNSS orbit data in backup RAM. This ensures that any subsequent re-starts after a **VCC** power failure will benefit from the stored data, providing a faster TTFF.

The GNSS satellite ephemeris data is typically valid for up to 4 hours. To enable hot starts, ensure that the battery or capacitor at **V\_BCKP** is able to supply the backup current for at least 4 hours. For warm starts or when using the AssistNow Autonomous, the **V\_BCKP** source must be able to supply current for up to a few days.

If no backup supply is available, **V\_BCKP** can be connected to the reserved neighbor pin G9.

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.

For description of the different power operating modes, see the *ZOE-M8 Data Sheet* [1].

## 2.2 Interfaces



The ZOE-M8 GNSS SiPs provide UART, SPI and DDC (I<sup>2</sup>C compatible) interfaces for communication with a host CPU. Additionally, an SQL interface is available for connecting the ZOE-M8 GNSS SiPs with an optional external flash memory.

The UART, SPI and DDC pins are supplied by **VCC** 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 the **D\_SEL** pin. Table 2 below provides the port mapping details.

Pin #	Pin D4 (D_SEL) = "high" (left open)	Pin D4 (D_SEL) = "Low" (connected to GND)
J5	UART TXD	SPI MISO
J4	UART RXD	SPI MOSI
B1	DDC SCL	SPI CLK
A2	DDC SDA	SPI CS_N

**Table 2: 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. DDC available that is independent from the application and accessible via test-points.

For each interface, define a dedicated pin to indicate that data is ready to be transmitted. The TXD Ready signal indicates that the receiver has data to transmit. Each TXD Ready signal is associated with a particular interface and cannot be shared. A listener can wait on the TXD 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 TXD Ready signal goes active. The TX Ready signal can be mapped for example, to UART TX. The TXD Ready function is disabled by default.

-  The TXD Ready functionality can be enabled and configured by using suitable AT commands sent to the u-blox cellular module in question that supports the feature. For more information, see the *GPS Implementation and Aiding Features in u-blox wireless modules* [5].
-  The TXD Ready feature is supported on several u-blox cellular module products.

### 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** 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 RXD pin can also be used to wake up the receiver in Power Save Mode (see the *u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification* [2]).

-  Designs must allow access to the UART and the **SAFEBOOT\_N** pin for future service, updates, and reconfiguration.

### 2.2.2 Display Data Channel (DDC) interface

An I<sup>2</sup>C 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 the speed and clock frequency, see the *ZOE-M8 Data Sheet* [1].
- To make use of DDC interface, the **D\_SEL** pin must be left open.
- The ZOE-M8 GNSS SiPs DDC interface provides serial communication with u-blox cellular modules. See the specification of the applicable cellular module to confirm compatibility.

### 2.2.3 SPI interface

Use the SPI interface 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.

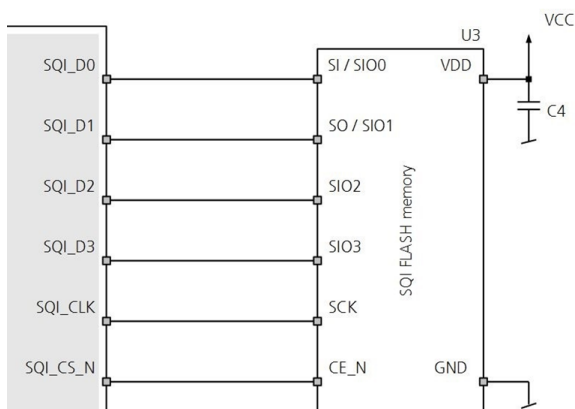
- To make use of the SPI interface, the **D\_SEL** pin must be connected to GND.

### 2.2.4 SQI interface

An external SQI (Serial Quad Interface) flash memory can be connected to the ZOE-M8 GNSS SiPs. The SQI interface provides the following options:



- Store the current configuration permanently
- Save data logging results
- Hold AssistNow Offline and AssistNow Autonomous data

- In addition, the ZOE-M8 GNSS SiPs can make use of a dedicated flash firmware with an external SQI flash memory. The flash memory with these SiPs can be use to run firmware out of flash and to update the firmware as well. Running the firmware from the SQI flash requires a minimum SQI flash size of 8 Mbit.
- If the flash is not used to run the firmware, it has to be programmed with the FIS only option.
- The voltage level of the SQI interface follows the **VCC** level. Therefore, the SQI flash must be supplied with the same voltage as **VCC** of the ZOE-M8 SiPs. It is recommended to place a decoupling capacitor (C4) close to the supply pin of the SQI flash.
- Make sure that the SQI flash supply range matches the voltage supplied at **VCC**.



**Figure 2: Connecting an external SQI flash memory**

An SQI flash size of 8 Mbit is sufficient to save AssistNow Offline and AssistNow Autonomous information as well as current configuration data. However, for ZOE-M8 SiPs to run Firmware from the SQI flash and provide space for logging results, a minimum size of 8 Mbit may not be sufficient depending on the amount of data to be logged.

-  For more information about supported SQI flash devices, see section A.3.
-  Make sure that the **SAFEBOOT\_N** pin is available for entering Safe Boot Mode. Programming the SQI flash memory with a flash firmware is done typically at production. For this purpose, the ZOE-M8 GNSS SiPs must enter the Safe Boot Mode. More information about **SAFEBOOT\_N** pin see section 2.6.

## 2.3 I/O Pins

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

### 2.3.1 Time pulse

A configurable time pulse signal is available with the ZOE-M8 GNSS SiPs.

The **TIMEPULSE** output generates pulse trains synchronized with GPS or UTC time grid with intervals configurable over a wide frequency range. Thus, it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.


By default, the time pulse signal is configured to 1 pulse per second. For more information, see the *u-blox 8 / u-blox M8 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** (see the *ZOE-M8 Data Sheet* [1] for more information). It can be used for wake-up functions in Power Save Mode on all u-blox M8 SiPs and modules and for aiding, leave open if unused. By default, the external interrupt is disabled.

If the **EXTINT** is not used for an external interrupt function, it can be used for some other purpose, e.g. as an output pin for the TXD Ready feature to indicate that the receiver has data to transmit.

For further information, see the *u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification* [2].

-  If the **EXTINT** is configured for on/off switching of the ZOE-M8 GNSS SiPs, the internal pull-up becomes disabled. Therefore ensure that the **EXTINT** input is always driven within the defined voltage level by the host.

### 2.3.3 External LNA enable

**LNA\_EN** pin can be used to turn on and off an external LNA. The external LNA will be turned off in Power Save Mode in On/Off operation in OFF stage or in software backup mode the external LNA will also be turned off.

### 2.3.4 Electromagnetic interference and I/O lines

Any I/O signal line (length > ~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, lines where 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 17).

In case of improper shielding, it is recommended to use resistors or ferrite beads (see Appendix A.7) on the I/O lines in series. These components should be chosen with care because they will affect also the signal rise times. Alternatively, feed-thru capacitors with good GND connection close to the GNSS receiver can be used (see Appendix A.8).

EMI protection measures are particularly useful when RF emitting devices are placed next to the GNSS receiver and/or to minimize the risk of EMI degradation due to self-jamming. An adequate layout with a robust grounding concept is essential in order to protect against EMI. More information can be found in section 2.13.6.3.

## 2.4 Real-Time Clock (RTC)

The use of the RTC is optional to maintain time in the event of power failure at **VCC**. It requires **V\_BCKP** to be supplied in case of power failure at **VCC**. 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 SiP, by connecting an external 32.768 kHz signal to the RTC input, or by time aiding of the GNSS receiver at every start-up.

If a power save mode is used then an external RTC crystal must be connected. Optionally an external 32.768 kHz signal can be provided.

### 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.

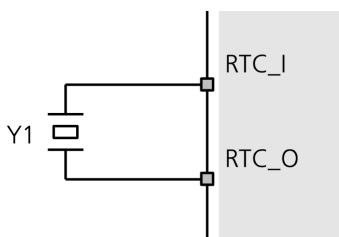


Figure 3: RTC crystal

### 2.4.2 RTC using an external clock



Some applications can provide a suitable 32.768 kHz external reference to drive the SiP 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. Adjustment of the voltage level (typ. 200 mVpp) 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 that the frequency versus temperature behavior of the external clock is within the recommended crystal specifications shown in section A.1.

### 2.4.3 Time aiding

Time can also be sent by UBX message at every start-up of the ZOE-M8 GNSS SiPs. 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 must be used.

For more information about time aiding or TimeMark, see the *u-blox 8/u-blox M8 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 ZOE-M8 GNSS SiPs turns from OFF status to ON status during an ON/OFF operation of Power Save Mode.

## 2.5 RF input

The ZOE-M8 GNSS SiPs RF-input is already matched to 50 Ohms and has an internal DC block. The ZOE-M8 SiPs are optimized to work with a passive antenna.

The ZOE-M8 GNSS SiPs can receive and track multiple GNSS systems (e.g. GPS, Galileo, GLONASS, BeiDou and QZSS signals). Because of the dual-frequency RF front-end architecture, two GNSS signals (from: GPS L1C/A, GLONASS L1OF, Galileo E1B/C and BeiDou B1) can be received and processed concurrently. This concurrent operation is extended to 3 GNSS systems whenever GPS and Galileo are used in addition to GLONASS or BeiDou.

### 2.5.1 Passive antenna

ZOE-M8 SiPs are optimized to work with passive antennas. The internal SAW filter inside followed by an LNA is a good compromise for most applications from jamming and performance point of view.

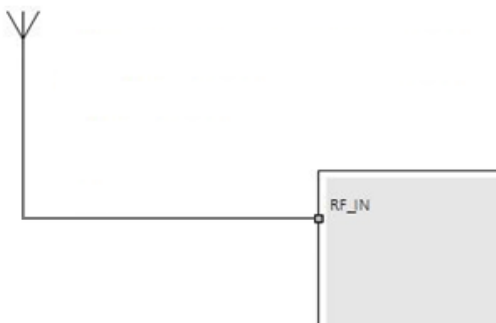


Figure 4: Typical circuit with passive antennas

Where best performance needs to be achieved and no jamming sources are present, an LNA (U1) can be placed close to the antenna.

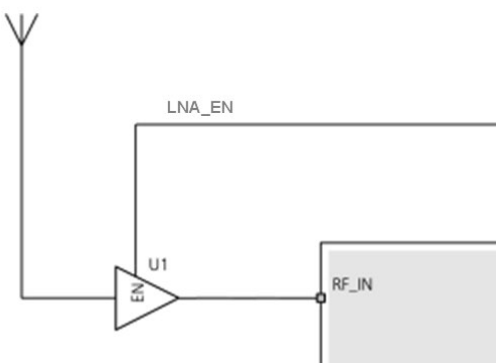


Figure 5: Circuit for best performance

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 achieve best performance.

If Power Save Mode is used and the minimum current consumption has to be achieved, then the external LNA should also be turned off. The **LNA\_EN** pin can be used to turn off the external LNA.

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 A.6, can be placed in front of the LNA to GND.

If the VCC supply is also used to supply the external LNA, make sure some good filtering is in place for the external LNA supply because of the noise on the VCC. This means that a series ferrite bead FB1, see section A.7, and a decoupling capacitor to GND must be used.

## 2.5.2 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 ZOE-M8 GNSS SiPs RF-input can be exceeded. In that case, the SAW filter (F1) must be put in front of the external LNA (U1).

It should be noted that the insertion loss of the SAW filter (F1) directly affects the system noise figure and hence the system performance.

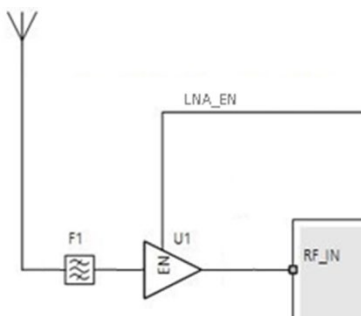


Figure 6: Circuit for improved jamming immunity

## 2.5.3 Active antenna

In case an active antenna is used, the active antenna supply circuit must be added just in front of the SiPs RF-input.

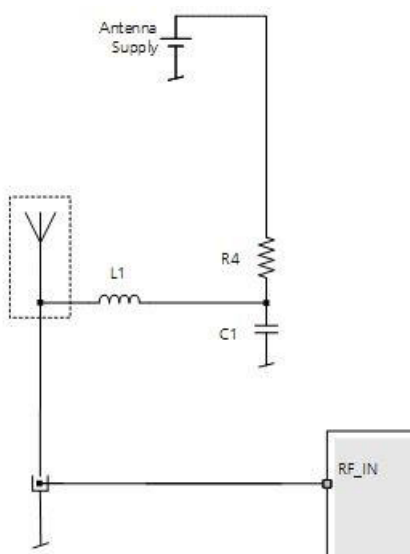


Figure 7: Active antenna supply circuit

## 2.6 Safe Boot Mode (SAFEBOOT\_N)


If the **SAFEBOOT\_N** pin is “low” at start-up, the ZOE-M8 GNSS SiPs start in Safe Boot Mode and does not begin GNSS operation. In Safe Boot Mode, the SiP runs from an internal LC oscillator and starts regardless of any configuration provided by the configuration pins. Thus, it can be used to recover from situations where the SQI flash has become corrupted.


For communication by UART in Safe Boot Mode, a training sequence (0x 55 55 at 9600 baud) can be sent by the host to the ZOE-M8 GNSS SiPs in order to enable communication. After sending the training sequence, the host must wait for at least 2 ms before sending messages to the receiver. For further information, see the *u-blox 8/u-blox M8 Receiver Description Including Protocol Specification* [2].

Safe Boot Mode is used in production to program the SQI flash. It is recommended to have the possibility to pull the **SAFEBOOT\_N** pin “low” when the SiP starts up. This can be provided using an externally connected test point or via a host CPUs digital I/O port.

## 2.7 System Reset (RESET\_N)

The ZOE-M8 GNSS SiPs provide 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** 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 SiP 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.

## 2.8 Pin description

Pin #	SiP	Name	I/O	Description	Remark
A1	All	GND		Ground	Ensure good GND connection
A2	All	SDA / SPI CS_N	I/O	Serial interface.	See section 2.2
A3	All	GND		Ground	Ensure good GND connection
A4	All	RF_IN	I	GNSS signal input	See section 2.5
A5	All	GND		Ground	Ensure good GND connection
A6	All	Reserved	I/O	Reserved. Do not connect.	Must be left open!
A7	All	GND		Ground	Ensure good GND connection
A8	All	GND		Ground	Ensure good GND connection
A9	All	GND		Ground	Ensure good GND connection
B1	All	SCL / SPI CLK	I	Serial interface.	See section 2.2
B9	All	GND		Ground	Ensure good GND connection
C1	All	SQI_D1	I	Data line 1 to external SQI flash memory or DC/DC configuration pin.	Leave open if not used.
C3	All	TIMEPLUSE	O	Time pulse output	Leave open if not used.
C4	All	SAFEBOOT_N	I	Used for programming the SQI flash memory and testing purposes.	Leave open if not used.
C5	All	LNA_EN	O	LNA on/off signal connected to internal LNA	Leave open if not used.
C6	All	PIO15	I/O	Digital I/O	Leave open if not used.
C7	All	GND		Ground	Ensure good GND connection

C9	All	GND		Ground	Ensure good GND connection
D1	All	SQI_D0	I/O	Data line 0 to external SQI flash memory or DC/DC configuration pin.	Leave open if not used.
D3	All	SQI_CS_N	I/O	Chip select for external SQI flash memory or DC/DC enable pin.	Leave open if not used.
D4	All	D_SEL	I	Interface selector	See section 2.2
D6	All	GND		Ground	Ensure good GND connection
D9	All	GND		Ground	Ensure good GND connection
E1	All	SQI_CLK	I/O	Clock for external SQI flash memory or DC/DC configuration pin.	Leave open if not used.
E3	All	SQI_D2	I/O	Data line 2 to external SQI flash memory or DC/DC configuration pin.	Leave open if not used.
E7	All	GND		Ground	Ensure good GND connection
E9	All	Reserved	I/O	Reserved	Do not connect. Must be left open!
F1	All	Reserved	I/O	Reserved	Do not connect. Must be left open!
F3	All	SQI_D3	I/O	Data line 3 to external SQI flash memory or DC/DC configuration pin.	Leave open if not used.
F4	All	Reserved	I/O	Reserved	Do not connect. Must be left open!
F6	All	PIO14	I/O	Digital I/O	Leave open if not used.
F7	All	GND		Ground	Ensure good GND connection
F9	All	Reserved	I/O	Reserved	Do not connect. Must be left open!
G1	ZOE-M8G	VCC	I	Supply voltage	Clean and stable supply needed
	ZOE-M8Q	V_CORE	I	Core Supply voltage	Connect to VCC if DCDC not used
G3	All	GND		Ground	Ensure good GND connection
G4	All	PIO13 / EXTINT	I	External interrupt	Leave open if not used.
G5	All	Reserved	I/O	Reserved	Do not connect. Must be left open!
G6	All	GND		Ground	Ensure good GND connection
G7	All	GND		Ground	Ensure good GND connection
G9	All	Reserved	I/O	Reserved	Do not connect. Must be left open! Only exception is V_BCKP, which can be connected to this pin if not used.
H1	ZOE-M8G	VCC	I	Supply voltage	Clean and stable supply needed
	ZOE-M8Q	V_DCDC_OUT	O	DC/DC converter output	Connect to VCC if DCDC not used
H9	All	V_BCKP	I	Backup supply	
J1	All	VCC	I	Supply voltage	Clean and stable supply needed
J2	All	VCC	I	Supply voltage	Clean and stable supply needed
J3	All	GND		Ground	Ensure good GND connection
J4	All	RXD/SPI MOSI	I	Serial interface	See section 2.2.
J5	All	TXD/SPI MISO	O	Serial interface	See section 2.2.
J6	All	RESET_N	I	System reset	See section 2.7.
J7	All	RTC_I	I	RTC Input	Connect to GND if no RTC Crystal attached.
J8	All	RTC_O	O	RTC Output	Leave open if no RTC Crystal attached.
J9	All	GND		Ground	Ensure good GND connection

**Table 3: Pinout**

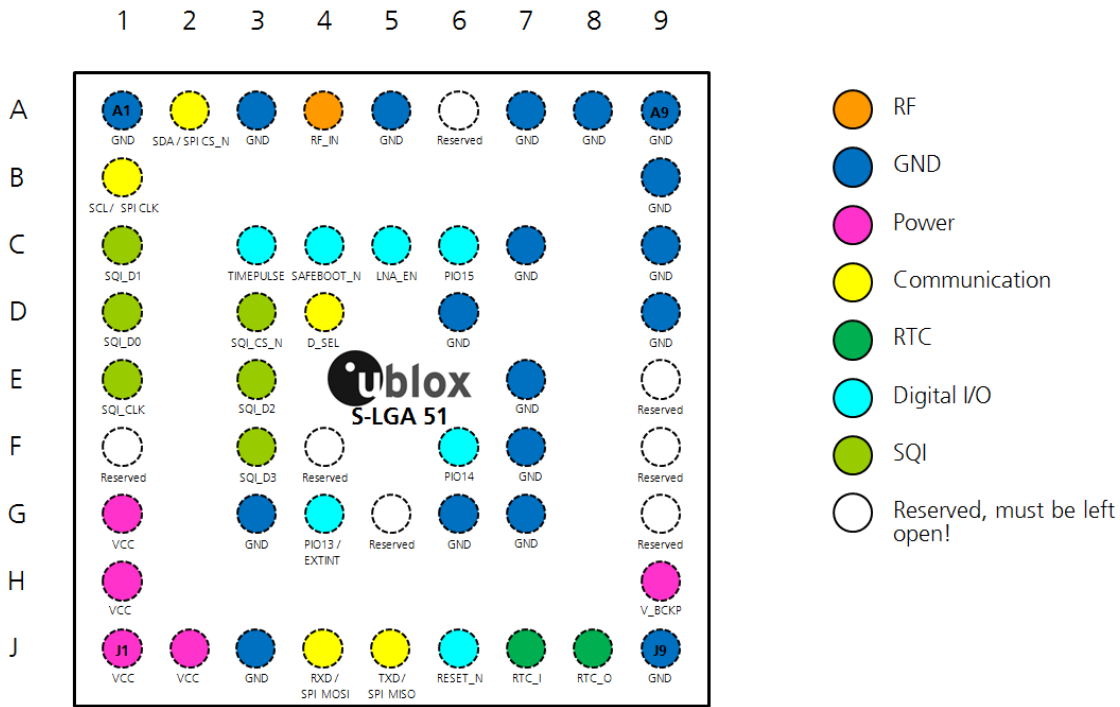


Figure 8: ZOE-M8G pin assignment

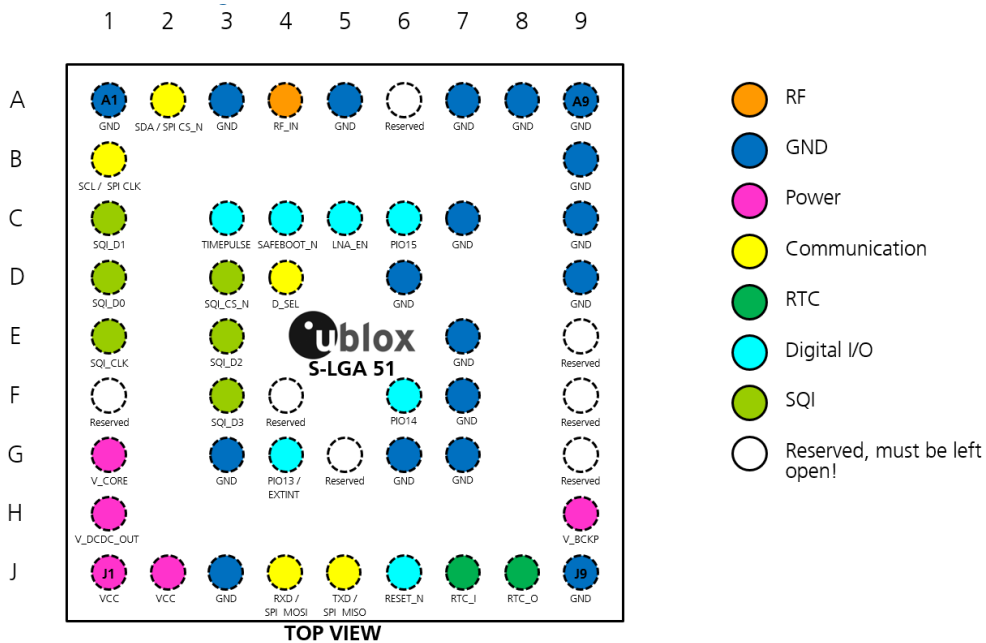


Figure 9: ZOE-M8Q pin assignment

For more information about the pin assignments, see the *ZOE-M8 Data Sheet* [1].



## 2.9 Typical schematic

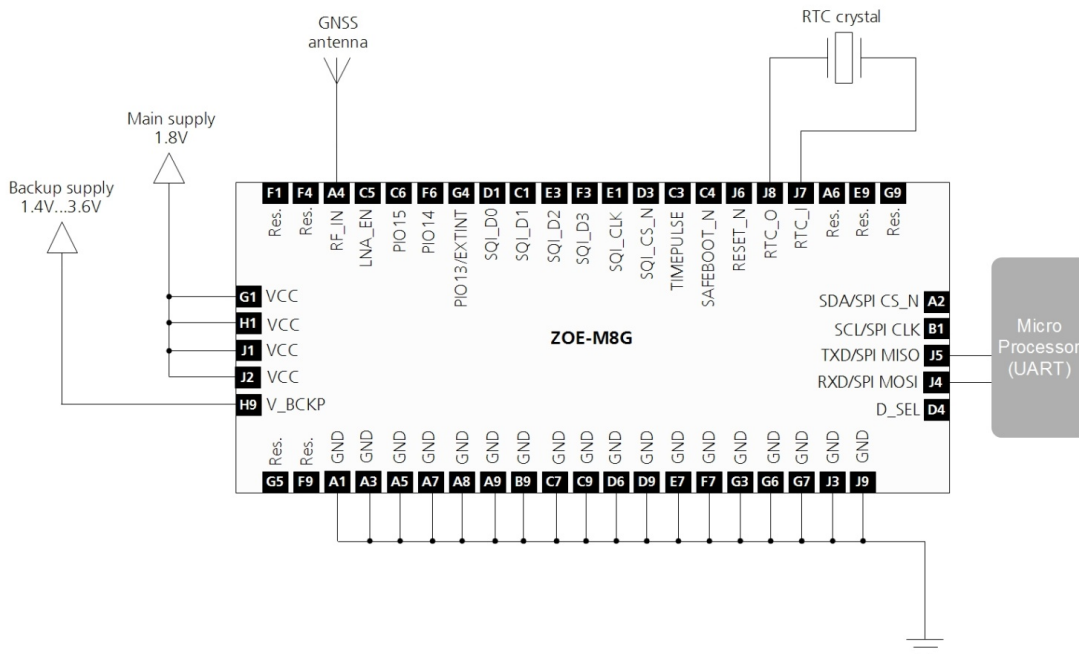


Figure 10: Typical schematic for the ZOE-M8G

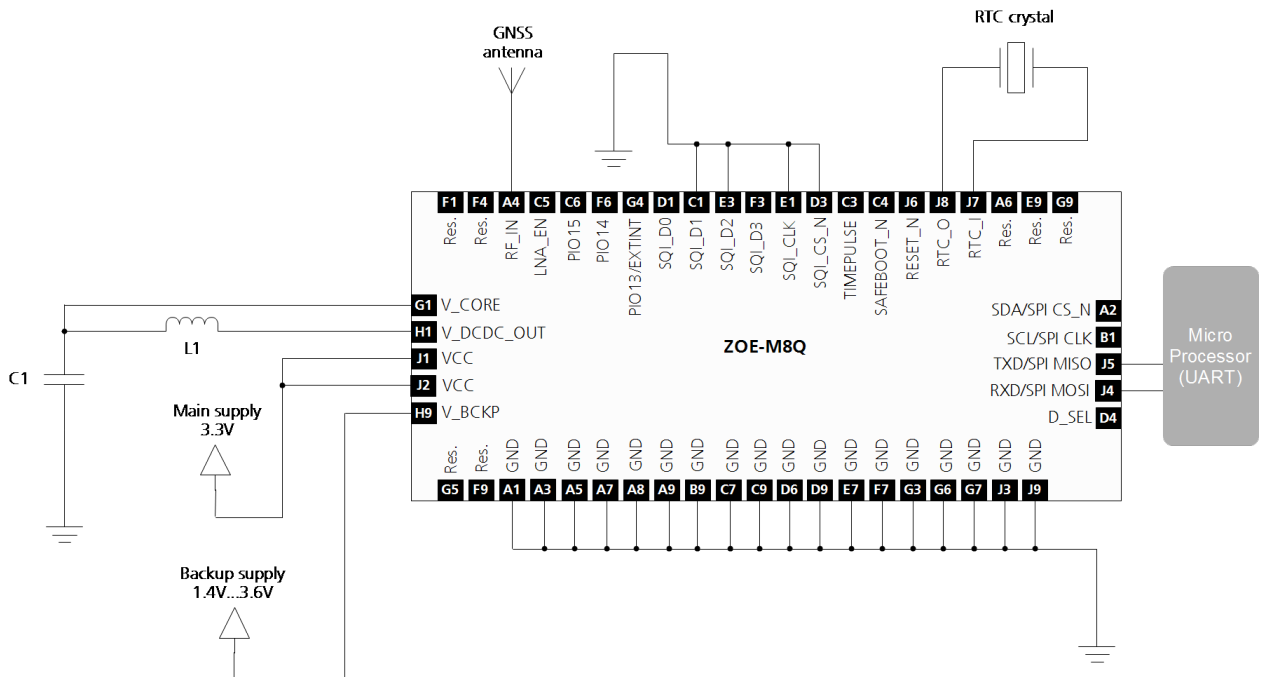


Figure 11: Typical schematic for the ZOE-M8GQ using a DC/DC converter

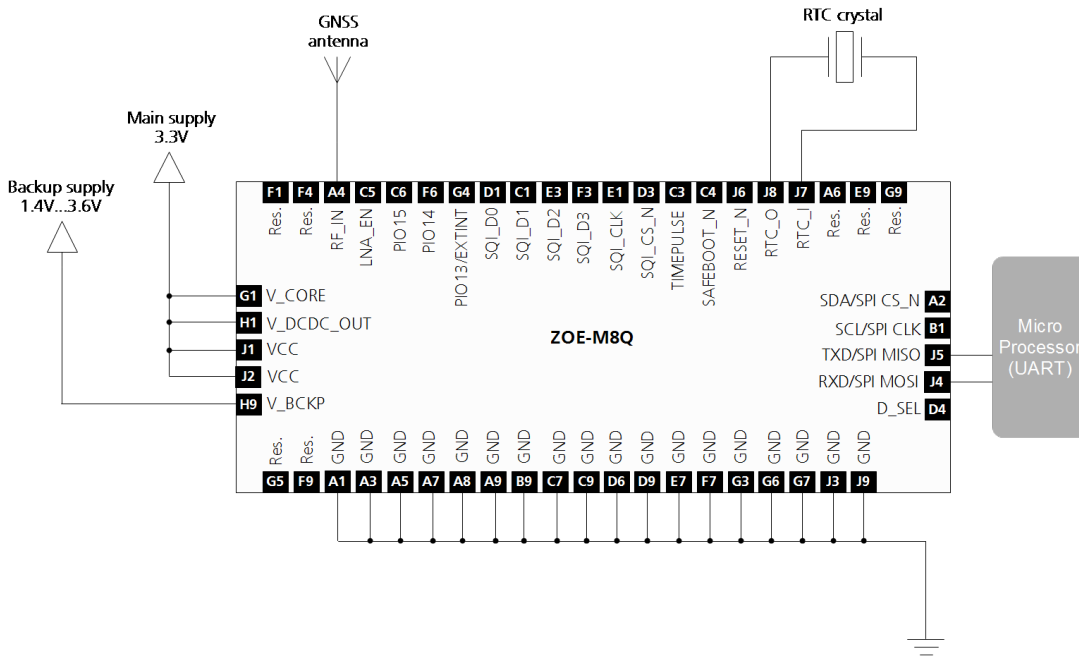


Figure 12: Typical schematic for the ZOE-M8Q without a DC/DC converter

## 2.10 Design-in checklist

### 2.10.1 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 and section 2.9.
- Compare the peak current consumption of ZOE-M8 GNSS SiPs 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 neighbor pin G9.

#### Antenna/ RF input

- 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.)
- Make sure your RF front end is chosen according your design, see section 2.5.

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

### 2.10.2 Schematic design-in for ZOE-M8 GNSS SiPs

For a minimal design with the ZOE-M8 GNSS SiPs, the following functions and pins need to be considered:

- Connect the power supply to **VCC** and **V\_BCKP**.
- If you use DC/DC converter on the ZOE-M8Q, ensure the external inductor and capacitor are in place in between **V\_DCDC\_OUT** and **V\_CORE**.
- Ensure an optimal ground connection to all ground pins of the ZOE-M8 GNSS SiPs.

- Choose the required serial communication interfaces (UART, 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 an RTC circuit.

## 2.11 Layout design-in checklist

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

### Layout optimizations (see Section 2.12)

- Is the ZOE-M8 GNSS SiP placed according to the recommendation in section 2.12.3?
- Is the grounding concept optimal?
- Are all the GND pins well connected with GND?
- Has the 50 Ohm line from the antenna to the SiP (micro strip / coplanar waveguide) been kept as short as possible?
- Assure low serial resistance in **VCC** power supply line (choose a line width > 400  $\mu\text{m}$ ).
- Assure all VCC pins are well connected with the power supply line.
- Keep the power supply line as short as possible.
- If DC/DC is used on the ZOE-M8Q, ensure the inductor and capacitor are connected close to the ZOE-M8Q V\_CORE and V\_DCDC\_OUT pins and the capacitor has a good GND connection.
- Design a GND guard ring around the optional RTC crystal lines and GND below the RTC circuit.
- Add a ground plane underneath the GNSS SiP 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 SiP, 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.

## 2.12 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.

### 2.12.1 Footprint

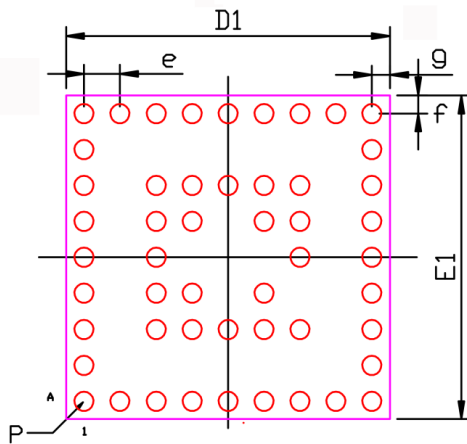


Figure 13: Recommended footprint (bottom view)

Symbol	Typ [mm]
e	0.50
g	0.25
f	0.25
D1	4.50
E1	4.50
P	0.27 diameter

Table 4: Footprint dimensions

### 2.12.2 Paste mask

The paste mask shall be same as the copper pads with a paste thickness of 80  $\mu\text{m}$ .

- 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.

### 2.12.3 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 SiP.

## 2.13 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 mechanisms are 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 *ZOE-M8 Data Sheet* [1].

### 2.13.1 Electrostatic Discharge (ESD)

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



### 2.13.2 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 14 can also avoid failures in the field.

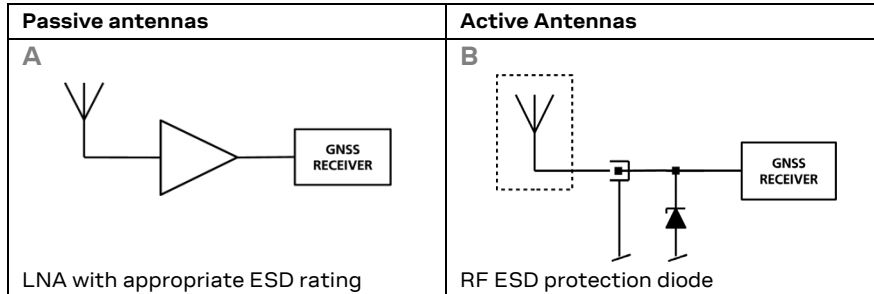


Figure 14: ESD Precautions

### 2.13.3 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.

### 2.13.4 EOS protection measures

EOS protection measures as shown in Figure 15 are recommended for any designs combining wireless communication transceivers (e.g. GSM, GPRS) and GNSS in the same design or in close proximity.

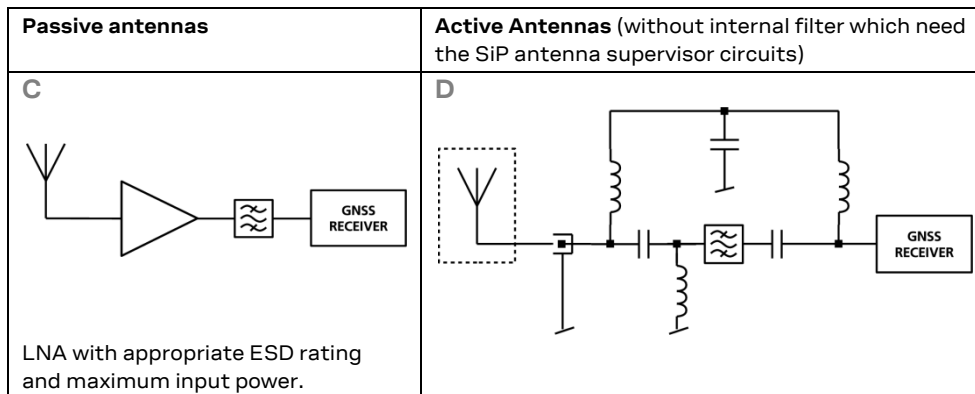


Figure 15: EOS and ESD Precautions

### 2.13.5 Electromagnetic interference (EMI)

Electromagnetic interference (EMI) is the addition or coupling of energy which causes a spontaneous reset of the GNSS receiver or results in unstable performance. In addition to EMI degradation due to self-jamming (see section 2.3.4), 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 16) into any unshielded PCB lines that are 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 16.

#### Intended use

-  In order to mitigate any performance degradation of a radio equipment under EMC disturbance, system integration shall adopt appropriate EMC design practice and not contain cables over three meters on signal and supply ports.

### 2.13.6 Applications with cellular modules

GSM terminals transmit power levels up to 2 W (+33 dBm) peak, 3G and LTE up to 250 mW continuous. Consult the *ZOE-M8 Data Sheet* [1] for the absolute maximum power input at the GNSS receiver. Make sure that the absolute maximum input power level of the GNSS receiver is not exceeded.

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

### 2.13.6.1 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, then 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.

### 2.13.6.2 Increasing interference immunity

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

### 2.13.6.3 In-band interference

With in-band interference, the signal frequency is very close to the GPS frequency of 1575 MHz (see Figure 16). Such interference signals are typically caused by harmonics from displays, micro-controllers, bus systems, etc.

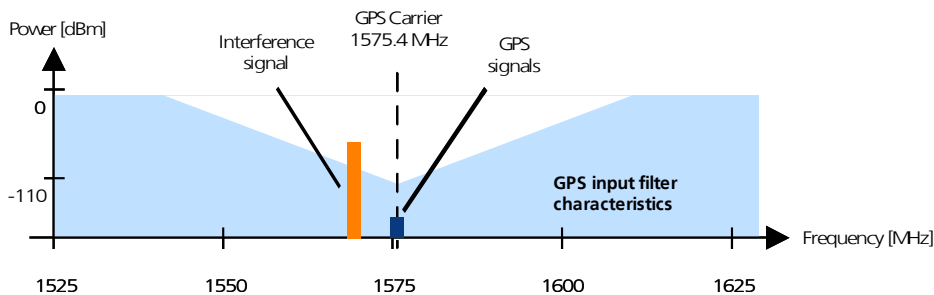


Figure 16: In-band interference signals

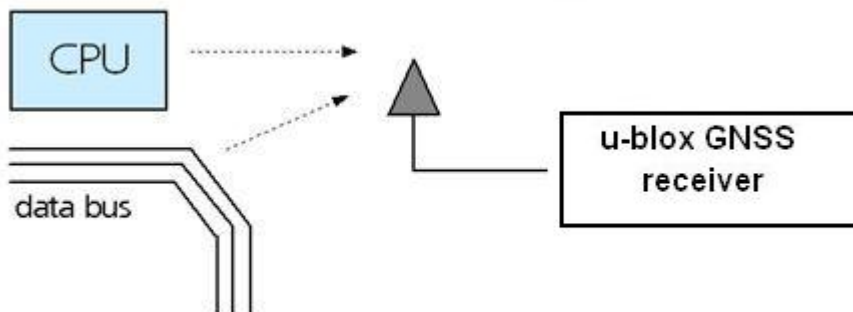


Figure 17: In-band interference sources

Measures against in-band interference include:

- Maintaining a good grounding concept in the design
- Shielding
- Layout optimization
- Filtering e.g. resistors and ferrite beads
- Placement of the GNSS antenna
- Adding a CDMA, GSM, WCDMA band-pass filter before handset antenna

### 2.13.6.4 Out-band interference

Out-band interference is caused by signal frequencies that are different from the GNSS carrier (see Figure 18). The main sources are wireless communication systems such as GSM, CDMA, WCDMA, Wi-Fi, BT, etc.

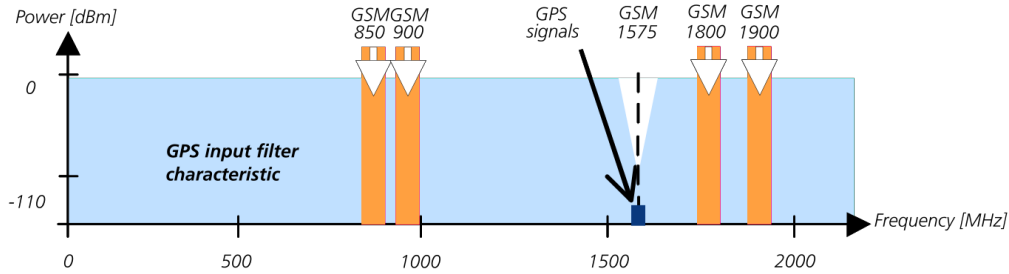


Figure 18: Out-band interference signals

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 2.13.6) into the antenna input line to the GNSS receiver (see Figure 19).



Figure 19: Measures against out-band interference



## 3 Product handling & soldering

### 3.1 Packaging, shipping, storage and moisture preconditioning

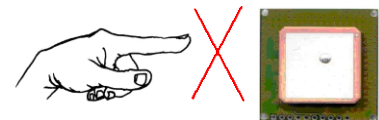
For information pertaining to reels and tapes, Moisture Sensitivity levels (MSD), shipment and storage information, as well as drying for preconditioning see the *ZOE-M8 Data Sheet* [1].


### 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 Safety precautions

ZOE-M8 SiPs must be supplied by an external limited power source in compliance with the clause 2.5 of the standard IEC 60950-1. In addition to external limited power source, only Separated or Safety Extra-Low Voltage (SELV) circuits are to be connected to the SiP including interfaces and antennas.

 For more information about SELV circuits see section 2.2 in *Safety standard IEC 60950-1* [6]

## 3.4 Soldering

### 3.4.1 Soldering paste

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


The paste-mask geometry for applying soldering paste should meet the recommendations given in section 2.12.2.

### 3.4.2 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 to 110 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
Average Ramp up rate ( $T_{smax}$ to $T_P$ )		0.8°C/ second max.
Time within +5°C...-5°C of $T_P$		20 to 40 seconds
Ramp down rate ( $T_P$ to $T_L$ )		6°C/ second max.
Time 25°C to $T_P$		8 minutes max.

**Table 5: Recommended conditions for reflow process**

The peak temperature must not exceed 255°C. The time above 245°C must not exceed 40 seconds.

 ZOE-M8 GNSS SiPs **must not** be soldered with a damp heat process.

### 3.4.3 Optical inspection

After soldering the SiPs, consider an optical inspection step to check whether the SiP is properly aligned and centered over the pads.

### 3.4.4 Repeated reflow soldering

Only single reflow soldering process is recommended.

### 3.4.5 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 ZOE-M8 GNSS SiPs.

### 3.4.6 Rework

Not recommended.

### 3.4.7 Use of ultrasonic processes

Some components on the ZOE-M8 GNSS SiPs 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 ZOE-M8 GNSS SiPs caused by any Ultrasonic Processes.

## 4 Product testing

### 4.1 Test parameters for the 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](http://www.positioningtechnology.co.uk)




Figure 20: 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-SVININFO message (e.g. with u-center).
5. Compare the results to a "Golden Device" or the u-blox EVK-M8GZOE 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 Component selection

This section provides information about components that are critical for the performance of the ZOE-M8 GNSS SiPs. 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 to +85 °C) are given.

### A.1 External RTC (Y1)

ID	Parameter	Value
<b>1</b>	<b>Frequency Specifications</b>	
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
<b>2</b>	<b>Electrical specifications</b>	
2.1	Load capacitance $C_L$	7 pF
2.2	Equivalent series resistance $R_s$	< 100 kΩ

**Table 6: RTC crystal specifications**

Manufacturer	Order No.
Micro Crystal	CC7V-T1A 32.768 kHz 7.0 pF +/- 100 ppm
Micro Crystal	CM7V-T1A 32.768 kHz 7.0 pF +/- 100 ppm
Micro Crystal	CM8V-T1A 32.768 kHz 7.0 pF +/- 100 ppm

**Table 7: Recommend parts list for RTC crystal**

### A.2 RF band-pass filter (F1)

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

Manufacturer	Order No.	System supported	Comments
TDK/ EPCOS	B8401: B39162B8401P810	GPS+GLONASS	High attenuation
TDK/ EPCOS	B3913: B39162B3913U410	GPS+GLONASS+BeiDou	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	B4327: B39162B4327P810	GPS+GLONASS+BeiDou	Low insertion loss
TDK/ EPCOS	B9482: B39162B9482P810	GPS+GLONASS	Low insertion loss
TDK/ EPCOS	B9850: B39162B9850P810	GPS	Low insertion loss
TDK/ EPCOS	B8400: B39162B8400P810	GPS	ESD protected and high input power
muRata	SAFFB1G56KB0F0A	GPS+GLONASS+BeiDou	Low insertion loss, Only for mobile application
muRata	SAFEA1G58KA0F00	GPS+GLONASS	Only for mobile application
muRata	SAFFB1G58KA0F0A	GPS+GLONASS	High attenuation, only for mobile application
muRata	SAFEA1G58KB0F00	GPS+GLONASS	Low insertion loss, only for mobile application
muRata	SAFFB1G58KB0F0A	GPS+GLONASS	Low insertion loss, only for mobile application
Triquint	856561	GPS	Compliant to the AEC-Q200 standard
TAI-SAW	TA1573A	GPS+GLONASS	Low insertion loss

Manufacturer	Order No.	System supported	Comments
TAI-SAW	TA1343A	GPS+GLONASS+BeiDou	Low insertion loss
NDK	WFC38P1588CD	GPS+GLONASS	Compliant to the AEC-Q200 standard
NDK	WFC72L1575CH	GPS	Compliant to the AEC-Q200 standard
NDK	WFF93A1582UE	GPS+GLONASS+BeiDou	Compliant to the AEC-Q200 standard
CTS	CER0032A	GPS	Ceramic filter also offers robust ESD Protection

**Table 8: Recommend parts list for RF band-pass filter**

### A.3 Optional SQI flash (U3)

Manufacturer	Order No.	Comments
Macronix	MX25L3233F	3 V, 32 Mbit, several package/temperature options
Macronix	MX25V8035F	3 V, 8 Mbit, several package/temperature options
Macronix	MX25V1635F	3 V, 16 Mbit, several package/temperature options
Macronix	MX25R1635FxxxH1	1.8 V and 3 V, 16 Mbit, several package/temperature options
Macronix	MX25R8035Fxxxx1	1.8 V and 3 V, 8 Mbit, several package/temperature options
Macronix	MX25R8035Fxxxx3	1.8 V and 3 V, 8 Mbit, several package/temperature options
Winbond	W25Q80DV	3 V, 8 Mbit, several package/temperature options
Winbond	W25Q16JV	3 V, 16 Mbit, several package/temperature options
Winbond	W25Q16FW	1.8 V, 16 Mbit, several package/temperature options
Winbond	W25Q16JVSNIM	3 V, 16 Mbit, several package/temperature options
Winbond	W25Q32JV	3 V, 32 Mbit, several package/temperature options
Winbond	W25Q64JV	3 V, 64 Mbit (only 32 Mbit used), several package/temperature options
Adesto	AT25SL641	1.8 V, 64 Mbit (only 32 Mbit used), several package/temperature options
Gigadevice	GD25Q32C	3 V, 32 Mbit, several package/temperature options
Spansion/Cypress	S25FL116K	3 V, 16 Mbit, several package/temperature options
Spansion/Cypress	S25FL132K	3 V, 32 Mbit, several package/temperature options

**Table 9: Recommend parts list for optional SQI flash**

### A.4 Inductor for the DC/DC converter (L1)

ID	Parameter	Value
1.1	Self-resonance frequency (SRF)	> 30 MHz
1.2	DC resistance (DCR)	< 0.2 $\Omega$
1.3	Rated current	> 0.5 A
1.3	Inductance	1.0...2.2 $\mu$ H

**Table 10: DC/DC inductor specifications**


It is recommended to use a shielded inductor.

Manufacturer	Order No.	Comments
muRata	LQM2MPN2R2NG0	Low DCR, for best efficiency of DC/DC (~85%)
muRata	LQM21PN1R0MCO	Low height, 0.5mm
muRata	LQM18FN2R2M00	Small size, limited efficiency of DC/DC (~70%)
TDK	MLP2016S2R2MT	

**Table 11: Recommend parts list for DC/DC inductor**

## A.5 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 12: 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, very small package size (WL-CSP)
Infineon	BGA524N6	Low noise figure, small package size

Table 13: Recommend parts list for external LNA

## A.6 RF ESD protection diode

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

Table 14: Recommend parts list for RF ESD protection diode

## A.7 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 15: Recommend parts list for ferrite beads FB1

## A.8 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 16: Recommend parts list for feed thru capacitors

## A.9 Standard capacitors

Name	Use	Type / Value
C1	Decoupling V_CORE (DC/DC converter used)	X5R 4U7 10% 6.3V
C4	Decoupling VCC at SQI flash supply pin	X5R 1U0 10% 6.3V

Table 17: Standard capacitors


## B Glossary

Abbreviation	Definition
<b>ANSI</b>	American National Standards Institute
<b>BeiDou</b>	Chinese satellite navigation system
<b>CDMA</b>	Code Division Multiple Access
<b>EMI</b>	Electromagnetic interference
<b>EOS</b>	Electrical Overstress
<b>EPA</b>	Electrostatic Protective Area
<b>ESD</b>	Electrostatic discharge
<b>Galileo</b>	European navigation system
<b>GLONASS</b>	Russian satellite system
<b>GND</b>	Ground
<b>GNSS</b>	Global Navigation Satellite System
<b>GPS</b>	Global Positioning System
<b>GSM</b>	Global System for Mobile Communications
<b>IEC</b>	International Electrotechnical Commission
<b>LGA</b>	Land Grid Array
<b>PCB</b>	Printed circuit board
<b>SBAS</b>	Satellite-Based Augmentation System
<b>S-LGA</b>	Soldered Land Grid Array
<b>QZSS</b>	Quasi-Zenith Satellite System
<b>WCDMA</b>	Wideband Code Division Multiple Access

**Table 18: Explanation of the abbreviations and terms used**

## Related documents

- [1] ZOE-M8 Data Sheet, Document No. UBX-16008094
- [2] u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification (Public version),  
Document No. UBX-13003221
- [3] GPS Antenna Application Note Document No. GPS-X-08014
- [4] GPS Compendium, Document No. GPS-X-02007
- [5] GPS Implementation and Aiding Features in u-blox wireless modules, Document No. GSM.G1-  
CS-09007
- [6] Information technology equipment – Safety Standard IEC 60950-1  
<https://webstore.iec.ch/publication/4024>

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



## Revision history

Revision	Date	Name	Comments
R01	21-Dec-2016	mdur	Objective Specification
R02	23-Jan-2017	mdur	Minor updates in section 2.1.1 and Figure 5
R03	21-Mar-2017	mdur	Advance Information, Updated footprint section (Figure 13) and Table 9 (Recommend optional SQI flash).
R04	11-Jul-2017	mdur	Added ZOE-M8Q variant and relevant content, added section 3.3 (Safety precautions), updated section A (recommended parts). Included instructions to configure the optional DCDC converter in section 2.1.3.
R05	13-Sep-2017	mdur	Added information on RED DoC in European Union regulatory compliance (page 2). Modified remark for G9 pin in Table 3. Added section 2.13.5 (EMI).
R06	23-Oct-2017	mdur	Early Production Information
R07	14-Mar-2018	mdur	Production Information. Updated Table 9 (Recommend optional SQI flash).
R08	27-Feb-2019	mdur	Modified the SQI flash section 2.2.4. Clarified alternative uses for the EXTINT pin in section 2.3.2. Updated power save limitations in section 2.4. Updated supported RF band-pass filter list in section A.2. Updated supported SQI Flash list in section A.3.

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