SARA-R510AWS

LTE-M AWS IoT ExpressLink module

Data sheet

Abstract

Technical data sheet describing SARA-R510AWS LTE-M AWS IoT ExpressLink modules, based on the u-blox UBX-R5 cellular chipset. The modules are a size-optimized solution specifically designed for IoT, integrating an in-house developed cellular modem, and silicon-to-cloud trusted domain security. The modules deliver direct AWS IoT cloud access in the very small and compact SARA form factor.

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This document applies to the following products:

Product name	Type number	Modem version	Application version	PCN reference	Product status
SARA-R510AWS	SARA-R510AWS-01B-00	83.19	A80.01	UBX- 23002330	Initial production

Contents

1 Functional description

1.1 Overview

SARA-R510AWS modules are AWS IoT ExpressLink modules based on u-blox's UBX-R5 cellular chipset, aimed at fast and easy development of secure IoT devices. By bridging the u-blox in-house chipset platform with the market-leading cloud computing services of AWS, this solution provides long-term availability and lifetime support from silicon to cloud.

The embedded AWS IoT ExpressLink certified software provides a new tailored AT command set that paves the way to AWS cloud access straight out-of-the-box, which significantly accelerates time-to-market. SARA-R510AWS modules provide AWS cloud service access without the need for the customer to integrate any additional API on their MCU; every single step is handled inside the IoT modules. SARA-R510AWS modules are the perfect fit for new applications requiring accelerated time-to-market as well as to renew resource-constrained legacy applications that cannot accommodate the additional code and APIs that are usually required to access to AWS cloud services.

These LTE-M modules support a comprehensive set of 3GPP Rel. 14 features that are relevant for IoT applications, like improvements to power consumption, coverage, data rate, mobility, and positioning. They are 5G-ready, meaning customers will be able to upgrade their deployed devices, once 5G LTE has been fully rolled out by mobile operators, greatly improving end-product scalability and lifetime.

The SARA-R510AWS modules are optimized for extremely low power consumption, using less than 1 µA of current in power-off/deep-sleep state, and are ideal for battery-powered applications. They offer data communications up to 1200 kbit/s over an extended operating temperature range of –40 °C to +85 °C. Combined with an internal, hardware-based secure element, a lightweight set of AT commands, and seamless access to AWS cloud, the solution protects business-critical data from device to cloud without heavily investing in R&D resources to master provisioning, authentication, certification, and security.

Customers can future-proof their solutions by over-the-air firmware updates, thanks to the uFOTA and HOTA (Host OTA) solutions.

The miniature SARA LGA form factor (26.0 x 16.0 mm, 96-pin) allows an easy integration into compact designs and a seamless drop-in migration from other u-blox cellular module families. SARA-R510AWS modules are form-factor compatible with the u-blox LISA, LARA and TOBY cellular module families and they are pin-to-pin compatible with the u-blox SARA-R4, SARA-N2, SARA-N3, SARA-N4, SARA-G3, SARA-G4 and SARA-U2 cellular modules families. This facilitates migration from other u-blox LPWA modules as well as from other u-blox GSM/GPRS, CDMA, UMTS/HSPA and higher LTE categories modules, maximizing customer investments, simplifying logistics, and enabling very short time-to-market.

1.2 Product features

Model	Region	RAT		u-blox services		Interfaces					Features							Grade		
		LTE category	LTE FDD bands	CellLocate®	Certificate Lifecycle Control: Zero Touch Provisioning for AWS IoT ExpressLink	UART	USB (for diagnostics)	I2C	USIM	GPIO	Root of trust: secure element	Secure boot, updates, and production	Embedded MQTT**	Ultra-low power consumption in deep-sleep state	FW update Over the Wire (OTW)	u-blox Firmware update Over The Air (uFOTA)	Host firmware update Over The Air (HOTA)	Standard	Professional	Automotive
SARA-R510AWS	Multi Region	M1	*	○	●	●	●		●	●	●	●	●	●	○	●	●		●	

* = LTE Bands 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, 71, 85
** = Protocol used by AWS IoT ExpressLink, not exposed
● = supported by current FW version
○ = supported by future FW version

Table 1: SARA-R510AWS main features summary

1.3 Block diagram

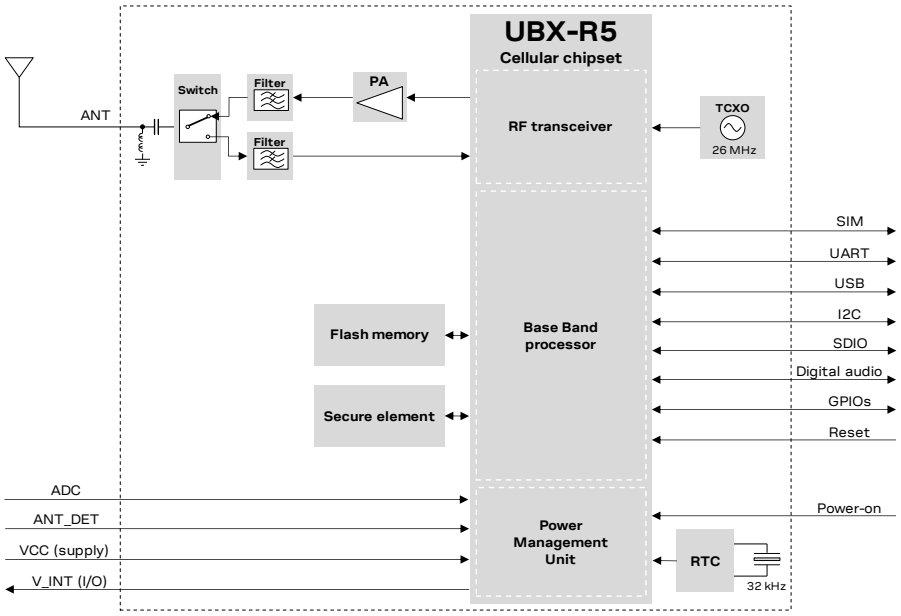

Figure 1: SARA-R510AWS block diagram

The SARA-R510AWS modules do not support the following interfaces that should be left unconnected and should not be driven by external devices:

- I2C interface
- SDIO interface
- Digital audio (I2S) interface
- ADC
- ANT_DET

1.4 Product description

Item	SARA-R510AWS
Cellular protocol stack	3GPP Release 13 LTE-M 3GPP Release 14 LTE-M: Coverage Enhancement Mode B, Uplink TBS of 2984b
Cellular Radio Access Technology	LTE-M Half-Duplex
Cellular operating bands	LTE FDD band 1 (2100 MHz) LTE FDD band 2 (1900 MHz) LTE FDD band 3 (1800 MHz) LTE FDD band 4 (1700 MHz) LTE FDD band 5 (850 MHz) LTE FDD band 8 (900 MHz) LTE FDD band 12 (700 MHz) LTE FDD band 13 (750 MHz) LTE FDD band 18 (850 MHz) LTE FDD band 19 (850 MHz) LTE FDD band 20 (800 MHz) LTE FDD band 25 (1900 MHz) LTE FDD band 26 (850 MHz) LTE FDD band 28 (700 MHz) LTE FDD band 66 (1700 MHz) LTE FDD band 71 (600 MHz) LTE FDD band 85 (700 MHz)
Cellular power class	LTE power class 3 (23 dBm)
Cellular data rate	LTE category M1: up to 1200 kbit/s UL up to 375 kbit/s DL

Table 2: SARA-R510AWS cellular main characteristics

1.5 AT commands support

The SARA-R510AWS modules support AT commands according to the AWS IoT ExpressLink programmer's guide [1].

1.6 Supported features

Table 3 lists some of the main features supported by SARA-R510AWS modules.

Feature	Description
AWS IoT ExpressLink	Implements AWS mandated security requirements, making it faster and easier to securely connect devices to the cloud and seamlessly integrate with a range of AWS services. Allow only authenticated access to device and features, safely manage changes of device ownership, and provide out-of-the-box, simple, secure and cost effective zero touch onboarding to AWS IoT services. • Zero touch provisioning for AWS: out-of-the-box, simple, secure, and cost-effective AWS onboarding • Pre-provisioned • MQTT data transfer with AWS IoT ExpressLink commands • Easy cloud access • Faster time to market

Feature	Description
AWS IoT ExpressLink commands	With AWS IoT ExpressLink commands as simple as “connect”, “send,” and “subscribe” the module will immediately start communicating with the cloud. Embedded Message Queuing Telemetry Transport (MQTT 3.1.1) publish-subscribe messaging protocols designed for lightweight M2M communications over TCP (MQTT) is used to exchange messages between the device and AWS IoT core.
AWS IoT Device Shadow [1]	The module can create and update device shadows. Device shadows communicate a device’s state to apps and other services regardless of whether that device is currently connected, so it is possible to see and modify the device’s state at any point in time.
CellLocate® [1]	Enables the estimation of device position based on the parameters of the mobile network cells visible to the specific device based on the CellLocate® database. CellLocate® is available via the +WHERE AT command of the IoT ExpressLink AT-command.
Device security	An immutable chip ID and hardware-based Root of Trust (RoT) embedded in a dedicated Common Criteria EAL5+ high certified secure element provide foundational security and a unique device identity. Device security features include: • Secure boot: software authenticity and integrity • Secure update: secure delivery of the correct FW to the module • Anticloning detection and rejection: system automatically identifies and blocks clones that use the same RoT
Over the Wire (OTW) module firmware update [1]	A direct module firmware update mechanism is offered as a convenient alternative for customers that intend to update module firmware during, or immediately after, the assembly/testing line. The feature can be enabled and configured through the +OTW AT command.
Module firmware update over UART interface	Module firmware update can be executed over UART interface using the u-blox EasyFlash windows application.
Host Processor OTA (HOTA)	Host (microcontroller) application updates can be sent to an ExpressLink module from AWS cloud.
u-blox Firmware update Over The Air (uFOTA)	u-blox firmware module update over the LTE air interface client/server solution using LwM2M.
Coverage Enhancement (mode A and mode B)	Coverage Enhancement modes introduced in 3GPP Rel.13 are used to improve the cell signal penetration.
LTE-M 3GPP release 14 features	Larger max UL TBS (2984 bits instead of 1000 bits), Enhanced PUCCH repetition in CE mode B (64 and 128 repetition factor)

Table 3: Some of the main features supported by SARA-R510AWS modules

[1] Support planned for future product versions

2 Interfaces

2.1 Power management

2.1.1 Module supply input (VCC)

SARA-R510AWS modules must be supplied through the **VCC** pins by a proper external DC power supply providing a nominal voltage within the normal operating range (see Table 9). Voltage must be stable, because during operation the current drawn from **VCC** may vary significantly, based on the power consumption profile of the LTE-M radio access technology.

The three **VCC** pins of SARA-R510AWS modules are internally connected to both the internal Power Amplifier and the internal Power Management Unit, which integrates voltage regulators generating all the internal supply voltages needed by the module for the designed operations, as the supply voltage for the generic digital interfaces (**V_INT**), and the supply voltage for the SIM interface (**VSIM**).

It is important that the system power supply circuit can withstand the maximum pulse current during a transmit burst at maximum power level (see Table 11).

2.1.2 Generic digital interfaces supply output (V_INT)

SARA-R510AWS modules provide a 1.8 V supply rail output on the **V_INT** pin, which is internally generated when the module is switched on. The same voltage domain is used internally to supply the generic digital interfaces of the module. The **V_INT** supply output can be used in place of an external discrete regulator.

☞ It is recommended to provide accessible test point directly connected to the **V_INT** pin.

2.2 Antenna interface

2.2.1 Cellular antenna RF interface (ANT)

The **ANT** pin is the cellular RF antenna I/O interface, designed with 50 Ω characteristic impedance.

2.2.2 GNSS antenna RF interface

☞ The GNSS antenna RF interface (**ANT_GNSS** pin) is not supported by SARA-R510AWS modules.

2.2.3 Antenna detection

☞ The antenna detection (**ANT_DET** pin) is not supported by SARA-R510AWS modules.

2.3 System functions

2.3.1 Module power-on

When the SARA-R510AWS modules are not powered, they can be switched on as follows:

- Apply a voltage at the **VCC** module supply input within the operating range (see Table 9), and then force a low level at the **PWR_ON** input pin for a valid time period (the **PWR_ON** pin is normally set high by an internal pull-up). See section 4.2.6, module switch-on.

When the SARA-R510AWS modules are in power-off/deep-sleep state (i.e. switched off, but with a valid voltage present at the **VCC** module supply input within the operating range reported in Table 9), they can be switched on as following:

- Force a low level at the **PWR_ON** input pin for a valid time period (the **PWR_ON** pin is normally set high by an internal pull-up). See section 4.2.6, module switch-on.

The **PWR_ON** line is intended to be driven by open drain, open collector or contact switch.

☞ It is recommended to provide accessible test point directly connected to the **PWR_ON** input pin.

2.3.2 Module power-off/deep-sleep

The proper graceful power-off/deep-sleep of the SARA-R510AWS modules, with storage of the current parameter settings in the module's non-volatile memory and a clean network detach, can be triggered by:

- AT+SLEEP1 command (for further details, see the AWS IoT ExpressLink programmer's guide [1])

☞ AT+SLEEP{#} with {#} from 2 to 9 is equivalent to AT+SLEEP1

An abrupt emergency hardware shutdown of the modules, without saving current parameter settings in the module's non-volatile memory and without clean network detach, can be executed by:

- Forcing a low pulse at the **PWR_ON** and **RESET_N** input pins, in the proper sequence described in section 4.2.6 with details in Figure 3

An abrupt under-voltage shutdown occurs on SARA-R510AWS modules when the **VCC** supply is removed. If this occurs, it is not possible to store the current parameter settings in the module's non-volatile memory or to perform the proper network detach.

2.3.3 Module reset

SARA-R510AWS modules can be reset (re-booted), saving current parameter settings in the module's non-volatile memory and performing a proper network detach, by:

- AT+RESET command (for further details, see the AWS IoT ExpressLink programmer's guide [1]). This causes a graceful software reset of the module.

An abrupt software reset of the module is executed by applying a low pulse at the **RESET_N** input pin, which is normally set high by an internal pull-up, for a valid time period (see section 4.2.7). The current parameter settings are not saved in the module's non-volatile memory and a proper network detach is not performed.

The **RESET_N** line is intended to be driven by open drain, open collector or contact switch.

☞ It is recommended to provide accessible test point directly connected to the **RESET_N** input pin.

2.4 SIM

2.4.1 SIM interface

SARA-R510AWS modules provide on the **VSIM**, **SIM_IO**, **SIM_CLK**, **SIM_RST** pins an interface to connect an external SIM card/chip. Both 1.8 V and 3.0 V SIM types are supported. Activation and deactivation with an automatic voltage switch from 1.8 V to 3.0 V is implemented according to the ISO-IEC 7816-3 specifications.

2.4.2 SIM detection

☞ The SIM detection is not supported by SARA-R510AWS modules.

2.5 Serial communication

The SARA-R510AWS provides the following serial communication interfaces:

- UART interface, available for communications with host processor and for FW upgrade (2.5.1)
- USB 2.0 compliant interface, available for diagnostics only (2.5.2)

2.5.1 UART interface

The SARA-R510AWS modules include 1.8 V unbalanced asynchronous serial interfaces (UART) for communication with external application host processor(s), and for FW update by the u-blox EasyFlash tool.

UART characteristics are:

- Serial port with data lines (**RXD** output, **TXD** input) conforming to ITU-T V.24 recommendation [6], with CMOS compatible levels (0 V for low data bit or ON state, 1.8 V for high data bit or OFF state)
- None flow control is supported
- 115,200 bit/s fixed baud rate
- 8N1 (8 data bits, no parity, 1 stop bit) fixed frame format

☞ The UART hardware flow control lines (**CTS** and **RTS**), and the modem status / control lines (**DTR**, **DSR**, **DCD** and **RI**) are not supported by the SARA-R510AWS modules.

☞ It is highly recommended to provide accessible test points directly connected to the **TXD** and **RXD** pins for diagnostics and for FW upgrade purpose.

☞ Naming for UART data lines in AWS IoT ExpressLink programmer's guide [1] is opposite than ITU-T V.24 recommendation [6], i.e. TX as module output and RX as module input,

2.5.2 USB interface

SARA-R510AWS modules include a high-speed USB 2.0 compliant interface with a maximum 480 Mbit/s data rate according to the USB 2.0 specification [7]. The module itself acts as a USB device and can be connected to any USB host equipped with compatible drivers.

The USB interface is available for diagnostic purpose only.

The **USB_D+** / **USB_D-** lines carry the USB data and signaling, while the **VUSB_DET** pin represents the input to enable the USB interface by applying an external valid USB VBUS voltage (5.0 V typical).

☞ It is highly recommended to provide accessible test points directly connected to the USB interface pins (**VUSB_DET**, **USB_D+**, **USB_D-**) for diagnostic purpose.

2.5.3 SDIO interface

☞ The SDIO interface (**SDIO_D0**, **SDIO_D1**, **SDIO_D2**, **SDIO_D3**, **SDIO_CLK** and **SDIO_CMD** pins) is not supported by the SARA-R510AWS modules.

2.5.4 I2C interface

☞ The I2C interface (**SDA** and **SCL** pins) is not supported by the SARA-R510AWS modules.

2.6 Audio

☞ The digital audio interface (**I2S_TXD**, **I2S_RXD**, **I2S_CLK** and **I2S_WA** pins) is not supported by the SARA-R510AWS modules.

2.7 ADC

☞ **ADC** is not supported by the SARA-R510AWS modules.

2.8 GPIO

SARA-R510AWS modules include **GPIO1** pin that is configured as low-power sleep state wakeup and **GPIO3** pin that is configured as Asynchronous Event Flag. For further details, see the AWS IoT ExpressLink programmer's guide [1].

☞ The **GPIO2**, **GPIO4**, **GPIO5** and **GPIO6** pins are not supported by the SARA-R510AWS modules.

2.9 GNSS peripheral output

☞ The GNSS peripheral output pins (the ANT_ON signal over the I2S_RXD pin, and the GEOFENCE signal over the I2S_CLK pin) are not supported by the SARA-R510AWS modules.

3 Pin definition

3.1 Pin assignment

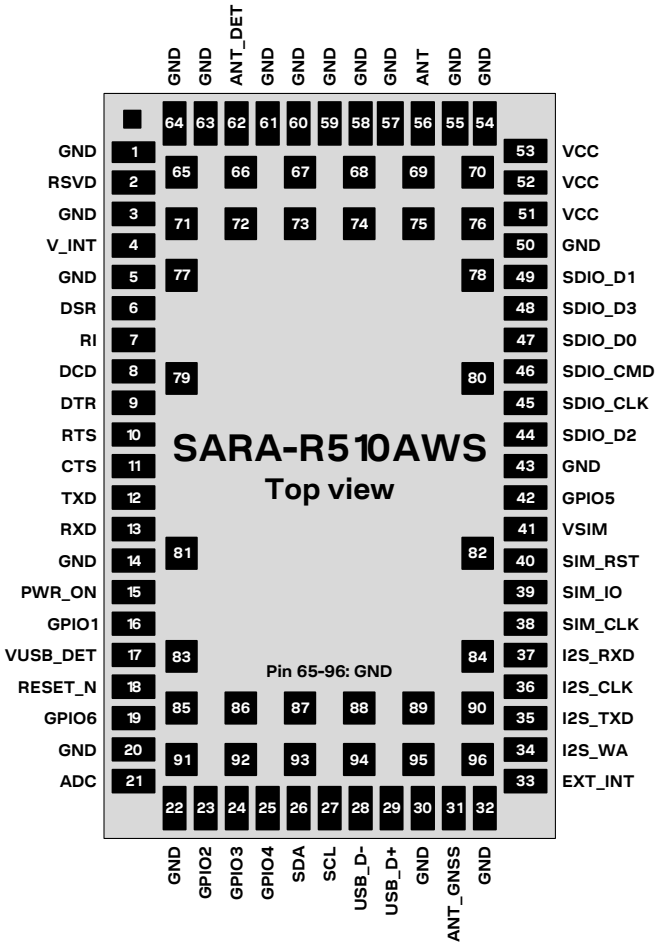

Figure 2: SARA-R510AWS modules pin assignment (top view)

No.	Name	Power domain	I/O	Description	Remarks
1	GND	-	N/A	Ground	All the GND pins must be connected to ground.
2	RSVD	-	N/A	Reserved pin	Leave unconnected.
3	GND	-	N/A	Ground	All the GND pins must be connected to ground.
4	V_INT	-	O	Generic Digital Interfaces supply output	V_INT generated by the module when is switched on. See section 2.1.2 for functional description. See section 4.2.3 for detailed electrical specs. Provide test point for diagnostic purposes.
5	GND	-	N/A	Ground	All the GND pins must be connected to ground.
6	DSR	GDI	O	UART data set ready	Not supported.
7	RI	GDI	O	UART ring indicator	Not supported.
8	DCD	GDI	O	UART data carrier detect	Not supported.
9	DTR	GDI	I	UART data terminal ready	Not supported.
10	RTS	GDI	I	UART request to send	Not supported.
11	CTS	GDI	O	UART clear to send	Not supported.

No.	Name	Power domain	I/O	Description	Remarks
12	TXD	GDI	I	UART data input	Circuit 103 in ITU-T V.24 (TxD data input, idle high, active low, with internal active pull-up enabled). See section 2.5.1 for functional description. See section 4.2.9 for detailed electrical specs. Provide test point for diagnostics and for FW update purposes.
13	RXD	GDI	O	UART data output	Circuit 104 in ITU-T V.24 (RxD data output, push-pull, idle high, active low). See section 2.5.1 for functional description. See section 4.2.9 for detailed electrical specs. Provide test point for diagnostics and for FW update purposes.
14	GND	-	N/A	Ground	All the GND pins must be connected to ground.
15	PWR_ON	POS	I	Power-on input	Internal active pull-up. Active low. See section 2.3.1 and 2.3.2 for functional description. See section 4.2.6 for detailed electrical specs. Provide test point for diagnostic purposes.
16	GPIO1	GDI	I	WAKE	Low-power sleep state wakeup (idle high, active low, with internal active pull-up enabled). See section 2.8 for functional description. See section 4.2.9 for detailed electrical specs.
17	VUSB_DET	USB	I	USB detect input	Input for VBUS (5 V typical) USB supply sense. USB interface supported for diagnostic purpose only. See section 2.5.2 for functional description. See section 4.2.10 for detailed electrical specs. Provide test point for diagnostic purposes.
18	RESET_N	GDI	I	External reset input	Internal active pull-up. Active low. See section 2.3.2 and 2.3.3 for functional description. See section 4.2.7 for detailed electrical specs. Provide test point for diagnostic purposes.
19	GPIO6	GDI	I/O	GPIO	Not supported.
20	GND	-	N/A	Ground	All the GND pins must be connected to ground.
21	ADC	ADC	I	ADC input	Not supported. This pin can be externally connected to GND.
22	GND	-	N/A	Ground	All the GND pins must be connected to ground.
23	GPIO2	GDI	I/O	GPIO	Not supported.
24	GPIO3	GDI	O	Event	Asynchronous Event Flag. Push-pull output type. See section 2.8 for functional description. See section 4.2.9 for detailed electrical specs.
25	GPIO4	GDI	I/O	GPIO	Not supported.
26	SDA	I2C	I/O	I2C bus data line	Not supported.
27	SCL	I2C	O	I2C bus clock line	Not supported.
28	USB_D-	USB	I/O	USB Data Line D-	90 Ω nominal differential impedance. Pull-up, pull-down and series resistors, as required by the USB 2.0 specifications [7], are part of the USB pin driver and shall not be provided externally. USB interface supported for diagnostic purpose only. See section 2.5.2 for functional description. See section 4.2.10 for detailed electrical specs. Provide test point for diagnostic purposes.

No.	Name	Power domain	I/O	Description	Remarks
29	USB_D+	USB	I/O	USB Data Line D+	90 Ω nominal differential impedance. Pull-up, pull-down and series resistors, as required by USB 2.0 specifications [7], are part of the USB pin driver and shall not be provided externally. USB interface supported for diagnostic purpose only. See section 2.5.2 for functional description. See section 4.2.10 for detailed electrical specs. Provide test point for diagnostic purposes.
30	GND	-	N/A	Ground	All the GND pins must be connected to ground.
31	ANT_GNSS	-	I	GNSS antenna	Not supported.
32	GND	-	N/A	Ground	All the GND pins must be connected to ground.
33	EXT_INT	GDI	I	External interrupt	Not supported.
34	I2S_WA	GDI	O	I2S word alignment	Not supported.
35	I2S_TXD	GDI	O	I2S transmit data	Not supported.
36	I2S_CLK	GDI	O	I2S clock	Not supported.
37	I2S_RXD	GDI	I	I2S receive data	Not supported.
38	SIM_CLK	SIM	O	SIM clock	See section 2.4.1 for functional description. See section 4.2.8 for detailed electrical specs.
39	SIM_IO	SIM	I/O	SIM data	See section 2.4.1 for functional description. See section 4.2.8 for detailed electrical specs.
40	SIM_RST	SIM	O	SIM reset	See section 2.4.1 for functional description. See section 4.2.8 for detailed electrical specs.
41	VSIM	-	O	SIM supply output	See section 2.4.1 for functional description. See section 4.2.8 for detailed electrical specs.
42	GPIO5	GDI	I/O	GPIO	Not supported.
43	GND	-	N/A	Ground	All the GND pins must be connected to ground.
44	SDIO_D2	GDI	I/O	SDIO serial data [2]	Not supported.
45	SDIO_CLK	GDI	O	SDIO serial clock	Not supported.
46	SDIO_CMD	GDI	I/O	SDIO command	Not supported.
47	SDIO_D0	GDI	I/O	SDIO serial data [0]	Not supported.
48	SDIO_D3	GDI	I/O	SDIO serial data [3]	Not supported.
49	SDIO_D1	GDI	I/O	SDIO serial data [1]	Not supported.
50	GND	-	N/A	Ground	All the GND pins must be connected to ground.
51	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. See section 2.1.1 for functional description. See section 4.2.3 for detailed electrical specs.
52	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. See section 2.1.1 for functional description. See section 4.2.3 for detailed electrical specs.
53	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. See section 2.1.1 for functional description. See section 4.2.3 for detailed electrical specs.
54	GND	-	N/A	Ground	All the GND pins must be connected to ground.
55	GND	-	N/A	Ground	All the GND pins must be connected to ground.
56	ANT	-	I/O	Cellular antenna	RF input/output for Cellular Rx/Tx antenna. 50 Ω nominal impedance. See section 2.2.1 and 4.2.5 for details.
57	GND	-	N/A	Ground	All the GND pins must be connected to ground.
58	GND	-	N/A	Ground	All the GND pins must be connected to ground.

No.	Name	Power domain	I/O	Description	Remarks
59	GND	-	N/A	Ground	All the GND pins must be connected to ground.
60	GND	-	N/A	Ground	All the GND pins must be connected to ground.
61	GND	-	N/A	Ground	All the GND pins must be connected to ground.
62	ANT_DET	ADC	I	Antenna detection	Not supported.
63	GND	-	N/A	Ground	All the GND pins must be connected to ground.
64	GND	-	N/A	Ground	All the GND pins must be connected to ground.
65-96	GND	-	N/A	Ground	All the GND pins must be connected to ground.

Table 4: SARA-R510AWS pin-out

☞ See appendix A for an explanation of the abbreviations and terms used.

4 Electrical specifications

⚠ Stressing the device above one or more of the ratings listed in the Absolute maximum rating section may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating Conditions sections (section 4.2) of the specification should be avoided. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

☞ Electrical characteristics are defined according to the verification on a representative number of samples or according to the simulation.

☞ Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum rating

☞ Limiting values given below are in accordance with Absolute Maximum Rating System (IEC 134).

Symbol	Description	Condition	Min.	Max.	Unit
VCC	Module supply voltage	Input DC voltage at VCC pins	-0.3	4.6	V
VUSB_DET	USB detection pin	Input DC voltage at VUSB_DET pin	-0.3	5.5	V
USB	USB D+/D- pins	Input DC voltage at USB interface pins	-0.3	3.6	V
GDI	Generic digital interfaces	Input DC voltage at Generic digital interfaces pins	-0.3	2.3	V
I2C	I2C interface	Input DC voltage at I2C interface pins	-0.3	2.3	V
SIM	SIM interface	Input DC voltage at SIM interface pins	-0.3	3.5	V
POS	Power-on input	Input DC voltage at PWR_ON pin	-0.3	4.6	V
ADC	ADC signal	Input DC voltage at ANT_DET and ADC pins	-0.3	2.3	V
P_RF	RF power	Input RF power at ANT pin		3	dBm
Rho_ANT	Antenna ruggedness	Output RF load mismatch ruggedness at ANT pins		10:1	VSWR
Tstg	Storage temperature		-40	+85	°C

Table 5: Absolute maximum ratings

⚠ The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the voltage specifications given in the table above, must be limited to values within the specified boundaries by using appropriate protection devices.

4.1.1 Maximum ESD

Parameter	Min	Max	Unit	Remarks
ESD sensitivity for all pins		1000	V	Human Body Model according to JS-001-2017
		500	V	Charged Device Model according to JS-002-2018

Table 6: Maximum ESD ratings

⚠ u-blox cellular modules are electrostatic sensitive devices and require special precautions when handling. See section 7.4 for ESD handling instructions.

4.2 Operating conditions

Unless otherwise indicated, all operating condition specifications are at an ambient temperature of +25 °C.

Operation beyond the operating conditions is not recommended and extended exposure beyond them may affect device reliability.

4.2.1 Operating temperature range

Parameter	Min.	Typical	Max.	Unit	Remarks
Normal operating temperature	-20	+25	+65	°C	Operating within 3GPP / ETSI specifications
Extended operating temperature	-40		+85	°C	Operating with possible slight deviation in RF performance outside normal operating range

Table 7: Environmental conditions

4.2.2 Thermal parameters

Symbol	Parameter	Min.	Typical	Max.	Unit	Remarks
Ψ_{M-A}	Module-to-Ambient thermal parameter		10		°C/W	Thermal characterization parameter $\Psi_{M-A} = (T_M - T_A) / P_H$ proportional to the delta between internal module temperature (T_M) and ambient temperature (T_A), due to heat power dissipation (P_H), with the module mounted on a 79 x 62 x 1.41 mm 4-Layer PCB with a high coverage of copper, in still air conditions
Ψ_{M-C}	Module-to-Case thermal parameter		2		°C/W	Thermal characterization parameter $\Psi_{M-C} = (T_M - T_C) / P_H$ proportional to the delta between internal module temperature (T_M) and ambient temperature (T_C), due to heat power dissipation (P_H), with the module mounted on a 79 x 62 x 1.41 mm 4-Layer PCB with a high coverage of copper, with a robust aluminum heat-sink and with forced air ventilation, i.e. reducing to a value close to 0 °C/W the thermal resistance from the case of the module to the ambient

Table 8: Thermal characterization parameters of the module

4.2.3 Supply/power pins

Symbol	Parameter	Min.	Typical	Max.	Unit
VCC	Module supply normal operating input voltage [2]	3.3	3.8	4.4	V
	Module supply extended operating input voltage [3]	3.0		4.5	V

Table 9: Input characteristics of the Supply/Power pins

Symbol	Parameter	Min.	Typical	Max.	Unit
VSIM	SIM supply output voltage with 1.8 V external SIM		1.8		V
	SIM supply output voltage with 3.0 V external SIM		3.0		V
V_INT	Generic Digital Interfaces supply output voltage		1.8		V
	Generic Digital Interfaces supply output current capability			70	mA

Table 10: Output characteristics of the Supply/Power pins

[2] Operating within 3GPP / ETSI specifications.
[3] Operating with possible slight deviation in RF performance outside normal operating range. The input voltage has to be above the extended operating range minimum limit to switch-on the module and to avoid possible switch-off of the module.
[4] Typical values with matched antenna, VCC = 3.8 V

4.2.4 Current consumption

Mode	Condition	Tx power	Min	Typical [4]	Max	Unit
Power-off/deep-sleep state (AT+SLEEP1)	Average current value	--		0.5		µA
Sleep state (AT+SLEEP)	Average current value (airplane mode)	--		0.7		mA
Active state (AT+DISCONNECT)	Average current value (no sleep enabled)	--		25		mA
LTE-M connected state	Average current value (Tx / Rx data transfer)	Minimum		95		mA
		0 dBm		100		mA
		8 dBm		115		mA
		14 dBm		140		mA
		20 dBm		170		mA
		Maximum		195		mA
	Maximum current value (during Tx only)	Maximum		395		mA

Table 11: VCC current consumption of SARA-R510AWS modules

☞ For further details on AWS IoT ExpressLink states, see the AWS IoT ExpressLink programmer's guide [1].

4.2.5 LTE RF characteristics

The LTE-M bands supported by SARA-R510AWS modules are defined in Table 2, while the following Table 12 describes the frequency ranges for each LTE band as per 3GPP TS 36.521-1 [5].

Parameter		Min.	Max.	Unit	Remarks
Frequency range FDD band 71 (600 MHz)	Uplink	663	698	MHz	Module transmits
	Downlink	617	652	MHz	Module receives
Frequency range FDD band 12 (700 MHz)	Uplink	699	716	MHz	Module transmits
	Downlink	729	746	MHz	Module receives
Frequency range FDD band 28 (700 MHz)	Uplink	703	748	MHz	Module transmits
	Downlink	758	803	MHz	Module receives
Frequency range FDD band 85 (700 MHz)	Uplink	698	716	MHz	Module transmits
	Downlink	728	746	MHz	Module receives
Frequency range FDD band 13 (750 MHz)	Uplink	777	787	MHz	Module transmits
	Downlink	746	756	MHz	Module receives
Frequency range FDD band 20 (800 MHz)	Uplink	832	862	MHz	Module transmits
	Downlink	791	821	MHz	Module receives
Frequency range FDD band 26 (850 MHz)	Uplink	814	849	MHz	Module transmits
	Downlink	859	894	MHz	Module receives
Frequency range FDD band 18 (850 MHz)	Uplink	815	830	MHz	Module transmits
	Downlink	860	875	MHz	Module receives
Frequency range FDD band 5 (850 MHz)	Uplink	824	849	MHz	Module transmits
	Downlink	869	894	MHz	Module receives

[4] Typical values with matched antenna, VCC = 3.8 V

Parameter		Min.	Max.	Unit	Remarks
Frequency range FDD band 19 (850 MHz)	Uplink	830	845	MHz	Module transmits
	Downlink	875	890	MHz	Module receives
Frequency range FDD band 8 (900 MHz)	Uplink	880	915	MHz	Module transmits
	Downlink	925	960	MHz	Module receives
Frequency range FDD band 4 (1700 MHz)	Uplink	1710	1755	MHz	Module transmits
	Downlink	2110	2155	MHz	Module receives
Frequency range FDD band 66 (1700 MHz)	Uplink	1710	1780	MHz	Module transmits
	Downlink	2110	2200	MHz	Module receives
Frequency range FDD band 3 (1800 MHz)	Uplink	1710	1785	MHz	Module transmits
	Downlink	1805	1880	MHz	Module receives
Frequency range FDD band 2 (1900 MHz)	Uplink	1850	1910	MHz	Module transmits
	Downlink	1930	1990	MHz	Module receives
Frequency range FDD band 25 (1900 MHz)	Uplink	1850	1915	MHz	Module transmits
	Downlink	1930	1995	MHz	Module receives
Frequency range FDD band 1 (2100 MHz)	Uplink	1920	1980	MHz	Module transmits
	Downlink	2110	2170	MHz	Module receives

Table 12: LTE operating RF frequency bands

SARA-R510AWS modules include a UE Power Class 3 LTE-M transmitter (see Table 2) and an LTE-M receiver, with output power and characteristics according to 3GPP TS 36.521-1 [5].

SARA-R510AWS modules LTE receiver characteristics are compliant to 3GPP TS 36.521-1 [5], with LTE conducted receiver sensitivity performance described in Table 13.

Parameter	Min.	Typical	Max.	Unit	Remarks
Receiver input sensitivity Band 71 (600 MHz)		–108.0		dBm	Without repetitions
Receiver input sensitivity Band 12 / 28 / 85 (700 MHz)		–108.0		dBm	Without repetitions
Receiver input sensitivity Band 13 (750 MHz)		–108.0		dBm	Without repetitions
Receiver input sensitivity Band 20 (800 MHz)		–108.0		dBm	Without repetitions
Receiver input sensitivity Band 5 / 18 / 19 / 26 (850 MHz)		–107.0		dBm	Without repetitions
Receiver input sensitivity Band 8 (900 MHz)		–107.0		dBm	Without repetitions
Receiver input sensitivity Band 3 (1800 MHz)		–107.0		dBm	Without repetitions
Receiver input sensitivity Band 2 / 25 (1900 MHz)		–107.0		dBm	Without repetitions
Receiver input sensitivity Band 1 / 4 / 66 (2100 MHz)		–107.0		dBm	Without repetitions

Condition: 50 Ω, throughput > 95%, QPSK modulation, other settings as per clause 7.3EA of 3GPP TS 36.521-1 [5]

Table 13: LTE-M receiver sensitivity performance

4.2.6 PWR_ON pin

Parameter	Min.	Typical	Max.	Unit	Remarks
Low-level input	-0.3		0.3	V	
Pull-up resistance		10		kΩ	Integrated pull-up to internal rail
Low-level input current		-300		µA	
PWR_ON low time	1		2	s	Low time to trigger module switch-on from power-off/deep-sleep state

Table 14: PWR_ON pin characteristics

The **PWR_ON** and **RESET_N** input lines have to be driven as described in Figure 3 to perform an abrupt emergency hardware shutdown of the SARA-R510AWS modules:

- First, set **PWR_ON** line to the LOW level
- Then, while keeping the **PWR_ON** line at the LOW level, set **RESET_N** line to the LOW level
- Then, after at least 23 s since the **PWR_ON** line has been set to the LOW level, the **PWR_ON** line has to be released to the HIGH level, keeping the **RESET_N** line set to the LOW level
- Then, after at least 1.5 s since the **PWR_ON** line has been released to the HIGH level, the **RESET_N** line has to be released to the HIGH level

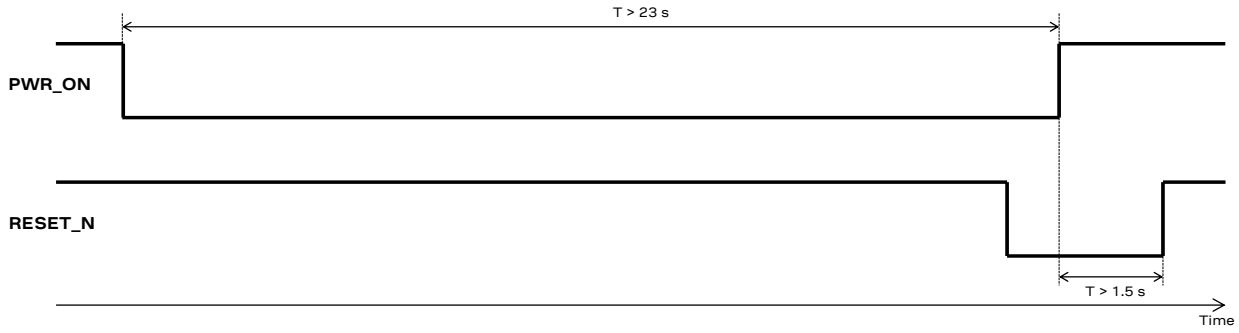

Figure 3: PWR_ON and RESET_N lines waveforms timings to perform an abrupt emergency hardware shutdown

4.2.7 RESET_N pin

Parameter	Min.	Typical	Max.	Unit	Remarks
Internal supply		1.8			Digital I/O Interfaces supply (V_INT)
Low-level input	-0.3		0.5	V	
Low-level input current	-18	-32	-56	µA	
RESET_N low time	100			ms	Low time to trigger module reset / reboot

Table 15: RESET_N pin characteristics

4.2.8 SIM pins

The SIM pins are a dedicated interface to the external SIM card/chip. The electrical characteristics fulfill the regulatory specification requirements. The values in Table 16 are for information only.

Parameter	Min.	Typical	Max.	Unit	Remarks
Internal supply domain for SIM interface		1.8		V	VSIM, with external 1.8 V SIM type
		3.0		V	VSIM, with external 3.0 V SIM type
Low-level input	-0.3		0.2*VSIM	V	
High-level input	0.6*VSIM		VSIM+0.3	V	
Low-level output		0.0		V	
High-level output		VSIM		V	
Internal pull-up resistor on SIM_IO		4.7		kΩ	Internal pull-up to VSIM supply
Clock frequency on SIM_CLK		3.13		MHz	

Table 16: SIM pin characteristics

4.2.9 Generic Digital Interfaces pins

Parameter	Min	Typical	Max	Unit	Remarks
Internal supply for GDI domain		1.8		V	Digital I/O Interfaces supply (V_INT)
Low-level input	-0.3		0.5	V	
High-level input	1.3		2.1	V	
Low-level output		0.0	0.4	V	
High-level output	1.4	1.8		V	
Input leakage current			1	µA	0 V < V_{IN} < 1.8 V
Output high driver strength	3.28	5.22	7.92	mA	V_{OUT} = 1.4
Output low driver strength	3.02	5.41	8.63	mA	V_{OUT} = 0.4
Pull-up input current	-18	-32	-56	µA	
Pull-down input current	15	30	56	µA	

Table 17: GDI pin characteristics

4.2.10 USB pins

USB data lines (**USB_D+** / **USB_D–**) are compliant with the USB 2.0 high-speed specification. See the USB 2.0 specification [7] for detailed electrical characteristics. The values in Table 18 related to USB 2.0 high-speed physical layer specifications are for information only.

Parameter	Min.	Typical	Max.	Unit	Remarks
VUSB_DET pin, High-level input	4.40	5.00	5.25	V	
High-speed squelch detection threshold (input differential signal amplitude)	100		150	mV	
High speed disconnect detection threshold (input differential signal amplitude)	525		625	mV	
High-speed data signaling input common mode voltage range	–50		500	mV	
High-speed idle output level	–10		10	mV	
High-speed data signaling output high level	360		440	mV	
High-speed data signaling output low level	–10		10	mV	
Chirp J level (output differential voltage)	700		1100	mV	
Chirp K level (output differential voltage)	–900		–500	mV	

Table 18: USB pins characteristics

4.3 Parameters for ATEX applications

This section provides useful parameters and information to integrate SARA-R510AWS modules in applications intended to be used in areas with potentially explosive atmospheres (ATEX), including:

- Total internal capacitance and inductance of the modules (see Table 19)
- Maximum RF output power at the antenna (**ANT**) pin of the modules (see Table 20)

☞ For any device integrating the SARA-R510AWS modules and intended to be used in potentially explosive atmospheres, check the detailed requisites on the pertinent normative for the application, for example the IEC 60079-0 [9], IEC 60079-11 [10], and IEC 60079-26 [11] standards. The requirements must be fulfilled according to the exact applicable standards.

☞ The certification of the application device that integrates a SARA-R510AWS module and the compliance of the application device with all the applicable certification schemes, directives and standards required for use in potentially explosive atmospheres are the sole responsibility of the application device manufacturer.

Table 19 describes the maximum total internal capacitance and the maximum total internal inductance, considering internal parts tolerance, of the SARA-R510AWS modules.

Parameter	Description	Value	Unit
Ci	Maximum total internal capacitance	379	µF
Li	Maximum total internal inductance	10.7	µH

Table 19: SARA-R510AWS maximum total internal capacitance and maximum total internal inductance

Table 20 describes the maximum RF output power transmitted by SARA-R510AWS modules from the antenna (**ANT**) pin as Power Class 3 User Equipment for the LTE bands.

Module	Parameter	Description	Value	Unit
All	ANT Pout	Maximum RF output power from ANT pin	25.00	dBm

Table 20: SARA-R510AWS maximum RF output power

☞ SARA-R510AWS modules do not contain internal blocks that increase the input voltage (such as step-up, duplicators, or boosters) except for the antenna (**ANT**) pin, for which the maximum RF output power shown in Table 20.

5 Mechanical specifications

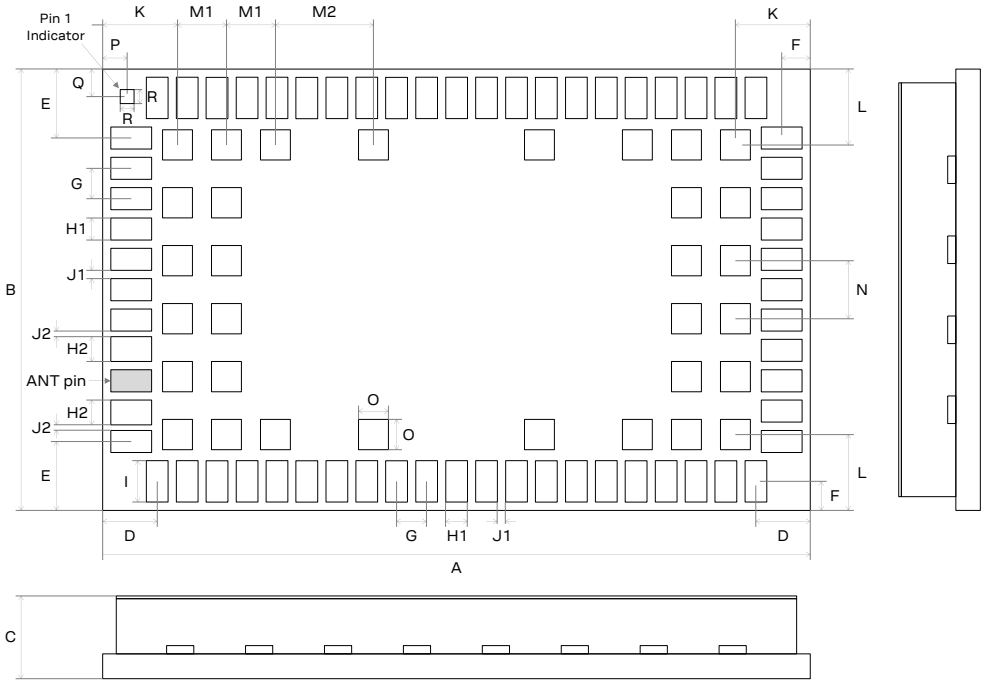

Figure 4: SARA-R510AWS dimensions (bottom and side views)

Parameter	Description	Typical		Tolerance	
A	Module height [mm]	26.0	(1023.6 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
B	Module width [mm]	16.0	(629.9 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
C	Module thickness [mm]	2.2	(86.6 mil)	+0.25/-0.15	(+9.8/-5.9 mil)
D	Horizontal edge to lateral pin pitch [mm]	2.0	(78.7 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
E	Vertical edge to lateral pin pitch [mm]	2.5	(98.4 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
F	Edge to lateral pin pitch [mm]	1.05	(41.3 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
G	Lateral pin to pin pitch [mm]	1.1	(43.3 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
H1	Lateral pin height [mm]	0.8	(31.5 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
H2	Lateral pin close to ANT height [mm]	0.9	(35.4 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
I	Lateral pin width [mm]	1.5	(59.1 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
J1	Lateral pin to pin distance [mm]	0.3	(11.8 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
J2	Lateral pin to pin close to ANT distance [mm]	0.2	(7.9 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
K	Horizontal edge to central pin pitch [mm]	2.75	(108.3 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
L	Vertical edge to central pin pitch [mm]	2.75	(108.3 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
M1	Central pin to pin horizontal pitch [mm]	1.8	(70.9 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
M2	Central pin to pin horizontal pitch [mm]	3.6	(141.7 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
N	Central pin to pin vertical pitch [mm]	2.1	(82.7 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
O	Central pin height and width [mm]	1.1	(43.3 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
P	Horizontal edge to pin 1 indicator pitch [mm]	0.9	(35.4 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
Q	Vertical edge to pin 1 indicator pitch [mm]	1.0	(39.4 mil)	+0.20/-0.20	(+7.9/-7.9 mil)
R	Pin 1 indicator height and width [mm]	0.5	(19.7 mil)	+0.05/-0.05	(+2.0/-2.0 mil)
Weight	Module weight [g]	< 3			

Table 21 : SARA-R510AWS dimensions

☞ Module height tolerance +/–0.20 mm may be exceeded close to the corners of the PCB due to the cutting process: in the worst cases, the height could be +0.40 mm longer than the typical value.

☞ For information regarding Footprint and Paste Mask recommended for the application board integrating the cellular module, see the SARA-R5 series system integration manual [2].

6 Qualification and approvals

6.1 Reliability tests

Reliability tests for SARA-R510AWS modules are executed according to u-blox qualification policy, based on AEC-Q104 standard.

6.2 Approvals

SARA-R510AWS modules comply with the Directive 2011/65/EU of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

SARA-R510AWS modules are RoHS 3 compliant.

No natural rubbers, hygroscopic materials, or materials containing asbestos are employed.

Table 22 summarizes the main approvals for SARA-R510AWS modules.

Certification	SARA-R510AWS
PTCRB	•
CE Europe	•
UKCA Great Britain	•
FCC United States FCC ID	• XPYUBX19KM01
ISED Canada ISED certification number	• 8595A-UBX19KM01
GITEKI Japan [R] Certificate Number [T] Certificate Number	• 003-230059 D230029003
AT&T with FirstNet	•
Verizon	•

Table 22: SARA-R510AWS main certification approvals summary

For the complete list of approvals and for specific details on all country, conformance and network operators' certifications available for the SARA-R510AWS modules, including related certificates of compliancy, please contact your nearest u-blox office or sales representative. Some of the certification approvals listed in Table 22 might not be currently available.

7 Product handling & soldering

7.1 Packaging

SARA-R510AWS modules are delivered as hermetically sealed, reeled tapes to enable efficient production, production lot set-up and tear-down. For more information about packaging, see the u-blox package information user guide [4].

7.1.1 Reels

SARA-R510AWS modules are deliverable in quantities of 250 pieces on a reel. The modules are delivered using reel type B2 described in the u-blox package information user guide [4].

Quantities of less than 250 pieces are also available. Contact u-blox for more information.

7.1.2 Tapes

Figure 5 shows the position and the orientation of SARA-R510AWS modules as they are delivered on the tape, while Figure 6 and Table 23 specify the dimensions of the tape.

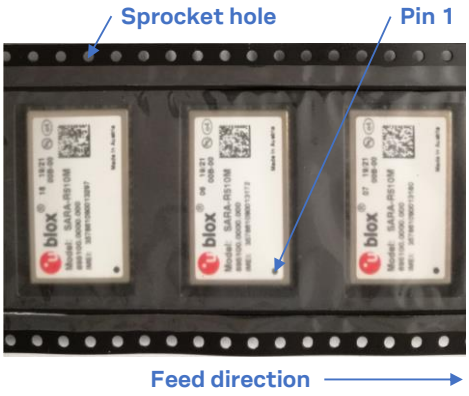

Figure 5: Orientation of SARA-R510AWS modules on tape

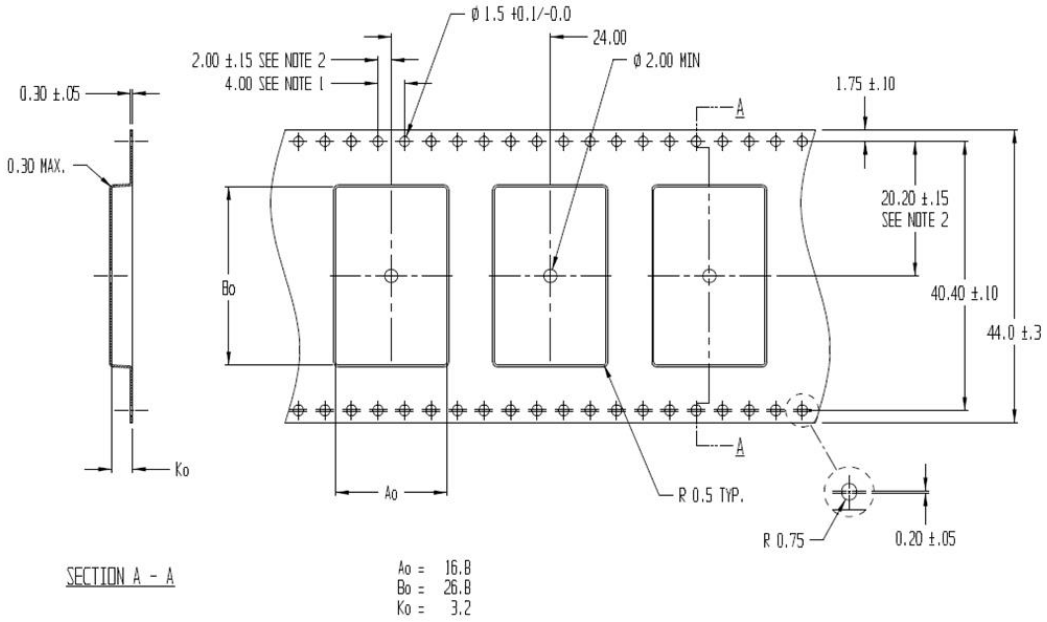

Figure 6: SARA-R510AWS modules tape

Parameter	Typical value	Tolerance	Unit
A_0	16.8	0.2	mm
B_0	26.8	0.2	mm
K_0	3.2	0.2	mm

Table 23 : SARA-R510AWS tape dimensions (mm)

☞ 10 sprocket hole pitch cumulative tolerance ± 0.2 mm.

☞ Pocket position relative to sprocket hole is measured as true position of pocket, not pocket hole.

☞ A_0 and B_0 are calculated on a plane at a distance “R” above the bottom of the pocket.

7.2 Moisture sensitivity levels

⚠ SARA-R510AWS modules are moisture sensitive devices (MSD) in accordance with the IPC/JEDEC specification.

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. SARA-R510AWS modules are rated at MSL level 4. For more information regarding moisture sensitivity levels, labeling, storage and drying, see the u-blox package information user guide [4].

☞ For the MSL standard, see IPC/JEDEC J-STD-020 (can be downloaded from www.jedec.org).

7.3 Reflow soldering

Reflow profiles are to be selected according to u-blox recommendations (see the SARA-R510AWS series system integration manual [2]).

⚠ Failure to observe these recommendations can result in severe damage to the device!

7.4 ESD precautions

⚠ SARA-R510AWS modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling SARA-R510AWS modules without proper ESD protection may destroy or damage them permanently.

SARA-R510AWS modules are Electrostatic Sensitive Devices (EDS) and require special ESD precautions typically applied to ESD sensitive components.

Table 6 details the maximum ESD ratings of the SARA-R510AWS modules.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates SARA-R510AWS modules.

ESD precautions should be appropriately implemented on the application board where the module is mounted, as described in the SARA-R5 series system integration manual [2].

⚠ Failure to observe these precautions can result in severe damage to the device!

8 Labeling and ordering information

8.1 Product labeling

The labels of SARA-R510AWS modules include important product information as described in this section. Figure 7 provides an illustrative example of SARA-R510AWS modules' label, which includes: the u-blox logo, production lot, Pb-free marking, product type number, IMEI number, certification information, and production country.

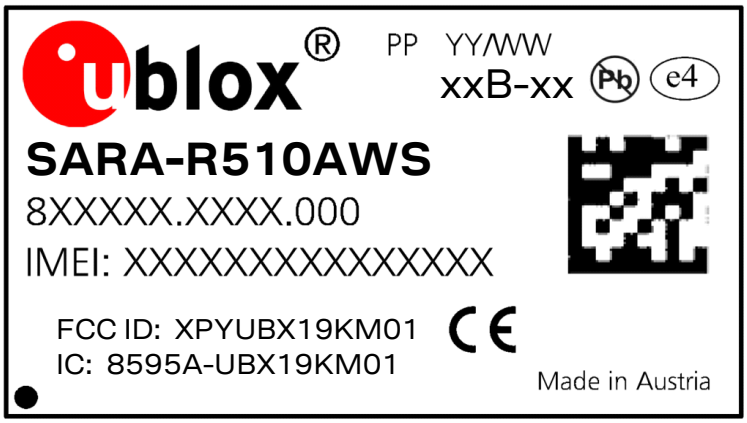

Figure 7: Illustrative example of SARA-R510AWS modules' label

8.2 Explanation of codes

Three different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all the u-blox products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and firmware versions. Table 24 details these 3 different formats:

Format	Structure
Product Name	PPPP-TGVVFFF
Ordering Code	PPPP-TGVVFFF-MMQ
Type Number	PPPP-TGVVFFF-MMQ-XX

Table 24: Product code formats

Table 25 explains the parts of the product code.

Code	Meaning	Example
PPPP	Form factor	SARA
TG	Platform (Technology and Generation) • Dominant technology: G = GSM, U = UMTS, C = CDMA, N = NB-IoT (LTE Cat NB1/NB2), R = LTE low data rate (Cat M1, Cat 1, Cat 1bis), L = LTE high data rate (Cat 3 and above) • Generation: 1…9	R5
VV	Variant function set based on the same platform: 00…99	10
FFF	Additional features: AWS = Amazon Web Services, …	AWS
MM	Major product version: 00…99	01
Q	Product grade: C = standard, B = professional, A = automotive	B
XX	Minor product version: 00…99	Default value is 00

Table 25: Part identification code

8.3 Ordering information

Ordering No.	Product
SARA-R510AWS-01B	Secure LTE-M AWS IoT ExpressLink module for multi-regional use. Designed for extremely low current consumption in power-off/deep-sleep state. 26.0 x 16.0 mm, 250 pieces/reel

Table 26: Product ordering codes

Appendix

A Glossary

Abbreviation	Definition
3GPP	3rd Generation Partnership Project
ACMA	Australian Communications and Media Authority
ADC	Analog to Digital Converter
AEC	Automotive Electronics Council
AT	AT Command Interpreter Software Subsystem, or attention
AWS	Amazon Web Services
BB	Baseband
BeiDou	Chinese satellite navigation system
Cat	Category
CBS	Cell Broadcast Service
CE	Coverage Enhancement
CE	European Conformity
CEP	Circular Error Probable
CLK	Clock
CIoT	Cellular Internet of Things
CMOS	Complementary Metal-Oxide-Semiconductor
CoAP	Constrained Application Protocol
CS	Chip Select
CTS	Clear To Send
DC	Direct Current
DCD	Data Carrier Detect
DDC	Display Data Channel
DL	Down Link (Reception)
DRX	Discontinuous Reception
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTLS	Datagram Transport Layer Security
DTR	Data Terminal Ready
DUN	Dial-Up Networking
E-CID	Enhanced Cell Identity
eDRX	Extended Discontinuous Reception
EPS	Evolved Packet System
ESD	Electrostatic Discharge
E-UTRA	Evolved Universal Terrestrial Radio Access
FCC	Federal Communications Commission (United States)
FDD	Frequency Division Duplex
FOAT	Firmware (update) Over AT commands
FOTA	Firmware (update) Over-The-Air
FTP	File Transfer Protocol
FW	Firmware

Abbreviation	Definition
Galileo	European satellite navigation system
GCF	Global Certification Forum
GDI	Generic Digital Interface
GITEKI	Gijutsu kijun tekigō shōmei - Technical standard conformity certification (Japan)
GLONASS	Russian satellite navigation system
GND	Ground
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input/Output
GPS	Global Positioning System
HARQ	Hybrid Automatic Repeat Request
HDLC	High-level Data Link Control
HTTP	HyperText Transfer Protocol
HW	Hardware
IEC	International Electrotechnical Commission
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
I/O	Input/Output
IMEI	International Mobile Equipment Identity
IP	Internet Protocol
ISED	Innovation, Science and Economic Development (Canada)
ISO	International Organization for Standardization
ITU	International Telecommunications Union
LGA	Land Grid Array
LNA	Low Noise Amplifier
LPWA	Low Power Wide Area
LTE	Long-Term Evolution
LTE-M	Long-Term Evolution – enhanced Machine Type Communication
LwM2M	Lightweight Machine-to-Machine protocol
M2M	Machine to Machine
MQTT	Message Queuing Telemetry Transport
MQTT-SN	Message Queuing Telemetry Transport for Sensor Networks
MSD	Moisture Sensitive Device
MSL	Moisture Sensitivity Level
MUX	Multiplexer
N/A	Not Applicable
NB-IoT	Narrowband Internet of Things
NCC	National Communications Commission (Taiwan)
PA	Power Amplifier
PCB	Printed Circuit Board
PCN	Product Change Notification / Sample Delivery Note / Information Note
PMU	Power Management Unit
POS	Power On Signal
PPS	Pulse Per Second
PSM	Power Saving Mode
PTCRB	PCS Type Certification Review Board
PUCCH	Physical Uplink Control Channel

Abbreviation	Definition
QPSK	Quadrature Phase Shift Keying modulation
QZSS	Quasi-Zenith Satellite System
RACH	Random Access Channel
RAM	Random Access Memory
RAT	Radio Access Technology
RF	Radio Frequency
RI	Ring Indicator
RIL	Radio Interface Layer
RRC	Radio Resource Control
RTC	Real Time Clock
RTS	Request To Send
Rx	Reception
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SCL	Serial Clock
SDA	Serial Data
SDIO	Secure Digital Input Output
SIM	Subscriber Identity Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
SSL	Secure Socket Layer
TBS	Transport Block Size
TCP	Transmission Control Protocol
TCXO	Temperature-Controlled Crystal Oscillator
TDD	Time Division Duplex
TLS	Transport Layer Security
TS	Technical Specification
Tx	Transmission
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
uCSP	u-blox Common Services Platform
UDP	User Datagram Protocol
UE	User Equipment
uFOTA	u-blox Firmware update Over-The-Air
UL	Uplink (Transmission)
URC	Unsolicited Result Code
USB	Universal Serial Bus
VoLTE	Voice over LTE
VSWR	Voltage Standing Wave Ratio
WA	Word Alignment

Related documentation

[1] AWS IoT ExpressLink programmer's guide, https://docs.aws.amazon.com/iot-expresslink/
[2] u-blox SARA-R5 series system integration manual, UBX-19041356
[3] u-blox SARA-R510AWS application development guide, UBX-22017004
[4] u-blox package information user guide, UBX-14001652
[5] 3GPP TS 36.521-1 - Evolved Universal Terrestrial Radio Access; User Equipment conformance specification; Radio transmission and reception; Part 1: Conformance Testing
[6] ITU-T Recommendation V24 - List of definitions for interchange circuits between Data Terminal Equipment (DTE) and Data Connection Equipment (DCE)
[7] Universal Serial Bus Revision 2.0 specification, https://www.usb.org/
[8] I2C-bus specification and user manual - UM10204, https://www.nxp.com/
[9] IEC 60079-0 - Explosive atmospheres, part 0: equipment general requirements
[10] IEC 60079-11 - Explosive atmospheres, part 11: equipment protection by intrinsic safety 'i'
[11] IEC 60079-26 - Explosive atmospheres, part 26: equipment with EPL Ga

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Revision history

Revision	Date	Name	Comments
R01	12-Jul-2022	fvid	Initial release
R02	16-Nov-2022	fvid	Updated SARA-R510AWS-01B product status
R03	06-Apr-2023	yatu	Updated SARA-R510AWS-01B product status

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