SARA-R52 series

LTE-M / NB-IoT modules based on UBX-R52 chipset

Data sheet

Abstract

Technical data sheet describing the SARA-R52 series LTE-M / NB-IoT modules, based on the latest u-blox UBX-R52 cellular chipset. The modules are a size-optimized solution specifically designed for IoT, integrating an in-house developed cellular modem and A-GPS technology, as well as the u-blox's leading M10 GNSS technology. The modules deliver high performance satellite positioning alongside data connectivity in the very small and compact SARA form factor.

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This document applies to the following products:

Product name	Type number	Firmware version	Notification reference	Product status
SARA-R520	SARA-R520-02B-00	Modem: 05.10 Application: A00.01	UBXDOC-686885345-2040	Initial production
SARA-R520M10	SARA-R520M10-02B-00	Modem: 05.10 Application: A00.01	UBXDOC-686885345-2040	Initial production

Contents

1 Functional description

1.1 Overview

SARA-R52 series includes the following modules based on the latest u-blox UBX-R52 cellular chipset, power-optimized for extremely low consumption in PSM / eDRX deep-sleep:

- SARA-R520, LTE Cat M1 / NB2 product designed for multi-regional deployments, integrating the u-blox SpotNow Assisted-GPS receiver technology with separate GPS antenna interface
- SARA-R520M10, LTE Cat M1 / NB2 product designed for multi-regional deployments, integrating the high-performance u-blox M10 standard precision concurrent GNSS receiver chip for global position acquisition using dedicated GNSS antenna interface

The miniature SARA LGA form factor (26.0 x 16.0 mm, 96-pin) allows easy integration into compact designs, form-factor compatibility with LISA, LARA, LENA and TOBY cellular modules, and pin-to-pin compatibility with other SARA cellular modules. This facilitates migration from other u-blox cellular modules, maximizing customer investments, simplifying logistics, enabling short time-to-market.

The modules offer multi-band configurability enabling multi-regional coverage, a comprehensive set of 3GPP Rel. 14 features that are relevant for IoT applications, data communications up to 1200 kbit/s coverage enhancement for deeper range into buildings and basements (and underground with NB2), over an extended operating temperature range of –40 °C to +85 °C.

By bringing all the technology building blocks in house and having full hardware and software ownership, on SARA-R52 series u-blox can guarantee long-term device availability and provide lifetime support of the entire platform, down to the chipset level.

With many interface options and an integrated IP stack, SARA-R52 series modules are the optimal choice for LPWA applications with low to medium data throughput rates, as well as devices that require long battery lifetimes, such as used in smart metering, smart lighting, telematics, asset tracking, remote monitoring, alarm panels, and connected healthcare.

Customers can future-proof their solutions by over-the-air firmware updates, thanks to the uFOTA client/server solution that utilizes LwM2M, a light and compact protocol ideal for IoT.

Model	Region	RAT		GNSS				u-blox Services					External Interfaces					Features															Grade		
		LTE category	LTE FDD bands	Integrated u-blox M10 GNSS receiver	Integrated u-blox SpotNow A-GPS receiver	Dedicated GNSS antenna interface	External GNSS control via modem	MQTT Anywhere	MQTT Flex	AssistNow™	CellLocate®	CloudLocate	UARTs	USB (for diagnostics)	I2C	USIM	GPIOs	u-blox open CPU solution (uCPU)	Secure boot, updates	Antenna dynamic tuning	Ultra-low consumption in PSM / eDRX	u-blox Smart Connection Manager (uSCM)	Embedded TCP/UDP	Embedded HTTP, FTP	Embedded TLS, DTLS	Embedded MQTT, MQTT-SN	Embedded COAP	FW update via serial (FOAT)	u-blox FW update Over the Air (uFOTA)	Last gasp	Jamming detection	Antenna and SIM detection	CellTime	Standard	Professional	Automotive
SARA-R520	Multi Region	M1 NB2	*		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	
SARA-R520M10	Multi Region	M1 NB2	*	•		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	

* = LTE Bands 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, 71, 85

Table 1: SARA-R52 series main features summary

1.2 Block diagram

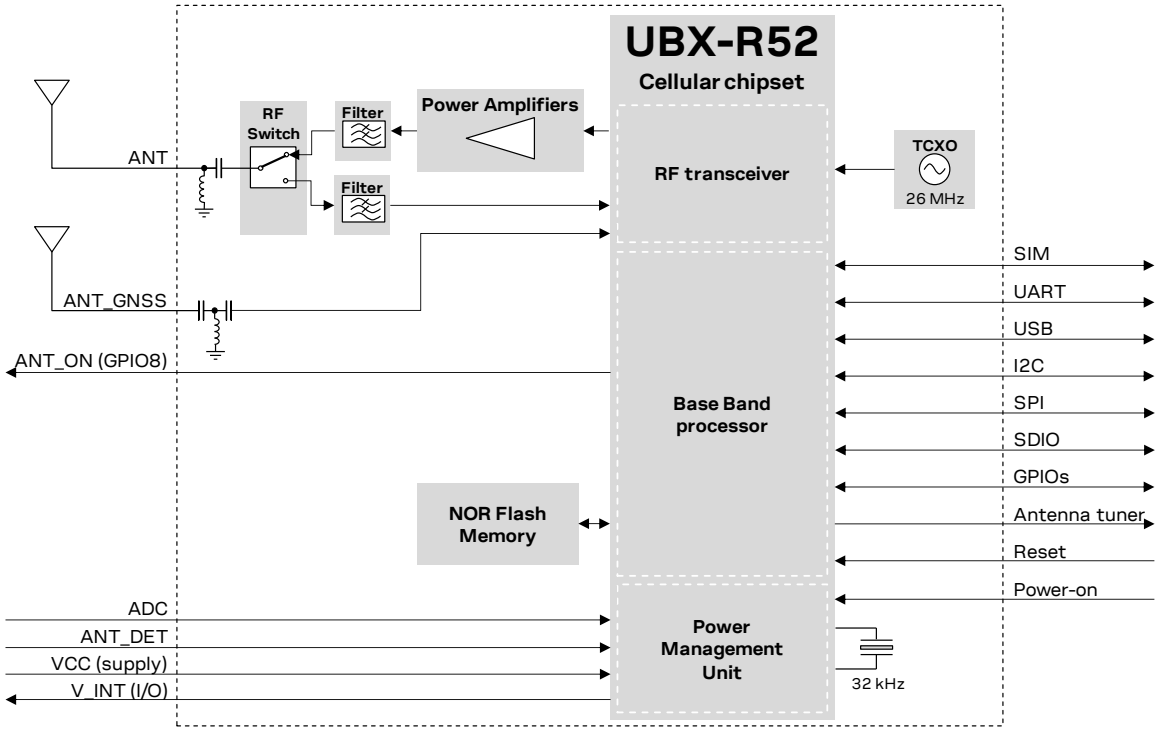

Figure 1: SARA-R520 simplified block diagram

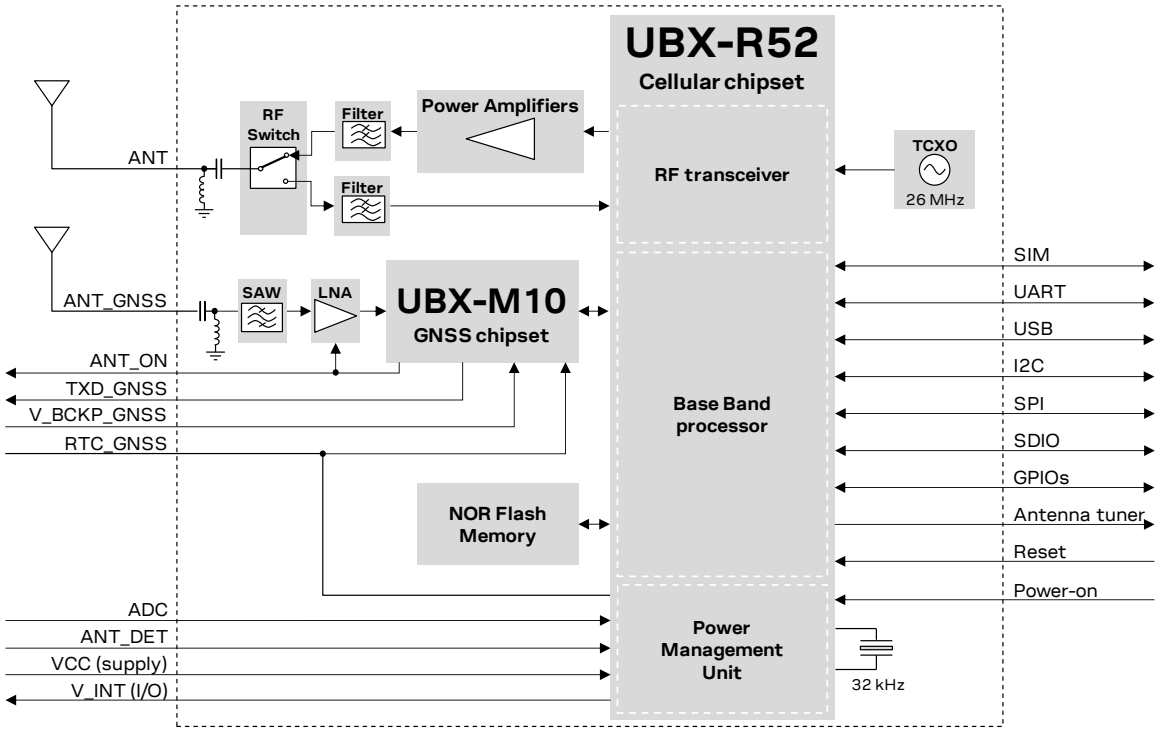

Figure 2: SARA-R520M10 simplified block diagram

☞ The current product versions of the SARA-R52 series modules do not support SPI interface except with uCPU or for diagnostic purposes, and do not support SDIO interface except for diagnostic purposes. Related SPI / SDIO pins must be left unconnected and must not be driven by external devices accordingly.

1.3 Product description

Item	SARA-R520	SARA-R520M10
Cellular protocol stack	3GPP Rel.13 LTE Cat M1 and NB1 3GPP Rel.14 LTE Cat M1: Coverage Enhancement Mode B, Uplink TBS of 2984b 3GPP Rel.14 LTE Cat NB2: Higher data rate (TBS of 2536b), Mobility enhancement (RRC connection re-establishment), E-Cell ID, two HARQ processes, Release Assistant, Random access on Non-Anchor Carrier	3GPP Release 13 LTE Cat M1 and NB1 3GPP Release 14 LTE Cat M1: Coverage Enhancement Mode B, Uplink TBS of 2984b 3GPP Release 14 LTE Cat NB2: Higher data rate (TBS of 2536b), Mobility enhancement (RRC connection re-establishment), E-Cell ID, two HARQ processes, Release Assistant, Random access on Non-Anchor Carrier
Cellular RAT	LTE Cat M1 Half-Duplex LTE Cat NB2 Half-Duplex	LTE Cat M1 Half-Duplex LTE Cat NB2 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)	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)	LTE power class 3 (23 dBm)
Cellular data rate	LTE category M1: up to 1200 kbit/s UL, up to 588 kbit/s DL LTE category NB2: up to 140 kbit/s UL, up to 125 kbit/s DL	LTE category M1: up to 1200 kbit/s UL, up to 588 kbit/s DL LTE category NB2: up to 140 kbit/s UL, up to 125 kbit/s DL
Positioning receiver type	u-blox SpotNow A-GPS receiver	u-blox M10050 SPG 5.10 receiver supporting concurrent reception of four GNSS systems GPS / QZSS L1C/A, Galileo E1-B/C, GLONASS L1OF, BeiDou B1I, BeiDou B1C, SBAS (EGNOS, GAGAN, MSAS and WAAS), QZSS L1S (SLAS)

Table 2: SARA-R52 series cellular and GNSS main characteristics

1.4 AT command support

The SARA-R52 series modules support AT commands according to 3GPP standards TS 27.007 [4], TS 27.005 [5], TS 27.010 [6], and the u-blox AT commands extension.

☞ For the full list of supported AT commands and their syntax, see the AT commands manual [1].

1.5 Supported features

Table 3 lists the main features supported by SARA-R52 series modules. For more details, see the SARA-R52 series system integration manual [2] and the AT commands manual [1].

Feature	Description
Integrated GNSS receiver[1]	SARA-R520M10 modules are pre-integrated with a u-blox UBX-M10050 concurrent GNSS chipset with SPG 5.10 firmware version, comprehensive of a dedicated GNSS antenna interface, additional LNA and SAW filter for a highly reliable, accurate positioning data. The GNSS system is independent from the LTE system and can run concurrently to an LTE communication.
Integrated SpotNow A-GPS receiver[2]	Integrated u-blox SpotNow feature, a SW implementation of an Assisted GPS receiver (A-GPS) running directly on the u-blox UBX-R52 chipset, removing the need of a dedicated GNSS receiver. With the unique SpotNow feature, cellular and GPS use two dedicated antennas. Inside the module, the radio resources are switched between the two inputs depending on the corresponding operation. SpotNow feature is mainly intended for sporadic tracking use cases and can be used when the cellular modem is offline or registered to a cell. SpotNow feature relies on assistance data that is automatically downloaded every few hours. Cellular and SpotNow may work together, with the GPS signals being tracked during the cellular paging cycles. This avoids any conflicts or possible interruptions of the cellular operations, bringing service continuity.
External GNSS control via modem[2]	Access to external u-blox GNSS positioning chips and modules through I2C interface. This means that any external host processor can control the SARA-R520 cellular module and the u-blox GNSS chip / module through a single serial port.
Embedded AssistNow Software	Embedded AssistNow Online and AssistNow Offline clients are available to provide better GNSS performance and faster TTFF(time to first fix). An AT command can enable / disable the clients.
CellLocate®	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 a set of AT commands for CellLocate® service configuration and position request.
Hybrid Positioning	Provides the module's current position using a u-blox positioning chip or module (external for SARA-R520, integrated UBX-M10 chip for SARA-R520M10) or the integrated A-GPS receiver (for SARA-R520) or the estimated position from CellLocate®, depending on which positioning method provides the best and fastest solution according to the user configuration. Hybrid positioning is implemented through a set of AT commands that allow the configuration and the position request.
Open CPU (uCPU)	Capability to run customer application code directly on SARA-R5 modules. The functionality is available upon request.
CellTime	Returns accurate timing retrieved from the LTE network and/or from the u-blox positioning chip or module (external for the SARA-R520 cellular modules, integrated UBX-M10 chip for the SARA-R520M10 modules). Can be used to provide periodic timestamps to an external application processor or to output a time indication associated to an interrupt detected on a GPIO (e.g. coming from an external sensor connected to the module). The implementation of CellTime can be extended to control and maintain timing info in a network of sensors, each one integrating a SARA-R5 module.
u-blox Smart Connection Manager (uSCM)	The u-blox Smart Connection Manager (uSCM) is an application running on the module that may be enabled to let the module automatically handle the connection with the network, setting up the link and reestablishing it if dropped according to some predefined and user-customizable profiles which set the module basic modes of operation. The uSCM feature massively reduces the complexity of the application code controlling the module, saving developers time, reducing time to market, and optimizing module behavior in typical operating modes.
Antenna dynamic tuning	Real-time control of an external antenna matching IC via two dedicated pins of the module according to the LTE band used by the module.

[1] Not supported by SARA-R520 modules
[2] Not supported by SARA-R520M10 modules

Feature	Description
Embedded TCP and UDP stack	Embedded TCP/IP and UDP/IP stack including direct link mode for TCP and UDP sockets. Sockets can be set in Direct Link mode to establish a transparent end-to-end communication with an already connected TCP or UDP socket via the serial interface.
HTTP, HTTPS (v1.0 for +UHTTP, v1.1 for LwM2M client)	Hyper-Text Transfer Protocol as well as Secure Hyper-Text Transfer Protocol (SSL encryption) functionalities are supported via AT commands.
FTP, FTPS	File Transfer Protocol and Secure File Transfer Protocol (SSL encryption of FTP control channel) functionalities are supported by AT commands.
CoAP (RFC 7252) [11]	Embedded Constrained Application Protocol (CoAP) datagram-based client/server application protocol designed to easily translate from HTTP for simplified integration with the web.
MQTT (v3.1.1) and MQTT-SN (v1.2)	Embedded Message Queuing Telemetry Transport (MQTT) and MQTT for Sensor Networks (MQTT-SN) publish-subscribe messaging protocols designed for lightweight M2M communications over TCP (MQTT) or over UDP (MQTT-SN). These allow one-to-one, one-to-many and many-to-one communications over a TCP or UDP connection.
LwM2M (v1.0)	The LwM2M is a light and compact communication protocol designed for managing IoT machine-to-machine communication between a LwM2M Server and a LwM2M Client located in lightweight, low power or resource-constrained LwM2M devices, with object data model.
TLS (v1.0, v1.1, v1.2, v1.3) and DTLS (v1.2)	Transport Layer Security (TLS) provides security for HTTP, FTP, MQTT and TCP communications. Embedded Datagram Transport Layer Security (DTLS) provides security for CoAP, LwM2M, MQTT-SN and UDP communications.
Device security	Hardware-based security functions of the chipset are used to provide • Secure boot: guarantees software authenticity and integrity • Secure update: supervises the secure delivery of the correct FW to the module
MQTT Anywhere, MQTT Flex	With u-blox's communication services – MQTT Anywhere or MQTT Flex – data overhead, time spent on-the-air, and energy consumption can be reduced, thus enabling users to extend device life cycles, lower costs, and improve ROI.
Jamming detection	Detects "artificial" interference that obscures the operator's carrier entitled to give access to the radio service and automatically reports the start and stop of such conditions to the application processor that can react accordingly.
Smart temperature supervisor	Constant monitoring of the module board temperature: • Warning notification when the temperature approaches an upper or lower predefined threshold (see section 4.2.19) • Shutdown notified and forced when the temperature value is outside the specified range (shutdown suspended in case of an emergency call in progress) The smart temperature supervisor feature can be enabled or disabled through an AT command (see the AT commands manual [1], +USTS AT command).
Last gasp	In case of power supply outage (i.e. main supply interruption, battery removal, battery voltage below a certain threshold) the cellular module can be configured through the +ULGASP AT command to send an alarm notification to a remote entity.
Network status indication	GPIO configured to indicate the network status: registered home network, registered roaming, data call enabled, no service. The feature can be enabled through the +UGPIOC AT command.
Antenna detection	The **ANT_DET** pin provides antenna presence detection capability, evaluating the resistance from the **ANT** pin to GND by means of an external antenna detection circuit implemented on the application board. The antenna supervisor (i.e. antenna detection) feature can be enabled through the +UANTR AT command.
BIP	Bearer Independent Protocol for over-the-air SIM provisioning.
Dual stack IPv4/Ipv6	Capability to move between Ipv4 and dual stack network infrastructures. Ipv4 and Ipv6 addresses can be used.
Firmware update Over AT commands (FOAT)	Firmware module update over AT command interface.
u-blox Firmware update Over The Air (uFOTA)	u-blox firmware module update over the LTE air interface client/server solution using LwM2M.
Power Saving Mode (PSM)	The Power Saving Mode (PSM) feature, defined in 3GPP Rel.13, allows further reduction of the module current consumption maximizing the amount of time a device can remain in PSM low power deep-sleep mode during periods of data inactivity.

Feature	Description
eDRX	Extended mode DRX, based on 3GPP Rel.13, reduces the amount of signaling overhead decreasing the frequency of scheduled measurements and/or transmissions performed by the module in idle mode (for eDRX sleep time shorter than 70 s) or in deep-sleep mode (for eDRX sleep time longer than 70 s). This in turn leads to a reduction in the module power consumption while maintaining a perpetual connection with the base station.
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 and NB-IoT 3GPP release 14 features	For LTE-M: Larger max UL TBS (2984 bits instead of 1000 bits), Enhanced PUCCH repetition in CE mode B (64 and 128 repetition factor) For NB-IoT: Cat-NB2 higher data rate (with 2536 bit TBS), Release assistance indication, RRC connection re-establishment for the control plane CioT EPS optimization, 2 UL/DL HARQ processes, Non-anchor paging and RACH, E-CID positioning

Table 3: Main features supported by SARA-R52 series modules

☞ u-blox is extremely mindful of user privacy. When a position is sent to the CellLocate® server, u-blox is unable to track the SIM used or the specific device.

2 Interfaces

2.1 Power management

2.1.1 Module supply input (VCC)

SARA-R52 series 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 11). Voltage must be stable, because during operation the current drawn from **VCC** may vary significantly, based on the power consumption profile of the LTE Cat M1 and LTE Cat NB2 radio access technologies (described in the SARA-R52 series system integration manual [2]).

The three **VCC** pins of SARA-R52 series 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**), the supply voltage for the SIM interface (**VSIM**), and the supply voltage for the internal GNSS receiver, where supported.

It is important that the system power supply circuit is able to withstand the maximum pulse current during a transmit burst at maximum power level (see Table 13).

2.1.2 Generic digital interfaces supply output (V_INT)

SARA-R52 series modules provide a 1.8 V supply rail output on the **V_INT** pin, which is internally generated when the module is switched on, outside the ultra-low power deep-sleep mode. 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.

2.1.3 GNSS backup supply input (V_BCKP_GNSS)

☞ The **V_BCKP_GNSS** pin is not supported by SARA-R520 modules.

Backup domain (BBR and RTC) of the internal u-blox M10 GNSS chip can be optionally supplied through the **V_BCKP_GNSS** pin, enabling the hardware backup mode when GNSS chip is switched off and allowing better TTFF, accuracy, availability, and power consumption at the next GNSS startup.

☞ To enable the GNSS RTC in HW backup mode, a 32.768 kHz clock must also be applied (see 2.10).

☞ Leave **V_BCKP_GNSS** pin unconnected if the GNSS hardware backup mode is not used.

2.2 Antenna interfaces

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 (ANT_GNSS)

For SARA-R520 modules, the **ANT_GNSS** pin is the RF input for the u-blox SpotNow A-GPS receiver.

For SARA-R520M10 modules, the **ANT_GNSS** pin is the RF input for the high performing u-blox M10 GNSS receiver, with built-in SAW filter followed by an LNA in front of the u-blox M10 GNSS receiver.

For both modules, the line is designed with 50 Ω characteristic impedance and with an internal DC block, suitable for both active and passive GPS / GNSS antennas.

2.2.3 Antenna detection (ANT_DET)

The **ANT_DET** pin is an analog-to-digital converter (ADC) input with a current source provided by SARA-R52 series modules to sense the presence of the external antenna (as an optional feature), evaluating the DC resistance to GND by an externally implemented circuit (see the SARA-R52 series system integration manual [2] and the AT commands manual [1]).

2.3 System functions

2.3.1 Module power-on

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

- Applying a voltage at the **VCC** module supply input within the operating range (see Table 11)

When the modules are in power-off mode (i.e. switched off, but with a valid voltage present at the **VCC** supply input within the operating range reported in Table 11), they can be switched on as follows:

- Forcing a low level at the **PWR_ON** input pin, which is normally set high by an internal pull-up, for a valid time period (see section 4.2.10, module switch-on).

When the modules are in low power PSM / eDRX deep-sleep mode, with a valid voltage present at the **VCC** supply input within the operating range reported in Table 11, they can be woken up as follows:

- Forcing a low level at the **PWR_ON** input pin, which is normally set high by an internal pull-up, for a valid time period (see section 4.2.10, module early wake-up from PSM / eDRX deep-sleep).

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

The proper graceful power-off of SARA-R52 series 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+CPWROFF command (see the AT commands manual [1])
- Forcing a low pulse at the **PWR_ON** input pin, for a valid time period (see section 4.2.10, module normal graceful switch-off)

A faster power-off procedure of the modules, with storage of the current parameter settings in the module's non-volatile memory and without a clean network detach, can be triggered by:

- AT+CFUN=10 command (see the AT commands manual [1])
- Forcing a rising edge at the GPIO pin configured with faster power-off function (see section 2.7, faster switch-off)

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** input pin, for a valid time period (see section 4.2.10, module emergency hardware shutdown)

An abrupt under-voltage shutdown occurs on the 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.

An over-temperature or under-temperature shutdown occurs on the modules when the temperature measured within the module reaches the dangerous area (see section 4.2.19), if the optional "Smart temperature supervisor" feature is enabled and configured by the dedicated AT command (see the AT commands manual [1], +USTS AT command).

2.3.3 Module reset

SARA-R52 series 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+CFUN=16 command (for other options and further details, see the AT commands manual [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 4.2.11). 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-R52 series modules provide an interface on the **VSIM**, **SIM_IO**, **SIM_CLK**, **SIM_RST** pins 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 **GPIO5** pin of SARA-R52 series modules is a 1.8 V digital input which can be configured as an external interrupt to detect the SIM card presence (as a feature which can be optionally used), as intended to be properly connected to the mechanical switch of an external SIM card holder.

For more details, see the system integration manual [2] and the AT commands manual [1].

2.5 Serial communication

2.5.1 UART interfaces

The SARA-R52 series modules include 1.8 V unbalanced asynchronous serial interfaces for communication with external application host processor(s). UART interfaces can be configured by dedicated AT command in the following variants:

- **Variant 0** (default configuration), consists of a single UART interface that supports AT commands, data communication, multiplexer protocol functionality, FW update by FOAT or by the u-blox EasyFlash tool, and provides the following lines:
  - Data lines (**RXD** as output, **TXD** as input),
  - Hardware flow control lines (**CTS** as output, **RTS** as input),
  - Modem status and control lines (**DTR** as input, **RI** as output)
- **Variant 1**, consists of a single UART interface that supports AT commands, data communication, multiplexer protocol functionality, FW update by FOAT or by the u-blox EasyFlash tool, and provides the following lines:
  - Data lines (**RXD** as output, **TXD** as input),
  - Hardware flow control lines (**CTS** as output, **RTS** as input),
  - Modem status and control lines (**DTR** as input, **DSR** as output, **DCD** as output, **RI** as output)

- **Variants 2, 3 and 4**, consists of two UART interfaces plus ring indicator function:
  - First primary UART interface supports AT commands, data communication, multiplexer protocol functionality, FW update by FOAT or by the u-blox EasyFlash tool, and provides the following lines:
    - Data lines (**RXD** as output, **TXD** as input),
    - Hardware flow control lines (**CTS** as output, **RTS** as input),
  - Second auxiliary UART interface supports AT commands (variant 2 only), data communication (variant 2 only), FW update by FOAT (variant 2 only), diagnostic trace logging (variant 3 only), and GNSS tunneling (variant 4 only), and provides the following lines:
    - Data lines (**DCD** as data output, **DTR** as data input),
    - Hardware flow control lines (**RI** as flow control output, **DSR** as flow control input),
  - Ring indicator function over the GPIO pin configured with RI function (see section 2.7)

UART general features, valid for all variants, are:

- Serial port with RS-232 functionality conforming to the ITU-T V.24 recommendation [8], with CMOS compatible levels (0 V for low data bit or ON state, and 1.8 V for high data bit or OFF state)
- Hardware flow control (default value) or none flow control are supported
- UART power saving indication available on the hardware flow control output, if hardware flow control is enabled: the line is driven to the OFF state when the module is not prepared to accept data by the UART interface
- One-shot autobauding is supported and it is enabled by default: automatic baud rate detection is performed only once, at module start up. After the detection, the module works at the fixed baud rate (the detected one) and the baud rate can only be changed via AT command (see the AT commands manual [1])
- Following baud rates are supported and can be auto detected: 9600 bit/s, 19200 bit/s, 38400 bit/s, 57600 bit/s, 115200 bit/s, 230400 bit/s, 460800 bit/s, 921600 bit/s
- Following baud rates are supported but cannot be auto detected: 3000000 bit/s, 3250000 bit/s
- The default frame format is 8N1 (8 data bits, no parity, 1 stop bit)
- Following frame formats are supported: 8N1, 8N2, 8E1, 8O1, 7N1, 7E1, 7O1

The UART interfaces can be conveniently configured through AT commands. For more details, see the AT commands manual [1] and the SARA-R52 series system integration manual [2].

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

☞ Accessible test points directly connected to the **DCD** and **DTR** pins may be provided for diagnostic purpose, alternatively to the highly recommended accessible test points on the USB pins.

2.5.1.1 Multiplexer protocol

The modules include multiplexer functionality as per 3GPP TS 27.010 [6] on UART physical interfaces. This is a data link protocol which uses HDLC-like framing and operates between the module (DCE) and the application processor (DTE), allowing a number of simultaneous sessions over the physical link.

When USIO variant 0 or 1 is set, the following virtual channels are defined:

- Channel 0: control channel
- Channel 1 – 3: AT commands / data communication
- Channel 4: GNSS tunneling

When USIO variant 2 is set, AT commands and data communication are available on the second auxiliary UART, and the following virtual channels are defined on the primary UART:

- Channel 0: control channel
- Channel 1 – 2: AT commands / data communication
- Channel 3: GNSS tunneling

When USIO variant 3 is set, diagnostic trace log is available on the second auxiliary UART, and the following virtual channels are defined on the primary UART:

- Channel 0: control channel
- Channel 1 – 3: AT commands / data communication
- Channel 4: GNSS tunneling

When USIO variant 4 is set, GNSS tunneling is available on the second auxiliary UART, and the following virtual channels are defined on the primary UART:

- Channel 0: control channel
- Channel 1 – 3: AT commands / data communication

2.5.2 USB interface

The modules include a USB 2.0 interface according to USB 2.0 specification [9]. 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.

☞ It is recommended to include a 10 Ohm series resistor along the **VUSB_DET** input line to avoid exceeding the related absolute maximum rating for the voltage ramp.

2.5.3 SPI interfaces

☞ The SPI interfaces are not supported by current product versions, except for diagnostic purpose, and on u-blox open CPU solution (uCPU).

SARA-R52 series modules include 1.8V Serial Peripheral Interfaces available for communications with a single external SPI target device, with the module acting as SPI host (opposite role is not supported):

- The pin named **SDIO_D0** can provide the SPI data output function (SPI_MOSI),
- The pin named **SDIO_D1** can provide the SPI data input function (SPI_MISO),
- The pin named **SDIO_D2** can provide the SPI clock output function (SPI_CLK),
- The pin named **SDIO_D3** can provide the SPI chip select output function (SPI_CS).

The u-blox open CPU solution (uCPU) allows configuring the SPI Interface clock output with frequency in the range from 147 kHz up to 18.75 MHz.

2.5.4 SDIO interface

☞ The SDIO interface is not supported by current product versions, except for diagnostic purpose.

The modules include a 1.8V 4-bit Secure Digital Input Output interface over the **SDIO_D0**, **SDIO_D1**, **SDIO_D2**, **SDIO_D3**, **SDIO_CLK** and **SDIO_CMD** pins, with the module acting as an SDIO host, available for communications with compatible external SDIO devices, and for diagnostic purpose.

☞ Accessible test points directly connected to the **SDIO_D0**, **SDIO_D1**, **SDIO_D2** and **SDIO_D3** pins may be provided for diagnostic purpose, alternatively to the highly recommended accessible test points provided on the USB interface pins.

2.5.5 I2C interface

☞ Communication with an external GNSS receiver is not supported by SARA-R520M10 modules.

The modules include a 1.8V I2C-bus compatible interface over the **SDA** and **SCL** pins, available to communicate with an external u-blox GNSS receiver and/or with external I2C devices: the module acts as an I2C host that can communicate with I2C devices in accordance with the I2C specifications [10].

2.6 ADC

SARA-R52 series modules include an analog-to-digital converter input pin, **ADC**, configurable via a dedicated AT command (for further details, see the AT commands manual [1]).

2.7 GPIO

The modules include pins that can be configured as general-purpose input/output or to provide custom functions as summarized in Table 4. For more details, see the system integration manual [2] and the AT commands manual [1], +UGPIOC, +UGPIOR, +UGPIOW AT commands.

Function	Description	Default GPIO	Configurable GPIOs
General purpose output	Output to set high or low digital level	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
General purpose input	Input to sense high or low digital level	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
Network status indication	Output indicating cellular network status: registered, data transmission, no service	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
External GNSS supply enable [3]	Output to enable/disable the supply of an external u-blox GNSS receiver connected to the cellular module by the I2C interface	-	GPIO2 [3]
External GNSS data ready [3]	Input to sense when an external u-blox GNSS receiver connected to the module is ready for sending data over the I2C interface	-	GPIO3 [3]
SIM card detection	Input for SIM card physical presence detection, to optionally enable / disable SIM interface upon detection of external SIM card physical insertion / removal	-	GPIO5
Module status indication	Output indicating module status: power-off or deep-sleep mode versus idle, active or connected mode	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
Module operating mode indication	Output indicating module operating mode: power-off, deep-sleep or idle mode versus active or connected mode	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
Ring indicator	Output providing events indicator	-	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3]
Last gasp	Input to trigger last gasp notification	-	GPIO1, GPIO2, GPIO3 [3], GPIO4, GPIO6
Time pulse output	Output providing accurate time reference, as a sequence with configurable PPS or as single time pulse, based on the GNSS system or the LTE system (CellTime)	-	GPIO6
Time stamp of external interrupt input [3]	Input triggering via interrupt the generation of an URC time stamp over AT serial interface	-	EXT_INT [3]
Faster power-off	Input with internal pull-down to trigger a faster shutdown (as AT+CFUN=10) by applying a rising edge	-	GPIO1, GPIO2, GPIO3 [3], GPIO4, GPIO6

[3] Not supported by SARA-R520M10 modules

Function	Description	Default GPIO	Configurable GPIOs
External GNSS time pulse [3]	Input to receive an accurate time reference, as a sequence with configurable PPS from an external GNSS system	-	SDIO_CMD [3]
External GNSS time stamp of external interrupt [3]	Output triggering via interrupt the generation of an URC time stamp from an external GNSS system	-	GPIO4 [3]
ANT_ON [3]	Output for switching on/off the power supply to an external active GPS antenna and/or an external separate LNA, synced with SpotNow activities	-	GPIO8 [3]
Pin disabled	Tri-state with an internal active pull-down enabled	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3], EXT_INT [3], SDIO_CMD	GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7 [3], GPIO8 [3], EXT_INT [3], SDIO_CMD

Table 4: GPIO custom functions configuration

2.8 Cellular antenna dynamic tuner interface

SARA-R52 series modules include two output pins, **RFCTRL1** and **RFCTRL2**, that can optionally be used to control in real time an external antenna tuning IC, as the two pins change their output value dynamically according to the specific current LTE band in use by the module. Table 5 illustrates the default factory-programmed configuration, which can be changed by dedicated AT command.

RFCTRL1	RFCTRL2	LTE frequency band in use
0	0	B71 (< 700 MHz)
0	1	B12, B13, B28, B85 (700..800 MHz)
1	0	B5, B8, B18, B19, B20, B26 (800..900 MHz)
1	1	B1, B2, B3, B4, B25, B66 (> 1000 MHz)

Table 5: SARA-R52 series modules antenna dynamic tuning truth table (default factory-programmed configuration)

For design guidelines and details about how to enable the feature, see the SARA-R52 series system integration manual [2] and the AT commands manual [1].

2.9 GNSS peripheral outputs

☞ The GNSS peripheral output pins are not supported by SARA-R520 modules.

SARA-R520M10 modules provide the following 1.8 V peripheral output pins directly connected to the internal u-blox M10 GNSS chipset (as illustrated in Figure 2):

- The **TXD_GNSS** pin provides the UART data output of the internal u-blox GNSS chipset.
- The **ANT_ON** output pin can provide optional control for switching off power to an external active GNSS antenna or an external separate LNA. This facility is provided to help minimize power consumption in power save mode operation.

2.10 GNSS real-time clock

☞ The GNSS real-time clock is not supported by SARA-R520 modules.

Real-time clock of the internal u-blox M10 GNSS chip can be optionally fed with a 32.768 kHz clock, enabling hot starts and warm starts, allowing in most cases better TTFF, accuracy, availability, and power consumption at the next GNSS startup.

This clock can be applied externally through the **RTC_GNSS** pin; alternatively, it can be enabled with a dedicated AT command and internally generated as long as the module does not enter deep-sleep mode or does not switch off.

☞ To enable the GNSS RTC in HW backup mode, the GNSS backup domain must also be supplied (see section 2.1.3).

☞ Leave **RTC_GNSS** pin unconnected if it is not used.

2.11 Reserved pin (RSVD)

SARA-R520 modules have a pin reserved for future use, marked as **RSVD**. This pin is to be left unconnected on the application board.

3 Pin definition

3.1 Pin assignment

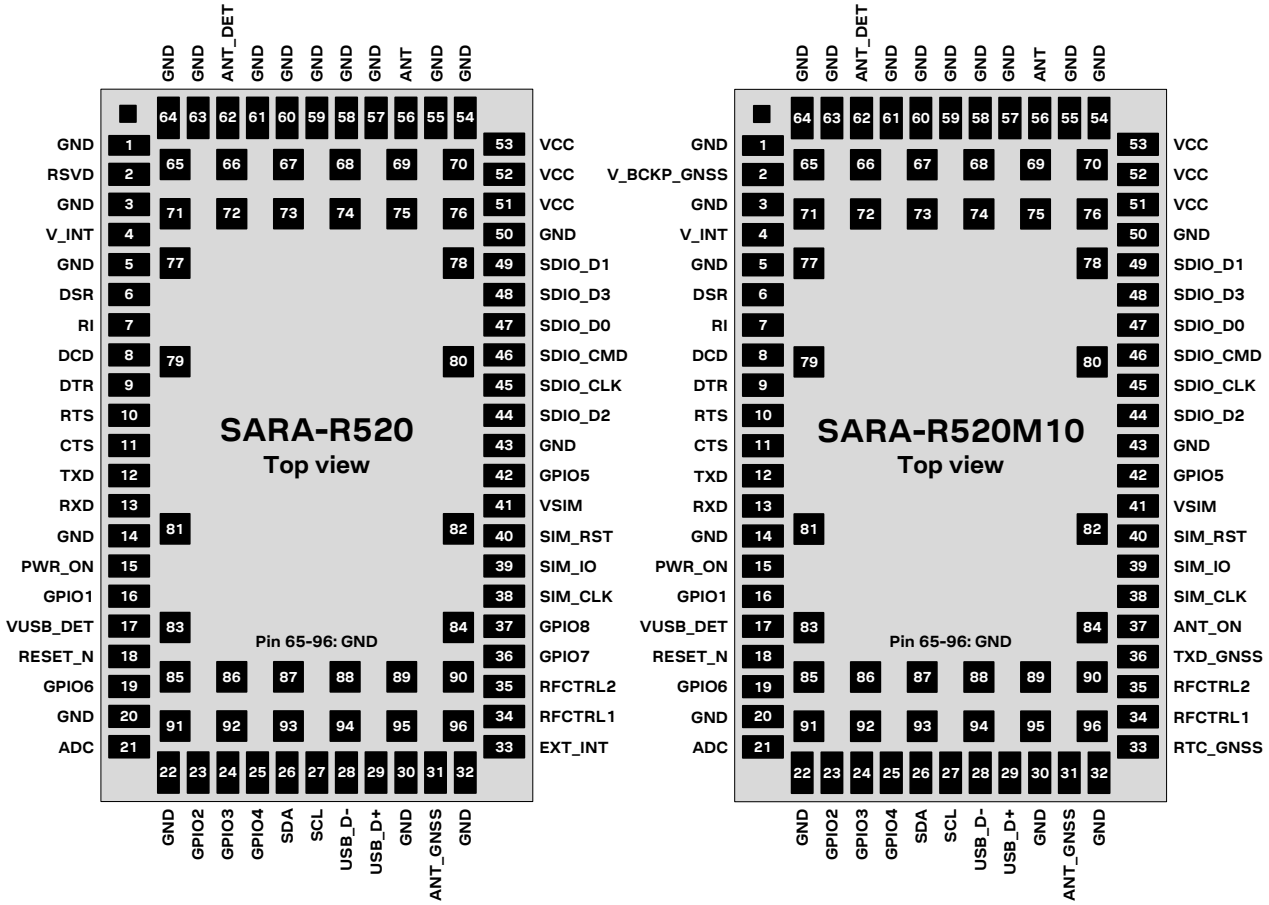

Figure 3: SARA-R52 series modules pin assignment (top view)

No.	Module	Name	Power domain	I/O	Description	Remarks
1	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
2	SARA-R520	RSVD	-	N/A	Reserved pin	Leave unconnected.
	SARA-R520M10	V_BCKP_GNSS	-	I	GNSS backup voltage supply	Supply to enable GNSS hardware backup mode. See section 2.1.3 for functional description. See section 4.2.3 for detailed electrical specs. Leave unconnected if not used.
3	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
4	All	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	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
6	All	DSR	GDI	O / I	UART data set ready / AUX UART request to send	Circuit 107 in ITU-T V.24 (DSR output, push-pull, idle high, active low), alternatively configurable as Second Auxiliary UART RTS (HW flow control input, idle high, active low, with internal active pull-up). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs.

No.	Module	Name	Power domain	I/O	Description	Remarks
7	All	RI	GDI	O / / O	UART ring indicator / AUX UART clear to send	Circuit 125 in ITU-T V.24 (RI output, push-pull, idle high, active low), alternatively configurable as Second Auxiliary UART CTS (HW flow control output, push-pull, idle high, active low). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs.
8	All	DCD	GDI	O / O	UART data carrier detect / AUX UART data output	Circuit 109 in ITU-T V.24 (DCD output, push-pull, idle high, active low), alternatively settable as Second Auxiliary UART RXD (data output, push-pull, idle high, active low). Fixed push-pull. See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs. Provide test point for diagnostic purposes.
9	All	DTR	GDI	I / I	UART data terminal ready / AUX UART data input	Circuit 108/2 in ITU-T V. 24 (DTR input, idle high, active low, with internal active pull-up), alternatively settable as Second Auxiliary UART TXD (data input, idle high, active low, with internal active pull-up). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs. Provide test point for diagnostic purposes.
10	All	RTS	GDI	I	UART request to send	Circuit 105 in ITU-T V.24 (RTS flow control input, idle high, active low, with internal active pull-up). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs.
11	All	CTS	GDI	O	UART clear to send	Circuit 106 in ITU-T V.24 (CTS hardware flow control output, push-pull, idle high, active low). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs.
12	All	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). See section 2.5.1 for functional description. See section 4.2.13 for detailed electrical specs. Provide test point for FW update purposes.
13	All	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 4.2.13 for detailed electrical specs. Provide test point for FW update purposes.
14	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
15	All	PWR_ON	POS	I	Power-on / power-off input	Internal active pull-up. Active low. See section 2.3.1 / 2.3.2 for functional description. See section 4.2.10 for detailed electrical specs. Provide test point for diagnostic purposes.
16	All	GPIO1	GDI	I/O	GPIO	Configurable GPIO. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
17	All	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 4.2.17 for detailed electrical specs. Provide test point with series 10 Ω for diagnostic.

No.	Module	Name	Power domain	I/O	Description	Remarks
18	All	RESET_N	GDI	I	External reset input	Internal active pull-up. Active low. See section 2.3.3 for functional description. See section 4.2.11 for detailed electrical specs. Provide test point for diagnostic purposes.
19	All	GPIO6	GDI	I/O / O	GPIO / Time pulse output	Configurable GPIO, alternatively settable as accurate time reference output. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
20	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
21	All	ADC	ADC	I	ADC input	12-bit Analog to Digital Converter input. See section 2.6 for functional description. See section 4.2.18 for detailed electrical specs. This pin can be externally connected to GND, if the ADC function is not needed.
22	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
23	All	GPIO2	GDI	I/O	GPIO	Configurable GPIO. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
24	All	GPIO3	GDI	I/O	GPIO	Configurable GPIO. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
25	All	GPIO4	GDI	I/O / O	GPIO / External GNSS time stamp of external interrupt [4]	Configurable GPIO, alternatively configurable as output indicating the generation of an URC time stamp. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
26	All	SDA	I2C	I/O	I2C bus data line	Open drain output type. Internal active pull-up. Idle high, active low. See section 2.5.5 for functional description. See section 4.2.16 for detailed electrical specs.
27	All	SCL	I2C	O	I2C bus clock line	Open drain output type. Internal active pull-up. Idle high, active low. See section 2.5.5 for functional description. See section 4.2.16 for detailed electrical specs.
28	All	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 [9], 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 4.2.17 for detailed electrical specs. Provide test point for diagnostic purposes.
29	All	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 [9], 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 4.2.17 for detailed electrical specs. Provide test point for diagnostic purposes.
30	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.

[4] Not supported by SARA-R520M10 modules

No.	Module	Name	Power domain	I/O	Description	Remarks
31	All	ANT_GNSS	-	I	GNSS antenna	RF input for GNSS Rx antenna. 50 Ω nominal impedance. See section 2.2.2 / Table 2 for functional description.
32	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
33	SARA-R520	EXT_INT	GDI	I	External interrupt	Configurable as interrupt input triggering an URC time stamp. Internal active pull-down. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
	SARA-R520M10	RTC_GNSS	-	I	GNSS RTC input	GNSS RTC clock input for external 32.768 kHz clock. See section 2.10 for functional description. See section 4.2.15 for detailed electrical specs. Leave unconnected if not used.
34	All	RFCTRL1	GDI	O	RF GPIO for cellular antenna tuning	Digital output to optionally control an antenna tuning IC. Push-pull output type. See section 2.8 for functional description. See section 4.2.13 for detailed electrical specs.
35	All	RFCTRL2	GDI	O	RF GPIO for cellular antenna tuning	Digital output to optionally control an antenna tuning IC. Push-pull output type. See section 2.8 for functional description. See section 4.2.13 for detailed electrical specs.
36	SARA-R520	GPIO7	GDI	I/O	GPIO	Configurable GPIO. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
	SARA-R520M10	TXD_GNSS	GNSS	O	GNSS data output	GNSS UART data output from internal GNSS chip. See section 2.9 for functional description. See section 4.2.14 for detailed electrical specs.
37	SARA-R520	GPIO8	GDI	I/O / O	GPIO / ANT_ON	Configurable GPIO, alternatively configurable as on/off signal for external GNSS active antenna and/or LNA. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
	SARA-R520M10	ANT_ON	GNSS	O	Antenna / LNA enable	External GNSS active antenna and/or LNA on/off signal driven by u-blox GNSS chip, connected to internal LNA. See section 2.9 for functional description. See section 4.2.14 for detailed electrical specs.
38	All	SIM_CLK	SIM	O	SIM clock	See section 2.4.1 for functional description. See section 4.2.12 for detailed electrical specs.
39	All	SIM_IO	SIM	I/O	SIM data	See section 2.4.1 for functional description. See section 4.2.12 for detailed electrical specs.
40	All	SIM_RST	SIM	O	SIM reset	See section 2.4.1 for functional description. See section 4.2.12 for detailed electrical specs.
41	All	VSIM	-	O	SIM supply output	See section 2.4.1 for functional description. See section 4.2.12 for detailed electrical specs.
42	All	GPIO5	GDI	I/O / I	GPIO / SIM card detection	Configurable GPIO, alternatively settable as input pin for SIM card detection. Push-pull output type. See sections 2.4.2 / 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
43	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
44	All	SDIO_D2	GDI	I/O / O	SDIO data [2] / SPI_CLK	SDIO not supported by current version. The pin is alternatively configurable as SPI_CLK, for diagnostic, or with uCPU. Push-pull output type.
45	All	SDIO_CLK	GDI	O	SDIO clock	SDIO not supported by current version.

No.	Module	Name	Power domain	I/O	Description	Remarks
46	All	SDIO_CMD	GDI	I/O / I	SDIO command / External GNSS time pulse input [5]	SDIO not supported by current version. Configurable as input for external GNSS time pulse. Push-pull output type. See section 2.7 for functional description. See section 4.2.13 for detailed electrical specs.
47	All	SDIO_D0	GDI	I/O / O	SDIO data [0] / SPI_MOSI	SDIO not supported by current version. The pin is alternatively configurable as SPI_MOSI, for diagnostic, or with uCPU. Push-pull output type.
48	All	SDIO_D3	GDI	I/O / O	SDIO data [3] / SPI_CS	SDIO not supported by current version. The pin is alternatively configurable as SPI_CS, for diagnostic, or with uCPU. Push-pull output type.
49	All	SDIO_D1	GDI	I/O / I	SDIO data [1] / SPI_MISO	SDIO not supported by current version. The pin is alternatively configurable as SPI_MISO, for diagnostic, or with uCPU.
50	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
51	All	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	All	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	All	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	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
55	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
56	All	ANT	-	I/O	Cellular antenna	RF input/output for Cellular Rx/Tx antenna. 50 Ω nominal impedance. See sections 2.2.1 and 4.2.7 for details.
57	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
58	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
59	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
60	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
61	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
62	All	ANT_DET	ADC	I	Antenna detection	Antenna presence detection function. See section 2.2.3 for details. See section 4.2.8 for detailed electrical specs.
63	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
64	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.
65 ... 96	All	GND	-	N/A	Ground	All the GND pins must be connected to ground.

Table 6: SARA-R52 series pin-out

For more information about pin-out, see the SARA-R52 series system integration manual [2].

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

[5] Not supported by SARA-R520M10 modules

4 Electrical specifications

⚠ Stressing the device above one or more of the ratings listed in section 4.1, absolute maximum rating, may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in section 4.2, operating conditions, must 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 voltage at VCC pins	-0.3	4.6	V
		Input voltage ramp at VCC pins		130	mV/µs
VUSB_DET	USB detection pin	Input voltage at VUSB_DET pin	-0.3	5.5	V
		Input voltage ramp at VUSB_DET pin		650	mV/µs
USB	USB D+/D- pins	Input voltage at USB interface pins	-0.3	3.6	V
GDI	Generic digital interfaces	Input voltage at Generic digital interfaces pins	-0.3	2.3	V
I2C	I2C interface	Input voltage at I2C interface pins	-0.3	2.3	V
GNSS	GNSS digital interfaces	Input voltage at GNSS digital interfaces pins	-0.3	2.3	V
V_BCKP_GNSS	GNSS backup supply	Input voltage at GNSS backup supply pin	-0.3	3.6	V
RTC_GNSS	GNSS RTC input	Input voltage at GNSS RTC input pin	-0.3	1.15	V
SIM	SIM interface	Input voltage at SIM interface pins	-0.3	3.5	V
POS	Power-on input	Input voltage at PWR_ON pin	-0.3	1.65	V
ADC	ADC signal	Input voltage at ANT_DET and ADC pins	-0.3	1.65	V
P_RF	RF power	Input RF power at ANT pin		3	dBm
		Input RF power at ANT_GNSS pin		0	dBm
Rho_ANT	Antenna ruggedness	Output RF load mismatch ruggedness at ANT pins		10:1	VSWR
Tstg	Storage temperature		-40	+85	°C

Table 7: 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 8: 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.	Typ.	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 9: Environmental conditions

4.2.2 Thermal parameters

Symbol	Parameter	Min.	Typ.	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 10: 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 [6]	3.3	3.8	4.4	V
	Module supply extended operating input voltage [7]	3.0		4.5	V
V_BCKP_GNSS	GNSS backup domain, supply voltage	1.65		3.6	V
I_BCKP_GNSS[8]	Backup current in GNSS hardware backup mode, at V_BCKP_GNSS = 3.3 V		32		µA

Table 11: 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 12: Output characteristics of the Supply/Power pins

[6] Operating within 3GPP / ETSI specifications.
[7] 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.
[8] I_BCKP_GNSS current during GNSS normal operation is ~3 µA

4.2.4 Current consumption

Mode	Condition	Tx power	Min	Typ[9]	Max	Unit
Power-off mode	Average current value (power-off mode)	--		0.5		µA
PSM deep-sleep mode	Average current value (PSM deep-sleep mode)	--		0.5		µA
Cyclic deep-sleep / active mode (+UPSV: 1)	Average current value (eDRX deep-sleep mode[10] rock bottom floor current)	--		0.5		µA
	Average current value (DRX = 2.56 s, PTW = 20.48 s, eDRX = 655.36 s, +UPSMVER: 8)	--		180		µA
Cyclic idle / active mode (+UPSV: 1)	Average current value (low power idle mode rock bottom floor current)	--		1.4		mA
	Average current value (DRX = 2.56 s, PTW = 20.48 s, eDRX = 655.36 s, +UPSMVER: 0)	--		1.4		mA
	Average current value (DRX = 2.56 s, no eDRX)	--		1.8		mA
	Average current value (DRX = 1.28 s, no eDRX)	--		2.2		mA
Idle mode (+UPSV: 1)	Average current value (airplane mode, +CFUN: 0)	--		1.4		mA
Active mode (+UPSV: 0)	Average current value (DRX = 1.28 s)	--		15		mA
LTE Cat M1 connected mode	Average current value (Tx / Rx data transfer)	Minimum (-50 dBm)		95		mA
		0 dBm		100		mA
		8 dBm		115		mA
		14 dBm		140		mA
		20 dBm		170		mA
		Maximum (23 dBm)		195		mA
	Maximum current value (during Tx only)	Maximum (23 dBm)		395		mA
LTE Cat NB2 connected mode	Average current value (Tx / Rx data transfer)	Minimum (-50 dBm)		85		mA
		0 dBm		90		mA
		8 dBm		100		mA
		14 dBm		110		mA
		20 dBm		125		mA
		Maximum (23 dBm)		135		mA
	Maximum current value (during Tx only)	Maximum (23 dBm)		395		mA

Table 13: VCC current consumption of SARA-R52 series modules with GNSS off

[9] Typical values with matched antenna, VCC = 3.8 V
[10] Supported for eDRX sleep time longer than 70 s

GNSS condition	Modem condition	GPS	GPS + GLO	GPS + GLO + GAL + BDS B1C	Unit
1s cyclic tracking	PSM, +UPSV: 1	8	8.5	N/A	mA
	DRX = 1.28 s, +UPSV: 1	9	9.5	N/A	mA
Continuous tracking	PSM, +UPSV: 1	12	14	16	mA
	DRX = 1.28 s, +UPSV: 1	13	15	17	mA
	DRX = 1.28 s, +UPSV: 0	25	27	29	mA
Acquisition	DRX = 1.28 s, +UPSV: 0	28	30	35	mA
Startup	DRX = 1.28 s, +UPSV: 0	≤ 120	≤ 120	≤ 120	mA

Table 14: Indicative VCC current consumption of the SARA-R520M10 modules with GNSS on

4.2.5 GNSS characteristics

Parameter	Specification	
Receiver type	u-blox UBX-M10050 SPG 5.10, supporting concurrent reception of up to 4 GNSS systems	
GNSS signals	GPS / QZSS Galileo GLONASS BeiDou[11]	L1C/A (1575.42 MHz) E1-B/C (1575.42 MHz) L1OF (1602 MHz + k*562.5 kHz, k = –7,..., 5, 6) B1I (1561.098 MHz), B1C (1575.42 MHz)
Operational limits[12]	Dynamics Altitude Velocity	≤ 4 g 80’000 m 500 m/s
Velocity accuracy[13]		0.05 m/s
Heading accuracy[13]		0.3 degrees
Time pulse signal	Accuracy	30 ns (RMS) 60 ns (99%)
	Frequency	Default 1 PPS (0.25 Hz to 10 MHz configurable)

Table 15: GNSS characteristics of the SARA-R520M10 modules

[11] BeiDou B1I cannot be enabled simultaneously with BeiDou B1C or GLONASS L1OF
[12] Assuming Airborne 4 g platform
[13] 50% at 30 m/s for dynamic operation

Parameter		GPS+Galileo	GPS+Galileo +GLONASS	GPS+Galileo +BeiDou B1I	GPS+Galileo +BeiDou B1C	GPS+Galileo +BeiDou B1C +GLONASS
Time-To-First-Fix (TTFF)[14]	Cold start	28 s	23 s	27 s	28 s	23 s
	Hot start	1 s	1 s	1 s	1 s	1 s
	Aided starts[15]	1 s	1 s	1 s	1 s	1 s
Max navigation update rate[16]	Default	10 Hz	10 Hz	10 Hz	10 Hz	5 Hz
	High performance[17]	20 Hz	16 Hz	12 Hz	16 Hz	10 Hz
Sensitivity[18]	Tracking and nav.	–165 dBm	–167 dBm	–162 dBm	–163 dBm	–163 dBm
	Reacquisition	–160 dBm	–160 dBm	–160 dBm	–160 dBm	–160 dBm
	Cold start	–148 dBm	–148 dBm	–148 dBm	–148 dBm	–148 dBm
	Hot start[19]	–159 dBm	–159 dBm	–159 dBm	–159 dBm	–159 dBm
Position accuracy[20]		1.5 m	1.5 m	1.5 m	1.5 m	1.5 m

Parameter		GPS	GLONASS	BeiDou B1I	Galileo	BeiDou B1C
Time-To-First-Fix (TTFF)[14]	Cold start	29 s	27 s	30 s	41 s	56 s
	Hot start	1 s	1 s	1 s	1 s	1 s
	Aided starts[15]	1 s	1 s	1 s	5 s	N/A
Max navigation update rate[16]	Default	18 Hz	18 Hz	18 Hz	18 Hz	18 Hz
	High performance[17]	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz
Sensitivity[18]	Tracking and nav.	–167 dBm	–166 dBm	–160 dBm	–161 dBm	–163 dBm
	Reacquisition	–160 dBm	–158 dBm	–158 dBm	–154 dBm	–156 dBm
	Cold start	–148 dBm	–147 dBm	–146 dBm	–141 dBm	–136 dBm
	Hot start[19]	–159 dBm	–159 dBm	–159 dBm	–155 dBm	–157 dBm
Position accuracy[20]		1.5 m	4 m	2 m	3 m	2 m

Table 16: GNSS performance of the SARA-R520M10 modules

4.2.6 SpotNow characteristics

Parameter	Specification
Receiver type	u-blox SpotNow A-GPS
GNSS signals	GPS L1C/A (1575.42 MHz)
Time-To-Fix (TTF)[21]	1 s
Sensitivity[18]	–148 dBm
Position accuracy[22]	5 m
Fix energy[21]	60 uWh

Table 17: SpotNow characteristics and performance of the SARA-R520 modules

[14] Commanded starts; all satellites at -130 dBm; GPS always in combination with QZSS and SBAS
[15] Dependent on the speed and latency of the aiding data connection
[16] Minimum 98% fix rate under typical conditions.
[17] Configuration required
[18] Good external LNA; room temperature
[19] Commanded starts
[20] CEP, 50%, 24 hours static, –130 dBm, > 6 SVs for each GNSS system; GPS is always in combination with SBAS and QZSS
[21] Commanded starts; all satellites at -130 dBm; aiding available
[22] CEP, 50%, static, –130 dBm, > 6 SVs

4.2.7 LTE RF characteristics

The LTE Cat M1 / NB2 bands supported by SARA-R52 series modules are defined in Table 2, while the following Table 18 describes the frequency ranges for each LTE band as per 3GPP TS 36.521-1 [7].

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
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 18: LTE operating RF frequency bands

SARA-R52 series modules include a UE Power Class 3 LTE Cat M1 / NB2 transmitter (see Table 2) and an LTE receiver, with output power and characteristics according to 3GPP TS 36.521-1 [7].

SARA-R52 series modules LTE receiver characteristics are compliant to 3GPP TS 36.521-1 [7], with LTE conducted receiver sensitivity performance described in Table 19 and Table 20.

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 [7]					

Table 19: LTE Cat M1 receiver sensitivity performance

Parameter	Min.	Typical	Max.	Unit	Remarks
Receiver input sensitivity Band 71 (600 MHz)		-116.0		dBm	Without repetitions
Receiver input sensitivity Band 12 / 28 / 85 (700 MHz)		-116.0		dBm	Without repetitions
Receiver input sensitivity Band 13 (750 MHz)		-116.0		dBm	Without repetitions
Receiver input sensitivity Band 20 (800 MHz)		-115.5		dBm	Without repetitions
Receiver input sensitivity Band 5 / 18 / 19 / 26 (850 MHz)		-115.5		dBm	Without repetitions
Receiver input sensitivity Band 8 (900 MHz)		-115.0		dBm	Without repetitions
Receiver input sensitivity Band 3 (1800 MHz)		-114.0		dBm	Without repetitions
Receiver input sensitivity Band 2 / 25 (1900 MHz)		-115.0		dBm	Without repetitions
Receiver input sensitivity Band 1 / 4 / 66 (2100 MHz)		-115.0		dBm	Without repetitions
Condition: 50 Ω, throughput > 95%, other settings as per clause 7.3F of 3GPP TS 36.521-1 [7]					

Table 20: LTE Cat NB2 receiver sensitivity performance

4.2.8 ANT_DET pin

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
ANT_DET	Output DC current pulse value		30		µA	
	Output DC current pulse time length		2		ms	

Table 21: ANT_DET pin characteristics

4.2.9 Time pulse

Parameter		Specification		Unit
Accuracy of time pulse / time stamp	GNSS source [23]	RMS	50	ns
		99%	100	ns
	LTE source	RMS	500	ns
		99%	1	µs
Configurable period of time pulse		0.5, 1.0, 2.0, 3.0 or 4.0		s

Table 22: Time pulse / time stamp characteristics

4.2.10 PWR_ON pin

Parameter	Min.	Typical	Max.	Unit	Remarks
Low-level input	-0.3		0.2	V	
Pull-up resistance		100		kΩ	Integrated pull-up to internal rail (typ. 1.2 V)
Low-level input current		-15		µA	
PWR_ON low time	0.1		0.9	s	Low time to trigger module switch-on from power-off mode
	0.1		0.9	s	Low time to trigger module early wake-up from deep-sleep
	1.5			s	Low time to trigger module normal graceful switch off
	17			s	Low time to trigger module emergency hardware shutdown

Table 23: PWR_ON pin characteristics

4.2.11 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 24: RESET_N pin characteristics

4.2.12 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 25 are for information only.

Parameter	Min.	Typ.	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 25: SIM pin characteristics

[23] Time pulse / time stamp is always generated by the UBX-R52 cellular chipset after the process of the GNSS time pulse signal.

4.2.13 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 26: GDI pin characteristics

4.2.14 GNSS digital interfaces pins

Parameter	Min	Typical	Max	Unit	Remarks
Internal supply for GNSS domain		1.80		V	
Low-level output		0.00	0.40	V	
High-level output	1.40	1.80		V	

Table 27: GNSS pins characteristics

4.2.15 RTC_GNSS pin

Parameter	Min	Typical	Max	Unit	Remarks
RTC_GNSS input capacitance	7	10	14	pF	With respect to GND
RTC_GNSS input resistance	47.5	50	52.5	kΩ	With respect to GND
Low-level input	0		0.22	V	
High-level input	0.71		1.1	V	

Table 28: RTC_GNSS pin characteristics

4.2.16 I2C pins

I2C lines (**SCL** and **SDA**) are compliant to the I2C-bus standard mode specification. See the I2C-bus specification [10] for detailed electrical characteristics.

Parameter	Min	Typical	Max	Unit	Remarks
Internal supply for I2C 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		V	
Pull-up input current		-450		µA	

Table 29: I2C pin characteristics

4.2.17 USB pins

USB data lines (**USB_D+** / **USB_D–**) are compliant with the USB 2.0 high-speed specification. See the Universal Serial Bus specification revision 2.0 [9] for detailed electrical characteristics. The values in Table 30 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 30: USB pins characteristics

4.2.18 ADC pin

Parameter	Min.	Typical	Max.	Unit	Remarks
Resolution		12		Bits	
Input voltage range	0.25		1.15	V	
Input resistance	1			MΩ	With respect to GND

Table 31: Analog to Digital Converter input pin (ADC) characteristics

4.2.19 Smart temperature supervisor

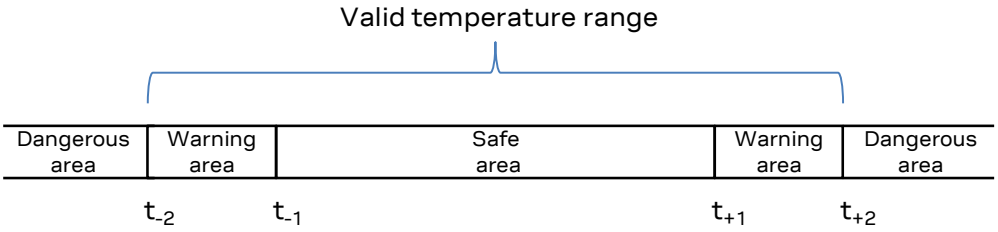

Figure 4: Temperature range and limits

Symbol	Parameter	Temperature
t_{-2}	Low temperature shutdown	–40 °C
t_{-1}	Low temperature warning	–30 °C
t_{+1}	High temperature warning	+77 °C
t_{+2}	High temperature shutdown	+97 °C

Table 32: Thresholds definition for the "Smart temperature supervisor" feature on the SARA-R52 series modules

☞ The sensor measures the board temperature inside the shield, which can differ from the ambient temperature.

4.3 Parameters for ATEX applications

This section provides useful parameters and information to integrate SARA-R52 series modules in applications intended for use in areas with potentially explosive atmospheres (ATEX), including:

- Total internal capacitance and inductance of the modules (see Table 33)
- Maximum RF output power at the antenna (**ANT**) pin of the modules (see Table 34)

☞ For any device integrating the SARA-R52 series modules and intended for use in potentially explosive atmospheres, check the detailed requisites on the pertinent normative for the application, as for example the IEC 60079-0 [12], IEC 60079-11 [13], and IEC 60079-26 [14] standards. The requirements must be fulfilled according to the exact applicable standards.

☞ The certification of the application device that integrates a SARA-R52 series 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 33 describes the maximum total internal capacitance and the maximum total internal inductance, considering internal parts tolerance, of the SARA-R52 series modules.

Module	Parameter	Description	Value	Unit
SARA-R520	Ci	Maximum total internal capacitance	244	µF
	Li	Maximum total internal inductance	2.85	µH
SARA-R520M10	Ci	Maximum total internal capacitance	256	µF
	Li	Maximum total internal inductance	2.84	µH

Table 33: SARA-R52 series maximum total internal capacitance and maximum total internal inductance

Table 34 describes the maximum RF output power transmitted by SARA-R52 series 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	dBm

Table 34: SARA-R52 series maximum RF output power

☞ SARA-R52 series 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 34.

5 Mechanical specifications

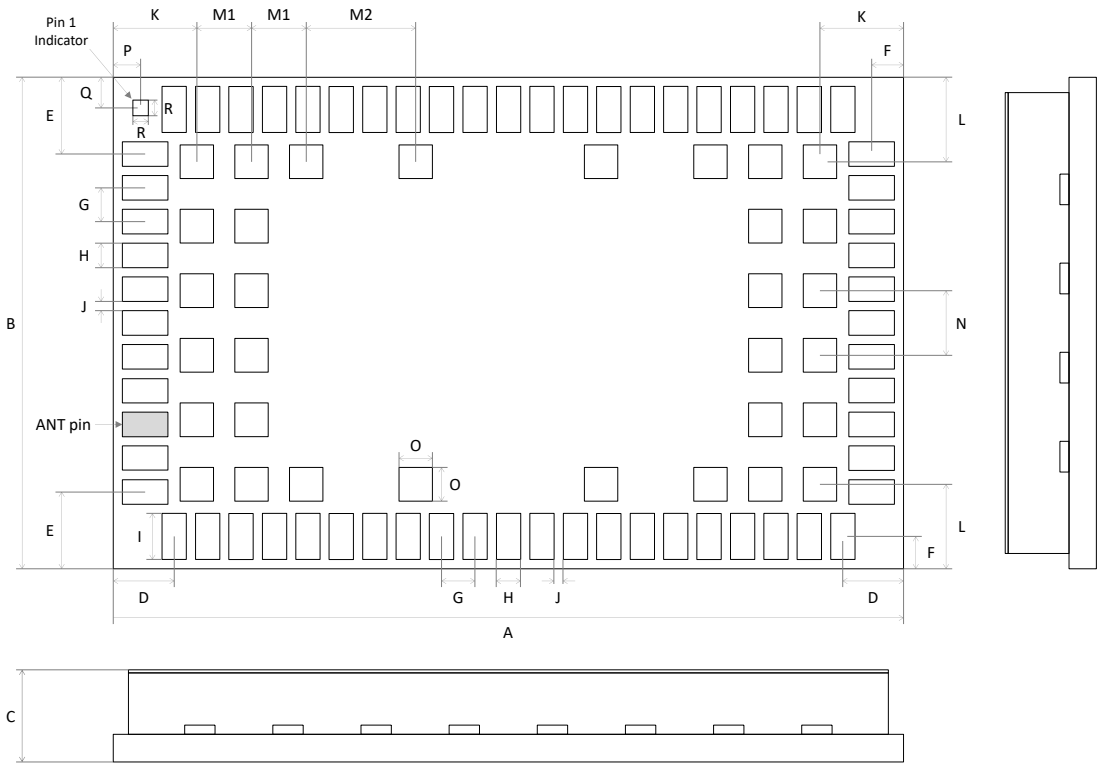

Figure 5: SARA-R52 series dimensions (bottom and side views)

Parameter	Description	Typical	Tolerance	Unit
A	Module height	26.0	+0.20/-0.20	mm
B	Module width	16.0	+0.20/-0.20	mm
C	Module thickness	2.2	+0.25/-0.15	mm
D	Horizontal edge to lateral pin pitch	2.0	+0.20/-0.20	mm
E	Vertical edge to lateral pin pitch	2.5	+0.20/-0.20	mm
F	Edge to lateral pin pitch	1.05	+0.20/-0.20	mm
G	Lateral pin to pin pitch	1.1	+0.05/-0.05	mm
H	Lateral pin height	0.8	+0.05/-0.05	mm
I	Lateral pin width	1.5	+0.05/-0.05	mm
J	Lateral pin to pin distance	0.3	+0.05/-0.05	mm
K	Horizontal edge to central pin pitch	2.75	+0.20/-0.20	mm
L	Vertical edge to central pin pitch	2.75	+0.20/-0.20	mm
M1	Central pin to pin horizontal pitch	1.8	+0.05/-0.05	mm
M2	Central pin to pin horizontal pitch	3.6	+0.05/-0.05	mm
N	Central pin to pin vertical pitch	2.1	+0.05/-0.05	mm
O	Central pin height and width	1.1	+0.05/-0.05	mm
P	Horizontal edge to pin 1 indicator pitch	0.9	+0.20/-0.20	mm
Q	Vertical edge to pin 1 indicator pitch	1.0	+0.20/-0.20	mm
R	Pin 1 indicator height and width	0.5	+0.05/-0.05	mm
Weight	Module weight	2		g

Table 35 : SARA-R52 series 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-R52 series system integration manual [2].

6 Qualification and approvals

6.1 Reliability tests

Reliability tests for SARA-R52 series modules are executed according to u-blox qualification policy, based on AEC-Q104 standard.

6.2 Approvals

SARA-R52 series 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-R52 series modules are RoHS 3 compliant.

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

Table 36 summarizes the main approvals for SARA-R52 series modules.

Certification	SARA-R520	SARA-R520M10
GCF	•	•
PTCRB	•	•
RED Europe	•	•
FCC United States FCC ID	• XPYUBX19KM01	• XPYUBX19KM01
ISED Canada ISED Certification Number	• 8595A-UBX19KM01	• 8595A-UBX19KM01
GITEKI Japan [R] Certificate Number [T] Certificate Number	• 003-230096 D230041003	• 003-230096 D230041003
NCC Taiwan NCC Certificate Number	• CCAF23Y0030AT7	• CCAF23Y0030BT9
ACMA RCM Australia	•	•
AT&T with FirstNet	•	•
Verizon	•	•
T-Mobile US	•	•
Telus	•	•
Telstra	•	•
Orange	•	•
Deutsche Telekom	•	•

Table 36: SARA-R52 series modules main certification approvals summary

☞ For guidelines and notices about compliance with certification approvals requirements integrating SARA-R52 series modules in the end-device, see SARA-R52 series system integration manual [2].

☞ For the complete list of approvals and for specific details on all country, conformance, and network operators' certifications available for all the different SARA-R52 series modules' ordering numbers, including related certificates of compliancy, please contact your nearest u-blox office or sales representative.

7 Product handling & soldering

7.1 Packaging

SARA-R52 series 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 [3].

7.1.1 Reels

SARA-R52 series 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 [3].

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

7.1.2 Tapes

Figure 6 shows the position and the orientation of SARA-R52 series modules as they are delivered on the tape, while Figure 7 and Table 37 specify the dimensions of the tape.

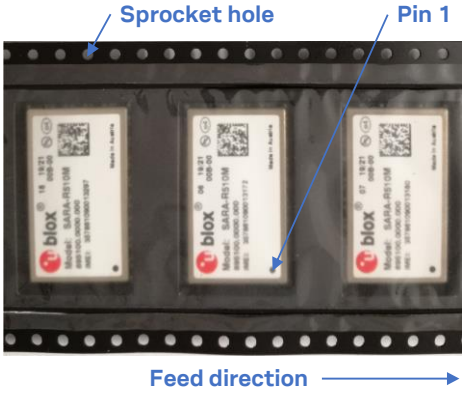

Figure 6: Orientation of SARA-R52 series modules on tape

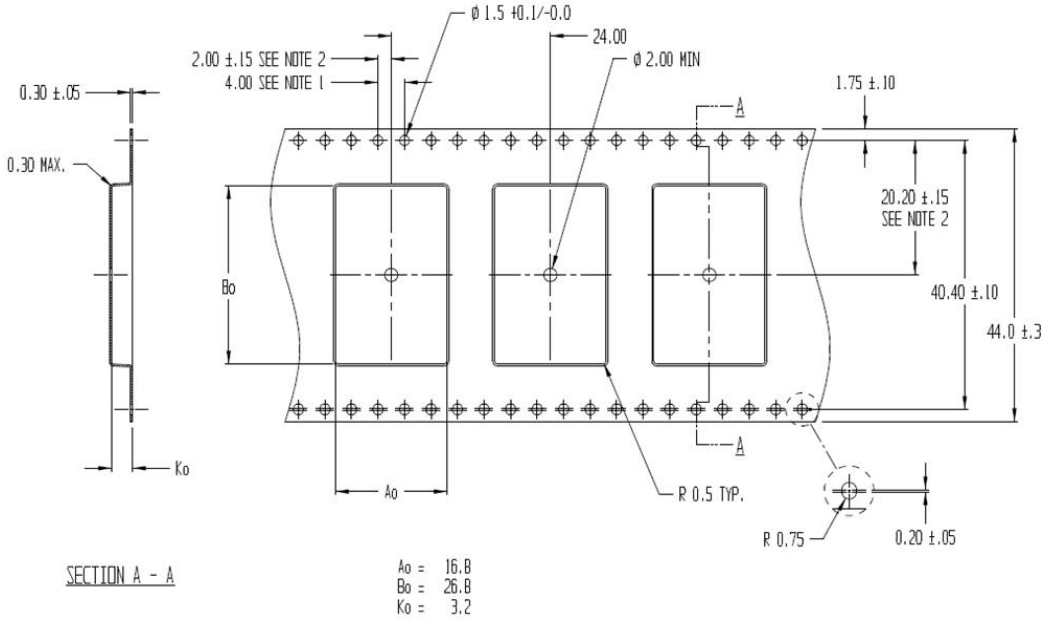

Figure 7: SARA-R52 series modules tape

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 37: SARA-R52 series 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-R52 series 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-R52 series 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 [3].

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

7.3 Reflow soldering

Reflow profiles must be selected according to u-blox recommendations (see the SARA-R52 series system integration manual [2]).

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

7.4 ESD precautions

⚠ SARA-R52 series modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling SARA-R52 series modules without proper ESD protection may destroy or damage them permanently.

SARA-R52 series modules are Electrostatic Sensitive Devices (EDS) and require special ESD precautions typically applied to ESD sensitive components.

Table 8 details the maximum ESD ratings of the SARA-R52 series modules.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates SARA-R52 series modules.

ESD precautions shall be appropriately implemented on the application board where the module is mounted, as described in the SARA-R52 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-R52 series modules include important product information as described in this section. Figure 8 provides an illustrative example of SARA-R52 series modules' label, which includes: the u-blox logo, production lot, Pb-free marking, product type number, IMEI number, certification information, and production country.

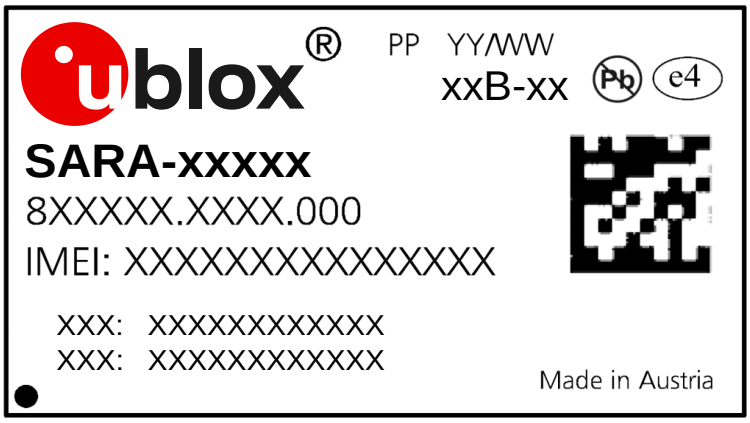

Figure 8: Illustrative example of SARA-R52 series modules' label

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 38 details these 3 different formats:

Format	Structure
Product Name	PPPP-TGVV(HH)(F)
Ordering Code	PPPP-TGVV(HH)(F)-MMQ
Type Number	PPPP-TGVV(HH)(F)-MMQ-XX

Table 38: Product code formats

Table 39 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	20
(HH)	GNSS generation (optional): M8 = u-blox M8, M10 = u-blox M10, …	M10
(F)	Additional features (optional): E = integrated SIM, …	E
MM	Major product version: 00…99	02
Q	Product grade: C = standard, B = professional, A = automotive	B
XX	Minor product version: 00…99	Default value is 00

Table 39: Part identification code

8.3 Ordering information

Ordering No.	Product
SARA-R520-02B	LTE Cat M1 / NB2 module for multi-region use. Designed with integrated u-blox SpotNow A-GPS receiver, with dedicated RF input for GPS antenna. 26.0 x 16.0 mm, 250 pieces/reel
SARA-R520M10-02B	LTE Cat M1 / NB2 module for multi-region use. Designed with integrated u-blox M10 GNSS receiver, concurrently available with LTE network access. 26.0 x 16.0 mm, 250 pieces/reel

Table 40: 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
BBR	Battery-Backed RAM
BeiDou	Chinese satellite navigation system
Cat	Category
CE	Coverage Enhancement
CE	European Conformity
CEP	Circular Error Probable
CLK	Clock
CloT	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
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
EGNOS	European Geostationary Navigation Overlay Service
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
GAGAN	GPS-aided GEO augmented navigation
Galileo	European satellite navigation system
GCF	Global Certification Forum

Abbreviation	Definition
GDI	Generic Digital Interface
GITEKI	Gijutsu kijun tek–gō 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
MSAS	Multi-functional Satellite Augmentation System
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
QPSK	Quadrature Phase Shift Keying modulation

Abbreviation	Definition
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
SLAS	Sub-meter Level Augmentation Service
SMS	Short Message Service
SPG	Standard Precision GNSS
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
TTFF	Time To First Fix
Tx	Transmission
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
uCPU	u-blox open CPU solution
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
VSWR	Voltage Standing Wave Ratio
WA	Word Alignment
WAAS	Wide Area Augmentation System

Related documentation

[1] u-blox LEXI-R520 / SARA-R5 series AT commands manual, UBX-19047455
[2] u-blox SARA-R52 series system integration manual, UBX-23004806
[3] u-blox package information user guide, UBX-14001652
[4] 3GPP–TS 27.007 - AT command set for User Equipment (UE)
[5] 3GPP–TS 27.005 - Use of Data Terminal–Equipment - Data Circuit terminating Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[6] 3GPP–TS 27.010 - Terminal Equipment to User Equipment (TE-UE) multiplexer protocol
[7] 3GPP T– 36.521-1 - Evolved Universal Terrestrial Radio Access; User Equipment conformance specification; Radio transmission and reception; Part 1: Conformance Testing
[8] ITU-T Recommendation V24 - List of definitions for interchange circuits between Data Terminal Equipment (DTE) and Data Connection Equipment (DCE)
[9] Universal Serial Bus Revision 2.0 specification, https://www.usb.org/
[10] I2C-bus specification and user manual – UM10204, https://www.nxp.com/
[11] RFC 7252 - Constrained Application Protocol (CoAP)
[12] IEC 60079-0 - Explosive atmospheres, part 0: equipment general requirements
[13] IEC 60079-11 - Explosive atmospheres, part 11: equipment protection by intrinsic safety 'i'
[14] IEC 60079-26 - Explosive atmospheres, part 26: equipment with EPL Ga

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

Revision history

Revision	Date	Name	Comments
R01	26-May-2023	fvid	Initial release
R02	16-Feb-2024	fvid / sses	Updated products status. Added absolute maximum rating for VCC and VUSB_DET voltage ramp. Updated current consumption and GNSS characteristics. Improved PWR_ON pin specifications. Edited mechanical specifications. Corrected approvals description. Minor other clarifications and corrections.
R03	05-Apr-2024	fvid	Updated products status. Reduced eDRX deep-sleep time threshold. Added parameters for ATEX applications. Other editorial changes, clarifications, and corrections.
R04	06-Sep-2024	fvid / sses	Updated electrical specifications for PWR_ON, ANT_DET and ADC pins. Added SPI interface for u-blox open CPU solution (uCPU).

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