



SARA migration guide

Guidelines to migrate between SARA modules

Application note



Abstract

This document provides hardware design guidelines to migrate between u-blox cellular modules based on SARA form factor. u-blox cellular modules having 2G, 3G, LTE-M, NB-IoT as dominant technology use this compact form factor to provide complete and cost-efficient solutions, specifically designed for IoT, offering multi-band data transmission.

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This document applies to the following products:

Product name	Ordering code
SARA-R410M	SARA-R410M-02B
	SARA-R410M-52B
	SARA-R410M-63B
	SARA-R410M-73B
	SARA-R410M-83B
SARA-R412M	SARA-R412M-02B
SARA-R422	SARA-R422-00B
	SARA-R422-01B
SARA-R422S	SARA-R422S-00B
	SARA-R422S-01B
SARA-R422M8S	SARA-R422M8S-00B
SARA-R422M10S	SARA-R422M10S-01B
SARA-R500S	SARA-R500S-00B
	SARA-R500S-01B
	SARA-R500S-61B
	SARA-R500S-71B
SARA-R510S	SARA-R510S-00B
	SARA-R510S-01B
	SARA-R510S-61B
	SARA-R510S-71B
SARA-R510M8S	SARA-R510M8S-00B
	SARA-R510M8S-01B
	SARA-R510M8S-61B
	SARA-R510M8S-71B
SARA-G300	SARA-G300-00S
SARA-G310	SARA-G310-00S
SARA-G340	SARA-G340-00S
	SARA-G340-01S
	SARA-G340-02S
SARA-G340 ATEX	SARA-G340-00X
	SARA-G340-02X

Product name	Ordering code
SARA-G350	SARA-G350-00S
	SARA-G350-01S
	SARA-G350-01B
	SARA-G350-02S
SARA-G350 ATEX	SARA-G350-00X
	SARA-G350-02X
SARA-G350 Automotive	SARA-G350-02A
SARA-G450	SARA-G450-00C
	SARA-G450-01C
SARA-U201	SARA-U201-03B
	SARA-U201-63B
	SARA-U201-04B
SARA-U201 ATEX	SARA-U201-03X
	SARA-U201-04X
SARA-U201 Automotive	SARA-U201-03A
	SARA-U201-04A
SARA-U260	SARA-U260-00S
	SARA-U260-03S
SARA-U270	SARA-U270-00S
	SARA-U270-03S
	SARA-U270-04B
	SARA-U270-53S
	SARA-U270-73S
SARA-U270 ATEX	SARA-U270-00X
SARA-U270 Automotive	SARA-U270-03A
SARA-U280	SARA-U280-00S
	SARA-U280-03S
SARA-N200	SARA-N200-02B
SARA-N201	SARA-N201-02B
SARA-N210	SARA-N210-02B
SARA-N211	SARA-N211-02X
SARA-N280	SARA-N280-02B
SARA-N310	SARA-N310-00X

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1 SARA-R4/SARA-R5 modules description

u-blox SARA-R4 series LTE-M/NB-IoT/EGPRS and SARA-R5 series LTE-M/NB-IoT modules are ideal for IoT solutions, in the miniature SARA LGA form factor (26.0 x 16.0 mm, 96-pin).

They are easily integrated into compact designs and provide a seamless drop-in migration from other u-blox LPWA, GSM/GPRS, CDMA, UMTS/HSPA and LTE module families. They 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-N, SARA-G and SARA-U cellular module families, thus maximizing customer investments, simplifying application design, and enabling a very short time-to-market.

[Table 1](#) summarizes the main features and interfaces of SARA-R4 and SARA-R5 series modules.

With a discrete, hardware-based secure element and a lightweight pre-shared key management system, SARA-R5 series modules offer state-of-the-art security that is ideal for IoT applications and includes data encryption and decryption, zero touch provisioning, anti-cloning, and secure chip-to-chip communication. SARA-R4 and SARA-R5 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 those used in smart metering, smart cities, telematics, and connected health.

The modules support handover capability and deliver the technology necessary for applications such as vehicle, asset and people tracking where mobility is a prerequisite. Other applications where the modules are well-suited include but are not limited to smart home, security systems, industrial monitoring, and control.

The modules support multi-band data communication over an extended operating temperature range of -40 to +85 °C, with extremely low power consumption, and with coverage enhancement for deeper range into buildings and basements (and underground with NB-IoT).

[Table 2](#) summarizes cellular and GNSS characteristics of SARA-R4/R5 modules.

Product version	Region	RAT	Positioning	Interfaces	Features	Grade
		3GPP release baseline 3GPP LTE category LTE FDD bands (E)GPRS 4-band	Integrated GNSS receiver External GNSS control via modem AssistNow software CellLocate®	UART USB SPI SDIO DDC (I2C) GPIOs ADC I2S audio interface	Secure Cloud services Root of trust: secure element Antenna dynamic tuning CellTime™ Ultra-low consumption in PSM Embedded TCP/UDP stack Embedded HTTPS, FTPS, TLS DTLS FW update via serial u-blox FOTA (uFOTA) LwM2M device management MQTT MQTT-SN CoAP Last gasp Jamming detection Antenna and SIM detection	Standard Professional Automotive
SARA-R410M-02B	Multi Region	13 M1 NB1 *	• • •	• • • •	• • • • • • • • •	•
SARA-R410M-52B	North America	13 M1 2,4,5 12,13	• •	• • • •	• • • • • • • • •	•
SARA-R410M-63B	Japan	13 M1 1,8,19	• • •	• • • •	• • • • • • • • • • •	•
SARA-R410M-73B	Korea	13 M1 3,5 26	• • •	• • • •	• • • • • • • • • • •	•
SARA-R410M-83B	Multi Region	13 M1 NB1 3,5,8 20,28	• • •	• • • •	• • • • • • • • • • •	•
SARA-R412M-02B	Multi Region	13 M1 NB1 * •	• • •	• • • •	• • • • • • • • •	•
SARA-R422-00B	Multi Region	14 M1 NB2 * •		• ■ • •	• • • • • •	•
SARA-R422-01B	Multi Region	14 M1 NB2 * •		• ■ • •	• • • • • • •	•
SARA-R422S-00B	Multi Region	14 M1 NB2 * •	• • •	• ■ • • ○	• • • • • • • • • • •	•
SARA-R422S-01B	Multi Region	14 M1 NB2 * •	• • •	• ■ • • ○	• • • • • • • • • • • •	•
SARA-R422M8S-00B	Multi Region	14 M1 NB2 * •	• • •	• ■ • • ○	• • • • • • • • • • • • • •	•
SARA-R422M10S-01B	Multi Region	14 M1 NB2 * •	• • •	• ■ • • ○	• • • • • • • • • • • • • • •	•
SARA-R500S-00B	Multi Region	14 M1 *	• • •	• † • •	• • • • • • • • • • • • • • • •	•
SARA-R500S-01B	Multi Region	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R500S-61B	Japan	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R500S-71B	Korea	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510S-00B	Multi Region	14 M1 *	• • •	• † • •	• • • • • • • • • • • • • • • •	•
SARA-R510S-01B	Multi Region	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510S-61B	Japan	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510S-71B	Korea	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510M8S-00B	Multi Region	14 M1 *	• • •	• † • •	• • • • • • • • • • • • • • • •	•
SARA-R510M8S-01B	Multi Region	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510M8S-61B	Japan	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•
SARA-R510M8S-71B	Korea	14 M1 NB2 *	• • •	• † ○ ○ • • • ○	• • • • • • • • • • • • • • • •	•

● = supported by all FW versions ■ = supported for FW update and diagnostic ◆ = supported for diagnostic ○ = supported by future FW versions
* = see [Table 2](#) for the complete list of LTE FDD bands supported by related product versions

Table 1: SARA-R4 and SARA-R5 series main features summary

Feature	SARA-R410M	SARA-R412M	SARA-R422 SARA-R422S SARA-R422M8S SARA-R422M10S	SARA-R500S SARA-R510S SARA-R510M8S
Protocol stack	3GPP release 13	3GPP release 13	3GPP release 14	3GPP release 14
Cellular RAT	LTE Cat M1 Half-Duplex LTE Cat NB1 Half-Duplex ^{1,2}	LTE Cat M1 Half-Duplex LTE Cat NB1 Half-Duplex 2G GPRS / EGPRS	LTE Cat M1 Half-Duplex LTE Cat NB2 Half-Duplex 2G GPRS / EGPRS	LTE Cat M1 Half-Duplex LTE Cat NB2 Half-Duplex ³
LTE FDD bands	Band 1 (2100 MHz) ^{1,5} Band 2 (1900 MHz) ^{2,5} Band 3 (1800 MHz) ¹ Band 4 (1700 MHz) ^{2,5} Band 5 (850 MHz) Band 8 (900 MHz) ¹ Band 12 (700 MHz) ^{2,5} Band 13 (750 MHz) ^{2,5} Band 18 (850 MHz) ^{1,2,5} Band 19 (850 MHz) ^{1,5} Band 20 (800 MHz) ^{1,2} Band 25 (1900 MHz) ^{1,2,4,5} Band 26 (850 MHz) ^{1,5} Band 28 (700 MHz) ^{1,2}	Band 2 (1900 MHz) Band 3 (1800 MHz) Band 4 (1700 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 12 (700 MHz) Band 13 (750 MHz) Band 20 (800 MHz) Band 26 (850 MHz) Band 28 (700 MHz)	Band 1 (2100 MHz) Band 2 (1900 MHz) Band 3 (1800 MHz) Band 4 (1700 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 12 (700 MHz) Band 13 (750 MHz) Band 18 (850 MHz) ⁶ Band 19 (850 MHz) ⁶ Band 20 (800 MHz) Band 25 (1900 MHz) Band 26 (850 MHz) Band 28 (700 MHz) Band 66 (1700 MHz) Band 85 (700 MHz)	Band 1 (2100 MHz) Band 2 (1900 MHz) Band 3 (1800 MHz) Band 4 (1700 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 12 (700 MHz) Band 13 (750 MHz) Band 18 (850 MHz) Band 19 (850 MHz) Band 20 (800 MHz) Band 25 (1900 MHz) Band 26 (850 MHz) Band 28 (700 MHz) Band 66 (1700 MHz) Band 71 (600 MHz) Band 85 (700 MHz)
2G bands		GSM 850 MHz E-GSM 900 MHz DCS 1800 MHz PCS 1900 MHz	GSM 850 MHz E-GSM 900 MHz DCS 1800 MHz PCS 1900 MHz	
Power class	LTE Cat M1 / NB1 ⁷ : Class 3 (23 dBm)	LTE Cat M1 / NB1: Class 3 (23 dBm) 2G GMSK: GSM/E-GSM bands: Class 4 (33 dBm) DCS/PCS bands: Class 1 (30 dBm) 2G 8-PSK: GSM/E-GSM bands: Class E2 (27 dBm) DCS/PCS bands: Class E2 (26 dBm)	LTE Cat M1 / NB2: Class 3 (23 dBm) 2G GMSK: GSM/E-GSM bands: Class 4 (33 dBm) DCS/PCS bands: Class 1 (30 dBm) 2G 8-PSK: GSM/E-GSM bands: Class E2 (27 dBm) DCS/PCS bands: Class E2 (26 dBm)	LTE Cat M1 / NB2 ³ : Class 3 (23 dBm)

¹ Not supported by SARA-R410M-52B-01 or SARA-R410M-52B-02 product version

² Not supported by SARA-R410M-63B or SARA-R410M-73B product versions

³ LTE Cat NB2 not supported by SARA-R500S-00B, SARA-R510S-00B, SARA-R510M8S-00B product versions

⁴ Not supported in LTE Cat NB1 by SARA-R410M-02B-01, SARA-R410M-02B-02, or SARA-R410M-02B-03 product version

⁵ Not supported by SARA-R410M-83B product version

⁶ Not supported by SARA-R422-00B, SARA-R422S-00B, SARA-R422M8S-00B

⁷ LTE Cat NB1 not supported by SARA-R410M-52B, SARA-R410M-63B, SARA-R410M-73B product versions

Feature	SARA-R410M	SARA-R412M	SARA-R422 SARA-R422S SARA-R422M8S SARA-R422M10S	SARA-R500S SARA-R510S SARA-R510M8S
Data rate	LTE Cat M1: up to 375 kbit/s UL up to 300 kbit/s DL LTE Cat NB1 ⁸ : up to 62.5 kbit/s UL up to 27.2 kbit/s DL	LTE Cat M1: up to 375 kbit/s UL up to 300 kbit/s DL LTE Cat NB1: up to 62.5 kbit/s UL up to 27.2 kbit/s DL GPRS multi-slot class 33 ⁹ up to 85.6 kbit/s UL up to 107 kbit/s DL EGPRS multi-slot class 33 ⁹ up to 236.8 kbit/s UL up to 296.0 kbit/s DL	LTE Cat M1: up to 1119 kbit/s UL up to 588 kbit/s DL LTE Cat NB2: up to 158.5 kbit/s UL up to 127 kbit/s DL GPRS multi-slot class 33 ⁹ up to 85.6 kbit/s UL up to 107 kbit/s DL EGPRS multi-slot class 33 ⁹ up to 236.8 kbit/s UL up to 296.0 kbit/s DL	LTE Cat M1: up to 1200 kbit/s UL up to 375 kbit/s DL LTE Cat NB2 ¹⁰ : up to 140 kbit/s UL up to 125 kbit/s DL
GNSS receiver			SARA-R422M8S only: u-blox UBX-M8030 SPG 3.01 with concurrent reception of up to 3 GNSS GPS L1C/A Galileo E1B/C GLONASS L1OF BeiDou B1I SARA-R422M10S only: u-blox UBX-M10050 SPG 5.10 with concurrent reception of up to 4 GNSS GPS L1C/A Galileo E1B/C GLONASS L1OF BeiDou B1I, B1C	SARA-R510M8S only: u-blox UBX-M8030 SPG 3.01 with concurrent reception of up to 3 GNSS GPS L1C/A Galileo E1B/C GLONASS L1OF BeiDou B1I

Table 2: SARA-R4 and SARA-R5 series modules cellular and GNSS characteristics summary

⁸ LTE Cat NB1 not supported by SARA-R410M-52B, SARA-R410M-63B, SARA-R410M-73B product versions

⁹ GPRS/EGPRS multi-slot class 33 implies a maximum of 5 slots in downlink and 4 slots in uplink, with 6 slots in total

¹⁰ LTE Cat NB2 not supported by SARA-R500S-00B, SARA-R510S-00B, SARA-R510M8S-00B product versions

2 SARA-N2/SARA-N3 modules description

SARA-N2 and SARA-N3 series modules are NB-IoT solutions in the miniature SARA LGA form factor (26.0x 16.0 mm, 96-pin), offering LTE Cat NB1 /NB2 data communication over an extended operating temperature range of -40 to +85 °C, with extremely low power consumption.

The SARA-N2 series includes four variants supporting single-band NB-IoT data communication for Europe, China, APAC and South America, plus a dual-band variant mainly designed for Europe.

The SARA-N3 series offers multi-band NB-IoT data communication enabling multi-regional coverage, and they introduce several new functionalities for NB-IoT products, including features like TCP, MQTT, DTLS, SSL/TLS, LwM2M, HTTP(S) and many others.

SARA-N2 and SARA-N3 modules are ideally suited to battery-powered IoT applications characterized by occasional communications of small amounts of data.

The modules are the optimal choice for IoT devices designed to operate in locations with very limited coverage and requiring low energy consumption to permit a very long operating life with the primary batteries. Examples of applications include and are not limited to: smart grids, smart metering, telematics, street lighting, environmental monitoring and control, security and asset tracking.

Table 3 describes a summary of interfaces and features provided by SARA-N2 and SARA-N3 modules.

[illegible]

● = Supported ○ = Available in future FW ★ = Additional bands (1, 2, 4, 12, 13, 18, 19, 26, 66, 71, 85) available in future FW

Table 3: SARA-N2 and SARA-N3 characteristics summary

Table 4 summarizes cellular radio access technology characteristics of SARA-N2 / SARA-N3 modules.

Item	SARA-N2 series	SARA-N310 ¹¹
Protocol stack	3GPP Release 13	3GPP Release 14 ¹²
Radio Access Technology	LTE Category NB1 Half-Duplex Single-tone Single HARQ process eDRX Power Saving Mode Coverage enhancement A and B	LTE Category NB2 Half-Duplex Multi-tone Two HARQ process eDRX Power Saving Mode Coverage enhancement A and B
Operating band	SARA-N200: • Band 8 (900 MHz) SARA-N201: • Band 5 (850 MHz) SARA-N210: • Band 20 (800 MHz) SARA-N211: • Band 8 (900 MHz) • Band 20 (800 MHz) SARA-N280: • Band 28 (700 MHz)	Band 3 (1800 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 20 (800 MHz) Band 28 (700 MHz)
Power class	Class 3 (23 dBm) ¹³	Class 3 (23 dBm) ¹³
Deployment mode	In-Band Guard-Band Standalone	In-Band Guard-Band Standalone
Radio link data rate	Up to 31.25 kb/s UL Up to 27.2 kb/s DL	Up to 140 kb/s UL Up to 125 kb/s DL

Table 4: SARA-N2 and SARA-N3 modules NB-IoT characteristics summary

¹¹ Additional bands (1, 2, 4, 12, 13, 18, 19, 26, 66, 71, 85) available in future FW versions

¹² Key subset of features

¹³ Configurable to other power class by AT command

3 Migration between SARA modules

3.1 Overview

The u-blox SARA form factor (26.0 x 16.0 mm, 96-pin LGA) includes the following series of modules, with compatible pin assignments as described in [Figure 1](#), so that the modules can be alternatively mounted on a single application PCB using exactly the same copper, solder resist and paste mask:

- SARA-R41 series modules supporting LTE Cat M1, LTE Cat NB1 and 2G radio access technologies
- SARA-R42 series modules supporting LTE Cat M1, LTE Cat NB2 and 2G radio access technologies
- SARA-R5 series modules supporting LTE Cat M1 and LTE Cat NB2 radio access technologies
- SARA-N2 series modules supporting LTE Cat NB1 radio access technology
- SARA-N3 series modules supporting LTE Cat NB2 radio access technology
- SARA-G3 series modules supporting 2G radio access technology
- SARA-G4 series modules supporting 2G radio access technology
- SARA-U2 series modules supporting 3G and 2G radio access technologies

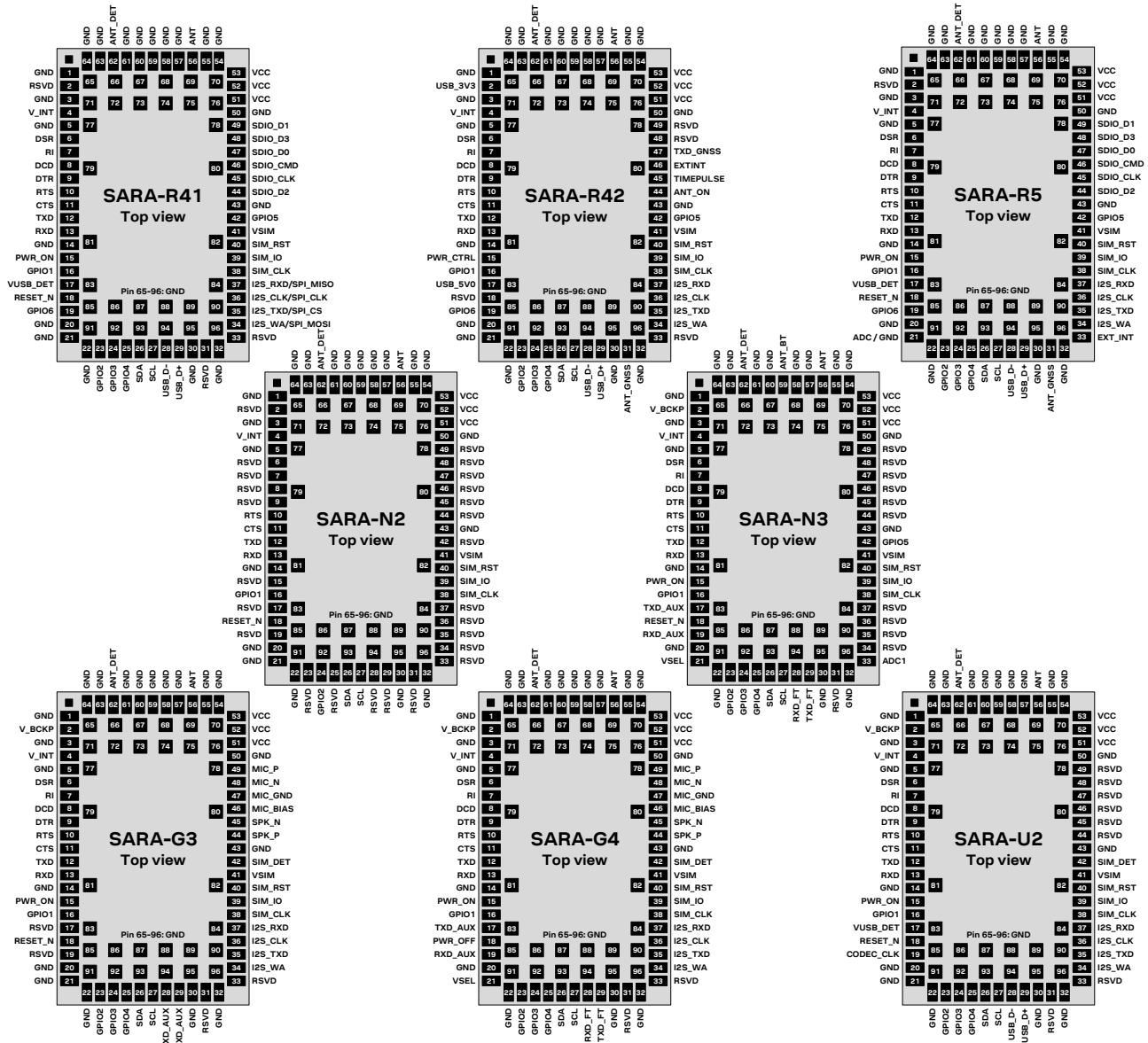


Figure 1: SARA-R4, SARA-R5, SARA-N2, SARA-N3, SARA-G3, SARA-G4, and SARA-U2 modules' layout and pinout

The SARA modules are also form-factor compatible with the u-blox LARA, LISA, and TOBY cellular module families. Although each has a different form factor, the footprints for the TOBY, LISA, LARA, and SARA modules have been developed to ensure layout compatibility.

With the u-blox “nested design” solution, any TOBY, LISA, LARA, or SARA module can be alternatively mounted on the same space of a single “nested” application board as described in [Figure 2](#). Guidelines to implement a nested application board, description of the u-blox reference nested design and comparison between TOBY, LISA, LARA and SARA modules are provided in the nested design application note [\[10\]](#).

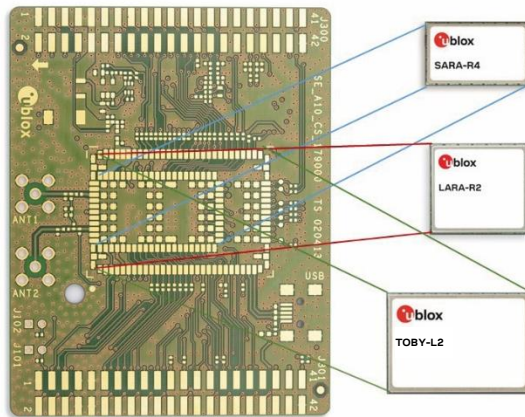


Figure 2: Cellular modules' layout compatibility: all modules can be mounted on the same nested footprint

[Table 5](#) summarizes the main interfaces provided by SARA modules:

Modules	RF				Power	System	SIM	Serial				Audio	Other															
	LTE Cat M1	LTE Cat NB1	LTE Cat NB2	2G	3G	Integrated GNSS receiver	RTC supply I/O	V_INT supply at 1.8V	V_INT supply configurable	Switch-on input pin	Switch-off input pin	Reset input pin	SIM interface	SIM detection	UART	UART AUX	USB	SPI	SDIO	DDC (I ² C)	Analog audio	Digital audio	13/26 MHz output	GPIOs	Network indication	Antenna detection	External GNSS control	
SARA-R41	●	●	●				●			●	●		●	●	●	●	●			●				●	●	●	●	
SARA-R42	●		●	●		●	●	●		●	●	●	●	●	●	●	■			●		○	○	●	●	●	●	●
SARA-R5	●		●			●	●	●		●	●	●	●	●	●	●	◆	○	○	●		○	○	●	●	●	●	●
SARA-N2		●					●				●		●		●									●	●			
SARA-N3			●				●	●	●	●	●	●	●	○	●	○				○				●	●	●		
SARA-G3				●			●	●		●		●	●	●	●	●				●	●	●		●	●	●	●	
SARA-G4				●			●	●	●	●	●		●	●	●	●				●	●			●	●	●	●	
SARA-U2				●	●		●	●		●	●	●	●	●	●	●	●			●		●	●	●	●	●	●	

• = supported by available product version ■ = supported for FW update & diagnostic ♦ = supported for diagnostic ○ = supported by future product versions

Table 5: Summary of interfaces in SARA modules

Figure 3 summarizes the frequency ranges of the SARA modules' operating bands.

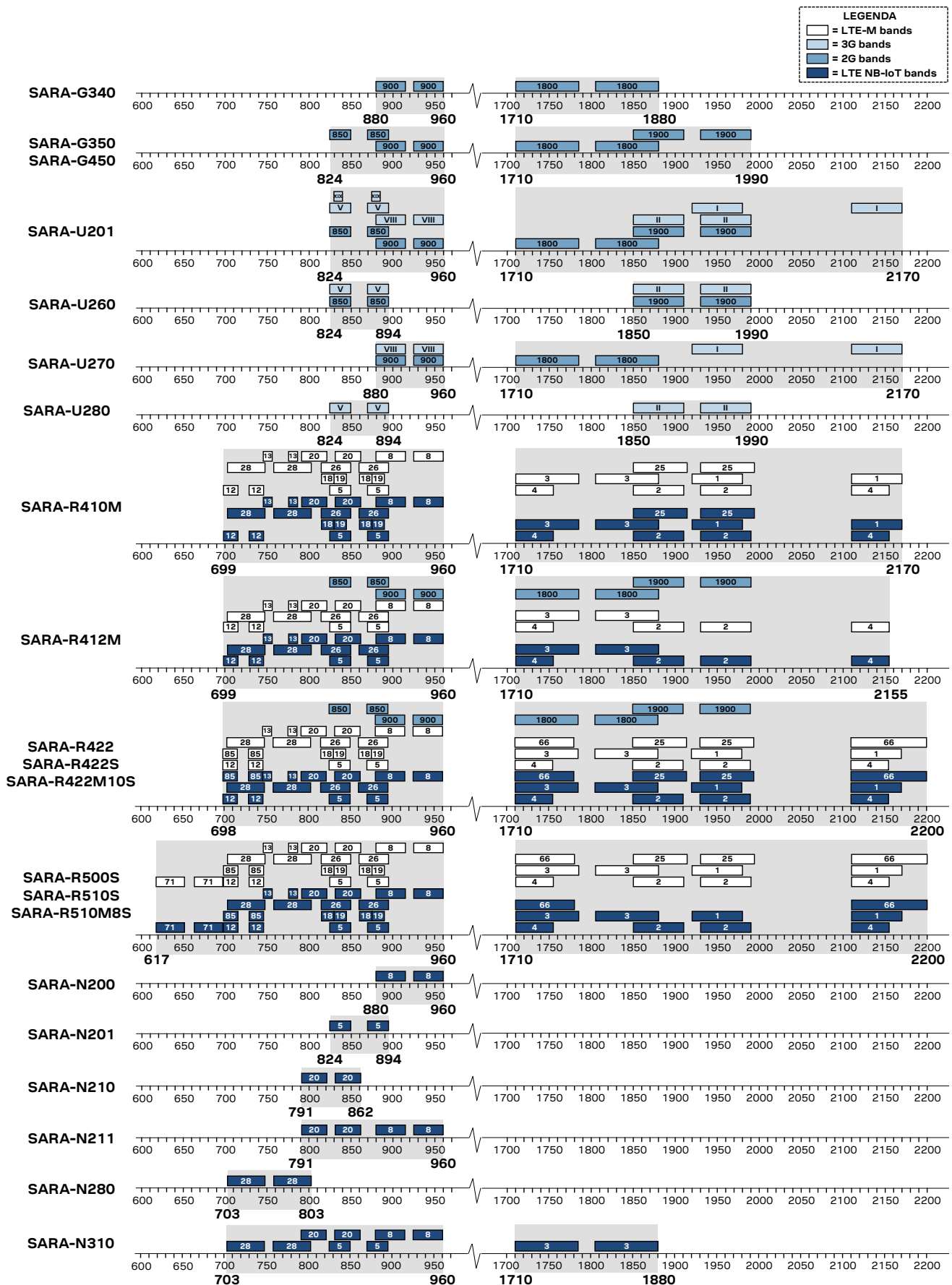


Figure 3: Summary of operating frequency bands supported by latest product versions of SARA modules

3.2 Pin-out comparison between SARA modules

Table 6 shows a pin-out comparison between the SARA-R4, SARA-R5, SARA-N2, SARA-N3, SARA-G3, SARA-G4, and SARA-U2 modules.

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
1	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
2	RSVD Reserved	USB_3V3 USB 3V3 supply Input TestPoint recommended	RSVD Reserved	RSVD Reserved	V_BCKP RTC supply I/O	V_BCKP RTC supply I/O	V_BCKP RTC supply I/O	V_BCKP RTC supply I/O
3	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
4	V_INT Supply output: 1.8 V typ ON when SARA is on, outside deep-sleep TestPoint recommended	V_INT Supply output: 1.8 V typ ON when SARA is on, outside deep-sleep TestPoint recommended	V_INT Supply output: 1.8 V typ ON when SARA is on, outside deep-sleep TestPoint recommended	V_INT Supply output: 1.8 V typ ON when radio is on TestPoint recommended	V_INT Supply output: 1.8 V typ / 2.8 V typ ON when SARA is on, outside deep-sleep Voltage value set by VSEL TestPoint recommended	V_INT Supply output: 1.8 V typ ON when SARA is on TestPoint recommended	V_INT Supply output: 1.8 V typ / 3.0 V typ ON when SARA is on Voltage value set by VSEL TestPoint recommended	V_INT Supply output: 1.8 V typ ON when SARA is on TestPoint recommended
5	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
6	DSR UART DSR output V_INT level (1.8 V) Driver strength: 2 mA	DSR UART DSR output V_INT level (1.8 V) Driver strength: 2 mA Also RTS for 2 nd UART	DSR UART DSR output V_INT level (1.8 V) Driver strength: 5 mA Also RTS for 2 nd UART	RSVD Reserved	DSR UART DSR output ¹⁴ V_INT level (1.8 / 2.8 V)	DSR UART DSR output V_INT level (1.8 V) Driver strength: 6 mA	DSR UART DSR output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	DSR UART DSR output V_INT level (1.8 V) Driver strength: 1 mA
7	RI UART RI output V_INT level (1.8 V) Driver strength: 2 mA	RI UART RI output V_INT level (1.8 V) Driver strength: 2 mA Also CTS for 2 nd UART	RI UART RI output V_INT level (1.8 V) Driver strength: 5 mA Also CTS for 2 nd UART	RSVD Reserved	RI UART RI output V_INT level (1.8 / 2.8 V) Driver strength: 3 mA Configurable as GPIO	RI UART RI output V_INT level (1.8 V) Driver strength: 6 mA	RI UART RI output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	RI UART RI output V_INT level (1.8 V) Driver strength: 2 mA
8	DCD UART DCD output V_INT level (1.8 V) Driver strength: 2 mA	DCD UART DCD output V_INT level (1.8 V) Driver strength: 2 mA Also RXD for 2 nd UART	DCD UART DCD output V_INT level (1.8 V) Driver strength: 5 mA Also RXD for 2 nd UART	RSVD Reserved	DCD UART DCD output ¹⁴ V_INT level (1.8 / 2.8 V)	DCD UART DCD output V_INT level (1.8 V) Driver strength: 6 mA	DCD UART DCD output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	DCD UART DCD output V_INT level (1.8 V) Driver strength: 2 mA
9	DTR UART DTR input V_INT level (1.8 V) Internal pull-up: ~100 kΩ Set low for URCs/Greeting	DTR UART DTR input V_INT level (1.8 V) Internal pull-up: ~100 kΩ Set low for greeting text Also TXD for 2 nd UART	DTR UART DTR input V_INT level (1.8 V) Internal pull-up: ~56 kΩ Set low for greeting text Also TXD for 2 nd UART	RSVD Reserved	DTR UART DTR input ¹⁵ V_INT level (1.8 / 2.8 V)	DTR UART DTR input V_INT level (1.8 V) Internal pull-up: ~33 kΩ	DTR UART DTR input V_INT level (1.8 / 3.0 V) Internal pull-up: ~166 kΩ	DTR UART DTR input V_INT level (1.8 V) Internal pull-up: ~14 kΩ Set low for greeting text

¹⁴ Not supported by "00" product version

¹⁵ Not supported by "00" product version

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
10	RTS UART RTS input V_INT level (1.8 V) Internal pull-up: ~100 kΩ Must be low to use UART on "00", "01" versions	RTS UART RTS input V_INT level (1.8 V) Internal pull-up: ~100 kΩ	RTS UART RTS input V_INT level (1.8 V) Internal pull-up: ~56 kΩ	RTS UART RTS input ¹⁶ VCC level (3.6 V typ.) Internal pull-up: ~78 kΩ	RTS UART RTS input V_INT level (1.8 / 2.8 V) Internal pull-up: ~171 kΩ Configurable as GPIO	RTS UART RTS input V_INT level (1.8 V) Internal pull-up: ~58 kΩ	RTS UART RTS input V_INT level (1.8 / 3.0 V) Internal pull-up: ~166 kΩ	RTS UART RTS input V_INT level (1.8 V) Internal pull-up: ~8 kΩ
11	CTS UART CTS output V_INT level (1.8 V) Driver strength: 2 mA	CTS UART CTS output V_INT level (1.8 V) Driver strength: 2 mA	CTS UART CTS output V_INT level (1.8 V) Driver strength: 5 mA	CTS UART CTS output ¹⁶ VCC level (3.6 V typ.) Driver strength: 1 mA Configurable as RI or Network Indicator	CTS UART CTS output V_INT level (1.8 / 2.8 V) Driver strength: 3 mA Configurable as GPIO or Network Indicator	CTS UART CTS output V_INT level (1.8 V) Driver strength: 6 mA	CTS UART CTS output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	CTS UART CTS output V_INT level (1.8 V) Driver strength: 6 mA
12	TXD UART data input V_INT level (1.8 V) Internal PU/PD ~100 kΩ	TXD UART data input V_INT level (1.8 V) Internal pull-up ~100 kΩ	TXD UART data input V_INT level (1.8 V) Internal pull-up: ~56 kΩ TestPoint recommended	TXD UART data input VCC level (3.6 V typ.) No internal pull-up/down TestPoint recommended	TXD UART data input V_INT level (1.8 / 2.8 V) Internal pull-up: ~171 kΩ	TXD UART data input V_INT level (1.8 V) Internal pull-up: ~18 kΩ	TXD UART data input V_INT level (1.8 / 3.0 V) Internal pull-up: ~166 kΩ	TXD UART data input V_INT level (1.8 V) Internal pull-up: ~8 kΩ
13	RXD UART data output V_INT level (1.8 V) Driver strength: 2 mA	RXD UART data output V_INT level (1.8 V) Driver strength: 2 mA	RXD UART data output V_INT level (1.8 V) Driver strength: 5 mA TestPoint recommended	RXD UART data output VCC level (3.6 V typ.) Driver strength: 1 mA TestPoint recommended	RXD UART data output V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	RXD UART data output V_INT level (1.8 V) Driver strength: 6 mA	RXD UART data output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	RXD UART data output V_INT level (1.8 V) Driver strength: 6 mA
14	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
15	PWR_ON Power-on/off input Internal pull-up: ~200 kΩ L-level: -0.30 ÷ 0.35 V ON L-level time: 0.15 s min – 3.2 s max OFF L-level pulse time: 1.5 s min TestPoint recommended	PWR_CTRL Power-on/off / reset input Internal pull-up L-level: -0.30 ÷ 0.35 V ON L-level pulse time: 0.01 s min – 1.7 s max OFF L-level pulse time: 1.5 s min – 14 s max Reset L-level pulse time: 16 s min TestPoint recommended	PWR_ON Power-on/off input Internal pull-up: ~10 kΩ L-level: -0.30 ÷ 0.30 V ON L-level time: 1 s min – 2 s max ¹⁷ 0.1 s min – 2 s max OFF L-level pulse time: Not Available TestPoint recommended	RSVD Reserved	PWR_ON Power-on/off input Internal pull-up: ~90 kΩ L-level: 0.00 ÷ 0.20 V ON L-level pulse time: 1 s min – 2.5 s max OFF L-level pulse time: 2.5 s min TestPoint recommended	PWR_ON Power-on input No internal pull-up L-level: -0.10 ÷ 0.65 V ON L-level time: 5 ms min OFF L-level pulse time: Not Available TestPoint recommended	PWR_ON Power-on input Internal pull-up: ~28 kΩ L-level: 0.00 ÷ 0.30 V ON L-level time: 2 s min OFF L-level time: Not Available TestPoint recommended	PWR_ON Power-on/off input No internal pull-up L-level: -0.30 ÷ 0.65 V ON L-level pulse time: 50 μs min / 80 μs max OFF L-level pulse time: 1 s min TestPoint recommended

¹⁶ Not supported by "02" product version

¹⁷ SARA-R510S

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
16	GPIO1 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO1 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO1 GPIO V_INT level (1.8 V) Driver strength: 5 mA	GPIO1 Trace data output V_INT level (1.8 V) Driver strength: 1 mA TestPoint recommended	GPIO1 GPIO V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	GPIO1 GPIO V_INT level (1.8 V) Driver strength: 6 mA	GPIO1 GPIO V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	GPIO1 GPIO V_INT level (1.8 V) Driver strength: 6 mA
17	VUSB_DET 5 V, USB detect input TestPoint recommended	USB_5V0 USB 5V0 supply Input TestPoint recommended	VUSB_DET 5 V, USB detect input TestPoint recommended	RSVD Reserved	TXD_AUX AUX UART data input ¹⁸ V_INT level (1.8 / 2.8 V)	RSVD Reserved	TXD_AUX AUX UART data input ¹⁹ V_INT level (1.8 / 3.0 V) Internal pull-up: ~166 kΩ	VUSB_DET 5 V, USB detect input TestPoint recommended
18	RESET_N Shutdown input Internal pull-up: ~37 kΩ L-level: -0.30 ÷ 0.63 V H-level: 1.17 ÷ 2.10 V It triggers shutdown of the whole module when set low or toggled. TestPoint recommended	RSVD Reserved	RESET_N Reset input Internal pull-up: ~56 kΩ L-level: -0.30 ÷ 0.50 V H-level: 1.3 ÷ 2.1 V It triggers module reboot when toggled, without PMU shutdown when low. TestPoint recommended	RESET_N Reset input Internal pull-up: ~78 kΩ L-level: 0 ÷ 0.36*VCC H-level: 0.52*VCC ÷ VCC It triggers module reboot when toggled, without PMU shutdown when low. TestPoint recommended	RESET_N Reset shutdown input Internal pull-up: ~70 kΩ L-level: 0.00 ÷ 0.20 V H-level: 0.90 ÷ 1.10 V It triggers module reboot when toggled, with PMU shutdown when low. TestPoint recommended	RESET_N Reset input Internal diode & pull-up L-level: -0.10 ÷ 0.15 V H-level: 1.40 ÷ 4.50 V It triggers module reboot when toggled, without PMU shutdown when low. TestPoint recommended	PWR_OFF Shutdown input Internal diode L-level: 0.00 ÷ 0.10 V H-level: 1.20 ÷ 1.50 V It triggers shutdown of the whole module when set low or toggled. TestPoint recommended	RESET_N Reset shutdown input Internal pull-up: 10 kΩ L-level: -0.30 ÷ 0.51 V H-level: 1.32 ÷ 2.01 V It triggers module reboot when toggled, with PMU shutdown when low. TestPoint recommended
19	GPIO6 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO6 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO6 GPIO V_INT level (1.8 V) Driver strength: 5 mA	RSVD Reserved	RXD_AUX AUX UART data output ¹⁸ V_INT level (1.8 / 2.8 V)	RSVD Reserved	RXD_AUX AUX UART data output ¹⁹ V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	CODEC_CLK 13 or 26 MHz output V_INT level (1.8 V) Driver strength: 4 mA
20	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
21	GND Ground	GND Ground	GND / ADC "00B" product version: Ground "x1B" versions onwards: 12-bit ADC input, which can also be grounded	GND Ground	VSEL V_INT voltage selection VSEL connected to GND: V_INT = 1.8 V VSEL unconnected: V_INT = 2.8 V	GND Ground	VSEL V_INT voltage selection VSEL connected to GND: V_INT = 1.8 V VSEL unconnected: V_INT = 3.0 V	GND Ground
22	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
23	GPIO2 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO2 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO2 GPIO V_INT level (1.8 V) Driver strength: 5 mA	RSVD Reserved	GPIO2 GPIO V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	GPIO2 GPIO V_INT level (1.8 V) Driver strength: 6 mA	GPIO2 GPIO V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	GPIO2 GPIO V_INT level (1.8 V) Driver strength: 6 mA
24	GPIO3 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO3 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO3 GPIO V_INT level (1.8 V) Driver strength: 5 mA	GPIO2 ²⁰ V_INT level (1.8 V) Driver strength: 1 mA	GPIO3 GPIO V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	GPIO3 GPIO V_INT level (1.8 V) Driver strength: 5 mA	GPIO3 GPIO V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	GPIO3 GPIO V_INT level (1.8 V) Driver strength: 6 mA

¹⁸ Not supported by "00" product version

¹⁹ Not supported by "00" product version

²⁰ Not supported by "02" product version

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
25	GPIO4 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO4 GPIO V_INT level (1.8 V) Driver strength: 2 mA	GPIO4 GPIO V_INT level (1.8 V) Driver strength: 5 mA	RSVD Reserved	GPIO4 GPIO V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	GPIO4 GPIO V_INT level (1.8 V) Driver strength: 6 mA	GPIO4 GPIO V_INT level (1.8 / 3.0 V) Driver strength: 3 mA	GPIO4 GPIO V_INT level (1.8 V) Driver strength: 6 mA
26	SDA I2C data ²¹ V_INT level (1.8 V) Open drain Internal pull-up: 2.2 kΩ	SDA I2C data V_INT level (1.8 V) Open drain Internal pull-up: 2.2 kΩ	SDA I2C data V_INT level (1.8 V) Open drain Internal active pull-up	SDA I2C data ²² V_INT level (1.8 V) Open drain No internal pull-up	SDA I2C data ²³ V_INT level (1.8 / 2.8 V) Open drain Internal pull-up: 10 kΩ	SDA I2C data V_INT level (1.8 V) Open drain No internal pull-up	SDA I2C data ²⁴ V_INT level (1.8 / 3.0 V) Open drain No internal pull-up	SDA I2C data / AUX UART input V_INT level (1.8 V) Open drain No internal pull-up
27	SCL I2C clock ²¹ V_INT level (1.8 V) Open drain Internal pull-up: 2.2 kΩ	SCL I2C clock V_INT level (1.8 V) Open drain Internal pull-up: 2.2 kΩ	SCL I2C clock V_INT level (1.8 V) Open drain Internal active pull-up	SCL I2C clock ²² V_INT level (1.8 V) Open drain No internal pull-up	SCL I2C clock ²³ V_INT level (1.8 / 2.8 V) Open drain Internal pull-up: 10 kΩ	SCL I2C clock V_INT level (1.8 V) Open drain No internal pull-up	SCL I2C clock ²⁴ V_INT level (1.8 / 3.0 V) Open drain No internal pull-up	SCL I2C clock / AUX UART out V_INT level (1.8 V) Open drain No internal pull-up
28	USB_D- USB data I/O (D-) High-speed USB 2.0 TestPoint recommended	USB_D- USB data I/O (D-) High-speed USB 2.0, only for FW update / diagnostic TestPoint recommended	USB_D- USB data I/O (D-) High-speed USB 2.0, only for diagnostic TestPoint recommended	RSVD Reserved	RXD_FT FW update & Trace output V_INT level (1.8 / 2.8 V) Driver strength: 3 mA TestPoint recommended	RXD_AUX AUX UART data output V_INT level (1.8 V) Driver strength: 5 mA TestPoint recommended	RXD_FT FW update & Trace output V_INT level (1.8 / 3.0 V) Driver strength: 3 mA TestPoint recommended	USB_D- USB data I/O (D-) High-speed USB 2.0 TestPoint recommended
29	USB_D+ USB data I/O (D+) High-speed USB 2.0 TestPoint recommended	USB_D+ USB data I/O (D+) High-speed USB 2.0, only for FW update / diagnostic TestPoint recommended	USB_D+ USB data I/O (D+) High-speed USB 2.0, only for diagnostic TestPoint recommended	RSVD Reserved	TXD_FT FW update & Trace input V_INT level (1.8 / 2.8 V) Internal pull-up: ~171 kΩ TestPoint recommended	TXD_AUX AUX UART data input V_INT level (1.8 V) Internal pull-up: ~18 kΩ TestPoint recommended	TXD_FT FW update & Trace input V_INT level (1.8 / 3.0 V) Internal pull-up: ~166 kΩ TestPoint recommended	USB_D+ USB data I/O (D+) High-speed USB 2.0 TestPoint recommended
30	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
31	RSVD Reserved	ANT_GNSS GNSS RF input ²⁵	ANT_GNSS GNSS RF input ²⁶	RSVD Reserved	RSVD Reserved	RSVD Reserved	RSVD Reserved	RSVD Reserved
32	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground
33	RSVD Reserved It can be grounded	RSVD Reserved TestPoint recommended	EXT_INT External interrupt It can be grounded	RSVD Reserved It can be grounded	ADC1 ADC input It can be grounded	RSVD Reserved It must be grounded	RSVD Reserved It can be grounded	RSVD Reserved It must be grounded

²¹ Not supported by "00" and "01" product versions

²² Not supported by "02" product version

²³ Not supported by "00" product version

²⁴ Not supported by "00" product version

²⁵ Not supported by SARA-R422, SARA-R422S

²⁶ Not supported by SARA-R500S, SARA-R510S

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
34	I2S_WA / SPI_MOSI I2S W.A. ²⁷ / SPI MOSI ²⁷ V_INT level (1.8 V) Driver strength: 2 mA	I2S_WA I2S Word Alignment ²⁸ V_INT level (1.8 V) Driver strength: 2 mA Configurable as antenna dynamic tuner on "01B" versions onwards	I2S_WA I2S Word Alignment ²⁹ V_INT level (1.8 V) Driver strength: 5 mA Configurable as antenna dynamic tuner	RSVD Reserved	RSVD Reserved	I2S_WA I2S Word Alignment V_INT level (1.8 V) Driver strength: 6 mA	I2S_WA Not supported	I2S_WA I2S Word Alignment V_INT level (1.8 V) Driver strength: 2 mA Configurable as GPIO
35	I2S_TXD / SPI_CS I2S out ²⁷ / SPI CS ²⁷ V_INT level (1.8 V) Driver strength: 2 mA	I2S_TXD I2S data output ²⁸ V_INT level (1.8 V) Driver strength: 2 mA Configurable as antenna dynamic tuner on "01B" versions onwards	I2S_TXD I2S data output ²⁹ V_INT level (1.8 V) Driver strength: 5 mA Configurable as antenna dynamic tuner	RSVD Reserved	RSVD Reserved	I2S_TXD I2S data output V_INT level (1.8 V) Driver strength: 5 mA	I2S_TXD Not supported	I2S_TXD I2S data output V_INT level (1.8 V) Driver strength: 2 mA Configurable as GPIO
36	I2S_CLK / SPI_CLK I2S clock ²⁷ / SPI clock ²⁷ V_INT level (1.8 V) Driver strength: 2 mA	I2S_CLK I2S clock ²⁸ V_INT level (1.8 V) Driver strength: 2 mA	I2S_CLK I2S clock ²⁹ V_INT level (1.8 V) GEOFENCE 1.8 V PIO15 of the internal UBX-M8 GNSS on SARA-R510M8S-x1B	RSVD Reserved	RSVD Reserved	I2S_CLK I2S clock V_INT level (1.8 V) Driver strength: 5 mA	I2S_CLK Not supported	I2S_CLK I2S clock V_INT level (1.8 V) Driver strength: 2 mA Configurable as GPIO
37	I2S_RXD / SPI_MISO I2S input ²⁷ / SPI MISO ²⁷ V_INT level (1.8 V)	I2S_RXD I2S input ²⁸ V_INT level (1.8 V)	I2S_RXD I2S data input ²⁹ V_INT level (1.8 V) ANT_ON 1.8 V PIO16 of the internal UBX-M8 GNSS on SARA-R510M8S-x1B	RSVD Reserved	RSVD Reserved	I2S_RXD I2S data input V_INT level (1.8 V) Internal pull-down: ~18 kΩ	I2S_RXD Not supported	I2S_RXD I2S data input V_INT level (1.8 V) Internal pull-down: ~8 kΩ Configurable as GPIO
38	SIM_CLK 1.8 V / 3 V SIM clock	SIM_CLK 1.8 V SIM clock	SIM_CLK 1.8 V / 3 V SIM clock	SIM_CLK 1.8 V SIM clock	SIM_CLK 1.8 V / 3 V SIM clock	SIM_CLK 1.8 V / 3 V SIM clock	SIM_CLK 1.8 V / 3 V SIM clock	SIM_CLK 1.8 V / 3 V SIM clock
39	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ	SIM_IO 1.8 V / 3 V SIM data I/O Internal pull-up: 4.7 kΩ
40	SIM_RST 1.8 V / 3 V SIM reset	SIM_RST 1.8 V SIM reset	SIM_RST 1.8 V / 3 V SIM reset	SIM_RST 1.8 V SIM reset	SIM_RST 1.8 V / 3 V SIM reset	SIM_RST 1.8 V / 3 V SIM reset	SIM_RST 1.8 V / 3 V SIM reset	SIM_RST 1.8 V / 3 V SIM reset
41	VSIM 1.8 V / 3 V SIM supply	VSIM 1.8 V SIM supply	VSIM 1.8 V / 3 V SIM supply	VSIM 1.8 V SIM supply	VSIM 1.8 V / 3 V SIM supply	VSIM 1.8 V / 3 V SIM supply	VSIM 1.8 V / 3 V SIM supply	VSIM 1.8 V / 3 V SIM supply
42	GPIO5 GPIO / SIM detection input V_INT level (1.8 V) Driver strength: 2 mA	GPIO5 GPIO / SIM detection input V_INT level (1.8 V) Driver strength: 2 mA	GPIO5 GPIO / SIM detection input V_INT level (1.8 V) Driver strength: 5 mA	RSVD Reserved	GPIO5 SIM detection ³⁰ / GPIO V_INT level (1.8 / 2.8 V) Driver strength: 3 mA	SIM_DET SIM detection input V_INT level (1.8 V)	SIM_DET SIM detection input V_INT level (1.8 V / 3.0 V)	SIM_DET SIM detection input V_INT level (1.8 V) Configurable as GPIO
43	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground	GND Ground

²⁷ Not supported by "00", "01", "x2" and "x3" product versions

²⁸ Not supported by "00" and "01" product version

²⁹ Not supported by "00" and "01" product versions

³⁰ Not supported by "00" product version

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
44	SDIO_D2	ANT_ON	SDIO_D2	RSVD	RSVD	SPK_P	SPK_P	RSVD
	SDIO serial data [2] ³¹	GNSS LNA on/off signal connected to the internal GNSS chip and LNA ³²	SDIO serial data [2] ³³ Configurable as SPI_CLK (diagnostic only)	Reserved	Reserved	Analog audio output (+)	Analog audio output (+) ³⁴	Reserved
45	SDIO_CLK	TIMEPULSE	SDIO_CLK	RSVD	RSVD	SPK_N	SPK_N	RSVD
	SDIO serial clock ³¹	GNSS time pulse output ³²	SDIO serial clock ³³	Reserved	Reserved	Analog audio output (-)	Analog audio output (-) ³⁴	Reserved
46	SDIO_CMD	EXTINT	SDIO_CMD	RSVD	RSVD	MIC_BIAS	MIC_BIAS	RSVD
	SDIO command ³¹	GNSS external interrupt ³²	SDIO command ³³	Reserved	Reserved	Microphone supply	Microphone supply ³⁴	Reserved
47	SDIO_D0	TXD_GNSS	SDIO_D0	RSVD	RSVD	MIC_GND	MIC_GND	RSVD
	SDIO serial data [0] ³¹	GNSS UART data output ³²	SDIO serial data [0] ³³ Configurable as SPI_MOSI (diagnostic only)	Reserved	Reserved	Microphone ground	Microphone ground ³⁴	Reserved
48	SDIO_D3	RSVD	SDIO_D3	RSVD	RSVD	MIC_N	MIC_N	RSVD
	SDIO serial data [3] ³¹	Reserved	SDIO serial data [3] ³³ Configurable as SPI_CS (diagnostic only)	Reserved	Reserved	Analog audio input (-)	Analog audio input (-) ³⁴	Reserved
49	SDIO_D1	RSVD	SDIO_D1	RSVD	RSVD	MIC_P	MIC_P	RSVD
	SDIO serial data [1] ³¹	Reserved	SDIO serial data [1] ³³ Configurable as SPI_MISO (diagnostic only)	Reserved	Reserved	Analog audio input (+)	Analog audio input (+) ³⁴	Reserved
50	GND	GND	GND	GND	GND	GND	GND	GND
	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
51-53	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC
	Module supply input Normal op. range: 3.20 ÷ 4.20 V Extended op. range: 3.00 ÷ 4.30 V No turn-on by VCC apply	Module supply input Normal op. range: 3.20 ÷ 4.50 V Extended op. range: 3.00 ÷ 4.50 V No turn-on by VCC apply	Module supply input Normal op. range: 3.30 ÷ 4.40 V Extended op. range: 3.00 ÷ 4.50 V SARA-R510S: No turn-on by VCC apply SARA-R500S/R510M8S: Turn-on by VCC apply	Module supply input Normal op. range: 3.10 ÷ 4.00 V Extended op. range: 2.75 ÷ 4.20 V Turn-on by VCC apply	Module supply input Normal op. range: 3.20 ÷ 4.20 V Extended op. range: 2.60 ÷ 4.20 V No turn-on by VCC apply	Module supply input Normal op. range: 3.35 ÷ 4.50 V Extended op. range: 3.00 ÷ 4.50 V Turn-on by VCC apply	Module supply input Normal op. range: 3.40 ÷ 4.20 V Extended op. range: 3.10 ÷ 4.50 V No turn-on by VCC apply	Module supply input Normal op. range: 3.30 ÷ 4.40 V Extended op. range: 3.10 ÷ 4.50 V Turn-on by VCC apply
54-55	GND	GND	GND	GND	GND	GND	GND	GND
	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
56	ANT	ANT	ANT	ANT	ANT	ANT	ANT	ANT
	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O	Cellular RF I/O
57-58	GND	GND	GND	GND	GND	GND	GND	GND
	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground

³¹ Not supported by "00", "01", "x2" and "x3" product versions

³² Not supported by SARA-R422, SARA-R422S

³³ Not supported by "00" and "01" product versions

³⁴ Not supported by "00" product version

No	SARA-R41 series	SARA-R42 series	SARA-R5 series	SARA-N2 series	SARA-N3 series	SARA-G3 series	SARA-G4 series	SARA-U2 series
59	GND	GND	GND	GND	ANT_BT	GND	GND	GND
	Ground	Ground	Ground	Ground	Bluetooth RF I/O ³⁵ It can be grounded	Ground	Ground	Ground
60-61	GND	GND	GND	GND	GND	GND	GND	GND
	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
62	ANT_DET	ANT_DET	ANT_DET	ANT_DET	ANT_DET	ANT_DET	ANT_DET	ANT_DET
	Antenna detection	Antenna detection	Antenna detection	Antenna detection ³⁶	Antenna detection / ADC	Antenna detection	Antenna detection	Antenna detection
63-96	GND	GND	GND	GND	GND	GND	GND	GND
	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground

Table 6: SARA-N2, SARA-N3, SARA-R4, SARA-R5, SARA-G3, SARA-G4 and SARA-U2 series modules pin assignment and description, with remarks for migration



For further details regarding characteristics, capabilities, usage or settings applicable for each interface of the SARA-N2, SARA-N3, SARA-R4, SARA-R5, SARA-G3, SARA-G4, and SARA-U2 cellular modules, see the related data sheet [\[1\]](#), [\[5\]](#), [\[6\]](#), [\[7\]](#), [\[11\]](#), [\[12\]](#), [\[13\]](#), the related integration manual [\[2\]](#), [\[8\]](#), [\[9\]](#), [\[14\]](#), [\[15\]](#) and the nested design application note [\[10\]](#).

³⁵ Not supported by "00" product version

³⁶ Not supported by "02" product version

3.3 Schematic for SARA modules integration

Figure 4 shows an example of a simple schematic diagram where a u-blox SARA-N2, SARA-N3, SARA-R4, SARA-R5, SARA-G3, SARA-G4, and/or SARA-U2 module is integrated in the same application board, using the main available interfaces and functions of the modules.

The different mounting options for the external parts are highlighted in different colors as described in the legend, according to the interfaces supported by each module, and related characteristics.

VCC supply

In the simple schematic diagram shown in Figure 4, the **VCC** supply of the SARA modules is provided by a suitable supply source, at 3.6 V nominal voltage, not illustrated in the diagram. The application processor controls the **VCC** supply of the modules by a high-side switch. Proper bypass capacitors and EMI filter parts are placed close to the **VCC** input pins of the modules.

While selecting the supply source for SARA cellular modules, consider with adequate safe design margin the maximum current consumption of each SARA cellular module (see related data sheet [1], [5], [6], [7], [11], [12], [13]), as it reflects the RATs supported. For additional specific design guidelines, see the **VCC** interface sections in the related system integration manual [2], [8], [9], [14], [15].

The switch-on sequence of SARA-N2, SARA-R500S, SARA-R510M8S, SARA-G3 and SARA-U2 starts by applying a valid **VCC** supply.

Instead, SARA-N3, SARA-R4, SARA-R510S and SARA-G4 modules continue to be switched off even after a valid **VCC** supply has been applied: the **PWR_ON** input line must be properly toggled, with valid **VCC** supply present, to start the switch-on sequence of these modules.

UART serial interface

The application processor is connected to the SARA modules over main UART interface in the simple schematic diagram illustrated in Figure 4.

The design is implemented with the UART interface configured at the same voltage level on both sides (application processor and SARA module), without using voltage translators, as recommended to minimize any possible leakage and benefit from the extremely low current consumption of the u-blox LPWA modules, particularly in deep sleep Power Saving Mode.

Thus, the supply level of the application processor is selected to properly set its UART voltage level:

- at the **VCC** level of the module (3.6 V nominal), in case of SARA-N2
- at the **V_INT** level of the module (2.8 V nominal, with **VSEL** unconnected), in case of SARA-N3
- at the **V_INT** level of the module (3.0 V nominal, with **VSEL** unconnected), in case of SARA-G4
- at the **V_INT** level of the module (1.8 V nominal), for all the other SARA modules

The **TXD** and **RXD** data lines, supported by all the SARA modules for AT and data communication, are directly connected with the application processors. For additional specific design guidelines, see the UART sections in the related system integration manual [2], [8], [9], [14], [15].

The **RTS**, **CTS** and **RI** lines are connected to the application processors by 0 Ω jumpers for all the u-blox SARA modules except the SARA-N2 series, which does not support hardware flow control functionality and instead supports **RI** functionality over the **CTS** output pin.

The other UART lines are not implemented in the simple example of design shown in Figure 4, and the **DTR** input is grounded as required to have URCs and/or the greeting text sent by SARA-R4, SARA-R5 and SARA-U2 modules.

System control interfaces

The application processor controls the **PWR_ON / PWR_CTRL** line by an open drain driver in the circuit illustrated in [Figure 4](#), with an external pull-up to **V_BCKP** for SARA-G3 and SARA-U2 modules. The whole circuit need not be populated for SARA-N2 modules, which do not provide **PWR_ON / PWR_CTRL** input.

The application processor controls the **RESET_N / PWR_OFF** line by open drain driver too. The assertion or toggling of this line causes different actions:

- the **RESET_N** line triggers an unconditional reboot of the module when toggled, without internal PMU shutdown when set low, in case of SARA-N2, SARA-R5 and SARA-G3
- the **RESET_N** line triggers an unconditional reboot of the module when toggled, with internal PMU shutdown when set low, in case of SARA-N3 and SARA-U2
- the **RESET_N / PWR_OFF** line triggers an unconditional shutdown of the module when set low or toggled, in case of SARA-R4 and SARA-G4

The circuit need not be populated for SARA-R42x modules, not providing **RESET_N / PWR_OFF** input.

The timings for proper control of the **PWR_ON / PWR_CTRL**, **RESET_N / PWR_OFF** lines of the SARA modules are reported in the related data sheet [\[1\]](#), [\[5\]](#), [\[6\]](#), [\[7\]](#), [\[11\]](#), [\[12\]](#), [\[13\]](#).

Cellular RF interface

[Figure 4](#) shows the **ANT** cellular antenna circuit implemented with the optional **ANT_DET** antenna detection circuit according to the design guidelines provided in the antenna interface sections of the related system integration manual [\[2\]](#), [\[8\]](#), [\[9\]](#), [\[14\]](#), [\[15\]](#).

While selecting the antenna for SARA cellular modules, consider the frequency range supported by each SARA module, as illustrated in [Figure 3](#).

Designers must consider the antenna from all perspectives at the very start of the design phase when the physical dimensions of the application board are under analysis/decision, since the RF compliance of the end-device integrating cellular modules with all the applicable required certification schemes depends on the antenna's radiating performance.

While implementing the cellular RF antenna design for SARA modules, consider providing the best possible return loss in the frequency range supported by the modules, and place the antenna far from **VCC** supply line and related parts, as well as far from any possible source of interference and/or noise.

GNSS RF interface

[Figure 4](#) shows the **ANT_GNSS** circuit implemented for the SARA-R422M8S, SARA-R422M10S and SARA-R510M8S modules, which integrate the u-blox GNSS receiver chip. The module **ANT_GNSS** RF input is connected to a GNSS antenna without additional external SAW and LNA, because dedicated band-pass SAW and LNA are already integrated in the modules along the internal GNSS RF path.

Similar to the cellular RF antenna design, the GNSS RF antenna design needs to provide the best possible return loss in the GNSS frequency range supported by the modules, and should have the antenna placed far from any possible source of interference or noise.

SIM interface

[Figure 4](#) also shows the SIM interface circuit implemented with the optional SIM detection function, according to the design guidelines provided in SIM interface sections of the related system integration manual [\[2\]](#), [\[8\]](#), [\[9\]](#), [\[14\]](#), [\[15\]](#). Bypass capacitors with proper self-resonant frequency are recommended to be placed close to the SIM connector, as well as ESD protections.

GPIO interface

Figure 4 also shows the **GPIO1** that controls an LED, which provides the network status indication. It is supported by all SARA modules (except SARA-N2 series) that can provide this function on the **CTS** pin. Other functions can be enabled on the GPIOs of the SARA modules, as described in the related data sheet [1], [5], [6], [7], [11], [12], [13] and related AT commands manual [3], [4], [16], [17].

Test-Points

Table 7 lists the interfaces dedicated for FW update and/or diagnostic purposes on SARA modules.

Module	FW update	Cellular diagnostic	GNSS diagnostic
SARA-R41 series	USB, PWR_ON	USB, RESET_N, V_INT	-
SARA-R42 series	USB, PWR_CTRL	USB, PWR_CTRL, V_INT, RSVD #33	TXD_GNSS
SARA-R5 series	UART, PWR_ON, V_INT	USB, RESET_N, V_INT	UART AUX (DCD, DTR)
SARA-N2 series	UART, RESET_N	GPIO1, RESET_N	-
SARA-N3 series	UART FT, PWR_ON, V_INT	UART FT, RESET_N, V_INT	-
SARA-G3 series	UART AUX, RESET_N, V_INT	UART AUX, PWR_ON, V_INT	-
SARA-G4 series	UART FT, PWR_ON, V_INT	UART FT, PWR_OFF, V_INT	-
SARA-U2 series	USB, RESET_N	USB, PWR_ON, V_INT	-


Table 7: Interfaces for FW update and/or diagnostic purposes on SARA modules

The schematic diagram illustrated in Figure 4 includes accessible test-points directly connected to the following pins, which are strongly recommended for FW update and diagnostic purposes:

- **V_INT**
- **PWR_ON/PWR_CTRL**
- **RESET_N/PWR_OFF**
- **TXD**
- **RXD**
- **GPIO1**
- **VUSB_DET/USB_5V0**
- **USB_3V3**
- **USB_D+/TXD_FT/TXD_AUX**
- **USB_D-/RXD_FT/RXD_AUX**
- **RSVD #33**
- **TXD_GNSS**
- **DCD**
- **DTR**

Other

All the GND pins are intended to be externally connected to ground, while other interfaces are not implemented or not used in the simple example of design as shown in Figure 4.

 For additional specific design guidelines, see the related system integration manual [2], [8], [9], [14], [15] of the u-blox SARA modules.



Appendix

A Glossary


Abbreviation	Definition
2G	2 nd Generation Cellular Technology (GSM, GPRS, EGPRS)
3G	3 rd Generation Cellular Technology (UMTS, HSDPA, HSUPA)
3GPP	3 rd Generation Partnership Project
8-PSK	8 Phase-Shift Keying modulation
ADC	Analog to Digital Converter
AT	AT Command Interpreter Software Subsystem, or attention
AUX	Auxiliary
Cat	Category
CDMA	Code Division Multiple Access
CoAP	Constrained Application Protocol
CTS	Clear To Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCS	Digital Cellular System
DDC	Display Data Channel interface
DL	Down-Link (Reception)
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTLS	Datagram Transport Layer Security
DTR	Data Terminal Ready
EDGE	Enhanced Data rates for GSM Evolution (EGPRS)
EGPRS	Enhanced General Packet Radio Service (EDGE)
EMI	Electro-Magnetic Interference
ESD	Electro-Static Discharge
E-UTRA	Evolved Universal Terrestrial Radio Access
FDD	Frequency Division Duplex
FOAT	Firmware update Over AT commands
FOTA	Firmware update Over The Air
FTPS	File Transfer Protocol Secure
FW	Firmware
GLONASS	GLobal Navigation Satellite System
GMSK	Gaussian Minimum-Shift Keying modulation
GND	Ground
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communication
HSPA	High-Speed Packet Access
HTTPS	HyperText Transfer Protocol Secure
I/O	Input/Output

Abbreviation	Definition
I2C	Inter-Integrated Circuit interface
I2S	Inter IC Sound interface
IoT	Internet of Things
LED	Light Emitting Diode
LGA	Land Grid Array
LNA	Low Noise Amplifier
LPWA	Low Power Wide Area
LTE	Long Term Evolution
LwM2M	Open Mobile Alliance Lightweight Machine-to-Machine protocol
MISO	Master Input Slave Output
MOSI	Master Output Slave Input
MQTT	Message Queuing Telemetry Transport
MQTT-SN	Message Queuing Telemetry Transport for Sensor Networks
NB	Narrow Band
PCS	Personal Communications Service
PMU	Power Management Unit
PSM	Power Saving Mode
QZSS	Quasi-Zenith Satellite System
RAT	Radio Access Technology
RF	Radio Frequency
RI	Ring Indication
RTC	Real Time Clock
RTS	Request To Send
SAIF	Sub-meter-class Augmentation with Integrity Function
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SDIO	Secure Digital Input Output
SIM	Subscriber Identification Module
SMS	Short Message Service
SPG	Standard Precision GNSS
SPI	Serial Peripheral Interface
TBD	To Be Defined
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TP	Test-Point
UART	Universal Asynchronous Receiver-Transmitter
UDP	User Datagram Protocol
UL	Up-Link (Transmission)
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USB	Universal Serial Bus

Table 8: Abbreviations and terms

Related documentation

- [1] u-blox SARA-R5 series data sheet, [UBX-19016638](#)
- [2] u-blox SARA-R5 series system integration manual, [UBX-19041356](#)
- [3] u-blox SARA-R5 series AT commands manual, [UBX-19047455](#)
- [4] u-blox SARA-R4 series AT commands manual, [UBX-17003787](#)
- [5] u-blox SARA-G3 series data sheet, [UBX-13000993](#)
- [6] u-blox SARA-U2 series data sheet, [UBX-13005287](#)
- [7] u-blox SARA-N2 series data sheet, [UBX-15025564](#)
- [8] u-blox SARA-G3/SARA-U2 series system integration manual, [UBX-13000995](#)
- [9] u-blox SARA-N2/SARA-N3 series system integration manual, [UBX-17005143](#)
- [10] u-blox nested design application note, [UBX-16007243](#)
- [11] u-blox SARA-R4 series data sheet, [UBX-16024152](#)
- [12] u-blox SARA-N3 series data sheet, [UBX-18066692](#)
- [13] u-blox SARA-G4 series data sheet, [UBX-18006165](#)
- [14] u-blox SARA-R4 series system integration manual, [UBX-16029218](#)
- [15] u-blox SARA-G4 series system integration manual, [UBX-18046432](#)
- [16] u-blox AT commands manual, [UBX-13002752](#)
- [17] u-blox SARA-N2/SARA-N3 series AT commands manual, [UBX-16014887](#)

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Revision history

Revision	Date	Name	Comments
R01	10-Oct-2019	fvid	Initial release
R02	11-Nov-2019	lpah	Updated document products applicability Minor update on SARA-R5 series products description
R03	24-Jan-2020	sses	Added SARA-R422, SARA-R422S, SARA-R422M8S products applicability Minor update on SARA-R5 series products description
R04	09-Mar-2020	sses	Added SARA-R410M-83B and SARA-R500S products applicability Added jamming detection feature to SARA-R422S and SARA-R422M8S Updated RAT supported by "00" products version of SARA-R5 series modules Minor other corrections and clarifications
R05	22-Jul-2020	sses	Updated SARA-R410M-x3B and SARA-R5 series products status Added second auxiliary UART interface on SARA-R42 series modules Added GNSS UART data output on SARA-R422M8S modules Corrected and clarified SARA-R4 series modules operating bands and RATs Revised schematic design example Minor other corrections and clarifications
R06	12-Oct-2020	sses	Updated SARA-R5 series and SARA-R42 series products status Revised recommended GNSS diagnostic interface for SARA-R5 series Revised supported bands for SARA-R42 series Minor other corrections and clarifications
R07	06-Jul-2021	sses	Extended document applicability to SARA-R410M-02B-03, SARA-R410M-63B-01, SARA-R410M-73B-01, SARA-R410M-83B-01, SARA-R412M-02B-03, SARA-R500S-00B-01, SARA-R500S-01B-00, SARA-R510S-00B-01, SARA-R510S-01B-00, SARA-R510M8S-00B-01 and SARA-R510M8S-01B-00 Updated SARA-R42 series products status Minor other corrections and clarifications
R08	02-Feb-2022	fvid	Extended document applicability to SARA-R500S-61B-00, SARA-R500S-71B-00, SARA-R510S-61B-00, SARA-R510S-71B-00, SARA-R510M8S-61B-00, and SARA-R510M8S-71B-00. Updated some product status. Minor clarifications.
R09	03-Oct-2022	sses	Extended document applicability to SARA-R422-01B, SARA-R422S-01B, and SARA-R422M10S-01B. Other minor corrections and clarifications.

Contact

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