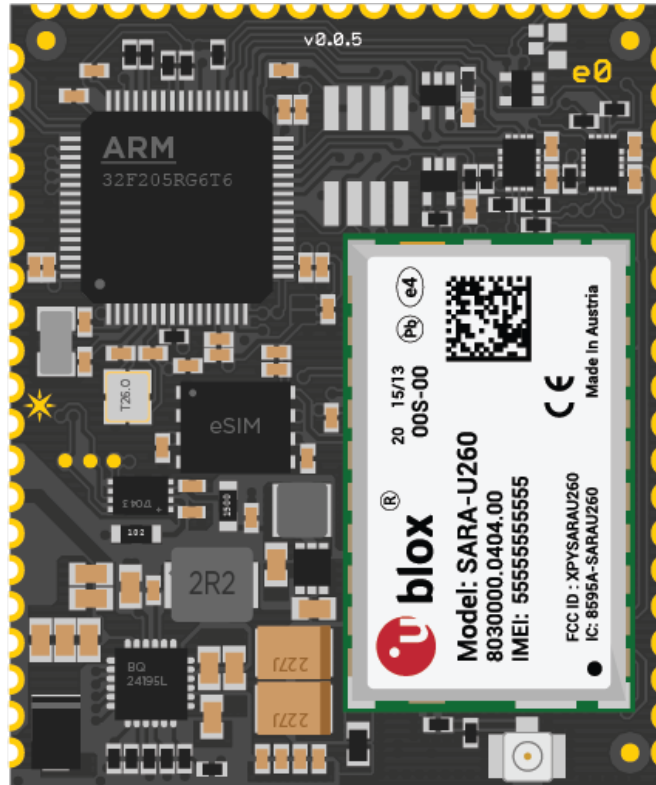# E Series Module Datasheet (v004)

The E Series models below have been deprecated. The recommended replacement for the E402/E404 is the E404X.

See the Supply Secure FAQ for more information.

Functional description

OVERVIEW

The E Series module is an IoT platform for creating cellular-connected products. It is an industrial version of Particle's Electron dev kit. It is specifically designed for mass scale manufacturing and integration. It comes with an affordable data plan for low-bandwidth applications. Plus the E Series is available for more than 100 countries worldwide!

It also comes with Particle's development tools and cloud platform for managing and interacting with your new connected hardware.

FEATURES

- U-blox SARA-U201, SARA-R410M, or SARA-R510S cellular module
- STM32F205RGT6 120MHz ARM Cortex M3 microcontroller
- 1MB flash, 128KB RAM
- BQ24195 power management unit and battery charger
- MAX17043 fuel gauge
- 30 mixed-signal GPIO and advanced peripherals
- Open source software design
- Real-time operation system (RTOS)
- FCC, CE and IC certified
- Embedded Particle EtherSIM (E314, E404, E404X)
- Embedded Particle SIM (E310, E402)

Interfaces

E SERIES MODULE
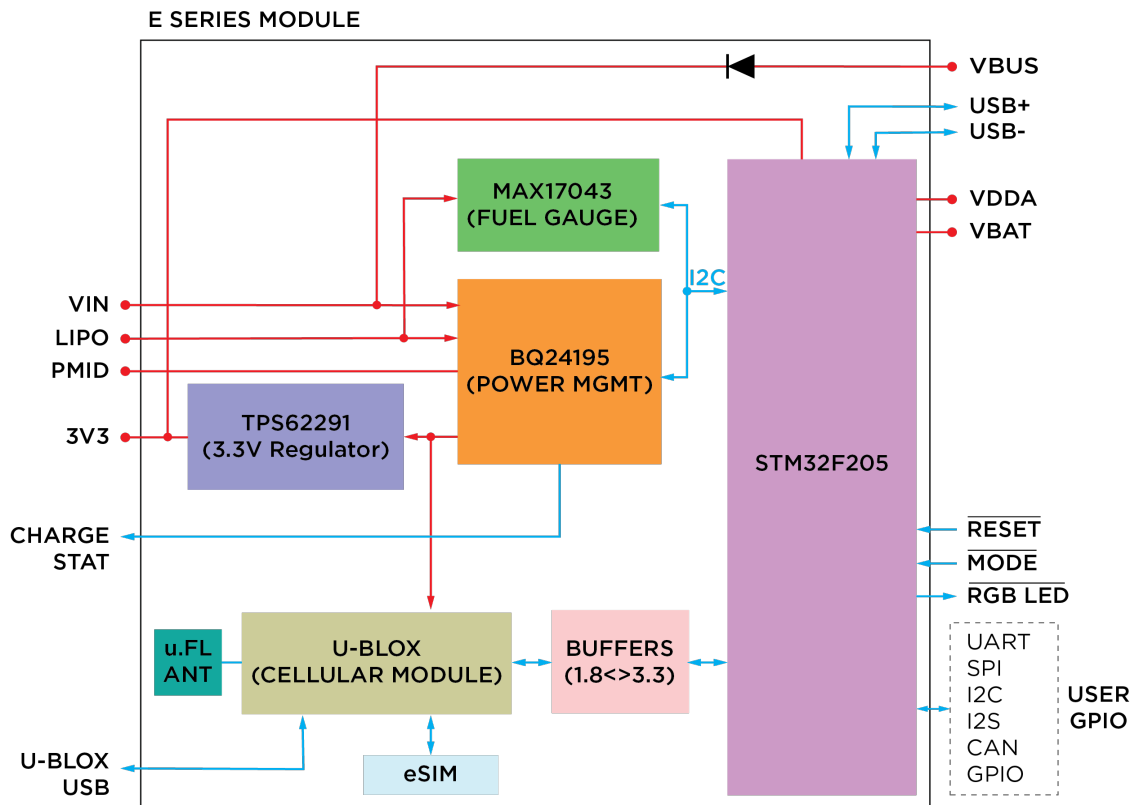
POWER

The E series can be powered via the VIN (3.88V-12VDC) pin, over USB, or a LiPo battery.

VIN

The input voltage range on VIN pin is 3.88VDC to 12VDC. When powering from the VIN pin alone, make sure that the power supply is rated at 10W (for example 5 VDC at 2 Amp). If the power source is unable to meet this requirement, you'll need connect the LiPo battery as well. An additional bulk capacitance of 470uF to 1000uF should be added to the VIN input when the LiPo Battery is disconnected. The amount of capacitance required will depend on the ability of the power supply to deliver peak currents to the cellular modem.

The E Series LTE (E402, LTE Cat M1) can be powered with as little as 550 mA at 5V.

LiPo

This pin serves two purposes. You can use this pin to connect a LiPo battery directly without having to use a JST connector or it can be used to connect an external DC power source (and this is where one needs to take extra precautions). When powering it from an external regulated DC source, the recommended input voltage range on this pin is between 3.6V to 4.4VDC. Make sure that the supply can handle currents of at least 3Amp. This is the most efficient way of powering the E series since the PMIC by-passes the regulator and supplies power to the E series module via an internal FET leading to lower quiescent current.

When powered from a LiPo battery alone, the power management IC switches off the internal regulator and supplies power to the system directly from the battery. This reduces the conduction losses and maximizes battery run time. The battery provided with the E series module is a Lithium-Ion Polymer battery rated at 3.7VDC 1,800mAh. You can substitute this battery with another 3.7V

LiPo with higher current rating. Remember to never exceed this voltage rating and always pay attention to the polarity of the connector.

Typical current consumption is around 180mA and up to 1.8A transients at 5VDC. In deep sleep mode, the quiescent current is 130uA (powered from the battery alone).

VBUS

This pin is internally connected to USB supply rail and will output 5V when the E series module is plugged into an USB port. It is intentionally left unpopulated. This pin will *NOT* output any voltage when the E series module is powered via VIN and/or the LiPo battery.

Most USB ports can supply only a maximum of 500mA, but the u-Blox GSM module on the E series alone can consume a peak of 800mA to 1800mA (2G/3G) or 550 mA (LTE Cat M1) of current during transmission. In order to compensate of this deficit, one must connect the LiPo battery at all times when powering from a traditional USB port for 2G/3G. The E series will intelligently source power from the USB most of the time and keep the battery charged. During peak current requirements, the additional power will be sourced from the battery. This reduces the charge-discharge cycle load on the battery, thus improving its longevity.

3V3 Pin

This pin is the output of the on-board 3.3V switching regulator that powers the microcontroller and the peripherals. This pin can be used as a 3.3V power source with a max load of 800mA. Unlike the Photon or the Core, this pin *CANNOT* be used as an input to power the E series module.

VDDA

Unlike the Electron, the E series module exposes the VDDA pin of the STM32 microcontroller separately. This pin powers the ADC block of the microcontroller. A maximum difference of 300 mV between VDD (in this case, 3V3) and VDDA can be tolerated during power-up and power-down operation. Under normal operations, connect the VDDA to 3V3 pin of the E0. Be sure to connect VDDA even if you are not using any analog circuitry; the device will fail to boot if not powered.

VBAT

This is the supply to the internal RTC, backup registers and SRAM. You can connect a backup battery to it (1.65 to 3.6VDC), if you wish to retain RTC/RAM when 3V3 is absent or simply tie it up to 3V3.

PMID

This pin is the output of the internal boost regulator of the PMIC that can source 5.1VDC from the battery in OTG (On The Go) mode. This feature is useful when your circuitry needs a 5V source from the E series module when powered by the battery alone.

The confusing bit about this pin is that it will continue to provide 5.1VDC but only when the input voltage (VIN) is between 3.6V to 5.1VDC. As soon as the input voltage exceeds this limit, the PMID starts tracking *that* voltage. For example if VIN = 9VDC, the PMID will be 9VDC and *NOT* 5.1VDC. So you need to be careful when using it as a source for powering your external circuitry. The max current draw on this pin is 2.1A but is not recommended due to thermal limitations of the circuit board.

Antenna Type	Manufacturer	MFG. Part #	Gain
2G/3G PCB antenna	Taoglas	PC104.07.0165C	1dBi ~ 2.39dBi
LTE flex antenna	Taoglas	FXUB63.07.0150C	5.00dBi peak

PERIPHERALS AND GPIO

Peripheral Type	Qty	Input(I) / Output(O)	FT[1] / 3V3[2]
Digital	30	I/O	FT/3V3
Analog (ADC)	12	I	3V3
Analog (DAC)	2	O	3V3
UART	3	I/O	3V3
SPI	2	I/O	3V3
I2S	1	I/O	3V3
I2C	1	I/O	FT
CAN	2	I/O	3V3[4]
USB	1	I/O	3V3
PWM	13[3]	O	3V3

Notes: [1] FT = 5.0V tolerant pins. All pins except A3 and DAC are 5V tolerant (when not in analog mode). If used as a 5V input the pull-up/pull-down resistor must be disabled.

[2] 3V3 = 3.3V max pins.

[3] PWM is available on D0, D1, D2, D3, B0, B1, B2, B3, A4, A5, WKP, RX, TX with a caveat: PWM timer peripheral is duplicated on two pins (A5/D2) and (A4/D3) for 11 total independent PWM outputs. For example: PWM may be used on A5 while D2 is used as a GPIO, or D2 as a PWM while A5 is used as an analog input. However A5 and D2 cannot be used as independently controlled PWM outputs at the same time.

[4] Technically these pins are 5.0V tolerant, but since you wouldn't operate them with a 5.0V transceiver it's proper to classify them as 3.3V.

JTAG AND SWD

Pin D3 through D7 are JTAG interface pins. These can be used to reprogram your E series module bootloader or user firmware image with standard JTAG tools such as the ST-Link v2, J-Link, R-Link, OLIMEX ARM-USB-TINI-H, and also the FTDI-based Particle JTAG Programmer. If you are short on available pins, you may also use SWD mode which requires less pins.

E series module Pin	JTAG	SWD	STM32F205RGT6 Pin	Default Internal[1]
D7	JTAG_TMS	SWD/SWDIO	PA13	~40k pull-up
D6	JTAG_TCK	CLK/SWCLK	PA14	~40k pull-down
D5	JTAG_TDI		PA15	~40k pull-up
D4	JTAG_TDO		PB3	Floating
D3	JTAG_TRST		PB4	~40k pull-up
3V3	Power			
GND	Ground			
RST	Reset			

Notes: [1] Default state after reset for a short period of time before these pins are restored to GPIO (if JTAG debugging is not required, i.e. `USE_SWD_JTAG=y` is not specified on the command line.)

Memory Map

STM32F205RGT6 FLASH LAYOUT OVERVIEW

- Bootloader (16 KB)
- DCD1 (16 KB), stores keys, mfg info, system flags, etc..
- DCD2 (16 KB), swap area for DCD1
- EEPROM emulation bank 1 (16 KB)
- EEPROM emulation bank 2 (64 KB) [only 16k used]
- Device OS (512 KB) [256 KB comms + 256 KB hal/platform/services]
- Factory backup, OTA backup and user application (384 KB) [3 x 128 KB]

DCD LAYOUT

The DCD area of flash memory has been mapped to a separate DFU media device so that we can incrementally update the application data. This allows one item (say, server public key) to be updated without erasing the other items.

DCD layout as of v0.4.9 found here in firmware

Region	Offset	Size
system flags	0	32
version	32	2
device private key	34	1216
device public key	1250	384
ip config	1634	128
claim code	1762	63
claimed	1825	1
device id	1852	6
version string	1858	32
dns resolve	1890	128
reserved1	2018	64
server public key	2082	768
padding	2850	2
flash modules	2852	100
product store	2952	24
cloud transport	2977	1
alt device public key	2978	128
alt device private key	3106	192
alt server public key	3298	192
alt server address	3490	128
reserved2	3618	1280

Note: Writing 0xFF to offset 3106 (DEFAULT key used on E series module) will cause the device to re-generate a new private UDP/ECC key on the next boot. TCP keys are currently unsupported on the E series module but would be located at offset 34. You should not need to use this feature unless your keys are corrupted.

```
// Regenerate Alternate Keys (Default)
echo -en "\xFF" > fillbyte && dfu-util -d 2b04:d00a -a 1 -s 3106 -D
fillbyte
// Regenerate TCP Keys (Unsupported)
echo -en "\xFF" > fillbyte && dfu-util -d 2b04:d00a -a 1 -s 34 -D fillbyte
```

MEMORY MAP (COMMON)

Region	Start Address	End Address	Size
Bootloader	0x8000000	0x8004000	16 KB
DCD1	0x8004000	0x8008000	16 KB
DCD2	0x8008000	0x800C000	16 KB
EEPROM1	0x800C000	0x8010000	16 KB
EEPROM2	0x8010000	0x8020000	64 KB

MEMORY MAP (MODULAR FIRMWARE - DEFAULT)

Before 0.6.0 firmware

Region	Start Address	End Address	Size
System Part 1	0x8020000	0x8040000	128 KB
System Part 2	0x8040000	0x8060000	128 KB
Application	0x8080000	0x80A0000	128 KB
Factory Reset/Extended Application	0x80A0000	0x80C0000	128 KB
OTA Backup	0x80C0000	0x80E0000	128 KB
Decompress region	0x80E0000	0x8100000	128 KB

Since 0.6.0 firmware

Region	Start Address	End Address	Size
System Part 2	0x8020000	0x8040000	128 KB
System Part 3	0x8040000	0x8060000	128 KB
System Part 1	0x8060000	0x8080000	128 KB
Application	0x8080000	0x80A0000	128 KB
Factory Reset/Extended Application	0x80A0000	0x80C0000	128 KB
OTA Backup	0x80C0000	0x80E0000	128 KB
Decompress region	0x80E0000	0x8100000	128 KB

MEMORY MAP (MONOLITHIC FIRMWARE - OPTIONAL)

Region	Start Address	End Address	Size
Firmware	0x8020000	0x8080000	384 KB
Factory Reset	0x8080000	0x80E0000	384 KB
Unused (factory reset modular)	0x80E0000	0x8100000	128 KB

Pin and button definition
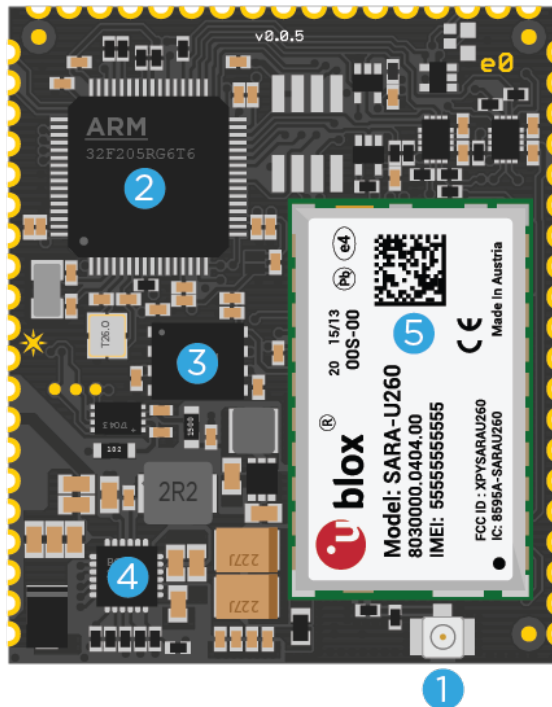
1. u.FL ANT CONN.
2. STM32 MICRO
3. MFF2 SMD SIM
4. PMIC
5. u-blox CELL MODULE

LED STATUS

Charge status LED

State	Description
ON	Charging in progress
OFF	Charging complete
Blink at 1Hz	Fault condition[1]
Rapid blinking	Battery disconnected[2]

Notes:

[1] A fault condition can occur due to several reasons, for example, battery over/under voltage, temperature fault or safety timer fault. You can find the root cause by reading the fault register of the power management IC in firmware.

[2] You can stop this behavior by either plugging in the LiPo battery or by disabling the charging using the appropriate firmware command.

System RGB LED

Unlike the Electron, the E series module does not have an on-board RGB status LED. We have provided its individual control pins for you to connect an LED of your liking. This will allow greater flexibility in the end design of your products.

For a detailed explanation of different color codes of the RGB system LED, please take a look here.

PINOUT DIAGRAM
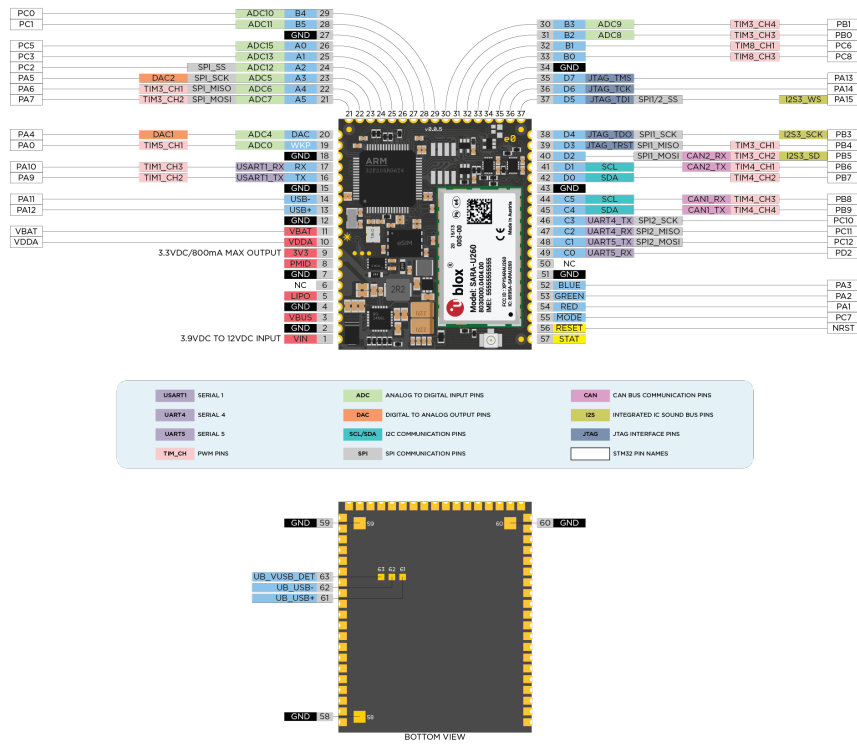
You can download a high resolution pinout diagram in a **PDF version here.**

PIN DESCRIPTION

#	PIN	FUNCTION	DESCRIPTION
1	VIN	POWER	This pin can be used as an input or output. As an input, supply 5VDC to 12VDC to power the Electron. When the Electron is powered via the USB port, this pin will output a voltage of approximately 4.8VDC due to a reverse polarity protection series Schottky diode between VBUS and VIN. When used as an output, the max load on VIN is 1Amp.
2	GND	POWER	System ground.
3	VBUS	POWER	This is connected to the VBUS power pin of the USB port.
4	GND	POWER	System ground.
5	LIPO	POWER	This is connected to the +LiPo connector.
6	NC	TBD	Do not connect.
7	GND	POWER	System ground.
8	PMID	POWER	This is connected to the PMID pin of the PMIC.
9	3V3	POWER	This is the output of the 3V3 regulator on the E0.
10	VDDA	POWER	This is the input to the analog block of the STM32.
11	VBAT	POWER	Supply to the internal RTC, backup registers and SRAM when 3V3 is not present (1.65 to 3.6VDC).
12	GND	POWER	System ground.
13	USB+	IO	Data+ pin of the USB port.
14	USB-	IO	Data- pin of the USB port.
15	GND	POWER	System ground.
16	TX	IO	Primarily used as UART TX, but can also be used as a digital GPIO or PWM.
17	RX	IO	Primarily used as UART RX, but can also be used as a digital GPIO or PWM.
18	GND	POWER	System ground.

19	WKP	IO	Active-high wakeup pin, wakes the module from sleep/standby modes. When not used as a WAKEUP, this pin can also be used as a digital GPIO, ADC input or PWM. Can be referred to as A7 when used as an ADC.
20	DAC	IO	12-bit Digital-to-Analog (D/A) output (0-4095), referred to as DAC or DAC1 in software. Can also be used as a digital GPIO or ADC. Can be referred to as A6 when used as an ADC.
21	A5	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
22	A4	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
23	A3	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
24	A2	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
25	A1	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
26	A0	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
27	GND	POWER	System ground.
28	B5	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
29	B4	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs.
30	B3	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), PWM and also digital GPIOs.
31	B2	IO	12-bit Analog-to-Digital (A/D) inputs (0-4095), PWM and also digital GPIOs.
32	B1	IO	Digital only GPIO, and PWM.
33	B0	IO	Digital only GPIO, and PWM.
34	GND	POWER	System ground.
35	D7	IO	Digital only GPIO.
36	D6	IO	Digital only GPIO.
37	D5	IO	Digital only GPIO.
38	D4	IO	Digital only GPIO.
39	D3	IO	Digital only GPIO, and PWM.
40	D2	IO	Digital only GPIO, and PWM.
41	D1	IO	Digital only GPIO, and PWM.
42	D0	IO	Digital only GPIO, and PWM.
43	GND	POWER	System ground.
44	C5	IO	Digital only GPIO, and PWM.
45	C4	IO	Digital only GPIO, and PWM.
46	C3	IO	Digital only GPIO.
47	C2	IO	Digital only GPIO.
48	C1	IO	Digital only GPIO.
49	C0	IO	Digital only GPIO.
50	NC	TBD	Do not connect.
51	GND	POWER	System ground.
52	BLU	IO	Blue pin of the RGB LED.
53	GRN	IO	Green pin of the RGB LED.
54	RED	IO	Red pin of the RGB LED.
55	MODE	IO	Connected to the MODE button input.
56	RST	I	Active-low reset input.
57	STAT	O	Connected to the charge status pin of the PMIC.
58	GND	POWER	System ground.
59	GND	POWER	System ground.
60	GND	POWER	System ground.

61	UB_USB+	IO	Data+ pin of the u-blox USB port.
62	UB_USB-	IO	Data- pin of the u-blox USB port.
63	UB_VUSB_DET	IO	USB detect pin of the u-blox USB port. 5V on this pin enables the u-blox's USB interface.

[1] PWM is available on D0, D1, D2, D3, B0, B1, B2, B3, A4, A5, WKP, RX, TX with a caveat: PWM timer peripheral is duplicated on two pins (A5/D2) and (A4/D3) for 11 total independent PWM outputs. For example: PWM may be used on A5 while D2 is used as a GPIO, or D2 as a PWM while A5 is used as an analog input. However A5 and D2 cannot be used as independently controlled PWM outputs at the same time.

Technical Specifications

ABSOLUTE MAXIMUM RATINGS [1]

Parameter	Symbol	Min	Typ	Max	Unit
Supply Input Voltage	V_{IN-MAX}			+17	V
Supply Output Current	$I_{IN-MAX-L}$			1	A
Battery Input Voltage	V_{LiPo}			+6	V
Supply Output Current	$I_{3V3-MAX-L}$			800	mA
Storage Temperature	T_{stg}	-30		+75	°C
ESD Susceptibility HBM (Human Body Mode)	V_{ESD}			2	kV

[1] Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Input Voltage	V_{IN}	+3.88[1]		+12	V
Supply Output Voltage	V_{IN}		+4.8		V
Supply Output Voltage	V_{3V3}		+3.3		V
LiPo Battery Voltage	V_{LiPo}	+3.6		+4.4	V
Supply Input Voltage	V_{VBAT}	+1.65		+3.6	V
Supply Input Current (VBAT)	I_{VBAT}			19	uA
Operating Current (uC on, Cellular ON)	$I_{IN\ avg}$		180	250	mA
2G/3G Peak Current (uC on, Cellular ON)	$I_{IN\ pk}$	800[2]		1800[3]	mA
LTE Peak Current (uC on, Cellular ON)	$I_{IN\ pk}$		550		mA
Operating Current (uC on, Cellular OFF)	$I_{IN\ avg}$		47	50	mA
Sleep Current (4.2V LiPo, Cellular OFF)	I_{Qs}		0.8	2	mA
Deep Sleep Current (4.2V LiPo, Cellular OFF)	I_{Qds}		110	130	uA
Operating Temperature	T_{op}	-40[4]		+85[4]	°C
Humidity Range Non condensing, relative humidity				95	%

Notes:

[1] The minimum input voltage is software defined with a user selectable range of 3.88V to 5.08V in 80mV increments. Out of the box, the minimum input voltage is set to 4.36V in order for the LiPo battery to be able to properly charge.

[2] 3G operation

[3] 2G operation

[4] When powering the E series module with a LiPo battery (or other battery chemistries), please note that the operating temperatures will be affected accordingly.

The E series is available in two different versions: A 2G/3G global model (SARA-U201) and a LTE Cat M1 model (SARA-R410M-02B).

Note that LTE is LTE Cat M1, not the standard LTE (LTE Cat 1) used by your mobile phone. It is a low-power and low-data-rate variation of LTE for use with IoT devices. It can only be used in the United States, Canada. and Mexico at this time.

For a complete list of carriers and supported countries, see the carrier guide.

2G cellular characteristics E314 & E310:

Parameter	SARA-U201
Protocol stack	3GPP Release 7
MS Class	Class B
Bands	GSM 850 MHz
	E-GSM 900 MHz
	DCS 1800 MHz
	PCS 1900 MHz
Power Class	Class 4 (33 dBm) for 850/900 bands
	Class 1 (30 dBm) for 1800/1900 bands

3G cellular characteristics E314 & E310:

Parameter	SARA-U201
Protocol stack	3GPP Release 7
UE Class	Class A
Bands	Band 5 (850 MHz)
	Band 8 (900 MHz)
	Band 2 (1900 MHz)
	Band 1 (2100 MHz)
Power Class	Class 3 (24 dBm) for all bands

u-blox SARA-R410M-02B or R410M-03

Parameter	Value
Protocol stack	3GPP Release 13
RAT	LTE Cat M1 Half-Duplex
LTE FDD Bands	Band 12 (700 MHz)
	Band 28 (700 MHz)
	Band 13 (750 MHz)
	Band 20 (800 MHz)
	Band 5 (850 MHz)
	Band 8 (900 MHz)
	Band 4 (1700 MHz)
	Band 3 (1800 MHz)
	Band 2 (1900 MHz)
Power class	Class 3 (23 dBm)

u-blox SARA-R510S-01B

Parameter	Value
Protocol stack	3GPP Release 13
RAT	LTE Cat M1 Half-Duplex
LTE FDD Bands	Band 12 (700 MHz)
	Band 13 (750 MHz)
	Band 26 (850 MHz)
	Band 5 (850 MHz)
	Band 4 (1700 MHz)
	Band 2 (1900 MHz)
	Band 25 (1900 MHz)
Power class	Class 3 (23 dBm)

I/O CHARACTERISTICS

These specifications are based on the STM32F205RGT6 datasheet, with reference to E series pin nomenclature.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Standard I/O input low level voltage	V_{IL}		-0.3		$0.28^*(V_{3V3}-2)+0.8$	V
I/O FT[1] input low level voltage	V_{IL}		-0.3		$0.32^*(V_{3V3}-2)+0.75$	V
Standard I/O input high level voltage	V_{IH}		$0.41^*(V_{3V3}-2)+1.3$		$V_{3V3}+0.3$	V
I/O FT[1] input high level voltage	V_{IH}	$V_{3V3} > 2V$	$0.42^*(V_{3V3}-2)+1$		5.5	V
	V_{IH}	$V_{3V3} \leq 2V$	$0.42^*(V_{3V3}-2)+1$		5.2	V
Standard I/O Schmitt trigger voltage hysteresis[2]	V_{hys}		200			mV
I/O FT Schmitt trigger voltage hysteresis[2]	V_{hys}		5% V_{3V3}[3]			mV
Input leakage current[4]	I_{lkg}	$GND \leq V_{io} \leq V_{3V3}$ GPIOs			±1	µA
Input leakage current[4]	I_{lkg}	R_{PU}	$V_{io} = 5V$, I/O FT		3	µA
Weak pull-up equivalent resistor[5]	R_{PU}	$V_{io} = GND$	30	40	50	k Ω
Weak pull-down equivalent resistor[5]	R_{PD}	$V_{io} = V_{3V3}$	30	40	50	k Ω
I/O pin capacitance	C_{IO}			5		pF
DAC output voltage (buffers enabled by default)	V_{DAC}		0.2		$V_{3V3}-0.2$	V
DAC output resistive load (buffers enabled by default)	R_{DAC}		5			k Ω
DAC output capacitive load (buffers enabled by default)	C_{DAC}				50	pF

Notes:

[1] FT = Five-volt tolerant. In order to sustain a voltage higher than $V_{3V3}+0.3$ the internal pull-up/pull-down resistors must be disabled.

[2] Hysteresis voltage between Schmitt trigger switching levels. Based on characterization, not tested in production.

[3] With a minimum of 100mV.

[4] Leakage could be higher than max. if negative current is injected on adjacent pins.

[5] Pull-up and pull-down resistors are designed with a true resistance in series with switchable PMOS/NMOS. This PMOS/NMOS contribution to the series resistance is minimum (~10% order).

Mechanical Specifications
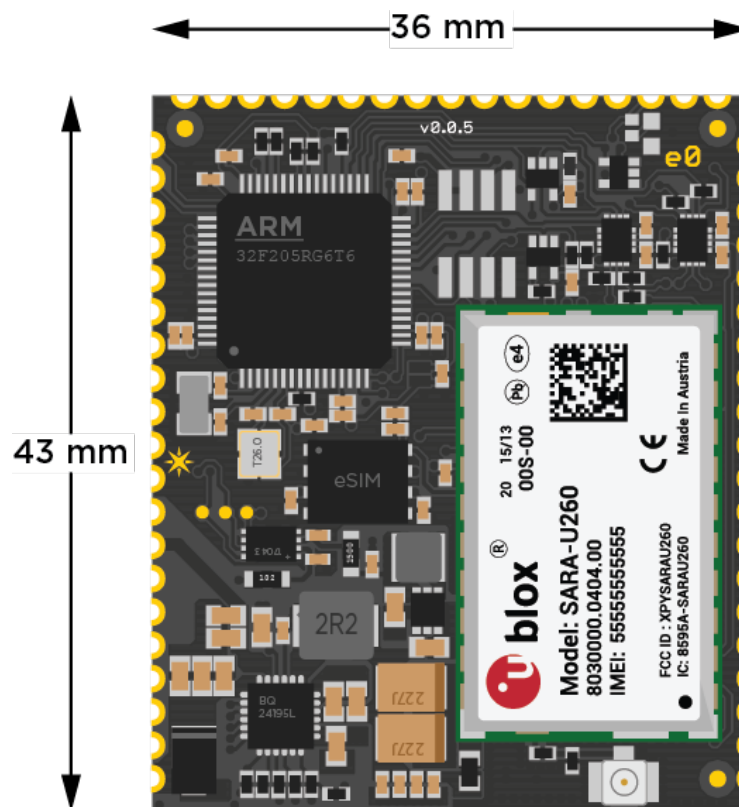
DIMENSIONS AND WEIGHT

- Width = 36 mm
- Height = 43 mm
- Thickness = 4.6 mm
- Weight = 8 gms

RECOMMENDED PCB LAND PATTERN
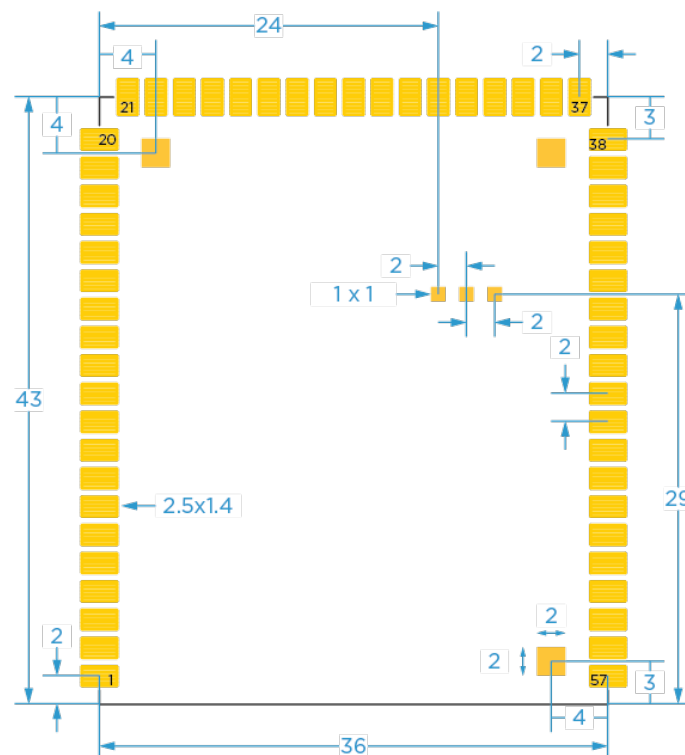
* ALL DIMENSIONS IN MM

An E series part for EAGLE can be found in the [Particle EAGLE library](#)

Schematics

USB

The USB data lines are terminated with 22 Ohm resistors. These data pins are also exposed via small through holes next to the USB connector and are labeled D+ and D-. The VBUS (+5VDC VCC of the USB port) is fed to the PMIC via a 3Amp Schottky diode (SS3P3). The VBUS pin is also available via the unpopulated header hole on the top-right side of the E series.

PMIC (POWER MANAGEMENT INTEGRATED CIRCUIT)

The E series uses TI's BQ24195 as the power management and charging unit. This PMIC intelligently sources power from either the VIN pin, the USB port and/or the LiPo battery. When all the power sources as connected, the unit tries to source power from the USB or VIN as default and continues to charge the LiPo battery. When the battery is completely charged, the power is then sourced from USB/VIN alone. If there is a power deficit (which generally occurs during cellular radio transmission), the additional power is then sourced from the battery as required. The unit can also seamlessly switch back to the battery when other sources of power are suddenly removed.

The DP data pin of the USB is used by the PMIC to detect the presence of a USB power source. It then adjusts the charge current and the limit based on the type of USB power source it detects. This does not always happen successfully since there are a lot of USB hubs and chargers out there that do not meet the USB design guidelines. If the detection is unsuccessful, the PMIC defaults to a 500mA current limit. A user can always adjust these parameters via software.

The microcontroller communicates with the PMIC via an I2C interface (pins PC9 and PA8). This interface allows the microcontroller to read the status of the PMIC and set its various parameters.

MICROCONTROLLER

The E series uses ST Microelectronics's STM32F205RGT6 ARM Cortex M3 microcontroller running at 120MHz.

CONN4
IPEX-20279-001E

15pF (Murata GRM1555C1H150JA01)
C46
L3
INDUCTOR-0402
MURATA LQG15HN39NJ02
GND

ANT_DET   ANT

GND

U10
U-BLOX-SARA-U260

For U201 module: replace R25, 0 ohm
jumper, with murata ferrite bead
(BLM18EG221SN1)

USYS
R25
R0.1/8W

C40   C39   C42   C43
15pF 68pF 10nF 0.1uF   C38   C41
220uF 220uF
GND

GND

1   VCC
2   VCC
3   VCC
4   GND
5   MIC_P
6   MIC_N
7   MIC_GND
8   MIC_BIAS
9   SPK_N
10 SPK_P
11 GND
12 SIM_DET
13 USIM
14 SIM_RST
15 SIM_IO
16 SIM_CLK

SIM_DET
SIM_VCC
SIM_RST
SIM_IO
SIM_CLK

C17   C22   C23   C24   C25
47pF 47pF 47pF 47pF 100nF

GND

MFF2 SIM
GND   VCC   SIM_VCC
VPP   RST   SIM_RST
IO   CLK   SIM_CLK
NA1   NA2

SIM_IO

GND

GND
V_BCKP
GND
V_INT
GND
DSR
RI
DCD
DTR
RTS
CTS
TXD
RXD
GND
PWR_ON
GPIO1
VUSB_DET
RESET_N
RSVD
GND
GND

V_BCKP
V_INT
+3V3
RI_UB
DTR_UB
RTS_UB
CTS_UB
TXD_UB
RXD_UB

R10
10K
C10
0.1uF
GND
R15
100K
PWR_UC
SN74LVC1G07 U6
+3V3
VUSB_DET

PWR_UB

R7
10K
C5
0.1uF
RESET_UC
SN74LVC1G07 U2
GND

C50
0.1uF
GND   GND
RESET_UB

1   UBLOX_USB_N
1   UBLOX_USB_P

GND

The u-blox cellular module talks to the microcontroller over a full-duplex USART interface using a standard set of AT commands. The MFF2 embedded SIM chip is directly connected to the u-blox module.

The MFF2 SMD SIM is not an e-sim and is not reprogrammable to other carriers. It's set to the Particle MVNO and cannot be changed.

BUFFERS

C6
0.1uF P_3V3   V_INT   C8
0.1uF

U4

GND   3   2   GND
CTS_UC   6   VCCA   VCCB   15   CTS_UB
RI_UC   7   1A1   1B1   14   RI_UB
RXD_UC   8   1A2   1B2   13   RXD_UB
         9   2A1   2B2   12
GND   1   2A2
        16   1/OE   GND
         4   2/OE
         5   1DIR
        10   2DIR
             GND   GND   11

R11 10K
R13 10K
R14 10K

GND   GND   SN74AVC4T245   GND   GND GND GND

+3V3
R4
C7
0.1uF   P_3V3   V_INT   0.1uF
C9

U5

GND   3   2   GND
RTS_UC   6   VCCA   VCCB   15   RTS_UB
TXD_UC   7   1A1   1B1   14   TXD_UB
DTR_UC   8   1A2   1B2   13   DTR_UB
         9   2A1   2B2   12
GND   1   2A2
        16   1/OE
         4   2/OE
P_3V3   5   1DIR
        10   2DIR
             GND   GND   11

R8 10K
R9 10K
10K
10K R12

GND GND   GND   SN74AVC4T245   GND

Since u-blox module's communication interface operates at 1.8VDC, while the STM32F205RGT6 microcontroller operates at 3.3VDC, we need voltage translators in-between them. This is achieved with two SN74AVC4T245 non-inverting buffers. The default state of the USART pins is set with the help of pull-up and pull-down resistors, and the unused input pins are tied to GND.

The output (3.8V net) of the PMIC is fed directly to the u-blox cellular module and a 3.3VDC high efficiency switching regulator (TPS62290). This 3.3VDC regulator helps power the microcontroller, fuel gauge and the buffers.

The E series employs a MAX17043 fuel gauge to monitor the LiPo battery voltage and it's state of charge. The microcontroller communicates with it over an I2C interface (same channel as the PMIC).

Product Variants

Name	Connectivity	Geography	u-blox variant	Band Support
E314	3G with 2G fallback (EtherSIM)	Global	SARA-U201	850/900/1800/1900/2100 MHz
E310	3G with 2G fallback (pre-2021)	Global	SARA-U201	850/900/1800/1900/2100 MHz
E404X	LTE M1 only (EtherSIM)	US, Canada, Mexico	R510S-01B	LTE M1: 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28
E404	LTE M1 only (EtherSIM)	US, Canada, Mexico	R410M-02B or -03	LTE M1: 1, 2, 3, 4, 5, 8, 12, 13, 20, 25, 26, 28, 39
E402	LTE M1 only (pre-2021)	US, Canada, Mexico	R410M-02B	LTE M1: 1, 2, 3, 4, 5, 8, 12, 13, 20, 25, 26, 28, 39

Name	Connectivity	Geography	u-blox variant	Band Support
E314	3G with 2G fallback (EtherSIM)	Global	SARA-U201	850/900/1800/1900/2100 MHz
E310	3G with 2G fallback (pre-2021)	Global	SARA-U201	850/900/1800/1900/2100 MHz
E404X	LTE M1 only (EtherSIM)	US, Canada, Mexico	R510S-01B	

Country compatibility

Country	Model	Technologies	Carriers
Afghanistan	E314	2G, 3G	MTN
Albania	E314	2G, 3G	ALBtelecom, Telekom, Vodafone
Algeria	E314	2G, 3G	Mobilis, Ooredoo
Anguilla	E314	2G, 3G	Flow
Antigua and Barbuda	E314	2G, 3G	Flow
Argentina	E314	2G, 3G	Claro, Movistar, Personal
Armenia	E314	2G, 3G	Beeline, Ucom
Aruba	E314	2G, 3G	Setar
Australia	E314	3G	Optus, Telstra, Vodafone
Austria	E314	2G, 3G	3 (Drei), A1, T-Mobile
Azerbaijan	E314	2G, 3G	Azercell, Bakcell, NAR Mobile
Bahamas	E314	2G, 3G	Aliv, BTC Bahamas
Bahrain	E314	2G, 3G	Zain
Bangladesh	E314	2G, 3G	Bangalink, GrameenPhone
Barbados	E314	2G, 3G	Flow
Belarus	E314	2G, 3G	A1
Belgium	E314	2G, 3G	Base, Orange, Proximus
Bolivia	E314	2G, 3G	NuevaTel
Bosnia and Herzegovina	E314	2G, 3G	BH Telecom, HT Eronet
Brunei	E314	2G, 3G	DST
Bulgaria	E314	2G, 3G	A1, Telenor, Vivacom
Burkina Faso	E314	2G, 3G	Orange
Cambodia	E314	2G, 3G	Metfone
Canada	E404	M1	Bell Mobility, Rogers Wireless, Telus
Cayman Islands	E314	2G, 3G	Flow
Chad	E314	2G, 3G	Airtel
Chile	E314	2G, 3G	Claro, Entel, Movistar
Colombia	E314	2G, 3G	Movistar, Tigo
Congo (Brazzaville)	E314	2G, 3G	Airtel
Congo (Kinshasa)	E314	2G, 3G	Airtel
Costa Rica	E314	2G, 3G	Movistar
Côte d'Ivoire	E314	2G, 3G	MTN
Croatia	E314	2G, 3G	Hrvatski Telekom, Tele2
Cyprus	E314	2G, 3G	Cytamobile-Vodafone, MTN, PrimeTel
Czechia	E314	2G, 3G	O2, T-Mobile, Vodafone
Denmark	E314	2G, 3G	3 (Tre), TDC, Telenor, Telia
Dominica	E314	2G, 3G	Flow
Dominican Republic	E314	2G, 3G	Altice Dominicana, Claro, Viva
Ecuador	E314	2G, 3G	Claro, Movistar
Egypt	E314	2G, 3G	Etisalat, Orange
El Salvador	E314	2G, 3G	Claro, Telefonica
Estonia	E314	2G, 3G	Elisa, Tele2, Telia

eSwatini	E314	2G, 3G	MTN
Ethiopia	E314	2G, 3G	Ethio Telecom
Faroe Islands	E314	2G, 3G	Faroese Telecom, Vodafone
Finland	E314	2G, 3G	DNA, Elisa, Telia
France	E314	2G, 3G	Bouygues, Free Mobile, Orange, SFR
French Guiana	E314	2G, 3G	Digicel
Gabon	E314	2G, 3G	Airtel
Georgia	E314	2G, 3G	Beeline, Geocell
Germany	E314	2G, 3G	O2, Telekom, Vodafone
Ghana	E314	2G, 3G	AirtelTigo, MTN, Vodafone
Gibraltar	E314	2G, 3G	Gibtel
Greece	E314	2G, 3G	Cosmote, Vodafone, Wind
Grenada	E314	2G	Flow
Guadeloupe	E314	2G, 3G	Orange
Guatemala	E314	2G, 3G	Claro, Movistar
Guinea	E314	2G, 3G	MTN
Guinea-Bissau	E314	2G, 3G	MTN
Guyana	E314	2G	Digicel
Haiti	E314	2G, 3G	Digicel
Honduras	E314	2G, 3G	Claro, Tigo
Hong Kong	E314	2G, 3G	CMHK, CSL, SmarTone
Hungary	E314	2G, 3G	Magyar Telekom, Telenor, Vodafone
Iceland	E314	2G, 3G	Nova, Siminn, Vodafone
Indonesia	E314	2G, 3G	Indosat, Telkomsel, XL Axiata
Ireland	E314	2G, 3G	3 (Tre), Meteor, O2, Vodafone
Israel	E314	2G, 3G	Hot Mobile, Orange, Pelephone
Italy	E314	2G, 3G	TIM, Vodafone, Wind
Jamaica	E314	2G, 3G	Digicel, Flow
Japan	E314	3G	NTT DoCoMo, Softbank
Jordan	E314	2G, 3G	Zain
Kazakhstan	E314	2G, 3G	Beeline, K-Cell
Kenya	E314	2G, 3G	Airtel
Kuwait	E314	2G, 3G	Viva, Zain
Kyrgyzstan	E314	2G, 3G	Beeline
Latvia	E314	2G, 3G	Bite, LMT, Tele2
Liechtenstein	E314	2G, 3G	Mobilkom, Orange
Lithuania	E314	2G, 3G	Bite, Omnitel, Tele2
Luxembourg	E314	2G, 3G	Orange, POST, Tango
Malawi	E314	2G, 3G	Airtel
Malaysia	E314	2G, 3G	Celcom, DiGi, Maxis
Malta	E314	2G, 3G	Go Mobile, Vodafone
Mexico	E404	M1	AT&T
Moldova	E314	2G, 3G	Moldcell, Orange
Mongolia	E314	2G, 3G	Mobicom, Unitel
Montenegro	E314	2G, 3G	Mtel, T-Mobile, Telenor

Mozambique	E314	2G, 3G	Vodacom
Myanmar	E314	2G, 3G	MPT, Telenor
Namibia	E314	2G, 3G	Telecom Namibia
Netherlands	E314	2G, 3G	KPN, T-Mobile, Vodafone
New Zealand	E314	2G, 3G	2degrees, Spark, Vodafone
Nicaragua	E314	2G, 3G	Movistar
Nigeria	E314	2G, 3G	9mobile, Airtel, Glo, MTN
Norway	E314	2G, 3G	TDC, Telenor, Telia
Oman	E314	2G, 3G	Ooredoo
Pakistan	E314	2G, 3G	Mobilink, Telenor, Ufone, Warid
Palestine	E314	2G, 3G	Jawwal
Panama	E314	2G, 3G	Digicel, Movistar
Papua New Guinea	E314	2G, 3G	bmobile
Paraguay	E314	2G, 3G	Claro, Personal, Tigo, Vox
Peru	E314	2G, 3G	Claro, Entel, Movistar
Philippines	E314	2G, 3G	Globe, Smart
Poland	E314	2G, 3G	Orange, Play, Plus, T-Mobile
Portugal	E314	2G, 3G	NOS, TMN, Vodafone
Puerto Rico	E314	2G, 3G	Claro
Qatar	E314	2G, 3G	Ooredoo, Vodafone
Romania	E314	2G, 3G	DigiMobil, Orange, Telekom Romania, Vodafone
Rwanda	E314	2G, 3G	Airtel, MTN
Saint Kitts and Nevis	E314	2G, 3G	Flow
Saint Lucia	E314	2G, 3G	Flow
Saint Vincent and the Grenadines	E314	2G, 3G	Flow
Saudi Arabia	E314	2G, 3G	Mobily, STC, Zain
Serbia	E314	2G, 3G	Telenor, VIP
Sint Maarten	E314	2G, 3G	TelCell
Slovakia	E314	2G, 3G	O2, Orange, Telekom
Slovenia	E314	2G, 3G	A1, Mobitel
South Africa	E314	2G, 3G	Cell C, MTN, Vodacom
South Korea	E314	3G	KT, SK Telecom
South Sudan	E314	2G, 3G	MTN
Spain	E314	2G, 3G	Orange, Telefonica, Vodafone, Yoigo
Sri Lanka	E314	2G, 3G	Dialog, Mobitel
Suriname	E314	2G, 3G	Telesur
Sweden	E314	2G, 3G	3 (Tre), Tele2, Telenor, Telia
Switzerland	E314	3G	Salt, Sunrise, Swisscom
Taiwan	E314	3G	Chunghwa, FarEasTone, T Star, Taiwan Mobile
Tajikistan	E314	2G, 3G	Beeline, Tcell
Tanzania	E314	2G, 3G	Airtel
Thailand	E314	2G, 3G	AIS, DTAC, True Move
Trinidad and Tobago	E314	2G, 3G	Digicel, TSTT
Tunisia	E314	2G, 3G	Orange Tunisie, Tunisie Telecom
Turks and Caicos Islands	E314	2G, 3G	Flow

Uganda	E314	2G, 3G	Africell, Airtel, MTN
Ukraine	E314	2G, 3G	Kyivstar, Life, MTS
United Kingdom	E314	2G, 3G	3, EE, Manx, O2, Sure, Vodafone
United States	E404	M1	AT&T
Uruguay	E314	2G, 3G	Antel, Claro, Movistar
Uzbekistan	E314	2G, 3G	Beeline
Venezuela	E314	2G, 3G	Movistar
Vietnam	E314	2G, 3G	MobiFone, Viettel, Vinaphone
Virgin Islands (British)	E314	2G, 3G	CCT, Flow
Zambia	E314	2G, 3G	Airtel

Ordering information

SKU	Description	Region	Modem	EtherSIM	Lifecycle	Replacement
E404XTRAY50	E Series LTE CAT-M1 (NorAm, EtherSIM), Tray [x50]	NORAM	R510	✓	In development	
E314KIT	E Series 2G/3G (Global - E314) Evaluation Kit, [x1]	Global	U201	✓	NRND-US	
E314MOD1	E Series 2G/3G (Global - E314), [x1]	Global	U201	✓	NRND-US	
E404KIT	E Series LTE CAT-M1 (NorAm) Evaluation Kit, [x1]	NORAM	R410	✓	NRND-US	
E404MOD1	E Series LTE CAT-M1 (NorAm), [x1]	NORAM	R410	✓	NRND-US	
E310TRAY50	E Series 2G/3G (Global - E310), Tray [x50]	Global	U201		Deprecated	
E314TRAY50	E Series 2G/3G (Global - E314), Tray [x50]	Global	U201	✓	Deprecated	
E402TRAY50	E Series LTE CAT-M1 (NorAm), Tray [x50]	NORAM	R410		Deprecated	E404TRAY50
E404TRAY50	E Series LTE CAT-M1 (NorAm), Tray [x50]	NORAM	R410	✓	Deprecated	
E310KIT	E Series 2G/3G (Global - E310) Evaluation Kit, [x1]	Global	U201		End of life	E314KIT
E310MOD1	E Series 2G/3G (Global - E310), [x1]	Global	U201		End of life	E314MOD1
E313EA	E Series 2G/3G (Global - E313), [x1]	Global	U201		End of life	
E313TRAY50	E Series 2G/3G (Global - E313), Tray [x50]	Global	U201		End of life	
E402KIT	E Series LTE CAT-M1 (NorAm) Evaluation Kit, [x1]	NORAM	R410		End of life	E404KIT
E402MOD1	E Series LTE CAT-M1 (NorAm), [x1]	NORAM	R410		End of life	E404MOD1

Product Handling

ESD PRECAUTIONS

The E series contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling an E series without proper ESD protection may destroy or damage it permanently. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates EØs. ESD precautions should be implemented on the application board where the E series is mounted. Failure to observe these precautions can result in severe damage to the E series!

CONNECTORS

There are two connectors on the E series that will get damaged with improper usage.

The micro B USB connector on the E series is soldered on the PCB with large surface pads as well as couple of through hole anchor points. Despite this reinforcement, it is very easy to rip out the connector if too much stress is put on in the vertical direction.

The U.FL antenna connector is not designed to be constantly plugged and unplugged. The antenna pin is static sensitive and you can destroy the radio with improper handling. A tiny dab of glue (epoxy, rubber cement, liquid tape or hot glue) on the connector can be used securely hold the plug in place.

Default settings

The E series comes pre-programmed with a bootloader and a user application called Tinker. This application works with an iOS and Android app also named Tinker that allows you to very easily toggle digital pins, take analog and digital readings and drive variable PWM outputs.

The bootloader allows you to easily update the user application via several different methods, USB, OTA, Serial Y-Modem, and also internally via the Factory Reset procedure. All of these methods have multiple tools associated with them as well.

You may use the Particle Web IDE to code, compile and flash a user application OTA (Over The Air). Particle Workbench is a full-featured desktop IDE for Windows, Mac, and Linux based on VSCode and supports both cloud-based and local gcc-arm compiles. The Particle CLI provides a command-line interface for cloud-based compiles and flashing code over USB.

Glossary

Term	Definition
SMPS	Switch Mode Power Supply
SIM	Subscriber Identity Module
RF	Radio Frequency
SMT	Surface Mount Technology (often associated with SMD which is a surface mount device).
LED	Light Emitting Diode
RGB LED	Red green and blue LEDs combined and diffused in one package.
USB	Universal Serial Bus
Quiescent current	Current consumed in the deepest sleep state.
FT	Five-tolerant; Refers to a pin being tolerant to 5V.
3V3	+3.3Volt; The regulated +3.3V supply rail. Also used to note a pin is only 3.3V tolerant.
PMIC	Power Management Integrated Circuit
LiPo	Lithium-ion Polymer Battery
GSM	Global System for Mobile Communications
CDMA	Code Division Multiple Access
OTA	Over The Air; describing how firmware is transferred to the device.
uC	Microcontroller

FCC IC CE Warnings and End Product Labeling Requirements

Federal Communication Commission Interference Statement This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Radiation Exposure Statement: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter. This End equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling The final end product must be labeled in a visible area with the following:

Contains FCC ID:

- XPY1CGM5NNN (For 3G E series module using the U201 module)
- XPY2AGQN4NNN (For LTE E series module using the R410 module)

Manual Information to the End User The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

Canada Statement This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage;
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution Exposure: This device meets the exemption from the routine evaluation limits in section 2.5 of RSS102 and users can obtain Canadian information on RF exposure and compliance. Le dispositif répond à l'exemption des limites d'évaluation de routine dans la section 2.5 de RSS102 et les utilisateurs peuvent obtenir des renseignements canadiens sur l'exposition aux RF et le respect.

The final end product must be labelled in a visible area with the following: The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains transmitter module IC:

- 8595A-SARAU201 (For 3G E series using the U201 module)
- 8595A-2AGQN4NNN (For LTE E series module using the R410 module)

This End equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body. Cet équipement devrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

The end user manual shall include all required regulatory information/warning as shown in this manual.

For an in-depth review on certifications, please click here.

Revision history

Revision	Date	Author	Comments
v001	07-Nov-2017	MB	Initial release
v002	31-Jul-2019	RK	Added LTE information
			Removed E201, E302, E303 models
v003	11-Mar-2020	RK	Corrected FCC ID for 2G/3G model
v004	14-Mar-2022	RK	Added deprecation notice

Known Errata

Contact

Web

https://www.particle.io

Community Forums

https://community.particle.io

Email

https://support.particle.io