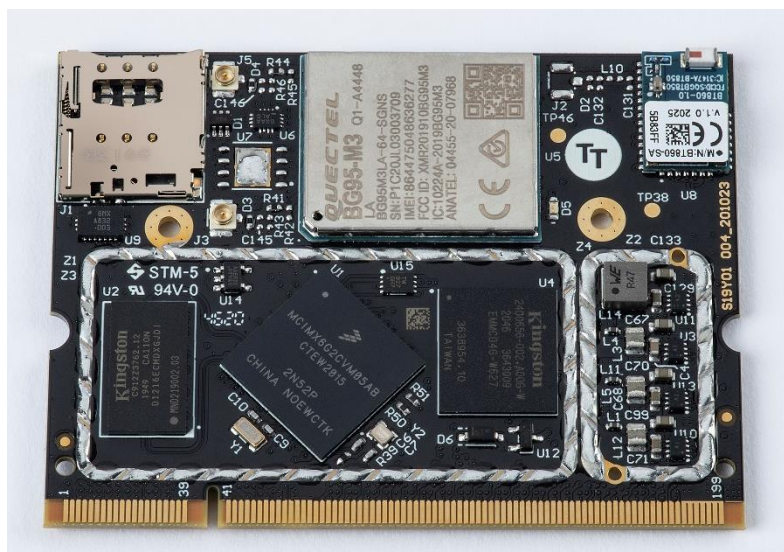


S-2CONNECT Creo SOM Hardware Guide



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Document Status

Version	Date	History	Writer
0.1	21/01/21	Initial Release	Ltn
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0.3	01/03/21	Boot configuration	Ltn
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0.7	13/04/21	Power/boot update	Ltn
1.0	13/04/21	Minor editorial changes. First released version	RC
1.1	19/04/21	Updated chapter 7 and editorial changes	RC
1.2	07/05/21	Updated chapter 6 and 9 and added appendix A. Graphical update on all tables	RC, AvA

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<https://www.ttelectronics.com/products/categories/industrial-iot/speed-to-connect/>

For technical support, or to report documentation errors, visit:

<https://www.s-2connect.com>

Or email: support.connectivity@ttelectronics.com

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1. Summary

1.1 Overview

The S-2CONNECT Creo System-On-Module (SOM) is a Communication Board with cellular connectivity and Bluetooth support. It is based on the ARM Cortex-A7 core i.MX 6 UltraLight processor.

The S-2CONNECT Creo SOM is designed to be integrated together with a carrier board of your own design into your product.

1.2 Features

- Fast time to market
- Reduction of production costs
- Cellular Connection
- Bluetooth Low Energy 5.0
- Tiny size - 67.6mm x 50mm x 5mm
- SO-DIMM standard form factor
- Universal for multiple projects
- Fast and high-performance processor
- Easy EMC certification
- Low heat dissipation

1.3 Applications

- Industrial Automation
- Home/Building Automation
- Medical Appliances
- HMI panels
- Internet of Things
- Metering Gateways
- Consumer Electronics

1.4 Description

The S-2CONNECT Creo SOM is an extremely low-power, state-of-the-art module based on ARM Cortex-A7 core i.MX 6UltraLight processor. SO-DIMM form factor makes it easy to embed to host device without any technical issues.

By placing the most critical signals in the module, even very complex peripherals can be placed using two PCB layers. This allows the delivery of cost-performance optimized designs and speeds up time to market. The S-2CONNECT Creo SOM targets a wide range of industrial applications where price sensitivity of the product is important. The module is designed to operate with all major OS. It is preconfigured for Linux.

With a rich set of peripherals, the module is designed to cater to a wide range of applications.

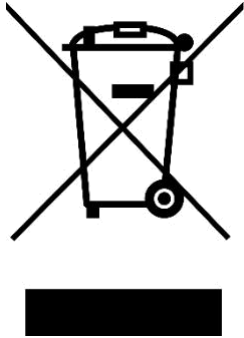
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A BG95-M3 and BT860-SA have been added to enhance the communications capabilities of the device, allowing the device to relay data gathered through the diverse interfaces available on this powerful CPU (I2C, SPI, Serial, Ethernet).

2 Environmental Information

	This symbol on the device or the package means that all electronic and electric equipment should not be mixed with general household waste. The disposal of the device after its lifecycle could harm the environment. Do not dispose the unit as unsorted municipal waste; it should be taken to a specialized company for recycling. This device should be returned to your distributor or to a local recycling service. Respect the local environmental rules If in doubt, contact your local waste disposal authorities. Please go to http://www.s-2connect.com/ for more information.
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2.1 REACH

TT Electronics complies with the REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals regulatory framework). Read more at:

<http://www.s-2connect.com/>

2.2 Safety Precautions and Prohibited Handling

	DO NOT ATTEMPT TO INSTALL, USE OR MAINTAIN THE S-2CONNECT Creo SOM UNTIL YOU HAVE READ AND FULLY UNDERSTOOD THESE INSTRUCTIONS. DO NOT PERMIT UN-TRAINED PERSONS TO INSTALL, USE OR MAINTAIN THIS PRODUCT. Inspect the device for physical damage and contamination. Do not connect the device if you detect oil, grease, water, broken or damaged parts. When unpacking the device, make sure to handle it with care. Rough handling may shock the device, causing damage. Check that the device is free from cracks, fractures, leakage. Do not allow the device to be immersed in water/sea-water. Do not attempt to disassemble or destroy the unit. The product must be handed over to an authorized workshop for maintenance and to a suitable recycling station when it is taken out of service. Use this product only within specified temperatures. S-2CONNECT Creo SOM contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling a S-2CONNECT Creo SOM 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 S-2CONNECT Creo SOM.
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2.3 General Guidelines



All modifications of the device are forbidden. Damage caused by user modifications to the device is not covered by warranty.

Only use the device for its intended purpose. Using the device in an unauthorised way will void the warranty.

Damage caused by disregard of guidelines in this manual is not covered by the warranty and the dealer will not accept responsibility for any ensuing defects or problems.

Nor TT Electronics, nor its authorized resellers can be held responsible for any damage (extraordinary, incidental or indirect) – of any nature (financial, physical....) arising from possession, use or failure of this product.

2.4 Operating conditions



Operating environment

Intended for indoor and outdoor use

Altitude

Use on maximum 2000 meter

Operating Temperature

-30°C to + 60°C

Storage Temperature

-30°C to + 60°C

Operating Humidity

20 – 80 % RH, non-condensing

Pollution Level

The device must be installed and operated only in an environment that ensures a pollution degree 2 (or better) according to IEC/EN 60664-1.

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3 Functional Description

3.1 General Information

The S-2CONNECT Creo SOM is provided together with a software development kit (SDK). There is also an evaluation board (EVB) available, that is provided with a manual that contains schematic examples. If building a carrier board for the SOM and an application code that are within what is covered by the SDK and the EVB there should be no need for any further documentation than what is provided by TT Electronics.

The S-2CONNECT Creo SOM is equipped with a powerful micro processing unit (MPU). A lot of the pins from the processor are available on the edge connector. It means that it is possible to use a lot of the features made available in the CPU also in a design based on the S-2CONNECT Creo SOM. For more advanced design TT Electronics recommend reading the full manual for the CPU. A good start to get an idea about what is possible is to check the MPU block diagram presented further below.

3.2 Block Diagram Creo SOM

The S-2CONNECT Creo SOM functional block diagram is shown in the figure below.

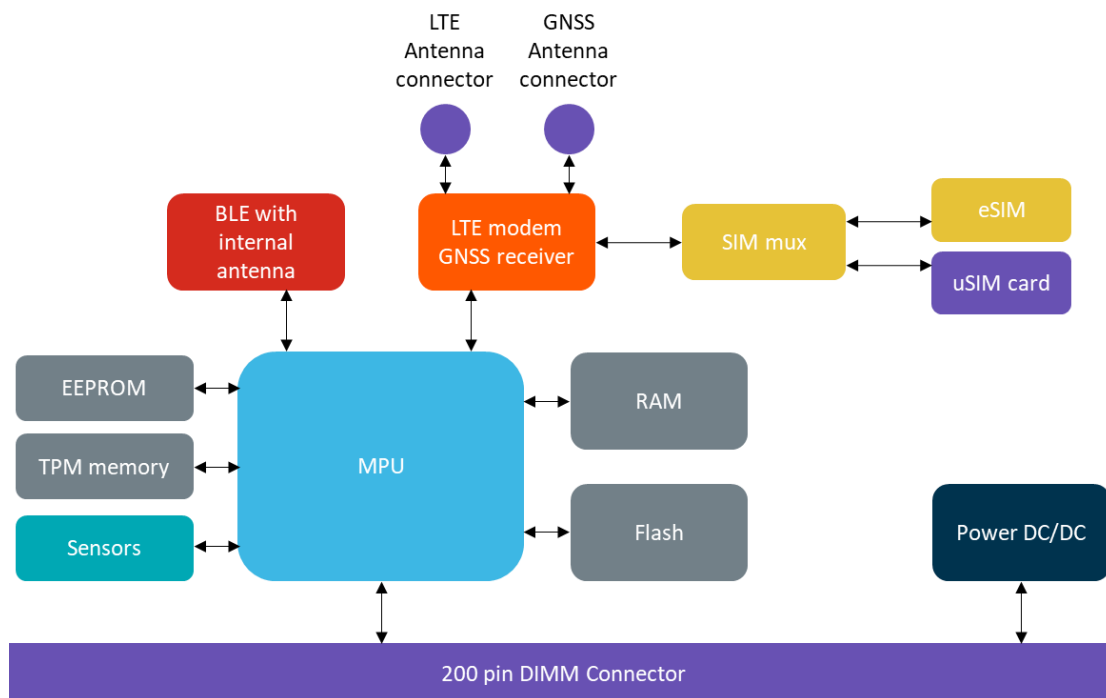


FIGURE 1: S-2CONNECT CREO SOM BLOCK DIAGRAM

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3.3 Block Diagram MPU

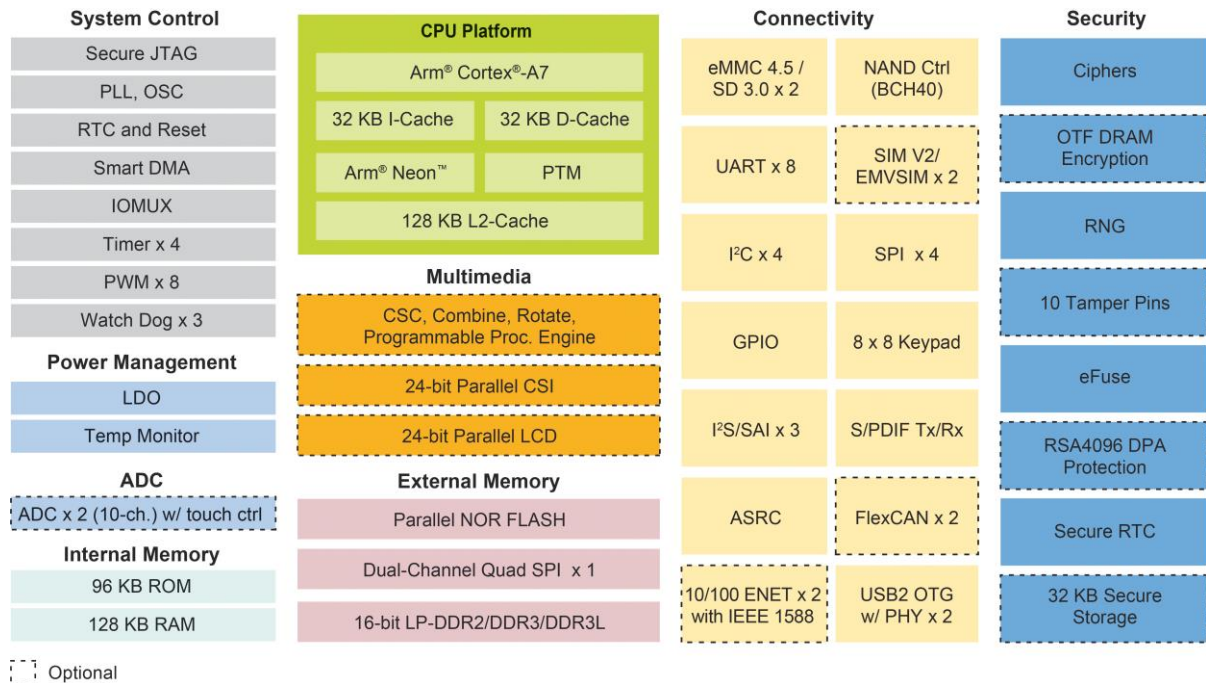


FIGURE 2: i.MX6UL BLOCK DIAGRAM

3.4 i.MX 6UltraLite Microprocessor

The S-2CONNECT Creo SOM is based on NXP i.MX 6UltraLite microprocessor. It is powered by a high performance, ultra-efficient and low power ARM Cortex-A7 core which operates at speeds 528 MHz the i.MX 6UltraLite applications processor includes an integrated power management module that reduces the complexity of external power supply and simplifies power sequencing. Processor includes 16-bit LPDDR2, DDR3, DDR3L, raw and managed eMMC, Quad SPI and a wide range of other interfaces for connecting peripherals such as WLAN, Bluetooth™, GPS, displays and camera sensors.

3.5 RAM Memory

The S-2CONNECT Creo SOM is available with 256MB of SDRAM DDR3 memory. The RAM memory is connected to i.MX 6UltraLite uses 16-bit interface running at frequency up to 400MHz, which gives bandwidth up to 12.8Gbit/s.

3.6 Flash Memory

The i.MX 6UltraLite supports external eMMC and NAND flash memory. The S-2CONNECT Creo SOM is available with 4GB eMMC memory. The eMMC memory located on the S-2CONNECT Creo SOM board enables direct system booting and user data storage.

3.7 Connectivity

The S-2CONNECT Creo SOM can be connected to the external world via:

- Cellular network thanks to the modem enabling CatM1, NB2 and EGPRS
- Ethernet connection

A Bluetooth 5.0 HCI controller has been added to relay data from potential satellite sensors.

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4 Terminal Description

4.1 Pin out

Table below shows S-2CONNECT Creo SOM pin assignments. For complete multifunction pins descriptions refer to section 4 in i.MX 6UltraLite Reference Manual

TABLE 1: SO-DIMM PINOUT

pin Number	name	i.MX 6UL Ball	power domain	comment	Direction
3	PORn	P8	VDD_SNVIS_IN	3V3 only	Input
4	SNVS_TAMPER9	R6	VDD_SNVIS_IN	3V3 only	Input
7	SNVS_TAMPER5	N8	VDD_SNVIS_IN	3V3 only	Input
8	ONOFF	R8	VDD_SNVIS_IN	3V3 only	IO
9	BOOT_MODE1	U10	VDD_SNVIS_IN	3V3 only	Input
10	PMIC_ON_REQ	T9	VDD_SNVIS_IN	3V3 only	Output
13	SNVS_TAMPER3	P10	VDD_SNVIS_IN	3V3 only	Input
14	SNVS_TAMPER1	R9	VDD_SNVIS_IN	3V3 only	Input
15	SNVS_TAMPER7	N10	VDD_SNVIS_IN	3V3 only	Input
16	SNVS_TAMPER2	P11	VDD_SNVIS_IN	3V3 only	Input
19	SNVS_TAMPER4	P9	VDD_SNVIS_IN	3V3 only	Input
20	PMIC_STBY_REQ	U9	VDD_SNVIS_IN	3V3 only	Output
21	SNVS_TAMPER0	R10	VDD_SNVIS_IN	3V3 only	Input
22	BOOT_MODE0	T10	VDD_SNVIS_IN	3V3 only	Input
25	SNVS_TAMPER6	N11	VDD_SNVIS_IN	3V3 only	Input
26	SNVS_TAMPER8	N9	VDD_SNVIS_IN	3V3 only	Input
27	I2C_SDA	L15	NVCC_GPIO	3V3 only	IO
28	I2C_SCL	K13	NVCC_GPIO	3V3 only	IO
31	JTAG_TRSTn	N14	NVCC_GPIO	3V3 only	Input
32	JTAG_TMS	P14	NVCC_GPIO	3V3 only	Input
35	JTAG_TCK	M14	NVCC_GPIO	3V3 only	Input
36	JTAG_MODE	P15	NVCC_GPIO	3V3 only	Input
37	JTAG_TDO	N15	NVCC_GPIO	3V3 only	Output
38	JTAG_TDI	N16	NVCC_GPIO	3V3 only	Input
43	GPIO7	L16	NVCC_GPIO	3V3 only	IO
45	GPIO6	K17	NVCC_GPIO	3V3 only	IO
49	UART1_TX_DATA	K14	NVCC_UART	3V3 only	IO
50	UART1_RX_DATA	K16	NVCC_UART	3V3 only	IO
51	UART1_CTSn	K15	NVCC_UART	3V3 only	IO
52	UART1_RTSn	J14	NVCC_UART	3V3 only	IO

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55	USB_OTG1_VBUS	T12	-		Input
56	nUSB_OTG1_CHD	U16	-		Input
59	USB_OTG1_D_P	U15	-		IO
61	USB_OTG1_D_N	T15	-		IO
64	CCM_CLK1_N ¹	P16	VDD_HIGH_CAP		Input
66	CCM_CLK1_P ¹	P17	VDD_HIGH_CAP		Input
71	UART2_TX_DATA	J17	NVCC_UART	3V3 only	IO
72	UART2_CTSn	J15	NVCC_UART	3V3 only	IO
75	UART2_RTSn	H14	NVCC_UART	3V3 only	IO
76	UART2_RX_DATA	J16	NVCC_UART	3V3 only	IO
77	UART5_RX_DATA	G13	NVCC_UART	3V3 only	IO
78	UART5_TX_DATA	F17	NVCC_UART	3V3 only	IO
81	ENET1_TX_EN	F15	NVCC_ENET	min 1V65, max 3V6	IO
82	ENET1_TX_DATA1	E14	NVCC_ENET	min 1V65, max 3V6	IO
83	ENET1_TX_DATA0	E15	NVCC_ENET	min 1V65, max 3V6	IO
84	ENET1_RX_ER	D15	NVCC_ENET	min 1V65, max 3V6	IO
87	ENET1_TX_CLK	F14	NVCC_ENET	min 1V65, max 3V6	IO
88	ENET1_RX_DATA0	F16	NVCC_ENET	min 1V65, max 3V6	IO
89	ENET1_RX_DATA1	E17	NVCC_ENET	min 1V65, max 3V6	IO
90	ENET1_RX_EN	E16	NVCC_ENET	min 1V65, max 3V6	IO
93	ENET2_RX_DATA0	C17	NVCC_ENET	min 1V65, max 3V6	IO
94	ENET2_RX_ER	D16	NVCC_ENET	min 1V65, max 3V6	IO
95	ENET2_RX_DATA1	C16	NVCC_ENET	min 1V65, max 3V6	IO
96	ENET2_RX_EN	B17	NVCC_ENET	min 1V65, max 3V6	IO
99	ENET2_TX_CLK	D17	NVCC_ENET	min 1V65, max 3V6	IO

¹ Pins can be used to:

- feed external reference clock to the PLLs and further on to the modules inside SoC.
- output internal SoC clock to be used outside the SoC as either reference clock or as a functional clock for peripherals.

See the i.MX 6UltraLite Reference Manual (IMX6ULRM) for details on the respective clock trees

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100	ENET2_TX_EN	B15	NVCC_ENET	min 1V65, max 3V6	IO
101	ENET2_TX_DATA0	A15	NVCC_ENET	min 1V65, max 3V6	IO
102	ENET2_TX_DATA1	A16	NVCC_ENET	min 1V65, max 3V6	IO
105	NVCC_ENET	F13	NVCC_ENET	min 1V65, max 3V6	Power
106	LCD_RESET	E9	NVCC_LCD	min 1V65, max 3V6	IO
107	NVCC_LCD	E13	NVCC_LCD	min 1V65, max 3V6	Power
108	LCD_DATA23 ²	B16	NVCC_LCD	min 1V65, max 3V6	IO
111	LCD_DATA22 ²	A14	NVCC_LCD	min 1V65, max 3V6	IO
112	LCD_DATA21 ²	B14	NVCC_LCD	min 1V65, max 3V6	IO
113	LCD_DATA20 ²	C14	NVCC_LCD	min 1V65, max 3V6	IO
114	LCD_DATA19 ²	D14	NVCC_LCD	min 1V65, max 3V6	IO
117	LCD_DATA18 ²	A13	NVCC_LCD	min 1V65, max 3V6	IO
118	LCD_DATA17 ²	B16	NVCC_LCD	min 1V65, max 3V6	IO
119	LCD_DATA16 ²	C13	NVCC_LCD	min 1V65, max 3V6	IO
120	LCD_DATA15 ²	D13	NVCC_LCD	min 1V65, max 3V6	IO
123	LCD_DATA14 ²	A12	NVCC_LCD	min 1V65, max 3V6	IO
124	LCD_DATA13 ²	B12	NVCC_LCD	min 1V65, max 3V6	IO
125	LCD_DATA12 ²	C12	NVCC_LCD	min 1V65, max 3V6	IO
126	LCD_DATA11 ²	D12	NVCC_LCD	min 1V65, max 3V6	IO
129	LCD_DATA10 ²	E12	NVCC_LCD	min 1V65, max 3V6	IO
130	LCD_DATA9 ²	A11	NVCC_LCD	min 1V65, max 3V6	IO
131	LCD_DATA8 ²	B11	NVCC_LCD	min 1V65, max 3V6	IO
132	LCD_DATA7 ²	D11	NVCC_LCD	min 1V65, max 3V6	IO

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135	LCD_DATA6 ²	A10	NVCC_LCD	min 1V65, max 3V6	IO
136	LCD_DATA5 ²	B10	NVCC_LCD	min 1V65, max 3V6	IO
137	LCD_DATA4 ²	C10	NVCC_LCD	min 1V65, max 3V6	IO
138	LCD_DATA3 ²	D10	NVCC_LCD	min 1V65, max 3V6	IO
141	LCD_DATA2 ²	E10	NVCC_LCD	min 1V65, max 3V6	IO
142	LCD_DATA1 ²	A9	NVCC_LCD	min 1V65, max 3V6	IO
143	LCD_VSYNC	C9	NVCC_LCD	min 1V65, max 3V6	IO
144	LCD_DATA0 ²	B9	NVCC_LCD	min 1V65, max 3V6	IO
147	LCD_HSYNC	D9	NVCC_LCD	min 1V65, max 3V6	IO
148	LCD_CLK	A8	NVCC_LCD	min 1V65, max 3V6	IO
151	NVCC_SD	C4	NVCC_SD1	3V3 or 1V8	Power
152	LCD_ENABLE	B8	NVCC_LCD	min 1V65, max 3V6	IO
155	SD1_DATA0	B3	NVCC_SD1	3V3 or 1V8	IO
156	SD1_DATA1	B2	NVCC_SD1	3V3 or 1V8	IO
157	SD1_DATA2	B1	NVCC_SD1	3V3 or 1V8	IO
158	SD1_DATA3	A2	NVCC_SD1	3V3 or 1V8	IO
161	SD1_CLK	C1	NVCC_SD1	3V3 or 1V8	IO
162	SD1_CMD	C2	NVCC_SD1	3V3 or 1V8	IO
163	CSI_VSYNC	F2	NVCC_CSI	3V3 or 1V8	IO
167	CSI_MCLK	F5	NVCC_CSI	3V3 or 1V8	IO
168	CSI_HSYNC	F3	NVCC_CSI	3V3 or 1V8	IO
169	CSI_DATA0	E4	NVCC_CSI	3V3 or 1V8	IO
170	CSI_PIXCLK	E5	NVCC_CSI	3V3 or 1V8	IO
173	CSI_DATA1	E3	NVCC_CSI	3V3 or 1V8	IO
174	CSI_DATA2	E2	NVCC_CSI	3V3 or 1V8	IO
175	CSI_DATA3	E1	NVCC_CSI	3V3 or 1V8	IO
176	CSI_DATA4	D4	NVCC_CSI	3V3 or 1V8	IO
179	CSI_DATA5	D3	NVCC_CSI	3V3 or 1V8	IO
180	CSI_DATA6	D2	NVCC_CSI	3V3 or 1V8	IO

² LCD_DATA[23:0] terminals are respectively BT_CFG1 [7:0] inputs, latched on power-up. External 10k-47k pull-up/pull-down resistors are needed on these terminals for proper boot configuration.

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181	CSI_DATA7	D1	NVCC_CSI	3V3 or 1V8	IO
182	NVCC_CSI	F4	NVCC_CSI	3V3 or 1V8	Power
183	3V3_SNVS	P12	-	3V3 only	Power Out ³
185	3V3	-	-	3V3 SOM supply (generated on SOM)	Power Out ³
1,2,5,6,11,12,17, 18,23,24,29,30, 33,34,39,40,41, 42,44,46,47,48, 53,54,57,58,60, 62,63,65,67,68, 73,74,79,80,85, 86,91,92,97,98, 103,104,109,110, 115,116,121,122, 127,128,133,134, 139,140,145,146, 149,150,153,154, 159,160,164,165, 166,171,172,177, 178,184,186,188, 190,192,194,196, 198,200	GND	-	-		Ground
187,189,191,193, 195,197,199	5V	-	-	main 5V (input)	Power
69,70	Not Connected				

³ Supply generated by the S-2CONNECT Creo SOM

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4.2 Boot Configuration pins⁴

Pins BOOT_MODE [1:0] are used to select system boot mode.

TABLE 2: BOOT CONFIGURATION

BOOT_MODE1	BOOT_MODE0	Boot Mode
LOW	LOW	Boot from Fuses
LOW	HIGH	Serial Downloader
HIGH	LOW	Internal Boot
HIGH	HIGH	Reserved

From the EVB implementation, the Internal Boot will allow the user to select if the processor will be started from the eMMC or the SD card with the following settings.

TABLE 3: EMMC AND SD CARD BOOT

BOOT_CFG1[5]	BOOT_CFG2[3]	BOOT_CFG2[5]	BOOT_CFG2[6]	
0	0	0	0	SDHC1 1-bit
1	1	0	0	eMMC2 1-bit
1	1	1	0	eMMC2 4-bit
1	1	0	1	eMMC2 8-bit

⁴ For complete Boot Mode configuration description see section 8 of i.MX 6UltraLite Reference Manual. During the boot process on the first mode i.MX 6UltraLite processor senses BOOT_CFGx[7:0] configuration pins (see LCD_DATA[23:0] for pin description). It is latched on power-up state, thus every BOOT_CFGx[7:0] fuse should have external pull-up/pull-down resistor connected. For complete BOOT_CFGx[7:0] pin configuration description see section 5 of i.MX 6UltraLite Reference Manual.

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5 Electrical Characteristics

5.1 Absolute Maximum Ratings

TABLE 4: ABSOLUTE MAXIMUM RATINGS

	min.	max.	unit
Supply voltage 5V0	-0.3	5.5	V
Supply USB OTGx VBUS	-	5.35	V
IO Supply for GPIO ⁹ Type Pins, NVCC CSI, NVCC LCD, NVCC SD, NVCC ENET, VCC GPIO, VCC UART	-0.5	3.7	V
Input/output Voltage range, Vin/Vout	-0.5	OVDD+0.3 ⁵	V
Current rating for S-2CONNECT Creo SOM	-	3 A ⁶	A
Current rating sinked by USB OTGx VBUS	-	500 ⁷	mA
Current rating for GPIO Type Pins: NVCC_CSI, NVCC_LCD, NVCC_SD, NVCC_ENET	-	Use maximum IO ⁸	mA
Operating ambient temperature (commercial)	-30	60	°C

5.2 Recommended Operating Conditions

TABLE 5: RECOMMENDED OPERATIONS

	min	nom	max	unit
Supply voltage, 5V	4.75	5	5.25	V
Supply USB_OTGx_VBUS	4.4	5	5.35	V
IO Supply for GPIO ^{9,10} Type Pins, NVCC_CSI, NVCC_LCD, NVCC_SD, NVCC_ENET	1.65	1.8-3.3	3.6	V

⁵ OVDD is the I/O supply voltage (3.3V)

⁶ The maximum current may be higher depending on the specific operating configurations

⁷ This is the maximum current per active USB physical interface

⁸ General equation for estimated, maximum power consumption of an IO power supply:

- $I_{max} = N \times C \times V \times (0.5 \times F)$ where:
 - N – Number of IO pins supplied by the power line
 - C – Equivalent external capacitive load
 - V – IO voltage
 - $(0.5 \times F)$ – Data change rate. Up to 0.5 of the clock rate (F)

In this equation, I_{max} is in Amps, C in Farads, V in Volts, and F in Hertz

⁹ NVCC_GPIO, NVCC_UART and NVCC_NAND are set to 3.3V and generated internally.

¹⁰ Even if not used in the application, we recommend those pins to be supplied.

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6 Radio Communications

6.1 Cellular Radio

BG95 is a series of embedded IoT (LTE Cat M1, LTE Cat NB2 and EGPRS) wireless communication modules. It provides data connectivity on LTE-FDD and GPRS/EGPRS networks and supports half-duplex operation in LTE network.

TABLE 6: COVERED BANDS

Supported Bands		Power Class
LTE-FDD bands: Cat M1:	B1/B2/B3/B4/B5/B8/B12/B13/ B20/B25/B26/B28/B66/B85	Power Class 5 (21 dBm +1.7/-3 dB)
LTE-FDD bands: Cat NB2:	B1/B2/B3/B4/B5/B8/B12/B13/ B20/B25/B28/B66/B85	
GSM bands:	850/900/1800/1900 MHz	Class 4 (33 dBm $\pm$ 2 dB) for GSM850 Class 4 (33 dBm $\pm$ 2 dB) for EGSM900 Class 1 (30 dBm $\pm$ 2 dB) for DCS1800 Class 1 (30 dBm $\pm$ 2 dB) for PCS1900 Class E2 (27 dBm $\pm$ 3 dB) for GSM850 8-PSK Class E2 (27 dBm $\pm$ 3 dB) for EGSM900 8-PSK Class E2 (26 dBm $\pm$ 3 dB) for DCS1800 8-PSK Class E2 (26 dBm $\pm$ 3 dB) for PCS1900 8-PSK

6.2 Bluetooth Radio

The BT860-SA is a UART HCI module which leverage the Cypress CYW20704 A2 chipset to provide exceptionally low power consumption with outstanding range for OEMs needing Bluetooth Low Energy support.

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6.3 GNSS Receiver

BG95 includes a fully integrated global navigation satellite system solution that supports Gen9 VT of Qualcomm (GPS, GLONASS, BeiDou, Galileo and QZSS).

The module supports standard NMEA-0183 protocol, and outputs NMEA sentences at 1 Hz data update rate via USB interface by default.

By default, BG95 GNSS engine is switched off. It must be switched on via AT command.

TABLE 7: GNSS PERFORMANCE

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold Start	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF (GNSS)	Cold start @ open sky	Autonomous	31.01	s
		XTRA enabled	10.4	s
	Warm start @ open sky	Autonomous	31.58	s
		XTRA enabled	1.53	s
	Hot start	Autonomous	1.6	s
		XTRA enabled	1.5	s
Accuracy (GNSS)	CEP-50	Autonomous @ open sky	< 2.5	m

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7 Antenna

7.1 Interfaces

The antenna interfaces consist of u.FL male connectors. Use the appropriate antenna, fulfilling the requirements as stated in the below antenna requirements, and connect it to the corresponding connector on the S-2CONNECT Creo SOM.

TABLE 8: ANTENNA INTERFACES

Pin Name	Comment
ANT (J5)	50 Ω characteristic impedance connected to the LTE Transceiver
ANT (J3)	50 Ω characteristic impedance connected to the GNSS receiver If unused, keep this pin open.

7.2 Antenna Requirements

The antenna requirements are the following:

TABLE 9: ANTENNA REQUIREMENTS

Antenna	Type Requirements
GNSS	Frequency range: 1559–1609 MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0 dBi
LTE/GSM	VSWR: ≤ 2 Efficiency: > 30 % Max Input Power: 50 W Passive antenna gain for USA and Canada: See table 10. Input Impedance: 50 Ω Cable Insertion Loss: < 1 dB (LTE B5/B8/B12/B13/B20/B26/B28/B85, GSM850/EGSM900) Cable Insertion Loss: < 1.5 dB (LTE B1/B2/B3/B4/B25/B66, DCS1800/PCS1900)
Bluetooth	Internal Antenna

An antenna can be chosen that supports a limited number of frequency bands, based on in which geographical region S-2CONNECT Creo SOM will be used. See [appendix A](#) for further information.

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TABLE 10: MAXIMUM PERMISSIBLE ANTENNA GAIN IN USA AND CANADA

Mode		Maximum Permissible Gains (dBi)	
		FCC	IC
GSM	850	7.02	3.73
	1900	8.64	8.64
LTE CatM1	Band 2	11.01	11.01
	Band 4	8.00	8.00
	Band 5	12.39	9.10
	Band 12	11.69	8.61
	Band 13	12.14	8.92
	Band 25	11.01	11.01
	Band 26	12.35	9.06
	Band 66	8.00	8.00
	Band 85	11.68	8.60
LTE NB2	Band 2	11.01	11.01
	Band 4	8.00	8.00
	Band 5	12.39	9.10
	Band 12	11.69	8.61
	Band 13	12.14	8.92
	Band 25	11.01	11.01
	Band 66	8.00	8.00
	Band 85	11.68	8.60

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7.3 Antenna Guidelines

The external antennas should be implemented at a recommended distance of at least 10 cm apart. Avoid plastic or any other dielectric material in contact with the antennas. This will negatively impact antenna efficiency and reduce range.

Any metallic objects in close proximity to the antenna will prevent the antenna from radiating freely.

Metal close to the Bluetooth Low Energy internal antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance. The amount of degradation is entirely system dependent which means some testing by customers is required (in their host application).

Any metal closer than 20 mm starts to significantly degrade performance (S11, gain, radiation efficiency).

It is recommended to test the range with mock-up (or actual prototype) of the product to assess the effects of nearby materials whether metal or plastic.

7.4 Antenna Proximity to Human Body

Placing the antenna in contact with or very close to the human body will negatively impact antenna efficiency and reduce range. Do not use S-2CONNECT Creo SOM in a hand-held device and make sure to keep at least 20 cm distance between human body and antenna.

7.5 Reference antennas

The following antennas has been used for testing and reference measurement.

For Europe:

Sectron AO-ALTE-FSMAK3

For North America:

Pulse W1696-M

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8 Mechanical Characteristics

8.1 Technical Drawing

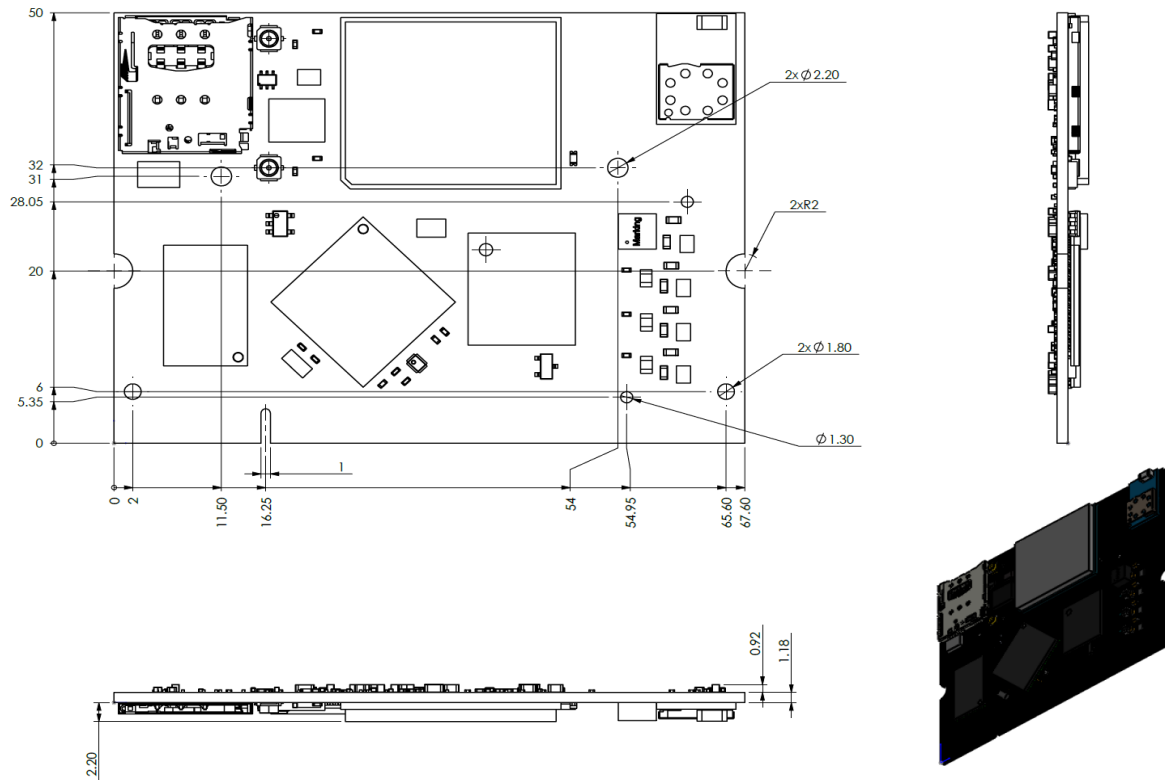


FIGURE 3: MECHANICAL DRAWING

8.2 Sockets for the S-2CONNECT Creo SOM

The S-2CONNECT Creo SOM can be connected to board via the 200-pin SO-DIMM connector. This type of SO-DIMM connector is available in two variants DDR and DDR2. The S-2CONNECT Creo SOM used standard DDR2. TT Electronics recommends using the TE Connectivity 1473005-4.

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9 Regulatory and Type Approval Information

9.1 EU and UK Declaration of Conformity

9.1.1 Simplified EU Declaration of Conformity

TT Electronics hereby declared that the S-2CONNECT Creo SOM is in compliance with the essential requirements of the following EU directives:

- RED 2014/53/EU
- RoHS 2011/65/EC
- WEEE 2012/19/EU

9.1.2 Simplified UK Declaration of Conformity

Hereby, TT Electronics declares that the S-2CONNECT Creo SOM is in compliance with applicable UK regulations.

Full text of the conformity is available at:

<http://www.s-2connect.com/>

This equipment complies with EU radiation exposure limits set fourth for an uncontrolled equipment. This equipment should be installed and operated with minimum distance 20 cm between the device and the user and/or any bystander.

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9.2 FCC and IC Compliance

S-2CONNECT Creo SOM holds approval for both FCC and IC. Approval numbers are:

FCC: 2AZF4-S19Y01

IC: 27105-S19Y01

The S-2CONNECT Creo SOM has been tested to fulfil the FCC requirements. Test reports are available upon request.

Applicable FCC rule parts are: §15.247, §22H, §90, §24E and §27

NOTE: 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 or more 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.*

This Class B digital apparatus complies with Canadian ICES-003.

9.3 Type approval information for integrators

The S-2CONNECT Creo SOM is designed tested and approved for the European market (CE), UK (UKCA), US (FCC) and Canada (ISED). Simplified approval procedures for end products should be possible for all integrators as long as the integrators are launching their products on the above mentioned/markets and as long as the integrator are following the guidelines in this manual.

9.3.1 Compliance with FCC and IC Rules and Regulations

Manufacturers of mobile or fixed devices incorporating S-2CONNECT Creo SOM modules are authorized to use the FCC Grants and Industry Canada Certificates of the S-2CONNECT Creo SOM modules for their own final products according to the conditions referenced to in this document.

The S-2CONNECT Creo SOM module transmitter is only FCC authorized for the specific rule parts listed on the grant, and that the manufacturers of mobile or fixed devices incorporating S-2CONNECT Creo SOM modules is responsible for compliance to any other FCC rules that apply to the final products not covered by the modular transmitter grant of certification. The final products still require Part 15 Subpart B compliance testing with the S-2CONNECT Creo SOM modular transmitter installed.

In this case, an FCC/ IC label of the module shall be visible from the outside, or the host device shall bear a second label stating, "Contains FCC ID: 2AZF4-S19Y01", and accordingly "Contains IC: 27105-S19Y01".

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The integration is limited to fixed or mobile categorized host devices, where a separation distance between the antenna and any person of min. 20 cm can be assured during normal operating conditions.

IMPORTANT:

Manufacturers of portable applications to be launched in US and/or Canada incorporating S-2CONNECT Creo SOM modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles.

Changes or modifications made to this equipment not expressly approved by the party responsible for compliance could void the FCC authorization to operate this equipment.

Manufacturers/OEM Integrators must ensure that the final user documentation does not contain any information on how to install or remove the module from the final product.

If Canadian approval is requested for devices incorporating S-2CONNECT Creo SOM modules the below note will have to be provided in the English and French language in the final user documentation.

NOTICE:

(EN) This device complies with Part 15 of the FCC Rules and contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS standard(s).

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.

(FR) L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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, et
- (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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(EN) This Class B digital apparatus complies with Canadian ICES-003 and RSS-210. 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.

(FR) Cet appareil numérique de classe B est conforme aux normes canadiennes ICES-003 et RSS-210. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférence et (2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.

(EN) Radio frequency (RF) Exposure Information

The radiated output power of the Wireless Device is below the Industry Canada (IC) radio frequency exposure limits. The Wireless Device should be used in such a manner that the potential for human contact during normal operation is minimized. This device has also been evaluated and shown compliant with the IC RF Exposure limits under mobile exposure conditions (antennas at least 20cm from a person's body).

(FR) Informations concernant l'exposition aux fréquences radio (RF)

La puissance de sortie émise par l'appareil de sans fil est inférieure à la limite d'exposition aux fréquences radio d'Industry Canada (IC). Utilisez l'appareil de sans fil de façon à minimiser les contacts humains lors du fonctionnement normal.

Ce périphérique a également été évalué et démontré conforme aux limites d'exposition aux RF d'IC dans des conditions d'exposition à des appareils mobiles (les antennes se situent à moins de 20cm du corps d'une personne).

9.3.2 FCC IC End Product Labelling Requirements

The final end product must be labelled in a visible area with the following:

- FCC ID: 2AZF4-S19Y01

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.

For further information read FCC document: KDB 784748

The final end product must be labelled in a visible area with the following:

- IC ID: 27105-S19Y01

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

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9.3.3 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 centimetres between the radiator and your body.

IMPORTANT NOTE: In the event that these conditions cannot 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 cannot 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.

9.3.4 Information about test modes

For some test modes during development and approval testing it might be necessary to manually control the transmitters on the S-2CONNECT Creo SOM.

Both radio transceivers are reachable via a serial interface. In order to access the test mode for the Cellular transceiver, the modem needs to be started with the command line **gsm-modem-on.sh**.

The AT commands interface will be then available through ttyUSB2. TT Electronics recommend the user to take contact with Quectel for access to a list of dedicated commands.

For the BLE module, TT Electronics recommend using the **hcitool** available in the embedded operating system to issue the testing commands available on the Laird BT-860-SA (Cypress Chipset). To start the module, one needs to issue the command **hciconfig hci0 up**. Dedicated test commands are available on request to Laird support as an NDA needs to be signed.

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9.4 Approved Modules

The S-2CONNECT Creo SOM include pre-approved radio modules. They are:

TABLE 11: PRE-CERTIFIED MODULES

Radio Interface	Manufacturer	Type number
Cellular modem + GNSS	Quectel	BG95-M3
Bluetooth	Laird	BT860-SA

9.4.1 Quectel BG95-M3

FCC Labelling

FCC ID: XMR201910BG95M3

IC ID: 10224A-2019BG95M3

9.4.2 Laird BT860-SA

9.4.2.1 FCC Labelling

FCC ID: SQGBT850

IC ID: 3147A-BT850

9.4.2.2 Bluetooth Qualification

The BT860-SA is a qualified design according to Bluetooth Qualification Program Reference Document (PRD) V2.3.

Declaration ID is: D043711

Qualified design is: 78666

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10 Reference Documentation

iMX6UL

- <https://www.nxp.com/docs/en/data-sheet/IMX6ULIEC.pdf>
- https://www.nxp.com/docs/en/reference-manual/i.MX_Reference_Manual_Linux.pdf
- <https://www.nxp.com/products/processors-and-microcontrollers/arm-processors/i-mx-applications-processors/i-mx-6-processors/i-mx-6ultralite-processor-low-power-secure-arm-cortex-a7-core:i.MX6UL>

BT860-SA

- <https://www.lairdconnect.com/documentation/datasheet-bt860>

BG95-M3

- https://www.quectel.com/UploadImage/Downlad/Quectel_BG95_Hardware_Design_V1.1.pdf

11 Contacts

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12 Appendix A: LTE Bands

Geographical usage of LTE bands supported by S-2CONNECT Creo SOM.

TABLE 12: GEOGRAPHICAL USE OF LTE BANDS

LTE Band	North America	Europe
1	No	Yes
2	Yes	No
3	No	Yes
4	Yes	No
5	Yes	No
8	No	Yes
12	Yes	No
13	Yes	No
20	No	Yes
25	Yes	No
26	Yes	No
28	No	Yes
66	Yes	No
85	Yes	No

LTE is designed to work across several frequency bands. Availability of specific bands varies per country and operator.

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