IMPC001-US / -EUR / -AUS

PRELIMINARY DATASHEET

Revision 1.5 20180920

electric imp

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1 DESCRIPTION

The impC001 is a secure IoT node with LTE cat 1 connectivity, in a card form factor compatible with NGFF M2 connectors. It provides a wide range of I/O options, and significant on-board processing ability, in addition to being able to support both wired and WLAN networks with additional circuitry.

1.1 CELLULAR SUPPORT

impC001 is currently available in three variants:

- impC001-us
  - LTE bands 2, 4, 5, 12
  - 3G fallback on UMTS bands 5, 4, 2
  - PTCRB end-device approvals
  - FCC/IC modular approval

- impC001-eur
  - LTE bands 1, 3, 8, 20, 28
  - 3G fallback on UMTS bands 1, 8
  - 2G fallback on 900 & 1800MHz
  - GCF tested
  - CE RED declaration of conformity

- impC001-aus
  - LTE bands 3, 5, 8, 28
  - 3G fallback on UMTS bands 1, 5, 8
  - GCF tested

All versions feature two u.FL antenna connectors; the primary antenna is used for transmit and receive, and the optional secondary antenna is used for RX diversity (LTE only).

1.2 IMP: THE INTELLIGENCE ON-BOARD

An on-board 400MHz ARM Cortex-M7 processor runs our secure operating system, impOS, and provides secure edge processing for applications. All RAM and flash areas on the device are ECC protected for reliable operation.

All upgrades of the OS and customer application are performed securely OTA.

A rich set of I/O is provided:

- 44x GPIO with programmable pullups/pulldowns
- 6x four-wire UART, 1x two-wire UART
- 5x SPI master
- 4x I2C master
- 11x ADC channels
- 2x DAC channels
- 1x USB host

The 44 pins are shared and runtime configurable to different peripherals; not all combinations of I/O are possible simultaneously.

In addition, the device is capable of driving two additional network interfaces: (impOS 42 onwards)

- 10/100 Ethernet via an external Ethernet RMII PHY
- 802.11b/g/n or 802.11/a/b/g/n WiFi via an external SDIO WiFi module
    - Murata type 1DX for 802.11b/g/n + BLE
    - Murata type 1MW for 802.11a/b/g/n + BLE

impOS also features an integrated BLE stack, and so can provide BLE functionality (advertising, sniffing, GATT) in conjunction with a supported BLE chip. One 4-wire UART and two GPIOs are required for this integration.

An on-module 8MB SPI flash is shared between the system (WiFi firmware storage) and the application, and can be accessed with the hardware.spiflash API.

1.3 APPLICATION ENVIRONMENT

impOS provides a bytecode VM environment for user applications. Currently, 256kB of non-volatile bytecode space is available for user applications, and approximately 600kB of RAM.

Applications can be developed and debugged from anywhere, via our secure cloud service, and compiled code pushed securely OTA to devices in the field.

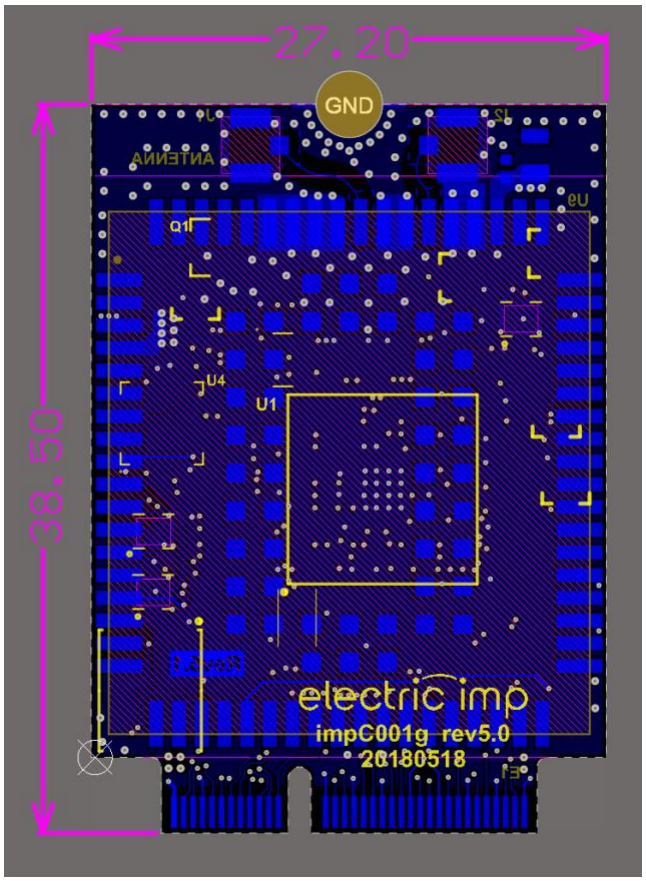
Every device in the field also gets a companion bytecode VM which runs within an impCloud server. This dual-VM environment allows heavyweight cloud integration tasks to be performed cloud-to-cloud, reducing cost, power consumption, and data traffic to/from the device itself.

2 PHYSICAL

The module measures 27.20mm x 38.50mm

The PCB is 0.8mm thick, and the maximum top height is 2.20mm (not including the mounted height of the customer's u.FL antenna connectors). The maximum component height on the underside is <1.5mm.

Note that this illustration shows the underside view; if looking at the module from the top side (ie, the side visible when the module is mounted), then the notch is on the right.



2.1 HOST CONNECTOR

The impC001 is connected to the host system via a M2 compatible NGFF (key E) connector, and secured with an M3 screw.

The recommended connector/hardware set is available from All Link Taiwan (http://alllink.com.tw):

- Connector NFSE0-S6701-TP40
- 2.45mm high SMT fixing post ST6N-M30-245
- M3 screw SC3N-M30-25N

Prototyping sets of all three parts can be purchased from the Electric Imp online store at https://store.electricimp.com

An alternate connector available in distribution is the JAE SM3ZS067U310AER1200, with the top-side screw terminal fixing using the threaded standoff SM3ZS067U310-NUT1-R1800. However, note that this threaded standoff is an M2.5 screw thread and slightly undersized – it is intended for mini-PCI cards, not NGFF.

With this height standoff connector, there is no clearance for parts between the customer PCB and mounted module. Higher standoff connectors can be used if required, please contact us for applicable part numbers.

2.2 ANTENNA CONNECTORS

There are two u.FL antenna connectors on the impC001.

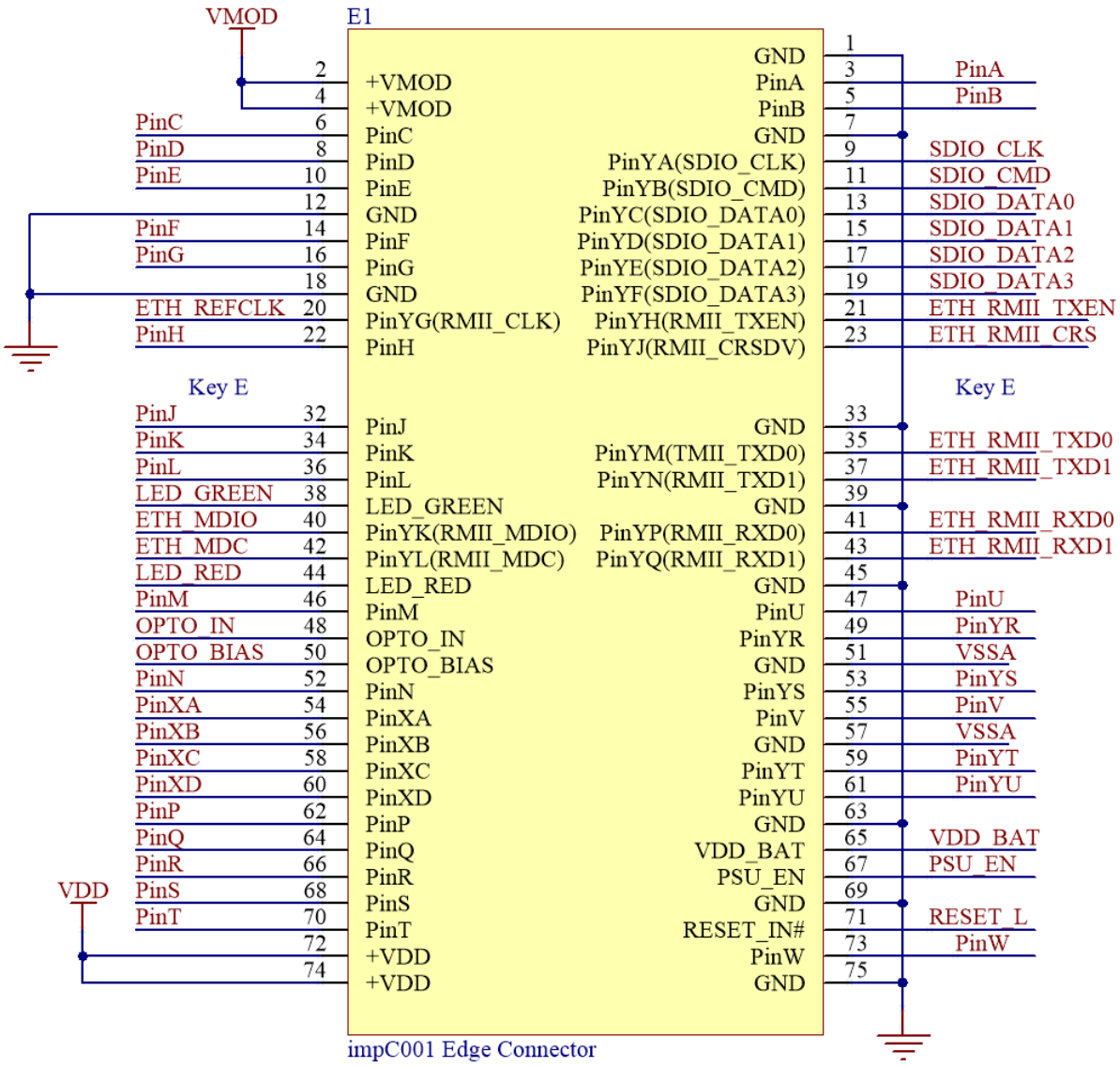
J1 is the primary antenna connection, which is used for both transmit and receive. An approved antenna must be connected to this port for device operation. This connector is labelled “ANTENNA”.

J2 is a secondary antenna connection, for diversity receive (LTE only). If diversity receive is not required, or two antennas cannot be used in this application, no antenna or termination needs to be connected to this port.

The antenna connections are both 50 ohm.

3 SCHEMATIC SYMBOL

CAD symbols/footprints for this part are available from Electric Imp in Altium format on https://developer.electricimp.com



4 PIN LISTING

Pin	Name	Type	Description
1	GND	Power	Ground
2	VMOD	Power	Radio supply (typically 3.9v, peak 2.4A)
3	pinA	I/O	GPIO, IRQ, USB-DP, uartDCAB RTS, spiDCAB SCK
4	VMOD	Power	Radio supply (typically 3.9v, peak 2.4A)
5	pinB	I/O	GPIO, USB-DM, uartDCAB CTS, spiDCAB NSS
6	pinC	I/O	GPIO, IRQ, uartDCAB RXD, spiDCAB MISO
7	GND	Power	Ground
8	pinD	I/O	GPIO, IRQ, PWM, uartDCAB TXD, spiDCAB MOSI
9	pinYA	I/O	GPIO, uartYABCD TXD, SDIO CLK
10	pinE	I/O	GPIO, IRQ, uartEVMT TXD, spiEVMT MOSI
11	pinYB	I/O	GPIO, uartYABCD RXD, SDIO_CMD
12	GND	GND	Ground
13	pinYC	I/O	GPIO, uartYABCD RTS, SDIO_DATA0
14	pinF	I/O	GPIO, IRQ
15	pinYD	I/O	GPIO, uartYABCD CTS, SDIO_DATA1
16	pinG	I/O	GPIO
17	pinYE	I/O	GPIO, spiYRFES SCK, SDIO_DATA2
18	GND	GND	Ground
19	pinYF	I/O	GPIO, spiYRFES MISO, SDIO_DATA3
20	pinYG	I/O	GPIO, RMII_CLK
21	pinYH	I/O	GPIO, spiYJTHU SCK, RMII_TXEN
22	pinH	I/O	GPIO, IRQ, PWM, uartHJKL TXD, i2cHJ SCL
23	pinYJ	I/O	GPIO, ADC, PWM, spiYJTHU MOSI, RMII_CRS
24-31	-	-	NGFF notch
32	pinJ	I/O	GPIO, IRQ, PWM, uartHJKL RXD, i2cHJ SDA
33	GND	GND	Ground

34	pinK	I/O	GPIO, uartHJKL RTS, i2cKL SCL
35	pinYM	I/O	GPIO, RMII_TXD0
36	pinL	I/O	GPIO, IRQ, uartHJKL CTS, i2cKL SDA
37	pinYN	I/O	GPIO, RMII_TXD1
38	LED_GREEN	O	Green LED drive (common anode/common cathode auto detect)
39	GND	GND	Ground
40	pinYK	I/O	GPIO, IRQ, WAKE1, ADC, RMII_MDIO
41	pinYP	I/O	GPIO, ADC, RMII_RXD0
42	pinYL	I/O	GPIO, IRQ, WAKE5, ADC, RMII_MDC
43	pinYQ	I/O	GPIO, ADC, RMII_RXD1
44	LED_RED	O	Red LED drive (common anode/common cathode auto detect)
45	GND	GND	Ground
46	pinM	I/O	GPIO, IRQ, PWM, uartEVMT RTS, spiEVMT SCK
47	pinU	I/O	GPIO, ADC, DAC, uartNU RXD
48	OPTO_IN	I	Phototransistor input
49	pinYR	I/O	GPIO, ADC, spiYRFES MOSI
50	OPTO_BIAS	O	Phototransistor power
51	AGND	AGND	Analog ground
52	pinN	I/O	GPIO, uartNU TXD
53	pinYS	I/O	GPIO, ADC, DAC, spiYRFES NSS
54	pinXA	I/O	GPIO, uartXBADC RXD, i2cXBA SDA
55	pinV	I/O	GPIO, IRQ, ADC, uartEVMT RXD, spiEVMT MISO
56	pinXB	I/O	GPIO, uartXBADC TXD, i2cXBA SCL
57	AGND	AGND	Analog ground
58	pinXC	I/O	GPIO, uartXBADC CTS, i2cXDC SDA
59	pinYT	I/O	GPIO, ADC, PWM, spiYJTHU MISO
60	pinXD	I/O	GPIO, PWM, uartXBADC RTS, i2cXDC SCL
61	pinYU	I/O	GPIO, ADC, spiYJTHU NSS

62	pinP	I/O	GPIO, PWM, uartPQSR TXD, spiPQRS MOSI
63	GND	GND	Ground
64	pinQ	I/O	GPIO, uartPQSR RXD, spiPQRS MISO
65	VDD_BAT	Power	RTC/NVRAM backup supply
66	pinR	I/O	GPIO, uartPQSR CTS, spiPQRS SCK
67	PSU_EN	O	Power supply enable, active high
68	pinS	I/O	GPIO, WAKE2, IRQ, uartPQSR RTS, spiPQRS NSS
69	GND	GND	Ground
70	pinT	I/O	GPIO, WAKE0, IRQ, uartEVMT CTS, spiEVMT NSS
71	RESET_IN#	I	Reset input, active low (pull-up on board)
72	VDD	Power	MCU power (typically 3.3v, peak 400mA)
73	pinW	I/O	GPIO, WAKE4, IRQ
74	VDD	Power	MCU power (typically 3.3v, peak 400mA)
75	GND	GND	Ground

5 GENERAL DESIGN INFORMATION

5.1 POWER REQUIREMENTS

The module accepts three supplies:

- VMOD supplies the radios, and is nominally 3.9v
- VDD supplies the MCU, and is nominally 3.3v
- VBAT supplies the sleep domain on the MCU, running the on-board RTC and nvram
    - This is designed for a backup cell or supercap
    - If no backup supply is used in the design, this pin should be connected to VDD

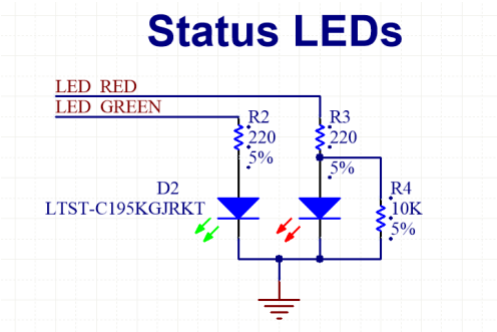
See the electrical characteristics section for more details.

5.2 STATUS INDICATORS

Every host board must include a bi-color LED connected to LED_RED and LED_GREEN. The imp will indicate its current connection state by flashing sequences on these LEDs.

Common cathode and common anode packages are supported. A 10k resistor across the red LED allows the imp to determine the polarity of the LED at boot time and drive it appropriately.

Current limiting resistors should be included in series with the LEDs.

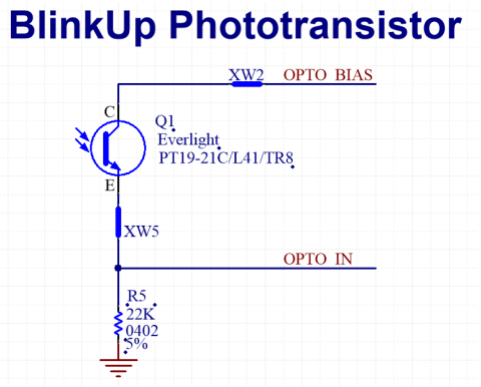


5.3 BLINKUP

Blinkup™ allows quick provisioning of devices, especially during development and production. All development devices must include a phototransistor to enable this functionality. In production, devices can be pre-provisioned at time of manufacture, so they require no provisioning at all in the field.

If desired, provisioning for manufacturing can be done electrically via a test point on the host board connected to the OPTO_IN signal – please contact us for more details. We strongly recommend that development units should include the phototransistor for ease of development.

An example part number and schematic is shown below:



5.4 ETHERNET INTERFACE

A 10/100 Ethernet interface is supported by the hardware; this requires connecting the RMII and MDIO pins to a supported Ethernet PHY, such as the Microchip LAN8720A.

When enabled, these pins are not available for user application use. Squirrel APIs allow for the interface to be configured, used for cloud connectivity, and used for LAN communication with socket APIs.

This feature is not available until impOS release 42. Please contact us for reference designs and design reviews.

5.5 WIFI/BLE INTERFACE

The impC001 supports an external SDIO WiFi/BLE device. Supported modules are the Murata 1DX (Cypress 43438, WiFi 802.11b/g/n and BLE) and Murata 1MW (Cypress 43455, WiFi 802.11a/b/g/n/ac and BLE).

As with Ethernet, use of this interface requires connecting all the appropriate SDIO pins to the external module, along with an enable and interrupt line. If BLE operation is also required, this needs an additional 4 wire UART and enable line to be dedicated to BLE operation.

This feature is not available until impOS release 42. Please contact us for reference designs and design reviews.

6 PERIPHERALS

6.1 GPIO

All pins can be configured as GPIOs in four modes:

- Input (with optional pull-up or pull-downs)
- Output (push-pull, max +/- 4mA)
- Open drain output (pull, max -4mA)

All I/O is at the VDD voltage, typically 3.3v.

6.2 STATE CHANGE (IRQ) PINS

These pins can have event handlers attached that will trigger on state change. Commonly they are used to detect button presses or IRQ events on external devices.

- pinA
- pinC
- pinD
- pinE
- pinF
- pinH
- pinJ
- pinL
- pinM
- pinS
- pinT
- pinV
- pinW
- pinYK
- pinYL

6.3 WAKE PINS

Several pins can be configured to wake the impC001 from deep sleep mode: pinS, pinT, pinW, pinYK, pinYL

Current software only supports pinW for wake.

6.4 UART

Seven UARTs are available. UARTs can be configured in one or two wire mode to leave other pins free if required by the application.

- uartDCAB
- uartHJKL
- uartEVMT
- uartPQSR
- uartXBADC
- uartYABCD
- uartNU

6.5 SPI

Five master mode SPIs are available. SPIs can be configured as simplex or clockless (for waveform generation).

- spiDCAB
- spiEVMT
- spiYFRES
- spiYJTHU
- spiPQRS

6.6 I2C

Four I2C masters are available.

- i2cHJ
- i2cXBA
- i2cKL
- i2cXDC

6.7 USB HOST

A single USB2.0-FS USB host PHY is available, on pinA & pinB. A squirrel library provides a framework to support arbitrary devices with minimal effort.

6.8 PWM

Eight pins can be configured as PWMs. All PWM outputs are independent, and can be configured either to prioritize number of steps (resolution) or timing.

- pinD
- pinP
- pinH
- pinXD
- pinJ
- pinYJ
- pinM
- pinYT

6.9 ADC

Eleven pins can be configured as analog inputs. An internal 12 bit ADC measures these with reference to the AGND and VDD supply pins.

Channels can be read ad-hoc, or sampled automatically and sequentially using the hardware.sampler API. An API also allows reading of the VDD rail, with relation to the internal voltage reference.

- pinU
- pinYQ
- pinV
- pinYR
- pinYJ
- pinYS
- pinYK
- pinYT
- pinYL
- pinYU
- pinYP

6.10 DAC

There are two DACs available, on pinU and pinYS.

Currently, the hardware.ffdac peripheral does not support these pins, but support will be added in a future impOS release.

7 ELECTRICAL AND ENVIRONMENTAL CHARACTERISTICS

7.1 POWER SUPPLY DESIGN REQUIREMENTS

Power supplies for the impC001 should meet the requirements below. Please contact us, and see our reference designs, for suggested parts and design reviews.

	Min	Typ	Max	Units	Description
VMOD All versions	3.3	3.9	4.5	V	Measured at the m2 connector. Note min voltage spec must be met at max current state
VMOD current, impC001-EUR			2.4	A	Peak current is in a 2G TX burst, average over a second is 850mA
VMOD current, impC001-US & impC001-AUS			0.57	A	Maximum is during an LTE band 4 data transfer
VMOD inrush current		1.0		A	When the on-board power gate is enabled to the radio, there is a current inrush as the on-board capactiors are charged. The current is limited by a soft turn on of the pass FET
VDD	2.7	3.3	3.6	V	MCU supply, measured at the m2 connector
VDD current			220	mA	Maximum @ 25C
VDD current			400	mA	Maximum @ 85C
VBAT	1.2		3.6	V	

7.2 TYPICAL CURRENT CONSUMPTION

VDD

	Typ	Units	Description
High activity	125	mA	Tight loop in squirrel, peripherals disabled
Idle, blinkup enabled	62	mA	ADC active, periphal buses clocked, squirrel idle
Idle	5	mA	Peripherals disabled, squirrel idle
Deep sleep	8	uA	RTC and nvram powered, no wakeup pins configured

VMOD

	Typ	Units	Description
Idle and associated to network	20	mA	Average current, associated to 2G/3G/LTE network but idle
Data transfer in progreess		mA	Sending data continuously on LTE

VBAT

	Typ	Units	Description
Sleep mode	2.35	uA	Typical at VBAT=3.4v, VDD=0v

7.3 I/O PORT CHARACTERISTICS

Input characteristics

	Min	Typ	Max	Units	Description
V_{IL}			0.3xVDD	V	Maximum logic 0 input voltage
V_{IH}	0.7xVDD			V	Minimum logic 0 input voltage
R_{PU}	30	40	50	kΩ	Internal pull-up equivalent resistor
R_{PD}	30	40	50	kΩ	Internal pull-down equivalent resistor
C_{IO}	5	15		pF	Some pins on the impC001 m2 connector are connected to up to three pins on the STM32 processor, which increases the pin capacitance of these pins

Output characteristics

All pins can sink or source up to 8mA

	Min	Typ	Max	Units	Description
V_{OL}			0.4	V	Maximum logic 0 output voltage, I_{IO}=8mA
V_{OH}	VDD-0.4			V	Minimum logic 0 output voltage, I_{IO}=-8mA

7.4 ENVIRONMENTAL CHARACTERISTICS

Operating temperature range

	Min	Typ	Max	Units	Description
Normal operation	-30	+25	+85	C	
Extended operation	-40		+90	C	In extended operation range, radio will operate for a limited time before automatic thermal shutdown takes effect.

8 CERTIFICATION DETAILS

8.1 IMPC001-US: COMPLIANCE WITH FCC AND IC RULES AND REGULATIONS

The Equipment Authorization Certification for the device references the Gemalto M2M application.

FCC Identifier:

QIPELS61-US

Industry Canada Certification Number:

7830A-ELS61US

Granted to Gemalto M2M GmbH

Manufacturers of mobile or fixed devices incorporating ELS61-US modules are authorized to use the FCC Grants and Industry Canada Certificates of the ELS61-US modules for their own final products according to the conditions referenced in these documents. 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: QIPELS61-US", and accordingly “Contains IC: 7830A-ELS61US“.

The integration is limited to fixed or mobile categorized host devices, where a separation distance between the antenna and any person of min. 20cm can be assured during normal operating conditions. For mobile and fixed operation configurations the antenna gain, including cable loss, must not exceed the limit 2.15 dBi for 700MHz, 850MHz, 1700MHz and 1900MHz.

IMPORTANT

Manufacturers of portable – as in, human-carried - applications incorporating ELS61-US 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 devices.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 and with Industry Canada license-exempt RSS standard(s). 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.

If Canadian approval is requested for devices incorporating ELS61-US modules the below notes will have to be provided in the English and French language in the final user documentation. 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.

NOTES (IC)

(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 such 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'exposltion aux fréquences radio (RF)

La puissance de sortie émise par l'appareil de sans fiI 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).

8.2 IMPC001-US END-DEVICE PTCRB APPROVAL

The impC001-US has been tested by a PTCRB approved lab to meet PTCRB end device requirements.

https://www.ptcrb.com/certified-devices/device-details/?model=40238

8.3 IMPC001-EUR: COMPLIANCE WITH CE RED AND GCF REQUIREMENTS

The radio on the impC001-EUR meets both CE RED and GCF requirements.

Please contact us for the ELS61-ER2 declaration of conformity and GCF documents.

9 REVISION HISTORY

Rev	Date	Notes
0.1	20170707	First revision
0.2	20170710	Change uartNUYUT to uartNU (now only a two-wire UART) Removed IRQ from pinK Added PEM part number for mounting hardware Added Australia/NZ variant PN Added note about TBD module growth
0.3	20170712	Final module dimensions
0.4	20170817	Added photos of actual module
0.5	20170824	uartHJKL was incorrectly referred to as uartJHKL; actual pins (TX,RX,RTS,CTS) were correctly labelled with their functions. The UART labeling was corrected Added note about pinW being the only currently supported wake pin
0.6	20170912	UART section incorrectly noted that there were 7x four wire UARTs, there are 6x and 1x two wire Removed spiNLUK from pin mux
0.7	20180102	Added antenna connection detail
0.8	20180316	Updated information on 3G fallback support for –EUR model Added information on USB host port Added information on BLE host stack Updated logo and module photos
0.9	20180613	Updated with new 27.20mm module width (was 26.85mm) Updated schematic symbol Added power requirements table
1.0	20180803	Remapped IRQ pins to ensure all wake-up pins are also IRQ capable. • Removed IRQ capability: pinA, pinR, pin YU • Added IRQ capability: pinW, pinYK, pin YL Added inrush spec for VMOD rail Typical RAM availability updated to 600kB

		Added detail on supported WiFi/BLE modules
1.1	20180814	Updated introductory text, added index pinR was incorrectly listed as WAKE capable There are only 5 SPIs, not 6
1.2	20180816	Added PWM, ADC, DAC sections Added information on Ethernet and WiFi/BLE support Added electrical & environmental characteristics section Added RF approvals & certifications section
1.3	20180820	pinA replaces pinB as IRQ/state change capable
1.4	20180904	Added typical VDD current for deep sleep mode Note that some early devices did not meet this spec; if you are seeing high sleep current on an early module (device ID less than c0010c2a69f00600) then please contact support@electricimp.com for a replacement
1.5	20180920	Updated section 2.1 with recommended M3 standoff and mass production vendor