LTEm2 User Guide

LooUQ Circuit River

The LooUQ LTEm2 is an advanced cellular interface for your IoT project/product. Incorporating the LTEm2 along with the LooUQ LTEmC device software in your design enables robust communications and rapid time to market.

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Thank you for your consideration/purchase of the LooUQ LTEm2 embedded modem. This guide will help you get familiar with the device and give you the information you need to integrate it into your project.

Applications

- Remote sensing of environmental conditions
- Machine and system monitoring
- Remote control of systems
- Location tracking

Features

- Module provided communication protocols: HTTP, MQTT, Sockets (UDP/TCP), and others.
- Module protocols offload protocol stack processing from host system.
- GNSS/GPS receiver with geo-fencing capability.
- USB connectivity (micro-USB) with 3 virtual serial ports (requires Quectel Device Driver) for data/command, high-speed diagnostics/firmware update, and NMEA sentence output.
- File system with approximately 2 MB of available persistent storage.
- Primary data/command serial port jumper seleLTEm2ble for either UART or SPI interface.
- SPI option provides 64-byte FIFO buffers for transmit and receive, with interrupt controlled I/O, further reducing communication overhead from host system.
- Side-accessible nano-SIM socket (push-push) supports in place SIM change.
- RoHS/no Pb assembly.

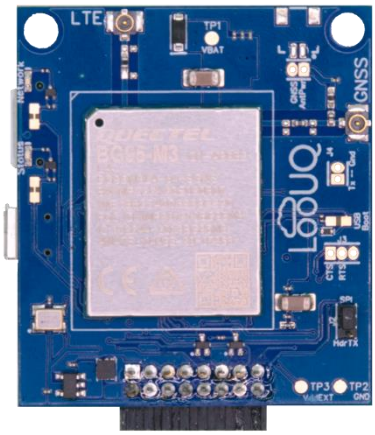
LTEmC

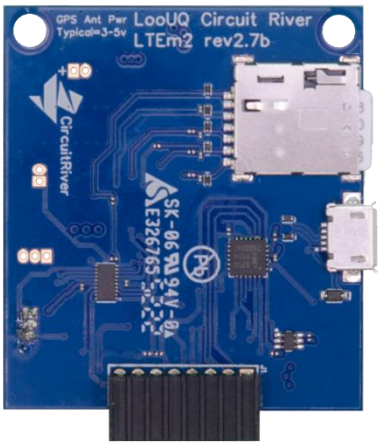
- C99 open-source MIT licensed device software (provided, not required).
- Straight forward and modular API to modem functions and BGx protocols.
- LTEmC dramatically reduces the need to understand the details of AT commands and responses.
- Supports HTTP, MQTT, Sockets (UDP/TCP), SSL/TLS, and file system (more planned).
- Common support for all LooUQ LTEm modems (LTEm1, LTEm2, and LTEm3F).
- Source available on GitHub at https://github.com/LooUQ/CircuitRiver-LTEmC
- Code documentation at https://loouq.github.io/sites/ltemc_doxy/html/index.html

If you need additional information or assistance, please contact us. We are eager to assist.

LooUQ Support Team Mailbox
answers@loouq.com

Our Support Website/Knowledgebase
http://answers.loouq.com





Getting Started

The CR-LTEM2 (LTEm2) device is designed to be integrated into your project/product. If you are using one of the LooUQ UXplor development adapters, you will find relevant information in the user guide for that adapter board. If you are creating a custom solution, please check out the ***Host Integration*** section later in this document.

LTEmC Device Software

The most expeditious way to incorporate the LTEm2 into your project/product is with the LooUQ LTEmC device software. LTEmC is written in C99 and architected to be compatible with most embedded systems. Support for standard GPIO, SPI, interrupts and simple millisecond counters is all that the host system must support to build and incorporate LTEmC into your product.

The LTEmC software supports the CR-LTEM1, CR-LTEm2 and CR-LTEM3F modems.

The LTEmC software is available on GitHub and is open source licensed (MIT license); the source documentation is available online. There are numerous use case specific test projects (targeting Arduino INO and built using Microsoft's VSCode Arduino extensions in the /tests folder.

GitHub Repository

https://github.com/LooUQ/CircuitRiver-LTEmC

Doxygen Online Software User Guide

https://loouq.github.io/sites/ltemc_doxy/html/index.html

Note: LTEmC version 3.0.1 is nearly ready for release in late February 2023. This is a major release incorporating numerous optimizations and enhancements to the codebase.

Communication With The LTEm2

1. **Use the SPI interface available on the host interface header J1 (seen above at the bottom-center of the device).**
2. Use the UART interface available on the host interface header J1.
3. Use the virtual COM port available through the USB interface.

SPI Interface

For embedded projects using the LooUQ provided LTEmC device software the required host interface is SPI; it offers reduced communications overhead to host MCU/CPU. The LTEm2 SPI interface incorporates a pair of 64-byte buffers and interrupt initiated I/O communications to minimize the number host processor cycles for sending/receiving data. The LTEmC device software is designed to leverage the advantages of the SPI interface and interrupt driven I/O.

For SPI communications, J2 will need to be set to SPI [factory default setting] (See ***Selecting Data/Command Interface***).

UART Interface

The UART interface may be preferred if you plan to use host-controlled protocols (like Linux shell Scripts for interhost communications). Using the modem transparently with host-controlled protocols, you will also likely want to support RTS/CTS flow control; flow control is available on the LTEm2 when it is pass-through data mode (not utilized with BGx embedded protocol implementations). The RTS/CTS interfaces are available on a header dedicated to that purpose and discussed in the section below on ***Host Integration.***

For UART communications, J2 will need to be set to TX-HDR (See ***Selecting Data/Command Interface***).

USB Interface

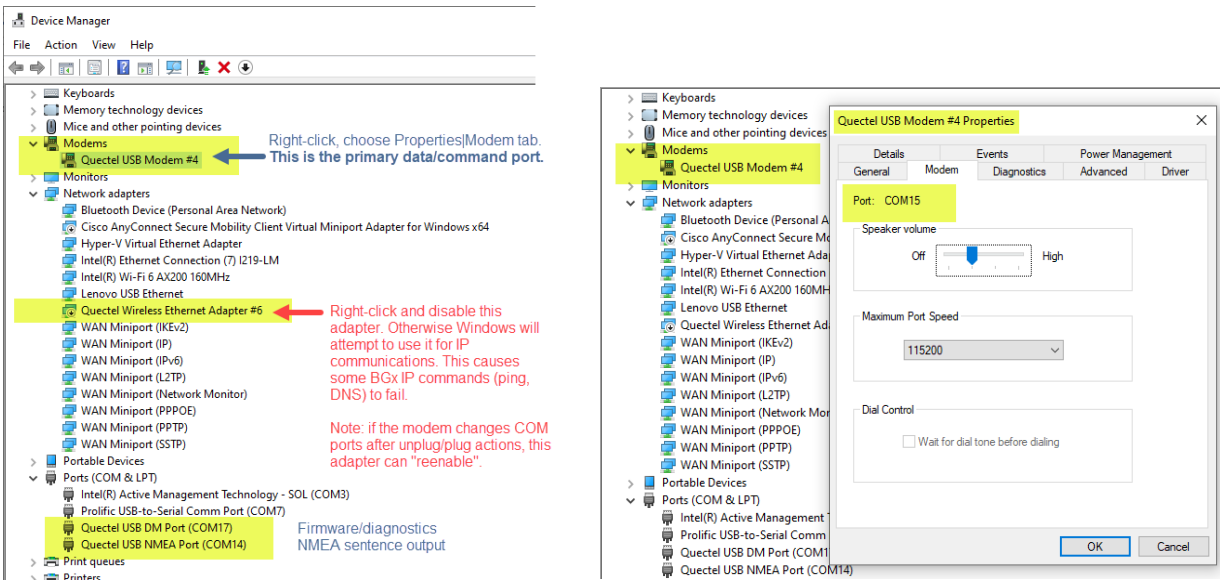
During design and development, you may benefit from access to the BG95 module interactively. This can be easily accomplished via the LTEm2's micro-USB interface located on the bottom of the LTEm2. The USB port provides 3 virtual COM ports: data/command, device diagnostics, and NMEA sentence output for GNSS. It is also possible to use the virtual COM data/command port under Linux to allow for shell script access to transparent data mode (Raspberry PI OS).

Note: The LTEm2 will consume an additional 20 mA (typical) to support the USB interface when physically connected.

To use the USB interface's virtual COM ports you will need to install a device driver provided by Quectel.

Windows USB Driver
Linux USB Driver

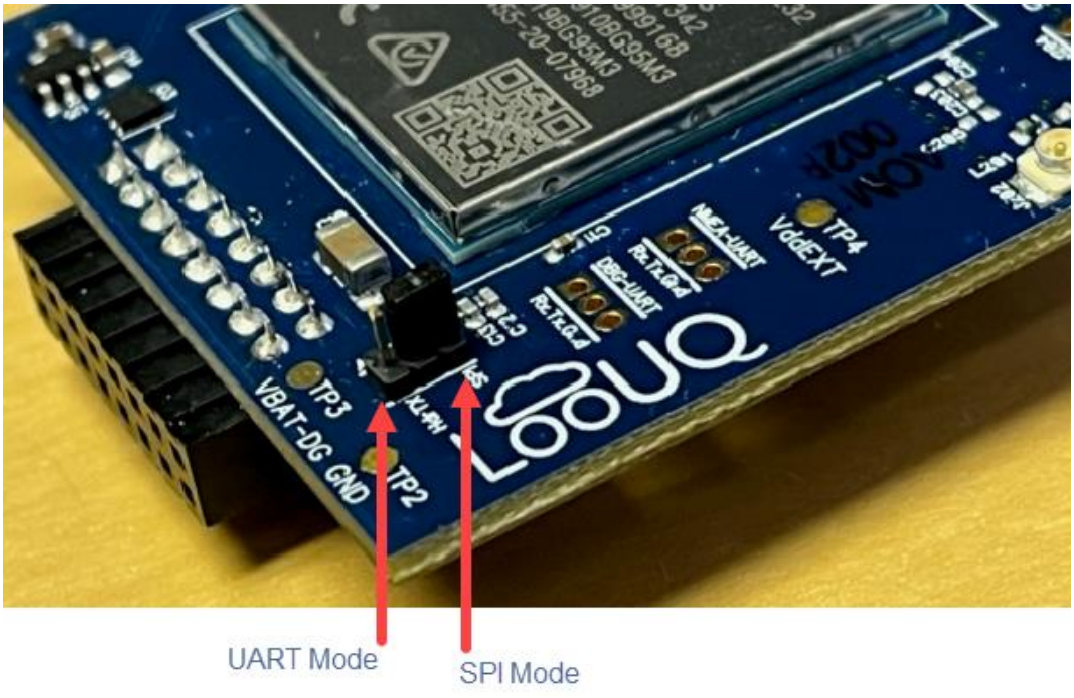
With the device driver installed a connected LTEm2 will appear in Windows Device Configuration as shown below.



Note: the *Quectel Wireless Ethernet Adapter X* (highlighted above) will cause difficulties for some BGx operations being attempted via USB; AT+QPING and AT+QIDNSGIP (DNS lookup) are known to be affected. LooUQ recommends that the *Quectel Wireless Ethernet Adapter* is disabled in Device Manager.

Selecting Data/Command Interface

The LTEm2 has the option to make the Data/Command (UART-1) interface available as either high-speed SPI interface with buffered I/O or a standard UART port (3.3v logic). SPI interfacing is the default factory configuration. SPI offers high-speed communications with less overhead on the host system to service the communications with the LTEm2; the LTEmC device software uses the SPI mode exclusively, supporting buffered, background (interrupt) driven I/O with the LTEm2.



SIM Socket

On the bottom of the LTEm2 is a card holder for a nano-SIM card (4FF form). The socket is a push-push type. The SIM is inserted into the socket with the contacts facing up towards the modem, then pushed into the socket until it is fully inserted. Once fully inserted, releasing the SIM card will allow it to travel outwards slightly. To remove, press the SIM in fully again and release; the SIM will be ejected about 1/3 of its length (grasp and remove).

Antenna Connections

There are 2 antenna connections on the LTEm2: one for the cellular network antenna (labeled LTE) and one for the GNSS/GPS antenna (labeled GNSS). They are both IPEX/U.FL/UMCC style, male, 50-ohm connectors commonly found in the marketplace.

GNSS Antenna Power

GNSS antennas come in active and passive configurations. An “active” antenna has a RF Low Noise Amplifier (LNA) integrated into the antenna; active antennas require a power source (3v to 5v) to energize the amplifier circuit. A “passive” antenna does not have this amplifier, it is simply an antenna and nothing more.

Active antennas are used when the antenna is connected to the receiver (LTEm2 in this case) over a lengthy cable. The amplifier circuit drives the cable’s distance, it does not amplify the satellite signal. The LTEm2 has a circuit to support energizing an active GNSS antenna, provided an external 3-volt to 5-volt power source is connected; the connection can be soldered or a JST style socket installed. LTEm2 modems can be factory equipped with the JST connection (special order) or a kit can be purchased from LooUQ which includes the board connector and short cable. The power inputs are found on the image below in the lower-right corner of the device; the top of the modem is labeled “GNSS AntPwr”, the polarity is marked on the bottom of the LTEm2.

Host Integration

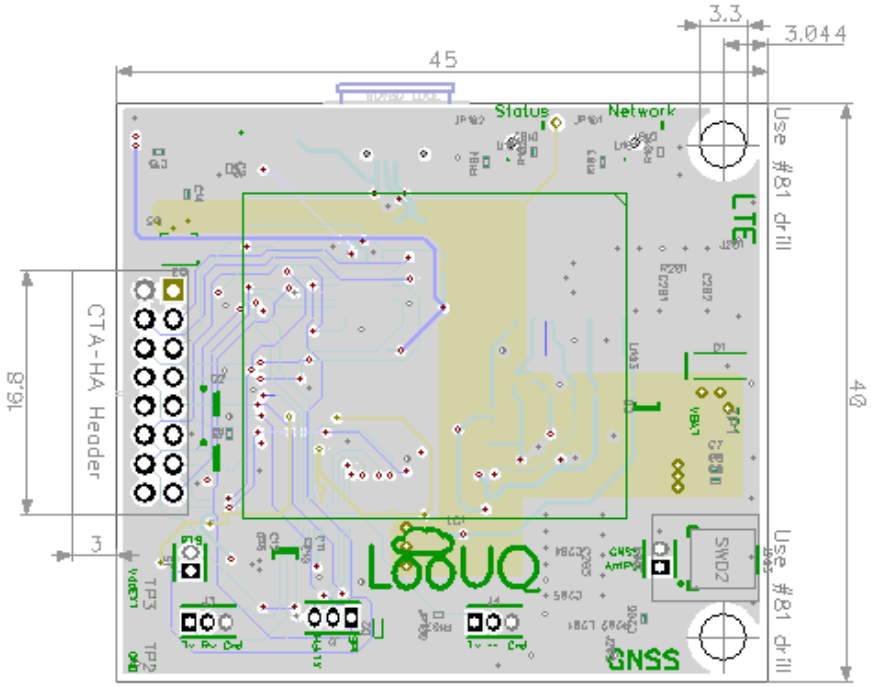
The LTEm2 is designed as an embedded modem to be incorporated into your project. It has advanced features that can help offload many communication tasks from your host system. The information below can assist you with the integration of the LTEm2 into your project/product. If LooUQ can assist in any way let us know, we are eager to help.

answers@loouq.com

Physical Mounting

The LTEm2 dimensions are 45mm x 40mm, height of 9.5mm (48mm with host header). When physically mounted as shown in the next two diagrams the total height from the surface of the host PCB is just under 11mm. A 3D STEP model is available at LTEm2 STEP Module.

The free, online AutoCAD STEP file viewer is available here.

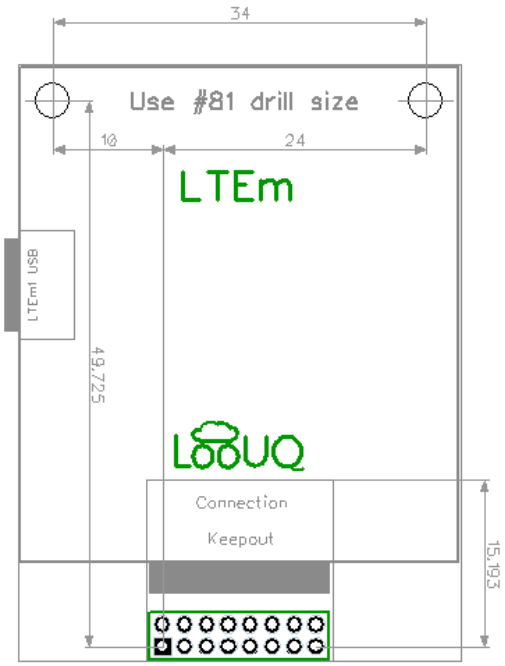


LTEm Host Mounting

The recommended mounting approach for the LTEm2 incorporates the 16-pin signal connector combined with 2 snap-pin posts. The layout of the 16-pin header and snap-pin posts is shown below. These are also available as an Eagle .BRD file on the LooUQ GitHub site.

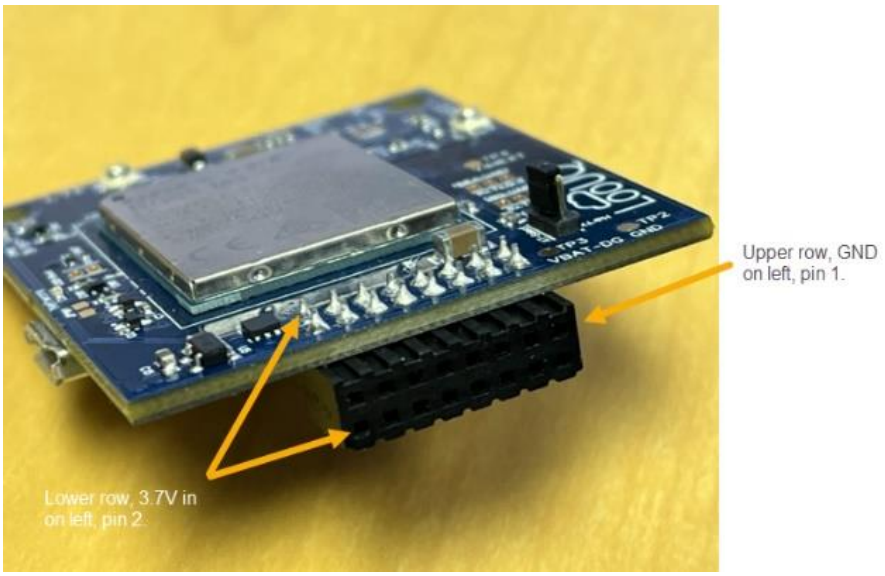
The host interface header on the LTEm2 is designed to mate with a Harwin M22-2040805 or equivalent right-angle pin header.

The (2) snap-pin posts are Keystone Electronics part number 8880; this post has locking clips for the host side and snap clips to secure the LTEm2.



Snap-pins (2) use
Keystone Electronics 8880
Digikey 36-8880-ND

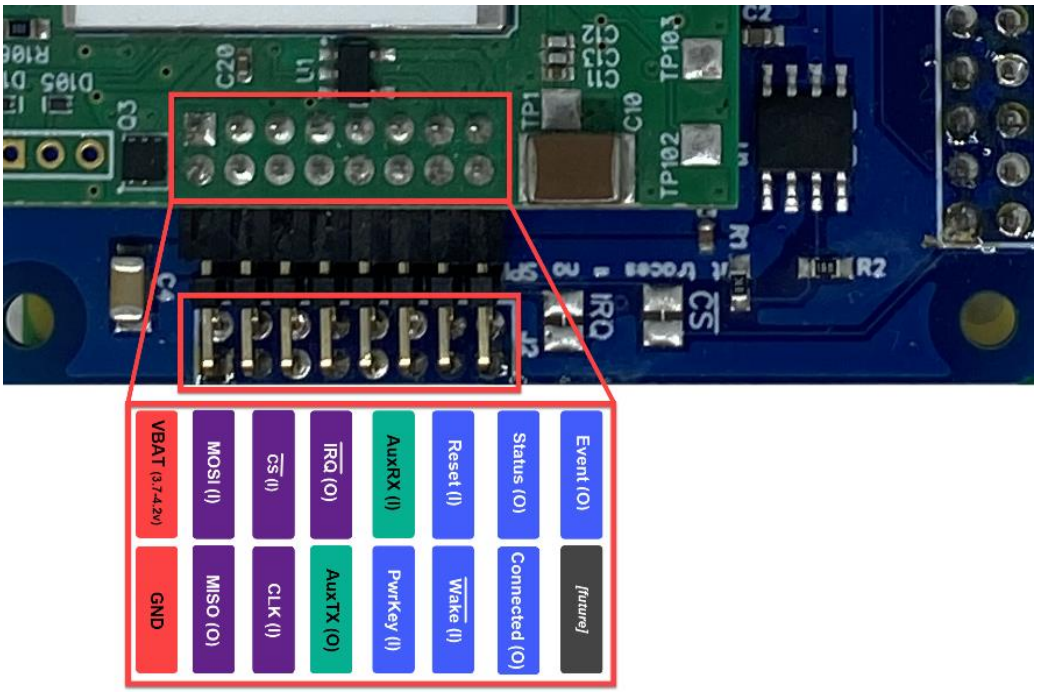
Signal/Power Interface



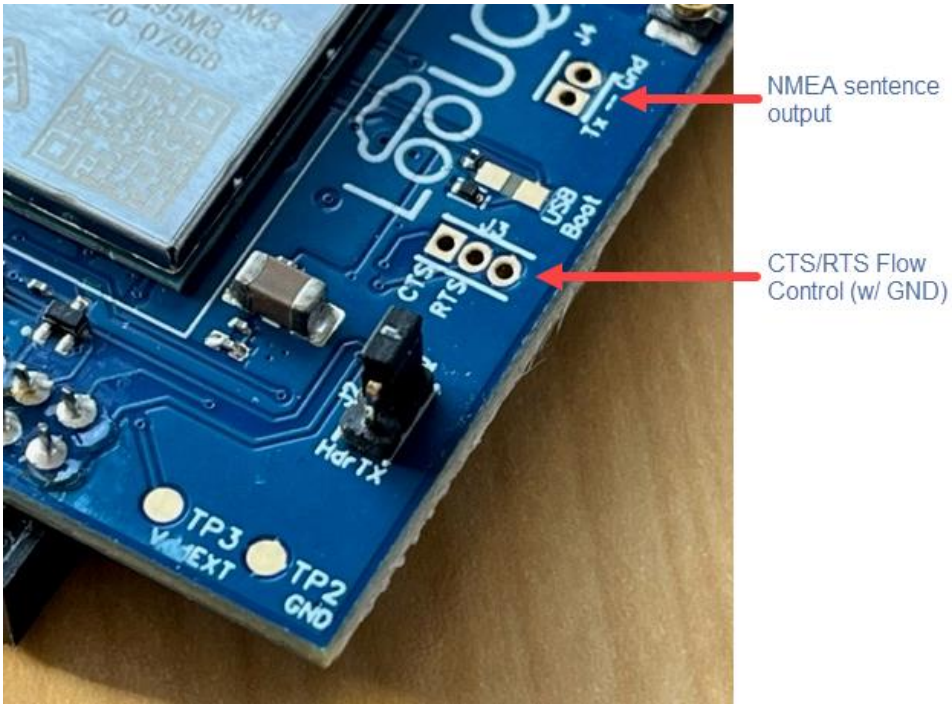
All signal and power connections between the LTEm2 and the host system are connected via a 16-pin (2x8 pin) header connection. Power to the LTEm2 is standard LiPo 3.7 volt; all signals are 3.3-volt interfaces. Note: the LTEm2 host connection is the same as the LooUQ LTEm1 modem. The signals are detailed in the table below.

Pin	Row	Signal	Type	Description
1	L	Vin	Power	Power in 3.7v – 4.2v
2	U	GND	Power	System ground
3	L	MOSI	Signal-In	SPI data out (from host to LTEm2)
4	U	MISO	Signal-Out	SPI data in (from LTEm2 to host)
5	L	~CS	Signal-In	SPI chip-select (inverted logic, GND=true)
6	U	CLK	Signal-In	SPI clock
7	L	~IRQ	Signal-Out	LTEm2 IRQ (inverted logic, GND=true)
8	U	TX	Signal-In	Data/Command UART (jumper selectable)
9	L	RX	Signal-Out	Data/Command UART
10	U	PwrKey	Signal-In	Power on/off (pulse to toggle LTEm2 power state)
11	L	Reset	Signal-In	Hardware resets the LTEm2
12	U	Wake	Signal-In	Wakes the LTEm2 from sleep mode
13	L	Status	Signal-Out	Indicates that the LTEm2 is on and operational
14	U	Connected	Signal-Out	Indicates that the LTEm2 is connected
15	L	Event	Signal-Out	Signals that the LTEm2 has a new URC
16	U			No connection, reserved

The photo below details a LTEm modem on the LooUQ LTEm-UXplor Raspberry PI adapter. When tracing out the signals pay close attention to the effect of the right-angle connectors.



Optional Interfaces



NMEA

The LTEm2 provides two ways to continuously receive NMEA sentences when the GNSS/GPS system is operating. NMEA sentence output is entirely optional and not required to use GNSS location and geo-fencing services.

- USB – Using the Quectel USB Virtualization driver, the NMEA sentences are output to virtual port 3 of the USB interface as a standard COM interface, operating at 9600 baud.
- NMEA Header
    - J4 2-pin 1.27mm pitch (Harwin M50-3530242 or equivalent).
    - Signal voltage is 3.3 volts.
    - 9600 baud.

UART Flow Control

If the LTEm2 is used as a pass-through data connection for the host system, the LTEm2 (BG95) supports flow control using the RTS and CTS signals. If the LTEm2 is used as a pass-through device the flow control signals are available via a dedicated header.

Note

These signals are not used by BGx module protocol communications (HTTP, MQTT, etc.).

- J3, 3-pin 1.27mm pitch (Harwin M50-3530342 or equivalent).
- Signal voltage is 3.3-volts.
- The flow-control header is not normally populated from factory, can be special ordered with it installed.

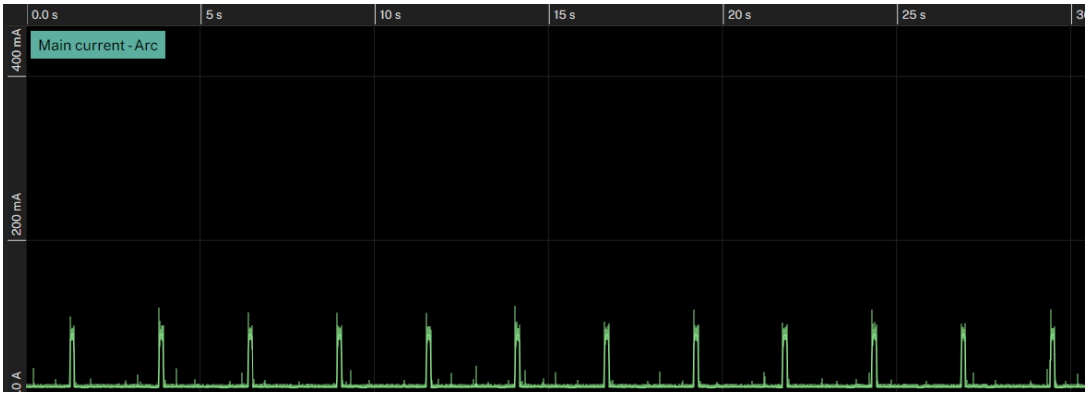
Power Requirements

The LTEm2 is designed to operate with a power source providing the standard 3.7-volt LiPo battery voltage range (3.65v to 4.2v). It can be powered directly from a voltage regulator circuit if the surge handling for some RF events can cover the approximately 400+ mA draw. For when a smaller capacity voltage regulator is used, LooUQ recommends a small LiPo battery be used to stabilize the 3.7-volt supply. Typically, a 100 mAh to 300 mAh battery works well for this need. By example the Adafruit Feather M0 (a board used frequently at LooUQ) cannot source the required current for startup of the LTEm2 and support internal needs with its 600mA voltage regulator.

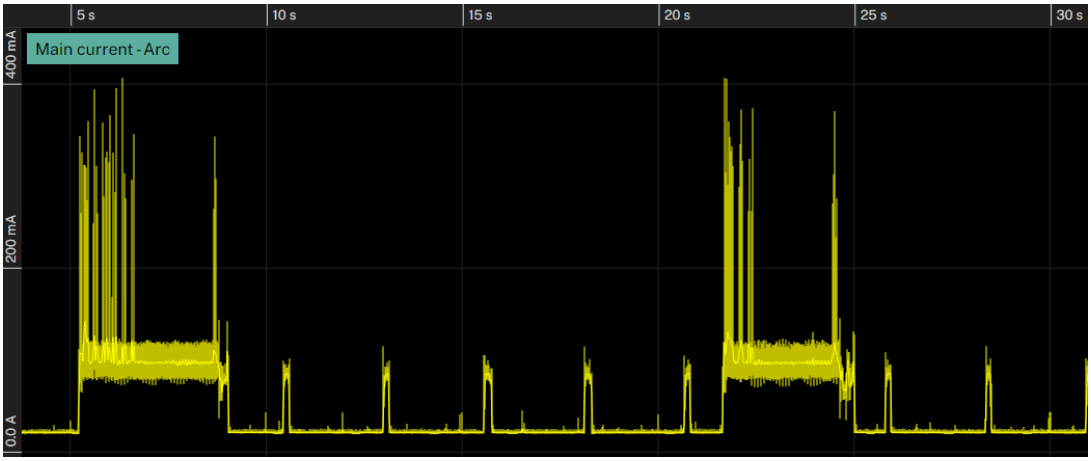
Power requirements		
Modem State/Event	**Avg**	**Max**
Power attached, modem OFF	3.07 mA	
Connected to network (idle)	24.2 mA	118 mA
Power Up	35.9 mA	391 mA
Ping	88.0 mA	406 mA
DNS Lookup	89.0 mA	406 mA
USB interface	30 mA	

The graphs below illustrate supply current details for common modem state/events. All were captured with a SIM installed and connected to network over CAT-M1. Supply voltage was 3.7-volts. Future information on Sleep, PSM, and eDRX will be made available as settings can be validated and tested.

Connected (M1, Idle)



Ping/DNS Lookup (M1 Connection)



Power Up