
USER MANUAL | CHRONOS 4G LTE-M EMBEDDED CELLULAR MODEM

Embedded Planet | Updated October 2020 | v1.0.0

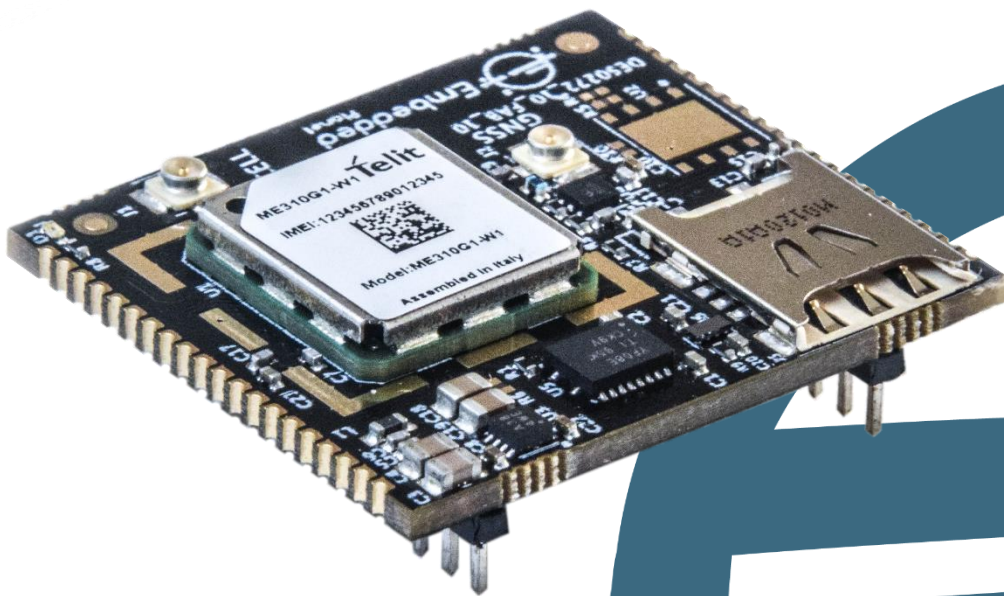


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1 Introduction

Chronos is a 4G LTE-M (CAT M1) embedded cellular modem based on Telit's acclaimed ME310 cellular module. The low power modem provides LTE and GPS connectivity and is compatible with most global LTE and NB-IoT networks.

Chronos operates as a client to an external host MCU or processor, accepting AT commands and providing responses over UART or USB.

Chronos offers the familiar 20-position modem pin header for easy integration into existing systems. Uniquely, Chronos offers a 40-position castellated footprint which, along with Telit's AppZone, provides additional serial and analog interfaces and GPIO.

With PTCRB and cellular carrier certifications complete, Chronos requires no further cellular certification, allowing designers to get to market quickly, without having to negotiate the expensive cellular certification processes.

At only 33mm x 29.5mm, Chronos is an excellent solution for designers seeking low power LTE connectivity in a compact, cost-effective package.

2 Orderable Part Numbers

Orderable Part Number	Mounting	GNSS
EP-CHRONOS-GNSS-H	2x10-pin headers	Yes
EP-CHRONOS-H	2x10-pin headers	No
EP-CHRONOS-GNSS-C	Castellated	Yes
EP-CHRONOS-C	Castellated	No

3 Additional Resources

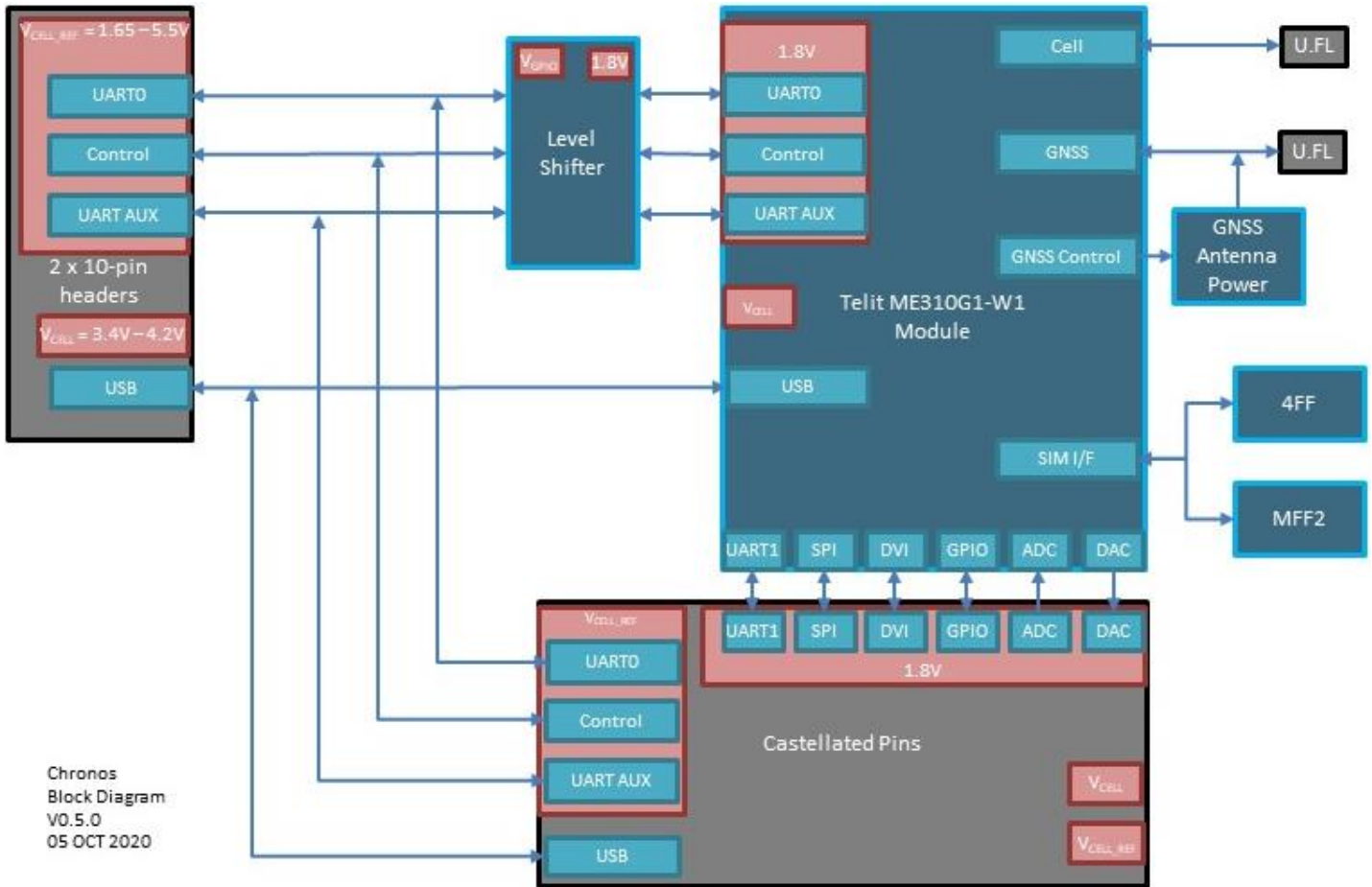
- <https://www.embeddedplanet.com/chronos/>
- [Telit ME310G1 Datasheet](#)
- [Telit ME310G1 User Guides and Application Notes](#)

4 Features

Feature / Specification	Description
Cellular Capabilities	Cellular Technologies: LTE-M (LTE CAT M1), LTE CAT NB2 SMS: over NAS Lower power modes: PSM, eDRX Operating frequencies: 699MHz to 1980MHz Cellular Operating Mode: Half-duplex FDD RF Output Power: up to +20dBm (Power Class 5)
Internet Protocols	IPv4/IPv6 stack with TCP and UDP protocols TLS/DTLS
LTE CAT M1 Specifications	Bands: B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B25, B26, B27, B28, B66, B71, B85 RX Sensitivity CAT M1: -102.2 to -107.5 dBm depending on band Uplink: up to 1Mbps Downlink: up to 588kbps
LTE CAT NB2 Specifications	Bands: B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B25, B26, B27, B28, B66, B71, B85 RX Sensitivity CAT NB2: -111.3 to -115.8dBm depending on band Uplink: up to 160kbps Downlink: up to 120kbps
SIM	Removable: 4FF (nano) SIM card slot Soldered down: MFF2 Internal: Telit simWISE™
Cellular Certifications	PTCRB: Complete AT&T: In Progress Verizon: In Progress
GNSS Specifications	Constellations: GPS, GLONASS, BeiDou, Galileo, QZSS Tracking Sensitivity: -159dBm Navigation Sensitivity: -155dBm Cold Start Sensitivity: -144dBm
Power Supply	Main Power Supply: 3.4Vdc to 4.2Vdc (3.8Vdc nominal) GPIO Reference Voltage: 1.65Vdc to 5.5Vdc

Feature / Specification	Description
Power Consumption Main supply = 3.8Vdc GPIO supply = 3.3Vdc	To be determined
Form Factor	Dimensions (with headers, unmated): 29.5 x 33.0 x 10.34mm Dimensions (with headers, mated): 29.5 x 33.0 x 7.14mm Dimensions (castellated): 29.5 x 33.0 x 4.35mm
Environmental	Operating Temperature Range: -40°C to +85°C Storage Temperature Range: -40°C to +85°C Humidity Range: 20% RH to 90% RH

5 Block Diagram

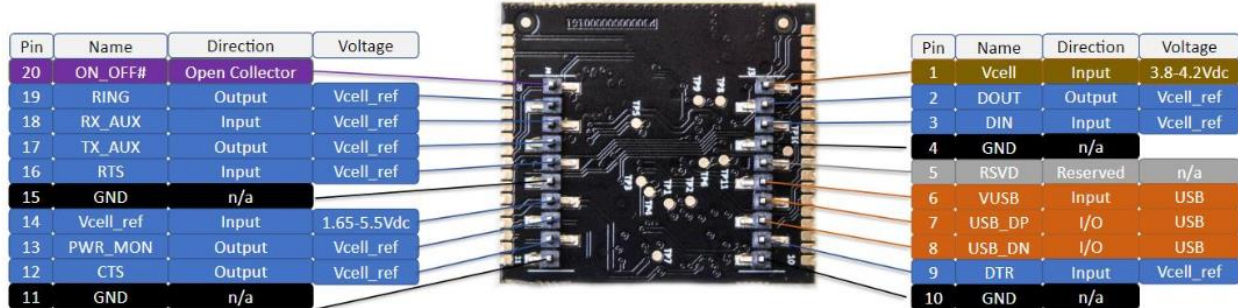


Chronos
Block Diagram
V0.5.0
05 OCT 2020

6 Device Specifications

6.1 2 x 10-pin headers

The diagram below shows the bottom side of Chronos:



Pin #	Pin Name	Pin Type	Description	If not used	Notes
1	Vcell	Power input	Main power supply input	Must be implemented	
2	DOUT	Digital output	Main UART data output from cell module	Leave open	
3	DIN	Digital input	Main UART data input to cell module	Leave open	
4	GND	n/a	GND	Must be implemented	
5	RSVD	n/a	Reserved for future use	Leave open	Do not connect pin
6	VUSB	Analog input	USB power sense	Leave open	
7	USB_DP	Digital I/O	USB data (+)	Leave open	
8	USB_DN	Digital I/O	USB data (-)	Leave open	
9	DTR	Digital input	Main UART DTR input to cell module	Leave open	If not used as DTR, this pin can be used as a GPIO
10	GND	n/a	GND	Must be implemented	
11	GND	n/a	GND	Must be implemented	
12	CTS	Digital output	Main UART CTS output from cell module	Leave open	

Pin #	Pin Name	Pin Type	Description	If not used	Notes
13	PWR_MON	Digital output	Cell module power monitor	Leave open	High when cell module is ON
14	Vcell_ref	Power input	Reference voltage for host GPIO	Leave open	
15	GND	n/a	GND	Must be implemented	
16	RTS	Digital input	Main UART RTS input to cell module	Leave open	
17	TX_AUX	Digital output	Aux UART output from cell module	Leave open	
18	RX_AUX	Digital input	Aux UART input to cell module	Leave open	
19	RING	Digital output	Output from cell module indicating incoming call	Leave open	If not used as RING, this pin can be used as a GPIO
20	ON_OFF#	Open collector input	Input command for power ON/OFF and to wake from deep sleep mode	Tie to GND (see note below)	Active Low

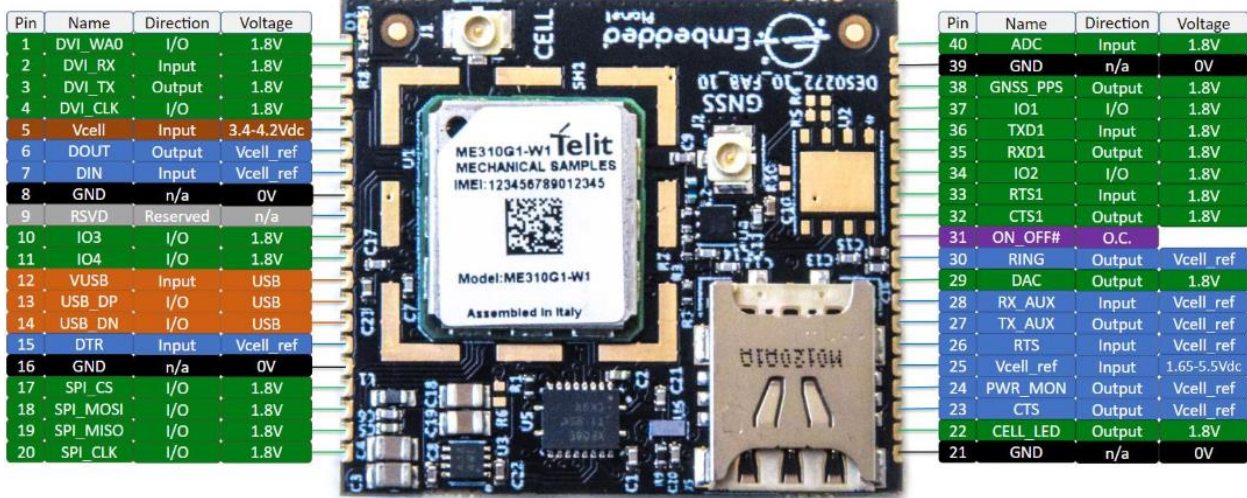
Note: In some use cases, ON_OFF# can be tied to GND.

If this is done, there are two items to consider:

1. PSM asynchronous wake-up capability will be lost.
2. To perform an unconditional shutdown in this configuration, it is necessary to send AT#SHDN and then turn off Vcell.

6.2 Castellated Pins

The diagram below shows the top side of Chronos:



Pin #	Pin Name	Pin Type	Description	If not used	Notes
1	DVI_WA0	Digital I/O	Digital audio	Leave open	
2	DVI_RX	Digital output	Digital audio	Leave open	
3	DVI_TX	Digital input	Digital audio	Leave open	
4	DVI_CLK	Digital I/O	Digital audio	Leave open	
5	Vcell	Power input	Main power supply input	Must be implemented	
6	DOUT	Digital output	Main UART data output from cell module	Leave open	
7	DIN	Digital input	Main UART data input to cell module	Leave open	
8	GND	n/a	GND	Must be implemented	
9	RSVD	n/a	Reserved for future use	Leave open	Do not connect pin
10	IO3	Digital I/O	GPIO	Leave open	
11	IO4	Digital I/O	GPIO	Leave open	
12	VUSB	Analog input	USB power sense	Leave open	
13	USB_DP	Digital I/O	USB data (+)	Leave open	
14	USB_DN	Digital I/O	USB data (-)	Leave open	

Pin #	Pin Name	Pin Type	Description	If not used	Notes
15	DTR	Digital input	Main UART DTR input to cell module	Leave open	If not used as DTR, this pin can be used as a GPIO
16	GND	n/a	GND	Must be implemented	
17	SPI_CS	Digital I/O	Standard 3-wire SPI master or slave with chip select control	Leave open	
18	SPI_MOSI	Digital I/O		Leave open	
19	SPI_MISO	Digital I/O		Leave open	
20	SPI_CLK	Digital I/O		Leave open	
21	GND	n/a	GND	Must be implemented	
22	CELL_LED	Digital output	Cell module status LED	Leave open	Refer to Telit documentation
23	CTS	Digital output	Main UART CTS output from cell module	Leave open	
24	PWR_MON	Digital output	Cell module power monitor	Leave open	High when cell module is ON
25	Vcell_ref	Power input	Reference voltage for host GPIO	Leave open	
26	RTS	Digital input	Main UART RTS input to cell module	Leave open	
27	TX_AUX	Digital output	Aux UART output from cell module	Leave open	
28	RX_AUX	Digital input	Aux UART input to cell module	Leave open	
29	DAC	Analog output		Leave open	Refer to Telit documentation
30	RING	Digital output	Output from cell module indicating incoming call	Leave open	If not used as RING, this pin can be used as a GPIO
31	ON_OFF#	Open collector input	Input command for power ON/OFF and to wake from deep sleep mode	Tie to GND (see note below)	Active Low
32	CTS1	Digital output	UART1	Leave open	
33	RTS1	Digital input	UART1	Leave open	Internal 100k pullup
34	IO2	Digital I/O	GPIO	Leave open	

Pin #	Pin Name	Pin Type	Description	If not used	Notes
35	RXD1	Digital output	UART1	Leave open	
36	TXD1	Digital input	UART1	Leave open	Internal 100k pullup
37	IO1	Digital I/O	GPIO	Leave open	
38	GNSS_PPS	Digital output	1 pulse per second	Leave open	
39	GND	n/a	GND	Must be implemented	
40	ADC	Analog input		Leave open	Refer to Telit documentation

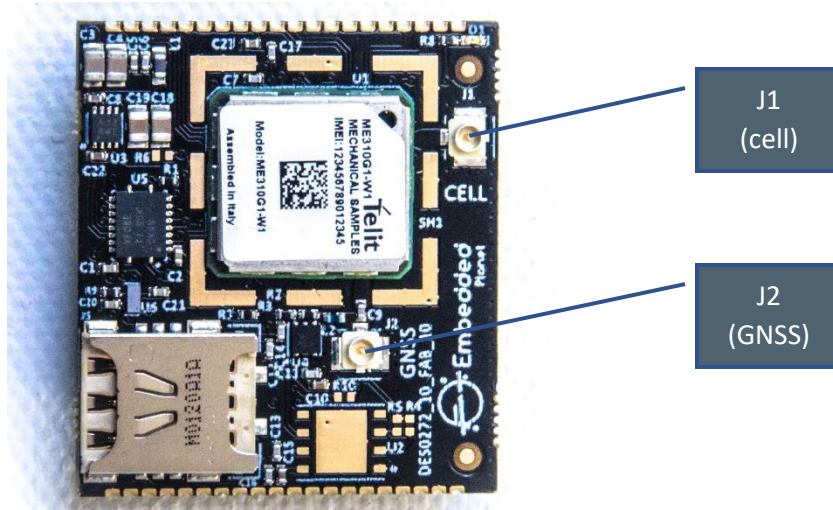
Note: In some use cases, ON_OFF# can be tied to GND.

If this is done, there are two items to consider:

1. PSM asynchronous wake-up capability will be lost.
2. To perform an unconditional shutdown in this configuration, it is necessary to send AT#SHDN and then turn off Vcell.

6.3 Antenna Connections

The modem has two U.FL connectors, J1 and J2, that are used to connect external antennae for the cellular interface and the GNSS interface, respectively.



6.4 Cellular Antenna Requirements

The cellular antenna shall fulfill the following requirements:

Frequency Range	The customer shall use the most suitable antenna for the bands provided by the network operator(s) used.
Impedance	50Ω
Input power	>24dBm average power
VSWR (abs max)	≤ 10:1 to avoid permanent damage
VSWR recommended	≤ 2:1 to fulfill all regulatory requirements

6.5 Recommended Cellular Antennae

The general recommendation is to use a wide-band LTE antenna with acceptable efficiency across applicable bands. The table below has examples of several LTE antennae that are compatible with Chronos.

Type	Manufacturer	Part Number	Notes
Internal adhesive	Taoglas	FXUB64.18.150A	Antenna has U.FL connector
External	Taoglas	TG.10.0113	Requires U.FL to SMA(F) adapter

6.6 GNSS Antenna Requirements

An active GNSS antenna must be used. The antenna must meet or exceed the following requirements:

Frequency Range	1559 – 1610MHz
Gain	15 – 30dB
Impedance	50Ω
Noise Figure of LNA	<1.5 recommended
DC supply voltage	1.8 – 3.3Vdc
VSWR recommended	≤ 3:1

6.7 Recommended GNSS Antennae

The general recommendation is to use a wide-band LTE antenna with acceptable efficiency across applicable bands. The table below has examples of several LTE antennae that are compatible with Chronos.

Type	Manufacturer	Part Number	Notes
Internal adhesive	Taoglas	AP.12F.07.0045A	Antenna has U.FL connector

7 Electrical Specifications

7.1 Absolute Maximum and Minimum Ratings

Modem Pin	Min	Max	Notes
Vcell	-0.3V	4.5V	With respect to GND
Vcell_ref	-0.5V	6.5V	With respect to GND
VUSB	-0.3V	6.0V	With respect to GND
Pins referred to Vcell_ref	-0.5V	6.5V	With respect to GND
All other pins	-0.3V	2.1V	With respect to GND

7.2 Recommended Operating Conditions

Modem Pin	Min	Typ	Max	Notes
Vcell	3.4V	3.8V	4.2V	With respect to GND
Vcell_ref	1.65V		5.5V	With respect to GND
VUSB		5.0V	5.25V	With respect to GND
Pins referred to Vcell_ref	0V		Vcell_ref	With respect to GND
All other pins	0V		1.8V	With respect to GND

Modem Pin	V _{IH(min)}	V _{IL(max)}	V _{OH(min)}	V _{OL(max)}	Notes
DOUT, CTS, RING, PWR_MON, TX_AUX	--	--	0.67*Vcell_ref	0.4V	
DIN, RTS, DTR, RX_AUX	0.7*Vcell_ref	0.3*Vcell_ref	--	--	
VUSB	1.0V	0.4V	--	--	
DVI_xx, IOx, SPI_xx, CELL_LED, TXD1, RXD1, CTS1, RTS1, GNSS_PPS	1.5V	0.35V	1.6V	0.2V	

7.3 Typical Power Consumption

To be determined

8 Mechanical Specifications

8.1 Physical Parameters

Parameter	Description	Min	Typ	Max
Dimensions, unmated	Modem with headers J3 and J4 not mated with host board	29.5 x 33.0 x 10.34 mm 1.161 x 1.299 x 0.407"		
Dimensions, mated	Modem with headers J3 and J4 mated with host board	29.5 x 33.0 x 7.14 mm 1.161 x 1.299 x 0.281"		
Dimensions, castellated	Modem without headers when soldered to host board	29.5 x 33.0 x 4.35 mm 1.161 x 1.299 x 0.171"		
Mass with headers			6g	
Mass without headers			5g	
J1 and J2 mating cycles	Number of insertions and removals until possible U.FL connector failure	30	>100	
J3 and J4 mating cycles	Number of insertions and removals until possible header connector failure		>500	

8.2 Mating Connectors

Chronos versions with headers may be installed into sockets on the host board.

The 2 x 10-pin headers populated on the modem are Samtec TMM-110-01-T-S-SM.

Refer to Samtec documentation for mating connector details.

<https://www.samtec.com/products/tmm>

Other manufacturers such as Sullins have similar offerings.

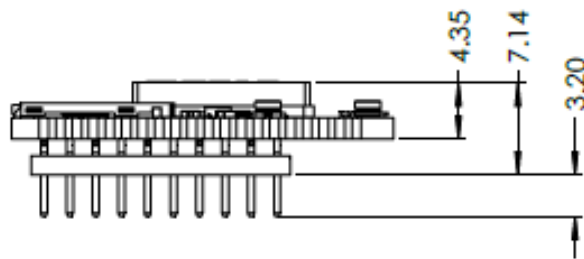
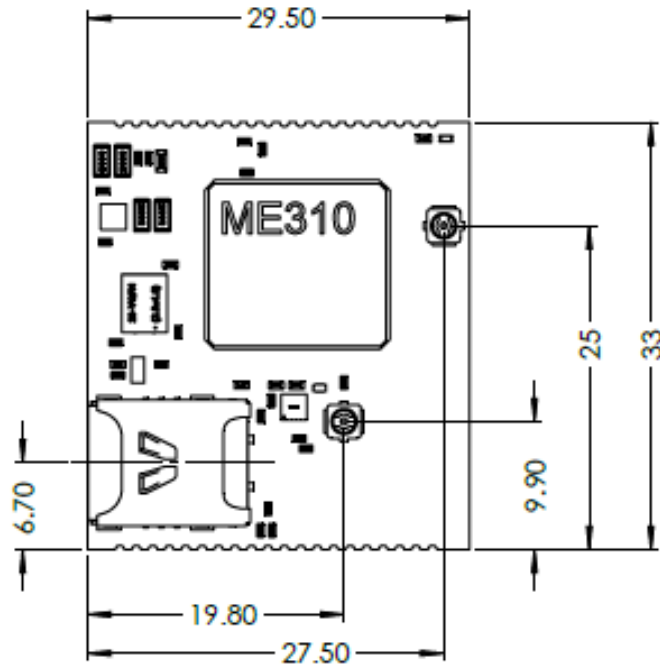
Please refer to the socket manufacturer's documentation for recommended PCB footprints.

The sockets should be located as shown in section 8.4 below; the required pads depend on the socket being used.

The U.FL connectors populated on the modem are Hirose U.FL-R-SMT-1(10). Refer to Hirose documentation for mating connector details:

<https://www.hirose.com/product/p/CL0331-0472-2-10?lang=en>

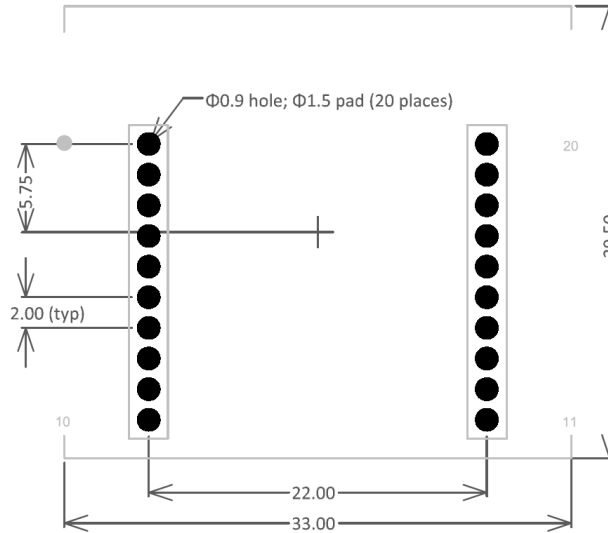
8.3 Mechanical Drawing



All dimensions in mm

8.4 Recommended PCB Footprint (2 x 10-pin headers)

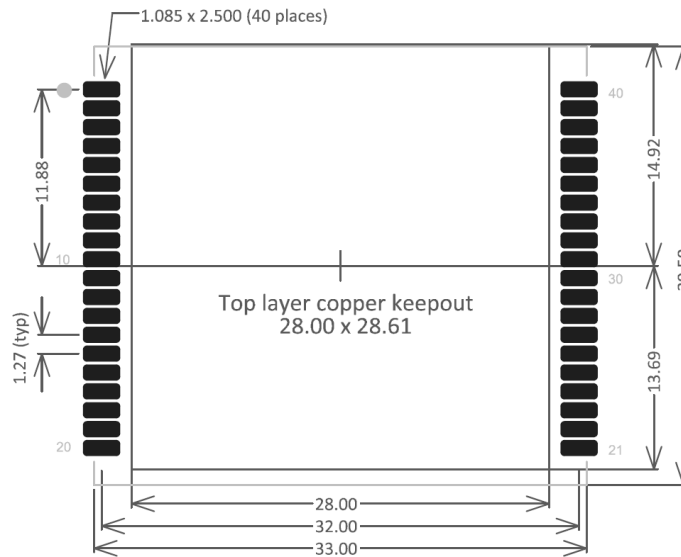
Chronos versions with headers may be soldered directly to the host board.



All dimensions in mm
Suggested 2 x 20-pin Header Footprint

8.5 Recommended PCB Footprint (Castellated pins)

The recommended PCB footprint for Chronos castellated versions is given below.



All dimensions in mm
Suggested Castellated Footprint

8.6 Environmental Specifications

Parameter	Min	Typ	Max
Operating Temperature	-40°C	+25°C	+85°C
Storage Temperature	-40°C	+25°C	+85°C
Operating Humidity, non-condensing	20% RH		90% RH

9 Design Considerations

9.1 Power Supply Design Considerations

Chronos contains the recommended power supply design, bypassing and layout to support the Telit ME310G10-W1.

The end user is cautioned to ensure that the host power supply that supplies Vcell is capable of supplying 1A peaks without browning out the voltage.

Short, wide traces to the Vcell and GND pins on Chronos are encouraged.

10 Getting Started

10.1 Telit Documentation

Chronos has been designed around the Telit ME310G1-W1 cellular module, and as such, can largely be integrated into a customer design by referring to the documentation provided by Telit.

For the latest documentation from Telit, including user guides, AT command reference guide, and application notes, refer to the link below:

<https://www.telit.com/m2m-iot-products/cellular-modules/standard-industrial-grade/xe310-family/#ME310%20downloads>

10.2 Arm Mbed OS Support

Embedded Planet has added a driver to the sources for Arm Mbed OS for the Telit ME310, which enables integration of Chronos into any Mbed-enabled target. Refer to the link below for the sources:

<https://github.com/ARMmbed/mbed-os/tree/master/connectivity/drivers/cellular/TELIT/ME310>

10.3 USB Compatibility

Operating System	Notes
Windows	<p>The Windows driver from Telit can be downloaded here: https://www.telit.com/evk-drivers</p> <p>By default, the device presents as 3 virtual COM ports to the host OS: 1 for Telit debug purpose, 2 for standard AT commands.</p> <p>NOTE: By default, Chronos presents as a WWAN network adapter in Windows but cannot be used for data traffic.</p>
Linux	<p>Compatible with a minimum kernel version of 5.5. Configure Chronos with the AT#USBCFG command set to a value of '3' to have the cellular modem present as an ECM network adapter.</p> <p>NOTE: The default value of the AT#USBCFG command is '0'.</p>
Mac OSX	Same as Linux.

10.4 Embedded Planet Online Documentation

For the most up to date documentation on Chronos from Embedded Planet, please see the link below:

<https://docs.embeddedplanet.com/docs/chronos/overview/>

11 Regulatory Information

11.1 Cellular Certifications

PTCRB: Complete

AT&T TRENDI: Complete

Verizon ODI: In process

11.2 RoHS Compliance

Chronos complies with the RoHS (Reduction of Hazardous Substances) directive of the European Union, EU Directive 2011/65/EU.

11.3 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 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.

11.4 FCC and ISED Compliance

If the modem's antenna is located farther than 20cm from the human body and there are no adjacent transmitters, the FCC and ISED approvals of the modem's Telit ME301G1-W1 cellular module can be reused by the end product.

If the modem's antenna is mounted closer than 20cm from the human body, or if there are adjacent transmitters, additional FCC/ISED testing may be required for the end device.

Orderable Device	FCC ID	ISED ID
Telit ME310G1W1	RI7ME310G1W1	5131A-ME310G1W1

The equipment's FCC ID certificate is available at the link below:

<https://www.fcc.gov/oet/ea/fccid>

The equipment's ISED ID certificate is available at the link below:

<https://sms-sgs.ic.gc.ca/equipmentSearch/searchRadioEquipments?execution=e1s3&index=0>

11.5 Wireless Notice

This device complies with FCC/ISED radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the ISED radio frequency (RF) Exposure rules. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body.

11.6 Antenna Notice: FCC

This radio transmitter has been approved by FCC to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Omnidirectional Antenna Gain: 2.14dBi	
Band	Max Gain for FCC (dBi)
FDD2	11.0
FDD 4	8.0
FDD 5	12.4
FDD 12	11.6
FDD 13	12.1
FDD 25	11.0
FDD 26	12.3
FDD 66	8.0
FDD 71	11.4
FDD 85	11.6

11.7 Antenna Notice: ISED

This radio transmitter has been approved by ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Omnidirectional Antenna Gain: 2.14dBi	
Band	Max Gain for FCC (dBi)
FDD2	11.0
FDD 4	8.0
FDD 5	9.1
FDD 12	8.6
FDD 13	8.9
FDD 25	11.0
FDD 26	9.0
FDD 66	8.0
FDD 71	8.4
FDD 85	8.6

11.8 End-Product Labeling Requirements

The product has an FCC ID label on the device itself. The OEM host end product manufacturer must display a label referring to the enclosed module. The exterior label will read as follows:

Device Uses Approved Radio: ME310G1-W1
Contains FCC ID: RI7ME310G1W1
Contains IC: 5131A-ME310G1W1

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.

11.9 FCC Additional Testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. The end product with an embedded module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

12 Revision History

Revision	Author	Description	Date
1.0.0	M. Leopold	Initial Release	09 OCT 2020