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# **emIoT-Edge**

IoT Edge Gateway

(Hardware and Software Manual)

Version 1.0

refers to product revision no.  
1.0

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Im Dörener Feld 8  
D-33100 Paderborn, Germany

Tel.: +49-5251-1550-0  
FAX: +49-5251-1550-190  
email: [support@janztec.com](mailto:support@janztec.com)  
Internet: [www.janztec.com](http://www.janztec.com)

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## About this Manual

This is the hardware manual for the emIOT-Edge IoT Edge Gateway.

## Conventions

If numbers are specified in this manual, they will be either decimal or hexadecimal. We use C-notation to identify hexadecimal numbers (the 0x prefix).

If we refer to low active signal names, they will be suffixed by a “#” character.

Some parts of the manual contains notices you have to observe to ensure your personal safety, or to prevent damage to property. These are visually marked with the following alert symbols:

**DANGER**

Indicates that death or severe personal injury *will* result if proper precautions are not taken.

**WARNING**

Indicates that death or severe personal injury *may* result if proper precautions are not taken.

**CAUTION**

Indicates that *minor* personal injury can result if proper precautions are not taken.

**NOTICE**

Indicates that damage to equipment can result if proper precautions are not taken.



Indicates information that we think you should have read to save your time by avoiding common problems. Important suggestions that should be followed will also be marked with this sign.

## Acronyms and Abbreviations

EMC	Electromagnetic capability.
ESD	Electrostatic discharge.
GND	System ground potential. Inside the product this is connected to the metal housing, which might be connected to protective earth by the installation. There exist some isolated reference grounds for communication interfaces or IO. These reference signals are referred to as GND-x, where x indicates function.
SELV	Safety extra low voltage.



# 1 Introduction

## 1.1 Features

- Sierra Wireless WP7502 LTE modem with 4G LTE as well as 3G and 2G fallback
- Cortex A5 Application core, running Legato Linux to enable powerful IoT applications
- 256 Mbytes soldered memory
- 128Mbyte Flash storage
- 10/100 Mbit Ethernet
- Isolated digital input and output
- Mini SIM card socket (internal)
- SMA antenna connectors for LTE and GSM
- 8 pin M12 (A-coded) for power, Console and Digital IOs
- 4 pin M12 (D-coded) for Ethernet
- Rugged construction
- IP65 housing
- 9..32 V DC power supply

Refer to technical data (section 8.1) for more details.

## 1.2 Ordering

### 1.2.1 Accessories

If required, these accessories need to be ordered separately:

PC-ANT-LT001	LTE antenna (non water proof)
PC-ANT-GP001	GPS antenna (non water proof)
EZ-KKA-ITE00	M-12 2m Cable Kit <ul style="list-style-type: none"> <li>• M12-4 D-coded to RJ45</li> <li>• M12-8 A-coded to open end</li> </ul>
MZ-ITE-WHA00	Wallmount kit
MZ-ITE-HSH00	Railmount kit

### 1.3 Functional Overview

The core of the emIOT-Edge is the Sierra Wireless WP7502 module. Refer to figure 1 for the block diagram.

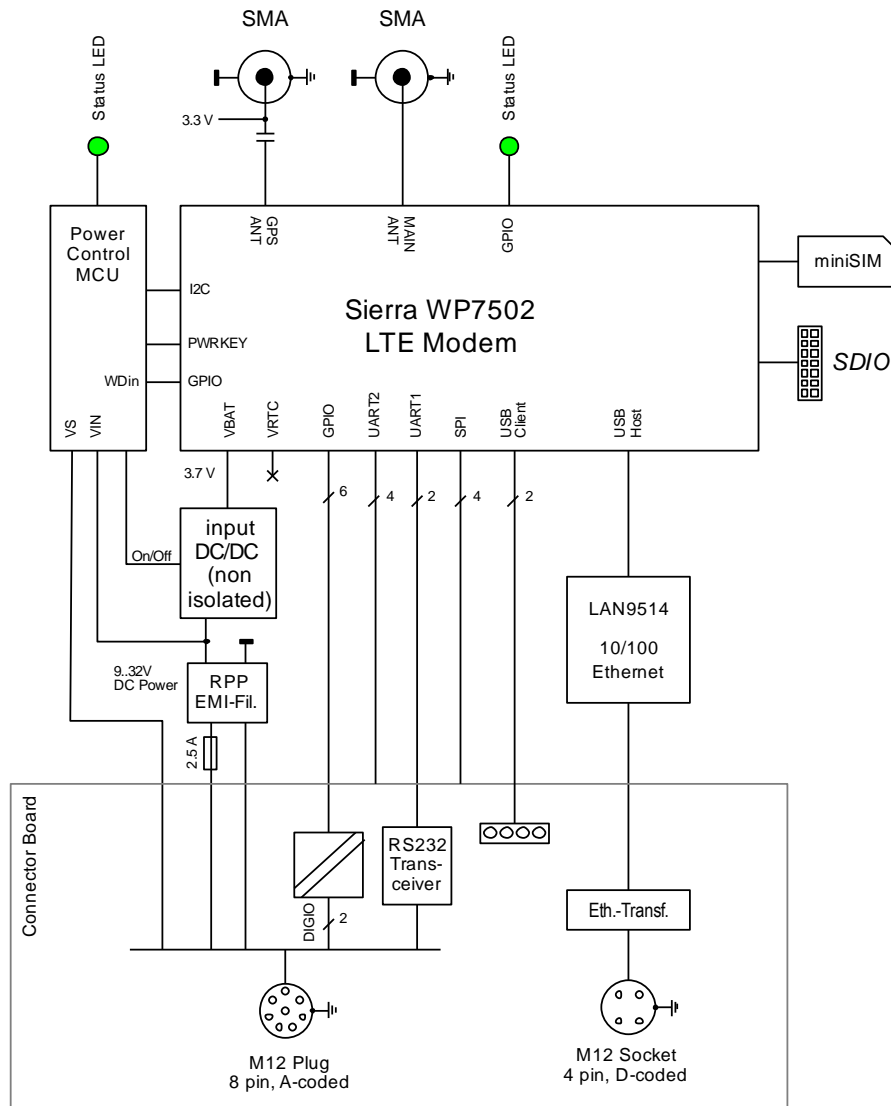


figure 1: emIOT-Edge block diagram

Power supply unit accepts wide range input voltage (9..32V) and generates the power for the LTE modem (3.7V).

LTE Antenna is connected through an SMA connector. A second SMA connector allows connecting GPS antenna. The GPS antenna connector is powered with 3.3 V to support active antenna.

An MCU is provided to manage power of the modem. It provides features like undervoltage lockout, periodic wakeup and external power control by a separate control input (VS). Furthermore, it implements a watchdog for the LTE modem. Not all features available in V1.0. Update of the MCU firmware is possible.



## 2 Safety Instructions

Refer to page iii for explanation of the warning notice system.

The product described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products.

### 2.1 Installation and Maintenance

**DANGER: Electrical Shock**

Danger to life.

This product operates with 9..32 V DC SELV power supply. Do not connect this product to an improper power supply (No AC power, no more than 32 V DC or no non-SELV circuit)!

**DANGER: Electrical Shock**

Danger to life.

The IO interfaces (connectors) of the product are only suited to be connected to SELV circuits. Use interfaces (connectors) for their intended use only.

**CAUTION: Fire Risk**

The digital IO must be powered by a SELV power supply, that complies with the requirements of a limited energy source (LPS) (By using an appropriate supply or an external fuse).

**WARNING: Health Impact**

The antenna of this product must not be installed closer than 20 cm (0,2 m) to human bodies.

## 2.2 Ambient and Environmental Conditions

**CAUTION: Damage**

Do not operate the product beyond the specified ambient conditions

**DANGER: Explosive Risk**

Do not operate the product in potentially explosive atmosphere.

**NOTICE: EMI**

This product is a class A device. This product may cause radio interference. In this case the user must take adequate measures.

## 3 Installation

The product can be operated with DC power supply from 9 to 32 V.

### 3.1 Mounting

There are no mounting requirements for the emIOT-Edge. Refer to section 8.3 for dimensions.

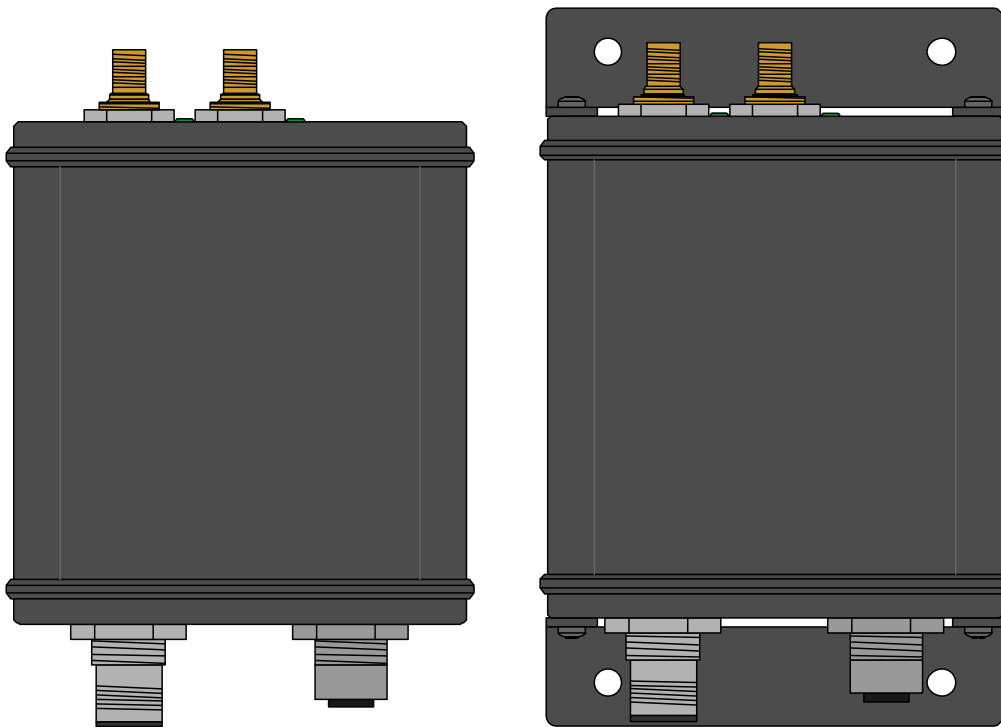


figure 2: emIOT-Edge  
(right side with wallmount kit installed)

### 3.2 Connectors and Operators

The 8 pin M12 connector provides interface to some of the emIOT-Edge interfaces that are described later.

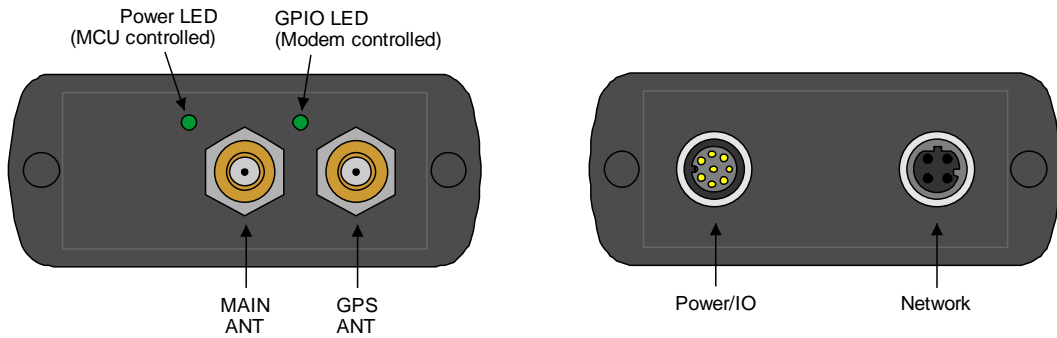
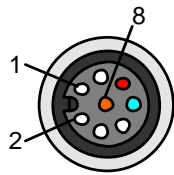


figure 3: emIOT-Edge connectors

#### 3.2.1 POWER IN

The system power supply is located on the 8 pin M12 connector.

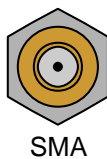


6	VIN (9..32 VDC)	5	GND
8	VS		

table 1: Power Supply connector pins

**! DANGER**  
 The product may only be operated with power supplies which can be considered SELV circuits.

#### 3.2.2 LTE Antenna



1	Antenna Input/Output
2	GND (Return)

**! WARNING: Health Impact**  
 The antenna of this product must not be installed closer than 20 cm (0,2 m) to human bodies.



Only connect approved antennas (such as optional delivered with the product) to the SMA connector.

#### 3.2.3 GPS Antenna



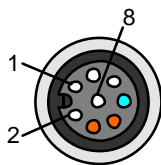
1	Antenna Input / Power Output
2	GND (Return)



Shorting the SMA Antenna input to GND will overload the power supply output and disrupt operation of the emIOT-Edge.

### 3.2.4 Serial Port (RS232)

The RS232 serial interface is the UART1 interface of the WP7502 module. The interface signals are located on the 8 pin M12 connector, table 2 shows the pin out.

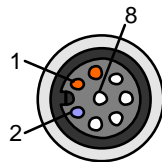


4	RxD-RS232 (in-data from DTE/host)	5	GND
3	TxD-RS232 (out-data to DTE/host)		

table 2: Serial port (RS232) connector pins

### 3.2.5 Digital IO

One digital input and one output port is provided on the 8 pin M12 connector (refer to table 3).



1	DIGIN	2	GND-IO
7	DIGOUT		

table 3: Digital IO connector pins



#### CAUTION

The digital IO must be powered by a SELV power supply, that complies with the requirements of a limited energy source (LPS) (By using an appropriate supply or an external fuse).

The digital inputs and outputs are isolated from system power supply. Refer to figure 4 for detailed schematic.

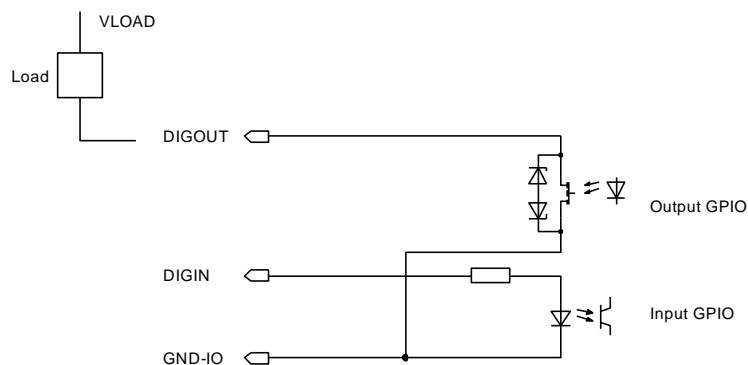


figure 4: digital IO detailed schematic

The digital input signals (DI1-DI4) refer to GND-IO and have an input impedance of about 5 kOhm. Switching level for *low* is  $\leq 6V$  and *high*  $\geq 15V$ .

The digital output shorts to GND-IO (low side switch). The load must be connected between the power supply and the DIGOUT pin.

The output driver supports resistive and inductive loads.

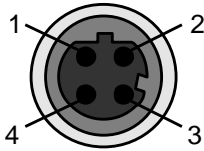


#### NOTICE

When using inductive loads, the output has an internal clamping diode (SMBJ40CA). Refer to the diodes datasheet if this is appropriate for your application (depending on the switching frequency, the load current, the load inductance and VLOAD voltage).

### 3.2.6 Ethernet

The Ethernet of the emIOT-Edge is located on a standard D-code 4 pin M12 connector. Refer to table 2 for the pin out.



1	TXP	2	RXP
3	TXN	4	RXN

table 4: Ethernet connector pins

## 3.3 Application Hints

### 3.3.1 Right Angle Cable

When using right angle M8/M12 connectors, you need to obey the exit direction of the cables when planning the cabling. In figure 5 you find an example with all right-angle cables.



Using all right-angle cables is not possible with V1.0 of the emIOT-Edge due to wrong rotation of the M12-4 connector. This will be fixed in later version.

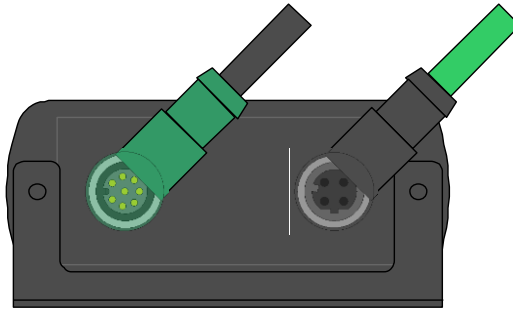


figure 5: right angle cable example

Note that different cable vendors might have different right-angle cable exit direction. The above exit direction was evaluated for cables from Phoenix Contact and MURR.

## 4 Maintenance

### 4.1 Tight Mounting the Housing

After having opened the housing, take care that it is assembled properly to ensure specified environment protection is met. Refer to figure 6 for instructions.

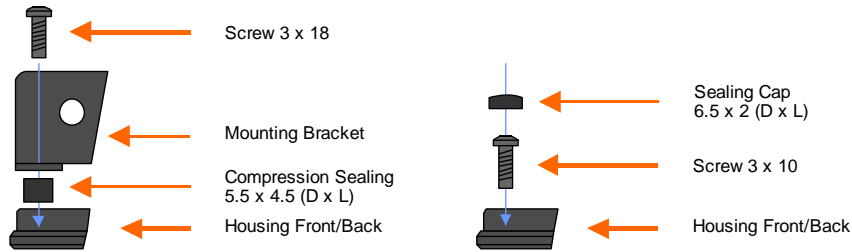


figure 6: IP proof housing assembly

### 4.2 Removing/Installing SIM Card

A mini SIM card connector is located inside the emIOT-Edge housing. Refer to figure 7 for removal instructions.

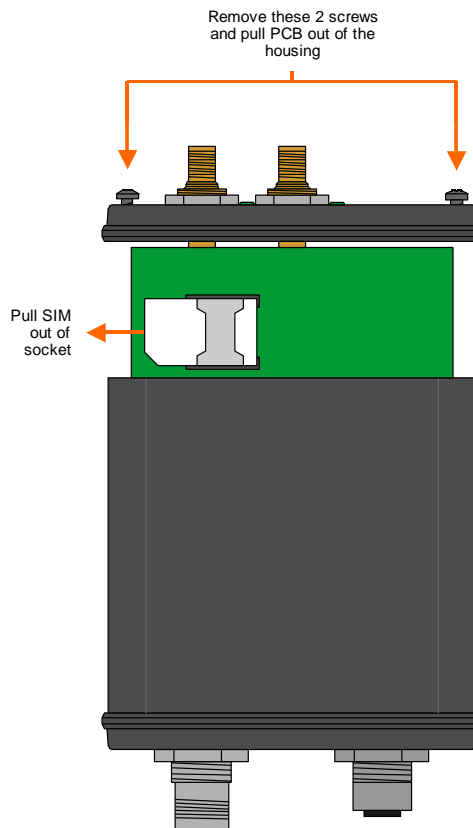


figure 7: SIM card removal

To close the housing, push the PCB back into the housing until it snaps to the internal connector.





If you pulled the PCB completely out of the housing, you must obey the correct insertion of the PCB into the mounting rails. Refer to figure 8 for details, check for the chamfer of the connector U5 to have correct orientation.

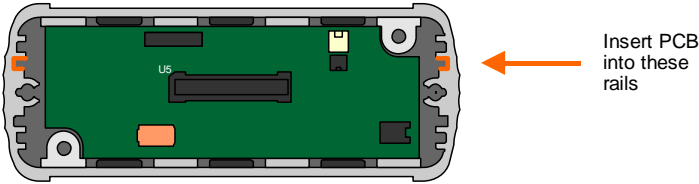


figure 8: PCB insertion to housing

## 5 First Steps

- Insert SIM card
  - See: [4.2 Removing SIM Card](#)
- Connect antenna
  - See: [3.2 Connectors and Operators](#)
- Connect network or serial with PC or notebook
  - See: [3.2 Connectors and Operators](#)
- Start terminal software (e.g. Tera Term)
  - Network
    - New Connection
    - TCP/IP
    - Host: **169.254.1.1**
    - Service: SSH
    - Login: [6.1.1 Linux Console](#)
  - Serial
    - New Connection
    - Serial
    - Port: The COM Port on your PC or notebook
    - Login: [6.1.1 Linux Console](#)
- Example Linux commands can be found in the following chapters
- If you made changes to the system, we recommend shutting down your system properly with the **halt** command

## 6 Software

The default Image was created with Yocto and contains a minimal configuration. You can use Yocto to create Linux distributions for embedded software that are independent of the underlying architecture of the embedded hardware.

For more information: [https://en.wikipedia.org/wiki/Yocto\\_Project](https://en.wikipedia.org/wiki/Yocto_Project)

### 6.1 Operating System

#### 6.1.1 Linux Console

Linux login console is available by SSH terminal connection to the IP address of the system (e.g. 192.168.5.114 on eth0):

- Username: **root**
- Password: **root1**

Recommended Terminal Software:

- PuTTY: <https://en.wikipedia.org/wiki/PuTTY>
- Tera Term: [https://en.wikipedia.org/wiki/Tera\\_Term](https://en.wikipedia.org/wiki/Tera_Term)
- WinSCP: <https://en.wikipedia.org/wiki/WinSCP>

#### 6.1.2 Static IP address

By default, the eth0 port is set to the static address **169.254.1.1**. If you want to change this configuration, you must edit the network configuration file: `/etc/network/interfaces`

```
vi /etc/network/interfaces
...
# Wired or wireless interfaces
auto eth0
iface eth0 inet static
    address 169.254.1.1
    netmask 255.255.0.0
    gateway 192.168.5.2
...
```

For more information: <https://wiki.debian.org/NetworkConfiguration>

#### 6.1.3 Serial Console

The Linux Console is accessible with the serial port (RS232).

The port was configured with this echo command:

```
echo -e "AT!MAPUART=16,1\r" > /dev/ttyAT
```

If you want to use the Serial Port for a Linux application then you have to enter this echo command:

```
echo -e "AT!MAPUART=17,1\r" > /dev/ttyAT
```

For more information: Legato Reference Manual (Chapter: Implementing SMACK > Customize UART)

#### 6.1.4 Firewall configuration

SSH and ICMP connections are only allowed on eth0. If required you can configure the firewall rules in this file: `/etc/iptables/rules.v4`

#### 6.1.5 Security Information

Do not connect this system to the internet, unless you have made appropriate security precautions to prevent incoming network connections (Firewall, VPN). We also recommend that you change the default password for the root user.

## 6.2 Cellular

To create a cellular connection type the following commands:

```
cm data info
cm data connect &
sleep 20
```

For more information: [http://legato.io/legato-docs/latest/toolsTarget\\_cm.html#toolsTarget\\_cm\\_data](http://legato.io/legato-docs/latest/toolsTarget_cm.html#toolsTarget_cm_data)

## 6.3 GPS

To get GPS information type the following commands:

```
gnss enable
gnss start
gnss fix
gnss get posInfo
```

For more information: [http://legato.io/legato-docs/latest/toolsTarget\\_gnss.html](http://legato.io/legato-docs/latest/toolsTarget_gnss.html)

## 6.4 IO

### 6.4.1 Digital IO

The GPIO system files are located in the directory `/sys/class/gpio/`. You can use the `echo` command to configure your GPIO pins.

```
# Add GPIOs
# GP_OUT
echo 32 > /sys/class/gpio/export
echo "out" > /sys/class/gpio/gpio32/direction
# GP_IN
echo 33 > /sys/class/gpio/export

# Toggle output (write 1 to turn output on (low impedance))
echo 0 > /sys/class/gpio/gpio32/value
echo 1 > /sys/class/gpio/gpio32/value

# Read inputs (read 1 if no signal is driven to the input)
cat /sys/class/gpio/gpio33/value
```

### 6.4.2 LED

Configure LED

```
echo 42 > /sys/class/gpio/export
echo "out" > /sys/class/gpio/gpio42/direction
```

### 6.4.3 Temperature

To read the current power amplifier temperature and power controller temperature type the following command:

```
cm temp
```

## 7 Programming Information

One possibility to create applications is the Legato Application Framework.  
For more information: <http://legato.io/legato-docs/latest/buildAppsMain.html>

### 7.1 GPIO Usage

WP7502 pin	Function
GPIO2 (Pin 10)	
GPIO7 (Pin 40)	
GPIO8 (Pin 41)	
GPIO13 (Pin 4)	
GPIO21 (Pin 147)	
GPIO22 (pin 148)	WDGTRIG (Not yet implemented in Power MCU)
GPIO23 (Pin 149)	
GPIO24 (Pin 150)	
GPIO25 (Pin 159)	
GPIO32 (Pin 104)	DIGOUT. Driving this pin high will turn on DIGOUT (short to GND-IO). Driving this pin low (or floating it) will turn off DIGOUT.
GPIO33 (Pin 105)	DIGIN. When voltage higher then threshold is applied to DIGIN, this pin is read as low.
GPIO35 (Pin 101)	
GPIO36 (pin 102)	
GPIO37 (Pin 103)	
GPIO38 (pin 92)	
GPIO40 (Pin 94)	
GPIO41 (Pin 95)	
GPIO42 (Pin 109)	LED. Driving pin high turn LED on. Do not let this pin float, as this leads to unpredictable LED state.

## 8 Appendices

### 8.1 Technical Data

FIXME: Need update. The data here is not maintained.

#### Wireless Core

Module	Sierra Wireless WP7502
4G LTE	Cat-3: B1,B3,B7,B8, B20
3G	HSPA+, UMTS: B1, B8
2G	EDGE, GSM, GPRS: 900 MHz, 1800 MHz
GNSS	GPS, Galileo, Glonass

#### Application Processor

CPU	ARM Cortex A5 (550 MHz)
Operating System	Linux, Legato® open source
Flash	256 Mbyte
RAM	128 Mbyte

#### External Interfaces

Main Antenna	SMA
GPS Antenna	SMA
Serial RS232	Tx and Rx only, M12-8, usually for console

Digital Out	<ul style="list-style-type: none"> <li>• Isolated from system ground (50V max)</li> <li>• Low side switching contact</li> <li>• Switching current: <math>\pm 150</math> mA max</li> <li>• Switching voltage: <math>\pm 40</math> V max</li> <li>• Not fused internally</li> </ul>
Digital In	<ul style="list-style-type: none"> <li>• Isolated from system ground (50V max)</li> <li>• Input voltage: <math>&lt; 6</math> V for low, <math>&gt; 15</math> V for high, <math>-34 \dots +40</math> V max</li> <li>• Input current: <math>&lt; 5</math> mA @ 24 V</li> </ul>

#### Indicators and Switches

Status LED	2
------------	---

#### System

Housing	Aluminium
---------	-----------

#### Power Requirements

Power Supply	DC power, 9 .. 32 V
Inv.-pol. protection	Yes
Fuse	Internal 2.5 A melting fuse in DC in, GND is unfused
potential separation	No, GND is connected to housing (e.g. at SMA connector)
Inrush Current (max)	TBD
Power Dissipation	TBD

#### Environmental Specifications

Ambient Temperature operating	$-40 \dots +TBD$ °C
Temperature storage	$-40 \dots +85$ °C
Humidity	5%..95% r.H., non condensing
Protection Class	IP20

**Physical Dimensions**

Size (WxHxD) 84,6 x 34,6 x 90,4 (w.o. connector overhang, see dimensions)

Weight

## Notes:

- 1) Power supply must not drop below minimum during the load pulses
- 2) This is the GSM module power specification for maximum throughput, unlikely to happen over time
- 3) Application developers must check that this value is not violated



## 8.2 References

These references direct you to manuals and specifications that you might need to know when you attempt to program the product. Most of the documents can be downloaded from the Internet. Look for the WWW servers of the component/chip manufacturers.

[1]

### WWW-References

Janz Tec AG  
Sierra Wireless

<http://www.janztec.com>  
<https://www.sierrawireless.com/>

### 8.3 Dimensions

Refer to figure 9 for the housing dimensions.

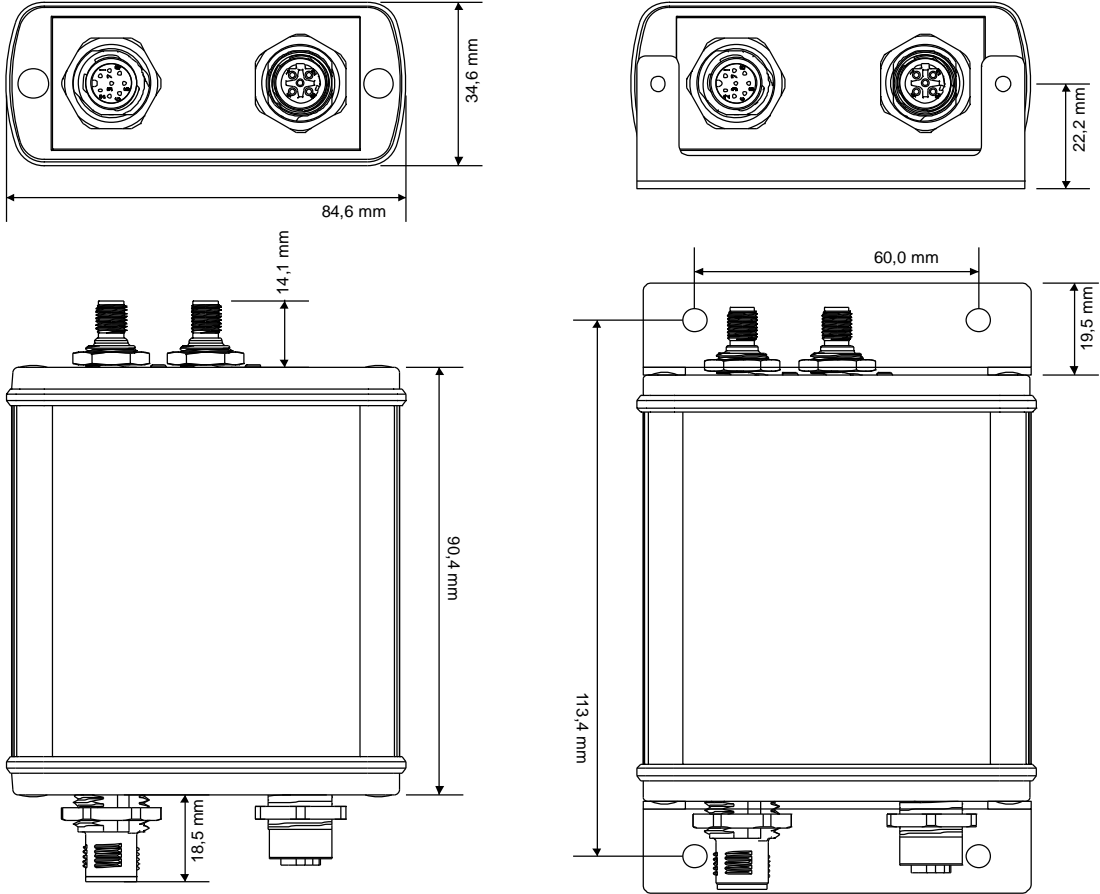


figure 9: housing dimensions (with and without wallmount kit)

### 8.4 Product History

Version	Release Date	Name	Changes
1.0		as	<ul style="list-style-type: none"><li>• Conformance Testing Prototype</li></ul>
			<ul style="list-style-type: none"><li>•</li></ul>

### 8.5 Manual History

Version	Release Date	Name	Changes
1.0	2017-11-31	as	<ul style="list-style-type: none"><li>• Initial release</li></ul>
			<ul style="list-style-type: none"><li>•</li></ul>