

EMB-Fem2GW-130X-O DOCUMENTATION

Rev 1.3

Embit s.r.l.

Document information

Revision	Date	Author	Comments
1.0	2021-02-09	Embit-AM	Initial release
1.1	2021-06-17	Embit-DL	Added installation guide
1.2	2022-11-21	Embit	Aligned to the new Hardware release with POE

Versions & Revisions

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1 Introduction

The **EMB-Fem2GW-130X-O** uses LoRa[®] technology and complies with the Semtech[®] 868MHz protocol stack which aims to emulate LoRaWAN[®] behavior. It enables IoT (Internet of Things) implementations mandating worldwide interoperability and battery-powered end devices over long-distance connectivity. The gateway is an IP67-grade outdoor product, with a plastic case.

This guide explains how to start using the **EMB-Fem2GW-130X-O**. The **EMB-Fem2GW-130X-O** gateway is a multi service up-gradable platform, designed to meet IoT (Internet of Things) and M2M (Machine-2-Machine) scenarios. It enables LoRa[®] 868MHz connectivity, having the role of fully compliant Gateway.

It provides the LoRaWAN[®] packet forwarder functionality.

The radio section is based on the EMBIT Mini PCI-express board, EMB-LR130X-mPCIe. It starts to operate as a LoRa[®] base station, receiving radio packets and forwarding them to a LoRa[®] Network Server. It has a TCP/IP connection through Ethernet, or via 4G connection, available through SIM card and 4G Mini PCI express module. Its functionalities will be described in details in the following paragraphs. It includes GPS connectivity to locate the device.

Thanks to the Semtech[®] SX130X performances and the efficient Embit RF design, the possible radio ranges are up to 15 km in the country side and up to 3 km in urban areas.

The OS system is Linux based, and the customer can configure it according to his needs, with a complete root access. The **EMB-Fem2GW-130X-O** provides a web interface to manage and configure the connectivity with the different network protocols.

The gateway must be by POE (Power over Ethernet) IEEE 802.3at.



Figure 1 EMB-Fem2GW-130X-0

2 Hardware Specification

- Processor: CPU ARM Cortex-A72 quad-core a 64 bit da 1,5 GHz
- RAM Memory: 2 GB, LPDDR2 SDRAM
- Flash Memory: 8/16/32 GB, EMMC Flash Memory
- LAN Connection: Ethernet RJ45 10/100/1000 Base-T
- LoRa[®] Connectivity: EMB-LR130X-mPCIe
- Receiver Sensitivity: down to -141 dBm @ SF12 BW 125kHz
- Connectivity: GPS Module U-Blox NEO-M8-Q
- Cellular Connectivity: 4G LTE / 3G UMTS / 2G GPRS through Mini Size SIM embedded inside
- Cellular Module: Quectel EC21-E Mini PCIe
- Power Source: IEEE 802.11at Power Over Ethernet
- Ports: Ethernet 10/100/1000 RJ 45 / N-Type antenna connector / Air Port
- Power Consumption: 5 Watt (average)
- Operating System: Linux 9.8 Stretch
- Dimensions: L: 165 mm W: 165 mm H: 45 mm

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- Weight: 1.0 kg
- Certifications: CE, RED

Absolute Maximum Ratings

The power consumption of the **EMB-Fem2GW-130X-O** has been tested in two different conditions: outside the thermal chamber and inside the thermal chamber. The results are represented on the following tables:

Outside Thermal Chamber:

LTE Transmission			
Idle Condition in LTE Mode	Connection in LTE Cell in LTE Mode		
405 mA peak	700 mA peak		

Table 1 Outside Thermal Chamber-LTE Transmission

GSM Transmission			
Idle Condition in GSM Mode	Connection in GSM Cell in GSM Mode		
405 mA peak	1110 mA peak		

Table 2 Outside Thermal Chamber-GSM Transmission

Inside Thermal Chamber:

LTE Transmission			
Idle Condition in LTE Mode	Connection in LTE Cell in LTE Mode		
400 mA peak	690 mA peak		
Send LoRa [®] Packet in LTE Mode	Switch from LTE to GSM Mode		
700 mA	1600 mA peak		

Table 3 Inside Thermal Chamber-LTE Transmission

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GSM Transmission			
Idle Condition in GSM Mode	Connection in GSM Cell in GSM Mode		
400 mA peak	1200 mA peak		
Send LoRa [®] Packet in LTE Mode	Switch from LTE to GSM Mode		
1200 mA peak	1600 mA peak		

Table 4 Inside Thermal Chamber-GSM Transmission

Note: the peak values are reached for a period of <1 ms and do not represent the continuous current consumption.

2.1 Thermal Tests

The **EMB-Fem2GW-130X-O** has been tested by using the Embit Thermo Camera and for three different supply voltage values.

All the temperatures were read 1 hour after switching on with Wi-Fi, LTE, LoRa[®] and GPS *turned on.*

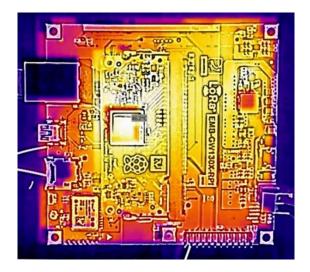


Figure 2 Thermal stress test

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The maximum temperature registered has been 46.2 °C on the MCU Core and the maximum current measured is 0.377 A.

3 Gateway Installation Guide

3.1 Pole mounting

In this section, it is described how to mount the **EMB-Fem2GW-130X-O** on a pole. It has to be in a position sufficiently high to guarantee a good communication range.

The **EMB-Fem2GW-130X-O** must be installed vertically, with the cables exposed on the lower side of the gateway (see Figure 6). Otherwise, the correct functioning of the product is not guaranteed.

EMB-Fem2GW-130X-O is provided with the mounting bracket, shown in the following picture.



Figure 5 Mounting Bracket with Gateway

The mounting bracket has to be attached to the back of the **EMB-Fem2GW-130X-O** using screws and washer and attached on the pole as the image below.

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Figure 6 EMB-Fem2GW-130X-O on the pole

3.2 Ethernet connection

In order to exploit the Ethernet connection of the **EMB-Fem2GW-130X-O**, you have to simply plug the proper cable (not provided) in the Ethernet port (see Figure 9).

Once the cable is fixed, you have to screw the outdoor IP68 socket adapter (Figure 7) to avoid water leaks.



Figure 7 Waterproof outdoor socket adapter

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3.3 Power supply and connection

The gateway must be powered by POE following the standard IEEE 802.3at. We recommend to use certified Power injectors capable to provide at least 20 watt.

3.4 Grounding and Cables Section

The **EMB-Fem2GW-130X-O** does not require ground connection.

Note: The external power supply, of course, must be grounded since it provides the ground reference. Please check that your power supply is properly grounded.

4 Operating System

EMB-Fem2GW-130X-O Operating System is Linux 9.8 Stretch.

It is allowed full SSH root access to the final user, using as username and password:

Username: user

Password: embit

The final user can install, uninstall, upgrade every single program.

Pay attention, each action may stop irretrievably the functionalities of the system.

5 LoRa[®] **868MHz** Feature

In this network Architecture, three main roles are defined:

- End-Device: endpoints with sensors embedded;
- Gateways: they provide LoRa[®] wireless connectivity to the devices. They are the connection between the devices and the IP backhaul network to the Network Server;

 Network Server: the intelligence of the network. It is centralized radio controller, which performs radio management, the provisioning and authentication of devices, and the delivery of the data to one or multiple application servers through a set of Application Programming Interfaces (APIs).

Another role is the **Application Server**. It is managed by the final customer and it is put on top of the Network Server. Full Network Image follows.

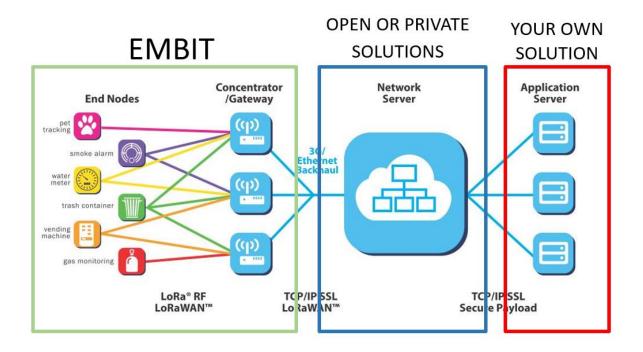


Figure 12 LoRa[®] Network Architecture

Each communication is fully encrypted with three keys, each one with a length of 128 bits. The algorithm used for it is AES-128. These algorithms have been analysed by the cryptographic community for many years, are NIST approved and widely adopted as a best security practice for constrained nodes and networks.

EMB-Fem2GW-130X-O provides LoRa[®] 868 MHz connectivity up to 3 km in urban area and up to 15 km in rural environment.

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The RF path is fully compliant to Semtech[®] specifications and it is able to achieve a Receiver Sensitivity up to -141 dBm.

6 Gateway Configuration Web Interface

EMB-Fem2GW-130X-O provides a web interface, which allows to select and configure the desired LoRa[®] packet forwarder.

It is reachable at *https://[gateway_IP_address]:10000*. The default data access is:

username: user

password:embit

Debian GNU/Linux
User name
Password
Other options
Login
Server: fem2gw Log in with your server user account.

Figure 13 Log In Page

	_			
user⊚ ▼ fem2gw				Accesso amministrativo (🧿 Aiuto 👻 🎒 👻
Q, Ricerca	fem2gw Debian GNU/Linux 11 (bullseye) in ese	cuzione		Riavvia 💌
Sistema				
Panoramica	Salute	Utilizzo	Informazioni di sistema	Configurazione
Log	Guide	CPU 3% di 4 CPU	ID macchina 423e5789a0eb4392965ba2bcf4ff9lef	Nome host fem2gw modifica
Rete		Memoria 0.2/18 GiB	Uptime 2 ore	Ora di sistema 15 feb 2023 16:37 (1
Account				Dominio Associa al dominio
Servizi				Profilo delle prestazioni nessuno
		Visualizza dettagli e cronologia	Visualizza i dettagli hardware	Chiavi secure shell Mostra le impronte digitali
Strumenti				
Embit				
Terminale				

Figure 14 Main Page

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Clicking "services" you can reach the "*Packet Forwarder*" page, the system state information is reported. In this page is possible to manage and monitor the LoRa[®] packet forwarder status.

It is recommended to turn off the packet forwarder before configuring new parameters, and turn it back on afterwards.

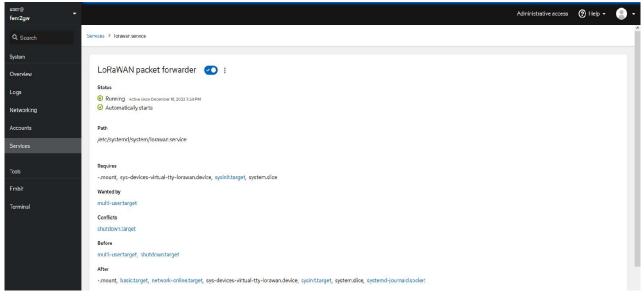


Figure 15 LoRaWAN packet forwarder Tab

"Embit Gateway Configuration" is located in the left menu, in the category Tools.

user⊜ fem2gw		Accesso amministrativo	? Aluto -	•
Q Ricerca				
Sistema	LTE APN			
Panoramica	Save			
Log	(go to interface)			
Rete	LoRaWAN			
Account	Zone EU066 v			
Servizi	Gateway ID 0018C50670210025 Server address evi doud thethings network			
Strumenti	Server port 1700			
Embit	Save (go to service)			
Terminale				
	Network Tools			
	Address 8.8.8.8			
	Ping			
	GPS			
	Latitude			
	Longitude			
	Altitude			

Figure 16 Embit Gateway Configuration Main Tab

rigare to Emple outerway configuration main tab	
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In the configuration tab, it is possible to customize the network parameter of the LoRaWAN[®] packet forwarder:

- Zone \rightarrow 868 MHz \ 915 MHz \ 490 MHz (Certified only for Europe 868 MHz)
- Gateway EUI \rightarrow 8-bytes (hex) usually Gateway S/N
- Network Server Address
- Network Server Port

Once all parameters are set, click "save" to confirm.

The following figure shows the TTN (The Thing Network) configuration for the European 868 MHz frequency band:

LoRaWAN

Zone	EU868 🗸
Gateway EUI	001BC50670210025
Server address	eu1.cloud.thethings.network
Server port	1700
Save	
(go to <u>service</u>)	

Figure 17 Embit Gateway Configuration Main Tab

7 LoRa[®] 130X Gateway EUI

EMB-Fem2GW-130X-O connects to the LoRa[®] network with a Gateway EUI (Extended Unique Identifier) written in the label. Gateway EUI can be changed using the LoRa[®] 130X Gateway Configuration Web Interface.

Step 1: Take your Unique Gateway EUI

The Unique Gateway EUI is a number which allows the Network Server to identify your gateway. This parameter is written in the label of the **EMB-Fem2GW-130X-O**

Gateway. It can be changed, according to your preferences, through Embit Gateway Configuration Web Interface, under the "Configuration Tab".

8 Example: The Things Network LoRaWAN[®] Network Server

This section provides a brief explanation to register a new gateway in a LoRaWAN[®] Network Server.

The LoRaWAN[®] Network Server taken into account for this example is "The Things Network" network server.

The references to all the complete procedure to be carried out can be found on The Thing Industries website in the "Registering Gateways" tab, at the link: <u>The Things</u> <u>Industries</u>

Step 1: Sign up with your Account or register a new one

	THE THINGS NETWORK	
)on't have a	n The Things ID n ID? Sign up for free	
-	-	
on't have a	-	

Figure 18 TTN Login Page

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Step 2: Add a new gateway

Once you are logged in, click on your profile name, go to "Console" and select your cluster (Example: Europe).

In the next page, click on "Go to gateways" (Figure 19) and then click on "Register gateway" (Figure 20).

	cumentation 앱 or <u>Get Support</u> 앱.
OOO Image: Contraction state	Go to gateways

Figure19 Gateway selection

+ Register gateway		
Created at 🔺		
(

Figure 20 Register gateway button

In the next window, you have to compile all the fields required (Figure 21). The Gateway EUI is the hexadecimal EUI written on the label "Gateway EUI" in the Embit Gateway Configuration Tab from the Gateway Web Interface.

Register gateway

Register your gateway to enable data traffic between nearby end devices and the network. Learn more in our guide on ■ Adding Gateways ☑.

Owner* embit	Here your ID name will appear
Gateway EUI ⑦ 00 1B C5 06 70 21 00 25 Reset	Configured Gateway EUI
Gateway ID ⑦ * eui-001bc50670210025	Gateway ID – Auto generated (can be modified)
Gateway name ⑦ My new gateway	Gateway name
Frequency plan ⑦ * Select	Can select frequency according to your location
☐ Require authenticated connection ⑦ Choose this option eg. if your gateway is powered by <u>LoRa Basic Station</u> ☑	Required for LoRaWAN [®] Basic-Station (Figure 21.1)
Share gateway information Select which information can be seen by other network participants, includi ✓ Share status within network ⑦ ✓ Share location within network ⑦	ng <u>Packet Broker</u> 🛛
Register gateway	

Figure 21 Add gateway settings

If your gateway is a LoRaWAN[®] Basic-Station and you need to generate the API Key for CUPS and LNS, you have to tick the proper check-box as shown in the image below.

Require authenticated connection ⑦
 Choose this option eg. if your gateway is powered by LoRa Basic Station ②
 Generate API key for CUPS ⑦

🗸 Generate API key for LNS ⊘

Figure 21.1 Add gateway settings - LoRaWAN[®] Basic-Station

Once that all the settings are completed, click on "Register gateway" button.

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Step 3: Check your connection

After that the adding procedure is completed, a general overview will appear (Figure 22)

emb-fem2g ID: emb-fem2gw-13	w-1302-o 302-o		
• Disconnected ⑦		<u>***</u> 1	Collaborator 🛛 🗛 0 API keys
General information		Live data	See all activity \rightarrow
Gateway ID	emb-fem2gw-1302-o	15:55:34 Create gateway	
Gateway EUI	n/a		
Gateway description	None		
Created at	Feb 16, 2023 15:55:34		
Last updated at	Feb 16, 2023 15:55:34		
Gateway Server address	eu1.cloud.thethings.network	Location	Change location settings →
LoRaWAN information Frequency plan	EU_863_870		
Global configuration	▲ Download global_conf.json		
		No location information available	

Figure 22 General overview of the added gateway

When your Gateway is connected, a green dot is showed in the upper side of the info. Near the connection status, you can also find the list of the collaborators of the new gateway and, by clicking "Collaborator" you can add a new member.

9 IP Backhaul Connection

EMB-Fem2GW-130X-O supports two kinds of backhaul IP connection:

- Ethernet IP connectivity;
- Cellular connectivity.

The system is connected to the Ethernet Network through Ethernet Cable. IP address is assigned through DHCP.

Cellular connectivity is achieved using Quectel LTE Module. **EMB-Fem2GW-130X-O** supports mini SIM Size, with a Push-Push connector. It automatically guarantees LTE connectivity, and without it switches to 3G/UMTS or to GPRS connection according to the cellular coverage.

10 LTE Connection

In this section is described how **EMB-Fem2GW-130X-O** manages the LTE peripheral.

How to set up an LTE Network is explained. In Linux OS, LTE interface is called ppp0. We setup the OS to start the LTE module at boot time, according to the Ite configuration file stored in /etc/ppp/peers.

11 End Device configuration on Network Server

In case you want to build a complete network consisting of a gateway and end devices (only with end devices "Embit Development Kit"), the additional configurations to be made on the Network Server are as follows:

11.1 Create New Application

Once you have configured your gateway, click on your profile name and then go to "Console". In this page, click on "Go to applications" (Figure 27) and in the next page click on "Create application" (Figure 28).

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Walk right through to your applications and/or gateways.

Need help? Have a look at our \blacksquare Documentation \square or Get Support \square .



Figure 27 TTN Console view

Applications (11)		Q Search		+ Create application
ID \$	Name 🗢		End devices	Created at



A window like the one in Figure 29 will be opened.

[Owner* Your ID	 	– Here your ID name will appear
Here you have to indicate the ID of the new application	Application ID* my-new-application		
	Application name My new application		_ Here you can write the name of the new application
Ī	Description	, 	
Here you can write a brief description of what your new app will do	Description for my new application		
	P Optional application description; can also be used to save notes about the	application	
	Create application		

Figure 29 Add new application procedure

"Application ID" and "Description" are human-readable string. Fill all the fields with your personal information and then press "Create application" button.

11.2 Add New Device

Once that your application is created, in the relative box you can find all the information related to the selected application and add a new device, by clicking on the "Register end device" button (Figure 30).

ID: new-applicatio	n-868					
• No recent activity ⊘				🙏 0 End devices	🚓 1 Collaborator 🛛 O	🖷 0 API keys
General information			Live data		See	all activity →
Application ID	new-application-868	6	🕀 16:23:31 new-applic… C	reate application		
Created at	Feb 16, 2023 16:23:31					
Last updated at	Feb 16, 2023 16:23:31					
End devices (0)			Q Search	=+ Import end o	device + Register e	end device
ID \$	Name 🗢	DevEUI	JoinEUI		Last	activity 🗢

Figure 30 Add a new end device

In the next window, select "Enter end device specifics manually" (Figure 31)

Register end device

Does your end device have a QR code? Scan it to speed up onboarding.

Scan end device QR code	Device registration help
End device type	
Input Method ⑦	

- Select the end device in the LoRaWAN Device Repository
- Enter end device specifics manually

End device brand ⑦*

Type to search	\sim
----------------	--------

Cannot find your exact end device? Get help here and try enter end device specifics manually option above.

Figure 31 Register end device window

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Now further settings will be proposed. Select a proper "frequency plan" and 1.0.3 LoRaWAN version. If the correct parameters have been selected, the ability to add advanced settings for configuration will be displayed (Figure 32)

Frequency plan ⊘ *	
Europe 863-870 MHz (SF12 for RX2)	
LoRaWAN version ⑦ *	
LoRaWAN Specification 1.0.3	· ·
Regional Parameters version ⑦ *	
RP001 Regional Parameters 1.0.3 revision A	\sim
Show advanced activation, LoRaWAN class and cluster sett	<u>ings</u> ∽

Figure 32 New device initial settings

Using the "advanced settings" section, you will be able to select OTAA (Over-The-Air-Activation), and the end-device LoRaWAN Class. (Figure 33)

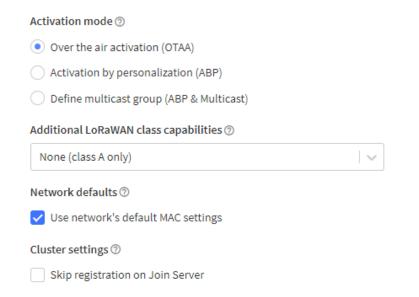


Figure 33 New device advanced settings

In the "Provisioning Information" section below the advanced settings you have to configure the device specific parameters and addresses (Figure 33):

- "JoinEUI" (formerly "App EUI") is an 8-bytes (hex) value used by the server for the join procedure. It is related to your application (it can be the same for every device registered for the application) and, if it is not provided by the manufacturer, it can be generated through to the appropriate button.
- "Dev EUI" is a unique 8-bytes (hex) value given by the manufacturer.
- "AppKey" is a 16-bytes (hex) key used by the network server for encrypt operation. It can be generated or directly created by the user and can be the same for every device registered for the application).

Provisioning information	
JoinEUI 🔿 *	
11 22 33 44 55 66 77 88 Reset	
This end device can be registered on the network	
DevEUI 🗇 *	
70 B3 D5 7E D0 05 AA C3	
AppKey ⑦*	
72 43 OF E7 C7 11 49 A6 B4 AE 15 CC 92 68 OB 2A	ϕ Generate
End device ID ⑦ *	
eui-70b3d57ed005aac3	
This value is automatically prefilled using the DevEUI	
After registration	
 View registered end device 	
Register another end device of this type	
Register end device	

Figure 34 Provisioning Information Setting

The "End device ID" is automatically generate from the "Dev EUI" but it can be modified using any name.

Once all parameters have been set, you can complete the registration clicking on "Register end device" (Figure 34).

Now an overview page will open. Please, check if all the parameters are correctly set (Figure 35).

After that the configuration is finished, in "Live data" section is possible to see all the packets which we are sending/receiving to/from the network server.

 Last seen info unavailable ↑ n/a ↓ n/a 					Created 45 seconds ago
Overview Live dat	a Messaging Location Payload formatters	Claim	ning	General settings	
Seneral information				Live data	See all activity +
End device ID	test-device		6		
Description	These device settings are an example				
Created at				Waiting for events fr	rom test-device
Activation information					
VppEUI	00 00 00 00 00 00 00 01	0	6		
DevEUI	00 01 02 03 04 05 06 07	0	8	Location	$Change \ location \ settings \rightarrow$
toot key ID	n/a				
АррКеу		8	۲		
NwkKey	n/a				
Session information				No location inform	mation available
io data available					

Figure 35 End device overview

13 Disclaimer of liability

The information provided in this and other documents associated to the product might contain technical inaccuracies as well as typing errors. Regulations might also vary in time. Updates to these documents are performed periodically and the information provided in these manuals might change without notice. The user is required to ensure that the documentation is updated and the information contained is valid. Embit reserves the right to change any of the technical/functional specifications as well as to discontinue manufacture or support of any of its products without any written announcement.

13.1 Disclaimer of liability

The user must read carefully all the documentation available before using the product. In particular, care must be taken in order to comply with the regulations (e.g., power limits, duty cycle limits, etc.).

13.2 Handling Precautions

This product is an ESD sensitive device. Handling precautions should be carefully observed.

13.3 Limitations

Every operation involving a modification on the internal components of the module will void the warranty.

13.4 Trademarks

Embit is a registered trademark owned by Embit s.r.l.

All other trademarks, registered trademarks and product names are the sole proprietary of their respective owners.