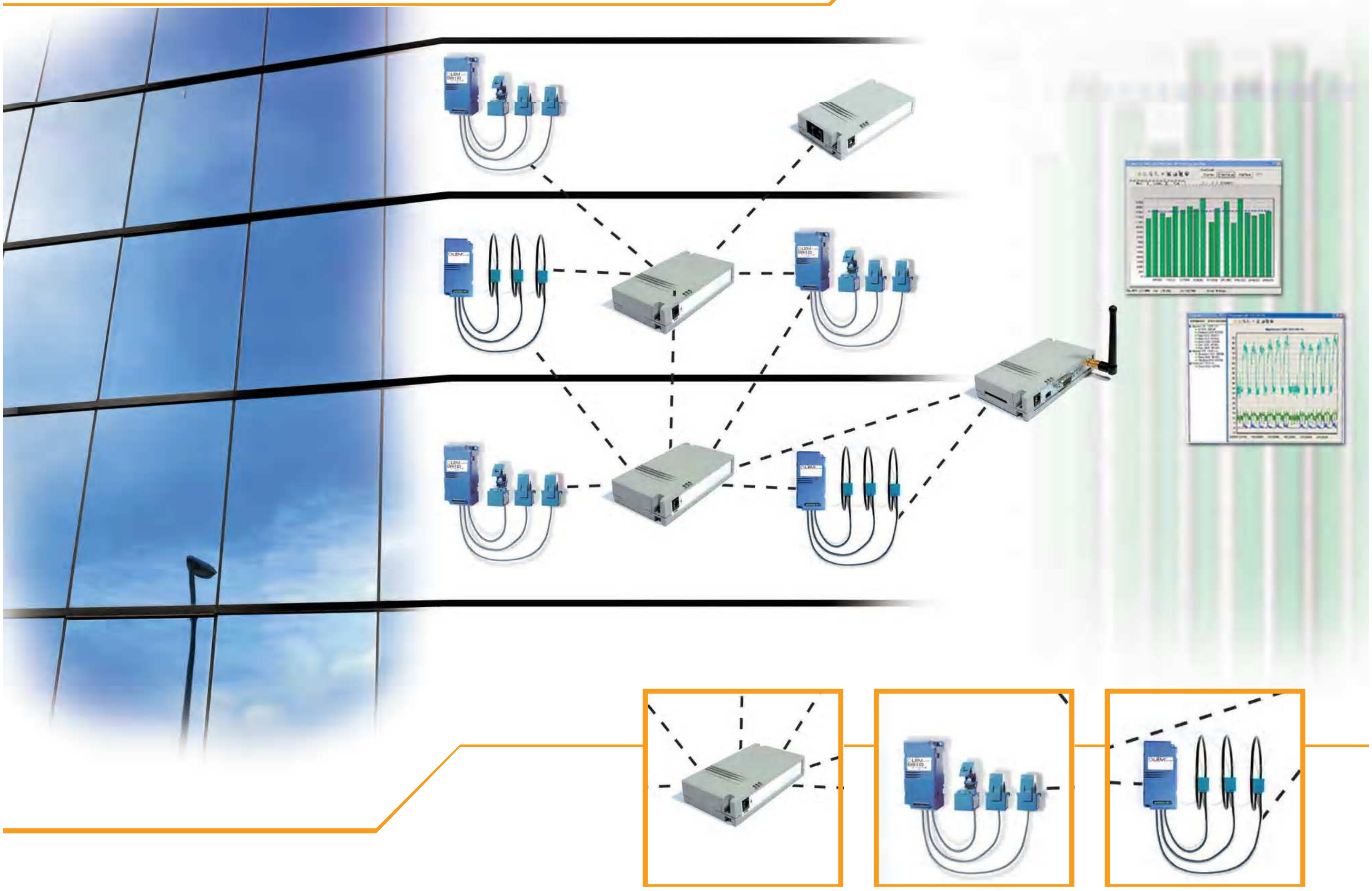
User Guide

Wi-LEM

Wireless Local Energy Meter



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I. IDENTIFICATION

I.1 DOCUMENT

Wireless Local Energy Meter (Wi-LEM) User Guide

Document version	Date	Evolution
V0	2007.03.16	Creation
V1	2007.09.28	Minor corrections
V2	2009.04.22	Add new EMN types built with Rogowski coils, MeshGate & MeshNode Long Range & Extra Long Range, Mesh Node-6424 (without antenna), Wi-Pulse, Wi-Zone. Add a network commissioning chapter.
V3	2009.06.17	[illegible]

I.2 MANUFACTURER

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1 NOTICE

1.1 Certification directives related to EMN

The present product is designed to fully agree with the following directives:

CE, FCC, IC and JAPAN

- Federal Communication Commission 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 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.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. (15.21)

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. (15.19)

IMPORTANT NOTE:

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

- Industry Canada statement:

This device complies with RSS-210 of the Industry Canada 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.

IMPORTANT NOTE:

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

For more information, contact LEM's customer service.

1.2 Safety instructions

1.2.1 Introduction

1.2.1.1 Principle

The user must have read and understood this chapter before undertaking any action with / in the system.

For all information considered inadequate, please contact the manufacturer or your local representative.

⚠CAUTION FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE SERIOUS ACCIDENTS !

All device users, such as:

- owners;
- installers, maintenance and service personnel, or any other person in related job functions;
- managers, operators, setters, programmers, foremen, mechanics;

must read and strictly follow the safety instructions in this document.

These regulations also pertain to options, components, installations, devices and systems related to the machine.

1.2.1.2 Importance of safety indications

All the safety and protection instructions given in this manual must be respected to prevent reversible or irreversible bodily injuries, material damages or environmental pollution. Similarly, legal regulations, accident prevention and environment protection measures, as well as recognized technical regulations, aimed at appropriate risk-free work methods in force in the country and in the machine workspace must be respected.

1.2.1.3 Failure to respect safety regulations

Any non-respect of the safety and protection rules, as well as existing legal and technical regulations, could cause reversible or irreversible bodily injuries, material damages or environmental pollution.

1.2.2 General rules for all users

⚠ WARNING READ AND FOLLOW THE USER INSTRUCTIONS AND MANUALS DELIVERED WITH THIS SYSTEM. ONLY PEOPLE TRAINED FOR MANIPULATIONS AND ACQUAINTED WITH THESE INSTRUCTIONS CAN WORK ON THE DEVICE.

1.2.3 User guide

- User instructions and user guide delivered by the manufacturer with the system or at a later date must be brought to the attention of all people operating on the device or responsible for it in any way;
- These people must read and strictly follow the user instructions and manuals;
- After the reception of updates, if any, the user will update the documentation.
- Anyone likely to work on the device must have access to the user instructions and manuals.

⚠CAUTION DOCUMENT TO BE KEPT TO REFER TO IT LATER ON.

1.2.4 Differentiation of degrees of risk

1.2.4.1 General risks

⚠ DANGER WARNS AGAINST A DIRECT DANGER OF DEATH OR SERIOUS INJURY.

⚠CAUTION INDICATES INCORRECT ACTIONS WHICH MAY CAUSE MINOR HUMAN INJURY OR MAJOR MATERIAL DAMAGE TO THE SYSTEM AND ENVIRONMENT.

⚠ WARNING FOR INFORMATION, INDICATES HANDLING ERRORS OR NEGLIGENCE WHICH MAY CAUSE MATERIAL DAMAGE ON THE DEVICE.

1.2.4.2 Electric cabinet or live components

⚠ DANGER ONLY A QUALIFIED PERSON IS AUTHORIZED TO INTERVENE INSIDE THE ELECTRIC CABINETS OR ON A LIVE COMPONENT.

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2. WI-LEM AND NETWORK DESCRIPTION

2.1 About the Wi-LEM

The Wi-LEM is a complete data acquisition platform to measure and transmit electrical parameters used for Energy Management application. As it is an open architecture, this platform can be easily interfaced with existing data logger and energy monitoring software.

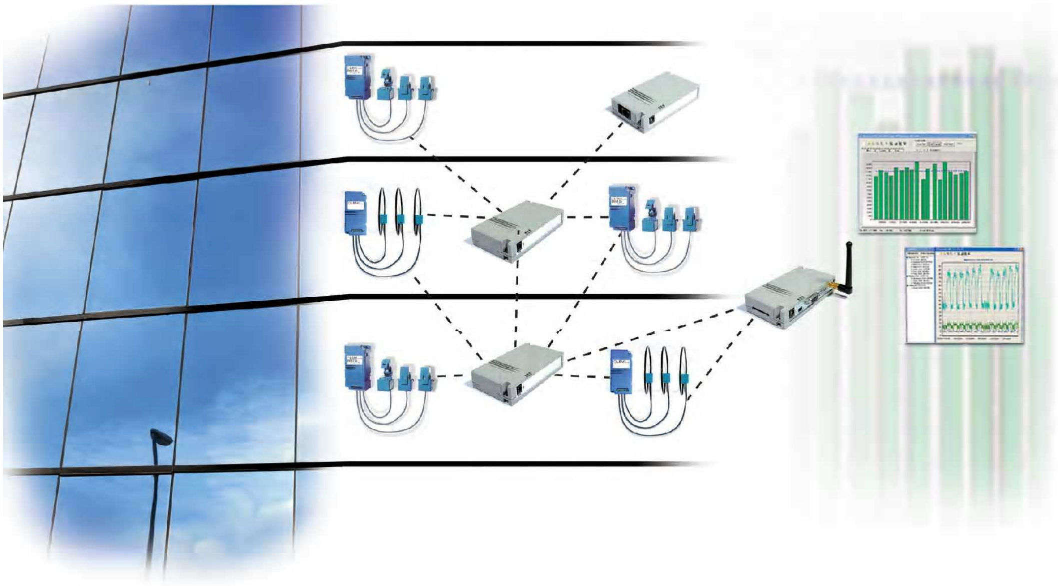


Fig. 2-1: Principle of Wireless Local Energy Meter (Wi-LEM)

The Wi-LEM is constituted by 3 mains parts:

- **Energy Meter Node (EMN)**: sub-meter which calculates several electrical parameters with pre-wired split core current transformers or Rogowski coils and embedded wireless data transmission (for more information, see next page).

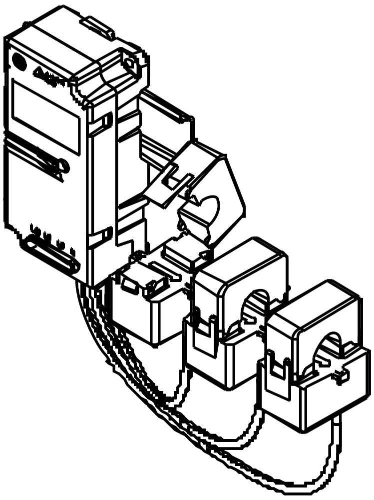


Fig. 2-2: Energy Meter Node
with Current Transformer (CT)

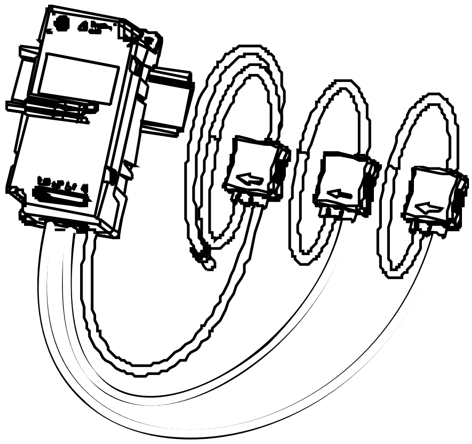


Fig. 2-3: Energy Meter Node
with Rogowski Coil (RT)

- **Mesh Gate (MG)**: stand alone gateway which manages the wireless network and collect the data periodically sent by the EMN. The MG can be accessed by the data logging system for analysis.

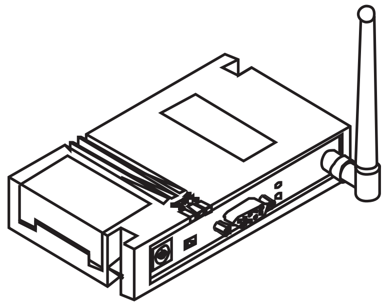


Fig. 2-4: Mesh Gate

- **Mesh Node (MN)**: repeater extending the distance of the transmission between the EMN and the MG when needed.

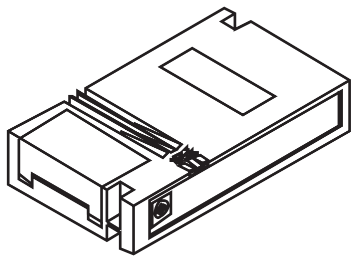


Fig. 2-5: Mesh Node

2.2 EMN

The Energy Meter Node (EMN) is a 3-phase electric meter with a wireless (radio) communication.

1. Led indicator

For more information about the LED indicator, see chapter 3.4.5.

2. Antenna
3. [illegible] DIN Rail
4. [illegible]ID)
5. Current Transformer (CT) or Rogowski coil (RT)
6. Voltage input

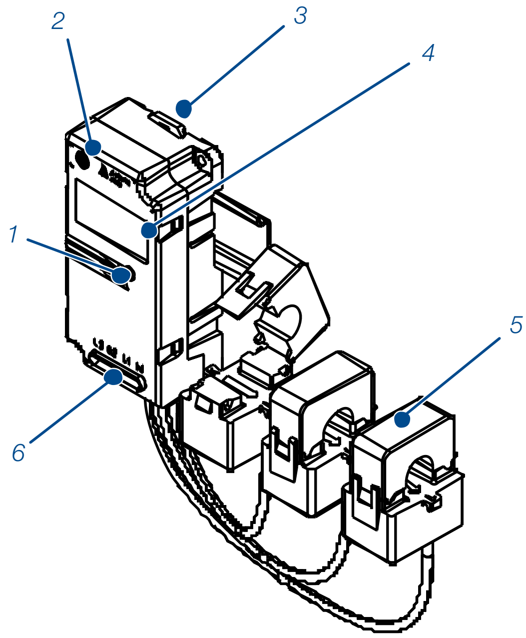


Fig. 2-6: Energy Meter Node built with CT

2.2.1 Detailed Description

Data from the meter is sent to the gateway for user access periodically.

The meter data is split into three sections:

- **Energy Meter:** Active, reactive and apparent energy per phase and sum with a time-stamp.
- **Recording Interval Meter:** Active, reactive and apparent energy per phase and sum with a time-stamp of the end of the recording interval; minimum voltage per phase and maximum current per phase during recording interval; frequency
- **Meter Identification and Configuration:** [illegible] interval time setup, command and status word.

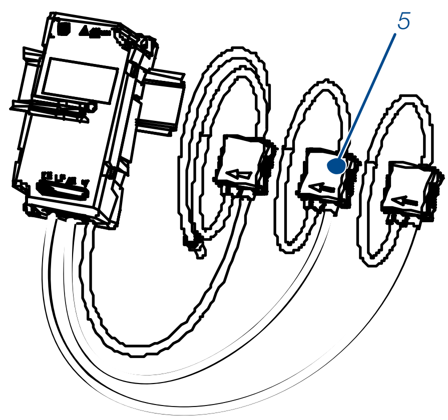
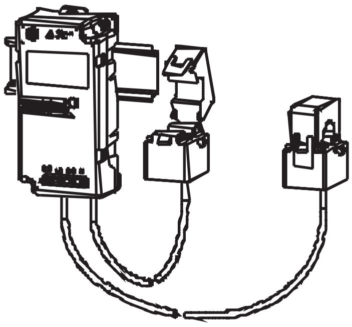
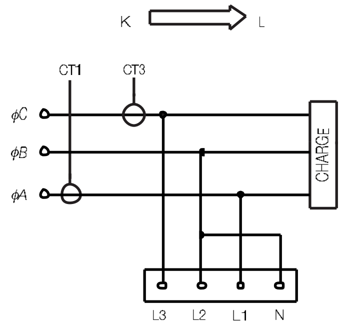


Fig. 2-7: Energy Meter Node built with RT

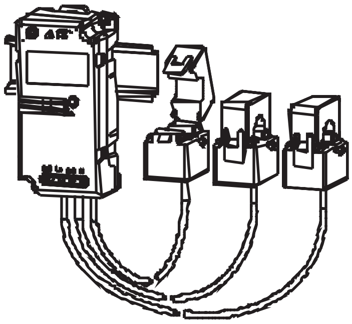
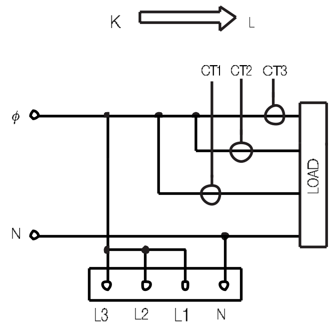
2.2.2 Models Description

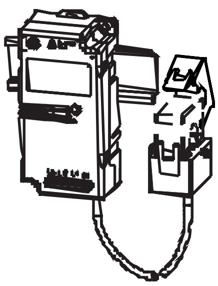
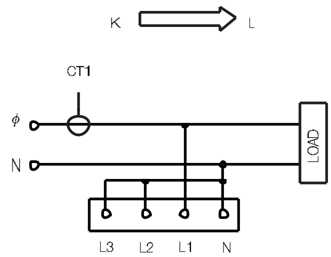
The following table lists the different models of Energy Meter Node available.

Table 2-1: Model Description

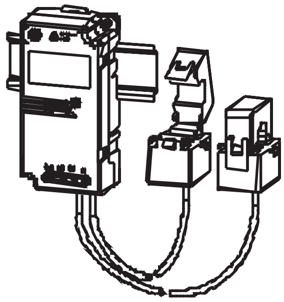
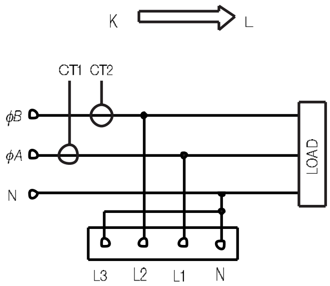
<table>
<tr><th>Model*</th><th>Wiring Diagram (CT and RT)</th></tr>
<tr><td>EMNxxxD3
(Delta - 3 wires)
Code: 111</td><td>



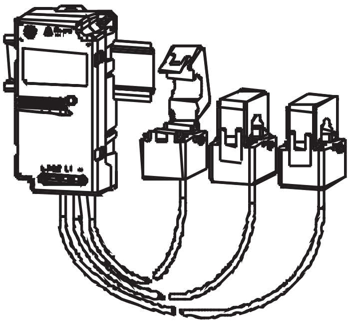
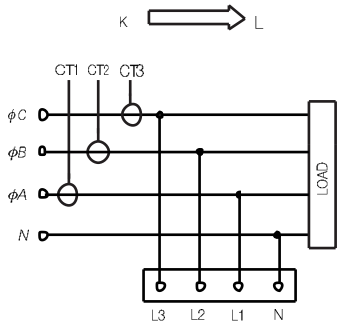
As the maximum voltage is 300 V_{rms}, this model can not be used on 400 or 480 V_{rms}. Delta Network.

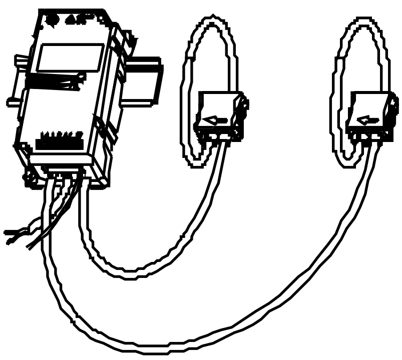
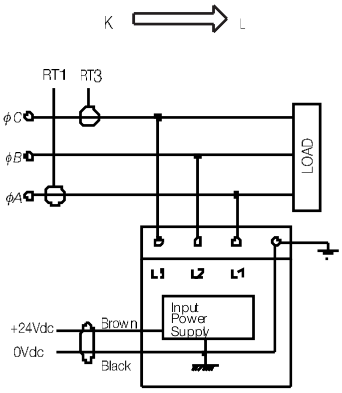
V_{BA} and V_{BC} $\leqslant$ 300 V_{rms}
</td></tr>
<tr><td>EMNxxxW0
(3 single phases on same voltage)
Code: 101</td><td>



$V_{N\phi}$ $<$ 300 V_{rms}
</td></tr>
<tr><td>EMNxxxW2
(Single phase - 2 wires)
Code: 010</td><td>



$V_{N\phi}$ $\leqslant$ 300 V_{rms}
</td></tr>
</table>

<table>
<tr><th>Model*</th><th>Wiring Diagram (CT and RT)</th></tr>
<tr><td>**EMNxxxW3**
(Wye - 3 wires)
Code: 011</td><td>



V_{NA} and V_{NB} $\leqslant$ 300 V_{rms}
</td></tr>
<tr><td>**EMNxxxW4**
(Wye - 4 wires)
Code: 000</td><td>



V_{NA} , V_{NB} and V_{NC} $\leqslant$ 300 V_{rms}
</td></tr>
<tr><td>**EMNxxx-D3/SP2**
(Delta - 3 wires)
Code: 111</td><td>



[illegible] V_{rms} Delta Network

V_{BA} and V_{BC} $\leqslant$ 520 V_{rms}
$V_{A,B,C}$ - earth $\leqslant$ 300 V_{rms}

This device being Isolation Class 1, it must be connected to Earth/Ground (use Green/Yellow wire)
</td></tr>
</table>

[illegible]

2.2.3 Main Characteristics

2.2.3.1 EMN Line powered up to 300V_{rms} (1)

- Primary Nominal Current:........................... 20A ... 2000A (according to the model)
- Primary Voltage,
  Measuring Range (neutral/phase) (V_{PN}) 1): .... 90 to 300 V_{rms}
- Primary Voltage , Nominal Range (N/L) (V_{PN}):.... 100 to 272 V_{rms}
- Absolute Min/Max input voltage (N/L): .... 90 to 300 V_{rms}
- Frequency (f):.. 50 / 60 Hz
- Maximum power consumption .... 2 W
- Maximum supply current (N-L1)................. 0.2 A_{rms}
- Ambient operating temperature (90% rH) (T_A)... -10 .. + 55°C
- For indoor use only
- Altitude.. Up to 2000m
- Protection degree.................................. IP2X
- Pollution degree..................................... PD2
- Isolation .... ☐ Isolation class II
  IEC 61010-1 CAT III 300 V_{rms}

2.2.3.2 EMN External power (SP2 model and other)

- Primary Nominal Current (I_{PN}): .... [illegible]
- Primary Voltage, Measuring Range (V_{PN}): .... 180 to 520 V_{rms}
- Frequency (f):.. 50 / 60 Hz
- External power supply (+/- 10%) 2) .... 24 VDC
- Maximum supply current .... 50 mA DC
- Ambient operating temperature (90% rH) (T_A)... -10 .. + 55°C
- For indoor use only
- Altitude.. up to 2000m
- Protection degree.................................. IP2X
- Pollution degree..................................... PD2
- Isolation .... ☐ Isolation class II
  IEC 61010-1 CAT III 300 V_{rms}
  ⏚ Product must be connected to earth (ground)

For more details about technical characteristics, refer to the datasheets about the EMN series.

1) Maximum voltage limited to 265$_{VRMS}$ [illegible]

2) Must comply with limited-energy circuit criteria and SELV conditions.

2.3 Mesh Gate description

This product is now available in 2 versions:

- Long Range (**L**) with RF power max. 10 mW
- Extra Long Range (**XL**) with RF power max.100 mW

1. LED indicators (see table hereunder)
2. Power supply 9 V DC
3. Mini USB connector "CONSOLE"
4. RS-232 connector
5. Antenna
6. Connector panel access cover

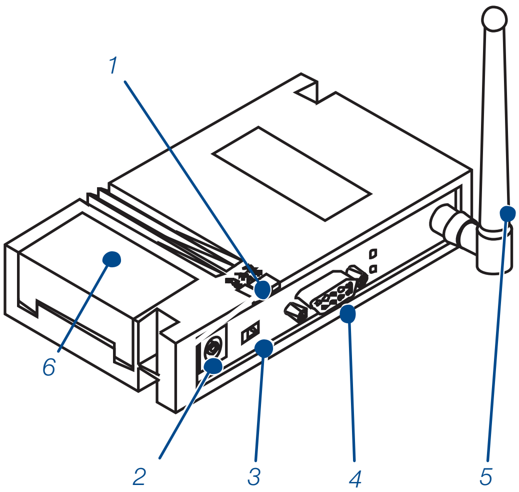


Fig. 2-8: Mesh Gate

Table 2-2

LED	LED Status	Description
PWR	ON	Connection with host device detected.
	Blinking	No host device detected or MeshScape Network Monitor not running.
	OFF	Power has been removed.
ACT	Flashing	Gateway detects RF activity. The activity LED [illegible] packets (packets destined for other devices) or environmental noise. Only valid packets are processed by the device.
	OFF	
STS	*(Reserved for future use.)*	

The lift-off connector panel access cover on the case provides access to a 12-pin terminal block connector, useful in case of RS-485 connection and to the general ON/OFF switch.

Before use, check switch ON/OFF to be "ON".

For detailed information on terminal block, refer to 3.5.2 paragraph.

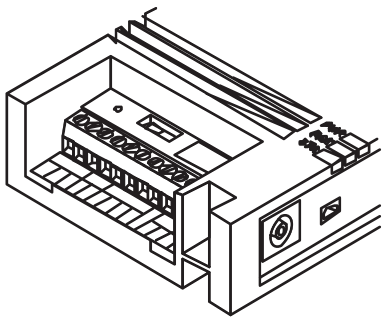


Fig. 2-9: Mesh Gate connections

2.4 Mesh Node description

This product is now available in 2 versions:

- Long Range (**L**) with RF power max. 10 mW
- Extra Long Range (**XL**) with RF power max. 100 mW

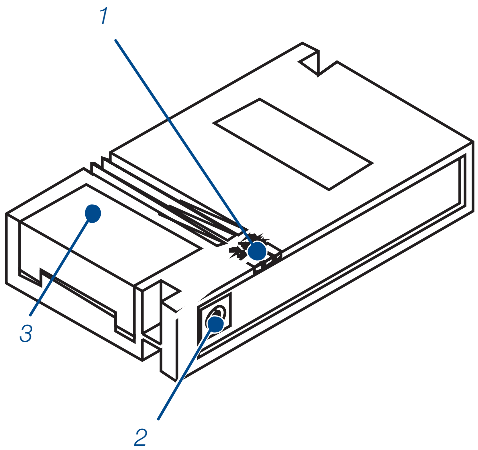


Fig. 2-10: Mesh Node

1. LED indicators (see table hereunder)
2. Power supply 9 V DC
3. Connector panel access cover (ON/OFF switch)

Table 2-3

LED	LED Status	Description
PWR	ON	Power ON
	OFF	No Power
RF Activity	Flashing	Mesh Node detects RF activity. The RF activity LED [illegible] packets (packets destined for other devices) or environmental noise. Only valid packets are processed by the device.
	OFF	No RF activity detected.
STS	ON Solid Green	Device has established two or more connections with other devices.
	Blinking	The Mesh Node has established a single connection; additional routers may be needed to increase robustness.
	OFF	The Mesh Node is not on the MeshScape network : additional routers are absolutely needed in order this device be connected to the network.

2.5 Network

2.5.1 Network Characteristics

- Radio standard: 802.15.4
- Protocol:.. Millennial.Net
- RF Band: .... 2.4 GHz
- RF Power and Operating range (line of sight) :

Table 2-4

	MG-L and MN-L	MG-XL and MN-XL	EMN
RF max. Power	10 mW (10 dBm)	100 mW (20 dBm)*	10mW (10dBm)
Operating range between EMN and MG or MN	30 m (95 ft)	30 m (95 ft)	-
Operating range between MG or MN	149 m (460 ft)	260 m (850 ft)	-

* 100 mW: when allowed, according to country regulations

⚠ WARNING DISTANCE MAY CHANGE WITH REGARDS TO BUILDING CONFIGURATION AND NETWORK LAYOUT.

2.5.2 Introduction

[illegible] Ds are factory programmed and usually do not need to be changed.

In a mesh network, there are often several different routes possible for a message from a EMN to the MG through Mesh Nodes. The path with the least **hops** (RF steps between 2 nodes) to routers will be used if available.

More routers can be used for long distances or to add routes from a EMN to the MG in areas with a changing environment.

D[illegible]

2.5.3 Description

Each EMN and the MG are equipped with a radio module.

The measurement values of the EMN are buffered in the gateways RAM.

The MG is updated by each EMN periodically depending on the network configuration.

When addressing a EMN Modbus slave, the MG responds directly. As the MG contains an image of the EMN values, there is no need to pass the message on to the EMN.

A write command, however, is forwarded to the EMN, a delay of 2 to 4 minutes can occur for the response message.

Refer to «Modbus interface» on Chapter 4.4.1. for more information.

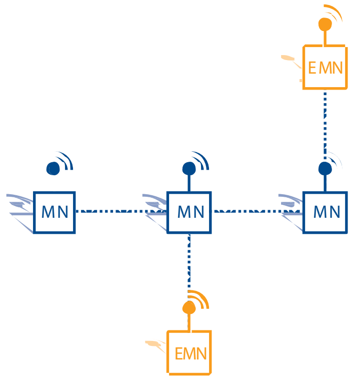


Fig. 2-11: Single path between MG, MN and EMN (Linear)

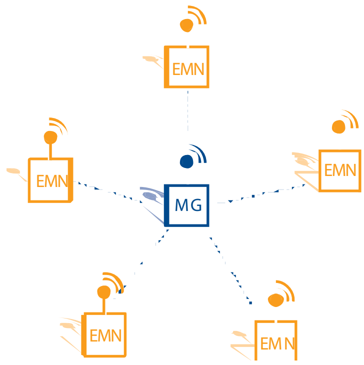


Fig. 2-12: Combination of low power EMN with a MG (Simple Star)

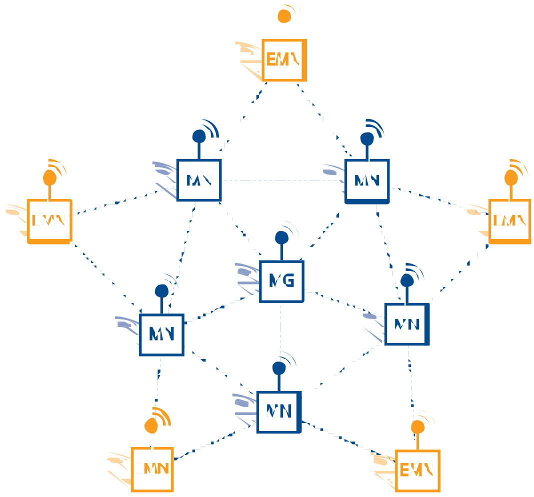


Fig. 2-13: Network with a combination of reliability and low power (Star Mesh Network Topology)

3. HARDWARE INSTALLATION AND CONTROL

This chapter describes how to install the hardware to set up the Wireless Mesh Sub-meter Network.

3.1 Important warning and notices

DANGER RISK OF ELECTRICAL SHOCK: THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGE THAT MAY CAUSE SERIOUS INJURY OR DEATH TO PERSONS IF PRECAUTIONS WITHIN THIS GUIDE ARE NOT FOLLOWED. DO NOT REMOVE ANY PART OR CUT SENSOR CABLE OF THE EMN.

CAUTION THIS ELECTRIC EQUIPMENT MUST BE USED IN ELECTRIC / ELECTRONIC EQUIPMENT WITH RESPECT TO APPLICABLE STANDARDS AND SAFETY REQUIREMENTS IN ACCORDANCE TO THE MANUFACTURER'S OPERATING INSTRUCTIONS.

WARNING INSTALLATION AND SERVICE MUST BE DONE BY QUALIFIED PERSONNEL ONLY ON POWER LOCKED CABINET.

WARNING IN CASE THIS EQUIPMENT WOULD BE USED IN A DIFFERENT MANNER AS SPECIFIED WITHIN THIS GUIDE, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

CAUTION EMN AND ITS PREWIRED CURRENT TRANSFORMER ARE DESIGNED FOR USE IN RESTRICTED ACCESS CABINET.

- Do not install the equipment in cabinet which does not provide [illegible] according to the datasheet
- Do not remove or change any part of the product, it may damage it or other equipment or cause serious injury or death.
- In case of accidental degradation of enclosure or other part, do not install the equipment or remove it from installation and carry out its replacement.
- Do not degrade or cut any part of the enclosure and cables.

3.2 Before You Start

- Check carefully that the EMN Model received is appropriate for the system to be monitored. Otherwise, wrong or incomplete data may be sent to the Mesh Gate (MG).
- Read carefully this manual and take care of the warning notes.

HARDWARE INSTALLATION AND CONTROL

3.3 Network deployment recommendations (Mesh Gate and other nodes installation)

[illegible]

⚠ WARNING IF POSSIBLE, FOR AN EASIER DEPLOYMENT OF A NEW NETWORK, THE MESH GATE SHOULD BE POWERED BEFORE ALL OTHER NODES .

⚠ WARNING ALL DEVICES ARE DESIGNED FOR INDOOR USE ONLY.

3.3.1 Basic guidelines

3.3.1.1 Building audit

[illegible] objects, heavy concrete walls, direction of installed devices, etc.).

[illegible]

- [illegible]
- Network topology – dense versus spread out/serial;
- Type of building material;
- Power availability for nodes not attached to meters;
- Any known obstacles or RF interferences (Heating pipes, electrical room, etc.);
- "Bridge" Mesh Node Placement;
- Detect other 2.4 GHz interference.

3.3.1.2 Walls and floors

[illegible]

In case of wall mounting or crossing, take care about both sides of the construction. Depending on materials and wall or [illegible]

[illegible]

3.3.1.3 Different materials

Glass, sheet rock and wood have least impact to the radio signal.

Concrete and brick walls are much harder to penetrate (maximum distance is half), but anyway distance between two devices will depend on how thick and how many obstacles there are in a way.

Metal is virtually impossible to penetrate and radio communication through such material is only possible thanks to actual open spaces (slits, holes and cracks in the metal.)

3.3.2 Network topologies

- Network strength primarily depends on the network topology .
- The more links the devices will have with other nodes, the more robust and reliable the network will be.

3.3.2.1 Best Case Scenario (Star-Mesh topology)

Ideal Meshscape topology is “Star-Mesh”, where all nodes are evenly distributed from the Gateway and have multiple communication links.

[illegible] with multiple nodes, so if one mesh node fails or if a radio link experiences interference, the network [illegible] Having multiple routes to the gateway will also decrease the estimated sampling rate.

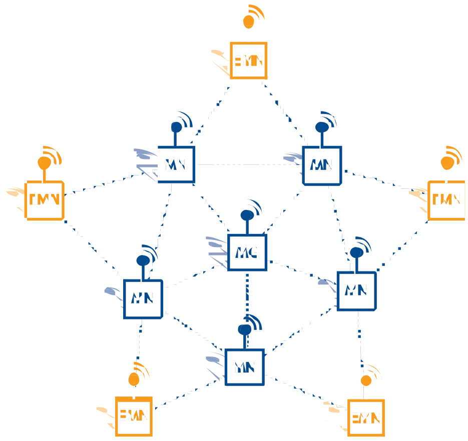


Fig. 3-1: Network with a combination of reliability and low power (Star Mesh Network Topology)

3.3.2.2 Worst Case Scenario (Data Bottle Neck)

In some cases sensors might be located far away from the Gateway and all data from the network has [illegible] situation creates bottleneck and increases the risk of loosing data packets.

Always try to avoid such topologies by adding additional routers to provide more links to the gateway.

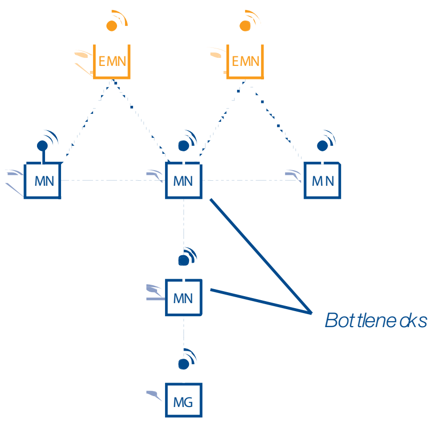


Fig. 3-2: Single path between MG and MN (linear)

3.3.3 EMN location

3.3.3.1 Basic guidelines

To obtain the best effectiveness of the network, apply the following recommendations.

- Do not install EMN in front of or close to metallic parts. They may reduce the efficiency of the embedded antenna.
- Avoid proximity of Electromagnetic Induction.
- Respect the illustrated layout to insure an optimized orientation of the antenna.

3.3.3.2 Inside a metallic cabinet

When EMN has to be placed inside a metallic cabinet, its location is much more important.

The cabinets are never completely sealed thanks to small open spaces and allow certain radio communication, but significantly reduced signal strength. To get the best effectiveness, apply the following recommendations:

- Do not install EMN in the centre of the cabinet where all electrical cables are.
- Put EMN on one side, in front of any door slit or any window (if existing).
- If there is some hole on bottom or top of the cabinet for cables pathways, put EMN in front of it.
- Add systematically a Mesh Node near the vicinity of the cabinet (1m) to ensure robust communications.

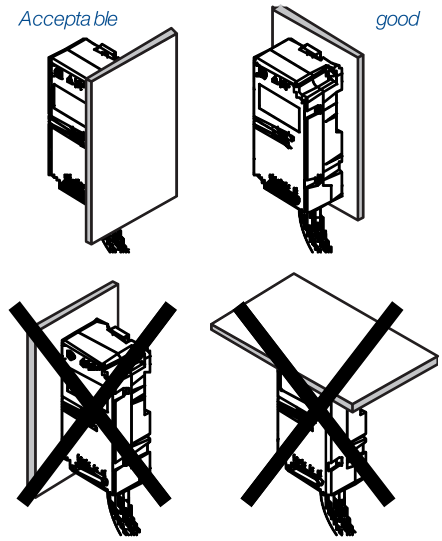


Fig. 3-3: Avoid the proximity of the antenna with metal parts

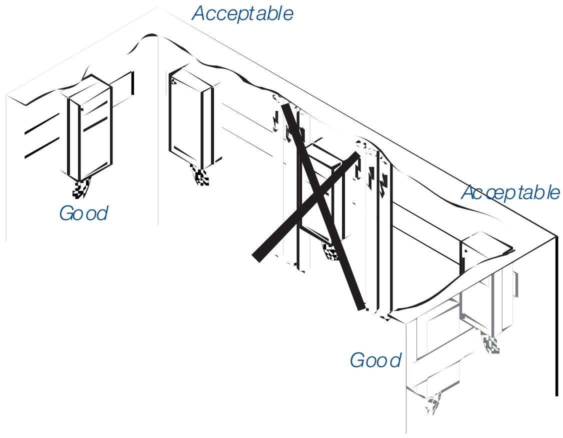


Fig. 3-4: EMN Location inside a metallic cabinet

3.3.4 Mesh Gate location and connection

- It is always preferable to place the Mesh Gate in middle of network.
- Need for PC (start-up/diagnostic/troubleshooting)

A Power on the Mesh Gate by plugging the power **supply adaptor 9 V**.

B Connect the Data Port **RS-232** to the COM port of the computer. If the **Meshscape Monitor** is not required, the Modbus Master can also be connected to the **RS-485** port situated inside the cover of the **Mesh Gate**

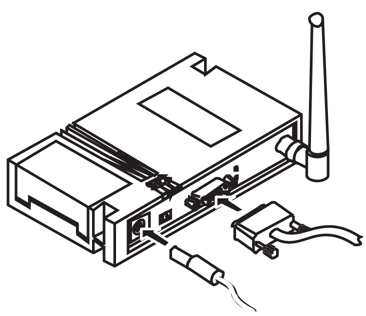


Fig. 3-5: Connect the Mesh Gate RS-232 port to the PC

3.3.5 Mesh Node location and connection

Orientation of the nodes in relation to other devices on the network impacts radio signal strength.

- Avoid placing Mesh Node right under an EMN.

WARNING TAKE CARE IF FIXING MESH NODE HORIZONTALLY ON A METALLIC PLANE TO LET A MINIMUM FREE INTERVAL (3-5 MMS) BETWEEN BOTH AREAS IN REGARDS.

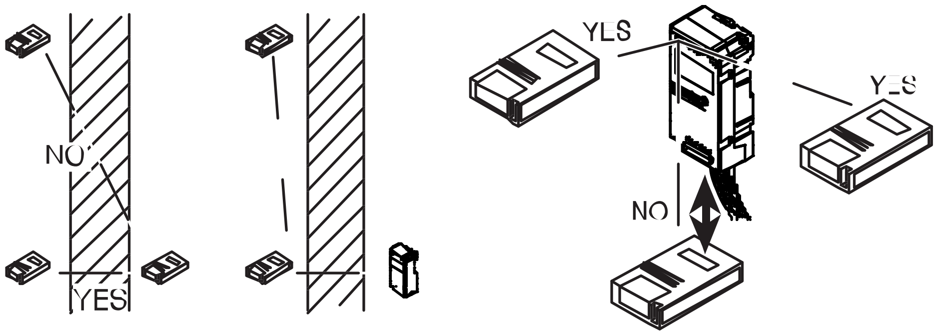


Fig. 3-6: location advising

Best radio signal is observed when all Mesh Node devices are positioned horizontally:

Good radio signal is also observed when one device is positioned horizontally and other vertically:

Radio signal is weaker, when all devices are positioned vertically:

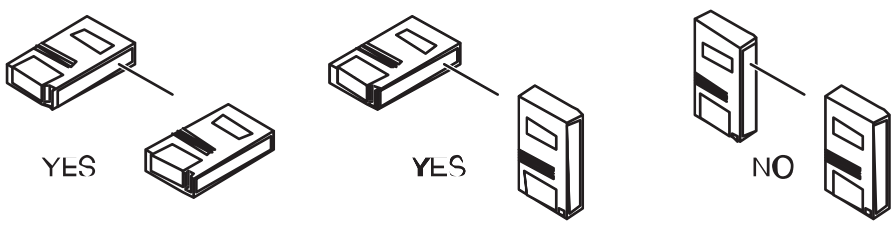


Fig. 3-7: Devices position

A Power on the Mesh Node by plugging the power supply adaptor 9V **(1)**.

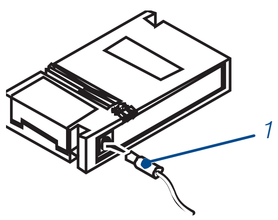


Fig. 3-8: Connect the Mesh Node power supply

3.4 Energy Meter Node Mounting

DANGER MAKE SURE THAT THE LOCATION WHERE THE ENERGY METER NODE HAS TO BE FIXED IS POWERED OFF.

⚠ WARNING EMN MODULE MUST BE INSTALLED VERTICALLY AS SHOWN ON THE FIGURE BELOW.

3.4.1 Wall and panel Mounting

A Prepare the mounting holes.

B Fixe the EMN to the wall or the panel with the screws **(1)**.

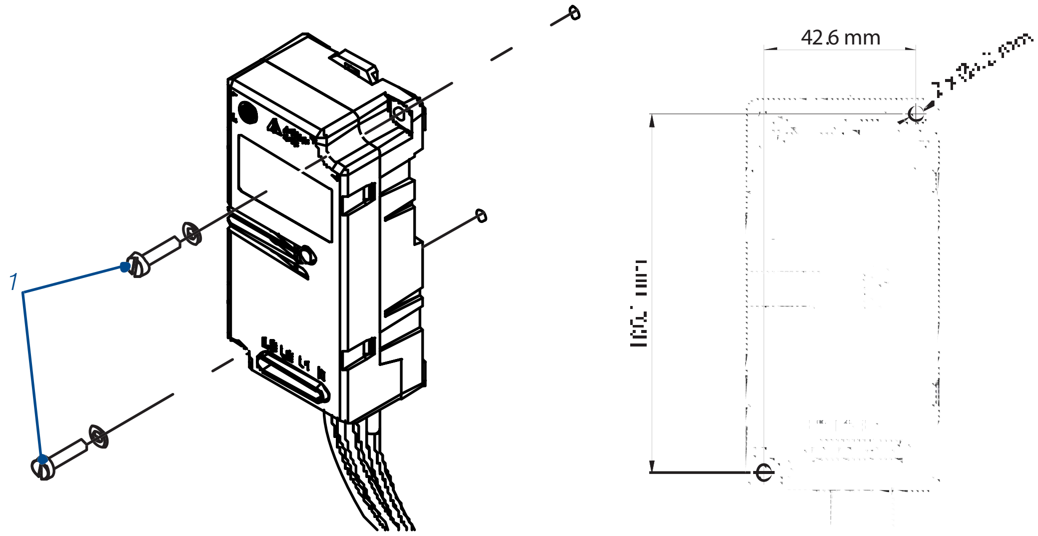


Fig. 3-9: Fixing the EMN on a wall or panel

Note: *Use maxi fastening torque 2.8 Nm (2 Lb.-Ft)*

3.4.2 DIN Rail Mounting

A Clip the EMN on the DIN Rail **(3)**.

B [illegible] **(2)** to remove the EMN from the DIN Rail.

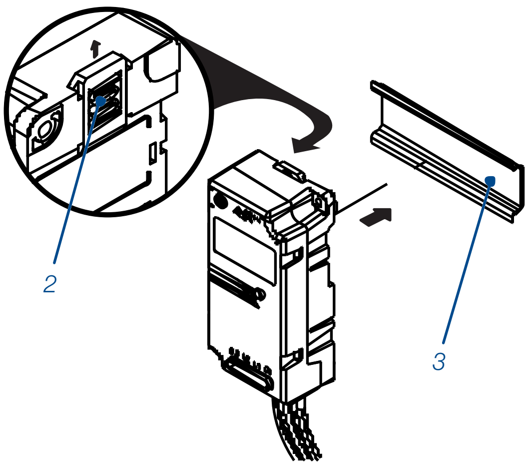


Fig. 3-10: Fixing the EMN on the DIN Rail

3.4.3 Current sensors mounting

⚠ DANGER MAKE SURE THAT THE POWER CABLE ON WHICH THE CURRENT SENSOR IS ATTACHED IS POWERED OFF.

⚠ CAUTION THESE CURRENT SENSOR ARE DESIGNED FOR LESS THAN 50 OPEN/CLOSE CYCLES, DO NOT USE AS A CLAMP ON METER.

⚠ CAUTION THESE CURRENT SENSOR HAVE BEEN DESIGNED FOR ISOLATED CABLE USE ONLY.

3.4.3.1 Current Transformer

⚠ WARNING KEEP THE MATING SURFACES (2) PARTICLE FREE OTHERWISE ACCURACY MAY BE DEGRADED.

A Respect the Current Transformer phase allocation according to Voltage phase allocation.

If the phase allocation is wrong, the EMN will send incorrect energy data.

Refer to chapter 2.2.2 for more details about the phase allocation.

B Make sure that the arrow **(3)** shows the way of the [illegible]
In this case, the label **(6)** is facing the load.

This allows the EMN to calculate Active Energy with the right sign.

C Close the Current Transformer around the cable **(1)**.

D Use the mounting clip **(5)** to attach the Current Transformer on the cable **(4)**.

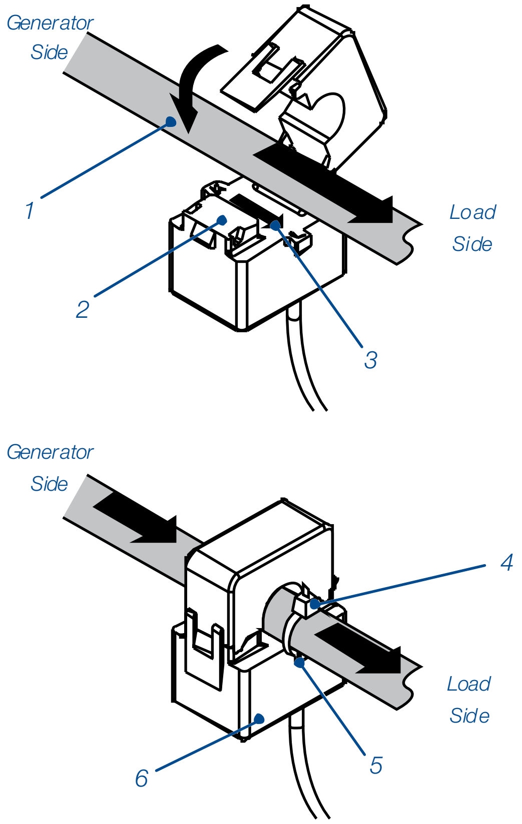


Fig. 3-11 : Current Transformer mounting

3.4.3.2 Rogowski coil

⚠ WARNING **IN ORDER NOT TO DRAMATICALLY DEGRADE THE ACCURACY, DO NOT STRESS THE COIL APPLYING ANY KIND OF MECHANICAL CONSTRAINT (TWISTING, PRESSING, PUNCHING, STRONG BENDING, ...)**

A Respect the Rogowski coil phase allocation according to Voltage phase allocation.

If the phase allocation is wrong, the EMN will send incorrect energy data.

Refer to chapter 2.2.2 for more details about the phase allocation.

B Make sure that the arrow **(3)** shows the way of the positive current flows from the generator to the load

This allows the EMN to calculate Active Energy with the right sign.

C Close the Rogowski **(2)** coil around the cable **(1)**

⚠ WARNING **ARROW INDICATING THE CURRENT DIRECTION MUST BE INSIDE THE LOOP (3) WHEN CLOSED AS SHOWN BESIDE**

*Be sure that the coil is well locked (fully inserted until the click is heard **(4)**) otherwise accuracy may be degraded.*

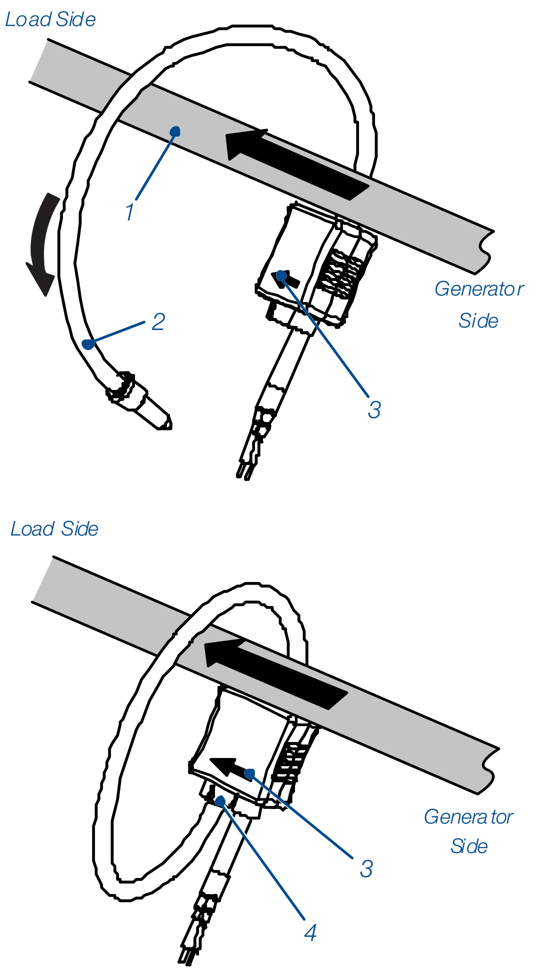


Fig. 3-12: Rogowski coil mounting

D The Rogowski coil can be let free around the cable / conductor and doesn't need to be attached.

The accuracy won't be affected more than 0.5%, as described within the datasheet, whatever the position of the coil around the conductor.

3.4.4 Voltage Input connection

⚠ WARNING FUSE OR CIRCUIT BREAKER MUST BE INSTALLED BETWEEN THE MAIN SUPPLY AND THE EMN FOR LINE PROTECTION. THE PROTECTION DEVICE MUST BE INSTALLED NEAR THE EMN, MUST BE EASILY ACCESSIBLE AND MUST BE IDENTIFIED AS PROTECTION UNIT OF THE EMN MODULE.

Use a protection with the following characteristics:

Table 3-1:

Protection range [A]	Wiring [mm^2]	Single fault condition Max trip time [ms]
6.3	1	30ms
10	1.5	30ms
16	2.5	30ms

⚠ DANGER MAKE SURE THAT THE WIRES YOU CONNECT TO THE VOLTAGE INPUT ARE POWERED OFF.

Refer to «Model Description» on Chapter 2 for more details about the Wiring Diagram of the Energy Meter Node.

3.4.4.1 Line powered EMN

A Connect the wires from the line to the right Input Voltage connecting points **(1)**.

Use 2.5 mm2 wire for single wire and 1 mm2 wire for 2 wires.

Use wire > 65°C temperature grade.

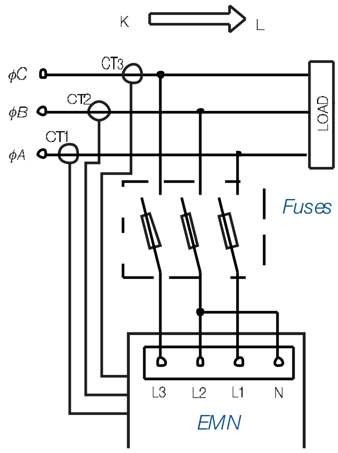


Fig. 3-13: Example of Fuse Holder connection

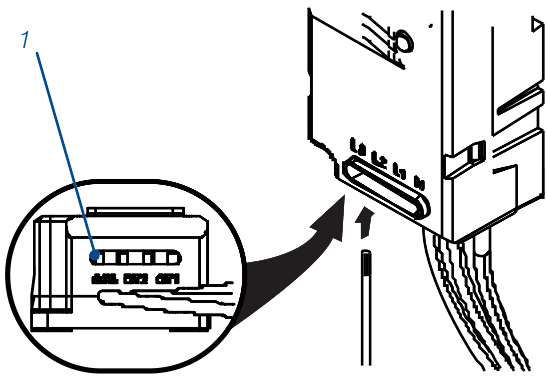


Fig. 3-14: Connecting the wires to the Input Voltage

3.4.4.2 24VDC powered EMN (SP2 models)

⚠ WARNING EMN MAY PRESENT DYSFUNCTIONS IF THE +/- 10% TOLERANCE AROUND 24 VDC IS NOT RESPECTED.

⚠ CAUTION THE 24 VDC POWER SUPPLY UNIT USED TO POWER THE EMN MODULE CANNOT BE USED IN THE SAME TIME TO SUPPLY OTHER DEVICES NEEDING SELV 24 VDC AND MUST BE KEPT INACCESSIBLE.

EXCEPTION: SEVERAL EMN MODULES CAN SHARE THE SAME 24 VDC POWER SUPPLY UNIT.

A Connect the 2 wires **(1)** to a 24VDC power supply:

Brown: +24VDC
Black: 0 VDC

B Connect the wire **(2)** to the earth/ground ⏚

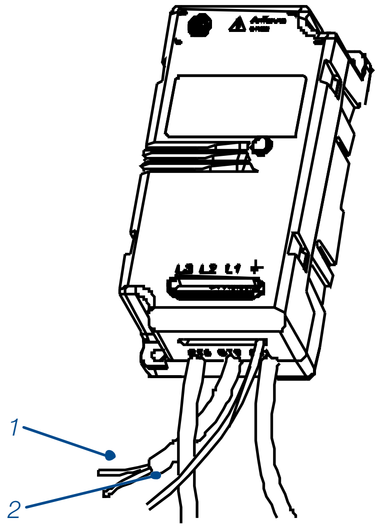


Fig. 3-15: Connecting the wires to the Input Voltage

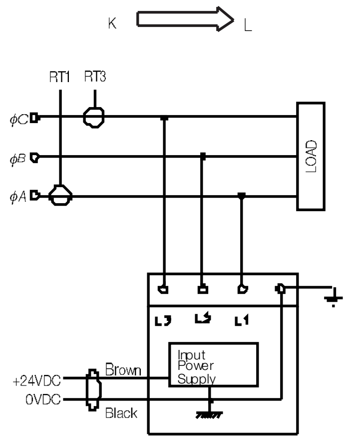


Fig. 3-16: Example of 24VDC connection

3.4.5. LED indicator description

The LED Indicator **(3)** has the following status on both models:

1 blink, wait 2 seconds:
Normal operation:

2 blinks, wait 1 second:
Radio module communication error: EMN is unable to send data.

3 blinks, wait 1 second:
Meter not synchronized to 50/60Hz: Frequency out of range of 50Hz - 10% to 60Hz + 10%.

4 blinks, wait 1 second:
Comm- & Synch error together:

5 blinks, wait 1 second:
Checksum Error: If a reset-meter command followed by an OFF/ON sequence does not reset this error, the calibration memory is corrupt and the device needs to be sent back to LEM.

6 blinks, wait 1 second:
Direct serial communication mode (factory use only).

7 blinks, wait 1 second:
Internal hardware failure.

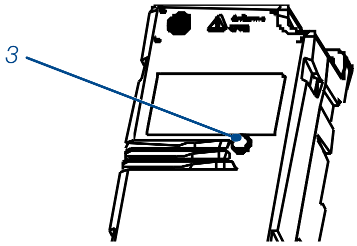


Fig. 3-17: LED indicator

3.5 Network commissioning

3.5.1 Modules Identification

Each module has two identification numbers: Group ID and Device ID, each defined by two bytes.

The Group ID and Device ID are printed on labels on:

- EMN front cover
- Mesh Node or Mesh Gate back side

All modules, including the Mesh Gate, must be set with same Group ID to communicate together on the same network. All parts are delivered from factory with default GID : 111.111

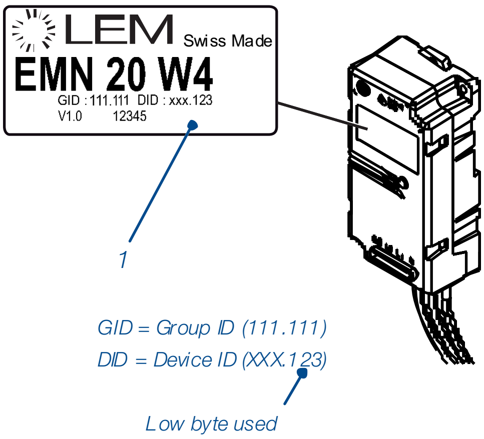


Fig. 3-18: ID labels

The nodes are already addressed at factory, respecting the following table:

Table 3-2:

Device Type	Device	High byte	Low Byte (Modbus address)
End Node Devices (high byte 1 - 159)	EMN	1 - 30	1 - 216
	Wi-Pulse	31 - 40	100 - 216
	Wi-IO	41 - 50	100 - 216
	Wi-Temp	51 - 60	100 - 216
	Wi-Zone	61 - 70	100 - 216
Mesh Node Devices (high byte 160 - 255, except 248 & 249)	reserved	160 - 209	1 - 216
	Mesh Node	240 - 247	217 - 246
Mesh Gate	Mesh Gate	160 - 255 (except 248 & 249)	247

⚠ WARNING THE DEVICE ID LOW BYTE IS ALSO THE MODBUS ADDRESS FOR THE MODULE. SO, THIS PARAMETER MUST ABSOLUTELY BE UNIQUE IN THE NETWORK BE ABSOLUTELY SURE TO HAVE ALL MODULES WITH A DIFFERENT ADDRESS BEFORE INSTALLING!

Considering the Mesh Gate, the Device ID high byte encodes the maximum number of nodes allowed in the network:

Table 3-3:

Mesh Gate ID high byte	Maximum number of nodes
170	10
200	100
220	200

⚠ WARNING BE SURE THE MESH GATE IS APPROPRIATE TO THE NETWORK (MAXIMUM NODES).

3.5.2 Mesh Gate connection

By default, the Mesh Gate is configured for **MODBUS** mode.

The network installation might need the MeshScape Monitor application which requires the Mesh Gate to be in **STANDARD** [illegible] **RS-232** at a baud-rate of **115200**, [illegible]

This **STANDARD** mode provides more information on the network status.

[illegible] **CONSOLE** interface. It can be used with any serial terminal such as **HyperTerminal** on Windows operating systems.

A Power on the Mesh Gate by plugging the **power supply adaptor 9V (1)**.

B Connect the **CONSOLE** (mini USB **(2)**) interface to the COM port of the computer (SUBD). Use cable ref.: 98.D2.98.008.0

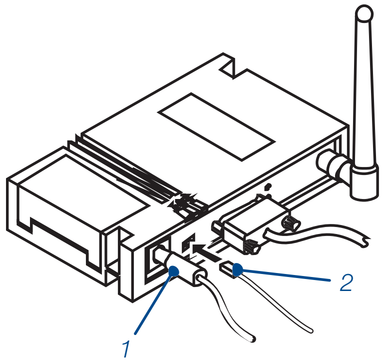


Fig. 3-19: Mesh Gate to PC connection

Table 3-4: Pin-out for the Mesh Gate terminal block

RS-485			PWR OUT		RS-232				PWR IN	
RTN	A	B	3.3V	GND	RTS	CTS	RX	TX	GND	+

The function of each Mesh Gate block pin is described as follows:

Table 3-5: Mesh Gate terminal block pin assignments

Pin	Label	Input / Output	Function
1	RTN	Reference	Reference connection for RS-485
2	A	I/O	RS-485 signal +
3	B	I/O	RS-485 signal -
4	3.3V	Output Power	3.3V Output power
5	GND	Power	Digital ground
6	RTS	Input	RS-232 Request to send
7	CTS	Output	RS-232 Clear to send
8	RX	Output	RS-232 Receive data
9	TX	Input	RS-232 Transmit data
10	N/A	N/A	Not used
11	GND	Power	Digital Ground
12	+	Power	Input power (4.5V to 30V)

3.5.2.1 Fixed CONSOLE port configuration

- Baud Rate 115200
- Data Bits 8
- Parity .... None
- Stop Bits 1
- No flow control

3.5.2.2 Standard or MODBUS modes selection

The HyperTerminal displays the message **"Starting SAG-Lite Mesh Gate Interface"**.

A Press **"ENTER"** to start the application.

B Press **"a"** to enter the **"Administration"** menu.

C Press **"a"** to change the Mesh Gate application.

- The **Standard (MACS)** needs to be set for use with the **MeshScape** network monitor.
- The **Modbus Data Logger** should be set for access to the **EMN in Modbus mode**.

D The Data Port setting for the **RS-232/RS-485** interface are accessed from the Administration menu, by pressing **"h"** for **"Configure Data Port"**.

Fig. 3-20: Mesh Gate Console Interface Main Menu

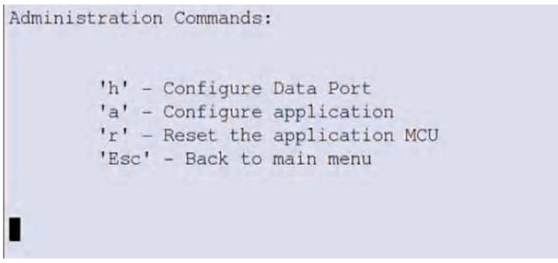


Fig. 3-21: Mesh Gate Console Interface Administration Menu

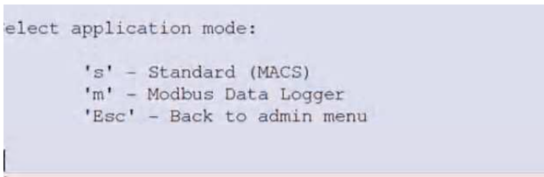


Fig. 3-22: Mesh Gate Console Interface Application Menu

3.5.2.3 Data port configuration (default RS-232)

DB-9 style connector:

RS-232 Data Port connector with standard DCE connections for transmit data, receive data, RTS input, and CTS output.

- Baud Rate 115200
- Data Bits 8
- Parity .... None
- Stop Bits 1

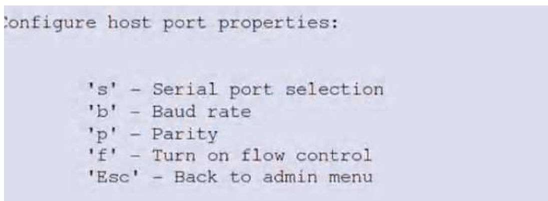


Fig. 3-23: Mesh Gate Console Interface Port Settings Menu

3.5.3 MeshScape Monitor

With the Mesh Gate switched to **Standard (MACS)**, the **MeshScape Monitor** software can be used to view the network.

1. Menu bar
2. Mesh Gate details
3. Network details
4. Mesh Node (MNEN symbol) and End Node (EN symbol) device list

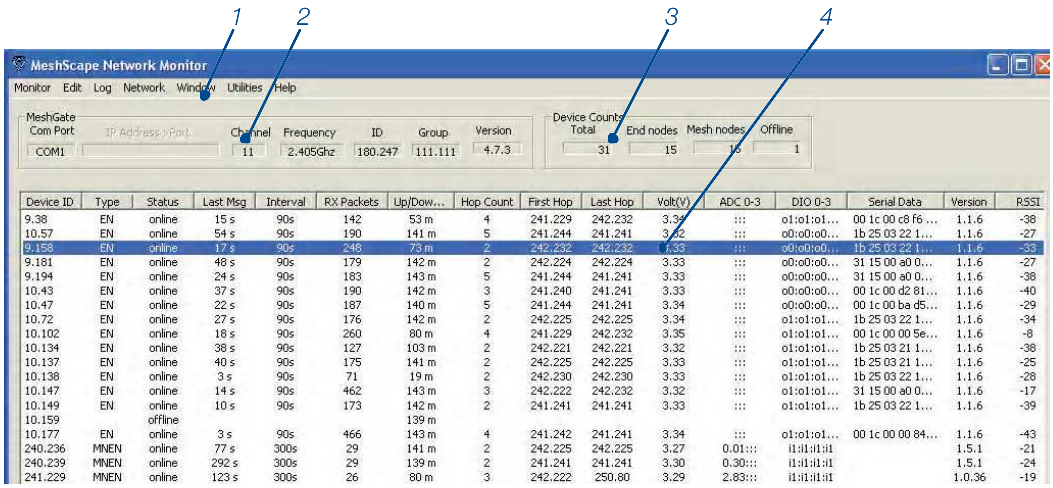


Fig. 3-24: MeshScape Monitor main screen

3.5.3.1 Network Initialisation and control

The network starts building itself once the Mesh Gate is powered on.

Depending on the physical topologies, a network may take up to 5 minutes to be formed.

- Each router (Mesh Node) or End Node (EMN, Wi-Pulse) that is powered on should be seen in the monitor application.
- [illegible] be doubled.
- RSSI (Received Signal Strength Information) can help to determine if the communication is too weak (value lower than –45) and so if additional Mesh Node is necessary
- If an End Node transducer is not “seen” by the Mesh Gate, verify the distance to the next Mesh Node / Mesh Gate and their locations. An additional Mesh Node should be placed between the EMN and the nearest Mesh Node.
- To verify the functioning of the EMN, observe the serial data of the corresponding line. At regular intervals there will be new data written.

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4. SOFTWARE INTERFACE

4.1 Introduction

This chapter describes the parameters and the registers available for software development.

Table 4-1 Modbus Register Map for all devices

Modbus Register	Description	Type / length	Storage	Unit	Access
201	Hop count	U16	V		R
202	First hop ID	U16	V		R
203	Last hop ID	U16	V		R
204	RSSI (MSB) & Supply voltage (LSB)	U16	V		R
220	Device ID (high byte and low byte)	U16	NV		R
221	Group ID (high byte and low byte)	U16	NV		R
222	Sampling interval	U16	NV		R
224	Network channel (11-26)	U16	NV		R
347	Device ID* (high byte and low byte)	U16	NV		W
348	Group ID* (high byte and low byte)	U16	NV		W
349	Sampling interval	U16	V		W
351	Network channel (11-26)	U16	NV		W

* *Before modifying any of both registers, refer to chapter 4.2.17*

4.2 Energy Meter Node

4.2.1 Modbus Register Table

[illegible]

Table 4-2 EMN Modbus Register Map

Modbus Register	Description	Type / length	Storage	Unit	Access
0	Active Energy Consumption, Phase 1 MSW	S32	NV	Wh	R
1	Active Energy Consumption, Phase 1 LSW		NV	Wh	R
2	Active Energy Consumption, Phase 2 MSW	S32	NV	Wh	R
3	Active Energy Consumption, Phase 2 LSW		NV	Wh	R
4	Active Energy Consumption, Phase 3 MSW	S32	NV	Wh	R
5	Active Energy Consumption, Phase 3 LSW		NV	Wh	R
6	Active Energy Consumption, Phase Sum MSW	S32	NV	Wh	R
7	Active Energy Consumption, Phase Sum LSW		NV	Wh	R
8	Reactive Energy Consumption, Phase 1 MSW	S32	NV	VARh	R
9	Reactive Energy Consumption, Phase 1 LSW		NV	VARh	R
10	Reactive Energy Consumption, Phase 2 MSW	S32	NV	VARh	R
11	Reactive Energy Consumption,Phase 2 LSW		NV	VARh	R
12	Reactive Energy Consumption, Phase 3 MSW	S32	NV	VARh	R
13	Reactive Energy Consumption, Phase 3 LSW		NV	VARh	R
14	Reactive Energy Consumption, Phase Sum MSW	S32	NV	VARh	R
15	Reactive Energy Consumption, Phase Sum LSW		NV	VARh	R

Modbus Register	Description	Type / length	Storage	Unit	Access
16	Apparent Energy Consumption, Phase 1 MSW	U32	NV	VAh	R
17	Apparent Energy Consumption, Phase 1 LSW		NV	VAh	R
18	Apparent Energy Consumption, Phase 2 MSW	U32	NV	VAh	R
19	Apparent Energy Consumption, Phase 2 LSW		NV	VAh	R
20	Apparent Energy Consumption, Phase 3 MSW	U32	NV	VAh	R
21	Apparent Energy Consumption, Phase 3 LSW		NV	VAh	R
22	Apparent Energy Consumption, Phase Sum MSW	U32	NV	VAh	R
23	Apparent Energy Consumption, Phase Sum LSW		NV	VAh	R
24	Energy Counter Timestamp, Min / Sec	U16	V		R
25	Energy Counter Timestamp, Day / Hour	U16	V		R
26	Energy Counter Timestamp, Year / Month	U16	V		R
27	Line Frequency	U16	V	Hz	R
28	Recording Interval Timestamp, Min / Sec	U16	V		R
29	Recording Interval Timestamp, Day / Hour	U16	V		R
30	Recording Interval Timestamp, Year / Month	U16	V		R
31	Recording Interval Active Energy, Phase 1	S16	V	Wh	R
32	Recording Interval Active Energy, Phase 2	S16	V	Wh	R
33	Recording Interval Active Energy, Phase 3	S16	V	Wh	R
34	Recording Interval Active Energy, Phase Sum	S16	V	Wh	R
35	Recording Interval Reactive Energy, Phase 1	S16	V	VARh	R
36	Recording Interval Reactive Energy, Phase 2	S16	V	VARh	R
37	Recording Interval Reactive Energy, Phase 3	S16	V	VARh	R
38	Recording Interval Reactive Energy, Phase Sum	S16	V	VARh	R
39	Recording Interval Apparent Energy, Phase 1	U16	V	VAh	R
40	Recording Interval Apparent Energy, Phase 2	U16	V	VAh	R
41	Recording Interval Apparent Energy, Phase 3	U16	V	VAh	R
42	Recording Interval Apparent Energy, Phase Sum	U16	V	VAh	R
43	Maximum Current in Interval, Phase 1	U16	V	A	R
44	Maximum Current in Interval, Phase 2	U16	V	A	R
45	Maximum Current in Interval, Phase 3	U16	V	A	R
46	Minimum Voltage in Interval, Phase 1	U16	V	V	R
47	Minimum Voltage in Interval, Phase 2	U16	V	V	R
48	Minimum Voltage in Interval, Phase 3	U16	V	V	R
49	[illegible] (current range, connection diagram)	U16	NV		R
50	Software Version (bits 8-15) Software Revision (bits 0-7)	U16	NV		R
51	Status Word	U16	NV		R
52	Command Word	U16	V		R/W
53	Recording Interval Time Setting	U16	NV	min	R/W
70	Zero Power Detection	U16	NV	LSB	R/W

Some networks parameters, general to any node, are also accessible through Modbus registers and are available for all Mesh devices.

Notes on table: NV: *Non-Volatile, restored after power-cycle;* **V:** *Volatile.* **S:** *Signed;* **U:** *Unsigned;* **R:** *Read;* **W:** *Write;*

4.2.2 Scaling factors

4.2.2.1 For EMN Line powered up to 300V_{rms}

Scaling Factor Table								
	Divide the result by:							
Current range	5A	20A	50A	100A	200A	500A	1000A	2000A
Active Energy Wh [Intvl]	64	16	6.4	3.2	1.6	0.64	0.32	0.16
Active Energy Wh [Counter]	8	2	0.8	0.4	0.2	0.08	0.04	0.02
Reactive Energy VARh [Intvl]	64	16	6.4	3.2	1.6	0.64	0.32	0.16
Reactive Energy VARh [Counter]	8	2	0.8	0.4	0.2	0.08	0.04	0.02
Apparent Energy VAh[Intvl]	64	16	6.4	3.2	1.6	0.64	0.32	0.16
Apparent Energy VAh[Counter]	8	2	0.8	0.4	0.2	0.08	0.04	0.02
V_{rms}	25	25	25	25	25	25	25	25
I_{rms}	1200	300	120	60	30	12	6	3
Frequency	16	16	16	16	16	16	16	16

Note on table: 5A and 50A models no longer used

4.2.2.2 For EMN/SP2 24 V_{DC} powered

Scaling Factor Table					
	Divide the result by:				
Current range	100A	200A	500A	1000A	2000A
Active Energy Wh [Intvl]	1.6	0.8	0.32	0.16	0.08
Active Energy Wh [Counter]	0.2	0.1	0.04	0.02	0.01
Reactive Energy VARh [Intvl]	1.6	0.8	0.32	0.16	0.08
Reactive Energy VARh [Counter]	0.2	0.1	0.04	0.02	0.01
Apparent Energy VAh[Intvl]	1.6	0.8	0.32	0.16	0.08
Apparent Energy VAh[Counter]	0.2	0.1	0.04	0.02	0.01
V_{rms}	12	12	12	12	12
I_{rms}	60	30	12	6	3
Frequency	16	16	16	16	16

Note on table: Intvl : *Interval*

4.2.3 Energy counters (register 0 to 26)

These objects contain the total consumed energy measured by the EMN. Writing the reset command to the command word resets the energy counters, the recording interval counters as well as the on-going interval accumulated values.

The time-stamp of the energy counters is written into the register when the data is sent to the gateway.

The energy counters will count positive for energy consumed, negative for energy generated and pushed into the grid.

Active, reactive and apparent energy consumption values are stored as 32-bit values, thus using 2 Modbus registers. The lower register address contains the high word (MSW), the higher register contains the low word value (LSW).

- Registers 0 to 26

Notes:
MSW: [illegible]
LSW: [illegible]

0	1
16-bits	16-bits
MSW	LSW

4.2.4 Recording Interval based energy (register 28 to 48)

[illegible]

[illegible]
The last completed interval values are stored in the register map.

The timestamp is set in the **Timestamp** Register at the end of the integration interval.

- Registers 28 to 48

4.2.5 Recording Interval Time (register 53)

The recording interval time is a **[illegible]** [illegible] **minutes**.

It can take the values 5, 6, 10, 12, 15, 20, 30.

The start of such an interval is at the hour + n* interval.

When writing a value other than the ones listed to this parameter it will be discarded and the EMN will continue to use the previous set value.

Not that the **Mesh Gate** will respond with an **"ACK"** to a write of a non-valid value as it **does not check** the contents of the message sent to the **EMN.**

When changing the interval time, the EMN will calculate the end of the next recording interval time while keeping the current interval measurements. This means that at the end of the Recording interval, the timestamp will be correct with [illegible] and thus should be discarded by the master application software.

4.2.6 Time-stamp

The **Time-stamp** of the energy counters and the recording interval have the same format using three Modbus registers.

Each of the registers is split into two parts as shown in the following table.

Register		High byte	Low byte
24	28	Minute	Second
25	29	Day	Hour
26	30	Year	Month

4.2.7 Frequency (register 27)

The **Line Frequency** is measured on the phase of the power supply only (phase 1).

Last value of the recording interval is kept in this register.

4.2.8 Maximum Current (register 43 to 45)

The rms current is averaged over 10 line periods (200ms in a 50Hz system). The maximum current average of the recording interval is kept in the register.

4.2.9 Minimum Voltage (register 46 to 48)

The rms voltage is averaged over 10 line periods (200 ms in a 50 Hz system). The minimum voltage value of the recording interval is kept in the register.

4.2.10 Model Configuration (register 49)

The **Model Configuration** [illegible]

Bit	Status Description
0,1,2	Connection
3,4,5,6	Current range
7,8,9,10	Reserved
11,12	Voltage range
13,14,15	Not used

Connection Diagram.

The connection diagram is encoded in bits **(2-0)**

Description	Model	Code [bits 2-0]	Number of Current Sensors
Wye 4-wires	W4	0 0 0	3
1-Phase 2-wires	W2	0 1 0	1
2-Phase 3-wires	W3	0 1 1	2
3 single Phase on same voltage	W0	1 0 1	3
Delta 3-wires	D3	1 1 1	2

Current Range

The nominal current value of the connected current sensors can be read from bits **[6-3]**.

Current Range	Code [bits 6-3]
5 A	0000
20 A	0010
50 A	0011
100 A	0100
200 A	0101
500 A	0110
1000 A	1000
2000 A	1010

Voltage range

The type of voltage range is encoded in bits **[12-11]**.

Voltage range	Code [bits 12-11]
Max. 300 V	00
Max. 520 V	01

4.2.11 Software Version (register 50)

The software version reflects the major release number of the LEM software

The MSB of this register contains the version number.

The LSB of this register contains the revision number.

4.2.12 Status Word (register 51)

The status of the EMN can be read from a read-only register

Bit	Status Description
0	Set when synchronized to 50/60Hz
1	Set if a checksum error has been detected at power-up
2,3,4,5,6,7	Not Used
8	Internal use only
9	Internal use only
10	Not Used
11	Internal use only
12	Internal use only
13,14,15	Not Used

4.2.13 Command Word (register 52)

The EMN is able to execute commands after a write to a command **word**, which is mapped to a **R/W** register.

Setting a bit in the command **word** executes the command.

Bit	Command
0	Reset Meter. This resets the device counters and the Interval counters
7	Place EMN in direct serial communication mode. Used during manufacturing. Do not place EMN in this mode, otherwise the EMN will not be able to communicate via radio module. If this is done, turn device OFF and ON again to reset the mode to normal radio communication
1,2,3,4,5,6,8,9,10,11, 12,13,14,15	Not Used / Ignored

Reset Meter

This command resets the energy counters to zero in both RAM and non-volatile RAM.

This command does not affect the reporting interval values.

Direct serial word

This able radio-communication to restore radio-communication mode, power cycle EMN (Switch OFF, then ON)

4.2.14 Zero Power Detection (register 70)

[illegible] be considered as noise measurement and to ensure that when there is no load on sensors, the EMN exactly counts 0.

[illegible]

1 LSB = 8.8 / Scaling factor for Intvl Energy (Watt).

For instance, considering a EMN-100 device.

1 LSB = 8.8 / 3.2 = 2.75 Watt and default power threshold is 8.25 Watt (3 x 2.75).

In case of 'No Load' detection, Active, Reactive, Apparent Energy registers and also Maximum Current registers are set to 0.

4.2.15 Hop count (register 201)

This register reports the number of network node hops taken by a packet delivered from the device to the MeshGate. A device with a hop count equals to 1 is communicating directly with the MeshGate.

For a greater hop count, the First Hop ID (reg. 202) and the Last Hop ID (reg. 203) report the device ID of respectively [illegible]

4.2.16 RSSI (register 204)

[illegible]

In general, RSSI value is a negative integer (a signed integer), and is represented in the high byte of Register 204 using 2's complements. The following table shows some examples of RSSI representation:

RSSI value	1st byte of register 204 in decimal	1st byte of register 204 in hex
-10	246	F6
-25	231	E7
-40	216	D8

Notes:
We would suggest RSSI segmentation as follows:
RSSI *> -20 strong*
-20 *> RSSI > -35 good*
-35 *> RSSI > -45 weak*
-RSSI *< -45 not acceptable*

The second byte of register 204 is the battery voltage raw data, which can be converted into voltage value in decimal as follows:

Battery Voltage = (1.225*1023.0)/(blRaw+344)

where blRaw is the raw value in decimal. For instance, a battery reading of 0x19 (2nd byte of register 204) would be 25 in decimal, then Battery Voltage = (1.225*1023) / (25+344) = 3.3961 V.

4.2.17 Device & Group ID

Device ID and Group ID can be directly read respectively in registers 220 and 221.

[illegible] (Device ID) and 348 (Group ID).

⚠ WARNING **ALWAYS WRITE TO BOTH REGISTERS 347 & 348 SIMULTANEOUSLY IN ONE WRITE MULTIPLE COMMAND. TO KEEP THE SAME VALUE IN EITHER REGISTER, USE 0X0000 IN WRITE COMMAND FOR THAT REGISTER.**

4.2.18 Network Channel

Network Channel can be read in register 224 and overwritten into register 351 by any value between 11 and 26.

⚠ WARNING **MODIFYING CHANNEL NUMBER MAY LEAD TO MAKE THE DEVICE INVISIBLE BY THE NETWORK.**

4.2.19 Sampling Interval

This interval time is the maximum period for hard bit to be sent by any node, if no data streams, in order to declare the device is still online. Value is given in tenths of seconds from 0 to 65535 (65535 = 109 minutes), read from register 222 and written into register 349.

EMN has default value of 30s (value 300 read back)

Notes: *Sampling Interval must be longer than Broadcast Interval (see chapter 4.5.5)*

4.3 Mesh Gate

4.3.1 Mesh Gate Register table

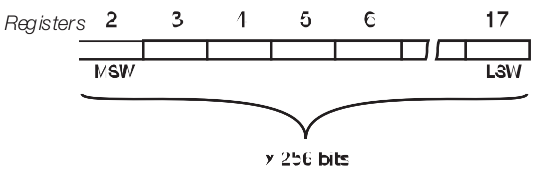
The registers hold information about the gateway as well as the MeshScape network

Modbus Register	Description	Type
0	Group ID	U16
1	Gateway Device ID (XXX.247)	U16
2 – 17	Active Endnode Device List Bit Map*	U16
18	Total online device count (MG, EN and EMN)	U16
19 – 20	UTC Time Stamp**	U16
21-36	Active Meshnode ID List Bit Map	U16
37-44	System Revision Number: eq. v1.1.x	ASCII

* Each bit of the 16 registers corresponds to a Modbus slave address. The Modbus address corresponds to bit number as follows:

Examples:

- EMN N° 25: register 16, bit 9 = 1
- EMN N°16: register 16, bit 0 = 1



** 32-bits value, R/W, Volatile MN and EMN will be synchronized with this value (MG)

Write the time value in this register

Mesh Gate UTC time registers: 19 (MSW) and 20(LSW). Concatenate to have a 32-bit UTC value

For * (Active Endnode Device List Bit Map) add the following:

[illegible]
(2 .. 17

and place them into an array (here, EMN_map[]). Them cycle through each bit and test it for "1" to see if it's online.

```
// read the meshgate data for EMN ids
read_gw_data ( );
for (i = 0 ; i < 16; i ++)          //  i is the bitmap register index
{
  for ( j = 0; j < 16 ; j ++ )      //  j is the bitmap bit index
  {    / / Test the bit
       if (( EMN_map [i] & (1 < < j ) )   ! = 0 ) / / EMN_map [ ] = regs 2 - 17 of the MG
       {
         [illegible]
         mbus_adr = 15 - i ) * 16 + j ;
         if (mbus-adr< 247)/ / only slave adr<247 are used by WILEM
         {
         ...
         }
  }
```

4.3.2 Read Device Identification

This **Read Device Identification** objects are listed below:

Object ID	Object Name / Description	Type	Max Byte Size	Value / Note
0x00	Vendor Name (GW only)	ASCII String	32 Bytes	"Millennial Net Inc."
0x01	Product Code (GW only)	ASCII String	16 Bytes	"RK-5424-XX"
0x02	Major Minor Revision (GW only)	ASCII String	16 Bytes	"v1.1.X"
0x03	Vendor URL (GW only)	ASCII String	32 Bytes	"www.millennial.com"
0x04	Product Name (GW only)	ASCII String	16 Bytes	"MeshScape"
0x05	Model Name (GW only)	ASCII String	16 Bytes	"5424"
0x06	User Application Name (GW only)	ASCII String	32 Bytes	"To be determined"

4.3.3 Setting of Mesh Gate Network Time

The Mesh Gate holds the reference time for the entire network.

Mesh Nodes and EMNs will synchronize their internal RTCs after power-up, then at periodic intervals (2-4 minutes).

The initial synchronisation can take up to 6 minutes. Depending on the network configuration (number of hops) from Mesh Gate to EMN.

The Mesh Gate is not equipped with a battery, so the internal time is not kept when power is removed. It is thus

necessary to set the Mesh Gate time immediately after power-up of the Mesh Gate.

The time drift according to Millenial is up to several seconds/day. Synchronizing the Mesh Gates time periodically with the Master-applications time is necessary.

⚠ WARNING **WHEN SETTING THE TIME IN THE MESH GATE, BOTH UTC REGISTERS NEED TO BE WRITTEN IN ONE COMMAND.**

The ongoing recording intervals in the EMNs will be disrupted by a change of the Mesh Gate time.

4.4 Network

4.4.1 Modbus Interface

The Wireless Mesh Network uses the Modbus RTU (Remote Terminal Unit) framing mode.

ASCII mode is not supported.

The gateway can act in two ways:

- Modbus Slave with Mesh Gate data
- EMN Slave proxy with EMN data

4.4.1.1 Mesh Gate Modbus slave

Indicate that this slave has adress 247 before the command list.

The following commands are known:

- Read Holding Registers (0x03)
- Write Multiple Registers (0x10)
- Read D[illegible]

4.4.1.2 EMN Modbus slave

The Mesh Gate responds to Modbus requests with Modbus slave addresses corresponding to a EMN. Available Modbus commands are:

- Read Holding Registers (0x03)
- Write Multiple Registers (0x10)

*Response of a write command will always be “**acknowledge**” response.*

To verify if a write command is successfull, poll the register that writtten to.

To the notice could be added the following:

From the Modbus Application Protocol:

Exception code 05 Acknowledge:

Specialized use in conjunction with programming commands.

The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occuring in the client (or master). The client (or master) can next issue a Poll Program Complete message to determine if processing is completed.

The format of this response is as follows:

EMN slave adr:	0xXX
Error code:	0x90
Exception code:	0x05
CRC_hi:	0xYY
CRC_lo:	0xZZ

4.4.2 Network Identification of EMN

Each of the EMNs has a unique **MeshScape 16-Bit ID** (DID) which is printed on the EMN in the form of **[High Byte].[Low Byte]**.

As the Modbus supports only 8-Bit addresses, only the **Low Byte** of the MeshScape address is used for Modbus communications.

4.4.3 Modbus Communication

For more information about Modbus protocol, see: **www.modbus.org**

The EMNs are seen as Modbus slaves through the Mesh Gate.

The maximum size of a **Modbus RTU** frame is 256 bytes.

A Modbus request has the following general format.

Description	Slave Address	Function Code	Request Data	CRC
Byte Count	1	1	4 (typical, see below)	2 (LSB I MSB)

4.4.3.1 Read Holding Registers (Function code 0x03)

Master Request Format

Description	Slave Address	Function Code	Request Data	CRC
Hex	0xID	0x03	0xXX ... 0x7D	0xLSB 0xMSB

Slave Request Format

Description	Slave Address	Function Code	Request Data	CRC
Hex	0xID	0x03	0xXX 0xYY	0xLSB 0xMSB

The following is a Modbus master read request packet. A request is referred to as a packet sent from the Modbus master application to the gateway slave. This has a function code value of 0x03.

The **Request Data** includes a 2 byte starting address offset value and a 2 byte length value specifying the length of data to be returned in a 16 bit word (number of Holding Registers, 1 to 125 (0x7D).

4.4.3.2 Examples

Read the frequency from EMN with ID 63

- Modbus address 0x3F
- Starting register ....0x1B (register 27 decimal)
- Length..0x01

```
[3F 03 00 1B 00 01 F0 D3]
```

Read all IRMS and URMS values from EMN with ID 63

- Modbus address 0x3F
- Starting register ....0x2B (register 43 decimal)
- Length..0x06

```
[3F 03 00 2B 00 06 B1 1E]
```

4.5 Software utilities

4.5.1 Addressing a Node

All devices communicating in the same Mesh network must have the same Channel number (same frequency), same Group ID and a different address given by the device ID low byte. They are delivered from factory with default Channel number 11 and Group ID 111.111

The nodes are also already addressed at factory.

However, in a existing network, it can be necessary to change the address of the node if the same address is already set to another device.

Most often, this is the only parameter you may need to change (refer to chapter 4.5.4).

4.5.2 Managing several Mesh networks

[illegible] case, each network must be isolated and in order to prevent cross-talk between the networks, they should have:

- different Group ID and different channel;
- different Device IDs for all devices in the site; particularly, Mesh Gate and Mesh Node devices must have unique ID. So, regarding the Mesh Gate, this can imply to change the ID high byte (as low byte is always 247) by adding +1. [illegible] 192.247, and so on ….

If the Group ID [illegible] with MeshScape Monitor (see chapter 4.5.4). Keep in mind the devices must communicate with the Mesh Gate (declared online) to be updated.

At the very end, change the Mesh Gate Group ID with MeshScape Programmer tool (refer to chapter 4.5.5).

If the network channel must be changed, thanks to the agility capability for all MeshScape devices, this parameter requires to be reprogrammed only for the Mesh Gate. All Slave devices (Mesh Nodes and End Nodes) will then scan for Mesh Gate and synchronize on same frequency.

4.5.3 Channel choice

If Meshscape wireless devices share radio space with other wireless networks around 2.4 GHz, it may be required to modify the default channel number.

Note: Thanks to the agility capability for all MeshScape devices, you only need to modify this parameter for the Mesh Gate. All Slave devices (Mesh Nodes and End Nodes) will then sacn for Mesh Gate and synchronise on the same channel.

⚠ WARNING CHANGING THE CHANNEL OF A WHOLE NETWORK BY USING THE CHANNEL AGILITY CAPABILITY MAY TAKE SEVERAL MINUTES BEFORE THE COMPLETE SYNCHRONIZATION, ACCORDING TO NETWORK SIZE AND TOPOLOGY.

4.5.4 Node Device ID & Group ID change

Modifying Node Device ID and Group ID can be performed with MeshScape Monitor (see §3.5.3)

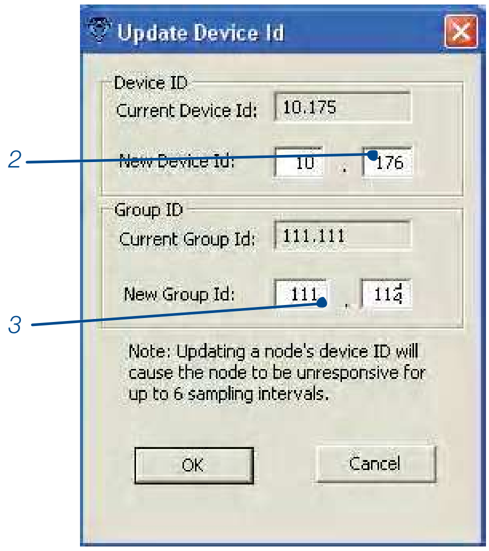


Fig. 4-1: Update Device ID

A Select **Utilities,** then the command "**Update Network Identity**".

The window beside is displayed.

B Enter the new ID [illegible] (**2**).

C Enter the new Group ID [illegible] (**3**) if required.

⚠ WARNING GROUP ID MODIFICATION MUST BE DONE WITH SPECIAL CARE, ONLY IF REQUIRED: MODIFYING THE GROUP ID OF A NODE WILL THEN MAKE IT INVISIBLE ON THIS NETWORK.

4.5.5 Reprogramming Group ID, Device ID and Channel on Mesh Gate

- A Connect the console cable between PC port com and Console port on MeshGate
- B Launch MeshScape Programmer
- C Select **MeshGate RF** [illegible] **(1)**; check the right programming port COM.
- D First, **unselect** everything in the Program Flash section.
- E To reprogram the Group ID, in Group & Device ID section, select Enable, then enter new Group ID [illegible] **(2)**. Take care that the Device ID. [illegible] **(4)**.
- F To reprogram the Radio Channel number, in **Radio Configuration** section, select Enable then select the new selected [illegible] **(3)**. Let the Channel Search Agility Enable.
- G Select **Get Device Type** in Programming section then click **Program** button.

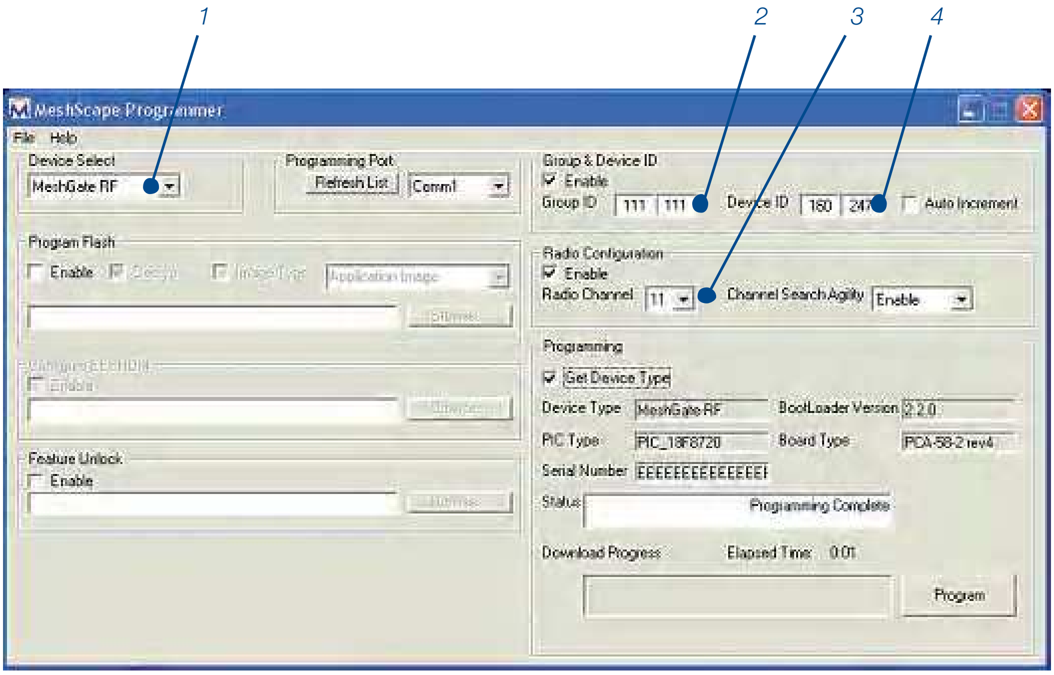


Fig. 4-2: MeshScape Monitor Programmer screen

4.5.6 Broadcast and Sampling Interval

4.5.6.1 Introduction

Considering the RF communication, by default, EMN module sends a packet every 20 seconds. As 3 packets are required to update all Modbus registers, then you get information refreshed every minute.

Now, in case of large network or network with bottleneck, if this interval, time between two packets transmission, is too [illegible]

The minimal interval time, in seconds, can be calculated using following formula, **valid for worst case situation:**

Min Interval (sec) = 2 x MN + EN

Notes

MN: *Amount of Mesh Node modules*

EN: *Amount of End Node modules (EMN, Wi-Pulse, ...)*

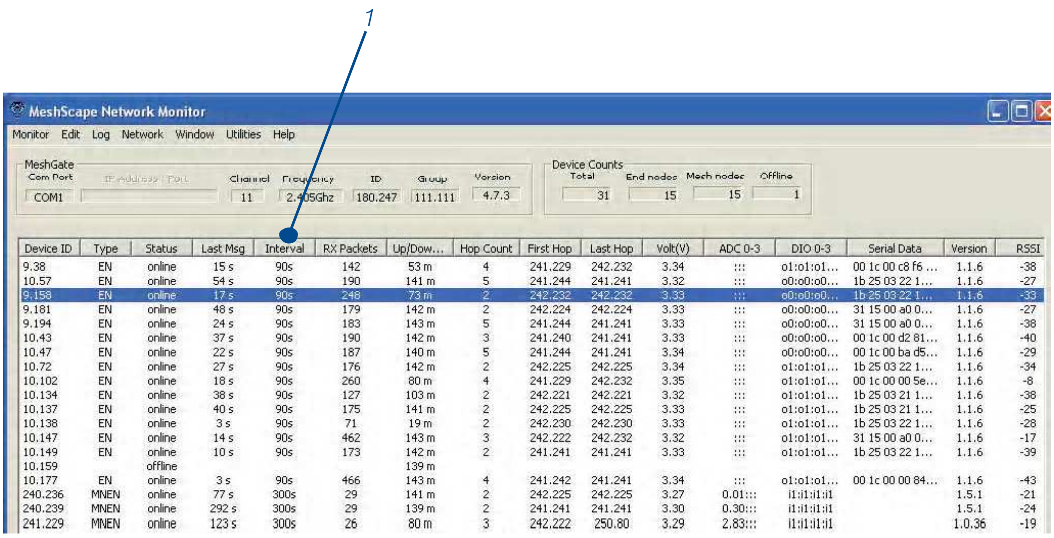
In a suitable environment, as a Star Mesh Network topology, this result can be slightly reduced.

This parameter, called Broadcast interval, is saved in EEPROM.

The End Node sub-module from Millenial has its own interval time, called Sampling interval, which is the maximum period for hard bit to be sent, if no data streams, in order to declare the device is still online.

This value must be higher than the broadcast interval, previously calculated. By default, it is set to 30 seconds for EMN module.

This parameter is reported in Interval row (1) by MeshScape Network Monitor but is written in RAM only, so you need to rewrite it in case of shutdown. Best solution is the application to periodically overwrite this value.



Device ID	Type	Status	Last Msg	Interval	RX Packets	Up/Dow...	Hop Count	First Hop	Last Hop	Volt(V)	ADC 0-3	DIO 0-3	Serial Data	Version	RSSI
9.38	EN	online	15 s	90s	142	53 m	4	241.229	242.232	3.34	:::	o1:o1:o1...	00 1c 00 c8 f6 ...	1.1.6	-38
10.57	EN	online	54 s	90s	190	141 m	5	241.244	241.241	3.32	:::	o0:o0:o0...	1b 25 03 22 1...	1.1.6	-27
9.158	EN	online	17 s	90s	248	73 m	2	242.232	242.232	3.33	:::	o0:o0:o0...	1b 25 03 22 1...	1.1.6	-33
9.181	EN	online	48 s	90s	179	142 m	2	242.224	242.224	3.33	:::	o0:o0:o0...	31 15 00 a0 0...	1.1.6	-27
9.194	EN	online	24 s	90s	183	143 m	5	241.244	241.241	3.33	:::	o0:o0:o0...	31 15 00 a0 0...	1.1.6	-38
10.43	EN	online	37 s	90s	190	142 m	3	241.240	241.241	3.33	:::	o0:o0:o0...	00 1c 00 d2 81...	1.1.6	-40
10.47	EN	online	22 s	90s	187	140 m	5	241.244	241.241	3.34	:::	o0:o0:o0...	00 1c 00 ba d5...	1.1.6	-29
10.72	EN	online	27 s	90s	176	142 m	2	242.225	242.225	3.34	:::	o1:o1:o1...	1b 25 03 22 1...	1.1.6	-34
10.102	EN	online	18 s	90s	260	80 m	4	241.229	242.232	3.35	:::	o1:o1:o1...	00 1c 00 00 5e...	1.1.6	-8
10.134	EN	online	38 s	90s	127	103 m	2	242.221	242.221	3.32	:::	o1:o1:o1...	1b 25 03 21 1...	1.1.6	-38
10.137	EN	online	40 s	90s	175	141 m	2	242.225	242.225	3.33	:::	o1:o1:o1...	1b 25 03 21 1...	1.1.6	-25
10.138	EN	online	3 s	90s	71	19 m	2	242.230	242.230	3.33	:::	o1:o1:o1...	1b 25 03 22 1...	1.1.6	-28
10.147	EN	online	14 s	90s	462	143 m	3	242.222	242.232	3.32	:::	o1:o1:o1...	31 15 00 a0 0...	1.1.6	-17
10.149	EN	online	10 s	90s	173	142 m	2	241.241	241.241	3.33	:::	o1:o1:o1...	1b 25 03 22 1...	1.1.6	-39
10.159		offline				139 m									
10.177	EN	online	3 s	90s	466	143 m	4	241.242	241.241	3.34	:::	o1:o1:o1...	00 1c 00 00 84...	1.1.6	-43
240.236	MNEN	online	77 s	300s	29	141 m	2	242.225	242.225	3.27	0.01:::	i1:i1:i1:i1		1.5.1	-21
240.239	MNEN	online	292 s	300s	29	139 m	2	241.241	241.241	3.30	0.30:::	i1:i1:i1:i1		1.5.1	-24
241.229	MNEN	online	123 s	300s	26	80 m	3	242.222	250.80	3.29	2.83:::	i1:i1:i1:i1		1.0.36	-19

Fig. 4-3: MeshScape Network Monitor screen

4.5.6.2 Reprogramming procedure

[illegible]

Remind:

Available Modbus commands are:

- Write Multiple registers (function code 0x10)
- Read Holding registers (function code 0x3).

They must be sent with Modbus Slave addresses corresponding to the EMN ID.

You must modify this setting for each EMN installed in the Mesh network.

A Set broadcast interval value (seconds) in register #297 (0x3c = 60 sec).

Wait until this value has been updated (same register).

B Set sampling interval value in tenth of seconds (900 or 0x384 for 90s) in register #349.

Read back this value in register #222.

Note: For EMN software releases prior to V2.0, register #297 is protected and EMN device requires to receive a pas- [illegible] by polling this register. EMN software version is printed on the front label and can be read from Modbus register #50.

5. COMPLEMENTARY PRODUCTS

Several wireless products have been developed by Millenial and can be added in the Mesh network in order to complete measurements of different parameters:

- **Wi-Pulse** Pulse Metering
  Wi-Pulse is used to wirelessly monitor and communicate pulse-output signals from meters such as water and fuels.
- **Wi-Zone** Temperature and Relative Humidity Metering
  Internal and external temperature and relative humidity sensing is provided by Wi-Zone.
- **Wi-Stat*** Thermostat
  [illegible]
  The Wi-Stat combines a local thermostat as an user friendly interface for occupants, and a wireless supervisory thermostat, enabling remote monitoring and energy policy enforcement.
- **Wi-Temp*** Relative Temperature Sensing
  Wi-Temp measures temperature conditions in various commercial, residential and industrial environments.
- **Wi-IO*** General Input/Output Metering
  Wi-IO is used as a general purpose device to monitor and control a wide variety of analogue, digital and serial input and/or outputs.

** For these products, please contact LEM for availibility.*

In battery powered end nodes, actual battery pack might obstruct the radio signal. If you are using such devices in your network, always consider position of the battery pack in relation to radio signal path.

1. **Radio antenna**
2. **Battery pack**

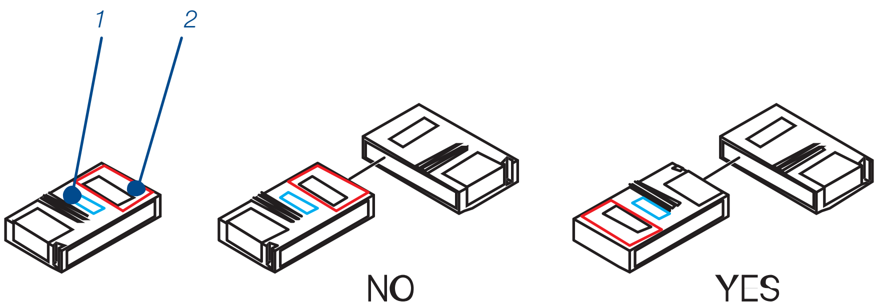


Fig. 5-1: RF link and battery pack position

5.1 Wi-Pulse

5.1.1 Description

1. Counter #1 (RJ14)
2. Counter #2 (RJ14)
3. Alternative source power
4. Includes 3x AA alkaline batteries

Wi-Pulse requires a specific tool to remove the four screws on backside in order to replace the batteries pack.

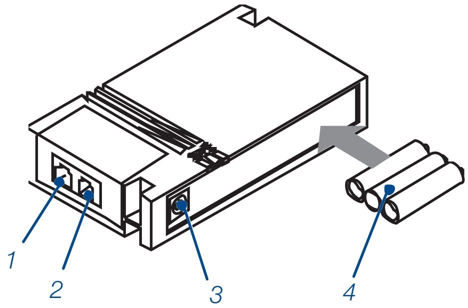


Fig. 5-1: Wi-Pulse

Wi-Pulse is a dual input pulse counter which has been designed with Wi-LEm concept in order to be compliant with existing EMN product. In particular, Wi-Pulse is able to provide 2 types of registers:

- **Counter register:** to accumulate pulses from first power on and end of life of the Wi-Pulse.
- **Interval register:** to accumulate pulses during a given and settable (5,6,10,12,15,20 and 30 minutes) interval of time.

When the module is powered with internal battery, the PWR LED is only ON during "a short time" when the module is switched ON (internal ON/OFF switch under the lift-off cover), then all LEDs are OFF.

When the unit is line powered, detection is automatically done and the PWR LED is permanently ON; the STS and ACT LEDs behavior is as follows.

- **One parent (one route to Mesh Gate):** STS ON
- **Two parents (or more):** both STS and ACT ON
- **No parent (no communication with Mesh Gate):** STS and ACT OFF.

5.1.2 Modbus Register Table

Modbus Register	Description	Remarks	R/W
28	Date time stamp minutes (MSB) and seconds (LSB)	Time stamp in data packet is converted into wall time by MeshGate and stored.	
29	Date time stamp day (MSB) and hour (LSB)		
30	Date time stamp year (MSB) and month (LSB)		
160	Cumulative Pulse count (high 16-bit) for meter #1	Pulse count stored in two registers; reset by writing 0xAA00 in register 364	R
161	Cumulative Pulse count (low 16-bit) for meter #1		R
162	Cumulative Pulse count (high 16-bit) for meter #2	Pulse count stored in two registers; reset by writing 0x00AA in register 364	R
163	Cumulative Pulse count (low 16-bit) for meter #2		R
164	Pulse count per interval for meter #1	[illegible] 166	R
165	Pulse count per interval for meter #2		
166	Data reporting & accumulation interval (wall time synchronized)	This register stores data reporting interval in minutes; this is also the interval for pulse accumulation with available values: 1 (5 min), 2 (6 min), 3 (10 min), 4 (12 min), 5 (15 min), 6 (20 min), 7 (30 min), 8 (1 min). Write value to register 363.	R
204	RSSI (MSB) & Supply voltage (LSB)	First byte stores RSSI (signed 8 bit, using 2's complement); second byte stores supply voltage BIRaw then Volt (V)=(1.225*1023)/(BIRaw+344) For more details, see chapter 4.2.16	R
363	Data reporting & accumulation interval (wall time synchronized)	This register stores data reporting interval in minutes; this is also the interval for pulse accumulation with available values: 1 (5 min), 2 (6 min), 3 (10 min), 4 (12 min), 5 (15 min), 6 (20 min), 7 (30 min), 8 (1 min). Read value back from register 166.	W
364	Cumulative counter reset for meters #1 & #2	0xAA00 resets meter #1 cumulative pulse counter 0x00AA resets meter #2 cumulative pulse counter [illegible] [illegible]	W/R

5.2 Wi-Zone

5.2.1 Description

1. **Sensor location**
2. **Alternative source power**
3. **Includes 3x AA alkaline batteries**

Wi-Zone requires a specific tool to remove the four screws on backside in order to replace the batteries pack.

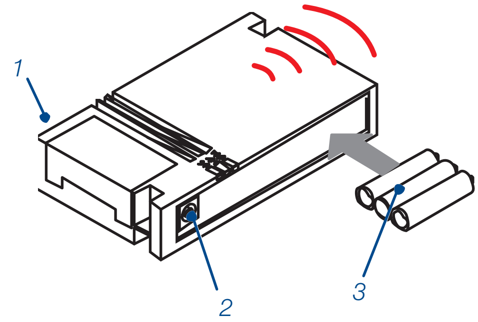


Fig. 5-2: Wi-Zone

Wi-Zone measures local temperature and relative humidity and is compliant to other Mesh products, with EMN format time stamp.

When the module is powered with internal battery, the PWR LED is only ON during "a short time" when the module is switched ON (internal ON/OFF switch under the lift-off cover), then all LEDs are OFF.

When the unit is line powered, detection is automatically done and the PWR LED is permanently ON; the STS and ACT LEDs behavior is as follows.

- One parent (one route to Mesh Gate): STS ON
- Two parents (or more): both STS and ACT ON
- No parent (no communication with Mesh Gate): STS and ACT OFF.

5.2.2 Modbus Register Table

Modbus Register	Description	Remarks	R/W
28	Date time stamp minutes (MSB) and seconds (LSB)	Time stamp in data packet is converted into wall time by Mesh Gate and stored.	R
29	Date time stamp day (MSB) and hour (LSB)		
30	Date time stamp year (MSB) and month (LSB)		
107	Wi-Zone temperature	This register stores the temperature; the value corresponds to current temperature, in °F, multiplied by 10.	R
108	Wi-Zone humidity	This register stores the percentage of measured relative humidity, multiplied by 10; e.g 300 means 30% relative humidity.	R
204	RSSI (MSB) & Supply voltage (LSB)	First byte stores RSSI (signed 8 bit, using 2's complement); second byte stores supply voltage BIRaw then Volt (V)=(1.225*1023)/(BIRaw+344) For more details, see chapter 4.2.16	R

LEM

6. TROUBLESHOOTING

Detected problems	Causes	Solution
No communication (MeshScape Monitor)	EMN or Mesh Node powered off	Check external power for Mesh Node and L1 powered for EMN
	EMN blinking twice and/or Mesh Node LED "STS" OFF	Check same GID for all modules. Add Mesh Node or move existing ones. Check [illegible]
Communication OK but EMN blinking 3 times	EMN not synchronized to 50/60 Hz	Check L1 line at EMN input: frequency (45-65) Hz and voltage above $70V_{rms}$
Network instability (Modules appear & disappear)	[illegible] number of EMN and Mesh Node	Increase the EMN broadcast/sampling interval Min Intl (sec) = 2 * MN + EN
	External RF perturbation (other network)	Try to relocate Mesh network far from the perturbation or if not possible use a different radio channel
Strange / wrong data (Modbus application)	Nodes (EMN, MN) with same ID	Change Device ID
	EMN installation	Voltage connection missing or wrong phases allocation
	Software interface	Check applied scaling factors
Counter values stuck	Intermittent communication loss	[illegible] communication loss but no more consumption
Spurious Counter values to 0	Mesh Gate register reset (if no Modbus access during 30 min.)	Don't consider Null value from counters in Energy calculation (difference)
Negative active energy on Intl registers or decrementing for counters	Current transducer or Rogowski coil mounted in the wrong direction	On both modules, the arrow indicates the current [illegible]
Negative reactive values	Can be normal as Q (VAR) = U_{eff} I_{eff} sin φ, φ current / voltage dephasis	sin φ < 0 if capacitive load sin φ > 0 if inductive load sin φ = 0 if pure resistive load

⚠ WARNING **IN CASE OF ESTABLISHED FAILURE OF THE EMN MODULE ONLY LEM'S ASS (AFTER SALES SERVICE) IS AUTHORIZED TO REPAIR IT.**

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7. EMN SOFTWARE RELEASE NOTE

Software release	Issue description	Workaround	Bug fixed with release
EMN_CT V1.0 EMN_RT V1.1	Communication from EMN locked: data streams not refreshed (very rarely)	Resetting EMN (power cycle) or sending a command as writing Recording Interval Time register #53, unlocks communication	EMN_CT V1.02 EMN_RT V1.11
EMN_CT V1.0, V1.02 EMN_RT V1.1, V1.11	Wrong date stamp (day +1) every year following a leap year	Correction might be done by the application software. Contact LEM Support for more details on procedure.	V2.0
V2.0			

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8. GLOSSARY AND SYMBOLS

- **EMN** Energy Meter Node
- **RTC** Real Time Clock
- **UTC** Coordinated Universal Time. Number of seconds passed since 1.1.1970
- **Mesh Gate** Millennialnet gateway that controls the RF network and provides a serial interface for the customer.
- **Mesh Node** Millennialnet RF router/repeater
- **End Node / Node** Millennialnet RF communication module integrated in the EMN
- **Hop Count** Number of network node hops taken by a packet delivered from a node to the Mesh Gate.

  For example: End Node — Mesh Gate = 1 hop,

  End Node — Mesh Node — Mesh Gate = 2 hops

  (each additional Mesh Node will add another hop).

- **Modbus** Communications protocol using RS-232/RS-485 used by the Mesh Gate.
- **SELV** Safety Extra Low Voltage
- Equipment protected throughout by double isolation or reinforced isolation.
- **CAT III** Measurement category III is for measurements performed in the bulding installation.
- «Caution, risk of danger» Documentation must be consulted in all cases where this symbol is marked
- Caution, risk of electrical shock
- Do not installed or removed on conductors carrying hazardous 12 V
- Earth (ground)
- Direct current

[illegible]