User's Guide

MC-MNR 5G Router

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Made in Germany

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1 INTRODUCTION

Thank you for choosing an MC Technologies product.

1.1 PURPOSE OF THE MANUAL

This document provides comprehensive instructions for the installation, operation, and maintenance of the 5G Router MC-MNR. It aims to ensure that users can effectively utilize the device while adhering to all relevant safety and regulatory standards.

1.2 TARGET AUDIENCE

This manual is intended for users who will be installing and operating the 5G Router MC-MNR in various environments, including vehicles, offices, machinery, and control cabinets. It assumes that the reader has basic technical knowledge and skills, but no special training or qualifications are required to follow the instructions provided.

1.3 OVERVIEW OF THE DEVICE

The 5G Router MC-MNR is a high-performance, Linux-based router designed for M2M (Machine-to-Machine) and industrial IoT (Internet of Things) applications. It integrates several advanced technologies to provide robust connectivity and reliable performance in various industrial and commercial environments. Key features include:

- **5G Technology**: Provides high-speed, low-latency connectivity for demanding applications.
- **LTE Support**: Ensures reliable connectivity in areas where 5G coverage is not available.
- **Wifi 2.4 GHz**: Offers wireless networking capabilities for local area connections.
- **GNSS Receiver**: Provides precise location tracking and navigation capabilities.

The MC-MNR is equipped with an industrial-grade RK3568 quad-core ARM Cortex-A55 processor, delivering outstanding performance per watt for embedded industrial IoT gateway and edge computing solutions. Its integrated GPU and 1 TOPs@INT8 NPU make it future-proof for advanced multimedia processing and machine learning frameworks, essential for applications such as robotics control, real-time diagnostics, surveillance, and image recognition.

2 VARIANTS

As an OEM, MC Technologies may produce variants of the MC-MNR deviating from the variants listed herein. For the basic variants model-specific information may be found in dedicated appendices on our website:

mc-technologies.com/service-support/download

In case, your model is not listed there, please contact your supplier for the correct user's guide.

2.1 BASIC FEATURES

All MC-MNR basic variants possess the following features:

- 2 x M.2 mPCIe extension slots (can be equipped to e.g. operate two 4G/5G network cards in parallel for increased availability)
- 2.4 GHz WiFi
- Externally accessible USB 3.0 port
- High precision GNSS
- 4 x Digital Input, 4x Digital Output
- 2 x Current-sense ADC (4...20 mA)
- 2 x Voltage-sense ADC (0...30 V)

2.2 PRODUCT MATRIX

This product matrix outlines the basic variants of models:

Interface	MNR-5GA 194110	MNR-5G 194174	MNR-450 194175	MNR-DLTE 194176	MNR-LTE 194177
M.2 Slot	5G	5G	–	4G	4G
mPCIe Slot	4G	–	450 MHz	4G	–
Ethernet RJ45	2x	2x/4x	2x/4x	2x/4x	2x/4x
Ethernet M12	2x	–	–	–	–
Audio	✓	–	–	–	–
Datasheet	MNR-5GA	MNR-5G	MNR-450	MNR-DLTE	MNR-LTE

3 WARRANTY PROVISIONS

Unauthorized use, non-observance of this documentation, the operation or maintenance by insufficiently qualified persons, and unauthorized modifications exclude the manufacturer's liability for resulting damages. Any modification to the device will void the manufacturer warranty. The provisions of our General Terms of Sale (AGB) apply. These can be found on our website:

https://mc-technologies.com/en/agb-aeb

3.1 LIMITATION OF LIABILITY

The manufacturer and seller are not liable for damages caused by improper use, installation or maintenance. This includes consequential damage, personal injury, damage to property and damage caused by failure to observe the safety instructions. This exclusion of liability does not affect the statutory warranty claims. Liability is assumed for material and manufacturing defects within the statutory warranty period.

3.2 APPROVED ACCESSORIES

This device must only be operated with suitable accessories approved for the appliance.

3.3 INSPECTION FOR DAMAGES

Check the device and all components for damages or anomalies before use. Do not use the appliance if it is damaged or shows signs of wear. Make sure that all cables are in a good condition. The appliance must not be used if cables or plugs are damaged.

3.4 TECHNICAL LIMITS

The product is exclusively intended for use within the technical limitations and maximum ratings specified in this document. The following limitations must be observed in particular:

- The ambient temperature must not be exceeded or dropped below limits.
- The maximum air humidity must not be exceeded, and condensation must be avoided.
- The supply voltage must be within limits and maximum input ratings must not be exceeded.
- The maximum switching voltage and current must not be exceeded.

4 SAFETY INSTRUCTIONS

These instructions enable the safe and efficient handling of the product. The instructions are an integral part of the product and must always be kept accessible to installation, maintenance, commissioning, and operating persons.

The safety and maintenance instructions must be strictly followed to ensure safe operation of the product. Only the consideration of all safety guidelines ensures protection of persons and the environment against hazards and the safe and trouble-free operation of the product.

General safety regulations and local guidelines for the area of application of the device as well as for the prevention of accidents along with procedures and operation instructions with safety-critical information must be followed strictly.

4.1 OBLIGATIONS OF THE OPERATOR

The operator must follow regional regulations regarding the operation, functional testing, repair and maintenance of electronic devices at all times.

4.2 QUALIFICATION OF INSTALLERS

Installation and maintenance of the product may only be carried out by trained authorised installers which possess the necessary levels of qualification to ensure safe maintenance and operation. The qualified installer must have read and understood this documentation and follow its guidelines and instructions. This product may only be operated by or under the supervision of trained persons.

4.3 GUIDELINES FOR TRANSPORT AND STORAGE

- Do not expose the product to moisture or other potentially harmful environmental conditions (radiation, gases, etc.) during transport or storage
- Protect the product from shocks during transport and storage (e.g. by using air-cushioned packaging)
- Before installing the product, check for damages caused by improper transport or storage. Damage in transit must be noted on the shipping documents. All claims for damages must be made immediately and before being handed to the carrier or company responsible for the storage or logistics respectively.

5 ELECTRIC SAFETY

5.1 ELECTRIC SAFETY REQUIREMENTS

Electrical installation, maintenance and commissioning of products operated with high or low voltage (>= 50 V AC or >=120 V DC respectively) may only be carried out by persons who, due to their specialist training, knowledge and experience including knowledge of the relevant standards and regulations, are authorized to carry out work on electrical systems and independently detect and avoid possible hazards e.g. as described in VDE 1000-10.

The electrical installation must be conducted in line with all applicable standards and regulations such as VDE 0100-200 and VDE 0105-100 while considering necessary safety requirements such as DIN VDE 0100-410. The electrical installation must only be operated when defect-free and after testing using a recognized examination procedure like VDE 0100-600 / IEC 60364-6, with all necessary safety measures in place before operation.

Equipment must be inspected immediately after installation, expansion or any other change e.g. according to DIN EN 50699 (VDE 0702). The inspector must be qualified for inspection as e.g. described in TRBS 1203 to perform inspections and determine the inspection intervals through a risk assessment process. The resulting inspection report must be archived. Equipment passing the inspection should be marked by an inspection sticker summarizing the results and showing the next due date.

5.2 ELECTRIC SAFETY PRECAUTIONS

- The appliance needs to be switched off before connecting it to the mains
- Improper installation can lead to electric shocks, short circuits or fires
- The cabling must be suitable e.g. according to DIN VDE 0100-520
- The supplying electric installation must be equipped with a residual-current device (RCD)

6 PRODUCT CARE AND HANDLING

6.1 MAINTENANCE

The product is maintenance-free and requires no special regular maintenance. The device may however require regular inspection (see chapter *Electric safety requirements*).

6.2 TROUBLESHOOTING

If a fault occurs during operation of the product and you need assistance, please contact MC Technologies support. You can reach our support department by email or phone:

support@mc-technologies.com +49-511-676 999-126

6.3 REPAIR

Only qualified personnel at MC Technologies GmbH are authorised to perform repairs. Send defective products with a detailed error description to:

MC Technologies
-Repair-
Kabelkamp 2
30179 Hannover
Germany

Before shipping the device make sure to:

- call our support team and ask for an RMA number (Return to Manufacturer Authorisation)
- remove any personal belongings like inserted SIM cards
- back up any relevant data like configurations on the device

7 ENVIRONMENTAL PROTECTION

The product and the associated transport packaging are made largely from recyclable raw materials. It can be sent to MC Technologies GmbH for proper recycling. At the end of its useful life, the product must not be disposed as household waste.

The disposal of the product and its packaging must be carried out in accordance with all relevant environmental protection regulations. Recycle responsibly by separating the packaging materials like cardboard and paper from plastic and use the dedicated waste collection systems.

7.1 DISPOSAL

In accordance with WEEE regulations, we offer the return and recycling of old MC Technologies equipment. For disposal, please send it carriage paid to the following address:

MC Technologies
-Disposal-
Kabelkamp 2
30179 Hannover
Germany

8 TECHNICAL LIMITS

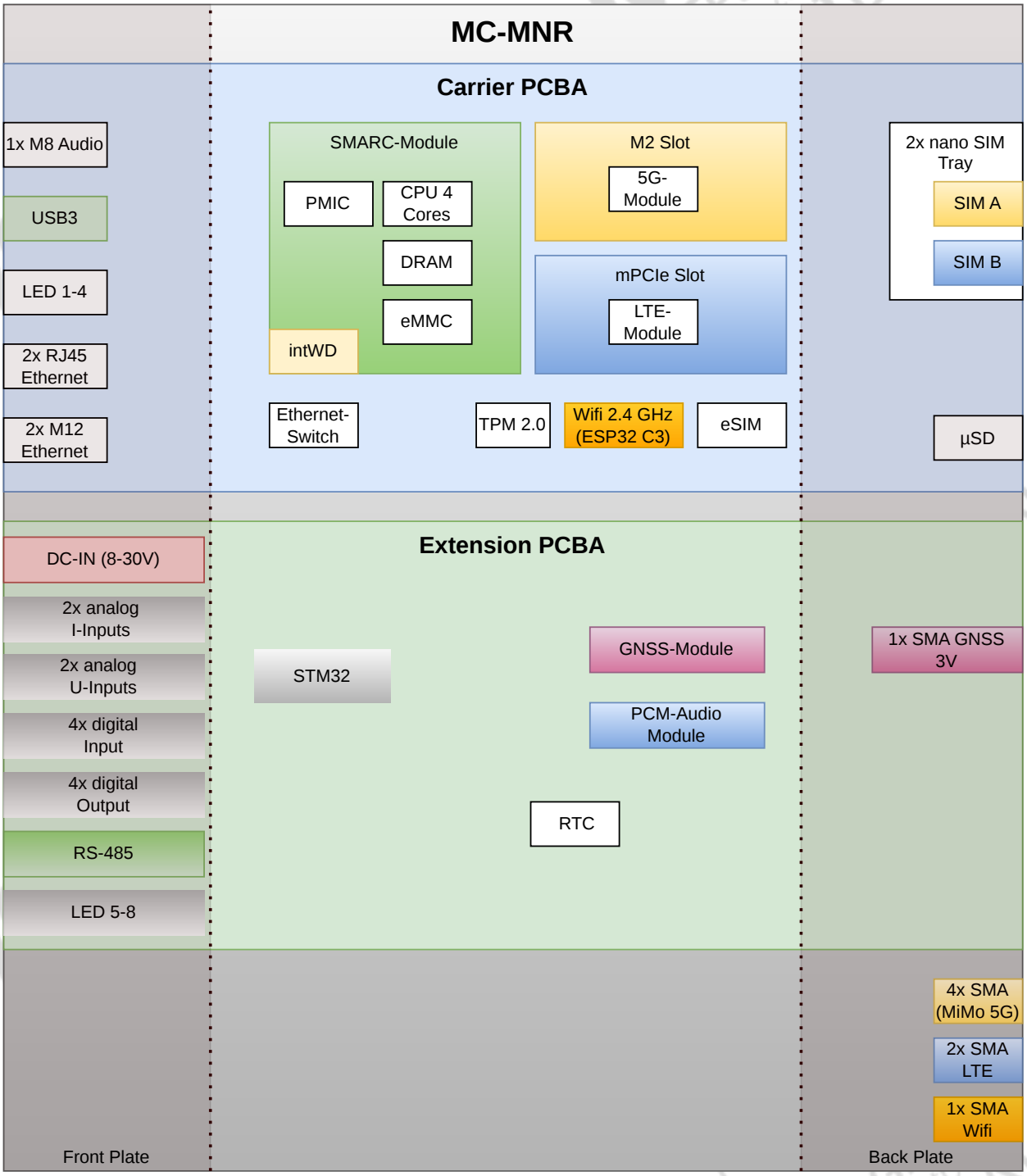
Physical characteristic / limitation	Value
Type	5G Router
Dimensions (W x H x D)	44 x 105 x 124 mm
Weight	approx. 500 g
Supply voltage	8...30 V DC
Operating temperature	-40°C...+70°C
Storage temperature	-40°C...+85°C
Housing	Aluminium
Protection class	IP20
Mounting	DIN rail, wall mounted
Processor	ARMv8, 64 bit, Cortex A55, Quad Core, up to 2GHz
RAM	LPDDR4 2 GByte
eMMC	16 GByte
Operating System	OpenWrt 24 [^1]

[^1]: open-source programmable and configurable embedded Linux system

9 HARDWARE

9.1 BLOCK DIAGRAM

The following diagram shows a schematic overview of the components available in the MC-MNR product line.



9.2 INSERTION OF SIM CARDS

The MNR can be quipped with 2x nano SIM (eSIM optional).

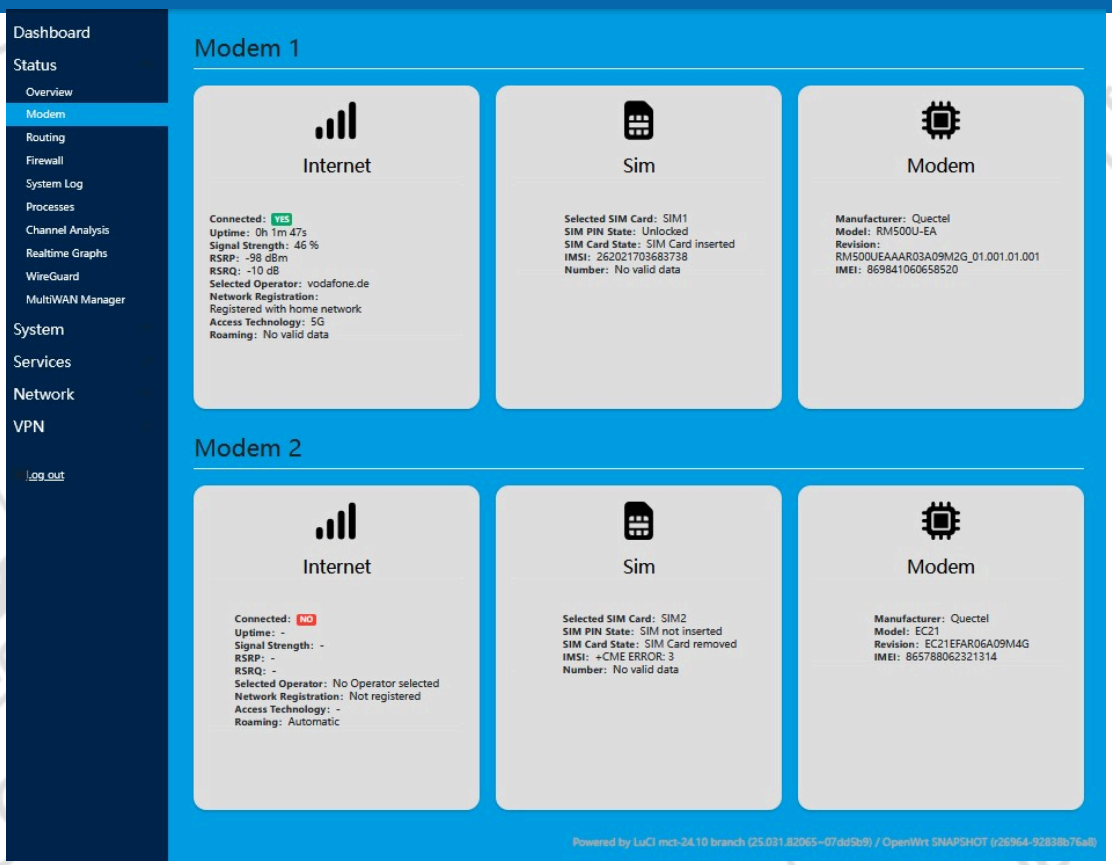
Preparation: Ensure the router is powered off. Locate the dual SIM card tray on the device.

Insertion: SIM1 (5G Module): Insert the nano SIM card designated for the 5G module (M2) into the SIM1 slot with the metal contacts facing downward. SIM2 (LTE Module): Insert the nano SIM card designated for the LTE module (mPCIe) into the SIM2 slot with the metal contacts facing upward. Tray Installation: Carefully slide the dual SIM card tray back into the device until it clicks securely into place.

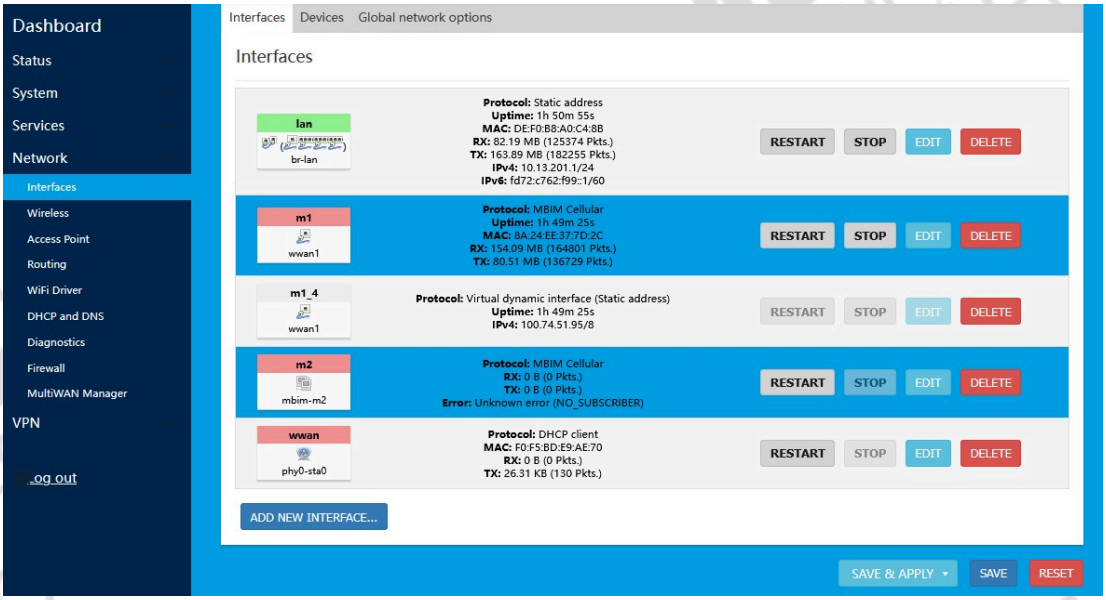
Power On: Turn on the router and verify that both SIM cards are detected and functioning correctly.

9.3 CONFIGURATION OF RADIO INTERFACES

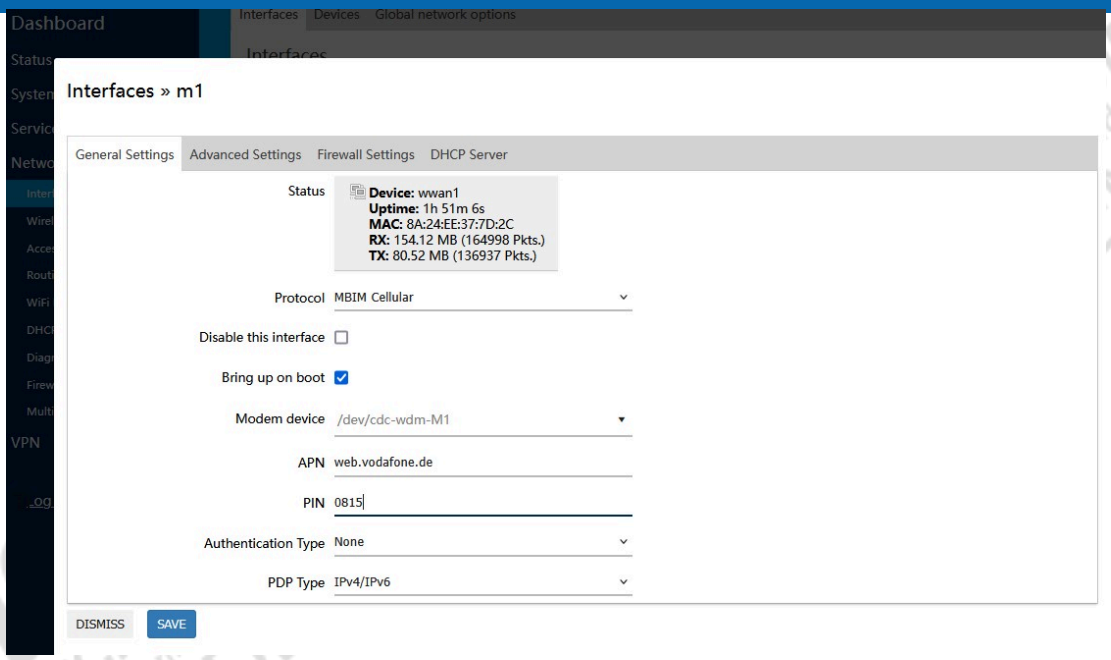
The radio modules are configured via the webinterace. The Modem status page shows the state of each radio module, SIM card and its internet connection:



Before the radio modules can establish an internet connection APN and SIM-Pin for each module and SIM-card needs to be configured. Please navigate to the network interfaces page and edit SIM-Pin and APN. The interface named with "m1" stands for the 5G-Module, The interface named with "m2" stands for the LTE-Module



The following picture shows the edit window to edit SIM-Pin and APN for the 5G-Module:



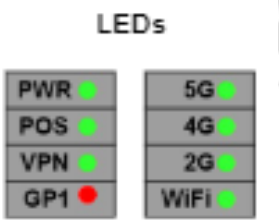
Here is a collection of APNs for German providers.

Provider	APN
Telekom	internet.telekom
Vodafone	web.vodafone.de
O2 (Telefónica)	internet
1&1	internet
Congstar	internet.telekom
Aldi Talk	internet.eplus.de
Blau	internet.eplus.de
Fonic	pinternet.interkom.de
Drillisch	internet
Tchibo Mobil	web.vodafone.de
simyo	internet.eplus.de
Yourfone	internet.eplus.de
sim.de	internet
wherever SIM	wsim

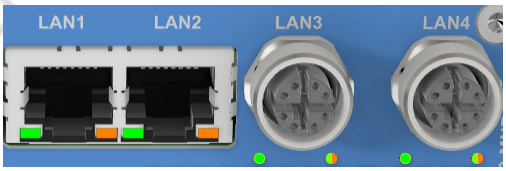
9.4 LEDS

The MC-MNR contains 8 LEDs on the front side plus two status LEDs for each Ehternet interface.

The 8 LEDs are assigned as follows:



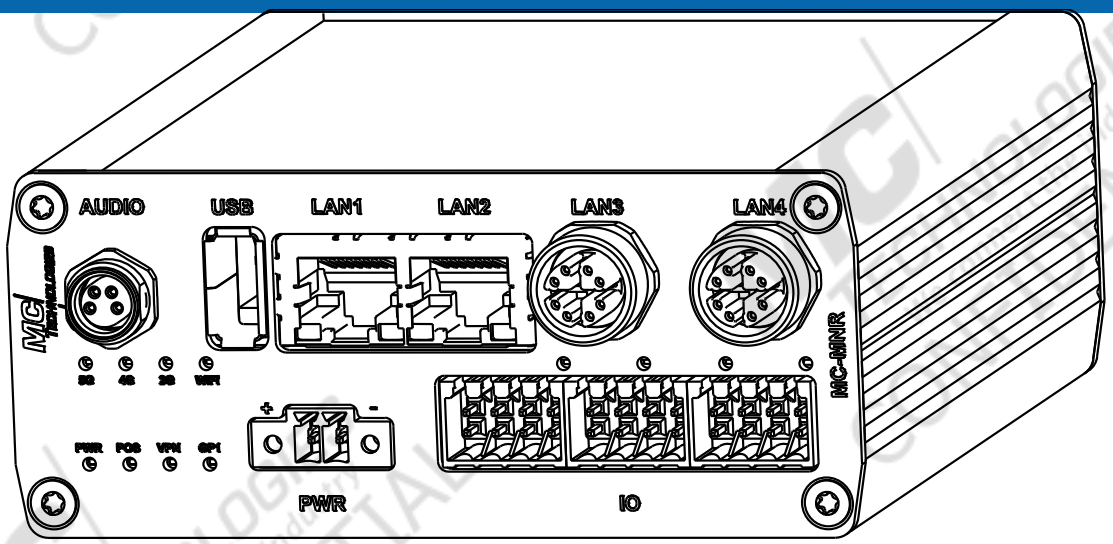
LED #	Name	Color	Function	State:on	State: off	State: blinking	State: flash 3s pause
1	5G	Green	5G network activity	5G Link Up	5G Link Down	5G Data traffic	establish connection
2	4G	Green	4G network activity	4G Link Up	4G Link Down	4G Data traffic	establish connection
3	2G	Green	2G network acitvity	2G Link Up	2G Link Down	2G Audio call	establish connection
4	WIFI	Green	WLAN network activity	Access Point active or Client connected	Power off		
5	PWR	Green	Power indicator	Power on	Power off		
6	POS	Green	GNSS	GNSS fix	Power off	OpenWrt boot in progress	establish connection
7	VPN	Green	VPN network status	Connected	Turned OFF	data transfer	establish connection
8	GP1	Red	Error indicator	ERROR	Status Okay	SW Update	



Port #	Green LED	Orange LED	Function
LAN 1 , 2, 3	off	off	Link Down / no cable inserted
LAN 1 , 2, 3	on	on	10 MBit Link up
LAN 1 , 2, 3	blinking	blinking	10 MBit Link up & data Traffic
LAN 1 , 2, 3	on	off	100 MBit Link up
LAN 1 , 2, 3	blinking	off	100 MBit Link up & data Traffic
LAN 1 , 2, 3	off	on	1 Gbit Link up
LAN 1 , 2, 3	off	blinking	1 GBit Link up & data Traffic

Port #	Left, Green LED	Right Dual Color LED	Function
LAN 4	off	off	Link Down / no cable inserted
LAN 4	off	green on	10 MBit Link up
LAN 4	off	green blinking	10 MBit Link up & data Traffic
LAN 4	on	off	100 MBit Link up
LAN 4	blinking	off	100 MBit Link up & data Traffic
LAN 4	off	orange on	1 Gbit Link up
LAN 4	off	orange blinking	1 GBit Link up & data Traffic

9.5 CONNECTOR OVERVIEW ON MC-MNR FRONT



Name	Connector Type	Function
POW	Power	Plug-in screw-type terminal
ETH	Ethernet	2x RJ45 + 2x M12 X-coded 10/100/1000 Base-T(X) acc. IEEE 802.3
AIN	Analog Inputs	2x 0 - 30 V + 2x 4 - 20 mA
RS485	RS-485	on IO-connector
USB	USB-A	USB 3.0
DOUT	Digital Output	4x 0 - 30 V (open drain)
DIN	Digital Input	4x 0..30 V [^1]
Audio	Audio	M8 microphone input and speaker output for calls via LTE module

[^1]: optional ignition power logic for vehicle use

9.5.1 POWER CONNECTOR

The router must be operated using a LPS (limited power source) power supply (according to IEC82368-1) with a supply voltage of 8 - 30V DC and a minimum rated output power of 18 W.

Warning: Make sure the polarity is correct as it might otherwise destroy the device.

Pin	Label	Function
-	-	GND
+	+	8V-30V

9.5.2 ETHERNET CONNECTORS

9.5.2.1 RJ45

T568A Standard (10/100 Mbps)

Pin	cable color	function
Pin 1	White/Green	TX+ (Transmit Data Positive)
Pin 2	Green	TX- (Transmit Data Negative)
Pin 3	White/Orange	RX+ (Receive Data Positive)
Pin 4	Blue	Not used (10/100 Mbps)
Pin 5	White/Blue	Not used (10/100 Mbps)
Pin 6	Orange	RX- (Receive Data Negative)
Pin 7	White/Brown	Not used (10/100 Mbps)
Pin 8	Brown	Not used (10/100 Mbps)

1000Base-T (Gigabit Ethernet)

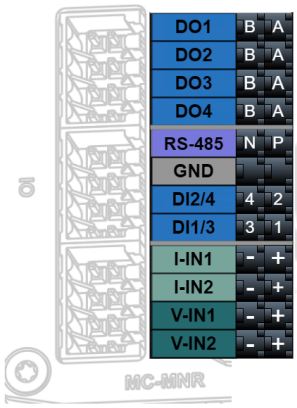
Pin	cable color	function
Pin 1	White/Orange	BI_DA+ (Bidirectional Data A Positive)
Pin 2	Orange	BI_DA- (Bidirectional Data A Negative)
Pin 3	White/Green	BI_DB+ (Bidirectional Data B Positive)
Pin 4	Blue	BI_DC+ (Bidirectional Data C Positive)
Pin 5	White/Blue	BI_DC- (Bidirectional Data C Negative)
Pin 6	Green	BI_DB- (Bidirectional Data B Negative)
Pin 7	White/Brown	BI_DD+ (Bidirectional Data D Positive)
Pin 8	Brown	BI_DD- (Bidirectional Data D Negative)

9.5.2.2 M12 X-CODED CONNECTOR TOR RJ45 MAPPING

This table shows the pin mapping between an M12 X-coded connector and an RJ45 cable. This configuration ensures correct and efficient data transmission between the two connector types.

M12 X-coded Pin	RJ45 Pin	Description
Pin 1	Pin 1	TX+ (Transmit Data Positive)
Pin 2	Pin 2	TX- (Transmit Data Negative)
Pin 3	Pin 3	RX+ (Receive Data Positive)
Pin 4	Pin 6	RX- (Receive Data Negative)
Pin 5	Pin 4	BI_DC+ (Bidirectional Data C Positive)
Pin 6	Pin 5	BI_DC- (Bidirectional Data C Negative)
Pin 7	Pin 7	BI_DD+ (Bidirectional Data D Positive)
Pin 8	Pin 8	BI_DD- (Bidirectional Data D Negative)

9.5.3 IO CONNECTOR



Pin	Label	Function
DOx A	Digital Output port A	Isolated Open Drain Ouptut between Port A and B
DOx B	Digital Output port B	Isolated Open Drain Ouptut between Port A and B
RS485 N, P	RS-485 interface	serial interface using RS485
DIx	Digital Inputs	Digital Input (0-30V) with reference to GND
I-INx +/-	Analog Current Input	Analog 4-20mA Current Input
V-INx +/-	Analog Voltage Input	Analog 0 - 30V Voltage Input

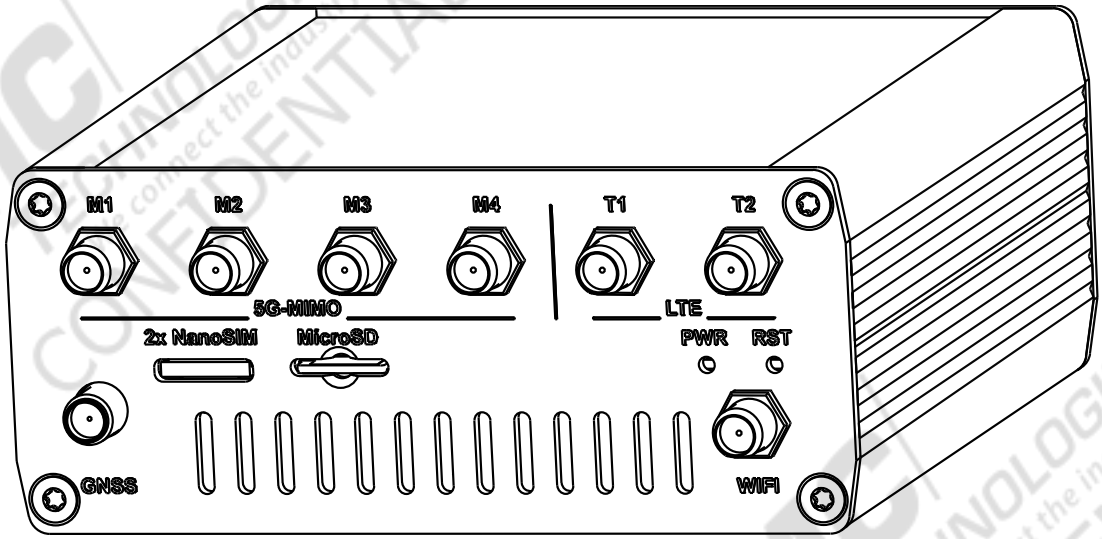
9.5.4 M8 AUDIO CONNECTOR

Pin	Label	Function
Pin 1	GND	GND
Pin 2	Speaker out	Audio Output
Pin 3	not connected	NA
Pin 4	Microphone in	Audio Input

9.5.5 USB-A CONNECTOR

Pin	Label	Function
Pin 1	VCC	+5V (Power)
Pin 2	D-	Data Negative
Pin 3	D+	Data Positive
Pin 4	GND	Ground

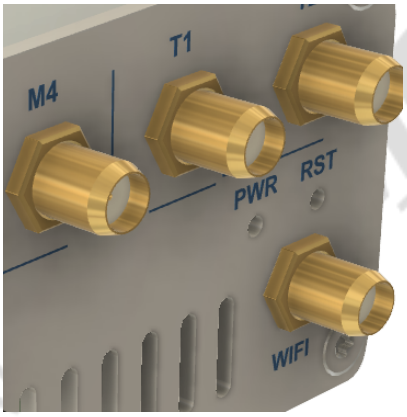
9.6 CONNECTOR OVERVIEW ON MC-MNR BACK



Name	Connector Type	Function
M1-M4	SMA-antenna connector female	5G MiMo antenna
T1+T2	SMA-antenna connector female	2G / LTE antenna with diversity
GNSS	SMA-antenna connector female	active GNSS antenna
WIFI	SMA-antenna connector female	2.4 GHz WIFI antenna
Nano SIM	slot for SIM card tray	inserting tray with SIM A and SIM B
Micro SD	push pull connector for Micro SD card	insertion of Micro SD card

9.7 BUTTONS

The MC-MNR has two buttons behind the back plate, a "RST" button and a "PWR" button. Those buttons can be used using a paper clip.



The "RST" button issues a facory reset. Press and hold Reset Button while powering on the device

Attention: A factory reset deletes all stored data and configuration of the system"

Additionally there are two other way to initiate a factory reset: - Shell: firstboot -y - LuCI: System → Backup/Flash Firmware → Perform Reset

The "PWR" button issues a restart of the Linux system. It can be pressed and released at any time.

Attention: Do not press this button whilst an software update!

9.8 GNSS

The MC-MNR is equipped with an industrial high-precision Multi-GNSS supporting concurrent reception of GPS, GLONASS, BDS, Galileo and QZSS, promising fast and accurate fixes even under rough conditions in interference-plagued environments.

- Low power consumption
- Industry-leading sensitivity
- Integrated LNA for improved sensitivity
- Embedded multi-tone active interference canceller for anti-jamming

Enable and operate GNSS as follows:

1. Plugin an active GNSS antenna to the external SMA-Antenna port.
2. Login to the router terminal via ssh
3. Type to console:

```
uci set gpsd.core.enabled=1
uci commit gpsd
```



```
/etc/init.d/gpsd enable
/etc/init.d/gpsd start
```

4. Test GPS typting "gpsmon".

10 WATCHDOG SYSTEM IN MNR

The MNR is equipped with two hardware watchdogs: adv-i2c-wdt and stm32-wdt. The latter is integrated into the MC-Extension module. While adv-i2c-wdt safeguards only the Single Board Computer (SBC) within the MNR, stm32-wdt also manages power control for both modems and the entire hardware system.

These watchdogs ensure the MNR remains operational and protect the system in the following cases:

- User-space inaccessibility
- Kernel crashes

10.1 USER-SPACE INACCESSIBILITY

A system must remain accessible at all times. However, corrupted user-space applications may render the system unresponsive. In such scenarios, a reboot or power cycle is necessary. To simulate a rogue application, we can use a fork bomb, a well-known denial-of-service attack that depletes system resources, leading to resource starvation and a crash.

```
foo () { foo | foo & } && foo
```

This recursive function overloads system resources, making user space inaccessible and subsequently triggering the watchdog reset.

10.2 KERNEL CRASH

Kernel modules may malfunction, causing kernel panics. The hardware watchdog ensures a clean restart in such cases. To simulate a kernel panic, we can use the following command:

```
echo c > /proc/sysrq-trigger
```

10.3 ADV-I2C-WDT

Since the adv-i2c-wdt is integrated into the SBC, it is directly managed by the Linux operating system and can be fully configured from user space.

10.3.1 USAGE VIA UBUS

OpenWrt includes a watchdog daemon (watchdogd), a system tool that automatically starts the Power Management IC (PMIC) watchdog and periodically writes "1" to /dev/watchdog to keep it active. watchdogd can be controlled via the UBUS API.

- View watchdog parameters and status:

  ubus call system watchdog
  {
  "status": "running",
  "timeout": 30,
  "frequency": 5,
  "magicclose": false
  }

- Change heartbeat (timeout), minimum value: 10 seconds:

  ubus call system watchdog '{"timeout":10}'

- Stop watchdog pings (this will lead to a reboot after the timeout period):

  ubus call system watchdog '{"stop":true}'

10.3.2 USAGE WITHOUT WATCHDOG DAEMON

1. Deactivate watchdogd.
2. Add the magic close flag to stop the watchdog device:

   ubus call system watchdog '{"stop":true,"magicclose":true}'

3. Start the hardware watchdog manually:

   echo 1 > /dev/watchdog

4. Ensure periodic pinging to prevent automatic reboot (default timeout: 4 seconds):

   while true; do echo 1 > /dev/watchdog; sleep 5; done

5. Stop the hardware watchdog:

   echo V > /dev/watchdog

10.4 STM32-WDT

Unlike adv-i2c-wdt, stm32-wdt is not configurable and cannot be disabled. It operates at the kernel level and will initiate a full hardware power cycle if it does not receive a ping within 5 minutes.

11 INITIAL STARTUP OF ROUTER

1. Insert SIM-Cards
2. Plugin Power Supply
3. Establish Network Connection to PC

> **Attention: DHCP-Server enabled!**
> Coming from factory the DHCP-Server on the MC-MNR is activated. After connecting to your PC an IP-Adress "192.168.2.x" is assigned automatically.

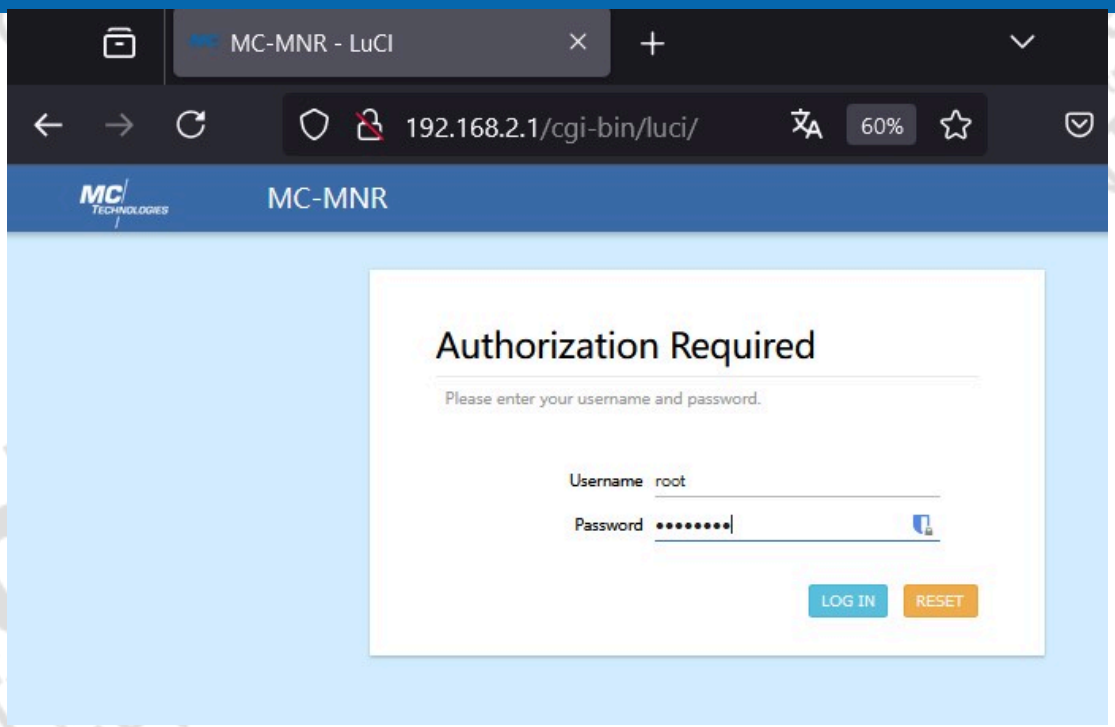
Alternative A: Plugin Ethernet Cable into RJ45-Port "LAN1" and Connect with your PC.

Alternative A: Wifi- Connection

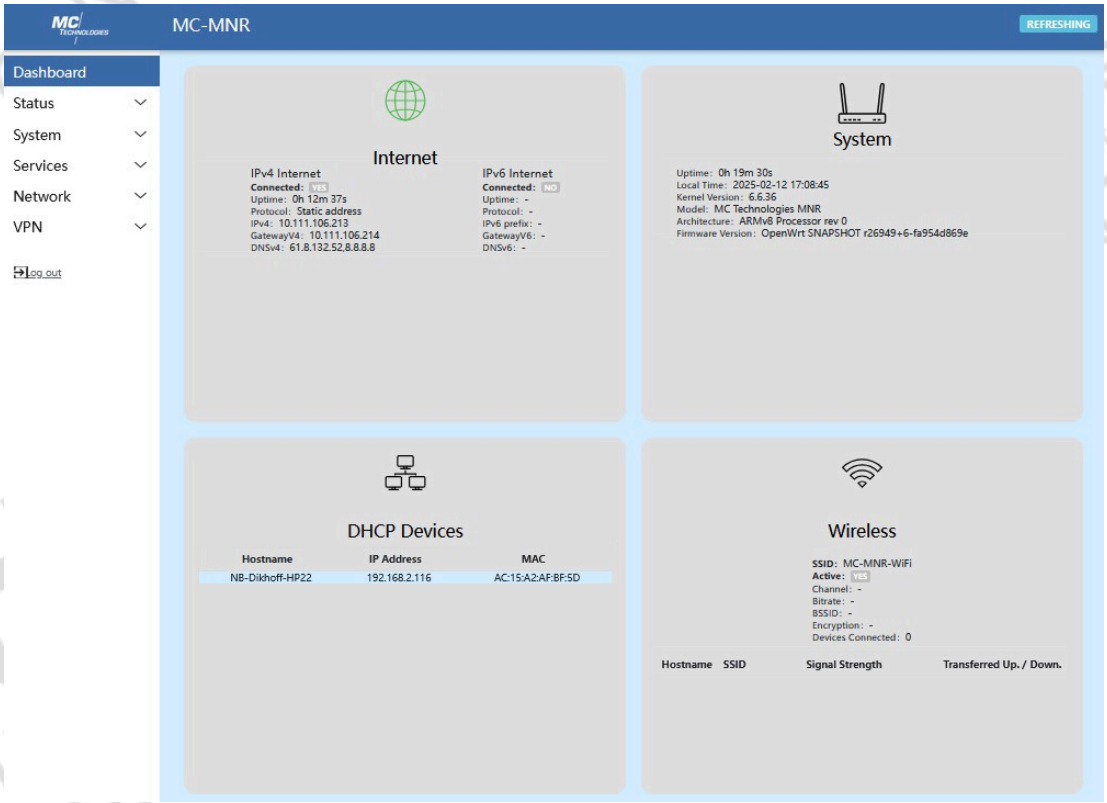
Scan QR-Code on Side of MC-MNR or this one:

Alternativly: Search SSID "MC-MNR-WiFi" with your wifi-client on your PC and enter password "mE5%VD2!"

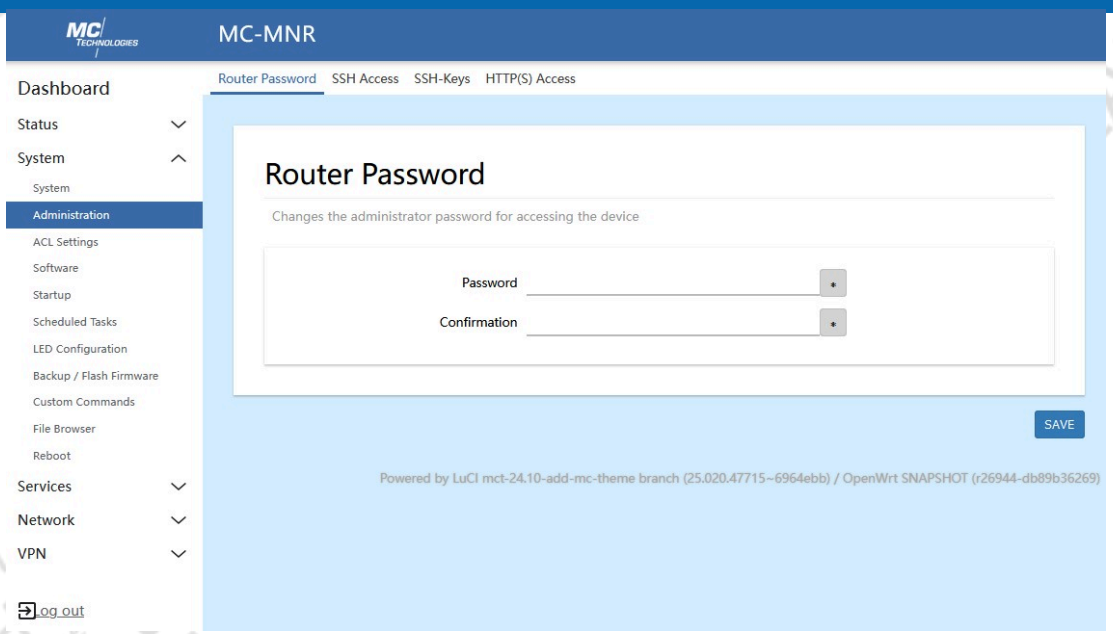
4. Open Web-Interface
   Type the IP-address "192.168.2.1 "of the router in a web browser on the PC.



Enter user "root" and passwd "Tech#5GR".



5. Change Password
   Please change the password before establishing an internet connection.



6. Setup SIM-Pin and APN

Well done, you are ready to go!

12 CONTACT INFORMATION

MC Technologies
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