

Operating Instructions (Original Version)

Mobile Communication Gateway (MCG)



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- Refer to "MCG_license_texts.txt" for the licence conditions of the software components used.

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Document History

Index	Date	Remarks
01	2021-01-28	First Edition based on MCG-CEK06DE_02_01

Product History

SPF- Index	Release Date	Change description	Operating Instructions
003	2020-01-02	Initial Release	MCG-CEK06EN_01_01

EN

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1 Introduction

1.1 Purpose of the operating instructions

This documentation is valid for the products listed in the following table.

Product key	Short description
MCG-001-1	Communication gateway with WLAN for worldwide usage (except America)

The Mobile Communication Gateway (MCG) is also referred to as "product" and "MCG" in this documentation.

This document describes the following topics:

- Scope of delivery, storage and transport
- Installation in or attachment to the machine/vehicle
- Description of the functions of the product
- Commissioning of the product
- Maintenance and care of the product
- Repair and disassembly of the product
- Disposal of the product

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1.2 Applicable Documents

Document name	Document description
xxxxxxx-EBZ_xx_yy	Installation drawing or 3D model
xxxxxxx-CEK01_xx_yy	EU declaration of conformity
L739-SDD01_xx_yy	Instructions for the software technical integration of the MCG

xxxxxxx is the article code (AC) of the product. With xx_yy the current version of the document is indicated (example: L739-SDD01EN_01_01)

For safe and proper use, standards and laws must be observed.

Note

The listed documents will be made available to purchasers of the product upon request.

2 Safety Guidelines

2.1 Symbols

The notes and symbols used in this document have the following meanings:



WARNING

Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

ATTENTION

Indicates a dangerous situation, which, if not avoided, may result in damage to property.



Information, tip, note

This symbol indicates helpful additional information

- ▶ This symbol is used for an instruction.
- ▷ This symbol is used for a result.
- This symbol is used for a list of equal items.

2.2 Basic Safety Instructions

The following basic safety instructions must be read carefully before using the product and observed when using the product.



WARNING

This product can expose you to chemicals such as Tetrabromobisphenol A (TBBPA) which is known to the state of California to cause cancer.

For more information go to
www.p65warnings.ca.gov



WARNING

This product can expose you to chemicals such as Bisphenol A (BPA) which is known to the state of California to cause birth defects or other reproductive harm.

For more information go to
www.p65warnings.ca.gov

2.2.1 Responsibility of the Original Equipment Manufacturer (OEM)

The product is fully programmable by the OEM. The OEM integrates the product into the machine.

All communication interfaces connected to a machine or vehicle are capable of causing malfunctions. This must be considered in particular when integrating the product.

The OEM must carefully develop and validate the software for the product on the target architecture.

The OEM must carefully integrate the product and check the functionality in the target architecture.

The OEM must use the approved antennas or carry out appropriate investigations and conformity tests.

The OEM of a machine or vehicle bears full responsibility for the safe and correct integration of the product into the machine or vehicle.

2.2.2 Handling of the Operating Instructions

Read the operating instructions carefully before using the product.

Always keep the operating instructions, including the applicable documents, easily accessible.

2.2.3 Staff requirements

These operating instructions are intended for developers, mechanical designers and other specialists of a machine manufacturer (OEM). This group of persons is qualified, based on their technical training, instruction and experience, to recognise risks in handling the product and to avoid possible hazards.

The installation of the product and its integration into the control system of the machine requires qualified knowledge of the relevant techniques, the relevant laws and normative requirements.

Only trained specialist personnel with basic electrical knowledge may carry out the measures and work described in these operating instructions.

Activity/Task	DEV	MDES	WHC	EIP	ESP	OSP
Developing software for and programming of the product	X					
Electrical integration into control system/machine	X					
Configuring the product	X			X		
Updating the software of the product ^{*)}	X				X	
Mechanical integration		X				
Storage/provisioning			X			
Assembly, electrical connection	X	X		X	X	
Commissioning, troubleshooting, repair	X				X	
Operation ^{*)}	X	X		X	X	X
Maintenance	X	X			X	X
Replacement of the product	X	X		X	X	X
Decommissioning and disposal	X	X		X	X	X
Transport/shipping in original packaging	X	X	X	X	X	X

^{*)} The product is operated by the OEM's control system. Manual operation of the product is not possible.

DEV: Hardware and software developers of the OEM. Because of their professional training, instruction and experience, this group can recognise risks when handling the product and can avoid possible hazards.

MDES: OEM's designers for mechanical integration of the product into the OEM machine. Because of their professional training, instruction and experience, this group can recognise risks when handling the product and can avoid possible hazards.

WHC: Warehouse clerks of the OEM. This group of persons is qualified based on their professional training, instruction and experience to assess the storage conditions and to handle electronic equipment properly.

EIP: Electrically instructed persons. Because of professional training, instruction and experience, this group is capable of assembling and connecting the product correctly in accordance with the OEM assembly instructions/diagram.

ESP: Electrical specialists. Because of their professional training, instruction and experience, this group can put the product into operation and test it properly. Electrical specialists are also able to identify and correct errors.

OSP: Other specialists. Because of their professional training, instruction and experience, this group can use the product in the OEM's machine, clean the product and carry out basic maintenance.

2.2.4 Precondition

In order to be able to use the product, the following conditions must be met:

- ▷ The specific functions for the target machine or vehicle were coded and tested by the OEM's developers.
- ▷ The product is integrated into the machine or vehicle electrically and in terms of control technology.
- ▷ The product is mechanically integrated into the machine or the vehicle.
- ▷ The product is configured to the network of the machine or vehicle.

2.2.5 Changes

Changes to the product can impair operational safety.

2.2.6 Intended Use

The product is a gateway for telematics applications for mobile machinery.

The product is used for bidirectional wireless transmission of data between the machine or vehicle and a remote network node.

The function of the product shall be defined and programmed by the OEM. The programmed function can use all measured physical inputs and all data that is available through the connected data interfaces.

The product can be used as a pure communication gateway, as a condition monitoring system or for fleet management.

The product is designed for use in mobile machinery. The product can also be used in other machines and vehicle types or stationary systems. Consult the manufacturer before such use.

Typical use for the Mobile Communication Gateway (MCG):

- Transmission of operating, machine and process data to a central data memory
- Data communication to other machines or in networks
- Freely programmable controller WITHOUT safety function according to DIN EN 13849 or DIN EN ISO 61508

DO NOT use the product

- as control unit for machine movements or movements of machine parts.
- in countries for which there is no approval.
- in public passenger and goods transport vehicles.

Operate the product within the operating ranges specified in this and the applicable documents.

Use the product within the technical specifications (see chapter 11, page 30).

The product is part of a complete system/machine and requires additional components to perform the intended function.

In order to be able to use the product, preparatory steps are necessary to integrate the functions into the product and the control of the machine/vehicle.

The OEM is responsible for ensuring the correct overall function in the system compound.

2.2.7 Electromagnetic Field Strength and non-ionising Radiation

The product generates electrical fields and non-ionising radiation to transmit information using radio waves and can interfere with other electronic devices.

The product's software controls the generation of the electromagnetic field strength and non-ionising radiation. The device can be freely programmed and configured and can emit radiation that is above the legal limit values. Use only certified and tested software and software configuration!

The OEM and the manufacturer of the product must evaluate the use of antennas other than those approved. The use of non-approved antennas may affect emissions and interfere with other products or cause health hazards. The use of such antennas may violate local law.

3 Storage/Transport

Storage and transport requirements:

- ▶ Transport and store the product in the unopened original packaging.
- ▶ Protect the product from dust, heat and moisture.
- ▶ Observe ambient conditions for transport and storage.
- ▶ Check the product for transport and storage damage before use.
- ▶ Replace damaged products.

ATTENTION

Malfunctions or property damage because of mechanical damage or contamination of the plug contacts or because of moisture in the plug.

- ▶ Fit mating connectors or protective caps to the connectors.

Information

Warranty claims due to mechanically damaged or corroded plugs are excluded.

4 Scope of delivery

The delivery includes:

- Mobile Communication Gateway (MCG)

Documentation (provided electronically)

- Operating instructions (this document)

Note

The SIM card required for operation, the antennas and the screws required for fastening to the machine or vehicle are not included in the scope of delivery.

5 Product and Functional Description

5.1 Product Description

The Mobile Communication Gateway (MCG) is a communication unit for telematics applications of mobile machines.

The product can be used both to connect machines with each other and to retrieve machine data of individual machines and fleets. This data can be used for efficient order control, predictive maintenance planning or fleet management.

The MCG is freely programmable by the OEM. The OEM can program the product according to the specific requirements of the machine/vehicle. The MCG provides the necessary transmission technology to transfer data reliably and securely to the intended recipient.

The Mobile Communication Gateway (MCG) is used for the following applications:

- Transfer location (fleet management)
- Transfer operating data (job control)
- Transferring machine data (remote diagnosis, service and predictive maintenance planning)
- Machine-to-machine communication for process optimisation

The Mobile Communication Gateway (MCG) provides the following functionalities:

- 2G Mobile Phone Communication
- 3G/4G mobile communications with antenna diversity
- WLAN/Bluetooth interface
- GNSS receivers for GPS, Galileo, GLONASS and Beidou
- IMU (3-axis accelerometer)
- Real-time clock

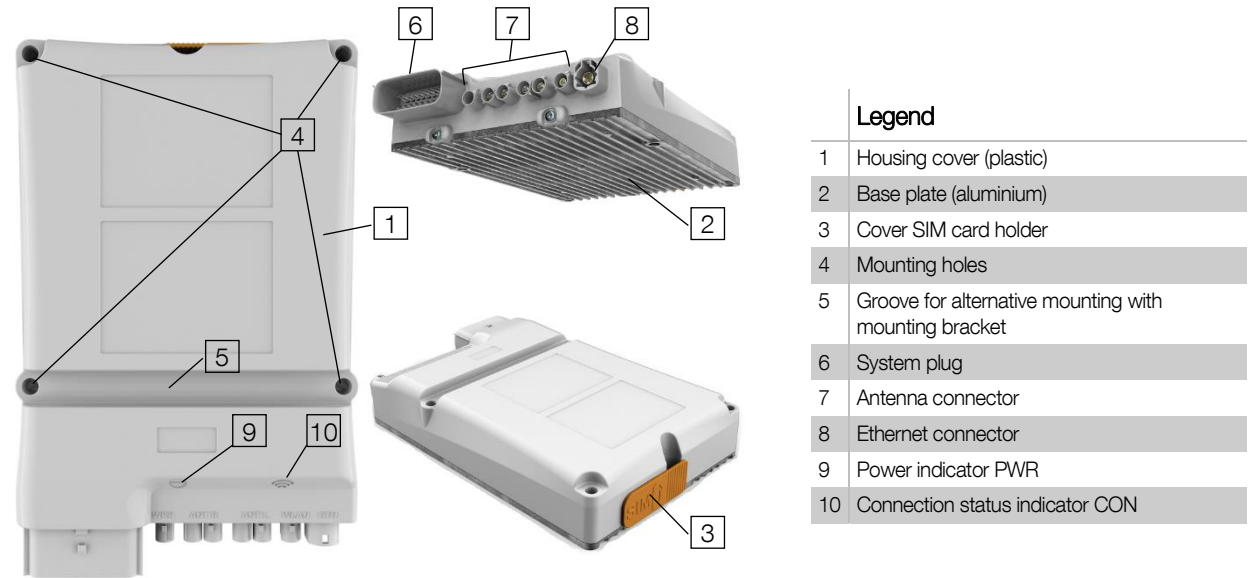


Figure 1: Components of the Mobile Communication Gateway (MCG)

5.2 Block diagram and Functional Blocks

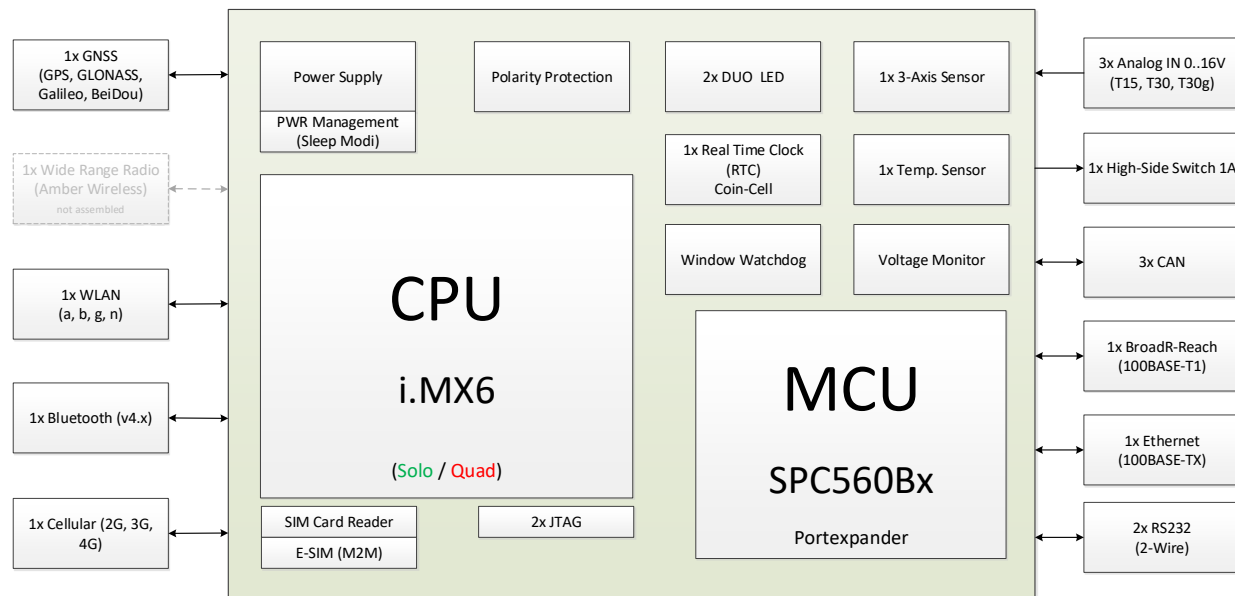


Figure 2: Block diagram

The product is based on the functional blocks:

- PSU with power monitoring power staging and protecting functions
- Microprocessor system with Flash and RAM
- Co-processor for expansion functions and functional safety
- Supervisory unit with
 - Watchdog
 - Real-Time clock
 - Temperature monitoring
 - Voltage monitoring
- LED-Indicators
- IMU (Three-axis accelerometer)

The product provides the following functions:

- Up to three CAN interfaces
- Up to two 2-wire RS232 interfaces
- A 100BASE-T1 interface
- One Ethernet interface
- One plus-switching switching output
- One GNSS receiver
- A WLAN interface
- A Bluetooth interface
- A cellular interface
- A broadband radio interface

5.3 Product Variants

The product will be available in different variants. The following description of the product key and the corresponding table provide an overview of the product variants.

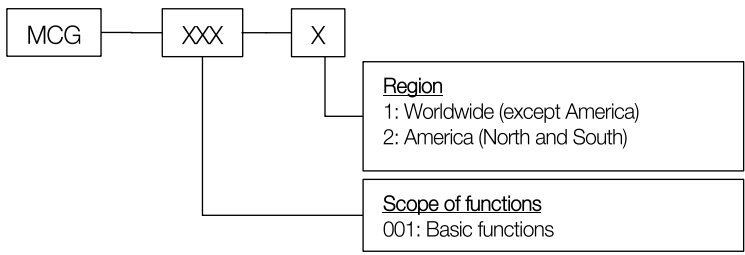


Figure 3: Product key

Product key	I.MX6 - Solo	I.MX6 - Quad	2G	3G	4G	WLAN	GNSS	Bluetooth	IMU	RTC	LED PWR	LED CON	CAN 1	CAN 2	CAN 3	ETH TX/T1	RS232	UI 1	UI 2	DOHS
MCG-001-1	•	◦	•	•	•	•	•	•	•	•	•	•	•	•	•	TX	•	•	•	•
MCG-001-2	•	◦	•	•	•	•	•	•	•	•	•	•	•	•	•	TX	•	•	•	•

• Standard equipment, ◦ Optional, – Not possible

5.4 Identification Plate

The identification plate contains the following information:

①

MODEL: MCG-001-1

②

AC: 10889540

③

SN: 0000155

④ ⑥

SUPP: 069030 VDC: 8V – 32V

⑤ ⑦

SPF: 001 DAT: 07.01.2021

⑨

IMEI: 
352255062064476

⑧

Liebherr-Elektronik GmbH
Peter-Dornier-Str. 11
D – 88131 Lindau, Germany

⑩

  10R – 058353 

①

Meaning

Example

②

Model name

MCG-001-1

③

AC (article code)

10889540

④

SN (Serial number)

0000155

⑤

SUPP (Supplier number)

069030

⑥

SPF (Specification index)

001

⑦

VDC (Operating voltage range)

8V – 32V

⑧

DAT (Date of manufacture)

07.01.2021

⑨

DataMatrix code



⑩

IMEI

352255062064476

⑪

CE-Mark



⑫

E-Mark

10R – 058353

⑬

Bluetooth



①

At position ⑩ only the information that applies to the respective variant is included.

DataMatrix code content: AC|SN|DAT|SUPP|SPF|IMEI|MAC|

DataMatrix code value: 10889540|0000155|07012021|001|352255062064476|0011B803D33D|

5.5 Housing and Dimensions

5.5.1 Housing

The housing of the MCG consists of a base plate made of aluminium (die-cast) and a cover made of plastic (PA66). A plastic cover made of TPU83 with Shore hardness A is implemented in the lid as a cover for the SIM card slot.

The housing of the MCG consists of the following components:

Part description	Material	Remarks
Base plate	Die-cast aluminium (EN AC-47100)	
Cover	Polyamide 66 (PA66)	UL94-V0 according to IEC 60695-11-10
SIM cover	TPU 83 Shore A	UL94-HB 75 according to IEC 60695-11-10, -20
Screws	Steel A2K Hexagonal socket (WN5151)	

5.5.2 Dimensions

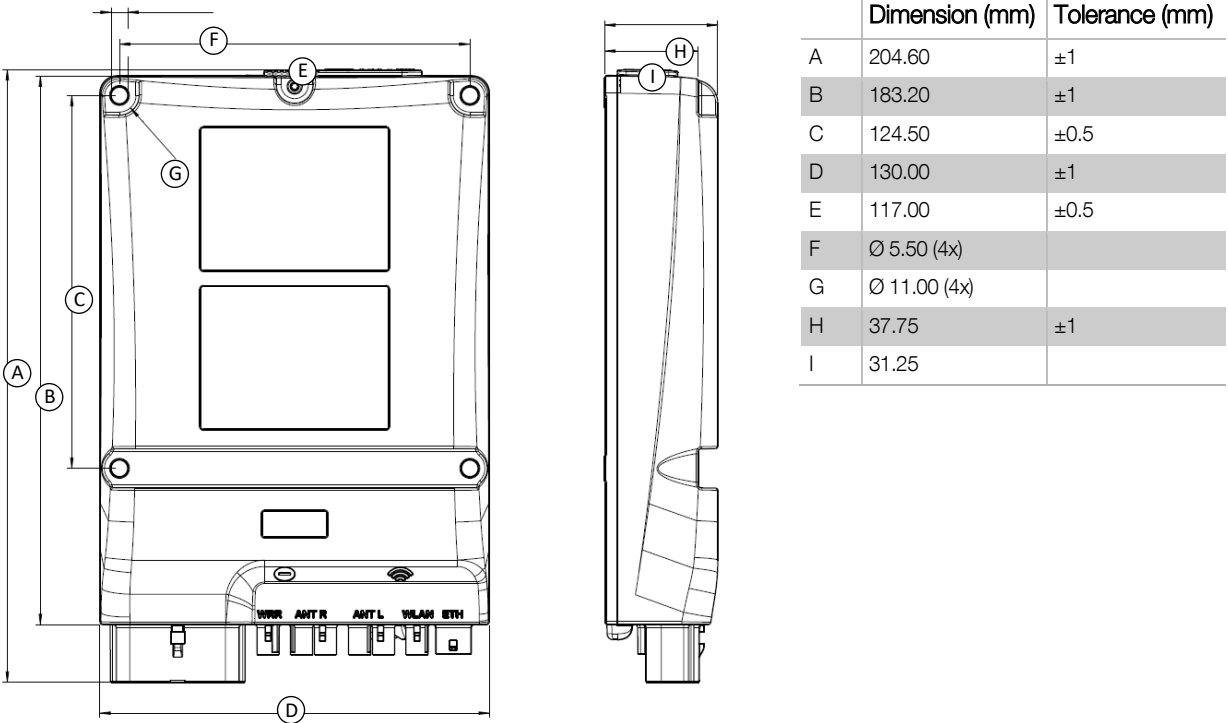


Figure 4: Dimensions and Fixing points

5.6 Electrical Connections

5.6.1 Overview of all connections

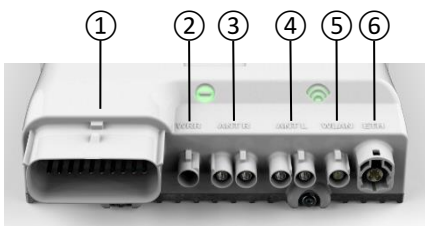


Figure 5: Connections

Pos.	Designation	Details
1	System connector (X1)	MX150, Molex
2	WRR antenna (X2)	FAKRA-HF, Rosenberger, 59S2DX-400T5, Code E
3	Antenna R (X3)	FAKRA-HF, Rosenberger, 59S2LH-400T5, Code D
4	Antenna L (X4)	FAKRA-HF, Rosenberger, 59S2LH-400T5, Code H
5	WLAN antenna (X5)	FAKRA-HF, Rosenberger, 59S2DX-400T5, Code I
6	ETH connector (X6)	HSD®, Rosenberger, D4S20G-400A5, Code D

EN

5.6.2 Pin assignment

System connector (X1) ①

PIN	Signal	PIN	Signal
1	Battery Plus/T30	11	Ignition switch /T15
2	Chassis/GND/T31	12	EX_UI
3	RS232 1 TX	13	RS232 2 TX
4	RS232 1 RX	14	RS232 2 RX
5	CAN 3 H	15	Digital Out
6	CAN 3 L	16	CAN 2 H
7	CAN 1 H	17	CAN 2 L
8	CAN 1 L	18	NC (Cap GND)
9	NC (Cap GND)	19	ETH 1 H
10	EX_UI2	20	ETH 1 L

Figure 6: Pin assignment of system connector X1

ATTENTION

Malfunctions or material damage due to overload of the supply lines!
► Protect supply lines on the machine/vehicle side with a fuse of maximum 3 A.

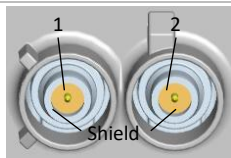
ATTENTION

Malfunctions or damage to property caused by connecting terminals marked NC.
► Do not connect pins marked NC.

WRR (X2) ②

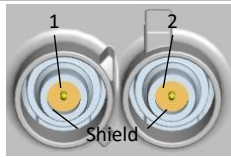
PIN	Signal
1	WRR-Antenna
Shield	Shield-GND
Coding „E“	

Figure 7: Pin assignment of Wide-range radio antenna X2

ANT R (X3) ③

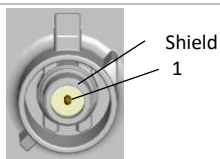
PIN	Signal
1	GNSS antenna
2	Cellular antenna 1
Shield	Shield-GND
Coding „D“	

Figure 8: Pin assignment GNSS antenna and cellular antenna 1

ANT L (X4) ④

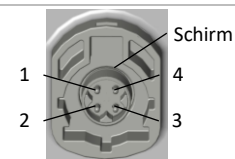
PIN	Signal
1	Cellular antenna 2
2	WLAN antenna 1
Shield	Shield-GND
Coding „H“	

Figure 9: Pin assignment cellular antenna 2 and WLAN antenna 1

WLAN (X5) ⑤

PIN	Signal
1	WLAN antenna 2 / BT antenna
Shield	Shield-GND
Coding „I“	

Figure 10: Pin assignment WLAN antenna 2/Bluetooth antenna

ETH (X6) ⑥

PIN	Signal
1	ETH2 TX-H
2	ETH2 RX-L
3	ETH2 TX-L
4	ETH2 RX-H
Shield	Shield-GND
Coding „D“	

Figure 11: Pin assignment Ethernet 100BASE-TX

ATTENTION

Product defect due to connection to networks with power supply via Power over Ethernet (PoE).

- ▶ Do not connect the product to networks with PoE.

5.6.3 Mating Connectors

- System connector (X1): MOLEX, MX150 Receptacle 2X10 sealed, Series 33472
Connector: 33472-2001
Female Terminal: 33012 or 33001
Sealed Cavity Plug: 34345-0001
Back shell: 34951-2011
- Antennas (X2 – X5): ROSENBERGER, Series: FAKRA, Coding D, H, I
Housing: 59Z115-000-D/ H/ I
Crimp-Contact: 59K130-102A4
- Ethernet (X6): ROSENBERGER, Series: HSD®, Coding D, LD5-135-0500-D

ATTENTION

Material damage due to moisture in the product as a result of using other, non-recommended mating connectors.

- In case of deviations, a new leak test must be carried out according to the manufacturer's specifications.

5.7 Power Supply

5.7.1 General

The product must be supplied with battery plus via terminal T30 (system plug X1 – connection 1). The ground connection T31 (system plug X1 – connection 2) to the voltage source must also be established.

The product is intended exclusively for machines or vehicles whose battery negative pole is connected to the chassis.

The product has an internal switch (internal power supply switch) that can disable the supply of all functions except for monitoring the starting conditions. This allows the product to enter a power-saving mode.

The product has a shutdown control that maintains the supply voltage for at least 2 ms after switching off the ignition (connector X1 – connection 11) until the software (the processor) switches off the supply.

ATTENTION

Malfunctions or material damage due to overload of the supply lines!

- Protect supply lines on the vehicle side with a fuse of maximum 3 A.

ATTENTION

Product defect due to connection to networks with power supply via Power over Ethernet (PoE).

- Do not connect the product to networks with PoE.

5.7.2 Self-Protection Functions

The product provides the following self-protection functions:

- Protection against reverse polarity of the supply connections. If the polarity is reversed, the product will NOT work.
- Protection against transient overvoltages through a 56 V – suppressor diode.

The supply connections of the connectors are directly connected to each other without additional protective measures.

5.7.3 Diagnostic Functions

The product provides several hardware diagnostic functions. The software can evaluate these functions and use them to control device functions.

- Measuring the supply voltage battery plus/T30 (system plug X1 – connection 1)
- Measuring the current through terminal T30
- Measuring the supply voltage at terminal T15
- Measuring the internal supply voltages
- Measuring one or more internal temperatures
- Measuring the acceleration in three axes
- Back measurement of the voltage at the digital output DOHS
- Measuring the current through digital output DOHS (>100 mA)

5.7.4 Operating States and State Changes

The hardware of the product provides signals to implement different operating states via software.

The product supports the following operating states:

- Off
- Deep sleep
- Sleep mode/energy saving
- Starting/booting
- Active/ON

The product supports waking up by the following signals and state changes:

- Wake up on ignition on (A voltage $>U_{TH,H}$ is applied to connector X1, terminal 11)
- Wake up at communication via Ethernet or CAN
- Wake up on acceleration (the product is moved)
- Wake up due to a trigger from the real-time clock

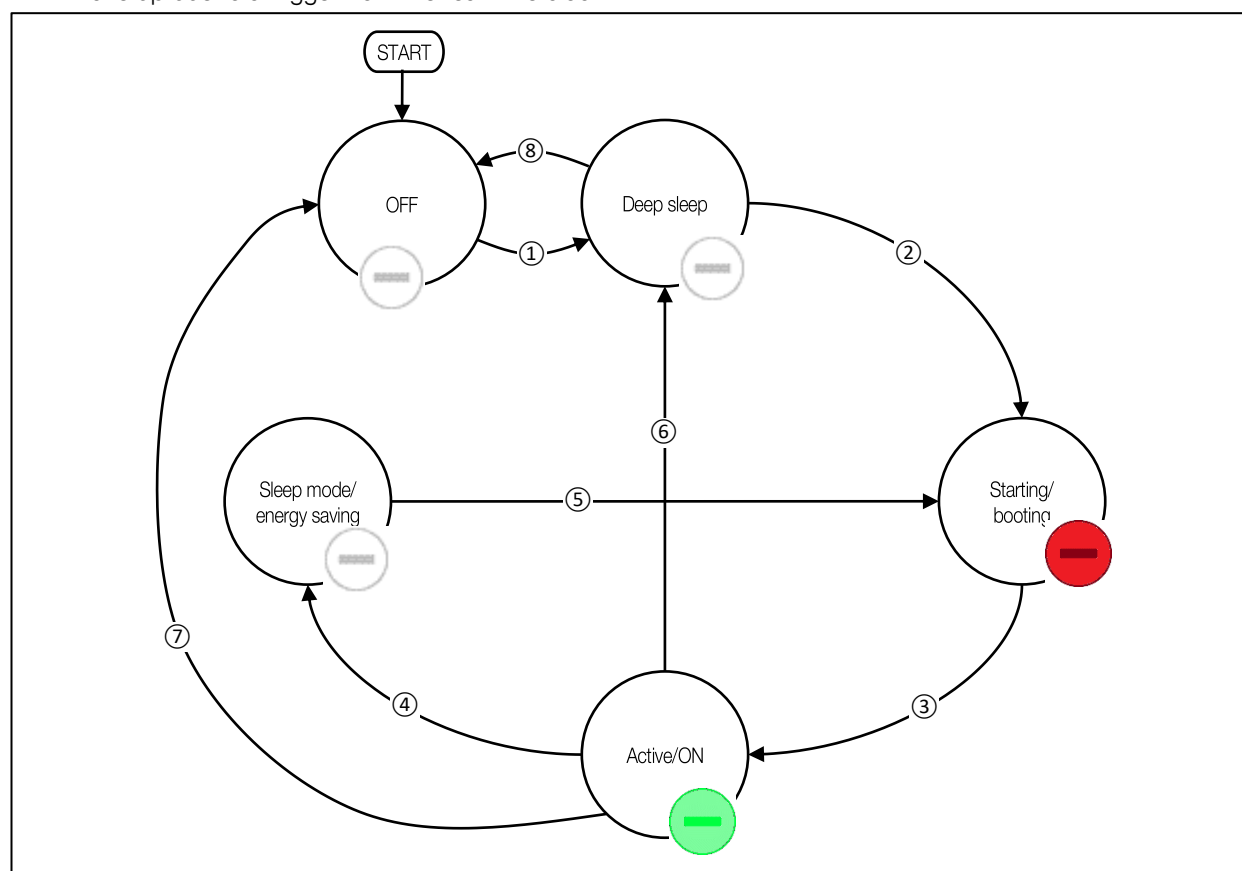


Figure 12: Operating states and state changes

No.	Initial condition	Alternating condition	Resulting operating mode	Condition description
1	OFF	The power supply is connected or switched on.	DEEP SLEEP	There is a voltage at connector X1, pin 1 (battery plus / KL30) that is above the switch-on threshold. The internal power switch is open. The product is waiting for one of the start conditions to be met: ■ Input T15 $\geq 6.5\text{ V} \pm 5\%$, ■ Expiry of the sleep timer or ■ Movement of the product.
2	DEEP SLEEP	A positive voltage greater than the switch-on threshold is applied to input KL15 (connector X1, pin 11) OR the preset timer of the real-time clock has expired OR the internal acceleration sensor supplies	BOOTING	The internal power supply switch is closed. All circuit parts are supplied with voltage. The power indicator lights red. Self-tests for hardware and software are executed. The interfaces are activated (CAN after $\leq 250\text{ ms}$).

No.	Initial condition	Alternating condition	Resulting operating mode	Condition description
		acceleration data (the product is being moved).		
3	BOOTING	The memory test was completed successfully and without errors.	ACTIVE / ON	The operating system is completely started. The power indicator lights green. The OEM application is running.
4	ACTIVE / ON	The measured voltage at input KL15 (connector X1, pin 11) falls below the switch-off threshold AND the software executes a command to switch off AND no start request is active. The OEM application defines the target status SLEEP and releases the action.	SLEEP	The internal power supply switch remains closed and all power supplies remain active. The software deactivates all functions except the functions for evaluating the start conditions. In addition, Ethernet interfaces remain active and are available as start requests. The power indicator is off.
5	SLEEP	A positive voltage greater than the switch-on threshold is applied to input KL15 (connector X1, pin 11) OR the preset timer of the real-time clock has expired OR the internal acceleration sensor supplies acceleration data (the product is being moved) OR a message is received via Ethernet interface 2.	BOOTING	All circuit parts are supplied with voltage. The operating indicator lights up red. Self-tests for hardware and software are carried out. The interfaces are activated (CAN after ≤ 250 ms). Continue with No. 3.
6	ACTIVE / ON	The measured voltage at input KL15 (connector X1, pin 11) falls below the switch-off threshold AND the software executes a command to switch off AND no start request is active. The OEM application defines the target status DEEP SLEEP and releases the action.	DEEP SLEEP	The start conditions are configured. The internal power supply switch is open and all circuit parts that are not required are off. The power indicator turns off. The software deactivates all functions except the functions for evaluating the start conditions. The product is waiting for one of the start conditions to be met: - Input T15 ≥ 6.5 V ± 5 %, - Expiry of the sleep timer or - Movement of the product.
7	ACTIVE / ON	The voltage at connector X1, pin 1 (battery plus / KL30) falls below the switch-off threshold. The product is switched off after at least 2 ms. Loss of data is possible.	OFF	The product is not supplied with voltage and has no function. All operation indicators are off.
8	DEEP SLEEP	The voltage at connector X1, pin 1 (battery plus / KL30) falls below the switch-off threshold. The product is switched off after at least 2 ms.	OFF	The product is not supplied with voltage and has no function. All operation indicators are off.

5.8 Interfaces

5.8.1 CAN Interfaces

The product has up to three CAN interfaces. These are designated CAN 1 to CAN 3.

All CAN interfaces comply with the ISO 11898 standard and are designed without terminating resistor. An external resistor must be provided in the cable for termination. Each interface can optionally be provided with a fixed, internal terminating resistor at the factory.

The connections of the CAN interfaces are short-circuit proof against ground and the supply voltage.

The product supports the CAN protocols CAN Raw and CAN ISO-TP.

The CAN interfaces of the Mobile Communication Gateway (MCG) are disabled at delivery.

Note

Bit rates of 1000 kB/s are not possible simultaneously for all CAN interfaces.

5.8.2 LAN Interfaces

The product has two alternative LAN interfaces. These are designated ETH 1 and ETH 2.

The interface ETH 1 complies with 100BASE-T1 according to IEEE 802.3bw.

The interface ETH 2 complies with 100BASE-TX according to IEEE 802.3 Clause 25.

The product is delivered with the following factory settings:

Parameter	Factory setting
Active interface	ETH 2
IP-Address	192.168.3.48
Subnet mask	255.255.255.0

The MAC address is permanently stored in the product and indicated on the identification plate in the DataMatrix code.

5.8.3 Wireless LAN Interface

5.8.3.1 General

This interface is optional and not available in every product variant. An overview of the variants is given in chapter 5.3 page 13.

The WLAN interface complies with:

Model / Product key	Standard	Operating frequency bands	Maximum transmitted radio-frequency power
MCG-XXX-X	IEEE 802.11abgn	2.4 GHz / 5 GHz	17.3 dBm / 18 dBm

Note

This interface requires an external antenna. The antenna is not included in the scope of delivery.

5.8.3.2 Antenna

The approval was performed with the following antenna types:

Manufacturer	Type designation
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_BL / K71LFR_0200_119_CL11.4_BL
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_xx / K71LFR_0200_119_CL11.4_xx

Information

Operation with other antennas requires an analysis/check of the electrical parameters and conformity tests if necessary.

5.8.4 Cellular Interface

5.8.4.1 General

The product has a cellular interface for mobile communication. Depending on the product variant (see chapter 5.3 page 13), the product can be used for North and South America or worldwide with exception of America.

Note

This interface requires an external antenna and a SIM card. The external antenna and SIM card are not included in the product.

5.8.4.2 SIM Card

The product is designed for mini-SIM cards (form factor 2FF). The SIM card is accessible to the user under a cover in the housing. The insertion of the SIM card is described in chapter 7.2, page 26.

5.8.4.3 Variants with cellular module AM (North and South America)

Variants for America (North and South America) are equipped with the "LTE/HSPA+/GSM Module America Cat 4". This professional 4G telematics module supports:

Model	Supported radio networks	Operating frequency bands	Maximum transmitted radio-frequency power
MCG-XXX-2	4G LTE	B2/B4/B5/B7/B17	23 dBm
MCG-XXX-2	3G UMTS	B2/B5	24 dBm
MCG-XXX-2	2G GSM	B2/B3/B5/B8	33 dBm / 30 dBm (DCS- and PCS-Bands)
MCG-XXX-2	2G EDGE	B2/B3/B5/B8	27 dBm

5.8.4.4 Variants with cellular module WW (Worldwide except America)

These variants are equipped with the "LTE/HSPA+/GSM module for Europe/Asia Cat 4". This professional 4G telematics module supports:

Model	Supported radio networks	Operating frequency bands	Maximum transmitted radio-frequency power
MCG-XXX-1	4G LTE	B1/B3/B5/B7/B8/B20	23 dBm
MCG-XXX-1	3G UMTS	B1/B2/B5/B8	24 dBm
MCG-XXX-1	2G GSM	B2/B3/B5/B8	33 dBm / 30 dBm (DCS- and PCS-Bands)
MCG-XXX-1	2G EDGE	B2/B3/B5/B8	27 dBm

5.8.4.5 Antenna

The approval was performed with the following antenna types:

Manufacturer	Type designation
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_BL / K71LFR_0200_119_CL11.4_BL
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_xx / K71LFR_0200_119_CL11.4_xx

The approval was additionally performed in accordance with EN301489 (RF Common Mode) with a cable length of more than 3 m. This allows a cable length of more than 3 m.

Information

Operation with other antennas requires an analysis/check of the electrical parameters and conformity tests if necessary.

5.8.5 GNSS Interface

5.8.5.1 General

The built-in GNSS module supports the positioning systems GPS, Galileo, GLONASS and Beidou. The module enables concurrent reception of up to three GNSS data. To use this function, the operation with active antenna is mandatory. The module for standard precision supports also:

- Assisted GNSS (A-GNSS)
- SBAS Satellite-Based Augmentation System
- Diagnosis of cable rupture and short circuit

5.8.5.2 Antenna

The approval was performed with the following antenna types:

Manufacturer	Type designation
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_BL / K71LFR_0200_119_CL11.4_BL
REEL Reinheimer Elektronik GmbH	F71LGAR_0200_118_78_CL10.4_xx / K71LFR_0200_119_CL11.4_xx

The approval was additionally performed in accordance with EN301489 (RF Common Mode) with a cable length of more than 3 m. This allows a cable length of more than 3 m.

Information

Operation with other antennas requires analysis/verification of electrical parameters and, if necessary, compliance checks.

5.9 Displays and Indicators

5.9.1 Power Indicator and Connection Status Indicator

The two operation indicators (position 9 and 10 in Figure 1, page 11) are designed as multi-coloured LEDs. The colours can be freely controlled via the software.

Product state	Description	 PWR	 CON
OFF	The product is switched off and not supplied with power.	Off	Off
Switch on	The product is started. Boot sequence 1: Boot loader is executed. Boot sequence 2: Kernel is started. Boot sequence 3: Linux is started.	Red, On Yellow, On Green, On	Off
Firmware update	The product is performing a firmware update.	Green, flashing (1 Hz)	Off
Radio interfaces off.	All radio interfaces are deactivated.	Green, On	Off
Establishing a connection	One of the existing radio interfaces is establishing a connection.	Green, On	Yellow, On
Radio connection established	One of the existing radio interfaces has established a radio connection.	Green, On	Green, On

Note

The operating indicators can also be used to display error states. The predefined error codes are described in chapter 8.2, page 28.

5.10 Inputs and Outputs

5.10.1 Digital Output

The product has a plus-switching digital output. This output is protected against short circuit to T30 (battery positive) and T31 (ground). The output has the additional diagnostic functions:

- Feedback measurement of the output voltage
- Actual output current
- Error status of the output driver
- Overload/Short circuit/Open

The output meets the following performance parameters:

- Load current: nominal 100 mA/maximum 2 A
- Switching frequency: 200 Hz
- Short circuit protection: against UBAT and ground
- Freewheeling diode: No
- Accuracy voltage: $\pm 3.5\%$
- Accuracy current: $\pm 19.5\%$

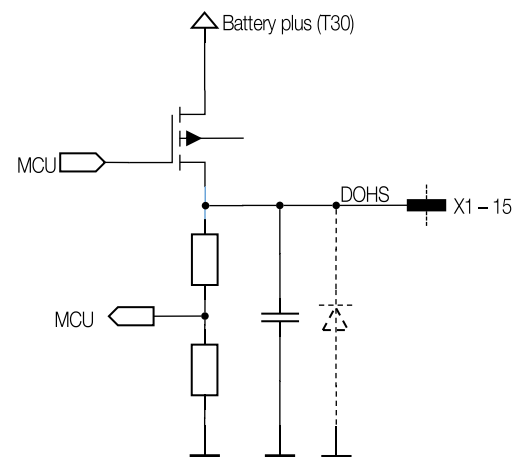


Figure 13: Structure of the switching output

5.10.2 Digital Input For Voltage Measurement

The product is equipped with one analogue input for voltage measurement. This input is protected against over-voltages and against short circuit to T30 (battery positive) and T31 (ground).

The voltage applied to the input is adapted to the internal measuring range by an internal voltage divider.

The inputs meet the following performance parameters:

- Measuring range: 0 – 16 V
- Resolution: 10 Bit
- Impedance: $\sim 38\text{ k}\Omega$
- Accuracy: 3.4 %
- Cut-off frequency (f3dB): 333 Hz

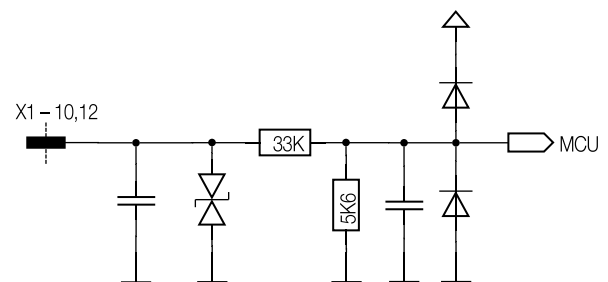


Figure 14: Structure of the input

5.11 Other Functions

5.11.1 3-axis accelerometer

The device is equipped with a sensor that detects acceleration in three axes. This internal sensor can be switched between the measuring ranges $\pm 2\text{ g}$, $\pm 4\text{ g}$ and $\pm 8\text{ g}$. The sensor is integrated into the product function in such a way that movements of the product are registered even in energy-saving mode and can be used to start the product.

5.11.2 Real-Time Clock

The product is equipped with a battery buffered real-time clock (RTC).

The integrated RTC of the product works without an active power supply for at least 2 weeks.

The integrated RTC of the product ensures a maximum fault of about 1 hour per year.

5.12 Product Functions and Software

The Mobile Communication Gateway (MCG) is application-specific and freely programmable. The OEM carries out this programming. A detailed description of the product functions is therefore not possible. Information on the development environment, the basic software and the software development for the product can be found in the corresponding separate documentation.

6 Installation

6.1 Installation locations

The product meets the requirements of protection class IP5K2. It is intended for use in splash-proof environments.

When choosing the installation location:

- ▶ Observe operating and storage temperatures of the product.
- ▶ Select locations protected from water and moisture.
- ▶ Avoid areas with strong vibrations like the engine compartment or the chassis.
- ▶ Avoid areas that expose the product to mechanical loads (for example, stone chips, shearing off the connection cable, or the like).

6.2 Mounting Positions

When choosing the mounting position:

- ▶ Install the product with the connections facing to the side or downwards.
- ▶ Avoid mechanical stress on cables and connectors.

6.3 Attachment to the Machine

The fixing points, dimensions and positions are described in chapter 5.5, page 14.

The MCG has four mounting holes (see position 4 in Figure 1, page 11) for mounting on the machine. Alternatively, the product can be attached to the machine using a mounting bracket (see groove with position 5 in Figure 1) or with two screws and a profile strip.

6.3.1 Preparation

Before attaching to the machine:

- ▶ Provide mounting points according to Figure 4, page 14 at the machine or vehicle
- ▶ Provide fixing screws (four times M5 or comparable with screw head or washer of at least 9.5 mm diameter).
- ▶ Provide connecting cable and plug connector on the machine.
- ▶ Provide a vehicle-side fuse for the supply lines with a maximum of 3 A.
- ▶ Check connecting cable and plug connector for damage.
- ▶ Repair or replace damaged connecting cables.
- ▶ Check the product for damage.
- ▶ Replace damaged products.
- ▶ Disconnect the machine's connecting cable from the power supply to connect the product.

6.3.2 Attaching to the Machine

- ▶ Position the product at the installation location.

ATTENTION

Damage to property due to mounting with the wrong tightening torque

- ▶ Secure the product to the machine or vehicle with the fixing screws and a maximum tightening torque of 3.1 ± 0.1 Nm.

ATTENTION

Malfunctions or defects due to leaks and damage caused by cable vibration

- ▶ Fix the cable to the machine at a maximum distance of 10 cm.



Note

Warranty claims due to mechanically damaged, dirty or corroded contacts are excluded.

EN

6.4 Connect Electrical Connections

All connections of the product are coded differently and cannot be interchanged if used correctly (Poka-Yoke).

6.4.1 Preparation

- ▶ Switch off the power supply for the supply line (switch off ignition if necessary).
- ▶ Check all cables and plugs for damage. Do not use damaged parts.
- ▶ Check whether there is an upstream fuse with maximum 3 A in the supply lines of terminal T30 and terminal T15.

6.4.2 Connect the Product to the Machine

ATTENTION

Damage or malfunctions due to live connection! The product is not hot-pluggable.

- ▶ Disconnect the connecting cable for the product from the power supply.

- ▶ Attach the cable connector to the system connector (X1). The plug engages with a "click".
- ▶ Connect the antenna cable to antenna connections X2 to X5. The plugs snap into place with a "click".
- ▶ Plug the connector of the Ethernet cable onto connector X6. The plug engages with a "click".

If not all connections are used:

- ▶ Fit all unused connectors of the product with protective caps suitable for the installation location.

7 Operation

Note

Residual risks are not known if the instructions for safety and the other instructions within this document are observed.

ATTENTION

Unforeseeable malfunctions or material damage due to disregard of the operating instructions

- ▶ Read the operating instructions carefully before installation and commissioning and follow the instructions.
- ▶ Observe regulations on occupational safety and accident prevention.

7.1 Preparation

In order to be able to use the product or put it into operation, the following requirements must be met.

- ▷ The requirements according to chapter 2.2.4, page 8 must be fulfilled.
- ▷ The product must be installed in the machine or vehicle according to chapter 6, page 24.
- ▷ The product must be completely and correctly connected.
- ▷ The product must be equipped with a SIM card (see chapter 7.2).

The following preparatory steps must be carried out:

- ▶ Check the product and the connecting cables for damage.
- ▶ Check that all necessary cables are connected.
- ▶ Only use undamaged and functional products.

7.2 Installing or replacing the SIM card

To use the cellular interface, a SIM card (form factor 2FF) must be inserted into the product. Additional measures must be taken to prevent damage from electrostatic discharge when inserting the SIM card.

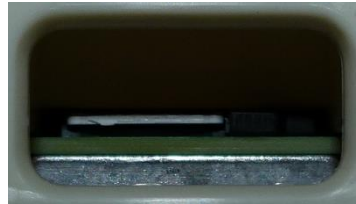
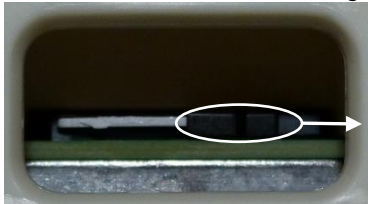


ATTENTION

Damage caused by electrostatic discharge when inserting the SIM card.

- ▶ Use SIM card in ESD protected environment or
- ▶ Take additional ESD protection measures when inserting the SIM card.
- ▶ Only use ESD-compatible aids (for example ESD tweezers).

- ▶ Disconnect the product from the power supply.
- ▶ Remove the card slot cover (see no. 3 in Figure 1, page 11).
- ▶ Slide the SIM card lock to the right.



- ▶ By pressing on the SIM card, it is ejected from the holder. A soft "click" can be heard.
- ▶ Grip the protruding SIM card with plastic tweezers (ESD-compatible) and pull it out of the product.
- ▶ Align the new SIM card with the bevelled edge facing left towards the product.
- ▶ Carefully insert the SIM card with the tweezers into the card holder as far as it will go.

- ▶ Press lightly on the SIM card to fix it in the holder. A soft "click" can be heard.
- ▶ Slide the SIM card lock to the left. A soft "click" can be heard.
- ▶ Close the card slot with the cover.
- ▶ Put the product into operation.

7.3 Commissioning

- ▶ Check whether preparatory steps according to chapter 7.1, page 26 have been carried out.
- ▶ Switch on the power supply of the product.
- ▷ The product starts with the configured/programmed mode of operation as soon as the supply voltage exceeds the switch-on threshold and at least one of the defined start conditions is fulfilled. Details can be found in the respective description of the OEM software.
- ▶ Check function in target application.

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7.4 Decommissioning

Trained specialist personnel (see chapter 2.2.3, page 8) only may carry out decommissioning. Carry out the following steps for disassembly and decommissioning.

- ▶ Switch off the product. Disconnect the power supply.
- ▶ Disconnect all connections.
- ▶ Loosen the mechanical fastenings.
- ▶ Transport and store the product in its original packaging.

8 Maintenance and Repair

8.1 Maintenance

When properly installed and used for its intended purpose, the product is maintenance-free.

At regular intervals (when cleaning or servicing the machine):

- ▶ Check that the product, the connectors and the connecting cables are firmly connected.
- ▶ Check the housing, connectors and connection cable for damage.
- ▶ Replace damaged products and materials.

8.2 Error description

8.2.1 System

Effect	Possible cause	Recommended action
Power indicator not lit	1. Upstream fuse defective 2. Cable not connected to connector X1	▶ Replace fuse and check product ▶ Check the position of the plug in X1. ▶ Check whether other consumers are ready for operation and check the power supply.
Incorrect system time	1. Time is not set. 2. Battery of the real-time clock is discharged.	▶ Set the time. If the clock is not set: ▶ Connect the unit to T30 and use it to charge the internal battery for the RTC. ▶ Set the clock again. i Information The internal battery of the RTC takes several hours to charge.

8.2.2 Data interfaces

Effect	Possible cause	Recommended action
No CAN communication possible	1. Connections on connector X1 not connected or reversed. 2. Wrong baud rate set 3. Incorrect assignment of CAN interfaces 4. CAN bus not terminated or terminated incorrectly	▶ Check the fit of the connector in X1. ▶ Check pin assignment. ▶ Check and set the baud rate. ▶ Adjust the HW and SW assignment. ▶ Check the CAN termination.
No communication possible via the Ethernet interface	1. Ethernet cable not connected to connector X6 2. Wrong pin assignment on the Ethernet cable 3. IP configuration incorrect	▶ Check the fit of the connector in X6. ▶ Check pin assignment. ▶ Check and set IP configuration.

8.3 Repair



NOTE

The product contains ESD-sensitive material. The housing may only be opened in an ESD-protected environment and by the manufacturer only.

It is NOT possible to repair the product in the field. Defective products can only be exchanged in the field. Return defective products to the manufacturer.

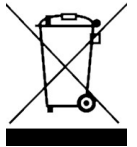
- ▶ Disconnect the machine or subsystem from the power supply.
- ▶ Disconnect all cables from the product.
- ▶ Loosen the mechanical fastening of the product.

- ▶ Attach replacement product according to specifications (see chapter 6.3, page 24).
- ▶ Connect replacement product electrically according to specifications (see chapter 6.4.2, page 25).
- ▶ Perform commissioning according to chapter 7.3, page 27.

9 Disposal

The product contains valuable materials. The product must therefore be disposed of separately from unsorted waste.

The products must be properly disposed of in accordance with national regulations and laws. Defective and replaced products should preferably be returned to the manufacturer.



EN

10 Standards

Applied standards

Environmental testing - Dry heat	DIN EN 60068-2-2
Environmental testing - Change of temperature	DIN EN 60068-2-14
Environmental testing - Damp heat, cyclic	DIN EN 60068-2-30
Environmental testing - Vibration (sinusoidal)	DIN EN 60068-2-6
Environmental testing - Shock (half sinus)	DIN EN 60068-2-27
Environmental testing - Vibration, broadband random	DIN EN 60068-2-64
Road vehicles - Degrees of protection (IP code)	ISO 20653
Tests for flammability of plastic materials for parts in devices and appliances	UL 94
Radio disturbance characteristics - Limits and methods of measurement	DIN EN 55025
Earth-moving machinery - EMC of machines with internal electrical power supply	ISO 13766-1
Road vehicles - Electrical loads	ISO 16750-2
Road vehicles - Mechanical loads	ISO 16750-3
Chemical loads	ISO 16750-5
Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy	ISO 11452-2
Road vehicles - BCI	ISO 11452-4
Road vehicles - Electrical transient conduction along supply lines only	ISO 7637-2
Road vehicles - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	ISO 7637-3
Road vehicles - ESD	ISO 10605
EMC - of combustion engine driven devices	DIN EN 55025
Audio/video, information and communication technology equipment - Part 1: Safety requirements	IEC 62368-1
ECE R10	



Note

The product falls under the Radio Equipment Directive. The standards complied with are listed in the EU Declaration of Conformity.

11 Technical Data

	Model	MCG-001-1	MCG-001-2
Processor	i.MX6 ARM Cortex-A9, @ 768MHz	Single	Single
Program memory	NOR/eMMC	8 GB	8 GB
RAM	DDR3	512 MB	512 MB
Operating system/Programming	Linux Yocto	●	●
Software package	Software variant		

Interfaces

Cellular Interface ²⁾			
SIM card	(provided by the customer)	○	○
Cellular module EU	Worldwide (except America)	●	—
Cellular module AM	America	—	●
WLAN	According to IEEE 802.11 abgn	●	●
Bluetooth® ²⁾	4.1 according to IEEE 802.15.1	●	●
GNSS ²⁾	GPS, Galileo, GLONASS, Beidou	●	●
ETH 1	100BASE-TX according to IEEE 802.3 Clause 25	●	●
ETH 2	100BASE-T1 according to IEEE 802.3bw	○	○
CAN	According to ISO 11898, 1 Mbit/s	3	3
RS232	According to ITU V.28	●	●

Inputs and Outputs

Universal Inputs	U_{IN} : 0 – U_{T30} , U_{TH} : $1/7 \cdot U_{T30}$	1	1
Digital Outputs	High Side, U_{OUT} : 0 V/ U_{BAT} , I_{OUT} : maximum 2 A	1	1

Additional functions

IMU (3-axis accelerometer)	configurable for ± 2 g / ± 4 g / ± 8 g	●	●
Real-Time Clock	± 1 hour per year, buffered for 14 days @25 °C	●	●
Keep Alive (LED)	RGB-LED	1	1

Operating conditions

Operating voltage range	U_{BAT}	8 V to 32 V
Switch-on threshold		≥ 6.5 V ± 5 %
Switch-off threshold		< 6.5 V ± 5 %
Power consumption ³⁾	$I_{T30 \max}$ (@ $U_{T30} = 24$ V, 25 °C)	≤ 1.5 A
Power consumption ³⁾	$I_{T30 \max}$ (@ $U_{T30} = 12$ V, 25 °C)	≤ 2.5 A
Operating temperature	Ambient temperature at the installation location	-30 °C to +70 °C
Storage temperature	Ambient temperature at product storage location	-30 °C to +70 °C
Operating altitude	Elevation above sea level	≤ 2000 m

Miscellaneous

Dimensions	W x H x D mm ³	205 x 130 x 38
Weight		530 g
Protection class ¹⁾	(ISO 20653)	IP5K2
Reliability (MTTF)	according to IEC/TR 62380	>20000 h

Character meaning: ● Standard, ○ Optional, — not possible

¹⁾ All connectors are connected or closed with suitable protective caps.

²⁾ Use only with approved antennas (REEL: F71LGAR_0200_118_78_CL10.4_BL or K71LFR_0200_119_CL11.4_BL)

³⁾ Connection T30 must be fitted with a 3 A fuse. Connections T15 and EX_UI must be fitted with a 1 A fuse.

12 Technical Terms and Abbreviations

Term / Abbreviation	Meaning	Description / Explanation
AC	article code	Number assigned to a product by Liebherr for purposes of identification.
CAN	Controller Area Network	Serial communications protocol which efficiently supports distributed real time control with a very high level of security.
CPU	Central processing unit	Central processing unit of an electronic product. A CPU can consist of several processor cores.
DOHS	Digital Output High Side	Switching output of an electronic product where the positive supply voltage is switched to the terminal contact.
EBZ	Installation drawing	Drawing showing an assembly in installation position, with overall dimensions, installation dimensions and other notes (maintenance points, technical data).
ESD	Electrostatic discharge	Transfer of electric charge between bodies of different electric potential in proximity or through direct contact.
ETH	Ethernet	Family of wired computer networking technologies commonly used in local area networks (LAN), metropolitan area networks (MAN) and wide area networks (WAN).
GND	Ground	Reference potential for all signal and operating voltages in an electrical circuit. Usually 0 V is assigned to this. A preceding letter "C" means chassis and indicates an electrical connection to the housing of the electronics.
GNSS	Global Navigation Satellite System	System for positioning and navigation on earth and in the air by receiving signals from navigation satellites and pseudolites.
GPL	General Public License	Licensing model of the Free Software Foundation for licensing free software.
IMEI	International Mobile Equipment Identity	Unique 15-digit serial number that can be used to uniquely identify any GSM or UMTS terminal worldwide.
IMU	Inertial Measurement Unit	Measuring system for the acquisition of accelerations and angular accelerations for the determination of spatial movements and thus positions and alignment.
LGPL	Lesser General Public License	Licensing model of the Free Software Foundation for licensing free software.
MCU	Micro Controller Unit	Electronic component containing both a processor and peripheral components.
MTTF	Mean Time To Failure	Average operating time until a fault occurs or a product fails.
OEM	Original Equipment Manufacturer	Manufacturers of machines, vehicles or industrial plants into which products of component manufacturers are integrated.
OSS	Open Source Software	Software, which is distributed under an OSD-compliant license which grants all the rights to use, study, change, and share the software in modified and unmodified form.
PoE	Power over Ethernet	Method in which an Ethernet terminal device is supplied with power via the data line.
RS232	Recommended Standard 232	Standard of the ITU (International Telecommunication Union), which was originally introduced in 1960 for serial data transmission.
RTC	Real-Time Clock	Computer clock (usually in the form of an integrated circuit) that measures physical time.
SIM card	Subscriber identity module or subscriber identification module	Integrated circuit in which the International Mobile Subscriber Identity (IMSI) number and associated key are stored, which are used to identify and authenticate subscribers on mobile devices (for example, mobile phones and computers).
SPF-Index	Specification index	Numerical value indicating the valid revision of a product specification.
UI	Universal Input	Measurement input of an electronic circuit with which various measured variables or signal forms can be measured.
VDC	Volts of Direct Current	Direct current voltage. Electrical voltage with constant amplitude.
WLAN	Wireless Local Area Network	Local area network in which data are transferred without the use of wires.

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