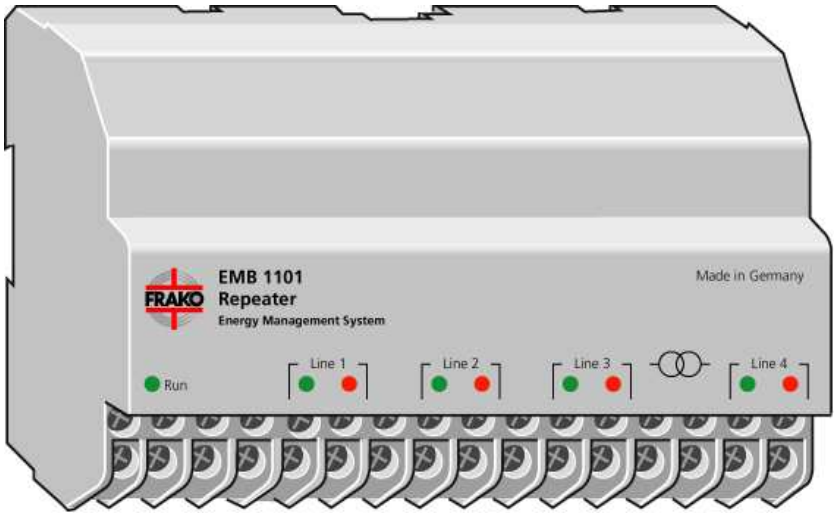
EMB 1101 Repeater

Operating Manual



Safety notes and warnings

Important – read before commissioning!

- The operator must ensure that all users are familiar with this operating manual, and follow its instructions.
- Read the operating manual carefully before installing and commissioning the equipment.
- Always follow the instructions in the operating manual.
- Installation and start-up must only be done by appropriately trained personnel, observing all existing rules and regulations.
- This device runs under line voltage, and must not be opened!
- If there is any visible damage to the device, it must not be installed, connected, or put into operation.
- If the device does not function after start-up, it must be disconnected from the power supply again.
- Any other laws, standards, guidelines, etc. relating to this product that may exist must be observed.

Table of Contents

Page

Illustrations

EG-Konformitätserklärung
Declaration of Conformity

Dokument-Nr. CE-EMB 1101-101A / 10.1998

Wir/*We* FRAKO Kondensatoren- und Anlagenbau GmbH
Tscheulinstraße 21 a
79331 Teningen
GERMANY

erklären in alleiniger Verantwortung, daß das Produkt
declare under our sole responsibility that the product

Repeater **EMB 1101** from HW-issue: 1.0
Repeater

auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder normativen Dokument(en) übereinstimmt:
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

1. EN 50 081-1 01.92 EMV, Fachgrundnorm Störaussendung Wohnbereich
   EN 50 081-2 08.93 EMV, Fachgrundnorm Störaussendung Industriebereich
   EN 50 082-1 03.93 EMV, Fachgrundnorm Störfestigkeit Wohnbereich
   EN 50 082-2 01.93 EMV, Fachgrundnorm Störfestigkeit Industriebereich

   gemäß der Bestimmungen der Richtlinien
   following the provisions of Directive

   89/336/EWG Elektromagnetische Verträglichkeit
   92/31/EWG Änderung der Richtlinie 89/336/EWG
   93/68/EWG Änderung der Richtlinien .. 89/336/EWG

2. EN 61010-1 1993 Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte

   gemäß der Bestimmungen der Richtlinien
   following the provisions of Directive

   73/23/EWG Niederspannungsrichtlinie
   93/68/EWG Änderung der Richtlinien .. 73/23/EWG

Teningen, den 01.04.2005

P. Herbst

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften. Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.
This declaration certify the conformity according to the mentioned directives, without any assurance of features. Please note the safety instructions of the attached product documentation.

1. Short instructions

- **Installation:**
  - Mount the unit by snapping it onto a 35-mm DIN Standard mounting rail (“top-hat rail”).
  - Wire up according to the wiring diagram Figure 1, page 9.

Important note:
During installation and when servicing, disconnect the unit from the power supply.

- **Start-up:**

  After installation, the EMB 1101 repeater can be connected to the power supply. The device does not require any further adjustments.

2. Function

The EMB 1101 repeater as per Figure 9, page 21, serves to condition and forward signals in the FRAKO power bus system. With the help of this device, bus lengths of up to 15 km can be implemented. Parts of the bus system can be electrically isolated by the repeater. By means of a supplementary module (EMB 1101/OPT), signals can be interchanged directly with a fibre-optic channel from the repeater.

2.1 Data transfer

To give an idea of the functioning of the repeater, the operation of the bus is outlined here.
A *master device* (e.g. an EMZ bus central processing unit or EMP 1100 communications processor) sends a enquiry to a specific *slave device* (data source) via the bus. All the devices connected to the bus system also hear this enquiry, but only the device with the corresponding bus address replies with an answer. This answer is also heard by all the devices connected to the bus, but is only processed by the master device which initiated the enquiry.
Electrically speaking, an enquiring master does the same as a replying slave: both devices send a data packet into the bus system. It is only the data contents which make an enquiry or a response out of these packets. The contents also determine to which device (which bus address) the packet is directed.

Thus there is no distinction between inputs and outputs at the repeater. All bus connections (*Line 1 - 4*) have equal access authorization.

In the idle condition, all lines are switched as inputs. As soon as the beginning of a data packet is recognized at one input, the other three lines become outputs, and forward the data arriving. In addition, the input channel is marked by the green LED. After the transmission, all the lines revert to the idle condition (all outputs).

2.2 Data monitoring

During the data transmission, the repeater monitors the protocol (contents of the packets). It checks whether the data contents are meaningful, and that the protection mechanisms contained in the data packet are not violated (e.g. the checksum or maximum data length). If an error is detected, this is signalled by the red LED at the respective input channel.

Note:
Despite a transmission error being detected, the forwarding of the data is not interrupted.

The repeater behaves differently if an electrical fault is detected. As soon as a bus connection is permanently active (e.g. if bus connection B is connected to ⊥), that input is disabled. The repeater signals this by alternating blinking of the red and green LEDs.
After about 4 seconds, the system checks again whether the bus connection concerned is still malfunctioning. If not, operation is resumed automatically.

2.3 Propagation delays

The propagation delays between the bus connections *Line 1* to *Line 3* within the repeater are approx. 0,2 µs. This corresponds to a cable length of about 60 m.
The propagation delays between the bus connections *Line 1* to *Line 3* and *Line 4* are approx. 1 µs. This corresponds to a cable length of about 280 m.

2.4 Electrical isolation

The bus connection *Line 4* is electrically isolated from the other bus connections. The maximum potential difference between *Line 4* and the other lines must not exceed 1,000 V DC.

2.5 Display

The EMB 1101 possesses nine LED indicators, with the following functions:

Run: This indicator blinks about once a second to show that the EMB 1101 is operating properly.

Lines: Indicates the data input with the green LED. The red LED indicates detected protocol errors.
Alternating blinking of the red and green LEDs indicates a detected electrical fault.

2.6 Fibre-optical interface

An EMB 1101/OPT fibre-optical interface can be connected to the EMB 1101 as well. By using two EMB 1101s, each combined with an EMB 1101/OPT, fibre-optical routes of up to 3 km can be bridged.
See the operating instructions of the fibre-optical interface for details.

3. Installation of the EMB 1101

3.1 Mounting

The EMB 1101 repeater possesses a standardized housing for mounting on a 35-mm DIN Standard mounting rail ("top-hat rail"). It can be installed in any position.

Caution:

The device is intended only for installation in distribution or switchgear cubicles. It must not be possible to touch the terminals during subsequent operation.

3.2 Electrical connection

The device must be connected in accordance with the wiring diagram in Figure 1.

Important note:

The device must be disconnected from the power supply during installation and servicing.

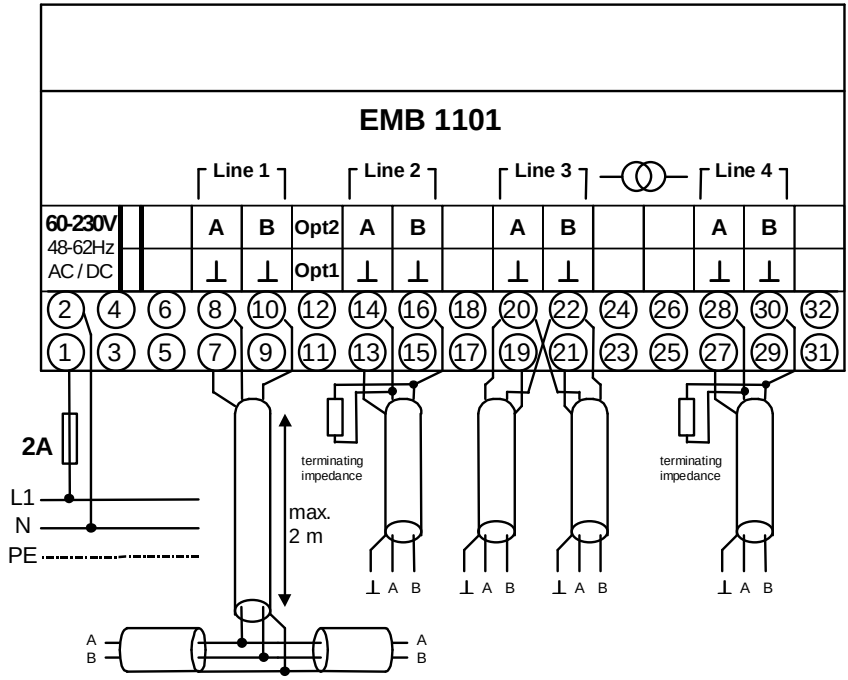


Figure 1: Wiring diagram

3.2.1 Supply voltage

The supply voltage must be in the range 60 V to 265 V. It can be either alternating or direct current. In the case of alternating current, the frequency must be in the range 48 Hz to 62 Hz. It must be connected to the "**60 - 230V"** terminals according to the wiring diagram in Figure 1.

Important note:

The connection for the supply voltage must be protected externally by a 2-A fuse.

3.2.2 Connection of the bus leads

The conductors **A**, **B**, and **GND** (⊥) of the bus cable must be connected in the bus connections ("lines") used. The connection **A** at the repeater is connected to the connection **A** of the other EM devices. Follow the same procedures for the connections **B** and **GND** (⊥).
If the repeater is within a bus link, the two cable ends must be clamped to one line (see Figure 1, page 9, *Line 3*), or connected by means of a spur line (see Figure 1page 9, *Line 1*).
Leave unused bus connections (lines) on the repeater unwired. Two bus connections of a repeater must not be connected together. If an EMB 1101/OPT (fibre-optical interface) is employed, it must be connected to Line 1.

Caution:

An external voltage must not be applied to the bus connections. The bus connections must not be connected to one another.

3.3 Terminating impedances

The bus lines are implemented as single strings, i.e. the bus cable runs from one device to the next, and so on to the last device. A terminating impedance is inserted between conductors **A** and **B** at the first and last devices. If the EMB 1101 is connected to one end of the string, a terminating impedance must also be attached to the device (see Figure 1, Page 9, *Line 2* and *Line 4*).
For example, if a cable with 120 ohms characteristic impedance is employed, a 120-ohm resistor must be used at each end of the string. The resistors must be designed for a capacity of 250 mW.

In strings with only a few bus users, it may be necessary to install additional loads. These should also be connected to the terminals at the ends of the string, between conductors **A** and **GND** (⊥). Their resistance is 1 kilohm each.

Caution:

If a long-distance link is established between two repeaters (see Section 5.3, Page 14), no terminating impedances are used for this string.

4. Start-up of EMB 1101

4.1 Before start-up

Important note:

Before starting up the device, make sure that people can no longer touch its terminals (e.g. by means of a closed door or an outer casing).

After the installation has been carried out, as described in Section 3, and the above note has been obeyed, power may be applied and the EMB 1101 put into operation.

4.2 Function check

After power has been applied, all the LEDs of the individual lines light up briefly. Then the **Run** LED begins to blink about once a second.

If the device must already forward data over the FRAKO power bus, the green LEDs of the corresponding inputs will also blink.

Caution:

If the EMB 1101 does not behave as described above, disconnect the power again, and check the installation.

4.3 Operation of the EMB 1101

The repeater is working properly if the green LEDs on the lines in use are alight or blinking. If no master device is connected to a line termination, **and** the devices on that bus link are not being addressed, the green LED for that link will not light up.

The **green LED** indicates that data are currently being received at this line termination, and distributed to the other line terminations.

The **red LED** is activated as soon as errors are detected in the data packet received. However, the data will still be forwarded.

Alternating blinking (the red and green LEDs blink alternately) occurs if a line termination is detected as being “permanently active” (e.g. terminal **B** is short-circuited with terminal ⊥).
As long as the blinking occurs, no data will be accepted from this terminal. After a period of about 4 seconds, the repeater checks the corresponding terminal again. If the terminal is in proper order again, the alternating blinking will be cancelled.

5. Bus structures

A brief explanation of some terms first, for better understanding:

Link / string: An uninterrupted bus cable connection (link) without any branches that are longer than 2 metres.

Bus system: The set of all the devices that can be addressed from a master device. The data may be transmitted via one or more repeaters or via fibre-optical conductors.

Long-distance link: An uninterrupted connection established with cables or fibre-optical conductors. An EMB 1101 is used at each of the two ends.

The EMB 1101 repeater is not absolutely necessary for setting up a bus system. The repeater only needs to be used if one of the following conditions is not met.

Boundary conditions for a bus system **without** EMB 1101:

- ***The maximum length of a string must not exceed 1000 metres.***
- ***The bus must be implemented as a string (single line).***
  The bus line runs from one device to the next. The length of a branch (spur line) must not exceed 2 metres.
- ***The entire route must be implemented with bus cables.***
  The permissible bus cables are listed in Appendix A. Mixing different varieties should be avoided.
- ***Only a maximum of 32 devices may be operated on one link.***

The use of EMBs puts the following limits on the bus system:

- ***The maximum distance between two master devices may not exceed 1500 metres***.
  - Master devices are EMZs or the EMP 1100
  - Repeaters may be employed between the master devices.
  - The distance is measured between the two devices that are furthest apart.
  - The propagation delay of the repeater must be taken into account when measuring the distance (see Section 2.3, Page 8 and Section 5.1, Page 13).
- ***The maximum distance between a master device and an EM device may not exceed 15 km.***
  It does not matter whether this master addresses the EM device or not. The propagation delays of the repeaters (see above) must be taken into account.
- ***No more than 6 repeaters may be connected between a master device and an EM device.***
- ***No more than 120 devices may be operated in the bus system.***

Caution:

Even if repeaters are used, each bus number may only be assigned once in the bus system.

5.1 Determining distances in the bus system

In Section 5, the boundary conditions for a bus system with repeaters are specified. The distances given there are derived from the cable length and the propagation delay of the repeaters.

Essentially, the physical cable lengths are used to determine the distances within a link. The physical lengths of the conductors are also calculated for fibre-optical links.

The EMB 1101 has a specific propagation delay for the transmission of data. The propagation delays and the line lengths corresponding to them are listed below:

	Line 1	**Line 2**	**Line 3**	**Line 4**
Line 1	---	60 m	60 m	280 m
Line 2	0,2 µs	---	60 m	280 m
Line 3	0,2 µs	0,2 µs	---	280 m
Line 4	1 µs	1 µs	1 µs	---

In order to determine the system distance between two users, the cable lengths and repeater propagation delays must be added together.

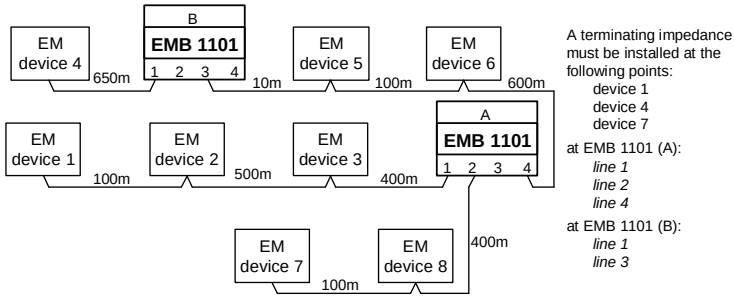


Figure 2: Determination of length

In the above illustration, the following system distances result:

a) *Distance between Device 1 and Device 7*
100 m + 500 m + 400 m + 60 m (propagation delay in repeater A) + 400 m + 100 m = 1,560 m

b) *Distance between Device 1 and Device 4*
100 m + 500 m + 400 m + 280 m (propagation delay in repeater A) + 600 m + 100 m + 10 m +
60 m (propagation delay in repeater B) + 650 m = 2,700 m

c) *Distance between Device 6 and Device 7*
600 m + 280 m (propagation delay in repeater A) + 400 m + 100 m = 1.380 m

The electrical isolation of the connection *Line 4* results in a longer propagation delay (1 µs == 280 m), due to the internal optical couplers.

In the example shown above, the bus of Devices 4 to 6 is electrically isolated from the other bus components. Despite this, all the devices belong to one bus system.

5.2 Extension of the bus system

In order to implement a bus system with distances greater than 1000 metres, one or more repeaters must be employed.

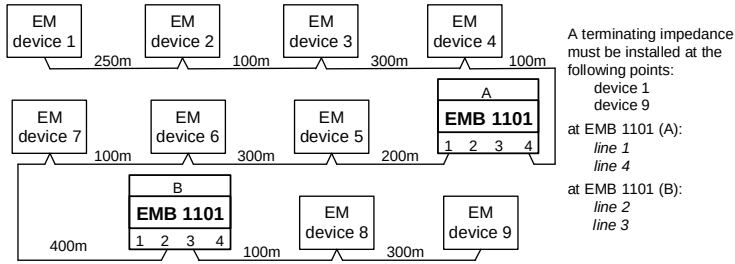


Figure 3: Extension of bus system

A distance of 2150 metres was bridged with the bus system shown above. The system distance (including the propagation delays) amounts to 2690 metres.

5.3 Long-distance links

Another way to extend the bus system is by setting up long-distance links. Distances of up to 4 km can be bridged by establishing long-distance links. The only requirement is that there are no other EM devices within the long-distance link. The connection can only be established between two repeaters.

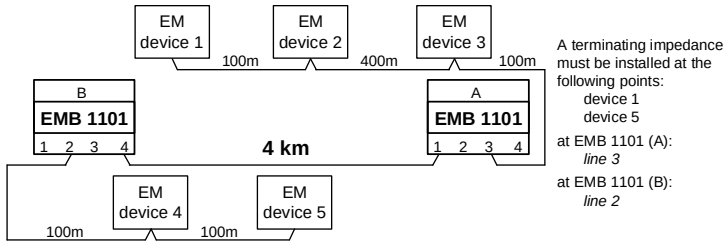


Figure 4: Long-distance link

Caution:
Terminating impedances must not be set in the long-distance link.

Long-distance links can also be cascaded; in other words, after 4 km, the next long-distance link begins immediately at the repeater. It is possible to connect up to four long-distance links to one repeater (a long-distance link at each terminal).

It is not essential to use bus cables for the long-distance link. Leads can be used without consideration of their characteristic impedance.

5.3.1 Links without bus cables

Sometimes a line has already been laid between two points that is not implemented as a bus cable. In such cases, the principle of a long-distance link must be applied, regardless of the distance (maximum 4 km).

5.3.2 Differing bus cables

If different varieties of bus cable are employed, a repeater should be employed at the reflection point.

5.4 Branches (radial circuits)

As mentioned previously, the maximum length of a spur line is limited to 2 metres. In order to serve longer branches, a repeater must be employed at the intersection.

Since the repeater is not necessarily located at the end of a string, two different types of circuit can be employed to set up a branch or a star point.

a) All links end at the repeater. Thus the entire bus system consists of three links.

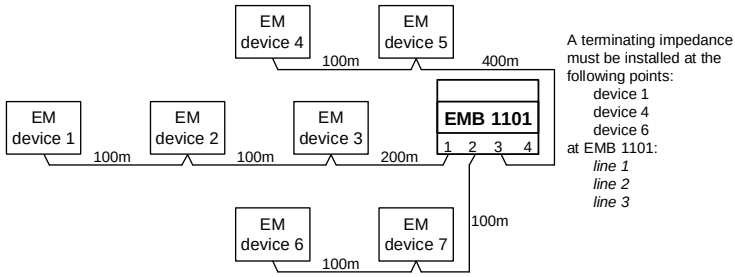


Figure 5: Repeater as star point

b) But it is also possible to set up a “real” branch point.

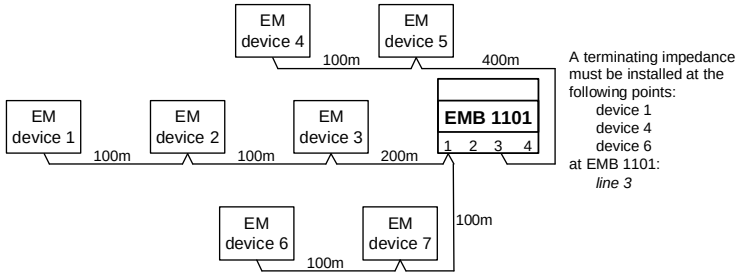
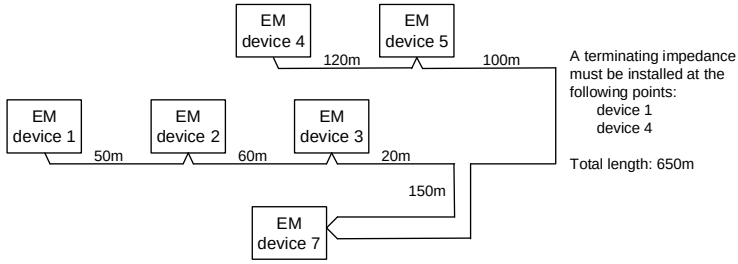


Figure 6: Repeater as branch point

In an extreme case, up to eight bus cables can thus arrive at one repeater, forming a total of four bus links.

Note:
Under some circumstances, it is possible to dispense with the use of a repeater in smaller bus systems, if the branch link is implemented with a send and a return conductor.



5.5 More than 32 devices

Another limit of the bus system is that not more than 32 devices may be operated on one string. In order to be able to operate the maximum number, 120 EM devices (with bus address), in the bus system, the bus system must be subdivided by means of repeaters into strings with not more than 32 devices.

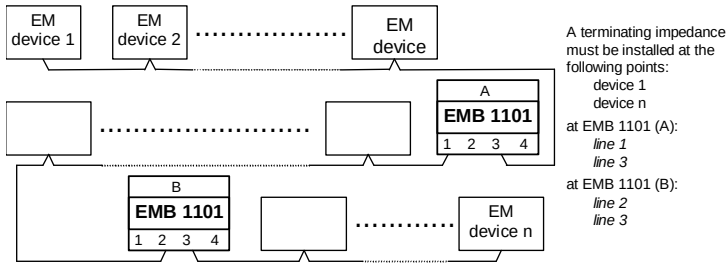


Figure 7: At most 32 devices per string

In order to determine the number of devices within a string, each repeater connected to this string must be counted as well. Thus one repeater counts as a device in more than one string. The number of devices of a string must not exceed 32.
But within one bus system, a total of 120 devices with bus addresses may be employed. Since repeaters do not have a bus address, they are not included in the count for the total number.

6. Setting up and commissioning a bus system

After customizing a bus system to one's own needs with the help of Section 5, the cables and devices are installed. Next, the bus system must be commissioned.

6.1 Selection of the bus structure

On the basis of the examples shown in Section 5 and the sections following, you should be able to adapt a bus system to your local circumstances.
The examples shown can be combined at will. The only important thing is that you observe all the boundary conditions named in your own bus system.

6.2 Installation of the bus system

Install and put into service all the devices in accordance with their operating instructions. Lay the bus cable according to your own plans. Only the cables named in Appendix A should be used.

Caution:

In the case of previously-laid cable links (e.g. long-distance links), make sure that these are floating (not earthed) and de-energized.

Also check that these links are not open or short circuited.

6.2.1 Earthing the system

Another important point is how the system is earthed. There must not be any floating strings or long-distance links within the bus system. Normally, the EMZ earths the GND terminal lead of the bus cable. Thus strings and long-distance links that are connected to the EMZ via *Line 1* to *Line 3* on the EMB 1101 also have a connection to earth. Only in the case of outgoing links via *Line 4* on an EMB 1101 is the connection to earth lost for that component. Such strings or long-distance links must be earthed separately.

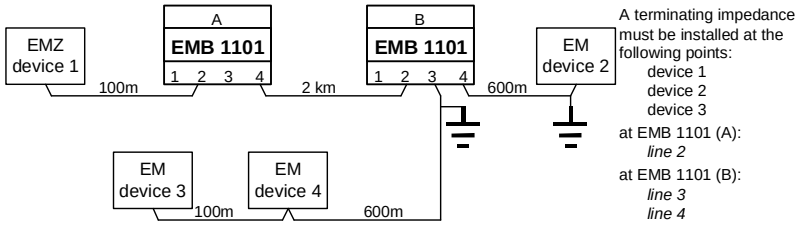


Figure 8: Earthing

The earthing must only be done at a single point within the isolated system (to avoid earth loops). If additional isolated strings need to be connected, these must be earthed as well.

6.3 Commissioning the bus system

When putting a new bus system into service, it is essential to perform the following steps.

Start with a string to which the master device (EMZ or EMP) is to be connected.

- **All devices, as well as the terminating impedances, must be removed from the bus cable.**
  However, the bus should remain interconnected (continuity).
- **Checking for earth connections, short circuits, or open circuits**

Test step	Desired value
Voltage between earth and bus-cable conductor A	< 1 V
Voltage between earth and bus-cable conductor B	< 1 V
Voltage between Earth and bus-cable conductor GND	< 1 V
Impedance between bus-cable conductors A and B	high
Impedance between bus-cable conductors A and GND	high
Impedance between bus-cable conductors B and GND	high

  Next, connect the three conductors of the bus cable to one another at one end of the string. Then check at the other end of the string:

Test step	Desired value
Impedance between bus-cable conductors A and GND	< 500 **Ω**
Impedance between bus-cable conductors B and GND	< 500 **Ω**

  Note:
  For long-distance lines, the impedance may be higher.
  Then eliminate the short-circuit at the end of the string again.
- **Check the polarity of A, B and GND at each device connecting point**
  To do this, connect any slave device (not an EMZ or EMP) to the string, and switch it on. Measure and note the voltage between conductors A and GND, and B and GND. You can now check at all other device connecting points which is conductor A, and which is conductor B.
- **Connect all devices and place the terminating impedances**
  Finally, connect all devices and terminating impedances to the bus cable. Where applicable, connect the string's earth now, as well (see Section 6.2.1, page 17).
- **Checking the bus connection**
  To do this, switch on all the devices of this string. Check the link to the devices concerned by means of the master device (EMZ or EMP).
  Note:
  Disconnect any unchecked strings from the EMB 1101.

Do the same for the other strings, until the entire system has been checked and is in operation.

7. Notes for commissioning and trouble-shooting

Malfunctions:	Possible causes:	Remedies:
The “Run” LED does not blink upon start-up.	No or the wrong operating voltage has been applied.	Check the connections (see Figure 1, page 9)
On one or more lines, the two LEDs are blinking alternately.	The bus cable is transposed, or there is a short circuit in the corresponding bus connection.	Check whether the bus cable is connected correctly to all the devices.
The red LEDs above the line connections light up occasionally.	The data on the corresponding line cannot be interpreted properly by the EMB 1101. However, the data will still be forwarded.	Check the corresponding string for loose contacts, missing terminating resistors, the wrong number of devices, or the wrong string length (see Section 5, page 12 ff). Radiated noise on the string is also possible.

7.1 Other important notes

- **Outgoing signals must never be returned to the same repeater. Direct or indirect (via other repeaters) loops between two *Line* connections are not permitted.**
- **Under certain circumstances, the bus will function with only two conductors connected (e.g. if only A and B are connected). But all three conductors must be attached to all devices. Check whether all conductors are interconnected, even if the bus is functioning.**
- **If the EMB 1101 detects data errors on a line, this need not necessarily lead to bus malfunctions at the EMZ or the EMP. These devices carry out enquiries several times, if necessary, before reporting the error. The EMB 1101 reports every data error.**
- **On the other hand, the EMZ or the EMP may detect an error without errors occurring in the data transmission (e.g. if a device fails to answer, or the device does not deliver the data requested).**
- **The EMZ has two terminals for the bus cable, but these are connected to one another directly on the circuit board. Therefore, the EMZ can only serve one string at a time. If the EMZ is connected within a string (incoming and outgoing connections at the device), do <u>not</u> install a terminating impedance at the EMZ. If the EMZ is employed at the end of the string, do install a terminating impedance.**

  <u>Two terminating impedances at one EMZ are not possible.</u>

8. Technical Specifications

Connections:

Number:	4 lines, one of which electrically isolated
Protocol:	FRAKO power bus (P-NET)
Electrical connection:	as per EIA Standard RS 485
Transmission rate:	76.8 kbit/s

Indications:

Operating:	blinking green LED
Data transfer:	one red and green LED per terminal

Power supply :

Supply voltage:	60 V to 230 V +15% AC or DC
Frequency:	If AC: 48 to 62 Hz
Power input:	ca. 5 VA
Design:	to VDE 0411 Safety Class II (also DIN EN 61 010 - 1)

Enclosure class:

Housing / terminals:	IP 40 / IP 20

Design data:

Housing material:	PC with 10% GF, V-0 flame-retardant to UL-94 V-0
Dimensions:	140 x 90 x 59 mm (W x H x D) see Figure 9
Weight:	0.60 kg
Installation:	on 35-mm DIN Standard mounting rail
Installed position:	any
Connections:	Screw terminals
Maximum conductor cross-section:	2,5 mm²

Operating conditions:

Ambient temperature:	0℃ to 50℃

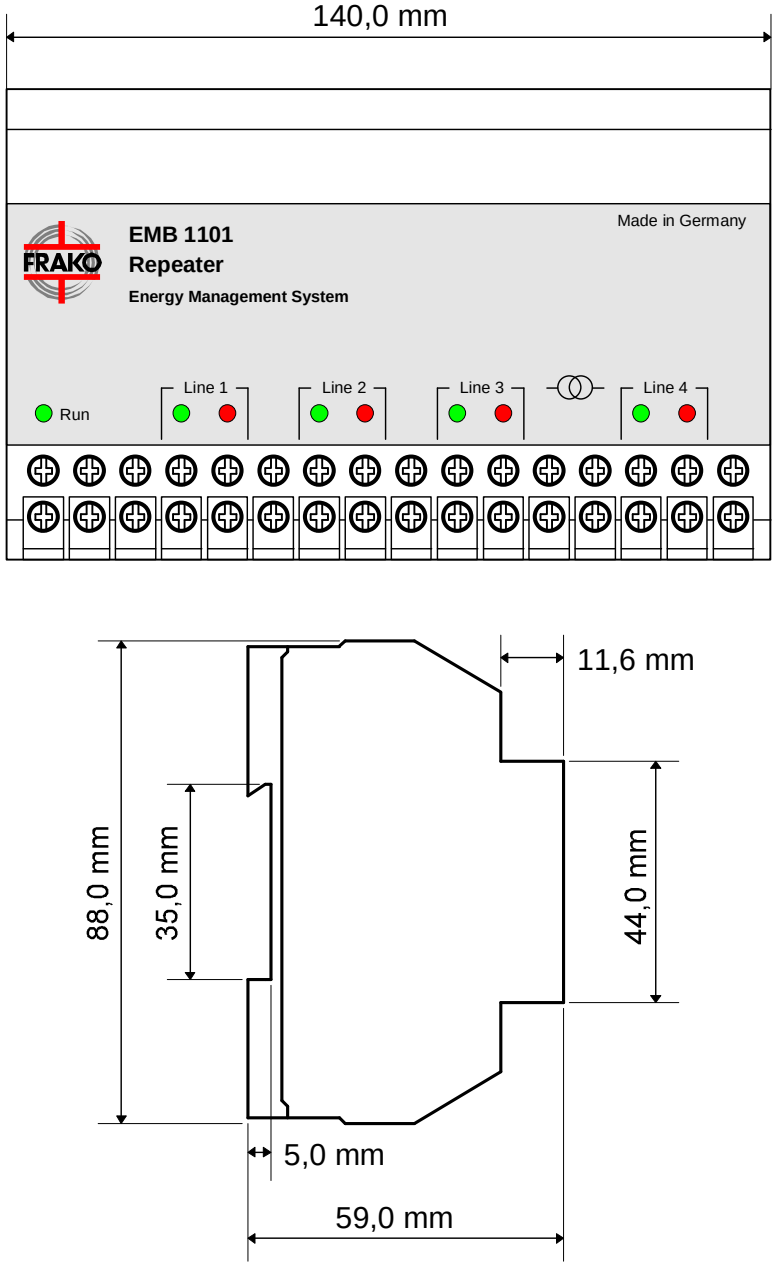


Figure 9: Dimensions

Appendix A

The bus cable used must conform to the following specifications:

- Characteristic impedance (wave impedance): 100-120 ohms
- Type: twisted-pair, shielded
- Cross-section: ≥ 0.3 mm²

The following varieties of cable can be used:

IBM Twinax 105Ω
Lapp Unitronic® Bus CAN 1x2x0,34
Helukabel CAN BUS 1x2x0,34
Leoni L-02YSCY 1x2x0.34/2.0-120 VI

Note:
Always avoid mixing various cable types.

Notice:

EMB 1101 Repeater

Sales Programme

Power capacitors for low voltage

Power factor correction systems

Power factor correction systems with reactors

Modules for power factor correction systems

Active filters

Dynamic compensation of harmonics

Reactive power control relays

Maximum demand control systems

Mains monitoring instruments

Cost allocation

Energy management systems

FRAKO 55-04807 / 11/06 / 7861 / ab V1.00 / V1.31
Subject to technical alteration

Reliable energy solutions.

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Quality has a Name
We are certified for
ISO 9001 and ISO 14001