TECHDOCS

Manual

WAGO I/O System 750

750-940

EnOcean RS-485 Gateway; 868 MHz

Version 1.3.0, valid from FW/HW Version 01/01

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Every conceivable measure has been taken to ensure the accuracy and completeness of this documentation. However, as errors can never be fully excluded, we always appreciate any information or suggestions for improving the documentation.

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We wish to point out that the software and hardware terms as well as the trademarks of companies used and/or mentioned in the present manual are generally protected by trademark or patent.

WAGO is a registered trademark of WAGO Verwaltungsgesellschaft mbH.

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1 Notes about this Documentation

Note

Always retain this documentation!
This documentation is part of the product. Therefore, retain the documentation during the entire service life of the product. Pass on the documentation to any subsequent user. In addition, ensure that any supplement to this documentation is included, if necessary.

1.1 Validity of this Documentation

This documentation is only applicable to the I/O module 750-940 (EnOcean RS-485 Gateway; 868 MHz).

This documentation is only applicable from FW/HW Version 01/01.

The I/O module **750-940** must only be installed and operated according to the instructions in these operating instructions.

1.2 Copyright

1.3 Symbols

⚠ DANGER

Personal Injury!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ DANGER

Personal Injury Caused by Electric Current!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Personal Injury!
Indicates a moderate-risk, potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Personal Injury!
Indicates a low-risk, potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Damage to Property!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

NOTICE

Damage to Property Caused by Electrostatic Discharge (ESD)!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

Note

Important Note!
Indicates a potential malfunction which, if not avoided, however, will not result in damage to property.

Information

Additional Information:
Refers to additional information which is not an integral part of this documentation (e.g., the Internet).

1.4 Number Notation

Table 1: Number Notation

Number Code	Example	Note
Decimal	100	Normal notation
Hexadecimal	0x64	C notation
Binary	'100' '0110.0100'	In quotation marks, nibble separated with dots (.)

1.5 Font Conventions

Table 2: Font Conventions

Font Type	Indicates
italic	Names of paths and data files are marked in italic-type. e.g.: *C:\Program Files\WAGO Software*
Menu	Menu items are marked in bold letters. e.g.: **Save**
>	A greater-than sign between two names means the selection of a menu item from a menu. e.g.: **File** > **New**
Input	Designation of input or optional fields are marked in bold letters, e.g.: **Start of measurement range**
“Value”	Input or selective values are marked in inverted commas. e.g.: Enter the value “4 mA” under **Start of measurement range**.
[Button]	Pushbuttons in dialog boxes are marked with bold letters in square brackets. e.g.: **[Input]**
[Key]	Keys are marked with bold letters in square brackets. e.g.: **[F5]**

2 Important Notes

This section includes an overall summary of the most important safety requirements and notes that are mentioned in each individual section. To protect your health and prevent damage to devices as well, it is imperative to read and carefully follow the safety guidelines.

2.1 Legal Bases

2.1.1 Subject to Changes

WAGO Kontakttechnik GmbH & Co. KG reserves the right to provide for any alterations or modifications. WAGO Kontakttechnik GmbH & Co. KG owns all rights arising from the granting of patents or from the legal protection of utility patents. Third-party products are always mentioned without any reference to patent rights. Thus, the existence of such rights cannot be excluded.

2.1.2 Personnel Qualifications

All sequences implemented on WAGO I/O System 750 devices may only be carried out by electrical specialists with sufficient knowledge in automation. The specialists must be familiar with the current norms and guidelines for the devices and automated environments.

All changes to the coupler or controller should always be carried out by qualified personnel with sufficient skills in PLC programming.

2.1.3 Intended Use

The EnOcean RS-485 Gateway 750-940 is used as a gateway for digital and analog signals from EnOcean actuators and sensors.

The product is designed for a work setting that meets the criterion of protection type IP 30 (only front side). Protection against finger injury and solid impurities ≥ 2.5 mm diameter is ensured; protection against water damage is not ensured. Unless otherwise specified, operation of the components in wet and dusty environments is prohibited.
Use without additional protective measures in environments within which dust, corrosive fumes, gases or ionized radiation can occur is considered improper use.

The EnOcean Gateway must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

Emergency stop functions and equipment must not be made ineffective. Please note the relevant standards; e.g., DIN EN 418.

Operating 750 Series products in home applications without further measures is permitted only if they meet the emission limits (emissions of interference) in compliance with EN 61000-6-3. You will find detailed information in the product manual, Section “WAGO I/O System 750” > “System Description” > “Technical Data.”

2.1.4 Technical Condition of Specified Devices

The devices to be supplied ex works are equipped with hardware and software configurations, which meet the individual application requirements. These modules contain no parts that can be serviced or repaired by the user. The following actions will result in the exclusion of liability on the part of WAGO Kontakttechnik GmbH & Co. KG:

- Repairs,
- Changes to the hardware or software that are not described in the operating instructions,
- Improper use of the components.

Further details are given in the contractual agreements. Please send your request for modified and new hardware or software configurations directly to WAGO Kontakttechnik GmbH & Co. KG.

2.1.4.1 Disposal

2.1.4.1.1 Electrical and Electronic Equipment

Electrical and electronic equipment may not be disposed of with household waste. This also applies to products without this symbol.

Electrical and electronic equipment contain materials and substances that can be harmful to the environment and health. Electrical and electronic equipment must be disposed of properly after use.
WEEE 2012/19/EU applies throughout Europe. Directives and laws may vary nationally.

Environmentally friendly disposal benefits health and protects the environment from harmful substances in electrical and electronic equipment.

- Observe national and local regulations for the disposal of electrical and electronic equipment.
- Clear any data stored on the electrical and electronic equipment.
- Remove any added battery or memory card in the electrical and electronic equipment.
- Have the electrical and electronic equipment sent to your local collection point.

Improper disposal of electrical and electronic equipment can be harmful to the environment and human health.

2.1.4.1.2 Packaging

Packaging contains materials that can be reused.
PPWD 94/62/EU and 2004/12/EU packaging guidelines apply throughout Europe. Directives and laws may vary nationally.

Environmentally friendly disposal of the packaging protects the environment and allows sustainable and efficient use of resources.

- Observe national and local regulations for the disposal of packaging.
- Dispose of packaging of all types that allows a high level of recovery, reuse and recycling.

Improper disposal of packaging can be harmful to the environment and wastes valuable resources.

2.2 Safety Advice (Precautions)

For installing and operating purposes of the relevant device to your system the following safety precautions shall be observed:

DANGER

Do not work on devices while energized!
All power sources to the device shall be switched off prior to performing any installation, repair or maintenance work.

DANGER

Ensure disconnect and overcurrent protection!
The device is intended for installation in automation technology systems. Disconnect protection is not integrated. Connected systems must be protected by a fuse.
Provide suitable disconnect and overcurrent protection on the system side!

DANGER

Use SELV power source only!
The device must only be powered from a SELV (Safety Extra Low Voltage) power source complying with the limited power source (LPS) requirements per DIN EN 60950-1.

DANGER

Ensure a standard connection!
To minimize any hazardous situations resulting in personal injury or to avoid failures in your system, the data and power supply lines shall be installed according to standards, with careful attention given to ensuring the correct terminal assignment. Always adhere to the EMC directives applicable to your application.

NOTICE

Replace defective or damaged devices!
Replace defective or damaged device/module (e.g., in the event of deformed contacts).

NOTICE

Protect the devices against seeping materials!
The devices are not resistant to materials having seeping properties such as aerosols, silicones and triglycerides (found in some hand creams). Prevent all such materials from contacting the devices. Clean tools and materials are imperative for handling devices.

NOTICE

Clean only with permitted materials!
Clean housing and soiled contacts with propanol.

NOTICE

Do not reverse the polarity of connection lines!
Avoid reverse polarity of data and power supply lines, as this may damage the devices involved.

NOTICE

Avoid electrostatic discharge!
The devices are equipped with electronic components that may be destroyed by electrostatic discharge when touched. Please observe the safety precautions against electrostatic discharge per DIN EN 61340-5-1/-3. When handling the devices, please ensure that environmental factors (personnel, work space and packaging) are properly grounded.

3 Device Description

The EnOcean RS-485 Gateway 750-940 is used to integrate radio sensors into intelligent controllers and other bus systems per ISO/IEC 14543-3-1x; e.g., to operation, control and reporting systems in building automation and to cabinet automation systems aboard ships; it enables creation of wireless, maintenance-free control solutions.
The module meets the standard EN 61000-6-3.

⚠ DANGER

Observe intended use.
The EnOcean RS-485 Gateway 750-940 must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

This arises from the module's ranking as Class 2 Equipment per ETSI EN 301 489-3 V2.1.1 (2019-03) “Specific conditions for short-range devices (SRD).”

⚠ WARNING

Observe statutory provisions for operating frequency range.
The EnOcean RS-485 Gateway 750-940 868 MHz must only be operated in compliance with the country-specific provisions regarding operation of radio equipment.

3 modes can be configured on the EnOcean Gateway with the DIP switch to suit a range of different applications:

- ESP3 mode:
  The module functions as a gateway and is connected with a remote station through the RS-485 interface. Communication is through a 1:1 connection with the remote station by means of native ESP3 telegrams.

- Modbus® mode:
  The module functions as a Modbus slave; it is connected to the Modbus through the RS-485 interface. Communication with a Modbus master is performed via the Modbus protocol. Up to ten EnOcean Gateways can be connected in a series to a Modbus line (daisy chain topology).

- EnOcean Repeater:
  The module functions as a repeater amplify and forward radio signals in an EnOcean network.

The radio transmission can be selected as through the internal module antenna or through a connected external antenna. The antenna is selected with a DIP switch; see Section “Operating Elements.”

In Modbus mode, the termination for the last module is switched on by default. Switching on and off is performed with a DIP switch; see Section “Operation

Elements.” In ESP3 mode, the termination is always switched on, in Repeater mode it is always switched off, regardless of the DIP switch position.

A BIAS network can by switched on and off with a DIP switch; see Section “Operation Elements.”

The EnOcean Gateway supports the “SMART ACK” functionality.

An LED indicates the operation status of the mode; see Section “Display Elements.”

The EnOcean Gateway is designed for mounting on a wall, ceiling or any other stable, level weight-bearing surface, as well as on a DIN-rail.

Note

A non-conductive mounting surface is necessary when internal antenna is used.
If the internal antenna is used, ensure the EnOcean Gateway is mounted on a non-conductive surface.

If it is not, performance may be adversely affected.

Modbus® is a registered trademark of Schneider Electric, licensed to the Modbus Organization, Inc.

3.1 View

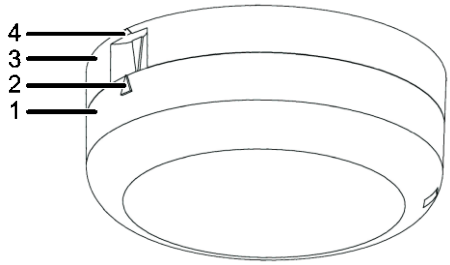


Figure 1: View of Closed EnOcean Gateway

Table 3: Legend for Figure “View of Closed EnOcean Gateway”

Item	Meaning
1	Enclosure cover
2	Closure mark on enclosure cover
3	Enclosure bottom
4	Closure mark on enclosure bottom

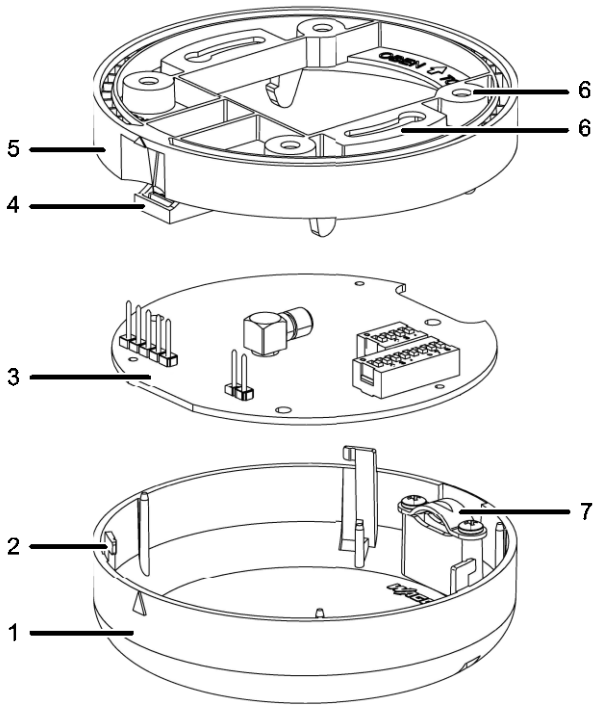


Figure 2: View of Opened EnOcean Gateway

Table 4: Legend for Figure “View of Opened EnOcean Gateway”

Item	Meaning
1	Enclosure cover
2	Latch
3	Printed circuit boards with PCB male header, SMA socket and DIP switches (see Sections “Connections” and “Operation Elements”)
4	Release bracket for DIN-rail
5	Enclosure bottom The positioning shown here shows the enclosure bottom for mounting on a flat surface. When mounting on a DIN-rail, the enclosure bottom is on the outside (Pos. 4 is on the outside).
6	Fastening holes for wall and ceiling mounting
7	Cable clamp with strain relief

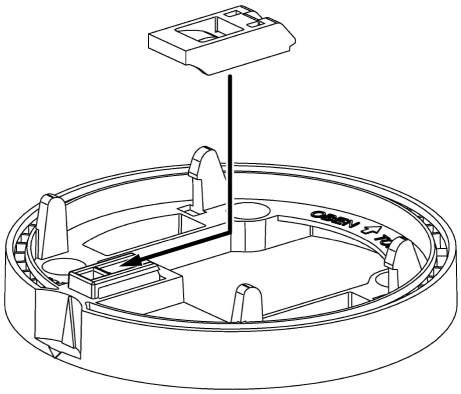


Figure 3: View of the mounting of the release bracket for the DIN-rail

3.2 Connectors

The EnOcean Gateway has the following connections:

- Connection for power supply
- Connection for signal lines
- Connection for external antenna

All connections are protected against reverse polarity.

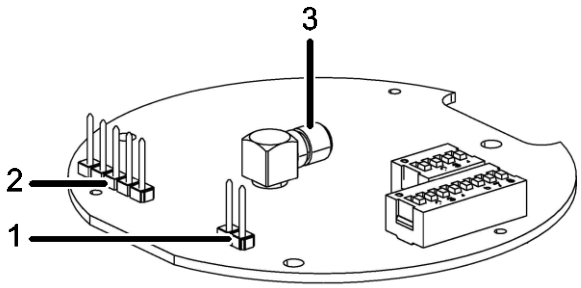


Figure 4: Connections on EnOcean Gateway

Table 5: Connections on EnOcean Gateway

Item	Description
1	2-pole PCB male header X1 for connecting power supply
2	5-pole PCB male header X2 for connecting power supply
3	SMA socket for attaching an external antenna

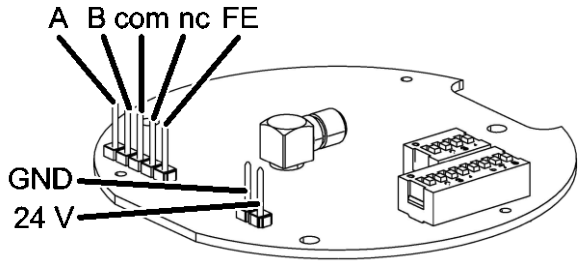


Figure 5: Pin assignment of the PCB male headers

3.2.1 2-Wire Modular PCB Connector

The external power supply is connected by two-conductor modular PCB connectors.

Figure 6: Two-Conductor Modular PCB Conductors (Example)

Additional information is available in Sections “Technical Data” and “Connecting Devices.”

3.2.1.1 Connection for the External Power Supply

The connection for the external SELV power supply is made through a 2-pole, 2-wire modular PCB connector that accepts the individual single strand and is plugged into the 2-pole PCB male header X1 of the EnOcean Gateway; see Figure “Connections on the EnOcean Gateway.”

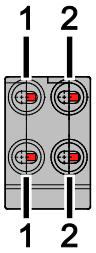


Figure 7: 2-Pole, 2-Wire Modular PCB Connector for Connecting the Power Supply

Table 6: Legend for Figure “2-Pole, 2-Wire Modular PCB Connector for Connecting the Power Supply

Position	Meaning	Description
1	V_{CC}	Power supply socket
2	GND	Socket for connecting power supply and RS-485 communication

3.2.1.2 Connection for Single Lines

The signal line connection is made through a 5-pole, 2-wire modular PCB connector that accepts the individual wires and is plugged into the 5-pole PCB male header X2 of the EnOcean Gateway; see Figure “Connections on the EnOcean Gateway.”

⚠ WARNING

Only connect common connection with galvanically isolated devices.
The common connection (“com”) must only be connected with galvanically isolated devices.

Otherwise, current loops may occur.

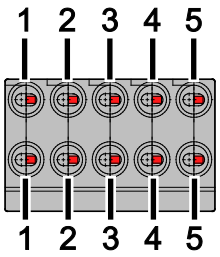


Figure 8: 5-Pole, 2-Wire Modular PCB Connector for Connecting the Signal Lines

Table 7: Legend for “5-Pole, 2-Wire Modular PCB Connector for Connecting the Signal Lines”

Position	Meaning	Description
1	FE	Socket for functional ground
2	NC	Not occupied; no line connections
3	com	Socket for common connection; corresponds to GND
4	B	Socket for RS-485 interface differential signal
5	A	Socket for RS-485 interface differential signal

3.2.2 Connection for External Antenna

The external antenna is connected via an SMA socket. The shielding is connected directly to GND.

NOTICE

Only use the Magnetic-Mount Antennas from WAGO.
Only use the WAGO Magnetic-Mount Antenna GSM 850/2100 (Art. No.: 758-911) as external antenna for the EnOcean Gateway.

The technical properties and compliance with the EMC and R&TTE Directives are only ensured when these antennas are used.

3.3 Display Elements

The EnOcean Gateway is equipped with two LEDs. The LEDs serve installation and service purposes and can only be seen when the enclosure is open.

Table 8: LED Display Elements

LED	Color	Status	Function
DS	Green	Flashes	EnOcean communication active
	Red	Illuminated	The EnOcean Gateway starts, or no firmware exists
	Off	Off	No EnOcean communication
–	Off	Off	No function: provided for future use

The LED “DS” can by switched on and off with a DIP switch; see Section “Operation Elements.”

3.4 Operating Elements

The EnOcean Gateway is configured with two DIP switch panels.

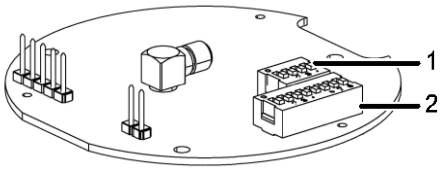


Figure 9: Operating Elements on the EnOcean Gateway

Table 9: Operating Elements on the EnOcean Gateway

Item	Description
1	Four-position DIP switch (“DIP2”) for setting the EnOcean Gateway hardware properties.
2	Eight-position DIP switch (“DIP1”) for the additional settings for Modbus mode

Note

To accept configuration changes, restart EnOcean Gateway.
The DIP switch settings are only read out when the EnOcean Gateway is started. To activate changed DIP switch settings during operation, the EnOcean Gateway must be restarted by switching the power supply off and back on.

3.4.1 DIP Switch Settings

The EnOcean Gateway hardware properties are set with the four-position DIP switch (“DIP2”).

Figure 10: Four-Position DIP Switch (“DIP2”) for Configuring the EnOcean Functions

Table 10: DIP Switch Panel for Configuring the EnOcean Functions

DIP Switch	Meaning	Function in ON Position	Function in OFF Position
1	LED functionality	LED “DS” switched off	LED “DS” switched on *)
2	Repeater mode	Repeater operation	Protocol selection *)
3	Antenna type	External antenna active	Internal antenna active *)
4	Protocol selection	Modbus protocol active	ESP3 protocol active *)

*) Default setting

When the Modbus protocol is selected with the four-position DIP switch (“DIP1”), other settings for Modbus mode are made with the eight-position DIP switch. Exception: DIP switch 8 functions for the ESP3 and Modbus protocols.

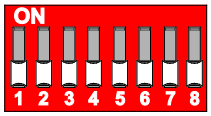


Figure 11: Eight-Position DIP Switch (“DIP1”) for Configuring the RS-485 Interface

Table 11: DIP Switch Panel for Configuring the RS-485 Interface

DIP Switch	Meaning	Function in ON Position	Function in OFF Position
1	Address 0	Setting the address LSB	See Table “Bit-Coded Modbus Address.”
2	Address 1	Setting the address	
3	Address 2	Setting the address	
4	Address 3	Setting the address MSB	
5	Baud rate A	Baud rate setting	See Table “DIP Switch Positions for Selecting Baud Rate.”
6	Baud rate B	Baud rate setting	
7	Termination	RS-485 termination switched off	RS-485 termination switched on *)
8	BIAS network	Switched on (effective with ESP3 and Modbus protocols)	Switched off *) (effective with ESP3 and Modbus protocols)

*) Default setting

Table 12: “Bit-Coded Modbus Address”

DIP Switch Positions				Modbus address
1	2	3	4	
OFF	OFF	OFF	OFF	Invalid address *)
ON	OFF	OFF	OFF	Valid address (1)
OFF	ON	OFF	OFF	Valid address (2)
ON	ON	OFF	OFF	Valid address (3)
OFF	OFF	ON	OFF	Valid address (4)
ON	OFF	ON	OFF	Valid address (5)
OFF	ON	ON	OFF	Valid address (6)
ON	ON	ON	OFF	Valid address (7)
OFF	OFF	OFF	ON	Valid address (8)
ON	OFF	OFF	ON	Valid address (9)
OFF	ON	OFF	ON	Valid address (10)
ON	ON	OFF	ON	Valid address (11)
OFF	OFF	ON	ON	Valid address (12)
ON	OFF	ON	ON	Valid address (13)
OFF	ON	ON	ON	Valid address (14)
ON	ON	ON	ON	An internally saved address is used; see Section “Function Description” > “Modbus Address.”

*) Default address

Table 13: DIP Switch Positions for Selecting Baud Rate

DIP Switch Positions		Set Baud Rate
5	6	
OFF	OFF	9600 *)
OFF	ON	19200
ON	OFF	115200
ON	ON	57600

*) Default setting

3.5 Schematic Diagram

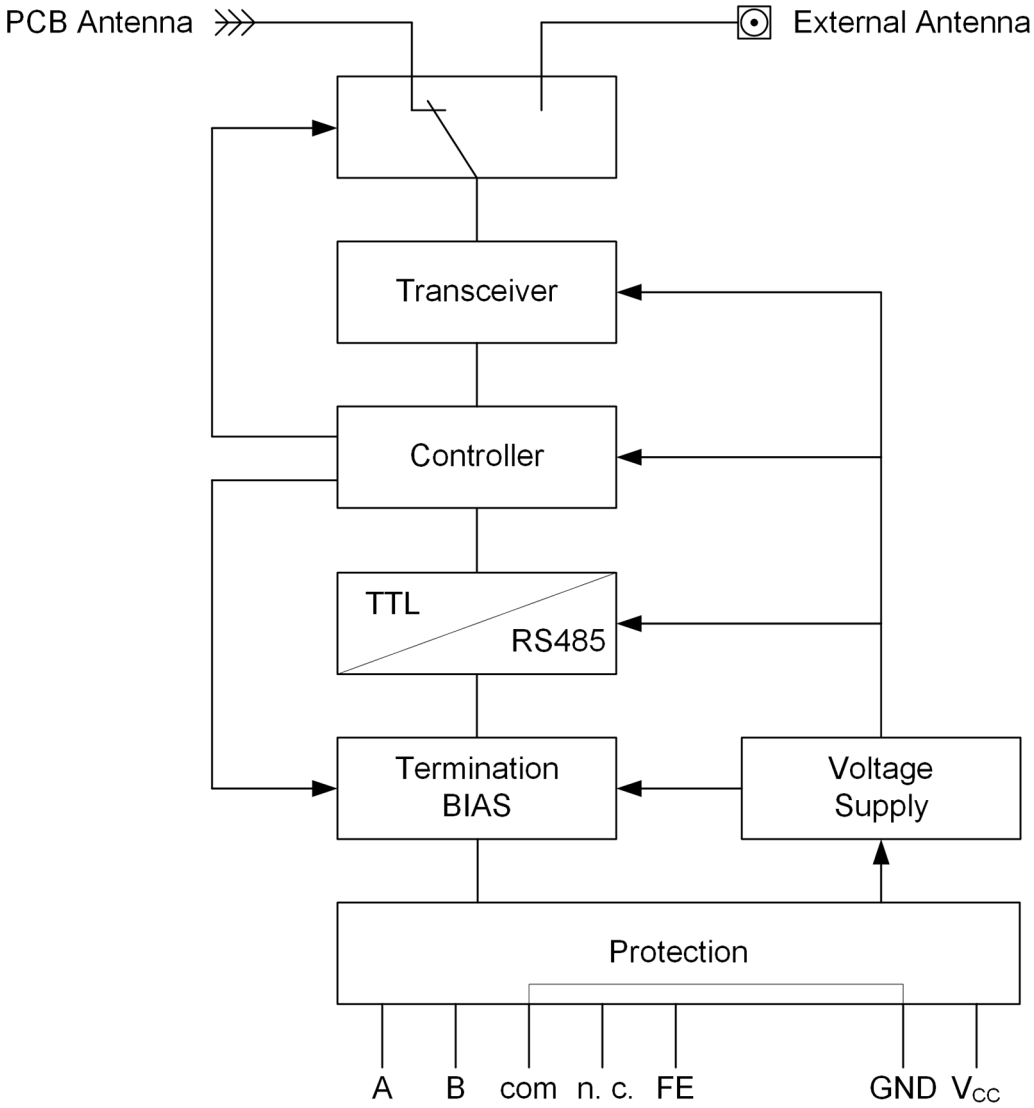


Figure 12: Schematic Circuit Diagram

3.6 Technical Data

3.7 Device Data

Table 14: Technical Data – Device

Diameter	Approx. 95 mm
Height	Approx. 36 mm
Weight	Approx. 103 g (including plug and DIN-rail locking clip)
Protection type	IP30
Pollution degree (EN 60664-1, EN 61131-2)	2
Protection class (EN 61140)	II

3.8 Power Supply

Table 15: Technical Data – Power Supply

Supply voltage	24 V DC (−25 % … +30 %)
Input current	Max. 40 mA
Overvoltage protection	±31.2 V DC
Overvoltage category (EN 60664-1)	III

Note

Voltage Buffers according to EN 61131-2
Plan for voltage buffering if the requirement for voltage buffering according to EN 61131-2 is to be met.

3.9 Communication

Table 16: Technical Data – Mechanical Conditions

Data width	50 bytes
Interface	RS-485
Protocol	ESP3, Modbus
Speed	9600 to 115,200 Baud; see Table “DIP Switch Positions for Selecting Baud Rate in Modbus Mode”
Cable length	Max. 100 m (e.g., JE-Y(ST)Y)
Number of devices connected in a series in Modbus mode	Max. 10
ESP3 mode	1:1 connection

3.10 Connection Technology

Table 17: Technical Data – Connection Technology

Connection technology	2-Conductor Compact PCB Connectors with PUSH WIRE®
Conductor cross-section: solid	0.4 mm² … 0.8 mm² / AWG 26 … 20
Strip length	6 mm … 7 mm / 0.24 in … 0.28 in
Conductor connection direction to PCB	0°
Pole number	5
Number of levels	1
Total number of connection points	10
Total number of potentials	5
Number of connection types	1

3.11 Mechanical Conditions

Table 18: Technical Data – Mechanical Conditions

Vibration resistance	Max. 4 g

3.12 Climatic Environmental Conditions

Table 19: Technical Data – Climatic Environmental Conditions

Operating temperature range	0 °C to +55 °C (+32 °F ... +131 °F)
Storage temperature range	−20 °C to +85 °C (−4 °F ... +185 °F)
Temperature change	3 K/min
Relative humidity	10 % to 95 %, non-condensing
Elevation above sea level	0 m to 2000 m
Storage altitude above sea level	0 m to 3000 m (70 kPa)

3.13 Approvals

The following approvals have been granted to 750-940 I/O modules:

CE Conformity Marking

Information

More information about approvals.
Detailed references to the approvals are listed in the document “**Overview on WAGO I/O System 750 approvals**”, which you can find via the internet under: www.wago.com → DOWNLOADS → Documentation → System Description.

3.14 Standards and Guidelines

750-940 I/O modules meet the following requirements on emission and immunity of interference:

EMC CE-Immunity to interference	EN 61000-6-2
EMC CE-Immunity to interference	EN 61131-2
EMC CE-Emission of interference	EN 61000-6-3 + A1
EMC CE-Emission of interference	EN 61131-2

4 Function Description

The EnOcean Gateway can be configured for different applications via DIP switches:

- As EnOcean Gateway in ESP3 mode
- As EnOcean Gateway in Modbus mode
- As repeater in an EnOcean network

The functions are activated or deactivated as called for by the respective application via DIP switches; see Section “Operation Elements.”

A separate power supply is needed to operate the EnOcean Gateway.

DANGER

Observe intended use

The EnOcean Gateway 750-940 must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

This arises from the module's ranking as Class 2 Equipment per ETSI EN 301 489-3 V2.1.1 (2019-03) “Specific conditions for short-range devices (SRD).”

4.1 Use as EnOcean Gateway in ESP3 Mode

In the standard setting, the EnOcean Gateway serves as a gateway for connecting EnOcean devices to the higher-order control level.

The module uses the ESP3 protocol for communication and supports the EnOcean profile EEP 2.1. The native ESP3 telegrams are exchanged between the EnOcean Gateway and a serial remote station (e.g., a WAGO 750-652 I/O Module) in a 1:1 connection. Communication is through an RS-485 interface.

After receiving a EnOcean telegram, the module checks whether its structure and length are valid. The maximum length of an EnOcean telegram is fifty bytes. Overly long or otherwise defective telegrams are rejected.

The EnOcean Gateway supports the “SMART ACK” functionality.

4.1.1 Telegram Synchronization with FEEEED Functionality

The EnOcean Gateway serial interface is based on an RS-485 bus that operates in half-duplex mode.

The permanently activated FEEEED functionality, contained in the function block “FB_ENOCEANCOM” can be used to avoid potential collisions between telegrams that overlap in time. The FEEEED functionality synchronizes the EnOcean Gateway with the serial remote station. In the process, the remote station initiates synchronization and sets the EnOcean Gateway into FEEEED mode by sending a telegram to the module once.
Then the module stays in FEEEED until it receives either another FEEEED telegram or an ESP3 telegram from the remote station, or the timeout period of 350 ms expires.

In FEEEED mode, first the EnOcean Gateway buffers all the telegrams received from the EnOcean radio module and only forwards the data to the remote station if it receives an additional FEEEED telegram or a native ESP3 telegram from the station. After all the buffered telegrams have been sent, the module buffers all telegrams once again and waits for a new FEEEED or ESP3 telegram from the remote station.
Once the set timeout period expires, the module deactivates FEEEED mode and sends all telegrams buffered up to that point to the remote station. Next, all ESP3 telegrams received by the EnOcean radio module are immediately sent to the remote station.

Specific FEEEED mode parameters:

- Activation telegram: [0xFE, 0xEE, 0xED]
- Timeout for deactivation: 350 milliseconds
- Buffer size for ESP3 telegrams: 6 ESP3 telegrams

4.1.2 ESP3 Protocol

ESP3 is a peer-to-peer protocol that uses a data packet structure, consisting of three groups:

- Header:
  The header group contains all information needed to analyze the ESP3 packet, including the data length, optional length and packet type (e.g., command, event, radio or report).
- Data:
  The data group contains the data of an ESP3 packet. To ensure upward compatibility, the format for this field is always the same for a specific ESP3 packet type (e.g., a specific ESP3 command).
- Optional data:
  An existing ESP3 packet can lengthened with the optional data group.

The sync byte indicates the start of an ESP3 packet. CRC8 checksums for the header (CRC8H) and data (CRC8D) are used to determine the validity of the telegrams.

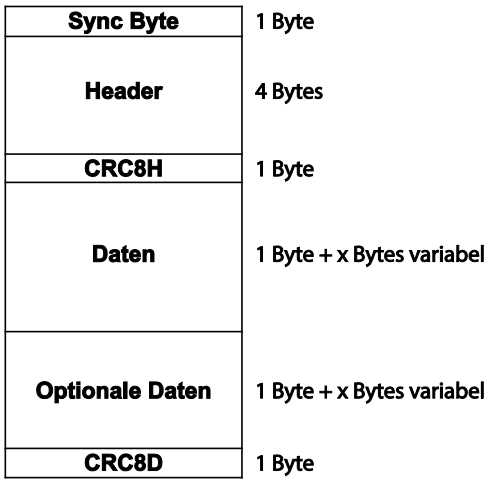


Figure 13: EPS3 Packet Structure

4.2 Use as EnOcean Gateway in Modbus Mode

In Modbus mode, the EnOcean Gateway serves as the Modbus slave and establishes a connection between the protocol types EnOcean ESP3 and Modbus.

Communication with a Modbus master is accomplished by Modbus telegrams via the serial interface; the EnOcean reports are embedded in these telegrams as a payload. In the process, Modbus-specific commands are written into and read out from special registers.

The registers are register entries with a length of 16-bits. They are numbered according to the Modbus specification. Thus, the registers are addressed as 0 to 95; see Table “Register Layout.”

The EnOcean Gateway supports the “SMART ACK” functionality.

Communication consists of the following data and tools:

- Modbus address
- Device reset
- Resetting ESP3 report buffer
- Process input data
- Process output data
- Basic device information

The following Modbus function codes are also supported:

- 0x03: Read Holding Registers
- 0x10: Write Multiple Registers
- 0x2B: Read Device Identity (basic device information)

4.2.1 Register Layout

Table 20: Register Layout

Reg. No.	Byte No.	Write Access	Default Value	Description
0	0 1	Yes	1	Modbus address Value range = 1 ... 247
1	2 3	Yes	0	Reset device Value range: 1 (reset)
2	4 5	Yes	0	Reset ESP3 report buffer. Value range: 1 (reset)
3	6 7	No	0	Status: Number of received and buffered ESP3 reports.
4	8 9	No	0	Status: Number of bytes for the next ESP3 report in the **Process input data**.
5	10 11	No	0	**Process input data** Received ESP3 report. Max. length: 50 bytes.
…	… …	…	…	
29	58 59	No	0	
30	60 61	Yes	0	**Process output data** ESP3 report to be sent. Max. length: 50 bytes.
…	… …	…	…	
54	108 109	Yes	0	
55	110 111	No	0	String length of the following basic device information in bytes.
56	112 113	No	–	**Basic device information** In ACSII format. Max. length: 80 bytes. Example: “*WAGO Kontakttechnik GmbH & Co. KG 2850-3151 001/001/000 001.003.00*”
…	… …	…	…	
95	190 191	No	–	

4.2.2 Modbus Address

The Modbus address is a value between 1 and 247 and is set with the DIP switches; see also Section “DIP Switches.”

Note

To accept configuration changes, restart EnOcean Gateway.
The DIP switch settings are only read out when the EnOcean Gateway is started. To activate changed DIP switch settings during operation, the EnOcean Gateway must be restarted by switching the power supply off and back on.

If a DIP switch setting gives a valid Modbus address, this Modbus address is used and written in the register.
If all DIP switches are set to 0 (OFF) for the Modbus address, the Modbus address 0x01 is automatically used and written in the register.
If all DIP switches are set to 1 (ON) for the Modbus address, a Modbus address saved in the module’s EEPROM is used. This address needs to have been previously communicated via a Modbus telegram. If the address saved in the module has a value that is outside the value range, 0x01 is used as the Modbus address and saved in the corresponding register.

DIP Switch	Register	EE	Description
0000	1	0	Modbus address: 0x01 The address set with the DIP switch is invalid.
0000	1	254	Modbus address: 0x01 The address set with the DIP switch is invalid.
0000	1	27	Modbus address: 0x01 The address set with the DIP switch is invalid.
1000	1	0	Modbus address: 0x01
1100	3	0	Modbus address: 0x03
1011	11	5	Modbus address: 0x0B (11)
1111	1	249	Modbus address: 0x01 The address saved in the module is not changed.
1111	230	230	Modbus address: 0xE6 (230) The address saved in the module is not changed.

4.2.3 Resetting the Device

If register 1 is written with a “1,” the EnOcean Gateway generates a response report and then automatically initiates a software-controlled restart.

E.g., if a new Modbus address is filed on the module via the register communication, the module must be restarted before the new Modbus address can be used for Modbus communication.

When the device is reset, all ESP3 reports are deleted.
When the device is restarted, the DIP switch settings are read in again.

4.2.4 Resetting the Report Buffer

If register 2 is written with a “1,” the EnOcean Gateway deletes all ESP3 reports from the receiving and sending buffer, resets the register value to “0” and generates a response report.

4.2.5 Process Input Data

The process input data reflects the received ESP3 report from the EnOcean radio module, the received ESP3 reports are always filed by the EnOcean Gateway in an internal buffer. After the process output data is read from a register, if another ESP3 report is pending, it is automatically filed in the register.

Register 3 (see Table “Register Layout”) signals the number of ESP3 reports present in the EnOcean Gateway to the host.
Register 4 (see Table “Register Layout”) signals the length of the current ESP3 report in the EnOcean Gateway receiving register to the host.

Instead of regularly polling the module status via the Modbus master, registers 3 and 4 can be read out together with the process input image. This can reduce data traffic at the system bus.

If there is an error, the corresponding error code as specified in the Modbus is read out. The error code can accept values from 0x01 to 0x04.

4.2.6 Process Output Data

The Modbus master sends an ESP3 report by writing in the EnOcean Gateway process output register. Next, the Modbus master receives a response with a message indicating whether the ESP3 report was received.

If there is an error, the corresponding error code as specified in the Modbus is read out. The error code can accept values from 0x01 to 0x04. When the value 0x04 is set, the Modbus master is informed that the ESP3 could not be written into the register because either the sending buffer is full or the ESP3 report is invalid.

4.2.7 Basic Device Data

There are two way to poll the basic device information:

- With function code 43 (0x2B), the data is sent in ASCII format as a response.

- The information is sent as an ASCII string to registers 56 to 95, which are dedicated for this purpose. Here, register 55 specifies the actual length of the string in bytes.
  The Modbus master reads out register 55, calculates the data string length it contains and then reads the basic device information from the corresponding registers.

4.3 Use as a Repeater in an EnOcean Network

In repeater mode, the EnOcean Gateway works in single-level mode. Radio telegrams received by the EnOcean devices are immediately forwarded once. Reports that have already been forwarded are not re-sent.

An external antenna can be used to extend the module's range; see Section "Connecting the External Antenna."
Additional information about radio transmission ranges is available in Section "Connecting Devices" > … > "Typical Ranges" as well as in the EnOcean document "APPLICATON NOTE AN001 – Range Planning Guide for Systems Using EnOcean Radio Standard."

4.4 SMART ACK Functionality

When functioning as a gateway, the EnOcean Gateway supports the "SMART ACK" functionality. After request from the radio network, saved values can be called from the radio module for the radio network device in an energy-efficient manner.

To use this functionality, first the respective radio network device must be taught in. The teach process must be initiated by the higher-order instance.
If the radio network device is taught in with the radio module, a short time is needed for sending a "Learn Request" telegram is needed. This telegram is provided by the EnOcean radio module.

5 Connect Devices

The EnOcean Gateway is connected according to the desired operating mode.

Note

Avoid sources with transient faults.
Do not install the EnOcean Gateway, the external antenna and the antenna line near sources of transient faults, such as fluorescent tubes with defective starters, frequency converters and power cables. Otherwise, communication disruptions and incorrect values may occur.

5.1 Connecting the Line to the 2-Wire Modular PCB Connector

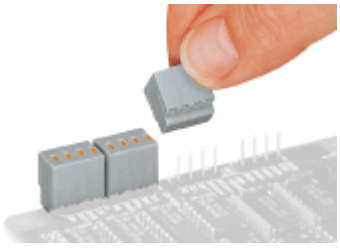
The two-wire modular PCB connectors are direct plug connectors with PUSH WIRE® connections.

NOTICE

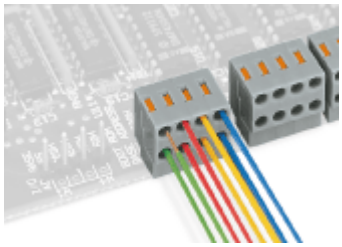
Use solid conductors only.
Only solid conductors are permitted for connecting the supply lines and voltage.

Observe the specifications in Section “Technical Data” > “Connection Technology.”

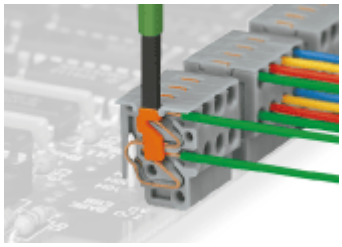
The PCB connectors are plugged onto the PCB male headers:



The line is inserted directly to the connection sockets easily and without tools:



To release the line, press the connector lock downward:



For the position of the two-wire modular PCB connector on the board, see Section “View.”

5.2 Connection of the EnOcean Gateway in ESP3 Mode

The EnOcean Gateway is connected with the RS-485 interface of the higher-level controller via a data cable. The connecting cable provides the communication signals and a shield potential.

A functional ground is provided via the data cable shield. Discharge is through the previous module in the chain.

The EnOcean Gateway power supply is provided through either a higher-level controller or an external power supply source.

NOTICE

Pay attention to the connection of the “com” connection
When the RS-485 interface of the higher-level controller is galvanically isolated from the power supply of the EnOcean Gateway, it is imperative that the “com” connection of the EnOcean Gateway is connected with GND.

Otherwise, the “com” connection must not be connected.

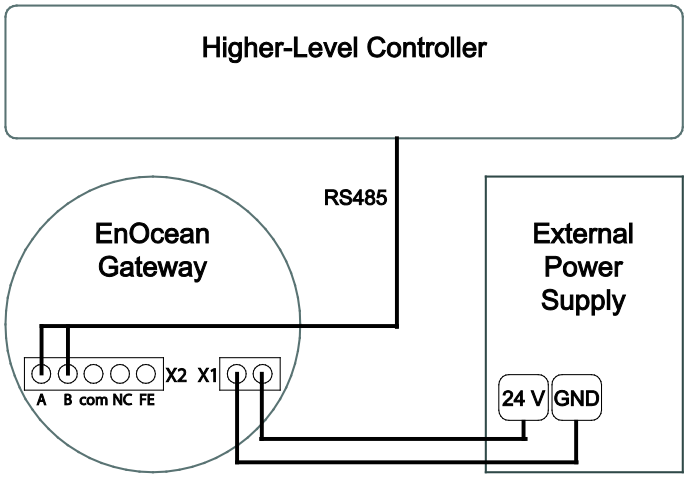


Figure 14: Connection of the EnOcean Gateway to a Higher-Level Controller with ESP3 Mode

To connect the EnOcean Gateway as a gateway in ESP3 mode, proceed as follows:

1. To open the EnOcean Gateway, disengage the enclosure cover by turning gently to the right.

2. Connect an RS-485 cable to the 5-pole, 2-wire modular PCB connector. Make sure the cable is routed in the direction of the strain relief.

3. Plug the modular PCB connector to the 5-pole male header (X2) on the printed circuit board.
   Make sure the cable is routed in the direction of the strain relief.

4. Mount a conductor for the external power supply to the 2-pole, 2-wire modular PCB connector.

5. Plug the modular PCB connector to the 2-pole male header (X1) on the printed circuit board.

6. Use the DIP switches to set the parameters for the EnOcean Gateway for ESP3 mode; see Section “Operation Elements”:

7. Connect the other end of the power supply line to the external power supply source.
   When so doing, observe the warning information about the connection of the "com" connection
   Also observe the maximum permissible input current; see Section “Technical Data.”

8. Optional: Connect an external antenna to the module SMA socket; see Section “Installing the External Antenna.”

9. Snap the bottom of the enclosure onto a DIN-rail or mount it on a flat, stable weight-beating surface; see Section “View.”
   When using the internal antenna of the EnOcean Gateway, be sure the

mounting surface is non-conductive to avoid negatively influencing the antenna performance.

10. Attach the mounted cable to the strain relief.

11. Set the enclosure cover with the printed circuit board onto the enclosure bottom of the EnOcean Gateway and close it by turning gently to the left.

Note

DIN-rail mounting is also possible when the Gateway is closed
As an alternative, the EnOcean Gateway can be completely prepared before mounting and then mounted to a DIN-rail when closed.

5.3 Connection of the EnOcean Gateway in Modbus Mode

The EnOcean Gateway is connected via RS-485 cable to the Modbus master and Modbus slave. The connecting cable provides the communication signals and a shield potential.
A functional ground is provided via the connection cable shield. Discharge is through the previous module in the chain.

The EnOcean Gateway power supply is provided through either a Modbus master or an external power supply source. When a Modbus slave is connected, the EnOcean Gateway forwards the supply power to it.

NOTICE

Pay attention to the connection of the “com” connection
When the RS-485 interface of the higher-level controller is galvanically isolated from the power supply of the EnOcean Gateway, it is imperative that the “com” connection of the EnOcean Gateway is connected with GND.

Otherwise, the “com” connection must not be connected.

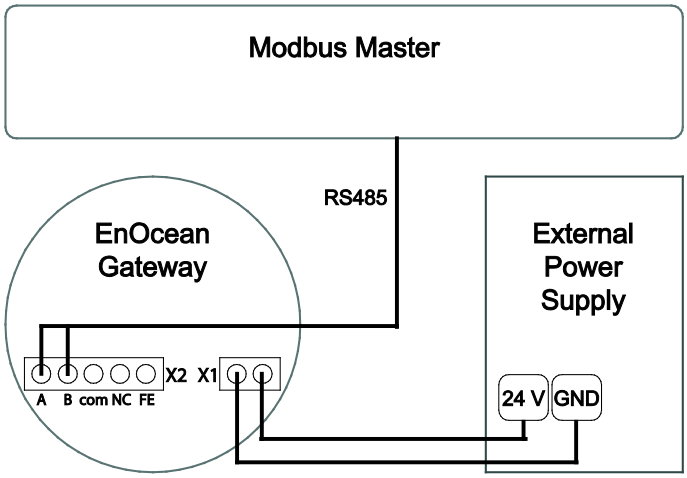


Figure 15: Connection of the EnOcean Gateway in a Modbus System with External Power Supply through a Modbus Master

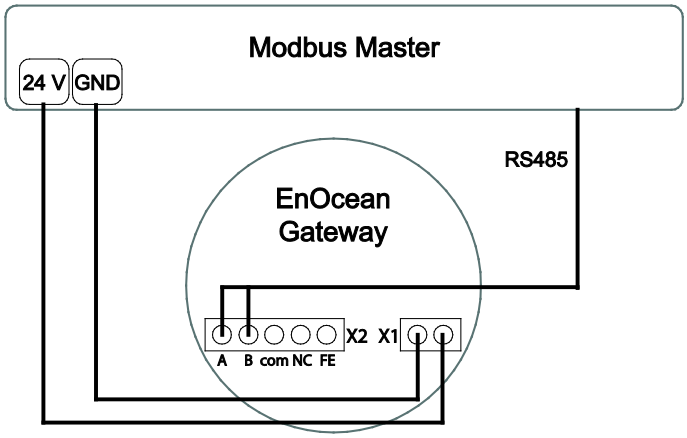


Figure 16: Connection of the EnOcean Gateway in a Modbus System with Power Supply through a Modbus Master

To connect the EnOcean Gateway as a gateway in Modbus mode, proceed as follows:

1. To open the EnOcean Gateway, disengage the enclosure cover by turning gently to the right.

2. Mount the RS-485 cable to the 5-pole, 2-wire modular PCB connector. Make sure the cable is routed in the direction of the strain relief.

3. Plug the modular PCB connector to the 5-pole male header (X2) on the printed circuit board.
Make sure the cable is routed in the direction of the strain relief.

4. Mount a conductor for the external power supply to the 2-pole, 2-wire modular PCB connector.

5. Plug the modular PCB connector to the 2-pole male header (X1) on the printed circuit board.

6. Optional: To build a daisy chain, repeat Steps 2 through 5; be sure to always plug the modular PCB connector to the corresponding male headers of the preceding EnOcean Gateway.

7. Use the DIP switches to set the parameters each connection EnOcean Gateway for Modbus mode; see Section “Operation Elements”:

8. Connect the other end of the power supply line to the external power supply source or the Modbus master; see above figures.
When so doing, observe the warning information about the connection of the "com" connection
Also observe the maximum permissible input current; see Section “Technical Data”.

9. Optional: Connect an external antenna to the module SMA socket; see Section “Installing the External Antenna.”

10. Snap the bottom of the enclosure onto a DIN-rail or mount it on a flat, stable weight-beating surface; see Section “View.”
When using the internal antenna of the EnOcean Gateway, be sure the mounting surface is non-conductive to avoid negatively influencing the antenna performance.

11. Attach the mounted cable to the strain relief.

12. Set the enclosure cover with the printed circuit board onto the enclosure bottom of the EnOcean Gateway and close it by turning gently to the left.

Note

DIN-rail mounting is also possible when the Gateway is closed.
As an alternative, the EnOcean Gateway can be completely prepared before mounting and then mounted to a DIN-rail when closed.

5.4 Connection as a Repeater in an EnOcean Network

The EnOcean Gateway is connected to the external power supply. Once the power supply has been properly connected, commissioning is complete.

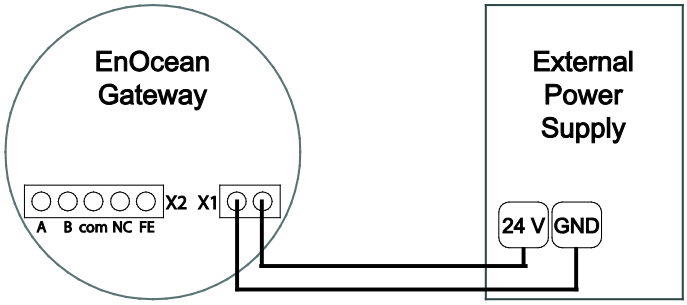


Figure 17: Connection as EnOcean Repeater

To connect the EnOcean Gateway as a repeater, proceed as follows:

1. To open the EnOcean Gateway, disengage the enclosure cover by turning gently to the right.
2. Mount a conductor for the external power supply to the 2-pole, 2-wire modular PCB connector.
3. Plug the modular PCB connector to the 2-pole male header on the printed circuit board.
4. Use the DIP switches to set the parameters for the EnOcean Gateway for repeater mode; see Section “Operation Elements.”
5. Connect the other end of the power supply line to the external power supply source.
6. Optional: Connect an external antenna to the module SMA socket; see Section “Installing the External Antenna.”
7. Snap the bottom of the enclosure onto a DIN-rail or mount it on a flat, stable weight-beating surface; see Section “View.”
   When using the internal antenna of the EnOcean Gateway, be sure the mounting surface is non-conductive to avoid negatively influencing the antenna performance.
8. Attach the mounted cable to the strain relief.

9. Set the enclosure cover with the printed circuit board onto the enclosure bottom of the EnOcean Gateway and close it by turning gently to the left.

Note

DIN-rail mounting is also possible when the Gateway is closed.
As an alternative, the EnOcean Gateway can be completely prepared before mounting and then mounted to a DIN-rail when closed.

5.5 External Antenna Connection

To increase radio range, an external antenna can be connected to the EnOcean Gateway.
Switching between internal and external antennas is selected with a DIP switch; see Section “Operating Elements”.

NOTICE

Only use the Magnetic-Mount Antennas from WAGO.
Only use the WAGO Magnetic-Mount Antenna GSM 850/2100 (Art. No.: 758-911) as external antenna for the EnOcean Gateway.

The technical properties and compliance with the EMC and R&TTE Directives are only ensured when these antennas are used.

5.5.1 Installation Information

Observe the following notes for install an external antenna (not included in scope of delivery):

- The antenna must be mounted on a plate measuring at least 25 × 25 cm (10 × 10 in.).
- The antenna and the antenna line must be at least 30 cm (12 in.) away from interference sources.
  There must be a free space of at least 35 cm (13.75 in.) between the antenna and the closest wall.
- The antenna cable must not, under any circumstances, be bent sharply, since irreversible damage may result to the antenna line (RG174 bending radius > 15 mm / 0.59 in.).

5.5.2 Installation for Mechanical Stress Conditions

Mechanical stress such as vibration, shock, etc., may strain and break cables. Therefore, suitable measures to fasten the antenna cable must be taken; e.g., in the strain relief on the EnOcean Gateway enclosure.

5.5.3 Installing the External Antennal

To mount the external antenna to the EnOcean Gateway, proceed as follows:

1. To open the EnOcean Gateway, disengage the enclosure cover by turning gently to the right.
2. Screw the external antenna to the SMA socket on the printed circuit board; see also Section “Connections.”
3. Attach the external antenna cable to the strain relief.
4. Parameterize the EnOcean gateway for the connection of an external antenna using the DIP switches, see Section “Operating elements.”
5. Set the enclosure cover with the printed circuit board onto the enclosure bottom of the EnOcean Gateway and close it by turning gently to the left.
6. Position the external antenna to a suitable point and adjust it.

5.5.4 Typical Range

The following maximum ranges apply to typical conditions:

- Visual connection: 30 m in passageways; 100 m in halls
- Gypsum board, wood: 30 m through maximum 5 walls
- Brick walls, porous concrete: 20 m through maximum 3 walls
- Reinforced concrete walls/ceilings: 10 m through maximum 1 ceiling

Supply blocks and lift shafts are considered as partitions.

5.5.5 Restrictions on Range

The following factors can restrict the radio signal range:

- Hollow lightweight walls with foil-faced mineral wool
- Suspended ceilings with metal or carbon fiber panels
- Leaded glass or glass with metal coat
- Steel furniture
- Module mounted on metal wall

If a radio signal is sent at an angle through a wall, the angle of incidence also influences the effective wall thickness and thereby, signal attenuation. Thus, radio signals should not run through walls at too shallow an angle and wall niches should be avoided.

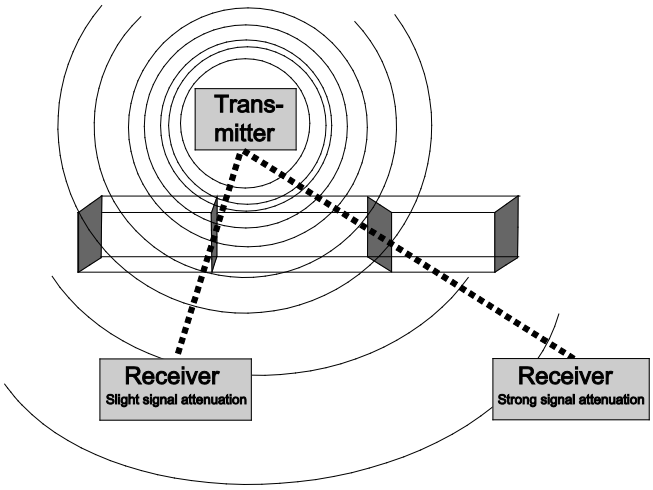


Figure 18: Effective Wall Thickness Depending on Angle of Incidence

Its maximum range must always be tested before commissioning.

5.5.6 Fresnel Zone

Just having a direct line of connection between transmitter and receiver without any obstacles is not enough to ensure the maximum radio range (open air) is reached.
There must also be a certain surrounding open area, known as the Fresnel zone. In spatial terms, the Fresnel zone is an ellipsoid.

The greatest widening of the ellipsoid falls at the center point of the connection line. Thus, to achieve maximum ranges, there must not be any prominent obstacle at this position.

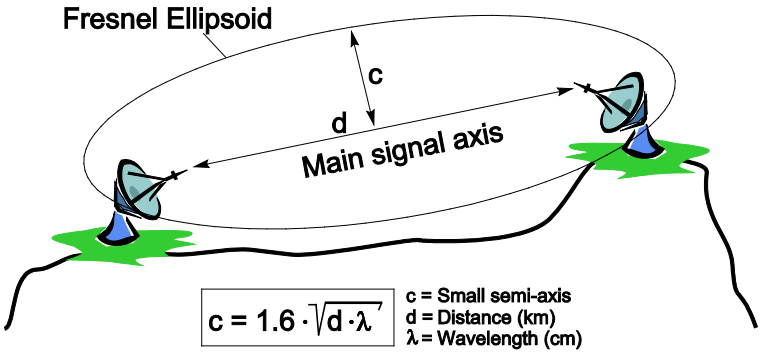


Figure 19: Fresnel Zone

6 EnOcean Performance Characteristics

The radio standard “EnOcean” was developed for automation solutions in the building technology area. Radio switches and sensors based on no-battery EnOcean technology power themselves by harvesting ambient energy; for example, the energy generated by pressing a switch or by sensors that exploit light energy. With this “energy harvesting,” this radio transmitter is completely maintenance-free and needs no cables to operate; further, the sensors can be repositioned at any time.
The radio transmitter range can be up to 300 m in open air and about 30 m in buildings.

In addition to the outstanding features of the EnOcean radio technology, maintenance-free operation and versatility, EnOcean offers even more distinguishing performance characteristics:

- Unique for systems with numerous sensors
- Four billion code numbers ensure clear-cut transmitter/receiver assignment.
- Time saved by fast integration, mounting and configuration
- Reduced fire risks
- Cost benefits during integration, installation and operation
- Reduced electrosmog

The ecological institute ECOLOG confirms that an EnOcean switch emits one hundred times less HF radiation than a conventional switch (spark breakaway). With one millionth the radiation energy of a mobile phone, the EnOcean radio radiation is very low.

Integrated power flux density in frequency range 100 MHz to 3.0 GHz:

- Radio switches $1.3\times10^{-5}\,W/m^2$
- Conventional switches $1.5\times10^{-3}\,W/m^2$

In addition, having significantly fewer power cables greatly reduces low-frequency electrosmog in the building.

6.1 EnOcean Characteristic Data

Table 21: EnOcean Characteristic Data

Conventional energy	Push of a button, vibration, motion, heat, light, etc.
Frequency band	868.3 MHz
Transmission power max.	10 mW EIRP
Modulation method	ASK
Transmission rate	120 Kbps
Bandwidth	280 KHz
Range	300 m free field
Radio telegram	Depending on sensor type (32-bit sensor ID no., up to 4 bytes sensor data, checksum), 53 to 130 bits
Transmission time	About 40 ms for three identical telegrams, each approx. 1 ms; randomly delayed

7 Appendix

7.1 Accessories

Table 22: Accessories

Accessories	Article Number
Magnetic-mount antenna, with 3 m connecting cable and SMA axial plug; white	758-911
2-conductor modular PCB connector; 2-pole, 0.50 mm²	252-152
2-conductor modular PCB connector; 5-pole, 0.50 mm²	252-155

7.2 Dimension drawing

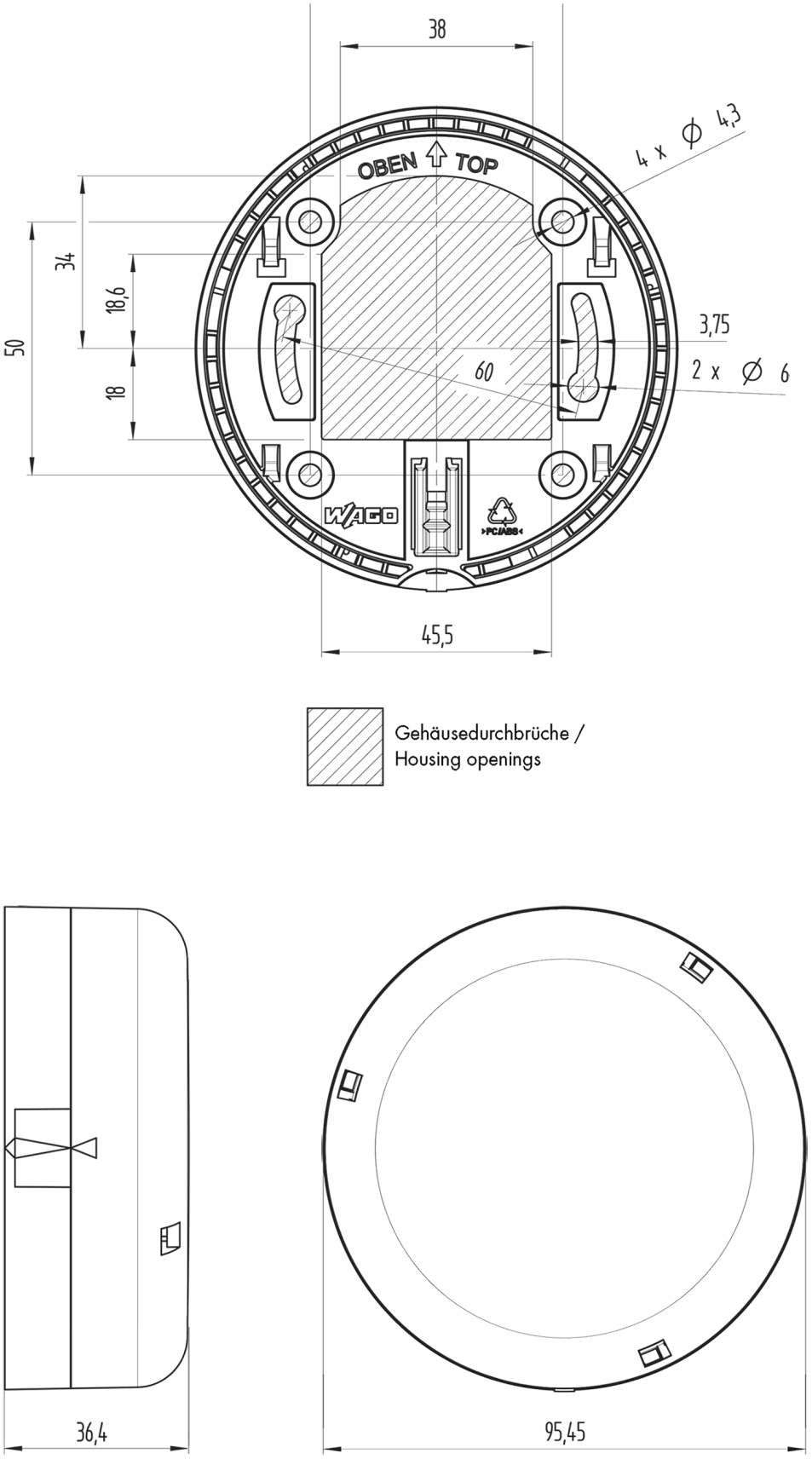


Figure 20: Dimension drawing

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