Radioline - 900 MHz wireless transmission system for serial interfaces and I/O signals

User manual

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User manual

Radioline - 900 MHz wireless transmission system for serial interfaces and I/O signals

This user manual is valid for:

Designation	Order No.
RAD-900-IFS	2901540
RAD-900-DAIO6	2702877
I/O extension modules:	
RAD-AI4-IFS	2901537
RAD-PT100-4-IFS	2904035
RAD-AO4-IFS	2901538
RAD-DI4-IFS	2901535
RAD-DI8-IFS	2901539
RAD-DOR4-IFS	2901536
RAD-DO8-IFS	2902811
RAD-DAIO6-IFS	2901533

3827_en_C

Table of contents

1 For your safety

Read this user manual carefully and keep it to hand for future reference.

1.1 Labeling of warning notes

This symbol indicates hazards that could lead to personal injury.
There are three signal words indicating the severity of a potential injury.

DANGER
Indicates a hazard with a high risk level. If this hazardous situation is not avoided, it will result in death or serious injury.

WARNING
Indicates a hazard with a medium risk level. If this hazardous situation is not avoided, it could result in death or serious injury.

CAUTION
Indicates a hazard with a low risk level. If this hazardous situation is not avoided, it could result in minor or moderate injury.

This symbol together with the **NOTE** signal word alerts the reader to a situation which may cause damage or malfunction to the device, hardware/software, or surrounding property.

Here you will find additional information or detailed sources of information.

1.2 Qualification of users

The use of products described in this user manual is oriented exclusively to:
– Qualified electricians or persons instructed by them. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.
– Qualified application programmers and software engineers. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.

1.3   Safety notes

> **i** Please note that, in combination with antennas, the maximum permissible transmission power may be exceeded. Please set the transmission power via the software.

The use of antennas with a gain greater than 6 dBi may require that the transmit power be reduced from the default setting of 30 dBm. Regulations limit the equivalent isotropically-radiated power (EIRP) to 36 dBm. The EIRP may be calculated as the transmit power (Pt) minus any cable loss (Lc) plus the antenna gain (Ga).

EIRP = Pt - Lc + Ga

For example, in the case of a 12 dBi antenna used with a cable run with a 4 dB loss, the transmit power must be reduced to 28 dBm or less such that the EIRP does not exceed 36 dBm.

> **i** The PSI-CONF configuration and diagnostic software can be used to configure the transmit power.

> **i** Operation of the wireless system is only permitted if accessories available from Phoenix Contact are used. The use of other accessory components may invalidate the device approval status

1.4   Installation and operation

Follow the installation instructions.

> **(!)** **NOTE:**
> Installation, operation, and maintenance may only be carried out by qualified specialist personnel.

Error-free operation of this device can only be ensured if transport, storage, and assembly are carried out correctly and operation and maintenance are carried out with care.

When installing and operating the device, the applicable safety directives (including national safety directives), accident prevention regulations, as well as general technical regulations, must be observed.

> **⚠** **WARNING: Risk of electrical shock**
> During operation, certain parts of this device may carry hazardous voltages. Disregarding this warning may result in damage to equipment and/or serious personal injury.

> **(!)** **NOTE:**
> Access to circuits within the device is not permitted.

Provide a switch/circuit breaker close to the device that is labeled as the disconnect device for this device.

Provide overcurrent protection (I ≤ 6A).

> **i** During maintenance work, disconnect the device from all effective power sources.

NOTE:

The IP20 degree of protection (IEC 60529/EN 60529) of the RAD-900-IFS is intended for a clean and dry environment. Do not subject the device to mechanical and/or thermal loads that exceed the specified limits.

The RAD-900-DAIO6 provides an IP65 degree of protection.

The radio should not be operated without an antenna or terminating load on the antenna connector.

NOTE:

Prolonged operation without an antenna or terminator may result in damage to the radio.

1.5 Safety regulations for installation in potentially explosive areas

Installation in areas with a danger of dust explosions

WARNING:

The device has not been designed for use in potentially dust-explosive atmospheres.

Installation in Class I, Div. 2 or Zone 2

WARNING:

The device is designed for installation in Class I, Division 2/Zone 2 (UL/cUL) potentially explosive areas. Observe the specified conditions for use in potentially explosive areas.

Install the RAD-900-IFS into a housing (control or distributor box) with at least IP54 protection (EN 60529) and is certified for use in Class I, Div. 2 or Zone 2.

The RAD-900-DAIO6 meets the IP65 degree of protection does not require an additional housing.

When installing and connecting the supply and signal circuits observe the requirements of EN 60079-14. Only devices suitable for operation in Ex zone 2 and the conditions at the application site may be connected to the circuits in zone 2.

In potentially explosive areas, only connect and disconnect cables when the power is disconnected.

Installation/removal of the devices on/from the TBUS DIN rail connector may only be performed when no voltage is applied.

1.6   Conformance

FCC

⊙

> **NOTE:**
>
> This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case, the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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

– FCC certificate: SGV-SHR-900

Industry Canada (IC)

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

This device has been designed to operate with the antennas listed in this document and having a maximum gain of 12 dB. Antennas not included in this list or having a gain greater than 12 dB are strictly prohibited for use with this device. The required antenna impedance is 50 Ω.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that necessary for successful communication.

– IC certificate: IC4720C-SHR900

NOM

IFT Instituto Federal de Telecomunicaciones México

"The operation of this equipment is subject to the following two conditions: (1) it is possible that this equipment or device may not cause harmful interference, and (2) this equipment or device must accept any interference including interference that may cause its undesired operation "

"This equipment has been designed to operate with antennas listed below and for an antenna´s maximum gain of 12.15 dBi gain. Use of this equipment with antennas not included in this list or having a higher gain than 12.15 dBi is prohibited. The required antenna impedance is 50 ohms".

Certificate number: IFT RCPPHRA17-1113

"La operación de este equipo esta sujeta a las siguientes dos condiciones: (1) es posible que este equipo o dispositivo no cause interferencia perjudicial y (2) este equipo o dispositivo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada."

"Este equipo ha sido diseñado para operar con las antenas que enseguida se enlistan y para una ganancia máxima de antena de 12.15 dBi. El uso con este equipo de antenas no incluidas en esta lista o que tengan una ganancia mayor que 12.15 dBi quedan prohibidas. La impedancia requerida de la antena es de 50 ohm."

Número de Certificado: IFT RCPPHRA17-1113

2 Short description

Radioline is a wireless system for the transmission of analog and digital I/O signals and serial data. A Radioline network may contain up to 250 stations, and features a self-healing network topology. The Radioline product family consists of a DIN rail-mounted 900MHz transceiver, a variety of I/O extension modules for connection to the transceiver, an outdoor NEMA 4X version with built in I/O, and an RS-485 multiplexer module for expansion of a wireless I/O system.

2.1 RAD-900-IFS wireless module

In addition to an RS-232 and RS-485 two-wire interface, the RAD-900-IFS wireless module supports the option of directly connecting up to 32 I/O extension modules in the station structure via the DIN rail connector.

Addressing of the wireless module and I/O mapping of the extension modules is carried out quickly and easily by means of the thumbwheel on the front. You can use the yellow thumbwheel on the wireless module in order to set the RAD ID, and the white thumbwheel on the extensions modules to set the I/O-MAP address. Programming knowledge is not required. You can easily start up the wireless network without the need for software.

The PSI-CONF configuration and diagnostic software for special functions and diagnostics options in the wireless module is available free of charge.

Features

- Flexible network applications: I/O data, serial data, PLC/Modbus RTU mode
- Adjustable data rates for the wireless interface
- Easy point-to-point or network structures (star, mesh)
- Yellow thumbwheel for the unique addressing of wireless modules in the wireless network
- Integrated RS-232 and RS-485 interface
- Can be extended with up to 32 I/O modules per station via DIN rail connector (hotswappable)
- 128-bit AES data encryption and authentication
- Unique network addressing via plug-in configuration memory (RAD-CONF) for secure, parallel operation of multiple networks with different RF bands
- Data rates and ranges can be configured using the PSI-CONF software
- UL/cUL listed for installation in Class I, Div. 2/Zone 2 environments

2.1.1 Structure
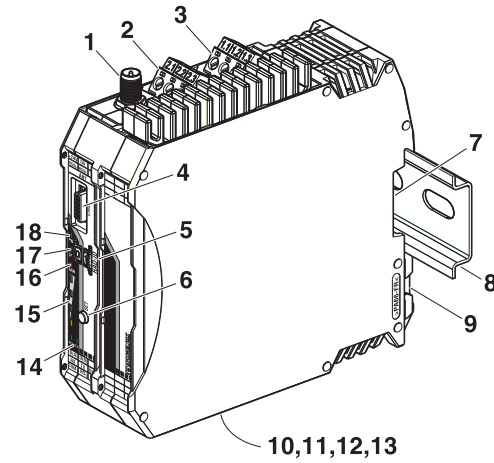
Figure 2-1   RAD-900-IFS structure

Table 2-1   RAD-900-IFS structure

Item	Designation
1	RSMA antenna connection (socket)
2	Test output RSSI (0...3 V DC) for evaluation of the wireless signal strength
3	Device supply (+24 V DC, 0 V)
4	12-pos. programming interface (S-PORT)
5	RAD ID address setting via thumbwheel
6	SET button
7	Connection option for TBUS DIN rail connector
8	DIN rail
9	DIN rail release latch
10	Connection terminal block RS-485 interface
11	Connection terminal block RS-232 interface
12	Relay output with PDT contact (floating)
13	D-SUB 9 connector (RS-232 interface)
14	RS-232/485 serial interface status LED (RX/TX)
15	LED bar graph for displaying the wireless signal strength
16	ERR status LED, red (communication error)
17	DAT status LED, green (BUS communication)
18	PWR status LED, green (supply voltage)

Circuit diagram
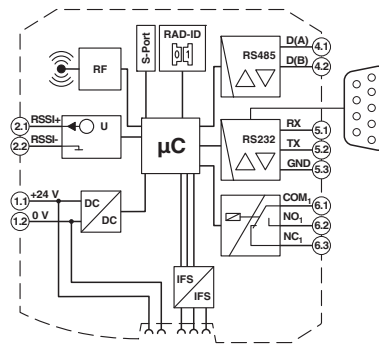
Figure 2-2   RAD-900-IFS circuit diagram

2.2   **RAD-900-DAIO6**

The RAD-900-DAIO6 is a NEMA 4X-rated wireless device with one analog input, one analog output, two digital inputs, and two digital outputs directly integrated. It does not have a serial interface.

The RAD-900-DAIO6 may be AC- or DC-powered, and addressing of the wireless module and I/O mapping of the extension modules is carried out quickly and easily by means of the thumbwheel on the front. You can use the yellow thumbwheel on the wireless module in order to set both the RAD ID and I/O-MAP address. Programming knowledge is not required. You can easily start up the wireless network without the need for software. It is interoperable with the RAD-900-IFS.

The PSI-CONF configuration and diagnostic software for special functions and diagnostics options in the wireless module is available free of charge.

2.2.1   Structure
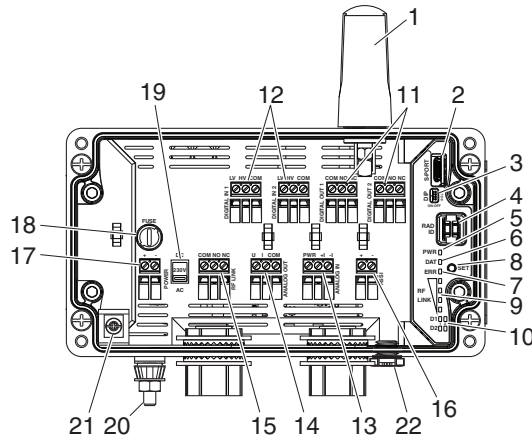
Figure 2-3   RAD-900-DAIO6 structure

Table 2-2   RAD-900-DAIO6 structure

Item	Designation
1	N-type antenna
2	12-pos. programming interface (S-PORT)
3	DIP switches for configuring I/O
4	RAD ID address setting via thumbwheel
5	PWR status LED, green (supply voltage)
6	DAT status LED, green (I/O communication)
7	ERR status LED, red (communication error)
8	SET button
9	LED bar graph for displaying the wireless signal strength
10	Status LEDs of the digital VO
11	Relay output with floating PDT contact
12	Digital input as wide-range input
13	Analog input for 2-, 3-, and 4-wire measuring transducers
14	Analog output (current or voltage)
15	RF link
16	Test output RSSI (0...3 V DC) for evaluation of the wireless signal strength
17	Device supply (+24 V DC/120 V AC, 0 V/neutral)
18	Fuse
19	Power selection switch
20	Ground lug
21	Internal ground screw
22	Breather

Table 2-3   DIP switches of the RAD-DAIO6-IFS

Setting	Output signal	DIP switch			
		1	2	3	4
Analog IN	0 ... 20 mA	OFF			
Analog IN	4 ... 20 mA	ON			
Analog OUT	RESET		OFF		
Analog OUT	HOLD		ON		
Digital OUT1	RESET			OFF	
Digital OUT1	HOLD			ON	
Digital OUT2	RESET				OFF
Digital OUT2	HOLD				ON

Circuit diagram
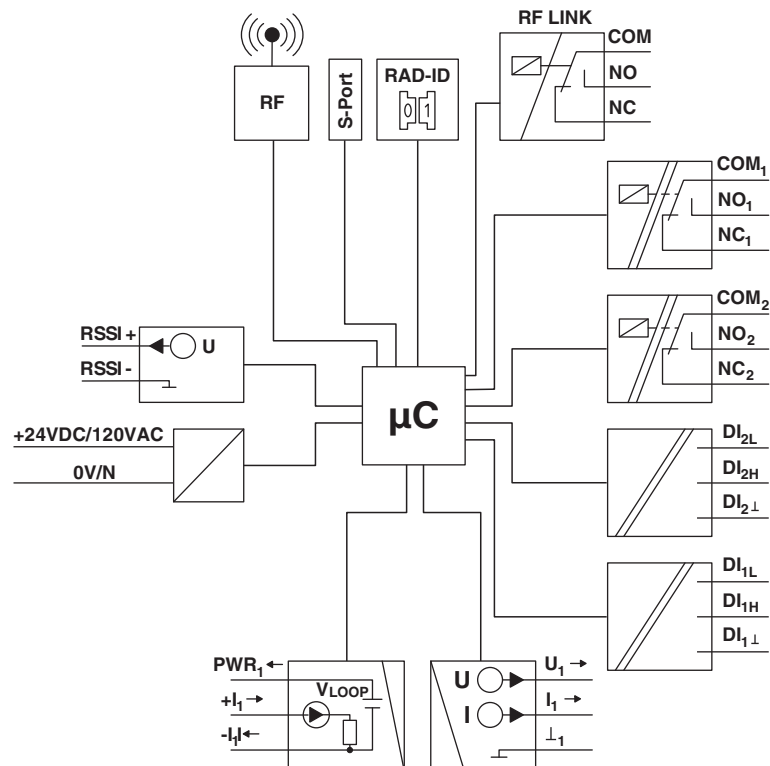
Figure 2-4   RAD-900-DAIO6 circuit diagram

3 Description of I/O extension modules

Various I/O extension modules are available for setting up the wireless system quickly and easily. This allows the number and type of I/O signals to be configured for specific applications.

For a detailed description of the available I/O extension modules, refer to the pages in Table 3-1.

Table 3-1   I/O extension modules

Module type		Descriptor	Order No.	See page
Analog	Four analog inputs	RAD-AI4-IFS	2901537	18
	Four Pt 100 inputs	RAD-PT100-4-IFS	2904035	22
	Four analog outputs	RAD-AO4-IFS	2901538	30
Digital	Four digital inputs	RAD-DI4-IFS	2901535	34
	Eight digital inputs or two pulse inputs	RAD-DI8-IFS	2901539	37
	Four digital relay outputs	RAD-DOR4-IFS	2901536	43
	Eight digital transistor - outputs	RAD-DO8-IFS	2902811	47
Analog/digital	One analog input/output, two digital wide-range - inputs/outputs	RAD-DAIO6-IFS	2901533	52

3.1 RAD-AI4-IFS - analog extension module with four inputs

The analog RAD-AI4-IFS I/O extension module can process up to four input signals between 0/4 mA ... 20 mA. All inputs are electrically isolated from one another, from the supply voltage, and from the electronics.

A supply voltage of 12 V DC, minimum, is available at the PWR_1 connection terminal block for passive sensors (see Figure 3-1, item 1).

3.1.1 Structure
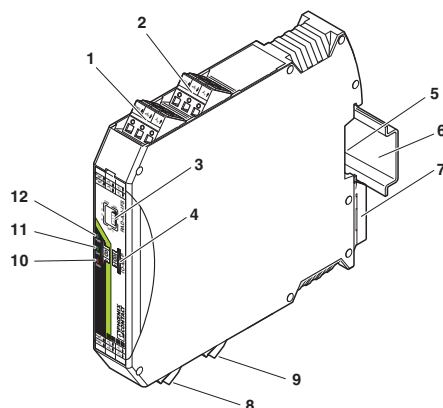
Figure 3-1   RAD-AI4-IFS structure

Item	Designation
1	Analog input 2 for 2-, 3-, 4-wire measuring transducers
2	Analog input 1 for 2-, 3-, 4-wire measuring transducers
3	DIP switches for configuring the analog inputs (current/voltage input)
4	White thumbwheel for setting the I/O-MAP address
5	Connection option for DIN rail connector
6	DIN rail
7	Metal foot catch for DIN rail fixing
8	Analog input 3 for 2-, 3-, 4-wire measuring transducers
9	Analog input 4 for 2-, 3-, 4-wire measuring transducers
10	ERR status LED, red (communication error)
11	DAT status LED, green (bus communication)
12	PWR status LED, green (supply voltage)

### 3.1.2 Basic circuit diagram
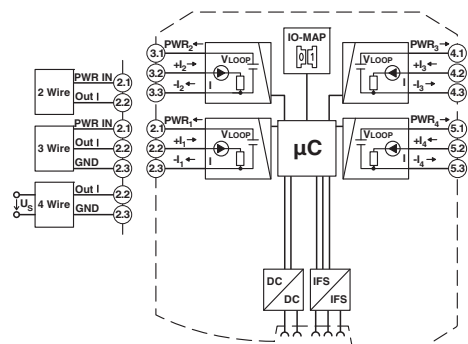
Figure 3-2   Basic circuit diagram for the RAD-AI4-IFS

3.1.3 Setting the DIP switches

Using the DIP switches on the front, you can configure the inputs signals (0 mA ... 20 mA or 4 mA ... 20 mA). Any changes in the setting of the DIP switches will be directly applied.

In PLC/Modbus RTU mode, the setting of the input signals is evaluated for error diagnostics. With the setting 4 mA ... 20 mA, it is, for example, possible to detect an open circuit.
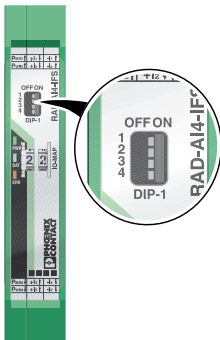
Figure 3-3   DIP switches of the RAD-AI4-IFS

Table 3-2   DIP switches of the RAD-AI4-IFS

Setting	Input signal	DIP switch			
		1	**2**	**3**	**4**
Analog IN1	0 mA ... 20 mA	OFF			
Analog IN1	4 mA ... 20 mA	ON			
Analog IN2	0 mA ... 20 mA		OFF		
Analog IN2	4 mA ... 20 mA		ON		
Analog IN3	0 mA ... 20 mA			OFF	
Analog IN3	4 mA ... 20 mA			ON	
Analog IN4	0 mA ... 20 mA				OFF
Analog IN4	4 mA ... 20 mA				ON

3.1.4   Diagnostic LEDs

The RAD-AI4-IFS I/O extension module uses a total of three LEDs to indicate the operating states.
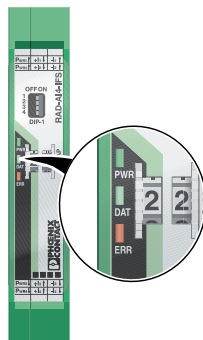
Figure 3-4   Diagnostic LEDs of the RAD-AI4-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF	No supply voltage
ON	Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF	No communication
Flashing	Configuration and addressing mode
ON	Cyclic data communication

ERR LED

The red ERR LED indicates the error status.

OFF	No error
Flashing	
Slow (1.4 Hz)	I/O-MAP address changed
Fast (2.8 Hz)	No bus communication
ON	Critical internal error

3.1.5 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-3   Setting the I/O-MAP address for the RAD-AI4-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.1.6 Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of six data words. For additional information, please refer to Section 3.1, "RAD-AI4-IFS - analog extension module with four inputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-AI4-IFS	20_{hex}	06_{hex}	30xx0 ... 30xx5	fc 04

3.2 RAD-PT100-4-IFS - extension module with four temperature inputs

ℹ️ Use the I/O extension modules in connection with the RAD-900-... wireless module, firmware version 1.40 or later. You can update the firmware free of charge using the PSI-CONF software, Version 2.04 or later.

The firmware and software can be found on the Internet at phoenixcontact.net/products.

The analog RAD-PT100-4-IFS I/O extension module has four Pt 100 inputs for temperatures between -50°C ... +250°C. The Pt 100 inputs T1 ... T4 can be mapped to the analog outputs I1/U1 ... I4/U4 of the RAD-AO4-IFS extension module. All the inputs are electrically isolated from one another, from the supply voltage, and from the remaining electronics.

Pt 100 resistance thermometers can be connected to the RAD-PT100-4-IFS I/O extension module. The thermometers change their resistance depending on the temperature. The Pt 100 input signals are acquired by the RAD-PT100-4-IFS and can be mapped to proportional, analog voltage or current signals of the RAD-AO4-IFS output module.

Example: At the Pt 100 input, a current of 0 mA or a voltage of 0 V is released at the output module at a temperature of -50°C. At the Pt 100 input, a current of 20 mA or a voltage of 10 V is released at the output at a temperature of 250°C.

Pt 100 input	Analog output
-50°C	0 mA or 0 V
+250°C	20 mA or 10 V

3.2.1 Connecting sensors

You can connect 2-wire or 3-wire sensors to the extension module. Observe the measuring errors depending on the different measuring methods.

2-wire connection technology

2-wire connection technology is the most cost-effective connection method. The temperature-related voltage is not directly measured at the sensor and therefore falsified by the two cable resistances R_L. The measuring errors that occur may lead to the entire measurement to become useless. Please observe the diagrams in Section "Measuring errors using 2-wire connection technology" on page 24.

With 2-wire technology, you need an insertion bridge between terminals x.2 and x.3.
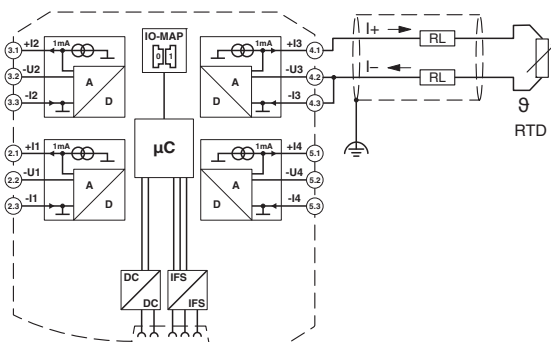
Figure 3-5   2-wire connection technology

3-wire connection technology

With 3-wire connection technology, the temperature-related voltage is measured several times. Corresponding calculations additionally reduce the effect of the cable resistance on the measurement result. The results are almost as good as those achieved using the 4-wire technology.

The cable resistances R_L at the terminals +I and -I must have the same value. This allows you to subtract the established cable resistance from the measurement result and to get the Pt 100 platinum resistance value.
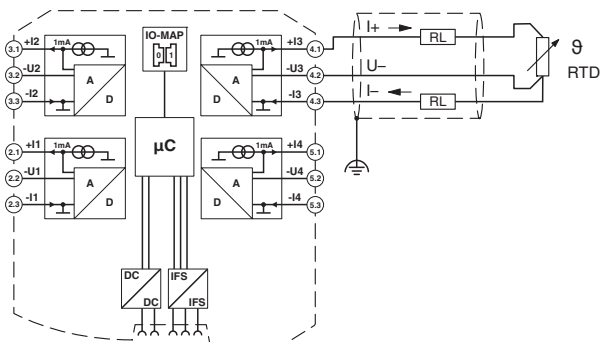
Figure 3-6   3-wire connection technology

4-wire connection technology

The RAD-PT100-4-IFS does not support the 4-wire connection technology.

- If you want to use a 4-wire sensor, only connect three of the four wires.
- The fourth wire should be left unwired. Otherwise there will be a different resistance in the +I and -I cables owing to the parallel connection of two cable resistances.

Figure 3-7   4-wire connection technology

3.2.2   Measuring errors using 2-wire connection technology

Figure 3-8   Systematic temperature measuring error ΔT depending on the cable length l

Curves depending on cable cross section A

1   Temperature measuring error for A = 0.25 mm^2

2   Temperature measuring error for A = 0.5 mm^2

3   Temperature measuring error for A = 1.0 mm^2

4   Temperature measuring error for A = 1.5 mm^2

(Measuring error valid for: copper cable χ = 57 m/Ωmm^2, T_A = 25°C and Pt 100 sensor)

Figure 3-9   Systematic temperature measuring error ΔT depending on the cable cross section A
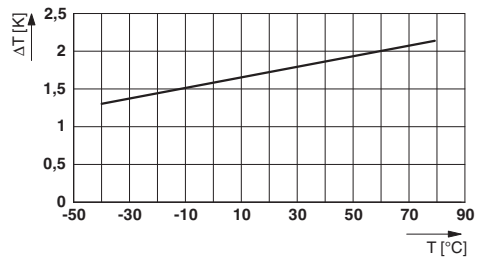
Figure 3-10   Systematic temperature measuring error ΔT depending on the cable temperature T_A

(Measuring error valid for: copper cable χ = 57 m/Ωmm^2, T_A = 25°C and Pt 100 sensor)

Make sure that the cable resistance and therefore the measuring error is as low as possible.

- Use sensor cables that are as short as possible.
- Avoid conductor cross sections smaller than 0.5 mm^2.

The temperature has only a small influence on the cable resistance.

You can calculate the cable resistance as follows:

$$R_L = R_{L20} \times [1 + 0.0039 \, \frac{1}{K} \times (T_A - 20°C)]$$

$$R_L = \frac{l}{\chi \times A} \times [1 + 0.0039 \, \frac{1}{K} \times (T_A - 20°C)]$$

R_L	Cable resistance in Ω
R_{L20}	Cable resistance at 20°C in Ω
l	Line length in m
χ	Specific resistance of copper in m/Ωmm^2
A	Cable cross section in mm^2
0.0039 1/K	Temperature coefficient for copper (degree of purity of 99.99%)
T_A	Ambient temperature (cable temperature) in °C

Due to there being two cable resistances in the measuring system, the value must be doubled. Using the average temperature coefficient α = 0.385 Ω/K for Pt 100, the absolute measuring error in Kelvin can be determined for platinum sensors according to DIN standards.

3.2.3   Shielding of the sensor cables

Always connect the analog sensors using shielded, twisted pair cables (e.g., LiYCY, TP 2 x 2 x 0.5 mm^2).

•   Immediately following entry in the control cabinet, connect the cable shields to the corresponding shield connection clamps.

> Please note that the electrical isolation between the channels may no longer occur when connecting the shields. The isolating distances between the individual channels need to be re-evaluated after connecting the shields. The distances between the individual wires and the common shields are crucial in this respect.
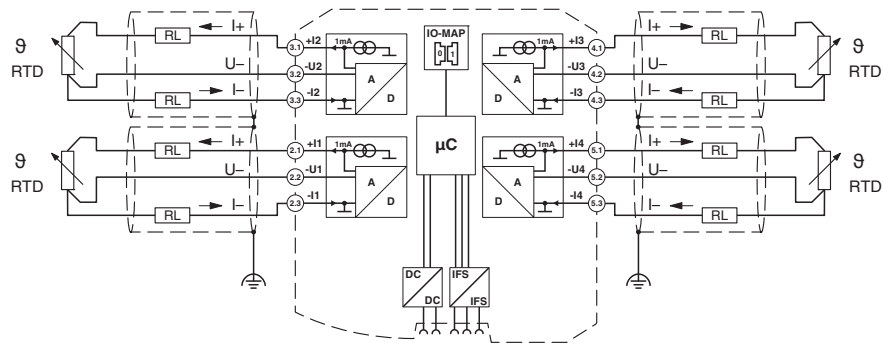
Figure 3-11   Shielding with 3-wire connection technology

2-wire connection technology with twisted pair cables and shielding
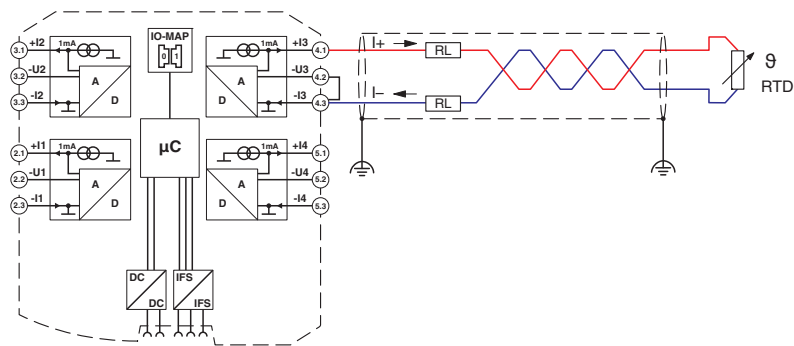
Figure 3-12   2-wire connection technology with twisted pair cables and shielding

3-wire connection technology with twisted pair cables and shielding
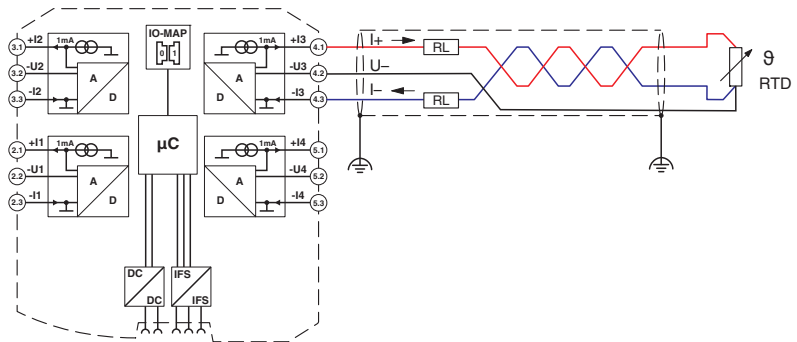
Figure 3-13   3-wire connection technology with twisted pair cables and shielding

3.2.4   Structure
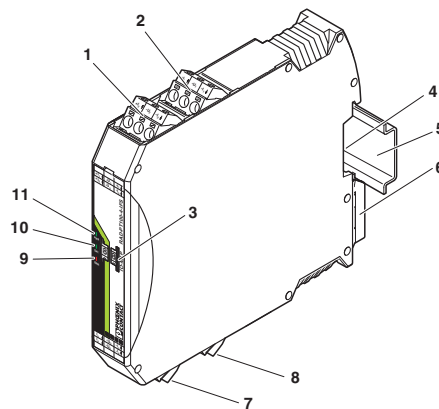
Figure 3-14   RAD-PT100-4-IFS structure

Item	Designation
1	Pt 100 input 2 for 2- and 3-wire sensors
2	Pt 100 input 1 for 2- and 3-wire sensors
3	White thumbwheel for setting the I/O-MAP address
4	Connection option for DIN rail connector
5	DIN rail
6	Metal foot catch for DIN rail fixing
7	Pt 100 input 3 for 2- and 3-wire sensors
8	Pt 100 input 4 for 2- and 3-wire sensors
9	ERR status LED, red (communication error)
10	DAT status LED, green (bus communication)
11	PWR status LED, green (supply voltage)

3.2.5 Basic circuit diagram
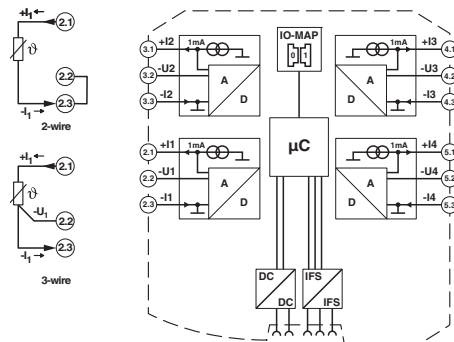
Figure 3-15   Basic circuit diagram for the RAD-PT100-4-IFS

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i

With 2-wire technology, you need an insertion bridge between terminals x.2 and x.3. In this case, the measuring accuracy is reduced (see "Measuring errors using 2-wire connection technology" on page 24).

3.2.6 Diagnostic LEDs

The RAD-PT100-4-IFS I/O extension module uses a total of three LEDs to indicate the operating states.
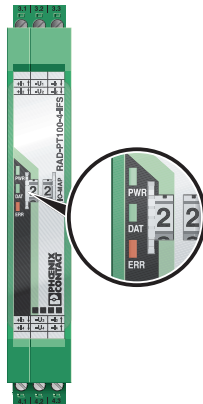
Figure 3-16   Diagnostic LEDs of the RAD-PT100-4-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF   No supply voltage

ON   Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF	No communication
Flashing	Configuration and addressing mode
ON	Cyclic data communication

ERR LED

The red ERR LED indicates the error status.

OFF		No error
Flashing		
	Slow (1.4 Hz)	I/O-MAP address changed
	Fast (2.8 Hz)	No bus communication
ON		Critical internal error

3.2.7 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-4   Setting the I/O-MAP address for the RAD-PT100-4-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.2.8 Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of six data words. For additional information, please refer to Section 3.2, "RAD-PT100-4-IFS - extension module with four temperature inputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-PT100-4-IFS	21$_{hex}$	06$_{hex}$	30xx0 ... 30xx5	fc 04

3.3 RAD-AO4-IFS - analog extension module with four outputs

Using the analog RAD-AO4-IFS I/O extension module, up to four signals between 0/4 mA ... 20 mA can be output. All the outputs are electrically isolated from one another, from the supply voltage, and from the electronics.

i | Use either the current or voltage output per analog channel.

3.3.1 Structure
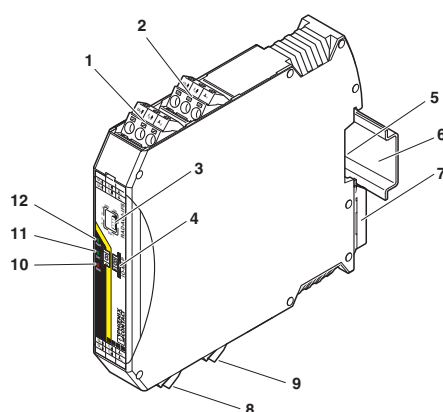
Figure 3-17   RAD-AO4-IFS structure

| Item	Designation
1	Analog output 2 (alternatively current or voltage)
2	Analog output 1 (alternatively current or voltage)
3	DIP switches for configuring the outputs (current/voltage output)
4	White thumbwheel for setting the I/O-MAP address
5	Connection option for DIN rail connector
6	DIN rail
7	Metal foot catch for DIN rail fixing
8	Analog output 3 (alternatively current or voltage)
9	Analog output 4 (alternatively current or voltage)
10	ERR status LED, red (communication error)
11	DAT status LED, green (bus communication)
12	PWR status LED, green (supply voltage)

3.3.2 Basic circuit diagram
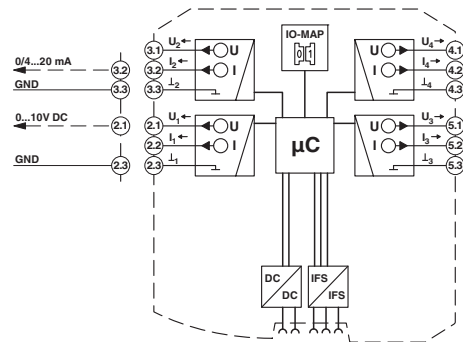
Figure 3-18   Basic circuit diagram for the RAD-AO4-IFS

3.3.3 Setting the DIP switches

You can use the DIP switches on the front to set the behavior of the outputs in the event of an error (e.g., interruption of the wireless connection). Any changes in the setting of the DIP switches will be directly applied.

–   RESET = Output value is set to 0
–   HOLD = Hold last valid output value
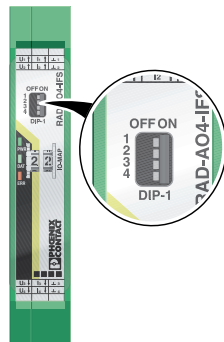
Figure 3-19   DIP switches of the RAD-AO4-IFS

Table 3-5   DIP switches of the RAD-AO4-IFS

Input	Output signal	DIP switch			
		1	2	3	4
Analog OUT1	RESET	OFF			
Analog OUT1	HOLD	ON			
Analog OUT2	RESET		OFF		
Analog OUT2	HOLD		ON		
Analog OUT3	RESET			OFF	
Analog OUT3	HOLD			ON	
Analog OUT4	RESET				OFF
Analog OUT4	HOLD				ON

3.3.4   Diagnostic LEDs

The RAD-AO4-IFS I/O extension module uses a total of three LEDs to indicate the operating states.
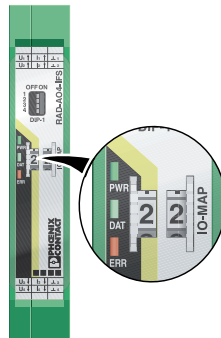
Figure 3-20   Diagnostic LEDs of the RAD-AO4-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF   No supply voltage

ON   Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF   No communication

Flashing   Configuration and addressing mode

ON   Cyclic data communication

ERR LED

The red ERR LED indicates the error status, e.g., if a corresponding input module has not been found.

OFF	No error
Flashing	
Slow (1.4 Hz)	I/O-MAP address changed
Fast (2.8 Hz)	**Wireless module in I/O data mode**

–   Missing input module

–   No bus communication

Wireless module in PLC/Modbus RTU mode

–   No Modbus communication (safe state of outputs, depending on DIP switch setting)

ON	Critical internal error

3.3.5   Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-6   Setting the I/O-MAP address for the RAD-AO4-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.3.6   Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of six data words. For additional information, please refer to Section 3.3, "RAD-AO4-IFS - analog extension module with four outputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-AO4-IFS	30_{hex}	06_{hex}	40xx0 ... 40xx5	fc 03, 16

3.4 RAD-DI4-IFS - digital extension module with four inputs

⚠️ **WARNING: Risk of electric shock**

Use the same phase for digital inputs and digital outputs. The isolating voltage between the individual channels must not exceed 300 V.

The digital RAD-DI4-IFS I/O extension module can process up to four input signals. The digital inputs process voltages between 0 V ... 50 V AC/DC at the low-voltage input and voltages between 0 V ... 250 V AC/DC at the high-voltage input. All inputs are electrically isolated from one another, from the supply voltage, and from the electronics.

3.4.1 Structure
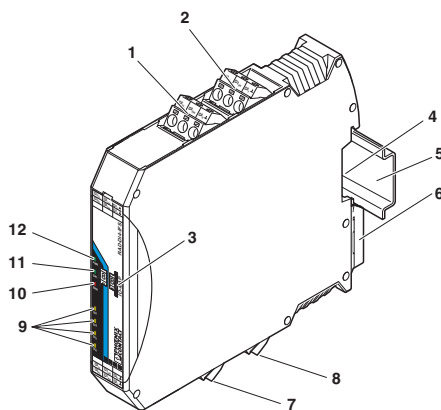
Figure 3-21   RAD-DI4-IFS structure

Item	Designation
1	Digital input as wide-range input
2	Digital input as wide-range input
3	White thumbwheel for setting the I/O-MAP address
4	Connection option for DIN rail connector
5	DIN rail
6	Metal foot catch for DIN rail fixing
7	Digital input as wide-range input
8	Digital input as wide-range input
9	Status LEDs for digital inputs DI1 ... DI4
10	ERR status LED, red (communication error)
11	DAT status LED, green (bus communication)
12	PWR status LED, green (supply voltage)

3.4.2 Basic circuit diagram
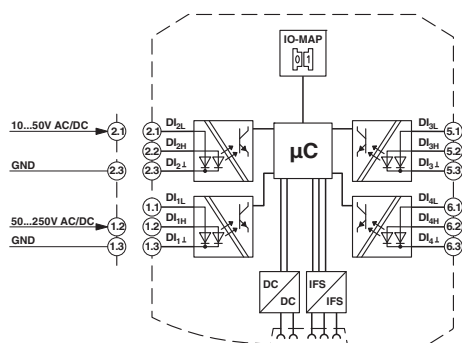
Figure 3-22   Basic circuit diagram for the RAD-DI4-IFS

3.4.3 Diagnostic LEDs

The RAD-DI4-IFS I/O extension module uses a total of seven LEDs to indicate the operating states.
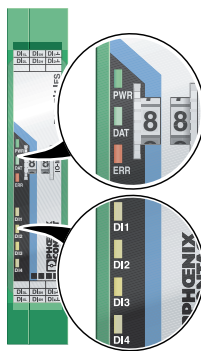
Figure 3-23   Diagnostic LEDs of the RAD-DI4-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF   No supply voltage

ON   Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF   No communication

Flashing   Configuration and addressing mode

ON   Cyclic data communication

ERR LED

The red ERR LED indicates the error status, e.g., if a corresponding output module has not been found.

OFF	No error
Flashing	
Slow (1.4 Hz)	I/O-MAP address changed
Fast (2.8 Hz)	No bus communication
ON	Critical internal error

DI1 ... DI4

The yellow DI1 ... DI4 LEDs indicate the status of the digital inputs.

3.4.4 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-7   Setting the I/O-MAP address for the RAD-DI4-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.4.5 Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of two data words. For additional information, please refer to Section 3.4, "RAD-DI4-IFS - digital extension module with four inputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DI4-IFS	01_{hex}	02_{hex}	30xx0 ... 30xx1	fc 04

3.5 RAD-DI8-IFS - digital extension module with eight inputs

ℹ️ Use the I/O extension modules in connection with the RAD-900-... wireless module, firmware version 1.40 or later. You can update the firmware free of charge using the PSI-CONF software, Version 2.04 or later.

The firmware and software can be found on the Internet at phoenixcontact.net/products.

The digital RAD-DI8-IFS I/O extension module can process up to eight digital input signals or two pulse signals. You can use DIP switch 1 to set the operating mode. For more detailed information on setting the DIP switch, please refer to page 38.

The eight digital inputs are arranged in two groups of four inputs each with a common reference potential (GND). The two DC groups are electrically isolated from one another, from the supply voltage, and from the electronics.

3.5.1 Structure
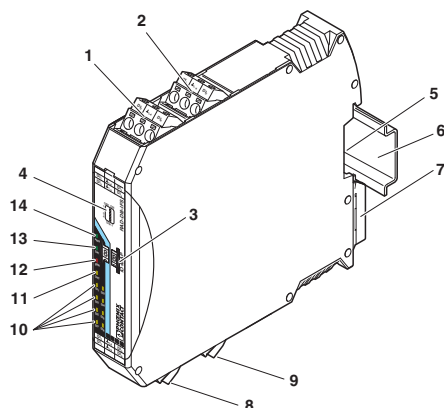
Figure 3-24   RAD-DI8-IFS structure

Item	Designation
1	Digital inputs 3 + 4
2	Digital inputs 1 + 2, DI1: pulse input 1
3	White thumbwheel for setting the I/O-MAP address
4	DIP switch for switching between static mode and pulse counter mode for digital inputs
5	Connection option for DIN rail connector
6	DIN rail
7	Metal foot catch for DIN rail fixing
8	Digital inputs 5 + 6
9	Digital inputs 7 + 8, DI7: pulse input 2
10	Status LEDs for digital inputs DI1 ... DI8

| Item	Designation
11	CNT status LED, green (pulse counter mode)
12	ERR status LED, red (communication error)
13	DAT status LED, green (bus communication)
14	PWR status LED, green (supply voltage)

3.5.2   Basic circuit diagram
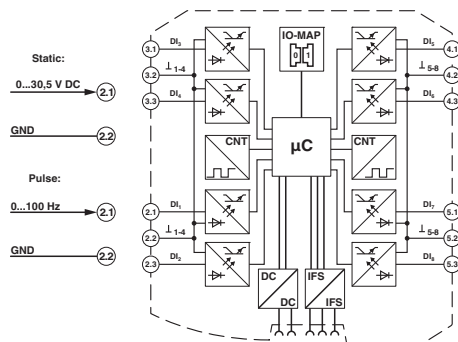
Figure 3-25   Basic circuit diagram for the RAD-DI8-IFS

3.5.3   Setting the DIP switches

You can use the DIP switches on the front to select between static mode or pulse counter mode.

– In static mode, the DI1 ... DI8 inputs are activated, 0 V ... 30.5 V DC voltage.
– In pulse counter mode, the DI1 and DI7 pulse inputs are activated, 0 Hz ... 100 Hz pulses.

> **i** The pulse counter function is only available in PLC/Modbus RTU mode. Set the operating mode using the PSI-CONF software (from Section 5.6, "Configuration via PSI-CONF software" onwards).
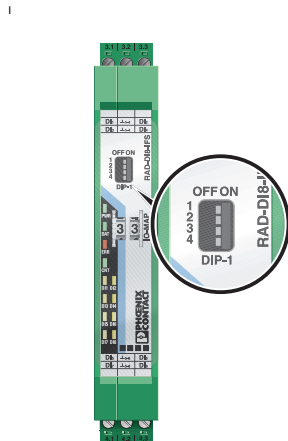
Figure 3-26   DIP switches of the RAD-DI8-IFS

Table 3-8   DIP switches of the RAD-DI8-IFS

Input	Output signal	DIP switch			
		1	2	3	4
Digital IN DI1 ... DI8	Static mode	OFF	n.c.	n.c.	n.c.
Counter IN DI1 + DI7	Pulse counter mode	ON	n.c.	n.c.	n.c.

n. c. = not connected, DIP switches 2 ... 4 have no function

• Use DIP switch 1 to select between static mode and pulse counter mode.
• Disconnect the device from the supply voltage.
• Switch the supply voltage back on.
• The selected mode is now active.

3.5.4   Functions in pulse counter mode

The counter state can only increase consecutively. When the maximum counter limit of 4,294,967,295 is reached, the counter is automatically set back to 0. In addition, you can manually reset the counter states in three different ways:

Reset counter state via power up

• Disconnect the device power supply and then reconnect the voltage.

Reset counter state via the Modbus RTU register

• Reset the counter states via Modbus RTU as follows:
    – DI1: bit 0 = 1 (register 40xx1)
    – DI7: bit 1 = 1 (register 40xx1)

Reset counter state by setting the inputs

• Set the corresponding input for at least 0.5 seconds:
    – Set the **DI3** input in order to reset the **DI1** counter state.
    – Set the **DI5** input in order to reset the **DI7** counter state.

3.5.5 Diagnostic LEDs

The RAD-DI8-IFS I/O extension module uses a total of twelve LEDs to indicate the operating states.
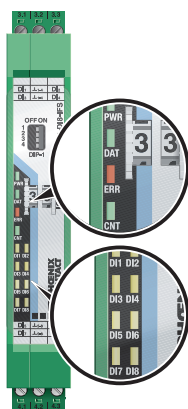
Figure 3-27   Diagnostic LEDs of the RAD-DI8-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF	No supply voltage
ON	Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF	No communication
Flashing	Configuration and addressing mode
ON	Cyclic data communication

ERR LED

The red ERR LED indicates the error status.

OFF	No error
Flashing	
Slow (1.4 Hz)	I/O-MAP address changed or mode switched using DIP switch 1, but not yet applied
Fast (2.8 Hz)	No bus communication
ON	Critical internal error

CNT LED

The green CNT LED indicates that pulse counter mode is activated.

OFF	No error
Flashing	Mode switched using DIP switch 1, but not yet applied
ON	Pulse counter mode of digital inputs DI1 and DI7

DI1 ... DI8

The yellow DI1 ... DI8 LEDs indicate the status of the digital inputs.

In pulse counter mode: The DI1 and DI7 LEDs flash in time with the recorded pulses. The DI3 and DI5 LEDs light up when the counter state is reset.

DI3	ON (0.5 second)	Counter state DI1 reset to 0
DI5	ON (0.5 second)	Counter state DI7 reset to 0

3.5.6 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-9   Setting the I/O-MAP address for the RAD-DI8-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.5.7   Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of eight data words. For additional information, please refer to Section 3.5, "RAD-DI8-IFS - digital extension module with eight inputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DI8-IFS	02_{hex} Static mode	02_{hex} Static inputs	30xx0 ... 30xx1	fc 04
	40_{hex} Pulse counter mode	06_{hex} Pulse inputs	30xx0 ... 30xx5	fc 04
	40_{hex} Pulse counter mode	02_{hex} Reset counter states	40xx0 ... 40xx1	fc 03, 16

3.6 RAD-DOR4-IFS - digital extension module with four outputs

⚠️ **WARNING: Risk of electric shock**

Use the same phase for digital inputs and digital outputs. The isolating voltage between the individual channels must not exceed 300 V.

The digital RAD-DOR4-IFS I/O extension module can process up to four input signals that are switched via relay outputs. The digital outputs are designed as floating relay contacts (PDT). All outputs are electrically isolated from one another, from the supply voltage, and from the electronics.

3.6.1 Structure
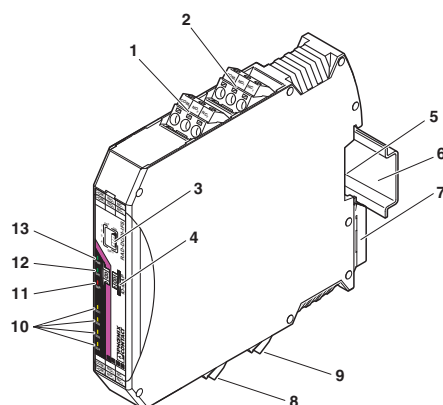
Figure 3-28   RAD-DOR4-IFS structure

Item	Designation
1	Relay output 2 with floating PDT contact
2	Relay output 1 with floating PDT contact
3	DIP switches for configuring the output behavior of the relay outputs (hold/reset)
4	White thumbwheel for setting the I/O-MAP address
5	Connection option for DIN rail connector
6	DIN rail
7	Metal foot catch for DIN rail fixing
8	Relay output 3 with floating PDT contact
9	Relay output 4 with floating PDT contact
10	Status LEDs for the relay outputs DO1 ... DO4
11	ERR status LED, red (communication error)
12	DAT status LED, green (bus communication)
13	PWR status LED, green (supply voltage)

3.6.2 Basic circuit diagram
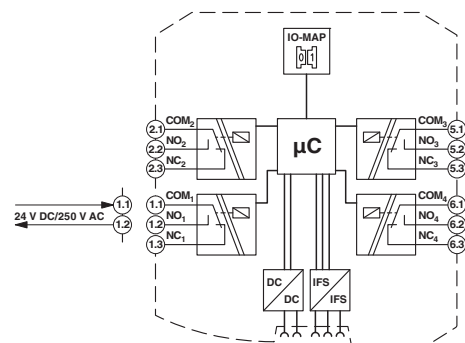
Figure 3-29   Basic circuit diagram for the RAD-DOR4-IFS

3.6.3 Setting the DIP switches

You can use the DIP switches on the front to set the behavior of the outputs in the event of an error (e.g., interruption of the wireless connection). Any changes in the setting of the DIP switches will be directly applied.

– RESET = Output value is set to 0
– HOLD = Hold last output value
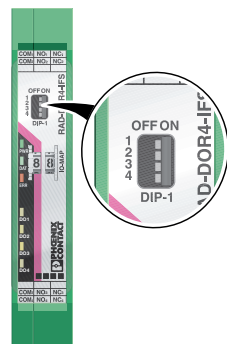
Figure 3-30   DIP switches of the RAD-DOR4-IFS

Table 3-10   DIP switches of the RAD-DOR4-IFS

		DIP switch			
Setting	Output signal	1	2	3	4
Digital OUT1	RESET	OFF			
Digital OUT1	HOLD	ON			
Digital OUT2	RESET		OFF		

Table 3-10   DIP switches of the RAD-DOR4-IFS

Setting	Output signal	DIP switch			
		1	2	3	4
Digital OUT2	HOLD		ON		
Digital OUT3	RESET			OFF	
Digital OUT3	HOLD			ON	
Digital OUT4	RESET				OFF
Digital OUT4	HOLD				ON

3.6.4   Diagnostic LEDs

The RAD-DOR4-IFS I/O extension module uses a total of seven LEDs to indicate the operating states.
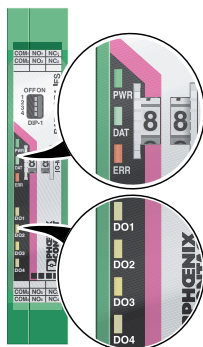
Figure 3-31   Diagnostic LEDs of the RAD-DOR4-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF   No supply voltage

ON   Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF   No communication

Flashing   Configuration and addressing mode

ON   Cyclic data communication

ERR LED

The red ERR LED indicates the error status, e.g., if a corresponding input module has not been found.

OFF   No error

Flashing

    Slow (1.4 Hz)   I/O-MAP address changed

    Fast (2.8 Hz)   **Wireless module in I/O data mode**

                     – Missing input module

                     – No bus communication

                 Wireless module in PLC/Modbus RTU mode

                     – No Modbus communication (safe state of outputs, depending on DIP switch setting)

ON   Critical internal error

DO1 ... DO4

The yellow LEDs DO1 ... DO4 LEDs indicate the status of the digital outputs.

3.6.5 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-11   Setting the I/O-MAP address for the RAD-DOR4-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of two data words. For additional information on process data, please refer to Section 3.6, "RAD-DOR4-IFS - digital extension module with four outputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DOR4-IFS	10$_{hex}$	02$_{hex}$	40xx0 ... 40xx1	fc 03, 16

3.7 RAD-DO8-IFS - digital extension module with eight outputs

i Use the I/O extension modules in connection with the RAD-900-... wireless module, firmware version 1.40 or later. You can update the firmware free of charge using the PSI-CONF software, Version 2.04 or later.

The firmware and software can be found on the Internet at phoenixcontact.net/products.

The digital RAD-DO8-IFS I/O extension module processes up to eight digital output signals that are switched via transistor outputs. The eight outputs are arranged in two groups of four outputs each with a common electrical supply. The two output groups are electrically isolated from one another, from the supply voltage, and from the electronics.

Since the DO1 ... DO4 and DO5 ... DO8 output groups are electrically isolated, the digital outputs must be externally supplied (see Figure 3-33).

- The DO1 ... DO4 outputs are supplied via:
  - Terminal 1.1 (12 V DC ... 30.5 V DC)
  - Terminals 1.2/1.3 (GND)
- The DO5 ... DO8 outputs are supplied via:
  - Terminal 6.1 (12 V DC ... 30.5 V DC)
  - Terminals 6.2/6.3 (GND)

3.7.1 Structure
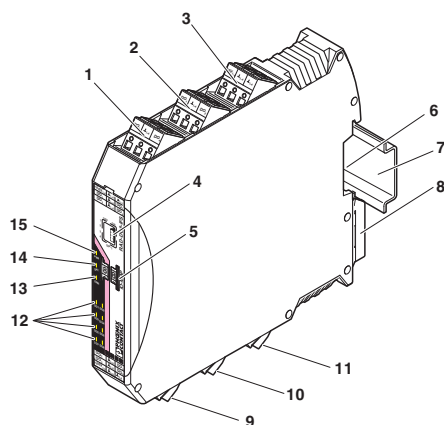
Figure 3-32   RAD-DO8-IFS structure

Item	Designation
1	Transistor outputs 3 + 4
2	Transistor outputs 1 + 2
3	Supply voltage for outputs 1 ... 4
4	DIP switches for setting the output behavior of the transistor outputs (hold/reset)
5	White thumbwheel for setting the I/O-MAP address
6	Connection option for DIN rail connector

Item	Designation
7	DIN rail
8	Metal foot catch for DIN rail fixing
9	Transistor outputs 5 + 6
10	Transistor outputs 7 + 8
11	Supply voltage for outputs 5 ... 8
12	Status LEDs of transistor outputs DO1 ... DO8
13	ERR status LED, red (communication error)
14	DAT status LED, green (bus communication)
15	PWR status LED, green (supply voltage)

3.7.2   Basic circuit diagram
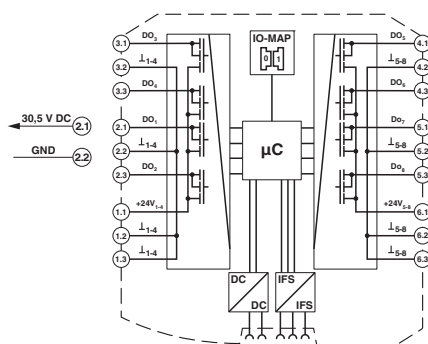
Figure 3-33   Basic circuit diagram for the RAD-DO8-IFS

3.7.3   Setting the DIP switches

You can use the DIP switches on the front to set the behavior of the outputs in the event of an error (e.g., interruption of the wireless connection). Any changes in the setting of the DIP switches will be directly applied.

– RESET = Output value is set to 0
– HOLD = Hold last output value
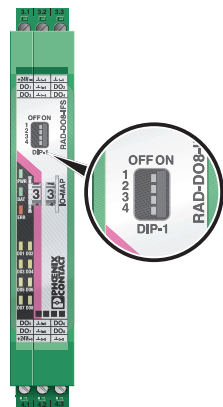
Figure 3-34   DIP switches of the RAD-DO8-IFS

Table 3-12   DIP switches of the RAD-DO8-IFS

		DIP switch			
Setting	**Output signal**	**1**	**2**	**3**	**4**
Digital OUT 1 ... 4	RESET	OFF		n. c.	n. c.
Digital OUT 1 ... 4	HOLD	ON		n. c.	n. c.
Digital OUT 5 ... 8	RESET		OFF	n. c.	n. c.
Digital OUT 5 ... 8	HOLD		ON	n. c.	n. c.

n. c. = not connected, DIP switches 3 and 4 have no function

3.7.4   Diagnostic LEDs

The RAD-DO8-IFS I/O extension module uses a total of eleven LEDs to indicate the operating states.
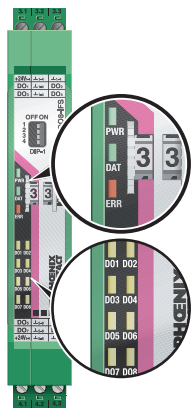
Figure 3-35   Diagnostic LEDs of the RAD-DO8-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF	No supply voltage
ON	Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF	No communication
Flashing	Configuration and addressing mode
ON	Cyclic data communication

ERR LED

The red ERR LED indicates the error status, e.g., if a corresponding input module has not been found.

OFF	No error
Flashing	**Wireless module in I/O data mode**
	– Missing input module
	– No bus communication
	Wireless module in PLC/Modbus RTU mode
	– No Modbus communication (safe state of outputs, depending on DIP switch setting)
	– Short circuit at one output or several outputs
ON	Critical internal error

DO1 ... DO8

The yellow DO1 ... DO8 LEDs indicate the status of the digital outputs.

DO1 ... DO4	Flashing	Short circuit at one output or several outputs 1 ... 4
DO5 ... DO8	Flashing	Short circuit at one output or several outputs 5 ... 8

3.7.5 Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-13   Setting the I/O-MAP address for the RAD-DO8-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.7.6 Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of four data words. For additional information, please refer to Section 3.7, "RAD-DO8-IFS - digital extension module with eight outputs".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DO8-IFS	11_{hex}	02_{hex} Outputs	40xx0 ... 40xx1	fc 03.16
		02_{hex} Short-circuit detection	30xx0 ... 30xx1	fc 04

3.8 RAD-DAIO6-IFS - analog/digital extension module with six channels

⚠️ **WARNING: Risk of electric shock**

Use the same phase for digital inputs and digital outputs. The isolating voltage between the individual channels must not exceed 300 V.

The analog/digital RAD-DAIO6-IFS I/O extension module has a total of six channels. The device is able to process two digital input and output signals as well as one analog input signal and one analog output signal. All inputs and outputs are electrically isolated from one another, from the supply voltage, and from the electronics.

Two digital inputs

The digital inputs process voltages between 0 V ... 50 V AC/DC at the low-voltage input and 0 V ... 250 V AC/DC at the high-voltage input.

Two digital outputs

The digital outputs are designed as floating relay contacts (PDT). The switching capacity is 2 A at 250 V AC/24 V DC.

Analog input

The analog input is able to process standard signals between 0/4 mA ... 20 mA. A supply voltage of at least 12 V DC is available at the PWR_1 connection terminal block for the use of passive sensors.

Analog output

The analog output is designed as active output. You can either select a current signal 0/4 mA ... 20 mA or a voltage signal 0 V ... 10 V.

ℹ️ Use either a current or voltage output at the analog output.

3.8.1 Structure
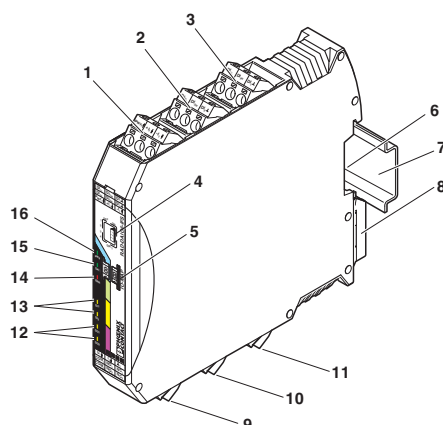
Figure 3-36   RAD-DAIO6-IFS structure

Item	Designation
1	Analog input for 2-, 3-, 4-wire measuring transducers
2	Digital input as wide-range input
3	Digital input as wide-range input
4	DIP switches for configuring the inputs and outputs
5	White thumbwheel for setting the I/O-MAP address
6	Connection option for DIN rail connector
7	DIN rail
8	Metal foot catch for DIN rail fixing
9	Analog output, alternatively current or voltage
10	Relay output with floating PDT contact
11	Relay output with floating PDT contact
12	Status LEDs of the digital DO1 ... DO2
13	Status LEDs of the digital DI1 ... DI2 inputs
14	ERR status LED, red (communication error)
15	DAT status LED, green (bus communication)
16	PWR status LED, green (supply voltage)

3.8.2 Basic circuit diagram
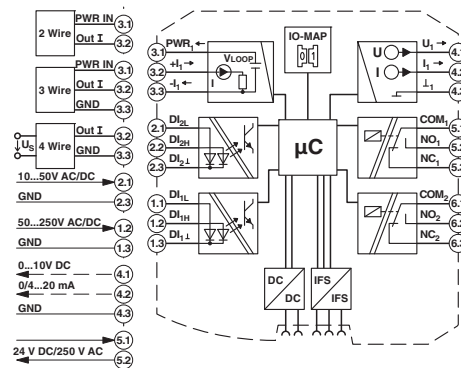
Figure 3-37   Basic circuit diagram for the RAD-DAIO6-IFS

3.8.3 Setting the DIP switches

The DIP switches on the front can be used to configure the input signals ranges. In addition, you can set the behavior of the outputs in the event of an error (e.g., interruption of the wireless connection). Any changes in the setting of the DIP switches will be directly applied.

Analog output

–   RESET = Output value is set to 0
–   HOLD = Hold last output value

Digital outputs

–   RESET = Relay drops out
–   HOLD = Hold last valid state
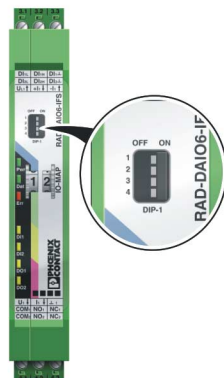
Figure 3-38   DIP switches of the RAD-DAIO6-IFS

Table 3-14   DIP switches of the RAD-DAIO6-IFS

		DIP switch			
Setting	**Output signal**	**1**	**2**	**3**	**4**
Analog IN	0 ... 20 mA	OFF			
Analog IN	4 ... 20 mA	ON			
Analog OUT	RESET		OFF		
Analog OUT	HOLD		ON		
Digital OUT1	RESET			OFF	
Digital OUT1	HOLD			ON	
Digital OUT2	RESET				OFF
Digital OUT2	HOLD				ON

3.8.4   Diagnostic LEDs

The RAD-DAIO6-IFS I/O extension module uses a total of seven LEDs to indicate the operating states.
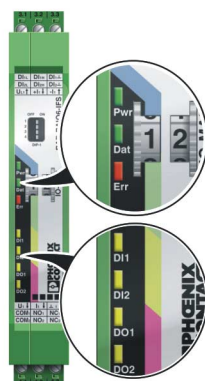
Figure 3-39   Diagnostic-LEDs of the RAD-DAIO6-IFS

PWR LED

The green PWR LED indicates the supply voltage status.

OFF	No supply voltage
ON	Supply voltage OK

DAT LED

The green DAT LED indicates the bus communication status.

OFF	No communication
Flashing	Configuration and addressing mode
ON	Cyclic data communication

ERR LED

The red ERR LED indicates the error status, e.g., if a corresponding output module has not been found.

OFF	No error
Flashing	
Slow (1.4 Hz)	I/O-MAP address changed
Fast (2.8 Hz)	**Wireless module in I/O data mode**

                                             –   Missing input module

                                             –   No bus communication

                                   Wireless module in PLC/Modbus RTU mode

                                             –   No Modbus communication (safe state of outputs, depending on DIP switch setting)

ON	Critical internal error

DI1 / DI2

The yellow DI1 and DI2 LEDs indicate the status of the digital inputs.

DO1/DO2

The yellow DO1 and DO2 LEDs indicate the status of the digital outputs.

3.8.5   Setting the I/O-MAP address

Use the thumbwheel to set the I/O-MAP address. The extension module in the Radioline wireless system is addressed using the I/O-MAP address. You can assign a maximum of 01 ... 99 addresses to the I/O extension modules in the entire wireless network.

Table 3-15   Setting the I/O-MAP address for the RAD-DAIO6-IFS

Thumbwheel setting	Description
01 ... 99	I/O-MAP address
00	Delivery state
**, 1* ... 9*	Setting not permitted
*1 ... *9	Interface System slave address, for use with other Interface System (IFS) master devices

3.8.6 Process data in PLC/Modbus RTU mode

The process image of the I/O extension module consists of six data words. For additional information, please refer to Section 3.8, "RAD-DAIO6-IFS - analog/digital extension module with six channels".

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DAIO6-IFS	60$_{hex}$	03$_{hex}$ (inputs)	30xx0 ... 30xx2	fc 04
		03$_{hex}$ (outputs)	40xx0 ... 40xx2	fc 03, 16

3.9 RAD-RS485-IFS modules

For some distributed systems, or networks with very large I/O counts, the master wireless device can be expanded with RAD-RS485-IFS modules. I/O extension modules in the wireless network can be mapped to I/O extension modules connected to RAD-RS485-IFS modules. This is only supported in Wire In/Wire Out mode.
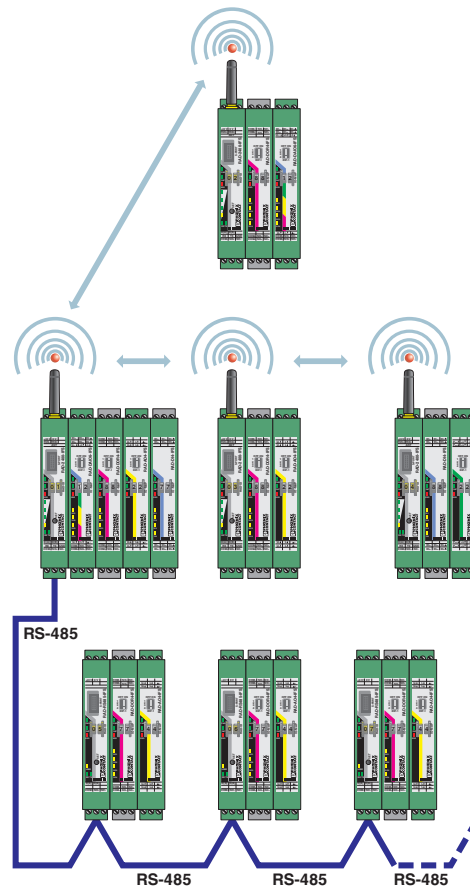
Figure 3-40   Typical RAD-RS485-IFS installation

4 Installation

4.1 DIN rail-mounted devices (RAD-900-IFS)

4.1.1 Mounting/removal

You can connect up to 32 different I/O extension modules to each wireless module via the DIN rail connector. Data is transmitted and power is supplied to the I/O extension modules via the bus foot.

When using the device in a connection station, use the supplied 17.5 mm wide DIN rail connector. Only use the DIN rail connector in connection with 24 V DC devices.

ℹ️ Mount the wireless module to the left and the I/O extension modules **exclusively to the right** of the wireless module.

The individual extension modules can be arranged in any order.

Figure 4-1   Radioline connection station with up to 32 I/O extension modules
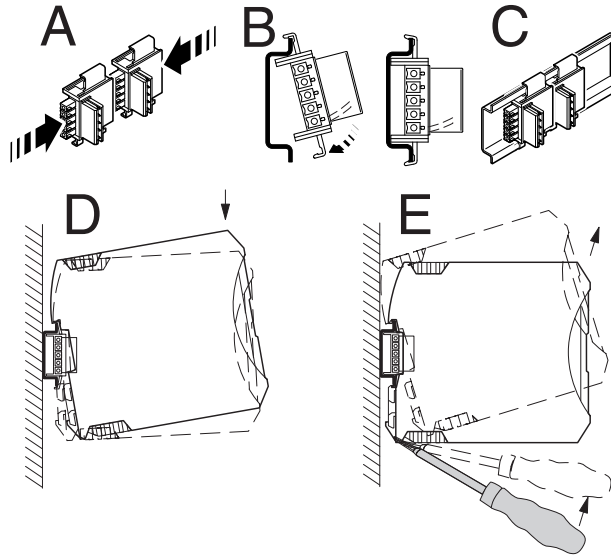
Figure 4-2   Mounting and removal

To mount a connection station with DIN rail connectors, proceed as follows:

1. Connect the DIN rail connectors together for a connection station.
2. Push the connected DIN rail connectors onto the DIN rail.
3. Place the device onto the DIN rail from above (see Figure 4-2, D). Make sure that the device and DIN rail connector are aligned correctly.
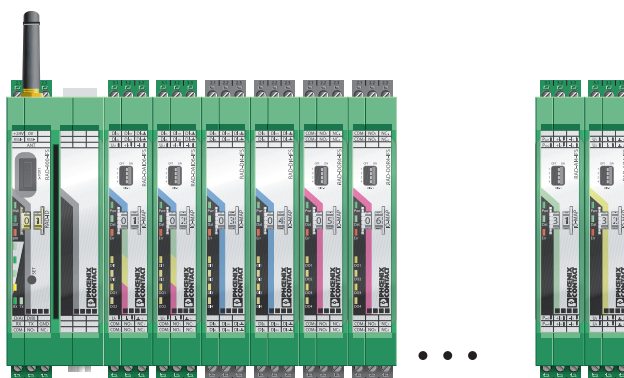4. Holding the device by the housing cover, carefully push the device towards the mounting surface so that the device bus connector is fixed securely on the DIN rail connector.
5. Once the snap-on foot snaps onto the DIN rail, check that it is fixed securely. The device is only mechanically secured via the DIN rail.
6. Connect the desired number of I/O extension modules to the wireless module via the DIN rail connector.

> **i** Device replacement is also possible during operation when outside the hazardous area.

Removal

1. Use a suitable screwdriver to release the locking mechanism on the snap-on foot of the device (see Figure 4-2, E).
2. Hold onto the device by the housing cover and carefully tilt it upwards.
3. Carefully lift the device off the DIN rail connector and the DIN rail.

4.1.2 Connecting wires
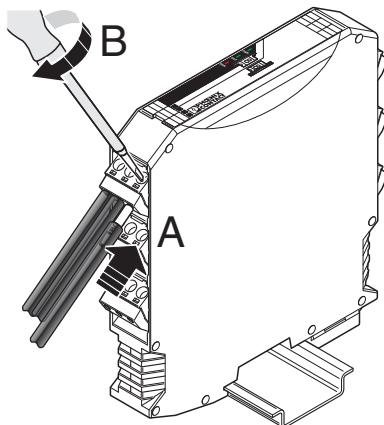
Figure 4-3   Connecting wires

ℹ️ For easy installation, it is also possible to pull out the screw terminal block from the device and to re-insert it after having connected the wires.

1. Crimp ferrules to the wires. Permissible cable cross section: 0.2 mm^2 ... 2.5 mm^2 (24 … 14 AWG).
2. Insert the wire with ferrule into the corresponding connection terminal block.
3. Use a screwdriver to tighten the screw in the opening above the connection terminal block. Tightening torque: 0.6 Nm

4.1.3 Connecting the power supply

Via screw terminal blocks

Connect a DC voltage source (10.8 V ... 30.5 V DC) to the wireless module. The nominal voltage is 24 V DC. Supply voltage to the device via the terminals 1.1 (24 V) and 1.2 (0 V). In the case of a connection station, it is sufficient to supply the first device in the group.

Ⓘ **NOTE:**
The power supply must be connected to terminals 1.1 and 1.2. Power supply via the DIN rail connector (TBUS) is not permitted.

Figure 4-4   Connecting the power supply

In order to prevent damage to the wireless module, we recommend the installation of a surge arrester. Wiring between the surge arrester and the wireless module should be as short as possible. Please also observe the manufacturer's specifications.
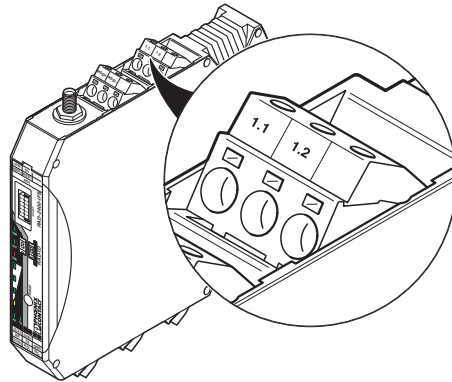
4.1.4   Serial interfaces

The RAD-900-IFS wireless module has one RS-232 interface and one RS-485 2-wire interface. Connect the I/O device to the wireless module via the corresponding serial interface.

> **i**
>
> Both serial interfaces are deactivated by default. Activate and configure the RS-232 or RS-485 interface using the PSI-CONF software (from Section 5.6, "Configuration via PSI-CONF software" onwards).
>
> You can only use one interface per wireless module. Parallel operation of both interfaces is not possible.

4.1.4.1   Connecting the RS-485 cable

In RS-485 mode, an RS-485 network with several I/O devices can be created. Use a twisted-pair, common shielded bus

> **NOTE:**
>
> Observe the polarity of the RS-485 cable. Install the bus cable with a termination network at the two furthest points of the RS-485 network.
>
> Termination resistors are integrated into the RAD-900-IFS and can be switched on using the DIP switches on the side of the module.

RS-485 pin assignment

In RS-485 mode, you can create a network with several I/O devices. Use a twisted-pair bus cable to connect the I/O devices. Install this bus cable with a termination network at the two furthest points.

*   Connect the single wires of the data cable to the COMBICON plug-in screw terminal block (Figure 2-1, item 10).
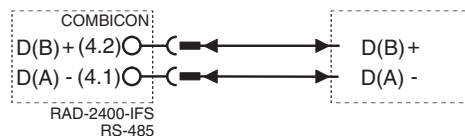*   Make sure the signal assignment is correct.

Figure 4-5   RS-485 interface pin assignment

RS-232 pin assignment

In RS-232 mode, point-to-point connections can be established.

	The RS-232 interface of the wireless module is a DTE type (Data Terminal Equipment). This means that terminal point 5.2 (Tx) is always used for transmission and terminal point 5.1 (Rx) is always used for reception.
	Only connect the wireless module to devices which meet the requirements of EN 60950.

According to the standard, you can connect a DCE device (Data Communication Equipment) to the RS-232 interface using a 1:1 cable (Figure 4-6). It is also possible to connect a DTE device using a crossed cable (Figure 4-7).
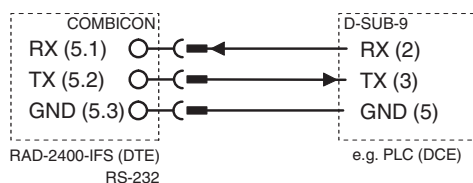

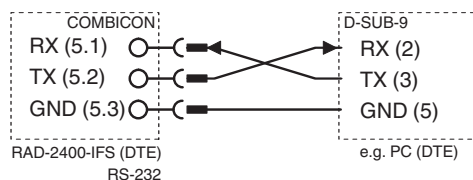Figure 4-6   RS-232 interface pin assignment (DTE - DCE)

Figure 4-7   RS-232 interface pin assignment (DTE - DTE)

If you are not sure whether the device to be connected is of DTE or DCE type, measure the voltage between TX and GND in the idle state.

–   If the voltage measures approximately -5 V, it is a DTE device.
–   If the voltage measures approximately 0 V, it is a DCE device.

D-SUB 9 pin assignment

The RAD-900-IFS provides a D-SUB 9 female connector for attaching RS-232 serial devices.
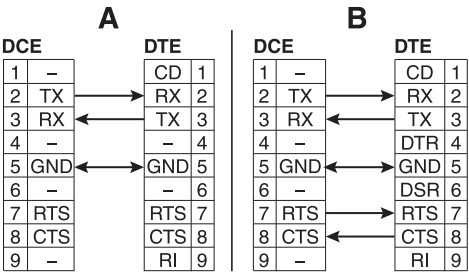
A

DCE		DTE	
1	–	CD	1
2	TX	RX	2
3	RX	TX	3
4	–	–	4
5	GND	GND	5
6	–	–	6
7	RTS	RTS	7
8	CTS	CTS	8
9	–	RI	9

B

DCE		DTE	
1	–	CD	1
2	TX	RX	2
3	RX	TX	3
4	–	DTR	4
5	GND	GND	5
6	–	DSR	6
7	RTS	RTS	7
8	CTS	CTS	8
9	–	RI	9

Figure 4-8   D-SUB 9 straight-through cable pinouts for 3-wire (A) and 5-wire (B)

A

DCE		DTE	
1	–	CD	1
2	TX	RX	2
3	RX	TX	3
4	–	–	4
5	GND	GND	5
6	–	–	6
7	RTS	RTS	7
8	CTS	CTS	8
9	–	RI	9

B

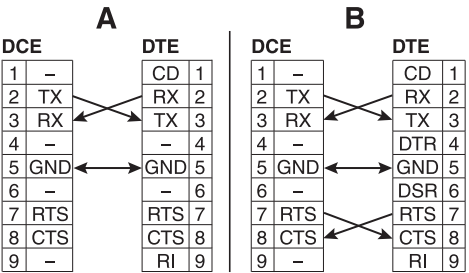| DCE		DTE	
1	–	CD	1
2	TX	RX	2
3	RX	TX	3
4	–	DTR	4
5	GND	GND	5
6	–	DSR	6
7	RTS	RTS	7
8	CTS	CTS	8
9	–	RI	9

Figure 4-9   D-SUB 9 null cable pinouts for 3-wire (A) and 5-wire (B)

4.1.5   Connecting the antenna

The wireless module is provided with an RSMA antenna socket for an external antenna.

> Install the antenna outside the control cabinet or building.
>
> Observe the installation instructions of the antenna and the "Installation and operation" on page 6.
>
> Observe the maximum permissible emitted transmission power of 36 dBm. The transmission power can be calculated as:
>   device transmission power + antenna gain - cable attenuation
>
> Reduce the device transmission power, if necessary.
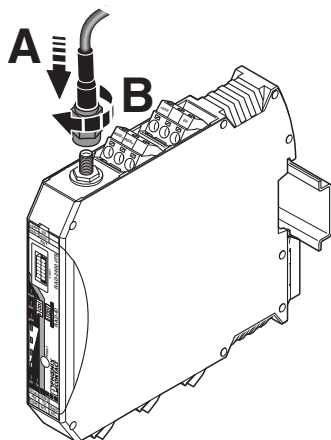
Figure 4-10   Connecting the antenna

4.2   Wall-mounted devices (RAD-900-DAIO6)

4.2.1   Mounting

The RAD-900-DAIO6 includes mounting feet for installing the device on a vertical surface.

1.   Loosen the four screws securing the cover and remove the cover.
2.   Attach the mounting feet to the RAD-900-DAIO6 in the desired orientation using the included screws, flat washers and lockwashers.
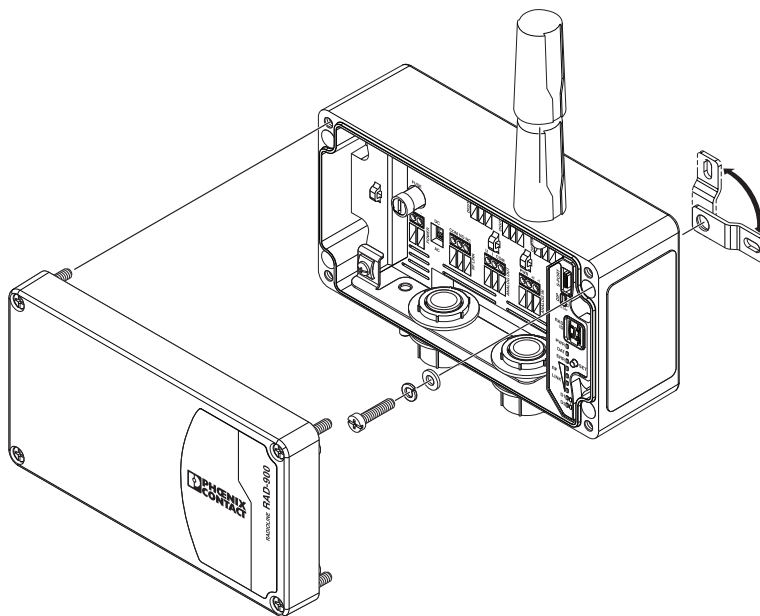

Figure 4-11   Mounting feet

3. Install the RAD-900-DAIO6 on the desired surface using appropriate hardware (not supplied).
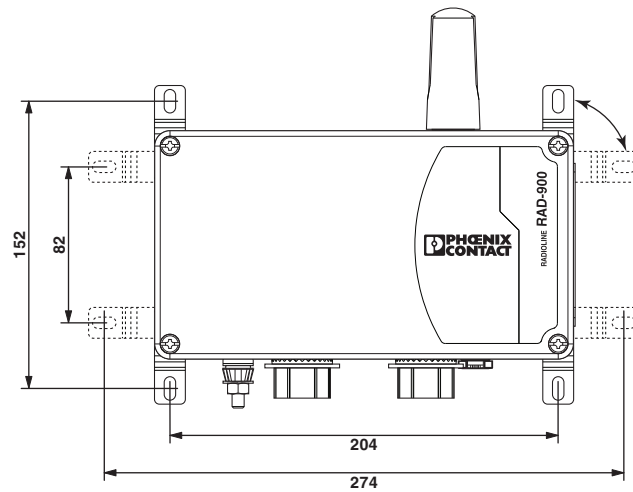

Figure 4-12   Mounting dimensions

Mounting considerations:
– Avoid mounting in direct sunlight to minimize the effects of solar loading (heating).
– Installation of a sun shield is recommended over the RAD-900-DAIO6 when it is mounted in direct sunlight and the ambient temperature can exceed 45°C.

4.2.2   Wire entry

The RAD-900-DAIO6 is supplied with two 1/2-in. NPT conduit hubs installed for connection to rigid or flexible conduit. Alternatively, cable glands may be installed using suitable cables. Use an approved thread sealant to ensure a water tight seal.

⚠ **WARNING:**

All connections must be sealed. If not, excess moisture accumulation can accumulate inside the device. Make sure to mount the transmitter with the electrical housing positioned downward for drainage. To avoid moisture accumulation in the housing, install wiring with a drip loop, and ensure the bottom of the drip loop is mounted lower than the conduit connections. The device is fitted with a breather vent to prevent excess moisture accumulation. Ensure the breather vent is kept free of debris.

4.2.3   Connecting wires

1. Crimp ferrules to the wires. Permissible cable cross section: 0.2 mm^2 ... 2.5 mm^2 (24 … 14 AWG).
2. Insert the wire with ferrule into the corresponding connection terminal block.
3. Use a screwdriver to tighten the screw in the opening above the connection terminal block. Torque screw to 0.6 Nm.
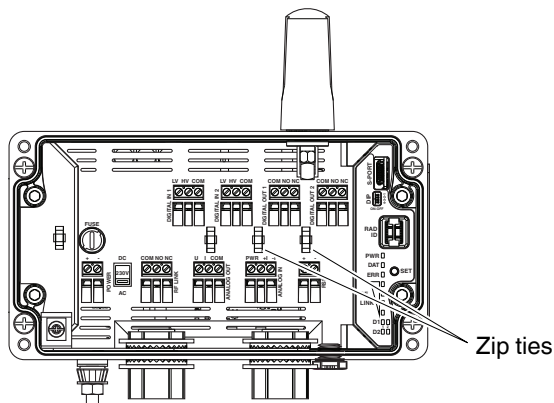
4. Install zip ties to manage wire routing.

Zip ties

Figure 4-13   Zip ties

4.2.4   Connecting power

⚠ **DANGER:**
Always disconnect power before installing or performing maintenance.

Select the input voltage range via the selector switch

• When the switch is set to DC mode, connect a DC voltage source (10.8 … 30.5 V DC) to the wireless module. The nominal voltage is 24 V DC.

• When the switch is set to AC mode, connect an AC voltage source (100 … 240 V AC) to the wireless module. When powered by an AC voltage source, the maximum temperature is 65°C.

⚠ **WARNING:**
The fuse protects the RAD-900-DAIO6 in case of an overcurrent event or if the selector switch is in the wrong position.

In order to prevent damage to the wireless module, Phoenix Contact recommends the installation of a surge arrester. Wiring between the surge arrester and the wireless module should be as short as possible. Please also observe the manufacturer's specifications.

4.2.4.1   Replacing the fuse

The fuse can be replaced using a 5x20 mm slow-blow fuse rated for 800 mA @ 250 V AC. Use types Littelfuse® 0215.800MXP, Bel Fuse 5HT 800-R or equivalent.

1. Disconnect supply voltage.
2. To remove the fuse, turn the fuse cover 90° counter-clockwise and remove it to access the fuse.
3. Install the replacement fuse.

⚠ **WARNING:**
Never operate the device without the cover installed.

4. Replace the cover.

4.2.5   Connecting the antenna

The wireless module has an N-type antenna socket for an external antenna. Although a 0 dB omni-directional antenna is included with the wireless module, it may be replaced with a coaxial cable and high-gain antenna.

Install the antenna outside the control cabinet or building.

Observe the installation instructions of the antenna and the "Installation and operation" on page 6.

Observe the maximum permissible emitted transmission power of 36 dBm. The transmission power can be calculated as:

device transmission power + antenna gain - cable attenuation

Reduce the device transmission power, if necessary.

If the antenna is removed and re-installed or a cable is attached for a remote antenna, torque the antenna or cable connector between 0.7 and 1.1 Nm.

5   Configuration and startup

5.1   Default settings of the wireless module

All RAD-900-… wireless modules have the same configuration by default upon delivery or by resetting to the default settings at a later stage.

Table 5-1   Default settings of the wireless module

Parameter	Setting
Operating mode	I/O data (wire in/wire out)
Wireless interface	
Net ID	127
RF band	1
Encryption	OFF
Network structure	Star
Device type	Slave
Data rate of the wireless interface	125 kbps
Transmission power	1 W (30 dBm)

ℹ️ In order to be able to cover the largest possible distances, the preamplifier has been activated and transmission power set to 30 dBm by default. When operating the devices directly next to one another, the receiver might become overloaded. In this case, remove the antennas, increase the distance between the devices and antennas or reduce transmission power using the PSI-CONF software (from page 76 onwards).

5.1.1   Resetting to the default settings

The device can be reset to the default settings either manually or using the PSI-CONF software.

Resetting manually

1. Disconnect the device from the supply voltage.
2. Hold down the SET button located on the front of the device and switch the supply voltage on.
3. Press and hold the SET button until the DAT LED flashes.

Resetting via PSI-CONF software

1. Select "Wireless, RAD-900-IFS" on the "Device Selection" page.
2. Select "Local Device".
3. Select "Set device to factory default configuration".