5.1.2 Firmware update

Download the latest firmware free of charge at phoenixcontact.net/products.

The firmware can be updated using the PSI-CONF software. The device is reset to the default settings after a firmware update.

1. Select “Wireless, RAD-900-IFS” on the “Device Selection” page.
2. Select “Update firmware”.

5.2 Operating mode of the wireless module

The Radioline wireless system offers four different options for signal and data transmission:

Operating mode	Configuration
I/O data mode	Default setting, configuration only possible via thumbwheel
Serial data mode	Configuration via PSI-CONF software
PLC/Modbus RTU mode	
PLC/Modbus RTU dual mode	

Only one operating mode can be selected. It is **not** possible to simultaneously transmit I/O signals and serial data.

If the wireless system is operated in an environment where other networks are also present (e.g., additional Radioline networks in the 900 MHz band), then a configuration memory can be used (see “Configuration via CONFSTICK” on page 73). For configuring extended settings of the wireless modules, it is also possible to use the PSI-CONF software (from page 76 onwards).

I/O data mode

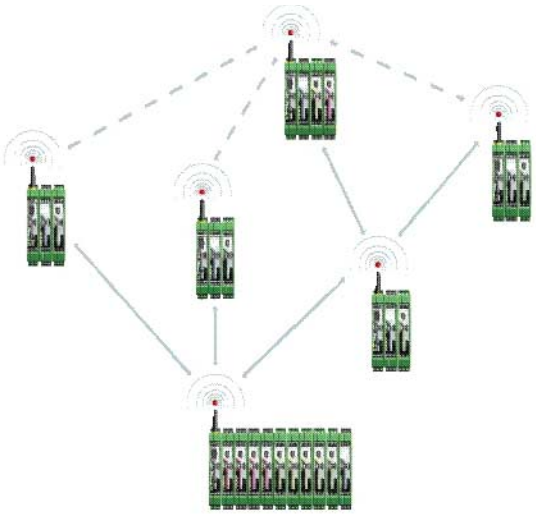


Figure 5-1 I/O data mode

By default, all wireless modules are in the I/O data mode. For simple I/O-to-I/O applications with extension modules, you can easily set the addresses using the thumbwheel. You can therefore establish a wireless connection to other wireless modules without any programming effort (see “Setting the address of the wireless module via the thumbwheel” on page 73 and “Setting the address of the extension modules via the thumbwheel” on page 82).

Serial data mode (RAD-900-IFS only)

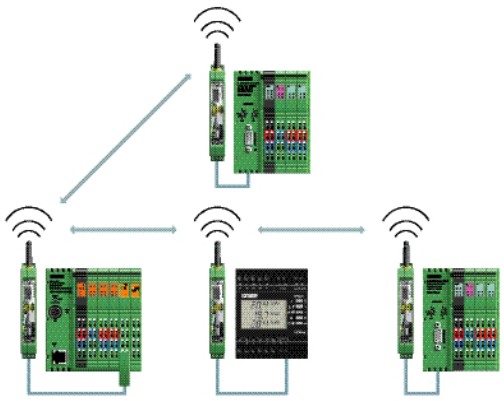


Figure 5-2 Serial data mode

In serial data mode, multiple controllers or serial I/O devices are networked easily and quickly using wireless technology. In this way, serial RS-232 or RS-485 cables can be replaced.

Each wireless module must be configured using the PSI-CONF software (from page 76 onwards).

PLC/Modbus RTU mode

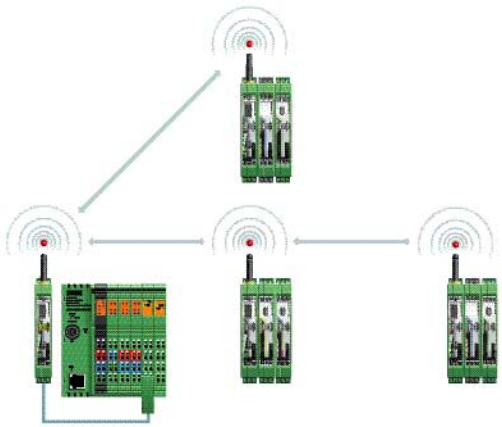


Figure 5-3 PLC/Modbus RTU mode

Connect the I/O extension modules to the controller directly via the integrated RS-232 and RS-485 interface by means of wireless communication. In PLC/Modbus RTU mode, the master wireless module (RAD ID = 01) operates as a Modbus slave. The master wireless module has its own Modbus address.

Connect I/O extension modules to each wireless module in the network. The I/O data of the extension module is stored in the internal Modbus memory map of the master wireless module. In addition, the diagnostic data from all wireless devices is stored here.

Each wireless module must be configured using the PSI-CONF software (from page 76 onwards).

PLC/Modbus RTU dual mode

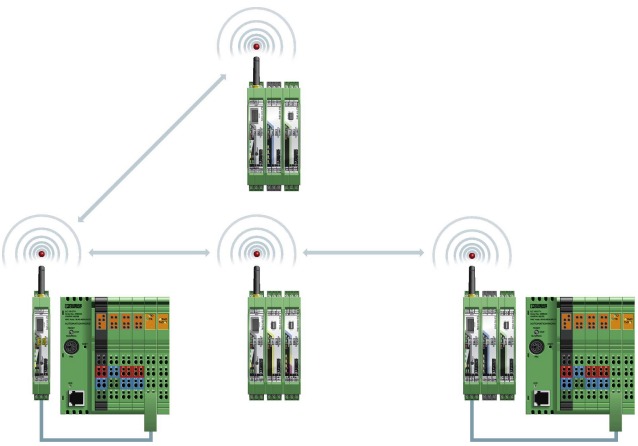


Figure 5-4 PLC/Modbus RTU dual mode

Dual mode combines the PLC/Modbus RTU mode and the serial data mode. Serial Modbus devices can be connected to the RS-232 or RS-485 ports, and connect I/O extension modules to each wireless module in the network.

The I/O data of the extension module and the diagnostic data is stored in the internal Modbus memory map of the wireless module. Each wireless module with I/O extension modules has its own Modbus address. In addition, the diagnostic data from all wireless devices can be read from the master wireless module.

Each wireless module must be configured using the PSI-CONF software (from page 76 onwards).

5.3 Setting the address of the wireless module via the thumbwheel

Set the desired station address with the yellow thumbwheel on the wireless module. There must be one master (RAD ID = 01) and at least one repeater/slave (RAD ID = 02 ... 99) in a network.

Unique addressing is required in a network. If two wireless modules have the same address in a network, the network will not function properly.

Setting the address via the thumbwheel has priority over setting the address via the PSI-CONF software.

After making any change to the module address, press the SET button for one second to apply the setting.

The following settings can be made using the yellow thumbwheel:

Thumbwheel setting	Description
01	Master address
02 ... 99	Slave address
00	Not permitted
	Addressing wireless modules using the PSI-CONF software (address 1 ... 250) IDs 100 to 250 must be configured using PSI-CONF software

5.4 Configuration via CONFSTICK

WARNING: Explosion hazard when used in potentially explosive areas

Do **not** insert or remove the CONFSTICK in a potentially explosive atmosphere.

By default upon delivery, all wireless modules have the same network ID and the same RF band. Using a configuration memory (CONFSTICK), you can configure a unique and secure network without the need for software.

The CONFSTICK is used as a network key. Its network address (network ID) is unique and cannot be assigned via the PSI-CONF software. Only wireless modules with the same network ID are allowed to connect with each other.

Each individual network device must be configured. Only one CONFSTICK is needed for all wireless modules in the network. After configuration, remove the CONFSTICK from the wireless module.

In addition, the CONFSTICK contains a preset frequency band (RF band). An RF band is a group of frequencies compiled of individual frequencies of the entire 900 MHz band. Different RF bands use different frequencies.

In order to operate several Radioline wireless systems, you should select different RF bands.

Set different RF bands between 1 ... 8 and network IDs between 1 ... 127 using the PSI-CONF software (see page 77).

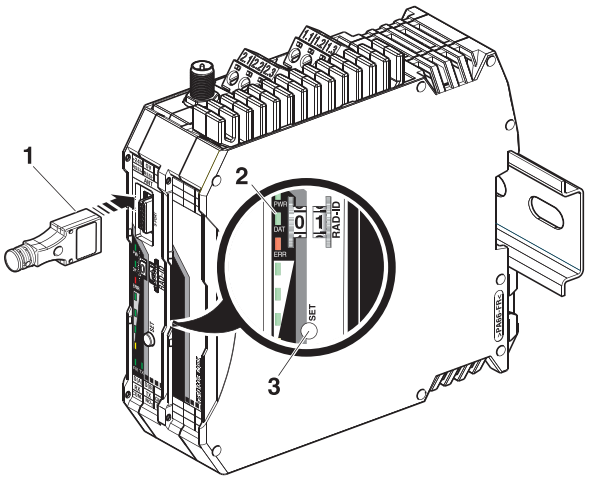


Figure 5-5 Configuration via CONFSTICK

Item	Description
1	RAD-CONF-RF CONFSTICK
2	Status LEDs
3	SET button

1. Carefully insert the CONFSTICK with the 12-pos. IFS connector into the S port of the wireless module.
2. Press the SET button on the wireless module for one second. Parameter read in is started. Read in has been completed when the DAT LED lights up once. The new parameters are activated.
3. Remove the CONFSTICK from the wireless module.
4. Repeat this process for each individual wireless module in the network.

5.5 Copying device settings via memory stick

To transfer the configuration of a wireless module to another wireless module, save the configuration to a memory stick (RAD-MEMORY, Order No. 2902828).

WARNING: Explosion hazard when used in potentially explosive areas

Do **not** insert or remove the memory stick in a potentially explosive atmosphere.

Pay attention to the firmware version of the wireless modules before using the memory stick. In order to ensure that a wireless module is capable of reading the memory stick, it must have the same or later firmware version as the wireless module whose configuration file is to be copied. Wireless modules with a lower firmware version are not able to read the memory stick.

Common network parameters

- Operating mode
- Network ID
- RF band
- Data rate of the wireless interface
- Encryption
- Network type

Individual device parameters

- Station name
- RAD ID
- Transmission power
- List of permitted connections
- Serial interface parameters

5.5.1 Saving parameters from the wireless module to the memory stick

Copying common network parameters and individual device parameters to the memory stick:

1. Press the SET button located on the wireless module and hold down for at least six seconds.
2. The four RSSI bar graph LEDs start a light sequence from bottom to top.
3. Insert the memory stick in the S port of the wireless module. The copying of parameters is started automatically.
4. Wait until the light sequence stops. The write process has been completed.
5. Remove the memory stick from the wireless module.

5.5.2 Reading the memory stick

Reading in common network parameters via the memory stick

1. Insert the memory stick in the S port of the wireless module.
2. Press the SET button located on the wireless module and hold down for at least one second. Parameter read in is started. Read in has been completed when the DAT LED lights up once. The new parameters are activated.
3. Remove the memory stick from the wireless module.

Reading in common network parameters and individual device parameters via the memory stick

This function enables all common network parameters and individual device parameters to be read into the wireless module. A full copy of devices can be created, e.g., as a backup copy.

1. Insert the memory stick in the S port of the wireless module.
2. Press the SET button located on the wireless module and hold down for at least six seconds. Parameter read in is started, the DAT LED flashes.
3. The read in process has been completed once the DAT LED stops flashing. The new parameters are activated.
4. Remove the memory stick from the wireless module.

If an error is detected while saving or checking the data, the DAT and ERR LEDs flash simultaneously.

5.6 Configuration via PSI-CONF software

You can make special settings using the PSI-CONF configuration and diagnostics software. The software is available to download at phoenixcontact.net/products. A PC with a Windows operating system is required to use the software. Use the RAD-CABLE-USB (Order No. 2903447) USB cable for configuration and diagnostics.

WARNING: Explosion hazard when used in potentially explosive areas

The USB cable must **not** be used in potentially explosive areas.

For additional information on the USB cable, please refer to the RAD-CABLE-USB package slip. The latest documentation can be downloaded at phoenixcontact.net/products.

Install the software and the USB driver for the RAD-CABLE-USB cable. Follow the software wizard.

5.6.1 Extended configuration, individual settings

After reading an existing network project or creating a new project, the network settings can be modified under “Individual Settings”. The wireless network can be optimized and adapted to your special requirements. When moving the mouse over the individual network parameters, you obtain a short description under “Help”.

If several wireless systems are operated parallel and in close proximity, you are required to set the RF band and the network ID. These parameters can be set via the PSI-CONF software or by using a CONFSTICK (see “Configuration via CONFSTICK” on page 73).

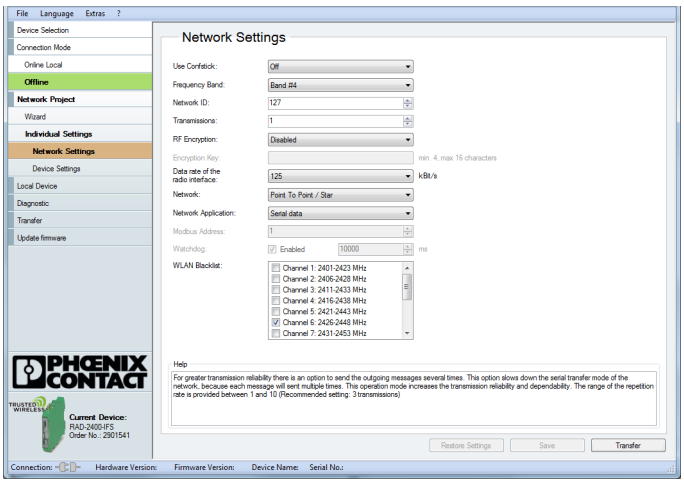


Figure 5-6 PSI-CONF software: Network Settings

5.6.2 Data transmission speed of the wireless interface

The range is an important parameter in industrial wireless applications, especially in outdoor applications. Even in cases where long ranges do not have to be covered, good receiver sensitivity enables transmission in harsh outdoor conditions, e.g., when there is no direct line of sight.

The receiver sensitivity determines the signal amplitude which can just about be received by the wireless module. The lower the data transmission speed of the wireless interface, the higher the receiver sensitivity and thereby the range.

Adjust the data transmission speed of the wireless interface to the respective application using the PSI-CONF software (default setting = 125 kbps).

Table 5-2 Data transmission speed of the wireless interface

Data transmission speed	Typical receiver sensitivity	Typical link budget	Potential distance with line of sight and a system reserve of 12 dB
500 kbps	-95 dBm	-125 dBm	12 km
250 kbps	-102 dBm	-132 dBm	25 km
125 kbps	-105 dBm	-135 dBm	35 km (default setting)
16 kbps	-112 dBm	-142 dBm	80 km

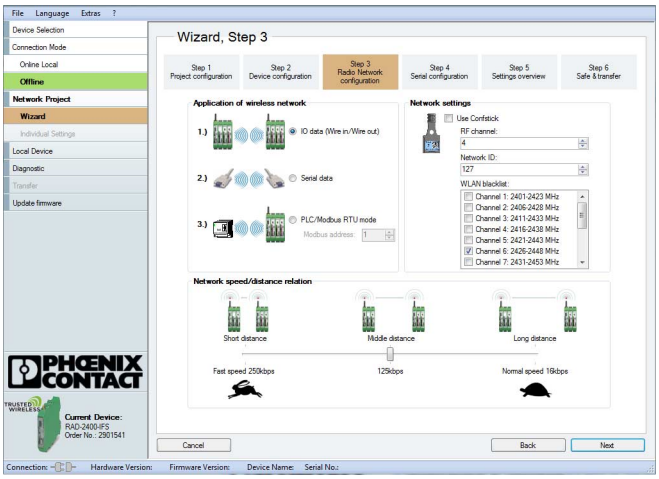


Figure 5-7 PSI-CONF software: Wizard, Step 3

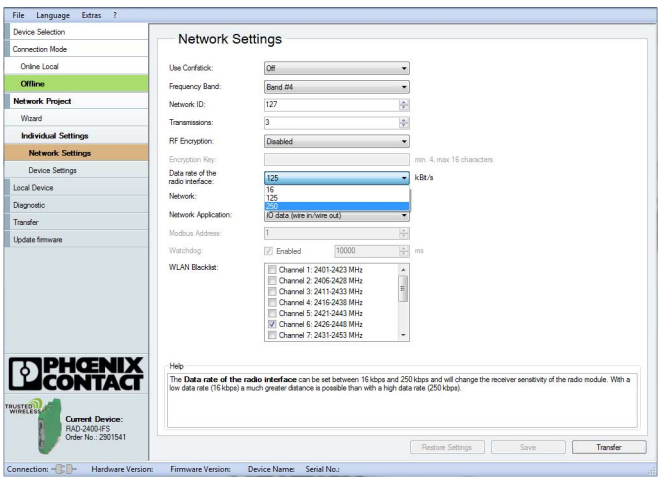


Figure 5-8 PSI-CONF software: Setting the data transmission speed

5.6.3 Device settings

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.

Assign a device name or set the transmission power under “Device Settings”. All device parameters are listed on the “Overview” tab.

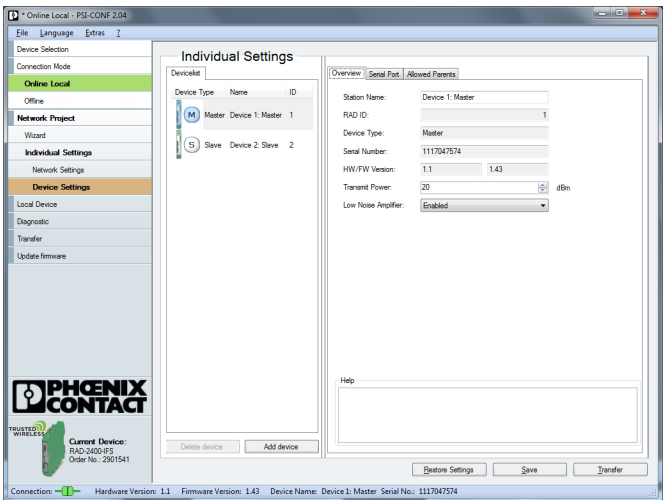


Figure 5-9 PSI-CONF software: Individual Settings, Overview

Depending on the operating mode, configure the serial interface under “Individual Settings” on the “Serial Port” tab.

In I/O data mode (default upon delivery), both interfaces are deactivated. To activate the serial interface, select the “Serial data,” “PLC/Modbus RTU mode,” or “PLC/Modbus RTU dual mode” network application under “Network Settings”.

Only use one interface per wireless module. Parallel operation of both interfaces is not possible.

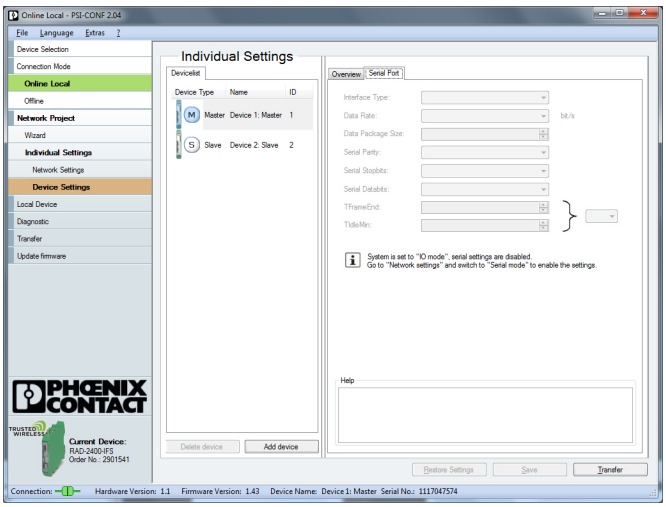


Figure 5-10 PSI-CONF software: Individual Settings, Serial Port

Define the wireless modules to which a connection may be established on the “Allowed Parents” tab under “Individual Settings”. This setting is required, for example, when creating repeater chains. Repeater chains are used to circumvent obstacles or to set up redundant wireless paths by means of several repeaters.

The “Allowed Parents” tab is only available if the “Line/Mesh” network type has been selected.

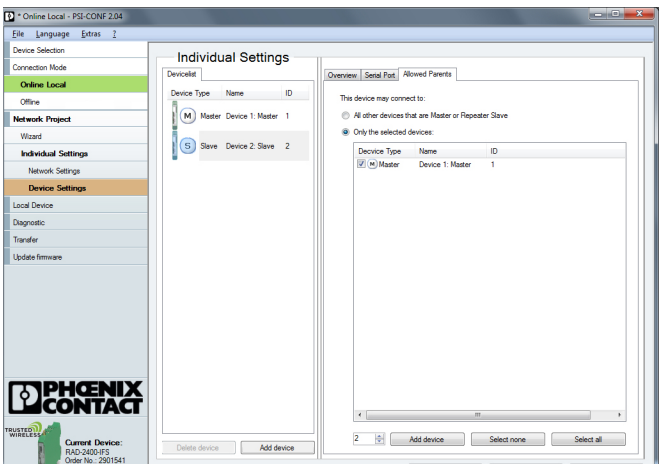


Figure 5-11 PSI-CONF software: Individual Settings, Allowed Parents

5.7 Starting up I/O extension modules

5.7.1 Combinations of extension modules

Several appropriate output modules at different stations can be assigned to one digital or analog input module. The inputs are transmitted in parallel to the outputs. The channels of the input module are mirrored to the channels of the output module.

It is not possible to separately assign the individual input channels of an extension module to different output modules.

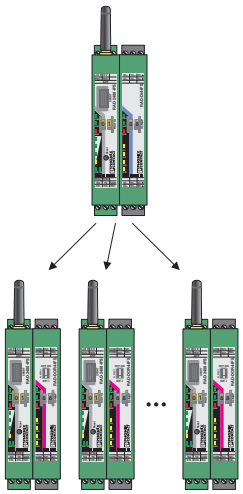


Figure 5-12 Assignment of digital inputs and digital outputs

The combined RAD-DAIO6-IFS extension modules can only be assigned in pairs, because each module is provided with inputs and outputs. That is why only two modules in the network may have the same I/O MAP address.

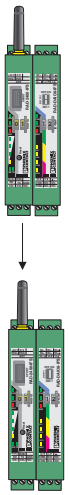


Figure 5-13 RAD-DAIO6-IFS assignment: analog/digital inputs and outputs

Table 5-3 Assignment of input and output modules

Input module		Output module	
2901537	RAD-AI4-IFS	2901538	RAD-AO4-IFS
2904035	RAD-PT100-4-IFS	2901538	RAD-AO4-IFS
2901535	RAD-DI4-IFS	2901536	RAD-DOR4-IFS
2901539	RAD-DI8-IFS	2902811	RAD-DO8-IFS
2901533	RAD-DAIO6-IFS	2901533	RAD-DAIO6-IFS

5.7.2 Setting the address of the extension modules via the thumbwheel

For an I/O-to-I/O transmission of signals, assign a corresponding output module to the input module. Set the I/O-MAP address (01 ... 99) using the white thumbwheel on the I/O extension module.

Addressing extension modules

- Use the thumbwheel to set the address.
- Press the SET button on the front of the wireless module to read the current configuration.

The following settings can be made using the white thumbwheel:

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

The following conditions must be met:

– Assign a maximum of 1 ... 99 addresses to the extension modules in the entire wireless network.

Wireless module in I/O data mode

– The input module **must** be provided with the same I/O-MAP address as the assigned output module at the other wireless station (I/O mapping). Output modules with the same I/O-MAP address may appear several times in the network at different stations.
– The I/O-MAP address of an input module may only appear once in the network.
– The channels of the input module are directly assigned to the channels of the output module:

Input module		Output module
Channel 1	→	Channel 1
Channel 2	→	Channel 2
...	→	...

It is **not** possible to individually assign the channels of the input and output modules.

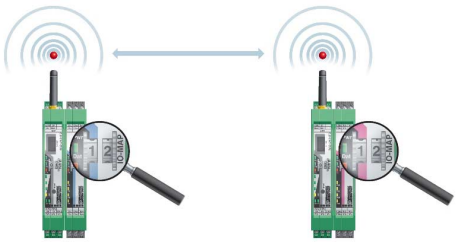


Figure 5-14 Input module and output module with the same address

Wireless module in PLC/Modbus RTU mode

– Output modules may not have the same I/O-MAP address as input modules. Exception: Output modules with the same I/O-MAP address may appear several times in the network at different stations.
– The I/O-MAP address of an input module may only appear once in the network.
– The input and output data is saved in a Modbus memory map in the master wireless module. You can read or write the process data via the serial interface of the master wireless module (RAD ID = 01) using the Modbus RTU command. The process data tables can be found starting at “Modbus memory map” on page 102.

5.7.3 Wireless module in PLC/Modbus RTU dual mode

– Each wireless module may be assigned a Modbus address. The master wireless module Modbus address may be changed from 01 if an existing Modbus device is already assigned this address. A Modbus address may only appear once in the network.
– Output modules may not have the same I/O-MAP address as input modules on a single wireless device (station). Exception: Output modules with the same I/O-MAP address may appear several times at the same station.

– The input and output data is saved in a Modbus memory map in the wireless module. You can read or write the process data via the serial interface of the master wireless module (RAD ID = 01) using the Modbus RTU command. The process data tables can be found starting at “Modbus memory map” on page 102.

5.8 Starting up the RAD-900-DAIO6

5.8.1 Setting the address of the RAD-900-DAIO6 via the thumbwheel

For an I/O-to-I/O transmission of signals, both the RAD ID and I/O-MAP address are set using the yellow thumbwheel on the RAD-900-DAIO6.

Addressing extension modules

- Use the thumbwheel to set the address.
- Press the SET button on the front of the wireless module to read the current configuration.

The following settings can be made using the yellow thumbwheel:

Thumbwheel setting	Description
01 ... 99	RAD ID and I/O-MAP address
01	Delivery state
**, 1* ... 9*, *1 … *9	Settings not permitted

The following conditions must be met:

– Assign a maximum of 1 ... 99 addresses to the RAD-900-DAIO6 in the entire wireless network. If the address is set to **01**, the RAD-900-DAIO6 may only be used in point-to-point mode with another RAD-900-DAIO6.

Wireless module in I/O data mode

The RAD-900-DAIO6 may be used to create a point-to-point or point-to-multipoint connection with RAD-900-IFS devices. In this case, set the I/O-MAP address to between **02** and **99** using the white thumbwheel on the corresponding RAD-DAIO6-IFS extension module(s) to match the yellow thumbwheel setting on the RAD-900-DAIO6.

– The I/O-MAP address of an input module may only appear once in the network.

– The input channels are directly assigned to the corresponding output channels at the other wireless station.

– The RAD-900-DAIO6 may be used to create a point-to-point connection with another RAD-900-DAIO6. In this case, one RAD-900-DAIO6 must have its address set to **01** and the other must be set to **02**.

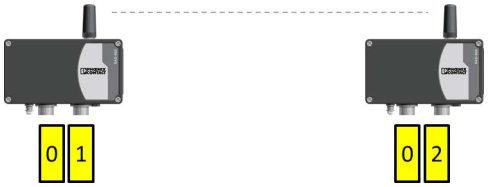


Figure 5-15 Thumbwheel addressing of the RAD-900-DAIO6 in point-to-point mode

Wireless module in PLC/Modbus RTU mode

– Multiple RAD-900-DAIO6 devices may not use the same thumbwheel address in a single network.
– The input and output data is saved in a Modbus memory map in the master wireless module. You can read or write the process data via the serial interface of the master wireless module (RAD ID = 01) using the Modbus RTU command. The process data tables can be found starting at “Modbus memory map” on page 102.

5.8.2 RAD-900-DAIO6 in PLC/Modbus RTU dual mode

– Each wireless module is assigned a Modbus address. The Modbus address of each module is that of the RAD-ID (yellow thumbwheel) set on the module. The master wireless module Modbus address may be changed from **01**, if an existing Modbus device is already assigned this address. A Modbus address may only appear once in the network.
– Each RAD-900-DAIO6 device must use a unique thumbwheel address within a single network.
– The input and output data is saved in a Modbus memory map in the wireless module. You can read or write the process data via the serial interface of the master wireless module (RAD ID = 01) using the Modbus RTU command. The process data tables can be found starting at “Modbus memory map” on page 102.

5.9 Startup time of the wireless station

Once a wireless station has been started (power “ON”), the wireless module will take 15 seconds to be ready for operation. Each linked I/O extension module increases the startup time by 3 seconds.

Startup time of a wireless station = 15 seconds + (number of I/O modules x 3 seconds)

Accordingly, a complete wireless station with 32 I/O extension modules requires a startup time of 111 seconds. Only after this period of time has elapsed is the wireless station ready for operation.

6 Serial data mode (RAD-900-IFS only)

In serial data mode, multiple controllers or serial I/O devices are networked quickly and easily using wireless technology. In this way, serial RS-232 or RS-485 cables can be replaced.

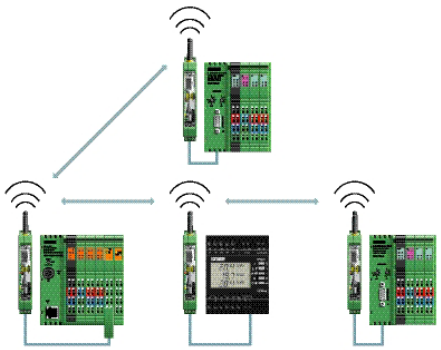


Figure 6-1 Serial data mode

Configure the serial interface of the RAD-900-IFS wireless module using the PSI-CONF software. In order to connect the wireless module to the PC, you need the RAD-CABLE-USB cable (Order No. 2903447).

WARNING: Explosion hazard when used in potentially explosive areas

The USB cable must **not** be used in potentially explosive areas.

When operating the network in serial data mode, it may not be possible to diagnose all devices. In this case, stop the serial application in order to allow for complete diagnostics.

Use PSI-CONF software to assign different serial settings to the devices under “Individual Settings”.

- Start the PSI-CONF software.
- Follow the software wizard.
- Once you have run through all steps of the wizard, save the project and transmit it to the wireless modules.

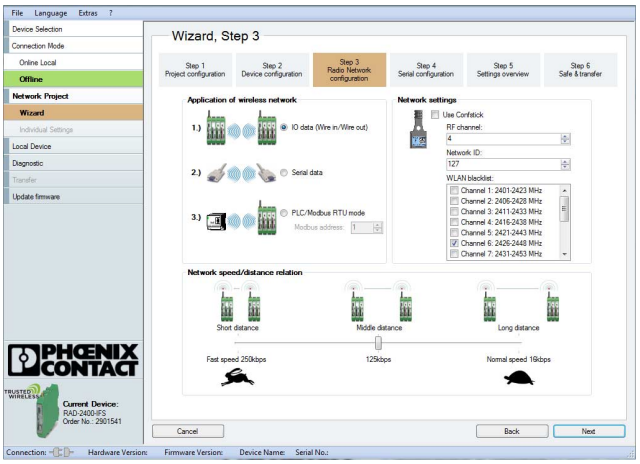


Figure 6-2 PSI-CONF software: Wizard, Step 3

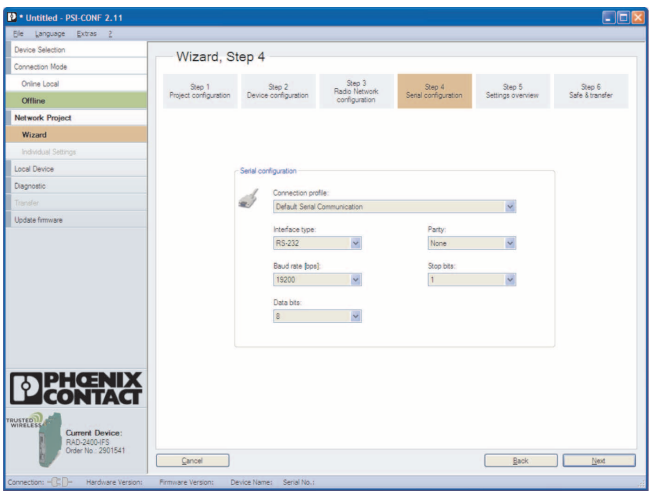


Figure 6-3 PSI-CONF software: Wizard, Step 4

6.1 Frame-based data transmission

$T_{IdleMin}$ parameter (minimum pause between two frames)

The $T_{IdleMin}$ parameter refers to the minimum pause that must elapse between two frames on the output side (wireless module is transmitting data via serial interface).

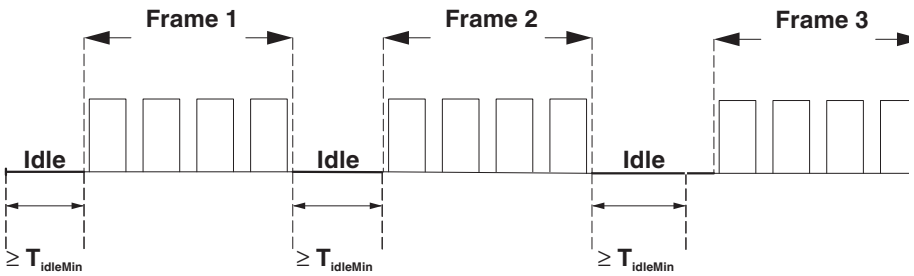


Figure 6-4 Frame-based data transmission: $T_{IdleMin}$ parameter

$T_{FrameEnd}$ parameter

$T_{FrameEnd}$ is the time which is kept by the transmitting wireless module between two frames.

If the data received by the wireless module is followed by a certain period of time where no further data is received, the wireless module assumes that the frame has arrived in its entirety. The frame is then transmitted. This period of time is referred to as $T_{FrameEnd}$.

$T_{FrameEnd}$ must be shorter than the minimum interval between two frames ($T_{FrameEnd} < T_{IdleMin}$). $T_{FrameEnd}$ must, however, also be greater than the maximum interval that is permitted between two characters in a frame. Otherwise the frame might be fragmented.

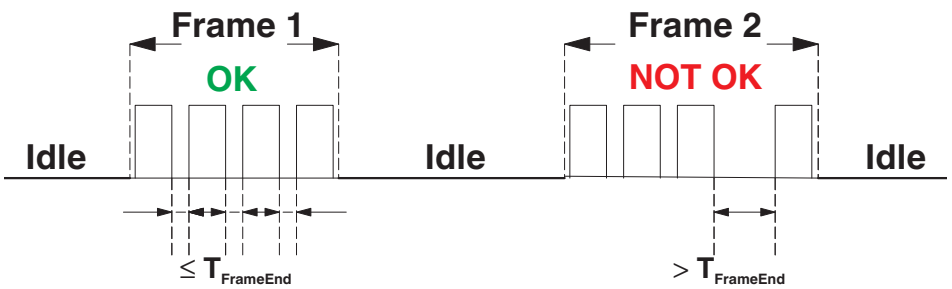


Figure 6-5 Frame-based data transmission: $T_{FrameEnd}$ parameter

Setting telegram pauses, based on the example of Modbus/RTU

A frame is also referred to as a telegram. The length of the transmission pause between the telegrams depends on the set data rate. The beginning and end of a telegram is recognized by means of a time condition. A pause of 3.5 characters means that the telegram is complete and the next character is to be interpreted as the slave address. A telegram must therefore be sent as a continuous data flow. If there is an interruption of more than 1.5 characters within a telegram, the data will be discarded by the receiver.

If the master is not able to transmit the successive characters quickly enough and the communication is aborted, you must increase the minimum pause time ($T_{FrameEnd}$) between the individual characters of a telegram. Frames with a length of 1480 characters can be transmitted by the Radioline wireless system.

- In order to adapt data transmission to other protocols, it is possible to adapt the $T_{FrameEnd}$ and $T_{IdleMin}$ parameters. Set the interface parameters under “Individual Settings”.

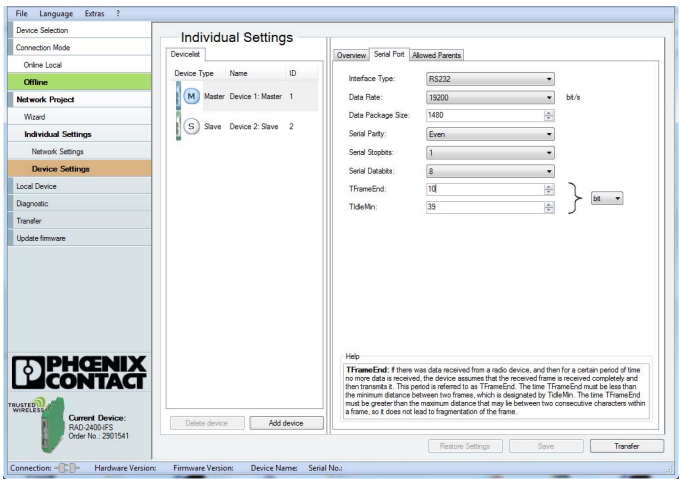


Figure 6-6 PSI-CONF software: Individual Settings

7 PLC/Modbus RTU mode

The PLC/Modbus RTU mode is available for firmware version 1.30 or later. If necessary, start an update using the PSI-CONF software (version 2.03 or later).

Activate the PLC/Modbus RTU mode using the PSI-CONF software (from Section 5.6, “Configuration via PSI-CONF software” onwards).

In PLC/Modbus RTU mode, you can read the I/O values of the extension modules connected to the wireless slave modules via the Modbus RTU protocol (I/O to serial). The wireless module provides an RS-232 or RS-485 interface for this purpose. In PLC/Modbus RTU mode, the master wireless module works as a Modbus slave and has its own Modbus slave address.

You can connect I/O extension modules to each wireless device in the network. A wireless network can have a maximum of 99 extension modules. Use the white thumbwheel to set the I/O-MAP addresses.

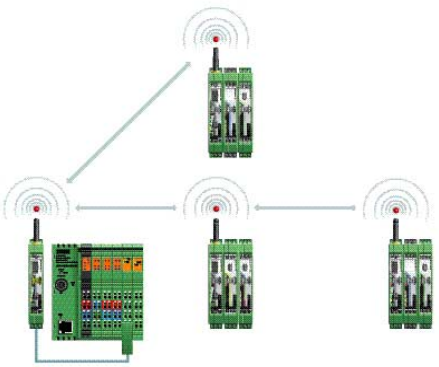


Figure 7-1 PLC/Modbus RTU mode

7.1 Configuration via PSI-CONF software

1. Start the PSI-CONF software (see Section 5.6, “Configuration via PSI-CONF software”).
2. Create a new network project.
3. Follow the software wizard.

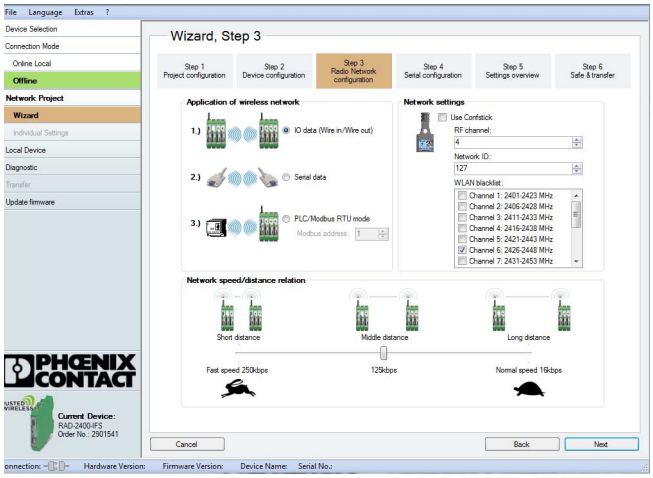


Figure 7-2 PSI-CONF software: Wizard, Step 3

4. Select “PLC/Modbus RTU mode” and assign a Modbus address.
5. Follow the software wizard.

The Modbus address is a unique address in the Modbus network. It is only assigned to the master wireless module (RAD ID = 01). Assign an address between 1 ... 247.

In order to enable the master wireless module to communicate with a controller via the RS-232 or RS-485 interface, you must set the interface parameters. Please note that the controller settings must match the settings of the wireless module.

Table 7-1 Configuration via PSI-CONF software

Parameter	Possible values	Default setting
Interface type	RS-232, RS-485	RS-232
Data rate	300 ... 115,200 bps	19,200 bps
Parity	None, even, odd	None
Number of stop bits	1; 2	1
Number of data bits	8	8
Modbus address	1 ... 247	1

The Modbus connection between the controller and the wireless module can be monitored via a watchdog. For additional information on the watchdog, refer to page 93.

7.2 Addressing I/O extension modules

In PLC/Modbus RTU mode, a wireless network can have a maximum of 99 I/O extension modules.

Use the white thumbwheel on the I/O extension module to set the I/O-MAP address. You can find information on addressing extension modules from “Setting the address of the extension modules via the thumbwheel” on page 82 onwards.

7.3 Watchdog

The Modbus telegram watchdog monitors the connection between the master wireless module and the controller. It is triggered each time a Modbus telegram is received correctly. Activate the watchdog using the PSI-CONF software.

- Select the “Network Settings” item under “Individual Settings”. Set a watchdog time between 200 ms ... 65,000 ms.

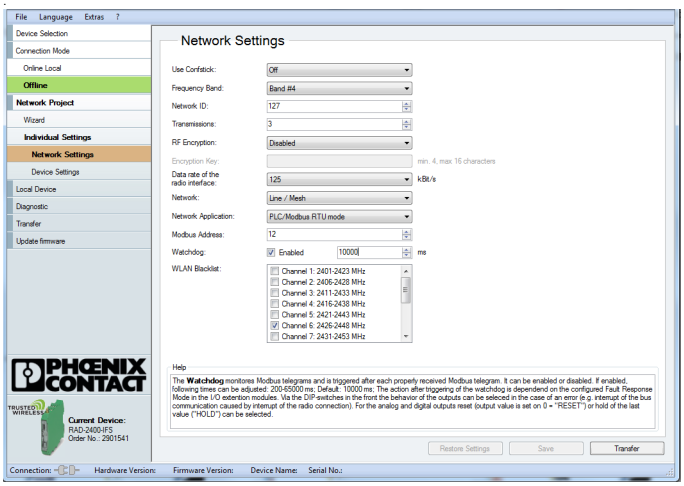


Figure 7-3 PSI-CONF software: Individual Settings, Network Settings

If the watchdog is triggered, an action will be performed on the I/O output modules. You can set this behavior in the event of an error using the DIP switches on the front.

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

For more detailed information regarding switch setting for the different extension modules, please refer to Section 3, “Description of I/O extension modules”.

If the watchdog is activated and Modbus communication interrupted, the red ERR LED will flash on all wireless modules in the network. Depending on the DIP switch settings, the output modules issue the corresponding hold or reset value.

8 PLC/Modbus RTU dual mode

PLC/Modbus RTU dual mode is available for firmware version 1.80 or later. You can update the firmware free of charge using the PSI-CONF software, Version 2.33 or later.

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

Activate the PLC/Modbus RTU dual mode using the PSI-CONF software (from Section 5.6, “Configuration via PSI-CONF software” onwards).

In PLC/Modbus RTU dual mode, you can read the I/O values of the extension modules connected to the wireless slave modules via the Modbus RTU protocol (I/O to serial). In addition, serial Modbus devices can be connected over the wireless network. The master wireless module provides an RS-232 or RS-485 interface to a Modbus RTU master.

In PLC/Modbus RTU dual mode, all the wireless modules work as Modbus slaves and have unique Modbus slave addresses. The Modbus ID of each wireless module is set using the yellow thumbwheel.

You can connect I/O extension modules to each wireless device in the network. A wireless station can have a maximum of 32 extension modules. Use the white thumbwheel to set the I/O-MAP addresses.

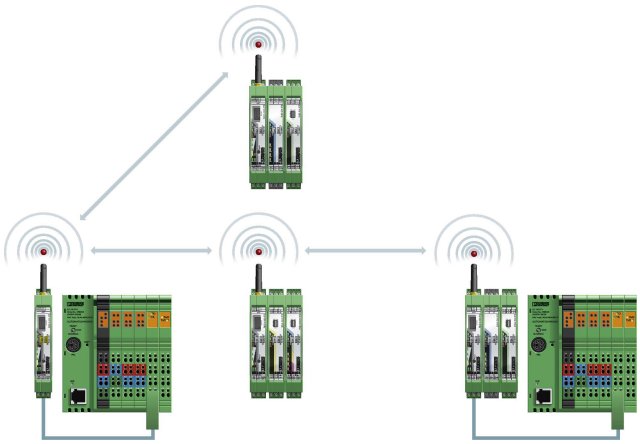


Figure 8-1 PLC/Modbus RTU dual mode

8.1 Configuration via PSI-CONF software

1. Start the PSI-CONF software (see Section 5.6, “Configuration via PSI-CONF software”).
2. Create a new network project.
3. Follow the software wizard.

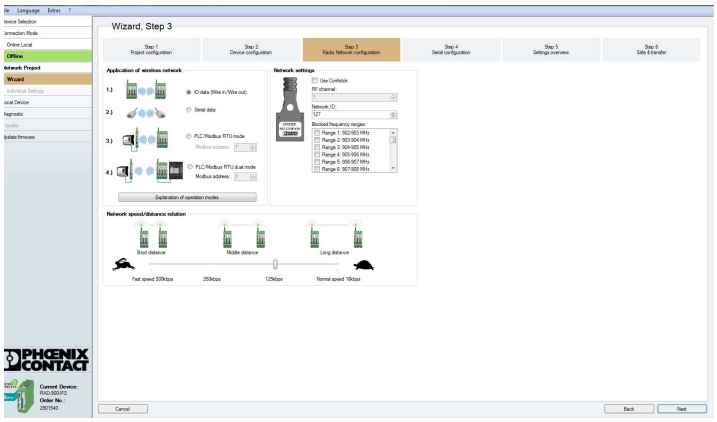


Figure 8-2 PSI-CONF software: Wizard, Step 3

4. Select “PLC/Modbus RTU dual mode” and assign a Modbus address.
5. Follow the software wizard.

The Modbus address is a unique address in the Modbus network. Assign an address between 1 ... 247.

In order to enable the master wireless module to communicate with a controller via the RS-232 or RS-485 interface, you must set the interface parameters. Please note that the controller settings must match the settings of the wireless module.

Table 8-1 Configuration via PSI-CONF software

Parameter	Possible values	Default setting
Interface type	RS-232, RS-485	RS-232
Data rate	300 ... 115,200 bps	19,200 bps
Parity	None, even, odd	None
Number of stop bits	1; 2	1
Number of data bits	8	8
Modbus address	1 ... 247	1

The Modbus connection between the controller and the wireless module can be monitored via a watchdog. For additional information on the watchdog, refer to page 97.

8.2 Addressing I/O extension modules

In PLC/Modbus RTU dual mode, a wireless station can have a maximum of 32I/O extension modules.

Use the white thumbwheel on the I/O extension module to set the I/O-MAP address. You can find information on addressing extension modules from “Setting the address of the extension modules via the thumbwheel” on page 82 onwards.

8.3 Watchdog

The Modbus telegram watchdog monitors the connection between the master wireless module and the controller. It is triggered each time a Modbus telegram is received correctly. You can activate the watchdog using the PSI-CONF software.

- Select the “Network Settings” item under “Individual Settings”. Set a watchdog time between 200 ms ... 65,000 ms.

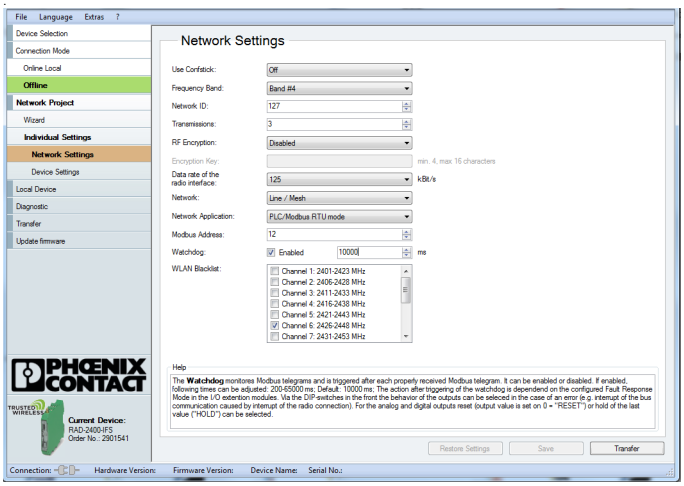


Figure 8-3 PSI-CONF software: Individual Settings, Network Settings

If the watchdog is triggered, an action will be performed on the I/O output modules. You can set this behavior in the event of an error using the DIP switches on the front.

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

For more detailed information regarding switch setting for the different extension modules, please refer to Section 3, “Description of I/O extension modules”.

If the watchdog is activated and Modbus communication interrupted, the red ERR LED will flash on all wireless modules in the network. Depending on the DIP switch settings, the output modules issue the corresponding hold or reset value.

9 Addressing I/O extension modules and RAD-900-DAIO6 with Modbus RTU

9.1 Modbus function codes

In the Modbus protocol, the function codes define which data is to be read or written. With a single request, the registers 1 ... 123 can be read or written.

Table 9-1 Supported Modbus function codes

Code number	Function code	Description
fc 03	Read Holding Register	Read process output data (address area 40010 ... 40999)
fc 04	Read Input Register	Read process input data (address area 30010 ... 30999)
fc 16	Write Multiple Registers	Write multiple output registers word by word

Other function codes exist in the Modbus protocol, but they are not supported.

9.2 Modbus protocol

The data is transmitted using the Modbus/RTU (Remote Terminal Unit) protocol. Communication takes place according to the master/slave method. The Modbus master initiates communication with a request to the slave. If the slave detects that its address has been accessed by the master, the slave always sends a response.

Only the master is able to initiate communication. The slaves are not able to initiate communication and do not communicate with each other.

The connected extension modules write the analog or digital input and output values to an internal register. The Modbus master (e.g., a PLC) can read the individual registers using the Modbus address of the slaves. The data to be transmitted is always included in a defined frame. The frame is referred to as telegram.

The Modbus protocol defines the format of the telegrams. If an error occurs when the telegram is received on the slave side, or if the slave is unable to carry out the master request, an error telegram is sent back to the master.

Request from master

The function code in the request informs the addressed slave which action is to be carried out. The address and data bytes contain all additional information that the slave requires in order to carry out the action.

Example: The master uses function code 03 to request the slave to read the process output data and send its content to the master. The data and address bytes need to include the following information: from which register reading should start and how many registers should be read. Using the CRC check value, the slave is able to detect whether the complete telegram has been received.

Response from slave

If the response from a slave is valid, the function code will match the request from the master. The address and data field contains the data recorded by the slave (e.g., register values).

The function code is modified in the event of an error. The address and data field then contains a code that describes the error. By using the CRC check value, the master is able to determine whether the telegram content is valid or not.

The Modbus/RTU telegrams are separated by telegram pauses known as end-of-frame times. The end-of-frame time must be at least 3.5 x as long as the time required for one transmitted character. The end-of-frame time cannot be changed.

Table 9-2 Modbus protocol: structure of telegrams (frames)

Frame	Description	Size
Slave address	Slave address, valid area 1 ... 247	8 bits
Function code	Definition whether the parameter is to be read or written	8 bits
Address	Register address	16 bits
Data	– E.g., from the master: Which parameters are requested? – E.g., from the slave: Content of the requested parameters	N x 16 bits
CRC (Cyclic Redundancy Check)	Test value for the cyclic redundancy check in order to detect errors in data transmission	16 bits

9.3 Addressing registers

Function code 04

You must enter 0000 (hex0000) as the start address in order to read register 30001. The address area 3xxxx is already defined by the function code field.

Function codes 03 and 16

In order to read/write registers 40032 ... 40039, you must enter 0031 (hex001F) as the start address. The address area 4xxxx is already defined by the function code field.

9.4 Module type and error code register

You can read the module type and data currentness of the I/O extension modules from the registers 30xx0 and 40xx0.

Table 9-3 Module type and currentness of data

30xx0, 40xx0[1]				Module type and currentness of data											
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
							X[2]	Module type							

1 xx = I/O-MAP address set using the thumbwheel

2 X = Currentness of data, bit 8

The individual I/O extension modules can be clearly distinguished by the module type. The module type ID of the extension module can be read in the Modbus register.

Table 9-4 Module type IDs

Module type	Order No.	Module type ID
Analog inputs		
RAD-AI4-IFS	2901537	20_{hex}
RAD-PT100-4-IFS	2904035	21_{hex}
Analog outputs		
RAD-AO4-IFS	2901538	30_{hex}
Digital inputs		
RAD-DI4-IFS	2901535	01_{hex}
RAD-DI8-IFS	2901539	02_{hex} (static mode)
		40_{hex} (pulse counter mode)
Digital outputs		
RAD-DOR4-IFS	2901536	10_{hex}
RAD-DO8-IFS	2902811	11_{hex}
Analog/digital inputs and outputs		
RAD-DAIO6-IFS	2901533	60_{hex}
RAD-900-DAIO6	2702877	60_{hex}

“Module type” register value

If the module type in the register is invalid or unavailable, then the register value is 0.

“Currentness of data” register value

If the data in the register is not up-to-date, the register value is 1. This is, for example, the case if the wireless connection to an input module fails. The input process data is then retained in the Modbus table, but is no longer updated. In the case of an output module, the “Currentness of data” register value is set to 1 until the output process data has been written to the Modbus registers.

The read I/O data is only valid and current if a valid module type value is returned by the slave and the “Currentness of data” register value equals 0.

9.4.1 Assigning I/O extension modules to the register

Use the white thumbwheel on the I/O extension module to assign an I/O-MAP address in the Modbus memory map. Example: If you set the thumbwheel of an input module to the I/O-MAP address = 01, the register assignment is 30010.

Table 9-5 Setting the white thumbwheel for register 30010 (read)

Read register	I/O-MAP address (white thumbwheel)	Consecutive number 0 ... 9
30	**01**	**0**

9.5 Modbus memory map

The I/O data from the extension modules is stored in an internal register, the Modbus memory map. In PLC/Modbus RTU mode, the Modbus memory map is contained in the master wireless module with the RAD ID = 01. In PLC/Modbus RTU dual mode, the Modbus memory map is contained within each wireless module. The data contained can be read or written by a Modbus master.

The following process data tables for the individual extension modules show at what position the I/O data is stored in the Modbus memory map. You can find a complete overview of the Modbus memory map from page 111 onwards.

The RSSI signal register can be found starting on page 115.

9.5.1 RAD-AI4-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-AI4-IFS	20_{hex}	06_{hex}	30xx0 ... 30xx5[1]	fc 04

[1] xx = I/O-MAP address set using the thumbwheel

30xx1	Reserved

30xx2	Analog input 1 (terminal point 2.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
AI1																

30xx3	Analog input 2 (terminal point 3.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
AI2																

30xx4	Analog input 3 (terminal point 4.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
AI3																

30xx5	Analog input 4 (terminal point 5.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
AI4																

30xx6 ... 30xx9	Reserved

9.5.2 RAD-PT100-4-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-PT100-4-IFS	21_{hex}	06_{hex}	30xx0 ... 30xx5[1]	fc 04

[1] xx = I/O-MAP address set using the thumbwheel

30xx1	Reserved

30xx2	Pt 100 input 1 (terminal point 2.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
T1																

30xx3	Pt 100 input 2 (terminal point 3.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
T2																

30xx4	Pt 100 input 3 (terminal point 4.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
T3																

30xx5	Pt 100 input 4 (terminal point 5.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
T4																

30xx6 ... 30xx9	Reserved

9.5.3 RAD-AO4-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-AO4-IFS	30_{hex}	06_{hex}	40xx0 ... 40xx5[1]	fc 03, 16

[1] xx = I/O-MAP address set using the thumbwheel

40xx1	Reserved

40xx2	Analog output 1 (terminal point 2.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AO1															

40xx3	Analog output 2 (terminal point 3.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AO2															

40xx4	Analog output 3 (terminal point 4.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AO3															

40xx5	Analog output 4 (terminal point 5.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AO4															

40xx6 ... 40xx9	Reserved

9.5.4 RAD-DI4-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DI4-IFS	01_{hex}	02_{hex}	30xx0 ... 30xx1[1]	fc 04

[1] xx = I/O-MAP address set using the thumbwheel

30xx1				Digital inputs											
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
												DI4	DI3	DI2	DI1
Terminal point															
												6.x	5.x	2.x	1.x

30xx2 ... 30xx9	Reserved

9.5.5 RAD-DI8-IFS process data

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[1]	fc 04
	40_{hex} Pulse counter mode	06_{hex} Pulse inputs	30xx0 ... 30xx5[1]	fc 04
	40_{hex} Pulse counter mode	02_{hex} Reset counter states	40xx0 ... 40xx1[1]	fc 03, 16

[1] xx = I/O-MAP address set using the thumbwheel

30xx1								Digital inputs DI1 ... DI8 (static mode)							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
								DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1
Terminal point															
								5.x	5.x	4.x	4.x	3.x	3.x	2.x	2.x

30xx2								DI1: 32-bit pulse input, pulse counter mode (terminal point 2.x)							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Counter state DI1, low word															

30xx3								DI1: 32-bit pulse input, pulse counter mode (terminal point 2.x)							
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Counter state DI1, high word															

30xx4								DI7: 32-bit pulse input, pulse counter mode (terminal point 5.x)							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Counter state DI7, low word															

30xx5								DI7: 32-bit pulse input, pulse counter mode (terminal point 5.x)							
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Counter state DI7, high word															

30xx6 ... 30xx9	Reserved

40xx1								Reset of counter states DI1/DI7							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
														X[1]	X[2]

[1] **Bit 1 = 1:** counter state DI7 reset to 0

[2] **Bit 0 = 1:** counter state DI1 reset to 0

40xx2 ... 40xx9	Reserved

9.5.6 RAD-DOR4-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DOR4-IFS	10_{hex}	02_{hex}	40xx0 ... 40xx1[1]	fc 03, 16

[1] xx = I/O-MAP address set using the thumbwheel

40xx1				Digital outputs											
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
												DO 4	DO 3	DO 2	DO 1
Terminal point															
												6.x	5.x	2.x	1.x

40xx2 ... 40xx9	Reserved

9.5.7 RAD-DO8-IFS process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DO8-IFS	11_{hex}	02_{hex} Outputs	40xx0 ... 40xx1[1]	fc 03.16
		02_{hex} Short-circuit detection	30xx0 ... 30xx1[1]	fc 04

1 xx = I/O-MAP address set using the thumbwheel

30xx1	Short-circuit detection at the digital outputs														
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Reserved														X[1]	X[2]

1 **Bit 1 = 1:** Short circuit detected at one or several outputs 5 ... 8.

2 **Bit 0 = 1:** Short circuit detected at one or several outputs 1 ... 4.

30xx2 ... 30xx9	Reserved

40xx1	Digital outputs DO1 ... DO8														
Channel (high byte)								Channel (low byte)							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Reserved								DO 8	DO 7	DO 6	DO 5	DO 4	DO 3	DO 2	DO 2
Terminal point															
								5.x	5.x	4.x	4.x	3.x	3.x	2.x	2.x

40xx2 ... 40xx9	Reserved

9.5.8 RAD-DAIO6-IFS and RAD-900-DAIO6 process data

I/O module	Module type ID	Number of registers	Address area	Function code
RAD-DAIO6-IFS	60_{hex}	03_{hex} (inputs)	30xx0 ... 30xx2[1]	fc 04
		03_{hex} (outputs)	40xx0 ... 40xx2[1]	fc 03, 16

[1] xx = I/O-MAP address set using the thumbwheel

30xx1															
Digital inputs															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
														DI2	DI1
Terminal point															
														2.x	1.x

30xx2															
Analog input (terminal point 3.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AI1															

30xx3 ... 30xx9	Reserved

40xx1															
Digital outputs															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
														DO 2	DO 1
Terminal point															
														6.x	5.x

40xx2															
Analog output (terminal point 4.x)															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
AO1															
Terminal point															
															4.x

40xx3 ... 40xx9	Reserved

9.5.9 Complete overview of the Modbus memory map

I/O input data, address area 30010 ... 30999, Modbus function code 04

RAD-DAIO6-IFS and RAD-900-DAIO6

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
30	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
30	xx	1		DI
				2 1
				X X
30	xx	2	AI1	
			X X X X X X X X X X X X X X X X	

30xx3 ... 30xx9 reserved

I/O output data, address area 40010 ... 40999 Modbus function code 03, 16

RAD-DAIO6-IFS and RAD-900-DAIO6

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
40	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
40	xx	1		DO
				2 1
				X X
40	xx	2	AO1	
			X X X X X X X X X X X X X X X X	

40xx3 ... 40xx9 reserved

RAD-DI4-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
30	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
30	xx	1		DI4 ... DI1
				X X X X

30xx2 ... 30xx9 reserved

RAD-DOR4-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
40	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
40	xx	1		DO4 ... DO1
				X X X X

40xx2 ... 40xx9 reserved

RAD-DI8-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
30	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
30	xx	1		DI8 ... DI1
				X X X X X X X X
30	xx	2	Counter state DI1 (low word)	
			X X X X X X X X X X X X X X X X	
30	xx	3	Counter state DI1 (high word)	
			X X X X X X X X X X X X X X X X	
30	xx	4	Counter state DI7 (low word)	
			X X X X X X X X X X X X X X X X	
30	xx	5	Counter state DI7 (high word)	
			X X X X X X X X X X X X X X X X	

30xx6 ... 30xx9 reserved

RAD-DI8-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
40	xx	0	Currentness of data	Module type ID
			X X X X X X X X	X X X X X X X X
40	xx	1	Bit 0 = 1: Reset DI1 Bit 1 = 1: Reset DI7	
				X X

40xx2 ... 40xx9 reserved

I/O input data, address area 30010 ... 30999
Modbus function code 04

RAD-DO8-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
30	xx	0	Currentness of data	Module type ID
				X X X X X X X X
30	xx	1	Short-circuit detection Bit 0: DO 1 ... 4, Bit 1: 5 ... 8	
				X X
30xx2 ... 30xx9 reserved				

I/O output data, address area 40010 ... 40999
Modbus function code 03, 16

RAD-DO8-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
40	xx	0	Currentness of data	Module type ID
				X X X X X X X X
40	xx	1		DO
				9 8 7 6 5 4 3 2 1
				X X X X X X X X X
40xx2 ... 40xx9 reserved				

RAD-AI4-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
30	xx	0	Currentness of data	Module type ID
				X X X X X X X X
30	xx	1	Reserved	
30	xx	2	AI1	
			X X X X X X X X X X X X X X X X	
30	xx	3	AI2	
			X X X X X X X X X X X X X X X X	
30	xx	4	AI3	
			X X X X X X X X X X X X X X X X	
30	xx	5	AI4	
			X X X X X X X X X X X X X X X X	
30xx6 ... 30xx9 reserved				

RAD-AO4-IFS

	I/O-MAP		High byte 15 ... 8	Low byte 7 ... 0
40	xx	0	Currentness of data	Module type ID
				X X X X X X X X
40	xx	1	Reserved	
40	xx	2	AO1	
			X X X X X X X X X X X X X X X X	
40	xx	3	AO2	
			X X X X X X X X X X X X X X X X	
40	xx	4	AO3	
			X X X X X X X X X X X X X X X X	
40	xx	5	AO4	
			X X X X X X X X X X X X X X X X	
40xx6 ... 40xx9 reserved				

I/O input data, address area 30010 ... 30999 Modbus function code 04																		
RAD-PT100-4-IFS																		
	I/O-MAP		High byte 15 ... 8								Low byte 7 ... 0							
30	xx	0	Currentness of data								Module type ID							
									X	X	X	X	X	X	X	X	X	X
30	xx	1	Reserved															
30	xx	2	T1															
			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30	xx	3	T2															
			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30	xx	4	T3															
			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30	xx	5	T4															
			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30xx6 ... 30xx9 reserved																		

Example for reading the temperature T1 (I/O-MAP = 02):
function code 04, start address 21 (hex15)

I/O output data, address area 40010 ... 40999 Modbus function code 03, 16

....
....

30	99	0																

....
....

40	99	0																

RSSI signals - address area 35001 ... 35250, function code 04

	RAD ID	15...4	3	2	1	0	Bit
35	001						RSSI: RAD ID = 01 - Master
	.						RSSI: RAD ID = 02
	.						RSSI: RAD ID = 03
	.						...
35	250						RSSI: RAD ID = 250

Example for reading an RSSI register of the station with RAD ID = 02:
function code 04, start address 5001 (hex1389)

9.6 Error codes and formats for analog input and output values

The measured value is represented in bits 0 ... 15. Values higher than 8000_{hex} indicate an error.

Analog RAD-AI4-IFS inputs

Table 9-6 Representation of analog RAD-AI4-IFS values

Data word			
hex	**dec/error code**	**0 mA ... 20 mA**	**4 mA ... 20 mA**
0000	0	0 mA	-
1770	6000	4 mA	4 mA
7530	30000	20 mA	20 mA
7F00	32512	21.67 mA	21.67 mA
8001	Overrange	>21.67 mA	>21.67 mA
8002	Open circuit	-	<3.2 mA
8080	Underrange	< 0 mA	-

Analog RAD-AO4-IFS outputs

Table 9-7 Representation of analog RAD-AO4-IFS values

Data word			
hex	**dec/error code**	**0 mA ... 20 mA**	**0 V ... 10 V**
0000	0	0 mA	0 V
7530	30000	20 mA	10 V
7F00	32512	21.67 mA	10.84 V

Analog RAD-DAIO6-IFS and RAD-900-DAIO6 inputs and outputs

Table 9-8 Representation of analog RAD-DAIO6-IFS values

Data word				
hex	**dec/error code**	**0 ... 20 mA**	**4 ... 20 mA**	**0 V ... 10 V**
0000	0	0 mA	-	0 V
1770	6000	4 mA	4 mA	2 V
7530	30000	20 mA	20 mA	10 V
7F00	32512	21.67 mA	21.67 mA	10.84 V
8001	Overrange	>21.67 mA	>21.67 mA	-
8002	Open circuit	-	<3.2 mA	-
8080	Underrange	<0 mA	-	-

Error codes and formats for Pt 100 values

Table 9-9 Representation of the RAD-PT100-4-IFS Pt 100 values

Data word		RAD-PT100-4-IFS Pt 100 input	RAD-AO4-IFS analog output		
hex	**dec / error code**	**-50°C ... +250°C**	**0 mA ... 20 mA**	**0 V ... 10 V**	**Possible cause**
0000	0	-50°C	0 mA	0 V	
7530	30000	+250°C	20 mA	10 V	
7F00	32512	+275.12°C	21.67 mA	10.84 V	
8001	Overrange				
8002	Open circuit				Sensor wired incorrectly, measuring line too long, cable resistance too high
8080	Underrange				

9.7 RSSI signal register

The RSSI values indicate the received signal strength on the wireless module. In both PLC/Modbus RTU and PLC/Modbus RTU dual modes, you can read the RSSI values via the serial interface of the master wireless module (RAD ID = 01) using Modbus/RTU commands. The RSSI values of all wireless modules are within the address area 35001 ... 35250.

Table 9-10 RSSI signal register

Address area		**35001 ... 35250**															
Modbus function code		**fc 04**															
Address	Wireless module	High byte								Low byte, RSSI value							
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
35001	RSSI - RAD ID = 1 (master)	Reserved								X	X	X	X	X	X	X	X
35002	RSSI - RAD ID = 2	Reserved								X	X	X	X	X	X	X	X
...	...	Reserved								X	X	X	X	X	X	X	X
35250	RSSI - RAD ID = 250	Reserved								X	X	X	X	X	X	X	X

– Bits 8 ... 15 are reserved.
– Values < 255 indicate the RSSI value in -dBm.
– The value 255 means that the RSSI value is invalid or the device cannot be reached.

Example for reading the RSSI register of the station with RAD ID = 2:
function code 04, start address 5001 (hex1389)

In PLC/Modbus RTU dual mode, the RSSI value is also within the register 35000 of each wireless module, since each one has its own Modbus address.

10 Detecting and removing errors

If the wireless system does not function properly, proceed as follows:

- First, ensure there is a good wireless signal (2 green bar graph LEDs or RSSI voltage ≥1.5 V).
- Check the status of the individual stations:
  – If the PSI-CONF software is installed, check the device status of all network devices via online diagnostics.
  – If the PSI-CONF software has not been installed, check the bar graph LEDs on the front of each device.
- Find the error using the tables from page 118 onwards.

Avoid contact between the antennas of two wireless module, otherwise the receiver might become overloaded.

Ground loops are caused by the grounding of the antenna via the antenna fixing unit, grounding the power supply or serial interface. To avoid ground loops, connect these components to a single ground point.

Strength of the receive signal

Determine the strength of the receive signal by means of the RSSI voltage. The signal strength is displayed on the LED bar graph on the wireless module.

– In a point-to-point connection, the LED bar graph is active on the master and on the repeater/slave.
– In a wireless network with more than one repeater/slave, only the yellow LED on the master is permanently on. The signal strength is displayed on the repeaters/slaves. The displayed signal strength is always related to the next wireless module in direction of the master (parents).

The RSSI indicator is a voltage output in the range between 0 V DC ... 3 V DC. The higher the voltage, the better the wireless connection. The measured voltage is directly related to the receive signal in -dB. However, please observe the small voltage fluctuation due to multipath propagation.

The recommended minimum signal strength is 1.5 V DC. This results in a power reserve of approximately 10 dB which ensures communication even in the event of unfavorable transmission conditions.

Measure the RSSI voltage at the RSSI test socket or read it using the PSI-CONF software. When connecting the master wireless module to a PC, you can read the RSSI voltages in the entire wireless network. At a slave or repeater, it is only possible to read the RSSI voltage of the specific wireless module connected.

Table 10-1 RSSI voltage

		16k	125k	250k	500k	RSSI voltage
LED 3		-75 dBm	-70 dBm	-65 dBm	-60 dBm	2.5 V
LED 2		-85 dBm	-80 dBm	-75 dBm	-70 dBm	2.0 V
LED 1		-95 dBm	-90 dBm	-85 dBm	-80 dBm	1.5 V
LINK LED		LINK	LINK	LINK	LINK	~1.0 V

Table 10-2 Detecting and removing errors: wireless module

LED, wireless module	Current state and possible cause	Solution
-	Wireless module cannot be configured using the PSI-CONF software	• Make sure that the wireless module is supplied with power. • Make sure that you are using the correct cable: – RAD-CABLE-USB (Order No. 2903447), power supply via the USB port on the PC – IFS-USB-DATACABLE (Order No. 2320500), external power supply • Install the USB driver. The driver is installed automatically during PSI-CONF software installation (see Section 5.6, “Configuration via PSI-CONF software”).
PWR off	No power supply, mains probably switched off.	• Switch the mains on, restore the power supply. • Ensure the power select switch is in the correct position for the type of power (RAD-900-DAIO6 only) • Check the fuse (RAD-900-DAIO6)
DAT off	No communication between wireless module and I/O extension module. Wireless module possibly in “Serial data” operating mode.	• Check whether the I/O extension module is properly snapped onto the DIN rail connector and whether it is connected to the wireless module. • Check the operating mode of the wireless module using the PSI-CONF software. The wireless module must either be in “I/O data” or “PLC/Modbus RTU” mode (see Section 5.6, “Configuration via PSI-CONF software”). • Reset the wireless module to the default settings (I/O data mode), if required. Disconnect the device from the supply voltage, hold down the SET button and switch the supply voltage on again (see “Resetting to the default settings” on page 69).
ERR on	Local bus error The input or output module is disconnected from the DIN rail connector and the bus.	• Check whether the I/O extension module is properly snapped onto the DIN rail connector. • Press the SET button on the front of the wireless module or carry out a power up. The data of the I/O extension modules are read in again.
ERR + DAT flashing	Writing to the memory stick has not been possible	• Repeat the process in order to correctly write to the memory stick.

Table 10-2 Detecting and removing errors: wireless module [...]

LED, wireless module	Current state and possible cause	Solution
ERR flashing fast (2.8 Hz), bar graph does not light up	No wireless connection, even though the wireless modules are **not** far away from each other	• Make sure that, in a network, only one wireless module is configured as the master (RAD ID = 01) and all other wireless modules are slaves or repeaters. Reconfigure the wireless network, if necessary. • Check whether the set RAD ID is a permitted address. • Make sure that each RAD ID (yellow thumbwheel) only occurs once in the network. • There could be an overload problem: In order to be able to cover the largest possible distances, the preamplifier has been activated and transmission power set to 20 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/antennas or reduce transmission power using the PSI-CONF software (from Section 5.6, “Configuration via PSI-CONF software” onwards). • Using the PSI-CONF software, check whether the network parameters have the same settings on all wireless modules (operating mode, network ID, RF band, data rate of the wireless interface, encryption, network type, from Section 5.6, “Configuration via PSI-CONF software” onwards). • Reset the wireless module to the default settings (I/O data mode), if required. Disconnect the device from the supply voltage, hold down the SET button and switch the supply voltage on again (see “Resetting to the default settings” on page 69).
	No wireless connection, the wireless modules are far away from each other	• Check whether the antennas are connected and aligned properly. • Make sure that the antenna connections are tight and free from corrosion. • Install the antenna at a higher point. Adhere to the Fresnel zone. • Use a different antenna with higher antenna gain or use shorter cables with lower signal attenuation. • Check whether there is another transmitting antenna in close proximity. Position the antenna further away from all other antennas (at least 1 m in the horizontal direction or 0.6 m in the vertical direction). • Make sure that the power supply is sufficient. • Make sure that there is no connection between the core and the shield of the cable in the connected antenna system.

Table 10-2 Detecting and removing errors: wireless module [...]

LED, wireless module	Current state and possible cause	Solution
LED bar graph, yellow LED is on only	Connection with low receive signal	• Check whether the antennas are connected and aligned properly. • Make sure that the antenna connections are tight and free from corrosion. • Install the antenna at a higher point. Observe the Fresnel zone. • Use a different antenna with higher antenna gain or use shorter cables with lower signal attenuation. • Check whether there is another transmitting antenna in close proximity. Position the antenna further away from all other antennas (at least 1 m in the horizontal direction or 0.6 m in the vertical direction). • Make sure that the power supply is sufficient. • Make sure that there is no connection between the core and the shield of the cable in the connected antenna system.
	Several repeaters/slaves at the wireless master	• No action required, normal display for a wireless network with more than one repeater/slave. The signal strength is indicated on the repeaters/slaves and is always related to the next wireless module in the direction of the master (parents).
In I/O data mode		
ERR flashing slowly (1.4 Hz)	Double assignment of IO-MAP address, two input modules have the same I/O-MAP address in a network	• The I/O MAP address of an input module may appear only once in the network. Use the white thumbwheel to set different I/O-MAP addresses.
	Missing input module Example: An output module does not have the corresponding input module with the same I/O-MAP address.	• Check whether an input module with the same I/O-MAP address has been assigned to each output module. • Set the I/O-MAP address (01 ... 99) using the white thumbwheel on the extension module. The input module must be provided with the same I/O-MAP address as the assigned output module at the other wireless station.
	Missing output module Example: An input module does not have the corresponding output module with the same I/O-MAP address.	• Check whether an output module with the same I/O-MAP address has been assigned to each input module. • Set the I/O-MAP address (01 ... 99) using the white thumbwheel on the extension module. The output module must be provided with the same I/O-MAP address as the assigned input module at the other wireless station.
	RAD ID changed Example: The yellow thumbwheel setting has accidentally been modified and the modification has not yet been confirmed via the SET button.	• Check the RAD ID setting on the yellow thumbwheel of the wireless module. • If necessary, set the correct RAD ID and press the SET button.

Table 10-2 Detecting and removing errors: wireless module [...]

LED, wireless module	Current state and possible cause	Solution
In PLC/Modbus RTU mode		
ERR flashing slowly (1.4 Hz)	Double assignment of I/O-MAP address, two input modules have the same I/O-MAP address in a network	• The I/O MAP address of an input module may appear only once in the network. Use the white thumbwheel to set different I/O-MAP addresses.
	RAD ID changed Example: The yellow thumbwheel setting has accidentally been modified and the modification has not yet been confirmed via the SET button.	• Check the RAD ID setting on the yellow thumbwheel of the wireless module. • If necessary, set the correct RAD ID and press the SET button.
	No Modbus communication (only if watchdog is activated) Example: The communication line between the Modbus/RTU controller and the master wireless module is broken.	• Check the communication line between the Modbus/RTU controller and the master wireless module with RAD ID 01. • Check the wiring of the RS-232/485 connections on the wireless modules. • Check the serial interface settings (baud rate, parity, data bits and stop bits) for the wireless modules and serial termination devices. • Check whether the I/O extension module is properly snapped onto the DIN rail connector. • Check whether the wireless module is in PLC/Modbus RTU mode using the PSI-CONF software (see Section 5.6, “Configuration via PSI-CONF software”). • Press the SET button on the wireless module or carry out a power up in order to read in the station structure.
In “Serial data” or “PLC/Modbus RTU” mode		
RX, TX off	Wireless connection present, but application does not transmit any data	• Check the wiring of the RS-232/485 connections on the wireless modules. • Check the serial interface settings (baud rate, parity, data bits and stop bits) for the wireless modules and serial termination devices (from Section 5.6, “Configuration via PSI-CONF software” onwards).

Table 10-3 Detecting and removing errors: I/O extension module

LED, I/O module	Current state and possible cause	Solution
PWR off	No power supply. Mains probably switched off.	• Switch the mains on, restore the power supply. • Ensure the power select switch is in the correct position for the type of power (RAD-900-DAIO6 only) • Check the fuse (RAD-900-DAIO6)
DAT off	No communication between wireless module and I/O extension module. Wireless module possibly in “Serial data” operating mode.	• Check whether the I/O extension module is properly snapped onto the DIN rail connector and whether it is connected to the wireless module. • Check the operating mode of the wireless module using the PSI-CONF software. The wireless module must either be in “I/O data” or “PLC/Modbus RTU” mode (see Section 5.6, “Configuration via PSI-CONF software”). • Reset the wireless module to the default settings (I/O data mode, see “Resetting to the default settings” on page 69), if required.
ERR on	Critical internal error Example: Technical defect	• Please contact Phoenix Contact technical support.
ERR flashing slowly (1.4 Hz)	I/O-MAP address changed Example: The white thumbwheel setting has accidentally been modified and the modification has not yet been confirmed via the SET button.	• Check the IO-MAP address setting on the white thumbwheel of the I/O extension module. • If necessary, set the correct I/O-MAP address and press the SET button on the wireless module.
In I/O data mode		
ERR flashing fast (2.8 Hz)	Missing input module Example: An output module does not have the corresponding input module with the same I/O-MAP address.	• Check whether an input module with the same I/O-MAP address has been assigned to each output module. • Set the I/O-MAP address (01 ... 99) using the white thumbwheel on the extension module. The input module must be provided with the same I/O-MAP address as the assigned output module at the other wireless station.
	No bus communication, no wireless connection present	• See measures for the wireless module, page 119

Table 10-3 Detecting and removing errors: I/O extension module [...]

LED, I/O module	Current state and possible cause	Solution
In PLC/Modbus RTU mode		
ERR flashing fast (2.8 Hz)	No Modbus communication (safe state of outputs, depending on DIP switch setting)	• Check the communication line between the Modbus/RTU controller and the master wireless module with RAD ID 01. • Check the wiring of the RS-232/485 connections on the master and the PLC. • Check the serial interface settings (baud rate, parity, data bits and stop bits) for the master and the PLC (from Section 5.6, “Configuration via PSI-CONF software” onwards). • Check whether the I/O extension module is properly snapped onto the DIN rail connector. • Check whether the wireless module is in PLC/Modbus RTU mode using the PSI-CONF software (see Section 5.6, “Configuration via PSI-CONF software”). • Press the SET button on the wireless module or carry out a power up in order to read in the station structure.
	No bus communication, no wireless connection present	• See measures for the wireless module, page 119

10.1 Loopback test during serial data transmission

With an RS-232 interface, you can use the loopback test to check the data path from the master to the slave and back again. To this end, you need to short-circuit two terminal points of the RS-232 interface on the slave wireless module. It is then possible to transmit characters to the master wireless module using a terminal program (e.g., HyperTerminal). The characters are echoed back to the terminal program.

Note for Windows 7 users:

HyperTerminal is no longer available in Windows 7. Instead you can use any other terminal program.

To carry out a loopback test, proceed as follows:

- Close all PC programs on your PC, including the PSI-CONF software.
- Connect the PC to the master wireless module and start HyperTerminal via “Start, All Programs, Accessories, Communication, HyperTerminal”. The COM port settings on the PC must correspond to the interface settings on the master wireless module.

- Connect the terminal points 5.1 and 5.2 of the RS-232 interface on the slave module you need to test.

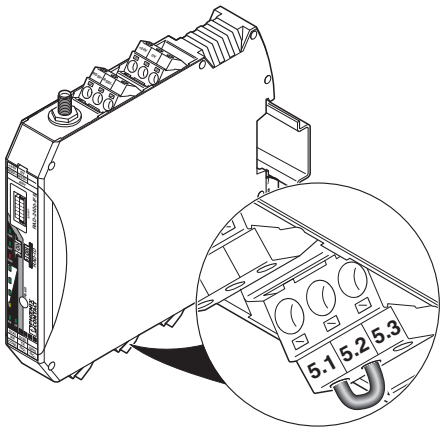


Figure 10-1 Loopback test for an RS-232 interface

- Connect both wireless modules to the power supply.
- Check the wireless connection via the LED bar graph.
- Enter several characters of your choice. HyperTerminal transmits these characters over the wireless path. On the slave side the characters are output (e.g., at terminal point 5.1, RX cable of the RS-232 interface) and immediately read again using the bridge (e.g., at terminal point 5.2, TX cable of the RS-232 interface). This returns the already transmitted characters and they appear twice on the HyperTerminal screen.
  - The screen remains blank if the check was not successful. Monitor the TX and RX LEDs on every wireless module. You can thereby determine the point up to which data has been transmitted.
  - In case the characters only appear once, check the HyperTerminal settings for hidden outgoing characters. The following options must be enabled under "File, Properties, Settings, ASCII Setup":
    "Echo typed characters locally" and
    "Append line feeds to incoming line ends"

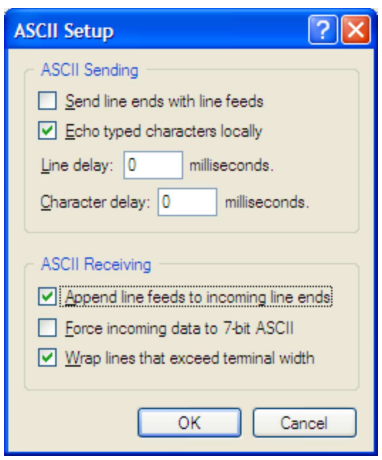


Figure 10-2 Settings in HyperTerminal

11 Diagnostics on the wireless module

11.1 Diagnostic LEDs

A total of nine LEDs on the wireless module indicate the operating states.

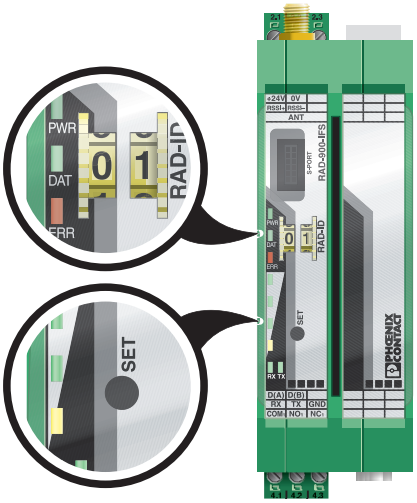


Figure 11-1 Diagnostic LEDs of the RAD-900-IFS

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 mode
ON	Cyclic data communication

ERR LED

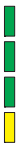
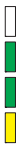
The red ERR LED indicates the error status.

OFF	No error	
Flashing	Slow (1.4 Hz)	**Wireless module in I/O data mode** – Double assignment of I/O-MAP address (e.g., two input modules with the same I/O-MAP address) – Missing input module – Missing output module – RAD ID changed **Wireless module in PLC/Modbus RTU mode** – Double assignment of I/O-MAP address (e.g., two input modules with the same I/O-MAP address) – RAD ID changed – No Modbus communication
	Fast (2.8 Hz)	Wireless connection interrupted
ON	Local bus error (e.g., input or output module not read)	

11.2 LED bar graph

The LED bar graph indicates the receive signal strength.

Table 11-1 LED bar graph

Bar graph	LEDs	Receive signal		RSSI voltage
	All 4 LEDs light up	Maximum signal strength		2.5 … 3 V
		16k	-75 dBm	
		125k	-70 dBm	
		250k	-65 dBm	
		500k	-60 dBm	
	Yellow and 2 green LEDs light up	Very good signal		2 … 2.5 V
		16k	-85 dBm	
		125k	-80 dBm	
		250k	-75 dBm	
		500k	-70 dBm	
	Yellow and 1 green LED lights up	Good signal		1.5 … 2 V
		16k	-95 dBm	
		125k	-90 dBm	
		250k	-85 dBm	
		500k	-80 dBm	
	Yellow LED lights up	Low signal		1 … 1.5 V
		16k	LINK	
		125k	LINK	
		250k	LINK	
		500k	LINK	
	OFF	Not connected, configuration mode or overload[1]		0 V

[1] In order to be able to cover the greatest 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.

LED bar graph - light sequence

The light sequence from bottom to top signalizes:

– Firmware update or
– Wireless module is in write mode for the memory stick

TX LED, transmit data

The green TX LED indicates communication with the RS-232/RS-485 interface. The wireless module is transmitting data.

When using “Wire in/Wire out” mode, the TX LED of the master wireless module always flashes to scan for RAD-RS485-IFS modules.

RX LED, receive data

The green RX LED indicates communication with the RS-232/RS-485 interface. The wireless module is receiving data.

SET button

You can confirm a station change with the SET button, without performing a power up. Station changes include:

– Changing the RAD ID address of the wireless module
– Changing the I/O-MAP address of the extension module
– Adding or remove an I/O extension module
– Using a CONFSTICK or memory stick

After making any change, press the SET button for at least one second to apply the settings. The DAT LED starts flashing. Read in has been completed when the DAT LED stops flashing.

RF link relay

The RF link relay in the wireless module diagnoses the state of the wireless connection. The relay picks up when the wireless connection is established. If the wireless module does not receive a data packet correctly over a period of 10 seconds, the relay drops out. The relay picks up again automatically when the wireless connection is re-established.

The RF link relay has been designed as a PDT contact.

The RF link relay can be used as a fault message contact to indicate the failure of the wireless connection to the controller.

RSSI test socket

A voltage measuring device can be connected to the RSSI test socket to measure the RSSI voltage between 0 V ... 3 V. The RSSI voltage depends on the data rate set for the wireless interface. The higher the RSSI voltage, the better the wireless connection.

For example, the RSSI voltage may be helpful when positioning and aligning the antenna. The recommended minimum signal strength is 2.0 V DC. This results in a power reserve of approximately 10 dB which ensures communication even in the event of unfavorable transmission conditions.

RSSI LED bar graph

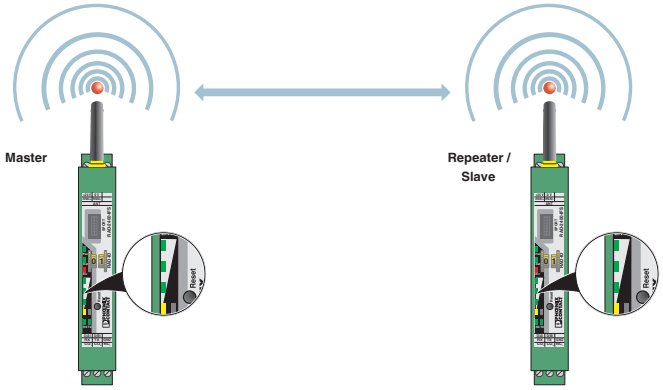


Figure 11-2 Bar graph for point-to-point connection

In a point-to-point connection with only two wireless modules, the LED bar graph is active on both the master and repeater/slave.

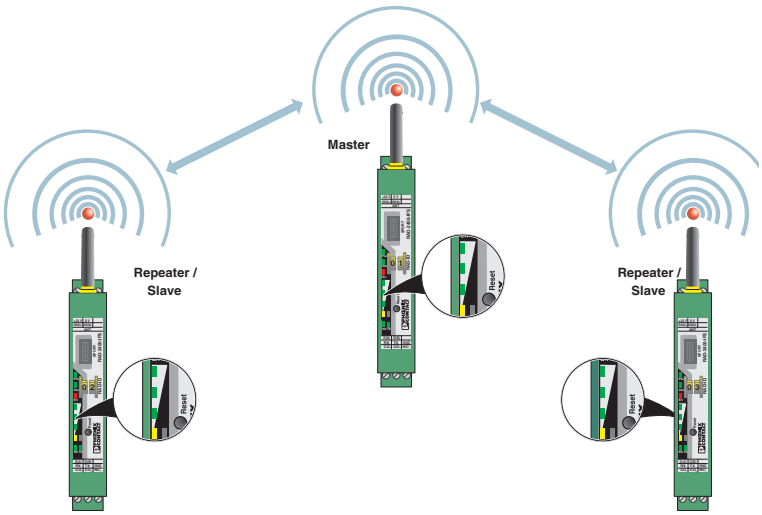


Figure 11-3 Bar graph for point-to-multipoint connection

In a wireless network with more than one repeater/slave, only the yellow LED on the master is permanently on. The signal strength is displayed on the repeaters/slaves. The signal strength indicated is always that of the next wireless module in the direction of the master (parents).

Read the RSSI values via the serial interface of the master wireless module using Modbus RTU commands (see “Modbus memory map” on page 102).

11.3 Diagnostics via PSI-CONF software

Display all current device settings for the station under “Diagnostic” on the “Overview” tab.

Select the desired station from the device list.

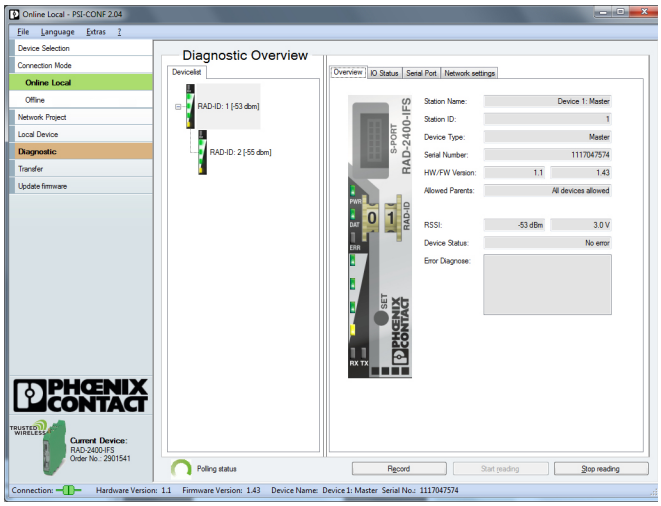


Figure 11-4 PSI-CONF software: Diagnostic, Overview

The entire wireless network can be diagnosed using the master wireless module (RAD ID = 01).

When operating the network in serial data mode, it may not be possible to diagnose all devices. In this case, stop the serial application in order to allow for complete diagnostics.

For information on troubleshooting, please refer to Section 10, “Detecting and removing errors”.

If an error occurs in the network, an error message is displayed under “Device Status”. If the error is no longer present, the error message is reset.

Possible error message:

- Missing input module
- Missing output module
- Double assignment of I/O-MAP address
- Error on IFS bus
- Wireless connection interrupted
- RAD ID changed
- CONFSTICK has not yet been inserted

The “I/O Status” tab displays the status and the current values of the connected I/O extension modules.

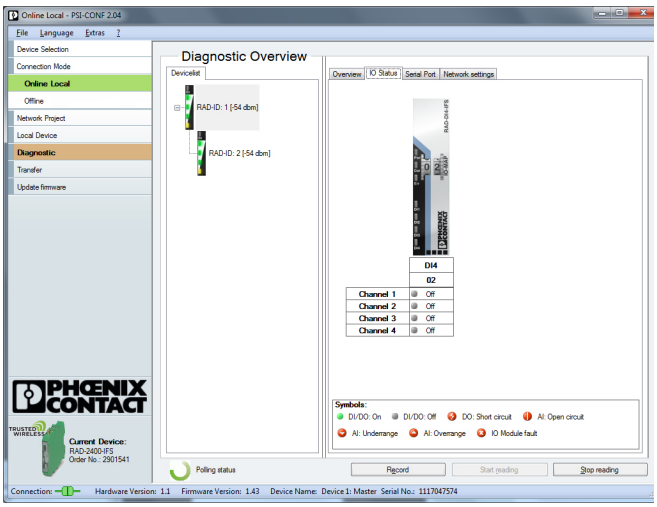


Figure 11-5 PSI-CONF software: Diagnostic, I/O Status

The “Serial Port” tab indicates the currently set parameters of the RS-232/RS-485 interface.

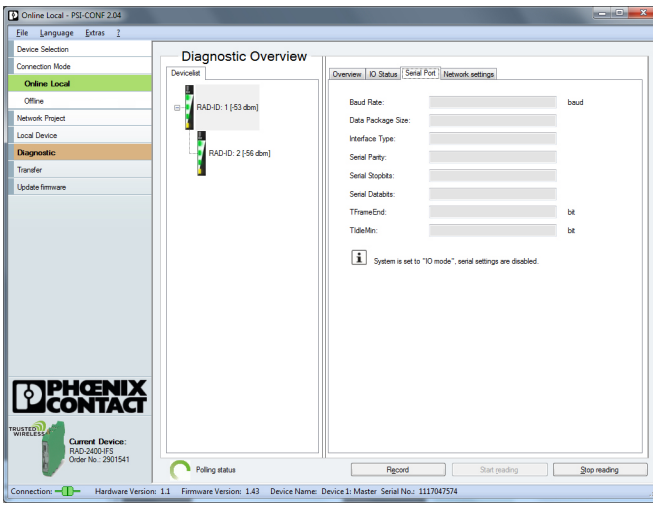


Figure 11-6 PSI-CONF software: Diagnostic, Serial Port

The “Network Settings” tab shows the currently set network parameters as well as the settings of the CONFSTICK, if used.

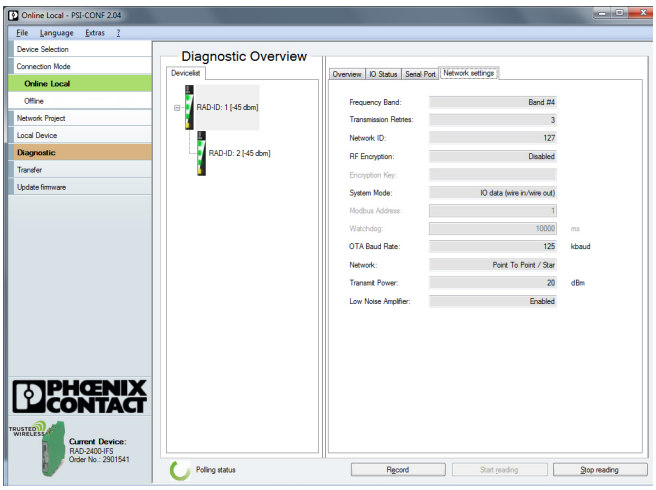


Figure 11-7 PSI-CONF software: Diagnostic, Network Settings

11.3.1 Recording parameters

The following parameters can be recorded using the PSI-CONF software:

– Signal strength
– Network structure
– Status and current values of the connected extension modules

1. Click “Record” under “Diagnostic”.
2. Select “Network diagnostics” or “I/O diagnostics” under “Select the type of data to record”.
3. Under “Recording interval”, you can specify how often the values should be recorded.
   For network diagnostics: Activate “Record signal strength” or “Record network structures”.
   For I/O diagnostics: Select the desired stations.
4. Select a storage location and click on “Start Recording”.

Diagnostic data is now written to a CSV file which can be opened, for example, with Excel.

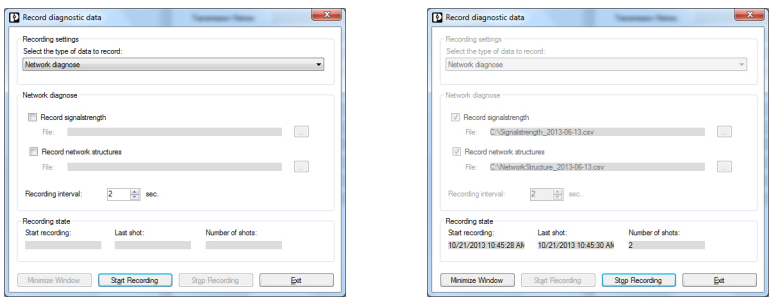


Figure 11-8 PSI-CONF software: Record diagnostic data, Network diagnostics

12 Appendixes

12 1 List of figures

Section 2

Section 3

Section 4

Section 5

Section 6

Section 7

Section 8

Section 10

Section 11

12 2 List of tables

Section 2

Section 3

Section 5

Section 7

Section 8

Section 9

Section 10

Section 11

Please observe the following notes

General terms and conditions of use for technical documentation

Phoenix Contact reserves the right to alter, correct, and/or improve the technical documentation and the products described in the technical documentation at its own discretion and without giving prior notice, insofar as this is reasonable for the user. The same applies to any technical changes that serve the purpose of technical progress.

The receipt of technical documentation (in particular user documentation) does not constitute any further duty on the part of Phoenix Contact to furnish information on modifications to products and/or technical documentation. You are responsible to verify the suitability and intended use of the products in your specific application, in particular with regard to observing the applicable standards and regulations. All information made available in the technical data is supplied without any accompanying guarantee, whether expressly mentioned, implied or tacitly assumed.

In general, the provisions of the current standard Terms and Conditions of Phoenix Contact apply exclusively, in particular as concerns any warranty liability.

Phoenix Contact reserves the right to register its own intellectual property rights for the product identifications of Phoenix Contact products that are used here. Registration of such intellectual property rights by third parties is prohibited.

Other product identifications may be afforded legal protection, even where they may not be indicated as such.

How to contact us

Internet

Up-to-date information on Phoenix Contact products and our Terms and Conditions can be found on the Internet at:
phoenixcontact.com

Make sure you always use the latest documentation.
It can be downloaded at:
phoenixcontact.net/products

Subsidiaries

If there are any problems that cannot be solved using the documentation, please contact your Phoenix Contact subsidiary.
Subsidiary contact information is available at phoenixcontact.com.

Published by

PHOENIX CONTACT GmbH & Co. KG
Flachsmarktstraße 8
32825 Blomberg
GERMANY

PHOENIX CONTACT Development and Manufacturing, Inc.
586 Fulling Mill Road
Middletown, PA 17057
USA

Should you have any suggestions or recommendations for improvement of the contents and layout of our manuals, please send your comments to:
tecdoc@phoenixcontact.com