Radioline

PLC/Modbus® RTU operating mode

Technical note
3371_en_A

1 Description

In PLC/Modbus® RTU mode (I/O to serial) the Radioline I/O expansion modules can be addressed via the Modbus protocol using the integrated RS-232 or RS-485 interface. In this mode, the wireless master (RAD ID = 01) works as a Modbus slave and receives its own Modbus address.

I/O expansion modules can be connected to each wireless device in the network whose I/O data is stored in the internal Modbus memory map of the master wireless module. Diagnostics data for the wireless device is also available.

The Modbus address is a unique address in the Modbus network. It is only assigned for the wireless master (RAD ID = 01). An address between 1 and 247 can be selected.

1.1 I/O extension modules in the wireless network

There is a maximum of 99 I/O extension modules in a wireless network configured in PLC/Modbus RTU mode. IO-MAP addresses 01 - 99 can be set on the I/O extension module using the white thumbwheel.

The following conditions must be met:

– The IO-MAP address may only appear once in the network.
– Output modules may not have the same IO-MAP address as input modules.

  Exception: Output modules with the same IO-MAP address may appear several times at different stations in the network, allowing multiple outputs to be controlled by a single write command (i.e., signal duplication).
– The input and output data is stored in a Modbus memory map in the master wireless module.

1.2 Modbus memory map

The data from the I/O extension modules in the network is stored in an internal register (Modbus memory map) of the wireless master (RAD ID = 01) and can then be read and written by a Modbus controller.

Make sure you always use the latest documentation.
It can be downloaded at phoenixcontact.com.

1.3 Modbus function codes

Modbus protocol function codes determine whether data is to be written or read and what type of data is involved. The following Modbus function codes are supported:

Code No.	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 register	Write multiple output registers word by word

Additional function codes are not supported.

Registers 1-123 can be read/written with a request.

1.4 Status displays: RAD-… wireless module

Nine LEDs on a RAD-… wireless module indicate the operating status.

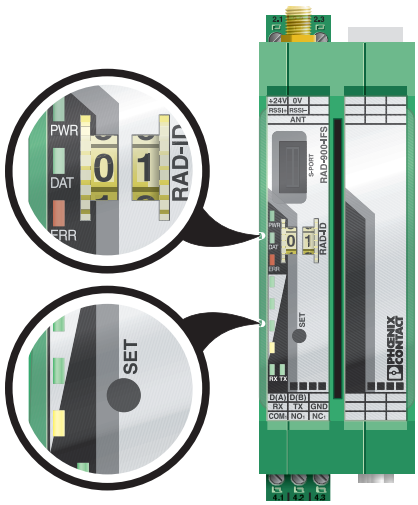

Figure 1 RAD-900-IFS LEDs

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 IO-MAP address (e.g., two input modules with the same IO-MAP address) – Missing input module – Missing output module – RAD ID changed Wireless module in PLC/Modbus RTU mode – Double assignment of IO-MAP address (e.g., two input modules with the same IO-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)

1.5 Status displays: Input modules

A total of three LEDs on the RAD-AI4-IFS, RAD-DI4-IFS and RAD-DI8-IFS I/O expansion modules indicate the operating status.

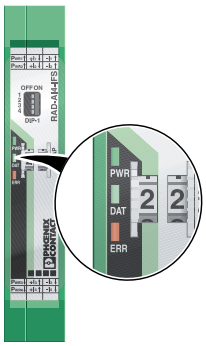

Figure 2 Diagnostic LEDs for input modules (RAD-AI4-IFS shown)

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)	IO-MAP address changed
Fast (2.8 Hz)	No bus communication
On	Critical internal error

1.6 Status displays: Output and input/output modules

A total of three LEDs on the RAD-AO4-IFS, RAD-DOR4-IFS, RAD-DAIO6-IFS and RAD-DO8-IFS I/O extension modules indicate the operating status.

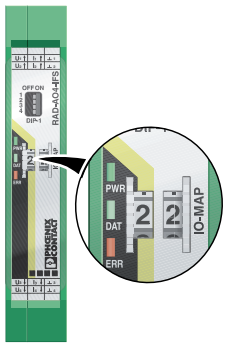

Figure 3 Diagnostics LEDs for output and I/O modules (RAD-AO4-IFS shown)

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)	IO-MAP address changed
Fast (2.8 Hz)	No Modbus communication (safe state of outputs, depending on DIP switch setting)
On	Critical internal error

1.7 Watchdog

The Modbus telegram watchdog (connection monitoring) monitors Modbus telegrams and is triggered each time a Modbus telegram is received correctly.

The watchdog can be deactivated or activated via the PSI-Conf software. The time can be set from 200 to 65,000 ms (default setting = 10,000 ms).

The action on the I/O extension modules, once the watchdog is triggered, depends on the behavior set on the I/O extension modules in the event of an error. The DIP switches on the front of the I/O extension modules can be used to set the behavior of the outputs in the event of an error, e.g. interruption of the Modbus communication or interruption of the wireless connection. For the analog and digital outputs you can either select the “reset” option (output value set to 0 = “RESET”) or the “hold last value” option (“HOLD”).

The red ERR LEDs flash on all wireless modules in the event that Modbus communication is unavailable, e.g. interruption of the connection to the controller, and the watchdog is activated. The output modules in the network display the hold or reset values defined by the DIP switches.

2 Modbus memory map

2.1 RSSI

The RSSI values indicate the received signal strength on the wireless module. 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 low byte of the address area 35001 to 35250.

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
35001	Reserved								RSSI RAD ID =1							
35002	Reserved								RSSI RAD ID =2							
…																
35250	Reserved								RSSI RAD ID =250							

– Bits 8 to 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.

2.2 RAD-4AI-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1	Reserved								Reserved							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx2	Analog input 1 (terminal 2.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx3	Analog input 2 (terminal 3.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx4	Analog input 3 (terminal 3.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx5	Analog input 4 (terminal 4.x)															

– xx = IO-MAP address set using the white thumbwheel.
– Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Example: the wireless connection fails.
– The module type value for RAD-4AI-IFS is 20_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.3 RAD-PT100-4-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1	Reserved								Reserved							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx2	PT100 Input 1															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx3	PT100 Input 2															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx4	PT100 Input 3															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx5	PT100 Input 4															

– xx = IO-MAP address set using the white thumbwheel.
– Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Example: the wireless connection fails.
– The module type value for RAD-PT100-4-IFS is 21_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.4 RAD-AO4-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx1	Reserved								Reserved							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx2	Analog output 1 (terminal 2.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx3	Analog output 2 (terminal 3.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx4	Analog output 3 (terminal 4.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx5	Analog output 4 (terminal 5.x)															

- xx = IO-MAP address set using the white thumbwheel.
- Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Once the process data is written to one of the Modbus registers, the currentness of data bit is set to 0 and remains that way.
- The module type value for RAD-AO4-IFS is 30_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.5 RAD-DI4-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1													DI4	DI3	DI2	DI1
	Terminal points												6.x	5.x	2.x	1.x

- xx = IO-MAP address set using the white thumbwheel.
- Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Example: the wireless connection fails. The process data is retained in the Modbus table, but is no longer updated.
- The module type value for RAD-DI4-IFS is 11_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.6 RAD-DI8-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1									DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1
	Terminal points								5.x	5.x	4.x	4.x	3.x	3.x	2.x	2.x

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx2	Digital input 1 (pulse counter mode) low word															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx3	Digital input 1 (pulse counter mode) high word															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx4	Digital input 7 (pulse counter mode) low word															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx5	Digital input 7 (pulse counter mode) high word															

– xx = IO-MAP address set using the white thumbwheel.
– Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Example: the wireless connection fails. The process data is retained in the Modbus table, but is no longer updated.
– The module type value for RAD-DI4-IFS is 02_{hex} in static mode and 40_{hex} in pulse counter mode. If the module type in the register is invalid or unavailable, then the register value is 0.

Address	Variable	High Byte								Low Byte							
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx1	Counter reset															DI7	DI1

– Set Bit 0 = 1 to reset counter state DI1 to 0
– Set Bit 1 = 1 to reset counter state DI7 to 0

2.7 RAD-DOR4-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx1													DO4	DO3	DO2	DO1
	Terminal points												6.x	5.x	2.x	1.x

– xx = IO-MAP address set using the white thumbwheel.
– Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Example: the wireless connection fails. Once the process data is written to one of the Modbus registers, the Currentness of data bit is set to 0 and remains that way.
– The module type value for RAD-DOR4-IFS is 10_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.8 RAD-DO8-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0 40xx0								Y	Module type							

Address	Variable	High Byte								Low Byte							
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1	Short circuit detection															R	S

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx1									DO8	DO7	DO6	DO5	DO4	DO3	DO2	DO1
	Terminal points								5.x	5.x	4.x	4.x	3.x	3.x	2.x	2.x

- xx = IO-MAP address set using the white thumbwheel.
- Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Once the process data is written to one of the Modbus registers, the Currentness of data bit in 40xx0 is set to 0 and remains that way. In the 30xx0 register, the bit returns to 1 if the short circuit detection status is not up to date. For example, if the wireless connection fails. The IN process data is retained in the Modbus table, but is no longer updated.
- If S = 1, a short circuit is detected at one or more outputs 1 to 4.
- If R = 1, a short circuit is detected at one or more outputs 5 to 8.
- The module type value for RAD-DO8-IFS is 11_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

2.9 RAD-DAIO6-IFS

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx0 40xx0								Y	Module type							

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx1															DI2	DI1
	Terminal points														2.x	1.x

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
30xx2	Analog input (terminal 3.x)															

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx1															DO2	DO1
	Terminal points														6.x	5.x

Address	High Byte								Low Byte							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40xx2	Analog output (terminal 4.x)															

– xx = IO-MAP address set using the white thumbwheel.
– Y = Currentness of data, bit 8. If the data in the register is not up to date, the register value is 1. Once the process data is written to one of the Modbus registers, the Currentness of the data bit is set to 0 and remains that way. The process data is retained in the Modbus table, but is no longer updated.
– The module type value for RAD-DAIO6-IFS is 60_{hex}. If the module type in the register is invalid or unavailable, then the register value is 0.

3 Error codes and formats for analog input and output values

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

3.1 RAD-AI4-IFS

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	–

3.2 RAD-AO4-IFS

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

3.3 RAD-DAIO6-IFS

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	-	-

3.4 Error codes and formats for 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				