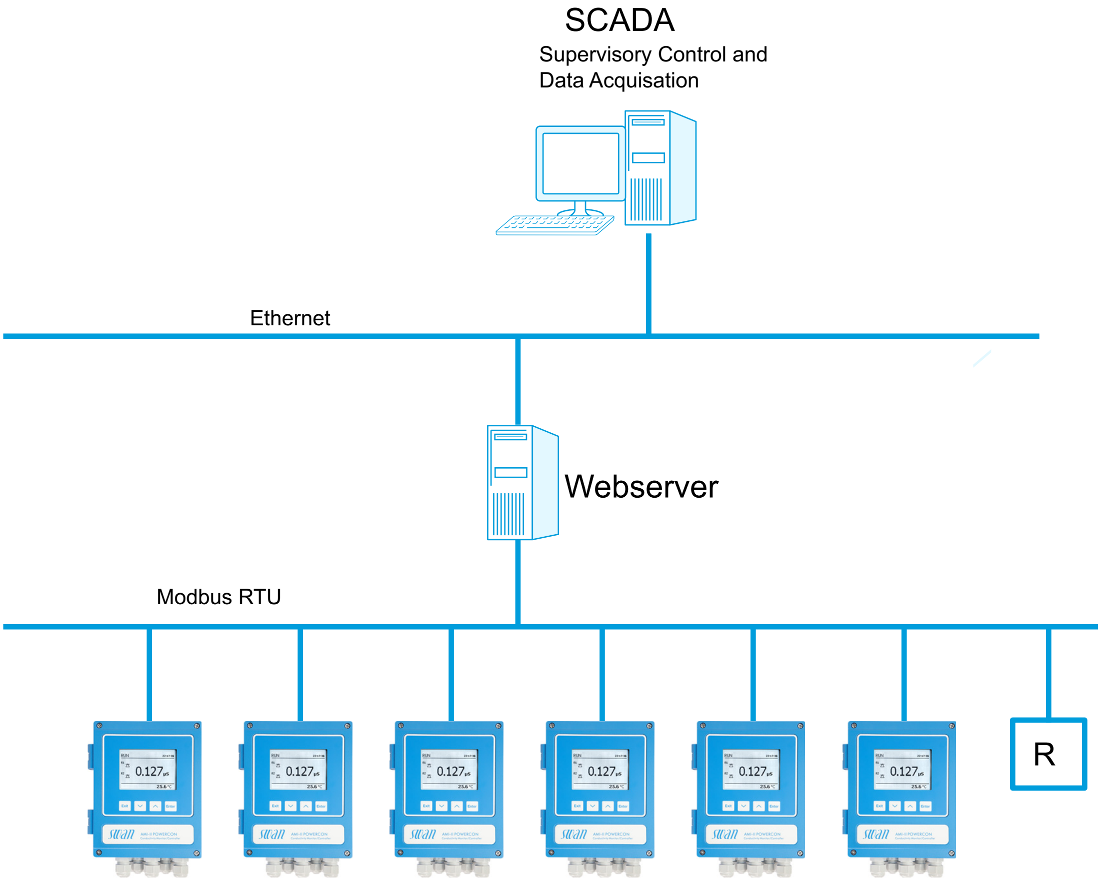
ANALYTICAL INSTRUMENTS

A-96.310.021 / 290524

Modbus Interface Description

For AMI-II Transmitters



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Customer Support
Swan and its representatives maintain a fully trained staff of technical specialists around the world. For any technical question, contact your nearest Swan representative, or the manufacturer:

Swan Analytische Instrumente AG
Studbachstrasse 13
8340 Hinwil
Switzerland

Internet: www.swan.ch
E-mail: support@swan.ch

Document Status

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1. Introduction

Modbus/Jbus

The Modbus/Jbus protocol communicates using a master-slave technique, in which only one device (the master) can initiate transactions (queries). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors, PLCs etc. Typical slaves can be PLCs or intelligent transmitters/controllers like the AMI-II transmitters.

In some cases several instruments provide the same set of data and are therefore covered in the same chapter. The instruments concerned and the corresponding chapters are listed in the following table.

Instruments providing the same set of data	See chapter
AMI-II CACE Degasser and AMI-II CACE	Product-Specific Data for AMI-II CACE

1.1. The Query-Response Cycle

The query

The function code in the query tells the addressed slave device what kind of action to perform. The data bytes contain any additional information the slave will need to function. For example, function code 03 will query the slave to read holding registers and respond with their contents. The data field must contain the information telling the slave which register to start at and how many registers to read.

The response

If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes contain the data collected by the slave.

Serial transmission modes

Modbus supports two transmission modes: ASCII or RTU. AMI-II Instruments support Modbus RTU (Remote Terminal Unit) mode only.

RTU mode

In RTU mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII for the same baud rate. Each message must be transmitted in a continuous stream. Users select the desired serial port communication parameters (baud rate, parity mode, etc). The serial parameters must be the same for all devices on a Modbus network.

Coding system

- Eight bit binary
- 1 start bit
- 8 data bits, least significant bit sent first
- 1 bit for even / odd parity, no bit for no parity
- 1 stop bit if parity is used, 2 bits if no parity
- Cyclic Redundancy Check (CRC)
- RTU framing: messages start with a silent interval of at least 3 ½ character times. A similar interval of at least 3 ½ character times marks the end of the message.

Tab. 2-1 Typical message frame

Start	Slave Address	Function	Data	CRC	END
T1-T2-T3-T4	8 Bits	8 Bits	n x 8 Bits	16 Bits	T1-T2-T3-T4

1.2. Data and Control Functions

Data address in Modbus messages

All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero. For example:

- Holding Register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a holding register operation. Therefore the 4x reference is implicit.

Modbus function codes

The list below shows the function codes supported by the AMI-II Instruments. Codes are listed in decimal. Function codes not supported return an exception response 02 to the master.

Tab. 2-2 *Modbus function codes*

Code	Name	Description
02	Read Input Status	Read Alarm & Status Bits
03	Read Holding Registers	Read Parameter Data
04	Read Input Registers	Read Process Data
05	Force Single Coil	Set Relays, Reset Instrument
16	Preset Multiple Registers	Preset Parameter Data (SWAN Use Only)

Data representation

The process and parameter data of the AMI-II Instruments are represented by float (IEEE 754), signed or unsigned integer values. Depending on the range of the value, float, integer8, unsigned8, integer16, unsigned16, integer32 or unsigned32 representation is used.

Discrete inputs

Alarm and status bits are packed as one input per bit of the data field.

Definition: big-endian and little-endian

Big-endian and little-endian are terms that describe the order in which a sequence of bytes are stored in computer memory. Big-endian is an order in which the "big end" (most significant value in the sequence) is stored first (at the lowest storage address). Little-endian is an order in which the "little end" (least significant value in the sequence) is stored first. For example, in a big-endian computer, the two bytes required for the hexadecimal number 4F52 would be stored as 4F52 in storage. In a little-endian system, it would be stored as 524F.

Note: *Big-endian format is used.*

2. Product-Specific Data for AMI-II CACE

2.1. Introduction

The AMI-II CACE is a microprocessor-controlled two-channel electronic transmitter & controller for the conductivity measurement in power cycles. It can be operated as an intelligent slave device on the Modbus/JBUS using twisted pair RS485 lines.

2.2. Function Description

2.2.1 Read Input Status (Alarm &Status Bits), Function 02

Up to 48 bits of alarms are available as summarized in the table below:

Addr.	Type	Description
0	Alarm	Cond. 1 Alarm high
1	Alarm	Cond. 1 Alarm low
2	Alarm	Cond. 2 Alarm high
3	Alarm	Cond. 2 Alarm low
4	Alarm	Cond. 3 Alarm high
5	Alarm	Cond. 3 Alarm low
6	Alarm	Temp. 1 high
7	Alarm	Temp. 1 low
8	Alarm	Sample Flow high
9	Alarm	Sample Flow low
10	Alarm	Temp. 1 shorted
11	Alarm	Temp. 1 disconnected
12	Alarm	Case Temp. high
13	Alarm	Case Temp. low
14	Alarm	pH Calculation undefined
15	Alarm	Degasser status
16	Alarm	Control Timeout
17	Alarm	Degasser disconnected
18	Alarm	Temp. 2 shorted
19	Alarm	Temp. 2 disconnected
20	Alarm	Temp. 3 shorted
21	Alarm	Temp. 3 disconnected
22	Alarm	Degasser Ctl Timeout
23	Alarm	Input Active
24	Alarm	IC MK41T56
25	Alarm	IC LM75
26	Alarm	-
27	Alarm	-
28	Alarm	Calibration Degasser
29	Alarm	I2C Frontend
30	Alarm	Calibration Recout
31	Alarm	Wrong Front-end
32	Alarm	pH Alarm high
33	Alarm	pH Alarm low

Addr.	Type	Description
34	Alarm	Alkali Alarm high
35	Alarm	Alkali Alarm low
36	Alarm	Temp. 2 high
37	Alarm	Temp. 2 low
38	Alarm	Temp. 3 high
39	Alarm	Temp. 3 low
40	Alarm	-
41	Alarm	Degasser blocked
42	Alarm	EDI out of range
43	Alarm	No sample flow
44	Alarm	EDI DAC disconnected
45	Alarm	EDI ADC disconnected
46	Alarm	EDI module worn out
47	Status	EDI module exhausted

2.2.2 Read Input Registers (Process data): Function 04

The process data are made up of the measuring values of the AMI-II CACE.

Tab. 3-1 Input Registers

Byte Offset	Data type	Description	Range of physical value	
0	Float	Cond. 1 (sc)	0–3000	µS
4	Float	Cond. 2 (cc)	0–3000	µS
8	Float	Cond. 3 (dc)	0–3000	µS
12	Float	Temp. 1	-25 to +270	°C
16	Float	Temp. 2	-25 to +270	°C
20	Float	Temp. 3	-25 to +270	°C
24	Float	Flow	0–50	l/h
28	Float	pH	7–11	pH
32	Float	Alkalyzer	0–100	mg
36	Float	Cond. 1 uc	0–3000	µS
40	Float	Cond. 2 uc	0–3000	µS
44	Float	Cond. 3 uc	0–3000	µS
48	Float	Pt 1000 Temp. 1	500–2400	Ohm
52	Float	Pt 1000 Temp. 2	500–2400	Ohm
56	Float	Pt 1000 Temp. 3	500–2400	Ohm
60	Float	Raw Flow	0–100	Hz
64	Float	Case Temperature	-55 to +125	°C
68	Float	EDI voltage	0–12000	mV
72	Float	EDI current	0–500	mA
76	Float	Degasser Temp. Heat. Exch.	-500 to +740	°C
80	Float	Degasser Temp. Steam	-500 to +740	°C
84	Float	Degasser Temp. Heater	-500 to +740	°C
88	Float	Degasser Temp. Setpoint	-500 to +740	°C
92	Float	Degasser PWM	0–100	%
96	Float	Degasser Air Pressure	0–1500	hPa

Tab. 3-1 Input Registers

Byte Offset	Data type	Description	Range of physical value	
100	Float	Degasser Case Temp.	-55–125	°C
104	Float	Signal Output 1	0–20	mA
108	Float	Signal Output 2	0–20	mA
116	INSTRUMENT_STATUS	Instrument Display Status		

2.2.3 Force Single Coil: Function 05

This function is used to set relays and reset the instrument. Relays can only be forced if set to fieldbus function

Tab. 3-2 Single Coil

Addr.	Description	OFF (0)	ON (1)
0–1	Relay Contacts 1 and 2	open	close
15	Reset Instrument (like hardware reset)		reset

2.2.4 Manufacturer-specific Data Types & Records

DATE_STAMP Format

YYYYYY	MMMM	DDDDD	HHHHH	MMMMMM	SSSSSS
Year 0–63	**Month 1–12**	**Date 1–31**	**Hour 0–23**	**Minutes 0–59**	**Seconds 0–59**

	Parameter	Size	Data Type	Description	Range
INSTRUMENT_STATUS		**32**	**Record**	**Instrument Display Status**	
	Language	1	Unsigned8	Language Selection	0 = German 1 = English 2 = French 3 = Spanish
	RunMode	1	Unsigned8	Run Mode	0 = Run 1 = Hold 2 = Off 3 = Grab
	AlaMode	1	Unsigned8	Alarm Mode	0 = Off 1 = on 2 = Blinking
	MaintMode	1	Unsigned8	Maintenance Mode	0 = Off 1 = on 2 = Blinking
	RelMode1	1	Unsigned8	Relais 1 Display Mode	0 = None 1 = Limit Hi On 2 = Limit Hi Off 3 = Limit Lo On 4 = Limit Lo Off 5 = Timer Off 6 = Timer On 7 = Percent Control 8 = Valve 9 = Bus
	RelMode2	1	Unsigned8	Relais 2 Display Mode	0 = None 1 = Limit Hi On 2 = Limit Hi Off 3 = Limit Lo On 4 = Limit Lo Off 5 = Timer Off 6 = Timer On 7 = Percent Control 8 = Valve 9 = Bus
	PercDos1	2	Unsigned16	Percent Dosage Relais 1	0–100 %
	PercDos2	2	Unsigned16	Percent Dosage Relais 2	0–100 %
	MaintValue	2	Unsigned16	Maintenance Value	0–100 %
	AlarmsActive	4	Unsigned32	Alarms Pending	Bit Coded
	AlarmsLatched	4	Unsigned32	Alarms no Acknowledged	Bit Coded
	AlarmsActiveE	4	Unsigned32	Extended Alarms Pending	Bit Coded
	AlarmsLatchedE	4	Unsigned32	Extended Alarms not Acknowledged	Bit Coded
	TimeStamp	4	DATE_-STAMP	Current Time	
end Record					

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Swan Analytical Instruments · CH-8340 Hinwil
www.swan.ch · swan@swan.ch

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