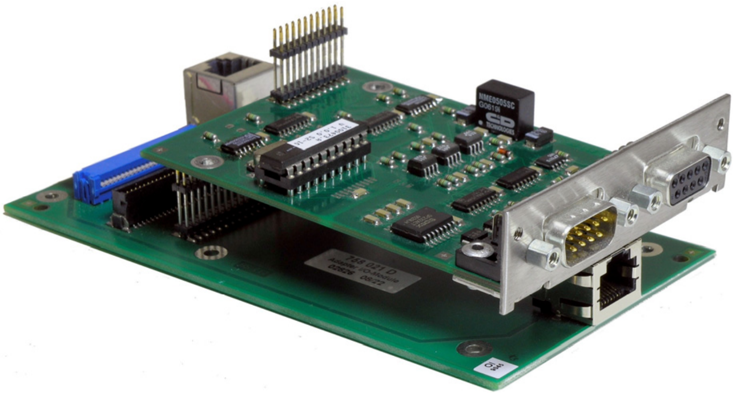
Advance Optima Continuous gas analyzers

AO2000
Modbus and AO-MDDE

Technical information

30/24-316 EN Rev. 6



Contents

Chapter 1 AO2000 Modbus

Description

Application

Information from the AO2000 gas analyzer can be transferred to a PC or DCS via the Modbus. Measurement values, status signals and also signals of analog and digital inputs and outputs are thus available for further usage.

Using the AO-MDDE server the signals can be integrated into standard software (e.g. Excel, Visual Basic or LabVIEW). For further information, see Chapter 4 "AO-MDDE server and demo programs", page 3535. AO-MDDE can be downloaded from the DVD-ROM which is delivered together with each gas analyzer. AO-MDDE does not support Modbus over TCP/IP.

Basic documents

- Modbus Application Protocol Specification V1.1b, December 28, 2006
- Modbus over Serial Line Specification and Implementation Guide V1.02, December 20, 2006
- Modbus Messaging on TCP/IP Implementation Guide V1.0b, October 24, 2006

These documents are available at http://www.modbus.org/specs.php.

Interfaces and connection versions

The RS232 and the RS485 interface located on the RS232 / RS485 module in AO2000 are supported, where only one can be operated at a time. Connection versions are described in Chapter 3 "Modbus connection", page 30.

As an alternative, the Ethernet 10/100BASE-T interface can be used for data transmission via Modbus TCP/IP protocol (from software version 5.1, see page 7).

Continued on next page

Transferred data	Read	Write	Example
Measurement values	x	–	CO, NO, H_2, etc.
Analog inputs	x	–	Indication of mA-values of external analyzers
Analog outputs	x	–	Indication of mA-values of measurement values or calculated values (function block application)
Digital inputs	x	–	Indication of external status signals
Digital outputs	x	–	Measurement range feedback, indication of solenoid or pump controls
Bus analog inputs	x	x	Entering analog values into the function block application
Bus analog outputs	x	–	Outputting analog values from the function block application
Bus digital inputs	x	x	Control of functions such as auto calibration, measuring range control, etc. after function block configuration
Bus digital outputs	x	–	Indication of all functions integrated by function block configuration such as alarm signaling etc.
Modbus configuration	x	–	Indication how many components, AOs, DOs, etc. have been configured or are in the gas analyzer
Status signals	x	–	Indication of failure, maintenance mode, maintenance request
Measurement range feedback	x	–	Index of the active measurement range
Measurement range configuration	x	–	Measurement range limits (start and end value)
Measurement range drift values	x	–	Offset drift, amplification drift, delta offset drift, delta amplification drift
QAL3 calibration data	x	–	Setpoints and actual values, measuring range and date of last calibration (not available in analyzer modules Limas11, Uras14, Magnos16, Magnos106, Caldos15, Caldos17, and MultiFID14)

Modbus frames and functions

Data transfer

For data transfer a combination of frames is used, that consists of 1/0 information, united to one or more telegrams.

Frame

The transfer values are decomposed in bytes (= 8 bit). Each of these bytes is completed by one start-bit, possibly one parity-bit (even number of “1”) and one stop-bit. In the following description the term “byte” will be used, even if ten or eleven bits will be transferred including the start-, stop- and parity-bits.

Telegrams

The Modbus telegrams consist of the following frames:
address (1 byte), function (1 byte), data (n bytes) and check sum (2 bytes).

The telegrams also take on the “shake-hands-function”: each telegram from master to slave must be responded, before a new telegram is allowed to be transmitted. The computer has to have in a adequate supervision, for excluding non answering bus participants (time-out-supervision).

Admissible addresses

As addresses for the participants of the bus the numbers 1 to 255 are admitted.

The address 0 is the global address (broadcast-address). When this address will be used in a telegram, all participants accept this telegram without an acknowledgment to the master.

Functions

Code	Term	Function
01	Read coil status	Reading of binary values of type coil
02	Read input status	Reading of binary values of type status
03	Read holding registers	Reading of 16 bit holding-registers
04	Read input registers	Reading of 16 bit input-registers
05	Force single coil	Setting of a single binary value
06	Preset single register	Set of a single 16 bit-register; for DINT or REAL two telegrams are necessary
08	Loopback diagnostic test	Testing telegram for diagnostics of the communication capability of slave
15	Force multiple coils	Set of several successive binary values
16	Preset multiple registers	Set of several successive 16 bit-registers

Check sum

The check sum is calculated over all bytes of one telegram without the start-, stop- and parity-bits.

Transfer rules

The neutral position of the data line corresponds with the logical “1”.

A distance of more than 3.5 bytes, however at least 10 ms is defined as separation between two telegrams. For the beginning of the data transfer the neutral position of the data line must be observed.

Modbus over TCP/IP

Integration

The AO2000 Modbus/TCP server expects requests from the current IP addresses via the communication port. A maximum of 4 clients can be connected to the Modbus/TCP server of an AO2000 at the same time. If the connection to a client breaks down, the connection status in the Modbus/TCP server is enabled again after a max. 60 seconds.

Reading out data from the AO2000 Modbus/TCP server

The following procedure must be executed on the Modbus client, in order to receive data from the AO2000 Modbus/TCP server:

1. Establish a TCP connection to port 502 on the server.
2. Create a Modbus request.
3. Send the Modbus request incl. the Modbus/TCP MBAP Header.
4. Wait for a response to the same TCP connection.
5. Read the first 6 bytes of the response; these state the length of the response.
6. Read the remaining bytes of the response.

Functions, addresses and registers

The supported functions and the addresses and registers of Modbus over TCP/IP are equivalent to those of Modbus over RS232/RS485.

Function code

Function code 43 with MEI 14 (MEI = Modbus Encapsulated Interface) is used to read the device parameters to

- read measured values,
- transfer simulation data,
- apply reference material.

Address assignment of the device parameters for the function code 43

There is read access to the device parameters.

Measurement components are mapped with the following structure:

- Name
- Measurement range start
- Measurement range end
- Unit

The number of the first measured values register is listed under BasisM in the device parameters list.

The measured value status is implemented as NAMUR status:

Bit	Assignmant
0	Error
1	Maintenance
2	Maintenance request
3	Beyond specification
4	Test operation, simulation measured value transmitted
5…15	Reserved for extensions
16…31	Vendor-specific

The number of the first simulation data register is listed under BasisS in the device parameters list.

The number of the register to apply reference material is listed under BasisR in the device parameters list. Maximum 32 Bus DIs are reserved for transferring reference material.

The register "status of application" is used for feedback of the DIs for which a hardware digital output is connected. When reference material is applied, the status "maintenance" is set and a message is displayed on the gas analyzer's screen.

Continued on next page

Device parameters list

Name	Object ID	Encoding	Table	Attribute	Description
VendorName	0x00	String	System_control	Fabrication_number	Manufacturer name
ProductCode	0x01	String	System_control	Product_Code	Manufacturer-specific device identifier
MajorMinorRevision	0x02	String	System_control	Version	Software version of measuring system
ProductName	0x04	String	System_control	Product_Name	Device name
SerialNumber	0x80	String	System_control	SerialNumber	Serial number of measuring system
ComponentNumber	0x81	Word	Detector_para	Classification = 0	Number of measurands
BasisM	0x82	Word	Modbus_conf	Registernumber	First register of the measurands block
BasisS	0x83	Word	Modbus_conf	Registernumber	First register of the simulation data
BasisR	0x84	Word	Modbus_conf	Registernumber	First register of the reference material data
Component1_Name	0x85	String	Component_para	Name	Name of measured component 1
Component1_ Range_Start	0x86	Float	Meas_range_para	Lower_meas_range	Lower limit of output range of measured component 1
Component1_ Range_End	0x87	Float	Meas_range_para	Upper_meas_range	Upper limit of output range of measured component 1
Component1_Unit	0x88	String	Component_para	Unit_name	Unit of measured component 1
Component2_Name	0x89	String	Component_para	Name	Name of measured component 2
Component2_ Range_Start	0x8A	Float	Meas_range_para	Lower_meas_range	Lower limit of output range of measured component 2
Component2_ Range_End	0x8B	Float	Meas_range_para	Upper_meas_range	Upper limit of output range of measured component 2
Component2_Unit	0x8C	String	Component_para	Unit_name	Unit of measured component 2
…	…	…	…	…	…

Reference material application

The Bus DIs used for reference material application are connected to the digital outputs used for calibration and described in the device documentation.

IEEE 754 format

Modbus protocol and IEEE 754 format

The Modbus-protocol allows only 16-bit-registers as transfer values. Some of the AO2000 data is stored in the IEEE 754-Format (32 bit). For this reason the data must be processed by the interrogating device..

Construction of IEEE 754 format

Term	Number of bits	Meaning
S	1	Sign bit; explains the sign (0 = positive, 1 = negative)
E	8	Two's complement exponent. The true value is the exponent minus 127.
M	23	The "most significant bit" of the normalized mantissa before the decimal point is implicitly 1, but is not stored. The value range is also between 1.0 (included) and 2.0.

Example

The number –12.5 is stored as the hexadecimal value 0xC1480000. The following table shows the storage configuration:

Address	+0	+1	+2	+3
format	SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM
binary	11000001	01001000	00000000	00000000
hexadecimal	C1	48	00	00

Explanations

- The sign bit is 1, i.e. the value is negative.
- The exponent is 10000010 binary, which corresponds to the decimal value 130. Subtracting 127 from 130 leaves 3, which is the actual exponent.
- The stored mantissa value is 10010000000000000000000. Adding the non stored 1 before the decimal point gives the value 1.10010000000000000000000.
- After adjusting the mantissa to the exponent (moving it three places) the result is 1100.10000000000000000000. This binary number corresponds to the decimal value 12.5. Finally the sign bit needs to be taken into account. This makes the final value of –12.5.

Modbus addresses and data format

Principle

The AO2000 series gas analyzers are modular and very flexible. A gas analyzer can consist of one or more analyzer modules which in itself can measure one or more components. It is also possible to connect different kinds of I/O-modules and I/O-boards to a device. For this reason the Modbus addressing schema is not static.

Data format

There are six flexible groups, four configurable groups and two fixed length groups of information defined in a AO2000 gas analyzer.

The grouped information can be read through “Single Modbus Request”.

Flexible groups

The flexible groups are:

- Measurement values (see page 12)
- Analog inputs (see page 12)
- Analog outputs (see page 13)
- Digital inputs (see page 13)
- Digital outputs (see page 14)
- Measurement range feedback (see page 17)
- Measurement range configuration (see page 18)
- Measurement range drift values (see page 19)
- QAL3 calibration data (see page 21)

Each flexible group has a fixed start address and, depending on the system layout, a variable number of elements.

Configurable groups

The configurable groups are:

- Bus analog inputs (see page 14)
- Bus analog outputs (see page 15)
- Bus digital inputs (see page 15)
- Bus digital outputs (see page 15)

Each configurable group has a fixed start address and, depending on the user configuration, a variable number of elements.

Fixed length groups

The fixed length groups are:

- Configuration display (see page 16)
- Status (see page 16)

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Measurement values

The measurement values are transmitted in the IEEE 32 bit standard floating point format. The floating point format is not a part of the Modbus specification. AO2000 devices use two word registers to represent a floating point value (high word, low word).

Modicon Modbus address	Type	Register number	Description/name
30001	Input register	0	Measurement Component 1
30002		1	
30003	Input register	2	Measurement Component 2
30004		3	
30005	Input register	4	Measurement Component 3
30006		5	
30007	Input register	6	Measurement Component 4
30008		7	
30009	Input register	8	Measurement Component 5
30010		9	
30011	Input register	10	Measurement Component 6
30012		11	
			etc.

Analog inputs

Analog inputs (AI) are transmitted in the IEEE 32 bit standard floating point format. The floating point format is not a part of the Modbus specification. AO2000 devices use two word registers to represent a floating point value (high word, low word).

Modicon Modbus address	Type	Register number	Description/name
30100	Input register	99	Analog Input 1 V-in
30101		100	
30102	Input register	101	Analog Input 1 I-in
30103		102	
30104	Input register	103	Analog Input 2 V-in
30105		104	
30106	Input register	105	Analog Input 2 I-in
30107		106	
30108	Input register	107	Analog Input 3 V-in
30109		108	
30110	Input register	109	Analog Input 3 I-in
30111		110	
30112	Input register	111	Analog Input 4 V-in
30113		112	
30114	Input register	113	Analog Input 4 I-in
30115		114	
			etc.

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Analog outputs

Analog outputs (AO) are transmitted in the IEEE 32 bit standard floating point format. The floating point format is not a part of the Modbus specification. AO2000 devices use two word registers to represent a floating point value (high word, low word).

Modicon Modbus address	Type	Register number	Description / name
30300	Input register	299	Analog Output 1
30301		300	
30302	Input register	301	Analog Output 2
30303		302	
30304	Input register	303	Analog Output 3
30305		304	
30306	Input register	305	Analog Output 4
30307		306	
30308	Input register	307	Analog Output 5
30309		308	
30310	Input register	309	Analog Output 6
30311		310	
30312	Input register	311	Analog Output 7
30313		312	
30314	Input register	313	Analog Output 8
30315		314	
			etc.

Digital inputs

The Modbus master has only read access to digital input values (DI).

Modicon Modbus address	Type	Input number	Description / name
10016	Input status	15	Syscon DI purge
10017	Input status	16	Digital Input 1
10018	Input status	17	Digital Input 2
10019	Input status	18	Digital Input 3
10020	Input status	19	Digital Input 4
10021	Input status	20	Digital Input 5
10022	Input status	21	Digital Input 6
10023	Input status	22	Digital Input 7
10024	Input status	23	Digital Input 8
			etc.

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Digital outputs

The Modbus master has only read access to digital output values (DO).

Modicon Modbus address	Type	Input number	Description / name
11036	Input status	1035	Digital Output 1
11037	Input status	1036	Digital Output 2
11038	Input status	1037	Digital Output 3
11039	Input status	1038	Digital Output 4
11040	Input status	1039	Digital Output 5
11041	Input status	1040	Digital Output 6
11042	Input status	1041	Digital Output 7
11043	Input status	1042	Digital Output 8
			etc.

Bus analog inputs

Bus analog inputs (Bus AI) are transmitted in the IEEE 32 bit standard floating point format. The floating point format is not a part of the Modbus specification. AO2000 devices use two word registers to represent a floating point value (high word, low word).

Bus AIs can be read and written by the Modbus Master. They can be used like physical (“real”) AIs when configuring function blocks [1)]. The Master has access to the configured variables (holding register) and uses function code 3 to read them. Due to the 32-bit register, the variables can only be written using function code 16. A maximum of 50 Bus AIs can be configured.

A waiting period of 250 msec per analog input should be observed after writing the Bus AIs.

Modicon Modbus address	Type	Register number	Description / name
40001 40002	Holding register	0 1	Bus AI 1
40003 40004	Holding register	2 3	Bus AI 2
…	Holding register	…	Bus AI …
40099 40100	Holding register	98 99	Bus AI 50

1) A detailed description of the "Function block" concept and detailed descriptions of the individual function blocks can be found in the technical information "Function blocks – descriptions and configuration".

Continued on next page

Bus analog outputs

Bus analog outputs (Bus AO) are transmitted in the IEEE 32 bit standard floating point format. The floating point format is not a part of the Modbus specification. AO2000 devices use two word registers to represent a floating point value (high word, low word).

Bus AOs can be used like physical ("real") AOs when configuring function blocks. A maximum of 50 Bus AOs can be configured.

Modicon Modbus address	Type	Register number	Description / name
30600 30601	Input register	599 600	Bus AO 1
30602 30603	Input register	601 602	Bus AO 2
…	Input register	…	Bus AO …
30698 30699	Input register	697 698	Bus AO 50

Bus digital inputs

Bus digital inputs (Bus DI) are bit variables in the gas analyzer. The Modbus master has read and write access to these variables.

Bus DIs can be used like physical ("real") DIs when configuring function blocks. The master has access to all configured variables and uses function code 1 to read and 5 or 15 to write the variables. A maximum of 50 Bus DIs can be configured.

Modicon Modbus address	Type	Coil number	Description / name
1	Coil status	0	Bus DI 1
2	Coil status	1	Bus DI 2
3	Coil status	2	Bus DI 3
…	Coil status	…	Bus DI …
50	Coil status	49	Bus DI 50

Bus digital outputs

Bus digital outputs (Bus DO) are bit variables in the gas analyzer which can only be read by the Modbus master.

Bus DOs can be used like physical ("real") DOs when configuring function blocks. A maximum of 50 Bus DOs can be configured.

Modicon Modbus address	Type	Input number	Description / name
12060	Input status	2059	Modbus DO 1
12061	Input status	2060	Modbus DO 2
12062	Input status	2061	Modbus DO 3
…	Input status	…	Modbus DO …
12109	Input status	2108	Modbus DO 50

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Configuration

The Modbus has read access to the configuration register. By means of the this register, a Master can determine how many components, AIs, AOs, etc. have been installed in the gas analyzer. The data are represented as 16-bit integers.

Modicon Modbus address	Type	Register number	Description / name
30500	Input register	499	Number of components
30501	Input register	500	Number of AIs
30502	Input register	501	Number of AOs
30503	Input register	502	Number of DIs
30504	Input register	503	Number of DOs
30505	Input register	504	Number of Modbus AIs
30506	Input register	505	Number of Modbus AOs
30507	Input register	506	Number of Modbus DIs
30508	Input register	507	Number of Modbus DOs
30509	Input register	508	Number of QAL3 component entries

Status

The Modbus has read access to the three status values.

Modicon Modbus address	Type	Input number	Description / name
10001	Input status	0	Failure
10002	Input status	1	Maintenance mode
10003	Input status	2	Maintenance request

Measurement range feedback

Measurement range feedback

Modbus will deliver one input register per configured sample component. This input will reflect the index 1 to 4 of the active measurement range.

Modicon Modbus address	Type	Input number	Description/name
32000	Input register	1999	Component 1 Active range no.
32001	Input register	2000	Component 2 Active range no.
32002	Input register	2001	Component 3 Active range no.
32003	Input register	2002	Component 4 Active range no.
32004	Input register	2003	Component 5 Active range no.
32005	Input register	2004	Component 6 Active range no.
32006	Input register	2005	Component 7 Active range no.
…			

Measurement range configuration

Structure of measurement range configuration

The range parameters are listed in order of the configured main components. For one component the system will always install structures for four ranges, even if a lower number of ranges is configured. Only the structures representing configured ranges are valid.

The range limits are sent via Modbus as displayed on HMI. The number of places is limited to the maximal supported number of places for the current measuring range span.

Every floating point value is transferred in two input registers (high word, low word).

Start index +	Name	Type	Meaning
0, 1	Range 1 Zero	Integer16	Zero value for range 1 (Range start)
2, 3	Range 1 Span	Integer16	Span value for range 1 (Range end)
4, 5	Range 2 Zero	Integer16	Zero value for range 2 (Range start)
6, 7	Range 2 Span	Integer16	Span value for range 2 (Range end)
8, 9	Range 3 Zero	Integer16	Zero value for range 3 (Range start)
10, 11	Range 3 Span	Integer16	Span value for range 3 (Range end)
12, 13	Range 4 Zero	Integer16	Zero value for range 4 (Range start)
14, 15	Range 4 Span	Integer16	Span value for range 4 (Range end)

Addresses of the parameters

Modicon Modbus address	Type	Register number	Description / name
32100 32101	Input register	2099 2100	Component 1 Range 1 Zero
32102 32103	Input register	2101 2102	Component 1 Range 1 Span
32104 32105	Input register	2103 2104	Component 1 Range 2 Zero
32106 32107	Input register	2105 2106	Component 1 Range 2 Span
32108 32109	Input register	2107 2108	Component 1 Range 3 Zero
32110 32111	Input register	2109 2110	Component 1 Range 3 Span
32112 32113	Input register	2111 2112	Component 1 Range 4 Zero
32114 32115	Input register	2113 2114	Component 1 Range 4 Span
32116 32117	Input register	2115 2116	Component 2 Range 1 Zero
32118 32119	Input register	2117 2118	Component 2 Range 1 Span
…			

Measurement range drift values

Structure of range drift values

The range parameters are listed in order of the configured main components. For one component the system will always install structures for four ranges, even if a lower number of ranges is configured. Only the structures representing configured ranges are valid.

Every floating point value is transferred in two input registers (high word, low word).

Start index +	Name	Type	Meaning
0, 1	Range 1 Offs	Integer16	Offset drift range 1
2, 3	Range 1 Ampl	Integer16	Amplification drift range 1
4, 5	Range 1 DeltaOffs	Integer16	Delta offset drift range 1
6, 7	Range 1 DeltaAmpl	Integer16	Delta amplification drift range 1
8, 9	Range 2 Offs	Integer16	Offset drift range 2
10, 11	Range 2 Ampl	Integer16	Amplification drift range 2
12, 13	Range 2 DeltaOffs	Integer16	Delta offset drift range 2
14, 15	Range 2 DeltaAmpl	Integer16	Delta amplification drift range 2
16, 17	Range 3 Offs	Integer16	Offset drift range 3
18, 19	Range 3 Ampl	Integer16	Amplification drift range 3
20, 21	Range 3 DeltaOffs	Integer16	Delta offset drift range 3
22, 23	Range 3 DeltaAmpl	Integer16	Delta amplification drift range 3
24, 25	Range 4 Offs	Integer16	Offset drift range 4
26, 27	Range 4 Ampl	Integer16	Amplification drift range 4
28, 29	Range 4 DeltaOffs	Integer16	Delta offset drift range 4
30, 31	Range 4 DeltaAmpl	Integer16	Delta amplification drift range 4

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Addresses of the parameters

Modicon Modbus address	Type	Register number	Description / name
33000 33001	Input register	2999 3000	Component 1 Range 1 offset drift
33002 33003	Input register	3001 3002	Component 1 Range 1 amplification drift
33004 33005	Input register	3003 3004	Component 1 Range 1 delta offset drift
33006 33007	Input register	3005 3006	Component 1 Range 1 delta ampl. drift
33008 33009	Input register	3007 3008	Component 1 Range 2 offset drift
33010 33011	Input register	3009 3010	Component 1 Range 2 amplification drift
33012 33013	Input register	3011 3012	Component 1 Range 2 delta offset drift
33014 33015	Input register	3013 3014	Component 1 Range 2 delta ampl. drift
33016 33017	Input register	3015 3016	Component 1 Range 3 offset drift
33018 33019	Input register	3017 3018	Component 1 Range 3 amplification drift
33020 33021	Input register	3019 3020	Component 1 Range 3 delta offset drift
33022 33023	Input register	3021 3022	Component 1 Range 3 delta ampl. drift
33024 33025	Input register	3023 3024	Component 1 Range 4 offset drift
33026 33027	Input register	3025 3026	Component 1 Range 4 amplification drift
33028 33029	Input register	3027 3028	Component 1 Range 4 delta offset drift
33030 33031	Input register	3029 3030	Component 1 Range 4 delta ampl. drift
33032 33033	Input register	3031 3032	Component 2 Range 1 offset drift
…			

Mapping the calibration data for QAL3

Reading out the calibration data

The Modbus interface includes a structure for each component which enables the setpoints and actual values, the measuring range and the date of the last calibration to be read out.

The system time of the AO2000 is used as a time-stamp. If a calibration has not yet been carried out, 0 is transmitted as a time-stamp and 0 as a measuring range.

The time-stamp of the structure must be periodically read at least, in order to record a change.

The setpoints and the actual values are transmitted in the unit of the measured value. If the unit of the component is changed, the transmitted values are also changed.

Mapping the calibration data

The following parameters are made available for each component via the Modbus. All the registers are based on a Modbus 16-bit "input register".

The setpoints and actual values are transmitted in the IEEE 32-bit floating-point format. Two word registers are used to represent a floating-point value.

The measuring range is transmitted as a consecutive number 1-4.

Start index +	Name	Type	Meaning
0	Zero Date 1	Integer16	Date part 1 of the zero point calibration Day / month (day × 100 + month)
1	Zero Date 2	Integer16	Date part 2 of the zero point calibration Year (4-digit year number)
2	Zero Time 1	Integer16	Time part 1 of the zero point calibration Hour / minute (hr. × 100 + min.)
3	Zero Time 2	Integer16	Time part 2 and measuring range number of the zero point calibration Second / MR no. (Sec. × 100 + MR no.)
4, 5	Setpoint Zero	Float32	Setpoint of the zero point calibration (IEEE 32-bit format)
6, 7	Value Zero	Float32	Actual value of the zero point calibration (IEEE 32-bit format)
8	Span Date 1	Integer16	Date part 1 of the span calibration Day / month (day × 100 + month)
9	Span Date 2	Integer16	Date part 2 of the span calibration Year (4-digit year number)
10	Span Time 1	Integer16	Time part 1 of the span calibration Hour / minute (hr. × 100 + min.)
11	Span Time 2	Integer16	Time part 2 and measuring range number of the span calibration Second / MR no. (Sec. × 100 + MR no.)
12, 13	Setpoint Span	Float32	Setpoint of the span calibration (IEEE 32-bit format)
14, 15	Value Span	Float32	Actual value of the span calibration (IEEE 32-bit format)

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Addresses of the parameters

Modicon Modbus address	Type	Register number	Description/name
30800	Input register	799	Component 1 Zero calibration day / month
30801	Input register	800	Component 1 Zero calibration year
30802	Input register	801	Component 1 Zero calibration hour / minute
30803	Input register	802	Component 1 Zero calibration second / range no.
30804 30805	Input register	803 804	Component 1 Zero calibration setpoint
30806 30807	Input register	805 806	Component 1 Zero calibration actual value
30808	Input register	807	Component 1 Span calibration day / month
30809	Input register	808	Component 1 Span calibration year
30810	Input register	809	Component 1 Span calibration hour / minute
30811	Input register	810	Component 1 Span calibration second / range no.
30812 30813	Input register	811 812	Component 1 Span calibration setpoint
30814 30815	Input register	813 814	Component 1 Span calibration actual value
30816	Input register	815	Component 2 Zero calibration day / month
…			

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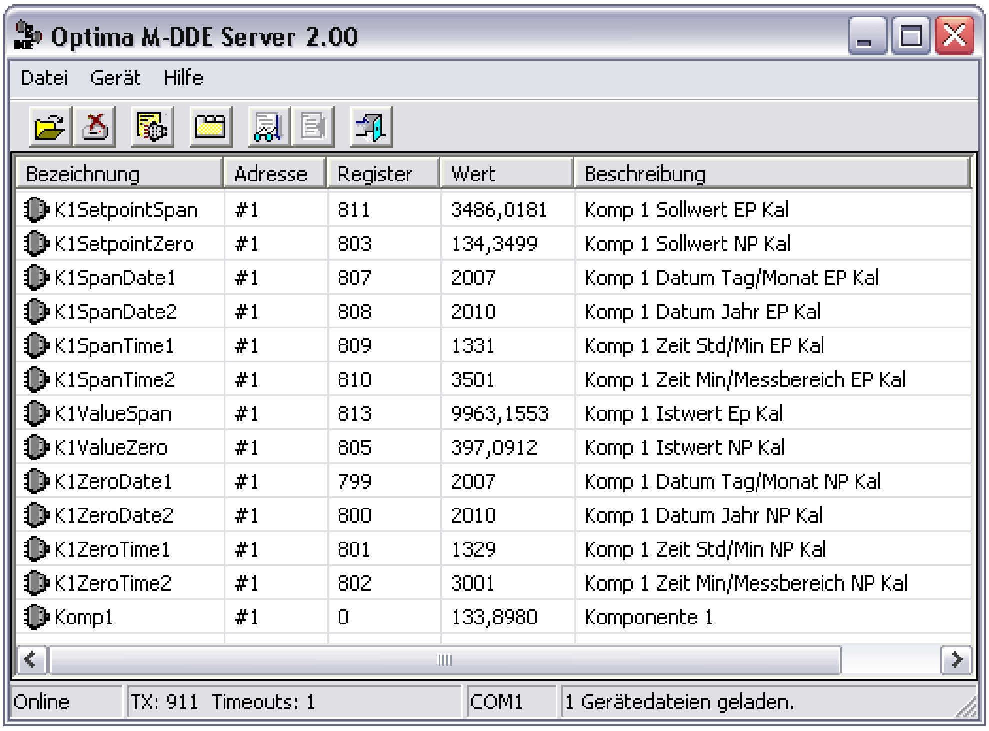
Figure 1

Example of a transmission with Modbus DDE server



Optima M-DDE Server 2.00

Datei Gerät Hilfe

Bezeichnung	Adresse	Register	Wert	Beschreibung
K1SetpointSpan	#1	811	3486,0181	Komp 1 Sollwert EP Kal
K1SetpointZero	#1	803	134,3499	Komp 1 Sollwert NP Kal
K1SpanDate1	#1	807	2007	Komp 1 Datum Tag/Monat EP Kal
K1SpanDate2	#1	808	2010	Komp 1 Datum Jahr EP Kal
K1SpanTime1	#1	809	1331	Komp 1 Zeit Std/Min EP Kal
K1SpanTime2	#1	810	3501	Komp 1 Zeit Min/Messbereich EP Kal
K1ValueSpan	#1	813	9963,1553	Komp 1 Istwert Ep Kal
K1ValueZero	#1	805	397,0912	Komp 1 Istwert NP Kal
K1ZeroDate1	#1	799	2007	Komp 1 Datum Tag/Monat NP Kal
K1ZeroDate2	#1	800	2010	Komp 1 Datum Jahr NP Kal
K1ZeroTime1	#1	801	1329	Komp 1 Zeit Std/Min NP Kal
K1ZeroTime2	#1	802	3001	Komp 1 Zeit Min/Messbereich NP Kal
Komp1	#1	0	133,8980	Komponente 1

Online | TX: 911 Timeouts: 1 | COM1 | 1 Gerätedateien geladen.

Data of a calibration read with the Modbus DDE server (see also page 35):

Current measured value of component 1 133.8980 [unit of component 1]

Last calibration:

Component 1 at zero point
- Measuring range 1
- on 20.07.2010 at 13:29:30
- Setpoint 134.3499 [Unit of component 1]
- Actual value 397.0912 [Unit of component 1]

Component 1 at end-point
- Measuring range 1
- on 20.07.2010 at 13:31:35
- Setpoint 3486.0181 [Unit of component 1]
- Actual value 9963.1553 [Unit of component 1]

The function "Mapping the calibration data for QAL3" is not available in these analyzer modules: Limas11, Uras14, Magnos16, Magnos106, Caldos15, Caldos17, and MultiFID14.

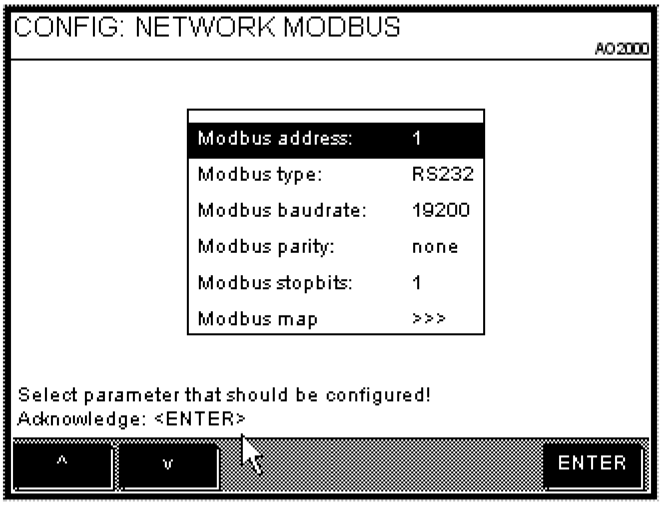
Modbus parameters

Menu path

`MENU → Configure → System → Network → Modbus`

Figure 2

Modbus configuration in AO2000



Function

The gas analyzer can be connected to a network with Modbus protocol via the RS232 or the RS485 interface.

The RS232/RS485 module must be installed in the gas analyzer. Only then the `Modbus` menu item is displayed.

As an alternative, the Ethernet 10/100BASE-T interface can be used for data transmission via Modbus TCP/IP protocol (from software version 5.1, see page 7).

Parameters

The `Modbus address` can be set in the 1–255 range.

For `Modbus type`, select the interface which connects the gas analyzer to the Modbus network (RS232 or RS485).

The data transfer default settings are shown in Figure 2.

The `Modbus map` provides an overview of the addresses of the Modbus registers (from software version 5.1, see page 25).

Request interval

The request response of AO2000 is < 500 ms. Therefore the times for the time-out-supervision in the master should be > 500 ms (recommendation: 1 s). Between two faultless requests a minimum waiting time of ≥ 100 ms needs to be kept.

Address overview in the AO2000 menu (software version ≥ 5.1)

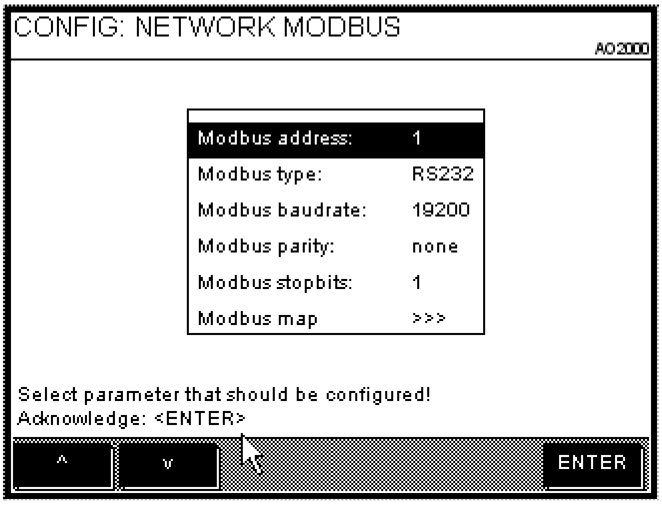
"Modbus map" sub-menu

The "Modbus map" sub-menu is integrated in the menu `Configure` → `System` → `Network` → `Modbus`, in order to provide an overview of the addresses of the Modbus registers.

Entry to the Modbus map menu with a Modbus module installed:

Figure 3

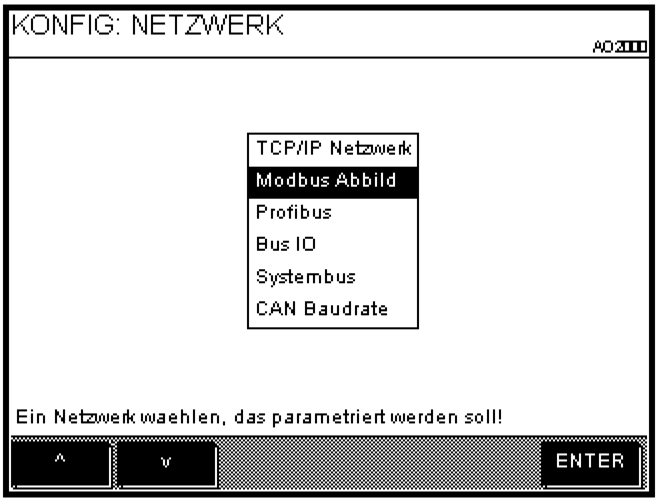
Modbus configuration menu



If a Modbus module has not been installed, the Modbus map menu is directly available in the network menu:

Figure 4

Network menu

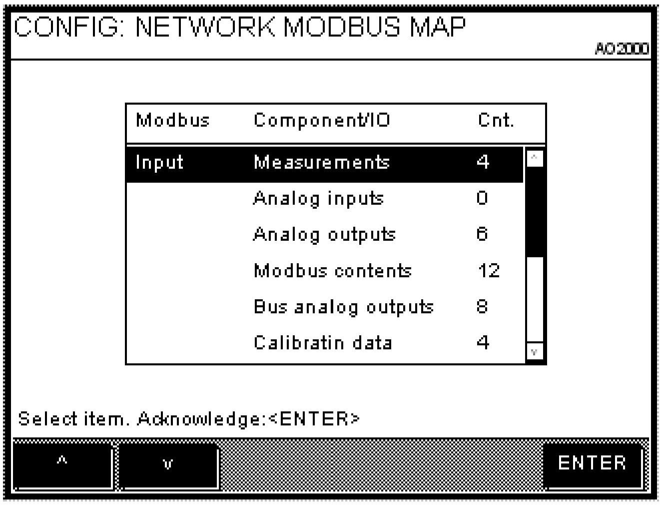


Continued on next page

In both cases, the sub-menu for displaying the Modbus registers is called by pressing the ENTER key.

Figure 5

Sub-menu for displaying the Modbus registers

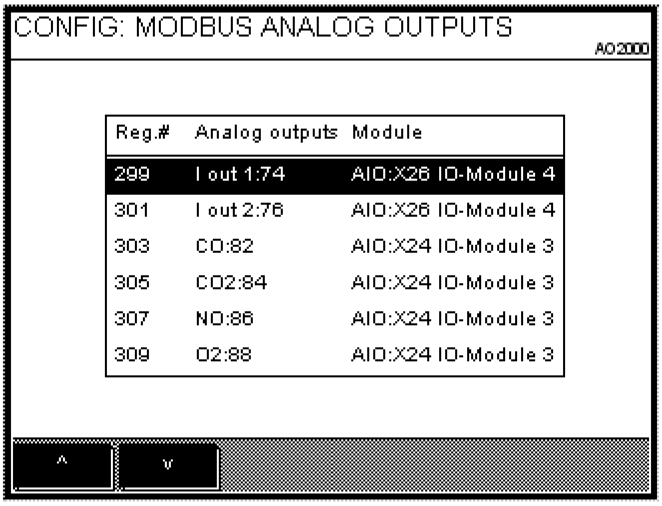


This general menu is subdivided into the Modbus main register groups:
- Input register (input)
- Status
- Holding register (holding)
- Coils

The AO2000 elements associated with the respective group and their number are listed in the Modbus register groups. If the number is > 0, elements exist, and the respective menu can be called by pressing the ENTER key (see the following example).

Figure 6

Example: Modbus analog outputs



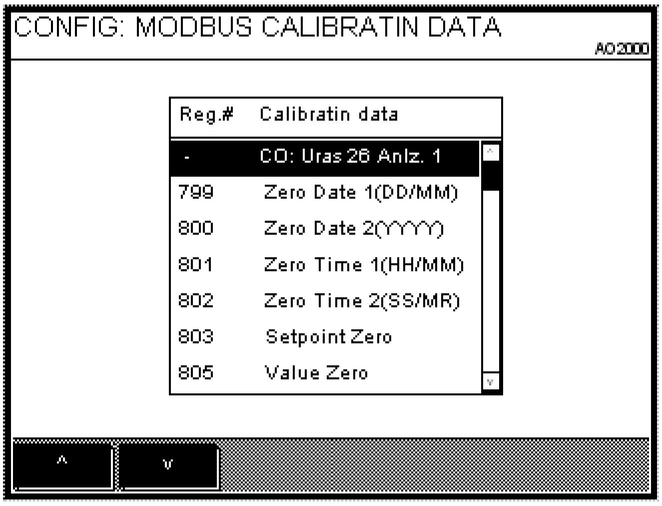
The following are displayed:
- The Modbus register number
- The name of the AO2000 function block with number
- The name of the I/O module

Continued on next page

An overview line with the component name followed by the parameters associated with this component are shown in the calibration data display:

Figure 7

Example: Calibration data



Action required to generate or delete components

If the generation or deletion of sample components has been provided for in the configuration of a measuring detector (currently only in Fidas24), this results in a change to the analyzer configuration and therefore also in a change in the number and registers of the measured values. A generated component is added to the components of the associated detector. All the other components are consequently shifted.

Modbus address assignment (software version < 5.1)

Assigning input and output signals to Modbus addresses

The assignment of input and output signals to Modbus addresses depends on
- the number of input and output signals available on the I/O modules and I/O boards in the gas analyzer and
- the sequence in which the I/O modules and I/O boards have been registered in the gas analyzer.

All existing inputs and outputs are mapped to the Modbus irrespective of their assignment to signals.

Note: The Modbus address assignment does not depend on the slot on which the I/O modules and I/O boards are installed.

Procedure

In principle proceed as follows to assign input and output signals to Modbus addresses for software versions < 5.1:

Step	Action
1	Determine the sequence of the I/O modules and I/O boards.
2	Determine the respective numbers of the input and output signals.
3	Assign input and output signals to Modbus addresses.

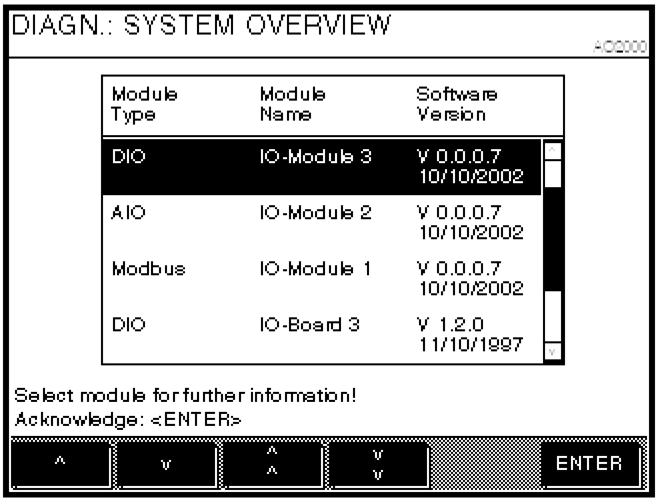
Step 1: Determine the sequence of the I/O modules and I/O boards.

Use the system overview menu item to determine the sequence in which the I/O modules and I/O boards have been registered in the gas analyzer (see Fig. 8).

Menu path: `MENU` → `Diagnostic/Information` → `System overview`

Figure 8

System overview (Example)



Continued on next page

Modbus address assignment (software version < 5.1), *continued*

Step 2:
Determine the numbers of the input and output signals

The numbers of the input and output signals can be obtained from the digital and analog input and output function block lists.

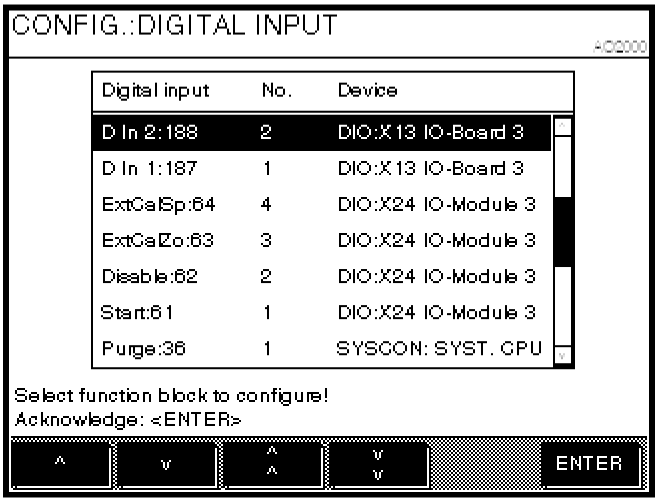
Menu path (example, see also Fig. 2): **`MENU`** → **`Configure`** → **`Function blocks`** → **`Inputs`** → **`Digital input`**

The inputs and outputs are listed in the registration sequence from the bottom up. Enumerate the list accordingly from the bottom up to determine the number of an input or output signal.

In the example shown in Fig. 9, digital input 2 on digital I/O board 3 has the consecutive number 7.

Figure 9

Digital input function blocks (example)



Step 3:
Assign input and output signals to Modbus addresses

Assign the number determined in step 2 to a Modbus address in that Modbus address list which corresponds to the input or output signal type. Enumerate this list top down to determine the address.

In the digital input address list (see page 13), Modbus address 10022 is assigned to number 7 determined in the above example.

Connection via the RS232 interface

Connecting

Connect the Modbus master to the RS232 interface of the gas analyzer. This connection only provides a point to point access (e.g. AO2000 and a PC, see Fig. 10).

Figure 10

Connection via the RS232 interface

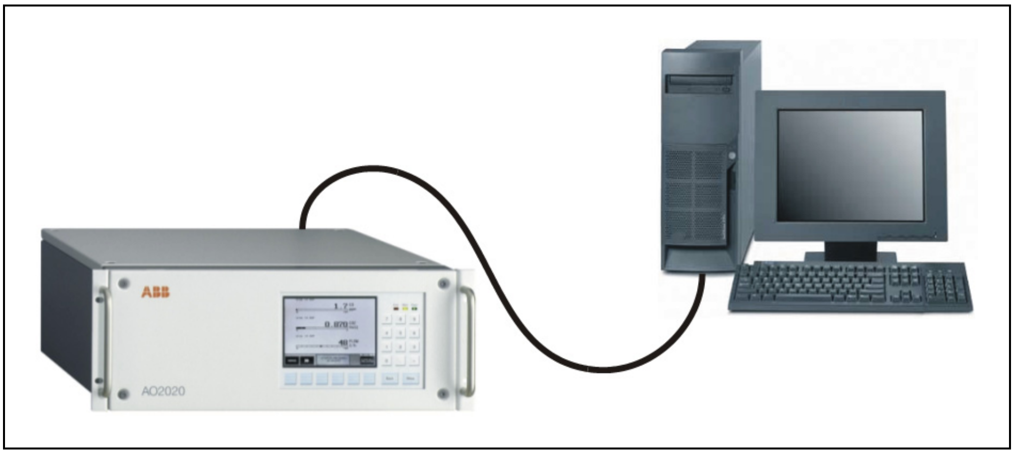
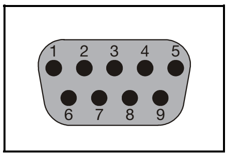


Figure 11

Pin configuration of the AO2000 RS232 interface



2 RxD
3 TxD
5 GND

Type: 9-pin male Sub-D connector

Materials needed

A cable with two 9-pin female Sub-D connectors, pins 2 and 3 twisted pair, is needed for connecting.

Connection via the RS485 interface

Connecting

In a network up to 32 gas analyzers may be connected to a PC via the RS485 interface.

The network uses a bus topology which needs to be terminated via a RC termination plugs (see Figure 12). This is also true for a point to point connection.

Figure 12

Connection via the RS485 interface

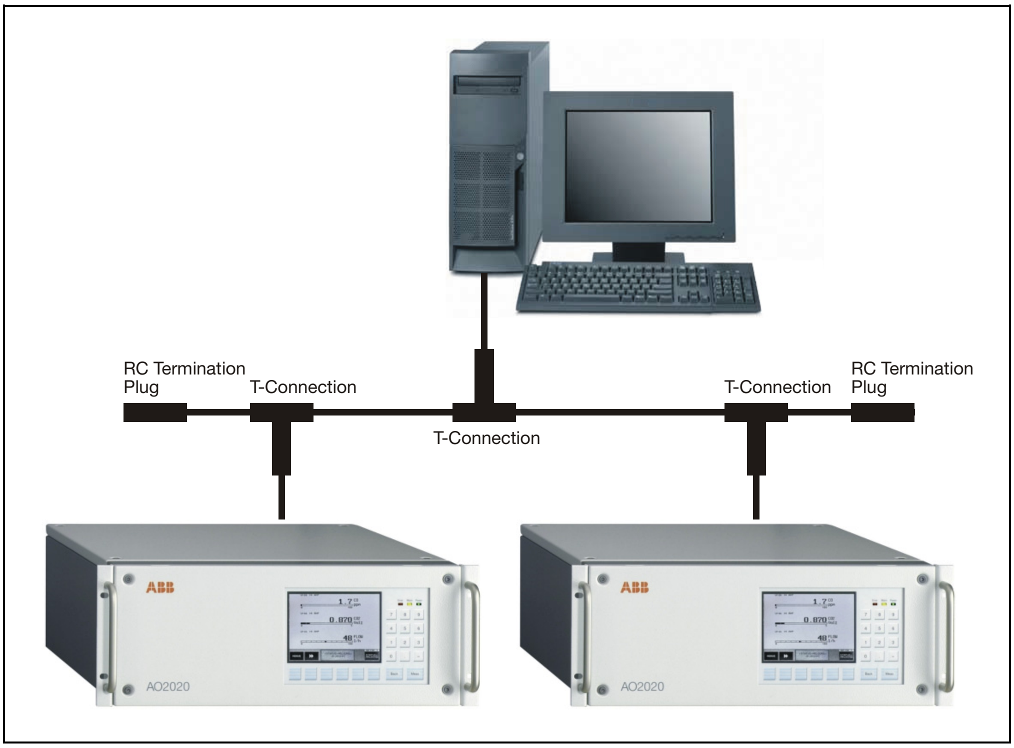
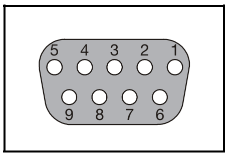


Figure 13

Pin configuration of the AO2000 RS485 interface



2 RTxD–
3 RTxD+
5 GND

Type: 9-pin female Sub-D connector

Materials needed

See Section “Components for RS485 Connection”, page 33.

Cable type

A three lines twisted pair cable e.g. Thomas & Betts Type LiYCY, 0.25 mm^2 is used for the Modbus connection. The max. cable length is limited to 1200 m.

Signal converter

If the PC has no RS485 interface, an RS232/RS485 signal converter must be linked between the PC and the Modbus network.

Continued on next page

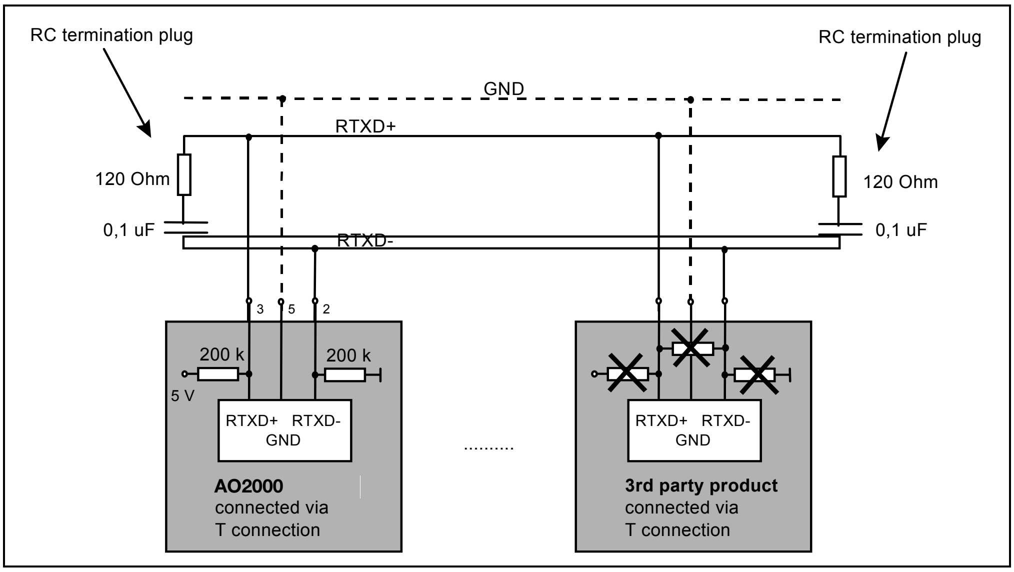
Technical details are depicted in Fig. 8. Note the input circuit of a Modbus slave.

Any internal termination need to be disconnected. AC termination is only allowed at the cable ends using the RC termination plugs.

You can also use other cables and connectors as long as they correspond to the specifications in Fig. 14.

Figure 14

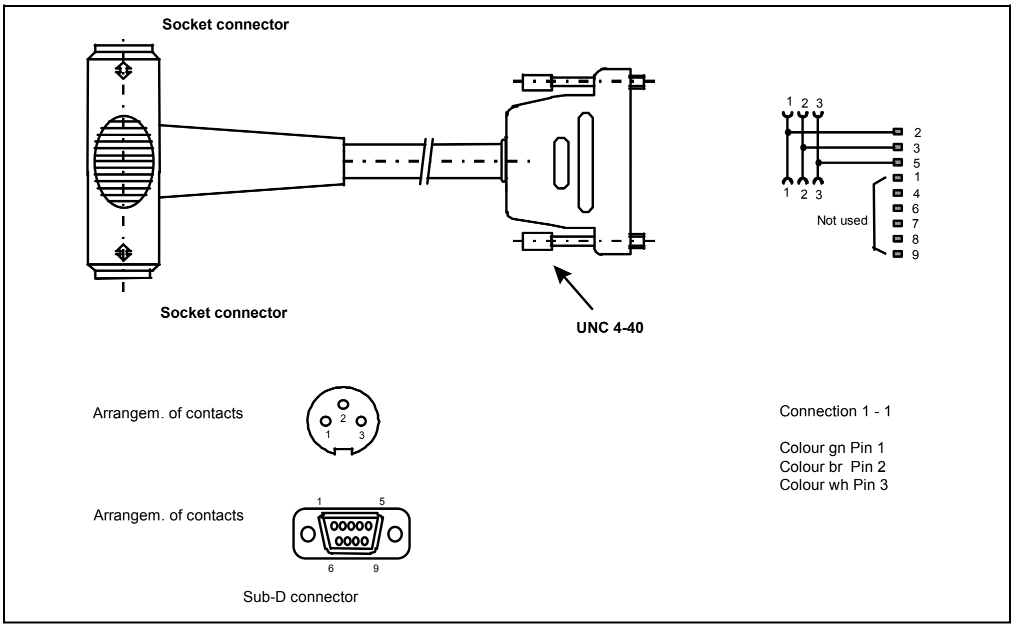
Cable ends with RC termination plugs



Components for RS485 connection

Figure 15

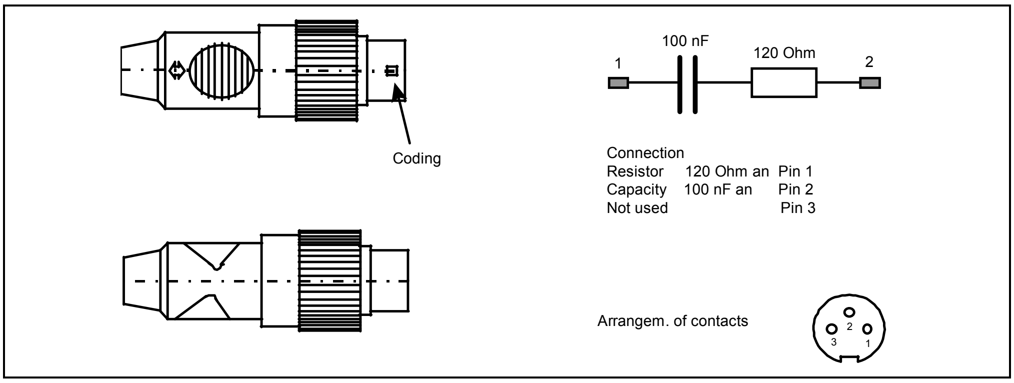
T connection



Catalog No. 24009-4-0746617

Figure 16

RC termination plug



Catalog No. 24009-4-0746616

Continued on next page

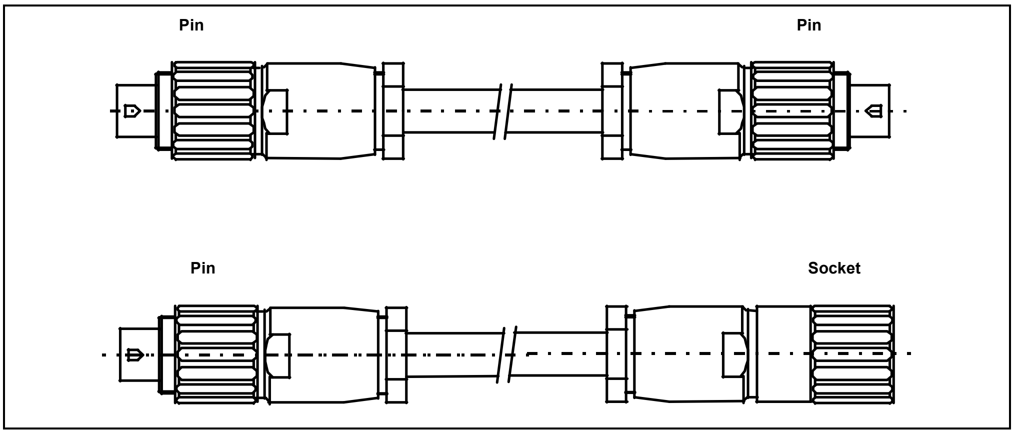
Modbus connections with user defined cable length

When using this type of cable one has to specify the desired length. Furthermore the connectors and the cable come as a set that need to be assembled. Two types of cables can be assembled.

- connection between two T-connections (pin connectors at each end)
- extension cord (pin and socket connector)

Figure 17

Variable connections



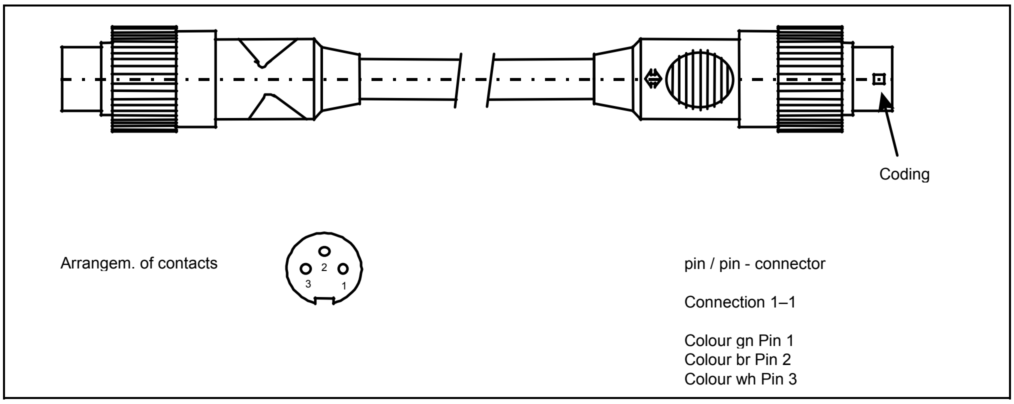
	Catalog No.
Cable with variable length	24009-4-0746622
Pin connector	24009-4-0746318
Socket connector	24009-4-0746471

Cables with predefined length

This option allows ordering cables of three different lengths. The cable can be used to connect two T-connections.

Figure 18

Cables with predefined length



Length	Catalog No.
1,0 m	24009-4-0746619
2,0 m	24009-4-0746620
5,0 m	24009-4-0746621

Chapter 4 AO-MDDE server and demo programs

Description

Application

The AO-MDDE server is an effective and easy-to-use tool for integrating AO2000 signals into standard software through the RS232 or the RS485 interface (AO-MDDE does not support Modbus over TCP/IP). Measured values, status signals and the signals of the analog and digital inputs and outputs can be easily integrated e.g. in Microsoft Excel or Microsoft Visual Basic and visualized.

AO-MDDE can be downloaded from the CD-ROM which is delivered together with each gas analyzer.

Program files

OPTIMDDE.EXE	DDE server
OPTIMDDE.HLP	Help file for DDE server
AODEF.DDB	Device description for AO2000 from SW Version 3.0
AODEF_KOMP20.DDB	Device description for AO2000 from SW Version 3.0 for integration into existing Modbus applications for Advance Optima with SW Versions ≤ 2.0
AODEF_FULL.DDB	Device file with all possible Modbus data (not executable with DDE server, since the size of the device file is restricted)
AODEFQAL3.DDB	Device file with QAL3 structures (without bus I/Os, since the size of the device file is restricted in the DDE server)
AOMDDEMO.EXE	Demo program based on LabVIEW
AO-DDESE.XLS	Demo program based on Excel
LVWUTIL32.DLL	Program file for LabVIEW demo program

Both demo programs are intended to show by example how AO2000 can be linked to standard PC programs. Neither the transfer nor the storage of data can be regarded as fail-safe. Modbus knowledge is not necessary for demo program operation. Demo programs do not support Modbus over TCP/IP. ABB offers no support for the demo programs.

Continued on next page

Description, *continued*

Transferred data	Read	Write	Example
Measurement values	x	–	CO, NO, H_2, etc.
Analog inputs	x	–	Indication of mA-values of external analyzers
Analog outputs	x	–	Indication of mA-values of measurement values or calculated values (function block application)
Digital inputs	x	–	Indication of external status signals
Digital outputs	x	–	Measurement range feedback, indication of solenoid or pump controls
Bus analog inputs	x	x	Entering analog values into the function block application
Bus analog outputs	x	–	Outputting analog values from the function block application
Bus digital inputs	x	x	Control of functions such as auto calibration, measuring range control, etc. after function block configuration
Bus digital outputs	x	–	Indication of all functions integrated by function block configuration such as alarm signaling etc.
Modbus configuration	x	–	Indication how many components, AOs, DOs, etc. have been configured or are in the gas analyzer
Status signals	x	–	Indication of failure, maintenance mode, maintenance request
Qal3 calibration data	x	–	Setpoints and actual values, measuring range and date of last calibration (not available in analyzer modules Limas11, Uras14, Magnos16, Magnos106, Caldos15, Caldos17, and MultiFID14)

Installation

Installing AO-MDDE

Step	Action
1	Insert the CD-ROM with the AO-MDDE program.
2	Run the “AO_MDDEE.EXE” file.
3	Follow the instructions of the installation program. Accept the recommendation of the installation program for the name of the folder in which AO-MDDE shall be installed.

AO-MDDE start

Start the AO-MDDE server in the Start menu or by running the program OPTIMDDE.EXE. Please refer to the integrated help function for further information about AO-MDDE.

Check that the bus transfer rates on the gas analyzer and the PC are identical.

Open the device description AODEF.DDB or AODEF_KOMP20.DDB and select the desired variables (see Figure 19). After this the data are transferred (see Figure 20).

Figure 19

Selection of variables (example)

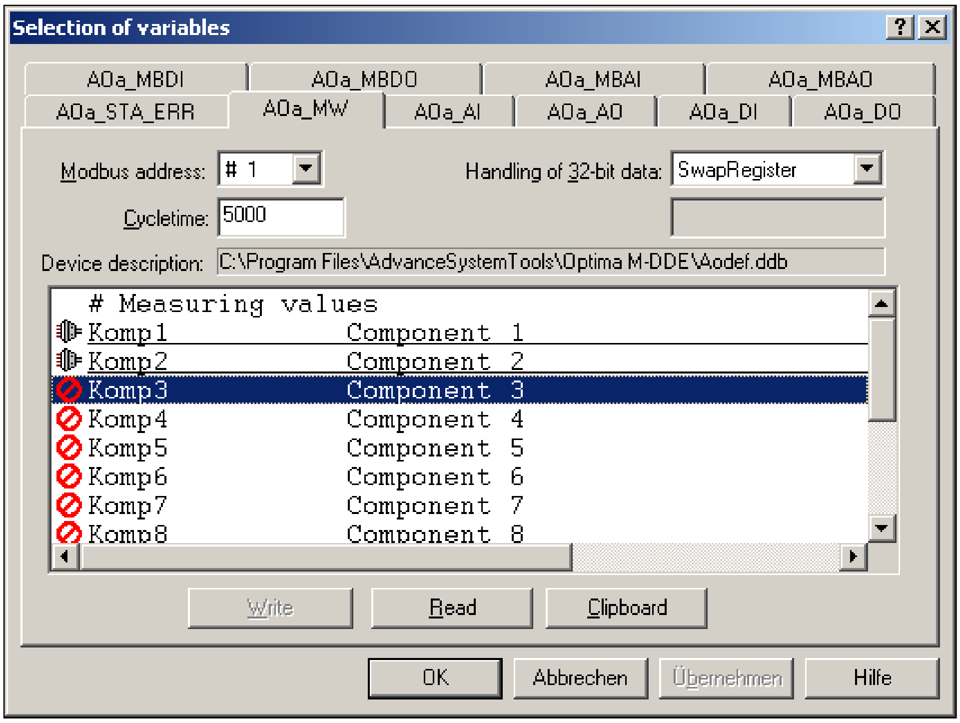
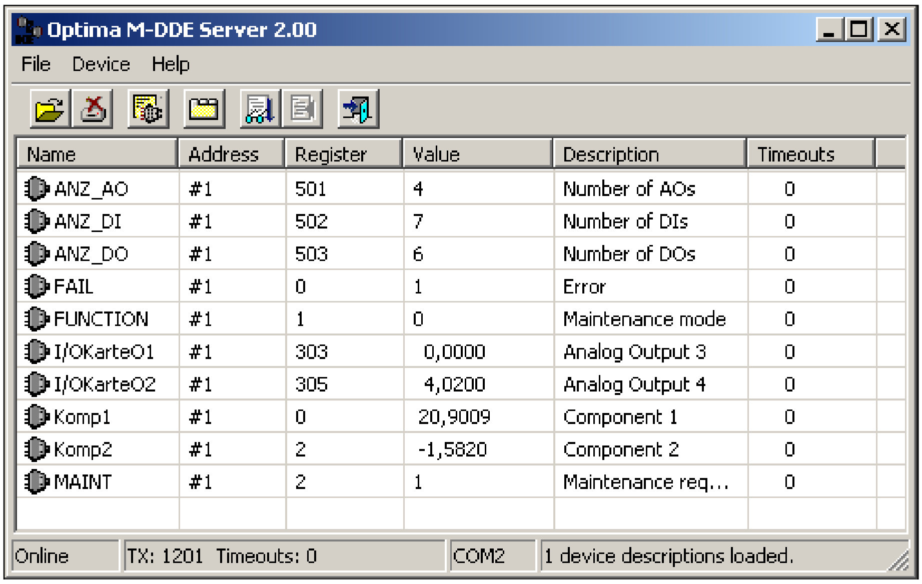


Figure 20

Device description (example)



LabVIEW demo program

Application

The LabVIEW demo program presents a possible digital and trend display for data visualization.

LabVIEW demo program start

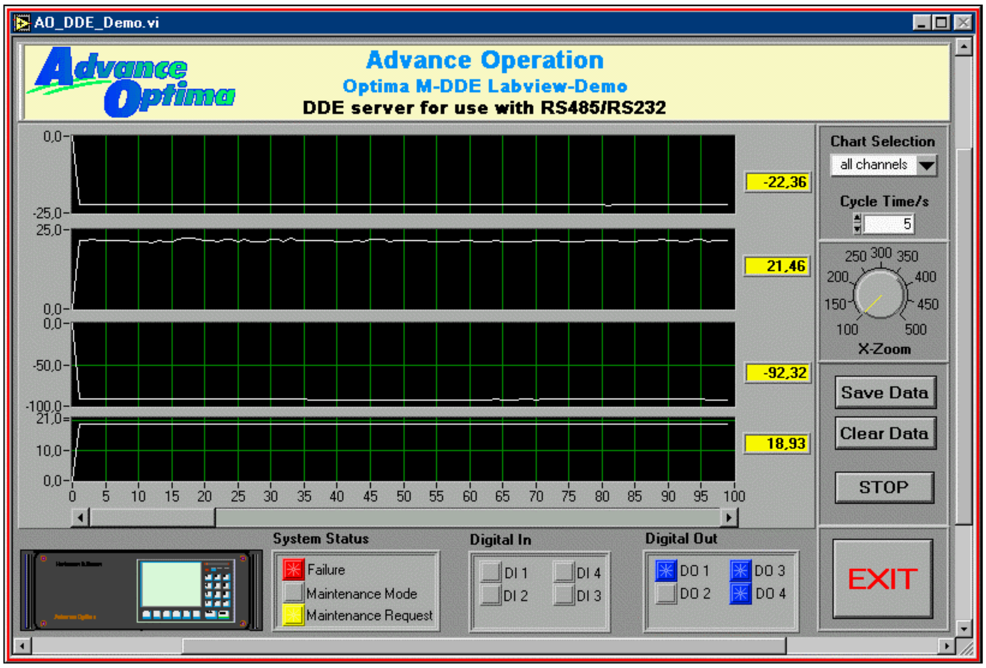
Start the demo program in the Start menu or by opening the file AOMDDEMO.EXE on your PC. The AO-MDDE server is started automatically by the demo program.

Basic settings in AO-MDDE server

- In the “File → Open device description…” menu: Open the device description file.
- In the “Device → Communication parameters…” menu: Deactivate the function “Bundle couple of registers” on the “Protocol” tab.

Figure 21

LabVIEW demo program (example)



Excel demo program

Excel demo program start

Start the demo program in the Start menu or by opening the file AO-DDESE.XLS on your PC. The AO-MDDE server is started automatically by the demo program.

Basic settings in AO-MDDE server

- In the “File → Open device description…” menu: Open the device description file.
- In the “Device → Communication parameters…” menu: Deactivate the function “Bundle couple of registers” on the “Protocol” tab.

Figure 22

Excel demo program (example)

Integration of information

The integration of information into standard software such as Microsoft Excel is straightforward: Select the required data field in AO-MDDE (see Fig. 19), copy it to the clipboard, select the required program, paste – and the data should appear and be ready for further processing. Please refer to the integrated help function for further information about AO-MDDE.

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