CONNECT INTERFACE

Interface electronics assembly for smartGAS sensors

Connection and operating manual

Edition 1.0

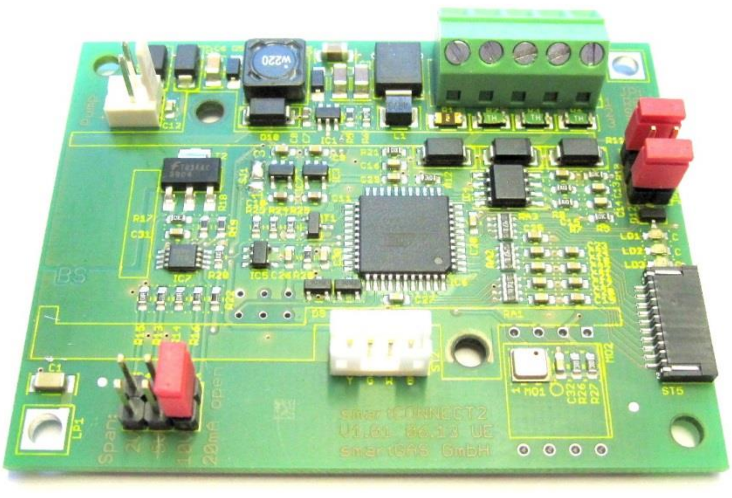


Table of contents

List of abbreviations

Abbreviations/symbols	Description
'D'	ASCII characters
0x5B	0x has no numerical significance. It merely indicates that the notation behind it - 5B - should be considered a hexadecimal character. In this example, the value is equal to the decimal number 91
124	Notation of a number in the decimal system
AC	Alternating current
DC	Direct current
FS	Full scale (measurement range end value)
Hex	Abbreviation for the hexadecimal character system
IR	Infra-red
JP	Jumper
kbps	Kilobit per second – data transmission rate
l	Litre (1l =1000cm^3) – volume unit
m	Meter – unit of length
mA	Milliampere – amperage in A x10^{-3}
mbar	Millibar – unit of pressure in bar x10^{-3}
MBE	Measurement range end value
min	Minute – unit of time
mm^2	Square millimetre – conductor cross section value in (m x10^{-3})^2
Ms	Milliseconds – unit of time in s x10^{-3}
mV	Millivolt – voltage in V x10^{-3}
OEM	Original Equipment Manufacturer
ppm	Parts per million - volume unit
sec	Second – unit of time
ST	Connector
UEG	Lower explosion limit
V	Volt – voltage

1. General

The CONNECT INTERFACE is an improved version of our proven smartCONNECT electronics assembly.
As well as the well known features, they offer you many further advantages and improvements:

- reworked voltage output with freely selectable 0-2V, 0-5V or 0-10VDC signal output
- improved current interface, NAMUR NE 43 conformity (option) *
- optical display of the sensor states by LEDs (green, yellow, red)
- Simplified calibration (including setting of the sensor zero point via jumpers)
- Integrated pressure compensation (ambient or optional internal cell pressure, 800 – 1150 mbar)
- Operation by short-stroke keyboard possible (option)
- Connection option for micro pumps (6V DC/max. 200mA)

The CONNECT INTERFACE has identical dimensions and is interface-compatible with the previous smartCONNECT electronics assembly. This means that the numerous improvements in existing systems can be used without any problem and without the need for extensive redesign.

** Namur NE 43 is an industrial standard for standardized signal levels as failure information for digital transducers with an analogue output signal, see also chap. 2.2.1.*

Intended use:

The CONNECT INTERFACE assembly is only intended for use in accordance with your specification in conjunction with a smartGAS sensor module. It is not suitable for any other measurement or testing purposes, and must not be used in any other way.
The CONNECT INTERFACE assembly must not be operated in potentially explosive environments or under harsh conditions (e.g. high, condensing humidity, heavy air flow, in aggressive atmospheres, or outdoors without a housing)!
When mounting and handling the CONNECT INTERFACE as well as the sensors used, the usual ESD protection measures for electronic assemblies should be observed and transportation may only take place in ESD-suitable packages or containers!
Please contact our Service department if you have any questions concerning the above-mentioned issues.

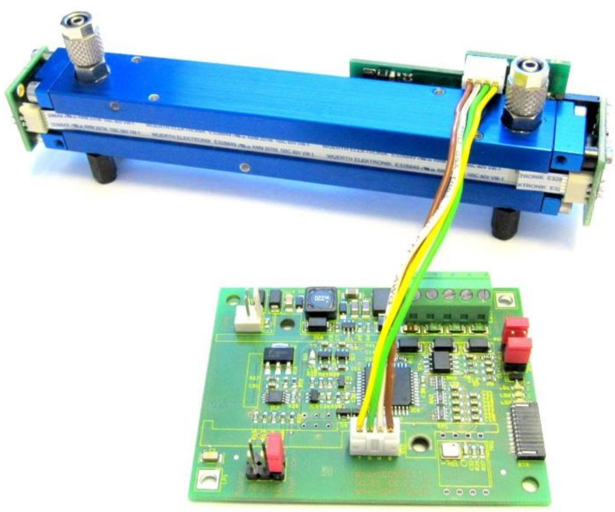
Warranty / liability / disclaimer:

Opening of sensors, manipulation or damage to devices and circuit boards as well as operations outside the specifications will invalidate the warranty!
The warranty may also be invalidated if aggressive chemicals are used, contamination occurs, visible damage results due to liquids/moisture or the instructions in this Description of Module and Communication are not observed!

The smartGAS Mikrosensorik GmbH shall not be liable for consequential loss, property damage or personal injury caused by improper handling or failure to observe the connection and operating manual.

1.1. Mounting and installation position of the gas sensor used

The smartGAS sensors allow for installation on the customer's devices in various installation positions. Since the calibration ex factory cannot cover every installation situation and ambient condition, the zero point needs to be checked after installation and if necessary recalibrated.
In any case we recommend a functional test of every device after final installation in the customer's application in the course of commissioning. ***Please also note the instructions regarding the installation and calibration in the manual of the smartGAS sensor used!***



CONNECT INTERFACE combined with smartGAS FLOW^{EVO} sensor

CONNECT INTERFACE combined with smartGAS BASIC^{EVO} sensor

2. Connections, interfaces

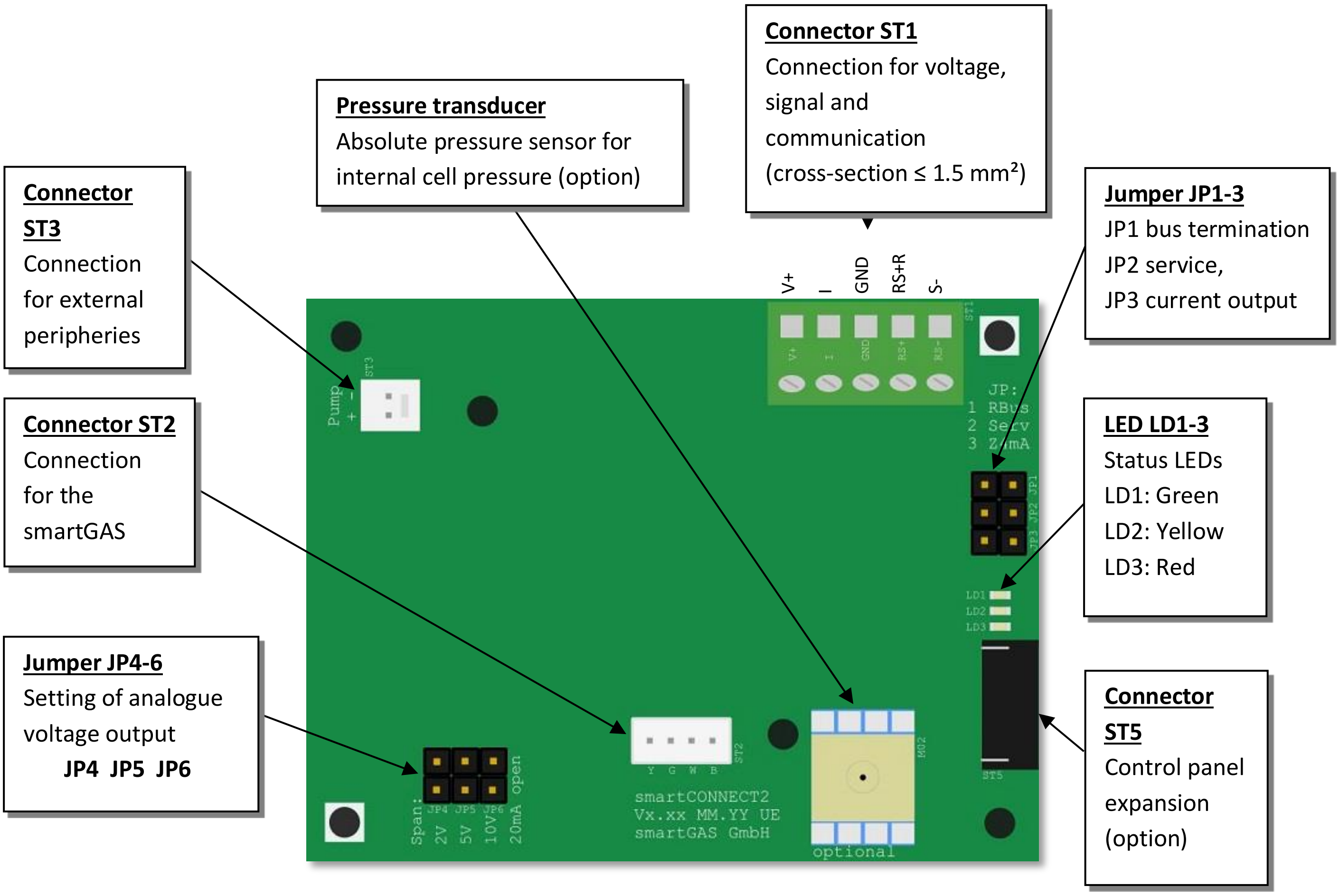


Figure 1: Connections of the CONNECT INTERFACE assembly

2.1. Operating voltage

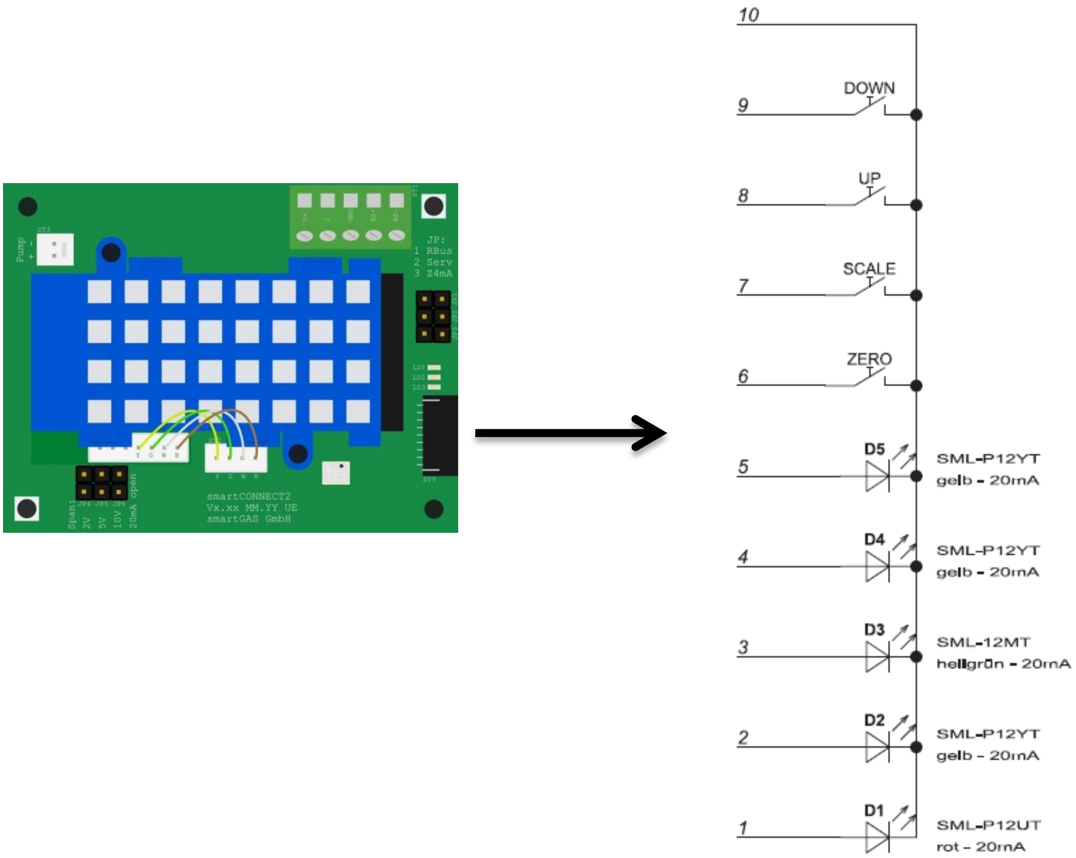
The CONNECT INTERFACE assembly is designed for operation with a supply voltage of 12 to 28V DC. Faultless functioning within these limits is guaranteed. Despite the internal voltage stabilisation function, the operating voltage must be kept as low as possible. In some cases, such as in plants where large loads are switched on and off, the relevant measures should therefore be taken. The supply voltage is connected to the plug connector ST1 (see figure 1).

Table 1: Operating voltage connection (ST1)

Designation	**Explanation**
V+	Supply voltage 12 - 28V DC
GND	Common ground for V+, I and RS485

2.1.1. Control panel expansion (option)

The CONNECT INTERFACE can be expanded with a control panel via the plug connector ST5 (Figure 1). The figure below shows how to connect the control panel:



The plug connector ST5 corresponds to a FFC/FPC socket (manufacturer's number: HFW10R-2STE1LF).

Please contact our customer service if you have any questions concerning the control panel expansion option!

2.2. Analogue outputs

2.2.1. Current output

The analogue current interface of the CONNECT INTERFACE offers two setting options for evaluating the measurement:

Current signal within the 0 to 20 mA range, linear with respect to the measurement or

current signal within the 4 to 20 mA range, linear with respect to the measurement, output signal according to Namur NE 43
(This option enables an open circuit or sensor failure to be detected)

Table 2: Setting at the current output

JP3	Explanation
Not connected	Current output 0 to 20 mA
Connected	Current output 4 to 20 mA

Note: If jumpers (JP4, JP5, JP6) are additionally used, a voltage signal can be generated from the current signal. More details in sub-para. 2.2.2.

Caution: None of jumpers JP4 to JP6 must be connected for the current output!
Caution: It is possible to switch between the modes via jumper only in a de-energised state (voltage supply isolated).

When using the analogue signal of 0 or 4 to 20 mA, the CONNECT INTERFACE can be regarded as a 3-conductor transmitter. Consequently, the line can be run as shown in Figure 2. Power can be directly fed via the evaluation unit (shown here as the controller), but steps must be taken to ensure that sufficient power is available. Otherwise, an additional power supply is required.

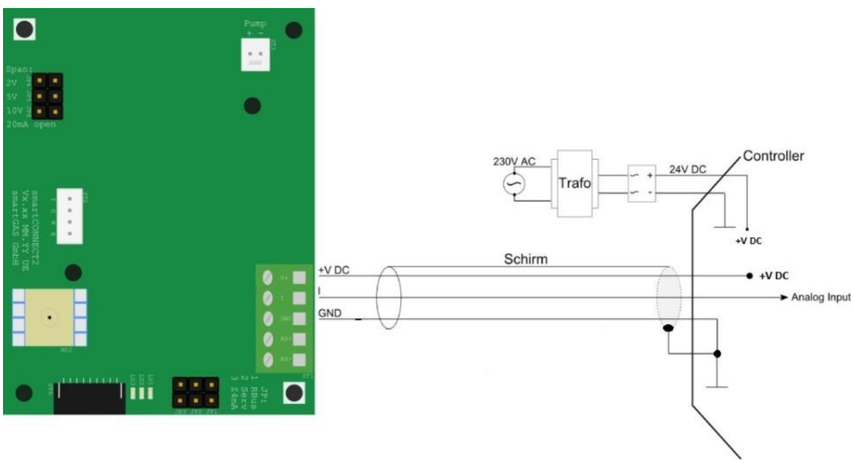


Figure 2: Current loop with 3-conductor connection

Table 3: Current output connection (ST1)

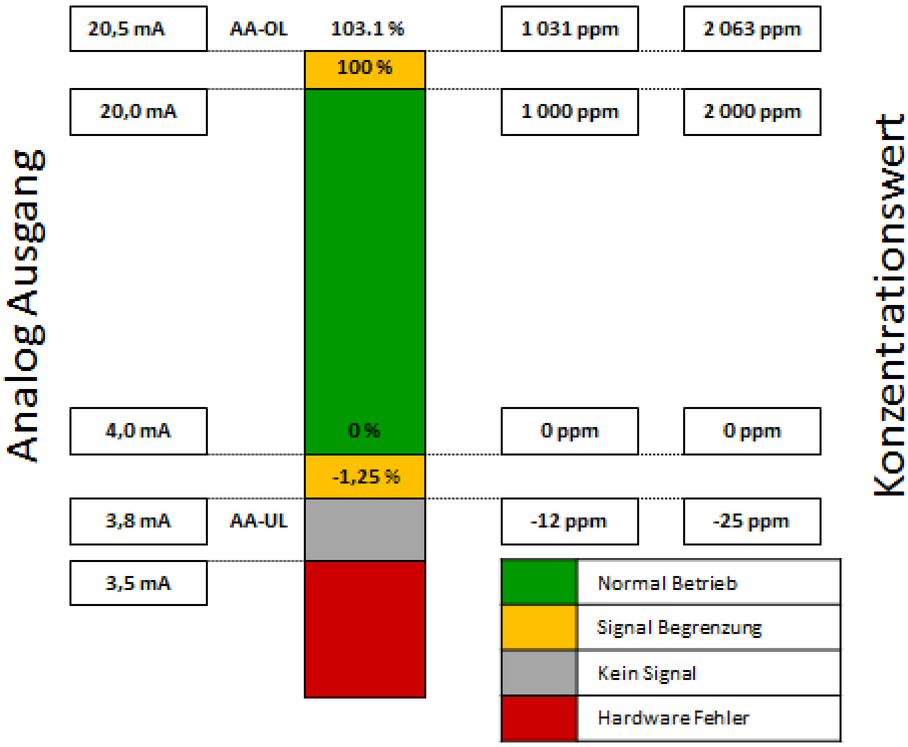
Designation	Explanation
I	Analogue output 0(4) – 20mA

GND	Common ground for V+, I and RS485

Output signals of the 4-20mA current interface according to Namur NE 43*

(here using the example of sensors with 1000ppm or 2000ppm measurement range end value)

AA-OL Analogue output upper limit
AA-UL Analogue output lower limit



* *NAMUR* is an international association linking users of automation technology within the process industry.
** Namur NE 43 is a standard for standardized signal levels as failure information for digital transducers with an analogue output signal.*
Further information at **www.namur.net**

2.2.2. Voltage outputs

In certain applications, it is necessary to convert the output signals from the sensor to a linear voltage signal. This requires the relevant jumper (JP4-6) to be connected.

Note: The voltage signal may vary from the ideal value depending on the current load (observe Ri)!

The following modes can be set, depending on the operating mode selected:

Caution: Only one of the following jumpers can be connected at a time!

0..2V → JP4 connected (Ri= 110Ω)

0..5 V → JP5 connected (Ri= 260Ω)

0..10 V → JP6 connected (Ri= 510Ω)

The configuration described above permits the following voltage values to be generated at the output:

Table 4: Possible analogue output configurations

	0-20mA (without JP3)	**4-20mA (with JP3)**
2 V (JP4)	0 V – 2 V	0.4 V – 2 V
5 V (JP5)	0 V – 5 V	1.0 V – 5 V
10V (JP6)	0V – 10V	2.0V – 10V

Table 5: Voltage output connection (ST1)

Designation	**Explanation**
I	Analogue output voltage (with JP 4/5/6)
GND	Common ground for V+, I and RS485

2.2.3. Open circuit

If communication between the sensor and evaluation unit is ever interrupted while a CONNECT INTERFACE is operating (unintentional disconnection or open circuit), this situation is indicated as follows at the voltage output:

Operation at 0-20 mA → Output current indicates 0 mA
Operation at 4-20 mA → Output current is frozen (typically) at 3.5 mA

Depending on the operating mode and the downstream evaluation unit, such a state can then be used for fault detection purposes. Once the defect has been remedied, the system has to be restarted.

Note: An open circuit can be accurately detected only in the 4 to 20 mA mode!

2.3. MODBUS digital output

2.3.1. RS485 mode

The CONNECT INTERFACE has an RS485 interface in 2-conductor mode (half-duplex) as a standard feature. Data transmission is serial and occurs via a symmetrical signal on the RS+ and RS- lines. The reference signal is GND.

Table 6: MODBUS interface connection (ST1)

Designation	Explanation
RS+	Non-inverted data line
RS-	Inverted data line
GND	Common ground for V+, I and RS485 (Reference signal)

The connection is established via the 5-pin plug ST1 (see Figure 1).

The RS485 interface facilitates single master/multiple slave mode, with the CONNECT INTERFACE acting as the slave. A PC or alternative evaluation unit (e.g. microcontroller, PLC...) can be used as the master.

To ensure trouble-free operation, we recommend that you choose a central power supply from the controller using shielded lines. Use a central ground point for the shield and ground line if possible.
If the users do not have the same null potential (the same ground), large potential differences can occur. Then, the RS 485 interface should be attached via optocouplers.

2.3.2. Termination

From a line length of > 30 m, it is advisable to use a terminating resistor to prevent reflections on the bus.
The resistors can be connected via jumper JP1.
The termination should occur only on the device at the end of the line.

1. JP1 not connected ⇔ No terminating resistor is connected (condition as supplied)
2. JP1 connected ⇔ Terminating resistor is connected

Note: The cable used for the wiring should be shielded and twisted (twisted pair cable).

2.4. Supply to external peripherals

The CONNECT INTERFACE provides 6 V with max. 200 mA at the output of ST3 for supplying system expansions (e.g. gas delivery pumps).

Table 7: Pin configuration ST3

Designation	Explanation
+	6V DC / 200 mA
-	GND

This interface can be accessed via the 2-pole connector (ST3 – see Figure 1).
Note: This voltage is not secured!

Further information on suitable gas delivery pumps can be obtained from our customer service on request.

2.5. Jumperfunctions

Table 8 summarises the different jumper functions of the CONNECT INTERFACE:

Table 8: Jumper

Jumper	Explanation and function
JP1	Terminating resistor for the digital communication via RS485. Further information in chapter 2.3.2.
JP2	Service jumper Further information in chapter 5.
JP3	Current output from 0 mA or 4 mA to 20 mA. Further information in chapter 2.2.1.
JP4	Generates a voltage output from 0 V or 0.4 V to 2 V. Further information in chapter 2.2.2.
JP5	Generates a voltage output from 0 V or 1 V to 5 V. Further information in chapter 2.2.2.
JP6	Generates a voltage output from 0 V or 2 V to 10 V. Further information in chapter 2.2.2.

2.6. Status LEDs

The CONNECT INTERFACE is equipped with three status LEDs (Position of the LEDs: see Figure 1)

Green LED O	Yellow LED O	Red LED O	Device status
on	off	off	Normal operation
Flashes	---	---	Initialisation/start phase
---	on/flashes	---	See notes in chap. 5
---	---	Flashes	Degraded mode
---	---	on	Hardware error (service necessary)

Normal operation
In normal operation, only the green LED lights up. The system is working error-free within its measurement range limits.

Degraded mode
A degraded mode (red LED flashing) exists if the concentration measuring range of the sensor has been exceeded or fallen short of to such an extent that a measuring range violation must be assumed. This state is reversible.

Hardware error
An irreversible hardware error exists when the red LED lights up permanently. This always requires an on-site service. An analogue value is output to indicate an error (see chap. 2.2.1.) if possible.

You can find further LED functions in chapter 5 (Operation/Calibration)

2.7. Pressure compensation

2.7.1. Ambient pressure

To achieve the most flexible CONNECT INTERFACE design possible and to enable applications at different altitudes, consideration must be given to the real gas equation. Owing to the physical properties of gases, their density changes depending on height and, as a result, the absorption of IR radiation in the measuring cell. Without the pressure compensation function, this would lead to inaccuracies in the concentration measurement.

If the gas outlet is open to the atmosphere, the ambient pressure must be included in the concentration measurement. An ambient pressure sensor is therefore already integrated into the CONNECT2 board.
A pressure compensation takes place within the range of 800 – 1150 mbar. If this range is fallen short of or exceeded, a loss of accuracy is to be expected. (These values apply to the ambient pressure measurement and optional internal cell pressure measurement, chap. 2.7.2).

Note: Configuration or parameterisation by the user is not required; the required
correction factors of the gases to be measured are already integrated in the software of the CONNECT2.
Further information on this can be obtained from our customer service!

2.7.2. Internal cell pressure measurement

Since the internal cell pressure must be included in the concentration measurement in continuous flow mode[1] (when using a smartGAS FLOW^{EVO} sensor), there is an ex works (optional) version of the CONNECT2 board with a mounted absolute pressure transducer.
The hose is then connected as shown in figure 3.
If you have any questions regarding this design as well as the use of aggressive gases, please contact our support!

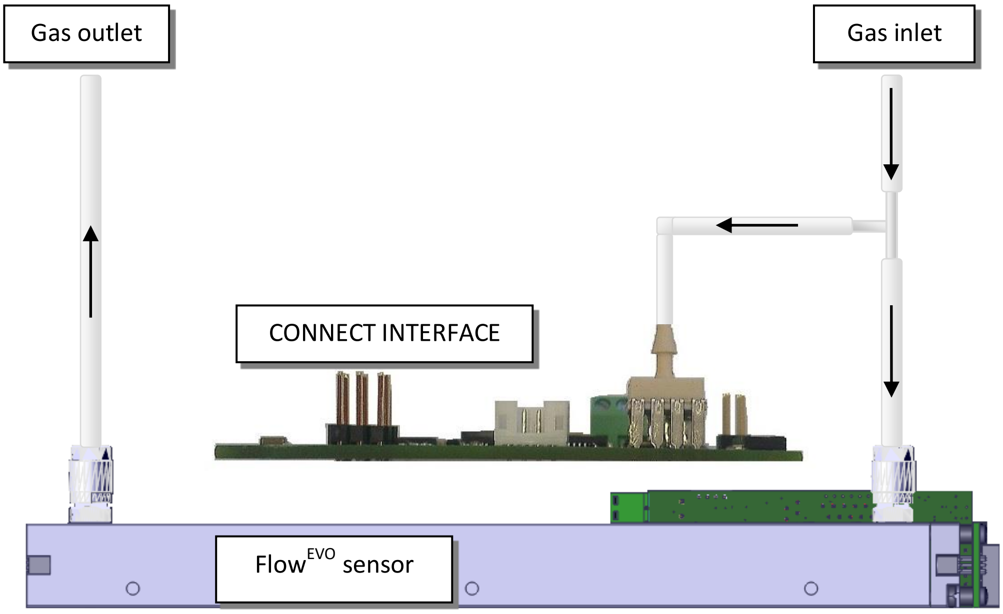


Figure 3: Hose connection of the (optional) pressure transducer for continuous flow mode

[1] Used for analysis measurement. The sample gas circulates in a closed system isolated from the environment.

3. Start-up

The CONNECT INTERFACE is connected and signals are output via connector ST1, see
Figure 1. To prevent errors and damage, the measuring system should be mounted and connected in the following order:

1. Ensure the system is de-energised.
2. Mount the CONNECT2 board in the desired position. Refer to Figure 4. The dimensions for the holes are shown here. At the same time, ensure that the screw heads are at a sufficient distance from components in order to prevent short-circuits or damage. Use spacer sleeves and plastic washers if necessary.
3. Connect supply voltage lines to V+ and GND.
4. Connect signal line for the current or voltage output to I and GND.
5. Connect digital output (RS485) to RS+, RS- and GND. GND is the common ground for the supply voltage, the analogue signal and the digital signal.
6. Mount the sensor module in the desired position (please observe the instructions in the corresponding manual of the sensor).
7. Connect the smartGAS sensor to the CONNECT INTERFACE via ST2.
8. Switch on supply voltage. The flashing of the (green) LED LD1, now indicates the establishment of a data connection between the sensor and CONNECT INTERFACE. This may take up to 2 minutes during the initial commissioning. Once data communication has been established between the sensor and CONNECT INTERFACE, the flashing of LD1 changes to a (green) continuous light, indicating that the system is now ready for operation. (If the red LED (LD3) permanently lights up after the 2 minutes have elapsed, this means that a data connection has not been established or the connected sensor has not been detected. This may be due to various reasons. In this case, please contact our Customer Service department).

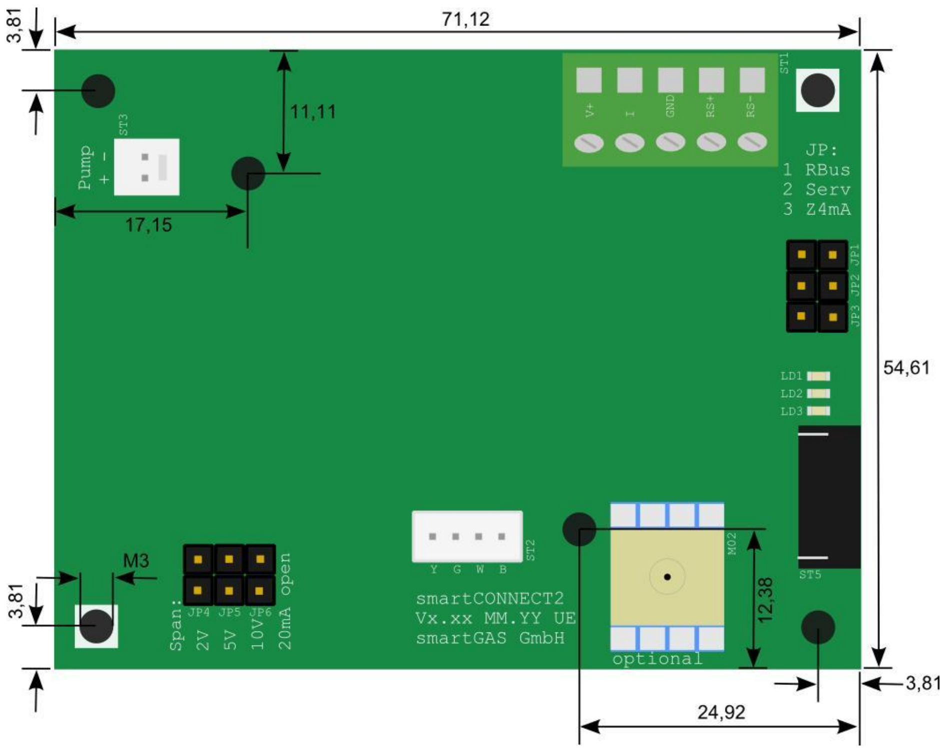


Figure 4: Connections and dimensions of the CONNECT INTERFACE board

Notes on wiring: The lines to be used must not have a cross-section of greater than 1.5 mm². Since screw terminals are used on connector ST1, ferrules must be fitted when connecting flexible lines.

You can find further information on connecting, installing and commissioning the different smartGAS sensors in the corresponding manual, which is included with the relevant sensor!

4. MODBUS communication

4.1. Operation with multiple slave subscribers

The RS485 data bus enables up to 32 subscribers to be integrated. The terminating resistors are used at the start and end of the data bus (JP1). The subscribers suspended between are guided on the terminated data bus by means of stubs or optimally by means of a "daisy chain" (series connection principle).

At a transmission rate of 2.4kbps (2400 baud), the total length of the data bus, including stubs, must be limited to 500 m. Basically, the higher the transmission rate, the smaller the total length of the stubs.
The baud rate is determined by the slowest respective subscriber and is the same for all subscribers.

Table 9: Example - Data bus with multiple subscribers

Subscriber position	Designation	Address	Baud rate	Role	Termination
1	CONNECT INTERFACE	22	2.4 kbps	Slave	Yes
2	Computer	-	2.4 kbps	Master	No
3	Temperature sensor	11	2.4 kbps	Slave	No
4	Pressure sensor	117	2.4 kbps	Slave	Yes

As Table 9 shows, the address assigned to the subscribers does not depend on their position in the topology. Since the MODBUS protocol is used, the master does not need an address. Only the slaves have to be clearly addressed. (You can find instructions regarding address settings on page 27).

The CONNECT INTERFACE is equipped with an autonomous baud rate detection function. This means that the CONNECT INTERFACE automatically detects the used framing as well as the MODBUS dialect. The framings listed in table 11 and the MODBUS baud rates harmonise with each another and can be freely combined among each other.

Table 11: Framing formats and MODBUS baud rates

Framing formats	Baud rates
7E1	2400 Bd
7E2	4800 Bd
7O1	9600 Bd
7O2	9200 Bd
7N2	38400 Bd
8E1	57600 Bd
8N1	115200 Bd
8N2	
8O1	

Table 11: The framing formats can be feely combined with the baud rates

Note: A framing format of 8 data bits must be used for the communication via MODBUS RTU. (You can find further information regarding framing formats in Chapter 4.6.).

4.2. Signal profiles

The signals are transmitted differentially at the RS485 interface. RS+ routes the signal unchanged, and RS- in its inverted form – see Figure 5. The data signal is evaluated via the difference between the two signals [RS+] - [RS-].

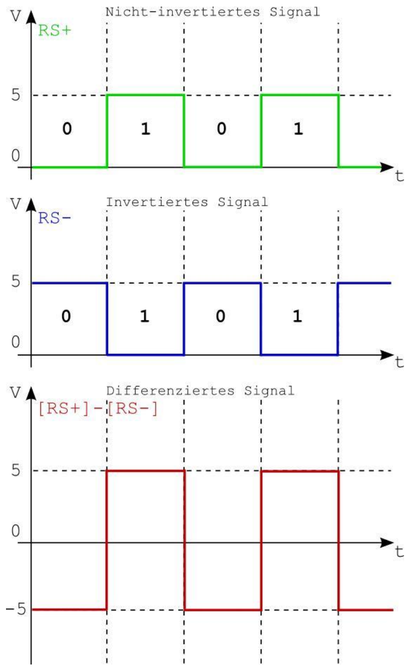


Figure 5: Signal transmission and evaluation on the RS485 data bus

Under load, RS485 transmitters provide a voltage difference of at least ± 2 V. The voltage difference can be smaller due to potential damping effects. The receivers are sensitive to ± 200 mV and are able to evaluate valid signals up to this value:

[RS+]-[RS-]	> 200 mV	→ Mark	→ logical "1"
[RS+]-[RS-]	< -200 mV	→ Space	→ logical "0"
[RS+]-[RS-]	< 200 mV		→ The data can be incorrectly interpreted.

4.3. Data exchange between master and CONNECT INTERFACE

Figure 6 shows a possible scenario between master and CONNECT INTERFACE.

Note: The following times refer to MODBUS ASCII and a baud rate of 2400 Bd.

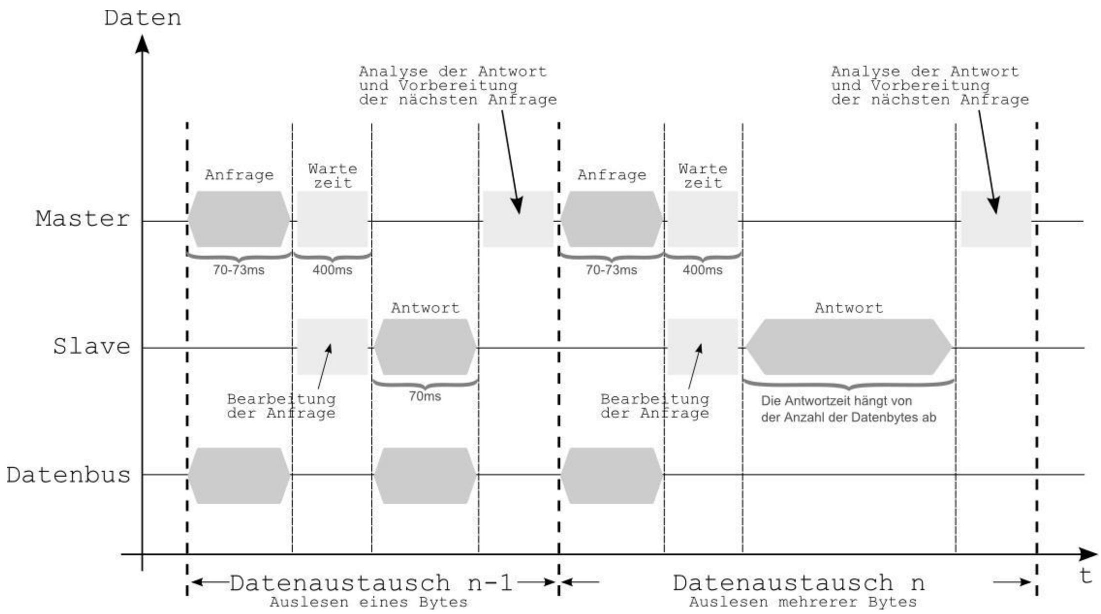


Figure 6: Time diagram – Data interchange between master and PREMIUM^{EVO}

The duration of a query string is 70–73 ms. A brief pause (max. 400 ms) may then follow. The module response then follows. This depends on the number of bytes being read out. If only one byte is read out, the module response is approx. 70 ms. When multiple bytes are being read out, the response phase is correspondingly longer.

Basically, it can be said that the CONNECT INTERFACE reacts to a query within 400ms. The character string is then sent immediately without a response pause.

Note: At higher baud rates (> 2400 Bd), significantly faster response times can be expected. This is also the case when using MODBUS RTU.

4.4. Communication via Modbus

The CONNECT INTERFACE supports the MODBUS protocol in ASCII as well as in RTU mode via its RS 485 interface. In ASCII mode, in addition to the standard variant, there is a smartGAS-specific derivative that differs from the standard in terms of the checksum calculation.

Modbus communication fundamentally functions based on a query/response mechanism. The master sends the query to one of possibly multiple slaves (subscribers). Each connected subscriber therefore receives a subscriber address that is unique in the network. Only the subscriber that has found its address in the query from the master will respond.

The type of query is determined by a control command (function code). This can, for example, be about writing data or reading data to/from the subscriber. Depending on the control command, there is a data portion for both the query and the response.

Each query and each response must be clearly identified by its beginning and by its end. The
use of a check field (=check word/CRC) is envisaged in the protocol to enable any possible communication errors to be detected. The Modbus derivatives implement this in different ways.

You can obtain detailed information about the Modbus protocol at www.modbus.org

4.5. Structure of Modbus data telegrams

The following two tables show the basic structure of an ASCII data telegram and a RTU data telegram. The tables show that the address, control command and data portion are based on the same source data for both telegram types:

Table 1: ASCII data telegram

Dialect	Start	Address	Control	Data	LRC	End
Modbus ASCII	1 characters ':'	2 characters e.g.:"A0"	2 characters e.g.:"03"	0 to 2x252 characters e.g.: "00050002"	2 characters e.g.:"A6"	2 characters CR,LF
Communi-cation:	0x3A	0x41, 0x30	0x30, 0x33	0x30,0x30,0x30,0x35 0x30,0x30,0x30,0x32	0x41, 0x36	0x0D, 0x0A

Table 2: RTU data telegram

Dialect	Start	Address	Control comm.	Data	CRC	End
Modbus RTU		1 byte e.g.:0xA0	1 byte e.g.:0x03	0 to 1x252 bytes e.g.:0x00,0x05, 0x00,0x02	2 bytes e.g.:0xA4, 0xD3	
Communi-cation:	Pause 3.5 characters	0xA0	0x03	0x00, 0x05, 0x00, 0x02	0xA4, 0xD3	Pause 3.5 characters

In ASCII mode, each 8-bit byte is therefore sent as two ASCII characters. One byte corresponds to two nibbles.
One nibble consists of 4 bits and represents precisely one hexadecimal character. As can be seen in the telegram examples, the result of the byte containing the information "0xA6" is the two ASCII characters "0x41" = 'A' and "0x36" = '6'.

In ASCII mode, 7 data bits are sufficient for transporting the characters via the interface. The ASCII mode has a historical advantage. All Modbus data telegrams can be "read" with a ASCII terminal; plain text appears on the screen.

In RTU mode, however, each 8-bit byte is handed over unchanged. This inevitably means that in RTU mode. UART frames with 8 data bits need to be used. The advantage of the RTU mode lies in the more effective utilisation of the interface because only around half of the data volume needs to be transmitted compared to the ASCII mode.

4.6. Structure of UART frames

A UART frame is structured as follows:

Start	N data bits	Parity	M stop

1 start bit (always 0), followed by
7 or 8 data bits, starting with the lowest-value bit,
1 parity bit (optional). If used, the parity bit can be even or odd,
1 or 2 stop bits (always 1).

The nomenclature for describing a UART frame consists of a number, followed by a letter and ending with a number. The first number denotes the number of data bits contained in the frame. The following letter describes the type of parity with N for none, E for even and O for odd. The last number indicates how many stop bits are being sent. The standard specification for Modbus RTU is **8E1**, and **7E1** for Modbus ASCII.

Examples:
8N1 means that 8 data bits are being used, there is no parity (N) and 1 stop bit is being used.
7E1 means that 7 data bits are being used, there is even parity (E) and 1 stop bit is being used.

Furthermore, when transporting a UART frame via the electrical cable, how “quickly” the transmission occurs is important. The term **baud rate** is a definition for this. The baud rate describes how many bits are transmitted per second. Standard baud rates are 2400, 4800, 9600, **19200** (Modbus standard), 38400, 57600 and 115200. All of these are fully supported by the CONNECT INTERFACE.

4.7. MODBUS control commands

Two command codes (function codes) are sufficient for communication with the CONNECT INTERFACE. These are 0x03 – Read (multiple) holding registers and 0x06 – Write (exactly one) register. One register is 16 bits wide and therefore consists of 2 bytes:

Register	
15 …	0
High order byte – Hi	Low order byte – Lo

All the sensor data that the user can access is shown on registers that are each 16 bits wide. The two control commands will now be explained using some examples.

Control command 0x03 – Read (multiple) holding registers

This control command allows you to read values from the smartGAS sensor. The main thing is that <u>only the registers described in the relevant sensor manuals</u> can be read. This must therefore be checked especially when queries are sent to multiple registers. (A register overview for a smartGAS FLOW^{EVO} sensor can be found on page 26).

Example 1 – Reading out the 4 registers for "Device Type" with a FLOW^{EVO} sensor:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	03	Control command	03	
Hi start address	00	Number of bytes	08	
Lo start address	80	Hi register value (128)	53	'S'
Number of Hi registers	00	Lo register value (128)	4D	'M'
Number of Lo registers	04	Hi register value (129)	46	'F'
		Lo register value (129)	43	'C'
		Hi register value (130)	4F	'O'
		Lo register value (130)	32	'2'
		Hi register value (131)	20	' ' = Empty characters
		Lo register value (131)	20	' ' = Empty characters

In this example, 4 registers of the FLOW^{EVO} sensor were read starting from register start address 0x0080 (decimal 128). The response consisted of a payload of 8 bytes. This was clearly a CO2 module. The 3 letters SMF mean that it is a FLOW sensor.

Example 2 – Reading out the “Concentration” register with a FLOW^{EVO} sensor:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	03	Control command	03	
Hi start address	00	Number of bytes	02	
Lo start address	0A	Hi register value (10)	01	Concentration is 456
Number of Hi registers	00	Lo register value (10)	C8	
Number of Lo registers	01			

In this example, (only) one register was read starting from register start address 0x000A (decimal 10). The two data bytes were transmitted combined as a hexadecimal value. If this value (0x01C8) is converted to a decimal number, the result is a concentration value of 456.

Example 3 – Reading out the “Unit” register:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	03	Control command	03	
Hi start address	00	Number of bytes	02	
Lo start address	4F	Hi register value (79)	00	3, means ppm x 1
Number of Hi registers	00	Lo register value (79)	03	
Number of Lo registers	01			

In this example, (only) one register was read starting from register start address 0x004F (decimal 79). The two data bytes were transmitted combined as a hexadecimal value. If this value (0x0003) is converted into a decimal number, the result is 3. This stands for the unit ppm with the scaling x 1. Combined with the data from examples 1 and 2, the FLOW^{EVO} sensor that was read has therefore measured a gas concentration of 456 ppm CO_2.

This subchapter explains the calculation of the checksum (LRC) specifically for the ASCII smartGAS operating mode. How the calculation of the LRC checksum in ASCII standard and CRC checksum in RTU functions is described thoroughly in the documents of the Modbus standard. It is helpful to have a conversion table for ASCII values in hexadecimal and decimal format as follows:

ASCII	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
Hex	30	31	32	33	34	35	36	37	38	39	41	42	43	44	45	46
Dec.	48	49	50	51	52	53	54	55	56	57	65	66	67	68	69	70

The checksum is calculated using the address, the control command and the associated data **after** the conversion to ASCII has occurred. By way of example, we generate a query for reading out the concentration register from the FLOW^{EVO} sensor with the address 35 (decimal).

Therefore, in hexadecimal format, the resulting byte string is **0x23, 0x03, 0x00, 0x0A, 0x00, 0x01.** After the ASCII conversion, the result is the data string **2303000A0001**. The data string is now converted and the checksum is formed:

	Address		Command		Start register				Number of registers				Sum
ASCII	2	3	0	3	0	0	0	A	0	0	0	1	---
	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Dec.	50	51	48	51	48	48	48	65	48	48	48	49	**602**

Sum = **602**
Checksum = 255 – 602 + 1 = - 346
Modulo sum (256) = - 346 + 256 + 256 = 166 (dec.) → **A6** (ASCII hex.)

Putting the starting character at the beginning and the calculated checksum and end code at the end would mean that the following data string would be sent:

:2303000A0001**A6**<CR><LF>

The checksum is included each time data is sent and is then recalculated by the recipient again. If the data set is corrupted or adulterated, the checksum calculated by the recipient would deviate from that which was sent. The data set would then be unusable.

Control command 0x06 – Write to (exactly one) register

This command enables a new value to be systematically written to an addressed register. However, it is only possible to write to those registers intended for this purpose. For more information on this, see register assignment in Chapter 4.9.

Example 1 – Writing to the “Modbus_address” register:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	06	Control command	06	
Hi register address	00	Hi register address	00	
Lo register address	C0	Lo register address	C0	
Hi register value	00	Hi register value (192)	00	The new address of the module (160)
Lo register value (192)	A0	Lo register value (192)	A0	

In this example, a new Modbus address for the FLOW^{EVO} was set. Once this communication sequence is complete, the device is only responsive at the new address!
Note: The addresses 0 or 256 must not be assigned!

Example 2 – Writing to the "IR_4tagneu" register:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	06	Control command	06	
Hi register address	00	Hi register address	00	
Lo register address	47	Lo register address	47	
Hi register value	00	Hi register value (71)	00	The zero point has been reset (1)
Lo register value (71)	01	Lo register value (71)	01	

In this example, the zero point FLOW^{EVO} sensor has been reset. This was done by writing the value 1 to register 0x0047 (decimal 71). The device subsequently internally calculated and saved the current corrected value for the zero point. Reading out the register 0x0047 after a restart then shows the new, corrected value of the correction.

The zero point must only be set when zero gas and then a stable concentration value are applied! (You can find more information in Chapter 5).

Example 3 – Writing to the "Span" register:

Query		Response		Meaning of the data
Field	(Hex)	Field	(Hex)	
Control command	06	Control command	06	
Hi register address	00	Hi register address	00	
Lo register address	54	Lo register address	54	
Hi register value	27	Hi register value (84)	27	Span was set to 10000 (pre-assignment)
Lo register value (84)	10	Lo register value (84)	10	

In this example, a new end point correction for the FLOW^{EVO} sensor was set. A value of 10000 means that the correction factor is 10,000. This is also the delivery condition. A value of 11000 would mean that the concentration value displayed is 10% higher than internally measured. This register therefore enables deviations of the FLOW^{EVO} sensor in the concentration display to be corrected.

The end point must only be set in this way when a suitable test gas and then a stable concentration value are applied! (You can find more information in Chapter 5).

Note: Before setting the end point, the zero point must have previously been set correctly!

4.8. Modbus ASCII communication device

Figure 5 shows the state diagram of the transmission and receiving devices in principle, regardless of whether it is master or slave.

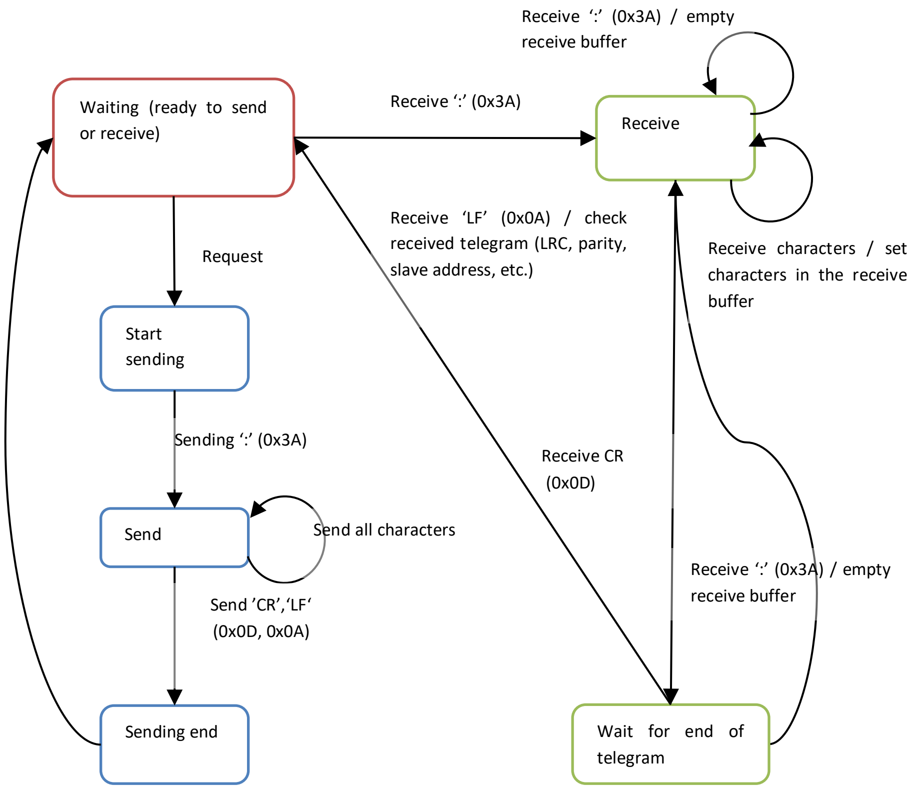


Figure 5: State diagram of a Modbus subscriber (ASCII operating mode)

If an incomplete query is sent to the CONNECT INTERFACE, it does not return a response. The module behaves as if at least one register in the register area being queried does not exist. Error-free telegrams are processed, others are discarded.

4.9. Example: Register overview of a FLOW^{EVO} sensor

Table 10: MODBUS register

Address	Register name	Function/explanation
0x03	T_m	Sensor temperature (x0.1°C)
0x10	Conc_corr	Gas concentration in pressure-compensated format. Output value is multiplied by the factor that indicates the unit code. Units: ppm, vol. % or %UEG
0x11	P_amb	Ambient or internal cell pressure Standard ambient pressure. Upon connecting an additional pressure sensor, output of the internal cell pressure. Output in hPa.
0x47	IR_4tagneu	Set value for sensor zeroing. Writing to the register with the value "1" sets the zero point.
0x4F	Unit	Unit code for the concentration (see list below)
0x60	conc_offs	Calibration of the zero point
0x61	conc_gain	Calibration of the end value
0x80	Device	Sensor type Example SMFSF6 (FLOW^{EVO} sensor for sulphur hexafluoride)
0x81	„	„
0x82	„	„
0x83	„	„
0x84	Version	Software version of the sensor Notation: X.XX
0x85	„	„
0x86	Serno	Serial number of the sensor Example SM-0000-001
0x87	„	„
0x88	„	„
0x89	„	„
0x8A	Version sC2	Software version of the CONNECT INTERFACE Notation: X.XX
0x8B	„	„
0xC0	mb_myaddr	Modbus address of the sensor Example 0x0001 The Modbus address must not be "0"!

Caution: Accessing registers not listed here can cause irreparable damage to the sensor!

Overview of unit codes (0 = unoccupied)

1 → ppm x 0.01
2 → ppm x 0.1
3 → ppm
4 → Vol.-% x 0.001
5 → Vol.-% x 0.01
6 → Vol.-% x 0.1
7 → %UEG x 0.01
8 → %UEG x 0.1

4.10. MODBUS address

In the examples above, the focus has been on the control commands without mentioning the scope of the telegram in detail. However, the telegram also includes the address of the slave subscriber, which is either queried or delivers a response to a query.
With CONNECT INTERFACE, the device address corresponds to the **last two numbers of the serial number** of the connected sensor (see Figure 7).

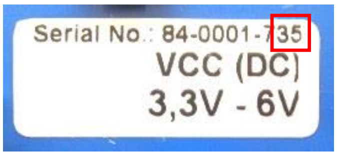


Figure 7: Determining the MODBUS- address

Please note:
Device address = #35 decimal → 0x23 hex
If the serial number ends with “00”,
the address is always #100 decimal = 0x64 hexadecimal.
Caution: The address "0" must never be used!

Figure 7 is a flow diagram that shows how unknown Modbus module addresses can be determined. Now, any register (e.g. serial number) can be queried via all module addresses (1–247) with a timeout of one second. If a module is queried with the correct address, it reacts by sending a response. The module address is included in this response. Thus, at the end of the search cycle, module responses can be used to analyse which module addresses are presently connected to the bus system. When querying the serial numbers, it is even possible to conclude which address is assigned to which module.
The permitted address range for the sensors is between 1 and 247. According to Modbus specifications, the addresses 248–255 are reserved. Address 0 stands for broadcast and must not be used!

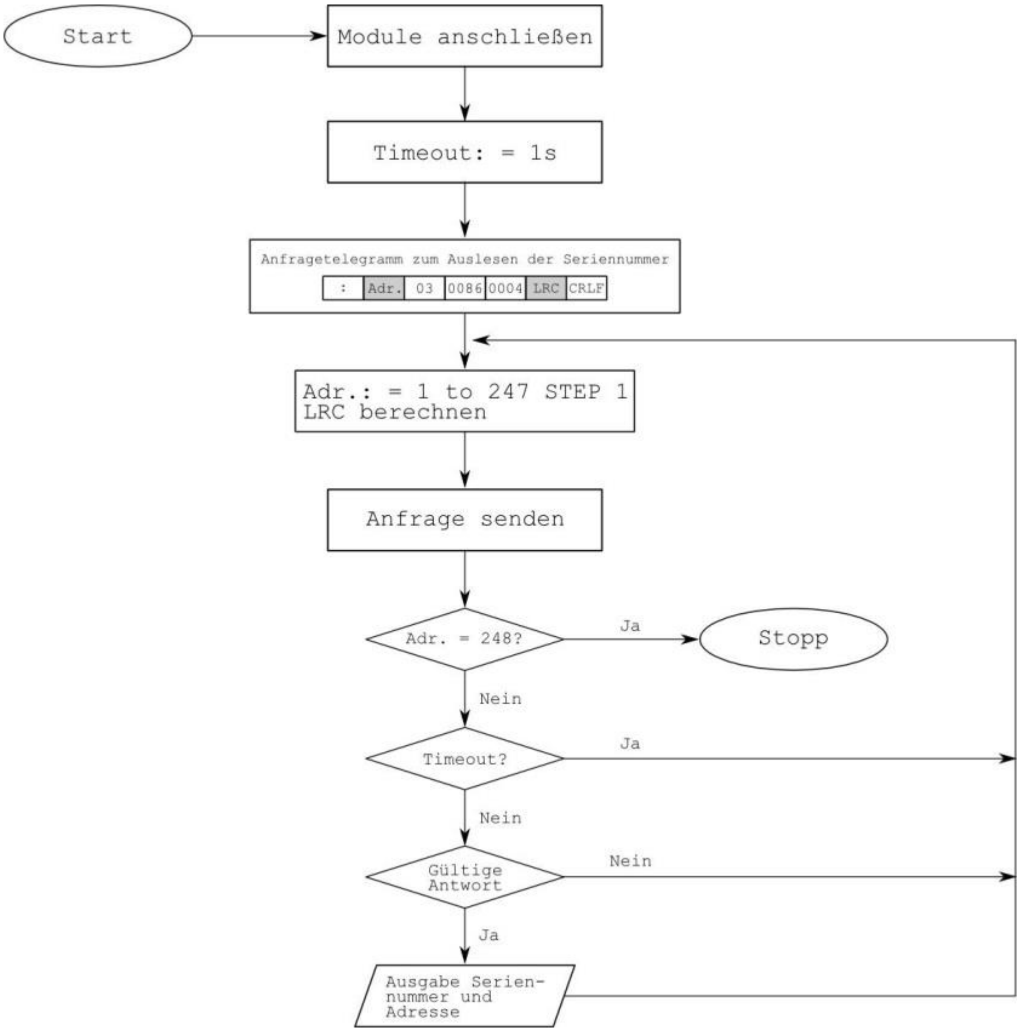


Figure 8: Flow diagram – Determining module addresses

Note: The permitted address range for CONNECT INTERFACE is between 1 and 247. According to MODBUS specifications, the addresses 248-255 are reserved. The address 0 stands for the broadcast.

5. Operation

5.1. Zero point calibration of the sensor via jumpers

It is used to set the zero point **in the connected sensor**. A genuine zero gas (e.g. nitrogen N_2 -100Vol%), with a concentration of 0% of the gas to be measured is required for the calibration.

Procedure of the sensor zero point calibration (please also observe table 12!):

JP2 and JP3 are not connected → Switch on device → LD3 (green) flashes → LD3 (green) lights up → connect zero gas, wait until lines are flushed and zero gas concentration is stably present → connect JP2 → LD2 (yellow) flashes
→ Device checks whether the concentration of gas corresponds to < 20% MBE (end point of the measurement range)
→ LD2 (yellow) lights up
→ Remove JP2 → LD3 (green) flashes 3 sec. → NP in sensor is set, LD3 (green) lights up → Device ready for operation

Notes:
If LD3 (yellow) flashes continuously, the device has detected a gas concentration > 20% MBE, and does not carry out the sensor zero calibration. In this case, the zero gas should be checked and the calibration repeated.
If LD1 (red) should flash during the calibration process, an error has occurred and the calibration must be repeated.
The values of the zero and span calibration of the analogue output are reset to the factory setting by this process.

5.2. Calibration of the analogue interface via jumpers

The CONNECT INTERFACE also offers the possibility to carry out a zero and span calibration of the analogue output via jumpers. In many applications, the used sensors have to be calibrated following initial start-up or at regular intervals.
Note:
It only makes sense to calibrate the analogue output if the zero point of the sensor was set previously (see chapter 5.1)!
The aforementioned calibration should be carried out at least once a year, and depending on the required accuracy, a more frequent calibration may also be necessary.

1. Zero point calibration (=zero calibration)
It tells the sensor what the gas concentration is in an environment corresponding to the normal zero point. A genuine zero gas with a concentration of 0% of the gas to be measured (e.g. nitrogen N_2 100Vol%) is required for the calibration.

2. End point calibration (=span calibration)
The end point calibration is used to establish the end point of the measurement range. This is the maximum measurement that can be safely and precisely detected by the sensor. A test gas with a concentration (as accurately as possible) of 100% of the gas to be measured is required for the calibration.

Below are the procedures of the different options, please also observe table 12:
(Jumpers that are not used can be connected unilaterally)

5.2.1. Clearing zero calibration (reset to factory setting)

Connect JP2 → Switch on device → LD2 (yellow) lights up → Remove JP2 → Device starts → LD3 (green) flashes → LD3 (green) lights up → Device ready for operation

5.2.2. Clearing span calibration (reset to factory setting)

Connect JP2 and JP3 → Switch on device → LD2 (yellow) lights up → Remove JP2 → Device starts → LD3 (green) flashes
→ LD3 (green) lights up → Device ready for operation

Notes:
JP3 and JP2 not connected when switching on: Analogue output = 0 - 20mA
JP3 (without JP2 connected) connected when switching on: Analogue output = 4 - 20mA

5.2.3. Zero (zero point) and span (end point) calibration

With the aid of the corresponding gas concentration the CONNECT INTERFACE automatically detects whether a zero or span calibration should be performed:
In the case of a corresponding **concentration <20% MBE, a zero calibration** is performed and in the case of a **concentration >40% MBE, a span calibration** is performed.

Procedure, please also observe table 12:
JP3 is connected (JP2 is not connected) → Switch on device → LD3 (green) flashes → LD3 (green) lights up → Connect zero gas or test gas, wait until lines are flushed and zero gas concentration is stably present → JP2 connect → LD2 (yellow) flashes → Device checks whether the gas concentration is < 20% or > 40% MBE → LD2 (yellow) lights up
→ Remove JP2 → LD3 (green) flashes 3 sec. → Calibration was applied, LD3 (green) lights up → Device ready for operation

Notes:
If LD3 (yellow) flashes continuously, the device has detected an implausible gas concentration and does not perform the
calibration. In this case, the zero gas or test gas should be checked and the calibration repeated.
If LD1 (red) should flash during the calibration process, an error has occurred and the calibration must
be repeated.

Table 11: Operation via jumpers

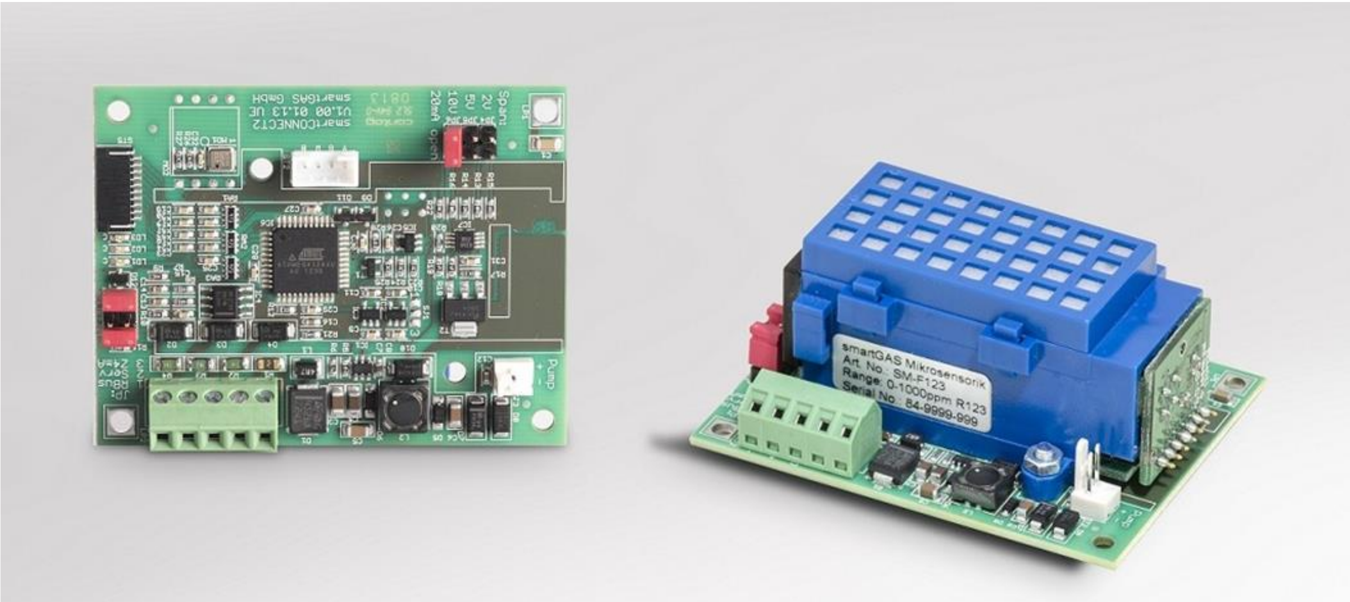
Time	JP2 Service	JP3 0 / 4 - 20 mA	Action
At switch-on	Not connected	Not connected	Zero point = 0% FS
„	Not connected	Connected	Zero point = 20% FS
„	Connected	Not connected	Clear zero calibration
„	Connected	Connected	Delete span calibration
During operation	Not connected	Irrelevant	Normal operation
„	Connect	Not connected	Determine sensor zero point
„	Remove	Not connected	Transfer zero point to the sensor
„	Connect	Connected	Determine zero/span
„	Remove	Connected	Transfer of zero/span calibration

6. Technical data

CONNECT INTERFACE

INNOVATIVE GAS SENSORS

New interface electronics assembly for smartGAS sensors



- Operating voltage 12 to 28V DC
- Indication of device status by LEDs
- Analogue interface:
  0 (4) – 20 mA (NAMUR NE43)
  0-2 V, 0-5 V, 0-10 V
- Digital interface: RS485
- Simple calibration of the analogue interface by means of jumpers
- Zero point calibration of the sensor by means of jumpers
- Integrated ambient pressure compensation (800 – 1150 mbar)
- Internal cell pressure measurement (optional)
- Connection for external peripherals (6 V / 200 mA)
- Dimensions compatible with the smartCONNECT electronics assembly

6.1. Service

Our Service is your expert partner at all times. We guarantee you full satisfaction, long-standing expertise and optimised quality.

Our Customer Service department is available during normal business hours on

Phone: +49 7131 / 797553 – 0
E-Mail: sales@smartgas.eu
http://www.smartgas.eu/de/kontakt/adresse.html

accessible.
You can of course also contact us by email or through our website.

Table 12: Our business hours

Our business hours	
Monday to Friday	0800 hrs to 1600 hrs
Saturday	Closed
Sundays and public holidays	Closed

6.2. Service

Regular care and maintenance will maintain the longevity and accuracy of your smartGAS products. From perfect handling to optimum care to professional repairs.

The CONNECT INTERFACE assembly has been designed in conjunction with a smartGAS sensor as a monitoring device for guaranteeing safety in potentially hazardous areas. Therefore, any kind of maintenance, parameterisation and all settings on the device are reserved for authorised personnel. Never attempt to dismantle a sensor, manipulate the hardware or modify the software yourself.
Mechanical damage, e.g. caused by improper fastening or handling as well as damage caused by moisture or dirt will invalidate any warranty provided by smartGAS Mikrosensorik GmbH!

6.3. Liability

smartGAS Mikrosensorik GmbH shall not be liable for consequential loss, property damage or personal injury caused by improper handling or failing to observe the safety instructions.

7. Legal information

CONNECT INTERFACE connection and operating manual in English (from SW version 1.16)

Edition V1.0 / March 2017

The figures and drawings used in this description may differ from the originals;
they are provided solely for illustrative purposes!
All information – including technical specifications – is subject to change
without notice.

Additional information can be obtained from www.smartgas.eu or send us an e-mail to sales@smartgas.eu.

smartGAS Mikrosensorik GmbH
Hünderstrasse 1
74080 Heilbronn
Germany
Telephone +49 7131 797553-0
Fax +49 7131 797553-10
www.smartgas.eu

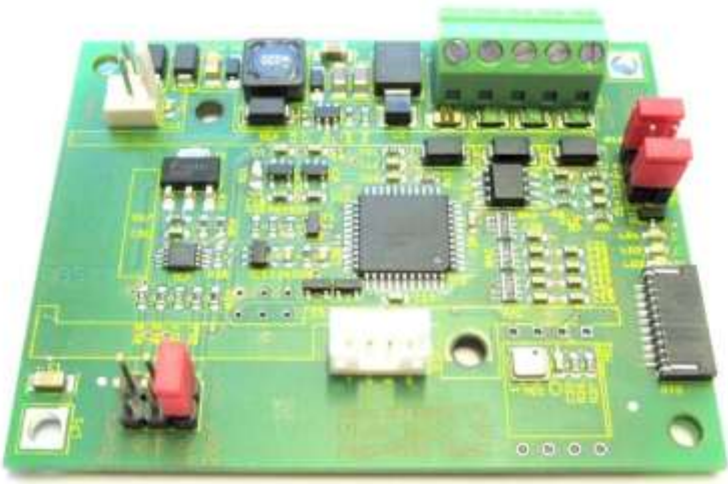
 Information updated: 03/2017

参考和訳

smartGAS.

CONNECT INTERFACE
取扱説明書

Edition 1.0



IRS

株式会社アイ・アール・システム https://www.irsystem.com

〒206-0041 東京都多摩市愛宕 4-6-20

TEL：042-400-0373 FAX：042-400-0374 e-mail：office@irsystem.com

目次

略語/記号一覧

本書では、一部語句を略語/記号で表しています。次の一覧で意味を確認してください。

略語/記号	説明
‘D’	ASCII 文字
0x5B	0x には数値的な意味はなく、後に続く文字(5B)が 16 進文字であることを示しています。この例「0x5B」では、値は 10 進数での 91 を示します。
124	10 進数法での数値表記
AC	交流
DC	直流
FS	Full scale (測定濃度範囲)
Hex	16 進数法の略語
IR	Infra-red(赤外線)
JP	Jumper (ジャンパ)
kbps	キロビット/秒 —データ伝送速度
L	リットル (1L =1000cm^3) —容積範囲
m	メートル —長さの単位
mA	ミリアンペア —A x10^{-3} のアンペア数
mbar	ミリバール –bar x10^{-3} の圧力値
MBE	測定範囲終了値
min	分 —時間の単位
mm^2	平方ミリメートル — (m x10^{-3})^2 の面積
Ms	ミリ秒 – s x10^{-3} の時間単位
mV	ミリボルト – V x10^{-3} の電圧
OEM	Original Equipment Manufacturer (受託製造)
ppm	Parts per million – 濃度の単位
sec	秒 —時間の単位
ST	コネクタ
UEG	LED(爆発限界)
V	ボルト —電圧

1 はじめに

警告サインと意味

本書では、安全のために注意が必要な項目について次の警告サインを使用しています。

危険な使用方法・状況

これを回避できない場合は、製品または環境に対する損傷や損傷が発生する可能性があります。

製品の使用に関する情報

FLOWEVO を接続して使用する前に、これらの指示をよく確認してください。不明点はお気軽にお問合せください。

CONNECT INTERFACE の特徴

・0-2V、0-5V または 0-10VDC 信号出力をユーザ側で選択可能
・NAMUR NE 43 適合(オプション)*
・LED でのステータス表示(緑、黄、赤)
・クイックキャリブレーション
・圧力補償(周囲または任意の内部セル圧力、800 - 1150 mbar)
・キーボードによる操作可能(オプション)
・ミニポンプの制御・給電可能(6V DC/max 200mA) ※評価段階向け

* Namur NE 43 は、アナログ出力信号を持つデジタルトランスデューサの故障情報として標準化された信号レベルの工業規格です。

使用目的

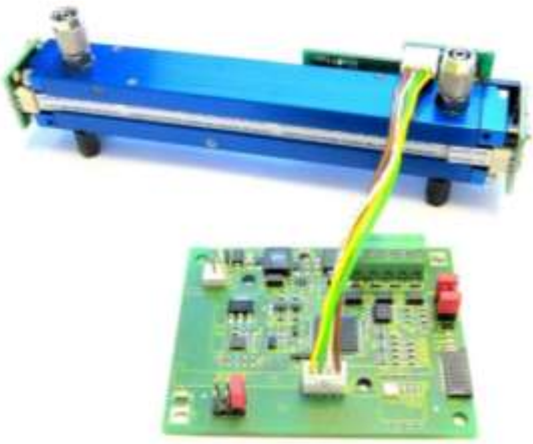
CONNECT INTERFACE は、smartGAS 社製センサを使用するために仕様範囲内で使用することを目的としています。他の測定や試験目的には適しておらず、他の方法で使用しないでください。

CONNECT INTERFACE は、爆発の可能性がある環境や過酷な条件下(例えば、高湿度、凝縮湿度、高い流量、衝撃のかかる環境、ハウジングのない屋外環境など)では使用しないでください。
CONNECT INTERFACE を取付け・使用する際には、電子アセンブリの ESD 保護対策を守り、輸送は ESD に適したパッケージまたはコンテナで行ってください。
使用環境に関し不明点がありましたら、お気軽にお問合せください。

保証の損失・責任・免責

センサ、CONNECT INTERFACE の分解・部品の交換や損傷をした場合、製品保証が無効となります。また、有害な化学物質を使用し内部の汚染や浸水が発生、出力が確認できない場合、保証は無効となる可能性があります。
smartGAS Mikrosensorik GmbH は、モジュールおよび通信の説明に記載した指示を遵守しなかったり、製品を不適切に取り扱ったりすることによって生じる損失、財産の損害、または人身傷害に対して責任を負わないものとします。

1.1 使用するガスセンサの取付けと設置



FLOW EVO との接続

BASIC EVO との接続

2 接続、インターフェイス

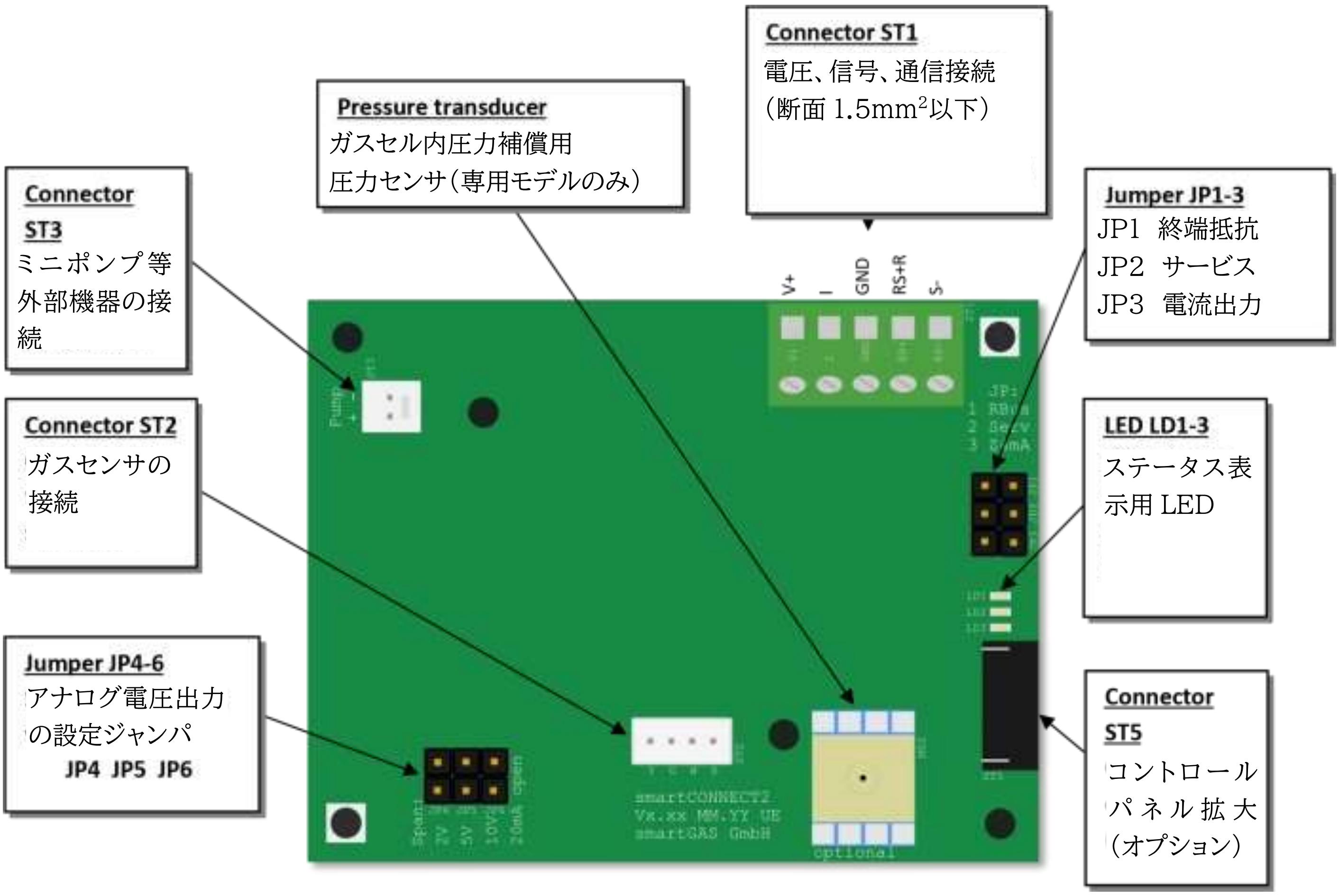


図1:コネクタ配置

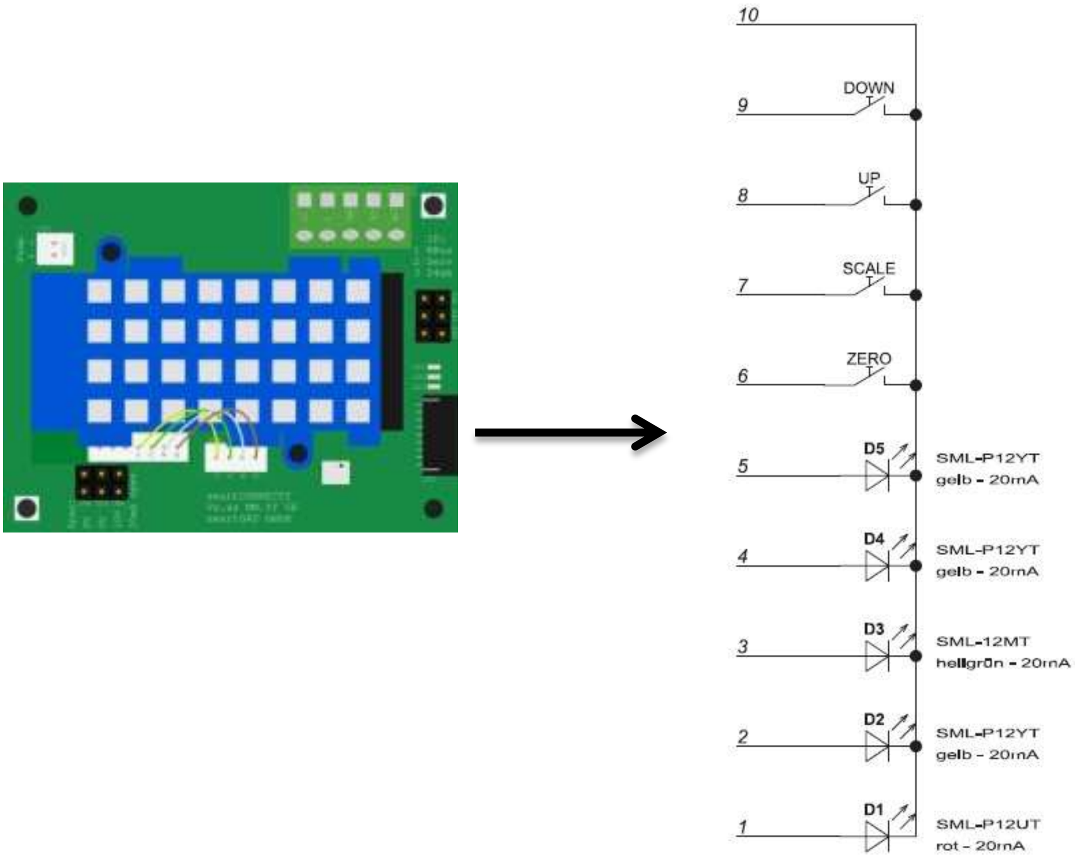
2.1 動作電圧

CONNECT INTERFACE は 12～28V DC の供給電圧で設計されています。
内部電圧安定化機能がありますが、供給電圧はできるだけ低くすることを推奨します。大きな負荷のオン/オフスイッチングが考えられるプラントなどでは、必要に応じて対策が必要となります。電源電圧はプラグコネクタ ST1 に接続してください（前ページ図1参照）。

表 1: 動作電圧接続（ST1）	
指定コネクタ	
V+	供給電圧 12 - 28V DC
GND	V+、I、RS485 の共通 GND

2.1.1 コントロールパネル拡張（オプション）

プラグコネクタ ST5 を介してコントロール パネルを拡張可能です（図1参照）。
次の図は、コントロール パネルを接続する方法を示しています。



プラグ コネクタ ST5 は FFC/FPC ソケット(製造元番号: HFW10R-2STE1LF)に対応しています。

コントロールパネル拡張オプションについてはお問合せください。

2.2 アナログ出力
2.2.1 電流出力
アナログ出力は2通りの設定を選択できます。
・0～20mA の電流信号(測定に対して線形)
・4～20mA の電流信号(測定に対して線形、Namur NE 43 に従った出力信号)
　(このモードでは、オープン回路またはセンサの障害を検出することができます)

表 2:電流出力の設定	
JP3 を…	説明
接続しない	電流出力 0～20 mA
接続する	電流出力 4～20 mA

ジャンパ(JP4、JP5、JP6)を接続すると電流信号から電圧信号を生成します。

電流出力をする際にはジャンパ(JP4、JP5、JP6)を接続しないでください。
電源電圧供給を完全に止めた状態(接続を外した状態)でジャンパの変更を行ってください。

アナログ信号 0/4～20mA を使用する場合、CONNECT INTERFACE を 3 本の導体送信機とみなします。図 2 の通り、この行を実行できます。電力はコントローラを介して直接給電することができますが、十分な電力を供給しているか確認をし、電力が不足している場合は追加の電源を用意してください。

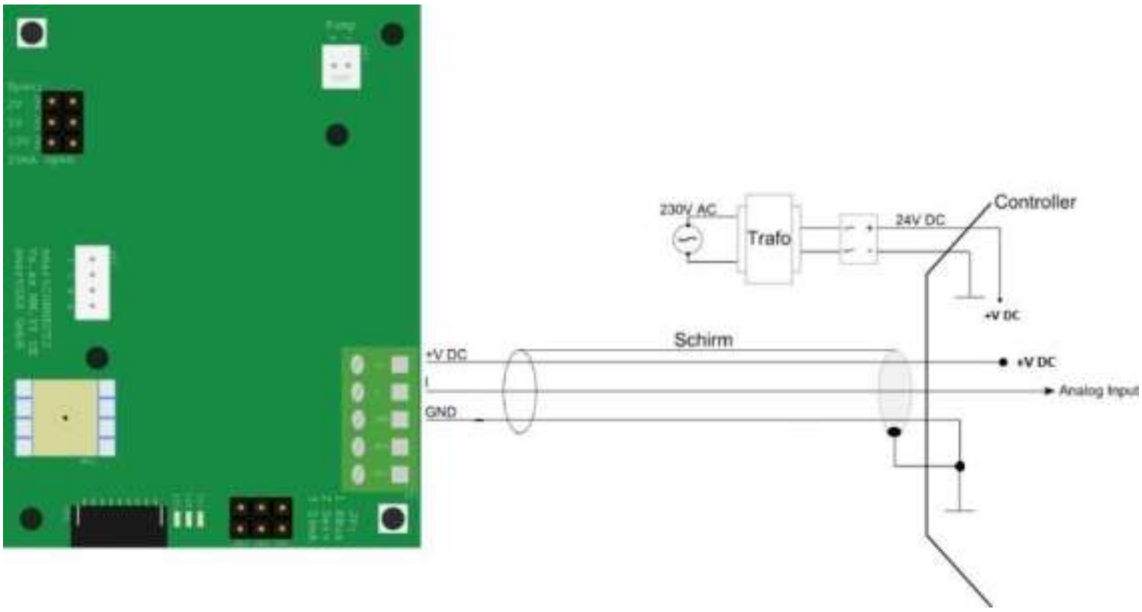


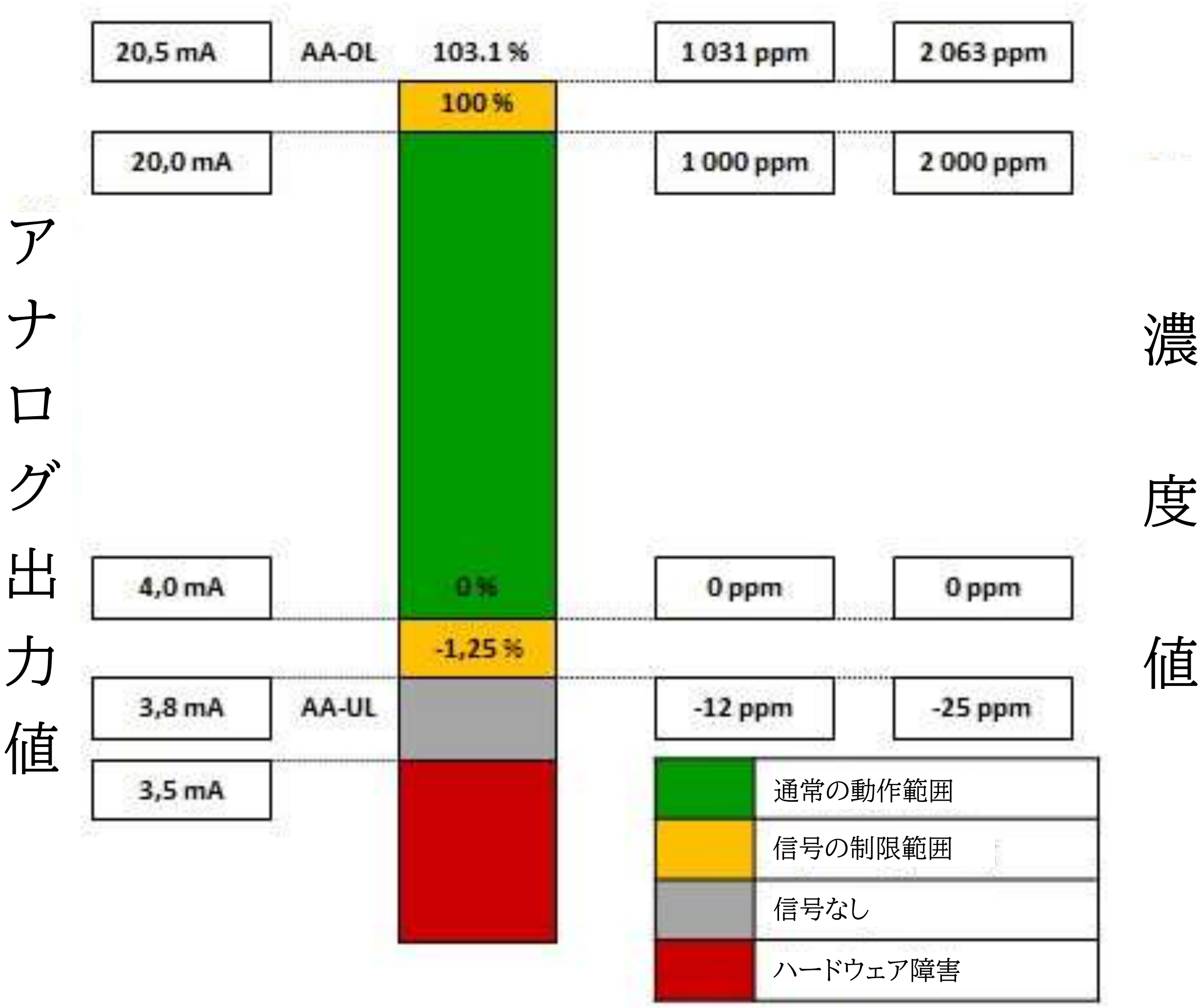
図 2: 3 導体接続を持つ電流ループ

表3:電流出力の接続	
コネクタ	説明
I	アナログ出力 0/4～20 mA
GND	V+、I、RS485 の共通 GND

Namur NE 43*に従った 4～20mA 電流インターフェイスの出力信号

（例：1000ppm または 2000ppm の測定値をしているセンサ）

AA-OL：アナログ出力上限
AA-UL：アナログ出力下限



* NAMUR は、プロセス業界のオートメーション技術ユーザが参加する国際協会です。
* Namur NE 43 は、アナログ出力信号を持つデジタルトランスデューサの故障情報として標準化された信号レベルの規格です。

2.2.2 電圧出力

電流信号から変換した電圧信号を使用することも可能です。電圧出力を使用の際には、設定用のジャンパ(JP4～6)を接続してください。

電圧信号は、電流負荷(参照 Ri)によって理想的な値とは異なる場合があります。

一度に接続できるジャンパは、次の表のうち1つのみです。

選択したジャンパに応じて、次のモードを設定できます。

モード	ジャンパ
0～2 V	JP4 を接続 (Ri= 110Ω)
0～5 V	JP5 を接続 (Ri= 260Ω)
0～10 V	JP6 を接続 (Ri= 510Ω)

各モードでは、ジャンパ JP3 の接続によって2通りの電圧出力範囲を選択可能です。

表 4: アナログ電力出力の組合せ

	0-20mA (JP3 接続なし)	4-20mA (JP3 を接続)
2 V (JP4)	0V – 2V	0.4V – 2V
5 V (JP5)	0V – 5V	1.0V – 5V
10V (JP6)	0V – 10V	2.0V – 10V

表 5: 電圧出力接続 (ST1)

コネクタ	**説明**
I	アナログ電圧出力 (JP4/5/6 のいずれかを接続)
GND	V+、I、RS485 の共通 GND

2.2.3 オープン回路

CONNECT INTERFACE が動作中にセンサと評価ユニット間の通信を中断した場合(意図しない切断またはオープン回路)、この状況は電圧出力で次のように示します。

0-20 mA で動作中: 出力電流は 0 mA
4-20 mA で動作中: 出力電流は(通常)3.5mA で固定

動作モードとダウンストリーム評価ユニットを用いて、故障検出のために使用することができます。不具合を解消した後にはシステムを再起動してください。

オープン回路は 4～20mA モードでのみ正確に検出が可能です。

2.3 Modbus デジタル出力

2.3.1 RS485 モード

CONNECT INTERFACE は標準機能として、2 コンダクタ モード(半二重)の RS485 インターフェイスを備えています。データ伝送はシリアルで、RS+ および RS- 回線の対称信号を介して発生します。基準信号は GND です。

表 6: Modbus インターフェイス接続(ST1)	
コネクタ	**説明**
RS+	非反転データライン
RS-	反転データライン
GND	V+、I、RS485 の共通 GND

5 ピンプラグ ST1 を介して接続を確立します(図 1 参照)。
RS485 インターフェイスは、単一の Master/マルチ Slave モードを容易にし、CONNECT INTERFACE は Slave として機能します。PC または代替評価ユニット(マイクロコントローラ、PLC 等)を Master として使用できます。

⚠ 正常に動作させるために、シールドライン(可能であればシールドとグラウンド ラインの中央のグラウンド ポイント)を使用してコントローラから中央電源を選択することを推奨します。
ユーザが同じ NULL ポテンシャル (同じグラウンド) を持っていない場合は、潜在的な大きなエラーが発生する可能性があります。また、RS 485 インターフェイスはオプトカプラを介して接続してください。

2.3.2 終端抵抗

30m以上のライン長の場合、bus の反射を防ぐために終端抵抗器の使用を推奨します。
抵抗はジャンパ JP1 を介して接続することができます。終端抵抗は回線の終わりにデバイス上でのみ行ってください。

1. JP1 接続なし ⇔ 終端抵抗の接続なし(供給状態)
2. JP1 が接続 ⇔ 終端抵抗が接続

⚠ 配線に使用するケーブルは、シールドとツイスト(ツイスト ペア ケーブル)にしてください。

2.4 外部機器への電源供給

CONNECT INTERFACE は、6 V・最大 200 mA で ST3 の2極コネクタ(図1参照)から電源供給が可能です(smartGAS 社製の評価用ミニポンプなど)。

表 7: ピン構成 (ST3)	
コネクタ	**説明**
+	6V DC / 200 mA
-	GND

⚠ この電源電圧は定電圧ではありません。

2.5 ジャンパの機能

表8:ジャンパ機能一覧	
ジャンパ	説明・機能
JP1	RS485 を介したデジタル通信用の終端抵抗 (章 2.3.2 参照)
JP2	サービスジャンパ (章 5 参照)
JP3	0/4～20 mA の電流出力 (章 2.2.1 参照)
JP4	0/0.4～2V の電圧出力 (章 2.2.2 参照)
JP5	0/1～5V の電圧出力 (章 2.2.2 参照)
JP6	0/2～10V の電圧出力 (章 2.2.2 参照)

2.6 ステータス表示(LED)

3 つのステータス表示用 LED を搭載しています(LED の位置: 図 1 を参照) 。

Green LED O	Yellow LED O	Red LED O	センサのステータス
点灯	消灯	消灯	通常動作中
点滅	---	---	初期化/起動中
---	点灯/点滅	---	5章参照
---	---	点滅	デグレードモード
---	---	on	ハードウェアエラー (お問合せください)

通常操作中:
緑色の LED のみが点灯します。センサは測定範囲の制限内で不具合なく動作しています。

デグレードモード:
センサの濃度測定範囲を超えたか、濃度が低すぎる場合にデグレードモード(赤色 LED 点滅)となります。
正しい濃度範囲になった場合、このモードは終了します。

ハードウェア エラー
赤い LED が連続点灯している際には、不可逆的なハードウェア エラーが発生しています。
このステータスを表示した際にはすみやかにお問合せください。
エラーを示すアナログ値を出力した場合は、お問合せの際にお知らせください。(2.2.1 参照)。

LED の機能については5章「操作/キャリブレーション」も参照してください。

2.7 圧力補償

測定時の圧力変化はガス密度の変化に直結し、測定セル内の IR 吸収の変化により測定の精度低下に繋がります。圧力補償機能により、より高精度な測定を実現します。

2.7.1 周囲圧力補償

ガス出口を大気に開放している場合、より高精度な測定のため周囲圧力を考慮する必要があります。周囲圧力センサは CONNECT INTERFACE に内蔵されています。圧力補償は 800～1150mbar の範囲内で行われます。この範囲を超えた場合、測定精度の低下が予想されます。（2.7.2 章を参照）

ユーザ側でのパラメータ設定等は必要ありません。測定ガスの補正係数は、CONNECT INTERFACE のソフトウェアに内蔵されています。詳細はお問合せください。

2.7.2 セル内圧力補償

FLOWEVO センサを使用する場合、絶対圧トランスデューサ内蔵の CONNECT INTERFACE（圧力補償モデル）を推奨します。図 3 の通りにガスチューブを接続してください。
接続などに関するご質問はお気軽にお問合せください。

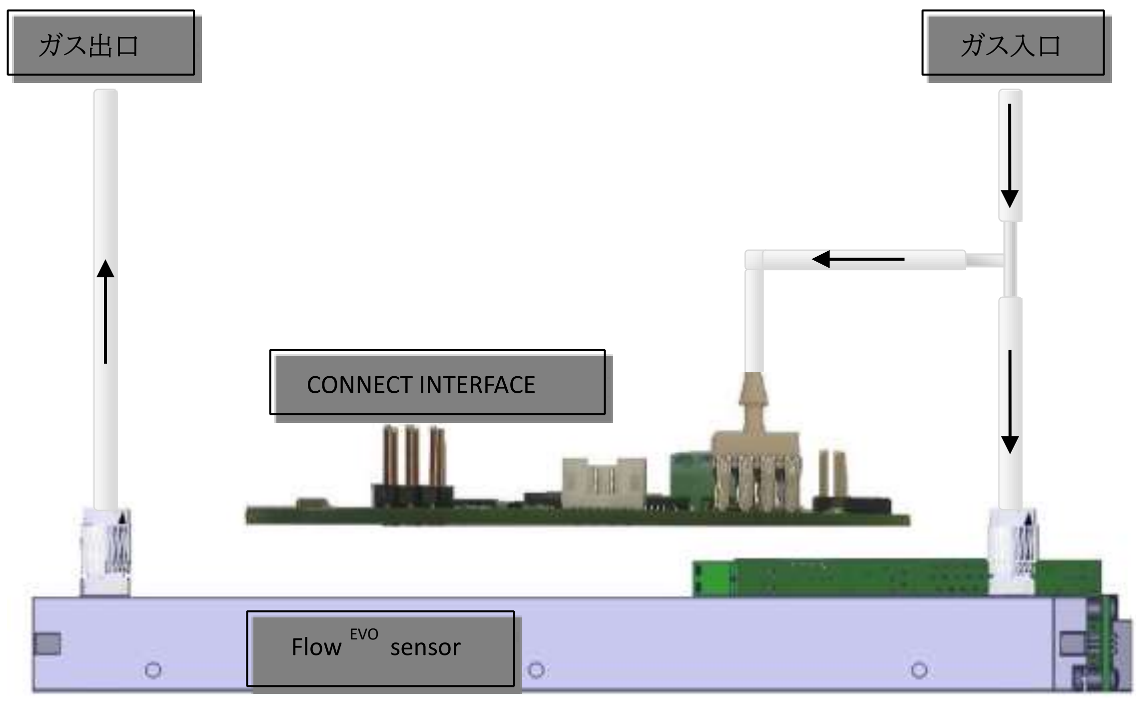


図 3: FLOWEVO センサと圧力トランスデューサのガスチューブ接続

3 セットアップ

CONNECT INTERFACE は接続すると、信号をコネクタ ST1 から出力します。
エラーや破損を防ぐために、図1を参照に次の順序で測定システムを取り付けてください。

1. センサに電源を接続していないことを確認します。
2. CONNECT INTERFACE ボードを希望位置に取り付けます(図4参照)。その際、ショートや破損を防ぐために、ネジヘッドがコンポーネントから十分な距離にあることを確認してください。必要に応じて、スペーサースリーブとプラスチックワッシャーを使用してください。
3. 電源電圧線を V+と GND に接続します。
4. 電流出力または電圧出力の信号線を I と GND に接続します。
5. デジタル出力(RS485)を RS+、RS-および GND に接続します。
6. センサを希望位置に取り付けます(センサの取扱説明書を参照)。
7. ST2 経由でセンサを接続インターフェイスに接続します。
8. 電源電圧をオンにします。センサと CONNECT INTERFACE 間が接続試行中の間、緑色 LED が点滅します。初回起動は最大で 2 分かかる場合があります。

センサと CONNECT INTERFACE 間が接続を確立すると緑色 LED が連続点灯し、システムが動作可能であることを示します。
2 分経過後に赤色 LED が連続点灯する場合、データ接続を確立していないか、接続されたセンサを正しく検出してないことを意味します。この場合はお問合せください。

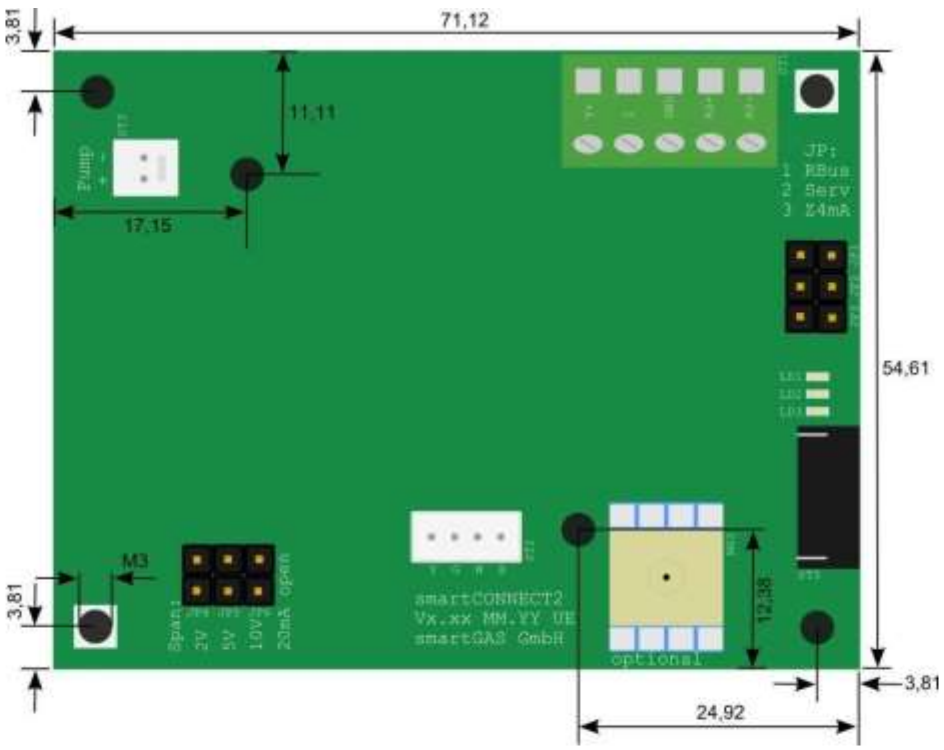


図4: CONNECT INTERFACE のコネクタと寸法

配線に関して: 断面 1.5 mm² 以上の線を使用してください。コネクタ ST1 はネジ端子固定のため、フレキシブル線を接続する際にはフェルールを取り付ける必要があります。

4 MODBUS 通信

4.1 サブスクライバ(Slave)での操作

RS485 データバスは最大 32 つのサブスクライバを統合可能です。終端抵抗は、データバス(JP1)の開始と終了で使用されます。間に中断されたサブスクライバは、スタブによって、または最適に「デイジーチェーン」(シリーズ接続原理)によって終了したデータバスに導かれます。

伝送速度が 2.4 kbps (2400 baud) の場合、スタブを含むデータ バスの全長は 500 m 以内にしてください。基本的に、伝送速度が高いほどスタブの全長は小さくなります。
Baud rate は、各サブスクライバの中で最も低速な値となり、全てのサブスクライバで同値となります。

表 9: 例 - 複数サブスクライバのサブスクライバポジションを持つデータ バス

サブスクライバポジション	デバイス	アドレス	Baud rate	役割	終端抵抗
1	CONNECT INTERFACE	22	2.4 kbps	Slave	Yes
2	コンピュータ	-	2.4 kbps	Master	No
3	温度センサ	11	2.4 kbps	Slave	No
4	圧力センサ	117	2.4 kbps	Slave	Yes

表 9 の通り、サブスクライバに割り当てられたアドレスは、トポロジ内でのポジションに依存しません。Modbus プロトコルを使用するため、Master はアドレスを必要としません。Slave だけが明確に対処する必要があります。(Modbus アドレスの章を参照)。

CONNECT INTERFACE は自律したボーレート検出機能が装備されています。自動的に使用されるフレーミングと MODBUS 方言の検出が可能です。表 11 の通りフレーミングフォーマットと Modbus ボーレートは自由に組合せて使用することが可能です。

表 11: フレーミングフォーマットと Modbus ボーレート

フレーミングフォーマット	ボーレート
7E1	2400 Bd
7E2	4800 Bd
7O1	9600 Bd
7O2	9200 Bd
7N2	38400 Bd
8E1	57600 Bd
8N1	115200 Bd
8N2	
8O1	

表 11: フレーミング形式はボーレートと組合せ可能

8 データ ビットのフレーミング形式は、Modbus RTU 経由の通信に使用してください。
(フレーミング形式に関する詳細は、4.6 章を参照)

4.2 シグナルプロファイル

信号はRS485 インターフェイスで差し込み送信されます。RS+ は信号を変更せずにルーティングし、RS- を反転形式でルーティングします (図 5 参照)。データ信号は、2 つの信号[RS+]-[RS-]の差を介して評価されます。

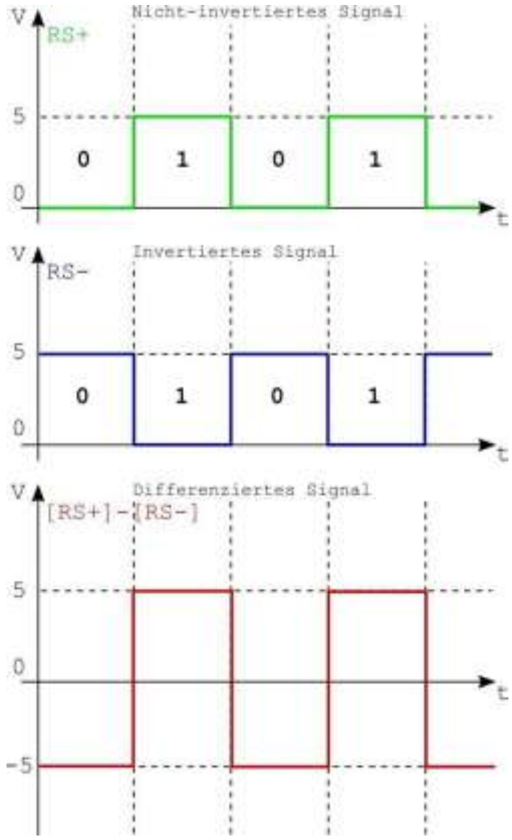


図 5: RS485 データバスでの信号伝達と評価

RS485 送信機は、負荷下では少なくとも±2V の電圧差を提供します。電圧差は、減衰の影響により小さくなることがあります。受信機は 200mV±まで有効な信号を評価することができます。

[RS+]-[RS-] > 200 mV →Mark →logical "1"
[RS+]-[RS-] < -200 mV →Space →logical "0"
[RS+]-[RS-] < 200 mV →データが正しく評価されない場合があります。

4.3 UART フレームの構造

UART フレームは、次のように構成されます。

Start	N data bits	Parity	M stop

1:　　スタートビット(常に 0)
7~8:　データ ビット、最小値ビットから始まる
1:　　パリティ ビット (オプション)、使用する場合パリティ ビットは偶数または奇数
1~2:　ストップ ビット(常に 1)

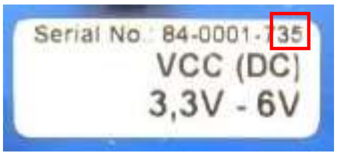
UART フレームを記述するための命名法は、数字、および数字で終わる文字列で構成されます。最初の数字は、フレームが含むデータビットの数を示します。次の文字は、なしの場合は N、偶数の場合は E、奇数の場合は O を持つパリティのタイプを表します。最後の番号は、送信されるストップビットの数を示します。モドバス RTU の標準仕様は 8E1、Modbus ASCII は 7E1 です。

例:
8N1 は、データ ビット8つ、パリティなし(N) 、ストップ ビット1つが使用されていることを意味します。
7E1 は、データビット7つ、パリティあり(E)、ストップ ビット1つが使用されていることを意味します。

さらに、電気ケーブルを介して UART フレームを転送する場合、伝送を「迅速に」行うことが重要であり、これをボーレートで定義します。ボー レートは、1 秒あたりに送信されるビット数を表します。標準ボーレートは 2400、4800、9600、19200(Modbus 標準)、38400、57600、115200 です。これらはすべて CONNECT INTERFACE で選択できます。

4.4 Modbus アドレス

CONNECT INTERFACE を使用すると、デバイスアドレスは接続されたセンサのシリアル番号末尾2字となります (図 7 参照)。→その他、詳細はセンサ(FLOW EVO、BASIC EVO)の取扱説明書を参照



デバイスアドレス = #35(10 進数)→ 0x23 (hex、16 進数)
シリアルナンバー末尾が「00」の場合、
アドレスは常に#100(10 進数)→ 0x64 (hex、16 進数)です。

図 7: MODBUS アドレスの判別

Master 機器とのデータ交換(Slave)
Modbus 通信
Modbus データテレグラムの構造
Modbus コントロールコマンド
コントロールコマンド 0x03 →読み取り(複数)レジスタ
コントロールコマンド 0x06 → レジスタの書き込み(1つのみ)
Modbus 通信デバイス
単位コード

→FLOW EVO の取扱説明書を参照してください。

4.5 レジスタ概要

Address	Name	説明
0x03	T_m	内部温度の測定値(x0.1°C)
0x10	Conc_corr	ppm、vol%または%LEL のガス濃度測定値 (単位コードを要確認)
0x11	P_amb	周囲または内部セル圧力(hPa) 標準的モデル:周囲圧力 圧力補償機能付きモデル:セル内圧力を取得
0x47	IR_4tagneu	センサの zero point を設定 (値「1」を書き込むことで設定)
0x4F	Unit	濃度の 単位とスケーリング係数 (詳細と計算例は以降のページ参照)
0x60	conc_offs	Zero point キャリブレーション
0x61	conc_gain	Span point キャリブレーション
0x80	Device	接続されているデバイスの種類
0x81	〃	〃
0x82	〃	〃
0x83	〃	〃
0x84	Version	接続されたデバイスのソフトウェアバージョン
0x85	〃	〃
0x86	Serno	接続されたデバイスのシリアル番号
0x87	〃	〃
0x88	〃	〃
0x89	〃	〃
0x8A	Version sC2	CONNECT INTERFACE のソフトウェアバージョン
0x8B	〃	〃
0xC0	mb_myaddr	接続されたデバイスの Modbus_address (変更後は、新しいアドレスでのみ接続可能)

表に記載のないレジスタの値は絶対に変更しないでください。

5 操作

5.1 ジャンパによるセンサの zero point キャリブレーション

接続されたセンサの zero point を設定します。→zero point キャリブレーションの手順も参照
測定対象ガスの濃度が0%の zero ガス(例:乾燥 N2、100Vol%)が必要です。

JP2 と JP3 を接続解除 → 電源 ON → 緑 LED 点滅 → 緑 LED 点灯 →
zero ガスによってガス流路が洗浄され、濃度が安定するまで待つ → JP2 接続 → 黄 LED 点滅
→ ガス濃度が 20%MBE 以下であることを確認 → 黄 LED 点灯
→ JP2 の接続解除→ 緑 LED 点滅(3秒間) → センサ内の NP 設定完了、緑 LED 点灯 → 設定完了

黄 LED が点滅し続ける場合、センサはガス濃度 20%MBE 以上を検知しているため、センサは zero point キャリブレーションを行いません。このような場合には zero ガスをチェックし、キャリブレーションをやり直してください。キャリブレーションプロセス中に赤 LED が点滅する場合は、エラーが発生しています。キャリブレーションをやり直してください。
アナログ出力の zero/span キャリブレーション値は、このプロセスによって工場出荷時の設定にリセットされます。

5.2 ジャンパによるアナログ出力のキャリブレーション

ジャンパを用いてアナログ出力の zero および span のキャリブレーションを行うことが可能です。測定精度を保つため、初回起動時や定期的にキャリブレーションを行ってください。

アナログインターフェイスのキャリブレーションは、zero point の正確なキャリブレーション完了後に行ってください。zero point キャリブレーションは、少なくとも年に 1 回、場合によってはより頻繁に行うことを推奨しています。

1. zero point キャリブレーション(=zero キャリブレーション)
zero point(測定対象ガス0%)の濃度を設定します。
測定対象ガスの濃度が0%の zero ガス(例:乾燥 N2、100Vol%)が必要です。

2. end point キャリブレーション(=span キャリブレーション)
測定可能な濃度範囲の最高値の濃度を設定します。
測定対象ガスの濃度が 100%の span ガスが必要です。

以下は、さまざまなオプションの手順です(使用されていないジャンパは一方に接続できます)。

5.2.1 zero キャリブレーションのクリア(工場出荷時設定へのリセット)

JP2 を接続 → 電源 ON → 黄 LED 点灯 → 緑 LED 点滅 → 緑 LED 点灯 → 設定完了

5.2.2 span キャリブレーションのクリア(工場出荷時設定にリセット)

JP2 と JP3 を接続 → 電源 ON → 黄 LED 点灯→ JP2 接続解除 → 緑 LED 点灯 → 設定完了

電源 ON 時に JP3 と JP2 の接続なし ： アナログ出力 = 0-20mA
電源 ON 時に JP3 接続、JP2 接続なし: アナログ出力= 4-20mA

5.2.3 zero (zero point)と span(end point)のキャリブレーション

対象ガスの濃度にあわせて CONNECT INTERFACE は自動的に zero または span のキャリブレーションのどちらを実行するか判断します。

ガス濃度が 20%MBE 以下の場合： zero キャリブレーションを行います。
ガス濃度が 40%MBE 以上の場合： span キャリブレーションを行います。

JP3 を接続･JP2 は接続解除 → 電源 ON → 緑 LED 点滅 → 緑 LED 点灯
→ zero ガスもしくは span ガスを流し、これらによってガス流路が洗浄され、濃度が安定するまで待つ
→ JP2 を接続 → 黄 LED 点滅 → ガス濃度が 20%MBE 以下、もしくは 40%MBE 以上の場合
→ 黄 LED 点灯 → JP2 接続解除 → 緑 LED 点滅(3秒間) →緑 LED 点灯 → 設定完了

黄 LED が点滅し続ける場合、センサはガス濃度 20%MBE 以上、40%MBE 以下を検知しているため、センサは zero point キャリブレーションを行いません。このような場合には zero ガスをチェックし、キャリブレーションをやり直してください。キャリブレーションプロセス中に赤 LED が点滅する場合は、エラーが発生しています。キャリブレーションをやり直してください。

表 12: ジャンパによる操作

タイミング	JP2 (サービス)	JP3 (0/4-20 mA)	操作内容
電源 ON	接続なし	接続なし	Zero point = 0% FS
〃	接続なし	接続	Zero point = 20% FS
〃	接続	接続なし	zero キャリブレーションクリア
〃	接続	接続	span キャリブレーションクリア
動作中	接続なし	(関与なし)	通常動作中
〃	接続	接続なし	zero point を設定
〃	接続解除	接続なし	センサに zero point を送信
〃	接続	接続	zero/span を設定
〃	接続解除	接続	zero/span キャリブレーションを送信

6 法的情報

smartGAS Heilbronn

メーカ：

© smartGAS Mikrosensorik GmbH
smartGAS Mikrosensorik GmbH |Huenderstr. 1 | 74080 Heilbronn | Germany
Phone: +49 7131/797553-0 | fax: +49 7131/797553-10
www.smartgas.eu| | mail@smartgas.eu

販売代理店：

株式会社アイ・アール・システム
〒206-0041 東京都多摩市愛宕 4-6-20
TEL： 042-400-0373、FAX: 042-400-0374、Email：office@irsystem.com
https://www.irsystem.com/

本取扱説明書に記載されている図と表は、説明目的にのみ使用され、実物とは異なる場合があります。ご了承ください。技術仕様を含むすべての情報は、予告なく変更される場合があります。

Edition V1.0 / March 2017