Modbus
on S12 CO_2

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1. Modbus protocol

Modbus is a simple, open protocol for both PLC and sensors [1, 2]. Details on Modbus can be found on the website www.modbus.org.

1. MODBUS Application Protocol Specification V1.1b
2. MODBUS over serial line specification and implementation guide V1.02

1.1. Serial line frame and addressing

Modbus over serial line specification distinguishes Modbus Protocol PDU and Modbus serial line PDU in the following way:

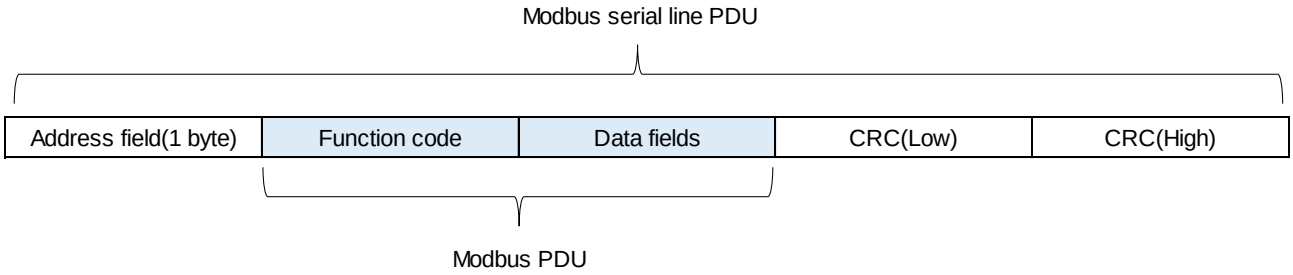

Figure 1.1 Serial line frame

1.2. Addressing rules

The addressing rules are summarized in the table:

Table 1.1 Addressing rules

Address	Modbus over serial line V1.0	S12 CO_2
0 (0x00)	Broadcast address	Sensor does not respond
1 to 247 (0x01 to 0xF7)	Server individual address	Server individual address
248 to 253 (0xF8 to 0xFD)	Reserved	Sensor does not respond
254 (0xFE)	Reserved	This address is for production / test purposes only
255 (0xFF)	Reserved	Sensor does not respond

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1.3. Modbus settings

Table 1.2 Modbus settings

Setting	Value
Default target address	0x68
Baud rate	9600 bps
Parity	None
DataBits	8
StopBits	1

Table 1.3 AC Characteristics of UART

Parameter	Symbol	Min.	Typ.	Max.	Unit
Baud Rate	rBAUD	-	9,600	-	bps
Baud Rate Accuracy [1] @0-50 ℃, Transmission only	bERR	-1.0		+1.0	%
Baud Rate Accuracy	bERR	-2.0		+2.0	%
DE hold time	tHD	0			µs
DE setup time	tSU	5			µs
Byte Data Send Wait Time	tMIN	0			µs
Command Turnaround Time	tTURN	0		180	ms

Note:

1. Values of these parameters are not guaranteed and not tested in production.

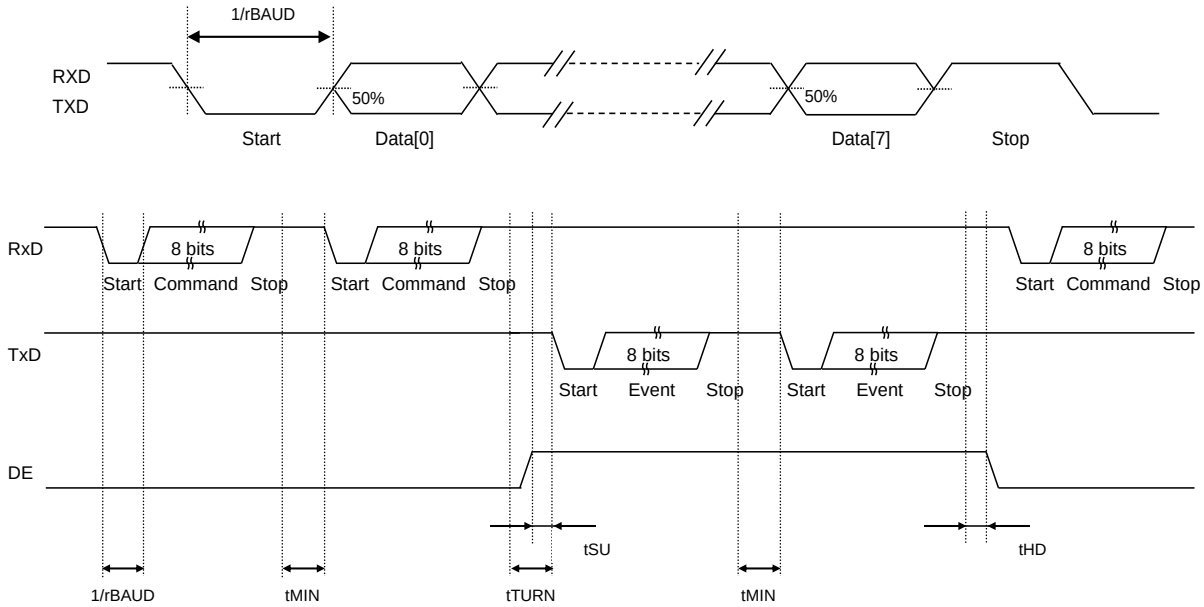

Figure 1.2 UART Bus Timing

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- Supported function code
  If an unsupported function code is input, exception code 0x1 is output.
  - 03（0x03） Read Holding Registers
  - 04（0x04） Read Input Registers
  - 16（0x10） Write Multiple Registers
  - 43/14（0x2B/0x0E） Read Device Identification

43/14（0x2B/0x0E） Read Device Identification

The sensor only supports Read Device ID code 4, individual access.
Objects 0x00 ..0x02 (basic identification) are available (Table 1.4).

Table 1.4 Read Device Identification

Object ID	Object Name / Description	Type	Modbus status	Category	Implementation status
0x00	Vendor Name	ASCII string*	Mandatory	Basic	Implemented
0x01	ProductCode	ASCII string*	Mandatory	Basic	Implemented
0x02	MajorMinorRevision	ASCII string*	Mandatory	Basic	Implemented
0x03	VendorUrl	ASCII string*	Optional	Regular	Not Implemented
0x04	ProductName	ASCII string*	Optional	Regular	Not Implemented
0x05	ModelName	ASCII string*	Optional	Regular	Not Implemented
0x06	UserApplicationName	ASCII string*	Optional	Regular	Not Implemented
0x07.. 0x7F	Reserved				
0x80	Memory map version	1 byte unsigned	Optional	Extended	Not Implemented
0x81	Firmware revision, consists of: Firmware type, Revision Main, Revision Sub	3 bytes unsigned	Optional	Extended	Not Implemented
0x82	Sensor serial number (sensor ID)	4 bytes unsigned	Optional	Extended	Not Implemented
0x83	Sensor type	3 bytes unsigned	Optional	Extended	Not Implemented

*The ASCII strings are different for different models and firmware revision. As an example:

Vendor Name = “Senseair” (length 8 bytes)

MajorMinorRevision = “1” (length 1 byte)

Product Code = “0” (length 1 byte)

See Table 1.5 to see list of Product code and corresponding article number of product.

Table 1.5 Product code and corresponding article number

Product code	Article number
0	012-0-0001

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2. Modbus on S12 CO_2

2.1. Modbus registers

The Modbus registers are mapped in memory, and the mapping is interpreted by the sensor at command reception.

The register maps are summarised in **Table 2.1** and **Table 2.2**. All registers are 16-bit words. The associated number is the Modbus register number. The register address is calculated as (register number -1). For example, the address of IR4 is 3.

Table 2.1 Input Registers (IR)

IR	Name	Address	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
IR1	ErrorStatus	0x0000	ErrorStatus[15:0]															
IR2	Reserved	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR3	Reserved	0x0002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR4	Measured concentration Filtered Pressure Compensated	0x0003	Measured concentration Filtered Pressure Compensated [15:0]															
IR5	Temperature	0x0004	Temperature [15:0]															
IR6	Reserved	0x0005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR7	Measurement count	0x0006	0	0	0	0	0	0	0	0	Measurement count [7:0]							
IR8	Measurement cycle time	0x0007	0	0	0	0	0	Measurement cycle time [10:0]										
IR9	Measured concentration Unfiltered Pressure Compensated	0x0008	Measured concentration Unfiltered Pressure Compensated [15:0]															
IR10	Measured concentration Filtered	0x0009	Measured concentration Filtered [15:0]															
IR11	Measured concentration Unfiltered	0x000A	Measured concentration Unfiltered [15:0]															
IR12	Reserved	0x000B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR13	Reserved	0x000C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR14	Reserved	0x000D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR15	Reserved	0x000E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR16	Reserved	0x000F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR17	Reserved	0x0010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR18	Reserved	0x0011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR19	Reserved	0x0012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR20	Reserved	0x0013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR21	Reserved	0x0014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR22	Reserved	0x0015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR23	Reserved	0x0016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR24	FW type	0x0017	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
IR25	Reserved	0x0018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR26	Reserved	0x0019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR27	Reserved	0x001A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR28	Reserved	0x001B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR29	FW rev.	0x001C	FW rev. [15:0]															
IR30	Sensor ID	0x001D	Sensor ID [31:16]															
IR31	Sensor ID	0x001E	Sensor ID [15:0]															
IR32	Reserved	0x001F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IR33	Reserved	0x0020																
IR34	Reserved	0x0021																
IR35	Reserved	0x0022																
IR36	Reserved	0x0023																
IR37	Reserved	0x0024																
IR38	Reserved	0x0025																
IR39	Reserved	0x0026																
IR40	Reserved	0x0027																
IR41	Reserved	0x0028																

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Register descriptions:

- ErrorStatus

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0000	0	0	0	0	0	Abnormal signal level	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	No measurement completed	0	Out of range	Self-diagnostics	Calibration	Algorithm	Communication	0

Initial value: 0x0080
Changes to 0x0000 after the first measurement

- Communication error: A read or write to a non-existent address / register was detected.
- Algorithm error: Corrupt parameter was detected.
- Calibration error: Calibration failure detected (ABC, zero, background or target calibration).
- Self-diagnostics error: Internal interface failure detected.
- Out of range: Out of range measurement was detected.
- No measurement completed: First measurement incomplete detected. This error cleared after first measurement.
- Abnormal signal level: Invalid measurement sample was detected. This flag is set in combination with the Self-diagnostic flag.

- Measured concentration Filtered Pressure Compensated

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0003	CFP_15	CFP_14	CFP_13	CFP_12	CFP_11	CFP_10	CFP_9	CFP_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CFP_7	CFP_6	CFP_5	CFP_4	CFP_3	CFP_2	CFP_1	CFP_0

Initial value: 0x0000

Filtered pressure compensated gas concentration. Singed 16bit value. This register equals the Measured concentration Filtered register if pressure compensation is disabled.
Pressure compensation can be set in the Meter control register.

- Temperature

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0004	TMP_15	TMP_14	TMP_13	TMP_12	TMP_11	TMP_10	TMP_9	TMP_8
	D7	D6	D5	D4	D3	D2	D1	D0
	TMP_7	TMP_6	TMP_5	TMP_4	TMP_3	TMP_2	TMP_1	TMP_0

Initial value: 0x0000

Chip temperature. Signed 16bit value, unit °C x100. For example, register value = 2223 means 22.23 °C.

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- Measurement count

Input register address	D7	D6	D5	D4	D3	D2	D1	D0
0x0006	MEAS _CNT_7	MEAS _CNT_6	MEAS _CNT_5	MEAS _CNT_4	MEAS _CNT_3	MEAS _CNT_2	MEAS _CNT_1	MEAS _CNT_0

Initial value: 0x00

Counter incremented after each measurement, range 0–255. The counter wraps around after the maximum value is reached. Counter value can for example be used by the host system to ensure that the sensor has done a measurement since last time measurement concentration was read.

- Measurement cycle time

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0007						MCT_10	MCT_9	MCT_8
	D7	D6	D5	D4	D3	D2	D1	D0
	MCT_7	MCT_6	MCT_5	MCT_4	MCT_3	MCT_2	MCT_1	MCT_0

Initial value: 0x0000

Measurement cycle time shows current time in present measurement cycle, incremented every 2 seconds. For example, Measurement cycle time = 3 means 6 seconds have passed in current measurement cycle. Value is set to 0 when sensor starts a new measurement. This value can be used by the host system to synchronize readings with sensor measurements.

- Measured concentration Unfiltered Pressure Compensated

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0008	CUFP_15	CUFP_14	CUFP_13	CUFP_12	CUFP_11	CUFP_10	CUFP_9	CUFP_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CUFP_7	CUFP_6	CUFP_5	CUFP_4	CUFP_3	CUFP_2	CUFP_1	CUFP_0

Initial value: 0x0000

Unfiltered pressure compensated gas concentration. Signed 16-bit value. This register equals the Measured concentration Unfiltered register if pressure compensation is disabled.
Pressure compensation can be set in the Meter control register.

- Measured concentration Filtered

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0009	CUF_15	CUF_14	CUF_13	CUF_12	CUF_11	CUF_10	CUF_9	CUF_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CUF_7	CUF_6	CUF_5	CUF_4	CUF_3	CUF_2	CUF_1	CUF_0

Initial value: 0x0000

Filtered gas concentration. Signed 16-bit value.

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- Measured concentration Unfiltered

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000A	CUF_15	CUF_14	CUF_13	CUF_12	CUF_11	CUF_10	CUF_9	CUF_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CUF_7	CUF_6	CUF_5	CUF_4	CUF_3	CUF_2	CUF_1	CUF_0

Initial value: 0x0000

Unfiltered gas concentration. Signed 16-bit value.

- Firmware type

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0017	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	1	1	0	0	0	0	1	0

Firmware type. Unsigned 16-bit value.
For S12 CO_2, fixed at 0x00C2.

- Firmware rev.

Input register address	D15	D14	D13	D12	D11	D10	D9	D8
0x001C	FW_R_15	FW_R_14	FW_R_13	FW_R_12	FW_R_11	FW_R_10	FW_R_9	FW_R_8
	D7	D6	D5	D4	D3	D2	D1	D0
	FW_R_7	FW_R_6	FW_R_5	FW_R_4	FW_R_3	FW_R_2	FW_R_1	FW_R_0

Firmware revision. Unsigned 16-bit value.
Bit 15 – 8: Main
Bit 7 – 0: Sub For S12 CO_2, fixed at 0x00

- Sensor ID

Input register address	D31	D30	D29	D28	D27	D26	D25	D24
0x001D	ID_31	ID_30	ID_29	ID_28	ID_27	ID_26	ID_25	ID_24
	D23	D22	D21	D20	D19	D18	D17	D16
	ID_23	ID_22	ID_21	ID_20	ID_19	ID_18	ID_17	ID_16
0x001E	D15	D14	D13	D12	D11	D10	D9	D8
	ID_15	ID_14	ID_13	ID_12	ID_11	ID_10	ID_9	ID_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ID_7	ID_6	ID_5	ID_4	ID_3	ID_2	ID_1	ID_0

Sensor ID. Unsigned 32-bit value.

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Table 2.2 Holding Registers (HR)

HR	Name	Address	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
HR1	Calibration Status	0x0000	0	0	0	0	0	0	0	0	Calibration status [7:0]							
HR2	Calibration Command	0x0001	Calibration Command [15:0]															
HR3	Calibration Target	0x0002	Calibration Target [15:0]															
HR4	Measured concentration Override	0x0003	Measured concentration Override [15:0]															
HR5	ABC Time	0x0004	ABC Time [15:0]															
HR6	ABC Par0	0x0005	ABC Par0 [15:0]															
HR7	ABC Par1	0x0006	ABC Par1 [15:0]															
HR8	ABC Par2	0x0007	ABC Par2 [15:0]															
HR9	ABC Par3	0x0008	ABC Par3 [15:0]															
HR10	Start Single Measurement	0x0009	Start Single Measurement [15:0]															
HR11	Measurement Mode (EE)	0x000A	0	0	0	0	0	0	0	0	Measurement Mode [7:0]							
HR12	Measurement Period (EE)	0x000B	0	0	0	0	0	Measurement Period [10:0]										
HR13	Number of samples (EE)	0x000C	0	0	0	0	0	0	Number of samples [9:0]									
HR14	ABC period (EE)	0x000D	ABC period [15:0]															
HR15	Clear ErrorStatus	0x000E	Clear ErrorStatus [15:0]															
HR16	ABC Target (EE)	0x000F	ABC target [15:0]															
HR17	Static IIR filter parameter (EE)	0x0010	0	0	0	0	0	0	0	0	Static IIR filter parameter [7:0]							
HR18	SCR	0x0011	0	0	0	0	0	0	0	0	SCR [7:0]							
HR19	Meter control (EE)	0x0012	0	0	0	0	0	0	0	0	Meter control [7:0]							
HR20	MB / I²C address (EE)	0x0013	0	0	0	0	0	0	0	0	MB / I²C address [7:0]							
HR21	Reserved	0x0014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR22	Reserved	0x0015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR23	Reserved	0x0016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR24	Reserved	0x0017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR25	Reserved	0x0018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR26	Reserved	0x0019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR27	Reserved	0x001A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR28	Reserved	0x001B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR29	Reserved	0x001C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR30	Reserved	0x001D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR31	Reserved	0x001E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR32	Reserved	0x001F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR33	Calibration Status	0x0020	Calibration status [15:0]															
HR34	Start Single Measurement	0x0021	Start Single Measurement [15:0]															
HR35	ABC Time	0x0022	ABC Time [15:0]															
HR36	ABC Par0	0x0023	ABC Par0 [15:0]															
HR37	ABC Par1	0x0024	ABC Par1 [15:0]															
HR38	ABC Par2	0x0025	ABC Par2 [15:0]															
HR39	ABC Par3	0x0026	ABC Par3 [15:0]															
HR40	Filter Par0	0x0027	0	0	0	0	0	0	0	0	Filter Par0 [7:0]							
HR41	Filter Par1	0x0028	0	0	0	0	0	0	0	0	Filter Par1 [7:0]							
HR42	Filter Par2	0x0029	0	0	0	0	0	0	0	0	Filter Par2 [7:0]							
HR43	Filter Par3	0x002A	Filter Par3 [15:0]															
HR44	Filter Par4	0x002B	0	0	0	0	0	0	0	0	Filter Par4 [7:0]							
HR45	Filter Par5	0x002C	Filter Par5 [15:0]															
HR46	Filter Par6	0x002D	0	0	0	0	0	0	0	0	Filter Par6 [7:0]							
HR47	Barometric air pressure value	0x002E	Barometric air pressure value [15:0]															
HR48	ABC barometric pressure value	0x002F	ABC barometric pressure value [15:0]															
HR49	Reserved	0x0030																

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HR	Name	Address	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
HR50	Reserved	0x0031																
HR51	Reserved	0x0032																

Note:
Registers marked as EE are EEPROM mapped, see section 1.7 EEPROM Characteristics in PSP15871 S12 CO_2.

Register descriptions:

- Calibration Status

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0000	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	0	Zero calibration	Background calibration	Target calibration	ABC calibration	Factory calibration restored	0	0

Initial value: 0x0000

These bits are set after successful calibrations. The bits need to be cleared / reset by host system; it is recommended to do this before starting a calibration.
The register is reset by writing 0b00000 to D[6:2]. Note that it is not possible to reset each bit individually.

- Calibration Command

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0001	CAL _COM_15	CAL _COM_14	CAL _COM_13	CAL _COM_12	CAL _COM_11	CAL _COM_10	CAL _COM_9	CAL _COM_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CAL _COM_7	CAL _COM_6	CAL _COM_5	CAL _COM_4	CAL _COM_3	CAL _COM_2	CAL _COM_1	CAL _COM_0

Initial value: 0x0000

Calibration is initiated by the commands in the table below.
The sensor will perform a calibration based on the first measurement immediately after the calibration command was received. Host system should trig a measurement after writing the calibration command in single measurement mode. After having performed the calibration, all following measurements will use the adjusted calibration parameters.
It is recommended that Calibration status is cleared before initiating a calibration.

Command	Name and description
0x7C02	Restore factory calibration. Restores calibration parameters to factory calibration values.
0x7C03	Forced ABC calibration. Sensor will perform an ABC calibration after receiving this command if sensor has valid ABC data. The command can be used if one for some reason wants to do an ABC adjustment before one ABC period has passed (when a normal ABC calibration is done). This command only works if ABC is enabled, see ABC period register and Meter control register.
0x7C05	Target calibration. Calibration using Calibration target register value as calibration target.

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0x7C06	Background calibration. Calibration using ABC target register value as calibration target.
0x7C07	Zero calibration. Calibration using 0ppm gas as calibration target.

- Calibration Target

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0002	CAL _TGT_15	CAL _TGT_14	CAL _TGT_13	CAL _TGT_12	CAL _TGT_11	CAL _TGT_10	CAL _TGT_9	CAL _TGT_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CAL _TGT_7	CAL _TGT_6	CAL _TGT_5	CAL _TGT_4	CAL _TGT_3	CAL _TGT_2	CA L_TGT_1	CAL _TGT_0

Initial value: 0x0000

This register used by target calibration.

- Measured concentration Override

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0002	CAL _TGT_15	CAL _TGT_14	CAL _TGT_13	CAL _TGT_12	CAL _TGT_11	CAL _TGT_10	CAL _TGT_9	CAL _TGT_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CAL _TGT_7	CAL _TGT_6	CAL _TGT_5	CAL _TGT_4	CAL _TGT_3	CAL _TGT_2	CA L_TGT_1	CAL _TGT_0

Initial value: 0x7FFF

Default value = 32767(no override).
If a value lower than default is written to the register, both the gas filtered and unfiltered registers will be set to this value.

- ABC Time

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0004	ABC_T_ 15	ABC_T_ 14	ABC_T_ 13	ABC_T_ 12	ABC_T_ 11	ABC_T_ 10	ABC_T_ 9	ABC_T_ 8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_T_ 7	ABC_T_ 6	ABC_T_ 5	ABC_T_ 4	ABC_T_ 3	ABC_T_ 2	ABC_T_ 1	ABC_T_ 0

Initial value: 0x0000

Time passed since last ABC calibration in hours.
If ABC is enabled when sensor is used in single measurement mode and powered down between measurements, the host system must increment this value every hour.

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- ABC Par0, 1, 2, 3

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0005	ABC _P0_15	ABC _P0_14	ABC _P0_13	ABC _P0_12	ABC _P0_11	ABC _P0_10	ABC _P0_9	ABC _P0_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC _P0_7	ABC _P0_6	ABC _P0_5	ABC _P0_4	ABC _P0_3	ABC _P0_2	ABC _P0_1	ABC _P0_0
0x0006	D15	D14	D13	D12	D11	D10	D9	D8
	ABC _P1_15	ABC _P1_14	ABC _P1_13	ABC _P1_12	ABC _P1_11	ABC _P1_10	ABC _P1_9	ABC _P1_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC _P1_7	ABC _P1_6	ABC _P1_5	ABC _P1_4	ABC _P1_3	ABC _P1_2	ABC _P1_1	ABC _P1_0
0x0007	D15	D14	D13	D12	D11	D10	D9	D8
	ABC _P2_15	ABC _P2_14	ABC _P2_13	ABC _P2_12	ABC _P2_11	ABC _P2_10	ABC _P2_9	ABC _P2_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC _P2_7	ABC _P2_6	ABC _P2_5	ABC _P2_4	ABC _P2_3	ABC _P2_2	ABC _P2_1	ABC _P2_0
0x0008	D15	D14	D13	D12	D11	D10	D9	D8
	ABC _P3_15	ABC _P3_14	ABC _P3_13	ABC _P3_12	ABC _P3_11	ABC _P3_10	ABC _P3_9	ABC _P3_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC _P3_7	ABC _P3_6	ABC _P3_5	ABC _P3_4	ABC _P3_3	ABC _P3_2	ABC _P3_1	ABC _P3_0

Initial value: 0x00000000

If ABC is enabled when the S12 CO_2 is used in single measurement mode and powered down between measurements, these registers must be read from the S12 CO_2 after each measurement and written back to the S12 CO_2 after each power on (enable) before a new measurement is started.

ABC Para3: Counts the number of luminescence.

- Start Single Measurement

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0009	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	ST_SME AS_7	ST_SME AS_6	ST_SME AS_5	ST_SME AS_4	ST_SME AS_3	ST_SME AS_2	ST_SME AS_1	ST_SME AS_0

Initial value: 0x0000

Writing 1(0x**01) initiates a measurement if the sensor is configured for single measurement mode.

Note:
**: don't care

- Measurement Mode (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000A	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	MM_7	MM_6	MM_5	MM_4	MM_3	MM_2	MM_1	MM_0

Initial value: 0x0000

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There are two measurement modes to choose between.
Value = 0(0x**00) continuous measurement mode (default)
Value = 1(0x**01), single measurement mode.
A system reset is required after changing measurement mode.

Note:
**: don't care

- Measurement Period (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000B	0	0	0	0	0	MEAS_PRD_10	MEAS_PRD_9	MEAS_PRD_8
	D7	D6	D5	D4	D3	D2	D1	D0
	MEAS_PRD_7	MEAS_PRD_6	MEAS_PRD_5	MEAS_PRD_4	MEAS_PRD_3	MEAS_PRD_2	MEAS_PRD_1	MEAS_PRD_0

Initial value: 0x0000

Measurement period in seconds (range from 1 to 2047). A system reset is required after changing configuration.

Note:
Measurement period is only used in continuous measurement mode.

Table 2.3 Measurement Period

MEAS_PRD[10:0]		Measurement Period[s]
Hex	Decimal	
7FF	2047	2047
7FE	2046	2046
7FD	2045	2045
⋮	⋮	⋮
708	1800	1800
⋮	⋮	⋮
11	17	17
10	16	16
0F	15	15
⋮	⋮	⋮
6	6	6
5	5	5
4	4	4
3	3	3
2	2	2
1	1	1
0	0	1

- Number of samples (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000C	0	0	0	0	0	0	NOS_9	NOS_8
	D7	D6	D5	D4	D3	D2	D1	D0
	NOS_7	NOS_6	NOS_5	NOS_4	NOS_3	NOS_2	NOS_1	NOS_0

Initial value: 0x0000

Number of samples in one measurement (range from 1 to 999). A higher number leads to better accuracy but also higher power consumption.

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A system reset is required after changing the configuration.
If time for executing all samples in a measurement is longer than time between measurements, the S12 CO_2 will execute all samples and after that start a new measurement. This means that actual time between measurements will be longer than expected.

The valid values for NOS[9:0] are as follows:
- From 0 to 20: All integer values (e.g., 0, 1, 2, ..., 20)
- From 29 to 79: Values in steps of 10, starting from 29 (e.g., 29, 39, 49, ..., 79)
- From 99 to 999: Values in steps of 50, starting from 99 (e.g., 99, 149, 199, ..., 999)

Any other values will result in undefined behaviour.

Table 2.4 Number of samples

NOS[9:0]		Number of samples[times]
Hex	Decimal	
3E7	999	999
⋮	⋮	⋮
C7	199	199
95	149	149
63	99	99
4F	79	79
⋮	⋮	⋮
31	49	49
27	39	39
1D	29	29
14	20	20
⋮	⋮	⋮
2	2	2
1	1	1
0	0	1

- ABC period (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000D	ABC _PRD_15	ABC _PRD_14	ABC _PRD_13	ABC _PRD_12	ABC _PRD_11	ABC _PRD_10	ABC _PRD_9	ABC _PRD_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC _PRD_7	ABC _PRD_6	ABC _PRD_5	ABC _PRD_4	ABC _PRD_3	ABC _PRD_2	ABC _PRD_1	ABC _PRD_0

Initial value: 0x0000

Period for ABC cycle in hours (range from 1 to 65534).
ABC is enabled by writing 1 to 65534 to the ABC period register and setting bit 1 = 0 in the Meter control register.
ABC is disabled by writing 0 or 65535 to the ABC period register or setting bit 1 = 1 in the Meter control register.

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- Clear ErrorStatus

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000E	CLR_ES_15	CLR_ES_14	CLR_ES_13	CLR_ES_12	CLR_ES_11	CLR_ES_10	CLR_ES_9	CLR_ES_8
	D7	D6	D5	D4	D3	D2	D1	D0
	CLR_ES_7	CLR_ES_6	CLR_ES_5	CLR_ES_4	CLR_ES_3	CLR_ES_2	CLR_ES_1	CLR_ES_0

Initial value: 0x0000

Write any values to this register to clear the ErrorStatus.

- ABC Target (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x000F	ABC_TGT_15	ABC_TGT_14	ABC_TGT_13	ABC_TGT_12	ABC_TGT_11	ABC_TGT_10	ABC_TGT_9	ABC_TGT_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_TGT_7	ABC_TGT_6	ABC_TGT_5	ABC_TGT_4	ABC_TGT_3	ABC_TGT_2	ABC_TGT_1	ABC_TGT_0

Initial value: 0x0000

Target value for background and ABC calibrations.

- Static IIR filter parameter (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0010	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	SIIR_PARAM_7	SIIR_PARAM_6	SIIR_PARAM_5	SIIR_PARAM_4	SIIR_PARAM_3	SIIR_PARAM_2	SIIR_PARAM_1	SIIR_PARAM_0

Initial value: 0x0000

Parameter for static IIR filter, recommended range from 2–10 and 1–16 is the allowable range. Use within the recommended range.
A higher value corresponds to a harder filtration.
If a value other than 1–16 is set when using the Dynamic IIR filter, an Algorithm error is reported.

- SCR

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0011	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	SCR_7	SCR_6	SCR_5	SCR_4	SCR_3	SCR_2	SCR_1	SCR _0

Initial value: 0x0000

The SCR register can be used to reset the sensor
Register value = 0xFF, sensor will reset/restart itself.

Communication becomes possible 30 ms after SCR.

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- Meter control (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0012	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	1	RDYN pin output	RDYN pin invert	Pressure compensation	Dynamic IIR filter	Static IIR filter	ABC	RDYN enable

Initial value 0x00FE

Bit field used to enable/disable the S12 CO_2 functions

Bit	Description
0	0 - RDYN enabled (default) 1 - RDYN disabled
1	0 - ABC enabled 1 - ABC disabled(default)
2	0 - Static IIR filter enabled 1 - Static IIR filter disabled(default)
3	0 - Dynamic IIR filter enabled 1 - Dynamic IIR filter disabled(default) To enable dynamic IIR filter both static IIR filter (bit2) and dynamic IIR filter (bit3) must be enabled
4	0 - Pressure compensation enabled 1 - Pressure compensation disabled (default)
5	0 - RDYN pin invert enabled, low during measurement 1 - RDYN pin invert (default), high during measurement
6	0 – RDYN pin push-pull output 1 – RDYN pin open drain output(default)

- MB address (EE)

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0013	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	ADD_7	ADD_6	ADD_5	ADD_4	ADD_3	ADD_2	ADD_1	ADD_0

Initial value: 0x0068

UART: Sensor address, range 1–247 (0x01– xF7). However, 254 (0xFE) is implemented for Senseair internal use.

A sensor reset is needed to activate the new address.

- Calibration Status

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0020	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	0	Zero calibration	Background calibration	Target calibration	ABC calibration	Factory calibration restored	0	0

Initial value: 0x0000

These bits are set after successful calibrations. The bits need to be cleared/reset by host system; it is recommended to do this before starting a calibration.

- Start Single Measurement

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Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0021	ST_SMEAS_15	ST_SMEAS_14	ST_SMEAS_13	ST_SMEAS_12	ST_SMEAS_11	ST_SMEAS_10	ST_SMEAS_9	ST_SMEAS_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ST_SMEAS_7	ST_SMEAS_6	ST_SMEAS_5	ST_SMEAS_4	ST_SMEAS_3	ST_SMEAS_2	ST_SMEAS_1	ST_SMEAS_0

Initial value: 0x0000

Writing 1(0x0001) initiates a measurement if the sensor is configured for single measurement mode.

- ABC Time

Mirror register of 0x0004

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0022	ABC_T_15	ABC_T_14	ABC_T_13	ABC_T_12	ABC_T_11	ABC_T_10	ABC_T_9	ABC_T_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_T_7	ABC_T_6	ABC_T_5	ABC_T_4	ABC_T_3	ABC_T_2	ABC_T_1	ABC_T_0

Initial value: 0x0000

Time passed since last ABC calibration in hours.
If ABC is enabled when the S12 CO_2 is used in single measurement mode and powered down between measurements, the host system must increment this value every hour.

- ABC Par0, 1, 2, 3

Mirror registers of 0x0005 – 0x0008

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0023	ABC_P0_15	ABC_P0_14	ABC_P0_13	ABC_P0_12	ABC_P0_11	ABC_P0_10	ABC_P0_9	ABC_P0_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_P0_7	ABC_P0_6	ABC_P0_5	ABC_P0_4	ABC_P0_3	ABC_P0_2	ABC_P0_1	ABC_P0_0
0x0024	D15	D14	D13	D12	D11	D10	D9	D8
	ABC_P1_15	ABC_P1_14	ABC_P1_13	ABC_P1_12	ABC_P1_11	ABC_P1_10	ABC_P1_9	ABC_P1_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_P1_7	ABC_P1_6	ABC_P1_5	ABC_P1_4	ABC_P1_3	ABC_P1_2	ABC_P1_1	ABC_P1_0
0x0025	D15	D14	D13	D12	D11	D10	D9	D8
	ABC_P2_15	ABC_P2_14	ABC_P2_13	ABC_P2_12	ABC_P2_11	ABC_P2_10	ABC_P2_9	ABC_P2_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_P2_7	ABC_P2_6	ABC_P2_5	ABC_P2_4	ABC_P2_3	ABC_P2_2	ABC_P2_1	ABC_P2_0
0x0026	D15	D14	D13	D12	D11	D10	D9	D8
	ABC_P3_15	ABC_P3_14	ABC_P3_13	ABC_P3_12	ABC_P3_11	ABC_P3_10	ABC_P3_9	ABC_P3_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_P3_7	ABC_P3_6	ABC_P3_5	ABC_P3_4	ABC_P3_3	ABC_P3_2	ABC_P3_1	ABC_P3_0

- Filter Par0, 1, 2, 3, 4, 5, 6

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Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x0027	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P0_7	FIL_P0_6	FIL_P0_5	FIL_P0_4	FIL_P0_3	FIL_P0_2	FIL_P0_1	FIL_P0_0
0x0028	D15	D14	D13	D12	D11	D10	D9	D8
	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P1_7	FIL_P1_6	FIL_P1_5	FIL_P1_4	FIL_P1_3	FIL_P1_2	FIL_P1_1	FIL_P1_0
0x0029	D15	D14	D13	D12	D11	D10	D9	D8
	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P2_7	FIL_P2_6	FIL_P2_5	FIL_P2_4	FIL_P2_3	FIL_P2_2	FIL_P2_1	FIL_P2_0
0x002A	D15	D14	D13	D12	D11	D10	D9	D8
	FIL_P3_15	FIL_P3_14	FIL_P3_13	FIL_P3_12	FIL_P3_11	FIL_P3_10	FIL_P3_9	FIL_P3_8
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P3_7	FIL_P3_6	FIL_P3_5	FIL_P3_4	FIL_P3_3	FIL_P3_2	FIL_P3_1	FIL_P3_0
0x002B	D15	D14	D13	D12	D11	D10	D9	D8
	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P4_7	FIL_P4_6	FIL_P4_5	FIL_P4_4	FIL_P4_3	FIL_P4_2	FIL_P4_1	FIL_P4_0
0x002C	D15	D14	D13	D12	D11	D10	D9	D8
	FIL_P5_15	FIL_P5_14	FIL_P5_13	FIL_P5_12	FIL_P5_11	FIL_P5_10	FIL_P5_9	FIL_P5_8
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P5_7	FIL_P5_6	FIL_P5_5	FIL_P5_4	FIL_P5_3	FIL_P5_2	FIL_P5_1	FIL_P5_0
0x002D	D15	D14	D13	D12	D11	D10	D9	D8
	0	0	0	0	0	0	0	0
	D7	D6	D5	D4	D3	D2	D1	D0
	FIL_P6_7	FIL_P6_6	FIL_P6_5	FIL_P6_4	FIL_P6_3	FIL_P6_2	FIL_P6_1	FIL_P6_0

Initial value: 0x0000

If the S12 CO_2 is used in single measurement mode with IIR filter enabled and powered down between measurements, these registers must be read from the S12 CO_2 after each measurement and written back to the S12 CO_2 after each power on (enable) before a new measurement is started.

- Barometric air pressure value

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x002E	BP_15	BP_14	BP_13	BP_12	BP_11	BP_10	BP_9	BP_8
	D7	D6	D5	D4	D3	D2	D1	D0
	BP_7	BP_6	BP_5	BP_4	BP_3	BP_2	BP_1	BP_0

Initial value: 0xFFFF

Barometric air pressure value. Signed 16bit, unit 0.1 hPa. Range from 3000–13000 (300–1300 hPa). For values outside pressure range, error flag “out of range” will be set and compensation will be done with min or max pressure value.

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- ABC barometric pressure value

Holding register address	D15	D14	D13	D12	D11	D10	D9	D8
0x002F	ABC_BP_15	ABC_BP_14	ABC_BP_13	ABC_BP_12	ABC_BP_11	ABC_BP_10	ABC_BP_9	ABC_BP_8
	D7	D6	D5	D4	D3	D2	D1	D0
	ABC_BP_7	ABC_BP_6	ABC_BP_5	ABC_BP_4	ABC_BP_3	ABC_BP_2	ABC_BP_1	ABC_BP_0

Initial value: 0xFFFF

If pressure compensation and ABC are both enabled when the S12 CO_2 is used in single measurement mode and powered down between measurements, this register must be read from the S12 CO_2 after each measurement and written back to the S12 CO_2 after each power on(enable) before a new measurement is started.

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3. Revision history

Date	Revision	Page (s)	Description
2025-09-19	1	All	First release of document.
2026-01-12	2	All	Removal of “Micro” from sensor name. Alignment of table indents.
2026-04-08	3	7	Change of “Measurement timeout” to “0” and removal of the comment about Memory error in ErrorStatus table.

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