User Manual
EE895
Miniature Sensor Module for CO₂, Temperature and Barometric Pressure

www.epluse.com
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1 General Information

This user manual serves for ensuring proper handling and optimal functioning of the device. The user manual shall be read before commissioning the equipment and it shall be provided to all staff involved in transport, installation, operation, maintenance and repair. E+E Elektronik Ges.m.b.H. does not accept warranty and liability claims neither upon this publication nor in case of improper treatment of the described products.

This document may contain technical inaccuracies and typographical errors. The content will be revised on a regular basis. These changes will be implemented in later versions. The described product(s) can be improved and changed at any time without prior notice.

The user manual may not be used for the purposes of competition without the written consent of E+E Elektronik Ges.m.b.H. and may not be forwarded to third parties. Copies may be made for internal purposes. All information, technical data and diagrams included in these instructions are based on the information available at the time of writing.

PLEASE NOTE
Find this document and further product information on our website at www.epluse.com/ee895.

1.1 Explanation of Warning Notices and Symbols

Safety precautions
Precautionary statements warn of hazards in handling the device and provide information on their prevention. The safety instruction labeling is classified by hazard severity and is divided into the following groups:

⚠️ DANGER
Danger indicates hazards for persons. If the safety instruction marked in this way is not followed, the hazard will very likely result in severe injury or death.

⚠️ WARNING
Warning indicates hazards for persons. If the safety instruction marked in this way is not followed, there is a risk of injury or death.

⚠️ CAUTION
Caution indicates hazards for persons. If the safety instruction marked in this way is not followed, minor or moderate injuries may occur.

NOTICE
Notice signals danger to objects or data. If the notice is not observed, damage to property or data may occur.

Informational notes
Informational notes provide important information which stands out due to its relevance.

ℹ️ INFO
The information symbol indicates tips on handling the device or provides additional information on it. The information is useful for reaching optimal performance of the device.

The title field can deviate from “INFO” depending on the context. For instance, it may also read “PLEASE NOTE”.
1.2 Safety Instructions

1.2.1. General Safety Instructions

**NOTICE**

Improper handling of the device may result in its damage.

- The EE895 housing and the circuit board shall not be exposed to unnecessary mechanical stress during installation and operation. The forces exerted shall not exceed 50 N.
- The EE895 electronics is sensitive to electrostatic discharge (ESD), appropriate protective measures shall be taken when touching it.
- Use the EE895 only as intended and observe all technical specifications.

1.2.2. Intended Use

The EE895 miniature sensor module measures the CO₂ concentration, the temperature (T) and the absolute barometric pressure (p). It is intended to be used as sensor module in devices for diverse uses in non-condensing environments. Applications can be, e.g., in building automation, demand controlled ventilation and process control.

**WARNING**

Non-compliance with the product documentation may cause safety risk for people and the entire measurement installation.

The manufacturer cannot be held responsible for damages as a result of incorrect handling, installation and maintenance of the device.

- Do not use EE895 in explosive atmosphere or for measurement of aggressive gases.
- This device is not appropriate for safety, emergency stop or other critical applications where device malfunction or failure could cause injury to human beings.

**NOTICE**

Failing to follow the instructions in this user manual may lead to measurement inaccuracy and device failures.

- The EE895 may only be operated under the conditions described in this user manual and within the specification included in chapter 5 Technical Data.
- The device may only be powered with safety extra-low voltage (SELV).
- Unauthorized product modification leads to loss of all warranty claims.

1.2.3. Mounting, Start-up and Operation

The EE895 has been produced under state of the art manufacturing conditions, has been thoroughly tested and has left the factory after fulfilling all safety criteria. The manufacturer has taken all precautions to ensure safe operation of the device. The user must ensure that the device is set up and installed in a way that does not impair its safe use. The user is responsible for observing all applicable local and international safety guidelines for safe installation and operation of the device. This user manual contains information and warnings that must be observed by the user in order to ensure safe operation.

**PLEASE NOTE**

The manufacturer or his authorized agent can be only be held liable in case of willful or gross negligence. In any case, the scope of liability is limited to the corresponding amount of the order issued to the manufacturer. The manufacturer assumes no liability for damages incurred due to failure to comply with the applicable regulations, operating instructions or the specified operating conditions. Consequential damages are excluded from the liability.
### 1.3 Environmental Aspects

**PLEASE NOTE**

Products from E+E Elektronik Ges.m.b.H. are developed and manufactured in compliance with all relevant environmental protection requirements. Please observe local regulations for the disposal of the device.

For disposal, the individual components of the device must be separated according to local recycling regulations. The electronics shall be disposed of correctly as electronics waste.

### 1.4 ESD Protection

The sensing elements and the electronics board are ESD (electrostatic discharge) sensitive components of the device and must be handled as such. The failure to do so may damage the device by electrostatic discharges when touching exposed sensitive components.

### 1.5 Product Description

Beside CO₂ concentration up to 10,000 ppm, the EE895 measures temperature (T) and absolute barometric pressure (p). The active pressure and temperature compensation minimizes the impact of altitude and ambient conditions on the CO₂ measured data.

The CO₂, T and p measured data is available on I²C or UART digital interfaces. The solder pads, the plated half-holes and the through-holes allow for various mounting options.

### 1.6 Operating Principle CO₂ Measurement

The CO₂ measurement is based on the dual wavelength Non Dispersive Infra-Red (NDIR) technology which compensates for ageing effects, is highly insensitive to pollution and offers outstanding long term stability.

The infrared detector 1 (IR-1) is tuned to 4.2 μm, which is the wavelength absorbed by CO₂, the infrared detector 2 (IR-2) is tuned to 3.9 μm, which is not affected by any gas. For every single flash of the infrared lamp (IR-L), the device calculates the CO₂ concentration from the outputs of both infrared detectors IR-1 and IR-2. The measuring interval is user selectable (factory default: 15 s).
2 Handling Instructions

EE895 is an ESD sensitive device and must be handled with corresponding precautions. Protect the sensor outside the EPA (Electrostatic Protected Area) using ESD protective packaging. The EE895 is packed in stacks of ESD trays with 50 pieces each. The tray dimension is 354.2 x 278.6 x 23.8 mm (13.94 x 10.97 x 0.94 inch).

Operating and storage conditions: -40…60 °C (-40…140 °F)
0…95 % RH (non-condensing)
700…1 100 mbar (10.15…15.95 psi)

**NOTICE**

Failing to follow the instructions in this user manual may lead to measurement inaccuracy and device failures.

- The EE895 housing and the circuit board shall not be exposed to unnecessary mechanical stress during installation and operation. The forces exerted shall not exceed 50 N.
- The sensor module deploys a fine dust filter for sensing element protection. If the EE895 is deployed in a device which is designed for harsh environments, the device shall deploy a filter as well.

3 Hardware

3.1 Dimensions

Values in mm / inch

<table>
<thead>
<tr>
<th>Side view</th>
<th>Bottom view</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air inlet through dust filter towards CO₂ sensing cell</strong></td>
<td><strong>35.0 (1.4)</strong></td>
</tr>
<tr>
<td><strong>T / p sensor</strong></td>
<td><strong>15.0 (0.6)</strong></td>
</tr>
<tr>
<td><strong>CO₂ sensing cell</strong></td>
<td><strong>2.54 (0.1)</strong></td>
</tr>
<tr>
<td><strong>Through-holes</strong></td>
<td><strong>Ø 1.0 (0.04)</strong></td>
</tr>
<tr>
<td><strong>Plated half-holes</strong></td>
<td><strong>Through-holes</strong></td>
</tr>
</tbody>
</table>

Recommended PCB footprint

![Recommended PCB footprint diagram](https://www.epluse.com)
3.2 Mounting Recommendation

**NOTICE**
The EE895 is not intended for reflow soldering and consequently it does not feature a moisture sensitivity level rate (MSL). Nevertheless, for storage and handling it shall be regarded as compatible with MSL 1.

---

**CAUTION**
EE895 may only be soldered manually. A max. temperature of 360 °C may be applied for max. 10 s per solder point.

ESD precautions shall be observed while manually soldering the EE895. The EE895 can be mounted facing either upwards or downwards.

### 3.2.1. Mounting via Solder Pads

The EE895 module can be mounted onto a pluggable female header or directly onto the electronics board by using a pin-header with 2.54 mm (0.1 inch) pitch.

The minimum clearance of 2 mm (0.08 inch) shall be strictly observed. This is necessary for free air flow around the CO₂ sensing cell and around the T/p sensor.

![Pluggable](image1)

![Soldered single pin header](image2)

**Fig. 1**  Mounting with soldered pin header

### 3.2.2. Mounting via Side Plated Contacts

The EE895 can be mounted by manually soldering the plated half-holes onto the host board.

![Solder](image3)

**Fig. 2**  Mounting by soldering at the side plated contacts
### 3.3 EE895 Block Diagram

![Block diagram](image)

#### Fig. 3  Block diagram

### 3.4 Pin Assignment

#### Bottom view

![Bottom view](image)

**Tab. 1  Pin assignment**

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>Name</th>
<th>Type</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCC_EM</td>
<td>Power supply</td>
<td>Power supply emitter infra-red lamp (IR-L)</td>
</tr>
<tr>
<td>2</td>
<td>VCC_IO</td>
<td>Power supply</td>
<td>Power supply for the microcontroller</td>
</tr>
<tr>
<td>3</td>
<td>EN</td>
<td>Input</td>
<td>Enable the module. Tie to Vcc_IO for normal operation</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Power supply</td>
<td>Ground¹)</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Power supply</td>
<td>Ground¹)</td>
</tr>
<tr>
<td>6</td>
<td>RDY</td>
<td>Output</td>
<td>Data ready (open drain output)</td>
</tr>
<tr>
<td>7</td>
<td>ISEL</td>
<td>Input</td>
<td>Interface selection</td>
</tr>
<tr>
<td>8</td>
<td>TX / SCL</td>
<td>I/O</td>
<td>Transmission line (TX) / Serial Clock (SCL)</td>
</tr>
<tr>
<td>9</td>
<td>RX / SDA</td>
<td>I/O</td>
<td>Receive line (RX) / Serial Data (SDA)</td>
</tr>
</tbody>
</table>

¹) Pins 4 and 5 shall be connected to the same potential.
3.5 Pin Description

Pin 1 - VCC_EM
Power supply for the infrared lamp (IR-L). For optimizing of the energy consumption such as in battery-powered devices, the IR-L can be powered separately.

The IR-L does not have to be powered continuously, as it needs power supply during the measurement cycle \( t_{\text{meas}} \) only, see Fig. 7. Between the measurement cycles the current consumption of IR-L is approx. 0.1 \( \mu \text{A} \).

Pin 2 - VCC_IO
Power supply for the microcontroller and the digital functional blocks.

Pin 3 – EN (Enable)
For battery-powered devices the user can optimize the energy consumption controlling the status of the EN pin by an external host controller.

When the EN pin is pulled-down to the logic Low \( (\leq 0.4 \text{ V}) \), the internal voltage regulator of EE895 is switched off and the current consumption is typically 1 \( \mu \text{A} \) (max 2 \( \mu \text{A} \)).

When pulled-up to the logic state High \( (\geq 0.9 \text{ V}) \), the EE895 operates normally.

If the energy consumption of EE895 is not relevant, the EN pin shall be connected to VCC_IO.

The EN pin may not be left open.

Pin 6 – RDY (Data ready)
During the measurement cycle \( t_{\text{meas}} \), when \( \text{CO}_2 \), \( T \) and \( p \) are measured and processed, the pin RDY is in logic state High. As soon as data is available for read out, the pin RDY goes to logic state Low. The falling edge at this pin indicates that measured data is available for reading, see Fig. 5.

If used, an external pull-up resistor is required. If not used, the RDY pin may be left open.

![Timing diagram](image)

| \( t_{\text{pwrup}} \) | power up time, approx. 150 ms |
| \( t_{\text{meas}} \) | measurement cycle (\( \text{CO}_2 \), RH, T, p), approx. 300 ms warm-up + 300 ms IR lamp pulse |
| \( t_{\text{rdy}} \) | measurement interval, user selectable 10…3600 s, +/-25% (default: 15 s) |

Fig. 5  Timing details (see also chapter 4.5.3. \( \text{CO}_2 \) Parameter Settings)
Pin 7 – ISEL (Interface selection)

The EE895 features \( \text{I}^2\text{C} \) and UART interfaces.

Interface selection:

<table>
<thead>
<tr>
<th>ISEL logic state</th>
<th>EE895 interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (0...0.9 V)</td>
<td>( \text{I}^2\text{C} )</td>
</tr>
<tr>
<td>High (2.1...5.5 V) or not connected</td>
<td>UART</td>
</tr>
</tbody>
</table>

Tab. 2 Interface selection

Serial interface pins:

Pin 8 – TX_SCL Transmission data / Serial clock
Pin 9 – RX_SDA Receiving data / Serial data

The function of pins 8 and 9 depends on the interface selected with pin 7 ISEL.

Pin 7 – ISEL connected to ground: EE895 features \( \text{I}^2\text{C} \) interface:

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>Mode</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>SCL (serial clock)</td>
<td>External pull-up resistor to V+ (bus high voltage level) is required.</td>
</tr>
<tr>
<td>9</td>
<td>SDA (serial data)</td>
<td>External pull-up resistor to V+ (bus high voltage level) is required.</td>
</tr>
</tbody>
</table>

Tab. 3 Pin assignment \( \text{I}^2\text{C} \) interface

Example:

![Fig. 6 Example \( \text{I}^2\text{C} \) interface](image)

- \( V_{CC} \) = EE895 supply voltage: 3.3 – 5.5 V
- \( V_{OE} \) = Bus high voltage, typical 3.3 – 5.5 V
- \( R_P \) = \( \text{I}^2\text{C} \) pull-up resistors, typical 10 k\( \Omega \)
- \( V_{OE} \) and \( V_{CC} \) are independent but may be connected together
- Independently of \( V_{CC} \), RX_SDA and TX_SCL pins are 5 V tolerant (max 5.5V)

Pin 7 – ISEL connected to \( V_{CC} \) or left open: EE895 features UART interface:

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>Mode</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>TX (transmission line)</td>
<td>CMOS compatible (( V_{\text{OutLowMax}} ) 0.4 V; ( V_{\text{OutHighMin}} ) 2.6 V)</td>
</tr>
<tr>
<td>9</td>
<td>RX (receive line)</td>
<td>CMOS compatible (( V_{\text{InLowMax}} ) 0.9 V; ( V_{\text{InHighMin}} ) 2.1 V)</td>
</tr>
</tbody>
</table>

Tab. 4 Pin assignment UART interface
3.6 Electrical Characteristics

A DC/DC converter is used to flash the lamp (VCC_EM). Therefore, the supply current is reduced with higher voltage and vice versa. The microcontroller (VCC_IO) is supplied via a linear regulator, hence the supply current is constant.

The average current consumption at a sampling interval of 15 s (factory default) is 1.6 mA. Tab. 5 lists the typical and maximum current values in each individual state during the sampling interval, which is shown in the current profile in Fig. 8.

<table>
<thead>
<tr>
<th>Status</th>
<th>Power Supply</th>
<th>VCC_IO</th>
<th>VCC_EM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle measurement</td>
<td>6.2 (9.9) mA</td>
<td>&lt;0.1 µA</td>
<td>&lt;0.1 µA</td>
</tr>
<tr>
<td>IR lamp pulse</td>
<td>6.2 (9.9) mA</td>
<td>85 (95) mA</td>
<td>60 (66) mA</td>
</tr>
<tr>
<td>Standby</td>
<td>190 (300) µA</td>
<td>&lt;0.1 µA</td>
<td>&lt;0.1 µA</td>
</tr>
<tr>
<td>Power off</td>
<td>&lt;2 µA</td>
<td>&lt;0.1 µA</td>
<td>&lt;0.1 µA</td>
</tr>
</tbody>
</table>

Tab. 5 Current values in the individual measurement states, typ. (max.)

Further electrical characteristics:

<table>
<thead>
<tr>
<th>Signal</th>
<th>Unit</th>
<th>Min</th>
<th>Max</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock frequency</td>
<td>Hz</td>
<td>500</td>
<td>100 000</td>
<td></td>
</tr>
<tr>
<td>Pull-up resistor</td>
<td>kΩ</td>
<td>4.7</td>
<td>100</td>
<td>Typical 10 kΩ</td>
</tr>
</tbody>
</table>

Tab. 6 Electrical characteristics
3.7 Typical Applications

3.7.1. EE895 Connected to USB Interface

Pin 7 - ISEL is not connected → the EE895 features UART interface.

VCC_EM is connected to the nominal 5 V from USB, the VCC_IO and EN are connected to 3.3 V voltage regulator.

The host can read the values at any time, pin 6 - RDY is not used.

3.7.2. EE895 in Battery Powered Devices

Pin 7 - ISEL is connected to the ground → the EE895 features I²C interface.

VCC_EM is supplied by a low ESR super-capacitor and VCC_IO is connected to a typical low drop 3.3 V regulator.

The I²C host enables the EE895 with pin 3 - EN.

By checking the status of pin 6 - RDY (pulled up), the host can read the data as soon as available. After reading the data, EE895 can be disabled with pin 3.
3.7.3. EE895 Connected to a KNX Bus

Pin 7 - ISEL is connected to the ground → the EE895 features I2C interface.
The VCC_EM and the VCC_IO are connected to the typical 5 V bus voltage.
The I2C host keeps the EE895 enabled with the pin 3 – EN and can read the values at any time, pin 6 - RDY is not used.

4 Digital Interface

The EE895 features standard I2C and UART interfaces. The interface selection is made with pin 7 – ISEL, see Tab. 2 Interface selection. On both interfaces, I2C and UART, the data is encapsulated in Modbus Protocol Data Units (Modbus PDUs).

PLEASE NOTE

Modbus implementation details and request/response examples are described in detail in the Modbus Application Note AN0103 (available at www.epluse.com/ee895).

4.1 I2C Interface


The I2C interface simultaneously supports two protocols on two different slave addresses:
- Modbus over I2C address 0x5F
- I2C simplified address 0x5E

These addresses are fixed, they cannot be changed by the user.

4.1.1. Modbus Protocol Over I2C Interface

I2C slave address: 0x5F

The I2C interface encapsulates the data according Modbus PDU packets, including CRC:

<table>
<thead>
<tr>
<th>S</th>
<th>Slave Address</th>
<th>W</th>
<th>A</th>
<th>Request: Modbus PDU + Modbus CRC</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Slave Address</td>
<td>R</td>
<td>A</td>
<td>Response: Modbus PDU + Modbus CRC</td>
<td>P</td>
</tr>
</tbody>
</table>

Every byte of the Modbus PDU and the Modbus CRC must be acknowledged (according to I2C specification, not shown above).
The EE895 module supports repeated START or STOP conditions between the request packet and the response packet. If a START condition and an address match are detected, the EE895 will stay active until a STOP condition is received or an idle timeout of 500 ms occurs. This might increase the power consumption and self-heating. The I²C master shall ensure that the data is retrieved as soon as possible in case of a repeated START.

For the Modbus register map please refer to chapter 4.3 Modbus Register Map.

**NOTICE**

The CRC16 shall be calculated including the unshifted slave address.

Example of command reading the temperature (floating point value) $T = 25.30 \, ^\circ\text{C}$ from the register 0x3EA:

```
Request [Hex]: S BE 03 03 EA 00 02 E8 C5 P
```

```
Response [Hex]: S BF 03 04 00 00 41 DC 74 3F P
```

For decoding of float values stored according standard IEEE 754, please refer also to the Modbus Application Note AN0103.

Example of Decoding:

<table>
<thead>
<tr>
<th>Byte 1</th>
<th>Byte 2</th>
<th>Byte 3</th>
<th>Byte 4</th>
<th>Decimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>DC</td>
<td>00</td>
<td>00</td>
<td>27.50</td>
</tr>
</tbody>
</table>

**PLEASE NOTE**

For obtaining the correct value, both registers have to be read with a single request. The measured value can change between two Modbus requests. Exponent and mantissa may get inconsistent in this case.

### 4.1.2. I²C Simplified Protocol

I²C slave address: 0x5E

This I²C protocol is intended for I²C master reading the measured values from EE895 in “EEPROM-like-mode”.

The simplified I²C does not support any error detection (such as CRC) and provides the measured data in 8 subsequent registers, as 16 bit integers.

<table>
<thead>
<tr>
<th>Slave address</th>
<th>0x00</th>
<th>0x01</th>
<th>0x02</th>
<th>0x03</th>
<th>0x04</th>
<th>0x05</th>
<th>0x06</th>
<th>0x07</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x5E</td>
<td>CO₂ high byte</td>
<td>CO₂ low byte</td>
<td>T high byte</td>
<td>T low byte</td>
<td>reserved*) high byte</td>
<td>reserved*) low byte</td>
<td>p high byte</td>
<td>p low byte</td>
</tr>
</tbody>
</table>

*) Reserved for future use

The read pointer is the first register to be set. Additional bytes are answered by the EE895 module with NACK. If more bytes are read than the 8 registers, the EE895 answers with 0xFF (i.e. the SDA line is not pulled down). If a START condition and an address match are detected, the EE895 will stay active until a STOP condition is received or an idle timeout of 500 ms occurs.
The measured data is available as a 16 bit integer and is expressed in SI units:

<table>
<thead>
<tr>
<th>Measurand</th>
<th>Register pointer</th>
<th>Unit</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ average, pc¹</td>
<td>0x00</td>
<td>ppm</td>
<td>1:1</td>
</tr>
<tr>
<td>T</td>
<td>0x02</td>
<td>°C</td>
<td>1:100</td>
</tr>
<tr>
<td>p</td>
<td>0x06</td>
<td>mbar</td>
<td>1:10</td>
</tr>
<tr>
<td>CO₂ average, npc²</td>
<td>0x08</td>
<td>ppm</td>
<td>1:1</td>
</tr>
<tr>
<td>CO₂ raw, pc¹</td>
<td>0x0A</td>
<td>ppm</td>
<td>1:1</td>
</tr>
<tr>
<td>CO₂ raw, npc²</td>
<td>0x0C</td>
<td>ppm</td>
<td>1:1</td>
</tr>
</tbody>
</table>

¹) pc ... pressure compensated  
²) npc ... not pressure compensated  
*) Example: 2 575 means 25.75 °C  
**) Example: 10 130 means 1.013 mbar

Tab. 7 Data availability from the EE895 Miniature Sensor Module

Example for reading all measurands (7-bit address shifted):

Request [Hex]: S BC 00 P

Response [Hex]: S BD 03 B0 0A B7 8D 00 26 70 P

Conversion:

<table>
<thead>
<tr>
<th>Measurand</th>
<th>Response [Hex]</th>
<th>Response [Dec]</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>0x03B0</td>
<td>944</td>
<td>944 ppm</td>
</tr>
<tr>
<td>T</td>
<td>0x0AB7</td>
<td>2743</td>
<td>27.43 °C</td>
</tr>
<tr>
<td>p</td>
<td>0x2670</td>
<td>9840</td>
<td>984.0 mbar</td>
</tr>
</tbody>
</table>

Tab. 8 Interpretation of data from the response
Example for reading the air pressure value (7-bit address shifted):

```
Request [Hex]: S BC 06 P
```

```
Response [Hex]: S BD 26 70 P
```

Conversion:

<table>
<thead>
<tr>
<th>Measurand</th>
<th>Response [Hex]</th>
<th>Response [Dec]</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>0x2670</td>
<td>9840</td>
<td>984.0 mbar</td>
</tr>
</tbody>
</table>

Tab. 9  Interpretation of data from the response

## 4.2 UART Interface

### 4.2.1. Modbus Protocol Over UART Interface

Modbus slave address: 0x5F

The interface settings are: Baud rate 9600, 8 Data, No parity, 1 Stop bit (9600 8 N 1)

The slave address and the interface settings are fixed, they cannot be changed by the user.

The EE895 module shall be addressed according to the specification "Modbus over serial line V1.02", see [https://modbus.org/docs/Modbus_over_serial_line_V1_02.pdf](https://modbus.org/docs/Modbus_over_serial_line_V1_02.pdf).

Modbus frame description (screenshot taken from the "Modbus over Serial Line Specification and Implementation Guide V1.02" mentioned above):

The MODBUS application protocol [1] defines a simple Protocol Data Unit (PDU) independent of the underlying communication layers:
4.3 Modbus Register Map

Following Modbus register map is valid for both, the I²C and the UART interface. The measured data is saved as 32 bit floating point values (data type FLOAT) and as 16 bit signed integer values (data type INTEGER), please refer to Tab. 10 and Tab. 11 below:

FLOAT 32

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Register number¹ [DEC]</th>
<th>Register address² [HEX]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature T</td>
<td>°C</td>
<td>1003</td>
<td>0x3EA</td>
</tr>
<tr>
<td>Temperature T</td>
<td>°F</td>
<td>1005</td>
<td>0x3EC</td>
</tr>
<tr>
<td>Temperature T</td>
<td>K</td>
<td>1009</td>
<td>0x3F0</td>
</tr>
<tr>
<td>CO₂ (average), pc³</td>
<td>ppm</td>
<td>1061</td>
<td>0x424</td>
</tr>
<tr>
<td>CO₂ (raw), pc³</td>
<td>ppm</td>
<td>1063</td>
<td>0x426</td>
</tr>
<tr>
<td>CO₂ (average), npc⁴</td>
<td>ppm</td>
<td>1065</td>
<td>0x428</td>
</tr>
<tr>
<td>CO₂ (raw), npc⁴</td>
<td>ppm</td>
<td>1067</td>
<td>0x42A</td>
</tr>
<tr>
<td>Pressure p</td>
<td>mbar</td>
<td>1201</td>
<td>0x4B0</td>
</tr>
<tr>
<td>Pressure p</td>
<td>psi</td>
<td>1203</td>
<td>0x4B2</td>
</tr>
</tbody>
</table>

¹) Register number starts from 1
²) Register address starts from 0
³) pc ... pressure compensated
⁴) npc ... not pressure compensated

Tab. 10  I²C and UART Modbus register map for 32 bit floating point values

INT16

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Scale³</th>
<th>Register number¹ [DEC]</th>
<th>Protocol address² [HEX]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature T</td>
<td>°C</td>
<td>100</td>
<td>4002</td>
<td>0xFA1</td>
</tr>
<tr>
<td>Temperature T</td>
<td>°F</td>
<td>50</td>
<td>4003</td>
<td>0xFA2</td>
</tr>
<tr>
<td>Temperature T</td>
<td>K</td>
<td>50</td>
<td>4005</td>
<td>0xFA4</td>
</tr>
<tr>
<td>CO₂ (average), pc⁴</td>
<td>ppm</td>
<td>1</td>
<td>4031</td>
<td>0xFBE</td>
</tr>
<tr>
<td>CO₂ (raw), pc⁴</td>
<td>ppm</td>
<td>1</td>
<td>4032</td>
<td>0xFB0</td>
</tr>
<tr>
<td>CO₂ (average), npc⁵</td>
<td>ppm</td>
<td>1</td>
<td>4033</td>
<td>0xFC0</td>
</tr>
<tr>
<td>CO₂ (raw), npc⁵</td>
<td>ppm</td>
<td>1</td>
<td>4034</td>
<td>0xFC1</td>
</tr>
<tr>
<td>Pressure p</td>
<td>mbar</td>
<td>10</td>
<td>4101</td>
<td>0x1004</td>
</tr>
<tr>
<td>Pressure p</td>
<td>psi</td>
<td>100</td>
<td>4102</td>
<td>0x1005</td>
</tr>
</tbody>
</table>

¹) Register number starts from 1
²) Register address starts from 0
³) Examples: For scale 100, the reading of 2550 means a value of 25.5. For scale 50, the reading of 2550 means a value of 51.
⁴) pc ... pressure compensated
⁵) npc ... not pressure compensated

Tab. 11  I²C and UART Modbus register map for 16 bit signed integer values

4.4 General Purpose Registers for Individual Use

There are two registers reserved for any customer use, e.g. serial number, traceability, etc.

<table>
<thead>
<tr>
<th>Register number¹ [DEC]</th>
<th>Register address² [HEX]</th>
<th>Space (standard Modbus register)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5801</td>
<td>0x16A8</td>
<td>16 bits / 2x8 bits / 2 bytes</td>
</tr>
<tr>
<td>5802</td>
<td>0x16A9</td>
<td>16 bits / 2x8 bits / 2 bytes</td>
</tr>
</tbody>
</table>

¹) Register number starts from 1
²) Register address starts from 0

Tab. 12  Registers for special customer purpose
4.5 EE895 Commands

The following commands are available via Modbus over I²C and Modbus over UART.

PLEASE NOTE

I²C simplified does not support Modbus encapsulation. Therefore, no Modbus communication and no settings are possible.

4.5.1. Information

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address¹) [HEX]</th>
<th>Description</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x03</td>
<td>0x00</td>
<td>Serial number</td>
<td>EE895 serial number, ASCII, 0 terminated</td>
</tr>
<tr>
<td></td>
<td>0x08</td>
<td>FW-Version (Major, Minor)</td>
<td>High-Byte = Major Version Low-Byte = Minor Version Example: 0x011A = 1.26 [01=1; 1A=26]</td>
</tr>
<tr>
<td></td>
<td>0x09</td>
<td>Sensor name</td>
<td>2 ASCII characters for each Register (“EE895”) String is 0-terminated</td>
</tr>
</tbody>
</table>

¹) Register address starts from 0

Tab. 13   Available commands for I²C and UART

PLEASE NOTE

When reading the serial number or the sensor name, it is always necessary to read all 8 registers, even if the desired information requires less.

4.5.2. General Settings

The following functions allow for EE895 settings. These are stored in the RAM, therefore they are volatile.

Measuring mode: continuous or single shot

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address¹) [HEX]</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read 0x03 Write 0x06</td>
<td>0x1F8</td>
<td>[Bit 0] Default status = 0 0 = continuous. The EE895 measures at the regular interval set with the command “CO₂ measuring interval”, see chapter 4.5.3. 1 = single shot. The EE895 measures only with the command “Measuring trigger”, see below. [Bit 1..15] reserved (must be written as 0)</td>
</tr>
</tbody>
</table>

¹) Register address starts from 0

Tab. 14   Continuous or single shot measurement
**Measuring status:** indicates when new single shot measurement is possible.

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address&lt;sup&gt;1)&lt;/sup&gt; [HEX]</th>
<th>Note</th>
</tr>
</thead>
</table>
| 0x03          | 0x1F9                            | [Bit 0]: Data ready. The data are available for read out. 0 = busy, 1 = ready  
[Bit 1]: Trigger ready. The EE895 is ready for new measurement cycle. The minimum time interval between two triggers is 10 s. 0 = trigger not possible 1 = ready for new trigger  
[Bit 2..15]: reserved (do not use) |

<sup>1)</sup> Register address starts from 0

Tab. 15  Single shot measurement possible

**Measuring trigger:** command for the single shot measurement. For accurate measurement results, there are recommended six single shot measurements under stable temperature conditions.

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address&lt;sup&gt;1)&lt;/sup&gt; [HEX]</th>
<th>Note</th>
</tr>
</thead>
</table>
| 0x06          | 0x1FA                            | [Bit 0]: Measurement Trigger 0 = don’t care 1 = Start new measurement cycle  
[Bit 1..15]: reserved (must be written as 0) |

<sup>1)</sup> Register address starts from 0

Tab. 16  Command single shot measurement

**EE895 detailed status**

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address&lt;sup&gt;1)&lt;/sup&gt; [HEX]</th>
<th>Note</th>
</tr>
</thead>
</table>
| 0x03          | 0x258                            | [Bit 0]: CO₂ measurement too high  
[Bit 1]: CO₂ measurement too low  
[Bit 2]: T measurement too high  
[Bit 3]: T measurement too low  
[Bit 6]: p measurement too high  
[Bit 7]: p measurement too low  
[Bit 8...15]: reserved (do not use) |

<sup>1)</sup> Register address starts from 0

Tab. 17  Status details
4.5.3. **CO₂ Parameter Settings**

The CO₂ parameter settings are non-volatile since they are stored in the flash memory.

<table>
<thead>
<tr>
<th>Function code</th>
<th>Register address¹) [HEX]</th>
<th>Description</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x06</td>
<td>0x1450</td>
<td>CO₂ measuring interval</td>
<td>S</td>
<td>16 bit integer unsigned Scale 1:10. Example: 150 = 15 seconds Range 100...36 000 Default 15 s</td>
</tr>
<tr>
<td></td>
<td>0x1451</td>
<td>CO₂ filter coefficient*)</td>
<td></td>
<td>16 bit integer unsigned Range 1…20 Default: 4</td>
</tr>
<tr>
<td></td>
<td>0x1452</td>
<td>CO₂ customer offset</td>
<td>ppm</td>
<td>16 bit integer signed Range -32 786…32 785 Default: 0 ppm</td>
</tr>
</tbody>
</table>

¹) Register address starts from 0

Tab. 18 CO₂ parameter settings

*) The EE895 features an exponential moving average filter which to a certain degree suppresses the influence of short-term CO₂ variations onto the output CO₂ data. The filter coefficient is user selectable and affects the response time of the EE895. A higher filter coefficient leads to smoother output data and to longer response time, see figure Fig. 12. Fig. 13 shows the number of samples required to reach 63% or 90% of a CO₂ step as function of the filter coefficient.

![Step response vs. samples](image-url)

**Fig. 12** Step response vs. samples
5 Technical Data

Measurands

CO₂

<table>
<thead>
<tr>
<th>Measurement principle</th>
<th>Dual wavelength non-dispersive infrared technology (NDIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>0...2 000 / 5 000 / 10 000 ppm</td>
</tr>
</tbody>
</table>
| Accuracy\(^1\)
  @ 25 °C (77 °F) and 1 013 mbar (14.7 psi)
  0...2 000 ppm                         | < ±(50 ppm + 2 % of measured value)                       |
  0...5 000 ppm                         | < ±(50 ppm + 3 % of measured value)                       |
  0...10 000 ppm                        | < ±(100 ppm + 5 % of the measured value)                  |
| T and p compensation of the CO₂ reading | With on-board sensors                                    |
| Temperature dependency, typ.          | ±(1 + CO₂ concentration [ppm] / 1 000) ppm°C (-20...45 °C) (-4...113 °F) |
| Residual pressure dependency\(^2\), typ. | ±0.014 % of the measured value / mbar (ref. to 1 013 mbar) |
| Initialisation time (power on)        | < 1 s                                                     |
| Response time \(t_{1\text{a}}\)        | 140 s with measured data averaging (smooth output)       |
| Sampling intervall                    | 75 s without measured data averaging                      |
| Calibration interval\(^3\)            | User configurable from 10 s up to 1 h; factory setup = 15 s |

1) With data averaging for smooth output signal. Operation without measured data averaging or in short-time mode might lead to additional measurement uncertainty.
2) The pressure dependency of a device without pressure compensation: 0.14 % of measured value / mbar.
3) Recommended under normal operating conditions in building automation.

Pressure (p)

<table>
<thead>
<tr>
<th>Working range</th>
<th>700...1 100 mbar (10.15...15.95 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy, typ.</td>
<td>±2 mbar (20...80 %RH)</td>
</tr>
<tr>
<td>@ 25 °C (77 °F)</td>
<td></td>
</tr>
<tr>
<td>Temperature dependency, typ.</td>
<td>±0.015 mbar/K</td>
</tr>
</tbody>
</table>

---

\(^1\) See Fig. 13 Step response vs. filter coefficient.

---

www.epluse.com
### Temperature (T)

<table>
<thead>
<tr>
<th>Measuring range</th>
<th>-40...60 °C (-40...140 °F)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>±0.5 °C (±0.9 °F)</td>
</tr>
<tr>
<td>@ 24 V DC, 20 °C (68 °F)</td>
<td></td>
</tr>
</tbody>
</table>

### General

<table>
<thead>
<tr>
<th>Digital interface (pin-selectable)</th>
<th><strong>I²C</strong>&lt;br&gt;UART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 100 kbit/s&lt;br&gt;9 600 Baud, 8 bits, no parity, 1 stop bit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module control</th>
<th>Enable pin&lt;br&gt;Data ready pin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous operation / power down&lt;br&gt;Indication of valid data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply voltage</th>
<th>3.3 - 5 V DC ± 5 %</th>
</tr>
</thead>
</table>

**Average current consumption, typ.**<br>for supply voltage 5 V<br>1.6 mA at 15 s sampling interval<br>198 µA at 1 h sampling interval with standby between measurements<br>8 µA at 1 h sampling interval with power down between measurements

<table>
<thead>
<tr>
<th>Current profile CO₂&lt;br&gt;typical values for supply voltage 5 V</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="chart.png" alt="Current profile diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical connection</th>
<th>Side plated contacts and solder pads, Ø 1 mm (0.04&quot;)</th>
</tr>
</thead>
</table>

**Working and storage conditions**<br>-40...60 °C (-40...140 °F)<br>0...95 %RH (non-condensing)<br>700...1 100 mbar (10...16 psi)