APPLICATION NOTE AN1611-1

Application Note

E2 Interface for EE871, EE892 and EE893

Rev. 1.0 11/2016

Relevant for:

This application note applies to EE871, EE892 and EE893

Introduction:

The E2 interface is used for the digital, bidirectional data transmission between a Master and a Slave device.
The data transmission takes place via synchronous and serial modes, the Master being responsible for generating the clock signal. The Slave cannot send any data independently.

CONTENT

1 Readable parameters

These parameters/values [hex] can be read via E2 interface:

command:	return-value	kind	format	Measuring range	output
Group (two bytes)	**EE871:** 0x0367 (871_d) **EE892:** 0x037C (892_d) **EE871:** 0x037D (873_d)		unsigned int.		
Sub-Group	0x09		byte		
Available measured variables	0x08		byte		
Statusbyte:[1)]	0x0_		byte		
Measuring value 1:		Not defined			
Measuring value 2:		Not defined			
Measuring value 3:		CO2 eg. for handhelds and fast response	unsigned int.	0 – 2000 or 0 – 5000 or 0 – 10000	ppm
Measuring value 4:		CO2 Averaged Value eg. for climate control	unsigned int.	0 – 2000 or 0 – 5000 or 0 – 10000	ppm

[1)] Gives information on whether last measurement was successful

1.1 Available parameters in custom area

- Firmware-Mainversion
- Firmware-Subversion
- Offset CO_2
- Gain CO_2
- Upper calibration point CO_2
- Lower calibration point CO_2
- Last customer adjustment
- Last customer adjustment of CO_2
- Serial number
- Part name
- Error code
- global measurement time interval

2 Electrical requirements

Symbol	Parameter	Minimum	Maximum	Unit	Remark
V_{DD}	Bus-High-Voltage	3,6	5,2	V	For minimizing the supply current use 4.5V to 5.0V
f_{CLK}	Clock frequency	500	5000	Hz	The highest achievable data rate depends on the combination of line capacity and the pull-up resistors.
Rup	Pull-up resistor	4,7	100	kΩ	

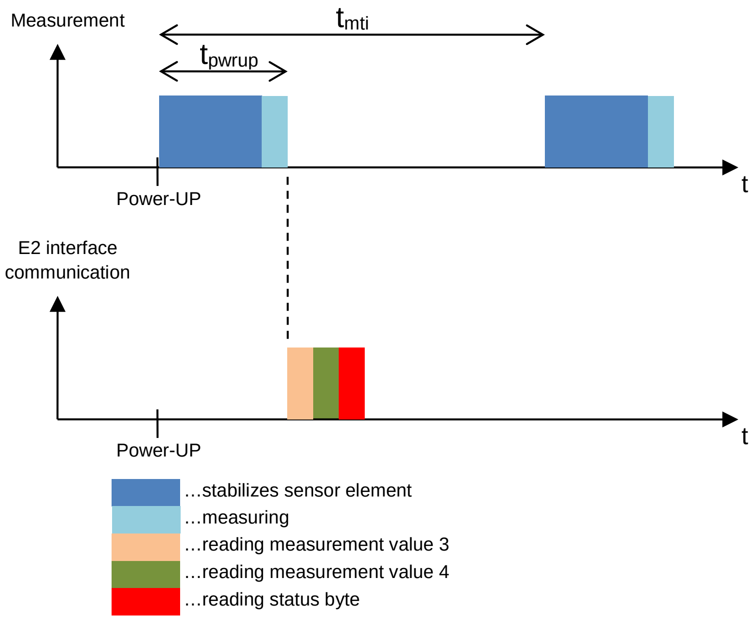
3 Error Code List

Error Code	Description
1	Supply Voltage Low detected
200	Sensor Counts Low possible damage of electronic or sensor-cell
201	Sensor Counts High possible damage of electronic or sensor-cell
202	Supply Voltage Breakdown at current peak for measurement maybe the internal resistance of supply unit is to high

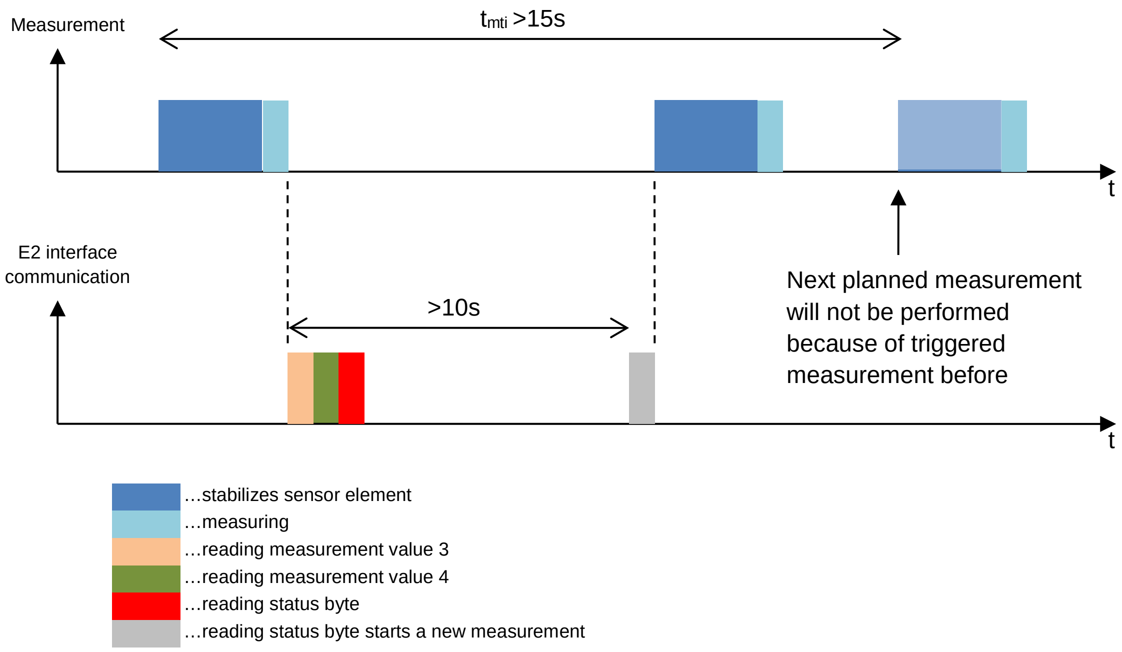
4 Measurement Timing

	minimum	typical	maximum
t_{pwrup}		5s	10s
t_{stab}		4,3s	9,3s
t_{meas}		0,7s	
t_{mti}	15s		3600s

Examples:



For measuring time interval > 15s a measurement can be triggered by reading the status byte, nevertheless only if the last measurement dates back longer than 10s



5 Timing for write commands

Writing a byte to the device (with control byte 0x10) takes <=150ms and can be done by writing the flash memory. During the writing time E2 communication interrupts are deactivated. The attempt to communicate with the device while the flash is being written forces the clock low extension which holds the clock line low until the write routine has finished.

Note: When writing the measurement interval (address 0xC6 and 0xC7) both values will be written together into the flash. Writing will start after sending both bytes and will cause a communication delay of <=300ms.

6 Optimizing the power consumption

6.1 Operation Modes

E+E CO_2 modules are designed to change their operation mode based on the actual status of measurement or communication. The supply current is different for each operation mode and it is shown given below as well as in Figure 1.

Mode	min. supply current	description
Sleep mode	40µA	The module is waiting for measurement or communication request
Warm-up mode	1.7mA	The module is in warm-up mode. Duration ~4.3s before a measurement is taken. Upon starting the warm-up mode a 10µF capacitor is charged. The current peak of up to ~1.2A lasts for ~200µs.
Communication mode	3.4mA	initiated by an interrupt on the E2 Bus and lasts for at least 1s
Measuring mode	120mA	average value over 350ms, caused by flashing the infrared lamp. For details see Figure 2.

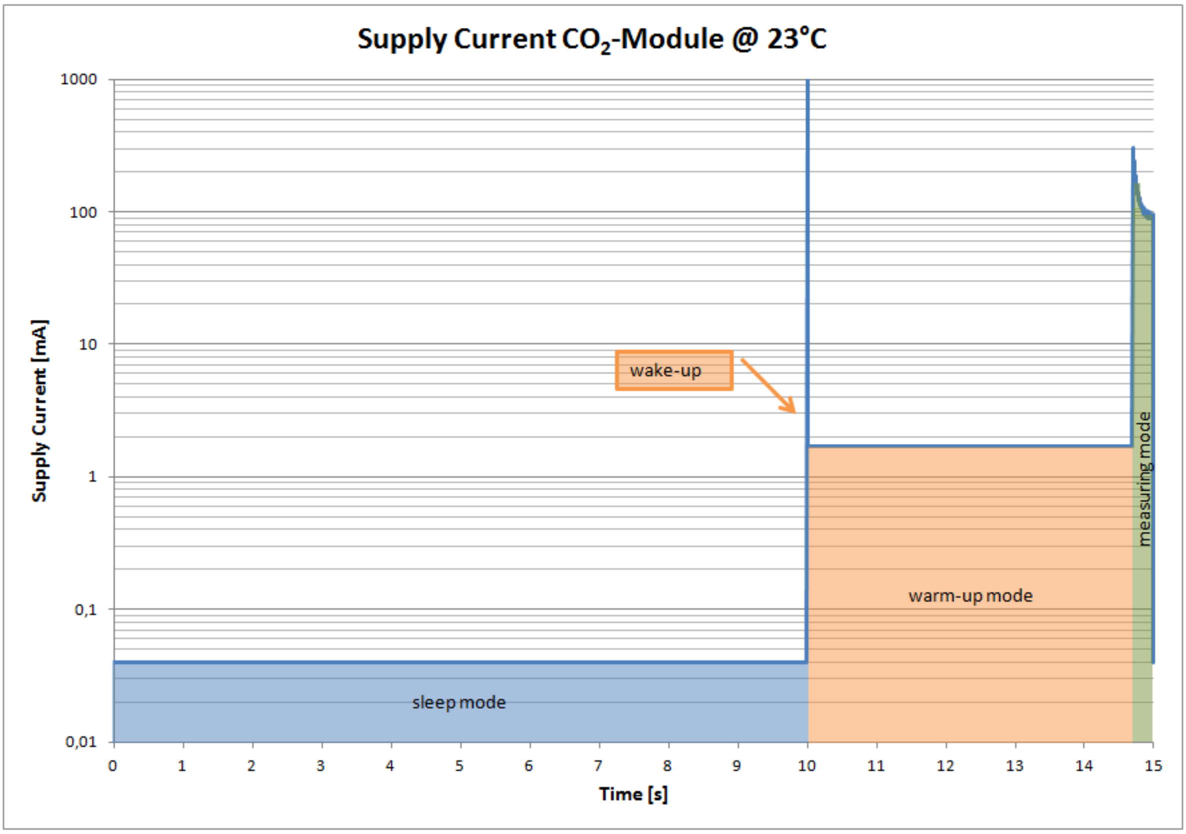


Figure 1: Supply current for 15s measuring time interval @23°C

Setting a longer measuring interval extends the sleep mode time.

After a reset the modules starts with the warm-up mode and continues with the first measurement after 4.3s.

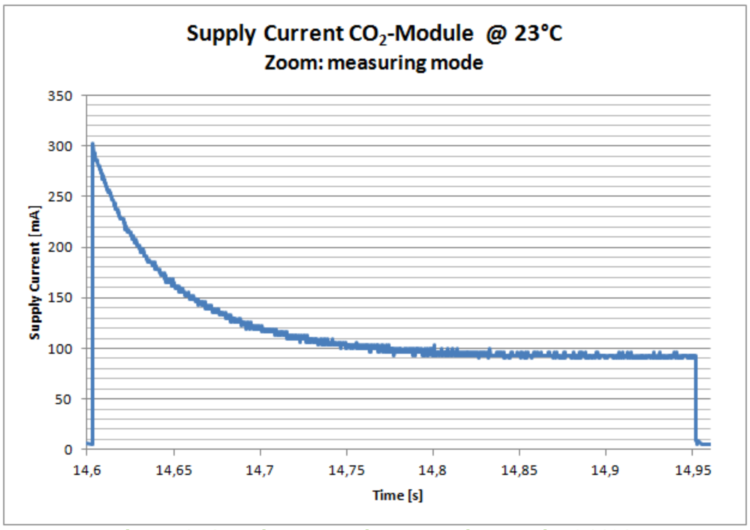


Figure 2: Supply current in measuring mode @23°C

6.2 Measuring Time Interval

The peak current during the measurement mode is conditioned by the infrared lamp and cannot be reduced. The average power consumption can be reduced by increasing the measuring interval.

The measuring interval can be set by writing the interval time to customer addresses 0xC6 and 0xC7 as an unsigned integer value in unit s/10. Figure 3 shows the impact of the measuring time interval on the average supply current.

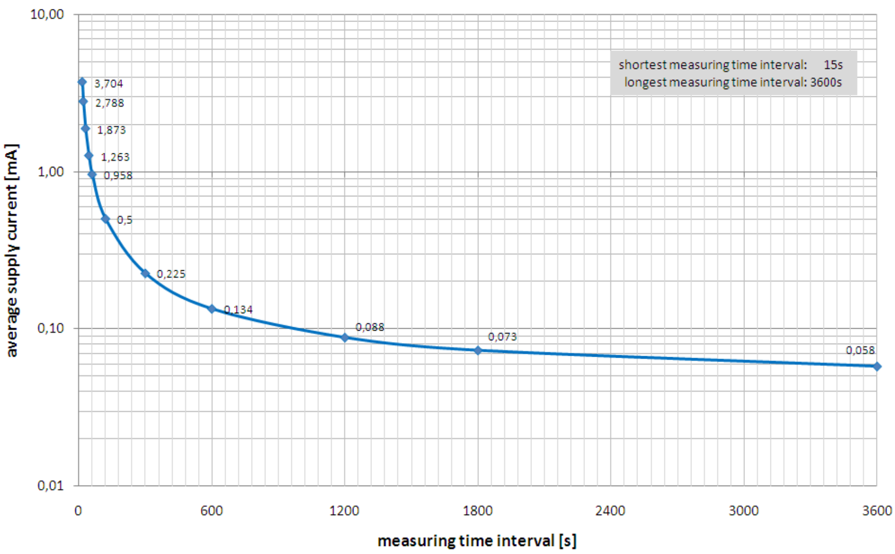


Figure 3: average supply current as function of the measuring interval

Example:

For 15 s measuring time interval four AA batteries (1.5V, 2500mAh) would last approx. 30 days. Changing the sampling rate to 600s (10min) would increase the battery lifetime to about 30 months.

6.3 Communication

Communication on the bus forces the module to switch to communication mode. The power consumption of the CO2 modules can be reduced by avoiding unnecessary communication.

For low power consumption it is important to avoid disturbances on the bus, which would prevent the CO2 module from getting into sleep mode.

6.4 Bus voltage level

The high level on the bus is likely to be 3.6V ... 5.2V. For minimising the supply current the high level on the bus should be 4.5V ... 5.0V.

7 Setting the measuring time interval

Following steps are necessary for setting the measurement time interval for E+E CO_2 modules.

7.1 Check if “Global Measurement Interval” function is supported

- Set the read pointer with control byte 0x50 *Set internal custom pointer* to address 0x07
- Read the value of byte 0x07 with control byte 0x51 *Read from internal custom address*

User setup of the measuring time interval is possible if bit 4 of the read byte is ‘1’.

7.2 Check current measuring time interval

- Set the read pointer with control byte 0x50 to address 0xC6
- Read the Global Measurement Interval low-byte with control byte 0x51
- Read the Global Measurement Interval high-byte with control byte 0x51 (pointer increments automatically after reading a byte)
- Calculate the measuring time interval using the following formula

$$measuring\ time\ interval = \frac{measuring\ time\ interval\ low\ byte + measuring\ time\ interval\ high\ byte * 256}{10}$$

Example:

$$measuring\ time\ interval = \frac{150 + 0 * 256}{10} = \frac{150}{10} = 15s$$

7.3 Set the measuring time interval

For setting the measuring time interval one must always write both the low and the high byte of the Global Measuring Interval (Bytes 0xC6 and 0xC7 in Custom Area). Values smaller than 150 (=15s) and higher than 36000 (=3600s) will be ignored by the firmware.

Calculation of byte values:

$$measuring\ time\ interval\ low\ byte = (measuring\ time\ interval * 10)\ MOD\ 256$$

$$measuring\ time\ interval\ high\ byte = (measuring\ time\ interval * 10)/256$$

MOD…modulo operation
For division only integer values are relevant.

Example for 60s interval:

$$measuring\ time\ interval\ low\ byte = (60 * 10)\ MOD\ 256 = 600\ MOD\ 256 = 88$$

$$measuring\ time\ interval\ high\ byte = \frac{(60*10)}{256} = \frac{600}{256} = 2$$

Writing values to custom area:
- Write the low byte with control byte 0x10 *Direct write to custom area* and address 0xC6.
- Write the high byte with control byte 0x10 *Direct write to custom area* and address 0xC7.

8 Selecting the Output Value

The E2 Interface provides up to 4 output values (measurement value 1 to measurement value 4).

Measurement value 4 (Value Index: 30 acc. E2 bus uniform measurement value table)is the standard CO_2 output value and it is appropriate for most applications. This CO_2 output value is optimized for low noise output signal and it is calculated out of the last 11 measurements

Measurement value 3 (Value Index: 31 acc. E2 bus uniform measurement value table) delivers fast response CO_2 value and is meaningful only for applications with fast changing CO_2 concentration. Measurement value 3 is the last measured CO_2 value without any averaging. It implies a noise of typ. ±30ppm which should be taken into account for the overall accuracy.

NOTE: When using measurement value 3 any disturbance affects immediately to the output

Example: The CO_2 level increase caused by the exhaled air of an individual passing by the sensor will be visible in the measurement value 3.

The choice of using one, the other or both measurement values depends on the application. Please contact E+E Elektronik or a local distributor for any support you might need.

9 Response time

The response time for measurement value 3 and 15s measurement interval is $\tau_{90} \approx 60s$.

For measurement value 4 with 15s measurement interval the response time is $\tau_{90} \approx 105s$. Longer response time is of advantage in climate control applications because it filters out short time peaks and consequently avoids changes in ventilation based on short time events.

Longer measuring interval increases the response time of measurement value 4.

10 Triggering a measurement

For measuring interval > 15s, the master device can trigger a measurement by reading the status byte (control byte = 0x71) if the last measurement value is older than 10s. The new measurement value will be available typically 5s to 10s after the trigger.

After each triggered measurement the interval time counter is set to ‘0’.

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