CO2 indicator userguide v 1.1

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Contents

1 Preliminaries 4
2 Overview 5
3 Behaviour overview 6
4 Downlink commands.... 10

1 Preliminaries

This userguide document is targeted at “system integrators”, who are defined but not limited to partners who integrate ZENNER devices into their readout systems, mostly by implementing own software which accesses the devices either via IR and/or by parsing the data sent via radio.

The content of this document does not constitute a performance declaration and is by no means a complete description of the device. Instead, items are selected which seem to be relevant for typical system integrators. The document will be modified over time and is provided as-is without any warranties.

All information within this document is confidential and shall not be distributed further.

AUS DIESEM DOKUMENT ABGELEITETE PRODUKTZUSAGEN BEDÜRFEN DER SEPARATEN FREIGABE.
PRODUCT FEATURES DERIVED FROM THIS DOCUMENT REQUIRE SEPARATE CONFIRMATION AND RELEASE.

2 Overview

This document gives some additional information for system integrators about the behavior and the communication interface of the CO2 indicator.

It is assumed that the reader is aware of the content given in [1].

3 Behaviour overview

Please refer to the description in [1].

Regarding the table provided there, indicating measuring range, evaluation and LED color, the value *upper_threshold* described further below defines start of the “high” region. Default value of *upper_threshold* is 1.000 ppm, as can be seen in the table. Smallest possible value of *upper_threshold* is 801.

Differently from other ZENNER devices, CO2 indicator provides no local configuration interface. Some configurations are possible via LoRa downlink command.

3.1 Operation modes

As described in [1], there are different operation modes:

- Device switched off: no measurement, display off, LED indicator off, radio off
- Display off / energy saving mode: measurement active, display off / in screen saver mode, radio active, LED indicator active

3.2 commissioning

When switched on or after reset network settings, the device will enter join procedure:

- Device will send out a join request and repeat max 4 times if no join accept was received
- During this first phase, the radio signal strength indicator (RSSI) will blink until a join accept was received or latest 2 minutes after last join request was sent
- If no join accept was received during this first phase, the device will continue to send out one join request every 24h
- RSSI will be switched off if no join accept was received during first phase
- RSSI will be active and stable as soon as a join accept was received. In that case the number of visible parts (min. 1) will indicate the RSSi value.

LoRa session keys are kept during power saving modes. While the display is being switched off, session keys are kept and the device keeps transmitting radio packets

3.3 Normal radio operation

There is only one CommunicationScenario the CO2 indicator supports, which is CommunicationScenario 204.

The following packets are sent:

Packet type	Schedule	Details	remarks
SP 0	N/A		
SP 1	N/A		
SP 2	N/A	N/A	
SP 3	N/A	N/A	
SP 4	N/A	N/A	
SP 5	N/A		
SP 6	N/A		
SP 7	N/A		
SP 8	N/A		
SP 9.0	N/A		
SP 9.1	Sent immediately after first join accept and from then on every 6 months	Up to 2 retransmissions	See explanations below
SP 9.2	Sent immediately after first join accept and from then on every 6 months	up to 2 retransmissions after first activation only	See explanations below
SP 9.3	N/A		
SP 12	N/A		
SP13	Sent every 45 minutes		See explanation below
AP 1.0	Event based	Max 4 AP packets of status codes 0x20 and/or 021 per hour, max 2 AP packets of status codes 0x05 and/or 0x22per day no retransmissions	See explanation below
AP 2.0	N/A		

Table 1: **overview of packet types and transmission rules**

3.3.1 SP 9.1

The SP9.1 packet follows the specification given in [2], with the following specific usage:

- Time stamp followiing EN13757-3, Annex A, Type F, local device time
- Status summmary: not used, should be ignored by receiver (might be used in future releases)
- Reserved: not used, should be ignored by receiver (might be used in future releases)

Example of 4 bytes of time stamp:

110E6725 converts to: 2019-May-07, 14:17:00

29007426 converts to: 2019-06-20, 00:41:00

Please note that the byte order is not swapped in this case, so a SP9.1 packet of the first example would be transmitted as follows:

91 11 0E 67 25 00 00 00 00 00 00

3.3.1 SP 9.2

The SP9.2 packet follows the specification given in [2], with the following specific usage:

- Minol device type: 03
- meterID: not used, set to 0xFF 0xFF

3.3.2 SP 13

The SP13 packet follows the specification given in [2], with the following specific usage:

- Ordering type 0xFF
- Encoding of ppm values in two bytes (the other two bytes will be 0x00)
- Unknown values are transmitted as 0xFF

3.3.3 AP1, status code 0x20

The AP1 packet, status code 0x20, follows the specification given in [2], with the following specific usage:

- Packet is sent immediately once the ppm value has been rising from a value below *upper_threshold* to a value above *upper_threshold*
- As long as the ppm value remains above *upper_threshold*, no further packet of this type is sent
- max 4 AP packets of status codes 0x20 and/or 0x21 are sent per hour

3.3.4 AP1, status code 0x21

The AP1 packet, status code 0x21, follows the specification given in [2], with the following specific usage:

- Packet is sent immediately once the ppm value has been falling from a value above *lower_threshold* to a value below *lower_threshold*
  This enables implementing a hysteresis and helps avoiding transmission of AP1 packets with status codes 0x20 and 0x21 in short interval.
- As long as the ppm value remains below *lower_threshold*, no further packet of this type is sent
- max 4 AP packets of status codes 0x20 and/or 0x21 are sent per hour

3.3.5 AP1, status code 0x05

The AP1 packet, status code 0x05, follows the specification given in [2], with the following specific usage:

- Packet is sent once battery is critically low
- Current Battery voltage is currently not being transmitted
- In total, max 2 AP1 packets with status code 0x05 are transmitted per day. This counter restarts once the device was rebooted or power cycled

3.3.6 AP1, status code 0x22

The AP1 packet, status code 0x22, follows the specification given in [2], with the following specific usage:

- Packet is sent once a hardware failure is detected
- An error code is currently not being transmitted
- In total, max 2 AP1 packets with status code 0x22 are transmitted per day. This counter restarts once the device was rebooted or power cycled

4 Downlink commands

There are two groups of downlink commands

- one group including a command to set the CO2 alarm threshold value, and another one to get (read) the configured alarm threshold value.
- a second group including commands to set and shift the internal device time

4.1.1 Set alarm threshold

The command „SetMetrologyParameter“ (FC 0x36 EFC 0x02) will be used to set the CO2 alarm thresholds.

Command structure is as follows:

Byte position	short name	value	remarks
1	FC	0x36	function code, downlinks with different FC field value have to be answered with "NACK"
2	EFC	0x02	extended function code, downlinks with different EFC field value have to be answered with "NACK"
3,4	Device identity	0x040	device identity of CO2 sensor, downlinks with different device identity value have to be answered with "NACK"
5,6	lower alarm threshold	[2 bytes, binary coded]	lower alarm threshold value overwrites the configured value of critical threshold. Unless a downlink with a different value was received, 900 (decimal) is the default value for critical threshold. A value of 0xFFFF indicates that this threshold value is not to be changed.
7,8	upper alarm threshold	[2 bytes, binary coded]	upper alarm threshold value overwrites the configured value of critical threshold. Unless a downlink with a different value was received, 1000 (decimal) is the default value for critical threshold A value of 0xFFFF indicates that this threshold value is not to be changed.
9-14	reserved	[6 bytes]	to be ignored
15-16	CRC		downlink command with invalid CRC value has to be completely ignored!

Table 2: **SetMetrologyParameter command to set CO2 threshold**

This command has to be sent from the LoRa network server down to the device using fport 1.

The 2 bytes CRC at the end of the packet will be compared with a local CRC calculation in the device. If local CRC calculation delivers a result which differs from CRC in downlink command, the downlink command will be discarded silently. CRC is calculated using polynome 0x8005 and start value 0xFFFF.

example:

Example for a command setting lower threshold value of 900 decimal (=0x384):

Payload: 36 02 40 00 84 03 FF FF FF FF FF FF FF FF 22 81 (CRC is 0x8122)

Payload: 36 02 40 00 84 03 00 00 00 00 00 00 00 00 03 03 (CRC is 0x0303)

In case the CRC matches and all other fields (FC, EFC, device identity) also match to the values given in the table 8, the configured threshold of the CO2 sensor is changed and the reception of the command is acknowledged using the following ACK packet as reply via LoRa:

Byte position	short name	value	remarks
1	ACK code	0xFE	indicates an ACK
2	FC	0x36	copy of FC field of request (only 0x36 possible)
3	[EFC]	0x02	copy of EFC field of request (only 0x02 possible)

Table 3: **ACK on SetMetrologyParameter command**

In case a downlink was received where CRC matches, and FC and EFC also match to the values given in the table 3, but the device identity does not match with table 3, a NACK will be sent in reply via LoRa, according to the following definition (if CRC does not match, the device shows no reaction at all):

Byte position	short name	value	remarks
1	NACK code	0xFF	indicates a NACK
2	FC	0x36	copy of FC field of request
3	[EFC]	0x02	copy of EFC field of request
4	error code	0x03	parameter error

Table 4: N**ACK on SetMetrologyParameter command**

4.1.2 Get alarm threshold:

The command „GetMetrologyParameter“ (FC 0x36 EFC 0x02) can be used to get (read) the CO2 alarm threshold. Definition of „GetMetrologyParameter“ as follows:

Byte position	short name	value	remarks
1	FC	0x36	Function Code
2	EFC	0x02	Extended Function Code
3-4	CRC	0xB402	fixed value

Table 5: **GetMetrologyParameter command to set (read) CO2 threshold**

This command has to be sent from the LoRa network server down to the device using fport 1.

If the CRC value is other than 0xB402, the downlink command will be discarded silently.

Example:

Complete command in payload: 360202B4.

In case the CRC matches and the other fields (FC, EFC) also match with the values given in the table above, the device will copy its currently internally configured alarm threshold into an answer packet via LoRa which is structured as follows:

Byte position	short name	value	remarks
1	FC	0x36	fixed in all answers
32	EFC	0x02	fixed in all answers
3,4	Device identity	0x0040	fixed in all answers
5-6	Depending on device identity	[2 bytes, binary coded]	value of currently configured lower alarm threshold
7-8	Depending on device identity	[2 bytes, binary coded]	value of currently configured upper alarm threshold
9-14	reserved	all 0xFF	

Table 6: **Answer on GetMetrologyParameter command**

4.1.3 SetSystemTime

The command „SetSystemTime“ (FC 0x87) will be used via LoRa downlink to set the device time (absolute value).

Byte position	short name	value	remarks
1	FC	0x87	Function code
2	Year	[0x21… 0x99]	offset from the year 2000
3	Month	[0x01… 0x0C]	1 for January, 12 for December
4	DayOfMonth	[0x01… 0x1F]	1 for the first day of the month
5	Hour	[0x00… 0x17]	0 - 23
6	Minute	[0x00… 0x3B]	0 - 59
7	Second	[0x00… 0x3B]	0 - 59
8	TimeZone	[0x00…0x60]	UTC time zone. Signed byte. Unit: ¼ hours.

Table 7: **SetSystemTime command**

The parameter TimeZone is not to evaluated by the device.

In case the CRC matches, FC field is 0x87 and the values of all other fields are within the ranges specified above, the device will immediately update its system time and send back an ACK which indicates successful reception as follows:

Byte position	short name	value	remarks
1	ACK code	0xFE	indicates an ACK
2	FC	0x87	copy of FC field of request (only 0x87 possible)

Table 8: **ACK on SetSystemTime command**

Example:

Complete command in payload: 871507060B3600020093

Which will set the device date and time to:

Year 2021, July, 06

11:54:00

4.1.4 GetSystemTime

The same function code which is used to set the system time can also be used to get (read out) the system time. For that, a shorter command packet has to be sent to the device, as follows:

Byte position	short name	value	remarks
1	FC	0x87	Function Code

Table 9: G**etSystemTime command**

In case the CRC matches, device will answer on GetSystemTime command as follows:

Byte position	short name	value	remarks
1	FC	0x87	Function code
2	Year	[0x21… 0x99]	offset from the year 2000
3	Month	[0x01… 0x0C]	1 for January, 12 for December
4	DayOfMonth	[0x01… 0x1F]	1 for the first day of the month
5	Hour	[0x00… 0x17]	0 - 23
6	Minute	[0x00… 0x3B]	0 - 59
7	Second	[0x00… 0x3B]	0 - 59
8	TimeZone	[0x00…0x60]	UTC time zone. Signed byte. Unit: ¼ hours.

Table 10: **Answer on GetSystemTime command**

4.1.5 TimeShift

The command TimeShift (FC 0x8E) can be used via LoRa downlink to shift the device time. It only covers a small range of +/- 10 hours (=36.000 seconds).

Byte position	short name	value	remarks
1	FC	8E	Function code
2,3	Time shift	[2 Bytes]	See explanation below

Table 11: **TimeShift command**

Explanations:

- Highest bit of Byte 3 gives the direction of the timeshift.
- Direction Bit == 0: Device shifts its local time by adding the value of Byte 2 and Byte 3 (except highest bit) in seconds to its current local time (device time moves to the future)
- Direction Bit == 1: Device shifts its local time by subtracting the value of Bytes 2 and Byte 3 (except highest bit) in seconds from its current local time (device time moves to the past)

In case the CRC matches and FC field is 0x8E the device will immediately update its system time and send back an ACK which indicates successful reception as follows:

Byte position	short name	value	remarks
1	ACK code	0xFE	indicates an ACK
2	FC	0x8E	copy of FC field of request (only 0x8E possible)

Table 12: **Answer on TimeShift command**

Example 1:

Complete command in payload: 8E1815A654

- 8E is the command ID
- 0x1518 = 5400 sec., highest bit = 0 means device will add 5400 seconds to its local time
- 0x54A6 is CRC16, using polynome 0x8005 and start value 0xFFFF

Example 2:

Complete command in payload: 8E1895A5D7

- 8E is the command ID
- 0x9518 = 5400 sec., highest bit = 1 means device will subtract 5400 seconds from its local time
- 0x54A6 is CRC16, using polynome 0x8005 and start value 0xFFFF

4.1.6 Unknown commands

In case a downlink is received where CRC matches, but which does not match to any of the above described commands the device will answer with a special NACK packet as follows:

Case A: FC is known, but EFC for this FC is unknown:

Byte position	short name	value	remarks
1	NACK code	0xFF	indicates a NACK
2	FC	0x36	copy of FC field of request
3	[EFC]	0x02	copy of EFC field of request
4	error code	0x00	unknown function

Table 13: **NACK on unknown EFC of a known FC command**

Case B: FC is unknown:

Byte position	short name	value	remarks
1	NACK code	0xFF	indicates a NACK
2	FC	0x36	copy of FC field of request
3	error code	0x00	unknown function

Table 14: **NACK on unknown FC command**