CO_2 Engine™ -BLG/ELG
Configuration guide
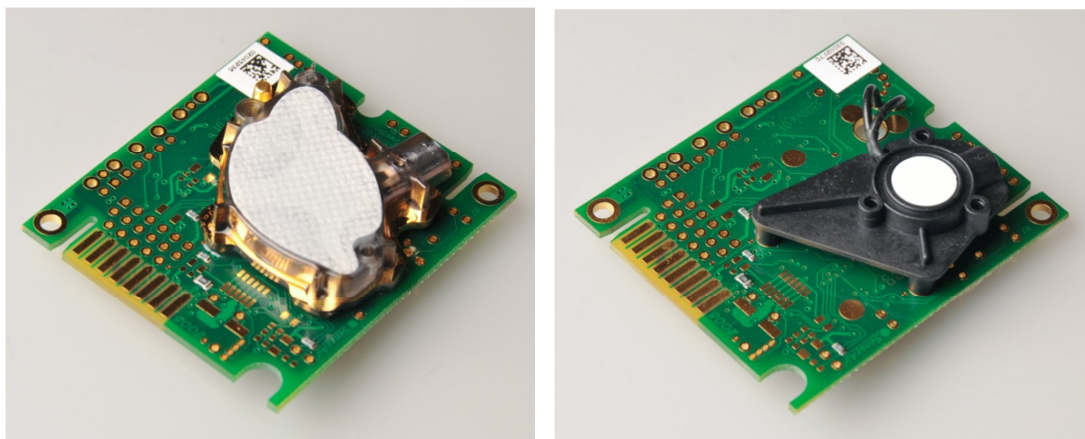

Figure 1   **CO_2Engine™ -ELG** *(left) and* **CO_2Engine™ -BLG** *(right)*

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1. Introduction

This document explains how to configure/use CO_2 Engine –BLG/ELG sensors. Examples explain data/parameters to write/read from specified addresses, not how to write/read data to the sensor. How to communicate with CO_2 Engine –BLG/ELG sensors is described in "I2C comm guide 2_12.pdf" (or later), "Modbus on CO2 Engine and eSense rev2_01.pdf" and "ModBus on CO2 Engine K30 - User Defined function codes rev1_00.pdf"

2. BLG/ELG configuration

2.1. Start measurement

Start single measurement on K33 BLG/ELG:

- Write 0x35 ("single measurement" command) to RAM address 0x60
- Read RAM address 0x1D and check that bit 5 is set (1), bit set means sensor has received "measurement" command and will start measurement cycle
- Wait 20s
- Read RAM address 0x1D again and check that bit 5 is cleared (0), bit cleared means that "measurement" cycle has finished
- Read CO2, temp, RH etc

Check of bit 5 in RAM 0x1D can be skipped, however then it's possible that sensor have not received the "single measurement" command or have not finished the measurement cycle and data read from sensor will be from previous measurement cycle.

To achieve specified accuracy on temperature and humidity measurements, time between measurements cycles must be 5 minutes or more. It is possible to activate "single measurement" with ~20s interval, but using a measurement interval less than 5 minutes will decrease the accuracy of temperature and humidity measurements significantly (this is also valid for continuous measurements, jumper set or "start continuous measurement").

Start continuous measurement on K33 ELG/BLG:

- Write 0x30 ("start continuous measurement" command) to RAM address 0x60
- Read RAM address 0x1D and check that bit 6 is set (1), bit set means sensor has received "continuous measurement" command and will start a measurement cycle after a 5 s start-up delay (default start-up delay = 5 s, see example below on how to adjust start-up delay).
- Write 0x31 ("stop continuous measurement" command) to stop measurement. Read 0x1D and check that bit 6 is cleared, bit cleared means sensor has received "stop continuous measurement" command.

The check of bit 6 in RAM 0x1D is only to verify that sensor actually received the commands.

Set/adjust sensor clock:

- Calculate nr of seconds since 1 Jan 2000.
- Write the calculated value to RAM address 0x65 (4b – most significant bit first).

Change measurement period (time between start of two measurement cycles):

- Write desired period in seconds to EEPROM address 0xB0 (3 byte, most significant bit first).

Adjust/change start-up delay:

- Write desired start-up delay (in seconds) to EEPROM address 0x23C (1 byte).

Read battery warning/alarm:

- Read alarm status from RAM 0x1C
    - Bit 5 set => low battery warning (battery voltage is less then 5.25)
    - Bit 4 set => low battery alarm (battery voltage is less than 4.75V)

Turn on ABC:
- Set bit 1 in MeterControl (RAM 0x03)
- Write calibration period/ABC period (unit = hours) to EEPROM address 0x40
- Restart sensor to activate the new settings

It is important that the sensor is exposed to fresh air (~400ppm) under at least one measurement during the ABC period; otherwise the sensor will end up with corrupt calibration parameters and show incorrect CO2 values (ABC has no effect on the accuracy of temperature and humidity measurements).

Switch off ABC:
- Clear bit 1 in MeterControl (RAM 0x03)
- Restart sensor to activate the new settings

2.2. LED/relay configuration

LED/relay (Status and out6-out9) structure start addresses

Parameter	Start address	Type/Size	Comment
Status structure	0xB4	5 bytes	
Out6 structure	0xB9	5 bytes	
Out7 structure	0xBE	5 bytes	
Out8 structure	0xC3	5 bytes	
Out9 structure	0xC8	5 bytes	

The name "Status" is historical; the output can configured exactly as out6-out9

LED/relay structure

Offset	Description
0, high nibble	Shape
0, low nibble	Input
1	Low limit, S16
3	High limit, S16

Shapes:

0 – Value>=High limit => Output set
Low limit < Value < High limit => no change
Value<=Low limit => Output cleared

1 – Value<=Low limit => Output set
Low limit < Value < High limit => No change
Value>=High limit => Output cleared

2 - Low limit < Value < High limit => Output set, else cleared

3 - Low limit < Value < High limit => Output cleared, else set

Inputs:

0 – CO2 value
1 – Space temp
2 – RH
3 – MR
4 – AnIn4

Input and shape byte = 0xFF => LED/relay (output) disabled

Since sensor use 0x7FFF as "Error data value" LED:s can also be used for error indications

Examples:

Configure status LED to go high at 2000ppm and to go low at 1000ppm.

Start to set input and shape nibbles
- Output set if value > high limit, cleared if value < low limit => shape nibble = 0
- Input = CO2 value => input nibble = 0

Status LED configuration

EEPROM Address	0xB4	0xB5	0xB6	0xB7	0xB8
Parameter value	0x00	0x03	0xE8	0x07	0xD0

Configure output 6 to go high above 50°C and below -20°C

Start with input and shape nibbles
- Output set if value <= low limit and if value >= high limit => shape nibble = 3
- Input = SpaceTemp => input nibble = 1

Out6 configuration

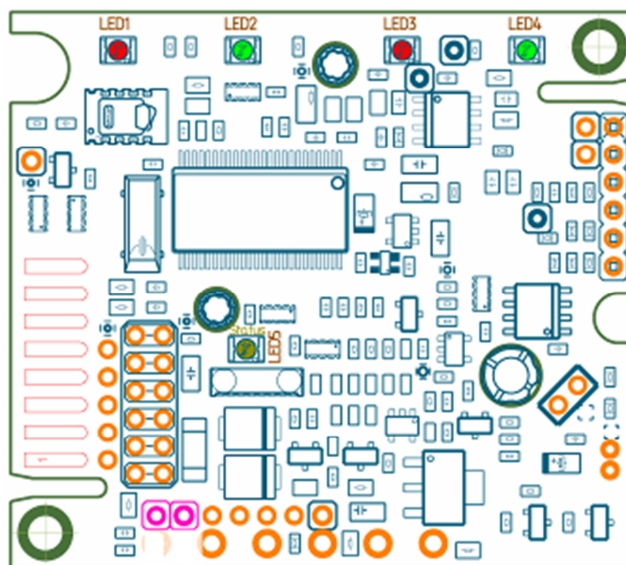| EEPROM Address	0xB9	0xBA	0xBB	0xBC	0xBD
Parameter value	0x31	0xF8	0x30	0x13	0x88

Figure 2, LED positions

LED1 – Heartbeat (see 2.4 Heartbeat configuration)
LED2 – Out6
LED3 – Out8
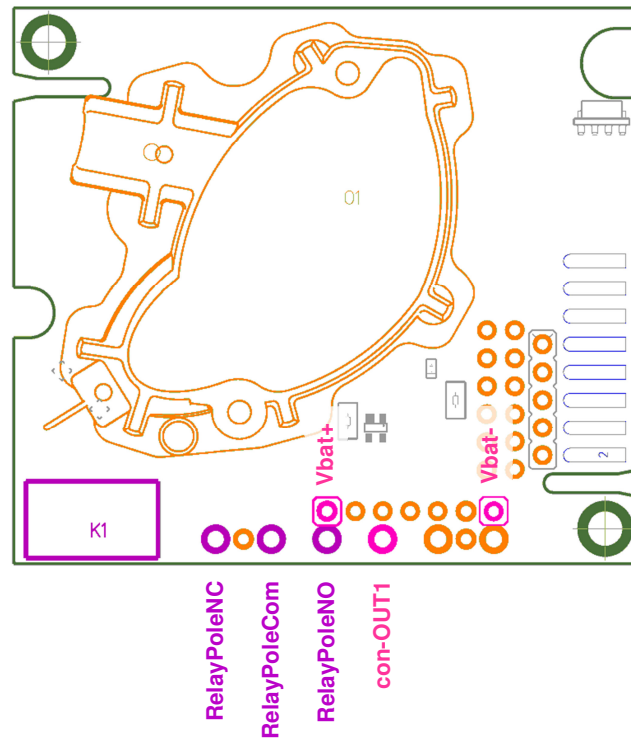LED4 – Out7
LED5 – Status
Relay – Out9

Figure 3, Relay connections

Out9 set => RelayPoleNO connected to RelayPoleCom
Out9 not set => RelayPoleNC connected to RelayPoleCom

Relays coil must be specified for a voltage bigger than or equal to sensors supply voltage, since the relay (coil) is controlled by power supply / ground voltage, a suitable relay is for example Omron G5V-1 12VDC.

2.3.   Pump signal configuration (Out1)

Out1 (digital outout) can be configured to be activated a predefined period before sensor start a measurement cycle.

Activation of pump signal

- Clear bit 9 in MeterConfig (U16, EEPROM start address 0x06)
- Write desired on time in seconds to PumpPeriod (U8, EEPROM address 0xA3)
- Restart/reset sensor

To deactivate pump sequence set bit 9 in MeterConfig and restart/reset the sensor

Actual pump on time will be ~0.5s longer than set in PumpPeriod (time to measure temperature and RH).

Activation of pump signal will increase sensors current consumption and is not suitable when sensor is powered by batteries.

2.4.   Heartbeat configuration

LED1 can be used to indicate power-up and that sensors measurement cycle is activated (jumper set, or force measurement flags are set). Time between LED flashes when sensor is active is set in "HeartbeatPeriod", LED on time is 10ms (not configurable).
At power up the LED will flash 3 times to indicate that sensors RAM has been cleared which mean that sensors virtual RTC has to be adjusted for correct timing. When sensor detect that supply voltage is below 4.75V sensor will stop flashing the LED and go into "sleep mode" until supply voltage rises above 5.25V (supply voltage measured every 32s in "sleep mode").

Activation of heartbeat

- Clear bit 8 in MeterConfig (U16, EEPROM start address 0x06)
- Write desired on time in seconds to HeartbeatPeriod (U8, EEPROM address 0xA2)
- Restart/reset sensor

To deactivate heartbeat set bit 8 in MeterConfig and restart/reset sensor.

2.5. General purpose analog input

The sensor has one general purpose analog input, AnIn4. Voltage range is 0-2.6V and measured value is stored in variable AnIn4 (U16, RAM start address 0x69). Measured value is expressed with 3 decimals, for example AnIn4 value = 1001 means that sensor measured 1.001V.
Before using the additional input resistor R1 has to be removed (pull-up resistor).
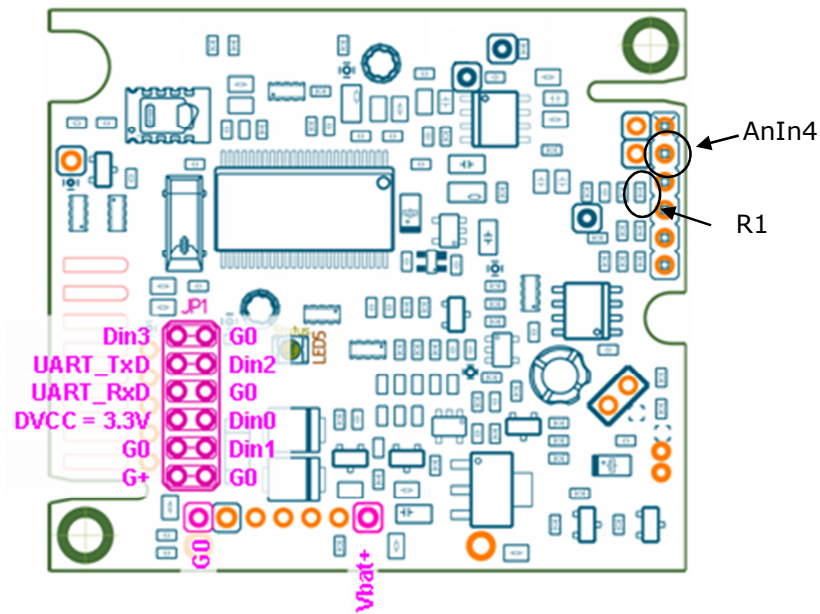

Figure 4, Different connectors

2.6. Backup capacitor

A backup capacitor can be added to make it possible to change battery without loosing RAM content (RTC for example). See figure below for position of the capacitor, both surface and hole mounted capacitors are possible to use, side closest to edge connector is gnd (small + on the other side).
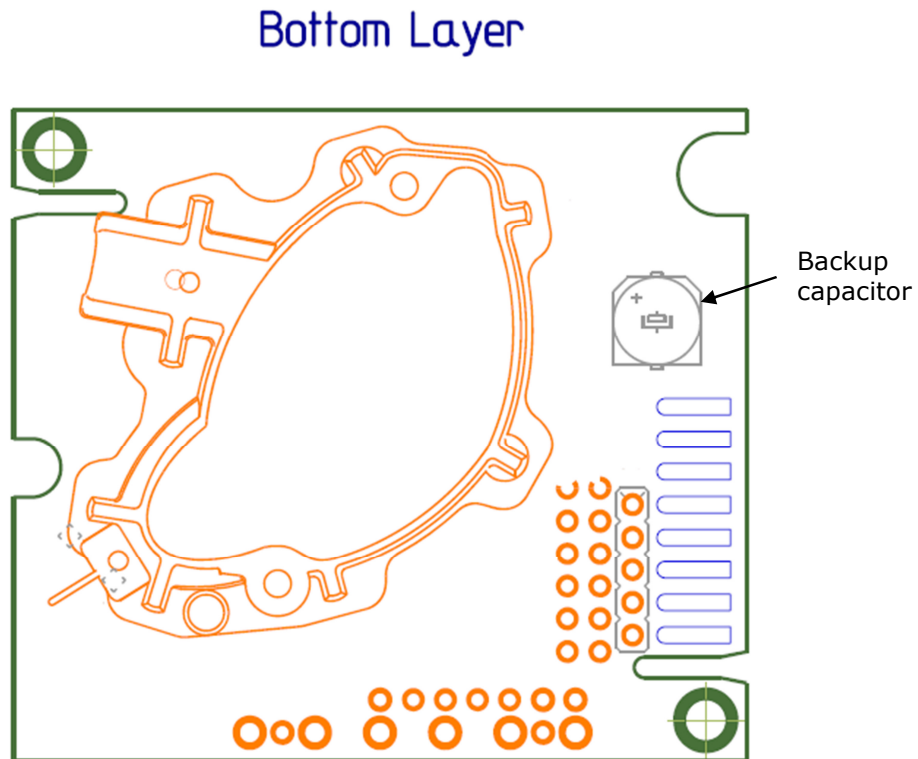

Figure 5, Backup capacitor

2.7. Background and zero calibration

Calibration trigged by digital inputs

Rough handling and transportation might result in a reduction of sensor reading accuracy. For post calibration convenience two switch inputs Din1 and Din2 are defined for the operator to select one out of two prepared calibration codes. If Din1 is shorted to ground when measurement is active (lamp is flashing), the internal calibration code **bCAL** *(background calibration)* is executed, in which case it is assumed that the sensor is operating in a fresh air environment (400 ppm CO_2). If Din2 is shorted instead during an active measurement (flashing lamp), the alternative operation code **zCAL** *(zero calibration)* is executed in which case the sensor must be purged by some gas mixture free from CO_2 (i.e. Nitrogen or Soda Lime CO_2 scrubbed air).

Calibration sequence:

- Connect zCal or bCal switch to G0
- Wait until next measurement cycle has finished (lamp stops flashing)
- Disconnect used switch from G0

If the actual BLG/ELG sensor is configured with a long measurement/sleep period it is usually difficult to know how long time it's left until next measurement cycle/calibration possibility, then one can use following calibration sequence.

Alternative calibration sequence:

- Stop current measurement cycle, remove jumper or send "stop continuous measurement" command (depending on which possibility is used)
- Connect zCal or bCal switch to G0
- Start a measurement cycle with the jumper (AnIn1) or "start continuous measurement" command
- Wait until sensors lamp stops flashing, takes ~30s (sensor has a predefined start-up delay, default delay is 5s, see 2.1 for details)
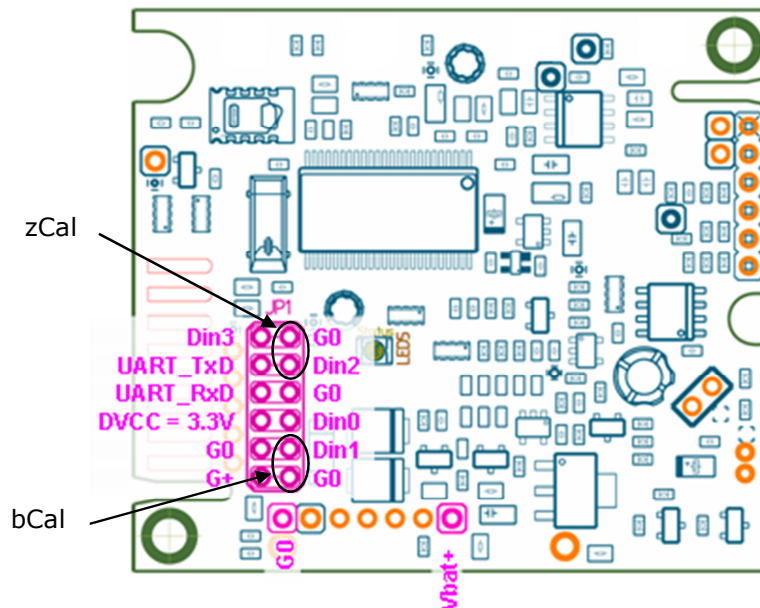- Disconnect zCal or bCal switch from G0

Figure 6, Calibration switches

Calibration trigged by I2C or UART

It is also possible to start a calibration cycle using I2C or UART. The two registers HR1 and HR2 are used to start the calibration cycle and to confirm that the calibration was successful.

Zero calibration sequence:

- Write 0x7C07 (zero calibration command) to HR2 (RAM - start address 0x42)
- Wait until next measurement cycle has finished
- Read HR1 (RAM - start address 0x40) and check that bit nr 6 is set (zero calibration acknowledge bit)
- Wait until another measurement cycle has finished
- Read CO2 value from the sensor and verify that the CO2 value is close to 0 ppm

Background calibration sequence:

- Write 0x7C06 (zero calibration command) to HR2 (RAM - start address 0x42)
- Wait until next measurement cycle has finished
- Read HR1 (RAM - start address 0x40) and check that bit nr 5 is set (zero calibration acknowledge bit)
- Wait until another measurement cycle has finished
- Read CO2 value from the sensor and verify that the CO2 value is close to 400 ppm

If the acknowledge bit is set the calibration was successful, however the new adjusted parameters will not be used for CO2 calculation until next measurement cycle, this mean that it is necessary to wait for another measurement cycle before the calibration can be verified.

If the measurement/sleep period used is too long to do a reliable calibration one can use following sequence.

- Stop current measurement (remove jumper or send "Force stop measurements" command)
- Write calibration command (0x7C06 or 0x7C07) to HR2 (RAM - start address 0x42)
- Start a measurement with "Single measurement" command (Write 0x35 to RAM address 0x60)
- Wait until the measurement cycle has finished
- Read HR1 (RAM - start address 0x40) and check that bit nr 5 or 6 is set (zero or background calibration acknowledge bits)
- Start another measurement with "Single measurement" command (0x35 to RAM address 0x60)
- Read CO2 value after finished measurement cycle and verify that the CO2 value is close to 0 or 400ppm
- Restart measurement (insert jumper of "Force start measurement" command)

2.8. Parameter and variable addresses

RAM

Variable	Start address	Type	Unit
Error status	0x1E	U8 (error flags)	
Meter status	0x1D	U8 (status flags)	
Alarm status	0x1C	U8 (alarm flags)	
CO2	0x08	S16	BLG - x.xxx% ELG - x ppm
Space temperature	0x12	S16	x.xx °C
Relative humidity	0x14	S16	x.xx %
Mixing ratio	0x16	S16	x.xx g/kg
HR1	0x40	U16	
HR2	0x42	U16	
AnIn4	0x69	U16	x.xxx volt
RTC (virtual real time clock)	0x65	U32	x seconds
SCR (special control register)	0x60	U8	

SCR commands

Value	Command
0x30	Force start measurement
0x31	Force stop measurement
0x32	Restart logger (logger data erased)
0x33	Reinitialize ligger (logger data unaffected)
0x34	Write timestamp to logger
0x35	Single measurement

Error status flags

Bit nr	Error description
7	Space temp out pf range
6	Memory error
5	CO2 out of range
4	Detector temperature out of range
3	
2	Temperature/humidity sensor communication error
1	CO2 measurement error (offset regulation)
0	Fatal error

Meter status flags

Bit nr	Description
7	Jumper state, 1=> jumper is set, 0=> no jumper
6	Force measurement, force measurement command received
5	Single measurement, single cycle measurement active
4	Reserved
3	
2	
1	
0	

Alarm status flags

Bit nr	Description
7	CO2 alarm
6	Battery warning
5	Battery alarm
4	Mixing ratio alarm
3	
2	
1	
0	

EEPROM

Parameter	Start address	Type/Size	Comment
MeterControl	0x03	U8	
MeterConfig	0x06	U16	
ABC period	0x40	U16	ABC period in hours
HeartbeatPeriod	0xA2	U8	Period in seconds
PumpPeriod	0xA3	U8	Period in seconds
Measurement/sleep period	0xB0	U24	Measurement period (unit = seconds)
Logger structure address	0x200	16b	Described in "BLG_ELG Logger Structure"