

Product Specification

Senseair[®] LP8

Miniature CO₂ sensor module
for battery-powered applications



General

LP8 is a miniature sensor module for battery-powered applications. It gives a full control on sensor integration into a host system, flexibility in changing of the CO₂ measurement, period and power consumption. One measurement requires 3.6mC of charge (or energy 11.9mJ at 3.3V battery supply). To minimise power consumption, the sensor should be turned OFF between measurements.

Item	LP8 Article No. 005-0-0001, 005-0-0003	
Target gas	Carbon dioxide (CO ₂)	
Operating Principle	Non-dispersive infrared (NDIR)	
Operating environment range	0 – 50°C, 0 – 85%RH (non-condensing)	
Measurement range, calibrated	0 – 2000ppm (extended range up to 10000ppm)	
Accuracy CO ₂	±50ppm, ±3% of reading ^{1, 2, 3} (extended range ±10% of reading) ^{1, 2, 3, 4}	
RMS noise CO ₂	14ppm @ 400ppm, 25°C, 25ppm @ 1000ppm, 25°C	
Accuracy Temperature	±0.7°C	
Storage Temperature	-40 – 70°C	
Power supply	2.9 – 5.5V unprotected against surges and reverse connection	
Peak current max	140mA @ 0°C (typical 125mA @ 25°C)	
Leakage Shutdown current	1µA ^{5, 6}	
Charge per measurement	3.6mC (worst case)	
Energy per measurement	11.9mJ @ 3.3V (measurement period 16s)	
Current consumption	16second sampling 225µA ^{5, 6} 60second sampling 61µA ^{5, 6} (3.2mJ)	
Measurement period	≥16s	
Measurement repeatability	Max. ±1% of specified CO ₂ concentration, ±10ppm @ 1000ppm	
Response time T _{90%}	Filtered signal	Non-filtered signal
16 seconds sampling	4 minutes	7 minutes
60 seconds sampling	3 minutes	10 minutes
Dimensions	005-0-0001 (with pin headers) 33.4 x 19.9 x 12.4mm (max dimensions L x W x H) 005-0-0003 (no pin headers) 33.4 x 19.9 x 8.5mm	
Life expectancy	>15 years	
Storage temperature	-40 – 70°C	
Weight	<8g	
CO ₂ Warm-up time @25°C	30 – 60 seconds	
T Warm-up time	10 minutes	
Serial communication	UART (host-slave protocol)	
Maintenance	A host system counts ABC (Automatic Baseline Correction) period itself and has to write ABC command to the Calculation Control byte when ABC period (eight (8) days) expires.	

Table 1. Key technical specification for the Senseair® LP8

- Note 1: Accuracy is met at 10 – 40°C, 0 – 60%RH, after minimum three (3) performed Automatic Baseline Corrections, preferably spanning eight (8) days in-between, or a successful zero-calibration.
- Note 2: Based on reading filtered CO₂ measurement data in stable environments and in continuous operation by control mode
- Note 3: Accuracy specification is referred to calibration gas mixtures with additional uncertainty of ±1%
- Note 4: Extended range accuracy is not calibrated or guaranteed, it is extrapolated from calibrated range
- Note 5: Resistor network for measuring VCAP voltage adds 14µA @ 5.5V
- Note 6: External super-capacitor leakage is not considered



Installation and soldering

See LP8 Handling manual (ANO1332).

Sample gas diffusion area

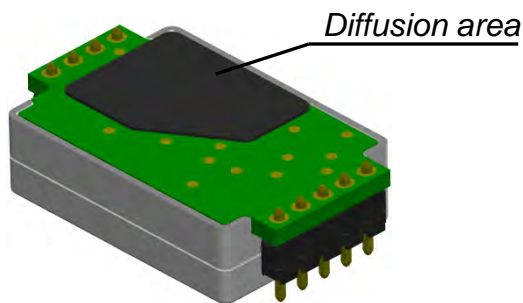


Figure 1. Diffusion area

Mechanical properties

See LP8 Handling manual (ANO1332).

Pin assignment

Bottom layer

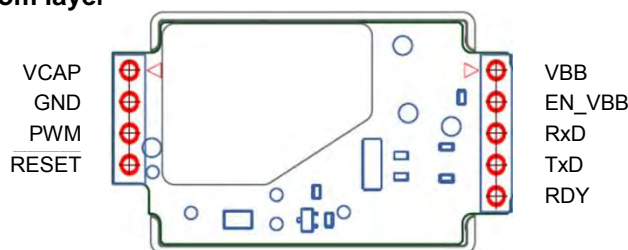


Figure 2. Pin assignment

Pin #	Name	Type	Maximum Voltage, V	Description
JP1 (4-pin header)				
1	VCAP	Power	6.5	Lamp driver supply voltage
2	GND	Power	-	Ground
3	PWM	Output	3.6	I/O pin. PWM output or other function can be assigned.
4	RESET	Input	2.5	Reset. Pull-up resistor (10k) is connected to 2.5V
JP2 (5-pin header)				
1	VBB	Power	5.5	Supply voltage
2	EN_VBB	Input	VBB	Enable pin to activate voltage regulator. $I_{Max} = 2\mu A$, in logic low state.
3	RxD	Input	3.6	UART receive pin to sensor MCU from host
4	TxD	Output	3.6	UART transmit pin from sensor MCU to host
5	RDY	Output	3.6	Signal is used to synchronise sensor with a host system.

Table 2. Terminals and I/O options dedicated in *Senseair*[®] LP8 model



Time diagram

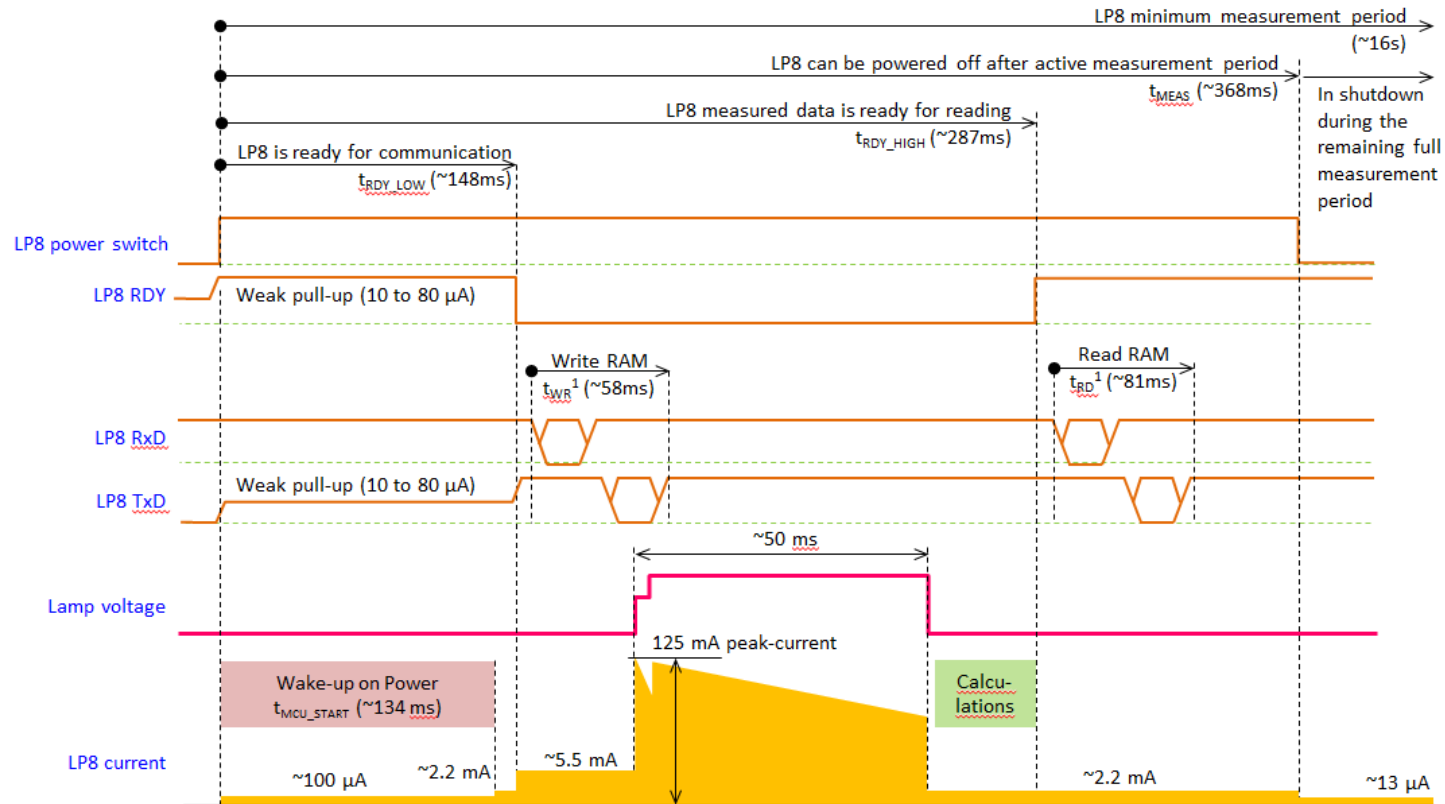


Figure 10. Time diagram

Note 1: typical values for 9600 baud rate



Self-diagnostics

All EEPROM updates are checked by subsequent memory read back and data comparisons.
EEPROM consistency is checked by page checksum calculation.

Electrical specification

Parameter	Min	Typical	Max	Unit	Test conditions
Power supply voltage: VBB (electronics) VCAP (lamp)	2.9 2.9		5.5 6.5	V V	
Peak current: VBB (electronics) ¹ VCAP (lamp) ² VCAP (lamp) ² Total (VBB + VCAP)		5.4 119	6 129 134	mA mA mA	VBB = VCAP = 2.9 – 5.5V T _{amb} = 0 – 50°C T _{amb} = 25°C T _{amb} = 0°C ³ T _{amb} = 25°C, VCAP = 5.5V
Leakage shutdown current VBB (electronics) ⁴ VCAP (lamp) 500kΩ resistor network VCAP (lamp) without voltage monitoring ⁵		1 12 0.1	2 14 0.2	µA µA µA	T _{amb} = 25°C T _{amb} = 25°C, VCAP = 5.5V T _{amb} = 25°C, VCAP = 5.5V
Charge per measurement cycle VBB (electronics) VCAP (lamp)		1.1 1.0 2.2	1.2 1.1 2.4	mC mC mC	T _{amb} = 0 – 50°C, VBB = VCAP = 2.9 – 5.5V Baudrate: 9600 Baudrate: 19200

Table 3. Electrical specification

Note 1: Charging of 20µF decoupling capacitance is not considered

Note 2: Charging of 220nF decoupling capacitance is not considered

Note 3: Peak-current decreases with increasing temperatures

Note 4: Without pull-down resistor 100k on EN_VBB (as default, this is not mounted on LP8)

Note 5: Currently not available as purchasable option

Recommended host connection

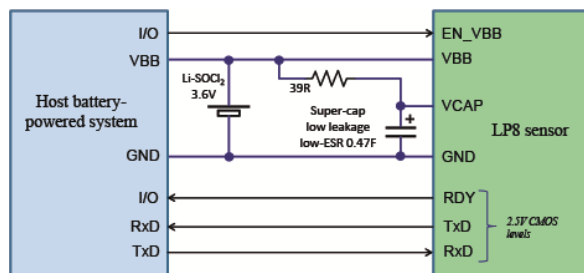


Figure 8. Recommended host connection

- In some battery-powered systems, current limiter can be a simply 5Ω resistor.
- Suggested super-capacitor type is Eaton Bussman PM-5R0H474-R (0.47F 5V). It is specified for 8µA leakage current @ 5V, 20°C and 500mΩ ESR.
- An external low-leakage switch (for example TPS22907) can be used to switch OFF both VCAP and VBB between measurements. VBB can be supplied from super-capacitor.



Sensor control by a host MCU system

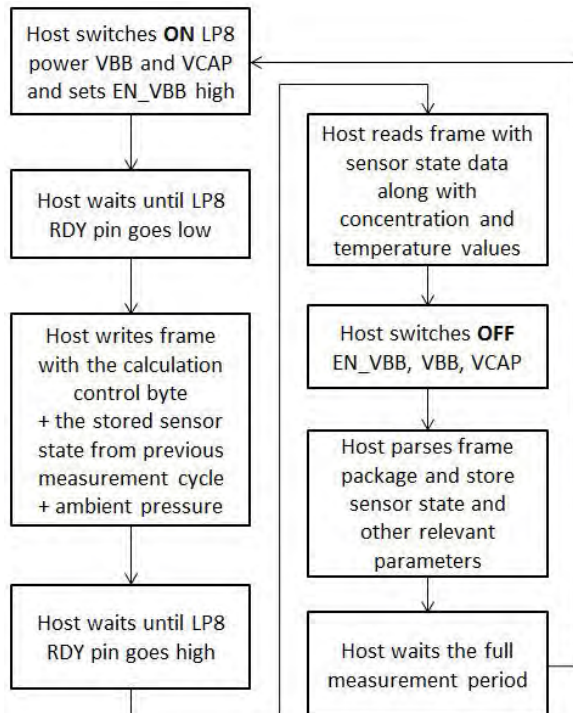


Figure 9. Sensor control by a host MCU system

Measurement period of the sensor is determined by customer host system and may vary without degrading measurement accuracy. Minimum allowed measurement period is 16 seconds (below 16 seconds, accuracy is not guaranteed).

Calibration

ABC:

A host system counts ABC period itself and has to write ABC command to the “Calculation Control byte” when ABC period (eight days) expires. The lowest CO₂ value (400ppm defines in this case as fresh air, included “remembered accompanying parameters”) measured during the period from the last “Initial state”- / “ABC”- / “Background”- / “Zero calibration” writes to the “Calculation Control” byte.

Background calibration:

- Using unfiltered channel, sensor considers current unfiltered measurement values to provide calibration.
- Using filtered channel, sensor considers filtered values to provide calibration (sensor has to be exposed for fresh air >40 lamp pulses/measurement periods).

Zero calibration:

- Using unfiltered channel, sensor considers current unfiltered measurement values to provide calibration.
- Using filtered channel, sensor considers filtered values to provide calibration (sensor has to be exposed for zero gas >40 lamp pulses).

The LP8 sensor works as a slave and totally acts on the host/master actions applied through the “Calculation Control” byte.

Default position: slave- power OFF (requires sensor power OFF).

Sensor power ON: the sensor can perform the next measurement.

Error code and action plan

ErrorStatus0 byte description

Bit	Bit Name	Error Description	Suggested Action
0	Fatal Error	Fatal Error The bit is a joint bit for different error sources when sensor cannot provide correct operation, among them: <ul style="list-style-type: none"> • Configuration EEPROM parameters are out of range or corrupted • Virtual EEPROM memory read/write error • Error in VCAP measurements 	Switch OFF/ON sensor power and start with "Initial Measurement" in the Calculation Control byte. Contact local distributor.
2	AlgError	Algorithm Error Configuration EEPROM parameters are out of range or corrupted	
3	Calibration	Calibration Calculation Error Out of range error at Zero-/Background calibration and ABC	Repeat recalibration or wait until next ABC event.
4	SelfDiag	Self-Diagnostics Error Hardware error is detected or important EEPROM parameters are corrupted	Contact local distributor.
5	OutOfRange	Out Of Range Error (OOR) Indicates an error which occurs at different stages of concentration calculation algorithm. Resets automatically after source of error disappears.	Try sensor in fresh air. Perform sensor zero or background calibration. Check sensor temperature readings.
6	Memory	Memory Error Virtual EEPROM read/write error: page checksum error during read or write verification, FLASH operation error.	Contact local distributor.
7	WarmUp	WarmUp bit Bit is not set in customer mode	-

Table 14. ErrorStatus0 byte description

ErrorStatus1 byte description

Bit	Bit Name	Error Description	Suggested Action
0	VCAP1 low	VCAP1 voltage low Voltage measured prior lamp pulse is below preset threshold. The threshold is 2.8V \pm 3%.	Check battery. Sensor supply voltage is below specified operational limit of 2.9V.
1	VCAP2 low	VCAP2 voltage low Average voltage measured at the beginning of lamp pulse (during inrush steps) is below preset threshold 2.7V \pm 3%.	ESR (Equivalent series resistance) of the sensor power supply source (a battery or super-capacitor) is not enough to provide low-voltage drop during 125mA lamp inrush step.
2	ADC Error	ADC Error MCU ADC out-of-range error has occurred.	Switch OFF/ON sensor power and apply "initial measurement" to the Calculation Control byte. Contact local distributor.
3	Reserved		
4-7	Parameters override bits	These bits indicate which parameter is forced to a predefined value in the debug mode. Should not appear during normal operation.	-

Table 15 ErrorStatus1 byte description

Bits 3 – 0 of the **ErrorStatus2-** and **ErrorStatus3** bytes decode on what algorithm stage an "Out Of Range Error" (OOR) has occurred in unfiltered- and filtered calculation channel respectively.



Maintenance

Senseair[®] LP8 has a built-in self-correcting ABC algorithm. ABC period is adjustable by host. Discuss your application with *Senseair*[®] in order to get advice for a proper calibration strategy.



Sensors for Life

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