Product Specification

Senseair® LP8

Miniature CO_2 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 CO_2 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 60second sampling	 225µA [5, 6] 61µA [5, 6] (3.2mJ)
Measurement period	≥16s
Measurement repeatability	Max. ±1% of specified CO_2 concentration, ±10ppm @ 1000ppm
Response time $T_{90\%}$ 16 seconds sampling 60 seconds sampling	Filtered signal Non-filtered signal 4 minutes 7 minutes 3 minutes 10 minutes
Dimensions 005-0-0001 (with pin headers) 005-0-0003 (no pin headers)	 33.4 x 19.9 x 12.4mm (max dimensions L x W x H) 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 **T Warm-up time**	$30 - 60$ seconds 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

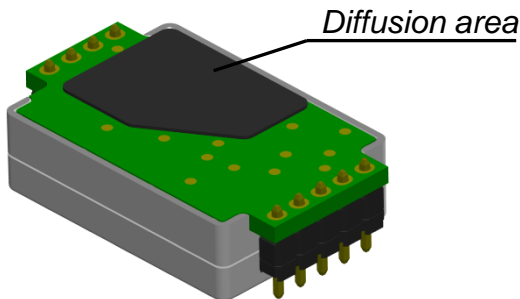See LP8 Handling manual (ANO1332).

Sample gas diffusion area

Figure 1. Diffusion area

Mechanical properties

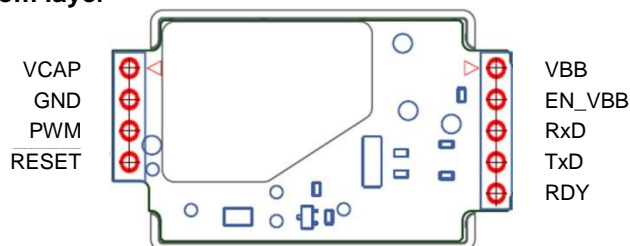See LP8 Handling manual (ANO1332).

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} = 2µA, 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.

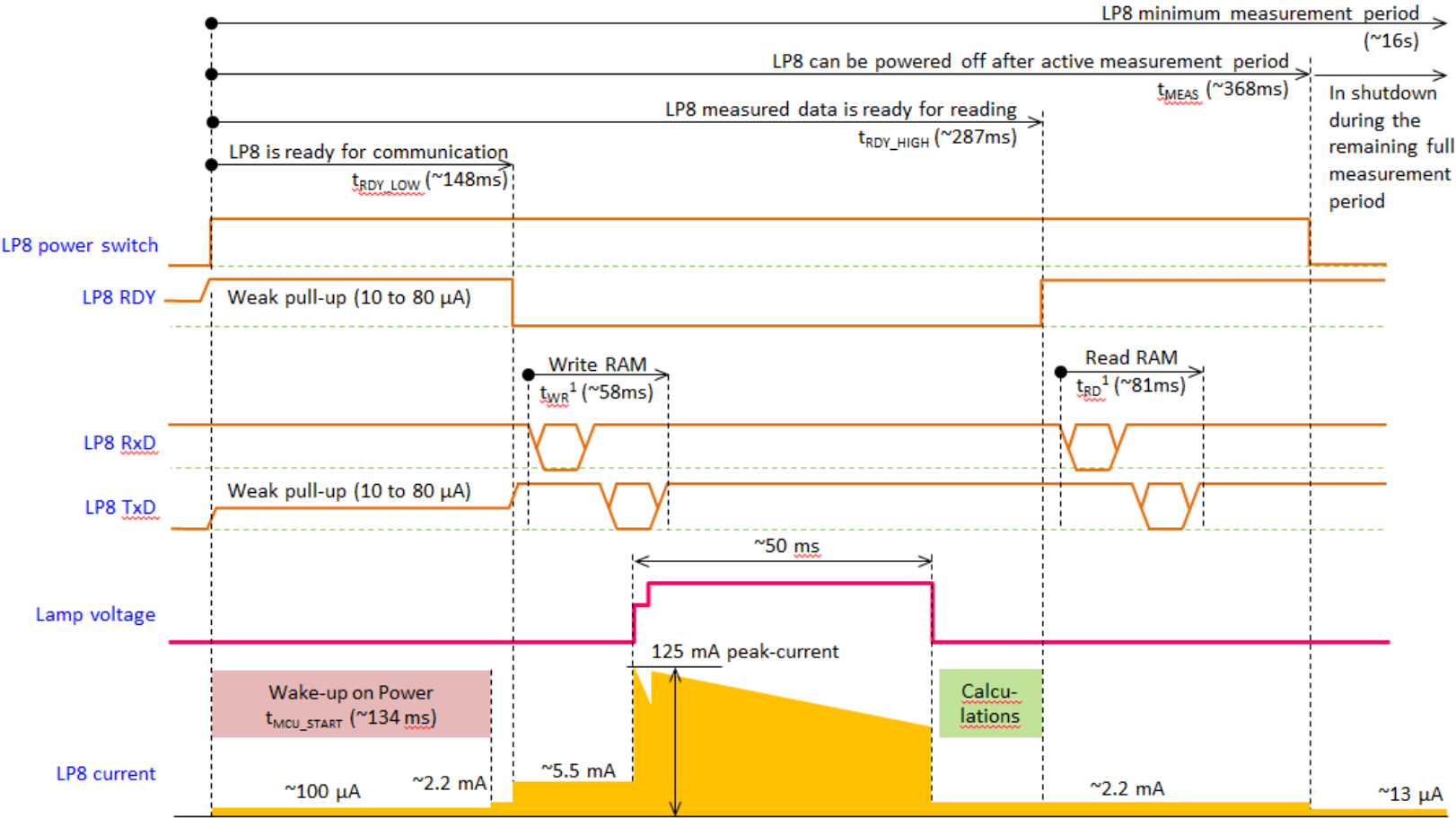*Table 2. Terminals and I/O options dedicated in Senseair® LP8 model*

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
		
		125
			
			6
			129
			134
			
			140
				
				mA
				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
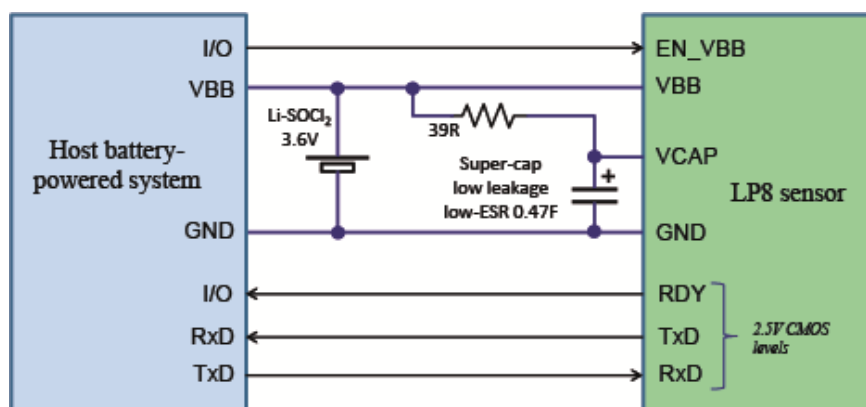
Recommended host connection

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.
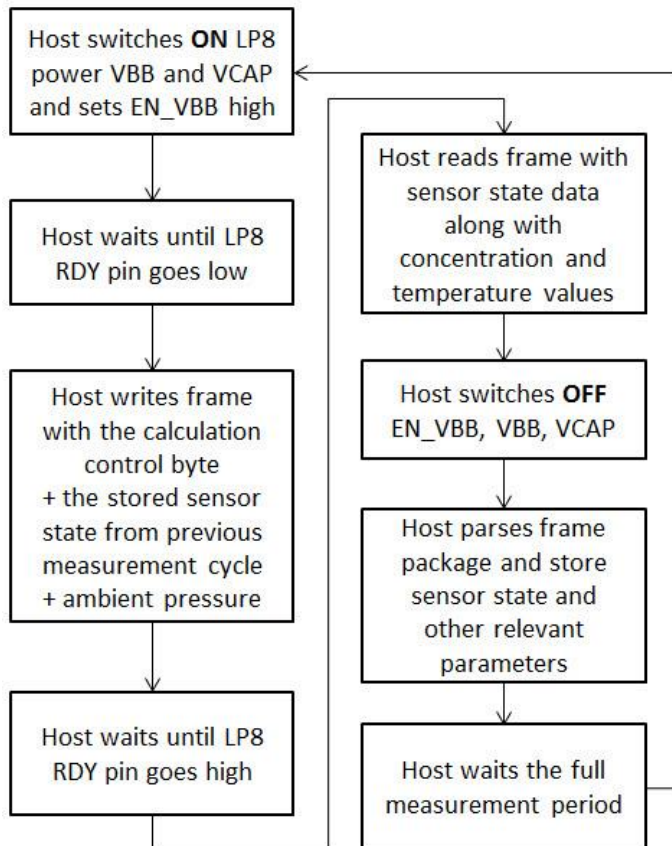
Sensor control by a host MCU system

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 writes ABC command to the "Calculation Control byte" when ABC period (eight days) expires. The lowest CO_2 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:
a) Using unfiltered channel, sensor considers current unfiltered measurement values to provide calibration.
b) 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:
a) Using unfiltered channel, sensor considers current unfiltered measurement values to provide calibration.
b) 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: • 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 ±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 ±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.

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