The purpose of this manual is to explain how the circuit operates, how to connect power and take readings, mount the circuit board and correct the data in Excel.

1. How the circuit operates

Figure 1 below shows the circuit for the ISB, issue 4. This circuit is designed for use only with Alphasense B4 family of four-electrode gas sensors. The ISB uses low noise components and in order to achieve good resolution, best practice for grounding and screening is necessary. Take time to optimise your EMC environment to a low level to achieve low ppb resolution.

The ISB includes a low noise bandgap to provide a bias voltage for NO sensors and can measure both oxidising (CO, H_2S, NO) and reducing (O_3, NO_2) gas sensors. The ISB is configured as four versions for specific sensors: NO, NO_2, O_3 and CO/ H_2S/ SO_2:

Part number	Sensor
810-0016-00	CO-B4, SO2-B4, H2S-B4
810-0016-01	NO-B4
810-0016-02	NO2-B4
810-0016-03	O3-B4

Table 1. Part numbers for the four types of ISBs

Ensure your ISB is matched to the sensor type according to Table 1 if the ISB has been supplied separate from the sensor.

The circuit uses a single op amp to provide balance current into the counter electrode. In addition, both the working electrode (*WE*) and auxiliary electrode (*Aux*- used to compensate for zero current) have equivalent two stage amplifiers: the first stage is a high gain transimpedance amplifier and the second buffer stage allows for inverting sensor signals for NO_2 and O_3 sensors. Both signals are available on the 6-way Molex socket as separate pairs, but note that the power and output ground (-) pins are connected together.

There are no adjustments on the ISB. The offset voltages for both channels have been measured and are marked on the label attached to the packing sleeve for the ISB. If the ISB was shipped with a B4 sensor, the label will include both the zero voltage (expressed as mV) and sensitivity (expressed as nA/ppm) for the sensor with ISB. If you swap the sensor and ISB then the offset voltage will change but the sensitivity will be the same (±1%) since sensitivity is dependent on the sensor, not the ISB.

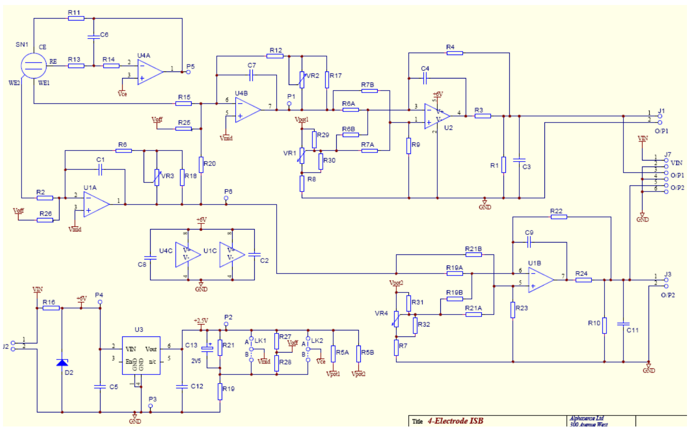

Figure 1. Schematic of Issue 4 ISB

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2 Connecting power and taking readings

The socket for power and signals is shown in figure 2 below. The Molex socket is polarised.

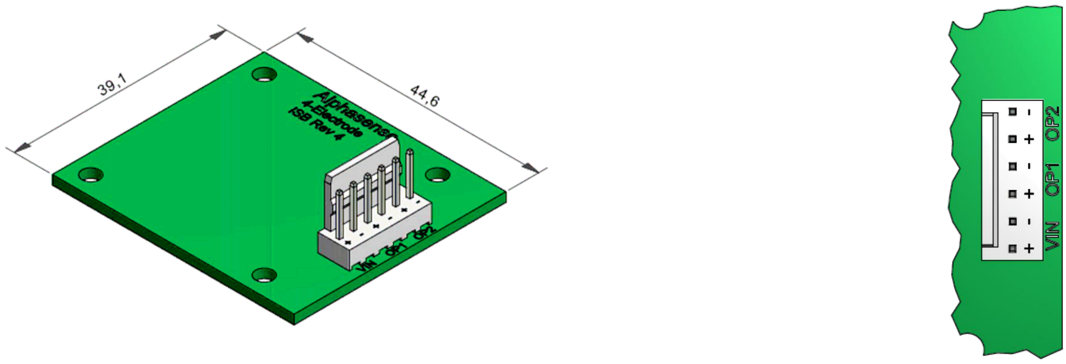

Figure 2. ISB socket for power and signals

DC power is required: 3.5 to 6.4 VDC. Ensure your power supply is low noise and decoupled, or its noise component will be added to the measured signal.

OP1 is the signal from the Working Electrode and OP2 is the signal from the Auxiliary Electrode. The –ve pins are connected so you can use either 6-way or 4-way cable to connect to the ISB. OP1 and OP2 are buffered DC signals so a normal A/D converter will be fine, so long as it does not inject noise back into the ISB. If you are concerned about noise injection, then decouple using 10nF plus 100nF capacitors close to the Molex connector.

Table 2 below lists expected outputs from ISB with a typical B4 sensor.

Gas	**Zero offset** WE/Aux (mV)	**Sensor sensitivity** (nA/ppm)	**ISB Gain** (mV/nA)	**WE Sensitivity** (mV/ppm)	**Noise** (ppb)
CO	270/ 340	525	0.8	420	4
H_2S	350/ 350	1750	0.8	1400	1
NO	545/ 510	650	0.8	520	15
NO_2	225/ 245	-425	-0.726	309	12
O_3	260/ 300	-400	-0.746	298	4
SO_2	355/ 345	350	0.8	280	5

Table 2. Offset, sensitivity and noise for typical B4 sensors with ISB

Noise

1 These gas sensors are very sensitive to gas and are also very susceptible to EMC pickup. Ideally the sensors would be housed in a Faraday cage, but this is not normally practicable, so shield and ground as best you can. Nearby digital circuits can also disrupt the signal quality.

2 Typical noise at Alphasense, when calibrating on a bench without additional shielding, but with good power supply is 3 mV (p-p). Digital averaging can reduce this to less than one mV, equivalent to typically 2 ppb. Further reduction of noise can be achieved by shielding.

3 It is important to decouple your power supply and A/D converter from the ISB. Since the 0V line is shared by the power supply and output, any noise injected by your power supply or reading circuit will appear on the measured signal. We recommend using two decoupling capacitors close to the Molex socket: 10nF and 100nF.

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3 Mounting the circuit board

The mounting hole locations and diameters are shown in figure 3 below.

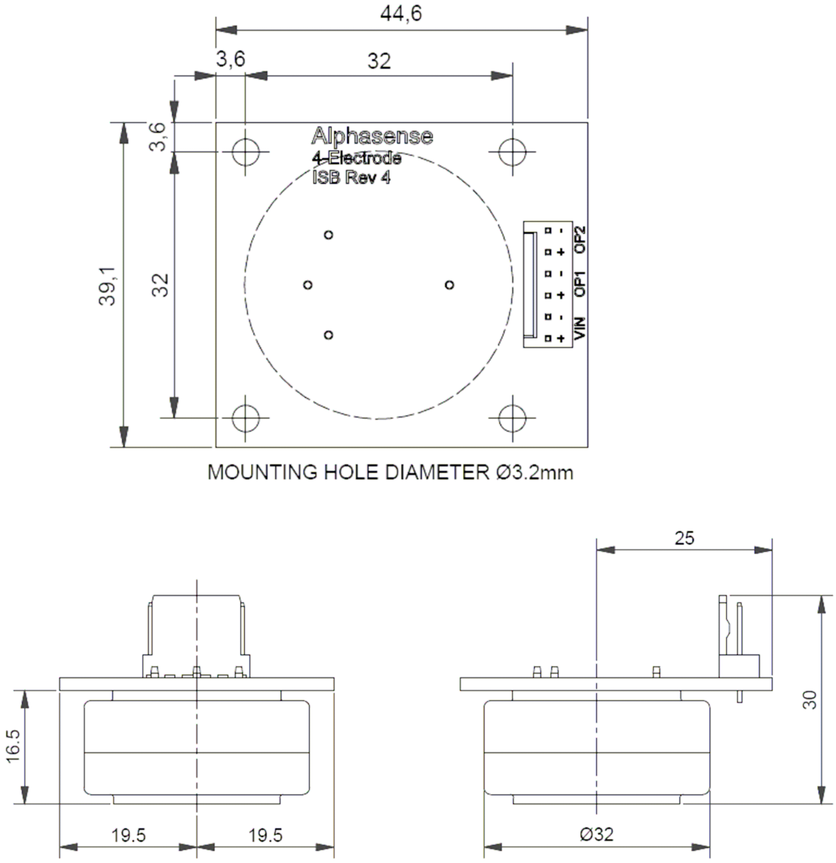

Figure 3. ISB dimensions and mounting hole locations

An optional **ISB Fitting Kit** can be purchased. Order part number **000-0ISB-KIT**. The kit includes:

4 x pillars	16.0 mm length, M3 tapped	
8 x washers	M3: fits between pillar and ISB to achieve 16.5 mm pillar height	
4 x screws	M3 x 8 button head	
1 x header	Molex 22-23-2061, 6-way, Series KK6373	
	Other Molex part references:	
	Housing:	Molex 22-01-2065, Series KK6471
	Crimp:	Molex 08-50-0032

4 Correcting the data using a spreadsheet

The two DC signals can be measured at any desired interval. It is normal to measure frequently and apply a smoothing algorithm to digitally filter noise.

The method for determining the concentration depends on whether you have purchased sensor with ISB or sensor and ISB separately. Alphasense recommends purchasing the ISB and sensor together- this allows us to measure accurately the zero gas voltage before shipping.

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4.1 Measuring when the ISB and sensor were shipped together

Create a spreadsheet similar to the layout below:

	Vo (OP1)		Vo(OP2)		mV/ppm		
Time	**WE (OP1)**	**WE- Vo**	**Aux (OP2)**	**Aux-Vo**	**ppm**	**We-Aux**	**ppm**

Each column is specified as:

Column	Label	Cell data	Comments
A	Time	From your data acquisition system	Sampling faster than 1 second is rarely useful unless it reduces noise.
B	WE (OP1)	mV from ISB channel 1	0.1 mV resolution is ideal
C	WE-Vo	Column B- Vo (constant specified on ISB bag label)	Subtract the WE offset voltage- typical values are the second column in table 2.
D	Aux (OP2)	mV from ISB channel 2	0.1 mV resolution is ideal.
E	Aux-Vo	Column D- Vo (constant specified on ISB bag label)	Calculates the Aux offset voltage shift- typical Vo are the second column in table 2.This difference is a few mV.
F	ppm	Column C / sensitivity (specified on ISB bag label)	ppm calculated from the sensitivity constant (mV/ppm), corrected for offset voltage but not the auxiliary electrode.
G	WE-Aux	Column C – Column E	Correction for any drift in the auxiliary and WE (as mV)
H	ppm	Column G / sensitivity (specified on ISB bag label)	ppm, corrected for offset drift

Table 3. Typical data spreadsheet layout and cell assignment

4.2 Measuring when the ISB and sensor were shipped separately

If the ISB and sensor were shipped separately then set up the same spreadsheet as above, but the zero voltage will be for the ISB only and does not include the sensor. You must measure the zero voltage with the sensor connected to the ISB:

Plug sensor into ISB and apply between 3.5 and 6.4 VDC to power the sensor/ISB pair.

1. Allow to stabilise in clean air for at least 6 hours.
2. Apply zero air (synthetic air or scrubbed/ cleaned zero air) for 20 minutes.
3. Record Vo for both WE (OP1) and Aux (OP2). Enter these values in cells C1 and E1.

Additionally, the sensor is calibrated as nA/ ppm but this must be converted to mV/ppm. The last column in Table 2 lists the scaling constant which must be applied for your sensor type. The ISBs have a gain that is repeatable ±1.2% (95% confidence interval) so this conversion constant is the same for all ISBs for a specific sensor/ gas.

5 Recalibration

The ISB with sensor calibration has been measured before leaving the factory, but environmental conditions and sensor drift mean that periodic checking of the calibration may be required.

Also, at low ppb concentrations both temperature and humidity will affect the offset voltage of both the WE and Auxiliary electrodes. Previously it was thought that simple subtraction of the Auxiliary would correct for ambient changes but this is not true. Contact Alphasense for help with the correct method for compensation in your application.

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5.1 Zero correction

Follow the procedure in 4.2 above and modify the Vo mV in your spreadsheet after zero calibration. Be careful that the zero air you use is very clean: ambient or lab air is not sufficiently clean to be used as a zero calibration air source.

CAUTION: Gain/sensitivity correction: unless you have access to an accurate 1 ppm (or less) gas supply, it is advisable to return the sensor and ISB to Alphasense for gain recalibration.

End.

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