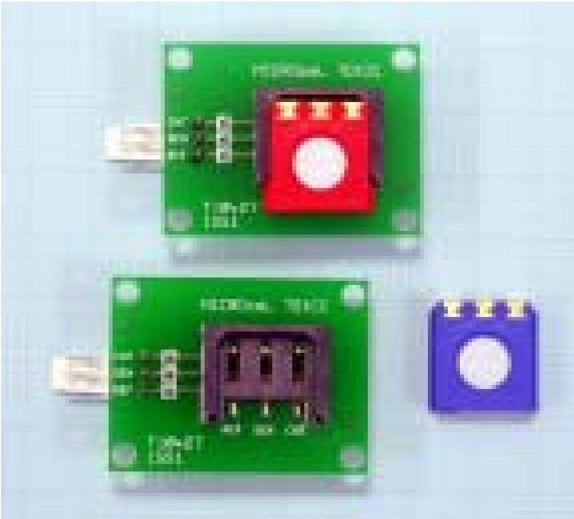
Sample Circuit Board Layout



Recomended Connector Mating Part:
Molex 22-01-2035 3 way housing

Operation

For correct operation, MICROceLs require a small supply of oxygen to the *Counter* and *Reference* electrodes. This is usually provided in the sample stream, by air diffusing to the front of the sensor, or by diffusion through the sides of the sensor (a few thousand ppm is normally sufficient). Continuous exposure to an anaerobic sample gas may cause the sensor to malfunction in spite of the oxygen access paths. The sensor must not therefore be completely potted with resin or totally immersed in an anaerobic gas mixture.

Start Up - Standard Operation MICROceLs

To maintain a sensor in a 'ready to work' condition, MICROceLs are supplied with a shorting link across the *Sensing* and *Reference* terminals. This must remain in place during storage, and only be removed when the sensor is ready to be used. Once in use, a sensor will require a long start up time if the electrodes are not reshorted when the instrument is switched off. In the recommended circuit, this is achieved by a shorting J-FET, which keeps the electrodes shorted when the circuit is unpowered.

Pressure Effects

MICROceLs give a transient response when exposed to a sudden change in pressure in the presence of a measured gas. The peak signal decays in only a few seconds. This can be a particular problem when using sampling pumps, as they may introduce pressure fluctuations into the gas stream.

Pressure pulsations can be avoided by ensuring the sensor is positioned at the atmospheric end of the sample train. Alternatively a flow restriction placed upstream from the MICROceL will also help to damp out pressure oscillations.

Another effective measure is to ensure that the back pressure downstream from the MICROceL is effectively zero, so allowing an unrestricted flow of gas to ambient air. However it is important to prevent back diffusion from the ambient air diluting the gas stream and lowering the gas concentration being measured. Back diffusion can be reduced for example by the provision of an exhaust gas tube of 4mm internal diameter and 8mm length.

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Circuitry - Three electrode MICROceLs

The schematic below shows the recommended circuit for use with any three electrode MICROceL designed to measure the following gases:- carbon monoxide (CO), hydrogen sulphide (H_2S). The output from the circuit will be **Positive** with respect to common for gases that are oxidised at the *Sensing* electrode - CO, H_2S.

The function of the *Counter* electrode is to complete the electrochemical circuit and its potential relative to the *Sensing* and *Reference* electrodes is not fixed by the circuit. Under quiescent conditions, the cell is drawing a very small current and the *Counter* electrode will be near its rest potential. When gas is detected, the cell current rises and the *Counter* electrode polarises with respect to the *Reference* electrode (negative for CO, H_2S).

While the cell current stabilises very quickly, the *Counter* electrode polarises slowly and may continue to drift even though the sensor signal is stable. This is normal, and in practice the maximum *Counter* electrode polarisation likely is 300-400mV with respect to the *Reference* electrode. In practical terms this means the circuit ground should be derived at a higher value than the negative supply rail (e.g. 1V), so that IC1 can give a negative output.

*It is important, on switch on, that IC1 has a low offset (e.g. <100µV), or the op amp will effectively bias the sensor. The sensor will then take a correspondingly long time to settle down from the shorted condition.

The voltage developed across R_{Load} should be restricted to less than 10mV under all conditions otherwise sensor performance will suffer. Keeping R_{Load} low also ensures a faster response time, and although in this circuit it can be reduced to zero, a small finite value is recommended. This ensures a better balance between circuit noise and response time, and in some cases reduces the humidity transient.

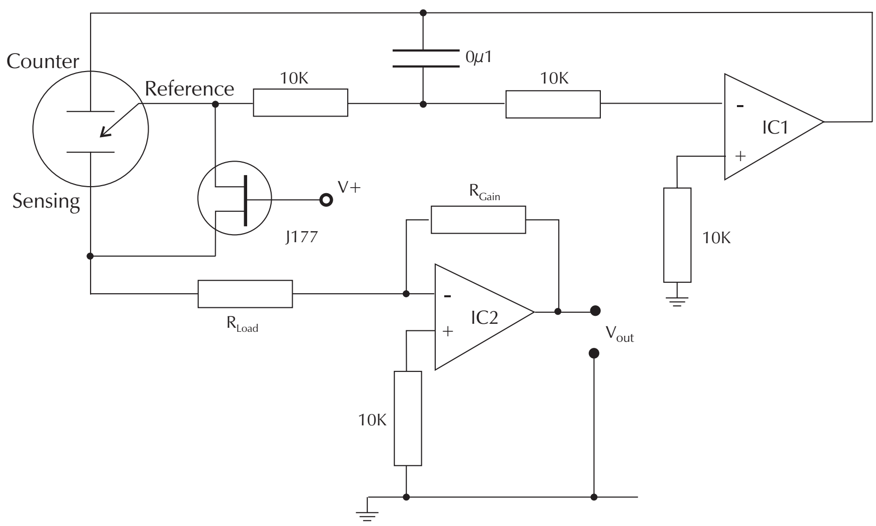
To maintain a MICROceL in a 'ready to work' state when an instrument is switched off, the *Reference* and *Sensing* electrodes must be shorted together. This is done by shorting the *Reference* to the circuit common with an FET, as shown , or using a ganged on/off switch. While shorted it is important to avoid exposure to active gases or solvent vapours.

MICROceL Standard operating circuit

***IC1** - This amplifier should have either a low offset or have its offset nulled out. The PMI OP-77 and OP-90 and Linear Technology LT1078 are all suitable.

IC2 - This amplifier acts as a current to voltage converter and its offset performance is less critical. The OP-77 or similar is a suitable choice

Recommended values of $\mathbf{R_{load}}$ are given on the relevant data sheet.



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Humidity Effects

Toxic Gas MICROceLs are based on the use of aqueous electrolytes which, in conjunction with the porous diffusion barrier, permit water vapour to be absorbed into the electrolyte under conditions of high water vapour pressure, and allow the electrolyte to dry out at very low ambient water vapour pressure. Provided conditions are non-condensing the performance is relatively unaffected by humidity and will simply follow the change in concentration of the measured gas which results from changes in humidity. However when rapid changes in humidity occur, some sensors will show a transient response which should die away after about 20-30 seconds.

Continuous operation is possible between 15% and 90% RH over the full operating temperature range. Under these conditions the electrolyte will reach an equilibrium with the external water vapour pressure at a volume and concentration which does not affect the sensor's life or performance. Operation is also possible outside these conditions, but water transfer may occur and must be considered.

High Humidity, High Temperature

Under continuous operation at high temperatures and 90-100% RH, water will slowly diffuse in. However water uptake is only harmful when the liquid volume increase exceeds the free space available. When this happens the sensor becomes prone to leakage - increasingly so as more and more water is taken up by the sensor. Removal from this humidity to a lower RH before leakage occurs will gradually restore the sensor to its original condition and no permanent harm will result from this exposure.

If a sensor shows signs of being affected by condensation, drying it with a soft tissue will restore normal operation. Under no circumstances should sensors be heated above 40°C to dry them out.

Low Humidity, High Temperature

Similarly in continuous operation at 0-15% RH water will diffuse out. This will only be a problem when the volume of electrolyte has decreased by more than 40%, at which point the sensor gas sensitivity will be affected and the housing and seals may be attacked by the very concentrated electrolyte. Provided a sensor is not left in this condition long enough for such a reduction in the electrolyte to take place, it can be restored by exposure to a RH above 15%. At this level water ingress will begin to restore the water balance.

The rate at which water transfer occurs depends on the ambient temperature and relative humidity at the sensor. It also depends on the electrolyte and capillary hole size, both of which vary from one type of MICROceL to another. In general, low sensitivity MICROceLs will have slower water transfer rates and can be used for longer periods of time, whereas high sensitivity MICROceLs will have higher water transfer rates, and should be operated for shorter periods of time in these conditions.

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