

## Application Note AN2

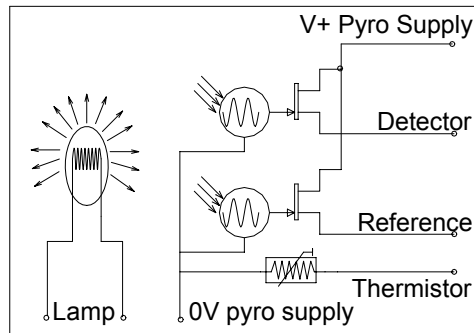
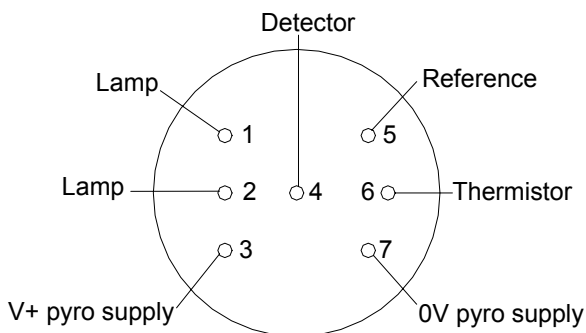
### MINIATURE INFRARED GAS SENSORS GOLD SERIES

UK Patent App. No. 2372099A  
USA Patent App. No. 09/783,711  
World Patents Pending

### SENSOR INTERFACE



In order to derive a signal from the Dynament range of infrared sensors the lamp should be pulsed at a constant frequency and duty cycle and power should be applied to the on-chip FET transistors. The signal can then be extracted from the on-chip FET transistor sources and the internal sensor temperature can also be monitored continuously. A schematic of the sensor along with a pin-out diagram is shown below to assist in this discussion.



### Lamp Driving:

The lamp can be driven by a square wave derived from a stable oscillator or a microprocessor I/O line. The magnitude of the sensor output signals are frequency dependent, and it is recommended that the lamp be pulsed at typically 4Hz with a 50% duty cycle. Lower pulsing frequencies will generally result in a higher signal level but if the frequency is below approximately 2.5Hz there is the possibility that the signal will exhibit some roll off and result in increased noise and some hysteresis. The maximum lamp voltage during the “on” phase of the lamp source is 5V, exceeding this voltage will shorten the life of the lamp. The lamp voltage during the “off” phase can be 0V and should be below 1V in order to obtain a good light to dark contrast in the final output signal. A simple method to obtain the drive is to use a 5V regulator containing a shutdown pin and toggle the shutdown pin directly from a microprocessor I/O line.

## FET load resistors:

The internal pyroelectric elements are connected to the gates of the on chip FET transistors and also to the 0V pyro supply connection. These elements act as AC signal sources responding in sympathy to the intensity of radiation received from the lamp via integral optical filters. In the absence of radiation they produce no signal and the gates of the on chip FET transistors are effectively at the 0V pyro supply potential. The FET transistor drains should be connected to a stable DC supply voltage of between 3V and 18V relative to the 0V pyro supply line. Exceeding 18V at the drains can cause irreparable damage to the devices. The signal generated by the internal pyroelectric elements is then translated to the sources of the on chip FET transistors.

The simplest method of interfacing the signal is to use the on chip FETs in a source follower configuration. A resistor loads the on chip FET transistor source to a voltage less than, or equal to, the 0V pyro supply line and therefore provides a current path through the FET transistor with the resulting signal appearing as a voltage across the load resistor. This voltage has two components: an AC output signal and a DC offset voltage upon which the AC signal is superimposed.

It is important to consider the effect of external temperature transients in designing this simple interface. A sudden fall in temperature can result in the gate of the FET transistors being pulled to a negative voltage and if this gate voltage falls sufficiently below the load resistor negative voltage then the DC offset voltage will be clipped and the AC signal voltage temporarily lost. In cases where sudden changes in ambient temperature are anticipated it is therefore good practice to connect the source load resistors to a voltage negative with respect to the 0V pyro supply line.

The DC offset voltages generated by the on chip FET transistors are typically between 0.6V and 1V (limits are 0.4V and 1.5V) above the 0V pyro supply line. The value of the load resistors should be such that between 10 $\mu$ A and 20 $\mu$ A of current is allowed to flow through the on chip FET transistors. Excessive current flow will dissipate power across the on chip FET transistors and cause an internal heating effect which will be detected by the internal pyroelectric elements. For example, with the load resistors connected to the 0V pyro supply line a value of 47k $\Omega$  is appropriate whereas with the load resistors connected to a voltage 5V below the 0V pyro supply line a value of 390k $\Omega$  is appropriate.

## AC coupling:

The DC offset voltage should be removed from the voltage generated across the load resistors and the resulting AC signal component should be amplified to produce a meaningful signal. This can be simply achieved by AC coupling the voltage generated across the load resistors to a convenient DC voltage level. The AC coupling should have a good transfer characteristic at the lamp pulse frequency and a 330nF - 470nF capacitor in combination with a 390k $\Omega$  resistor will suffice. This transfers the AC component of the signal to a convenient DC voltage level, typically at mid rail or mid range of an A/D converter.

## AC amplification:

The resulting AC component of the FET transistor signals requires amplification in order to optimise A/D conversion. Typical AC signal levels are in the region of 1mV - 10mV peak to peak, dependent on the sensor type and gas concentration, appearing as approximate sine waves with a frequency equal to the lamp drive frequency. Typically these signals are amplified in a single stage with fixed and equal gain for both the detector and reference signals. Applying the gain referenced to mid rail or mid range of an A/D results in the signal centred on a convenient voltage where the maxima and minima of the waveforms allow for high resolution of peak-to-peak changes.

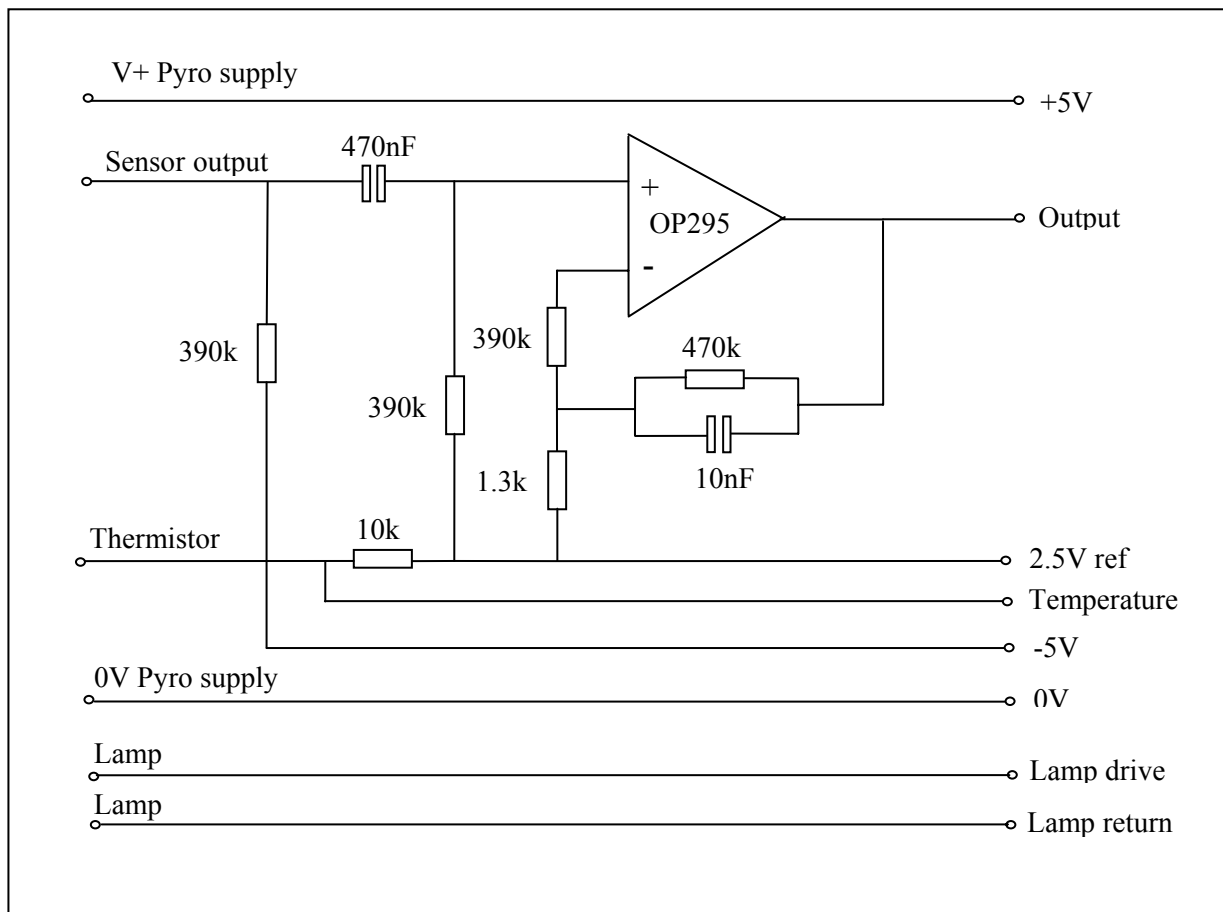
## Internal temperature sensor:

A thermistor is included in the Dynament infrared sensors to enable the internal sensor temperature to be continuously monitored. This measurement is used to apply temperature compensation to the signal measurements and the derived gas concentration; see the "Signal Extraction" application note for details of temperature compensation methods. The thermistor temperature/resistance characteristics are as follows:

TEMPERATURE - °C	RESISTANCE - kΩ
-40	100.950
-30	53.100
-20	29.121
-10	16.599
0	9.795
+10	5.970
+20	3.747
+25	3.000
+30	2.417
+40	1.598
+50	1.081
+60	0.746

The thermistor is internally connected to the 0V pyro supply line and a voltage divider comprising the thermistor in series with a fixed resistor connected to a reference voltage is a simple means to obtain a temperature dependent voltage with which to measure the internal sensor temperature. Using a 10kΩ series resistor connected to a 2.5V reference the temperature can be derived directly from voltage across the thermistor by using the expression:  $\text{Temperature } (^\circ\text{C}) = 77.595 - 126.9 \cdot v + 73.193 \cdot v^2 - 17.681 \cdot v^3$

An example interface circuit is shown below:



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