

INTRODUCTION

This application note can be used to assist with the design of the electronics used to control and monitor the infrared gas sensors. The information in this document details the minimum requirements necessary to obtain an indication of the target gas concentration. The circuits suggested in the application note are for guidance only and more suitable alternatives should be considered, depending on the requirements.

To operate the sensors, the built-in lamp must be pulsed (via the Lamp Drive Voltage) as the pyroelectric detectors only detect a change in incident radiation. The active detector signal is affected by the lamp intensity, temperature and the absorption of radiation by the target gas within the spectrum of the filter on the active detector. The lamp intensity and temperature also affect the reference detector but there is no absorption of radiation to the target gas, due to the different filter being used. The nature of the signals from the detectors is to follow the pulsing of the lamp and the ratio of the amplitudes between the active and reference detector signals is related to the concentration of the target gas.

It is known that a shift in temperature will cause a variation in the output of the detectors. Some devices contain a built-in temperature sensor or thermistor to assist with temperature compensation, via associated software. The devices without a built-in temperature sensor will require a means of monitoring ambient temperature close to the infrared sensor.

The inputs and outputs of the infrared gas sensors have been summarised in the Table 1.

	Input/Output	Std Mini (Series 1)	Std Mini (Series 2)	IR15T and IR25T Series	IR600 Series
Detector Supply Voltage	Input	Yes	Yes	Yes	Yes
Common	Input	Yes	Yes	Yes	Yes
Lamp Drive Voltage	Input	Yes	Yes	Yes	Yes
Lamp Return	Output	Yes	Yes	Yes	Yes
Reference Detector Signal	Output	Yes*	Yes	Yes	Yes
Active 1 Detector Signal	Output	Yes	Yes	Yes	Yes
Active 2 Detector Signal	Output	No	No	Yes	No
Thermistor Output	Output	No	Yes	Yes	No
Temperature Sensor Output	Output	No		No	Yes
Reference Voltage (+2.5 V)	Input	No	No	No	Yes

* - Except for IR31SE and IR31SC

Table 1 – Summary Table of Input/Outputs for all Infrared Gas Sensors

The electronics used to operate the infrared gas sensors can be broken down in to the areas shown in Figure 1.

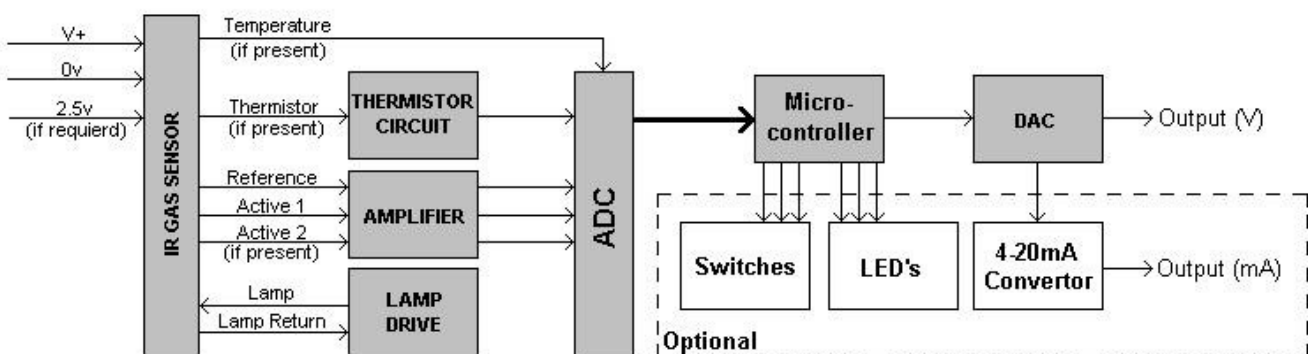


Figure 1 – Block Diagram of Electronics Design

INFRARED SENSOR PIN CONNECTIONS

Detector Supply Voltage/Common

The supply voltage to the detector can range between 3 Vdc and 5 Vdc with respect to 0 V (common). However, the performance data stated in the data sheets are normally based on a 5 V supply.

Lamp Drive Voltage/Lamp Return

The lamp must be pulsed in order to generate a change in incident radiation at the detectors. The optimum lamp pulse rate is 4 Hz at 50% duty cycle, but can be varied if required. The nature of the detectors is dependent on both the electrical and thermal time constants of the pyroelectric material. As the lamp pulses, the signal from the detectors will be related to the change in incident radiation emitted from the lamp.

For a square wave pulsed supply to the lamp at 4 Hz and a 50% duty cycle and due to the time constants associated with the heating and cooling of the lamp filament, a sine wave output is obtained from each detector, at the lamp pulse frequency of 4 Hz as shown in Figure 2.

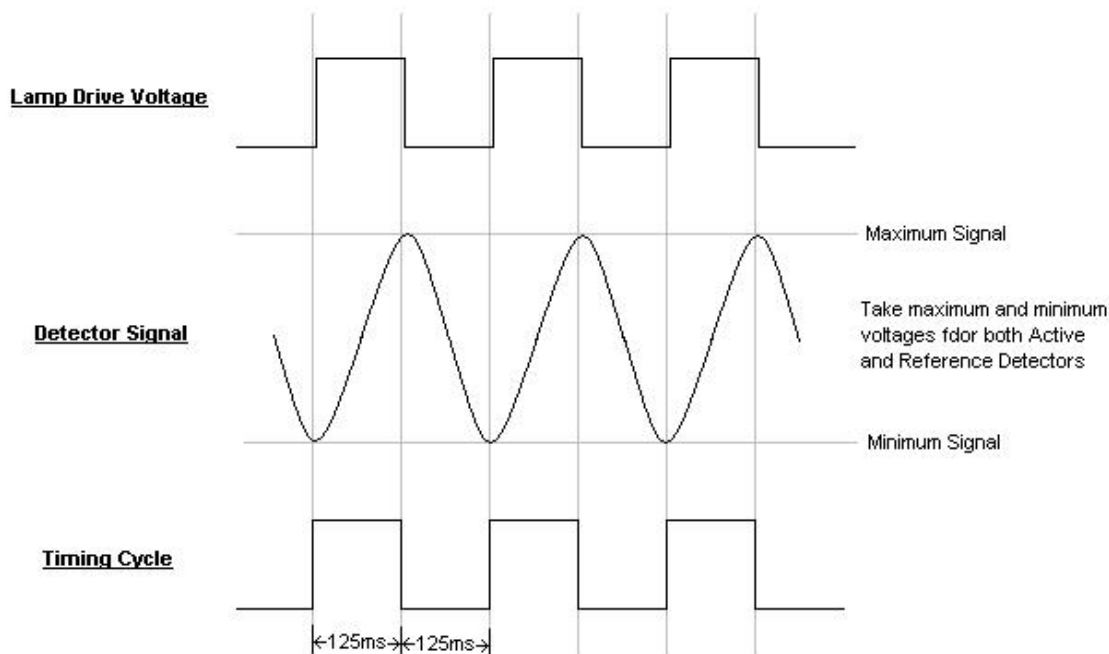


Figure 2 – Detector Signal as a Function of Lamp Drive

The lamp drive voltage (see Figure 3) should be capable of supplying the inrush current expected from a cold filament. Setting the “off” voltage to be above 0 V (typically 0.4 V), thereby maintaining a small current through the lamp filament, can reduce this inrush current. The “on” voltage can be set between 3 V and 5 V (the performance data stated in the data sheets is normally based upon a 5 V supply). The lamp drive can be triggered by a logic circuit originating from the microprocessor. Figure 3 shows an example of a lamp drive circuit.

Note: If the drive voltage is unable to supply the inrush current then the rising edges of the voltage waveform (lamp) will be slow and the associated detector output signals will be distorted, resulting in errors in the determination of the maximum meaningful signal.

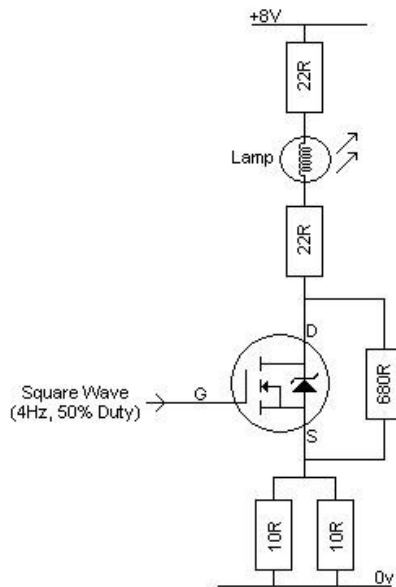


Figure 3 – An Example Lamp Drive Voltage

The lamp drive tracking and circuitry should be isolated from the detector signal tracking and circuitry, because the current pulses within the lamp drive circuit can generate “sympathetic” pulses in the signal lines. This particularly applies to the lamp return line, which may often connect to a common 0 V reference point.

Detector Signals

The detector signals (except the IR600 series) are the raw signals from the pyroelectric detectors, buffered by an on-chip FET. The outputs from these detectors will be typically in the region of 15 mV peak-to-peak. It is therefore recommended that these signals be immediately amplified (except IR600 series devices, which have a built-in amplifier circuit) to generate more manageable detector signals. Single- and dual-rail amplifier circuits are explained in this application note.

Note: The amplifier circuit should be placed as close as possible to the sensor in order to minimise any noise due to cable or tracking prior to the amplification.

An example single-rail circuit for the sensor detector signals is shown in Figure 4. The raw output from the detectors (see Figure 2) consists of the changing detector signal superimposed on a DC voltage pedestal. Note that the DC voltage pedestal is not fixed as it is a function of temperature, signal history and supply voltage. To amplify the changing detector signal, AC coupling of the detector signals is used to remove the DC voltage pedestal. This refers the changing signal to a known convenient reference voltage, V_{ref} (suggested half the input voltage). The AC component is then amplified to produce the signal output.

Note: The circuit in Figure 4 shows an adjustable gain, via a variable resistor. The circuit can be changed to obtain a fixed gain if required. The sensor data sheets contain peak-to-peak voltage information for each detector for the specified sensor type.

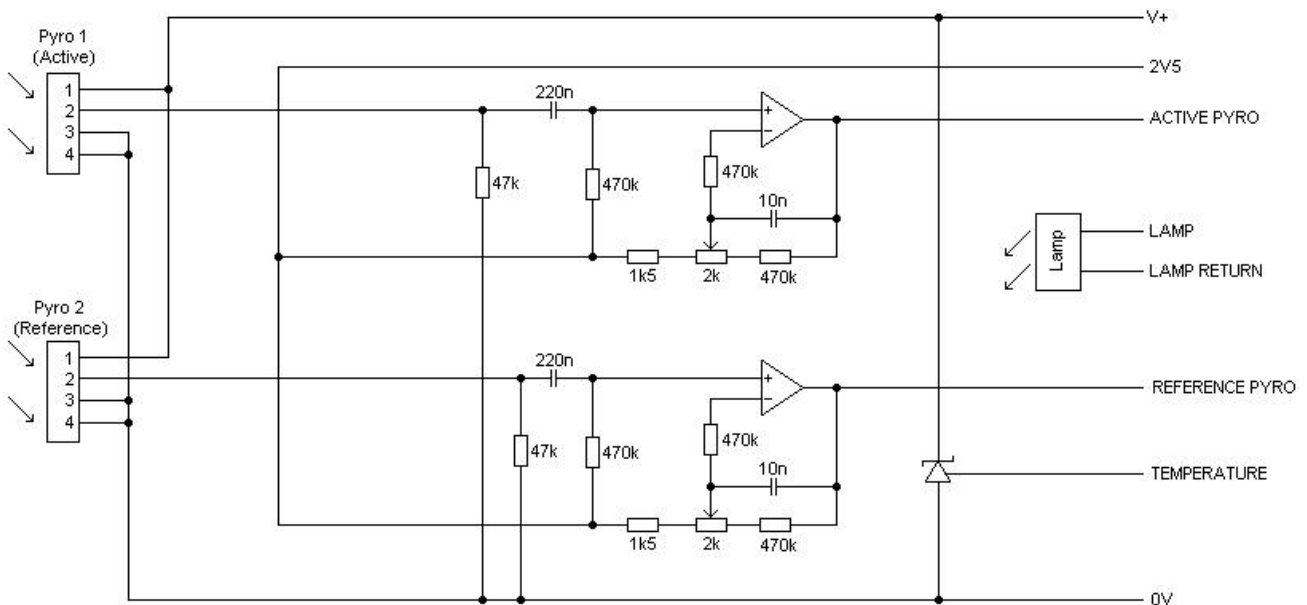


Figure 4 – An Example Single-Rail Amplifier Circuit for Infrared Gas Sensors

A dual-rail (e.g. +8 V and -8 V rail) version of the circuit could also be used, which uses 0 V as the reference voltage. The main advantage of this circuit is that it can cater for rapidly falling temperatures resulting in a negative shift of the DC voltage pedestal of the detectors. If the fall in temperature is excessive, the DC pedestal could fall below 0 V and the sensor signal could be clipped unless the load is connected to a negative rail. This phenomenon will be less significant with the IR600 series devices due to the increased size of the sensor and therefore a larger thermal mass, when compared with the standard mini, IR15T series and IR25T series devices.

The amplified detector signals can then be connected to the A-D converter, for peak-to-peak measurements.

Thermistor/Temperature Sensor

In order to perform temperature compensation, an indication of the sensor temperature will be required. Some sensors in the e2v technologies infrared range have a built-in means of monitoring temperature as follows:

- a.) Temperature Sensor – A temperature sensor producing a DC voltage output linear with temperature. The output of this sensor can be connected straight into the A-D converter in the circuit.
- b.) Thermistor – One end of the thermistor is internally connected to the 0 V line. The output of the thermistor needs to be placed in series with a 10 kΩ resistor as shown in Figure 5. The voltage output at the mid-point can be used to calculate the temperature.

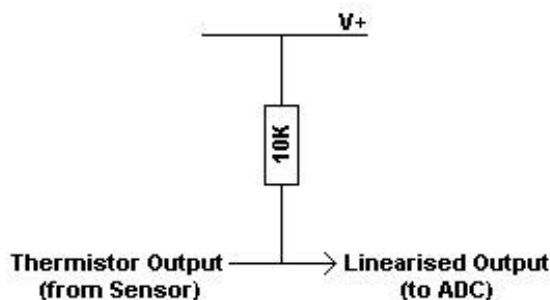


Figure 5 – Thermistor circuitry

Reference Voltage

The reference voltage is used as a DC voltage pedestal. It is used to ensure the detector output waveform centres at this level to minimise the possibilities of “clipping”.

A-D AND D-A CONVERTER

To save space and minimise components, it is recommended that the A-D and D-A converters be incorporated into the microprocessor. It is recommended that minimum resolutions of 12-bit and 10-bit be used for the A-D and D-A respectively. The engineer involved with the circuit design shall determine resolution of the A-D converter along with the addition of a reference voltage to improve the resolution of the measurements. The circuitry linked to the output of the D-A converter is normally designed to express the target gas concentration as either a voltage and/or 4 – 20 mA output.

MICROPROCESSOR

The choice of the microprocessor will depend upon the number of A-D converters, D-A converters and memory. The quantity of functions required for the microprocessor will depend upon the complexity of the circuit and shall be determined by the design engineer. A means of storing calibration values in a non-volatile memory will be required.

CALIBRATION

A means of calibrating the device will be required. The simplest method involves having two push-button switches (“zero” and “span”) that are monitored by the microprocessor software at regular intervals.

The “zero” button can be pressed during the exposure to a gas void of the target gas. The software will be required to calculate the “zero” reading and store the value in the non-volatile memory, to be used during future calculations. The “span” button can be pressed during the exposure of the target calibration gas. The software will be required to calculate the “span” reading and store the value in the non-volatile memory, to be used during future calculations (refer to Infrared Application Note 3 for more details).

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