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AMETEK®

NDIR: Electronic Interface and Signal Extraction for Pyroelectric Sensor

1. Introduction

The Alphasense IRC-A1 NDIR sensor consists of an infrared source, optical cavity, dual channel pyroelectric detector and internal thermistor. This application note details the electronic interface necessary to obtain useful signals from the sensor.

2. Source Drive

The infrared source should be switched at a low frequency with a 50% duty cycle. A switching frequency of 2 to 2.5Hz, derived from a crystal oscillator source is recommended. The source should be driven from a constant voltage source and care should be taken to ensure the supply does not contain low frequency ripple that would otherwise modulate the output. The nominal resistance of the source is approximately 9 to 10 Ohms at ambient temperatures and will draw approximately 50 to 60 mA at 5 V. The average current will be half of this figure when driven at 50% duty cycle.

The circuit shown in Figure 2 uses an n-channel MOSFET to switch the low side of the source with the high side connected to a stable supply (typically +5 VDC). The MOSFET should have a low RDS ON resistance to minimise its voltage drop. If the high side is driven and the low side is grounded, care must be taken to keep the detector ground separate from the source ground to avoid pickup due to the source current circulating in the detector ground. The source is galvanically isolated from the detectors and thermistor in the sensor.

3. Detector Signal Amplification and Filtering

The raw active and reference signals are composed of a DC offset voltage (typically 0.7 V - 1.0 V) with a small (~20 - 50 mV peak-to-peak) superimposed response signal alternating in phase with the source drive voltage (see Figure 1 (a) and (b), which show the active channel only). The alternating signal should be extracted and amplified (Figure 1 (c)) in order to obtain a measure of the peak-topeak amplitude of this oscillating component. This peak-to-peak amplitude can then be used to determine the gas concentration (see Application Note AAN 201).

A suitable circuit for driving an Alphasense IRC-A1 sensor is shown in Figure 2. There are two identical detector FET's inside the dual sensor pyroelectric detector. The CO_2 detector will respond to changes in CO_2 levels while the reference will be substantially unaffected by CO_2 levels. Both detectors will be affected by ambient temperature and the IR source luminosity and appropriate processing of both channels will alleviate these unwanted effects (see Application Note AAN 201).

The detector FET's are arranged as source followers. The load resistors (R1 and R2 in Figure 2) should be set to give approximately 30 µA bias current in the FET's. The nominal output voltage on the FET sources is between 0.6 and 1.2 V. The load resistors should be connected to a negative bias supply to allow a greater output voltage swing that may be necessary if the sensor is subjected to sudden temperature changes. A -2 VDC supply is recommended, which must be well de-coupled to AGND.

The source and detectors have a significant response time (hence the reason for the relatively low pulse frequency). The amplification stage should include a high pass response with a roll off of about four times the switching frequency to reduce high frequency noise, and a low pass (AC coupling) stage of approx. 0.1 Hz to remove the DC bias from the FET's.

The frequencies need not be exact, but both detectors (reference and active) should have matching characteristics. The detectors will have a typical output of 45 mV peak-to-peak so the circuit should provide sufficient gain to give a reasonable input to any ADC used.

The circuit shown in Figure 2 will give approximately 3 V peak-to-peak (bipolar around 0 V). For unipolar ADCs, C1, C2, R5, R6, R7 & R8 could be connected to a mid rail supply that is well decoupled to AGND.
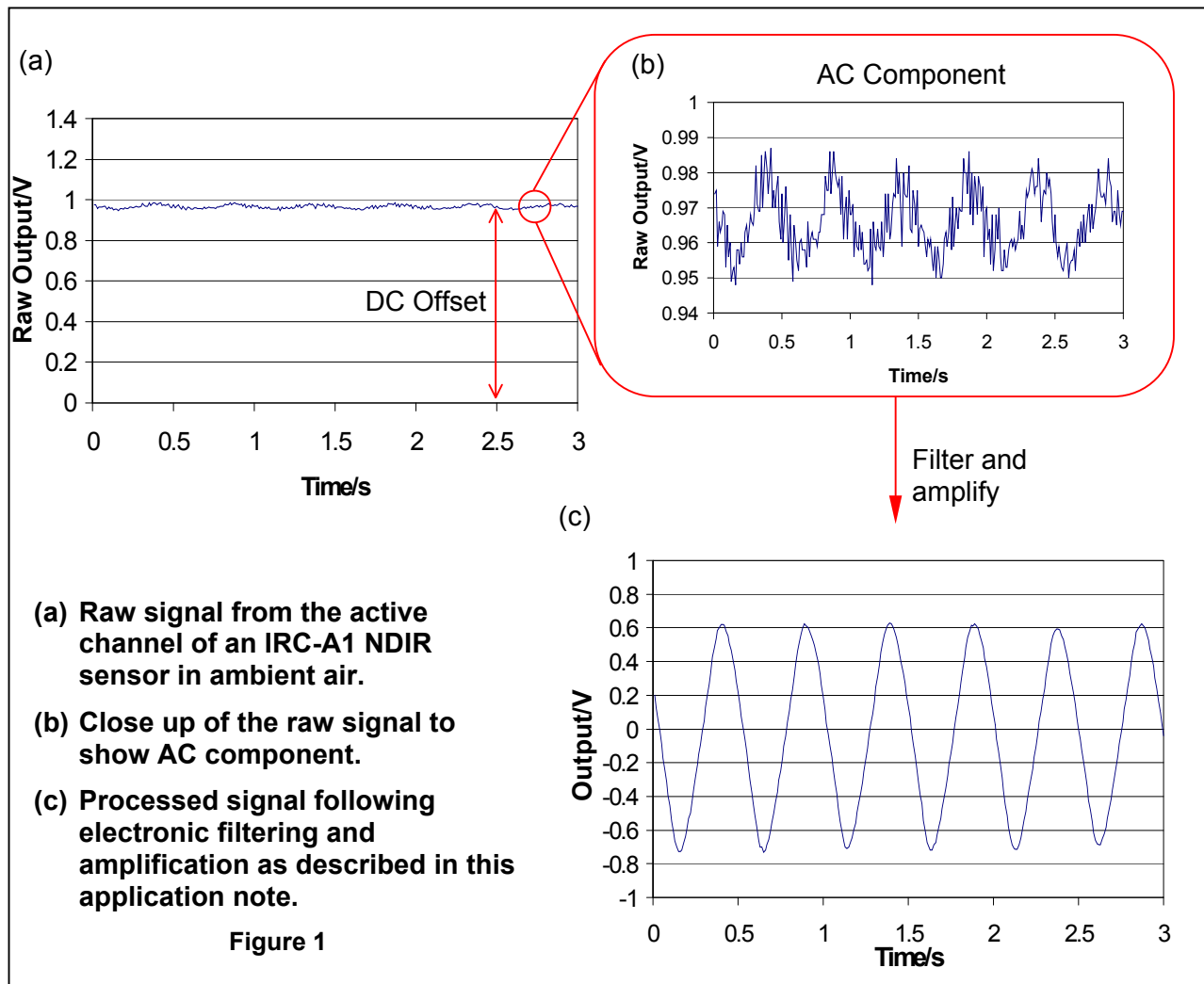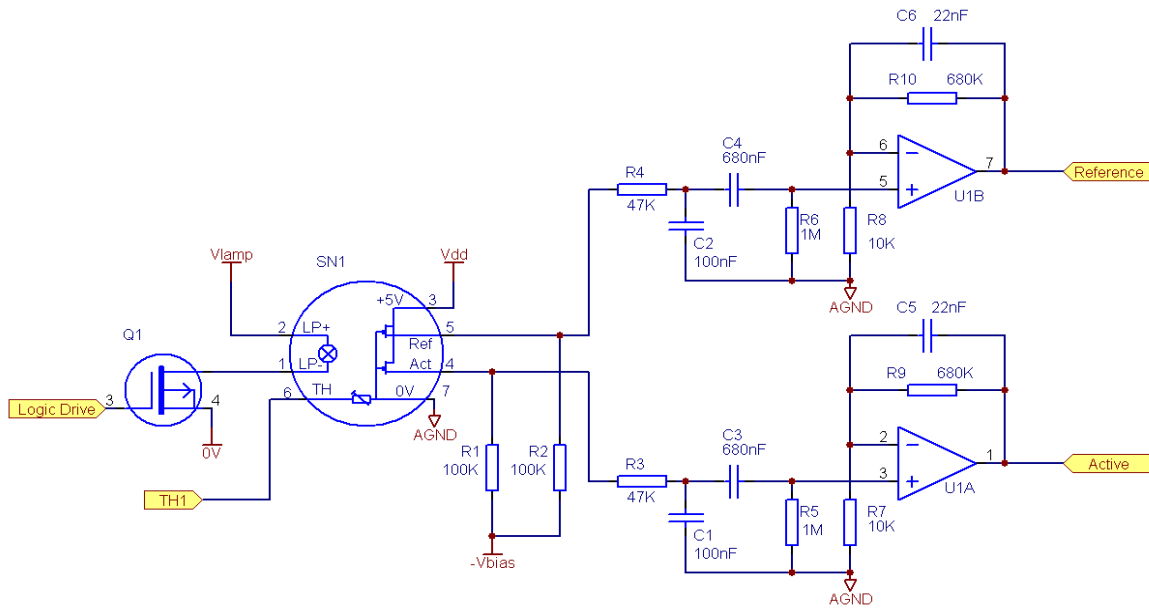
(a) **Raw signal from the active channel of an IRC-A1 NDIR sensor in ambient air.**

(b) **Close up of the raw signal to show AC component.**

(c) **Processed signal following electronic filtering and amplification as described in this application note.**

Figure 1

Figure 2. Circuit suitable for driving the lamp and amplifying the signal from an IRC–A1 sensor

4. Thermistor Output

The sensor includes an integral thermistor to monitor the internal temperature. Internally, the thermistor is connected to AGND. The thermistor output should be connected in series with a known resistor and reference voltage. The potential at the junction between the resistors can then be used to determine the thermistor resistance and the temperature via the tables below.

Temp (°C)	IRC–A1 R (Ohms)
25	3000
–30	41222
–20	23519
–10	14003
0	8661
10	5541
20	3655
30	2478
40	1723
50	1225
60	889

Note that although you may have another temperature sensor in your gas detector to monitor ambient temperature, you should use the thermistor in the sensor to correct the NDIR readings for temperature because the NDIR sensor will operate between 2°C and 5°C warmer than the ambient temperature due to heat generated by the IR light source.