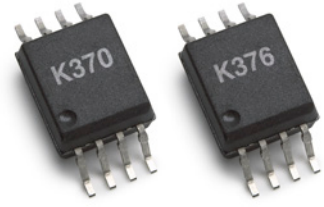
Voltage/Current Threshold Sensing Using Avago ACPL-K370 / K376 Optocouplers



Introduction

Isolated voltage/current sensing has many uses in industrial applications as shown in Figure 1. It can be used to detect overvoltage in an event of power surge or undercurrent in an event of power loss. Furthermore, it provides signal isolation and suppression of electrical noise and transient interference preventing system malfunction.

The ACPL-K370/K376 are analog optocoupler devices with built-in voltage/current threshold detection circuits. The devices have high detection accuracy, a wide AC or DC voltage detection range and low threshold current. The ACPL-K370/K376 are ideal for use in many industrial sensing applications such as power monitoring and temperature sensing.

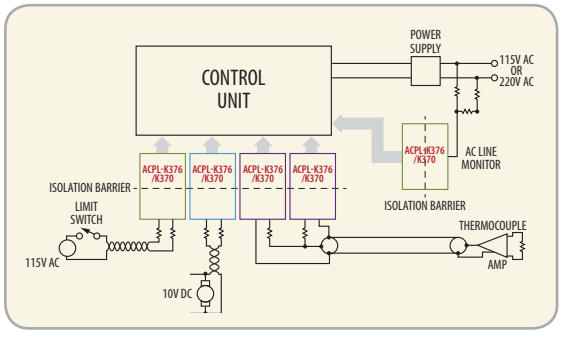


Figure 1: Application Examples of Voltage/Current Detection using ACPL-K370 / K376 in Industrial Environments

Optically-Isolated Voltage/Current Detector

In a typical electrical control system for voltage/current detection, the input signal will be either a DC or AC signal and the internal diode bridge at the input of the ACPL-K370/K376 allows for easy use with an AC input signal by using Pin 1 and Pin 4 as shown from Figure 2. The input section of the ACPL-K370/K376 consists of a full wave bridge rectifier, a threshold detection integrated circuit, and an LED. The Zener diode of the bridge circuit protects the threshold circuitry and LED from over voltage/current stress conditions. Hysteresis provides enhanced noise immunity, delivering an accurate temperature-compensated threshold level. The signal is optically coupled to the output detector integrated circuit, consisting of a photodiode and a high gain Darlington configuration amplifier.

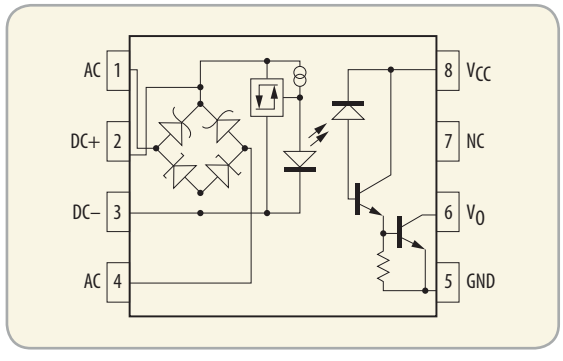


Figure 2: ACPL-K370 / K376 IC Functional Diagram

Voltage/Current Detection Using ACPL-K370/K376

The ACPL-K370/K376 have pre-programmed upper and lower voltage and current threshold levels, V_{TH+}, V_{TH-}, I_{TH+} and I_{TH-}. To achieve a higher external threshold detection level (V_+ or V_-), a resistor, Rx can be connected in series externally and the resistor can be split in half to reduce power dissipation and improve transient protection. Rx is used to determine the threshold levels, either V_{TH+}/I_{TH+} or V_{TH-}/I_{TH-}. A connection diagram with ACPL-K370/K376 is shown in Figure 3. In some applications, in order to have more control over the external threshold detection level, both upper and lower voltage threshold levels and a combination of R_x and R_p. R_p connected in parallel is required with the ACPL-K370/K376. Figure 4 illustrates AC power detection with a combination of R_x and R_p. To get R_x and R_p, as governed by both equations 1 and 2, is shown below.

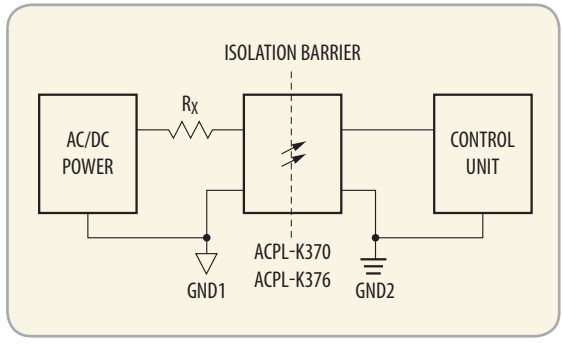


Figure 3: AC / DC Power Threshold Sensing with ACPL-K370 / K376

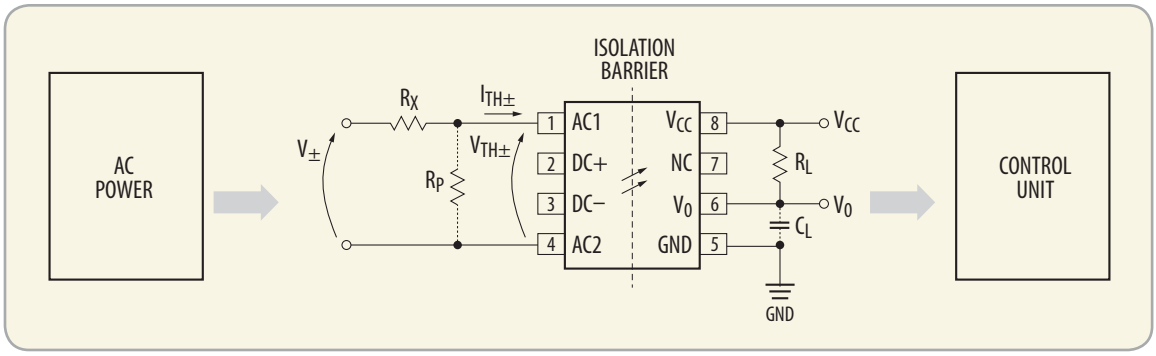


Figure 4: AC Power Threshold Sensing Improvement with ACPL-K370 / K376

Eq. 1

$$V_+ = R_X \left(I_{TH+} + \frac{V_{TH+}}{R_P} \right) + V_{TH+}$$

Eq. 2

$$V_- = R_X \left(I_{TH-} + \frac{V_{TH-}}{R_P} \right) + V_{TH-}$$

Equation 1 and 2: For Dual External Threshold Voltages

Part No	Upper Threshold Current, I_{TH+} (typ)	Lower Threshold Current, I_{TH-} (typ)	Upper Threshold Voltage DC Input, V_{TH+} (typ)	Lower Threshold Voltage DC Input, V_{TH-} (typ)	Upper Threshold Voltage AC Input, V_{TH+} (typ)	Lower Threshold Voltage AC Input, V_{TH-} (typ)	Hysterisis (typ)
ACPL-K370	2.77mA	1.44mA	3.8V	2.59V	5V	3.8V	1.2mA
ACPL-K376	1.32mA	0.86mA	3.8V	2.59V	5V	3.8V	0.6mA

Table 1: Electrical Specifications of the ACPL-K370 / K376

Key Specifications

Electrical specifications for the ACPL-K370/K376 are summarized in Table 1. The ACPL-K370/K376 is available in the industry-standard stretched SO8 package with 8mm creepage and clearance, and delivers a high working insulation voltage, high CMR and wide operating temperature range with details summarized in Table 2. The ACPL-K370/K376 has a voltage detection accuracy of +/-5% for DC input signal and +/-6% for an AC input signal. The ACPL-K376 delivers lower threshold current and thus can reduce power consumption by 52% (based on the nominal turn-on threshold) as compared to the ACPL-K370.

Features	ACPL-K370 / K376
Creepage / Clearance	8mm / 8mm
Operating Temperature	-40°C to +105°C
Supply Voltage	Guaranteed AC and DC specs from 3.3V to 5V
Isolation Voltage	5000V
CMR	1kV/us @ V_{CM} = 600V

Table 2: Key Specifications of the ACPL-K370 / K376

Calculation Tool & Application Note

An Excel® calculation tool can aid customers in choosing the appropriate external resistor values, R_x and R_p when using the ACPL-K370/K376 for AC or DC input signal. Users will need to enter the external upper (V_+) or lower (V_-) threshold voltage level, or both, depending on the detection criteria. This Excel calculation tool is available upon request from Avago sales. An application note which explains more about the details can be downloaded from the following link: http://www.avagotech.com/docs/AV02-3699EN

Evaluation Board

Evaluation boards and manuals for the ACPL-K370/K376 are available upon request from Avago sales. These enable designers to learn how to quickly and easily implement the ACPL-K370/K376 opto-isolated voltage/current threshold detectors for their applications.

Please visit the Avago website for details about isolated voltage/current threshold sensing products: http://www.avagotech.com/pages/en/optocouplers_plastic/isolated_voltage_current_detector/

Contact us for your design needs at: **www.avagotech.com/optocouplers**

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