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An AC Power Fail Warning Circuit for the PF600-1

In this application note, you will find a circuit described that provides for an AC Power Fail warning function for use in conjunction with the PF600-1. Additional information on the PF600-1, including features and complete specifications can be found on our website at <http://www.murata-ps.com>.

AC Power Fail Warning Circuit for PF600-1

SUGGESTED CIRCUIT

The circuit presented in Figure 1 shows a “mains fail detector”, or “AC power fail warning circuit”. It uses two means of recognizing the presence of an AC voltage, one fast but less accurate, the other slower but more accurate. Between the two, the circuit attempts to give a correct indication, whether loss of voltage occurs quickly or slowly.

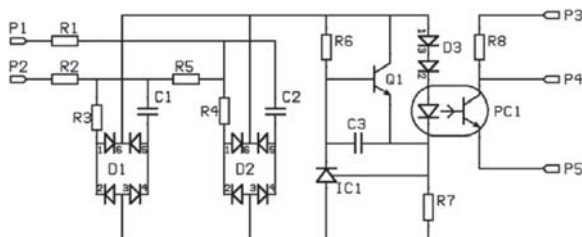


Figure 1: AC Power Fail Warning Circuit

APPLICATION

The circuit can be used in any situation where an isolated indication of mains failure is required. Its output is essentially just the receive transistor of an optoisolator. In the typical connection shown above, it produces a low logic level during normal operation, and a high level on loss of mains. Clearly, by exchanging the resistor and opto receive transistor, this logic can be inverted.

Note that there is little drive capability from this output. It should either be connected to a CMOS input or otherwise buffered if the load is more than a few microamps or has a capacitance of more than about 100pF.

FEATURES

- Can be built with only surface-mount parts – no electrolytics, even tantalums.
- Adjustable threshold (R7)
- Fast response and accurate slow threshold
- Able to detect failure even near a zero-crossing
- Includes isolation, to a level dependant on the choice of optoisolator

THEORY OF OPERATION

Most of the incoming voltage is dropped across resistors R1 and R2, feeding a current input to the rest of the circuit. This current is split into two parts in quadrature with one another.

The two currents are rectified and added. When one is near its zero crossing, the other is near a peak. There is therefore never a moment when both currents fall to zero, and the rectified output is therefore continuous. This current passes through the transmit diode of an optoisolator and through a relatively accurate current detector.

The current detector uses a 2.5V “shunt regulator”, IC1. With its input above 2.5V, the shunt regulator normally stays “on”. This keeps Q1 reverse-biased.

In the event of the average mains voltage falling below this threshold, IC1 turns off, and Q1 turns on, shorting the transmit diode of PC1. This turns off the receive transistor, registering a “fail”.

Because the rectified current passes through the transmit diode directly, any discontinuity also quickly appears in the receive current, achieving the required fast response to the abrupt failure.

The diode pair D3 is present only to increase the volt drop through the transmit diode, so that the simple bypass circuit through Q1 can extinguish it.

CONSTRUCTION

The circuit can be built using only surface-mount components. Some suitable parts are listed below.

| Reference | Type | Description | Comment |
|-----------|----------------------|---|--|
| C1, C2 | Capacitor | 100nF 10% 50V X7R 0805 | |
| C3 | Capacitor | 2.2µF 20% 10V X7R 0805 | |
| D1, D2 | Quad diode | BAV756S | |
| D3 | Dual diode | BAV99W | |
| IC1 | Shunt regulator 2.5V | Zetex ZR431 | |
| PC1 | Optoisolator | Toshiba TLP181GR | |
| Q1 | NPN transistor | BC846 | |
| R1, R2 | Resistor | 33k 2% 0.5W eg Bourns CR2010-FX-3302E or Koa RK73B 2H TD 333G | Or use 4 off 1206 type (33kΩ 0.125W) for each of R1 and R2 |
| R3, R4 | Resistor | 22k 1% 63mW 0603 | |
| R5 | Resistor | 47k 1% 125mW 1206 | |
| R6 | Resistor | 47k 5% 63mW 0603 | |
| R7 | Resistor | 4k3 1% 63mW 0603 | |
| R8 | Resistor | 100k 5% 63mW 0603 | |

PERFORMANCE

A prototype circuit was characterized at 50Hz.

“Slow” threshold: 79Vrms Required to be close to, but less than 85Vrms.

Voltage below which the “fast” mode responds: 60Vrms

This is measured by doubling the sense resistor R7 and measuring the “slow” (static) threshold. The true slow threshold will then be below the fast one, and thus irrelevant.

The output logic threshold for these tests was assumed to be 30% of the pull-up supply voltage.

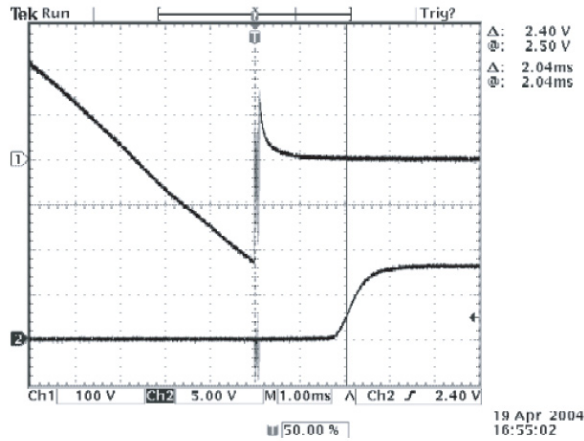
RESPONSE TIME

The response time was generally greater at higher input voltages, and smallest near the zero crossing. These values should be regarded at best as typical, as they were measured on one sample and at room temperature only. The figures are based on the number “Qty” of randomly-timed traces at each test voltage.

At a given mains voltage, the timing variation was associated mainly with the phase of interruption, the small values occurring close to the zero-crossing.

| Input Voltage, Vrms | Maximum, ms | Minimum, ms | Typical, ms | Qty |
|---------------------|-------------|-------------|-------------|-----|
| 90 | 1.78 | 0.28 | 1.7-1.75 | 9 |
| 120 | 2.06 | 0.20 | 1.9-1.95 | 9 |
| 220 | 2.76 | 0.64 | 2.6-2.7 | 14 |
| 265 | 3.08 | 0.86 | 2.85-2.95 | 11 |

A TYPICAL WAVEFORM:



A typical waveform is shown in Figure 2 above.

CH1: INPUT, INITIALLY 220VRMS 50HZ

CH2: OUTPUT, (8V PULL-UP SUPPLY)

The circuit was supplied from a Variac with a switch on its input. After switching off, a decay “tail” from the transformer slightly extends the response, though something of the kind will usually occur in service.

This trace was selected because it shows the behavior at the most critical moment, 45° after the zero crossing, when the reservoir capacitor is at it lowest voltage. Note that the response time here is less than later in the cycle.