Model ACM-1 AC Current Monitor

Version 2.00

Description

The Sine Systems model ACM-1 AC Current Monitor is designed to allow monitoring of AC current by the RFC-1 remote control system. A common application is to verify the proper operation of obstruction lighting on communications towers. More generally, it may be used to telemeter the AC current consumption of any 115 or 230 volt device drawing from 1 to 70 amperes.

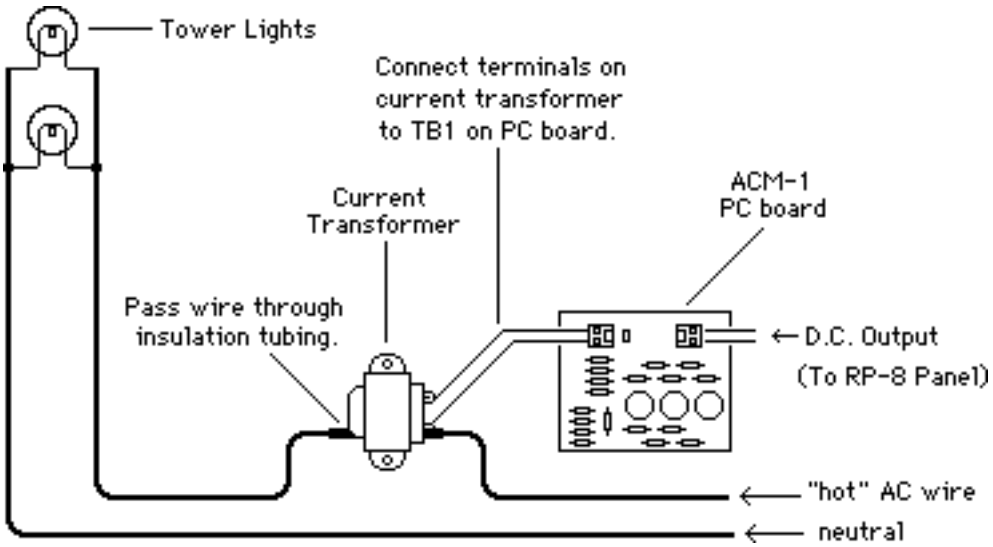
WARNING! The ACM-1 AC Current Monitor can, as can any individual monitoring system, fail suddenly and without warning. In cases where a dangerous or life-threatening condition could exist if the ACM-1 AC Current Monitor were to fail, the ACM-1 should not be used as the sole monitoring means. One or more redundant monitoring means should be used as necessary to achieve the reliability required by the application.

The ACM-1 AC Current Monitor consists of a current transformer, a PC board containing the electronics necessary to convert the output of the current transformer to the DC voltage required by the RFC-1, and installation instructions/engineering documentation. The user must supply any enclosures and/or junction boxes which may be required by national or local electrical codes.

Installation

WARNING! The ACM-1 AC Current Monitor should be installed only by a person who is familiar with industrial electrical wiring and the requirements of the national and local electrical codes. Installation by other persons could result in a danger of fire or electrocution.

The ACM-1 consists of a current transformer and a PC board which converts the output of the current transformer to a DC voltage. The following diagram shows a typical installation:



The current transformer should be mounted at a location convenient to the AC wiring to be monitored. The "hot" AC lead should be passed through the insulation tubing in the current transformer. The two terminals on the current transformer should be connected to terminal strip TB1 on the ACM-1 PC board with a length of two-conductor wire (not supplied). The ACM-1 PC board can be mounted in any location. Applicable national and local electrical codes should be followed in the installation and wiring of the current transformer. Under normal conditions, the output of the current transformer is low voltage AC (less than 20 volts rms). However, during lightning strikes or other transient voltage conditions, the voltage may be very high and appropriate precautions should be taken.

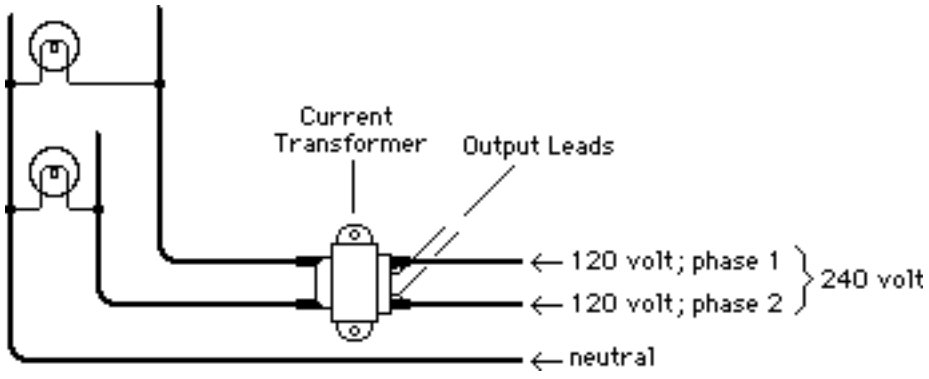
WARNING! Mounted on the output terminals of the current transformer is a metal-oxide varistor. It is a black disc about 5/8" inch in diameter with two wires. DO NOT under any circumstances operate the current transformer without the varistor connected. This could present a significant danger that might not be immediately apparent. If the varistor is disconnected, normal operation will occur as long as the current transformer output leads are connected to the load resistors on the ACM-1 PC board. If, however, the load resistors become disconnected, the voltage at the output terminals of the current transformer will instantly rise to several thousand volts and will be quite dangerous. The function of the varistor is to provide a back-up load to the current transformer and limit the output voltage to a safe level in the event the ACM-1 PC board is disconnected.

The DC output terminals (TB2) on the ACM-1 PC board should connect to the telemetry terminals on the RP-8 panel. If the ACM-1 is connected to monitor the lights on a communications tower or other application susceptible to very high voltage transients, it is highly recommended that an SP-8 Surge Protector be used with the RP-8 panel. Alternately, two varistors should be installed at the telemetry terminals on the RP-8 panel to which the ACM-1 is connected. One lead of one varistor should connect to the "+" telemetry terminal

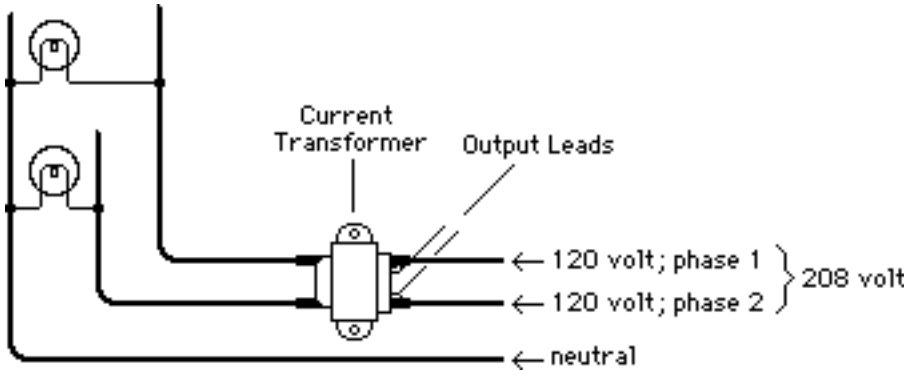
and one lead of the other varistor should connect to the "-" telemetry terminal. The remaining two leads should connect to the metal rack in which the RP-8 panel is mounted. The varistor leads should be as short as possible. Two varistors are supplied with the ACM-1 for this purpose.

As factory wired, the ACM-1 PC board is set up to monitor a tower lighting circuit. The DC conversion circuit will "smooth out" the voltage generated by the lighting current to a nearly constant value, even if flashing beacons are used. Because of this, it is easy to monitor with a voice-reporting telemetry system like the RFC-1. Also, because the monitored voltage is an analog value, very small changes in lighting current can be observed. A 1% change in current can easily be resolved. In most cases this is sufficient to detect the failure of a single bulb in the lighting system.

Note that the current transformer has two holes that wires may be passed through. If the tower lighting circuit is powered by both legs of a 240 volt circuit, the other hole may contain the additional leg. Passing the wires through the holes from the same side of the current transformer to the other will cause the output of the ACM-1 to be proportional to the sum of the currents in each leg (assuming the legs are 180° out of phase). A piece of insulating tubing should be added to the wire passing through the second hole.



For load circuits powered by two legs of a 208 volt 3 phase “Y” service, the same technique may be used:



It should be noted, however, that the output of the ACM-1 will not be proportional to the arithmetic sum of the currents in each leg. This is because the current in the sampled conductors is 120° out of phase and not 180° as above. For many applications, this is not important. As an example, assume that 10 amperes is flowing in both legs and the output of the ACM-1 is calibrated to 100%. If the current in one leg drops to zero amperes, the ACM-1 output will drop to 57% instead of 50%. This is not good enough for precise measurements but it is acceptable for approximate or "go/no go" measurements. If more precision is required, it may be practical to measure a number of known failure conditions in advance. It then becomes easy to correlate an unknown failure condition with previously observed ACM-1 output data.

Setting Current-Range Jumpers

The voltage at the output of the ACM-1 PC board is in the range of 0.75 to 2 volts DC. The input current range which produces this output is determined by the jumpers installed at locations JP1, JP2, JP3 and JP4 on the ACM-1 PC board. The following chart shows the jumpers to be installed for various current ranges:

AC Current	Install Jumpers	Cut Jumpers
2-5 amperes	JP1	JP2, JP3, JP4
5-9 amperes	JP2	JP1, JP3, JP4
9-13 amperes	JP1, JP2	JP3, JP4
13-17 amperes	JP3	JP1, JP2, JP4
17-26 amperes	JP2, JP3	JP1, JP4
26-37 amperes	JP4	JP1, JP2, JP3
37-50 amperes	JP3, JP4	JP1, JP2
50-70 amperes	JP1, JP2, JP3, JP4	none

As an example, suppose that a lighting system has two 620 watt bulbs in a flashing beacon and four 120 watt obstruction bulbs. This totals 1720 watts. We divide 1720 watts by 115 volts and get 14.9 amperes peak lighting current. Looking at the chart above we see that we need to cut jumpers JP1, JP2 and JP4. JP3 should remain installed.

Linearity and Peak Current Weighting Jumpers

For special applications, JP5, JP6 and JP7 are provided. If linear operation over a wide range of AC current is required, the load resistor for the current transformer should be placed at the output of the bridge rectifier. This virtually eliminates the non-linearity at the low range of the scale caused by the forward drop of the diodes. To do this, cut the jumpers at JP1, JP2, JP3 and JP4. Install jumper JP5. A 1.8K resistor is already installed but this may need to be changed depending on the AC current which is monitored. To determine the resistor value, divide 6500 by the AC current to be monitored. For example, for a full scale reading of about 20 amperes, the load resistor (R5) should be about 325 (330) ohms. When monitoring tower lighting circuits with a flashing beacon, JP5 should be left open and the load resistor(s) placed at the input of the bridge rectifier. This permits the peak current to be monitored and reduces changes in monitored current caused by slight variations in the beacon flasher duty-cycle.

Output Averaging Jumpers

With jumpers JP6 and JP7 installed, the ACM-1 board has a long integration time-constant which requires about two minutes to reach a final value. For the monitoring of lighting systems with flashing beacons, this is a desirable characteristic. For other applications, either JP6 or both JP6 and JP7 may be removed to reduce the integration time-constant.

Operation

With the current transformer and ACM-1 PC board installed and connected to the RP-8 panel, the AC circuit should be turned on. After waiting two minutes for the DC output voltage to stabilize, the telemetry may be calibrated with the potentiometer on the appropriate channel of the RP-8 panel. The reading may be calibrated to read directly in amperes if desired. For example 14.9 amperes could be calibrated to "1490." For tower lighting circuits, however, it is usually easier to calibrate the "normal" current, with all bulbs good, to something easy to remember, like "1000." In other words, normal lighting current is "1000" or "100.0%." If the reading drops to "0981" it means that the lighting current is 98.1% of normal.

When monitoring tower lighting current, the following points should be noted:

1) Remember that if the reading is calibrated to "1000," a change of 10 units is only a 1% change in lighting current. Do not be alarmed at readings that "wander around" some as long as the percentage variation is within appropriate limits.

2) The "normal" tower lighting current will rise and fall somewhat as the AC line voltage rises and falls throughout its daily cycle. If absolute precision is required, monitor the AC line voltage on a separate channel and compute the load resistance mathematically.

3) If a flashing beacon is used, variations in duty-cycle (ratio of off-to-on) will show up as variations in lighting current. The ACM-1 is designed to minimize this effect but it still can happen to some degree. In particular, an intermittently "sticky" mechanical flasher might be responsible for erratic results. A flasher that fails in the "on" position will cause a very high reading and a flasher that fails in the "off" position will cause a very low reading.

4) Tower lighting current can change seasonally, particularly if the tower is tall or if the AC run to the base of the tower is long. Due to the negative temperature coefficient of copper wire, it may be normal to notice a slightly higher lighting current in the cold winter months.

5) The current change by the failure of one bulb can be predicted mathematically. For example, if a lighting system consists of two 620 watt and four 120 watt bulbs, a total of 1720 watts will be consumed if all bulbs are working. If one 120 watt bulb burns out, the power consumption is reduced to 1600 watts. This is a change of about 7%. Therefore, if the normal lighting current was calibrated to "1000," then the reading should drop to about 0930 (down 7%) with the failure of one 120 watt bulb.

Parts List

R4	resistor, carbon film, 1/2 watt, 5%, 220 ohms
R3	resistor, carbon film, 1/2 watt, 5%, 430 ohms
R6, 7, 8, 9, 10, 11, 12, 13	resistor, carbon film, 1/2 watt, 5%, 510 ohms
R2	resistor, carbon film, 1/2 watt, 5%, 910 ohms
R1, 5	resistor, carbon film, 1/2 watt, 5%, 1.8K ohms
R14	resistor, carbon film, 1/2 watt, 5%, 3.3K ohms
D1, D2, D3, D4	diode, 1N4005
C1, C2, C3	capacitor, aluminum electrolytic, 4700 µF, 16 VDC
C4, C5	capacitor, monolythic ceramic, 0.1µF, 50 V
T1	current transformer, part number 3017