



Application of AC03-CS, AC05-CS (UL 1412 Approved) Leaded Wirewound Safety Fusible Resistors in Energy Meters

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ELECTRONIC METER (SOLID STATE METER)

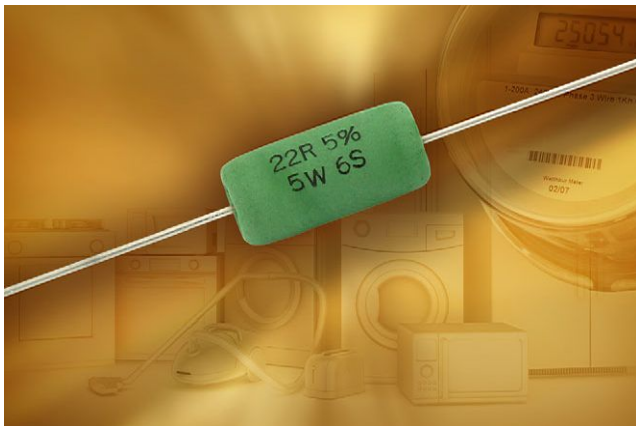
An energy meter is a device that measures the amount of electrical energy supplied to a residence or business. It is also known as (k)Wh meter.

An electronic meter provides an order of substantial improvement in measurement accuracy over that of a conventional mechanical meter, also lowering the meter's power consumption. Another plus is the electronic energy meter's ability to detect and guard against meter tampering.

The main unit of measurement in the electricity meter is the kilowatt-hour which is equal to the amount of energy used by a load of one kW over a period of one hour.

The power used is displayed on an LCD, while advanced electronic meters can be read automatically using communication ports such as an optical port, RS232 port, or RF modules. Wireless protocols like Zigbee are also used.

Most solid-state meters use a current transformer or shunt, energy metering IC, and LCD display. The IC measures voltage and current and generates a pulse output proportional to power.



TYPICAL USAGE OF AC03-CS, AC05-CS, LEADED FUSIBLE WIREWOUND SAFETY RESISTORS IN ENERGY METER

The following parameters must be considered while designing a circuit with a suitable fusible safety wirewound resistor to withstand sudden surge in line voltage:

1. Nominal power rating P_{40} : AC05-CS: 5W and AC03-CS: 3 W
2. Ohmic value $\leq 100 \Omega$ is used. This allows high current to pass through and enhance fusing in case of a fault. 22 Ω and 47 Ω are most commonly used.
3. Winding material (resistive wire alloy composition and mass) to withstand the energy of a 1.2 μ s/50 μ s pulse.

4. High-grade ceramic core with necessary alumina content to dissipate Energy in short time.
5. Body size (length, diameter) of the resistor.
6. A lacquering system that allows the heat energy generated (during fusing) to be dissipated without explosion. AC03-CS, AC05-CS are UL 1412 recognized for safety (UL file no. E362452).

APPLICATION NOTE

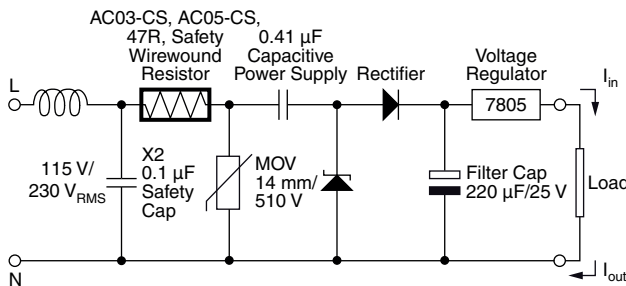
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CAPACITIVE DROP POWER SUPPLY

Power Supply Section in Energy Meter

The power supply in an electronic meter is generally a capacitive drop power supply where the voltage at the load remains constant as long as current out (I_{out}) is less than the in current (I_{in}). The main advantages of using a capacitive drop power supply is that it is significantly smaller than one based on a transformer, more cost effective than transformer-based or switch-mode based, and immune to magnetic effects. Energy meter designers use following topology in designing capacitive power supply circuits, using AC03-CS, AC05-CS safety wirewound resistor in the supply input side

Capacitive Power Supply for 1-Phase Energy Meter with AC03-CS, AC05-CS Safety Wirewound Resistor



Fusible Safety Resistor for Inrush Current Control

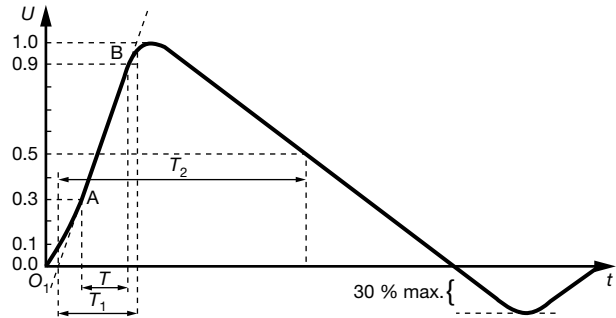
The resistor limits inrush current. The value is selectively chosen to avoid dissipating too much power while being large enough to limit inrush current. The current through the resistor is the full wave current equivalent to line voltage divided by impedance of line capacitor. The details and features of safety resistors are exclusively mentioned in the respective datasheets which can be found at the links as given below www.vishay.com/doc?28861 and www.vishay.com/doc?28894.

The permissible pulse load depends on the shape and on the duration of the pulse. The standard lighting pulse (LEMP) is one of the main EMC test pulses for electronic and electrical equipment. The value shown before the slash is the front time T_1 in μs is the pulse voltage and the figure after the slash is the time to half value T_2 of the peak value. The EN standard EN 60115-1, clause 4.27 defines pulse generators for single high-voltage pulses (source pulse):

- 1.2 μs /50 μs

The test conditions are:

- 5 pulses of 1.2 μs /50 μs with a period of not less than 12 s



Front time: $T_1 = 1.67 \times T = 1.2 \mu s \pm 30 \%$

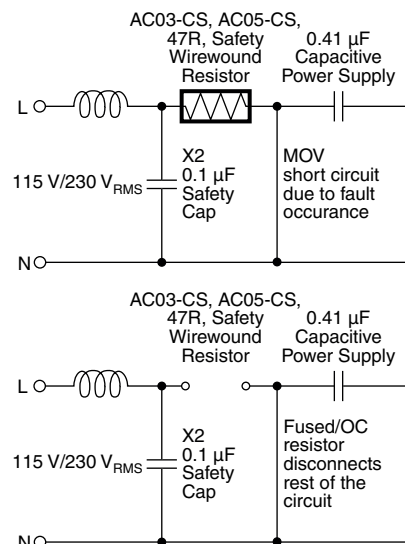
Time to half-value: $T_2 = 50 \mu s \pm 20 \%$

Waveform of open-circuit voltage (1.2 μs /50 μs) at the output of pulse generator

The specially designed AC03-CS and AC05-CS resistors are tested for surge handling capability by applying a surge voltage as per the 1.2 μs /50 μs exponential open circuit voltage waveform according to IEC 61000-4-5 standard as in the curve. Impedance of surge tester is 2 Ω . Also, it generates 10 pulses at 30 s interval.

The AC03-CS, AC05-CS safety resistor fuses “without a bang or heavy spark” when AC mains voltage is applied. At the same time, it acts as an in-rush current limiting resistor under normal operation. This eliminates the need for an extra fusible input resistor.

When the MOV is short-circuited in a fault condition, the mains voltage (115 V/230 V_{RMS}) appears across the safety resistor, drawing a high current and eventually fusing the resistor, making the circuit open. This way later circuit sections are protected from the voltage surge.



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Pulse energy handling capability for a AC03-CS, AC05-CS resistor is given by the basic relation below.

$$E = V^2/R \times \Delta T$$

Where:

E = Pulse energy dissipation (J)

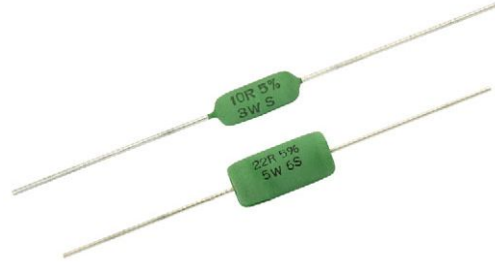
V = Surge voltage in volts (V)

R = Ohmic value in Ω

ΔT = Effective pulse interval in μs , But generally effective peak energy pulse interval for 1.2\50 μs pulse is estimated to 35 μs , this is because the time at which pulse reaches its peak and again decays down, doesn't reflect the true peak energy pulse timing.

For Example: The calculation for pulse energy for a 100 Ω resistor subjected to a pulse of 6 kV will be given by:

$$E = (6000)^2/100 \times 35 = 12.6 \text{ J}$$



Both axial and radial versions are available for mounting in the circuit. The axial version comes with 83 mm and 93 mm tape widths. Radial versions are available in bulk form as well

FEATURES

- Surge voltage capability as per IEC 61000-4-5 for AC05-CS: 4 kV (10 Ω to 20 Ω) and 6 kV (22 Ω to 100 Ω); and for AC03..CS: 2 kV (10 Ω to 91 Ω) and 4 kV (100 Ω)
- Fusing time for AC05-CS: < 45 s for 100 W overload; and for AC03-CS: < 30 s for 45 W overload
- Tinned Cu wire terminations
- $P_{40} = 3 \text{ W}$ and 5 W
- Ohmic Range for AC05-CS: 10 Ω to 100 Ω ; and for AC03-CS: 4.7 Ω to 100 Ω
- Special cement coating for immediate interruption without flame and explosion when mains voltage (220 V_{RMS}) is applied
- Exclusively designed for applications in electric appliances, energy meters