# Application of Leaded Resistors in Energy Meters

*By Nirbhay Gopal*

An electric meter or 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.

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.

## TYPES OF METERS

Modern electricity meters operate by continuously measuring the instantaneous voltage (V) and current (A) and finding the product of these to give instantaneous electrical power (W) which is then integrated against time to give energy used (J, kWh etc). The meters fall into two basic categories, electromechanical and electronic (solid state).

Meters are available in single phase and three phase (also called trivector) meter.

A single phase meter generally finds applications in all residential complexes, while three phase meter is widely used for commercial and industrial purpose.

Choosing between either depends on the total load and types of loads that need to be served.

## ELECTROMECHANICAL METER

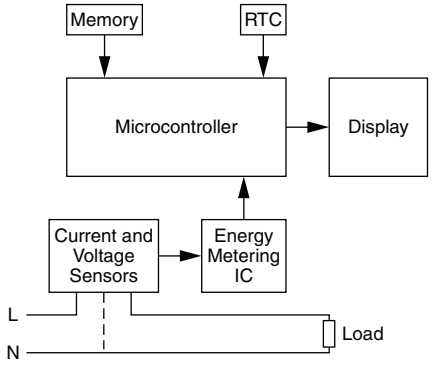
The most common type of electricity meter is the electromechanical induction meter.

The electromechanical induction meter operates by counting the revolutions of an aluminum disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage.

## ELECTRONIC METER (SOLID STATE METER)

The figure shows typical block diagram of a solid-state electronic meter. The power used is displayed on an LCD, while advanced electronic meters can be read automatically using communication ports like optical port, RS232 or RF modules.

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.




Basic Blocks of Electronic Energy Meter

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

APPLICATION NOTE

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## TYPICAL USAGE OF LEADED RESISTORS IN ENERGY METER

### CAPACITIVE DROP POWER SUPPLY

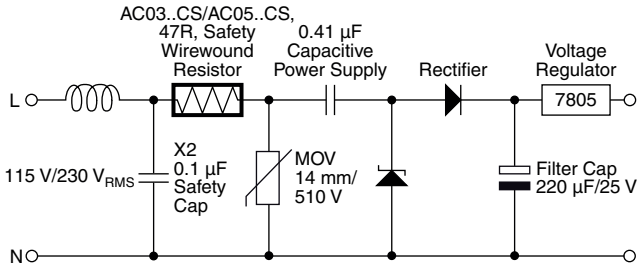
#### Power Supply Section in Energy Meter

The power supply in electronic meter is generally a capacitive drop power supply where voltage at the load remains constant as long as current out ($I_{out}$) is less than in current ($I_{in}$). The main advantages of using capacitive drop power supply is that it is significantly smaller than the transformer based one, more cost effctive than transformer based or switch mode based and immune to magnetic effects. Energy Meter designers use two topologies in designing capacitive power supply circuits as per the requirement; using AC03..CS/AC05..CS safety wirewound resistor or Z300-C high surge wirewound resistor in the supply input side.

#### Fusible Safety Resistor for Inrush Current Control

The safety resistor AC03..CS/AC05..CS fuses “without a bang, smoke or spark” when AC mains voltage is applied. At the same time, it acts as a in-rush current limiting resistor for the normal operation. This eliminates the need of adding an extra fusible input resistor. Whenever the MOV is short circuited due to repetitive action of surge, AC03..CS/AC05..CS handles the entire mains voltage across itself.

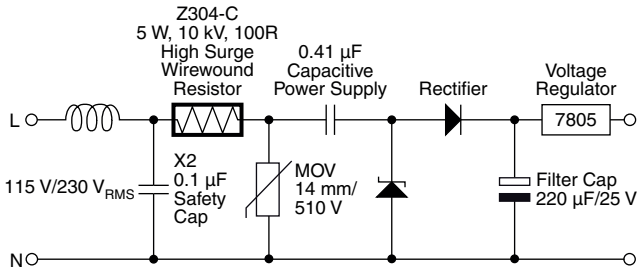
#### Capacitive Power Supply for 1-Phase Energy Meter with AC03/AC05..CS Safety Wirewound Resistor




Capacitive Drop Power Supply

The resistor limits in rush current. The value is so chosen that it does not dissipate too much power yet is large enough to limit inrush current. The current through the resistor is full wave current equivalent to line voltage divided by impedance of line capacitor.

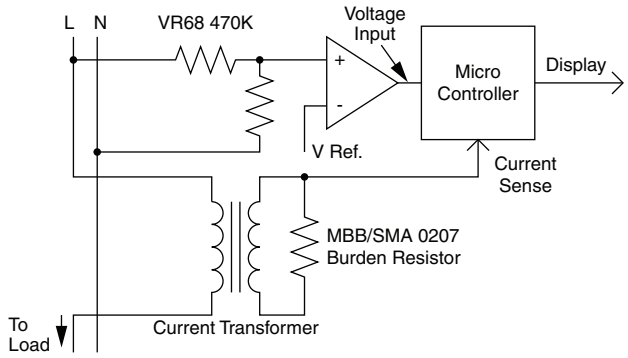
#### Capacitive Power Supply for 1-Phase Energy Meter with Z300-C High Surge Wirewound Resistor




#### Function of High Surge Wirewound Resistor in Power Supply

The Z300-C series is capable of withstanding high voltage surge in line. Presently Z300-C series is available with capability to withstand surge upto 12 kV. Other details regarding the ohmic value - surge table is given in the datasheet www.vishay.com/doc?21027.

### METERING CIRCUIT



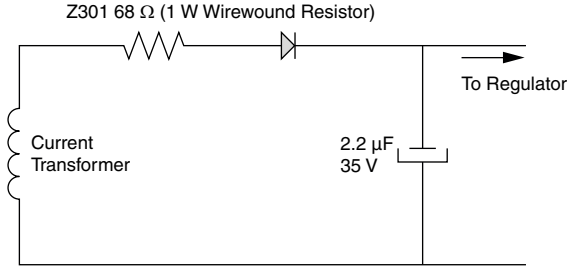

The key feature of an electronic meter is its measurement accuracy. In order to satisfy this condition it is required that the sensing circuitry should be precise and accurate.

The voltage sensing circuit consists of a resistor divider network consisting of a high voltage VR68 resistor and a current sensing consisting of a precision resistor MBB/SMA 0207.

VR68 perfoms dual role of a surge resistor and a voltage sense resistor.

### TAMPER DETECTION CIRCUIT

Connecting only phase wire to the meter and neutral directly to load can tamper meters bypassing the metering circuit. To prevent this additional CT is used to monitor tampering. Circuit can be powered with current present in single wire i.e without connecting neutral. Under small load condition the CT creates enough voltage, which is used to power ON the metering circuit. The resistor used in circuit is to restrict flow of current so that stable output is obtained.




Tamper Detection Ciruit

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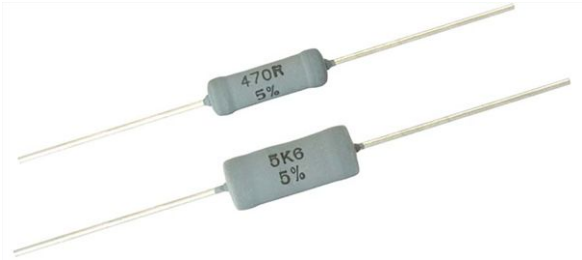
## FEATURES/BENEFITS OF VISHAY LEADED RESISTORS

### Z300-C Wirewound Resistors

(www.vishay.com/doc?21027)

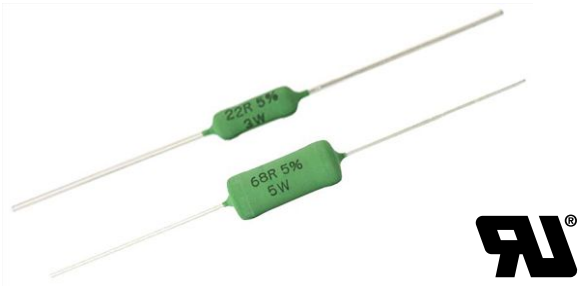



#### FEATURES

- Standard version Z300-C00
- High voltage surge (up to 12 kV) for special version
- Non flammable cement coating
- High grade ceramic core

### AC03..CS/AC05..CS Fusible Safety Wirewound Resistors

(AC03..CS: www.vishay.com/doc?28861;
AC05..CS: www.vishay.com/doc?28894)

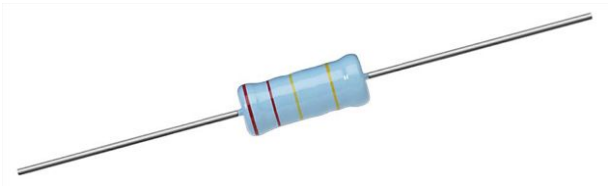



#### FEATURES

- Surge voltage capability: As per IEC 6100-4-5 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 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

### VR68 High Ohmic/High Voltage Resistors

(www.vishay.com/doc?28734)



#### FEATURES

- High pulse loading capability (10 kV)
- Small size (0718)
- Meet the safety requirements of:
  "UL1676" (510 kΩ to 11 MΩ); file no: E171160
  IEC 60065, clause 14.1.a)
  DIN EN 60065, clause 14.1.a)
  VDE 0860, clause 14.1.a)
  "CQC" (China)

### MBB/SMA 0207 Precision Thin Film Leaded Resistors

(www.vishay.com/doc?28767)

#### FEATURES

- Advanced thin film technology
- Low TCR/tolerance (15 ppm, 0.1 %)
- Superior overall stability: Class 0.05
- Wide precision range: 10 Ω to 1.5 MΩ
- IECQ-CECC approved to EN 140101-806

APPLICATION NOTE