Resistor Selection for Energy Metering Designs

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As a consequence of rising energy costs, utility suppliers now need to have more accurate measurements, not only of consumption but also demand trends to allow them to efficiently manage supply in-line with Green energy policies. The combination of these requirements has brought about staggering growth in the energy metering market.

The demand for increasingly accurate data has resulted in a wave of new Smart Metering designs. That demand will increase further as renewable energy installations such as Photo Voltaic (PV), wind turbines and gas boiler waste heat re-generators multiply and legislation requires that utility companies buy-back from these domestic and industrial users.

Energy meter design has had to change radically in recent years as application specific standard ICs have enabled digital designs to replace electromechanical ones at costs compatible with high volume application. No matter how advanced the digital design is, though, they all still depend on analogue interface components for reliability and accuracy.

TT electronics resistor specialists IRC & Welwyn Components have extensive application experience in working with designers to solve protection and measurement problems and enhance the energy metering product performance.

For example, input protection is a vital element of smart meter design and components can be provided with established pulse capacity. This critical performance feature, which is often omitted from manufacturers' data, cannot be established with certainty by one-off testing on qualification samples but relies on experience and knowledge of product functionality.

A typical low-cost transformerless power supply section for an energy meter is shown in Figure 1. Prior to voltage regulation the high voltage supply is stepped down by a capacitive divider and rectified. The remaining components provide protection against supply-bourne EMC disturbances. These include radio frequency interference (RFI), filtered by the choke and X2 capacitor, electrical fast transient (EFT) pulses, shunted mainly by the X2 capacitor and lightning strike transients, clamped by the MOV.

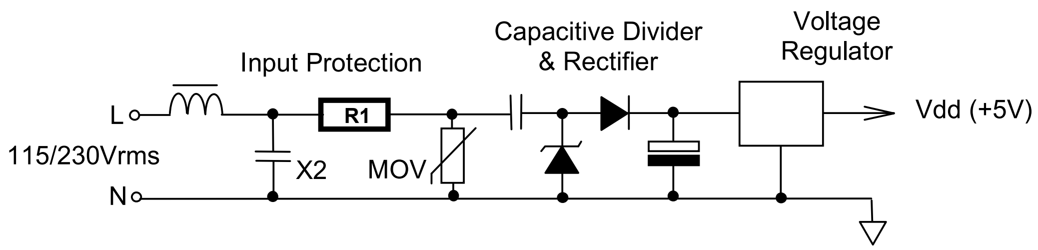

Figure 1

The input protection resistor R1 serves a number of functions here. The first relates to circuit function, namely limiting the zener peak current at switch-on to a safe level. The remainder relate to protection functions. Regarding RFI, a resistor can assist not only by contributing to series inductance, but also by reducing the Q factor of the input network, thereby minimising the effect of any resonances. Critically, it serves to limit the peak MOV current during a lightning strike transient, reducing the stress on the MOV by dissipating a share of the pulse energy. And finally, it can offer failsafe flameproof fusing in the event of a short circuit failure.

The pulse used to test immunity to lightning strike transients defined in IEC61000-4-5 is shown in Figure 2. It is important to realise that a MOV has a finite lifetime and that permanent and progressive changes occur at each pulse event. If a safe number of pulses is exceeded during the product lifetime (see Figure 3) then the MOV voltage will begin to rise then drop rapidly until reaching short circuit failure. The use of an input resistor placed before the MOV as shown can greatly extend the lifetime of the MOV, and also permits lower cost parts to be selected.

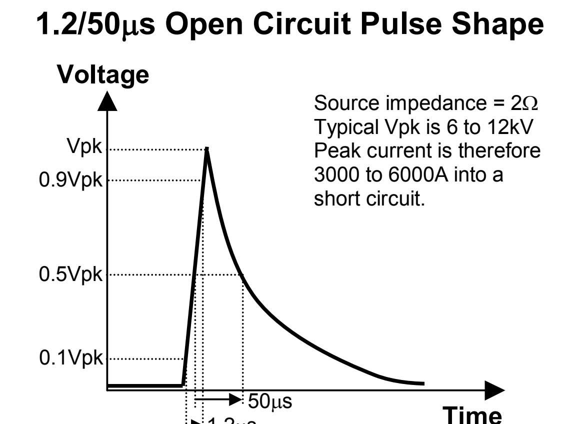

Figure 2

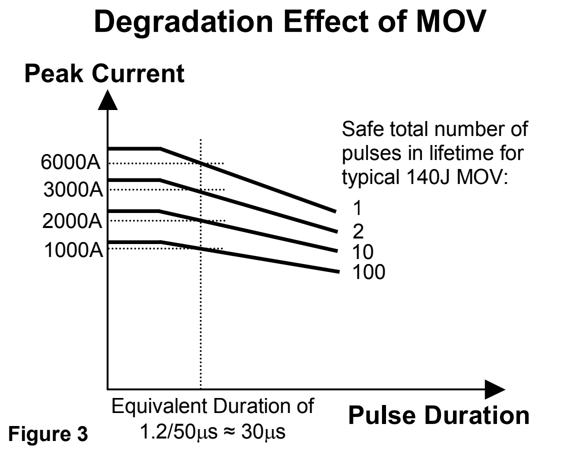

Figure 3

When calculating the peak voltage across the line input resistor it is necessary to subtract the clamping voltage of the MOV, typically 700 to 1000V, from the peak voltage applied to the circuit. An alternative arrangement is to place the MOV in front of the line input resistor, in which case the resistor sees a rectangular pulse at the clamping voltage of around 100μs duration (unless restricted by the series capacitor.) In this case most of the energy is absorbed by the MOV with the input resistor providing a secondary stage of protection.

TT electronics has a wide range of standard pulse withstanding resistors for this application with full pulse data available. In addition, variants can easily be created to meet high pulse demands within custom size and cost constraints. Wirewound technology combined with flameproof cement coating is often used, with 3W to 5W sizes generally being chosen, although for higher ohmic values pulse resistant oxides are suitable. Increasing the pulse capacity of wirewound parts by a factor of two or three is often possible without affecting the component body size. The pulse performance may be estimated from the design of the winding, but this should be verified practically and pre-qualification testing at up to 12kV peak is also offered.

A further example of a specialist resistor application is the voltage measurement input which is derived by resistive division of the line voltage. This entails direct connection to the line input and therefore exposure to the same high voltage pulses as the line input resistor. However, as the divider feeds a high impedance input, much higher ohmic values (typically 470K to 1M0) may be used, so pulse energy is correspondingly reduced. This is often achieved by means of a series chain of between four and eight metal film mini-MELF resistors, which provide the required stability and, in series combination, the required rating and pulse capacity.

The market for Smart Metering is continuing to evolve at a rapid pace and the need to include safe, reliable voltage management components is becoming increasingly necessary to achieve relevant standards. Partnering with a knowledgeable supplier with engineering expertise and production capability, that understands this dynamic market and can advise and guide you through the design process will result in reduced time to market and ensure the latest Smart Meter designs meet the exacting demands of this growing market.