APPLICATION NOTE: HVM BZR 102M

SURGE SUSCEPTIBILITY OF ELECTRONIC ENERGY METERS

Design Imperative

The modern Electronic Energy Meters, a vast improvement over the traditional mechanical meters, are prone to the vagaries of power disturbances on the power lines (which they draw upon for circuit power – up). The frequent voltage surges or spikes caused by lightning strikes or by inductive load switching leave the various Surface Mounted Devices and ASICs permanently damaged or most generally degraded. The degraded SMDs and the controller ICs usually lead to faulty power consumption reading and disturbed calibration. Fully damaged on-board components may lead to permanent Ground or Reverse connection errors.

Inadequacy of Conventional Protection

Most manufacturers recognize the inherent risks posed to the energy meters in their operational environment and use Metal Oxide Varistors (MOV) to provide protection against surges and spikes. The generally accepted and recommended rule of thumb is to use a MOV rating of two times the nominal mains voltage viz. An MOV rating of 470VAC in India. This recommendation has been arrived at as the optimum trade-off between the protection level provided by the MOV and the life of protection provided by the MOV. Protection level is usually measured in terms of the clamping voltage provided on standard waveforms specified by bodies like to IEEE, ANSI, UL, FCC etc

A 470 VAC MOV clamps the incoming surge voltage at around 1300 V for a surge current of 25A – 50A depending on the device diameter (size). Any attempt to reduce the clamping voltage results in early degradation of the MOV due to Thermal Runaway thereby compromising the protection life.

MOVs in general suffer from three problems:-

a) High Clamping Voltage
b) Thermal runaway
c) High Capacitance

The prevalent failures in the energy meters can be directly attributed to the above shortcomings. The protection imperative is to provide:-

a) Low Clamping voltage
b) Long Protection Life
c) Low capacitance for better performance under fast transient bursts.

Punsumi's High Voltage Modules (HVM) provide all three solutions.

General Performance Comparison of Siemens MOV (511/14) and HVM BZR 102M

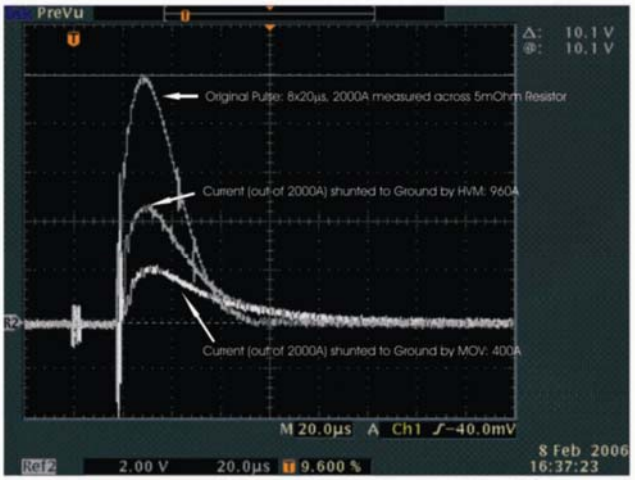
Voltage Surge : 1.2x50μs, 2000V

The adjacent screen capture illustrates the relative exposure levels of a hypothetical Equipment on which the MOV or the HVM is mounted. Against the Open Circuit waveform amplitude of 2000V (original wave) – the MOV allows almost 1550V to pass through but the HVM allows only 1150V. The HVM also discharges to a low level of about 200V within 20μsec and thereby prevents damage to the equipment. In case of the MOV the pulse dissipates to about 700V from a peak of 1550V and thereafter discharges to zero very slowly exposing the equipment to avoidable and destructive surge energy

Surge Response of Siemens MOV 511/14 and HVM BZR 102M
on
1.2x50μs, 2000V Surge

Current Surge: 8x20μs, 2000A

Along with the lower Clamping Voltages (as shown above) the HVM also shunts a much larger chunk of the destructive Surge Current as evident from the adjacent screen capture. Against the original wave carrying a current of 2000A the HVM shunts to ground almost 950A and in comparison the MOV manages to shunt only about 400A. The remaining current in each case is absorbed as destructive surge energy in the Equipment where the HVM and MOV are mounted. In each case in the adjoining picture the measurements have been taken across a 5 milliOhm Shunt Resistance.



Surge Response of Siemens MOV (511/14) and HVM BZR 102M
on
8x20μs, 2000A

TO verify their own claims on the performance of the HVM, the engineers at Punsumi tested some energy meters (manufactured by industry leaders in India) – the findings are presented below.

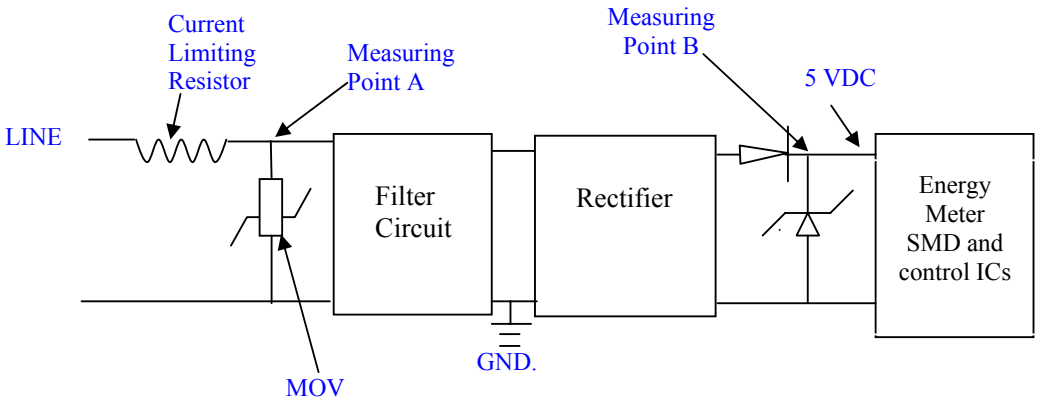
Original Protection Used by Manufacturers

a) 510 VAC Metal Oxide Varistor in 14mm diameter package
b) in some cases a wire wound resistor was also used to limit the surge current.

Surge Voltage Waveform Used

a) standard 1.2x50□Sec Voltage waveform – Peak voltage 2200 V, Energy: 2.2 Joules
b) standard 8x20 □ Sec, 2000A surge current waveform – Energy: 100 Joules

Block Diagram Representation of an Electronic Energy Meter



Tests Conducted and Results

a) Measurement of clamping voltage across MOV and with MOV replaced by HVM
Results : - self explanatory Plot A

b) Measurement of Voltage at Point B in above circuit to check transmitted voltages
Results : - Self explanatory Plot B

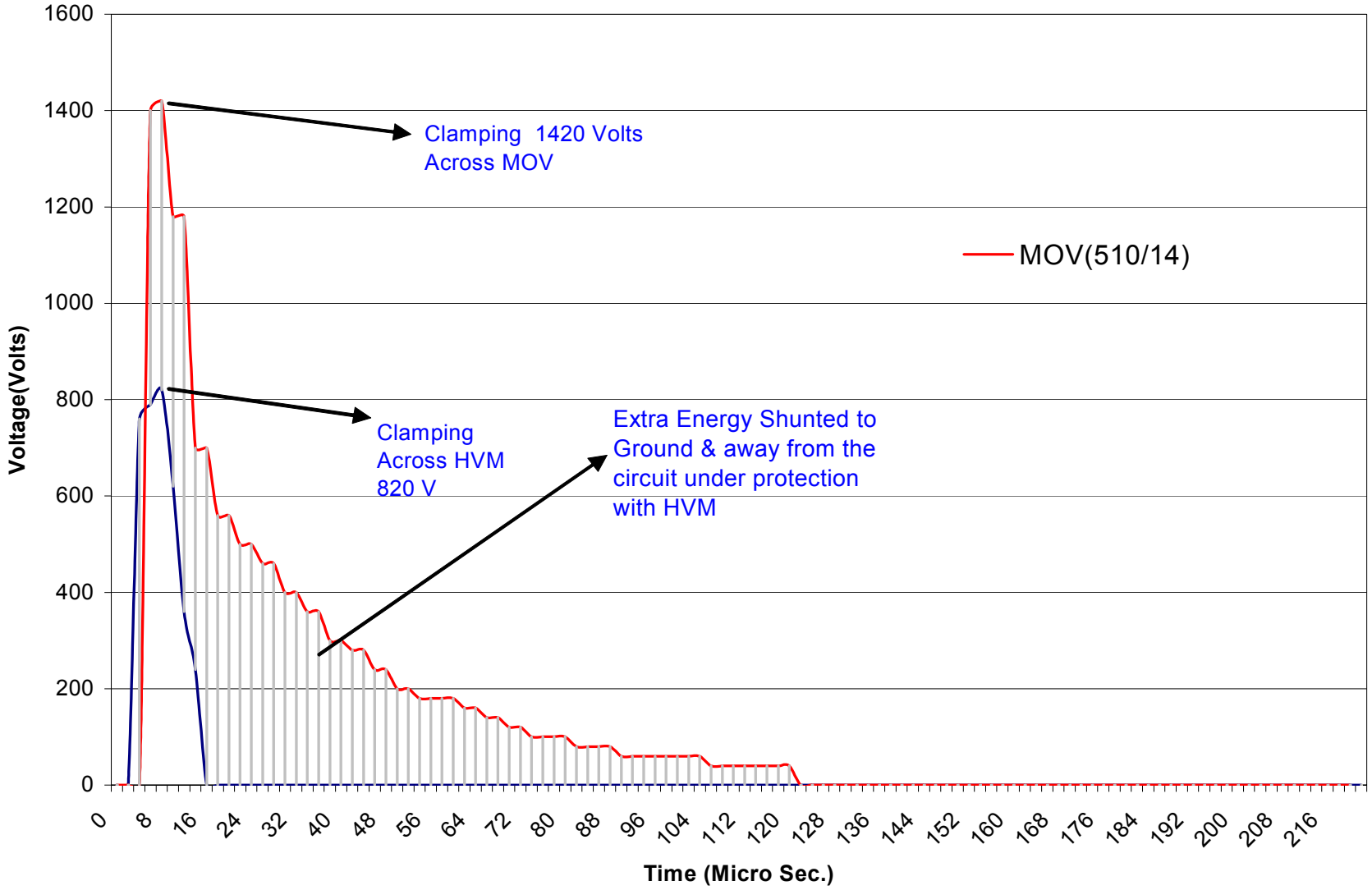
c) Endurance Test with MOV protection vs HVM protection against 20 surges of 8x20□s, 2000A, 100 J waveform at 1 min intervals

Results:

i) Circuit with MOV protection showed abnormal LED behavior after 15 surges and was found to be defective after the completion of the test. The current shunted to ground by the MOV was measured at 700 Amperes – the balance 1300 Amperes was dissipated as destructive energy in the subsequent circuit components thereby leading to their being damaged.

ii) Circuit with HVM protection remained operative even after 21 surges beyond which the test was discontinued. The current shunted to Ground by the HVM was measured at 1300 Amperes.

PLOT A: Test Performed on Electronic Energy Meter
Clamping At MOV vs HVM (Point A)
1.2/50 Micro Sec. 2200 Volt



PLOT B: Test Performed On Electronic Energy Meter

Voltage After Diode Point B

At 1.2/50 Micro Sec. 2200 Volts