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Metal Oxide Varistor Planar Arrays

Introduction

Syfer Technology Limited has been manufacturing and supplying Planar Capacitor Arrays since 1990, and is the world's leading supplier. The multilayer ceramic Planar Capacitor Array is an application specific component designed for use in multi-line EMI/RFI filter circuits, typically found in filtered connectors. Planar Capacitor Array technology affords the user weight and volumetric efficiency as well as performance and reliability advantages compared to other capacitor technologies. Syfer's leading position has been achieved through utilisation of the advantages inherent in our "Wet-Stack" process. A stress-free component is produced with mechanical precision, enabling a filter assembly to withstand the most rigorous of electrical specifications.

The MOV (Metal Oxide Varistor) Planar Array is an extension of the Capacitor Planar Array concept also for use in filtered connectors. MOV Planar Arrays, when used in isolation or together with Syfer's Capacitor Planar Arrays, can provide a complete over-voltage transient protection and EMI filtering solution to connector manufacturers. With the MOV Planar Array's inherent capacitance, it can be used as a simple C filter or as one half of a Pi or unbalanced Pi filters. The same volumetric benefits apply to MOV planars as to capacitor planars, the space weight and packaging savings can be significant.

What is an MOV?

MOV stands for Metal Oxide Varistor. MOVs are over voltage transient protection devices which are available in many formats, historically they were high voltage single layer radial leaded components but are now most commonly seen in surface mount form utilising multilayer construction as found in the MLCC industry. Syfer have taken the technology one step further and produce multilayer MOVs in planar array and discoidal formats.

Metal oxide varistor devices consist mainly of zinc oxide, this base material is then doped with small quantities of bismuth, cobalt and manganese amongst other metal oxide additives. The varistor is built up from layers of the zinc oxide material interleaved with platinum forming the highly conductive electrodes, during the firing process the dopants within the dielectric material migrate to the grain boundaries and cause each grain to act as a P-N junction with an activation voltage of approximately 3.6 volts. In order to achieve higher working voltages many layers of ceramic are used, the grains are effectively linked in series and parallel creating multiples of their discrete properties.

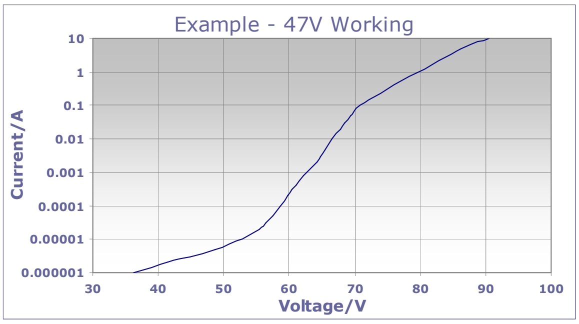


Fig. 1 Current vs. Voltage 47V working

At operational, or "Working", voltages an MOV acts as a high value resistor which obeys Ohms law with a maximum leakage current specified of 5μA, once the voltage reaches a certain value the device becomes highly conductive and provides a path to ground, it is this property which makes it ideal for use as transient protection. Other points on the V-I curve are specified at 1mA of current flow at "Nominal" or "Breakdown" voltage, and 5 or 10A of current at "Clamp Voltage". These properties are bi-directional so the MOV will perform equally as well for both positive and negative transient events, Fig.2. Figure 1 shows an example of the V-I properties of a 47V working component, note the log scale on the Y axis, at 47V current is approx 5μA, Nominal voltage at 1mA is 63V, Clamp Voltage at 10A is 90V. In this case the part specification would be: Working Voltage 47V, Nominal Voltage 53 – 69V and Clamp Voltage 100V maximum at 10A.

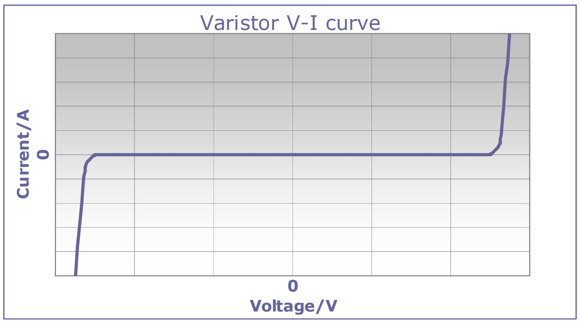


Fig. 2 Bi directional properties

When exposed to high transient voltage, the varistor clamps the voltage to a safe level. A metal oxide varistor absorbs potentially destructive energy and dissipates it as heat, thus protecting vulnerable circuit components and preventing system damage. There are limitations to the level of current which can flow and the amount of energy which can dissipate within the varistor; typical limits are 500A peak current and 3J of energy with a transient. These limitations are dependant on the geometry of the planar, high density and thin varieties may have lower capabilities.

How can MOV Planars be utilised?

The MOV array is designed for use within the shell of a mil or aerospace type connector either complimentary to, or replacing a capacitor planar array.

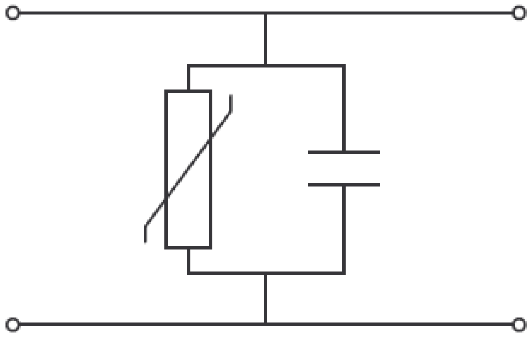


Fig. 3 MOV C filter

Common circuit configurations include:

1. A simple low capacitance C filter consisting solely of the MOV: Fig. 3.
2. A high capacitance C filter when used in parallel with a capacitor planar: Fig. 4.
3. A balanced or unbalanced Pi filter; additional capacitor planars can be matched with the varistor planar to provide equal capacitance either side of the inductor. Fig. 5.

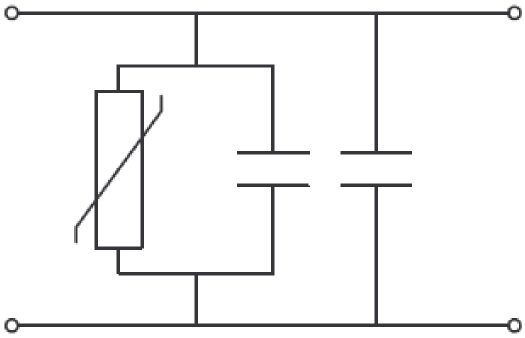


Fig. 4 MOV C filter with additional capacitor planar

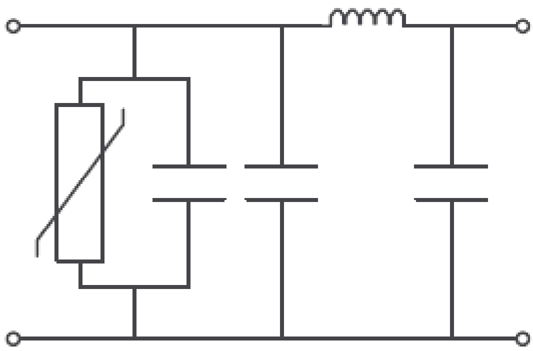


Fig. 5 MOV protected Pi filter

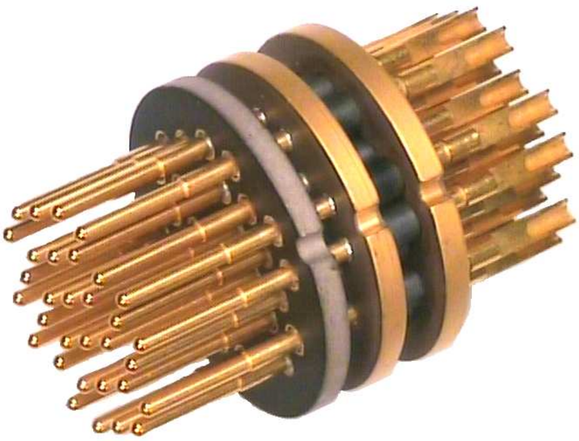


Fig. 6 *The internal configuration of a varistor protected unbalanced* Pi

Fig. 6 shows the typical format of an MOV protected connector, the MOV is the left hand planar of the three, the other two are capacitor planars with ferrite beads placed over the pins in between to form an unbalanced Pi filter.

Types of transient and capabilities.

MOVs are suitable for protecting against several types of transient event. With a material response time of less than 500ps and a no lead/track low inductance geometry MOVs are More than capable of suppressing lightning induced transients.

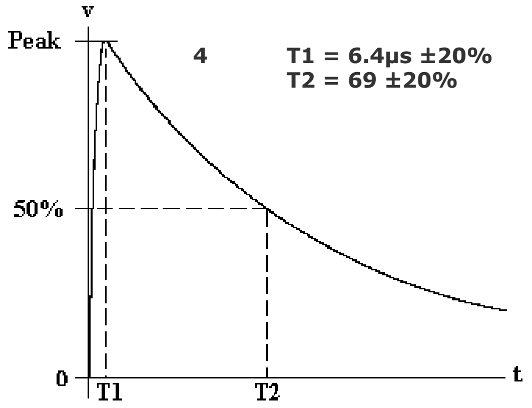


Fig. 7 RTCA/DO-160E Waveform 4

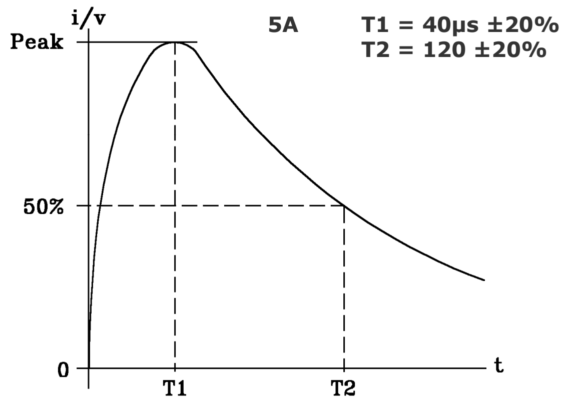


Fig. 8 RTCA/DO-160E Waveform 5A

Syfer MOV arrays have been tested to RTCA DO160-E section 22 waveform 4 level 5 and waveform 5 level 3, see Fig. 10. 47V and 8V parts were tested for leakage current, nominal voltage and clamp voltage, the same parts were the subjected to 500 pulses at 10 second intervals and then re-measured, failure is defined as greater than a 10% shift in parameters, no failures were observed. Testing has also been undertaken in order to demonstrate the speed of response capabilities. Parts were subjected to a 1MHz 175V square wave with a rise time of less than 400ns, Fig. 9 shows the response of a 47V working planar, note there is no voltage overshoot present prior to full clamping.

Test Levels for Pin Injection as per RTCA/DO-160E

Level	*Waveforms*		
	3	*4*	*5A*
	Voc/Isc	**Voc/Isc**	**Voc/Isc**
1	100/4	50/10	50/50
2	250/10	125/25	125/125
3	600/24	300/60	**300/300**
4	1500/60	750/150	750/750
5	3200/128	**1600/320**	1600/1600

Fig. 10 RTCA/DO-160E levels

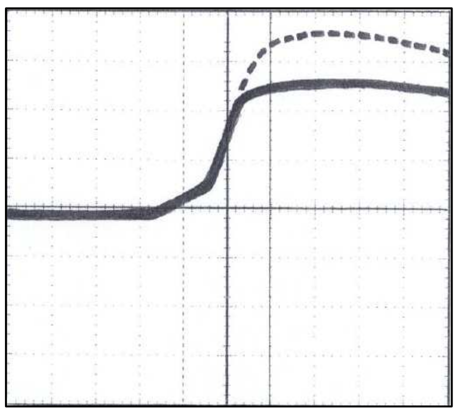
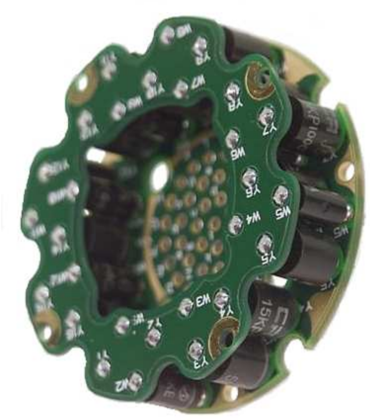


Fig. 9 Response of 47V Working - no voltage overshoot present.

Advantages over other technologies



The main alternatives to MOV planar arrays are TVS (Transient Voltage Suppression) diodes. Each technology has its advantages in different circumstances, Diodes are available for lower working voltages than Syfer MOV arrays and also have lower leakage and sharper clamping characteristics. MOVs can compete on Energy and Current capabilities and are more volumetrically efficient as many components are contained within one device, this also has cost saving benefits.

The images to the right and below illustrate some of the drawbacks of TVS diodes, not only are extra piece parts required to mount and connect the diodes to the pins but those extra parts add significant bulk and weight to the overall connector package. The planar array can be manufactured to the same dimensional specifications and tolerances as the capacitor planars generally used in the connector; this means that adding transient suppression need not have an impact on the size of the connector. See Fig. 6. No other transient voltage suppression technology can match the MOV planar when it comes to efficient use of connector real estate. Syfer has a stock and secure supply of raw materials and manufacture to demand. With a typical lead-time of 8 weeks concerns over consistency of supply, which can be a problem for users of diodes, need not be an issue.

Range

Syfer Capacitor and MOV planar arrays are generally customer specific items, we work with our customers in order to provide a bespoke product which meets their exact requirements. For the purposes of providing a guide to the capabilities available in various planforms and hole sizes a range showing the maximum energy and peak current ratings can be seen below. A mix of up to three voltages can be combined in one array depending on available space and specification requirements.

Hole size 22					
Working Voltage / Thickness	8V	15V	28V	33V	47V
65 thou/mils	1.2J/500A	1.2J/440A	1.1J/240A	1.0J/200A	0.5J/80A
100 thou/mils	1.2J/500A	1.7J/500A	1.8J/440A	1.7J/360A	1.2J/160A
125 thou/mils	1.2J/500A	1.7J/500A	2.4J/500A	2.3J/480A	1.5J/200A

Hole size 20					
Working Voltage / Thickness	8V	15V	28V	33V	47V
65 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	2.7J/500A
100 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	3.0J/500A
125 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	3.2J/500A

Hole size 16					
Working Voltage / Thickness	8V	15V	28V	33V	47V
65 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	3.2J/500A
100 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	3.2J/500A
125 thou/mils	1.3J/500A	1.5J/500A	2.2J/500A	2.5J/500A	3.2J/500A

Syfer MOV planars are available in a wide range of standard mil sizes, examples:

Circular shell sizes 8 – 24
Arinc 600 and 404 series
Rect 24308 series

Also available are discoidal MOVs from 4.5mm OD upwards.

Other standard and non standard sizes and specifications may be available; contact Syfer Technology Ltd at sales@syfer.co.uk for further information.