HARRIS SEMICONDUCTOR

"C" III Series

January 1998

Radial Lead Metal-Oxide Varistors

Features

- **Recognized as "Transient Voltage Surge Suppressors" to UL 1449; File # E75961**
- **Recognized as "Transient Voltage Surge Suppressors" to CSA C22.2, No. 1; File # LR91788**
- **High Energy Absorption Capability**
  W_{TM} . . . . 45J to 210J (2ms)
- **High Peak Pulse Current Capability**
  I_{TM} . . . . 6000A to 9000A (8/20μs)
- **Wide Operating Voltage Range**
  $V_{M(AC)RMS}$ . . . . 130V to 320V
- **Available in Tape and Reel for Automatic Insertion; Also Available with Crimped and/or Trimmed Lead Styles**
- **No Derating Up to 85°C Ambient**

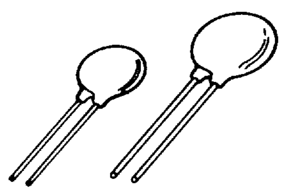
Description

The expanded version of the LA Series of metal-oxide varistors, designation "C" III Series, consists of AC line voltage rated MOVs with high current and energy handling capabilities. The "C" III Series of MOVs was primarily designed for the transient voltage surge suppressor (TVSS) product environment. They provide the increased level of protection for the transients expected in this environment. This special version of the Harris 14mm and 20mm LA Series of metal oxide varistors is also available with 10mm lead spacing, tape and reel, and in a variety of crimped and trimmed lead forms. Also see the Harris UltraMOV™ Series.

See "C" III Series Ratings table for part number and brand information.

Packaging

"C" III SERIES



Absolute Maximum Ratings For ratings of individual members of a series, see Device Ratings and Specifications chart

	"C" III SERIES	UNITS
Continuous:		
Steady State AC Voltage Range ($V_{M(AC)RMS}$)	130 to 320	V
Transients:		
Single-Pulse Peak Current (I_{TM}) 8/20μs Wave (See Figure 2)	6000 to 9000	A
Single-Pulse Energy Range (W_{TM}) 2ms Rectangular Wave	45 to 210	J
Maximum Temporary Overvoltage of $V_{M(AC)}$, (5 Minutes Duration)	130 (25°C) 120 (125°C)	% %
Operating Ambient Temperature Range (T_A)	-55 to 85	°C
Storage Temperature Range (T_{STG})	-55 to 125	°C
Temperature Coefficient (αV) of Clamping Voltage (V_C) at Specified Test Current	<0.01	%/°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

"C" III Series Ratings

PART NUMBER	BRAND	MAXIMUM RATINGS (85°C)			
		CONTINUOUS	TRANSIENT		
		MAXIMUM V_{RMS} $V_{M(AC)}$ (V)	WITHSTANDING ENERGY (2ms) W_{TM} (J)	PEAK CURRENT (8/20μs) I_{TM1} 1 PULSE (A)	PEAK CURRENT (8/20μs) I_{TM2} 2 PULSES (A)
V130LA10C	130L10C	130	45	6000	5000
V130LA20C	130L20C	130	90	9000	7000
V130LA20CX325	130CX325	130	90	9000	7000
V140LA10C	140L10C	140	50	6000	5000
V140LA20C	140L20C	140	100	9000	7000
V140LA20CX340	140CX340	140	100	9000	7000
V150LA10C	150L10C	150	55	6000	5000
V150LA20C	150L20C	150	110	9000	7000
V150LA20CX360	150CX360	150	110	9000	7000
V175LA10C	175L10C	175	60	6000	5000
V175LA20C	175L20C	175	120	9000	7000
V175LA20CX425	175CX425	175	120	9000	7000
V230LA20C	230L20C	230	80	6000	5000
V230LA40C	230L40C	230	160	9000	7000
V230LA40CX570	230X570	230	160	9000	7000
V250LA20C	250L20C	250	100	6000	5000
V250LA40C	250L40C	250	170	9000	7000
V250LA40CX620	250CX620	250	170	9000	7000
V275LA20C	275L20C	275	110	6000	5000
V275LA40C	275L40C	275	190	9000	7000
V275LA40CX680	275CX680	275	190	9000	7000
V300LA20C	300L20C	300	120	6000	5000
V300LA40C	300L40C	300	210	9000	7000
V300LA40CX745	300CX745	300	210	9000	7000
V320LA20C	320L20C	320	130	6000	5000
V320LA40C	320L40C	320	220	9000	7000

“C” III Series Specifications

PART NUMBER	MODEL SIZE DISC DIAMETER (mm)	SPECIFICATIONS (25°C) VARISTOR VOLTAGE AT 1mA DC TEST CURRENT V_N MIN (V)	V_N MAX (V)	MAXIMUM CLAMPING VOLTAGE (8/20µs) V_C (V)	I_P (A)	DUTY CYCLE SURGE RATING 3kA (8/20µs) # PULSES	750A (8/20µs) # PULSES
V130LA10C	14	184	228	340	50	10	80
V130LA20C	20	184	228	340	100	20	120
V130LA20CX325	20	184	220	325	100	20	120
V140LA10C	14	198	242	360	50	10	80
V140LA20C	20	198	242	360	100	20	120
V140LA20CX340	20	198	230	340	100	20	120
V150LA10C	14	212	268	395	50	10	80
V150LA20C	20	212	268	395	100	20	120
V150LA20CX360	20	212	243	360	100	20	120
V175LA10C	14	247	303	455	50	10	80
V175LA20C	20	247	303	455	100	20	120
V175LA20CX425	20	247	285	425	100	20	120
V230LA20C	14	324	396	595	50	10	80
V230LA40C	20	324	396	595	100	20	120
V230LA40CX570	20	324	384	570	100	20	120
V250LA20C	14	354	429	650	50	10	80
V250LA40C	20	354	429	650	100	20	120
V250LA40CX620	20	354	413	620	100	20	120
V275LA20C	14	389	473	710	50	10	80
V275LA40C	20	389	473	710	100	20	120
V275LA40CX680	20	389	453	680	100	20	120
V300LA20C	14	420	517	775	50	10	80
V300LA40C	20	420	517	775	100	20	120
V300LA40CX745	20	420	490	745	100	20	120
V320LA20C	14	462	565	850	50	10	80
V320LA40C	20	462	565	850	100	20	120

NOTE: Average power dissipation of transients not to exceed 0.6W and 1W for model sizes 14mm and 20mm, respectively.

Power Dissipation Ratings

Continuous power dissipation capability is not an applicable parameter for a varistor. When transients occur in rapid succession, the average power dissipation is the energy (watt-seconds) per pulse times the number of pulses per second. The power so developed must be within the specifications shown on the Device Ratings and Specifications table for the specific device. The operating values of a MOV need to be derated at high temperatures as shown in Figure 1. Because varistors only dissipate a relatively small amount of average power they are not suitable for repetitive applications that involve substantial amounts of average power dissipation.

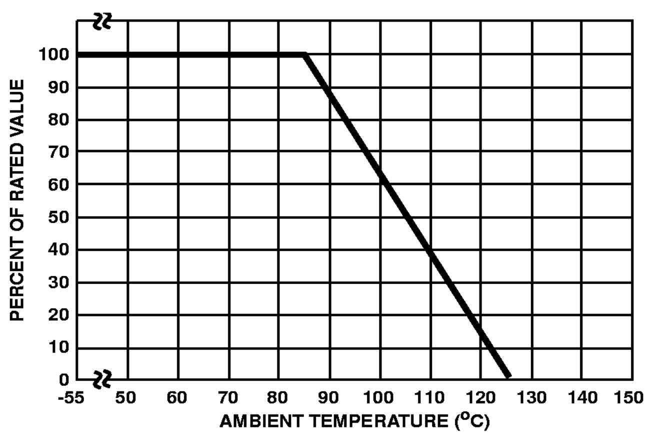
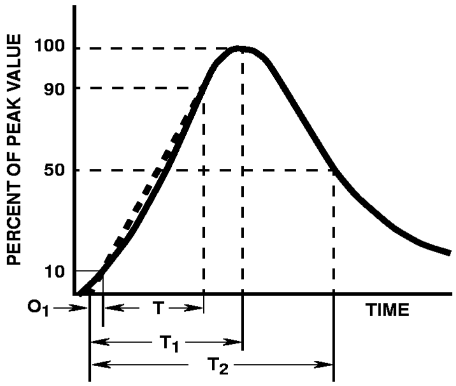


FIGURE 1. CURRENT, ENERGY AND POWER DERATING CURVE



O1 = Virtual Origin of Wave
T = Time From 10% to 90% of Peak
T1 = Virtual Front time = 1.25 • t
T2 = Virtual Time to Half Value (Impulse Duration)
Example: For an 8/20µs Current Waveform:
8µs = T1 = Virtual Front Time
20µs = T2 = Virtual Time to Half Value

FIGURE 2. PEAK PULSE CURRENT TEST WAVEFORM

Transient V-I Characteristics Curves

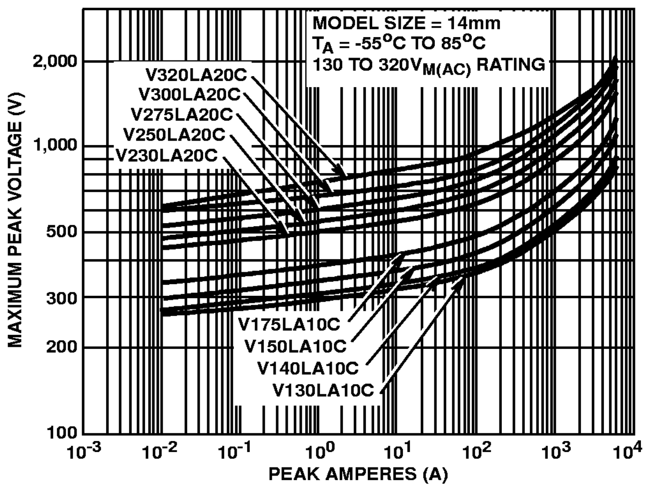


FIGURE 3. MAXIMUM CLAMPING VOLTAGE FOR V130LA10C TO V320LA20C

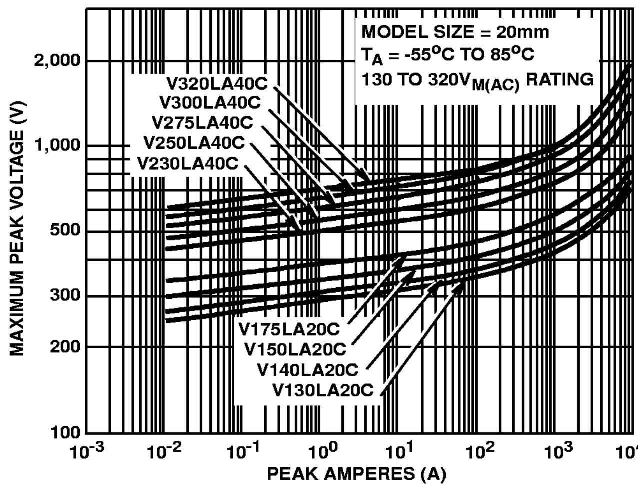


FIGURE 4. MAXIMUM CLAMPING VOLTAGE FOR V130LA20C TO V320LA40C

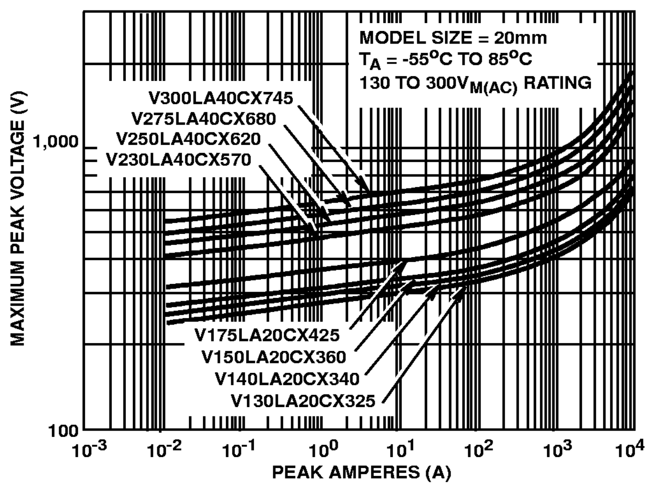


FIGURE 5. MAXIMUM CLAMPING VOLTAGE FOR V130LA20CX325 TO V300LACX745

Pulse Rating Curves

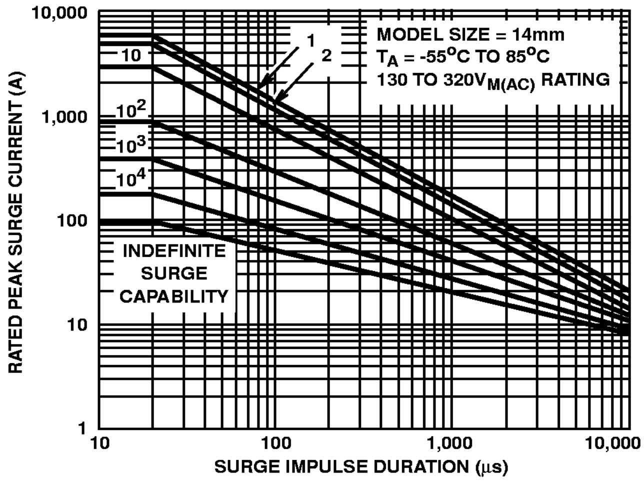


FIGURE 6. REPETITIVE SURGE CAPABILITY FOR V130LA10C TO V320LA20C

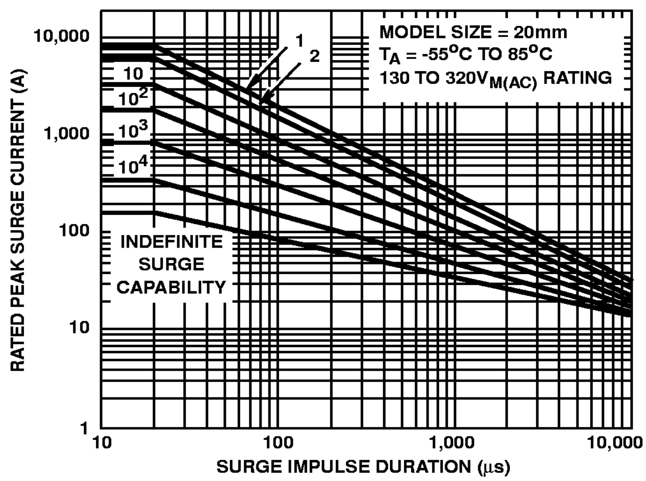
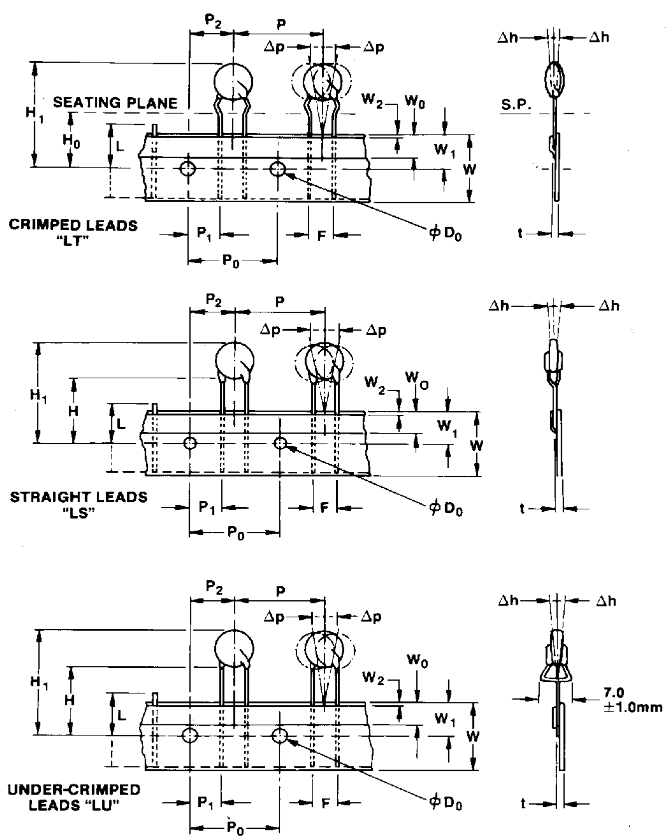


FIGURE 7. REPETITIVE SURGE CAPABILITY FOR V130LA20C TO V320LA40C

Tape and Reel Specification



SYMBOL	DESCRIPTION	MODEL SIZE	
		14mm	20mm
P	Pitch of Component	25.4 ± 1.0	
P_0	Feed Hole Pitch	12.7 ± 0.2	
P_1	Feed Hole Center to Pitch	2.60 ± 0.7	
P_2	Hole Center to Component Center	6.35 ± 1.0	
F	Lead to Lead Distance	7.50 ± 0.8	
h	Component Alignment	2.00 Max	
W	Tape Width	18.25 ± 0.75	
W_0	Hold Down Tape Width	6.00 ± 0.3	12.0 ± 0.3
W_1	Hole Position	9.125 ± 0.625	
W_2	Hold Down Tape Position	0.5 Max	
H	Height From Tape Center To Component Base	19.0 ± 1.0	
H_0	Seating Plane Height	16.0 ± 0.5	
H_1	Component Height	40 Max	46.5 Max
D_0	Feed Hole Diameter	4.0 ± 0.2	
t	Total Tape Thickness	0.7 ± 0.2	
L	Length of Clipped Lead	12.0 Max	
p	Component Alignment	3° Max	

Tape and Reel Data

- Conforms to ANSI and EIA Specifications
- Can be supplied to IEC publication 286-2
- Radial devices on tape and reel are supplied with either crimped leads, straight leads, or under-crimped leads.

Tape and Reel Ordering Information

- Crimped leads are standard on LA types supplied in tape and reel and are denoted by the model letter “T”. Also, in tape and reel, model letter “S” denotes straight leads and letter “U” denotes special under-crimped leads.

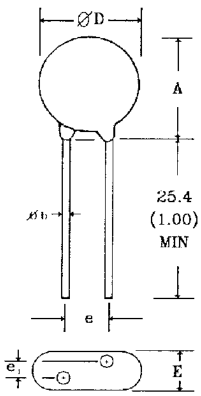
Example:

STANDARD MODEL	CRIMPED LEADS	STRAIGHT LEADS	UNDER CRIMP LEADS
V130LA20C	V130LT20C	V130LS20C	V130LU20C

Shipping Quantity

DEVICE SIZE	QUANTITY PER REEL		
	“T” REEL	“S” REEL	“U” REEL
14mm	500	500	500
20mm	500	500	500

Mechanical Dimensions



SYMBOL	VARISTOR MODEL SIZE			
	14mm		20mm	
	MIN	MAX	MIN	MAX
A	13.5 (0.531)	20 (0.787)	17.5 (0.689)	26.5 (1.043)
ØD	13.5 (0.531)	17 (0.669)	17.5 (0.689)	23 (0.906)
e	6.5 (0.256)	8.5 (0.335)	6.5 (0.256)	8.5 (0.335)
e1	1.5 (0.059)	3.5 (0.138)	1.5 (0.059)	3.5 (0.138)
E	- -	5.6 (0.220)	- -	5.6 (0.220)
Øb	0.76 (0.030)	0.86 (0.034)	0.76 (0.030)	0.86 (0.034)

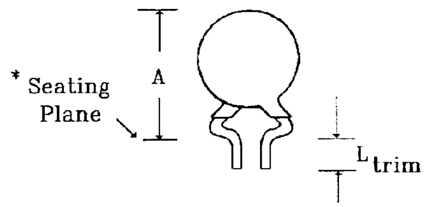
Dimensions are in millimeters (inches)
NOTE: 10mm lead spacing also available. See additional lead style options.

Additional Lead Style Options

Radial lead types can be supplied with combination preformed crimp and trimmed leads. This option is supplied to the dimensions shown below.

SYMBOL	VARISTOR MODEL SIZE			
	14mm		20mm	
	MIN	MAX	MIN	MAX
A	-	24.5 (0.96)	-	31 (1.22)
L_{TRIM}	2.41 (0.095)	4.69 (0.185)	2.41 (0.095)	4.69 (0.185)

NOTE: Dimensions are in millimeters (inches)



CRIMPED AND TRIMMED LEAD

*Seating plane interpretation per IEC-717

- To order this crimped and trimmed lead style, the standard radial type model number “LA” is changed to the model number “LC”. This option is supplied in bulk only.

Example:

STANDARD MODEL	ORDER AS
V130LA20C	V130LC20C

- For 10 ± 1mm lead spacing on 20mm units only; append standard model numbers by adding “X10” suffix.

Example:

STANDARD MODEL	ORDER AS
V130LA20C	V130LA20CX10

- For other lead style variations to the above, please contact Harris Semiconductor Power Marketing

The Origins of Surge Overvoltages

There are a wide variety of transient overvoltage environments, each with radically different levels of exposure. Transients may be caused by lightning, which can inject very high currents into the electrical system, or by switching transients. Lightning strikes usually occur to the primary transmission lines with resulting coupling to the secondary line through mutual inductive or capacitive coupling. Even a lightning hit that misses the primary AC line can induce substantial voltage onto the primary conductors, triggering lightning arresters and thus creating transients.

Switching transients, while of a lower magnitude than lightning, occur more frequently and thus are of a greater threat to the AC system. Switching transients may result from fuse blowing, capacitor bank switching, fault clearing or grid switching.

Field studies and laboratory investigation of residential and industrial low power AC voltage systems have shown that the amplitude of a transient is proportional to the rate of its occurrence, i.e. lower magnitude transients occur most often. Governing bodies, in particular IEC, UL, IEEE and ANSI have established guidelines on the transient environment one may expect to encounter in a low voltage AC power system. Table 1 reflects the surge voltages and currents deemed to represent the indoor environment.

LOCATION CATEGORY		TRANSIENT WAVEFORM/MAGNITUDE	
A	Long Branch Circuits and Outlets	0.5µs 100kHz	6kV 200A
B	Major Feeders and Short Branch Circuits	1.2/50µs 8/20µs	6kV 3kA
		0.5µs 100kHz	6kV 500A

"C" III MOV Series

The "C" III series of Harris radial MOVs represent the third generation of improvements in device performance and characteristics. The technology effort involved in the development of this new series concentrated on extending the existing performance and capability of the Harris second generation of metal oxide varistors.

The characteristics of greatest importance for a metal oxide varistor in an AC surge environment are the peak current, energy handling, repetitive surge and temporary over-voltage capabilities. The focus of the design effort was on improving these characteristics and therefore offering the maximum protection presently available to the end user.

The "C" III series are designed to survive the harsh environments of the AC low-power indoor environment. Their much improved surge withstand capability is well in excess of the transients expected in the AC mains environment. Further design rules for the development of the "C" III series included considerations of the expected steady state operating conditions and the repetitive surge environment.

Investigation of the AC low-power indoor environment show that most transients occur where the power enters the building and at major feeders and short branch circuits. Surges recorded at this service entrance, location Category B from C62.41-1992, may be both oscillatory and unidirectional in nature. The typical "lightning surge" has been established as a 1.2/50µs voltage wave and a 8/20µs current wave. A short circuit current of 3000A and open circuit voltage 6000V are the expected worst case transients at this location.

TEST	REFERENCE STANDARD	TEST CONDITIONS	TEST RESULTS
Surge Current	UL 1449 IEEE/ANSI C62.41 IEC 1051	9000A (8/20µs) 1 Pulse	0/165
		7000A (8/20µs) 2 Pulses	0/105
		3000A (8/20µs) 20 Pulses	0/75
		750A (8/20µs) 120 Pulses	0/65
Surge Energy	UL 1449 IEEE/ANSI C62.41 IEC 1051	90J (2ms) 1 Pulse	0/125
Operating Life	Mil-Std-202 Method 204D	125°C, 1000 Hours, Rated Bias Voltage	0/180
Temporary Overvoltage	N/A	120% Maximum Rated Varistor Voltage For 5 minutes	0/70

The further into the facility one goes, the lower the magnitude of the transients encountered. ANSI/IEEE C62.41 differentiates between the service entrance and the interior of a facility. Per this specification, the internal location or long branch circuits and outlets are classified as Location Category A. The transients encountered here have oscillatory waveshapes with frequency ranges from 5kHz to 500kHz; with 100kHz deemed most common. Transients of the magnitude of 500A are expected in this location.

Reliability Performance of "C" III Series

The electrical ratings of the "C" III series of MOVs are conservatively stated. Samples of these devices have been tested under additional stresses, over and above those called out in the datasheet. The results of this testing show an enhanced device performance.

The series of stress tests to which the units were subjected are a combination of electrical, environmental and mechanical tests. A summary of the reliability tests performed on the "C" III series are described in Table 2.

AC Bias Reliability

The "C" III series of metal oxide varistors was designed for use on the AC line. The varistor is connected across the AC line and is biased with a constant amplitude sinusoidal voltage. It should be noted that the definition of failure is a shift in the nominal varistor voltage (V_N) exceeding ± 10%. Although this type of varistor is still functioning normally after this magnitude of shift, devices at the lower extremities of V_N tolerance will begin to dissipate more power.

Because of this possibility, an extensive series of statistically designed tests were performed to determine the reliability of the "C" III type of varistor under AC bias combined with high levels of temperature stress. To date, this test has generated over 50,000 device hours of operation at a temperature of 125°C, although only rated at 85°C. Changes in the nominal varistor voltage, measured at 1mA, of less than 2% have been recorded (Figure 8).

Transient Surge Current/Energy Capability

The transient surge rating serves as an excellent figure of merit for the "C" III suppressor. This inherent surge handling capability is one of the "C" III suppressor's best features. The enhanced surge absorption capability results from improved process uniformity and enhanced construction. The homogeneity of the raw material powder and improved control over the sintering and assembly processes are contributing factors to this improvement.

In the low power AC mains environment, industry governing bodies (UL, IEC, NEMA and IEEE) all suggest that the worst case surge occurrence will be 3kA. Such a transient event may occur up to five times over the equipment life time (approximately 10 years). While the occurrences of five 3 kiloamps transients is the required capability, the conservatively rated, repetitive surge current for the "C" III series is 20 pulses for the 20mm units and 10 pulses for the 14mm series.

As a measure of the inherent device capability, samples of the 20mm V130LA20C devices were subjected to a worst case repetitive transient surges test. After 100 pulses, each of 3kA, there was negligible change in the device characteristics. Changes in the clamping voltage, measured at 100 amps, of less than 3% were recorded (Figure 9). Samples of the 14mm Series V175LA20C were subjected to repetitive surge occurrences of 750A. Again, there was negligible changes in any of the device characteristics after 250 pulses (Figure 10). In both cases the inherent device capability is far in excess of the expected worst case scenario.

Terms and Descriptions

Rated AC Voltage ($V_{M(AC)RMS}$)

This is the maximum continuous sinusoidal voltage which may be applied to the MOV. This voltage may be applied at any temperature up to the maximum operating temperature of 85°C.

Maximum Non-Repetitive Surge Current (I_{TM})

This is the maximum peak current which may be applied for an 8/20µs impulse, with rated line voltage also applied, without causing device failure. (See Figure 2)

Maximum Non-Repetitive Surge Energy (W_{TM})

This is the maximum rated transient energy which may be dissipated for a single current pulse at a specified impulse and duration (2ms), with the rated V_{RMS} applied, without causing device failure.

Nominal Voltage ($V_{N(DC)}$)

This is the voltage at which the device changes from the off state to the on state and enters its conduction mode of operation. This voltage is characterized at the 1mA point and has specified minimum and maximum voltage levels.

Clamping Voltage (V_C)

This is the peak voltage appearing across the MOV when measured at conditions of specified pulse current amplitude and specified waveform (8/20µs)

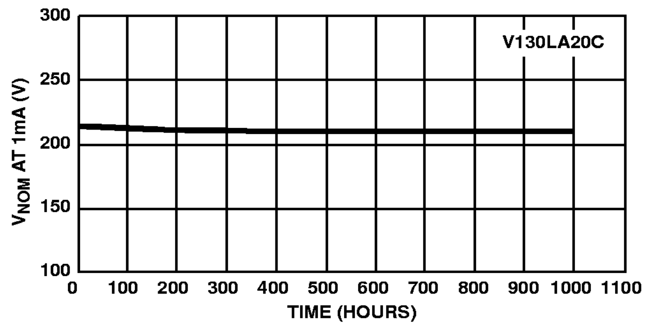


FIGURE 8. HIGH TEMPERATURE OPERATING LIFE 125°C FOR 1000 HOURS AT RATED BIAS

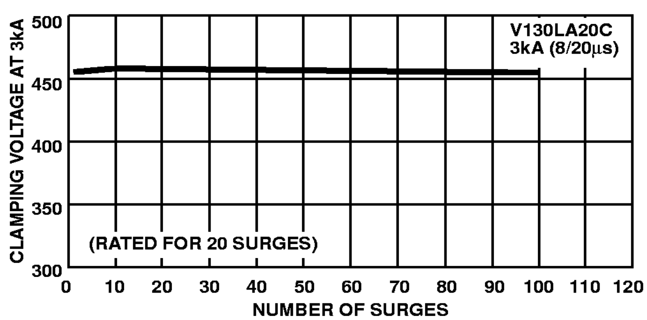


FIGURE 9. TYPICAL REPETITIVE SURGE CURRENT CAPABILITY OF "C" III SERIES MOVs

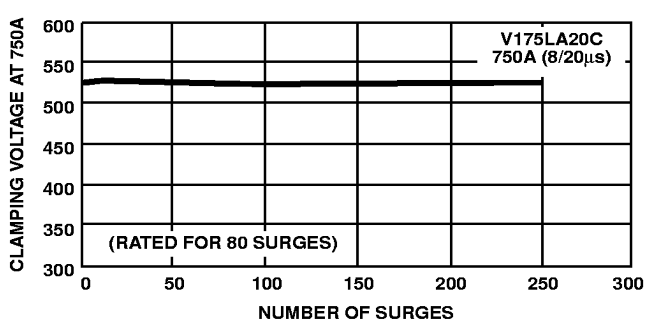


FIGURE 10. TYPICAL REPETITIVE SURGE CURRENT CAPABILITY OF "C" III SERIES MOVs