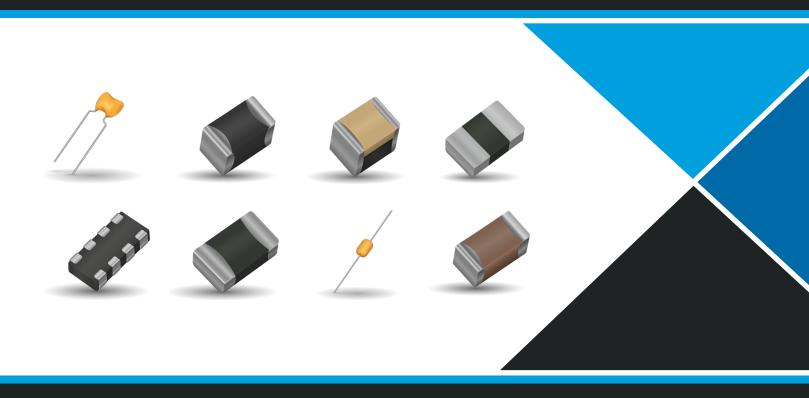


Transient Suppression Products





IMPORTANT INFORMATION/DISCLAIMER

All product specifications, statements, information and data (collectively, the "Information") in this datasheet or made available on the website are subject to change. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed. All Information given herein is believed to be accurate and reliable, but it is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on KYOCERA AVX knowledge of typical operating conditions for such applications, but are not intended to constitute and KYOCERA AVX specifically disclaims any warranty concerning suitability for a specific customer application or use.

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Transient Suppression Products

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IEC 61000-4 Requirements Turn on Time Characteristics of Multilayer Varistors The Impact of ESD on Insulated Portable Equipment Motor and Relay Application Study Multilayer Varistors In Automobile MUX Bus Applications



TransGuard [®] 162	
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KY<u>OCERa</u>

PACKAGING

Paper Carrier Configuration	
Embossed Carrier Configuration	
Packaging of Chip Components	
Axial (Leads/Packaging)	
Radial Leads/Packaging	



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Introduction

- Introduction
- Product Selection Guide

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Introduction

Multilayer Ceramic Transient Voltage Suppressors





TRANSGUARD - MULTILAYER VARISTORS

The KYOCERA AVX TransGuard® Varistors - Transient Voltage Suppressors (TVS) with unique high-energy multilayer construction represent state-of-the-art overvoltage circuit protection. Monolithic multilayer construction provides protection from voltage transients caused by ESD (e.g. IEC 61000-4-2), lightning, inductive switching, automotive related transients such as load dump (ISO 7637-2-5), jump start with and other automotive transients (e.g. ISO 7637 Pulse 1-3, AEC-Q200-002, ISO 10605, ISO 16750-2, CI-220, CI-260) and more.

KYOCERA AVX varistors provide bi-directional transient voltage protection in the on-state and EMI/RFI attenuation in the off-state which allows designers to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device. Parts are designed for use in temperatures from -55°C to +125°C (+150°C components available) with no derating, exhibit very fast response, multiple strikes capability and high reliability. In addition, KYOCERA AVX automotive series varistors are AEC-Q200 qualified.

KYOCERA AVX Varistors are provided in different mounting options, covering wide range of applications requirements. Surface mount varistors are available in single element or multiple element (array) EIA industry standard packages. The parts are RoHS compliant and offer excellent solderability thanks to Ni Barrier/100% Sn termination; Pd/Ag parts for hybrid assembly are also available as option upon request. KYOCERA AVX also offers SnPb termination as a special option. Thru-hole components are supplied as conformally epoxy coated axial and radial devices and are RoHS compliant.

BENEFITS AND FEATURES

- · SMT 0201 3220, Axial and Radial configuration
- · Bi Directional transient voltage protection
- EMI Filtering in the off-state
- Very fast response (< 1ns)
- Multiple strikes capability
- · High reliability
- No derating over operating temperature range -55°C to +125°C (+150°C components available)
- · High peak current and high energy options
- Low capacitance parts for RF, high speed data lines and capacitance sensitive applications
- AEC-Q200 gualified automotive series
- RoHS Compliant

APPLICATIONS

KYOCERA AVX Varistors are used in wide range of application sectors such as:

Medical

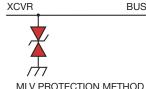
Militarv

Industrial/Professional

Renewable/Smart Energy

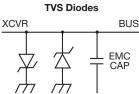
- Automotive
- Consumer
- Home appliances
- Automation
- Lighting

MultiLayer Varistors (MLVs)



SINGLE COMPONENT SOLUTION

TVS & EMI



DIODE PROTECTION METHOD THREE COMPONENT SOLUTION

TVS + EMI

Introduction

Multilayer Ceramic Transient Voltage Suppressors













TRANSGUARD® DESCRIPTION

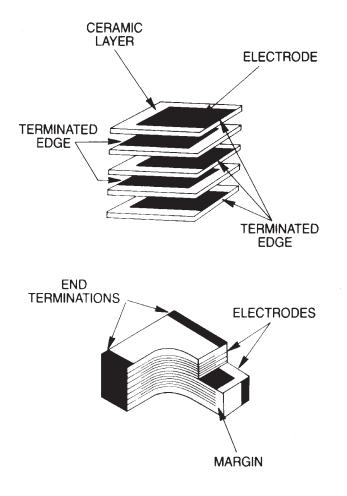
TransGuard[®] products are zinc oxide (ZnO) based ceramic semiconductor devices with non-linear voltage-current characteristics (bi-directional) similar to back-to-back zener diodes. They have the added advantage of greater current and energy handling capabilities as well as EMI/RFI attenuation. Devices are fabricated by a ceramic sintering process that yields a structure of conductive ZnO grains surrounded by electrically insulating barriers, creating varistor-like behavior.

KYOCERA AVX VG series parts (large case size, high energy) are glass encapsulated. These parts provide the same high reliability as traditional VC series parts. The glass encapsulation provides enhanced resistance against harsh environment or process such as acids, salts, chlorite flux.

The number of grain-boundary interfaces between conducting electrodes determines "Breakdown Voltage" of the device. High voltage applications such as AC line protection require many grains between electrodes while low voltage requires few grains to establish the appropriate breakdown voltage. Single layer ceramic disc processing proved to be a viable production method for thick cross section devices with many grains, but attempts to address low voltage suppression needs by processing single layer ceramic disc formulations with huge grains has had limited success.

KYOCERA AVX, the world leader in the manufacture of multilayer ceramic capacitors, now offers the low voltage transient protection marketplace a true multilayer, monolithic surface mount varistor. Technology leadership in processing thin dielectric materials and patented processes for precise ceramic grain growth have yielded superior energy dissipation in the smallest size. Now a varistor has voltage characteristics determined by design and not just cell sorting whatever falls out of the process.

Multilayer ceramic varistors are manufactured by mixing ceramic powder in an organic binder (slurry) and casting it into thin layers of precision thickness. Metal electrodes are deposited onto the green ceramic layers which are then stacked to form a laminated structure. The metal electrodes are arranged so that their terminations alternate from one end of the varistor to the other. The device becomes a monolithic block during the sintering (firing) cycle providing uniform energy dissipation in a small volume.





VARISTORS – PRODUCT SELECTION GUIDE

Series	PN Code	Fig.	Technica	l Data	Features / Applications	Page
TransGuard®	VC VG	Se .	Case size: Working Voltage: Energy: Peak Current:	0402 - 3220 3.3 - 85Vdc 0.05J - 12J 20A - 2000A	Wide range of multilayer varistors for bi-directional overvoltage protection as well as EMI/RFI attenuation.	5-13
TransGuard® Automotive Series	VCAS VGAS		Case size: Working Voltage: Energy: Peak Current:	0402 - 3220 5.6 - 85Vdc 0.05J - 13J 20A - 2000A	Wide range multilayer varistors for bi-directional overvoltage protection as well as EMI/RFI attenuation in automotive applications (AEC-Q200).	14-23
StaticGuard	VC**LC	C.	Case size: Working Voltage: Energy: Capacitance:	0402 - 1206 18Vdc 0.02J - 0.1J 40 - 200pF	Lower capacitance version of TransGuard® for bi-directional ESD protection as well as EMI/RFI attenuation.	24-26
StaticGuard Automotive Series	VCAS**LC	-	Case size: Working Voltage: Energy: Capacitance:	0402 - 0805 18Vdc 0.02 - 0.1J 40 - 80pF	Lower capacitance version of TransGuard® for bi-directional ESD protection as well as EMI/RFI attenuation in automotive applications (AEC-Q200).	27-29
Miniature 0201 MLV	VC0201		Case size: Working Voltage: Energy: Peak Current:	0201 3.5 - 16Vdc 0.01, 0.02J 1 - 10A	Miniature 0201 varistor for any circuits with space constraints or for embedded applications.	30-31
MultiGuard Array	MG	-	Case size: Working Voltage: Energy: Peak Current:	0405 - 0612 5.6 - 18Vdc 0.02 - 0.1J 15 - 30A	2 and 4-element MLV arrays to protect multiple lines against ESD while saving board space and pick and place costs.	32-36
UltraGuardLow Leakage Varistors	VCUG MGUG		Case size: Working Voltage: Energy: Peak Current:	0402 - 0612 3.0 - 32Vdc 0.02 - 0.4J 10 - 150A	Low leakage (<1µA) varistors for battery operated devices, high clock speed IC, low voltage power conversion circuits and low leakage requirements.	37-39
Communication Bus Varistors	CAN FLX		Case size: Working Voltage: Peak Current: Capacitance:	0402 - 0612 18, 32Vdc 4 - 15A 15 - 50pF	Low capacitance varistors designed for protection of communication bus, data lines and other capacitance sensitive automotive (AEC-Q200) as well as general applications.	40-43
Low Capacitance USB Series	USB		Case size: Working Voltage: Peak Current: Capacitance:	0402 - 0612 18Vdc 4A 3 - 10pF	Low capacitance varistors designed for use in high-speed data lines and other capacitance sensitive applications.	44-47
AntennaGuard Low Capacitance Varistors	VC**AG		Case size: Working Voltage: Capacitance:	0402 - 0603 18Vdc 2 - 12pF	Low capacitance varistors designed for protection in RF circuits, antennas, sensors, high-speed data lines, optic circuits and other capacitance sensitive applications etc.	48-51
AntennaGuard Low Capacitance Automotive Series	VCAS**AG		Case size: Working Voltage: Capacitance:	0402 - 0603 18Vdc 2 - 12pF	Low capacitance varistors designed for protection in RF circuits, antennas, sensors, high-speed data lines, optic circuits and capacitance sensitive applications in automotive applications (AEC-Q200).	52-54
AntennaGuard PowerGuard Low Capacitance Varistors	VCAS**AP		Case size: Working Voltage: Capacitance:	0402 - 0603 18 - 30Vdc 1.5 - 3.3pF	Low capacitance varistors with higher energy rating and low signal distortion designed for protection in RF circuits, high-speed data lines, radars and other capacitance sensitive automotive (AEC-Q200). and general applications.	55-57
Sub pF AG Series Ultra-Low Capacitance	VCH4**AG		Case size: Working Voltage: Capacitance:	0201, 0402 10 - 18Vdc 0.47 - 0.8pF	Ultra-low capacitance (<1pF) varistors designed for protection in RF circuits, antennas, sensors, high-speed data lines, optic circuits and capacitance sensitive applications.	58-59
Sub pF AG Automotive Series Ultra-Low Capacitance	VCASH4		Case size: Working Voltage: Capacitance:	0402 16Vdc 0.8pF	Ultra-low capacitance (<1pF) varistor designed for protection in RF circuits, sensors, high-speed data lines, optic circuits and capacitance sensitive automotive (AEC-Q200) applications.	60-62
Controlled Capacitance	VCAC		Case size: Working Voltage: Peak Current: Capacitance:	0402, 0603 9 - 30Vdc 2 - 120A 33 - 1000pF	Varistors developed for use in mixed signal environment for targeted EMI/ RFI filtering and transient suppression in automotive (AEC-Q200) and general applications.	63-64

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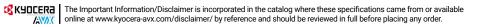
Product Selection Guide

Multilayer Ceramic Transient Voltage Suppressors

Series	PN Code	Fig.	Technica	al Data	Features / Applications	Page
Miniature MAV Series	MAV		Case size: Working Voltage: Peak Current: Capacitance:	0402 - 0603 70Vdc 1 - 3A 6-22pF	Varistors designed for low power AC circuit protection, transient suppression in LC resonant circuits and higher DC voltage data lines protection in automotive (AEC-Q200) and general applications.	65-67
Glass Encapsulated TransGuard®	VG	VG Case size: Working Voltage: Energy: Peak Current: 1206 - 3220 16 -125Vdc 0.7 - 12J 200 - 2000A High energy range extension of TransGuard varistors. In addition the glass encapsulation provides enhanced resistance against harsh environment.				
Glass Encapsulated TransGuard® Automotive Series	VGAS		Case size: Working Voltage: Energy: Peak Current:	1206 - 3220 16 - 85Vdc 0.7 - 13J 200 - 2000A	High energy range extension of TransGuard automotive series varistors for automotive (AEC-Q200) applications. In addition the glass encapsulation provides enhanced resistance against harsh environment.	70-71
High Temperature Automotive Series	CANAT VCAT		Case size: Working Voltage: Peak Current: Capacitance:	0603 - 0612 18Vdc 4A 12, 22pF	High temperature varistors specified to +150°C for automotive (AEC-Q200) and general applications.	72-73
High Temperature Low Leakage Automotive Series	CANATL	P	Case size: Working Voltage: Peak Current: Capacitance:	0603 32Vdc 5A 10pF	High temperature varistors with low leakage, specified to +150°C for high temperature automotive (AEC-Q200) and general applications.	74-75
Radial Leaded Automotive TransGuard®	VR**AS		Case size: Working Voltage: Energy: Peak Current:	Radial 18 - 48Vdc 0.7 - 1.6J 200 - 500A	Radial leaded epoxy coated varistors, designed for durability in harsh environments for automotive (AEC-Q200) and general applications.	76-77
Radial Leaded High Temperature Automotive TransGuard®	VR**AT	/11	Case size: Working Voltage: Energy: Peak Current:	Radial 14 - 48Vdc 0.1 - 2.0J 30 - 250A	High temperature, radial leaded epoxy coated varistors, specified to +150°C. Designed for durability in harsh environments and for high temperature automotive (AEC-Q200) and general applications.	78-79
Radial CapGuard™	CG		Case size: Working Voltage: Peak Current: Capacitance:	Radial 26, 45Vdc 200A 0.47, 1pF	TransGuard varistor and RF filtering high capacitance ceramic capacitor integrated into single radial leaded component for bi-directional overvoltage protection and RFI noise suppression in automotive (AEC-Q200) and general applications.	80-81
Axial TransGuard and StaticGuard	VA	eeeee	Case size: Working Voltage: Energy: Peak Current:	Axial 3.3 - 60Vdc 0.1 - 2.0J 30 - 300A	Axial Version of TransGuard® and StaticGuard varistors for bi-directional overvoltage protection as well as EMI/RFI attenuation in the off-state.	84-85
TransFeed	V*F		Case size: Working Voltage: Energy: Peak Current:	0805 5.6 - 26Vdc 0.05 - 0.3J 20 - 120A	Varistor with FeedThru filter construction for transient protection with enhanced attenuation characteristics for EMI reduction.	86-92
TransFeed Automotive Series	V*AF		Case size: Working Voltage: Energy: Peak Current:	0805 5.6 - 26Vdc 0.05 - 0.3J 15 -120A	Varistor with FeedThru filter construction for transient protection with enhanced attenuation characteristics for EMI reduction for automotive (AEC-Q200) applications.	93-97
SnPb Multilayer Varistors	VCLD	000	Case size: Working Voltage: Energy: Peak Current:	0603 - 1210 5.6 - 85Vdc 0.1 - 2.0J 30 - 500A	Varistors with SnPb termination for bi-directional overvoltage protection as well as EMI/RFI attenuation in the off-state.	98-99
Glass Encapsulated MLV	VJ	17-	Case size: Working Voltage: Energy: Peak Current:	1206 - 3220 16 - 385Vdc 0.3 - 15J 120 -3000A	Special series of high energy, large case size varistors for automotive, industrial/commercial and telecom applications.	100-111

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GENERAL DESCRIPTION

TransGuard® multilayer varistors are zinc oxide (ZnO) based ceramic semiconductor devices with non-linear voltage-current characteristics (bi-directional) similar to back- to-back zener diodes. They have the added advantage of greater current and energy handling capabilities as well as EMI/RFI attenuation.

The increasing use of electronics technologies in all areas require reliable protection against transient voltages that could damage the electronics circuitry as well as EMI/RFI attenuation to prevent signal distortion and to meet regulatory requirements. KYOCERA AVX TransGuard components help achieve both functions with single component.

580 = 60V

GENERAL CHARACTERISTICS

- Operating Temperature: -55°C to +125°C
- Working Voltage: 3.3 85Vdc
- Case Size: 0402 1812
- Energy: 0.05 4.2J
- Peak Current: 20 2000A

HOW TO ORDER



- Bi-Directional protection
- Very fast response to ESD strikes
- Multi-strike capability
- High Reliability
- EMI/RFI Filtering
- Wide range of components

APPLICATIONS

- IC Protection
- . Micro Controllers
- Relays
- I/0 Ports
- Keyboard Protection •
- Portable devices •
- Industrial Controllers
- Automation .
- Smart Grid

- Telecom
- LED Lights
- · Cameras
- Base Stations
- Motion detector
- Alarms
- and more

VC	1206	1	8		D T	4	00	R T	Р Т
Varistor Chip	Case Size		rking Itage		nergy ating		nping tage	Packaging D = 7" (1000)*	Termination P = Ni/Sn plated
VC = Varistor Chip VG = Varistor Glass	0402 0603 0805 1206 1210 1812 2220 3220	03 = 3.3Vdc 05 = 5.6Vdc 09 = 9Vdc 12 = 12Vdc 14 = 14Vdc 16 = 16Vdc 18 = 18Vdc 22 = 22Vdc 26 = 26Vdc 30 = 30Vdc	31 = 31Vdc 38 = 38Vdc 42 = 42Vdc 45 = 45Vdc 48 = 48Vdc 56 = 56Vdc 60 = 60Vdc 65 = 65Vdc 85 = 85Vdc	X= 0.05J A= 0.1J B= 0.2J C= 0.3J D= 0.4J E= 0.5J F= 0.7J G= 0.9J H= 1.2J J= 1.5-1.6J K= 0.6J	M= 1.0J N= 1.1J P= 2.5-3.7J R= 1.7J L= 0.8J S= 1.9-2.0J U= 4.0-5.0J W= 5.1-6.0J Y= 6.5-12J	100 = 12V $150 = 18V$ $200 = 22V$ $350 = 27V$ $300 = 32V$ $380 = 38V$ $390 = 42V$ $400 = 42V$ $440 = 44V$ $490 = 49V$ $540 = 54V$ $560 = 60V$	620 = 67V 650 = 67V 770 = 77V 800 = 80V 900 = 90V 101 = 100V 111 = 110V 121 = 120V 131 = 135V 151 = 150V 161 = 165V	R = 7" (4000 or 2000)* T = 13" (10,000)* W = 7" (10,000)** *Not available for 0402 **Only available for 0402	Z = FLEXITERM®* *Only available for VC0603 - VC1210

The following series are available with industry proven KYOCERA AVX flexible termination system FLEXITERM®:

VC0603, VC0805, VC1206, VC1210

FLEXITERM® is designed to enhance the mechanical flexure and temperature cycling performance provides up to 5mm of flexure without internal cracks.



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ELECTRICAL CHARACTERISTICS

Dent Namel an	V _w (DC)	V _w (AC)	V _R	V,	I _{vc}	I,	E,	١	Сар	F	
Part Number	Vdc	Vac	V	V	Ă	μÂ	J	Á	pF	Freq	Case
VC060303A100	3.3	2.3	5.0±20%	12	1	100	0.1	30	1450	К	0603
VC080503A100	3.3	2.3	5.0±20%	12	1	100	0.1	40	1400	К	0805
VC080503C100	3.3	2.3	5.0±20%	12	1	100	0.3	120	5000	К	0805
VC120603A100	3.3	2.3	5.0±20%	12	1	100	0.1	40	1250	К	1206
VC120603D100	3.3	2.3	5.0±20%	12	1	100	0.4	150	4700	К	1206
VC040205X150	5.6	4.0	8.5±20%	18	1	35	0.05	20	175	М	0402
VC060305A150	5.6	4.0	8.5±20%	18	1	35	0.1	30	750	К	0603
VC080505A150	5.6	4.0	8.5±20%	18	1	35	0.1	40	1100	К	0805
VC080505C150	5.6	4.0	8.5±20%	18	1	35	0.3	120	3000	К	0805
VC120605A150	5.6	4.0	8.5±20%	18	1	35	0.1	40	1200	К	1206
VC120605D150	5.6	4.0	8.5±20%	18	1	35	0.4	150	3000	к	1206
VC040209X200	9.0	6.4	12.7±15%	22	1	25	0.05	20	175	M	0402
VC060309A200	9.0	6.4	12.7±15%	22	1	25	0.1	30	550	K	0603
VC080509A200	9.0	6.4	12.7±15%	22	1	25	0.1	40	750	K	0805
VC080512A250	12.0	8.5	16±15%	27	1	25	0.1	40	525	K	0805
VC040214X300	14.0	10.0	18.5±12%	32	1	15	0.05	20	85	K	0402
VC060314A300	14.0	10.0	18.5±12%	32	1	15	0.00	30	350	K	0402
VC080514A300	14.0	10.0	18.5±12%	32	1	15	0.1	40	325	K	0805
VC080514A300 VC080514C300	14.0	10.0	18.5±12%	32	1	15	0.1	120	900	K	0805
VC120614A300	14.0	10.0	18.5±12%	32	1	15	0.3	40	600	K	1206
VC120614D300	14.0	10.0	18.5±12%	32	1	15	0.1	150	1050	K	1200
VC120014D300	14.0	13.0	25.5±10%	40	2.5	10	1.6	500	3100	K	1200
VG181216P390	16.0	11.0	23.5±10% 24.5±10%	40	5	15	2.9	1000	7000	K	1210
	16.0	11.0	24.5±10%	40	5	10	2.9	1000	5000	K	1812
VG181216P400 VG222016Y400	16.0	11.0	24.5±10% 24.5±10%	42	10	10	7.2	1500	13000	K	2220
VC040218X400	18.0	13.0	24.5±10%	42	10	10	0.05	20	65	M	0402
VC040218A400 VC060318A400	18.0	13.0	25.5±10%	42	1	10	0.03	30	150	K	0402
VC080518A400	18.0	13.0	25.5±10%	42	1	10	0.1	30	225	K	0805
VC080518A400 VC080518C400	18.0	13.0	25.5±10%	42	1	10	0.1	100	550	K	0805
VC080518C400 VC120618A400	18.0	13.0	25.5±10%	42	1	10	0.3	30	350	K	1206
VC120618A400 VC120618D400	18.0	13.0	25.5±10%	42	1	10	0.1	150	900	K	1206
VC120618E380	18.0	13.0	25.5±10%	38	1	15	0.4	200	930	K	1206
VG121018J380	18.0	14.0	23.3110% 22±10%	38	2.5	15	1.5	400	2300	K	1200
VC121018J390	18.0	14.0	25.5±10%	42	5	10	1.6	500	3100	K	1210
VG181218P380	18.0	13.0	23.3±10% 22±10%	38	5	10	2.3	800	5000	K	1210
VG181218P380	18.0	14.0	27.5±10%	44	5	15	2.3	800	5000	K	1218
VG181218F440 VG222018W380	18.0	14.0	27.5±10%	38	10	15	5.8	1200	18000	K	2220
VG121022R440	22.0	14.0	27±10%	44	2.5	15	1.7	400	1600	K	1210
VG121022K440	22.0	17.0	27±10%	44	10	15	7.2	1200	18000	K	2220
VG2220221440	22.0	17.0	30±10%	44	10	15	6.8	1200	12000	K	2220
			34.5±10%		-	-					
VC060326A580	26.0	18.0		60	1	10	0.1	30	155 120	к к	0603 0805
VC080526A580	26.0	18.0	34.5±10%	60		10	0.1	30			
VC080526C580	26.0	18.0 18.0	34.5±10%	60	1	10 10	0.3	100 120	250 500	K	0805
VC120626D580	26.0		34.5±10%	60 54						K	
VC120626F540	26.0	20.0	33.0±10%	54	1	15	0.7	200	600	K	1206
VC121026H560	26.0	18.0	34.5±10%	60 54	5	10	1.2	300	2150	K	1210
VG121026S540	26.0	20.0	33±10%	54	2.5	15	1.9	400	1600	K	1210
VG181226P540	26.0	20	35±10%	54	5	15	3	800	3000	К	1812

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ELECTRICAL CHARACTERISTICS

Dant Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	E _T	I _P	Сар	F ire in	0
Part Number	Vdc	Vac	V	V	Α	μA	J	Α	pF	Freq	Case
VG181226P570	26.0	23.0	35.0±10%	57	5	15	2.5	600	3000	К	1812
VG181226P540	26.0	20.0	35.0±10%	54	5	15	3.0	800	3000	К	1812
VG222026Y540	26.0	20.0	33.0±10%	54	10	15	7.8	1200	11000	К	2220
VG222026Y570	26.0	23.0	35.0±10%	57	10	15	6.8	1100	7000	К	2220
VG322026N570	26.0	20.0	33.0±10%	57	10	15	1.1	400	5500	К	3220
VC060330A650	30.0	21.0	41.0±10%	67	1	10	0.1	30	125	к	0603
VC080530A650	30.0	21.0	41.0±10%	67	1	10	0.1	30	90	М	0805
VC080530C650	30.0	21.0	41.0±10%	67	1	10	0.3	80	250	К	0805
VC120630D650	30.0	21.0	41.0±10%	67	1	10	0.4	120	400	К	1206
VC121030G620	30.0	21.0	41.0±10%	67	5	10	0.9	220	1750	К	1210
VC121030H620	30.0	21.0	41.0±10%	67	5	10	1.2	280	1850	К	1210
VC121030S620	30.0	21.0	41.0±10%	67	5	10	1.9	300	1500	К	1210
VC080531C650	31.0	25.0	39.0±10%	65	1	10	0.3	80	250	К	0805
VC120631M650	31.0	25.0	39.0±10%	65	1	15	1.0	200	500	К	1206
VG121031R650	31.0	25.0	39.0±10%	65	2.5	15	1.7	300	1200	К	1210
VG181231P650	31.0	25.0	39.0±10%	65	5	15	3.7	800	2600	К	1812
VG222031Y650	31.0	25.0	39.0±10%	65	10	15	9.6	1200	6100	К	2220
VC080538C770	38.0	30.0	47.0±10%	77	1	10	0.3	80	200	к	0805
VC120638N770	38.0	30.0	47.0±10%	77	1	15	1.1	200	400	К	1206
VG121038S770	38.0	30.0	47.0±10%	77	2.5	15	2.0	400	1000	К	1210
VG181238U770	38.0	30.0	47.0±10%	77	5	15	4.2	800	1300	К	1812
VG222038Y770	38.0	30.0	47.0±10%	77	10	15	12	2000	4200	к	2220
VG322038J920	38.0	30.0	47.0±10%	92	10	15	1.5	400	2600	К	3220
VC120642L800	42.0	32.0	51.0±10%	80	1	15	0.8	180	600	К	1206
VC120645K900	45.0	35.0	56.0±10%	90	1	15	0.6	200	260	К	1206
VG121045S900	45.0	35.0	56.0±10%	90	2.5	15	2	300	800	к	1210
VG181245U900	45.0	35.0	56.0±10%	90	5	15	4.0	500	1200	К	1812
VG222045Y900	45.0	35.0	56.0±10%	90	10	15	12	1000	5000	К	2220
VC120648D101	48.0	34.0	62.0±10%	100	1	10	0.4	100	225	К	1206
VC121048G101	48.0	34.0	62.0±10%	100	5	10	0.9	220	450	К	1210
VC121048H101	48.0	34.0	62.0±10%	100	5	10	1.2	250	500	К	1210
VC120656F111	56.0	40.0	68.0±10%	110	1	15	0.7	100	180	К	1206
VG121056P111	56.0	40.0	68.0±10%	110	2.5	15	2.3	250	500	К	1210
VG181256U111	56.0	40.0	68.0±10%	110	5	15	4.8	500	800	К	1812
VG222056Y111	56.0	40.0	68.0±10%	110	10	15	9	1000	2000	K	2220
VC121060J121	60.0	42.0	76.0±10%	120	5	10	1.5	250	400	K	1210
VC120665L131	65.0	50.0	82.0±10%	135	1	15	0.8	100	250	К	1206
VC120665M131	65.0	50.0	82.0±10%	135	1	15	1.0	150	250	К	1206
VG121065P131	65.0	50.0	82.0±10%	135	2.5	15	2.7	350	600	K	1210
VG181265U131	65.0	50.0	82.0±10%	135	5	15	4.5	400	600	K	1812
VG222065Y131	65.0	50.0	82.0±10%	135	10	15	6.5	800	3000	K	2220
VC121085S151	85.0	60.0	100±10%	150	1	35	2.0	250	275	К	1210
VG181285U161	85.0	60.0	100±10%	165	5	15	4.5	400	500	К	1812
VG222085Y161	85.0	60.0	100±10%	165	10	15	6.8	800	1500	K	2220

- V_w (DC) DC Working Voltage (V)
- V_w (AC) AC Working Voltage (V)
 - Typical Breakdown Voltage (V $@ 1mA_{DC})$
 - V_B V_C Clamping Voltage (V @ I_{vc})
 - Test Current for V_c (A, 8x20µS) $\mathbf{I}_{\rm VC}$
 - Maximum Leakage Current at the
 - \mathbf{I}_{L} Working Voltage (µA)

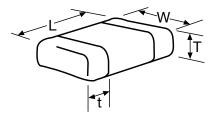
- Ε_τ Transient Energy Rating (J, 10x1000µS)
- \mathbf{I}_{P} Peak Current Rating (A, 8x20µS)
- Typical Capacitance (pF) @ frequency specified and 0.5 $\rm V_{\rm \tiny RMS}$ Сар

Frequency at which capacitance is measured Freq

(K = 1kHz, M = 1MHz)

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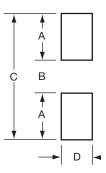
DIMENSIONS:

mm (inches)

Style		0402	0603	0805	1206	1210	1812	2220	3220
(L) Length	mm	1.00±0.10	1.60±0.15	2.01±0.20	3.20±0.20	3.20±0.20	4.50±0.30	5.70±0.40	8.20±0.40
	(in.)	(0.040±0.004)	(0.063±0.006)	(0.079±0.008)	(0.126±0.008)	(0.126±0.008)	(0.177±0.012)	(0.224±0.016)	(0.323±0.016)
(W) Width	mm	0.50±0.10	0.80±0.15	1.25±0.20	1.60±0.20	2.49±0.20	3.20±0.30	5.00±0.40	5.00±0.40
	(in.)	(0.020±0.004)	(0.031±0.006)	(0.049±0.008)	(0.063±0.008)	(0.098±0.008)	(0.126±0.012)	(0.197±0.016)	(0.197±0.016)
(T) Max Thickness	mm (in.)	0.6 (0.024)	0.9 (0.035)	1.02 (0.040)	1.02 (0.040) 1.27 (0.050) ¹⁾ 1.70 (0.067) ²⁾	1.70 (0.067)	2.00 (0.080)	2.50 (0.098)	2.50 max. (0.098 max.)
(t) Land mm		0.25±0.15	0.35±0.15	0.71 max. (0.028	0.94 max. (0.037	1.14 max. (0.045	1.00 max. (0.039	1.00 max. (0.039	1.30 max. (0.051
Length (in.)		(0.010±0.006)	(0.014±0.006)	max.)	max.)	max.)	max.)	max.)	max.)

1) Applicable for: VC120618E380

2) Applicable for: VC120626F540, VC120631M650, VC120638N770, VC120642L800, VC120645K900, VC120656F111, VC120660M131



SOLDERING PAD:

mm (inches)

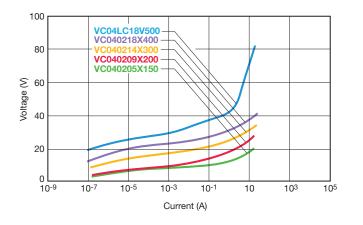
								(/
Pad Layout	0402	0603	0805	1206	1210	1812	2220	3220
А	1.61 (0.024)	0.89 (0.035)	1.02 (0.040)	1.02 (0.040)	1.02 (0.040)	1.00 (0.039)	1.00 (0.039)	2.21 (0.087)
В	1.51 (0.020)	0.76 (0.030)	1.02 (0.040)	2.03 (0.080)	2.03 (0.080)	3.60 (0.142)	4.60 (0.18)	5.79 (0.228)
С	1.70 (0.067)	2.54 (0.100)	3.05 (0.120)	4.06 (0.160)	4.06 (0.160)	5.60 (0.220)	6.60 (0.26)	10.21 (0.402)
D	1.51 (0.020)	0.76 (0.030)	1.27 (0.050)	1.65 (0.065)	2.54 (0.100)	3.00 (0.118)	5.00 (0.20)	5.50 (0.217)



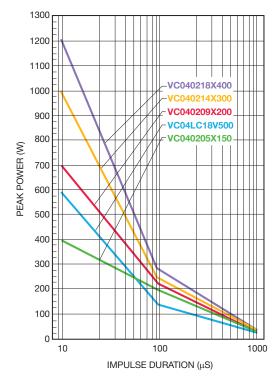
TYPICAL PERFORMANCE CURVES (0402 CHIP SIZE)

VOLTAGE/CURRENT CHARACTERISTICS

Multilayer construction and improved grain structure result in excellent transient clamping characteristics up to 20 amps peak current, while maintaining very low leakage currents under DC operating conditions. The VI curves below show the voltage/current characteristics for the 5.6V, 9V, 14V, 18V and low capacitance StaticGuard parts with currents ranging from parts of a micro amp to tens of amps.



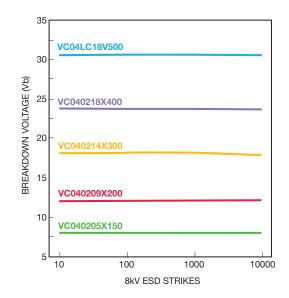
PEAK POWER VS PULSE DURATION



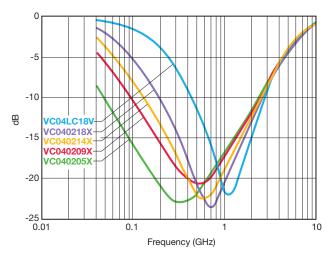
PULSE DEGRADATION

Traditionally varistors have suffered degradation of electrical performance with repeated high current pulses resulting in decreased breakdown voltage and increased leakage current. It has been suggested that irregular intergranular boundaries and bulk material result in restricted current paths and other non-Schottky barrier paralleled conduction paths in the ceramic. Repeated pulsing of TransGuard[®] transient voltage suppressors with 150Amp peak 8 x 20µS waveforms shows negligible degradation in breakdown voltage and minimal increases in leakage current.

ESD TEST OF 0402 PARTS



INSERTION LOSS CHARACTERISTICS

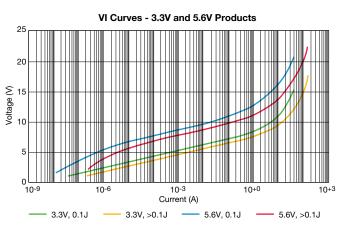


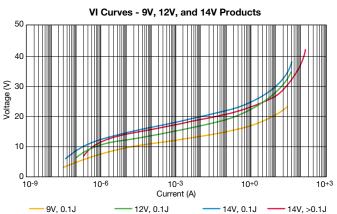
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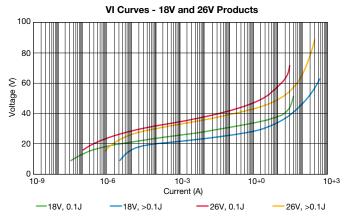
TYPICAL PERFORMANCE CURVES (0603, 0805, 1206 & 1210 CHIP SIZES)

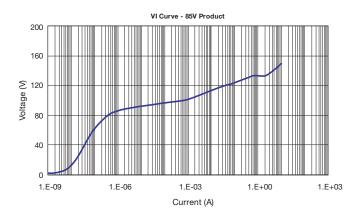
VOLTAGE/CURRENT CHARACTERISTICS

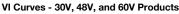
Multilayer construction and improved grain structure result in excellent transient clamping characteristics up to 500 amps peak current, depending on case size and energy rating, while maintaining very low leakage currents under DC operating conditions. The VI curve below shows the voltage/current characteristics for the 3.3V, 5.6V, 12V, 14V, 18V, 26V, 30V, 48V and 60VDC parts with currents ranging from parts of a micro amp to tens of amps.

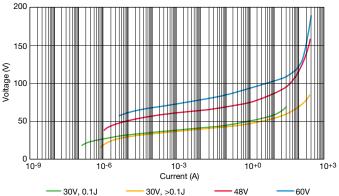






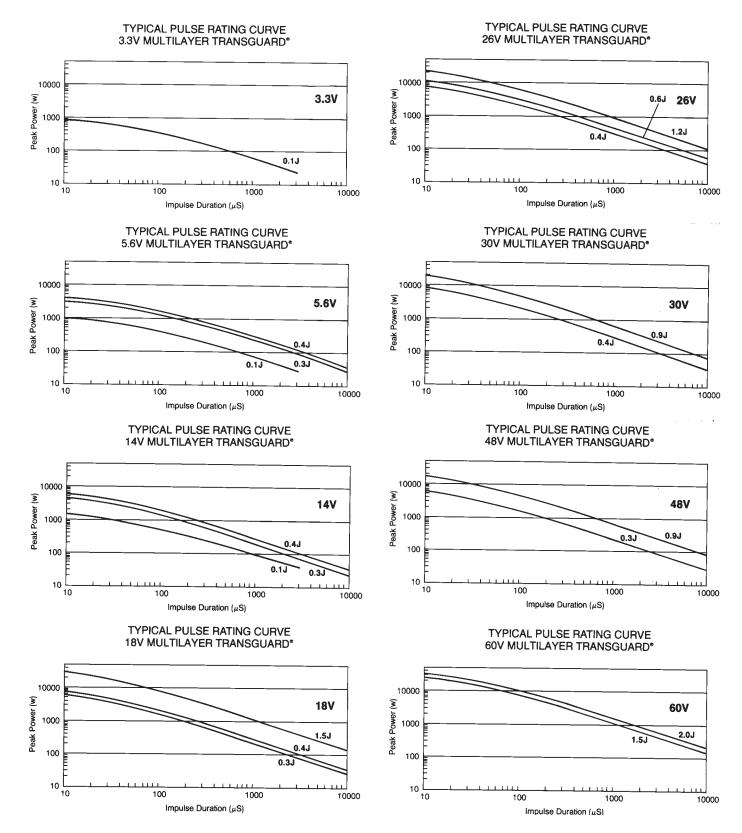






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TYPICAL PERFORMANCE CURVES (0603, 0805, 1206 & 1210 CHIP SIZES)



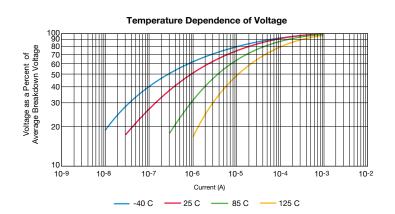
012317

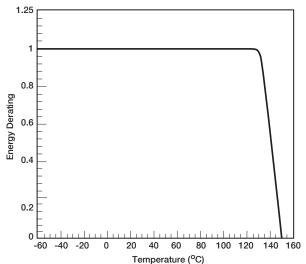
KY<u>OCERa</u>

TYPICAL PERFORMANCE CURVES (0603, 0805, 1206 & 1210 CHIP SIZES)

TEMPERATURE CHARACTERISTICS

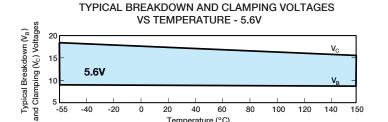
TransGuard[®] suppressors are designed to operate over the full temperature range from -55°C to +125°C. This operating temperature range is for both surface mount and axial leaded products.





TYPICAL ENERGY DERATING VS TEMPERATURE

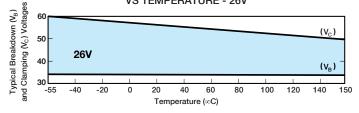
KY<u>OCERa</u>



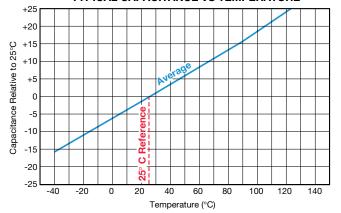
Temperature (°C)
TYPICAL BREAKDOWN AND CLAMPING VOLTAGES

VS TEMPERATURE - 18V and Clamping (V_c) Voltages Typical Breakdown (V_B) 50 (V_c) 40 18V 30 (V_B) 20 -55 -40 -20 0 20 40 60 80 100 120 140 150 Temperature (°C)





TYPICAL CAPACITANCE VS TEMPERATURE



TYPICAL PERFORMANCE CURVES (0603, 0805, 1206 & 1210 CHIP SIZES) **PULSE DEGRADATION**

Traditionally varistors have suffered degradation of electrical performance with repeated high current pulses resulting in decreased breakdown voltage and increased leakage current. It has been suggested that irregular intergranular boundaries and bulk material result in restricted current paths and other non-Schottky barrier paralleled conduction paths in the ceramic. Repeated pulsing of both 5.6 and 14V TransGuard® transient voltage suppressors with 150 Amp peak 8 x 20µS waveforms shows negligible degradation in breakdown voltage and minimal increases in leakage current. The plots of typical breakdown voltage vs number of 150A pulses are shown below.

KYOCERa

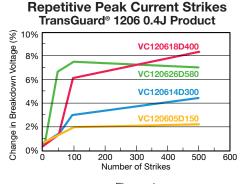
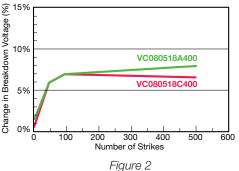
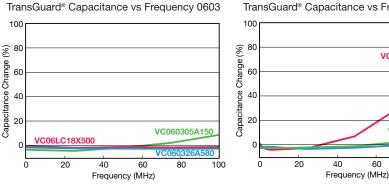


Figure 1





CAPACITANCE/FREQUENCY CHARACTERISTICS



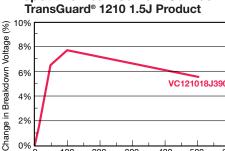
TransGuard® Capacitance vs Frequency 0805

VC080505C150

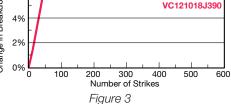
VC080518C400

80

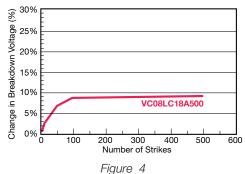
VC080514A300



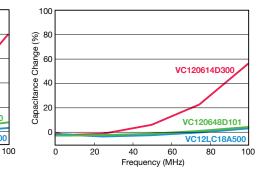
Repetitive Peak Current Strikes



Repetitive Peak Current Strikes StaticGuard 0805 0.1J Product



TransGuard® Capacitance vs Frequency 1206



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012317

TransGuard® Automotive Series Multilayer Varistors for Automotive Applications





COMPLIAN

GENERAL DESCRIPTION

The TransGuard Automotive Series are zinc oxide (ZnO) based ceramic semiconductor devices with nonlinear, bi-directional voltage-current characteristics.

They have the advantage of offering bi-directional overvoltage protection as well as EMI/RFI attenuation in a single SMT package. The Automotive Series high current and high energy handling capability make them well suited for protection against automotive related transients.

KYOCERA AVX VG series parts (large case size, high energy) are glass encapsulated. These parts provide the same high reliability as traditional VC series parts. The glass encapsulation provides also enhanced resistance against harsh environment or process such as acids, salts, chlorite flux.

Operating Temperature: -55°C to +125°C

FEATURES

- High Reliability
 High Energy Absorption (Load Dump
- High Energy Absorption (Load Dump)
 High Current Handling
- High Current HandlingAEC Q200 Qualified
- AEC Q200 Qualified
 Bi-Directional protection
- BI-Directional protection
- EMI/RFI attenuation Multi-strike capability
- Sub 1nS response to ESD strike

APPLICATIONS

- Internal Combustion Engine (ICE) Vehicles
- Hybrid Electric Vehicles (HEV)
- Plug-in Hybrid Electric Vehicles (PHEV)
- Commercial Vehicles
 - CAN, LIN, FLEXRAY based modules
 - Sensors

570 = 57V

- Module load dump protection
- Motor/inductive load transient suppression

HOW TO ORDER

LEAD-FREE LEAD-FREE COMPATIBLE COMPONENT

VC	AS	1206	18	D	400	R	Р
T	T	Т	Т	Т	\top	Т	Т
Varistor Chip VC = Varistor Chip	Automotive Series	Case Size	Working Voltage	Energy Rating	Clamping Voltage	Package D = 7" (1000)*	Termination P = Ni/Sn plated
VG = Varistor Glass Encapsulated Chip		0402 0603 0805 1206 1210 1812 2220 3220	03 = 3.3Vdc 31 = 31Vdc 05 = 5.6Vdc 34 = 34Vdc 09 = 9Vdc 38 = 38Vdc 12 = 12Vdc 42 = 42Vdc 14 = 14Vdc 45 = 45Vdc 16 = 16Vdc 48 = 48Vdc 18 = 18Vdc 56 = 56Vdc 22 = 22Vdc 60 = 60Vdc 26 = 26Vdc 65 = 65Vdc 30 = 30Vdc 85 = 85Vdc	$\begin{array}{llllllllllllllllllllllllllllllllllll$	$\begin{array}{c} 140 = 14V & 580 = 60V \\ 150 = 18V & 620 = 67V \\ 220 = 22V & 650 = 67V \\ 250 = 27V & 770 = 77V \\ 300 = 32V & 800 = 80V \\ 380 = 38V & 900 = 90V \\ 390 = 42V & 101 = 100V \\ 400 = 42V & 111 = 110V \\ 440 = 44V & 131 = 135V \\ 490 = 49V & 151 = 150V \\ \end{array}$	R = 7" (4000)* T = 13" (10,000)* W = 7" (10,000)** 0402 only *Not available for 0402 **Only available for 0402	Z = FLEXITERM® *Only available for 0603-1210 case

KYDEERA AWXX The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

ELECTRICAL CHARACTERISTICS

Dant Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	E _T	ELD	I _P	Сар	Freq	V _{Jump}	_
Part Number	Vdc	Vac	V	V	A	μA	J	J	A	pF	V	W	P _{Diss. Max}
VCAS060303A140	3.3	2.3	6.0±20%	14	1	50	0.1	-	30	1450	К	-	0.002
VCAS080503A140	3.3	2.3	6.0±20%	14	1	50	0.1	-	40	1000	K	-	0.002
VCAS080503C140	3.3	2.3	6.0±20%	14	1	50	0.3	-	120	4500	K	-	0.006
VCAS120603A140	3.3	2.3	6.0±20%	14	1	50	0.1	-	40	1500	K	-	0.002
VCAS120603D140	3.3	2.3	6.0±20%	14	1	50	0.4	-	150	4000	К	-	0.009
VCAS040205X150	5.6	4	8.5±20%	18	1	35	0.05	-	20	175	M	-	0.001
VCAS060305A150	5.6	4	8.5±20%	18	1	35	0.1	-	30	750	K	-	0.001
VCAS080505A150	5.6	4	8.5±20%	18	1	35	0.1	-	40	1100	K	-	0.001
VCAS080505C150	5.6 5.6	4	8.5±20% 8.5±20%	18 18	1	35 35	0.3	-	120 40	3000 1200	K K	-	0.005
VCAS120605D150	5.6	4	8.5±20%	18	1	35	0.1	-	150	3000	K	-	0.002
VCAS040209X200	9	6.4	12.7±15%	22	1	25	0.05	-	20	175	M	-	0.000
VCAS060309A200	9	6.4	12.7±15%	22	1	25	0.1	-	30	550	K	-	0.002
VCAS080509A200	9	6.4	12.7±15%	22	1	25	0.1	-	40	750	K	-	0.002
VCAS080512A250	12	8.5	16±15%	27	1	25	0.1	-	40	525	K	-	0.002
VCAS040214X300	14	10	18.5±12%	32	1	15	0.05	-	20	85	K	16	0.001
VCAS060314A300	14	10	18.5±12%	32	1	15	0.1	-	30	350	K	16	0.002
VCAS080514A300	14	10	18.5±12%	32	1	15	0.1	-	40	325	K	16	0.002
VCAS080514C300	14	10	18.5±12%	32	1	15	0.3	-	120	900	К	20	0.006
VCAS120614A300	14	10	18.5±12%	32	1	15	0.1	-	40	600	K	20	0.002
VCAS120614D300	14	10	18.5±12%	32	1	15	0.4	-	150	1050	K	20	0.008
VCAS060316B400	16	11	25.5±10%	42	1	10	0.2	0.25	30	150	K	27.5	0.003
VCAS120616K380 VCAS121016J390	16 16	11 11	25.5±10% 25.5±10%	38 42	5	10 10	0.6	1.5 3	200 500	930 3100	K K	27.5 27.5	0.01
VGAS121016S390	16	14	25.5±10% 24.5±10%	42	2.5	10	2	5	500	3000	K	27.5	0.03
VGAS1210103390 VGAS181216P390	16	14	24.5±10%	40	5	15	2.9	10	1000	7000	K	27.5	0.07
VGAS1812101 390	16	11	24.5±10%	40	10	15	10.2	35	1500	20000	K	27.5	0.07
VGAS181216P400	16	11	24.5±10%	42	5	10	2.9	10	1000	5000	K	27.5	0.07
VGAS222016Y400	16	11	24.5±10%	42	10	10	7.2	25	1500	13000	К	25.5	0.1
VCAS222016W400	16	11	24.5±10%	42	10	15	7.6	20	2000	20000	К	27.5	0.15
VCAS222016Y390	16	11	24.5±10%	40	10	15	10.2	37	2000	25000	K	27.5	0.2
VCAS222016Z400	16	11	24.5±10%	42	10	15	16	45	2000	28000	K	27.5	0.32
VCAS040218X400	18	13	25.5±10%	42	1	10	0.05	0.05	20	65	М	27.5	0.001
VCAS060318A400	18	13	25.5±10%	42	1	10	0.1	0.25	30	150	K	27.5	0.003
VCAS080518A400	18	13	25.5±10%	42	1	10	0.1	0.1	30	225	K	27.5	0.002
VCAS080518C400	18 18	13 13	25.5±10% 25.5±10%	42 42	1	10 10	0.3	1 0.5	120 30	550 350	К К	27.5 27.5	0.007
VCAS120618A400 VCAS120618D400	18	13	25.5±10% 25.5±10%	42	1	10	0.1	1.5	150	900	K	27.5	0.002
VCAS120018D400	18	13	25.5±10%	38	1	10	0.4	1.5	200	930	K	27.5	0.000
VCAS121018J390	18	13	25.5±10%	42	5	10	1.6	3	500	3100	K	27.5	0.03
VGAS181218P440	18	14	27.5±10%	44	5	15	2.9	6	800	5000	K	27.5	0.05
VGAS222022Y490	22	17	30±10%	49	10	15	6.8	25	1200	12000	К	27.5	0.03
VCAS060326A580	26	18	34.5±10%	60	1	10	0.1	0.1	30	155	K	27.5	0.002
VCAS080526A580	26	18	34.5±10%	60	1	10	0.1	0.15	30	120	К	27.5	0.002
VCAS080526C580	26	18	34.5±10%	60	1	10	0.3	0.5	100	250	К	27.5	0.006
VCAS120626D580	26	18	34.5±10%	60	1	10	0.4	1	120	500	K	27.5	0.008
VCAS120626F540	26	18	33.0±10%	54	1	15	0.7	1.5	200	600	K	27.5	0.008
VCAS121026H560 VGAS181226P570	26 26	18 23	34.5±10% 35.0±10%	60 57	5	10 15	1.2 2.5	3 8	300	2150	K	27.5	0.018
VGAS181226P570 VGAS222026Y570	26	23	35.0±10% 35±10%	57 57	10	15	6.8	25	600 1100	3000 7000	К К	30 30	0.015
VGAS2220267570 VGAS322026Z570	26	23	35±10% 35±10%	57	10	15	13	50	1800	15000	K	30	0.03
VCAS060330A650	30	23	41.0±10%	67	1	10	0.1	0.15	30	125	K	29	0.002
VCAS080530A650	30	21	41.0±10%	67	1	10	0.1	0.15	30	90	M	29	0.002
VCAS080530C650	30	21	41.0±10%	67	1	10	0.3	0.5	80	250	K	29	0.005
VCAS120630D650	30	21	41.0±10%	67	1	10	0.4	1	120	400	К	29	0.008
VCAS121030H620	30	21	41.0±10%	67	5	10	1.2	3	280	1850	K	30	0.018
VCAS121030S620	30	21	41.0±10%	67	5	10	1.9	3	300	1500	К	29	0.038
VCAS080531C650	31	25	39.0±10%	65	1	10	0.3	0.5	80	250	K	29	0.005
VCAS120631M650	31	25	39.0±10%	65	1	15	1	1.5	200	500	K	29	0.008
VGAS121031R650	31	25	39±10%	65	2.5	15	1.7	4.5	300	1200	K	30	0.05
VGAS181231P650	31	25	39.0±10%	65	5	15	3.7	8	800	2600	K	30	0.06
VGAS222031Y650	31	25	39±10%	65	10	15	9.6	23	1200	6100	K	30	0.03



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ELECTRICAL CHARACTERISTICS

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	Ε _τ	E _{LD}	I _P	Сар	Freq	V _{Jump}	D
Part Number	Vdc	Vac	V	V	A	μÂ	J	J	A	рF	V	W	P _{Diss. Max}
VCAS120634N770	34	30	47.0±10%	77	1	15	1.1	1.5	200	400	K	48	0.008
VGAS121034S770	34	30	47.0±10%	77	2.5	15	2	3	400	1000	K	48	0.04
VGAS181234U770	34	30	47.0±10%	77	5	15	5	6.1	800	1500	K	48	0.08
VGAS222034Y770	34	30	47.0±10%	77	10	15	12	25	2000	6300	K	48	0.240
VGAS322034Z770	34	30	47±10%	77	10	15	13	50	2000	18000	K	48	0.26
VCAS080538C770	38	30	47.0±10%	77	1	10	0.3	-	80	200	K	48	0.006
VCAS120642L800	42	32	51.0±10%	80	1	15	0.8	-	180	600	K	48	0.016
VCAS120642K900	42	32	56±10%	90	1	15	0.6		200	260	K	48	0.012
VGAS181242U900	42	35	56.0±10%	90	5	15	4.0	6	500	1200	К	48	0.015
VGAS222042Y900	42	37	56±10%	90	10	15	12	24	1000	5000	K	48	0.06
VCAS120645K900	45	35	56±10%	90	1	25	0.6		200	260	K	48	0.012N
VCAS120648D101	48	34	62.0±10%	100	1	10	0.4	-	100	225	K	48	0.008
VCAS121048H101	48	34	62.0±10%	100	1	10	1.2	-	250	500	K	48	0.022
VCAS120656F111	56	40	68.0±10%	110	1	15	0.7	-	100	180	K	48	0.014
VGAS181256U111	56	40	68±10%	110	5	15	4.8	-	500	1100	K	48	0.04
VCAS120660M131	60	50	82.0±10%	135	1	15	1	-	150	250	K	48	0.008
VCAS121060J121	60	42	76±10%	120	5	10	1.5		250	400	K	48	0.03
VGAS121065P131	65	50	82±10%	135	2.5	15	2.7		350	600	K	48	0.05
VGAS181265U131	65	50	82±10%	135	5	15	4.5	-	400	800	K	48	0.03
VGAS222065Y131	65	50	82±10%	135	10	15	6.5	-	1100	3000	K	48	0.06
VCAS121085S151	85	60	100.0±10%	150	1	35	2	-	250	275	K	48	0.040
VGAS181285U161	85	60	100±10%	165	5	15	4.5	-	400	500	K	48	0.04

 V_w (DC) DC Working Voltage (V)

 $V_w(AC)$ AC Working Voltage (V)

V_B V_C Typical Breakdown Voltage (V @ $1mA_{DC}$)

Clamping Voltage [V @ I

Test Current for $\rm V_{c}$

- I_{vc} I_L Maximum Leakage Current at the working voltage, 25°C (µA)
- Transient Energy Rating (J, 10x1000µS)
- Peak Current Rating (A, 8x20µS)

Ċap Typical Capacitance (pF) @ frequency specified and $0.5 V_{_{RMS'}} 25^{\circ}C$ Jump Start (V)

KY<u>OCERa</u>

 I_{P} V_{Jump} P

Е,

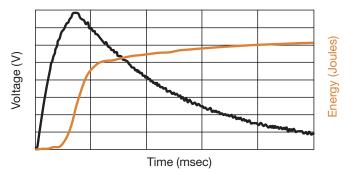
Power Dissipation (W)





AUTOMOTIVE SERIES – LOAD DUMP TEST ACCORDING TO ISO DP7637 REV 2 PULSE 5

Automotive Load Dump Pulse (According to ISO 7637 Pulse 5)



When using the test method indicated below, the amount of Energy dissipated by the varistor must not exceed the Load Dump Energy value specified in the product table.

LOAD DUMP LIBRARY

TYPICAL MAX VZ VERSUS PULSE DURATION AND RI 12V SYSTEMS 24V SYSTEMS

VCAS060316B400	0.5Ω	1Ω	4Ω
100ms	37	38	42
200ms	36	37	41
400ms	35	36	39
VCAS120616K380	0.5Ω	1Ω	4Ω
100ms	42	45	55
200ms	40	43	50
400ms	39	40	45
VCAS121016J390	0.5Ω	10	4Ω
100ms	48	53	74
200ms	46	50	64
400ms	43	46	56
VGAS181216P400	0.5Ω	1Ω	4Ω
100ms	46	52	72
200ms	37	41	59
400ms	32	35	51
VGAS222016Y400	0.5Ω	10	4Ω
100ms	53	60	77
200ms	50	55	73
400ms	47	50	66
VCAS040218X400	0.5Ω	10	<u>4Ω</u>
100ms	38	39	40
200ms	37	33	38
400ms	34	37	36
VCAS060318A400	0.5Ω	<u></u>	<u>4Ω</u>
100ms	37	38	40
200ms	36	38	42
400ms	35	37	39
VCAS080518A400	0.5Ω	<u>1Ω</u>	<u> </u>
100ms	37	39	40
200ms	35	39	39
400ms	33	38	39
VCAS080518C400	0.5Ω	<u> </u>	<u>4Ω</u>
100ms	40	41	40
200ms	39	41	48
400ms	38	39	43
VCAS120618A400	0.5Ω	<u> </u>	42 4Ω
100ms	43	45	55
200ms	43	43	48
400ms	40	43	48
VCAS120618D400	0.5Ω	10	43 4Ω
100ms	42	45	55
200ms	40	43	50
400ms	39	42	45
VCAS120618E380	0.5Ω	40 1Ω	45 4Ω
100ms	42	45	55
200ms	42 40	43	50
400ms	39	43	45
	0.5Ω	40 1Ω	45 4Ω
VCAS121018J390 100ms	48	53	4 <u>0</u> 74
200ms	48 46	53	64
200ms 400ms	46	46	56
4001115	43	40	1 30

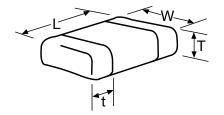
24V SYSTEMS VCAS060326A580 100ms 200ms

VCAS060326A580	1Ω	4Ω	8Ω
100ms	51	56	58
200ms	50	54	56
400ms	49	51	53
VCAS080526A580	1Ω	4Ω	8Ω
100ms	51	53	59
200ms	49	51	57
400ms	48	50	51
VCAS080526C580	1Ω	4Ω	8Ω
100ms	51	54	62
200ms	49	51	56
400ms	48	49	51
VCAS120626D580	1Ω	4Ω	8Ω
100ms	52	60	68
200ms	50	57	65
400ms	47	54	61
VCAS121026H560	1Ω	4Ω	8Ω
100ms	61	74	91
200ms	59	69	82
400ms	55	64	70
VCAS060330A650	1Ω	4Ω	8Ω
100ms	57	59	63
200ms	56	58	61
400ms	54	57	58
VCAS080530A650	1Ω	4Ω	8Ω
100ms	58	62	66
200ms	56	61	64
400ms	53	57	61
VCAS080530C650	1Ω	4Ω	8Ω
100ms	58	61	63
200ms	57	58	62
400ms	55	56	59
VCAS120630D650	1Ω	4Ω	8Ω
100ms	61	70	75
200ms	57	66	69
400ms	56	62	64
VCAS121030H620	1Ω	4Ω	8Ω
100ms	70	77	98
200ms	64	70	89
400ms	56	65	70
VGAS181234U770	1Ω	4Ω	8Ω
100ms	87	110	125
200ms	82	97	114
400ms	75	85	95
VGAS222034Y770	1Ω	4Ω	8Ω
100ms	100	125	165
200ms	91	115	155
400ms	84	104	120

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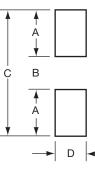




DIMENSIONS: MM (INCHES)

Style		0402	0603	0805	1206	1210	1812	2220	3220
(L) Length	mm	1.00±0.10	1.60±0.15	2.01±0.20	3.20±0.20	3.20±0.20	4.50±0.30	5.70±0.40	8.20±0.40
	(in.)	(0.040±0.004)	(0.063±0.006)	(0.079±0.008)	(0.126±0.008)	(0.126±0.008)	(0.177±0.012)	(0.224±0.016)	(0.323±0.016)
(W) Width	mm	0.50±0.10	0.80±0.15	1.25±0.20	1.60±0.20	2.49±0.20	3.20±0.30	5.00±0.40	5.00±0.40
	(in.)	(0.020±0.004)	(0.031±0.006)	(0.049±0.008)	(0.063±0.008)	(0.098±0.008)	(0.126±0.012)	(0.197±0.016)	(0.197±0.016)
(T) Max Thickness	mm (in.)	0.6 (0.024)	0.9 (0.035)	1.02 (0.040)	1.02 (0.040) 1.27 (0.050) ¹⁾ 1.70 (0.067) ²⁾	1.70 (0.067)	2.00 (0.080)	2.50 (0.098)	2.50 max. (0.098 max.)
(t) Land	mm	0.25±0.15	0.35±0.15	0.71 max. (0.028	0.94 max. (0.037	1.14 max. (0.045	1.00 max. (0.039	1.00 max. (0.039	1.30 max. (0.051
Length	(in.)	(0.010±0.006)	(0.014±0.006)	max.)	max.)	max.)	max.)	max.)	max.)

1) Applicable for: VCAS120618E380 2) Applicable for: VCAS120626F540, VCAS120631M650, VCAS120638N770, VCAS120642L800, VCAS120645K900, VCAS120656F111, VCAS120660M131



SOLDERING PAD: MM (INCHES)

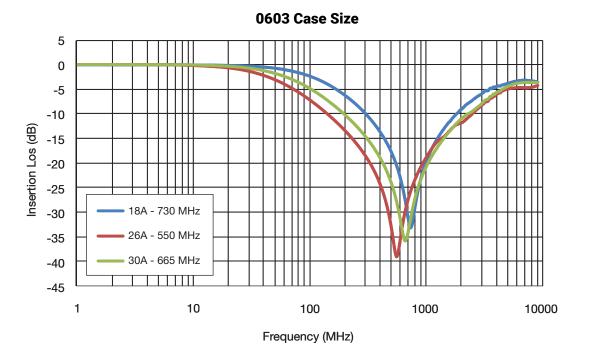
Pad Layout	0402	0603	0805	1206	1210	1812	2220	3220
А	1.61 (0.024)	0.89 (0.035)	1.02 (0.040)	1.02 (0.040)	1.02 (0.040)	1.00 (0.039)	1.00 (0.039)	2.21 (0.087)
В	1.51 (0.020)	0.76 (0.030)	1.02 (0.040)	2.03 (0.080)	2.03 (0.080)	3.60 (0.142)	4.60 (0.18)	5.79 (0.228)
С	1.70 (0.067)	2.54 (0.100)	3.05 (0.120)	4.06 (0.160)	4.06 (0.160)	5.60 (0.220)	6.60 (0.26)	10.21 (0.402)
D	1.51 (0.020)	0.76 (0.030)	1.27 (0.050)	1.65 (0.065)	2.54 (0.100)	3.00 (0.118)	5.00 (0.20)	5.50 (0.217)

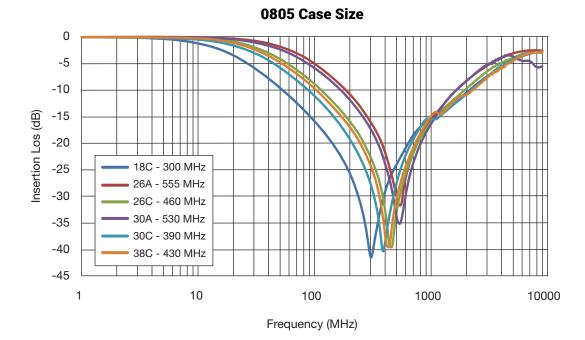
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Multilayer Varistors for Automotive Applications

FORWARD TRANSMISSION CHARACTERISTICS (S21)



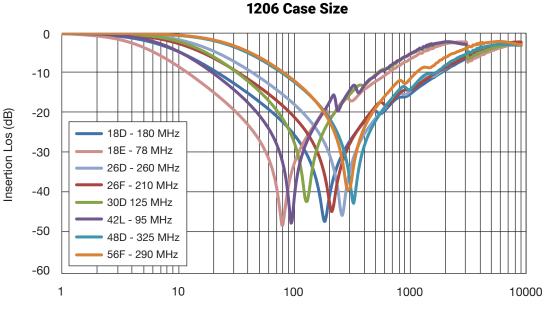


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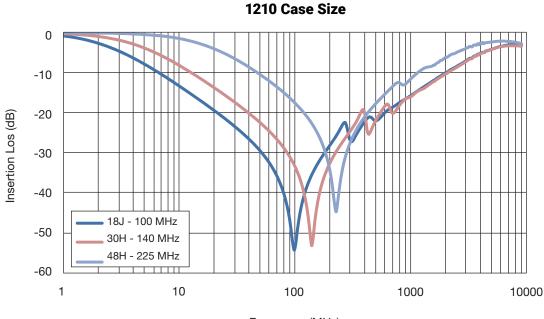


Multilayer Varistors for Automotive Applications

FORWARD TRANSMISSION CHARACTERISTICS (S21)



Frequency (MHz)

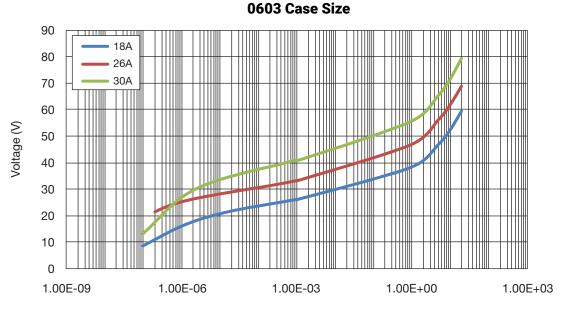


Frequency (MHz)

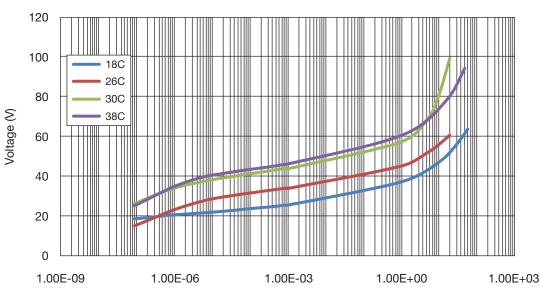
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V-I CHARACTERISTICS



Current (A)



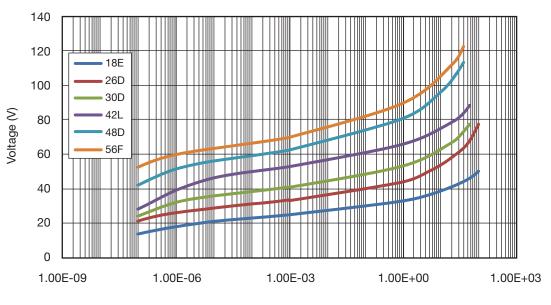
0805 Case Size

Current (A)

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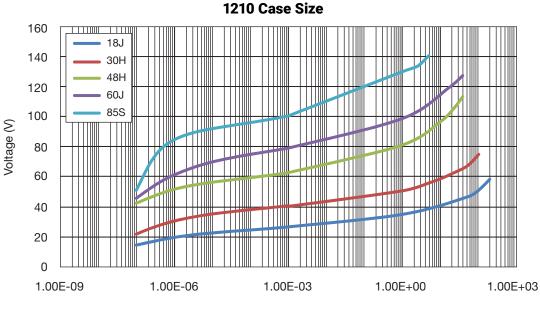


FORWARD TRANSMISSION CHARACTERISTICS (S21)



1206 Case Size

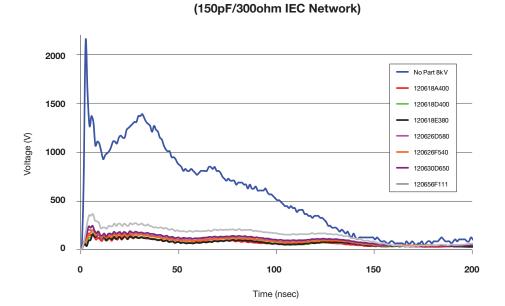








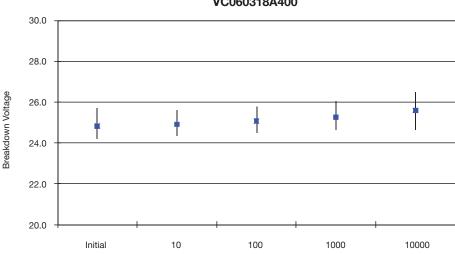
ESD V-I CHARACTERISTICS



8 kV ESD Vc

TYPICAL VOLTAGE AT 8 KV PULSE

8kV Pulse	Peak Voltage (V)	30ns Voltage (V)	100ns Voltage (V)
No Part (No Suppression)	2130	1370	517
120618A400	171	123	65
120618D400	177	133	66
120618E380	161	121	63
120626D580	203	155	88
102626F540	201	159	84
120630D650	249	177	106
120656F111	366	262	169



ESD 8 kV IEC 61000-4-2 150pF / 330Ω Resistor VC060318A400

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Pulses

Low Clamp Automotive TransGuard®

Multilayer Varistors with Low Clamping to Working Voltage Ratio

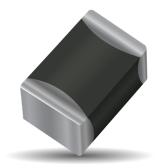


RoHS

COMPLIANT

MSL 1

Pb Free 260°C



GENERAL DESCRIPTION

KYOCERA AVX Low Clamping Automotive TransGuard[®] Multilayer Varistors are designed for applications where lower clamping to working voltage ratio is required. Parts are suitable for automotive, industrial and general applications. Parts are AEC-Q200 qualified.

They offer bi-directional ESD overvoltage protection as well as EMI/RFI attenuation in a single SMT package. This allows designers the ability to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device.

Compared to standard varistors, low clamp varistors exhibit lower breakdown and clamping to working voltage ratio and provide enhanced protection for components with higher sensitivity to overvoltage.

Available in 0603 to 1210 case size, 16-30 Vdc working voltage, energy rating 0.1 - 1.6J, load dump energy 0.7 - 3J, peak current 50 - 500A and capacitance 275 - 5000 pF. Operating temperature range is -55° C to $+125^{\circ}$ C. Parts offer excellent lead free solderability thanks to Ni Barrier/100% Sn termination.

GENERAL CHARACTERISTICS

- Operating Temp.: -55 to +125°C
- Working Voltage: 16-30 Vdc
- Case Size: 0603 1210

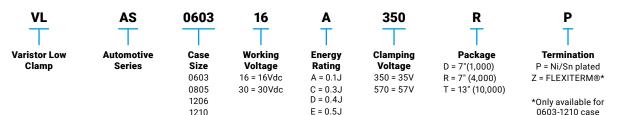
FEATURES & BENEFITS

- AEC-Q200 Qualified
- Low Clamping to Working Voltage ratio
- EMI/RFI attenuation

APPLICATIONS

- Infotainment
- ECU
- Displays
- Microcontrollers
- Low V_c to V_w ratio requirements

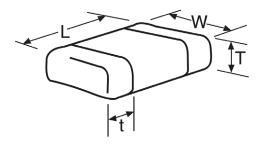
HOW TO ORDER



J = 1.6J

DIMENSIONS

Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
0603	1.60±0.15	0.80±0.15	0.90	0.35±0.15
	(0.063±0.006)	(0.031±0.006)	(0.035)	(0.014±0.006)
0805	2.01±0.20	1.25±0.20	1.02	0.71 max.
	(0.079±0.008)	(0.049±0.008)	(0.040)	(0.028 max.)
1206	3.20±0.20	1.60±0.20	1.02	0.94 max
	(0.126±0.008)	(0.063±0.008)	(0.040)	(0.037 max.)
1210	3.20±0.20	2.49±0.20	1.70	1.14 max.
	(0.126±0.008)	(0.098±0.008)	(0.067)	(0.045 max.)



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TDS-TS-0010 | REV 1

Multilayer Varistors with Low Clamping to Working Voltage Ratio

ELECTRICAL CHARACTERISTICS

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	V _{стур}	I _{vc}	I,	Ε _τ	ELD	I _P	Сар	V _{Jump}	P _{Diss. Max}
i art Number	Vdc	Vac	V	V	V	Α	μA	J	J	Α	рF	V	W
VLAS060316A350	16	11	19.5+12%	35	30	1	10	0.1	-	50	400	20	0.003
VLAS080516C350	16	11	19.5+12%	35	30	1	10	0.3	0.7	120	900	20	0.006
VLAS120616E350	16	11	19.5+12%	35	30	1	10	0.5	1.3	200	1400	20	0.010
VLAS121016J350	16	11	19.5+12%	35	30	2.5	10	1.6	3	500	5000	20	0.030
VLAS080522C440	22	17	27+13%	44	39	1	10	0.3	1	120	450	27.5	0.007
VLAS080530D570	30	21	34+13%	57	50	1	15	0.4	0.6	125	275	29	0.008
VLAS060334B650	34	30	39+13%	65	60	1	10	0.2	0.25	50	90	29	0.004
VLAS080534C650	34	30	39+13%	65	60	1	10	0.3	1	80	275	29	0.006
VLAS120634M650	34	30	39+13%	65	60	1	10	1	2	200	1100	29	0.02
VLAS121034R650	34	30	39+13%	65	60	5	10	1.7	4.5	300	1500	29	0.03

E,

 I_{P}

VW(DC) DC Working Voltage [V]

VW(AC) AC Working Voltage [V]

 $V_{_B}$ Breakdown Voltage [V @ 1mADC]

V_c Clamping Voltage [V @ IVC]

V_{CTVP} Typical Clamping Voltage [V @ IVC]

I_{vc} Test Current for VC

Maximum leakage current at the working voltage, $25^{\circ}C$ [µA]

Transient Energy	Rating [J,	10x1000µS]
------------------	------------	------------

Peak Current Rating [A, 8x20µS]

Cap Typical capacitance [pF] @ 1kHz and 0.5VRMS, 25°C

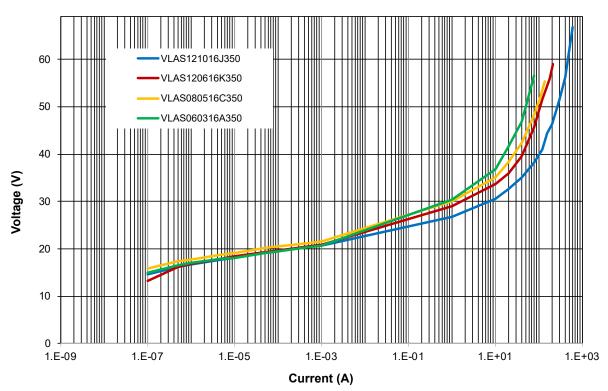
KYOCER3

V_{Jump} Jump Start (V)

P_{Diss Max} Max Power Dissipation (W)

V-I CHARACTERISTICS

 \mathbf{I}_{L}

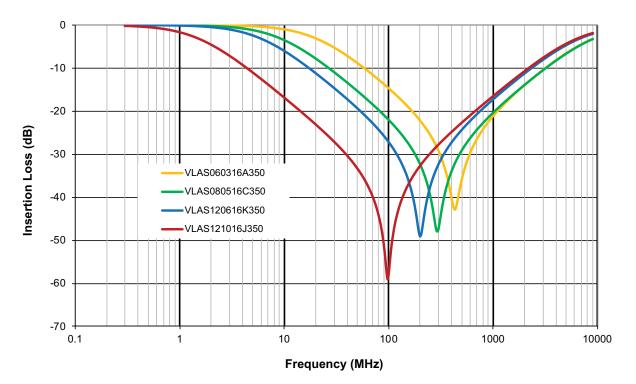


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Multilayer Varistors with Low Clamping to Working Voltage Ratio

FORWARD TRANSMISSION CHARACTERISTICS (S21)



TDS-TS-0010 | REV 1

StaticGuard

Multilayer Ceramic Transient Voltage Suppressors ESD Protection for CMOS, Bi Polar and SiGe Based Systems





GENERAL DESCRIPTION

The StaticGuard Series are low capacitance versions of the TransGuard and are designed for general ESD protection of CMOS, Bi-Polar, and SiGe based systems. The low capacitance makes these products suitable for use in high speed data transmission lines.

GENERAL **CHARACTERISTICS**

- **Operating Temperature:** -55°C to 125°C
- Working Voltage: ≤ 18Vdc
- Case Size: 0402, 0603, 0805, 1206

FEATURES

- Typical ESD failure voltage for CMOS and/or Bi Polar is ≥ 200V
- Low capacitance (<200pF) is required for highspeed data transmission.
- Low leakage current (IL) is necessary for battery operated equipment.
- 15kV ESD pulse (air discharge) per IEC 61000-4-2, Level 4, generates < 20 millijoules of energy.

API	PLI	CAT	IS
~			

- . Sensors CMOS
- SIGe based systems
- Higher speeed data lines
- Capacitance sensitive applications and more

HOW TO ORDER



18	
T	
Working	
Voltage	
18 = 18.0VDC	

Energy Rating A = 0.10 Joules V = 0.02 Joules X = 0.05 Joules

Х

500 Х Clamping Packaging Voltage (PCS/REEL) 500 = 50V D = 1,000* R = 4,000*

Termination P = Ni/Sn

Ρ

*Not available for 0402 **Only available for 0402

T = 10,000*

W = 10,000**

ELECTRIAL CHARACTERISTICS

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	E _T	I _P	Сар	Freq	Size
VC04LC18V500	≤18.0	≤14.0	25-40	50	1	10	0.02	15	40	М	0402
VC06LC18X500	≤18.0	≤14.0	25-40	50	1	10	0.05	30	50	М	0603
VC08LC18A500	≤18.0	≤14.0	25-40	50	1	10	0.1	30	80	М	0805
VC12LC18A500	≤18.0	≤14.0	25-40	50	1	10	0.1	30	200	K	1206

ľ

1

V_w(DC) DC Working Voltage [V]

 $V_w(AC)$ AC Working Voltage [V]

 $V_{\rm B}$ Typical Breakdown Votage (Min-Max) [V @ 1mA_{DC}, 25°C]

 V_{c} I_{vc}

Clamping Voltage [V @ I_{VC}] Test Current for V_c [A, 8x20µs]

Maximum leakage current at the working voltage, 25°C [µA]

E, Transient Energy Rating [J, 10x1000µS]

Peak Current Rating [A, 8x20µS]

Typical capacitance [pF] @ frequency specified Cap

and $0.5V_{RMS}$, 25°C, K = 1kHz, M = 1MHz

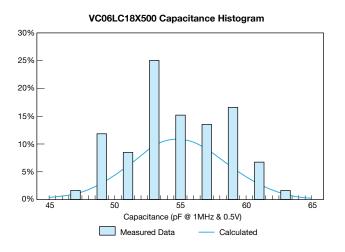
KIDCERE | The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

StaticGuard

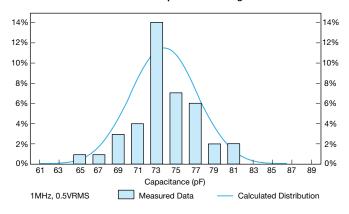
Multilayer Ceramic Transient Voltage Suppressors ESD Protection for CMOS, Bi Polar and SiGe Based Systems



TYPICAL PERFORMANCE DATA

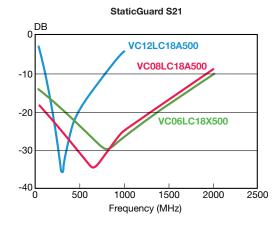


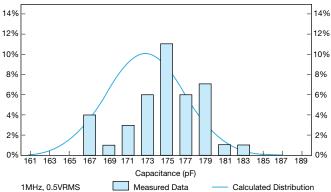
VC08LC18A500 Capacitance Histogram

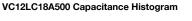


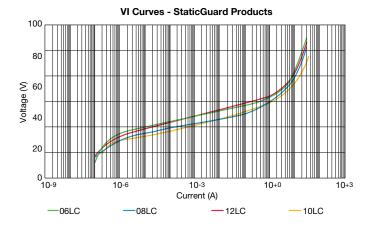
IEC 61000-4-2 (8 Kv Contact Discharge) 50 45 45 40 40 35 -30 1 10 100 1000 10000 Number of ESD Strikes

StaticGuard ESD RESPONSE









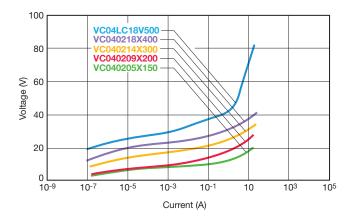
KYDEERE The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.



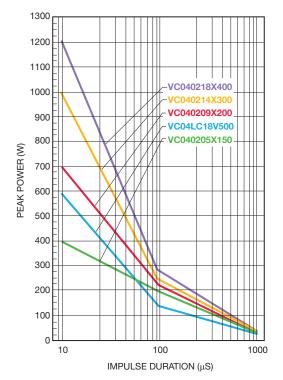
TYPICAL PERFORMANCE CURVES (0402 CHIP SIZE)

VOLTAGE/CURRENT CHARACTERISTICS

Multilayer construction and improved grain structure result in excellent transient clamping characteristics up to 20 amps peak current, while maintaining very low leakage currents under DC operating conditions. The VI curves below show the voltage/current characteristics for the 5.6V, 9V, 14V, 18V and low capacitance StaticGuard parts with currents ranging from parts of a micro amp to tens of amps.



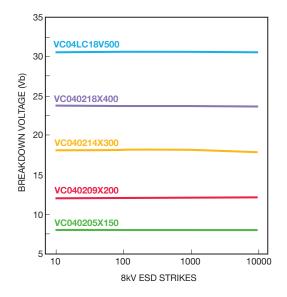
PEAK POWER VS PULSE DURATION



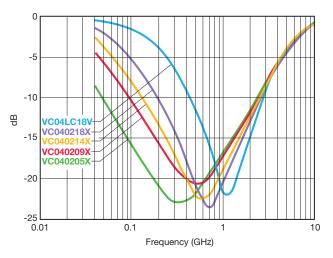
PULSE DEGRADATION

Traditionally varistors have suffered degradation of electrical performance with repeated high current pulses resulting in decreased breakdown voltage and increased leakage current. It has been suggested that irregular intergranular boundaries and bulk material result in restricted current paths and other non-Schottky barrier paralleled conduction paths in the ceramic. Repeated pulsing of TransGuard® transient voltage suppressors with 150Amp peak 8 x 20µS waveforms shows negligible degradation in breakdown voltage and minimal increases in leakage current.

ESD TEST OF 0402 PARTS



INSERTION LOSS CHARACTERISTICS



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StaticGuard Automotive Series

Multilayer Varistors for Automotive Applications





GENERAL DESCRIPTION

The StaticGuard Automotive Series are low capacitance versions of the TransGuard and are designed for general ESD protection of CMOS, Bi-Polar, and SiGe based systems. The low capacitance makes these products suitable for use in automotive CAN and LIN bus communication lines as well as other high speed data transmission applications requiring low capacitance protection.

GENERAL **CHARACTERISTICS**

- **Operating Temperature:** -55°C to 125°C
- Working Voltage: ≤ 18Vdc
- Case Size: 0402, 0603, 0805 •

FEATURES

- AEC Q200 Qualified
- ISO 7637 Pulse 1-3 capability
- Meet 27.5Vdc Jump Start requirements

R

= 10,000

10000

- Multi-strike capability
- Sub 1nS response to ESD strike •

APPLICATIONS

- CAN BUS
- LIN BUS
- CMOS
- Module interfaces
- Switches
- Sensors
- Camera modules
- Datalines
- Capacitance sensitive applications and more

HOW TO ORDER





LC

E_τ

1

Cap

P_{DISS}

Working Voltage 18 = 18.0VDC

Energy Rating A = 0.10 Joules V = 0.02 Joules X = 0.05 Joules

Clamping	Packagir
Voltage	(PCS/REE
150 = 18V	D = 1,000
200 = 22V	R = 4.000
300 = 32V	T = 10,000
400 = 42V	
500 = 50V	W = 0402





Ρ



COMPLIANT

ELECTRIAL CHARACTERISTICS

Part Number	VW (DC)	VW (AC)	VB	VC	IVC	IL	ET	IP	Сар	Freq	VJUMP	PDISS	Size
VCAS04LC18V500	≤18.0	≤14.0	25-40	50	1	10	0.02	15	40	M	27.5	0.0004	0402
VCAS06LC18X500	≤18.0	≤14.0	25-40	50	1	10	0.05	30	50	M	27.5	0.001	0603
VCAS08LC18A500	≤18.0	≤14.0	25-40	50	1	10	0.1	30	80	М	27.5	0.002	0805

V_w(DC) DC Working Voltage [V]

V_w(AC) AC Working Voltage [V] V_B V_C Typical Breakdown Votage [V @ 1mADC, 25°C]

Clamping Voltage [V @ IIVC]

Test Current for VC [A, 8x20µs] I_{vc} I, Maximum leakage current at the working

voltage, 25°C [µA]

Transient Energy Rating [J, 10x1000µS]

Peak Current Rating [A, 8x20µS]

Typical capacitance [pF] @ frequency specified

and $0.5V_{RMS}$, 25°C, M = 1MHz, K = 1kHz V_{Jump}

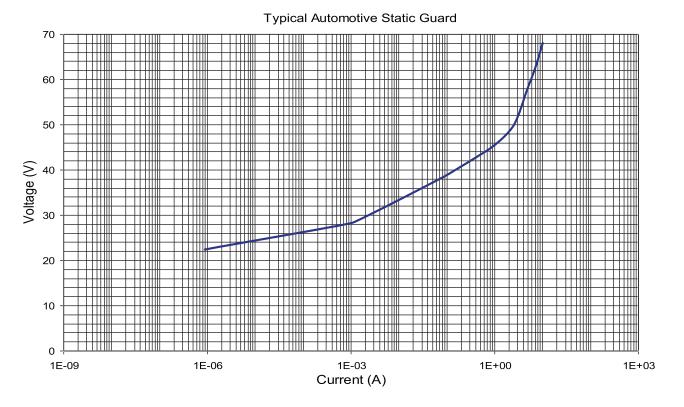
Jump Start [V, 5 min] Power Dissipation [W

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080916

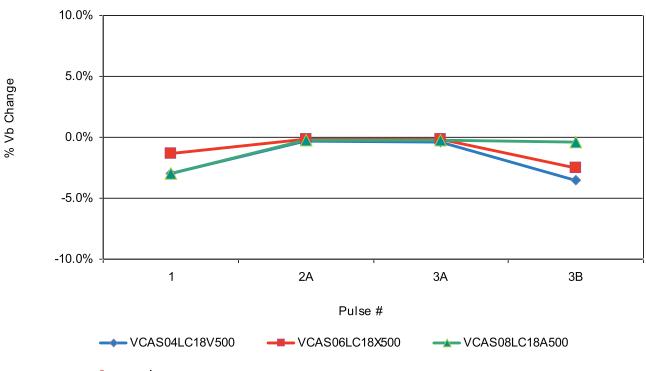
500 18 Х

VOLTAGE/CURRENT CHARACTERISTICS



ELECTRICAL TRANSIENT CONDUCTION



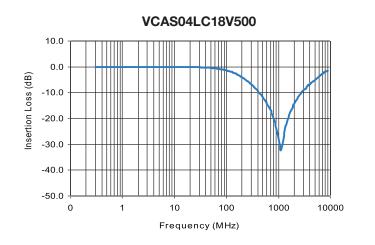


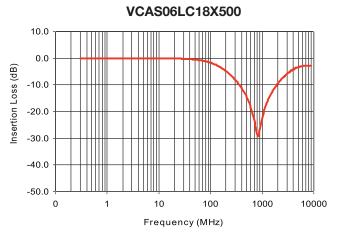
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080916



VOLTAGE/CURRENT CHARACTERISTICS





VCAS08LC18A500 10.0 0.0 Insertion Loss (dB) -10.0 -20.0 -30.0 -40.0 -50.0 0 10 100 1000 10000 1 Frequency (MHz)

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Miniature 0201 MLV

Multilayer Ceramic Transient Voltage Suppressors ESD Protection for any Circuit with Board Space Constraints





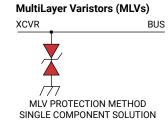
GENERAL CHARACTERISTICS

- Operating Temperature: -55°C to +125°C
- Working Voltage: 3.5Vdc 16Vdc
- Case Size: 0201

GENERAL DESCRIPTION

AVX 0201 Multi-Layer Varistors are designed for circuits where board space is a premium. 0201 MLV offer bidirectional ESD protection in the smallest package available today. The added advantage is EMI/RFI attenuation. 0201 MLV can replace 2 diodes and the EMC capacitor for a one chip solution.

The miniature size and one chip solution team to offer designers the best in ESD protection and EMI filtering in one ultra compact device.



TVS & EMI

APPLICATIONS

- Cell phone
- PDA
- Camera modules
- Embedded components
- Hearing aid
- Any circuit with space constraints

TVS Diodes XCVR BUS DIODE PROTECTION METHOD THREE COMPONENT SOLUTION

TVS & EMI

FEATURES

- Capacitance 15pF to 150pF
- Low VB Version
- Bi-Directional protection
- Fastest response time to ESD strikes

Pb Free 260°C

- Multi-strike capability
- Ultra compact 0201 case size

HOW TO ORDER

VC	AS	0201	09	v	300	W	Р	
Varistor Clamp	Automotive Series	Chip Size 0201	Working Voltage 09 = 9V	Energy Rating V = 0.02J	Capacitance 300 = 32V	Package W = 7" 10kpcs	Termination P = Ni Barrier/ 100% Sn (matte)	ROHS COMPLIANT MSL 1

Part Number V_w (DC) V_w (AC) V_R V, E₊ Cap I. L I.,, 4.76 min VC020103V101WP 50 0.02 10 100pF ±30% 3.5 20 14max 1 8.84 max 4.76 min VC020103V121WP 35 2.0 1 50 0.02 10 125pF ±30% 14max 8.84 max 4.76 min VC020103V151WP 3.5 2.0 14max 1 50 0.02 10 150pF ±30% 8.84 max 10.0 min VC020105T150WP 0.01 2 15pF ±30% 5.6 4.0 35max 1 50 15.6 max 10.0 min VC020105T330WP 0.01 4 33pF ±30% 5.6 4.0 35max 1 50 15.6 max 10.0 min VC020105T500WP 5.6 4.0 35max 1 50 0.01 5 50pF ±30% 15.6 max 10.0 min VC020105T101WP 5 100pF ±30% 5.6 4.0 35max 1 50 0.01 15.6 max 6.4 min VC020105V101WP 5.6 40 17max 1 50 0.02 4 100pF ±30% 9.6 max 9.6 min VC020107V101WP 7.0 5.6 20max 1 50 0.02 5 100pF ±30% 14.4 max 21.7 min VC020116T150WP 16 11 45max 1 50 0.01 1 15pF ±30% 29.3 max

 $V_w(DC)$ DC Working Voltage [V]

- V_w(AC) AC Working Voltage [V]
- V_B Breakdown Votage [V @ 1mADC]
- V_c Clamping Votage [V @ IVC]

 I_{vc} Test Current for VC [A, 8x20µS]

- Maximum leakage current at the working voltage [μ A]
- $E_{_T}$ Transient Energy Rating [J, 10x1000µS]
 - Peak Current Rating [A, 8x20µS]
- Cap Capacitance [pF] @ 1KHz specified and 0.5VRMS

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I,

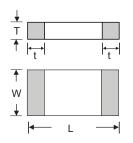
I_P

Miniature 0201 MLV

Multilayer Ceramic Transient Voltage Suppressors ESD Protection for any Circuit with Board Space Constraints

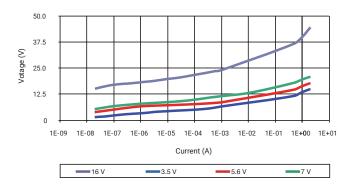


PHYSICAL DIMENSIONSL: mm (inches)

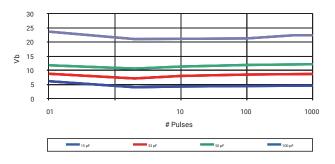


Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Terminal
0201	0.60±0.03	0.30±0.03	0.33 max.	0.15±0.05
0201	(0.024±0.001)	(0.011±0.001)	(0.013 max.)	(0.006±0.002)

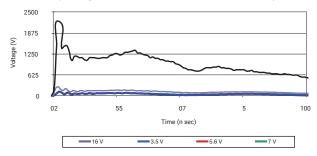
VOLTAGE/CURRENT CHARACTERISTICS



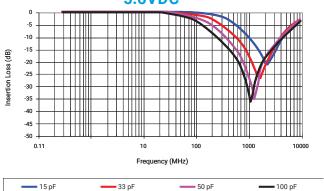
TYPICAL 8 KV ESD PERFORMANCE (150pF / 3000hm IEC Network)



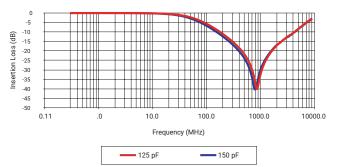
8 kV CONTACTED ESD PULSE 1 Mohm Input (150pF / 300ohm IEC Network)



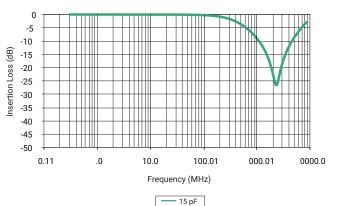
TRANSMISSION CHARACTEROSTICS 5.6VDC



3.5VDC





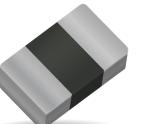


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Miniature 0201 Automotive MLV

ESD Protection for Automotive Circuits with Board Space Constraints

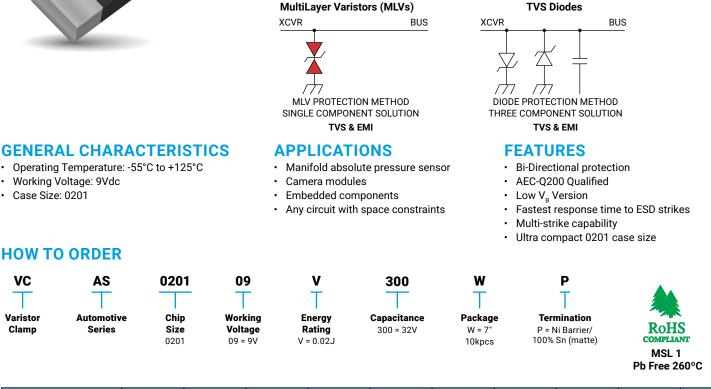




GENERAL DESCRIPTION

KYOCERA AVX 0201 Multi-Layer Automotive Varistors are designed for circuits where board space is a premium. 0201 MLV offer bi-directional ESD protection in the smallest package available today. The added advantage is EMI/RFI attenuation. 0201 MLV can replace 2 diodes and the EMC capacitor for a one chip solution.

The miniature size and one chip solution team to offer designers the best in ESD protection and EMI filtering in one ultra compact device.



	Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I _L	E _T	I _P	Сар	Cap tol
	Part Number	Vdc	Vac	v	v	Α	μA	J	Α	pF	
Î	VCAS020109V300WP	9.0	6.4	16.5±10%	32	1	10	0.02	5	30	±40%

I,

E_τ

I,

V_w(DC) DC Working Voltage [V]

•

.

VC

Varistor

Clamp

Case Size: 0201

V_w(AC) AC Working Voltage [V]

V_B Breakdown Votage [V @ 1mADC]

 V_{c} Clamping Votage [V @ IVC]

Test Current for VC [A, 8x20µS] I_{vc}

Maximum leakage current at the working voltage [µA]

Transient Energy Rating [J, 10x1000µS]

Peak Current Rating [A, 8x20µS]

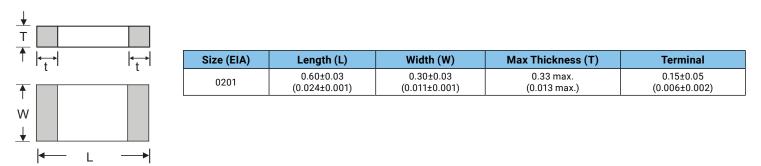
Cap Capacitance [pF] @ 1KHz specified and 0.5V_{RMS}

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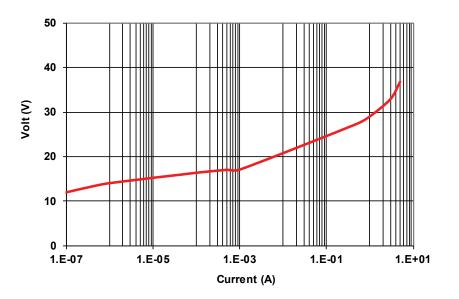
Miniature 0201 Automotive MLV

ESD Protection for Automotive Circuits with Board Space Constraints

PHYSICAL DIMENSIONSL: mm (inches)



VOLTAGE/CURRENT CHARACTERISTICS



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MultiGuard[®] Series

(2&4 Elements) Multilayer Ceramic Transient Voltage Suppression Arrays – ESD Protection for CMOS and Bi Polar Systems

GENERAL DESCRIPTION





GENERAL CHARACTERISTICS

- **Operating Temperature:** -55°C to 125°C
- Working Voltage: 5.6Vdc-18Vdc
- Case Size: 0405 2x Array 0508 2x Array 0612 4x Array
- Energy: 0.02-0.1J
- Peak Current: 15-30A

HOW TO ORDER

MG 04 14 300 т 2 Α **MultiGuard®** Case Configuration Style Working **Energy Rating** Clamping Packaging Size Voltage Voltage 2 = 2 Elements S = Standard Construction A = 0.10 Joules (PCS/REEL) 04 = 0405 4 = 4 Elements 05 = 5.6VDC V = 0.02 Joules 150 = 18V L = Low Capacitance D = 1,000

05 = 0508 06 = 0612

09 = 9.0VDC 14 = 14.0VDC 18 = 18.0VDC

protection and LCD driver protection for portable computing devices.

X = 0.05 Joules

200 = 22V 300 = 32V 400 = 42V 500 = 50V R = 4,000 T = 10,000

Ρ Termination Finish P = Ni/Sn (Plated)

APPLICATIONS

placing only one chip, makes MultiGuard® the TVS component of choice for ESD protection of I/O lines in portable equipment and programming ports in cellular phones. Other applications include differential data line protection, ASIC

- I/O Lines
- Portable equipment
- · Cell phones, radios
- · Programming ports
- Differential data lines
- ASIC
- LCD driver

KYOCERA AVX Transient Voltage Suppression (TVS) Arrays address six trends in today's electronic circuits: (1) mandatory ESD protection, (2) mandatory EMI control, (3) signal integrity improvement, (4) PCB downsizing, (5) reduced component placement costs, and (6) protection from induced slow speed transient voltages and currents. KYOCERA AVX MultiGuard[®] products offer numerous advantages, which include a faster turn-on-time (<1nS), repetitive strike capability, and space savings. In some cases, MultiGuard® consumes less than 75% of the PCB real estate required for the equivalent number of discrete chips. This size advantage, coupled with the savings associated with

FEATURES

Space saving

Bi-Directional protection

2 and 4 element arrays

Multiple lines protection

Pick & place cost savings

Very fast response time to ESD strikes

EMI/RFI filtering in the off-state

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MultiGuard® Series

(2&4 Elements) Multilayer Ceramic Transient Voltage Suppression Arrays – ESD Protection for CMOS and Bi Polar Systems

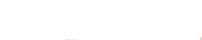
ELECTRICAL CHARACTERISTICS PER ELEMENT

	Part Number	Working Voltage (DC)	Working Voltage (AC)	Breakdown Voltage	Clamping Voltage	Test Current For V _c	Maximum Leakage Current	Transient Energy Rating	Peak Current Rating	Typical Cap
	MG042S05X150	5.6	4.0	8.5±20%	18	1	35	0.05	15	300
2 Element 0405 Chip	MG042L14V400	14.0	10.0	18.5±12%	32	1	15	0.02	15	45
Chip	MG042L18V500	18.0	14.0	28.0±10%	50	1	10	0.02	15	40
	MG052S05A150	5.6	4.0	8.5±20%	18	1	35	0.10	30	825
	MG052S09A200	9.0	6.4	12.7±15%	22	1	25	0.10	30	550
2 Element 0508 Chip	MG052S14A300	14.0	10.0	19.5±12%	32	1	15	0.10	30	425
Cliip	MG052S18A400	18.0	14.0	25.5±10%	42	1	10	0.10	30	225
	MG052L18X500	≤18.0	≤14.0	28.0±10%	50	1	10	0.10	20	50
	MG064S05A150	5.6	4.0	8.5±20%	18	1	35	0.10	30	825
	MG064S09A200	9.0	6.4	12.7±15%	22	1	25	0.10	30	550
4 Element 0612 Chip	MG064S14A300	14.0	10.0	19.5±12%	32	1	15	0.10	30	425
Cilip	MG064S18A400	18.0	14.0	25.5±10%	42	1	10	0.05	15	120
	MG064L18X500	≤18.0	≤14.0	28.0±10%	50	1	10	0.10	20	75

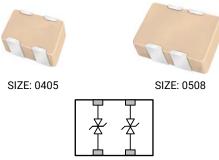
^L Termination Finish Code

└─ Packaging Code

- V_w (DC) DC Working Voltage (V)
- V_w (AC) AC Working Voltage (V)
- V_{B} Typical Breakdown Voltage
- V_{B} (V@1mA_{DC})
- $V_{\rm B}$ Tol VB Tolerance is ± from Typical Value
- V_c Clamping Voltage (V @ I_{vc})
- $I_{_{VC}}$ _ Test Current for VC (A, 8x20 μ S)
- $I_{_{\rm L}}$ Maximum Leakage Current at the Working Voltage (µA)
- E_{T} Transient Energy Rating (J, 10x1000µS)
- I_{p} Peak Current Rating (A, 8x20µS)
- Cap Typical Capacitance (pF) @ 1MHz and 0.5 $\rm V_{\rm \tiny RMS}$

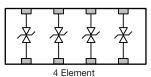


COMPONENT LAYOUT



2 Element



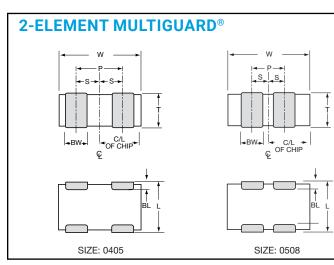


MultiGuard[®] Series

(2&4 Elements) Multilayer Ceramic Transient Voltage Suppression Arrays - ESD Protection for CMOS and Bi Polar Systems

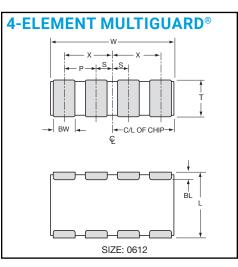


PHYSICAL DIMENSIONS AND PAD LAYOUT



BW

0.36+0.10



0612 4 ELEMENT DIMENSIONS

mm (inches)

L	W	Т	BW	BL	Р	Х	S
1.60±0.20 (0.063±0.008)	3.20±0.20 (0.126±0.008)	1.22 MAX (0.048 MAX)	0.41±0.10 (0.016±0.004)	0.18 ^{+0.25} -0.08 (0.007 ^{+.010} 003)	0.76 REF (0.030 REF)	1.14±0.10 (0.045±0.004)	0.38±0.10 (0.015±0.004)

mm (inches)

0508 2 ELEMENT DIMENSIONS

0.66 MAX

(0.026 MAX)

0405 2 ELEMENT DIMENSIONS

W

 1.37 ± 0.15

(0.054±0.006)

(0.079

1.00+0.15

(0.039±0.006)

1.25±0.20 (0.049±0.008)

LEMEN	EMENT DIMENSIONS mm (inches						
W	Т	BW	BL	Р	S		
2.01±0.20 (0.079±0.008)	1.02 MAX (0.040 MAX)	0.41±0.1 (0.016±0.004)	0.18 ^{+0.25} -0.08 (0.007 ^{+.010} 003	0.76 REF (0.030 REF)	0.38±0.10 (0.015±0.004)		

(0.014±0.004) (0.008±0.004)

BI

0.20+0.10

PAD LAYOUT DIMENSIONS

mm (inches)

mm (inches)

064 RFF

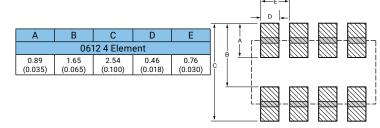
(0.025 REF)

S

0.32±0.10

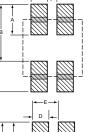
(0.013±0.004)

PAD LAYOUT DIMENSIONS



Α	В	С	D	E		
0405 2 Element						
0.46 (0.018)	0.74 (0.029)	1.20 (0.047)	0.38 (0.015)	0.64 (0.025)		

D E	С	A B						
0508 2 Element								
0.46 0.76	2.16	1.27	0.89					
i) (0.018) (0.03	(0.085)	(0.050)	(0.035)					



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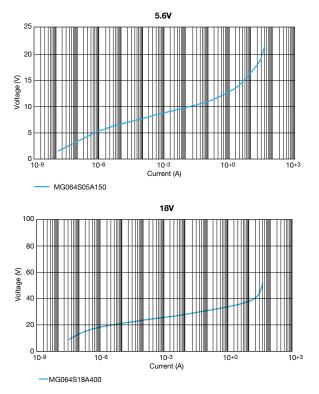
MultiGuard[®] Series

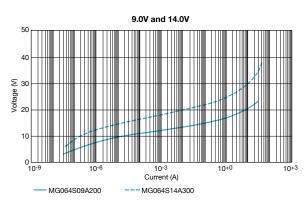
(2&4 Elements) Multilayer Ceramic Transient Voltage Suppression Arrays - ESD Protection for CMOS and Bi Polar Systems

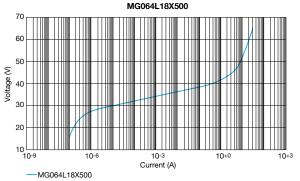


TYPICAL PERFORMANCE CURVES – VOLTAGE/CURRENT CHARACTERISTICS

Multilayer construction and improved grain structure result in excellent transient clamping characteristics in excess of 30 amps (20 amps on MG064L18X500) peak current while maintaining very low leakage currents under DC operating conditions. The VI curves below show the voltage/ current characteristics for the 5.6V, 9V, 14V and 18V parts with currents ranging from fractions of a micro amp to tens of amps.

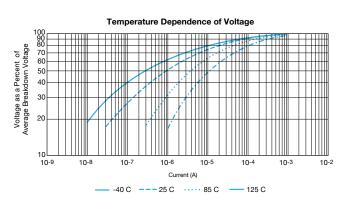


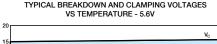


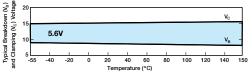


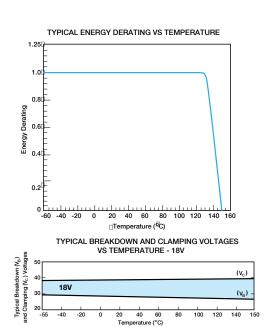
TYPICAL PERFORMANCE CURVES – TEMPERATURE CHARACTERISTICS

MultiGuard® suppressors are designed to operate over the full temperature range from -55°C to +125°C.









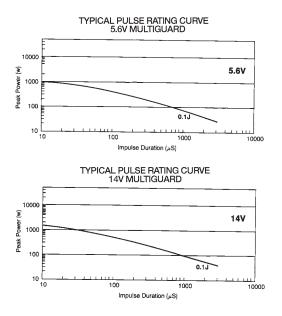
KIDCERE | The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order. 1:XVXX

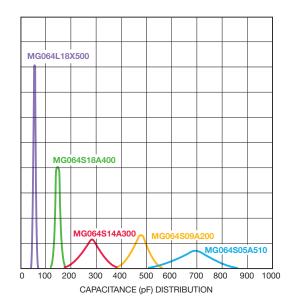
MultiGuard® Series

(2&4 Elements) Multilayer Ceramic Transient Voltage Suppression Arrays – ESD Protection for CMOS and Bi Polar Systems

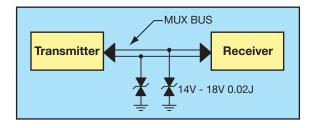


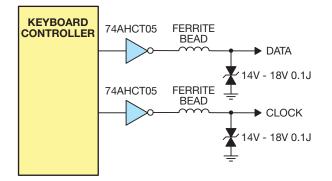
TRANSIENT VOLTAGE SUPPRESSORS – TYPICAL PERFORMANCE CURVES





APPLICATION





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UltraGuard[®] Series

ESD Protection for Low Leakage Requirements

GENERAL DESCRIPTION

Faster semiconductor clock speeds and an increasing reliance on batteries as power sources have resulted in the need for varistors that exhibit very low leakage current. The UltraGuard® (UG) Series of KYOCERA AVX Transient Voltage Suppressors address this problem.

The UG[®] Series is the ideal transient protection solution for high clock speed integrated circuit application, battery-operated device, backlit display, medical/instrument application, low voltage power conversion circuits and power supervisory chip sets. In addition, UltraGuard[®] has low leakage characteristics that are also suitable for optic circuits like LDD, SerDes, and laser diodes.

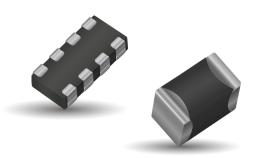




レム ムー 2-Element Arrays (0405 and 0508)



Element Arra (0612)



🔇 КУОСЕRа

GENERAL CHARACTERISTICS

- Operting Teperature: -55°C to +125°C
- Working Voltage: 3.0dc 32Vdc
- Case Size: 0402-1206
 0405 2xArray, 0508 2xArray
 0612 4xArray
- Leakage: 1µA Max
- Energy: 0.02-1.2J
- Peak Current: 80-200A
- Typ Cap: 30-5000pF

FEATURES

- Bi-Directional protection
- Ultra low leakage 1uA max
- Multi-strike capability
- Single, 2 and 4 element components
- Compact footprint
- EMI/RFI filtering

0150 = 15.0VDC

APPLICATIONS

- Battery operated devices
- High clock speed IC
- Low voltage power conversion
- Power supervisory chip sets
- Optic circuits (LDD, SerDes
- Laser diodes
- Any circuit with low leakage requirements

HOW TO ORDER

VC	UG	04	0180	L	1	W	Р
		· T		Т	Т	Т	Т
Surface Mount Cl		04 = 0402 06 = 0603	Maximum Working Voltage 0030 = 3.0VDC 0050 = 5.0VDC 0075 = 7.5VDC 0100 = 10.0VDC 0150 = 15.0VDC 0180 = 18.0VDC 0320 = 32.0VDC	Capacitance L = Low H = High	No. of Elements	Packaging (pieces per reel) D = 1,000 (7" reel) R = 4,000 (7" reel) T = 10,000 (13" reel) W = 10,000 (7" reel, 0402 only)	Termination Finish P = Ni/Sn (Plated)
MG Array	UG Series Low Leakage Series		0150 Maximum Working Voltage 0030 = 3.0VDC 0050 = 5.0VDC 0075 = 7.5VDC 0100 = 10.0VDC	L Capacitance L = Low H = High	4 No. of Elements 2 = 2 Elements 4 = 4 Elements	W Packaging (pieces per reel) D = 1,000 (7" reel) R = 4,000 (7" reel) T = 10,000 (13" reel)	P Termination Finish P = Ni/Sn (Plated)

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UltraGuard® Series

ESD Protection for Low Leakage Requirements

Part Number	vw	vw	VB (Min)	VC	IVC	IL	ET	IP	Сар	Freq	Case	Elements
MGUG040030L2	3.0	2.3	6.8	18	1	1	0.05	15	300	М	0405	2
MGUG050030L2	3.0	2.3	17.2	32	1	1	0.1	30	425	М	0508	2
MGUG060030L4	3.0	2.3	17.2	32	1	1	0.1	30	425	М	0612	4
VCUG040030L1	3.0	2.3	6.8	18	1	1	0.05	20	175	М	0402	1
VCUG060030L1	3.0	2.3	6.8	18	1	1	0.1	30	750	К	0603	1
VCUG080030H1	3.0	2.3	6.8	18	1	1	0.3	120	3000	К	0805	1
VCUG080030L1	3.0	2.3	6.8	18	1	1	0.1	40	1100	K	0805	1
VCUG120030H1	3.0	2.3	6.8	18	1	1	0.4	150	3000	K	1206	1
VCUG120030L1	3.0	2.3	6.8	18	1	1	0.1	40	1200	K	1206	1
MGUG040050L2	5.0	3.5	20	50	1	1	0.02	15	40	M	0405	2
MGUG050050L2	5.0	3.5	17.2	32	1	1	0.1	30	425	M	0508	2
MGUG060050L4	5.0	3.5	17.2	32	1	1	0.1	30	425	M	0612	4
VCUG040050L1	5.0 5.0	3.5 3.5	10.8	22 22	1	1	0.05	20	175	M	0402	1
VCUG060050L1	5.0	3.5	10.8	22	1	1	0.1	30 40	550 750	к К	0603	1
VCUG080050L1	5.0	3.5	10.8 16.3		1	1	0.1	40 150	1050	K K	0805	1
VCUG120050H1 VCUG120050L1	5.0	3.5	16.3	32 32	1	1	0.4	40	600	K K	1206 1206	1
	7.5	5.3	20	50	1	1	0.02	40 15	40	M	0405	2
MGUG040075L2			-		1			-	-			
MGUG050075L2	7.5	5.3	17.2	32	L	1	0.1	30	425	M	0508	2
MGUG060075L4	7.5	5.3	17.2	32	1	1	0.1	30	425	M	0612	4
VCUG040075L1	7.5	5.3	16.3	32	1	1	0.05	20	85	M	0402	1
VCUG060075L1	7.5	5.3	16.3	32	1	1	0.1	30	350	K	0603	1
VCUG080075H1	7.5	5.3	16.3	32		1	0.3	120	900	K	0805	1
VCUG080075L1	7.5	5.3	16.3	32	1	1	0.1	40	325	K	0805	1
VCUG120075H1	7.5	5.3	16.3	32	1	1	0.4	150	1050	К	1206	1
VCUG120075L1	7.5	5.3	16.3	32	1	1	0.1	40	600	К	1206	1
MGUG040100L2	10	7.1	20	50	1	1	0.02	15	40	М	0405	2
MGUG050100L2	10	7.1	23	42	1	1	0.1	30	225	М	0508	2
MGUG060100L4	10	7.1	23	42	1	1	0.1	15	120	M	0612	4
VCUG040100L1	10	7.1	23	42	1	1	0.05	20	65	M	0402	1
VCUG060100L1	10	7.1	23	42	1	1	0.1	30	150	K	0603	1
VCUG080100H1	10	7.1	23	42	1	1	0.3	100	550	K	0805	1
VCUG080100L1	10	7.1	23	42	1	1	0.1	30	225	K	0805	1
VCUG120100H1	10 10	7.1	23 23	42 42	1	1	0.4	150 30	900	K	1206	1
VCUG120100L1									350	K	1206	
MGUG040150L2	15 15	11 11	20	50	1	1	0.02	15	50	M	0405	2
MGUG050150L2 MGUG060150L4	15	11	20 20	50 50	1	1	0.1	20 20	50 75	M	0508 0612	2 4
VCUG040150L1	15	11	20	50	1	1	0.05	20	40	M	0612	4
VCUG060150L1	15	11	31.1	60	1	1	0.02	30	155	K	0402	1
VCUG080150L1 VCUG080150H1	15	11	31.1	60	1	1	0.1	100	250	K K	0803	1
VCUG080150H1	15	11	31.1	60	1	1	0.3	30	120	K	0805	1
VCUG120150H1	15	11	31.1	60	1	1	0.1	120	500	K	1206	1
VCUG040180L1	13	14	28	55	1	1	0.4	120	300	M	0402	1
VCUG080320L1	32	22	42.3	77	1	1	0.03	40	50	M	0402	1
VC00000320L1			72.5				0.1			191	0000	

L Termination Finish Code

-Packaging Code

V _{CIR} (DC)	DC Circuit Voltage (V)	
11 (10)		

V_{CIR} (AC) AC Circuit Voltage (V)

Cap Req Standard or Low I_L Maximum Leaka

Maximum Leakage Current at the Circuit Voltage (μA)

Cap Typical Capacitance (pF) @ frequency specified and 0.5 Vrms

Freq Frequency at which capacitance is measured (K = 1kHz, M = 1MHz)

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KY<u>OCERa</u>

UltraGuard® Series

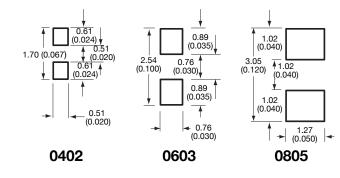
ESD Protection for Low Leakage Requirements

PHYSICAL DIMENSIONS

	0402 Discrete	0603 Discrete	0805 Discrete
Length	1.00 ±0.10 (0.040 ±0.004)	1.60 ±0.15 (0.063 ±0.006)	2.01 ±0.20 (0.079 ±0.008)
Width	0.50 ±0.10 (0.020 ±0.004)	0.80 ±0.15 (0.032 ±0.006)	1.25 ±0.20 (0.049 ±0.008)
Thickness	0.60 Max. (0.024 Max.)	0.90 Max. (0.035 Max.)	1.02 Max. (0.040 Max.)
Term Band Width	0.25 ±0.15 (0.010 ±0.006)	0.35 ±0.15 (0.014 ±0.006)	0.71 Max. (0.028 Max.)

	0405 Array	0508 Array	0612 Array
Length	1.00 ±0.15 (0.039 ±0.006)	1.25 ±0.20 (0.049 ±0.008)	1.60 ±0.20 (0.063 ±0.008)
Width	1.37 ±0.15 (0.054 ±0.006)	2.01 ±0.20 (0.079 ±0.008)	3.20 ±0.20 (0.126 ±0.008)
Thickness	0.66 Max. (0.026 Max.)	1.02 Max. (0.040 Max.)	1.22 Max. (0.048 Max.)
Term Band Width	0.36 ±0.10 (0.014 ±0.004)	0.41 ±0.10 (0.016 ±0.004)	0.41 ±0.10 (0.016 ±0.004)

SOLDER PAD DIMENSIONS



0612 4-Element Array

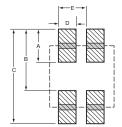
Α	В	С	D	E
0.89	1.65	2.54	0.46	0.76
(0.035)	(0.065)	(0.100)	(0.018)	(0.030)

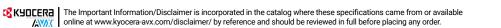
2-Element Arrays

	Α	В	С	D	E
0405	0.46	0.74	1.20	0.38	0.64
	(0.018)	(0.029)	(0.047)	(0.015)	(0.025)
0508	0.89	1.27	2.16	0.46	0.76
	(0.035)	(0.050)	(0.085)	(0.018)	(0.030)

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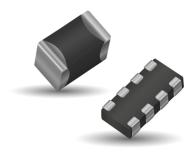


101320

mm (inches)

mm (inches)





GENERAL DESCRIPTION

The CAN BUS and FlexRay varistor is a zinc oxide (ZnO) based ceramic semiconductor device with non-linear voltage-current characteristics (bi-directional) similar to back-to-back Zener diodes and an EMC capacitor in parallel (see equivalent circuit model). They have the added advantage of greater current and energy handling capabilities as well as EMI/RFI attenuation. Devices are fabricated by a ceramic sintering process that yields a structure of conductive ZnO grains surrounded by electrically insulating barriers, creating varistor like behavior.

KYOCERA AVX Communication Bus Varistors offer the advantages of large in-rush current capability, low capacitance to minimize signal distortion, fast turn on time to conservatively clamp the energy before its maximum and off state EMI filtering through their bulk capacitance. These features coupled with an extremely low FIT rate and excellent process capability make an ideal device for today's automotive or general circuit protection.

GENERAL CHARACTERISTICS

- Operting Teperature: -55°C to +125°C
- Working Voltage: ≤18Vdc
- Case Size: 0402, 0603 0405 2xArray
 - 0612 4xArray

FEATURES

- Compact footprint
- High ESD capability (25kV)
- High Inrush Current (8x20µs)
- EMI/RFI Attenuation
- Low Capacitance/Low Insertion Loss
- Very Fast Response Time

Termination

P = Ni/Sn

(Plated)

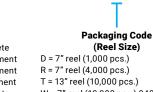
- High Reliability <0.1 FIT
- AEC-Q200 Qualified

APPLICATIONS

- Communication Bus: CAN Bus, FlexRay, etc.
- General I/O Protocols
- Keyboard Interfaces
- Datalines
- Sensors
- Capacitance sensitive applications and more

HOW TO ORDER

CAN	0001
Style	Case Size
CAN = CAN BUS	0001 = 0603 Discrete
FLX = FlexRay	0002 = 0405 2-Elemer
	0003 = 0405 2-Elemer
	0004 = 0612 4-Elemer
	0005 = 0402 Discrete
	0007 = 0603 Discrete



W = 7" reel (10,000 pcs.) 0402 only

D



PERFORMANCE CHARACTERISTICS

Part Number	V _w (DČ)	V _w (AČ)	V _B	V _c	I _{vc}	I _L	Ε _τ	I _P	Сар	Freq	VJump	PDiss Max	Case	Elements
CAN0001	≤ 18	≤ 14	120	225	1	2	0.015	4	22 Max	М	27.5	0.003	0603	1
CAN0002	≤ 18	≤ 14	70	145	1	2	0.015	4	22 Max	М	27.5	0.003	0405	2
CAN0003	≤18	≤14	28.5	50	1	5	0.02	15	50 Max	М	27.5	0.0008	0405	2
CAN0004	≤ 18	≤ 14	100	180	1	2	0.015	4	22 Max	М	27.5	0.003	0612	4
CAN0005	≤ 18	≤ 14	33	55	1	2	0.05	10	37 Max	М	27.5	0.01	0402	1
CAN0007	≤ 32.0	≤ 25.0	61	120	1	5	0.05	5	15 Max	М	27.5	0.003	0603	1
FLX0005	≤ 18	≤ 14	26	45	1	5	0.02	4	17 Max	М	27.5	0.004	0402	1

I,

E_τ

 I_{P}

Сар

Termination Finish Code
 Packaging Code

r dokuging oode

DC Working Voltage (V)

V_w (DC)

I_{vc}

- V_w^(AC) AC Working Voltage (V) , Typical Breakdown Voltage
- V_B (V @ 1mADC)
- V_c Clamping Voltage (V @ IVC)
 - Test Current for VC (A, 8x20µS)

Maximum Leakage Current at the Working Voltage (μ A)

Transient Energy Rating (J, 10x1000µS)

Peak Current Rating (A, 8x20µS)

Maximum Capacitance (pF) @ 1 MHz and 0.5Vrms

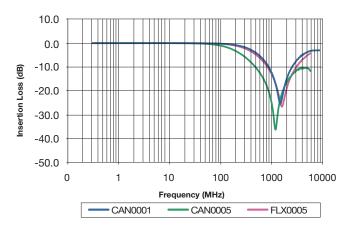
Temp Range -55°C to +125°C

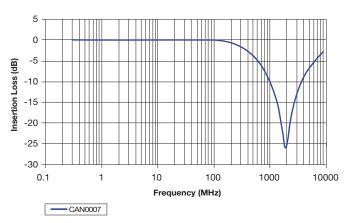
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TDS-TS-0012 | Rev 1



S21 CHARACTERISTICS





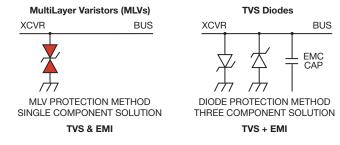
Typical Pulse Rating Curve

Pulse Duration (µS)

1000

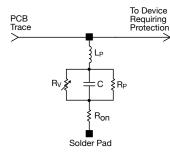
10000

TYPICAL MLV IMPLEMENTATION



EQUIVALENT CIRCUIT MODEL

Discrete MLV Model



Where:

 R_{v} = Voltage Variable resistance (per VI curve)

TYPICAL PULSE RATING CURVE

R ≥ 1012 Ω

10L

Peak Power (W) 10 Lou

С = defined by voltage rating and energy level

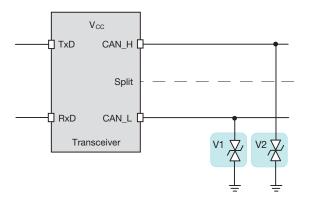
100

 R_{on} = turn on resistance

= parallel body inductance L

TDS-TS-0012 | Rev 1

TYPICAL CAN BUS IMPLEMENTATION SCHEME

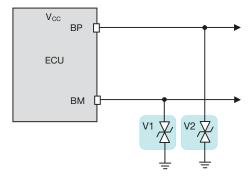


TYPICAL FLEX RAY IMPLEMENTATION SCHEME

KYOCERa

mm (inches)

mm (inches)



PHYSICAL DIMENSIONS

	0402 D iscrete	0603 Discrete	0405 Array	0612 Array
Length	1.00 ±0.10 (0.040 ±0.004)	1.60 ±0.15 (0.063 ±0.006)	1.00 ±0.15 (0.039 ±0.006)	1.60 ±0.20 (0.063 ±0.008)
Width	0.50 ±0.10 (0.020 ±0.004)	0.80 ±0.15 (0.032 ±0.006)	1.37 ±0.15 (0.054 ±0.006)	3.20 ±0.20 (0.126 ±0.008)
Thickness	0.60 Max. (0.024 Max.)	0.90 Max. (0.035 Max.)	0.66 Max. (0.026 Max.)	1.22 Max. (0.048 Max.)
Term Band Width	0.25 ±0.15 (0.010 ±0.006)	0.35 ±0.15 (0.014 ±0.006)	0.36 ±0.10 (0.014 ±0.004)	0.41 ±0.10 (0.016 ±0.010)

SOLDER PAD DIMENSIONS

¥

0402, 0603

Discrete

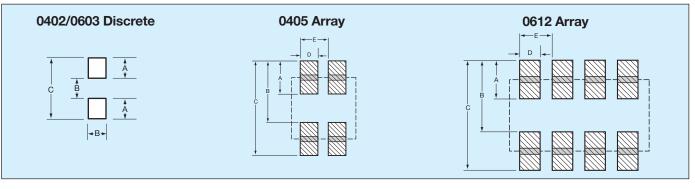
X

0612

Array

0405

Array



	Α	В	С	D	E
0402 Discrete	0.61 (0.024)	0.51 (0.020)	1.70 (0.067)	-	-
0603 Discrete	0.89 (0.035)	0.76 (0.030)	2.54 (0.100)	-	-
0405 Array	0.46 (0.018)	0.74 (0.029)	1.12 (0.047)	0.38 (0.015)	0.64 (0.025)
0612 Array	0.89 (0.035)	1.65 (0.065)	2.54 (0.100)	0.46 (0.018)	0.76 (0.030)

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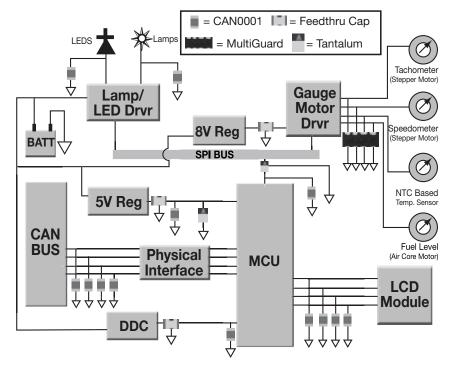
TDS-TS-0012 | Rev 1

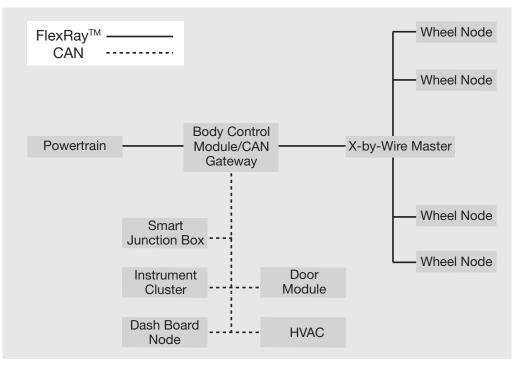


APPLICATION

KYOCERA AVX CAN BUS and FlexRay varistors offer significant advantages in general areas of a typical CAN or FlexRay network as shown on the right. Some of the advantages over diodes include:

- space savings
- higher ESD capability @ 25kV contact
- higher in rush current (4A) 8 x 20µS
- FIT rate ≤0.1 failures (per billion hours)





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USB Series

Low Capacitance Multilayer Varistors





GENERAL DESCRIPTION

USB Series varistors are designed to protect the high speed data lines against ESD transients. They have very low capacitance and fast turn on times that make this series ideal for data and transmission lines with high data rates. The unique design enables these devices to meet the rigorous testing criteria of the **IEC 61000-4-2** standards. New and improved manufacturing process has created these USB series to be one of the best plated varistors in the market today.

GENERAL CHARACTERISTICS

- Operating Temperature: -55°C to 125°C
- Working Voltage: ≤ 18Vdc
- Case Size: 0402, 0603, 0405 2x array, 0612 4x array
- Typical Capaciatane: 3pF, 6pF, 10pF

FEATURES

- Zinc Oxide (ZnO) based ceramic semiconductor devices with non-linear voltage-current characteristics
- Bi-directional device, similar to back-to-back Zener diodes plus an EMC capacitor in parallel
- Entire structure made up of conductive ZnO grains surrounded by electrically insulating barriers, creating varistor-like behavior
- Electrical advantages over Zener diodes are repetitive strike capability, high in rush current capability, fast turn-on-time and EMI attenuation

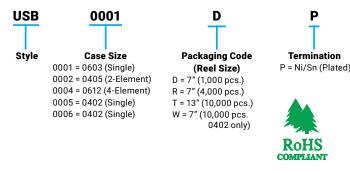
TYPICAL APPLICATIONS

- USB BUS Lines/Firewire Data BUS Lines
- I/O BUS Lines
- 10/100/1000 Ethernet
- Transmission Lines
- Handheld DevicesLaptop Computers

Video Card Data Lines

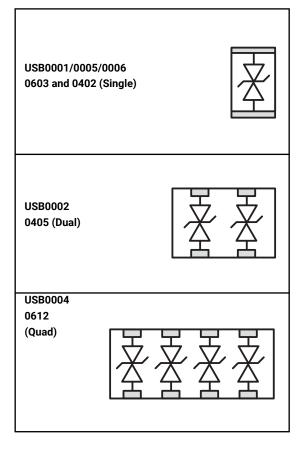
 LCD Monitors and more

PART NUMBERING



- Protects against ESD to meet IEC 61000-4-2 15kV (air) and 8kV (contact)
- · Low capacitance for high speed data lines
- · Available in discrete and array packages (2 and 4 element)
- Low Clamping Voltage
- Low Operating Voltage
- Response time is < 1ns

PINOUT CONFIGURATION



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USB Series

Low Capacitance Multilayer Varistors



RATINGS

Air Discharge ESD	15kV
Contact Discharge ESD	8kV
Operating Temperature	-55°C to +125°C
Soldering Temperature	260°C

PERFORMANCE CHARACTERISTICS

Part No.	VW (DC)	VW (AC)	VB	IL	ET	IP	Cap.	Case Size	Elements
USB0001	≤18	≤14	120	2	0.015	4	10	0603	1
USB0002	≤18	≤14	70	2	0.015	4	10	0405	2
USB0004	≤18	≤14	100	2	0.015	4	10	0612	4
USB0005	≤18	≤14	300	2	0.015	4	3	0402	1
USB0006	≤18	≤14	65	2	0.015	4	6	0402	1

L Termination Finish Code

Packaging Code

V_w (DC) DC Working Voltage (V)

 V_w (AC) AC Working Voltage (V)

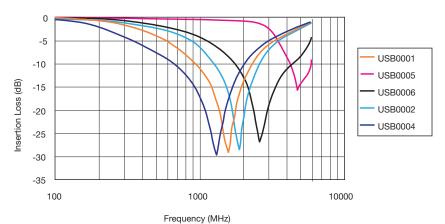
- $V_{\scriptscriptstyle B}$ Typical Breakdown Voltage (V @ 1mADC)
- Maximum Leakage Current at the Working Voltage (µA) I_{L}

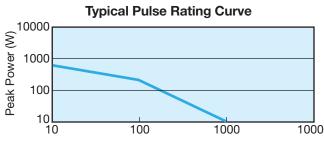
Ε_τ Transient Energy Rating (J, 10x1000µS)

Peak Current Rating (A, 8x20µS) I_P

Сар Typical Capacitance (pF) @ 1 MHz and 0.5Vrms

USB TYPICAL S21 CHARACTERISTICS







100

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061820

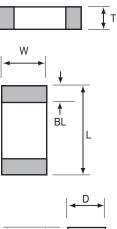
1000

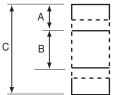
USB Series Low Capacitance Multilayer Varistors

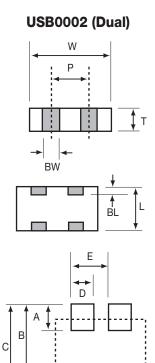


PHYSICAL DIMENSIONS AND PAD LAYOUT

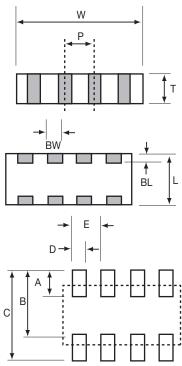
USB0001/5/6 (Single)







USB0004 (Quad)



mm (inches)

L	W	Т	BW	BL	Р			
	USB0001							
1.60±.15 (0.063±0.006)	0.80±0.15 (0.032±0.006)	0.90 Max (0.035 Max.)	N/A	0.35±0.15 (0.014±0.006)	N/A			
		US	B0002					
1.00±0.15	1.37±0.15	0.66 Max	0.36±0.10	0.20±0.10	0.64 REF			
(0.039±0.006)	(0.054±0.006)	(0.026 Max.)	(0.014±0.004)	(0.008±0.004)	(0.025 REF)			
		US	B0004					
1.60±0.20	3.20±0.20	1.22 Max	0.41±0.10	0.18+0.25/-0.08	0.76 REF			
(0.063±0.008)	(0.126±0.008)	(0.048 Max.)	(0.016±0.004)	(0.007+.01/003)	(0.030 REF)			
USB0005 / USB0006								
1.0±0.10 (0.040±0.004)	0.50±0.10 (0.020±0.004)	0.60 Max (0.024 Max.)	N/A	0.25±0.15 (0.010±0.006)	N/A			

Α	В	С	D	E				
	USB0001							
0.89 (0.035)	0.76 (0.030)	2.54 (0.100)	0.76 (0.030)	N/A				
	USB0002							
0.46 (0.018)	0.74 (0.029)	1.20 (0.047)	0.30 (0.012)	0.64 (0.025)				
		USB0004						
0.89 (0.035)	1.65 (0.065)	2.54 (0.100)	0.46 (0.018)	0.76 (0.030)				
USB0005 / USB0006								
0.61	0.51	1.70	0.51	NI / A				

(0.067)

mm (inches)

N/A

(0.020)

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(0.024)

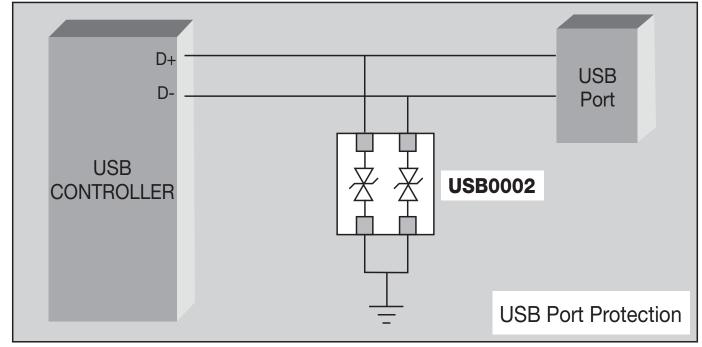
(0.020)

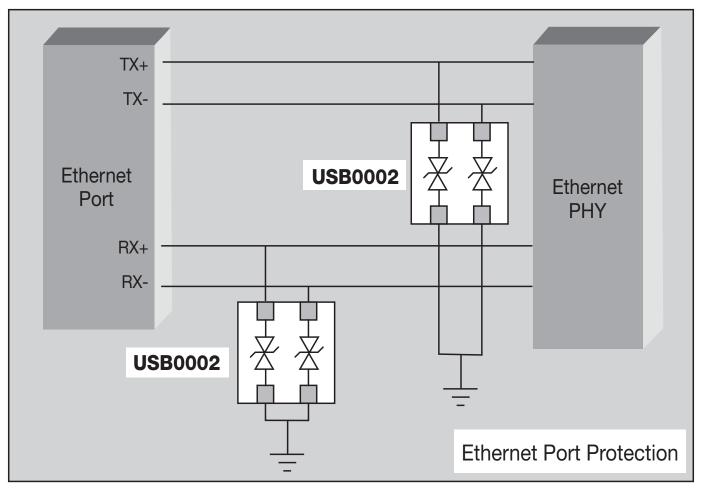
USB Series

Low Capacitance Multilayer Varistors



APPLICATIONS





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0402/0603 Low Capacitance Multilayer Varistors ESD Protection for Antennas and Low Capacitor Loading Applications

GENERAL DESCRIPTION

KYOCERA AVX 0402/0603 AntennaGuard products are an ultra-low capacitance extension of the proven TransGuard® TVS (transient voltage suppression) line of multilayer varistors. RF designers now have a single chip option over conventional protection methods (passive filters with diode clamps), which not only gives superior performance over traditional schemes, but also provides the added benefits of reduced PCB real estate and lower installation costs.

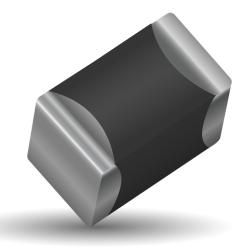
KYOCERA AVX AntennaGuard products are available in capacitance ratings of \leq 3pF (0402 & 0603 chips), 2 and 12pF (0603 chip). These low capacitance values have low insertion loss, as well as give other TransGuard® advantages such as small size, subnanosecond response time, low leakage currents and unsurpassed reliability (FIT Rate of 0.2) compared to diodes.

RF antenna/RF amplifier protection against ESD events is a growing concern of RF circuit designers today, given the combination of increased signal "gain" demands, coupled with the required downsizing of the transistor package. The ability to achieve both objectives is tied to a reduced thickness of the SiO2 gate insulator layer within the semiconductor. The corresponding result of such a change increases the Power Amplifier's (PA's) vulnerability to ESD strikes — a common event with handheld electronic products with RF transmitting and/or receiving features. KYOCERA AVX Low Capacitance AG Series parts are ideal solution for this type of applications as well as for many more where low capacitance ESD protection is needed.

GENERAL CHARACTERISTICS FEATURES

- Operating Temperature: -55°C to +125°C
- Working Voltage: ≤18Vdc
- Case Size: 0402, 0603

- Smallest TVS Component
- Single Chip Solution
 - Low Insertion Loss
- Fastest Response Time to ESD Strikes
- Capacitance: 2, 3 and 12pF

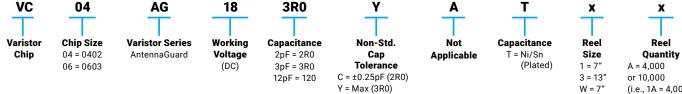


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APPLICATIONS

- RF Amplifiers
- Antennas
- Laser Drivers
- Sensors
- Radars
- RFID
- Keyless entry
- Near fileld communication
- Datalines
- Capacitance sensitive
- applications and more





Y = +4, -2pF (120)

A = 4,000 or 10,000 (i.e., 1A = 4,000 3A = 10,000) WA = 10,000

(0402 only)



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0402/0603 Low Capacitance Multilayer Varistors ESD Protection for Antennas and Low Capacitor Loading Applications

ANTENNAGUARD CATALOG PART NUMBERS/ELECTRICAL VALUES

Part Number	VW (DC)	VW (AC)	IL	Сар	Cap Tolerance	Case Size
VC04AG183R0YAT	≤ 18	≤ 14	0.1	3	Max	0402
VC06AG182R0CAT	≤ 18	≤ 14	0.1	2	±0.25pF	0603
VC06AG183R0YAT	≤ 18	≤ 14	0.1	3	Max	0603
VC06AG18120YAT	≤ 18	≤ 14	0.1	12	+4, -2pF	0603

 \Box Termination Finish Code

Packaging Code

V_w (DC) V_w (AC) I_L

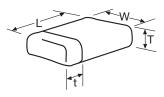
Сар

DC Working Voltage (V) AC Working Voltage (V)

Maximum Leakage Current at the Working Voltage (μ A)

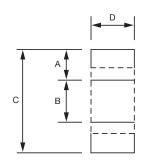
Maximum Capacitance (pF) @ 1 MHz and 0.5 Vrms; VC06AG18120YAT capacitance tolerance: +4, -2pF

PHYSICAL DIMENSIONS



Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
0402	1.00±0.10	0.50±0.10	0.60	0.25±0.15
	(0.040±0.004)	(0.020±0.004)	(0.024)	(0.010±0.006)
0603	1.60±0.15	0.80±0.15	0.90	0.35±0.15
	(0.063±0.006)	(0.031±0.006)	(0.035)	(0.014±0.006)

SOLDERING PAD DIMENSIONS



Suppression		Pad Dim	ensions	
Device	Α	В	C	D
0402	1.70 (0.067)	0.61 (0.024)	0.51 (0.020)	0.61 (0.024)
0603	2.54 (0.100)	0.89 (0.035)	0.76 (0.030)	0.89 (0.035)

mm (inches)

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0402/0603 Low Capacitance Multilayer Varistors ESD Protection for Antennas and Low Capacitor Loading Applications

ANTENNA VARISTORS

KYOCERA AVX offers a series of 0402 and 0603 chip varistors, designated the AntennaGuard series, for RF antenna/RF amplifier protection. These devices offer ultra-low capacitance (<3pF in 0402 chips, and <3pF & <12pF in 0603 packages), as well as low insertion loss. Antenna varistors can replace output capacitors and provide ESD suppression in RF and capacitance sensitive applications.

It is very common to employ some form of a FET in many types of efficient/ miniature RF amplifiers. Typically, these RF transistors have nearly ideal input gate impedance and outstanding noise figures. However, FETs are very susceptible to ESD damage due to the very thin layer of SiO2 uses as the gate insulator. The ultra-thin SiO2 layer is required to improve the gain of the transistor. In other words, the upside of the performance enhancement becomes the downside of the transistors survival when subjected to an ESD event.

ESD damage to the RF Field Effect Transistors (FETs) is a growing concern

among RF designers due to the following trends: (1) RF amplifiers continue to shrink in size, and (2) FET gains figures continue to increase. Both trends relate to decreasing gate oxide thickness, which in turn, is directly proportional to increased ESD sensitivity. As miniaturization trends accelerate, the traditional methods to protect against ESD damage (i.e., PC board layout, passive filters, and diode clamps) are becoming less and less effective.

KYOCERA AVX AntennaGuard varistor can be used to protect the FET and offer superior performance to the previously mentioned protection methods given above. The standard EIA 0603 chip size, and particularly the 0402 chip, offer designers an ESD protection solution consistent with today's downsizing trend in portable electronic products. Savings in component volume up to 86%, and PC board footprint savings up to 83% are realistic expectations. These percentages are based upon the following table and Figures 1A and 1B.

mm (inches)

🔀 KYOCERa

	Pad Dimensions								
Suppression Device	D1	D2	D3	D4	D5				
0402 TransGuard®	1.70 (0.067)	0.61 (0.024)	0.51 (0.020)	0.61 (0.024)	0.51 (0.020)				
0603 TransGuard®	2.54 (0.100)	0.89 (0.035)	0.76 (0.030)	0.89 (0.035)	0.76 (0.030)				
Competitor's SOT23 Diode			See Below						

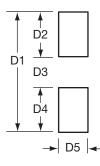


Figure 1A. 0402/0603 IR Solder Pad Layout

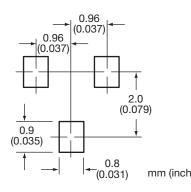


Figure 1B. SOT23- Solder Pad Layout

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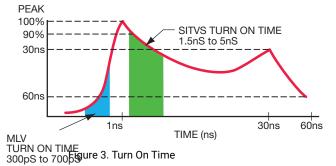
0402/0603 Low Capacitance Multilayer Varistors ESD Protection for Antennas and Low Capacitor Loading Applications

Antenna varistors offer excellent ESD repetitive strike capability compared to a SOT23 diode when subjected to IEC 61000-4-2 8Kv contact discharge. A performance summary is shown in Figure 2.

ESD TEST OF ANTENNAGUARD RATINGS 520 0402 & 0603 3pF Ratings 0603 - 12pF Bati 500 60 12pF 480 50 0603 1 0603 - 3pF 460 40 (aN Breakdown Voltage (Vb) Breakdown Voltage 30 440 20 420 400 10 0402 - 3pF 380 0 100 1000 10,000 0 8kV ESD Strikes

Figure 2. Repetitive 8kV ESD Strike

Antenna varistors also turn on and divert ESD overvoltages at a much faster rate than SOT23 devices (typically 300pS vs 1500pS - 5000pS). See Figure 3.



The equivalent circuit model for a typical antenna varistor is shown in Figure 4.

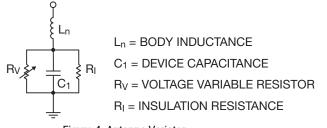
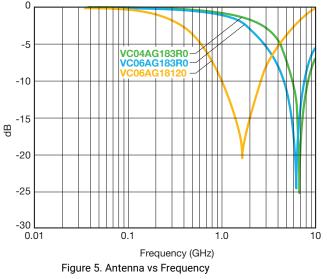


Figure 4. Antenna Varistor

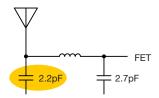
The varistor shown exhibits a capacitance of \leq 3pF which can be used to replace the parallel capacitance typically found prior to the antenna output of an RF amplifier. In the off state, the varistor acts as a capacitor and helps to filter RF output. The varistor is not affected by RF output power or voltage and has little insertion loss. See Figure 3.

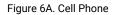
ANTENNA VARISTOR S21



🔇 КУОСЕRа

Typical implementations of the antenna varistors are shown for use in cell phone, pager and wireless LAN applications in Figures 6A, 6B and 6C.





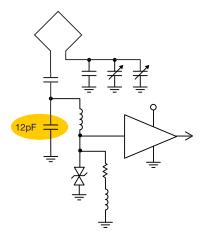
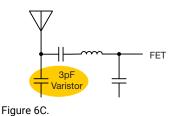


Figure 6B. Pager



ng Applications

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AntennaGuard Automotive Series

0402/0603 Low Capacitance Automotive Varistors ESD Protection for Automotive Circuits Sensitive to Capacitance



GENERAL DESCRIPTION

KYOCERA AVX 0402/0603 Automotive AntennaGuard products are an ultra low capacitance extension to the Automotive TransGuard[®] Series and are intended for use in RF and other capacitance sensitive circuits.

These low capacitance values have low insertion loss, low leakage current and unsurpassed reliability compared to diode options. These advantages combined with size advantages and bi-directional protection make the AntennaGuard the right choice for automotive applications including RF circuits, sensors, high speed signal transmission lines, etc...



GENERAL CHARACTERISTICS

- Operting Teperature: -55°C to +125°C
- Working Voltage: ≤18Vdc
- · Case Size: 0402, 0603

FEATURES

- AEC Q200 Qualified
- 25kV ESD rating
- · Meet 27.5Vdc Jump Start requirements
- Multi-strike capability
- · Sub 1nS response to ESD strike

APPLICATIONS

- RF Circuit
- Sensors
- Antennas
- Data lines
- · Keyless entry
- · Capacitance sensitive applications

HOW TO ORDER

	AS	06	AG	<u>18</u>	<u>3R0</u>	Y ↓	A T	Ŧ
Varistor Chip	Series AS = Automotive	Case Size 04 = 0402 06 = 0603	Туре	Working Voltage 18 = 18.0VDC	Capacitance 2R0 = 2pF 3R0 = 3pF 120 = 12pF	Non-Std Cap Tol C = ±0.25pF (2R0) Y = Max	Not Applicable	Termination T = Ni/Sn Plated

	Ť	Ť
ation	Reel Size	Reel Qty
Plated	1 = 7" reel	A = 4K or 10K pcs
	3 = 13" reel	(i.e.: 1A = 4,000
	W = 7" reel	3A = 10,000
	(0402 only)	WA = 10,000

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ELECTRIAL CHARACTERISTICS

Part Number	VW (DC)	VW (AC)	IL	Сар	Cap Tolerance	VJump	Case Size
VCAS04AG183R0YAT	≤ 18	≤ 14	0.1	3	Max	27.5	0402
VCAS06AG182R0CAT	≤ 18	≤ 14	0.1	2	±0.25pF	27.5	0603
VCAS06AG183R0YAT	≤ 18	≤ 14	0.1	3	Max	27.5	0603
VCAS06AG18120YAT	≤ 18	≤ 14	0.1	12	+4, -2pF	27.5	0603

(for 3pF) Y = +4/-2pF (for 12pF)

^L Termination Finish Code

Packaging Code

V_w (DC) V_w (AC) I_L Cap V_{Jump}

DC Working Voltage (V)

AC Working Voltage (V)

Maximum Leakage Current at the Working Voltage (µA)

Maximum Capacitance (pF) @ 1 MHz and 0.5 Vrms; VC06AG18120YAT capacitance tolerance: +4, -2pF

Jump Start (V)

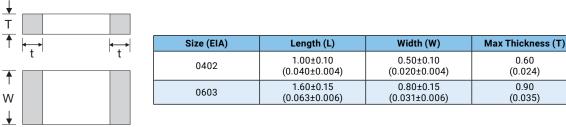
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AntennaGuard Automotive Series

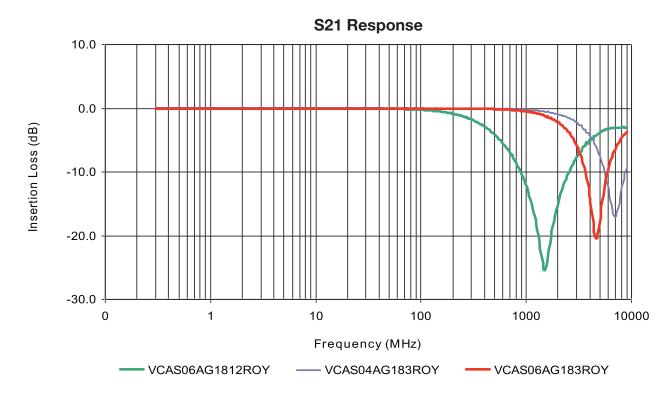
0402/0603 Low Capacitance Automotive Varistors ESD Protection for Automotive Circuits Sensitive to Capacitance

PHYSICAL DIMENSIONS:

L



S21 TRANSMISSION CHARACTERISTICS



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080216

mm (inches)

Land Length (t)

0.25±0.15

(0.010±0.006)

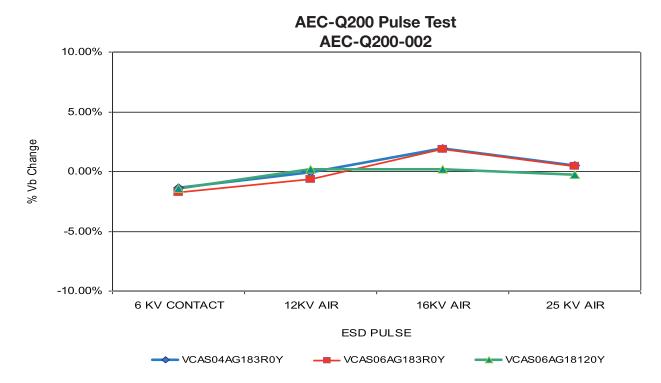
0.35±0.15

(0.014±0.006)

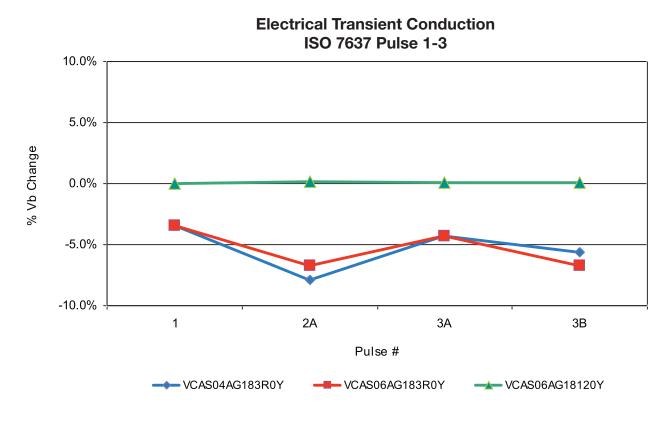
AntennaGuard Automotive Series

0402/0603 Low Capacitance Automotive Varistors ESD Protection for Automotive Circuits Sensitive to Capacitance

ESD CHARACTERISTICS



ELECTRICAL TRANSIENT CONDUCTION



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080216

KY<u>OCERa</u>

ASPGuard[®]

Low Capacitance Varistors ESD Protection for Circuits Sensitive to Capacitance





GENERAL DESCRIPTION

KYOCERA AVX ASPGuard® products are an ultra low capacitance extension of reliable AntennaGuard range with new voltage, capacitance and energy ratings. Designed for use in RF circuits, sensors, high-speed lines, optic circuits and capacitance sensitive applications.

The ability to handle larger transients makes the ASPGuard® series useful in applications where capacitance sensitive circuit needs to be protected against higher energy and AEC-Q200 qualification allows for use in automotive applications.

These low capacitance values have low insertion loss, low leakage current and unsurpassed reliability compared to diode options. These advantages combined with size advantages and bi-directional protection make the ASPGuard® the right choice for automotive and general applications, that are sensitive to capacitance.

GENERAL CHARACTERISTICS

- Operating Temperature: -55°C to+150°C
- Case Size: 0402,0603
- Working Voltage: 18 70Vdc
- Capacitance: 1.5 4.7pF
- Energy: 0.02 -0.04J
- Peak Current: 1 3A

FEATURES

- · AEC-Q200Qualified
- 25kV ESD rating
- Meet 48Vdc Jump Start requirements
- Multi-strike capability
- Sub 1nS response to ESD strike

APPLICATIONS

- **RF** Circuit
- Sensors
- Antennas
- Data lines Radars
- Ethernet (IEEE 802.3bw and IEEE 802.3bp)

Bluetooth

VCAS06AP303R3LAT

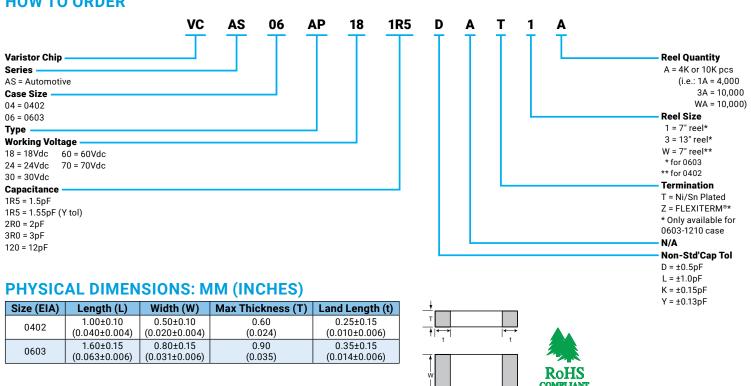
KYOCERA AVX is an adopting member of the OPEN Alliance to collaborate with other technology providers and the customers to further develop and standardize Ethernet-based networks in Automotive applications.

The following parts are fully compliant and qualified for OPEN Alliance Ethernet standards:

- 1000BASE-T1 Ethernet: VCAS04AP701R5YATWA
- 100BASE-T1 Ethernet: VCAS04AP704R7LATWA



HOW TO ORDER



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ASPGuard®

Low Capacitance Varistors ESD Protection for Circuits Sensitive to Capacitance

KY<u>OCERa</u>

ELECTRIAL CHARACTERISTICS

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _L	Ε _τ	I _P	Сар	Cap Tolerance	V_{Jump}	Case Size
VCAS04AP181R5KAT	18	14	150-210	350	0.1	0.02	1	1.5	±0.15pF	48	0402
VCAS04AP181R5DAT	18	14	150-210	350	0.1	0.02	1	1.5	±0.5pF	48	0402
VCAS04AP181R5YAT	18	14	150-210	350	0.1	0.02	1	1.55	±0.13pF	48	0402
VCAS04AP182R0LAT	18	14	80-140	300	0.1	0.02	1	2.0	±1.0pF	48	0402
VCAS06AP181R5DAT	18	14	150-200	375	0.1	0.02	1	1.5	±0.5pF	48	0603
VCAS06AP182R0LAT	18	14	150-200	350	0.1	0.03	2	2.0	±1.0pF	48	0603
VCAS06AP243R3LAT	24	17	90-150	240	0.1	0.04	3	3.3	±1.0pF	48	0603
VCAS04AP301R5KAT	30	21	150-210	350	0.1	0.02	1	1.5	±0.15pF	48	0402
VCAS04AP301R5DAT	30	21	150-210	350	0.1	0.02	1	1.5	±0.5pF	48	0402
VCAS04AP301R5YAT	30	21	150-210	350	0.1	0.02	1	1.55	±0.13pF	48	0402
VCAS06AP302R0LAT	30	21	150-200	350	0.1	0.03	2	2.0	±1.0pF	48	0603
VCAS06AP303R3LAT	30	21	90-150	240	0.1	0.04	3	3.3	±1.0pF	48	0603
VCAS04AP423R5LAT	42	32	50.4-61.6	135	10	0.03	2	3.5	±1.0pF	48	0402
VCAS06AP423R54AT	42	32	50.4-61.6	135	10	0.03	2	3.5	±2.0pF	48	0603
VCAS04AP601R5DAT	60	42	150-210	350	0.1	0.02	1	1.5	±0.5pF	48	0402
VCAS06AP602R0LAT	60	42	150-200	350	0.1	0.03	2	2.0	±1.0pF	48	0603
VCAS06AP603R3LAT	60	42	90-150	240	0.1	0.04	3	3.3	±1.0pF	48	0603
VCAS04AP701R5KAT	70	52	150-210	350	0.1	0.02	1	1.5	±0.15pF	48	0402
VCAS04AP701R5DAT	70	52	150-210	350	0.1	0.02	1	1.5	±0.5pF	48	0402
VCAS04AP701R5YAT	70	52	150-210	350	0.1	0.02	1	1.55	±0.13pF	48	0402
VCAS04AP704R7LAT	70	52	90-110	190	1	0.03	1	4.7	±1pF	48	0402
VCAS06AP701R5DAT	70	52	150-200	375	1	0.02	1	1.5	±0.5pF	48	0603
MGAS04AP704R7LAT	70	52	102-138	225	10	0.02	3	4.7	±1pF	48	0405

V_w (DC) DC Working Voltage [V] VB

 V_w (AC) AC Working Voltage [V]

Breakdown Votage [V @ 1mA_{DC}]

V_B V_C Clamping Votage [V @ 1A]

Maximum leakage current at the working voltage [µA]

E_T I_p

Ċap

 V_{Jump}

Cap Tol

Transient Energy Rating [J, 10x1000µS]

Peak Current Rating [A, 8x20µS]

Capacitance [pF] @ 1MHz specified and 0.5VRMS

Capacitance tolerance (pF) from Typ value

Jump Start (V, 5min)

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ASPGuard[®]

Low Capacitance Varistors ESD Protection for Circuits Sensitive to Capacitance

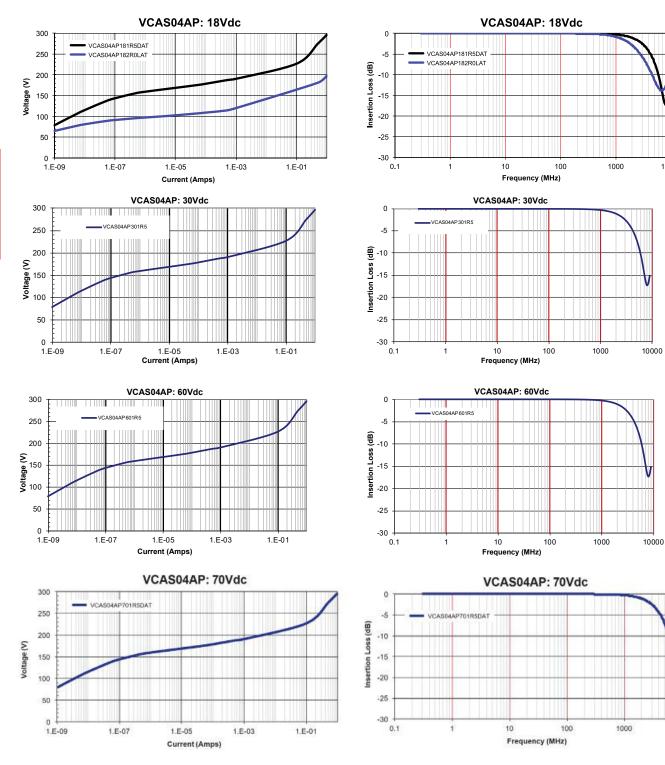


10000

10000

V/I CHARACTERISTICS

S21 CHARACTERISTICS



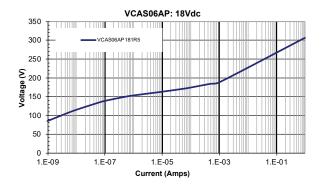
ASPGuard®

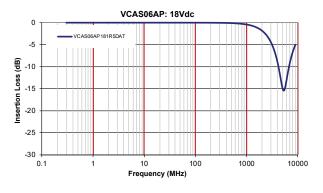
Low Capacitance Varistors ESD Protection for Circuits Sensitive to Capacitance

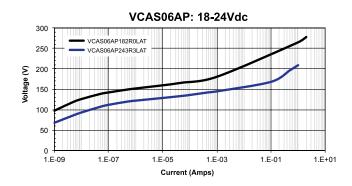


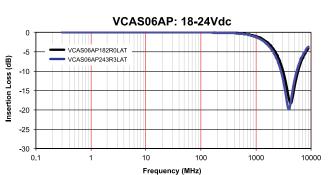
V/I CHARACTERISTICS

S21 CHARACTERISTICS

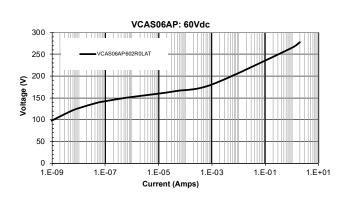


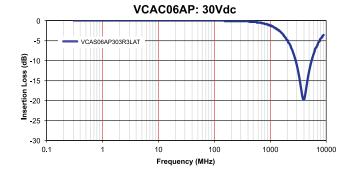


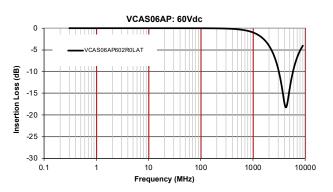




VCAS06AP: 30Vdc 300 VCAS06AP303R3LAT 250 Voltage (V) 200 150 100 50 0 1.E-09 1.E-07 1.E-05 1.E-03 1.E-01 Current (Amps)







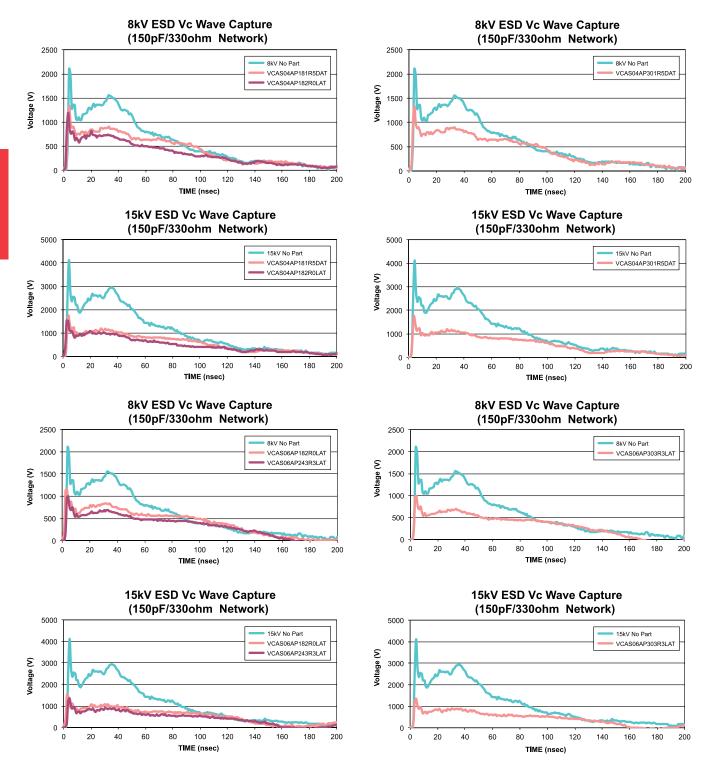
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ASPGuard® Low Capacitance Varistors ESD Protection for Circuits Sensitive to Capacitance



ESD CHARACTERISTIC



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AntennaGuard® Series Sub pF

Ultra-low Capacitance Multilayer Varistors ESD Protection for any Circuit Sensitive to Capacitance

GENERAL DESCRIPTION

KYOCERA AVX offers ultra-low capacitance ESD protection in the Sub 1pF range for use in circuits that are sensitive to capacitance. The Sub pF Varistor (SPV) is available in 0.8pF and 0.4pF capacitance values in a compact 0402 low profile package. SPV devices provide excellent response time to ESD strikes to protect sensitive circuits from over voltage conditions.

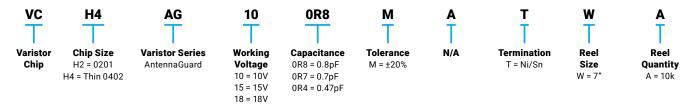
The development of new information processing technologies call for ever increasing digital system speeds. Higher speeds necessitate the use of ultra-low capacitance values in order to minimize signal distortion.

FEATURES

APPLICATIONS Antennas

- High Reliability
- Capacitance <1pF
- **Bi-Directional protection**
- Fastest response time to ESD strikes
- . Multi-strike capability
- Low insertion loss
- · Low profile 0402 case size
- Optics HDMI
- RF circuits
- FlexRay
- Portable devices
- Analog sensors
- Any circuit sensitive to capacitance

HOW TO ORDER



ANTENNAGUARD CATALOG PART NUMBERS/ELECTRICAL VALUES

Part Number	V _w (DC)	V _B	I _L	Сар	Cap Tolerance	3db Freq (MHz)	Case Size
VCH4AG100R8MA	≤10	125	<10 nA	0.8	±20%	5800	LP 0402
VCH4AG150R8MA	≤15	125	<10 nA	0.8	±20%	5800	LP 0402
VCH4AG150R4MA	≤15	135	<100 nA	0.47	±20%	6700	LP 0402
VCH2AG180R7MA	≤18	135	<5µA	0.7	±20%	10800	0201

V_w(DC) DC Working Voltage (V)

Typical Breakdown Voltage (V @ 1mADC) $V_{\rm B}$

 \mathbf{I}_{L} Typical leakage current at the working voltage

Cap Typical capacitance (pF) @ frequency specified and 0.5VRMS

Freq Frequency at which capacitance is measured (M = 1MHz)



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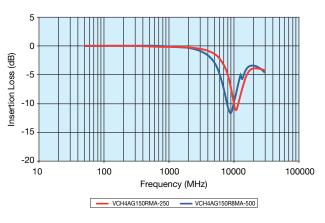


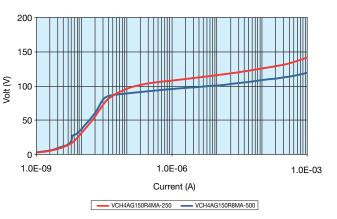


AntennaGuard® Sub pF

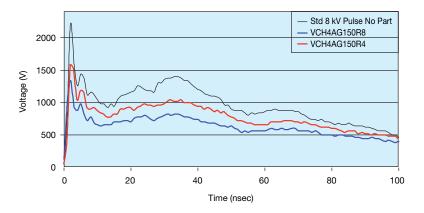
Ultra-low Capacitance Multilayer Varistors ESD Protection for any Circuit Sensitive to Capacitance

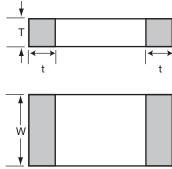
S21 TRANSMISSION CHARACTERISTICS - SPV V/I CURVE - SPV



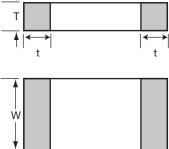


ESD WAVE ABSORPTION CHARACTERISTICS





	mm (inches)
Size (EIA)	0402
Length (L)	1.00 ±0.10 (0.040 ± 0.004)
Width (W)	0.50 ±0.10 (0.020 ±0.004)
Max Thickness (T)	0.35 (0.014)
Terminal (t)	0.25±0.15 (0.010±0.006)



AntennaGuard Automotive Series Sub pF

Ultra-low Capacitance Automotive Varistor for ESD Protection for Automotive Circuits Sensitive to Capacitance

GENERAL DESCRIPTION

KYOCERA AVX offers ultra-low capacitance ESD protection in the Sub 1pF range for use in automotive circuits that are sensitive to capacitance. The Automotive Sub pF Varistor (ASPV) is available in 0.8pF capacitance value in a compact 0402 low profile package. ASPV devices provide excellent response time to ESD strikes to protect sensitive circuits from over voltage.

The development of new information processing technologies call for ever increasing digital system speeds. Higher speeds necessitate the use of ultra-low capacitance values in order to minimize signal distortion.

GENERAL CHARACTERISTICS

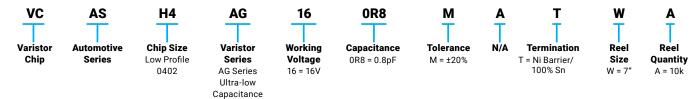
- Operating Temperature: -55°C to +125°C
- Working Voltage: 16Vdc
- Case Size: 0402 low profile
- Capacitance < 1pF

- **FEATURES**
- High Reliability
- Capacitance <1pF
- Bi-Directional protection
- Fastest response time to ESD strikes
- Multi-strike capability
- Low insertion loss
- · Low profile 0402 case size
- AEC-Q 200 Qualified

APPLICATIONS

- Antennas, RF circuits
- Optics
- HDMI, Firewire, Thunderbolt
- High speed communication bus
- GPS
- Camera link
- Sensors
- Touch screen interfaces
- Circuits sensitive to capacitance

HOW TO ORDER

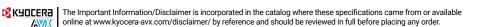


ANTENNAGUARD CATALOG PART NUMBERS/ELECTRICAL VALUES

Part Number	V _w (DC)	V _B	I _L	Сар	Cap Tolerance	3db Freq (MHz)	Case Size
VCASH4AG160R8MA	≤16	125	1	0.8	±20%	5800	LP 0402

V _w (DC)	DC Working Voltage (V)
V _B	Typical Breakdown Voltage (V @ 1mADC)
I _L	Typical leakage current at the working voltage
Сар	Typical capacitance (pF) @ frequency specified and $0.5V_{\scriptscriptstyle {\sf RMS}}$
Freq	Frequency at which capacitance is measured (M = 1MHz)







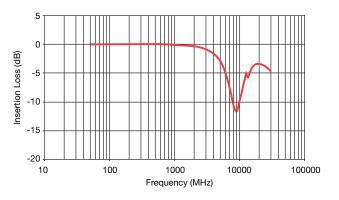


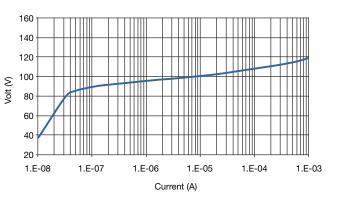
AntennaGuard Automotive Series Sub pF

Ultra-low Capacitance Automotive Varistor for ESD Protection for Automotive Circuits Sensitive to Capacitance

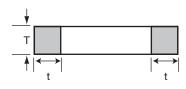


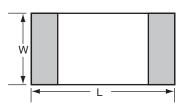
S21 TRANSMISSION CHARACTERISTICS -SPV V/I CURVE - SPV





DIMENSIONS





	mm	(inches)

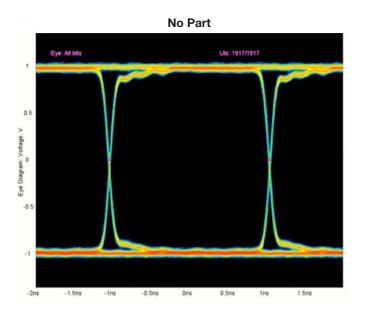
Size (EIA)	0402
Length (L)	1.00 ±0.10 (0.040 ± 0.004)
Width (W)	0.50 ±0.10 (0.020 ±0.004)
Max Thickness (T)	0.35 (0.014)
Terminal (t)	0.25±0.15 (0.010±0.006)

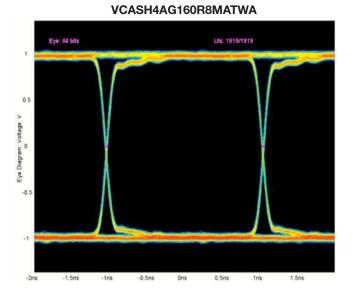
AntennaGuard Automotive Series Sub pF

Ultra-low Capacitance Automotive Varistor for ESD Protection for Automotive Circuits Sensitive to Capacitance

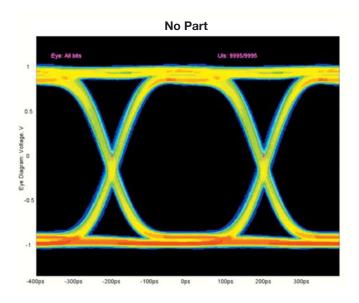


EYE DIAGRAM - USB-HS (480MHZ) TEST

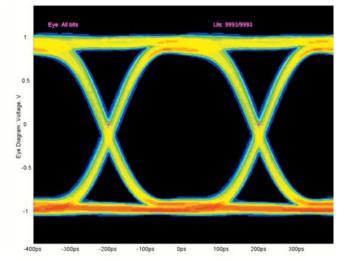




EYE DIAGRAM - PCI-E (2.5GHZ) TEST



VCASH4AG160R8MATWA



Controlled Capacitance Multilayer Varistor





GENERAL DESCRIPTION

The Controlled Capacitance TransGuard is an application specific bi- directional transient voltage suppressor developed for use in mixed signal environments. The Controlled Cap MLV has three purposes: 1) reduce emissions from a high speed ASIC, 2) prevent induced E fields from conducting into the IC, and 3) clamp transient voltages By controlling capacitance of the MLV, the center frequency and 20db range for filtering purposes can be targeted. A

Controlled Cap MLV can greatly improve overall system EMC performance and reduce system size.

GENERAL CHARACTERISTICS

- Operating Teperature: -55°C to +125°C
- Working Voltage: 9 30Vdc
- Case Size: 0402, 0603

FEATURES

- Single Chip Solution
- Tageted EMI/RFI Filtering
- 20dB Range for tiltering purposes
- Improves system EMC performance
- Very fast response to ESD
- 25kV ESD

APPLICATIONS

- EMI TVS Module Control
- High Speed ASICS
 - Mixed Signal Environment

COMPLIAN

• Sensors and more

HOW TO ORDER

VCAC	0603	22	Α	470	N	R	P
Varistor Chip Automotive Capacitance	Chip Size 0402 0603	Working Voltage 09 = 9V 17 = 17V 22 = 22V 26 = 26V 30 = 30V	Energy Rating X = 0.05J A = 0.1J B = 0.2J C = 0.3J	Capacitance 15 = 15pF 330 = 33pF 380 = 38pF 470 = 47pF 820 = 82pF 102 = 1000pF	Tolerance N = ±30% M = ±20%	Packaging R = 4k pcs D = 7" reel (1,000 pcs) R = 7" reel (4,000 pcs) T = 13" reel (10,000 pcs) W = 7" Reel (10,000 pcs 0402 only)	Termination P = Ni Barrier/ 100% Sn (matte)

Part Number	VW (DC)	VW (AC)	VB	VC	IL	ET	IP	Сар	Cap Tolerance	Case Size
VCAC060309B102N	9.0	6.4	12.7±15%	22	25	0.2	120	1000	±30%	0603
VCAC060317X150N	17	12	27±20%	52	10	0.05	2	15	±30%	0603
VCAC060317X330M	17	12	27±20%	52	10	0.05	2	33	±20%	0603
VCAC060322A470N	22	17	32.5±25%	50	10	0.1	30	47	30%	0603
VCAC060326C820M	26	20	36.0±15%	67	10	0.3	30	82	20%	0603
VCAC040230X380N	30	21	41±10%	67	5	0.05	10	38	±30%	0402

VW(DC)	DC Working Voltage [V]	I,
VW(AC)	AC Working Voltage [V]	Ε _τ
VB	Breakdown Votage [V @ 1mADC]	I _P
VC	Clamping Votage [V @ 1A]	Сар

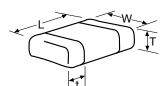
Maximum leakage current at the working voltage, 25°C [µA]

Transient Energy Rating [J, 10x1000µS]

- Peak Current Rating [A, 8x20µS]
- Capacitance [pF] @ 1KHz specified and 0.5VRMS, 25°C

0603 DISCRETE DIMENSIONS

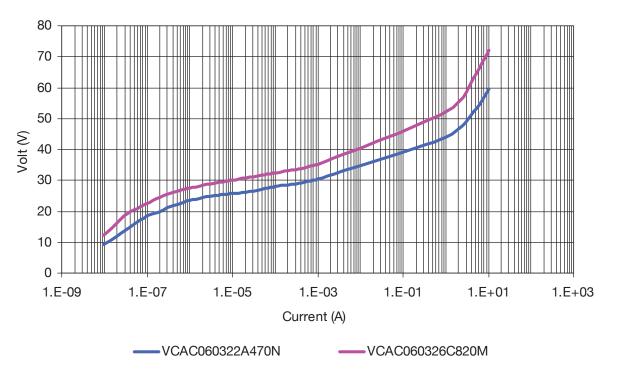
3 DISCR	mm (inches)			
Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
0402	1.00±0.10	0.50±0.10	0.60	0.25±0.15
	(0.040±0.004)	(0.020±0.004)	(0.024)	(0.010±0.006)
0603	1.60±0.15	0.80±0.15	0.90	0.35±0.15
	(0.063±0.006)	(0.031±0.006)	(0.035)	(0.014±0.006)



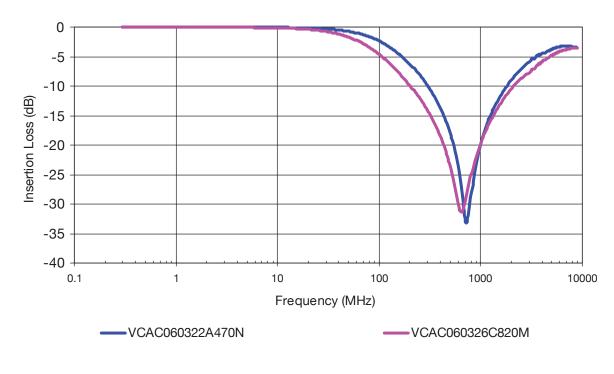
Controlled Capacitance Multilayer Varistor



V-I Curve







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Miniature AC Varistor – MAV

Low Power AC and Low Capacitance DC Circuit Protection

GENERAL DESCRIPTION

KYOCERA AVX Miniature AC Varistors are designed for use in low power AC circuit protection. MAV series devices are an ideal solution to transient suppression in LC resonant circuits intended for signal & power transfer. The KYOCERA AVX part provides low loss in the resonant circuit yet is able to clamp large amounts of transients in a bi-directional manner.

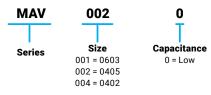
The ability to handle large transients makes the MAV series useful in low power AC circuit protection and the AEC Q200 qualification allows for use in automotive applications.

Low capacitance makes these parts useful also for higher DC voltage data lines and other capacitance sensitive applications.

GENERAL CHARACTERISTICS

- Operating Temperature: -55 to +125°C
- Working Voltage: 70Vdc / 52Vac
- Case Size: 0402, 0603, 0405 2xArray

HOW TO ORDER



FEATURES

- · 110 Pk-Pk @ 125kHz capability
- AEC Q200 qualified
- ESD rated to 25kV (HBM ESD Level 6)
- EMI/RFI attenuation in off state

Packaging

- Bi-Directional protection

- Transformer secondaries
- GFI modules
- Immobilizers
- · Keyless entry
- Data lines







D = 7'' reel (1,000 pcs)

R = 7'' reel (4,000 pcs)

T = 13" reel (10,000 pcs) W = 7" Reel (10,000 pcs 0402 only)

Part Number	VW (DC)	VW (AC)	VB	VC	IVC	ET	IP	IL	Сар	Elements
MAV0010_P	70	52	120 ±15%	225	1	0.015	2	10	22pF Max	1
MAV0020_P	70	52	120 ±15%	225	1	0.020	3	10	8pF Max	2
MAV0040_P	70	52	120 ± 15%	225	1	0.020	1	10	6pF Max	1

Packaging Code

V _w (DC)	DC Working Voltage [V]	I _L
V _w (AC)	AC Working Voltage [V]	Ε _τ
V _B	Breakdown Votage [V @ 1mA _{DC}]	I _P
V _c	Clamping Voltage [V @ IVC]	Cap

Maximum leakage current at the working voltage [µA] Transient Energy Rating [J, 10x100µS] Peak Current Rating [A, 8x10µS] Maximum capacitance @ 1MHz and 0.5V_{RMS}



- · LC resonant circuits
- AC sampling circuitry

- Capacitance sensitive applications and more



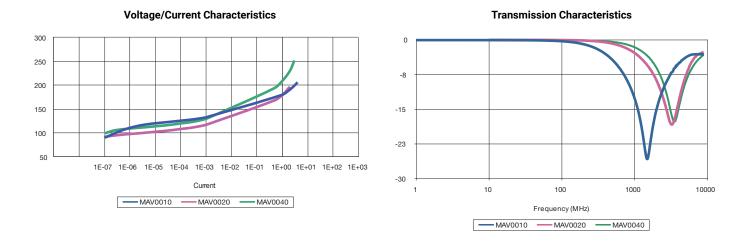
KYOCERa

Miniature AC Varistor – MAV

Low Power AC and Low Capacitance DC Circuit Protection

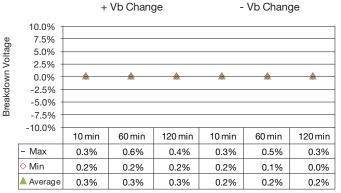


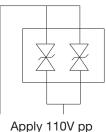
TYPICAL PERFORMANCE CURVES



TYPICAL PERFORMANCE CURVES

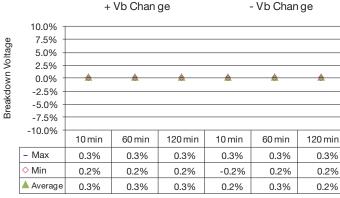
Impact of AC Voltage on Breakdown Voltage Parallel 110VPP @ 125 kHz

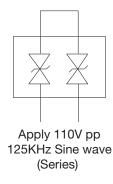




125KHz Sine wave (Parallel)

Series 110VPP @ 125 kHz





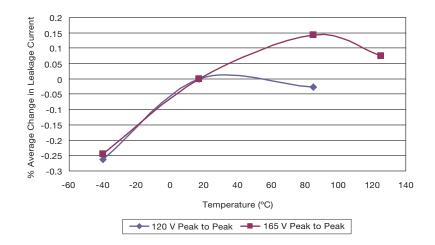
Impact of AC Voltage on Breakdown Voltage

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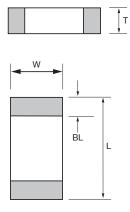
Miniature AC Varistor – MAV

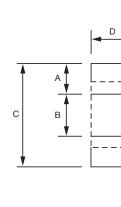
Low Power AC and Low Capacitance DC Circuit Protection

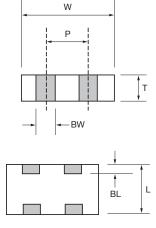


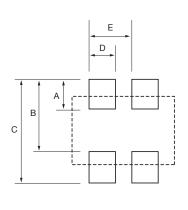


PHYSICAL DIMENSIONS AND RECOMMENDED PAD LAYOUT









KY<u>OCERa</u>

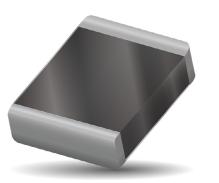
L	w	т	BW	BL	Р	Α	В	С	D	E	
	MAV0010										
1.60 ± 0.15 (0.063±0.006)	0.80 ± 0.15 (0.032±0.006)	0.90 Max (0.035) Max	N/A	0.35 ± 0.15 (0.014±0.006)	N/A	0.89 (0.035)	0.76 (0.030)	2.54 (0.100)	0.76 (0.030)	N/A	
	MAV0020										
1.00 ± 0.15 (0.039±0.006)	1.37 ± 0.15 (0.054±0.006)	0.66 Max (0.026) Max	0.36 ± 0.10 (0.014±0.004)	0.20 ± 0.10 (0.008±0.004)	0.64 REF (0.025)REF	0.46 (0.018)	0.74 (0.029)	1.20 (0.047)	0.30 (0.012)	0.64 (0.025)	
				MAV0040							
1.00±0.10 (0.040±0.004)	0.50±0.10 (0.020±0.004)	0.60 Max (0.024) Max	N/A	0.25±0.15 (0.010±0.006)	N/A	0.61 (0.024)	0.51 (0.020)	1.70 (0.067)	0.51 (0.020)	N/A	

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Glass Encapsulated TransGuard®

Multilayer Varistors





GENERAL DESCRIPTION

The Glass Encapsulated TransGuard® multilayer varistors are zinc oxide (ZnO) based ceramic semiconductor devices with non-linear, bi-directional V-I characteristics.

They have the advantage of offering bi-directional overvoltage protection as well as EMI/RFI attenuation in a single SMT package.

These large case size parts extend TransGuard range into high energy applications. In addition the glass encapsulation provides enhanced resistance against harsh environment or process such as acidic environment, salts or chlorite flux.

GENERAL CHARACTERISTICS

- **Operating Temperature:** . -55°C to 125°C
- Case Size: 1206-2200
- Working Voltage: 16-85Vdc
- . Energy: 0.7-12J
- Peak Current: 200-2000A •

HOW TO ORDER

ν Varistor

Gla Encaps Ch

G

FI	EA	UF	RE	S
		 	_	

- **Bi-Directional protection**
- EMI/RFI attenuation in off-state
- Multi-strike capability
- Sub 1nS response to ESD strike
- High energy / High current
- Glass Encapsulated

APPLICATIONS

- · Proffesional / Industrial / Commercial Applications
- IC Protection, DC motor protection
- Relays, Controllers, Sensors
- Smart Grids
- Alarms
- Various Applications where Glass Encapsulation is Needed for Harsh Environment / Acid-Resistance

R

Package

D = 7" reel

R = 7" reel

T = 13" reel

and more

101 = 100V

111 = 110V 121 = 120V 131 = 135V 161 = 165V 201 = 200V 251 = 250V

3	1812	16	P T	4	00
ass sulated	Chip Size	Working Voltage	Energy	Clampin	g Voltage
sulated hip	1206 1210 1812 2220 3220	Voltage 16 = 16Vdc 18 = 18Vdc 22 = 22Vdc 26 = 26Vdc 30 = 30Vdc 31 = 31Vdc 38 = 38Vdc 45 = 45Vdc 48 = 48Vdc 56 = 56Vdc 60 = 60Vdc 65 = 65Vdc 85 = 85Vdc 101 = 100Vdc	Rating D = 0.4J F = 0.7J H = 1.2J J = 1.5-1.6J K = 0.6J N = 1.1J R = 1.7J S = 2.0J P = 2.5-3.7J U = 4.0-5.0J W = 5.1-6.0J Y = 6.5-12J	380 = 38V 390 = 40V 400 = 42V 440 = 44V 540 = 54V 560 = 60V 570 = 57V 620 = 67V 650 = 65V 770 = 77V 900 = 90V	101 = 10 111 = 111 121 = 12 131 = 13 161 = 16 201 = 20 251 = 25
		101 = 100Vac			



Termination P = Ni/Sn plated

PHYSICAL DIMENSIONS: MM (INCHES)

Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
1206	3.20±0.20 (0.126±0.008)	1.60±0.20 (0.063±0.008)	1.70 (0.067)	0.94 max. (0.037 max.)
1210	3.20±0.20 (0.126±0.008)	2.49±0.20 (0.098±0.008)	1.70 (0.067)	0.14 max. (0.045 max.)
1812	4.50±0.30 (0.177±0.012)	3.20±0.30 (0.126±0.012)	2.00 (0.079) 2.50 (0.098)1)	1.00 max. (0.040 max.)
2220	5.70±0.40 (0.224±0.016)	5.00±0.40 (0.197±0.016)	2.50 (0.098)	1.00 max. (0.040 max.)
3220	8.20±0.40 (0.323±0.016)	5.00±0.40 (0.197±0.016)	2.50 max. (0.098 max.)	1.30 max. (0.051 max.)

1) Applicable for: VG181285W201, VG1812101W251, VG1812125U271

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Multilayer Varistors

ELECTRICAL CHARACTERISTICS

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	Ι	Ε _τ	I _P	Сар	Freq
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	VG120616K390	16	11	24.5±10%	40	1	15	0.6	200	900	K
VG181216P400 16 11 24.5±10% 42 5 10 2.9 1000 5000 K VG22016Y400 16 11 24.5±10% 42 10 10 7.2 1500 13000 K VG120618E380 18 14 22±10% 38 1.0 15 0.5 200 1000 K VG12018J380 18 14 22±10% 38 2.5 15 1.5 400 2300 K VG12018J400 18 13 25.5±10% 42 5 10 1.6 500 3100 K VG181218P440 18 14 22±10% 38 10 15 5.8 1200 18000 K VG220221440 22 17 27±10% 44 10 15 7.2 1200 18000 K VG120262F40 26 18 33.0±10% 54 15 1.7 400 1600 K <t< td=""><td>VG120616N390</td><td>16</td><td>11</td><td>24.5±10%</td><td>40</td><td>1</td><td>15</td><td>1.1</td><td>300</td><td>1300</td><td>K</td></t<>	VG120616N390	16	11	24.5±10%	40	1	15	1.1	300	1300	K
VG222016V400 16 11 24.5±10% 42 10 10 7.2 1500 13000 K VG120618200 18 14 22±10% 38 1.0 15 0.5 200 1000 K VG120618280 18 14 22±10% 38 2.5 15 1.5 400 2300 K VG120181400 18 13 25.5±10% 42 5 10 1.6 500 3100 K VG120181400 18 14 22.5±10% 44 5 15 2.9 800 5000 K VG22018980 18 14 2.2±10% 38 10 15 5.8 1200 18000 K VG22022Y440 22 17 27±10% 44 2.5 15 1.7 400 1600 K VG22022Y440 22 17 27±10% 44 10 15 6.8 1200 18000 K VG12102645540	VG181216P390	16	11	24.5±10%	40	5	15	2.9	1000	7000	K
VG120618D400 18 13 25.5±10% 42 1 15 0.4 150 1200 K VG12018J380 18 14 22±10% 38 1.0 15 0.5 200 1000 K VG121018J380 18 14 22±10% 38 2.5 15 1.5 400 2300 K VG121018J380 18 14 22±10% 38 5.0 15 2.3 800 5000 K VG181218P440 18 14 22±10% 38 10 15 5.8 1200 18000 K VG22022V440 22 17 27±10% 44 10 15 7.8 1200 18000 K VG12026F40 26 18 33.0±10% 54 1 15 0.7 200 600 K VG12026F540 26 20 35±10% 54 5 15 1.2 300 1200 K	VG181216P400	16	11	24.5±10%	42	5	10	2.9	1000	5000	K
VG120618E380 18 14 22±10% 38 1.0 15 0.5 200 1000 K VG121018J400 18 13 25.5±10% 42 5 10 1.6 500 3100 K VG121018J400 18 14 22±10% 38 5.0 15 2.3 800 5000 K VG121018J400 18 14 22.5±10% 44 5 15 2.9 800 5000 K VG12102R440 22 17 27±10% 44 10 15 7.4 400 1600 K VG22022Y440 22 17 30±10% 49 10 15 6.8 1200 18000 K VG121026H560 26 18 33.0±10% 54 2.5 15 1.2 300 1600 K VG121026H560 26 20 3±10% 54 2.5 15 3.0 800 3000 K	VG222016Y400	16	11	24.5±10%	42	10	10	7.2	1500	13000	K
VG121018J380 18 14 22±10% 38 2.5 15 1.5 400 2300 K VG121018J400 18 13 25.5±10% 42 5 10 1.6 500 3100 K VG181218P340 18 14 22±10% 38 5.0 15 2.9 800 5000 K VG121022R440 18 14 22±10% 38 10 15 5.8 1200 18000 K VG12022R440 22 17 27±10% 44 10 15 7.2 1200 18000 K VG120262F540 26 18 33.6±10% 54 1.5 1.9 400 1600 K VG121026F540 26 20 33±10% 54 2.5 15 3.0 800 3000 K VG121026F540 26 20 33±10% 57 5 15 3.0 800 3000 K <tr< td=""><td>VG120618D400</td><td>18</td><td>13</td><td>25.5±10%</td><td>42</td><td>1</td><td>15</td><td>0.4</td><td>150</td><td>1200</td><td>К</td></tr<>	VG120618D400	18	13	25.5±10%	42	1	15	0.4	150	1200	К
VG121018J400 18 13 25.5±10% 42 5 10 1.6 500 3100 K VG181218P380 18 14 22±10% 38 5.0 15 2.3 800 5000 K VG18218P440 18 14 22±10% 38 10 15 5.8 1200 18000 K VG22022V40 22 17 27±10% 44 10 15 5.8 1200 18000 K VG22022V440 22 17 27±10% 44 10 15 6.8 1200 12000 K VG22022V40 22 17 30±10% 54 1 15 0.7 200 600 K VG1210261560 26 18 33.0±10% 54 5 15 3.0 3000 K VG1210261560 26 23 35±10% 57 15 1.2 300 3000 K VG12102615670 </td <td>VG120618E380</td> <td>18</td> <td>14</td> <td>22±10%</td> <td>38</td> <td>1.0</td> <td>15</td> <td>0.5</td> <td>200</td> <td>1000</td> <td>К</td>	VG120618E380	18	14	22±10%	38	1.0	15	0.5	200	1000	К
VG181218P380 18 14 22±10% 38 5.0 15 2.3 800 5000 K VG181218P440 18 14 22.5±10% 44 5 15 2.9 800 5000 K VG22018W380 18 14 22.17 27±10% 44 2.5 15 1.7 400 1600 K VG22022Y440 22 17 27±10% 44 10 15 7.2 1200 18000 K VG22022Y440 22 17 30±10% 54 1 15 0.7 200 600 K VG1210265540 26 18 34.5±10% 60 5 15 1.2 300 1200 K VG181226P540 26 20 35±10% 57 5 15 2.5 600 3000 K VG22026Y570 26 23 35:010% 57 10 15 1.8 110 7000	VG121018J380	18	14	22±10%	38	2.5	15	1.5	400	2300	К
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG121018J400	18	13	25.5±10%	42	5	10	1.6	500	3100	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG181218P380	18	14	22±10%	38	5.0	15	2.3	800	5000	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG181218P440	18	14	27.5±10%	44	5	15	2.9	800	5000	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG222018W380	18	14	22±10%	38	10	15	5.8	1200	18000	К
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG121022R440	22	17	27±10%	44	2.5	15	1.7	400	1600	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG222022Y440	22	17	27±10%	44	10	15	7.2	1200	18000	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG222022Y490	22	17	30±10%	49	10	15	6.8	1200	12000	К
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG120626F540	26	18	33.0±10%	54	1	15	0.7	200	600	K
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		26	18	34.5±10%	60	5	15	1.2	300	1200	К
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	VG121026S540	26	20	33±10%	54	2.5	15	1.9	400	1600	К
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		26		35±10%	54	5	15	3.0	800	3000	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$					57		15				
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		26	-		54		15				
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		-	-					-			
VG121030H620 30 21 41.0±10% 67 5 15 1.2 280 1850 K VG181230Y650 30 21 39±10% 65 5 50 6.5 800 3500 K VG181230Y770 30 21 47.5±10% 77 5 50 6.5 800 3300 K VG120631M650 31 25 39±10% 65 2.5 15 1.7 300 1200 K VG121031R650 31 25 39±10% 65 5 15 3.7 800 2600 K VG120638N770 38 30 47.0±10% 77 1.0 15 1.1 200 500 K VG121038S770 38 30 47.0±10% 77 5 15 4.2 800 1300 K VG22038V770 38 30 47.0±10% 77 10 15 12 2000 4200 K											
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$											
VG181230Y770 30 21 47.5±10% 77 5 50 6.5 800 3300 K VG120631M650 31 25 39±10% 65 1.0 15 1.0 200 700 K VG121031R650 31 25 39±10% 65 2.5 15 1.7 300 1200 K VG181231P650 31 25 39±10% 65 5 15 3.7 800 2600 K VG222031Y650 31 25 39.0±10% 65 10 15 9.6 1200 6100 K VG120638N770 38 30 47.0±10% 77 1.0 15 1.1 200 500 K VG181238U770 38 30 47.0±10% 77 10 15 1.2 2000 4200 K VG22038Y770 38 30 47.10% 92 10.0 15 1.5 400 2600 K </td <td></td>											
VG120631M650 31 25 39±10% 65 1.0 15 1.0 200 700 K VG121031R650 31 25 39±10% 65 2.5 15 1.7 300 1200 K VG181231P650 31 25 39±10% 65 5 15 3.7 800 2600 K VG222031Y650 31 25 39.0±10% 65 10 15 9.6 1200 6100 K VG120638N770 38 30 47.0±10% 77 1.0 15 1.1 200 500 K VG121038S770 38 30 47.0±10% 77 15 15 4.2 800 1300 K VG222038Y770 38 30 47.0±10% 77 10 15 1.5 400 2600 K VG12104S900 45 35 56±10% 90 2.5 15 2 300 800 K						-					
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$											
VG181231P650 31 25 39±10% 65 5 15 3.7 800 2600 K VG222031Y650 31 25 39.0±10% 65 10 15 9.6 1200 6100 K VG120638N770 38 30 47±10% 77 1.0 15 1.1 200 500 K VG121038S770 38 30 47.0±10% 77 2.5 15 2 400 1000 K VG181238U770 38 30 47.0±10% 77 5 15 4.2 800 1300 K VG222038Y770 38 30 47.0±10% 77 10 15 1.5 400 2600 K VG322038J920 38 30 47.10% 92 10.0 15 1.5 400 2600 K VG181245U900 45 35 56±10% 90 5 15 4.0 500 1200 K		-	-			-					
VG222031Y650 31 25 39.0±10% 65 10 15 9.6 1200 6100 K VG120638N770 38 30 47±10% 77 1.0 15 1.1 200 500 K VG12038S770 38 30 47.0±10% 77 2.5 15 2 400 1000 K VG121038S770 38 30 47.0±10% 77 2.5 15 2 400 1000 K VG181238U770 38 30 47.0±10% 77 5 15 4.2 800 1300 K VG222038J920 38 30 47.0±10% 92 10.0 15 1.5 4.00 2600 K VG322038J920 45 35 56.0±10% 90 2.5 15 2 300 800 K VG121045S900 45 35 56.0±10% 90 10 15 12 1000 5000 K		-	-			-	-				
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VG222085Y161 85 60 100±10% 165 10 15 6.8 800 1500 K							-	-			

TELECOM APPLICATIONS

Parts are specified in accordance to CCITT 10x700µs pulse test in addition to standard industrial specifications.

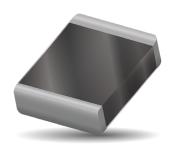
Part	Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	E _T	I _P	Сар	Freq	ССІТТ
VG181	285W201	85	60	110±10%	200	45	15	6.0	400	800	К	45
VG181	2101W251	100	75	120±10%	250	45	15	6.0	400	500	K	45
VG181	2125U271	125U271 125 95 150±10% 270 4						5	250	250	K	45
V _w (DC) V _w (AC) V _B V _c	(DC) DC Working Voltage [V] (AC) AC Working Voltage [V] Typical Breakdown Votage [V @ 1mADC, 25°C]						E _T I _P Cap	Peak C Typica 0.5VRN	current Ra I capacit MS, 25°C,	ating [A, 8 ance [pF] M = 1MH	@ frequ z, K = 1kH	iency speci Iz
I _{vc}	Test Curre	nt for VC [A		CCITT	10 puls	ses applie	ed at 1 mir	n intervals	s [A, 10x700			
I _L	Maximum	leakage cui	rent at the	e working vol	tage, 25°0	C [μΑ]						

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Glass Encapsulated TransGuard® Automotive Series



Multilayer Varistors for Automotive Applications



GENERAL CHARACTERISTICS

- Operating Temperature: -55°C to 125°C
- Case Size: 1206-2200
- Working Voltage: 16-65Vdc
- Energy: 07-12J
- Peak Current: 200-2000A

GENERAL DESCRIPTION

The Glass Encapsulated TransGuard® Automotive Series are zinc oxide (ZnO) based ceramic semiconductor devices with non-linear, bi-directional voltage-current characteristics.

They have the advantage of offering bi-directional overvoltage protection as well as EMI/RFI attenuation in a single SMT package. The Automotive Series high current and high energy handling capability make them well suited for protection against automotive related transients.

These large case size parts extend TransGuard range into high energy applications. In addition the glass encapsulation provides enhanced resistance against harsh environment or process such as acidic environment, salts or chlorite flux.

FEATURES

- High Reliability
- High Energy Absorption (Load Dump)
- High Current Handling
- Bi-Directional protection
- EMI/RFI attenuation in off-state
- Multi-strike capability
- Sub 1nS response to ESD strike
- AEC Q200 Qualified

APPLICATIONS

- · Various Automotive Applications
- Internal Combustion Engine (ICE) Vehicles
- Hybrid Electric Vehicles (HEV)
- Plug-in Hybrid Electric Vehicles (PHEV)
- Commercial Vehicles
- Sensors
 DC Motor
- LIN BUS
 Relays
- ECU
 and more
- Applications where Glass Encapsulation is needed for Harsh Environment/Acid-Resistance

HOW TO ORDER

V	G	AG	1812	16	Ρ	400	R	Р
Т	Т	Т		Т	T		Т	Т
Varistor	Glass	Automotive	Chip Size	Working	Energy	Clamping Voltage	Package	Termination
	Encapsulated	Series	1206	Voltage	Rating	390 = 40V	D = 7" reel	P = Ni/Sn plated
	Chip		1210	16 = 16Vdc	D= 0.4J	400 = 42V	R = 7" reel	
			1812	18 = 18Vdc	F= 0.7J	440 = 44V	T = 13" reel	
			2220	22 = 22Vdc	H= 1.2J	490 = 49V		
			3220	26 = 26Vdc	J = 1.6J	540 = 54V		
				30 = 30Vdc	K = 0.6J	560 = 60V		
				31 = 31Vdc	N = 1.1J	570 = 57V		
				34 = 34Vdc	S = 2.0J	650 = 65V		
				42 = 42Vdc	P = 2.5-3.7J	770 = 77V		
				48 = 48Vdc	U = 4.0-5.0J	900 = 90V		
				60 = 60Vdc	Y = 6.5-12J	101 = 100V		
				65 = 65Vdc		121 = 120V		
						131 = 135V		

PHYSICAL DIMENSIONS:

				. ,
Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
1206	3.20±0.20	1.60±0.20	1.70	0.94 max.
	(0.126±0.008)	(0.063±0.008)	(0.067)	(0.037 max.)
1210	3.20±0.20	2.49±0.20	1.70	0.14 max.
	(0.126±0.008)	(0.098±0.008)	(0.067)	(0.045 max.)
1812	4.50±0.30	3.20±0.30	2.00	1.00 max.
	(0.177±0.012)	(0.126±0.012)	(0.079)	(0.040 max.)
2220	5.70±0.40	5.00±0.40	2.50	1.00 max.
	(0.224±0.016)	(0.197±0.016)	(0.098)	(0.040 max.)
3220	8.20±0.40	5.00±0.40	2.50 max.	1.30 max.
	(0.323±0.016)	(0.197±0.016)	(0.098 max.)	(0.051 max.)

mm (inches)



Multilayer Varistors for Automotive Applications

ELECTRICAL CHARACTERISTICS

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	Ε _τ	ELD	I _P	Сар	Freq	V_{Jump}	P _{Diss, MAX}
VGAS120616K390	16	11	24.5±10%	40	1	15	0.6	1.5	200	900	K	27.5	0.01
VGAS120616N390	16	11	24.5±10%	40	1	15	1.1	2	200	1300	K	27.5	0.01
VGAS121016S390	16	14	24.5±10%	40	2.5	15	2.0	5.00	500	3000	K	27.5	0.01
VGAS121016J400	16	13	25.5±10%	42	5	10	1.6	3	500	3100	K	27.5	0.03
VGAS181216P390	16	11	24.5±10%	40	5	15	2.9	10	1000	7000	K	27.5	0.07
VGAS181216P400	16	11	24.5±10%	42	5	10	2.9	10	1000	5000	K	27.5	0.07
VGAS222016Y390	16	11	24.5±10%	40	10	15	10.2	45	1500	20000	K	27.5	0.08
VGAS222016Y400	16	11	24.5±10%	42	10	10	7.2	25	1500	13000	K	27.5	0.10
VGAS120618D400	18	13	25.5±10%	42	1	15	0.4	1.5	150	1200	K	27.5	0.008
VGAS121018J400	18	13	25.5±10%	42	5	15	1.6	3.0	500	2300	K	27.5	0.03
VGAS181218P440	18	14	27.5±10%	44	5	15	2.9	6	800	5000	K	27.5	0.05
VGAS222022Y490	22	17	30.0±10%	49	10	15	6.8	25	1200	12000	K	27.5	0.03
VGAS120626F540	26	18	33.0±10%	54	1	15	0.7	1.5	200	600	К	27.5	0.008
VGAS121026H560	26	18	34.5±10%	60	5	15	1.2	3	300	1200	K	27.5	0.018
VGAS181226P570	26	23	35.0±10%	57	5	15	2.5	8	600	3000	K	30	0.015
VGAS222026Y570	26	23	35.0±10%	57	10	15	6.8	25	1100	7000	K	30	0.03
VGAS322026Z570	26	23	35.0±10%	57	10	15	13.0	50	1800	15000	K	30	0.04
VGAS121030H620	30	21	41.0±10%	67	5	15	1.2	3	280	1850	K	30	0.018
VGAS120631M650	31	25	39.0±10%	65	1	15	1	2.5	200	700	K	30	0.03
VGAS121031R650	31	25	39.0±10%	65	2.5	15	1.7	4.5	300	1200	K	30	0.05
VGAS181231P650	31	25	39.0±10%	65	5	15	3.7	8	800	2600	K	30	0.06
VGAS222031Y650	31	25	39.0±10%	65	10	15	9.6	23	1200	6100	K	30	0.03
VGAS120634N770	34	30	47.0±10%	77	1.0	15	1.1	1.50	200	500	K	47	0.02
VGAS121034S770	34	30	47.0±10%	77	2.5	15	2	3	400	1000	K	48	0.04
VGAS181234U770	34	30	47.0±10%	77	5	15	5	6.1	800	1500	K	48	0.08
VGAS222034Y770	34	30	47.0±10%	77	10	15	12	25	2000	6300	K	48	0.24
VGAS181242U900	42	35	56.0±10%	90	5	15	4.0	6	500	1200	K	48	0.015
VGAS222042Y900	42	37	56.0±10%	90	10	15	12	24	1000	5000	K	48	0.06
VGAS121048H101	48	34	62.0±10%	100	5	15	1.2	-	250	500	К	48	0.022
VGAS181256U111	56	40	68.0±10%	110	5.0	15	4.8	-	500	1100	K	48	0.04
VGAS121060J121	60	42	76.0±10%	120	5	15	1.5	-	250	400	K	48	0.03
VGAS121065P131	65	50	82.0±10%	135	2.5	15	2.7	-	350	600	K	48	0.05
VGAS181265U131	65	50	82.0±10%	135	5.0	15	4.5	-	400	800	K	48	0.03
VGAS222065Y131	65	50	82.0±10%	135	10	15	6.5	-	1100	3000	K	48	0.06
VGAS181285U161	85	60	100±10%	165	5.0	15	4.5	-	400	500	K	48	0.04

Ε_τ

 E_{LD}

I_P

Cap

 V_{Jump}

PDISS

V _w (DC)	DC Working Voltage [V]
• w(DO)	Do wonding voltage [v]

$V_w(AC)$ AC Working Voltage [V]

- V_B Typical Breakdown Votage [V @ 1mADC, 25°C]
- V_c Clamping Voltage [V @ IIVC]
- I_{vc} Test Current for VC [A, 8x20µs]
- I_L Maximum leakage current at the working voltage, 25°C [μA]

Transient Energy Rating [J, 10x1000µS]

Load Dump Energy (x10) [J]

Peak Current Rating [A, 8x20µS]

Typical capacitance [pF] @ frequency specified and

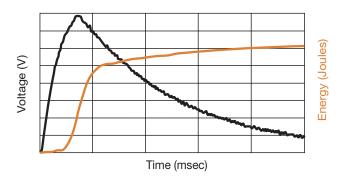
0.5V_{RMS}, 25°C, M = 1MHz, K = 1kHz

Jump Start [V, 5 min]

Power Dissipation [W]

AUTOMOTIVE SERIES – LOAD DUMP TEST ACCORDING TO ISO DP7637 REV 2 PULSE 5

Automotive Load Dump Pulse (According to ISO 7637 Pulse 5)



When using the test method indicated below, the amount of Energy dissipated by the varistor must not exceed the Load Dump Energy value specified in the product table.

12V SYSTEMS

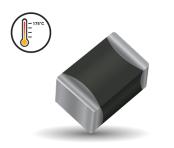
VGAS181216P400	0.5Ω	1Ω	4Ω
100ms	46	52	72
200ms	37	41	59
400ms	32	35	51
VGAS222016Y400	0.5Ω	1Ω	4Ω
100ms	53	60	77
200ms	50	55	73
400ms	47	50	66

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High Temp. Automotive VT Series

+150°C and 175°C Rated Varistors





GENERAL DESCRIPTION

High Temperature 150/175°C Multi-Layer Varistors are designed for underhood and other high temperature automotive or industrial applications. Parts are AEC-Q200 qualified.

They offer bi-directional overvoltage protection as well as EMI/RFI attenuation in a single SMT package. This allows designers the ability to combine the circuit protection and EMI/ RFI attenuation function into a single highly reliable device.

Products have been tested, qualified, and specified to 150/175°C and they do not require any derating over specified operating temperature range.

GENERAL DESCRIPTION

- Operating Temp.:
- VTA3: -55 to +150°C VTA7: -55 to +175°C
- Working Voltage: 14 31Vdc
- Case Size: 0603 1210

FEATURES

- +150/175°C rated, with no derating
- · High Reliability
- AEC Q200Qualified
- Bi-Directional protection

48=48Vdc

- EMI/RFI attenuation
- ESD rated to 25kV (HBM ESD Level 6)

APPLICATIONS

- Under hood
- Down Hole Drilling
- High temperature Automotive and Industrial Applications

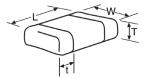
HOW TO ORDER

VT	A7	0603	18	A	<u>400</u>	R	P	
Varistor Temp Rated	Automotive 175°C A3 = 150°C A7 = 175°C	Case Size 0603 0805 1206 1210	Working Voltage 12=12Vdc 14=14Vdc 18=18VdC 26=26Vdc 31=31Vdc 38=38Vdc	Energy Rating A=0.1J C=0.3J E=0.5J J=1.6J	Clamping Voltage 300=32V 350=35V 400=42V 650=65V 670=67V	Package D = 7" (1,000) R = 7" (4,000) T = 13" (10,000)	Termination P = Ni/Sn plated Z = FLEXITERM®	MSL 1 Pb Free 260°C

mm(inches)

DIMENSIONS

Size (EIA)	Length (L)	Width (W)	Max Thickness (T)	Land Length (t)
0603	1.60±0.15	0.80±0.15	0.90	0.35±0.15
	(0.063±0.006)	(0.031±0.006)	(0.035)	(0.014±0.006)
0805	2.01±0.20	1.25±0.20	1.02	0.71 max.
	(0.079±0.008)	(0.049±0.008)	(0.040)	(0.028 max.)
1206	3.20±0.20	1.60±0.20	1.02	0.94 max.
	(0.126±0.008)	(0.063±0.008)	(0.040)	(0.037 max.)
1210	3.20±0.20	2.49±0.20	1.70	1.14 max.
	(0.126±0.008)	(0.098±0.008)	(0.067)	(0.045 max.)



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+150°C and 175°C Rated Varistors

ELECTRICAL CHARACTERISTICS VTA3 (150°C)

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	E _T	E _{LD}	I _P	Сар	Freq	V _{Jump}	P _{Diss. Max}
Part Number	Vdc	Vac	V	V	Α	μA	J	J	Α	рF		v	W
VTA3040205X150	5.6	4	8.5±20%	18	1	10	0.05	-	20	200	К	-	0.001
VTA3080505C150	5.6	4	8.5±20%	18	1	10	0.5	-	200	3000	К	-	0.01
VTA3080512D250	12	8.5	16±15%	27	1	10	0.4	-	200	900	К	-	0.008
VTA3080514C300	14	10	18.5±12%	32	1	10	0.3	0.7	120	900	К	20	0.006
VTA3120614E300	14	10	18.5±12%	32	1	10	0.5	1.3	200	1400	К	20	0.01
VTA3121014J300	14	10	18.5±12%	32	1	10	1.6	3	500	5000	К	20	0.03
VTA3222014Y350	14	10	20.5±10%	35	5	15	7.5	35	2000	55000	К	20	0.15
VTA30402018X400	18	13	25.5±10%	42	1	10	0.05	-	20	60	К	27.5	0.001
VTA3120618K390	18	13	24.5±10%	40	1	10	0.6	1.5	200	1500	К	27.5	0.012
VTA3121018J390	18	13	25.5±10%	42	5	10	1.6	3	500	2200	К	27.5	0.03
VTA3060322C400	22	17	27±10%	44	1	10	0.3	-	30	500	К	27.5	0.011
VTA3120626F540	26	18	33±10%	54	1	10	0.7	1.5	200	600	К	27.5	0.014
VTA3121026H560	26	18	34.5±10%	60	5	10	1.2	3	2150	300	К	27.5	0.02
VTA3120631M650	31	25	39±10%	65	1	10	1	2	200	1100	К	29	0.02
VTA3121031R650	31	25	39±10%	65	2.5	10	1.7	4.5	300	1500	К	29	0.03
VTA3080538E770	38	30	47±10%	77	1	10	0.5	1	120	275	К	48	0.01
VTA3120642R800	42	32	51±10%	80	1	10	1.7	2	250	750	К	48	0.003

ELECTRICAL CHARACTERISTICS VTA7 (175°C)

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	ار	E _T	E _{LD}	I _P	Сар	Freq	V _{Jump}	P _{Diss. Max}
Part Nulliber	Vdc	Vac	V	v	Α	μA	J	J	Α	рF		V	W
VTA7060314A300	14	10	18.5±12%	32	1	10	0.1	-	50	400	K	20	0.003
VTA7060314E350	14	10	20.5±10%	35	1	10	0.5	-	120	900	K	20	0.01
VTA7060318A400	18	13	23±10%	42	1	10	0.1	0.25	30	275	K	27.5	0.003
VTA7080518C400	18	13	25.5±10%	42	1	10	0.3	1	120	450	K	27.5	0.006
VTA7080526D580	26	18	34.5±10%	60	1	10	0.1	0.25	30	155	K	27.5	0.002
VTA7080526D580	26	18	34.5±10%	60	1	10	0.4	0.6	100	275	K	29	0.008
VTA7120630M650	30	21	41±10%	67	1	10	1	1	200	800	K	29	0.02
VTA7060331A670	31	25	39±10%	67	1	10	0.1	0.25	30	90	М	29	0.003
VTA7080531C650	31	25	39±10%	65	1	10	0.3	1	80	275	K	29	0.006
VTA7120648M101	48	34	62±10%	100	1	10	1.0	1.5	200	300	K	48	0.02

- $V_w(DC)$ DC Working Voltage [V]
- $V_w(AC)$ AC Working Voltage [V]
- $V_{_B}$ Typical Breakdown Votage [V @ 1mA_{DC}]
- V_c Clamping Voltage [V @I_{IV}]
- I_{vc} Test Current for V_c
- $\rm I_{\scriptscriptstyle L}$ Maximum leakage current at the working voltage, 25°C [µA]
- E_τ Transient Energy Rating [J, 10x1000μS]
- E_{LD} Load Dump Energy (x10)
- I_P Peak Current Rating [A, 8x20µS]

Cap Typical capacitance [pF] @ frequency specified and $0.5V_{RMS}$, 25°C V_{Jump} Jump Start (V)

 $\mathsf{P}_{_{\text{Diss.\,Max}}}$ Power Dissipation (W)

The following series are available with industry proven KYOCERA AVX flexible termination system **FLEXITERM®**: VTA30603, VTA30805, VTA31206, VTA31210 **FLEXITERM®** is designed to enhance the mechanical flexure and temperature cycling performance provides up to 5mm of flexure without internal cracks. VTA70603, VTA70805, VTA71206 series with Flexterm used only up to 150°C

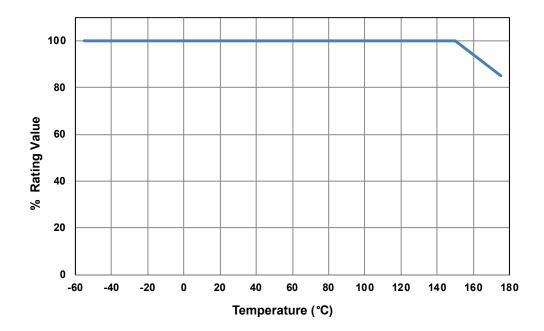
online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.



ESD RATING

Part Number	IEC 61000-4-2	ISO ⁻	10605	AEC-Q200 (Lvl.6)
i art Number	150 pF / 330 Ω	330 pF / 330 Ω	330 pF / 2000 Ω	150 pF / 2000 Ω
	Contact Discharge		Contact Discharge	Air Discharge
		VTA3 (150°C)		
VTA3080514C300	30kV	30kV	30kV	25kV
VTA3120614E300	30kV	30kV	30kV 30kV	
VTA3121014J300	30kV	30kV	30kV	25kV
VTA3121031R650	30kV	30kV	30kV	25kV
		VTA7 (175°C)		
VTA7060318A400	25 kV	30 kV	30 kV	25 kV
VTA7080518C400	30 kV	30 kV	30 kV	25 kV
VTA7060331A670	30 kV	30 kV 30 kV		25 kV
VTA7080531C650	30 kV	30 kV	30 kV	25 kV

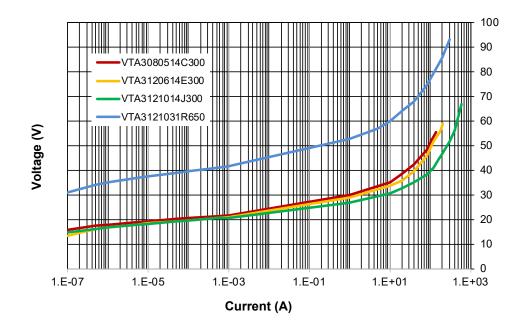
VTA3 (+150°C): POWER DERATING CURVE (CURRENT, ENERGY, POWER)



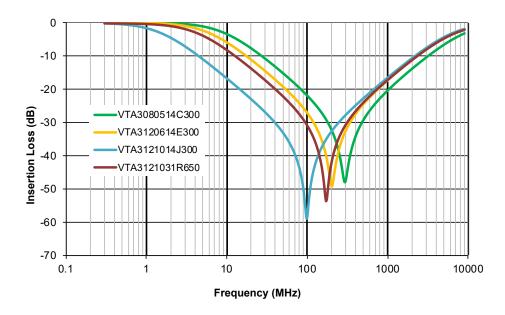
KYDEER The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.



VTA3 (+150°C): V-I CHARACTERISTICS



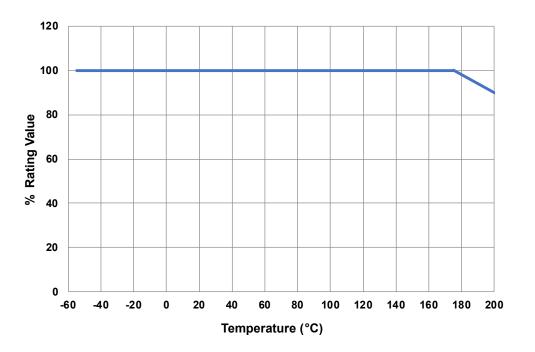
VTA3 (+150°C): FORWARD TRANSMISSION CHARACTERISTICS (S21)



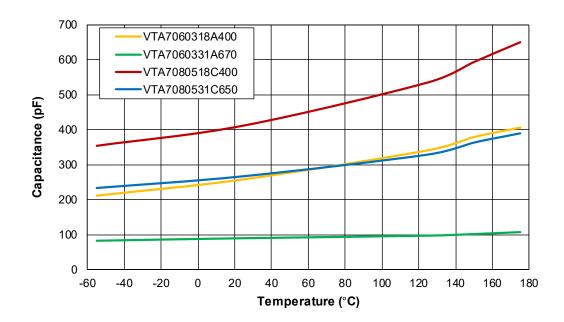
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VTA7 (+175°C): POWER DERATING CURVE (CURRENT, ENERGY, POWER)



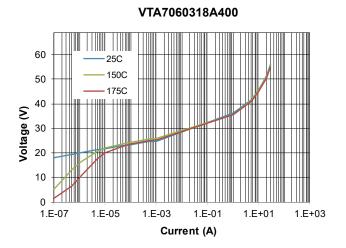
VTA7 (+175°C): CAPACITANCE VS TEMPERATURE



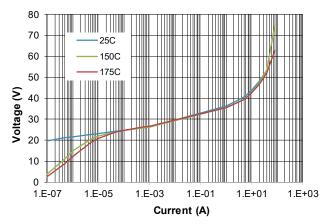
KYDCERR The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

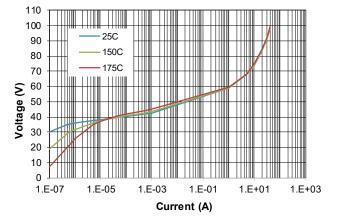
High Temp. Automotive VT Series +150°C and 175°C Rated Varistors

VTA7 (+175°C): V-I CHARACTERISTICS



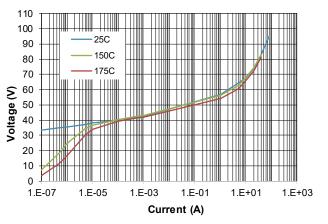
VTA7080518C400

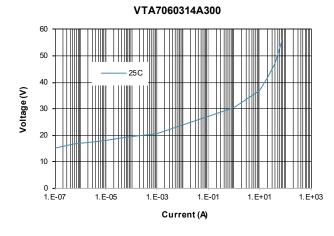




VTA7060331A650

VTA7080531C650

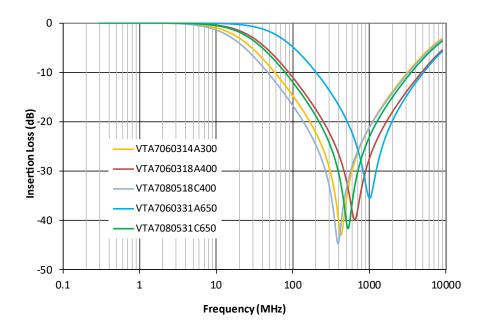




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VTA7 (+175°C): FORWARD TRANSMISSION CHARACTERISTICS (S21)

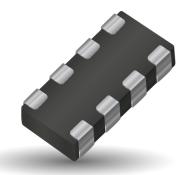


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High Temp. Automotive CAN Series

150°C Rated Varistors





GENERAL DESCRIPTION

KYOCERA AVX High Temperature Multi-Layer Varistors are designed for underhood applications. Products have been tested, qualified, and specified to 150°C. The MLV advantage is EMI/RFI attenuation in the off state. This allows designers the ability to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device.

FEATURES

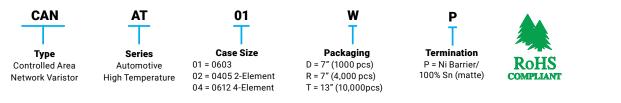
- Operating Temperature:
- -55°C to +150°C • AEC Q200 qualified
- ESD rating to 25kV contact
- EMI/RFI attenuation in off state
- EMI/RFT attenuation in on state
- Excellent current and energy handling

APPLICATIONS

- Under hood
- Down Hole Drilling
- High temperature applications
- Communication Bus
- Sensors
- RF Circuits
- · Capacitance sensitive applications and more

CAN HIGH TEMPERATURE SERIES

HOW TO ORDER

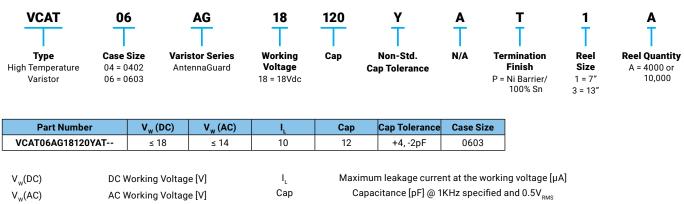


Part Number	V _w (DC)	V _w (AC)	V _B	I,	E _T	I _p	Сар	Case Size	Elements
CANAT01	≤ 18	≤ 14	120	10	0.015	4	22	0603	1
CANAT02	≤ 18	≤ 14	70	10	0.015	4	22	0405	2
CANAT04	≤ 18	≤ 14	100	10	0.015	4	22	0612	4

V _w (DC)	DC Working Voltage [V]	I _L	Maximum leakage current at the working voltage [μ A]
V _w (AC)	AC Working Voltage [V]	Ε _τ	Transient Energy Rating [J, 10x1000µS]
 V _в	Breakdown Votage [V @ 1mADC]	I _P	Peak Current Rating [A, 8x20µS]
V _c	Clamping Voltage [V @ IVC]	Сар	Capacitance [pF] @ 1KHz specified and 0.5V _{RMS}

ANTENNAGUARD HIGH TEMPERATURE SERIES

HOW TO ORDER

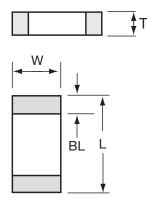


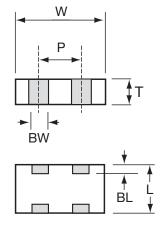
KYDEERA AWXXX The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

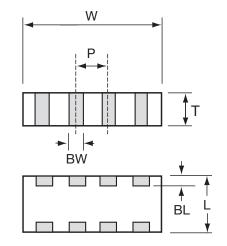
High Temp. Automotive CAN Series

150°C Rated Varistors

PHYSICAL DIMENSIONS







mm (inches)

mm (inches)

mm (inches)

KY<u>OCERa</u>

0603 DISCRETE DIMENSIONS

L	W	Т	BW	BL	Р
1.60±0.15 (0.063±0.006)	0.80±0.15 (0.032±0.006)	0.90 MAX (0.035 MAX)	N/A	0.35±0.15 (0.014±0.006)	N/A

0405 2 ELEMENTS ARRAY DIMENSIONS

L	W	Т	BW	BL	Р
1.00±0.15	1.37±0.15	0.66 MAX	0.36±0.10	0.20±0.10	0.64 REF
(0.039±0.006)	(0.054±0.006)	(0.026 MAX)	(0.014±0.004)	(0.008±0.004)	(0.025 REF)

0612 4 ELEMENTS ARRAY DIMENSIONS

W Т BW BL Ρ L 0.18 +0.25 -0.08 +0.10 -0.00 0.76 REF 1.60±0.20 3.20±0.20 1.22 MAX 0.41±0.10 (0.016±0.004) (0.030 REF) (0.063 ± 0.008) (0.126±0.008) (0.048 MAX)

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High Temp. Low Leakage Automotive Varistors

150°C Rated Low Leakage Automotive Varistors



GENERAL DESCRIPTION

KYOCERA AVX High Temperature Low Leakage Multi-Layer Varistors are designed for underhood and high temperature applications where low leakage component is required Parts are tested, qualified and specified to 150°C.

The MLV advantage is EMI/RFI attenuation in the off state. This allows designers the ability to to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device.

GENERAL CHARACTERISTICS

Operating Temperature: -55°C to +150°C

FEATURES

- Rated at 150°C
- AEC Q200 qualified • ESD rating to 25kV
- (HBM ESD Level 6) EMI/RFI attenuation in off state
- Very Low Leakage

APPLICATIONS

- Under hood
- High temperature applications
- · Bus Interface Protection
- CAN Bus
- BCM, TCU

· Capacitance sensitive applications and more

COMMUNICATION BUS - HIGH TEMPERATURE LOW LEAKAGE VARISTOR

Maximum leakage current at the working voltage, 25°C [µA]

HOW TO ORDER

Type Controlled Area Network Varistor	Se Auto High Te	eries motive mperature Leakage	07 Case Size 07 = 0603	D = 7" R = 7"	R ckaging (1000 pcs) (4,000 pcs) (10,000 pcs))	P Termin P = Ni Barrie	ation	COMPLIANT				
PN	VW (DC)	VW (AC)	VB	vc	IVC	IL	ET	IP	Тур Сар	Cap Tol	Freq	VJump	PDiss max
CANATL07	32	25	61±15%	120	1	<1	0.05	5	10	±50%	М	27.5	0.003
V _w (DC) V _w (AC) V _B V _c	DC Working Voltage [V] AC Working Voltage [V] Breakdown Votage [V @ 1mADC, 25°C] Clamping Voltage [V @ IVC] Test Current for VC [A, 8x20µs]						E _T I _P Cap V _{Jump}	Ca	Peak pacitance	Current R [pF] @ 1K Jump Sta	ating [A, 8 Hz specifi irt [V, 5 mii	ed and 0.5V n]	RMS
I _{vc}	Aovinouno L		rent for VC [A, 8x2				P _{DISS}		М	ax Power I	Dissipatior	n [W]	

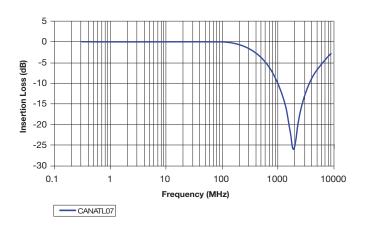
KIDCERE | The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

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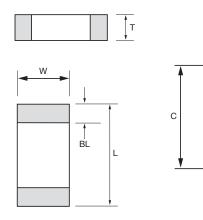
S21 CHARACTERISTICS



PHYSICAL DIMENSIONS AND RECOMMENDED PAD LAYOUT

Α

В



0603 DISCRETE DIMENSIONS

	L	W	Т	BL
ſ	1.60±0.15	0.80±0.15	0.90 MAX	0.35±0.15
	(0.063±0.006)	(0.032±0.006)	(0.035 MAX)	(0.014±0.006)

0603 SOLDERING PAD

mm (inches)

mm (inches)

А	В	С	D
0.89	0.76	2.54	0.76
(0.035)	(0.030)	(0.100)	(0.030)

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Radial Leaded Automotive TransGuard®

Radial Leaded Varistors





GENERAL DESCRIPTION

KYOCERA AVX Radial Leaded Multi-Layer Varistors are AEC-Q200 Qualified and are designed for durability in harsh environments or applications where leaded component is prefered. The MLV advantage is bi-directional transient voltage protection and EMI/RFI attenuation in the off state. This allows designers to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device.

GENERAL CHARACTERISTICS • Operating Temperatures:

-55°C to +125°C

Working Voltage:

18-48Vdc

FEATURES

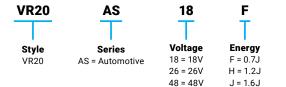
- · AEC Q200 qualified
- ESD rated to 25kV (HBM ESD Level 6)
- · EMI/RFI attenuation in off state

· Excellent current and energy handling

APPLICATIONS

- · Harsh environment
- Inductive switching
- DC Motors
- Water pump
- Fuel pump
- · Relays and more

HOW TO ORDER



	••••
,	Clamping
	Voltage
J	390 = 42V
J	540 = 54V
	560 = 60V

390

101 = 100V

Pack	nine
Blank	•
TR1 = T&R	Star
TP2 = T&P	Star

g ılk ndard 1 TR2 = T&R Standard 2

TR2



ELECTRICAL CHARACTERISTICS

Part Number	V _w DC	V _w AC	V _B	V _c	I _{vc}	I _L	Ε _τ	ELD	l _p	Сар	Freq	V _{JUMP}	P _{DISS}
VR20AS18J390	18.0	13.0	25.5±10%	42	5	10	1.6	3	500	3100	К	27.5	0.030
VR20AS26F540	26.0	18.0	33.0±10%	54	1	15	0.7	1.5	200	600	К	27.5	0.008
VR20AS26H560	26.0	18.0	34.5±10%	60	5	10	1.2	3	300	1200	К	27.5	0.018
VR20AS48H101	48.0	34.0	62.0±10%	100	1	10	1.2	-	250	500	К	48	0.022

R

Leads

R = RoHS

Compliant

V_w(DC)

- DC Working Voltage [V] AC Working Voltage [V] V_w(AC)
 - V_B Typical Breakdown Votage [V @ 1mA_{pc}]
 - Clamping Voltage [V @ I
 - ٧_c Test Current for V
 - Maximum leakage current at the working voltage [µA]

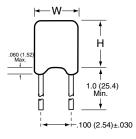
E, Transient Energy Rating [J, 10x1000µS]

E_{LD} Load Dump Energy (x10) [J]

Peak Current Rating [A, 8x20µS]

- Typical capacitance [pF] @ frequency specified and 0.5V_{RMS} Cap
- V_{Jump} P_{DISS} Jump Start (V)
 - Power Dissipation (W)

PHYSICAL DIMENSIONS



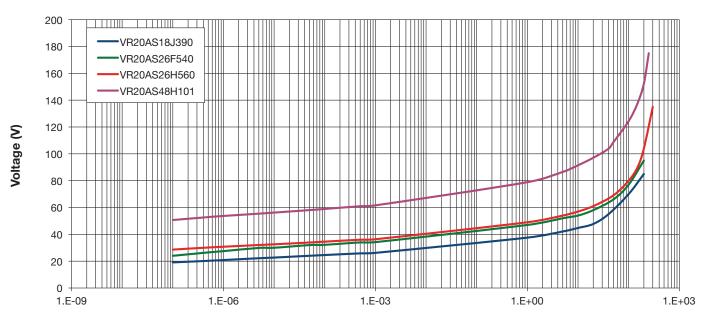
				m	m (inches)
Style	Width (W)	Height (H)	Thickness (T)	Lead Spacing	Lead Diameter
VR20	5.59 Max (0.220)	5.08 Max (0.200)	3.175 Max (0.125)	2.54 (0.100)	0.508) (0.020

Radial Leaded Automotive TransGuard®

Radial Leaded Varistors

TYPICAL PERFORMANCE CURVES

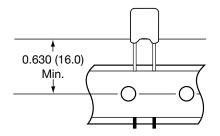
Typical Voltage Current Characteristics



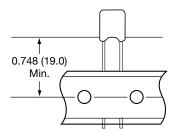
Current (Amps)

TAPE & REEL PACKAGING OPTIONS

TR1 Tape & Reel Standard 1



TR2 Tape & Reel Standard 2



Radial Leaded High Temp. Automotive TransGuard®

150°C Rated Radial Leaded Varistors



APPLICATIONS

Down Hole Drilling

Inductive Loads High Temperature/

Harsh environment and more

Under hood

DC Motors

Relays



GENERAL DESCRIPTION

KYOCERA AVX High Temperature Multi-Layer Varistors are designed for underhood applications. Products have been tested, gualified, and specified to 150°C. The Radial Leaded TransGuard is built for durability in harsh environments. The MLV advantage is EMI/RFI attenuation in the off state. This allows designers to combine the circuit protection and EMI/RFI attenuation function into a single highly reliable device.

GENERAL CHARACTERISTICS

Operating Temperatures:

- -55°C to +150°C Working Voltage:
- 14-48Vdc

FEATURES

- Rated at 150°C
- AEC Q200 qualified
- ESD rated to 25kV (HBM ESD Level 6)
- · EMI/RFI attenuation in off state
- · Excellent current and energy handling

HOW TO ORDER

VR15	AT	18	Α	650	R	TR2	
	T	Т	Т	T	Т	T	
Style VR15	Series AT = 150°C	Voltage 14 = 14V	Energy A = 0.1J	Clamping Voltage	Leads R = RoHS	Packaging Blank = Bulk	RoHS
VR20	Automotive	18 = 18V 26 = 26V 48 = 48V	D = 0.4J S = 2.0J	580 = 60V 650 = 67V 101 = 100V	Compliant	TR1 = T&R Standard 1 TR2 = T&R Standard 2	COMPLIANT

151 = 150V

ELECTRICAL CHARACTERISTICS

Part Number	V _{WDC}	V _{WAC}	V _B	V _c	I _{vc}	١	Ε _τ	ELD	I _P	Сар	Freq	V _{JUMP}	P _{DISS}
VR15AT14A580	14.0	10.0	34.5±10%	60	1	10	0.1	0.15	30	120	K	27.5	0.002
VR15AT18A650	18.0	13.0	41.0±10%	67	1	10	0.1	0.15	30	90	М	29	0.002
VR20AT26D101	26.0	18.0	62.0±10%	100	1	10	0.4	1.5	100	225	К	48	0.008
VR20AT48S151	48.0	34.0	100.0±10%	150	1	10	2.0	3.5	250	275	K	48	0.040

E,

E_{LD}

Cap V_{Jump} P_{DISS}

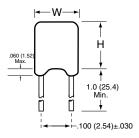


DC Working Voltage [V] AC Working Voltage [V] Typical Breakdown Votage [V @ 1mA_{DC}] Clamping Voltage [V @ I_{IV}] Test Current for V

Maximum leakage current at the working voltage [µA]

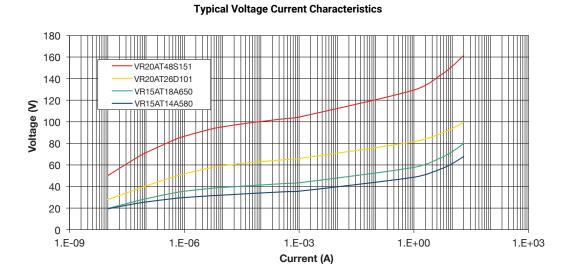
Transient Energy Rating [J, 10x1000µS] Load Dump Energy (x10) [J] Peak Current Rating [A, 8x20µS] Typical capacitance [pF] @ frequency specified and 0.5V_{RMS} Jump Start (V) Power Dissipation (W)

PHYSICAL DIMENSIONS

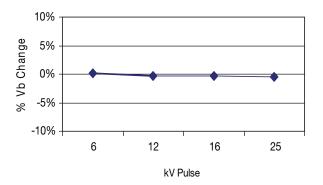


					mm (inches)
Style	Width (W)	Height (H)	Thickness (T)	Lead Spacing	Lead Diameter
VR15	4.32 Max.	3.81 Max.	2.54 Max.	2.54	0.508
	(0.170)	(0.150)	(0.100)	(0.100)	(0.020)
VR20	5.59 Max	5.08 Max	3.175 Max	2.54	0.508)
	(0.220)	(0.200)	(0.125)	(0.100)	(0.020

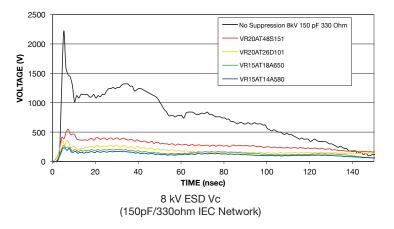
TYPICAL PERFORMANCE CURVES



AEC-Q200-002 ESD Characteristics

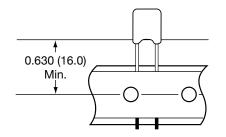


ESD Wave Absorption Characteristics

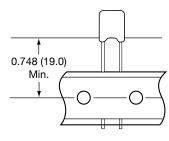


TAPE & REEL PACKAGING OPTIONS









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Radial Leaded CapGuard®

Varistor/Capacitor Combination for EMI/Surge Suppression



GENERAL DESCRIPTION

KYOCERA AVX radial leaded CapGuard® products are designed to provide both transient voltage protection and EMI/ RFI suppression for electronic circuits. CapGuards® are ideally suited to filter out EMI/RFI noise generated by switch mode power supplies or motors on DC lines or I/O lines in electronic circuits. With multilayer varistor (MLV) utilized in CapGuard® product, effective transient voltage protection is achieved to protect sensitive electronics from high voltage transients. The capacitor, on the other hand, absorbs high frequency noise on the line. The MLCC capacitors are designed with temperature stable X7R dielectric, allowing for wide temperature use with good capacitance stability.

GENERAL CHARACTERISTICS

- Operating Temperature:
- -55 to +125°C Working Voltage:
- 26Vdc, 45Vdc Capacitance: 0.47µF - 4.7µF
- **FEATURES**
- High Capacitance / EMI Filtering
- **Bi-Directional Protection**
- AEC Q200 gualified
 - Multiple Strike Capability
- · Radial, epoxy encapsulated

APPLICATIONS

· EMI filtering with surge protection

🔇 КУОСЕRа

- DC motors
 - Inductive switching
- Relays
 - Power supplies
- I/O Ports
- and more

HOW TO ORDER

CG	21	AS	26	F T	474	M	R
Series	Size 21	Automotive Series	Working Voltage 26 = 26Vdc 45 = 45Vdc	Energy K = 0.6J F = 0.7J H = 1.2J	Capacitance 474 = 0.47μF 105 = 1.0μF 475 = 4.7μF	Tolerance M = ±20%	Leads R = RoHS Compliant

۱t



TR2 = T&R Standard 2

ELECTRICAL CHARACTERISTICS

Part Number	V _{wdc}	V _{wac}	V _B	V _c	I _{vc}	I,	E _T	ELD	I _P	Сар	Tol	V _{JUMP}
CG21AS26F474MR	26.0	18.0	33.0±10%	54	1	15	0.7	1.5	200	0.47	±20%	27.5
CG21AS26F105MR	26.0	18.0	33.0±10%	54	1	15	0.7	1.5	200	1	±20%	27.5
CG21AS26H475MR	26.0	18.0	34.5±10%	60	5	15	1.2	3	300	4.7	±20%	27.5
CG21AS45K474MR	45.0	35.0	56.0±10%	90	1	15	0.6	1.25	200	0.47	±20%	48
CG21AS45K105MR	45.0	35.0	56.0±10%	90	1	15	0.6	1.25	200	1	±20%	48

V_w(DC) DC Working Voltage [V] V (AC)

- AC Working Voltage [V]
- V_R Typical Breakdown Votage [V @ 1mA_{pc}] Clamping Voltage [V @ I_{IV}]
- V_c Test Current for V_c
- Maximum leakage current at the working voltage [µA]



Transient Energy Rating [J, 10x1000µS] Load Dump Energy (x10) [J]

Peak Current Rating [A, 8x20µS]

Typical capacitance [pF] @ frequency specified and $0.5V_{\rm RMS}$ Сар

- Tol Capacitance tolerance [%] from Typ value
- V_{Jump} Jump Start (V)

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Radial Leaded CapGuard®

Varistor/Capacitor Combination for EMI/Surge Suppression



Lead Spacing

5.08±0.76

 (0.200 ± 0.030)

mm (inches)

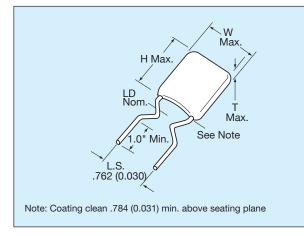
Lead

Diameter

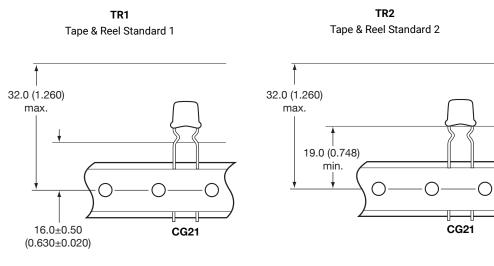
0.508 nom.

(0.020)

PHYSICAL DIMENSIONS



Drawings are for illustrative purposes only. Actual lead form shape could vary within stated tolerances based on body size.



Width

(W)

6.35 Max

(0.250)

Schematic Diagram

С

Style

CG21

Height

(H)

8.25 Max

(0.325)

Lead 1

Lead 2

Thickness

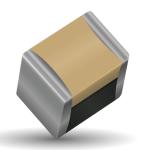
(T)

5.08 Max (0.200)

Surface Mount CapGuard™

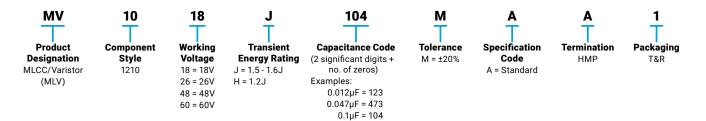
Varistor/Capacitor Combination for EMI/Surge Suppression





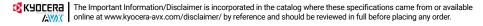
KYOCERA AVX surface mount CapGuard[™] products are designed to provide both transient voltage protection and EMI/RFI suppression for electronic circuits. CapGuards are ideally suited to filter out EMI/RFI noise generated by switch mode power supplies or motors on DC lines or I/O lines in electronic circuits. With multilayer varistor (MLV) utilized in CapGuard product, effective transient voltage protection is achieved to protect sensitive electronics from high voltage transients. The capacitor, on the other hand, absorbs high frequency noise on the line. The MLCC capacitors are designed with temperature stable X7R dielectric, allowing for wide temperature use with good capacitance stability. The surface mount CapGuards are characterized with a very small form factor to minimize board space. The parts are assembled using high melting point solder (268°C solidus / 290°C liquidus) allowing for standard reflow processing during board level assembly without a risk of reflowing HMP solder.

HOW TO ORDER



PRODUCT OFFERING

Part Number	Operating Voltage (V)	Nominal Breakdown Voltage (V)	Breakdown Voltage Range (V)	Clamping Voltage (V)	Current for Clamping Voltage (Amp)	Transient Energy (J)	Peak Current (Amp)	Typical Capacitance (uF)
MV1018J123MAA1	18	25	23 - 28	42	5	1.6	500	0.012
MV1018J473MAA1	18	25	23 - 28	42	5	1.6	500	0.047
MV1018J104MAA1	18	25	23 - 28	42	5	1.6	500	0.1
MV1026H123MAA1	26	34.5	31 - 38	60	5	1.2	300	0.012
MV1026H473MAA1	26	34.5	31 - 38	60	5	1.2	300	0.047
MV1026H104MAA1	26	34.5	31 - 38	60	5	1.2	300	0.1
MV1048H123MAA1	48	62	55 - 69	100	5	1.2	250	0.012
MV1048H473MAA1	48	62	55 - 69	100	5	1.2	250	0.047
MV1048H104MAA1	48	62	55 - 69	100	5	1.2	250	0.1
MV1060J123MAA1	60	76	68 - 84	120	5	1.5	250	0.012
MV1060J473MAA1	60	76	68 - 84	120	5	1.5	250	0.047
MV1060J104MAA1	60	76	68 - 84	120	5	1.5	250	0.1



Surface Mount CapGuard™

Varistor/Capacitor Combination for EMI/Surge Suppression

TARGET APPLICATIONS

· Avionics, Military, I/O port protection

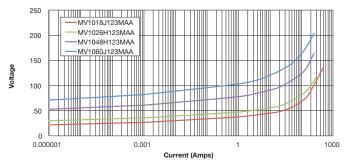
· EMI filtering with surge protection

FEATURES

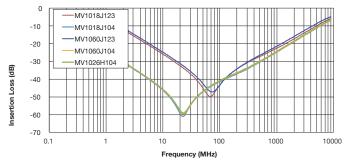
High Capacitance / EMI Filtering .

- **Bi-Directional Protection**
- . Fast Turn-On Time
- . Multiple Strike Capability
- HMP Solder Termination
- 1210 EIA Case Size

TYPICAL VOLTAGE CURRENT RESPONSE



TYPICAL HIGH FREOUENCY CHARACTERISTICS

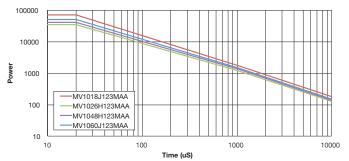


GENERAL CHARACTERISTICS

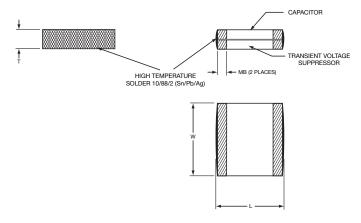
Storage Temperature: -55°C to +125°C

• Operating Temperature: -55°C to +125°C

TYPICAL PULSE POWER DURATION



DIMENSIONS



millimeters (inches)

Lenght (L)	Width (W)	Thickness (T)	Metallized Bands (MB)
3.302 ± 0.381	2.540 ± 0.381	2.794 (0.110)	0.5 ± 0.25
(0.130) ± (0.015)	(0.100) ± (0.015)	Max.	(0.02) ± (0.01)

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Axial TransGuard® and StaticGuard



Axial Multilayer Ceramic Transient Voltage Suppressors



GENERAL DESCRIPTION

Axial TransGuard® multilayer varistors are zinc oxide (ZnO) based ceramic semiconductor devices with nonlinear voltage-current characteristics (bi-directional) similar to back-to-back zener diodes. They have the added advantage of greater current and energy handling capabilities as well as EMI/RFI attenuation.

Axial StaticGuard is low capacitance version of the TransGuard and are designed for general ESD protection of CMOS, Bi-Polar, and SiGe based systems.

KYOCERA AVX Axial varistors are designed for applications where leaded component is prefered and for durability in harsh environment.

RoHS

COMPLIANT

GENERAL CHARACTERISTICS

- Operating Temperatures: -55°C to +125°C
- Working Voltage: 3.3 60Vdc
- Case Size: Axial
- Energy: 0.1 2.0J
- · Peak Current: 30 300A

FEATURES

R

- Axial leaded, epoxy encapsulated
- Fast Response
- EMI/RFI filtering in the off-state
- · Multiple strikes capability

APPLICATIONS

- White Goods
- Industrial Equipment
- Sensors
- Relays
- DC Motors
- and more

HOW TO ORDER - AXIAL TRANSGUARD®

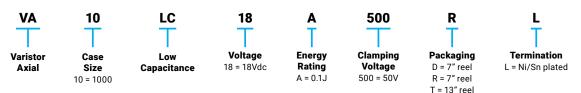
VA	1000	26	D	400
T		Т	Т	T
Varistor	Case	Voltage	Energy	Clamping
Axial	Size	03 = 3.3Vdc	Rating	Voltage
	1000	05 = 5.6Vdc	A = 0.1J	100 = 12V
	2000	14 = 14Vdc	D = 0.4J	150 = 18V
		18 = 18Vdc	K = 0.6J	300 = 32V
		26 = 26Vdc		400 = 42V
		30 = 30Vdc		580 = 60V
		48 = 48Vdc		650 = 67V
		60 = 60Vdc		101 = 100V
				121 = 120V

Т	Т
Packaging	Termination
D = 7" reel	L = Ni/Sn plated
R = 7" reel	
T = 13" reel	

Packaging (Pcs/Reel:										
STYLE	D	R	Т							
VA1000	1,000	3,000	7,500							
VA2000	1,000	2,500	5,000							

L

HOW TO ORDER - AXIAL STATICGUARD



Axial Multilayer Ceramic Transient Voltage Suppressors

AXIAL TRANSGUARD®

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I,	Ε _τ	l _p	Сар	Freq	Case
VA100003A100	3.3	2.3	5.0±20%	12	1	100	0.1	40	1500	К	1000
VA100003D100	3.3	2.3	5.0±20%	12	1	100	0.4	150	4700	к	1000
VA100005A150	5.6	4.0	8.5±20%	18	1	35	0.1	40	1000	К	1000
VA100005D150	5.6	4.0	8.5±20%	18	1	35	0.4	150	2800	К	1000
VA100014A300	14.0	10.0	18.5±12%	32	1	15	0.1	40	325	к	1000
VA100014D300	14.0	10.0	18.5±12%	32	1	15	0.4	150	1100	к	1000
VA100018A400	18.0	13.0	25.5±10%	42	1	10	0.1	40	350	К	1000
VA100018D400	18.0	13.0	25.5±10%	42	1	10	0.4	150	900	К	1000
VA100026D580	26.0	18.0	34.5±10%	60	1	10	0.4	120	650	К	1000
VA100030D650	30.0	21.0	41.0±10%	67	1	10	0.4	120	550	К	1000
VA100048D101	48.0	34.0	62.0±10%	100	1	10	0.4	100	200	К	1000
VA200060K121	60.0	42.0	76.0±10%	120	1	10	2.0	300	400	К	2000

AXIAL STATICGUARD

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I _L	Ε _τ	l _p	Сар	Freq	Case
VA10LC18A500	≤18.0	≤14.0	25-40	50	1	10	0.1	30	200	К	1000

- $V_w(DC)$ DC Working Voltage [V]
- $V_w(AC)$ AC Working Voltage [V]

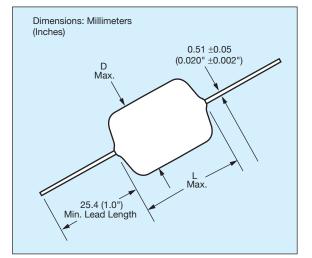
 V_{B}^{W} Typical Breakdown Votage (V @ 1mA_{DC})

 $V_{_{\rm B}}$ Tol $V_{_{\rm B}}$ Tolerance is ± from Typical Value

 V_c Clamping Voltage (V @ I_{vc})

 I_{vc} Test Current for V_c (A, 8x20µS)

 I_L Maximum Leakage Current at the Working Voltage (µA)



DIMENSIONS:

mm (inches)

Style		VA1000	VA2000
(L) Max Length	mm	4.32	4.83
	(in.)	(0.170)	(0.190)
(D) Max Diameter	mm	2.54	3.56
	(in.)	(0.100)	(0.140)

Lead Finish: Copper Clad Steel, Solder Coated

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 E_{T} Transient Energy Rating (J, 10x1000µS)

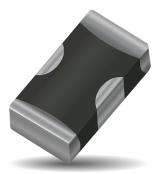
I_P Peak Current Rating (A, 8x20µS)

Cap Typical Capacitance (pF) @ frequency specified and 0.5 V_{RMS}

Freq Frequency at which capacitance is measured (K = 1kHz, M = 1MHz)

TransFeed[®] Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

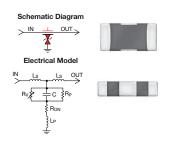




GENERAL DESCRIPTION

KYOCERA AVX has combined the best electrical characteristics of its TransGuard® Transient Voltage Suppressors (TVS) and its Feedthru Capacitors into a single chip for state-of-the-art overvoltage circuit protection and EMI reduction over a broad range of frequencies. This unique combination of multilayer ceramic construction in a feedthru configuration gives the circuit designer a single 0805 chip that responds to transient events faster than any TVS device on the market today, and provides significant EMI attenuation when in the off-state.

The reduction in parallel inductance, typical of the feedthru chip construction when compared to the construction of standard TVS or ceramic capacitor chips, gives the TransFeed® product two very important electrical advantages: (1) faster "turn-on" time. Calculated response times of <200 pSec are not unusual with this device, and measured response times range from 200 - 250 pSec. The TransFeed® "turn-on" characteristic is less than half that of an equivalent TransGuard® part - and TransGuards® clamp transient voltages faster than any other bipolar TVS solution such as diodes; (2) the second electrical advantage of lower parallel inductance, coupled with optimal series inductance, is the enhanced attenuation characteristics of the TransFeed® product. Not only is there significantly greater attenuation at a higher self-resonance frequency, but the roll-off characteristic becomes much flatter, resulting in EMI filtering over a much broader frequency spectrum. Typical applications include filtering/protection on Microcontroller I/O Lines, Interface I/O Lines, Power Line Conditioning and Power Regulation.



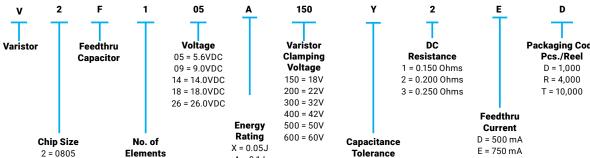
TYPICAL APPLICATIONS

- Fingerprint ID Circuit
- Magnetic Field Circuit
- LCD Dashboard Driver

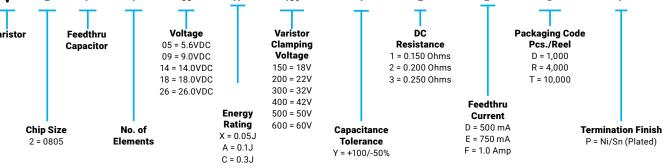
Where designers are concerned with both transient voltage protection and EMI attenuation, either due to the electrical performance of their circuits or due to required compliance to specific EMC regulations, the TransFeed[®] product is an ideal choice.

GENERAL CHARACTERISTICS

- **Operating Teperature:** -55°C to +125°C
- Working Voltage: 5.6Vdc 26 Vdc
- Case Size: 0805
- Energy Rating: 0.05 0.3J
- Current: 20 120A
- Max Feedthru Current: 0.5 1A



HOW TO ORDER



TransFeed® Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

TRANSFEED ELECTRICAL SPECIFICATIONS

Part Number	Working Voltage (DC)	Working Voltage (AC)	Breakdown Voltage	Clamping Voltage	Maximum Leakage Current	Transient Energy Rating	Peak Current Rating	Typical Cap	DC Resistance	Maximum Feedthru Current
V2F105A150Y2E	5.6	4.0	8.5±20%	18	35	0.10	30	800	0.200	0.75
V2F105C150Y1F	5.6	4.0	8.5±20%	18	35	0.30	120	2500	0.150	1.00
V2F109A200Y2E	9.0	6.4	12.7±15%	22	25	0.10	30	575	0.200	0.75
V2F109C200Y1F	9.0	6.4	12.7±15%	22	25	0.30	120	1800	0.150	1.00
V2F114A300Y2E	14.0	10.0	18.5±12%	32	15	0.10	30	300	0.200	0.75
V2F114C300Y1F	14.0	10.0	18.5±12%	32	15	0.30	120	900	0.150	1.00
V2F118A400Y2E	18.0	13.0	25.5±10%	42	10	0.10	30	200	0.200	0.75
V2F118C400Y1F	18.0	13.0	25.5±10%	42	10	0.30	120	500	0.150	1.00
V2F118X500Y3D	18.0	13.0	25.5±10%	50	10	0.05	20	75	0.250	0.50
V2F126C600Y2E	26.0	18.0	34.5±10%	60	10	0.3	80	250	0.2	0.75

 I_{p}

Сар

DCR

 I_{FT}

L Termination Finish Code

–Packaging Code

V _w (DC)	DC Working	Voltage (V)
---------------------	------------	-------------

 V_w (AC) AC Working Voltage (V)

V_B Typical Breakdown Voltage (V @ 1mADC)

 $V_{_B}$ Tol VB Tolerance is ± from Typical Value

 V_c Clamping Voltage (V @ 1A 8x20µS)

 $\rm I_{\rm L}$ Maximum Leakage Current at the Working Voltage (µA)

 E_{T} Transient Energy Rating (J, 10x1000µS)

Peak Current Rating (A, 8x20µS)

Typical Capacitance (pF) @ 1MHz and 0.5 V

DC Resistance (Ohms)

Maximum Feedthru Current (A)

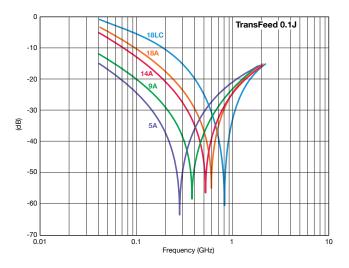
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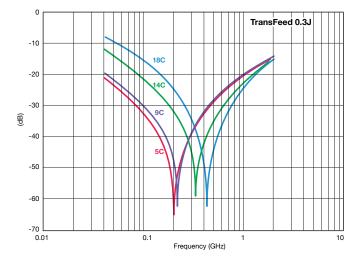
TransFeed® Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

mm (inches)

mm (inches)

dB Attenuation vs Frequency



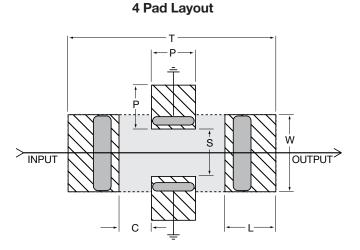


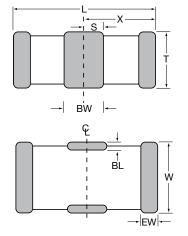
DIMENSIONS

	L	W	Т	BW	BL	EW	Х	S
0805	2.01 ± 0.20 (0.079 ± 0.008)	1.25 ± 0.20 (0.049 ± 0.008)	1.143 Max. (0.045 Max.)	0.46 ± 0.10 (0.018 ± 0.004)	0.18 + 0.25 -0.08 (0.007 + 0.010 -0.003)	0.25 ± 0.13 (0.010 ± 0.005)	1.02 ± 0.10 (0.040 ± 0.004)	0.23 ± 0.05 (0.009 ± 0.002)

RECOMMENDED SOLDER PAD LAYOUT (Typical Dimensions)

		Т	Р	S	W	L	С
	0805	3.45 (0.136)	0.51 (0.020)	0.76 (0.030)	1.27 (0.050)	1.02 (0.040)	0.46 (0.018)

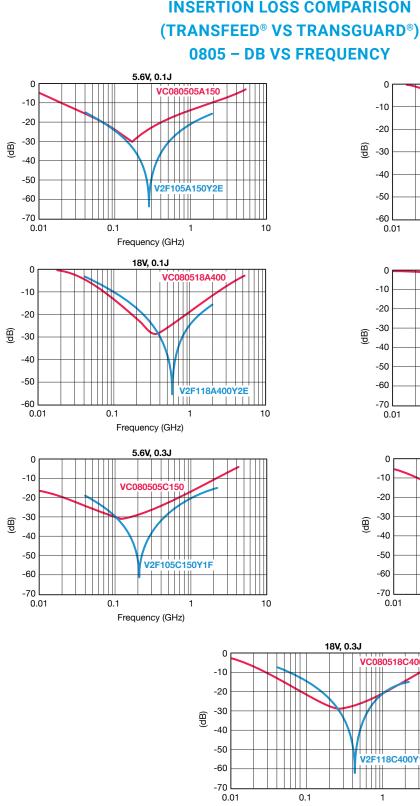


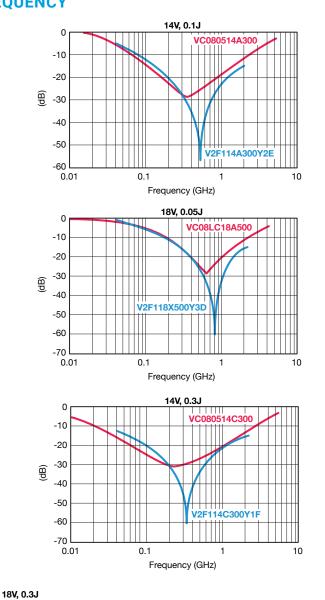


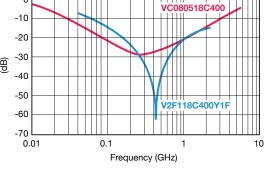
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PERFORMANCE CHARACTERISTICS







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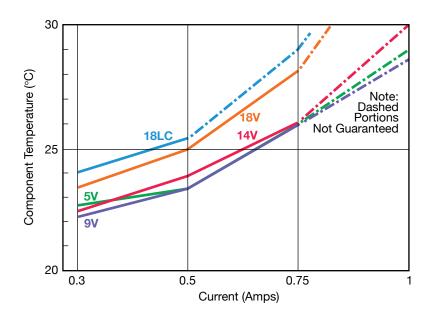
TransFeed® Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip



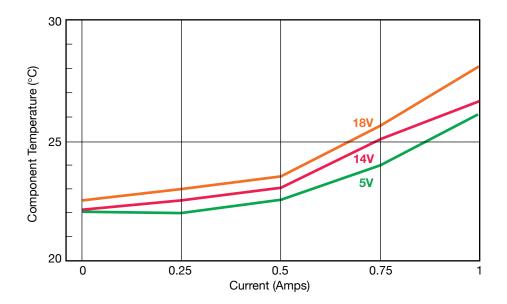
PERFORMANCE CHARACTERISTICS

CURRENT VS TEMPERATURE

0805 - 0.1 JOULE



CURRENT VS TEMPERATURE 0805 – 0.3 JOULE



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101320

TransFeed[®] Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

PERFORMANCE CHARACTERISTICS

FEEDTHRU VARISTORS

KYOCERA AVX Multilayer Feedthru Varistors (MLVF) are an ideal choice for system designers with transient strike and broadband EMI/RFI concerns. Feedthru Varistors utilize a ZnO varistor material and the electrode pattern of a feedthru capacitor. This combination allows the package advantage of the feedthru and material advantages of the ZnO dielectric to be optimized. ZnO MLV Feedthrus exhibit electrical and physical advantages over standard ZnO MLVs. Among them are:

1. Faster Turn on Time

Where:

- 2. Broadband EMI attenuation
- 3. Small size (relative to discrete MLV and EMI filter schemes)

The electrical model for a ZnO MLV and a ZnO Feedthru MLV are shown below. The key difference in the model for the Feedthru is a transformation in parallel to series inductance. The added series inductance helps lower the injected transient peak current (by 2π fL) resulting in an additional benefit of a lower clamping voltage. The lowered parallel inductance decreases the turn on time for the varistor to <250ps.

Discrete MLVF Model

To Device To Device PCB Requiring Requiring Trace Protection Protection Ls Ls > Solder Pad Solder Pad Lp ξR_P С С Ron Ron Lp Solder Pad Solder Pad R_v = Voltage Variable resistance Where: R_v = Voltage Variable resistance (per VI curve) (per VI curve) $R_n \ge 10^{12} \Omega$ R_n ≥ Body IR C = defined by voltage rating and energy level C = defined by voltage rating and energy level R_{on} = turn on resistance R_{on} = turn on resistance L_n = parallel body inductance L_n = minimized parallel body inductance L_s = series body inductance

Discrete MLV Model

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TransFeed® Multilayer Ceramic Transient Voltage Suppressors **TVS Protection and EMI Attenuation in a Single Chip**



INTERFACED

PERFORMANCE CHARACTERISTICS

APPLICATIONS

- EMI Suppression
- Broadband I/O Filtering
- Vcc Line Conditioning

FEATURES

- Small Size .
- Low ESR .
- Ultra-fast Response Time
- **Broad S21 Characteristics**

MARKET SEGMENTS

- Computers
- Automotive
- **Power Supplies**
- Multimedia Add-On Cards
- **Bar Code Scanners**
- **Remote Terminals**
- Medical Instrumentation
- **Test Equipment** •
- Transceivers
- Cellular Phones / Pagers

TYPICAL CIRCUITS REQUIRING TRANSIENT **VOLTAGE PROTECTION AND EMI FILTERING**

The following applications and schematic diagrams show where TransFeed® TVS/ EMI filtering devices might be used:

- System Board Level Interfaces: (Fig. 1) Digital to RF Analog to Digital
 - Digital to Analog
- Voltage Regulation (Fig. 2)
- Power Conversion Circuits (Fig. 3)
- GaAs FET Protection (Fig. 4)

Fig. 1 – System Interface

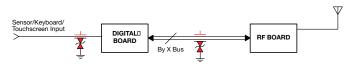


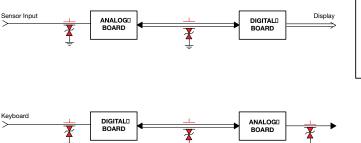
Fig. 2 - Voltage Regulators



Fig. 3 - Power Conversion Circuits/Power Switching Circuits

POWERD

⊦3.3V



SPECIFICATION COMPARISON

MLVF 0805		PARAMETER	MLV 0805
5ph	Ls	typical	N/A
<600nh	Lp	typical	<1.5nh
<0.025Ω	Ron	typical	<0.1Ω
100pf to 2.5nf	С	typical	100pf to 5.5nf
see VI curves	Rv	typical	see VI curves
>0.25 x 1012Ω	Rp	typical	>1 x 1012Ω
<250ps		pical turn on time Il frequency response	<500ps

A comparison table showing typical element parameters and resulting performance features for MLV and MLVF is shown above.

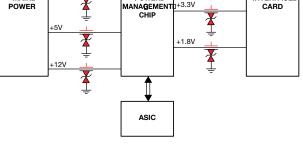
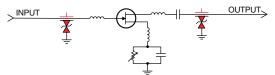


Fig. 4 - GaAs FET Protection



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MAIND

TransFeed® Automotive Series Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

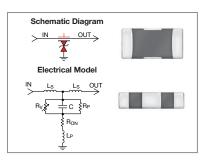


GENERAL DESCRIPTION

KYOCERA AVX has combined the best electrical characteristics of its TransGuard[®] Transient Voltage Suppressors (TVS) and its Feedthru Capacitors into a single chip for state-of-the-art overvoltage circuit protection and EMI reduction over a broad range of frequencies. This unique combination of multilayer ceramic construction in a feedthru configuration gives the circuit designer a single 0805 chip that responds to transient events faster than any TVS device on the market today, and provides significant EMI attenuation when in the off-state.

Automotive TransFeed® is designed for automotive applications and are AEC-Q 200 qualified.

The reduction in parallel inductance, typical of the feedthru chip construction when compared to the construction of standard TVS or ceramic capacitor chips, gives the TransFeed® product two very important electrical advantages: (1) faster "turn-on" time. Calculated response times of <200 pSec are not unusual with this device, and measured response times range from 200 – 250 pSec. The TransFeed® "turn-on" characteristic is less than half that of an equivalent TransGuard® part – and TransGuards® clamp transient voltages faster than any other bipolar TVS solution such as diodes; (2) the second electrical advantage of lower parallel inductance, coupled with optimal series inductance, is the enhanced attenuation characteristics of the TransFeed® product. Not only is there significantly greater attenuation at a higher self-resonance frequency, but the roll-off characteristic becomes much flatter, resulting in EMI filtering over a much broader frequency spectrum. Typical applications include filtering/ protection on Microcontroller I/O Lines, Interface I/O Lines, Power Line Conditioning and Power Regulation.



TYPICAL APPLICATIONS

- Drive by Wire
- Dimming Mirror Circuit
- Filtering/protection on Microcontroller I/O lines
- Filtering/protection on Interface I/O lines
- Power Line Conditioning
- Power Regulation

•

· LCD Dashboard driver

Where designers are concerned with both transient voltage protection and EMI attenuation, either due to the electrical performance of their circuits or due to required compliance to specific EMC regulations, the TransFeed product is an ideal choice.

GENERAL CHARACTERISTICS

- Operting Teperature: -55°C to +125°C
- Working Voltage: 5.6Vdc 26Vdc
- Case Size: 0805
- Energy Rating: 0.05 0.3J
- Current: 20 120A
- Max Feedthru Current: 0.5 1A

FEATURES

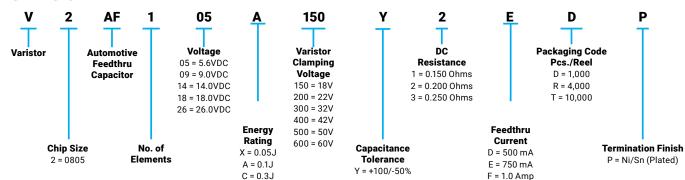
- Bi-directional TVS
- · Narrow band, high attenuation filter
- · EMI Filtering over broader frequency range
- Fastest Response Time to ESD Strikes
- · AEC-Q 200 Qualified

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TransFeed® Automotive Series

Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

HOW TO ORDER



TRANSFEED ELECTRICAL SPECIFICATIONS

Part Number	Working Voltage (DC)	Working Voltage (AC)	Breakdown Voltage	Clamping Voltage	Maximum Leakage Current	Transient Energy Rating	Peak Current Rating	Typical Cap	DC Resistance	Maximum Feedthru Current	Jump Start Voltage
V2AF105A150Y2E	5.6	4.0	8.5±20%	18	35	0.10	30	800	0.200	0.75	-
V2AF105C150Y1F	5.6	4.0	8.5±20%	18	35	0.30	120	2500	0.150	1.00	-
V2AF109A200Y2E	9.0	6.4	12.7±15%	22	25	0.10	30	575	0.200	0.75	-
V2AF109C200Y1F	9.0	6.4	12.7±15%	22	25	0.30	120	1800	0.150	1.00	-
V2AF114A300Y2E	14.0	10.0	18.5±12%	32	15	0.10	30	300	0.200	0.75	27.5
V2AF114C300Y1F	14.0	10.0	18.5±12%	32	15	0.30	120	900	0.150	1.00	27.5
V2AF118A400Y2E	18.0	13.0	25.5±10%	42	10	0.10	30	200	0.200	0.75	27.5
V2AF118C400Y1F	18.0	13.0	25.5±10%	42	10	0.30	120	500	0.150	1.00	27.5
V2AF118X500Y3D	18.0	13.0	25.5±10%	50	10	0.05	20	75	0.250	0.50	27.5
V2AF126C600Y2E	26.0	18.0	34.5±10%	60	10	0.3	80	250	0.2	0.75	27.5

└ Termination Finish Code

–Packaging Code

V _w (DC)	DC Working Voltage (V)	Ε _τ
V _w (AC)	AC Working Voltage (V)	I _P
V _B	Typical Breakdown Voltage (V @ 1mA _{pc})	Сар
V _B Tol	$V_{_{\rm B}}$ Tolerance is ± from Typical Value	DCR
V _c	Clamping Voltage (V @ 1A 8x20µS)	I _{FT}

IL Maximum Leakage Current at the Working Voltage (µA) $V_{_{JUMP}}$

Transient Energy Rating (J, 10x1000µS)

Peak Current Rating (A, 8x20µS)

Typical Capacitance (pF) @ 1MHz and 0.5 V

🔇 КУОСЕRа

DC Resistance (Ohms)

Maximum Feedthru Current (A)

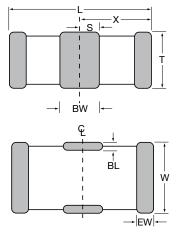
Jump Start Voltage (V, 5 min)

TransFeed[®] Automotive Series

Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

DIMENSIONS

	L	W	Т	BW	BL	EW	Х	S
080	2.01 ± 0.20	1.25 ± 0.20	1.143 Max.	0.46 ± 0.10	0.18 + 0.25 -0.08	0.25 ± 0.13	1.02 ± 0.10	0.23 ± 0.05
	(0.079 ± 0.008)	(0.049 ± 0.008)	(0.045 Max.)	(0.018 ± 0.004)	(0.007 + 0.010 -0.003)	(0.010 ± 0.005)	(0.040 ± 0.004)	(0.009 ± 0.002)

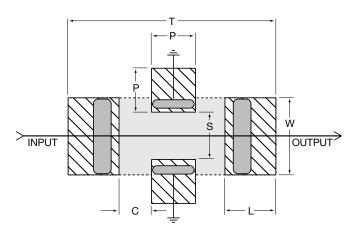


RECOMMENDED SOLDER PAD LAYOUT (TYPICAL DIMENSIONS)

mm (inches)

	Т	Р	S	W	L	С
0805	3.45 (0.136)	0.51 (0.020)	0.76 (0.030)	1.27 (0.050)	1.02 (0.040)	0.46 (0.018)

4 Pad Layout



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mm (inches)

TransFeed[®] Automotive Series

Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip

PERFORMANCE CHARACTERISTICS

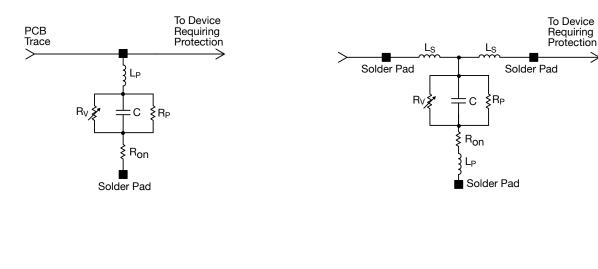
FEEDTHRU VARISTORS

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- 1. Faster Turn on Time
- 2. Broadband EMI attenuation
- 3. Small size (relative to discrete MLV and EMI filter schemes)

The electrical model for a ZnO MLV and a ZnO Feedthru MLV are shown below. The key difference in the model for the Feedthru is a transformation in parallel to series inductance. The added series inductance helps lower the injected transient peak current (by 2π fL) resulting in an additional benefit of a lower clamping voltage. The lowered parallel inductance decreases the turn on time for the varistor to <250ps.

K Y O C E R a



Discrete MLV Model

Where. Voltage Variable resistance Where[.] Voltage Variable resistance R R. (per VI curve) (per VI curve) 1012 0 R Body IR ≥ R ≥ С = defined by voltage rating and energy level С defined by voltage rating and energy level = R_{on} R_{on} = turn on resistance turn on resistance = parallel body inductance L = minimized parallel body inductance L, L = series body inductance

Discrete MLVF Model

TransFeed® Automotive Series

Multilayer Ceramic Transient Voltage Suppressors TVS Protection and EMI Attenuation in a Single Chip



PERFORMANCE CHARACTERISTICS

APPLICATIONS

- EMI Suppression
- Broadband I/O Filtering
- Vcc Line Conditioning

FEATURES

- Small Size
- Low ESR
- Ultra-fast Response Time
- · Broad S21 Characteristics

MARKET SEGMENTS

- Computers
- Automotive
- Power Supplies
- Multimedia Add-On Cards
- Bar Code Scanners
- Remote Terminals
- Medical Instrumentation
- Test Equipment
 Transceivers
- Transceivers
- Cellular Phones / Pagers

TYPICAL CIRCUITS REQUIRING TRANSIENT VOLTAGE PROTECTION AND EMI FILTERING

The following applications and schematic diagrams show where TransFeed $^{\oplus}$ TVS/ EMI filtering devices might be used:

- System Board Level Interfaces: (Fig. 1) Digital to RF Analog to Digital
- Digital to AnalogVoltage Regulation (Fig. 2)
- Voltage Regulation (Fig. 2)
- Power Conversion Circuits (Fig. 3)
- GaAs FET Protection (Fig. 4)

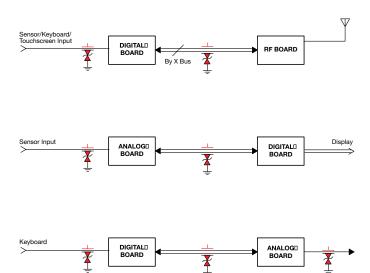


Fig. 1 - System Interface

Fig. 2 – Voltage Regulators

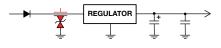
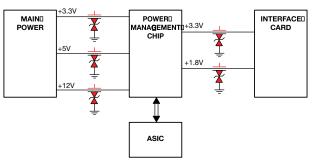


Fig. 3 – Power Conversion Circuits/Power Switching Circuits



SPECIFICATION COMPARISON

MLVF 0805		PARAMETER	MLV 0805
5ph	Ls	typical	N/A
<600nh	Lp	typical	<1.5nh
<0.025Ω	Ron	typical	<0.1Ω
100pf to 2.5nf	С	typical	100pf to 5.5nf
see VI curves	Rv	typical	see VI curves
>0.25 x 1012Ω	Rp	typical	>1 x 1012Ω
<250ps		pical turn on time Il frequency response	<500ps

A comparison table showing typical element parameters and resulting performance features for MLV and MLVF is shown above.

Fig. 4 – GaAs FET Protection

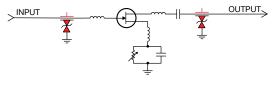
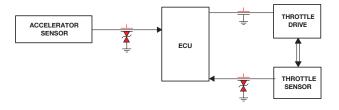


Fig. 5 – Automotive TransFeed - Throttle by Wire



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SnPb Multilayer Varistors Multilayer Varistors with Tin/Lead Termination





GENERAL DESCRIPTION

KYOCERA AVX designed specific TransGuard® and StaticGuard VCLD series with Sn/Pb termination (5% Pb Min) to support customers that cannot accept pure tin components in their applications. They have the advantage of offering bi-directional overvoltage protection against transient events such as ESD, inductive switching, lightning, NEMP as well as EMI/RFI attenuation in a single SMT package.

GENERAL CHARACTERISTICS

Operating Temperature: -55°C to +125°C

FEATURES

- Sn/Pb termination (5% Pb min)Bi-Directional protection
- Very fast response to ESD strikes
- Multi-strike capability
- Reliability
- EMI/RFI Filtering in the off-state
- Radiation resistant

APPLICATIONS

- IC Protection
- Micro Controllers
- Relays
- I/O Ports
- Keyboard Protection
- Portable devices
- Radios and more

HOW TO ORDER - TRANSGUARD®

VCLD	1206	1	8	<u> </u>		4	00	R T	B
Varistor Leaded	Case Size	Ene Rat		Ene Rat	rgy ing		n mping Itage	Packaging D = 7" (1000)	Termination B = Sn/Pb
Termination (Sn/Pb)	0603 0805 1206 1210	05 = 5.6Vdc 09 = 9Vdc 12 = 12Vdc 14 = 14Vdc 18 = 18Vdc 26 = 26Vdc 30 = 30Vdc 31 = 31Vdc	38 = 38Vdc 42 = 42Vdc 45 = 45Vdc 48 = 48Vdc 56 = 56Vdc 60 = 60Vdc 65 = 65Vdc 85 = 85Vdc	X = 0.05J A = 0.1J C = 0.3J D = 0.4J G = 0.9J F = 0.7J H = 1.2J	J = 1.5J K = 0.6J L = 0.8J M = 1J N = 1.1J S = 1.9-2.0J	150 = 18V $200 = 22V$ $250 = 27V$ $300 = 32V$ $390 = 42V$ $400 = 42V$ $540 = 54V$ $560 = 60V$ $580 = 60V$ $620 = 67V$	650 = 67V 770 = 77V 800 = 80V 900 = 90V 101 = 100V 111 = 110V 121 = 120V 131 = 135V 151 = 150V	R = 7" (4000 or 2000) T = 13" (10,000)	(5% Pb Min)
	URDER	- 31A11	C GUARD					Sn/P	b termination
VCLD	06	LC	18	Х	500	R	В		
Varistor Leaded Termination (Sn/Pb)	Case Size 06 = 0603 08 = 0805	Low Cap Design	Working Voltage 18 = 18Vdc	Energy Rating X = 0.05J A = 0.1J	Clamping Voltage 500 = 50V	Packaging D = 7" (1000) R = 7" (4000) T = 13" (10,000)	Termination B = Sn/Pb (5% Pb Min)		

Please contact KYOCERA AVX for availability of other varitstors with SnPb termination.

PHYSICAL DIMENSIONS:

12 = 1206

¥ Size (EIA) Length (L) Width (W) Max Thickness (T) Land Length (t) Т 0.35±0.15 1.60±0.15 0.80±0.15 0.90 0603 (0.063±0.006) (0.031±0.006) (0.035) (0.014±0.006) 2.01±0.20 1.25±0.20 1.02 0.71 max. 0805 1 (0.079±0.008) (0.049±0.008) (0.040) (0.028 max.) 3.20±0.20 1.60±0.20 0.94 max. 1.02 W 1206 (0.040) (0.126 ± 0.008) (0.063±0.008) (0.037 max.) 3.20±0.20 2.49±0.20 1.70 0.14 max. 1210 (0.126±0.008) (0.098±0.008) (0.067) (0.045 max.) L

SOLDER PAD DIMENSIONS:

						iiiii (iiiciico)
	Size (EIA)	D1	D2	D3	D4	D5
D2	0603	2.54 (0.100)	0.89 (0.035)	0.76 (0.030)	0.89 (0.035)	0.76 (0.030)
D1 D3	0805	3.05 (0.120)	1.02 (0.040)	1.02 (0.040)	1.02 (0.040)	1.27 (0.050)
	1206	4.06 (0.160)	1.02 (0.040)	2.03 (0.080)	1.02 (0.040)	1.65 (0.065)
	1210	4.06 (0.160)	1.02 (0.040)	2.03 (0.080)	1.02 (0.040)	2.54 (0.100)
-> D5 -						

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mm (inches)

mm (inches)

ELECTRICAL CHARACTERISTICS – TRANSGUARD®

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I _L	Ε _τ	I _P	Сар	Freq
VCLD060305A150_B	5.6	4.0	8.5±20%	18	1	35	0.1	30	750	К
VCLD080505A150_B	5.6	4.0	8.5±20%	18	1	35	0.1	40	1100	K
VCLD080505C150_B	5.6	4.0	8.5±20%	18	1	35	0.3	120	3000	К
VCLD120605A150_B	5.6	4.0	8.5±20%	18	1	35	0.1	40	1200	K
VCLD120605D150_B	5.6	4.0	8.5±20%	18	1	35	0.4	150	3000	K
VCLD060309A200_B	9.0	6.4	12.7±15%	22	1	25	0.1	30	550	К
VCLD080509A200_B	9.0	6.4	12.7±15%	22	1	25	0.1	40	750	K
VCLD080512A250_B	12.0	8.5	16.0±15%	27	1	25	0.1	40	525	K
VCLD060314A300_B	14.0	10.0	18.5±12%	32	1	15	0.1	30	350	K
VCLD080514A300_B	14.0	10.0	18.5±12%	32	1	15	0.1	40	325	К
VCLD080514C300_B	14.0	10.0	18.5±12%	32	1	15	0.3	120	900	K
VCLD120614A300_B	14.0	10.0	18.5±12%	32	1	15	0.1	40	600	K
VCLD120614D300_B	14.0	10.0	18.5±12%	32	1	15	0.4	150	1050	K
VCLD060318A400_B	18.0	13.0	25.5±10%	42	1	10	0.1	30	150	K
VCLD080518A400_B	18.0	13.0	25.5±10%	42	1	10	0.1	30	225	K
VCLD080518C400_B	18.0	13.0	25.5±10%	42	1	10	0.3	100	550	К
VCLD120618A400_B	18.0	13.0	25.5±10%	42	1	10	0.1	30	350	К
VCLD120618D400_B	18.0	13.0	25.5±10%	42	1	10	0.4	150	900	K
VCLD121018J390_B	18.0	13.0	25.5±10%	42	5	10	1.5	500	3100	К
VCLD060326A580_B	26.0	18.0	34.5±10%	60	1	10	0.1	30	155	K
VCLD080526A580_B	26.0	18.0	34.5±10%	60	1	10	0.1	30	120	K
VCLD080526C580_B	26.0	18.0	34.5±10%	60	1	10	0.3	100	250	K
VCLD120626D580_B	26.0	18.0	34.5±10%	60	1	10	0.4	120	500	K
VCLD120626F540_B	26.0	20.0	33.0±10%	54	1	15	0.7	200	600	K
VCLD121026H560_B	26.0	18.0	34.5±10%	60	5	10	1.2	300	2150	K
VCLD060330A650_B	30.0	21.0	41.0±10%	67	1	10	0.1	30	125	К
VCLD080530A650_B	30.0	21.0	41.0±10%	67	1	10	0.1	30	90	М
VCLD080530C650_B	30.0	21.0	41.0±10%	67	1	10	0.3	80	250	К
VCLD120630D650_B	30.0	21.0	41.0±10%	67	1	10	0.4	120	400	К
VCLD121030G620_B	30.0	21.0	41.0±10%	67	5	10	0.9	220	1750	К
VCLD121030H620_B	30.0	21.0	41.0±10%	67	5	10	1.2	280	1850	K
VCLD080531C650_B	31.0	25.0	39.0±10%	65	1	10	0.3	80	250	К
VCLD120631M650_B	31.0	25.0	39.0±10%	65	1	15	1.0	200	500	К
VCLD080538C770_B	38.0	30.0	47.0±10%	77	1	10	0.3	80	200	К
VCLD120638N770_B	38.0	30.0	47.0±10%	77	1	15	1.1	200	400	К
VCLD120642L800_B	42.0	32.0	51.0±10%	80	1	15	0.8	180	600	К
VCLD120645K900_B	45.0	35.0	56.0±10%	90	1	15	0.6	200	260	К
VCLD120648D101_B	48.0	34.0	62.0±10%	100	1	10	0.4	100	225	К
VCLD121048G101_B	48.0	34.0	62.0±10%	100	5	10	0.9	220	450	К
VCLD121048H101_B	48.0	34.0	62.0±10%	100	5	10	1.2	250	500	К
VCLD120656F111_B	56.0	40.0	68.0±10%	110	1	15	0.7	100	180	К
VCLD121060J121_B	60.0	42.0	76.0±10%	120	5	10	1.5	250	400	К
VCLD120665M131_B	65.0	50.0	82.0±10%	135	1	15	1.0	150	250	К
VCLD121085S151_B	85.0	60.0	100±10%	150	1	35	2.0	250	275	К

ELECTRICAL CHARACTERISTICS – STATICGUARD

Part Number	V _w (DC)	V _w (AC)	V _B	V _c	I _{vc}	I _L	Ε _τ	I _P	Сар	Case
VCLD06LC18X500_B	≤18	≤14	25-40	50	1	10	0.05	30	50M	0603
VCLD08LC18A500_B	≤18	≤14	25-45	50	1	10	0.1	30	80M	0805
VCLD12LC18A500_B	≤18	≤14	25-45	50	1	10	0.1	30	200K	1206

 $V_w(DC)$ DC Working Voltage (V)

 $V_{\rm c}$

V_w(AC) AC Working Voltage (V) VB

Min-Max Breakdown Votage (V @ 1mA_{DC}, 25°C)

Clamping Voltage (V @ I_{vc})

I_{vc} I_L Test Current for V_c (A, 8x20µS)

Maximum Leakage Current at the Working Voltage (µA, 25°C)

Transient Energy Rating (J, 10x1000µS) E_{T} I_P

Peak Current Rating (A, 8x20µS)

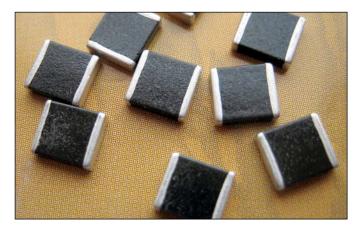
Ċap Typical Capacitance (pF) @ frequency specified and $0.5 V_{RMS}$, 25°C, K = 1kHz,M = 1MHz

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KY<u>OCERa</u>

Transient Voltage Suppression, ESD Protection Devices & EMI Devices





TYPICAL APPLICATIONS

Mainly used to reduce transient over-voltages in a very wide range of electronic products. Some example applications are:

- 1) Telecom
- 2) Automotive
- 3) Consumer Electronics
- 4) Industrial Applications

GENERAL DESCRIPTION

KYOCERA AVX Professional Multilayer Varistors include 3 series of glass coated products as listed below:

- Standard M0/MC/PC Series
- **Telecom MT Series**
- Automotive MA/PA/QA Series

The glass encapsulation process ensures high insulation resistance values after reflow soldering and excellent SMT compatibility. This protection ensures reliability and acidresistance against harsh environment like chlorite flux.

PHYSICAL CHARACTERISTICS

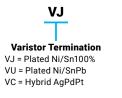


- 1. Zinc varistor
- Glass lead-free encapsulation 2. 3. Silver termination
- 4. Nickel barrier
- 5 Tin 100%

PHYSICAL DIMENSIONS:

mm (inches) **IEC Size** w т Land Length t Туре L 2.01±0.20 1.25±0.15 1.3 max. (0.051 0.15...0.55 VJ12 0805 (0.079±0.008) (0.049±0.006) (0.006...0.022)max.) 3.20±0.20 1.60±0.20 1.7 max. (0.067 0.25...0.75 VJ20 1206 (0.126 ± 0.008) (0.063 ± 0.008) (0.010...0.030)max.) 3.20±0.30 2.50±0.25 1.7 max. (0.067 0.25...0.75 VJ13 1210 (0.126 ± 0.012) (0.098±0.010) max.) (0.010...0.030)4.50±0.30 3.20±0.30 0.25...1.00 2.0 max. (0.079 VJ14 1812 (0.177±0.012) (0.126 ± 0.012) max.) (0.010...0.039)5.70±0.40 5.00±0.40 2.5max. 0.25...1.00 VJ15 2220 (0.197±0.016) (0.010...0.039) (0.224±0.016) (0.098 max.) 0.35...1.30 8.20±0.40 5.00±0.40 2.5 max. (0.098 VJ32 3220 (0.323±0.016) (0.197±0.016) max.) (0.014...0.051)

PART NUMBERING



Chip Size 12 = 0805 20 = 1206 13 = 1210 14 = 1812 15 = 2220 32 = 3220

14

МТ
Т
Series Code
M0,MC/QC = Industri
MT = Telecom

ial Telecom MA/PA/QA = Automotive



Operating Voltage AC or DC

κ 1mA Voltage

Tolerance

K = +10%



Packaging BA = Tape & Reel VJ12 = 4000 pcs/reel VJ20 = 3000 pcs/reel VJ13 = 2000 pcs/reel VJ14 = 1250 pcs/reel VJ15 = 1250 pcs/reel VJ32 = 1000 pcs/reel

BA



Glass Encapsulated MLV SMD Varistor (VJ12, 20, 13, 14, 15, 32) Automotive MLV Range – MA, PA and QA Series



AUTOMOTIVE SERIES - VJ12, 20, 13, 14, 15, 32 MA AND PA SERIES

FEATURES

- · Well suited to protect against automotive related transients
- Response time <1ns
- Load Dump capability 1J to 50J according to ISO standard DP7637 pulse 5
- Jump start capability
- Complying to AEC-Q 200
- VJ: Nickel and Tin (100%) plated Termination suitable for lead free soldering
- VC: PdPtAg termination for hybrid assembly without glass coating
- RoHS Compliant, IMDS Registration upon request

GENERAL CHARACTERISTICS

Storage Temperature: -55°C to +150°C Operating Temperature: -55°C to +125°C* * 150°C upon request Available in case size 0805 to 3220 Working voltage from 16Vdc to 85Vdc

APPLICATIONS

- Protection of various semiconductor elements from overvoltage.
- Absorption of switching surge and electrostatic surge for relays and motors.
- Protection of electronic equipment for automobiles from induced lightning surge.

PART NUMBERS

	Case Size EIA	Worl Volt	-		Breakdow tage at 1			amp 20µs)	Max. Peak current (8x20µs)	Max. leakage current at Vdc	Energy (10x 1000µs)	Energy Load- Dump (x10**)	Jump Start (5mn)	Mean Power Dissipation	Typical Cap 1KHz/ .5Vrms	T max.
		V _{rms}	V _{dc}	min	Nom	max	V _p	I _p (A)	Amp.	μA	J	J	max. V	W	pF	mm
							12	2-16 V Po	, ower Supply							
*VJ12PA0160K	0805	14	16	22	24.5	27	40	1	120	15	0.3	1	24.5	0.005	500	1.3
VJ20MA0160K	1206	14	16	22	24.5	27	40	1	200	15	0.6	1.5	24.5	0.008	800	1.7
VJ20PA0160K	1206	14	16	22	24.5	27	40	1	300	15	1.1	2	24.5	0.008	1 100	1.7
VJ13MA0160K	1210	14	16	22	24.5	27	40	2.5	400	15	1.6	3	24.5	0.010	1 800	1.7
VJ13PA0160K	1210	14	16	22	24.5	27	40	2.5	500	15	2	5	24.5	0.010	2 300	1.7
VJ14MA0160K	1812	14	16	22	24.5	27	40	5	800	15	2.4	6	24.5	0.015	5 400	2.0
VJ14PA0160K	1812	14	16	22	24.5	27	40	5	1000	15	2.9	10	24.5	0.015	6 200	2.0
VJ15MA0160K	2220	14	16	22	24.5	27	40	10	1200	15	5.8	12	24.5	0.030	11 000	2.0
VJ15PA0160K	2220	14	16	22	24.5	27	40	10	1500	15	7.2	25	24.5	0.030	16 000	2.0
VJ15QA0160K	2220	14	16	22	24.5	27	40	10	2000	15	7.5	35	24.5	0.030	25 000	2.0
VJ32PA0160K	3220	14	16	22	24.5	27	40	10	3000	15	13.8	50	24.5	0.040	30 000	2.5
							12	2-22 V Po	ower Supply	r						
VJ20PA0220K	1206	17	22	27	30	33	49	1	250	15	1	2	26	0.008	1 000	1.7
VJ13PA0220K	1210	17	22	27	30	33	49	2.5	400	15	1.7	5	26	0.010	2 000	1.7
VJ14PA0220K	1812	17	22	27	30	33	49	5	700	15	2.5	10	26	0.015	6 000	2.0
VJ15PA0220K	2220	17	22	27	30	33	49	10	1500	15	6.8	25	26	0.030	15 000	2.0
VJ32PA0220K	3220	17	22	27	30	33	49	10	3000	15	13	50	26	0.040	25 000	2.5
							12	2-26 V Po	ower Supply	r						
VJ20PA0260K	1206	23	26	31.5	35	38.5	57	1	200	15	1	2	30	0.008	600	1.7
VJ13PA0260K	1210	23	26	31.5	35	38.5	57	2.5	300	15	1.7	5	30	0.010	1 200	1.7
VJ14PA0260K	1812	23	26	31.5	35	38.5	57	5	600	15	2.5	10	30	0.015	3 000	2.0
VJ15PA0260K	2220	23	26	31.5	35	38.5	57	10	1500	15	6.8	25	30	0.030	7 000	2.0
VJ32PA0260K	3220	23	26	31.5	35	38.5	57	10	3000	15	13	50	30	0.040	15 000	2.5
							24	1-34 V Po	ower Supply	/				•		
VJ20PA0340K	1206	30	34	42.3	47	51.7	77	1	200	15	1.5	1.5	47	0.008	300	1.7
VJ13PA0340K	1210	30	34	42.3	47	51.7	77	2.5	350	15	3.5	3	47	0.010	650	1.7
VJ14PA0340K	1812	30	34	42.3	47	51.7	77	5	600	15	5	6	47	0.015	1 800	2.0
VJ15MA0340K	2220	30	34	42.3	47	51.7	77	10	1200	15	10	12	47	0.030	4 000	2.0
VJ15PA0340K	2220	30	34	42.3	47	51.7	77	10	1500	15	12	25	47	0.030	7 000	2.0
VJ32PA0340K	3220	30	34	42.3	47	51.7	77	10	3000	15	13	50	47	0.040	10 000	2.5
		24-42 V Power Supply														
*VJ20PA0420K	1206	37	42	50.4	56	61.6	91	1	150	15	1.5	1.5	47	0.008	140	1.7
*VJ13PA0420K	1210	37	42	50.4	56	61.6	91	2.5	250	15	3.5	3	47	0.010	300	1.7
*VJ14PA0420K	1812	37	42	50.4	56	61.6	91	5	500	15	5	6	47	0.015	800	2.0
*VJ15PA0420K	2220	37	42	50.4	56	61.6	91	10	1500	15	12	12	47	0.030	1 800	2.0
*VJ32PA0420K	3220	37	42	50.4	56	61.6	91	10	3000	15	13	50	47	0.040	2 800	2.5

* under development

** time interval between pulses: 60s min.

VC with hybrid solderable termination same electrical characteristics

Other voltage or energy values available upon request



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Automotive MLV Range – MA, PA and QA Series

	Case Size EIA	Work Volta			eakdow age at 1			amp 20µs)	Max. Peak current (8x20µs)	Max. leakage current at Vdc	Energy (10x 1000µs)	Energy Load- Dump (x10**)	Jump Start (5mn)	Mean Power Dissipation	Typical Cap 1KHz/ .5Vrms	T max.
		V _{rms}	V _{dc}	min	Nom	max	V _p	I _p (A)	Amp.	μA	J	J	max. V	W	pF	mm
							24	-65 V Po	wer Supply							
*VJ20MA0650K	1206	50	65	76.5	85	93.5	135	1	150	15	1.5	1.5	70	0.008	200	1.7
*VJ13MA0650K	1210	50	65	76.5	85	93.5	135	2.5	250	15	3.5	3	70	0.010	200	1.7
*VJ14MA0650K	1812	50	65	76.5	85	93.5	135	5	500	15	5	6	70	0.015	400	2.0
*VJ15MA0650K	2220	50	65	76.5	85	93.5	135	10	1000	15	12	12	70	0.030	800	2.0
*VJ32MA0650K	3220	50	65	76.5	85	93.5	135	10	1500	15	13	50	70	0.040	3500	2.5
							24	-85 V Po	wer Supply							
*VJ20MA0850K	1206	60	85	99	110	121	165	1	120	15	1.5	1.5	90	0.008	120	1.7
*VJ13MA0850K	1210	60	85	99	110	121	165	2.5	200	15	3.5	3	90	0.010	200	1.7
*VJ14MA0850K	1812	60	85	99	110	121	165	5	500	15	5	6	90	0.015	400	2.0
*VJ15MA0850K	2220	60	85	99	110	121	165	10	1000	15	12	12	90	0.030	800	2.0
*VJ32MA0850K	3220	60	85	99	110	121	165	10	1500	15	13	50	90	0.040	2500	2.5

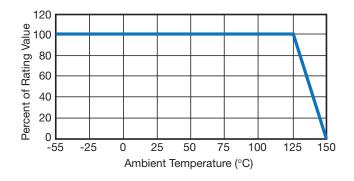
* under development

** time interval between pulses: 60s min.

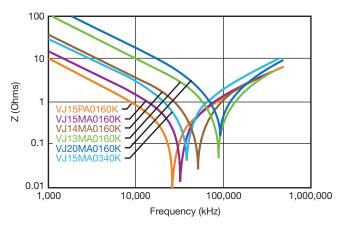
VC with hybrid solderable termination same electrical characteristics Other voltage or energy values available upon request

TEMPERATURE CHARACTERISTICS

For Current, Energy and Power



IMPEDANCE CHARACTERISTICS

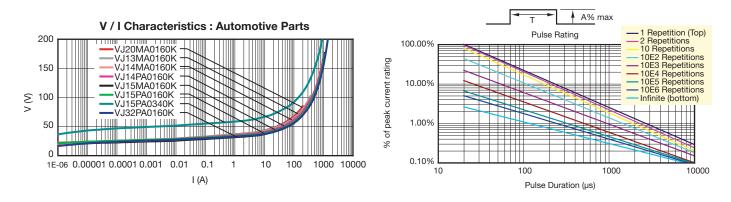




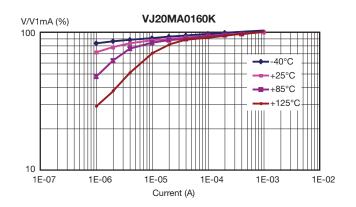
AUTOMOTIVE SERIES - VJ12, 20, 13, 14, 15, 32 MA AND PA SERIES

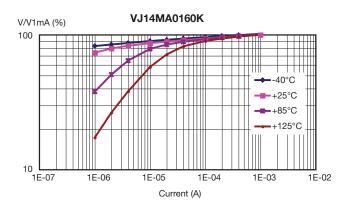
V / I CHARACTERISTICS

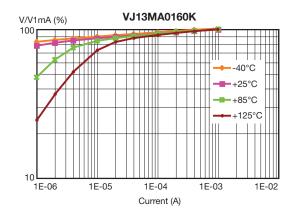
PULSE RATING

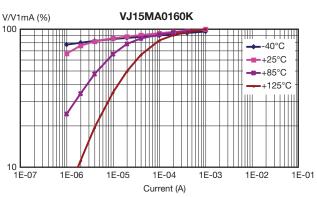


TEMPERATURE DEPENDENCE OF V/I CHARACTERISTICS







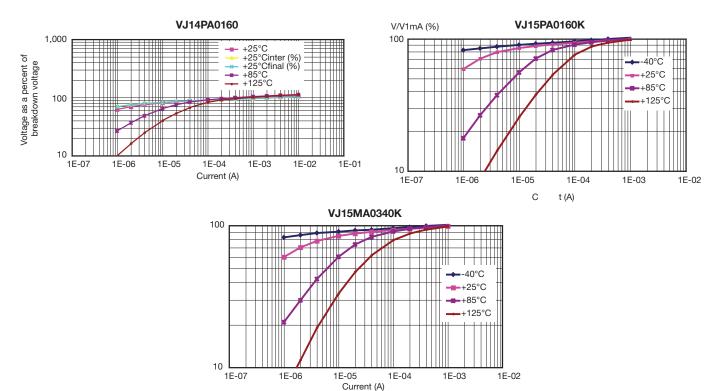




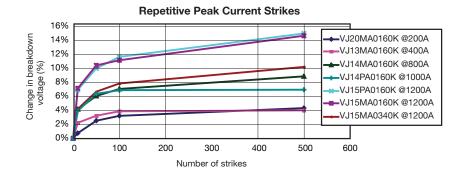
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PULSE DEGRADATION





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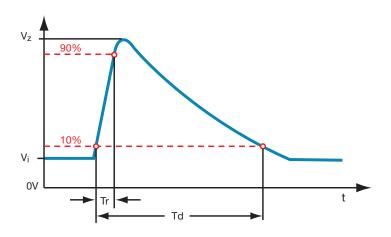


Automotive MLV Range – MA and PA Series

AUTOMOTIVE SERIES – VJ12, 20, 13, 14, 15, 32 MA AND PA SERIES

AUTOMOTIVE LOAD DUMP TEST

(According to ISO DP7637/2 Pulse 5)



When using the test method indicated below, the amount of Energy dissipated by the varistor must not exceed the Load Dump Energy value specified in the product table.

Voltage Pulse applied to the varistor:

12V Network

Vi = 13.5V Td = 100 to 350ms Ri = 2 Ohms (Internal Resistance) Vz - 70 to 200V Number of Pulses = 10 Pulses Other Load Dump Simulations can be achieved

24V Network

Vi = 27V Td = 100 to 350ms Ri = 2 Ohms (Internal Resistance) Vz - 70 to 200V Number of Pulses = 10 Pulses

Pulse 5: Typical Vz max versus Pulse duration and Rs

VJ20PA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
50ms	33	34	39	49
100ms	31	31	34	43
200ms	27	28	33	43
400ms	28	30	34	42
VJ13PA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
50ms	44	48	57	75
100ms	36	39	46	60
200ms	33	33	39	50
400ms	28	28	34	46
VJ14PA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
50ms	60	68	85	125
100ms	46	52	62	77
200ms	37	41	50	63
400ms	32	35	43	54
VJ15PA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
50ms	80	116	145	188
100ms	61	80	104	140
200ms	47	60	78	100
400ms	39	47	58	74

VJ15QA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
100ms	65	78	91	117
200ms	54	60	73	92
400ms	44	51	60	75
VJ15MA0340K	0.5 Ω	1Ω	2 Ω	4 Ω
100ms	66	78	91	117
200ms	55	60	73	92
400ms	49	53	60	75
VJ15PA0340K	0.5 Ω	1Ω	2 Ω	4 Ω
100ms	80	90	108	134
200ms	60	67	80	106
400ms	58	62	69	85
VJ32PA0160K	0.5 Ω	1Ω	2 Ω	4 Ω
100ms	102	120	175	200
200ms	72	85	120	158
400ms	53	62	78	105
VJ32PA0340K	0.5 Ω	1Ω	2 Ω	4 Ω
100ms	90	105	133	170
200ms	70	79	98	132
400ms	62	70	83	106



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INDUSTRIAL MLV RANGE - VJ12, 20, 13, 14, 15 M0 SERIES

FEATURES

- Glass encapsulation device with very low leakage current under DC operating conditions
- Device available in case size 1206, 1210, 1812, 2220 (3220)
- Nickel and Tin (100%) plated Termination (Hybrid AgPdPt termination available upon request)
- Bi-Directional protection. Fast Turn-On Time.
- · Excellent transient clamping characteristics up to 1200amps peak current
- Multi strike capability. Provide EMC Capacitance
- RoHS Compliant

GENERAL CHARACTERISTICS

Storage Temperature: -55°C to +150°C Operating Temperature: -55°C to +125°C

TYPICAL APPLICATIONS

Many uses to reduce transient over-voltage in the very wide range of electronic products in the Professional, Industrial and Consumer Applications.

Туре	Case Size	Vrms	VDC	Breakdown Voltage	Max. Clamping Voltage		Maximum Leakage Current	Energy 10*1000µs	Max. Peak Current 8*20µs	Cap. Typical (1KHz/0.5V)
		(V)	(V)	(V)	Vp (V)	lp (A)	μA	(J)	(A)	(pF)
VJ20M00140K	1206	14	18	22±10%	38	1	15	0.5	200	800
VJ13M00140K	1210	14	18	22±10%	38	2.5	15	1.5	400	1800
VJ14M00140K	1812	14	18	22±10%	38	5	15	2.3	800	4200
VJ15M00140K	2220	14	18	22±10%	38	10	15	5.8	1200	9600
VJ20M00170K	1206	17	22	27±10%	44	1	15	0.6	200	800
VJ13M00170K	1210	17	22	27±10%	44	2.5	15	1.7	500	1600
VJ14M00170K	1812	17	22	27±10%	44	5	15	2.7	800	3700
VJ15M00170K	2220	17	22	27±10%	44	10	15	7.2	1200	8600
VJ20M00200K	1206	20	26	33±10%	54	1	15	0.7	200	600
VJ13M00200K	1210	20	26	33±10%	54	2.5	15	1.9	400	1200
VJ14M00200K	1812	20	26	33±10%	54	5	15	3	800	3000
VJ15M00200K	2220	20	26	33±10%	54	10	15	7.8	1200	6400
VJ20M00250K	1206	25	31	39±10%	65	1	15	1	200	400
VJ13M00250K	1210	25	31	39±10%	65	2.5	15	1.7	300	1100
VJ14M00250K	1812	25	31	39±10%	65	5	15	3.7	800	2400
VJ15M00250K	2220	25	31	39±10%	65	10	15	9.6	1200	5500
VJ20M00300K	1206	30	38	47±10%	77	1	15	1.1	200	350
VJ13M00300K	1210	30	38	47±10%	77	2.5	15	2	300	750
VJ14M00300K	1812	30	38	47±10%	77	5	15	4.2	800	1900
VJ15M00300K	2220	30	38	47±10%	77	10	15	12	1200	4200
VJ20M00350K	1206	35	45	56±10%	90	1	15	0.6	200	260
VJ13M00350K	1210	35	45	56±10%	90	2.5	15	1.5	300	530
VJ14M00350K	1812	35	45	56±10%	90	5	15	4	500	1400
VJ15M00350K	2220	35	45	56±10%	90	10	15	7.7	1000	2800
VJ20M00400K	1206	40	56	68±10%	110	1	15	0.7	200	180
VJ13M00400K	1210	40	56	68±10%	110	2.5	15	2.3	250	380
VJ14M00400K	1812	40	56	68±10%	110	5	15	4.8	500	800
VJ15M00400K	2220	40	56	68±10%	110	10	15	9	1000	2000
VJ20M00500K	1206	50	65	82±10%	135	1	15	0.8	200	160
VJ13M00500K	1210	50	65	82±10%	135	2.5	15	1.6	200	300
VJ14M00500K	1812	50	65	82±10%	135	5	15	4.5	400	800
VJ15M00500K	2220	50	65	82±10%	135	10	15	5.6	800	1400
VJ20M00600K	1206	60	85	100±10%	165	1	15	0.9	120	100
VJ13M00600K	1210	60	85	100±10%	165	2.5	15	2.0	200	210
VJ14M00600K	1812	60	85	100±10%	165	5	15	5.8	400	600
VJ15M00600K	2220	60	85	100±10%	165	10	15	6.8	800	1100

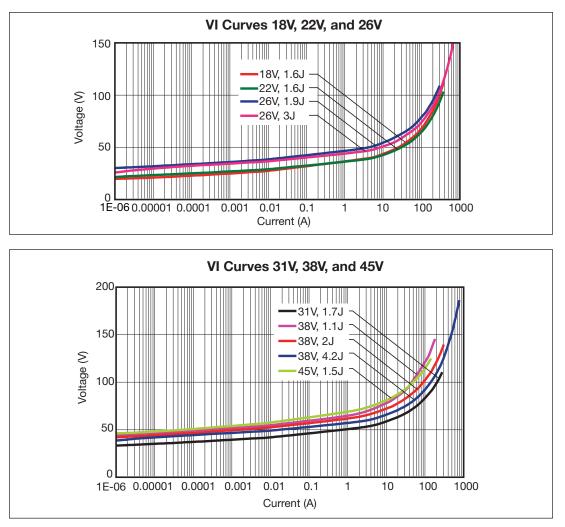


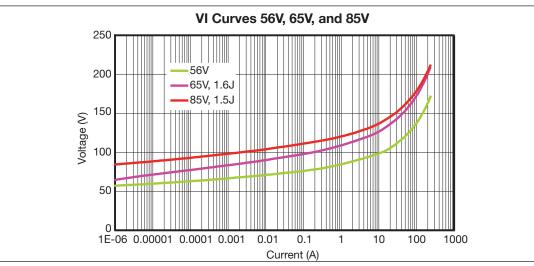
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Industrial MLV Range – M0 Series

INDUSTRIAL MLV RANGE – VJ12, 20, 13, 14, 15 M0 SERIES V/I CHARACTERISTIC





RoHS

KUDECERA AWAX
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Industrial MLV Range – MC/PC Series

INDUSTRIAL MLV RANGE - VJ13 MC/PC SERIES

FEATURES

- Glass encapsulation device with very low leakage current under DC operating conditions
- Device available in 1210 case size
- Bi-Directional protection. Fast Turn-On Time.
- Nickel and Tin (100%) plated Termination (Hybrid AgPdPt termination available upon request)
- Excellent transient clamping characteristics up to 500amps peak current
- Multi strike capability. Provide EMC Capacitance
- RoHS Compliant

GENERAL CHARACTERISTICS

Storage Temperature: -55°C to +150°C Operating Temperature: -55°C to +125°C Working Voltage: 18Vdc to 60Vdc

TYPICAL APPLICATIONS

- · Protection of various semiconductor elements from overvoltage
- Industrial equipment
- Consumer Electronics
- Plug-in cards, remote controls
- Home automation

Part Number	Working Voltage	e Breakdown Voltage Voltage at 1mA				lamp 20µs)	max. peak current (8x20µs)	Energy (10x1000µs)	CAP (1KHz/.5Vrms)
	Vdc	min	Nom	max	Vp	lp(A)	Amp.	J	pF
VJ13MC0180K	18	21.6	24	26.5	45	10	500	1.5	2200
VJ13MC0260K	26	29.7	33	36.3	62	10	300	1.2	1200
VJ13MC0300K	30	35.1	39	42.9	73	10	220	0.9	1000
VJ13PC0300K	30	35.1	39	42.9	73	10	280	1.2	1000
VJ13MC0480K	48	54.5	60.5	66.5	110	10	220	0.9	530
VJ13PC0480K	48	54.5	60.5	66.5	110	10	250	1.2	500
VJ13MC0600K	60	67	75	83	126	10	250	1.5	400

VC with hybrid solderable termination same electrical characteristics

Other voltage values available upon request

Telecom MLV Range – MT Series



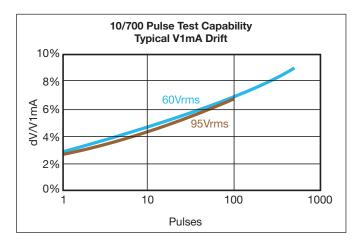
TELECOM MLV RANGE - VJ14 MT SERIES

FEATURES

- Effective alternative to leaded MOVs between 60 and 90 Vrsm
- High Energy Ratings up to 6 Joules with 1812 case size
- Nickel barrier or hybrid AgPdPt terminations
- · Multiple Strike Capability
- Provide EMC Capacitance
- Specified in accordance to CCITT 10/1000µs Pulse test
- RoHS Compliant and IMDS Registration

CCITT 10X700MS TEST

A pulse of 10 x 700 μ s duration as specified by CCITT or IEC 61000-4-5 is often used to check the interference immunity of Telecom equipment. The curves show that the 60Vrms Varistor can reduce the interference of the equipment from 2KV to less than 200V.



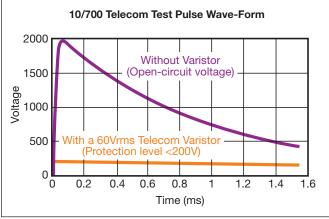
PART NUMBERS

TARGET APPLICATIONS

- · Phone Lines, ADSL Lines, and other Telecom Circuits
- Consumer Products

GENERAL CHARACTERISTICS

Storage Temperature: -55°C to +125°C Operating Temperature: -55°C to +125°C



Ten pulses with a duration of 10x700µs applied at one minute intervals are specified for telecom equipment.

The curves show the V1mA drift when more than 10 pulses are applied.

Part Number	Case Size	Oper Volt	ating age	Breakdown Voltage		lamping tage	CCITT 10 Pulses 10*700µs	l max. 8*20µs	Energy 10*1000µs	Mean Power Dissipation	Typical Cap.
	EIA	Vac	Vdc	V(1mA)	V	Amp.	Amp.	Amp.	Joules	W	pF
VJ14MT0600	1812	60	85	107	200	45	45	400	6	0.015	400
VJ14MT0750	1812	75	100	120	250	45	45	400	6	0.015	400
VJ14MT0950	1812	95	125	150	270	45	45	250	5	0.015	280

Hybrid termination AgPdPt (VC Range) upon request



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Glass Encapsulated MLV SMD Varistor (VJ32/VC32)





GENERAL DESCRIPTION

The VJ32/VC32M0 Series offers the designer a surface mount solution with higher voltage ratings and transient energy ratings. This Multilayer Layer Surface Mount Varistor replaces the traditional radial-lead Varistors with reduced size and weight. The glass encapsulation ensures the high performances in voltage up to 300Vrms reliability and acid-resistance against harsh environment like chlorite soldering flux.

APPLICATIONS

- MOV (Radial) Replacement •
- Suppression of transient on line voltage
- **Electric Meters** • •
- Industrial Equipment
- Mains PSUs

•

- Telecommunications
- . **Consumer Electronics**

FEATURES

- Lead less surface mount chip 3220 Case Size
- Voltage Ratings from 175Vrms to 300 Vrms
- . VJ32 with Ni barrier/100% Sn Termination (for lead free soldering applications)
- VC32 with hybrid PdPtAg Termination (not suitable • for lead free soldering)
- Operating temperature from -55°C to +85°C .
- **RoHS Compliant**



PART NUMBERS

Part Number	Case Size	Operating	g voltage		akdown Volta oltage at 1mA		Max. Cla Voltage 8		Max. Leakage Current	Energy 10*1000µs	Max. Peak Current 8*20µs 1 Pulse	Cap. Typical (1KHz,0.5V)
		Vrms	Vdc	Min.	Average	Max.	V	Α	μA	Joule	A	pF
VJ32M00140K	3220	14	18	19.8	22	24.2	47	10	15	0.7	1500	15000
VJ32M00170K	3220	17	22	24.3	27	29.7	57	10	15	0.9	1500	15000
VJ32M00200K	3220	20	26	29.7	33	36.3	68	10	15	1.1	1500	15000
VJ32M00250K	3220	25	31	35.1	39	42.9	79	10	15	1.2	1500	15000
VJ32M00300K	3220	30	38	42.3	47	51.7	92	10	15	1.5	1500	15000
VJ32M00350K	3220	35	45	50.4	56	61.6	107	10	15	1.8	1200	5000
VJ32M00400K	3220	40	56	61.2	68	74.8	127	10	15	2.2	1200	5000
VJ32M00500K	3220	50	66	73.8	82	90.2	135	10	15	2.5	1000	3500
VJ32M00600K	3220	60	85	90.0	100	110	165	10	15	3	1000	2500
VJ32M00750K	3220	75	102	108	120	132	200	10	15	3.5	600	2000
VJ32M00900K	3220	95	127	135	150	165	250	10	15	6	600	1500
VJ32M01150K	3220	115	153	162	180	198	295	10	15	6.5	300	350
VJ32M00131K	3220	130	175	180	200	220	340	10	15	7	300	170
VJ32M00141K	3220	140	180	198	220	242	360	10	15	7.5	300	140
VJ32M00151K	3220	150	200	216	240	264	395	10	15	9	300	130
VJ32M01750K	3220	175	225	243	270	297	455	10	15	9.5	300	120
VJ32M00231K	3220	230	300	324	360	396	595	10	15	10	300	80
VJ32M00251K	3220	250	330	351	390	429	650	10	15	11	300	75
VJ32M02750K	3220	275	369	387	430	473	710	10	15	13	300	70
VJ32M00301K	3220	300	385	423	470	517	775	10	15	15	300	65

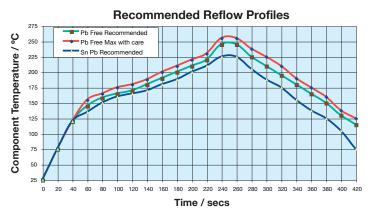
VC32 Series with solderable hybrid termination. Glass encapsulation from 115Vrms to 300Vrms. Other voltage values available upon request

Surface Mounting Guide



Dimensions in mm (inches)

SURFACE MOUNTING GUIDE (VJ13, 14, 15, 20, 32) APPLICATIONS NOTES



Case D2 D3 D5 D1 D4 Size 4 0 0 1 0 0 1206 1.00 (0.039) 2.00 (0.079) 1.06 (0.042) (0.039)(0.157)4.00 1.00 1210 1.00 (0.039) 2.00 (0.079) 2.05 (0.081) (0.157) (0.039) 5.60 1.00 1.00 (0.039) 3.60 (0.142) 3.00 (0.118) 1812 (0.220)(0.039)

1.00 (0.039)

2.21 (0.087)

WAVE SOLDERING

6.60

(0.260)

10.21

(0.402)

2220

3220

REFLOW SOLDERING

Dimensions in mm (inches)

5.00 (0.197)

5.50 (0.217)

1.00

(0.039)

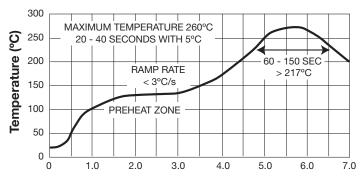
2.21 (0.087)

RECOMMENDED SOLDERING PROFILES

VJ products are compatible with a wide range of soldering conditions consistent with good manufacturing practice for surface mount components. This includes Pb free reflow processes and peak temperatures up to 270°C. Recommended profiles for reflow and wave soldering are show below for reference.

VC products are recommended for lead soldering application or gluing techniques.

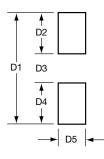
VJ Products Lead-Free Reflow Profile



The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.

Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

RECOMMENDED SOLDER PAD LAYOUT



Case D1 D3 D4 D2 D5 Size 5.00 1.50 2.00 1.50 1.06 1206 (0.059)(0.042) (0.197)(0.079)(0.059)5.00 1.50 2.00 1.50 2.05 1210 (0.197)(0.059)(0.079)(0.059)(0.081)1.50 3.60 1.50 3.00 6.60 1812 (0.260)(0.059) (0.142)(0.059) (0.118) 7.60 1.50 4.60 1.50 5.00 2220 (0.299)(0.059)(0.181)(0.059)(0.197)1.50 5 79 1 50 5 50 3220 11.21 (0.441) (0.059)(0.228)(0.059)(0.217)

4.60

(0.181)

5.79 (0.228)



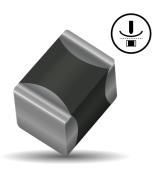
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Multilayer Varistor with FLEXITERM®

General Specifications



ROHS



GENERAL DESCRIPTION

With increased requirements from the automotive industry for additional component robustness, KYOCERA AVX recognized the need to product a MLV with enhancedmechanical strength. It was noted that many components may be subject to severe flexing and vibration when used under the hood automotive and other harsh environment applications.

To satisfy the requirement for enhanced mechanical strength, KYOCERA AVX had to find a way of ensuring electrical integrity is maitaied whilst external forces are being applied to the component. It was found that the structure of the termination needed to be flexible and after uch research and development, KYOCERA AVX launched FLEXITERM®, multilayer varistor. The industry standard for flexure is 2mm miimum. Using FLEXITERM®, KYOCERA AVX provides up to 5mm of flexure without internal cracking.

As well as for automotive applications, FLEXITERM[®] will product Design Engineers with a satisfactory solution when designing PCB's which may be sbject to high levels of board flexure.

PRODUCT ADVANTAGES

- Operating Temperature Range: -55°C to +125/150°C
- Qualified in 0603, 0805, 1206, and 1210 Case Sizes
- High Mechanical Performance Guaranteed to withstand 5mm Bend Test
- Increased Temperature Cycling Performance ≥ 3000 Cycles
- Flexible Termination System
- Reduction in Circuit Board Flex Failures
- Reduction in Circuit Board Flex Failures
- AEC-Q200 Qualified or Commercial Grade Products Available

APPLICATIONS

High Flexure Stress

• e.g. Depanelization: Components Near Edges of Board

Variable Temperature Applications

- Soft Termination Offers Improved Reliability Performance in Applications Where There is a Large Termperature Variation
- e.eg. Engine Sensors: Direct Connection to Battery Rail

Automotive Applications

- Improved Reliability
- · Excellent Mechanical and Thermo-Mechanical Performance

HOW TO ORDER

VC	AS	0805	18	Α	400	R	Z
	T	Т	T	Т	Т	Т	Т
Varistor Chip VC = Varistor Chip VT = Varistor Temp	Automotive Series AS = 125℃	Size 0603 0805	Working Voltage 05 = 5.6V _{dc} 14 = 14V _{dc}	Energy Rating A = 0.1J C = 0.3J	Clamping Voltage 150= 18V	Packaging D = 7" (1000)* R = 7" (4000)*	Terminations Z = FLEXITERM®
Rated	A3 = 150°C	1206 1210	$18 = 18V_{dc}^{dc}$ 26 = 26V_{dc}^{dc} 30 = 30V_{dc}^{dc}	D = 0.4J J = 1.5J	300 = 32V 390 = 42V 400 = 42V 580 = 60V	T = 13" (1000)	
					650 = 67V		DoUC

NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers.

Multilayer Varistor with FLEXITERM®

Specifications and Test Methods

PERFORMANCE TESTING

AEC-Q200 Qualification

- Created by the Automotive Electronics
 Council
- Specification defining stress test qualification for passive components

Testing

- Key tests used to compare soft termination to AEC-Q200 qualifications:
- Bend Test
- Temperature Cycle Test



BOARD BEND TEST RESULTS

AEC-Q200 Vrs KYOCERA AVX FLEXITERM® Bend Test

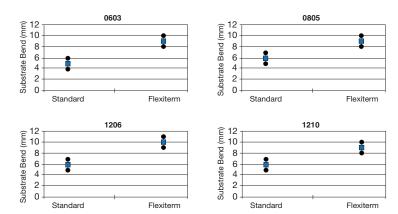


TABLE SUMMARY

Typical bend test results are show below:

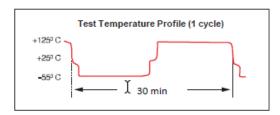
Style	Conventional Termination	FLEXTERM
0603	>2mm	>5mm
0805 1206	>2mm >2mm	>5mm >5mm
1206		
1210	>2mm	>5mm

TEMPERATURE CYCLE TEST PROCEDURE

Test Procedure as per AEC-Q200:

The test is conducted to determine the resistance of the component when it is exposed toextremes of alternating high and low temperatures.

- Sample lot size quantity 77 pieces
- TC chamber cycle from -55°C to +125°C for 1000 cycles
- Interim electrical measurements at 250, 500, 1000 cycles
- Measure parameter capacitance leakage current, breakdown voltage



BOARD BEND TEST PROCEDURE

According to AEC-Q200

•

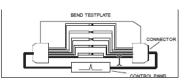
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Test Procedure as per AEC-Q200: Sample Size: 20 components

Span: 90mm Minimum deflection spec: 2mm

Components soldered onto FR4 PCB (Figure 1)

Board connected electrically to the test equipment



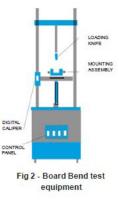
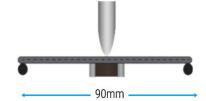


Fig 1 - PCB layout with electrical connections

KYOCERA AVX ENHANCED SOFT TERMINATION BEND TEST PROCEDURE

Bend Test

The varistor is soldered to the printed circuit board as shown and is bent up to 10mm at 1mm per second:



- The board is placed on 2 supports yomm apart (varistor side down)
- The row of capacitors is aligned with the load stressing knife



- The load is applied and the deflection wherethe part starts to crack is recorded (Note: Equipment detexts the start of the crack using a highly sensitive current detection circuit)
- The maximum deflection capability is 10mm

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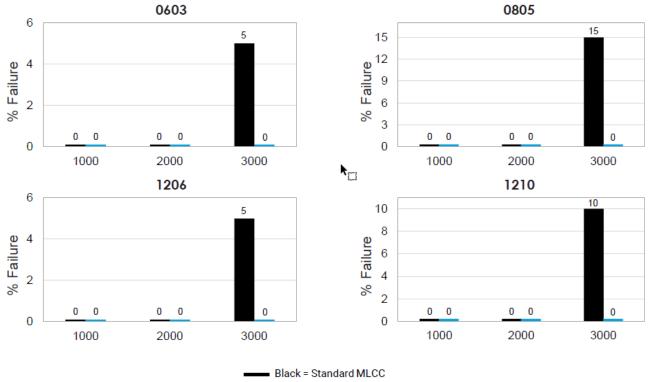


Multilayer Varistor FLEXITERM®



Specifications and Test Methods

BEYOND 1000 CYCLES: TEMPERATURE CYCLE TEST



Blue = Soft Term MLV (Flexiterm)

Soft Term - No Defects up to 3000 Cycles

AEC-Q200 specification states 1000 cycles compared to KAVX 3000 témperature cycles

WITH SOFT TERMINATION

FLEXITERM® TEST SUMMARY

- Qualified to AEC-Q200 test/specification with the exception of using KAVX 3000 temperature cycles (up to +150°C bend test guarenteed greater than 5mm).
- FLEXITERM provides performance compared to standardtermination systems.
- · Board bend test improvement by a factor of 2 or 4 times.
- **Temperature Cycling:**
- 0% Failure up to 3000 cycles .
- o sigificant change in electrical characteristics up to 3000 cycles

WITHOUT SOFT TERMINATION

Soft Term Ag Layer **Ni Layer Tin Layer** Major fear is of latent board flex failures. Far superior mechanical performance.

Generally open failure mode beyond 5mm flexure.

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TDS-TS-0036 | Rev 1

VW80808 Qualified Failsafe Varistors with FLEXITERM®

General Specifications





GENERAL DESCRIPTION

With increased requirements from the automotive industry for additional component robustness, KYOCERA AVX recognized the need to product a MLV with enhancedmechanical strength. It was noted that many components may be subject to severe flexing and vibration when used under the hood automotive and other harsh environment applications.

To satisfy the requirement for enhanced mechanical strength, KYOCERA AVX had to find a way of ensuring electrical integrity is maitaied whilst external forces are being applied to the component. It was found that the structure of the termination needed to be flexible and after uch research and development, KYOCERA AVX launched FLEXITERM®, multilayer varistor. The industry standard for flexure is 2mm milmum. Using FLEXITERM®, KYOCERA AVX provides up to 5mm of flexure without internal cracking.

As well as for automotive applications, FLEXITERM[®] will product Design Engineers with a satisfactory solution when designing PCB's which may be sbject to high levels of board flexure.

PRODUCT ADVANTAGES

- Operating Temperature Range: -55°C to + 125/150 °C
- Qualified in 0805, 1206, and 1210 Case Sizes
- Flexible Termination Guaranteed to Withstand 5mm Bend Test
- Increased Temperature Cycling Performance ≥ 3000 Cycles
- Reduction in Circuit Board Flex Failures
- AEC-Q200 Qualified
- · Approved to VW 80808 Specification
- Pass VW 80808 Failsafe Requirements

APPLICATIONS

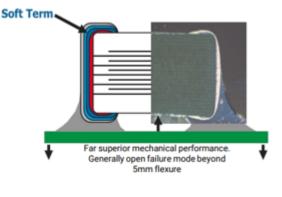
- Non-connected electrical system terminals
- · Connected electrical system terminals
- Voltage supply terminals (30, 15 etc.), potentials derived from them or connected potentials

HOW TO ORDER

VC	AS	0805	18	Α	400	R	Z
	T	Т	\top	Т	Т	Т	Т
Varistor Chip VC = Varistor Chip VT = Varistor Temp Rated	Automotive Series AS = 125℃ A3 = 150℃	Size 0805 1206 1210	Working Voltage $18 = 18V_{dc}$ $26 = 26V_{dc}$	Energy Rating C = 0.3J D = 0.4J E= 0.5J F = 0.7J	Clamping Voltage 380 = 38V 390 = 42V 400 = 42V	Packaging D = 7" (1000)* R = 7" (4000)* T = 13" (1000)	Terminations Z = FLEXITERM*
				H =1.2J J = 1.5J	540 = 54V 560 = 60V 580 = 60V		compliant

NOTE: Additional parts can be qualified to VW80808 upon request

+ 12	5 °C	+ 15	0°C
18V	26V	18V	26V
VCAS080518C400*Z	VCAS080526C580*Z	VTA3080518C400*Z	VTA3080526D540*Z
VCAS120618E380*Z	VCAS120626F540*Z	VTA3120618D380*Z	VTA3120626F540*Z
VCAS121018J390*Z	VCAS121026H560*Z	VTA3121018J390*Z	VTA3121026H560*Z



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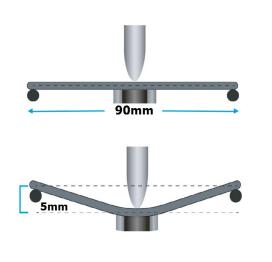
TDS-TS-0037 | Rev 0

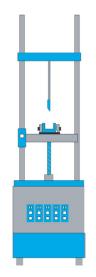
VW80808 Qualified Failsafe Varistors with FLEXITERM®

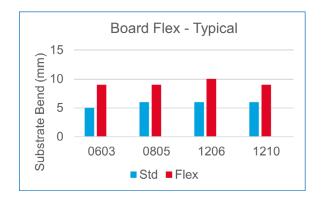


Specifications and Test Methods

BOARD BEND FLEX TEST







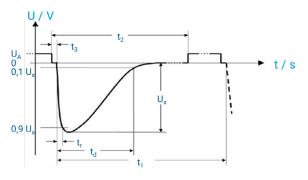
 Varistors with FLEXITERM[®] passed 5mm bend test required in VW 80808

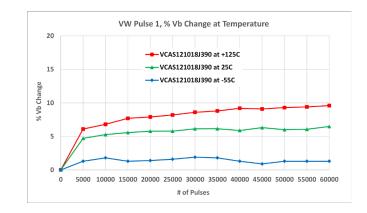
ELECTRICAL PULSE

POWER LINE TEST PROCEDURE:

- TL 81000: Pulse 1 Non-connected terminals: 5,000 pulsesConnected terminals: 60,000 pulses
- Temperature: -55°C, 25°C, & +125°C or +150°C

Pulse 1





Pulse		+ (up)	+ (110)		Ri (Ω)	t, (s)	t, (µs)
Quantity	$\mathbf{v}_{s}(\mathbf{v})$	t _d (µs)	ι, (μs)	12 V	42V / 48V	ι ₁ (s)	ι ₂ (μs)
60,000	-100	2,000	0.5 - 1	4	10	5	V _{off}

- Varistors with FLEXITERM[®] pass VW 80808 failsafe requirements
- US Patent 2022/0246334 A1

- TRANSIENT SUPPRESSION PRODUCTS -



Application Guide Typical Circuits Requiring Protection

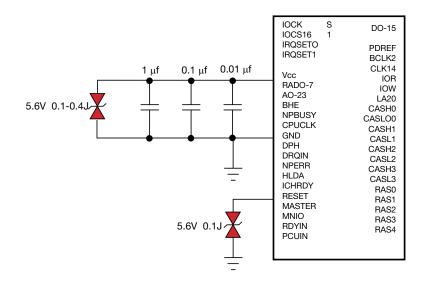
The following applications and schematic diagrams show where TransGuards[®] might be used to suppress various transient voltages:

- ASIC Reset & Vcc Protection
- Micro Controllers, Relays, DC Motors
- I/O Port Protection
- Keyboard Protection
- Modem Protection
- Sensor Protection
- Preamplifier Protection
- Audio Circuit Protection
- LCD Protection
- Optics Protection

Multilayer Transient Voltage Protection Typical Circuits Requiring Protection



ASIC RESET & Vcc PROTECTION

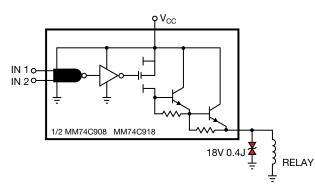


MICRO CONTROLLERS RELAYS, DC MOTORS

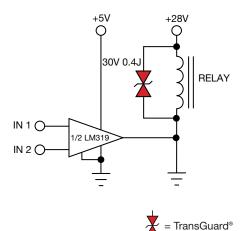
TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE ≥ RELAY OR MOTOR VOLTAGE ENERGY RATING TYPICALLY > 0.3J CAPACITANCE IS OF NO CONCERN

CMOS RELAY DRIVER



LM319 RELAY DRIVER



Multilayer Transient Voltage Protection Typical Circuits Requiring Protection

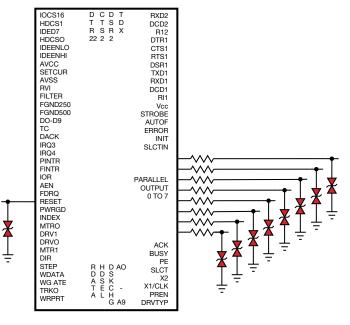


I/O PORT PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE TYPICALLY 14V - 18V ENERGY RATING TYPICALLY 0.05J - 0.1J CAPACITANCE SHOULD BE MINIMIZED

SUB NOTEBOOK & PDA'S



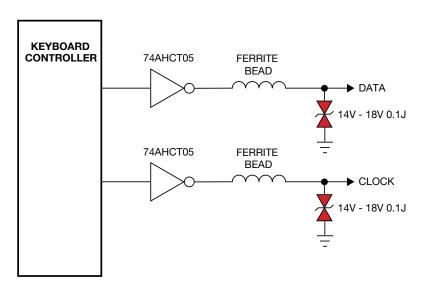
MAX 211 DRVR/RCVR

NOTEBOOK & WORK STATION

KEYBOARD PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE >5.6V ENERGY RATING TYPICALLY <0.4J CAPACITANCE PREFERRED TO BE MINIMUM





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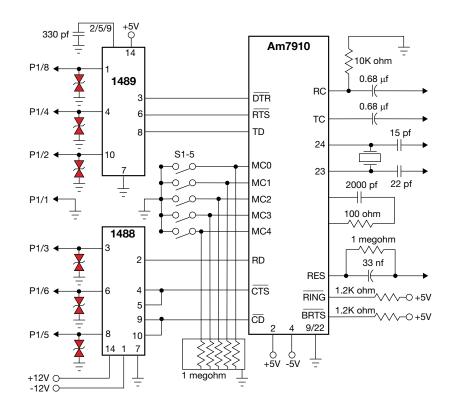
Multilayer Transient Voltage Protection Typical Circuits Requiring Protection



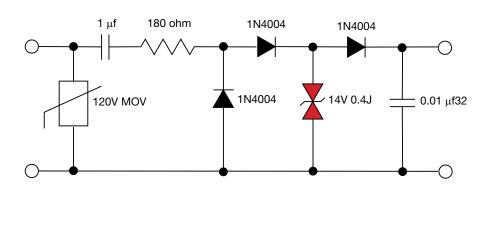
MODEM PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE <26V ENERGY RATING ≥ 0.1J



SENSOR PROTECTION TRANSGUARD® CHARACTERISTICS WORKING VOLTAGE TYPICALLY >14V ENERGY RATING > 0.4J CAPACITANCE IS NO CONCERN



🛣 = TransGuard®

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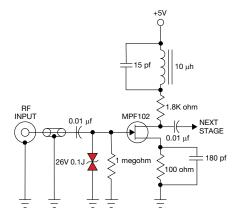


ANTENNA AND PREAMPLIFIER PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE TYPICALLY 18V - 26V ENERGY RATING 0.05J - 0.9J CAPACITANCE OF CONCERN ON MANY DESIGNS

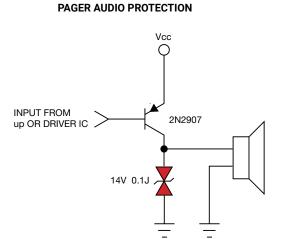
PREAMPLIFIER PROTECTION



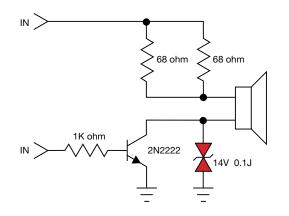
AUDIO CIRCUIT PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE TYPICALLY 14V - 18V ENERGY RATING 0.1J



NOTEBOOK, WORK STATION AUDIO PROTECTION



= TransGuard®

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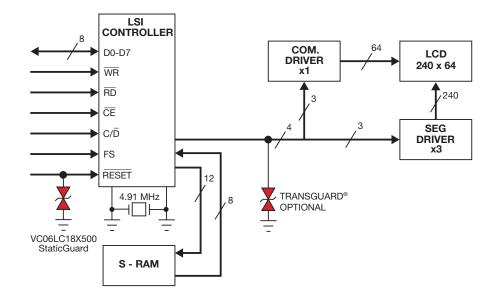
Multilayer Transient Voltage Protection Typical Circuits Requiring Protection



LCD PROTECTION

TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE < 5.6V ENERGY RATING < 0.1J

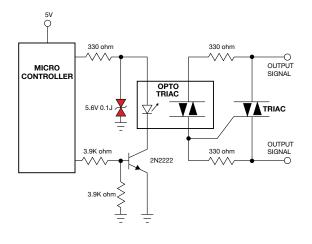


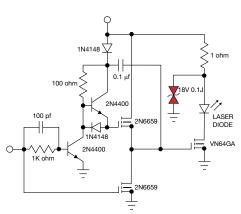
OPTICS PROTECTION TRANSGUARD® CHARACTERISTICS

WORKING VOLTAGE ≤ 18V ENERGY RATING 0.1J CAPACITANCE SHOULD BE MINIMIZED

OPTO ISOLATER PROTECTION









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General Applications (TransGuard®) Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications

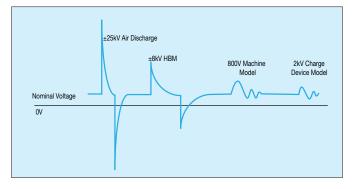
AUTOMOTIVE TRANSIENTS

Todays automobiles are using new technologies based on electronics systems connected by wide variety of networks to provide increased safety, convenience and comfort, to reduce emissions, increase fuel efficiency and more.

During the lifetime these systems are subjected to many overvoltage transient surges. To ensure safe and reliable function it is necessary to protect these sensitive systems against overvoltage surges.

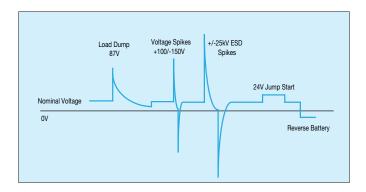
AUTOMOTIVE POWER RAIL TRANSIENTS

The transients on automotive power rails are usually medium to high energy transients and are caused by engine start such as Jump start (connecting other cars battery to jump start the engine), Load Dump (sudden load disconnect from alternator) or inductive switching (caused by DC motors on/off switching - e.g. window lifter, wipers, adaptive headlights). These transients are typically bi-directional.



AUTOMOTIVE DATA LINE TRANSIENTS

Data lines connecting the automotive systems need to be protected against varisous ESD pulses to ensure sensitive electronics protection. These transients are mainly caused by human interaction with the electronics systems (controls, buttons, ports) or by interaction between systems due to different charge build up. These transients are typically bi- directional and very fast.



MULTILAYER VARISTORS

The EMC requirements of today's automotive electronics are a natural fit for the use of KYOCERA AVX MultiLayer Varistors (MLVs).

AUTOMOTIVE VARISTORS ADVANTAGES

- AEC-Q200 gualified
- Bi-directional protection
- Compact footprint
- Very fast response sub ns
- EMI/RFI filtering in the off state
- · Multiple strikes capability
- No derating over operating temperature range (-55°C to +125°C, 150°C available)
- RoHS compliant
- Optional hybrid termination (Pd/Ag) available

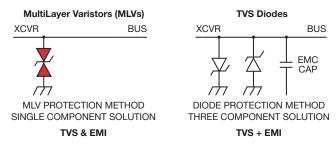
KYOCERA AVX Automotive Series Varistors provide reliable protection against automotive related transients - such as Load Dump, Jump Start and ESD to protect the growing number of electronics systems used in automotive applications. Transient examples:

•	Load dump (ISO 7637-2-5)	• AEC-Q200-002	• CI-220
•	Jump Start	 ISO 10605 	• CI-260
•	ISO 7637 Pulse 1-3	 ISO 16750-2 	
•	IEC 61000-4-2, etc.		

The parts offer fast turn on time, bi-directional protection, excellent multiple strikes capability and in addition also EMI/RFI filtering in the off-state that can improve overall system EMC performance.

High power MLV designs have been revised and miniaturized to allow efficient protection of today's most widely used communication bus designs.

When used in communication bus designs, MLVs can save approximately 90% of the board area involved with diode/EMC cap solutions. In addition, MLVs offer a FIT rate <0.1, an ability to be used at temperatures up to 150°C and a fast turn on time.



Automotive Application (TransGuard®) Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



MLVs have traditionally been used in inductively generated automotive transient suppression applications such as motors, relays and latches. MLVs offer a large in rush current capability in a small package, highenergy transient suppression and a broad and definable off state bulk EMC capacitance. These, coupled with an extremely low FIT rate and excellent process capability makes MLVs a common device in today's intermediate to high power automotive circuit protection.

AUTOMOTIVE COMMUNICATION BUS

KYOCERA AVX varistors are indeal choice for automotive circuit protection thanks to wide range of automotive qualified parts covering wide range of applications from low capacitance components for high speed data lines/RF circuits up to high energy varistors for load dump and jump start requirements on power lines or low speed data lines such as LIN Bus. KYOCERA AVX also offers automotive varistors for targeted and enhanced EMI filtering that help to improve overall EMC system performance.

Automotive electronic systems are connected by various network systems depending on the data speed requirements. Most common networks include:

LIN (LOCAL INTERCONNECT NETWORK)

LIN Bus operates at slower data speeds up to 20kbps and provides reliable low cost automotive networking. Typical applications are e.g. window lifter, door lock, seat controls, mirror controls, wipers, rain sensors etc.

CAN (CONTROLLER AREA NETWORK)

CAN Bus is is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer. CAN Bus supports data speeds up to 1Mbps. Typical applications are ECU connection to transmission, door locks, adaptive headlights, climate control, etc.

MOST (MEDIA ORIENTED SYSTEMS TRANSPORT)

MOST is standard for high-bandwidth automotive multimedia networking. This network provides excellent Quality of Service and seamless connectivity for audio/video streaming through variety of multimedia interfaces such as DVD player, head set, voice control.

FLEXRAY

FlexRay is an automotive network communications protocol to govern onboard automotive computing. It is designed to be faster and more reliable than CAN and TTP intended for drive-by-wire applications.

Example of suitable KYOCERA AVX series based on data speed and line type is shown below:

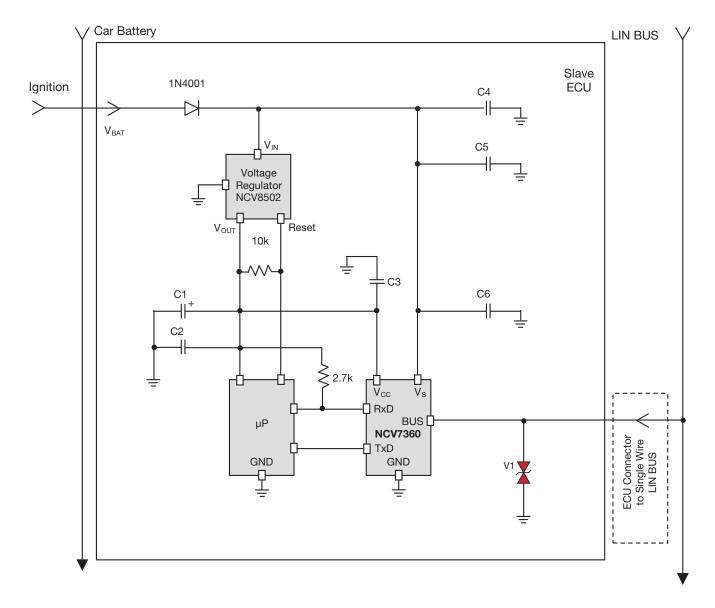
SERIES	BUS		DATA SPEED	
Sub pF AntennaGuard	HDMI		3.2 Gbps	High Speed
Automotive Series	1394a		400 Mbps	
AG/Sub pF AG Automotive Series,	MOST		45 Mbps	
Miniature AC	TTP		25 Mbps	
FlexRay	FlexRay		10 Mbps	Data
CAN, FlexRay, AG Series	TTCAN		1 Mbps	
	CAN	-	1 Mbps - 50 Kb	ps
TransGuard [®] Automotive Series, StaticGuard Automotive Series,	Safe-by-Wire		150 Kbps	
Radial Varistor	LIN		<20 Kbps	Low Speed
TransGuard® Automotive Series, StaticGuard Automotive Series, Radial Varistor, Miniature MAC, TransFeed Automotive Series	ALL			Power Line
TransFeed Automotive Series, Controlled Capacitance 10-100 M			I	Cutoff Frequency

Automotive Application (TransGuard®)

Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



LIN BUS



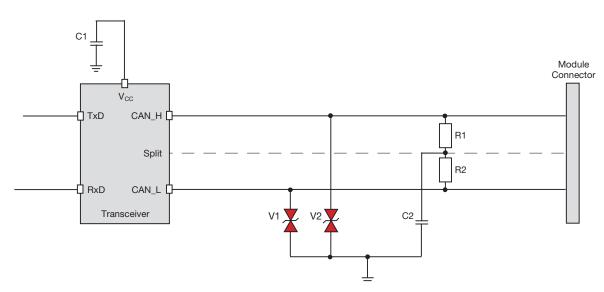
Component	Product	Part number	Specification
V1	Multilayer Varistor	VCAS080518C400RP	0805, 18Vdc, 0.3J, 120A, 550pF typ

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Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications

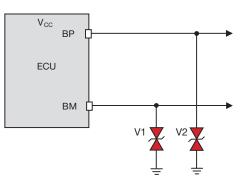


CAN BUS



Component	Product	Part number	Specification
V1, V2 Multilayer Varistor		CAN0001RP	0603, 18Vdc, 0.015J, 4A, 22pF max
(V1+V2)	Multilayer Varistor	or CAN0002RP 0405 Dual A	0405 Dual Array, 0.015J, 4A, 22pF max

CAN BUS

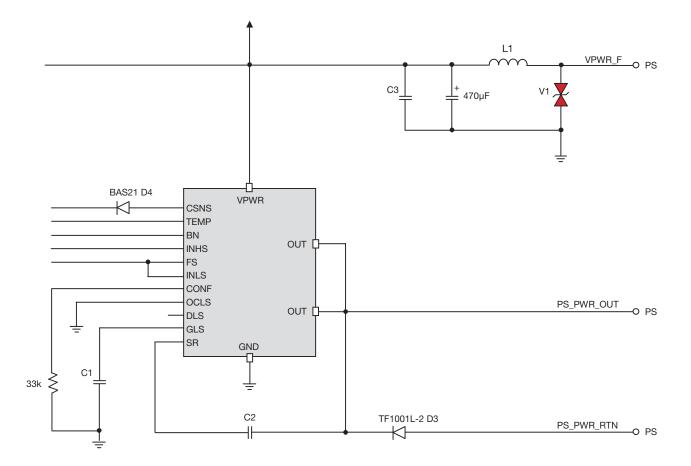


Component	Product	Part number	Specification	
V1, V2	Multilayer Varistor	FLX0005WP	0402, 18Vdc, 0.02J, 4A, 17pF max	

Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



ELECTRIC POWER STEERING



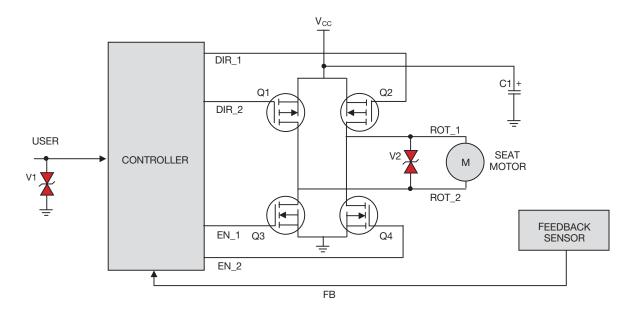
Component	Product	Part number	Specification	
V1	Multilayer Varistor	VCAS121018J390RP	1210, 18Vdc, 1.5J, 500A, 3100pF typ	

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Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications

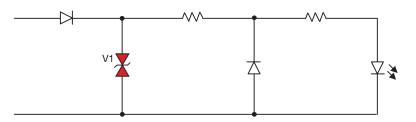


SEAT MOTOR CIRCUIT



	Component Product		Part number	Specification
	V1 Multilayer Varistor V2 Multilayer Varistor			0402, 18Vdc, 0.05J, 20A, 65pF typ
				1210, 18Vdc, 1.5J, 500A, 3100 pF typ

LED DOOR LAMP

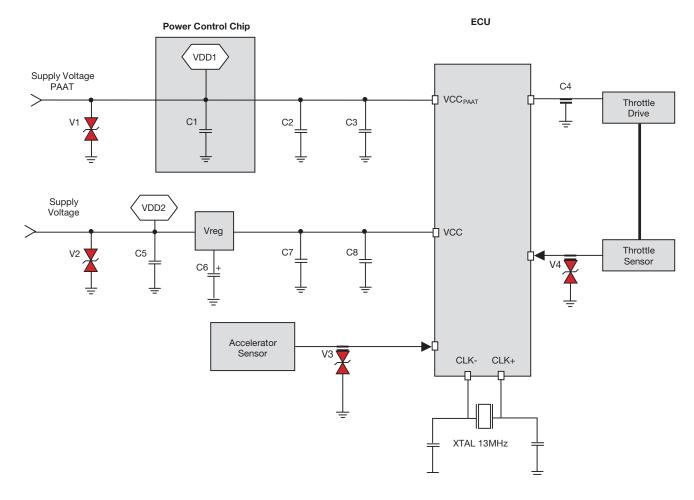


Component Product		Part number	Specification	
V1	Multilayer Varistor	VCAS120618D400RP	1206, 18Vdc, 0.4J, 150A, 900pF typ	

Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



DRIVE BY WIRE – THROTTLE



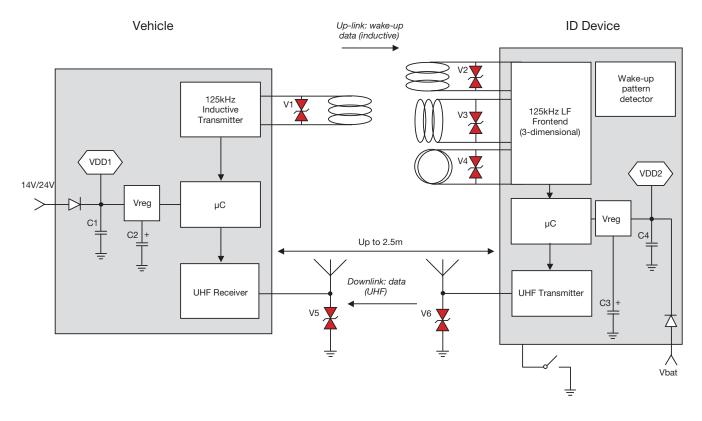
	Component Product V1, V2 Multilayer Varistor V3, V4 TransFeed		Part number	Specification	
			VCAS080518C400DP	0805, 18Vdc, 0.3J, 120A, 550pF typ	
			V2AF118X500Y3DDP	0805, 18Vdc, 0.05J, 20A, 75pF typ	

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Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications

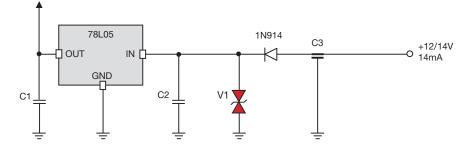


KEYLESS ENTRY



Component Product		Part number	Specification	
V1, V2, V3, V4	Multilayer Varistor	MAV0010DP	0603, 52Vac, 110 Pk-Pk @ 125kHz, 0.015J, 2A, 22pF Max	
V5, V6	Multilayer Varistor	VCAS04AG183R0YATWA	0402, 18Vdc, 3pF Max	

VOLTAGE REGULATOR



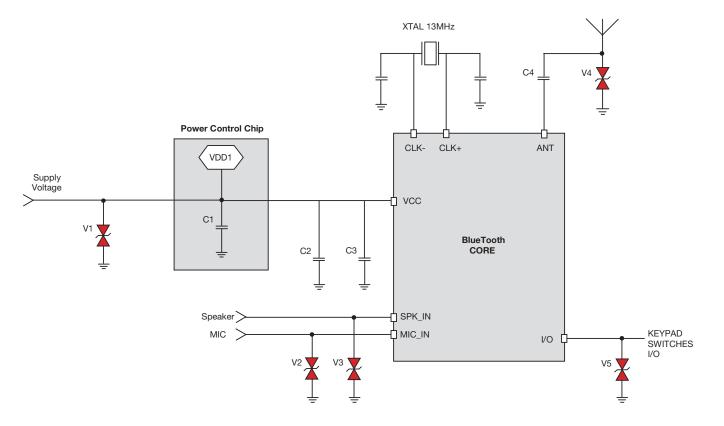
Component	Product	Part number	Specification	
V1	Multilayer Varistor	VCAS080518C400DP	0805, 18Vdc, 0.3J, 120A, 550pF typ	

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Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



BLUETOOTH



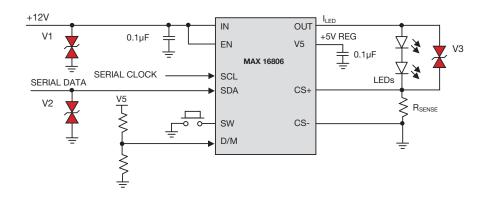
Component	Component Product		Specification
V1	V1 Multilayer Varistor VCAS080518C400DP 0805, 18Vdc, 0.3J, 120A, 55		0805, 18Vdc, 0.3J, 120A, 550pF typ
V2, V3	Multilayer Varistor VCAS060314A300DP 06		0603, 14Vdc, 0.1J, 30A, 350pF typ
V4	Multilayer Varistor	Multilayer Varistor VCAS06AG183R0YAT3A 0603, 18Vdc, 3pF max	
V5	V5 Multilayer Varistor VCAS040218X400WP 0402		0402, 18Vdc, 0.05J, 20A, 65pF typ

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Multilayer Transient Voltage Protection Circuit Protection in Automotive Applications



LED DRIVER



Component	Product	Part number Specification	
V1	V1 Multilayer Varistor VCAS120618E380 1206, 18Vdc, 0.5J, 200A, 9		1206, 18Vdc, 0.5J, 200A, 930pF
V2	Multilayer Varistor VCAS060318A400 0603, 18Vdc, 0.1J, 30A, 150		0603, 18Vdc, 0.1J, 30A, 150pF
V3	V3 Multilayer Varistor VCAS06LC18X500 0603, 18Vdc, 0.05J, 30A,		0603, 18Vdc, 0.05J, 30A, 50pF



Application Notes

- IEC-61000-4 Requirements
- Turn On Time Characteristics of Multilayer Varistor
- The Impact of ESD on Insulated Portable Equipment
- TransGuard Motor and Relay Application Study
- Multilayer Varistors in Automobile MUX Bus Applications

TransGuard®

Multilayer Ceramic Transient Voltage Suppressors Application Notes: IEC 61000-4 Requirements

WHAT IS IEC 61000-4?

The International Electrotechnical Commission (IEC) has written a series of specifications, IEC 61000-4, which man-date the performance of all electronic devices in a variety of transient and incident RF conditions. This specification requirement resulted as part of Europe's move toward a single market structure and a desire to formalize and harmonize current member countries' requirements. As of January 1, 1996, all electronic and electrical items sold to Europe must meet IEC 61000-4 series specifications.

WHY IS IEC 61000-4 REQUIRED BY EUROPE?

The various regulatory agencies within Europe feel that the IEC 61000-4 series of specifications is necessary to insure acceptable performance of electronic equipment in a world filled with increasingly more Electromagnetic Interference - EMI. Furthermore, as electronic systems become more portable, and the transient susceptibility of semiconductors increases, government regulations are essential to maintain a minimum level of performance in all equipment. Europe is so serious about the problem that they require that equipment be certified via testing to meet IEC 61000-4 series specifications after 1/1/96 to avoid fines and prosecution.

HOW DO COMPANIES SELLING ELECTRONIC SYSTEMS MEET IEC 61000-4 PARTS 2-5 SPECIFICATIONS?

Companies and design engineers must now use protective circuits or devices to meet these requirements. First, a description of IEC 61000-4/2-6 is in order:

IEC 61000-4-2 ESD TESTING REQUIREMENTS

All equipment destined for Europe must be able to withstand 10 strikes of ESD waveforms with Tr < 1ns in contact discharge mode (preferred) at pre-selected points accessible during normal usage or maintenance. Testing shall be performed at one or more of four (4) severity levels, depending upon equipment category.

Level	Contact Discharge ¹ Mode Test Voltage kV	Air Discharge Mode Test Voltage kV
1	2	2
2	4	4
3	6	8
4	8	15

61000-4-2 Test Conditions

1Preferred mode of testing due to repeatability.

WAVEFORM PARAMETERS

Level	Test Voltage Level kV	First Peak of Discharge Current Amps ± 10%	TR nS	30 nS Current Amps ± 30%	60 nS Current Amps ± 30%
1	2	7.5	0.7 -1	4	2
2	4	15	0.7 -1	8	4
3	6	22.5	0.7 -1	12	6
4	8	30	0.7 -1	16	8

Upon completion of the test, the system must not experience upset (data or processing errors) or permanent damage. The waveforms are to be injected at or along the DUT's body which is accessible in normal set-up and operation.

IEC 61000-4-3 ELECTROMAGNETIC COMPATIBILITY IMPACT TESTING (EMC)

This test is concerned with the susceptibility of equipment when subjected to radio frequencies of 27 MHz to 500 MHz. The system must be able to withstand three (3) incident radiation levels:

Level 1 1V/m field strength

Level 2 3V/m field strength

Level 3 10V/m field strength

Level X User defined > 10V/m field strength

The system must not experience upset (data or processing errors) or permanent errors.

IEC 61000-4-4 ELECTRICAL FAST TRANSIENT (EFT) TESTING

The EFT test is modeled to simulate interference from inductive loads, relay contacts and switching sources. It consists of coupling EFT signals on I/O parts, keyboard cables, communication lines and power source lines. The system, depending upon appropriate severity level, must be able to withstand repetition rates of 2.5 kHz to 5 kHz for \ge 1 minute as follows:

Open Circuit Output Voltage/10%

On Powe	er Supply	On I/O, Signal, Data, Control lines
Level 1	0.5kV	0.25kV
Level 2	1kV	0.5kV
Level 3	2kV	1kV
Level 4	4kV	2kV

TransGuard[®]

Multilayer Ceramic Transient Voltage Suppressors Application Notes: IEC 61000-4 Requirements



IEC 61000-4-5 UNIDIRECTIONAL POWER LINE SURGE TEST

The details of this specification for high energy disturbances are being addressed in several drafts under discussion within the EC at this time.

IEC 61000-4-6 CONDUCTED RF TEST FROM 9KHZ TO 80MHZ

The details of this specification for conducted broad band RF signals are being addressed in a first edition draft within the EC at this time.

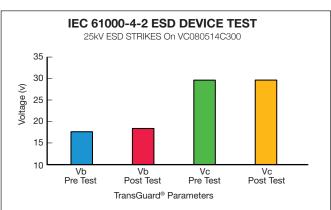
Designers have the option of using KYOCERA AVX TransGuards[®] to meet IEC 61000-4-2, 3 and 4.

In the case of IEC 61000-4-2 TransGuards[®] can be used to suppress the incoming Transient just like a Zener diode would. TransGuards[®], however, exhibit bipolar characteristics, a faster turn-on-time (<1nS), a better repetitive strike capability and superior thermal stability to the Zener suppression device. Furthermore, TransGuards[®] are typically smaller and lighter when placed on SMT circuit boards. See Figure 1 for data illustrating IEC 61000-4-2 repetitive strike capability.

The TransGuards[®] effective capacitance allows the device to be used to meet IEC 61000-4-3 and 61000-4-4. The device's parallel capacitance can be used as effectively as a capacitor to block low level incident and conducted RF energy. If in the case of some levels of IEC 61000-4-3 and IEC 61000-4-4 when the intensity of pulse is greater than the device's breakdown capability it will then turn on and suppress via MOV means rather than capacitance (as in the small signal case). Effectiveness hinges upon the proper placement of the device within the PCB (which is usually easily accomplished since TransGuards[®] are so small).

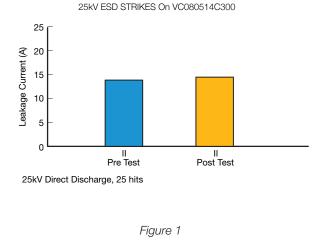
SUMMARY

KYOCERA AVX TransGuards[®] are exceptionally suited to meet the defined portions of the IEC 61000-4 document. Experimentation is critical to proper choice and selection of devices to suppress 61000-4-3/4. Samples are available from your local sales representative.



25kV Direct Discharge, 25 hits

IEC 61000-4-2 ESD DEVICE TEST



TransGuard[®]

Multilayer Ceramic Transient Voltage Suppressors Application Notes: Turn on Time Characteristics of Multilayer Varistors

INTRODUCTION

Due to the growing importance of ESD immunity testing, as required by the EMC Directive, proper selection of voltage suppressor devices is critical. The proper selection is a function of the performance of the device under transient conditions. An ideal transient voltage suppressor would reach its "clamping voltage" in zero time. Under the conditions imposed by the 1991 version of IEC 61000-4-2, the actual turn-on-time must be less than one nanosecond to properly respond to the fast leading edge of the waveform defined in the standard.

It has been found during testing of transient suppressors that the response time is very closely dictated by the packaging of the device. Inductance that is present in the connection between the silicon die and the leads of the device creates an impedance in series with the suppressor device; this impedance increases the overall device response time, reducing the effectiveness of the suppressor device.

The purpose of this paper is to present the Turn on Time characteristics of Multilayer Varistors (MLVs) and to compare the MLV Turn on Time to that of various silicon transient voltage suppressors (SiTVs).

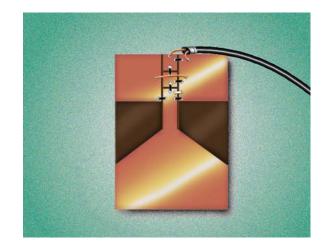
The Turn on Time of a transient voltage suppressor (TVS) is of growing importance since IEC 61000-4-2 now specifies ESD waveform with a rise time < 1 ns. Therefore, TVS's must have a turn on time < 1 ns to effectively suppress ESD. In many, if not all, ESD suppression applications, TVS turn on time can be of more importance than absolute clamping voltage (Vc) of the TVS (assuming that the TVS clamping voltage is less than the damage voltage of the circuit or IC).

To measure the turn on time of today's TVS's, a broad cross section of MLVs and SiTVs were chosen. Only surface mount devices were chosen in order to best represent today's TVS current usage/trends and to keep the test matrix to a reasonable level of simplicity. The following devices were tested:

TEST PROCEDURE

The TVS device under test (DUT) was placed on a PCB test fixture using SN60/40 solder. The test fixture (see Figure 1) was designed to provide an input region for an 8kV contact ESD discharge waveform (per IEC 61000-4-2 level 4 requirements). In addition, the fixture was designed to provide low impedance connections to the DUTs.

SMT MLV	SiTVS			
	MA141WA			
0603	BAV 99			
0805	SOT 23 type			
1206	SMB - 500W gull-wing SM device			
1210	SMC - 1500W gull-wing SM device			



🔇 KYOCERa

Figure 1. DUT Test Fixture

The ESD pulse was injected to the PCB from a Keytek minizap ESD simulator. Additionally, the fixture was to channel the ESD event to a storage oscilloscope to monitor the suppressor's response. Six resistors were used on the PCB to provide waveshaping and an attenuated voltage to the storage scope (see Figure 2):

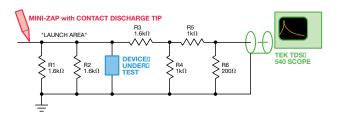


Figure 2. Schematic of Test Set Up

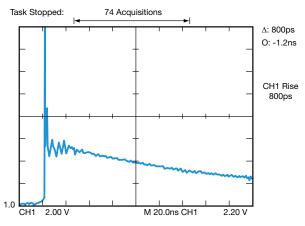
TransGuard® Multilayer Ceramic Transient Voltage Suppressors Application Notes: Turn on Time Characteristics of Multilayer Varistors



The functions of the resistors are as follows: The resistor values were adjusted in "open circuit" conditions to obtain best open circuit response. R1, R2 (1.6K) - provide wave shaping during the ESD discharge event R3 (1.6K), R4 (1K), R5 (1K) - Form a 60 dB Attenuator (1000:1 ratio) for input

of Tektronix TDS 540 1 giga sample/second storage oscilloscope

R6 (200 $\Omega)$ - provides matching to the 50 ohm coax feeding the TDS 540 oscilloscope.



The open circuit response of the ESD test fixture with a 9kV ESD pulse is shown in Figure 3.

Figure 3. Open Circuit Response of Test Fixture to an Injected ESD Waveform

The graph shows the voltage attenuated by a factor of 1000, with a 800ps risetime for the ESD waveform (this agrees with typical data given by Keytek for equipment performance). It should be noted that only the positive polarity was tested. Prior testing showed turn on time was not dependent upon waveform polarity (assuming that DUTs are bidirectional).

TEST RESULTS

MLV TURN ON TIME TRANSGUARDS®

The turn on time test results for KYOCERA AVX TransGuards[®] showed that all case sizes were capable of a sub-nanosecond turn on response. This corresponds favorably with the calculated turn on time of less than 1 ns. Specific performance data follows:

TransGuard®					
CASE SIZE	TURN ON SPEED				
0603	< 0.7 ns				
0805	< 0.9 ns				
1206	< 0.9 ns				
1210	< 0.8 ns				

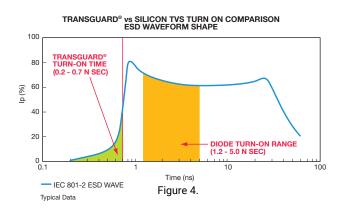
TVS TURN ON TIME

Test results for SiTVs varied widely depending upon the physical size and silicon die mounting configuration of the device. The results agree with several SiTVs manufacturers papers indicating that the absolute response from the silicon die could be < 1 ns. However, when the die is placed in a package, the turn on time delay increases dramatically. The reason for this is the series inductance of the SiTVs packaging decreases the effective response time of the device. Reports of 1-5 ns are frequently referred to in SiTVs manufacturers publications. Further, the turn on times for SiTVs vary dramatically from manufacturer to manufacturer and also vary within a particular manufacturers lot. The data provided in the following table generally agreed with these findings:

SiTVS					
CASE SIZE	TURN ON SPEED				
MA141WA	0.8ns				
BAV 99	0.9ns to 1.2ns				
SOT 23 Type	0.8ns				
SMB	1.5ns to 2.2ns				
SMC	1.5ns to 3ns				

SUMMARY

This test confirms calculations that show that KYOCERA AVX TransGuards[®] have a true sub-nanosecond turn on time. Although the silicon die of a SiTVs has a sub-nanosecond response, the packaged SiTVs typically has a response time much slower than a TransGuard[®]. If the two devices were directly compared on a single graph (see Figure 4), it could be shown that the TransGuard[®] diverts significantly more power than even the fastest SiTVs devices. Additionally, TransGuard[®] have a multiple strike capability, high peak inrush current, high thermal stability and an EMI/RFI suppression capability which diodes do not have.



TransGuard® Multilayer Ceramic Transient Voltage Suppressors Application Notes: The Impact of ESD on Insulated Portable Equipment

KYOCERa <u>/_\\/`(</u>

The purpose of this discussion is to recap the impact ESD has on portable, battery powered equipment. It will be shown that ESD can cause failures in "floating ground systems" in a variety of ways. Specifically, ESD induced failures can be caused by one or more of its complex components:

Predischarge - Corona Generated RF

Predischarge - E Field

Discharge - Collapsing E Field

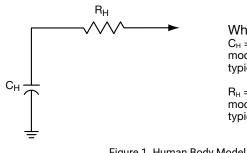
Discharge - Collapsing H Field

Discharge - Current Injection...Voltage...Additional Fields

With this in mind it will be shown that the only way to insure equipment survivability to ESD is to use a Transient Voltage Suppressor (in addition to proper circuit layout, decoupling, and shielding).

In order to get a better understanding of what happens in an ESD event the charge developed by a human body should be defined. The ESD schematic equivalent of the human body model is shown in Figure 1. Typically, the charge developed on a person can be represented by a 150pF capacitor in series with a resistance of 330 ohms. The energy of an ESD waveform generated from this model is Q = 1/2 CV2 where Q = total energy in Joules, C = capacitance of the human body model in farads and V = charging voltage in volts.

Voltages can be as high as 25 kV, however typical voltages seen are in the 8 to 15 kV regions.



Where: $C_{H} =$ Human body model capacitance typically 150pF

 $R_{H} =$ Human body model resistance typically 330 Ω

Figure 1. Human Body Model

PREDISCHARGE E FIELD FAILURES

Now that we have a definition of the basic ESD human body model we can discuss the predischarge E field failure mode.

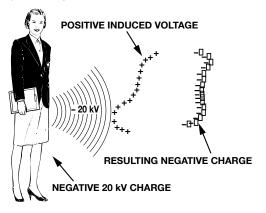


Figure 2. Pre-Discharge Scenario

In the predischarge scenario (Figure 2) a human charged to -20 kV may approach a battery powered "system" on a table. As the person reaches toward the system electrostatics dictate that the system will have an equal and opposite charge on the system's surface nearest to the person. Since the system we are approaching is isolated from ground, the charge is only redistributed among the device. (If the system were grounded a current would be generated by the loss of electrons to ground. The system would then become positive relative to ground). The rate of approach of the human body model affects the charging current to a small extent. However, most importantly, it is the electrostatic field and the unequal voltages which developed across the equipment that cause the destruction of components within the system. In general, unprotected IC's (particularly CMOS) are susceptible to damage due to induced E field voltages. This problem is further complicated by the device type and complexity and the fact that the breakdown voltage of a generic IC will vary greatly from manufacturer to manufacturer (Figure 3). This brief discussion should be adequately convincing that electrostatically induced E field can impact system reliability. IC protection can be achieved by placing a transient suppressor on the most susceptible pins of the sensitive IC's (e.g., Vcc and I/O pins, etc.).

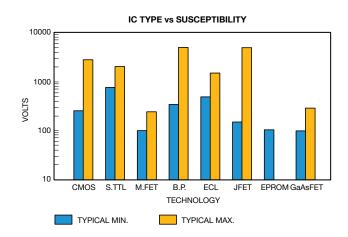


Figure 3. IC Type E Field Susceptibility

CONTACT DISCHARGE FAILURES

As the charged person gets closer to the system, the situation is more complex. First a much more detailed human body model is needed to represent the complex transmission line which will transport energy to the system (see Figure 4). In this discussion we will only consider the case of a single contact discharge. In the real world, however, multiple discharges will likely occur (possibly caused by a person's hand reacting to an ESD spark and then touching the system again, etc.).

In contact discharge, when a charged person approaches the system, E fields are induced. As the person gets closer to the system, the field intensity becomes greater, eventually reaching a point large enough to draw an arc between the person and the system. In contrast to the noncontrast

TransGuard[®] Multilayer Ceramic Transient Voltage Suppressors Application Notes: The Impact of ESD on Insulated Portable Equipment

E field example, the speed of approach is of great importance in the contact discharge model. A fast approach causes a more intensive discharge and faster current rise times and peaks.

The model shown on Figure 4 can be broken up into 4 sections for the sake of simplification. The first section is the human body model input voltage. This section is identical to the simplified human body model shown in Figure 1.

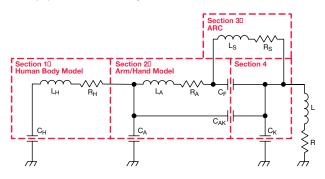
Section 2 takes into account how the human body model gets the energy to the system. This section considers the inductance, resistance and capacitance of the human's arm and finger and its capacitance relative to ground and the system.

The third section is the inductance and resistance of the arc which is created as section 2 approaches the system (Section 4).

Section four is the system itself.

The combination of the capacitances and inductances in these sections form a complex network of LC tank circuits which will inject a variety of waveforms (transients) into the system. These waveforms will range in frequency from very high (5 GHz) to high (100 MHz) to low (20-50 MHz) plus a variety of under damped and over damped waveforms.

Finally, in addition to current/voltage injection occurring as a result of the discharge, there will be collapsing E and H fields and significant high frequency RF waveforms. Many times these waveforms propagate into shielded equipment and cause system/device failures.



- Where: C_u = Lumped capacitance between the human body and earth
 - R₁₁ = Lumped resistance of the human body
 - L_{μ} = Lumped inductance of the human body
 - C₄ = Lumped capacitance between the person's arm and earth
 - C_{AV} = Lumped capacitance between the person's arm (and near portions of the body) and the keyboard
 - R₄ = Lumped resistance of the person's arm's discharge path
 - ${\rm L}_{\rm A}$ = Lumped inductance of the person's arm's discharge path
 - $\rm C_{\scriptscriptstyle F}$ = Capacitance between person's finger, hand, and the keyboard
 - C_{κ} = Lumped capacitance keyboard to earth
 - R_{ν} = Lumped resistance of the keyboard earth ground path
 - L_{κ} = Lumped inductance of the keyboard earth ground path

Figure 4. Contact Discharge Model

SUMMARY

Designers may be inclined to think that E field variation due to near field electrostatics (as in the person being close to the system but not touching it) can be eliminated by shielding. This is usually not the case because it is difficult to get a tight columbic shield around internal circuitry without incurring significant additional manufacturing costs. Additionally, the shielding will likely have seams, ventilation holes, or I/O ports which represent a significant portion of a wavelength (at 5 GHz). Therefore, E fields and corona generated RF can be a problem. Finally, if the system has I/O connectors, keyboards, antennas, etc., care must be taken to adequately protect them from direct/and indirect transients. The most effective resolution is to place a TransGuard[®] as close to the device in need of protection as possible. These recommendations and comments are based upon case studies, customer input and Warren Boxleitner's book Electrostatic Discharge and Electronic Equipment - A Practical Guide for Designing to Prevent ESD Problems.

🔀 KYOCERa

TransGuard[®] Multilayer Ceramic Transient Voltage Suppressors Application Notes: Motor and Relay Application Study



PURPOSE

A significant number of end customers have experienced failures of circuitry in and around low voltage relays and motors. Additionally, EMI problems have been associated with running motors.

This study is aimed at evaluating how TransGuards[®] can reduce EMI from running motors and clamp transients generated from relays and motors during power off.

DESCRIPTION

Three different motors and two different relays were chosen to represent the wide range of possible devices used by designers. Device choices were as follows:

MOTORS

	Cramer	8001 series Geared Motor 12V, 30rpm (4800 RPM armature speed) 170ma Start/Run Torque 30oz
	Comair	Rotron DC Biscut Fan - 24V, 480ma
	Comair	Rotron DC Biscut Fan - 12V, 900ma
YS		

RELAYS

Potter and Brumfield 24V Relay 1/3 HP 120V AC, 10A 240 VAC Rating

Potter and Brumfield 12V Relay

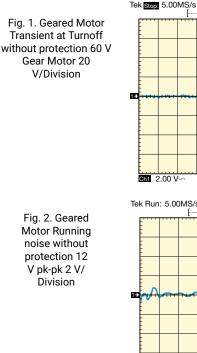
Ch1 200 V~

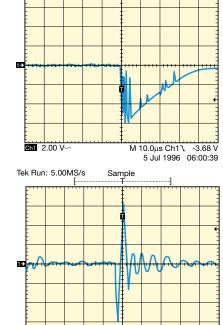
1:XVXX

1/3 HP 120V AC, 10A 240 VAC Rating

251 Acqs

A Tektronix TDS 784A four channel 1GHz 4G S/s digitizing storage scope was used to capture the -1/2 LI2 transient peak from the relays and motors.





M 100ns Ch1 \ 364mV 5 Jul 1996 05:07:06 A x10 probe was connected to the scope and one leg of the relay/motor coil; the probe's ground was connected to the other relay coil/motor wire. The scope was triggered on the pulse and waveforms printed.

When suppression was introduced into the circuit, it was placed directly on the relay coils/motor lead wires. The axial TransGuard® and capacitors had a 19mm (3/4") total lead length in each case. Upon careful consideration, it was determined that this was a fairly common lead length for such applications.

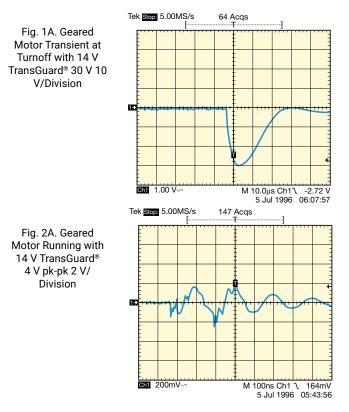
SUMMARY

GEARED MOTOR

The Cramer geared motor was tested while running (under load) to determine its "on state" noise as well as under loaded turn off conditions. Both TransGuards® and ceramic capacitors were tested to determine the level of protection they offer.

A 14V axial TransGuard® provided the best protection during running and turn off. The VA100014D300 TransGuard® cut the 60V unprotected turn off voltage spike to 30V. It also cut the on state noise to 4.0V pk-pk due to its internal capacitance. The following is a summary of measured voltages (scope traces are shown in Figures 1, 1A, 2, 2A).

Test Condition	Transient without Protection	Transient with .1µF cap	Transient with .01µF cap	Transient with 14v TransGuard®	
Geared motor at turn off	60V	32V	48V	30V	
Geared motor during running	12V pk-pk	4.0V pk-pk	4.0V pk-pk	4.0V pk-pk	



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TransGuard®

Fig. 3. 24 V Biscut Fan

without protection 165 V Biscut 50 V/

Division

Multilayer Ceramic Transient Voltage Suppressors Application Notes: Motor and Relay Application Study



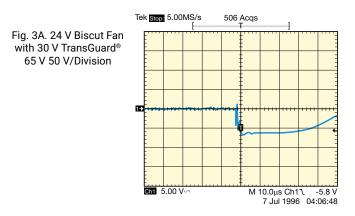
BISCUT FAN

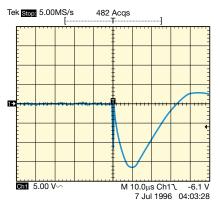
The Comair 24V and 12V biscut fans were tested only for transients at turn off. Results of those tests are shown in the table at the right (as well as slope traces 3, 3A, 4, 4A).

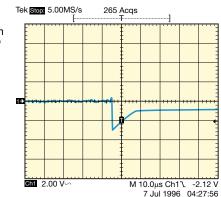
Tek Stop: 5.00MS/s

Motor Type	Transient without Protection	Transient with .1µF cap	Transient with .01µF cap	Transient with 14v TransGuard®
24V Fan	165V	120V	140V	65V(1)
12V Fan	60V	52V	64V	30V(2)

(1) VA100030D650 TransGuard® / (2) VA100014D300 TransGuard®







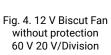
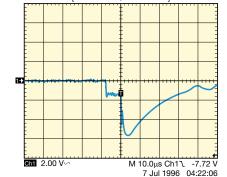
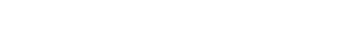


Fig. 4A. 12 V Biscut Fan with 14 V TransGuard® 30 V 20 V/Division



58 Acqs



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Multilayer Ceramic Transient Voltage Suppressors Application Notes: Motor and Relay Application Study

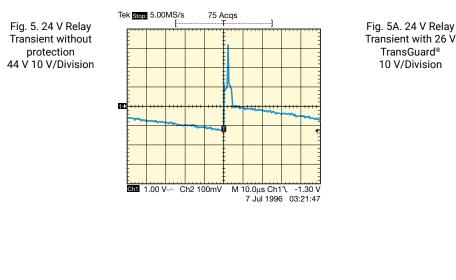


RELAYS

The 12V and 24V relays were tested only for transients at turn off. The results of those tests are shown in the table at the right (as well as scope traces 5, 5A, 6, 6A).

Relay Type	Transient without Protection	Transient with .1µF cap	Transient with .01µF cap	Transient with 14v TransGuard®	
24V	44V	24V	28V	28V(3)	
12V	105V	63V	100V	30V(4)	

(3) VA100026D580 TransGuard® / (4) VA100014D300 TransGuard®



Tek Stop 5.00MS/s 6873 Acqs

Fig. 6. 12 V Relay Transient without protection 105 V 50 V/Division

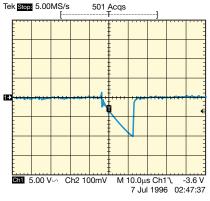
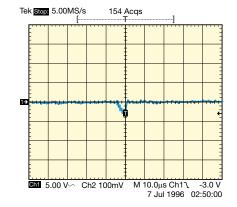


Fig. 6A. 12 V Relay Transient with 14 V TransGuard® 30 V 50 V/Division



CONCLUSIONS

TransGuards[®] can clamp the wide range of voltages coming from small/medium motors and relays due to inductive discharge. In addition, TransGuards[®] capacitance can help reduce EMI/RFI. Proper selection of the TransGuards[®] voltage is critical to clamping efficiency and correct circuit operation.

TransGuard[®] Multilayer Ceramic Transient Voltage Suppressors Application Notes: Multilayer Varistors In Automobile MUX Bus Applications



The current trend in automobiles is towards increased performance, comfort and efficiency. To achieve these goals, automobile companies are incorporating an ever increasing array of electronics into cars. As the electronic content within cars increases, auto manufacturers are utilizing multiplex bus designs to network all the sensors to a central point (usually the engine control unit [ECU]). Multiplex lines save wiring harness weight and decrease the harness' complexity, while allowing higher communication speeds. However, the multiplex structure tends to increase the occurrence and severity of Electromagnetic Interference (EMC) and Electrostatic Discharge (ESD).

Multilayer varistors (MLVs) are a single component solution for auto manufacturers to utilize on multiplex nodes to eliminate both ESD and EMC problems. MLVs also offer improved reliability rates (FIT rates <1 failure/ billion hours) and smaller designs over traditional diode protection schemes.

TYPICAL MUX NODE APPLICATION

There are a variety of SAE recommended practices for vehicle multiplexing (J-1850, J-1939, J-1708, J-1587, CAN). Given the number of multiplexing specifications, it is easy to understand that bus complexity will vary considerably.

Each node has an interface circuit which typically consists of a terminating resistor (or sometimes a series limiting resistor), back to back Zener diodes (for over voltage protection) and an EMC capacitor. Such a method is compared to that of a multilayer varistor in Figure 1.

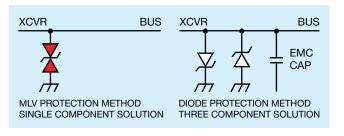


Figure 1. Comparison of past node protection methods to MLV node protection methods.

To more clearly understand the functional structure of a MLV, see the equivalent electrical model shown in Figure 2.

- MULTIPLE ELECTRODES YIELD A CAPACITANCE
- THE CAPACITANCE CAN BE USED IN DECOUPLING
- CAPACITANCE CAN BE SELECTED FROM 30pF TO 4700pF

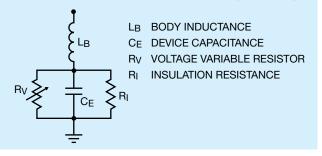


Figure 2. TransGuard® Equivalent Model.

As the schematic in Figure 1 illustrates, the implementation of MLV protection methods greatly simplifies circuit layout, saves PCB space and improves system reliability. The MLV offers many additional electrical improvements over the Zener/passive schemes. Among those advantages are higher multiple strike capability, faster turn on time and larger transient overstrike capability. Further clarification on the types of varistors compared to the performance of Zener diodes follows.

CONSTRUCTION AND PHYSICAL COMPARISON

The construction of Zinc Oxide (ZnO) varistors is a well known, relatively straightforward process in which ZnO grains are doped with cobalt, bismuth, manganese and other oxides. The resulting grains have a Schottky barrier at the grain interface and a typical grain breakdown voltage (Vb) of approximately 3.6V per grain.

Currently, there are two types of varistors. Single layer varistors (SLVs) an older technology referred to as "pressed pill," typically are larger, radial leaded components designed to handle significant power. Multilayer varistors (MLVs) are a relatively new technology packaged in true EIA SMT case sizes.

Beyond the ZnO material system and grain breakdown similarity, MLVs and SLVs have little in common. That is, to design a low voltage SLV, the grains must be grown as large as possible to achieve a physically large enough part to be handled in the manufacturing process. Typically it is very difficult to obtain a consistent grain size in a low voltage SLV process.

The electrical performance of SLV is affected by inconsistent grain size in two ways. First, low voltage SLVs often exhibit an inconsistent Vb and leakage current (IL) from device to device within a particular manufacturing lot of a given rating. This contributes to early high voltage repetitive strike wear out.

Secondly, SLVs with similar voltage and energy ratings as MLVs typically exhibit a lower peak current capability due in part to increased resistance of the long current path of the large grains. This contributes to early repetitive high current wear out.

At higher voltages, the grain size variations within SLVs play a much smaller percentage role in Vb and leakage current values. As a result, SLVs are the most efficient cost effective way to suppress transients in high voltages (e.g., 115 VAC, 220 VAC).

TransGuard®

Multilayer Ceramic Transient Voltage Suppressors Application Notes: Multilayer Varistors In Automobile MUX Bus Applications

MLV MANUFACTURE

The construction of a MLV was made possible by employing a variety of advanced multilayer chip capacitors (MLCC) manufacturing schemes coupled with a variety of novel and proprietary ZnO manufacturing steps. In the MLCC process, thin dielectrics are commonly employed to obtain very large capacitance values. It is that capability to design and manufacture multilayer structures with dielectric thicknesses of ≤ 1 mil that allows MLVs to be easily made with operating/ working voltages (Vwm) as low as 3.3V (for use in next generation silicon devices).

Once a particular working voltage has been determined (by altering the ZnO dielectric thickness), the multilayer varistor's transient energy capability is determined by the number of layers of dielectric and electrodes. It is, therefore, generally easy to control the grain size and uniformity within a MLV due to the relative simplicity of this process.

MLVs exhibit capacitance due to their multiple electrode design and the fact that ZnO is a ceramic dielectric. This capacitance can be utilized with the device's series inductance to provide a filter to help limit EMI/RFI. The equivalent model of a MLV is shown in Figure 2.

MLVs are primarily used as transient voltage suppressors. In their "on" state, they act as a back-to-back Zener, diverting to ground any excess, unwanted energy above their clamping voltage. In their "off" state, they act as an EMC capacitor (capacitance can be minimized for high speed applications). A single MLV, therefore, can replace the diode, capacitor and resistor array on multiplex node applications.

Any TVS will see a large number of transient strikes over its lifetime. These transient strikes will result from different events such as well known ESD HBM, IC MM, alternator field decay, load dump models and uncontrolled random events. It is because of the repetitive strikes that all TVS suppressors should be tested for multiple strike capability. Typically, a TVS will fail due to high voltage, high current or over-energy strikes.

High voltage repetitive strikes are best represented by IEC 61000-4-2 8kV waveforms. MLVs demonstrate a greatly superior capability to withstand repetitive ESD high voltage discharge without degradation.

High current repetitive strikes are represented by 8x20µs 150A waveforms. A comparison between MLVs, SLVs and SiTVS is shown in Figures 3A, B, C respectively.

SILICON TVS MANUFACTURE

The construction of a silicon TVS departs dramatically from that of either single layer varistor or multilayer varistor construction. Devices are generally produced as Zener diodes with the exception that a larger junction area is designed into the parts and additional testing was likely performed. After the silicon die is processed in accordance to standard semi-conductor manufacturing practice, the TVS die is connected to a heavy metal lead frame and molded into axial and surface mount (SMT) configuration.

MLVS COMPARED TO DIODES

The response time for a silicon diode die is truly sub-nanosecond. The lead frame into which the die is placed and the wire bonds used for die connections introduce a significant amount of inductance. The large inductance of this packaging causes a series impedance that slows the response time of SiTVS devices. A best case response time of 8nS on SOT23 and a 1.5nS to 5nS response time on SMB and SMC products respectively are rather typical. MLVs turn on time is <7nS. MLVs turn on time is faster than SiTVS and that fast turn on time diverts more energy and current away from the IC than any other protection device available.

CONCLUSION

The technology to manufacture MLVs exists and allows the manufacture of miniature SMT surge suppressors. MLVs do not have the wear out failure mode of first generation (single layer) varistors. In fact, MLVs exhibit better reliability numbers than that of TVS diodes. MLVs are a viable protection device for auto multiplex bus applications.

Written by Ron Demcko

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150 AMP Current Repetitive Strike Comparison

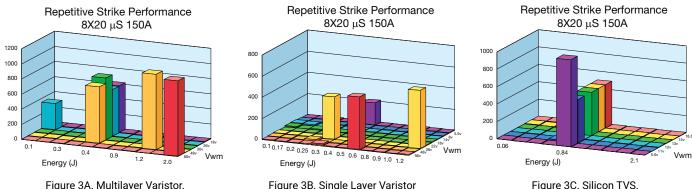


Figure 3C. Silicon 1V



Soldering – Assembly Guidelines

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TRANSGUARD[®] SURFACE MOUNT DEVICES

The move toward SMT assembly of Transient Voltage Suppressors (TVS) will continue accelerating due to improved long-term reliability, more efficient transient voltage attenuation and size/functionality/cost issues.

TransGuards[®] are uniquely suited for wide-scale usage in SMT applications. TransGuards[®] exhibit many advantages when used in SMT assemblies. Among them are:

- Available in standard EIA chip sizes 0402/0603/0805/ 1206/1210.
- Placed with standard equipment (8mm tape and reel).
- Processed with fewer guidelines than either ceramic chip or resistor chip devices.
- Exhibit the highest energy/volume ratio of any EIA size TVS.

This general guideline is aimed at familiarizing users with the characteristics of soldering multilayer SMT ZnO TransGuards[®]. TransGuards[®] can be processed on wave or infrared reflow assembly lines. For optimum performance, EIA standard solder pads (land areas) shown in Figure 1 are recommended regardless of the specific attachment method.

Dimensions: mm (inches)

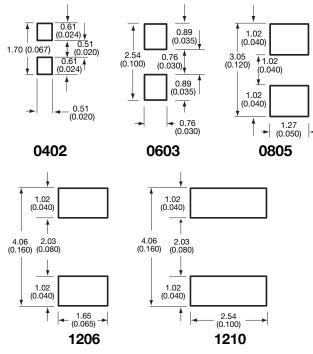


Figure 1: TransGuard® Solder Pad Dimensions

STORAGE

Good solderability of plated components is maintained for at least twelve months, provided the components are stored in their "as received" packaging at less than 30°C and 85% RH.

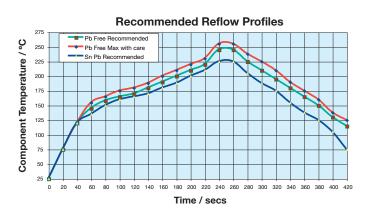
SOLDERABILITY

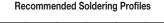
Plated terminations will be well soldered after immersion in a 60/40 tin/lead solder bath at 235°C \pm 5°C for 5 \pm 1 seconds.

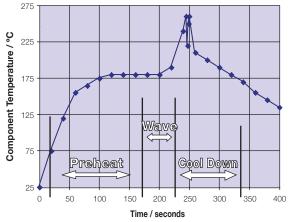
LEACHING

Plated terminations will resist leaching for at least 30 seconds when immersed in 60/40 tin/lead solder at $260^{\circ}C \pm 5^{\circ}C$.

RECOMMENDED SOLDERING PROFILES







GENERAL

Surface mount multilayer varistors (MLVs) are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

TransGuard[®] Multilayer Varistors – Assembly Guidelines

HANDLING

MLVs should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pickups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provide the ideal medium for direct presentation to the placement machine.

PREHEAT

It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second and a target figure 2°C/second is recommended.

SOLDERING

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. KYOCERA AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

COOLING

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4° C/second.

CLEANING

Flux residues may be hygroscopic or acidic and must be removed. KYOCERA AVX MLVs are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol-based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with MLVs.

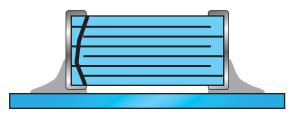
POST SOLDER HANDLING

Once the components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Surface mount devices are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is high leakage current (or low breakdown voltage). Also, a significant loss of capacitance due to severing of contact between sets of internal electrodes may be observed.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Type A: Angled crack between bottom of device to top of solder joint.



Type B:

Fracture from top of device to bottom of device.

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board flexure.

COMMON CRACKS OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v- cutters and shear presses. Improperly aligned or dull cutters may cause torquing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby components may be broken.

A third common source is board-to-board connections at the vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.



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REWORKING ASSEMBLIES

Thermal shock is common in MLVs that are manually attached or reworked with a soldering iron. KYOCERA AVX strongly recommends that any reworking of MLVs be done with hot air reflow rather than soldering irons.

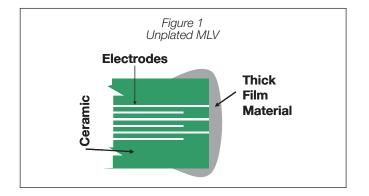
Direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300°C. Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the component.

VARISTOR SOLDERABILITY

Historically, the solderability of Multilayer Varistors (MLVs) has been a problem for the electronics manufacturer. He was faced with a device that either did not wet as well as other electronic components, or had its termination material leached away during the assembly process. However, by utilizing proprietary procedures, KYOCERA AVX Corporation provides the market with a MLV that has solderability comparable to that of other electronic components, and resists leaching during assembly.

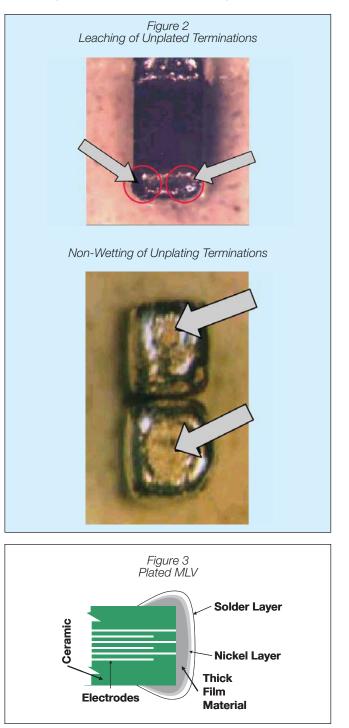
BACKGROUND

The basic construction of an unplated MLV is presented in Figure 1. The external termination is a metal that connects the internal electrodes to



the circuitry of the assembly using the MLV. The external electrode must accomplish two goals. First, it must be sufficiently solderable to allow the solder used in assembly to wet the end of the chip and make a reliable connection to the traces on the circuit board. Second, it must be robust enough to withstand the assembly process. This is particularly important if wave soldering is used. Unfortunately these two goals are competing. In order to achieve good solderability, an alloy high in silver content is chosen. However, this alloy is prone to leaching during assembly, so an additional metal is added to improve the leach resistance. While this improves the leach resistance, this addition makes the termination less solderable. The results are either terminations that leach away, or do not solder well (see the photographs in Figure 2). Clearly, a plated termination system (as seen in Figure 3) is desired. This system, which is typical of other electronic components such as capacitors and resistors, produces a much better assembled product.

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TransGuard® Multilayer Varistors – Assembly Guidelines

In the plated termination, the base termination layer is still used (it provides contact from the electrodes to the circuitry). On top of the base termination is a layer of nickel. This is the surface to which the solder bonds during assembly. It must be thick enough to stay intact during IR reflow or wave soldering so that the thick film material does not leach away. It must also be thick enough to prevent the inter-metallic layer between the thick film termination and the nickel layer from affecting the solderability.

In order to protect the nickel (i.e., maintain its solderability), a layer of solder is plated on top of the nickel. The solder preserves the solderability of the nickel layer. It must be thick and dense to keep oxygen and water from reaching the nickel layer.

THE CHALLENGE

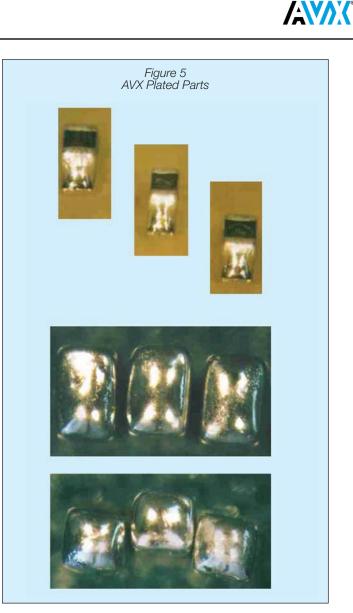
Zinc oxide varistors are semi-conductive in nature - that is what allows them to "turn on" and divert a damaging transient away from sensitive electronic circuitry and safely to ground. This semi-conduction poses a major problem for the manufacturer that wants to plate the terminations - the ceramic plates also! This condition, overplating, must be controlled, as it is cosmetically undesirable and could result in an unwanted path of conduction across the chip.

Early efforts in plating MLVs revolved around limiting the time that the chip was in the plating bath. This helped prevent overplating, but also produced chips with marginal solderability. The photographs in Figure 4 depict the problems that occur when the plated layers are not thick enough.

THE SOLUTION

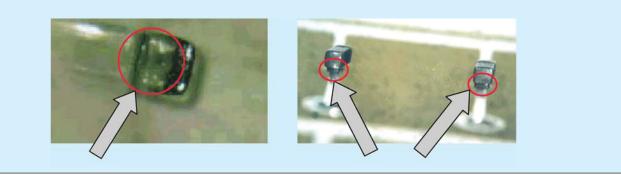
KYOCERA AVX has developed a proprietary process that passivates the ceramic surface of the MLV. This allows us to plate the parts for a longer time without getting the overplate. This results in significantly thicker layers of nickel and alloy plated onto the base termination. These thicker layers translate into bond strengths that are typically twice those of our competitors and solder fillets and parts that pass all measured of solderability (as seen in Figure 5).

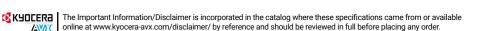
KYOCERA AVX: The solution for MLV assembly problems.



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Figure 4 Problems when the Plated Layers are Too Thin









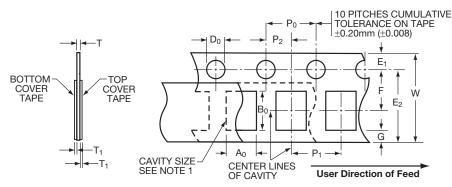
- Chips
- Axial Leads
- Radial Leads

Paper Carrier Configuration

8mm Tape Only



mm (inches)



8MM PAPER TAPE METRIC DIMENSIONS WILL GOVERN

CONSTANT DIMENSIONS

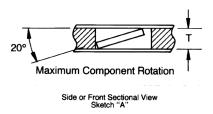
Tape Size Do E Po P2 T1 G. Min. R Min. 8mm 1.550004 (0.059-0004) 1.75±0.10 (0.069±0.004) 4.00±0.10 (0.157±0.004) 2.00±0.05 (0.079±0.002) 0.10 (0.004) 0.75 (0.030) 25.0 (0.984) See Note 2 Min.								
Tape Size	D ₀	E	P ₀	P ₂	T ₁	G. Min.	R Min.	
8mm	1.5 ^{‡0.10} 1.5 ^{‡0} 904 (0.059 _{-0.0})							

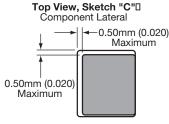
VARIABLE DIMENSIONS

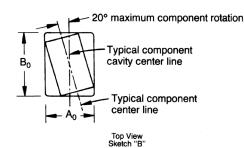
Tape Size	P ₁ See Note 4	E ₂ Min.	F	W	А ₀ В0	т				
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	+0.30 8.00 -0.10 +0.012 (0.315 -0.004)	See Note 1	1.10mm (0.043) Max. for Paper Base Tape and 1.60mm (0.063) Max. for Non-Paper Base Compositions				

NOTES:

- 1. The cavity defined by $A_{\ensuremath{n\!\prime}}$ B , and T shall be configured to provide sufficient clearance surrounding the component so that:
 - the component does not protrude beyond either surface of the carrier tape; _ the component can be removed from the cavity in a vertical direction
 - without mechanical restriction after the top cover tape has been removed;
 - rotation of the component is limited to 20° maximum (see Sketches A & B); _
 - lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).







Bar Code Labeling Standard

KYOCERA AVX bar code labeling is available and follows latest version of EIA-556

2. Tape with or without components shall pass around radius "R" without damage.

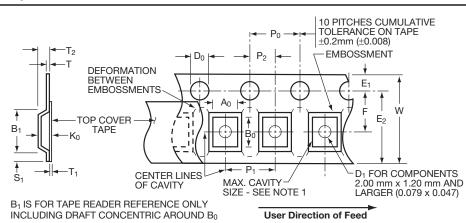
3. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.

4. If P1 = 2.0mm, the tape may not properly index in all tape feeders.

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Embossed Carrier Configuration

8 & 12mm Tape Only



8 & 12MM EMBOSSED TAPE METRIC DIMENSIONS WILL GOVERN

CONSTANT DIMENSIONS

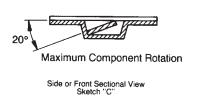
Tape Size	D ₀	E	P ₀	P ₂	S ₁ Min.	T Max.	T ₁
8mm and 12mm	+0.10 1.50 -0.0 (0.059 ^{+0.004})	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.60 (0.024)	0.60 (0.024)	0.10 (0.004) Max.

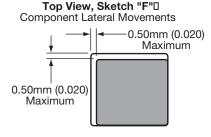
VARIABLE DIMENSIONS

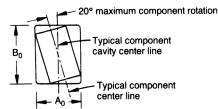
	Tape Size	B ₁ Max.	D ₁ Min.	E ₂ Min.	F	P ₁ See Note 5	R Min. See Note 2	T ₂	W Max.	A ₀ B ₀ K ₀
ſ	8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
	12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
0	Tape with or without components shall pass around radius "R" without damage.									

NOTES:

- 1. The cavity defined by A0, B0, and K0 shall be configured to provide the following: Surround the component with sufficient clearance such that:
 - the component does not protrude beyond the sealing plane of the cover tape. _ the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
 - rotation of the component is limited to 20° maximum (see Sketches D & E). _ lateral movement of the component is restricted to 0.5mm maximum (see Sketch F)







Top View Sketch "D"

Bar code labeling (if required) shall be on the side of the reel opposite the round

B1 dimension is a reference dimension for tape feeder clearance only.

If P1 = 2.0mm, the tape may not properly index in all tape feeders.

sprocket holes. Refer to EIA-556.

mm (inches)

mm (inches)

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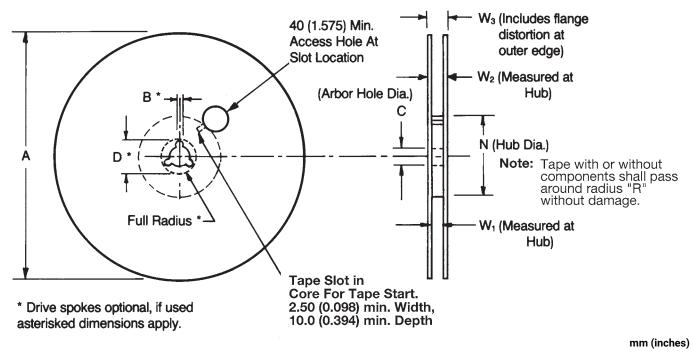
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Packaging of Chip Components

Automatic Insertion Packaging



REEL DIMENSIONS



Tape Size	A Max.	B* Min.	С	D* Min.	N Min.	W1	W2 Max.	W3
8mm	- 330 (12.992)	1.5 (0.059)	+0.50 13.0 -0.20 +0.020 (0.512 -0.008)	20.2 (0.795)	50.0 (1.969)	8.40 ^{+1.5} 8.40 - <u>0.0</u> (0.331 ^{+0.059} _{-0.0})	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm						12.4 +2.0 +0.079 (0.488 -0.0)	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

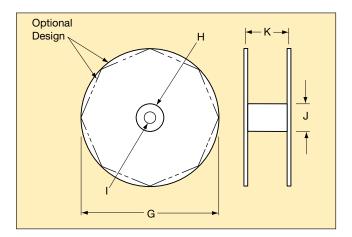
Metric dimensions will govern.

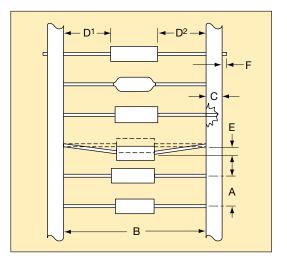
English measurements rounded and for reference only.



TRANSGUARD®

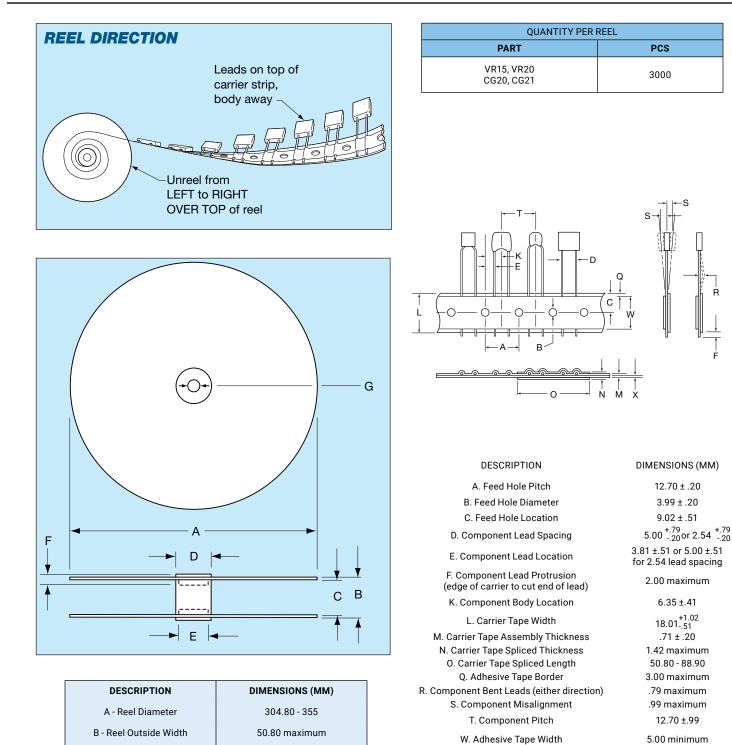
CLASS I / RS-296					
А.	5mm ± 0.5mm (0.200" ± 0.020")				
В*.	52.4mm ± 1.5mm (2.063" ± 0.059")				
C.	6.35mm ± 0.4mm (0.250" ± 0.016")				
D1-D2.	1.4mm (0.055″ MAX.)				
E.	1.2mm (0.047" MAX.)				
F.	1.6mm (0.063" MAX.)				
G.	356mm (14.00" MAX.)				
H.	76mm (3.000")				
l.	25.4mm (1.000")				
J.	84mm (3.300")				
К.	70mm (2.750")				





Leader Tape: 300mm min. (12") Splicing: Tape Only Missing Parts: 0.25% of component count max.- No consecutive missing parts





W. Adhesive Tape Width
X. Carrier Tape Thickness

38.10 - 46.02

102.01 maximum

86.36 maximum

9.50 minimum

25.40 - 30.48

Y. Cumulative Pitch over 20 Pitches

C - Reel Inside Width

D - Core Diameter (0.D.)

E - Hub Recess Diameter

F - Hub Recess Depth

G - Arbor Hole Diameter

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.51 ±.10

254 ±2.00



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