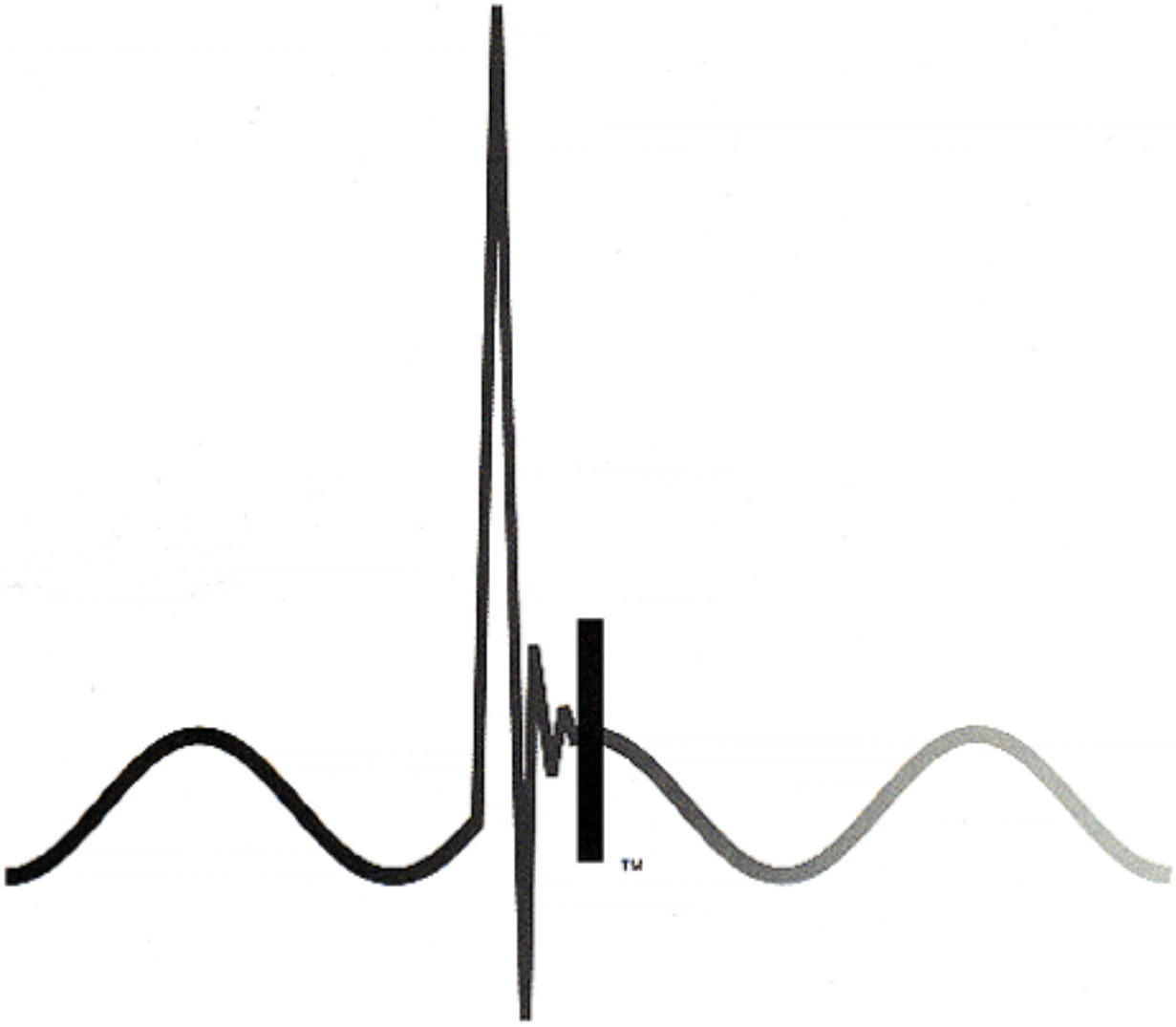
W O R L D P R O D U C T S

PPG Product Applications and Training



Protection Products Group

WORLD PRODUCTS INC.

Compliance Engineering - July/August 1997
Can Zener Diodes Provide ESD Protection?

By BENNY LEE
World Products

There are many circuit design engineers using zener diodes for ESD protection. Zener diodes provide a certain degree of ESD protection but not nearly as much as TVS (transient voltage suppressor) diodes. The primary function of a zener diode is voltage regulation, which does not require fast heat dissipation at the PN junction. TVS diodes, on the other hand, are designed for fast heat dissipation when conducting a surge current maintaining low junction impedance. As a result, the clamping voltage is very low and flat.

In order to achieve these characteristics, the doping process of a TVS diode wafer is very different from zener diodes. The number of minority for a TVS diode is much less than a zener diode. Also, a TVS diode has a larger area of PN junction than that of a zener diode. This makes minority movement faster and reduces heat generation at the wafer junction.

When a 5.58KV ESD simulated waveform **(figure 1)** is surged on a 6V, 5W zener diode, the voltage clamping level is 144V **(figure 3).**When the same ESD waveform is surged on 6.8V TVS diode (600W, equivalent Zener value is 1W), the voltage clamping is 33.5V, as shown in **figure 2**. This example illustrates that a TVS diode clamping level is less than 1/4 of that of a zener clamping level.

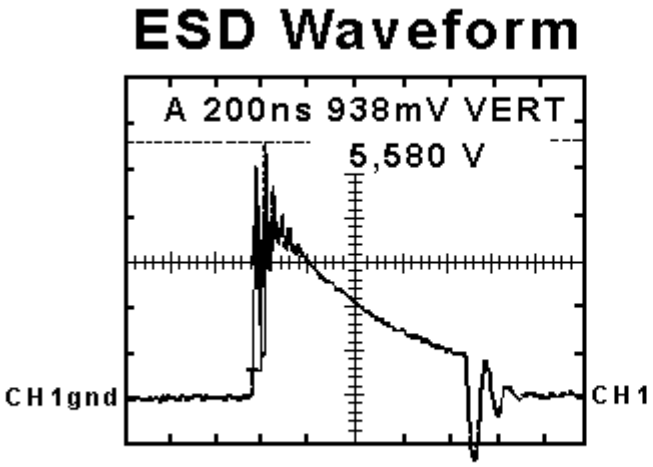


Figure 1

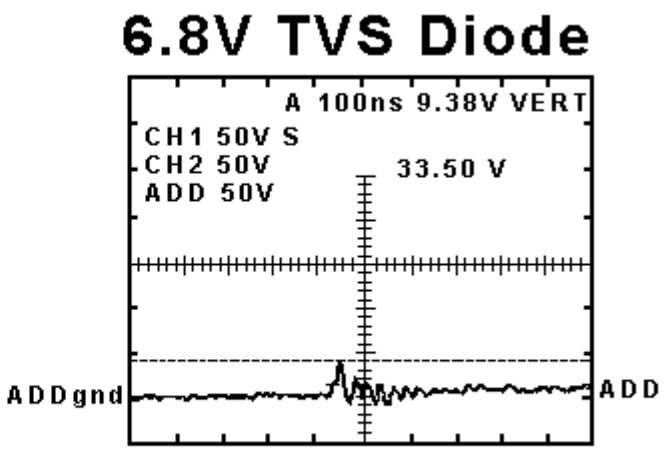


Figure 2

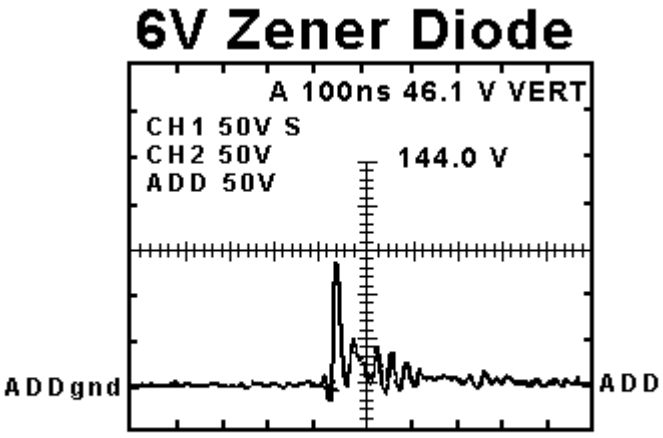


Figure 3

When a 5.58KV ESD simulated waveform is surged on a 6V, 5W zener diode, the voltage clamping level is 144V. When the same ESD waveform is surged on 6.8V TVS diode (600W, equivalent Zener value is 1W), the voltage clamping is 33.5V. This example illustrates that a TVS diode clamping level is less than 1/4 of that of a zener clamping level.

The transient voltage suppressor diode is specifically designed to protect electronic circuits against transient and over voltages. It is a silicon avalanche device available in both unidirectional or bi-directional configurations. With a unidirectional, the specified clamping characteristic is only apparent in one direction, the other direction exhibiting a Vf (forward voltage) normally experienced with conventional rectifier diodes.

When selecting a TVS diode there are important parameters to be considered. These are: reverse standoff voltage (Vr), peak pulse current (Ipp) and maximum clamping voltage (Vc max). The most important is Vr, this is the parameter key to selecting a TVS diode. The Vr of the device should be equal to, or greater than, the peak operating level of the circuit to be protected. This will ensure that the TVS diode does not clip the circuit drive voltage. The peak pulse current (Ipp) is the maximum current the TVS diode can withstand without damage. The required lpp can only be determined by dividing the peak transient voltage by the source impedance. The TVS diode failure mode is short circuit, therefore if the device fails due to a transient, the circuit will still be protected. The maximum clamping voltage (Vc) is the peak voltage that will appear across the TVS diode when subjected to the peak pulse current (Ipp) based on a 10/1000 microsecond waveform. When selecting a TVS diode, Vc must be lower than the maximum level of the circuit components to withstand voltage.

Conclusion

The amplitude of ESD that is built up in a human body walking on the carpet is frequently over 20KV. It is very difficult for a zener diode to clamp this level of ESD below 200V which is required to protect many IC components. TVS diodes can clamp ESD down to the safety level of all electronic components. Also, a zener diode has much less surge current handling capability than TVS diodes due to a smaller PN junction area.

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RFI SUPPRESSORS - Definition - Q&A

WHAT'S NEW IN WPI RFI SUPPRESSORS?

In May of 1996 the last round of testing to upgrade Climatic Category was completed and all WPI RFI Suppressors now have a climatic category code of 40/100/56: These suppressors can be operated within -40°C to +100°C temperature limits.

WHAT IS AN RFI SUPPRESSOR?

An RFl Suppressor is a special type capacitor for use on the AC Power Line input to electronic or electrical equipment. It's purpose is to attenuate Radio Frequency Interference signals originated in this equipment and conducted through the AC Line to other equipment supplied by the same branch., These interference signals, if not attenuated, would mutually disturb their operations.

How do they work?

To prevent such situations, each piece of AC operated equipment must have its RFl signal filtered and attenuated to the levels established by International and National Regulatory Agencies (FCC in the USA). Almost every kind of electronic equipment, such as radio and TV receivers, computers, switch mode power supplies and household appliances generate their own "electrical signature" of Radio Frequency spectrum, depending on individual designs or modes of operation. This spectrum can affect other equipment either by being conducted onto the AC line, or by being radiated by small radio and high frequency "transmitters" hidden in internal circuits and traveling by air to affect the operation of other equipment in adjacent locations. RFI Suppressors are used in filter circuits to attenuate conducted interference.

What makes RFI Suppressors unique?

You must have realized by now, that RFI Suppressors are very special and that worldwide there are only a few. manufacturers who are capable to provide them to OEM producers We are proud to say that World Products' RFI Suppressors offer superior characteristics over the competition in the following areas:

- All International Safety Approvals
- High Dv/Dt Levels
- Excellent Self Healing
- Preferred Industry Standard Dimensions
- Available With Modified Lead Configurations
- Flame Retardant Encapsulation (94V - 0)
- Each Lot Tested 100%
- Standard Electrical AQL - 0.065

What kind of equipment uses RFI Suppressors?

Every newly designed piece of electronic equipment must have its conducted and radiated interference measured and reduced to the levels established by Regulatory Agencies. Depending on the particular design and its other components in the AC line input, various values of capacitance (C) of RFI Suppressors may be required to tune AC line filtering performance for Radio Frequencies appearing in its "electrical signature." To allow for such tuning our selection of RFI Suppressors consists of twenty-six types.

What kind of conditions require RFI Suppressors?

These suppressors (which also act as RFI filters) must also endure very harsh conditions existing on the 60 or 50 HZ AC Power line. These conditions include sudden increases of the AC line that may greatly exceed nominal operating conditions large transients with high Dv/Dt edges and lightning. For these reasons, RFI Suppressors must withstand voltages exceeding their nominal voltage ratings. They also must have "self healing" properties, which is the ability of the suppressor to cure itself when the dielectric is punctured due to an abnormal AC line disturbance or lightning strike. Due to these hazardous conditions and stringent requirements, these suppressors must be approved by all important Regulatory Agencies in the USA, Canada and Europe. These Agencies are subjecting RFI Suppressors to strict tests to assure their performance and safe operation on the AC line.

How many different types of RFI suppressors are there?

There are two (2) basic types of RFl Suppressors:
X2 - WXE and WXP Series - Placed Line-to-Line
Y2 - WYE Series - Placed Line-to-Ground

How are they different?

Suppressor X2 (WXE or WXP) can be used in electrical circuits between the "live" wires carrying incoming AC current. In this location, suppressor damage will not cause any electrical shock hazards and usually will open the fuse and turn the equipment off.
Suppressor Y2 (WYE) used between lines and grounds have higher voltage withstand limits and smaller capacitance values because:

- If damage occurs, they will not activate any safety fuse.
- Even if they are in a perfect condition, there is some current flowing through them from line to equipment ground that would become "hot" if disconnected from the earth grounding. If larger C values were allowed for Y suppressors (the largest WYE capacitor has C = 0.022uF), leakage current would be too high for Agency standards.
- If lightning should strike the AC power line, Y suppressors would be the most likely to be subjected to damage.
- Our X2 suppressor (WXE and WXP) have a voltage rating of 275VAC, and the Y suppressors are rated at 250VAC. It is interesting to note that Y suppressors are tested at 300OVDC vs. 2200-200OVDC for X2 suppressors. Similarly, in the lightning simulation test, the Y suppressor must be approved at 5KV vs. 2.5KV for X2.

Are Y and X2 Suppressors interchangeable?

Actually, Y suppressors could be substituted for X2 suppressors in an across-the-line location, if not for the fact that their C values are usually too small for that. However X2 suppressors should never be substituted for Y2 suppressors

How do I get more technical information on WXE and WYE suppressors ?

Contact your World Products salesperson or representative for an RFI Suppressor Data Sheet. It contains all the information you will need. Because of mandatory compliance with FCC, UL, CSA and other International Safety Agencies, most manufacturers have a specialized Engineering Department dealing with RFI matters. These departments have a very good knowledge about the required RFI Suppressors and will know exactly what their needs and requirements are.

What kinds of companies use RFI Suppressors ?

Many OEM companies producing AC operated equipment: computers, computer terminals, radio and television

equipment, communication gear, etc. will use RFI suppressors. Even portable equipment companies may need RFI Suppressors for battery chargers and other stationary equipment. Automotive products may be the only example of an unlikely application since automobiles, with-their 12 volt systems, normally would not need, our AC line rated suppressors. However, there can be some applications where there is a need for tough components having a climatic category rating of 56 days in the humidity chamber. Please note that the climatic category rating achieved by WPI RFI Suppressors is among the highest in the industry.

Will RFI suppressors play a part in the future of electronics ?

The prospect for increasing usage of RFI suppressors in the future is excellent. RFI attenuation was first required for consumer products such as television and stereo's in the 1970's, and then it was extended to include computers, and their peripherals: monitors, terminals, printers, etc., in the 1980's. In Europe, household appliances and electric, tools must also meet RFI regulation limits. In the USA, these devices are not yet included in RFI limits, but many companies are implementing them on their own. With the expansion of various new electronic products, this will be a growing and continuous business. Once customers recognize the advantages of buying RFI Suppressors from WPI there will be increased demand for equipment currently in production and new designs in development.

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Power Supply AC Line Input Protection

Agencies such as IEC (IEC950) and UL (UL1414) require line isolation from the ground while maintaining impulse breakdown levels. In an effort to meet these requirements, manufacturers of Power Supplies must develop protection circuitry at the input side of their power supplies.

The impulse breakdown waveforms are defined by IEC6100-4 and IEC6100-5. The isolation requires less than 0.5mA when two times the line voltage plus 1000VAC are applied between lines (hot and neutral) and ground.

In order to meet these contradicting requirements, some unique protection configurations are required. The **Protection Products Group of World Products Inc**. has been proactive in developing a complete solution which satisfies the various agency requirements and ensures proper overvoltage protection (see circuit and circuit description below):

Circuit Description:
MOV 1 - VZ14D471KBS (Rated at 300 VRMS). This value of Metal Oxide Varistor is selected specifically for 22OV applications. This value is also acceptable for 110V applications and is typically the choice of design engineers for standardizing protection circuitry for both 110V and 200V applications.

MOV 2 & 3 - VZ14D471KBS (Rated at 300 VRMS) this Metal Oxide Varistor is necessary to limit AC follow-on current which flows on the AC line after an overvoltage condition ceases. The zero crossing of the AC line is not sufficient to deionize the gas tube and cause it to extinguish.

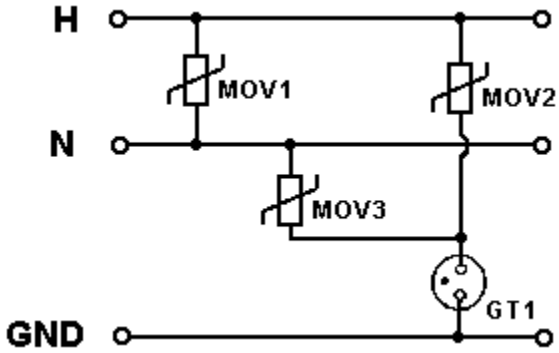
GT1 - Y08SV-272B (see attached specifications). These specially developed gas tubes meet the required UL and VDE Line-to-Ground insulation requirements. As with VZ14D471KBS, these gas tubes can be used for either 110V or 200V line conditions.

Sample kits containing all necessary protection components described in this application note are available upon request.

MOV 1: VZ14D471KBS

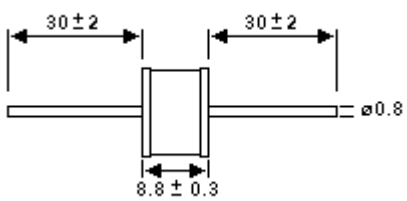
MOV 2 & 3: VZ14D471KBS

GT1: Y08SV-272B

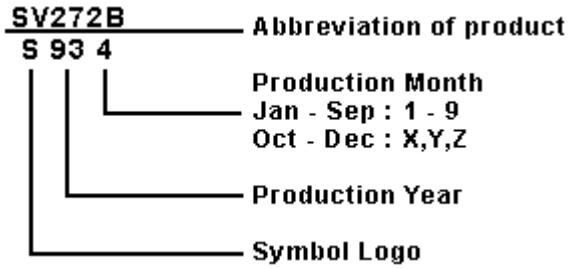


Ceramic Arrester Y08SV-272

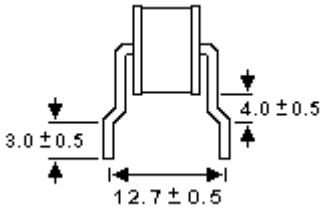
Leadforming (B)



Part Marking



Leadforming (L2)



All Dimensions in mm

Gap distance: 3.1mm (typically)
Lead finish: Tinned
Other lead formations available

This part is UL1449 recognized under File No. E96234 and UL1414 recognized under File No. E165829 along with series varistor VZ14D471KBS. Also, CSA C-22.2 No.1 certified under File No. CA62353-3.

Electrical Characteristics:		
1. DC Breakdown Voltage	≤5kV/s	2430-2970V
2. Impulse Breakdown Voltage	1kV/µs	≤3500V
3. Insulation Resistance	DC 1000V	≥100Mohms
4. Capacitance	1MHz	≤1.0 pF
5. Impulse Discharge Current	8/20µs + 10, -10 times Interval 3 minute	3kA
6. Impulse Life	8/20us 100A Interval 1-2 minute	≥300 times
After Test of Item 5 and 6		
DC Breakdown Voltage	≤5kV/s	2230-3170V
Impulse Breakdown Voltage	1kV/µs	≤4200V
Insulation Resistance	DC 1000V	≥1Mohm

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Business Computer Products

	TVS Diode	Multilayer Varistor	Ferrite Bead	Ferrite Inductor	Surge Absorber	RFI Suppressor	Metal Oxide Varistor	Gas Tube
PCMCIA	P4SMAJ	VL-1608 VL-B1005	HB-1M1005	FI-A1608	SA-B2012 SA-B1608 SA-B1005	WXP, WXPC, WXE 103K-224K WYE 102M-472M		
KEY BOARDS	P4SMAJ P6SMBJ	VL-2012 VA-2012	HB-1M1608 HB-1H2012	FI-A1608	SA-B2012 SA-D2012 SA-B3212 SA-D3216	WXP, WXPC, WXE 103K-224K WYE 102M-472M	VZ05D	
BAR CODES	P4SMAJ P6SMBJ	VL-B1005 VA-1608 VA-2012	HB-1M1608 HB-1T2012	FI-A1005 FI-A1608	SA-D2012 SA-S3216	WXP, WXPC, WXE 103K-224K WYE 102M-472M	VZ05D	
MOUSE/ JOYSTICKS	P4SMAJ P6SMBJ	VL-B1005 VA-1608 VA-2012	HB-1M1608 CM-2M2012	FI-A1608	SA-B1005 SA-B1608	WXP, WXPC, WXE 103K-224K WYE102M-472M	VZ05D	
MOTHER BOARDS	P4SMAJ P6SMBJ	VA-1608 VA-2012 VA-3216	HB-1M1005 HB-1T1608 HH-1M2012 HU-1M3216 CM-2M3216	FI-A1608 FI-A2012 FI-B2012 FI-B3216 FI-C3216	SA-D2012 SA-D1608	WXP, WXPC, WXE 103K-224K WYE 102M-472M	VZ05D VZ07D VZ10D	
MONITORS	1.5KE	FI-A3216 FI-C3216	HB-1M2012 EF-4T3216 TCF-A3216	FI-A2012		WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ18D VZ18E VZ20D	Y08SV
DISC DRIVES	P4SMAJ P6SMBJ	VL-B1005 VL-1608 VA-1608	HH-1M1608 CM-2M3216		SA-B1005 SA-B1608	WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ05D	
MODEMS	P4SMAJ P6SMBJ	VL-B1005 VL-1608 VA-2012	HB-1M1608 CM-2M3216	FI-A1608 FI-A2012	SA-D2012	WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ05D VZ07D	3J 3Y06
COPY MACHINES	P6SMBJ 1.5KE	VA-3216 VA-2012	HB-1T2012 HB-1M3216 CM-2M3216	FI-A3216 FI-C3216 FI-A2012		WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ18D VZ18E VZ20D	
GRAPHICS	P4SMAJ	VA-1608 VL-B1005	HB-1M1608 CM-2M3216 EF-4T3216	FI-A1608	SA-D2012	WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ05D	
POWER SUPPLIES	P6SMBJ P4KE P6KE 1.5KE		CM-2M3216 CM-2S3216 CM-2T3216 CM-2B3216			WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ18D VZ18E VZ20E VZ20D	Y08SV
PRINTERS	P45MAJ P6SMBJ	VL-B1005 VA-1608 VA-2012	EF-4T3216 CM-2M3216	FI-A1608 FI-C3216		WXP, WXPC, WXE 223K-155K WYE 102M-223M	VZ05D VZ07D	

APPLICATIONS GUIDE

Automotive Products

	TVS Diode	Multilayer Varistor	Ferrite Bead	Ferrite Inductor	Surge Absorber	Ceramic Inductor	RFI Suppressor	Metal Oxide Varistor	Gas Tube
RADIOS	P4SMAJ P6SMBJ P6KE	VL-1608 VL-2012 VA-1608 VA-2012	HB-1M1608 HB-1T2012 CM-2M3216	FI-A3216 FI-A2016 FI-A1608	SA-B2012 SA-D2012 SA-B1608 SA-B1608		WXP, WXPC, WXE 334K-225K	VZ05D	
ENGINE CONTROLS	3KP 15KP	VA-321 VM-4M3216	HH-1M3216 HU-1H4516 CM-3M3216	FI-A1608 FI-A2012			WXP, WXPC, WXE 334K-225K	VZ20E VZ20E	3J 3Y06
INFORMATION CENTERS	P4SMAJ	VL-1608 VA-2012 VM-4M3216	HB-1M1608 HB-1H2012 CM-2M3216	FI-A1005 FI-A1608 FI-B2016	SA-B2012 SA-D2012	CI-B1005 CI-B1608		VZ05D VZ07D VZ10D	
THEFT DETECTORS	P4SMAJ P6SMBJ	VL-1608 VA-2012	HB-1H1005	FI-A1005		CI-B1005		VZ10E VZ10D	
VOLTAGE REGULATORS	1.5KE 3KP							VZ20D VZ20E	
REMOTE KEYLESS ENTRY	P4SMAJ P6SMBJ	VL-1608 VM-4B3216 VM-4A3216	HB-1M1005 HB-1T1608 CM-2M3216	FI-A1005 FI-A1608 FI-A2012	SA-B1005 SA-B2012 SA-D2012 SA-B1608	CI-B1005 CI-B1608 CI-B2016		VZ05D	
WIPERS	P6SMBJ	VA-3216	HB-1T3216					VZ10D	
AIR BAGS	P4SMAJ P6SMBJ	VA-2012						VZ10D VA18D	
AUTO BRAKING SYSTEMS	P6SMBJ 1.5KE	VA-3216						VZ10E VZ18E	
SUSPENSION CONTROL SYSTEMS	P6SMBJ 1.5KE	VA-3216						VZ18E VZ20E	
CLIMATE CONTROLS	P4SMAJ P6SMBJ	VA-1608 VA-2012	HB-1M1608 HB-1T2012		SA-B2012 SA-D2012 SA-B1608 SA-D1608			VZ05D VZ07D	
DEFROSTERS	P6SMBJ	VA-B	HH-1H4516					VZ10E	

Note: Part numbers provided in this guide are based on typical calculations and are subject to change depending on the actual application. For further information contact World Products Inc.

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Industrial and Control Equipment

	Metal Oxide Varistor	TVS Diode	RFI Suppressor	Bead Inductor	Gas Tube
MOTORS 480/277V 3-PHASE Y	VZ20E821 / VZ20E471 VZ32D781 / VZ32D431 VZ32D821 / VZ32D471 VZ32D781 / VZ40D431		WXP, WXPC 334K-225K WYE 472M-223M		3YVJ-550 (LINE-CASE)
MOTORS 208/120V 3-PHASE Y D	VZ20E361 / VZ20E201 VZ32D331 / VZ32D201 VZ40D331 / VZ40D201		WXP, WXPC 334K-225K WYE 472M-223M		3J-7 (LINE-CASE)
MOTORS 240/120V 3-PHASE	VZ20E391 / VZ20E221 VZ32D391 / VZ32D201 VZ40D391 / VZ40D201		WXP, WXPC WXE 224K-225K		3J-7 (LINE-CASE)
MOTORS 120/240V SINGLE PHASE	VZ20E391 / VZ20E431 VZ32D391 / VZ32D431 VZ40D391 / VZ40D431		WXP, WXPC WXE 224K-225K		3J-7 (LINE-CASE)
MACHINE CONTROL PANELS 120/240V	VZ10D391 / VZ14D431 VZ14D391 / VZ20D431 VZ20D391 / VZ20E431 VZ20E391	1.5KE400CA/ 1.5KE200CA	WXP, WXPC WXE 473K-105K	HB-1M3216 HB-1T3216 FI-A3216 CI-B2016	3J-7 (LINE-GROUND)
MACHINE CONTROL PANELS 48/24VDC	VZ07E820 VZ10E820 VZ14D(E)820 VZ18D(E)820	1.5KE68 1.5SMCJ48 P6SMBJ48	WXP, WXPC WXE 683K-155K	HB-1M3216 HB-1T3216 FI-A3216 CI-B2016	U-2 (LINE-GROUND)
REMOTE CONTROL DEVICES	VZ05E820 VZ07E820	P4SMAJ48 P6SMBJ48 SA48	WXP, WXPC WXE 103K-104K WYE 102M-223M	HB-1M1608 FI-A1608 CI-B1608	
DISPLAY DEVICES	VZ05E820 VZ05E331 (DISPLAY PANEL)	SA48 P6SMBJ48	WXP, WXPC WXE 103K-104K WYE 102M-223M	HB-1M1608 FI-A1608	

APPLICATIONS GUIDE

Telecom Products

	TVS Diode	Multilayer Varistor	Ferrite Bead	Ferrite Inductor	Ceramic Inductor	Metal Oxide Varistor	Surge Absorber	Gas Tube
TELEPHONES	1.5KE P6SMBJ P6KE	VA-B3216 VA-B2016 VM-4B3216	HB-1M3216 HB-1T2012 TCF-A3216	FI-A3216 FI-A2016 FI-A1608	CI-B1005 CI-B1608	VZ20E VZ20D VZ18E		3J 3Y06
CELL PHONES	P4SMAJ P6SMBJ	VL-B1005 VM-4B3216 VL-B1608	HB-1M1005 EF-1T3216 LC-2012	FI-A1005 FI-A1608	CI-B1005 CI-B1608		SA-B1005 SA-D1608	
PAGERS	P4SMAJ	VL-B1005 VL-B1608	HB-1M1005 HB-1H1608	FI-A1005 FI-A1608	CI-B1005 CI-B1608		SA-B1005 SA-D1608	
MICRO MODULES	P4SMAJ	VL-B1005	HB-1H1005	FI-A1005	CI-B1005			
PHONE LINE PROTECTORS	1.5KE					VZ20E VZ20D		3J 3Y06
WALKIE-TALKIES	P6SMBJ 1.5KE	VL-B1608 VL-B2012	HB-1M1005 HB-1T1608 LC-2012	FI-A1005 FI-A1608	CI-B1005 CI-B1608		SA-B1005 SA-D1608	
WIRELESS PALM PILOTS	P4SMAJ P6SMBJ	VL-B1005 VM-4B VM-4A	HB-1M1005 HB-1T1608 LC-2012 EF-1T3216 CM-2M3216	FI-A1005 FI-A1608 FI-A2012	CI-B1005 CI-B1608 CI-B2016		SA-B1005 SA-D1005 SA-B1608 SA-D1608	
RADIO BASE STATIONS	1.5KE 3KP	VL-A3216 VL-2012	HB-1M3216 CM-2M3216	FI-A3216 FI-A3216	CI-B1608 CI-B2016	VZ20D VZ20E		3J 3Y06
WIRELESS CONTROLLERS	P4SMAJ P6SMBJ SA, P6KE	VL-B1608 VM-4B VM-2B	HB-1M1608 HB-1T1608 CM-2M3216	FI-A1608 FI-B2012 FI-B3216	CI-B1608 CI-B2012 CI-B3216	VZ05D	SA-B1608 SA-D2012	3J

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Home Appliances and Entertainment

	TVS Diode	Multilayer Varistor	Ferrite Bead / Inductor	Metal Oxide Varistor	RFI Suppressor	Gas Tube
WASHER/DRYER 240V SYSTEMS				VZ20E391 / VZ20E431 VZ32D391 / VZ32D431	WXP, WXPC WXE 104K-225K WYE 222M-223M	
MICROWAVE OVENS 120V				VZ20D201 / VZ20E201	WXP, WXPC WXE 104K-225K WYE 222M-223M	U-1 (IGNITE)
GAS FURNACES 120V	1.5KE56CA (CONTROL PANEL)	VA-A3216-560		VZ18E201 / VZ18E241 VZ18E680	WXP, WXPC WXE 104K-225K WYE 222M-223M	
AIR CONDITIONERS 120/240V SINGLE PHASE	1.5KE56	VA-A3216-560		VZ20E201 / VZ20E241 VZ20E391 / VZ20E431	WXP, WXPC WXE 104K-225K WYE 222M-223M	
GARAGE DOOR OPENERS	1.5KE33 P6SMBJ33	VA-A3216-260 VA-A3216-330	HB-1M3216 FI-A3216	VZ18E201 / VZ18E241 VZ18E201 / VZ18E241	WXP, WXPC WXE 104K-225K WYE 222M-223M	
SUBMERSIBLE WATER PUMPS					WXP, WXPC WXE 104K-225K WYE 222M-223M	U-4
DIGITAL TELEVISIONS		SA-B1608-101-01	HB-1M2012 EF-IT3216 CM-2M3216	VZ18E201 / VZ10E820	WXP, WXPC WXE 104K-225K WYE 222M-223M	3J-3 (CRT-GRID) 3J-1 (CABLE-IN)
HOME ENTERTAINMENT SYSTEMS	1.5KE18 P6SMBJ18	SA-B1608-101-01	HB-1M1608	VZ18E201 / VZ10D220	WXP, WXPC WXE 104K-225K WYE 222M-223M	3J-1 (CABLE-IN)
NOTE: PLEASE CONTACT WORLD PRODUCTS INC. FOR COMPLETE LINE OF APPLIANCE FILTERS						

APPLICATIONS GUIDE

Surge Protection Modules

	Metal Oxide Varistor	TVS Diode	RFI Suppressor	Gas Tube
HOME/OFFICE AC LINE PROTECTORS 117V SYSTEM	VZ20D(E)201 VZ20D(E)221 VZ20D(E)241	1.5KE220C 1.5KE250C 3KP250C	WXP, WXPC WXE 104K-105K WYE 102M-472M	
BUILDING CIRCUIT BREAKER PROTECTORS 117V SYSTEM	3 X VZ20D(E)241 3 X VZ20D(E)271 2 X VZ32D(E)241 1 X VZ40D(E)241	3 X 20KP250C 3 X 20KP300C 2 X 20KP250C (IN PARALLEL) 2 X 20KP230C (IN PARALLEL)	WXP, WXPC WXE 104K-225K WYE 222M-223M	
HOME/OFFICE AC LINE PROTECTORS 230V SYSTEM	VZ20D(E)391 VZ20D(E)431	1.5KE400C 1.5KE400CA 1.5KE440C 1.5KE440CA 5KP440CA	WXP, WXPC WXE 104K-105K WYE 102M-472M	
BUILDING CIRCUIT BREAKER PROTECTORS 230V SYSTEM	3 X VZ20D(E)391 3 X VZ20D(E)431 2 X VZ32D(E)391 1 X VZ40D(E)391 1 X VZ40D(E)431	3 X 20KP400C 3 X 20KP440C 2 X 20KP400C (IN PARALLEL) 2 X 20KP440C (IN PARALLEL)	WXP, WXPC WXE 104K-225K WYE 22M-223M	
SPRINKLER CONTROL BOXES 24-48VDC	3 X VZ20D820 2 X VZ20E820	1.5KE68C 1.5KE82C 3KP82C 5KP82C	WXP, WXPC WXE 224K-155K	U-1, 3J-1 Y06S-100 3Y06-90
TELEPHONES PROTECTORS	VZ18D201 VZ18E201	1.5KE220C 1.5KE250C		3J-3J1F2 3J-4J1F2 Y06SZ-230 3Y06-230
SURGE BOX FOR CABLE				3J-1 U-1, U-2 Y06S-100 3Y06-90
Note: Part numbers provided in this guide are based on typical calculations and are subject to change depending on the actual application. For further information contact World Products Inc.				