Littelfuse®

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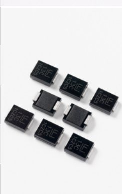
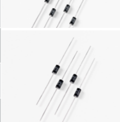
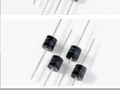
PRODUCT CATALOG & DESIGN GUIDE

TVS DIODE

Transient Voltage Suppression Diode Devices

TABLE OF CONTENTS

Series Name	Photo	Package Type	Reverse Standoff Voltage (V_R)	Peak Pulse Power Range† (P_{PP}10/1000μs)	Peak Pulse Current (I_{PP} 8/20μs)	Operating Temperature	Halogen-Free	RoHS Compliant
Surface Mount-Standard Application (200-5000W)								
SMF		SOD-123	5.0-54	200W		-85° to +302° F (-55° to +150° C)	•	•
SMAJ		DO-214AC	5.0-440	400W			•	•
P4SMA		DO-214AC	5.8-495	400W			•	•
SMA6J		DO-214AC	5.0-12	600W			•	•
SMA6L		DO-221AC	5.0-85	600W			•	•
SACB		DO-214AA	5.0-50	500W			•	•
SMBJ		DO-214AA	5.0-440	600W			•	•
P6SMB		DO-214AA	5.8-495	600W			•	•
1KSMB		DO-214AA	5.8-136	1000W			•	•
SMCJ		DO-214AB	5.0-440	1500W			•	•
1.5SMC		DO-214AB	5.8-495	1500W			•	•
3.0SMC		DO-214AB	20-33				•	•
SMDJ		DO-214AB	5.0-220	3000W			•	•
5.0SMDJ		DO-214AB	12-170	5000W			•	•
Axial Leaded-Standard Application (400-5000W)								
P4KE		DO-41	5.8-495	400W		-85° to +302° F (-55° to +150° C)	•	•
SA		DO-15	5.0-180	500W			•	•
SAC		DO-15	5.0-50	500W			•	•
P6KE		DO-15	5.8-512	600W			•	•
1.5KE		DO-201	5.8-512	1500W			•	•
LCE		DO-201	6.5-90	1500W			•	•
3KP		P600	5.0-220	3000W			•	•
5KP		P600	5.0-250	5000W			•	•
Axial Leaded-High Power (15000-30000W; 1-15kA)								
15KPA		P600	17-280	15000W		-85° to +302° F (-55° to +150° C)	•	•
20KPA		P600	20-300	20000W			•	•
30KPA		P600	28-288	30000W			•	•
AK1		Radial Lead	76		1000A	-85° to +257° F (-55° to +125° C)	•	•
AK3		Radial Lead	15-430		3000A		•	•
AK6		Radial Lead	30-430		6000A		•	•
AK10		Radial Lead	30-530		10000A		•	•
AK15		Radial Lead	58-76		15000A		•	•
Automotive								
SLD		P600	10-36	2200 based on 10ms/150ms pulse		-85° to +302° F (-55° to +150° C)	•	•

TVS Diode Overvoltage Suppression Facts

Transient Threats – What Are Transients?

Voltage Transients are defined as short duration surges of electrical energy and are the result of the sudden release of energy previously stored or induced by other means, such as heavy inductive loads or lightning. In electrical or electronic circuits, this energy can be released in a predictable manner via controlled switching actions, or randomly induced into a circuit from external sources.

Repeatable transients are frequently caused by the operation of motors, generators, or the switching of reactive circuit components. Random transients, on the other hand, are often caused by Lightning and Electrostatic Discharge (ESD). Lightning and ESD generally occur unpredictably, and may require elaborate monitoring to be accurately measured, especially if induced at the circuit board level. Numerous electronics standards groups have analyzed transient voltage occurrences using accepted monitoring or testing methods. The key characteristics of several transients are shown in the table below.

	VOLTAGE	CURRENT	RISE-TIME	DURATION
Lighting	25kV	20kA	10 µs	1ms
Switching	600V	500A	50µs	500ms
EMP	1kV	10A	20ns	1ms
ESD	15kV	30A	<1ns	100ns

Table 1. Examples of transient sources and magnitude

Characteristics of Transient Voltage Spikes

Transient voltage spikes generally exhibit a "double exponential" wave, as shown below for lightning and ESD.

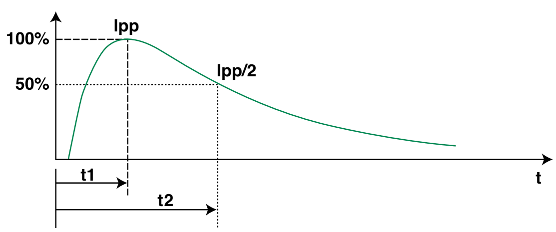


Figure 1. Lightning Transient Waveform

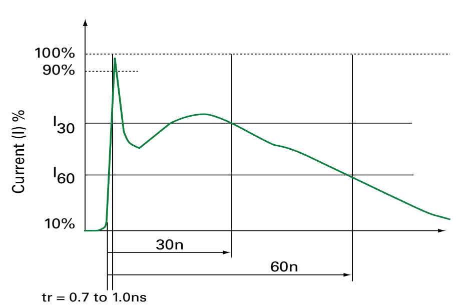


Figure 2. ESD Test Waveform

The exponential rise time of lightning is in the range 1.2µsec to 10µsec (essentially 10% to 90%) and the duration is in the range of 50µsec to 1000µsec (50% of peak values). ESD on the other hand, is a much shorter duration event. The rise time has been characterized at less than 1.0ns. The overall duration is approximately 100ns.

Why are Transients of Increasing Concern?

Component miniaturization has resulted in increased sensitivity to electrical stresses. Microprocessors for example, have structures and conductive paths which are unable to handle high currents from ESD transients. Such components operate at very low voltages, so voltage disturbances must be controlled to prevent device interruption and latent or catastrophic failures.

Sensitive microprocessors are prevelant today in a wide range of devices. Everything from home appliances, such as dishwashers, to industrial controls and even toys use microprocessors to improve functionality and efficiency.

Most vehicles now also employ multiple electronic systems to control the engine, climate, braking and, in some cases, steering, traction and safety systems.

Many of the sub- or supporting components (such as electric motors or accessories) within appliances and automobiles present transient threats to the entire system.

Careful circuit design should not only factor environmental scenarios but also the potential effects of these related components. Table 2 below shows the vulnerability of various component technologies.

Device Type	Vulnerability (volts)
VMOS	30-1800
MOSFET	100-200
GaAsFET	100-300
EPROM	100
JFET	140-7000
CMOS	250-3000
Schottky Diodes	300-2500
Bipolar Transistors	380-7000
SCR	680-1000

Table 2: Range of device vulnerability.

TVS Diode Transient Voltage Scenarios

Electrostatic Discharge (ESD)

Electrostatic discharge is characterized by very fast rise times and very high peak voltages and currents. This energy is the result of an imbalance of positive and negative charges between objects.

ESD that is generated by everyday activities can far surpass the vulnerability threshold of standard semiconductor technologies. Following are a few examples:

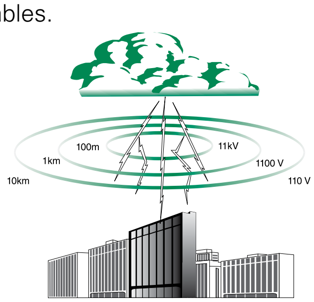
- **Walking across a carpet:**
  35kV @ RH = 20%;1.5kV @ RH = 65%
- **Walking across a vinyl floor:**
  12kV @ RH = 20%;250V @ RH = 65%
- **Worker at a bench:**
  6kV @ RH = 20%;100V @ RH = 65%
- **Vinyl envelopes:**
  7kV @ RH = 20%;600V @ RH = 65%
- **Poly bag picked up from desk:**
  20kV @ RH = 20%;1.2kV @ RH = 65%

Lightning Induced Transients

Even though a direct strike is clearly destructive, transients induced by lightning are not the result of a direct strike.

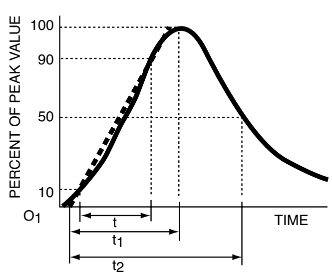
When a lightning strike occurs, the event creates a magnetic field which can induce transients of large magnitude in nearby electrical cables.

A cloud-to-cloud strike will effect not only overhead cables, but also buried cables. Even a strike 1 mile distant (1.6km) can generate 70 volts in electrical cables.



In a cloud-to-ground strike (as shown at right) the transient-generating effect is far greater.

This diagram shows a typical current waveform for induced lightning disturbances.



Inductive Load Switching

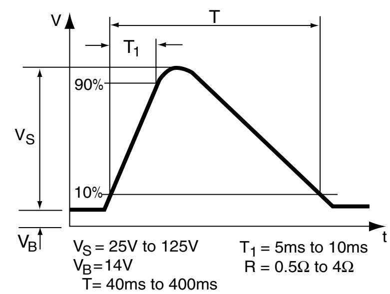
The switching of inductive loads generates high energy transients which increase in magnitude with increasingly heavy loads. When the inductive load is switched off, the collapsing magnetic field is converted into electrical energy which takes the form of a double exponential transient. Depending on the source, these transients can be as large as hundreds of volts and hundreds of Amps, with duration times of 400 milliseconds.

Typical sources of inductive transients include:

- **Generator**
- **Motor**
- **Relay**
- **Transformer**

These examples are common in electrical and electronic systems. Because the sizes of the loads vary according to the application, the wave shape, duration, peak current and peak voltage are all variables which exist in real world transients. Once these variables can be approximated, a suitable suppressor technology can be selected.

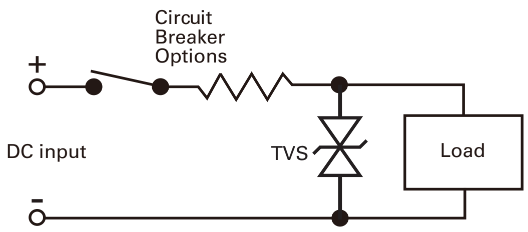
The diagram at right shows a transient which is the result of stored energy within the alternator of an automobile charging system.



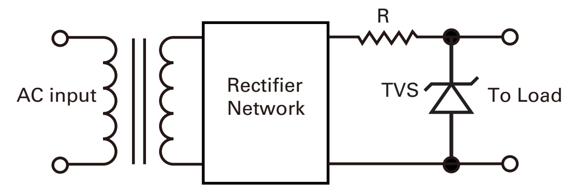
A similar transient can also be caused by other DC motors in a vehicle. For example, DC motors power amenities such as power locks, seats and windows. These various applications of a DC motor can produce transients that are just as harmful to the sensitive electronic components as transients created in the external environment.

TVS Diode Device Typical Applications

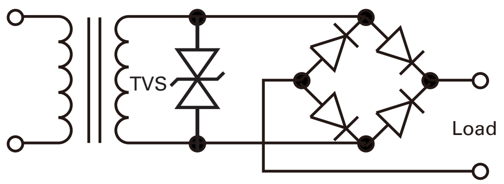
DC Supply Protection



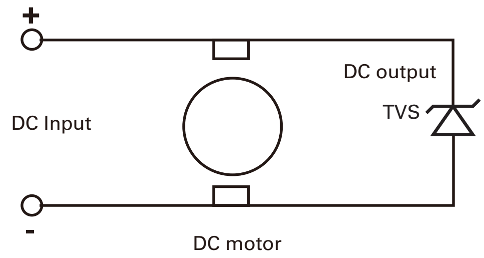
DC Load Protection



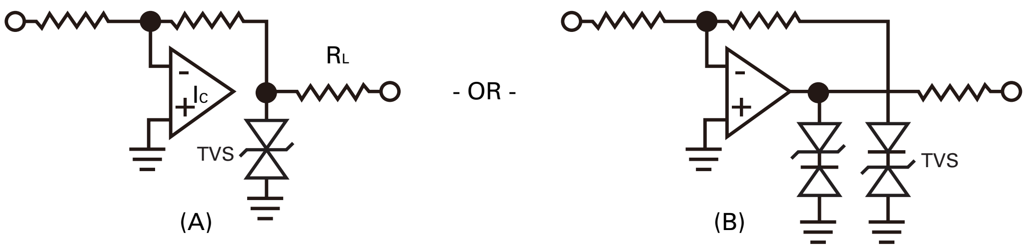
AC Supply Protection



Elector-Magnetic Interference Limiting

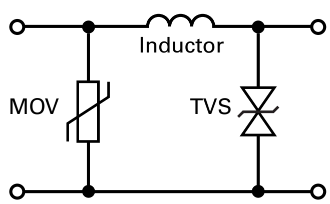


Operational Amplifier Protection



Combined MOV Varistor and TVS Diode Protection Scenarios

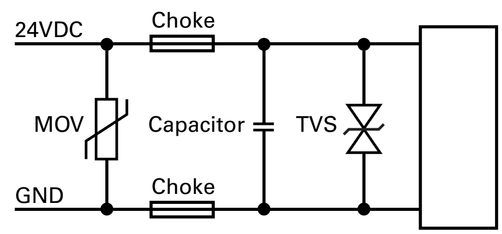
MOV + TVS Combination:



MOV Varistor
High Energy
Withstand

TVS Diode
Low Clamping
Voltage

MOV + Choke + TVS Combination:

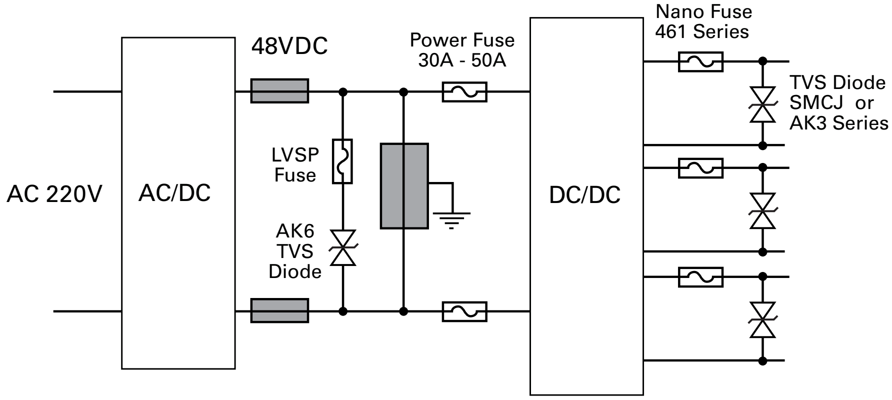


MOV Varistor
V33ZA70PX
Special low voltage
20mm diameter MOV
3KA@8/20μs (1 time)

TVS Diode
SMBJ28A/SMBJ30A
SMCJ28A/SMCJ30A

TVS Diode Device Typical Applications (continued)

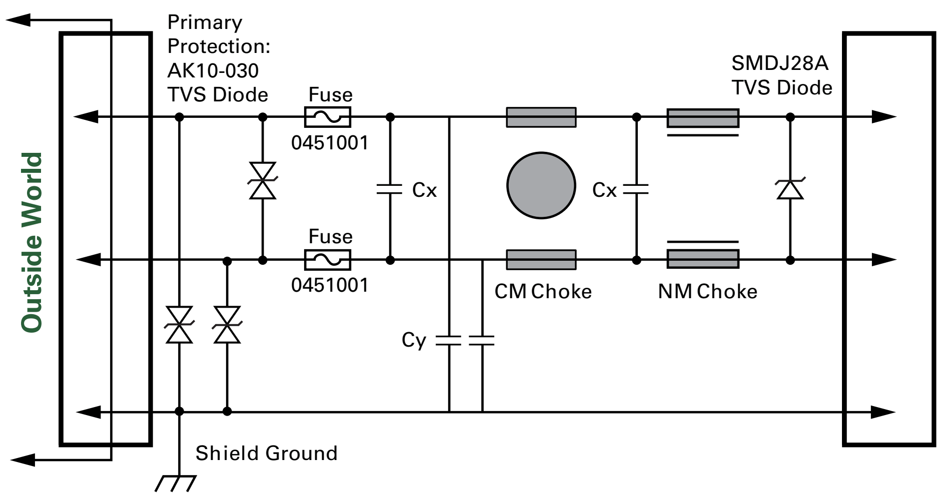
Telecom DC/DC Protection



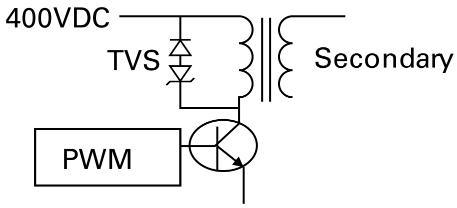
For 48vdc Lightning Protection:
TVS Diode: AK6-66CL
Lightning Fuse: LVSP15-R
Power fuse: TLS035L/456020

For 5vdc Lightning Protection:
Fuse: 461 Series
TVS:AK3-7.5CL, 5.0SMDJ

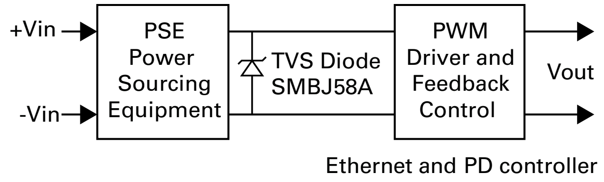
Circuit Protection of 24VDC with High Surge Capatbility



Pulse Width Modulated (PWM) Driver Protection

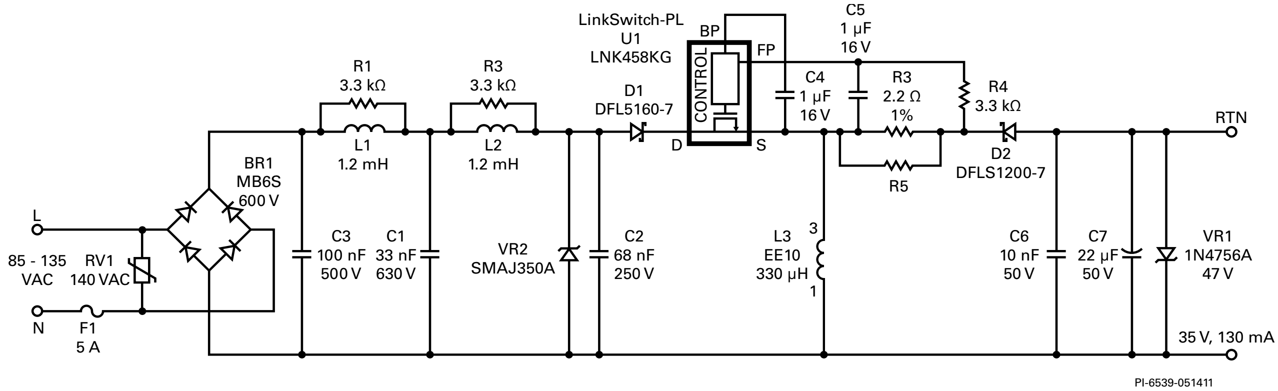


Power Over Ethernet (PoE) Protection

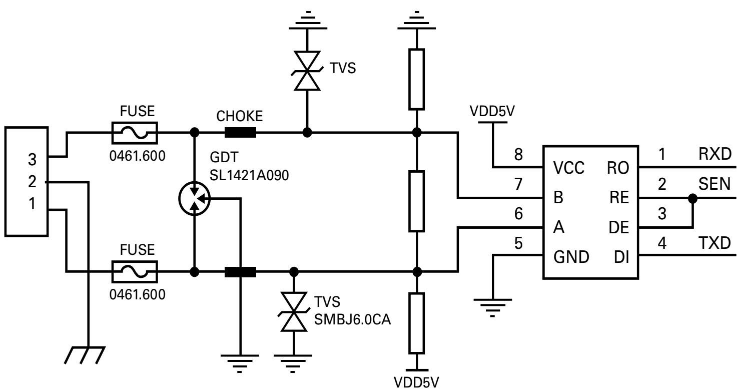


TVS Diode Device Typical Applications (continued)

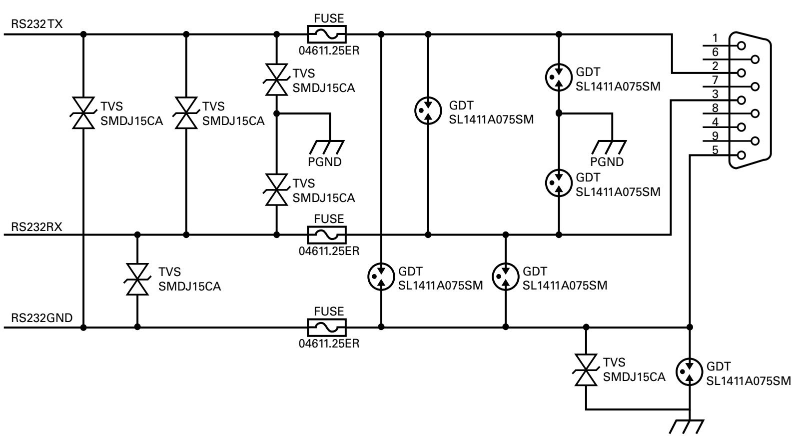
LED Driver Protection



RS485 Interface Protection



RS232 Interface Protection with High Surge Requirement



TVS Diode FIT Calculation Method

Reference

JEDEC JESD 85, methods for calculating failure rates in units of FITs

JEDEC JESD 91A, method for developing acceleration models for electronic component failure mechanisms.

Life Test

FIT is calculated based on life test result.

Littelfuse conducts Blocking test as following condition at any qualification or on-going reliability monitoring activity.

Temperature: 150°C, Duration: 504 hours, Sample number: 40

Note, this is minimum requirement and the duration and sample number could be increased per test purpose.

Acceleration Factor

Acceleration Factor or AT is calculated per JEDEC JESD 91A, Arrhenius equation with Eaa (activation energy) of 1.0eV by dielectric breakdown mechanism.

$A_T = \exp[(-Eaa/k)(1/Tt - 1/Ts)]$

A_T: the acceleration factor due to changes in temperature

Eaa: the apparent activation energy (eV)

k: Boltzmann's constant (8.62×10^{-5} eV/K)

Tt: the absolute temperature of the test (K)

Ts: the absolute temperature of the system (K)

From the life test, Tt = 150°C, assuming Ts = 30°C, acceleration factor is

$A_T = \exp[(-1/8.62 \times 10^{-5})(1/(150+273.16) - 1/(30+273.16)] = 5.2 \times 10^4$

Failure Rate Calculation

Failure rate or λ_{CL} is calculated per JEDEC JESD 85, using the upper confidence bound of the failure rate.

$\lambda_{CL} = X2(CL, 2f+2) \times 10^9 / (2 \times t \times ss \times A)$

λ_{CL}: Failure rate in FIT

X2: Chi-square distribution function

CL: confidence level

f: number of failures

t: test time in hours

ss: number of samples

A: acceleration factor

From life test result, f=0, t= 504 hours, ss =40.Assuming Ts=30°C, and using CL=60%, failure rate is

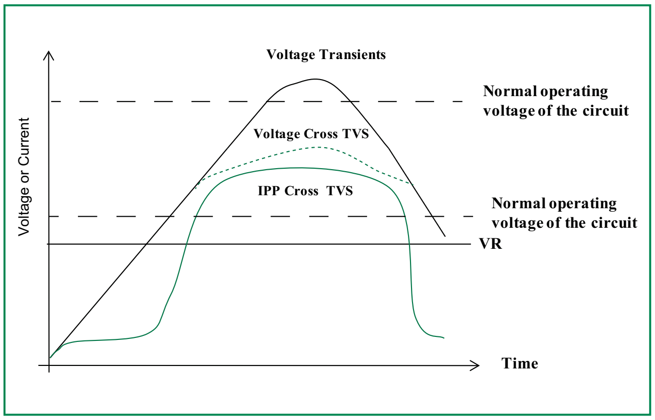
$\lambda_{CL} = X2(60\%, 2) \times 10^9 / (2 \times 504 \times 40 \times 5.2 \times 10^4)$

$= 1.897 \times 10^9 / (2 \times 504 \times 40 \times 5.2 \times 10^4)$

$= 0.9$ FIT

Note: the published reliability test report usually rounds up the failure rate to 1 FIT at 30°C.

TVS Transients Clamping Waveform



TVS Diode Selection Checklist

1. Define Circuit Operating Parameters

Normal operating voltage type in DC or AC: _______

Device Type Required: Uni-directional Bi-directional

Normal operating voltage in volts:_______________

Maximum transient current (Ipp):_______________

Maximum clamping voltage (Vc):_______________

Required peak reverse surge power rating:________

Product mounting type (package):_______________

Operating temperature:______________________

2. Narrow TVS Diode Series for the Application

Please refer to the product selection charts and data sheets within this guide, factoring these key parameters:

Reverse Standoff Voltage (V_R):
The device V_R should be equal to, or great than, the peak operating level of the circuit (or part of the circuit) to be protected. This is to ensure that TVS Diode does not clip the circuit drive voltage.

Peak Pulse Current (I_{PP}):
The Peak Pulse Current (I_{PP}) identifies the maximum current the TVS Diode can withstand without damage. The required I_{PP} can only be determined by dividing the peak transient voltage by the source impedance. Note that the TVS Diode failure mechanism is a short circuit; if the TVS Diode fails due to a transient, the circuit will still be protected.

Maximum Clamping Voltage (V_C):
This the peak voltage that will appear across the TVS Diode when subjected to the Peak Pulse Current (I_{PP}), based on 10/1000μs exponential waveform. The V_C of each TVS Diode is identified in each series data sheet electrical characteristics table.

3. Verify Ambient Operating Parameters

Ensure that the application voltage is less than or equal to the device's standoff voltage, and that the operating temperature limits are within those specified by the device.

4. Verify Device Mounting Style and Dimensions

Please refer to the dimension drawings contained within the data sheet of each series.

5. Test the Selected Device in Actual Application

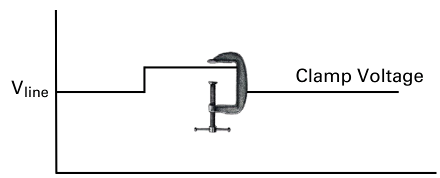
Please contact Littelfuse if you would like assistance with testing and verifying suitability of a Littelfuse device within your product. We have extensive product testing lab capabilities and technical expertise to assist you.

TVS Diode Terms & Definitions

Clamping Device

TVS is a clamping device that limits voltage spikes by low impedance avalanche breakdown of a rugged silicon PN junction. It is used to protect sensitive components from electrical overstress generated by induced lightning, inductive load switching and electrostatic discharge.

Clamping Device



Operating Temperature Range

The minimum and maximum ambient operating temperature of the circuit in which a device will be applied. Operating temperature does not allow for the effects of adjacent components, this is a parameter the designer must take into consideration.

Capacitance

The property of a circuit element that permits it to store an electrical charge. In circuit protection, the off-state capacitance is typically measured at 1 MHz.

Reverse Standoff Voltage (V_R)

In the case of a uni-directional TVS diode, this is the maximum peak voltage that may be applied in the 'blocking direction' with no significant current flow. In the case of a bi-directional transient, it applies in either direction. It is the same definition as Maximum Off-state Voltage and Maximum Working Voltage.

Breakdown Voltage (V_{BR})

Breakdown voltage measured at a specified DC test current, typically 1mA. Usually a minimum and maximum is specified.

Peak Pulse Current (I_{PP})

Maximum pulse current which can be applied repetitively. Usually a 10/1000μs double exponential waveform, but can also be 8/20μs, if stated.

Maximum Clamping Voltage (V_C or V_{Cl})

Maximum voltage which can be measured across the protector when subjected to the Maximum Peak Pulse Current.

Peak Pulse Power (P_{PP})

Expressed in Watts or Kilowatts, for a 1ms exponential transient (see figure 1, page 31) it is I_{PP} multiplied by V_{CL}.

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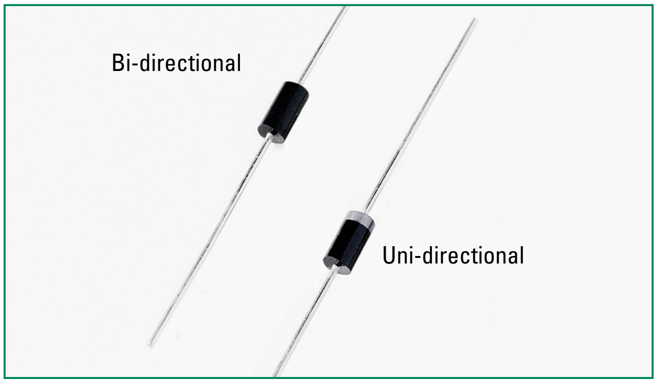
P6KE Series

HF RoHS



Agency Approvals

AGENCY	AGENCY FILE NUMBER
UL	E128662/E230531

Maximum Ratings and Thermal Characteristics (T_A=25°C unless otherwise noted)

Parameter	Symbol	Value	Unit
Peak Pulse Power Dissipation by 10/1000μs Test Waveform (Fig.2) (Note 1)	P_{PPM}	600	W
Steady State Power Dissipation on Inifinite Heat Sink at T_L=75ºC (Fig. 6)	P_D	5.0	W
Peak Forward Surge Current, 8.3ms Single Half Sine Wave Unidirectional Only (Note 2)	I_{FSM}	100	A
Maximum Instantaneous Forward Voltage at 50A for Unidirectional Only (Note 3)	V_F	3.5/5.0	V
Operating Junction and Storage Temperature Range	T_J, T_{STG}	-55 to 150	°C
Typical Thermal Resistance Junction to Lead	R_{uJL}	20	°C/W
Typical Thermal Resistance Junction to Ambient	R_{uJA}	75	°C/W

Notes:

1. Non-repetitive current pulse , per Fig. 3 and derated above T_A = 25ºC per Fig. 2.
2. Measured on 8.3ms single half sine wave or equivalent square wave, duty cycle=4 per minute maximum.
3. V_F<3.5V for devices of $V_{BR} \leq$ 200V and V_F< 5.0V for devices of $V_{BR} \geq$ 201V.

Description

The P6KE Series is designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events.

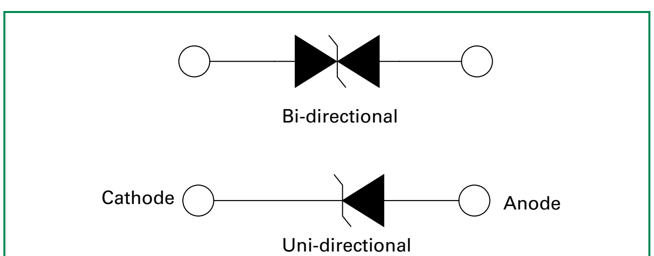
Features

- V_{BR} @T_J= V_{BR}@25°C × (1+αT x (T_J - 25))
  (αT: Temperature Coefficient)
- Glass passivated chip junction in DO-15 Package
- 600W peak pulse capability at 10/1000μs waveform, repetition rate (duty cycles):0.01%
- Fast response time: typically less than 1.0ps from 0 Volts to BV min
- Excellent clamping capability
- Typical failure mode is short from over-specified voltage or current
- Whisker test is conducted based on JEDEC JESD201A per its table 4a and 4c
- IEC-61000-4-2 ESD 15kV(Air), 8kV (Contact)
- ESD protection of data lines in accordance with IEC 61000-4-2 (IEC801-2)
- EFT protection of data lines in accordance with IEC 61000-4-4 (IEC801-4)
- Low incremental surge resistance
- Typical I_R less than 1μA above 13V
- High temperature soldering guaranteed: 260°C/40 seconds / 0.375",(9.5mm) lead length, 5 lbs., (2.3kg) tension
- Plastic package has underwriters laboratory flammability classification 94V-O
- Matte tin lead–free plated
- Halogen free and RoHS compliant

Applications

TVS devices are ideal for the protection of I/O interfaces, V_{CC} bus and other vulnerable circuits used in telecom, computer, industrial and consumer electronic applications.

Functional Diagram



Additional Information

Datasheet | Resources | Samples

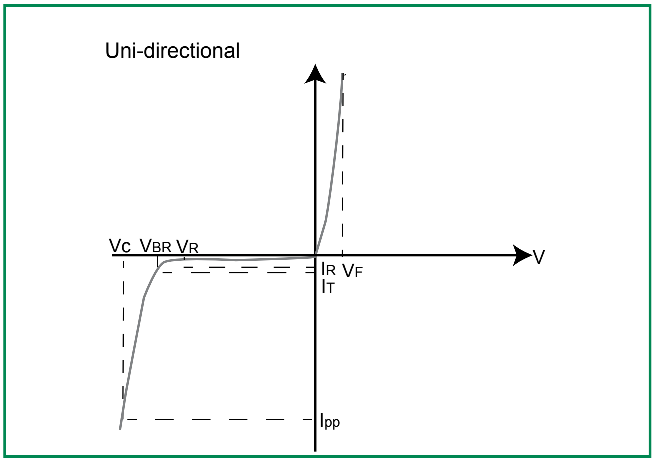
Revised: 09/13/13

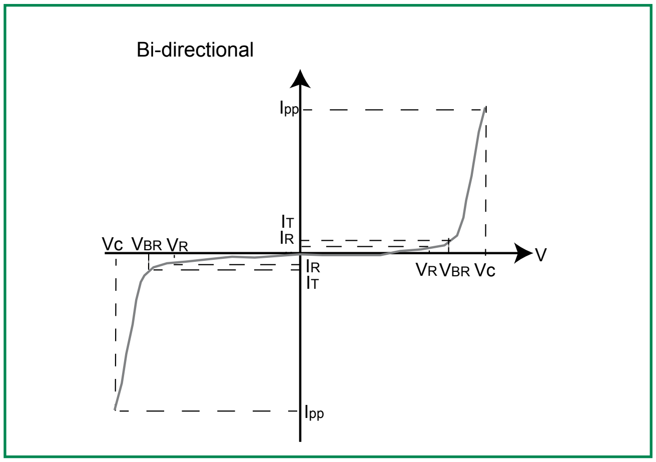
Electrical Characteristics (T_A=25°C unless otherwise noted)

Part Number (Uni)	Part Number (Bi)	Reverse Stand off Voltage V_R (Volts)	Breakdown Voltage V_{BR} (Volts) @ I_T		Test Current I_T (mA)	Maximum Clamping Voltage V_C @ I_{pp} (V)	Maximum Peak Pulse Current I_{pp} (A)	Maximum Reverse Leakage I_R@ V_R (µA)	Agency Approval
			MIN	MAX					
P6KE6.8A	P6KE6.8CA	5.80	6.45	7.14	10	10.5	58.1	1000	X
P6KE7.5A	P6KE7.5CA	6.40	7.13	7.88	10	11.3	54.0	500	X
P6KE8.2A	P6KE8.2CA	7.02	7.79	8.61	10	12.1	50.4	200	X
P6KE9.1A	P6KE9.1CA	7.78	8.65	9.55	1	13.4	45.5	50	X
P6KE10A	P6KE10CA	8.55	9.50	10.50	1	14.5	42.1	10	X
P6KE11A	P6KE11CA	9.40	10.50	11.60	1	15.6	39.1	5	X
P6KE12A	P6KE12CA	10.20	11.40	12.60	1	16.7	36.5	5	X
P6KE13A	P6KE13CA	11.10	12.40	13.70	1	18.2	33.5	1	X
P6KE15A	P6KE15CA	12.80	14.30	15.80	1	21.2	28.8	1	X
P6KE16A	P6KE16CA	13.60	15.20	16.80	1	22.5	27.1	1	X
P6KE18A	P6KE18CA	15.30	17.10	18.90	1	25.2	24.2	1	X
P6KE20A	P6KE20CA	17.10	19.00	21.00	1	27.7	22.0	1	X
P6KE22A	P6KE22CA	18.80	20.90	23.10	1	30.6	19.9	1	X
P6KE24A	P6KE24CA	20.50	22.80	25.20	1	33.2	18.4	1	X
P6KE27A	P6KE27CA	23.10	25.70	28.40	1	37.5	16.3	1	X
P6KE30A	P6KE30CA	25.60	28.50	31.50	1	41.4	14.7	1	X
P6KE33A	P6KE33CA	28.20	31.40	34.70	1	45.7	13.3	1	X
P6KE36A	P6KE36CA	30.80	34.20	37.80	1	49.9	12.2	1	X
P6KE39A	P6KE39CA	33.30	37.10	41.00	1	53.9	11.3	1	X
P6KE43A	P6KE43CA	36.80	40.90	45.20	1	59.3	10.3	1	X
P6KE47A	P6KE47CA	40.20	44.70	49.40	1	64.8	9.4	1	X
P6KE51A	P6KE51CA	43.60	48.50	53.60	1	70.1	8.7	1	X
P6KE56A	P6KE56CA	47.80	53.20	58.80	1	77.0	7.9	1	X
P6KE62A	P6KE62CA	53.00	58.90	65.10	1	85.0	7.2	1	X
P6KE68A	P6KE68CA	58.10	64.60	71.40	1	92.0	6.6	1	X
P6KE75A	P6KE75CA	64.10	71.30	78.80	1	103.0	5.9	1	X
P6KE82A	P6KE82CA	70.10	77.90	86.10	1	113.0	5.4	1	X
P6KE91A	P6KE91CA	77.80	86.50	95.50	1	125.0	4.9	1	X
P6KE100A	P6KE100CA	85.50	95.00	105.00	1	137.0	4.5	1	X
P6KE110A	P6KE110CA	94.00	105.00	116.00	1	152.0	4.0	1	X
P6KE120A	P6KE120CA	102.00	114.00	126.00	1	165.0	3.7	1	X
P6KE130A	P6KE130CA	111.00	124.00	137.00	1	179.0	3.4	1	X
P6KE150A	P6KE150CA	128.00	143.00	158.00	1	207.0	2.9	1	X
P6KE160A	P6KE160CA	136.00	152.00	168.00	1	219.0	2.8	1	X
P6KE170A	P6KE170CA	145.00	162.00	179.00	1	234.0	2.6	1	X
P6KE180A	P6KE180CA	154.00	171.00	189.00	1	246.0	2.5	1	X
P6KE200A	P6KE200CA	171.00	190.00	210.00	1	274.0	2.2	1	X
P6KE220A	P6KE220CA	185.00	209.00	231.00	1	328.0	1.9	1	X
P6KE250A	P6KE250CA	214.00	237.00	263.00	1	344.0	1.8	1	X
P6KE300A	P6KE300CA	256.00	285.00	315.00	1	414.0	1.5	1	X
P6KE350A	P6KE350CA	300.00	332.00	368.00	1	482.0	1.3	1	X
P6KE400A	P6KE400CA	342.00	380.00	420.00	1	548.0	1.1	1	X
P6KE440A	P6KE440CA	376.00	418.00	462.00	1	602.0	1.0	1	X
P6KE480A	P6KE480CA	408.00	456.00	504.00	1	658.0	0.9	1	
P6KE510A	P6KE510CA	434.00	485.00	535.00	1	698.0	0.9	1	
P6KE530A	P6KE530CA	477.00	503.50	556.50	1	725.0	0.8	1	
P6KE540A	P6KE540CA	486.00	513.00	567.00	1	740.0	0.8	1	
P6KE550A	P6KE550CA	495.00	522.50	577.50	1	760.0	0.8	1	
P6KE600A	P6KE600CA	512.00	570.00	630.00	1	828.0	0.75	1	

For bidirectional type having V_R of 10 volts and less, the I_R limit is double.
For parts without A , the V_{BR} is ± 10% and V_C is 5% higher than with A parts

I-V Curve Characteristics





P_{PPM} Peak Pulse Power Dissipation -- Max power dissipation
V_R Stand-off Voltage -- Maximum voltage that can be applied to the TVS without operation
V_{BR} Breakdown Voltage -- Maximum current that flows though the TVS at a specified test current (I_T)
V_C Clamping Voltage -- Peak voltage measured across the suppressor at a specified Ippm (peak impulse current)
I_R Reverse Leakage Current -- Current measured at V_R
V_F Forward Voltage Drop for Uni-directional

Ratings and Characteristic Curves (T_A=25°C unless otherwise noted)

Figure 1 - TVS Transients Clamping Waveform

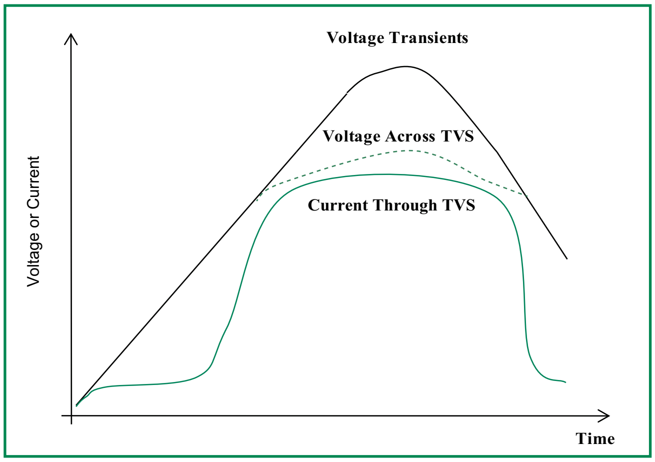
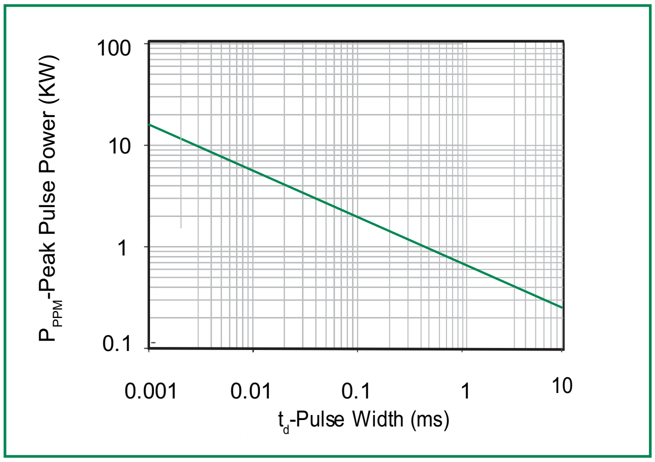


Figure 2 - Peak Pulse Power Rating



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Ratings and Characteristic Curves (T_A=25°C unless otherwise noted) (Continued)

Figure 3 - Pulse Derating Curve

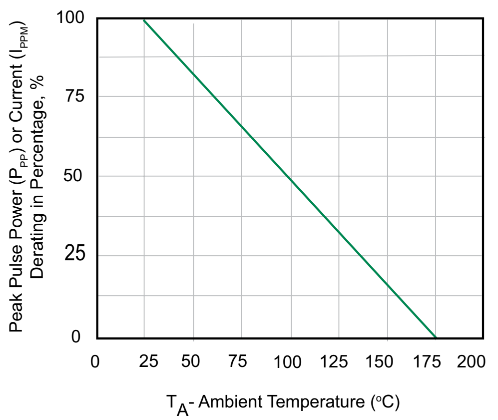


Figure 4 - Pulse Waveform

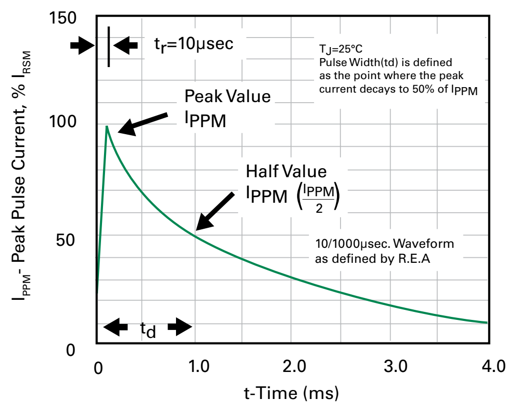


Figure 5 - Typical Junction Capacitance Uni-Directional

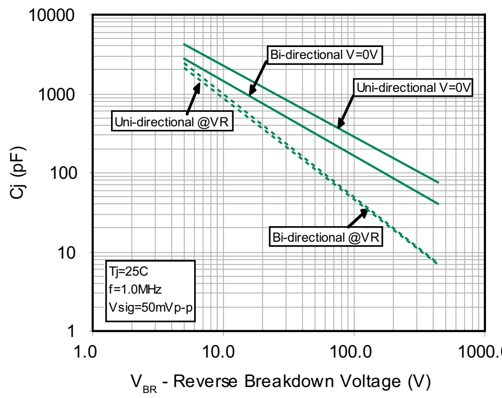


Figure 6 - Steady State Power Derating Curve

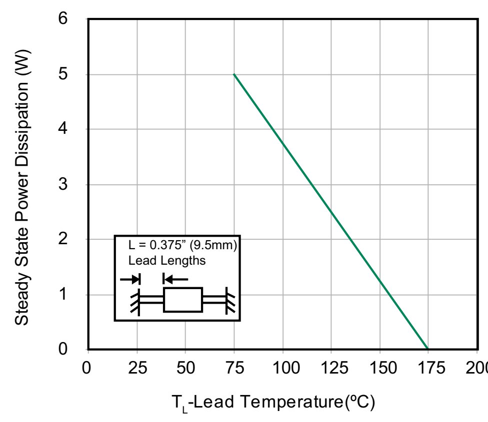
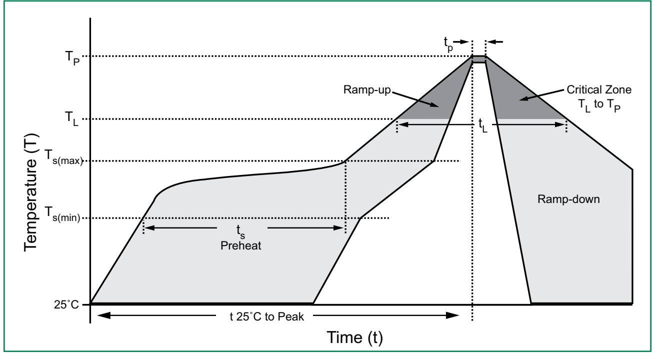


Figure 7 - Maximum Non-Repetitive Forward Surge Current

Soldering Parameters

Reflow Condition		Lead–free assembly
Pre Heat	-Temperature Min ($T_{s(min)}$)	150°C
	-Temperature Max ($T_{s(max)}$)	200°C
	-Time (min to max) (t_s)	60 – 180 secs
Average ramp up rate (Liquidus Temp (T_L) to peak		3°C/second max
$T_{S(max)}$ to T_L - Ramp-up Rate		3°C/second max
Reflow	-Temperature (T_L) (Liquidus)	217°C
	-Time (min to max) (t_s)	60 – 150 seconds
Peak Temperature (T_P)		$260^{+0/-5}$ °C
Time within 5°C of actual peak Temperature (t_p)		20 – 40 seconds
Ramp-down Rate		6°C/second max
Time 25°C to peak Temperature (T_P)		8 minutes Max.
Do not exceed		280°C



Flow/Wave Soldering (Solder Dipping)

Peak Temperature :	265°C
Dipping Time :	10 seconds
Soldering :	1 time

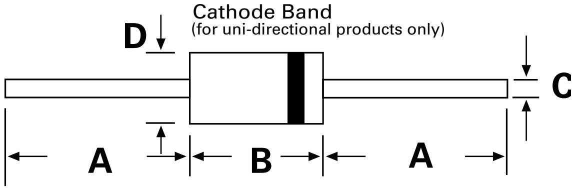
Physical Specifications

Weight	0.015oz., 0.4g
Case	JEDEC DO-204AC (DO-15) molded plastic body over passivated junction.
Polarity	Color band denotes the cathode except Bipolar.
Terminal	Matte Tin axial leads, solderable per JESD22-B102D.

Environmental Specifications

High Temp. Storage	JESD22-A103
HTRB	JESD22-A108
Thermal Shock	JESD22-A106
H3TRB	JESD22-A101
RSH	JESD22-B106C

Dimensions



DO-204AC (DO-15)

Dimensions	Inches		Millimeters	
	Min	Max	Min	Max
A	1.000	-	25.40	-
B	0.230	0.300	5.80	7.60
C	0.022	0.034	0.56	0.86
D	0.104	0.140	2.60	3.60

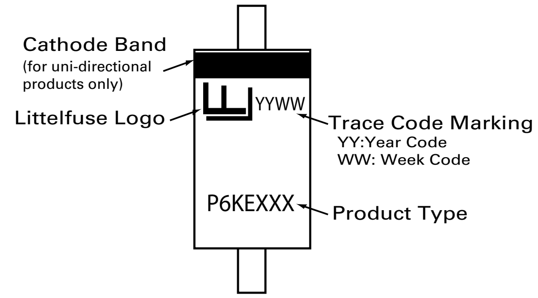
Revised: 09/13/13

Part Numbering System

P6KE xxx XX X

- **OPTION CODE:**
  - **BLANK** Reel Tape
  - **-B** Bulk Packaging
- **TYPE CODE:**
  - **A** Uni-Directional (5% V_{BR} Voltage Tolerance)
  - **CA** Bi-Directional (5% V_{BR} Voltage Tolerance)
- **V_{BR} VOLTAGE CODE**
  (Refer to the Electrical Characteristics table)
- **SERIES CODE**

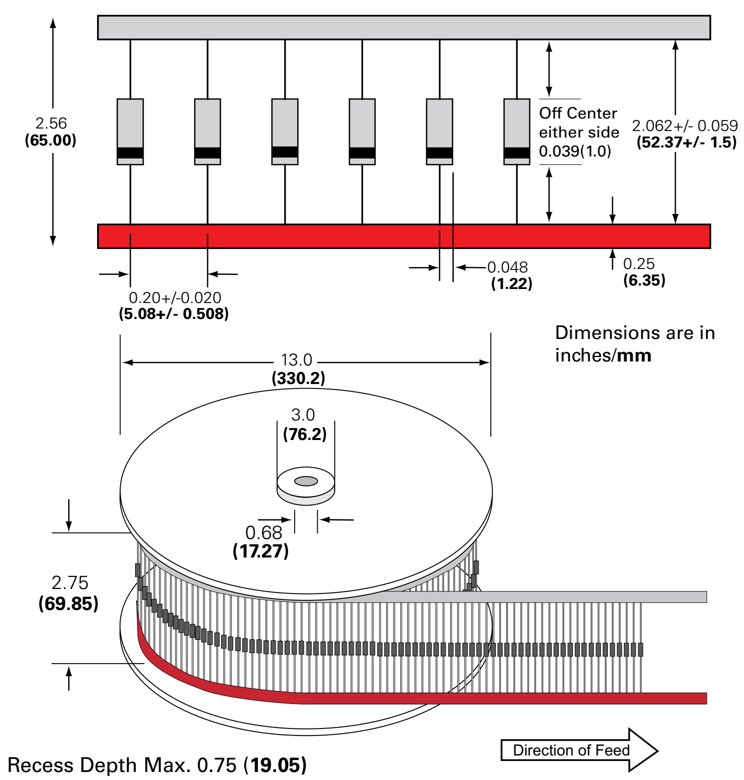
Part Marking System



Packaging

Part Number	Component Package	Quantity	Packaging Option	Packaging Specification
P6KExxxXX	DO-204AC	4000	Tape & Reel	EIA STD RS-296E
P6KExxxXX-B	DO-204AC	1000	BULK	Littelfuse Concord Packing Spec. DM-0016

Tape and Reel Specification



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