130 kW Transient Voltage Suppressor (TVS) Device

MRT130KP275CV–MXLRT130KP275CAE3/MRT130KP295CV–MXLRT130KP295CAE3

Product Overview

The MRT130KP series of 130 kW Transient Voltage Suppressors (TVSs) provide stand-off voltages (V_{WM}) of 275 or 295V. They protect a variety of voltage-sensitive components from destruction or degradation. These high-reliability devices are available with a variety of upscreening options for enhanced reliability. RoHS compliant versions are available. They can protect against the secondary effects of lightning per IEC61000-4-5 (see the following protection classes), RTCA/DO-160, and against voltage pulses from inductive switching environments or induced by RF radiation. Since their response time is virtually instantaneous at < 5ns, they can also be used in protection from ESD and EFT per IEC61000-4-2 and IEC61000-4-4.

Figure 1. DO-204AR Package

Features

- Suppresses transients up to 130 kW at 6.4/69 µs
- Fast response with less than 5 ns turn-on time
- Preferred 130 kW TVS for aircraft power bus protection
- 3σ lot norm screening performed on standby current I_D for all M prefix devices
- 100% surge tested devices
- Available as either low clamp with “CV” suffix or normal clamping features with “CA” suffix
- Enhanced reliability screening in reference to MIL-PRF-19500 are available. Refer to Hi-Rel Non-Hermetic Product Portfolio for more details on the screening options.
  (See Part Nomenclature for all options.)
- High reliability controlled devices have wafer fabrication and assembly lot traceability for all M prefix devices.
- Moisture classification is level 1 with no dry pack required per IPC/JEDEC J-STD-020F for all M prefix devices.
- RoHS compliant versions are available.

Applications/Benefits

- Available in working stand-off voltages (V_{WM}) 275 or 295 volts
- Economical axial-lead plastic encapsulated TVS series for thru-hole mounting
- Protection from high power switching transients, induced RF, and lightning threats with comparatively small package size (0.25 inch diameter)
- Protection from ESD and EFT per IEC61000-4-2 and IEC61000-4-4
- Pin injection protection per RTCA/DO-160G up to Level 5 for Waveform 4 (6.4/69 µs)
- Pin injection protection per RTCA/DO-160G up to Level 3 for Waveform 5A (40/120 µs)
- Compatible with “abnormal surge voltage” as described in 16.5.2.3.1b of RTCA/DO-160G
- The very low clamping with “CV” suffix is designed for low clamping protection of 400V transistors, IGBTs and MOSFETs in off-line switching power supplies.
- The normal clamp device with “CA” suffix is for use in less-sensitive applications including RFI/EMI filters and general across-the-line protection.

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1. Maximum Ratings

Table 1-1. Maximum Ratings at 25 °C Unless Otherwise Noted

Parameters/Test Conditions		Symbol	Value	Unit
Junction and storage temperature		T_J and T_{STG}	–55 to +150	°C
Average power dissipation	at T_L = 25 °C[1] at T_A = 25 °C[2]	P_D	7 1.61	W
Peak pulse power dissipation[3]	At 6.4/69 µs	—	130	kW
$T_{clamping}$ (0 volts to $V_{(BR)}$ min, theoretical)	Unidirectional Bidirectional	—	< 100 < 5	ps ns
Solder temperature at 10 seconds		—	260	°C

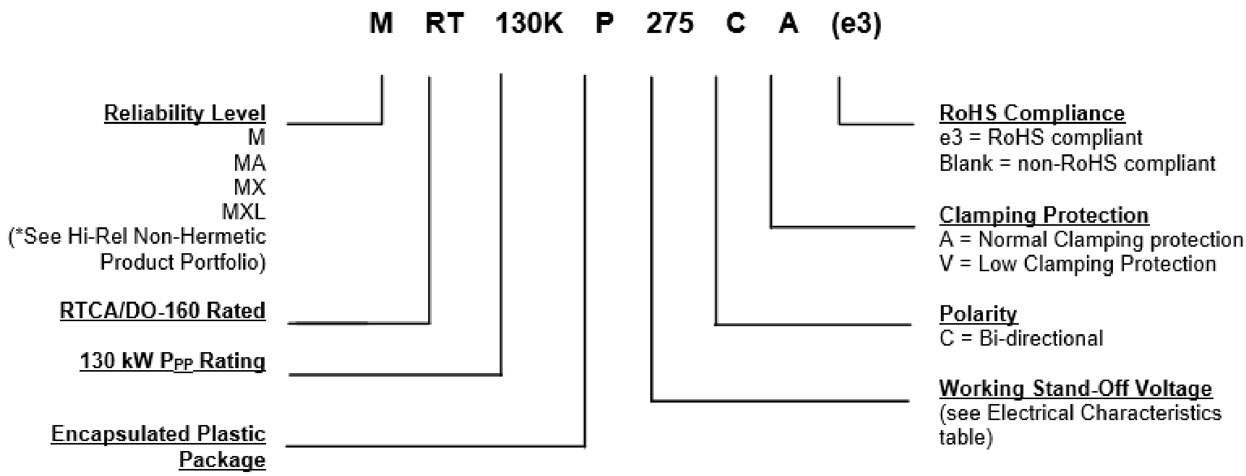
Notes:
1. At 3/8 (10 mm) lead length from body
2. When mounted on FR4 PC board with 4 mm^2 copper pads (1 oz) and track width 1 mm, length 25 mm
3. With impulse repetition rate (duty factor) of 0.01 % or less (see Figure 4-1 and Figure 4-2 for t_W waveform and derating effects)

1.1 Mechanical Packaging

- Case: Void-free transfer molded thermosetting epoxy body meeting UL94V-0.
- Terminals: Tin-lead or RoHS compliant annealed matte-tin plating. Solderable per MIL-STD-750, method 2026
- Marking: Reliability level, part number, date code.
- Polarity: No cathode bidirectional devices
- Tape and Reel option: Standard per EIA-296 (add “TR” suffix to part number). Consult factory for quantities.
- Weight: Approximately 1.7 grams
- See Package Dimensions

2. Part Nomenclature

Figure 2-1. Part Nomenclature



2.1 Symbols and Definitions

Table 2-1. Symbols and Definitions

Symbol	Definition
$\alpha_{V(BR)}$	Temperature coefficient of breakdown voltage: The change in breakdown voltage divided by the change in temperature that caused it expressed in %/°C or mV/°C.
C_T	Total capacitance: The total small signal capacitance between the diode terminals of a complete device.
$I_{(BR)}$	Breakdown current: The current used for measuring Breakdown Voltage $V_{(BR)}$.
I_D	Standby current: The current through the device at rated stand-off voltage.
I_{FSM}	Surge peak forward current: The forward current including all nonrepetitive transient currents but excluding all repetitive transients (ref JESD282-B).
I_{PP}	Peak impulse current: The peak current during an impulse.
P_{PP}	Peak pulse power: The peak power that can be applied for a specific pulse width and waveform. The product of I_{PP} and V_C.
$V_{(BR)}$	Breakdown voltage: The voltage across the device at a specified current $I_{(BR)}$ in the breakdown region.
V_C	Clamping voltage: The voltage across the device in a region of low differential resistance during the application of an impulse current (I_{PP}) for a specified waveform.
V_{WM}	Working stand-off voltage: The maximum-rated value of dc or repetitive peak positive cathode-to-anode voltage that may be continuously applied over the standard operating temperature.

3. Electrical Characteristics

Table 3-1. Electrical Characteristics at 25 °C Unless Otherwise Stated[1–6]

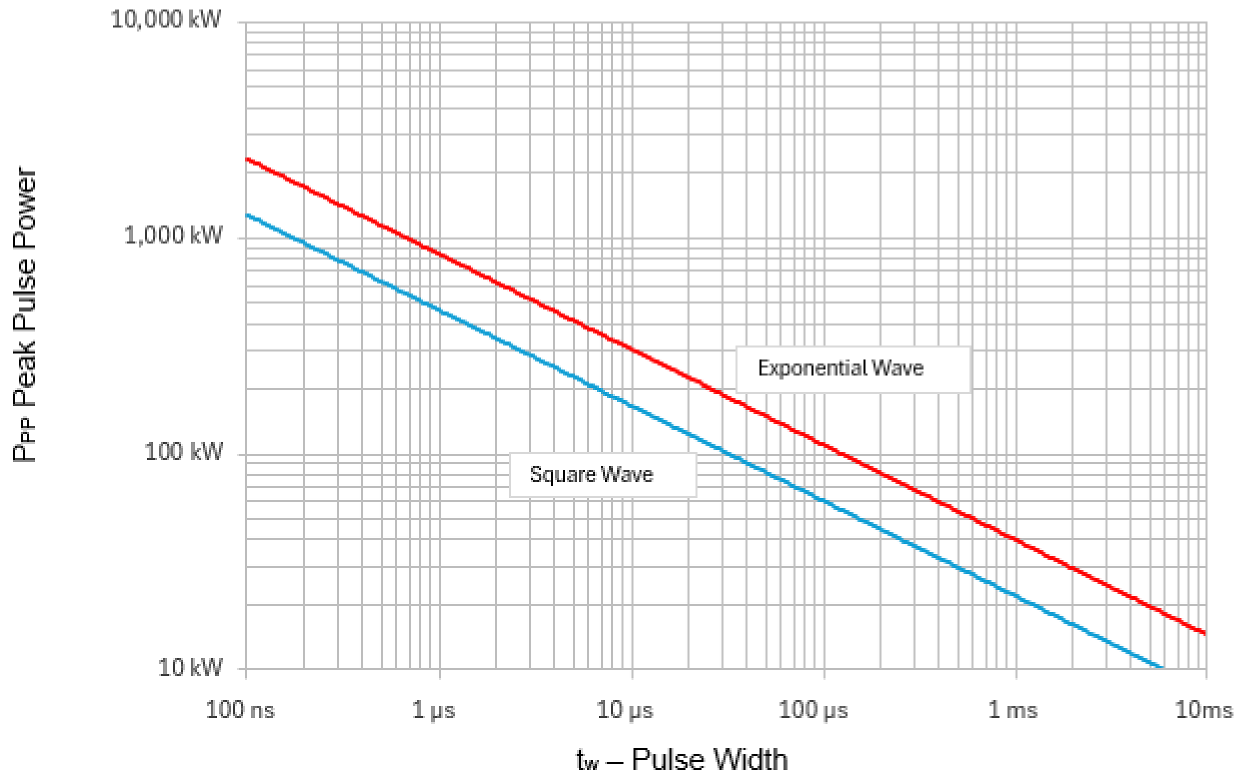
Part Number	Working Stand-Off Voltage V_{WM}	Maximum Standby Current at V_{WM} I_D	Minimum Breakdown Voltage $V_{(BR)}$ Volts at $I_{(BR)}$		Maximum Clamping at I_{PP} V_C	Maximum Peak Pulse Current at 6.4/69 µS I_{PP}
	Volts	µA	$V_{(BR)}$ Volts	$I_{(BR)}$ mA	Volts	Amps
MRT130KP275CV	275	5	300	5	400	292
MRT130KP275CA	275	5	300	5	445	292
MRT130KP295CV	295	5	300	5	410	282
MRT130KP295CA	295	5	300	5	460	282

Notes:

1. Normal selection criteria for TVS devices is by working stand-off voltage (V_{WM}) and should be equal or greater than DC or continuous peak operating voltage.
2. TVS devices are tested to maximum peak pulse current (I_{PP}) with clamping voltage monitored. This surge capability is one of the most significant electrical characteristics of the device and should be considered as part of customer quality inspections. The maximum peak pulse current (I_{PP}) shown represents the performance capabilities by design.
3. Clamping voltage does not include any variable parasitic lead inductance effects observed during the 6.4 µs rise time due to lead length.
4. See MicroNote 108 for lower Clamping Voltage performance at reduced I_P values relative to I_{PP} and P_{PP} ratings and Figure 4-1.
5. I_{PP} equivalent to 90 and 87 amps (P_{PP} 40 kW) respectively at a longer impulse of 10/1000 ms (see Figure 4-1) with clamping voltages shown. Also see other equivalent peak pulse power performance levels for aircraft waveforms.
6. Temperature coefficient of breakdown voltage: max 0.1%/°C.

4. Graphs

Figure 4-1. Peak Pulse Power Vs. Pulse Time at 25 °C[1]



Note:

1. This P_{PP} vs. Time graph allows the designer to use these parts over a broad power spectrum using the guidelines illustrated in MicroNote 104 on Microchip's website. Aircraft transients are described with exponential decaying waveforms. For suppression of square waveforms, derate power and current to 66% of that for exponential decay.

Figure 4-2. Power Derating

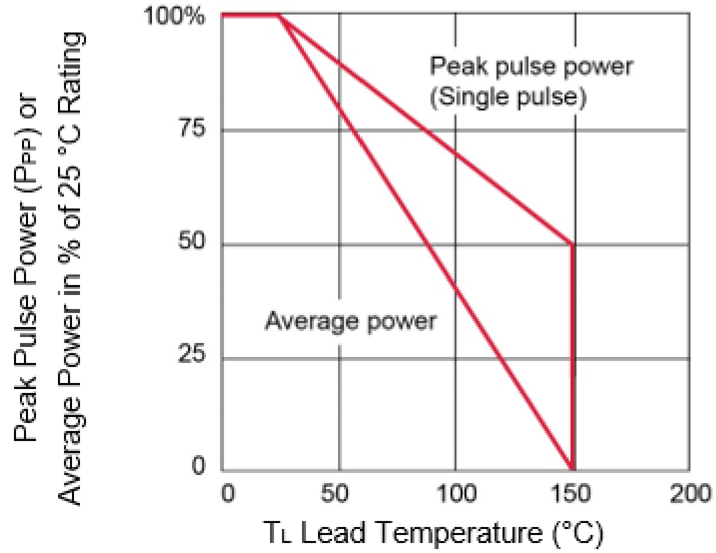


Figure 4-3. Minimal Parasitic Inductance

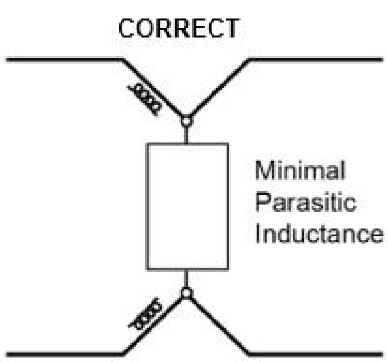
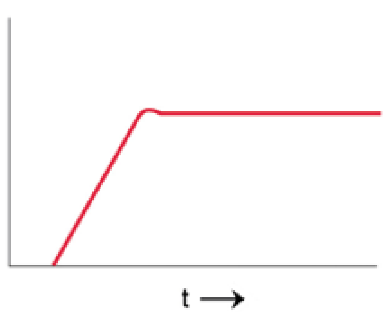


Figure 4-4. No Overshoot Voltage



Installation

TVS devices used across power lines are subject to relatively high magnitude surge currents and are more prone to adverse parasitic inductance effects in the mounting leads. Minimizing the shunt path of the lead inductance and their V = –Ldi/dt effects will optimize the TVS effectiveness. Examples of optimum installation and poor installation are illustrated in the figures to the left and right. Figure 4-3 illustrates minimal parasitic inductance with attachment at end of device. Inductive voltage drop is across the input leads. Virtually no "overshoot" voltage results as illustrated with Figure 4-4. The loss of effectiveness in protection caused by excessive parasitic inductance is illustrated in Figure 4-5 and Figure 4-6. Also see MicroNote 111 for further information on "Parasitic Lead Inductance in TVS".

Figure 4-5. Excessive Parasitic Inductance

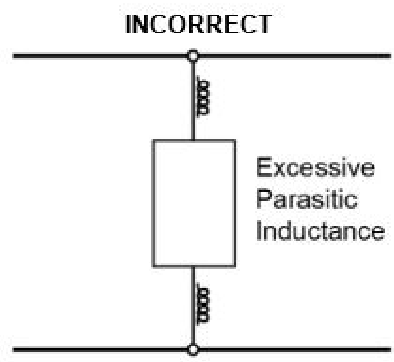


Figure 4-6. Overshoot Voltage

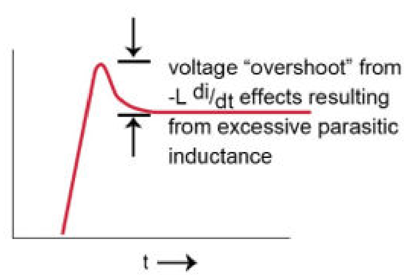


Figure 4-7. Waveform 3

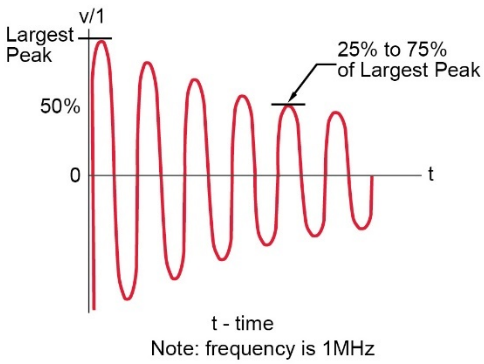


Figure 4-8. Waveform 4

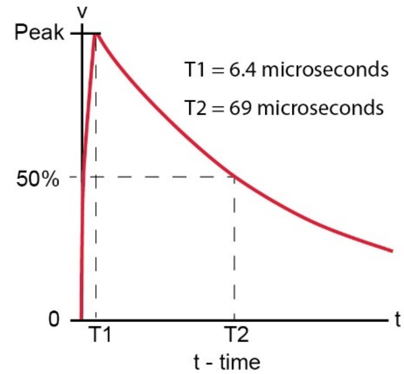
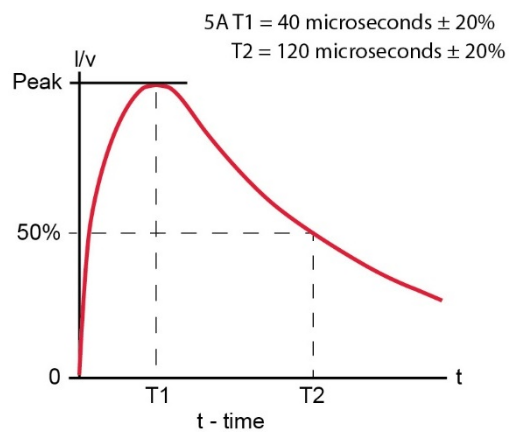


Figure 4-9. Waveform 5A



Note: The 1 MHz damped oscillatory waveform (3) has an effective pulse width of 4 μs. Equivalent peak pulse power at each of the pulse widths represented in RTCA/DO-160 for waveforms 3, 4 and 5A have been determined referencing Figure 4-1 as well as MicroNotes 104 and 120 and are listed in the following table.

Table 4-1. Peak Pulse Power at Pulse Widths[1–2]

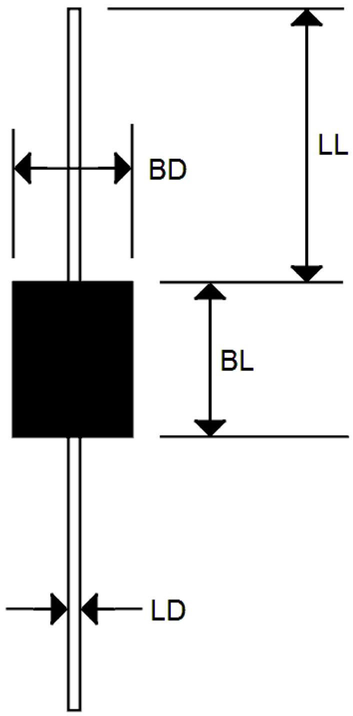
Waveform Number	Pulse Width μs	Peak Pulse Power[3] kW
3	4	580
4	6.4/69	130
5A	40/120	980

Notes:

1. High current fast rise-time transients of 250 ns or less can more than triple the V_C from parasitic inductance effects (V= –Ldi/dt) compared to the clamping voltage shown in Table 3-1 as also described in Figure 4-5 and Figure 4-6.
2. See MicroNotes 127, 130, and 132 for further information on transient voltage suppressors with reference to aircraft industry specification RTCA/DO-160.
3. Refer to MicroNote 126 to acquire the conversion factor used to multiply the maximum rated I_{PP} listed in Table 3-1 for different waveforms.

5. Package Dimensions

Figure 5-1. Package Dimensions



Dim.	Dimensions			
	Inch		Millimeters	
	Min.	Max.	Min.	Max.
LL	1.100	1.500	27.95	38.1
BL	0.365	0.375	9.27	9.52
BD	0.240	0.250	6.1	6.35
LD	0.048	0.052	1.22	1.32

6. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
A	09/2024	Document was converted to Microchip template and assigned literature number DS00005551A.
RF01014 Rev. B	05/2024	Microsemi document was created and assigned literature number RF01014.

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