100 kW Transient Voltage Suppressor (TVS) Device

MRT100KP40A – MXLRT100KP400CA(e3)

Product Overview

The MRT100KP40A – MXLRT100KP400CA series of 100 kW Transient Voltage Suppressors (TVSs) provide a selection of standoff voltages (V_{WM}) from 40 to 400 volts. They protect a variety of voltage-sensitive components from destruction or degradation. These high-reliability devices are available in either unidirectional or bidirectional versions and 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 protection classes below), RTCA/DO-160 and against voltage pulses from inductive switching environments or induced by RF radiation. Since their response time is virtually instantaneous at < 5 ns, they can also be used in protection from ESD and EFT per IEC61000-4-2 and IEC61000-4-4.

Features

- Available in both unidirectional and bidirectional configurations
- Suppresses transients up to 100 kW at 6.4/69 μs
- Fast response with less than 5 ns turn-on time
- Preferred 100 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
- 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.

Figure 1. DO-204AR Package

Applications/Benefits

- Available in working standoff voltage (V_{WM}) range 40 to 400 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-160 up to Level 4 for Waveform 4 (6.4/69 μs) on all devices
- Pin injection protection per RTCA/DO-160 up to Level 5 for Waveform 4 (6.4/69 μs) on device types MRT100KP40A up to MXLRT100KP260CA
- Pin injection protection per RTCA/DO-160 up to Level 3 for Waveform 5A (40/120 μs) on all devices
- Pin injection protection per RTCA/DO-160 up to Level 4 for Waveform 5A (40/120 μs) on device types MRT100KP40A up to MXLRT100KP64CA
- Consult factory for other voltages with similar Peak Pulse Power (P_{PP}) capabilities.

Table of Contents

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}	–65 to +150	°C
Thermal resistance, junction to lead[1]		$R_{ΘJL}$	17.5	°C/W
Thermal resistance, junction to ambient[2]		$R_{ΘJA}$	77.5	°C/W
Peak pulse power dissipation[3]	at 6.4/69 µs	P_{PP}	100	kW
Average power dissipation	at T_L = 25 °C[1] at T_A = 25 °C[2]	P_D	7 1.61	W
$T_{clamping}$ (0 volts to $V_{(BR)}$ min, theoretical)	Unidirectional Bidirectional	—	< 100 < 5	ps ns
Surge peak forward current[4]		I_{FSM}	250	A
Solder temperature at 10 seconds		—	260	°C

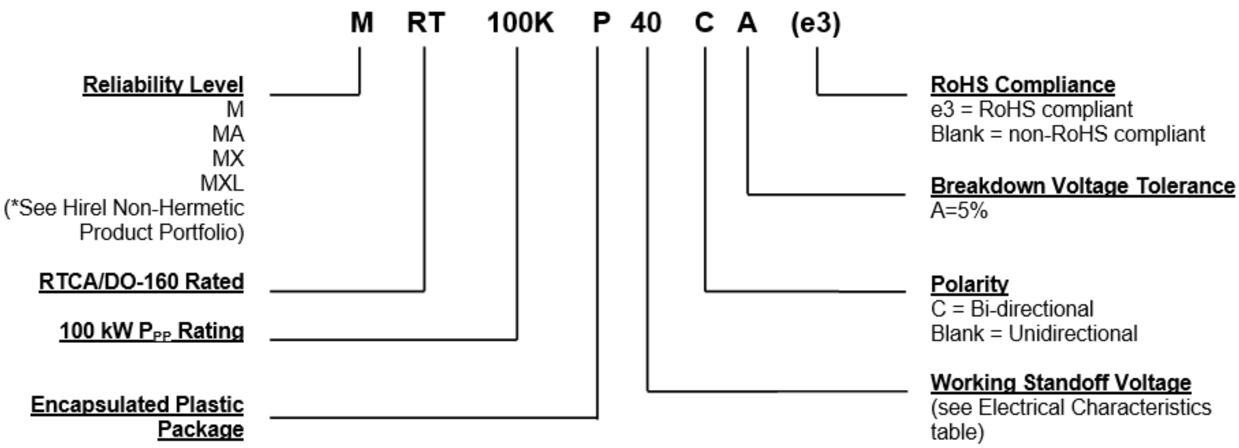
Notes:
1. At 3/8 (10 mm) lead length from body
2. Mounted on FR4 PC board with 4 mm^2 copper pads (1 oz) and track width 1 mm, length 25 mm
3. With impulse repetition rate (duty factor) of 0.01 % or less (see Figure 4-1 and Figure 4-2 for t_W waveform and derating effects)
4. At 8.3 ms half-sine wave (unidirectional only)

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: Cathode indicated by band. Bidirectional not marked.
- 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 working standoff 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 standoff 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

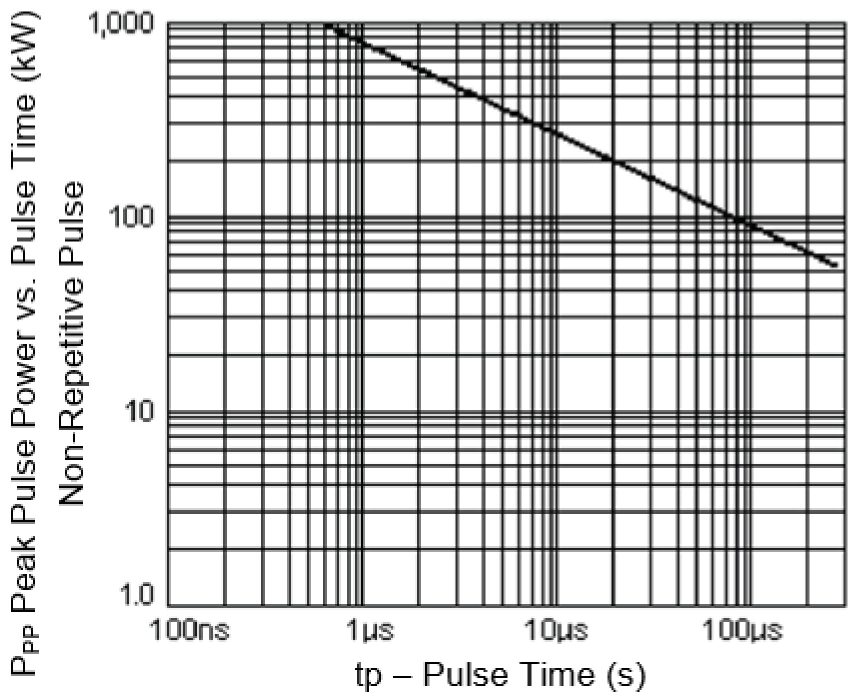
Part Number	Working Standoff Voltage	Breakdown Voltage $V_{(BR)}$ Volts at $I_{(BR)}$		Maximum Clamping at I_{PP}	Maximum Standby Current at V_{WM}	Maximum Peak Pulse Current at 6.4/69 µs	Maximum $V_{(BR)}$ Temperature Coefficient
	V_{WM}	$V_{(BR)}$	$I_{(BR)}$	V_C	I_D	I_{PP}	$\alpha_{V(BR)}$
	Volts	Volts	mA	Volts	µAmps	Amps	mV/°C
MRT100KP40(C)A	40	44.4-49.1	20	78.6	1500	1273 [4]	46
MRT100KP43(C)A	43	47.8-52.8	10	84.5	500	1184 [4]	50
MRT100KP45(C)A	45	50.0-55.3	5	88.5	150	1130 [4]	52
MRT100KP48(C)A	48	53.3-58.9	5	94.3	150	1061 [4]	56
MRT100KP51(C)A	51	56.7-62.7	5	101	50	990	60
MRT100KP54(C)A	54	60.0-66.3	5	106	25	943	63
MRT100KP58(C)A	58	64.4-71.2	5	114	15	878	68
MRT100KP60(C)A	60	66.7-73.7	5	118	15	848	71
MRT100KP64(C)A	64	71.1-78.6	5	126	10	795	76
MRT100KP70(C)A	70	77.8-86.0	5	138	10	725	83
MRT100KP75(C)A	75	83.3-92.1	5	147	10	680	89
MRT100KP78(C)A	78	86.7-95.8	5	153	10	655	93
MRT100KP85(C)A	85	94.4-104	5	166	10	602	102
MRT100KP90(C)A	90	100-111	5	178	10	563	109
MRT100KP100(C)A	100	111-123	5	197	10	508	121
MRT100KP110(C)A	110	122-135	5	216	10	463	133
MRT100KP120(C)A	120	133-147	5	235	10	426	145
MRT100KP130(C)A	130	144-159	5	254	10	394	157
MRT100KP150(C)A	150	167-185	5	296	10	338	183
MRT100KP160(C)A	160	178-197	5	315	10	318	195
MRT100KP170(C)A	170	189-209	5	334	10	300	207
MRT100KP180(C)A	180	200-221	5	354	10	283	219
MRT100KP200(C)A	200	222-245	5	392	10	256	243
MRT100KP220(C)A	220	245-271	5	434	10	231	269
MRT100KP250(C)A	250	278-308	5	493	10	203	306
MRT100KP260(C)A	260	289-320	5	512	10	196	318
MRT100KP280(C)A	280	311-345	5	552	10	181	344
MRT100KP300(C)A	300	333-369	5	590	10	170	368
MRT100KP350(C)A	350	389-431	5	690	10	145	430
MRT100KP400(C)A	400	444-492	5	787	10	127	490

Notes:

1. Normal selection criteria for TVS devices is by working standoff 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. Surge test screening is only performed up to 1,000 amps (test equipment limitations).

4. Graphs

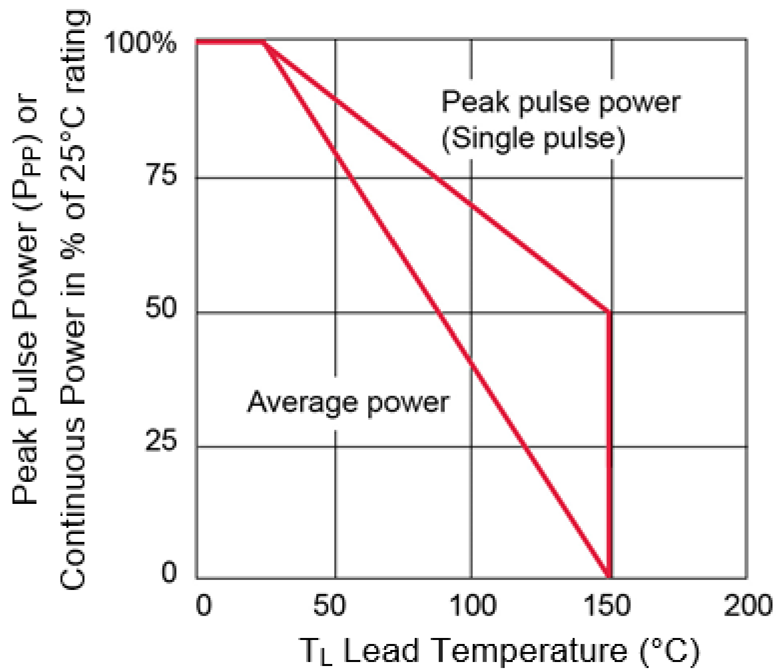
Figure 4-1. Peak Pulse Power Vs. Pulse Time To 50% of Exponentially Decaying Pulse



Note:

1. This P_{PP} versus time graph allows the designer to use these parts over a broad power spectrum using the guidelines illustrated in MicroNote 104. Aircraft transients are described with exponential decaying waveforms. For suppression of square-wave impulses, derate power and current to 66% of that for the exponential decay shown in the preceding figure.

Figure 4-2. Power Derating



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 Figure 4-3 to Figure 4-6. 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 4-5. The loss of effectiveness in protection caused by excessive parasitic inductance is illustrated in Figure 4-4 and Figure 4-6. Also see MicroNote 111 for further information on “Parasitic Lead Inductance in TVS”.

Figure 4-3. Minimal Parasitic Inductance

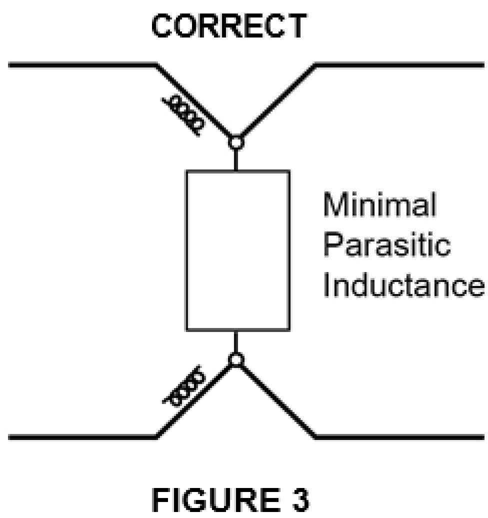


Figure 4-4. Excessive Parasitic Inductance

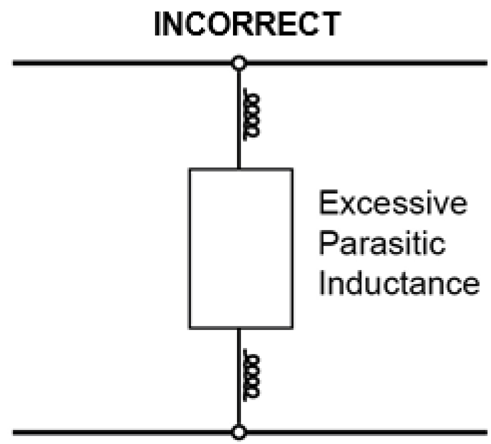


Figure 4-5. No "Overshoot" Voltage Results

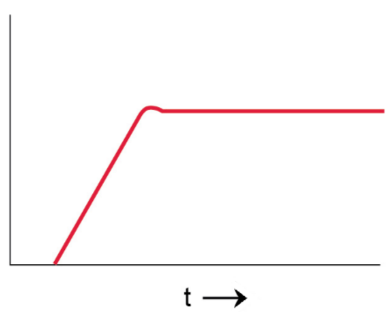


Figure 4-6. Voltage "Overshoot"

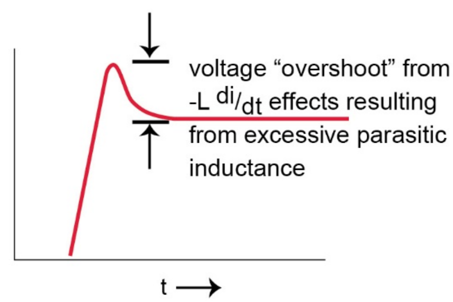


Figure 4-7. Waveform 3

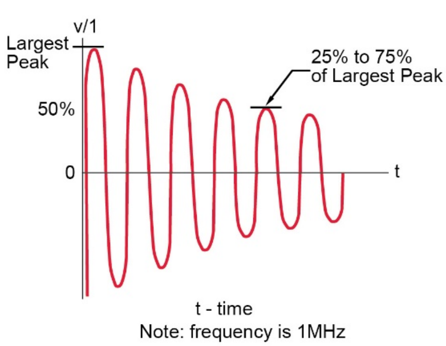


Figure 4-8. Waveform 4

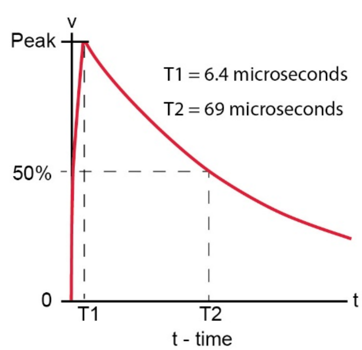
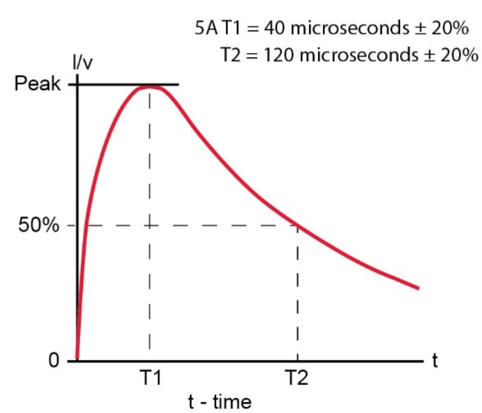


Figure 4-9. Waveform 5A



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 and Pulse Widths for Waveforms[1-2]

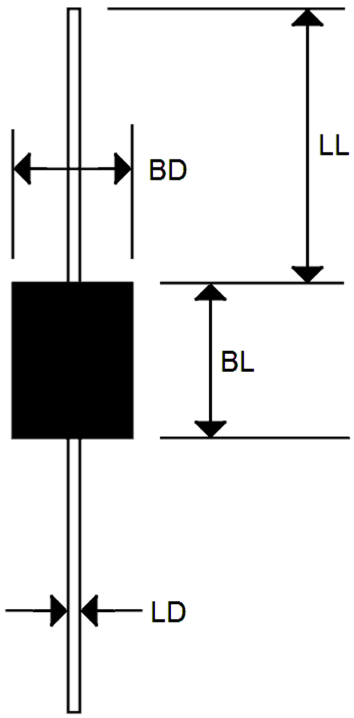
Waveform Number	Pulse Width µs	Peak Pulse Power kW	Peak Pulse Current Conversion Factor from Rated IPP at 6.4/69 µs[3]
3	4	340	3.40x
4	6.4/69	100	1.00x
5A	40/120	70	0.70x

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 the initial electrical characteristics Table 3-1 as also described in Figure 4-4 and Figure 4-6.
2. Also see MicroNotes 127, 130, and 132 for further information on transient voltage suppressors with reference to aircraft industry specification RTCA/DO-160.
3. Multiply by the conversion factor shown with reference to the maximum rated I_{PP} in the electrical characteristics Table 3-1.

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	6.10	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	01/2024	Initial revision.

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