## 65 kW Transient Voltage Suppressor (TVS) Device

MRT65KP48A - MXLRT65KP75CA(e3)



#### **Product Overview**

The MRT65KP48A – MXLRT65KP75CA series of 65 kW Transient Voltage Suppressors (TVSs) provide a selection of standoff voltages ( $V_{WM}$ ) from 48 to 75V. 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), 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 65 kW at 6.4/69  $\mu s$
- Fast response with less than 5 ns turn-on time
- Preferred 65 kW TVS for aircraft power bus protection
- 3σ lot norm screening performed on standby current I<sub>D</sub> for all M prefix devices
- 100% surge tested devices
- Enhanced reliability screening in reference to MIL-PRF-19500 is 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 standoff voltage (V<sub>WM</sub>) range 48 to 75 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 (1/4 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), up to Level 3 for Waveform 5A (40/120 μs) at 70 °C
- Compatible with "abnormal surge voltage (dc)" in 16.6.2.4 (Category A, B, and Z) of RTCA/DO-160G
- The MRT65KP48(C)A is designed for Category A in protecting 80V components<sup>1</sup>.
- The MRT65KP54A to MRT65KP60CA is designed for Category B in protecting 90V or 100V components<sup>1</sup>.
- The MRT65KP75(C)A is designed for Category Z in protecting 125V components<sup>1</sup>.
- Consult factory for other voltages with similar Peak Pulse Power (Ppp) capabilities.

#### Note:

1. Including switching transistors, MOSFETS & IGBTs in offline switching power supplies





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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 <sub>J</sub> and T <sub>STG</sub>	-55 to +150	°C
Peak pulse power dissipation <sup>1</sup>	at 6.4/69 µs	P <sub>PP</sub>	65	kW
Average power dissipation	at T <sub>L</sub> = 25 °C <sup>2</sup>	P <sub>D</sub>	7	W
T <sub>clamping</sub> (0 volts to V <sub>(BR)</sub> min, theoretical)	Unidirectional Bidirectional	_	< 100 < 5	ps ns
Solder temperature at 10 seconds		_	260	°C

#### Notes:

- 1. 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)
- 2. At 3/8 (10 mm) lead length from body

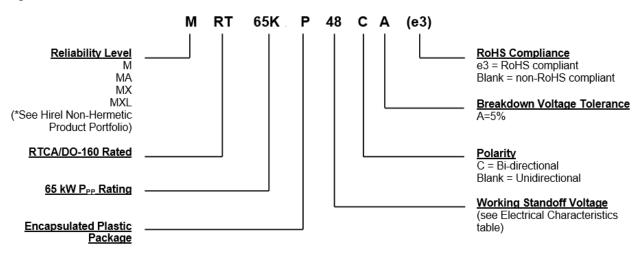
### 1.1 Mechanical Packaging

- 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 1.6 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 <sub>T</sub>	Total capacitance: The total small signal capacitance between the diode terminals of a complete device.
I <sub>(BR)</sub>	Breakdown current: The current used for measuring breakdown voltage V <sub>(BR)</sub> .
$I_D$	Standby current: The current through the device at working standoff voltage.
I <sub>PP</sub>	Peak impulse current: The peak current during an impulse.
P <sub>PP</sub>	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 <sub>(BR)</sub>	Breakdown voltage: The voltage across the device at a specified current $I_{(BR)}$ in the breakdown region.
V <sub>C</sub>	Clamping voltage: The voltage across the device in a region of low differential resistance during the application of an impulse current (I <sub>PP</sub> ) for a specified waveform.
V <sub>WM</sub>	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

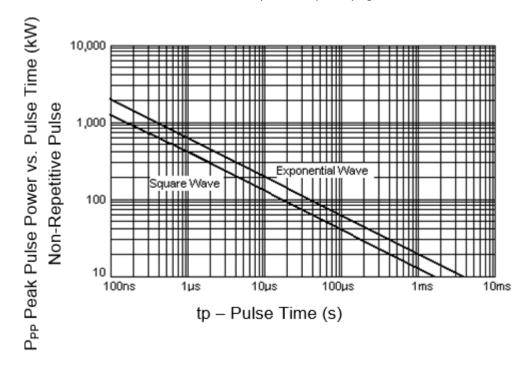
Part Number	Working Standoff Voltage <sup>1</sup> V <sub>WM</sub>	Minimum Br Voltage a V <sub>(BR)</sub> l	at I <sub>(BR)</sub>	Maximum Clamping at I <sub>PP</sub> <sup>2</sup> V <sub>C</sub>	Maximum Standby Current at V <sub>WM</sub> I <sub>D</sub>	Maximum Peak Pulse Current <sup>3</sup> at 6.4/69 μs Ι <sub>ΡΡ</sub>
	Volts	Volts	mA	Volts	μΑ	Amps
MRT65KP48(C)A	48	53.3	5	77.7	5	836
MRT65KP54(C)A	54	60.0	5	87.5	5	742
MRT65KP60(C)A	60	66.7	5	97.3	5	668
MRT65KP75(C)A	75	83.3	5	122	5	533

- 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. Clamping voltage does not include any variable parasitic lead inductance effects observed during the  $6.4~\mu s$  rise time due to lead length.
- 3. TVS devices are tested to maximum peak pulse current (I<sub>PP</sub>) 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<sub>PP</sub>) shown represents the performance capabilities by design.



## 4. Graphs

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

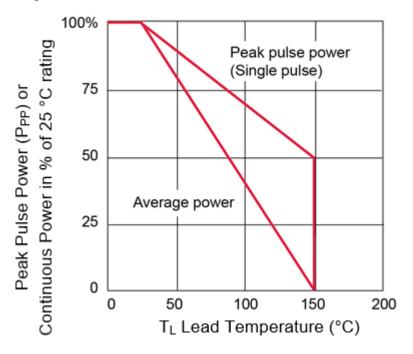


#### Note:

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

Minimal Parasitic Inductance

Figure 4-4. Excessive Parasitic Inductance

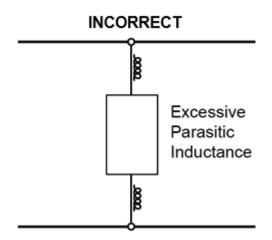


Figure 4-5. No "Overshoot" Voltage Results

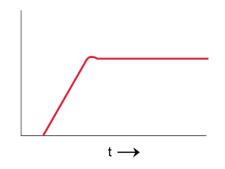


Figure 4-6. Voltage "Overshoot" Results

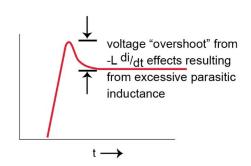


Figure 4-9. Waveform 5A

Figure 4-7. Waveform 3

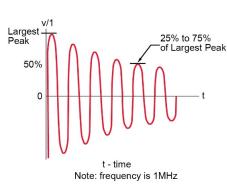
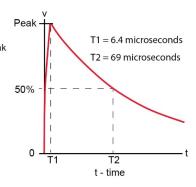
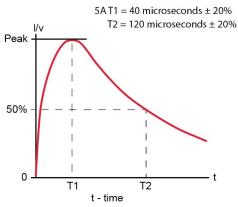


Figure 4-8. Waveform 4





The 1 MHz damped oscillatory waveform (3) has an effective pulse width of 4  $\mu$ s. 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 of Waveforms 1-2

Waveform Number	Pulse Width μs	Peak Pulse Power kW	Peak Pulse Current Conversion Factor From Rated I <sub>PP</sub> at 6.4/69 μs <sup>3</sup>
3	4	220	3.40x
4	6.4/69	65	1.00x
5A	40/120	45	0.70x

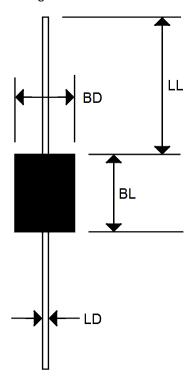
#### Notes:

- 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



	Dimensions				
Dim.	Inch		Millimeters		
	Min.	Мах.	Min.	Max.	
LL	0.750	_	19.05	_	
BL	0.365	0.385	9.27	9.78	
BD	0.235	0.255	5.97	6.48	
LD	0.047	0.053	1.194	1.346	



## 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
Α	01/2024	Initial revision.



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Boston	Austin, TX	Tel: 86-571-8792-8115	Tel: 82-2-554-7200	Germany - Haan
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Chicago         Tel: 86-532-8502-7355         Tel: 63-2-634-9065         Germany - Munich           Itasca, IL         China - Shanghai         Singapore         Tel: 49-89-627-144-0           Tel: 630-285-0071         Tel: 86-21-3326-8000         Tel: 66-6334-8870         Fax: 49-89-627-144-4           Fax: 630-285-0075         China - Shenyang         Taiwan - Hsin Chu         Germany - Rosenheim           Dallas         Tel: 86-24-2334-2829         Tel: 886-3-577-8366         Tel: 49-8031-354-560           Addison, TX         China - Shenzhen         Taiwan - Kaohsiung         Israel - Raranana           Tel: 972-818-7423         Tel: 86-75-8864-2200         Tel: 886-7-213-7830         Tel: 792-97-44-7705           Fax: 972-818-2924         China - Suzhou         Taiwan - Taipel         Italy - Milan           Detroit         Tel: 86-18-66233-1526         Tel: 886-2-2508-8600         Tel: 39-0331-742611           Novi, MI         China - Wuhan         Thailand - Bangkok         Fax: 39-0331-466781           Tel: 248-848-4000         Tel: 86-27-5980-5300         Tel: 68-2-6941351         Italy - Padova           Houston, TX         China - Xiam         Vietnam - Ho Chi Minh         Tel: 39-049-7625286           Tel: 281-894-5983         Tel: 86-29-2883138         Tel: 86-592-2388138         Tel: 48-29-3524	Tel: 774-760-0087	Tel: 86-25-8473-2460	Tel: 60-4-227-8870	Germany - Karlsruhe
Itasca, IL   China - Shanghai   Tel: 86-21-3326-8000   Tel: 86-21-3326-8000   Tel: 86-6334-8870   Fax: 49-89-627-144-40   Fax: 49-89-627-144-44   Fax: 630-285-0075   China - Shenyang   Taiwan - Hsin Chu   Germany - Rosenheim   Tel: 86-22-2334-2829   Tel: 886-357-8366   Tel: 49-8031-354-560   Saradiana   Tel: 86-22-2334-2829   Tel: 886-357-8366   Tel: 49-8031-354-560   Saradiana   Tel: 972-818-7423   Tel: 86-755-8864-2200   Tel: 886-7213-7830   Tel: 972-9-744-7705   Tel: 972-9-744-7705   Tel: 86-186-6233-1526   Tel: 86-86-22-88600   Tel: 39-0331-742611   Nowi, Ml   China - Suzhou   Taiwan - Taipei   Italy - Milan   Tel: 39-0331-466781   Tel: 248-848-4000   Tel: 86-27-5980-5300   Tel: 66-2-694-1351   Italy - Padova   Tel: 248-848-4000   Tel: 86-27-5980-5300   Tel: 66-2-694-1351   Italy - Padova   Tel: 248-848-84000   Tel: 86-28-8833-7252   Tel: 84-28-5448-2100   Netherlands - Drunen   Tel: 248-848-84000   Tel: 86-29-8833-7252   Tel: 84-28-5448-2100   Netherlands - Drunen   Tel: 31-416-690399   Fax: 31-416-690399   Fax: 31-416-690340   Norway - Trondheim   Tel: 31-773-8323   China - Zhuhai   Tel: 86-756-3210040   Tel: 86-756-800   Spain - Madrid   Tel: 34-91-708-08-90   Fax: 34-91-708-08-90   Fax: 34-91-708-08-90   Fax: 34-91-708-08-90   Fax: 34-91-708-08-90   Fax: 34-91-708-08-90   Tel: 86-756-600   Sweden - Stockholm   Tel: 46-8-5090-4654   UK-Wokingham   Tel: 46-81-5000   Tel: 46-81-50	Fax: 774-760-0088	China - Qingdao	Philippines - Manila	Tel: 49-721-625370
Tel: 630-285-0071 Tel: 86-21-3326-8000 Tel: 65-6334-8870 Fax: 49-89-627-144-44 Fax: 630-285-0075 China - Shenyang Taiwan - Hsin Chu Germany - Rosenheim Tel: 86-24-2334-2829 Tel: 86-3-577-8366 Tel: 49-8031-354-560 Tel: 49-8031-354-560 Tel: 972-818-7423 Tel: 66-24-2334-2820 Tel: 86-75-8864-2200 Tel: 88-75-73830 Tel: 972-9744-7705 Tel: 39-72-818-2924 China - Suzhou Taiwan - Taipei Italy - Milan Tel: 297-2818-2924 China - Suzhou Taiwan - Taipei Italy - Milan Tel: 297-2818-2924 China - Suzhou Tel: 86-22-5808-8600 Tel: 390-3031-742611 Tel: 248-848-4000 Tel: 66-2-5980-5300 Tel: 66-2-694-1351 Tel: 248-748-848-84000 Tel: 86-25-5980-5300 Tel: 86-25-5980-5300 Tel: 86-25-5980-5300 Tel: 86-25-5980-5300 Tel: 86-25-5980-5300 Tel: 86-29-8833-7252 Tel: 84-28-5448-2100 Netherlands - Drunen Indianapolis China - Xiame Noblesville, IN Tel: 281-894-593 Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 949-462-9523 Tel: 949-462-9523 Tel: 949-462-9508 Tel:	Chicago	Tel: 86-532-8502-7355	Tel: 63-2-634-9065	Germany - Munich
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Fax: 972-818-2924	Addison, TX	China - Shenzhen	Taiwan - Kaohsiung	Israel - Ra'anana
Detroit         Tel: 86-186-6233-1526         Tel: 886-2-2508-8600         Tel: 39-0331-742611           Novi, MI         China - Wuhan         Thailand - Bangkok         Fax: 39-0331-466781           Tel: 248-848-4000         Tel: 86-27-5980-5300         Tel: 66-2-694-1351         Italy - Padova           Houston, TX         China - Xian         Vietnam - Ho Chi Minh         Tel: 39-049-7625286           Tel: 281-894-5983         Tel: 86-29-8833-7252         Tel: 84-28-5448-2100         Netherlands - Drunen           Indianapolis         China - Xiamen         Nolesville, IN         Tel: 31-416-690349         Norway - Trondheim           Fax: 317-773-8323         China - Zhuhai         Norway - Trondheim         Norway - Trondheim           Fax: 317-773-5453         Tel: 86-756-3210040         Tel: 47-72884388         Poland - Warsaw           Los Angeles         Poland - Warsaw         Tel: 48-22-3325737         Romania - Bucharest           Fel: 949-462-9523         Fax: 34-9462-9608         Spain - Madrid         Tel: 40-14-07-87-50         Spain - Madrid           Tel: 951-273-7800         Fax: 951-273-7800         Fax: 34-91-708-08-90         Fax: 34-91-708-08-91         Sweden - Gothenberg           Rei: 61-435-6000         Sweden - Stockholm         Sear Jose, CA         Tel: 46-83-1704-60-40         Wet Work, PV         Wet Work, PV <td>Tel: 972-818-7423</td> <td>Tel: 86-755-8864-2200</td> <td>Tel: 886-7-213-7830</td> <td>Tel: 972-9-744-7705</td>	Tel: 972-818-7423	Tel: 86-755-8864-2200	Tel: 886-7-213-7830	Tel: 972-9-744-7705
Novi, MI         China - Wuhan         Thailand - Bangkok         Fax: 39-0331-466781           Tel: 248-848-4000         Tel: 86-27-5980-5300         Tel: 66-2-694-1351         Italy - Padova           Houston, TX         China - Xian         Vietnam - Ho Chi Minh         Tel: 39-049-7625286           Tel: 281-894-5983         Tel: 86-29-8833-7252         Tel: 84-28-5448-2100         Netherlands - Drunen           Indianapolis         China - Xiamen         Tel: 86-592-2388138         Fax: 31-416-690340           Noblesville, IN         Tel: 86-592-2388138         Norway - Trondheim           Fax: 317-773-8323         China - Zhuhai         Norway - Trondheim           Fax: 317-773-5453         Tel: 86-756-3210040         Poland - Warsaw           Los Angeles         Poland - Warsaw         Tel: 47-72884388           Hoission Viejo, CA         Romania - Bucharest         Tel: 40-21-407-87-50           Fax: 949-462-9523         Fax: 34-91-708-08-90         Spain - Madrid           Tel: 919-844-7510         Fax: 34-91-708-08-91         Sweden - Gothenberg           New York, NY         Sweden - Stockholm         Tel: 46-31-704-60-40         Sweden - Stockholm           Tel: 408-735-9110         Tel: 408-735-9110         Tel: 44-118-921-5800         Fax: 44-118-921-5820           Tel: 905-695-1980         Fax: 44-1	Fax: 972-818-2924	China - Suzhou	Taiwan - Taipei	Italy - Milan
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San Jose, CA       Tel: 46-8-5090-4654         Tel: 408-735-9110       UK - Wokingham         Tel: 408-436-4270       Tel: 44-118-921-5800         Canada - Toronto       Fax: 44-118-921-5820         Tel: 905-695-1980       Fax: 44-118-921-5820	New York, NY			Tel: 46-31-704-60-40
Tel: 408-735-9110 Tel: 408-436-4270 Tel: 408-436-4270 Canada - Toronto Tel: 905-695-1980  UK - Wokingham Tel: 44-118-921-5800 Fax: 44-118-921-5820	Tel: 631-435-6000			Sweden - Stockholm
Tel: 408-436-4270  Canada - Toronto Tel: 905-695-1980  Tel: 905-695-1980  Tel: 44-118-921-5820	San Jose, CA			Tel: 46-8-5090-4654
Canada - Toronto         Fax: 44-118-921-5820           Tel: 905-695-1980         Fax: 44-118-921-5820	Tel: 408-735-9110			UK - Wokingham
Tel: 905-695-1980	Tel: 408-436-4270			Tel: 44-118-921-5800
	Canada - Toronto			Fax: 44-118-921-5820
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