# 6.5 kW, Unidirectional and Bidirectional TVS Protection Device

## MPLAD6.5KP10A(e3) – MPLAD6.5KP48CA(e3)

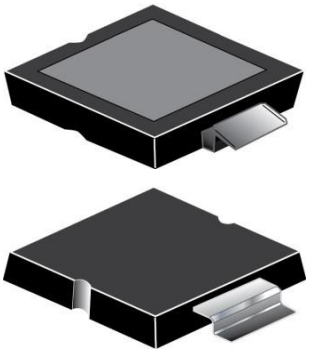
## Product Overview

These 6.5 kW rated transient voltage suppressors (TVS) in a surface mount PLAD package are provided with design features to minimize thermal resistance and cumulative heating. These devices have the ability to clamp dangerous high voltage, short term transients such as those produced by electrostatic discharge, radiated RFI, inductive load dumps, and the secondary effects of lightning strikes before they reach sensitive component regions of a circuit. Typical applications include lightning and automotive load dump protection. They are particularly effective at meeting the multi-stroke lightning standard RTCA DO-160, section 22 for aircraft design. The all-metal bottom of this space-efficient, low-profile package provides a very low thermal impedance path for heat to escape to the mounting substrate, keeping the junction temperature low. The PLAD6.5KP is offered with stand-off voltages ($V_{WM}$) from 10 to 48 volts in either unidirectional or bidirectional versions. High-reliability screening is available in reference to MIL-PRF-19500, and the product is tested in accordance with the requirements of AEC-Q101. For more information on PLAD packaged products and our broad range of TVS solutions, please see our website.

**Features**

- Available in both unidirectional and bidirectional construction (bidirectional with CA suffix)
- High reliability with wafer fabrication and assembly lot traceability
- All parts surge tested
- Low profile surface mount package
- Optional upscreening is available with various screening and conformance inspection options based on MIL-PRF-19500. Refer to Hi-Rel Non-Hermetic Products brochure on our web site for more details on the screening options.
- Suppresses transients up to 6,500W at 10/1000 µs (see Figure 4-1)
- Moisture classification is Level 1 with no dry pack required per IPC/JEDEC J-STD-020
- 3σ lot norm screening performed on standby current ($I_D$)
- RoHS compliant (2002/95/EC) devices available
- Halogen free (IEC 61249-2-21)

**Figure 1.** mini-PLAD



The cathode is the heat sink under the body of this device.

**Applications/Benefits**

- Protection from switching transients and induced RF
- Protection from ESD, and EFT per IEC 61000-4-2 and IEC 61000-4-4
- Secondary lightning protection per IEC 61000-4-5 with 42 ohms source impedance:
  Class 1, 2, 3, 4, 5: MPLAD6.5KP10A to 48CA
- Secondary lightning protection per IEC 61000-4-5 with 12 ohms source impedance:
  Class 1, 2, 3, 4: MPLAD6.5KP10A to 48CA
- Secondary lightning protection per IEC 61000-4-5 with 2 ohms source impedance:
  Class 2, 3: MPLAD6.5KP10A to 48CA
  Class 4: MPLAD6.5KP10A to 22CA
- Pin injection protection per RTCA/DO-160G for Waveform 4 (6.4/69 µs at 25 °C)[1]:
  Level 1, 2, 3, 4: MPLAD6.5KP10A to 48CA
  Level 5: MPLAD6.5KP10A to 43CA
- Pin injection protection per RTCA/DO-160G for Waveform 5A (40/120 µs at 25 °C)[1]:
  Level 1 and 2: MPLAD6.5KP10A to 48CA
  Level 3: MPLAD6.5KP10A to 36CA
  Level 4: MPLAD6.5KP10A to 12CA
- Longer transient pulse width capability if well heat sunk for automotive load dump
- $I_{PP}$ rating of 85 amps to 383 amps
- $V_{WM}$ rating of 10 volts to 48 volts
- $V_{(BR)(Min)}$ range of 11.1 volts to 53.3 volts
- $V_{C(Max)}$ rating of 17 volts to 77.4 volts

**Note:**

1. See MicroNote 132 for further temperature derating selection.

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# 1. Absolute Maximum Ratings

**Table 1-1.** Absolute Maximum Ratings at 25 °C Unless Otherwise Specified

| Parameters/Test Conditions | | Symbol | Value | Unit |
|---|---|---|---|---|
| Junction and storage temperature | | $T_J$ and $T_{STG}$ | –55 to +150 | °C/W |
| Thermal resistance junction-to-ambient[1] | | $R_{\Theta JA}$ | 50 | °C/W |
| Thermal resistance junction-to-case | | $R_{\Theta JC}$ | 1.5 | °C/W |
| Peak pulse power at 10/1000 µs[2] | | $P_{PP}$ | 6,500 | W |
| $t_{clamping}$ (0 volts to $V_{(BR)}$ min) | Unidirectional<br>Bidirectional | — | < 100<br>< 5 | ps<br>ns |
| Forward clamping voltage at 300 amps[3] | | $V_{FS}$ | 2.5 | V |
| Forward surge current[3] | | $I_{FSM}$ | 400 | A |
| Solder temperature at 10 s | | $T_{SP}$ | 260 | °C |
| Rated average power dissipation[5] | TA = 25 °C<br>TC = 100 °C | $P_{M(AV)}$ | 2.5[1]<br>33.3[4] | W<br>W |

**Notes:**

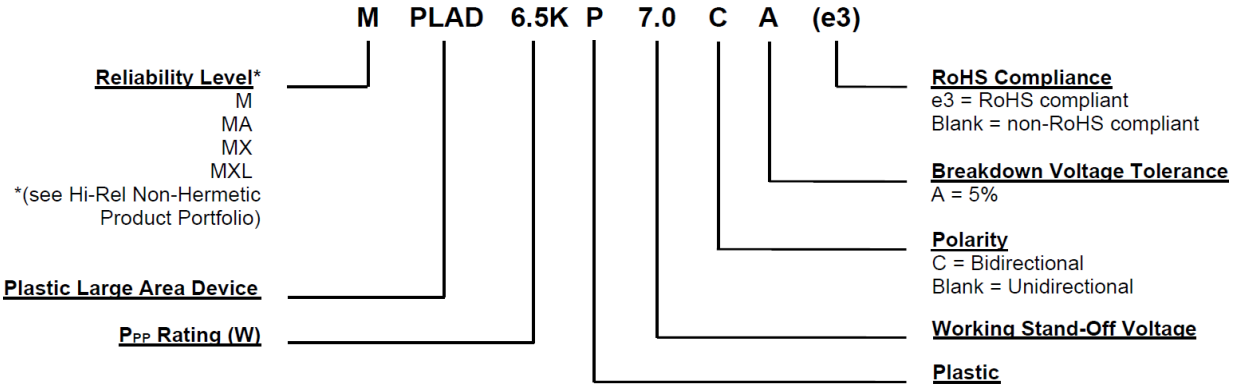
1. When mounted on FR4 PC board with recommended mounting pad (see Pad Layout)
2. Also see Figure 4-1 and Figure 4-2. With impulse repetition rate (duty factor) of 0.05% or less
3. At 8.3 ms half-sine wave (unidirectional devices only)
4. Case temperature controlled on heat sink as specified
5. See MicroNote 134 for derating $P_{PP}$ when also applying steady-state power

## 1.1 Mechanical and Packaging

- Case: Epoxy, meets UL94V-0
- Terminals: Tin/lead or matte-tin (fully RoHS compliant) plating
- Marking: Reliability level, part number, polarity symbol (unidirectional only), and date code
- Delivery option: Tape and reel (13 inch)
- 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. |
| $I_{(BR)}$ | Breakdown current: The current used for measuring breakdown voltage $V_{(BR)}$. |
| $I_D$ | Standby current: The current at the working stand-off voltage $V_{WM}$. |
| $I_{PP}$ | Peak impulse current: The peak current during the impulse. |
| $P_{PP}$ | Peak pulse power: The peak power that can be applied for a specific pulse width and waveform. The product of $V_C$ and $I_{PP}$. |
| $V_{(BR)}$ | 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

| Device[1] | Working Stand-Off Voltage $V_{WM}$ | Breakdown Voltage $V_{(BR)}$ $V_{(BR)}$ at $I_{(BR)}$ | | Maximum Clamping Voltage $V_C$ at $I_{PP}$ | Maximum Standby Current $I_D$ at $V_{WM}$ | Maximum Peak Pulse Current (Figure 4-2) $I_{PP}$ | Maximum Temperature Coefficient of $V_{(BR)}$ $\alpha_{V(BR)}$ |
|---|---|---|---|---|---|---|---|
| | Volts | Volts | mA | Volts | µA | Amps | mV/°C |
| MPLAD6.5KP10(C)A(e3) | 10 | 11.1-12.3 | 5 | 17.0 | 15 | 383 | 9 |
| MPLAD6.5KP11(C)A(e3) | 11 | 12.2-13.5 | 5 | 18.2 | 10 | 358 | 10 |
| MPLAD6.5KP12(C)A(e3) | 12 | 13.3-14.7 | 5 | 19.9 | 10 | 327 | 11 |
| MPLAD6.5KP13(C)A(e3) | 13 | 14.4-15.9 | 5 | 21.5 | 10 | 302 | 12 |
| MPLAD6.5KP14(C)A(e3) | 14 | 15.6-17.2 | 5 | 23.2 | 10 | 280 | 13 |
| MPLAD6.5KP15(C)A(e3) | 15 | 16.7-18.5 | 5 | 24.4 | 10 | 267 | 15 |
| MPLAD6.5KP16(C)A(e3) | 16 | 17.8-19.7 | 5 | 26.0 | 10 | 250 | 16 |
| MPLAD6.5KP17(C)A(e3) | 17 | 18.9-20.9 | 5 | 27.6 | 10 | 236 | 18 |
| MPLAD6.5KP18(C)A(e3) | 18 | 20.0-22.1 | 5 | 29.2 | 10 | 223 | 19 |
| MPLAD6.5KP20(C)A(e3) | 20 | 22.2-24.5 | 5 | 32.4 | 10 | 202 | 22 |
| MPLAD6.5KP22(C)A(e3) | 22 | 24.4-26.9 | 5 | 35.5 | 10 | 183 | 24 |
| MPLAD6.5KP24(C)A(e3) | 24 | 26.7-29.5 | 5 | 38.9 | 10 | 167 | 27 |
| MPLAD6.5KP26(C)A(e3) | 26 | 28.9-31.9 | 5 | 42.1 | 10 | 154 | 29 |
| MPLAD6.5KP28(C)A(e3) | 28 | 31.1-34.4 | 5 | 45.5 | 10 | 143 | 30 |
| MPLAD6.5KP30(C)A(e3) | 30 | 33.3-36.8 | 5 | 48.4 | 10 | 135 | 35 |
| MPLAD6.5KP33(C)A(e3) | 33 | 36.7-40.6 | 5 | 53.3 | 10 | 123 | 38 |
| MPLAD6.5KP36(C)A(e3) | 36 | 40.0-44.2 | 5 | 58.1 | 10 | 111 | 40 |
| MPLAD6.5KP40(C)A(e3) | 40 | 44.4-49.1 | 5 | 64.5 | 10 | 101 | 45 |
| MPLAD6.5KP43(C)A(e3) | 43 | 47.8-52.8 | 5 | 69.4 | 10 | 93 | 49 |
| MPLAD6.5KP45(C)A(e3) | 45 | 50.0–55.3 | 5 | 72.7 | 10 | 89 | 51 |
| MPLAD6.5KP48(C)A(e3) | 48 | 53.3–58.9 | 5 | 77.4 | 10 | 85 | 54 |

**Note:**

1. See Part Nomenclature for additional screening prefixes and C suffix bidirectional option.

# 4. Graphs

**Figure 4-1.** Peak Pulse Power vs. Pulse Time (to 50% of Exponentially Decaying Pulse)

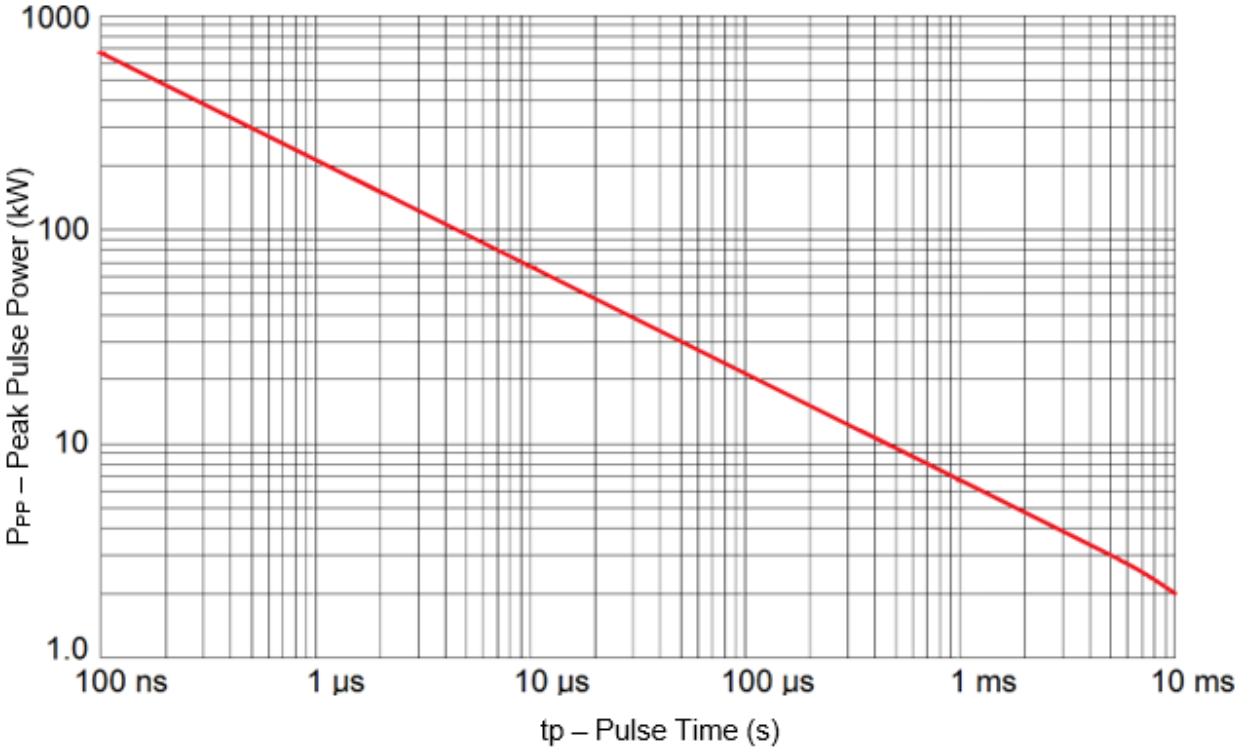



**Figure 4-2.** Pulse Waveform

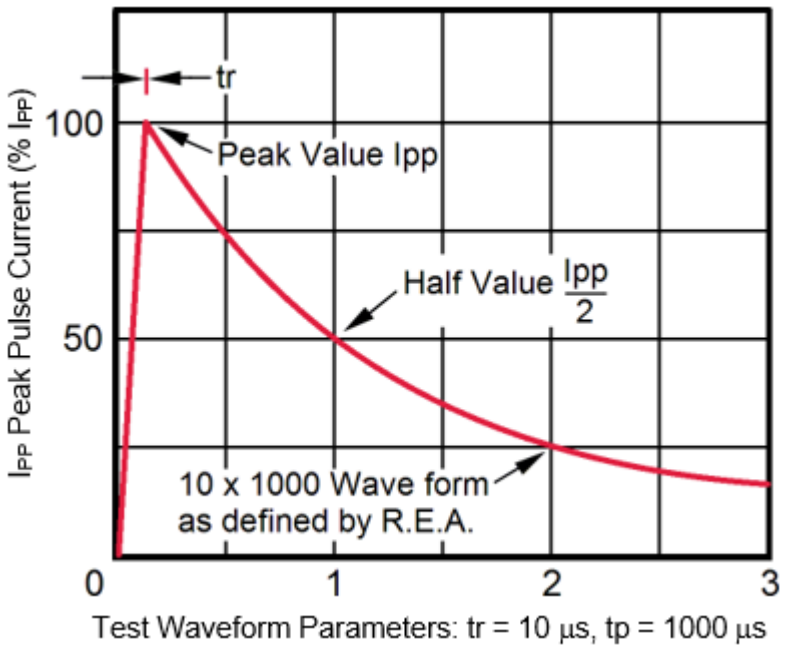
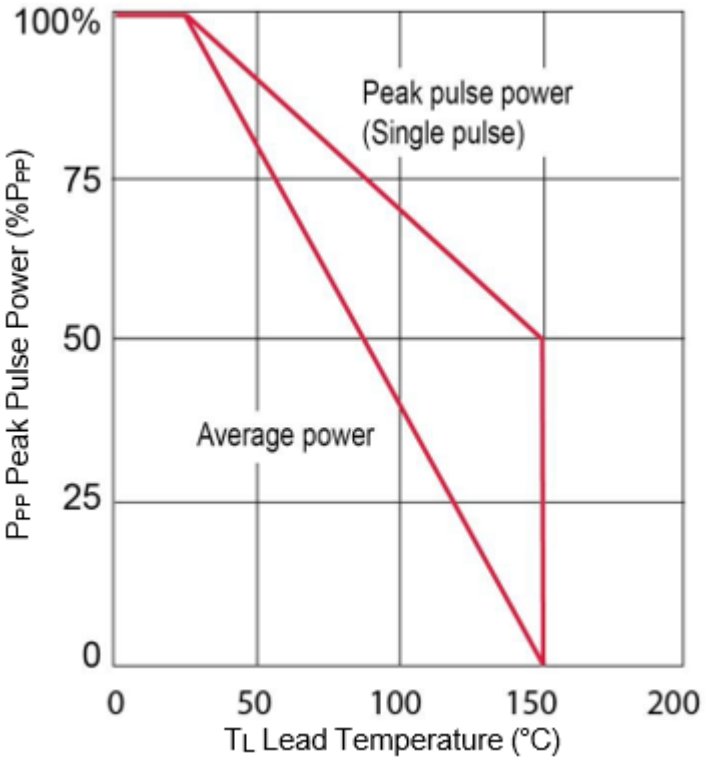
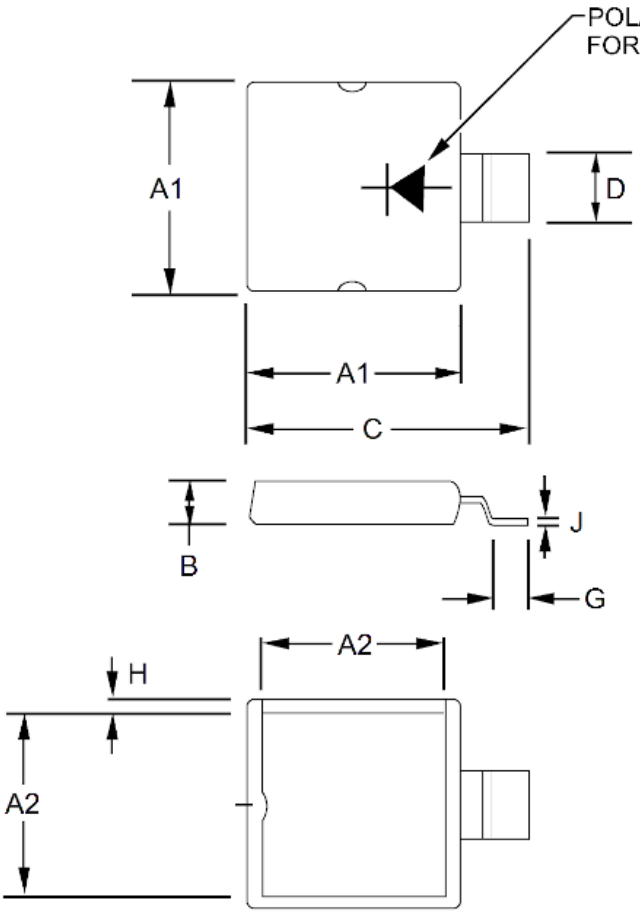


**Figure 4-3.** Derating Curve



# 5. Package Dimensions

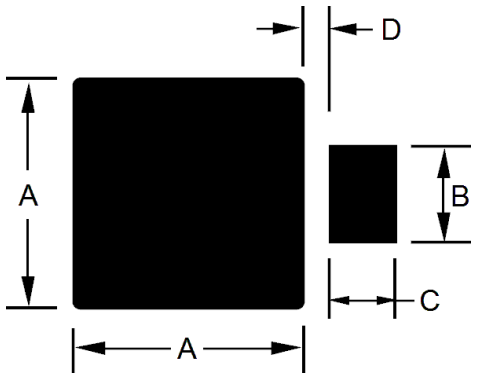
**Figure 5-1.** Package Dimensions




| Ref. | Dimensions | | | |
|---|---|---|---|---|
| | Inch | | Millimeters | |
| | Min. | Max. | Min. | Max. |
| A1 | 0.337 | 0.353 | 8.56 | 8.97 |
| A2 | 0.277 | 0.293 | 7.04 | 7.44 |
| B | 0.117 | 0.133 | 2.97 | 3.38 |
| C | 0.436 | 0.452 | 11.07 | 11.48 |
| D | 0.092 | 0.108 | 2.34 | 2.74 |
| G | 0.062 | 0.078 | 1.57 | 1.98 |
| H | 0.022 | 0.038 | 0.56 | 0.96 |
| J | 0.008 | 0.012 | 0.20 | 0.30 |

## 5.1 Pad Layout

**Figure 5-2.** Pad Layout




| Ref. | Dimensions | |
|---|---|---|
| | Inch | Millimeters |
| | Typical | Typical |
| A | 0.353 | 8.97 |
| B | 0.117 | 2.97 |
| C | 0.078 | 1.98 |
| D | 0.033 | 0.84 |

# 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 | 10/2023 | Initial revision. |

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