1,500 Watt Low Capacitance Transient Voltage Suppressor

MLCE6.5 – MXLLCE170A(e3)

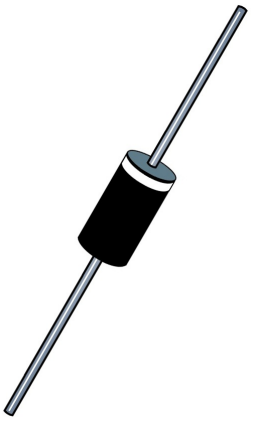
Product Overview

This high-reliability plastic encapsulated Transient Voltage Suppressor (TVS) diode series for thru-hole mounting includes a rectifier diode element in series and in the opposite direction. This allows it to present a very low <100 pF capacitance to the system it is protecting (see Figure 6-1). They feature working standoff voltages V_{WM} from 6.5 to 170 volts and are available in RoHS compliant versions. The low capacitance of these devices makes them particularly useful for protecting lines carrying high frequency signals. They are also useful in protecting from the secondary effects of lightning in airborne avionics per IEC61000-4-5, RTCA/DO-160G, and ARINC 429. If bidirectional transient capability is required, two of these low capacitance TVS devices may be used in parallel and opposite directions (anti-parallel) for complete AC protection. They also protect from ESD and EFT per IEC61000-4-2 and IEC61000-4-4.

Features

- High reliability controlled devices with wafer fabrication and assembly lot traceability for all M prefix devices
- All devices are 100% surge tested.
- Unidirectional low capacitance device (< 100 pF). For bidirectional applications, see Figure 6-3.
- Suppresses transients up to 1,500 watts at 10/1000 µs (see Figure 4-1)
- 3σ lot norm screening performed on standby current I_D
- Enhanced reliability screening in reference to MIL-PRF-19500 are available. Refer to High Reliability Non-Hermetic Product Portfolio for more details on the screening options.
  (See Part Nomenclature for all options.)
- Moisture classification is level 1 with no dry pack required per IPC/JEDEC J-STD-020F for all M prefix devices
- RoHS compliant versions available

Figure 1. Case 1 Package



Also available in:

SMCG & SMCJ package

(tabbed surface mounts)

SMCG(J)LCE6.5 – SMCG(J)LCE170

Applications/Benefits

- Protection from switching transients and induced RFI
- Available in working standoff voltage (V_{WM}) range from 6.5 to 170V
- Economical axial-lead plastic encapsulated TVS series for thru-hole mounting
  - Low capacitance for data line protection to 1 MHz
  - Protection for fast data rate lines in aircraft up to:
    RTCA/DO-160G – level 5 Waveform 4 and level 2 Waveform 5A (also see MicroNote 130)
    ARINC 429, part 1, paragraph 2.4.1.1 with bit rates of 100 kb/s
  - 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: MLCE6.5A to MXLLCE170A
    Class 2: MLCE6.5A to MXLLCE150A
    Class 3: MLCE6.5A to MXLLCE70A
    Class 4: MLCE6.5A to MXLLCE36A
  - Secondary lightning protection per IEC 61000-4-5 with 12 Ohms source impedance:
    Class 1: MLCE6.5A to MXLLCE90A
    Class 2: MLCE6.5A to MXLLCE45A
    Class 3: MLCE6.5A to MXLLCE22A
    Class 4: MLCE6.5A to MXLLCE11A
  - Secondary lightning protection per IEC 61000-4-5 with 2 Ohms source impedance:
    Class 2: MLCE6.5A to MXLLCE20A
    Class 3: MLCE6.5A to MXLLCE10A

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]	$R_{\Theta JL}$	22	°C/W
Thermal resistance, junction to ambient[2]	$R_{\Theta JA}$	82	°C/W
Peak pulse power dissipation (at 10/1000 µs, see Figure 4-1)[3]	P_{PP}	1,500	W
Average power dissipation T_L = +40 °C T_A = +25 °C	$P_{M(AV)}$	5.0 1.52	W
Solder temperature at 10 seconds	T_{SP}	260	°C

Notes:

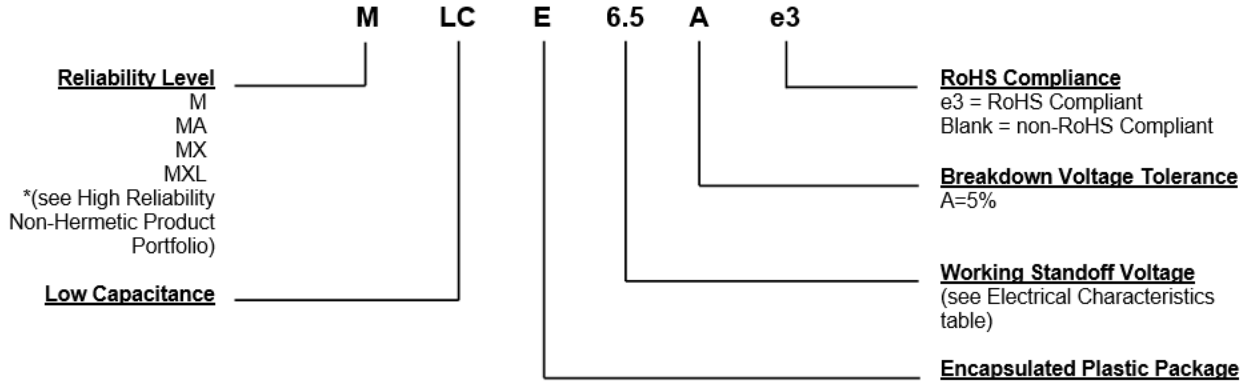
1. At 3/8 inch (10 mm) from body
2. Mounted on FR4 PC board with 4 mm^2 copper pads (1 oz), track width 1 mm, length 25 mm
3. With an impulse repetition rate of 0.01% or less. TVS devices are not typically used for DC power dissipation and are instead operated at ≤ V_{WM} except for transients that briefly drive the device into avalanche breakdown (V_{BR} to V_C region) of the TVS element. Also see Application Schematics for further protection details in rated peak power for unidirectional and bidirectional configurations respectively.

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 to MIL-STD-750, method 2026.
- Marking: Reliability level, part number, date code
- Polarity: Cathode indicated by band
- Tape and Reel option: Standard per EIA-296 (add “TR” suffix to part number). Consult factory for quantities.
- Weight: Approximately 1.5 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_{IB}	Inverse blocking leakage current: The current through a unidirectional-blocking low capacitance device at working inverse blacking voltage (V_{WIB}).
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_{PIB}	Peak inverse blocking voltage: Minimum breakdown voltage of the series low capacitance rectifier.
V_{WIB}	Working inverse blocking voltage: The maximum-rated value of DC or peak blocking voltage that may be applied to a unidirectional-blocking low-capacitance diode in the inverse direction. Note: above this rated voltage, the diode is not to be surge or impulse tested for any reason.
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[1] V_{WM} Volts	Breakdown Voltage $V_{(BR)}$ at $I_{(BR)}$ Volts			Maximum Standby Current I_D at V_{WM} µA	Maximum Clamping Voltage V_C at I_{PP} Volts	Maximum Peak Pulse Current[2] at 10/1000 µs I_{PP} Amps	Working Inverse Blocking Voltage[4] V_{WIB} Volts	Peak Inverse Blocking Voltage V_{PIB} Volts
		Min.	Max.	mA					
MLCE6.5A	6.5	7.22	7.98	10	1000	11.2	100	75	100
MLCE7.0A	7.0	7.78	8.60	10	500	12.0	100	75	100
MLCE7.5A	7.5	8.33	10.2	10	250	12.9	100	75	100
MLCE8.0A	8.0	8.89	9.83	1	100	13.6	100	75	100
MLCE8.5A	8.5	9.44	10.4	1	50	14.4	100	75	100
MLCE9.0A	9.0	10.0	11.1	1	10	15.4	97	75	100
MLCE10A	10	11.1	12.3	1	5	17.0	88	75	100
MLCE11A	11	12.2	13.5	1	5	18.2	82	75	100
MLCE12A	12	13.3	14.7	1	5	19.9	75	75	100
MLCE13A	13	14.4	15.9	1	5	21.5	70	75	100
MLCE14A	14	15.6	17.2	1	5	23.2	65	75	100
MLCE15A	15	16.7	18.5	1	5	24.4	61	75	100
MLCE16A	16	17.8	19.7	1	5	26.0	57	75	100
MLCE17A	17	18.9	20.9	1	5	27.6	54	75	100
MLCE18A	18	20.0	22.1	1	5	29.2	51	75	100
MLCE20A	20	22.2	24.5	1	5	32.4	46	75	100
MLCE22A	22	24.4	26.9	1	5	35.5	42	75	100
MLCE24A	24	26.7	29.5	1	5	38.9	39	75	100
MLCE26A	26	28.9	31.9	1	5	42.1	36	75	100
MLCE28A	28	31.1	34.4	1	5	45.5	33	75	100
MLCE30A	30	33.3	36.8	1	5	48.4	31	75	100
MLCE33A	33	36.7	40.6	1	5	53.3	28.1	75	100
MLCE36A	36	40.0	44.2	1	5	58.1	25.8	75	100
MLCE40A	40	44.4	49.1	1	5	64.5	23.3	75	100
MLCE43A	43	47.8	52.8	1	5	69.4	21.6	150	200
MLCE45A	45	50.0	55.3	1	5	72.7	20.6	150	200
MLCE48A	48	53.3	58.9	1	5	77.4	19.4	150	200
MLCE51A	51	56.7	62.7	1	5	82.4	18.2	150	200
MLCE54A	54	60.0	66.3	1	5	87.1	17.2	150	200
MLCE58A	58	64.4	71.2	1	5	93.6	16.0	150	200
MLCE60A	60	66.7	73.7	1	5	96.8	15.5	150	200
MLCE64A	64	71.1	78.6	1	5	103	14.6	150	200
MLCE70A	70	77.8	86.0	1	5	113	13.3	150	200
MLCE75A	75	83.3	92.1	1	5	121	12.4	150	200
MLCE80A	80	88.7	98.0	1	5	129	11.6	150	200
MLCE90A	90	100	111	1	5	146	10.3	300	200

.....continued

Part Number	Working Standoff Voltage[1] V_{WM} Volts	Breakdown Voltage $V_{(BR)}$ at $I_{(BR)}$ Volts			Maximum Standby Current I_D at V_{WM} µA	Maximum Clamping Voltage V_C at I_{PP} Volts	Maximum Peak Pulse Current[2] at 10/1000 µs I_{PP} Amps	Working Inverse Blocking Voltage[4] V_{WIB} Volts	Peak Inverse Blocking Voltage V_{PIB} Volts
		Min.	Max.	mA					
MLCE100A	100	111	123	1	5	162	9.3	300	200
MLCE110A	110	122	135	1	5	178	8.4	300	400
MLCE120A	120	133	147	1	5	193	7.8	300	400
MLCE130A	130	144	159	1	5	209	7.2	300	400
MLCE150A	150	167	185	1	5	243	6.2	300	400
MLCE160A	160	178	197	1	5	259	5.8	300	400
MLCE170A	170	189	209	1	5	275	5.4	300	400

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. Test in TVS avalanche direction. Do not pulse in “forward” direction. See section for Application Schematics.
3. Maximum capacitance of MLCE series at 0 Volts:
   a. is 100 pF for V_{WM} 6.5 to 58V
   b. is 90 pF for V_{WM} 60 to 170V
4. V_{WIB} at Inverse Blocking Leakage Current (I_{IB}) 10 µA.

4. Graphs

Figure 4-1. Peak Pulse Power Vs. Pulse Time (t_W) in µs

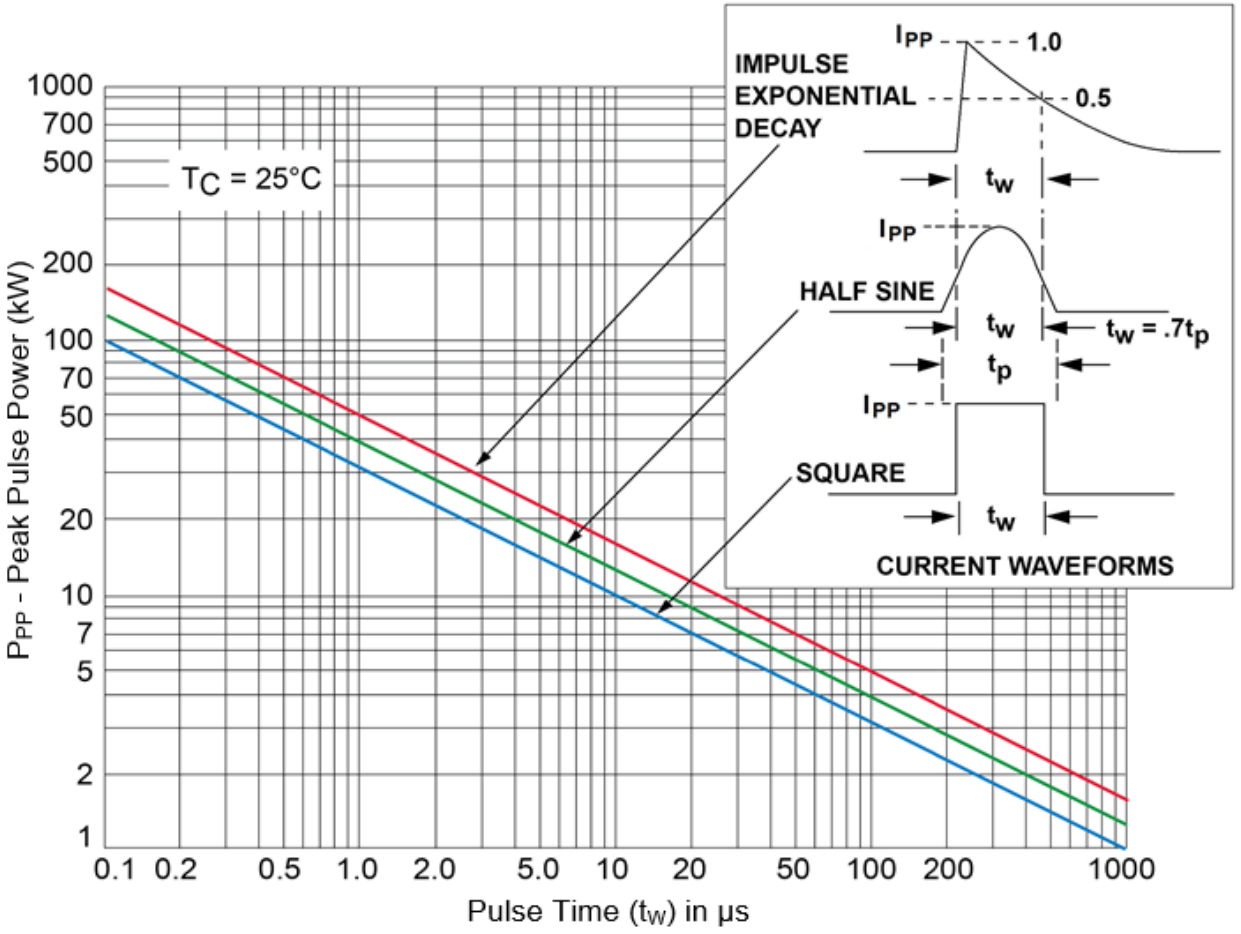
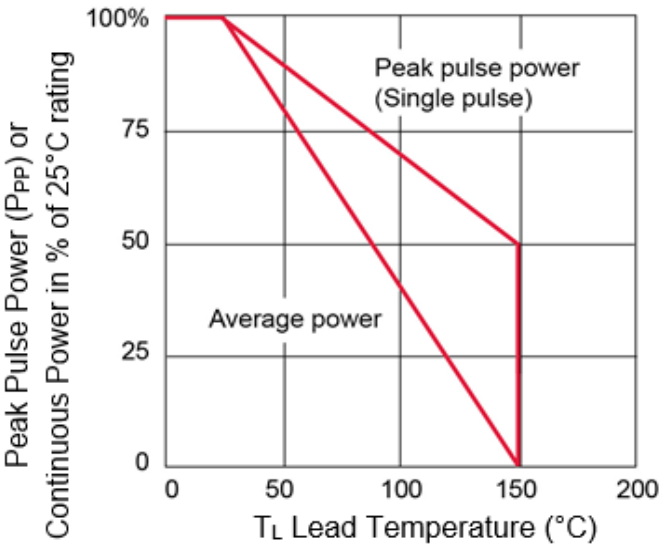
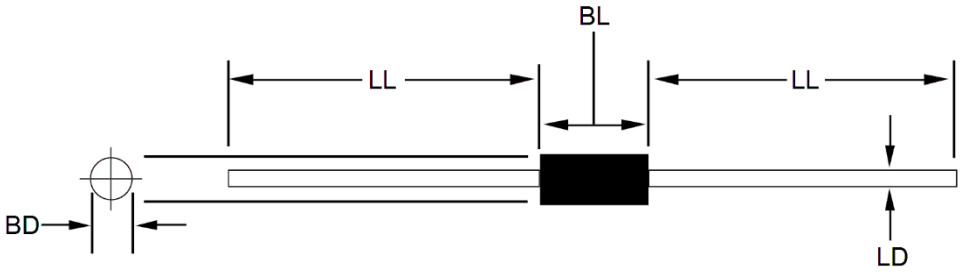


Figure 4-2. Power Derating



5. Package Dimensions

Figure 5-1. Package Dimensions[1-4]



Notes:

1. Dimensions are in inches.
2. Millimeter equivalents are given for information only.
3. The major diameter is essentially constant along its length.
4. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.

Symbol	Dimensions			
	Inches		Millimeters	
	Min.	Max.	Min.	Max.
BD	0.190	0.205	4.826	5.207
BL	0.360	0.375	9.146	9.527
LD	0.038	0.042	0.958	1.074
LL	1.10	1.625	27.9	41.28

6. Application Schematics

The TVS low capacitance device configuration is shown in Figure 6-1. As a further option for unidirectional applications, an additional low capacitance rectifier diode may be used in parallel in the same polarity direction as the TVS as shown in Figure 6-2. In applications where random high voltage transients occur, this will prevent reverse transients from damaging the internal low capacitance rectifier diode and also provide a low voltage conducting direction. The added rectifier diode should be of similar low capacitance and also have a higher reverse voltage rating than the TVS clamping voltage V_C. The Microchip recommended rectifier part number is the “ELCR80” for the application in Figure 6-2. If using two (2) low capacitance TVS devices in anti-parallel for bidirectional applications, this added protective feature for both directions (including the reverse of each rectifier diode) is also provided. The unidirectional and bidirectional configurations in Figure 6-2 and Figure 6-3 will both result in twice the capacitance of Figure 6-1.

Figure 6-1. TVS With Internal Low Capacitance Diode

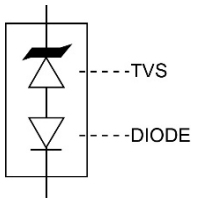


Figure 6-2. Optional Unidirectional Configuration (TVS and Separate Rectifier Diode in Parallel)

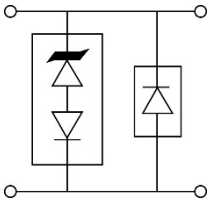
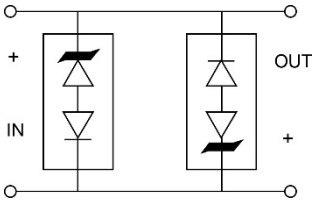


Figure 6-3. Optional Bidirectional Configuration (Two TVS Devices in Anti-Parallel)



7. 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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