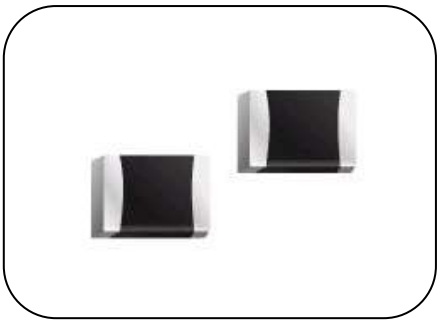
Metal Oxide Varistor for Automotive: TVM-C Series

SMD Type for Transient Overvoltage Protection

■ Features

1. Qualification based on AEC-Q200 Rev-D
2. High surge suppression capability for automotive application (load dump)
3. No temperature derating up to 125 °C
4. Bidirectional and symmetrical V/I characteristics
5. Stability in high-temperature and high-humidity environment
6. RoHS & Halogen Free (HF) compliant



■ Recommended Applications

Transient overvoltage protection in automotive applications: engine management, airbag, control units, electro hydraulic brake, ABS/ESP, sunroof

■ Part Number Code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Product Type	
TVM	THINKING SMD Varistor TVM Series

Size(EIA)	
0	0402
1	0603
2	0805
3	1206
4	1210
5	1812
6	2220

Max. Continuous Voltage(V_{DC})	
5R5	5.5V
090	$9x10^0$=9V
330	$33x10^0$=33V

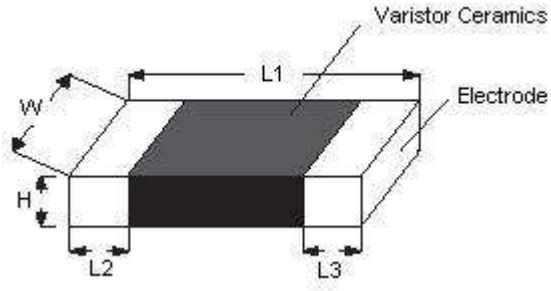
Series	
C	Automotive Series

Typical Capacitance	
M330	$33x10^0$pF=33pF (@1MHz)
K102	$10x10^2$pF=1000pF (@1KHz)

Packaging	
R	Reel
B	Bulk

Optional Suffix
001 ~ZZZ

■ Structures and Dimensions



(Unit: mm)

Part No.	Size (EIA)	L1	W	H max.	L2 and L3
TVM0	0402	1.00±0.15	0.50±0.10	0.60	0.20±0.10
TVM1	0603	1.60 ±0.15	0.80±0.15	0.95	0.35±0.15
TVM2	0805	2.00 ±0.20	1.25±0.20	1.20	0.40±0.20
TVM3	1206	3.20 ±0.30	1.60±0.20	1.50	0.50±0.20
TVM4	1210	3.20 ±0.30	2.50±0.25	1.50	0.50±0.20
TVM5	1812	4.50 ±0.40	3.20±0.30	2.00	0.60±0.30
TVM6	2220	5.70±0.40	5.00±0.30	2.50	0.60±0.30

■ Electrical Characteristics

● 0402 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance		Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	1MHz	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)	(pF)	
TVM0C140K800R	16~21	11	14	35	1	10	0.05	80±30%	--	-55~+125
TVM0C180M120R	22~28	14	18	55	1	2	0.03	--	12±30%	
TVM0C180M400R	22~28	14	18	50	1	20	0.05	--	40±30%	
TVM0C180M500R	22~28	14	18	50	1	20	0.05	--	50±30%	
TVM0C180M600R	22~28	14	18	50	1	20	0.05	--	60±30%	
TVM0C180M650R	22~28	14	18	50	1	20	0.05	--	65±30%	

● 0603 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance		Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	1MHz	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)	(pF)	
TVM1C090M491R	11~16	7	9	29	1	30	0.1	--	490±30%	
TVM1C160K561R	21.6~26.4	12	16	45	1	30	0.1	560±30%	--	
TVM1C180K300R	23~30	14	18	52	1	4	0.03	30±30%	--	-55~+125
TVM1C180M300R	23~30	14	18	52	1	4	0.03	--	30±30%	
TVM1C180M900R	23~30	14	18	48	1	30	0.1	--	90±30%	
TVM1C180K101R	23~30	14	18	48	1	30	0.1	100±30%	--	
TVM1C180K431R	23~30	14	18	45	1	50	0.1	430±30%	--	
TVM1C220K530R	25~40	17	22	50	1	30	0.1	53±30%	--	
TVM1C220K101R	25~33	17	22	50	1	30	0.1	100±30%	--	
TVM1C260M111R	31~38	20	26	60	1	30	0.1	--	110±30%	
TVM1C310K900R	35.1~42.9	25	31	67	1	30	0.3	90±30%	--	
TVM1C320M100R	51.9~70.1	25	32	120	1	5	0.05	--	10±30%	

■ Electrical Characteristics

● 0805 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance	V_{jump} (5min)	W_{LD} (10x)	Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	(V)	(J)	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)			
TVM2C160K651R	21.6~26.4	12	16	40	1	120	0.3	650±20%	24.5	1	-55~+125
TVM2C180K651R	23~28	14	18	44	1	120	0.3	650±20%	24.5	1	
TVM2C180K751R	23~28	14	18	44	1	120	0.3	750±20%	24.5	1	
TVM2C260K501R	29.7~36.3	20	26	56	1	80	0.3	500±20%	27	1	
TVM2C310K251R	35.1~42.9	25	31	67	1	80	0.3	250±20%	29	0.5	

● 1206 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance	V_{jump} (5min)	W_{LD} (10x)	Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	(V)	(J)	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)			
TVM3C160K102R	21.6~26.4	12	16	40	1	200	0.6	1000±20%	24.5	1.5	-55~+125
TVM3C160K242R	21.6~26.4	12	16	38	1	400	0.6	2400±20%	24.5	2	
TVM3C180K102R	22.95~28.05	14	18	42	1	150	0.6	1000±20%	24.5	1.5	
TVM3C260K801R	29.7~36.3	20	26	54	1	200	0.7	800±20%	27.5	1.2	
TVM3C260K132R	29.7~36.3	20	26	54	1	250	0.7	1300±20%	27.5	1.5	
TVM3C340K551R	42.3~51.7	26	34	77	1	200	0.4	550±20%	50	1.5	
TVM3C450K301R	50.4~61.6	35	45	90	1	100	0.4	300±20%	59	1.2	
TVM3C480K271R	55.8~68.2	37	48	100	1	100	0.4	270±20%	59	1.2	
TVM3C560K251R	61.2~74.8	40	56	110	1	100	0.5	250±20%	65	1.5	

■ Electrical Characteristics

● 1210 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance	V_{jump} (5min)	W_{LD} (10x)	Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	(V)	(J)	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)			
TVM4C160K242R	21.6~26.4	12	16	40	2.5	400	1.6	2400±20%	24.5	3	-55~+125
TVM4C180K312R	22.95~28.05	14	18	42	2.5	500	1.6	3100±20%	27.5	3	
TVM4C260K152R	29.7~36.3	20	26	54	2.5	400	1.9	1500±20%	27	3	
TVM4C310K122R	35.1~42.9	25	31	65	2.5	300	1.7	1200±20%	29	3	
TVM4C340K112R	42.3~51.7	26	34	75	2.5	300	2.3	1100±20%	50	3	
TVM4C450K601R	50.4~61.6	35	45	90	2.5	250	2	600±20%	60	1.5	

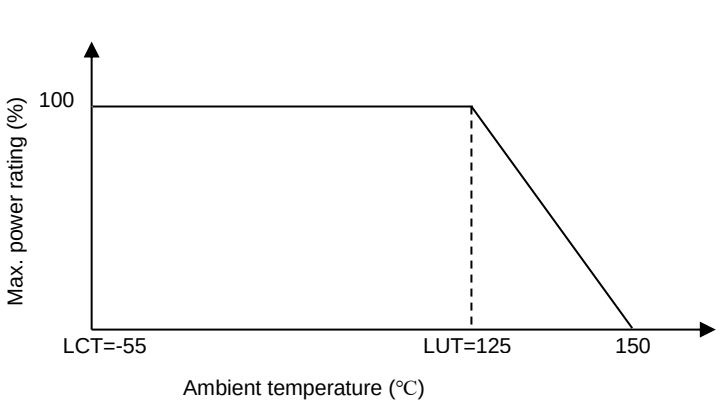
● 1812 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance	V_{jump} (5min)	W_{LD} (10x)	Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	(V)	(J)	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)			
TVM5C160K452R	21.6~26.4	12	16	40	5	800	2.4	4500±20%	24.5	6	-55~+125
TVM5C260K322R	29.7~36.3	20	26	54	5	800	3	3200±20%	30	6	
TVM5C300K172R	35~43	23	30	77	5	600	3.8	1700±20%	45	6	

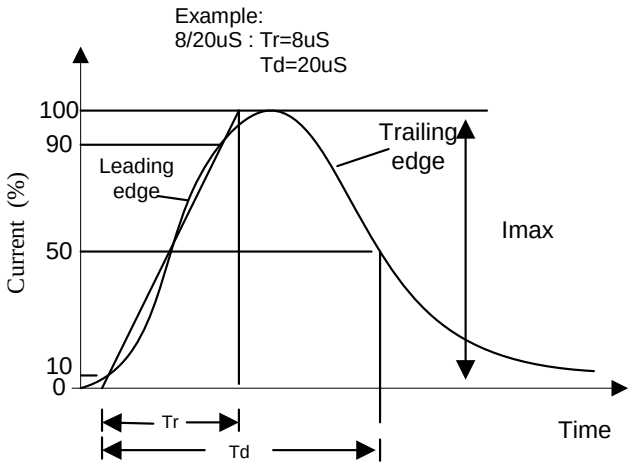
● 2220 Series

Part No.	Varistor Voltage	Max. Continuous Voltage		Max. Clamping Voltage (8/20μs)		Max. Surge Current (8/20μs)	Max. Energy (10/1000μs)	Typical Capacitance	V_{jump} (5min)	W_{LD} (10x)	Operating Temp. Range
	V_{1mA}	V_{AC}	V_{DC}	V_P	I_P	I_{max}	W_{max}	1KHz	(V)	(J)	(°C)
	(V)	(V)	(V)	(V)	(A)	(A)	(J)	(pF)			
TVM6C160K103R	21.6~26.4	12	16	42	10	1200	5.8	10000±20%	24.5	12	-55~+125
TVM6C160K203R	21.6~26.4	12	16	42	10	1200	10	20000±20%	24.5	25	
TVM6C340K652R	42.3~51.7	26	34	77	10	1200	12	6500±20%	50	12	
TVM6C380K302R	42.3~51.7	30	38	77	10	1000	12	3000±20%	50	12	

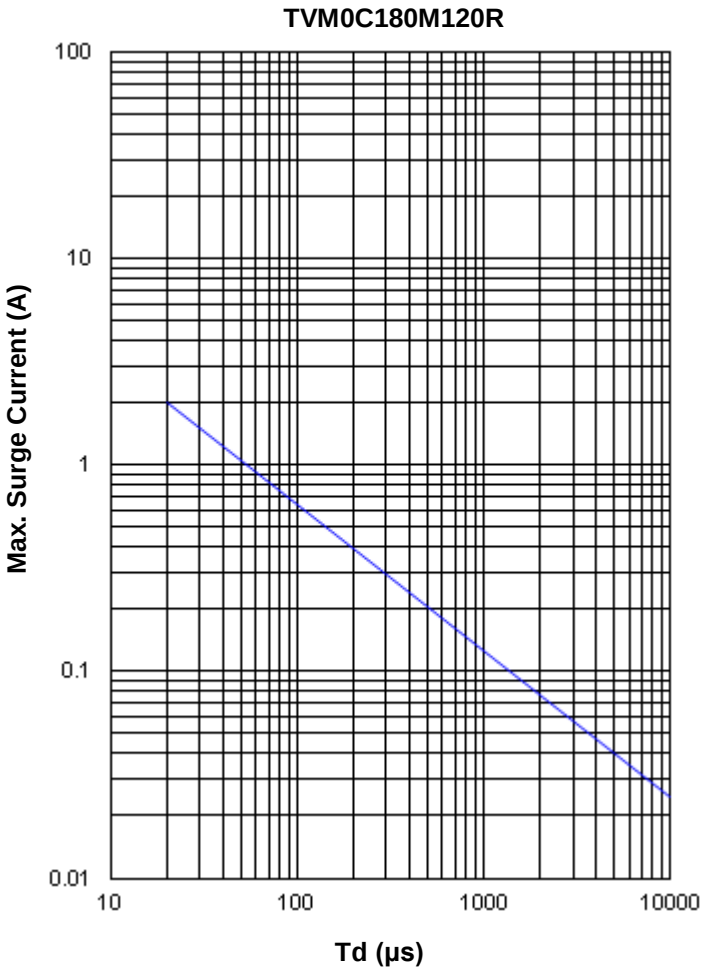
■ Power Derating Curve

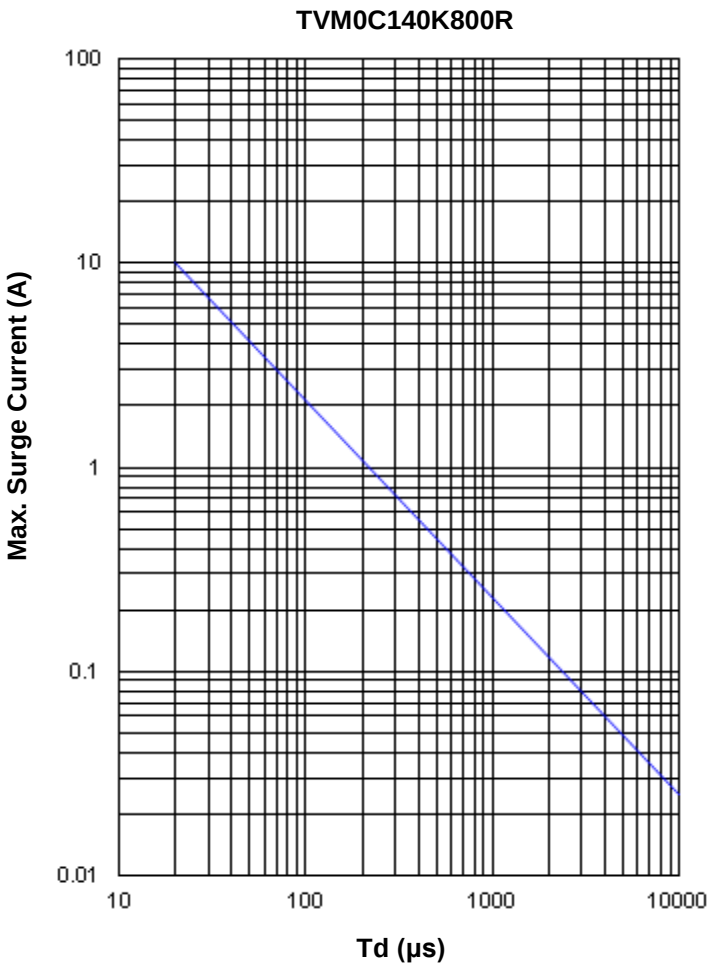


■ Surge Current Standard Waveform



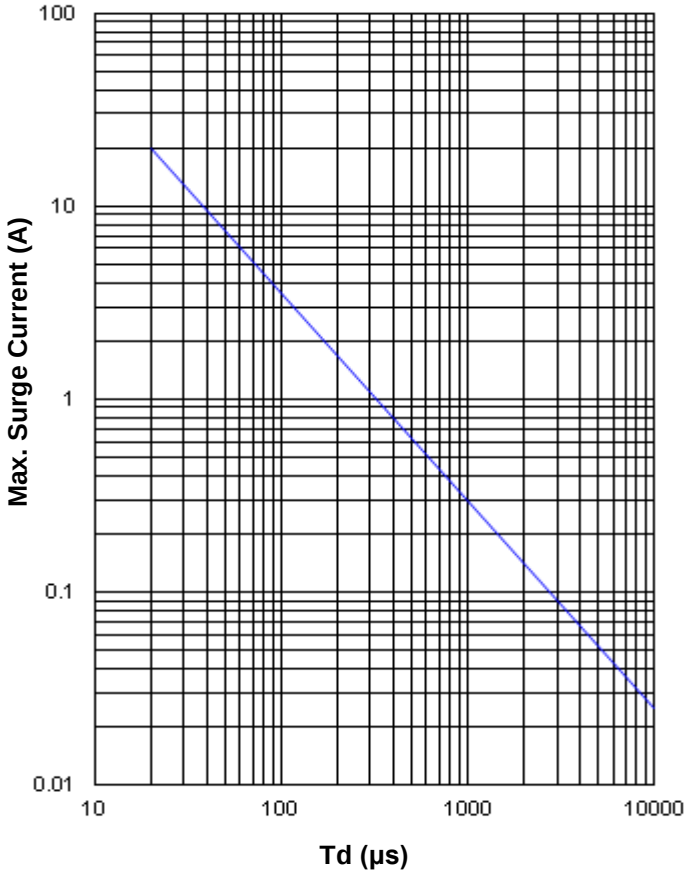
■ Max. Surge Current Derating Curves



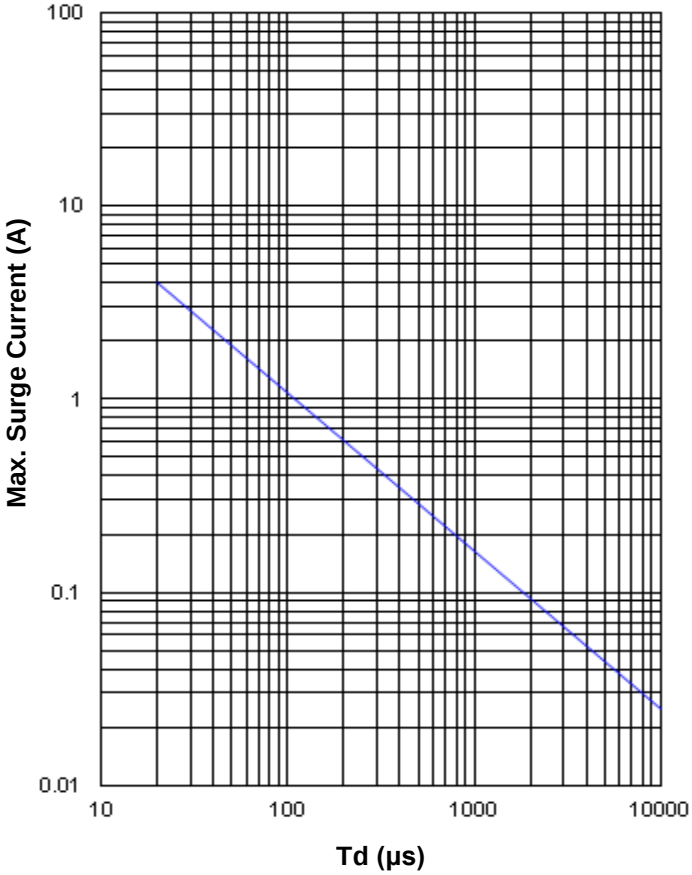


■ Max. Surge Current Derating Curves

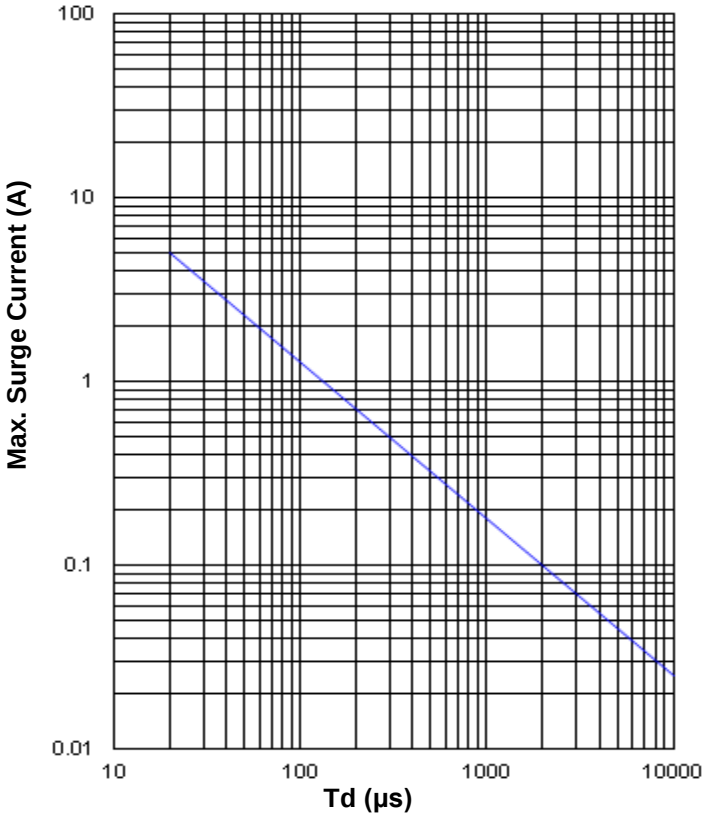
TVM0C180M400R~TVM0C180M650R



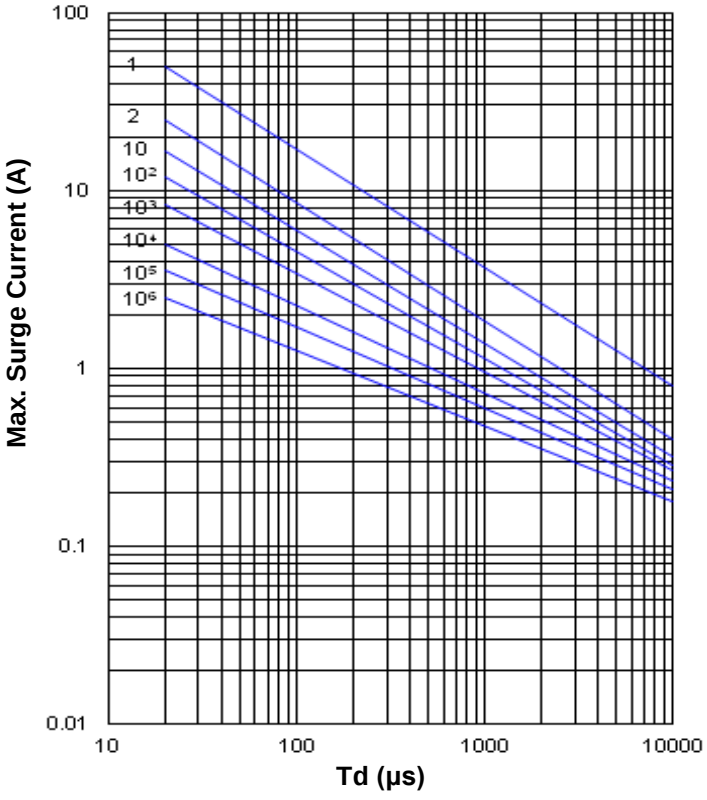
TVM1C180K300R/TVM1C180M300R



TVM1C320M100R

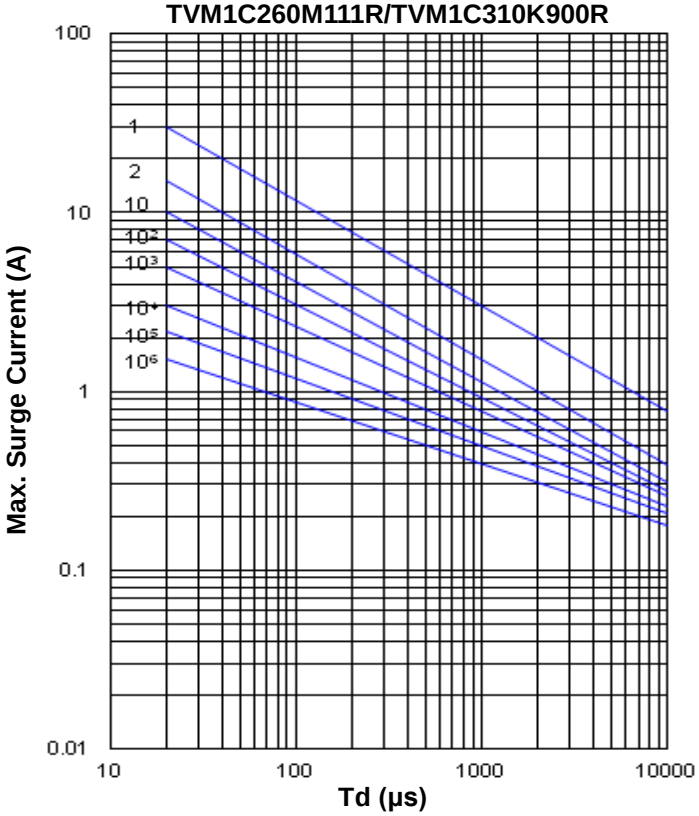


TVM1C180K431R

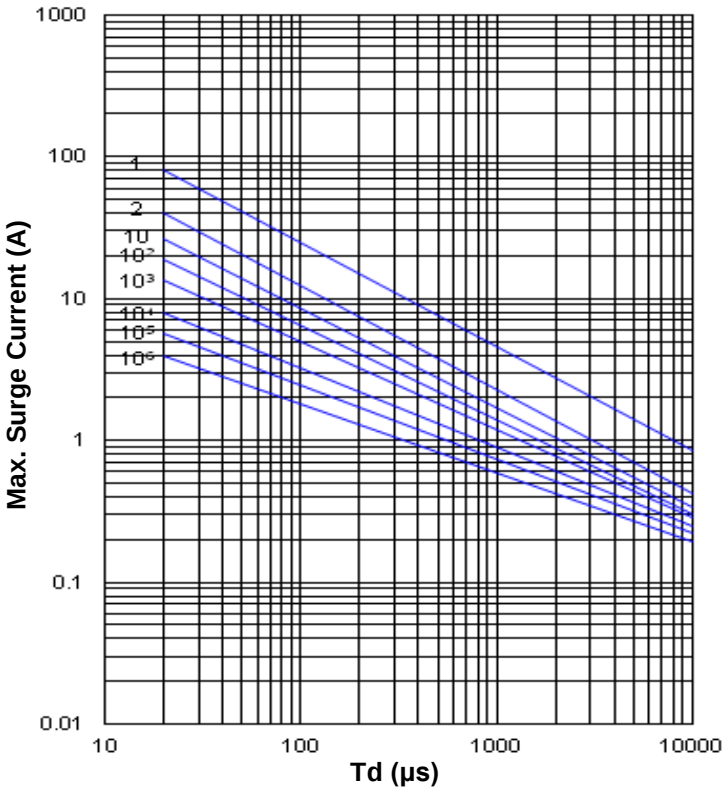


■ Max. Surge Current Derating Curves

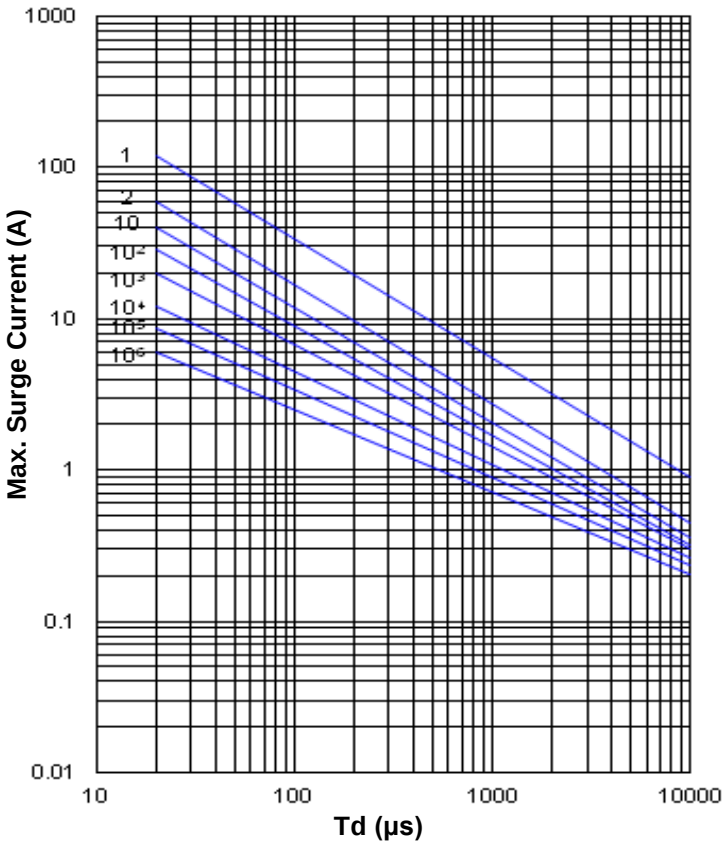
TVM1C090M491R/TVM1C160K561R/ TVM1C180M900R/TVM1C180K101R/ TVM1C220K530R/TVM1C220K101R/ TVM1C260M111R/TVM1C310K900R



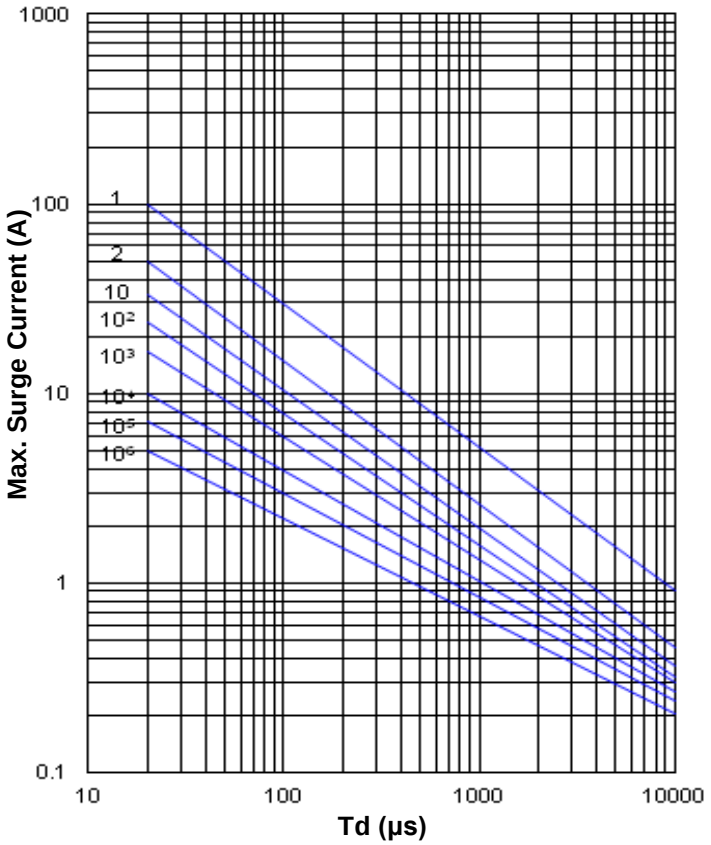
TVM2C260K501R TVM2C310K251R



TVM2C160K651R TVM2C180K651R / TVM2C180K751R

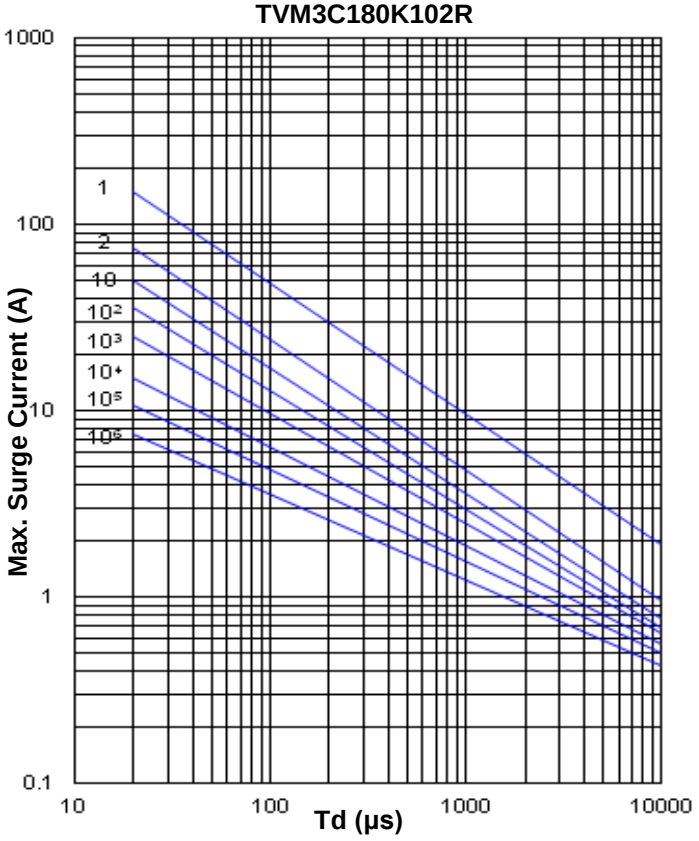


TVM3C450K301R/TVM3C480K271R/ TVM3C560K251R

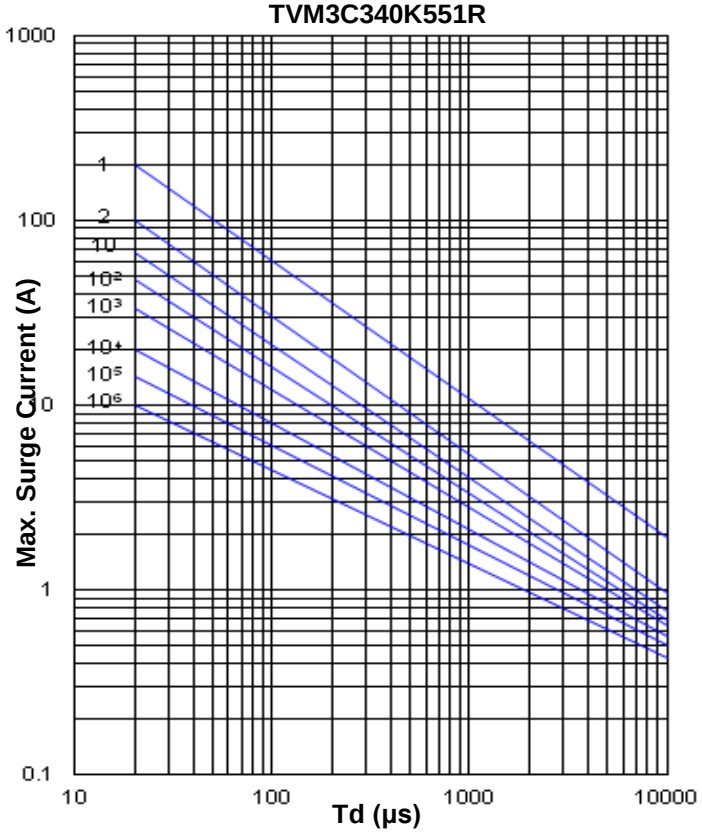


■ Max. Surge Current Derating Curves

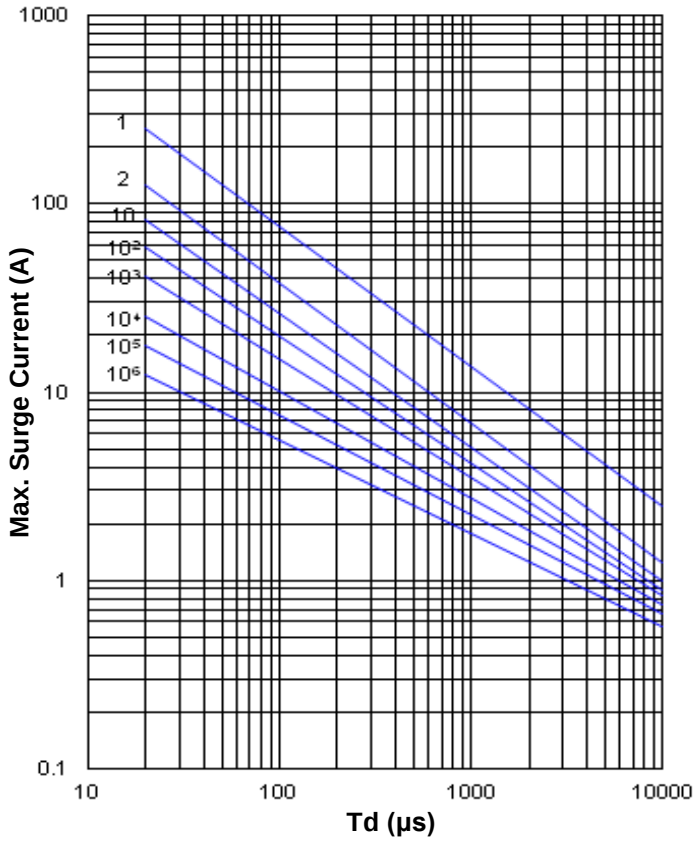
TVM3C180K102R



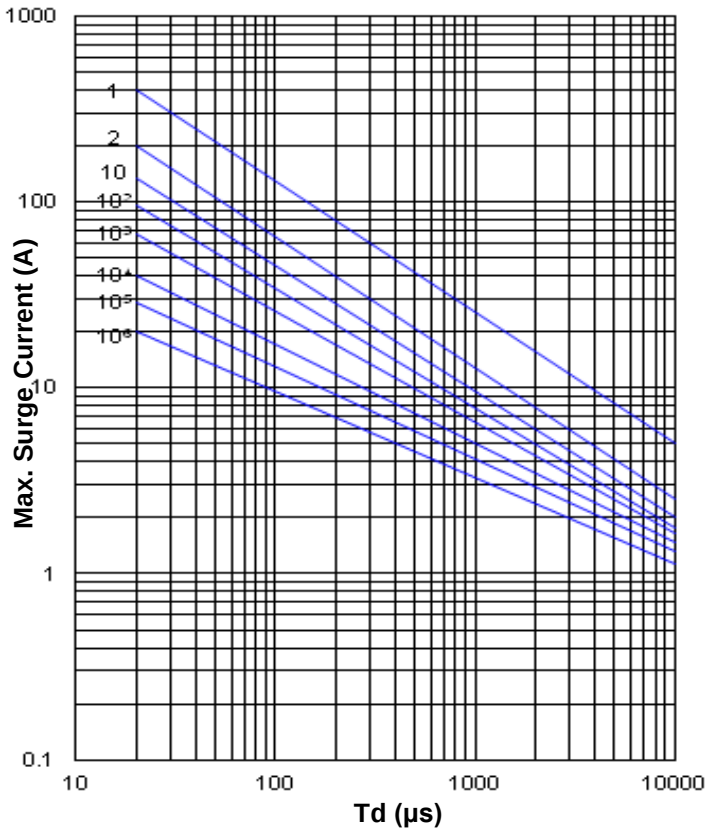
TVM3C160K102R/TVM3C260K801R/ TVM3C340K551R



TVM3C260K132R

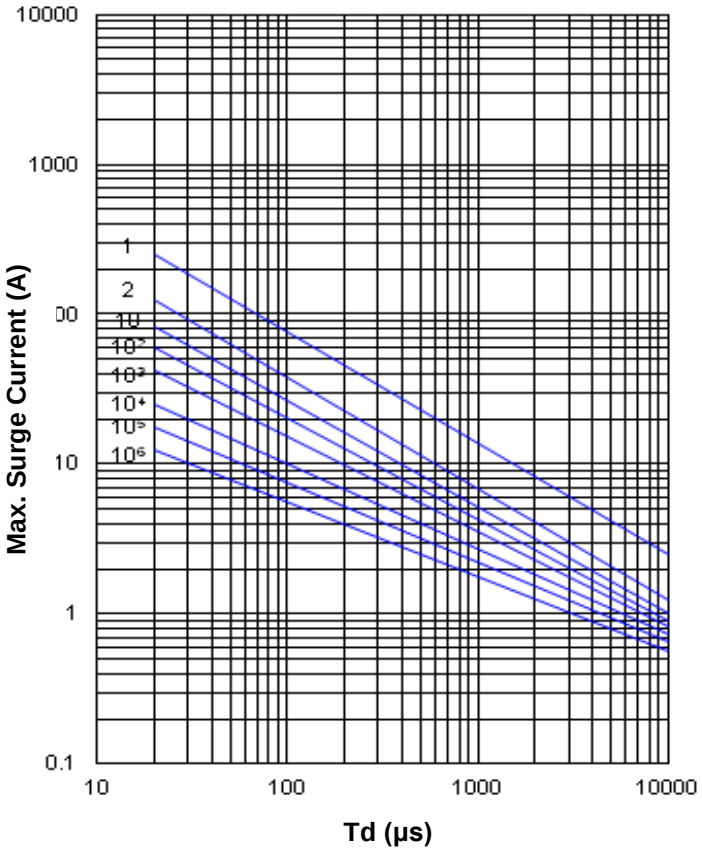


TVM3C160K242R

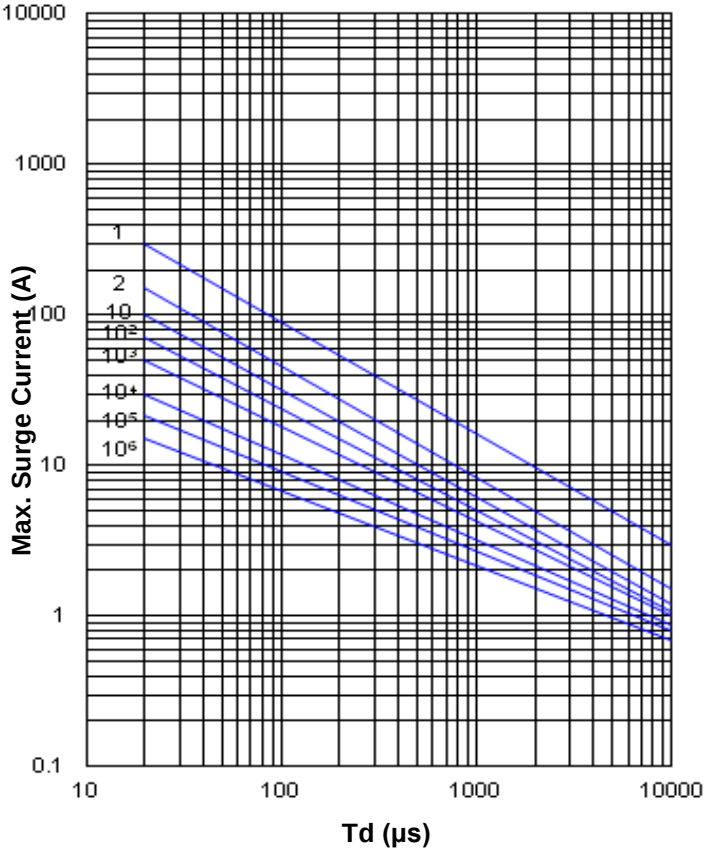


■ Max. Surge Current Derating Curves

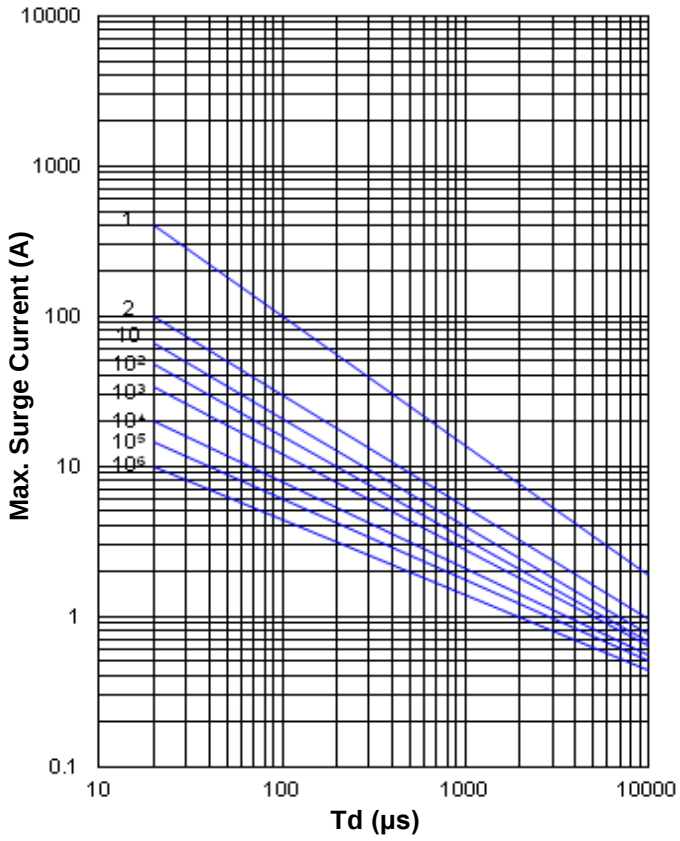
TVM4C450K601R



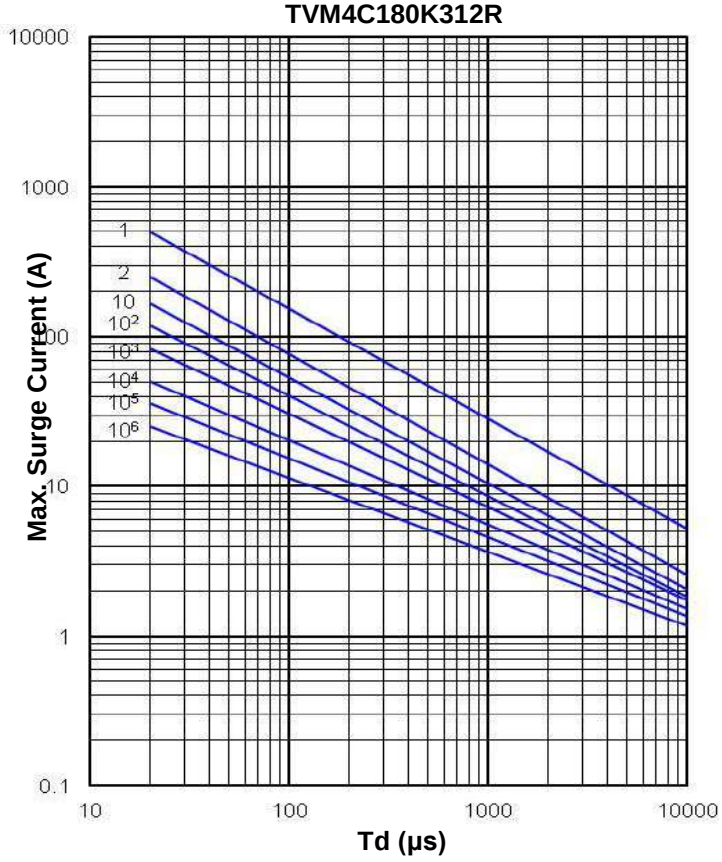
TVM4C310K122R/TVM4C340K112R



TVM4C160K242R/TVM4C260K152R

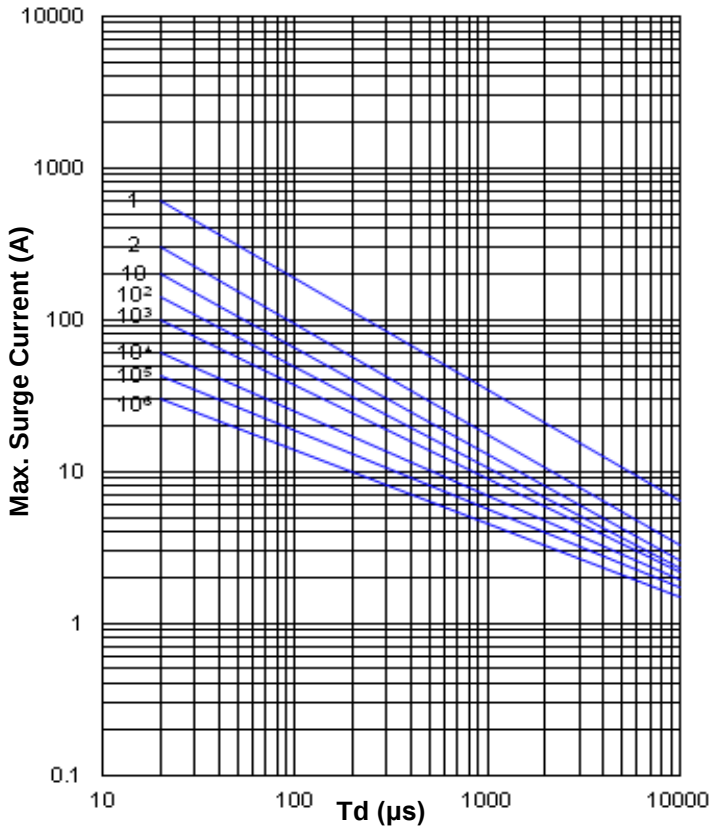


TVM4C180K312R

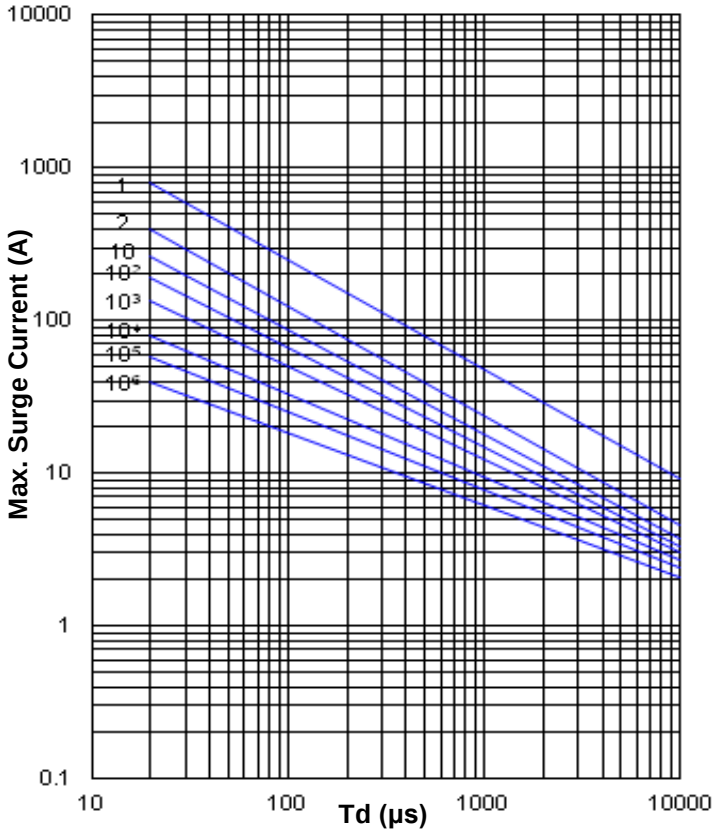


■ Max. Surge Current Derating Curves

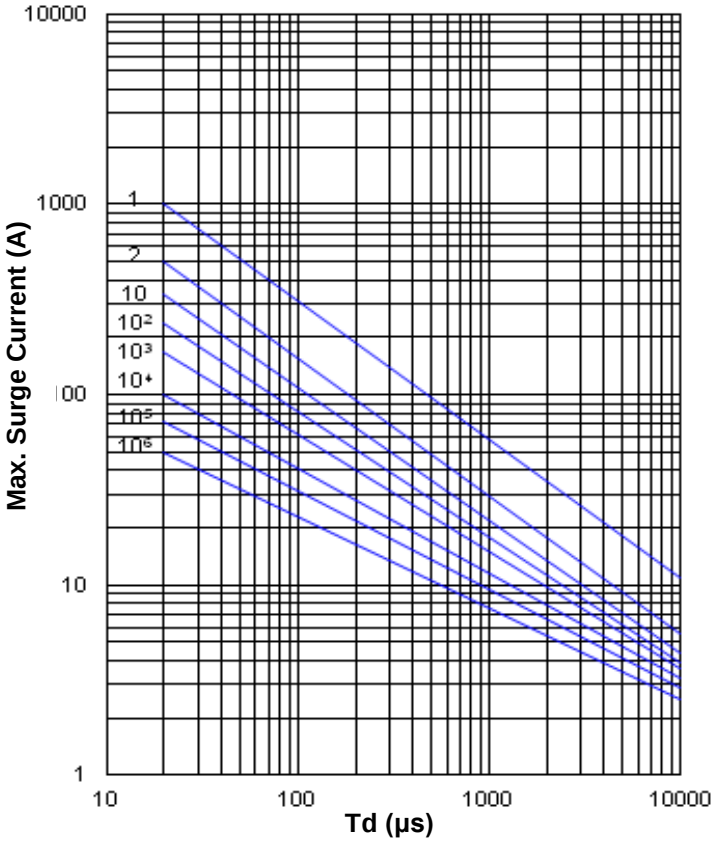
TVM5C300K172R



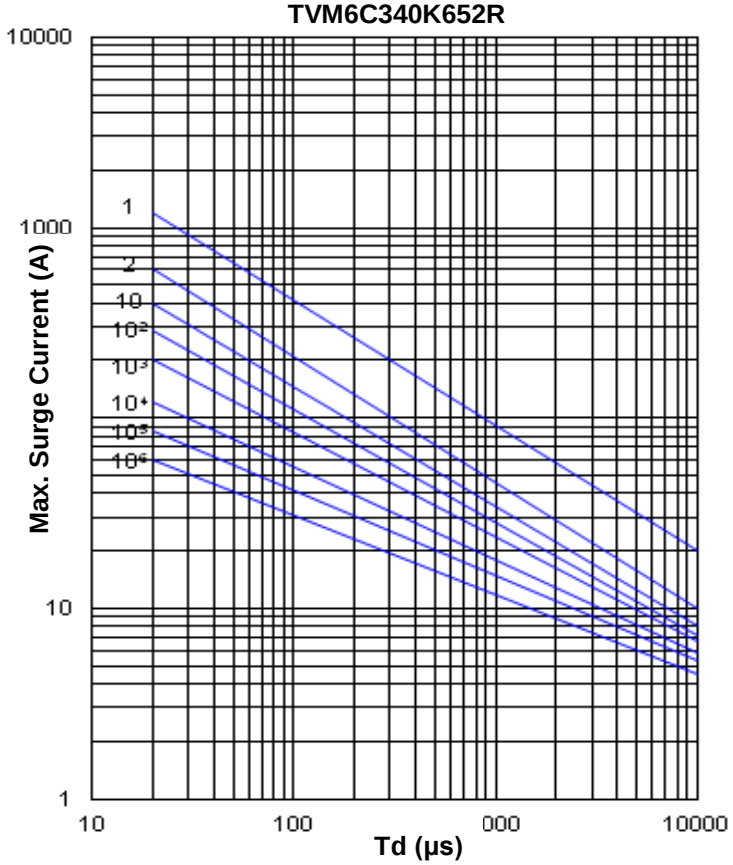
TVM5C160K452R/TVM5C260K322R



TVM6C380K302R

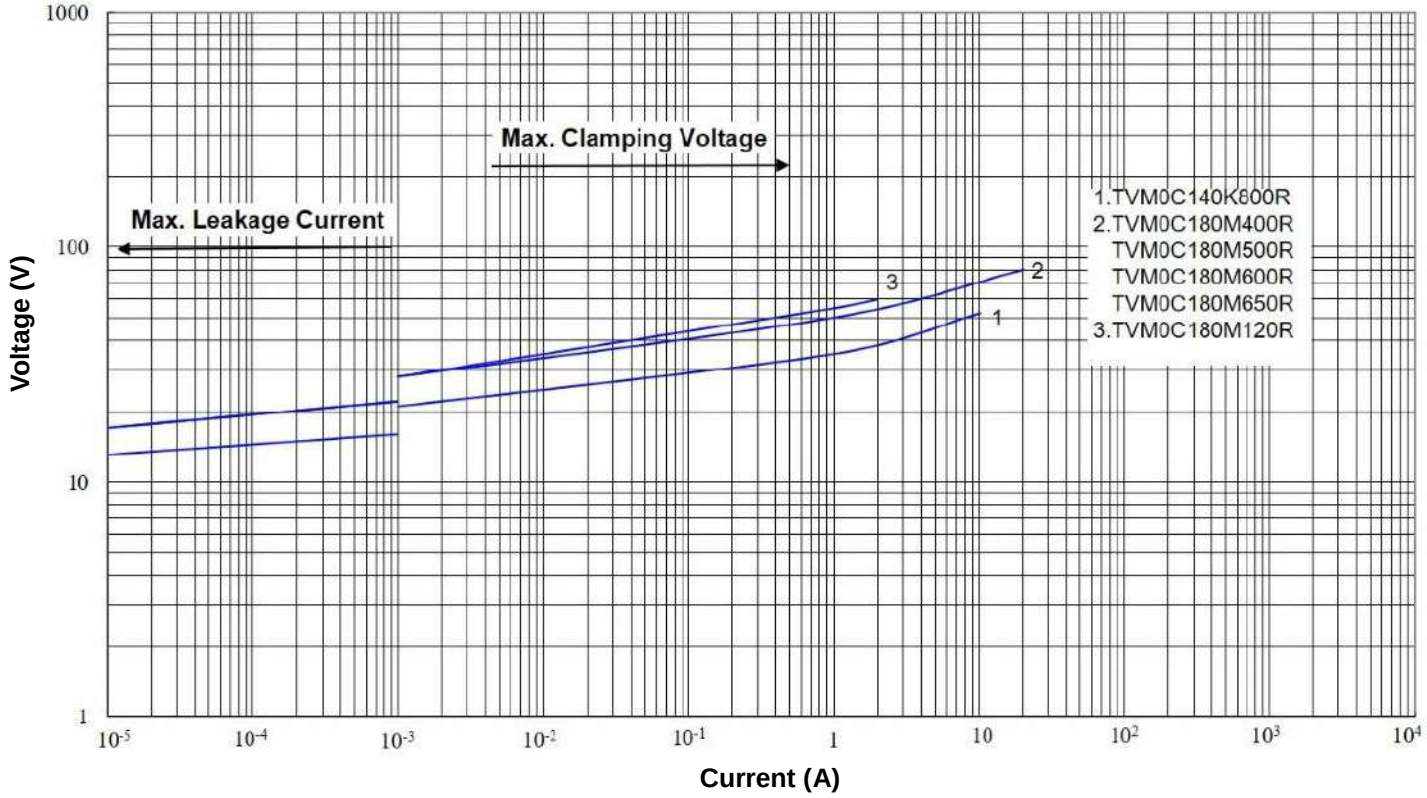


TVM6C160K103R/TVM6C160K203R/ TVM6C340K652R

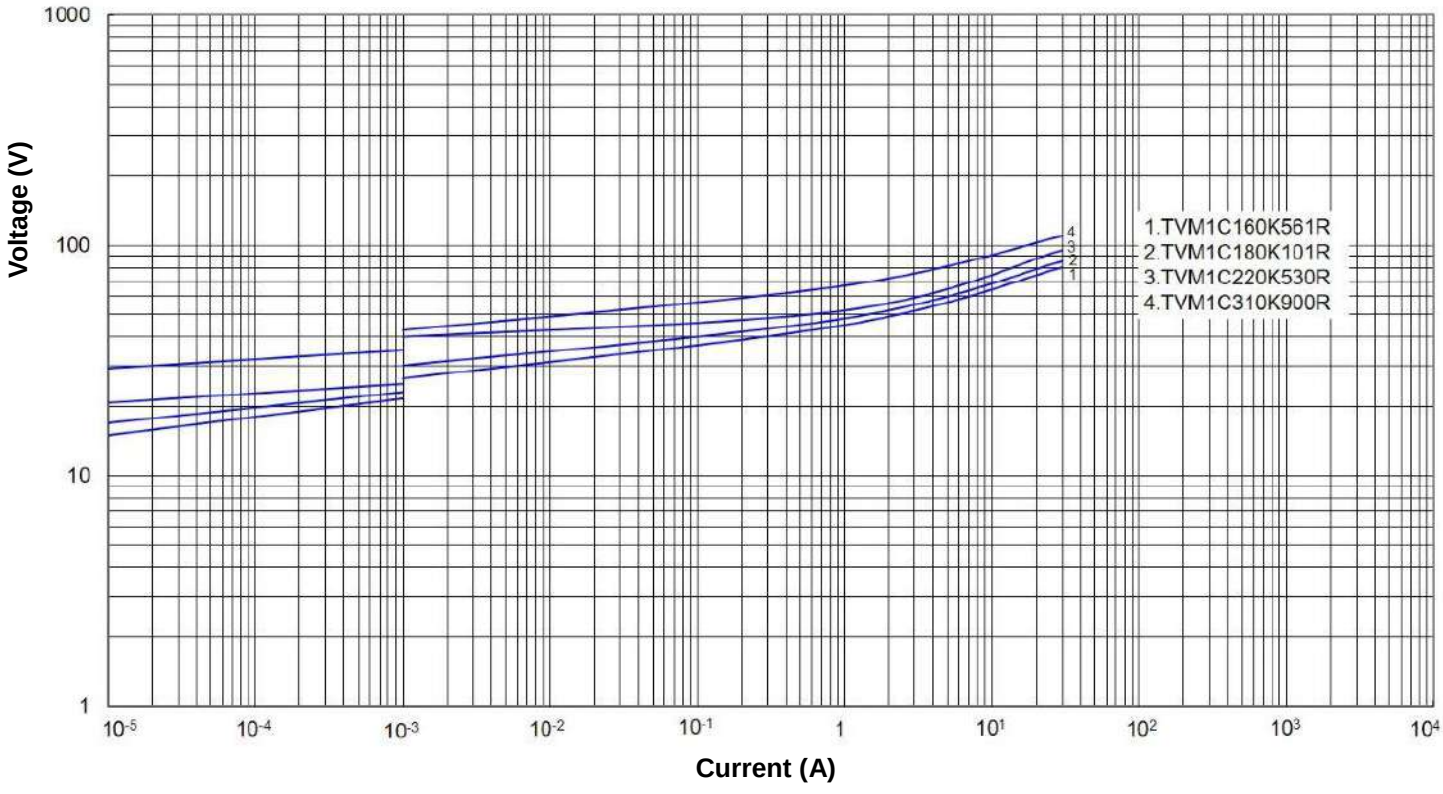


■ Max. Leakage Current and Max. Clamping Voltage Curves

Max. Leakage Current and Max. Clamping Voltage Curves (TVM0C140K800R~TVM0C180M120R)

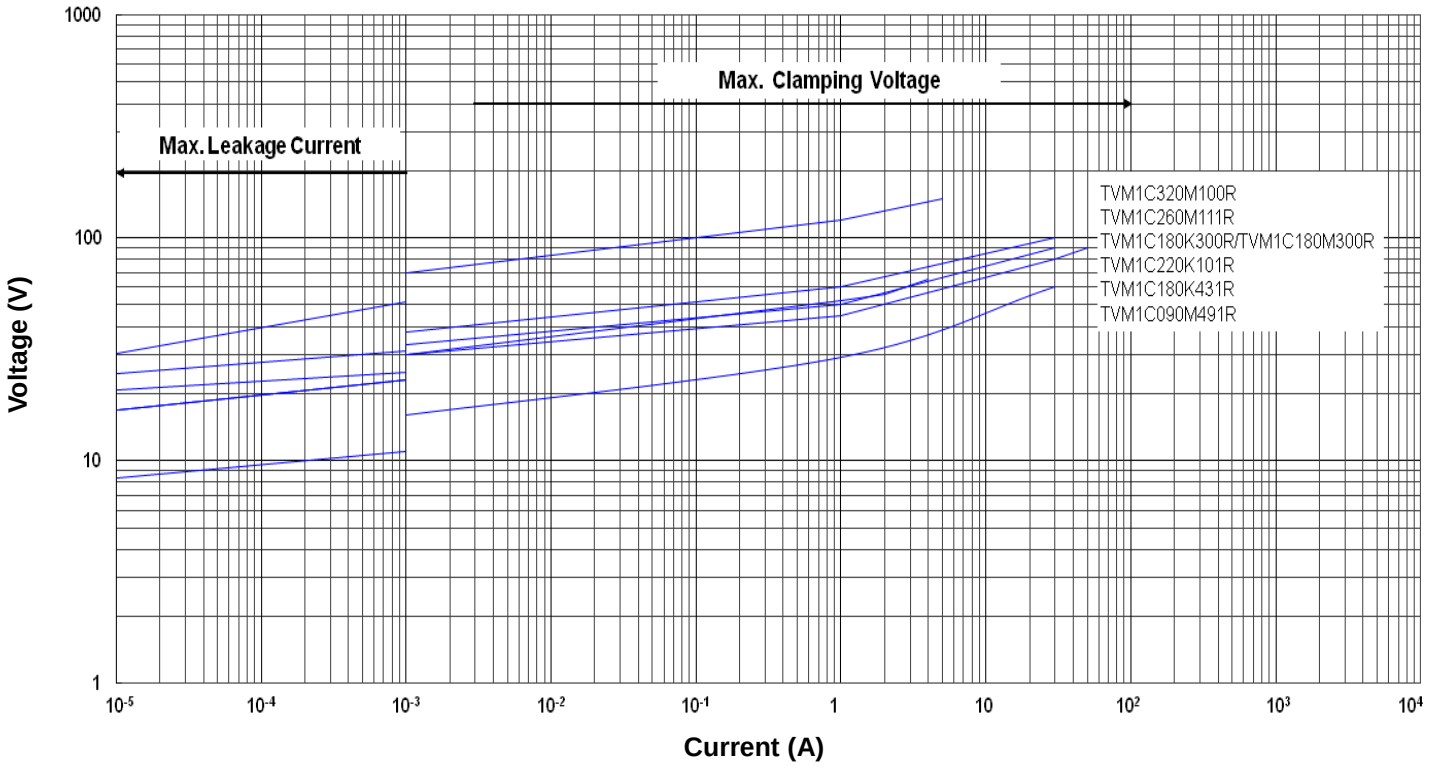


Max. Leakage Current and Max. Clamping Voltage Curves (TVM1C5R5M271R~TVM1C310K900R)

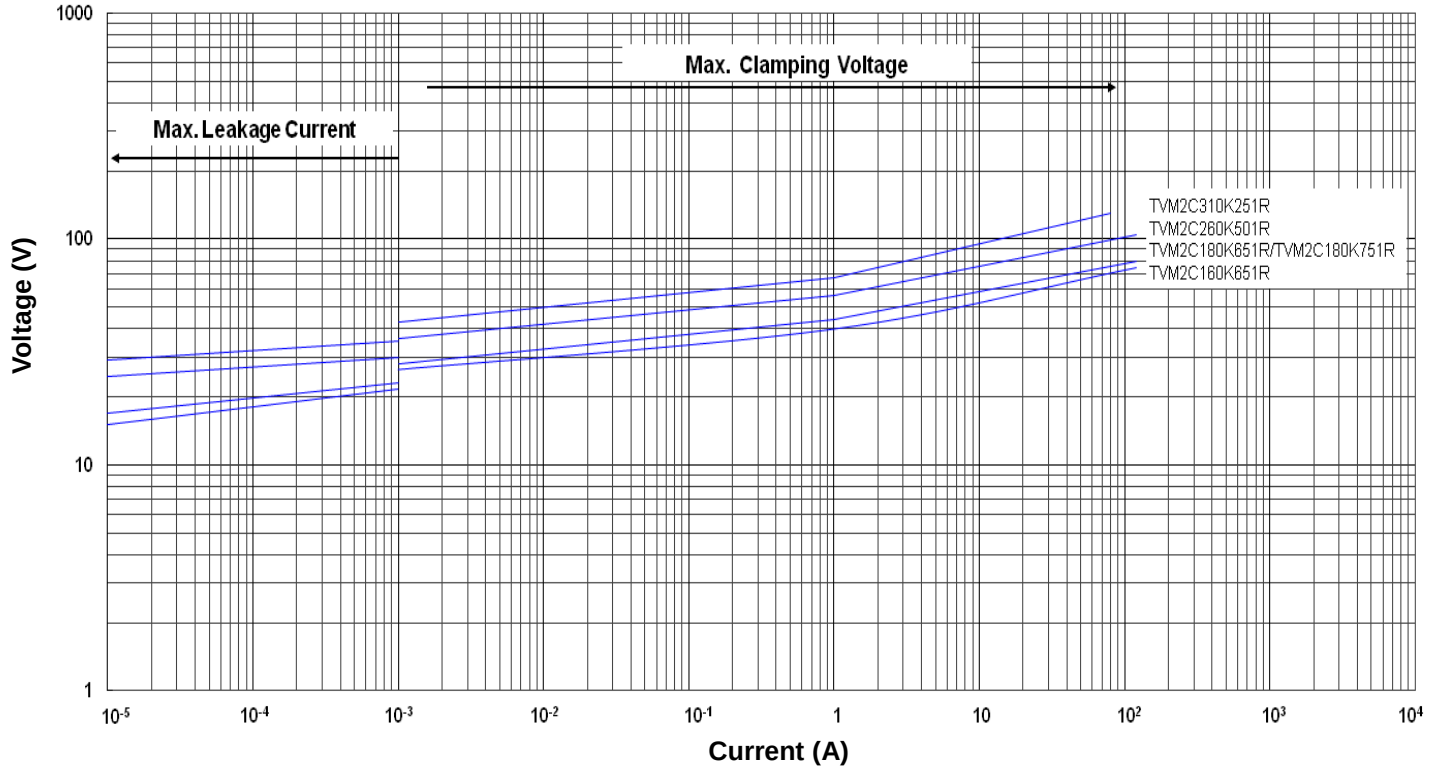


■ Max. Leakage Current and Max. Clamping Voltage Curves

Max. Leakage Current and Max. Clamping Voltage Curves (TVM1C090M491R~TVM1C320M100R)

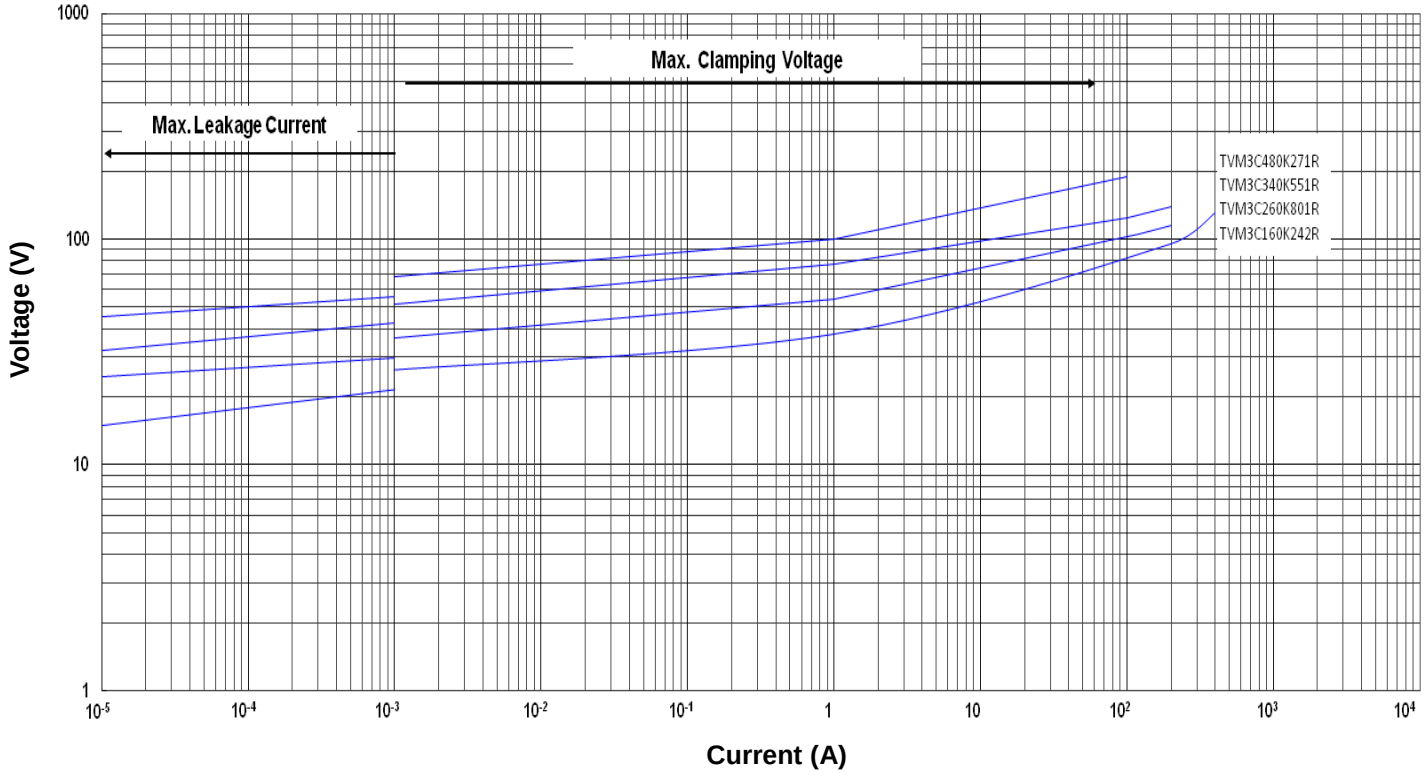


Max. Leakage Current and Max. Clamping Voltage Curves (TVM2C160K651R~TVM2C310K251R)

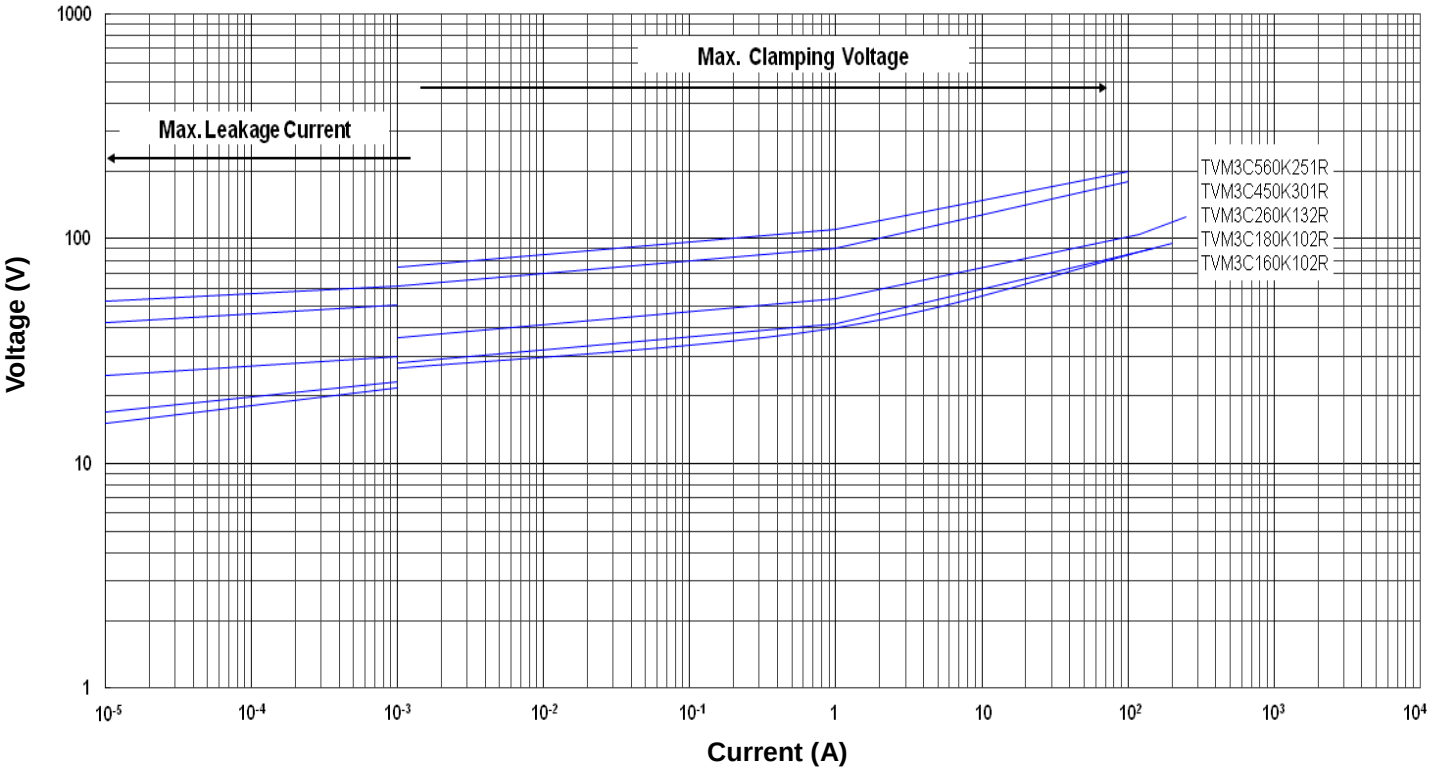


■ Max. Leakage Current and Max. Clamping Voltage Curves

Max. Leakage Current and Max. Clamping Voltage Curves (TVM3C160K242R~TVM3C480K271R)

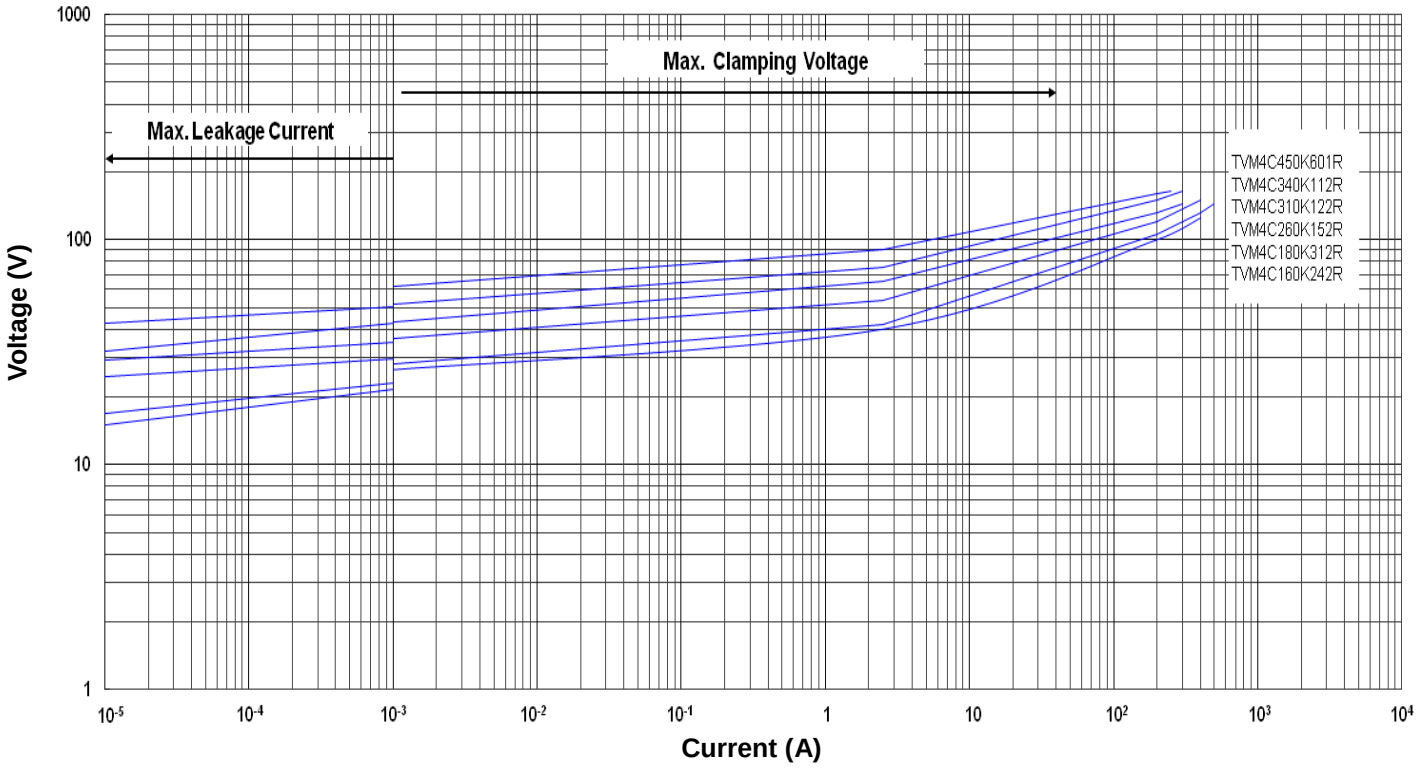


Max. Leakage Current and Max. Clamping Voltage Curves (TVM3C160K102R~TVM3C560K251R)

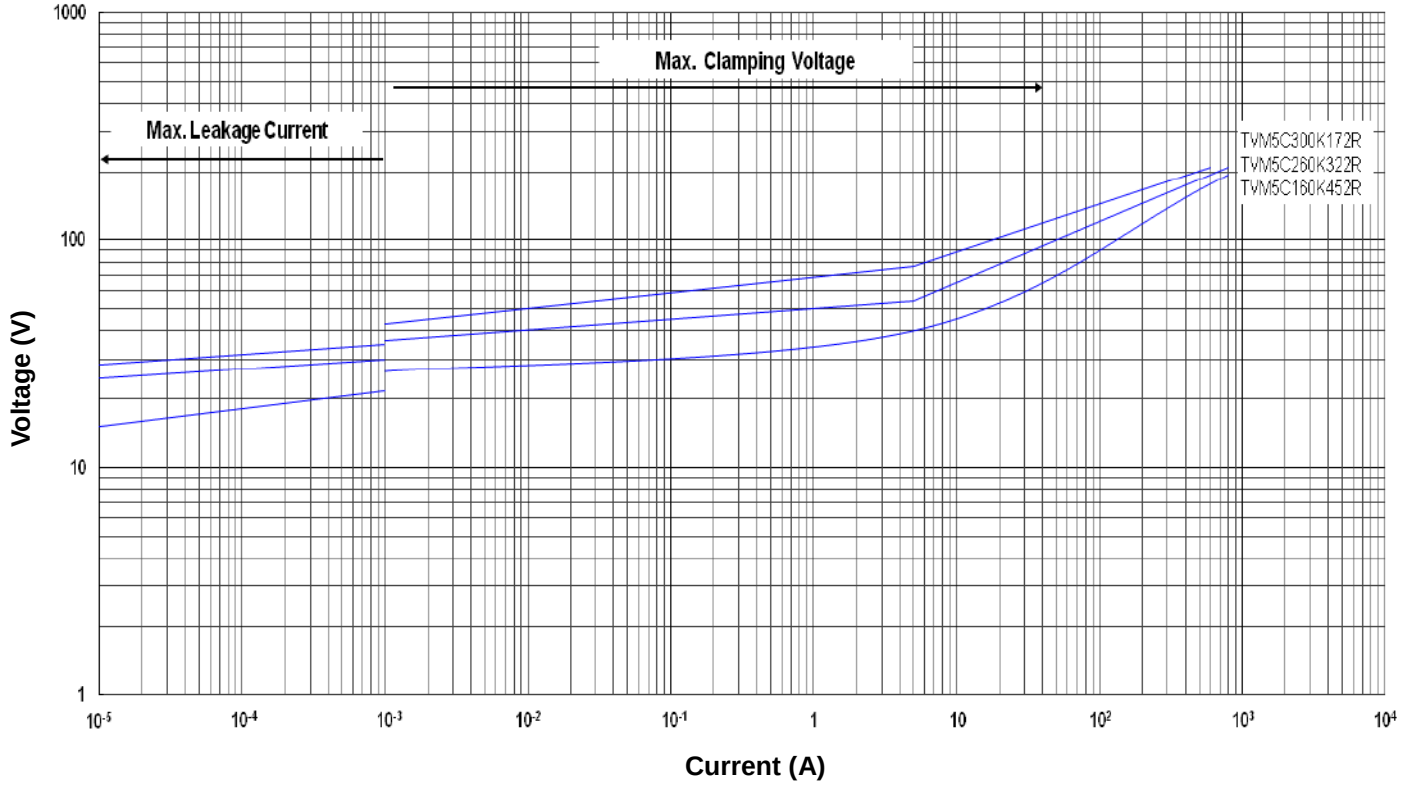


■ Max. Leakage Current and Max. Clamping Voltage Curves

Max. Leakage Current and Max. Clamping Voltage Curves (TVM4C160K242R~TVM4C560K601R)

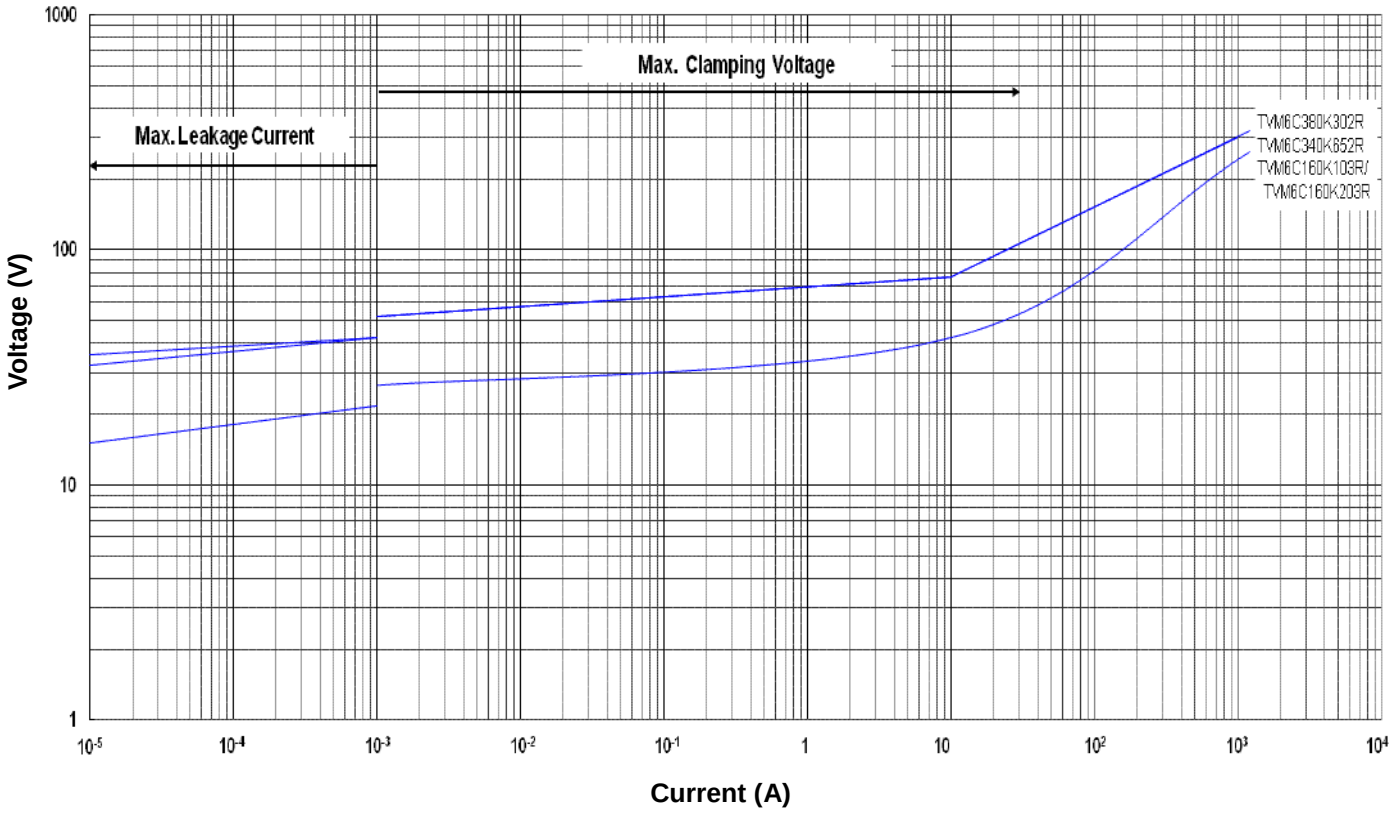


Max. Leakage Current and Max. Clamping Voltage Curves (TVM5C160K452R~TVM5C300K172R)



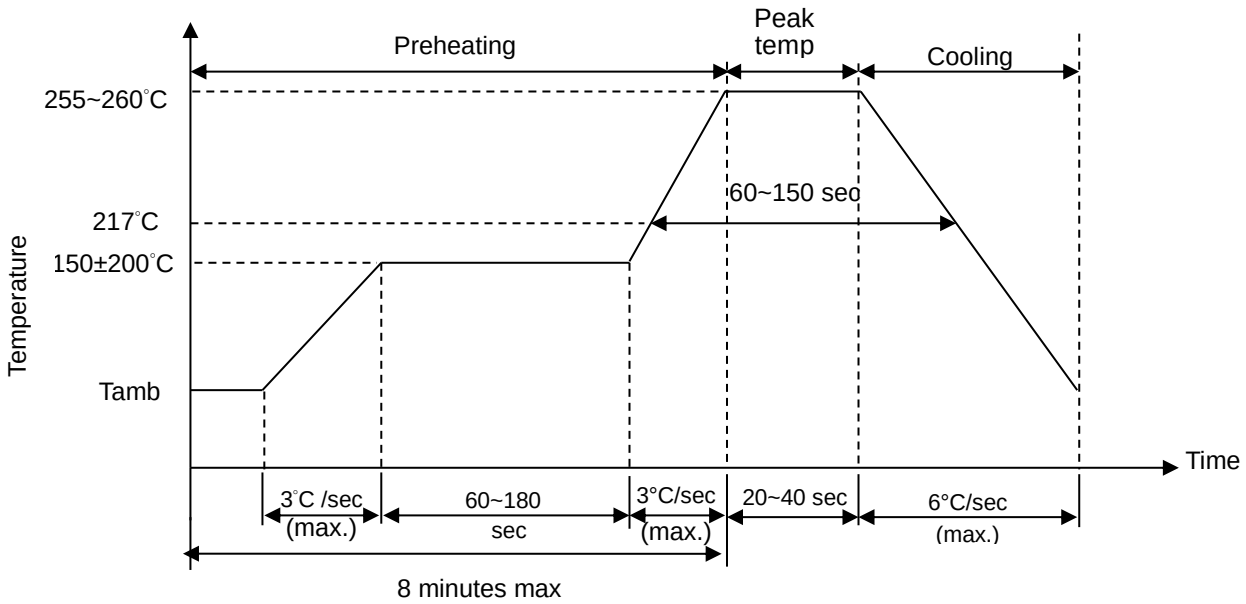
■ Max. Leakage Current and Max. Clamping Voltage Curves

Max. Leakage Current and Max. Clamping Voltage Curves (TVM6C160K203R~TVM6C380K302R)



■ Soldering Recommendation

● IR-Reflow Soldering Profile

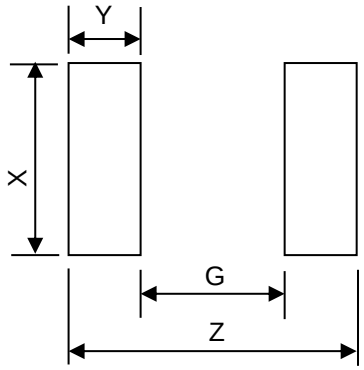


- **Reworking Conditions with Soldering Iron**

Item	Conditions
Temperature of Soldering Iron-tip	360℃ (max.)
Soldering Time	3 sec (max.)
Diameter of Soldering Iron-tip	Φ3mm (max.)

Caution: Do not touch the component surface with soldering iron directly to
prevent it from damage.

■ Recommended Soldering Pad Dimensions



Size	Z (mm)	G (mm)	X (mm)	Y (mm)
0402	1.4	0.4	0.5	0.5
0603	2.8	0.8	1.0	1.0
0805	3.4	1.0	1.4	1.2
1206	4.5	2.1	1.8	1.2
1210	4.5	2.1	2.8	1.2
1812	6.0	3.0	3.6	1.5
2220	7.2	4.2	5.5	1.5

■ Reliability (based on AEC-Q200 Rev-D)

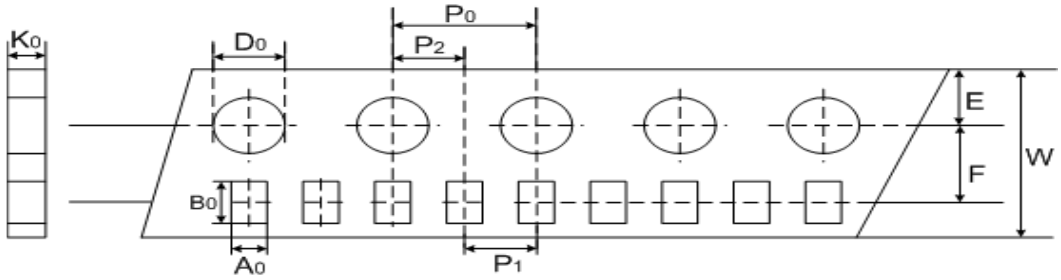
Item	Standard	Test conditions / Methods	Specifications
High Temperature Exposure (Storage)	MIL-STD-202 Method 108	Test temp. : 150 +3/-0°C Duration: 1000 h Unpowered Measurement at 24±2 hours after test conclusion.	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Temperature Cycling	JESD22 Method JA-104	Lower test temp.：-55 +0/-3°C Upper test temp.：125 +3/-0°C Soak Time at Lower or Upper Temp.：30 min Maximum transition time : 1 min. Number of cycles：1000 Measurement at 24±4 hours after test conclusion.	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Biased Humidity	MIL-STD-202 Method 103	Test temp：85°C Rel. humidity of air：85% +5/-0% Duration: 1000 h Bias at Working Voltage V_{DC}. Measurement at 24±4 hours after test conclusion.	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$

Item	Standard	Test conditions / Methods	Specifications
Operational Life	MIL-STD-202 Method 108	Test temp.: 125 +3/-0°C Duration: 1000 h Bias at Working Voltage V_{DC} Measurement at 24±4 hours after test conclusion.	No visible damage $\lvert \triangle V_{1mA}/V_{1mA} \rvert \leqq 10\%$
External Visual	MIL-STD-883 Method 2009	Inspect device construction, marking and workmanship.	No visible damage
Physical Dimension	JESD22 Method JB-100	Verify physical dimensions to the applicable device specification.	Within the specified values
Resistance to Solvents	MIL-STD-202 Method 215	Per MIL-STD-202 Method 215 Solvent 1: 1 part (by volume) of isopropyl alcohol 3 part (by volume) of mineral spirits.	No visible damage
Mechanical Shock	MIL-STD-202 Method 213	Test Condition F Peak value: 1500g's Half sine Waveform Normal duration (D) : 0.5ms In 3 directions perpendicularly intersecting each other (total 18 times).	No visible damage $\lvert \triangle V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Vibration	MIL-STD-202 Method 204	Acceleration: 5 g's Sweep time: 20 min Frequency range: 10 to 2000 Hz 3×12 cycles	No visible damage $\lvert \triangle V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Resistance to Soldering Heat	MIL-STD-202 Method 210	Condition B No pre-heat of samples. Temperature：260±5°C,Time：10±1s Immersion and emersion rate：25±6 mm/s Number of heat cycles：1	No visible damage $\lvert \triangle V_{1mA}/V_{1mA} \rvert \leqq 5\%$

Item	Standard	Test conditions / Methods	Specifications
ESD	AEC-Q200-002	Discharge capacitance：150 pF Test from 6KV DC to 25KV AD 1 pulse in each polarity (DC=Direct Contact Discharge, AD=Air Discharge)	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Solderability	IEC 60068-2-58 J-STD-002	a) 4 h @ 155°C dry heat Dip @245±5°C 3±0.3sec b)Steam aging 8h±15min @93±3°C Dip @260±5°C 7±0.5sec	95% of termination wetted
Electrical Characterization	Specifications	V1mA(-55°C), V1mA(25°C), V1mA(125°C)	Within the specified values
Board Flex	AEC-Q200-005	Bend the board: 2mm (Min.) Duration: 60 (+5) Sec	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Terminal Strength	AEC-Q200-006	Apply force： 0201=0.15kg (1.5 N) 0402=0.5kg (5 N) 0603=1.0kg (10 N) ≧ 0805=1.8kg (17.7 N) Duration ： 60 (+1) Sec	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 10\%$
Electrical Transient Conduction	ISO-7637-2	Test pulses 5a Number of pulses: 10 Test Energy: W_{LD} (Load dump)	No visible damage $\lvert \Delta V_{1mA}/V_{1mA} \rvert \leqq 15\%$

■ Packaging

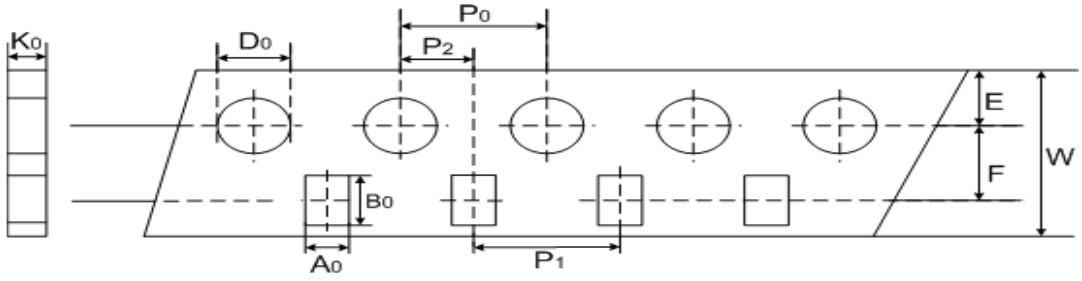
● Taping Specification (SMD 0402)



(Unit: mm)

Index / Size	A_0 ±0.05	B_0 ±0.12	W ±0.2	E ±0.1	F ±0.05	P_1 ±0.1	P_2 ±0.05	P_0 ±0.1	D_0 ±0.1	K_0 ±0.1
0402	0.62	1.12	8	1.75	3.5	2	2	4	1.55	0.60

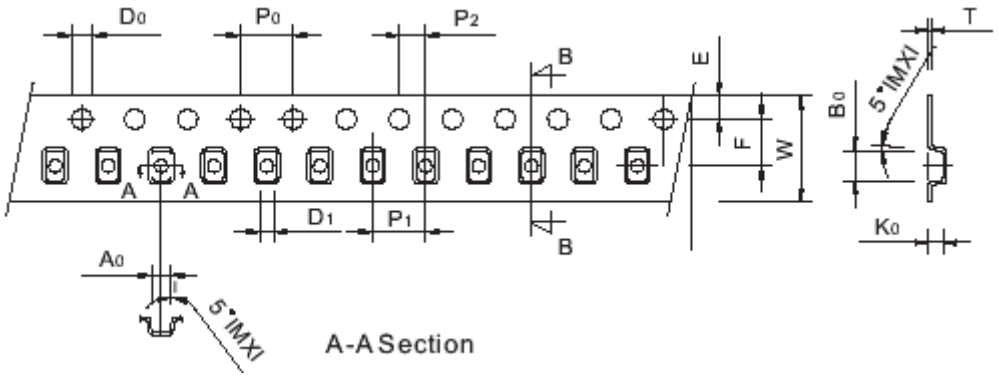
● Taping Specification (SMD 0603 & 0805)



(Unit: mm)

Index / Size	A_0 ±0.2	B_0 ±0.2	W ±0.2	E ±0.1	F ±0.05	P_1 ±0.1	P_2 ±0.05	P_0 ±0.1	D_0 ±0.1	K_0 ±0.1
0603	1.1	1.9	8	1.75	3.5	4	2	4	1.55	0.95
0805	1.5	2.3	8	1.75	3.5	4	2	4	1.55	1.0

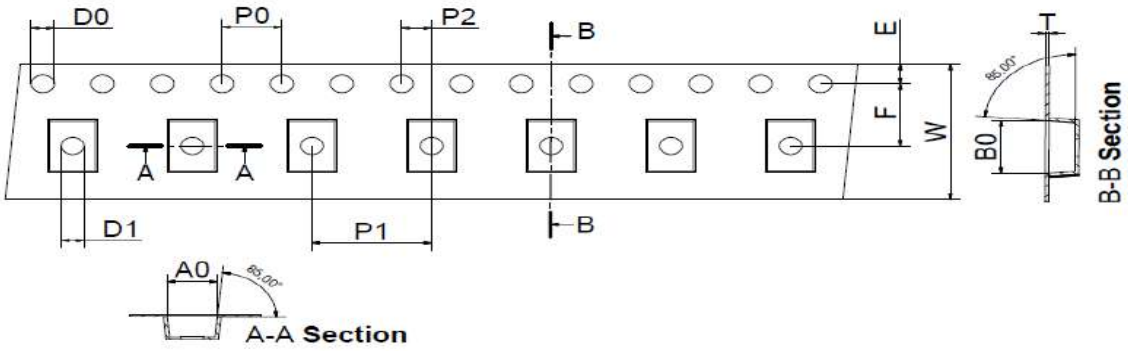
- **Taping Specification(SMD 1206 & 1210)**



(Unit: mm)

Index / Size	A_0 ±0.2	B_0 ±0.2	W ±0.2	E ±0.1	F ±0.05	P_1 ±0.1	P_2 ±0.05	P_0 ±0.1	D_0 ±0.1	D_1 ±0.1	T ±0.1
1206	1.85	3.45	8	1.75	3.5	4	2	4	1.55	1	0.25
1210	2.75	3.55	8	1.75	3.5	4	2	4	1.55	1	0.25

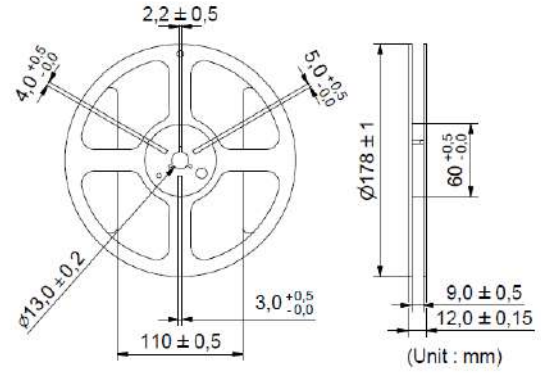
- **Taping Specification(SMD 1812 ~ 2220)**



(Unit: mm)

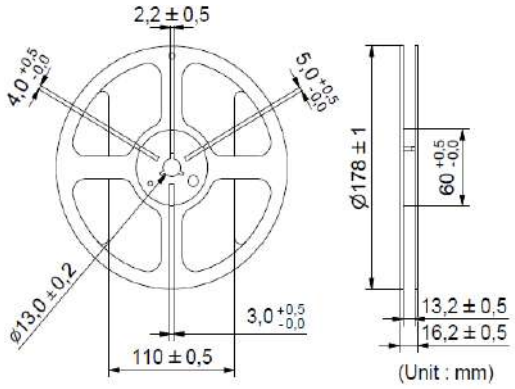
Index / Size	A_0 ±0.2	B_0 ±0.2	W ±0.3	E ±0.1	F ±0.05	P_1 ±0.1	P_2 ±0.05	P_0 ±0.1	D_0 ±0.1	D_1 ±0.1	T ±0.1
1812	3.65	4.96	12	1.75	5.5	8	2	4	1.55	1.5	0.25
2220	5.50	6.25	12	1.75	5.5	8	2	4	1.55	1.5	0.25

- **Quantity**
  - **0402 ~ 1210**



Type	Quantity (pcs/reel)
0402	10,000
0603	4,000
0805	3,000
1206	2,000
1210	2,000

  - **1812~2220**



Type	Quantity (pcs/reel)
1812	1,000
2220	800

■ Warehouse Storage Conditions of Products

- Storage Conditions :

  1. Storage Temperature: -10℃~+40℃
  2. Relative Humidity: ≦75%RH
  3. Keep away from corrosive atmosphere and sunlight.

- Period of Storage : 1 year