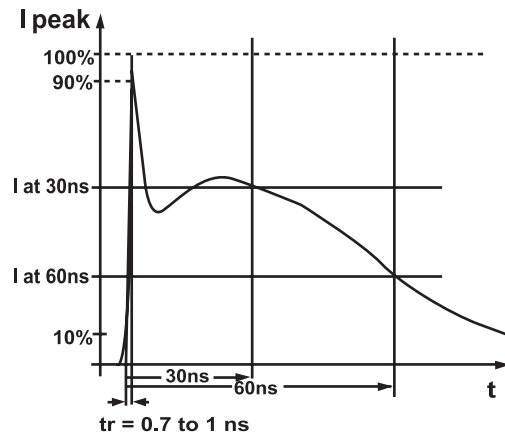


Multi Layer Chip Varistors

■ Introduction

Multilayer Chip Varistors (MLV) have good nonlinear voltage-current characteristics and high surge capability. They also have fast-response characteristics in several hundred pico second level. They are very suitable and widely used for the problems of transient over-voltage protection caused by ESD (Electro Static Discharge).



IEC 61000-4-2 ESD Waveform

■ Application

- ▶ Latch up protection for CMOS
- ▶ MOSFET protection for ESD / EOS
- ▶ High speed data I/O Port protection
- ▶ Keypad, Keyboard protection
- ▶ CDMA, GSM, Cordless phone
- ▶ Notebook, Workstations
- ▶ Digital camcorder
- ▶ CD-ROM, DVD-ROM, MD, MP3-PLAYER
- ▶ Automotive Application
- ▶ Onboard computer, electric motor control

■ Features

- ▶ The fastest response time about 300~700 ps
- ▶ Repetitive pulse characteristics
- ▶ High discharge transient current and energy handling capability
- ▶ Thermal stability through 125 °C
- ▶ EMI / RFI Attenuation characteristics

Multi Layer Chip Varistors

How to order (Product Identification)

VSN **1005** **X** **05** **N** **R**
 ① ② ③ ④ ⑤ ⑥

① Series Name

Code	Product Name
VSN	Chip Varistor Normal Type
VSL	Low Capacitance Type
VSH	High Surge Current Type
VHS	High Speed Type

② Size Code

The first two digits : length(mm)

The last two digits : width (mm)

③ Energy Rating Code

Code	Energy rating	Code	Energy rating
A	0.1J	H	1.2J
B	0.2J	J	1.5J
C	0.3J	K	2.0J
D	0.4J	P	3.0J
E	0.6J	U	0.01J
F	0.7J	V	0.02J
G	0.9J	X	0.05J

④ Working voltage code

Code	Working voltage
03	3.5 Vdc
05	5.6 Vdc
09	9.0 Vdc
□□	Two digits are real value

⑤ Termination Code

T : Ag / Pd / Pt, Ag / Pt

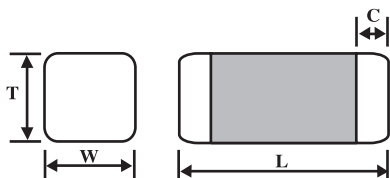
P : Ag / Pd

N : Nickel barrier

⑥ Packaging Code

Code	Packaging
B	Bulk Pack
R	Tape & Reel Pack
E	Embossed Tape Pack

Shape & Dimensions



Size Code	L	W	Tmax	Cmin
1005(0402)	1.0±0.05	0.5±0.05	0.55	0.1
1608(0603)	1.6±0.15	0.8±0.15	0.9	0.2
2012(0805)	2.0±0.20	1.25±0.20	1.3	0.2
3216(1206)	3.2±0.25	1.60±0.20	1.4	0.2
3225(1210)	3.2±0.25	2.50±0.25	1.7	0.2



SAMWHA CAPACITOR CO., LTD.

Multi Layer Chip Varistors

How to order (Product Identification)

MP **4** **N** **1632** **A** **05** **T** **R**
 ① ② ③ ④ ⑤ ⑥ ⑦ ⑧

① Series Name

Multi-Line Protection
Chip Varistor Array

② Array Type

4 : 4 Arrays
2 : 2 Arrays

③ Style

N : Normal construction
L : Low capacitance type

④ Size Code

The first two digits : width(mm)
The last two digits : length(mm)

⑤ Energy Rating Code

A : 0.1 Joules
X : 0.05 Joules

⑥ Working voltage code

Code	Working voltage
05	5.6 Vdc
09	9.0 Vdc
14	14 Vdc
□ □	Two digits are real value

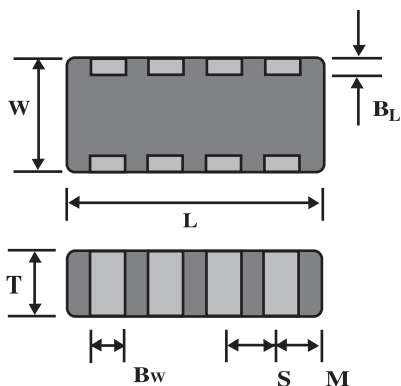
⑦ Termination Code

T : Ag / Pd / Pt, Ag/Pt
N : Nickel barrier

⑧ Packing Code

Code	Packaging
B	Bulk Pack
R	Tape & Reel Pack
E	Embossed Tape Pack

Shape & Dimensions



TYPE	MP2N1220	MP4N1632
L	2.0 ± 0.20	3.2 ± 0.2
W	1.25 ± 0.20	1.60 ± 0.20
T	0.8 ± 0.1	1.2max
S	0.76 ± 0.1	0.80 ± 0.1
M	0.62 ± 0.1	0.40 ± 0.1
BL	0.4 ± 0.15	0.4 ± 0.15
BW	0.10~0.18	0.20~0.45

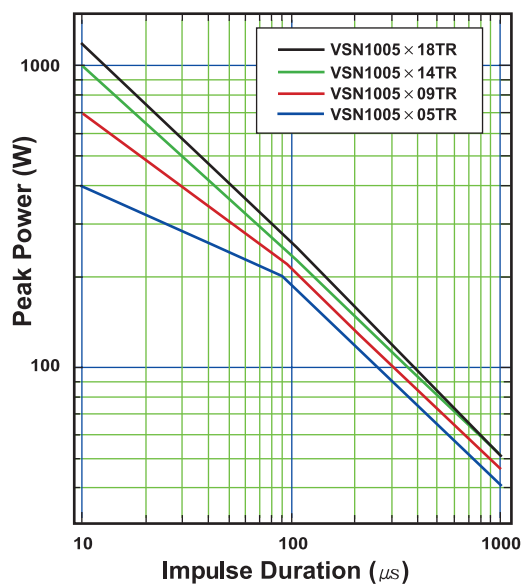
Multi Layer Chip Varistors

■ Specifications (1005 Normal Type)

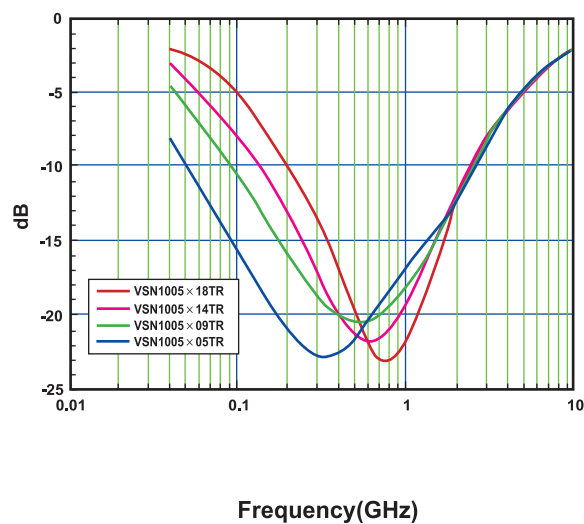
ESD protection of RF amplifier, FET, High speed data line

Part No	Working Voltage	Varistor Voltage	Clamping Voltage V _c	Max. Peak Current	Max. Energy	Typical Capacitance pF@1MHz
	V _{W(DC)}	V _b (@1mA)	V _c	I _p (A)	E _t (J)	
VSN1005X05□□	5.6	7.6~9.3	15.5	20	0.05	360
VSN1005X09□□	9.0	11.0~14.0	20	20	0.05	230
VSN1005X14□□	14	16.5~20.3	30	20	0.05	120
VSN1005X18□□	18	22.9~28.0	40	20	0.05	90

Note) See page29.



Peak Power vs Pulse Duration



Insertion Loss Characteristics

Multi Layer Chip Varistors

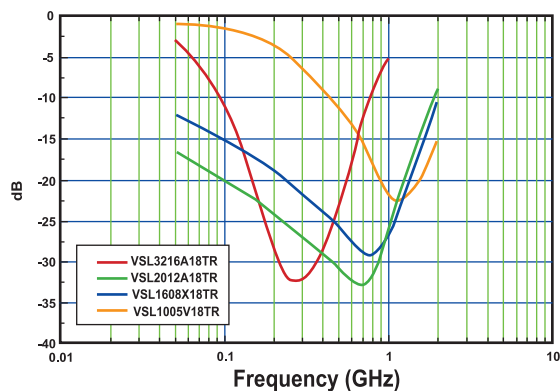
Specifications (Low Capacitance)

Protect for high speed data transmission line

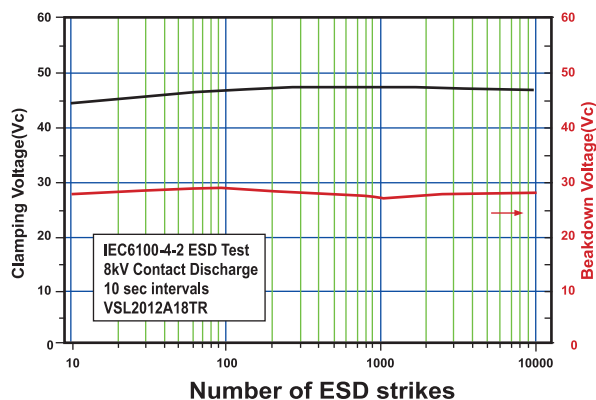
- Very low leakage current type for battery operated equipment.
- Very low capacitance about < 200 pF proper to high speed data transmission.
- Suitable for USB, IEEE1394 Data Line Protection

Part No	Working Voltage	Varistor Voltage	Clamping Voltage	Max. Peak Current	Max. Energy	Typical Capacitance pF@1MHz
	V _{W(DC)}	V _{1mA}	V _c	I _p (A)	E _t (J)	
VSL1005X03□□	3.6	8	15.5	15	0.05	150
VSL1005X05□□	5.6	12	20	20	0.05	100
VSL1005U05□□	5.6	12	20	15	0.01	50
VSL1005X12□□	12	18	30	20	0.05	50
VSL1005V12□□	12	18	30	15	0.02	25
VSL1005V18□□	18	27	50	15	0.02	30
VSL1005U18□□	18	27	50	10	0.01	15
VSL1608A05□□	5.6	12	20	25	0.1	400
VSL1608X05□□	5.6	12	20	20	0.05	100
VSL1608V05□□	5.6	12	20	15	0.02	50
VSL1608X12□□	12	18	30	20	0.05	80
VSL1608X18□□	18	27	50	20	0.05	75
VSL2012A18□□	18	27	50	20	0.10	150

Note) See page29.



Insertion Loss Characteristics



ESD Repetitive Characteristics

Multi Layer Chip Varistors

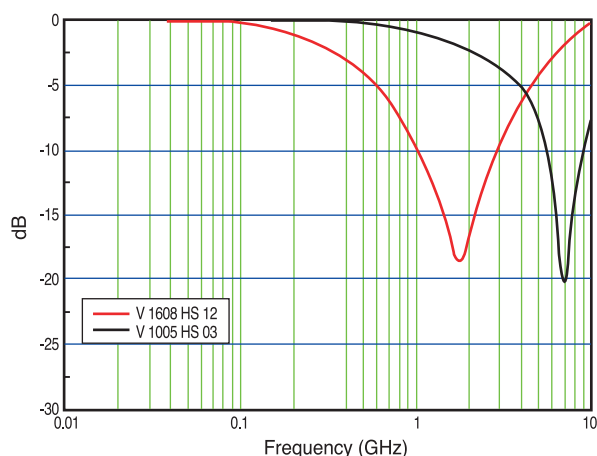
■ Specifications (High Speed Type)

Protect for very high speed data transmission line

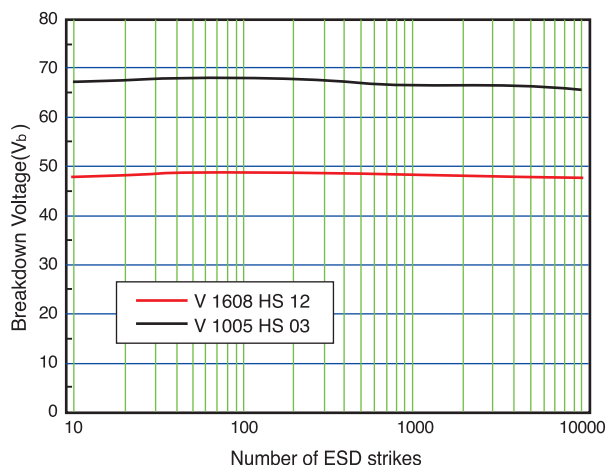
- ▲ 3pF & 12pF Capacitance Versions Suitable for High Speed Data-Rate Lines
- ▲ Very low Leakage Currents
- ▲ ESD Rated to IEC 61000-4-2 (Level 4)
- ▲ Very Suitable for USB, IEEE 1394 Data Line Protection
- ▲ Mobile Communications / Cellular Phone etc.

Part No	Working Voltage	Maximum Leakage Current at specified DC voltage				Typical Capacitance pF@1MHz	Typical Inductance (di/dt=0.1A/ns)
	V _{W(DC)}	3.5V	5.5V	9V	15V		
V 1005 HS 03	< 30	0.05	0.10	0.15	0.25	3	< 1.0
V 1005 HS 06	< 30	0.05	0.10	0.15	0.25	6	< 1.0
V 1005 HS 12	< 18	0.10	0.15	0.25	0.50	12	< 1.0
V 1608 HS 03	< 30	0.05	0.10	0.15	0.25	3	< 1.0
V 1608 HS 06	< 30	0.05	0.10	0.15	0.25	6	< 1.0
V 1608 HS 12	< 18	0.10	0.15	0.25	0.50	12	< 1.0

Note) See page29.



Insertion loss characteristics



ESD Repetitive characteristics

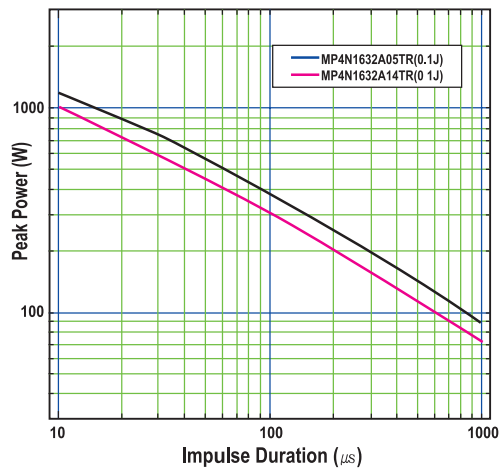
Multi Layer Chip Varistors

■ Specifications (Array Type)

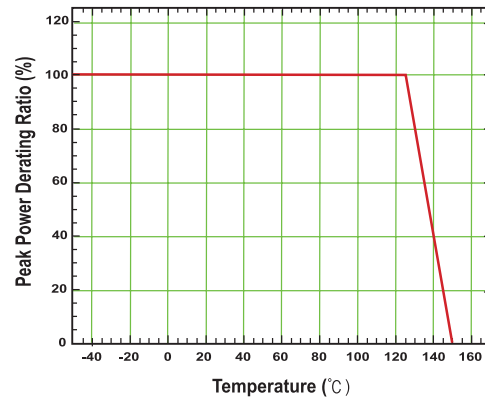
ESD protection of Keypad, I/O port protection

Part No	Working Voltage	Varistor Voltage	Clamping Voltage Vc	Max. Peak Current	Max. Energy	Typical Capacitance pF@1MHz
	V _W (DC)	V _b (@1mA)	V _c	I _p (A)	E _t (J)	
MP2N1220A05□□	5.6	6.8~9.3	15.5	30	0.1	360
MP2N1220A09□□	9	10.0~14.0	20	30	0.1	230
MP2N1220A14□□	14	14.7~20.3	30	30	0.1	120
MP2N1220A18□□	18	20.4~28.0	40	30	0.1	90
MP4N1220X05□□	5.6	6.8~9.3	15.5	20	0.05	270
MP4L1220X05□□	5.6	typ.12	20	20	0.05	100
MP4L1220U05□□	5.6	typ.12	20	15	0.01	50
MP4L1220X12□□	12	typ.18	30	20	0.05	50
MP4L1220V12□□	12	typ.18	30	15	0.02	25
MP4N1220X18□□	18	typ.27	40	20	0.05	50
MP4L1220V18□□	18	typ.27	50	15	0.02	30
MP4L1220U18□□	18	typ.27	50	10	0.01	15
MP4N1632A05□□	5.6	6.9~9.3	16	30	0.1	800
MP4N1632A09□□	9	10.0~14.0	20	30	0.1	500
MP4N1632A14□□	14	14.7~20.3	30	30	0.1	450
MP4N1632A18□□	18	20.4~28.0	40	30	0.1	250
MP4L1632A18□□	18	typ.27	50	20	0.05	75

Note) See page29.



Peak Power vs Pulse Duration



Temperature Derating

Multi Layer Chip Varistors

■ Specifications (Normal Type)

For ESD, CMOS latch up, FET protection

Part No	Working Voltage	Varistor Voltage	Clamping Voltage V _c	Max. Peak Current	Max. Energy	Typical Capacitance pF@1MHz
	V _W (DC)	V _b (@1mA)	V _c	I _p (A)	E _t (J)	
VSN1608A05□□	5.6	7.6~9.3	16	30	0.1	800
VSN1608A09□□	9.0	11.0~14.0	20	30	0.1	500
VSN1608A12□□	12	14.8~18.5	27	30	0.1	475
VSN1608A14□□	14	16.5~20.3	30	30	0.1	450
VSN1608A18□□	18	22.9~28.0	40	30	0.1	250
VSN1608A26□□	26	31.0~38.0	58	30	0.1	160
VSN1608A30□□	30	37.0~46.0	65	30	0.1	150
VSN2012A05□□	5.6	7.6~9.3	16	40	0.1	1250
VSN2012A09□□	9	11.0~14.0	20	40	0.1	740
VSN2012A12□□	12	14.8~18.5	25	40	0.1	525
VSN2012A14□□	14	16.5~20.3	30	40	0.1	375
VSN2012A18□□	18	22.9~28.0	40	30	0.1	350
VSN2012A26□□	26	31.0~38.0	58	30	0.1	140
VSN2012A30□□	30	37.0~46.0	65	30	0.1	100
VSN3216A05□□	5.6	7.6~9.3	16	40	0.1	850
VSN3216A09□□	9	11.0~14.0	20	40	0.1	650
VSN3216A14□□	14	16.5~20.3	30	40	0.1	500
VSN3216A18□□	18	22.9~28.0	40	30	0.1	290

Note) See page29.

Multi Layer Chip Varistors

■ Specifications (High Surge Current Type)

For Line surge, Switching surge, ESD protection

Part No	Working Voltage		Varistor Voltage	Clamping Voltage Vc	Max. Peak Current	Max. Energy	Typical Capacitance pF@1MHz
	V _{W(DC)}	V _{W(AC)}	V _b (@1mA)	V _c	I _p (A)	E _t (J)	
VSH2012C05□□	5.6	4.0	7.6~9.3	15.5	120	0.3	1600
VSH2012C09□□	9	6.4	11.0~14.0	20	120	0.3	1200
VSH2012C14□□	14	10	16.5~20.3	30	120	0.3	600
VSH2012C18□□	18	12	22.9~28.0	40	100	0.3	400
VSH2012C26□□	26	18	31.0~38.0	58	100	0.3	250
VSH2012C30□□	30	21	37.0~46.0	65	100	0.3	200
VSH3216D05□□	5.6	4.0	7.6~9.3	16	150	0.4	1800
VSH3216D09□□	9	6.4	11.0~14.0	20	150	0.4	1500
VSH3216D14□□	14	10	16.5~20.3	30	150	0.4	900
VSH3216D18□□	18	12	22.9~28.0	40	150	0.4	600
VSH3216D26□□	26	18	31.0~38.0	58	120	0.4	400
VSH3216D30□□	30	21	37.0~46.0	65	120	0.4	300
VSH3216D48□□	48	34	56.0~68.0	100	100	0.4	200
VSH3225J18□□	18	12	21.5~28.0	40	500	1.5	1500
VSH3225H26□□	26	18	30.5~38.0	58	300	1.2	1200
VSH3225H30□□	30	21	36.0~46.0	65	280	1.2	1000
VSH3225G30□□	30	21	36.0~46.0	65	220	0.9	800
VSH3225H48□□	48	34	56.0~68.0	100	250	1.2	800
VSH3225G48□□	48	34	56.0~68.0	100	220	0.9	700
VSH3225J60□□	60	42	67.0~83.0	120	250	1.5	600

Note) See page29.

Multi Layer Chip Varistors

■ Terminology

① Working Voltage

$V_{W(DC)}$ - Maximum Continuous DC Voltage with which the waveform is flat. When a ripple voltage is supplied as from a rectifier source, make sure that the peak voltage is kept under the V_{dc} .

$V_{W(AC)}$ - Maximum Continuous AC Voltage from a sine-wave shape. When the distortion in the waveform is extensive, make sure that peak voltage is less than $\sqrt{2}$ times the $V_{W(AC)}$

② Varistor Voltage ($V_b(@1mA)$, Breakdown Voltage)

The varistor terminal voltage which measured with supplying 1mA DC current.

③ Maximum Transient Clamping Voltage (V_c)

The peak terminal voltage which measured with an 8/20 μs impulse of a given peak current

Transient Energy Rating	Specified Peak Current & Waveform
$\leq 0.05J$	1A 8/20 μs
0.1 J	2A 8/20 μs
0.2~0.3 J	5A 8/20 μs
$\geq 0.4 J$	10A 8/20 μs

④ Maximum Transient Peak Current (I_p)

Maximum single peak current which is based on 8/20 μs current wave shape, without the device failure

⑤ Maximum Transient Energy (E_t)

Maximum allowable transient energy for a single impulse of 10/1000 μs current without device failure

⑥ Capacitance

The Capacitance measured at a specified frequency 1MHz and zero voltage bias with 0.5 Vrms

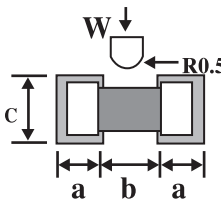
Multi Layer Chip Varistors

■ Reliability and Test conditions

Item	Requirements	Test Condition
Operating Temp. Range	-40℃ ~ +125℃	-
Storage Temp	40℃ max, 70%RH max	At packing condition
Temperature cycle	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	1. -40±3℃ for 30 minutes 2. 85±3℃ for 30 minutes 3. repeat 24 cycles
Low Temperature Resistance	① No visible damage such as cracks ② $\Delta V/V1mA \leq \pm 10\%$	Temperature : 40±2℃ Humidity : 90~95% RH Time : 500±12 hours Measurement at room temperature after placing for 24 hours
Humidity Resistance	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	Temperature : 40±2℃ Humidity : 90~95% RH Time : 500±12 hours Measurement at room temperature after placing for 24 hours
Humidity Load Resistance	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	Temperature : 40±2℃ Humidity : 90~95% RH Applied voltage : rated Vdc Time : 500±12 hours Measurement at room ambient temperature after placing for 24 hours
High Temperature Load Resistance	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	Temperature : 125±5℃ Applied voltage : rated Voltage Time : 1000+72/-24 hours Measurement at room ambient temperature after placing for 24 hours
Resistance to Soldering Heat	① No visible damage such as cracks ② $\Delta V/V1mA \leq \pm 10\%$	Preheat : 120~150℃ 1min Solder temperature : 260±5℃ Immersion time : 10±1 sec Take it out and set it for 1~2hours then measure.

Multi Layer Chip Varistors

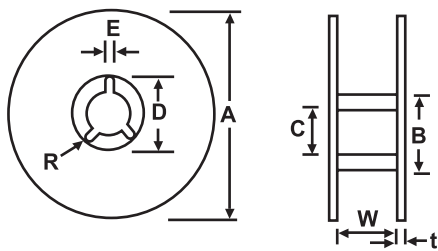
Reliability and Test conditions

Item	Requirements	Test Condition																									
Solderability	① More than 90% of the terminal electrode shall be covered with new solder ② $\Delta V/V1mA \leq \pm 10\%$	Preheat temperature : 120~150℃ Solder : 60 Sn / 40 Pb Preheat time : 60 sec Solder temperature : $230 \pm 5^\circ\text{C}$ Soldering time : 3 ± 1 Sec.																									
Reflow Soldering	① More than 90% of the terminal electrode shall be covered with new solder ② $\Delta V/V1mA \leq \pm 10\%$	At Reflow soldering profile about 230℃																									
Lateral Push Strength	No mechanical damage <table><tr><td>Chip size</td><td>1005</td><td>1608</td><td>2012</td><td>3216</td></tr><tr><td>a [mm]</td><td>-</td><td>1.0</td><td>1.0</td><td>1.3</td></tr><tr><td>B [mm]</td><td>-</td><td>0.8</td><td>1.0</td><td>1.5</td></tr><tr><td>c [mm]</td><td>-</td><td>1.3</td><td>1.3</td><td>3.0</td></tr><tr><td>W [kgf]</td><td>-</td><td>2.0</td><td>4.0</td><td>5.0</td></tr></table>	Chip size	1005	1608	2012	3216	a [mm]	-	1.0	1.0	1.3	B [mm]	-	0.8	1.0	1.5	c [mm]	-	1.3	1.3	3.0	W [kgf]	-	2.0	4.0	5.0	
Chip size	1005	1608	2012	3216																							
a [mm]	-	1.0	1.0	1.3																							
B [mm]	-	0.8	1.0	1.5																							
c [mm]	-	1.3	1.3	3.0																							
W [kgf]	-	2.0	4.0	5.0																							
Bending Strength	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	According to JIS C 6485 Distance : 1mm Speed : 30mm/min																									
Maximum Peak Current Ip (A)	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	8/20μs waveform impulse of +/- each polarity Measurement at room temperature after placing for 24 hours																									
Max Transient Energy Et (J)	① No visible damage ② $\Delta V/V1mA \leq \pm 10\%$	On standard circumstance Impulse the 10/1000μs specified current wave 1 times Measurement at room temperature after placing for 24 hours																									

Multi Layer Chip Varistors

■ Packing (Reel, Emboss Packing)

Reel Dimension

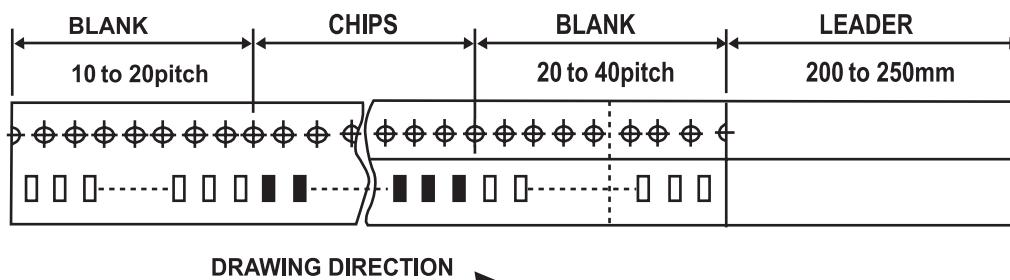


Number of packages

Type	Quality (pcs/Reel)
1005 (0402)	10,000
1608 (0603)	4,000
2012 (0805)	4,000
3216 (1206)	3,000
3225 (1210)	3,000

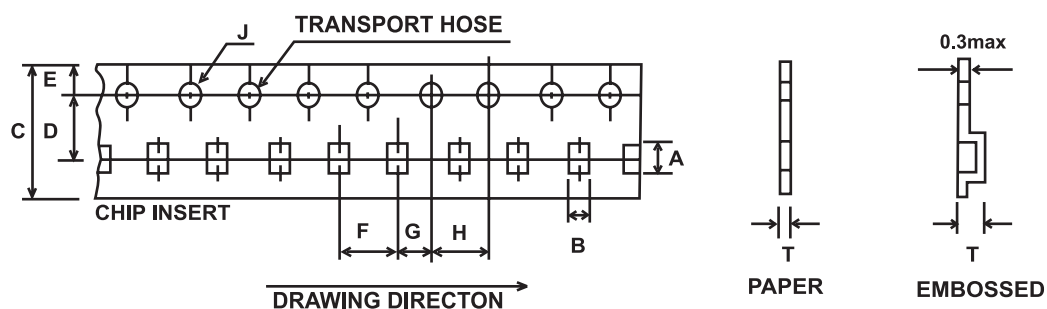
A	B	C	D	E	W	R	t
$\phi 178 \pm 2$	$\phi 50 \text{min}$	$\phi 13 \pm 0.5$	21.0 ± 0.8	2.0 ± 0.5	10.0 ± 0.5	1.0	2.0 ± 0.5

Leader and blank portion



Multi Layer Chip Varistors

■ Taping dimension



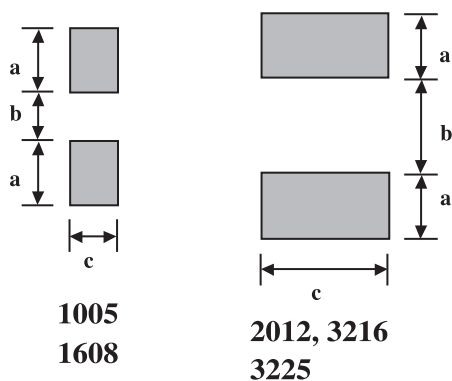
TYPE	EIA CODE	A	B	C	D	E
1005	0402	1.15 ± 0.1	0.65 ± 0.1	8.0 ± 0.3	3.5 ± 0.05	1.75 ± 0.1
1608	0603	2.0 ± 0.2	1.20 ± 0.2			
2012	0805	2.4 ± 0.2	1.65 ± 0.2			
3216	1206	3.6 ± 0.2	2.00 ± 0.2			
3225	1210	3.6 ± 0.2	2.90 ± 0.2			

TYPE	EIA CODE	F	G	H	J	T(max)	
						Paper	Emboss
1005	0402	2.0±0.05	1.0±0.05	2.0±0.05	1.5±0.1/-0	0.8	-
1608	0603	4.0±0.1	2.0±0.05	4.0±0.1		1.1	-
2012	0805					1.1	2.0
3216	1206					1.1	2.0
3225	1210					-	2.0

Multi Layer Chip Varistors

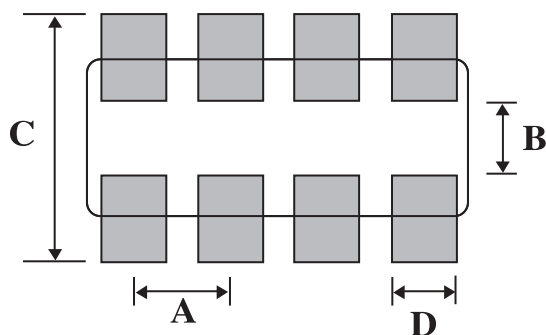
Land Pattern Design

General Chip Pattern



Size	a	b	c
1005	0.7	0.5	0.5
1608	1.0	0.8	0.8
2012	1.0	1.0	1.2
3216	1.1	2.2	1.6
3225	1.1	2.2	2.5

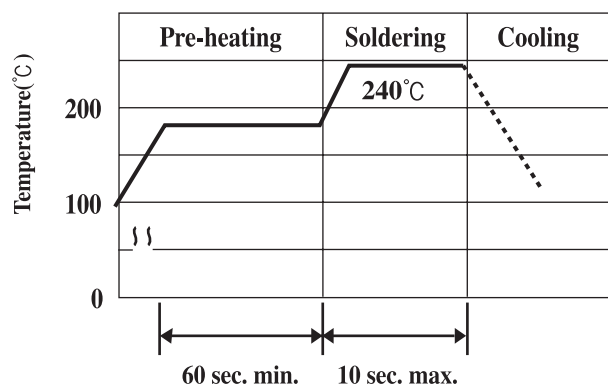
Array Pattern



SIZE	MP2N1220	MP4N1632
A	1.2	0.8
B	0.6	0.8
C	2.6	3.0
D	0.4	0.4

Soldering profile

Flow Soldering



Reflow Soldering

