

## ES Series of Surface Mount Multilayer Varistors

### Features:

- Fast Response < 0.5ns
- Low Working Voltage 3.3V
- Low Capacitance
- Low Leakage Current < 1 $\mu$ A
- Low Clamping Voltage

### Applications:

- Cell Phones
- Digital Cameras
- PDAs
- MP3
- Notebooks

Part Number	Working Voltage (max)	Clamping Voltage (max)	Leakage Current	Cap.	Tolerance of Cap.
	DC (V)	(V)	I <sub>LDC</sub> ( $\mu$ A)	(pF)	(%)
MLV0402ES005V0100N	5	55	1	100	$\pm 30$
MLV0402ES005V0056N	5	55	1	56	$\pm 30$
MLV0402ES005V0033N	5	55	1	33	$\pm 30$
MLV0402ES005V0022N	5	55	1	22	$\pm 30$
MLV0402ES005V0010N	5	60	1	10	$\pm 30$
MLV0402ES005V0005P	5	76	1	5~9	+80 / -20
MLV0402ES006V00R2P	6	30	0.05	0.2	$\pm 50$
MLV0402ES012V0100N	12	55	1	100	$\pm 30$
MLV0402ES012V0056N	12	55	1	56	$\pm 30$
MLV0402ES012V0033N	12	55	1	33	$\pm 30$
MLV0402ES012V0022N	12	55	1	22	$\pm 30$
MLV0402ES012V0010N	12	60	1	10	$\pm 30$
MLV0402ES012V0005P	12	80	1	4~9	+80 / -20
MLV0402ES024V02R5P	24	198	1	2~4	+80 / -20
MLV0402ES024V00R8P	24	200	1	0.8~1.5	+80 / -20
MLV0402ES024V00R1P	24	50	0.001	0.05~0.15	+80 / -20
MLV0603ES005V0100N	5	55	1	100	$\pm 30$
MLV0603ES005V0056N	5	55	1	56	$\pm 30$
MLV0603ES005V0033N	5	55	1	33	$\pm 30$
MLV0603ES005V0022N	5	55	1	22	$\pm 30$
MLV0603ES005V0010N	5	60	1	10	$\pm 30$
MLV0603ES005V0005P	5	76	1	5~9	+80 / -20
MLV0603ES006V00R2P	6	30	0.05	0.2	$\pm 50$
MLV0603ES012V0100N	12	55	1	100	$\pm 30$
MLV0603ES012V0056N	12	55	1	56	$\pm 30$
MLV0603ES012V0033N	12	55	1	33	$\pm 30$
MLV0603ES012V0022N	12	55	1	22	$\pm 30$
MLV0603ES012V0010N	12	60	1	10	$\pm 30$
MLV0603ES012V0005P	12	80	1	4~9	+80 / -20
MLV0603ES024V02R5P	24	198	1	2~4	+80 / -20
MLV0603ES024V00R8P	24	200	1	0.8~1.5	+80 / -20
MLV0603ES024V00R1P	24	50	0.001	0.05~0.15	+80 / -20

# NA Series of Surface Mount Multilayer Varistors

## Features:

- Fast Response < 0.5ns
- Low Capacitance
- Low Clamping Voltage and High Energy Absorption

## Applications:

- Telecommunications
- Automotive Systems
- Data Systems
- Power Supplies

Part Number	Working Voltage (max)		Breakdown Voltage	Peak Current (max)	Clamping Voltage (max)		Energy Absorption (max)	Typical Capacitance
	AC (V <sub>RMS</sub> )	DC (V)			1mA (V)	8/20μs (A)		
MLV0402NA006V0020	4	5.5	8(7.5~10.5)	20	1	20	0.05	200
MLV0402NA009V0020	6	9	12(10.2~13.8)	20	1	23	0.05	135
MLV0402NA011V0020	8	11	15(12.8~17.3)	20	1	23	0.05	75
MLV0402NA014V0020	11	14	18(16.2~19.8)	20	1	25	0.05	50
MLV0402NA018V0020	14	18	24(21.6~26.4)	20	1	30	0.05	45
MLV0603NA006V0030	4	5.5	8(7.5~10.5)	30	1	20	0.1	360
MLV0603NA009V0030	6	9	12(10.2~13.8)	30	1	23	0.1	300
MLV0603NA014V0030	11	14	18(15.3~20.7)	30	1	30	0.1	210
MLV0603NA018V0030	14	18	24(21.6~26.4)	30	1	39	0.1	160
MLV0603NA022V0030	17	22	27(24.3~29.7)	30	1	44	0.1	145
MLV0603NA030V0030	25	30	39(35.1~42.9)	30	1	65	0.1	110
MLV0603NA038V0030	30	38	47(42.3~51.7)	30	1	77	0.1	90
MLV0805NA006V0080	4	5.5	8(7.5~10.5)	80	1	20	0.1	1400
MLV0805NA009V0080	6	9	12(10.2~13.8)	80	1	23	0.1	650
MLV0805NA011V0100	8	11	15(12.75~17.25)	100	1	25	0.2	410
MLV0805NA014V0100	11	14	18(15.3~20.7)	100	1	30	0.2	350
MLV0805NA018V0100	14	18	24(21.6~26.4)	100	1	39	0.2	300
MLV0805NA022V0100	17	22	27(24.3~29.7)	100	1	44	0.2	250
MLV0805NA026V0100	20	26	33(29.7~36.3)	100	1	54	0.3	220
MLV0805NA030V0100	25	30	39(35.1~42.9)	100	1	65	0.3	200
MLV0805NA038V0100	30	38	47(42.3~51.7)	100	1	77	0.3	150
MLV0805NA045V0080	35	45	56(50.4~61.6)	80	1	90	0.3	110

## NA Series of Surface Mount Multilayer Varistors

Part Number	Working Voltage (max)		Breakdown Voltage	Peak Current (max)	Clamping Voltage (max)		Energy Absorption (max)	Typical Capacitance
	AC (V <sub>RMS</sub> )	DC (V)			1mA (V)	8/20μs (A)		
MLV1206NA006V0100	4	5.5	8(7.5~10.5)	100	1	20	0.2	3100
MLV1206NA014V0100	11	14	18(15.3~20.7)	100	1	30	0.3	800
MLV1206NA018V0100	14	18	24(21.6~26.4)	100	1	38	0.3	620
MLV1206NA022V0100	17	22	27(24.3~29.7)	100	1	44	0.4	700
MLV1206NA026V0100	20	26	33(29.7~36.3)	100	1	54	0.5	480
MLV1206NA030V0100	25	30	39(35.1~42.9)	100	1	65	0.6	400
MLV1206NA038V0100	30	38	47(42.3~51.7)	100	1	77	0.7	260
MLV1206NA045V0100	35	45	56(50.4~61.6)	100	1	90	0.8	230
MLV1206NA056V0100	40	56	68(61.2~74.8)	100	1	110	1.0	200
MLV1206NA065V0100	50	65	82(73.8~90.2)	100	1	135	0.5	175
MLV1206NA085V0100	60	85	100(90~110)	100	1	165	0.6	150
MLV1210NA006V0250	4.5	5.5	8(7.5~10.5)	250	2.5	20	0.5	5200
MLV1210NA018V0250	14	18	24(21.6~26.4)	250	2.5	38	0.8	1150
MLV1210NA022V0250	17	22	27(24.3~29.7)	250	2.5	44	1.0	1720
MLV1210NA026V0250	20	26	33(29.7~36.3)	250	2.5	54	1.2	610
MLV1210NA030V0250	25	30	39(35.1~42.9)	250	2.5	65	1.4	920
MLV1210NA038V0250	30	38	47(42.3~51.7)	250	2.5	77	1.6	780
MLV1210NA045V0250	35	45	56(50.4~61.6)	250	2.5	90	2.0	400
MLV1210NA056V0250	40	56	68(61.2~74.8)	250	2.5	110	2.3	300
MLV1210NA085V0200	60	85	100(90~110)	200	2.5	165	1.4	210
MLV1812NA018V0500	14	18	24(21.6~26.4)	500	5	38	1.7	2000
MLV1812NA030V0500	25	30	39(35.1~42.9)	500	5	65	2.9	2500
MLV1812NA038V0500	30	38	47(42.3~51.7)	500	5	77	3.5	2200
MLV1812NA045V0500	35	45	56(50.4~61.6)	500	5	90	4.2	1000
MLV2220NA018V1000	14	18	24(21.6~26.4)	1000	10	38	3.1	8500
MLV2220NA030V1000	25	30	39(35.1~42.9)	1000	10	65	5.5	3900
MLV2220NA038V1000	30	38	47(42.3~51.7)	1000	10	77	6.3	4600

# HA Series of Surface Mount Multilayer Varistors

## Features:

- Fast Response < 0.5ns
- Low Capacitance
- Low Clamping Voltage and High Energy Absorption

## Applications:

- Telecommunications
- Automotive Systems
- Data Systems
- Power Supplies

Part Number	Working Voltage (max)		Breakdown Voltage	Peak Current (max)	Clamping Voltage (max)		Energy Absorption (max)	Typical Capacitance
	AC (V <sub>RMS</sub> )	DC (V)			1mA (V)	8/20μs (A)		
MLV1206HA014V0200	11	14	18(15.3~20.7)	200	1	30	0.5	1200
MLV1206HA018V0200	14	18	24(21.6~27.0)	200	1	39	0.5	780
MLV1206HA022V0200	17	22	27(24.3~29.8)	200	1	44	0.7	750
MLV1206HA026V0200	20	26	33(29.7~36.3)	200	1	54	1.0	700
MLV1206HA030V0200	25	30	39(35.1~42.9)	200	1	65	1.0	510
MLV1206HA038V0200	30	38	47(42.3~51.7)	200	1	77	1.1	440
MLV1210HA014V0400	11	14	18(15.3~20.7)	400	2.5	30	1.2	2000
MLV1210HA018V0400	14	18	24(21.6~26.4)	400	2.5	39	1.4	1600
MLV1210HA022V0400	17	22	27(24.3~29.7)	400	2.5	44	1.7	1500
MLV1210HA026V0400	20	26	33(29.7~36.3)	400	2.5	54	1.9	880
MLV1210HA030V0400	25	30	39(35.1~42.9)	400	2.5	65	1.7	800
MLV1210HA038V0400	30	38	47(42.3~51.7)	400	2.5	77	2.0	530
MLV1812HA018V0800	14	18	24(21.6~27.0)	800	5	38	2.3	3500
MLV1812HA030V0800	25	30	39(35.1~42.9)	800	5	65	3.7	2350
MLV1812HA038V0800	30	38	47(42.3~51.7)	800	5	77	4.2	1600
MLV1812HA045V0800	35	45	56(50.4~61.6)	800	5	90	4.2	1200
MLV2220HA014V1200	11	14	18(15.3~20.7)	1200	10	30	5.4	10500
MLV2220HA018V1200	14	18	24(21.6~27.0)	1200	10	39	5.8	8500
MLV2220HA022V1200	17	22	27(24.3~29.8)	1200	10	44	7.2	8300
MLV2220HA026V1200	20	26	33(29.7~36.3)	1200	10	54	7.8	8000
MLV2220HA030V1200	25	30	39(35.1~42.9)	1200	10	65	9.6	6000
MLV2220HA038V1200	30	38	47(42.3~51.7)	1200	10	77	12.0	4000
MLV2220HA045V1200	35	45	56(50.4~61.6)	1200	10	90	12.0	3500

# Surface Mount Multilayer Varistors

## Product Identification

MLV 0402 ES 012V 0100 N T  
 (1) (2) (3) (4) (5) (6) (7)

- (1) Series Code:  
**MLV** – Surface Mount Multilayer Varistor
- (2) Size Code:  
 Standard EIA Chip Size
- (3) Application Code:  
**ES** – Electro-static Discharge Protection  
**NA** – Normal Surge Protection  
**HA** – High Surge Protection
- (4) Max. Working Voltage:  
**012V** – 12V
- (5) Capacitance for ES Series:  
**0100** – 100pF  
**02R5** – 2.5pF  
 Peak Current for HA/NA Series:  
**0100** – 100A
- (6) Capacitance Tolerance for ES Series:  
**N** –  $\pm 30\%$   
**P** –  $+80\% / -20\%$
- (7) Packaging Code:  
**T** – Tape & Reel

## Operating Temperatures:

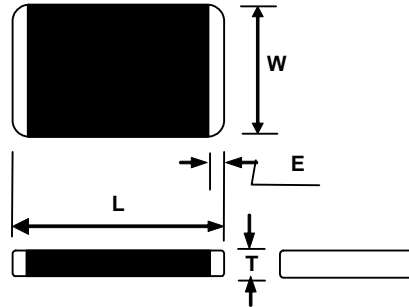
- 55°C to +85°C for size 0603 or smaller  
 -55°C to +125°C for size 0805 or larger

## Terms and Definitions

Term	Definition
Max. Working Voltage	Maximum steady-state DC operating voltage with typical leakage current less than 50 $\mu$ A at 25°C
Varistor Voltage (BDV)	Breakdown DC voltage measured at current of 1mA
Max. Clamping Voltage	Maximum peak voltage across the part, measured at a specified pulse current and waveform
Surge Current	Maximum peak current with the specified 8/20 $\mu$ s waveform without damage
Surge Shift $\Delta V/V$	The change of varistor voltage after applying the specified surge current
Energy Absorption	Maximum energy dissipated with a specified 10/1000 $\mu$ s waveform without damage
Typical Capacitance	Capacitance measured with voltage bias less than 0.5V <sub>RMS</sub> at 1KHz
Nonlinear Exponent $\alpha$	$\alpha = \left( \log (V_{1mA}/V_{0.1mA}) / \log (I_{V1mA}/I_{V0.1mA}) \right)$
Leakage Current	Typical leakage current at 25°C < 50 $\mu$ A; Maximum leakage 200 $\mu$ A.

# Surface Mount Multilayer Varistors

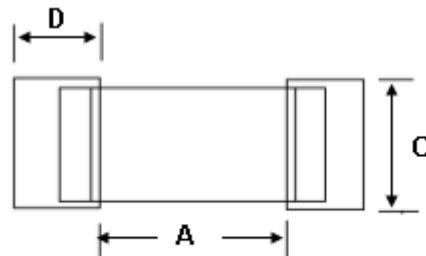
## Shape and Dimensions



Size	L (mm)	W (mm)	T (mm)	E (mm)
0402	1.00 ± 0.10	0.50 ± 0.10	0.50 ± 0.10	0.25 ± 0.10
0603	1.60 ± 0.15	0.80 ± 0.15	0.90 max.	0.30 ± 0.10
0805	2.00 ± 0.20	1.25 ± 0.15	1.00 max.	0.30 ± 0.10
1206	3.20 ± 0.20	1.60 ± 0.15	1.20 max.	0.50 ± 0.20
1210	3.20 ± 0.20	2.50 ± 0.20	1.50 max.	0.50 ± 0.20
1812	4.50 ± 0.20	3.20 ± 0.20	2.00 max.	0.60 ± 0.20
2220	5.70 ± 0.20	5.00 ± 0.20	3.00 max.	0.60 ± 0.20

## Recommended Land Patterns

Size	Solder pad layout		
	A (mm)	C (mm)	D (mm)
0402	0.4~0.6	0.5~0.6	0.5~0.7
0603	0.9~1.2	0.6~1.0	0.8~1.2
0805	1.0~1.5	1.2~1.5	1.0~1.4
1206	1.8~2.5	1.2~1.8	1.0~1.4
1210	1.8~2.5	2.2~3.0	1.0~1.4
1812	2.5~3.3	2.8~3.6	1.2~1.8
2220	3.8~4.6	4.8~5.5	1.2~1.8



# Surface Mount Multilayer Varistors

## Environmental Tests

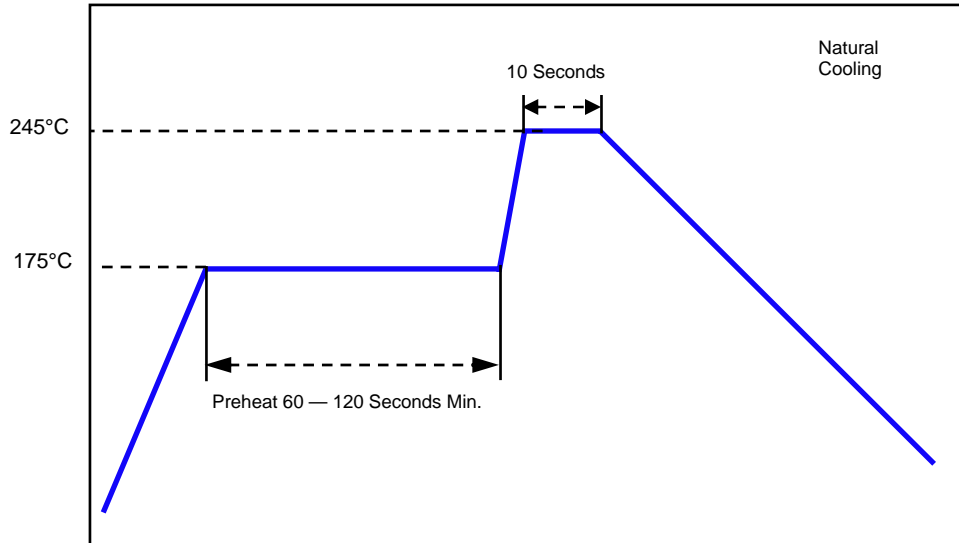
No.	Test	Requirement	Test condition	Test reference
1	Soldering heat resistance	BDV change $\leq \pm 10\%$ No mechanical damage	One dip at 260°C for 5 sec.	MIL-STD-202 Method 210 IEC 60068-2-20
2	Solderability	New solder coverage $\geq 80\%$	One dip at 255°C for 5 sec. Non-active flux	MIL-STD-202 Method 208 IEC 60068-2-20
3	Maximum surge current	BDV change $\leq \pm 10\%$ No mechanical damage	100 pulses of 8/20 $\mu\text{s}$ with maximum surge current and 30 sec. interval at 25°C and 30~65% RH	CECC 42000 IEC 1051-1 Test 4.5
4	Maximum surge energy	BDV change $\leq \pm 10\%$ No mechanical damage	100 pulses of 10/1000 $\mu\text{s}$ with maximum surge current and 90 sec. interval at 25°C and 30~65% RH	CECC 42000
5	Thermal cycling	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	5 cycles between -40°C and 125°C with 30 min. dwell time at the temperature extremes and 60 min. dwell time at 25°C	CECC 42000 IEC 60068-2-14
6	Low temperature resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	1000 hr at -50°C	IEC 60068-2-1
7	Low temperature load resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	1000 hr at -50°C with working voltage applied	IEC 60068-2-1
8	High temperature resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	1000 hr at 150°C	MIL-STD-202 Method 108 CECC 42000
9	High temperature load resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	1000 hr at 85°C with working voltage applied	CECC 42000
10	Humidity resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	500 hr at 40°C and 90~95% RH	MIL-STD-202 Method 103 IEC 60068-2-3 CECC 42000;
11	Humidity load resistance	BDV change $\leq \pm 10\%$ No mechanical damage Leakage current $\leq 200 \mu\text{A}$	500 hr at 40°C and 90~95% RH with working voltage applied	MIL-STD-202 Method 103 IEC 60068-2-3 CECC 42000
12	ESD contact test*	Varistor voltage change $>115\%$ working voltage	Contact electrostatic discharge 100 times with 1 second intervals at 8KV (Level 4) and polarity: +,-	IEC 61000-4-2
13	ESD air test*	Varistor voltage change $>115\%$ working voltage	Air contact electrostatic discharge 100 times with 1 second intervals at 15KV (Level 4) and polarity:+,-	IEC 61000-4-2

\* For ES series only.

# Surface Mount Multilayer Varistors

## Soldering Temperature Profiles

Recommended Temperature Profile  
for Reflow Soldering



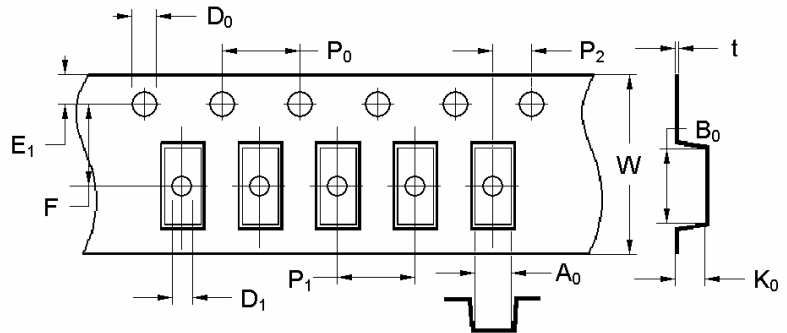
# Packaging and Storage

## Packaging

AEM's multilayer components are provided on tape-and-reel for use in pick-and-place machines or in bulk for special applications. Both tape-and-reel and bulk products are sealed in plastic bags with desiccant. The reel size can be 7 inches or 13 inches, depending on customers' preference.

### Dimensions of Tape in Inches (mm)

Size	A <sub>o</sub>	B <sub>o</sub>	K <sub>o</sub>	Type
<b>0402 (1005)</b>	0.026 ± 0.004 (0.67 ± 0.10)	0.046 ± 0.004 (1.17 ± 0.10)	0.025 ± 0.004 (0.63 ± 0.10)	Paper
<b>0603 (1608)</b>	0.039 ± 0.004 (0.98 ± 0.10)	0.071 ± 0.004 (1.80 ± 0.10)	0.037 ± 0.003 (0.95 ± 0.08)	Paper
	0.039 ± 0.004 (1.00 ± 0.10)	0.071 ± 0.004 (1.80 ± 0.10)	0.024 ± 0.003 (0.60 ± 0.08)	Paper (for FF)
	0.036 ± 0.004 (0.92 ± 0.10)	0.071 ± 0.004 (1.80 ± 0.10)	0.033 ± 0.004 (0.85 ± 0.10)	Plastic
<b>0805</b>	0.063 ± 0.004	0.093 ± 0.004	0.047 ± 0.004	Plastic
<b>1206</b>	0.071 ± 0.004	0.138 ± 0.004	0.050 ± .004	Plastic
<b>1210</b>	0.106 ± 0.004	0.137 ± 0.004	0.056 ± 0.004	Plastic
<b>1812</b>	0.144 ± 0.004	0.195 ± 0.004	0.072 ± 0.004	Plastic
<b>2220</b>	0.201 ± 0.004	0.235 ± 0.004	0.110 ± 0.004	Plastic



Size	E <sub>1</sub>	F	W	P <sub>1</sub>	P <sub>0</sub>	P <sub>2</sub>	D <sub>0</sub>	D <sub>1</sub>	t
0402(1005)	0.069 ± 0.004 (1.75 ± 0.10)	0.138 ± 0.002 (3.50 ± 0.05)	0.318 ± 0.004 (8.00 ± 0.10)	0.079 ± 0.004 (2.00 ± 0.10)	0.157 ± 0.004 (4.00 ± 0.10)	0.040 ± 0.002 (1.00 ± 0.05)	0.059 ± 0.004/-0.00 (1.50 ± 0.10/-0.00)	N/A	0.009 ± 0.001 (0.23 ± 0.02)
0603(1608)				0.157 ± 0.004 (4.00 ± 0.10)		0.079 ± 0.002 (2.00 ± 0.05)		0.039 max. (1.00 max.)	
0805(2012)				0.318 ± 0.004 (8.00 ± 0.10)					
1206(3216)			0.472 ± 0.004 (12.00 ± 0.10)	0.004(8.00 ± 0.10)					
1812(4532)			0.004(8.00 ± 0.10)						
2220(5750)			0.004(8.00 ± 0.10)						

### Packaging Data

Chip Size	Parts on 7 inch (178 mm) Reel
<b>0402(1005)</b>	<b>10,000</b>
<b>0603(1608)</b>	<b>4,000</b>
<b>0805(2012)</b>	<b>3,000</b>
<b>1206(3216)</b>	<b>3,000</b>
<b>1210(3225)</b>	<b>2,000</b>
<b>1812(4532)</b>	<b>1,000</b>
<b>2220(5750)</b>	<b>1,000</b>

## Packaging and Storage

### ***Storage***

The maximum ambient temperature shall not exceed 40°C. Storage temperatures higher than 40°C could result in the deformation of packaging materials. The maximum relative humidity recommended for storage is 70%. High humidity with high temperature can accelerate the oxidation of the solder plating on the termination and reduce the solderability of the components. Sealed plastic bags with desiccant shall be used to reduce the oxidation of the termination and should only be opened prior to use. The products should not be stored in areas where harmful gases containing sulfur or chlorine are present.

Specifications and descriptions in this literature are as accurate as known at the time of publish, but are subject to change without notice. For the most updated information, please consult the factory.

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