

## Surface Mount Multilayer Varistors

### Normal Surge Protection (NA) Series

#### Features:

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

#### Application Fields:

- Telecommunications
- Automotive Systems
- Data Systems
- Power Supplies

#### Ordering Information:

| Part Number       | Working Voltage (max)  |        | Breakdown Voltage<br>1 mA (V) | Peak Current (max)<br>8/20 $\mu$ s (A) | Clamping Voltage (max) |     | Energy Absorption (max)<br>10/1000 $\mu$ s (J) | Typical Capacitance Ref.<br>1 KHz (pF) |
|-------------------|------------------------|--------|-------------------------------|----------------------------------------|------------------------|-----|------------------------------------------------|----------------------------------------|
|                   | AC (V <sub>RMS</sub> ) | DC (V) |                               |                                        | (A)                    | (V) |                                                |                                        |
| 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                      | 25  | 0.05                                           | 75                                     |
| MLV0402NA014V0020 | 11                     | 14     | 18 (15.3~20.7)                | 20                                     | 1                      | 30  | 0.05                                           | 50                                     |
| MLV0402NA018V0020 | 14                     | 18     | 24 (21.6~26.4)                | 20                                     | 1                      | 39  | 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                                    |
| 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                                    |

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| Part Number       | Working Voltage (max)     |           | Breakdown Voltage<br>1 mA<br>(V) | Peak Current (max)<br>8/20 $\mu$ s<br>(A) | Clamping Voltage (max) |     | Energy Absorption (max)<br>10/1000 $\mu$ s<br>(J) | Typical Capacitance<br>1 KHz<br>(pF) |
|-------------------|---------------------------|-----------|----------------------------------|-------------------------------------------|------------------------|-----|---------------------------------------------------|--------------------------------------|
|                   | AC<br>(V <sub>RMS</sub> ) | DC<br>(V) |                                  |                                           | (A)                    | (V) |                                                   |                                      |
| 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                                 |
| MLV2220NA056V1000 | 40                        | 56        | 68 (61.2~74.8)                   | 1000                                      | 10                     | 110 | 8.8                                               | 4000                                 |

## 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

**MVA** -- MLV Array

(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** – 12 V

(5) Capacitance for ES Series:

**0100** – 100 pF

**02R5** – 2.5 pF

Peak Current for HA/NA Series: **0100** – 100 A

(6) Capacitance Tolerance for ES Series:

**N** – ± 30%

**P** – **Special**

(7) Packaging Code:

**T** – Tape & Reel

### Operating Temperatures:

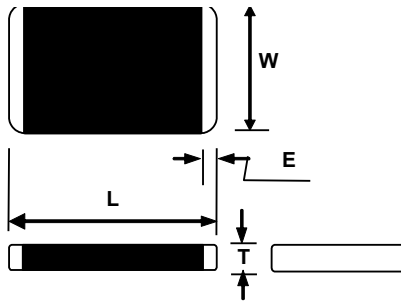
-55°C to +85°C for size 0603 or smaller

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

## Surface Mount Multilayer Varistors

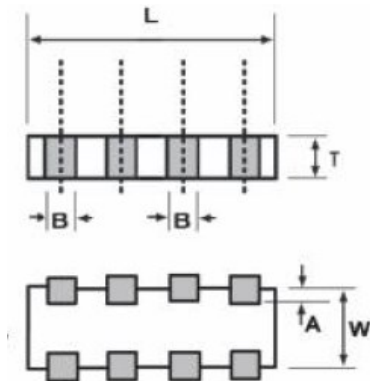
### Shape and Dimensions:

#### MLV Series



| Size | L (mm)      | W (mm)      | T (mm)      | E (mm)      |
|------|-------------|-------------|-------------|-------------|
| 0201 | 0.60 ± 0.03 | 0.30 ± 0.03 | 0.30 ± 0.03 | 0.30 ± 0.03 |
| 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 |

#### ESD Array



| Size   | 0508        | 0612        |
|--------|-------------|-------------|
| L (mm) | 2.00 ± 0.20 | 3.20 ± 0.20 |
| W (mm) | 1.25 ± 0.20 | 1.60 ± 0.15 |
| T (mm) | 0.80 max.   | 0.95 max.   |
| A (mm) | 0.20 ± 0.10 | 0.20 ± 0.10 |
| B (mm) | 0.25 ± 0.05 | 0.40 ± 0.15 |

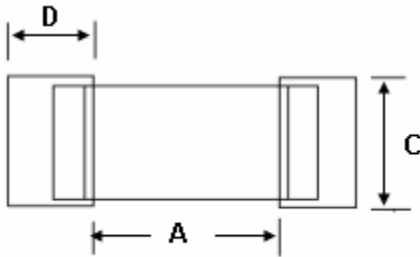
### Terms and Definitions:

| 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 1 mA                                                    |
| 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 0.5 $V_{RMS}$ at 1 KHz or 1 MHz                    |
| Nonlinear Exponent $\alpha$ | $\alpha = (\log(V_{1mA}/V_{0.1mA}) / \log(I_{V1mA}/I_{V0.1mA}))$                                    |
| Leakage Current             | Typical leakage current at 25 °C < 50 $\mu$ A; Maximum leakage 200 $\mu$ A.                         |
| Cut-off Frequency           | The frequency of -3 dB insertion loss                                                               |

# Surface Mount Multilayer Varistors

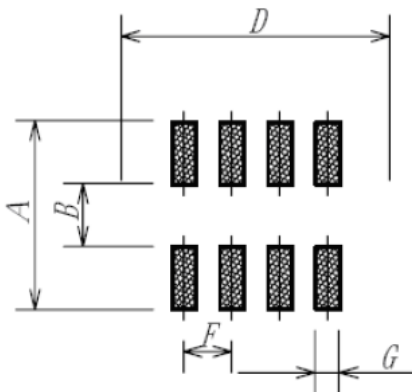
## Recommended Land Patterns:

### MLV Series



| Size | Solder pad layout |           |           |
|------|-------------------|-----------|-----------|
|      | A (mm)            | C (mm)    | D (mm)    |
| 0201 | 0.25~0.35         | 0.20~0.30 | 0.25~0.35 |
| 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   |

### ESD Array Series



| Size | A (mm) | B (mm) | D (mm) | F (mm) | G (mm) |
|------|--------|--------|--------|--------|--------|
| 0508 | 2.10   | 0.40   | 2.50   | 0.50   | 0.35   |
| 0612 | 2.60   | 0.80   | 3.60   | 0.80   | 0.50   |

## Surface Mount Multilayer Varistors

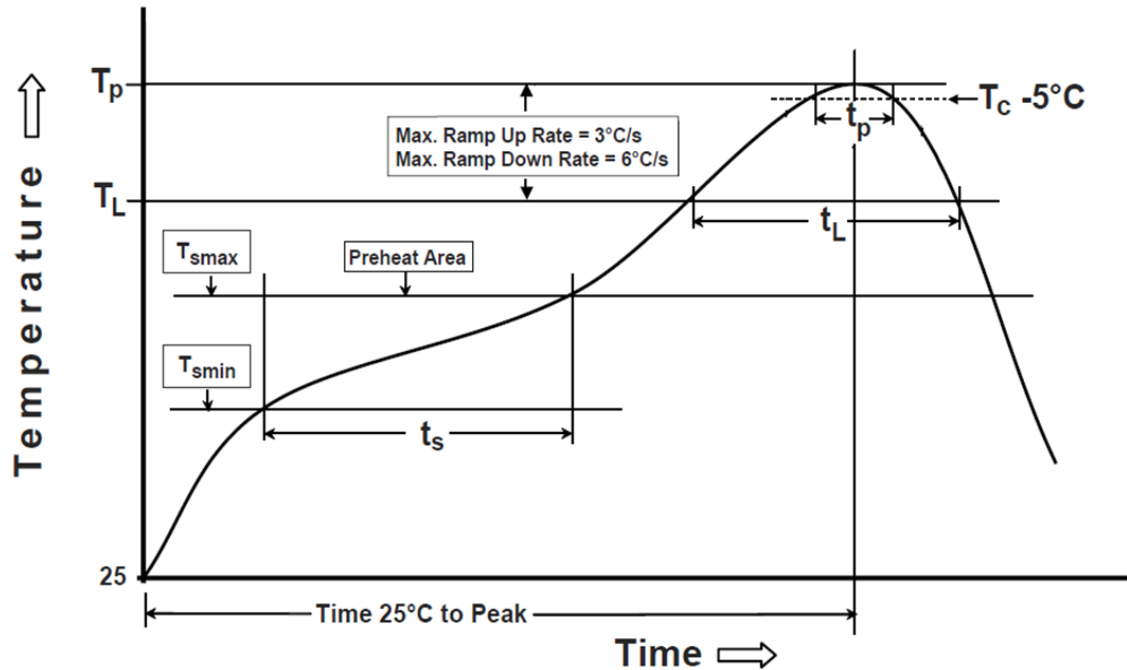
### Environmental Tests:

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

\* For ES series only.

## Surface Mount Multilayer Varistors

### Soldering Temperature Profile:



| Profile Feature                                                                                                                             | Pb-Free Assembly                 |
|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>Preheat/Soak</b><br>Temperature Min ( $T_{smin}$ )<br>Temperature Max ( $T_{smax}$ )<br>Time ( $t_s$ ) from ( $T_{smin}$ to $T_{smax}$ ) | 150°C<br>200°C<br>60~120 seconds |
| Ramp-up rate ( $T_L$ to $T_p$ )                                                                                                             | 3°C/second max.                  |
| Liquidous temperature ( $T_L$ )<br>Time ( $t_L$ ) maintained above $T_L$                                                                    | 217°C<br>60~150 seconds          |
| Peak package body temperature ( $T_p$ )                                                                                                     | 260°C                            |
| Time ( $t_p$ )* within $5^\circ\text{C}$ of the specified classification temperature ( $T_c$ )                                              | 30 seconds *                     |
| Ramp-down rate ( $T_p$ to $T_L$ )                                                                                                           | 6°C/second max.                  |
| Time 25°C to peak temperature                                                                                                               | 8 minutes max.                   |
| * Tolerance for peak profile temperature ( $T_p$ ) is defined as a supplier minimum and a user maximum                                      |                                  |

## Disclaimer

*Specifications are subject to change without notice. AEM products are designed for specific applications and should not be used for any purpose (including, without limitation, automotive, aerospace, medical, life-saving applications, or any other application which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property) not expressly set forth in applicable AEM product documentation. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Warranties granted by AEM shall be deemed void for products used for any purpose not expressly set forth in applicable AEM product documentation. AEM shall not be liable for any claims or damages arising out of products used in applications not expressly intended by AEM as set forth in applicable AEM product documentation. The sale and use of AEM products is subject to AEM terms and conditions of sale. Please refer*