

Multilayer Ceramic Chip Capacitors for Automotive Powertrain & Safety

E0402X7R222K500NTB (0402,X7R,2.2 nF,DC 50V)

1. Scope

This specification applies to Automotive-grade Power Safety-Critical Multilayer Ceramic Capacitors (MLCCs). Specifically intended for:

Powertrain safety-critical applications including: Triple-electric systems; Body Control Modules (BCM); Electromechanical Braking Systems.

Application Scope: Wide-bandgap power devices (e.g. SiC); Triple-electric platforms: On-board chargers (OBC), DC-DC converters, Inverters, E-drive systems, DC-Link capacitors

Core systems: Propulsion systems, Safety-critical systems, Mission-critical sensors

2. Part Number System

|             |           |                             |                     |                       |               |                  |                |                |
|-------------|-----------|-----------------------------|---------------------|-----------------------|---------------|------------------|----------------|----------------|
| E           | 0402      | X7R                         | 222                 | K                     | 500           | N                | T              | B              |
| ①           | ②         | ③                           | ④                   | ⑤                     | ⑥             | ⑦                | ⑧              | ⑨              |
| Series Code | Size Code | Temperature Characteristics | Nominal Capacitance | Capacitance Tolerance | Rated Voltage | Termination Type | Packaging Code | Thickness Code |

① Series Code E-Multilayer Ceramic Chip Capacitors for Automotive Powertrain & Safety

② Size Code (Unit: mm)



Fig.1 Structure & Dimension

| Size Code | L           | W           | L1,L2     | g        | T           | ⑨ Thickness Code |
|-----------|-------------|-------------|-----------|----------|-------------|------------------|
| 0402      | 1.00 ± 0.05 | 0.50 ± 0.05 | 0.15-0.35 | 0.30 min | 0.50 ± 0.05 | B                |

③ Temperature Characteristics

| Temperature Characteristics | Operating Temp. Range | Temperature Characteristics |               |            |
|-----------------------------|-----------------------|-----------------------------|---------------|------------|
|                             |                       | Temp. coeff. or Cap. Change | Temp. Range   | Ref. Temp. |
| X7R                         | -55 °C-125 °C         | ±15%                        | -55 °C-125 °C | 25 °C      |

④ Nominal Capacitance

| Code | Nominal Capacitance |
|------|---------------------|
| 222  | 2.2 nF              |

⑤ Capacitance Tolerance

| Code | Capacitance Tolerance |
|------|-----------------------|
| K    | ±10%                  |

⑥ Rated Voltage

| Code | Voltage Values |
|------|----------------|
| 500  | DC 50 V        |

⑦ Termination Type

| Code | Terminal Electrodes | Plating Material |
|------|---------------------|------------------|
| N    | Cu                  | Ni/Sn            |

⑧ Packaging Code

| Code | Square Hole Spacing | Disc Size | Carrier Tape | QTY (Kpcs) |
|------|---------------------|-----------|--------------|------------|
| T    | 2 mm                | 7 ″       | Paper        | 10         |

3. Technical Specifications and Test Methods

1. Operating Environment

| Temp. Characteristics | Temp. Range   | Relative Humidity | Atmospheric Pressure |
|-----------------------|---------------|-------------------|----------------------|
| X7R                   | -55 °C-125 °C | ≤95% (25 °C)      | 86 Kpa-106 KPa       |

3.2 Reliability Test Specifications and Methods

Table 1: Specifications and Test Methods

| No.             | Item<br>AEC-Q200 Test Item                   |               | Specification<br>Class 2 ( High dielectric constant type)                                                                          | Test Method                                |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|-----------------|----------------------------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------|------------|---|-----|--------|---|------------|---|---|-----|--------|---|------------|---|
| 1               | Pre-and Post-Stress<br>Electrical Test       |               |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 2               | High<br>Temperature<br>Exposure<br>(Storage) | Appearance    | No defects or abnormalities.                                                                                                       | Pre-treatment                              | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure.                                                                                                                                                                                                          |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| Cap. Change     |                                              | See Table 1-3 | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| IR (Room Temp.) |                                              | See Table 1-3 | Test temperature                                                                                                                   | (150 ± 3) °C                               |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| DF              |                                              | See Table 1-3 | Test time                                                                                                                          | (1000 ± 12) h                              |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Post-treatment                             | Let sit for (24 ± 2) h at room temperature, then measure.                                                                                                                                                                                                                                                               |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 3               | Temperature<br>Cycling                       | Appearance    | No defects or abnormalities.                                                                                                       | Pre-treatment                              | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure.                                                                                                                                                                                                          |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| Cap. Change     |                                              | See Table 1-3 | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| IR (Room Temp.) |                                              | See Table 1-3 | Mounting method                                                                                                                    | Solder the capacitor to the test substrate |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| DF              |                                              | See Table 1-3 | The number of cycles                                                                                                               | 1000 cycles                                |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Temperature Step                           | <table><tr><td>Step</td><td>Temp.(°C)</td><td>Time (min)</td></tr><tr><td>1</td><td>-55</td><td>30 ± 3</td></tr><tr><td>2</td><td>Room Temp.</td><td>1</td></tr><tr><td>3</td><td>125</td><td>30 ± 3</td></tr><tr><td>4</td><td>Room Temp.</td><td>1</td></tr></table>                                                  | Step | Temp.(°C) | Time (min) | 1 | -55 | 30 ± 3 | 2 | Room Temp. | 1 | 3 | 125 | 30 ± 3 | 4 | Room Temp. | 1 |
| Step            | Temp.(°C)                                    | Time (min)    |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 1               | -55                                          | 30 ± 3        |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 2               | Room Temp.                                   | 1             |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 3               | 125                                          | 30 ± 3        |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 4               | Room Temp.                                   | 1             |                                                                                                                                    |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Post-treatment                             | Let sit for (24 ± 2) h at room temperature, then measure.                                                                                                                                                                                                                                                               |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 4               | Destructive Physical Analysis<br>(DPA)       |               | No defects or abnormalities.                                                                                                       | EIA-469                                    |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| 5               | Biased Humidity<br>(8585)                    | Appearance    | No defects or abnormalities.                                                                                                       | Pre-treatment                              | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure.                                                                                                                                                                                                          |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| Cap. Change     |                                              | See Table 1-3 | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                            |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| IR (Room Temp.) |                                              | See Table 1-3 | Mounting method                                                                                                                    | Solder the capacitor to the test substrate |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
| DF              |                                              | See Table 1-3 | Test temperature                                                                                                                   | (85 ± 3) °C                                |                                                                                                                                                                                                                                                                                                                         |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Test humidity                              | (85 ± 3)% RH                                                                                                                                                                                                                                                                                                            |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Test time                                  | (1000 ± 12) h                                                                                                                                                                                                                                                                                                           |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Test voltage                               | Rated voltage (U <sub>R</sub> ≤ 1000 V) and 1.3 V-1.5 Vdc (Add 100 kfi resister)<br><br>1000 ± 50 V (U <sub>R</sub> > 1000 V) and 1.3 V-1.5 Vdc (Add 100 kfi resister)<br><br>Note: For silver-containing ceramics (e.g., palladium-silver electrodes), low-voltage partial testing must be carried out simultaneously. |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | The charge/discharge current               | ≤ 50 mA                                                                                                                                                                                                                                                                                                                 |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |
|                 |                                              |               |                                                                                                                                    | Post-treatment                             | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure.                                                                                                                                                                                                          |      |           |            |   |     |        |   |            |   |   |     |        |   |            |   |

Table 1: Specifications and Test Methods

| No. | Item<br>AEC-Q200 Test Item   |                 | Specification<br>Class 2 ( High dielectric constant type) | Test Method                                                                                                                        |                                                                                                                |
|-----|------------------------------|-----------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 6   | Operational Life             | Appearance      | No defects or abnormalities.                              | Pre-treatment                                                                                                                      | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure. |
|     |                              | Cap. Change     | See Table 1-3                                             | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                                                                                                |
|     |                              | IR (Room Temp.) | See Table 1-3                                             | Mounting method                                                                                                                    | Solder the capacitor to the test substrate                                                                     |
|     |                              | DF              | See Table 1-3                                             | Test temperature                                                                                                                   | 125 °C ± 3 °C                                                                                                  |
|     |                              |                 |                                                           | Test time                                                                                                                          | (1000 ± 12) h                                                                                                  |
|     |                              |                 |                                                           | Test voltage                                                                                                                       | See Table 1-3                                                                                                  |
|     |                              |                 |                                                           | The charge/discharge current                                                                                                       | ≤ 50 mA                                                                                                        |
|     |                              |                 |                                                           | Post-treatment                                                                                                                     | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure. |
| 7   | Appearance                   |                 | No defects or abnormalities.                              | Visual inspection under 10x microscope                                                                                             |                                                                                                                |
| 8   | Physical Dimension           |                 | See Fig.1                                                 | Measuring by gages which precision is not less than 0.01 mm.                                                                       |                                                                                                                |
| 9   | Mechanical Shock             | Appearance      | No defects or abnormalities.                              | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                                                                                                |
|     |                              | Cap. Change     | Within the specified initial value                        | Mounting method                                                                                                                    | Solder the capacitor to the test substrate                                                                     |
|     |                              | IR (Room Temp.) | Within the specified initial value                        | Holding Time                                                                                                                       | 0.5 ms                                                                                                         |
|     |                              | DF              | Within the specified initial value                        | Peak value                                                                                                                         | 1500 g                                                                                                         |
|     |                              |                 |                                                           | Velocity change                                                                                                                    | 4.7 m/s                                                                                                        |
|     |                              |                 |                                                           | Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks).             |                                                                                                                |
|     |                              |                 |                                                           | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                                                                                                |
|     |                              |                 |                                                           | Mounting method                                                                                                                    | Solder the capacitor to the test substrate                                                                     |
| 10  | Vibration                    | Cap. Change     | Within the specified initial value                        | Frequency                                                                                                                          | 10 Hz to 2000 Hz and return to 10 Hz                                                                           |
|     |                              | IR (Room Temp.) | Within the specified initial value                        | Amplitude                                                                                                                          | 1.5 mm                                                                                                         |
|     |                              | DF              | Within the specified initial value                        | Vibration Time                                                                                                                     | 20 min                                                                                                         |
|     |                              |                 |                                                           | This motion should be applied for 12 cycles in each 3 mutually perpendicular directions (total of 36 times).                       |                                                                                                                |
|     |                              |                 |                                                           | Pre-treatment                                                                                                                      | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure. |
|     |                              |                 |                                                           | Pre-heating                                                                                                                        | 120 °C-150 °C,Time: 60 s                                                                                       |
|     |                              |                 |                                                           | Test Method                                                                                                                        | Solder bath                                                                                                    |
|     |                              |                 |                                                           | Solder alloy                                                                                                                       | Sn-Ag-Cu (Lead Free Solder)                                                                                    |
| 11  | Resistance to Soldering Heat | Cap. Change     | Within the specified initial value                        | Solder temp.                                                                                                                       | (260 ± 5) °C                                                                                                   |
|     |                              | IR (Room Temp.) | Within the specified initial value                        | Duration of immersion                                                                                                              | (10 ± 1) s                                                                                                     |
|     |                              | DF              | Within the specified initial value                        | Depth of immersion                                                                                                                 | (10 ± 1) mm                                                                                                    |
|     |                              |                 |                                                           | Post-treatment                                                                                                                     | Let sit for (24 ± 2) h at room temperature, then measure.                                                      |
|     |                              |                 |                                                           | Per AEC-Q200-002                                                                                                                   |                                                                                                                |
|     |                              |                 |                                                           | Pre-treatment                                                                                                                      | Perform heat treatment at (150 +0/−10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure. |
|     |                              |                 |                                                           | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                                                                                                |
|     |                              |                 |                                                           | Mounting method                                                                                                                    | Solder the capacitor to the test substrate                                                                     |
| 12  | ESD                          | Appearance      | No defects or abnormalities.                              | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles. |                                                                                                                |
|     |                              | Cap. Change     | Within the specified initial value                        | Mounting method                                                                                                                    | Solder the capacitor to the test substrate                                                                     |
|     |                              | IR (Room Temp.) | Within the specified initial value                        | Holding Time                                                                                                                       | 0.5 ms                                                                                                         |
|     |                              | DF              | Within the specified initial value                        | Peak value                                                                                                                         | 1500 g                                                                                                         |

Table 1: Specifications and Test Methods

| No. | Item<br>AEC-Q200 Test Item |                 | Specification<br>Class 2 ( High dielectric constant type)         | Test Method                                                                                                      |                                                                                                                                                                                                                                             |
|-----|----------------------------|-----------------|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13  | Solderability              | Appearance      | 95% of the terminations is to be soldered evenly and continuously | Pre-heating<br>Test Method<br>Flux<br>Solder alloy<br>Temperature<br>Duration of immersion<br>Depth of immersion | Temp.: 155 °C/Time: 4 h<br>Solder bath<br>Solution of rosin ethanol<br>Sn-Ag-Cu (Lead Free Solder)<br>(245 ± 5) °C<br>(5.0 ± 0.5) s<br>(10 ± 1) mm                                                                                          |
| 14  |                            | Capacitance     | Within the specified tolerance                                    | Measurement Temperature                                                                                          | 18 °C-28 °C                                                                                                                                                                                                                                 |
| 15  |                            | DF              | See Table 1-2                                                     | Relative Humidity<br>Measurement Frequency<br>Measurement Voltage                                                | ≤80% RH<br>$C \leq 10 \mu\text{F}$ , $f = 1.0 \pm 0.1 \text{ KHz}$ ; $C > 10 \mu\text{F}$ , $f = 120 \pm 24 \text{ Hz}$<br>$C \leq 10 \mu\text{F}$ , $U = 1.0 \pm 0.2 \text{ Vrms}$ ; $C > 10 \mu\text{F}$ , $U = 0.5 \pm 0.1 \text{ Vrms}$ |
| 16  |                            | IR (Room Temp.) | See Table 1-2                                                     | Measurement Temperature<br>Measurement Voltage<br>Charging Time<br>The charge/discharge current                  | 25 °C<br>$U_R < 500 \text{ V}$ : $U_R$<br>$U_R \geq 500 \text{ V}$ : $500 \text{ V} \pm 50 \text{ V}$<br>1 min<br>≤ 50 mA                                                                                                                   |
| 17  |                            | IR (High Temp.) | See Table 1-2                                                     | Measurement Temperature<br>Measurement Voltage<br>Charging Time<br>The charge/discharge current                  | 125 °C<br>$U_R < 500 \text{ V}$ : $U_R$<br>$U_R \geq 500 \text{ V}$ : $500 \text{ V} \pm 50 \text{ V}$<br>1 min<br>≤ 50 mA                                                                                                                  |
| 18  |                            | Voltage proof   | No defects or abnormalities.                                      | Test Voltage<br>Applied Time<br>The charge/discharge current                                                     | $\geq 2.5 \times U_R$<br>$t = 1-5 \text{ s}$<br>≤ 50 mA                                                                                                                                                                                     |
| 19  | Board Flex                 | Appearance      | No defects or abnormalities.                                      | Mounting method                                                                                                  | Solder the capacitor to the test substrate as shown in Fig 2                                                                                                                                                                                |
|     |                            | Cap. Change     | Within the specified initial value                                | Pressurization Method                                                                                            | Shown in Fig 3                                                                                                                                                                                                                              |
|     |                            | IR (Room Temp.) | See Table 1-3                                                     | Speed                                                                                                            | 1 mm/s                                                                                                                                                                                                                                      |
|     |                            | DF              | Within the specified initial value                                | Flexure<br>Holding Time<br>then measure the capacitance                                                          | 2 mm<br>$t = (60 \pm 1) \text{ s}$                                                                                                                                                                                                          |

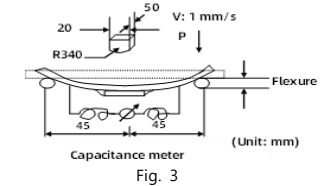
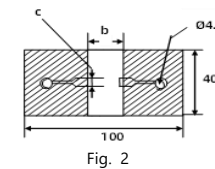


Table 1: Specifications and Test Methods

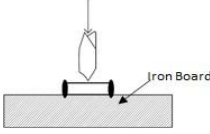
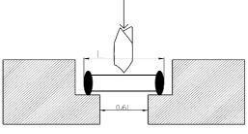
| No. | Item<br>AEC-Q200 Test Item                    |                   | Specification<br>Class 2 ( High dielectric constant type) | Test Method                                                                                                                                          |                                                                                                                |
|-----|-----------------------------------------------|-------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 20  | Terminal<br>Strength                          | Appearance        | No defects or abnormalities.                              | Subjected to 3 cycles of lead-free reflow at 260 °C (standard profile) for thermal shock testing, with ~30 minutes between cycles.                   |                                                                                                                |
|     |                                               | Cap. Change       | Within the specified initial value                        | Mounting method                                                                                                                                      | Solder the capacitor to the test substrate as shown in Fig 4                                                   |
|     |                                               | IR (Room Temp.)   | See Table 1-3                                             | Holding Time                                                                                                                                         | t = (60 ± 1) s                                                                                                 |
|     |                                               | DF                | Within the specified initial value                        | Pushing force                                                                                                                                        | 0402: F = 2 N                                                                                                  |
| 21  | Beam Load<br>Test                             | Destruction value | Should be exceed following one                            | Mounting method                                                                                                                                      | Place the capacitor in the beam load fixture as Fig 5/6                                                        |
|     |                                               | Size Code         | Destruction value                                         | Speed supplied the Stress Load                                                                                                                       | 0402 min: 0.5 mm/s, 0201: 0.1 mm/s                                                                             |
|     |                                               | 0402              | ≥ 8 N                                                     | <Size Code: 0805 max >                                                                                                                               | <Size Code: 1206 min>                                                                                          |
|     |                                               |                   |                                                           |                                                                    |                             |
|     |                                               |                   |                                                           | Fig. 5                                                                                                                                               | Fig. 6                                                                                                         |
| 22  | Temperature Characteristics of<br>Capacitance |                   | X7R: $\Delta C/C \leq \pm 15\%$                           | Pre-treatment                                                                                                                                        | Perform heat treatment at (150 +0/-10) °C for 1 h, then soak at room temperature for (24 ± 2) h, then measure. |
|     |                                               |                   |                                                           | Measure the capacitance separately in 25 °C, $\theta 1, 25$ °C, $\theta 2, 25$ °C, should satisfied related Temperature Coefficient of Capacitance . |                                                                                                                |
|     |                                               |                   |                                                           | X7R                                                                                                                                                  | $\theta 1 = -55$ °C, $\theta 2 = 125$ °C                                                                       |
|     |                                               |                   |                                                           | T.C. Measurement Voltage                                                                                                                             | $\leq 1.0 \pm 0.2$ Vrms ※ [※ Please contact our technical support staff for more information.]                 |

Table 1-2: Electrical tests

| Series | Size | Temp.<br>Chara. | U <sub>R</sub><br>(DC) | Thickness<br>Code | Cap.   | Electrical Characterization |                             |                             |                               |                          |
|--------|------|-----------------|------------------------|-------------------|--------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|--------------------------|
|        |      |                 |                        |                   |        | DF<br>[max]                 | IR (Room<br>Temp.)<br>[min] | IR (High<br>Temp.)<br>[min] | Measurement<br>Voltage [Vrms] | Measurement<br>Frequency |
| E      | 0402 | X7R             | 50 V                   | B                 | 2.2 nF | 0.025                       | 10000Mfi                    | 1000Mfi<br>10fi.F           | 1.0±0.2                       | 1.0±0.1KHz               |

Table 1-3: Cap.¥ D.¥ IR changes after test

| Series | Size | Temp.<br>Chara. | U <sub>R</sub><br>(DC) | Thickness<br>Code | Cap.   | High Temperature Exposure<br>(Storage)     |                             |             | Temperature<br>Cycling                     |                          |             | Biased Humidity<br>(8585)                   |                          |             | Operational Life                           |                          |             |                           | Board Flex                  | Terminal<br>Strength     |
|--------|------|-----------------|------------------------|-------------------|--------|--------------------------------------------|-----------------------------|-------------|--------------------------------------------|--------------------------|-------------|---------------------------------------------|--------------------------|-------------|--------------------------------------------|--------------------------|-------------|---------------------------|-----------------------------|--------------------------|
|        |      |                 |                        |                   |        | Cap.Change<br>[ $\Delta C/C \leq \pm \%$ ] | IR (Room<br>Temp.)<br>[min] | DF<br>[max] | Cap.Change<br>[ $\Delta C/C \leq \pm \%$ ] | IR (Room<br>Temp.) [min] | DF<br>[max] | Cap. Change<br>[ $\Delta C/C \leq \pm \%$ ] | IR (Room<br>Temp.) [min] | DF<br>[max] | Cap.Change<br>[ $\Delta C/C \leq \pm \%$ ] | IR (Room<br>Temp.) [min] | DF<br>[max] | Test<br>voltage<br>[Vrms] | IR (Room<br>Temp.)<br>[min] | IR (Room<br>Temp.) [min] |
| E      | 0402 | X7R             | 50 V                   | B                 | 2.2 nF | 10                                         | 10000Mfi                    | 0.03        | 10                                         | 10000Mfi                 | 0.03        | 12.5                                        | 1000Mfi                  | 0.035       | 12.5                                       | 1000Mfi                  | 0.035       | 2.0 × U <sub>R</sub>      | 10000Mfi                    | 10000Mfi                 |

#### 4. Packaging, Shipment and storage

##### 4.1 Packaging

###### 4.1.1 packaging type

Reel Packaging (standard carrier tape disc packaging), single disc smallest package see ⑧ Packaging Code

First packaging: Each multi-disc material is packed into a box.

The second packaging: the first packaged packaging box is loaded into the paper packaging box, and the remaining space in the box is filled with light auxiliary materials.

The above packaging forms can also be packaged according to user needs.

###### 4.1.2 Carrier Tape size



Fig. 7-1 0402 (Paper tape/ 2 mm pitch)

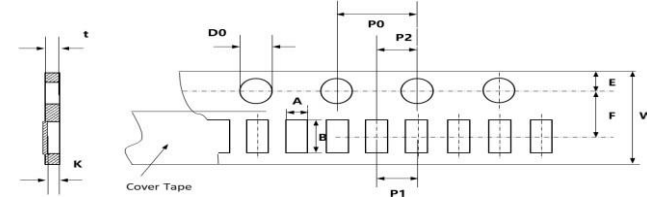


Fig. 7-2 0201 (Paper tape/ 2 mm pitch)



Fig. 7-3 0201 (Paper tape/ 1 mm pitch)

Table 2-1: Carrier size (Size Code: 0201, 0402)

(Unit:mm)

| Size Code | Thickness code | Carrier Tape Type | Packaging Code | A               | B               | F               | P1              | E               | D0              | P2              | K               | W               | P0              | t       |
|-----------|----------------|-------------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------|
| 0201      | A              | Paper             | T              | $0.38 \pm 0.03$ | $0.68 \pm 0.03$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | $0.36 \pm 0.02$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.5 max |
| 0201      | A              | Paper             | J              | $0.38 \pm 0.03$ | $0.68 \pm 0.03$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | $0.36 \pm 0.02$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.5 max |
| 0201      | A              | Paper             | H              | $0.38 \pm 0.03$ | $0.68 \pm 0.03$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | $0.36 \pm 0.02$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.5 max |
| 0201      | A              | Paper             | D              | $0.38 \pm 0.03$ | $0.68 \pm 0.03$ | $3.50 \pm 0.05$ | $1.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $1.00 \pm 0.05$ | $0.36 \pm 0.02$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.5 max |
| 0201      | A              | Paper             | L              | $0.38 \pm 0.03$ | $0.68 \pm 0.03$ | $3.50 \pm 0.05$ | $1.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $1.00 \pm 0.05$ | $0.36 \pm 0.02$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.5 max |
| 0201      | F              | Paper             | T              | $0.44 \pm 0.06$ | $0.74 \pm 0.06$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | $0.40 \pm 0.05$ | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.6 max |
| 0402      | B              | Paper             | T              | $0.63 \pm 0.05$ | $1.13 \pm 0.05$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |
| 0402      | B              | Paper             | J              | $0.63 \pm 0.05$ | $1.13 \pm 0.05$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |
| 0402      | N              | Paper             | T              | $0.70 \pm 0.10$ | $1.20 \pm 0.10$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |
| 0402      | N              | Paper             | J              | $0.70 \pm 0.10$ | $1.20 \pm 0.10$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |
| 0402      | C              | Paper             | T              | $0.75 \pm 0.10$ | $1.30 \pm 0.10$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |
| 0402      | C              | Paper             | J              | $0.75 \pm 0.10$ | $1.30 \pm 0.10$ | $3.50 \pm 0.05$ | $2.00 \pm 0.05$ | $1.75 \pm 0.10$ | $1.55 \pm 0.05$ | $2.00 \pm 0.05$ | /               | $8.00 \pm 0.10$ | $4.00 \pm 0.10$ | 0.8 max |



Fig. 7-4 0603, 0805, 1206, 1210, 2220 (Paper tape)



Fig. 7-5 0603, 0805, 1206, 1210, 2220 (Plastic tape)

Table 2-2: Carrier size (Size Code:0603, 0805, 1206, 1210, 2220)

(Unit:mm)

| Size Code | Thickness code | Carrier Tape Type | Packaging Code | A           | B           | F           | P           | E           | D0          | P2          | K | W           | P0          | t        |
|-----------|----------------|-------------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---|-------------|-------------|----------|
| 0603      | D              | Paper             | T              | 1.00 ± 0.10 | 1.80 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | D              | Paper             | A              | 1.00 ± 0.10 | 1.80 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | D              | Plastic           | O              | 1.00 ± 0.10 | 1.80 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | D              | Paper             | W              | 1.00 ± 0.10 | 1.80 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Paper             | T              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Paper             | A              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Plastic           | O              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Paper             | W              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Plastic           | Q              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0603      | K              | Plastic           | R              | 1.10 ± 0.10 | 1.90 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | C              | Paper             | T              | 1.45 ± 0.10 | 2.20 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 0.9 max  |
| 0805      | C              | Plastic           | R              | 1.45 ± 0.10 | 2.20 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 0.9 max  |
| 0805      | K              | Paper             | T              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | K              | Plastic           | R              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | K              | Plastic           | E              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | Y              | Paper             | T              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | Y              | Plastic           | E              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | Y              | Plastic           | P              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | Y              | Plastic           | R              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 0805      | G              | Plastic           | R              | 1.45 ± 0.10 | 2.20 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.75 max |
| 0805      | G              | Plastic           | P              | 1.45 ± 0.10 | 2.20 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.75 max |
| 0805      | G              | Plastic           | O              | 1.45 ± 0.10 | 2.20 ± 0.10 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.75 max |
| 0805      | H              | Plastic           | R              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 2.00 max |
| 0805      | H              | Plastic           | P              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 2.00 max |
| 0805      | H              | Plastic           | O              | 1.45 ± 0.20 | 2.20 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 2.00 max |
| 1206      | E              | Plastic           | R              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 1206      | E              | Plastic           | P              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.15 max |
| 1206      | O              | Plastic           | R              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.45 max |
| 1206      | O              | Plastic           | P              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 1.45 max |
| 1206      | H              | Plastic           | R              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 2.00 max |
| 1206      | H              | Plastic           | P              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20 | 4.00 ± 0.10 | 2.00 max |

Table 2-2: Carrier size (Size Code:0603, 0805, 1206, 1210,2220)

(Unit:mm)

| Size Code | Thickness code | Carrier Tape Type | Packaging Code | A           | B           | F           | P           | E           | D0          | P2          | K | W            | P0          | t        |
|-----------|----------------|-------------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---|--------------|-------------|----------|
| 1206      | L              | Plastic           | P              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1206      | L              | Plastic           | R              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1206      | L              | Plastic           | E              | 1.80 ± 0.20 | 3.40 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1206      | P              | Plastic           | P              | 1.90 ± 0.20 | 3.50 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1210      | Q              | Plastic           | F              | 2.70 ± 0.20 | 3.50 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1210      | Q              | Plastic           | S              | 2.70 ± 0.20 | 3.50 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1210      | Q              | Plastic           | Z              | 2.70 ± 0.20 | 3.50 ± 0.20 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 2.50 max |
| 1210      | R              | Plastic           | Z              | 2.70 ± 0.20 | 3.50 ± 0.30 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 3.00 max |
| 1210      | R              | Plastic           | S              | 2.70 ± 0.20 | 3.50 ± 0.30 | 3.50 ± 0.05 | 4.00 ± 0.10 | 1.75 ± 0.10 | 1.55 ± 0.05 | 2.00 ± 0.05 | / | 8.00 ± 0.20  | 4.00 ± 0.10 | 3.00 max |
| 2220      | R              | Plastic           | S              | 5.50 ± 0.20 | 6.20 ± 0.20 | 7.50 ± 0.10 | 8.00 ± 0.10 | 1.75 ± 0.10 | 1.50 ± 0.10 | 2.00 ± 0.10 | / | 16.00 ± 0.30 | 4.00 ± 0.10 | 3.50 max |
| 2220      | I              | Plastic           | A              | 5.50 ± 0.20 | 6.20 ± 0.20 | 7.50 ± 0.10 | 8.00 ± 0.10 | 1.75 ± 0.10 | 1.50 ± 0.10 | 2.00 ± 0.10 | / | 16.00 ± 0.30 | 4.00 ± 0.10 | 4.00 max |

## 4.1.3 Disc size

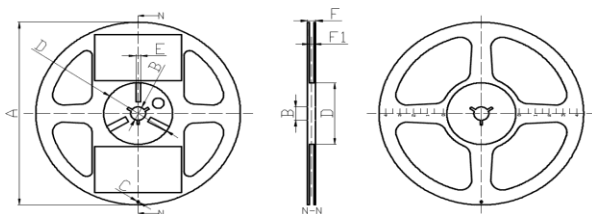


Fig. 8-1 Disc (Width of carrier-8 mm)

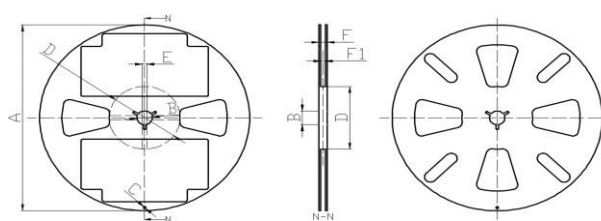


Fig. 8-2 Disc (Width of carrier-16 mm)

Table 3: Disc size

(Unit:mm)

| Disc size | Width of carrier | A          | B         | C          | D          | E         | F          | F1         | Size Code |
|-----------|------------------|------------|-----------|------------|------------|-----------|------------|------------|-----------|
| 7"        | 8.00 ± 0.10      | Φ178 ± 2.0 | Φ13 ± 1.0 | Φ4.0 ± 0.5 | Φ60 ± 2.0  | 4.0 ± 1.0 | 11.5 ± 1.0 | 10.0 ± 2.0 | All       |
| 13"       | 8.00 ± 0.10      | Φ330 ± 2.0 | Φ13 ± 1.0 | Φ4.0 ± 0.5 | Φ108 ± 2.0 | 4.0 ± 1.0 | 13.5 ± 2.0 | 10.0 ± 2.0 | All       |
| 13"       | 16.00 ± 0.30     | Φ330 ± 2.0 | Φ13 ± 1.0 | /          | Φ100 ± 2.0 | 5.0 ± 1.0 | 16.0 ± 2.0 | 19.0 ± 2.0 | 2220      |

## 4.1.4 Carrier Tape specifications

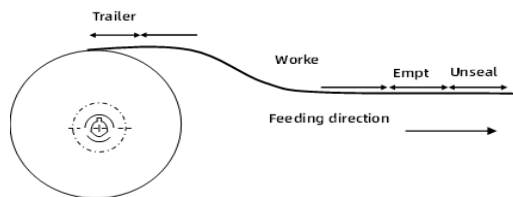


Fig. 9 Carrier

| Packaging | The minimum length of the reserved spaces |        |        |
|-----------|-------------------------------------------|--------|--------|
| Carrier   | Trailer                                   | Empty  | Unseal |
|           | 60 mm                                     | 200 mm | 160 mm |

#### 4.1.5 Performance of Carrier Taping

##### 4.1.5.1 Strength of Carrier Tape and Top Cover Tape

###### a. Carrier Tape

When a tensile force 1.02 kgf is applied in the direction to unreel the tape, the tape shall withstand this force.

###### b. Top cover Tape

When a tensile force 1.02 kgf is applied to the tape, the tape shall withstand this force.

##### 4.1.5.2 Peeling Strength of Top Cover Tape

Unless otherwise specified, the peeling strength of top cover tape shall be within 10.2 gf to 71.4 gf when the top cover tape is pulled at a speed of 300 mm/min with the angle of 0° to 15° (see Fig. 10).

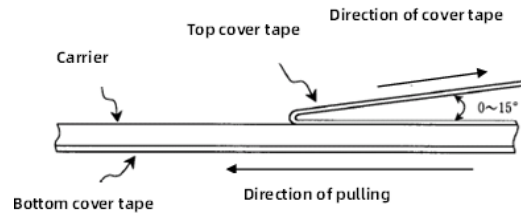


Fig. 10 Cover tape peel-off force

## 2. Shipment

Transport packaging products to adapt to the modern means of transport, but the product in the process of transport to prevent rain and acid and alkali corrosion, shall not be whipped extrusion casting and gravity.

## 3. Storage

### 1. Storage conditions:

The recommended temperature is less than 30 °C.

A temperature is 5 °C to 40 °C and a relative humidity is 20% to 70% as a standard condition.(MSL Level 1)

MLCC may be affected by the storage conditions. Please use them promptly after delivery.

High temperature and humidity conditions and/or prolonged storage may cause deterioration of the packaging materials.

If more than one year has elapsed since delivery, also check the solderability before use.

### 2. Corrosive gas can react with the termination (external) electrodes or lead wires of capacitors, and result in poor solderability.

Do not store the capacitors in an atmosphere consisting of corrosive gas (e.g.,hydrogen sulfide, sulfur dioxide, chlorine, ammonia gas etc.)

## 5. MLCC Application of Technical Requirements

### 5.1 Circuit Design

#### 5.1.1 Operating Temperature

- Do not use capacitor above the maximum allowable operating temperature.
- Surface temperature including self-heating should be below maximum operating temperature.

#### 5.1.2 Operating Voltage

The operating voltage for capacitors must always be lower than their rated voltage.

### 5.2 PCB Design

#### 5.2.1 Design of Land-patterns

When the capacitors are mounted on a PCB, the amount of solder at the terminations has a direct effect on the performance of the capacitors.

The greater the amount of solder, the higher the stress on the capacitor. Therefore, when designing land-patterns, it is necessary to consider the appropriate size and configuration of the solder pads.

Size and recommended land dimensions are shown in the following figure and table.



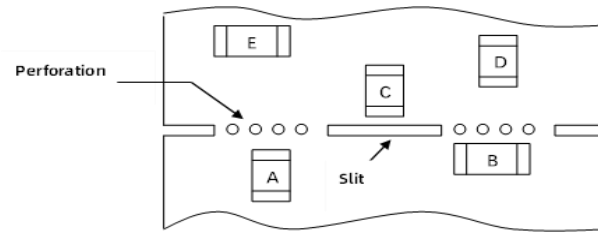
Recommended land dimensions for reflow-soldering

(unit: mm)

| Size Code | Length | Width | Tolerance              | A           | B           | C           |
|-----------|--------|-------|------------------------|-------------|-------------|-------------|
| 0201      | 0.6    | 0.3   | ± 0.03                 | 0.20 - 0.25 | 0.20 - 0.30 | 0.20 - 0.35 |
| 0201      | 0.6    | 0.3   | ± 0.05                 | 0.20 - 0.25 | 0.25 - 0.35 | 0.30 - 0.40 |
| 0201      | 0.6    | 0.3   | ± 0.09, ± 0.1          | 0.23 - 0.30 | 0.25 - 0.35 | 0.30 - 0.40 |
| 0402      | 1.0    | 0.5   | ± 0.05                 | 0.30 - 0.50 | 0.35 - 0.45 | 0.40 - 0.60 |
| 0402      | 1.0    | 0.5   | ± 0.15, ± 0.20         | 0.40 - 0.60 | 0.40 - 0.50 | 0.50 - 0.70 |
| 0402      | 1.0    | 0.5   | ± 0.30                 | 0.40 - 0.60 | 0.40 - 0.50 | 0.50 - 0.80 |
| 0603      | 1.6    | 0.8   | ± 0.10                 | 0.60 - 0.80 | 0.60 - 0.70 | 0.60 - 0.80 |
| 0603      | 1.6    | 0.8   | ± 0.20                 | 0.70 - 0.90 | 0.70 - 0.80 | 0.80 - 1.00 |
| 0603      | 1.6    | 0.8   | ± 0.25, ± 0.30         | 0.70 - 0.90 | 0.70 - 0.90 | 0.80 - 1.10 |
| 0805      | 2.0    | 1.25  | ± 0.10, ± 0.15, ± 0.20 | 1.00 - 1.40 | 0.60 - 0.80 | 1.20 - 1.40 |
| 0805      | 2.0    | 1.25  | ± 0.25                 | 1.00 - 1.40 | 0.70 - 0.90 | 1.35 - 1.55 |
| 1206      | 3.2    | 1.6   | ± 0.15, ± 0.20         | 1.80 - 2.00 | 0.90 - 1.20 | 1.50 - 1.70 |
| 1206      | 3.2    | 1.6   | ± 0.30                 | 1.90 - 2.10 | 1.00 - 1.30 | 1.60 - 1.90 |
| 1210      | 3.2    | 2.5   | ± 0.20                 | 2.00 - 2.40 | 1.00 - 1.20 | 2.50 - 2.70 |
| 1210      | 3.2    | 2.5   | ± 0.30                 | 2.00 - 2.40 | 1.10 - 1.30 | 2.50 - 2.80 |
| 2220      | 5.7    | 2.5   | ± 0.20                 | 4.10 - 4.80 | 1.20 - 1.40 | 2.50 - 2.70 |
| 2220      | 5.7    | 5.0   | ± 0.40                 | 4.10 - 4.80 | 1.20 - 1.40 | 4.00 - 5.00 |

### 5.2.2 Capacitor Layout on PC Board

Mechanical stress varies according to the location of capacitors on PC board. The recommendation for better design is as follows

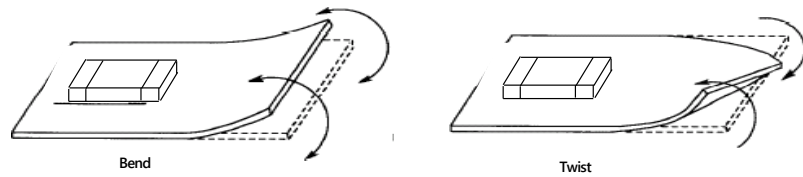


The stress in capacitors is in the following order:  $A > B = C > D > E$

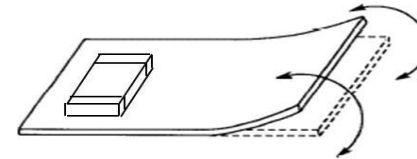
Pay attention not to bend or distort the PC board otherwise the capacitor may crack.

Please refer to the following examples of good and bad capacitors layout.

a. Not recommended

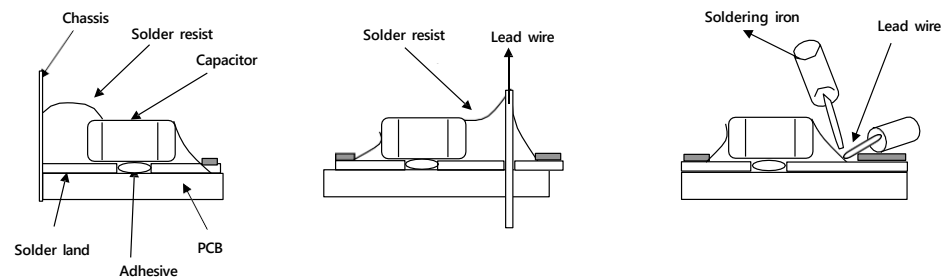


b. Recommended

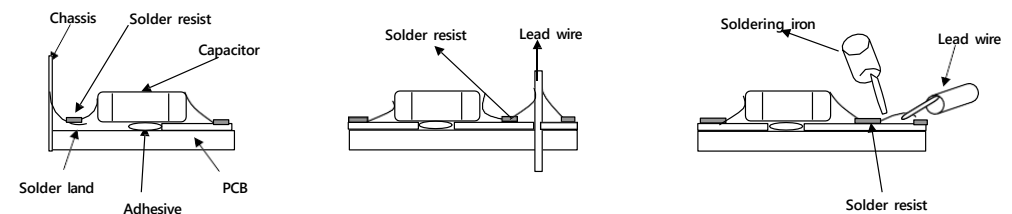


### 5.2.3 Solder Buildup and Soldering

a. Examples of soldering method not recommended



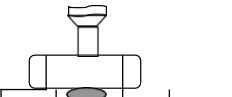
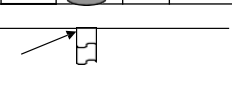
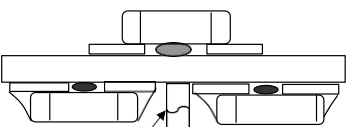
b. Examples of soldering method recommended



5.3 Consideration for Automatic Placement

- If the mounting head is adjusted too low, it may induce excessive stress in the chip capacitor to result in cracking. Please take following precautions
- a. Adjust the bottom dead center of the mounting head to reach on the PC board surface and not press it ;
  - b. Adjust the mounting head pressure to be 1N to 3N of static weight ;
  - c. To minimize the impact energy from mounting head, it is important to provide support from the bottom side of the PC board.

Please refer to the following samples

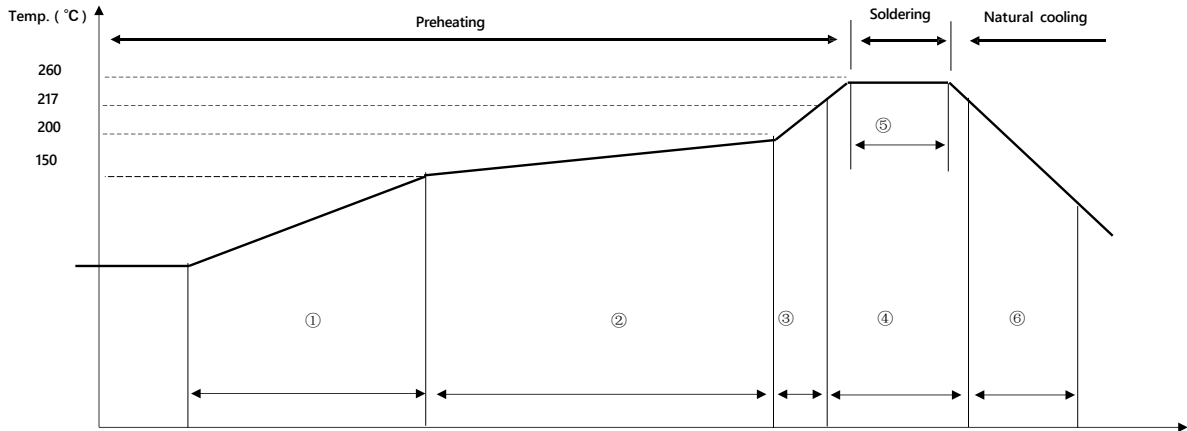
| Mounting              | Not recommended                                                                                               | Recommended                                                                                        |
|-----------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Singel-sided Mounting | <br>Cracks                   | <br>Support pin |
|                       |                                                                                                               |                 |
| Double-sided Mounting | <br>Solder peeling<br>Cracks | <br>Support pin  |

4. Soldering

1. Flux Selection

- a. It is recommended to use a mildly activated rosin flux (less than 0.1wt% chlorine). Strong flux is not recommended.
- b. Please provide proper amount of flux. Excessive flux must be avoided.
- c. When water-soluble flux is used, enough washing is necessary.

5.4.2 Recommended Soldering Profile



5.4.2.1 Reflow Soldering Condition

| NO. | Reflow Soldering zone | Reflow Soldering Condition                                                                            |
|-----|-----------------------|-------------------------------------------------------------------------------------------------------|
| ①   | Preheating 1          | $\leq 3\text{ }^{\circ}\text{C/s}, \geq 60\text{ s}$                                                  |
| ②   | Constant temperature  | $150^{\circ}\text{C}-200^{\circ}\text{C}, 60\text{ s}-120\text{ s}, \leq 1\text{ }^{\circ}\text{C/s}$ |
| ③   | Preheating 1          | $1-5\text{ }^{\circ}\text{C/s}$                                                                       |
| ④   | Soldering 1           | Above $217\text{ }^{\circ}\text{C}$ , 60-150 s                                                        |
| ⑤   | Soldering 1           | Above $260\text{ }^{\circ}\text{C}$ , over 10 s                                                       |
| ⑥   | Natural cooling       | $\leq 6\text{ }^{\circ}\text{C/s}$                                                                    |

Caution

a.Excessive solder will induce higher tensile force in chip capacitor when temperature changes and result in cracking. Insufficient solder may detach the capacitor from the PC board.  
The ideal condition is to have solder mass controlled to 1/2 to 1/3 of the thickness of the capacitors.



b.Soldering duration should be kept as close to recommended times as possible, because excessive duration can detrimentally affect solderability.  
c.The peak temperature of reflow soldering is  $245\text{ }^{\circ}\text{C} \pm 15\text{ }^{\circ}\text{C}$ .

6. All products in this specification comply with the EU RoHS directive

The EU RoHS Directive refers to the "Directive 2011/65/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment" stipulated by the European Union.

ORIGINAL MFG PART No.: **E0402X7R222K500NTB**

|                           |                                                                              |
|---------------------------|------------------------------------------------------------------------------|
| PRODUCT NAME:             | MLCC For Automotive Powertrain & Safety E Series SMD 0402 X7R 2.2nF ±10% 50V |
| REVISION:                 | A3                                                                           |
| NEXTGEN ORDER PART CODE*: | E0402B222K500B                                                               |
| CROSS REF. PART NO.:      |                                                                              |
| ORIGINAL MFG PART NO.:    | E0402X7R222K500NTB                                                           |
| ORIGINAL MANUFACTURER:    | EYang Technology/Eyang MLCC                                                  |

*Image shown is a representation only.  
Exact specifications should be obtained  
from the product dimension*

\*: Please Indicate this Part Code For RFQ/Order Support

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## HOW TO ORDER

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| CODE | NAME                        | KEY SPECIFICATION OPTION                                                                                                                                                                                |
|------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E    | Series Code                 | E: Multilayer Ceramic Chip Capacitors For Automotive Powertrain & Safety                                                                                                                                |
| 0402 | Case Size                   | 0105 : L0.40*W0.20mm; 0201 : L0.60*W0.30mm; 0402 : L1.00*W0.50mm; 0603 : L1.60*W0.80mm<br>0805 : L2.00*W1.25mm; 1206 : L3.20*W1.60mm; 1210 : L3.20*W2.50mm                                              |
| B    | Temperature Characteristics | N: NP0 (COG); B: X7R; W: X5R; S: X6S; Y: Y5V; T: X7S; R: X7T                                                                                                                                            |
| 222  | Capacitance                 | Two significant digits followed by number of Zero, The 3rd digit signifies the multiplying factor, and letter R is decimal point.<br>1R0: 1pF; 100: 10pF; 222: 2.2nF; 680: 68pF; 101: 100pF; 475: 4.7μF |
| K    | Capacitance Tolerance       | A: ±0.05pF; B: ±0.1pF; C: ±0.25pF; D: ±0.5pF; F: ±1%; G: ±2%; J: ±5%; K: ±10%<br>L: ±15%; M: ±20%; N: ±30%; P: ±0.02pF; X: ±40%; S: 50%/-20%; Y: 150%/-20% Z: 80%/-20%                                  |
| 500  | Rated Voltage               | Two significant digits followed by No. of zeros. "R" is in place of decimal point.<br>6R3: 6.3VDC; 160: 16 VDC; 250: 25 VDC; 100: 10 VDC; 500: 50 VDC; 101: 100VDC                                      |
| B    | Case Thickness              | B: 0.8mm Max, See Page 6 (T's Symbol) for Different part code                                                                                                                                           |
| XX   | Internal Control Code       | Blank: N/A; XX: Letter A~Z, a~z or digits (0~9) for Special/Custom Parameters                                                                                                                           |

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2. REACH COMPLIANCE: REACH substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future, REACH Test Report for this product can be obtained can be obtained at Download Center.
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