

**Chip Monolithic Ceramic Capacitor for General**  
**GRM022B31A821JE19\_ (01005, B:JIS, 820pF, DC10V)**  
 \_: packaging code

**Reference Sheet**

**1.Scope**

This product specification is applied to Chip Monolithic Ceramic Capacitor used for General Electronic equipment.

**2.MURATA Part NO. System**

|       |                      |                    |                                   |                     |                           |                             |                             |                   |   |
|-------|----------------------|--------------------|-----------------------------------|---------------------|---------------------------|-----------------------------|-----------------------------|-------------------|---|
| (Ex.) | GRM                  | 02                 | 2                                 | B3                  | 1A                        | 821                         | J                           | E19               | L |
|       | (1)L/W<br>Dimensions | (2)T<br>Dimensions | (3)Temperature<br>Characteristics | (4)Rated<br>Voltage | (5)Nominal<br>Capacitance | (6)Capacitance<br>Tolerance | (7)Murata's Control<br>Code | (8)Packaging Code |   |

**3. Type & Dimensions**



(Unit:mm)

| (1)-1 L  | (1)-2 W  | (2) T    | e            | g         |
|----------|----------|----------|--------------|-----------|
| 0.4±0.02 | 0.2±0.02 | 0.2±0.02 | 0.07 to 0.14 | 0.13 min. |

**4.Rated value**

| (3) Temperature Characteristics<br>(Public STD Code):B(JIS) |                            | (4)<br>Rated<br>Voltage | (5) Nominal<br>Capacitance | (6)<br>Capacitance<br>Tolerance | Specifications and Test<br>Methods<br>(Operating<br>Temp. Range) |
|-------------------------------------------------------------|----------------------------|-------------------------|----------------------------|---------------------------------|------------------------------------------------------------------|
| Temp. coeff<br>or Cap. Change                               | Temp. Range<br>(Ref.Temp.) |                         |                            |                                 |                                                                  |
| -10 to 10 %                                                 | -25 to 85 °C<br>(20 °C)    | DC 10 V                 | 820 pF                     | ±5 %                            | -25 to 85 °C                                                     |

**5.Package**

| mark | (8) Packaging               | Packaging Unit  |
|------|-----------------------------|-----------------|
| L    | φ180mm Reel<br>EMBOSED W4P1 | 40000 pcs./Reel |

Product specifications in this catalog are as of Jul.5,2016,and are subject to change or obsolescence without notice.  
 Please consult the approval sheet before ordering.  
 Please read rating and !Cautions first.

## Specifications and Test Methods

| No                                 | Item                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Specification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Test Method<br>(Ref. Standard:JIS C 5101, IEC60384)                                                                                                                                                                                                              |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
|------------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------|----------------------------|------------------------|---------------------|------------------------|------------------------|---------------------|------------------------|------------------|---------------------|------------------------|---------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|---------|-----------------------------------|--------------|---------------|------------------------------------|--------------|---------------|---------------|------------|---------------|
| 1                                  | Rated Voltage                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Shown in Rated value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | The rated voltage is defined as the maximum voltage which may be applied continuously to the capacitor.<br><br>When AC voltage is superimposed on DC voltage, $V^{P-P}$ or $V^{O-P}$ , whichever is larger, should be maintained within the rated voltage range. |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 2                                  | Appearance                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No defects or abnormalities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Visual inspection.                                                                                                                                                                                                                                               |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 3                                  | Dimension                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Within the specified dimensions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Using calipers. (GRM02 size is based on Microscope)                                                                                                                                                                                                              |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 4                                  | Voltage proof                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No defects or abnormalities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Measurement Point : Between the terminations<br>Test Voltage : 250% of the rated voltage<br>Applied Time : 1 to 5 s<br>Charge/discharge current : 50mA max.                                                                                                      |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 5                                  | Insulation Resistance(I.R.)                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | More than 2000MΩ or 50Ω · F (Whichever is smaller)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Measurement Point : Between the terminations<br>Measurement Voltage : DC Rated Voltage<br>Charging Time : 1 min<br>Charge/discharge current : 50mA max.<br>Measurement Temperature Room Temperature                                                              |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 6                                  | Capacitance                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Shown in Rated value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Measurement Temperature Room Temperature                                                                                                                                                                                                                         |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 7                                  | Dissipation Factor (D.F.)                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | B1,R1,B3,R6,R7,C6,C7,C8,E7,D7 : 0.1 max.<br>D8,GRM31CR60J107 : 0.15 max<br>GRM31CR71E106 : 0.125<br><div><div>*Table 1</div><table><tr><td>GRM022 B3/R6 1A 681 to 103</td></tr><tr><td>GRM033 B3/R6 1A 123 to 823</td></tr><tr><td>GRM033 B3/R6 1A 104</td></tr><tr><td>GRM155 B3/R6 1A 124 to 105</td></tr><tr><td>GRM185 B3/R6 1C/1A 105</td></tr><tr><td>GRM185 C8/D7 1A 105</td></tr><tr><td>GRM188 B3/R6 1C/1A 225</td></tr><tr><td>GRM188 R7/C8/D7 1A 225</td></tr><tr><td>GRM188 B3/R6 1A 335</td></tr><tr><td>GRM219 B3/R6 1C/1A 475</td></tr><tr><td>GRM219 C8 1A 475</td></tr><tr><td>GRM219 B3/R6 1A 106</td></tr><tr><td>GRM21B B3/R6 1C/1A 106</td></tr><tr><td>GRM21B R7/C8 1A 106</td></tr><tr><td>GRM319 B3/R6 1C/1A 106</td></tr></table></div> | GRM022 B3/R6 1A 681 to 103                                                                                                                                                                                                                                       | GRM033 B3/R6 1A 123 to 823 | GRM033 B3/R6 1A 104 | GRM155 B3/R6 1A 124 to 105 | GRM185 B3/R6 1C/1A 105 | GRM185 C8/D7 1A 105 | GRM188 B3/R6 1C/1A 225 | GRM188 R7/C8/D7 1A 225 | GRM188 B3/R6 1A 335 | GRM219 B3/R6 1C/1A 475 | GRM219 C8 1A 475 | GRM219 B3/R6 1A 106 | GRM21B B3/R6 1C/1A 106 | GRM21B R7/C8 1A 106 | GRM319 B3/R6 1C/1A 106 | <table><tr><th>Capacitance</th><th>Frequency</th><th>Voltage</th></tr><tr><td>*1 <math>C \leq 10\mu F</math><br/>(10V min.)</td><td>1.0+/-0.1kHz</td><td>1.0+/-0.2Vrms</td></tr><tr><td>*2 <math>C \leq 10\mu F</math><br/>(6.3V max.)</td><td>1.0+/-0.1kHz</td><td>0.5+/-0.1Vrms</td></tr><tr><td><math>C &gt; 10\mu F</math></td><td>120+/-24Hz</td><td>0.5+/-0.1Vrms</td></tr></table><br><br>*1 For items listed in Table 1 on the left, the capacitance should be measured using a voltage of 0.5+/-0.1Vrms instead of 1.0+/-0.2Vrms.<br>*2 For item GRM188R70J105, the capacitance should be measured using a voltage of 1.0+/-0.2Vrms instead of 0.5+/-0.1Vrms. | Capacitance | Frequency | Voltage | *1 $C \leq 10\mu F$<br>(10V min.) | 1.0+/-0.1kHz | 1.0+/-0.2Vrms | *2 $C \leq 10\mu F$<br>(6.3V max.) | 1.0+/-0.1kHz | 0.5+/-0.1Vrms | $C > 10\mu F$ | 120+/-24Hz | 0.5+/-0.1Vrms |
| GRM022 B3/R6 1A 681 to 103         |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM033 B3/R6 1A 123 to 823         |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM033 B3/R6 1A 104                |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM155 B3/R6 1A 124 to 105         |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM185 B3/R6 1C/1A 105             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM185 C8/D7 1A 105                |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM188 B3/R6 1C/1A 225             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM188 R7/C8/D7 1A 225             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM188 B3/R6 1A 335                |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM219 B3/R6 1C/1A 475             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM219 C8 1A 475                   |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM219 B3/R6 1A 106                |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM21B B3/R6 1C/1A 106             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM21B R7/C8 1A 106                |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| GRM319 B3/R6 1C/1A 106             |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| Capacitance                        | Frequency                                  | Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| *1 $C \leq 10\mu F$<br>(10V min.)  | 1.0+/-0.1kHz                               | 1.0+/-0.2Vrms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| *2 $C \leq 10\mu F$<br>(6.3V max.) | 1.0+/-0.1kHz                               | 0.5+/-0.1Vrms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| $C > 10\mu F$                      | 120+/-24Hz                                 | 0.5+/-0.1Vrms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |
| 8                                  | Temperature Characteristics of Capacitance | No bias<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                  |                            |                     |                            |                        |                     |                        |                        |                     |                        |                  |                     |                        |                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |         |                                   |              |               |                                    |              |               |               |            |               |

| No                 | Item                                                                 |                    | Specification                                                                         | Test Method<br>(Ref. Standard:JIS C 5101, IEC60384)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|--------------------|----------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------|------------|---|--------------------------|--------|---|-----------|--------|---|--------------------------|--------|---|-----------|--------|
| 10                 | Vibration                                                            | Appearance         | No defects or abnormalities.                                                          | Solder the capacitor on the test substrate shown in Fig.3.<br><br>Kind of Vibration : A simple harmonic motion<br>10Hz to 55Hz to 10Hz (1min)<br>Total amplitude : 1.5mm<br>This motion should be applied for a period of 2h in each 3 mutually perpendicular directions(total of 6h).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | Capacitance        | Within the specified initial value.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | D.F.               | Within the specified initial value.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| 11                 | Substrate Bending test                                               | Appearance         | No defects or abnormalities.                                                          | Solder the capacitor on the test substrate shown in Fig.1.<br>Pressurization method : Shown in Fig.2<br>Flexure : 1mm<br>Holding Time : 5+/-1s<br>Soldering Method : Reflow soldering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | Capacitance Change | Within +/-10%                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| 12                 | Solderability                                                        |                    | 95% of the terminations is to be soldered evenly and continuously.                    | Test Method : Solder bath method<br>Flux : Solution of rojin ethanol 25(wt)%<br>Preheat : 80°C to 120°C for 10s to 30s<br>Solder : Sn-3.0Ag-0.5Cu<br>Solder Temp. : 245+/-5°C<br>Immersion time : 2+/-0.5s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| 13                 | Resistance to Soldering Heat                                         | Appearance         | No defects or abnormalities.                                                          | <GRM03 size min.><br>Test Method : Solder bath method<br>Solder : Sn-3.0Ag-0.5Cu<br>Solder Temp. : 270+/-5°C<br>Immersion time : 10+/-0.5s<br>Exposure Time : 24+/-2h<br>Preheat : GRM31 size max.: 120°C to 150°C for 1 min<br>GRM32 size : 100°C to 120°C for 1 min and 170°C to 200°C for 1 min<br><br>· Initial measurement<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.<br><br><GRM02 size only><br>Test Method : Reflow soldering (hot plate)<br>Solder : Sn-3.0Ag-0.5Cu<br>Solder Temp. : 270+/-5°C<br>Reflow Time : 10+/-0.5s<br>Test Substrate : Glass epoxy PCB<br>Exposure Time : 24+/-2h<br>Preheat : 120°C to 150°C for 1 min<br>· Initial measurement<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure. |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | Capacitance Change | B1,R1,B3,R6,R7,C6,C7,C8,E7,D7,D8 : Within +/-7.5%<br>GRM188B30J106M : Within +/-12.5% |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | D.F.               | Within the specified initial value.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | I.R.               | Within the specified initial value.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | Voltage proof      | No defects.                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| 14                 | Temperature Sudden Change                                            | Appearance         | No defects or abnormalities.                                                          | Solder the capacitor on the test substrate shown in Fig.3.<br>Perform the five cycles according to the four heat treatments shown in the following table. <table><tr><td>Step</td><td>Temp.(°C)</td><td>Time (min)</td></tr><tr><td>1</td><td>Min.Operating Temp.+0/-3</td><td>30+/-3</td></tr><tr><td>2</td><td>Room Temp</td><td>2 to 3</td></tr><tr><td>3</td><td>Max.Operating Temp.+3/-0</td><td>30+/-3</td></tr><tr><td>4</td><td>Room Temp</td><td>2 to 3</td></tr></table><br>Exposure Time : 24+/-2h<br><br>· Initial measurement<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.<br>· GRM188B30J106M Measurement after test:<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.                                 | Step       | Temp.(°C) | Time (min) | 1 | Min.Operating Temp.+0/-3 | 30+/-3 | 2 | Room Temp | 2 to 3 | 3 | Max.Operating Temp.+3/-0 | 30+/-3 | 4 | Room Temp | 2 to 3 |
|                    |                                                                      | Step               | Temp.(°C)                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Time (min) |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | 1                  | Min.Operating Temp.+0/-3                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 30+/-3     |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | 2                  | Room Temp                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2 to 3     |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | 3                  | Max.Operating Temp.+3/-0                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 30+/-3     |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | 4                  | Room Temp                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2 to 3     |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| Capacitance Change | B1,R1,B3,R6,R7,C6,C7,C8,D7,D8 : Within +/-7.5%<br>E7 : Within +/-30% |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| D.F.               | Within the specified initial value.                                  |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| I.R.               | Within the specified initial value.                                  |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| Voltage proof      | No defects.                                                          |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      |                    |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
| 15                 | High Temperature High Humidity (Steady)                              | Appearance         | No defects or abnormalities.                                                          | Solder the capacitor on the test substrate shown in Fig.3.<br>Test Temperature : 40+/-2°C<br>Test Humidity : 90%RH to 95%RH<br>Test Time : 500+/-12h<br>Applied Voltage : DC Rated Voltage<br>Charge/discharge current : 50mA max.<br>Exposure Time : 24+/-2h<br><br>· Initial measurement<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.<br>· Measurement after test<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.                                                                                                                                                                                                                                                                                                 |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | Capacitance Change | Within +/-12.5%                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | D.F.               | 0.2 max.                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |
|                    |                                                                      | I.R.               | More than 500MQ or 12.5Ω · F (Whichever is smaller)                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |           |            |   |                          |        |   |           |        |   |                          |        |   |           |        |

| No | Item       | Specification      | Test Method<br>(Ref. Standard:JIS C 5101, IEC60384)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----|------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16 | Durability | Appearance         | No defects or abnormalities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|    |            | Capacitance Change | Within +/-12.5%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|    |            | D.F.               | 0.2 max.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|    |            | I.R.               | More than 1000MΩ or 25Ω · F (Whichever is smaller)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|    |            |                    | Solder the capacitor on the test substrate shown in Fig.3.<br><br>Test Temperature : Max. Operating Temp. +/-3°C<br>Test Time : 1000+/-12h<br>Applied Voltage : 150% of the rated voltage<br>Charge/discharge current : 50mA max.<br>Exposure Time : 24+/-2h<br><br>· Initial measurement<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure.<br><br>· Measurement after test<br>Perform a heat treatment at 150+0/-10°C for 1h and then let sit for 24+/-2h at room temperature,then measure. |

Test method : Substrate Bending test

- Test substrate

Material : Copper-clad laminated sheets for PCBs  
(Glass fabric base, epoxy resin)  
Thickness : 1.6mm (GRM02/GRM03/GRM15: t:0.8mm)  
Copper foil thickness : 0.035mm  
 : Solder resist  
(Coat with heat resistant resin for solder)



Fig.1 (in mm)

| Type  | Dimension (mm) |      |      |
|-------|----------------|------|------|
|       | a              | b    | c    |
| GRM02 | 0.2            | 0.56 | 0.23 |
| GRM03 | 0.3            | 0.9  | 0.3  |
| GRM15 | 0.4            | 1.5  | 0.5  |
| GRM18 | 1.0            | 3.0  | 1.2  |
| GRM21 | 1.2            | 4.0  | 1.65 |
| GRM31 | 2.2            | 5.0  | 2.0  |
| GRM32 | 2.2            | 5.0  | 2.9  |

• Kind of Solder : Sn-3.0Ag-0.5Cu

- Pressurization method

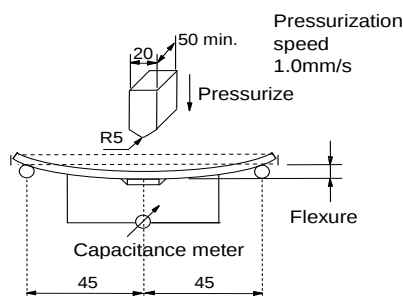


Fig.2 (in mm)

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, Resistance to Soldering Heat (Reflow method)

High Temperature High Humidity(Steady) , Durability

- Test substrate

Material : Copper-clad laminated sheets for PCBs  
(Glass fabric base, epoxy resin)  
Thickness : 1.6mm or 0.8mm  
Copper foil thickness : 0.035mm

- Kind of Solder : Sn-3.0Ag-0.5Cu

- Land Dimensions



Fig.3

| Type  | Dimension (mm) |      |      |
|-------|----------------|------|------|
|       | a              | b    | c    |
| GRM02 | 0.2            | 0.56 | 0.23 |
| GRM03 | 0.3            | 0.9  | 0.3  |
| GRM15 | 0.4            | 1.5  | 0.5  |
| GRM18 | 1.0            | 3.0  | 1.2  |
| GRM21 | 1.2            | 4.0  | 1.65 |
| GRM31 | 2.2            | 5.0  | 2.0  |
| GRM32 | 2.2            | 5.0  | 2.9  |

# 1. Tape Carrier Packaging(Packaging Code:D/E/W/L/J/F/K)

## 1.1 Minimum Quantity(pcs./reel)

| Type  |                                                                          | φ180mm reel |             |              | φ330mm reel |              |
|-------|--------------------------------------------------------------------------|-------------|-------------|--------------|-------------|--------------|
|       |                                                                          | Paper Tape  |             | Plastic Tape | Paper Tape  | Plastic Tape |
|       |                                                                          | Code:D/E    | Code:W      | Code:L       | Code:J/ F   | Code:K       |
| GRM01 |                                                                          |             |             | 50000(W4P1)  |             |              |
| GRM02 |                                                                          |             |             | 40000(W4P1)  |             |              |
| GRM03 | 2                                                                        | 15000(W8P2) |             |              | 50000(W8P2) |              |
|       | 3                                                                        | 15000(W8P2) | 30000(W8P1) |              | 50000(W8P2) |              |
|       | 5                                                                        | 10000(W8P2) |             |              | 50000(W8P2) |              |
| GRM15 | 2                                                                        | 20000(W8P2) |             |              | 50000(W8P2) |              |
|       | 3/X                                                                      | 10000(W8P2) |             |              | 50000(W8P2) |              |
|       | 5(LWT Dimensions Tolerance:±0.05)                                        | 10000(W8P2) | 20000(W8P1) |              | 50000(W8P2) |              |
|       | 5(LWT Dimensions Tolerance:±0.1min.)                                     | 10000(W8P2) |             |              | 40000(W8P2) |              |
|       | 5 (LW Dimensions Tolerance:±0.1min.<br>and T Dimensions Tolerance:±0.05) | 10000(W8P2) |             |              | 50000(W8P2) |              |
|       | 5(LW Dimensions Tolerance:±0.2<br>and T Dimensions:0.5 +0/-0.1)          | 10000(W8P2) |             |              |             |              |
| GRM18 |                                                                          | 4000        |             |              | 10000       |              |
| GRM21 | 6                                                                        | 4000        |             |              | 10000       |              |
|       | 9                                                                        | 4000        |             | 3000         | 10000       | 10000        |
|       | A/B                                                                      |             |             | 3000         |             | 10000        |
| GRM31 | 6/9                                                                      | 4000        |             |              | 10000       |              |
|       | M/X                                                                      |             |             | 3000         |             | 10000        |
|       | C                                                                        |             |             | 2000         |             | 6000         |
| GRM32 | 9                                                                        | 4000        |             |              | 10000       |              |
|       | A/M                                                                      |             |             | 3000         |             | 10000        |
|       | N                                                                        |             |             | 2000         |             | 8000         |
|       | C                                                                        |             |             | 2000         |             | 6000         |
|       | R/D/E                                                                    |             |             | 1000         |             | 4000         |
| GRM43 | M                                                                        |             |             | 1000         |             | 5000         |
|       | N/R/D                                                                    |             |             | 1000         |             | 4000         |
|       | E                                                                        |             |             | 500          |             | 2000         |
|       | S                                                                        |             |             | 500          |             | 1500         |
| GRM55 | M                                                                        |             |             | 1000         |             | 5000         |
|       | N/C/R/D                                                                  |             |             | 1000         |             | 4000         |
|       | E                                                                        |             |             | 500          |             |              |
|       | F                                                                        |             |             | 300          |             | 1500         |

## 1.2 Dimensions of Tape

### (1)GRM01/02 (W4P1 CODE:L)

\*1, 2 : 1. 0±0. 02

(in:mm)



| Type  |   | Dimensions(Chip) |             |             | A *3  | B *3 | t        |
|-------|---|------------------|-------------|-------------|-------|------|----------|
|       |   | L                | W           | T           |       |      |          |
| GRM01 | 1 | 0.25±0.013       | 0.125±0.013 | 0.125±0.013 | 0.145 | 0.27 | 0.4 max. |
|       |   | 0.4±0.02         | 0.2±0.02    | 0.2±0.02    | 0.23  | 0.43 | 0.5 max. |
|       |   | 0.4±0.05         | 0.2±0.05    | 0.2±0.05    | 0.26  | 0.46 |          |

\*3 Nominal value

(2)GRM03/15(W8P2 CODE:D/E/J/F)

(in:mm)



| Type  |          | Dimensions(Chip) |          |                                    | A *3 | B *3 | t        |
|-------|----------|------------------|----------|------------------------------------|------|------|----------|
|       |          | L                | W        | T                                  |      |      |          |
| GRM03 | 2        | 0.6±0.03         | 0.3±0.03 | 0.2 +0.02/-0.04                    | 0.37 | 0.67 | 0.5 max. |
|       | 0.3±0.03 |                  |          |                                    |      |      |          |
|       | 3        | 0.6±0.05         | 0.3±0.05 | 0.3±0.05                           | 0.39 | 0.69 |          |
|       | 5        | 0.6±0.09         | 0.3±0.09 | 0.3±0.09<br>0.5±0.05               | 0.44 | 0.74 | 0.6 max. |
| GRM15 | 2        | 1.0±0.05         | 0.5±0.05 | 0.2 +0.02/-0.04                    | 0.65 | 1.15 | 0.8 max. |
|       | X        |                  |          | 0.25±0.05                          |      |      |          |
|       | 3        | 1.0±0.2          | 0.5±0.2  | 0.3±0.03                           | 0.78 | 1.29 |          |
|       | 5        | 1.0±0.05         | 0.5±0.05 | 0.5±0.05                           | 0.65 | 1.15 |          |
|       |          | 1.0±0.07         | 0.5±0.07 | 0.5±0.07                           | 0.70 | 1.20 |          |
|       |          | 1.0±0.1          | 0.5±0.1  | 0.5±0.1                            | 0.72 | 1.25 |          |
|       |          | 1.0±0.15         | 0.5±0.15 | 0.5±0.15                           | 0.78 | 1.29 |          |
|       |          | 1.0±0.2          | 0.5±0.2  | 0.5 +0/-0.1<br>0.5±0.2<br>0.5±0.05 |      |      |          |

\*3 Nominal value

(3)GRM033/155(W8P1 CODE:W)

(in:mm)



| Type  |   | Dimensions(Chip) |                |                | A *3 | B *3 | t        |
|-------|---|------------------|----------------|----------------|------|------|----------|
|       |   | L                | W              | T              |      |      |          |
| GRM03 | 3 | $0.6 \pm 0.03$   | $0.3 \pm 0.03$ | $0.3 \pm 0.03$ | 0.37 | 0.67 | 0.5 max. |
|       |   | $0.6 \pm 0.05$   | $0.3 \pm 0.05$ | $0.3 \pm 0.05$ | 0.39 | 0.69 |          |
|       |   | $0.6 \pm 0.09$   | $0.3 \pm 0.09$ | $0.3 \pm 0.09$ | 0.44 | 0.74 | 0.6 max. |
| GRM15 | 5 | $1.0 \pm 0.05$   | $0.5 \pm 0.05$ | $0.5 \pm 0.05$ | 0.65 | 1.15 | 0.8 max. |

\*3 Nominal value

(4)GRM18/21/31/32

(in:mm)



| Type    |                 | Dimensions(Chip) |           |                  | A         | B         | t         | Dimensions of Tape |          |              |  |          |
|---------|-----------------|------------------|-----------|------------------|-----------|-----------|-----------|--------------------|----------|--------------|--|----------|
|         |                 | L                | W         | T                |           |           |           |                    |          |              |  |          |
| GRM18   | 5               | 1.6±0.1          | 0.8±0.1   | 0.5 +0/-0.1      | 1.05±0.10 | 1.85±0.10 | 0.8 max.  | Paper Tape         |          |              |  |          |
|         |                 | 1.6±0.2          | 0.8±0.2   | 0.5±0.05         | 1.10±0.10 | 2.00±0.10 |           |                    |          |              |  |          |
|         |                 |                  |           | 0.6 +0/-0.1      |           |           |           |                    |          |              |  |          |
|         | 6               |                  |           | 0.7±0.1          |           |           |           |                    |          |              |  |          |
|         | 8               | 1.6±0.1          | 0.8±0.1   | 0.8±0.1          | 1.05±0.10 | 1.85±0.10 |           |                    |          |              |  |          |
|         |                 | 1.6±0.15         | 0.8±0.15  | 0.8±0.15         |           |           |           |                    |          |              |  |          |
| 1.6±0.2 |                 | 0.8±0.2          | 0.8±0.2   | 1.10±0.10        | 2.00±0.10 |           |           |                    |          |              |  |          |
| GRM21   | 6               | 2.0±0.1          | 1.25±0.1  | 0.6±0.1          | 1.55±0.15 | 2.30±0.15 | 1.15 max. |                    |          |              |  |          |
|         | 0.6 +0/-0.15    |                  |           |                  |           |           |           |                    |          |              |  |          |
|         | 0.85±0.05       |                  |           |                  |           |           |           |                    |          |              |  |          |
|         | 0.85±0.1        |                  |           |                  |           |           |           |                    |          |              |  |          |
|         | 0.85 +0.15/-0.1 |                  |           |                  |           |           |           |                    |          |              |  |          |
|         | 0.85 +0/-0.2    |                  |           |                  |           |           |           |                    |          |              |  |          |
|         |                 | 2.0±0.15         | 1.25±0.15 | 0.85±0.1         |           |           |           |                    |          |              |  |          |
|         |                 | 2.0±0.2          | 1.25±0.2  | 0.85 +0.15/-0.05 | 1.50±0.20 | 2.30±0.20 | 1.7 max.  |                    |          |              |  |          |
|         | A               | 2.0±0.1          | 1.25±0.1  | 1.0 +0/-0.2      | 1.45±0.20 | 2.25±0.20 |           |                    |          |              |  |          |
|         |                 | 2.0±0.2          | 1.25±0.2  | 1.0±0.2          | 1.50±0.20 | 2.30±0.20 |           |                    |          |              |  |          |
|         | B               | 2.0±0.1          | 1.25±0.1  | 1.25±0.1         | 1.45±0.20 | 2.25±0.20 |           | 2.0 max.           |          |              |  |          |
|         |                 | 2.0±0.15         | 1.25±0.15 | 1.25±0.15        | 1.50±0.20 | 2.30±0.20 |           |                    |          |              |  |          |
| 2.0±0.2 |                 | 1.25±0.2         | 1.25±0.2  |                  |           |           |           |                    |          |              |  |          |
| GRM31   | 6               | 3.2±0.15         | 1.6±0.15  | 0.6±0.1          | 2.00±0.20 | 3.60±0.20 | 1.15 max. | Paper Tape         |          |              |  |          |
|         | 9               |                  |           | 0.85±0.1         |           |           |           |                    |          |              |  |          |
|         |                 | 3.2±0.2          | 1.6±0.2   |                  |           |           |           |                    |          |              |  |          |
|         | B               | 3.2±0.15         | 1.6±0.15  | 1.25±0.1         | 1.90±0.20 | 3.50±0.20 | 1.7 max.  | Plastic Tape       |          |              |  |          |
|         | M               |                  |           | 1.15±0.1         |           |           |           |                    |          |              |  |          |
|         |                 |                  |           | 1.15±0.15        |           |           |           |                    |          |              |  |          |
|         | X               | 3.2±0.2          | 1.6±0.2   | 1.2±0.1          |           |           |           |                    |          |              |  |          |
| 1.6±0.2 |                 |                  |           |                  |           |           |           |                    |          |              |  |          |
| C       | 3.2±0.3         | 1.6±0.3          | 1.6±0.3   | 2.10±0.20        | 3.60±0.20 | 2.5 max.  |           |                    |          |              |  |          |
| GRM32   | 9               | 3.2±0.3          | 2.5±0.2   | 0.85 +0.15/-0.05 | 2.80±0.20 | 3.60±0.20 | 1.15 max. | Paper Tape         |          |              |  |          |
|         | A               |                  |           |                  |           |           | 2.80±0.20 | 3.50±0.20          | 1.7 max. | Plastic Tape |  |          |
|         | M               |                  |           |                  |           | 1.15±0.1  |           |                    |          |              |  |          |
|         | N               |                  |           |                  |           | 1.35±0.15 |           |                    |          |              |  |          |
|         | C               |                  |           |                  |           | 1.6±0.2   |           |                    |          |              |  |          |
|         | R               |                  |           |                  |           | 1.8±0.2   |           |                    |          |              |  | 2.5 max. |
|         | D               |                  |           |                  |           | 2.0±0.2   |           |                    |          |              |  | 3.0 max. |
|         | E               |                  |           |                  |           | 2.5±0.2   |           |                    |          |              |  | 3.7 max. |

(5)GRM43/55

(in:mm)



| Type  |   | Dimensions(Chip) |               |                 | A *1 | B *1 | t        |
|-------|---|------------------|---------------|-----------------|------|------|----------|
|       |   | L                | W             | T               |      |      |          |
| GRM43 | M | $4.5 \pm 0.4$    | $3.2 \pm 0.3$ | $1.15 \pm 0.1$  | 3.6  | 4.9  | 2.5 max. |
|       | N |                  |               | $1.35 \pm 0.15$ |      |      |          |
|       | R |                  |               | $1.8 \pm 0.2$   |      |      |          |
|       | D |                  |               | $2.0 \pm 0.2$   |      |      | 3.7 max. |
|       | E |                  |               | $2.5 \pm 0.2$   |      |      |          |
|       | S |                  |               | $2.8 \pm 0.2$   |      |      |          |
| GRM55 | M | $5.7 \pm 0.4$    | $5.0 \pm 0.4$ | $1.15 \pm 0.1$  | 5.2  | 6.1  | 2.5 max. |
|       | N |                  |               | $1.35 \pm 0.15$ |      |      |          |
|       | C |                  |               | $1.6 \pm 0.2$   |      |      |          |
|       | R |                  |               | $1.8 \pm 0.2$   |      |      | 3.7 max. |
|       | D |                  |               | $2.0 \pm 0.2$   |      |      |          |
|       | E |                  |               | $2.5 \pm 0.2$   |      |      |          |
|       | F |                  |               | $3.2 \pm 0.2$   |      |      | 4.7 max. |

\*1 Nominal value

Fig.1 Package Chips



Fig.2 Dimensions of Reel



Fig.3 Taping Diagram

|                      | W         | w <sub>1</sub> |
|----------------------|-----------|----------------|
| GRM01/02             | 8.0 max.  | 5 $\pm$ 1.5    |
| GRM03/15/18/21/31/32 | 16.5 max. | 10 $\pm$ 1.5   |
| GRM43/55             | 20.5 max. | 14 $\pm$ 1.5   |



1.3 Tapes for capacitors are wound clockwise shown in Fig.3.  
(The sprocket holes are to the right as the tape is pulled toward the user.)

1.4 Part of the leader and part of the vacant section are attached as follows.



1.5 Accumulate pitch : 10 of sprocket holes pitch =  $20 \pm 0.3 \text{ mm}$  (GRM01/02)  
 $40 \pm 0.3 \text{ mm}$  (GRM03 min.)

1.6 Chip in the tape is enclosed by top tape and bottom tape as shown in Fig.1.

1.7 The top tape and base tape are not attached at the end of the tape for a minimum of 5 pitches.

1.8 There are no jointing for top tape and bottom tape.

1.9 There are no fuzz in the cavity.

1.10 Break down force of top tape : 5N min.

Break down force of bottom tape : 5N min. (Only a bottom tape existence )

1.11 Reel is made by resin and appeaser and dimension is shown in Fig 2.

There are possibly to change the material and dimension due to some impairment.

1.12 Peeling off force :  $0.1 \text{ N}$  to  $0.6 \text{ N}^*$  in the direction as shown below.

\* GRM01/02/03:  $0.05 \text{ N} \sim 0.5 \text{ N}$



1.13 Label that show the customer parts number, our parts number, our company name, inspection number and quantity, will be put in outside of reel.

## ■ Limitation of Applications

Please contact us before using our products for the applications listed below which require especially high reliability for the prevention of defects which might directly cause damage to the third party's life, body or property.

- ①Aircraft equipment    ②Aerospace equipment    ③Undersea equipment    ④Power plant control equipment
- ⑤Medical equipment    ⑥Transportation equipment(vehicles, trains, ships, etc.)    ⑦Traffic signal equipment
- ⑧Disaster prevention / crime prevention equipment    ⑨Data-processing equipment
- ⑩Application of similar complexity and/or reliability requirements to the applications listed in the above.

## ■ Storage and Operation condition

1. The performance of chip monolithic ceramic capacitors may be affected by the storage conditions.

1-1. Store the capacitors in the following conditions:

Room Temperature of +5°C to +40°C and a Relative Humidity of 20% to 70%.

(1) Sunlight, dust, rapid temperature changes, corrosive gas atmosphere, or high temperature and humidity conditions during storage may affect solderability and packaging performance.

Therefore, please maintain the storage temperature and humidity. Use the product within six months after receipt, as prolonged storage may cause oxidation of the terminations (outer electrodes).

(2) Please confirm solderability before using after six months.

Store the capacitors without opening the original bag.

Even if the storage period is short, do not exceed the specified atmospheric conditions.

1-2. 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.).

1-3. Due to moisture condensation caused by rapid humidity changes, or the photochemical change caused by direct sunlight on the terminal electrodes and/or the resin/epoxy coatings, the solderability and electrical performance may deteriorate. Do not store capacitors under direct sunlight or in high humidity conditions

## ■ Rating

### 1. Temperature Dependent Characteristics

1. The electrical characteristics of the capacitor can change with temperature.

1-1. For capacitors having larger temperature dependency, the capacitance may change with temperature changes. The following actions are recommended in order to ensure suitable capacitance values.

(1) Select a suitable capacitance for the operating temperature range.

(2) The capacitance may change within the rated temperature.

When you use a high dielectric constant type capacitor in a circuit that needs a tight (narrow) capacitance tolerance (e.g., a time-constant circuit), please carefully consider the temperature characteristics, and carefully confirm the various characteristics in actual use conditions and the actual system.

[Example of Temperature Characteristics X7R(R7)]

Sample: 0.1μF, Rated Voltage 50VDC



[Example of Temperature Characteristics X5R(R6)]

Sample: 22μF, Rated Voltage 4VDC



## 2.Measurement of Capacitance

1. Measure capacitance with the voltage and frequency specified in the product specifications.

1-1. The output voltage of the measuring equipment may decrease occasionally when capacitance is high.

Please confirm whether a prescribed measured voltage is impressed to the capacitor.

1-2. The capacitance values of high dielectric constant type capacitors change depending on the AC voltage applied.

Please consider the AC voltage characteristics when selecting a capacitor to be used in a AC circuit.

## 3.Applied Voltage

1. Do not apply a voltage to the capacitor that exceeds the rated voltage as called out in the specifications.

1-1. Applied voltage between the terminals of a capacitor shall be less than or equal to the rated voltage.

(1) When AC voltage is superimposed on DC voltage, the zero-to-peak voltage shall not exceed the rated DC voltage.

When AC voltage or pulse voltage is applied, the peak-to-peak voltage shall not exceed the rated DC voltage.

(2) Abnormal voltages (surge voltage, static electricity, pulse voltage, etc.) shall not exceed the rated DC voltage.

Typical Voltage Applied to the DC capacitor



(E : Maximum possible applied voltage.)

1-2. Influence of over voltage

Over voltage that is applied to the capacitor may result in an electrical short circuit caused by the breakdown of the internal dielectric layers .

The time duration until breakdown depends on the applied voltage and the ambient temperature.

## 4.Type of Applied Voltage and Self-heating Temperature

1.Confirm the operating conditions to make sure that no large current is flowing into the capacitor due to the continuous application of an AC voltage or pulse voltage.

When a DC rated voltage product is used in an AC voltage circuit or a pulse voltage circuit, the AC current or pulse current will flow into the capacitor; therefore check the self-heating condition.

Please confirm the surface temperature of the capacitor so that the temperature remains within the upper limits of the operating temperature, including the rise in temperature due to self-heating. When the capacitor is used with a high-frequency voltage or pulse voltage, heat may be generated by dielectric loss.

<Applicable to Rated Voltage of less than 100VDC>

1-1. The load should be contained to the level such that when measuring at atmospheric temperature of 25°C, the product's self-heating remains below 20°C and the surface temperature of the capacitor in the actual circuit remains within the maximum operating temperature.

[Example of Temperature Rise (Heat Generation) in Chip Monolithic Ceramic Capacitors in Contrast to Ripple Current]  
Sample: R(R1) characteristics 10μF, Rated voltage: DC10V



## 5. DC Voltage and AC Voltage Characteristic

1. The capacitance value of a high dielectric constant type capacitor changes depending on the DC voltage applied. Please consider the DC voltage characteristics when a capacitor is selected for use in a DC circuit.
- 1-1. The capacitance of ceramic capacitors may change sharply depending on the applied voltage. (See figure) Please confirm the following in order to secure the capacitance.
  - (1) Determine whether the capacitance change caused by the applied voltage is within the allowed range .
  - (2) In the DC voltage characteristics, the rate of capacitance change becomes larger as voltage increases, even if the applied voltage is below the rated voltage. When a high dielectric constant type capacitor is used in a circuit that requires a tight (narrow) capacitance tolerance (e.g., a time constant circuit), please carefully consider the voltage characteristics, and confirm the various characteristics in the actual operating conditions of the system.
2. The capacitance values of high dielectric constant type capacitors changes depending on the AC voltage applied. Please consider the AC voltage characteristics when selecting a capacitor to be used in a AC circuit.

### [Example of DC Voltage Characteristics]

Sample: X7R(R7) Characteristics 0.1 $\mu$ F, Rated Voltage 50VDC



### [Example of AC Voltage Characteristics]

Sample: X7R(R7) Characteristics 10 $\mu$ F, Rated Voltage 6.3VDC



## 6. Capacitance Aging

1. The high dielectric constant type capacitors have an Aging characteristic in which the capacitance value decreases with the passage of time. When you use a high dielectric constant type capacitors in a circuit that needs a tight (narrow) capacitance tolerance (e.g., a time-constant circuit), please carefully consider the characteristics of these capacitors, such as their aging, voltage, and temperature characteristics. In addition, check capacitors using your actual appliances at the intended environment and operating conditions.

### [ Example of Change Over Time (Aging characteristics) ]



## 7.Vibration and Shock

1. Please confirm the kind of vibration and/or shock, its condition, and any generation of resonance. Please mount the capacitor so as not to generate resonance, and do not allow any impact on the terminals.
2. Mechanical shock due to being dropped may cause damage or a crack in the dielectric material of the capacitor. Do not use a dropped capacitor because the quality and reliability may be deteriorated.
3. When printed circuit boards are piled up or handled, the corner of another printed circuit board should not be allowed to hit the capacitor in order to avoid a crack or other damage to the capacitor.



## ■ Soldering and Mounting

### 1. Mounting Position

1. Confirm the best mounting position and direction that minimizes the stress imposed on the capacitor during flexing or bending the printed circuit board.

- 1-1. Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.  
[Component Direction]



Locate chip horizontal to the direction in which stress acts.

#### [Chip Mounting Close to Board Separation Point]

It is effective to implement the following measures, to reduce stress in separating the board.

It is best to implement all of the following three measures; however, implement as many measures as possible to reduce stress.

| Contents of Measures                                                                       | Stress Level |
|--------------------------------------------------------------------------------------------|--------------|
| (1) Turn the mounting direction of the component parallel to the board separation surface. | $A > D^{*1}$ |
| (2) Add slits in the board separation part.                                                | $A > B$      |
| (3) Keep the mounting position of the component away from the board separation surface.    | $A > C$      |



\*1  $A > D$  is valid when stress is added vertically to the perforation as with Hand Separation.  
If a Cutting Disc is used, stress will be diagonal to the PCB, therefore  $A > D$  is invalid.

#### [Mounting Capacitors Near Screw Holes]

When a capacitor is mounted near a screw hole, it may be affected by the board deflection that occurs during the tightening of the screw. Mount the capacitor in a position as far away from the screw holes as possible.



### 2. Information before Mounting

1. Do not re-use capacitors that were removed from the equipment.
2. Confirm capacitance characteristics under actual applied voltage.
3. Confirm the mechanical stress under actual process and equipment use.
4. Confirm the rated capacitance, rated voltage and other electrical characteristics before assembly.
5. Prior to use, confirm the solderability of capacitors that were in long-term storage.
6. Prior to measuring capacitance, carry out a heat treatment for capacitors that were in long-term storage.
7. The use of Sn-Zn based solder will deteriorate the reliability of the MLCC.  
Please contact our sales representative or product engineers on the use of Sn-Zn based solder in advance.

### **3.Maintenance of the Mounting (pick and place) Machine**

1. Make sure that the following excessive forces are not applied to the capacitors.

1-1. In mounting the capacitors on the printed circuit board, any bending force against them shall be kept to a minimum to prevent them from any damage or cracking. Please take into account the following precautions and recommendations for use in your process.

(1) Adjust the lowest position of the pickup nozzle so as not to bend the printed circuit board.

(2) Adjust the nozzle pressure within a static load of 1N to 3N during mounting.



2.Dirt particles and dust accumulated between the suction nozzle and the cylinder inner wall prevent the nozzle from moving smoothly. This imposes greater force upon the chip during mounting, causing cracked chips. Also, the locating claw, when worn out, imposes uneven forces on the chip when positioning, causing cracked chips. The suction nozzle and the locating claw must be maintained, checked and replaced periodically.

#### 4-1.Reflow Soldering

1. When sudden heat is applied to the components, the mechanical strength of the components will decrease because a sudden temperature change causes deformation inside the components. In order to prevent mechanical damage to the components, preheating is required for both the components and the PCB. Preheating conditions are shown in table 1. It is required to keep the temperature differential between the solder and the components surface ( $\Delta T$ ) as small as possible.
2. Solderability of tin plating termination chips might be deteriorated when a low temperature soldering profile where the peak solder temperature is below the melting point of tin is used. Please confirm the solderability of tin plated termination chips before use.
3. When components are immersed in solvent after mounting, be sure to maintain the temperature difference ( $\Delta T$ ) between the component and the solvent within the range shown in the table 1.

Table 1

| Series | Chip Dimension(L/W) Code | Temperature Differential            |
|--------|--------------------------|-------------------------------------|
| GRM    | 01/02/03/15/18/21/31     | $\Delta T \leq 190^{\circ}\text{C}$ |
| GRM    | 32/43/55                 | $\Delta T \leq 130^{\circ}\text{C}$ |

#### Recommended Conditions

|                  | Lead Free Solder      |
|------------------|-----------------------|
| Peak Temperature | 240 to 260°C          |
| Atmosphere       | Air or N <sub>2</sub> |

Lead Free Solder: Sn-3.0Ag-0.5Cu

#### [Standard Conditions for Reflow Soldering]



#### [Allowable Reflow Soldering Temperature and Time]



In the case of repeated soldering, the accumulated soldering time must be within the range shown above.

#### 4. Optimum Solder Amount for Reflow Soldering

- 4-1. Overly thick application of solder paste results in a excessive solder fillet height.  
This makes the chip more susceptible to mechanical and thermal stress on the board and may cause the chips to crack.
- 4-2. Too little solder paste results in a lack of adhesive strength on the termination, which may result in chips breaking loose from the PCB.
- 4-3. Please confirm that solder has been applied smoothly to the termination.

#### Inverting the PCB

Make sure not to impose any abnormal mechanical shocks to the PCB.

## 4-2.Flow Soldering

1. Do not apply flow soldering to chips not listed in Table 2.

Table 2

| Series | Chip Dimension(L/W) Code | Temperature Differential            |
|--------|--------------------------|-------------------------------------|
| GRM    | 18/21/31                 | $\Delta T \leq 150^{\circ}\text{C}$ |

2. When sudden heat is applied to the components, the mechanical strength of the components will decrease because a sudden temperature change causes deformation inside the components. In order to prevent mechanical damage to the components, preheating is required for both of the components and the PCB. Preheating conditions are shown in table 2. It is required to keep the temperature differential between the solder and the components surface ( $\Delta T$ ) as low as possible.
3. Excessively long soldering time or high soldering temperature can result in leaching of the terminations, causing poor adhesion or a reduction in capacitance value due to loss of contact between the inner electrodes and terminations.
4. When components are immersed in solvent after mounting, be sure to maintain the temperature differential ( $\Delta T$ ) between the component and solvent within the range shown in the table 2.

### Recommended Conditions

|                             | Lead Free Solder      |
|-----------------------------|-----------------------|
| Preheating Peak Temperature | 100 to 120°C          |
| Soldering Peak Temperature  | 250 to 260°C          |
| Atmosphere                  | Air or N <sub>2</sub> |

Lead Free Solder: Sn-3.0Ag-0.5Cu

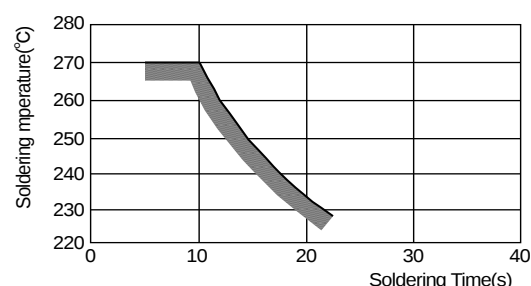
### 5. Optimum Solder Amount for Flow Soldering

- 5-1. The top of the solder fillet should be lower than the thickness of the components. If the solder amount is excessive, the risk of cracking is higher during board bending or any other stressful condition.

### [Standard Conditions for Flow Soldering]



### [Allowable Flow Soldering Temperature and Time]



In the case of repeated soldering, the accumulated soldering time must be within the range shown above.



### 4-3. Correction of Soldered Portion

When sudden heat is applied to the capacitor, distortion caused by the large temperature difference occurs internally, and can be the cause of cracks. Capacitors also tend to be affected by mechanical and thermal stress depending on the board preheating temperature or the soldering fillet shape, and can be the cause of cracks.

Please refer to "1. PCB Design" or "3. Optimum solder amount" for the solder amount and the fillet shapes.

#### 1. Correction with a Soldering Iron

- 1-1. In order to reduce damage to the capacitor, be sure to preheat the capacitor and the mounting board.  
Preheat to the temperature range shown in Table 3. A hot plate, hot air type preheater, etc. can be used for preheating.
- 1-2. After soldering, do not allow the component/PCB to cool down rapidly.
- 1-3. Perform the corrections with a soldering iron as quickly as possible. If the soldering iron is applied too long, there is a possibility of causing solder leaching on the terminal electrodes, which will cause deterioration of the adhesive strength and other problems.

Table 3

| Series | Chip Dimension (L/W) Code | Temperature of Soldering Iron Tip | Preheating Temperature | Temperature Differential( $\Delta T$ ) | Atmosphere |
|--------|---------------------------|-----------------------------------|------------------------|----------------------------------------|------------|
| GRM    | 03/15/18/21/31            | 350°C max.                        | 150°C min.             | $\Delta T \leq 190^\circ\text{C}$      | Air        |
| GRM    | 32/43/55                  | 280°C max.                        | 150°C min.             | $\Delta T \leq 130^\circ\text{C}$      | Air        |

Lead Free Solder: Sn-3.0Ag-0.5Cu

\* Please manage  $\Delta T$  in the temperature of soldering iron and the preheating temperature.

#### 2. Correction with Spot Heater

Compared to local heating with a soldering iron, hot air heating by a spot heater heats the overall component and board, therefore, it tends to lessen the thermal shock. In the case of a high density mounted board, a spot heater can also prevent concerns of the soldering iron making direct contact with the component.

- 2-1. If the distance from the hot air outlet of the spot heater to the component is too close, cracks may occur due to thermal shock. To prevent this problem, follow the conditions shown in Table 4.
- 2-2. In order to create an appropriate solder fillet shape, it is recommended that hot air be applied at the angle shown in Figure 1.

Table 4

|                                   |                                                        |
|-----------------------------------|--------------------------------------------------------|
| Distance                          | 5mm or more                                            |
| Hot Air Application angle         | 45° *Figure 1                                          |
| Hot Air Temperature Nozzle Outlet | 400°C max.                                             |
| Application Time                  | Less than 10 seconds<br>(3216M / 1206 size or smaller) |
|                                   | Less than 30 seconds<br>(3225M / 1210 size or larger)  |

(3216M , 3225M : Metric size code)

[Figure 1]



#### 3. Optimum solder amount when re-working with a soldering iron

- 3-1. If the solder amount is excessive, the risk of cracking is higher during board bending or any other stressful condition.  
Too little solder amount results in a lack of adhesive strength on the termination, which may result in chips breaking loose from the PCB.  
Please confirm that solder has been applied smoothly is and rising to the end surface of the chip.
- 3-2. A soldering iron with a tip of  $\phi 3\text{mm}$  or smaller should be used.  
It is also necessary to keep the soldering iron from touching the components during the re-work.
- 3-3. Solder wire with  $\phi 0.5\text{mm}$  or smaller is required for soldering.



## 5. Washing

Excessive ultrasonic oscillation during cleaning can cause the PCBs to resonate, resulting in cracked chips or broken solder joints. Take note not to vibrate PCBs.

## 6. Electrical Test on Printed Circuit Board

1. Confirm position of the support pin or specific jig, when inspecting the electrical performance of a capacitor after mounting on the printed circuit board.
  - 1-1. Avoid bending the printed circuit board by the pressure of a test-probe, etc.  
The thrusting force of the test probe can flex the PCB, resulting in cracked chips or open solder joints. Provide support pins on the back side of the PCB to prevent warping or flexing. Install support pins as close to the test-probe as possible.
  - 1-2. Avoid vibration of the board by shock when a test -probe contacts a printed circuit board.

[Not Recommended]



[Recommended]



## 7. Printed Circuit Board Cropping

1. After mounting a capacitor on a printed circuit board, do not apply any stress to the capacitor that caused bending or twisting the board.
  - 1-1. In cropping the board, the stress as shown may cause the capacitor to crack.  
Cracked capacitors may cause deterioration of the insulation resistance, and result in a short. Avoid this type of stress to a capacitor.

[Bending]



[Twisting]



2. Check the cropping method for the printed circuit board in advance.

- 2-1. Printed circuit board cropping shall be carried out by using a jig or an apparatus (Disc separator, router type separator, etc.) to prevent the mechanical stress that can occur to the board.

| Board Separation Method  | Hand Separation<br>Nipper Separation                                            | (1) Board Separation Jig                                                                                                        | Board Separation Apparatus                                                                                                                                                           |                          |
|--------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
|                          |                                                                                 |                                                                                                                                 | 2) Disc Separator                                                                                                                                                                    | 3) Router Type Separator |
| Level of stress on board | High                                                                            | Medium                                                                                                                          | Medium                                                                                                                                                                               | Low                      |
| Recommended              | ×                                                                               | △*                                                                                                                              | △*                                                                                                                                                                                   | ○                        |
| Notes                    | Hand and nipper separation apply a high level of stress.<br>Use another method. | <ul style="list-style-type: none"> <li>Board handling</li> <li>Board bending direction</li> <li>Layout of capacitors</li> </ul> | <ul style="list-style-type: none"> <li>Board handling</li> <li>Layout of slits</li> <li>Design of V groove</li> <li>Arrangement of blades</li> <li>Controlling blade life</li> </ul> | Board handling           |

\* When a board separation jig or disc separator is used, if the following precautions are not observed, a large board deflection stress will occur and the capacitors may crack.  
Use router type separator if at all possible.

# (1) Example of a suitable jig

[In the case of Single-side Mounting]

An outline of the board separation jig is shown as follows.

Recommended example: Stress on the component mounting position can be minimized by holding the portion close to the jig, and bend in the direction towards the side where the capacitors are mounted.

Not recommended example: The risk of cracks occurring in the capacitors increases due to large stress being applied to the component mounting position, if the portion away from the jig is held and bent in the direction opposite the side where the capacitors are mounted.

[Outline of jig]



[Hand Separation]



[In the case of Double-sided Mounting]

Since components are mounted on both sides of the board, the risk of cracks occurring can not be avoided with the above method. Therefore, implement the following measures to prevent stress from being applied to the components.

(Measures)

(1) Consider introducing a router type separator.

If it is difficult to introduce a router type separator, implement the following measures.

(Refer to item 1. Mounting Position)

(2) Mount the components parallel to the board separation surface.

(3) When mounting components near the board separation point, add slits in the separation position near the component.

(4) Keep the mounting position of the components away from the board separation point.

# (2) Example of a Disc Separator

An outline of a disc separator is shown as follows. As shown in the Principle of Operation, the top blade and bottom blade are aligned with the V-grooves on the printed circuit board to separate the board.

In the following case, board deflection stress will be applied and cause cracks in the capacitors.

(1) When the adjustment of the top and bottom blades are misaligned, such as deviating in the top-bottom, left-right or front-rear directions

(2) The angle of the V groove is too low, depth of the V groove is too shallow, or the V groove is misaligned top-bottom

IF V groove is too deep, it is possible to brake when you handle and carry it. Carefully design depth of the V groove with consideration about strength of material of the printed circuit board.

[ Outline of Machine ]



[ Principle of Operation ]



[ Cross-section Diagram ]



[Disc Separator]

| Recommended                          | Not recommended                      |                                      |                                      |
|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
|                                      | Top-bottom Misalignment              | Left-right Misalignment              | Front-rear Misalignment              |
| <p>Top Blade</p> <p>Bottom Blade</p> | <p>Top Blade</p> <p>Bottom Blade</p> | <p>Top Blade</p> <p>Bottom Blade</p> | <p>Top Blade</p> <p>Bottom Blade</p> |

[V-groove Design]

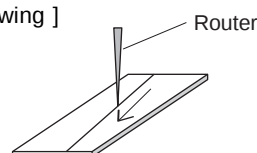
| Example of Recommended | Not Recommended         |           |                   |                |
|------------------------|-------------------------|-----------|-------------------|----------------|
|                        | Left-right Misalignment | Low-Angle | Depth too Shallow | Depth too Deep |
|                        |                         |           |                   |                |

### (3) Example of Router Type Separator

The router type separator performs cutting by a router rotating at a high speed. Since the board does not bend in the cutting process, stress on the board can be suppressed during board separation.

When attaching or removing boards to/from the router type separator, carefully handle the boards to prevent bending.

[ Outline Drawing ]



## 8. Assembly

### 1. Handling

If a board mounted with capacitors is held with one hand, the board may bend.

Firmly hold the edges of the board with both hands when handling.

If a board mounted with capacitors is dropped, cracks may occur in the capacitors.

Do not use dropped boards, as there is a possibility that the quality of the capacitors may be impaired.

### 2. Attachment of Other Components

#### 2-1. Mounting of Other Components

Pay attention to the following items, when mounting other components on the back side of the board after capacitors have been mounted on the opposite side.

When the bottom dead point of the suction nozzle is set too low, board deflection stress may be applied to the capacitors on the back side (bottom side), and cracks may occur in the capacitors.

- After the board is straightened, set the bottom dead point of the nozzle on the upper surface of the board.
- Periodically check and adjust the bottom dead point.



#### 2-2. Inserting Components with Leads into Boards

When inserting components (transformers, IC, etc.) into boards, bending the board may cause cracks in the capacitors or cracks in the solder. Pay attention to the following.

- Increase the size of the holes to insert the leads, to reduce the stress on the board during insertion.
- Fix the board with support pins or a dedicated jig before insertion.
- Support below the board so that the board does not bend. When using multiple support pins on the board, periodically confirm that there is no difference in the height of each support pin.



#### 2-3. Attaching/Removing Sockets

When the board itself is a connector, the board may bend when a socket is attached or removed.

Plan the work so that the board does not bend when a socket is attached or removed.



#### 2-4. Tightening Screws

The board may be bent, when tightening screws, etc. during the attachment of the board to a shield or chassis. Pay attention to the following items before performing the work.

- Plan the work to prevent the board from bending.
- Use a torque screwdriver, to prevent over-tightening of the screws.
- The board may bend after mounting by reflow soldering, etc. Please note, as stress may be applied to the chips by forcibly flattening the board when tightening the screws.



## ■ Others

### 1. Under Operation of Equipment

- 1-1. Do not touch a capacitor directly with bare hands during operation in order to avoid the danger of an electric shock.
- 1-2. Do not allow the terminals of a capacitor to come in contact with any conductive objects (short-circuit).  
Do not expose a capacitor to a conductive liquid, inducing any acid or alkali solutions.
- 1-3. Confirm the environment in which the equipment will operate is under the specified conditions.  
Do not use the equipment under the following environments.
  - (1) Being splattered with water or oil.
  - (2) Being exposed to direct sunlight.
  - (3) Being exposed to ozone, ultraviolet rays, or radiation.
  - (4) Being exposed to toxic gas (e.g., hydrogen sulfide, sulfur dioxide, chlorine, ammonia gas etc.)
  - (5) Any vibrations or mechanical shocks exceeding the specified limits.
  - (6) Moisture condensing environments.
- 1-4. Use damp proof countermeasures if using under any conditions that can cause condensation.

### 2. Others

- 2-1. In an Emergency
  - (1) If the equipment should generate smoke, fire, or smell, immediately turn off or unplug the equipment.  
If the equipment is not turned off or unplugged, the hazards may be worsened by supplying continuous power.
  - (2) In this type of situation, do not allow face and hands to come in contact with the capacitor or burns may be caused by the capacitor's high temperature.
- 2-2. Disposal of waste  
When capacitors are disposed of, they must be burned or buried by an industrial waste vendor with the appropriate licenses.
- 2-3. Circuit Design
  - (1) Addition of Fail Safe Function  
Capacitors that are cracked by dropping or bending of the board may cause deterioration of the insulation resistance, and result in a short. If the circuit being used may cause an electrical shock, smoke or fire when a capacitor is shorted, be sure to install fail-safe functions, such as a fuse, to prevent secondary accidents.
  - (2) This series are not safety standard certified products.
- 2-4. Remarks  
Failure to follow the cautions may result, worst case, in a short circuit and smoking when the product is used.  
The above notices are for standard applications and conditions. Contact us when the products are used in special mounting conditions.  
Select optimum conditions for operation as they determine the reliability of the product after assembly.  
The data herein are given in typical values, not guaranteed ratings.

## ■ Rating

### **1. Operating Temperature**

1. The operating temperature limit depends on the capacitor.
  - 1-1. Do not apply temperatures exceeding the maximum operating temperature.  
It is necessary to select a capacitor with a suitable rated temperature that will cover the operating temperature range.  
It is also necessary to consider the temperature distribution in equipment and the seasonal temperature variable factor.
  - 1-2. Consider the self-heating factor of the capacitor  
The surface temperature of the capacitor shall not exceed the maximum operating temperature including self-heating.

### **2. Atmosphere Surroundings (gaseous and liquid)**

1. Restriction on the operating environment of capacitors.
  - 1-1. Capacitors, when used in the above, unsuitable, operating environments may deteriorate due to the corrosion of the terminations and the penetration of moisture into the capacitor.
  - 1-2. The same phenomenon as the above may occur when the electrodes or terminals of the capacitor are subject to moisture condensation.
  - 1-3. The deterioration of characteristics and insulation resistance due to the oxidization or corrosion of terminal electrodes may result in breakdown when the capacitor is exposed to corrosive or volatile gases or solvents for long periods of time.

### **3. Piezo-electric Phenomenon**

1. When using high dielectric constant type capacitors in AC or pulse circuits, the capacitor itself vibrates at specific frequencies and noise may be generated.  
Moreover, when the mechanical vibration or shock is added to capacitor, noise may occur.

## ■ Soldering and Mounting

### 1. PCB Design

#### 1. Notice for Pattern Forms

1-1. Unlike leaded components, chip components are susceptible to flexing stresses since they are mounted directly on the substrate.  
They are also more sensitive to mechanical and thermal stresses than leaded components.  
Excess solder fillet height can multiply these stresses and cause chip cracking.  
When designing substrates, take land patterns and dimensions into consideration to eliminate the possibility of excess solder fillet height.

1-2. There is a possibility of chip cracking caused by PCB expansion/contraction with heat, because stress on a chip is different depending on PCB material and structure. When the thermal expansion coefficient greatly differs between the board used for mounting and the chip, it will cause cracking of the chip due to the thermal expansion and contraction. When capacitors are mounted on a fluorine resin printed circuit board or on a single-layered glass epoxy board, it may also cause cracking of the chip for the same reason.

#### Pattern Forms

|                                                   | Prohibited                                                                          | Correct                                                                              |
|---------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Placing Close to Chassis                          |   |   |
| Placing of Chip Components and Leaded Components  |  |  |
| Placing of Leaded Components after Chip Component |  |  |
| Lateral Mounting                                  |  |  |

## 2. Land Dimensions

2-1. Chip capacitors can be cracked due to the stress of PCB bending , etc. if the land area is larger than needed and has an excess amount of solder. Please refer to the land dimensions in table 1 for flow soldering, table 2 for reflow soldering.

Please confirm the suitable land dimension by evaluating of the actual SET / PCB.



Table 1 Flow Soldering Method

| Series | Chip Dimension (L/W) Code | Chip(L×W) | a          | b          | c          |
|--------|---------------------------|-----------|------------|------------|------------|
| GRM    | 18                        | 1.6×0.8   | 0.6 to 1.0 | 0.8 to 0.9 | 0.6 to 0.8 |
| GRM    | 21                        | 2.0×1.25  | 1.0 to 1.2 | 0.9 to 1.0 | 0.8 to 1.1 |
| GRM    | 31                        | 3.2×1.6   | 2.2 to 2.6 | 1.0 to 1.1 | 1.0 to 1.4 |

Flow soldering can only be used for products with a chip size of 1.6x0.8mm to 3.2x1.6mm. (in mm)

Table 2 Reflow Soldering Method

| Series | Chip Dimension (L/W) Code | Chip(L×W) (Dimensions Tolerance) | a            | b            | c              |
|--------|---------------------------|----------------------------------|--------------|--------------|----------------|
| GRM    | 01                        | 0.25×0.125                       | 0.10 to 0.11 | 0.07 to 0.12 | 0.125 to 0.145 |
| GRM    | 02                        | 0.4×0.2                          | 0.16 to 0.2  | 0.12 to 0.18 | 0.2 to 0.23    |
| GRM    | 03                        | 0.6×0.3                          | 0.2 to 0.3   | 0.2 to 0.35  | 0.2 to 0.4     |
| GRM    | 15                        | 1.0×0.5 (within ±0.10)           | 0.3 to 0.5   | 0.35 to 0.45 | 0.4 to 0.6     |
|        |                           | 1.0×0.5 (±0.15/±0.20)            | 0.4 to 0.6   | 0.4 to 0.5   | 0.5 to 0.7     |
| GRM    | 18                        | 1.6×0.8 (within ±0.10)           | 0.6 to 0.8   | 0.6 to 0.7   | 0.6 to 0.8     |
|        |                           | 1.6×0.8 (±0.15/±0.20)            | 0.7 to 0.9   | 0.7 to 0.8   | 0.8 to 1.0     |
| GRM    | 21                        | 2.0×1.25 (within ±0.10)          | 1.2          | 0.6          | 1.25           |
|        |                           | 2.0×1.25 (±0.15)                 | 1.2          | 0.6 to 0.8   | 1.2 to 1.4     |
|        |                           | 2.0×1.25 (±0.20)                 | 1.0 to 1.4   | 0.6 to 0.8   | 1.2 to 1.4     |
| GRM    | 31                        | 3.2×1.6 (within±0.20)            | 1.8 to 2.0   | 0.9 to 1.2   | 1.5 to 1.7     |
|        |                           | 3.2×1.6 (±0.30)                  | 1.9 to 2.1   | 1.0 to 1.3   | 1.7 to 1.9     |
| GRM    | 32                        | 3.2×2.5                          | 2.0 to 2.4   | 1.0 to 1.2   | 1.8 to 2.3     |
| GRM    | 43                        | 4.5×3.2                          | 3.0 to 3.5   | 1.2 to 1.4   | 2.3 to 3.0     |
| GRM    | 55                        | 5.7×5.0                          | 4.0 to 4.6   | 1.4 to 1.6   | 3.5 to 4.8     |

(in mm)

### 3. Board Design

When designing the board, keep in mind that the amount of strain which occurs will increase depending on the size and material of the board.

Relationship with amount of strain to the board thickness, length, width, etc.]

$$\epsilon = \frac{3PL}{2Ewh^2}$$

Relationship between load and strain



$\epsilon$  : Strain on center of board ( $\mu\text{st}$ )  
 $L$  : Distance between supporting points (mm)  
 $w$  : Board width (mm)  
 $h$  : Board thickness (mm)  
 $E$  : Elastic modulus of board ( $\text{N/m}^2=\text{Pa}$ )  
 $Y$  : Deflection (mm)  
 $P$  : Load (N)

When the load is constant, the following relationship can be established.

- As the distance between the supporting points ( $L$ ) increases, the amount of strain also increases.  
→ Reduce the distance between the supporting points.
- As the elastic modulus ( $E$ ) decreases, the amount of strain increases.  
→ Increase the elastic modulus.
- As the board width ( $w$ ) decreases, the amount of strain increases.  
→ Increase the width of the board.
- As the board thickness ( $h$ ) decreases, the amount of strain increases.  
→ Increase the thickness of the board.

Since the board thickness is squared, the effect on the amount of strain becomes even greater.

### 2. Adhesive Application

- Thin or insufficient adhesive can cause the chips to loosen or become disconnected during flow soldering.

The amount of adhesive must be more than dimension  $c$ , shown in the drawing at right, to obtain the correct bonding strength. The chip's electrode thickness and land thickness must also be taken into consideration.



- Low viscosity adhesive can cause chips to slip after mounting. The adhesive must have a viscosity of  $5000\text{Pa} \cdot \text{s}$  ( $500\text{ps}$ ) min. (at  $25^\circ\text{C}$ )

### 3. Adhesive Coverage

| Size (L×W) (in mm) | Adhesive Coverage* |
|--------------------|--------------------|
| 1.6 × 0.8          | 0.05mg min.        |
| 2.0 × 1.25         | 0.1mg min.         |
| 3.2 × 1.6          | 0.15mg min.        |

\*Nominal Value

### 3. Adhesive Curing

- Insufficient curing of the adhesive can cause chips to disconnect during flow soldering and causes deterioration in the insulation resistance between the terminations due to moisture absorption.  
Control curing temperature and time in order to prevent insufficient hardening.

### 4. Flux (for Flow soldering)

- An excessive amount of flux generates a large quantity of flux gas, which can cause a deterioration of solderability, so apply flux thinly and evenly throughout. (A foaming system is generally used for flow soldering.)
- Flux containing too high a percentage of halide may cause corrosion of the terminations unless there is sufficient cleaning. Use flux with a halide content of 0.1% max.
- Do not use strong acidic flux.
- Do not use water-soluble flux.\*  
(\*Water-soluble flux can be defined as non-rosin type flux including wash-type flux and non-wash-type flux.)

### **5.Flow Soldering**

Set temperature and time to ensure that leaching of the terminations does not exceed 25% of the chip end area as a single chip (full length of the edge A-B-C-D shown at right) and 25% of the length A-B shown as mounted on substrate.



### **6.Reflow soldering**

The halogen system substance and organic acid are included in solder paste, and a chip corrodes by this kind of solder paste.

Do not use strong acid flux.

Do not use water-soluble flux.\*

(\*Water-soluble flux can be defined as non-rosin type flux including wash-type flux and non-wash-type flux.)

### **7.Washing**

1. Please evaluate the capacitor using actual cleaning equipment and conditions to confirm the quality, and select the solvent for cleaning.
2. Unsuitable cleaning solvent may leave residual flux or other foreign substances, causing deterioration of electrical characteristics and the reliability of the capacitors.
3. Select the proper cleaning conditions.
- 3-1. Improper cleaning conditions (excessive or insufficient) may result in the deterioration of the performance of the capacitors.

### **8.Coating**

1. A crack may be caused in the capacitor due to the stress of the thermal contraction of the resin during curing process. The stress is affected by the amount of resin and curing contraction. Select a resin with low curing contraction. The difference in the thermal expansion coefficient between a coating resin or a molding resin and the capacitor may cause the destruction and deterioration of the capacitor such as a crack or peeling, and lead to the deterioration of insulation resistance or dielectric breakdown. Select a resin for which the thermal expansion coefficient is as close to that of the capacitor as possible. A silicone resin can be used as an under-coating to buffer against the stress.
2. Select a resin that is less hygroscopic. Using hygroscopic resins under high humidity conditions may cause the deterioration of the insulation resistance of a capacitor. An epoxy resin can be used as a less hygroscopic resin.
3. The halogen system substance and organic acid are included in coating material, and a chip corrodes by the kind of Coating material. Do not use strong acid type.

■ Others

**1.Transportation**

1. The performance of a capacitor may be affected by the conditions during transportation.

1-1. The capacitors shall be protected against excessive temperature, humidity and mechanical force during transportation.

(1) Climatic condition

- low air temperature : -40°C
- change of temperature air/air : -25°C/+25°C
- low air pressure : 30 kPa
- change of air pressure : 6 kPa/min.

(2) Mechanical condition

Transportation shall be done in such a way that the boxes are not deformed and forces are not directly passed on to the inner packaging.

1-2. Do not apply excessive vibration, shock, or pressure to the capacitor.

(1) When excessive mechanical shock or pressure is applied to a capacitor, chipping or cracking may occur in the ceramic body of the capacitor.

(2) When the sharp edge of an air driver, a soldering iron, tweezers, a chassis, etc. impacts strongly on the surface of the capacitor, the capacitor may crack and short-circuit.

1-3. Do not use a capacitor to which excessive shock was applied by dropping etc.

A capacitor dropped accidentally during processing may be damaged.

**2.Characteristics Evaluation in the Actual System**

1. Evaluate the capacitor in the actual system, to confirm that there is no problem with the performance and specification values in a finished product before using.

2. Since a voltage dependency and temperature dependency exists in the capacitance of high dielectric type ceramic capacitors, the capacitance may change depending on the operating conditions in the actual system. Therefore, be sure to evaluate the various characteristics, such as the leakage current and noise absorptivity, which will affect the capacitance value of the capacitor.

3. In addition, voltages exceeding the predetermined surge may be applied to the capacitor by the inductance in the actual system. Evaluate the surge resistance in the actual system as required.

1. Please make sure that your product has been evaluated in view of your specifications with our product being mounted to your product.
2. You are requested not to use our product deviating from this product specification.
3. We consider it not appropriate to include any terms and conditions with regard to the business transaction in the product specifications, drawings or other technical documents. Therefore, if your technical documents as above include such terms and conditions such as warranty clause, product liability clause, or intellectual property infringement liability clause, they will be deemed to be invalid.