⚠Caution/Notice

⚠Caution

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2. Soldering and Mounting
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⚠Caution

■ Storage and Operation Conditions

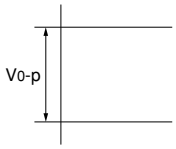
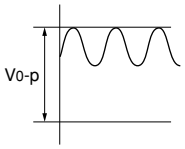
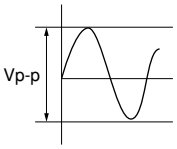
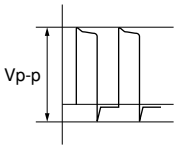
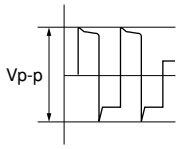
The insulating coating of capacitors does not form a perfect seal; therefore, do not use or store capacitors in a corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt or the like are present. Also avoid exposure to moisture. Before cleaning, bonding or molding this product, verify that these processes do not affect product quality by testing the performance of a cleaned, bonded or molded product in the intended equipment. Store the capacitors where the temperature and relative humidity do not exceed 5 to 40 degrees centigrade and 20 to 70%.
Use capacitors within 6 months after delivery.

■ Rating

1. Operating Voltage

When DC-rated capacitors are to be used in AC or ripple current circuits, be sure to maintain the Vp-p value of the applied voltage or the V0-p which contains DC bias within the rated voltage range.
When the voltage is applied to the circuit, starting or stopping may generate irregular voltage for a transit period because of resonance or switching. Be sure to use a capacitor with a rated voltage range that includes these irregular voltages.

When DC-rated capacitors are to be used in input circuits from commercial power source (AC filter), be sure to use Safety Recognized Capacitors because various regulations on withstand voltage or impulse withstand established for all equipment should be taken into consideration.

Voltage	DC Voltage	DC+AC Voltage	AC Voltage	Pulse Voltage (1)	Pulse Voltage (2)
Positional Measurement					

2. Operating Temperature and Self-generated Heat

Keep the surface temperature of a capacitor below the upper limit of its rated operating temperature range. Be sure to take into account the heat generated by the capacitor itself. When the capacitor is used in a high-frequency current, pulse current or similar current, it may have self-generated heat due to dielectric loss. In the case of "High Dielectric Constant Type Capacitors," applied voltage load should be such that self-generated heat is within 20 °C under the condition where the capacitor is subjected at an atmosphere temperature of 25 °C. Please contact us if self-generated heat occurs with "Temperature Compensating Type Capacitors".

When measuring, use a thermocouple of small thermal capacity -K of ø0.1mm under conditions where the capacitor is not affected by radiant heat from other components or wind from surroundings. Excessive heat may lead to deterioration of the capacitor's characteristics and reliability. Never attempt to perform measurement with the cooling fan running. Otherwise, accurate measurement cannot be ensured.

3. Fail-Safe

Be sure to provide an appropriate fail-safe function on your product to prevent a second damage that may be caused by the abnormal function or the failure of our product.

Continued on the following page.

⚠Caution

Continued from the preceding page.

■ Soldering and Mounting

1. Vibration and Impact

Do not expose a capacitor or its leads to excessive shock or vibration during use.

2. Soldering

When soldering this product to a PCB/PWB, do not exceed the solder heat resistance specification of the capacitor. Subjecting this product to excessive heating could melt the internal junction solder and may result in thermal shocks that can crack the ceramic element.

3. Bonding, Resin Molding and Coating

In case of bonding, molding or coating this product, verify that these processes do not affect the quality of the capacitor by testing the performance of the bonded, molded or coated product in the intended equipment.

In case the amount of application, dryness/ hardening conditions of adhesives and molding resins containing organic solvents (ethyl acetate, methyl ethyl ketone, toluene, etc.) are unsuitable, the outer coating resin of a capacitor may be damaged by the organic solvents and may result, worst case, in a short circuit.

The variation in thickness of adhesive or molding resin or coating may cause an outer coating resin cracking and/or ceramic element cracking of a capacitor in a temperature cycling.

4. Treatment after Bonding, Resin Molding and Coating

When the outer coating is hot (over 100 degrees centigrade) after soldering, it becomes soft and fragile, so please be careful not to give it mechanical stress.

FAILURE TO FOLLOW THE ABOVE CAUTIONS MAY RESULT, WORST CASE, IN A SHORT CIRCUIT AND CAUSE FUMING OR PARTIAL DISPERSION WHEN THE PRODUCT IS USED.

Notice

■ Rating

1. Capacitance change of capacitor

In case of F/X7R/X7S/X7T/X8L/Y5V/Z5U char.

Capacitors have an aging characteristic, whereby the capacitor continually decreases its capacitance slightly if the capacitor is left on for a long time. Moreover, capacitance might change greatly depending on the surrounding temperature or an applied voltage.

■ Soldering and Mounting

1. Cleaning (ultrasonic cleaning)

To perform ultrasonic cleaning, observe the following conditions.

Rinse bath capacity: Output of 20 watts per liter or less.

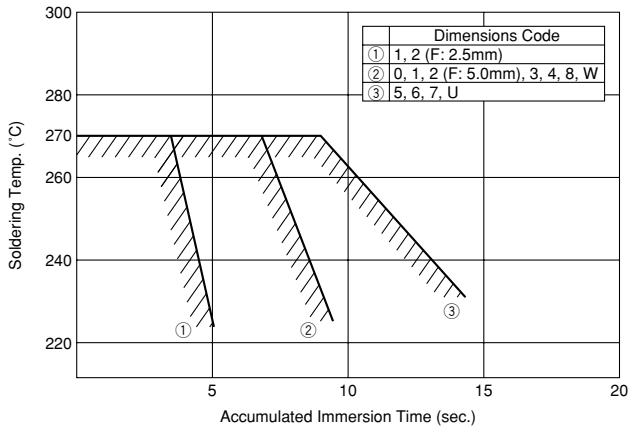
Rinsing time: 5 min. maximum.

Do not vibrate the PCB/PWB directly.

Excessive ultrasonic cleaning may lead to fatigue destruction of the lead wires.

2. Soldering and Mounting

(1) Allowable Conditions for Soldering Temperature and Time



Perform soldering within tolerance range (shaded portion).

(2) Insertion of the Lead Wire

· When soldering, insert the lead wire into the PCB without mechanically stressing the lead wire.

· Insert the lead wire into the PCB with a distance appropriate to the lead space.

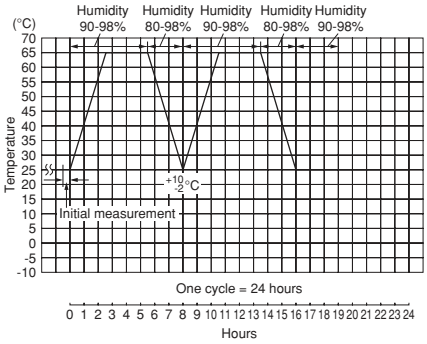
Dimensions Code	Type	Temperature Compensating Type	High Dielectric Constant Type	
	Rated Voltage	DC50V, DC100V	DC50V	DC100V
	Temp. Char.	X8G	X8L	
0				
1				
2		—		
3, W		—		—
Temperature Characteristics		Marked with code (X8G, X8L char.: 8)		
Nominal Capacitance		Marked with 3 figures		
Capacitance Tolerance		Marked with code		
Rated Voltage		Marked with code (DC50V: 5, DC100V: 1) A part is omitted (Please refer to the marking example.)		
Manufacturer's Identification		Marked with Ⓜ A part is omitted (Please refer to the marking example.)		

RH Series 150°C max. (for Automotive) Specifications and Test Methods

No.	AEC-Q200 Test Item		Specification: Temperature Compensating Type (Char. X8G)	Specification: High Dielectric Constant Type (Char. X8L)	AEC-Q200 Test Method
1	Pre-and Post-Stress Electrical Test		–		
2	High Temperature Exposure (Storage)		The measured and observed characteristics should satisfy the specifications in the following table.		Sit the capacitor for 1,000±12h at 150±3°C. Let sit for 24±2h at room temperature, then measure.
		Appearance	No defects or abnormalities		
		Capacitance Change	Within ±3% or ±0.3pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧350	0.04 max.	
		I.R.	More than 1,000MΩ or 50MΩ · μF (Whichever is smaller)		
3	Temperature Cycling		The measured and observed characteristics should satisfy the specifications in the following table.		Perform the 1,000 cycles according to the four heat treatments listed in the following table. Let sit for 24±2h at *room condition, then measure.
		Appearance	No defects or abnormalities except color change of outer coating		
		Capacitance Change	Within ±5% or ±0.5pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧350	0.05 max.	
		I.R.	1,000MΩ or 50MΩ · μF min. (Whichever is smaller)		
4	Moisture Resistance		The measured and observed characteristics should satisfy the specifications in the following table.		Apply the 24h heat (25 to 65°C) and humidity (80 to 98%) treatment shown below, 10 consecutive times. Let sit for 24±2h at *room condition, then measure.
		Appearance	No defects or abnormalities		
		Capacitance Change	Within ±5% or ±0.5pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧200	0.05 max.	
		I.R.	500MΩ or 25MΩ · μF min. (Whichever is smaller)		
5	Biased Humidity		The measured and observed characteristics should satisfy the specifications in the following table.		Apply the rated voltage and DC1.3+0.2/-0V (add 6.8kΩ resistor) at 85±3°C and 80 to 85% humidity for 1,000±12h. Remove and let sit for 24±2h at *room condition, then measure. The charge/discharge current is less than 50mA.
		Appearance	No defects or abnormalities		
		Capacitance Change	Within ±5% or ±0.5pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧200	0.05 max.	
		I.R.	500MΩ or 25MΩ · μF min. (Whichever is smaller)		
6	Operational Life		The measured and observed characteristics should satisfy the specifications in the following table.		Apply 150% of the rated voltage for 1,000±12h at 150±3°C. Let sit for 24±2h at *room condition, then measure. The charge/discharge current is less than 50mA.
		Appearance	No defects or abnormalities except color change of outer coating		
		Capacitance Change	Within ±3% or ±0.3pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧350	0.04 max.	
		I.R.	1,000MΩ or 50MΩ · μF min. (Whichever is smaller)		
7	External Visual		No defects or abnormalities		Visual inspection
8	Physical Dimension		Within the specified dimensions		Using calipers and micrometers.
9	Marking		To be easily legible.		Visual inspection

Step	1	2	3	4
Temp. (°C)	-55+0/-3	Room Temp.	150+3/-0	Room Temp.
Time (min.)	15±3	1	15±3	1

•Pretreatment
Perform the heat treatment at 150+0/-10°C for 60±5 min and then let sit for 24±2h at *room condition. (for Char. X8L)



•Pretreatment
Perform the heat treatment at 150+0/-10°C for 60±5 min and then let sit for 24±2h at *room condition. (for Char. X8L)

•Pretreatment
Apply test voltage for 60±5 min at test temperature.
Remove and let sit for 24±2h at *room condition.
(for Char. X8L)

* "room condition" Temperature: 15 to 35°C, Relative humidity: 45 to 75%, Atmosphere pressure: 86 to 106kPa

Continued on the following page.

RH Series 150°C max. (for Automotive) Specifications and Test Methods

Continued from the preceding page.

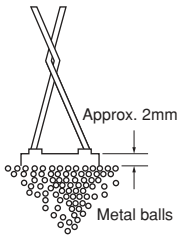
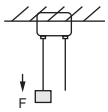
No.	AEC-Q200 Test Item		Specification: Temperature Compensating Type (Char. X8G)	Specification: High Dielectric Constant Type (Char. X8L)	AEC-Q200 Test Method
10	Resistance to Solvents	Appearance	No defects or abnormalities		Per MIL-STD-202 Method 215 Solvent 1: 1 part (by volume) of isopropyl alcohol 3 parts (by volume) of mineral spirits Solvent 2: Terpene defluxer Solvent 3: 42 parts (by volume) of water 1 part (by volume) of propylene glycol monomethyl ether 1 part (by volume) of monoethanolamine
		Capacitance	Within the specified tolerance		
		Q/D.F.	Q≧1,000	0.025 max.	
		I.R.	More than 10,000MΩ or 500MΩ · μF (Whichever is smaller)		
11	Mechanical Shock	Appearance	No defects or abnormalities		Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks). The specified test pulse should be Half-sine and should have a duration: 0.5ms, peak value: 1,500G and velocity change: 4.7m/s.
		Capacitance	Within the specified tolerance		
		Q/D.F.	Q≧1,000	0.025 max.	
12	Vibration	Appearance	No defects or abnormalities		The capacitor should be subjected to a simple harmonic motion having a total amplitude of 1.5mm, the frequency being varied uniformly between the approximate limits of 10 and 2,000Hz. The frequency range, from 10 to 2,000Hz and return to 10Hz, should be traversed in approximately 20min. This motion should be applied for 12 items in each 3 mutually perpendicular directions (total of 36 times).
		Capacitance	Within the specified tolerance		
		Q/D.F.	Q≧1,000	0.025 max.	
13	Resistance to Soldering Heat		The measured and observed characteristics should satisfy the specifications in the following table.		The lead wire is immersed in the melted solder 1.5 to 2mm from the main body at 260±5°C for 10±1s. The specified items are measured after 24±2h. •Pretreatment Perform the heat treatment at 150+0/-10°C for 60±5 min and then let sit for 24±2h at *room condition. (for Char. X8L)
		Appearance	No defects or abnormalities		
		Capacitance Change	Within ±2.5% or ±0.25pF (Whichever is larger)	Within ±7.5%	
		Dielectric Strength (Between Terminals)	No defects		
14	Thermal Shock		The measured and observed characteristics should satisfy the specifications in the following table.		Perform the 300 cycles according to the two heat treatments listed in the following table (Maximum transfer time is 20s.). Let sit for 24±2h at *room condition, then measure. Step 1: Temp. (°C) -55+0/-3, Time (min.) 15±3 Step 2: Temp. (°C) 150+3/-0, Time (min.) 15±3 •Pretreatment Perform the heat treatment at 150+0/-10°C for 60±5min and then let sit for 24±2h at *room condition. (for Char. X8L)
		Appearance	No defects or abnormalities		
		Capacitance Change	Within ±5% or ±0.5pF (Whichever is larger)	Within ±12.5%	
		Q/D.F.	Q≧350	0.05 max.	
		I.R.	1,000MΩ or 50MΩ · μF min. (Whichever is smaller)		
15	ESD	Appearance	No defects or abnormalities		Per AEC-Q200-004
		Capacitance	Within the specified tolerance		
		Q/D.F.	Q≧1,000	0.025 max.	
		I.R.	More than 10,000MΩ or 500MΩ · μF (Whichever is smaller)		
16	Solderability		Lead wire should be soldered with uniform coating on the axial direction over 95% of the circumferential direction.		The terminal of a capacitor is dipped into a solution of ethanol (JIS-K-8101) and rosin (JIS-K-5902) (25%rosin in weight propotion) and then into molten solder (JIS-Z-3282) for 2±0.5 sec. In both cases the depth of dipping is up to about 1.5 to 2mm from the terminal body. Temp. of solder: 245±5°C Lead Free Solder (Sn-3.0Ag-0.5Cu) 235±5°C H60A or H63A Eutectic Solder

* "room condition" Temperature: 15 to 35°C, Relative humidity: 45 to 75%, Atmosphere pressure: 86 to 106kPa

Continued on the following page.

RH Series 150°C max. (for Automotive) Specifications and Test Methods

Continued from the preceding page.

<table>
<tr><th rowspan="2" colspan="2">No.</th><th rowspan="2" colspan="2">AEC-Q200 Test Item</th><th colspan="3">Specification</th><th rowspan="2">AEC-Q200 Test Method</th></tr>
<tr><th colspan="2">Temperature Compensating Type (Char. X8G)</th><th>High Dielectric Constant Type (Char. X8L)</th></tr>
<tr><td rowspan="7">17</td><td rowspan="7">Electrical Charac-terization</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td>Visual inspection.</td></tr>
<tr><td>Capacitance</td><td colspan="2">Within the specified tolerance</td><td rowspan="2">The capacitance, Q/D.F. should be measured at 25°C at the frequency and voltage shown in the table.
<table><tr><th>Char.</th><th>Nominal Cap.</th><th>Frequency</th><th>Voltage</th></tr><tr><td>X8G</td><td>C≦1,000pF</td><td>1±0.1MHz</td><td>AC0.5 to 5V (r.m.s.)</td></tr><tr><td>X8G</td><td>C>1000pF</td><td>1±0.1kHz</td><td>AC1±0.2V (r.m.s.)</td></tr><tr><td>X8L</td><td>–</td><td>1±0.1kHz</td><td>AC1±0.2V (r.m.s.)</td></tr></table></td></tr>
<tr><td>Q/D.F.</td><td colspan="2">Q≧1,000</td><td>0.025 max.</td></tr>
<tr><td rowspan="2">Insulation Resistance (I.R.)</td><td>Room Temperature</td><td colspan="2">10,000MΩ or 500MΩ · μF min.
(Whichever is smaller)</td><td>The insulation resistance should be measured at 25±3°C with a DC voltage not exceeding the rated voltage at normal temperature and humidity and within 2min. of charging.
(Charge/Discharge current ≦ 50mA.)</td></tr>
<tr><td>High Temperature</td><td colspan="2">100MΩ or 5MΩ · μF min.
(Whichever is smaller)</td><td>The insulation resistance should be measured at 150±3°C with a DC voltage not exceeding the rated voltage at normal temperature and humidity and within 2min. of charging.
(Charge/Discharge current ≦ 50mA.)</td></tr>
<tr><td rowspan="2">Dielectric Strength</td><td>Between Terminals</td><td colspan="2">No defects or abnormalities</td><td>The capacitor should not be damaged when DC voltage of 300% of the rated voltage (for Char. X8G) or DC voltage of 250% of the rated voltage (for Char. X8L) is applied between the terminations for 1 to 5 seconds.
(Charge/Discharge current ≦ 50mA.)</td></tr>
<tr><td>Body Insulation</td><td colspan="2">No defects or abnormalities</td><td>The capacitor is placed in a container with metal balls of 1mm diameter so that each terminal, short-circuit is kept approximately 2mm from the balls, and 250% of the rated DC voltage is impressed for 1 to 5 seconds between capacitor terminals and metal balls.
(Charge/Discharge current ≦ 50mA.)
  </td></tr>
<tr><td rowspan="2">18</td><td rowspan="2">Terminal Strength</td><td>Tensile Strength</td><td colspan="2">Termination not to be broken or loosened</td><td>As in the figure, fix the capacitor body, apply the force gradually to each lead in the radial direction of the capacitor until reaching 10N and then keep the force applied for 10±1 seconds.
  </td></tr>
<tr><td>Bending Strength</td><td colspan="2">Termination not to be broken or loosened</td><td>Each lead wire should be subjected to a force of 2.5N and then be bent 90° at the point of egress in one direction. Each wire is then returned to the original position and bent 90° in the opposite direction at the rate of one bend per 2 to 3 seconds.</td></tr>
<tr><td>19</td><td colspan="2">Capacitance Temperature Characteristics</td><td colspan="2">Within the specified Tolerance.
(Table A)

Capacitance Drift is within ±0.2% or ±0.05pF
(Whichever is larger)</td><td>Within ±15%
(Temp. Range: -55 to +125°C)
Within +15/-40%
(Temp. Range: +125 to +150°C)</td><td>The capacitance change should be measured after 5min. at each specified temperature step.
<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>25±2</td></tr><tr><td>2</td><td>-55±3</td></tr><tr><td>3</td><td>25±2</td></tr><tr><td>4</td><td>150±3</td></tr><tr><td>5</td><td>25±2</td></tr></table>The temperature coefficient or the ranges of capacitance change is determined using the capacitance measured in step 3 as a reference.
•Pretreatment
Perform the heat treatment at 150+0/-10°C for 60±5 min and then let sit for 24±2h at *room condition.
Perform the initial measurement. (for Char. X8L)</td></tr>
</table>

* “room condition” Temperature: 15 to 35°C, Relative humidity: 45 to 75%, Atmosphere pressure: 86 to 106kPa

Table A

Char.	Nominal Values (ppm/°C) *	Capacitance Change from 25°C (%)					
		–55°C		–30°C		–10°C	
		Max.	Min.	Max.	Min.	Max.	Min.
X8G	0±30	0.58	–0.24	0.40	–0.17	0.25	–0.11

* Nominal values denote the temperature coefficient within a range of 25°C to 150°C.

■ Packaging

Two types of packaging for monolithic ceramic capacitors are available.

1. Bulk Packaging

Minimum Quantity

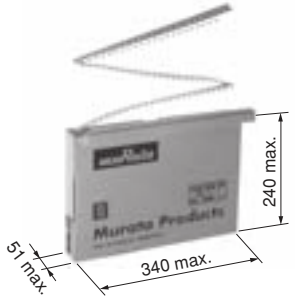
Dimensions Code	Dimensions (L×W)	Minimum Quantity (pcs./Bag)*
0	3.6×3.5mm or 4.0×3.5mm or 5.0×3.5mm (Depends on Part Number)	500
1	4.0×3.5mm or 4.5×3.5mm or 5.0×3.5mm (Depends on Part Number)	
2	5.0×3.5mm or 5.5×4.0mm or 5.7×4.5mm (Depends on Part Number)	
3	5.0×4.5mm or 5.5×5.0mm or 6.0×5.5mm (Depends on Part Number)	
4	7.5×5.5mm	
5	7.5×7.5mm or 7.5×8.0mm (Depends on Part Number)	
6	10.0×10.0mm	
8	7.5×5.5mm	
7	12.5×12.5mm	100
U	7.7×12.5mm or 7.7×13.0mm (Depends on Part Number)	200
W	5.5×7.5mm or 6.0×8.0mm (Depends on Part Number)	500

Please order with an integral multiple of the minimum quantity above.

* Minimum Quantity may change depends on part number.
  Please check our website 'Product details'.

2. Tape Carrier Packaging

(1) Dimensions of Ammo Pack



(in mm)

(2) Minimum Quantity

Dimensions Code	Dimensions (L×W)	Minimum Quantity (pcs./Ammo Pack)*
0	3.6×3.5mm or 4.0×3.5mm or 5.0×3.5mm (Depends on Part Number)	2000
1	4.0×3.5mm or 4.5×3.5mm or 5.0×3.5mm (Depends on Part Number)	
2	5.0×3.5mm or 5.5×4.0mm or 5.7×4.5mm (Depends on Part Number)	
3	5.0×4.5mm or 5.5×5.0mm or 6.0×5.5mm (Depends on Part Number)	
4	7.5×5.5mm	
5	7.5×7.5mm or 7.5×8.0mm (Depends on Part Number)	2000
6	10.0×10.0mm	1500
8	7.5×5.5mm	
U	7.7×12.5mm or 7.7×13.0mm (Depends on Part Number)	1000
W	5.5×7.5mm or 6.0×8.0mm (Depends on Part Number)	1500

Please order with an integral multiple of the minimum quantity above.

* Minimum Quantity may change depends on part number.
  Please check our website 'Product details'.

"Minimum Quantity" means the numbers of units of each delivery or order. The quantity should be an integral multiple of the "minimum quantity".
(Please note that the actual delivery quantity in a package may change sometimes.)

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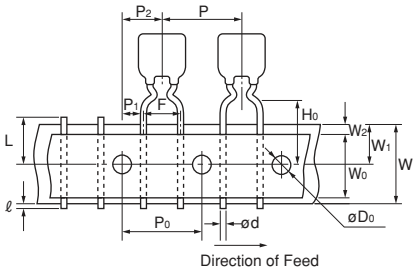
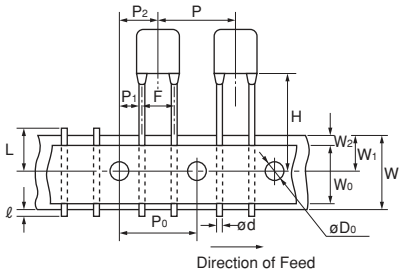
Taping Dimensions

Inside Crimp Taping



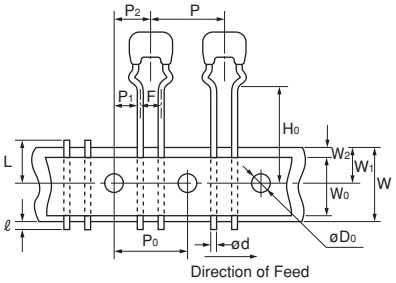
Dimensions and Lead Style Code
0M1
1M1
2M1
2M2
3M1
3M2
4M1
4M2
8M1
8M2
WM1

Straight Taping

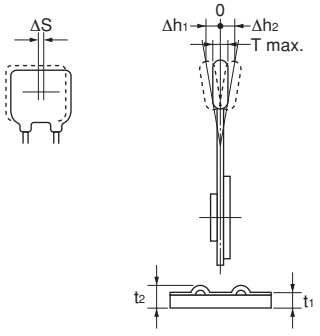


Dimensions and Lead Style Code
1DB
2DB
3DB
5E1
5E2
6E1
6E2
UE1

Outside Crimp Taping



Dimensions and Lead Style Code
0S1
1S1
2S1
2S2
3S1
3S2



Item	Code	Dimensions (mm)	
Pitch of Component	P	12.7±1.0	
Pitch of Sprocket Hole	P0	12.7±0.2	
Lead Spacing	F	$2.5^{+0.4}_{-0.2}$ (DB) (S1) (S2)	
		$5.0^{+0.6}_{-0.2}$	
Length from Hole Center to Component Center	P2	6.35±1.3	
Length from Hole Center to Lead	P1	3.85±0.7	
		5.1±0.7 (DB) (S1) (S2)	
		254±1.5 Total length of components pitch X 20	
Body Dimension		Depends on Part Number	
Deviation Along Tape, Left or Right Defect	ΔS	±2.0	
Carrier Tape Width	W	18.0±0.5	
Position of Sprocket Hole	W1	$9.0^{+0}_{-0.5}$	
Lead Distance between Reference and Bottom Plane	H0	16.0±0.5 (M1) (S1)	
		20.0±0.5 (M2) (S2)	
For Straight Lead Type	H	20±0.5 (E2), 17.5±0.5 (E1), 16±0.5 (DB)	
Diameter of Sprocket Hole	D0	4.0±0.1	
Lead Diameter	d	0.5±0.05	
Total Tape Thickness	t1	0.6±0.3	
Total Thickness of Tape and Lead Wire	t2	1.5 max.	
Body Thickness	T	Depends on Part Number	
Deviation Across Tape	Δh1 Δh2	2.0 max.	Dimensions Code: W, U
		1.5 max.	RHD Series
		1.0 max.	except as above
Portion to Cut in Case of Defect	L	$11.0^{+0}_{-1.0}$	
Protrusion Length	ℓ	0.5 max.	
Hold Down Tape Width	W0	9.5 min.	
Hold Down Tape Position	W2	1.5±1.5	
Coating Extension		Depends on Dimensions	