SPECIFICATION

SPEC. No. D2013-C9
DATE: 2013 Sep.

To

Non-Controlled Copy

CUSTOMER'S PRODUCT NAME	TDK'S PRODUCT NAME Multilayer ceramic capacitors Dipped radial lead type FK-Series General (Up to 50V) Mid voltage (100 to 630V)

RECEIPT CONFIRMATION

DATE: YEAR MONTH DAY

TDK Corporation
Sales

Electronic Components Sales & Marketing Group

Engineering

TDK-EPC CORPORATION
Ceramic Capacitors Business Group
TDK-MCC CORPORATION
DIELECTRIC PRODUCTS ENGINEERING DEPT.

APPROVED	Person in charge

APPROVED	CHECKED	Person in charge

1. SCOPE

This specification is applicable to multilayer ceramic capacitors dipped radial lead type with a priority over the other relevant specifications.
Production places defined in this specification shall be TDK Xiamen Co., Ltd. (China).

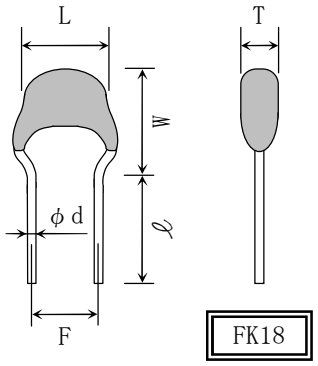
EXPLANATORY NOTE:
This specification warrants the quality of the lead type ceramic capacitor. The parts should be evaluated or confirmed a state of used on your product.
If the use of the parts go beyond the bounds of the specification, we can not afford to guarantee.

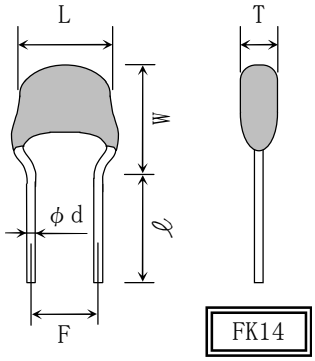
2. CODE CONSTRUCTION

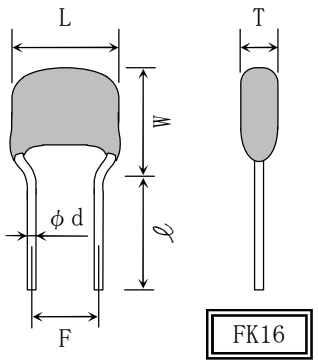
(Example)

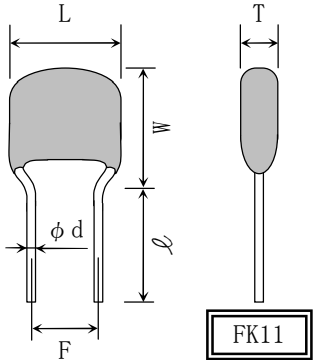
FK28	X7R	1H	104	K	N006
(1)	(2)	(3)	(4)	(5)	(6)

(1)Type







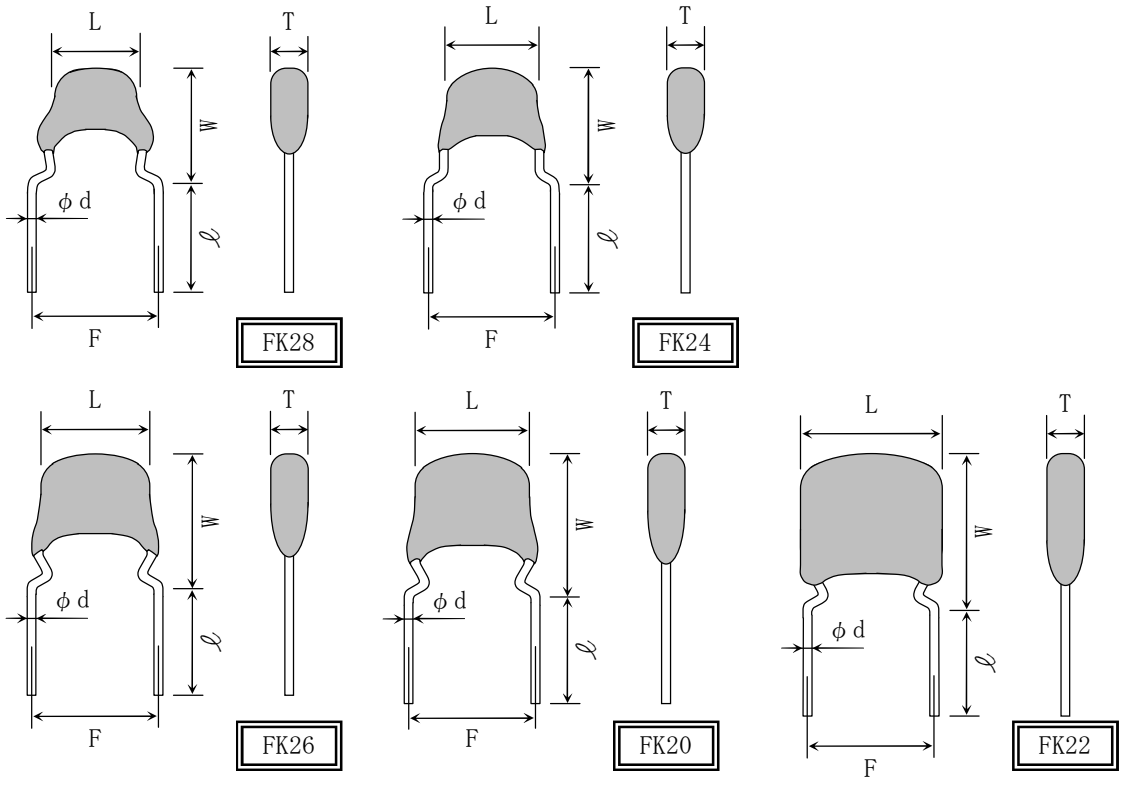


Type	Dimensions (Unit : mm)							
	L(max.)	W(max.)	T(max.)	F	ℓ		ϕ d	
FK18	4.0	5.5	2.5	2.5±0.8	5.0	+3.0 -1.0	0.5	+0.10 -0.03
FK14	4.5	5.5	2.5					
FK16	5.5	6.0	3.5					
FK11	5.5	7.0	4.0					

＊FK denotes forming lead.
The first digit refers to a distance between leads (1－2.5mm),
the second digit is for TDK internal code.

＊Dimension ℓ is applied to bulk packaging.
Refer to Appendix 2 for dimension of taping packaging.

(1)Type



Type	Dimensions (Unit : mm)					
	L(max.)	W(max.)	T(max.)	F	ℓ	ϕ d
FK28	4.0	5.5	2.5	5.0±1.0	7.0±2.0	0.5 +0.10 -0.03
FK24	4.5	5.5	2.5			
FK26	5.5	6.0	3.5			
FK20	5.5	7.0	4.0			
FK22	7.5	8.0	4.0			

＊FK denotes forming lead.
The first digit refers to a distance between leads (2－5.0mm),
the second digit is for TDK internal code.

＊Dimension ℓ is applied to bulk packaging.
Refer to Appendix 3 for dimension of taping packaging.

(2)Temperature Characteristics (Details are shown in para 7 No.7,8)

(3)Rated Voltage

Symbol	Rated Voltage
2 J	DC 630 V
2 E	DC 250 V
2 A	DC 100 V
1 H	DC 50 V
1 E	DC 25 V
1 C	DC 16 V
1 A	DC 10 V
0 J	DC 6.3 V

(4)Rated Capacitance

Stated in three digits and in units of pico farads (pF). The first and second digits identify the first and second significant figures of the capacitance, the third digit identifies the multiplier.
R is designated for a decimal point.

Example 2R2 → 2.2pF
104 → 100,000pF

(5)Capacitance tolerance

Symbol	Tolerance	Capacitance(C)
C	±0.25 pF	C≦5pF
D	±0.5 pF	5pF＜C≦10pF
J	± 5 %	Over 10pF
K	±10 %	
M	±20 %	

(6)Internal code

Symbol	Applied voltage of Life	Packaging
N020	Rated voltage ×2	Bulk (FK1*type)
N000		Bulk (FK2*type)
N006		Ammo Pack
R020	Rated voltage ×1	Bulk (FK1*type)
R000		Bulk (FK2*type)
R006		Ammo Pack

3.1 Standard combination of rated capacitances and tolerances

Class	Temperature Characteristics	Capacitance tolerance (*1)		Rated capacitance
1	C0G	C≦5	C (±0.25 pF)	1, 1.5, 2, 2.2, 3, 3.3, 4, 4.7, 5
		5＜C≦10	D (±0.5 pF)	6, 6.8, 7, 8, 9, 10
		10＜C≦10,000	J (± 5 %)	E-12 series
		10,000＜C	J (± 5 %)	E- 6 series
2	X5R X7R X7S	C≦0.1	K (±10 %)	E- 6 series
		0.1＜C≦10	K (±10 %)	E- 6 series
		10＜C	M (±20 %)	

*1 C denotes Capacitance.
Unit : pF for Class1 and μF for Class2.

3.2 Capacitance Step in E series

E series	Capacitance Step											
E- 3	1				2.2				4.7			
E- 6	1		1.5		2.2		3.3		4.7		6.8	
E-12	1	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2

4. OPERATING TEMPERATURE RANGE

T.C.	Min. operating Temperature	Max. operating Temperature	Reference Temperature
X5R	-55℃	85℃	25℃
C0G X7R X7S	-55℃	125℃	25℃

5. STORING CONDITION AND TERM

5 to 40℃ at 20 to 70%RH
6 months Max.

6. INDUSTRIAL WASTE DISPOSAL

Dispose this product as industrial waste in accordance with the industrial Waste Law.

7. PERFORMANCE

table 1

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td>1</td><td colspan="2">External Appearance</td><td>No defects which may affect performance.</td><td>By visual checking.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Indication</td><td>Appearance</td><td>Meet a requirement per para 8.</td><td rowspan="2"><table><tr><th>solvent</th><th>Solvent temp.</th><th>Dipping time</th></tr><tr><td>Isopropyl alcohol</td><td>20～25 ℃</td><td>30±5s.</td></tr></table></td></tr>
<tr><td>Resistance to solvent</td><td>Shall be visible.</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Voltage Proof</td><td>Between termination</td><td>No insulation breakdown or other damage.</td><td><table><tr><th>Class</th><th>Rated voltage</th><th>Apply voltage</th></tr><tr><td rowspan="2">Class1</td><td>100V and under</td><td>Rated voltage ×3</td></tr><tr><td>Over 100V</td><td>Rated voltage ×1.5</td></tr><tr><td rowspan="2">Class2</td><td>100V and under</td><td>Rated voltage ×2.5</td></tr><tr><td>Over 100V</td><td>Rated voltage ×1.5</td></tr></table>Above DC voltage shall be applied for 1～5s.

Charge / discharge current shall not exceed 50mA.</td></tr>
<tr><td>Between termination coating</td><td>No insulation breakdown or other damage.</td><td>Apply ×2.5 rated voltage.
(By metallic small ball method.)</td></tr>
<tr><td>4</td><td colspan="2">Insulation Resistance</td><td>10,000MΩ or 500 MΩ・μF min.
(As for the capacitor of rated voltage 16,10 and 6.3V DC, 10,000 MΩ or 100 MΩ・μF min.,) whichever smaller.</td><td>≪250V DC and under≫
Apply rated voltage.
≪630V DC≫
Apply DC500V.
Applying time : 60sec.</td></tr>
<tr><td>5</td><td colspan="2">Capacitance</td><td>Within the specified tolerance.</td><td>Class 1<table><tr><th>Rated capacitance</th><th>Measuring frequency</th><th>Measuring voltage</th></tr><tr><td>1,000pF and under</td><td>1MHz±10%</td><td rowspan="2">0.5～5 Vrms.</td></tr><tr><td>Over 1,000pF</td><td>1kHz±10%</td></tr></table>Class 2<table><tr><th>Rated capacitance</th><th>Measuring frequency</th><th>Measuring voltage</th></tr><tr><td>10μF and under</td><td>1kHz±10%</td><td>1.0±0.2 Vrms.</td></tr><tr><td>Over 10μF</td><td>120Hz±10%</td><td>0.5±0.2 Vrms.</td></tr></table></td></tr>
<tr><td rowspan="2">6</td><td colspan="2">Q
(Class 1)</td><td>As per Table 2.</td><td rowspan="2">See No.5 in this table for measuring condition.

For information which product has which Dissipation Factor, please contact with our sales representative.</td></tr>
<tr><td colspan="2">Dissipation Factor
(Class 2)</td><td><table><tr><th>T.C.</th><th>D.F.</th></tr><tr><td></td><td>0.03 max.</td></tr><tr><td>X5R</td><td>0.05 max.</td></tr><tr><td>X7R</td><td>0.075 max.</td></tr><tr><td>X7S</td><td>0.10 max.</td></tr><tr><td></td><td>0.15 max.</td></tr></table></td></tr>
</table>

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td>7</td><td>Temperature Characteristics of Capacitance (Class 1)</td><td></td><td>Temperature Coefficient (ppm/℃)
C0G : 0 ± 30
Capacitance drift
Within ±0.2% or ±0.05pF, whichever larger.</td><td>Temperature Coefficient shall be calculated based on values at 25℃ and 85℃ temperature.

Measuring temperature below 20℃ shall be -10℃ and -25℃</td></tr>
<tr><td>8</td><td>Temperature Characteristics of Capacitance (Class 2)</td><td></td><td>Capacitance Change(%)
No voltage applied
X5R: ±15
X7R: ±15
X7S: ±22</td><td>Capacitance shall be measured by the steps shown in the following table, after thermal equilibrium is obtained for each step.
ΔC be calculated ref. STEP3 reading.
<table><tr><th>Step</th><th>Temperature (℃)</th></tr><tr><td>1</td><td>Reference temp. ±2</td></tr><tr><td>2</td><td>Min. operating temp. ±2</td></tr><tr><td>3</td><td>Reference temp. ±2</td></tr><tr><td>4</td><td>Max. operating temp. ±2</td></tr></table>As for the capacitor of rated voltage 10V DC(1A) and 6.3V DC(0J), 0.2Vrms. shall be applied.</td></tr>
<tr><td>9</td><td>Lead Strength</td><td>Tensile Strength</td><td>No mechanical damage such as lead breakage and loosing.</td><td>With holding the parts, apply pulling force to lead drawing direction gradually.
Pulling strength : 5N
Holding time : 10±1s.</td></tr>
<tr><td></td><td></td><td>Bending Strength</td><td>No mechanical damage such as lead breakage and loosing.</td><td>With holding the capacitors to keep the axis vertical, bend it 90 degrees with weighting and put it back to the original position.
This operation shall be done for 2～3s. and repeat the following times.
Bending forth : 5N (weight : 0.51kg)
Testing time : 2 times</td></tr>
<tr><td>10</td><td>Vibration</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="4">Solder the capacitors on a P.C.Board shown in Appendix1 before testing.
Vibrate the capacitor with amplitude of 1.5mm P-P changing the frequencies from 10Hz to 55Hz and back to 10Hz in about 1min.
Repeat this for 2h each in 3 perpendicular directions.</td></tr>
<tr><td></td><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td rowspan="2">Class1</td><td>C0G</td><td>±2.5% or ±0.25pF, whichever larger.</td></tr><tr><td rowspan="3">Class2</td><td>X5R</td><td>±7.5 %</td></tr><tr><td>X7R</td><td>±7.5 %</td></tr><tr><td>X7S</td><td>±7.5 %</td></tr></table></td></tr>
<tr><td></td><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td></td><td>D.F.
Class2</td><td>Meet the initial spec.</td></tr>
</table>

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td>11</td><td colspan="2">Solderability</td><td>Leads shall be covered by new solder more than 75% of its surface.</td><td>Completely soak both terminations in solder at 245±5℃ for 2±0.5s.

Solder : Sn-3.0Ag-0.5Cu(Pb-free)
Flux : Isopropyl alcohol(JIS K 8839)
Rosin(JIS K 5902)
25% solid solution.
Dipping : By 1.5～2.0mm from the root of lead.</td></tr>
<tr><td rowspan="5">12</td><td rowspan="5">Resistance to solder heat</td><td>External appearance</td><td>No defects which may affect performance.</td><td rowspan="5">Completely soak both terminations in solder at 250±5℃ for 5±1s.

Solder : Sn-3.0Ag-0.5Cu(Pb-free)
Flux : Isopropyl alcohol(JIS K 8839)
Rosin(JIS K 5902)
25% solid solution.
Dipping : By 1.5～2.0mm from the root of lead.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>±2.5 % or ±0.25pF whichever larger.</td></tr><tr><td>Class2</td><td>X5R
X7R
X7S</td><td>±7.5 %
±7.5 %
±7.5 %</td></tr></table></td></tr>
<tr><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td>D.F.
Class2</td><td>Meet the initial spec.</td></tr>
<tr><td>Insulation Resistance</td><td>Meet the initial spec.</td></tr>
<tr><td>Voltage proof</td><td>No insulation breakdown or other damage.</td></tr>
<tr><td rowspan="7">13</td><td rowspan="7">Temperature Cycle and Dipping Cycle</td><td></td><td></td><td rowspan="7">Temperature Cycle
<table><tr><th>Step</th><th>Temp.(℃)</th><th>Time(min.)</th></tr><tr><td>1</td><td>Min. operating Temp. ±3</td><td>30 ± 3</td></tr><tr><td>2</td><td>Reference temp.</td><td>Less than 3</td></tr><tr><td>3</td><td>Max. operating Temp. ±3</td><td>30 ± 3</td></tr><tr><td>4</td><td>Reference temp.</td><td>Less than 3</td></tr></table>
Dipping Cycle
<table><tr><th>Step</th><th>Temp.(℃)</th><th>Time (min.)</th><th>Solidy liquid</th></tr><tr><td>1</td><td>65 +5 0</td><td>15±2</td><td>Pure water</td></tr><tr><td>2</td><td>0±3</td><td>15±2</td><td>Saturation salt water</td></tr></table>
Solder the capacitors on a P.C.Board shown in Appendix1 before testing.

Leave the capacitors in ambient condition for the following time before measurement.

Class1 : 24±2h
Class2 : 48±4h

Perform Temperature cycle(5 cycle) and dipping cycle(2 cycle) consecutively.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>±2.5 % or ±0.25pF whichever larger.</td></tr><tr><td>*Class2</td><td>X5R
X7R
X7S</td><td>± 7.5 %
± 10 %</td></tr></table>*Applied for some parts</td></tr>
<tr><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td>D.F
Class2</td><td>Meet the initial spec.</td></tr>
<tr><td>Insulation Resistance</td><td>Meet the initial spec.</td></tr>
<tr><td>Voltage proof</td><td>No insulation breakdown or other damage.</td></tr>
<tr><td></td><td></td></tr>
</table>

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Moisture Resistance (Steady State)</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Solder the capacitors on a P.C.Board shown in Appendix1 before testing.
Leave at temperature 40±2℃, 90 to 95%RH for 500 +24,0h.
Leave the capacitors in ambient condition for the following time before measurement.
Class1 : 24±2h
Class2 : 48±4h</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>±5% or 0.5pF whichever larger.</td></tr><tr><td>*Class2</td><td>X5R
X7R
X7S</td><td>±12.5%
±25 %</td></tr></table>*Applied for some parts</td></tr>
<tr><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td>D.F.
Class2</td><td>Characteristics
200% of initial spec max.</td></tr>
<tr><td>Insulation Resistance</td><td>1,000MΩ or 50 MΩ・μF min.
(As for the capacitor of rated voltage 16,10 and 6.3V DC,
1,000 MΩ or 10 MΩ・μF min.,)
whichever smaller.</td></tr>
<tr><td rowspan="5">15</td><td rowspan="5">Moisture Resistance</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Solder the capacitors on a P.C.Board shown in Appendix1 before testing.
Apply the rated voltage at temperature 40±2℃ and 90 to 95%RH for 500 +24,0h.
Charge/discharge current shall not exceed 50mA.
Leave the capacitors in ambient condition for the following time before measurement.
Class1 : 24±2h
Class2 : 48±4h
Voltage conditioning : (Only Class2)
Voltage treat the capacitor under testing temperature and voltage for 1hour.
Leave the capacitors in ambient condition for48±4h before measurement.
Use this measurement for initial value.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>±7.5% or ±0.75pF whichever larger.</td></tr><tr><td>*Class2</td><td>X5R
X7R
X7S</td><td>±12.5 %
±25 %</td></tr></table>*Applied for some parts</td></tr>
<tr><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td>D.F.
Class2</td><td>Characteristics
200% of initial spec max.</td></tr>
<tr><td>Insulation Resistance</td><td>500MΩ or 25MΩ・μF min.
(As for the capacitor of rated voltage 16,10 and 6.3V DC,
500 MΩ or 5MΩ・μF min.,)
whichever smaller.</td></tr>
</table>

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td rowspan="5">16</td><td rowspan="5">Life</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Solder the capacitors on a P.C.Board shown in Appendix1 before testing.

Below the voltage shall be applied at maximum operating temperature ±2℃ for 1,000 +48,0h.
<table><tr><th>Applied voltage</th></tr><tr><td>Rated voltage ×2</td></tr><tr><td>Rated voltage ×1</td></tr></table>
For information which products has which applied voltage, please contact with our sales representative.

Charge/discharge current shall not exceed 50mA.

Leave the capacitors in ambient condition for the following time before measurement.
Class1 : 24±2h
Class2 : 48±4h

Voltage conditioning : (Only Class2)
Voltage treat the capacitor under testing temperature and voltage for 1hour.

Leave the capacitors in ambient condition for 48±4h before measurement.

Use this measurement for initial value.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td rowspan="2">Class1</td><td>C0G</td><td>±3% or ±0.3% whichever larger.</td></tr><tr><td>*Class2</td><td>X5R
X7R
X7S</td><td>±15 %
±25 %</td></tr></table>*Applied for some parts</td></tr>
<tr><td>Q
Class1</td><td>Shown in Table2.</td></tr>
<tr><td>D.F.
Class2</td><td>characteristics
200% of initial spec max.</td></tr>
<tr><td>Insulation Resistance</td><td>1,000MΩ or 50MΩ・μF min.
(As for the capacitor of rated voltage 16,10 and 6.3V DC, 1,000 MΩ or 10MΩ・μF min.,) whichever smaller.</td></tr>
</table>

* As for the initial measurement of capacitors (Class2) on number 8, 10, 12, 13, and 14, leave capacitors at 150 -10,0℃ for 1h and measure the value after leaving capacitors for 48±4h in ambient condition.

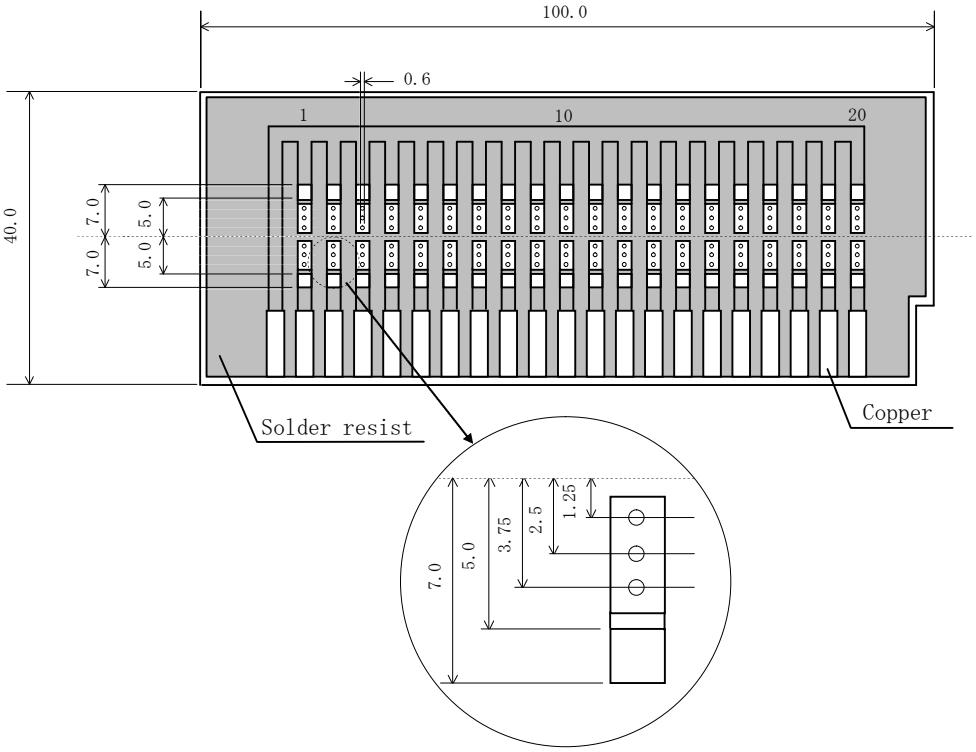
table2

Specification		Applicable numbers of Table1
30pF and over	Q ≧ 1,000	6, 10, 12, 13
Less than 30pF	Q ≧ 400+20・C	
30pF and over	Q ≧ 350	14, 16
Less than 30pF	Q ≧ 275+5/2・C	
30pF and over	Q ≧ 200	15
Less than 30pF	Q ≧ 100+10/3・C	

(Note) : C denotes Rated Capacitance(pF)

Appendix1

P.C. board



(Unit : mm)

1. Material :Glass Epoxy(As per JIS C6484 GE4)

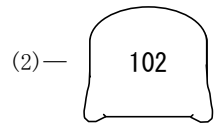
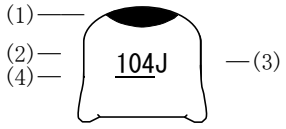
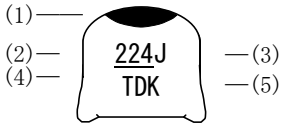
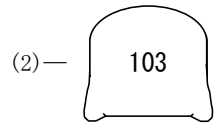
2. Thickness : 1.6mm

Copper(Thickness:0.035mm)

Solder resist

8. INDICATION

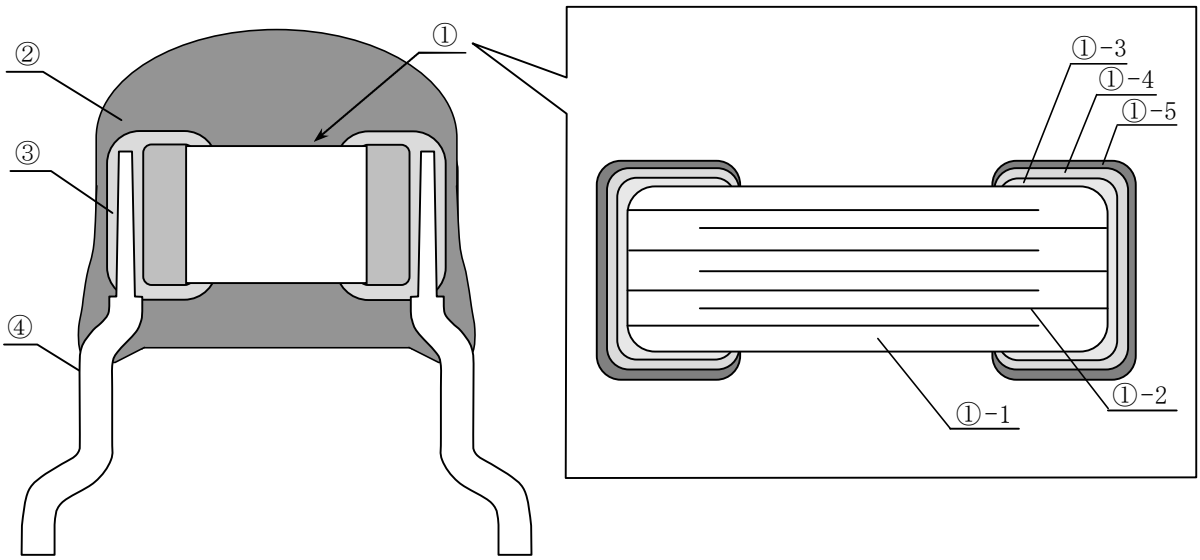
8.1 Indication (Example)

Type / T.C.	ＦＫ１８　ＦＫ１４ ＦＫ２８　ＦＫ２４	ＦＫ１６　ＦＫ１１ ＦＫ２６　ＦＫ２０	ＦＫ２２
ＣＯＧ			
Ｘ５Ｒ Ｘ７Ｒ Ｘ７Ｓ			

8.2 Meaning of indication

Item	Detail	Type		
		FK18, FK14 FK28, FK24	FK16, FK11, FK26, FK20	FK22
(1) T.C.	For C0G, indicate Black mark on the head.	——	○	○
(2) Rated Capacitance	Indicate in three digits.	○	○	○
(3) Capacitance tolerance	Indicates the symbol.	——	○	○
(4) Rated voltage	For DC50V, indicate a bar under the rated capacitance.	——	○	○
(5) Manufacturer	Indicates ″ TDK ″.	——	——	○

9. INSIDE STRUCTURE AND MATERIAL



No.	NAME	No.	NAME	MATERIAL	
				Class 1	Class 2
①	Multilayer Ceramic Chip Capacitors	①-1	Dielectric	$CaZrO_3$	$BaTiO_3$
		①-2	Electrode	Ni	
		①-3	Termination	Cu	
		①-4		Ni	
		①-5		Sn	
②	Coating			Epoxy	
③	Solder for joint			High temp. solder	
④	Lead wire			Solder coated copper wire	

10. PACKAGING

Packaging shall be done to protect the components from the damage during Transportation and storing, and a label which has the following information shall be attached.

1) Total number of components in a plastic bag: 500pcs.max.
2) Tape packaging is as per TDK tape packaging specification.

1) Inspection No. *
2) TDK P/N
3) Customer's P/N
4) Quantity

* Composition of Inspection No.

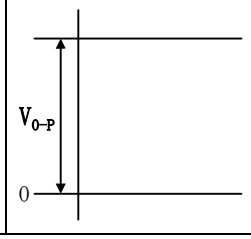
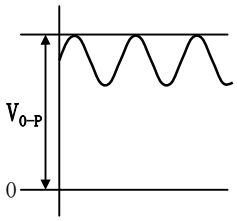
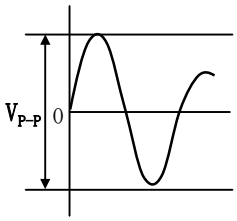
Example $\underset{(a)}{\underline{X}}\ \underset{(b)}{\underline{3}}\ \underset{(c)}{\underline{A}} - \underset{(d)}{\underline{○○}} - \underset{(e)}{\underline{○○○}}$

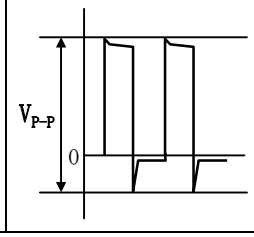
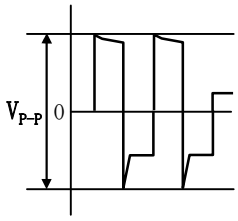
a) Line code
b) Last digit of year
c) Month and A for January and B for February and so on. (Skip I)
d) Inspection Date of the month.
e) Serial No. of the day

11. Caution

No.	Process	Condition
1	Operating Condition (Storage, Transportation)	1-1. Storage 1) The capacitor must be stored in an ambient temperature of 5～40℃ with a relative humidity of 20～70%. The products should be used within 6 months upon receipt. 2) The capacitors must be operated and stored in an environment free of dew condensation and these gases such as Hydrogen Sulphide, Hydrogen Sulphate, Chlorine, Ammonia and sulfur. 3) Avoid storing in sun light and wet with dew. 4) Do not use capacitors under high humidity and high and low atmospheric pressure which may affect capacitors reliability. 5) Capacitors should be tested for the solderability when they are stored for long time. 1-2. Handling in transportation 1) In case of the transportation of the capacitors, the performance of the capacitors may be deteriorated depending on the transportation condition. (Refer to JEITA RCR-2335B 9.2 Handling in transportation)
2	Circuit design ⚠ Caution	2-1. Operating temperature Operating temperature should be followed strictly within this specification, especially be careful with the maximum temperature. 1) Do not use capacitor above the maximum allowable operating temperature. 2) Surface temperature including self heating should be below maximum operating temperature. (Due to dielectric loss, capacitor will heat itself when AC is applied. Especially at high frequencies around its SRF, the heat might be so extreme that it may damage itself or the product mounted on. Please design the circuit so that the maximum temperature of the capacitor including the self heating to be below the maximum allowable operating temperature. Temperature rise shall be bellow 20℃.) 3) The electrical characteristics of the capacitors will vary depending on the temperature. The capacitors should be selected and designed in taking the temperature into consideration. 2-2. Operating voltage 1) Operating voltage across the terminals should be below the rated voltage. When AC and DC are super imposed, V0-P must be below the rated voltage. ——— (1) and (2) AC or pulse with overshooting, V_{P-P} must be below the rated voltage. ———(3), (4) and (5) When the voltage is started to apply to the circuit or it is stopped applying, the irregular voltage may be generated for a transit period because of resonance or switching. Be sure to use a capacitor within rated voltage containing these irregular voltage.

No.	Process	Condition
2	Circuit design ⚠ Caution	

Voltage	(1) DC voltage	(2) DC+AC voltage	(3) AC voltage
Positional Measurement (Rated voltage)			

Voltage	(4) Pulse voltage (A)	(5) Pulse voltage (B)
Positional Measurement (Rated voltage)		

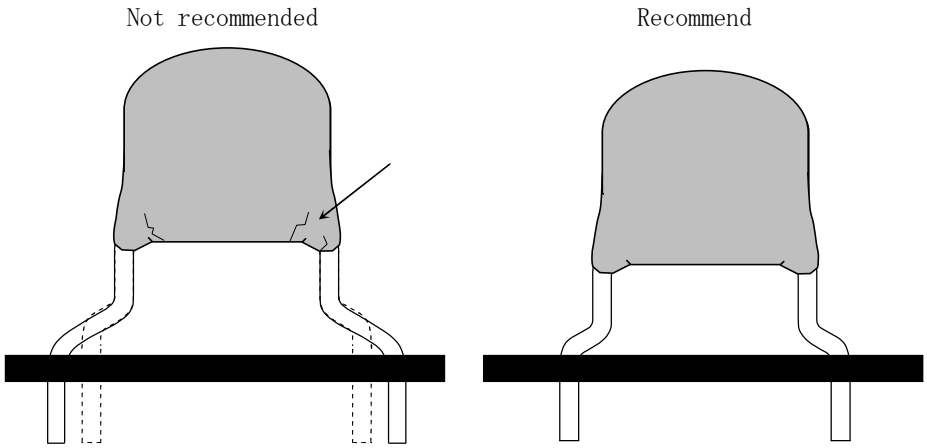
2) Even below the rated voltage, if repetitive high frequancy AC or pulse is applied, the reliability of the capacitor may be reduced.

3) The effective capacitance will vary depending on applied DC and AC voltages. The capacitors should be selected and designed in taking the voltages into consideration.

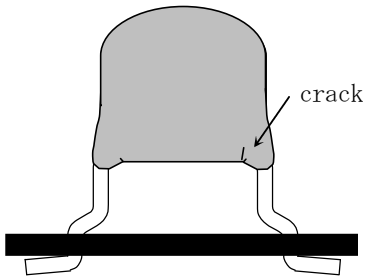
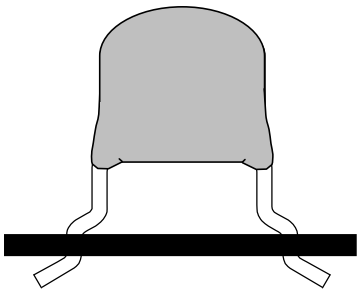
2-3. Frequency

1) When the capacitors (Class 2) are used in AC and/or pulse voltages, the capacitors may vibrate themselves and generate audible sound.

No.	Process	Condition
3	Designing P.C.board	If capacitor leads are inserted into different pitch holes, it may induce excessive stress in the capacitor or outer resin to result in cracking, and it may degrade the quality. Recommend capacitor layout is as following.



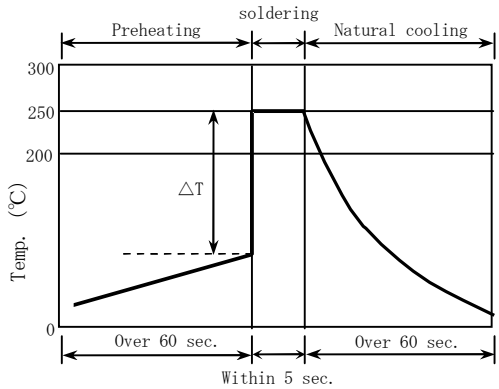
No.	Process	Condition
4	Lead wire insertion	1) If the leads clinching is too tight, the lead wire tend to be pulled excessively to cause lead wire breakage or cracking of the coating and quality degradation. Please adjust the clinching and provide sufficient preventive maintenance. Recommended capacitor layout is as following.

	Not recommended	Recommended
Clinching		

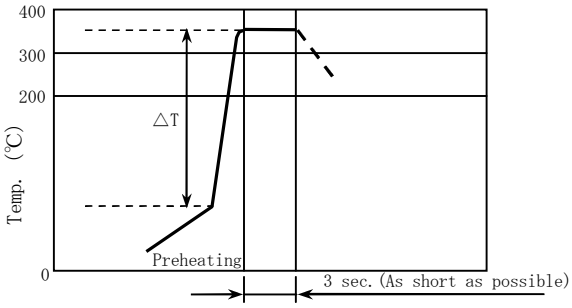
2) If capacitor leads are inserted into different pitch holes, it may induce excessive stress in the capacitor or outer resin to result in cracking, and it may degrade the quality.
When the lead pitch does not fit with the through hole on the pc board, please adjust the lead pitch so that the capacitor body would not receive excessive force.

5	Soldering	5-1. Flux selection Although highly-activated flux gives better solderability, substances which increase activity may also degrade the insulation of the capacitors. To avoid such degradation, it is recommended following. 1) It is recommended to use a mildly activated rosin flux (less than 0.1wt% chlorine). Do not use acidic flux is not recommended. 2) Excessive flux must be avoided. Please provide proper amount of flux. 3) When water-soluble flux is used, enough washing is necessary. 5-2. Recommended soldering profile by various methods

Flow soldering



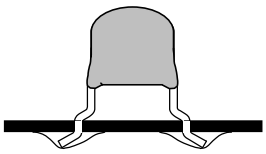
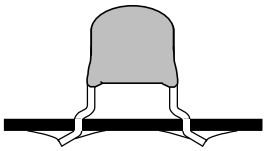
Manual soldering
(Solder iron)



5-3. Avoiding thermal shock
1) Preheating condition

Soldering	Temp. (℃)
Wave soldering	ΔT≦150
Manual soldering	ΔT≦190

<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>5</td><td>Soldering</td><td>
2) Cooling condition
Natural cooling using air is recommended. If the chips are dipped into a solvent for cleaning, the temperature difference(ΔT) must be less than 100℃.

5-4. Amount of solder
In sufficient solder may detach the capacitor from the P.C.board.
See bellow for example of solder amount.
<table>
<tr><td>Adequate</td><td>  </td><td></td></tr>
<tr><td>Insufficient solder</td><td>  </td><td>Low robustness may cause contact failure or capacitor comes off the P.C.board.</td></tr>
</table>

5-5. Solder repair by solder iron
Tip temperature of solder iron varies by its type, P.C.board material and solder land size. Higher the tip temperature , quick the operation is, but the heat shock may crack the capacitor. Following condition is recommended.
(Recommended solder iron condition)
<table>
<tr><th>Temp. (℃)</th><th>Wattage (W)</th><th>Shape (mm)</th><th>Time (sec.)</th></tr>
<tr><td>350 MAX.</td><td>20 MAX.</td><td>φ3.0 MAX.</td><td>3 MAX.</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Cleaning</td><td>
1) If an unsuitable cleaning fluid is used, flux residue or some foreign articles may stick to capacitor surface to deteriorate especially the insulation resistance.

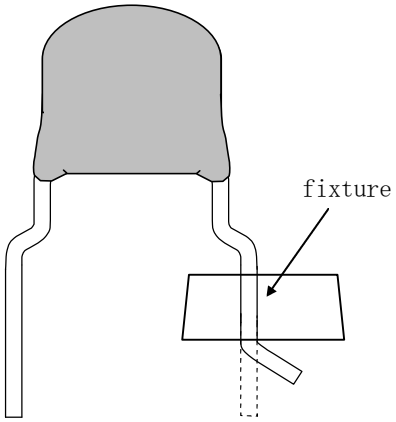
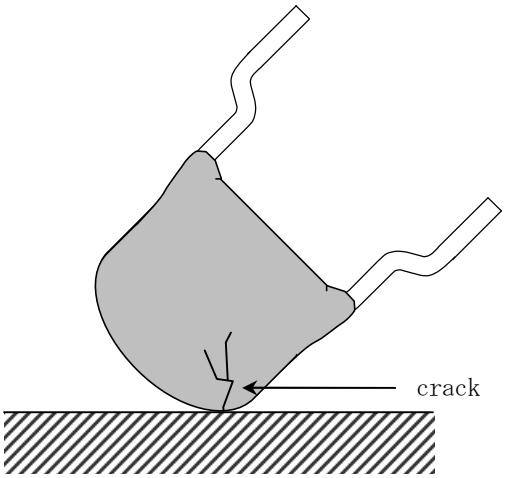
2) If cleaning condition is not suitable, it may damage the capacitor.

2)-1. Insufficient washing
(1) Terminal electrodes may corrode by Halogen in the flux.
(2) Halogen in the flux may adhere on the surface of capacitor, and lower the insulation resistance.
(3) Water soluble flux has higher tendency to have above mentioned problems (1) and (2).

2)-2. Excessive washing
(1) Excessive washing way damage the coating material of coated capacitor and deteriorate it.
(2) When ultrasonic cleaning is used, excessively high ultrasonic energy output can affect the adhesion between the ceramic dielectric and the terminal electrodes.
To avoid this, following is the recommended condition.

Power : 20W/ℓ max.
Frequency : 40kHz max.
Washing time : 5 minutes max.

2)-3. If the cleaning fluid is contaminated, density of Halogen increases, and it may bring the same result as insufficient cleaning.
</td></tr>
</table>

No.	Process	Condition
7	Coating and molding of the P.C.board	1) When the P.C.board is coated, please verify the quality influence on the product. 2) Please verify carefully that there is no harmful decomposing or reaction gas emission during curing which may damage the capacitor. 3) Please verify the curing temperature.
8	Lead wire bending	During lead wire bending process, mechanical stress often concentrates in one part of capacitor body and it may damage the ceramic and the coating. Refer to following for bending the lead wire.  When bending the lead wire, hold the wire closer to the capacitor with a fixture so that the lead bending would not affect the capacitor body.
9	Handling of loose capacitor	If dropped the capacitor may crack. Once dropped do not use it. Especially, the large case sized capacitor is tendency to have cracks easily, so please handle with care. 
10	Capacitance aging	The capacitors (Class 2) have aging in the capacitance. They may not be used in precision time constant circuit. In case of the time constant circuit, the evaluation should be done well.

No.	Process	Condition
11	Estimated life and estimated failure rate of capacitors	The estimated life and the estimated failure rate depend on the temperature and the voltage. This can be calculated by the equation described in JEITA RCR-2335B Annex F(Informative) Calculation of the estimated lifetime and the estimated failure rate (Temperature acceleration : 3rd powered low, Voltage acceleration : 10degC law) The failure rate can be decreased by reducing the temperature and the voltage but they will not be guaranteed.
12	Others ⚠ Caution	The products listed on this specification sheet are intended for use in general electronic equipment (AV equipment, telecommunications equipment, home appliances, amusement equipment, computer equipment, personal equipment, office equipment, measurement equipment, industrial robots) under a normal operation and use condition. The products are not designed or warranted to meet the requirements of the applications listed below, whose performance and/or quality require a more stringent level of safety or reliability, or whose failure, malfunction or trouble could cause serious damage to society, person or property. Please understand that we are not responsible for any damage or liability caused by use of the products in any of the applications below or for any other use exceeding the range or conditions set forth in this specification sheet. Aerospace/Aviation equipment. Transportation equipment (cars, electric trains, ships, etc.) Medical equipment. Power-generation control equipment. Atomic energy-related equipment. Seabed equipment. Transportation control equipment. Public information-processing equipment. Military equipment. Electric heating apparatus, burning equipment. Disaster prevention/crime prevention equipment. Safety equipment. Other applications that are not considered general-purpose applications. When using this product in general-purpose applications, you are kindly requested to take into consideration securing protection circuit/equipment or providing backup circuits, etc., to ensure higher safety.

TAPE PACKAGING SPECIFICATION

1. CONSTRUCTION AND DIMENSION OF TAPING

Dimensions of FK1* type shall be according to Appendix 2.
Dimensions of FK2* type shall be according to Appendix 3.

2. QUANTITY

Type	Parts quantity/box (pcs.)
FK18, FK28 FK14, FK24 FK16, FK26	2,000
FK11, FK20 FK22	1,500

3. PERFORMANCE SPECIFICATIONS

3-1. The missing of components shall be within consecutive 3pcs.

3-2. Empty part for min 3pcs shall be provided at the beginning and the end of taping.

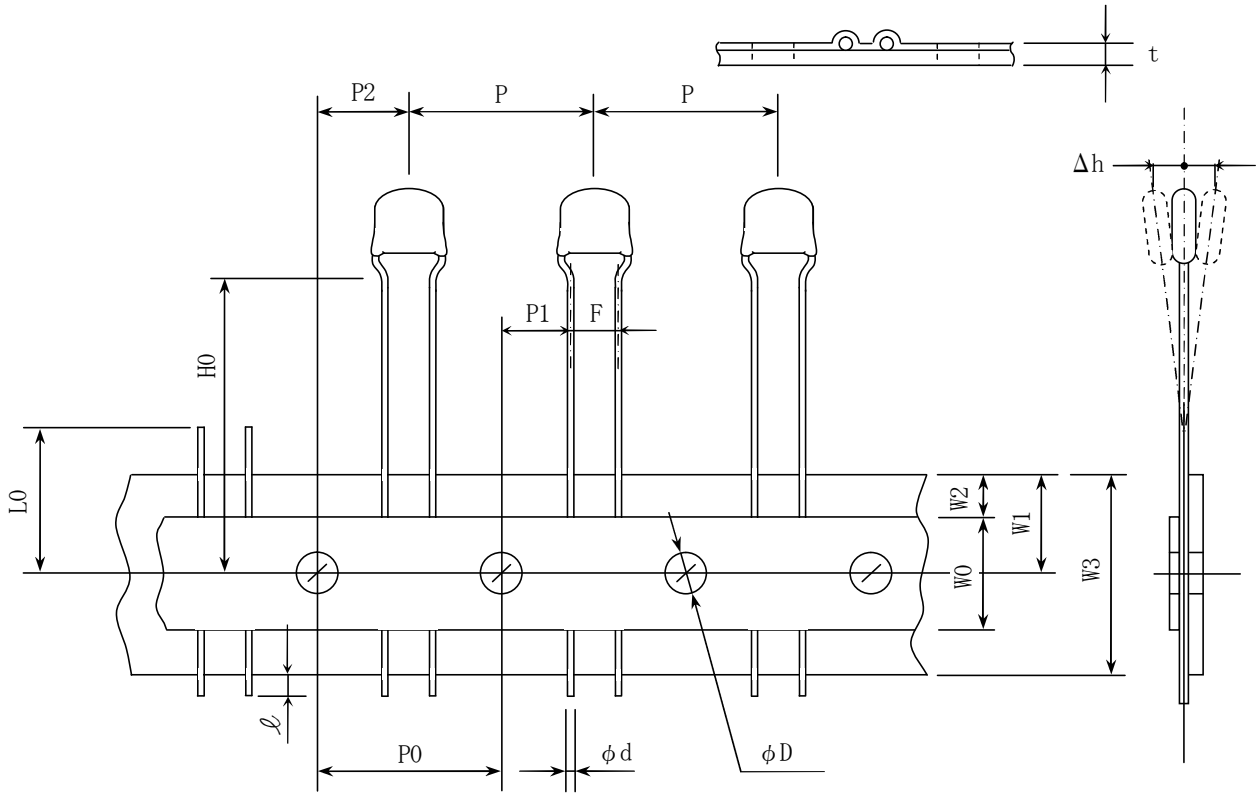
3-3. Shipping label must be attached at the side of carton.

3-4. When pull the carrier tape for left side with keeping the head of capacitors to the direction of the above figure, adhesive tape shall be upper side.

3-5. Folded tape shall contain 25pcs. of components.

Appendix 2　　Taping dimensions

(FK18, FK14, FK16, FK11)



(Unit : mm)

Symbol	Dimensions	Tolerance
P	12. 7	±1. 0
P0 ※1	12. 7	±0. 3
P1	5. 1	±0. 7
P2	6. 35	±1. 3
W0	12. 0	±1. 0
W1	9. 0	±0. 5
W2 ※2	3. 0	3. 0 and under
W3	18. 0	+1. 0, −0. 5
H0	16. 0	±0. 5
ℓ	1. 0	1. 0 and under
t	0. 6	±0. 2
L0	11. 0	11. 0 and under
F	2. 5	+0. 5, −0. 2
φd	φ0. 5	+0. 1, −0. 03
φD	φ4. 0	±0. 2
Δh	———	±2

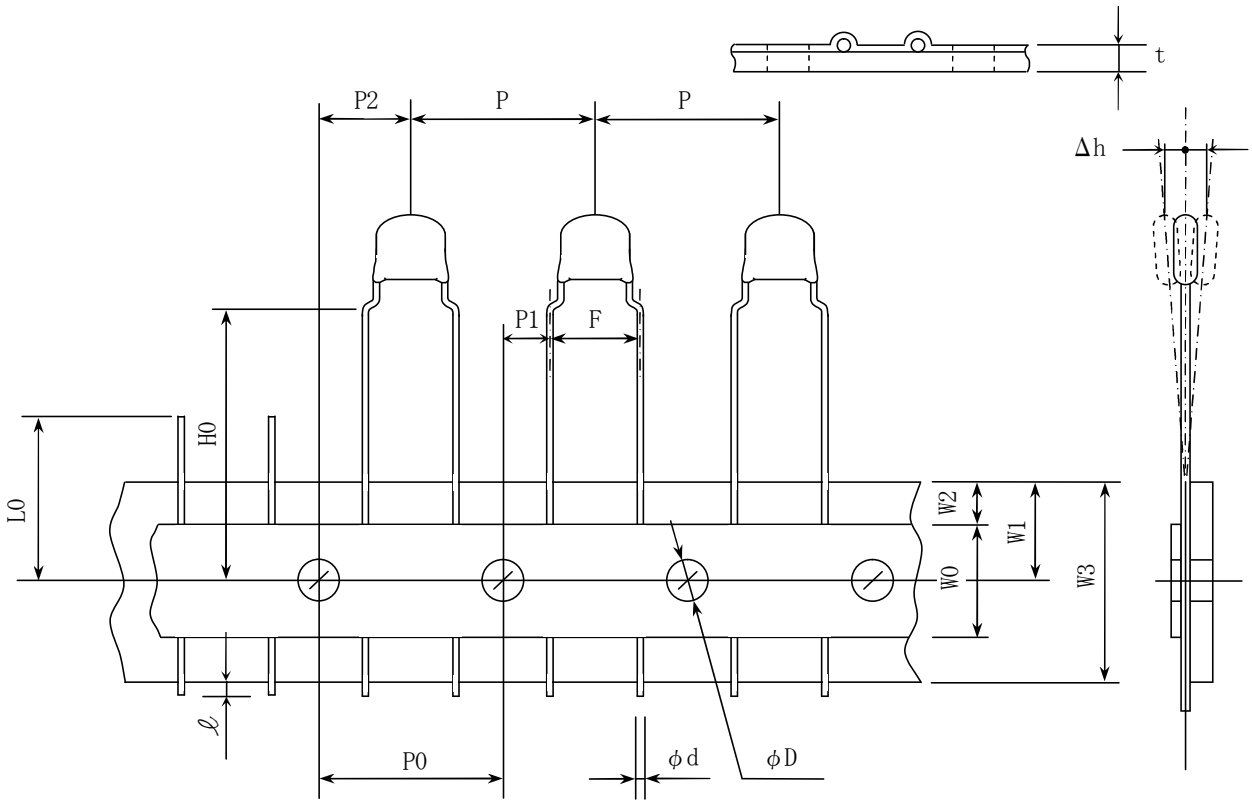
※1 Accumulated pitch tolerance shall be ±2mm for 20 pitches.

※2 Adhesive tape shall not stick out from carrier tape.

TDK

Appendix 3　　Taping dimensions

(FK28, FK24, FK26, FK20, FK22)



(Unit : mm)

Symbol	Dimensions	Tolerance
P	12. 7	±1. 0
P0 ※1	12. 7	±0. 3
P1	3. 85	±0. 7
P2	6. 35	±1. 3
W0	12. 0	±1. 0
W1	9. 0	±0. 5
W2 ※2	3. 0	3. 0 and under
W3	18. 0	+1. 0, −0. 5
H0	16. 0	±0. 5
ℓ	1. 0	1. 0 and under
t	0. 6	±0. 2
L0	11. 0	11. 0 and under
F	5. 0	+0. 8, −0. 2
φd	φ0. 5	+0. 1, −0. 03
φD	φ4. 0	±0. 2
Δh	———	±2

※1 Accumulated pitch tolerance shall be ±2mm for 20 pitches.

※2 Adhesive tape shall not stick out from carrier tape.

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