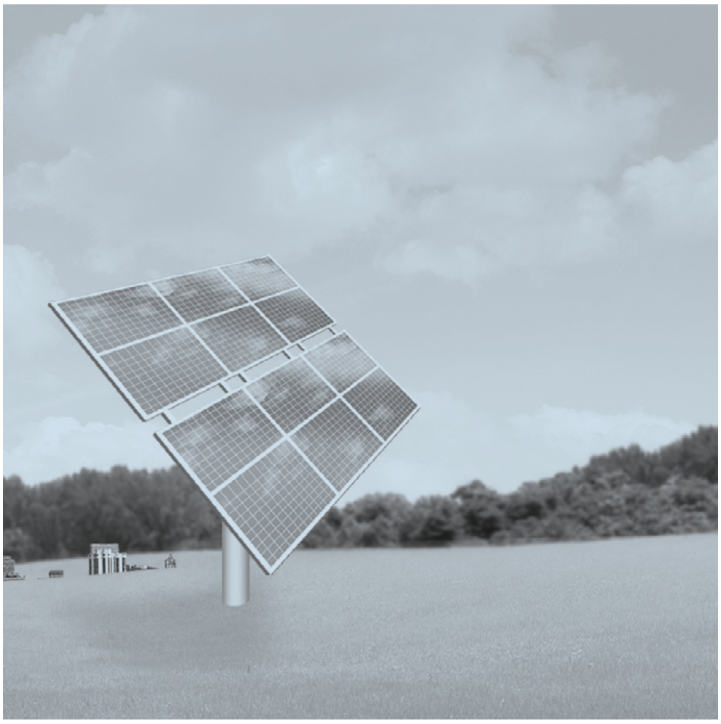
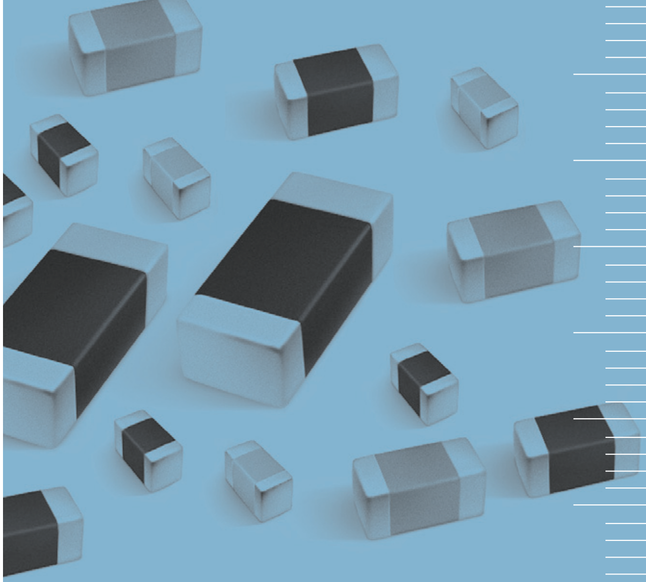


C O N T E N T S

Passion for Challenges

SAMWHA Energy Saving
Products Guide



INDEX

High Voltage MLCC

High Voltage MLCC

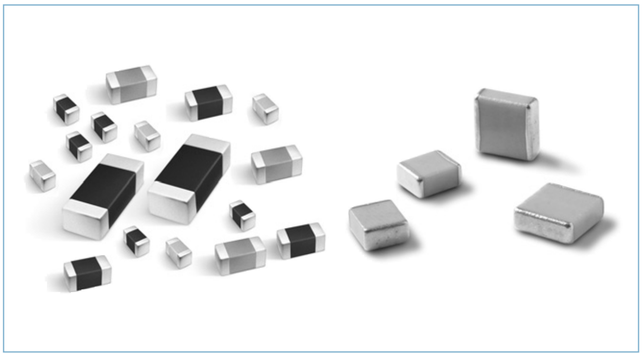


Fig. 1. Appearances of various MLCCs

SAMWHA high voltage MLCC products with the temperature characteristics of C0G and X7R are designed for commercial and industrial applications. The products are applied to DC-DC converters and ballast circuit to reduce ripple noise and diverting potentially unsafe transients in various sizes with working voltage up to DC 7kV. These high voltage capacitors feature a special internal electrode design which has capacitor network to reduce voltage concentrations by distributing voltage throughout the entire capacitor.

Features

- High reliability
- The highest voltage rating by the special internal electrode design
- Wide voltage level : from 100VDC to 7,000VDC
- Surface mount suited for wave and reflow soldering
- RoHS compliant

Applications

- DC-DC Converters
- Network Equipments
- Back-Lighting Inverter
- Lighting Ballast
- Modem & Power Supply
- LAN/WLAN Interface

Special Options for the Safety

- Inset electrode margins to prevent short mode failure resulted from the crack by mechanical bending stress
- Soft termination is optionally available to reduce possibility for the crack of MLCCs by mechanical bending stress

C0G Lineup

Size	Vr(V)	100pF	220pF	470pF	1.0nF	2.2nF	4.7nF	10nF	22nF
1005	100								
	250								
1608	100								
	250								
2012	100								
	250								
	630								
	1,000								
3216	100								
	250								
	630								
	1,000								
	2,000								
4520	100								
	250								
	630								
	1,000								
	2,000								
	3,000								
4532	100								
	250								
	630								
	1,000								
	2,000								
	3,000								

Size	Vr(V)	10pF	22pF	47pF	68pF	100pF	180pF	220pF	330pF
7566	3,000								
	4,000								
9595	3,000								
	4,000								
	5,000								
	7,000								

X7R Lineup

Size	Vr(V)	2.2nF	4.7nF	10nF	22nF	47nF	100nF	220nF	470nF	1.0uF
1005	100									
	250									
1608	100									
	250									
2012	100									
	250									
	630									
	1,000									
3216	100									
	250									
	630									
	1,000									
	2,000									
4520	100									
	250									
	630									
	1,000									
	2,000									
	3,000									
4532	100									
	250									
	630									
	1,000									
	2,000									
	3,000									

Size	Vr(V)	100pF	470pF	1.0nF	2.2nF	10nF	47nF	100nF	150nF
7566	3,000								
	4,000								
9595	3,000								
	4,000								
	5,000								
	7,000								

* For the special capacitance or design, please contact our sales representatives or product engineers.

MLCC Applications for DC-DC Converter Modules

High voltage MLCCs are mainly used to DC-DC converter modules for industrial applications which have high input voltage of typical 48V. These are used as functions of high frequency noise filtering(decoupling) of power line and snubber capacitor to protect switching device from unsafe transients by inductance of transformer or connection line due to switching operation. For these applications, MLCCs have merits for high allowable ripple current and high reliability.
Figure 2 shows isolated DC-DC converter circuit diagram and MLCC applications such as decoupling and snubber. Input voltage is 36~75VDC (typical 48VDC) for general industrial applications such as base station, server and network equipments. Decoupling MLCCs are applied to input and output (based on viewpoint of switch or transformer) power line to reduce ripple voltage, and MLCCs for snubber application used to absorb surge energy. SAMWHA MLCCs are recommended for each application as shown in Table 1.

Table 1. MLCC recommendation for isolated type DC-DC converter module

Items	MLCC Recommendation
* Input (C1, C2)	1210 X7R 470nF 100V 1812 X7R 1.0μF 100V
Snubber (C3~C6)	Available wide range of products 250V~2kV (Available up to 7.2kV) 100pF~2.2nF (Available up to 470nF)
Output (C7)	(High Capacitance Application) 1210 X5R 100μF 6.3V 1206 X5R 47μF 6.3V 0805 X5R 47μF 6.3V

* Typical input voltage of 48V for industrial application

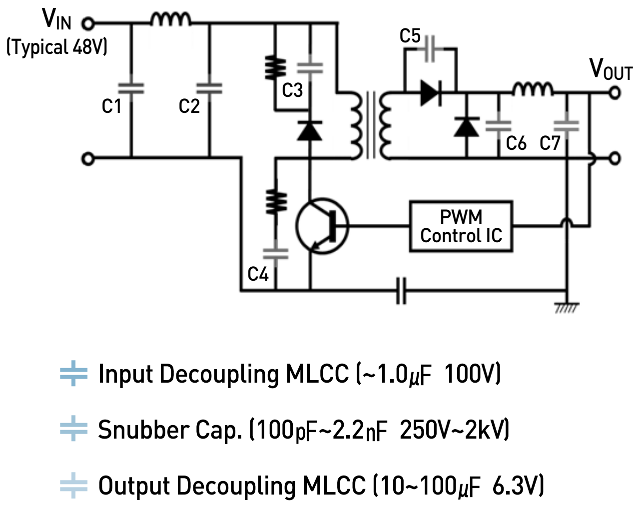
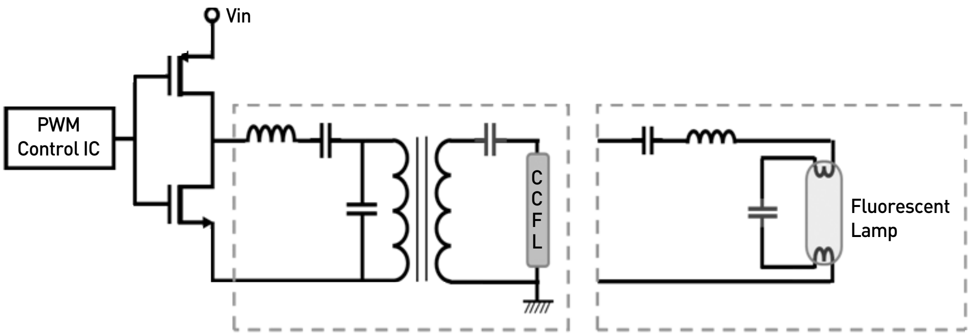


Fig. 2. General circuit diagram of isolated DC-DC converter and MLCC application

MLCC Applications for Ballast Circuits

High voltage MLCCs are suitable for the ballast circuit as a function of resonant capacitor as presented in Figure 3. MLCCs with high voltage rating from 1kV to 3kV (available up to 7.2kV) are mainly used for these application. SAMWHA offers wide range of capacitance and rated voltage with high reliability.



Resonant Cap.

10pF~10nF

1kV~3kV (Available up to 7.2kV)

Fig. 3. Typical electronic ballast circuit and MLCC application

Type Designation

CS	7566	COG	100	J	302	N	R	E
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

1) Series Name : CS : Leadless Type
AR : Axial Type
RB : Ribbon Type

2) Size Code: This is expressed in tens of a millimeter.
The first two digits are the length, The last two digits are width.

3) Temperature Coefficient Code

Classification	Code	Temperature Range	Capacitance Tolerance
Class I	COG	-55 to +125°C	±30 ppm/°C
Class II	X7R	-55 to +125°C	±15%

4) Capacitance Code (pF):

The nominal Capacitance Value in pF is expressed by three digit numbers.

The first two digits represents significant figures and the last digit denotes the number of zero.

ex) 104 = 100000 pF
R denotes decimal
8R2 = 8.2 pF

5) Capacitance Tolerance Code

Code	Tolerance
B	± 0.1 pF
C	± 0.25 pF
D	± 0.5 pF
F	± 1.0%
G	± 2.0%
J	± 5%
K	± 10%
M	± 20%

6) Voltage Code

code	101	201	251	501	631	102	202	302	402	502	602	722
Vol.	DC 100V	DC 200V	DC 250V	DC 500V	DC 630V	DC 1KV	DC 2KV	DC 3KV	DC 4KV	DC 5KV	DC 6KV	DC 7.2KV

7) Termination Code

ex) N: Ni-Sn (Nickel-Tin Plate)

8) Packing Code

ex) R: Reel Type   C: Case Box   B: Bulk Type

9) Thickness option

Code	Thickness (mm)	
	t	Tol (±)
B	0.80	0.10
B	0.85	0.15
E	1.00	0.15
E	1.10	0.15
E	1.15	0.15
E	1.25	0.15

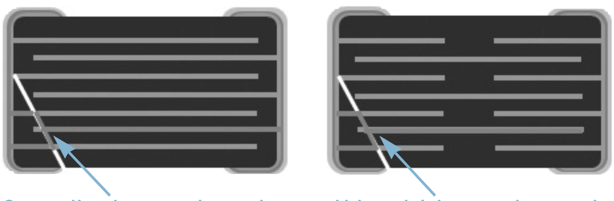
Code	Thickness (mm)	
	t	Tol (±)
E	1.30	0.20
H	1.35	0.20
I	1.60	0.30
J	1.80	0.30
K	2.00	0.50
L	2.50	0.50
M	2.80	0.50
N	3.20	0.50
O	5.00	0.50

Technical Background for the Safety

Additional robustness is required to electronic components for the special applications such as network equipments, DC-DC converter modules for industrial applications, lighting ballast and etc. Based on the fact that high voltage MLCCs are mainly used to those applications, and most of the problems with failed MLCCs (>90%) as a short-circuit are caused by bending-cracks, SAMWHA introduces several technical design to minimize the risk of cracks and short circuits.

I. Floating Electrode Design

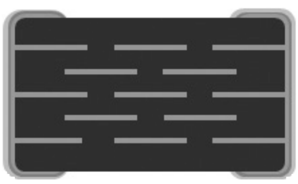
Floating electrode (or serial) design creates two or several separate capacitors in series, and provides no pathway for the part to short circuit. Figure 4 shows differences of inner electrode designs between normal and floating. MLCCs with normal electrode design can be easily short circuit failure by bending-cracks as shown in Figure 4-(a). On the contrary, MLCCs with floating electrode design do not occur short circuit, even if it has bending-cracks as shown in Figure 4-(b). However, MLCC with floating electrode design has lower capacitance, because capacitance is divide by the number of series capacitors, and its active (or overlap) area is smaller than those of MLCC with normal electrode design.



(a) Normal Electrode (b) Floating Electrode

Fig. 4. Schematic diagram of MLCCs with normal and floating electrode (or serial) design

For the MLCCs with floating electrode design, applied voltage is divided by the number of nods of floating pattern as presented in Figure 5. Generally, breakdown voltage is increased with the increase of the number of nods due to the decrease of applied voltage per each nod. SAMWHA offers up to 8-nod for the safety of the ultra high voltage MLCCs up to 7.2kV.



(a) 4-Nod Floating Pattern

Fig. 5. Schematic diagram of MLCCs with 4-Nod floating pattern and its equivalent circuit

II. Open Mode Design

MLCC with open mode design is similar to a typical MLCC except for the active area. It has a sufficient margin to prevent short circuit failure by bending cracks as shown in Figure 6. Since the crack does not pass through the active area, there is no pathway to short circuit. It will only fail as open circuit (or low capacitance) by bending cracks.

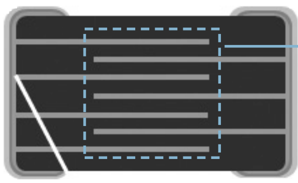
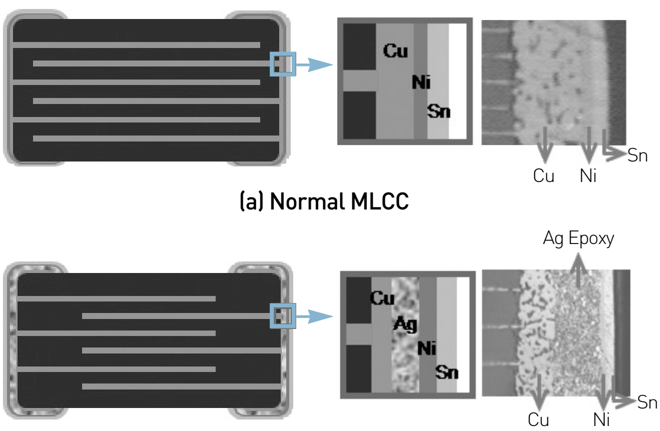


Fig. 6. Schematic diagram of MLCCs with open mode design

III. Flexible (or Soft) Termination

Flexible termination material can reduce mechanical stress by excessive bending of PCB. As illustrated in Figure 7, a silver loaded epoxy is inserted between the copper and nickel layer to absorb the strain on a board due to their flexibility. Therefore, MLCC with flexible termination withstands much higher bending stress.

An additional assurance to prevent a short circuit by bending cracks is possible by combining flexible termination with floating electrode or open mode design.

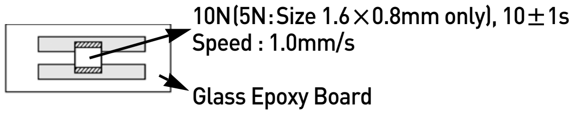
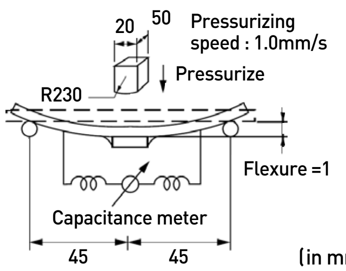


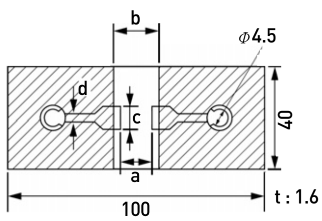
(b) MLCC with Flexible Termination

Fig. 7. Schematic diagram of MLCCs with different terminations

Specifications and Test Methods

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class Ⅰ</th><th>Class Ⅱ</th></tr>
<tr><td>1</td><td>Operating Temperature Range</td><td>COG : -55 to +125℃</td><td>X7R : -55 to +125℃</td><td></td></tr>
<tr><td>2</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td>Visual inspection</td></tr>
<tr><td>3</td><td>Dimensions</td><td colspan="2">Within the specified dimension</td><td>Using calipers</td></tr>
<tr><td>4</td><td>Dielectric Strength</td><td colspan="2">No defects or abnormalities</td><td>No failure should be observed when voltage in table is applied between the terminations, provided the charge/discharge current is less than 50mA.
<table>
<tr><th>Cap.</th><th>Rated voltage</th><th>Test voltage</th><th>Time</th></tr>
<tr><td rowspan="2">COG</td><td>DC100V~630V</td><td>150% of the rated voltage</td><td rowspan="4">1to5 sec.</td></tr>
<tr><td>DC1kV, DC2kV
DC3kV, DC7.2kV</td><td>120% of the rated voltage</td></tr>
<tr><td rowspan="2">X7R</td><td>DC100V~630V</td><td>150% of the rated voltage</td></tr>
<tr><td>DC1kV~DC5kV</td><td>120% of the rated voltage</td></tr>
</table></td></tr>
<tr><td>5</td><td>Insulation Resistance</td><td>More than 10,000㏁</td><td>-DC100V~1KV
:C≥0.01㎌:More than 100㏁·㎌
:C<0.01㎌: More than 10,000㏁
-DC2~3KV: More than 6,000㏁</td><td>Rated voltage <DC500V : Applied the rated voltage for 2 minutes of charging.
Rated voltage ≥ DC500V : The insulation resistance should be measured with DC500±50V and within 2 minutes of charging.</td></tr>
<tr><td>6</td><td>Capacitance</td><td colspan="2">within the specified tolerance</td><td rowspan="2">
<table>
<tr><th>Cap.</th><th>Testing frequency</th><th>Testing Voltage</th><th>Measure temperature</th></tr>
<tr><td>COG</td><td>1±0.2㎒</td><td rowspan="2">AC 1±0.2Vrms</td><td rowspan="2">25℃</td></tr>
<tr><td>X7R</td><td>1±0.2㎑</td></tr>
</table>
* Pretreatment
Perform a heat treatment at 150+0,-10℃ for 60±5 min. and then let sit for 24±2hrs.(Class Ⅰ), 48±4hrs.(Class Ⅱ) at room Temperature</td></tr>
<tr><td>7</td><td>Dissipation Factor(D.F.)</td><td>1MHz (% Maximum)
0.05</td><td>1KHz (% Maximum)
2.5</td></tr>
<tr><td>8</td><td>Capacitance Temperature Characteristics</td><td>Temp. Coefficient
COG char. :
0±30ppm/℃
(Temp. Range : -55 to +125℃)</td><td>Cap. Change within ±15%
(Temp. Range : -55 to +125℃)</td><td>COG : The temperature coefficient is determined using the capacitance measured in step 3 as a reference.
When cycling the temperature sequentially from step 1 through 5 the capacitance should be within the specified tolerance for the temperature coefficient.
<table>
<tr><th>Step</th><th>Temperature(℃)</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>125±3 (for COG)</td></tr>
<tr><td>5</td><td>25±2</td></tr>
</table>
X7R : The range of capacitance change compared with the 25℃ value should be within the specified range.
-Pretreatment
Perform a heat treatment at 150 -10, +0℃ for 60±5min. and then let sit for 24±2hrs.(Class Ⅰ), 48±4hrs.(Class Ⅱ) at room Temperature</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Item</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class I</th><th>Class II</th></tr>
<tr><td>9</td><td colspan="2">Adhesive Strength of Termination</td><td colspan="2">No removal of the terminations or other defect should occur</td><td>Solder the capacitor to the testing jig(glass epoxy board) shown in Fig. 1 using a eutectic solder.
Then apply 10N force in the direction of the arrow.
The soldering should be done either with an iron or using the reflow method and should be conducted with care so that the soldering is uniform and free of defects such as heat shock.

</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Vibration Resistance</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td rowspan="3">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 55Hz. The frequency range, from 10 to 55Hz and return to 10Hz, should be traversed in approximately 1 min. This motion should be applied for a period of 2hrs. in each 3mutually perpendicular directions(total of 6hrs.)</td></tr>
<tr><td>Capacitance Change</td><td colspan="2">Within the specified tolerance</td></tr>
<tr><td>Dissipation Factor(%)</td><td>COG char. : 0.05</td><td>2.5 max</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2" colspan="2">Bending strength</td><td colspan="2">No cracking defects should occur.</td><td rowspan="2">Solder the capacitor to the testing jig(glass epoxy board) shown in Fig. 2 using a eutectic solder.
Then apply a force in the direction shown in Fig. 3.
The soldering should be done either with an iron or using the reflow method and should be conducted with care so that the soldering is uniform and free of defects such as heat shock.


(in mm)
- Holding time : 5±1sec</td></tr>
<tr><td colspan="2">

<table>
<tr><th rowspan="2">L×X (mm)</th><th colspan="4">Dimension(mm)</th></tr>
<tr><th>a</th><th>b</th><th>c</th><th>d</th></tr>
<tr><td>1.6×0.8</td><td>1.0</td><td>3.0</td><td>1.2</td><td rowspan="6">1.0</td></tr>
<tr><td>2.0×1.25</td><td>1.2</td><td>4.0</td><td>1.65</td></tr>
<tr><td>3.2×1.6</td><td>2.2</td><td>5.0</td><td>2.0</td></tr>
<tr><td>3.2×2.5</td><td>2.2</td><td>5.0</td><td>2.9</td></tr>
<tr><td>4.5×2.0</td><td>3.5</td><td>7.0</td><td>2.4</td></tr>
<tr><td>4.5×3.2</td><td>3.5</td><td>7.0</td><td>3.7</td></tr>
</table></td></tr>
<tr><td>12</td><td colspan="2">Solderability of Termination</td><td colspan="2">75% of the terminations are to be soldered evenly and continuously.</td><td>Immerse the capacitor in a solution of ethanol and rosin (25% rosin in weight proportion).
Immerse in eutectic solder solution for 2±0.5 sec. at 235±5℃
Immersing speed : 25±2.5mm/s</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Item</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class I</th><th>Class II</th></tr>
<tr><td rowspan="4">13</td><td rowspan="4">Resistance to Soldering Heat</td><td>Appearance</td><td colspan="2">No marked defect</td><td rowspan="4">Preheat the capacitor at 120 to 150℃ * for 1 min.
Immerse the capacitor in eutectic solder solution at 260±5℃ for 10±1 sec.

- Immersing speed : 25±2.5mm/s
· Initial measurement
Perform the initial measurement according to Note1 for Class II
· Measurement after test
Let sit at room Temperature for
24±2hrs. (Class I), 48±4hrs. (Class II) then measure.
* Preheating for more than 3.2×2.5mm<table><tr><th>Step</th><th>Temperature</th><th>Time</th></tr><tr><td>1</td><td>100℃ to 120℃</td><td>1 min</td></tr><tr><td>2</td><td>170℃ to 200℃</td><td>1 min</td></tr></table></td></tr>
<tr><td>Capacitance Change</td><td>within ±2.5% or ±0.25pF
(whichever is larger)</td><td>within ±10%</td></tr>
<tr><td>Dissipation Factor
(or Q)</td><td>COG Char. :
C≧30pF : Q≧1,000
C〈30pF : Q≧400+20C</td><td>0.025 max</td></tr>
<tr><td>I.R.</td><td>More than 10,000MΩ</td><td>-DC100V~1KV
:C≥0.01μF:More than 100MΩ·μF
:C〈0.01μF: More than 10,000MΩ
-DC2~3KV: More than 1,000MΩ</td></tr>
<tr><td rowspan="4">14</td><td rowspan="4">Temperature cycle</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Perform the 5 cycles according to the 4 heat treatments listed in the following table.<table><tr><th>Step</th><th>1</th><th>2</th><th>3</th><th>4</th></tr><tr><td>Temp (℃)</td><td>Min. operating temp. ±3</td><td>Room Temp</td><td>Max. operating temp. ±2</td><td>Room Temp</td></tr><tr><td>Time (min)</td><td>30±3</td><td>2 to 3</td><td>30±3</td><td>2 to 3</td></tr></table>· Initial measurement
Perform the initial measurement according to Note1 for Class II
· Measurement after test
Perform the final measurement according to Note2</td></tr>
<tr><td>Capacitance Change</td><td>within ±2.5% or ±0.25pF
(whichever is larger)</td><td>within ±15%</td></tr>
<tr><td>Dissipation Factor
(or Q)</td><td>COG Char. :
C≧30pF : Q≧1,000
C〈30pF : Q≧400+20C</td><td>DC100V~1KV: 0.025max
DC2~3KV : 0.05 max</td></tr>
<tr><td>I.R.</td><td>More than 10,000MΩ</td><td>-DC100V~1KV
:C≥0.01μF:More than 100MΩ·μF
:C〈0.01μF: More than 10,000MΩ
-DC2~3KV: More than 3,000MΩ</td></tr>
<tr><td rowspan="4">15</td><td rowspan="4">Humidity (Steady State)</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Let the capacitor sit at 40±2℃ and relative humidity of 90 to 95% for 500+24/-0 hrs.

· Initial measurement
Perform the initial measurement according to Note1 for Class II
· Measurement after test
Perform the final measurement according to Note2</td></tr>
<tr><td>Capacitance Change</td><td>within ±5% or ±0.5pF
(Whichever is larger)</td><td>Within ±15%</td></tr>
<tr><td>Dissipation Factor
(or Q)</td><td>COG Char. : (%Max 0.05)</td><td>2.5 (%Max) 1KHz</td></tr>
<tr><td>I.R.</td><td>More than 1,000MΩ</td><td>-DC100V~1KV
:C≥0.01μF:More than 10MΩ·μF
:C〈0.01μF: More than 1,000MΩ
-DC2~7.2KV: More than 1,000MΩ</td></tr>
<tr><td rowspan="4">16</td><td rowspan="4">High Temperature Load</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="3">Apply the voltage in following table for 1,000+48/-0hrs. at maximum operating temperature ±3℃

The charge/discharge current is less than 50mA.<table><tr><th>Operating temperature range</th><th>Rated voltage</th><th>Test voltage</th></tr><tr><td rowspan="2">COG</td><td>Rated voltage ≥DC1KV</td><td>Rated voltage</td></tr><tr><td>Rated voltage 〈DC1KV</td><td>120% of the rated voltage</td></tr><tr><td rowspan="3">X7R</td><td>DC100V~250V</td><td>150% of the rated voltage</td></tr><tr><td>DC500V~630V</td><td>120% of the rated voltage</td></tr><tr><td>DC1KV~DC7.2KV</td><td>110% of the rated voltage</td></tr></table></td></tr>
<tr><td>Capacitance Change</td><td>within ±3% or ±0.3pF
(Whichever is larger)</td><td>DC100V,630V:Within ±15%
DC1KV:Within ±20%
DC2~7.2KV:Within ±20%</td></tr>
<tr><td>Dissipation Factor
(or Q)</td><td>COG Char. :
0.05</td><td>2.5 max</td></tr>
<tr><td>I.R.</td><td>More than 1,000MΩ</td><td>-DC100V~1KV
:C≥0.01μF:More than 10MΩ·μF
:C〈0.01μF: More than 1,000MΩ

-DC2~7.2KV: More than 2,000MΩ</td><td>· Initial measurement
Perform the initial measurement according to Note1 for Class II
· Measurement after test
Perform the final measurement according to Note2</td></tr>
</table>

No.	Item		Specification		Test Methods and Conditions
			Class I	Class II	
17	Humidity Load (Application: DC250V item)	Appearance		No marking defects	Apply the rated voltage at 40±2℃ and relative humidity of 90 to 95 for 500+24/-0 hrs. · Initial measurement Perform the initial measurement according to Note1 for Class II · Measurement after test Perform the final measurement according to Note2
		Capacitance Change		Within ±15%	
		Dissipation (Factor)		2.5 (1khz,%)	
		I.R.		:C≥0.01㎌:More than 10㏁·㎌ :C<0.01㎌: More than 1,000㏁	

* Note1. Initial Measurement for Class II
Perform a heat treatment at 150+0, -10℃ for one hour and then let sit for 48±4 hours at room temperature, then measure.

* Note2. Measurement after test
1. Class I
Let sit for 24±2 hours at room temperature,then measurement
2. Class II
Perform a heat treatment at 150+0, -10℃ for one hour and then let sit for 48±4 hours at room temperature, then measure.

Caution

▶Reflow Soldering

1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.

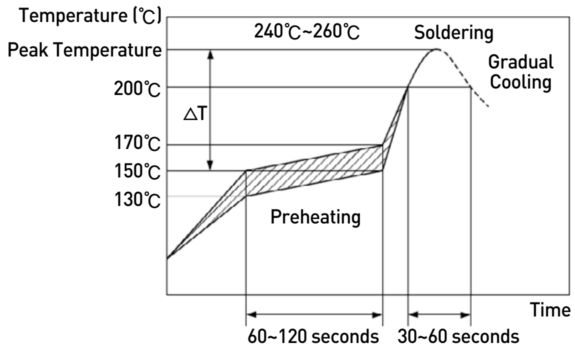
2. Please refer to the recommended soldering profiles as shown in figures, and keep the temperature difference(△T) within the range recommended in Table 1.

Table 1

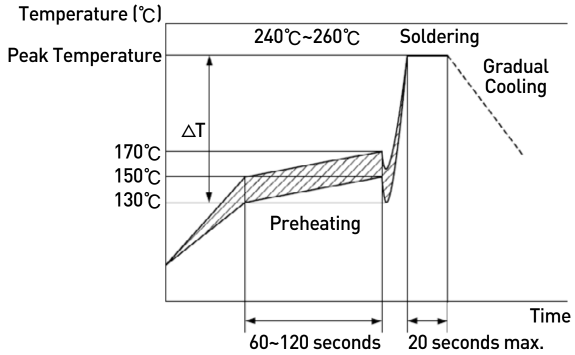
Size code	Temperature Difference
1608, 2012, 3216	△T≤190℃
3225 size and over	△T≤130℃

[Standard Conditions for Reflow Soldering]

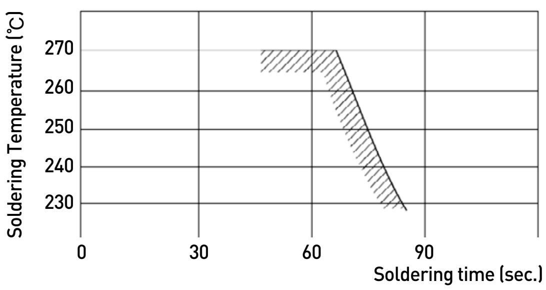
Infrared Reflow



Vapor Reflow



[Allowable Soldering Temperature and Time]



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

▶Storage Condition

* When Solderability is considered, Capacitor are recommended to be used in 12 months.

(1) Temperature : 25℃ ± 10℃
(2) Relative Humidity : Below 70% RH

▶The Regulation of Environmental Pollution Materials.

* Never use materials mentioned below in MLCC products regulated this document.
Pb, Cd, Hg, Cr+6, PBB(Polybromide biphenyl), PBDE(Polybrominated diphenyl ethers), asbestos.

Packing

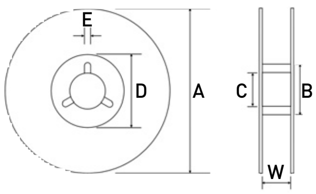
1) Bulk packing

① 1000 pcs per Polybag
② 5 Polybags per Inner box
③ 10 Inner boxes per Out box
④ 50pcs per box

2) Reel Packing

① 8~10 Reels per Inner box
② 10 Inner boxes per Out box

3) Reel Dimensions



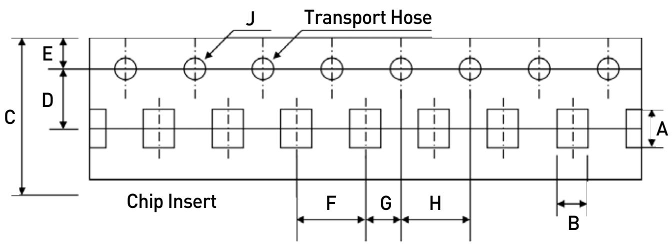
(Unit : mm)

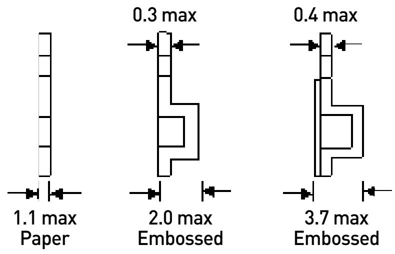
MARK	SIZE	A	B	C	D	E	W
7"REEL	0603~3225	Φ178±2	Φ50Min	Φ13±0.5	Φ21±0.8	2±0.5	10±1.5
	4520~4532	Φ180+0,-3	Φ60-0,+1	Φ13±0.2	Φ57-0+1	3±0.2	13±0.5
13"REEL	1005~3225	Φ330±2	Φ70Min	Φ13±0.5	Φ21±0.8	2±0.5	10±1.5

4) Number of Package

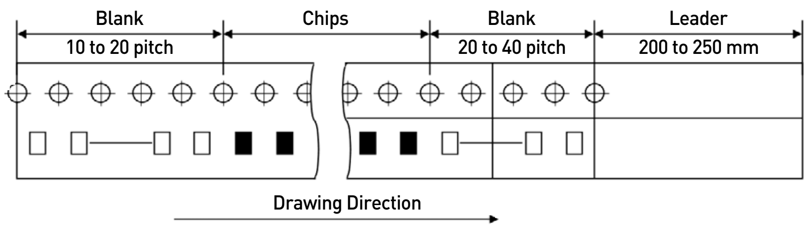
TYPE	EIA CODE	7" Qt/REEL	13" Qt/REEL
CS0603	CC0201	15,000	
CS1005	CC0402	10,000	50,000
CS1608	CC0603	4,000	16,000
CS2012	CC0805	3,000 ~ 4,000	10,000
CS3216	CC1206	2,000 ~ 4,000	6,000 ~ 10,000
CS3225	CC1210	1,000 ~ 3,000	4,000 ~ 10,000
CS4520	CC1808	1,500 ~ 3,000	-
CS4532	CC1812	500 ~ 1,000	-

5) Tape Dimensions





TYPE	EIA CODE	A	B	C	D	E	F	G	H	J
CS0603	CC0201	0.67±0.05	0.37±0.05	8.0±0.3	3.5±0.05	1.75±0.1	2.0±0.05	2.0±0.1	4.0±0.1	1.5±0.1
CS1005	CC0402	1.15±0.1	0.65±0.1	8.0±0.3	3.5±0.05	1.75±0.1	2.0±0.05	2.0±0.1	4.0±0.1	1.5±0.1
CS1608	CC0603	1.9±0.2	1.10±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
CS2012	CC0805	2.4±0.2	1.65±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
CS3216	CC1206	3.6±0.2	2.00±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
CS3225	CC1210	3.6±0.2	2.80±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
CS4520	CC1808	4.8±0.2	2.3±0.2	12.0±0.3	5.5±0.1	1.75±0.1	4.0±0.1 8.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
CS4532	CC1812	4.9±0.2	3.6±0.2	12.0±0.3	5.5±0.1	1.75±0.1	8.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1



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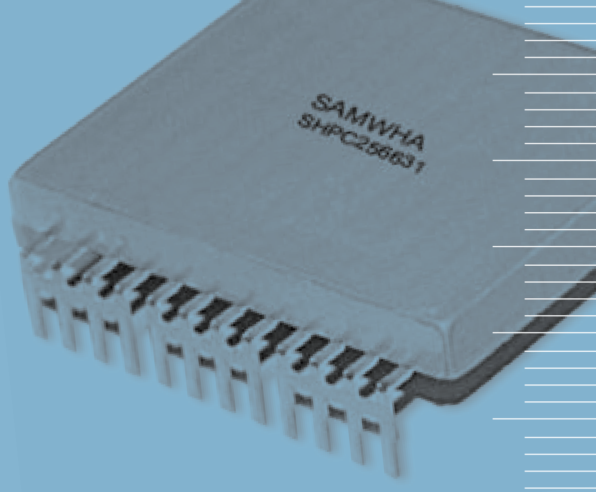

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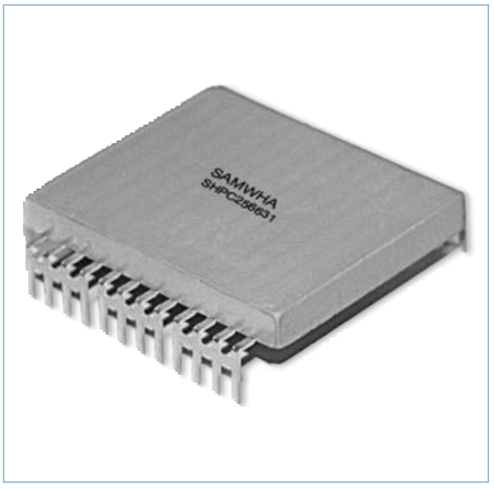
PEA (Power Electronic Applications)



SAMWHA PEA series uses the most advanced ceramic technology for long life, high reliability in DC link applications. Their high voltage and high current ratings allow for replacement of series-parallel banks of ceramic capacitors in high ripple current.

Features

- Higher permissive ripple current capabilities,
- High voltage and large capacitance,
- The capacitors enable downsizing & high temperature operating solutions
- lower ESR and ESL
- Surface mountable, lead free termination, leads, re-flow soldering compatibility and high resistance to thermal cycling

Applications

- High current application
- Inverters : Power Supplies and Motor Drives
- Industrial : Welders, Motor Drives, Elevators

Type Designation

LS	400390	L	406	K	451	B
(1)	(2)	(3)	(4)	(5)	(6)	(7)

1) Series Name : CS : Leadless type
LS : Lead type

2) Size Code : This is expressed in tens of a millimeter.
The first three digits are the length, The last three digits are width.

3) Characteristic Type : G : General
L : Low-Loss & High capacitance
H : High Power & High Frequency

4) Capacitance Code (pF) :
The nominal Capacitance Value in pF is expressed by three digit numbers.
The first two digits represents significant figures and the last digit denotes the number of zero.
ex) 104 = 100000pF

5) Capacitance Tolerance Code

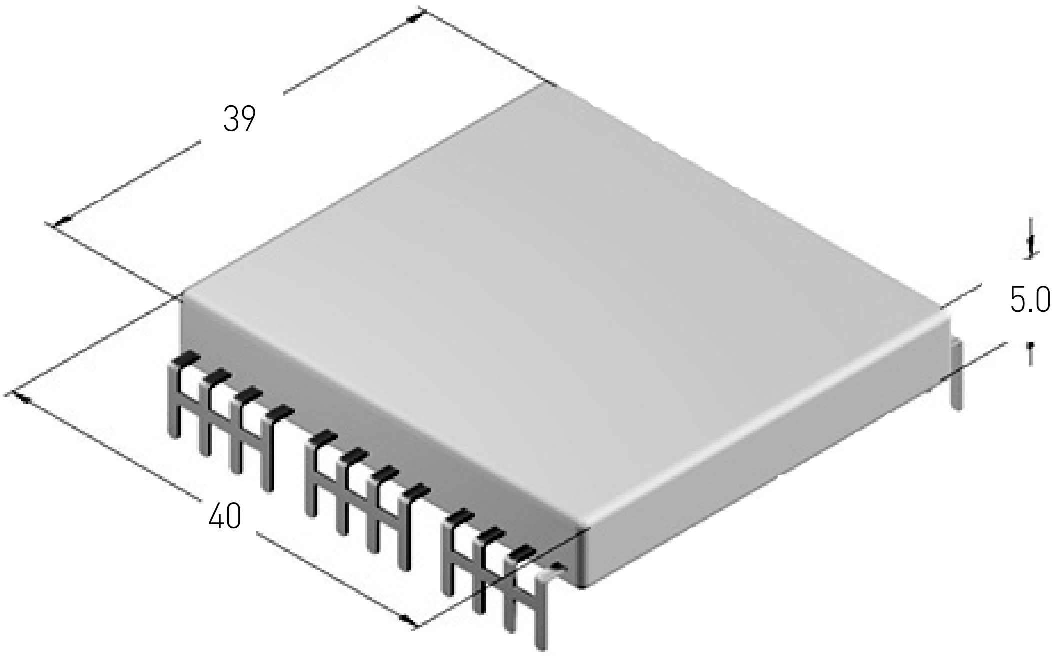
Code	Tolerance
B	± 0.1pF
C	± 0.25pF
D	± 0.5pF
F	± 1.0%
G	± 2.0%
J	± 5%
K	± 10%
M	± 20%

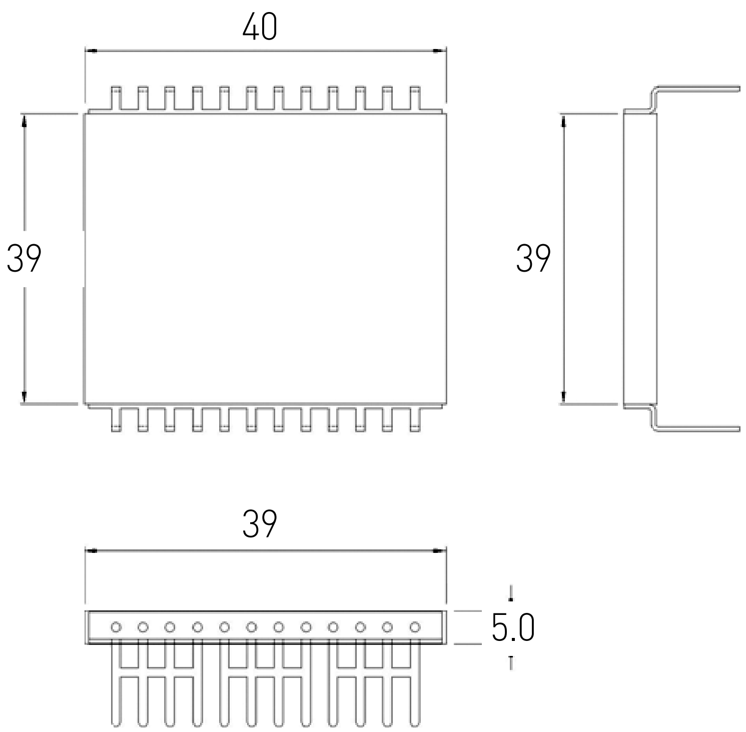
6) Voltage Code
The first two digits represents significant figures and the last digit denotes the number of zero.
ex) 451 : 45 X 10^1 = 450

7) Packing Code
ex) R: Reel Type B: Bulk Type

Specifications

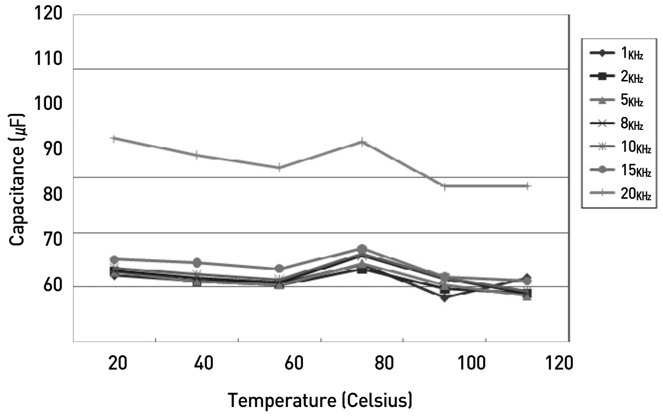
Capacitance	30㎌
Tolerance	±10%
Rated Voltage	250Vdc ~ 630Vdc
Operating Temperature Range With Ripple	-55℃ to +105℃
Allowable ripple current	15A (r.m.s.) at 20kHz
Dielectric withstanding voltage	750V
Effective capacitance	12uF at DC 400V



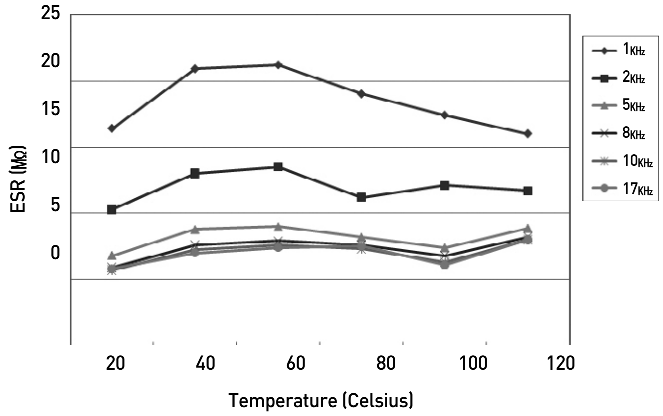


Electrical Characteristics Data

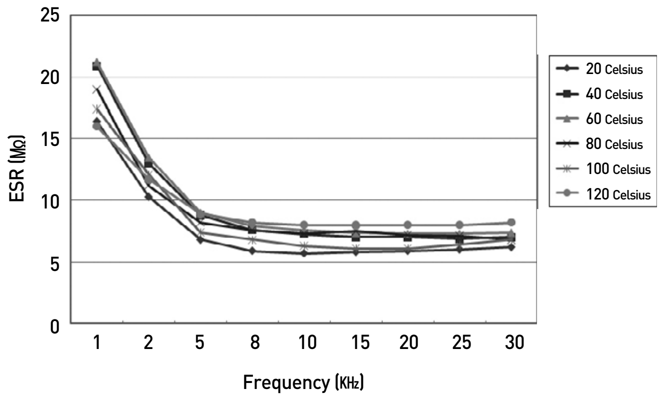
PEA capacitor 70μF Capacitance vs Temperature



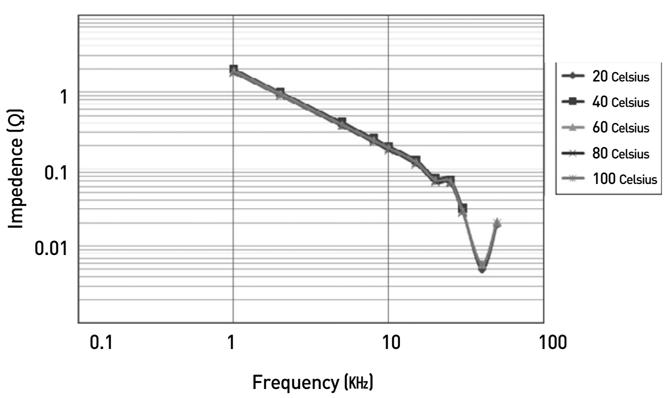
PEA capacitor 70μF ESR vs Temperature



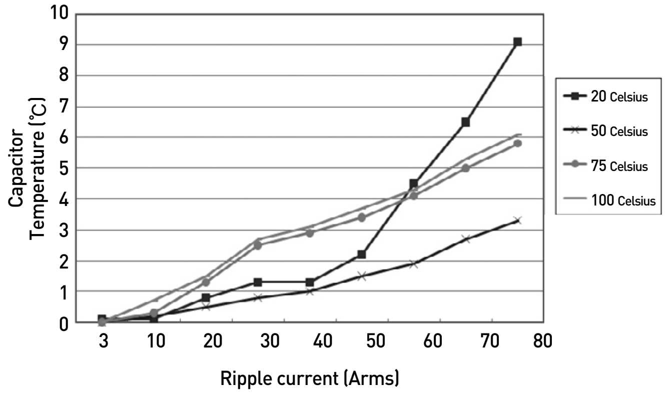
PEA capacitor 70μF ESR vs Frequency



PEA capacitor 70μF Impedence vs Frequency



Ripple Test : PEA capacitor 560μF Module



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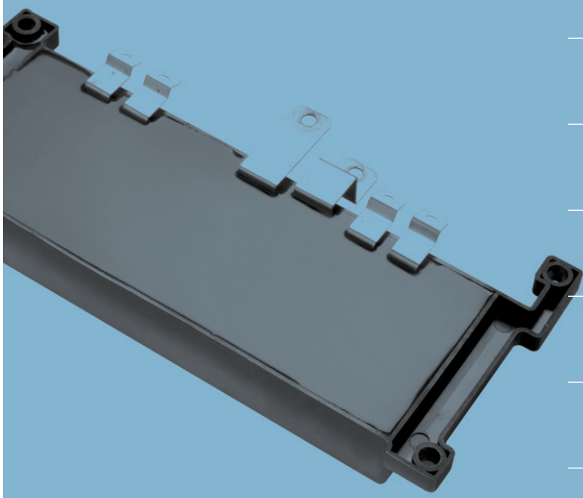


HEV DC link Capacitor

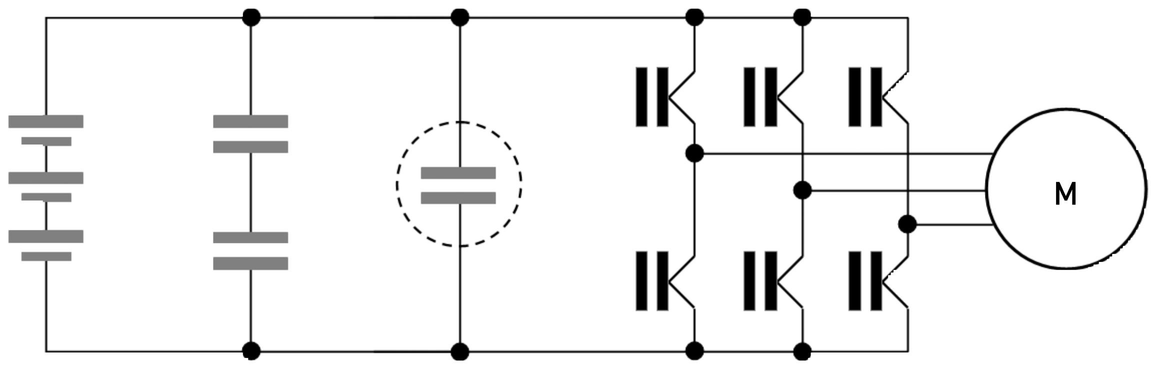
HEV DC link Capacitor

Features

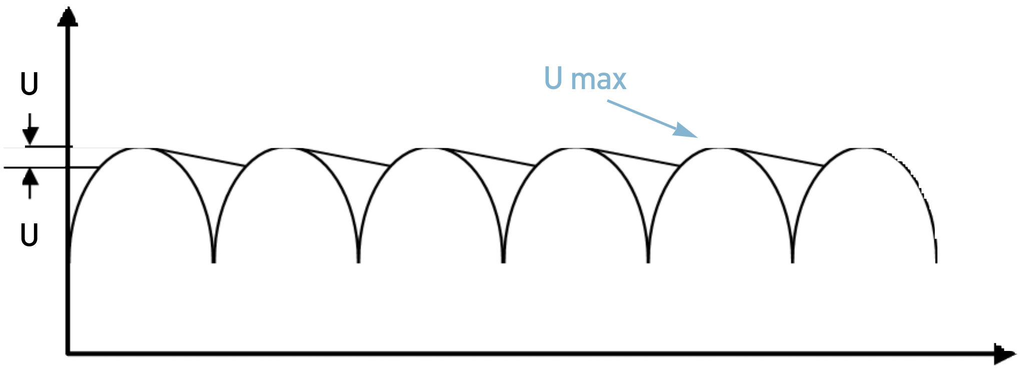
The HEV series uses a metalized poly-propylene dielectric, which features a controlled self-healing process, and treated to have a very dielectric strength in operating conditions up to 105℃.
The HEV designed to withstand high ripple current, there is low-level series inductance (Ls).

Application

- battery powered car, hybrid electric vehicle, Etc.
- electric folk-lift truck,



DC link Capacitor



Type Designation

HEV	601V	105	K
(1)	(2)	(3)	(4)

1) Series Name

2) Rated Voltage:

The first two digits represents significant figures and the last digit denotes the number of zero.

ex) 601V : 60 X 10^1 = 600V

3) Capacitance Code (pF @1kHz, 1volt):

The first two digits represents significant figures and the last digit denotes the number of zero.

ex) 105 = 10 X 10^5 [pF] = 1[μF]

4) Capacitance Tolerance Code

Code	Tolerance
B	± 0.1pF
C	± 0.25pF
D	± 0.5pF
F	± 1.0%
G	± 2.0%
J	± 5%
K	± 10%
M	± 20%

Specifications

Operation Temperature	-40℃ ~ +105℃
Capacitance Range	200㎌ ~ 2000㎌
Capacitance Tolerance	±10%
Rated DC Voltage	300V ~ 2000V
ESR	Below 10mΩ
Test voltage between terminal @25℃	1.5 x Vn DC x 10s
Test voltage case - terminal @25℃	7kV rms x 60s

Appearance

The case appearance is variable. Classifies with two kind of the case appearance that is a cylinder- type and a box-type.
The shape and count of electrode is various, that is determined by customer.
Figure 1. is an representative exterior of HEV series.
Before ordering consult with head-office certainly about exterior.
Case material is two kinds. One is plastics, and other is metal.

· Plastics case : Self-extinguishing plastic case (V0 = in accordance with UL 94) filled thermosetting resin.
· Metal case : Metal case filled thermosetting resin.

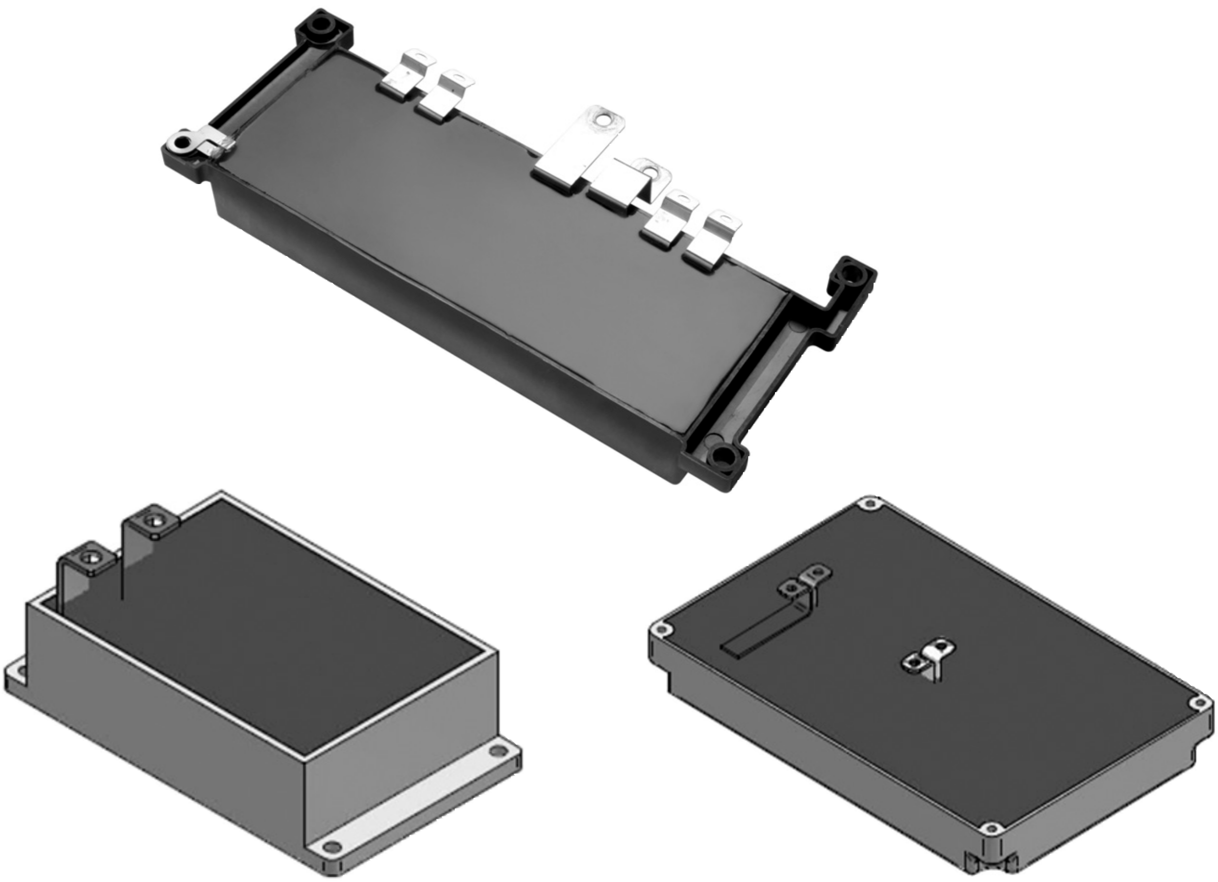


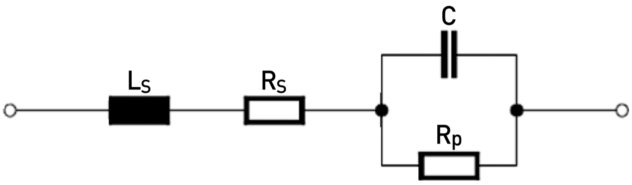
Figure 1. an representative exterior of HEV series.

General technical report

Electrical characteristics

1) Equivalent circuit diagram

Real capacitor can be modeled.



L_S	Series inductance
R_S	Series resistance, due to contacts (leads, sprayed metal and film metallization)
R_P	Parallel resistance, due to insulation resistance
C	Capacitance

In DC, RP is a magnitude defined (Insualtion Resistance)
In AC, C, RS and LS are magnitudes that vary in the frequency domain

Equivalent circuit diagram

2) Capacitance

A. Rated Capacitance

Rated capacitance is measured under standard conditions to IEC 60068-1.

Measuring conditions	Standard conditions	Referee conditions
Temperature	15 ~ 35℃	(23 ± 5) ℃
Relative humidity	45 ~ 75 %	(50 ± 2) %
Ambient atmospheric. pressure	86 ~ 106 kPa	86 ~ 106 kPa
Frequency	1 kHz	1 kHz
Voltage	0.03 x VR (max. 5V)	0.03 x VR (max. 5V)

B. Variation of capacitance with temperature.

Within a range of temperatures between the upper and lower category temperatures, capacitance changes.
The gradient of the capacitance/ temperature curve is given by the temperature coefficient of the capacitance.
This is defined as next equations.
The temperature coefficient of the capacitance is almost -250 [10^-6/K]

$$Temperature\_cofficient = \frac{C_2 \quad C_1}{C_3 \times (T_2 \quad T_1)}$$

C1	Capacitance measured at temperature T1
C2	Capacitance measured at temperature T2
C3	Reference capacitance measured at (25±5)℃

C. Variation of capacitance with humidity.

The PP-film capacitor will undergo a reversible change of value in relation to any change in the ambient humidity. Depending on the type of capacitor design, both the dielectric and the effective air gap between the films will react to changes in the ambient humidity, which will thus affect the measured capacitance.
The humidity coefficient is defined as the relative capacitance change determined for a 1% change in humidity (at constant temperature). The humidity coefficient of PP-film is from 40 to 100 [10^-6 /%R.H]

$$Humidity\_cofficient = \frac{2 \times (C_2 \quad C_1)}{(C_2 + C_1)(F_2 \quad F_1)}$$

C1	Capacitance at relative humidity F1
C2	Capacitance at relative humidity F2

D. Variation of capacitance with frequency

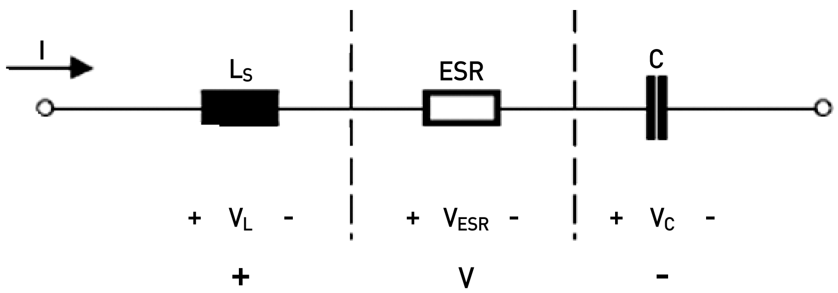
In the vicinity of the natural resonant frequency of the capacitors, self-inductance leads to an additional decrease of impedance. This has the same effect as an increase in capacitance.

E. Variation of capacitance with time

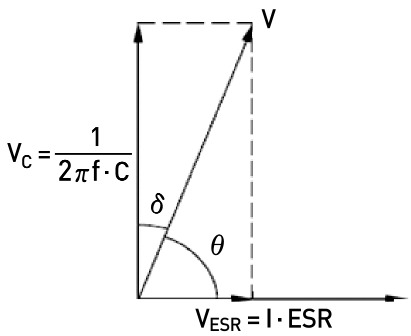
In addition to the changes described, the capacitance of a capacitor is also subjected to irreversible changes known as change rate = △C/C□. The values stated for capacitance drift (see table below) are maximum values and refer to a two-year period and a temperature up to 40℃. Here the reversible effects of temperature changes (bc) and changes in relative humidity (ac) are not taken into consideration. Approximately variational rate of capacitance with time is 3%.

3) ESR and dissipation factor

Under an AC voltage signal of specified frequency, the equivalent circuit diagram can be simplified to a series connection of the capacitance C, an equivalent series resistance (ESR) and the series inductance Ls.



Equivalent series circuit diagram



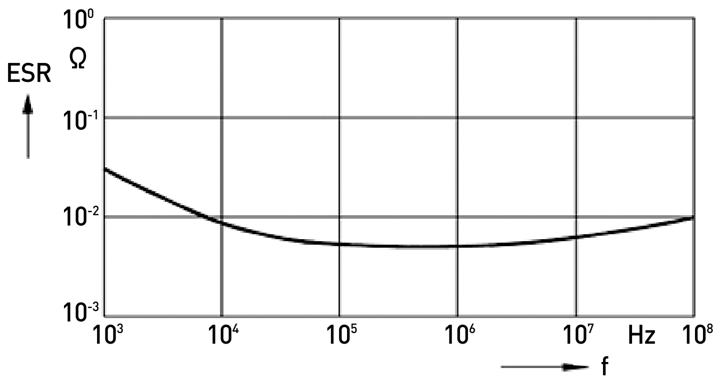
Impedance diagram

In AC source, capacitor generated loss. This is called to dissipation Factor ratio, expressed with 'tan δ'.
The followed equation calculated with capacitor ESR loss.

$$\tan\delta = ESR \times 2\pi f \times C$$

Power loss calculated

$$P = \frac{V^2_{ESR}}{ESR} = ESR \times I^2$$



ESR vs Frequency

Both ESR and tan d are important because they dictate the power dissipation of a capacitor and thus its self-heating.
ESR depends in frequency.

4) Self - Inductance

The self-inductance or series inductance Ls of a film capacitor is due to the magnetic field created by the current in the film metallization and the connections. It is thus determined by the winding structure, the geometric design and the length and thickness of the contact paths. As far as possible, all capacitors described in this data book are constructed with low-inductance bifilar electrode current paths or extended-foil contacts, and thus feature very low inductance. A general rule for deducing Ls states that the maximum value is 1nH per mm of lead length and capacitor length. Ls can also be calculated from the resonant frequency.

5) Impedance, resonant frequency

The impedance Z represent the component's opposition to current flow and is both resistive and reactive in nature. It is thus of particular importance in AC and ripple current filtering.

From the capacitor model in figure 5, Z is defined as the magnitude of the vector's sum of ESR and the total reactance (inductive reactance minus capacitive reactance) :

$$Z = \sqrt{ESR^2 + (2\pi f L_S - \frac{1}{2\pi f C})^2}$$

At low frequencies, the capacitive reactance $X_c = 1 / (2\pi f \cdot C)$ prevails, whereas at very high frequencies the inductive reactance $X_L = (2\pi f \cdot L_s)$ is dominant. When capacitive reactance equals inductive reactance, natural resonance occurs. At this point the reactance cancel each other out and impedance equals ESR. The natural resonant frequency is therefore given by :

$$f_{resonant} = \frac{1}{2\pi \sqrt{C \cdot L_S}}$$

Definitions

C	Rated Capacitance
Ur	Rated (repetitive peak) voltage
Urms	Rated rms ripple voltage = 0.1 x UN max (max 150 Vrms)
Us	Surge (not repetitive) peak voltage
Ui	rms value of the AC voltage for which the terminal to case insulation has been designed and tested
Imax	Maximum rms current value for continuous operation
Clearance	shortest distance in air between terminals conducting parts or between terminal and case
Creepage	shortest distance along an insulated surface between terminals conducting parts or between terminal and case
Q	Reactive power = 2 x π x f x C x Urms^2
F	Fundamental frequency
Rs	Series resistance representing the sum of all ohmic resistancesin the capacitor
ESR	Equivalent Series Resistance defined asESR = RS+ tan δ0 / (2 x π x f x C)
tan δ0	Dielectric dissipation factor. It can be considered constant in the normal working frequency range. Typical value for polypropylene is 2 x 10-4
tan δ	Dissipation factor calculated as follows tan δ0 + 2 x π x f x C x RS.
dv/dt	Maximum slope of the voltage waveform
IPK	Peak current IPK = C dV/dt.
P	Active power (losses) = Q x δ0 + RS x Irms^2
Rth	Thermal resistance between the hot-spot in the winding and the environment(natural cooling), so that: P = (θh - θ0) / Rth In case of forced air cooling the thermal resistance will be reduced of 20%.
θhot	Hottest point in the capacitor winding = Rth x P+θ0
θoper	Operating ambient temperature. It is the air temperature measured under steady conditions at 0,1m from the capacitor case.
Ln	Expected life at rated voltage UN and hot-spot temperature
L	Expected life at the actual working conditions
LS	Self inductance of the capacitor. It is due to the internal connections, terminals, winding characteristics and physical dimensions.
λ	Failure rate (FIT) = 109 x failures/component x hour

※ According to IEC 61071

Inquiry Form

In case of custom design, or for any special request/question, please complete the following form.

Company Name

Contact Person

Tele-phone / Fax / E-mail

Application

Electrical characteristics

	value	unit	note (condition, time, etc.)
Capacitance			
Rated Capacitance		μF	
Capacitance tolerance		%	
Voltage			
Rated DC Voltage (Un)		V	
Rated AC Voltage (Urms)		V	
Superimposed ripple voltage (Ur)		Vpp	
Frequency of ripple voltage (fr)		Hz	
Maximum recurrent peak volatge		V	
Maximum surge volatge (Us)		V	
Voltage raise of rise (dv/dt)		V/μs	
Current			
Rated rms current		A	
Maximum rms current @ θMAX (Imax)		A	
Maximum surge current (Is)		kA	
Operation data			
Maximum permissible inductance		nH	
Maximum series resistance (Rs)		mΩ	
Maximum tan δ (10e-4) @ 60Hz			
Min. Operating Temperature (θmin)		℃	
Max.Operating Temperature (θmax)		℃	
Storage Temp. min/max		℃	
Forced cooling		m/s	
Type of installation			
Expected life time		Hours	
Mechinical Requirements			
Maximun dimension (W x L x H)		mm	
Flash over distance		mm	
Creepage distance		mm	
Terminals			
Further requirements			
Quantity		pcs/year	
Start of delivery			

* Please, attach circuits schematics or mechincal scematic.

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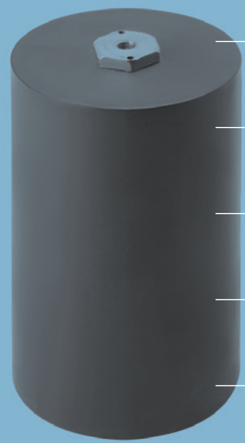
SAMWHA Energy Saving

Products Guide



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RNE (Renwable Energy Capacitor)

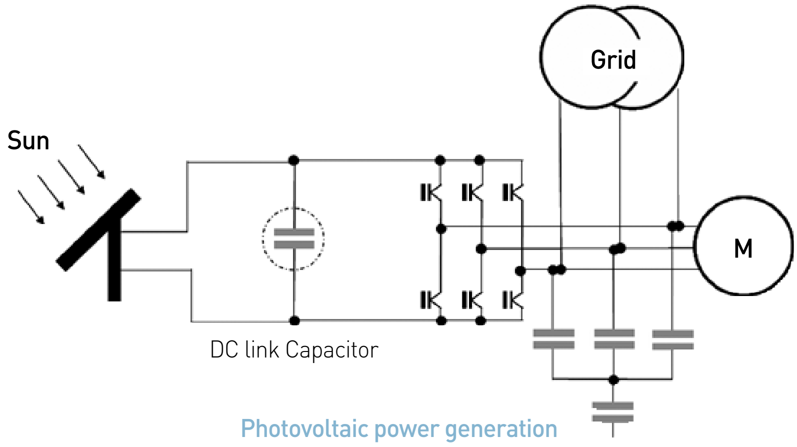
RNE (Renewable Energy Capacitor)

Features

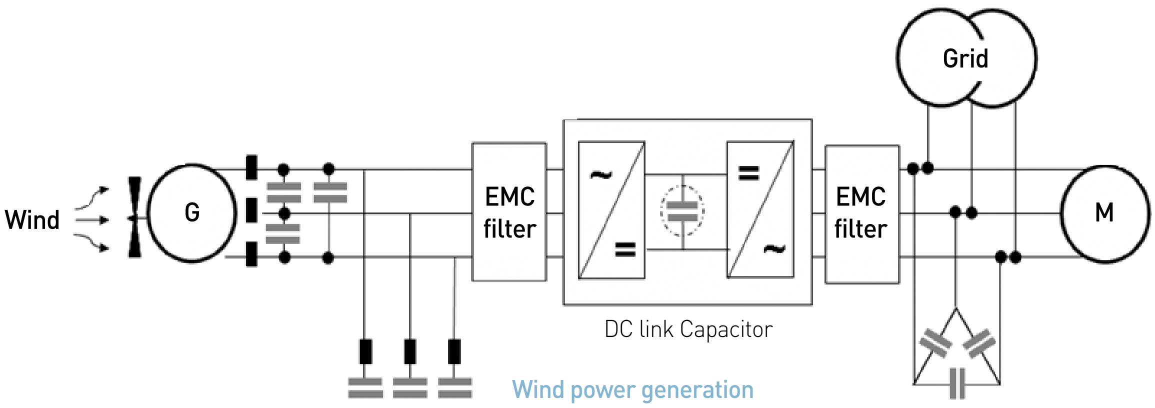
We have consequently supplied numerous solutions to customer applications in the sectors of environmentally friendly power generation and renewable sources of energy. These have involved not only EMC components but also power capacitors. This is the film capacitor in the process of developing will be used that power generation and renewable sources of energy (Solar & Wind). They will be able to apply in the inverter systems of above 100kw.
It will be produced with the shape which is various.

Application

· photovoltaic power generation
· wind power generation



Photovoltaic power generation



Wind power generation

Type Designation

RNE	601V	105	K
(1)	(2)	(3)	(4)

1) Series Name

2) Rated Voltage :

The first two digits represents significant figures and the last digit denotes the number of zero.

ex) 601V : 60 X 10^1 = 600V

3) Capacitance Code (pF @1kHz, 1volt) :

The first two digits represents significant figures and the last digit denotes the number of zero.

ex) 105 = 10 X 10^5 [pF] = 1[μF]

4) Capacitance Tolerance Code

Code	Tolerance
B	± 0.1pF
C	± 0.25pF
D	± 0.5pF
F	± 1.0%
G	± 2.0%
J	± 5%
K	± 10%
M	± 20%

Specifications

Operation Temperature	-40℃ ~ +105℃
Capacitance Range	2μF ~ 3000μF
Capacitance Tolerance	±5%, ±10%, ±20%
Rated DC Voltage	500V ~ 3000V
ESR	Below 10mΩ
Test voltage between terminal @25℃	2.15 x Vn DC x 10s
Test voltage case - terminal @25℃	6kV AC x 10s

Appearance

The case appearance is variable. Classifies with two kind of the case appearance that is a cylinder- type and a box-type. The shape and count of electrode is various, that is determined by customer.
Figure 1. is an representative exterior of RNE series.
Before ordering consult with head-office certainly about exterior. Case material is two kinds. One is plastics, and other is metal.

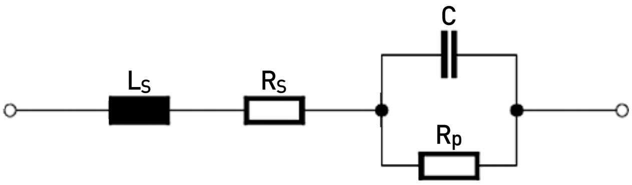
Figure 1. an representative exterior of RNE series.

General technical report

Electrical characteristics

1) Equivalent circuit diagram

Real capacitor can be modeled.



L_S	Series inductance
R_S	Series resistance, due to contacts (leads, sprayed metal and film metallization)
R_P	Parallel resistance, due to insulation resistance
C	Capacitance

In DC, RP is a magnitude defined (Insualtion Resistance)
In AC, C, RS and LS are magnitudes that vary in the frequency domain

Equivalent circuit diagram

2) Capacitance

A. Rated Capacitance

Rated capacitance is measured under standard conditions to IEC 60068-1.

Measuring conditions	Standard conditions	Referee conditions
Temperature	15 ~ 35℃	(23 ± 5)℃
Relative humidity	45 ~ 75 %	(50 ± 2)%
Ambient atmospheric. pressure	86 ~ 106 kPa	86 ~ 106 kPa
Frequency	1 kHz	1 kHz
Voltage	0.03 x VR (max. 5V)	0.03 x VR (max. 5V)

B. Variation of capacitance with temperature.

Within a range of temperatures between the upper and lower category temperatures, capacitance changes.
The gradient of the capacitance/temperature curve is given by the temperature coefficient of the capacitance.
This is defined as next equations.
The temperature coefficient of the capacitance is almost -250 [10^-6/K]

$$Temperature\_cofficient = \frac{C_2 \quad C_1}{C_3 \times (T_2 \quad T_1)}$$

C1	Capacitance measured at temperature T1
C2	Capacitance measured at temperature T2
C3	Reference capacitance measured at (25±5)℃

C. Variation of capacitance with humidity.

The PP-film capacitor will undergo a reversible change of value in relation to any change in the ambient humidity. Depending on the type of capacitor design, both the dielectric and the effective air gap between the films will react to changes in the ambient humidity, which will thus affect the measured capacitance.
The humidity coefficient is defined as the relative capacitance change determined for a 1% change in humidity (at constant temperature). The humidity coefficient of PP-film is from 40 to 100 [10^-6 /%R.H]

$$Humidity\_cofficient = \frac{2 \times (C_2 \quad C_1)}{(C_2 + C_1)(F_2 \quad F_1)}$$

C1	Capacitance at relative humidity F1
C2	Capacitance at relative humidity F2

D. Variation of capacitance with frequency

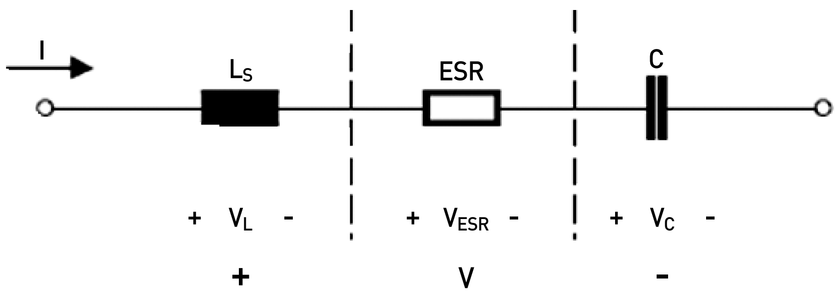
In the vicinity of the natural resonant frequency of the capacitors, self-inductance leads to an additional decrease of impedance. This has the same effect as an increase in capacitance.

E. Variation of capacitance with time

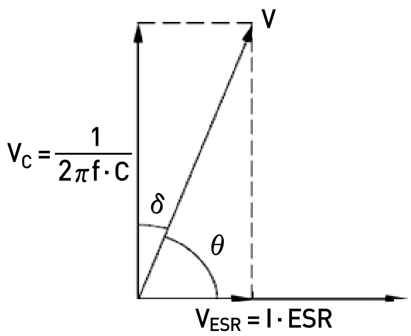
In addition to the changes described, the capacitance of a capacitor is also subjected to irreversible changes known as change rate = △C/C□. The values stated for capacitance drift (see table below) are maximum values and refer to a two-year period and a temperature up to 40℃. Here the reversible effects of temperature changes (bc) and changes in relative humidity (ac) are not taken into consideration. Approximately variational rate of capacitance with time is 3%.

3) ESR and dissipation factor

Under an AC voltage signal of specified frequency, the equivalent circuit diagram can be simplified to a series connection of the capacitance C, an equivalent series resistance (ESR) and the series inductance Ls.



Equivalent series circuit diagram



Impedance diagram

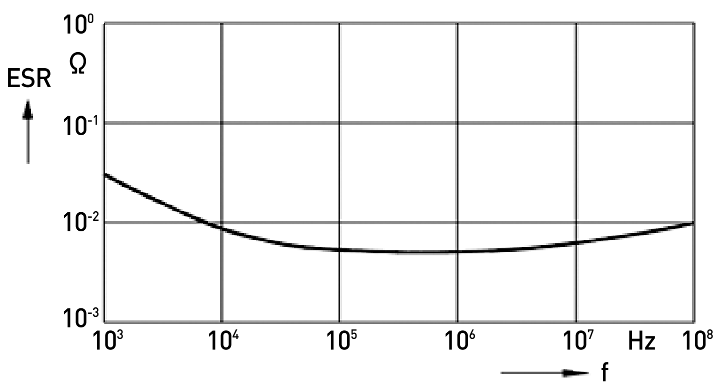
In AC source, capacitor generated loss. This is called to dissipation Factor ratio, expressed with 'tan δ'.
The followed equation calculated with capacitor ESR loss.

$$\tan\delta = ESR \times 2\pi f \times C$$

Power loss calculated

$$P = \frac{V^2_{ESR}}{ESR} = ESR \times I^2$$

Both ESR and tan d are important because they dictate the power dissipation of a capacitor and thus its self-heating.
ESR depends in frequency.



ESR vs Frequency

4) Self - Inductance

The self-inductance or series inductance Ls of a film capacitor is due to the magnetic field created by the current in the film metallization and the connections. It is thus determined by the winding structure, the geometric design and the length and thickness of the contact paths. As far as possible, all capacitors described in this data book are constructed with low-inductance bifilar electrode current paths or extended-foil contacts, and thus feature very low inductance. A general rule for deducing Ls states that the maximum value is 1nH per mm of lead length and capacitor length. Ls can also be calculated from the resonant frequency.

5) Impedance, resonant frequency

The impedance Z represent the component's opposition to current flow and is both resistive and reactive in nature. It is thus of particular importance in AC and ripple current filtering.
From the capacitor model in figure 5, Z is defined as the magnitude of the vector's sum of ESR and the total reactance (inductive reactance minus capacitive reactance) :

$$Z = \sqrt{ESR^2 + (2\pi f L_S - \frac{1}{2\pi f C})^2}$$

At low frequencies, the capacitive reactance $Xc = 1/(2\pi f \cdot C)$ prevails, whereas at very high frequencies the inductive reactance $XL = (2\pi f \cdot Ls)$ is dominant. When capacitive reactance equals inductive reactance, natural resonance occurs. At this point the reactance cancel each other out and impedance equals ESR. The natural resonant frequency is therefore given by :

$$f_{resonant} = \frac{1}{2\pi\sqrt{C \cdot L_S}}$$

Definitions

C	Rated Capacitance
Ur	Rated (repetitive peak) voltage
Urms	Rated rms ripple voltage = 0.1 x UN max (max 150 Vrms)
Us	Surge (not repetitive) peak voltage
Ui	rms value of the AC voltage for which the terminal to case insulation has been designed and tested
Imax	Maximum rms current value for continuous operation
Clearance	shortest distance in air between terminals conducting parts or between terminal and case
Creepage	shortest distance along an insulated surface between terminals conducting parts or between terminal and case
Q	Reactive power = 2 x π x f x C x Urms^2
F	Fundamental frequency
Rs	Series resistance representing the sum of all ohmic resistancesin the capacitor
ESR	Equivalent Series Resistance defined asESR = RS+ tan δ0 / (2 x π x f x C)
tan δ0	Dielectric dissipation factor. It can be considered constant in the normal working frequency range. Typical value for polypropylene is 2 x 10-4
tan δ	Dissipation factor calculated as follows tan δ0 + 2 x π x f x C x RS.
dv/dt	Maximum slope of the voltage waveform
IPK	Peak current IPK = C dV/dt.
P	Active power (losses) = Q x δ0 + RS x Irms^2
Rth	Thermal resistance between the hot-spot in the winding and the environment(natural cooling), so that: P = (θh - θ0) / Rth In case of forced air cooling the thermal resistance will be reduced of 20%.
θhot	Hottest point in the capacitor winding = Rth x P+θ0
θoper	Operating ambient temperature. It is the air temperature measured under steady conditions at 0,1m from the capacitor case.
Ln	Expected life at rated voltage UN and hot-spot temperature
L	Expected life at the actual working conditions
LS	Self inductance of the capacitor. It is due to the internal connections, terminals, winding characteristics and physical dimensions.
λ	Failure rate (FIT) = 109 x failures/component x hour

※ According to IEC 61071

Inquiry Form

In case of custom design, or for any special request / question, please complete the following form.

Company Name

Contact Person

Tele-phone / Fax / E-mail

Application

Electrical characteristics

	value	unit	note (condition, time, etc.)
Capacitance			
Rated Capacitance		μF	
Capacitance tolerance		%	
Voltage			
Rated DC Voltage (Un)		V	
Rated AC Voltage (Urms)		V	
Superimposed ripple voltage (Ur)		Vpp	
Frequency of ripple voltage (fr)		Hz	
Maximum recurrent peak volatge		V	
Maximum surge volatge (Us)		V	
Voltage raise of rise (dv/dt)		V/μs	
Current			
Rated rms current		A	
Maximum rms current @ θMAX (Imax)		A	
Maximum surge current (Is)		kA	
Operation data			
Maximum permissible inductance		nH	
Maximum series resistance (Rs)		mΩ	
Maximum tan δ (10e-4) @ 60Hz			
Min. Operating Temperature (θmin)		℃	
Max.Operating Temperature (θmax)		℃	
Storage Temp. min/max		℃	
Forced cooling		m/s	
Type of installation			
Expected life time		Hours	
Mechinical Requirements			
Maximun dimension (W x L x H)		mm	
Flash over distance		mm	
Creepage distance		mm	
Terminals			
Further requirements			
Quantity		pcs/year	
Start of delivery			

* Please, attach circuits schematics or mechincal scematic.

MEMO

Passion for Challenges

SAMWHA Energy Saving
Products Guide

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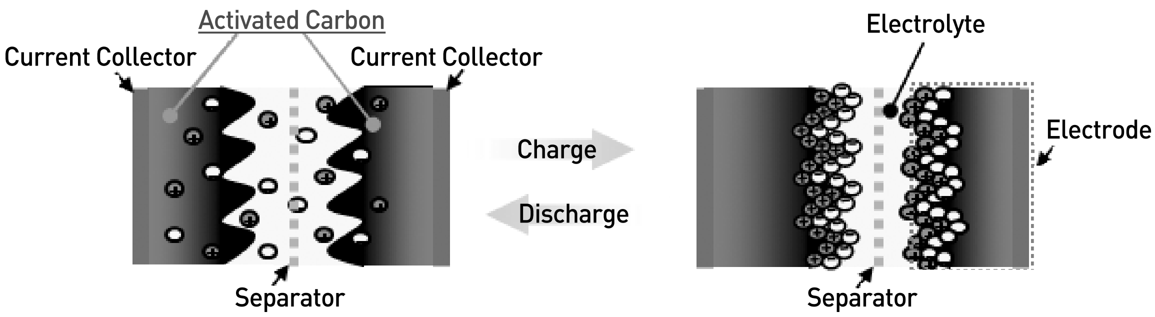
Green-Cap

Green-Cap (Electric Double Layer Capacitor)

Electric double layer capacitor(EDLC) is a next-generation energy storage device. In recent years, there has been much exploration of new uses for EDLC, and it is expected that they will become even more commonly used in the future.

What is electrical double layer capacitor (EDLC)?

A conventional capacitors have a dielectric sandwiched between two opposing electrodes. An aluminum electrolytic capacitor, as an example, uses an aluminum oxide film as a dielectric. However, EDLC does not have a dielectric. EDLC uses the electric double layer to function as the dielectric of activated carbon, therefore EDLC does not use a chemical reaction such as a redox reaction but rather store electricity by means of the physical adsorption of ions to the large specific surface area of activated carbon. EDLC consists of environmentally friendly active carbon and an organic solvent, whereas a conventional battery is made from heavy metals such as lead. EDLC does not harm the environment.



Electric Double Layer Capacitor Principle

Features

1 Stable charge and discharge cycle

Life is not affected by charging/ dischargecycles because there is no chemical reaction

2 The advantages of EDLCs over rechargeable batteries

· Very safe, No risk of explosion or ignition
· Environmentally-friendly, with no heavy metals used
· Rapid charging and discharging (at heavy current)
· Long cycle life, charging / discharging tens of thousands of times
· Wide range of temperatures, operation even at low temperatures
· Recycling is unnecessary (required for batteries)

3 Character of Energy storage Devices

Section		EDLC (Electric Double Layer Capacitor)	Ni-MH (Nickel metal hydride battery)	LiB (Li-ion secondary battery)
Voltage (Operating range)		2.5 (2.5 ~ 0)	1.2 (1.4 ~ 0.9)	3.7 (4.2 ~ 3.0)
Operating Temperature Range		-25 ~ 70℃	Charge : 0~45℃ Discharge : -10~65℃	Charge : 0~45℃ Discharge : -20~60℃
High Temperature Spec.	Test Condition	Max. Operating temp. and Max. Operating Voltage hold	Cycle life by Temperature	Max. Operating temp. and Max. Operating Voltage hold
	Guarantee Condition	1000 hrs	0~20℃ : 500 cycle 45℃ : 250 cycle	168hrs (after 3 cycle)
Electrolyte	Solvent	PC (Propylene carbonate)	1000 hrs	EC(Ethylene carbonate)
	Salt	TEABF4 (Tetraethylammonium tetrafluorobotate)	KOH (Potassium hydroxide)	LiPF6 (Lithium hexafluorophosphate)
Dangerous		None	Corrosiveness(Electrolyte)	Firing, Explosion (Degradation phenomenon)
Permissible Current (A)		Cap.(Farad)×0.1	Cap.(mAh)×0.0005	Cap.(mAh)×0.0001
Eco-friendly		Very good	Good	Bad (Li, Cobalt)

Application Guidelines

1. Polarity

Be sure verity the polarity of the capacitor before use. If a reverse voltage is applied for a long time, capacitor lifetime is shortened and serious damage such as electrolyte leakage may occur.
Further more,there may be leftover electric charge from capacitor testing that could damage other circuit components such as the low-withstanding voltage parts of semiconductors, etc.

2. Voltage

If a EDLC is used at a voltage exceeding its rated voltage, not only is its life shortened, but depending on the actual voltage, gas generated by electrochemical reactions inside the capacitor may cause it to leak or rupture.

3. Ambient Temperature

(1) Capacitor life is affected by operating temperature. In general, lowering ambient temperature by 10℃ will double the life of a capacitor. Use the capacitor at the lowest possible temperature under the maximum guaranteed temperature.
(2) Operation above the maximum specified temperature not only shortens capacitor life, but can also cause serious damage such as electrolyte leakage. Verify the operating temperature of the capacitor by taking into consideration not only the ambient temperature and temperature inside the unit, but also the radiation from heat generating elements inside the unit(power transistors, IC's, resistors, etc.) and self-heating due to ripple current. Be careful not to place heat-generating elements across from the capacitor on the opposite of the PCB.

4. Ripple Current

Green-Cap have a higher internal resistance than do electrolytic capacitors and are more susceptible to internal heat generation when exposed to ripple current. When the temperature of the element rises, a reacting current flows inside the Green-Cap, generating reaction products and raising internal resistance even further. This makes it difficult to maintain capacitance. Set the allowable limit for the ripple current-induced rise in capacitor temperature to 3℃ measured at the surface of the capacitor.

5. Heat Stress During Soldering

Excessive heat stress may result in the deterioration of the electrical characteristics of the capacitor, loss of air-tightness, and electrolyte leakage due to the rise in internal pressure.
(1) If the tip of the soldering iron touches the capacitor's external sleeve, the sleeve will melt or break.
(2) Use the general reference chart bellow to set soldering temperature and time.
(3) When soldering with a soldering iron, do not touch the tip to the body of the capacitor.
Minimize the time that soldering iron is in contact with the capacitor terminals.
(4) When using equipment such as a UV curing oven for pre-heating and adhesive hardening, do not set the temperature above 150℃. If the temperature is higher than this, the external sleeve may crack and the end seal may suffer reduced erformance.
(5) Never perform reflow soldering on EDLC using infrared or atmospheric methods.

6. Circuit Board Cleaning

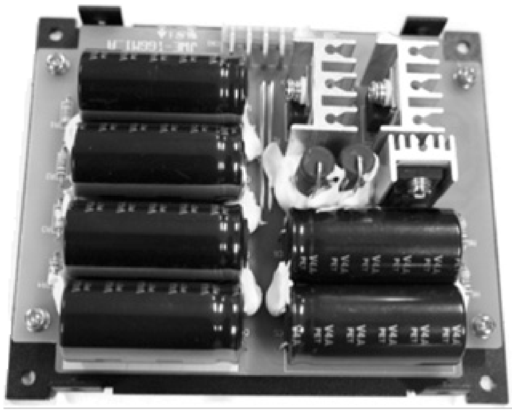
Circuit board can be immersed or ultrasonically cleaned using suitable cleaning solvents for up to 5 minutes and up to 60℃ maximum temperature. The board should be thoroughly rinsed and dried. Recommended cleaning solvent include. Pine Alpha ST-100S, Sunelec B-12, DK beclear CW-5790, Aqua Cleaner 210SEP, Cold Cleaner P3-375, Telpen Cleaner EC 7R, Clean-thru 750H, Clean-thru 750L Clean-thru 710M, Techno Cleaner 219, Techno Care FRV-1.

・Consult with us if you are using a solvent other than any of those listed above
・The use of ozone depelting cleaning agents are not recommended in the interest of protecting the environment

Module Application

▶ Power Solution 〉〉 Voltage DIP/SAG

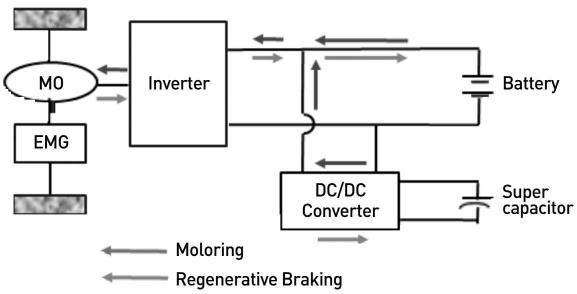
Instantaneous power compensation of precise devices



Part Number	Module Spec	Structure	Operating Temperature	Dimension (mm)
DM01620083WSS001	16.2V 8.3F	2.7V 50F 6EA Series	-25 ~ +60℃	220 X 170 X 180

▶ Transportation 〉〉 Regenerative Braking System (Car)

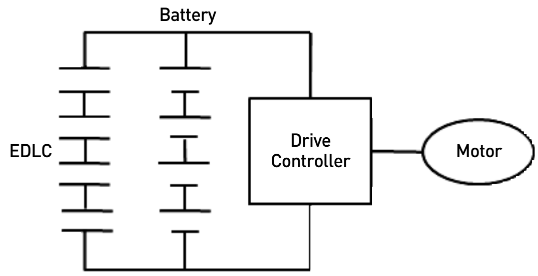
Auxiliary power for the regenerative braking of cars



Part Number	Module Spec	Structure	Operating Temperature	Dimension (mm)
DM04501500WSS001	45V 150F	2.7V 2700F 18EA Series	-25 ~ +60℃	388 X 171 X 176

▶ Power Solution 〉〉 Auxiliary power for battery

Battery cycle life extension & Power Quality improvement by EDLC module



Part Number	Module Spec	Structure	Operating Temperature	Dimension (mm)
DM01502500WSS001	15V 250F	2.7V 1500F 6EA Series	-25 ~ +60℃	205 X 113 X 176

▶ Transportation 〉〉 Regenerative Braking System (Scooter)

Auxiliary power for the regenerative bracking of cars

Part Number	Module Spec	Structure	Operating Temperature	Dimension (mm)
DM05750087WSS001	57.5V 8.7F	2.7V 200F 23EA Series	-25 ~ +60℃	200 X 140 X 52

Type Designation

▶ Single Cell

DP	0E	107	M	10	020	XX	XXX
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

1) Series Name

DP	Screw type, High power density
DE	Screw type, High energy density
DB	Snap-in type, Standard series
DS	Lead type, The small size and high capacitance

2) Rated Working Voltage

WV	2.5	2.7	3
Code	0E	5U	0U

3) Capacitance Code

ex) 1F 105
10F 106
100F 107
1000F 108

4) Capacitance Tolerance Code

Tolerance (%)	± 20
Code	M

5) Case Diameter

ex) Φ10 10
Φ16 16
Φ18 18

6) Case Height

ex) 20mm 020
25mm 025
30mm 030

▶ Module

DM	0135	0016	W	01	010	XX
(1)	(2)	(3)	(4)	(5)	(6)	(7)

1) Series Name

DM	Green-Cap Module

2) Rated Working Voltage

ex) 5.0V 0050
13.5V 0135
135V 1350

3) Capacitance Code

ex) 1.6F 0016
16F 0160
160F 1600

4) Capacitance Tolerance Code

Tolerance (%)	0 ~ +20
Code	W

5) Revision Number

ex) 01, 02

6) Single Cell Number in Module

ex) 10ea 010

DM Green-Cap Module

Features

- Low internal resistance
- Balancing and overvoltage protection of individual cell
- Efficient heat transfer to outside
- Compliant with RoHS requirement

Application

- Next Generation Vehicle(FCEV,HEV) & Heavy Duty Transportation
- Short term UPS and telecommunications
- Portable Power Tool
- Wind Turbine Pitch System
- Electric Scooter
- Golf Car

Specifications

Item	Characteristics	
Capacitance tolerance	0% ~ +20% at 20℃	
Operating temperature range	-40 ~ 60℃	
Storage Temperature Range	-40 ~ 70℃	
Low Temperature Characteristics	Capacitance Change	Within ±5% of initial value at +20℃
	Internal Resistance	Within 150% of initial value at +20℃
Endurance(60℃)	Test Time	1000 hours
	Capacitance Change	Within ±30% of initial specified value
	Internal Resistance	Within 100% of initial specified value
Shelf Life(60℃)	After 1000 hours no load test same as endurance	
Life Time at RT(1)	10 years	(1) |△C|<30% and△ESR<200% of initially specified value, respectively and LC<specified value
Cycle Life (25℃)[1][2]	500,000 cycles	(2) Cycle : between rated vlotage and half rated voltage under constant current at 25℃

Part Number	Rated Voltage	Capacitance (F)	ESR, 1KHz (mΩ)	ESR, DC (mΩ)	Max. Continuous current (A)	Max. Peak Current (A)	Stored Energy (wh)	Specific Energy (wh/kg)	Dimension (mm)			Weight (kg)
									L	M	T	
DM00500015W01002	5	1.5	110	143	0.2	3.1	0.005	1.47	23	10	18	0.0034
DM00500025W01002	5	2.5	53	69	0.3	5.3	0.009	1.80	23	12	22	0.005
DM01500666W01006	15	66.6	18	30	20	167	2.43	4.05	117	81	80	0.6
DM01502883W01006	15	288.3	9	10	85	571	10.33	3.03	205	113	176	5
DM02501700W01010	25	170	15	16	85	571	17.21	2.06	263	108	198	8.2
DM04501666W01018	45	166.6	14,5	18	150	938	54.68	3.90	446	195	198	14
DM10000025W01040	100	2.5	400	520	5	54	4.05	4.70	200	140	52	0.86
DM35000214W01140	350	21.4	112	140	150	938	425.20	2.83	1,000	684	230	150

Note : Other Green-Cap modules are supplied on custom-made basis. Dimension and Weight could be changed

DP Screw Terminal Type, High Power Density Type

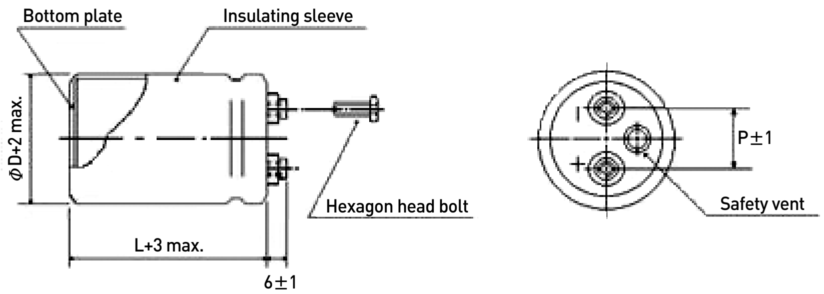
Features

- High Power Density
- Rapid charge and discharge
- Charge and discharge efficiency are higher than in batteries

Specifications

Item	Characteristics	
Operating temperature range	-40 ~ +60℃	
Rated voltage	2.7 VDC	
Capacitance tolerance	- 20 ~ + 20 % or 0% ~ 20% at 20℃	
Low temperature characteristics	Capacitance change	Within ±5% of initial value at +20℃
	Internal resistance	Within 150% of initial value at +20℃
Endurance (60℃)	Test time	1000 hours
	Capacitance change	Within ±30% of the initial value
	Internal resistance	Less than 100% of initial at specified value
Shelf life (60℃)	After 1000 hours no load test same as endurance	
Life Time at RT[1]	10 years	(1) I△CI<30% and△ESR<200% of initially specified value, respectively and LC<specified value
Cycle Life (25℃)[1][2]	500,000 cycles	(2) Cycle : between rated vlotage and half rated voltage under constant current at 25℃

Angle Drawing & Size Table



Unit : mm

ΦD	P	Bolt
35	12.7	M5
51	22	M5
63.5	28.6	M6

Characteristic List & Dimensions

Rated Voltage	Capacitance	ESR, 1KHz (mΩ)	ESR,DC (mΩ)	L/C (72hr) (mA)	Specific Energy		Weight (g)	Volume (mℓ)	Dimension ΦD×L(mm)
					(Wh/kg)	(Wh/L)			
2.7	400	3.0	5.0	1.08	5.79	6.19	70	65	35×68
	700	2.5	4.5	1.89	6.01	4.14	120	115	35×120
	1,700	1.5	1.6	4.59	6.62	6.48	260	266	51×130
	3,000	0.8	1.0	8.10	7.02	7.38	435	412	63.5×130

DE Screw Terminal Type, High Power Density Type

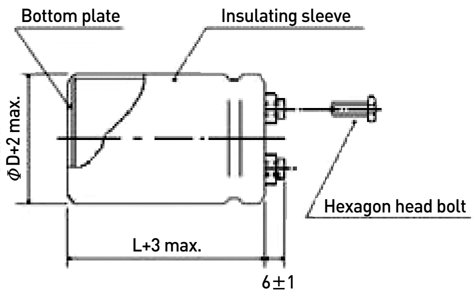
Features

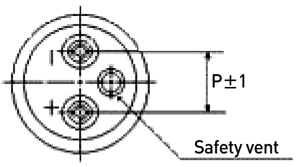
- High Energy Density
- Suitable for electric power storage
- Charge and discharge efficiency are higher than in batteries

Specifications

Item	Characteristics	
Operating temperature range	-40 ~ +60℃	
Rated voltage	2.5 VDC	
Capacitance tolerance	- 20 ~ + 20 % or 0% ~ 20% at 20℃	
Low temperature characteristics	Capacitance change	Within ±5% of initial value at +20℃
	Internal resistance	Within 150% of initial value at +20℃
Endurance (60℃)	Test time	1000 hours
	Capacitance change	Within ±30% of the initial value
	Internal resistance	Less than 100% of initial at specified value
Shelf life (60℃)	After 1000 hours no load test same as endurance	
Life Time at RT[1]	10 years	(1) l△Cl<30% and△ESR<200% of initially specified value, respectively and LC<specified value
Cycle Life (25℃)[1][2]	500,000 cycles	(2) Cycle : between rated vlotage and half rated voltage under constant current at 25℃

Angle Drawing & Size Table





Unit : mm

ΦD	P	Bolt
35	12.7	M5
51	22	M5
63.5	28.6	M6
76.2	31.8	M6
89	31.8	M6

Characteristic List & Dimensions

Rated Voltage	Capacitance	ESR, 1KHz (mΩ)	ESR,DC (mΩ)	L/C (72hr) (mA)	Specific Energy (Wh/kg)	Specific Energy (Wh/L)	Weight (g)	Volume (mℓ)	Dimension ΦD×L(mm)
2.5	700	4.0	7.0	1.75	5.96	6.32	102	96	35×100
	1,400	2.0	2.2	3.5	6.17	5.95	197	204	51×100
	3,000	1.0	1.3	7.5	6.51	6.85	400	380	63.5×120
	5,000	0.8	1.0	12.5	6.89	6.34	630	684	76.2×150
	6,500	0.7	0.9	16.25	6.52	6.05	866	933	89.0×150

DB Snap-in Terminal Type, Standard Series

Features

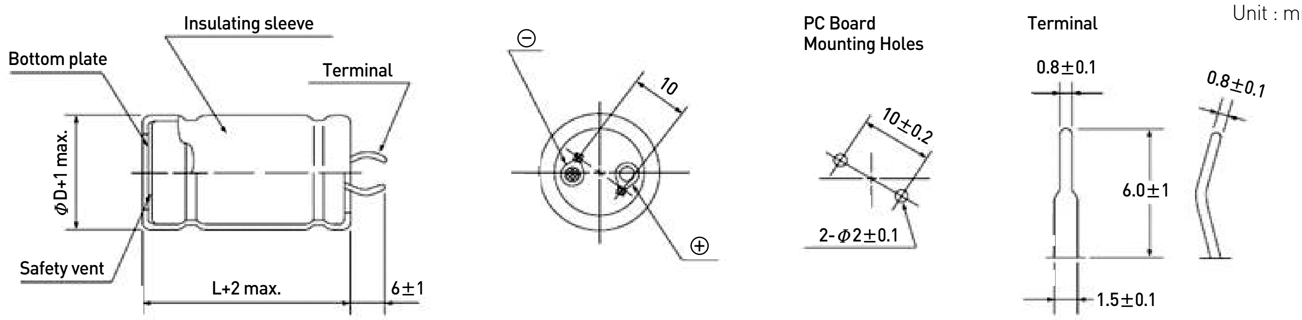
- Endurance : 2.5V 70℃ 1000hours, 2.7V 60℃ 1000hours
- The middle size and high capacitance, low resistance
- Charge and discharge efficiency are higher than in batteries

Specifications

Item	Characteristics		
Operating temperature range	-25 ~ +70℃		-40 ~ +60℃
Rated voltage	2.5 VDC		2.7 VDC
Capacitance tolerance	- 20 ~ + 20 % or 0% ~ +20% at 20℃		
Low temperature characteristics	Capacitance change	Within ±30% of initial value at +20℃	
	Internal resistance	Within 150% of initial value at +20℃	
Endurance (2.5V:70℃, 2.7V:60℃)	Test time	1000 hours	
	Capacitance change	Within ±30% of the initial value	
	Internal resistance	Less than 100% of initial at specified value	
Shelf life (2.5V:70℃, 2.7V:60℃)	After 1000 hours no load test same as endurance		
Life Time at RT[1]	10 years	(1) l△Cl〈30% and△ESR〈200% of initially specified value, respectively and LC〈specified value	
Cycle Life (25℃)[1][2]	500,000 cycles	(2) Cycle : between rated vlotage and half rated voltage under constant current at 25℃	

Angle Drawing & Size Table

Unit : mm

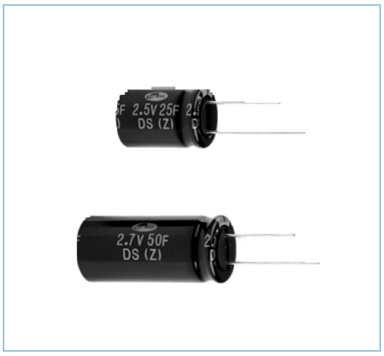


Characteristic List & Dimensions

Rated Voltage	Capacitance (F)	ESR, 1KHz (mΩ)	ESR,DC (mΩ)	L/C (72hr) (mA Max.)	Specific Energy (Wh/kg)	Specific Energy (Wh/L)	Weight (g)	Volume (㎖)	Dimension ΦD×L(㎜)
2.5	100	15	35	0.25	4.11	5.07	21	17	22×45
	200	10	20	0.5	4.54	5.46	38	32	30×45
	300	6	15	0.7	4.49	5.41	58	48	35×50
	360	6	12	0.9	4.81	5.41	65	58	35×60
	400	6	10	1	4.96	6.01	70	58	35×60
2.7	100	10	13	0.27	5.5	5.92	18	17	22×45
	200	8	9	0.54	6.03	6.37	34	32	30×45
	300	3.5	5	0.81	5.73	6.31	53	48	35×50
	360	3.5	5	0.97	6.08	6.31	60	58	35×60
	400	3.5	5	1.06	6.23	7.02	65	58	35×60

※ Φ35 4pin Type Terminal Drawing is same See pages 140

DS Radial Type, Standard Series



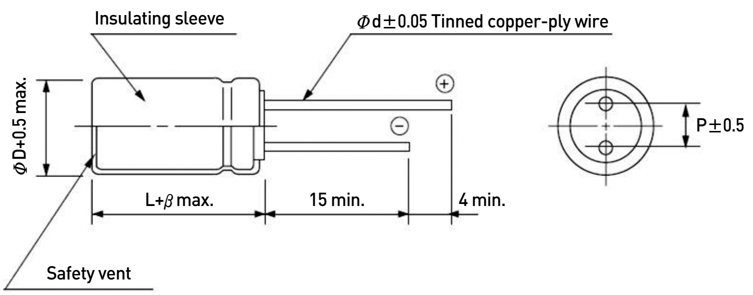
Features

- Endurance : 2.5V 70℃1000hours, 2.7V 60℃ 1000hours
- The small size and high capacitance, low resistance
- Can be charge and discharged more times than secondary batteries

Specifications

Item	Characteristics		
Operating temperature range	-25 ~ +70℃	-40 ~ +60℃	
Rated voltage	2.5 VDC	2.7 VDC	
Capacitance tolerance	- 20 ~ + 20 % or 0% ~ +20% at 20℃		
Low temperature characteristics	Capacitance change	Within ±30% of initial value at +20℃	
	Internal resistance	Within 150% of initial value at +20℃	
Endurance (2.5V:70℃, 2.7V:60℃)	Test time	1000 hours	
	Capacitance change	Within ±30% of the initial value	
	Internal resistance	Less than 100% of initial at specified value	
Shelf life (2.5V:70℃, 2.7V:60℃)	After 1000 hours no load test same as endurance		
Life Time at RT[1]	10 years	(1) l△Cl(30% and△ESR(200% of initially specified value, respectively and LC(specified value	
Cycle Life (25℃)[1][2]	500,000 cycles	(2) Cycle : between rated vlotage and half rated voltage under constant current at 25℃	

Angle Drawing & Size Table



Unit : mm

ΦD	8	10	16	18
P	3.5	5	7.5	7.5
Φd	0.6	0.6	0.8	0.8
β	1.5		2	

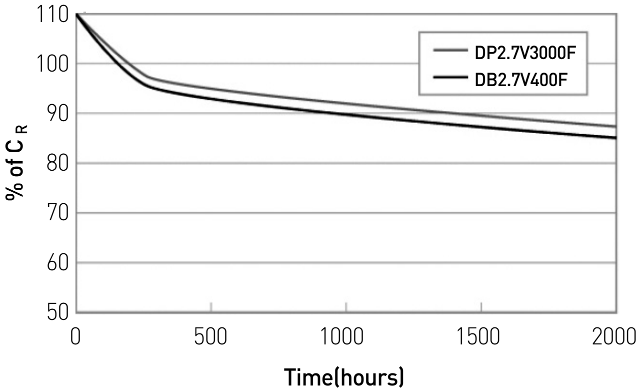
Characteristic List & Dimensions

Rated Voltage	Capacitance (F)	ESR, 1KHz (mΩ)	ESR,DC (mΩ)	L/C (72hr) (mA Max.)	Specific Energy		Specific Power		Weight (g)	Volume (㎖)	Dimension ΦD×L(㎜)
					(Wh/kg)	(Wh/L)	(Wh/kg)	(Wh/L)			
2.5	3	140	350	0.008	1.63	2.59	13.39	2,132	1.6	1.0	8×20
	5	110	250	0.013	1.97	2.76	1,364	1,910	2.2	1.6	10×20
	10	65	120	0.025	2.48	3.68	1,786	2,653	3.5	2.4	10×30
	25	35	65	0.063	2.89	4.32	1,538	2,296	7.5	5.0	16×25
	60	20	30	0.15	3.77	5.12	1,812	2,456	13.8	10.2	18×40
2.7	3	60	90	0.008	2.17	3.02	6,943	9,669	1.4	1.0	8×20
	5	45	70	0.014	2.41	3.22	5,951	7,956	2.1	1.6	10×20
	10	30	50	0.027	3.49	4.30	6,033	7,426	2.9	2.4	10×30
	25	20	35	0.068	3.78	5.04	3,730	4,972	6.7	5.0	16×25
	50	15	20	0.14	4.40	4.97	3,803	4.297	11.5	10.2	18×40

Technical Data

Chart 1

▶ Load Life Test(60℃)



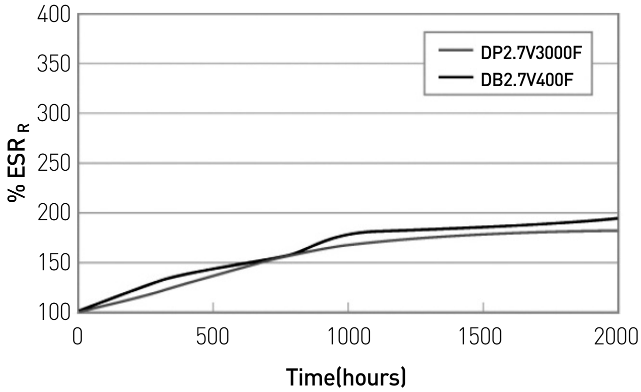
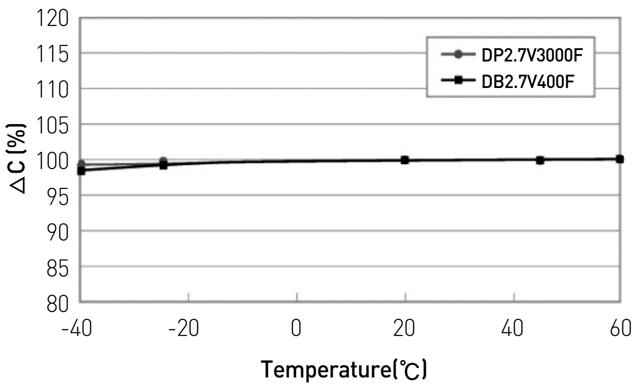


Chart 2

▶ Environment Test(Temperature Effect)



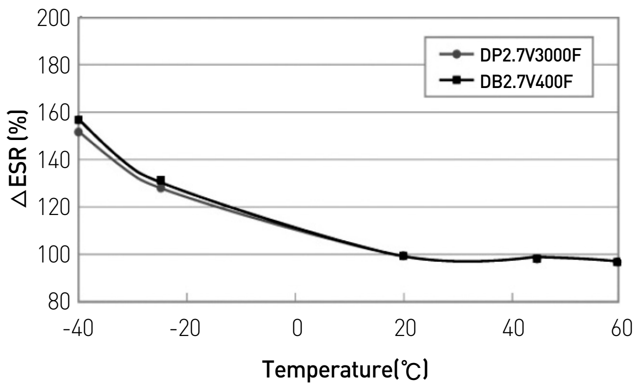
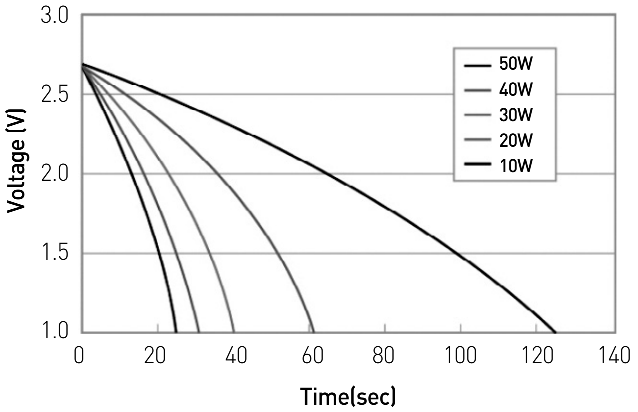
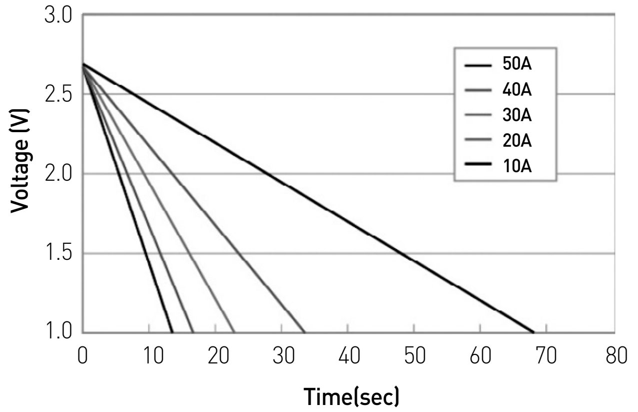


Chart 3

▶ Voltage Profile ▶ DB 2.7V400F



Voltage Profile with Const. Power Discharge

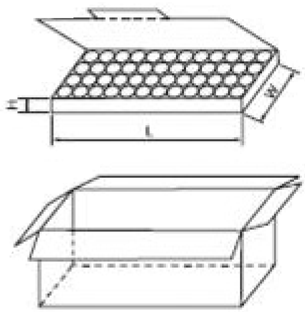


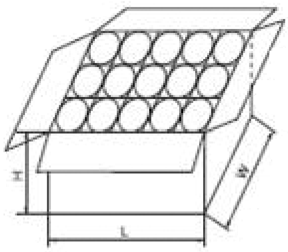
Voltage Profile with Const. Current Discharge

Packing

Bulk Type Packing

Figure 1	Figure 2
SNAP-IN Type Inner, Middle Box	SCREW Type Box





▶ SNAP-IN Type(DB, DH series) Packing Quantity(pcs) / Box(Figure 1)

Size		SNAP-IN(Quantity)	
ΦD	L	Inner Box	Middle Box
22	35, 45	150	450
30	45	50	200
	60	50	150
35	50~60	50	150

▶ SCREW Type(DE, DP series) Packing Quantity(pcs) / Box(Figure 2)

Size		SCREW (Quantity)
ΦD	L	
35	68~120	60
51	100, 130	30
64	120, 130	25
76	150	16

Radial Type Packing

▶ DS series Bulk Packing Quantity(pcs) / Box

Size		Bulk (Quantity)		
ΦD	L	V-Bag	Inner Box	Middle Box
8	20	300	2,400	9,600
10	20	200	1,600	6,400
	30	200	1,200	4,800
16	25	50	500	2,000
18	40	50	300	1,200

Passion for Challenges

SAMWHA Energy Saving
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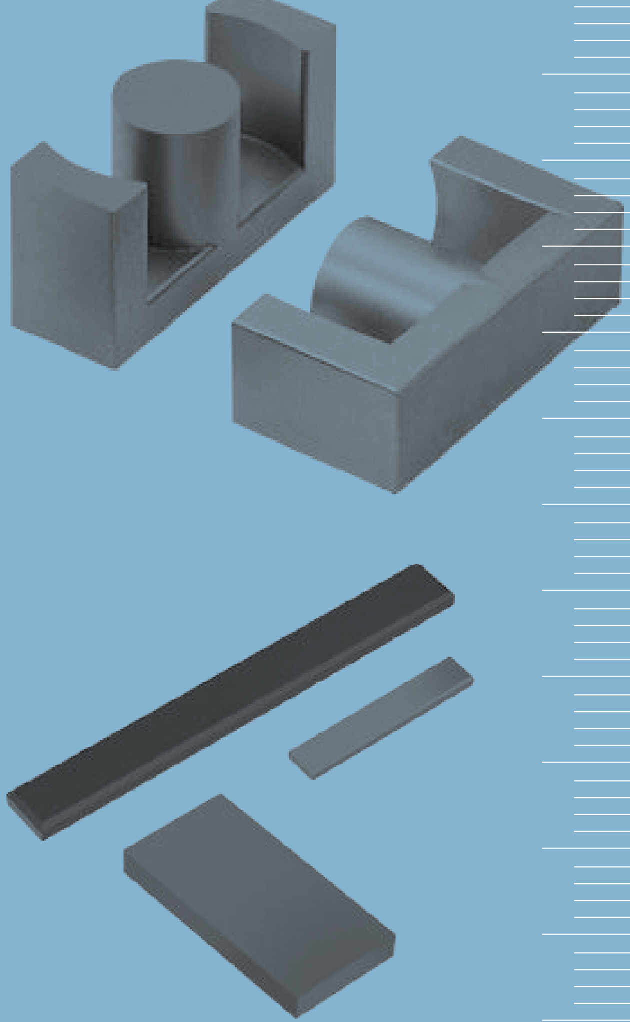


Ferrite Cores

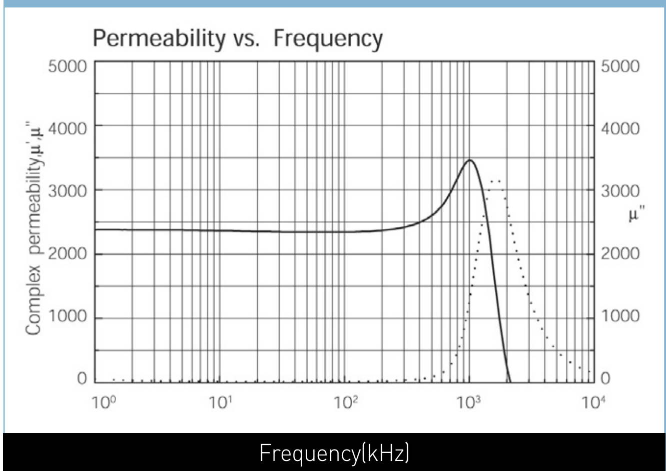
Material Characteristics

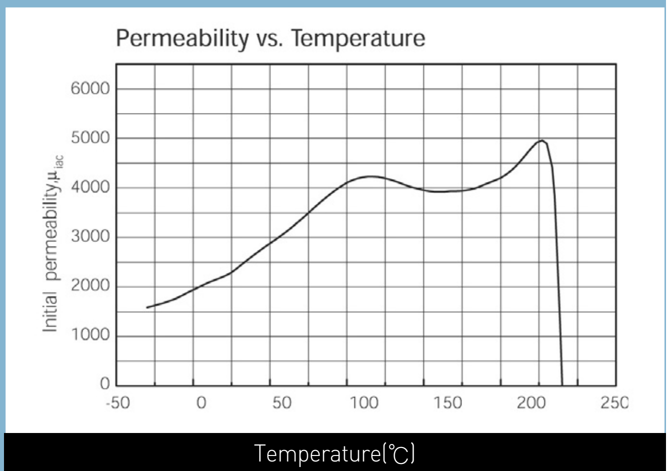
Power Material

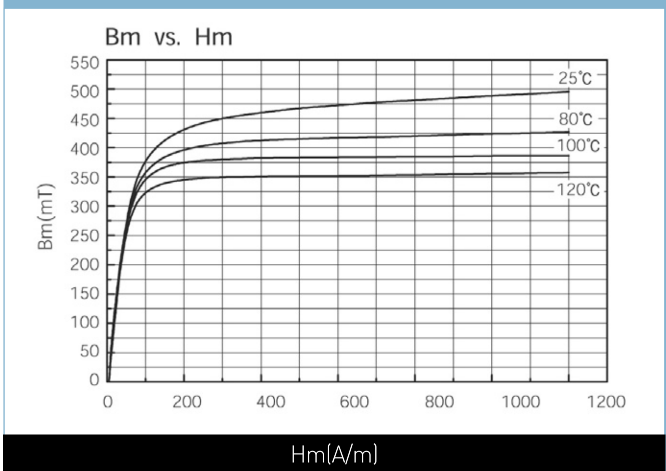
Material				PL-7
Initial permeability	μ_{iac}			2,400±25%
Core loss(100kHz, 200mT)	Pcv	kW/m³	25℃	650
			80℃	450
			100℃	410
			120℃	500
Saturation flux density(1194A/m)	Bs	mT	25℃	490
			100℃	390
Remanence	Br	mT	25℃	150
Coercivity	Hc	A/m	25℃	12
Curie temperature	Tc	℃		〉220
Density	d	kg/m³		4.85×10^3
Resistivity	ρ	Ω m	25℃	〉5.0

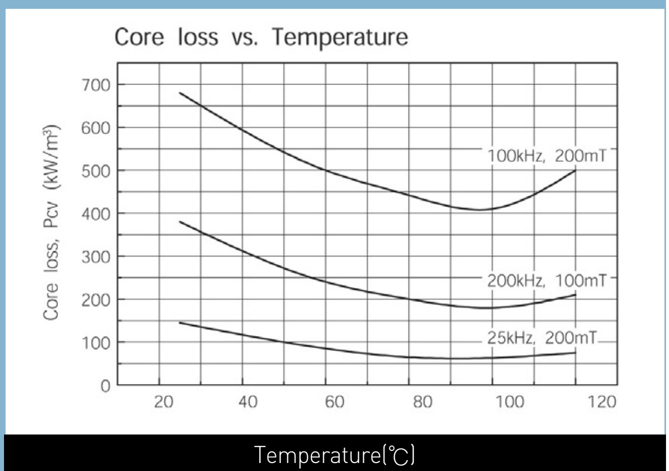
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise







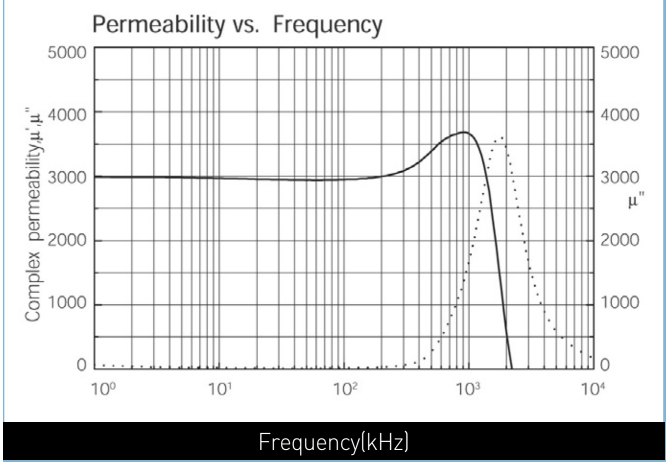


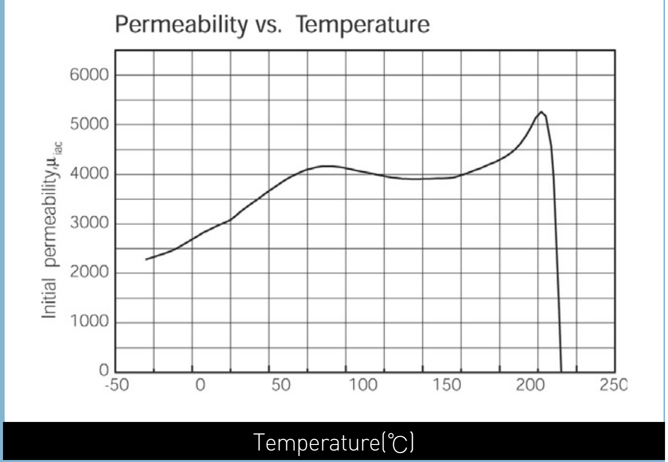
Power Material

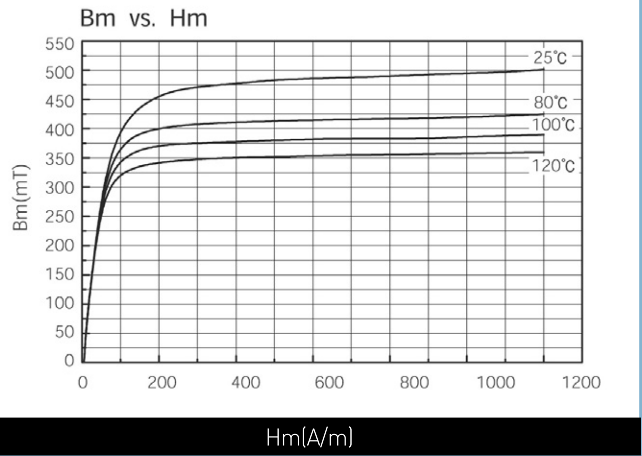
Material				PL-9
Initial permeability	μ_{iac}			3,000±25%
Core loss(100kHz, 200mT)	Pcv	kW/m³	25℃	450
			80℃	350
			100℃	390
			120℃	450
Saturation flux density(1194A/m)	Bs	mT	25℃	500
			100℃	390
Remanence	Br	mT	25℃	80
Coercivity	Hc	A/m	25℃	10
Curie temperature	Tc	℃		〉220
Density	d	kg/m³		4.85×10³
Resistivity	ρ	Ω m	25℃	〉7.0

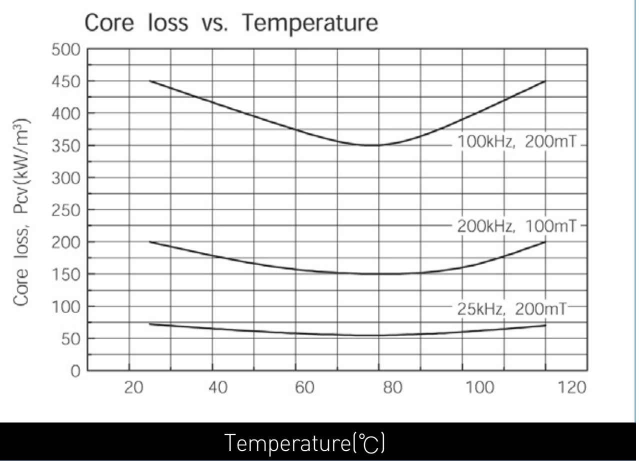
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise







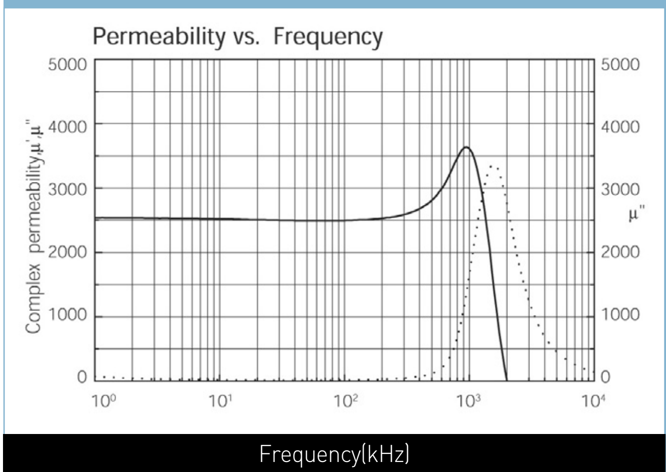


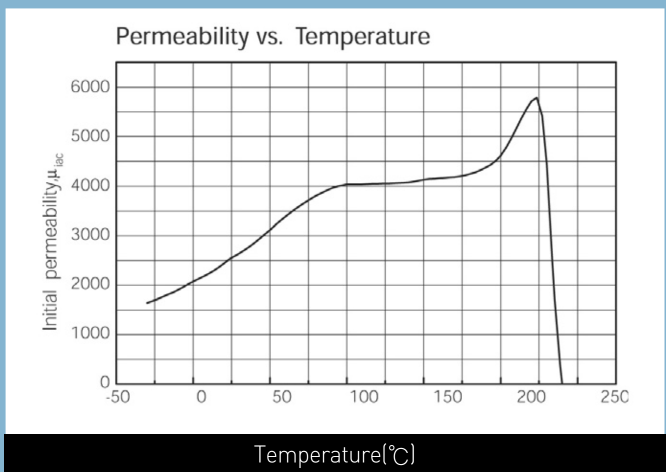
Power Material

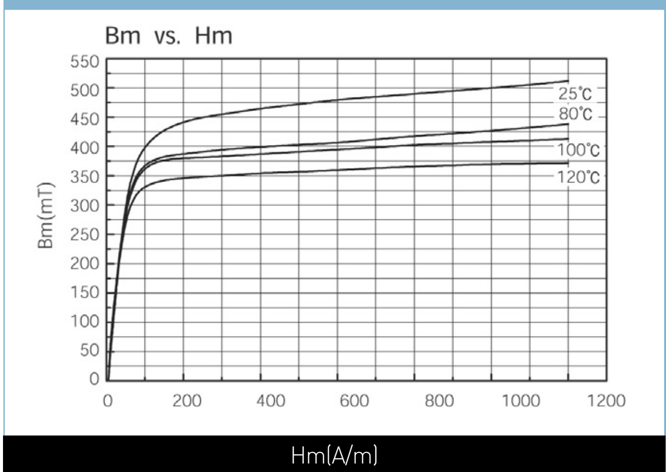
Material				PL-11
Initial permeability	μ_{iac}			2,500±25%
Core loss(100kHz, 200mT)	Pcv	kW/m³	25℃	650
			80℃	350
			100℃	320
			120℃	400
Saturation flux density(1194A/m)	Bs	mT	25℃	510
			100℃	410
Remanence	Br	mT	25℃	130
Coercivity	Hc	A/m	25℃	10
Curie temperature	Tc	℃		〉220
Density	d	kg/m³		4.90×10^{3}
Resistivity	ρ	Ω m	25℃	〉5.0

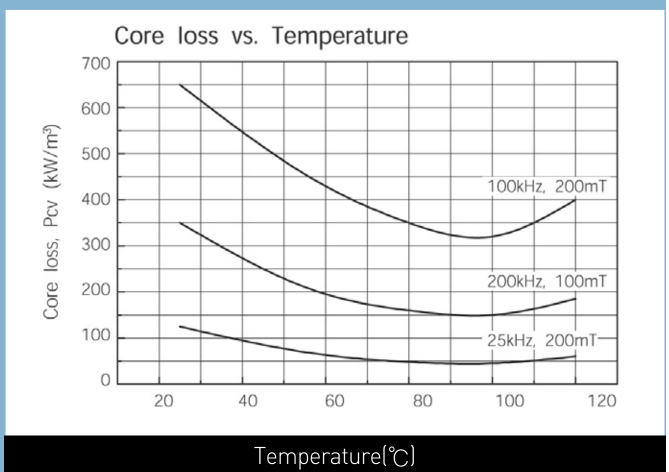
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise







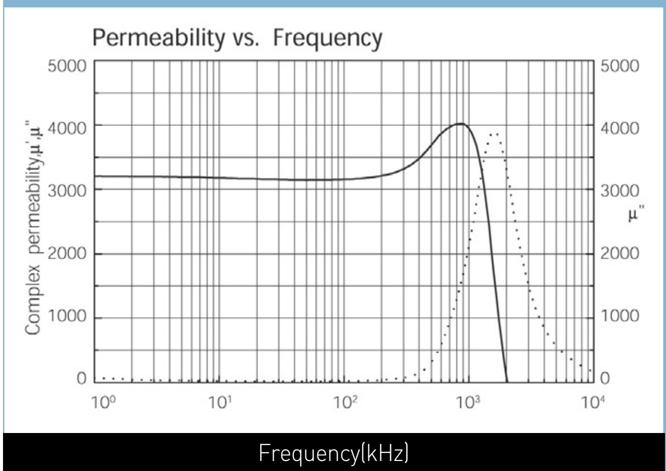


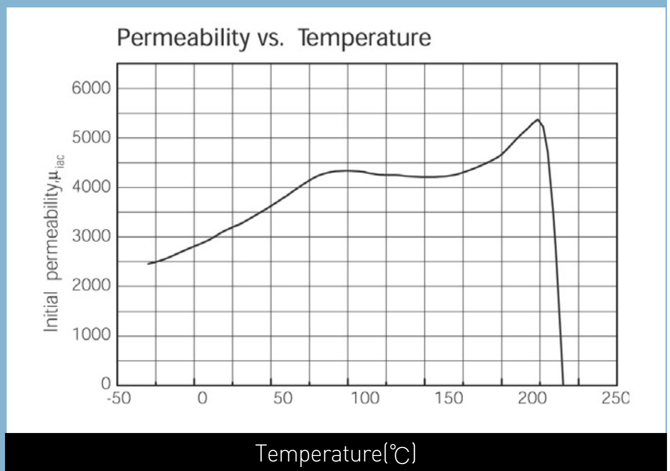
Power Material

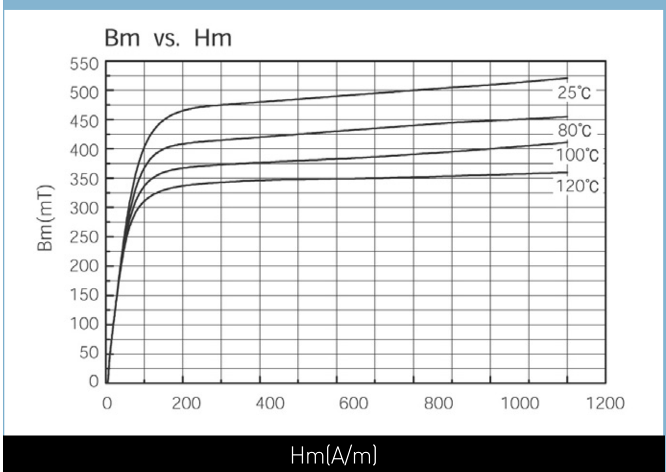
Material				PL-13
Initial permeability	μ_{iac}			3,200±25%
Core loss(100kHz, 200mT)	Pcv	kW/m³	25℃	400
			80℃	300
			100℃	340
			120℃	400
Saturation flux density(1194A/m)	Bs	mT	25℃	520
			100℃	410
Remanence	Br	mT	25℃	60
Coercivity	Hc	A/m	25℃	8
Curie temperature	Tc	℃		〉220
Density	d	kg/m³		4.90×10^3
Resistivity	ρ	Ω m	25℃	〉7.0

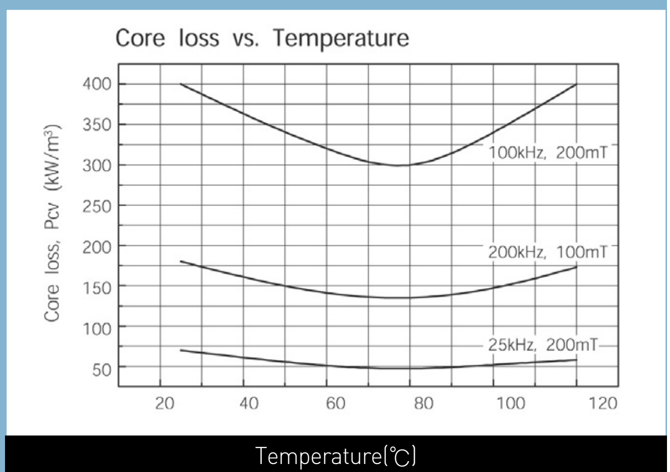
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise







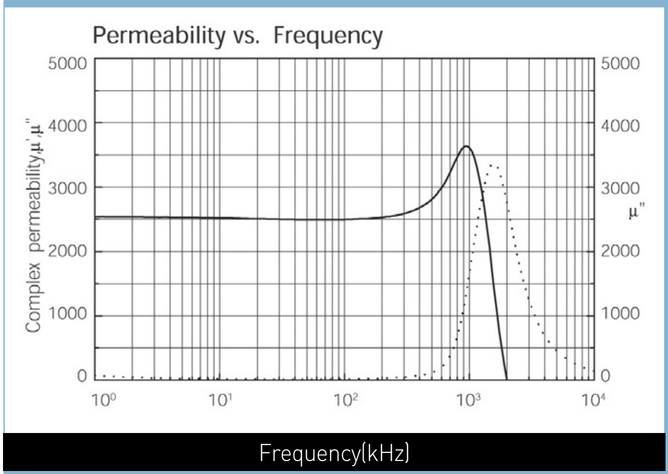


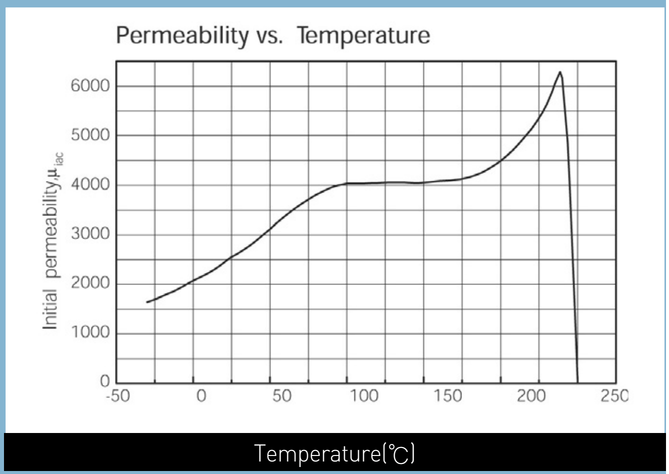
Power Material

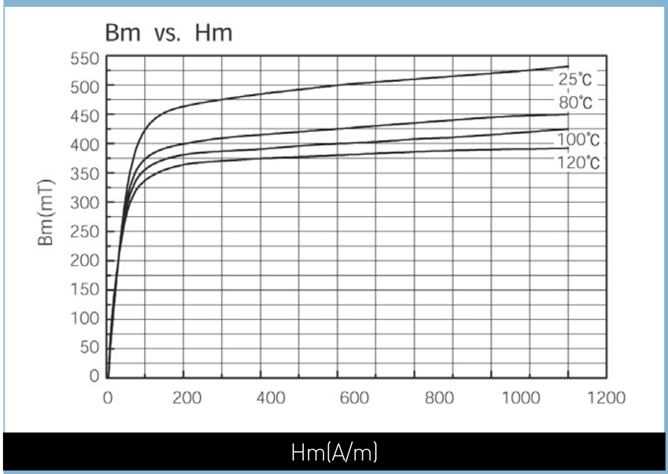
Material				PL-15
Initial permeability	μ_{iac}			2,500±25%
Core loss(100kHz, 200mT)	Pcv	kW/m³	25℃	600
			80℃	320
			100℃	250
			120℃	350
Saturation flux density(1194A/m)	Bs	mT	25℃	530
			100℃	420
Remanence	Br	mT	25℃	150
Coercivity	Hc	A/m	25℃	10
Curie temperature	Tc	℃		〉230
Density	d	kg/m³		4.90×10³
Resistivity	ρ	Ω m	25℃	〉5.0

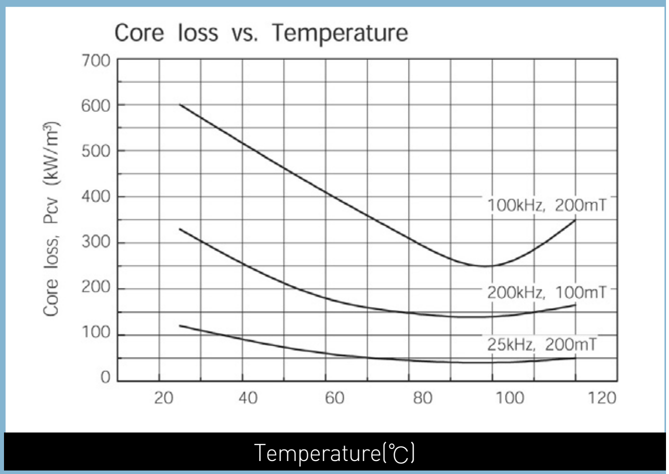
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise







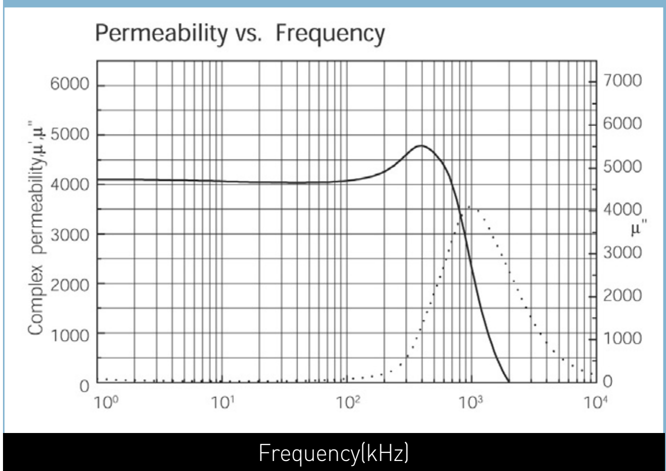


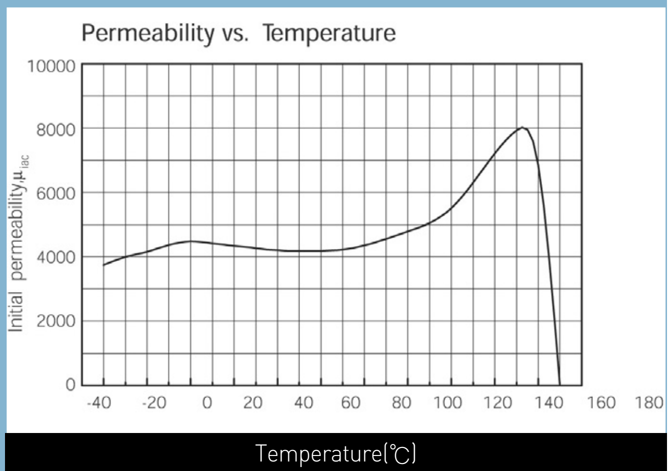
High Q Material

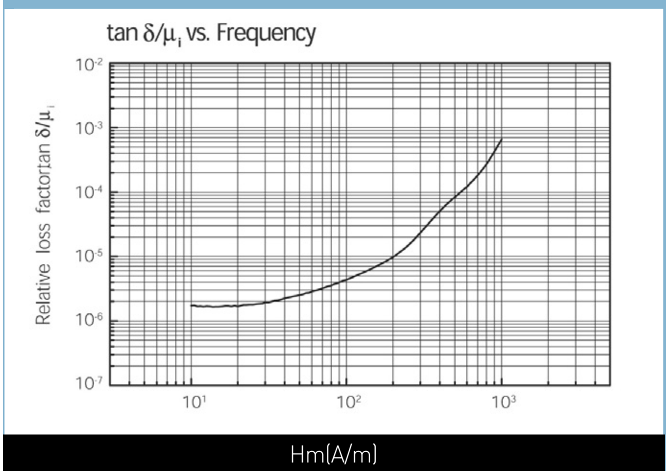
Material				SM-43T
Initial permeability	μ_{iac}			4,300±25%
Relative loss factor	$\tan\delta/\mu_{iac}$	$\times 10^{-6}$	f:100kHz	〈5
Saturation flux density(1194A/m)	Bs	mT	25℃	450
Remanence	Br	mT	25℃	40
Coercivity	Hc	A/m	25℃	5
Relative temp. factor	$\alpha\mu\gamma$	$\times 10^{-6}$/℃	-30~20℃	-0.5~0.5
			0~20℃	0~1.0
			20~70℃	0~1.0
Hysterisis material constant	η_B	$\times 10^{-6}$/mT	10kHz, 25℃	〈0.8
Curie temperature	Tc	℃		〉160
Density	d	kg/m³		4.80×10^3
Resistivity	ρ	Ω m	25℃	〉5

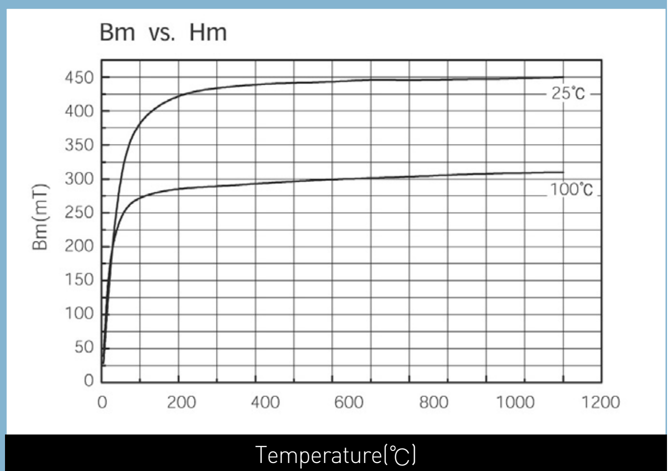
Note : 1) Typical values

2) The values were obtained with toroidal cores(30X8-20H)at room temperature unless indicated otherwise

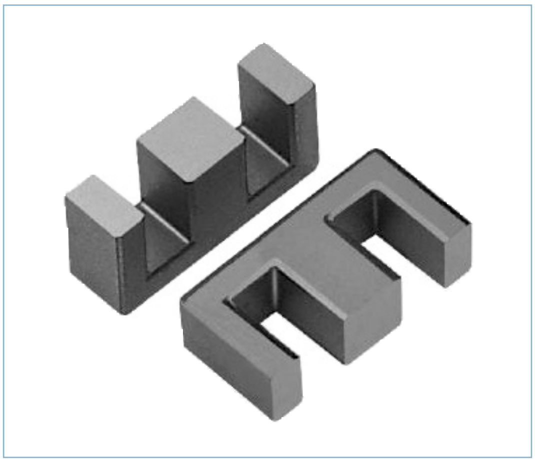


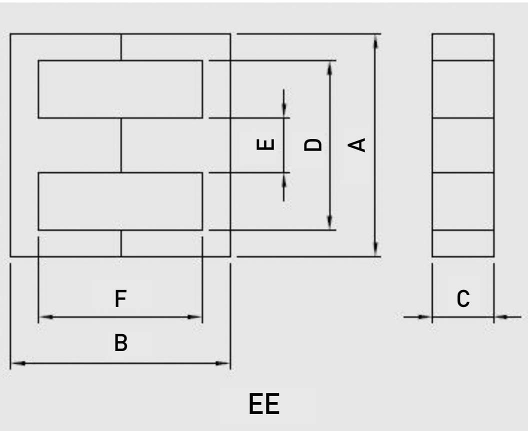






EE CORES



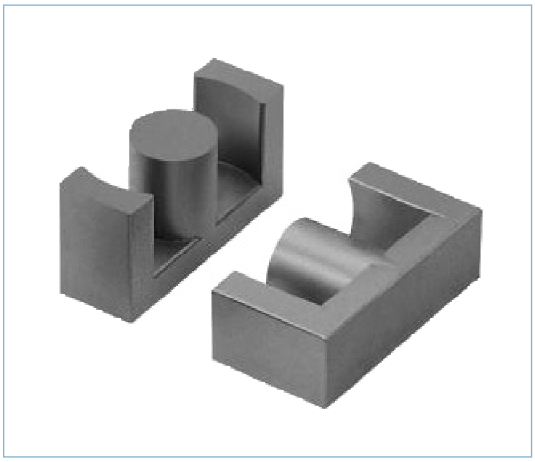


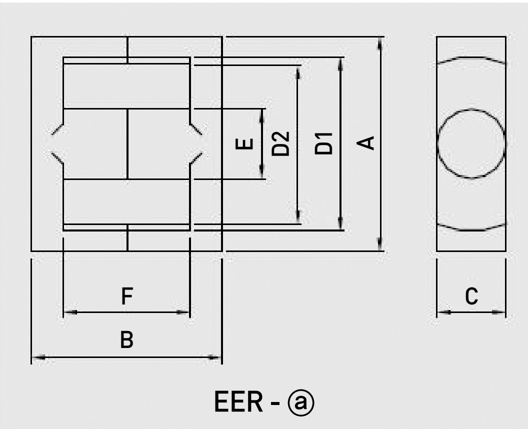
Part No.			EE5555A	EE6565S	EE7066A	EE8076S
Type			EE	EE	EE	EE
Dimensions in mm	A		55.15±1.05	65.15±1.35	70.00±1.00	80.00±0.80
	B		55.00±0.60	65.00±0.60	33.00±0.20	76.10±0.40
	C		21.00±0/-0.80	27.00±0.40	31.60±0.50	20.00±0.40
	D		38.10±0.60	45.10±0.90	48.60±0.70	60.00±0.60
	E		16.95±0.25	19.65±0.35	21.50±0.40	20.00±0.40
	F		37.60±0.60	45.20±0.80	22.20±0.20	56.10±0.60
Core Set Parameters	C1(mm^{-1})		0.349	0.275	0.349	0.349
	Le(mm)		123.0	123.0	123.0	123.0
	Ae(mm^2)		352.0	352.0	352.0	352.0
	Ve(mm^3)		4347.0	4347.0	4347.0	4347.0
	Ac(mm^2)		349.0	349.0	349.0	349.0
	Aw(mm^2)		397.0	397.0	397.0	397.0
	W(g/set)		219	219	219	219
Electrical Characteristics[1][2]	A_L value	PL-7	6,000	8,000	9,500	4,500
		PL-9	7,100	9,600	11,500	5,200
		PL-11	6,300	8,000	10,000	4,700
		PL-13	8,500	10,000	12,500	5,540
		PL-15	6,300	8,000	10,000	4,700
	Core loss	PL-7	3.75	6.30	10.20	6.60
		PL-9	3.30	5.70	9.20	6.00
		PL-11	3.30	5.70	9.20	6.00
		PL-13	3.30	5.70	9.20	6.00
		PL-15	3.10	5.30	8.60	5.60

Note : 1) Core Loss
- Unit : Watt max.
- Measuring conditions
  PL-7, PL-11, PL-15: 100kHz, 100mT, at 100℃
  PL-9, PL-13: 100kHz, 100mT, at 80℃

2) A_L value
- Unit : nH/N^2
- Measuring conditions : 1 kHz, 0.1 V, 23℃
- Tolerance : ±25%

EER CORES



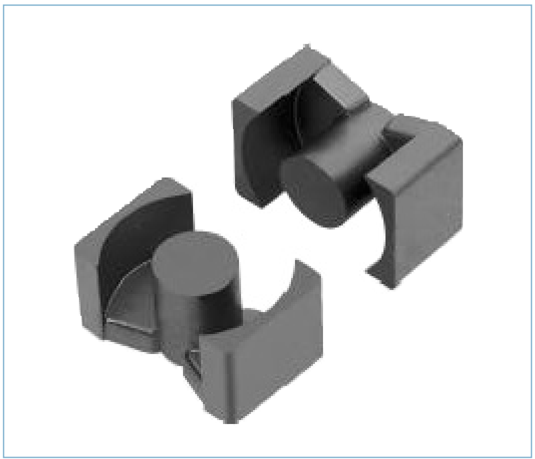


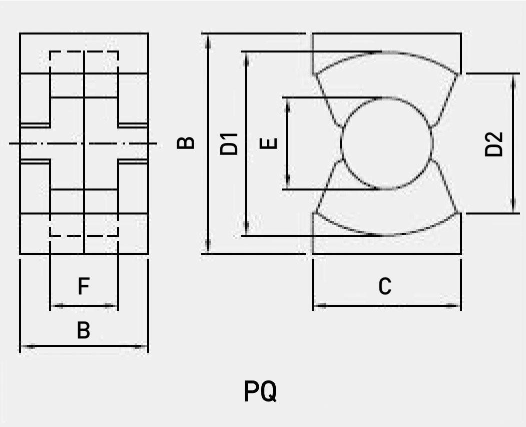
Part No.			EER4950S	EER4954S	EER5455A	EER6062S
Type			EER-ⓐ	EER-ⓐ	EER-ⓐ	EER-ⓐ
Dimensions in mm	A		48.70±1.00	49.00±0.80	54.50±1.30	59.80±1.30
	B		49.40±0.40	54.00±0.40	55.20±0.40	62.00±0.40
	C		16.30±0.40	17.20±0.30	18.90±0.40	20.65±0.45
	D1		37.00±0.90	36.40min	41.20±0.10	44.70±1.10
	D2		33.15min	33.20min	36.20min	40.15min
	E		16.30±0.40	17.25±0.25	18.90±0.40	21.65±0.45
	F		36.20±0.80	37.00±0.40	40.40±0.80	45.00±0.80
Core Set Parameters	C1(mm^{-1})		0.540	0.490	0.455	0.384
	Le(mm)		114.0	118.0	127.0	141.0
	Ae(mm^2)		211.0	241.0	279	367
	Ve(mm^3)		4347.0	28460.0	35620	51630
	Ac(mm^2)		349.0	232	281	368
	Aw(mm^2)		397.0	370.0	450	518
	W(g/set)		219	147.0	176	257
Electrical Characteristics[1][2]	A_L value	PL-7	4,000	4,500	4,800	5,400
		PL-9	4,750	5,300	5,800	6,500
		PL-11	4,200	4,700	5,000	5,500
		PL-13	5,060	5,650	6,180	6,930
		PL-15	4,200	4,700	5,000	5,500
	Core loss	PL-7	13.28	15.65	19.59	6.20[2]
		PL-9	12.07	14.23	17.81	4.50[1]
		PL-11	12.07	14.23	17.81	4.50[1]
		PL-13	11.6	13.66	17.10	4.50[1]
		PL-15	10.86	12.81	16.03	4.20[1]

Note : 1) Core Loss
- Unit : Watt max.
- Measuring conditions
  PL-7, PL-11, PL-15 : 100kHz, 100mT, at 100℃
  PL-9, PL-13 : 100kHz, 100mT, at 80℃
  [1]100kHz, 100mT, at 100℃
  [2]25kHz, 200mT, at 100℃

2) A_L value
- Unit : nH/N^2
- Measuring conditions : 1 kHz, 0.1 V, 23℃
- Tolerance : ±25%

PQ CORES



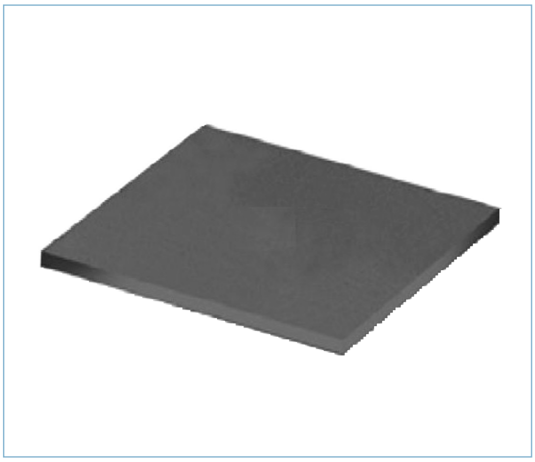


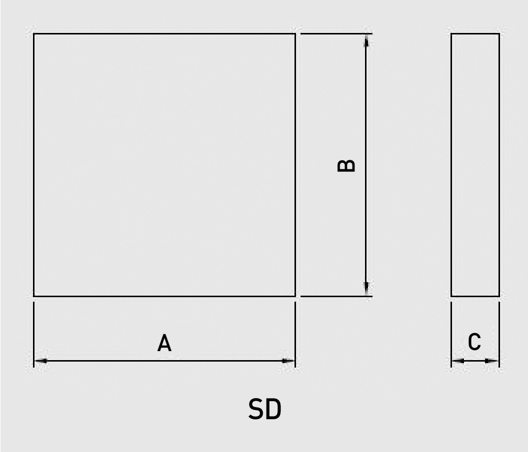
Part No.			PQ3230S	PQ3535S	PQ4040A	PQ5050S
Type			PQ	PQ	PQ	PQ
Dimensions in mm	A		32.00±0.50	35.10±0.60	40.50±0.90	50.00±0.70
	B		30.35±0.25	34.75±0.25	39.75±0.25	49.95±0.25
	C		22.00±0.50	26.00±0.50	28.00±0.60	32.00±0.60
	D1		27.50±0.50	32.00±0.50	37.00±0.60	44.00±0.70
	D2		19.00min	23.50min	28.00min	31.50min
	E		13.45±0.25	14.35±0.25	14.90±0.30	20.00±0.35
	F		21.30±0.30	25.00±0.30	29.50±0.30	36.10±0.30
Core Set Parameters	C1(mm^{-1})		0.464	0.448	0.455	0.384
	Le(mm)		74.6	87.9	127.0	113.0
	Ae(mm^2)		161.0	196.0	201.0	328.0
	Amin(mm^2)		142.1	161.7	174.4	314.0
	Ve(mm^3)		11970	17260	20450	37240
	Vmin(mm^3)		10599	14216	17768	35480
	Ac(mm^2)		142.0	162.0	174.0	314.0
	Aw(mm^2)		149.6	220.6	326.0	433.0
	W(g/set)		57	72	94	194
Electrical Characteristics[1][2]	A_L value	PL-7	5,830	5,700	4,200	6,400
		PL-9	5,000	4,700	5,200	7,700
		PL-11	3,500	3,700	4,200	6,400
		PL-13	5,330	5,010	5,540	8,210
		PL-15	3,500	3,700	4,200	6,400
	Core loss	PL-7	7.18	10.36	12.27	3.70[1]
		PL-9	6.58	9.49	11.25	3.30[1]
		PL-11	6.58	9.49	11.25	3.30[1]
		PL-13	6.34	9.15	10.84	3.30[1]
		PL-15	5.99	8.63	10.23	3.07[1]

Note : 1) Core Loss
- Unit : Watt max.
- Measuring conditions
  PL-7, PL-11, PL-15 : 100kHz, 100mT, at 100℃
  PL-9, PL-13 : 100kHz, 100mT, at 80℃
  [1]100kHz, 100mT, at 100℃

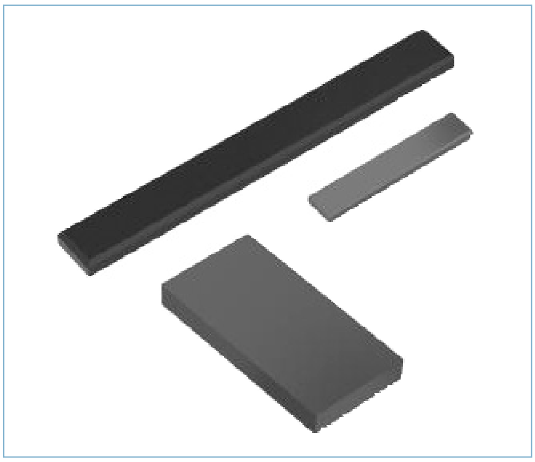
2) A_L value
- Unit : nH/N^2
- Measuring conditions : 1 kHz, 0.1 V, 23℃
- Tolerance : ±25%

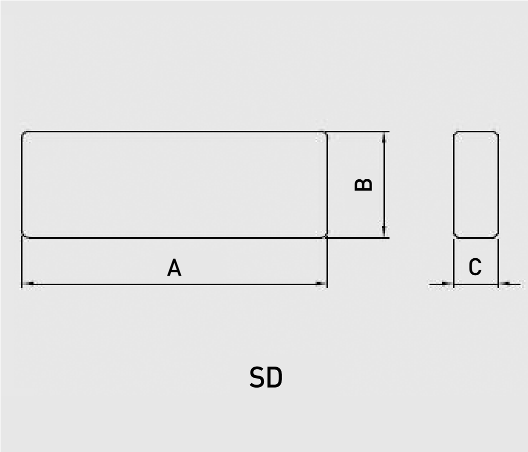
SD CORES





Part No.	MATERIAL	TYPE	A	B	C
SD100x100x10T	PL-7	SD	99.9±0.15	99.9±0.15	10±0.15
SD100x100x4T	PL-7	SD	101±1.50	101±1.50	4±0.40

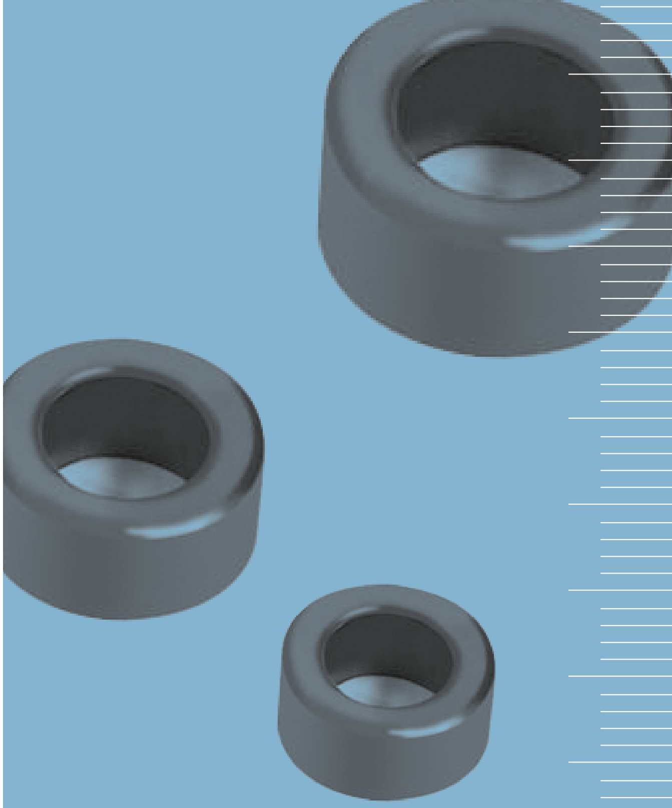




Part No.	MATERIAL	TYPE	A	B	C
SD50x12x3T	SM-43T	SD	50.00±0.4	12.00±0.15	3.00±0.06
SD53x12x3T	SM-43T	SD	53.00±0.4	12.00±0.15	3.00+0.50/-0.10
SD60x6x2T	SM-43T	SD	60.00±0.0/-0.40	6.00±0.15	2.00±0.10
SD60x15x5T	SM-43T	SD	60.00±0.7	15.00±0.3	5.00+0.10/-0.20
SD60x20x4T	SM-43T	SD	60.00±0.7	20.00±0.3	4.00±0.15
SD80x15x5T	SM-43T	SD	80.00±0.7	15.00±0.3	5.00+0.10/-0.20
SD100x16x9	SM-43T	SD	101.00±0.50/-0.20	16.00±0.30	9.00±0.30
SD100x25x4.5	SM-43T	SD	100.00±0.50/-0.20	25.00±0.30	4.50±0.30
SD100x25x5T	SM-43T	SD	100.00±1.00	25.00±0.30	5.00±0.30
SD100x25x8T	SM-43T	SD	100.00±1.00	25.00±0.30	8.00±0.30
SD105x15x5T	SM-43T	SD	105.00±0.8	15.00±0.2	5.00±0.2

Passion for Challenges

SAMWHA Energy Saving
Products Guide



MPC (Magnetic Powder Cores)

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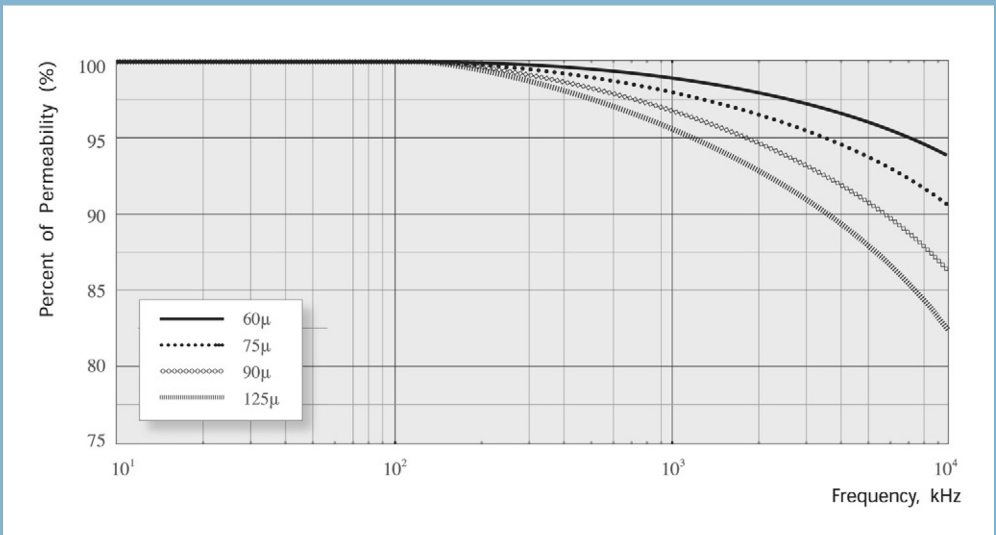
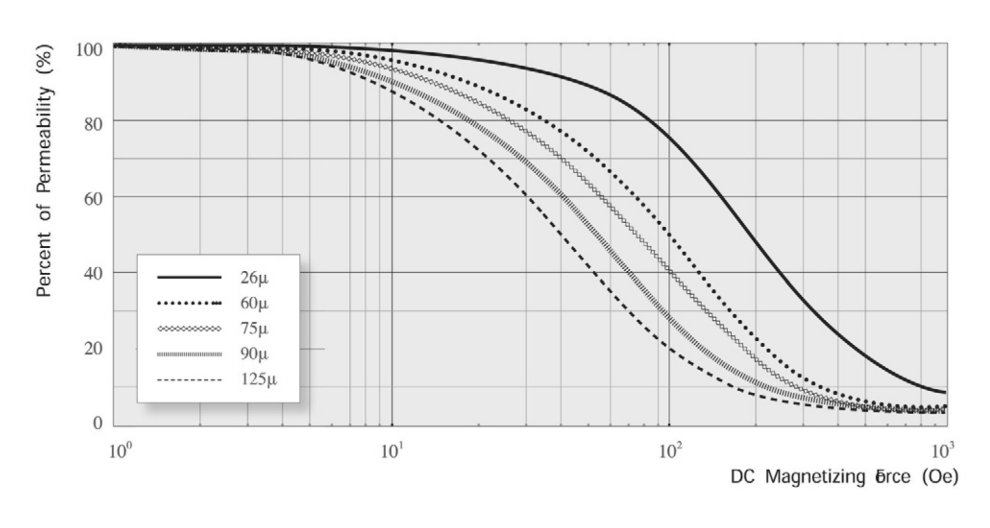
Material Characteristics

SENDUST

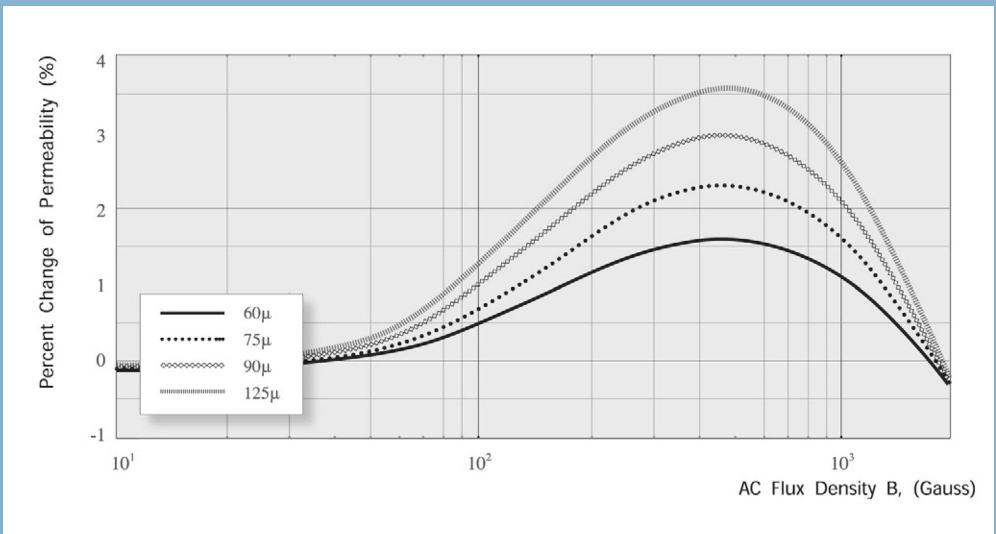
Permeability vs. Frequency



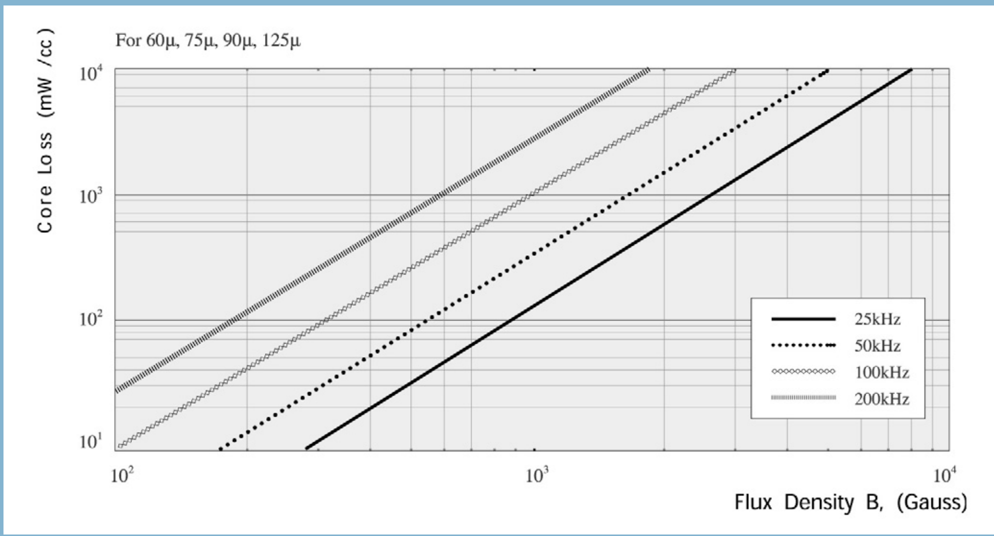
Permeability vs. DC Bias

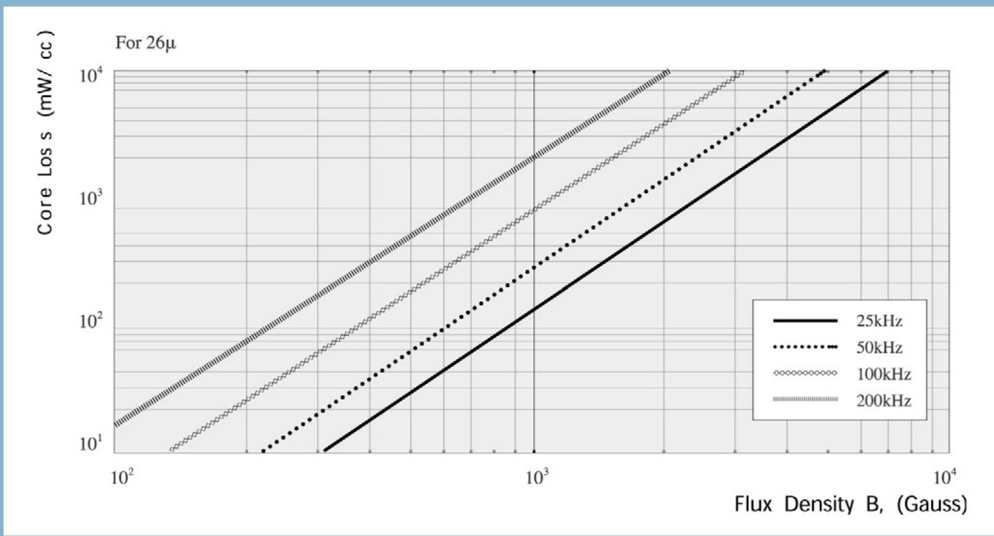


Permeability vs. AC Flux Density

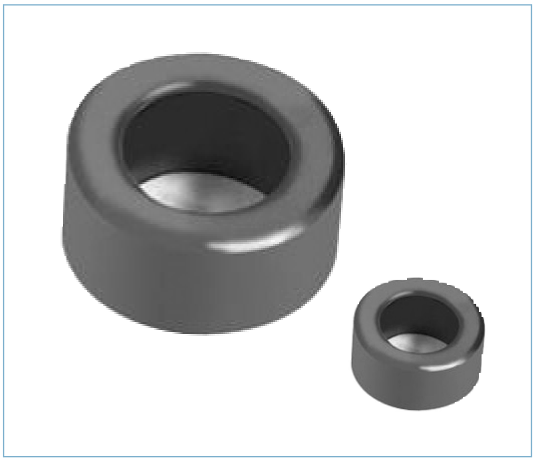


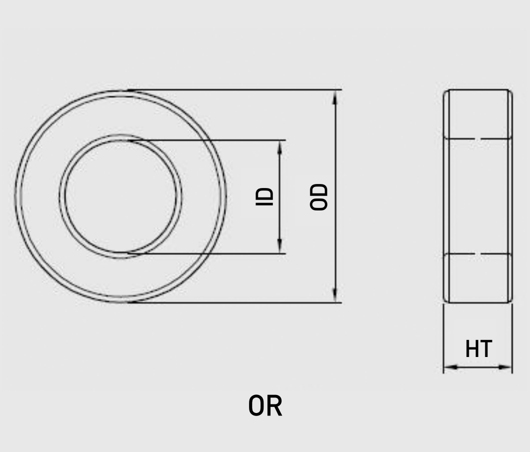
Core Loss vs. Flux Density





MPC Magnetic Powder Cores

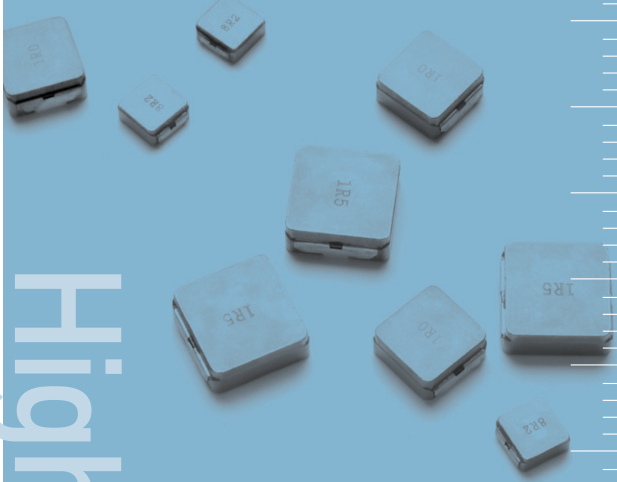




Part No.	TYPE	OD		ID		HT		Perm
		Inch	mm	Inch	mm	Inch	mm	
OR035S125	OR	0.14	3.56	0.07	1.78	0.06	1.52	125
OR039S125	OR	0.155	3.94	0.09	2.24	0.1	2.54	125
OR046S125	OR	0.18	4.65	0.09	2.36	0.1	2.54	125
OR063S125	OR	0.25	6.35	0.11	2.79	0.11	2.79	125
OR066S125	OR	0.26	6.6	0.105	2.67	0.1	2.54	125
OR066S125	OR	0.26	6.6	0.105	2.67	0.1	2.54	125
OR078S125	OR	0.31	7.87	0.156	3.96	0.125	5.08	125
OR096S125	OR	0.38	9.65	0.188	4.78	0.125	3.17	125
OR097S125	OR	0.38	9.65	0.188	4.78	0.156	3.96	125
OR102S125	OR	0.4	10.16	0.2	5.08	0.156	3.96	125
OR112S125	OR	0.44	10.16	0.2	5.08	0.156	3.96	125
OR127S125	OR	0.5	12.7	0.3	7.62	0.187	4.75	125
OR166S125	OR	0.65	16.51	0.4	10.16	0.25	6.35	125
OR172S125	OR	0.68	17.27	0.38	9.65	0.25	6.35	125
OR203S125	OR	0.8	20.32	0.5	12.7	0.25	6.35	125
OR229S125	OR	0.9	22.86	0.55	13.97	0.3	7.62	125
OR234S125	OR	0.928	23.57	0.567	14.4	0.35	8.89	125
OR270S125	OR	1.06	26.92	0.58	14.73	0.44	11.18	125
OR330S125	OR	1.3	33.02	0.785	19.94	0.42	10.67	125
OR343S125	OR	1.35	34.29	0.92	23.37	0.35	8.89	125
OR358S125	OR	1.41	35.81	0.88	22.35	0.412	10.46	125
OR400S125	OR	1.57	39.88	0.95	24.13	0.57	14.48	125
OR467S125	OR	1.84	46.74	0.95	24.13	0.71	18.03	125
OR468S125	OR	1.84	46.74	1.13	28.7	0.6	15.24	125
OR508S125	OR	2	50.8	1.25	31.75	0.53	13.46	125
OR571S125	OR	2.25	57.15	1.04	26.39	0.6	15.24	125
OR572S125	OR	2.25	57.15	1.4	35.56	0.55	13.97	125
OR777S125	OR	3.063	77.8	1.94	49.23	0.5	12.7	125
OR778S125	OR	3.063	77.8	1.94	49.23	0.625	15.87	125

Passion for Challenges

SAMWHA Energy Saving Products Guide



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High Current SMD Power Inductor

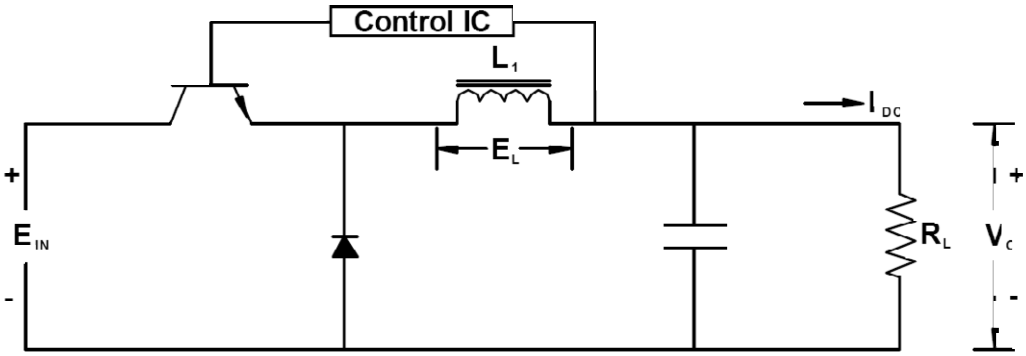
High Current SMD Power Inductor (MPC Inductor)

Features

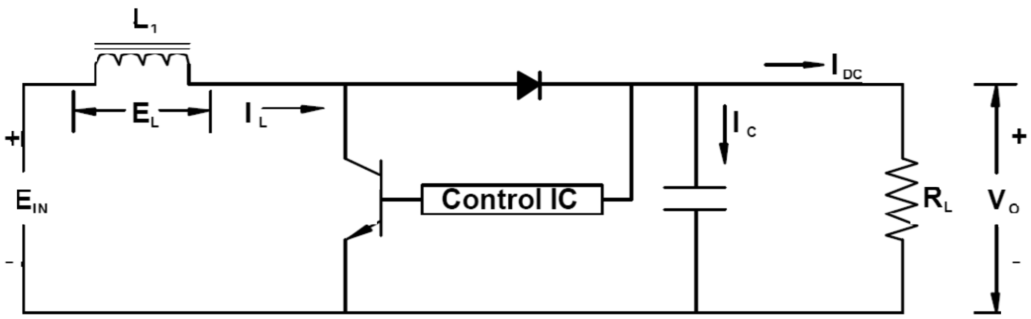
- Lowest height(2.0mm~5.0mm) in this package footprint
- Frequency range up to 5.0MHz.
- Lowest DCR/μH, in this package size
- Handles high transient current spikes without saturation
- Ultra low buzz noise, due to composite construction

Applications

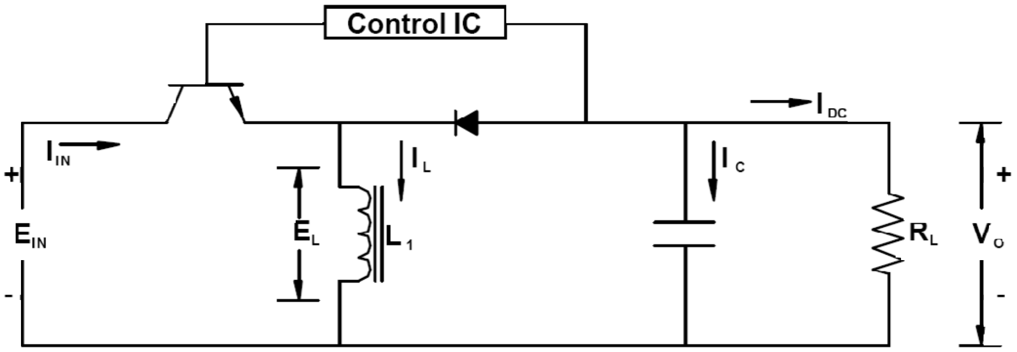
- DC/DC Converters for power system distribution
- Low profile, high current power supplies
- PDA/Notebook/Desktop/Server applications



Buck

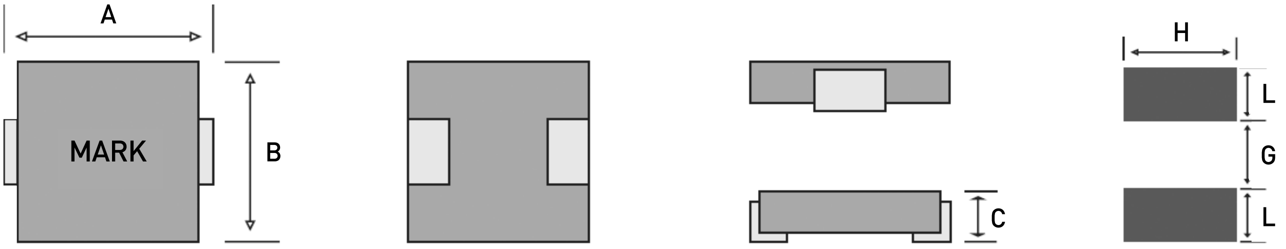


Boost



Buck / Boost

Dimensions & Recommended Land Pattern



(Unit : mm, Tolerance : ±0.3)

Part No.	AxBxC(Max.)	L	G	H	Type
SFCB64722HC	7.0x6.47x2.4	2.10	3.80	3.50	SFCB-ⓐ
SFCB64728HC	7.0x6.47x3.0	2.10	3.80	3.50	SFCB-ⓐ
SFCB64738HC	7.0x6.47x4.0	2.10	3.80	3.50	SFCB-ⓐ
SFCB10738HC	10.7x10.0x4.0	3.80	5.00	4.60	SFCB-ⓐ
SFCB10748HC	10.7x10.0x5.0	3.80	5.00	4.60	SFCB-ⓐ
SFCB12733HC	13.2x12.7x3.5	3.40	8.00	3.50	SFCB-ⓐ
SFCB12748HC	13.2x12.7x5.0	3.40	8.00	3.50	SFCB-ⓐ

Type Designation

SF	CB	10733	HC	-	4R7
(1)	(2)	(3)	(4)		(5)

1) Series Name

2) Type

O : Unshielded Type SMD
B : Base Type
C : Shielded Type SMD
P : Silver Paste Type

3) Size Code

See the 'Dimensions & Recommended Land Pattern'

3) Applications Code

HC : High Current SMD Power Inductor

3) Inductance Code

The nominal Inductance Value in is expressed by three digit numbers.
The first two digits represents significant figures and the last digit denotes the number of zero.

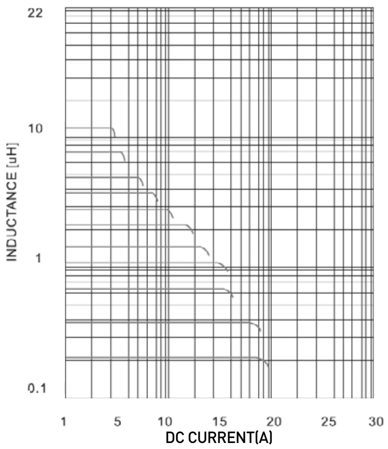
Specifications

Parts No.	SPEC	INDUCTANCE (μH)	DCResistance (Typical,MΩ)	DCResistance (Max,MΩ)	SaturationRatedCurrent (Typical,A)	TemperatureRiseCurrent (Typical,A)
SFCB64722HC	R47	0.47±20%	5.5	6.5	19.0	14.0
	R68	0.68±20%	7.5	9.4	18.0	11.5
	R82	0.82±20%	8.0	11.8	16.0	10.5
	1R0	1.0±20%	9.0	14.2	15.0	10.0
	1R5	1.5±20%	19.0	21.2	13.0	8.0
	2R2	2.2±20%	25.0	34.0	12.0	7.0
	3R3	3.3±20%	48.0	51.6	9.0	5.5
	4R7	4.7±20%	55.0	63.0	7.5	5.0
	6R8	6.8±20%	82.0	95.0	6.0	4.0
	8R2	8.2±20%	98.0	106.0	5.5	3.5
	100	10±20%	112.0	129.0	5.0	3.0
SFCB64728HC	R47	0.47±20%	4.0	4.2	26.0	17.5
	R68	0.68±20%	5.0	5.5	25.0	15.5
	R82	0.82±20%	6.7	8.0	24.0	13.0
	1R0	1.0±20%	9.0	10.0	22.0	11.0
	1R5	1.5±20%	14.0	15.0	18.0	9.0
	2R2	2.2±20%	18.0	20.0	14.0	8.0
	3R3	3.3±20%	28.0	30.0	13.5	6.0
	4R7	4.7±20%	37.0	40.0	10.0	5.5
	6R8	6.8±20%	54.0	60.0	8.0	4.5
	8R2	8.2±20%	60.0	65.0	7.5	4.0
	100	10±20%	63.0	70.0	7.0	3.0
SFCB64738HC	R47	0.47±20%	2.5	3.0	22.0	22.0
	R68	0.68±20%	4.0	5.0	20.0	18.0
	R82	0.82±20%	5.5	6.5	18.0	16.0
	1R0	1.0±20%	6.0	7.0	17.0	14.0
	1R5	1.5±20%	7.0	8.5	15.0	12.0
	2R2	2.2±20%	15.0	17.0	13.0	10.0
	3R3	3.3±20%	24.0	27.0	11.0	9.0
	4R7	4.7±20%	32.0	35.0	9.0	7.0
	6R8	6.8±20%	42.0	45.0	8.0	6.0
	8R2	8.2±20%	53.0	60.0	7.0	5.0
	100	10±20%	65.0	70.0	6.0	4.0
SFCB10738HC	R22	0.22±20%	1.1	1.5	50.0	32.0
	R36	0.36±20%	1.3	1.4	60.0	31.5
	R56	0.56±20%	1.7	1.8	49.0	27.5
	1R0	1.0±20%	3.7	4.1	36.0	17.5
	1R5	1.5±20%	5.3	5.8	27.5	15.0
	2R2	2.2±20%	8.2	9.0	25.6	12.0
	3R3	3.3±20%	10.8	11.8	18.6	10.0
	4R7	4.7±20%	15.0	16.5	17.0	9.5
	5R6	5.6±20%	17.6	19.3	16.0	8.5
	8R2	8.2±20%	21.2	23.3	13.5	8.0
	100	10±20%	33.2	36.5	12.0	6.8
	150	15±20%	85.0	90.0	7.0	3.5
	220	22±20%	116.5	120.0	3.0	2.0

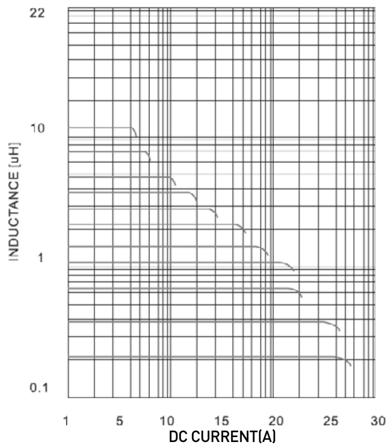
Parts No.	SPEC	INDUCTANCE (μH)	DCResistance (Typical,MΩ)	DCResistance (Max,MΩ)	SaturationRatedCurrent (Typical,A)	TemperatureRiseCurrent (Typical,A)
SFCB10748HC	1R0	1.0±20%	3.0	3.5	38.0	20.0
	2R2	2.2±20%	5.8	7.0	30.0	17.0
	3R3	3.3±20%	11.5	14.0	24.0	11.5
	4R7	4.7±20%	14.0	17.0	19.5	10.0
	6R8	6.8±20%	15.6	19.0	15.0	8.5
	100	10±20%	26.5	29.0	14.0	7.5
SFCB12733HC	R47	0.47±20%	1.6	2.0	55.0	32.0
	R60	0.60±20%	1.8	2.2	51.0	29.0
	R68	0.68±20%	2.3	2.5	49.0	28.0
	R82	0.82±20%	2.6	3.0	44.0	25.0
	1R0	1.0±20%	3.3	3.5	40.0	24.0
	1R5	1.5±20%	5.1	5.5	35.0	19.0
	1R8	1.8±20%	6.5	7.0	30.0	16.5
	2R2	2.2±20%	7.2	8.0	29.0	16.0
	3R3	3.3±20%	11.0	12.0	27.0	12.0
	4R7	4.7±20%	14.3	15.0	24.0	10.0
	5R6	5.6±20%	18.3	19.0	19.0	9.5
	6R8	6.8±20%	19.8	22.0	18.0	9.0
	8R2	8.2±20%	24.8	28.0	16.0	8.5
	100	10±20%	30.4	34.0	14.0	7.0
	220	22±20%	86.1	90.0	4.5	3.0
SFCB12748HC	R47	0.47±20%	1.1	1.3	65.0	38.0
	R82	0.82±20%	2.0	2.3	53.0	31.0
	1R0	1.0±20%	2.1	2.5	50.0	29.0
	1R5	1.5±20%	3.4	4.1	48.0	23.0
	1R8	1.8±20%	4.2	4.9	40.0	19.0
	2R2	2.2±20%	4.6	5.5	32.0	20.0
	3R3	3.3±20%	7.7	9.2	32.0	15.0
	4R7	4.7±20%	12.8	15.0	27.0	12.0
	5R6	5.6±20%	14.0	16.5	22.0	11.5
	6R8	6.8±20%	15.4	18.5	21.0	11.0
	8R2	8.2±20%	18.9	22.5	18.0	9.5
	100	10±20%	21.4	25.5	16.0	9.0

* Testing Instrument
  1) Inductance : HP 4284A LCR METER
  2) DC Resistance : HIOKI MΩ HI-TESTER 3220
* Tested at 100kHz, 0.25Vrms.
* Saturation Rated Current [A] : The current when the inductance becomes 20% lower than it's nominal value or temperature rise of coil becomes.

DC Superimposed Inductance Characteristics



SFCB64722HC-Series



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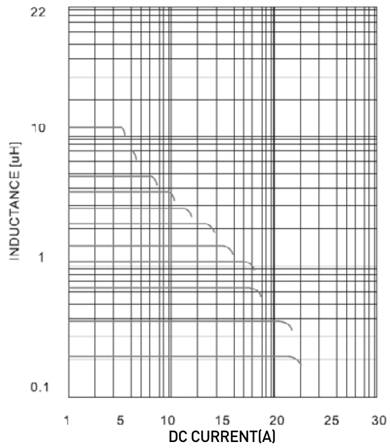
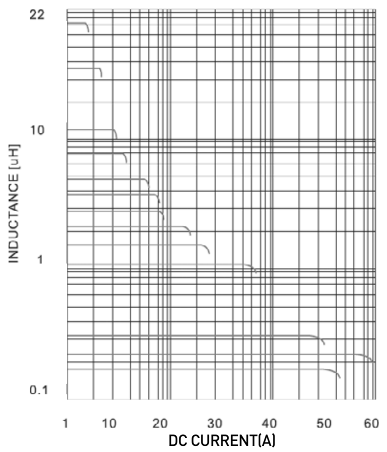
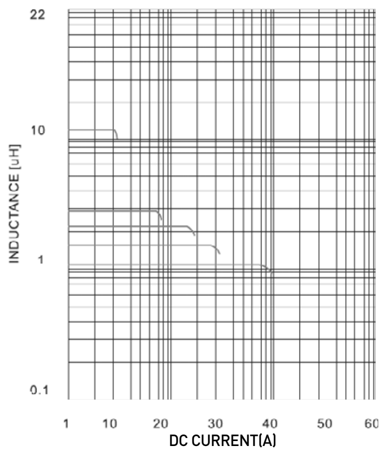


SFCB64738HC-Series



SFCB10738HC-Series



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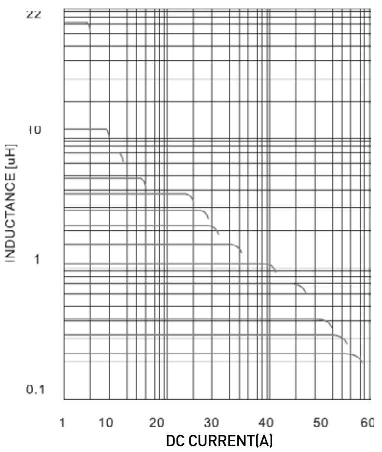
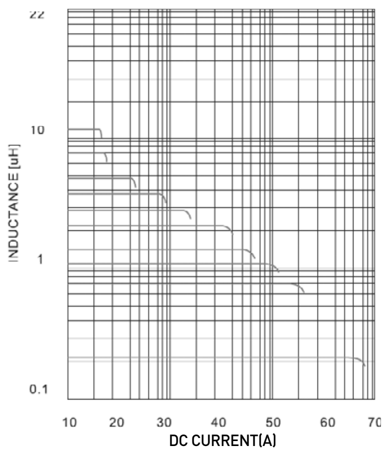


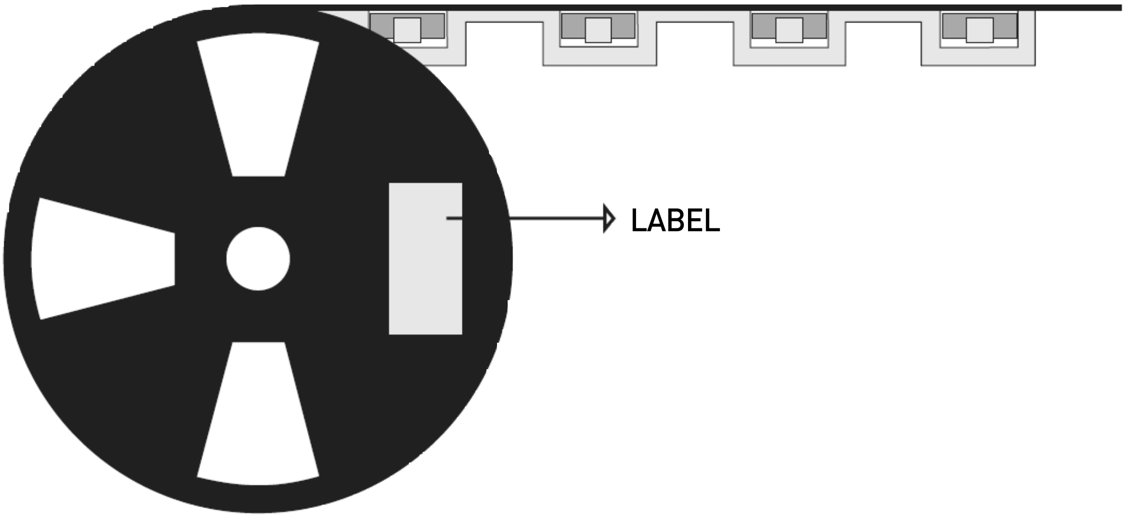
SFCB12733HC-Series

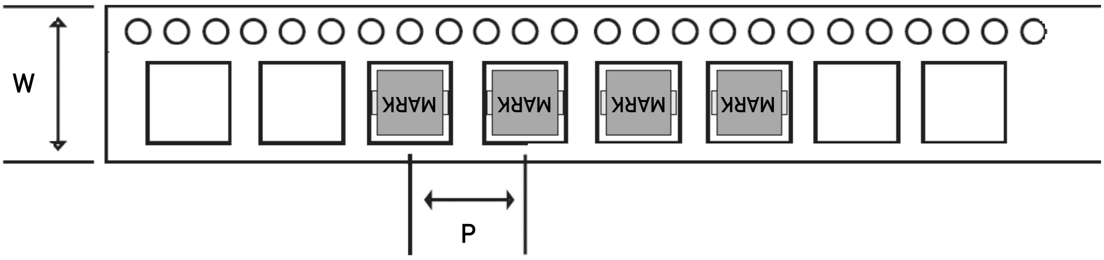


SFCB12748HC-Series

* Items not indicated in the list are available upon the Customers request
* All specifications are subject to change without notice

Packing





Part No.	Tape Pitch [P]	Emboss Pitch [w]	Unit per Reel
SFCB64722HC	12.0	16.0	1,000
SFCB64728HC	12.0	16.0	1,000
SFCB64738HC	12.0	16.0	1,000
SFCB10738HC	16.0	24.0	500
SFCB10748HC	16.0	24.0	500
SFCB12733HC	18.0	24.0	500
SFCB12748HC	18.0	24.0	500

MEMO