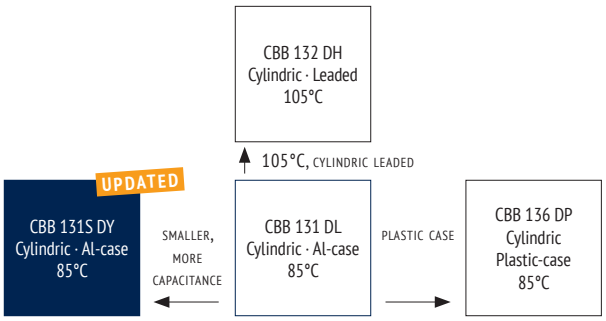
FILM CAPACITORS · **DC LINK**

CBB **131S** DY SERIES

FEATURES

- **DC-Link**
- Miniaturized
- Higher Capacitance
- Low ESR, high Currents
- Self-healing
- Long Lifetime
- Aluminum case

OVERVIEW



PRODUCT

APPLICATIONS

- Photovoltaic and wind inverters
- Electric and hybrid electric vehicles
- Motion control, welding equipment, elevators
- High power frequency converters

CHARACTERISTICS

ITEM	CHARACTERISTICS
Climatic Category	40/85/56 (IEC 61071)
Operating Temperature	–40 ~ +85 °C ($\Theta_{hotspot}$ ⩽ 85 °C)
Storage Temperature	–40 ~ +85 °C
Rated Voltage U_{RDC}	600 ~ 1 500V_{DC}
Capacitance Range	110 ~ 1 600 µF
Capacitance Tolerance	±10 % (K), ±5 % (J)
Voltage between Terminals U_{TT}	1,5 * U_{RDC} (20 °C, 10 s)
Voltage between Terminals & Case U_{TC}	⩾ 3 000V_{AC} (20°C, 50Hz, 10s)
Max. Overvoltage	Please see IEC 61071
Insulation Resistance R_i*C	⩾ 10 000 MΩ * µF (20 °C, 100 V_{DC}, 1 min)
Dielectric Dissipation Factor tan б$_o$	⩽ 2 * 10^{-4} (20 °C, 100 Hz)
Life Time Expectancy	⩾ 100 000h, failure rate ⩽ 100 FIT ($\Theta_{hotspot}$ ⩽ 70°C, U_{RDC})
Reference Standard	IEC 61071:2007

ENVIRONMENTAL

The products are RoHS, WEEE and REACh compliant.

The detailed version please see seperate "Environmental Certificates" document or www.jianghai-europe.com

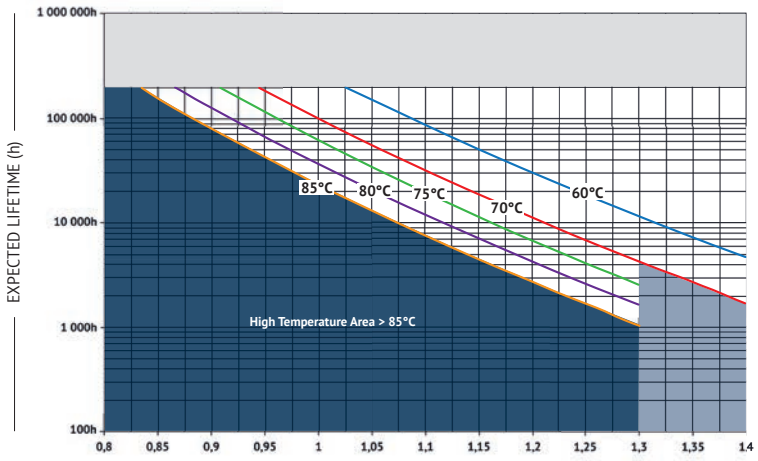
APPROVALS

UL94-V0:

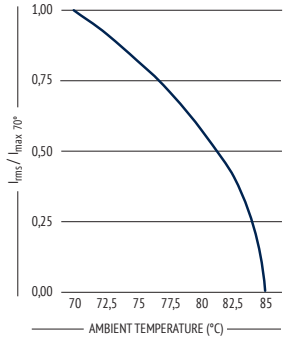
Plastic & Compound Mass

LIFETIME

END OF LIFE: 3% REDUCTION OF CAPACITANCE

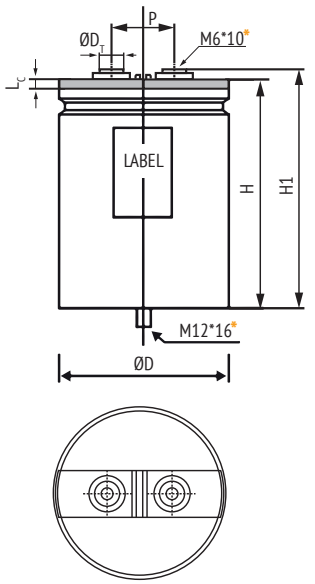


CURRENT DERATING



CAN STYLES

CAN STYLE B



H1=H+5mm

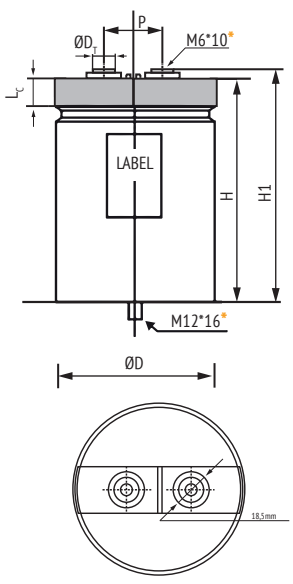
Aluminum Case
with Flanging
Anti-Creep Insulation

D_T = 12mm*

M6*10 screw female*

*preferred

CAN STYLE H/I



H1=H+5mm

Aluminum/Plastic Case
with Flanging
Anti-Creep Insulation

Can Style **H/I**: D_T = 14 mm

M6*10 screw female*

*preferred

DIMENSIONS

Diameter D ± 1,0 mm	Can Style	Pitch P ± 0,5mm	Length Cab Lc ± 1,0 mm	Diameter Terminal D_T ± 0,5mm
76	B	32	32	12
86	B	32	32	12
116	H	50	10	14
116	I	50	45	14

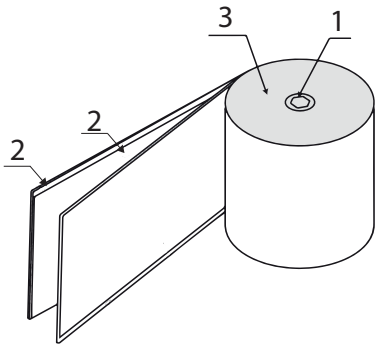
Max. Torque for terminals: 3 Nm (M5), 5 Nm (M6), 6 Nm (M8), 8 Nm (M10)

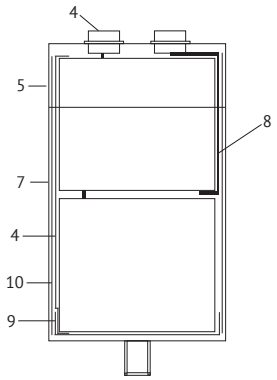
ORDER CODE

FC	C	2S	DY	107	K	H	136	0	3	1	J	1	E 3
Capacitor type	Product shape	DC rated voltage code (V)	Series code	Capacitance Code Examples (µF)	Capacitance tolerance	Diameter (mm)	Height (mm)	Terminal style	Terminal pitch (mm)	Stud bolt mounting	Can style	Inner Construction	For internal use
Film Cap. = FC	cylindrical = C	600 **2S**	CBB131S **DY**	100 **107**	±5% **J**	76 **H**	95 **095**	Female M5*7 **8**	32 **3**	flat, with Y bracket **Y**	Style B **B**	**1**	
		700 **2Q**		220 **227**	±10% **K**	86 **L**	120 **120**	Female M6*10 **0**		flat, without bracket **0**	Style H **H**	**2**	
		800 **2K**		420 **427**	±20% **M**		136 **136**	Female M8*10 **2**		bolt M12x16 **1**	Style i **I**		
		900 **R2**		500 **507**			155 **155**	Female M8*12 **6**		bolt M16x25 **2**			
		1000 **3A**		1000 **108**			175 **175**	Female M10*10 **4**		bolt M12x12 **3**			
		1100 **A3**		1100 **118**				Female M10*12 **B**					
		1200 **3B**						Male M6*20 **1**					
		1500 **C3**						Male M8*12 **9**					
								Male M8*15 **A**					
								Male M8*17 **7**					
								Male M8*20 **3**					
								Male M10*20 **5**					

INTERNAL CONSTRUCTION

(Example: Can Style J, double inner construction)

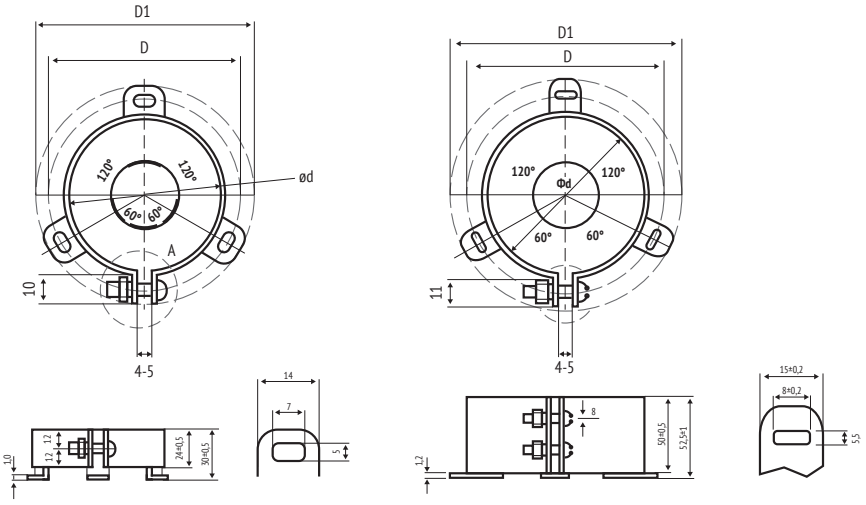




NO.	ITEM	MATERIAL
1	Winding Core	PC
2	Metallized Film	PP + Al, Zn
3	Metal Sprayed Electrode	Zn + Sn/Zn
4	Terminals	Cu, Sn-plated
5	Deck	PC

NO.	ITEM	MATERIAL
6	Aluminum Case	Al
7	Potting Compound	PU resin (+Epoxy)
8	Connection Electrode	Cu
9	Insulation Cover	PP
10	Winding Insulation	Paper + PP

ACCESSOIRES FOR BRACKET MOUNTING (ORDER CODE „Y“)



in mm

MARKING

Jianghai	BRAND
CBB 131S	SERIES DESIGNATION
540µF ±10%	CAPACITANCE AND TOLERANCE
U_R = 600V_{DC} SH	U_R RATED VOLTAGE
U_{TC} = 3000V 50/60 HZ	U_{TC} VOLTAGE BETWEEN TERMINALS AND CASE, FREQUENCY
-40~+85°C IEC61071	TEMPERATURE RANGE, REFERENCE STANDARD
Discharge before handling	SAFETY WARNING
JE37F26104	DATE CODE

RATINGS

U_R ≤85°C (V_{DC})	C_R (µF)	I_{max} 70°C, 1kHz (A)	60°C, 1kHz (A)	50°C, 1kHz (A)	≤40°C, 1kHz (A)	$\hat{I}$ (1) (A)	ESR_{typ} 20°C, 1kHz (mΩ)	R_{th} (2) (K/W)	L_S 20°C (nH)	D ±1,0 (mm)	H H1=H+5mm ±1,0 (mm)	ORDER CODE "#" to be defined, see ordering code table
600 2S	570	36	51	63	72	1600	1,5	5,1	≤50	76	95	FCC2SDY577#H095#3##2E3
	700	36	51	62	71	2100	1,4	5,6	≤50	86	95	FCC2SDY707#L095#3##2E3
	800	34	49	60	69	1650	1,8	4,7	≤60	76	120	FCC2SDY807#H120#3##2E3
	1 000	45	65	70	70	3200	1,1	4,3	≤60	76	155	FCC2SDY108#H155#3##2E3
	1 100	37	53	65	75	2300	1,5	4,8	≤60	86	120	FCC2SDY118#L120#3##2E3
	1 200	46	66	70	70	2150	1,1	4,2	≤60	76	175	FCC2SDY128#H175#3##2E3
		35	51	62	70	2150	1,7	4,6	≤60	86	136	FCC2SDY128#L136#3##2E3
	1 300	36	52	63	70	2230	1,7	4,4	≤60	86	155	FCC2SDY138#L155#3##2E3
	1 600	48	68	70	70	4500	1,0	4,3	≤60	86	175	FCC2SDY168#L175#3##2E3
700 2Q	500	35	50	61	70	1680	1,6	5,1	≤50	76	95	FCC2QDY507#H095#3##2E3
	660	36	51	62	71	2200	1,4	5,6	≤50	86	95	FCC2QDY667#L095#3##2E3
	700	32	46	56	65	1680	2,0	4,7	≤60	76	120	FCC2QDY707#H120#3##2E3
	850	31	45	55	64	1680	2,3	4,3	≤60	76	155	FCC2QDY857#H155#3##2E3
	900	35	50	61	70	3350	1,7	4,8	≤60	86	120	FCC2QDY907#L120#3##2E3
	1 000	44	63	70	70	3200	1,2	4,2	≤60	76	175	FCC2QDY108#H175#3##2E3
	1 200	43	67	70	70	2350	1,2	4,4	≤60	86	155	FCC2QDY128#L155#3##1E3
	1 400	48	68	70	70	4500	1,0	4,3	≤50	86	175	FCC2QDY148#L175#3##2E3
800 2K	350	34	48	59	68	1550	1,7	5,1	≤50	76	95	FCC2KDY357#H095#3##2E3
	490	35	49	60	69	2000	1,5	5,6	≤50	86	95	FCC2KDY497#L095#3##2E3
	500	31	45	55	64	1600	2,1	4,7	≤60	76	120	FCC2KDY507#H120#3##2E3
	650	34	48	59	68	3200	1,8	4,8	≤60	86	120	FCC2KDY657#L120#3##2E3
	730	44	63	70	70	3100	1,2	4,2	≤60	76	175	FCC2KDY737#H175#3##2E3
	770	33	48	59	68	2100	1,9	4,6	≤60	86	136	FCC2KDY777#L136#3##2E3
	780	33	48	58	67	2150	2,0	4,4	≤60	86	155	FCC2KDY787#L155#3##2E3
	850	47	67	70	70	4100	1,0	4,4	≤60	86	155	FCC2KDY857#L155#3##2E3
	950	45	65	70	70	4130	1,1	4,3	≤60	86	175	FCC2KDY957#L175#3##2E3
900 R2	350	34	48	59	68	1500	1,7	5,1	≤50	76	95	FCCR2DY357#H095#3##2E3
	490	35	49	60	69	2000	1,5	5,6	≤50	86	95	FCCR2DY497#L095#3##2E3
	500	31	45	55	64	1600	2,1	4,7	≤60	76	120	FCCR2DY507#H120#3##2E3
	600	31	44	54	62	1580	2,4	4,3	≤60	76	155	FCCR2DY607#H155#3##2E3
	650	34	48	59	68	3100	1,8	4,8	≤60	86	120	FCCR2DY657#L120#3##2E3
	730	44	63	70	70	3200	1,2	4,2	≤60	76	175	FCCR2DY737#H175#3##2E3
	770	33	48	59	68	2100	1,9	4,6	≤60	86	136	FCCR2DY777#L136#3##2E3
	780	33	48	58	67	2150	2,0	4,4	≤60	86	155	FCCR2DY787#L155#3##2E3
	850	47	67	70	70	4000	1,0	4,4	≤60	86	155	FCCR2DY857#L155#3##2E3
	950	45	65	70	70	4150	1,1	4,3	≤60	86	175	FCCR2DY957#L175#3##2E3
1000 3A	300	32	45	56	64	1500	1,9	5,1	≤50	76	95	FCC3ADY307#H095#3##2E3
	400	31	44	54	62	1580	2,2	4,7	≤60	76	120	FCC3ADY407#H120#3##2E3
		33	47	58	67	1580	1,6	5,6	≤50	86	95	FCC3ADY407#L095#3##2E3
	490	29	42	52	60	1600	2,6	4,3	≤60	76	155	FCC3ADY497#H155#3##2E3
	540	33	47	57	66	2000	1,9	4,8	≤60	86	120	FCC3ADY547#L120#3##2E3
	590	42	61	70	70	3000	1,3	4,2	≤60	76	175	FCC3ADY597#H175#3##2E3
	600	32	47	57	66	3120	2,0	4,6	≤60	86	136	FCC3ADY607#L136#3##2E3
	640	32	47	57	66	3250	2,1	4,4	≤60	86	155	FCC3ADY647#L155#3##2E3
	680	44	64	70	70	3280	1,1	4,4	≤60	86	155	FCC3ADY687#L155#3##2E3
	780	45	65	70	70	4000	1,1	4,3	≤60	86	175	FCC3ADY787#L175#3##2E3
1100 A3	220	31	44	54	63	1550	2,0	5,1	≤50	76	95	FCCA3DY227#H095#3##2E3
	300	29	41	51	58	1600	2,5	4,7	≤60	76	120	FCCA3DY307#H120#3##2E3
		32	46	56	65	1600	1,7	5,6	≤50	86	95	FCCA3DY307#L095#3##2E3
	350	27	39	48	56	1650	3,0	4,3	≤60	76	155	FCCA3DY357#H155#3##2E3
	400	31	45	55	63	3100	2,1	4,8	≤60	86	120	FCCA3DY407#L120#3##2E3
	430	30	43	52	60	3250	2,4	4,6	≤60	86	136	FCCA3DY437#L136#3##2E3
	440	41	58	70	70	3280	1,4	4,2	≤60	76	175	FCCA3DY447#H175#3##2E3
	500	43	62	70	70	3940	1,2	4,4	≤60	86	155	FCCA3DY507#L155#3##2E3
	580	44	62	70	70	3980	1,2	4,3	≤60	86	175	FCCA3DY587#L175#3##2E3

(1) Maximum permissible peak current, (2) Thermal resistance from hotspot to ambient (free convection)

U_R ≤85°C (V_{DC})	C_R (µF)	I_{max} 70°C, 1kHz (A)	60°C, 1kHz (A)	50°C, 1kHz (A)	≤40°C, 1kHz (A)	$\hat{I}$ (1) (A)	ESR_{typ} 20°C, 1kHz (mΩ)	R_{th}(2) (K/W)	L_S 20°C (nH)	D ±1,0 (mm)	H H1=H+5mm ±1,0 (mm)	ORDER CODE "#" to be defined, see ordering code table
1200 3B	180	31	43	53	61	1520	2,1	5,1	≤60	76	95	FCC3BDY187#H095#3##2E3
	250	27	39	48	55	1980	2,8	4,7	≤60	76	120	FCC3BDY257#H120#3##2E3
		31	45	55	63	1980	1,8	5,6	≤50	86	95	FCC3BDY257#L095#3##2E3
	330	42	59	70	70	2130	1,3	4,3	≤60	76	155	FCC3BDY337#H155#3##2E3
	370	41	58	70	70	2590	1,4	4,2	≤60	76	175	FCC3BDY377#H175#3##2E3
	380	29	42	51	59	2600	2,5	4,6	≤60	86	136	FCC3BDY387#L136#3##2E3
	400	29	42	51	59	2800	2,6	4,4	≤60	86	155	FCC3BDY407#L155#3##2E3
	420	44	62	70	70	3000	1,2	4,4	≤60	86	155	FCC3BDY427#L155#3##2E3
	480	42	60	70	70	3190	1,3	4,3	≤60	86	175	FCC3BDY487#L175#3##2E3
1500 C3	110	27	39	48	55	1340	2,6	5,1	≤50	76	95	FCCC3DY117#H095#3##2E3
	140	28	40	49	57	1360	2,2	5,6	≤50	86	95	FCCC3DY147#L095#3##2E3
	150	25	36	44	51	1420	3,3	4,7	≤60	76	120	FCCC3DY157#H120#3##2E3
	160	24	34	42	48	1450	4,0	4,3	≤60	76	155	FCCC3DY167#H155#3##2E3
	180	28	39	48	56	1560	2,7	4,8	≤60	86	120	FCCC3DY187#L120#3##2E3
	200	37	53	65	70	2200	1,7	4,2	≤60	76	175	FCCC3DY207#H175#3##2E3
	220	26	37	46	53	2460	3,1	4,6	≤60	86	136	FCCC3DY227#L136#3##2E3
	240	40	57	70	70	2590	1,4	4,4	≤60	86	155	FCCC3DY247#L155#3##2E3
	270	39	56	68	70	3100	1,5	4,3	≤60	86	175	FCCC3DY277#L175#3##2E3

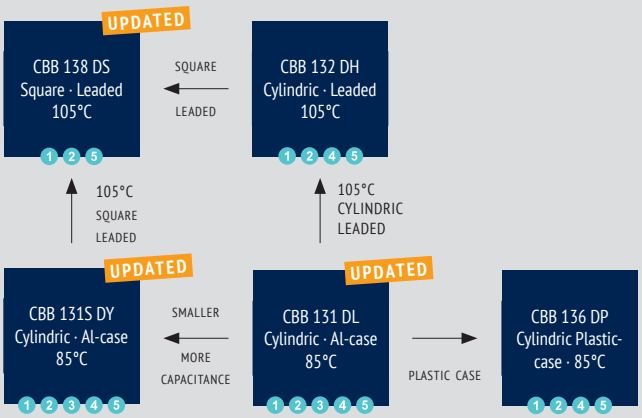
(1) Maximum permissible peak current, (2) Thermal resistance from hotspot to ambient (free convection)

DC LINK OVERVIEW

DC-LINK

APPLICATIONS:

1. High power frequency converters
2. Motion control, welding equipment, elevators
3. Electric and hybrid electric vehicles
4. Photovoltaic and wind inverters
5. Industry high-end power supplies

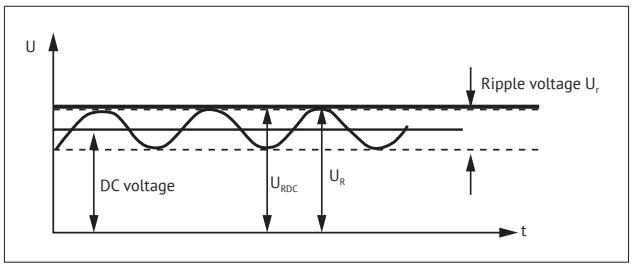


WARRANTY The information contained in this datasheet does neither form part of any quotation nor of a contract, it is believed to be accurate, reliable and up to date. Quality data are based on the statistical evaluations of a large quantity of parts and do not constitute a guarantee in a legal sense. However, agreement on these specifications does mean that the customer may claim for replacement of individual defective capacitors within the terms of delivery. We cannot assume any liability beyond the replacement of defective components. This applies in particular to any further consequences of component failure. Furthermore it must be taken into consideration that the figures stated for lifetime and failure rates refer to the average production status and are therefore to be understood as mean values (statistical expectations) for a large number of delivery lots of identical capacitors. These figures are based on application experience and data obtained from preceding tests under normal conditions, or – for purpose of accelerated aging – more severe conditions. JIANGHAI reserves the right to change these specifications without prior notice. Any application information given is advisory and does not form part of any specification. The products are not primarily designed for use in life supporting applications, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. JIANGHAI customers using or selling these products for use in such applications without prior written consent of JIANGHAI do so at their own risk and agree fully to indemnify JIANGHAI for any damage resulting from such improper use or sale. This version of the datasheet supersedes all previous versions.

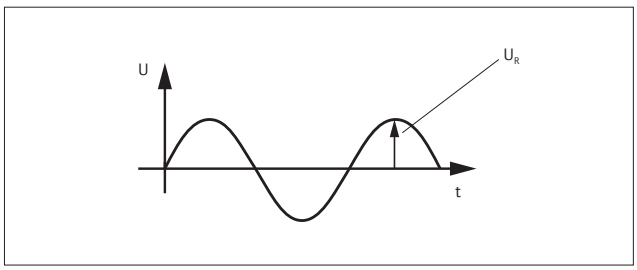
NOMINAL CAPACITANCE C_R Nominal Capacitance is defined at 20°C and 50Hz (120Hz).

RATED VOLTAGE U_R

DC Capacitors: U_{RDC} Maximum operating peak voltage of either polarity but of a non-reversing type waveform, for which the capacitor has been designed, for continuous operation. The maximum DC voltage is the sum of the DC voltage and peak AC voltage.



AC Capacitors: U_{RAC} Maximum operating peak recurrent voltage of either polarity of a reversing type waveform for which the capacitor has been designed.



OPERATING VOLTAGE The plastic film capacitor varies in the maximum applicable voltage depending on the applied voltage waveform, current waveform, frequency, ambient temperature (capacitor surface temperature), capacitance value, etc. Be sure to use capacitors within the specified values by checking the voltage waveform, current waveform, and frequency applied to them (In the application of high frequency, the permissible voltage varies with the type of the capacitor. Refer to the specification for details. See also Voltage Derating tables.).

NON-RECURRENT SURGE VOLTAGE U_S Peak voltage induced by a switching or any other disturbance of the system which is allowed for a limited number of times and for durations shorter than the basic period.

- Maximum duration: 50 ms / pulse
- Maximum number of occurrences: 1000 (during load)

MAXIMUM RATE OF VOLTAGE RISE dV/dt Maximum permissible repetitive rate of voltage rise of the operational voltage.

OPERATING CURRENT Due to the fact that the dissipation factor of the capacitor is greater than zero, heat will be generated in any application where alternating currents or pulses occur. The resulting internal temperature rise may cause a severe deterioration of the capacitor's withstanding voltage, or may lead to a breakdown (even smoke or fire may result). Therefore, the safe use of capacitor must be within the rated voltage (or category voltage) and the permissible current ranges. The rated current must be considered by dividing into pulse current (peak current) and continuous current (rms current) depending on the break down mode, and when using, should make sure the both currents are within the permissible range.

MAXIMUM CURRENT I_{MAX} Maximum Rms Current for continuous operation, see Current Derating tables.

MAXIMUM PEAK CURRENT $\hat{I}$ Maximum permissible repetitive peak current which can occur during continuous operation.

$\hat{I} = C_R * (dV/dt)$

MAXIMUM SURGE CURRENT $\hat{I}_S$

- Maximum duration: 50 ms / pulse
- Maximum number of occurrences: 1000 (during load)

SERIES RESISTANCE R_S Effective ohmic resistance of the conducting elements of the capacitor.

EQUIVALENT SERIES RESISTANCE ESR The ESR represents all ohmic resistances: $ESR = \tan\delta/(\omega C) = R_s + \tan\delta_o/(\omega C)$

DIELECTRIC DISSIPATION FACTOR $\tan\delta_0$ Constant dissipation factor of the dielectric material.

LOSS FACTOR $\tan\delta$ The dissipation factor is the ratio between the reactive and effective power.

HOTSPOT TEMPERATURE $\Theta_{HOTSPOT}$ Temperature at the hottest position inside the capacitor. $\Theta_{hotspot} = \Theta_{ambient} + P_{loss} * R_{th}$

R_{th}: thermal resistance, P_{loss}: Powerloss $P_{loss} = ESR * I_{rms}^2$,

$\Theta_{ambient}$ = ambient temperature

CHARGING AND DISCHARGING Because the charging and discharging current of capacitor is obtained by the product of voltage rise rate (dV/dt) and capacitance, low voltage charging and discharging may also cause deterioration of capacitor such as

shorting and open due to sudden charging and discharging current. When charging and discharging, pass through a resistance of 20Ω/V to 1000Ω/V or more to limit the current. When connecting multiple film capacitors in parallel in withstand voltage test or life test, connect a resistance of 20Ω/V to1000Ω/V or more in series to each capacitor. In addition, **capacitors must be discharged via a resistor before handling**. Because the capacitors do not have any discharge resistors built-in, there is a risk of residual voltages and electric energy contents that might be dangerous.

TEMPERATURE RANGE AND ALTITUDE Use film capacitors only within the specified operating temperature range. The altitude and barometic pressure have an impact on the functionality of the capacitor. Max. Altitude: 2000m above sea level.

ALTITUDE/m	CURRENT DERATING COEFFICIENT
⩽ 2 000	1,00
2 500	0,95
3 000	0,90
3 500	0,85
4 000	0,80
4 500	0,75
5 000	0,70

EXPECTED LIFETIME The expected lifetime of the capacitor depends on the applied voltage and the hot spot temperature during operation. For capacitors applied in different situations, the obtainable average service lives are different. Please refer to the life time diagrams of each series.

FAILURE RATE λ (FAILURE IN TIME FIT) 1 FIT = $1/10^{-9}$h (1 failure per 10^9 components test hours), $\lambda=r/(nt)$
r= number of failure, n= test number, t= test time

INSULATION VOLTAGE U_i Rms value of AC voltage designed for the insulation between terminals of the capacitor to case or earth. The insulation voltage is equal to the rated voltage of the capacitor, divided by , unless otherwise specified.

INSULATION RESISTANCE R_i Ration between applied DC Voltage and resulting leakage current after 1 minute of charge. It is defined in MΩ. Typically it is given as time constant R_i*C [µF] in seconds.

VOLTAGE BETWEEN TERMINALS U_{TT} Voltage between terminals.

VOLTAGE BETWEEN TERMINALS AND CASE U_{TC} Voltage between terminals and case.

BUZZING NOISE Any buzzing noise produced by a capacitor is caused by the vibration of the film due to the Coulomb force that is generated between the electrodes with opposite poles. It is of no harm to the capacitor.

DIELECTRICAL ABSORPTION Due to the dielectrical absorption voltages may occure between the terminals. Please discharge the capacitor before usage.

SURFACE OVER TEMPERATURE $\Delta\theta_{case}$ When current continuously flow through the capacitor, the temperature inside the capacitor will rise induced by dissipated heat. If the temperature exceeds the maximum allowed hot-spot temperature, it might cause a short circuit or fire. The limits described in the catalogue must not be exceeded and it's necessary to check the temperature on the capacitor's surface in operation.

FLAME RETARDATION Although flame retarding PU resin or plastic case material is used in the coating or encapsulation of plastic film capacitors, continuous exposure to high temperature ambient or fire will break the coating layer or plastic case of the capacitor, and may lead to melting and ignition of the capacitor element.

HUMID AMBIENT If used for a long time in a humid ambient, the capacitor might absorb humidity and oxidize the electrodes causing damage to the capacitor. In case of AC application, high humidity would increase the corona effect. This phenomenon causes a drop in capacitance and an increase of capacitor losses. Humidity needs to be avoided. If needed please inform Jianghai separately for technical adopted components.

STORAGE CONDITIONS 1) Capacitors must not be stored in corrosive atmospheres, particularly not when chlorides, sulfides, alkali, acids, lye, salts, organic solvents or similar substances are present. 2) It must not be stored in high temperature and/or high humidity environments. The following storage conditions must be kept (applicable only for storage in the original package): Temperature: ⩽ 35 °C; Humidity: ⩽ 80% RH, no dew allowed on the capacitor; Storage time: ⩽ 24 months

MOUNTING Other devices, which are mounted near the capacitor, should not touch the capacitor. Additional heat coming from other components near the capacitor may reduce the lifetime of the capacitor. Do never attempt to bend or twist the capacitor after mounting and avoid any mechanical stress on the terminals. Never exceed the max. permissible torques when tightening the terminal screws or the mounting bolt's cap nuts.

CAUTION & WARNINGS Do not touch the terminals of capacitors. The energy stored in capacitors may be lethal. Ensure that the operating environment of the equipment into which the capacitor has been built, is within the specified conditions. Capacitors must not be used in corrosive atmospheres, particularly not when chlorides, sulfides, alkali, acid, lye, salts, organic solvents or similar substances are present. Electrical or mechanical misapplication may be hazardous. Personal injury or property damage may result from bursting of the capacitors or from expulsion of melted material.

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