NOISE SUPPRESSION CAPACITORS

Fax Back Document #1100

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• Safety Standards

Okaya noise suppression capacitors have been recognized by the following safety standards organizations:

Organization (country)		Applicable Standard	
		Household Appliances	Office Appliances and others
IEC		PUB 65	PUB 950
UL	(USA)	UL-1414 (capacitor)	UL-1283 (filter)
CSA	(Canada)	C22.2 No. 0 No. 1	C22.2 No.8
VDE	(Germany)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
SEV	(Switzerland)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
BS	(Great Britian)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
SEMKO	(Sweden)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
DEMKO	(Denmark)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
NEMKO	(Norway)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
EI	(Finland)	IEC384-14II(EN132400)	IEC384-14II(EN132400)
ÖVE	(Austria)	----------	IEC384-14II(EN132400)
IMQ	(Italy)	----------	IEC384-14II(EN132400)

- Electrical apparatus are classified roughly into two categories, i.e., (a) household appliances and (b) office appliances including office automation (OA) and others.
- The standards for noise suppression capacitors to be used in the household appliances are more strict than those in the office appliances and others.
- The products enumerated in the following pages (with a few exceptions) have been approved under standards applicable to the household appliances, so that you may use them for almost all applications.
- In order to avoid any accidents in machine applications which may experience unexpected abnormal surge voltage, or which are subjected to continuous 24-hour use, it is necessary to build in an extra measure of reliability. Here, the strict test conditions conducted by the above-mentioned safety standards organizations can be considered as one of the criteria from a reliability point of view.
- The product should be selected on the basis of a thorough consideration of such safety standards according to its application.

- **OUTLINE OF CAPACITOR CLASS RATINGS**

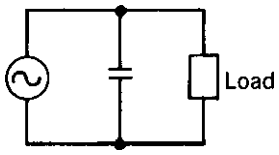
Capacitor are classified by the IEC into two categories (these designations are used by most European countries).

Class Y: Capacitors used in applications where damage to the capacitor may involve danger of electrical shock.

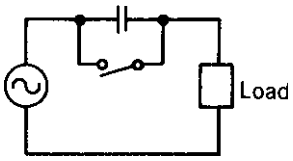
Class X: Capacitors used in applications where damage to the capacitor will not lead to the danger of electrical shock.

These X and Y Classifications are further divided into subcategories as shown in the tables.
(Ref. IEC 384-14, 2nd edition, 1993)

In addition, in North America, Designations of Across-the-Line capacitors, Antenna couplings, and Line bypass capacitors refer to the following applications:



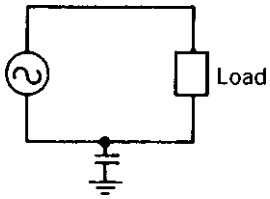
Class X: Across-the-line



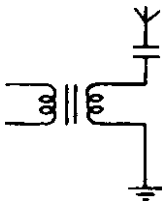
Class X: Across-the-line

Subclass	Peak Voltage	IEC 664 Category	Application
X1	>2.5kV <4.0kV	III	Hi-pulse
X2	<2.5kV	II	General
X3	<1.2kV	I	General

Subclass	Type Insulation	Voltage Range	Peak Voltage
Y1	Double	<250V	8.0kV
Y2	Basic	>150V <250V	5.0kV
Y3	Basic	<150V	None
Y4	Basic		2.5kV



Class Y: Line bypass



Class Y: Antenna coupling

- **SAFETY AGENCY TEST PARAMETERS**

INSULATION RESISTANCE TEST (OHMS)

	UL1283	UL1414	CSA	IEC384-14
X cap	NONE	500M	500M	15,000M
Y cap	2M			
CASE				30,000M

WITHSTAND VOLTAGE TEST
(ONE MINUTE TEST)

	UL1283 250V	UL1414 250V	CSA	IEC384-14
X cap	1000AC	1500AC	1000AC	WV x 4.3(DC)
Y cap	1500AC			1500AC
CASE		1000AC		

ENDURANCE TEST

	UL1283	UL1414		CSA	IEC384-14	
		125V	250V		X2	Y
TEST VOLTAGE	WVx1.5	220	440	220	WVx1.25	WVx1.7
MAX VOLTAGE	NONE	440	880	440	1000	1000
TEST TIME HR	1000	1000	1000	1000	1000	1000

LIGHTNING SURGE TEST

IEC 384-14II Test:	1.2µsec x 50µsec wave form.
Repetition:	Three Times
Voltage Peak:	X1 cap - 4Kv, X2 cap - 2.5kV Y2 cap - 5kV

Okaya characterizes all capacitors using the standard test procedures outlined in JIS C 5102, 5150, 5151. These test parameters are confirmed by a Q.A. audit and are published as guaranteed specifications shown as “dielectric withstanding voltage”.

Okaya performs 100% screen testing of all capacitors during the production process. These tests are subject to changes due to improvements in test equipment and procedures and are published for reference only.

NOISE SUPPRESSION CAPACITORS

• FEATURES

The design and manufacture of OKAYA AC capacitors incorporates many features which make them superior in noise suppression applications.

Both single and double wound construction of the metallized polyester and polypropylene films insure long term reliability.

Many series are oil impregnated to prevent annoying buzz and hum. This also provides additional protection against "Corona" by eliminating air gaps.

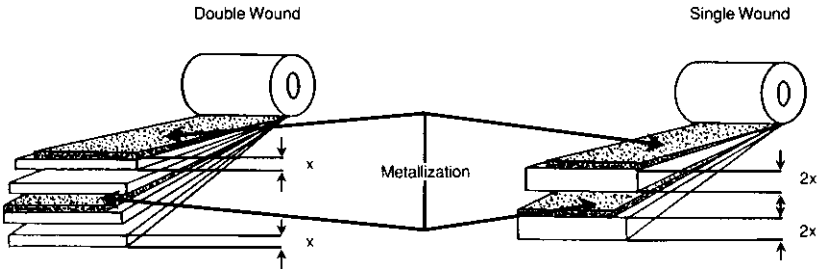
The electrical connection to the metallized film is made via a special multi-element solder which provides excellent surge current withstand capability and a decrease in Dissipation Factor.

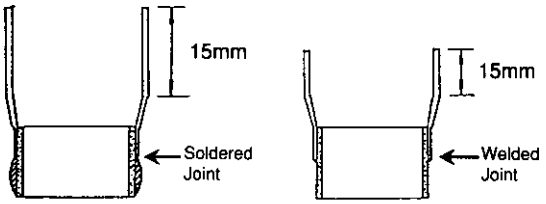
Lead wires are soldered or welded to provide a strong bond to the metallized element. This is particularly important during wave soldering and the ability to withstand current surges while protecting equipment.

OKAYA's proprietary potting process prevents the outer case of the capacitor from exploding when exposed to "killer surges". Some competitive devices are designated "suitable for use with special enclosure only" by certain safety approval agencies.

OKAYA's AC capacitors employ a case made of FR-PBT (Polybutylene Terephthalate) which is impervious to most cleaning processes. The case and potting material are both rated UL94 Flame Class V-O.

OKAYA has one of the highest dv/dt ratings of any capacitor in its class. In many cases 1.5 to 4 times higher than competitive devices.





Class X dv/dt (v/μs)

Cap Val.	COMPETITOR			OKAYA	
	A	B	C	PA(X2)	XE(X1)
103	1200		1200	2800	3000
153	1200		1200	2800	3000
223	1200		1200	2400	2800
333	1200		1200	2400	2800
473	1200		1200	2000	2400
683	1200		1200	2000	2400
104	600		600	1600	2000
154	600	100	600	1600	2000
224	600	100	600	1200	1600
334	400	100	400	1200	1600
474	400	100	400	1000	1400
684	400	100	400	1000	1200
105	400	100		800	1000
155	400			800	
225	400			600	

Class Y dv/dt (v/μs)

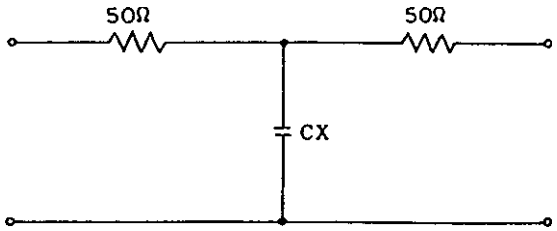
Cap Val.	COMPETITOR			OKAYA		
	A	B	C	XA	XE	YE
102	2000	2000		3000	3000	3000
152	2000	2000		3000	3000	3000
222	2000	2000	2000	3000	3000	3000
332	2000	2000	2000	3000	3000	3000
472	2000	2000	2000	3000	3000	3000
682	1400	1400	1400	3000	3000	3000
103	1400	1400	1400			3000
153	1400	1400	1400			3000
223	1400	1400	1400			3000
333		1000	1000			2800
473		1000	1000			2600
683			1000			2400
104			600			2400

• INSERTION LOSS

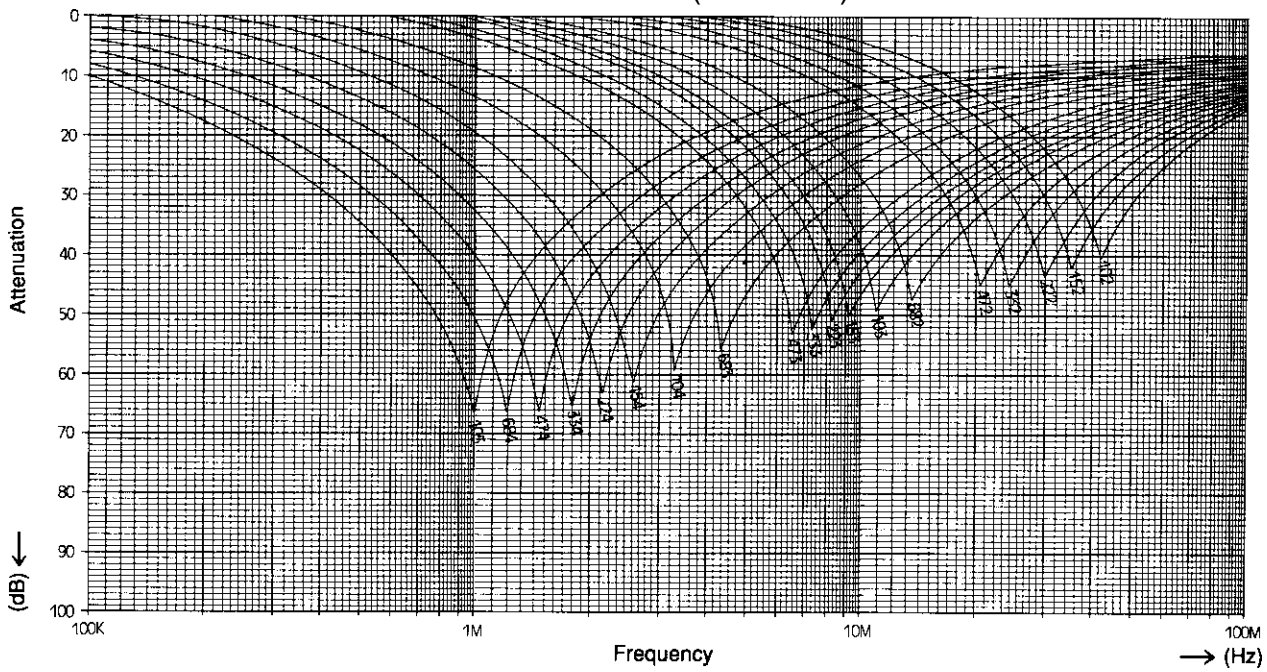
The insertion loss of a capacitor is measured in a 50Ω system.

Insertion Loss = 20 $\log_{10}$ (V2/V1) (dB)

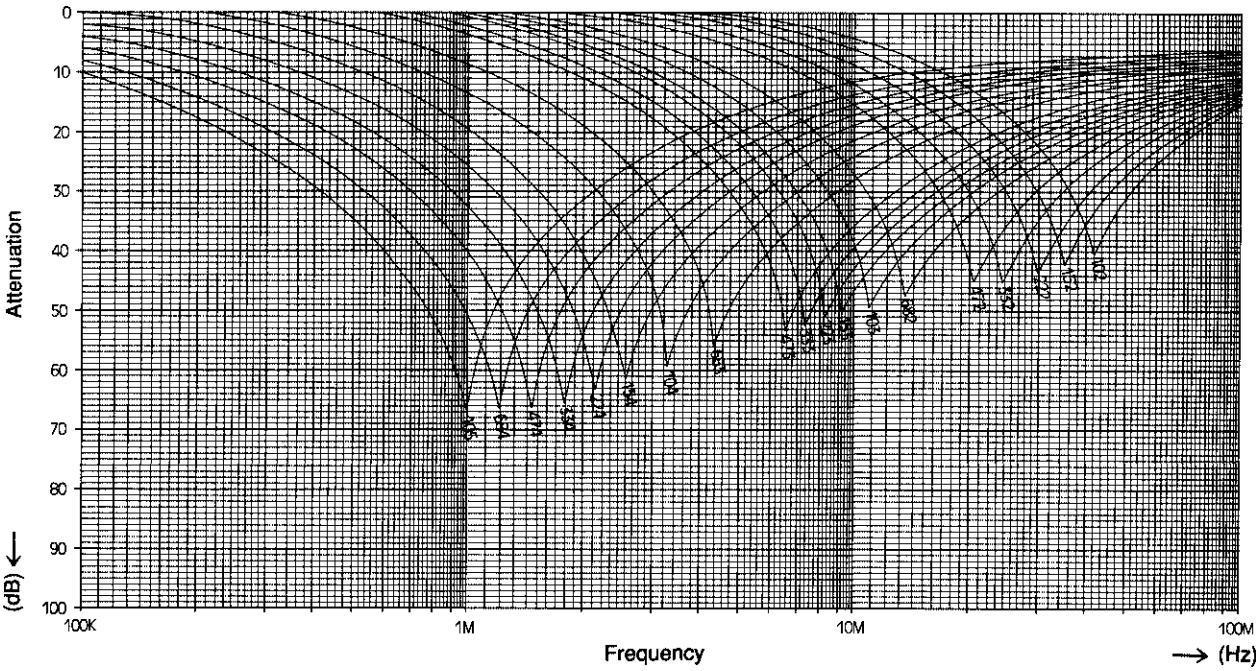
V1 Level without test sample
V2 Level with test sample



INSERTION LOSS (PA Series)



INSERTION LOSS (XE Series)



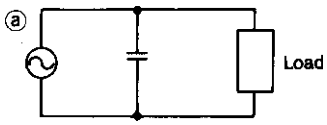
NOISE SUPPRESSION CAPACITORS

• APPLICATION EXAMPLES

Electrical noise, which effects the correct operation of electrical equipment, can originate from sources both external and internal to the product. For example, high frequency noise can be generated by the rotation of a brush motor. As a counter measure to such noise, a capacitor can be introduced into the noise prevention circuitry to lower the circuit impedance. It is necessary to use a capacitor with excellent, high-frequency characteristics. This is why metallized polyester film is used by OKAYA as the capacitor dielectric in all AC noise suppression capacitors.

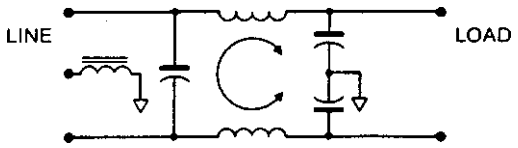
• Examples of Uses:

a) Effective as countermeasure for low-energy noise produced by high frequencies in DC motor brushes. Applications include power tools using multi-pole brush motors, vacuum cleaners, mixers, etc.



b) Here, a common coil is used to compose a filter circuit as a means of improving attenuation and expanding band range.
Applications include a wide variety of office appliances, switching power units, etc.

c) This shows countermeasures against common mode noise taken in addition to the measures shown in b).



*NOTE: For applications of the type shown in b) and c), see the OKAYA Noise Filter catalog.

• RATED CURRENT

The following is used to calculate the current for a supply voltage. Values for 250V rms, 50/60Hz are shown in the table (Precautions should be taken with regard to voltage fluctuation and permissible deviation of electrostatic capacitance when calculating maximum values.)

$I=2\pi fCE$ (A)

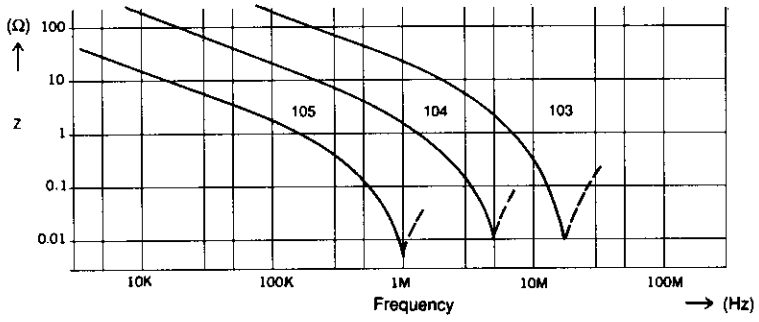
I: Current ..... Amps (A)
f: Operating frequency ..... (Hz)
C: Electrostatic capacitance ..... Farads(F)
E: Supply voltage ..... RMS(V)

Frequency \ Capacitance μF	0.001	0.0015	0.0022	0.0033	0.0047	0.0068	0.01	0.015	0.022	0.033
50Hz	0.1	0.1	0.2	0.3	0.4	0.5	0.8	1.18	1.73	2.59
60Hz	0.1	0.1	0.2	0.3	0.4	0.6	0.9	1.41	2.07	3.11

Frequency \ Capacitance μF	0.047	0.068	0.1	0.15	0.22	0.33	0.47	0.68	1.0
50Hz	3.69	5.34	7.85	11.8	17.3	25.9	36.9	53.4	78.5
60Hz	4.43	6.41	9.42	14.1	20.7	31.1	44.3	64.1	94.2

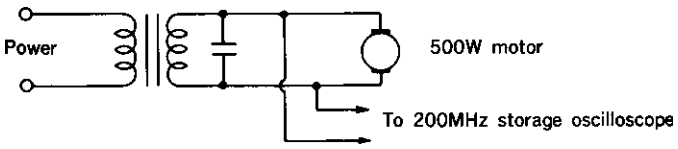
Unit : mA

Impedance vs Frequency

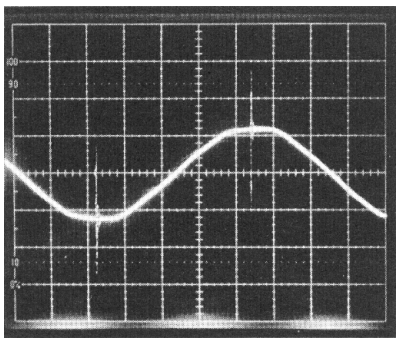


• EXAMPLES OF NOISE SUPPRESSION EFFECTS

Noise suppression capacitors are most widely applied as countermeasures to noise occurring in inverters, switching power units, brush motors, and to the full range of Office Automation equipment.

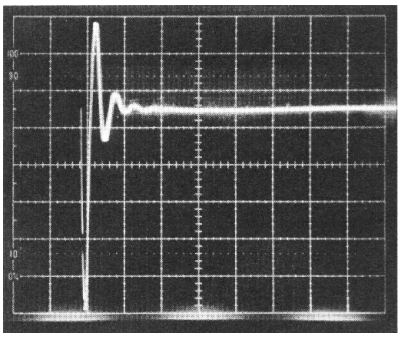


These illustrations show examples of the noise suppression effects produced with a 500W class brush motor used on a commercial 120V line. The load is driven through an isolation transformer.



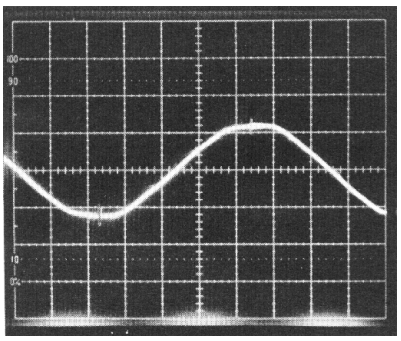
2msec/div
100V/div

A) This illustration shows the line waveform without any noise countermeasures. A damped oscillation wave of about 800Vp-p is visible at the instant of positive and negative peak.



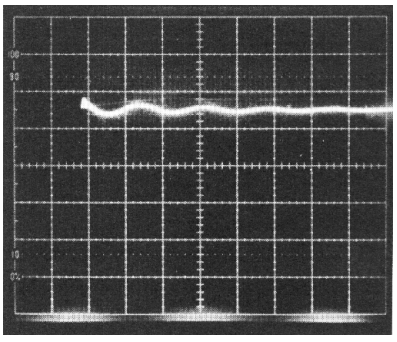
10μsec/div
100V/div

B) This illustration shows an observation of the noise component alone. (Time axis 10μsec/div.)



2msec/div
100V/div

C) This illustration shows the results of noise countermeasures taken by inserting an XE474 (0.47μF) capacitor in the line. A minute amount of noise appears to remain in the sine curve, but it is not considered significant.

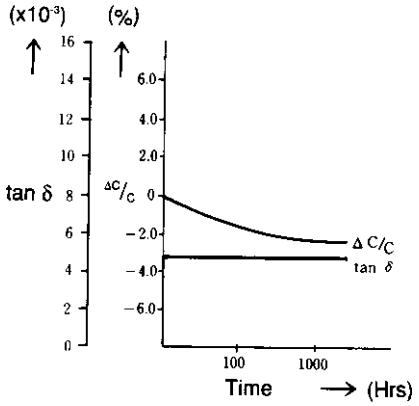


10μsec/div
100V/div

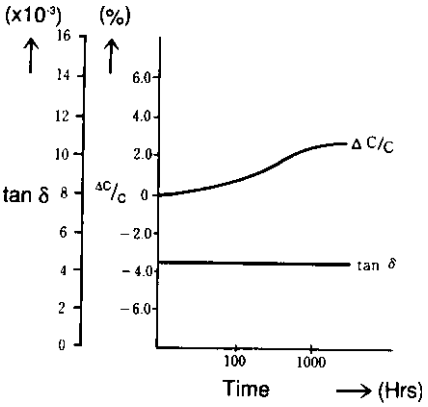
D) This illustration shows the same isolation of the noise at a time axis of 10μsec/div. By the insertion of the electrostatic capacitance of 0.47μF, the period of damping oscillation has become longer, but the peak voltage is well damped, thus producing excellent results.

• PERFORMANCE CHARACTERISTICS

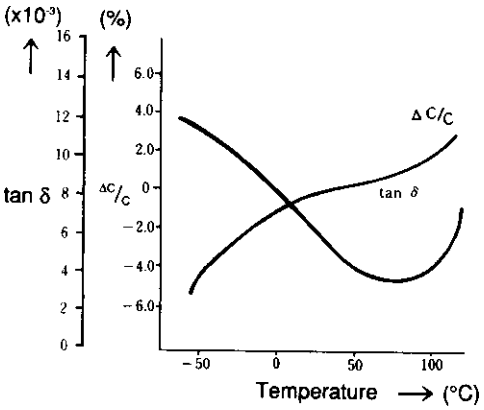
Temperature Endurance (XE type)



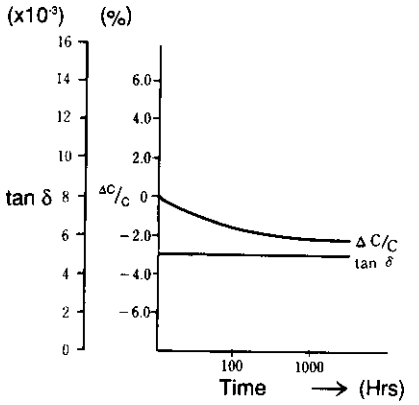
Damp Heat Endurance (XE type)



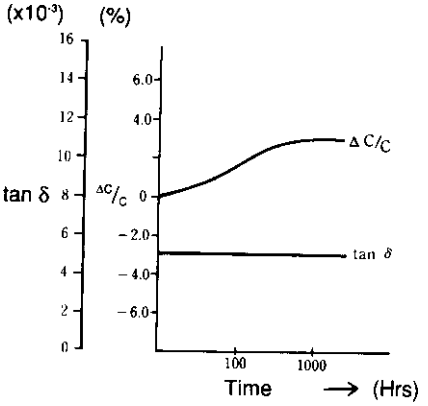
Temperature Characteristics (XE type)



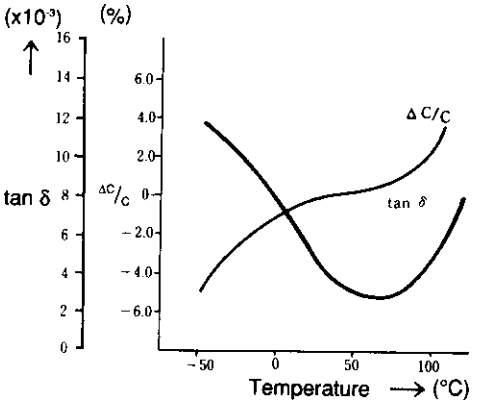
Temperature Endurance (PA type)



Damp Heat Endurance (PA type)



Temperature Characteristics (PA type)



• TEST CONDITIONS

Temperature Endurance:

While operating at maximum rated temperature and at 125% of rated voltage, input 500 Vrms (PA series) or 1000 Vrms (XE Series) four times per hour for 0.1 second.

Damp Heat Endurance:

60°C, 90~95% RH
100% Rated Voltage

Temperature Characteristics:

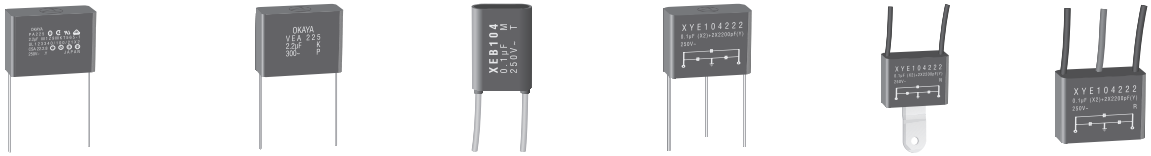
-50°C to +100°C
100% Rated Voltage

• FORM

Rated Voltage	Safety Standard	Lead Type	Forms	Model
275V AC*		Bare Wire	a	PA Series
300V AC		Bare Wire	b	VEA Series
275V AC*		Bare Wire	a	RE Series
250V AC	BS	Bare Wire	a	YE Series
275V AC*		Bare Wire	a	XE Series
250V AC		Flex Wire	c	XEB Series
250V AC		Bare Wire	d	XYE-AN
250V AC		Flex Wire	e	XYE-BN
250V AC		Flex Wire	f	XYE-BE

* UL and CSA = 250V AC

a. b. c. d. e. f.



• APPLICATIONS

AC Motors	Machine Tools	Contact Protection	AC Line Suppression
DC Motors	Washers	Industrial Controls	Vacuum Cleaners
Brush Motors	Power Supplies	Robotics	Tumblers
Grinders	Automotive	NC Controls	Electric Switching
Motor Controls	Lighting	CNC Controls	Power Snubbers
Mixers	Frequency Controls	Antenna Coupling	Mechanical Switching
Dryers			

• DESIGN CAUTIONS

1) When protecting switching contacts, always include a resistor in series with the noise suppression capacitors. See OKAYA's Spark Quencher section for products specifically designed for such applications.

2) In high speed circuits, the addition of a noise suppression capacitor may slow the response time of the circuit. For best response characteristics, do not use a larger capacitor than is absolutely necessary to suppress the noise level.

3) Noise suppression capacitors are most effective when located close to the offending noise source. Excessive lead length may cause abnormal oscillation and decrease the energy absorption capability of the capacitor.

4) When noise suppression capacitors are connected across power lines, care must be taken that the resulting in-rush current does not cause the fuse or circuit breaker to open. Special consideration must be given to both the capacitor value and the breaker ratings.

5) OKAYA noise suppression capacitors are specifically designed for standard line frequencies and should not be used in circuits where normal operation will exceed 70Hz.

6) To prevent permanent damage to noise suppression capacitors, they should not be allowed to self-heat more than 5 degrees centrigrade above ambient.

7) These products do absorb normal line surges. However they are not intended to absorb high-energy surges such as induced lightning. See OKAYA's Transient Voltage Suppressor section for products specifically designed for such applications.