Film Capacitors

EMI suppression capacitors (MKP)

Date: May 2009

1 General / Standards

EMI suppression capacitors, **as the name implies**, are used to reduce electromagnetic interference. They are connected directly to line and are therefore exposed to overvoltages and transients, which could damage the capacitors. For this reason, EMI suppression capacitors must comply with the requirements of the following safety standards:

Region	Standard	Approval marks
Europe	EN 60384-14 IEC 60384-14	
USA	UL 1414 UL 1283	
Canada	CSA C22.2, No.1 CSA C22.2, No.8	1) or
China	CQC (GB/T 14472-1998)	

1) Approved by UL according to CSA

EN 60384-14 / IEC 60384-14, 2nd edition

With the aim of harmonizing all the European national standards and having only one standard of reference, EN 132400 was issued in 1995 to replace all European national standards. The reference European standard EN 132400 is identical to IEC 60384-14, 2nd edition.

The ENEC (European Norms Electrical Certification) mark has replaced the following national marks:

UL 1414 (across the line and line bypass application)

UL 1414 approval is limited to capacitors with the following specifications:

Maximum capacitance: 1 µF
Maximum operating temperature: +85 °C
Maximum operating voltage: 250 V AC

There is no specific UL standard for EMI capacitors above these ratings. The UL 1283 standard must be applied for UL compliance of EMI capacitors, even though it is a general standard for EMI filters.

UL 1283 (electromagnetic interference filters)

UL 1283 approval can also be requested for

capacitance > 1 µF,
temperature > +85 °C,
operating voltage > 250 V AC.

By agreement between UL and CSA, UL can test capacitors and certify compliance to CSA standards and vice-versa. For example, if UL is requested to evaluate an EMI suppression capacitor for UL 1414 and CSA 22.2, No 1, UL will conduct the tests common to both standards and those that are different, if any. Such a capacitor will bear the UL mark and a new "cUL" (c UL) mark that is fully accepted by CSA.

CSA C22.2, No.1 and CSA C22.2, No.8

CSA requirements are almost similar to UL, with CSA C22.2 No.1 being equivalent to UL 1414 and CSA 22.2 No.8 to UL 1283.

CQC (GB/T 14472-1998)

A CQC (China Qualification Certificate) must be obtained for products marketed and imported into China. This came into effect on 1st May 2003.

2 Classification of EMI suppression capacitors

EN 60384-14 and IEC 60384-14 divide EMI suppression capacitors into two groups:

- X capacitors (for line-to-line or line-to-neutral connection) and
- Y capacitors (for line-to-ground or neutral-to-ground connection).

2.1 X capacitors

These are capacitors for applications in which failure of the capacitor will not lead to a dangerous electrical shock. EN 60384-14 divides X capacitors into 3 sub-classes according to the peak pulse voltage to which they are exposed in operation, in addition to the rated voltage. This kind of impulse can be caused by lightning in overhead cables, switching surges in neighbouring equipment or in the device in which the capacitor is used to suppress interferences.

Sub-class	Peak pulse voltage V_p in operation	Application	Peak values of surge voltage V_p (before endurance test)
X1	2.5 kV < V_p ≤ 4.0 kV	High pulse application	C_R ≤ 1.0 µF: V_p = 4.0 kV
			C_R > 1.0 µF: (enter C_R in µF) $V_p = \frac{4}{\sqrt{C_R}}$ kV
X2	V_p ≤ 2.5 kV	General purpose	C_R ≤ 1.0 µF: V_p = 2.5 kV
			C_R > 1.0 µF: (enter C_R in µF) $V_p = \frac{2.5}{\sqrt{C_R}}$ kV
X3	V_p ≤ 1.2 kV	General purpose	No test

Note: Sub-class X3 corresponds to sub-class X2 as described in EC 60384-14 (1st edition).

2.2 Y capacitors

These capacitors are intended for use where failure of the capacitor could result in a dangerous electrical shock. Y capacitors are capacitors of enhanced electrical and mechanical reliability and limited capacitance. The enhanced electrical and mechanical reliability are intended to eliminate short-circuits in the capacitor. Limitation of the capacitance is intended to reduce the current passing through the capacitor when AC voltage is applied and to reduce the energy content of the capacitor to a limit that is not dangerous when DC voltage is applied.

Y capacitors are used in electrical equipment and machines to bridge operational insulation that provides safety, in connection with additional protective measures, in order to avert danger to humans and animals.

EN 60384-14 divides Y capacitors into the following sub-classes:

Sub-class	Type of bridged insulation	Rated AC voltage	Peak values of surge voltage V_p (before endurance test)
Y1	Double or reinforced insulation	$V_R \leq 250$ V	8.0 kV
Y2	Basic or supplementary insulation	150 V $\leq V_R \leq$ 250 V	5.0 kV
Y3	Basic or supplementary insulation	150 V $\leq V_R \leq$ 250 V	No test
Y4	Basic or supplementary insulation	$V_R <$ 150 V	2.5 kV

Note: Sub-class Y3 corresponds to class Y as described in IEC 60384-14 (1st edition).

3 Some important tests to IEC/EN 60384-14

Impulse voltage test

Each capacitor except those of sub-classes X3 and Y3 is tested with the surge voltage (V_p) as shown in the above table.

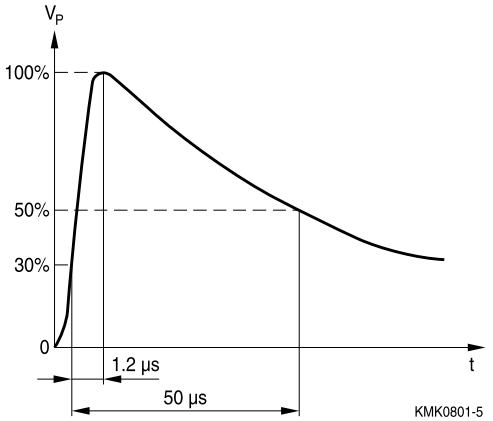

Figure 1
Impulse voltage test for X and Y capacitors

Endurance test

Capacitors are tested with a voltage of 1.25 times the rated voltage for class X2 and 1.7 times for class Y2 at the upper category temperature for 1000 h.

Each hour the test voltage is increased to 1000 V_{RMS}, 50 Hz for a period of 0.1 s.

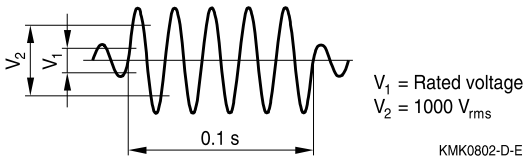

Figure 2
Endurance test for X and Y capacitors

Active flammability test

This test is to ensure that capacitors do not ignite at a defined electrical overload. Capacitors are applied the rated voltage at 50 Hz with 20 superimposed pulses of 2.5 kV for class X2 and 5 kV for class Y2.

The rated voltage is maintained for 2 min. after the last discharge. This is a destructive test, and the failure condition is that cheesecloth around the capacitor shall not burn with a flame. No electrical measurements are required.

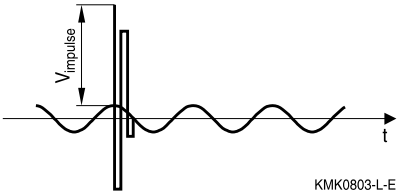

Figure 3
Active flammability test for X and Y capacitors

4 Typical application

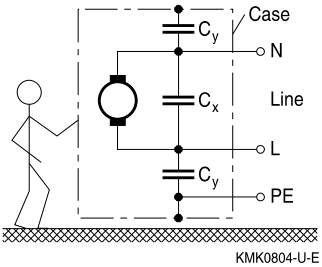

Figure 4
Example of EMI suppression with X and Y capacitors

Depending on how they are connected, X and Y capacitors are effective against different kinds of electromagnetic interference. X capacitors connected between the line phases are effective against symmetrical interference (differential mode). Y capacitors connected between a phase and neutral (zero potential) are effective against asymmetrical interference (common mode).

5 Humidity resistant X2 EMI suppression capacitors

The series B32922*7 ... B32924*7 is an enhanced X2 series for severe ambient conditions. This series can withstand the following damp heat tests:

Test 1:	Temperature:	+40 °C
	Relative humidity:	93% ±2%
	Test duration:	1000 hours
Test 2:	Temperature:	+85 °C
	Relative humidity:	85% ±2%
	Test duration:	200 hours
	Voltage value:	240 V AC, 50 Hz
Test 3:	Temperature:	+40 °C
	Relative humidity:	93% ±2%
	Test duration:	500 hours
	Voltage value	240 V AC, 50 Hz

Capacitance change ($\Delta C/C$):	≤ 10%
Dissipation factor change ($\Delta \tan \delta$):	≤ $0.5 \cdot 10^{-3}$ (at 1 kHz) ≤ $1.0 \cdot 10^{-3}$ (at 10 kHz)
Insulation resistance R_{ins} or time constant $\tau = C_R \cdot R_{ins}$	≥ 50% of minimum as-delivered values

These harsh conditions are normally required in applications such as power meters or household appliances, where the capacitors are used in serial connection with mains in the capacitive power supply configuration as shown in figure 5.
The MKP series B3265x can be used if UL/IEC approvals are not required.

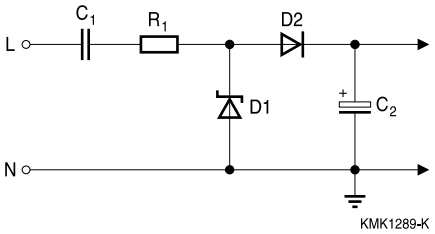

Figure 5
Example of capacitive power supply