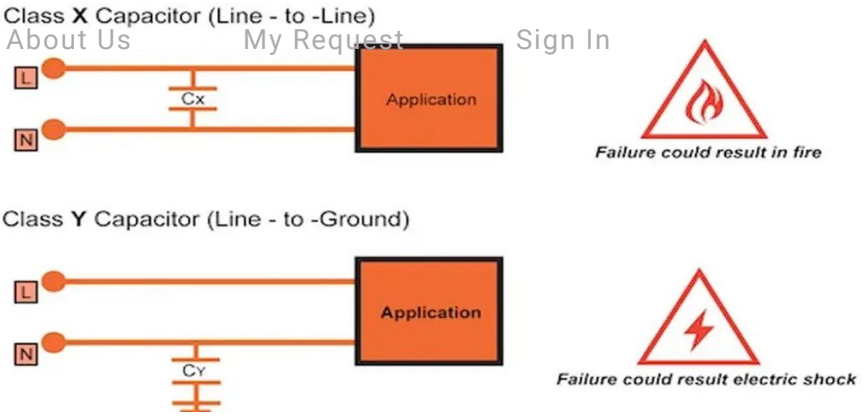

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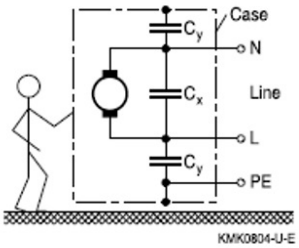
X And Y Safety Capacitor Applications Explained

Posted by doEEEt Media Group On November 10, 2020 0

X and Y Safety Capacitor Applications were discussed among two major passive manufacturers in a virtual roundtable organized by *EE World*. Jeff Shepard from *EE World* hosted Eduardo Drehmer, Director of Marketing for Film Capacitors & Power Quality Solutions with TDK Electronics, Inc. and Daniel West (DW), Field Application Engineer with AVX Corp.

The main difference between X and Y safety capacitors



Their main difference is in the level of safety they provide. X capacitors are required for connections between mains or neutral. Y capacitors are required whenever there is a connection to grounded nodes. Due to the fact that equipment cases are usually grounded, Y caps require higher safety to avoid risks of electrical shocks to users.

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Here is some interesting info on this:

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

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 ≤ 250 V	8.0 kV
Y2	Basic or supplementary insulation	150 V ≤ V_R ≤ 250 V	5.0 kV
Y3	Basic or supplementary insulation	150 V ≤ V_R ≤ 250 V	No test
Y4	Basic or supplementary insulation	V_R < 150 V	2.5 kV

Keeping up with classifications and certifications, knowing where they should go and which are interchangeable can be very confusing for designers. In addition, there are multiple capacitor technologies to consider, all with varying lists of features and benefits.

Ceramic or Film capacitors, what fit better as X and Y safety capacitors

Some characteristics to consider would be the temperature profile over the life of the application, size constraints, and maybe even cost or ease of assembly. Ceramics can achieve higher capacitance values in a smaller volume, while the film has a self-healing feature inherent in the technology.

Ceramic safety caps are usually preferred for low power applications due to their reduced size, but higher capacitance value safety caps are only found in film technology.

Most important design considerations and industry standards for safety capacitors

However, the market for stringent applications has been defining requirements beyond the ones found by these

The industry follows several standards, the most common are:

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

standards. That is why it's very important that designers understand the limitations of the components they are using.

The capacitor class and subclass are very important, it tells the designer what voltages and impulses the capacitor can withstand, in addition to which application it should be used for i.e. across-the-line or line-to-ground. Certifications are also important to confirm IEC 60384-14.4 safety tests.

Safety capacitors in DC/DC converter applications

Safety capacitors can be used to isolate the input and/or output if it is referenced back to a non-isolated buck on mains voltages, especially if a user has access to the connections or interface.

Standards require the usage of protection and safety devices for all equipment connected to the grid or to subcircuits. These must be used as input filters and can operate as generic filters through the circuit.

Source: Power Electronics

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