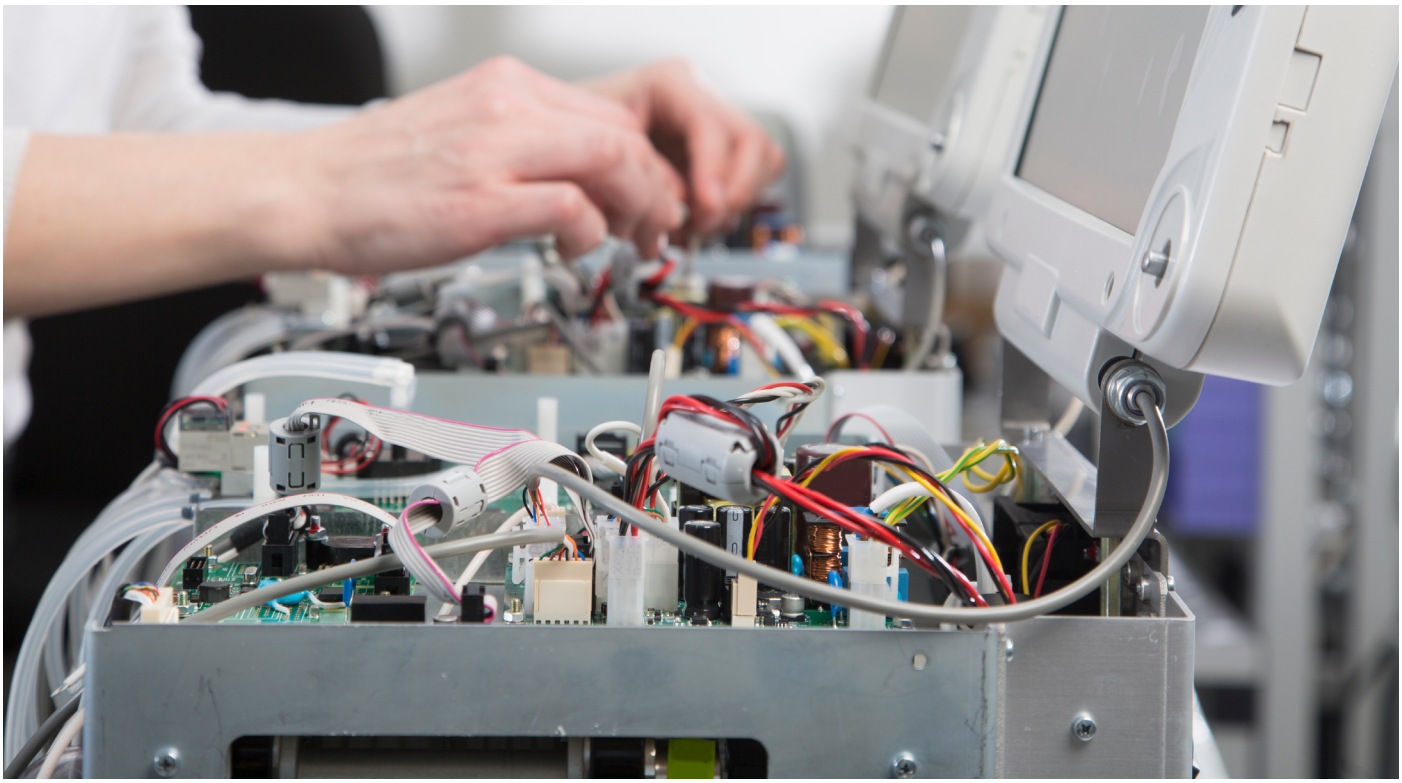
SUPPORTING ALL YOUR SAFETY CAPACITOR NEEDS



In high-voltage, high-reliability applications, safety is non-negotiable, which is why safety capacitors are essential. These passive components are engineered to mitigate the risks associated with transient voltages and electrical interference, helping protect both users and equipment from hazards, even in the event of component failure.

Let's briefly recap the role of safety capacitors and the distinctions between Class X and Class Y before diving into how we can help meet your needs with our safety capacitor offerings.

- **Class X capacitors** (also called across-the-line) are used between the wires carrying incoming AC current. These are designed to fail short, but without creating a shock hazard.

- **Class Y capacitors** (also called line-to-ground or line-bypass) are placed between the AC line and ground. If a ground failure occurs, there's a risk of electric shock, so these capacitors are built to fail open, minimizing that risk.

As shown in Table 1 below, these capacitors are further divided into subclasses based on factors like rated voltage and impulse voltage withstand capability.

Class	Rated voltage	Impulse voltage	Insulation bridging	May be used in primary circuit
Y1	250Vac	8000V	Double or reinforced	Line to protective earth
Y2	250Vac	5000V	Basic or supplementary*	Line to protective earth
Y4	150Vac	2500V	Basic or supplementary*	Line to protective earth
X1	250Vac	4000V	—	Line to line
X2	250Vac	2500V	—	Line to line
X3	250Vac	None	—	Line to line

**2x Y2 or Y4 rated may bridge double or reinforced insulation when used in series*

Table 1. A high-level overview of the key specifications for a range of different safety-certified capacitor classes.

A Comprehensive Safety Capacitor Portfolio

At Knowles, we offer a broad range of safety-certified multilayer ceramic (MLC) and film capacitors designed to meet rigorous standards and support diverse applications from electric vehicle (EV) battery systems to industrial power supplies. Below is a breakdown of what we offer.

Class X Safety Capacitors

Our Class X offerings range from 5.6 pF to 40 µF and are available in both MLCC and film formats.

Key options include:

- **SYX/UYX family:** These are both X1 and Y2 capacitors and are ideal for use in high-voltage EV battery systems
- **MXT Class X2:** Film capacitors that meet demanding 85/85 temperature-humidity-bias (THB) standards, making them ideal for use in harsh environments.

Refer to Table 2 for a full comparison of our Class X product lines.

Class Y Safety Capacitors

Our Class Y safety capacitors, which are most commonly MLCCs, range from 5.pF to 1 µF and include the following options:

- SYX/UYX family
- SYS: Class X1/Y2 safety capacitors that have a humidity robustness grade III rating and 5kV impulse and a 1kVdc rating approved by TÜV and UL
- MYH series: Film capacitors that are AEC-Q200 qualified and meet a 2,000-hour THB life test. Ideal for use in many applications including motors, automated meter readers, uninterruptible power supplies (UPS), power supplies, charging systems, and appliances

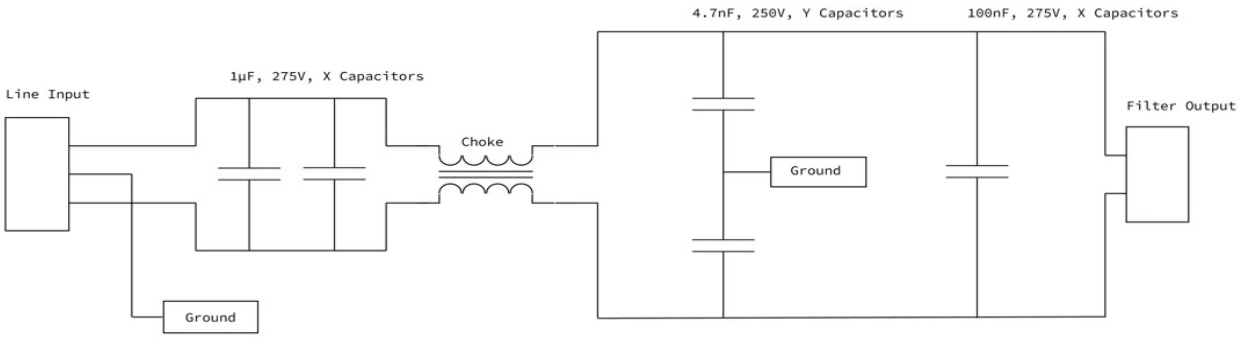
Table 2 provides a comparison of the characteristics of our Class Y safety capacitor offerings.

Class	Series/ Family	Type	Voltage Rating (AC)	Capacitance Range	Package/ Lead Type	Certification	Special Features
X1	SYS/UYS	MLCC	305	5.6 pF – 3.9 nF	1808, 1812 SMD	UL, TÜV, CSA, IEC 60384-14	For IEC 62368, 4 mm creepage, AEC-Q200
X2	S2X	MLCC	250	150 pF – 10 nF	1808, 1812 SMD	UL, TÜV, CSA, IEC 60384-14	FlexiCap™; RoHS; AEC-Q200 (auto)
X1	SYX/UYX	MLCC	305-500	5.6 pF – 12 nF	1808–2720 SMD	UL, TÜV, CSA, IEC 60384-14	FlexiCap™, 4–5 mm creepage, AEC-Q200, humidity grade III
X1	SYM/UYM (Open Mode)	MLCC	305-500	150 pF – 12 nF	2220, 2720 SMD	UL, TÜV, CSA, IEC 60384-14	Open Mode (crack-resistant), 4–5 mm creepage, AEC-Q200
X2	S3X	MLCC	305	10 nF – 56 nF	2220 SMD	UL, TÜV, CSA, IEC 60384-14	FlexiCap™; RoHS; AEC-Q200 (auto)
X2	MXH	Film	305	0.1 µF – 15 µF	Leaded, box	UL, CSA, VDE, CQC, IEC 60384-14	AEC-Q200; flame-retardant; self-healing
X2	MXT	Film	305	0.1 µF – 40 µF	Leaded, box	UL, CSA, VDE, CQC, IEC 60384-14	Flame-retardant; self-healing; RoHS
Y2	SYS/UYS	MLCC	250	5.6 pF – 3.9 nF	1808, 1812 SMD	UL, TÜV, CSA, IEC 60384-14	For IEC 62368, 4 mm creepage, AEC-Q200
Y2	SYX/UYX	MLCC	250–500	5.6 pF – 12 nF	1808–2720 SMD	UL, TÜV, CSA, IEC 60384-14	FlexiCap™, 4–5 mm creepage, AEC-Q200, humidity grade III
Y2	SYM/UYM (Open Mode)	MLCC	250–500	150 pF – 12 nF	2220, 2720 SMD	UL, TÜV, CSA, IEC 60384-14	Open Mode (crack-resistant), 4–5 mm creepage, AEC-Q200
Y2	MYH	Film	300	1.0 nF – 1 µF	Leaded, box (various sizes)	UL, CSA, VDE, CQC, IEC 60384-14, AEC-Q200	

Table 2. A summary comparing many of our most popular Class X and Class Y capacitors.

A Real-World Example

Class X and Class Y capacitors often work in tandem within the same circuit. For example, Figure 1 shows a section of a schematic for an EMI filter board in and AC/DC power converter. In this example the input and output X capacitors are our MXT series film safety capacitors and the Y capacitors are SYS series MLCC safety capacitors.



Capacitor	Type	Example
1µF, 275V, X Capacitors	Film	MXT105K305G20
4.7nF, 250V, Y Capacitors	MLCC	2220YA250472JJTSYX
100nF, 275V, X Capacitors	Film	MXT104K305E10

Whether you're designing electrical components for EVs, consumer appliances, or industrial systems, Knowles is sure to have a safety-certified capacitor that fits your needs, including our newly released extended range of enhanced safety capacitors. You can also learn more about safety capacitors in general by downloading *The Electrical Engineer's Guide to Safety Capacitors* ebook.

Learn More

If you need help selecting from our portfolio please contact us and we can guide you through the selection process.

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