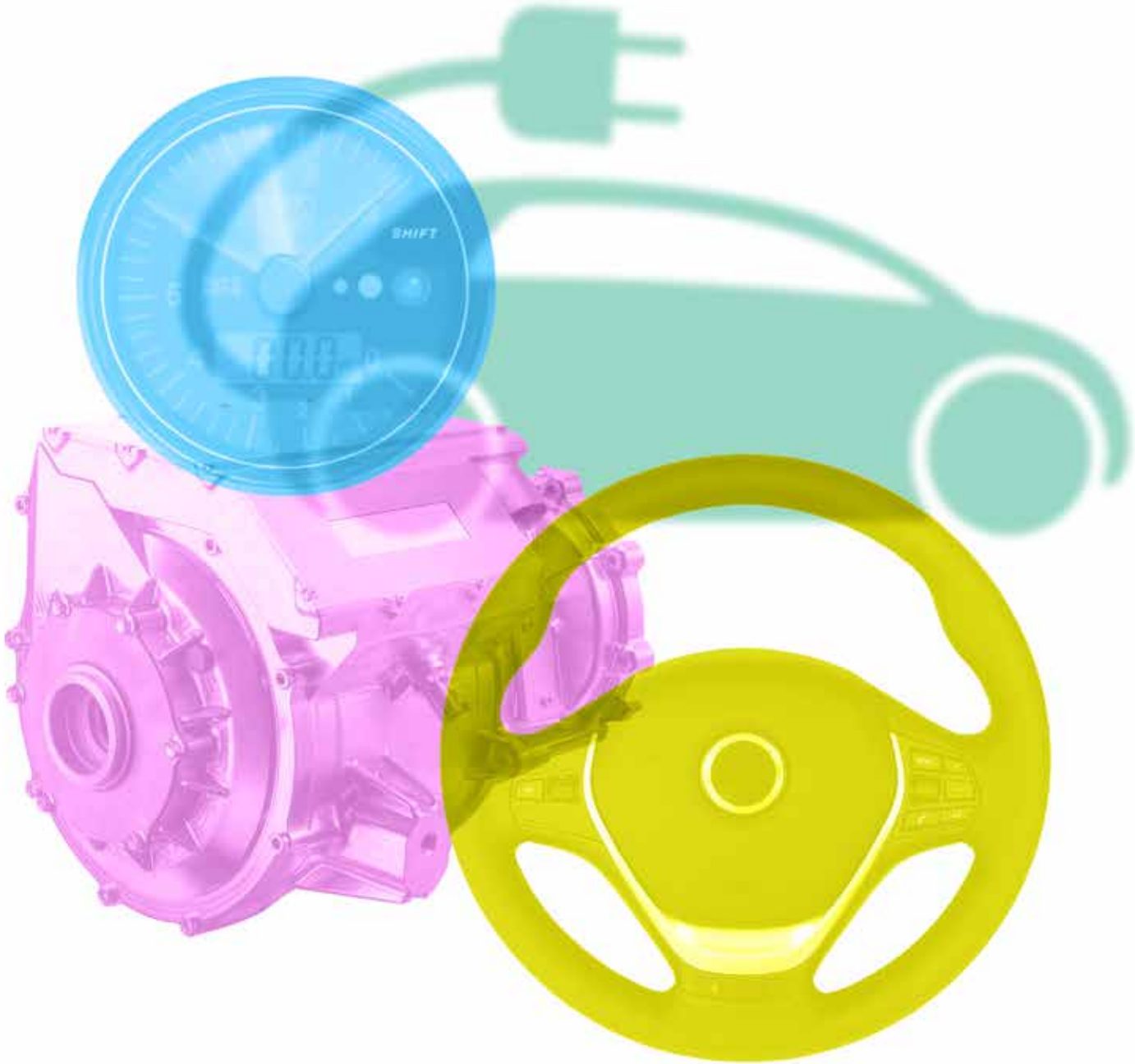
AEC-Q200
Automotive Grade Capacitors



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AEC-Q200 Automotive Grade Capacitors

At Knowles Capacitors we manufacture Single Layer, Multilayer, High Reliability and Precision Variable Capacitors; EMI Filters and Thin Film Devices.

One of our fields of expertise is the design and manufacture of components important to engineers in the automotive industry. Today's vehicles have many electronic control units that enable absolute precision and control.

The Automotive Electronics Council (AEC) Component Technical Committee is the standardization body for establishing standards for reliable, high quality electronic components. Components meeting these specifications are suitable for use in the harsh automotive environment without additional component-level qualification testing.

The Component Technical Committee established AEC-Q200 "Stress Test Qualification for Passive Components" to define the minimum stress test driven qualification requirements for passive electrical devices including ceramic capacitors.

Knowles has developed a range of MLC capacitors and surface mount EMI filters qualified to AEC-Q200 rev D to meet the needs of high reliability and automotive manufacturers.

Please refer to the following pages for details of the product ranges offered by Knowles.

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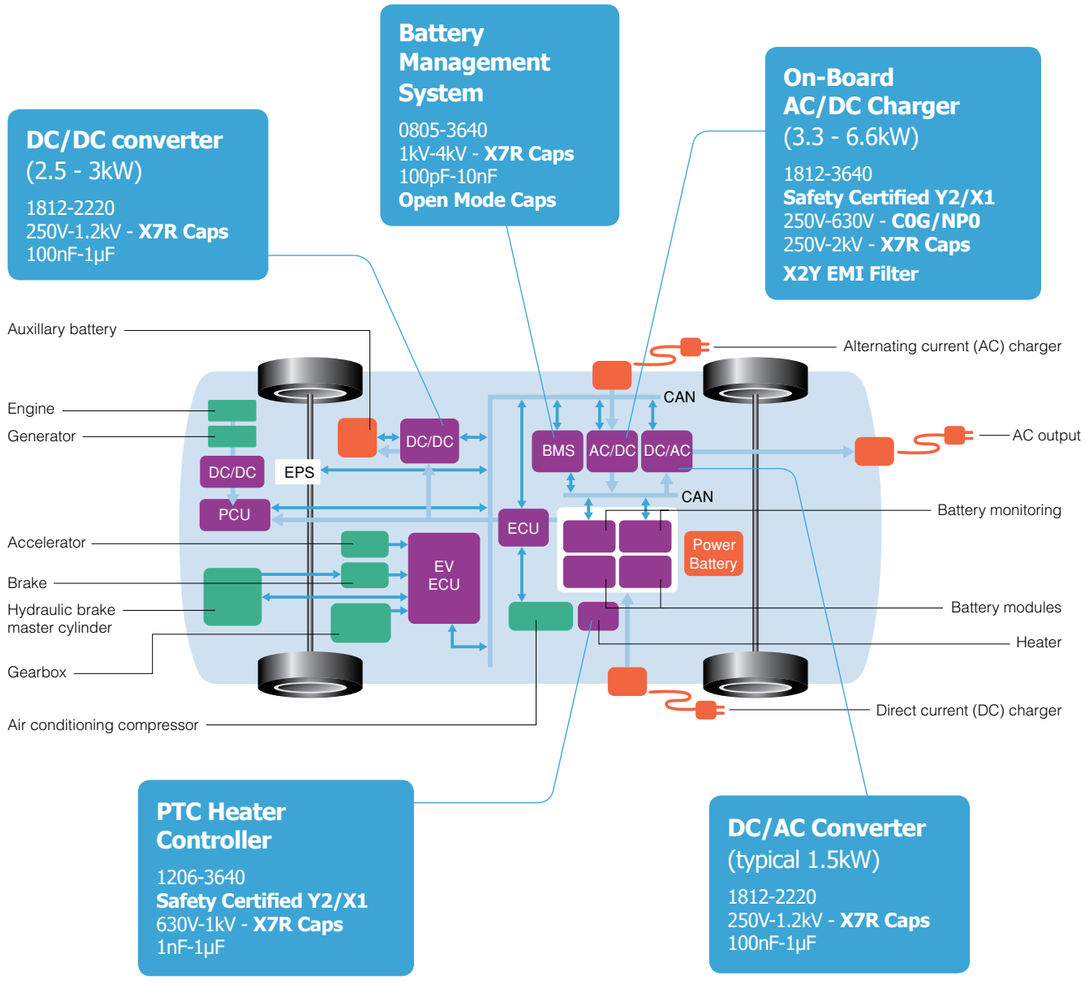

Electric Vehicle Charging - EV/HEV/PHEV

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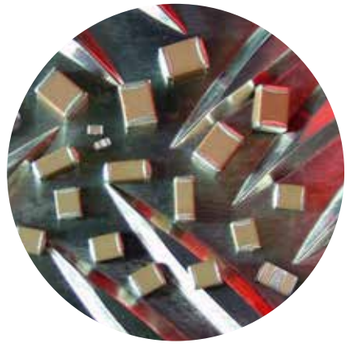

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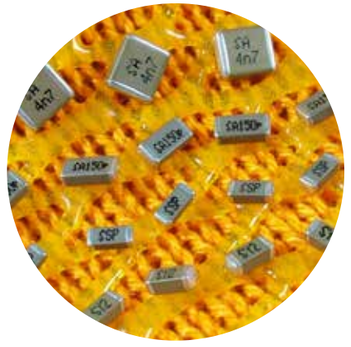

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Automotive Grade Capacitors - AEC-Q200 range

We offer a range of high quality automotive grade components. With AEC-Q200 approved ranges up to a voltage rating of 1kV we provide for the requirements of modern automotive applications including EV and HEV.

Ranges include :-

1. Standard MLCCs
2. StackiCap™ - large capacitance/small case size MLCCs
3. Open Mode and Tandem capacitors
4. 3 terminal EMI components
5. X2Y Integrated Passive Component
6. X8R high temperature MLCCs
7. Safety Certified MLCCs

All fully tested / approved and available with a range of suitable termination options, including tin/lead plating and Knowles FlexiCap™.

AEC-Q200 MLCC range - maximum capacitance values

		0603	0805	1206	1210	1808	1812		1825	2220		2225	3640	
								StackiCap™ 3.2mm max thickness			StackiCap™ 4.2mm max thickness			StackiCap™ 4.2mm max thickness
50/63V	C0G/NP0	1nF	4.7nF	15nF	27nF	27nF	47nF	-	82nF	100nF	-	150nF	220nF	-
	X7R	100nF *	220nF	470nF	1µF	-	2.2µF	-	2.2µF	3.3µF	-	3.3µF	4.7µF	-
100V	C0G/NP0	470pF	2.2nF	8.2nF	15nF	15nF	39nF	-	47nF	56nF	-	68nF	180nF	-
	X7R	47nF	100nF	220nF	680nF	-	1µF	-	1.5µF	1.5µF	-	2.2µF	3.3µF	-
	X8R	-	33nF	100nF	220nF	220nF	470nF	-	-	1.0µF	-	1.5µF	-	-
200/250V	C0G/NP0	220pF	1nF	3.3nF	8.2nF	8.2nF	18nF	-	27nF	33nF	-	33nF	82nF	-
	X7R	10nF	47nF	150nF	330nF	-	680nF	1.0µF	1.0µF	1.0µF	2.2µF	1.5µF	1.5µF	5.6µF
	X8R	-	15nF	68nF	150nF	150nF	330nF	-	-	680nF	-	1.0µF	-	-
500V	C0G/NP0	-	680pF	2.7nF	6.8nF	5.6nF	15nF	-	18nF	22nF	-	22nF	56nF	-
	X7R	-	15nF	68nF	150nF	-	330nF	470nF	560nF	560nF	1.2µF	680nF	1.0µF	2.7µF
	X8R	-	4.7nF	22nF	47nF	47nF	120nF	-	-	330nF	-	470nF	-	-
630V	C0G/NP0	-	560pF	2.7nF	6.8nF †	5.6nF	15nF	-	10nF	15nF	-	15nF	39nF	-
	X7R	-	10nF	47nF	100nF	-	150nF	330nF	200nF	330nF	1.0µF	390nF	680nF	2.2µF
	X8R	-	2.2nF	10nF	33nF	33nF	68nF	-	-	180nF	-	220nF	-	-
1kV	C0G/NP0	-	150pF	1.5nF	2.2nF	2.2nF	5.6nF	-	10nF	10nF	-	10nF	22nF	-
	X7R	-	3.3nF	10nF	47nF	-	68nF	180nF	200nF	120nF	470nF	150nF	180nF	1.0µF
	X8R	-	1.5nF	3.3nF	6.8nF	6.8nF	27nF	-	-	68nF	-	82nF	-	-
1.2kV	C0G/NP0	-	68pF	390pF	680pF	1.0nF	3.3nF	-	4.7nF	4.7nF	-	6.8nF	18nF	-
	X7R	-	-	3.3nF	18nF	-	33nF	100nF	68nF	82nF	220nF	100nF	150nF	470nF
	X8R	-	-	2.2nF	5.6nF	5.6nF	15nF	-	-	47nF	-	56nF	-	-
1.5kV	C0G/NP0	-	68pF	390pF	680pF	680pF	2.2nF	-	3.9nF	4.7nF	-	4.7nF	12nF	-
	X7R	-	-	2.7nF	6.8nF	-	22nF	56pF	47nF	47nF	150nF	68nF	100nF	330nF
	X8R	-	-	1.5nF	3.3nF	3.3nF	10nF	-	-	27nF	-	33nF	-	-
2kV	C0G/NP0	-	47pF	220pF	390pF	470pF	1.5nF	-	1.8nF	2.2nF	-	2.2nF	5.6nF	-
	X7R	-	-	2.2nF	4.7nF	-	10nF	33pF	10nF	27nF	100nF	33nF	47nF	150nF
	X8R	-	-	680pF	1.5nF	1.5nF	5.6nF	-	-	15nF	-	22nF	-	-
2.5kV	C0G/NP0	-	-	100pF	180pF	270pF	680pF	-	-	1.5nF	-	-	-	-
	X8R	-	-	-	-	1.2nF	3.3nF	-	-	10nF	-	12nF	-	-
3kV	C0G/NP0	-	-	68pF	150pF	220pF	470pF	-	-	1nF	-	-	-	-
	X8R	-	-	-	-	820pF	2.7nF	-	-	5.6nF	-	6.8nF	-	-

Notes: 1) * 0603 Max thickness 0.9mm above 56nF, FB6 suffix code. 2) † 1210 Max thickness 2.2mm as suffix AG1.
3) See page 6 for full details of the StackiCap™ range.

Safety Certified Capacitors

Dielectric	Approval Body	X1 PY2		X2 SP	Y2/X1 SP		Y2/X1 B16	X2 B17
		1808	1812	1808	2211	2215	2220	2220
C0G/NP0	TÜV, UL	4.7pF - 390pF	4.7pF - 470pF	4.7pF - 1.5nF	4.7pF - 1.0nF	820pF - 1.0nF	-	-
X7R	TÜV, UL	150pF - 1nF	150pF - 2.2nF	150pF - 4.7nF	100pF - 3.9nF	2.7nF - 3.9nF	150pF - 10nF	150pF - 22nF (TÜV approval only)

Note: See pages 7, 8 and 9 for full details of 250Vac Safety Certified AC Capacitors and ordering information.

Automotive Grade Capacitors - AEC-Q200 range

AEC-Q200 range - Open Mode - max capacitance values

	0603	0805	1206	1210	1808	1812	2220	2225
	X7R	X7R	X7R	X7R	X7R	X7R	X7R	X7R
50/63V	22nF	100nF	220nF	470nF	470nF	1.0µF	1.5µF	2.7µF
100V	6.8nF	27nF	100nF	220nF	220nF	680nF	1.0µF	1.5µF
200/250V	2.7nF	15nF	68nF	100nF	100nF	330nF	680nF	1.0µF
500V	-	5.6nF	39nF	68nF	68nF	180nF	330nF	390nF
630V	-	-	22nF	33nF	27nF	100nF	180nF	220nF
1kV	-	-	6.8nF	15nF	15nF	47nF	82nF	100nF

See page 10 for full details of the product range.

AEC-Q200 range - Tandem - max capacitance values

	0603	0805	1206	1210	1812
	X7R	X7R	X7R	X7R	X7R
50/63V	6.8nF	33nF	100nF	180nF	390nF
100V	2.2nF	10nF	47nF	82nF	220nF
200/250V	1.0nF	4.7nF	22nF	47nF	100nF

See page 10 for full details of the product range.

AEC-Q200 range - 3 Terminal EMI Components (E01 & E07) - max capacitance values

		E01			E07		
		0805	1206	1806	0805	1206	1806
50V	C0G/NP0	820pF	1.0nF	2.2nF	220pF	1nF	1.5nF
	X7R	47nF	100nF	200nF	47nF	100nF	200nF
100V	C0G/NP0	560pF	1.0nF	2.2nF	120pF	560pF	680pF
	X7R	15nF	15nF	68nF	15nF	15nF	68nF

Note: For some lower capacitance parts, higher voltage rated parts may be supplied. See page 12 for full details of the product range.

AEC-Q200 range - X2Y Integrated Passive Components (E03) - capacitance values

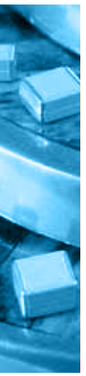
		0805	1206	1410	1812
50V	C0G/NP0	390pF - 470pF	1.2nF - 1.5nF	4.7nF - 5.6nF	8.2nF - 10nF
	X7R	18nF - 33nF	56nF - 150nF	180nF - 330nF	390nF - 560nF
100V	C0G/NP0	10pF - 330pF	22pF - 1.0nF	100pF - 3.9nF	820pF - 6.8nF
	X7R	470pF - 15nF	1.5nF - 47nF	4.7nF - 150nF	8.2nF - 330nF

Note: For some lower capacitance parts, higher voltage rated parts may be supplied. See page 14 and 15 for full details of the product range.

Ordering information - AEC-Q200 ranges

1210	Y	100	0103	K	S	T	_ _ _
Chip size	Termination	Voltage	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric Release codes	Packaging	Suffix code
0603 **0805** **1206** **1210** **1808** **1812** **1825** **2220** **2225** **3640**	**Y** = FlexiCap™ termination base with Ni barrier (100% matte tin plating). RoHS compliant. **H** = FlexiCap™ termination base with Ni barrier (Tin/lead plating with min. 10% lead). Not RoHS compliant. **J** = Nickel barrier (100% matte tin plating). RoHS compliant. Lead free. **A** = Nickel barrier (Tin/lead plating with min. 10% lead). Not RoHS compliant. Note: AEC-Q200 X7R is only available in Y or H termination.	**050** = 50V **063** = 63V **100** = 100V **200** = 200V **250** = 250V **500** = 500V **630** = 630V **1K0** = 1kV **1K2** = 1.2kV **1K5** = 1.5kV **2K0** = 2kV **2K5** = 2.5kV **3K0** = 3kV	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following Example: **0103** = 10nF	**F** = ±1% **G** = ±2% **J** = ±5% **K** = ±10% **M** = ±20%	**S** = X7R (BME) AEC-Q200 **E** = X7R (2R1) AEC-Q200 **K** = C0G/NP0 (BME/NP0) AEC-Q200 **A** = C0G/NP0 (1B/NP0) AEC-Q200 **T** = X8R with AEC-Q200 release	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays	**WS2** = StackiCap™ **M01** = Open Mode **T01** = Tandem **E01 & E07**= 3 terminal EMI component **E03** = X2Y product

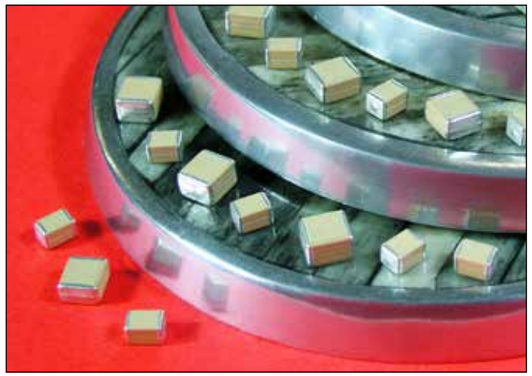
StackiCap™ Capacitors - X7R



The StackiCap™ range offers a significant reduction in 'PCB real estate' for an equivalent capacitance value when board space is at a premium. For example, a standard 150nF chip in a 8060 case size is now available in a much smaller 3640 case size.

Knowles's unique patented* construction and FlexiCap™ termination material make the StackiCap™ range suitable for applications including: power supplies, lighting, aerospace electronics and high voltage applications where a large amount of capacitance is required. Further developments are on-going, please contact the Sales Office for details of the full range.

* StackiCap™ technology is protected by international patents (pending) EP2847776, WO2013186172A1, US20150146343A1 and CN104471660A.



Maximum capacitance
Up to 5.6µF

Maximum voltage
Up to 2kV

Insulation resistance
Time Constant (RxCr) (whichever is the least - 500s or 500MΩ)

Maximum capacitance values - StackiCap™ Capacitors

Chip size	1812	2220	3640
Thickness max.	3.2mm	4.2mm	4.2mm
200/250V	1.0µF	2.2µF	5.6µF
500V	470nF	1.2µF	2.7µF
630V	330nF	1.0µF	2.2µF
1kV	180nF	470nF	1.0µF
1.2kV	100nF	220nF	470nF
1.5kV	56nF	150nF	330nF
2kV	33nF	100nF	150nF

= AEC-Q200

Ordering information - StackiCap™ Capacitors

1812	Y	500	0474	K	J	T	WS2
Chip size	Termination	Voltage	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric	Packaging	Suffix code
1812 **2220** **3640**	**Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). RoHS compliant. Lead free. **H** = FlexiCap™ Termination base with nickel barrier (Tin/lead plating with minimum 10% lead). Not RoHS compliant.	**200/250** = 200/250V **500** = 500V **630** = 630V **1K0** = 1kV **1K2** = 1.2kV **1K5** = 1.5kV **2K0** = 2kV	First digit is 0. Second and third digits are significant figures of capacitance code in picofarads (pF). Fourth digit is number of zeros eg. **0474** = 470nF Values are E12 series	**J** = ±5% **K** = ±10% **M** = ±20%	**J** = X7R (BME) **E** = X7R (2R1) AEC-Q200 **S** = X7R (BME) AEC-Q200 **X** = X7R	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays	**WS2**

Reeled quantities - StackiCap™ Capacitors

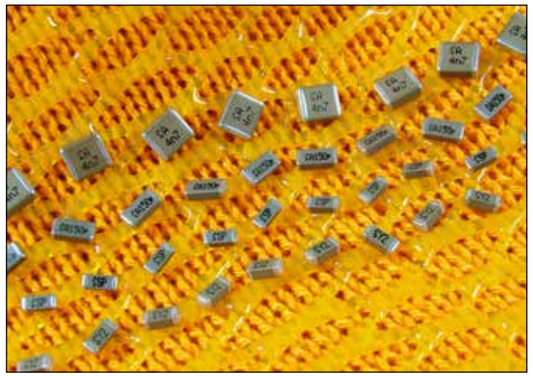
	1812	2220	3640
178mm (7") Reel	500	500	-
330mm (13") Reel	2,000	2,000	500

Note: Parts in this range may be defined as dual-use under export control legislation as such may be subject to export licence restrictions.
Please refer to page 12 of the Knowles MLC Capacitors catalogue for more information on the dual-use regulations and contact the Sales Office for further information on specific part numbers.

250Vac Safety Certified AC Capacitors

Safety Certified capacitors comply with international UL and TÜV specifications to offer designers the option of using a surface mount ceramic multilayer capacitor to replace leaded film types. Offering the benefits of simple pick-and-place assembly, reduced board space required and lower profile, they are also available in a FlexiCap™ version to reduce the risk of mechanical cracking.

Knowles's high voltage capacitor expertise means the range offers among the highest range available of capacitance values in certain case sizes. Applications include: modems, AC-DC power supplies and where lightning strike or other voltage transients represent a threat to electronic equipment.



- Surface mount multilayer ceramic capacitors
- Meet Class Y2/X1, X1 and X2 requirements
- Approved for mains ac voltages, up to 250Vac
- Approved by UL and TÜV
- Sizes 1808, 1812, 2211, 2215 and 2220
- Smaller sizes suitable for use in equipment certified to EN60950
- Certification specifications for larger sizes include IEC/EN60384-14, UL/CSA60950 and UL60384-14
- Surface mount package
- Reduces board area and height restrictions
- Reduced assembly costs over conventional through hole components
- FlexiCap™ option available on all sizes

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

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

250Vac Safety Certified AC Capacitors - Certification Chart

Classification and approval specification - Safety Certified capacitors

CHIP SIZE	SUFFIX CODE	DIELECTRIC	CAP RANGE	CLASSIFICATION	APPROVAL SPECIFICATION	APPROVAL BODY	AEC-Q200
1808	**SP**(1)	C0G/NP0	4.7pF to 1.5nF	**X2** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE
1808	**SP**(1)	X7R	150pF to 4.7nF	**X2** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE 'Y' TERM ONLY
1808	**PY2**(1)	C0G/NP0	4.7pF to 390pF	**X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE
1808	**PY2**(1)	X7R	150pF to 1nF	**X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL 1nF max. 'Y' TERM ONLY
1812	**PY2**(1)	C0G/NP0	4.7pF to 390pF	**X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE
1812	**PY2**(1)	X7R	150pF to 2.2nF	**X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL 2.2nF max. 'Y' TERM ONLY
2211	**SP**(2)	C0G/NP0	4.7pF to 1nF	**Y2/X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE
2211	**SP**(2)	X7R	100pF to 3.9nF	**Y2/X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE 'Y' & 'H' TERM ONLY
2215	**SP**(2)	C0G/NP0	820pF to 1.0nF	**Y2/X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE
2215	**SP**(2)	X7R	2.7nF to 3.9nF	**Y2/X1** / NWGQ2, NWGQ8	IEC60384-14 EN60384-14 / UL-60950-1, 2nd Ed CSA 60950-1-07 2nd Ed	TÜV / UL	TÜV & UL FULL RANGE 'Y' & 'H' TERM ONLY
2220	**B16**	X7R	150pF to 10nF	**Y2/X1** / FOWX2, FOWX8	IEC60384-14 EN60384-14 / UL-60384-14:2010 CSA E60384-14:09	TÜV / UL	TÜV & UL FULL RANGE 'Y' & 'H' TERM ONLY
2220	**B17**(2)	X7R	150pF to 22nF	**X2**	IEC60384-14 EN60384-14	TÜV	TÜV ONLY 22nF max. 'Y' & 'H' TERM ONLY

Notes: Termination availability

(1) J & Y terminations only.
(2) J, Y, A & H terminations available.
PY2 Unmarked capacitors also available as released in accordance with approval specifications. Suffix Code SY2 applies.
SP Unmarked capacitors also available as released in accordance with approval specifications. Suffix Code SPU applies.

250Vac Safety Certified AC Capacitors - Ordering Information

Ordering information - Safety Certified capacitors - Class SPU/SP ranges

1808	J	A25	0102	J	C	T	SP
Chip size	**Termination**	**Voltage**	**Capacitance in picofarads (pF)**	**Capacitance tolerance**	**Dielectric codes**	**Packaging**	Suffix code
1808 **2211** **2215**	**J** = Nickel barrier (100% matte tin plating). RoHS compliant. Lead free. **Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). RoHS compliant. **2211/2215 only** **A** = Nickel barrier (Tin/lead plating with min. 10% lead). Not RoHS compliant. **H** = FlexiCap™ termination base with nickel barrier (Tin/lead plating with minimum 10% lead). Not RoHS compliant.	**A25** = 250Vac	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following. Example: **0102** = 1.0nF	<10pF **B** = ±0.10pF **C** = ±0.25pF **D** = ±0.50pF ≥ 10pF **F** = ±1% **G** = ±2% **J** = ±5% **K** = ±10% **M** = ±20%	**C** = C0G/NP0 **X** = X7R **A** = C0G/NP0 (1B/NP0) AEC-Q200 **E** = X7R (2B1) AEC-Q200	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays	**SP** = Surge Protection capacitors (marked and approved) **SPU** = Surge Protection capacitors (un-marked parts are in accordance with but not certified)

Ordering information - Safety Certified capacitors - Class PY2/SY2

1808	J	A25	0102	J	X	T	PY2
Chip size	**Termination**	**Voltage**	**Capacitance in picofarads (pF)**	**Capacitance tolerance**	**Dielectric codes**	**Packaging**	Suffix code
1808 **1812**	**J** = Nickel barrier (100% matte tin plating). RoHS compliant. Lead free. **Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). RoHS compliant.	**A25** = 250Vac	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following. Example: **0102** = 1.0nF	<10pF **B** = ±0.10pF **C** = ±0.25pF **D** = ±0.50pF ≥ 10pF **F** = ±1% **G** = ±2% **J** = ±5% **K** = ±10% M = ±20%	**C** = C0G/NP0 **X** = X7R **A** = C0G/NP0 (1B/NP0) AEC-Q200 **E** = X7R (2B1) AEC-Q200	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays	**PY2** = Safety tested Surge Protection capacitors (marked and approved) **SY2** = Surge Protection capacitors (un-marked parts are in accordance with but not certified)

Ordering information - Safety Certified capacitors - Class B16/B17 ranges

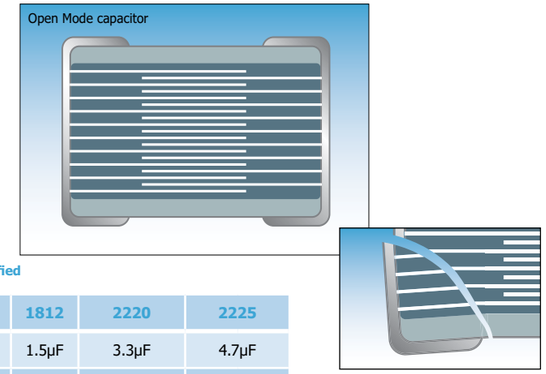
2220	J	A25	0102	J	X	T	B16
Chip size	**Termination**	**Voltage**	**Capacitance in picofarads (pF)**	**Capacitance tolerance**	**Dielectric codes**	**Packaging**	Suffix code
2220	**J** = Nickel barrier (100% matte tin plating). RoHS compliant. Lead free. **Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). RoHS compliant. **A** = Nickel barrier (Tin/lead plating with min. 10% lead). Not RoHS compliant. **H** = FlexiCap™ termination base with nickel barrier (Tin/lead plating with minimum 10% lead). Not RoHS compliant.	**A25** = 250Vac	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following. Example: **0102** = 1.0nF	**J** = ±5% **K** = ±10% **M** = ±20%	**X** = X7R **E** = X7R (2B1) AEC-Q200	**T** = 178mm (7") reel 1000 pieces **R** = 330mm (13") reel 4000 pieces **B** = Bulk pack - tubs or trays	**B16** = Type A: X^1/Y^2 **B17** = Type B: X^2

Open Mode and Tandem Capacitors - X7R

Open Mode capacitors have been designed specifically for use in applications where mechanical cracking is a severe problem and short circuits due to cracking are unacceptable.

Open Mode capacitors use inset electrode margins, which prevent any mechanical cracks which may form during board assembly from connecting to the internal electrodes.

When combined with FlexiCap™ termination, Open Mode capacitors provide a robust component with the assurance that if a part becomes cracked, the crack will be unlikely to result in short circuit failure.



Qualification included cracking the components by severe bend tests. Following the bend tests cracked components were subjected to endurance / humidity tests, with no failures evident due to short circuits.
Note: Depending on the severity of the crack, capacitance loss was between 0% and 70%.

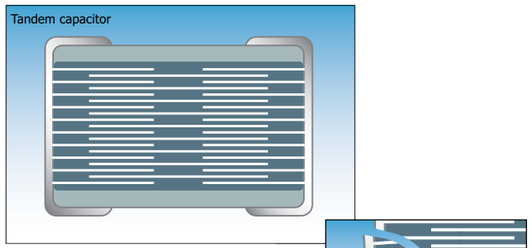
Open Mode max capacitance (X7R only) = AEC-Q200 qualified

	0603	0805		1206		1210		1808	1812	2220	2225
16V	39nF	100nF	150nF	220nF	100nF	470nF	680nF	680nF	1.5µF	3.3µF	4.7µF
25V	33nF	100nF	120nF	220nF	330nF	470nF	560nF	560nF	1.2µF	2.2µF	3.9µF
50/63V	22nF	100nF		220nF		470nF		470nF	1.0µF	1.5µF	2.7µF
100V	6.8nF	27nF		100nF		220nF		220nF	680nF	1.0µF	1.5µF 1.8µF
200/250V	2.7nF	15nF		68nF		100nF		100nF	330nF	680nF	1.0µF
500V	-	5.6nF		39nF		68nF		68nF	180nF	330nF	390nF
630V	-	-		22nF		33nF		27nF	100nF	180nF	220nF
1kV	-	-		6.8nF		15nF		15nF	47nF	100nF	100nF

Tandem Capacitors have been designed as a fail safe range using a series section internal design, for use in any application where short circuits would be unacceptable.

When combined with FlexiCap™ termination, Tandem capacitors provide an ultra robust and reliable component, for use in the most demanding applications.

Non-standard voltages are available. For more information please consult the Sales Office.



Qualification included cracking the components by severe bend tests. Following the bend tests cracked components were subjected to endurance / humidity tests, with no failures evident due to short circuits.
Note: Depending on the severity of the crack, capacitance loss was between 0% and 50%.

Tandem max capacitance (X7R only) = AEC-Q200 qualified

	0603	0805	1206	1210	1812	2220	2225
16V	12nF	47nF	150nF	270nF	560nF	1.2µF	1.5µF
25V	10nF	39nF	120nF	220nF	470nF	1.0µF	1.2µF
50/63V	6.8nF	33nF	100nF	180nF	390nF	680nF	1.0µF
100V	2.2nF	10nF	47nF	82nF	220nF	470nF	680nF
200/250V	1.0nF	4.7nF	22nF	47nF	100nF	220nF	330nF

Ordering information - Open Mode and Tandem Capacitors

1206	Y	050	0224	K	X	T	_ _ _
Chip size	Termination	Voltage	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric codes	Packaging	Suffix code
0603 **0805** **1206** **1210** **1808** **1812** **2220** **2225**	**Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). RoHS compliant. ***H** = FlexiCap™ (Tin/Lead) Not RoHS compliant.	**016** = 16V **025** = 25V **050** = 50V **063** = 63V **100** = 100V **200** = 200V **250** = 250V **500** = 500V **630** = 630V **1K0** = 1kV	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following. Example: **0224** = 220000pF	**J** = ±5% **K** = ±10% **M** = ±20%	**X** = X7R **S** = X7R BME (AEC-Q200) **E** = X7R (AEC-Q200 product)	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays	**M01** = Open Mode capacitor **T01** = Tandem capacitor

Note: *FlexiCap™ termination only available in X7R material. Please contact our Sales Office for any special requirements.

High Temperature Caps - up to 150°C X8R, Commercial, AEC-Q200

The X8R dielectric will operate from -55°C to +150°C, with a maximum capacitance change ±15% (without applied voltage).

The devices are available in sizes 0805 to 2225, with voltage ranges from 25V to 3kV and capacitance values from 100pF to 2.2µF.

The capacitors have been developed by Knowles to meet demand from various applications in the automotive and industrial markets and in other electronic equipment exposed to high temperatures. The increased use of electronics in automotive "under the hood" applications has created demand for this product range.

The X8R range incorporates a specially formulated termination with a nickel barrier finish that has been designed to enhance the mechanical performance of these SMD chip capacitors in harsh environments typically present in automotive applications.

Capacitance Range
100pF to 2.2µF (0805 to 2225)
Temperature Coefficient of Capacitance (TCC)
±15% from -55°C to +150°C
Dissipation Factor (DF)
≤ 0.025
Termination
Nickel Barrier Tin Plated

Insulation Resistance (IR)
100G Ω or 1000secs (whichever is the less).
Dielectric Withstand Voltage (DWV)
2.5 x rated voltage for 5±1 seconds, 50mA charging current maximum.
Ageing Rate
1% per decade (typical)

X8R High Temperature Capacitors - minimum/maximum cap. values according to the rated d.c. voltage

	0805	1206	1210	1808	1812	2220	2225	4540*	7565*
Min cap	100pF	100pF	100pF	100pF	150pF	220pF	330pF	1nF	2.2nF
Min cap	220pF	220pF	220pF	220pF	220pF	220pF	330pF	5.6µF	15µF
50V	47nF	150nF	330nF	330nF	680nF	1.2µF	2.2µF	4.7µF	12µF
100V	33nF	100nF	220nF	220nF	470nF	1.0µF	1.5µF	3.9µF	10µF
200/250V	15nF	68nF	150nF	150nF	330nF	680nF	1.0µF	2.7µF	6.9µF
500V	4.7nF	22nF	47nF	47nF	120nF	330nF	470nF	1.2µF	3.2µF
630V	2.2nF	10nF	33nF	33nF	68nF	180nF	220nF	-	-
1kV	1.5nF	3.3nF	6.8nF	6.8nF	27nF	68nF	82nF	-	-
1.2kV		2.2nF	5.6nF	5.6nF	15nF	47nF	56nF	-	-
1.5kV		1.5nF	3.3nF	3.3nF	10nF	27nF	33nF	-	-
2kV		680pF	1.5nF	1.5nF	5.6nF	15nF	22nF	-	-
2.5kV				1.2nF	3.3nF	10nF	12nF	-	-
3kV				820pF	2.7nF	5.6nF	6.8nF	-	-

Notes: = X8R ranges in yellow available as qualified AEC-Q200. *Only available as Novacap parts, Non-RoHS compliant.

Ordering information - Syfer X8R High Temperature Capacitors

1206	Y	100	0473	K	N	T
Chip size	Termination	Voltage d.c.	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric codes	Packaging
0805 **1206** **1210** **1808** **1812** **2220** **2225**	**Y** = FlexiCap™ termination base with nickel barrier (100% matte tin plating). ***H** = FlexiCap™ (Tin/Lead) Not RoHS compliant.	**025** = 25V **050** = 50V **100** = 100V **200** = 200V **250** = 250V **500** = 500V **630** = 630V **1K0** = 1kV **1K2** = 1.2kV **1K5** = 1.5kV **2K0** = 2kV **2K5** = 2.5kV **3K0** = 3kV	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following. Example: **0473** = 47000pF = 47nF	**J** = ±5% **K** = ±10% **M** = ±20%	**N** = X8R **T** = X8R AEC-Q200 RoHS compliant.	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk pack - tubs or trays

Note: *FlexiCap™ termination only available in X7R material. Please contact our Sales Office for any special requirements.

Ordering information - Novacap High Temperature Capacitors

4540	S	125	K	501	N	T	M
Chip size	Dielectric codes	Capacitance in picofarads (pF)	Capacitance tolerance code	Voltage code	Termination codes	Packaging	Marking
0805 **1206** **1210** **1812** **1825** **2225** **4540** **7565**	**S** = X8R High Temp. (up to 150ºC) Non-RoHS.	Value in Picofarads. Two significant figures, followed by number of zeros: **125** = 1.2nF	**J** = ±5% (X8R) **K** = ±10% (Class II) **M** = ±20% (Class II)	Two significant figures, followed by number of zeros: **250** = 25 Volts **500** = 50 Volts **101** = 100 Volts **251** = 250 Volts **501** = 500 Volts	**P** = Palladium Silver **PR** = Palladium Silver* **K** = Solderable Palladium Silver* **N** = Nickel Barrier* 100% tin **Y** = Nickel Barrier* 90% tin, 10% lead **C** = FlexiCap™/Nickel Barrier* 100% tin **D** = FlexiCap™/Nickel Barrier* 90% tin, 10% lead **S** = Solderable Silver* *Indicates RoHS terminations	**None** = Bulk **T** = Tape & Reel **W** = Waffle Pack	**None** = Unmarked **M** = Marked

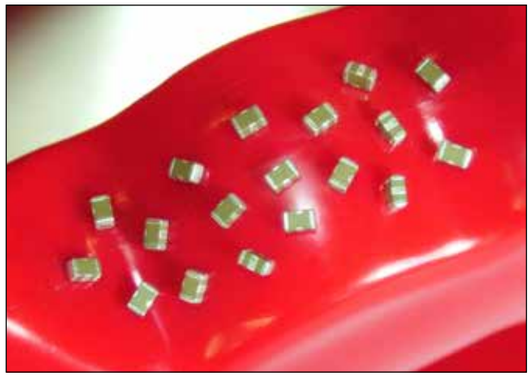
Surface Mount EMI Filters - E01 & E07 feedthrough capacitors

The Syfer E01 and E07 ranges of feedthrough MLCC chip 'C' filters are 3 terminal chip devices designed to offer reduced inductance compared to conventional MLCCs when used in signal line filtering.

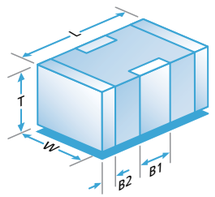
The filtered signal passes through the chip internal electrodes and the noise is filtered to the grounded side contacts, resulting in reduced length noise transmission paths.

Available in C0G/NP0 and X7R dielectrics, with current ratings of 300mA, 1A, 2A, 3A and voltage ratings of 25Vdc to 200Vdc. Also available with FlexiCap™ termination which is strongly recommended for new designs.

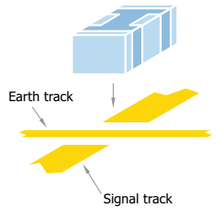
Commonly used in automotive applications, a range qualified to AEC-Q200 is also available.



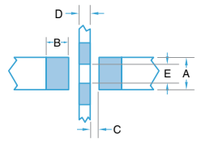
E01 300mA, E07 1A/2A/3A



E01/E07



Recommended solder lands



Dimensions

	0805	1206	1806	1812
L	2.0 ± 0.3 (0.079 ± 0.012)	3.2 ± 0.3 (0.126 ± 0.012)	4.5 ± 0.35 (0.177 ± 0.014)	4.5 ± 0.35 (0.177 ± 0.014)
W	1.25 ± 0.2 (0.049 ± 0.008)	1.6 ± 0.2 (0.063 ± 0.008)	1.6 ± 0.2 (0.063 ± 0.008)	3.2 ± 0.3 (0.126 ± 0.012)
T	1.0 ± 0.15 (0.039 ± 0.006)	1.1 ± 0.2 (0.043 ± 0.008)	1.1 ± 0.2 (0.043 ± 0.008)	2.0 ± 0.3 (0.079 ± 0.012)
B1	0.60 ± 0.2 (0.024 ± 0.008)	0.95 ± 0.3 (0.037 ± 0.012)	1.4 ± 0.3 (0.055 ± 0.012)	1.45 ± 0.35 (0.055 ± 0.012)
B2	0.3 ± 0.15 (0.012 ± 0.006)	0.5 ± 0.25 (0.02 ± 0.01)	0.5 ± 0.25 (0.02 ± 0.01)	0.75 ± 0.25 (0.02 ± 0.01)

	0805	1206	1806	1812
A	0.95 (0.037)	1.20 (0.047)	1.2 (0.047)	2.65 (0.104)
B	0.90 (0.035)	0.90 (0.035)	1.40 (0.055)	1.40 (0.055)
C	0.30 (0.012)	0.60 (0.024)	0.80 (0.031)	0.80 (0.031)
D	0.40 (0.016)	0.80 (0.031)	1.40 (0.055)	1.40 (0.055)
E	0.75 (0.030)	1.0 (0.039)	1.0 (0.039)	2.05 (0.080)

Notes: 1) All dimensions mm (inches).
2) Pad widths less than chip width gives improved mechanical performance.
3) The solder stencil should place 4 discrete solder pads. The unprinted distance between ground pads is shown as dim E.
4) Insulating the earth track underneath the filters is acceptable and can help avoid displacement of filter during soldering but can result in residue entrapment under the chip.

Standard Range - E01 & E07 Feedthrough Capacitors

Type		E01			E07			
Chip Size		0805	1206	1806	0805	1206	1806	1812
Max Current		300mA	300mA	300mA	1A	2A	2A	3A
Rated Voltage	Dielectric	Minimum and maximum capacitance values						
25Vdc	C0G/NP0	180pF-1.5nF	560pF-3.9nF	820pF-4.7nF	180pF-1.5nF	560pF-3.9nF	820pF-4.7nF	-
	X7R	470pF-100nF	5.6nF-330nF	3.9nF-560nF	820pF-100nF	10nF-330nF	22nF-560nF	560nF-1.8µF
50Vdc	C0G/NP0	22pF-820pF	22pF-3.3nF	22pF-3.9nF	10pF-220pF	22pF-1nF	100pF-1.5nF	-
	X7R	560pF-68nF	4.7nF-220nF	3.3nF-330nF	1nF-68nF	10nF-220nF	22nF-330nF	330nF-1.5µF
100Vdc	C0G/NP0	22pF-560pF	22pF-2.2nF	22pF-3.3nF	10pF-120pF	22pF-560pF	100pF-680pF	-
	X7R	560pF-27nF	1.8nF-100nF	3.3nF-180nF	1nF-27nF	10nF-100nF	22nF-180nF	180nF-820nF
200Vdc	C0G/NP0	-	560pF-1.2nF	56pF-1nF	-	15pF-180pF	56pF-470pF	-
	X7R	-	2.7nF-56nF	3.9nF-100nF	-	12nF-56nF	22nF-100nF	100nF-270nF

Note: E07 25Vdc C0G/NP0 1206 and 1806 ranges in green, have maximum current of 1A.

AEC-Q200 Qualified Range - E01 & E07 Feedthrough Capacitors - maximum capacitance values

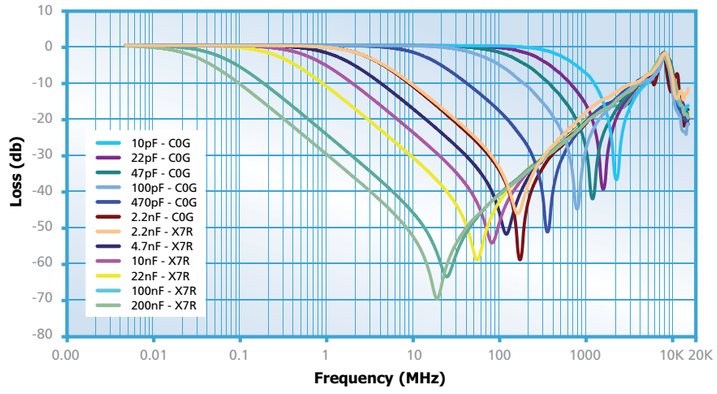
Type		E01			E07		
Chip Size		0805	1206	1806	0805	1206	1806
50V	C0G/NP0	820pF	1nF	2.2nF	220pF	1nF	1.5nF
	X7R	47nF	100nF	200nF	47nF	100nF	200nF
100V	C0G/NP0	560pF	1nF	2.2nF	120pF	560pF	680pF
	X7R	15nF	15nF	68nF	15nF	15nF	68nF

Notes: = AEC-Q200. For some lower capacitance parts, higher voltage rated parts may be supplied.

Surface Mount EMI Filters - E01 & E07 feedthrough capacitors

Open board insertion loss performance in 50Ω system

	Open Board Performance					
Capacitance	0.1MHz	1MHz	10MHz	100MHz	1GHz	Resonance Freq (MHz) approx.
10pF	0	0	0	0	7.5	2200
22pF	0	0	0	0	16	1600
33pF	0	0	0	1	22	1350
47pF	0	0	0	2	28	1150
68pF	0	0	0	3	41	900
100pF	0	0	0	5	28	800
150pF	0	0	0	8	24	700
220pF	0	0	0	12	20	600
330pF	0	0	1	15	20	500
470pF	0	0	2	18	20	425
560pF	0	0	3	20	20	350
680pF	0	0	4	22	20	300
820pF	0	0	5	24	20	260
1nF	0	0	7	27	20	220
1.5nF	0	0	9	31	20	200
2.2nF	0	0	12	34	20	170
3.3nF	0	1	14	39	20	135
4.7nF	0	2	18	46	20	110
6.8nF	0	3	21	50	20	90
10nF	0	5	24	48	20	80
15nF	0	8	27	45	20	65
22nF	0	12	31	43	20	56
33nF	1	14	34	40	20	40
47nF	2	17	38	40	20	34
68nF	4	20	41	40	20	30
100nF	6	24	45	40	20	28
150nF	8	26	48	40	20	24
220nF	10	30	52	40	20	17
330nF	13	33	55	40	20	15.5
470nF	16	36	60	40	20	14
560nF	18	39	65	40	20	12



Ordering Information - E01 & E07 feedthrough capacitors

1206	Y	100	0103	M	X	T	E07
Chip size	Termination	Voltage	Capacitance in picofarads (pF)	Tolerance	Dielectric	Packaging	Type
0805 **1206** **1806**	**J** = Nickel Barrier (Tin) ***Y** = FlexiCap™ (Tin - X7R only) **A** = (Tin/Lead) Not RoHS compliant. ***H** = FlexiCap™ (Tin/Lead) Not RoHS compliant.	**025** = 25V **050** = 50V **100** = 100V **200** = 200V	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following Example: **0103** = 10000pF.	**M** = ±20%	**A** = C0G/NP0 AEC-Q200 **C** = C0G/NP0 **E** = X7R AEC-Q200 **X** = X7R	**T** = 178mm (7") reel **R** = 330mm (13") reel **B** = Bulk	**E01** **E07**

Note: *FlexiCap™ termination only available in X7R material. Please contact our Sales Office for any special requirements.

Reeled quantities	178mm (7") reel	0805	1206	1806	330mm (13") reel	0805	1206	1806
		3000	2500	2500		12000	10000	10000

Surface Mount EMI Filters - E03 X2Y Integrated Passive Components

The Syfer X2Y Integrated Passive Component is a 3 terminal EMI chip device.

When used in balanced line applications, the revolutionary design provides simultaneous line-to-line and line-to-ground filtering, using a single ceramic chip. In this way, differential and common mode filtering are provided in one device.

For unbalanced applications, it provides ultra low ESL (equivalent series inductance). Capable of replacing 2 or more conventional devices, it is ideal for balanced and unbalanced lines, twisted pairs and dc motors, in automotive, audio, sensor and other applications.

Available in sizes from 0805 to 1812, these filters can prove invaluable in meeting stringent EMC demands.

Manufactured by Knowles Capacitors under licence from X2Y Attenuators LLC.

Dielectric
X7R or C0G/NP0

Electrical configuration
Multiple capacitance

Capacitance measurement
At 1000hr point

Typical capacitance matching
Better than 5%
(down to 1% available on request)

Temperature rating
-55°C to 125°C

Insulation resistance
100Gohms or 1000s (whichever is the less)

Dielectric withstand voltage
≤200V 2.5 times rated Volts for 5 secs 500V 1.5 times rated Volts for 5 secs Charging current limited to 50mA Max.

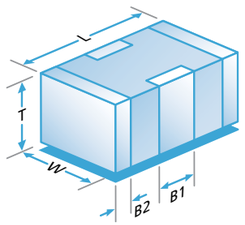
Type		E03			
Chip size		0805	1206	1410	1812
Rated voltage	Dielectric				
25Vdc	C0G/NP0	560pF - 820pF	1.8nF - 3.3nF	6.8nF - 8.2nF	12nF - 15nF
	X7R	56nF - 68nF	-	470nF	820nF
50Vdc	C0G/NP0	390pF - 470pF	1.2nF - 1.5nF	4.7nF - 5.6nF	8.2nF - 10nF
	X7R	18nF - 47nF	56nF - 220nF	180nF - 400nF	390nF - 680nF
100Vdc	C0G/NP0	10pF - 330pF	22pF - 1.0nF	100pF - 3.9nF	820pF - 6.8nF
	X7R	470pF - 15nF	1.5nF - 47nF	4.7nF - 150nF	8.2nF - 330nF
200Vdc	C0G/NP0	-	22pF - 1.0nF	100pF - 3.3nF	820pF - 5.6nF
	X7R	-	820pF - 33nF	1.2nF - 120nF	2.7nF - 180nF
500Vdc	C0G/NP0	-	-	-	820pF - 3.9nF
	X7R	-	-	-	2.7nF - 100nF

Note: For some lower capacitance parts, higher voltage rated parts may be supplied.

AEC-Q200 range (E03) - capacitance values

Chip size		0805	1206	1410	1812
50Vdc	C0G/NP0	390pF - 470pF	1.2nF - 1.5nF	4.7nF - 5.6nF	8.2nF - 10nF
	X7R	18nF - 33nF	56nF - 150nF	180nF - 330nF	390nF - 560nF
100Vdc	C0G/NP0	10pF - 330pF	22pF - 1.0nF	100pF - 3.9nF	820pF - 6.8nF
	X7R	470pF - 15nF	1.5nF - 47nF	4.7nF - 150nF	8.2nF - 330nF

Note: = AEC-Q200.

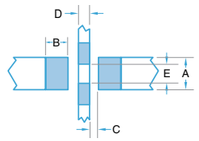


	0805	1206	1410	1812
L	2.0±0.3 (0.08±0.012)	3.2±0.3 (0.126±0.012)	3.6±0.3 (0.14±0.012)	4.5±0.35 (0.18±0.014)
W	1.25±0.2 (0.05±0.008)	1.60±0.2 (0.063±0.008)	2.5±0.3 (0.1±0.012)	3.2±0.3 (0.126±0.012)
T	1.0±0.15 (0.04±0.006)	1.1±0.2 (0.043±0.008)	2.0 max. (0.08 max.)	2.1 max. (0.08 max.)
B1	0.5±0.25 (0.02±0.01)	0.95±0.3 (0.037±0.012)	1.20±0.3 (0.047±0.012)	1.4±0.35 (0.06±0.014)
B2	0.3±0.15 (0.012±0.006)	0.5±0.25 (0.02±0.01)	0.5±0.25 (0.02±0.01)	0.75±0.25 (0.03±0.01)

Notes: 1) All dimensions mm (inches).
2) Pad widths less than chip width gives improved mechanical performance.
3) The solder stencil should place 4 discrete solder pads. The un-printed distance between ground pads is shown as dim E.
4) Insulating the earth track underneath the filters is acceptable and can help avoid displacement of filter during soldering but can result in residue entrapment under the chip.

Surface Mount EMI Filters - E03 X2Y Integrated Passive Components

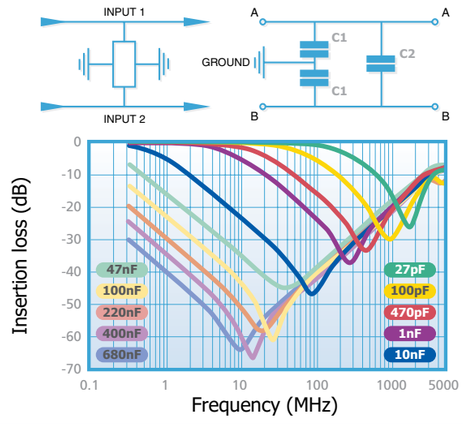
Recommended solder lands



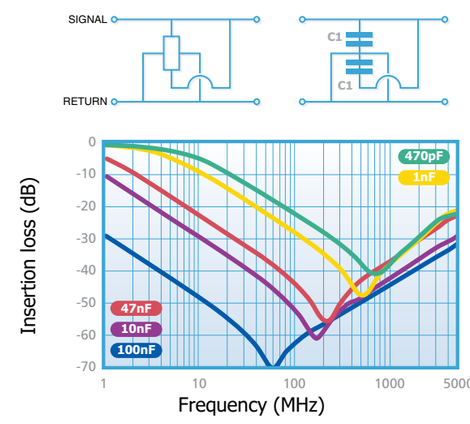
	0805	1206	1410	1812
A	0.95 (0.037)	1.2 (0.047)	2.05 (0.08)	2.65 (0.104)
B	0.9 (0.035)	0.9 (0.035)	1.0 (0.040)	1.4 (0.055)
C	0.3 (0.012)	0.6 (0.024)	0.7 (0.028)	0.8 (0.031)
D	0.4 (0.016)	0.8 (0.031)	0.9 (0.035)	1.4 (0.055)
E	0.75 (0.030)	1.0 (0.039)	1.85 (0.071)	2.05 (0.080)

Component	Advantages	Disadvantages	Applications
Chip capacitor	Industry standard	Requires 1 per line High inductance Capacitance matching problems	By-pass Low frequency
3 terminal feedthrough	Feedthrough Lower inductance	Current limited	Feedthrough Unbalanced lines High frequency
Syfer X2Y Integrated Passive Component	Very low inductance Replaces 2 (or 3) components Negates the effects of temperature, voltage and ageing Provides both common mode and differential mode attenuation Can be used on balanced & unbalanced lines	Care must be taken to optimise circuit design	By-pass Balanced lines High frequency dc electric motors Unbalanced lines Audio amplifiers CANBUS

Filtering application



Decoupling application



Ordering Information - X2Y IPC range

1812	Y	100	0334	M	X	T	E03
Chip Size	Termination	Voltage	Capacitance in picofarads (pF) C_1	Tolerance	Dielectric	Packaging	Type
0805 **1206** **1410** **1812**	**J** = Nickel Barrier (Tin) ***Y** = FlexiCap™ (Tin - X7R only) **A** = (Tin/Lead) Not RoHS compliant. ***H** = FlexiCap™ (Tin/Lead) Not RoHS compliant.	**025** = 25V **050** = 50V **100** = 100V **200** = 200V **500** = 500V	First digit is 0. Second and third digits are significant figures of capacitance code. The fourth digit is number of zeros following Example: **0334**=330nF. Note: $C_1 = 2C_2$	**M** = ±20% (Tighter tolerances may be available on request).	**A** = C0G/NP0 AEC-Q200 **C** = C0G/NP0 **E** = X7R AEC-Q200 **X** = X7R	**T** = 178mm (7″) reel **R** = 330mm (13″) reel **B** = Bulk	Syfer X2Y Integrated Passive Component

Note: *FlexiCap™ termination only available in X7R material. Please contact the sales office for any special requirements.

Reeled quantities

178mm (7″) reel	0805	1206	1410	1812
	3000	2500	2000	1000

330mm (13″) reel	0805	1206	1410	1812
	12000	10000	8000	4000

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Knowles Capacitors designs, manufactures and sells special electronic components. Our products are used in military, space, telecom infrastructure, medical and industrial applications where function and reliability are crucial.

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Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
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- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
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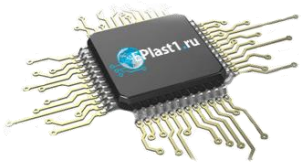
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



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