Metallized Polypropylene Film EMI Suppression Capacitors

R47 Series, Class X2, 520 VAC, 85ºC (Automotive Grade)

Electronic Components
KEMET CHARGED.

Overview

The R47 Series is constructed of metallized polypropylene film encapsulated with self-extinguishing resin in a box of material meeting the requirements of UL 94 V–0.

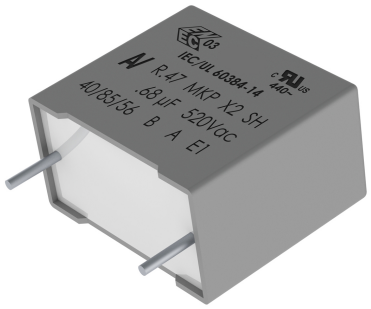
Automotive Grade devices are available (up to 22.5 mm Lead Spacing) and meet the demanding Automotive Electronics Council's AEC–Q200 qualification requirements.

Applications

For worldwide use in electromagnetic interference (EMI) suppression in across-the-line applications requiring X2 safety classification. Intended for use in situations where capacitor failure would not result in exposure to electric shock.

Benefits

- Approvals: ENEC, UL, cUL
- Class X2 (IEC 60384-14)
- Rated voltage: 520 VAC 50/60 Hz
- Capacitance range: 0.0047 – 2.2 µF
- Lead spacing: 10.0 – 37.5 mm
- Capacitance tolerance: ±20%, ±10%
- Climatic category: 40/85/56, IEC 60068–1
- Tape and reel in accordance with IEC 60286–2
- RoHS Compliant and lead-free terminations
- Operating temperature range of -40˚C to +85˚C
- 100% screening factory test at 2,200 VDC/1,500 VAC
- Self-healing properties
- Automotive (AEC–Q200) grades available up to 22.5 mm Lead Spacing



Click image above for interactive 3D content

Open PDF in Adobe Reader for full functionality

Part Number System

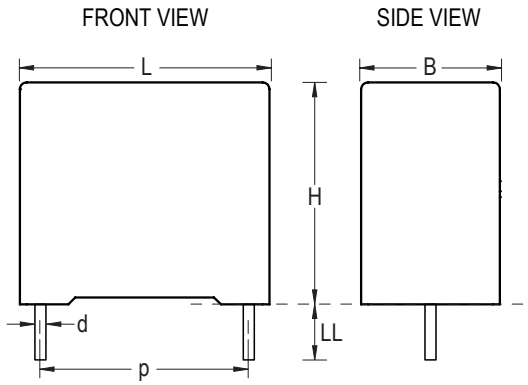
R47	5	I	2100	00	01	M
Series	Rated Voltage (VAC)	Lead Spacing (mm)	Capacitance Code (pF)	Lead and Packaging Code	Internal Use	Capacitance Tolerance
X2, Metallized Polypropylene	5 = 520	F = 10.0 I = 15.0 N = 22.5 R = 27.5 W = 37.5	Digits 2 – 4 indicate the first three digits of the capacitance value. First digit indicates the number of zeros to be added.	See Ordering Options Table	01 02 03	K = ±10% M = ±20%

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Ordering Options Table

Lead Spacing Nominal (mm)	Type of Leads and Packaging	Lead Length (mm)	Lead and Packaging Code
10, 15, 22.5	**Standard Lead and Packaging Options**		
	Bulk (Bag) – Short Leads	4 +2/-0	00
	Ammo Pack	H_0= 18.5 +/-0.5	DQ
	Other Lead and Packaging Options		
	Tape & Reel (Large Reel)	H_0= 18.5 +/-0.5	CK
	Bulk (Bag) – Short Leads	3.5 +0.5/-0	JB
	Bulk (Bag) – Short Leads	4.0 +0.5/-0	JE
	Bulk (Bag) – Long Leads	30 +5/-0	40
	Bulk (Bag) – Long Leads	25 +2/-1	50
27.5, 37.5	**Standard Lead and Packaging Options**		
	Bulk (Bag) – Short Leads	4 +2/-0	00
	Tape & Reel (Large Reel)	H_0= 18.5 +/-0.5	CK
	Other Lead and Packaging Options		
	Bulk (Bag) – Short Leads	3.5 +0.5/-0	JB
	Bulk (Bag) – Long Leads	30 +5/-0	40
	Bulk (Bag) – Long Leads	25 +2/-1	50

Dimensions – Millimeters



p		B		H		L		d	
Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance
10.0	+/-0.4	4.0	+0.2	9.0	+0.1	13.0	+0.2	0.6	+/-0.05
10.0	+/-0.4	5.0	+0.2	11.0	+0.1	13.0	+0.2	0.6	+/-0.05
10.0	+/-0.4	6.0	+0.2	12.0	+0.1	13.0	+0.2	0.6	+/-0.05
15.0	+/-0.4	5.0	+0.2	11.0	+0.1	18.0	+0.3	0.6	+/-0.05
15.0	+/-0.4	6.0	+0.2	12.0	+0.1	18.0	+0.3	0.6	+/-0.05
15.0	+/-0.4	6.0	+0.2	17.5	+0.1	18.0	+0.3	0.6	+/-0.05
15.0	+/-0.4	7.5	+0.2	13.5	+0.1	18.0	+0.5	0.6	+/-0.05
15.0	+/-0.4	7.5	+0.2	18.5	+0.1	18.0	+0.5	0.8	+/-0.05
15.0	+/-0.4	8.5	+0.2	14.5	+0.1	18.0	+0.5	0.6	+/-0.05
15.0	+/-0.4	9.0	+0.2	12.5	+0.1	18.0	+0.5	0.8	+/-0.05
15.0	+/-0.4	10.0	+0.2	16.0	+0.1	18.0	+0.5	0.8	+/-0.05
15.0	+/-0.4	11.0	+0.2	19.0	+0.1	18.0	+0.5	0.8	+/-0.05
15.0	+/-0.4	13.0	+0.2	12.0	+0.1	18.0	+0.5	0.8	+/-0.05
22.5	+/-0.4	6.0	+0.2	15.0	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	6.5	+0.2	13.5	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	7.0	+0.2	16.0	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	8.5	+0.2	17.0	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	10.0	+0.2	18.5	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	11.0	+0.2	20.0	+0.1	26.5	+0.3	0.8	+/-0.05
22.5	+/-0.4	13.0	+0.2	22.0	+0.1	26.5	+0.3	0.8	+/-0.05
27.5	+/-0.4	9.0	+0.2	17.0	+0.1	32.0	+0.3	0.8	+/-0.05
27.5	+/-0.4	11.0	+0.2	20.0	+0.1	32.0	+0.3	0.8	+/-0.05
27.5	+/-0.4	13.0	+0.2	22.0	+0.1	32.0	+0.3	0.8	+/-0.05
27.5	+/-0.4	14.0	+0.2	28.0	+0.1	32.0	+0.3	0.8	+/-0.05
27.5	+/-0.4	18.0	+0.2	33.0	+0.1	32.0	+0.3	0.8	+/-0.05
27.5	+/-0.4	22.0	+0.2	37.0	+0.1	32.0	+0.3	0.8	+/-0.05
37.5	+/-0.4	11.0	+0.3	22.0	+0.1	41.5	+0.3	1.0	+/-0.05
37.5	+/-0.4	13.0	+0.3	24.0	+0.1	41.5	+0.3	1.0	+/-0.05
37.5	+/-0.4	16.0	+0.3	28.5	+0.1	41.5	+0.3	1.0	+/-0.05
37.5	+/-0.4	19.0	+0.3	32.0	+0.1	41.5	+0.3	1.0	+/-0.05
37.5	+/-0.4	20.0	+0.3	40.0	+0.1	41.5	+0.3	1.0	+/-0.05

Note: See Ordering Options Table for lead length (LL/H_0) options.

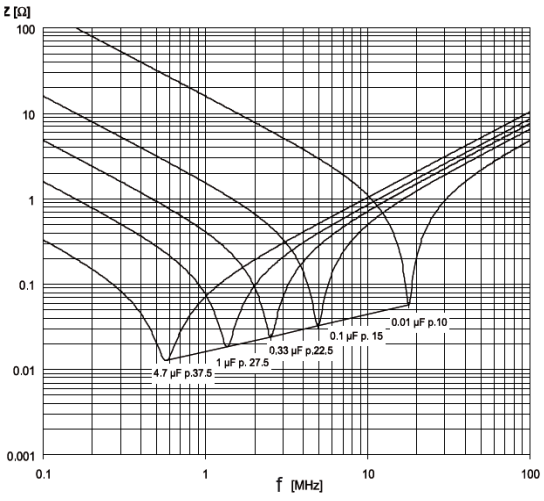
Performance Characteristics

Dielectric	Polypropylene film
Plates	Metal layer deposited by evaporation under vacuum
Winding	Non-inductive type
Leads	Tinned wire
Protection	Plastic case, thermosetting resin filled. Box material is solvent resistant and flame retardant according to UL94.
Related documents	IEC 60384-14, EN 60384-14
Rated Voltage (V_R)	520 VAC (50/60 Hz), 1000 VDC
Capacitance Range	4700 pF to 1 µF
Capacitance Values	E6 series (IEC 60063) measured @ 1 kHz and +20 ±1°C
Capacitance Tolerance	±10%, ±20%
Temperature Range	-40°C to +85°C
Climatic Category	40/85/56 IEC 60068-1
Approvals	ENEC, UL, cUL
Dissipation Factor (tanδ)	≤ 0.1% (0.06%*) @ 1kHz , +25°C ±5°C (* typical value)
Test Voltage Between Terminals	The 100% screening factory test is carried out at 2,700 VDC/1,700 VAC. The voltage level is selected to meet the requirements in applicable equipment standards. All electrical characteristics are checked after the test. It is not permitted to repeat this test as there is a risk to damage the capacitor. KEMET is not liable in such case for any failures.
Insulation Resistance	Measured at +25°C ±5°C, according to IEC 60384–2

Minimum Values Between Terminals			
Voltage Charge	Voltage Charge Time	C ≤ 0.33 µF	C > 0.33 µF
100 VDC	1 min	≥ 1 • 10^5 MΩ	≥ 30,000 MΩ • µF

In DC Applications	Recommended voltage ≤ 1000 VDC

Impedance Graph



Environmental Test Data

Test	IEC Publication	Procedure
Endurance	EN/IEC 60384–14	1.25 x V_R VAC 50 Hz, once every hour increase to 1,000 VAC for 0.1 second, 1,000 hours at upper rated temperature
Vibration	IEC 60068–2–6 Test Fc	3 directions at 2 hours each 10 – 55 Hz at 0.75 mm or 98 m/s^2
Bump	IEC 60068–2–29 Test Eb	1,000 bumps at 390 m/s^2
Change of Temperature	IEC 60068–2–14 Test Na	Upper and lower rated temperature 5 cycles
Active Flammability	IEC 60384–14	V_R + 20 surge pulses at 2.5 kV (pulse every 5 seconds)
Passive Flammability	IEC 60384–14	IEC 60384–1, IEC 60695–11–5 Needle flame test
Damp Heat Steady State	IEC 60068–2–78 Test Cab	+40°C and 93% RH, 56 days

Approvals

Mark	Specification	File Number
	EN/IEC 60384-14	CA08.00101
	UL 60384-14 and CAN/CSA E60384-14 (440VAC)	E97797

Environmental Compliance

All KEMET EMI capacitors are RoHS Compliant.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

Capacitance Value (µF)	Dimensions in mm			Lead Spacing (p)	dV/dt (V/µs)	New KEMET Part Number	Legacy Part Number
	B	H	L				
0.0047	4.0	9.0	13.0	10.0	750	475F1470(1)01(2)	R475F1470(1)01(2)
0.0068	5.0	11.0	13.0	10.0	750	475F1680(1)01(2)	R475F1680(1)01(2)
0.0082	6.0	12.0	13.0	10.0	750	475F1820(1)01(2)	R475F1820(1)01(2)
0.010	6.0	12.0	13.0	10.0	750	475F2100(1)01(2)	R475F2100(1)01(2)
0.010	5.0	11.0	18.0	15.0	600	475I2100(1)01(2)	R475I2100(1)01(2)
0.012	5.0	11.0	18.0	15.0	600	475I2120(1)01(2)	R475I2120(1)01(2)
0.015	5.0	11.0	18.0	15.0	600	475I2150(1)01(2)	R475I2150(1)01(2)
0.018	5.0	11.0	18.0	15.0	600	475I2180(1)01(2)	R475I2180(1)01(2)
0.022	6.0	12.0	18.0	15.0	600	475I2220(1)01(2)	R475I2220(1)01(2)
0.027	6.0	12.0	18.0	15.0	600	475I2270(1)01(2)	R475I2270(1)01(2)
0.033	6.0	12.0	18.0	15.0	600	475I2330(1)01(2)	R475I2330(1)01(2)
0.039	7.5	13.5	18.0	15.0	600	475I2390(1)01(2)	R475I2390(1)01(2)
0.047	7.5	13.5	18.0	15.0	600	475I2470(1)01(2)	R475I2470(1)01(2)
0.047	6.0	17.5	18.0	15.0	600	475I2470(1)02(2)	R475I2470(1)02(2)
0.047	9.0	12.5	18.0	15.0	600	475I2470(1)03(2)	R475I2470(1)03(2)
0.056	8.5	14.5	18.0	15.0	600	475I2560(1)01(2)	R475I2560(1)01(2)
0.068	10.0	16.0	18.0	15.0	600	475I2680(1)01(2)	R475I2680(1)01(2)
0.068	7.5	18.5	18.0	15.0	600	475I2680(1)02(2)	R475I2680(1)02(2)
0.068	13.0	12.0	18.0	15.0	600	475I2680(1)03(2)	R475I2680(1)03(2)
0.082	10.0	16.0	18.0	15.0	600	475I2820(1)01(2)	R475I2820(1)01(2)
0.10	11.0	19.0	18.0	15.0	600	475I3100(1)01(2)	R475I3100(1)01(2)
0.047	6.0	15.0	26.5	22.5	300	475N2470(1)01(2)	R475N2470(1)01(2)
0.047	6.5	13.5	26.5	22.5	300	475N2470(1)02(2)	R475N2470(1)02(2)
0.068	6.0	15.0	26.5	22.5	300	475N2680(1)01(2)	R475N2680(1)01(2)
0.10	7.0	16.0	26.5	22.5	300	475N3100(1)01(2)	R475N3100(1)01(2)
0.12	8.5	17.0	26.5	22.5	300	475N3120(1)01(2)	R475N3120(1)01(2)
0.15	10.0	18.5	26.5	22.5	300	475N3150(1)01(2)	R475N3150(1)01(2)
0.18	10.0	18.5	26.5	22.5	300	475N3180(1)01(2)	R475N3180(1)01(2)
0.22	11.0	20.0	26.5	22.5	300	475N3220(1)01(2)	R475N3220(1)01(2)
0.27	13.0	22.0	26.5	22.5	300	475N3270(1)01(2)	R475N3270(1)01(2)
0.33	13.0	22.0	26.5	22.5	300	475N3330(1)01(2)	R475N3330(1)01(2)
0.15	9.0	17.0	32.0	27.5	225	475R3150(1)01(2)	R475R3150(1)01(2)
0.18	9.0	17.0	32.0	27.5	225	475R3180(1)01(2)	R475R3180(1)01(2)
0.22	9.0	17.0	32.0	27.5	225	475R3220(1)01(2)	R475R3220(1)01(2)
0.27	9.0	17.0	32.0	27.5	225	475R3270(1)02(2)	R475R3270(1)02(2)
0.33	11.0	20.0	32.0	27.5	225	475R3330(1)02(2)	R475R3330(1)02(2)
0.39	11.0	20.0	32.0	27.5	225	475R3390(1)01(2)	R475R3390(1)01(2)
0.47	13.0	22.0	32.0	27.5	225	475R3470(1)01(2)	R475R3470(1)01(2)
0.56	13.0	22.0	32.0	27.5	225	475R3560(1)01(2)	R475R3560(1)01(2)
0.68	14.0	28.0	32.0	27.5	225	475R3680(1)01(2)	R475R3680(1)01(2)
0.82	18.0	33.0	32.0	27.5	225	475R3820(1)01(2)	R475R3820(1)01(2)
1.0	18.0	33.0	32.0	27.5	225	475R4100(1)01(2)	R475R4100(1)01(2)
1.2	18.0	33.0	32.0	27.5	225	475R4120(1)01(2)	R475R4120(1)01(2)
1.5	22.0	37.0	32.0	27.5	225	475R4150(1)01(2)	R475R4150(1)01(2)
0.47	11.0	22.0	41.5	37.5	150	475W3470(1)01(2)	R475W3470(1)01(2)
0.56	11.0	22.0	41.5	37.5	150	475W3560(1)01(2)	R475W3560(1)01(2)
0.68	13.0	24.0	41.5	37.5	150	475W3680(1)01(2)	R475W3680(1)01(2)
0.82	16.0	28.5	41.5	37.5	150	475W3820(1)01(2)	R475W3820(1)01(2)
1.0	16.0	28.5	41.5	37.5	150	475W4100(1)01(2)	R475W4100(1)01(2)
1.2	19.0	32.0	41.5	37.5	150	475W4120(1)01(2)	R475W4120(1)01(2)
1.5	19.0	32.0	41.5	37.5	150	475W4150(1)01(2)	R475W4150(1)01(2)
1.8	20.0	40.0	41.5	37.5	150	475W4180(1)01(2)	R475W4180(1)01(2)
2.2	20.0	40.0	41.5	37.5	150	475W4220(1)01(2)	R475W4220(1)01(2)
Capacitance Value (µF)	**B (mm)**	**H (mm)**	**L (mm)**	**Lead Spacing (p)**	**dV/dt (V/µs)**	**New KEMET Part Number**	**Legacy Part Number**

(1) Insert ordering code for lead type and packaging. See Ordering Options Table for available options.
(2) M = ±20%, K = ±10%

Soldering Process

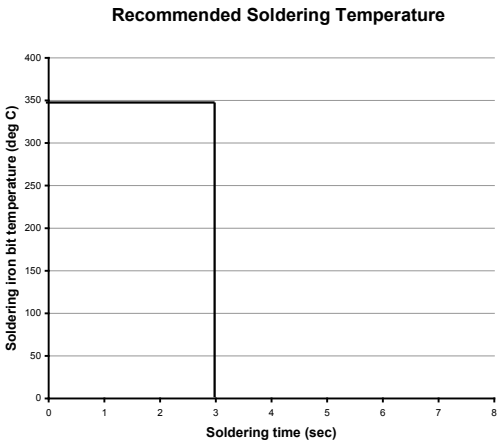
The implementation of the RoHS directive has resulted in the selection of SnAgCu (SAC) alloys or SnCu alloys as primary solder. This has increased the liquidus temperature from that of 183ºC for SnPb eutectic alloy to 217 – 221ºC for the new alloys. As a result, the heat stress to the components, even in wave soldering, has increased considerably due to higher pre-heat and wave temperatures. Polypropylene capacitors are especially sensitive to heat (the melting point of polypropylene is 160 – 170ºC). Wave soldering can be destructive, especially for mechanically small polypropylene capacitors (with lead spacing of 5 mm to 15 mm), and great care has to be taken during soldering. The recommended solder profiles from KEMET should be used. Please consult KEMET with any questions. In general, the wave soldering curve from IEC Publication 61760-1 Edition 2 serves as a solid guideline for successful soldering. Please see Figure 1.

Reflow soldering is not recommended for through-hole film capacitors. Exposing capacitors to a soldering profile in excess of the above the recommended limits may result to degradation or permanent damage to the capacitors.

Do not place the polypropylene capacitor through an adhesive curing oven to cure resin for surface mount components. Insert through-hole parts after the curing of surface mount parts. Consult KEMET to discuss the actual temperature profile in the oven, if through-hole components must pass through the adhesive curing process. A maximum two soldering cycles is recommended. Please allow time for the capacitor surface temperature to return to a normal temperature before the second soldering cycle.

Manual Soldering Recommendations

Following is the recommendation for manual soldering with a soldering iron.



The soldering iron tip temperature should be set at 350°C (+10°C maximum) with the soldering duration not to exceed more than 3 seconds.

Wave Soldering Recommendations

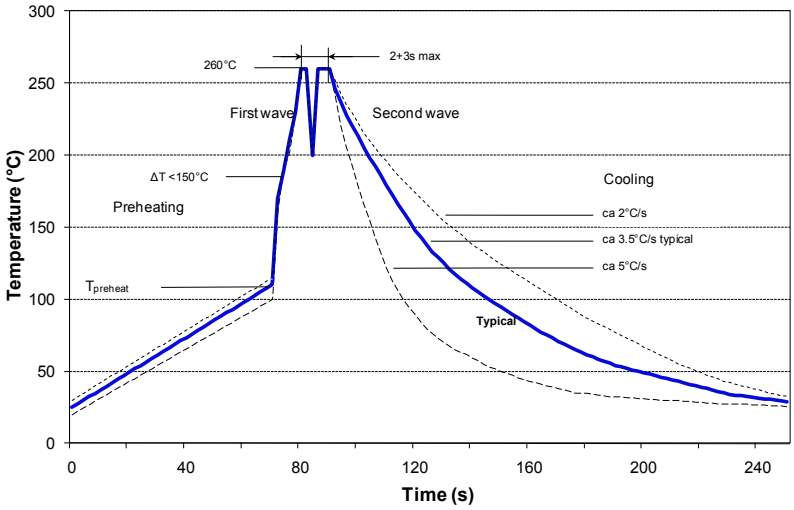


Figure 1

Dielectric Film Material	Maximum Preheat Temperature			Maximum Peak Soldering Temperature	
	Capacitor Pitch ≤ 10 mm	Capacitor Pitch = 15 mm	Capacitor Pitch > 15 mm	Capacitor Pitch ≤ 15 mm	Capacitor Pitch > 15 mm
Polyester	130°C	130°C	130°C	270°C	270°C
Polypropylene	100°C	110°C	130°C	260°C	270°C
Polyphenylene Sulphide	150°C	150°C	160°C	270°C	270°C

Soldering Process cont'd

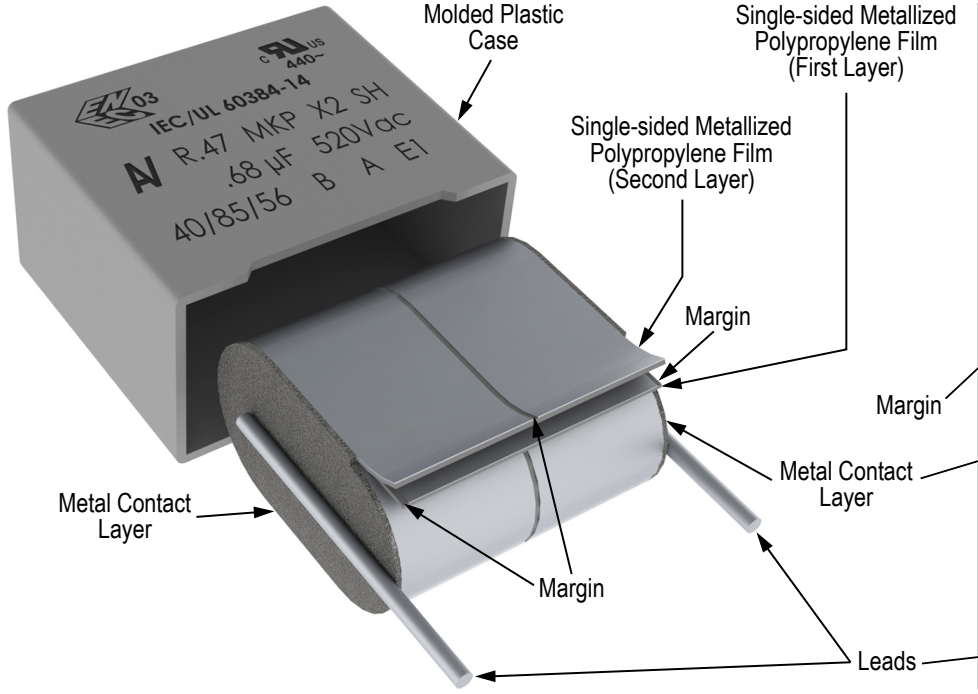
Selective Soldering Recommendations

Selective dip soldering is a variation of reflow soldering. In this method, the printed circuit board with through-hole components to be soldered is preheated and transported over the solder bath as in normal flow soldering without touching the solder. When the board is over the bath, it is stopped and pre-designed solder pots are lifted from the bath with molten solder only at the places of the selected components, and pressed against the lower surface of the board to solder the components.

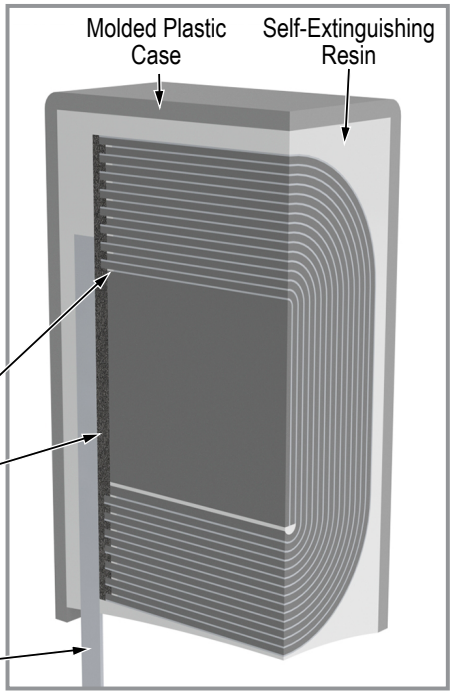
The temperature profile for selective soldering is similar to the double wave flow soldering outlined in this document, **however, instead of two baths, there is only one bath with a time from 3 to 10 seconds.** In selective soldering, the risk of overheating is greater than in double wave flow soldering, and great care must be taken so that the parts are not overheated.

Construction

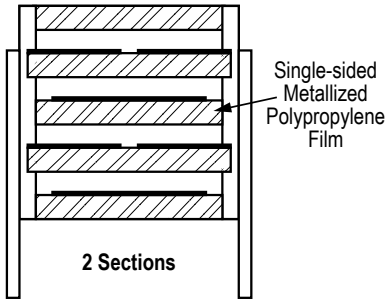
2 Sections



Detailed Cross Section

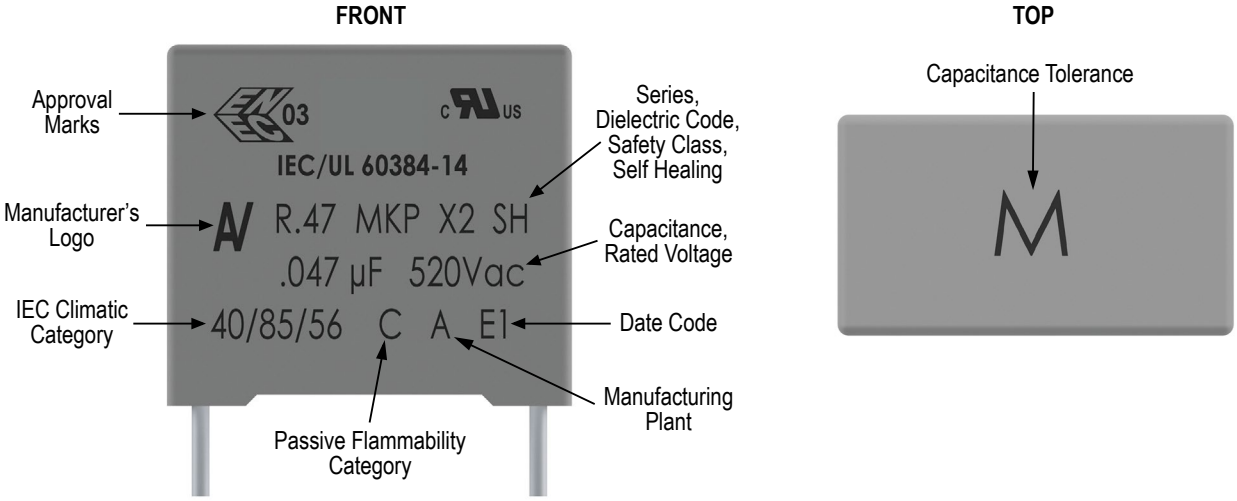


Winding Scheme

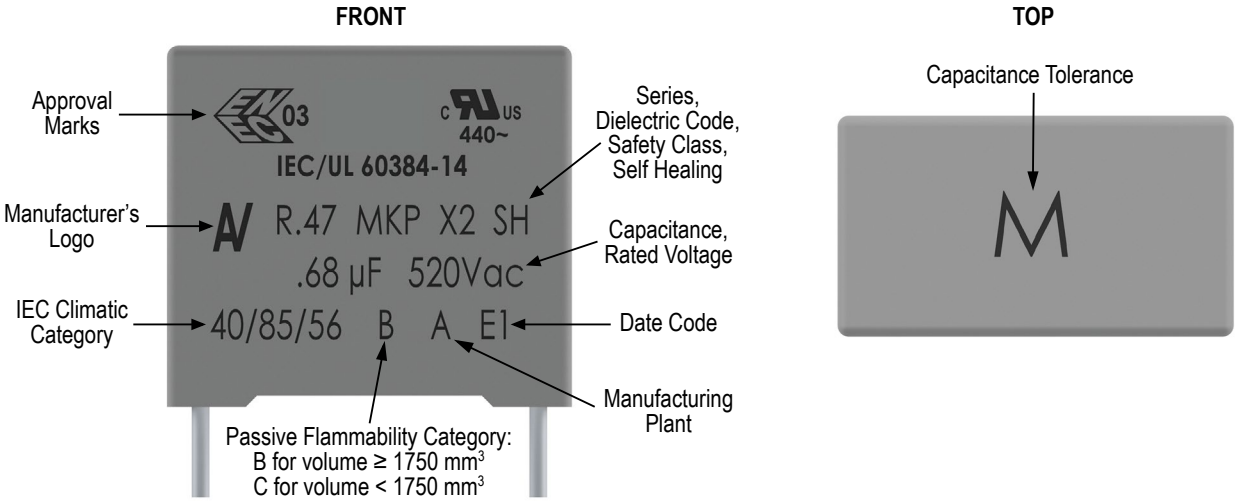


Marking

Lead Spacing 10 mm

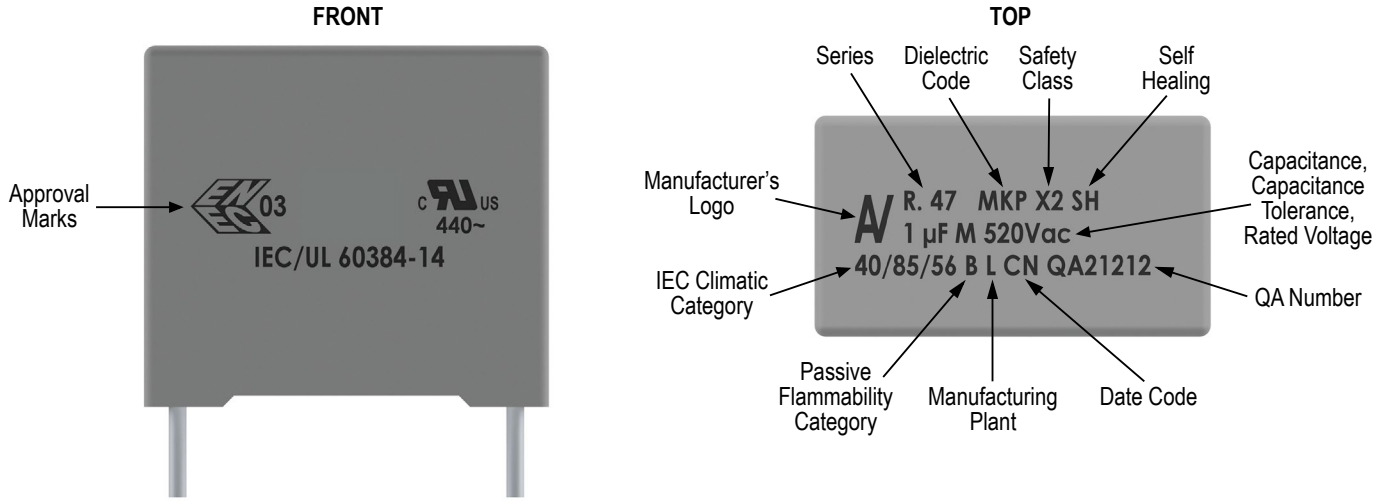


Lead Spacing 15 mm, 22.5 mm (small case sizes)



Marking cont'd

Lead Spacing 22.5 mm (large case sizes), 27.5 mm, 37.5 mm



Manufacturing Date Code (IEC 60062)			
Y = Year, Z = Month			
Year	**Code**	**Month**	**Code**
2000	M	January	1
2001	N	February	2
2002	P	March	3
2003	R	April	4
2004	S	May	5
2005	T	June	6
2006	U	July	7
2007	V	August	8
2008	W	September	9
2009	X	October	O
2010	A	November	N
2011	B	December	D
2012	C		
2013	D		
2014	E		
2015	F		
2016	H		
2017	J		
2018	K		
2019	L		
2020	M		

Packaging Quantities

Lead Spacing (mm)	Thickness (mm)	Height (mm)	Length (mm)	Bulk Short Leads	Bulk Long Leads	Standard Reel ø 355 mm	Large Reel ø 500 mm	Ammo Taped
10	4	9	13	2000	1800	750	1500	1000
	5	11	13	1300	1500	600	1250	800
	6	12	13	1000	1200	500	1000	680
15	5	11	18	2000	1000	600	1250	800
	6	12	18	1750	900	500	1000	680
	6	17.5	18	1000	700	500	1000	680
	7.5	13.5	18	1000	700	350	800	500
	7.5	18.5	18	900	500	–	800	500
	8.5	14.5	18	1000	500	300	700	440
	9	12.5	18	1000	520	270	650	410
	10	16	18	750	500	300	600	380
	11	19	18	450	350	–	500	340
	13	12	18	750	490	200	480	280
22.5	6	15	26.5	805	500	–	700	464
	6.5	13,5	26.5	800	–	–	–	–
	7	16	26.5	700	500	–	550	380
	8.5	17	26.5	468	300	–	450	280
	10	18.5	26.5	396	300	–	350	235
	11	20	26.5	360	250	–	350	217
	13	22	26.5	300	200	–	300	–
27.5	9	17	32	816	408	–	450	–
	11	20	32	560	336	–	350	–
	13	22	32	480	288	–	300	–
	14	28	32	352	176	–	–	–
	18	33	32	256	128	–	–	–
	22	37	32	168	112	–	–	–
37.5	11	22	41.5	420	252	–	–	–
	13	24	41.5	360	216	–	–	–
	16	28.5	41.5	216	108	–	–	–
	19	32	41.5	192	96	–	–	–
	20	40	41.5	126	84	–	–	–

Lead Taping & Packaging (IEC 60286–2)

Figure 1
Lead Spacing 10 mm

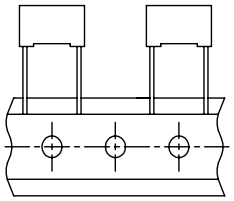


Figure 2
Lead Spacing 15 mm

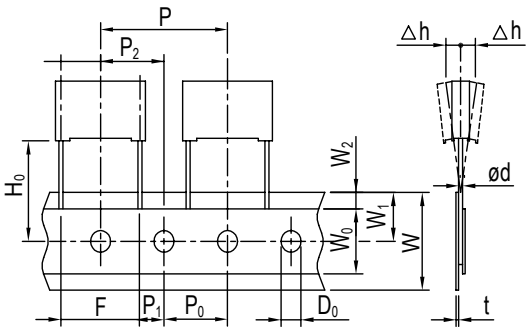
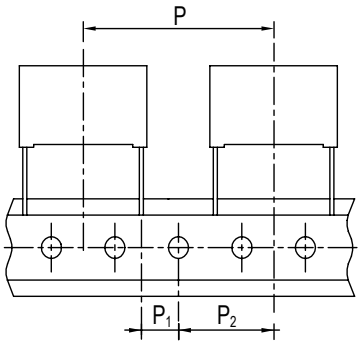


Figure 3
Lead Spacing 22.5 – 27.5 mm



Taping Specification

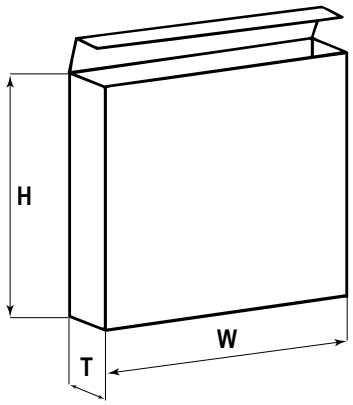
Description	Symbol	Dimensions (mm)				
		Lead Space				Tol.
		10	15	22.5	27.5	
		Fig. 1	Fig. 2	Fig. 3	Fig. 3	
Lead wire diameter	d	0.6	0.6-0.8	0.8	0.8	±0.05
Taping lead space	P	25.4	25.4	38.1	38.1	±1
Feed hole lead space *	P_0	12.7	12.7	12.7	12.7	±0.2 **
Centering of the lead wire	P_1	7.7	5.2	7.8	5.3	±0.7
Centering of the body	P_2	12.7	12.7	19.05	19.05	±1.3
Lead spacing (pitch) ***	F	10	15	22.5	27.5	+0.6/-0.1
Component alignment	∆h	0	0	0	0	±2
Height of component from tape center	H_0 ****	18.5	18.5	18.5	18.5	±0.5
Carrier tape width	W	18	18	18	18	+1 / -0.5
Hold down tape width	W_0	9	10	10	10	Minimum
Hole position	W_1	9	9	9	9	±0.5
Hold down tape position	W_2	3	3	3	3	Maximum
Feed hole diameter	D_0	4	4	4	4	±0.2
Tape thickness	t	0.7	0.7	0.7	0.7	±0.2

** Also available in 15 mm.*
*** Max 1 mm on 20 lead spaces.*
**** Pitches 15 mm and 10 mm taped to 7.5 mm (crimped leads) available upon request.*
***** H_0 = 16.5 mm available upon request.*

Lead Taping & Packaging (IEC 60286–2) cont'd

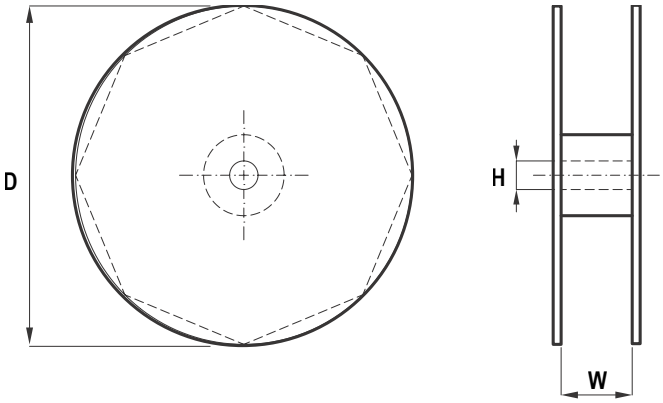
Ammo Specifications

Dimensions (mm)		
H	W	T
360	340	59



Reel Specifications

Reel Size	Dimensions (mm)		
	D	H	W
Standard	355	30	55 Maximum
Large	500	25	



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Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicted or that other measures may not be required.