

# Metallized Polypropylene Film EMI Suppression Capacitors

## R41-T, THB, Class Y2, 300 VAC, 125°C

### (Automotive Grade)

## Overview

The R41 is constructed of metallized polypropylene film encapsulated with self-extinguishing resin, in a box of material meeting the requirements of UL 94 V-0.

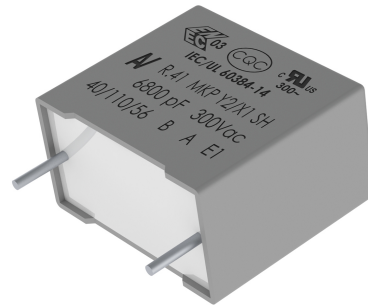
Automotive Grade devices meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

## Applications

For use in electromagnetic interference (EMI) suppression filter in "line-to-ground" and "across-the-line" applications, requiring Y2/X1 safety classification. Suitable for use in situations where failure of the capacitor could lead to danger of electric shock. Not for use in "series with mains" type applications.

## Benefits

- Approvals: ENEC, UL, cUL, CQC
- Class Y2/X1 (IEC 60384-14)
- THB Grade IIIB: 85°C, 85% RH, 1,000 hours at 300 V URAC/1,500 V URDC acc. to IEC 60384-14: 2013/AMD1: 2016
- Rated voltage: 300 VAC 50/60 Hz
- Capacitance range: 0.0047 – 0.22 µF
- Lead spacing: 15 – 22.5 mm
- Capacitance tolerance: ±20%, ±10%
- Climatic category 40/110/56, 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 +125°C
- 100% screening factory test at 5,000 VDC/2,500 VAC
- Self-healing properties
- Automotive (AEC-Q200) grades available



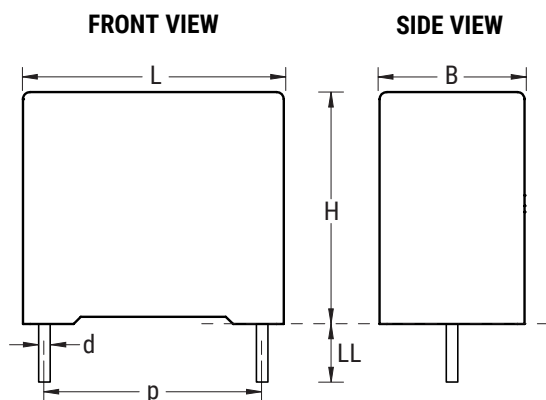
## Part Number System

R41	3	I	2330	00	T0	M
Series	Rated Voltage (VAC)	Lead Spacing (mm)	Capacitance Code (pF)	Packaging	Internal Use	Capacitance Tolerance
Y2, Metallized Polypropylene	3 = 300	I = 15.0 N = 22.5	The last three digits represent significant figures. The first digit specifies number of zeros to be added.	See Ordering Options Table	T0 T1	K = ±10% M = ±20%

## Ordering Options Table

Lead Spacing Nominal (mm)	Type of Leads and Packaging	Lead Length (mm)	Lead and Packaging Code
15  22.5	<b>Standard Lead and Packaging Options</b>		
	Bulk (Bag) – Short Leads	4 +2/-0	00
	Ammo Pack	$H_0 = 18.5 \pm 0.5$	DQ
	<b>Other Lead and Packaging Options</b>		
	Tape & Reel (Large Reel)	$H_0 = 18.5 \pm 0.5$	CK
	Tape & Reel (Standard Reel)	$H_0 = 18.5 \pm 0.5$	GY
	Bulk (Bag) – Short Leads	3.5 +0.5/-0	JB
	Bulk (Bag) – Short Leads	4.0 +0.5/-0	JE
	Bulk (Bag) – Short Leads	3.2 +0.3/-0.2	JH
	Bulk (Bag) – Long Leads	18 ±1	JM
	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
15.0	±0.4	5.0	+0.2/-0	11.0	+0.1/-0	18.0	+0.3/-0	0.6	±0.05
15.0	±0.4	6.0	+0.2/-0	12.0	+0.1/-0	18.0	+0.3/-0	0.6	±0.05
15.0	±0.4	7.5	+0.2/-0	13.5	+0.1/-0	18.0	+0.3/-0	0.6	±0.05
15.0	±0.4	8.5	+0.2/-0	14.5	+0.1/-0	18.0	+0.3/-0	0.6	±0.05
15.0	±0.4	10.0	+0.2/-0	16.0	+0.1/-0	18.0	+0.3/-0	0.8	±0.05
15.0	±0.4	11.0	+0.2/-0	19.0	+0.1/-0	18.0	+0.3/-0	0.8	±0.05
22.5	±0.4	6.0	+0.2/-0	15.0	+0.1/-0	26.5	+0.3/-0	0.8	±0.05
22.5	±0.4	7.0	+0.2/-0	16.0	+0.1/-0	26.5	+0.3/-0	0.8	±0.05
22.5	±0.4	8.5	+0.2/-0	17.0	+0.1/-0	26.5	+0.3/-0	0.8	±0.05
22.5	±0.4	10.0	+0.2/-0	18.5	+0.1/-0	26.5	+0.3/-0	0.8	±0.05
22.5	±0.4	11.0	+0.2/-0	20.0	+0.1/-0	26.5	+0.3/-0	0.8	±0.05
22.5	±0.4	13.0	+0.2/-0	22.0	+0.1/-0	26.5	+0.3/-0	0.8	±0.05

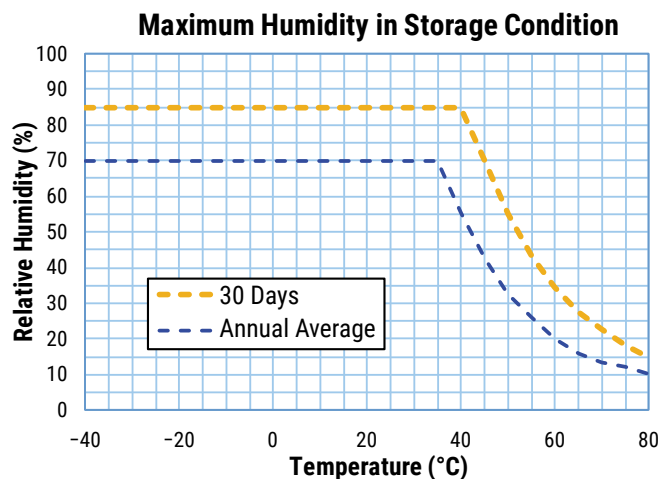
**Note:** See Ordering Options Table for lead length (LL/H<sub>0</sub>) options.

## 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 UL 94			
Related Documents	IEC 60384-14, EN 60384-14			
Rated Voltage ( $V_R$ )	300 VAC (50/60 Hz), 1,500 VDC			
Capacitance Range	0.0047 – 0.22 $\mu$ F			
Capacitance Values	E6 series (IEC 60063)			
Capacitance Tolerance	$\pm 10\%$ , $\pm 20\%$			
Temperature Range	-40°C to +125°C			
Climatic Category	40/110/56 IEC 60068-1			
Reliability	Operational life > 100,000 hours at 85°C; > 2,000 hours at 125°C			
Storage Conditions	Storage time: $\leq 24$ months from the date marked on the label package			
	Average relative humidity per year $\leq 70\%$			
	RH $\leq 85\%$ for 30 days randomly distributed throughout the year			
	Dew is absent			
	Temperature: -40 to 80°C (see "Maximum Humidity in Storage Conditions" graph below)			
Approvals	ENEC, UL, cUL, CQC			
Dissipation Factor ( $\tan\delta$ )	$\leq 0.3\%$ (0.2%*) at 1 kHz, +25°C $\pm 5^\circ$ C (* typical value)			
Test Voltage Between Terminals	The 100% screening factory test is carried out at 5,000 VDC/2,500 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. Hi-Pot test 4.0kVdc (EOL 2 seconds/Typtest 60 seconds, each ramp 5 seconds) - Terminal-to-terminal/to-housing.			
Insulation Resistance	Measured at +25°C $\pm 5^\circ$ C, according to IEC 60384-2			
	Minimum Values Between Terminals			
	Voltage Charge	Voltage Charge Time	$C \leq 0.33 \mu\text{F}$	$C > 0.33 \mu\text{F}$
	100 VDC	1 minute	$\geq 1 \cdot 10^5 \text{ M}\Omega$ ( $\geq 5 \cdot 10^5 \text{ M}\Omega$ )*	$\geq 30,000 \text{ M}\Omega \cdot \mu\text{F}$ ( $\geq 150,000 \text{ M}\Omega \cdot \mu\text{F}$ )*
In DC Applications	Recommended voltage $\leq 1,500$ VDC			

\* Typical value

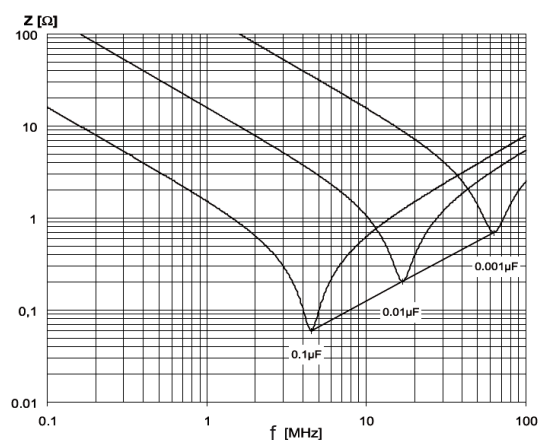
## Performance Characteristics cont.



## Qualification

Automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. For additional information regarding the Automotive Electronics Council and AEC-Q200, please visit their website at [www.aecouncil.com](http://www.aecouncil.com).




## Impedance Graph



## Environmental Test Data

Test	IEC Publication	Procedure
Endurance	IEC 60384-14	1.7 x V <sub>R</sub> 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 98m/s <sup>2</sup>
Bump	IEC 60068-2-29 Test Eb	1,000 bumps at 390 m/s <sup>2</sup>
Change of Temperature	IEC 60068-2-14 Test Na	Upper and lower rated temperature 5 cycles
Active Flammability	IEC 60384-14	V <sub>R</sub> +20 surge pulses at 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
THB test1		65°C, 93% RH and 1,000 VDC, 1,600 hours Capacitance change ( $\Delta C/C$ ): $\leq 10\%$ Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 150 \times 10^{-4}$ (at 1 kHz for Cap > 1 $\mu$ F) Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 240 \times 10^{-4}$ (at 10 kHz for Cap $\leq 1 \mu$ F) IR $\geq 50\%$ of initial limit or minimum 200 M $\Omega$
THB test2		85°C, 85% RH and 1,500 VDC, 1,000 hours Capacitance change ( $\Delta C/C$ ): $\leq 10\%$ Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 150 \times 10^{-4}$ (at 1 kHz for Cap > 1 $\mu$ F) Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 240 \times 10^{-4}$ (at 10 kHz for Cap $\leq 1 \mu$ F) IR $\geq 50\%$ of initial limit or minimum 200 M $\Omega$
THB test3		85°C, 85% RH and 300 VAC, 1,000 hours Capacitance change ( $\Delta C/C$ ): $\leq 10\%$ Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 150 \times 10^{-4}$ (at 1 kHz for Cap > 1 $\mu$ F) Dissipation factor change ( $\Delta \tan\delta$ ): $\leq 240 \times 10^{-4}$ (at 10 kHz for Cap $\leq 1 \mu$ F) IR $\geq 50\%$ of initial limit or minimum 200 M $\Omega$

## Approvals

Mark	Specification	File Number
	EN/IEC 60384-14	V4160
	UL 60384-14 and CAN/CSA E60384-14 (300 VAC)	E97797
	IEC 60384-14	CQC13001087758 CQC13001101264 CQC14001116018 CQC14001116611

## Environmental Compliance

All KEMET EMI capacitors are 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	5.0	11.0	18.0	15.0	600	413I1470(1)T0(2)	R413I1470(1)T0(2)
0.0068	5.0	11.0	18.0	15.0	600	413I1680(1)T0(2)	R413I1680(1)T0(2)
0.010	5.0	11.0	18.0	15.0	600	413I2100(1)T0(2)	R413I2100(1)T0(2)
0.015	5.0	11.0	18.0	15.0	600	413I2150(1)T1(2)	R413I2150(1)T1(2)
0.015	6.0	12.0	18.0	15.0	600	413I2150(1)T0(2)	R413I2150(1)T0(2)
0.022	6.0	12.0	18.0	15.0	600	413I2220(1)T1(2)	R413I2220(1)T1(2)
0.022	7.5	13.5	18.0	15.0	600	413I2220(1)T0(2)	R413I2220(1)T0(2)
0.033	7.5	13.5	18.0	15.0	600	413I2330(1)T1(2)	R413I2330(1)T1(2)
0.033	8.5	14.5	18.0	15.0	600	413I2330(1)T0(2)	R413I2330(1)T0(2)
0.047	10.0	16.0	18.0	15.0	600	413I2470(1)T0(2)	R413I2470(1)T0(2)
0.068	11.0	19.0	18.0	15.0	600	413I2680(1)T0(2)	R413I2680(1)T0(2)
0.047	6.0	15.0	26.5	22.5	500	413N2470(1)T0(2)	R413N2470(1)T0(2)
0.068	7.0	16.0	26.5	22.5	500	413N2680(1)T0(2)	R413N2680(1)T0(2)
0.10	8.5	17.0	26.5	22.5	500	413N3100(1)T1(2)	R413N3100(1)T1(2)
0.10	10.0	18.5	26.5	22.5	500	413N3100(1)T0(2)	R413N3100(1)T0(2)
0.15	10.0	18.5	26.5	22.5	500	413N3150(1)T1(2)	R413N3150(1)T1(2)
0.15	11.0	20.0	26.5	22.5	500	413N3150(1)T0(2)	R413N3150(1)T0(2)
0.22	13.0	22.0	26.5	22.5	500	413N3220(1)T0(2)	R413N3220(1)T0(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 lead and packaging code. See Ordering Options Table for available options.

(2) M = ±20%, K = ±10%

(3) M = ±20% (only available tolerance).

## Soldering Process

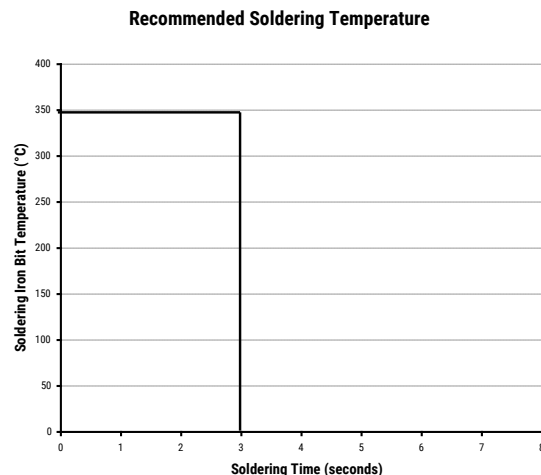
The implementation of the RoHS directive has resulted in the selection of SnAgCu (SAC) alloys or SnCu alloys as primary solder. This has increased the liquidus temperature from that of 183°C for SnPb eutectic alloy to 217 – 221°C for the new alloys. As a result, the heat stress to the components, even 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 – 170°C). 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.

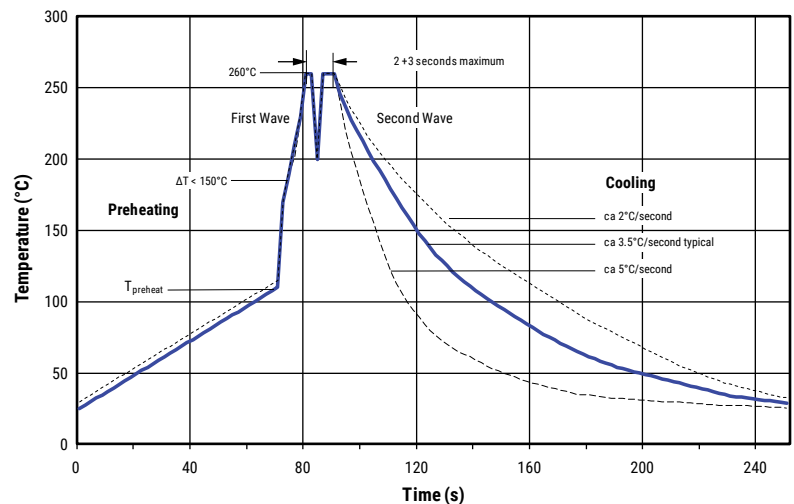
### Manual Soldering Recommendations

The 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



## Soldering Process cont.

### Wave Soldering Recommendations cont.

1. The table indicates the maximum set-up temperature of the soldering process

Figure 1

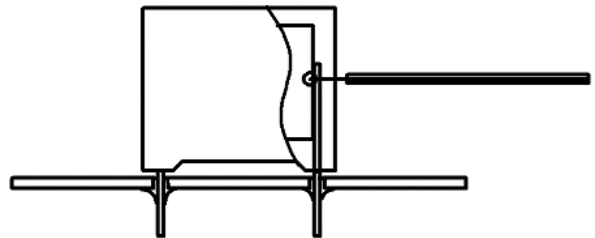
Dielectric Film Material	Maximum Preheat Temperature		Maximum Peak Soldering Temperature	
	Capacitor Pitch ≤ 15 mm	Capacitor Pitch > 15 mm	Capacitor Pitch ≤ 15 mm	Capacitor Pitch > 15 mm
Polyester	130°C	130°C	270°C	270°C
Polypropylene	110°C	130°C	260°C	270°C
Paper	130°C	140°C	270°C	270°C
Polyphenylene Sulphide	150°C	160°C	270°C	270°C

2. The maximum temperature measured inside the capacitor:

Set the temperature so that inside the element the maximum temperature is below the limit:

Dielectric Film Material	Maximum temperature measured inside the element
Polyester	160°C
Polypropylene	110°C
Paper	160°C
Polyphenylene sulphide	160°C

*Temperature monitored inside the capacitor.*



### Selective Soldering Recommendations

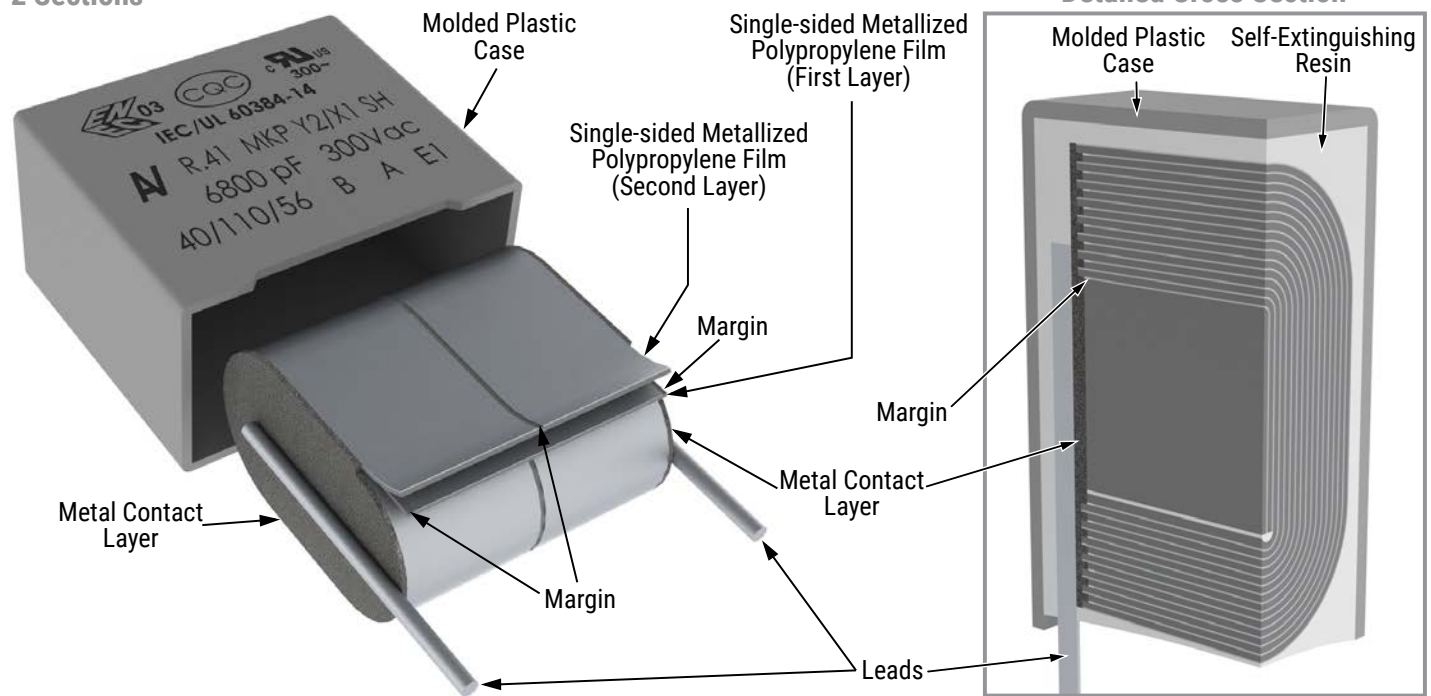
Selective dip soldering is a variation of reflow soldering. In this method, the printed circuit board with through-hole components to be soldered is preheated and transported over the solder bath as in normal flow soldering without touching the solder. When the board is over the bath, it is stopped and 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.

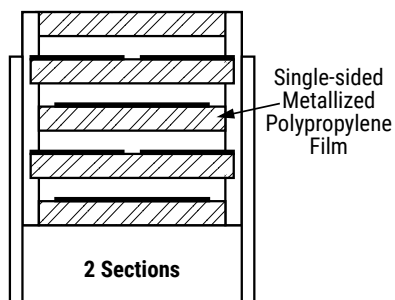


## Construction

### 2 Sections

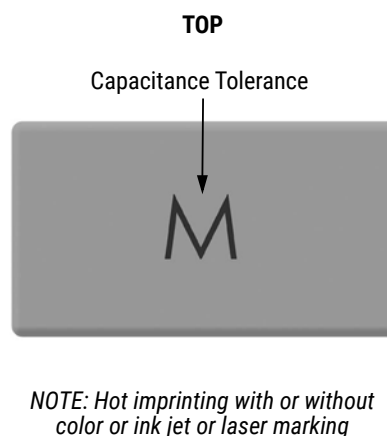
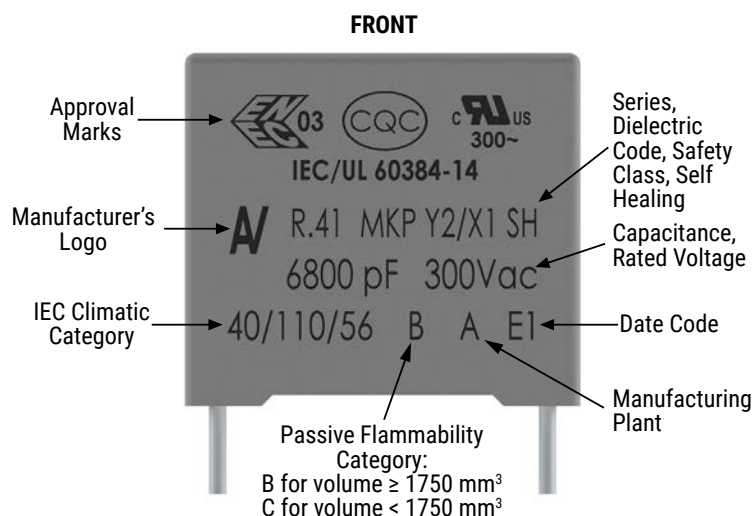


### Winding Scheme

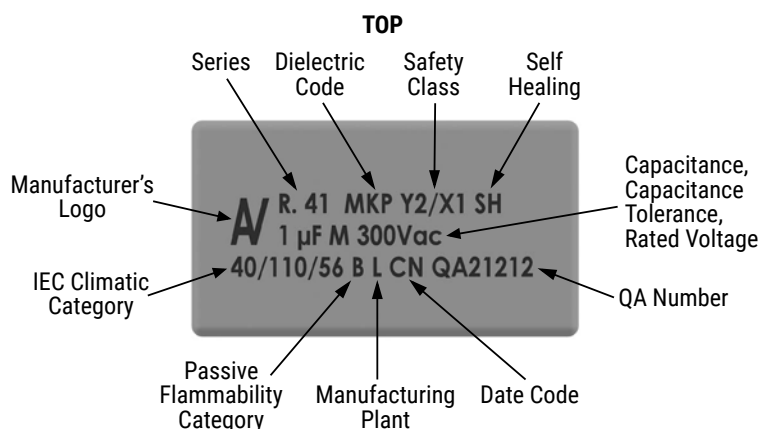
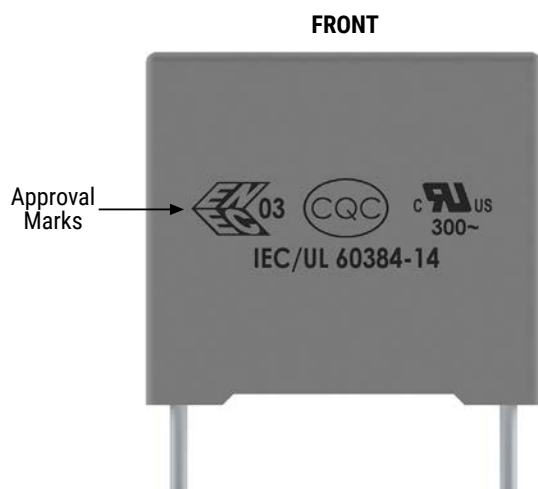


## Marking

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



### Lead Spacing 22.5 and 27.5 mm (alternatives\*) and 37.5 mm



### Manufacturing Date Code (IEC 60062)

Y = Year, Z = Month

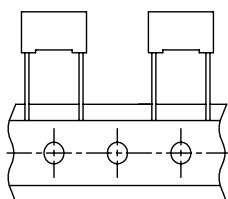
Year	Code	Year	Code	Year	Code	Month	Code	Month	Code
2010	A	2017	J	2024	S	January	1	July	7
2011	B	2018	K	2025	T	February	2	August	8
2012	C	2019	L	2026	U	March	3	September	9
2013	D	2020	M	2027	V	April	4	October	0
2014	E	2021	N	2028	W	May	5	November	N
2015	F	2022	P	2029	X	June	6	December	D
2016	H	2023	R	2030	M				

## Packaging Quantities

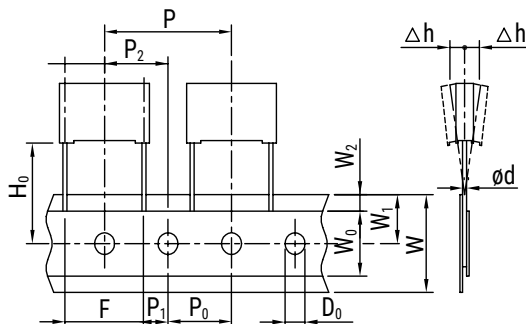
Lead Spacing (mm)	Thickness (mm)	Height (mm)	Length (mm)	Bulk Short Leads	Bulk Long Leads	Standard Reel ø 355 mm	Large Reel ø 500 mm	Ammo Taped
15	5.0	11.0	18.0	2000	1000	600	1,250	800
	6.0	12.0	18.0	1750	900	500	1,000	680
	7.5	13.5	18.0	1000	700	350	800	500
	8.5	14.5	18.0	1000	500	300	700	440
	11.0	19.0	18.0	450	350	–	500	340
22.5	6.0	15.0	26.5	805	500	–	700	464
	7.0	16.0	26.5	700	500	–	550	380
	8.5	17.0	26.5	468	300	–	450	280
	10.0	18.5	26.5	396	300	–	350	235
	13.0	22.0	26.5	300	200	–	300	–

## Lead Taping & Packaging (IEC 60286-2)

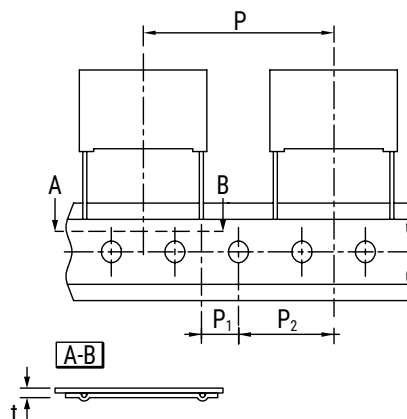
**Figure 1**  
Lead Spacing 10 mm



**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 Fig. 1	15 Fig. 2	22.5 Fig. 3	27.5 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 <sub>0</sub>	12.7	12.7	12.7	12.7	±0.2 **	
Centering of the lead wire	P <sub>1</sub>	7.7	5.2	7.8	5.3	±0.7	
Centering of the body	P <sub>2</sub>	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	Δh	0	0	0	0	±2	
Height of component from tape center	H <sub>0</sub> ****	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 <sub>0</sub>	9	10	10	10	Minimum	
Hole position	W <sub>1</sub>	9	9	9	9	±0.5	
Hold down tape position	W <sub>2</sub>	3	3	3	3	Maximum	
Feed hole diameter	D <sub>0</sub>	4	4	4	4	±0.2	
Total tape thickness	t	0.7	0.7	0.7	0.7	±0.2	

\* 15 mm also available

\*\* Maximum of 1 mm on 20 lead spaces

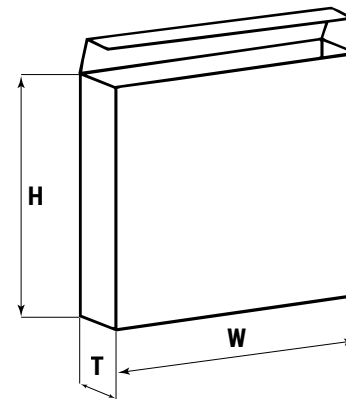
\*\*\* Pitches 15 mm and 10 mm taped to 7.5 mm (crimped leads) available upon request

\*\*\*\* H<sub>0</sub> = 16.5 mm is available upon request

## Lead Taping & Packaging (IEC 60286-2) cont.

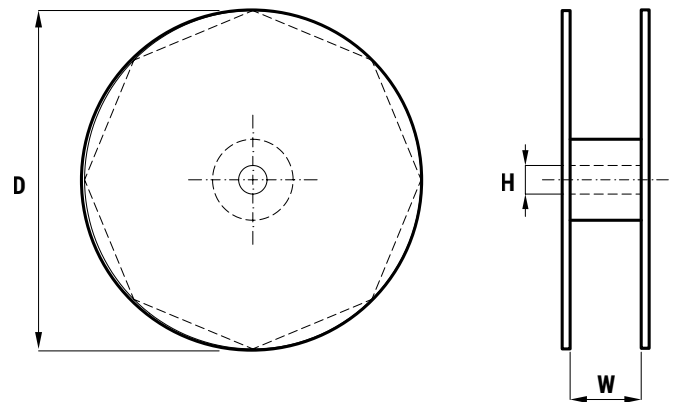
### Ammo Specifications

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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