# R41, Class X1/Y2, 300 VAC, 110°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 (up to 22.5 mm Lead Spacing) 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, CQCClass X1 / Y2 (IEC 60384-14)

Rated voltage: 300 VAC 50/60 Hz
Capacitance range: 0.001 – 1 μF

• Lead spacing: 10 - 37.5 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 +110°C

• 100% screening factory test at 5,000 VDC/2,500 VAC

Self-healing properties

 Automotive (AEC-Q200) grades available up to 22.5 mm Lead Spacing



## **Part Number System**

R41	3	I	2330	00	M1	M
Series	Rated Voltage (VAC)	Lead Spacing (mm)	Capacitance Code (pF)	Packaging	Internal Use	Capacitance Tolerance
Y2, Metallized Polypropylene	3 = 300	F = 10.0 I = 15.0 N = 22.5 R = 27.5 W = 37.5	The last three digits represent significant figures. The first digit specifies number of zeros to be added.	See Ordering Options Table	00 M1	K = ±10% M = ±20%



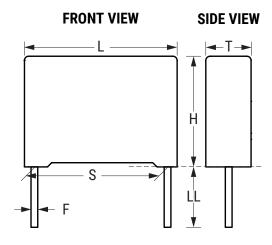
# **Ordering Options Table**

Lead Spacing Nominal (mm)	Type of Leads and Packaging	Lead Length (mm)	Lead and Packaging Code	
	Standard Lead and Packaging Options			
	Bulk (Bag) – Short Leads	4 +2/-0	00	
	Ammo Pack	H <sub>0</sub> = 18.5 ±0.5	DQ	
	Other Lead and Packaging Options			
10,	Tape & Reel (Large Reel)	H <sub>0</sub> = 18.5 ±0.5	СК	
15,	Bulk (Bag) – Short Leads	3.5 +0.5/-0	JB	
22.5	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	
	Standard Lead and Packaging Options			
	Bulk (Tray) – Short Leads	4 +2/-0	00	
27.5	Tape & Reel (Large Reel)	H <sub>0</sub> = 18.5 ±0.5	CK <sup>1</sup>	
	Other Lead and Packaging Options			
	Bulk (Tray) – Long Leads	30 +5/-0	40	
	Bulk (Tray) – Long Leads	25 +2/-1	50	
	Standard Lead and Packaging Options			
		4.27.0	00	
37.5	Bulk (Tray) - Short Leads	4 +2/-0	UU	
37.3	Other Lead and Packaging Options			
	Bulk (Tray) – Long Leads	30 +5/-0	40	
	Bulk (Tray) – Long Leads	25 +2/-1	50	

<sup>&</sup>lt;sup>1</sup> Not for all sizes, see "Packaging Quantities" table



## **Dimensions - Millimeters**



	S T		H	1	L		F			
Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	
10.0	±0.4	4.0	+0.2/-0.5	9.0	+0.1/-0.5	13.0	+0.3/-0.5	0.6	±0.05	
10.0	±0.4	5.0	+0.2/-0.5	11.0	+0.1/-0.5	13.0	+0.3/-0.5	0.6	±0.05	
10.0	±0.4	6.0	+0.2/-0.5	12.0	+0.1/-0.5	13.0	+0.3/-0.5	0.6	±0.05	
15.0	±0.4	5.0	+0.2/-0.5	11.0	+0.1/-0.5	18.0	+0.3/-0.5	0.6	±0.05	
15.0	±0.4	6.0	+0.2/-0.5	12.0	+0.1/-0.5	18.0	+0.3/-0.5	0.6	±0.05	
15.0	±0.4	7.5	+0.2/-0.5	13.5	+0.1/-0.5	18.0	+0.3/-0.5	0.6	±0.05	
15.0	±0.4	8.5	+0.2/-0.5	14.5	+0.1/-0.5	18.0	+0.3/-0.5	0.6	±0.05	
15.0	±0.4	11.0	+0.2/-0.5	19.0	+0.1/-0.5	18.0	+0.3/-0.5	0.8	±0.05	
22.5	±0.4	6.0	+0.2/-0.5	15.0	+0.1/-0.5	26.5	+0.3/-0.5	0.8	±0.05	
22.5	±0.4	7.0	+0.2/-0.5	16.0	+0.1/-0.5	26.5	+0.3/-0.5	0.8	±0.05	
22.5	±0.4	8.5	+0.2/-0.5	17.0	+0.1/-0.5	26.5	+0.3/-0.5	0.8	±0.05	
22.5	±0.4	10.0	+0.2/-0.5	18.5	+0.1/-0.5	26.5	+0.3/-0.5	0.8	±0.05	
22.5	±0.4	13.0	+0.2/-0.5	22.0	+0.1/-0.5	26.5	+0.3/-0.5	0.8	±0.05	
27.5	±0.4	13.0	+0.2/-0.7	22.0	+0.1/-0.7	32.0	+0.3/-0.7	0.8	±0.05	
27.5	±0.4	14.0	+0.2/-0.7	28.0	+0.1/-0.7	32.0	+0.3/-0.7	0.8	±0.05	
27.5	±0.4	18.0	+0.2/-0.7	33.0	+0.1/-0.7	32.0	+0.3/-0.7	0.8	±0.05	
37.5	±0.4	13.0	+0.2/-0.7	24.0	+0.1/-0.7	41.5	+0.3/-0.7	1.0	±0.05	
37.5	±0.4	16.0	+0.2/-0.7	28.5	+0.1/-0.7	41.5	+0.3/-0.7	1.0	±0.05	
37.5	±0.4	20.0	+0.2/-0.7	40.0	+0.1/-0.7	41.5	+0.3/-0.7	1.0	±0.05	
	Note: See Ordering Options Table for lead length (LL/H <sub>o</sub> ) options.									



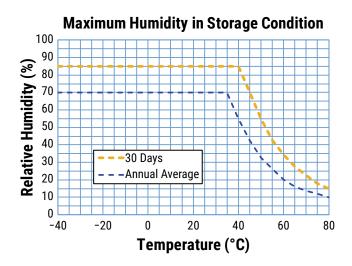
## **Performance Characteristics**

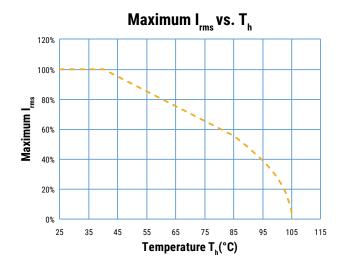
Dielectric	Polypropylene film						
Plates	Metal layer deposited by	Metal layer deposited by evaporation under vacuum					
Winding	Non-inductive type						
Leads	Tinned wire						
Protection	Plastic case, thermosetting	g resin filled. Box material is so	olvent resistant and flame ret	ardant according to UL94.			
Related documents	IEC 60384-14, EN 60384-	14					
Rated Voltage (V <sub>R</sub> )	300 VAC (50/60 Hz)						
Recommended DC Voltage	1,000 VDC						
Capacitance Range	0.0010 to 1 μF						
Capacitance Values	E6 series (IEC 60063)						
Capacitance Tolerance	±10%, ±20%						
Temperature Range	-40°C to +110°C						
Climatic Category	40/110/56 IEC 60068-1	40/110/56 IEC 60068-1					
	Storage time: ≤ 24 months from the date marked on the label package						
	Average relative humidity per year ≤ 70%						
Storage Conditions	RH ≤ 85% for 30 days randomly distributed throughout the year						
	Dew is absent						
	Temperature: -40 to 80°0	C (see "Maximum Humidity i	n Storage Conditions" grap	h below)			
Approvals	ENEC, UL, cUL, CQC						
Dissipation Factor (tanδ)		Maximum Value	s at +25°C ±5°C				
at 1 kHz		≤ 0.3% (0.2%*) at 1	kHz , +25°C ±5°C				
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.						
		Measured at	+25°C ±5°C				
		Minimum Values B	etween Terminals				
Insulation Resistance	Voltage Charge	Voltage Charge Time	C ≤ 0.33 µF	C > 0.33 µF			
	100 VDC	1 minute	$\geq 1 \cdot 10^5 \mathrm{M}\Omega$ ( $\geq 5 \cdot 10^5 \mathrm{M}\Omega$ )*	≥ 30,000 MΩ • μF ( ≥ 150,000 MΩ • μF )*			
In DC Applications	Recommended voltage ≤	1,000 VDC					

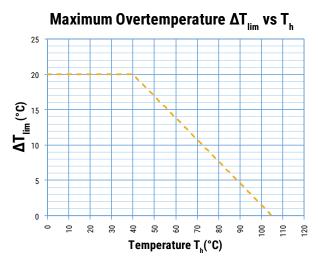
<sup>\*</sup> Typical value



#### **Performance Characteristics cont.**



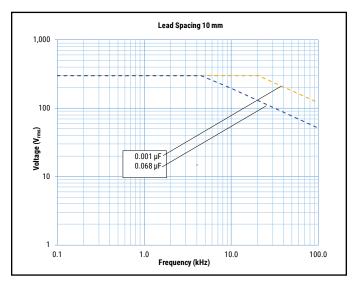


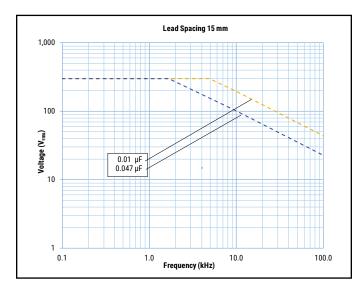


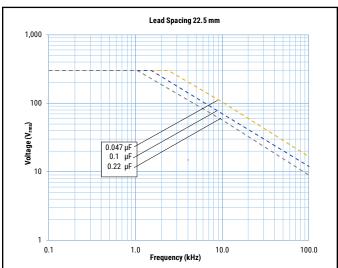
 $T_h$  is the maximum ambient temperature surrounding the capacitor or hottest contact point (e.g. tracks), whichever is higher, in the worst operation conditions in °C.

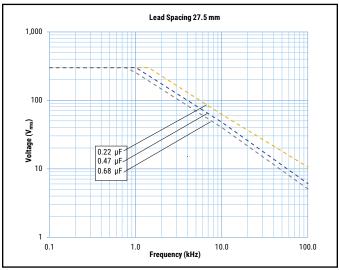


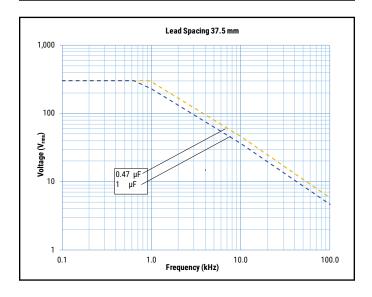
# Maximum Voltage ( $V_{rms}$ ) Versus Frequency (Sinusoidal Waveform/Th $\leq 40$ °C)





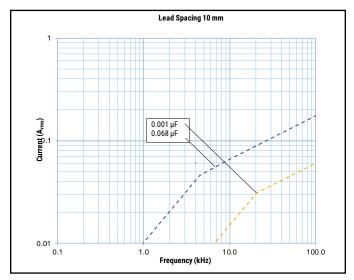


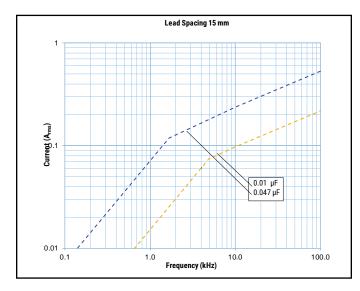


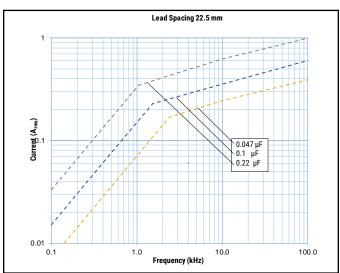


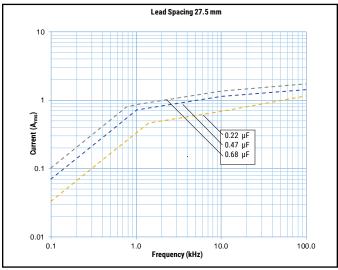


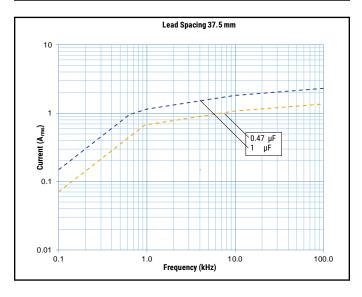
# Maximum Current (I<sub>rms</sub>) Versus Frequency (Sinusoidal Waveform/Th ≤ 40°C)









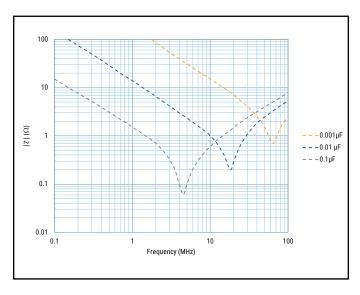




## Qualification

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.

## **Impedance Graph**



#### **Environmental Test Data**

Test	IEC Publication	Procedure
Endurance	EN/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 98 m/s²
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



# **Approvals**

Certification Body	Mark	Specification	File Number
IMQ S.p.A.		EN/IEC 60384-14	V4160
UL	c FW us	UL 60384-14 and CAN/CSA E60384-14 (300 VAC)	E97797
CQC	Cec	IEC 60384-14	CQC14001116018 CQC13001101264 CQC15001128704 CQC19001218777 CQC13001087758

# **Environmental Compliance**

All KEMET EMI capacitors are RoHS Compliant.





## **Table 1 - Ratings & Part Number Reference**

Capacitance Dimensions in m		n mm	Lead Spacing	dV/dt	KEMET	Customer	
Value (μF)	T	Н	L	<b>(S)</b>	(V/µs)	Part Number	Part Number
0.0010	4.0	9.0	13.0	10.0	800	413F1100(1)00(2)	R413F1100(1)00(2)
0.0015	4.0	9.0	13.0	10.0	800	413F1150(1)00(2)	R413F1150(1)00(2)
0.0022	4.0	9.0	13.0	10.0	800	413F1220(1)00(2)	R413F1220(1)00(2)
0.0033	4.0	9.0	13.0	10.0	800	413F1330(1)M1(2)	R413F1330(1)M1(2)
0.0047	5.0	11.0	13.0	10.0	800	413F1470(1)M1(2)	R413F1470(1)M1(2)
0.0068	6.0	12.0	13.0	10.0	800	413F1680(1)00(3)	R413F1680(1)00(3)
0.010	6.0	12.0	13.0	10.0	800	413F2100(1)M1(3)	R413F2100(1)M1(3)
0.0033	5.0	11.0	18.0	15.0	600	41311330(1)00(2)	R413I1330(1)00(2)
0.0047	5.0	11.0	18.0	15.0	600	41311470(1)00(2)	R413I1470(1)00(2)
0.0068	5.0	11.0	18.0	15.0	600	413 1680(1)00(2)	R413I1680(1)00(2)
0.010	5.0	11.0	18.0	15.0	600	41312100(1)00(2)	R413I2100(1)00(2)
0.015	5.0	11.0	18.0	15.0	600	413I2150(1)M1(2)	R413I2150(1)M1(2)
0.022	6.0	12.0	18.0	15.0	600	413I2220(1)M1(2)	R413I2220(1)M1(2)
0.033	7.5	13.5	18.0	15.0	600	413I2330(1)M1(2)	R413I2330(1)M1(2)
0.047	8.5	14.5	18.0	15.0	600	413I2470(1)M1(2)	R413I2470(1)M1(2)
0.068	11.0	19.0	18.0	15.0	600	41312680(1)00(2)	R413I2680(1)00(2)
0.047	6.0	15.0	26.5	22.5	500	413N2470(1)00(2)	R413N2470(1)00(2)
0.068	6.0	15.0	26.5	22.5	500	413N2680(1)M1(3)	R413N2680(1)M1(3)
0.068	7.0	16.0	26.5	22.5	500	413N2680(1)00(2)	R413N2680(1)00(2)
0.10	8.5	17.0	26.5	22.5	500	413N3100(1)M1(2)	R413N3100(1)M1(2)
0.15	10.0	18.5	26.5	22.5	500	413N3150(1)M1(2)	R413N3150(1)M1(2)
0.22	13.0	22.0	26.5	22.5	500	413N3220(1)00(2)	R413N3220(1)00(2)
0.22	13.0	22.0	32.0	27.5	400	413R3220(1)00(2)	R413R3220(1)00(2)
0.33	14.0	28.0	32.0	27.5	400	413R3330(1)00(2)	R413R3330(1)00(2)
0.33	13.0	22.0	32.0	27.5	400	413R3330(1)M1(2)	R413R3330(1)M1(2)
0.47	18.0	33.0	32.0	27.5	400	413R3470(1)00(2)	R413R3470(1)00(2)
0.68	18.0	33.0	32.0	27.5	400	413R3680(1)00(2)	R413R3680(1)00(2)
0.47	13.0	24.0	41.5	37.5	300	413W3470(1)00(2)	R413W3470(1)00(2)
0.68	16.0	28.5	41.5	37.5	300	413W3680(1)00(2)	R413W3680(1)00(2)
1.0	20.0	40.0	41.5	37.5	300	413W4100(1)00(2)	R413W4100(1)00(2)
Capacitance Value (µF)	T (mm)	H (mm)	L (mm)	Lead Spacing (S)	dV/dt (V/μs)	KEMET Part Number	Customer Part Number

<sup>(1)</sup> Insert lead and packaging code. See Ordering Options Table for available options.

<sup>(2)</sup>  $M = \pm 20\%$ ,  $K = \pm 10\%$ 

<sup>(3)</sup> 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.

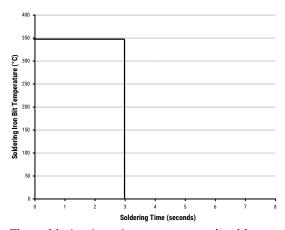
Reflow soldering is not recommended for through-hole film capacitors. Exposing capacitors to a soldering profile in excess of the above the recommended limits may result to degradation or permanent damage to the capacitors.

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**

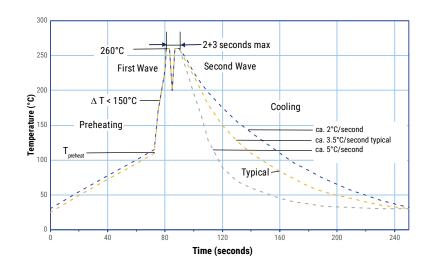
The following is the recommendation for manual soldering with a soldering iron.

#### **Recommended Soldering Temperature**



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.**

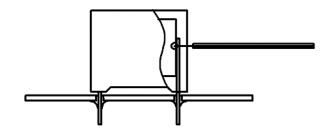
1. The table indicates the maximum set-up temperature of the soldering process Figure 1

Dielectric	Pre	mum heat erature	Maximum Peak Soldering Temperature		
Film Material	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.

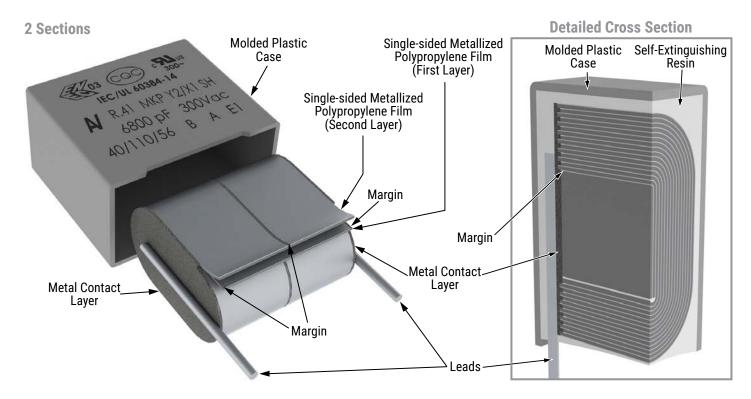
#### **Selective Soldering Recommendations**

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.

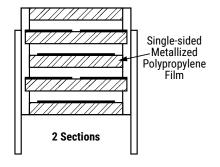
The temperature profile for selective soldering is similar to the double wave flow soldering outlined in this document, however, instead of two baths, there is only one bath with a time from 3 to 10 seconds. In selective soldering, the risk of overheating is greater than in double wave flow soldering,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



#### Construction



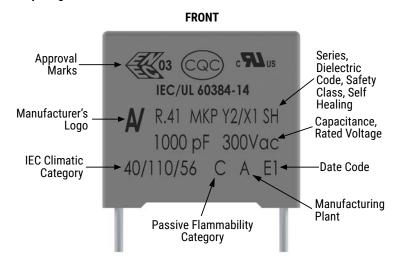
#### **Winding Scheme**

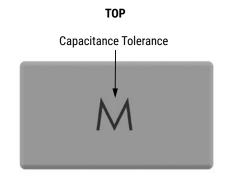




#### **Marking**

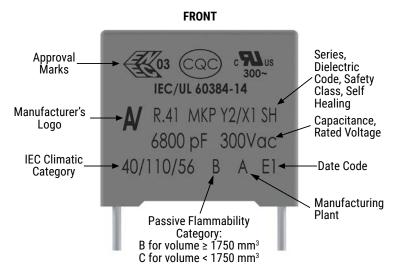
#### Lead Spacing 10 mm

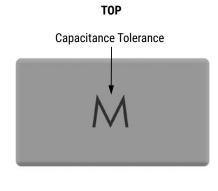




NOTE: Hot imprinting with or without color or ink jet or laser marking

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





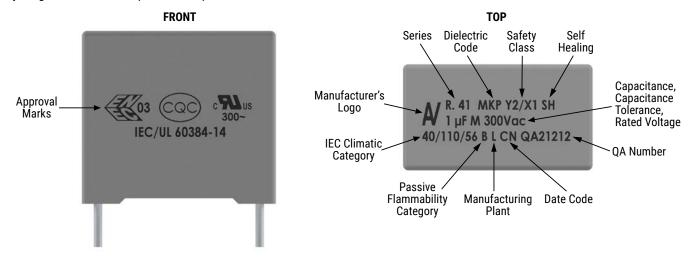
NOTE: Hot imprinting with or without color or ink jet or laser marking

<sup>\*</sup> Differences caused by technology (clichee, laser or ink jet) and production line



## Marking cont.

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



<sup>\*</sup> Differences caused by technology (clichee, laser or ink jet) and production line

Mai	Manufacturing Date Code (IEC 60062)									
Year	Code	Month	Code							
2010	Α	January	1							
2011	В	February	2							
2012	С	March	3							
2013	D	April	4							
2014	E	May	5							
2015	F	June	6							
2016	Н	July	7							
2017	J	August	8							
2018	K	September	9							
2019	L	October	0							
2020	M	November	N							
2021	N	December	D							
2022	Р									
2023	R									
2024	S									
2025	Т									
2026	U									
2027	V									
2028	W									
2029	Х									
2030	Α									



# **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
Lea	d And Packagi	ng Code:		00 - JA - JB JE - JH	JM - 40 - 50	GY - CK <sup>1</sup>	СК	DQ
	4.0	9.0	13.0	2000	1800	750	1,500	1000
10	5.0	11.0	13.0	1300	1500	600	1,250	800
	6.0	12.0	13.0	1000	1200	500	1,000	680
	5.0	11.0	18.0	2000	1000	600	1.250	800
		11.0			900		1,250	
15	6.0	12.0	18.0	1750		500	1,000	680
15	7.5	13.5	18.0	1000	700	350	800	500
	8.5	14.5	18.0	1000	500	270	700	440
	11.0	19.0	18.0	450	350	270	500	340
	6.0	15.0	26.5	805	500	300	700	464
	7.0	16.0	26.5	700	500	250	550	380
22.5	8.5	17.0	26.5	468	300	250	450	280
	10.0	18.5	26.5	396	300	160	350	235
	13.0	22.0	26.5	300	200	130	300	-
					·			
	13.0	22.0	32.0	480	288	-	300	
27.5	14.0	28.0	32.0	352	176	-	-	-
	18.0	33.0	32.0	256	128	_	_	
	13.0	24.0	41.5	360	216	_	_	_
37.5	16.0	28.5	41.5	216	108	_	_	_
07.0	20.0	40.0	41.5	126	84	_	_	_

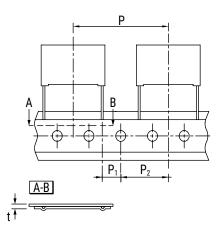


## Lead Taping & Packaging (IEC 60286-2)

Figure 1 Lead Spacing 10 mm

Figure 2 Lead Spacing 15 mm

Figure 3 Lead Spacing 22.5 – 27.5 mm



# **Taping Specification**

		Dimensions (mm)					
Description	Symbol						
Description	Cymbol	10	15	22.5	27.5	Tol.	
		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	Р	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 <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	$W_{0}$	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	

<sup>\* 15</sup> mm also available

<sup>\*\*</sup> Maximum of 1 mm on 20 lead spaces

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

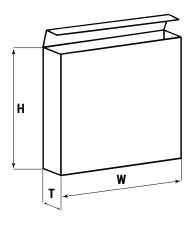
<sup>\*\*\*\*</sup>  $H_0$  = 16.5 mm is available upon request



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

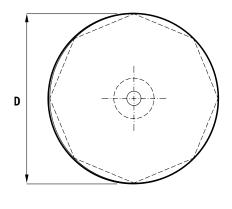
# **Ammo Specifications**

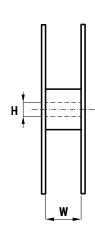
Dimensions (mm)				
Н	W	Т		
360	340	59		



# **Reel Specifications**

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







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