

Overview

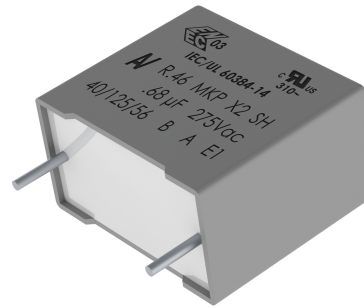
The R46 Series is constructed of metallized polypropylene film encapsulated with self-extinguishing resin in a box of material meeting the requirements of UL 94 V-0.

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. Not for use in "series with mains" type applications.

Benefits

- Approvals: ENEC, UL, cUL
- Class X2 (IEC 60384-14)
- Rated voltage: 275 VAC 50/60 Hz
- Capacitance range: 0.01 – 1 μ F
- Lead spacing: 10.0 – 22.5 mm
- Capacitance tolerance: \pm 20%, \pm 10%
- Climatic category: 40/125/56, 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 2,200 VDC/1,500 VAC
- Self-healing properties



Part Number System

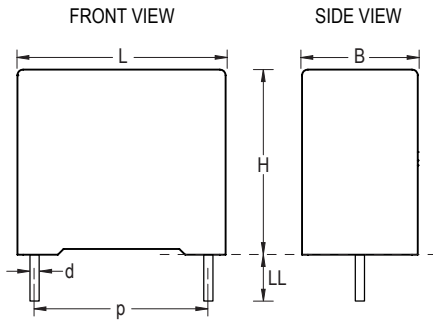
| R46 | K | N | 3220 | 00 | H1 | M |
|------------------------------|---------------------|----------------------------------|---|----------------------------|--|--------------------------------|
| Series | Rated Voltage (VAC) | Lead Spacing (mm) | Capacitance Code (pF) | Packaging | Internal Use | Capacitance Tolerance |
| X2, Metallized Polypropylene | K = 275 | F = 10.0 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 | H = High Temperature H1 H2 H3 H4 | K = \pm 10% M = \pm 20% |

Ordering Options Table

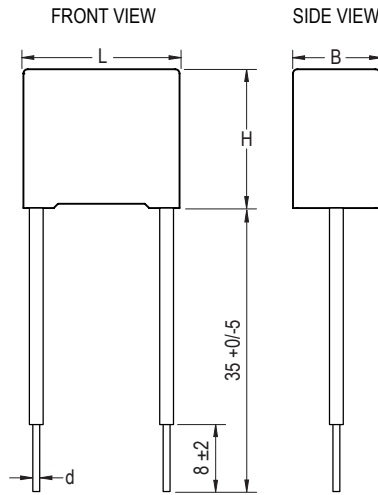
| Lead Spacing Nominal (mm) | Type of Leads and Packaging | Lead Length (mm) | Lead and Packaging Code |
|---------------------------|--|------------------------------|-------------------------|
| 10, 15, 22.5 | Standard Lead and Packaging Options | | |
| | Bulk (Bag) – Short Leads | 4 +2/-0 | 00 |
| | 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 | 2.7 +0.5/-0 | JA |
| | 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/-1 | JM |
| | Bulk (Bag) – Long Leads | 30 +5/-0 | 40 |
| | Bulk (Bag) – Long Leads | 25 +2/-1 | 50 |
| | Bulk (Bag) – Insulated Rigid Leads | 30 +5/-0 (sp 8+2/-2) | 51 |
| | Bulk (Bag) – Insulated Flexible Leads | 150 +5/-5 (sp 8+2/-2) | 52 |

Dimensions – Millimeters

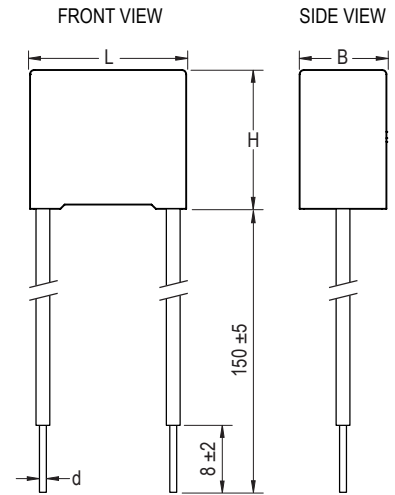
Loose



Insulated Rigid Leads



Insulated Flexible Leads 0.5 mm²



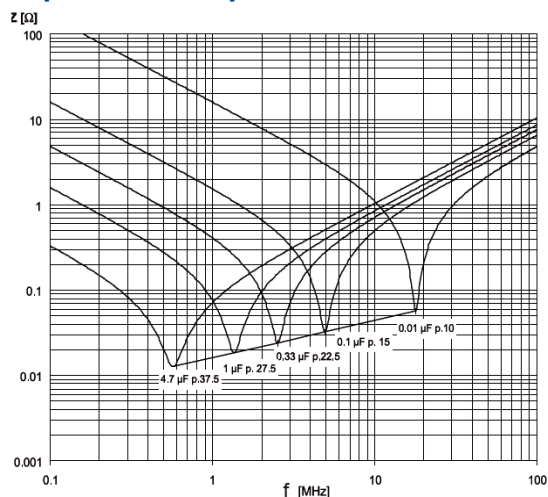
| p | | B | | H | | L | | d | |
|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|
| Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance |
| 10.0 | +/-0.4 | 5.0 | +0.2 | 11.0 | +0.1 | 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 | 0.6 | +/-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 | 7.0 | +0.2 | 16.0 | +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 |

Note: See Ordering Options Table for lead length (LL/H₀) 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) | 275 VAC (50/60 Hz), 560 VDC | | | |
| Capacitance Range | 0.010 μ F to 1 μ F | | | |
| Capacitance Values | E6 series (IEC 60063) measured @ 1 kHz and +20 \pm 1°C | | | |
| Capacitance Tolerance | \pm 10%, \pm 20% | | | |
| Temperature Range | -40°C to +125°C | | | |
| Climatic Category | 40/125/56 IEC 60068-1 | | | |
| Approvals | ENEC, UL, cUL | | | |
| Dissipation Factor ($\tan\delta$) | \leq 0.1% (0.06%*) @ 1kHz, +25°C \pm 5°C (* typical value) | | | |
| Test Voltage Between Terminals | The 100% screening factory test is carried out at 2,200 VDC/1,500 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. | | | |
| Insulation Resistance | Measured at +25°C \pm 5°C, according to IEC 60384-2 | | | |
| | Minimum Values Between Terminals | | | |
| | Voltage Charge | Voltage Charge Time | C \leq 0.33 μ F | C > 0.33 μ F |
| | 100 VDC | 1 min | \geq 1 \cdot 10 ⁵ M Ω (\geq 5 \cdot 10 ⁵ M Ω)* * typical value | \geq 30,000 M Ω \cdot μ F (\geq 150,000 M Ω \cdot μ F)* * typical value |
| In DC Applications | Recommended voltage \leq 560 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 | V4413 |
|  | UL 60384-14 and CAN/CSA E60384-14 (310VAC) | E97797 |

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 | | | | |
| 0.010 | 5.0 | 11.0 | 13.0 | 10.0 | 500 | 46KF2100(1)H1(2) | R46KF2100(1)H1(2) |
| 0.015 | 5.0 | 11.0 | 13.0 | 10.0 | 500 | 46KF2150(1)H1(2) | R46KF2150(1)H1(2) |
| 0.022 | 5.0 | 11.0 | 13.0 | 10.0 | 500 | 46KF2220(1)H1(2) | R46KF2220(1)H1(2) |
| 0.033 | 5.0 | 11.0 | 13.0 | 10.0 | 500 | 46KF2330(1)H1(2) | R46KF2330(1)H1(2) |
| 0.047 | 6.0 | 12.0 | 13.0 | 10.0 | 500 | 46KF2470(1)H1(2) | R46KF2470(1)H1(2) |
| 0.068 | 6.0 | 12.0 | 13.0 | 10.0 | 500 | 46KF2680(1)H1(3) | R46KF2680(1)H1(3) |
| 0.010 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2100(1)H1(2) | R46KI2100(1)H1(2) |
| 0.015 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2150(1)H1(2) | R46KI2150(1)H1(2) |
| 0.022 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2220(1)H1(2) | R46KI2220(1)H1(2) |
| 0.033 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2330(1)H1(2) | R46KI2330(1)H1(2) |
| 0.047 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2470(1)H1(2) | R46KI2470(1)H1(2) |
| 0.068 | 5.0 | 11.0 | 18.0 | 15.0 | 400 | 46KI2680(1)H1(2) | R46KI2680(1)H1(2) |
| 0.10 | 6.0 | 12.0 | 18.0 | 15.0 | 400 | 46KI3100(1)H1(2) | R46KI3100(1)H1(2) |
| 0.15 | 6.0 | 17.5 | 18.0 | 15.0 | 400 | 46KI3150(1)H2(2) | R46KI3150(1)H2(2) |
| 0.15 | 9.0 | 12.5 | 18.0 | 15.0 | 400 | 46KI3150(1)H3(2) | R46KI3150(1)H3(2) |
| 0.15 | 7.5 | 13.5 | 18.0 | 15.0 | 400 | 46KI3150(1)H1(2) | R46KI3150(1)H1(2) |
| 0.22 | 8.5 | 14.5 | 18.0 | 15.0 | 400 | 46KI3220(1)H1(2) | R46KI3220(1)H1(2) |
| 0.22 | 6.0 | 17.5 | 18.0 | 15.0 | 400 | 46KI3220(1)H2(3) | R46KI3220(1)H2(3) |
| 0.22 | 9.0 | 12.5 | 18.0 | 15.0 | 400 | 46KI3220(1)H3(3) | R46KI3220(1)H3(3) |
| 0.22 | 7.5 | 18.5 | 18.0 | 15.0 | 400 | 46KI3220(1)H4(2) | R46KI3220(1)H4(2) |
| 0.33 | 10.0 | 16.0 | 18.0 | 15.0 | 400 | 46KI3330(1)H1(3) | R46KI3330(1)H1(3) |
| 0.33 | 7.5 | 18.5 | 18.0 | 15.0 | 400 | 46KI3330(1)H2(3) | R46KI3330(1)H2(3) |
| 0.33 | 13.0 | 12.0 | 18.0 | 15.0 | 400 | 46KI3330(1)H3(3) | R46KI3330(1)H3(3) |
| 0.47 | 11.0 | 19.0 | 18.0 | 15.0 | 400 | 46KI3470(1)H1(3) | R46KI3470(1)H1(3) |
| 0.15 | 6.0 | 15.0 | 26.5 | 22.5 | 200 | 46KN3150(1)H1(2) | R46KN3150(1)H1(2) |
| 0.22 | 6.0 | 15.0 | 26.5 | 22.5 | 200 | 46KN3220(1)H1(2) | R46KN3220(1)H1(2) |
| 0.33 | 7.0 | 16.0 | 26.5 | 22.5 | 200 | 46KN3330(1)H1(2) | R46KN3330(1)H1(2) |
| 0.47 | 10.0 | 18.5 | 26.5 | 22.5 | 200 | 46KN3470(1)H1(2) | R46KN3470(1)H1(2) |
| 0.68 | 11.0 | 20.0 | 26.5 | 22.5 | 200 | 46KN3680(1)H1(2) | R46KN3680(1)H1(2) |
| 1.0 | 13.0 | 22.0 | 26.5 | 22.5 | 200 | 46KN4100(1)H1(2) | R46KN4100(1)H1(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

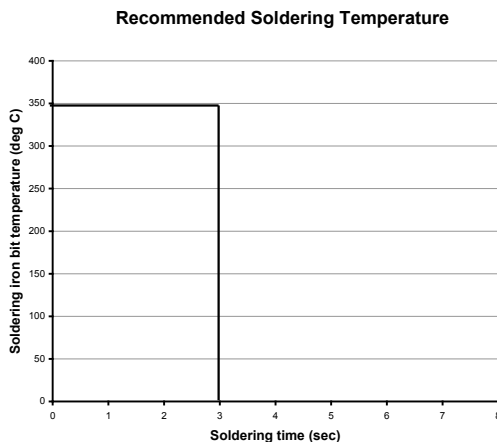
The implementation of the RoHS directive has resulted in the selection of SnAgCu (SAC) alloys or SnCu alloys as primary solder. This has increased the liquidus temperature from that of 183°C for SnPb eutectic alloy to 217 – 221°C for the new alloys. As a result, the heat stress to the components, even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

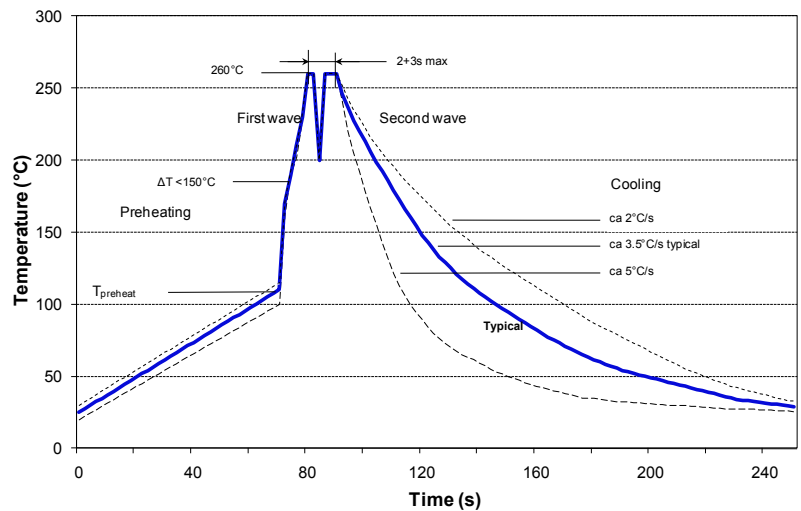
Manual Soldering Recommendations

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'd

Wave Soldering Recommendations cont'd

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

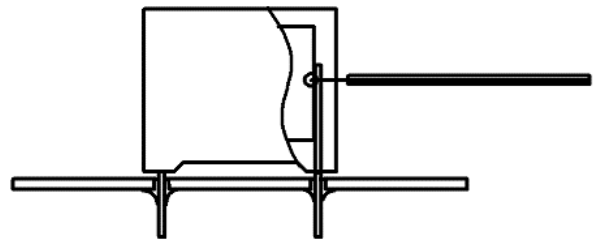
Figure 1

| Dielectric Film Material | Maximum Preheat Temperature | | | Maximum Peak Soldering Temperature | |
|--------------------------|-----------------------------|-------------------------|-------------------------|------------------------------------|-------------------------|
| | Capacitor Pitch ≤ 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 |
| Paper | 130°C | 130°C | 140°C | 270°C | 270°C |
| Polyphenylene Sulphide | 150°C | 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 |



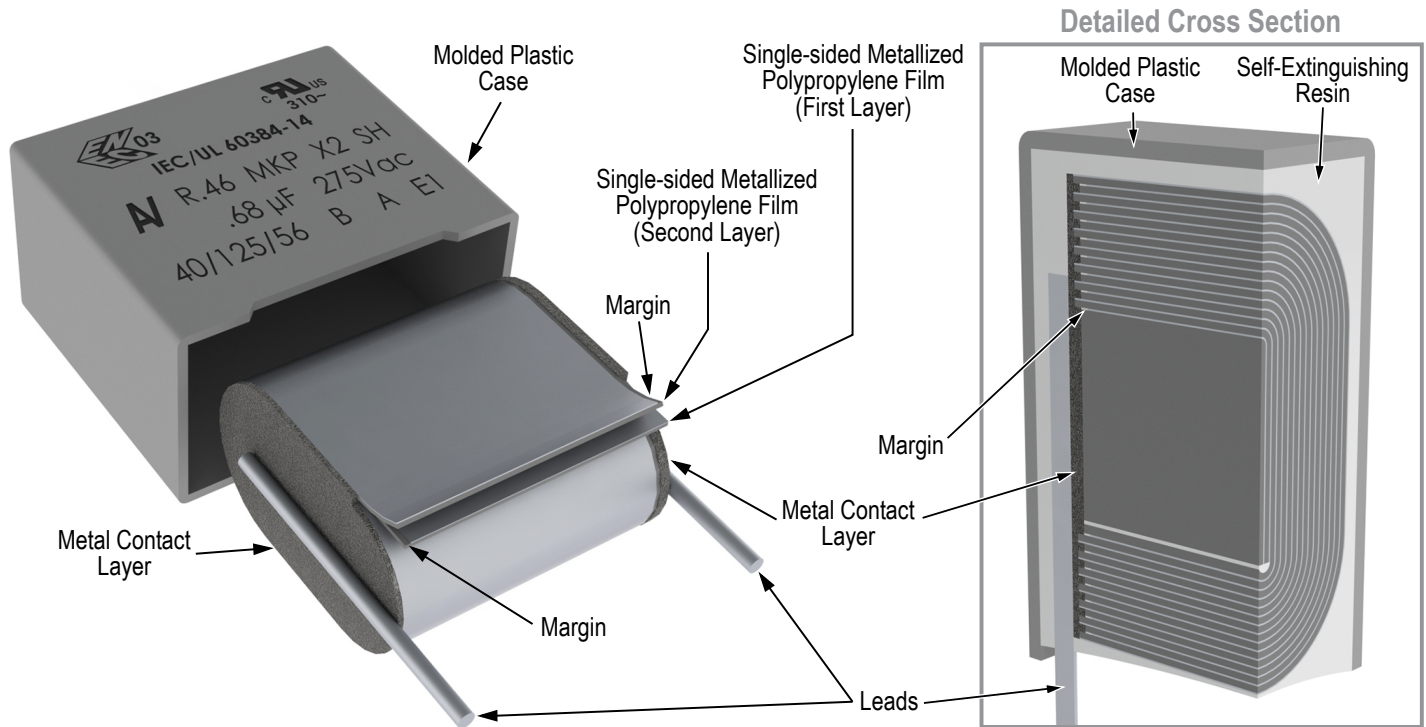
Temperature monitored inside the capacitor.

Selective Soldering Recommendations

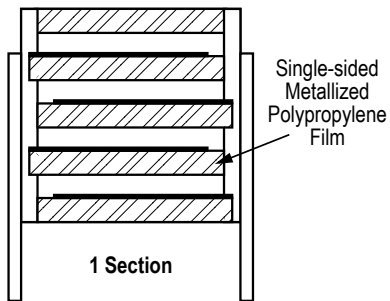
Selective dip soldering is a variation of reflow soldering. In this method, the printed circuit board with through-hole components to be soldered is preheated and transported over the solder bath as in normal flow soldering without touching the solder. When the board is over the bath, it is stopped and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

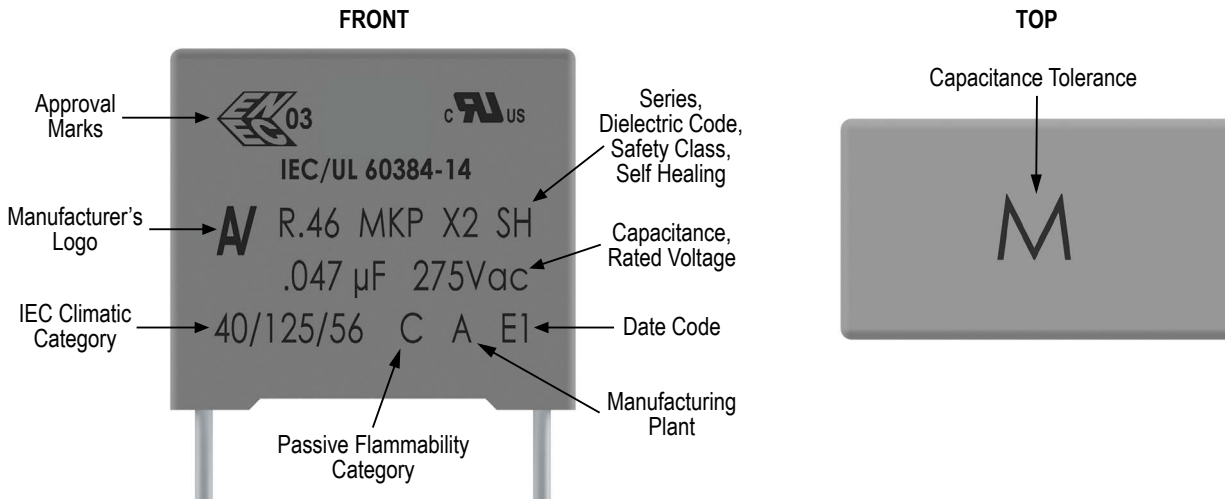


Winding Scheme

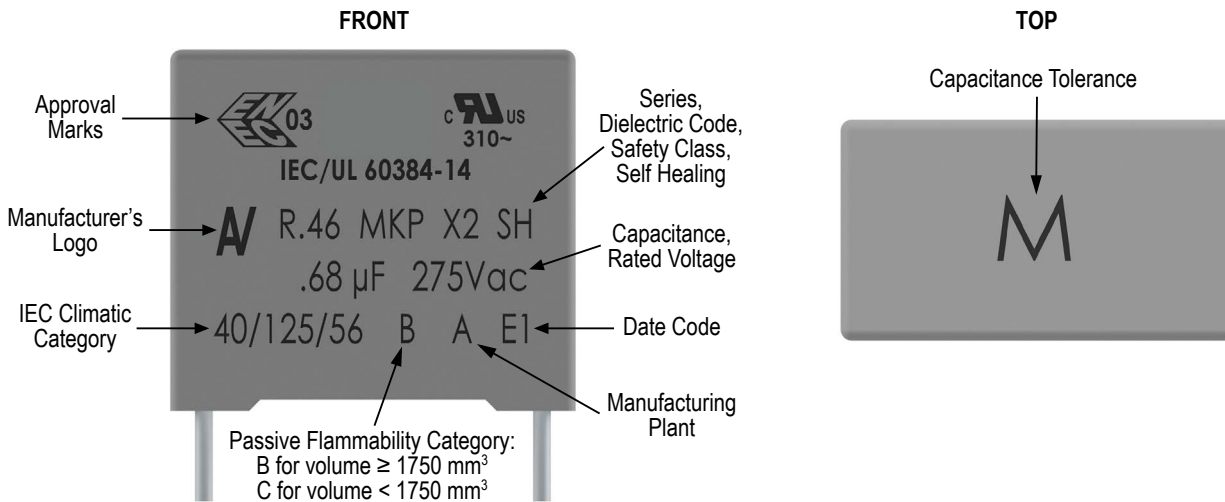


Marking

Lead Spacing 10 mm

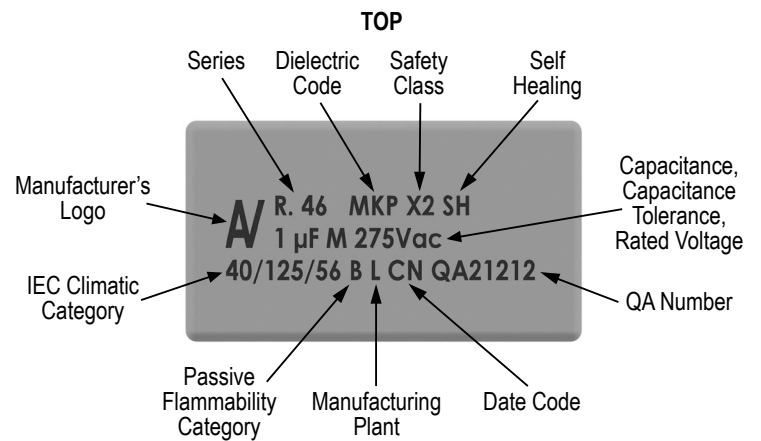
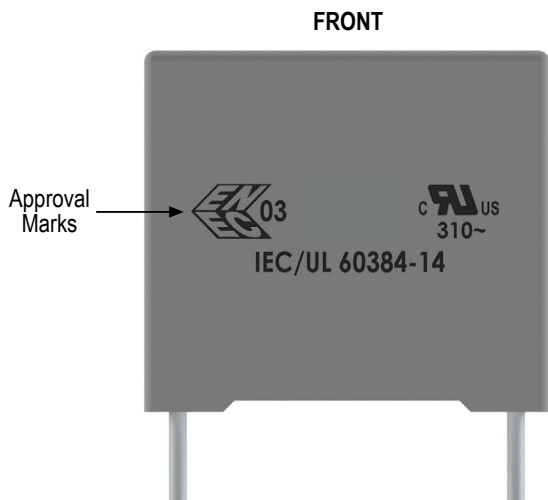


Lead Spacing 15 mm, 22.5 mm (small case sizes)



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 | 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 |
| | 7 | 16 | 26.5 | 700 | 500 | – | 550 | 380 |
| | 10 | 18.5 | 26.5 | 396 | 300 | – | 350 | 235 |
| | 11 | 20 | 26.5 | 360 | 250 | – | 350 | 217 |
| | 13 | 22 | 26.5 | 300 | 200 | – | 300 | – |

Lead Taping & Packaging (IEC 60286-2)

Figure 1
Lead Spacing 10 mm

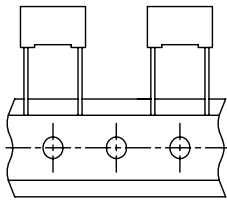


Figure 2
Lead Spacing 15 mm

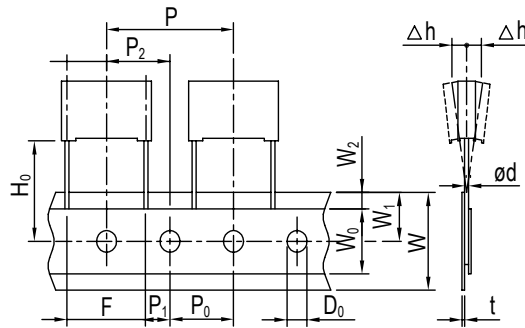
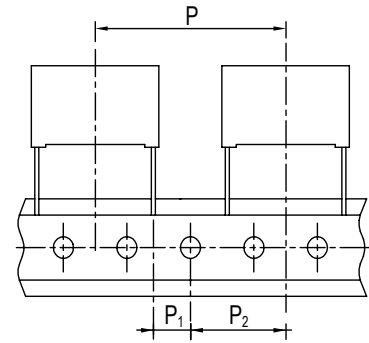


Figure 3
Lead Spacing 22.5 – 27.5 mm



Taping Specification

| Description | Symbol | Dimensions (mm) | | | | Tol. |
|--------------------------------------|---------------------|-----------------|--------------|----------------|----------------|-----------|
| | | Lead Space | | | | |
| | | 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 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 | Δh | 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.

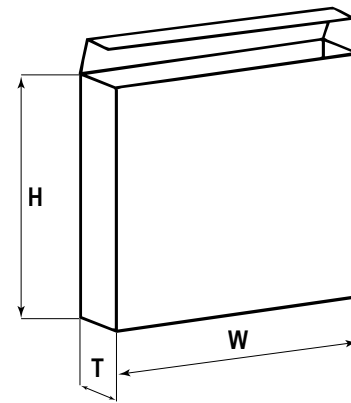
*** Pitches 15 mm and 10 mm taped to 7.5 mm (crimped leads) available upon request.

**** H₀ = 16.5 mm available upon request.

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

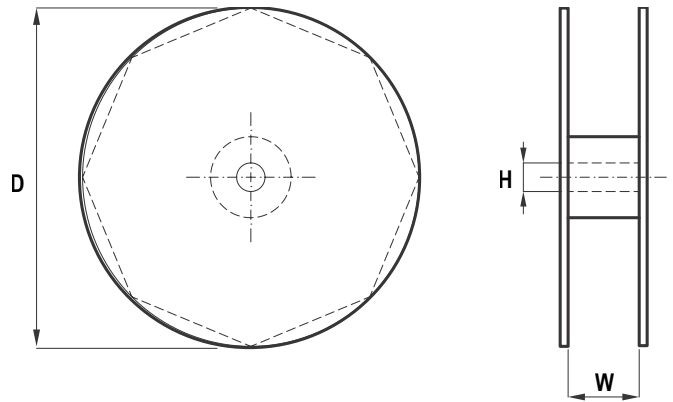
Ammo Specifications

| 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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