

Overview

KEMET's VM series of dual function protective devices protect against voltage surges in an automotive voltage region and against radio frequency noise. This component replaces two components – a low voltage varistor and a capacitor.

KEMET's VM series incorporate a varistor function in automotive applications in a voltage region of 12 V, 24 V and 42 V and a function of a radio-frequency filtering capacitor in a high capacitance range from 0.47 to 1.5 μF , making them ideal for protection in automobile electronic applications.

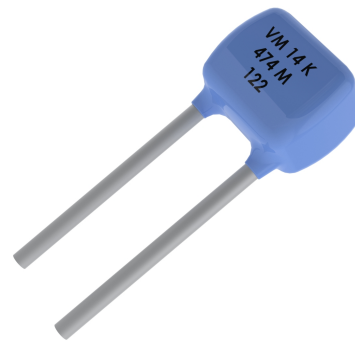
KEMET's VM series are square shaped components with in-line leads and require at least 30% less mounting space.

Applications

Typical applications include the protection against voltage transients and suppression of radio-frequency interference in automobile electronics including wiper motors, central locking systems, seat adjustment motors, seat heating and electric window systems.

Benefits

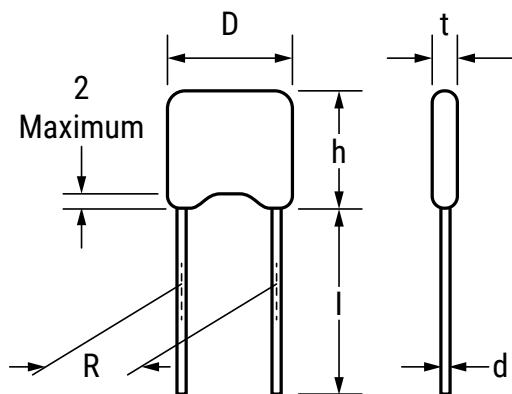
- Through-hole form factor
- Operating ambient temperature of -40°C to $+125^{\circ}\text{C}$
- Supply voltage of 12 V, 24 V and 42 V
- Operating voltage of 16 to 56 VDC
- Capacitance range at 1 kHz of 0.47 to 1.5 μF
- X7R capacitor temperature characteristics
- Dimensional and weight savings on the board
- RoHS 2 2011/65/EC, REACH compliant
- AEC-Q200 qualified Grade 1



Ordering Information

| VM | 474 | M | K | 801 | R | 014 | P050 |
|---|--------------------------------------|----------------------------|-------------------------------|------------------------------|--|--|---------------------------|
| Series | Capacitance Code (μF) | Capacitance Tolerance Code | Tolerance of Varistor Voltage | Maximum Surge Current Code | Packaging/Lead Style | Maximum Continuous Working Voltage (Vrms AC) | Pitch Code |
| Varistor Dual Function Leaded 125°C Automotive Grade Varistor/ Capacitor (X7R Dielectric) | 474 = 0.47 105 = 1.0 155 = 1.5 | M = ±20% | K = ±10% | 801 = 800 A 122 = 1,200 A | B = Bulk /Straight Lead R = Reel /Straight Lead | 12 V Power Supply 014 = 14 Vrms AC 017 = 17 Vrms AC 24 V Power Supply 020 = 20 Vrms AC 030 = 30 Vrms AC 42 V Power Supply 040 = 40 Vrms AC | P050 = 5mm P120 = 12mm |

Dimensions – Millimeters



As per part number table.

Environmental Compliance

RoHS 2 2011/65/EC, REACH

Performance Characteristics

| Continuous | Units | Value |
|---|------------|--------------|
| Steady State Applied Voltage | | |
| DC Voltage Range (V_{dc}) | V | 16 to 56 |
| AC Voltage Range (V_{rms}) | V | 14 to 40 |
| Transient | | |
| Load Dump Energy, (WLD) | J | 6 to 12 |
| Non-Repetitive Surge Current, 8/20 μ s Waveform (I_{max}) | A | 800 to 1,200 |
| Non-Repetitive Surge Energy, 10/1000 μ s Waveform (W_{max}) | J | 2.4 to 10.5 |
| Capacitance Range | μ F | 0.47 to 1.5 |
| Capacitor Temperature Characteristics | | X7R |
| Operating Ambient Temperature | °C | -40 to +125 |
| Storage Temperature Range | °C | -40 to +150 |
| Threshold Voltage Temperature Coefficient | %/°C | < + 0.05 |
| Insulation Resistance | G Ω | > 1 |
| Isolation Voltage Capability | kV | > 1.25 |
| Response Time | ns | < 25 |
| Climatic Category | | 40/125/56 |

Qualifications

| Reliability Parameter | Test | Tested According to | Condition to be Satisfied after Testing |
|-----------------------|------|--|--|
| Voltage Proof | Vt | EN 132 400, Test 4.2.1. - the voltage shall be raised from near zero to the test voltage Vt at a rate not exceeding 150 V/s, Where for: Class X1 Capacitors Vt = 2*Vrms + 1,500 V~, 1 minute Class Y1 Capacitors Vt = 4000 V~, 1 minute Class Y2 Capacitors Vt = 2*Vrms + 1,500 V~, 1 minute | no permanent breakdown of flash-overs during the test period |
| Impulse Voltage | | EN 132 400, Test 4.13. - 24 impulses of the same polarity shall be applied to the capacitor. The time between impulses shall be no less than 10s, where for: Class X1 Capacitors Vp = 4 kV Class Y1 Capacitors Vp = 8 kV Class Y2 Capacitors Vp = 5 kV | no self-healing breakdowns or flash-overs |

Qualifications cont'd

| Reliability Parameter | Test | Tested According to | Condition to be Satisfied after Testing |
|---|------------------------------|--|---|
| AC/DC Bias Reliability | AC/DC Life Test | EN 132 400, Test 4.14, 1000 h at UCT, where: - for X Class Capacitors: at $V = 1.25 V_{rms}$ and once per hour the voltage shall be increased to 1000 V~ for 0,1 s - for Y Class Capacitors: at $V = 1.7 V_{rms}$ and once per hour the voltage shall be increased to 1,000 V~ for 0,1 s | no visible damage $ \Delta C/C < 20 \%$ $\tan \delta < 0.008$ IR greater than 50 % of the applicable limits no permanent breakdown or flash-over during voltage proof |
| Charge and Discharge | | EN 132 400, Test 4.15. - 10.000 cycles of charge and discharge at the rate of one operation per minute with the test voltage of $\sqrt{2} * V_{rms}$ discharge rate adjusted to 100 V/ μ s | $ \Delta C/C < 10 \%$ $\tan \delta < 0,008$ IR greater than 50 % of the applicable limits |
| Radio – Frequency Characteristics | | EN 132 400, Test 4.16. - measurement of capacitor impedance over a range of frequencies | with specification |
| Capacitance – Temperature Characteristics | | Measurement of capacitance and $\tan \delta$ in the temperature chamber at 20 °C and at UCT and LTC | with specification |
| Environmental and Storage Reliability | Climatic Sequence | EN 132 400, Test 4.11 a) Dry heat, 16 h, UCT, Test Ba, IEC 68–2–2 b) Damp heat, cyclic, the first cycle: 55°C, 93 % RH, 24 H, test DB, IEC 68–2–1 c) Cold, LCT, 2 h, Test Aa, IEC 68–2–1 d) Damp heat cyclic, remaining 5 cycles: 55°C, 93 % RH, 24 h/cycle, Test Bd, IEC 68–2–30 | no visible damage $ \Delta C/C < 20 \%$ $\tan \delta < 0.008$ IR greater than 50 % of the applicable limits no permanent breakdown or flash-over during voltage proof |
| | Thermal Shock | EN 132 400, Test 4.6, Test Na, IEC 68–2–14, 5 cycles UCT/LCT, 30 minutes | no visible damage |
| | Steady State Damp Heat | EN 132 400, Test 4.6, Test Na, IEC 68–2–14, 5 cycles UCT/LCT, 30 minutes | no visible damage $ \Delta C/C < 20 \%$ $\tan \delta < 0.008$ IR greater than 50 % of the applicable limits no permanent breakdown or flash-over during voltage proof |
| | Storage Test | ICE 68–2–2, Test Ba 1,000 h at maximum storage temperature | no visible damage $ \Delta C/C < 20 \%$ $\tan \delta < 0.008$ IR greater than 50 % of the applicable limits no permanent breakdown or flash-over during voltage proof |
| Mechanical Reliability | Solderability | EN 132 400, Test 4.5., Test Ta, IEC 68–2–20, solder bath and reflow method | Solderable at shipment and after 2 years of storage - limits |
| | Resistance to Soldering Heat | EN 132 400, Test 4.4., Test Tb, IEC 68–2–20, solder bath and reflow method | no visible damage $ \Delta C/C < 10 \%$ |
| | Robustness of Termination | EN 132 400, Test 4.3., Test Ua, IEC 68–2–21 | no visible damage |
| | Vibration | EN 131 400, Test 4.7., Test Fc, IEC 68–2–6, Frequency range 10 to 55 Hz; Amplitude 0.75 mm or 98 m/s ² Total duration 6 h (3 x 2 h); Waveshape – half sine | no visible damage |
| | Mechanical Shock | EN 132 400, Test 4.9, Test Ea, IEC 68–2–27 Acceleration = 490 m/s ² ; 100 g 6ms and 50 g 11 ms Waveshape – half sine; Number of shocks = 3 x 6 | " $ \Delta C/C < 10 \%$ $\tan \delta$ within specification no visible damage" |

Application Circuit

Provides for the elimination of transients and EMI noise in automotive electronics such as engine control, exhaust gas control, safety systems, etc. against disturbances caused by small motors used in automobiles. Most frequently, small motors in an automobile are those used for windscreen wipers, window mechanisms, seat adjustments and automatic door locking.

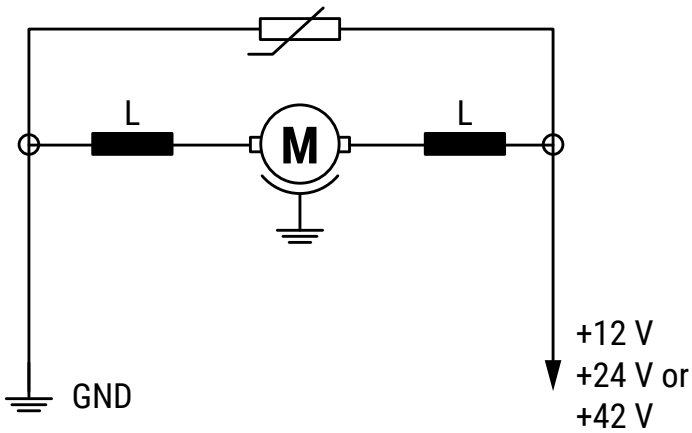


Table 1 – Ratings & Part Number Reference

| KEMET Part Number | D _{max} (mm) | A _{max} (mm) | R (mm) | t _{max} (mm) | V _{rms} | VDC | V _n 1 mA | V _{jump} 5 min. | V _c | I _c (A) | W _{max} 10/1000 μs (J) | WLD 10 x (J) | P _{max} (W) | I _{max} 8/20 μs (A) | C _{typ} at 1 kHz (μF) |
|--------------------------|-----------------------|-----------------------|--------|-----------------------|------------------|-----|---------------------|--------------------------|----------------|--------------------|---------------------------------|--------------|----------------------|------------------------------|--------------------------------|
| 12 V Power Supply | | | | | | | | | | | | | | | |
| VM474MK801(1)014P050 | 7.5 | 9 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 5 | 2.4 | 6 | 0.015 | 800 | 0.47 |
| VM105MK801(1)014P050 | 7.5 | 9 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 5 | 2.4 | 6 | 0.015 | 800 | 1.00 |
| VM155MK801(1)014P050 | 7.5 | 9 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 5 | 2.4 | 6 | 0.015 | 800 | 1.50 |
| VM474MK122(1)014P050 | 8.0 | 12 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 10 | 5.8 | 12 | 0.03 | 1200 | 0.47 |
| VM105MK122(1)014P050 | 8.0 | 12 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 10 | 5.8 | 12 | 0.03 | 1200 | 1.00 |
| VM155MK122(1)014P050 | 8.0 | 12 | 5 | 5.5 | 14 | 16 | 24 | 24.5 | 40 | 10 | 5.8 | 12 | 0.03 | 1200 | 1.50 |
| VM474MK801(1)017P050 | 7.5 | 9 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 5 | 2.8 | 6 | 0.015 | 800 | 0.47 |
| VM105MK801(1)017P050 | 7.5 | 9 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 5 | 2.8 | 6 | 0.015 | 800 | 1.00 |
| VM155MK801(1)017P050 | 7.5 | 9 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 5 | 2.8 | 6 | 0.015 | 800 | 1.50 |
| VM474MK122(1)017P050 | 8.0 | 12 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 10 | 7.4 | 12 | 0.030 | 1200 | 0.47 |
| VM105MK122(1)017P050 | 8.0 | 12 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 10 | 7.4 | 12 | 0.030 | 1200 | 1.00 |
| VM155MK122(1)017P050 | 8.0 | 12 | 5 | 5.5 | 17 | 20 | 27 | 30 | 44 | 10 | 7.4 | 12 | 0.030 | 1200 | 1.50 |
| 24 V Power Supply | | | | | | | | | | | | | | | |
| VM474MK801(1)020P050 | 7.5 | 9 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 5 | 3.2 | 6 | 0.015 | 800 | 0.47 |
| VM105MK801(1)020P050 | 7.5 | 9 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 5 | 3.2 | 6 | 0.015 | 800 | 1.00 |
| VM155MK801(1)020P050 | 7.5 | 9 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 5 | 3.2 | 6 | 0.015 | 800 | 1.50 |
| VM474MK122(1)020P050 | 8.0 | 12 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 10 | 7.8 | 12 | 0.03 | 1200 | 0.47 |
| VM105MK122(1)020P050 | 8.0 | 12 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 10 | 7.8 | 12 | 0.030 | 1200 | 1.00 |
| VM155MK122(1)020P050 | 8.0 | 12 | 5 | 5.5 | 20 | 26 | 33 | 36 | 54 | 10 | 7.8 | 12 | 0.030 | 1200 | 1.50 |
| VM474MK801(1)030P050 | 7.5 | 9 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 5 | 4.5 | 6 | 0.015 | 800 | 0.47 |
| VM105MK801(1)030P050 | 7.5 | 9 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 5 | 4.5 | 6 | 0.015 | 800 | 1.00 |
| VM155MK801(1)030P050 | 7.5 | 9 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 5 | 4.5 | 6 | 0.015 | 800 | 1.50 |
| VM474MK122(1)030P050 | 8.0 | 12 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 10 | 10.0 | 12 | 0.030 | 1200 | 0.47 |
| VM105MK122(1)030P050 | 8.0 | 12 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 10 | 10.0 | 12 | 0.030 | 1200 | 1.00 |
| VM155MK122(1)030P050 | 8.0 | 12 | 5 | 5.5 | 30 | 38 | 47 | 50 | 77 | 10 | 10.0 | 12 | 0.030 | 1200 | 1.50 |
| 42 V Power Supply | | | | | | | | | | | | | | | |
| VM474MK801(1)040P050 | 7.5 | 9 | 5 | 5.5 | 40 | 56 | 68 | 65 | 110 | 5 | 4.8 | 6 | 0.015 | 800 | 0.47 |
| VM105MK801(1)040P050 | 7.5 | 9 | 5 | 5.5 | 40 | 56 | 68 | 65 | 110 | 5 | 4.8 | 6 | 0.015 | 800 | 1.00 |
| VM155MK801(1)040P050 | 7.5 | 9 | 5 | 5.5 | 40 | 56 | 68 | 65 | 110 | 5 | 4.8 | 6 | 0.015 | 800 | 1.50 |
| VM474MK122(1)040P050 | 8.0 | 12 | 5 | 5.5 | 40 | 56 | 68 | 65 | 110 | 10 | 10.5 | 12 | 0.030 | 1200 | 0.47 |
| VM105MK122(1)040P120 | 8.0 | 12 | 12 | 5.5 | 40 | 56 | 68 | 65 | 110 | 10 | 10.5 | 12 | 0.030 | 1200 | 1.00 |
| VM155MK122(1)040P120 | 8.0 | 12 | 12 | 5.5 | 40 | 56 | 68 | 65 | 110 | 10 | 10.5 | 12 | 0.030 | 1200 | 1.50 |

(1) Insert packaging/lead Style code. See Ordering Options Table for available options.

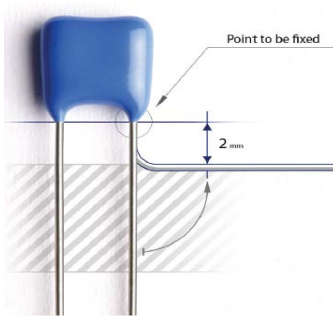
Soldering

Very often before soldering through-hole components, their leads get bent. It is important not to damage the component during lead bending. Typical damage incurred during bending is cracks in epoxy parts, which can lead to increased humidity sensitivity of a component and consequentially to a shorter life time.

In order to avoid epoxy parts damage it is necessary to:

- fix the most sensitive point (epoxy parts) of a component body
- bend the wire at least 2 mm below the end of epoxy parts

Other potential damage to a component which can lead to component failure or a shorter life time is thermal shock during manual soldering with a soldering iron. This can occur in the case when a soldering iron is placed too close to one point of the component body and most often it happens if the solder joint is too close to the varistor body.

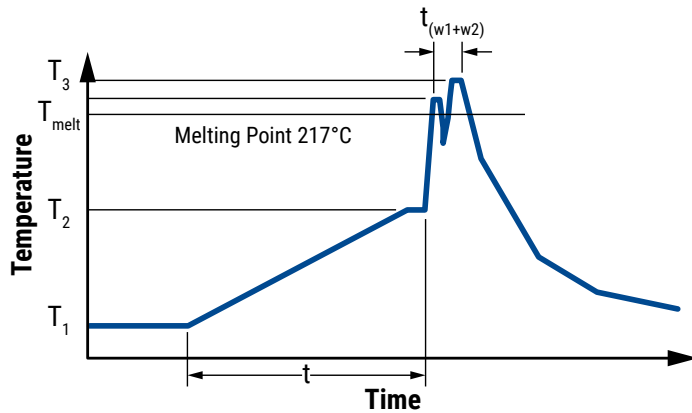


Resistance to Soldering Heat – In the case of automatic wave soldering, it is important to provide sufficient resistance to soldering heat. In order to prevent any potential problems the standard for testing the resistance to soldering heat of through-hole components is 300°C, 10s.

Pb-free Wave Soldering Profile Recommendations – Recommended soldering profiles for all above components are in accordance with JEDEC standard curves (J-STD-020D) and therefore compatible with the new Pb-free process.

Soldering (cont'd)

Lead-free Wave Soldering Profile

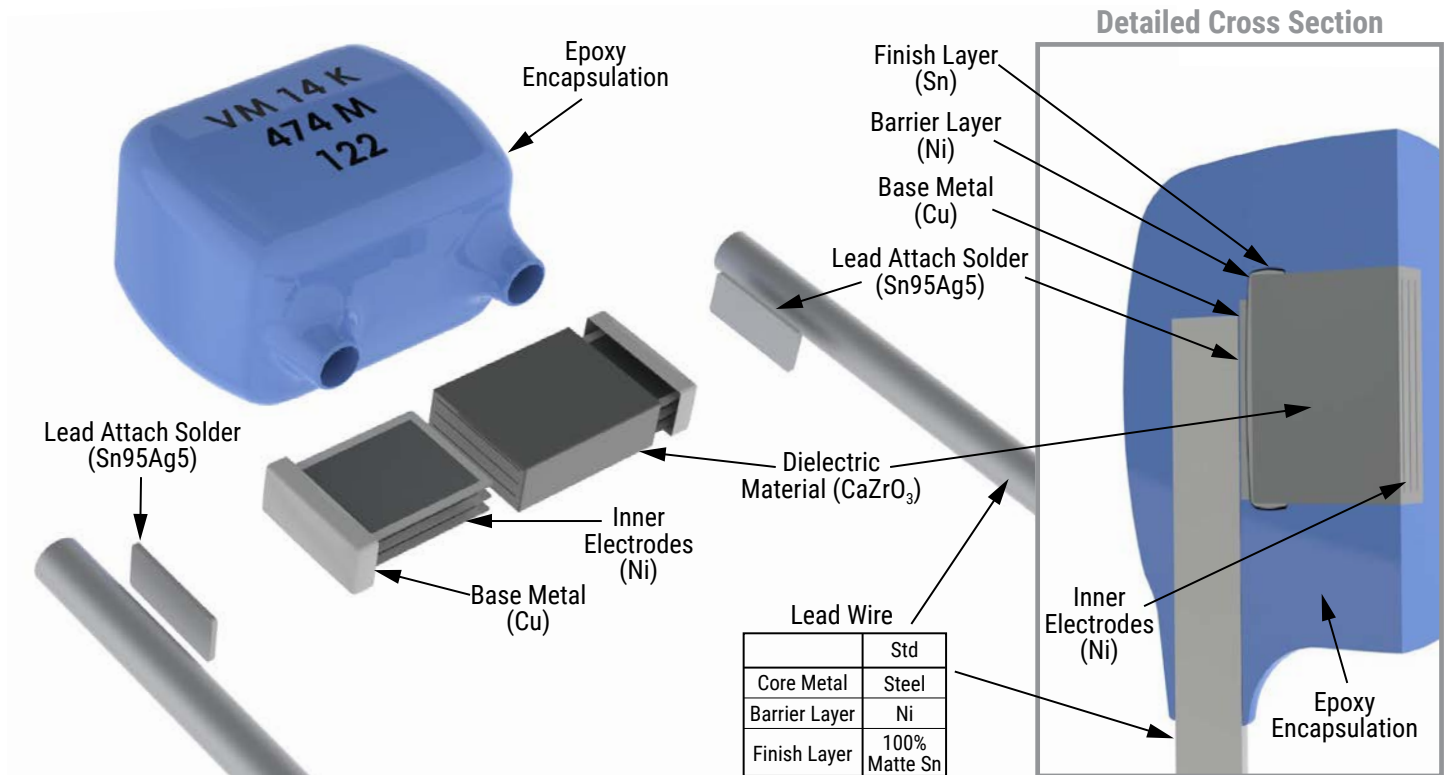


| Parameters | Symbol | Specification |
|--|-----------------|---------------------|
| Preheating temperature gradient | | 4°C/s maximum |
| Preheating time | t_1 | 2 to 5 minutes |
| Minimum preheating temperature | T_1 | 130°C |
| Maximum preheating temperature | T_2 | 180°C |
| Melting temperature/point | T_{melt} | 217°C |
| Time in wave soldering phase (w1+w2) | t_{w1+w2} | 10 seconds |
| Maximum wave temperature (w1+w2) | T_3 | 265°C +0/-5°C |
| Cooling temperature gradient | | 6°C/seconds maximum |
| Temperature jump from T_2 to T_3 (w1) | $T_3(w1) - T_2$ | 120°C maximum |
| Time from 25°C to T_3 (wave temperature) | | 8 minutes maximum |

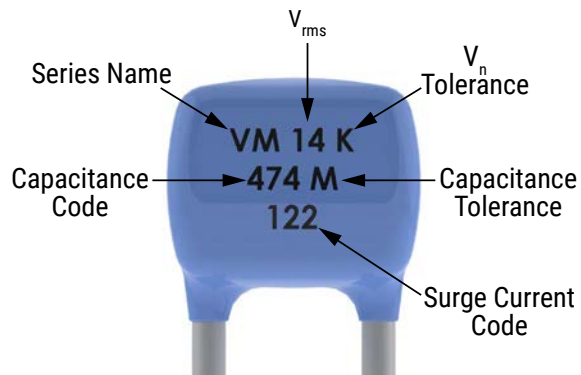
Packaging

| B | R |
|-------|-------|
| 1,000 | 1,000 |

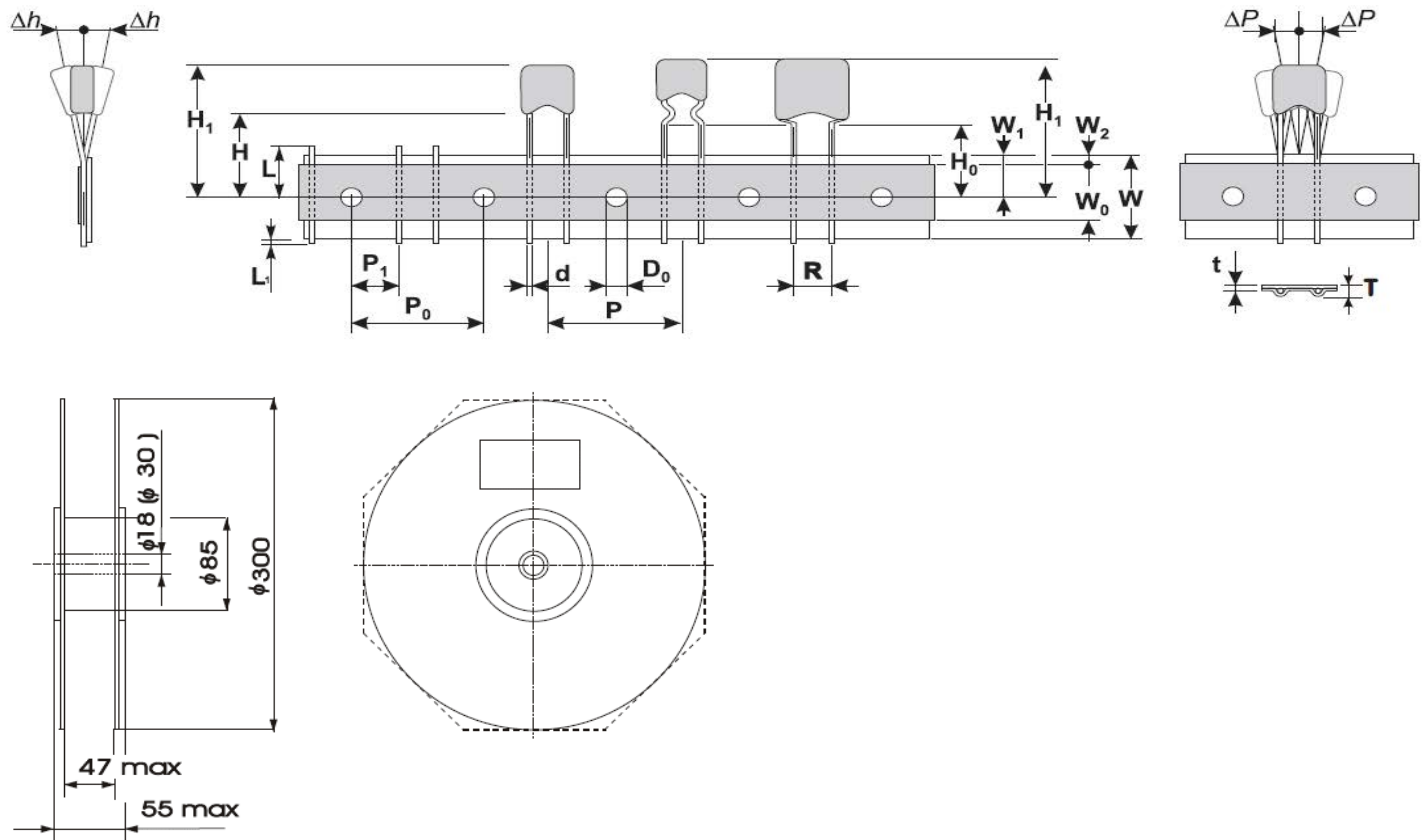
Construction



Capacitor Marking



Taping & Reel Specifications



| Symbol | Parameter | Dimension (mm) |
|----------------|---|----------------|
| W | Carrier tape with | 18+1.0/-0.5 |
| W ₀ | Hold down tape width | 5 minimum |
| W ₁ | Sprocket hole position | 9+0.75/-0.5 |
| W ₂ | Distance between the upper edges of the carrier tape and hold-down tape | 3 maximum |
| T | Total tape thickness | 1.5 maximum |
| t | Tape thickness | 0.9 maximum |
| P | Pitch of component | 12.7±1.0 |
| P ₀ | Feed hole pitch | 12.7±0.3 |
| P ₁ | Feed hole center to pitch | 3.85±0.7 |
| R | Lead Spacing | 5+0.5/-0.2 |
| ΔP | Component alignment | ±1.3 maximum |
| Δh | Component alignment | ±2 maximum |
| d | Wire diameter | 0.6 maximum |
| D ₀ | Feed hole diameter | 4±0.2 |
| H | Height from tape center to comp. base | 18+2.0/-0.0 |
| H ₀ | Seating plane height | 16±0.5 |
| H ₁ | Component height | 32.2 maximum |
| L | Protrusion – cut out | 11 maximum |
| L ₁ | Protrusion – cut off | 0.5 maximum |

Note: Table for R = 5 mm only. Dimensions for R = 12 mm available on request

Terms and Definitions

| Term | Symbol | Definition |
|---|---------------|---|
| Rated AC Voltage | V_{rms} | Maximum continuous sinusoidal AC voltage (<5% total harmonic distortion) which may be applied to the component under continuous operation conditions at 25°C |
| Rated DC Voltage | V_{dc} | Maximum continuous DC voltage (<5% ripple) which may be applied to the component under continuous operating conditions at 25°C |
| Supply Voltage | V | The voltage by which the system is designated and to which certain operating characteristics of the system are referred; $V_{rms} = 1,1 \times V$ |
| Leakage Current | I_{dc} | The current passing through the varistor at V_{dc} and at 25°C or at any other specified temperature |
| Varistor Voltage | V_n | Voltage across the varistor measured at a given reference current I_n |
| Reference Current | I_n | Reference current = 1 mA DC |
| Clamping Voltage Protection Level | V_c | The peak voltage developed across the varistor under standard atmospheric conditions, when passing an 8/20 μs class current pulse |
| Class Current | I_c | A peak value of current which is 1/10 of the maximum peak current for 100 pulses at two per minute for the 8/20 μs pulse |
| Voltage Clamping Ratio | V_c/V_{app} | A figure of merit measure of the varistor clamping effectiveness as defined by the symbols V_c/V_{app} , where ($V_{app} = V_{rms}$ or V_{dc}) |
| Jump Start Transient | V_{jump} | The jump start transient resulting from the temporary application of an overvoltage in excess of the rated battery voltage. The circuit power supply may be subjected to a temporary overvoltage condition due to the voltage regulation failing or it may be deliberately generated when it becomes necessary to boost start the car |
| Rated Single Pulse Transient Energy | W_{max} | Energy which may be dissipated for a single 10/1000 μs pulse of a maximum rated current, with rated AC voltage or rated DC voltage also applied, without causing device failure |
| Load Dump Transient | WLD | Load Dump is a transient which occurs in an automotive environment. It is an exponentially decaying positive voltage which occurs in the event of a battery disconnect while the alternator is still generating charging current with other loads remaining on the alternator circuit at the time of battery disconnect |
| Rated Peak Single Pulse Transient Current | I_{max} | Maximum peak current which may be applied for a single 8/20 μs pulse, with, rated line voltage also applies, without causing device failure |
| Rated Transient Average Power Dissipation | P | Maximum average power which may be dissipated due to a group of pulses occurring within a specified isolated time period, without causing device failure at 25°C |
| Capacitance | C | Capacitance between two terminals of the varistor measured at at 1 kHz |
| Response Time | tr | The time lag between application of a surge and varistor's "turn-on" conduction action |
| Varistor Voltage Temperature Coefficient | TC | $(V_n \text{ at } 85^\circ\text{C} - V_n \text{ at } 25^\circ\text{C}) / (V_n \text{ at } 25^\circ\text{C}) \times 60^\circ\text{C} \times 100$ |
| Insulation Resistance | IR | Minimum resistance between shorted terminals and varistor surface |
| Isolation Voltage | | The maximum peak voltage which may be applied under continuous operating conditions between the varistor terminations and any conducting mounting surface |
| Operating Temperature | | The range of ambient temperature for which the varistor is designed to operate continuously as defined by the temperature limits of its climatic category |
| Climatic Category | LCT/UCT/DHD | UCT = Upper Category Temperature – the maximum ambient temperature for which a varistor has been designed to operate continuously, LCT = Lower Category Temperature – the minimum ambient temperature at which a varistor has been designed to operate continuously DHD = Dump Heat Test Duration |
| Storage Temperature | | Storage temperature range without voltage applied |