AC Line EMI Suppression and RC Networks

# P295, Metallized Impregnated Paper, Class Y1, 500 VAC

## Overview

Multilayer metallized paper, encapsulated and impregnated in self-extinguishing material that meets the requirements of UL 94 V–0.

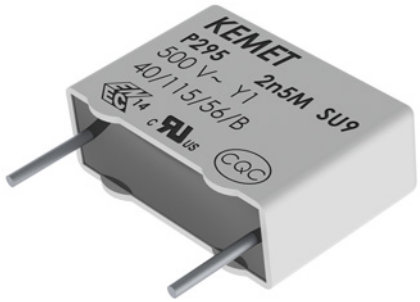
Automotive grade devices meet the demanding Automotive Electronics Council's AEC–Q200 qualification requirements.

## Applications

Safety capacitors for bridging of double or reinforced insulation applications that require a voltage test up to 4,000 VAC at 60 seconds. P295 series capacitors can be left in place during this test.

## Benefits

- Approvals: ENEC, UL, cUL, CQC
- Rated voltage: 500 VAC 50/60 Hz
- Capacitance range: 470 – 4,700 pF
- Lead spacing: 15.0 mm
- Capacitance tolerance: ±20%
- Climatic category: 40/115/56/B, IEC 60068–1
- Tape and reel packaging in accordance with IEC 60286–2
- RoHS Compliant and lead-free terminations
- Operating temperature range of −40°C to +115°C
- 100% screening factory test at 4,000 VAC, 50 Hz, 2 seconds
- Highest possible safety regarding active and passive flammability
- Excellent self-healing properties ensure long life even when subjected to frequent over voltages
- Good resistance to ionization due to impregnated dielectric
- High dV/dt capability
- Impregnated paper provides excellent stability and reliability properties, particularly in applications with continuous operation
- Automotive Grade (AEC-Q200)




## Part Number System

| P | 295 | B | E | 471 | M | 500 | A |
|---|---|---|---|---|---|---|---|
| Capacitor Class | Series | Lead Spacing (mm) | Size Code | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VAC) | Packaging |
| P = Paper | Y1, Metallized Paper | B = 15.0 | See Dimension Table | First two digits represent significant figures. Third digit specifies number of zeros. | J = ±5%<br>K = ±10%<br>M = ±20% | 500 = 500 | See Ordering Options Table |



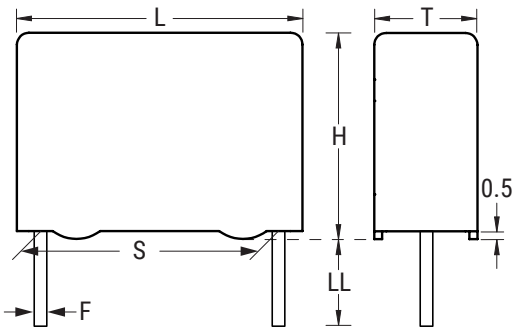
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## Ordering Options Table

| Lead Spacing Nominal (mm) | Type of Leads and Packaging | Lead Length (mm) | KEMET Part Number (Insert at 14th character) |
|---|---|---|---|
| 15 | **Standard Lead and Packaging Options** | | |
| | Bulk – Short Leads | 6 +0/−1 | C |
| | Bulk – Maximum Length Leads | 30 +5/−0 | A |
| | Tape and Reel (Standard Reel Φ = 360 mm) | $H_0$ = 18.5 +/−0.5 | L |

## Dimensions – Millimeters

**FRONT VIEW** **SIDE VIEW**

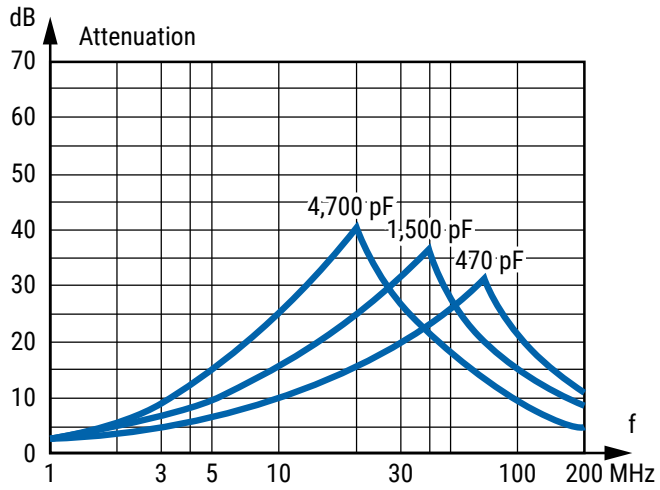



| Size Code | S | | T | | H | | L | | F | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance | Nominal | Tolerance |
| BE | 15.0 | ±0.4 | 5.5 | Maximum | 12.5 | Maximum | 18.0 | Maximum | 0.8 | ±0.05 |
| BJ | 15.0 | ±0.4 | 6.5 | Maximum | 12.5 | Maximum | 18.0 | Maximum | 0.8 | ±0.05 |
| BL | 15.0 | ±0.4 | 7.5 | Maximum | 14.5 | Maximum | 18.0 | Maximum | 0.8 | ±0.05 |
| BQ | 15.0 | ±0.4 | 8.5 | Maximum | 16.0 | Maximum | 18.0 | Maximum | 0.8 | ±0.05 |
| **Note: See Ordering Options Table for lead length (LL) options.** | | | | | | | | | | |

## Performance Characteristics

| | | |
|---|---|---|
| Rated Voltage | 500 VAC 50/60 Hz | |
| Capacitance Range | 0.00047 – 0.0047 µF | |
| Capacitance Tolerance | ±20% | |
| Operating Temperature Range | –40°C to +115°C | |
| Rated Temperature | +115°C | |
| Climatic Category | 40/115/56/B | |
| Approvals | ENEC, UL, cUL, CQC | |
| Dissipation Factor | Maximum Values at +23°C | |
| | 1 kHz | 1.3% |
| Test Voltage Between Terminals | The 100% screening factory test is carried out at 4,000 VAC, 50 Hz, 2 seconds. The voltage level is selected to meet the requirements in applicable equipment standards. All electrical characteristics are checked after the test. | |
| Insulation Resistance | Measured at 500 VDC after 60 seconds, +23°C | |
| | Minimum Value Between Terminals | |
| | ≥ 12,000 MΩ | |
| In DC Applications | Recommended voltage ≤ 1,500 VDC | |
| Resonance Frequency | Tabulated self-resonance frequencies $f_0$ refer to 5 mm lead length | |

## Suppression vs. Frequency, Typical Values



## Environmental Test Data

| Test | IEC Publication | Procedure |
|---|---|---|
| Endurance | IEC 60384–14 | 1.7 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<br>10–500 Hz at 0.75 mm or 98m/second$^2$ |
| Bump | IEC 60068–2–29 Test Eb | 4,000 bumps at 390 m/second$^2$ |
| Change of Temperature | IEC 60068–2–14 Test Na | Upper and lower rated temperature 5 cycles |
| 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 |
|---|---|---|---|
| Intertek Semko AB | | EN/IEC 60384–14 | SE/0140–34A |
| UL | | UL 60384–14<br>CAN/CSA-E60384–14–09 | E73869 |
| CQC | | IEC 60384–14 | CQC16001145222 |

## Environmental Compliance

All KEMET EMI capacitors are RoHS compliant.

## Table 1 – Ratings & Part Number Reference

| Capacitance Value (µF) | Maximum Dimensions in mm | | | Lead Spacing (S) | $f_o$ (MHz) | dV/dt (V/µs) | KEMET Part Number |
|---|---|---|---|---|---|---|---|
| | T | H | L | | | | |
| 0.00047 | 5.5 | 12.5 | 18.0 | 15.0 | 64 | 2,000 | P295BE471(3)500(1) |
| 0.00056 | 5.5 | 12.5 | 18.0 | 15.0 | 59 | 2,000 | P295BE561(3)500(1) |
| 0.00068 | 5.5 | 12.5 | 18.0 | 15.0 | 54 | 2,000 | P295BE681(3)500(1) |
| 0.00082 | 5.5 | 12.5 | 18.0 | 15.0 | 49 | 2,000 | P295BE821(3)500(1) |
| 0.001 | 5.5 | 12.5 | 18.0 | 15.0 | 46 | 2,000 | P295BE102(2)500(1) |
| 0.0012 | 6.5 | 12.5 | 18.0 | 15.0 | 43 | 2,000 | P295BJ122(2)500(1) |
| 0.0015 | 6.5 | 12.5 | 18.0 | 15.0 | 40 | 2,000 | P295BJ152(2)500(1) |
| 0.0018 | 6.5 | 12.5 | 18.0 | 15.0 | 37 | 2,000 | P295BJ182(2)500(1) |
| 0.0022 | 6.5 | 12.5 | 18.0 | 15.0 | 33 | 2,000 | P295BJ222(2)500(1) |
| 0.0025 | 7.5 | 14.5 | 18.0 | 15.0 | 31 | 2,000 | P295BL252(2)500(1) |
| 0.0027 | 7.5 | 14.5 | 18.0 | 15.0 | 30 | 2,000 | P295BL272(2)500(1) |
| 0.0033 | 7.5 | 14.5 | 18.0 | 15.0 | 27 | 2,000 | P295BL332(2)500(1) |
| 0.0039 | 8.5 | 16.0 | 18.0 | 15.0 | 24 | 2,000 | P295BQ392(2)500(1) |
| 0.0047 | 8.5 | 16.0 | 18.0 | 15.0 | 22 | 2,000 | P295BQ472(2)500(1) |
| **Capacitance Value (µF)** | **T (mm)** | **H (mm)** | **L (mm)** | **Lead Spacing (S)** | **$f_o$ (MHz)** | **dV/dt (V/µs)** | **KEMET Part Number** |

*(1) Insert ordering code for lead type and packaging. See Ordering Options Table for available options.*
*(2) Insert tolerance letter (J = ±5%, K = ±10%, M ±20%)*
*(3) Insert tolerance letter (K = ±10%, M ±20%)*

## Soldering Process

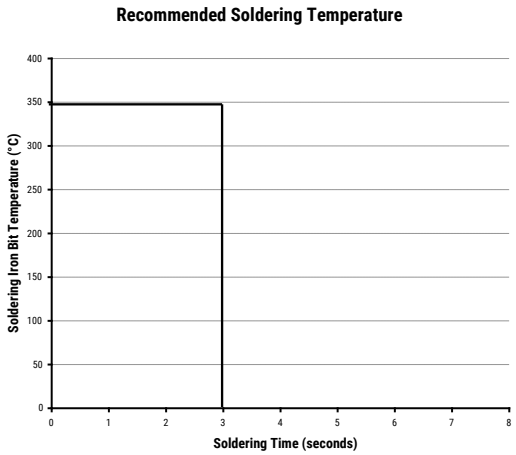
The implementation of the RoHS directive has resulted in the selection of SnAuCu (SAC) alloys or SnCu alloys as primary solder. This has increased the liquidus temperature from 183ºC for SnPb eutectic alloys to 217 – 221ºC for the new alloys. As a result, the heat stress to the components, even in wave 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 must be taken during soldering. The recommended solder profiles from KEMET should be used. 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. See Figure 1.

Reflow soldering is not recommended for through-hole film capacitors. Exposing capacitors to a soldering profile in excess of the recommended limits may result in degradation of 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 of two soldering cycles is recommended. Allow time for the capacitor surface temperature to return to normal before the second soldering cycle.

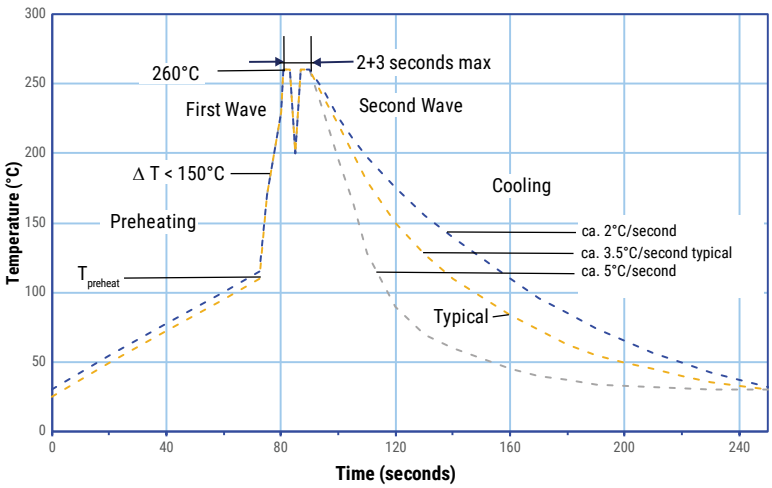
### Manual Soldering Recommendations

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.

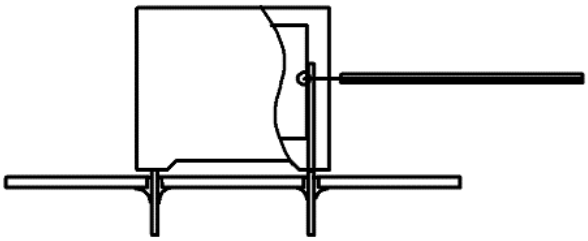
**Wave Soldering Recommendations cont.**

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

| 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 |



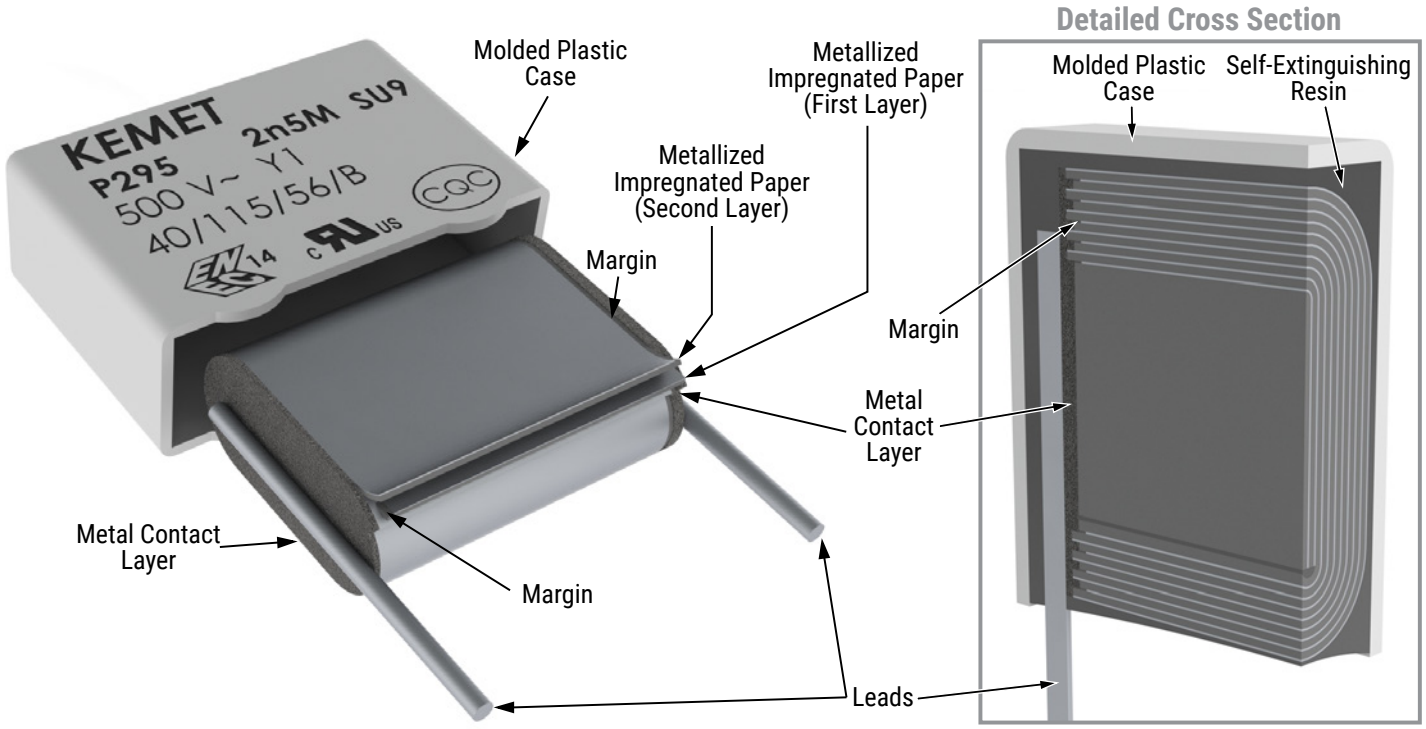
*Temperature monitored inside the capacitor.*

**Selective Soldering Recommendations**

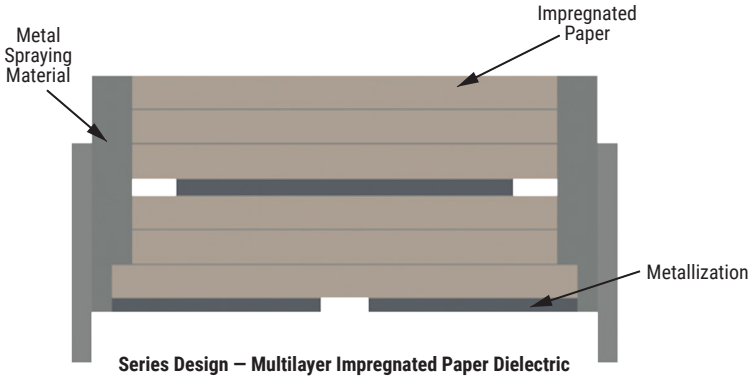
Selective dip soldering is a variation of reflow soldering. In this method, the printed circuit board with through-hole components to be soldered is preheated and transported over the solder bath, as in normal flow soldering, without touching the solder. When the board is over the bath, it is stopped. Pre-designed solder pots are lifted from the bath with molten solder only at the places of the selected components, and then 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 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 do not overheat.

## Construction

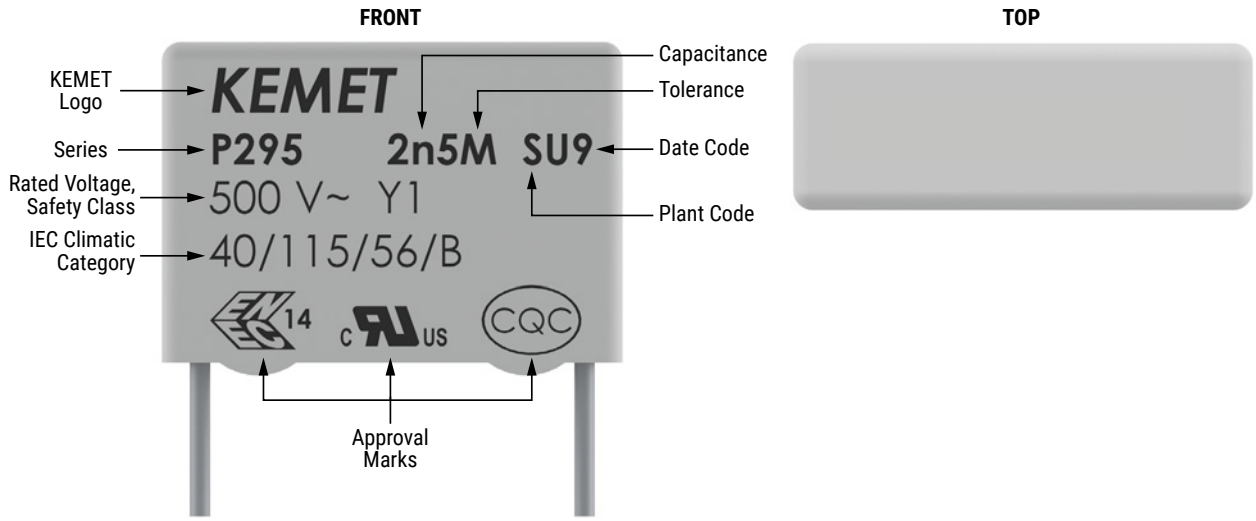



### Winding Scheme




**Series Design — Multilayer Impregnated Paper Dielectric 2 Section**

## Marking



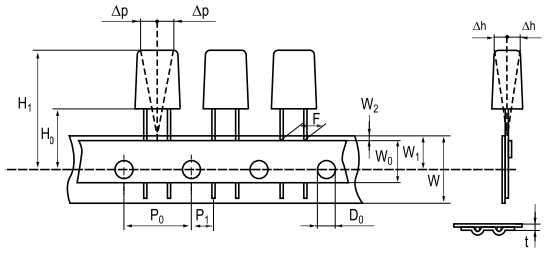

| Manufacturing Date Code (IEC 60062) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Code | Year | Code | Year | Code | Month | Code | Month | Code |
| 2020 | M | 2027 | V | 2034 | E | January | 1 | July | 7 |
| 2021 | N | 2028 | W | 2035 | F | February | 2 | August | 8 |
| 2022 | P | 2029 | X | 2036 | H | March | 3 | September | 9 |
| 2023 | R | 2030 | A | 2037 | J | April | 4 | October | O |
| 2024 | S | 2031 | B | 2038 | K | May | 5 | November | N |
| 2025 | T | 2032 | C | 2039 | L | June | 6 | December | D |
| 2026 | U | 2033 | D | 2040 | M | | | | |

## Packaging Quantities

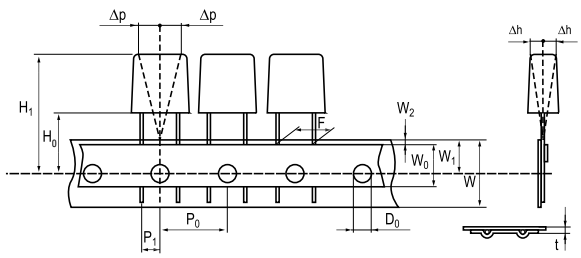
| Lead Spacing (mm) | Thickness (mm) | Height (mm) | Length (mm) | Bulk Short Leads | Bulk Long Leads | Standard Reel 360 mm |
|---|---|---|---|---|---|---|
| Lead and Packaging Code | | | | C | A | L |
| 15 | 5.5 | 12.5 | 18 | 1,000 | 500 | 600 |
| | 7.5 | 14.5 | 18 | 600 | 400 | 400 |
| | 6.5 | 12.5 | 18 | 600 | 400 | 400 |
| | 8.5 | 16 | 18 | 400 | 250 | 400 |

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

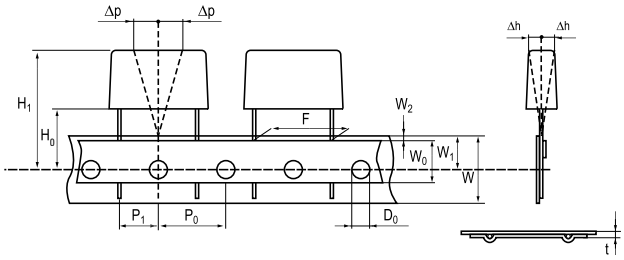
**Lead Spacing 5 mm**



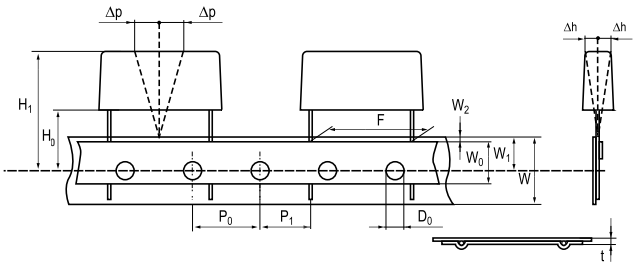

**Lead Spacing 7.5 mm**



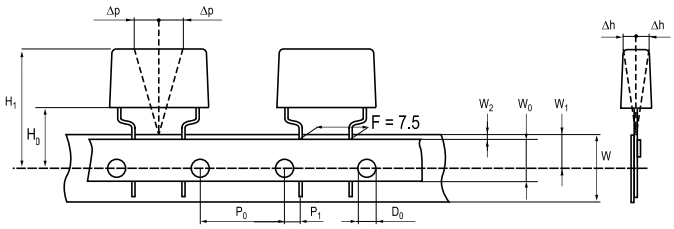

**Lead Spacing 10 – 15mm**




**Lead Spacing 22.5 – 27.5 mm**




**Formed Leads from 10 and 15 mm to 7.5 mm**




## Taping Specification

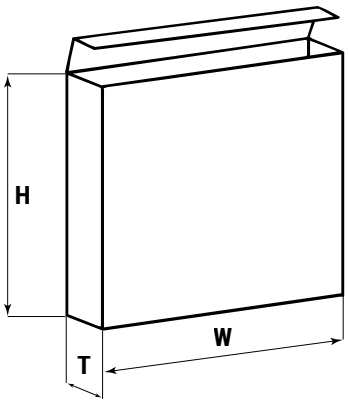
| Dimensions in mm | | | | | | | | | | Standard IEC 60286-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Lead Spacing | +0.6/−0.1 | F | 5 | 7.5 | Formed 7.5 | 10 | 15 | 22.5 | 27.5 | F |
| Carrier Tape Width | ±0.5 | W | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18+1/−0.5 |
| Hold-down Tape Width | Minimum | $W_0$ | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| Position of Sprocket Hole | ±0.5 | $W_1$ | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9+0.75/−0.5 |
| Distance Between Tapes | Maximum | $W_2$ | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Sprocket Hole Diameter | ±0.2 | $D_0$ | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Feed Hole Lead Spacing | ±0.3 | $P_0$ (1) | 12.7 | 12.7 | 12.7 (4) | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 |
| Distance Lead – Feed Hole | ±0.7 | $P_1$ | 3.85 | 3.75 | 3.75 | 7.7 | 5.2 | 5.3 | 5.3 | P1 |
| Deviation Tape – Plane | Maximum | Δ p | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| Lateral Deviation | Maximum | Δ h | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Total Thickness | ±0.2 | t | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.9 Maximum | 0.9 Maximum | 0.9 Maximum |
| Sprocket Hole/Cap Body | Nominal | $H_0$ (2) | 18.5±0.5 | 18.5±0.5 | 18.5±0.5 | 18.5±0.5 | 18.5±0.5 | 18.5±0.5 | 18.5±0.5 | 18.0+2/−0 |
| Sprocket Hole/ Top of Cap Body | Maximum | $H_1$ (3) | 32 | 31 | 43 | 43 | 43 | 58 | 58 | 58 Maximum |

*(1) Maximum cumulative feed hole error, 1 mm per 20 parts*
*(2) 16.5 mm available on request*
*(3) Depending on case size*
*(4) 15 mm available on request*

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

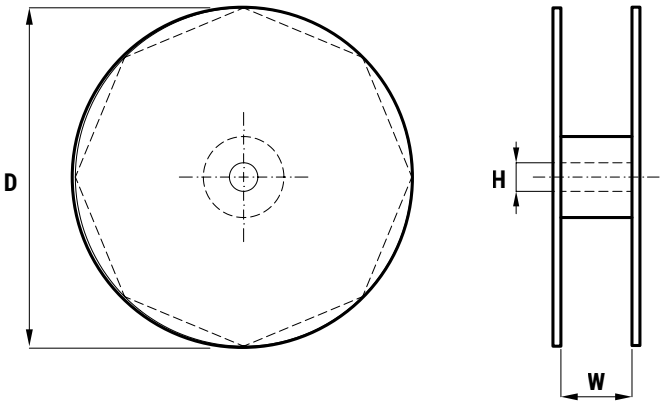
## Ammo Specifications

| Series | Dimensions (mm) | | |
|---|---|---|---|
| | H | W | T |
| P295 | 330 | 330 | 50 |




## Reel Specifications

| Series | Dimensions (mm) | | |
|---|---|---|---|
| | D | H | W |
| P295 | 360<br>500 | 30 | 46 (Max) |



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