OBSOLETE

AC Line EMI Suppression and RC Networks

P278, Metallized Impregnated Paper, Class X1, 480 VAC

Overview

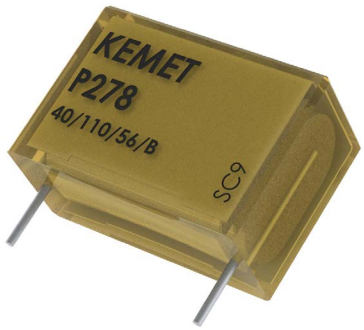
Multilayer metallized paper encapsulated and impregnated in self-extinguishing material that meets the requirements of UL 94 V–0.

Applications

Typical applications include worldwide use as an electromagnetic interference suppressor in all X1 and across-the-line applications.

Benefits

- Approvals: ENEC, UL, cUL
- Rated voltage: 480 VAC 50/60 Hz
- Capacitance range: 0.001 – 0.15 µF
- Lead Spacing: 10.2 – 25.4 mm
- Capacitance tolerance: ±20%
- Climatic category: 40/110/56, IEC 60068–1
- Tape & Reel in accordance with IEC 60286–2
- RoHS compliance and lead-free terminations
- Operating temperature range of −40°C to +110°C
- 100% screening factory test at 2,700 VDC
- Highest possible safety regarding active and passive flammability
- Excellent self-healing properties that ensure long life, even when subjected to frequent over-voltages
- Good resistance to ionization due to impregnated paper dielectric
- Impregnated paper that ensures excellent stability and reliability properties, particularly in applications that operate continuously



Part Number System

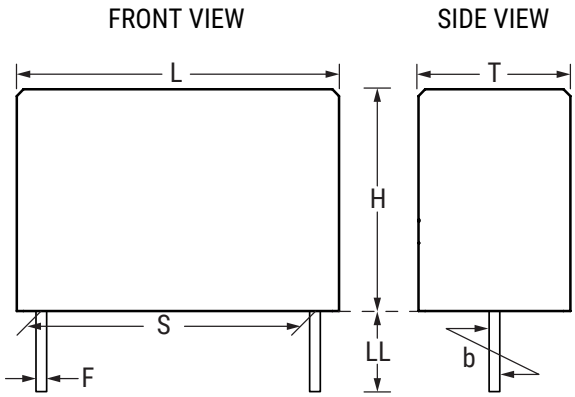
P	278	H	E	102	M	480	A
Capacitor Class	Series	Lead Spacing (mm)	Size Code	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VAC)	Packaging
P = Paper	X1, Metallized Paper	H = 10.2 Q = 15.2 C = 20.3 S = 22.5 E = 25.4	See Dimension Table	First two digits represent significant figures. Third digit specifies number of zeros.	M = ±20%	480 = 480	See Ordering Options Table

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Ordering Options Table

Lead Spacing Nominal (mm)	Type of Leads and Packaging	Lead Length (mm)	Part Number (Insert at 14th character)
10.2	**Standard Lead and Packaging Options**		
	Bulk – Short Leads	6 +0/–1	C
	Bulk – Maximum Length Leads	30 +5/–0	A
	Tape & Reel (Standard Reel)	H_0 = 18.5 ±0.5	L
	Other Lead and Packaging Options		
	Ammo Pack formed to Tape & Reel (Large Reel)	H_0 = 18.5 ±0.5	XLAF1
		H_0 = 18.5 ±0.5	P
15.2	**Standard Lead and Packaging Options**		
	Bulk – Short Leads	6 +0/–1	C
	Bulk – Maximum Length Leads	30 +5/–0	A
	Tape & Reel (Standard Reel)	H_0 = 18.5 ±0.5	L
	Other Lead and Packaging Options		
	Tape & Reel (Large Reel)	H_0 = 18.5 ±0.5	P
20.3	**Standard Lead and Packaging Options**		
	Tray – Short Leads	6 +0/–1	C
	Bulk – Maximum Length Leads	30 +5/–0	A
	Tape & Reel (Standard Reel)	H_0 = 18.5 ±0.5	L
	Other Lead and Packaging Options		
	Tape & Reel (Large Reel)	H_0 = 18.5 ±0.5	P
22.5	**Standard Lead and Packaging Options**		
	Tray – Short Leads	6 +0/–1	C
	Bulk – Maximum Length Leads	30 +5/–0	A
	Tape & Reel (Standard Reel)	H_0 = 18.5 ±0.5	L
	Other Lead and Packaging Options		
	Tape & Reel (Large Reel)	H_0 = 18.5 ±0.5	P
25.4	**Standard Lead and Packaging Options**		
	Tray – Short Leads	6 +0/–1	C
	Bulk – Maximum Length Leads	30 +5/–0	A

Dimensions – Millimeters



Size Code	S		T		H		L		F		b
	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Tolerance
HE	10.2	±0.4	3.9	Maximum	7.5	Maximum	13.5	Maximum	0.6	±0.05	±0.4
HH	10.2	±0.4	4.1	Maximum	8.2	Maximum	13.5	Maximum	0.6	±0.05	±0.4
HL	10.2	±0.4	5.1	Maximum	10.5	Maximum	13.5	Maximum	0.6	±0.05	±0.4
QE	15.2	±0.4	5.2	Maximum	10.5	Maximum	18.5	Maximum	0.8	±0.05	±0.4
QJ	15.2	±0.4	5.5	Maximum	11.1	Maximum	18.5	Maximum	0.8	±0.05	±0.4
QS	15.2	±0.4	8.5	Maximum	14.3	Maximum	18.5	Maximum	0.8	±0.05	±0.4
CE	20.3	±0.4	7.6	Maximum	14.0	Maximum	24.0	Maximum	0.8	±0.05	±0.4
CJ	20.3	±0.4	9.0	Maximum	15.0	Maximum	24.0	Maximum	0.8	±0.05	±0.4
CP	20.3	±0.4	11.3	Maximum	16.5	Maximum	24.0	Maximum	0.8	±0.05	±0.4
SJ	22.5	±0.4	8.0	Maximum	17.0	Maximum	27.0	Maximum	0.8	±0.05	±0.4
SP	22.5	±0.4	10.0	Maximum	19.0	Maximum	27.0	Maximum	0.8	±0.05	±0.4
SU	22.5	±0.4	12.0	Maximum	22.0	Maximum	27.0	Maximum	0.8	±0.05	±0.4
EJ	25.4	±0.4	12.1	Maximum	19.0	Maximum	30.5	Maximum	1.0	±0.05	±0.4
EL	25.4	±0.4	15.3	Maximum	22.0	Maximum	30.5	Maximum	1.0	±0.05	±0.4

Note: See Ordering Options Table for lead length (LL) options.

Performance Characteristics

Rated Voltage	480 VAC 50/60Hz	
Capacitance Range	0.001 – 0.15 µF	
Capacitance Tolerance	±20%	
Temperature Range	–40°C to +110°C	
Climatic Category	40/110/56/B	
Approvals	ENEC, UL, cUL	
Dissipation Factor	Maximum Values at +23°C	
	1 kHz	1.3%
Test Voltage Between Terminals	The 100% screening factory test is carried out at 2,700 VDC. The voltage level is selected to meet the requirements in applicable equipment standards. All electrical characteristics are checked after the test. This test may not be repeated due to potential capacitor damage. KEMET is not liable for any failures that result from performing the test again.	
Insulation Resistance	Minimum Value Between Terminals:	
	≥ 12,000 MΩ	
In DC Applications	Recommended voltage ≤ 1,000 VDC	
Resonance Frequency	Tabulated self-resonance frequencies (f_0) refer to 5 mm lead length	

Environmental Test Data

Test	IEC Publication	Procedure
Endurance	IEC 60384–14	1.25 x V_R VAC 50 Hz , once every hour increase to 1,000 VAC for 0.1 seconds, 1,000 hours at upper rated temperature
Vibration	IEC 60068–2–6 Test Fc	3 directions at 2 hours each 10 – 500 Hz at 0.75 mm or 98m/seconds^2
Bump	IEC 60068–2–29 Test Eb	4,000 bumps at 390 m/seconds^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 4.0 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
Intertek Semko AB		EN/IEC 60384–14	SE/0140–35A
UL		UL 60384–14 CAN/CSA-E60384–14–09	E73869

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				
0.001	3.9	7.5	13.5	10.2	53	2,000	P278HE102M480(1)
0.0015	3.9	7.5	13.5	10.2	44	2,000	P278HE152M480(1)
0.0022	3.9	7.5	13.5	10.2	37	2,000	P278HE222M480(1)
0.0033	4.1	8.2	13.5	10.2	30	2,000	P278HH332M480(1)
0.0047	5.1	10.5	13.5	10.2	24	2,000	P278HL472M480(1)
0.0068	5.2	10.5	18.5	15.2	18.5	1,400	P278QE682M480(1)
0.010	5.2	10.5	18.5	15.2	15.5	1,400	P278QE103M480(1)
0.015	5.5	11.1	18.5	15.2	13	1,400	P278QJ153M480(1)
0.022	8.5	14.3	18.5	15.2	9.6	1,400	P278QS223M480(1)
0.033	7.6	14.0	24.0	20.3	9.6	1,000	P278CE333M480(1)
0.047	9.0	15.0	24.0	20.3	7.5	1,000	P278CJ473M480(1)
0.068	11.3	16.5	24.0	20.3	6.2	1,000	P278CP683M480(1)
0.033	8.0	17.0	27.0	22.5	7.2	1,000	P278SJ333M480(1)
0.047	8.0	17.0	27.0	22.5	6	1,000	P278SJ473M480(1)
0.068	10.0	19.0	27.0	22.5	4.8	1,000	P278SP683M480(1)
0.1	12.0	22.0	27.0	22.5	3.6	600	P278SU104M480(1)
0.1	12.1	19.0	30.5	25.4	3.9	600	P278EJ104M480(1)
0.15	15.3	22.0	30.5	25.4	3.2	600	P278EL154M480(1)
Capacitance Value (µF)	**B (mm)**	**H (mm)**	**L (mm)**	**Lead Spacing (p)**	**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.

Soldering Process

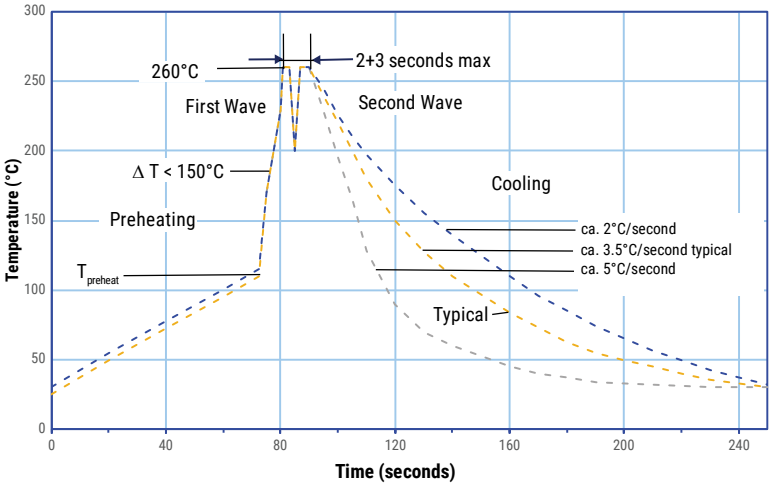
The implementation of the RoHS directive has resulted in the selection of SnAuCu (SAC) alloys or SnCu alloys as primary solder. This has increased the liquidus temperature from that of 183°C for the SnPb eutectic alloy to 217 – 221°C for the new alloys. As a result, the heat stress to the components,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

Figure 1

Wave Soldering Recommendations



Soldering Process cont.

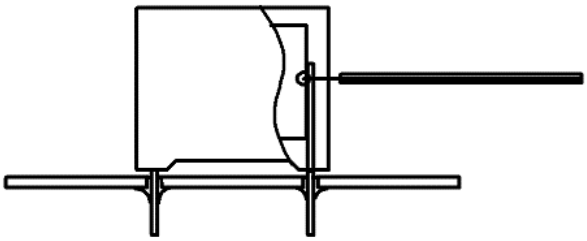
Wave Soldering Recommendations cont.

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 ≥ 10 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



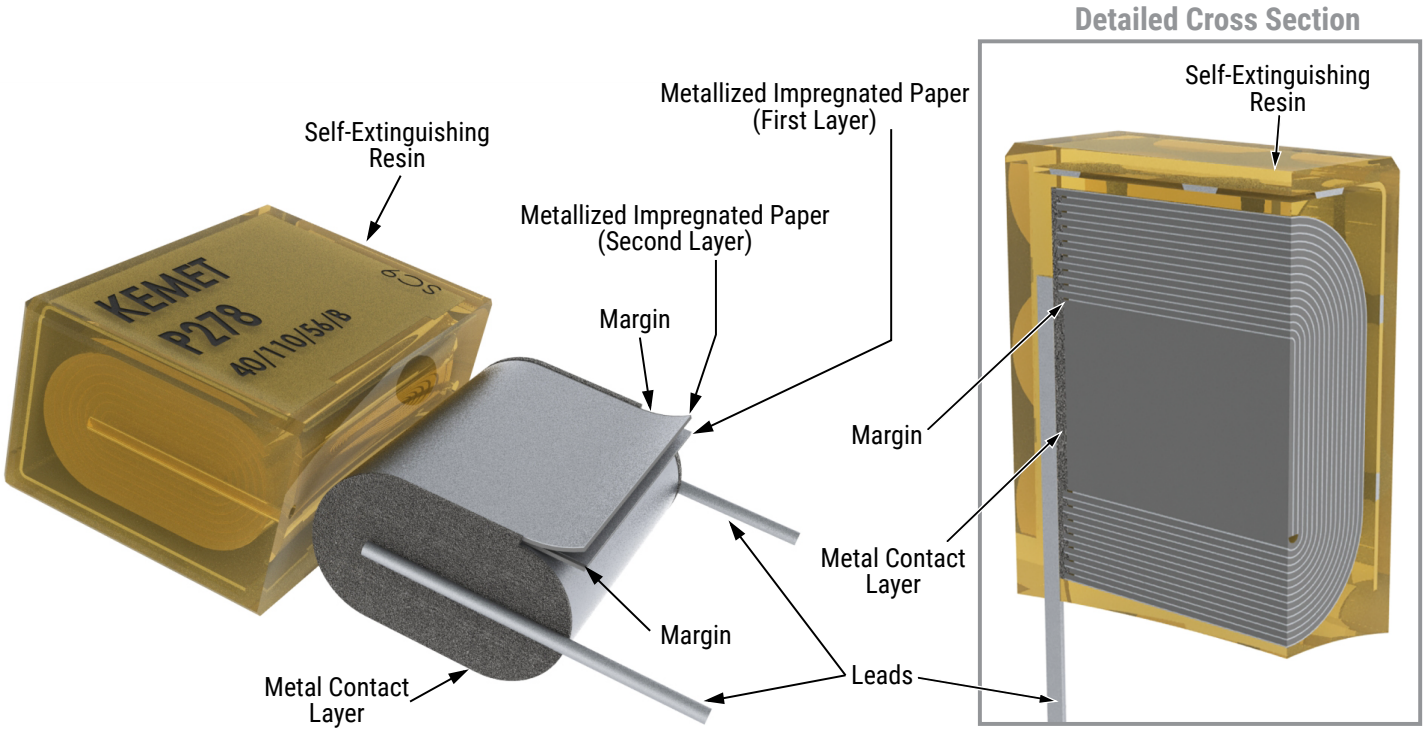
Temperature monitored inside the capacitor.

Selective Soldering Recommendations

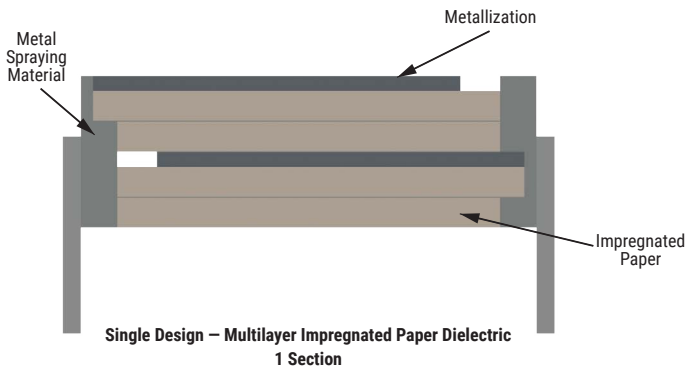
Selective dip soldering is a variation of reflow soldering. In this method, the printed circuit board with through-hole components to be soldered is preheated and transported over the solder bath, as in normal-flow soldering, without touching the solder. When the board is over the bath, it is stopped.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

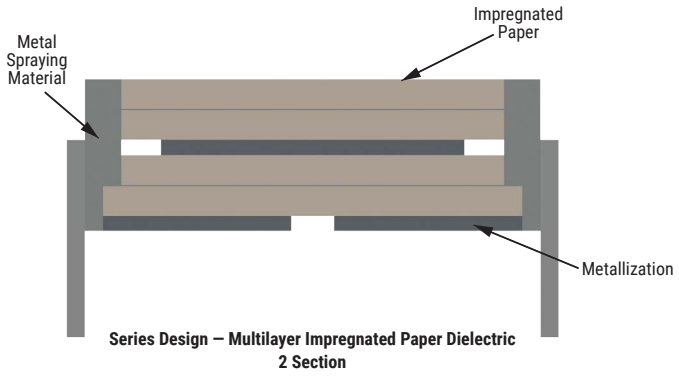
Construction



Winding Scheme

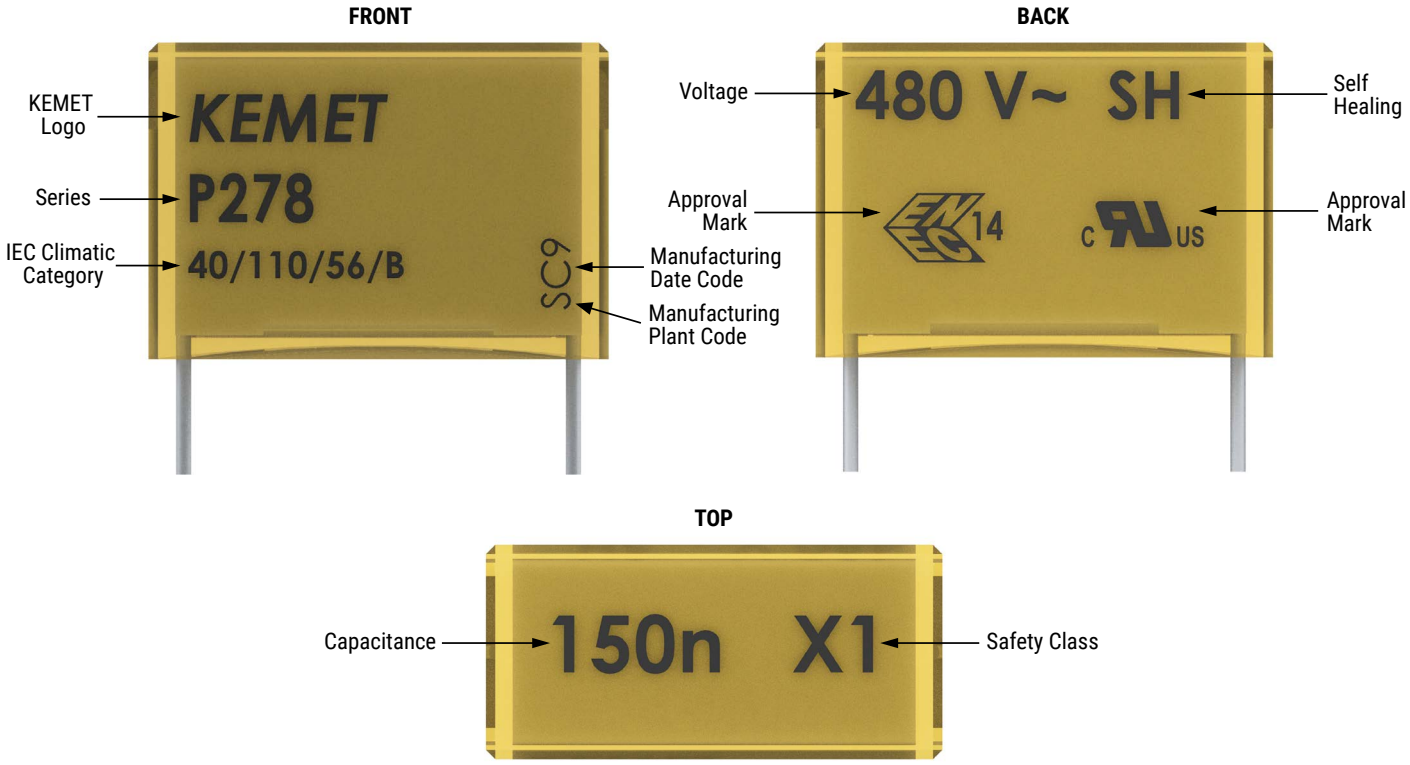


Single Design — Multilayer Impregnated Paper Dielectric
1 Section



Series Design — Multilayer Impregnated Paper Dielectric
2 Section

Marking



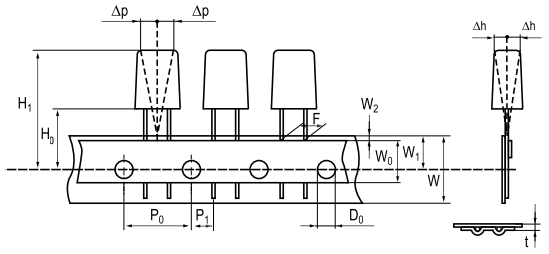
Manufacturing Date Code (IEC 60062)									
Year	Code	Year	Code	Year	Code	Month	Code	Month	Code
2020	M	2027	V	2034	E	January	1	July	7
2021	N	2028	W	2035	F	February	2	August	8
2022	P	2029	X	2036	H	March	3	September	9
2023	R	2030	A	2037	J	April	4	October	O
2024	S	2031	B	2038	K	May	5	November	N
2025	T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

Packaging Quantities

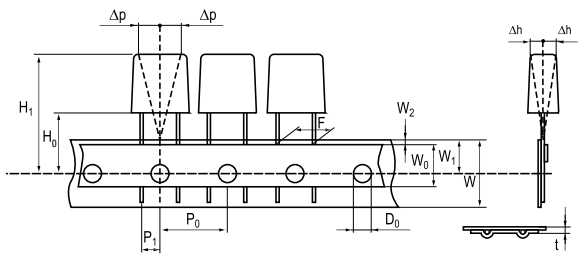
Lead Spacing (mm)	Thickness (mm)	Height (mm)	Length (mm)	Bulk Short Leads	Bulk Long Leads	Standard Reel 360 mm	Large Reel 500 mm	Ammo Formed
10.2	3.9	7.5	13.5	2,000	1,000	700	1,400	800
	4.1	8.2	13.5	2,000	1,000	600		780
	5.1	10.5	13.5	1,600	800	600	1,200	630
15.2	5.5	12.5	18.0	1,000	500	600		
	6.5	12.5	18.0	600	400	400		
	7.5	14.5	18.0	600	400	400		
	8.5	16.0	18.0	400	250	400		
	5.2	10.5	18.5	1000	500	600		
	5.5	11.1	18.5	1,000	500	500		
	6.0	12.5	18.5	600	400	400		
	7.3	13.0	18.5	600	400	400	800	
	7.8	13.5	18.5	600	400	400		
	8.5	14.3	18.5	500	300	350		
20.3	7.6	14.0	24.0	1,500	250	250	500	
	8.4	14.0	24.0	1,200	200	250	500	
	9.0	15.0	24.0	1,500	200	250		
	11.3	16.5	24.0	1,000	150	180	400	
22.5	8.0	17.0	27.0	1,200	200			
	10.0	19.0	27.0	1,000	150	200		
	12.0	22.0	27.0	800	100	180	350	
25.4	10.6	16.1	30.5	1,000	150			
	10.5	17.3	30.5	1,000	100			
	12.1	19.0	30.5	800	100			
	15.3	22.0	30.5	600	75			

Lead Taping & Packaging (IEC 60286–2)

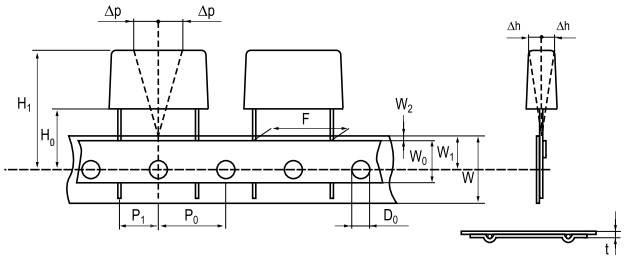
Lead Spacing 5 mm



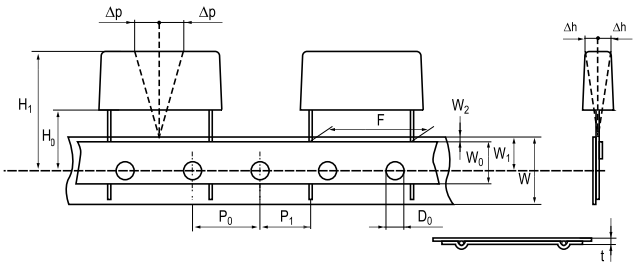
Lead Spacing 7.5 mm



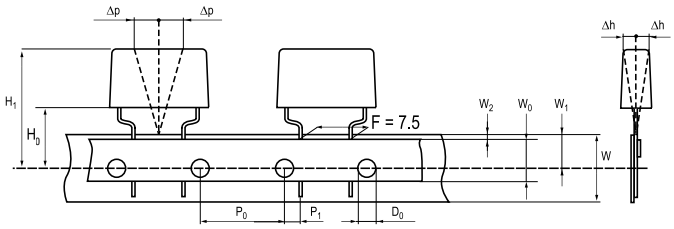
Lead Spacing 10 – 15mm



Lead Spacing 22.5 – 27.5 mm



Formed Leads from 10 and 15 mm to 7.5 mm



Taping Specification

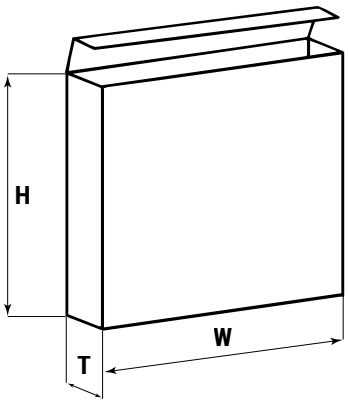
Dimensions in mm										Standard IEC 60286-2
Lead Spacing	+0.6/−0.1	F	5	7.5	Formed 7.5	10	15	22.5	27.5	F
Carrier Tape Width	±0.5	W	18	18	18	18	18	18	18	18+1/−0.5
Hold-down Tape Width	Minimum	W_0	5	5	5	5	5	5	5	
Position of Sprocket Hole	±0.5	W_1	9	9	9	9	9	9	9	9+0.75/−0.5
Distance Between Tapes	Maximum	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.

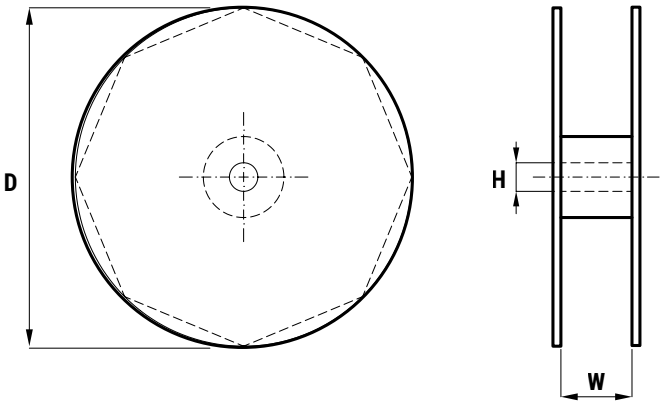
Ammo Specifications

Series	Dimensions (mm)		
	H	W	T
P278	330	330	50



Reel Specifications

Series	Dimensions (mm)		
	D	H	W
P278	360 500	30	46 (Max)



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C0805F104K4RACTU C0603V102KDRACTU C0805C475K9RACTU MPXV1D0830L330 SCT29XV-120-1R6A017JV T491D107K016AT C0805W153KCRACTU C4AQIBU4800M11J L0201C1N0SRMST MPXV1D0624L3R3 PHBC12-1R0A0080V SC-05-503 MA-2023 PHBC20-1R7A0097V R82CC4220Z370K T495C107K016ATE200 C0603C683K4RACTU C1206C100J1GACTU VE0805K121R025 SC-10-500 ALA8AA391DD450 C0805W103KCRACTU C1206T104K1RACTU C1808C102KDRACAUTO CBR06C100JAGAC SC-05-700JH C0603C102J1RACAUTO C0603W102KDRACTU C1206C102KDGACTU MPLCH0740L1R5