EFX1A

Automotive metalized polypropylene film EMI suppression capacitors

Product features

- High stability of capacitance
- Self-healing property
- Over voltage stress withstanding
- Flame-retardant plastic case and resin
- AEC-Q200
- THB Grade IIIB

Applications

- Class X1 for interference suppression
- EMI filtering in across-the-line applications
- xEV traction inverter
- On board charger (OBC)
- xEV DC/DC converter
- Solar inverter
- UPS
- AC motor drive
- Air conditioner
- Switch mode power supplies

Environmental compliance and general specifications

- Operating temperature range: -40 °C to +110 °C

Agency information

Approval mark	Standard	File number
	UL 60384-14 CAN/CSA-E60384-14	E529574
	IEC 60384-14:2013 IEC 60384-14:2013/AMD1:2016	40055921
	IEC 60384-14:2013+AMD1:2016 CQC11-471112-2015	CQC22001363199

Powering Business Worldwide

Part number system

EF	X1	A	48	K	103	B01	2L	H
Capacitor type	**Family**	**Grade**	**Voltage (Vac)**	**Tolerance**	**Capacitance (pF)**	**Size code**	**Terminal code**	**Lead length code**
EF = film capacitors	X1	A = automotive grade	48 = 480	K = ±10% M = ±20%	First two digits= significant figures, third digit = number of zeros example: 103 = 10000 pF	Refer to size code table	Refer to terminal code table	Refer to lead length code table

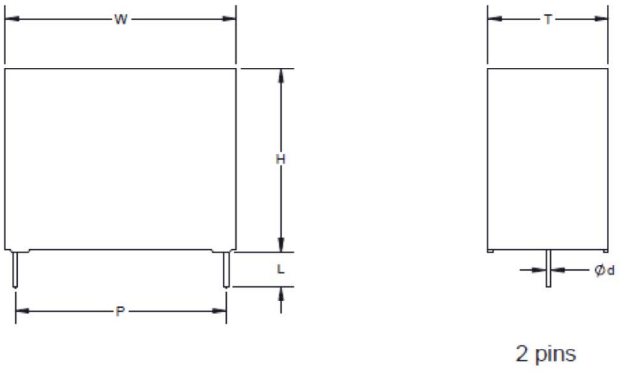
Terminal code table

Digit one (Lead/terminal type)		Digit two (Lead Ipsilateral)	
Straight cut	2	N/A	L
Taping straight	V	-	-

Lead length code table

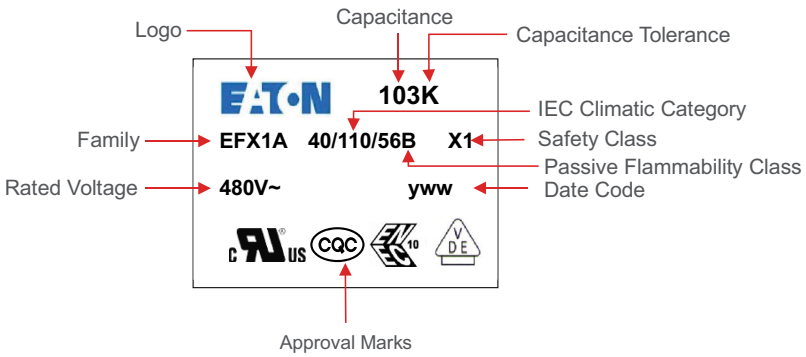
Lead length	
3.0±0.5 mm (Bulk)	D
3.5±0.5 mm (Bulk)	E
4.0±0.5 mm (Bulk)	F
4.5±0.5 mm (Bulk)	G
5.0±0.5 mm (Bulk)	H
25±2 mm (Ammo)	T

Dimensions-mm



2 pins

Part marking



Size code table

Size	Dimension-mm						Pitch-mm		Lead wire-mm		Lead length
Code	W	Tolerance (±)	H	Tolerance (±)	T	Tolerance (±)	P	Tolerance (±)	Ød	Tolerance (±)	L
B01	18	0.5	11	0.5	5	0.5	15	0.5	0.6	0.05	Refer to Lead Length Code Table, Pitch 27.5 without Ammo package
B02	18	0.5	12	0.5	6	0.5	15	0.5	0.6	0.05	
B07	18	0.5	13.5	0.5	7.5	0.5	15	0.5	0.8	0.05	
B11	18	0.5	16	0.5	10	0.5	15	0.5	0.8	0.05	
B16	18	0.5	19	0.5	11	0.5	15	0.5	0.8	0.05	
C01	26	0.5	15.5	0.5	6	0.5	22.5	0.5	0.6	0.05	
C02	26	0.5	16.5	0.5	7	0.5	22.5	0.5	0.8	0.05	
C03	26	0.5	17	0.5	8.5	0.5	22.5	0.5	0.8	0.05	
C05	26	0.5	20	0.5	11	0.5	22.5	0.5	0.8	0.05	
C08	26	0.5	24.5	0.5	13	0.5	22.5	0.5	0.8	0.05	
C09	26	0.5	25	0.5	15	0.5	22.5	0.5	0.8	0.05	
C10	26	0.5	29.5	0.5	14.5	0.5	22.5	0.5	0.8	0.05	
D02	32	0.8	18	0.8	9	0.8	27.5	0.5	0.8	0.05	
D03	32	0.8	20	0.8	11	0.8	27.5	0.5	0.8	0.05	
D04	32	0.8	22	0.8	13	0.8	27.5	0.5	0.8	0.05	
D06	32	0.8	24.5	0.8	13	0.8	27.5	0.5	0.8	0.05	
D08	32	0.8	28	0.8	14	0.8	27.5	0.5	0.8	0.05	
D09	32	0.8	28	0.8	18	0.8	27.5	0.5	0.8	0.05	
D12	32	0.8	33	0.8	18	0.8	27.5	0.5	0.8	0.05	
D13	32	0.8	37	0.8	22	0.8	27.5	0.5	0.8	0.05	

Case color is black.

Rating and part number

Rated voltage 480 Vac/1000 Vdc

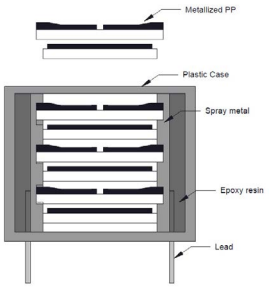
	Dimensions							
Capacitance value (µF)	W (mm)	H (mm)	T (mm)	P (mm)	Peak current (A)	Surge current (A)	dv/dt (V/µs)	Part number[1]
0.01	18	11	5	15	6	18	600	EFX1A48K103B012LH
0.015	18	11	5	15	9	27	600	EFX1A48K153B012LH
0.018	18	11	5	15	10.8	32.4	600	EFX1A48K183B012LH
0.022	18	11	5	15	13.2	39.6	600	EFX1A48K223B012LH
0.033	18	11	5	15	19.8	59.4	600	EFX1A48K333B012LH
0.047	18	12	6	15	28.2	84.6	600	EFX1A48K473B022LH
0.068	18	13.5	7.5	15	40.8	122.4	600	EFX1A48K683B072LH
0.1	18	16	10	15	60	180	600	EFX1A48K104B112LH
0.15	18	19	11	15	90	270	600	EFX1A48K154B162LH
0.047	26	15.5	6	22.5	14.1	42.3	300	EFX1A48K473C012LH
0.056	26	15.5	6	22.5	16.8	50.4	300	EFX1A48K563C012LH
0.068	26	15.5	6	22.5	20.4	61.2	300	EFX1A48K683C012LH
0.082	26	15.5	6	22.5	24.6	73.8	300	EFX1A48K823C012LH
0.1	26	15.5	6	22.5	30	90	300	EFX1A48K104C012LH
0.15	26	16.5	7	22.5	45	135	300	EFX1A48K154C022LH
0.22	26	17	8.5	22.5	66	198	300	EFX1A48K224C032LH
0.33	26	20	11	22.5	99	297	300	EFX1A48K334C052LH
0.47	26	24.5	13	22.5	141	423	300	EFX1A48K474C082LH
0.56	26	25	15	22.5	168	504	300	EFX1A48K564C092LH
0.68	26	29.5	14.5	22.5	204	612	300	EFX1A48K684C102LH
0.15	32	18	9	27.5	30	90	200	EFX1A48K154D022LH
0.22	32	18	9	27.5	44	132	200	EFX1A48K224D022LH
0.33	32	18	9	27.5	66	198	200	EFX1A48K334D022LH
0.47	32	20	11	27.5	94	282	200	EFX1A48K474D032LH
0.56	32	22	13	27.5	112	336	200	EFX1A48K564D042LH
0.68	32	24.5	13	27.5	136	408	200	EFX1A48K684D062LH
0.82	32	28	14	27.5	164	492	200	EFX1A48K824D082LH
1	32	28	18	27.5	200	600	200	EFX1A48K105D092LH
1.2	32	33	18	27.5	240	720	200	EFX1A48K125D122LH
1.5	32	33	18	27.5	300	900	200	EFX1A48K155D122LH
1.8	32	37	22	27.5	360	1080	200	EFX1A48K185D132LH

1. Standard part numbers listed---addition confirgurations available for tolerance, terminal and lead length. See part number system for available tolerances and terminal and lead length tables for available options.

General information

Application	Interference suppression \ Across-the-line (Class X1)
Dielectric	Metallized Polypropylene Film
Reference standard	IEC 60384-14; UL 60384-14; GB/T 6346.14-2015, AEC-Q200D
Climatic category	40/110/56 IEC60068-1
Passive flammability class	B
Operating temperature range	-40 °C to +110 °C
Protection	Solvent resistant plastic case UL94 V-0, Thermosetting resin sealing UL 94V-0 compliant
Installation	Any position
Packaging	Packed in cardboard boxes with protection for the terminals
Storage conditions	Storage time: ≤24 months from the date marked on the label package, Average relative humidity per year ≤70%, RH≤85% for 30 days in one year, Dew is absent, Temperature: -40 °C to +85 °C
RoHS compliant	Compliant with the restricted substance requirements of Directive 2011/65/EU
Flame retardant grade	Flame retardant performance accords with horizontal combustion grade HB and vertical combustion grade V-0

Construction

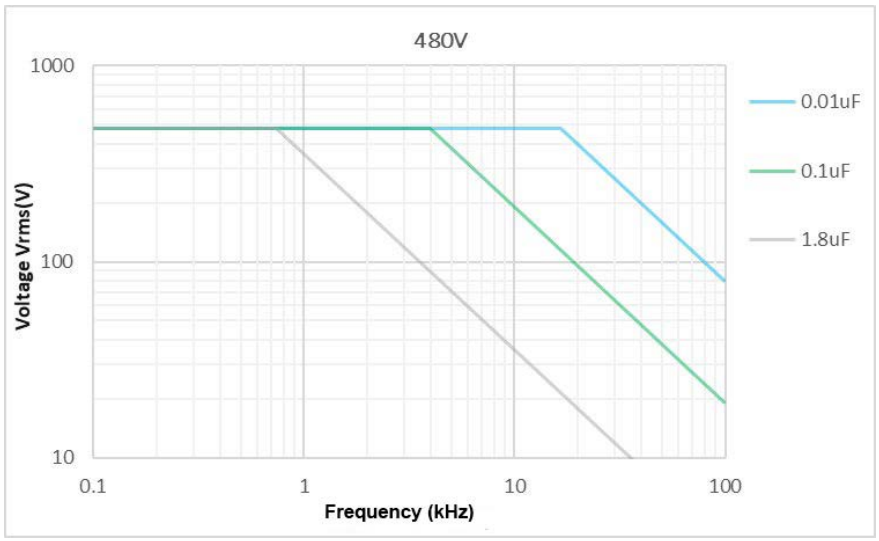
Metallized film	OPP & Al/Zn
Metal sprayed	Sn/Zn Alloy
Connection electrode	Tinned Copper clad steel wire
Plastic case	Plastic case (UL94V-0)
Filling	Epoxy resin (UL94V-0)
Film construction	Internal series connection 

Electrical and general characteristics

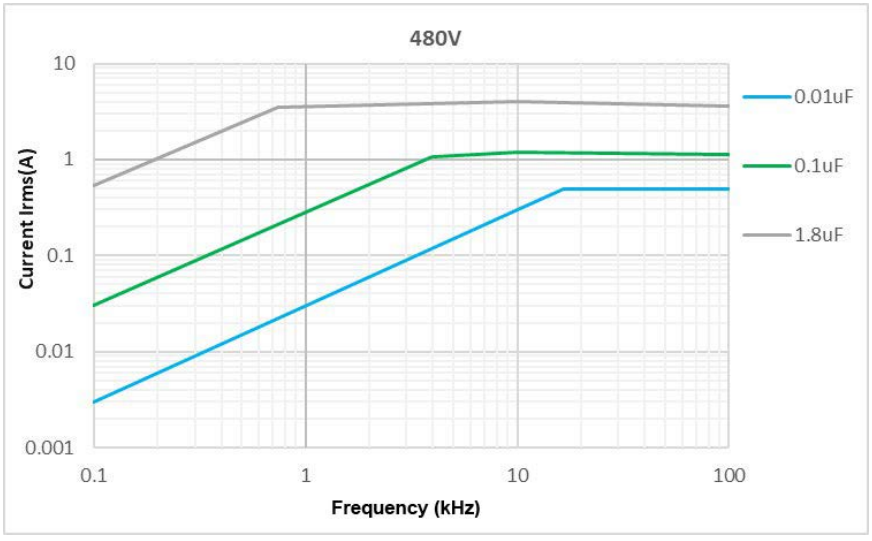
Voltage range (U_R)	480 Vac 50/60 Hz
Recommended DC voltage	1000 Vdc
Capacitance range	0.01 µF to 1.8 µF
Capacitance tolerance	±10% or ±20% at +20 °C
Capacitance	Measuring Frequency at 1 KHz, +20°C Measuring Voltage:1 ± 0.2 V
Standard atmospheric conditions for static test	Ambient temperature +15 °C to +35 °C Relative humidity 45% to 75% Air pressure 86 kPa to 106 kPa.
Withstanding DC voltage between terminals U_{TT}	DC Voltage: 4.3 x UR for 60 seconds (at +20 ±2 °C) *The U_R in this DC test is the rated AC voltage value
Withstanding AC voltage between terminal and case $_{UTC}$	$2U_R$ + 1500 Vac, 60 s (at +20 ± 2 °C)
Dissipation factor	≤20 * 10^{-4} at 10 kHz. (C ≤ 1 µF) at +20 °C ≤30 * 10^{-4} at 1 kHz. (C > 1 µF) at +20 °C
Insulation resistance	R between leads, for C ≤ 0.33 µF at 100 V 20°C; 1 min > 15 000 MΩ RC between leads, for C > 0.33 µF at 100 V 20°C; 1 min > 5000 MΩ*µF
Life expectancy	100,000 hours (U_R hotspot = +85° C) (ΔC/C≤10%)
Failure rate	100 FIT
Maximum altitude	2000 m

Charcteristics curves

Maximum voltage (V_{rms}) vs frequency

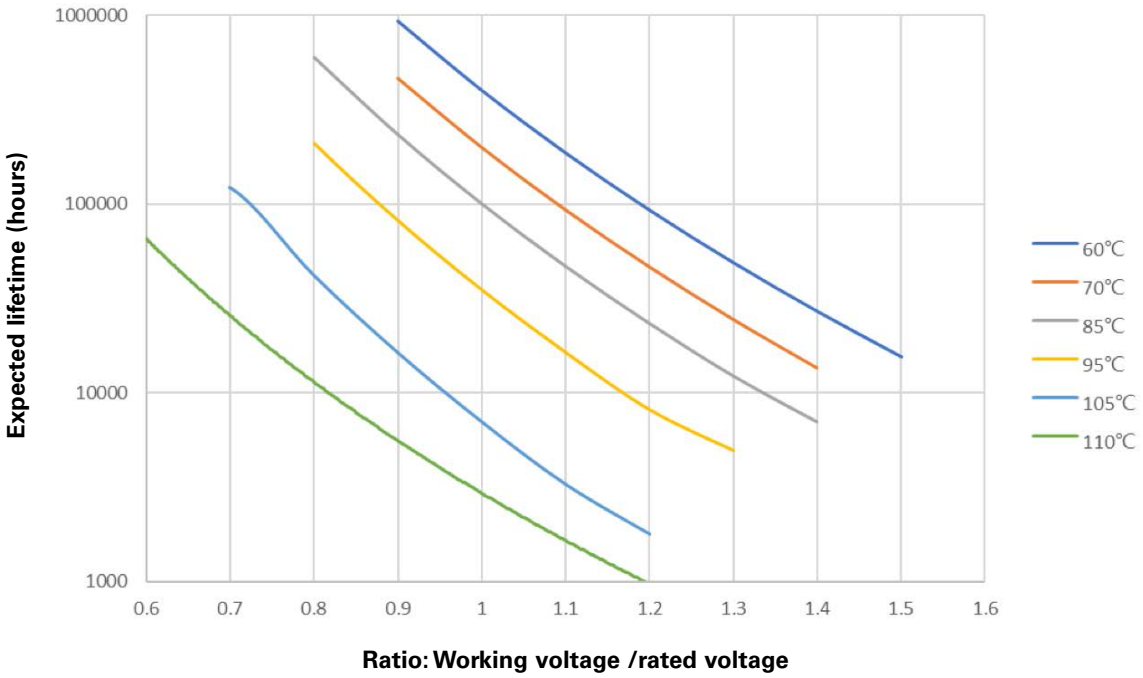


Maximum current (I_{rms}) vs frequency

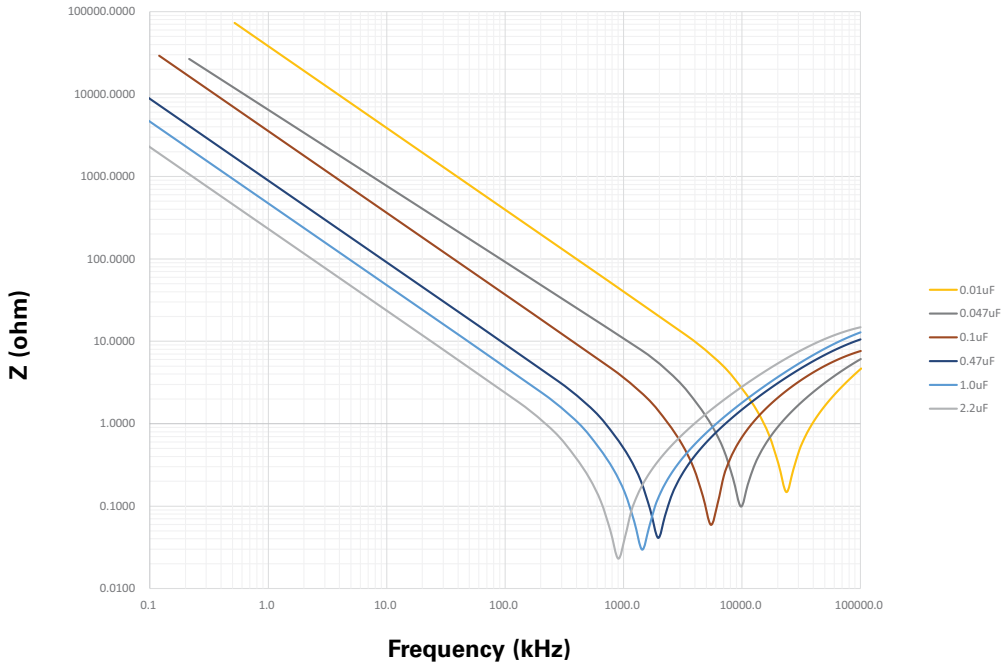


Charcteristics curves

Expected life curve



Impedance vs frequency



Environmental test

Test	Test condition	Performance
High temperature exposure	Reference: MIL-STD-202 Method 108, +110 +/- 2 °C 1000 hours	Capacitance change rate (ΔC/C) : ≤±3% DF change (Δtg): : ≤80δ10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtg): : ≤50$_{\delta}$* 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Temperature cycling	Reference: JESD22 Method JA-104, High temperature: +110 +/-5 °C, Low lemperature: -40 +/-5 °C, 1000 cycles, 30 minutes for each temperature	Capacitance change rate (ΔC/C) : ≤±3% DF change (Δtg): : ≤80δ10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtg): : ≤50$_{\delta}$* 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Moisture resistance	Reference: MIL-STD-202 Method 106 (+25 °C to 65 °C for 2.5 hours) , (+65 °C for 3 hours) , (+65 °C to +25 °C for 2.5 hours) , (+25 °C to +65 °C for 2.5 hours) , (+65 °C for 3 hours) , (+65 °C to +25 °C for 2.5 hours) , (+25 °C for 8 hours) Keep humidity 90%~100% for 10 cycles	Capacitance change rate (ΔC/C) : ≤±5% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Biased humidity 1	Reference: MIL-STD-202 Method 103, +60 °C + 95% R.H, Rated voltage, 1000 hours	Capacitance change rate (ΔC/C) : ≤±5% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Biased humidity 2	Reference: MIL-STD-202 Method 103, +85 °C + 85% R.H, Rated voltage, 1000 hours	Capacitance change rate (ΔC/C) : ≤±10% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Operational life	Testing method per IEC 60384-14, Test temperature: +110 +/-2 °C., Apply 125% of rated voltage for 1,000 +24/-0 hours. Each of these voltages shall be applied to each capacitor individually through a resistor of 47Ω ±5%. Once every hour the voltage is increased to 1000 V rms, for 0,1 seconds.	Capacitance change rate (ΔC/C) : ≤±10% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Terminal strength (leaded)	Tension: 0.50 < D ≤0.80, 10 N, 0.80 < D ≤ 1.25, 20 N Bending force: 0.50 < D ≤ 0.80, 5 N, 0.80 < D ≤ 1.25, 10 N Make two successive bends in each direction	Shall be no abnormality
Resistance to solvents	Reference: MIL-STD-202 Method 215, Solvent: propanol, Immersion time: 3 minutes, Drying time: 5 minutes, Mechanical treatment: 10 rubbing (toothbrush), 3 cycles	Capacitance change rate (ΔC/C) : ≤±1% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Mechanical shock	Reference: MIL-STD-202 Method 213, Pulse-shape: half-sine wave, Acceleration: 100 g, Duration of pulse: 6 ms, 18 times	Capacitance change rate (ΔC/C) : ≤±3% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Vibration	Reference: MIL-STD-202 Method 204, Frequency Change: 10 ~ 2000 Hz. 5 g force, 20 minutes, Direction: X, Y, Z, 12 cycles in each direction	Capacitance change rate (ΔC/C) : ≤±3% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Resistance to soldering heat	Reference: MIL-STD-202 Method 210, +260 +/- 5 °C 1.5 mm from roots	Capacitance change rate (ΔC/C) : ≤±2% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Solderability	Reference: J-STD-002, Soldering temperature: +245 +/-5 °C	More than 95% of circumferential surface of lead wire shall be covered with new solder

Environmental test

Test	Test condition	Performance
Electrical characterization	Parametrically test per lot at room, -40 °C, +110 °C	Electrical performance within specfication
Passive flammability class B	Test duration for actual volume V V ≤ 250 for 10 s 250 < V ≤ 500 for 20 s 500 < V ≤ 1750 for 30 s V > 1750 for 60 s	After removing test flame from capacitor, the capacitor must not continue to burn for more than 10 seconds. No burning particle must drop from the sample.
Humidity resistance	Reference: MIL-STD-202 Method 106, 40 +/-2 °C 90% to 95% R.H, 56 days	Capacitance change rate (ΔC/C) : ≤±5% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Active flammability	20 cycles of 4 kV discharges on the test capacitor connected to U_R	The cheese cloth around the capacitors shall not burn with a flame. No electrical measurements are required

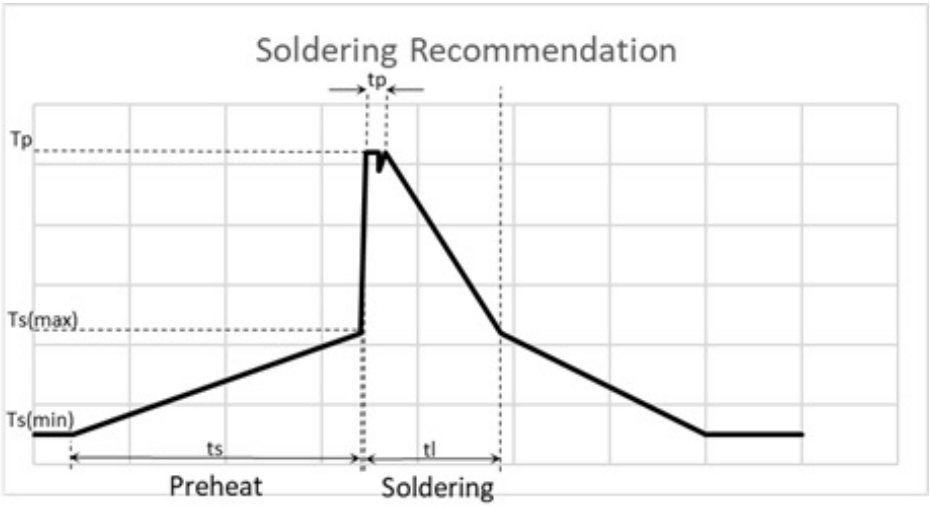
Electrical test

Test	Test condition	Performance
Charge and discharge	10000 cycles Charge to √2 x UR(DC) Charge resistance: $R = \frac{220 \times 10^{-6}}{C_N}\ \Omega$ Discharge resistance: $R = \frac{\sqrt{2} \times U_R\,(DC)}{1.25 \times C(dv/dt)}\ \Omega$	Capacitance change rate (ΔC/C) : ≤±5% DF change (Δtgδ): : ≤80*10^{-4} at 10 kHz. (C ≤ 1 µF) DF change (Δtgδ): : ≤50 * 10^{-4} at 1 kHz. (C > 1 µF) Insulation resistance: ≥50% of initial limit (T-T) test voltage: 4.3 U_R (dc)/60 s (T-C) test voltage: 2 U_R + 1500 V (ac)/60 s
Impulse voltage	3 successive impulses, full wave, peak voltage: X1: 4 kV for C ≤ 1 µF X1: 4 kV/√C for C > 1 µF 24 pulses maximum	No self-healing breakdowns or flashover

Packaging information

Pitch	SIze	Dimension-mm			Package quantity	
mm	Code	W	H	T	Bulk pack/box	Ammo pack/box
15	B01	18	11	5	1,054	680
	B02	18	12	6	867	560
	B07	18	13.5	7.5	697	450
	B11	18	16	10	527	340
	B16	18	19	11	476	300
22.5	C01	26	15.5	6	612	350
	C02	26	16.5	7	528	300
	C03	26	17	8.5	432	250
	C05	26	20	11	336	190
	C08	26	24.5	13	276	160
	C09	26	25	15	240	140
	C10	26	29.5	14.5	252	140
27.5	D02	32	18	9	340	NA
	D03	32	20	11	280	NA
	D04	32	22	13	230	NA
	D06	32	24.5	13	230	NA
	D08	32	28	14	220	NA
	D09	32	28	18	170	NA
	D12	32	33	18	170	NA
	D13	32	37	22	140	NA

Wave solder profile



Profile feature		
Preheat	• Ts maximimum	110 °C
	• Ts minimum	NA
	• ts	< 150 seconds
Preheat	• Tp	260 °C ±5 °C
	• tp	< 10 seconds
	• tl	≤60 seconds

Capacitor body maximum temperature at wave soldering ≤120 °C

Manual solder

+400 °C, 3 seconds maximum by soldering iron, generally manual, hand soldering is not recommended

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Printed in USA
Publication No. ELX1261 BU-ELX22125a
June 2023

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