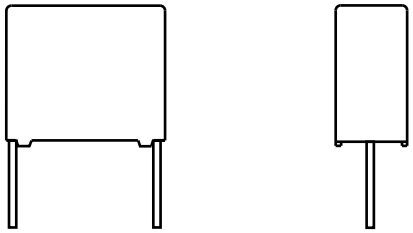
Interference Suppression Film Capacitor - Class X1
Radial MKP 440 V_{AC} - Standard Across the Line



FEATURES

- 15 mm to 27.5 mm lead pitch
- 440 V rated AC voltage
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

APPLICATIONS

For standard across the line X1 applications.

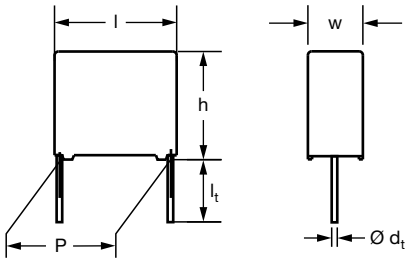
See also application note: www.vishay.com/doc?28153

QUICK REFERENCE DATA	
Capacitance range (E12 series)	0.01 µF to 1 µF (referred values acc. to E6)
Capacitance tolerance	± 20 %, ± 10 %, ± 5 %
Rated AC voltage	440 V_{AC}; 50 Hz to 60 Hz
Permissible DC voltage	1000 V_{DC}
Climatic testing class acc. to IEC 60068-1	50/105/56/C for product volumes > 1750 mm^3 50/105/56/B for volumes ≤ 1750 mm^3
Maximum application temperature	105 °C
Reference standards	IEC 60384-14 ed-4 (2013) and EN 60384-14 IEC 60065 pass. flamm. class B for volumes > 1750 mm^3 UL 60384-14
Dielectric	Polypropylene film
Electrodes	Metallized film
Construction	Mono construction
Encapsulation	Plastic case, epoxy resin sealed, flame retardant UL-class 94 V-0
Leads	Tinned wire
Marking	C-value; tolerance; rated voltage; sub-class; manufacturer's type; code for dielectric material; manufacturer location, year and week; manufacturer's logo or name; safety approvals

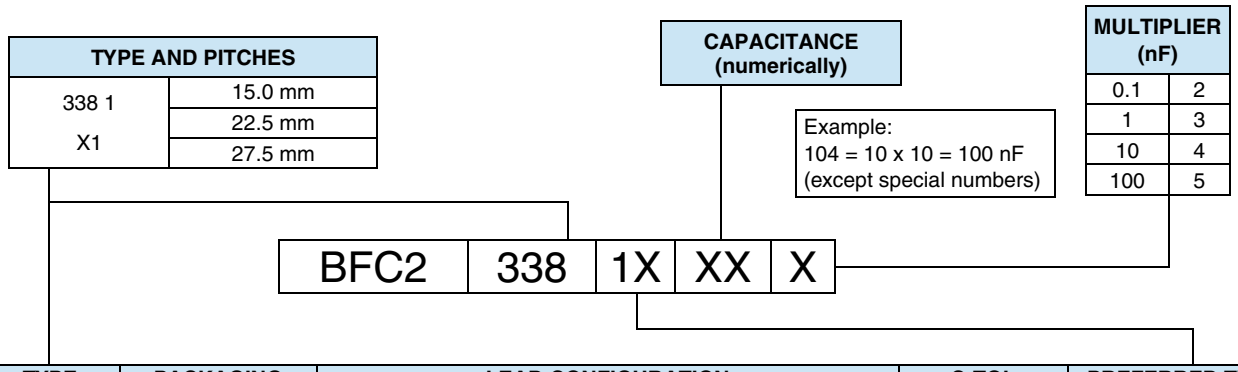
Note

- For more detailed data and test requirements, contact rfi@vishay.com

DIMENSIONS



COMPOSITION OF CATALOG NUMBER



TYPE	PACKAGING	LEAD CONFIGURATION	C-TOL.	PREFERRED TYPES
338 1 X1	Loose in box	Lead length 3.5 mm ± 0.3 mm	± 20 %	BFC2 338 10 ...
		Lead length 5.0 mm ± 1.0 mm		BFC2 338 12 ...
		Lead length 25.0 mm ± 2.0 mm		BFC2 338 14 ...
	Taped on reel (1)	H = 18.5 mm; for P_0 = 12.7 mm; reel diameter = 500 mm		BFC2 338 17 ...
TYPE	**PACKAGING**	**ALTERNATIVE C-TOL.**	**C-TOL.**	**ON REQUEST**
338 1 X1	Loose in box	Lead length 3.5 mm ± 0.3 mm	± 10 %	See tables for detail
			± 5 %	
		Lead length 5.0 mm ± 1.0 mm	± 10 %	
			± 5 %	
		Lead length 25.0 mm ± 2.0 mm	± 10 %	
			± 5 %	
	Taped on reel (1)	H = 18.5 mm; P_0 = 12.7 mm; reel diameter = 500 mm	± 10 %	
			± 5 %	

Note

(1) For detailed tape specification refer to packaging information: www.vishay.com/doc?28139

SPECIFIC REFERENCE DATA		
DESCRIPTION	**VALUE**	
Rated AC voltage (U_{RAC})	440 V	
Permissible DC voltage (U_{RDC})	1000 V	
Tangent of loss angle:	at 1 kHz	at 10 kHz
C ≤ 470 nF	≤ 10 x 10^{-4}	≤ 20 x 10^{-4}
C > 470 nF	≤ 20 x 10^{-4}	≤ 70 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$ at 615 V_{DC}		
Pitch = 15 mm	250 V/µs	
Pitch = 22.5 mm	150 V/µs	
Pitch = 27.5 mm	100 V/µs	
R between leads, for C ≤ 0.33 µF at 100 V, 1 min	> 15 000 MΩ	
RC between leads, for C > 0.33 µF at 100 V, 1 min	> 5000 s	
R between leads and case, 100 V, 1 min	> 30 000 MΩ	
Withstanding (DC) voltage (cut off current 10 mA) (1), rise time ≤ 1000 V/s	3400 V, 1 min	
Withstanding (AC) voltage between leads and case	2380 V, 1 min	
Maximum application temperature	105 °C	

Note

(1) See “Voltage Proof Test for Metallized Film Capacitors”: www.vishay.com/doc?28169

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RAC}	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g) [3]	CATALOG NUMBER BFC2 338 1XXXX AND PACKAGING						
				LOOSE IN BOX					TAPED REEL [1][2]	
				SHORT LEADS			LONG LEADS		Ø = 500 mm	
				l_t = 3.5 mm ± 0.3 mm	l_t = 5.0 mm ± 1.0 mm	SPQ	l_t = 25.0 mm ± 2.0 mm	SPQ	H = 18.5 mm; P_0 = 12.7 mm	SPQ
440	**PITCH = 15.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm; C-tol. = ± 20 %**									
	0.010	5.0 x 11.0 x 17.5	1.0	10103	12103	1000	14103	1000	17103	1100
	0.012			10123	12123		14123		17123	
	0.015			10153	12153		14153		17153	
	0.018			10183	12183		14183		17183	
	0.022			10223	12223		14223		17223	
	0.027	6.0 x 12.0 x 17.5	1.4	10273	12273	1000	14273	1000	17273	900
	0.033			10333	12333		14333		17333	
	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 20 %									
	0.039	7.0 x 13.5 x 17.5	1.8	10393	12393	750	14393	500	17393	800
	0.047			10473	12473		14473		17473	
	0.056	8.5 x 15.0 x 17.5	2.4	10563	12563	750	14563	500	17563	650
	0.068			10683	12683		14683		17683	
	0.082	10.0 x 16.5 x 17.5	3.0	10823	12823	500	14823	450	17823	600
	0.10			10104	12104		14104		17104	
	PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 20 %									
	0.12	8.5 x 18.0 x 26.0	3.8	10124	12124	200	14124	250	17124	450
	0.15			10154	12154		14154		17154	
	0.18	10.0 x 19.5 x 26.0	6.8	10184	12184	200	14184	200	17184	350
	0.22			10224	12224		14224		17224	
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 20 %									
	0.27	11.0 x 21.0 x 31.0	7.4	10274	12274	100	14274	125	-	-
	0.33	13.0 x 23.0 x 31.0	9.2	10334	12334	100	14334	125		
	0.39	15.0 x 25.0 x 31.5	12.3	10394	12394	100	14394	125		
	0.47			10474	12474		14474			
	0.56	18.0 x 28.0 x 31.5	16.1	10564	12564	100	14564	100		
	0.68			10684	12684		14684			
	0.82	21.0 x 31.0 x 31.0	20.3	10824	12824	50	14824	75		
	1.00			10105	12105		14105			
	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm; C-tol. = ± 10 %									
	0.010	5.0 x 11.0 x 17.5	1.0	18114	18314	1000	18514	1000	18914	1100
	0.012			18115	18315		18515		18915	
	0.015			18116	18316		18516		18916	
	0.018			18117	18317		18517		18917	
	0.022	6.0 x 12.0 x 17.5	1.4	18118	18318	1000	18518	1000	18918	900
	0.027			18119	18319		18519		18919	
	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 10 %									
	0.033	7.0 x 13.5 x 17.5	1.8	18121	18321	750	18521	500	18921	800
	0.039			18122	18322		18522		18922	
	0.047	8.5 x 15.0 x 17.5	2.4	18123	18323	750	18523	500	18923	650
	0.056			18124	18324		18524		18924	
	0.068	10.0 x 16.5 x 17.5	3.0	18125	18325	500	18525	450	18925	600
	0.082			18126	18326		18526		18926	

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RAC}	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g) (3)	CATALOG NUMBER BFC2 338 1XXXX AND PACKAGING						
				LOOSE IN BOX					TAPED REEL (1)(2)	
				SHORT LEADS			LONG LEADS		Ø = 500 mm	
				l_t = 3.5 mm ± 0.3 mm	l_t = 5.0 mm ± 1.0 mm	SPQ	l_t = 25.0 mm ± 2.0 mm	SPQ	H = 18.5 mm; P_0 = 12.7 mm	SPQ
440	**PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 10 %**									
	0.10	7.0 x 16.5 x 26.0	2.9	18127	18327	200	18527	250	18927	550
	0.12 0.15	8.5 x 18.0 x 26.0	3.8	18128 18129	18328 18329	200	18528 18529	250	18928 18929	450
	0.18	10.0 x 19.5 x 26.0	6.8	18131	18331	200	18531	200	18931	350
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 10 %									
	0.22 0.27	11.0 x 21.0 x 31.0	7.4	18132 18133	18332 18333	100	18532 18533	125		
	0.33	13.0 x 23.0 x 31.0	9.2	18134	18334	100	18534	125		
	0.39 0.47	15.0 x 25.0 x 31.0	12.3	18135 18136	18335 18336	100	18535 18536	125	-	-
	0.56 0.68	18.0 x 28.0 x 31.0	16.1	18137 18138	18337 18338	100	18537 18538	100		
	0.82	21.0 x 31.0 x 31.0	20.3	18139	18339	50	18539	75		
	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm; C-tol. = ± 5 %									
	0.010 0.012 0.015 0.018	5.0 x 11.0 x 17.5	1.0	18214 18215 18216 18217	18414 18415 18416 18417	1000	18614 18615 18616 18617	1000	18934 18935 18936 18937	1100
	0.022 0.027	6.0 x 12.0 x 17.5	1.4	18218 18219	18418 18419	1000	18618 18619	1000	18938 18939	900
	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 5 %									
	0.033 0.039	7.0 x 13.5 x 17.5	1.8	18221 18222	18421 18422	750	18621 18622	500	18941 18942	800
	0.047 0.056	8.5 x 15.0 x 17.5	2.4	18223 18224	18423 18424	750	18623 18624	500	18943 18944	650
	0.068 0.082	10.0 x 16.5 x 17.5	3.0	18225 18226	18425 18426	500	18625 18626	450	18945 18946	600
	PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 5 %									
	0.10 0.12	8.5 x 18.0 x 26.0	3.8	18227 18228	18427 18428	200	18627 18628	250	18947 18948	450
	0.15 0.18	10.0 x 19.5 x 26.0	6.8	18229 18231	18429 18431	200	18629 18631	200	18949 18951	350
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-tol. = ± 5 %									
	0.22	11.0 x 21.0 x 31.0	7.4	18232	18432	100	18632	125		
	0.27 0.33	13.0 x 23.0 x 31.0	9.2	18233 18234	18433 18434	100	18633 18634	125		
	0.39 0.47	15.0 x 25.0 x 31.5	12.3	18235 18236	18435 18436	100	18635 18636	125	-	-
	0.56 0.68	18.0 x 28.0 x 31.5	16.1	18237 18238	18437 18438	100	18637 18638	100		
	0.82	21.0 x 31.0 x 31.0	20.3	18239	18439	50	18639	75		

Notes

- SPQ = Standard Packing Quantity

(1) H = in-tape height; P_0 = sprocket hole distance; for detailed specifications refer to packaging information: www.vishay.com/doc?28139

(2) Reel diameter = 356 mm is available on request

(3) Weight for short lead product only

APPROVALS				
SAFETY APPROVALS X1	**VOLTAGE**	**VALUE**	**FILE NUMBERS**	**LINKS**
EN 60384-14 (ENEC) (= IEC 60384-14 ed-4 (2013))	440 V_{AC}	10 nF to 1 µF	ENEC16/FI/19/10003	www.vishay.com/doc?28202
UL 60384-14	440 V_{AC}	10 nF to 1 µF	E354331	www.vishay.com/doc?28190
CSA E384-14	440 V_{AC}	10 nF to 1 µF	E354331	
CB-test certificate	440 V_{AC}	10 nF to 1 µF	FI-39829	www.vishay.com/doc?28201
The ENEC-approval together with the CB-certificate replace all national marks of the following countries (they have already signed the ENEC-agreement): Austria; Belgium; Czech. Republic; Denmark; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Luxembourg; Netherlands; Norway; Portugal; Slovenian; Spain; Switzerland and United Kingdom.				

MOUNTING

Normal Use

The capacitors are designed for mounting on printed-circuit boards. The capacitors packed in bandoleers are designed for mounting in printed-circuit boards by means of automatic insertion machines.

For detailed tape specifications refer to packaging information: www.vishay.com/doc?28139

Specific Method of Mounting to Withstand Vibration and Shock

In order to withstand vibration and shock tests, it must be ensured that the stand-off pips are in good contact with the printed-circuit board:

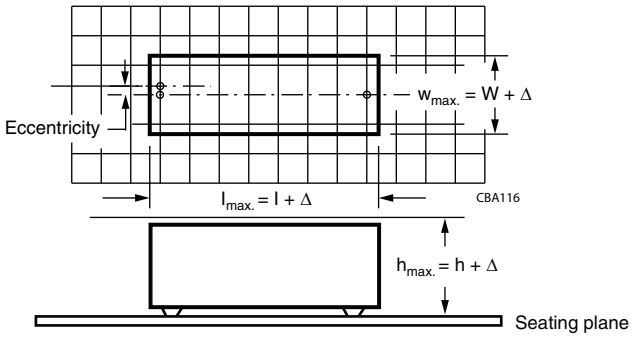
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For longer pitches the capacitors shall be mounted in the same way and the body clamped

Space Requirements on Printed Circuit Board

The maximum space for length ($l_{max.}$), width ($w_{max.}$), and height ($h_{max.}$) of film capacitors to take in account on the printed circuit board is shown in the drawings.

- For products with pitch ≤ 15 mm, $\Delta w = \Delta l = 0.3$ mm; $\Delta h = 0.1$ mm

Eccentricity defined as in drawing. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned.



SOLDERING

For general soldering conditions and wave soldering profile, we refer to the application note:
"Soldering Guidelines for Film Capacitors": www.vishay.com/doc?28171

Storage Temperature

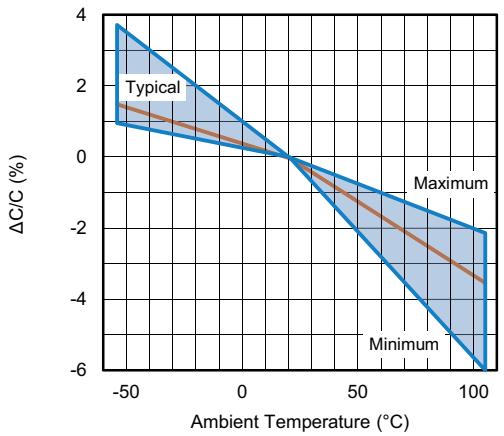
T_{stg} = -25 °C to +35 °C with RH maximum 75 % without condensation

Ratings and Characteristics Reference Conditions

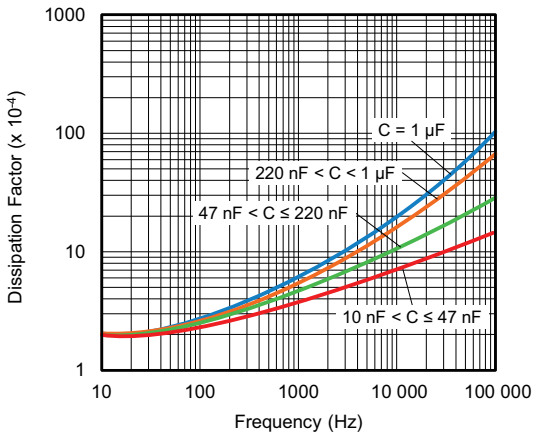
Unless otherwise specified, all electrical values apply to an ambient temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

For reference testing, a conditioning period shall be applied over 96 h ± 4 h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.

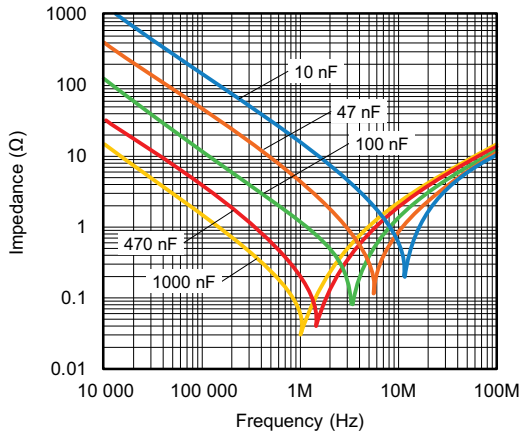
CHARACTERISTICS



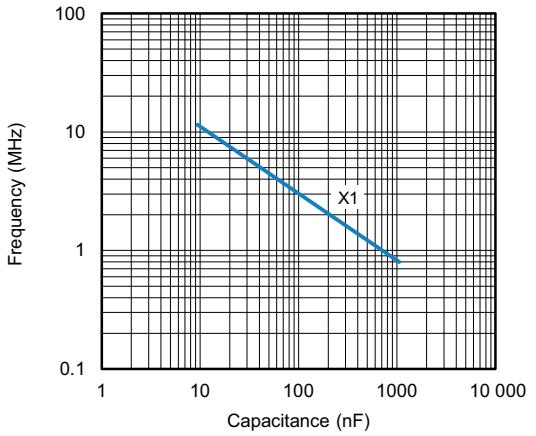
Capacitance as a function of ambient temperature (typical curve)



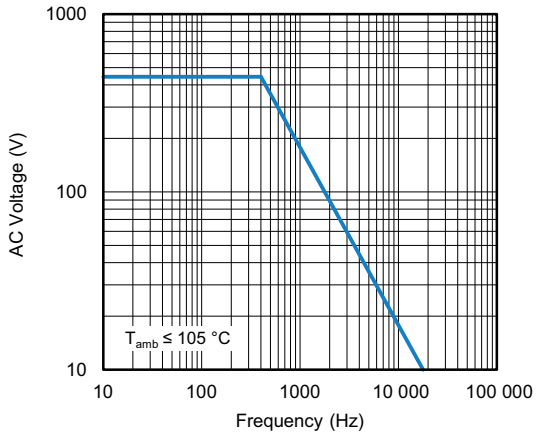
Tangent of loss angle as a function of frequency (typical curve)



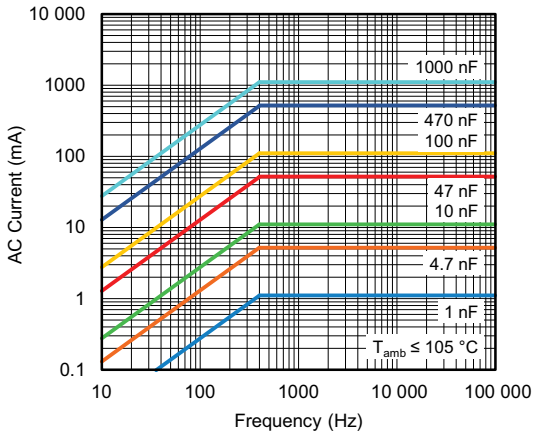
Impedance as a function of frequency (typical curve)



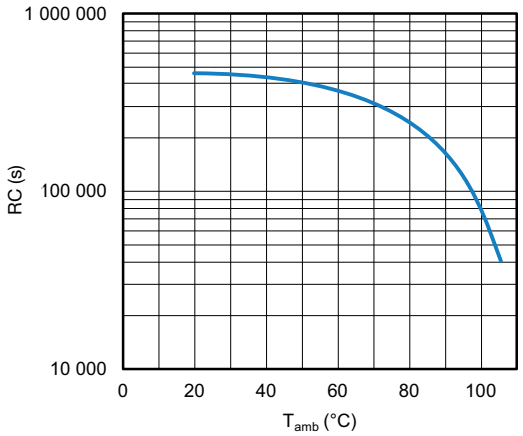
Resonant frequency as a function of capacitance (typical curve)



Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency



Insulation resistance as a function of ambient temperature

APPLICATION NOTES

- For X1 electromagnetics interference suppression in **standard across the line applications** (50 Hz/60 Hz) with a maximum mains voltage of 440 V_{AC}.
- For series impedance applications we refer to application note: www.vishay.com/doc?28153
- For capacitors connected in parallel, normally the proof voltage and possibly the rated voltage must be reduced. For information depending of the capacitance value and the number of parallel connections contact: rfi@vishay.com
- These capacitors are not intended for continuous pulse applications. For these situations, capacitors of the AC and pulse programs must be used.
- The maximum ambient temperature must not exceed 105 °C.
- Rated voltage pulse slope:
  If the pulse voltage is lower than the rated voltage, the values of the specific reference data can be multiplied by 615 V_{DC} and divided by the applied voltage.

INSPECTION REQUIREMENTS

General Notes

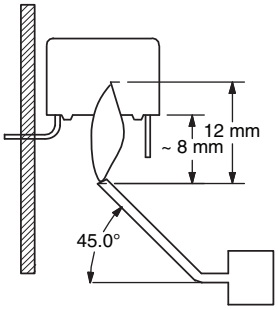
Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-14 ed-3 and Specific Reference Data”.

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1		
4.1 Dimensions (detail)		As specified in chapters “General data” of this specification
Initial measurements	Capacitance Tangent of loss angle at 10 kHz	
4.3 Robustness of terminations	Tensile: Load 10 N; 10 s Bending: Load 5 N; 4 x 90°	No visible damage
4.4 Resistance to soldering heat	No pre-drying Method: 1A Solder bath: 280 °C ± 5 °C Duration: 10 s	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1		
4.19 Component solvent resistance	Isopropylalcohol at room temperature Method: 2 Immersion time: 5 min ± 0.5 min Recovery time: Min. 1 h, max. 2 h	
4.4.2 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\|\Delta C/C\| \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured initially
	Insulation resistance	As specified in section “Insulation Resistance” of this specification
SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1		
Initial measurements	Capacitance Tangent of loss angle at 10 kHz	
4.20 Solvent resistance of the marking	Isopropylalcohol at room temperature Method: 1 Rubbing material: Cotton wool Immersion time: 5 min ± 0.5 min	No visible damage Legible marking
4.6 Rapid change of temperature	θA = - 55 °C θB = + 105 °C 5 cycles Duration t = 30 min	
4.6.1 Inspection	Visual examination	No visible damage
4.7 Vibration	Mounting: See section “Mounting” of this specification Procedure B4 Frequency range: 10 Hz to 55 Hz Amplitude: 0.75 mm or acceleration 98 m/s² (whichever is less severe) Total duration: 6 h	
4.7.2 Final inspection	Visual examination	No visible damage
4.9 Shock	Mounting: See section “Mounting” for more information Pulse shape: Half sine Acceleration: 490 m/s² Duration of pulse: 11 ms	
4.9.2 Final measurements	Visual examination	No visible damage
	Capacitance	$\|\Delta C/C\| \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured initially
	Insulation resistance	As specified in section “Insulation Resistance” of this specification

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B		
4.11 Climatic sequence		
4.11.1 Initial measurements	Capacitance Measured in 4.4.2 and 4.9.2 Tangent of loss angle Measured initially in C1A and C1B	
4.11.2 Dry heat	Temperature: 105 °C Duration: 16 h	
4.11.3 Damp heat cyclic Test Db First cycle		
4.11.4 Cold	Temperature: - 55 °C Duration: 2 h	
4.11.5 Damp heat cyclic Test Db Remaining cycles		
4.11.6 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured in 4.11.1.
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured in 4.11.1.
	Voltage proof 1900 V_{DC}; 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP C2		
4.12 Damp heat steady state	56 days, 40 °C, 90 % to 95 % RH No load	
4.12.1 Initial measurements	Capacitance Tangent of loss angle at 1 kHz	
4.12.3 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured in 4.12.1.
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured in 4.12.1.
	Voltage proof 1900 V_{DC}; 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C3		
4.13.1 Initial measurements	Capacitance Tangent of loss angle at 10 kHz	
4.13 Impulse voltage	3 successive impulses, full wave, peak voltage: X1: 4 kV Max. 24 pulses	No self healing breakdowns or flash-over
4.14 Endurance	Duration: 1000 h 1.25 x U_{RAC} at 105 °C Once in every hour the voltage is increased to 1000 V_{RMS} for 0.1 s via resistor of 47 Ω ± 5 %	
4.14.7 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % compared to values measured in 4.13.1.
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured in 4.13.1.
	Voltage proof 1900 V_{DC}; 1 min between terminations 2380 V_{AC}; 1 min between terminations and case.	No permanent breakdown or flash-over
	Insulation resistance	≥ 50 % of values specified in section "Insulation Resistance" of this specification
SUB-GROUP C4		
4.15 Charge and discharge	10 000 cycles Charged to 615 V_{DC} Discharge resistance: $R = \frac{615\ V_{DC}}{1.5 \times C\ (dU/dt)}$	
4.15.1 Initial measurements	Capacitance Tangent of loss angle at 10 kHz	
4.15.3 Final measurements	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % compared to values measured in 4.15.1.
	Tangent of loss angle	Increase of tan $\delta \leq 0.008$ Compared to values measured in 4.15.1.
	Insulation resistance	≥ 50 % of values specified in section "Insulation Resistance" of this specification
SUB-GROUP C5		
4.16 Radio frequency characteristic	Resonance frequency	≥ 0.9 times value as specified in section "Resonant Frequency" of this specification

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C6		
4.17 Passive flammability Class B	Bore of gas jet: Ø 0.5 mm Fuel: Butane Test duration for actual volume V in mm^3: $V \leq 250$: 10 s $250 < V \leq 500$: 20 s $500 < V \leq 1750$: 30 s $V > 1750$: 60 s One flame application  	After removing test flame from capacitor, the capacitor must not continue to burn for more than 10 s. No burning particle must drop from the sample.
SUB-GROUP C7		
4.18 Active flammability	20 cycles of 4 kV discharges on the test capacitor connected to U_{RAC}.	The cheese cloth around the capacitors shall not burn with a flame. No electrical measurements are required.

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