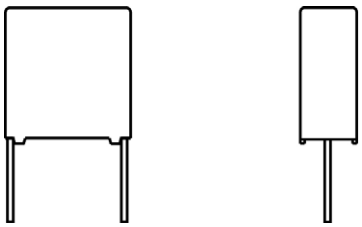
Interference Suppression Film Capacitors
MKP Radial Potted Type



FEATURES

- AEC-Q200 qualified (rev. C) up to 105 °C
- Compliant with IEC 60381-14: AMD1 grade IIB for pitch ≥ 15 mm
  - THB: 85 °C / 85 % RH, 500 h at U_{RAC}
- Compliant with IEC 60381-14: AMD1 grade IA for pitch < 15 mm
  - THB: 40 °C / 93 % RH, 21 days at U_{RAC}
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

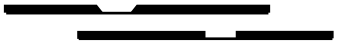
Pb-free

RoHS COMPLIANT

APPLICATIONS

For standard line bypass (between line and ground) Y2 applications

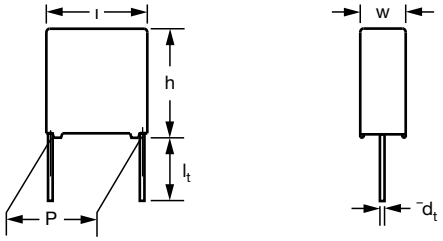
See also application note: www.vishay.com/doc?28153

QUICK REFERENCE DATA	
Capacitance range (E12 series)	0.001 µF to 0.1 µF (preferred values acc. to E6)
Capacitance tolerance	± 20 %
Rated voltage	300 V_{AC}; 50 Hz to 60 Hz
Permissible DC voltage	1000 V_{DC} at 105 °C 1250 V_{DC} at 85 °C
Climatic testing class (according to EN 60068-1)	55/105/56/C for product volumes ≤ 1750 mm^3
	55/105/56/B for product volumes > 1750 mm^3
Maximum application temperature	105 °C
Reference standards	IEC 60384-14 ed-4 (2013) and EN 60384-14 IEC 60065 requires pass. flamm. class B for volumes > 1750 mm^3 UL 60384-14 2nd edition; CSA E60384-1:14 3rd edition
Dielectric	Polypropylene film
Electrodes	Metallized film
Construction	Series construction 
	Triple construction 
Encapsulation	Plastic case, epoxy resin sealed, flame retardant class UL 94 V-0
Terminals	Tinned wire
Marking	C-value; tolerance; rated voltage; sub-class; manufacturer's type designation; code for dielectric material, manufacturer location; manufacturer's logo, year and week; safety approvals

Note

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

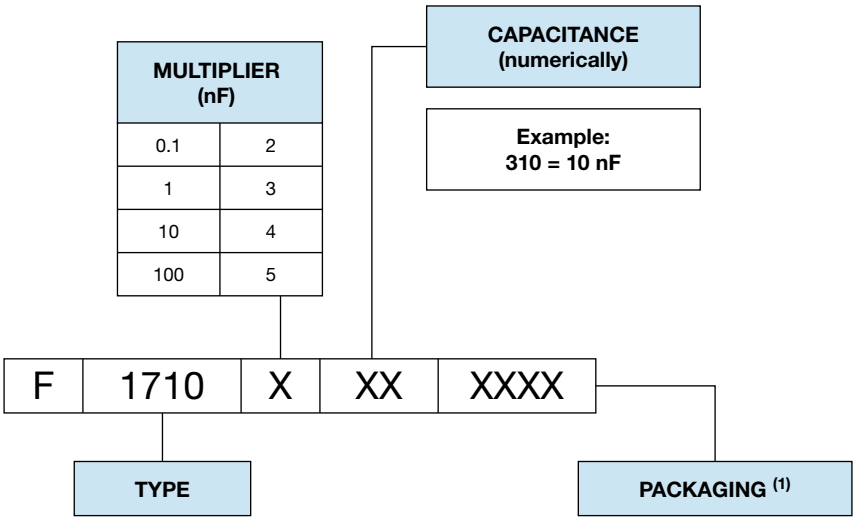
DIMENSIONS



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COMPOSITION OF CATALOG NUMBER



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})	300 V	
Permissible DC voltage (U_{RDC})	1000 V_{DC} at 105 °C 1250 V_{DC} at 85 °C	
Tangent of loss angle	At 1 kHz	At 10 kHz
C ≤ 100 nF	≤ 10 x 10^{-4}	≤ 20 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$ at 420 V_{DC}	100 V/µs	
R between leads at 100 V; 1 min	> 15 000 MΩ	
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	2100 V; 1 min	
Maximum application temperature	105 °C	

Note

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

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ELECTRICAL DATA AND ORDERING INFORMATION

U_{RDC} (V)	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g) [3]	CATALOG NUMBER F1710... AND PACKAGING						
				LOOSE IN BOX					TAPED	
				SHORT LEADS			LONG LEADS			
				l_t = 4 mm - 1 mm	l_t = 6.0 mm - 1.0 mm	SPQ	l_t = 30.0 mm + 5.0 mm	SPQ	REEL: Ø = 500 mm [1][2] H = 18.5 mm; P_0 = 12.7 mm	SPQ
1000	PITCH = 15 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm; C-TOL. = ± 20 %									
	0.0010	5.0 x 11.0 x 17.5	1	2101004	2101000	750	2101030	900	2101901	1000
	0.0012			2121004	2121000		2121030		2121901	
	0.0015			2151004	2151000		2151030		2151901	
	0.0018			2181004	2181000		2181030		2181901	
	0.0022			2221004	2221000		2221030		2221901	
	0.0027			2271004	2271000		2271030		2271901	
	0.0033			2331004	2331000		2331030		2331901	
	0.0039			2391004	2391000		2391030		2391901	
	0.0047			2471004	2471000		2471030		2471901	
	0.0056			2561004	2561000		2561030		2561901	
	0.0068			2681004	2681000		2681030		2681901	
	0.0082			2821004	2821000	500	2821030	750	2821901	1000
	0.010			3101004	3101000		3101030		3101901	
	0.012			3121004	3121000	450	3121030	500	3121901	800
	0.015	6.0 x 12.0 x 17.5	1.4	3151004	3151000		3151030		3151901	
	0.018			3181004	3181000	300	3181030	500	3181901	700
	PITCH = 15 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.022	7.0 x 13.5 x 17.5	1.8	3221004	3221000	300	3221030	500	3221901	700
	PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.027	6.0 x 15.5 x 26.0	2.4	3271004	3271000	260	3271030	750	3271901	600
	0.033			3331004	3331000		3331030		3331901	
	0.039	7.0 x 16.5 x 26.0	2.9	3391004	3391000	235	3391030	750	3391901	500
	0.047			3471004	3471000	200	3471030	750	3471901	450
	0.056			3561004	3561000	170	3561030	500	3561901	400
	0.068	8.5 x 18.0 x 26.0	3.8	3681004	3681000		3681030		3681901	
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.082	9.0 x 19.0 x 31.0	5.5	3821004	3821000	125	3821030	400	3821901	250
	0.100			4101004	4101000		4101030		4101901	

Notes

- SPQ = Standard Packing Quantity

(1) Reel diameter = 365 mm is available on request

(2) H = In-tape height; P_0 = Sprocket hole distance; for detailed specifications refer to “Packaging Information”

(3) Weight for short lead product only

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APPROVALS				
SAFETY APPROVALS Y2	**VOLTAGE**	**VALUE**	**FILE NUMBERS**	**LINKS**
EN 60384-14 (ENEC) (= IEC 60384-14 ed-4 (2013))	300 V_{AC}	0.001 µF to 0.1 µF	ENEC16/FI/21/01048/A3	www.vishay.com/doc?28212
UL 60384-14 2nd edition	300 V_{AC}	0.001 µF to 0.1 µF	E354331	www.vishay.com/doc?28189
CSA E60384-1:14 3rd edition	300 V_{AC}	0.001 µF to 0.1 µF	E354331	
CB-test certificate	300 V_{AC}	0.001 µF to 0.1 µF	FI-39810/A1	www.vishay.com/doc?28213
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; Sweden, 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:

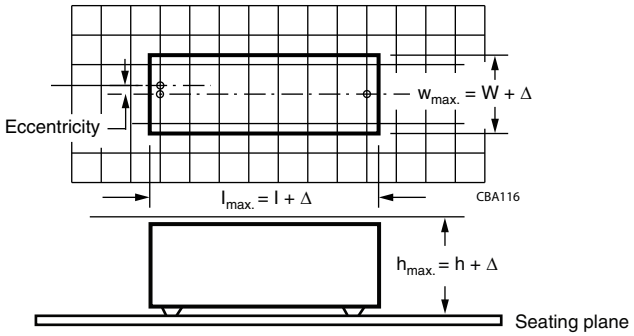
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

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
- For products with 15 mm < pitch, ≤ 27.5 mm, $\Delta w = \Delta l = 0.5$ 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 CONDITIONS

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

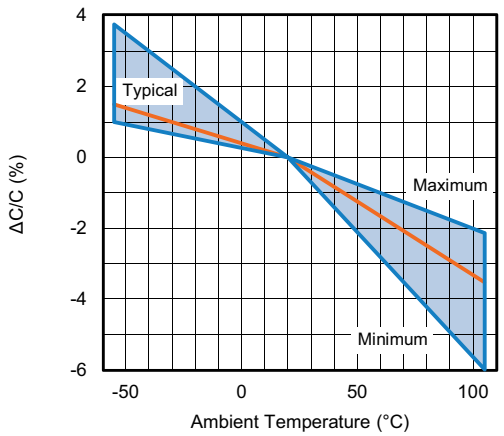
Unless otherwise specified, all electrical values apply to an ambient temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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 %.

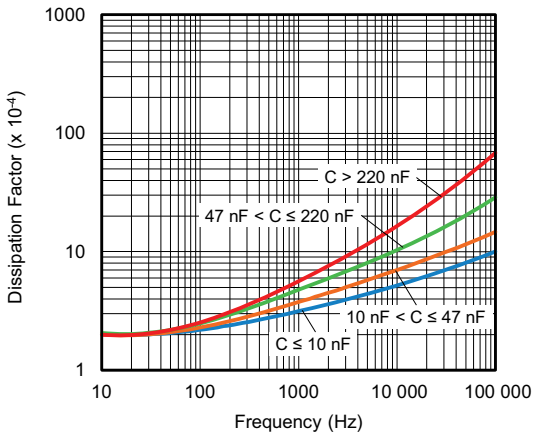
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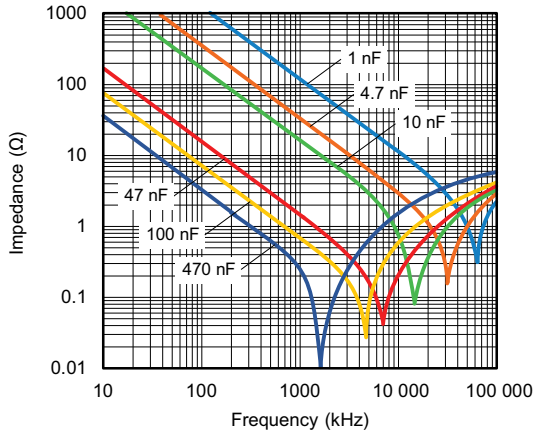
CHARACTERISTICS



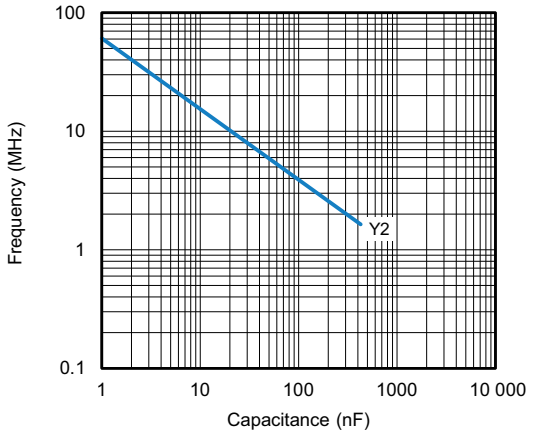
Capacitance as a function of ambient temperature (typical curve)



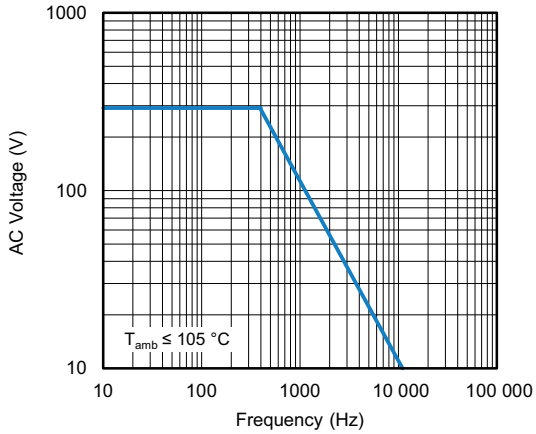
Tangent of loss angle as a function of frequency (typical curve)



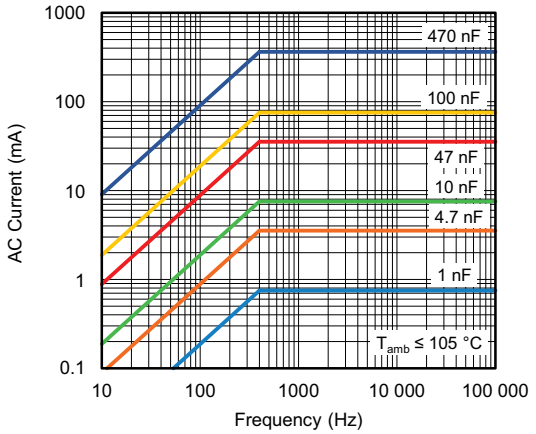
Impedance as a function of frequency (typical curve)



Resonant frequency as a function of capacitance (typical curve)



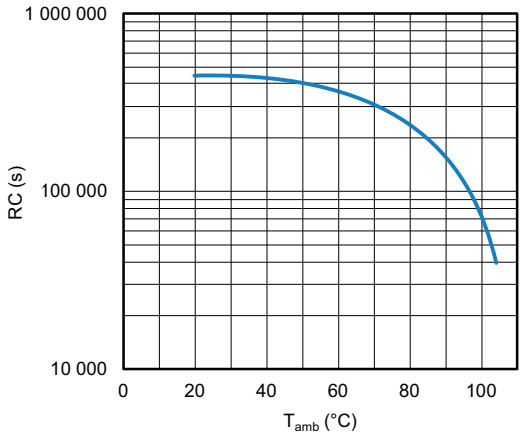
Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency

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Insulation resistance as a function of ambient temperature

APPLICATION NOTES

- For X2 electromagnetic interference suppression in **standard across the line application** (50 Hz / 60 Hz) with a maximum mains voltage of 310 V_{AC}
- For series impedance applications we refer to the “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 program must be used
- The maximum ambient temperature must not exceed 110 °C (125 °C for less than 1000 h) for C ≤ 470 nF and 110 °C for C > 470 nF
- 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 435 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-4 (2013) 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	

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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 4.7 Vibration	Visual examination 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	No visible damage
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

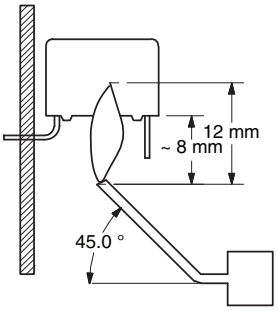
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GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B		
4.11 Climatic sequence		
4.11.1 Initial measurements	Capacitance Measured 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 2250 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 capacitance	
4.12.1 Initial measurements	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 $\delta \leq 0.007$ Compared to values measured in 4.12.1.
	Voltage proof 2250 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

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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: 5 kV Max. 24 pulses	No selfhealing breakdowns or flash-over
4.14 Endurance	Duration: 1000 h 1.7 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 2250 V_{DC}; 1 min between terminations 2100 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 420 V_{DC} Discharge resistance: $R = \frac{420\ V_{DC}}{1.5 \times C\ (dU/dt)}$	
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 the value as specified in section “Resonant Frequency” of this specification

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GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C6		
4.17 Passive flammability Class B/C	Bore of gas jet: Ø 0.5 mm Fuel: Butane Test duration for actual volume V in mm^3: $V \leq 250$: 5 s $250 < V \leq 500$: 10 s $500 < V \leq 1750$: 20 s $V > 1750$: 60 s One flame application 	After removing test flame from capacitor, the capacitor must not continue to burn for more than 30 s for $V \leq 1750$ mm^3 and 10 s for $V > 1750$ mm^3. No burning particle must drop from the sample.
SUB-GROUP C7		
4.18 Active flammability	20 cycles of 5 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.
SUB-GROUP ADD6 (FOR PITCH ≥ 15 mm)		
A.6 Damp heat steady state with load	RH: 85 %, temp.: 85 °C Load: 300 V_{AC}, duration: 500 h	
A.6.1 Initial measurements	Capacitance	
	Tangent of loss angle: at 10 kHz	
A.6.2 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % of the value measured in A.6.1
	Tangent of loss angle	Increase of tan $\delta \leq 0.024$ Compared to values measured in A.6.1 No permanent breakdown or flash-over
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP ADD7		
A.7 Damp heat steady state with voltage	RH: 40 %, temp.: 93 °C Voltage: 300 V_{AC}, duration: 21 days	
A.7.1 Initial measurements	Capacitance	
	Tangent of loss angle: at 10 kHz	
A.7.2 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % of the value with initial measurement
	Tangent of loss angle	Increase of tan $\delta \leq 0.024$ Compared to values with initial measurement
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

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TEST CONDITIONS AND REQUIREMENTS ACCORDING AEC-Q200 REVISION C				
NO.	**TEST NAME**	**REFERENCE**	**TEST CONDITIONS**	**PERFORMANCE REQUIREMENTS**
1	Pre- and post-stress electrical test	User spec.	-	-
2	High temperature exposure (storage)	MIL-STD 202 method 108	1000 h; 105 °C; unpowered	$\|\Delta C/C\| \leq \pm 5$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR ≥ 50 % of initial requirement
3	Temperature cycling	JESD22 method JA-104	1000 cycles: -55 °C to +105 °C 10 min. dwell time each	$\|\Delta C/C\| \leq \pm 5$ % Increase of tan δ = 0.008 at 10 kHz IR ≥ 50 % of initial requirement
4	Moisture resistance	MIL-STD 202 method 106	10 cycles at 24 h/cycle unpowered	$\|\Delta C/C\| \leq \pm 5$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR ≥ 50 % of initial requirement
5	Biased humidity	MIL-STD 202 method 103	1000 h; 40 °C; 93 % RH with U_{RAC}	$\|\Delta C/C\| \leq \pm 10$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR ≥ 50 % of initial requirement
6	Operational life	MIL-STD 202 method 108	T_{amb} = 105 °C; 1000 h; U_{test} = 1 x U_{RAC}	$\|\Delta C/C\| \leq \pm 10$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR ≥ 50 % of initial requirement
7	Terminal strength (leaded)	MIL-STD 202 method 211	Leaded device lead integrity only.	$\|\Delta C/C\| \leq \pm 5$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR = initial requirement
8	Resistance to solvents	MIL-STD 202 method 215	Short term	No visual damage Legible marking
9	Mechanical shock	MIL-STD 202 method 213	Figure a of method 213, condition C	No visual damage
10	Vibration	MIL-STD 202 method 204	5 *g*'s for 20 min; 12 cycles, 3 orientations	No visual damage
11	Resistance to soldering heat	MIL-STD 202 method 210	260 °C; 10 s	$\|\Delta C/C\| \leq \pm 5$ % Increase of tan δ 0.008 for C ≤ 1 µF at 10 kHz IR = initial requirement
12	Solderability	J-STD-002	235 °C / 5 s	Good tinning as evidence by free flowing of the solder with wetting of terminations > 95 %
13	Electrical characterization	User spec.	-	User spec.
14	Flammability	UL 94	Electrical test not required	Maximum permitted burning time < 10 s

For technical questions, contact: rfi@vishay.com
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