THB Interference Suppression Film Capacitors - Class X2 Radial MKP 305 V_{AC} - Across the Line

FEATURES

- AEC-Q200 qualified (rev. D)
- IEC 60384-14: 2013 / AMD1: 2016 grade IIB: 85 °C, 85 % RH, 500 h at U_{RAC}
- Compliant with 85 °C, 85 % RH, 1000 h at 240 V_{AC}
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

APPLICATIONS

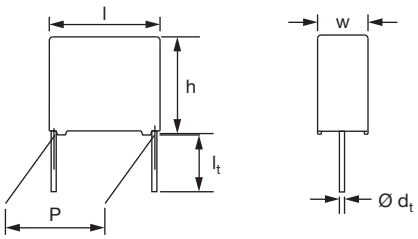
For standard across the line X2 applications.
See also application note: www.vishay.com/doc?28153

QUICK REFERENCE DATA	
Rated capacitance range	E12 series 0.1 µF to 4.7 µF (preferred values according to E12)
Capacitance tolerance	± 20 %; ± 10 %
Rated voltage range, U_{RAC}	305 V_{AC}; 50 Hz to 60 Hz
Permissible DC voltage	630 V_{DC} at 105 °C
Climatic testing class	40 / 105 / 56 / B
Rated temperature	105 °C
Reference standards	IEC 60384-14:2013 IEC 60384-14:2013 / AMD1:2016 EN 60384-14 IEC 60065 requires passive flammability class B UL 60384-14 (2nd edition) CSA-E60384-1:14 (3rd edition) CQC
Dielectric	Polypropylene film
Electrodes	Metallized
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, manufacturer logo; year and week; safety approvals

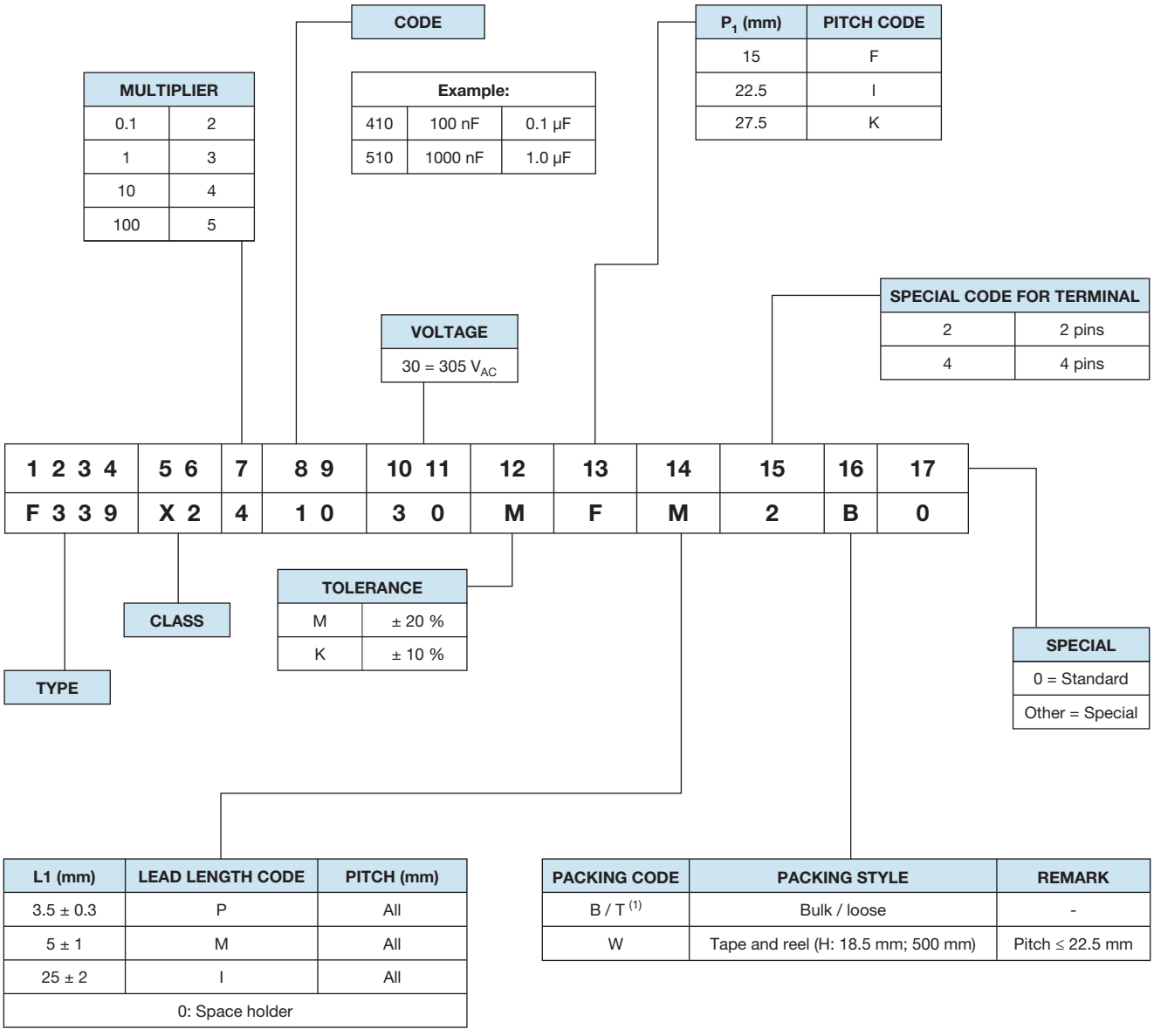
Note

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

DIMENSIONS in millimeters



COMPOSITION OF CATALOG NUMBER



Notes

- For detailed tape specifications refer to packaging information www.vishay.com/doc?28139
- Taped on reel pitch 27.5 mm is not available

(1) Packaging will be bulk for all capacitors with pitch 15 mm. Capacitors with short leads up to 5 mm and pitch > 15 mm will be in tray and asking code will be “T”

SPECIFIC REFERENCE DATA

DESCRIPTION	VALUE	
Rated voltage range, U_{RAC}	305 V_{AC}	
Rated voltage range, U_{RDC}	630 V_{DC}	
Tangent of loss angle:	At 1 kHz	At 10 kHz
C < 470 nF	≤ 20 x 10^{-4}	≤ 30 x 10^{-4}
470 nF ≤ C ≤ 1 µF	≤ 30 x 10^{-4}	≤ 80 x 10^{-4}
C > 1 µF	≤ 40 x 10^{-4}	-
Rated voltage pulse slope $(dU/dt)_R$ at 430 V_{DC}		
Pitch = 15 mm	400 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:		
C ≤ 1 µF	2200 V; 1 min	
C > 1 µF	1800 V; 1 min	
Withstanding (AC) voltage between leads and case	2110 V; 1 min	

Note

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

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RAC} (V)	CAP. (µF)	DIMENSIONS (3) w x h x l (mm)	MASS (g) (2)	CATALOG NUMBER F339X2... AND PACKAGING						
				LOOSE IN BOX					TAPED REEL (500 mm) (1)	
				SHORT LEADS			LONG LEADS			
				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
305	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.10	7.0 x 13.5 x 17.5	1.8	41030MFP2B0	41030MFM2B0	750	41030MFI2B0	500	41030MF02W0	800
	0.15	8.5 x 15.0 x 17.5	2.4	41530MFP2B0	41530MFM2B0	750	41530MFI2B0	500	41530MF02W0	650
	0.22	10.0 x 16.5 x 17.5	3.0	42230MFP2B0	42230MFM2B0	500	42230MFI2B0	450	42230MF02W0	600
	0.33	10.5 x 17.5 x 18.0	4.0	43330MFP2B0	43330MFM2B0	225	43330MFI2B0	400	43330MF02W0	
	0.47	13.5 x 22.5 x 18.0	6.5	44730MFP2B0	44730MFM2B0	185	44730MFI2B0	400	44730MF02W0	425
	PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.22	7.0 x 16.5 x 26.0	2.9	42230MIP2T0	42230MIM2T0	200	42230MII2B0	250	42230MI02W0	500
	0.33	8.5 x 18.0 x 26.0	3.8	43330MIP2T0	43330MIM2T0	200	43330MII2B0	250	43330MI02W0	450
	0.47	10.0 x 19.5 x 26.0	6.8	44730MIP2T0	44730MIM2T0	200	44730MII2B0	200	44730MI02W0	350
	0.68	12.0 x 22.0 x 26.0	7.8	46830MIP2T0	46830MIM2T0	150	46830MII2B0	200	46830MI02W0	300
	1.0	12.5 x 22.5 x 26.5	10.0	51030MIP2T0	51030MIM2T0	140	51030MII2B0	400	51030MI02W0	300
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %									
	0.47	11.0 x 21.0 x 31.0	7.4	44730MKP2T0	44730MKM2T0	100	44730MKI2B0	125	-	-
	0.68			46830MKP2T0	46830MKM2T0		46830MKI2B0			
	1.0	13.0 x 23.0 x 31.0	9.2	51030MKP2T0	51030MKM2T0	100	51030MKI2B0	125	-	-
	1.5	15.0 x 25.0 x 31.5	12.3	51530MKP2T0	51530MKM2T0	100	51530MKI2B0	125	-	-
	2.2	18.0 x 28.0 x 31.0	16.1	52230MKP2T0	52230MKM2T0	100	52230MKI2B0	100	-	-
	3.3	21.0 x 31.0 x 31.0	20.3	53330MKP2T0	53330MKM2T0	50	53330MKI2B0	75	-	-
	4.7	22.0 x 38.0 x 32.0	29.3	54730MKP2T0	54730MKM2T0	60	54730MKI2B0	60	-	-

Notes

- SPQ = Standard Packing Quantity

(1) H = in-tape height; P_0 = sprocket hole distance; for detailed specifications refer to “Packaging Information”

(2) Weight for short lead product only

(3) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RAC} (V)	CAP. (µF)	DIMENSIONS [3] w x h x l (mm)	MASS (g) [2]	CATALOG NUMBER F339X2... AND PACKAGING						
				LOOSE IN BOX					TAPED REEL (500 mm) [1]	
				SHORT LEADS			LONG LEADS			
				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
305	PITCH = 15.0 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %									
	0.1	7.0 x 13.5 x 17.5	1.8	41030KFP2B0	41030KFM2B0	750	41030KFI2B0	500	41030KF02W0	800
	0.12	8.5 x 15.0 x 17.5	2.4	41230KFP2B0	41230KFM2B0	750	41230KFI2B0	500	41230KF02W0	650
	0.15			41530KFP2B0	41530KFM2B0		41530KFI2B0		41530KF02W0	
	0.18			41830KFP2B0	41830KFM2B0		41830KFI2B0		41830KF02W0	
	0.22	10.0 x 16.5 x 17.5	3.0	42230KFP2B0	42230KFM2B0	500	42230KFI2B0	450	42230KF02W0	600
	0.27			42730KFP2B0	42730KFM2B0		42730KFI2B0		42730KF02W0	
	0.33	10.5 x 17.5 x 18.0	3.9	43330KFP2B0	43330KFM2B0	225	43330KFI2B0	400	43330KF02W0	
	0.39	11.0 x 18.5 x 18	4.1	43930KFP2B0	43930KFM2B0	225	43930KFI2B0	350	43930KF02W0	550
	0.47	13.5 x 22.5 x 18.0	6.3	44730KFP2B0	44730KFM2B0	185	44730KFI2B0	400	44730KF02W0	425
	PITCH = 22.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %									
	0.22	7.0 x 16.5 x 26.0	2.9	42230KIP2T0	42230KIM2T0	200	42230KII2B0	250	42230KI02W0	500
	0.27	8.5 x 18.0 x 26.0	3.8	42730KIP2T0	42730KIM2T0	200	42730KII2B0	250	42730KI02W0	450
	0.33			43330KIP2T0	43330KIM2T0		43330KII2B0		43330KI02W0	
	0.39			43930KIP2T0	43930KIM2T0		43930KII2B0		43930KI02W0	
	0.47	10.0 x 19.5 x 26.0	6.8	44730KIP2T0	44730KIM2T0	200	44730KII2B0	200	44730KI02W0	350
	0.56			45630KIP2T0	45630KIM2T0		45630KII2B0		45630KI02W0	
	0.68	12.0 x 22.0 x 26.0	7.8	46830KIP2T0	46830KIM2T0	150	46830KII2B0	200	46830KI02W0	300
	0.82			48230KIP2T0	48230KIM2T0		48230KII2B0		48230KI02W0	
	1.0	12.5 x 22.5 x 26.5	10.0	51030KIP2T0	51030KIM2T0	140	51030KII2B0	400	51030KI02W0	300
	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %									
	0.47	11.0 x 21.0 x 31.0	7.4	44730KKP2T0	44730KKM2T0	100	44730KKI2B0	125	-	-
	0.56			45630KKP2T0	45630KKM2T0		45630KKI2B0			
	0.68			46830KKP2T0	46830KKM2T0		46830KKI2B0			
	0.82	13.0 x 23.0 x 31.0	9.2	48230KKP2T0	48230KKM2T0	100	48230KKI2B0	125		
	1.0			51030KKP2T0	51030KKM2T0		51030KKI2B0		-	-
	1.2	15.0 x 25.0 x 31.5	12.3	51230KKP2T0	51230KKM2T0	100	51230KKI2B0	125	-	-
	1.5			51530KKP2T0	51530KKM2T0		51530KKI2B0		-	-
	1.8	18.0 x 28.0 x 31.0	16.1	51830KKP2T0	51830KKM2T0	100	51830KKI2B0	100		
	2.2			52230KKP2T0	52230KKM2T0		52230KKI2B0		-	-
	2.7	21.0 x 31.0 x 31.0	20.3	52730KKP2T0	52730KKM2T0	50	52730KKI2B0	75	-	-
	3.3			53330KKP2T0	53330KKM2T0		53330KKI2B0		-	-
	3.9	22.0 x 38.0 x 32.0	29.2	53930KKP2T0	53930KKM2T0	60	53930KKI2B0	60	-	-
	4.7			54730KKP2T0	54730KKM2T0		54730KKI2B0		-	

Notes

- SPQ = Standard Packing Quantity

(1) H = in-tape height; P_0 = sprocket hole distance; for detailed specifications refer to “Packaging Information”

(2) Weight for short lead product only

(3) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

APPROVALS				
SAFETY APPROVALS X2	**VOLTAGE**	**VALUE**	**FILE NUMBERS**	**LINK**
EN 60384-14 (ENEC) (= IEC 60384-14 ed-4 (2013))	305 V_{AC}	100 nF to 4.7 µF	ENEC/FI 2017049	www.vishay.com/doc?28243
UL 60384-14 (2nd edition)	305 V_{AC}	100 nF to 4.7 µF	E354331	www.vishay.com/doc?28242
CSA-E60384-1:14 (3rd edition)	305 V_{AC}	100 nF to 4.7 µF	E354331	www.vishay.com/doc?28242
CQC	305 V_{AC}	100 nF to 4.7 µF	Pending	-
CB-test certificate	305 V_{AC}	100 nF to 4.7 µF	CB FI-34417	www.vishay.com/doc?28241
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 capacitor unit is designed for mounting on a printed circuit board. The capacitors packed in bandoliers 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/docs?28139

Specific Method of Mounting to Withstand Vibration and Shock

The capacitors are designed for mounting on printed-circuit boards. 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. The capacitor shall be mechanically fixed by the leads and the body clamped.

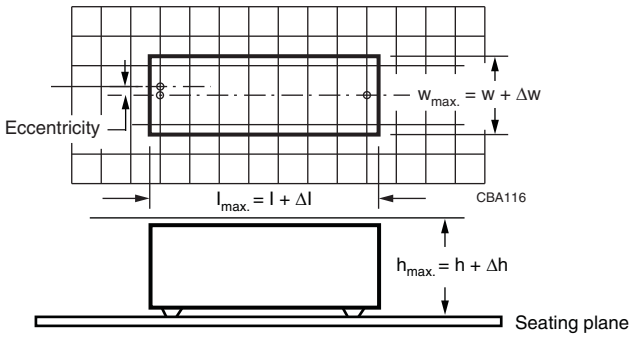
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances

For the maximum product dimensions and maximum space requirements for length ($l_{max.}$), width ($w_{max.}$), and height ($h_{max.}$) following tolerances must be taken in account in the envelopment of the components as shown in the drawings below.

- For products with pitch ≤ 15 mm, $\Delta w = \Delta l = 0.3$ mm, and $\Delta h = 0.1$ mm
- For products with 15 mm < pitch < 27.5 mm, $\Delta w = \Delta l = 0.5$ mm, and $\Delta h = 0.1$ mm
- For products with pitch = 27.5 mm, $\Delta w = \Delta l = \Delta h = 0.7$ mm

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



For the minimum product dimensions for length ($l_{min.}$), width ($w_{min.}$), and height ($h_{min.}$) following tolerances of the components are valid:

$l_{min.} = l - \Delta l$, $w_{min.} = w - \Delta w$, and $h_{min.} = h - \Delta h$ following

- For products with pitch = 15 mm, $\Delta l = 0.5$ mm, and $\Delta w = \Delta h = 0.5$ mm
- For products with 15 mm < pitch < 27.5 mm, $\Delta l = 1.0$ mm, and $\Delta w = \Delta h = 0.5$ mm
- For products with pitch = 27.5 mm, $\Delta w = \Delta l = \Delta h = 1.0$ mm

SOLDERING CONDITIONS

For general soldering conditions and wave soldering profile we refer to the document “Soldering Guidelines for Film Capacitors”: www.vishay.com/doc?28171

STORAGE TEMPERATURE

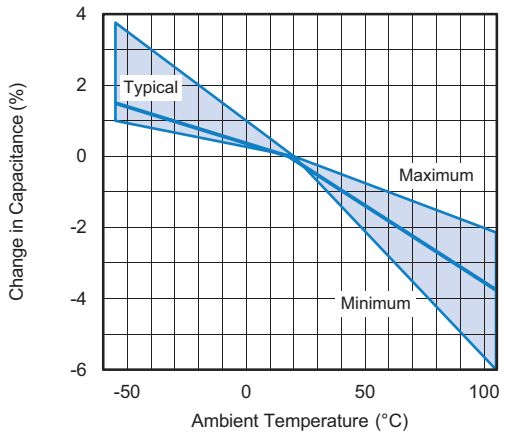
T_{stg} = -25 °C to +35 °C with RH maximum 75 % without condensation

RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

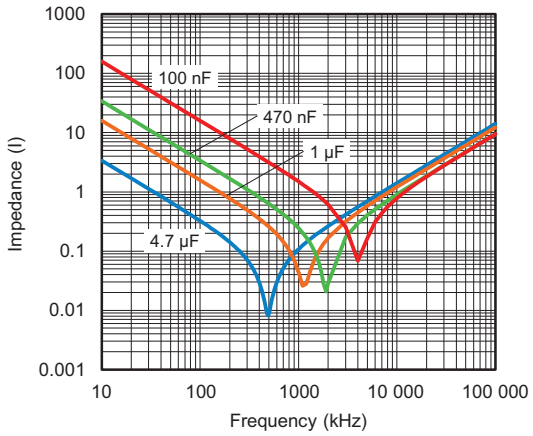
Unless otherwise specified. all electrical values apply to an ambient temperature of 23 °C ± 1°C. an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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

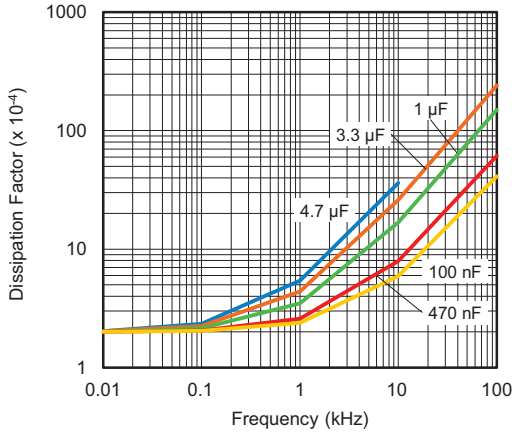
CHARACTERISTICS



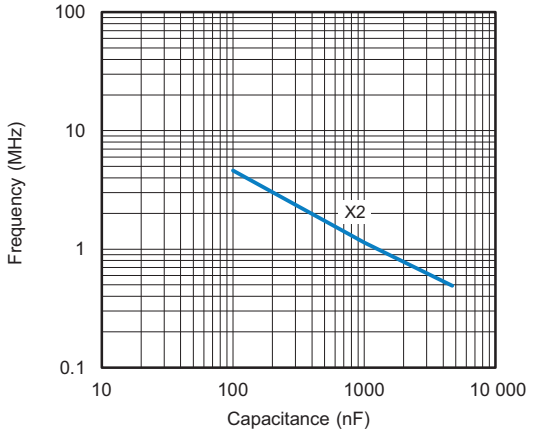
Capacitance as a function of ambient temperature (typical curve)



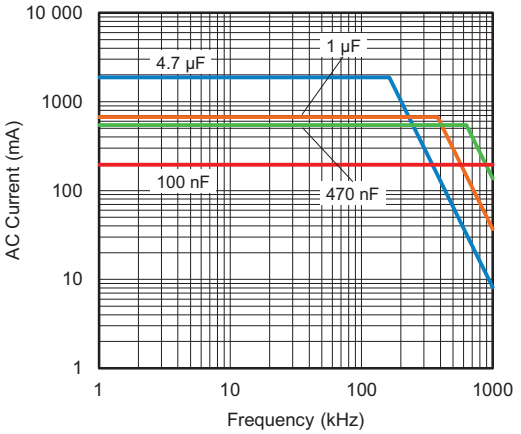
Impedance as a function of frequency (typical curve)



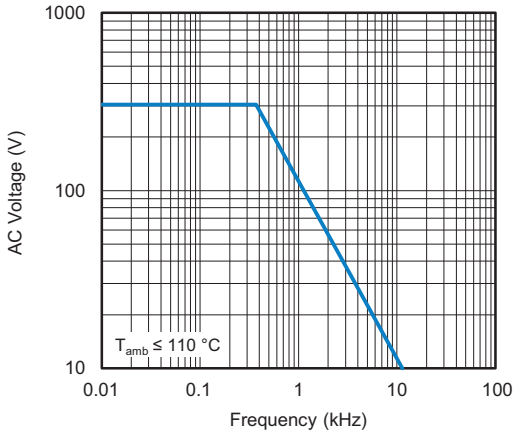
Tangent of loss angle as a function of frequency (typical curve)



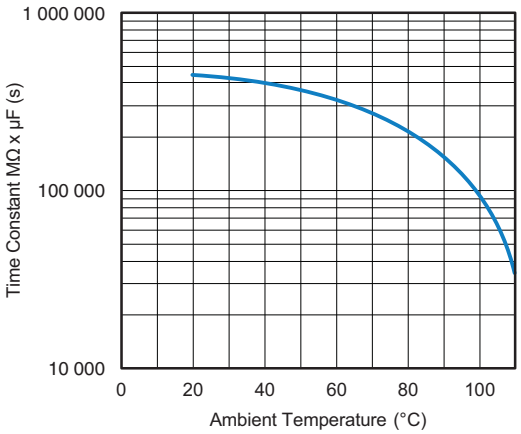
Resonant frequency as a function of capacitance (typical curve)



Max. RMS current as a function of frequency



Max. RMS voltage as a function of frequency



Insulation resistance as a function of ambient temperature
(typical curve)

APPLICATION NOTES

- For X2 electromagnetic interference suppression in standard across the line applications (50 Hz / 60 Hz) with a maximum of 305 V_{AC} rated voltage including fluctuation of the mains. It is recommended to use these components in a mains with maximum nominal voltage of 240 V_{AC}. Higher continuous applied voltages will shorten the life time
- For series impedance applications we refer to application note www.vishay.com/doc?28153
- To ensure withstanding high humidity requirements in the application the epoxy adhesion at the leads shall not be damaged. Therefore the leads may not be damaged or not be bent before soldering
- 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 application. 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 430 V_{DC} and divided by the applied voltage

INSPECTION REQUIREMENTS

General Notes

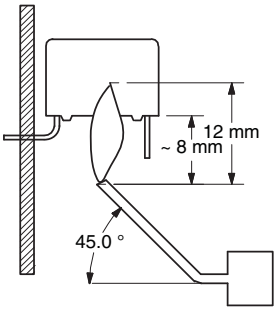
Sub-clause numbers of tests and performance requirements refer to the "Sectional Specification, Publication IEC 60384-14 ed-4 (2013) and Specific Reference Data".

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: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 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	
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	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF or ≤ 0.005 for: C > 1 µF Compared to values measured initially
	Insulation resistance	As specified in section "Insulation Resistance" of this specification
SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1		
Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz	
4.20 Solvent resistance of the marking	Isopropyl alcohol 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 = -40 °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	

INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1		
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	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: $C \leq 1$ µF or ≤ 0.005 for: $C > 1$ µF Compared to values measured initially
	Insulation resistance	As specified in section “Insulation Resistance” of this specification
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	
4.11.3 Damp heat cyclic Test Db First cycle	Duration: 16 h	
4.11.4 Cold	Temperature: -40 °C	
4.11.5 Damp heat cyclic Test Db remaining cycles	Duration: 2 h	
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 δ: ≤ 0.008 for: $C \leq 1$ µF or ≤ 0.005 for: $C > 1$ µF Compared to values measured in 4.11.1
	Voltage proof 1350 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

INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
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: for C ≤ 1 µF at 10 kHz for C > 1 µF 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 δ: ≤ 0.008 for: C ≤ 1 µF or ≤ 0.005 for: C > 1 µF Compared to values measured in 4.12.1.
	Voltage proof 1350 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 C2A		
4.12A Damp heat steady state with load	85 °C, 85 % RH, load: 305 V_{AC} Duration: 500 h	
4.12.1A Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz	
4.12.3A Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % of the value measured in 4.12.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.0240 for: C ≤ 1 µF or ≤ 0.0150 for: C > 1 µF Compared to values measured in 4.12.1.
	Voltage proof 1350 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

INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C3		
4.13.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz	
4.13 Impulse voltage	3 successive impulses, full wave, peak voltage: X2: 2.5 kV for C ≤ 1 µF X2: 2.5 kV√C for C > 1 µF 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	|ΔC/C| ≤ 10 % compared to values measured in 4.13.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF or ≤ 0.005 for: C > 1 µF Compared to values measured in 4.13.1
	Voltage proof 1350 V_{DC}; 1 min between terminations 2120 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 430 V_{DC} Discharge resistance: $R = \frac{430\ V_{DC}}{1.25 \times C\ (du/dt)}$	
4.15.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz	
4.15.3 Final measurements	Capacitance	|ΔC/C| ≤ 10 % compared to values measured in 4.15.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF or ≤ 0.005 for: C > 1 µF Compared to values measured in 4.15.1
	Insulation resistance	≥ 50 % of values specified in section "Insulation Resistance" of this specification

INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C5		
4.16 Radio frequency characteristic	Resonance frequency	≥ 0.9 times the value as specified in section "Resonant Frequency" of this specification
SUB-GROUP C6		
4.17 Passive flammability Class B	Bore of gas jet: Ø 0.5 mm Fuel: butane / propane Test duration for actual volume V in mm^3: Class B 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 for V > 1750 mm^3. No burning particle must drop from the sample.
SUB-GROUP C7		
4.18 Active flammability	20 cycles of 2.5 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.

AUTOMOTIVE AEC-Q200, REVISION D QUALIFICIATION				
STRESS	**REVISION**	**CONDITION**	**SAMPLE SIZE**	**PERFORMANCE REQUIREMENTS**
1. High temperature exposure (storage)	D	Temp.: 105 °C; unpowered 250 h / 500 h / 1000 h	77	|ΔC/C| ≤ 5 % Increase of tan δ: ≤ 0.008 for C ≤ 1 µF at 10 kHz Increase of tan δ: ≤ 0.005 for C > 1 µF at 1 kHz IR > 50 % of initial specified value
2. Temperature cycling	D	Total no. of cycles: 1000 cycles Lower temp.: -40 °C Upper temp: +105 °C 30 min dwell time at each temperature Transition time < 1 min	77	|ΔC/C| ≤ 5 % Increase of tan δ: ≤ 0.008 for C ≤ 1 µF at 10 kHz IR > 50 % of initial specified value
3. Moisture resistance		No. of cycle: 10 cycles t = 24 h/cycle	77	|ΔC/C| ≤ 5 % Increase of tan δ: ≤ 0.008 for C ≤ 1 µF at 10 kHz IR > 50% of initial specified value
4. Biased humidity AC	D	Temp.: 40 °C; RH: 93 %; U_{RAC} 250 h / 500 h / 1000 h	77	|ΔC/C| ≤ 10 % Increase of tan δ: ≤ 0.008 for C ≤ 1 µF at 10 kHz IR > 50 % of initial specified value
5. Operational life AC	D	Temp. = 105 °C; U_{RAC} 1000 h	77	|ΔC/C| ≤ 10 % Increase of tan δ: ≤ 0.008 for C ≤ 1 µF at 10 kHz IR > 50 % of initial specified value
6. Terminal strength (leaded)	D	Test leaded device lead integrity only. - A (pull-test): 2.27 kg (10 s) - C (wire-lead bend test): 227 g (3 x 3 s)	30	No visual damage

AUTOMOTIVE AEC-Q200, REVISION D QUALIFICIATION				
STRESS	**REVISION**	**CONDITION**	**SAMPLE SIZE**	**PERFORMANCE REQUIREMENTS**
7. Resistance to solvents	D	MIL-STD-202 method 215. - Also aqueous chemical - OKEM clean or equivalent. Do not use banned solvents.	5	No visual damage Legible marking
8. Mechanical shock	D	100 g's ; 6 ms half-sine; 3.75 m/s	30	No visual damage
9. Vibration	D	5 g's for 20 min 12 cycles x 3 directions 10 Hz to 2000 Hz	30	No visual damage
10. Resistance to soldering heat	D	Temp.: 280 °C; time: 10 s solder within 1.5 mm of device body	30	$\|\Delta C/C\| \leq 5$ % Increase of tan δ: ≤ 0.008 for C $\leq$ 1 µF at 10 kHz IR > 50 % of initial specified value
11. Solderability	D	Leaded: method A at 235 °C, category 3 (245 °C / 3 s)	15	Good tinning as evidence by free flowing of the solder with wetting of terminations > 95 %
12. Electrical characterization		-	30	-
13. Flammability		One flame application Class B	15	V-0 or V-1 are acceptable. Class B or C according IEC is also acceptable