

### METALLIZED POLYESTER FILM CAPACITOR MULTIPURPOSE APPLICATIONS

**Typical application:** blocking, coupling, decoupling, by-passing, interference suppression in low voltage applications (i.e.:AUTOMOTIVE)

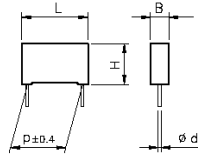
**PRODUCT CODE: R60**

**NOTE:** Special version, in compliance with DIN 44122 is available upon request.

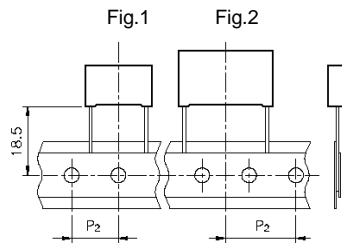
#### Construction:

- **STACKED technology for pitch 10 mm**  
( Rated Voltage from 63 to 630Vdc)
- **WOUND technology from pitch 10 to 27.5mm**  
(Rated Voltage from 63 to 1000Vdc)

Loose



Taped



∅ d ± 0.05	p = 10	p > 10
	0.6	0.8

All dimensions are in mm.

#### PRODUCT CODE SYSTEM

The part number, comprising 14 digits, is formed as follows:

1	2	3	4	5	6	7	8	9	10	11	12	13	14
R	6	0										-	

Digit 1 to 3 Series code.

Digit 4 d.c. rated voltage:

D = 63V E = 100V G = 160V I = 250V  
M = 400V P = 630V Q = 1000V

Digit 5 Pitch:

F = 10mm; I = 15mm; N = 22.5mm; R = 27.5mm  
W = 37.5mm

Digit 6 to 9 Digits 7 - 8 - 9 indicate the first three digits of Capacitance value and the 6th digit indicates the number of zeros that must be added to obtain the Rated Capacitance in pF.

Digit 10 to 11 Mechanical version and/or packaging (table 1)

Digit 12 Identifies the dimensions and electrical characteristics.

Digit 13 Internal use

Digit 14 Capacitance tolerance:  
J=5%; K=10%; M=20%

#### GENERAL TECHNICAL DATA

**Dielectric:** polyester film (polyethylene terephthalate).

**Plates:** aluminium layer deposited by evaporation under vacuum.

**Winding:** non-inductive type.

**Leads:** tinned wire.

**Protection:** plastic case, thermosetting resin filled.  
Box material is solvent resistant and flame retardant according to UL94 V0.

**Marking:** Manufacturer's logo, capacitance, tolerance, D.C. rated voltage.

**Climatic category:** 55/100/56 IEC 60068-1

**Operating temperature range:** -55 to +105°C

For stacked technology an upper operating temperature of +125°C is allowed for a max. operating time of 1000h.

**Related documents:** IEC 60384-2

#### Winding scheme

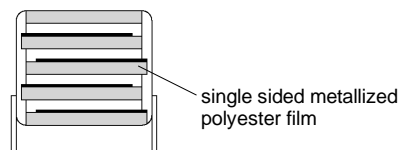


Table 1 (for more detailed information, please refer to page 16)

Standard packaging style	Lead length (mm)	Taping style			Ordering code (Digit 10 to 11)
		P <sub>2</sub> (mm)	Fig. (No.)	Pitch (mm)	
AMMO-PACK		12.70	1	10.0/15.0	DQ
AMMO-PACK		19.05	2	22.5	DQ
REEL ∅ 355mm		12.70	1	10.0/15.0	GY
REEL ∅ 500mm		12.70	1	10.0/15.0	CK
REEL ∅ 500mm		19.05	2	22.5/27.5	CK
Loose, short leads	4 +2				AA
Loose, long leads (p=10mm)	17 +1/-2				Z3
Loose, long leads (p ≥ 15mm)	30 +5 25 +2/-1				40 50

Note: Ammo-pack is the preferred packaging for taped version.

NEW

STACKED VERSION

Rated Cap.	63Vdc/40Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
1.0μF	4.0	9.0	13.0	10.0	50	6.3 E3	R60DF 4100--6--
1.5μF	5.0	11.0	13.0	10.0	50	6.3 E3	R60DF 4150--6--
2.2μF	5.0	11.0	13.0	10.0	50	6.3 E3	R60DF 4220--6--
3.3μF	6.0	12.0	13.0	10.0	50	6.3 E3	R60DF 4330--6--

Rated Cap.	250Vdc/160Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
0.10μF	4.0	9.0	13.0	10.0	150	75 E3	R60IF 3100--6--
0.15μF	4.0	9.0	13.0	10.0	150	75 E3	R60IF 3150--6--
0.22μF	5.0	11.0	13.0	10.0	150	75 E3	R60IF 3220--6--
0.33μF	5.0	11.0	13.0	10.0	150	75 E3	R60IF 3330--6--
0.47μF	6.0	12.0	13.0	10.0	150	75 E3	R60IF 3470--6--

Rated Cap.	100Vdc/63Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
0.33μF	4.0	9.0	13.0	10.0	75	15 E3	R60EF 3330--6--
0.47μF	4.0	9.0	13.0	10.0	75	15 E3	R60EF 3470--6--
0.68μF	4.0	9.0	13.0	10.0	75	15 E3	R60EF 3680--6--
1μF	5.0	11.0	13.0	10.0	75	15 E3	R60EF 4100--6--
1.5μF	5.0	11.0	13.0	10.0	75	15 E3	R60EF 4150--6--

Rated Cap.	400Vdc/200Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
0.033μF	4.0	9.0	13.0	10.0	175	140 E3	R60MF 2330--6--
0.047μF	4.0	9.0	13.0	10.0	175	140 E3	R60MF 2470--6--
0.068μF	4.0	9.0	13.0	10.0	175	140 E3	R60MF 2680--6--
0.10μF	5.0	11.0	13.0	10.0	175	140 E3	R60MF 3100--6--
0.15μF	6.0	12.0	13.0	10.0	175	140 E3	R60MF 3150--6--

Rated Cap.	160Vdc/90Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
0.22μF	4.0	9.0	13.0	10.0	100	32 E3	R60GF 3220--6--
0.33μF	4.0	9.0	13.0	10.0	100	32 E3	R60GF 3330--6--
0.47μF	5.0	11.0	13.0	10.0	100	32 E3	R60GF 3470--6--
0.68μF	6.0	12.0	13.0	10.0	100	32 E3	R60GF 3680--6--

Rated Cap.	630Vdc/220*Vac				Max dv/dt (V/μs)	Max K <sub>0</sub> (V <sup>2</sup> /μs)	Part Number
	B	H	L	p			
1000pF	4.0	9.0	13.0	10.0	200	250 E3	
1500pF	4.0	9.0	13.0	10.0	200	250 E3	
2200pF	4.0	9.0	13.0	10.0	200	250 E3	
3300pF	4.0	9.0	13.0	10.0	200	250 E3	
4700pF	4.0	9.0	13.0	10.0	200	250 E3	
6800pF	4.0	9.0	13.0	10.0	200	250 E3	
0.010μF	4.0	9.0	13.0	10.0	200	250 E3	R60PF 2100--6--
0.015μF	4.0	9.0	13.0	10.0	200	250 E3	R60PF 2150--6--
0.022μF	4.0	9.0	13.0	10.0	200	250 E3	R60PF 2220--6--
0.033μF	5.0	11.0	13.0	10.0	200	250 E3	R60PF 2330--6--
0.047μF	5.0	11.0	13.0	10.0	200	250 E3	R60PF 2470--6--

Mechanical version and packaging (Table 1) \_\_\_\_\_  
 Internal use \_\_\_\_\_  
 Tolerance: J (± 5%); K (± 10%); M (± 20%) \_\_\_\_\_

Mechanical version and packaging (Table 1) \_\_\_\_\_  
 Internal use \_\_\_\_\_  
 Tolerance: J (± 5%); K (± 10%); M (± 20%) \_\_\_\_\_

All dimensions are in mm.

Note: If the working voltage (V) is lower than the rated voltage (V<sub>R</sub>), the capacitor may work at higher dv/dt. In this case the maximum value allowed is obtained multiplying the above value (see table dv/dt) with the ratio V<sub>R</sub>/V.  
 The pulse characteristic K<sub>0</sub> depends on the voltage wave-form and in any case it cannot overcome the value given in the above table.

\*Not suitable for across-the-line applications. Please refer to Interference Suppression Capacitors (page 109).



**METALLIZED POLYESTER FILM CAPACITOR  
MULTIPURPOSE APPLICATIONS**  
PRODUCT CODE: R60

**WOUND VERSION**

Rated Cap.	400Vdc/200Vac				Max dv/dt (V/ $\mu$ s)	Max $K_0$ ( $V^2/\mu$ s)	Part Number
	B	H	L	p			
0.015 $\mu$ F	4.0	9.0	13.0	10.0	30.0	24.0 E3	R60MF2150--3--
0.022 $\mu$ F	4.0	9.0	13.0	10.0	30.0	24.0 E3	R60MF2220--3--
0.033 $\mu$ F	4.0	9.0	13.0	10.0	30.0	24.0 E3	R60MF2330--3--
0.047 $\mu$ F	4.0	9.0	13.0	10.0	30.0	24.0 E3	R60MF2470--3--
0.068 $\mu$ F	5.0	11.0	13.0	10.0	30.0	24.0 E3	R60MF2680--3--
0.10 $\mu$ F	6.0	12.0	13.0	10.0	30.0	24.0 E3	R60MF3100--3--
0.047 $\mu$ F	5.0	11.0	18.0	15.0	20.0	16.0 E3	R60MI 2470--3--
0.068 $\mu$ F	5.0	11.0	18.0	15.0	20.0	16.0 E3	R60MI 2680--3--
0.10 $\mu$ F	5.0	11.0	18.0	15.0	20.0	16.0 E3	R60MI 3100--3--
0.15 $\mu$ F	5.0	11.0	18.0	15.0	20.0	16.0 E3	R60MI 3150--3--
0.22 $\mu$ F	6.0	12.0	18.0	15.0	20.0	16.0 E3	R60MI 3220--3--
0.33 $\mu$ F	7.5	13.5	18.0	15.0	20.0	16.0 E3	R60MI 3330--3--
0.33 $\mu$ F	9.0	13.5	18.0	15.0	20.0	16.0 E3	R60MI 3330--L--
0.47 $\mu$ F	8.5	14.5	18.0	15.0	20.0	16.0 E3	R60MI 3470--3--
0.47 $\mu$ F	13.0	12.0	18.0	15.0	20.0	16.0 E3	R60MI 3470--L--
0.68 $\mu$ F	11.0	19.0	18.0	15.0	20.0	16.0 E3	R60MI 3680--3--
0.22 $\mu$ F	6.0	15.0	26.5	22.5	10.0	8.0 E3	R60MN3220--3--
0.33 $\mu$ F	6.0	15.0	26.5	22.5	10.0	8.0 E3	R60MN3330--3--
0.47 $\mu$ F	6.0	15.0	26.5	22.5	10.0	8.0 E3	R60MN3470--3--
0.68 $\mu$ F	7.0	16.0	26.5	22.5	10.0	8.0 E3	R60MN3680--3--
1.0 $\mu$ F	10.0	18.5	26.5	22.5	10.0	8.0 E3	R60MN4100--3--
1.5 $\mu$ F	11.0	20.0	26.5	22.5	10.0	8.0 E3	R60MN4150--3--
0.68 $\mu$ F	9.0	17.0	32.0	27.5	8.5	3.4 E3	R60MR3680--3--
1.0 $\mu$ F	9.0	17.0	32.0	27.5	8.5	3.4 E3	R60MR4100--3--
1.5 $\mu$ F	10.0	20.0	32.0	27.5	8.5	3.4 E3	R60MR4150--3--
2.2 $\mu$ F	13.0	22.0	32.0	27.5	8.5	3.4 E3	R60MR4220--3--
3.3 $\mu$ F	14.0	28.0	32.0	27.5	8.5	3.4 E3	R60MR4330--3--
4.7 $\mu$ F	18.0	33.0	32.0	27.5	8.5	3.4 E3	R60MR4470--3--
6.8 $\mu$ F	22.0	37.0	32.0	27.5	8.5	3.4 E3	R60MR4680--3--
3.3 $\mu$ F	11.0	22.0	41.5	37.5	6.0	2.4 E3	R60MW4330--3--
4.7 $\mu$ F	13.0	24.0	41.5	37.5	6.0	2.4 E3	R60MW4470--3--
6.8 $\mu$ F	16.0	28.5	41.5	37.5	6.0	2.4 E3	R60MW4680--3--
10.0 $\mu$ F	19.0	32.0	41.5	37.5	6.0	2.4 E3	R60MW5100--3--
15.0 $\mu$ F	24.0	44.0	41.5	37.5	6.0	2.4 E3	R60MW5150--3--

Rated Cap.	630Vdc/220*Vac				Max dv/dt (V/ $\mu$ s)	Max $K_0$ ( $V^2/\mu$ s)	Part Number
	B	H	L	p			
4700pF	4.0	9.0	13.0	10.0	40	50 E3	R60PF 1470--3--
6800pF	4.0	9.0	13.0	10.0	40	50 E3	R60PF 1680--3--
0.010 $\mu$ F	4.0	9.0	13.0	10.0	40	50 E3	R60PF 2100--3--
0.015 $\mu$ F	4.0	9.0	13.0	10.0	40	50 E3	R60PF 2150--3--
0.022 $\mu$ F	5.0	11.0	13.0	10.0	40	50 E3	R60PF 2220--3--
0.033 $\mu$ F	6.0	12.0	13.0	10.0	40	50 E3	R60PF 2330--3--
0.047 $\mu$ F	6.0	12.0	13.0	10.0	40	50 E3	R60PF 2470--3--
0.033 $\mu$ F	5.0	11.0	18.0	15.0	25	31 E3	R60PI 2330--3--
0.047 $\mu$ F	5.0	11.0	18.0	15.0	25	31 E3	R60PI 2470--3--
0.068 $\mu$ F	6.0	12.0	18.0	15.0	25	31 E3	R60PI 2680--3--
0.10 $\mu$ F	7.5	13.5	18.0	15.0	25	31 E3	R60PI 3100--3--
0.15 $\mu$ F	8.5	14.5	18.0	15.0	25	31 E3	R60PI 3150--3--
0.10 $\mu$ F	6.0	15.0	26.5	22.5	12	15 E3	R60PN3100--3--
0.15 $\mu$ F	6.0	15.0	26.5	22.5	12	15 E3	R60PN3150--3--
0.22 $\mu$ F	7.0	16.0	26.5	22.5	12	15 E3	R60PN3220--3--
0.33 $\mu$ F	10.0	18.5	26.5	22.5	12	15 E3	R60PN3330--3--
0.33 $\mu$ F	9.0	17.0	32.0	27.5	10	12 E3	R60PR3330--3--
0.47 $\mu$ F	11.0	20.0	32.0	27.5	10	12 E3	R60PR3470--3--
0.68 $\mu$ F	13.0	22.0	32.0	27.5	10	12 E3	R60PR3680--3--
1.0 $\mu$ F	14.0	28.0	32.0	27.5	10	12 E3	R60PR4100--4--
1.5 $\mu$ F	18.0	33.0	32.0	27.5	10	12 E3	R60PR4150--3--
2.2 $\mu$ F	22.0	37.0	32.0	27.5	10	12 E3	R60PR4220--3--
1.0 $\mu$ F	11.0	22.0	41.5	37.5	8	9.6 E3	R60PW4100--3--
1.5 $\mu$ F	13.0	24.0	41.5	37.5	8	9.6 E3	R60PW4150--3--
2.2 $\mu$ F	16.0	28.5	41.5	37.5	8	9.6 E3	R60PW4220--3--
3.3 $\mu$ F	20.0	40.0	41.5	37.5	8	9.6 E3	R60PW4330--3--
4.7 $\mu$ F	24.0	44.0	41.5	37.5	8	9.6 E3	R60PW4470--3--

Mechanical version and packaging (Table 1)  
Internal use  
Tolerance: J ( $\pm 5\%$ ); K ( $\pm 10\%$ ); M ( $\pm 20\%$ )

Rated Cap.	1000Vdc/250Vac*				Max dv/dt (V/ $\mu$ s)	Max $K_0$ ( $V^2/\mu$ s)	Part Number
	B	H	L	p			
1000pF	4.0	9.0	13.0	10.0	60	120 E3	R60QF 1100--0--
1500pF	4.0	9.0	13.0	10.0	60	120 E3	R60QF 1150--0--
2200pF	4.0	9.0	13.0	10.0	60	120 E3	R60QF 1220--0--
3300pF	4.0	9.0	13.0	10.0	60	120 E3	R60QF 1330--0--
4700pF	5.0	11.0	13.0	10.0	60	120 E3	R60QF 1470--0--
6800pF	6.0	12.0	13.0	10.0	60	120 E3	R60QF 1680--0--
0.010 $\mu$ F	5.0	11.0	18.0	15.0	30	60 E3	R60QI 2100--0--
0.015 $\mu$ F	5.0	11.0	18.0	15.0	30	60 E3	R60QI 2150--3--
0.022 $\mu$ F	6.0	12.0	18.0	15.0	30	60 E3	R60QI 2220--3--
0.033 $\mu$ F	7.5	13.5	18.0	15.0	30	60 E3	R60QI 2330--3--
0.033 $\mu$ F	9.0	12.5	18.0	15.0	30	60 E3	R60QI 2330--L--
0.047 $\mu$ F	10.0	16.0	18.0	15.0	30	60 E3	R60QI 2470--0--
0.047 $\mu$ F	13.0	12.0	18.0	15.0	30	60 E3	R60QI 2470--L--
0.068 $\mu$ F	11.0	19.0	18.0	15.0	30	60 E3	R60QI 2680--0--
0.033 $\mu$ F	6.0	15.0	26.5	22.5	15	30 E3	R60QN2330--0--
0.047 $\mu$ F	6.0	15.0	26.5	22.5	15	30 E3	R60QN2470--0--
0.068 $\mu$ F	7.0	16.0	26.5	22.5	15	30 E3	R60QN2680--3--
0.10 $\mu$ F	8.5	17.0	26.5	22.5	15	30 E3	R60QN3100--3--
0.15 $\mu$ F	13.0	22.0	26.5	22.5	15	30 E3	R60QN3150--0--
0.15 $\mu$ F	9.0	17.0	32.0	27.5	12	24 E3	R60QR3150--3--
0.22 $\mu$ F	11.0	20.0	32.0	27.5	12	24 E3	R60QR3220--3--
0.33 $\mu$ F	13.0	22.0	32.0	27.5	12	24 E3	R60QR3330--3--
0.47 $\mu$ F	14.0	28.0	32.0	27.5	12	24 E3	R60QR3470--3--
0.68 $\mu$ F	18.0	33.0	32.0	27.5	12	24 E3	R60QR3680--3--
1.0 $\mu$ F	22.0	37.0	32.0	27.5	12	24 E3	R60QR4100--3--
0.47 $\mu$ F	11.0	22.0	41.5	37.5	10	20 E3	R60QW3470--3--
0.68 $\mu$ F	13.0	24.0	41.5	37.5	10	20 E3	R60QW3680--3--
1.0 $\mu$ F	16.0	28.5	41.5	37.5	10	20 E3	R60QW4100--3--
1.5 $\mu$ F	20.0	40.0	41.5	37.5	10	20 E3	R60QW4150--3--
2.2 $\mu$ F	24.0	44.0	41.5	37.5	10	20 E3	R60QW4220--3--

Mechanical version and packaging (Table 1)  
Internal use  
Tolerance: J ( $\pm 5\%$ ); K ( $\pm 10\%$ ); M ( $\pm 20\%$ )

All dimensions are in mm

Note 1: If the working voltage (V) is lower than the rated voltage ( $V_R$ ), the capacitor may work at higher dv/dt. In this case the maximum value allowed is obtained multiplying the above value (see table dv/dt) with the ratio  $V_R/V$ . The pulse characteristic  $K_0$  depends on the voltage wave-form and in any case it cannot overcome the value given in the above table.

Note 2: Rated voltages higher than 1000Vdc are available upon request

\* Not suitable for across-the-line applications. Please refer to Interference Suppression Capacitors (page 109).

**ELECTRICAL CHARACTERISTICS**

**Rated voltage (V<sub>R</sub>):** 63 Vdc-100 Vdc- 160 Vdc-250 Vdc  
400 Vdc-630 Vdc-1000 Vdc.

**Rated temperature (T<sub>R</sub>):** +85°C

**Temperature derated voltage:**

for temperatures between +85°C and the upper operating temperature (+105°C for wound technology and +125°C for stacked technology) a decreasing factor of 1.25% per degree °C on the rated voltage V<sub>R</sub> has to be applied.

**Capacitance range:** 1000pF to 100µF

**Capacitance values:**

E6 series (IEC 60063 Norm).

**Capacitance tolerances** (measured at 1 kHz):

± 5% (J); ± 10% (K); ± 20% (M).

**Total self-inductance (L):** (lead length ~2mm)

Pitch (mm)	10	15	22.5	27.5	37.5
L(nH) ≈	9	10	18	18	22

**Dissipation factor (DF):**

tgδ × 10<sup>-4</sup> at +25°C ± 5°C

kHz	C ≤ 1µF	C > 1µF
1	≤ 100	≤ 100
10	≤ 150	

**Insulation resistance:**

**Test conditions**

Temperature: +25°C ± 5°C  
Voltage charge time: 1 min  
Voltage charge: 50 Vdc for V<sub>R</sub> < 100 Vdc  
100 Vdc for V<sub>R</sub> ≥ 100 Vdc

**Performance**

For V<sub>R</sub> ≤ 100 Vdc

≥ 3750 MΩ for C ≤ 0.33µF (50000 MΩ)\*

≥ 1250 s for C > 0.33µF ( 5000 s)\*

For V<sub>R</sub> > 100 Vdc

≥ 30000 MΩ for C ≤ 0.33µF (50000 MΩ)\*

≥ 10000 s for C > 0.33µF (17000 s)\*

\*Typical value

**Test voltage between terminations:**

1.6 × V<sub>R</sub> applied for 2 s at +25°C ± 5°C

**TEST METHOD AND PERFORMANCE**

**Damp heat, steady state:**

**Test conditions**

Temperature: +40°C ± 2°C  
Relative humidity (RH): 93% ± 2%  
Test duration: 56 days

**Performance**

Capacitance change |ΔC/C|: ≤ 5%  
DF change (Δtgδ): ≤ 50 × 10<sup>-4</sup> at 1kHz  
Insulation resistance: ≥ 50% of initial limit.

**Endurance:**

**Test conditions**

Temperature: +100°C ± 2°C  
Test duration: 2000 h  
Voltage applied: 1.25 × V<sub>C</sub>

**Performance**

Capacitance change |ΔC/C|: ≤ 5%  
DF change (Δtgδ): ≤ 50 × 10<sup>-4</sup> at 10kHz for C ≤ 1µF  
≤ 30 × 10<sup>-4</sup> at 1kHz for C > 1µF

Insulation resistance: ≥ 50% of initial limit.

**Resistance to soldering heat:**

**Test conditions**

Solder bath temperature: +260°C ± 5°C  
Dipping time (with heat screen): 10 s ± 1 s

**Performance**

Capacitance change |ΔC/C|: ≤ 2%  
DF change (Δtgδ): ≤ 50 × 10<sup>-4</sup> at 10kHz for C ≤ 1µF  
≤ 30 × 10<sup>-4</sup> at 1kHz for C > 1µF

Insulation resistance: ≥ initial limit.

**Long term stability** (after two years):

**Storage:** standard environmental conditions (see page 11).

**Performance**

Capacitance change |ΔC/C|: ≤ 3% for C ≤ 0.1µF  
≤ 2% for C > 0.1µF

**RELIABILITY:**

Reference MIL HDB 217

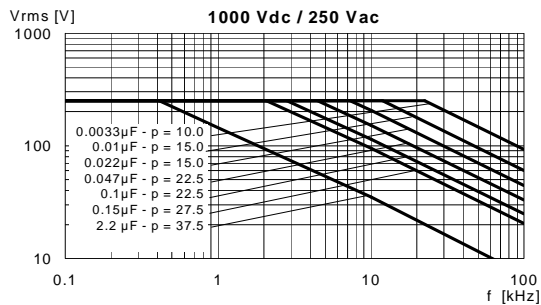
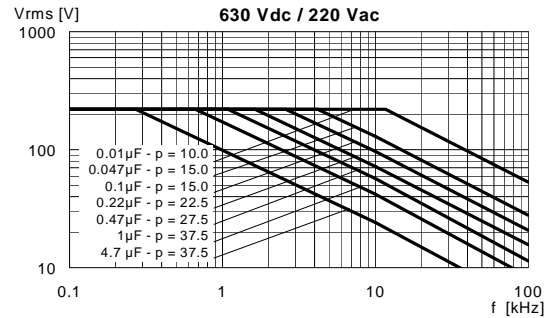
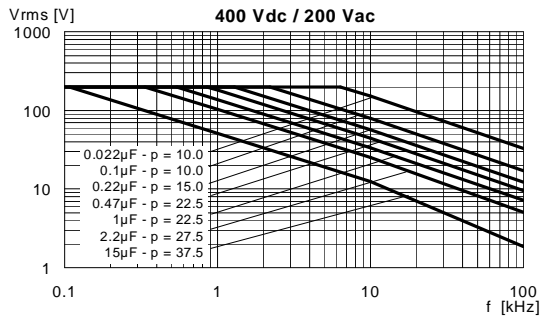
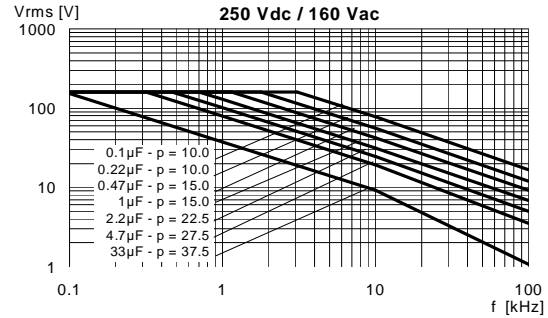
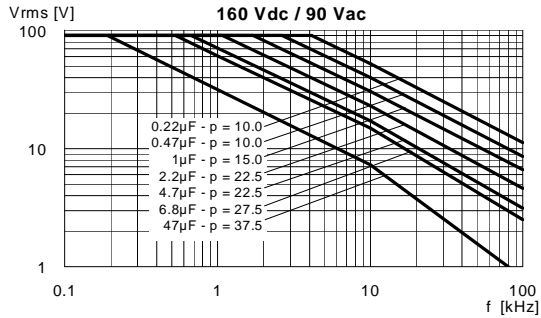
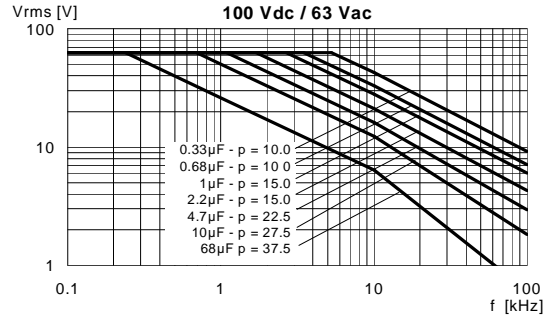
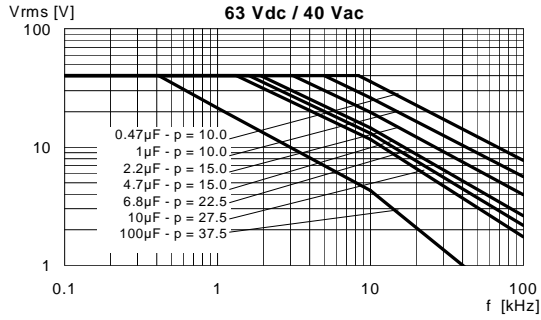
**Application conditions:**

Temperature: +40°C ± 2°C  
Voltage: 0.5 × V<sub>R</sub>  
Failure rate: ≤ 5 FIT  
(1 FIT = 1 × 10<sup>-9</sup> failures/components × h)

**Failure criteria:**

Short or open circuit  
Capacitance change |ΔC/C|: > 10%  
DF change (Δtgδ): > 2 × initial limit.  
Insulation resistance: < 0.005 × initial limit.

MAX. VOLTAGE (Vr.m.s.) VERSUS FREQUENCY (sinusoidal wave-form /  $T_h \leq 40^\circ\text{C}$ )



Note:  $\rho$  (pitch) in mm.