

AC and pulse metallized polypropylene film capacitors

MKP/MKP 378

MKP/MKP RADIAL POTTED CAPACITORS

PITCH 15/22.5/27.5 mm

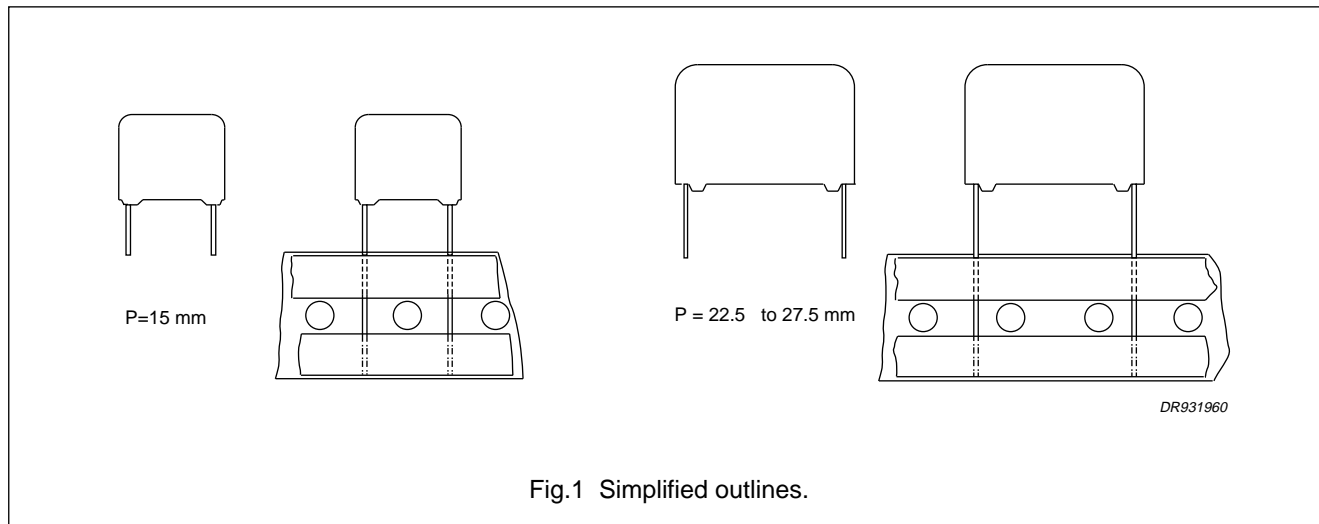


Fig.1 Simplified outlines.

FEATURES

- 15 to 27.5 mm lead pitch
- Low contact resistance
- Low loss dielectric
- Small dimensions for high density packaging
- Supplied loose in box and taped on reel.

APPLICATIONS⁽¹⁾

- Where steep pulses occur e.g. SMPS (switch mode power supplies)
- Motor control circuits
- S-correction.

(1) It is not advised to use these products as resonance capacitors in fly-back applications.

QUICK REFERENCE DATA

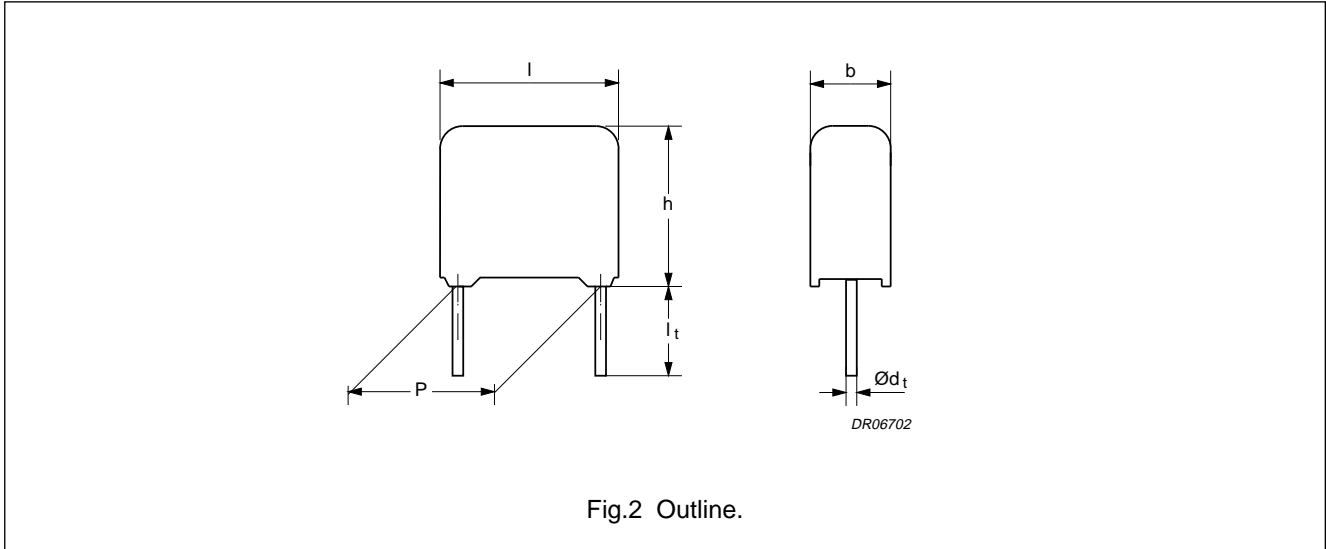
DESCRIPTION	VALUE
Capacitance range (E24 series)	0.001 to 0.68 μ F
Capacitance tolerance	\pm 5%
Rated voltage (DC) available on request	630 V; 1 000 V; 1 600 V; 2 000 V; 2 500 V 5 000 V
Rated voltage (AC) available on request	300 V; 400 V; 500 V; 600 V; 675 V 1 200 V
Rated peak-to-peak voltage available on request	850 V; 1 130 V; 1 400 V; 1 700 V; 1 900 V 3 400 V
Climatic category	55/085/56
Rated temperature (DC)	85 °C
Rated temperature (AC)	70 °C
Maximum application temperature	85 °C
Reference specification	IEC 384-17
Performance grade	grade 1 (long life)
Stability grade: pitch 15 mm pitch 22.5 and 27.5 mm	grade 2 grade 1

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MKP/MKP 378 GENERAL DATA

PITCH 15 mm



Specific reference data for the 630 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: $C \leq 0.051 \mu\text{F}$	$\leq 8 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$ at U_{Rdc}	500 V/ μs	
R between leads, for $C \leq 1 \mu\text{F}$	>100000 M Ω	
Ionization voltage (typical value) at 50 pC peak discharge	>400 V (AC)	

Available 630 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	$l_t = 3.5 \pm 0.3 \text{ mm}$	$\pm 5\%$	2222 378 64...	preferred
	$l_t = 5.0 \pm 1.0 \text{ mm}$	$\pm 5\%$	2222 378 62...	on request
Taped on reel	H = 18.5 mm; note 1	$\pm 5\%$	2222 378 65...	on request

Available 630 V DC versions on request

C (μF)	Pitch = $15.0 \pm 0.4 \text{ mm}$; $b \times h \times l = 8.5 \text{ mm} \times 15.0 \text{ mm} \times 17.5 \text{ mm}$		
	LOOSE IN BOX; SPQ = 1000		REEL; SPQ = 650
	$l_t = 3.5 \pm 0.3 \text{ mm}$	$l_t = 5.0 \pm 1.0 \text{ mm}$	H = 18.5 mm ⁽¹⁾
0.056	2222 378 90042	2222 378 90043	2222 378 90044
0.062	2222 378 90046	2222 378 90047	2222 378 90048

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

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 $U_{Rdc} = 630 \text{ V}$; $U_{Rac} = 300 \text{ V}$ / $U_{p-p} = 850 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $15.0 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.015	5.0 × 11.0 × 17.5	1.2	64153	1000	1100
0.016			64163		
0.018			64183		
0.02			64203		
0.022			64223		
0.024	6.0 × 12.0 × 17.5	1.4	64243	1000	900
0.027			64273		
0.03			64303		
0.033			64333		
0.036	7.0 × 13.5 × 17.5	1.9	64363	1000	800
0.039			64393		
0.043			64433		
0.047	8.5 × 15.0 × 17.5	2.6	64473	1000	650
0.051			64513		

Note

1. The shading indicates preferred types.

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metallized polypropylene film capacitors

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MKP/MKP 378 GENERAL DATA

PITCH 22.5/27.5 mm

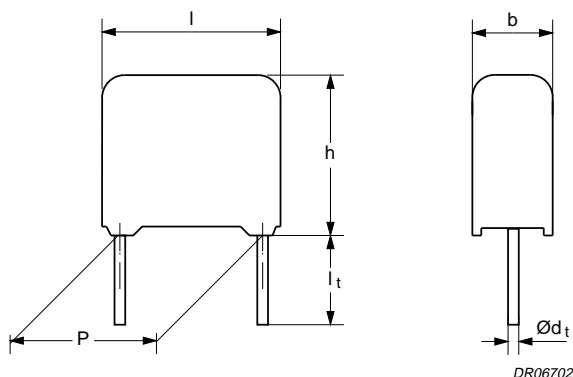


Fig.3 Outline.

Specific reference data for the 630 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle:		
$C \leq 0.18 \mu\text{F}$	$\leq 8 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
$0.20 \mu\text{F} \leq C \leq 0.30 \mu\text{F}$	$\leq 10 \times 10^{-4}$	$\leq 25 \times 10^{-4}$
$0.33 \mu\text{F} \leq C \leq 0.39 \mu\text{F}$	$\leq 10 \times 10^{-4}$	$\leq 30 \times 10^{-4}$
$0.43 \mu\text{F} \leq C \leq 0.51 \mu\text{F}$	$\leq 10 \times 10^{-4}$	$\leq 40 \times 10^{-4}$
$C > 0.51 \mu\text{F}$	$\leq 10 \times 10^{-4}$	$\leq 45 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$ at U_{Rdc} :		
$P = 22.5 \text{ mm}$	370 V/ μs	
$P = 27.5 \text{ mm}$	230 V/ μs ($b < 15 \text{ mm}$)	
$P = 27.5 \text{ mm}$	120 V/ μs ($b \geq 15 \text{ mm}$)	
R between leads, for $C \leq 1 \mu\text{F}$	>100000 M Ω	
Ionization voltage (typical value) at 50 pC peak discharge	>400 V (AC)	

Available 630 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	$l_t = 3.5 \pm 0.3 \text{ mm}$	$\pm 5\%$	2222 378 64...	preferred
	$l_t = 5.0 \pm 1.0 \text{ mm}$	$\pm 5\%$	2222 378 62...	on request
Taped on reel	$H = 18.5 \text{ mm}$; note 1	$\pm 5\%$	2222 378 65...	on request

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

AC and pulse metallized polypropylene film capacitors

MKP/MKP 378

 $U_{Rdc} = 630 \text{ V}; U_{Rac} = 300 \text{ V}/U_{p-p} = 850 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $22.5 \pm 0.4 \text{ mm}; d_t = 0.80 \pm 0.08 \text{ mm}$					
0.056	6.0 × 15.5 × 26.0	2.6	64563	200	600
0.062			64623		
0.068	7.0 × 16.5 × 26.0	3.2	64683	200	550
0.075			64753		
0.082			64823		
0.091			64913		
0.1	8.5 × 18.0 × 26.0	4.4	64104	200	450
0.11			64114		
0.12			64124		
0.13			64134		
0.15	10.0 × 19.5 × 26.0	5.5	64154	200	350
0.16			64164		
0.18			64184		
Pitch = $27.5 \pm 0.4 \text{ mm}; d_t = 0.80 \pm 0.08 \text{ mm}$					
0.2	11.0 × 21.0 × 31.0	7.8	64204	100	300
0.22			64224		
0.24			64244		
0.27			64274		
0.3	13.0 × 23.0 × 31.0	10.4	64304	100	250
0.33			64334		
0.36			64364		
0.39			64394		
0.43	15.0 × 25.0 × 31.0	12.8	64434	100	200
0.47			64474		
0.51			64514		
0.56	18.0 × 28.0 × 31.0	17.2	64564	100	150
0.62			64624		
0.68			64684		

Note

1. The shading indicates preferred types.

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MKP/MKP 378 GENERAL DATA

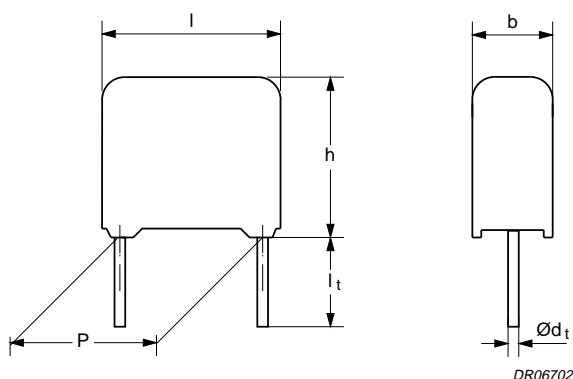
PITCH 15 mm


Fig.4 Outline.

Specific reference data for the 1000 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: $C \leq 0.011 \mu\text{F}$	$\leq 6 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$ at U_{Rdc}	1300 V/ μs	
R between leads, for $C \leq 1 \mu\text{F}$	>100000 M Ω	
Ionization voltage (typical value) at 50 pC peak discharge	>500 V (AC)	

Available 1000 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	$l_t = 3.5 \pm 0.3 \text{ mm}$	$\pm 5\%$	2222 378 74...	preferred
	$l_t = 5.0 \pm 1.0 \text{ mm}$	$\pm 5\%$	2222 378 72...	on request
Taped on reel	H = 18.5 mm; note 1	$\pm 5\%$	2222 378 75...	on request

Available 1000 V DC versions on request

C (μF)	Pitch = $15.0 \pm 0.4 \text{ mm}$; $b \times h \times l = 8.5 \text{ mm} \times 15.0 \text{ mm} \times 17.5 \text{ mm}$		
	LOOSE IN BOX; SPQ = 1000		REEL; SPQ = 650
	$l_t = 3.5 \pm 0.3 \text{ mm}$	$l_t = 5.0 \pm 1.0 \text{ mm}$	H = 18.5 mm ⁽¹⁾
0.012	2222 378 90051	2222 378 90052	2222 378 90053
0.013	2222 378 90055	2222 378 90056	2222 378 90057
0.015	2222 378 90059	2222 378 90061	2222 378 90062
0.016	2222 378 90064	2222 378 90065	2222 378 90066
0.018	2222 378 90068	2222 378 90069	2222 378 90071

Note

- H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

AC and pulse metallized polypropylene film capacitors

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 $U_{Rdc} = 1000 \text{ V}$; $U_{Rac} = 400 \text{ V}$ / $U_{p-p} = 1130 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $15.0 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.003	$5.0 \times 11.0 \times 17.5$	1.2	74302	1000	1100
0.0033			74332		
0.0036			74362		
0.0039			74392		
0.0043			74432		
0.0047			74472		
0.0051			74512		
0.0056			74562		
0.0062			74622		
0.0068			74682		
0.0075			74752		
0.0082	$6.0 \times 12.0 \times 17.5$	1.4	74822	1000	900
0.0091			74912		
0.01			74103		
0.011			74113		

Note

1. The shading indicates preferred types.

AC and pulse
metallized polypropylene film capacitors

MKP/MKP 378

MKP/MKP 378 GENERAL DATA

PITCH 22.5/27.5 mm

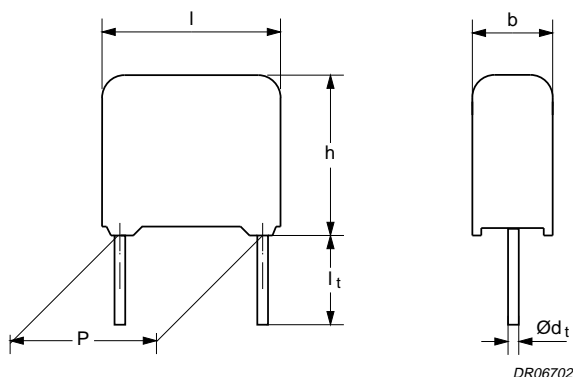


Fig.5 Outline.

Specific reference data for the 1000 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: $C \leq 0.051 \mu\text{F}$ $0.056 \mu\text{F} \leq C \leq 0.22 \mu\text{F}$	$\leq 6 \times 10^{-4}$ $\leq 8 \times 10^{-4}$	$\leq 15 \times 10^{-4}$ $\leq 20 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$ at U_{Rdc} : $P = 22.5 \text{ mm}$ $P = 27.5 \text{ mm}$ $P = 27.5 \text{ mm}$	1200 V/ μs 600 V/ μs ($b < 15 \text{ mm}$) 300 V/ μs ($b \geq 15 \text{ mm}$)	
R between leads, for $C \leq 1 \mu\text{F}$	$>100000 \text{ M}\Omega$	
Ionization voltage (typical value) at 50 pC peak discharge	$>500 \text{ V (AC)}$	

Available 1000 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	$l_t = 3.5 \pm 0.3 \text{ mm}$	$\pm 5\%$	2222 378 74...	preferred
	$l_t = 5.0 \pm 1.0 \text{ mm}$	$\pm 5\%$	2222 378 72...	on request
Taped on reel	$H = 18.5 \text{ mm}$; note 1	$\pm 5\%$	2222 378 75...	on request

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

AC and pulse metallized polypropylene film capacitors

MKP/MKP 378

 $U_{Rdc} = 1000 \text{ V}$; $U_{Rac} = 400 \text{ V}$ / $U_{p-p} = 1130 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $22.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.012	6.0 × 15.5 × 26.0	2.6	74123	200	600
0.013			74133		
0.015			74153		
0.016			74163		
0.018			74183		
0.02	7.0 × 16.5 × 26.0	3.2	74203	200	550
0.022			74223		
0.024			74243		
0.027	8.5 × 18.0 × 26.0	4.4	74273	200	450
0.03			74303		
0.033			74333		
0.036			74363		
0.039	10.0 × 19.5 × 26.0	5.5	74393	200	350
0.043			74433		
0.047			74473		
0.051			74513		
Pitch = $27.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.056	11.0 × 21.0 × 31.0	7.8	74563	100	300
0.062			74623		
0.068			74683		
0.075			74753		
0.082			74823		
0.091	13.0 × 23.0 × 31.0	10.4	74913	100	250
0.1			74104		
0.11			74114		
0.12	15.0 × 25.0 × 31.0	12.8	74124	100	200
0.13			74134		
0.15			74154		
0.16	18.0 × 28.0 × 31.0	17.5	74164	100	150
0.18			74184		
0.2			74204		
0.22			74224		

Note

1. The shading indicates preferred types.

AC and pulse
metallized polypropylene film capacitors

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MKP/MKP 378 GENERAL DATA

PITCH 22.5/27.5 mm

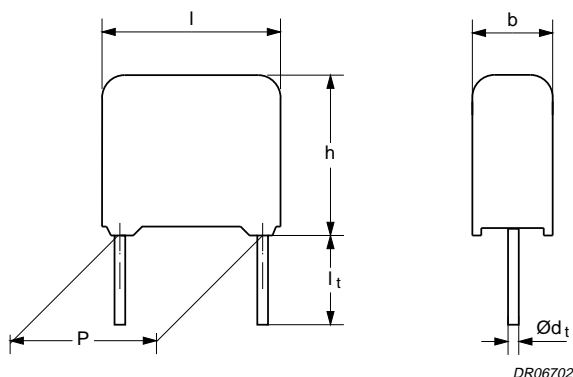


Fig.6 Outline.

Specific reference data for the 1600 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: $C \leq 0.022 \mu\text{F}$ $0.024 \mu\text{F} \leq C \leq 0.10 \mu\text{F}$	$\leq 5 \times 10^{-4}$ $\leq 6 \times 10^{-4}$	$\leq 10 \times 10^{-4}$ $\leq 15 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$ at U_{Rdc} : $P = 22.5 \text{ mm}$ $P = 27.5 \text{ mm}$ $P = 27.5 \text{ mm}$	1600 V/ μs 900 V/ μs ($b < 15 \text{ mm}$) 450 V/ μs ($b \geq 15 \text{ mm}$)	
R between leads, for $C \leq 1 \mu\text{F}$	$> 100000 \text{ M}\Omega$	
Ionization voltage (typical value) at 20 pC peak discharge	$> 600 \text{ V (AC)}$	

Available 1600 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	$l_t = 3.5 \pm 0.3 \text{ mm}$	$\pm 5\%$	2222 378 84...	preferred
	$l_t = 5.0 \pm 1.0 \text{ mm}$	$\pm 5\%$	2222 378 82...	on request
Taped on reel	$H = 18.5 \text{ mm}$; note 1	$\pm 5\%$	2222 378 85...	on request

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

AC and pulse metallized polypropylene film capacitors

MKP/MKP 378

 $U_{Rdc} = 1600 \text{ V}$; $U_{Rac} = 500 \text{ V}$ / $U_{p-p} = 1400 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $22.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.0056	6.0 × 15.5 × 26.0	2.6	84562	200	600
0.0062			84622		
0.0068			84682		
0.0075	7.0 × 16.5 × 26.0	3.2	84752	200	550
0.0082			84822		
0.0091			84912		
0.01			84103		
0.011	8.5 × 18.0 × 26.0	4.4	84113	200	450
0.012			84123		
0.013			84133		
0.015			84153		
0.016			84163		
0.018	10.0 × 19.5 × 26.0	5.5	84183	200	350
0.02			84203		
0.022			84223		
Pitch = $27.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.024	11.0 × 21.0 × 31.0	7.8	84243	100	300
0.027			84273		
0.03			84303		
0.033			84333		
0.036			84363		
0.039	13.0 × 23.0 × 31.0	10.4	84393	100	250
0.043			84433		
0.047			84473		
0.051			84513		
0.056	15.0 × 25.0 × 31.0	12.8	84563	100	200
0.062			84623		
0.068			84683		
0.075	18.0 × 28.0 × 31.0	17.2	84753	100	150
0.082			84823		
0.091			84913		
0.1			84104		

Note

1. The shading indicates preferred types.

AC and pulse
metallized polypropylene film capacitors

MKP/MKP 378

MKP/MKP 378 GENERAL DATA

PITCH 22.5/27.5 mm

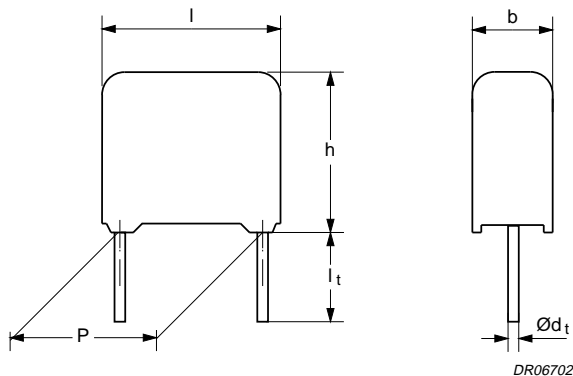


Fig.7 Outline.

Specific reference data for the 2000 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: C ≤ 0.051 µF	≤ 5 × 10 ⁻⁴	≤ 10 × 10 ⁻⁴
Rated voltage pulse slope (dU/dt) _R at U _{Rdc} : P = 22.5 mm P = 27.5 mm P = 27.5 mm	2000 V/µs 1200 V/µs (b < 15 mm) 600 V/µs (b ≥ 15 mm)	
R between leads, for C ≤ 1 µF	> 100000 MΩ	
Ionization voltage (typical value) at 20 pC peak discharge	> 700 V (AC)	

Available 2000 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	l _t = 3.5 ± 0.3 mm	±5%	2222 378 94...	preferred
	l _t = 5.0 ± 1.0 mm	±5%	2222 378 92...	on request
Taped on reel	H = 18.5 mm; note 1	±5%	2222 378 95...	on request

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

AC and pulse metallized polypropylene film capacitors

MKP/MKP 378

 $U_{Rdc} = 2000 \text{ V}$; $U_{Rac} = 600 \text{ V}$ / $U_{p-p} = 1700 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number ⁽¹⁾	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $22.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.0033 0.0036	6.0 × 15.5 × 26.0	2.6	94332 94362	200	600
0.0039 0.0043 0.0047 0.0051	7.0 × 16.5 × 26.0	3.2	94392 94432 94472 94512	200	550
0.0056 0.0062 0.0068 0.0075 0.0082	8.5 × 18.0 × 26.0	4.4	94562 94622 94682 94752 94822	200	450
0.0091 0.01 0.011 0.012	10.0 × 19.5 × 26.0	5.5	94912 94103 94113 94123	200	350
Pitch = $27.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.013 0.015 0.016 0.018 0.02	11.0 × 21.0 × 31.0	7.8	94133 94153 94163 94183 94203	100	300
0.022 0.024 0.027	13.0 × 23.0 × 31.0	10.4	94223 94243 94273	100	250
0.030 0.033 0.036	15.0 × 25.0 × 31.0	12.8	94303 94333 94363	100	200
0.039 0.043 0.047 0.051	18.0 × 28.0 × 31.0	17.5	94393 94433 94473 94513	100	150

Note

1. The shading indicates preferred types.

AC and pulse
metallized polypropylene film capacitors

MKP/MKP 378

MKP/MKP 378 GENERAL DATA

PITCH 22.5/27.5 mm

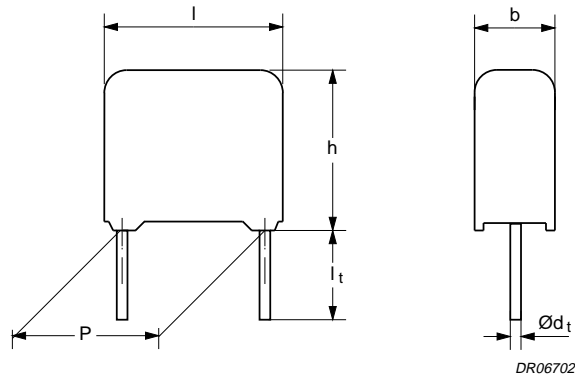


Fig.8 Outline.

Specific reference data for the 2500 V DC capacitors

DESCRIPTION	VALUE	
	at 10 kHz	at 100 kHz
Tangent of loss angle: C ≤ 0.030 μF	≤ 5 × 10 ⁻⁴	≤ 10 × 10 ⁻⁴
Rated voltage pulse slope (dU/dt) _R at U _{Rdc} : P = 22.5 mm P = 27.5 mm P = 27.5 mm	2000 V/μs 2000 V/μs (b < 15 mm) 1000 V/μs (b ≥ 15 mm)	
R between leads, for C ≤ 1 μF	>100000 MΩ	
Ionization voltage (typical value) at 5 pC peak discharge	>900 V (AC)	

Available 2500 V DC versions

PACKAGING	DIMENSIONS	C-tol	FIRST 9 DIGITS OF CATALOGUE NUMBER	ORDERING
Loose in box	l _t = 3.5 ± 0.3 mm	±5%	2222 378 04...	preferred
	l _t = 5.0 ± 1.0 mm	±5%	2222 378 02...	on request
Taped on reel	H = 18.5 mm; note 1	±5%	2222 378 05...	on request

Note

1. H = in-tape height; for detailed specifications refer to this handbook, Chapter "Packaging".

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 $U_{Rdc} = 2500 \text{ V}$; $U_{Rac} = 675 \text{ V}$ / $U_{p-p} = 1900 \text{ V}$

loose and taped

C (μF)	DIMENSIONS $b \times h \times l$ (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 AND PACKAGING		
			LOOSE IN BOX		REEL
			$l_t = 3.5 \pm 0.3 \text{ mm}$	short leads	H = 18.5 mm
			last 5 digits of catalogue number	SPQ	SPQ
			C-tol = $\pm 5\%$		
Pitch = $22.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.002 0.0022 0.0024 0.0027	6.0 × 15.5 × 26.0	2.6	04202 04222 04242 04272	200	600
0.003 0.0033 0.0036	7.0 × 16.5 × 26.0	3.2	04302 04332 04362	200	550
0.0039 0.0043 0.0047 0.0051 0.0056	8.5 × 18.0 × 26.0	4.4	04392 04432 04472 04512 04562	200	450
0.0062 0.0068 0.0075 0.0082	10.0 × 19.5 × 26.0	5.5	04622 04682 04752 04822	200	350
Pitch = $27.5 \pm 0.4 \text{ mm}$; $d_t = 0.80 \pm 0.08 \text{ mm}$					
0.0091 0.01 0.011	11.0 × 21.0 × 31.0	7.8	04912 04103 04113	100	300
0.012 0.013 0.015	13.0 × 23.0 × 31.0	10.4	04123 04133 04153	100	250
0.018 0.02	15.0 × 25.0 × 31.0	12.8	04183 04203	100	200
0.022 0.024 0.027 0.03	18.0 × 28.0 × 31.0	17.2	04223 04243 04273 04303	100	150

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Available on request

loose and taped

PITCH	d_t	CAPACITANCE RANGE (μF) ⁽¹⁾
$U_{\text{Rdc}} = 3000 \text{ V}; U_{\text{Rac}} = 800 \text{ V}/U_{\text{p-p}} = 2300 \text{ V}$		
22.5 \pm 0.4 mm	0.80 \pm 0.08 mm	0.0015 to 0.0047
27.5 \pm 0.4 mm		0.0051 to 0.018
$U_{\text{Rdc}} = 4000 \text{ V}; U_{\text{Rac}} = 1000 \text{ V}/U_{\text{p-p}} = 2800 \text{ V}$		
27.5 \pm 0.4 mm	0.80 \pm 0.08 mm	0.0010 to 0.010
$U_{\text{Rdc}} = 5000 \text{ V}; U_{\text{Rac}} = 1200 \text{ V}/U_{\text{p-p}} = 3400 \text{ V}$		
27.5 \pm 0.4 mm	0.80 \pm 0.08 mm	0.0010 to 0.0062

Note

1. E24 series.

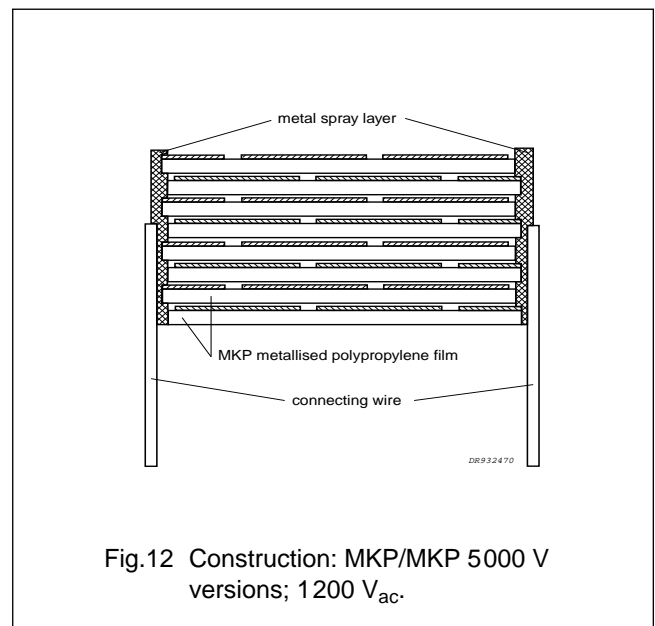
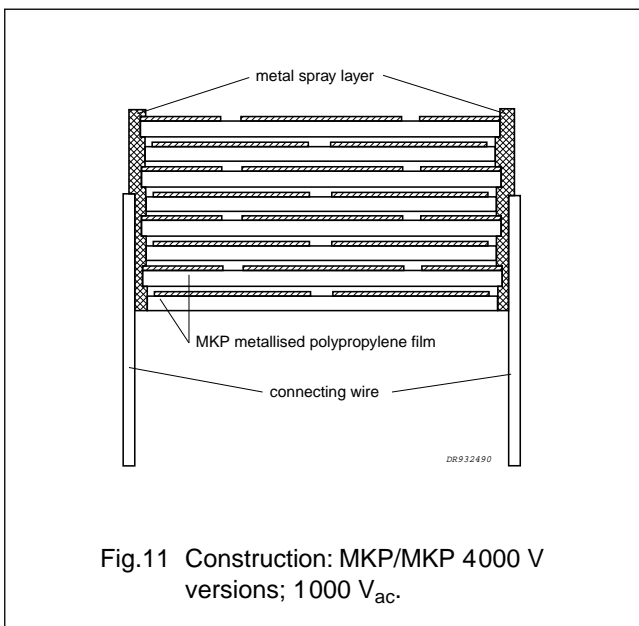
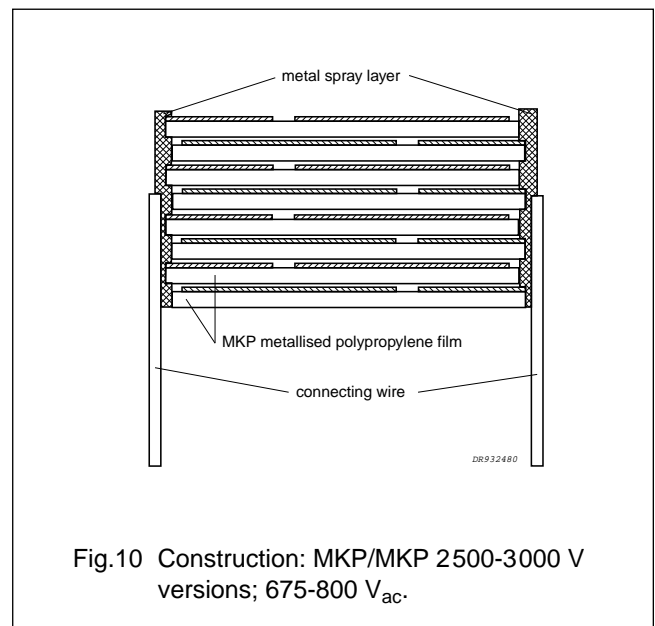
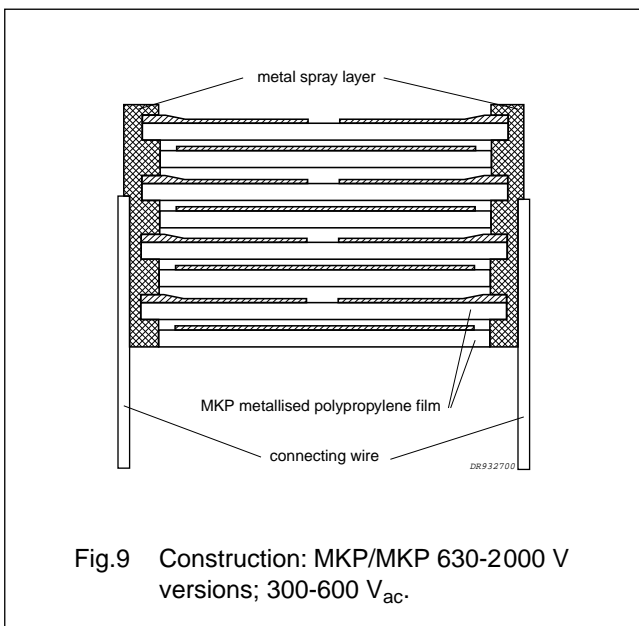
AC and pulse metallized polypropylene film capacitors

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CONSTRUCTION

Description

- Low-inductive wound cell of metallized polypropylene (PP) film, potted with epoxy resin in a flame-retardant polypropylene case
- Radial leads, solder-coated:
 - Copper clad steel wire (pitch = 6e)
 - Copper wire (pitch = 9e and 11e)
- Small stand-off pips allow removal of solder flux etc. during cleaning of the printed-circuit board.



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Mounting

NORMAL USE

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

For detailed tape specifications refer to this handbook, Chapter "Packaging".

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 of 15 mm the 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 length and width of film capacitors is shown in Fig.13:

- Eccentricity as in Fig.13. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned.
- Product height with seating plane as given by "IEC 717" as reference: $h_{\max} \leq h + 0.3 \text{ mm}$.

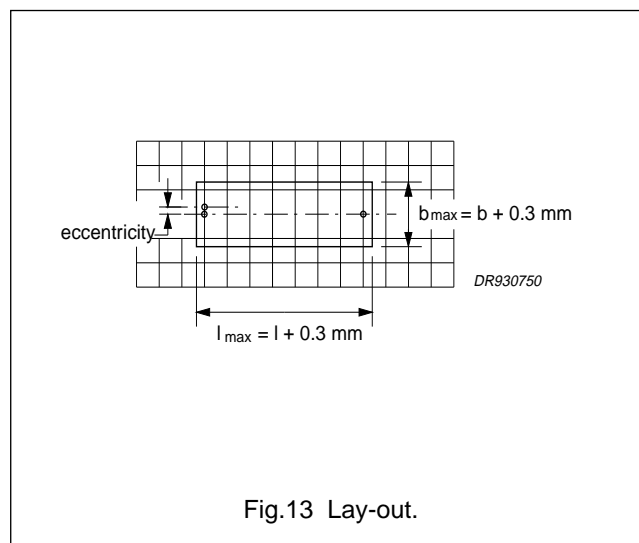


Fig.13 Lay-out.

RATINGS AND CHARACTERISTICS

Unless otherwise specified, all electrical values apply at an ambient free air temperature of $23 \pm 1 \text{ }^\circ\text{C}$, an atmospheric pressure of 86 to 106 kPa and a relative humidity of $50 \pm 2\%$.

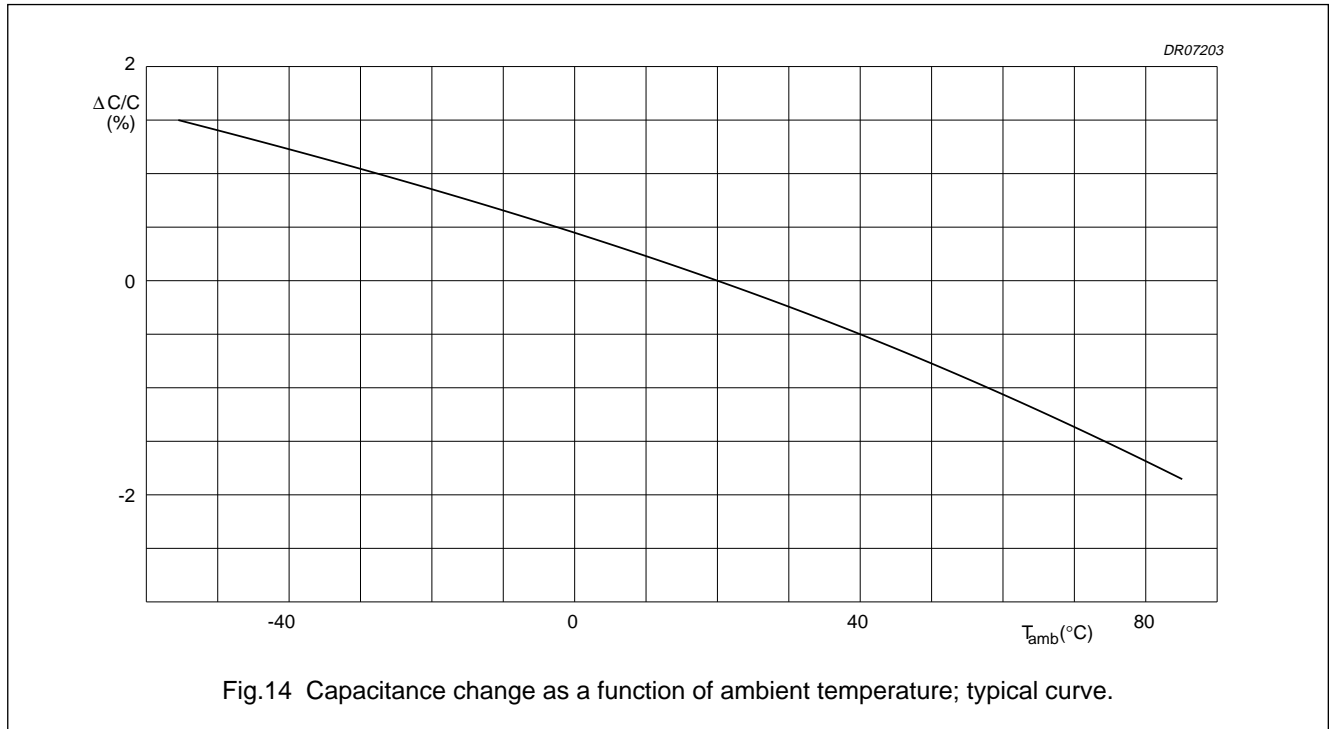
For reference testing, a conditioning period shall be applied over 96 ± 4 hours by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20%.

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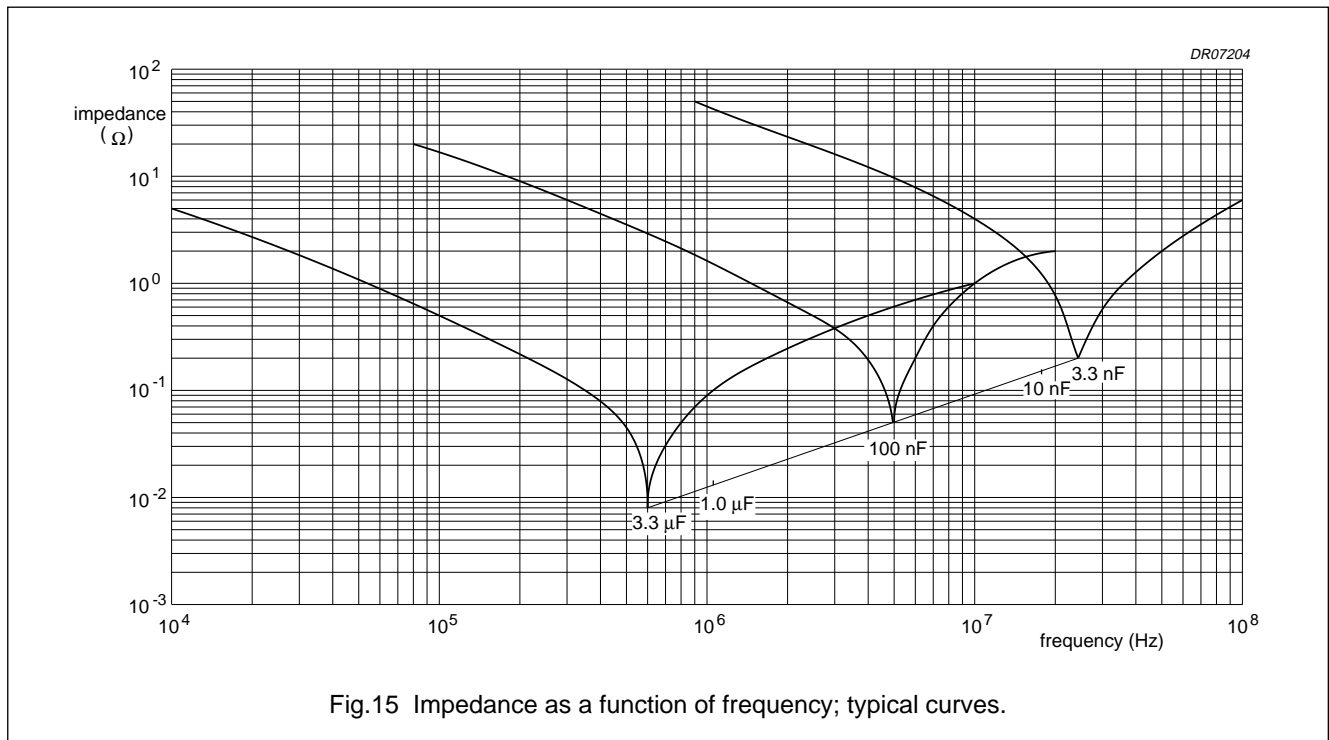
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Capacitance

All capacitance values are specified at 1 kHz.



Impedance



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Temperature

- Storage temperature: $T_{stg} = -25$ to $+40$ °C with RH maximum 80% and without condensation.

Voltage

- Category voltage:
 - $U_{Cdc} = U_{Rdc}$ for $T = 85$ °C
 - $U_{Cac} = 0.7 \times U_{Rac}$ for $T = 85$ °C
- Test voltage between leads:
 - $1.6 \times U_{Rdc}$ for $U_{Rdc} < 2500$ V
 - $1.4 \times U_{Rdc}$ for $U_{Rdc} \geq 2500$ V
- Test voltage between interconnected leads and case (foil method): 2840 V (DC).

Maximum RMS voltage (sinewave) as a function of frequency for $T_{amb} \leq 70$ °C

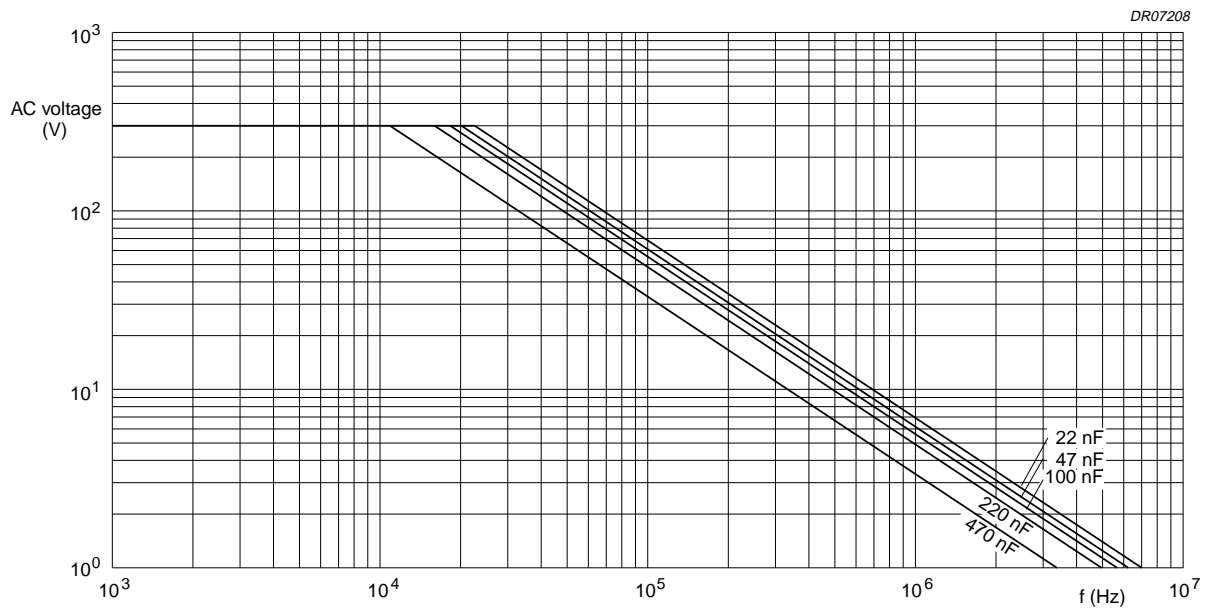


Fig.16 AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 70$ °C for $U_{Rdc} = 630$ V.

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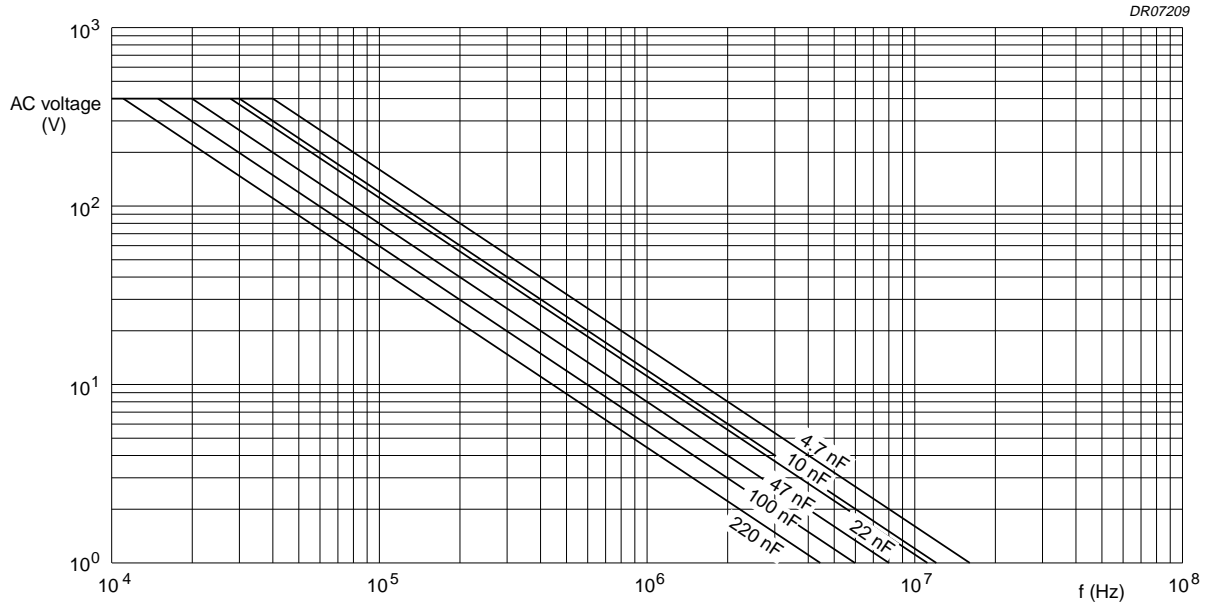


Fig.17 AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 70\text{ }^{\circ}\text{C}$ for $U_{Rdc} = 1000\text{ V}$.

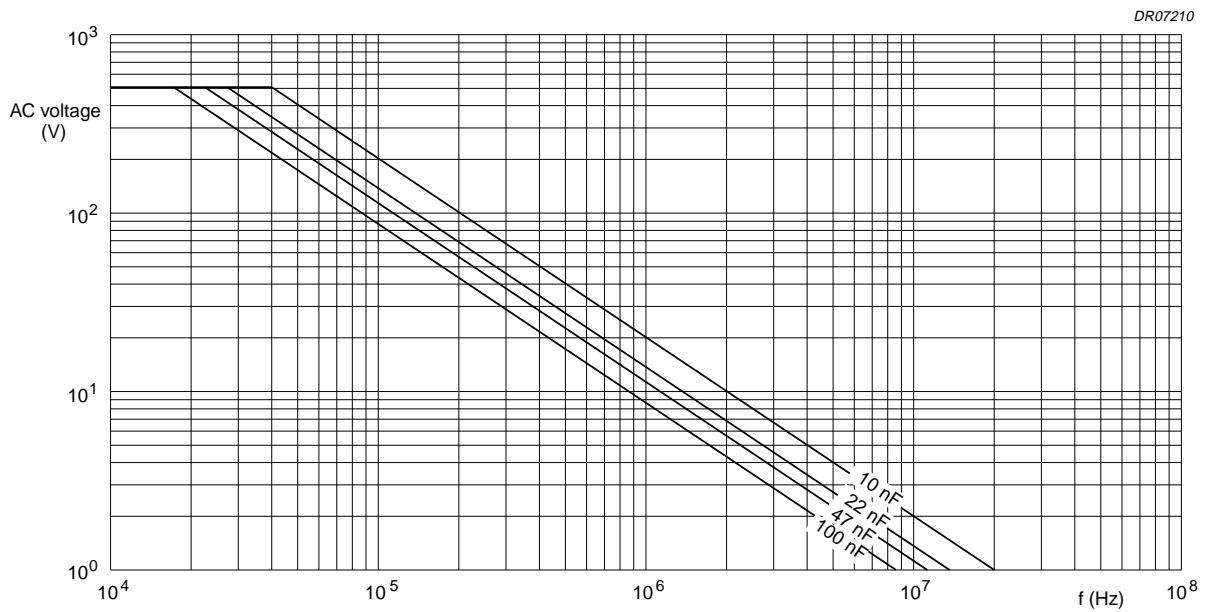
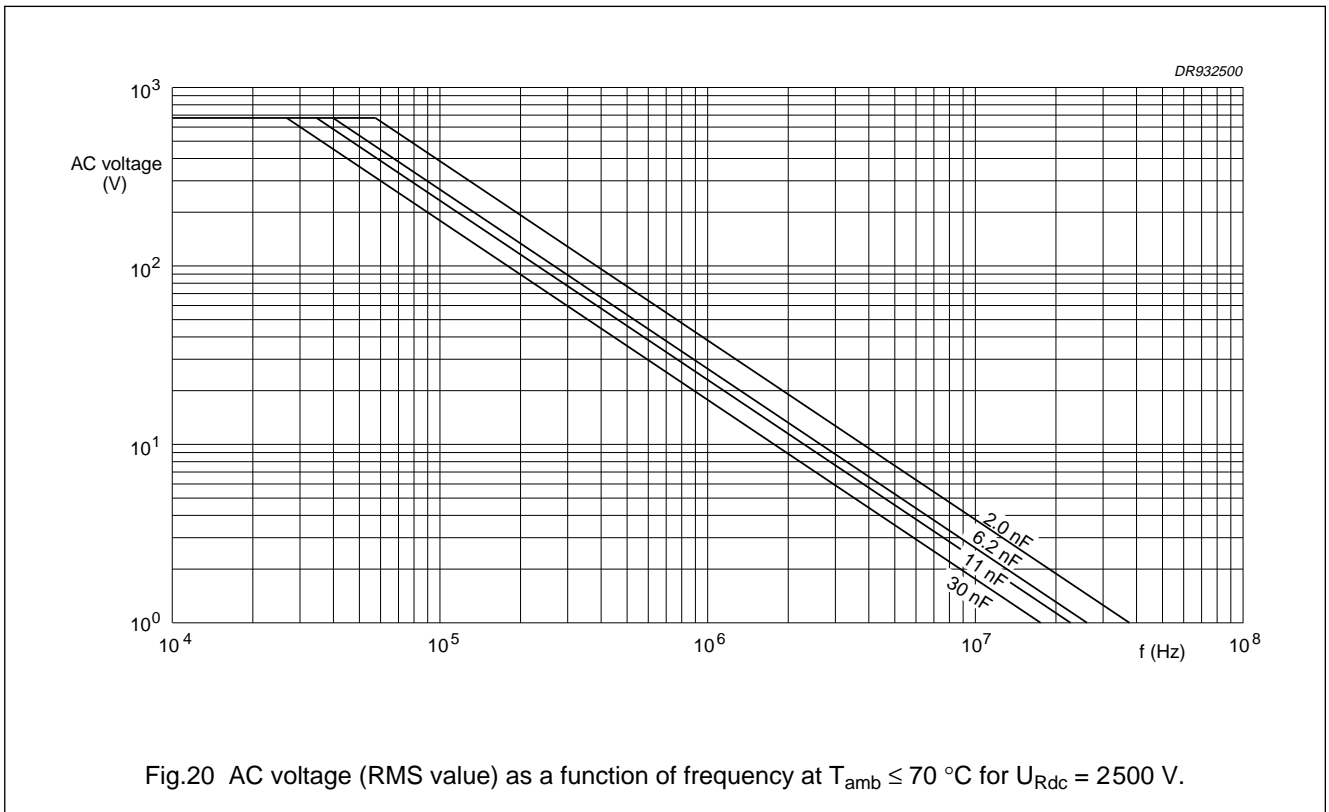
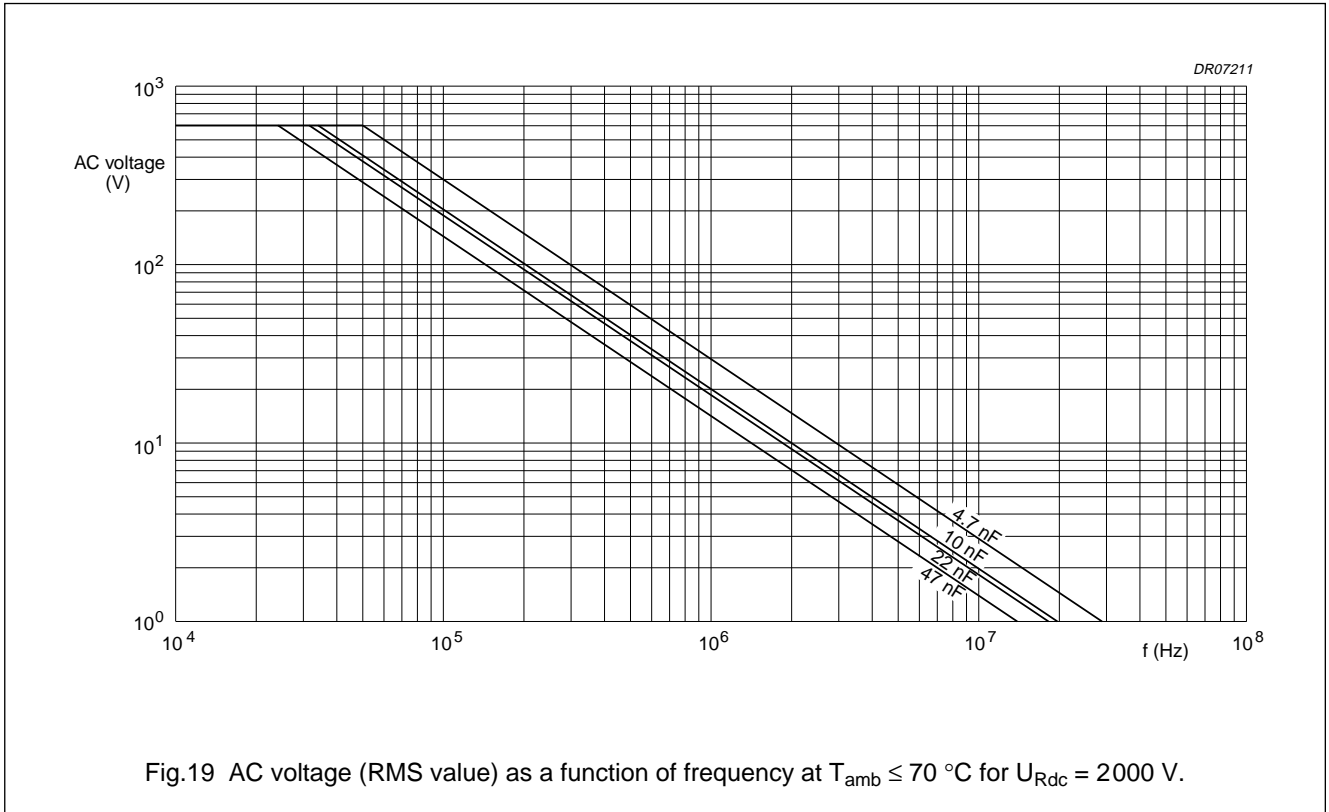


Fig.18 AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 70\text{ }^{\circ}\text{C}$ for $U_{Rdc} = 1600\text{ V}$.

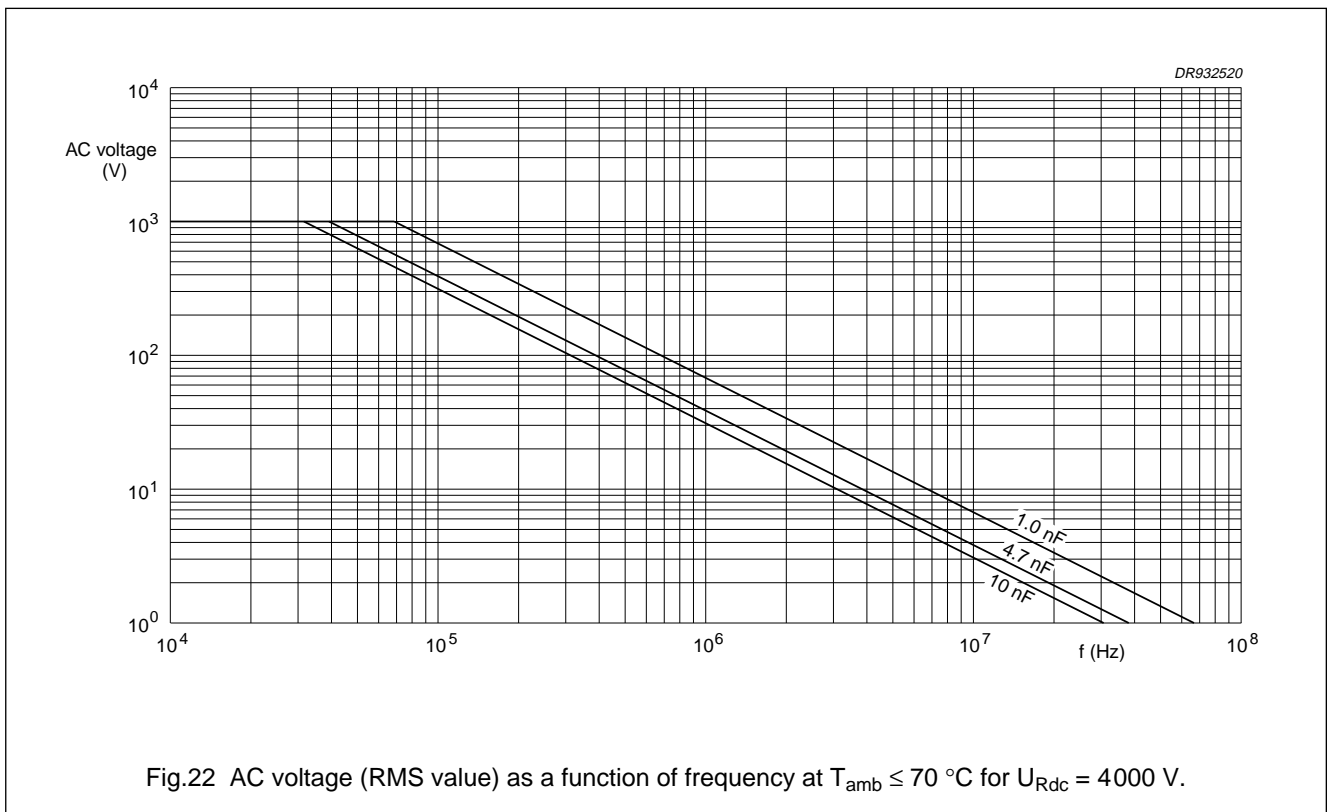
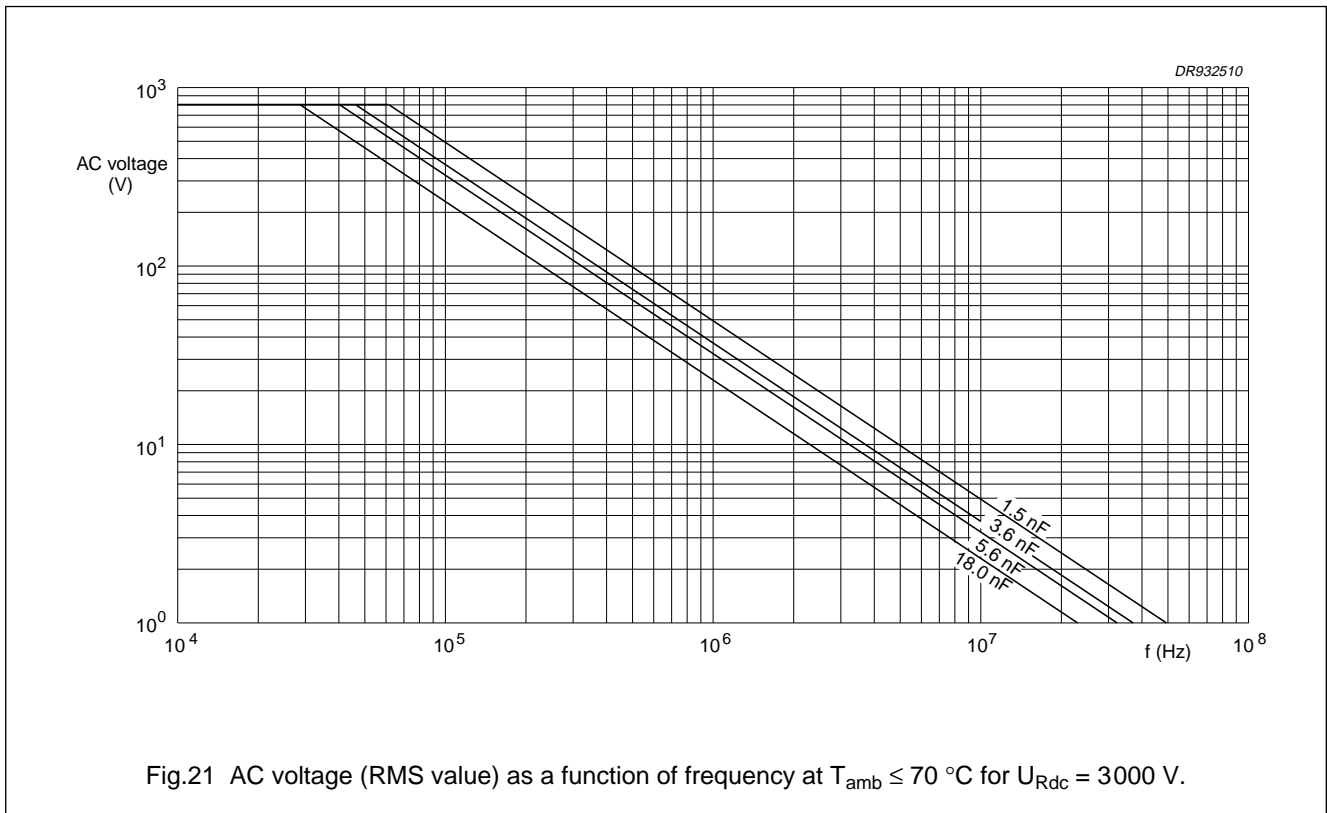
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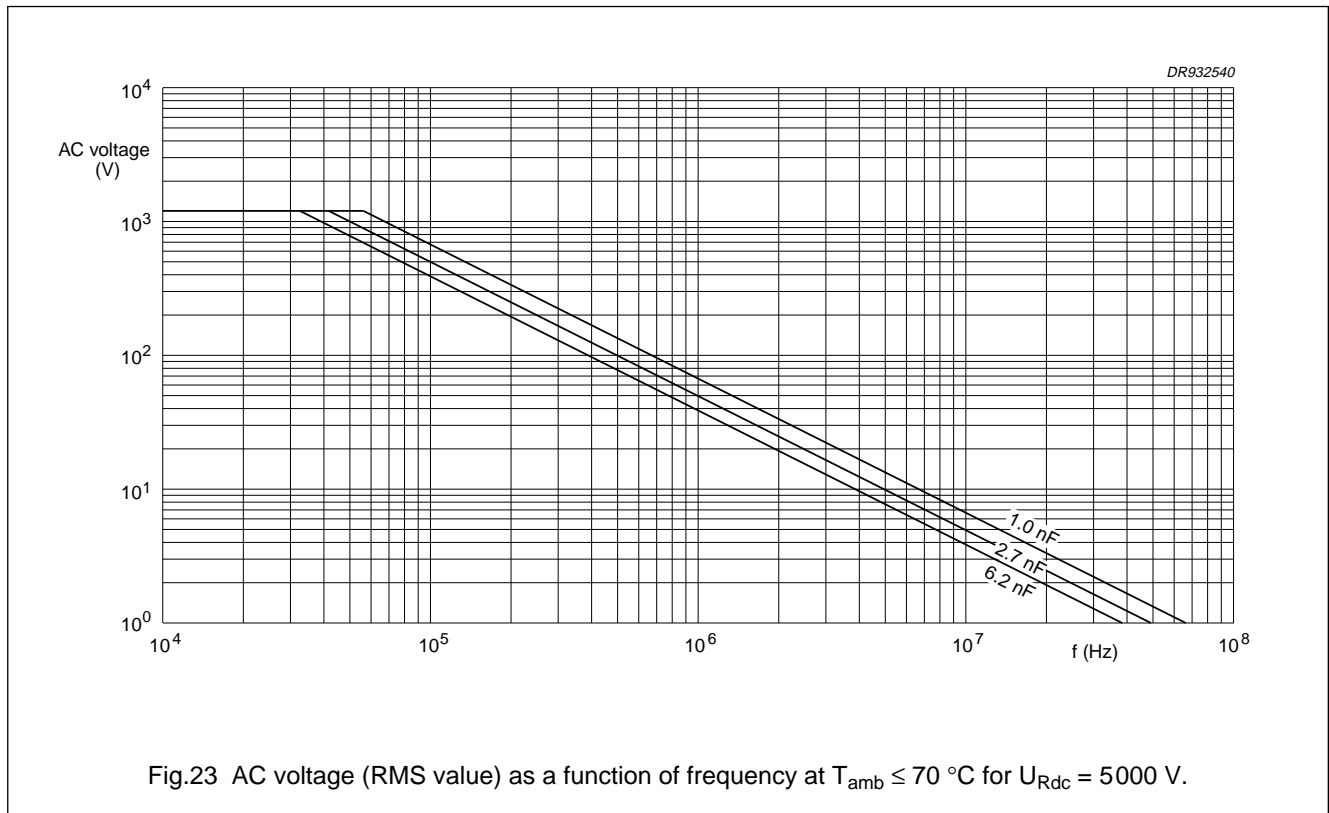
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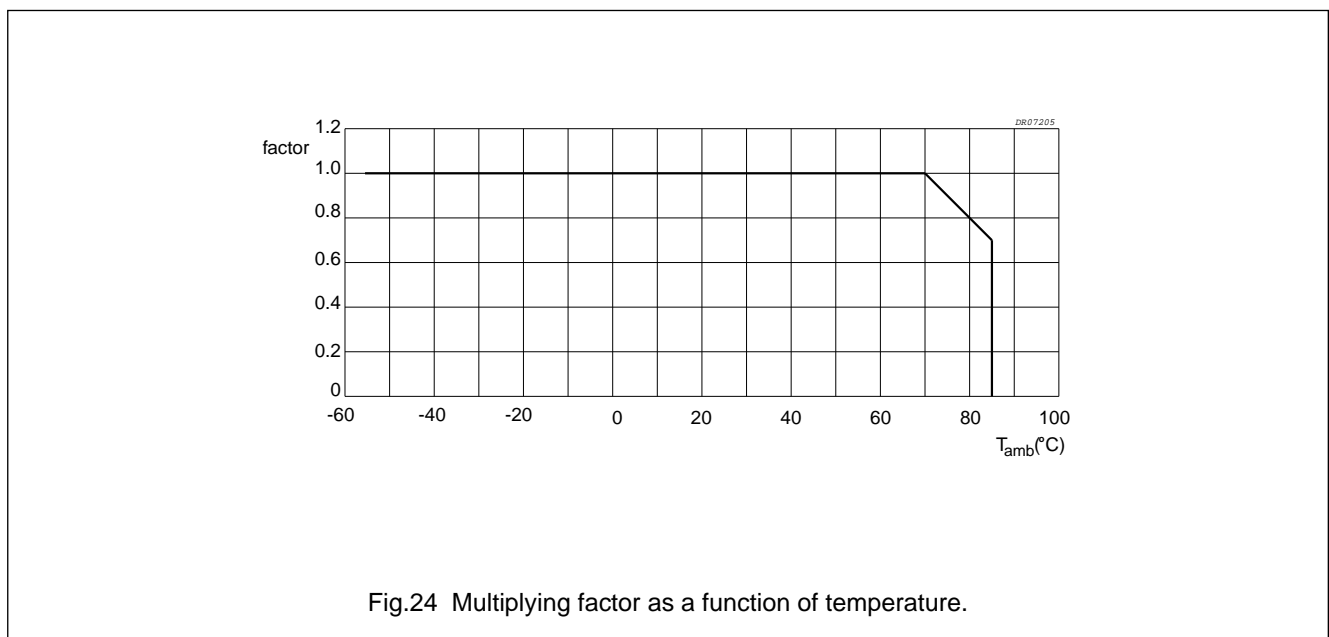
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Maximum RMS voltage (sinewave) as a function of frequency for $T_{amb} > 70\text{ }^{\circ}\text{C}$ (voltage derating)

The maximum RMS voltage in Figs 16 to 23 has to be multiplied by a factor given in Fig.24.

The power dissipation has to be checked, and must not exceed the maximum allowed power shown in Figs 27 and 28.



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Tangent of loss angle

RATED VOLTAGE		CAPACITANCE (μF)	TANGENT OF LOSS ANGLE	
U_{Rdc} (V)	U_{Rac} (V)		at 10 kHz	at 100 kHz
630	300	≤ 0.18	$\leq 8 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
		0.2 to 0.3	$\leq 10 \times 10^{-4}$	$\leq 25 \times 10^{-4}$
		0.33 to 0.39	$\leq 10 \times 10^{-4}$	$\leq 30 \times 10^{-4}$
		0.43 to 0.51	$\leq 10 \times 10^{-4}$	$\leq 40 \times 10^{-4}$
		0.56 to 0.68	$\leq 10 \times 10^{-4}$	$\leq 45 \times 10^{-4}$
1000	400	≤ 0.051	$\leq 6 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
		0.056 to 0.22	$\leq 8 \times 10^{-4}$	$\leq 20 \times 10^{-4}$
1600	500	0.0056 to 0.022	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$
		0.024 to 0.1	$\leq 6 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
2000	600	0.0033 to 0.051	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$
2500	675	≤ 0.030	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$
3000	800	≤ 0.018	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$
4000	1000	≤ 0.010	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$
5000	1200	≤ 0.0062	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$

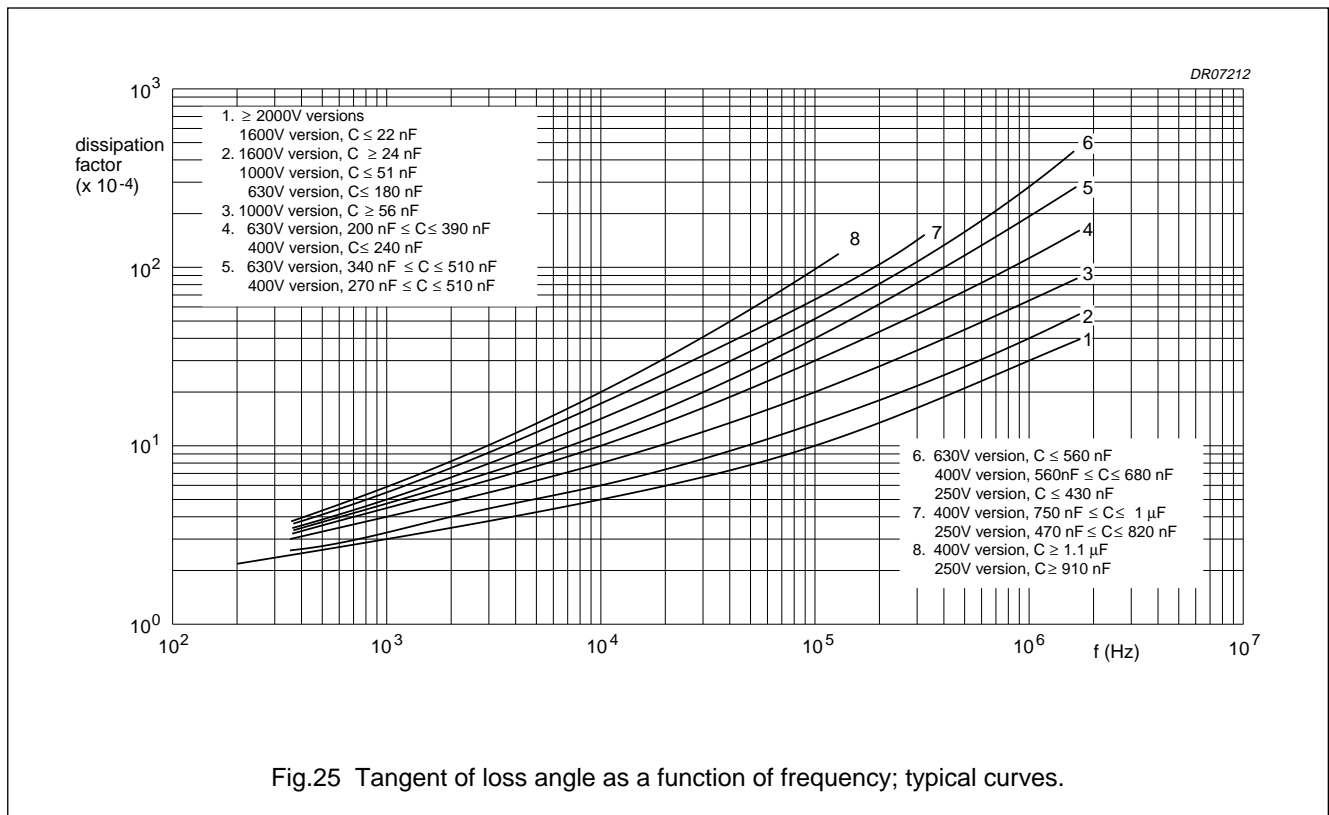


Fig.25 Tangent of loss angle as a function of frequency; typical curves.

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Rated voltage pulse slope

Table 1 Rated voltage pulse slope (dU/dt)_R

RATED VOLTAGE		MAXIMUM RATED PULSE LOAD (V/μs)			
		P = 15.0 mm	P = 22.5 mm	P = 27.5 mm	
U _{Rdc} (V)	U _{Rac} (V)			b < 15 mm	b ≥ 15 mm
630	300	500	370	230	120
1000	400	1300	1200	600	300
1600	500	–	1600	900	450
2000	600	–	2000	1200	600
2500	675	–	2000	2000	1000
3000	800	–	2000	2000	1000
4000	1000	–	–	2000	1000
5000	1200	–	–	2000	1000

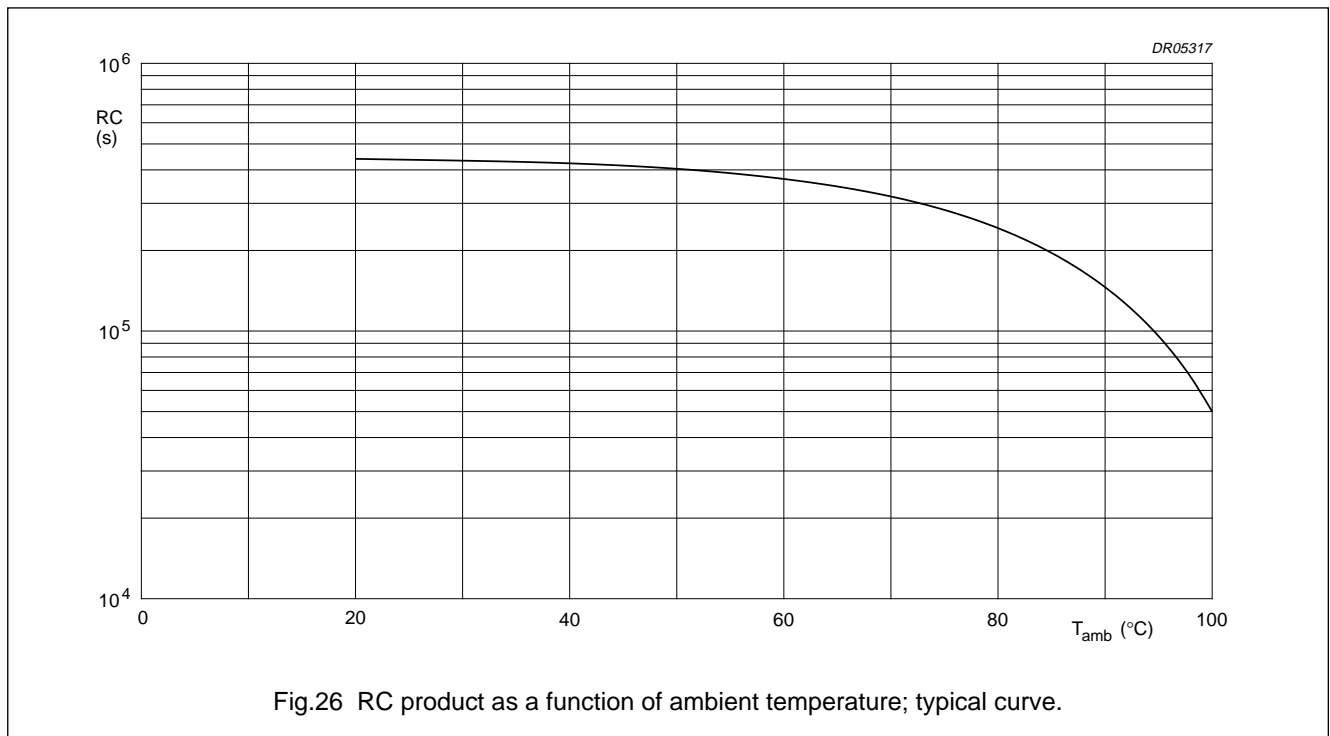
If the pulse voltage is lower than the rated voltage, the values of the specific reference data may be multiplied by U_{Rdc} and divided by the applied peak-to-peak voltage.

The rated voltage pulse slope is valid for ambient temperatures up to 70 °C. For higher temperatures a derating factor of 3% per Kelvin shall be applied.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ±5 seconds, the voltage being 500 ±50 V:

- R between leads, for C ≤ 1 μF: >100000 MΩ
- RC between leads, for C > 1 μF: >100000 s
- R between interconnected leads and case (foil method): >100000 MΩ.



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Maximum dissipation

Power dissipation curves as a function of pitch and capacitor thickness (see Figs 27 and 28)

b _{max} (mm)	PITCH (mm)		
	15	22.5	27.5
5.0	1	–	–
6.0	2	5	–
7.0	3	6	–
8.5	4	7	–
10.0	–	8	–
11.0	–	–	9
13.0	–	–	10
15.0	–	–	11
18.0	–	–	12

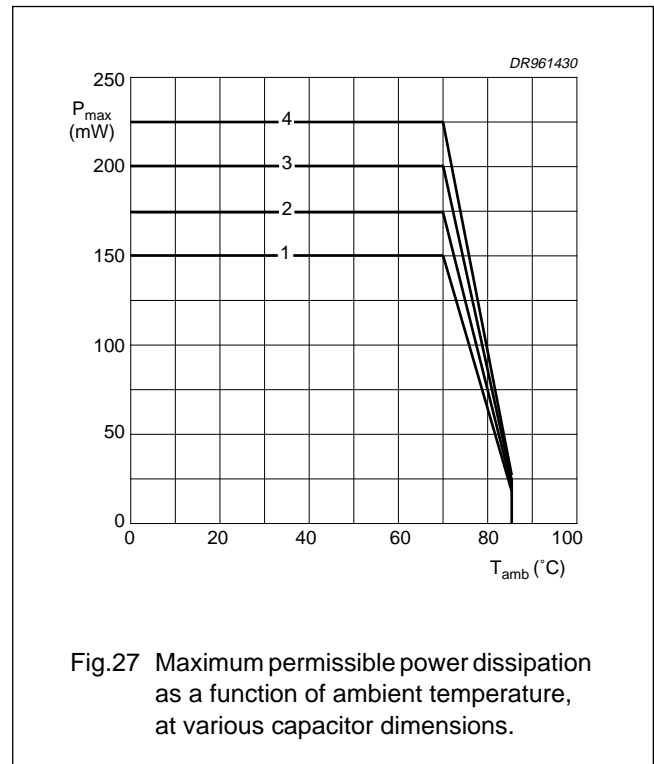


Fig.27 Maximum permissible power dissipation as a function of ambient temperature, at various capacitor dimensions.

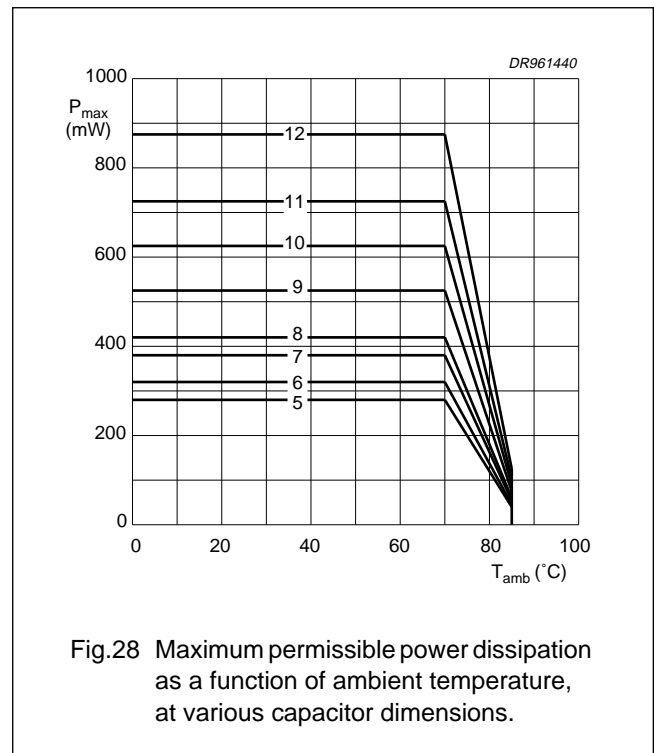


Fig.28 Maximum permissible power dissipation as a function of ambient temperature, at various capacitor dimensions.

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Application note⁽¹⁾

To select the capacitor for a certain application, the following conditions must be checked:

1. The peak voltage (U_p) shall not be greater than the rated DC voltage (U_{Rdc}).
2. The peak-to-peak voltage (U_{p-p}) shall not be greater than $2 \times \sqrt{2}$ times the rated AC voltage (U_{Rac}) to avoid the ionisation inception level.
3. The peak current (I_p) shall not exceed the maximum peak current, defined as maximum voltage pulse slope (dU/dt) multiplied by the capacitance:

$$I_{p\max} = C \left(\frac{dU}{dt} \right)_{\max}$$

Or the voltage pulse slope shall not exceed the rated voltage pulse slope. If the peak-to-peak pulse voltage is lower than the rated voltage, the values (see Table 1 "Rated voltage pulse slope (dU/dt)R" for more details) may be multiplied by U_{Rdc} and divided by the applied peak-to-peak voltage.

4. The dissipated power shall not be greater than the maximum permissible power dissipation as given in Figs 27 and 28.

5. The free air ambient temperature for the capacitor does not exceed the category temperature.
6. Since in circuits used at voltages over 280 V peak-to-peak the risk for an intrinsically active flammability after a capacitor breakdown (short circuit) increases, it is recommended that the power in the capacitor be limited to 10 times the maximum allowed power dissipation (P_{\max}) during the short circuit failure mode of the capacitor.

Example: $C = 10 \text{ nF} - 1600 \text{ V}$ used for the voltage signal shown in Fig.29.

This is a pulse with:

$$U_{p-p} = 1200 \text{ V}; U_p = 1100 \text{ V}; T_1 = 12 \mu\text{s}; T_2 = 64 \mu\text{s}; T_3 = 4 \mu\text{s}$$

The ambient temperature is $50 \text{ }^\circ\text{C}$.

Checking the conditions:

1. The peak voltage $U_p = 1100 \text{ V}$ is lower than 1600 V (DC).
2. The peak-to-peak voltage 1200 V is lower than $2 \times \sqrt{2} \times 500 \text{ V (AC)} = 1414 U_{p-p}$.
3. The voltage pulse slope $dU/dt = 1200 \text{ V}/4\mu\text{s} = 300 \text{ V}/\mu\text{s}$. This is lower than $1600 \text{ V}/\mu\text{s}$ (see specific reference data for each version).
4. The dissipated power is 270 mW as calculated with Fourier terms. This is less than 320 mW , allowed for a capacitor with dimensions: $b_{\max} = 7.0 \text{ mm}$ and pitch = 22.5 mm .
5. The free air ambient temperature is more than $50 \text{ }^\circ\text{C}$, and lower than $70 \text{ }^\circ\text{C}$.
6. In case of failure, the power is switched off.

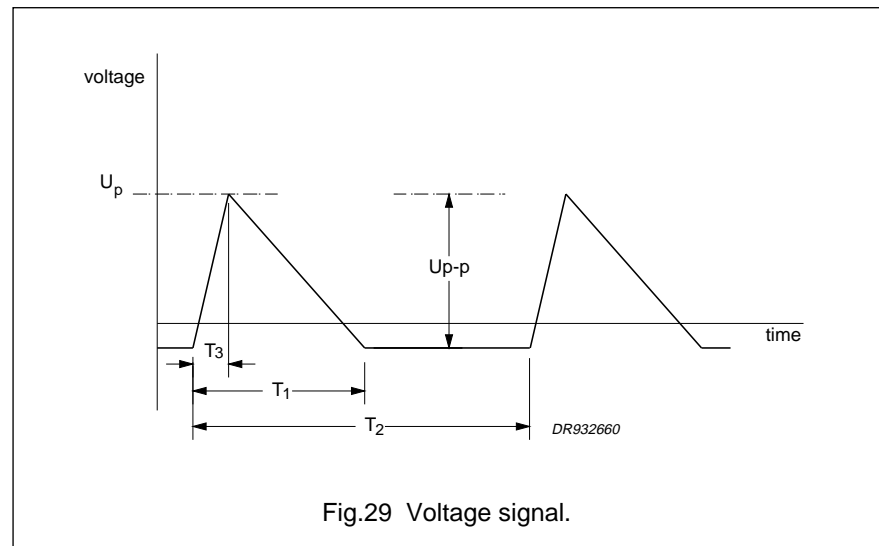


Fig.29 Voltage signal.

(1) Peak-to-peak current tables for S-correction application, are available on request.

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MARKING

Product marking

CAPACITORS WITH PITCH 15 TO 27.5 mm

The capacitors are marked by laser print; on the top (pitch ≥ 22.5 mm) or on the top and one side (pitch = 15 mm), with the following information:

1. Rated capacitance code in accordance with "IEC 62"
2. Tolerance on rated capacitance: J = $\pm 5\%$
3. Rated voltage (DC) (e.g. 1000 V)
4. Code for dielectric material (MKP/MKP)
5. Code for factory of origin (HQ)
6. Manufacturer's type designation (378)
7. Manufacturer' name (PHILIPS)
8. Year and week of manufacture (e.g. 9225).

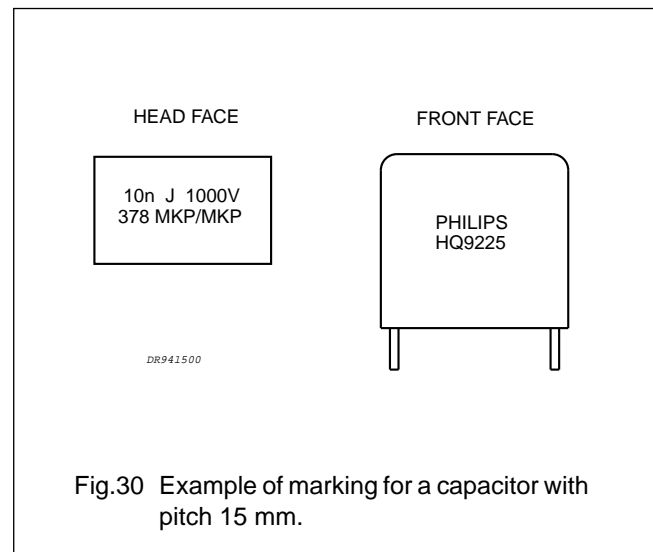


Fig.30 Example of marking for a capacitor with pitch 15 mm.

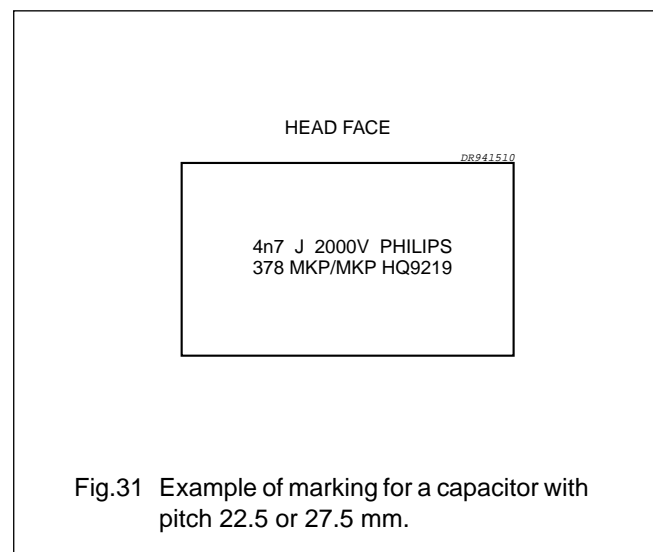


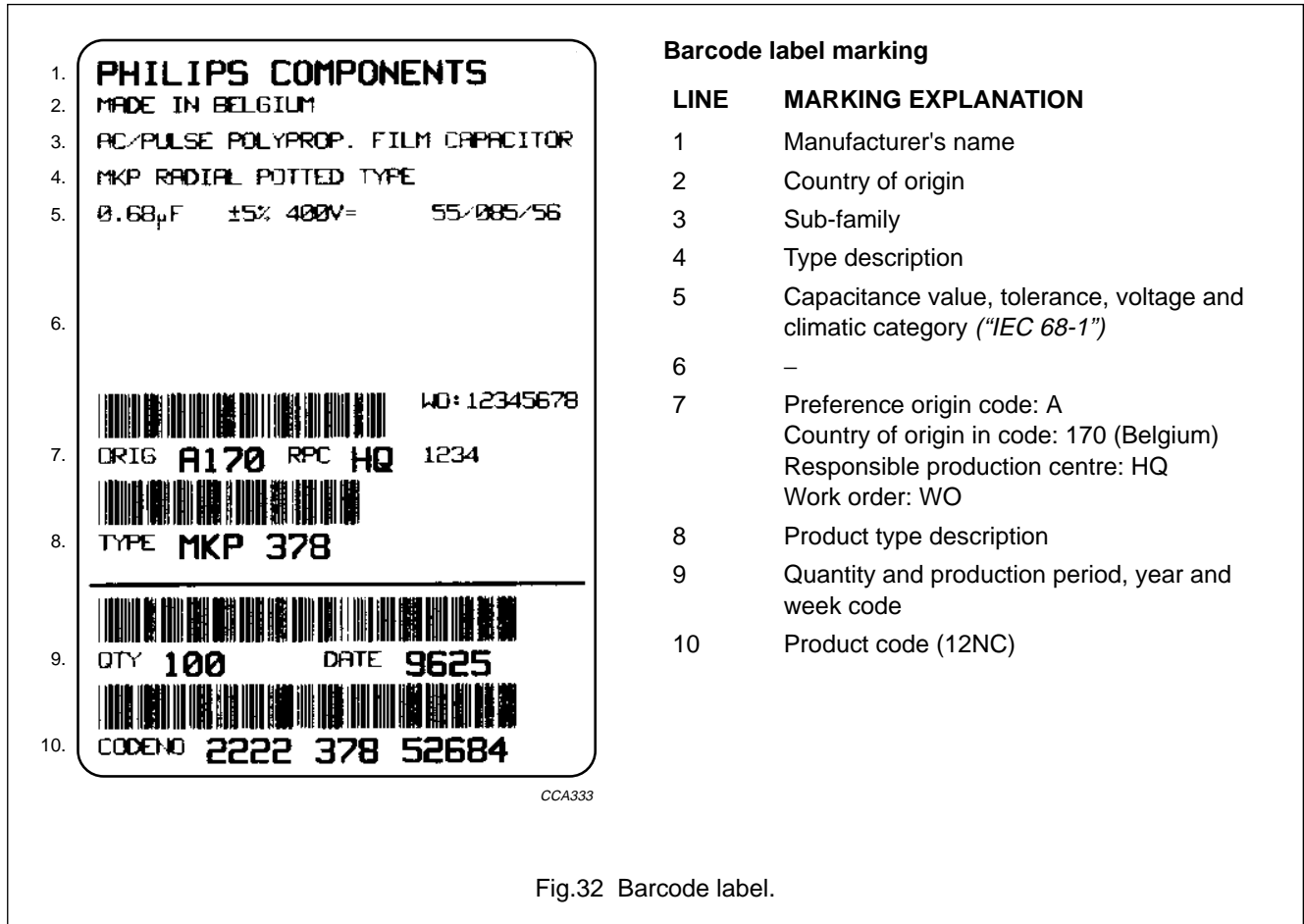
Fig.31 Example of marking for a capacitor with pitch 22.5 or 27.5 mm.

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Package marking

The package containing the capacitors is marked as shown in Fig.32.



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QUICK REFERENCE TEST REQUIREMENTS (see note 1)

TEST	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of leads		
Tensile and bending: "IEC 68-2-21"	solder bath: 260 °C; 10 s isopropyl alcohol; 23 °C; 5 minutes	no visible damage legible marking
Resistance to soldering heat: "IEC 68-2-20"		$ \Delta C/C \leq 1\%$
Component solvent resistance		$\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF)
Robustness of component		
Vibration: "IEC 68-2-6"	10 Hz to 55 Hz; amplitude 0.75 mm or acceleration 98 m/s ² ; 6 hours	$ \Delta C/C \leq 1\%$ $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF)
Shock: "IEC 68-2-27"	half sinewave; 490 m/s ² ; 11 ms	$\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF)
Climatic sequence		
Dry heat: "IEC 68-2-2"	16 hours; 85 °C	$ \Delta C/C \leq 1\%$ (22.5/27.5 mm pitch) $ \Delta C/C \leq 2\%$ (15 mm pitch)
Damp heat, cyclic, test Db, first cycle: "IEC 68-2-30"	2 hours; -55 °C	$\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF)
Cold: "IEC 68-2-1"		$\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF)
Damp heat, cyclic, test Db, remaining cycles: "IEC 68-2-30"		$R_{ins} \geq 50\%$ of specified value

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TEST	PROCEDURE (quick reference)	REQUIREMENTS
Other applicable tests		
Damp heat, steady state: "IEC 68-2-3"	56 days; 40 °C; 90 to 95% RH	$ \Delta C/C \leq 1\%$ (22.5/27.5 mm pitch) $ \Delta C/C \leq 2\%$ (15 mm pitch) $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF) $\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF) $R_{ins} \geq 50\%$ of specified value
Endurance (AC): "IEC 384-17"	1000 h: 85 °C $1.25 \times U_{Rac}$ (RMS); 50 Hz	$ \Delta C/C \leq 5\%$ $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF) $\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF) $R_{ins} \geq 50\%$ of specified value
Heat storage: "IEC 384-17"	2000 hours; 85 °C	$ \Delta C/C \leq 1\%$ (22.5/27.5 mm pitch) $ \Delta C/C \leq 2\%$ (15 mm pitch) $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF) $\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF)
Resistance to soldering heat with preheating: "IEC 384-17"	body temperature: 85 °C; bath temperature: 260 °C; dwell time: 10 s	$ \Delta C/C \leq 1\%$ $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF) $\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF)
Passive flammability: "IEC 695-2-2"	class C	no burning
Endurance (DC): "IEC 384-17"	2000 hours; $1.25 \times U_{Rdc}$; 85 °C	$ \Delta C/C \leq 1\%$ (22.5/27.5 mm pitch) $ \Delta C/C \leq 2\%$ (15 mm pitch) $\Delta \tan \delta \leq 5 \times 10^{-4}$ ($C \leq 100$ nF) $\Delta \tan \delta \leq 10 \times 10^{-4}$ (100 nF < $C \leq 470$ nF) $\Delta \tan \delta \leq 15 \times 10^{-4}$ ($C > 470$ nF) $R_{ins} \geq 50\%$ of specified value

Note

- For detailed information, see "Type specification".