VISHAY BCcomponents

MKP 378 MKP/MKP 378 AC and Pulse metallized polypropylene film capacitor

File under TPD sheet 190, HQN-384-17/102

Pb-free

AC and Pulse Metallized Polypropylene Film Capacitors MKP and MKP/MKP Radial Potted Type

APPLICATIONS
Where steep pulses occur e.g. SMPS (switch mode power supplies). Motor control circuits. S-correction. It is not advised to use these products as resonance capacitors in fly-back applications

MARKING
C-value; tolerance; rated voltage; manufacturer's type designation; code for dielectric material; manufacturer's emblem; code for factory of origin; year and week of manufacture

DIELECTRIC
Polypropylene film

ELECTRODES
Metallized film

ENCAPSULATION
Flame retardant plastic case and epoxy resin
(UL-class 94 V-0)

CONSTRUCTION
Internal serial construction

LEADS
Tinned wire (e3)

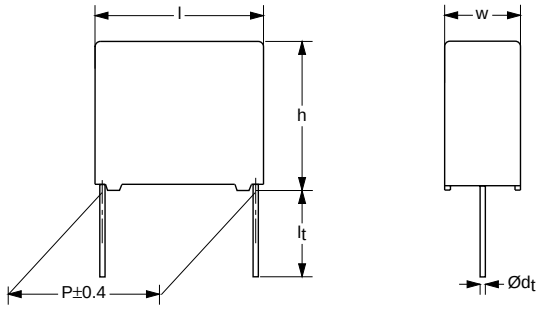
CAPACITANCE RANGE (E24 SERIES)
MKP: 0.18 to 3.3 µF
MKP/MKP: 0.003 to 0.68 µF

CAPACITANCE TOLERANCE
±5%

RATED (DC)VOLTAGE
MKP: 250V; 400V
MKP/MKP: 630V; 1000V; 1600V; 2000V

RATED (AC) VOLTAGE
MKP: 160V; 200V
MKP/MKP: 300V; 400V; 500V; 600V

RATED PEAK-TO-PEAK VOLTAGE
MKP: 450V; 560V
MKP/MKP: 850V; 1130V; 1400V; 1700V



CBB817

CLIMATIC CATEGORY
55/085/56

RATED (DC) TEMPERATURE
85 °C

RATED (AC) TEMPERATURE
70 °C

MAXIMUM APPLICATION TEMPERATURE
85 °C

REFERENCE SPECIFICATIONS
IEC 60384-17

PERFORMANCE GRADE
Grade 1 (long life)

STABILITY GRADE
Pitch 15 mm: grade 2
Pitch 22.5 and 27.5 mm: grade 1

FEATURES
15.0 to 27.5 mm pitch.
Supplied loose in box, taped on reel
RoHS compliant

DETAIL INSPECTION AND TEST REQUIREMENTS
See Technical Product Documentation sheet 191.

COMPOSITION OF CATALOGUE NUMBER

TYPE AND PITCHES	
378	15.0 mm
	22.5 mm
	27.5 mm

CAPACITANCE (numerically)

MULTIPLIER (nF)	
0.1	2
1	3
10	4

Example:
104= 10 x 10 = 100 nF

2222	**378**	**XX**	**XX**	**X**
BFC2(*)	**378**	**XX**	**XX**	**X**

(*) Use this part number for those with access to the Vishay SAP system and Partners websites within the Americas

TYPE	PACKAGING	LEAD CONFIGURATION	PREFERRED TYPES						
			C-TOL	250V	400V	630V	1000V	1600V	2000V
378 MKP/MKP	loose in box	lead length 3.5 ± 0.3 mm	±5%	-	-	64	74	84	94
			ON REQUEST						
378 MKP	loose in box	lead length 3.5 ± 0.3 mm	±5%	44	54	-	-	-	-
	loose in box	lead length 5.0 ± 1.0 mm		42	52	-	-	-	-
	Taped on reel	H = 18.5 mm; P_0 = 12.7 mm		45	55	-	-	-	-
378 MKP/MKP	loose in box	lead length 5.0 ± 1.0 mm	±5%	-	-	62	72	82	92
	Taped on reel	H = 18.5 mm; P_0 = 12.7 mm		-	-	65	75	85	95

AVAILABLE VERSIONS 378 MKP/MKP ON SPECIAL REQUEST				
Pitch = 15.0 ± 0.4 mm; w x h x l = 8.5mm x 15.0mm x 17.5 mm				
Voltage (V DC)	C (µF)	Loose in box; SPQ=1000		Taped on reel; SPQ=650
		lead length 3.5 ± 0.3 mm	lead length 5.0 ± 1.0 mm	H = 18.5 mm; P_0 = 12.7 mm
630	0.056	2222 378 90042	2222 378 90043	2222 378 90044
	0.068	2222 378 90046	2222 378 90047	2222 378 90048
1000	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

Specific reference data MKP (250VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.43 µF	≤15 x 10^{-4}	≤45 x 10^{-4}
0.47 µF ≤ C ≤ 0.62 µF	≤15 x 10^{-4}	≤55 x 10^{-4}
0.68 µF ≤ C ≤ 0.82 µF	≤15 x 10^{-4}	≤60 x 10^{-4}
0.91 µF ≤ C ≤ 1.0 µF	≤20 x 10^{-4}	≤90 x 10^{-4}
1.1 µF ≤ C ≤ 3.3 µF	≤20 x 10^{-4}	≤200 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$: Pitch = 22.5 mm Pitch = 27.5 mm Pitch = 27.5 mm	 90 V/µs 60 V/µs (w < 15mm) 30 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 100 V; 1 minute	> 100 000 MΩ	
RC between leads, for C > 1 µF at 100 V; 1 minute	> 100 000 s	
Ionization (AC) voltage (typical value) at 50 pC peak discharge	> 220 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	400 V; 1 minute	
Withstanding (DC) voltage between leads and case	500 V; 1 minute	

U_{Rdc} = 250 V; U_{Rac} = 160 V; U_{p-p}=450V

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 …AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 5.0±1.0 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.33 0.36 0.39	7.0x16.5x26.0	2.9	42334 42364 42394	200	550
0.43 0.47 0.51 0.56 0.62	8.5x18.0x26.0	3.8	42434 42474 42514 42564 42624	200	450
0.68 0.75 0.82	10.0x19.5x26.0	6.8	42684 42754 42824	200	350
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.91 1.0 1.1 1.2 1.3	11.0x21.0x31.0	7.4	42914 42105 42115 42125 42135	100	
1.5 1.6 1.8	13.0x23.0x31.0	9.2	42155 42165 42185	100	
2.0 2.2	15.0x25.0x31.0	12.3	42205 42225	100	
2.4 2.7 3.0 3.3	18.0x28.0x31.0	16.1	42245 42275 42305 42335	100	

Specific reference data MKP (400VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.24 µF	≤10 x 10^{-4}	≤30 x 10^{-4}
0.27 µF ≤ C ≤ 0.36 µF	≤10 x 10^{-4}	≤35 x 10^{-4}
0.39 µF ≤ C ≤ 0.51 µF	≤10 x 10^{-4}	≤40 x 10^{-4}
0.56 µF ≤ C ≤ 0.68 µF	≤15 x 10^{-4}	≤50 x 10^{-4}
0.75 µF ≤ C ≤ 1.0 µF	≤15 x 10^{-4}	≤70 x 10^{-4}
1.1 µF ≤ C ≤ 2.0 µF	≤15 x 10^{-4}	≤150 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$: Pitch = 22.5 mm Pitch = 27.5 mm Pitch = 27.5 mm	 100 V/µs 70 V/µs (w < 15mm) 35 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 100V; 1 minute	> 100 000 MΩ	
RC between leads, for C > 1 µ F at 100V; 1 minute	> 100 000 s	
Ionization (AC) voltage (typical value) at 50 pC peak discharge	> 250 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	640 V; 1 minute	
Withstanding (DC) voltage between leads and case	800 V; 1 minute	

U_{Rdc} = 400 V; U_{Rac} = 200 V; U_{p-p}=560V

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 …AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 5.0±1.0 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.18 0.20 0.22	7.0x16.5x26.0	2.9	52184 52204 52224	200	550
0.24 0.27 0.30 0.33	8.5x18.0x26.0	3.8	52244 52274 52304 52334	200	450
0.36 0.39 0.43 0.47	10.0x19.5x26.0	6.8	52364 52394 52434 52474	200	350
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.51 0.56 0.62 0.68	11.0x21.0x31.0	7.4	52514 52564 52624 52684	100	
0.75 0.82 0.91 1.0	13.0x23.0x31.0	9.2	52754 52824 52914 52105	100	
1.1 1.2 1.3	15.0x25.0x31.0	12.3	52115 52125 52135	100	
1.5 1.6 1.8 2.0	18.0x28.0x31.0	16.1	52155 52165 52185 52205	100	

Specific reference data MKP/MKP (630VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.18 µF	≤8 x 10^{-4}	≤15 x 10^{-4}
0.20 µF ≤ C ≤ 0.30 µF	≤10 x 10^{-4}	≤25 x 10^{-4}
0.33 µF ≤ C ≤ 0.39 µF	≤10 x 10^{-4}	≤30 x 10^{-4}
0.43 µF ≤ C ≤ 0.51 µF	≤10 x 10^{-4}	≤40 x 10^{-4}
C > 0.51 µF	≤10 x 10^{-4}	≤45 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$: Pitch = 15 mm Pitch = 22.5 mm Pitch = 27.5 mm Pitch = 27.5 mm	 500 V/µs 370 V/µs 230 V/µs (w < 15mm) 120 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 500 V; 1 minute	> 100 000 MΩ	
R between leads and case; 500 V; 1 minute	> 100 000 MΩ	
Ionization (AC) voltage (typical value) at 50 pC peak discharge	> 400 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	1008 V; 1 minute	
Withstanding (DC) voltage between leads and case	2840 V; 1 minute	

U_{Rdc} = 630 V; U_{Rac} = 300 V; U_{p-p}=850V

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 …AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 15.0 ± 0.4 mm; d_t = 0.60 ± 0.06 mm					
0.015	5.0x11.0x17.5	1.0	64153	1000	1100
0.016			64163		
0.018			64183		
0.020			64203		
0.022			64223		
0.024	6.0x12.0x17.5	1.4	64243	1000	900
0.027			64273		
0.030			64303		
0.033			64333		
Pitch = 15.0 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.036	7.0x13.5x17.5	1.8	64363	1000	800
0.039			64393		
0.043			64433		
0.047	8.5x15.0x17.5	2.4	64473	1000	650
0.051			64513		
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.056	6.0x15.5x26.0	2.4	64563	300	600
0.062			64623		
0.068	7.0x16.5x26.0	2.9	64683	200	550
0.075			64753		
0.082			64823		
0.091			64913		
0.10	8.5x18.0x26.0	3.8	64104	200	450
0.11			64114		
0.12			64124		
0.13			64134		
0.15	10.0x19.5x26.0	6.8	64154	200	350
0.16			64164		
0.18			64184		

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 ...AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.20	11.0x21.0x31.0	7.4	64204	100	
0.22			64224		
0.24			64244		
0.27			64274		
0.30	13.0x23.0x31.0	9.2	64304	100	
0.33			64334		
0.36			64364		
0.39			64394		
0.43	15.0x25.0x31.0	12.3	64434	100	
0.47			64474		
0.51			64514		
0.56	18.0x28.0x31.0	16.1	64564	100	
0.62			64624		
0.68			64684		

Specific reference data MKP/MKP (1000VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.051 µF	≤6 x 10^{-4}	≤15 x 10^{-4}
0.056 µF ≤ C ≤ 0.22 µF	≤8 x 10^{-4}	≤20 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$:		
Pitch = 15 mm	1300 V/µs	
Pitch = 22.5 mm	1200 V/µs	
Pitch = 27.5 mm	600 V/µs (w < 15mm)	
Pitch = 27.5 mm	300 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 500 V; 1 minute	> 100 000 MΩ	
R between leads and case; 500 V; 1 minute	> 100 000 MΩ	
Ionization (AC) voltage (typical value) at 50 pC peak discharge	> 500 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	1600 V; 1 minute	
Withstanding (DC) voltage between leads and case	2840 V; 1 minute	

U_{Rdc} = 1000 V; U_{Rac} = 400 V; U_{p-p}=1130V

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 ...AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 15.0 ± 0.4 mm; d_t = 0.60 ± 0.06 mm					
0.0030	5.0x11.0x17.5	1.0	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		

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 ...AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
0.0082	6.0x12.0x17.5	1.4	74822	1000	900
0.0091			74912		
0.010			74103		
0.011			74113		
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.012	6.0x15.5x26.0	2.4	74123	300	600
0.013			74133		
0.015			74153		
0.016			74163		
0.018			74183		
0.020	7.0x16.5x26.0	2.9	74203	200	550
0.022			74223		
0.024			74243		
0.027	8.5x18.0x26.0	3.8	74273	200	450
0.030			74303		
0.033			74333		
0.036			74363		
0.039	10.0x19.5x26.0	6.8	74393	200	350
0.043			74433		
0.047			74473		
0.051			74513		
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.056	11.0x21.0x31.0	7.4	74563	100	
0.062			74623		
0.068			74683		
0.075			74753		
0.082			74823		
0.091	13.0x23.0x31.0	9.2	74913	100	
0.10			74104		
0.11			74114		
0.12	15.0x25.0x31.0	12.3	74124	100	
0.13			74134		
0.15			74154		
0.16	18.0x28.0x31.0	16.1	74164	100	
0.18			74184		
0.20			74204		
0.22			74224		

Specific reference data MKP/MKP (1600VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.022µF	≤5 x 10^{-4}	≤10 x 10^{-4}
0.024 µF ≤ C ≤ 0.1 µF	≤6 x 10^{-4}	≤15 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$: Pitch = 22.5 mm Pitch = 27.5 mm Pitch = 27.5 mm	1600 V/µs 900 V/µs (w < 15mm) 450 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 500 V; 1 minute	> 100 000 MΩ	
R between leads and case; 500 V; 1 minute	> 100 000 MΩ	
Ionization (AC) voltage (typical value) at 20 pC peak discharge	> 600 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	2560 V; 1 minute	
Withstanding (DC) voltage between leads and case	2840 V; 1 minute	

U_{Rdc} = 1600 V; U_{Rac} = 500 V; U_{p-p}=1400V

C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 …AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.0056 0.0062 0.0068	6.0x15.5x26.0	2.4	84562 84622 84682	300	600
0.0075 0.0082 0.0091 0.010	7.0x16.5x26.0	2.9	84752 84822 84912 84103	200	550
0.011 0.012 0.013 0.015 0.016	8.5x18.0x26.0	3.8	84113 84123 84133 84153 84163	200	450
0.018 0.020 0.022	10.0x19.5x26.0	6.8	84183 84203 84223	200	350
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.024 0.027 0.030 0.033 0.036	11.0x21.0x31.0	7.4	84243 84273 84303 84333 84363	100	
0.039 0.043 0.047 0.051	13.0x23.0x31.0	9.2	84393 84433 84473 84513	100	
0.056 0.062 0.068	15.0x25.0x31.0	12.3	84563 84623 84683	100	
0.075 0.082 0.091 0.10	18.0x28.0x31.0	16.1	84753 84823 84913 84104	100	

Specific reference data MKP/MKP (2000VDC)

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
C ≤ 0.051µF	≤5 x 10^{-4}	≤10 x 10^{-4}
Rated voltage pulse slope $(dU/dt)_R$: Pitch = 22.5 mm Pitch = 27.5 mm Pitch = 27.5 mm	2000 V/µs 1200 V/µs (w < 15mm) 600 V/µs (w ≥ 15mm)	
R between leads, for C ≤ 1 µF at 500 V; 1 minute	> 100 000 MΩ	
R between leads and case; 500 V; 1 minute	> 100 000 MΩ	
Ionization (AC) voltage (typical value) at 20 pC peak discharge	> 600 V	
Withstanding (DC)voltage (cut off current 10 mA); rise time 100 V/s:	3200 V; 1 minute	
Withstanding (DC) voltage between leads and case	2840 V; 1 minute	

U_{Rdc} = 2000 V; U_{Rac} = 600 V; U_{p-p}=1700V

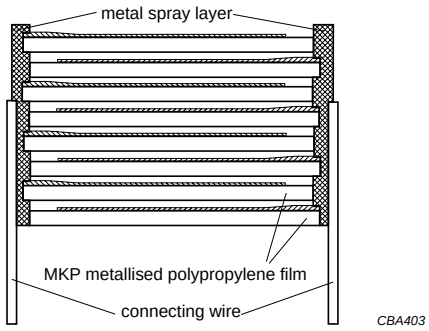
C (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOGUE NUMBER 2222 378 …AND PACKAGING		
			LOOSE IN BOX		REEL
			L_t= 3.5±0.3 mm	all leads	
			Last 5 digits	SPQ	SPQ
Pitch = 22.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.0033 0.0036	6.0x15.5x26.0	2.4	94332 94362	300	600
0.0039 0.0043 0.0047 0.0051	7.0x16.5x26.0	2.9	94392 94432 94472 94512	200	550
0.0056 0.0062 0.0068 0.0075 0.0082	8.5x18.0x26.0	3.8	94562 94622 94682 94752 94822	200	450
0.0091 0.010 0.011 0.012	10.0x19.5x26.0	6.8	94912 94103 94113 94123	200	350
Pitch = 27.5 ± 0.4 mm; d_t = 0.80 ± 0.08 mm					
0.013 0.015 0.016 0.018 0.020	11.0x21.0x31.0	7.4	94133 94153 94163 94183 94203	100	
0.022 0.024 0.027	13.0x23.0x31.0	9.2	94223 94243 94273	100	
0.030 0.033 0.036	15.0x25.0x31.0	12.3	94303 94333 94363	100	
0.039 0.043 0.047 0.051	18.0x28.0x31.0	16.1	94393 94433 94473 94513	100	

CONSTRUCTION

Description

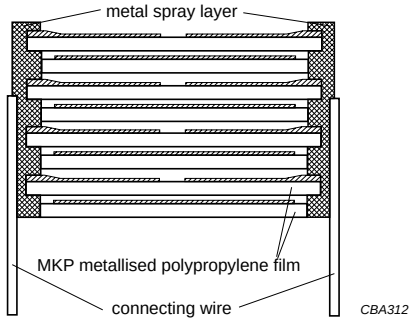
- Low-inductive wound cell of metallized polypropylene (PP) film, potted with epoxy resin in a flame-retardant polypropylene case
- Radial leads, solder-coated:
- Small stand-off pips allow removal of solder flux etc. during cleaning of the printed-circuit board.

1 SECTION



CBA403
Construction: MKP 250-400V versions; 160-200 V (AC)

2 SECTIONS



CBA312
Construction: MKP/MKP 630-2000V versions; 300-600 V (AC)

Mounting

NORMAL USE

The capacitors are designed for mounting on printed-circuit boards. 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 Type detail specification *"HQN-384-01/102, Packaging information"*.

SPECIFIC METHOD OF MOUNTING TO WITHSTAND VIBRATION AND SHOCK

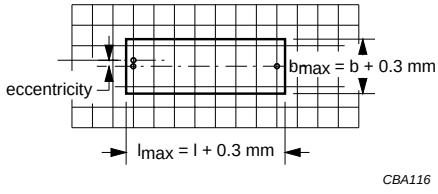
In order to withstand vibration and shock tests, it must be ensured that the stand-off pips are in good contact with the printed-circuit board:

- For pitches of15 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 length and width of film capacitors is shown in Figure:

- Eccentricity as in Figure. 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 60717" as reference: hmax ≤ h +0.3 mm



CBA116

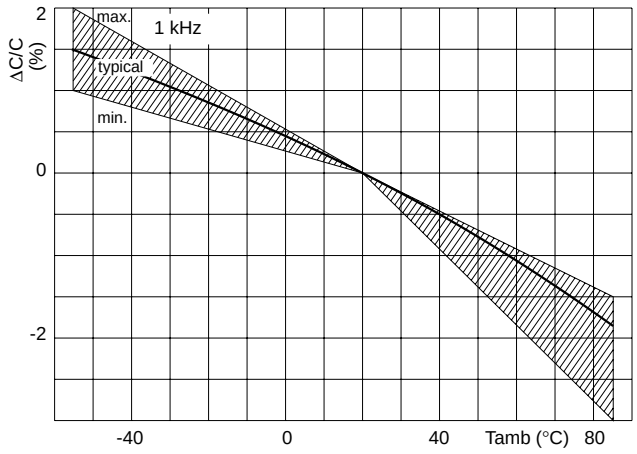
RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

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

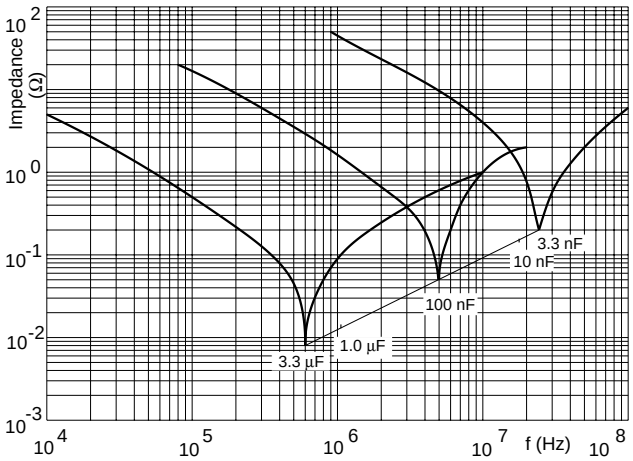
CHARACTERISTICS

Capacitance



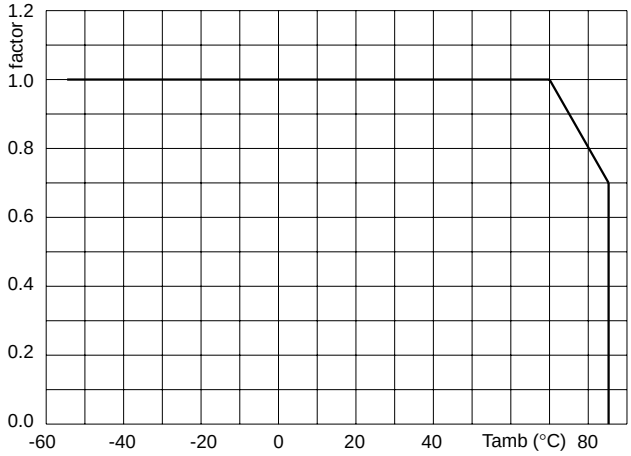
CBB828

Impedance



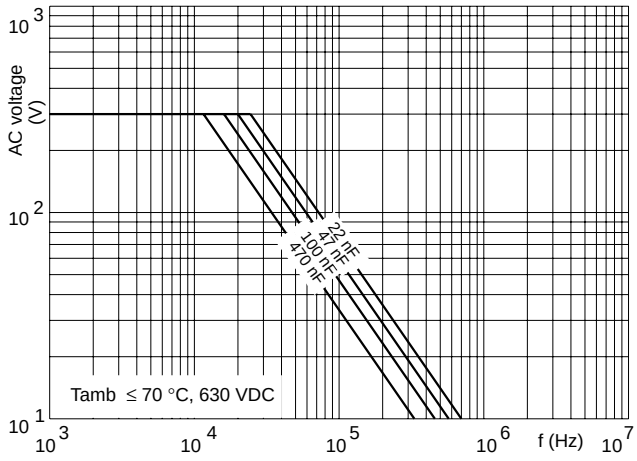
CBB829

Max RMS voltage (sinewave) as a function of temperature

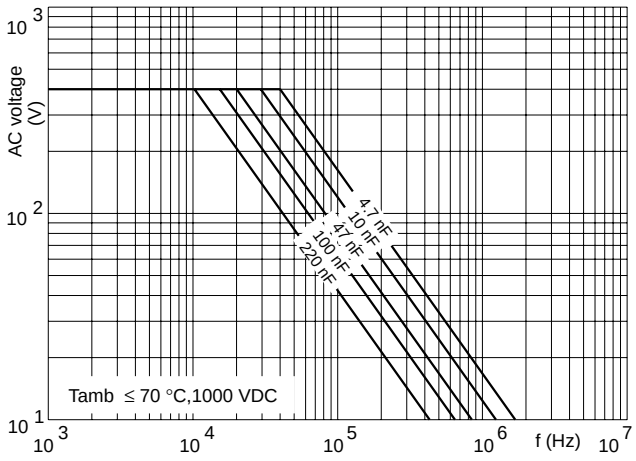


CBB960

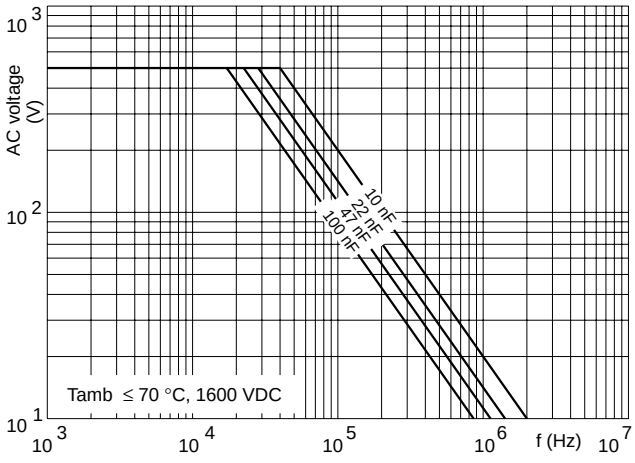
Maw RMS voltage and AC current (sinewave)



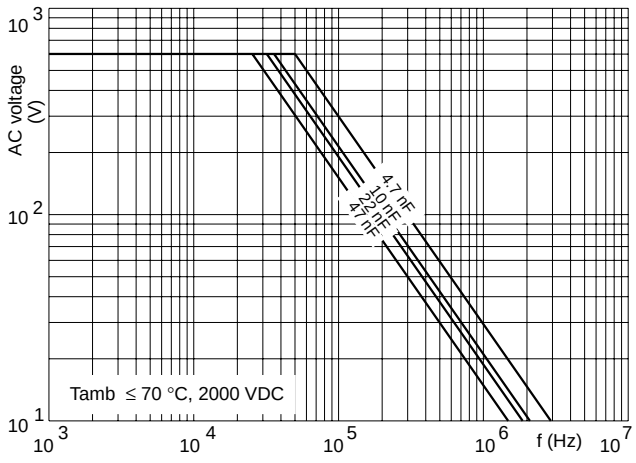
CBB824



CBB825



CBB826



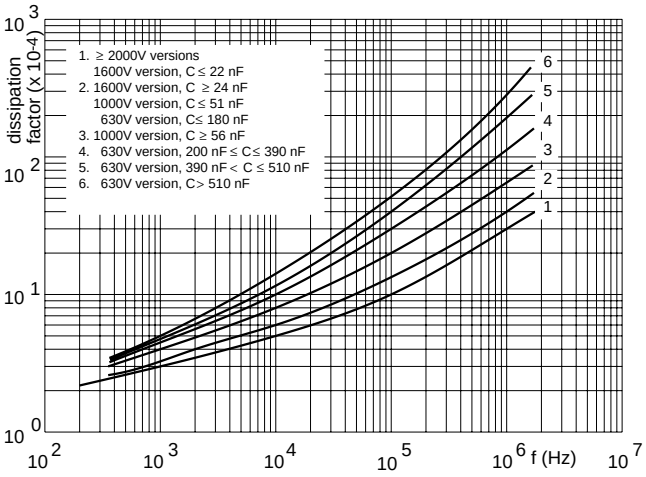
CBB827

Maximum RMS current (sinewave) as a function of frequency

The maximum RMS current is defined by $I_{ac} = \omega \times C \times U_{ac}$.

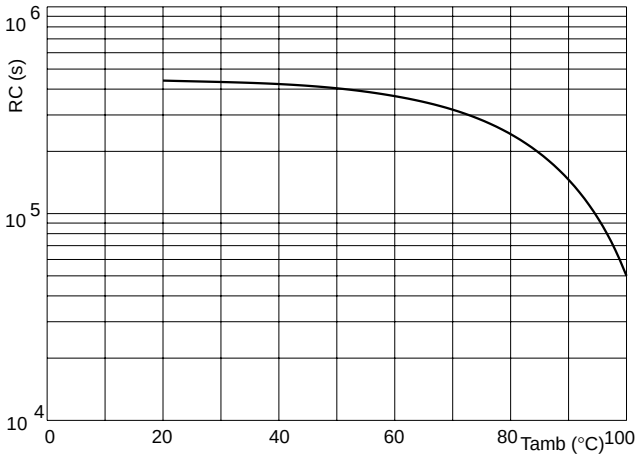
U_{ac}. is the maximum AC voltage depending on the ambient temperature in the curves "Max RMS voltage and AC current as a function of frequency"

Tangent of loss angle



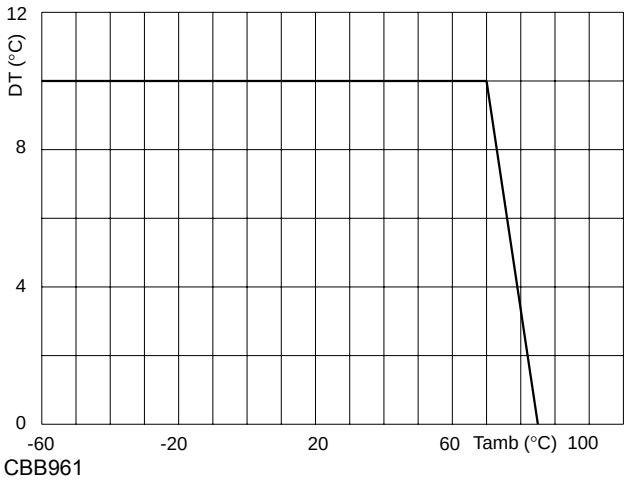
CBB959

Insulation resistance



CBB840

Maximum allowed component temperature rise (ΔT) as a function of the ambient temperature (T_{amb})



CBB961

HEAT CONDUCTIVITY (G) AS A FUNCTION OF (ORIGINAL) PITCH AND CAPACITOR BODY THICKNESS IN mW/°C

w_{max} (mm)	Heat conductivity (mW/°C)		
	Pitch 15 mm	Pitch 22.5 mm	Pitch 27.5 mm
4.0	-	-	-
5.0	10	-	-
6.0	11	19	-
7.0	12	21	-
8.5	16	25	-
10.0	18	28	-
11.0	-	-	36
13.0	-	-	42
15.0	-	-	48
18.0	-	-	57

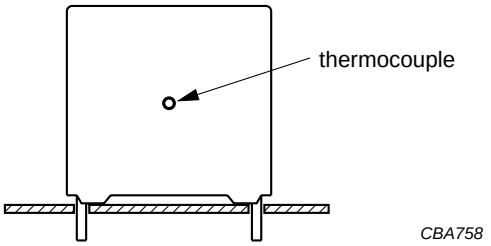
POWER DISSIPATION AND MAXIMUM COMPONENT TEMPERATURE RISE

The power dissipation must be limited in order not to exceed the maximum allowed component temperature rise as a function of the free ambient temperature.
The power dissipation can be calculated according Type detail specification *"HQN-384-01/101: Technical information film capacitors*
The component temperature rise (ΔT) can be measured (see Section "Measuring the component temperature" for more details) or calculated by ΔT = P/G:

- ΔT = component temperature rise (°C)
- P = power dissipation of the component (mW)
- G = heat conductivity of the component (mW/°C)

MEASURING THE COMPONENT TEMPERATURE

A thermocouple must be attached to the capacitor body as in:



CBA758

The temperature is measured in unloaded (T_{amb}) and maximum loaded condition (T_c).
The temperature rise is given by $\Delta T = T_c - T_{amb}$.
To avoid radiation or convection, the capacitor should be tested in a wind-free box.

APPLICATION NOTE AND LIMITING CONDITIONS

These capacitors are not suitable for mains applications as across-the-line capacitors without additional protection, as described hereunder. These mains applications are strictly regulated in safety standards and therefore electromagnetic interference suppression capacitors conforming the standards must be used.

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 the maximum U_{p-p} to avoid the ionisation inception level
3. The voltage peak slope (dU/dt) shall not exceed the rated voltage pulse slope in an RC-circuit at rated voltage and without ringing. If the pulse voltage is lower than the rated DC voltage, the rated voltage pulse slope may be multiplied by U_{Rdc} and divided by the applied voltage.
   For all other pulses following equation must be fulfilled:

$$2 \times \int_0^T \left(\frac{dU}{dt} \right)^2 \times dt < U_{Rdc} \times \left(\frac{dU}{dt} \right)_{rated}$$

   T is the pulse duration
   The rated voltage pulse slope is valid for ambient temperatures up to 70 °C. For higher temperatures a derating factor of 3% per K shall be applied
4. The maximum component surface temperature rise must be lower than the limits (see figure max allowed component temp rise)
5. Since in circuits used at voltages over 280V peak-to-peak the risk for an intrinsically active flammability after a capacitor breakdown (short circuit) increases, it is recommended that the power to the component is limited to 100 times the values mentioned in the table: “Heat conductivity”
6. When using these capacitors as across-the-line capacitor in the input filter for mains applications or as series connected with an impedance to the mains the applicant must guarantee that the following conditions are fulfilled in any case (spikes and surge voltages from the mains included).

VOLTAGE CONDITIONS FOR 6 ABOVE

ALLOWED VOLTAGES	$T_{amb} \leq 70$ °C	70 °C $< T_{amb} \leq 85$ °C
Maximum continuous RMS voltage	U_{Rac}	0.7 x U_{Rac}
Maximum temperature RMS-overvoltage (<24 hours)	1.25 x U_{Rac}	0.875 x U_{Rac}
Maximum peak voltage (V_{o-p}) (<2s)	1.6 x U_{Rdc}	1.1 x U_{Rdc}

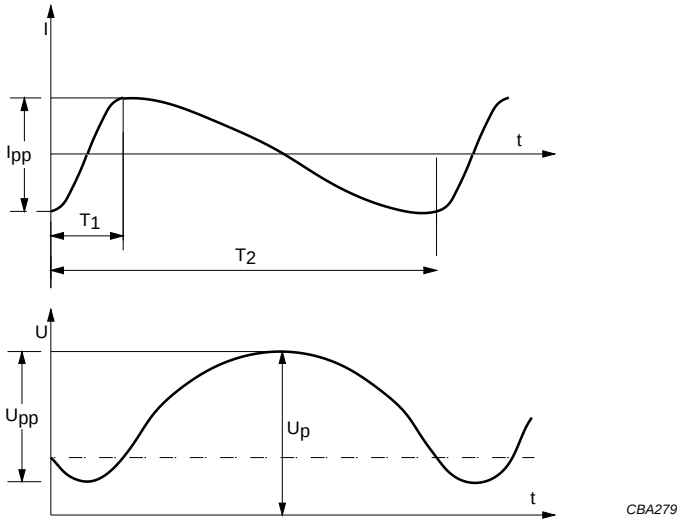
Example

C = 470 nF -630V used for S-correction. This is the signal shown in next figure.
U_{p-p} = 108V; U_p = 170V; T1 = 12µs; T2 = 64µs; I_{p-p} = 5A
The ambient temperature is 50 °C

Checking conditions:

1. The peak voltage U_p = 170V is lower than 630 V (DC)
2. The peak-to-peak voltage 108V is lower than $2\sqrt{2}$ x 300V (AC) = 850 U_{p-p}
3. Ip = 2.5A is lower than 0.47 µF x 370 V/µs = 174 A
4. The dissipated power is 40 mW as calculated with Fourier terms and tdg maximum values
   This gives a temperature rise of 40 mW / 48 mW/°C = 0.8 °C
   This is allowed according figure max allowed component temp rise
5. Depends on actual application
6. Not applicable

Voltage signal:



CBA279

MARKING

Product marking

The capacitors are marked by laser print on the top or head face (see figures) with the following information:

1. Rated capacitance code in accordance with "IEC 60062"
2. Tolerance on rated capacitance; J=±5%
3. Rated (DC) voltage (e.g.1000 V)
4. Manufacturer's type designation (e.g.378)
5. Code for dielectric material (MKP /MKP)
6. Manufacturers name
7. Code for factory of origin: R: Roeselare
8. Year and week of manufacture (e.g. 0516)

FRONT FACE

15n J 630V
378 MKP/MKP R0602

Example of marking for a capacitor with pitch = 15 mm

HEAD OR FRONT FACE

100n J 1000V
378 MKP/MKP R0604

Example of marking for a capacitor with pitch = 22.5 mm.

HEAD FACE

4n7 J 2000V VISHAY
378 MKP/MKP R0516

Example of marking for a capacitor with pitch = 27.5 mm.

Package marking

The package containing the capacitors is marked as shown

LB990160

Barcode label marking

LINE	MARKING EXPLANATION
1	Manufacturer's name
2	Country of origin
3	Sub-family
4	Type description
5	Capacitance value, tolerance, voltage and Climatic category *("IEC 60068-1")*
6	-
7	Preference origin code: A Country of origin in code: 170 (Belgium) Responsible production centre: R
8	Product type description
9	Batch code
10	Quantity and production period, year and week code
11	Product code (12NC)

QUICK REFERENCE TEST REQUIREMENTS

TEST	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of leads		
Tensile and bending: *"IEC 60068-2-21"*	-	No visible change Ligible marking $\lvert\Delta C/C\rvert \le 1\%$ $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF)
Resistance to soldering heat: *"IEC 60068-2-20"*	Solder bath: 260 °C; 10 s	
Component solvent resistance	Isopropyl alcohol; 23 °C; 5 minutes	
Robustness of component		
Vibration: *"IEC 60068-2-6"*	10 to 55 Hz; amplitude 0.75 mm or acceleration 98 m/s²; 6 hours	$\lvert\Delta C/C\rvert \le 1\%$ $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF)
Shock: *"IEC 60068-2-27"*	Half sinewave; 490 m/s²; 11 ms	
Climatic sequence		
Dry heat: *"IEC 60068-2-2"*	16 hours; 85 °C	$\lvert\Delta C/C\rvert \le 1\%$ (22.5/27.5 mm pitch) $\lvert\Delta C/C\rvert \le 2\%$ (15 mm pitch) $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF) $R_{ins} \ge 50\%$ of specified value
Damp heat, cyclic, test Db, First cycle: *"IEC 60068-2-30"*		
Cold: *"IEC 60068-2-1"*	2 hours; -55 °C	
Damp heat, cyclic, test Db, Remaining cycles: *"IEC 60068-2-30"*		
Other applicable tests		
Damp heat, steady state: *"IEC 60068-2-3"*	56 days; 40 °C 90 to 95 % RH	$\lvert\Delta C/C\rvert \le 1\%$ (22.5/27.5 mm pitch) $\lvert\Delta C/C\rvert \le 2\%$ (15 mm pitch) $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF) $R_{ins} \ge 50\%$ of specified value
Endurance (AC): *"IEC 60384-17"*	1000 hours; 85°C 1.25 x U_{Rac} (RMS); 50 Hz	$\lvert\Delta C/C\rvert \le 5\%$ $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF) $R_{ins} \ge 50\%$ of specified value
Heat storage: *"IEC 60384-17"*	2000 hours; 85 °C	$\lvert\Delta C/C\rvert \le 1\%$ (22.5/27.5 mm pitch) $\lvert\Delta C/C\rvert \le 2\%$ (15 mm pitch) $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF)
Resistance to soldering heat with preheating: *"IEC 60384-17"*	Preheating: 85 °C Solder bath: 260°C; 10 s	$\lvert\Delta C/C\rvert \le 1\%$ $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF)
Passive flammability *"IEC 60384-1"*	Class B	No burning
Endurance (DC): *"IEC 60384-17"*	2000 hours; 85°C 1.25 x U_{Rdc}	$\lvert\Delta C/C\rvert \le 1\%$ (22.5/27.5 mm pitch) $\lvert\Delta C/C\rvert \le 2\%$ (15 mm pitch) $\Delta\tan\delta \le 5 \times 10^{-4}$ ($C \le 100$ nF) $\Delta\tan\delta \le 10 \times 10^{-4}$ (100 nF< $C \le 470$ nF) $\Delta\tan\delta \le 15 \times 10^{-4}$ ($C >$ 470 nF) $R_{ins} \ge 50\%$ of specified value

History (Publisher: Roeselare)

Revision	Description	Date
A	First issue	1992-02-25
B	New layout	1993-05-04
C	P27 HQ2285K: change from taping method from one tape to two small tapes	1993-08-24
D	Different corrections, add of reference testing	1993-10-19
E	P36:sub-group ADD4: A4 body temp 85°C iso 80°C	1994-01-11
F	P13: 2000V: cap range 0.016-0.051 AFD, add of mass	1994-03-22
G	Lead diameter 0.8± 0.08mm	1994-04-19
H	Adj of ADD2 and ADD6; adj of 630 and 1000V pitch 15mm; new layout	1995-02-07
I	Add of 2222 378 44…: MKP 250V –Lt=3.5± 0.5mm; Add of 2222 378 54…: MKP 400V –Lt=3.5± 0.5mm	1996-02-06
J	New layout and renumbering tests (WV-HQ7012K); test “solvent resistance of marking” before “rapid change of temp” (WV-HQ6140K)	1997-09-16
K	P8->19: adj of header MKP/MKP iso MKP378	1998-03-17
L	Pitch 27.5mm: taped on reel products no longer available (WV-HQ8060K); MKP lt=3.5± 0.3mm iso lt=3.5± 0.5mm; lt=3.2± 0.5mm is cancelled (WV-HQ8092 and 6117K)	1998-05-26
M	Adj of product marking and label (WV-HQ9128K); Philips becomes BC Components	1999-12-07
N	Adj of package quantities; BC Beyschlag Centralab Components becomes BCcomponents (WV-HQ0011K)	2000-02-15
O	Case 1770-1785 becomes copper wire (WV-HQ0066K)	2000-05-09
P	Add if there must be a voltage proof test after damp heat test (WV-HQ0198K); adj of delta C/C in ADD6 test (WV-HQ0240K)	2000-12-05
Q	Replacement of AQL 0.65% by zero defect (WV-HQ0252K); pass flammability becomes class B iso C (WV-HQ01009K)	2001-10-23
R	Corr passive flammability test	2001-12-11
S	Adj of packing quantities for case 2560 (WV-HQ01132K)	2003-02-18
T	Transition to Word, Vishay logo, code of origin R iso HQ (CP03168); inspection requirements in TPD191; Lead 0.6 mm iso 0.8 mm for cases 1750 and 1760 (CP-R04072);jedec symbols on label (CP-R04130), label completely Pb free products (CP-R04130 & CP-R05012); VISHAY iso Vishay on label (CP-R05052); add e3 symbol in text and add RoHS compliant (CP-R05053)	2005-03-29
U	Corrections: Urdc iso Urac in tables, above capacitance values.	2005-12-20
V	CO2->YAG 15mm and 22.5mm (CP R05164 & CP R06026); BFC2 code; change position batch code on label (CP R06080). P. 8: correction quantity loose in box for case size 1760 -> 1000 iso 1100.	2006-06-20
W	Correction : Voltage for 250V and 400V products (CP R06130), correction weights (CP R06005); Wire not specified	2006-10-16