SIEMENS

Metalized Plastic Film Capacitors

Data Book 1985/86

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The sign ∅ on drawings denotes diameter.
A comma in the outline drawings and tables represents the decimal point.

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Summary of Type Numbers

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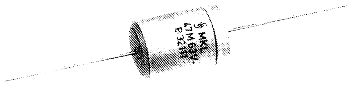
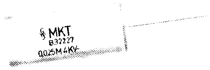
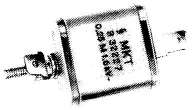
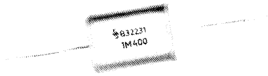
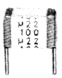
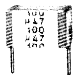
[1] Designation in accordance with DIN 41379

Summary of Types

Type	Lead spacing	Rated capacitance	Rated voltage	
MKL capacitors (DIN designation: MKU capacitors)				
B 32110 	22.5 to 40 mm	0.1 to 10 µF	25 to 250 Vdc	
B 32111 	40 and 52.5 mm	22 to 100 µF	63 Vdc	
B 32112 	22.5 to 40 mm	0.033 to 4.7 µF	630 Vdc	
B 32120 	25 to 45 mm	0.1 to 10 µF	63 to 250 Vdc	
B 32121 	–	22 to 100 µF	100 Vdc	
B 32122 	30 to 45 mm	0.033 to 3.3 µF	630 Vdc	

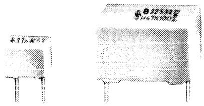
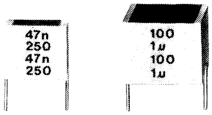
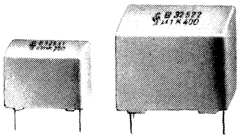
DIN climatic category IEC climatic category	Standards and qualifications	Design	Features and applications	Page
FPE/JR 55/085/56	Quality-assessed version (ESA, GfW, VDE) see B 95 020.	Tubular winding in metal tube, epoxy resin sealed; insulating sleeve.	Optimum self-healing capability; high volumetric efficiency; high pulse handling capability. B 32 110 and B 32 112 up to 18.7 mm dia available as taped versions.	54
FPE/JR 55/085/56				60
FPE/JR 55/085/56				65
FPC/JR 55/085/56	Quality-assessed version in acc. with VG 95 296, Part 4 (MKU 04) and VDE see B 95 017.	Tubular winding in hermetically sealed, non-magnetic metal can, insulating sleeve.	For high climatic requirements; optimum self-healing capability; high volumetric efficiency; high pulse handling capability.	70
FPC/JR 55/085/56	–			77
FPC/JR 55/085/56	–	Tubular winding in hermetically sealed, non-magnetic metal can, insulating sleeve.	For high climatic requirements; reliable self-healing capability; high Q insulation.	81

Summary of Types

Type	Lead spacing	Rated capacitance	Rated voltage
MKT capacitors			
 B 32227-J	40 to 50 mm	0.01 to 0.25 μF	1 to 6.3 kVdc
 B 32227-A	–	0.025 to 0.25 μF	1 to 6.3 kVdc
 B 32231	20 to 50 mm	0.01 to 10 μF	100 to 630 Vdc
 B 32237	30 to 60 mm	680 pF to 0.025 μF	1 to 12.5 kVdc
  B 32510	7.5 mm	0.47 to 1.0 μF	63 and 100 Vdc
B 32511	10 mm	0.22 to 1.0 μF	100 and 250 Vdc
B 32512	15 mm	0.22 to 2.2 μF	100 to 400 Vdc
B 32513	22.5 mm	0.68 to 6.8 μF	100 to 400 Vdc

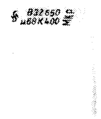
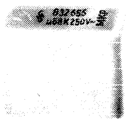
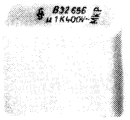
DIN climatic category IEC climatic category	Standards and qualifications	Design	Features and applications	Page
GMG/KS 40/100/21	–	Flat winding with insulating sleeve, epoxy resin sealed face ends. Axial leads or thread bolts with flat plugs.	Version for high voltage applications, e. g. in high voltage generators and testing instruments used in industrial electronics.	88
GMG 40/100/21	DIN 44113	Flat winding with insulating sleeve, epoxy resin sealed face ends; central axial leads.	Coupling and blocking in circuits used in industrial, audio and video electronics.	93
GMG/KS 40/100/21	–	Tubular winding in plastic tube, epoxy resin sealed face ends; central axial leads.	Version for high voltage applications, e. g. in high voltage generators and testing instruments.	100
FME/JR 55/100/56	Similar to DIN 44112; CECC 30401-007, Version B	Stacked-film construction, fully insulated, tinned leads, plug-in in the lead spacing.	Complementary types to B 32520...523. Blocking and coupling.	105

Summary of Types

Type		Lead spacing	Rated capacitance	Rated voltage
MKT capacitors				
	B 32529	5 mm	4700 pF to 1.0 µF	63 Vdc
	B 32520	7.5 mm	1000 pF to 0.68 µF	63 to 400 Vdc
	B 32521	10 mm	0.01 to 0.33 µF	100 to 400 Vdc
	B 32522	15 mm	0.033 to 1.0 µF	100 to 630 Vdc
	B 32523	22.5 mm	0.1 to 3.3 µF	100 to 630 Vdc
	B 32524	27.5 mm	0.33 to 10 µF	100 to 630 Vdc
	B 32539	5 mm	4700 pF to 1.0 µF	63 Vdc
	B 32530	7.5 mm	1000 pF to 0.68 µF	63 to 400 Vdc
	B 32531	10 mm	0.01 to 0.33 µF	100 to 400 Vdc
	B 32532	15 mm	0.047 to 1.0 µF	100 to 400 Vdc
	B 32533	22.5 mm	0.22 to 3.3 µF	100 to 400 Vdc
	B 32534	27.5 mm	0.68 to 10 µF	100 to 400 Vdc
	B 32560	7.5 mm	1000 pF to 0.68 µF	100 to 400 Vdc
	B 32561	10 mm	0.01 to 1.0 µF	100 to 400 Vdc
	B 32562	15 mm	0.068 to 2.2 µF	100 to 400 Vdc
	B 32563	22.5 mm	0.47 to 3.3 µF	100 to 400 Vdc
MKC capacitors				
	B 32550	7.5 mm	1000 pF to 0.22 µF	100 and 250 Vdc
	B 32551	10 mm	0.01 to 0.22 µF	100 and 250 Vdc
	B 32552	15 mm	0.15 to 0.33 µF	160 Vdc
	B 32553	22.5 mm	0.47 to 1.0 µF	160 Vdc

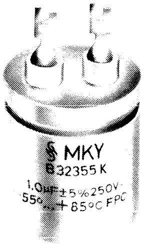
	DIN climatic category IEC climatic category	Standards and qualifications	Design	Features and applications	Page
	FME/JR 55/100/56	DIN 44 112, CECC 30 401-043, Version 1	Flame-retardant in acc. with UL 94 V-0, epoxy resin sealed plastic can; tinned leads, plug-in in the lead spacing.	Standard version for commercial electronics; taped version available for 5 mm and 7.5 mm lead spacings.	107
	FME/JR (LS 5 mm) FMD/JR (LS 7.5 to 27.5 mm) 55/100/56	DIN 44 122, CECC 30 401-026, Version 3		High rel version for industrial electronics; taped version available for 5 mm and 7.5 mm lead spacings.	121
	FME/JR 55/100/21 or 55/100/56	CECC 30 401-007, Version A	Stacked-film construction; tinned leads, plug-in in the lead spacing.	Space saving mounting at high packing density	135
	FMD/JR 55/100/56	DIN 44 116	Flame-retardant in acc. with UL 94 V-0, epoxy resin sealed plastic can; tinned leads, plug-in in the lead spacing.	Minor temperature dependence of capacitance, low dissipation factor, high capacitance stability; high rel version.	148

Summary of Types

Type	Lead spacing	Rated capacitance	Rated voltage
MKP capacitors			
B 32650 	15 mm	0.022 to 0.33 µF	250 to 1500 Vdc (300 to 1500 V_{pp})
	22.5 mm	1500 pF to 1.0 µF	
	27.5 mm	0.022 to 4.7 µF	
B 32655 	15 mm	0.047 to 0.15 µF	250 Vac (630 Vdc)
	22.5 mm	0.22 to 0.47 µF	
	27.5 mm	0.68 to 1.0 µF	
B 32656 	22.5 mm	2220 pF to 0.033 µF	400 Vac (1000 Vdc)
	27.5 mm	0.047 to 0.1 µF	
B 32662 	–	3300 pF to 1.2 µF	4 to 40 kVdc

	DIN climatic category IEC climatic category	Standards and qualifications	Design	Features and applications	Page
	GPE 40/085/56	–	Wound capacitor with face-end contacts. Built into flame-retardant plastic-can; epoxy resin sealed leads to ensure humidity resistance; plug-in in the lead spacing.	High insulation resistance; pulse-proof; for TV deflection circuits, high voltage stages and SMPS.	159
	GPE 40/085/56	–		Suitable for line ac voltage load and pulse circuits.	159
	FPD/JS 55/085/56	–		For high reliability applications, in particular suitable for line ac voltage load and pulse operation.	159
	GSF 40/070/21	–	High-voltage capacitor, selfhealing, encapsulated in plastic case; tinned wire tags.	Suitable e.g. in transmitting, or radar equipment, in voltage multipliers.	167

Summary of Types

Type	Lead spacing	Rated capacitance	Rated voltage
MKY capacitors			
B 32355 	35 mm	0.10 to 0.5 µF	250 Vdc
	–	>0.15 to 10 µF	250 Vdc
Qualified Types – MKL capacitors			
B 95017 	25 to 45 mm	0.1 to 10 µF	63 to 250 Vdc
B 95020 	22.5 to 52.5 mm	0.033 to 100 µF	25 to 630 Vdc

	DIN climatic category IEC climatic category	Standards and qualifications	Design	Features and applications	Page
	FPC/JR 55/085/56	–	Tubular windings, hermetically enclosed in metal can; with insulating sleeve, central axial leads at both ends.	Very close capacitance tolerances, very low dissipation factor, suitable for resonant circuit applications.	170
	FPC/JR 55/085/56	–	Tubular windings, hermetically enclosed in metal can; closed by a metal cover with low loss ceramic lead-throughs, single-ended solder tag connections.		170
	VG 95 296, Part 4 (military type specification for plastic film capacitors, type MKU 04). Quality assessment △		like type B 32 120	For military applications and use under extreme climatic stress.	178
	SCC 3006 SCC 3006/009 SCC 3006/012 CF 100, 101, CF 104 Quality assessment △		like types B 32 110, B 32 111, B 32 112	Capacitors with quality assessment, permitted for space applications in acc. with ESA and GfW specifications.	180

Available Capacitance and Voltage Ratings

MKL Capacitors

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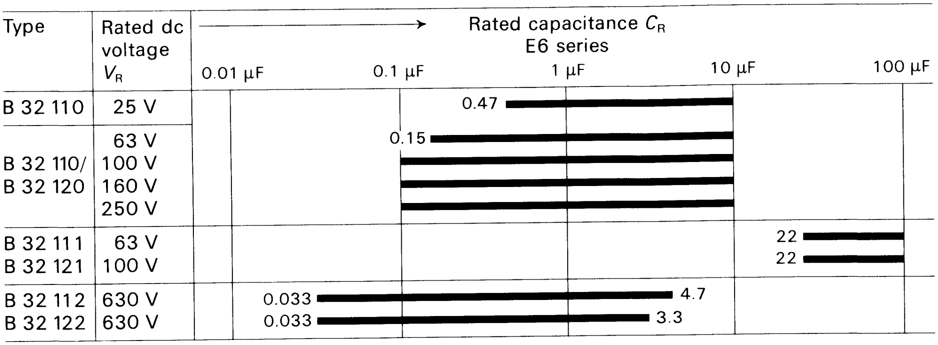
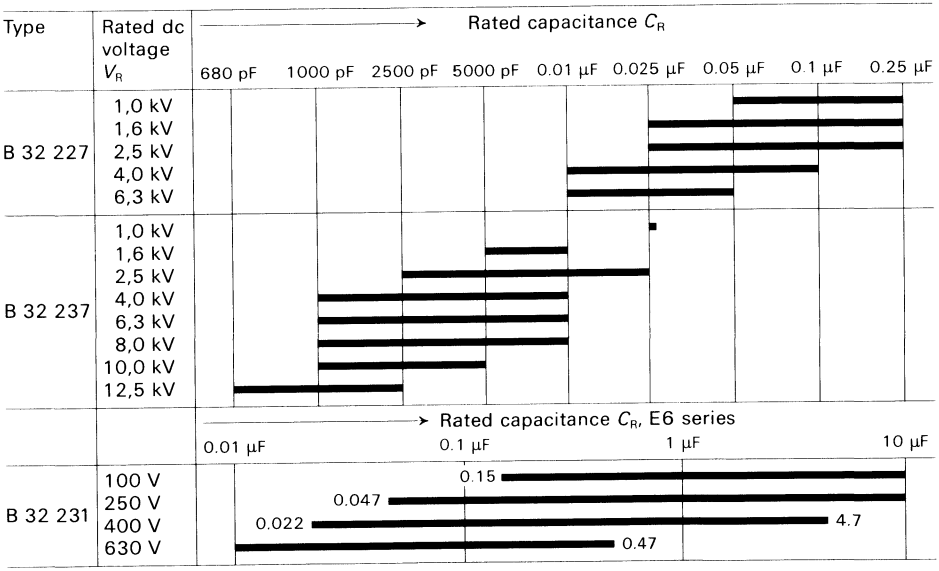


MKT Capacitors (axial leads)

Page 88 to 100



Available Capacitance and Voltage Ratings

MKT Capacitors (leads plug-in in the lead spacing)

Type	Lead spacing mm	Rated dc voltage V_R	➤ Rated capacitance C_R (µF)										
			0.001	0.0015	0.0022	0.0033	0.0047	0.0068	0.01	0.015	0.022	0.033	0.047
B 32529/B 32539	5	63 V					■	■	■	■	■	■	■
B 32520/B 32530	7,5	63 V											
		100 V											■
		250 V								■	■	■	■
		400 V	■	■	■	■	■	■	■	■	■	■	■
B 32521/B 32531 (B 32511)	10	100 V											
		250 V											■
		400 V							■	■	■	■	■
B 32522/B 32532 (B 32512)	15	100 V											
		250 V											
		400 V											■
B 32522		630 V										■	■
B 32523/B 32533 (B 32513)	22,5	100 V											
		250 V											
		400 V											
B 32523		630 V											
B 32524/B 32534	27,5	100 V											
		250 V											
		400 V											
B 32524		630 V											
B 32560	7,5	100 V											
		250 V							■	■	■	■	■
		400 V	■	■	■	■	■	■	■	■			
B 32561	10	100 V											
		250 V									■	■	■
		400 V							■	■	■	■	■
B 32562	15	100 V											
		250 V											
		400 V											
B 32563	22,5	100 V											
		250 V											
		400 V											

▪▪▪▪▪▪ B 32510...B 32513 are complementary types to the new series B 32520...B 32523.

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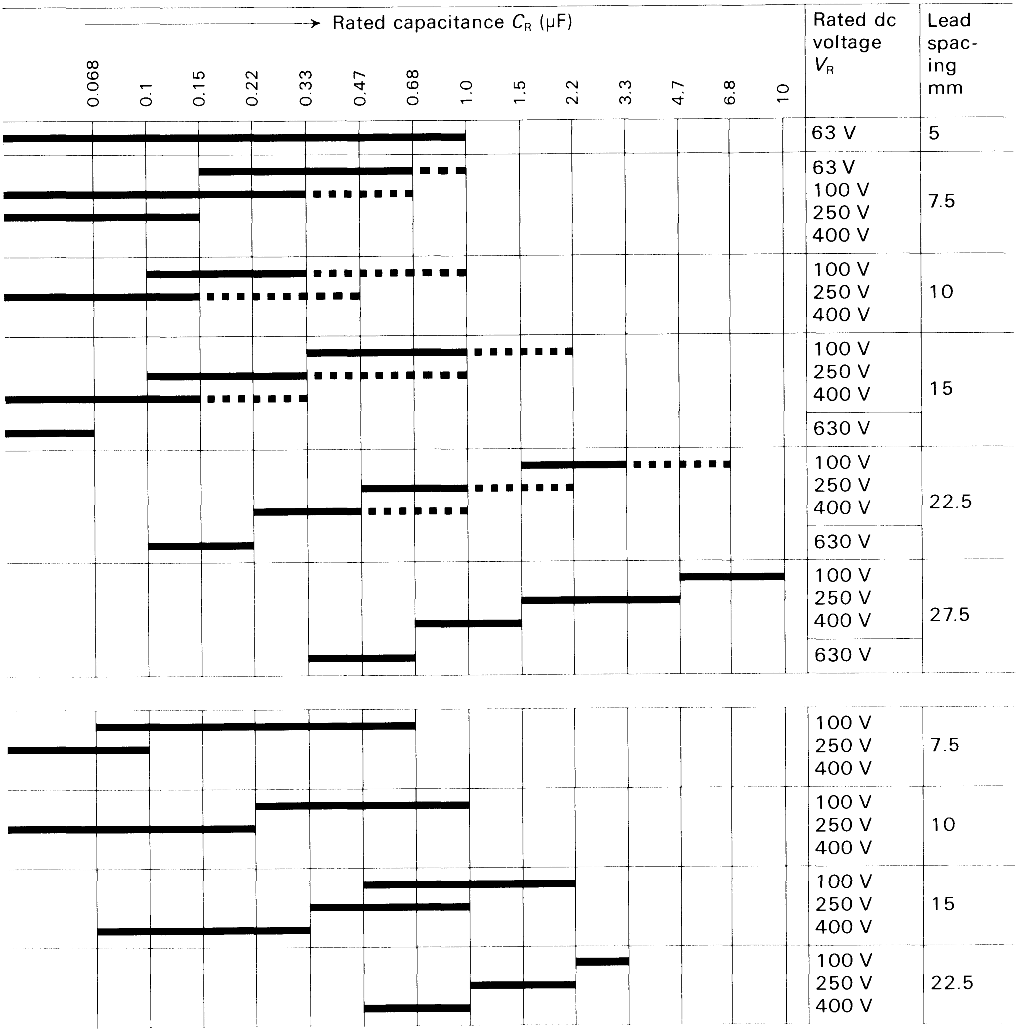

Available Capacitance and Voltage Ratings

MKC Capacitors

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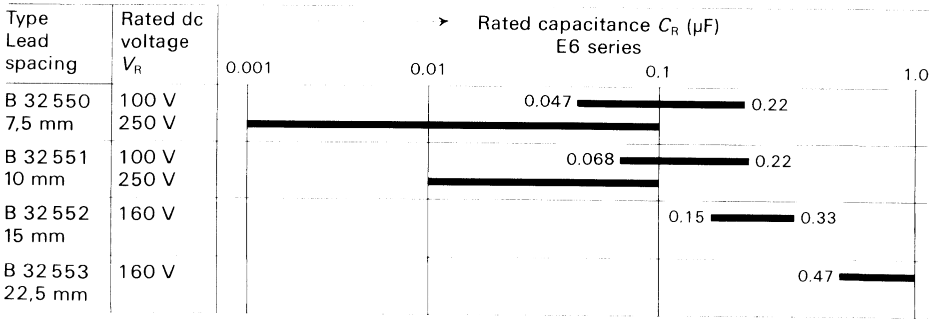

MKP Capacitors

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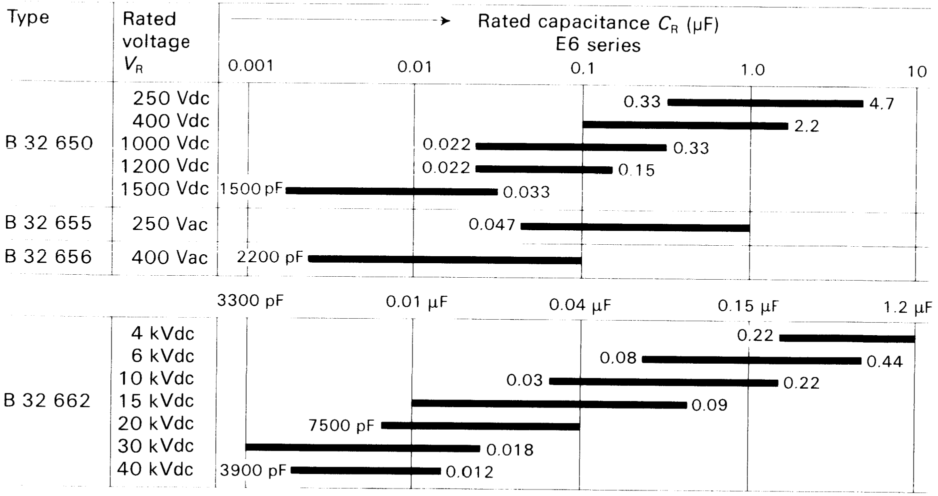

MKY Capacitors

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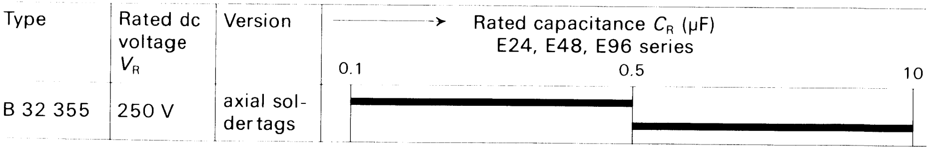


Comparison of Previous and New Types

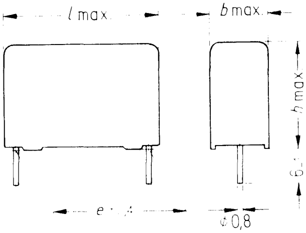
Metalized Polyester Film Capacitors

The MKT types B 32 234, B 32 509 and B 32 535, still contained in the Data Book 1982/83, are no longer available. They were replaced by a new range of capacitors, some of them exhibiting reduced dimensions. The types B 32 510 ... B 32 513 were replaced as well, nevertheless some of them are still contained in this book for reasons of complementation (see page 105). Due regard has been paid to the interchangeability of lead spacings and capacitance ratings.
In the survey below the previously available types are compared with the corresponding new ones.

Previous types (Data Book 1982/83)

B 32 234

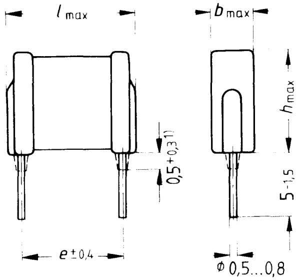
MKT capacitors in acc. with DIN 44112



Type	Lead spacing	Rated dc voltage
B 32 234	10 mm	100 ... 630 V
	15 mm	100 ... 630 V
	22.5 mm	100 ... 630 V
	27.5 mm	100 ... 630 V

B 32 509 ... 513

MKT stacked-film capacitors

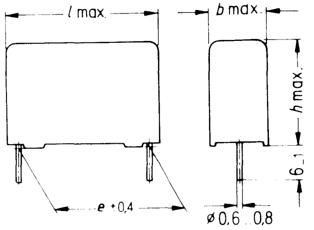


Type	Lead spacing	Rated dc voltage
B 32 509	5 mm	63 V
B 32 510	7.5 mm	100 ... 400 V
B 32 511	10 mm	100 ... 400 V
B 32 512	15 mm	100 ... 400 V
B 32 513	22.5 mm	100 ... 400 V

New types (Data Book 1985/86)

B 32 521 ... 524

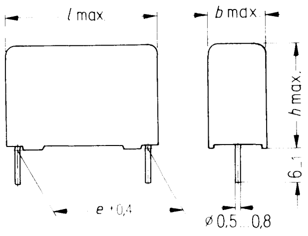
MKT capacitors in acc. with DIN 44112



Type	Lead spacing	Rated dc voltage
B 32 521	10 mm	100 ... 400 V
B 32 522	15 mm	100 ... 630 V
B 32 523	22.5 mm	100 ... 630 V
B 32 524	27.5 mm	100 ... 630 V

B 32 520 ... 529

MKT capacitors in acc. with DIN 44112



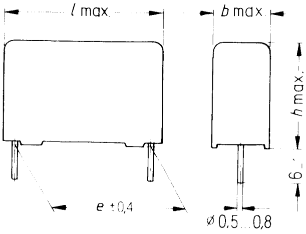
Type	Lead spacing	Rated dc voltage
B 32 529	5 mm	63 V
B 32 520	7.5 mm	63 ... 400 V
B 32 521	10 mm	100 ... 400 V
B 32 522	15 mm	100 ... 630 V
B 32 523	22.5 mm	100 ... 630 V

Comparison of Previous and New Types

Previous types (Data Book 1982/83)

B 32535

MKT capacitors in acc. with DIN 44122, high rel version

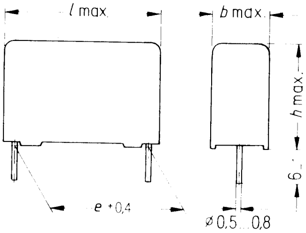


Type	Lead spacing	Rated dc voltage
B 32535	5 mm	63 V
	7.5 mm	100...400 V
	10 mm	100...400 V
	15 mm	100...400 V
	22.5 mm	100...400 V
	27.5 mm	100...400 V

New types (Data Book 1985/86)

B 32530...539

MKT capacitors in acc. with DIN 44122, high rel version



Type	Lead spacing	Rated dc voltage
B 32539	5 mm	63 V
B 32530	7.5 mm	100...400 V
B 32531	10 mm	100...400 V
B 32532	15 mm	100...400 V
B 32533	22.5 mm	100...400 V
B 32534	27.5 mm	100...400 V

Comparison of Previous and New Types

Metalized Polycarbonate Film Capacitors

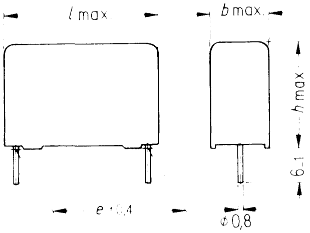
The types B 32435, B 32540, B 32541 and B 32545, still contained in the Data Book 1982/83, are no longer available. They were replaced by the new type series B 32550 to 32553.

The unprotected types B 32540 and B 32541 have largely been integrated into the new can versions B 32550 and B 32551, this kind of encapsulation resulting, however, in slightly increased dimensions. The lead spacings remained unaltered up to the capacitance value 0.1 µF; for capacitance values >0.1 µF Siemens recommends the series B 32552 with the lead spacing 15 mm/160 V.

In the survey below the previously available types are compared with the corresponding new ones with special reference to the differences in rated voltage and the E-series.

Previous types (Data Book 1982/83)

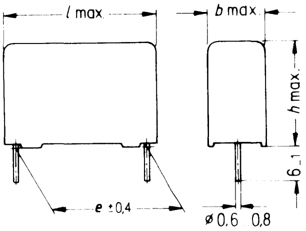
B 32435
MKC capacitors in acc. with DIN 44116, high rel version



Type	Lead spacing	Rated dc voltage	E-series
B 32435	10 mm	160 V	E 12
	15 mm	160 V	E 12
	22.5 mm	160 V	E 12

New types (Data Book 1985/86)

B 32551 ... 553
MKC capacitors in acc. with DIN 44116, high rel version

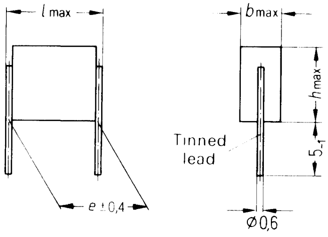


Type	Lead spacing	Rated dc voltage	E-series
B 32551	10 mm	250 V	E 6
B 32552	15 mm	160 V	E 6
B 32553	22.5 mm	160 V	E 6

Comparison of Previous and New Types

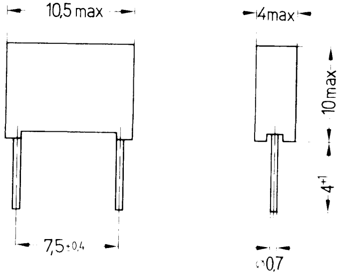
Previous types (Data Book 1982/83)

B 32540, B 32541
MKC capacitors,
standard version



Type	Lead spacing	Rated dc voltage	Cap. range
B 32540	7.5 mm	250 V	1000 pF to 0.1 µF
B 32541	10 mm	250 V	0.01 to 0.47 µF

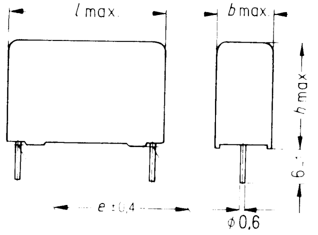
B 32545
MKC capacitors,
high rel version



Type	Lead spacing	Rated dc voltage	E-series
B 32545	7.5 mm	100 to 400 V	E 12

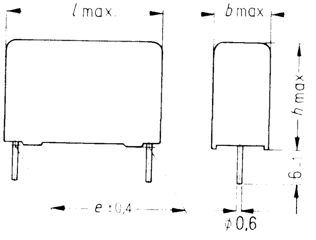
New types (Data Book 1985/86)

B 32550, B 32551
MKC capacitors in acc. with DIN 44116,
high rel version



Type	Lead spacing	Rated dc voltage	Cap. range
B 32550	7.5 mm	250 V	1000 pF to 0.1 µF
B 32551	10 mm	250 V	0.01 to 0.1 µF

B 32550
MKC capacitors in acc. with DIN 44116,
high rel version



Type	Lead spacing	Rated dc voltage	E-series
B 32550	7.5 mm	100 and 250 V	E 6

General Information

General Information

1 Introduction

Metalized plastic film dielectric capacitors – briefly MK capacitors – are outstanding for their self-healing property. The dielectric of these capacitors consists of plastic films onto which metal layers of approximately 0.02 to 0.05 µm are vacuum-deposited. The metalized films are either of wound construction in tubular or flattened form or arranged in the more recent stacked construction. A hot metal spray technique is used for making electrical contact to the edges of the metalized winding. This ensures low loss and low inductance characteristics of the finished capacitor. MK capacitors comply with VDE specification 0560, Part 1, and DIN Standard 44110 as well as with the standard sheets for the individual capacitor types.

2 Self-healing

The electric arc, which occurs with voltage breakdown of the dielectric, evaporates the metalization in the area of the breakdown without impairing the dielectric. This results in effectively isolating the region of the failure. The time necessary for the self-healing process is less than 10 µs. Since only fractions of the energy stored in the capacitor are dissipated in the self-healing process, the potential drop remains accordingly low. The capacitor design ensures that self-healing processes occur only occasionally, even when the parameters of category voltage and upper category temperature apply; statistical measurements with MKL capacitors reveal that approx. 0.2 self-healing processes are to be expected per year and per µF. The capacitance variation would therefore be less than 1 % after 10^3 breakdowns. The self-healing characteristic is independent of maintaining the specified limit conditions, and can even be effective at low voltage ratings where electrochemical action takes place.

3 Types

Metalized plastic film dielectric – MK – capacitors are distinguished by their dielectric materials:

MKL capacitors	comprising lacquer films (cellulose acetate) as dielectric and vacuum deposited metal layers. In accordance with DIN 41 379 also designated as MKU capacitors.
MKT capacitors	comprising polyethyleneterephthalate (trade name e.g. Hostaphan®, Mylar®, etc.) as dielectric and vacuum-deposited metal layers.
MKC capacitors	comprising polycarbonate (trade name Makrofol®) as dielectric and vacuum-deposited metal layers.
MKP capacitors	comprising polypropylene as dielectric and vacuum-deposited metal layers.
MKY capacitors	self-healing capacitors with highly insulating, low loss dielectric (polypropylene) and vacuum-deposited metal layers.

Characteristics in brief

Type	MKL (MKU)	MKT	MKC	MKP	MKY
Dielectric	Lacquer film (cellulose acetate)	Polyethylene-terephthalate	Polycarbonate	Polypropylene	Polypropylene
Capacitance range	33000 pF to 100 μF	680 pF to 10 μF	1000 pF to 1.0 μF	2200 pF to 2.2 μF	0.1 μF to 10 μF
Rated dc voltages	25 to 630 V	63 V to 12.5 kV	100 to 250 V	250 V to 40 kV	250 V
Temperature range (category values)	−55 ... +85°C	−55 ... +100°C	−55 ... +100°C	−55 ... +85°C	−55 ... +85°C
Capacitance drift $\Delta C/C$	+6/−3% or ±2%	±3%	±3%	±2%	±1%
Dissipation factor $\tan \delta$ (average values)					
1 kHz	$15 \cdot 10^{-3}$	$5 \cdot 10^{-3}$	$3 \cdot 10^{-3}$	$0.25 \cdot 10^{-3}$	$0.5 \cdot 10^{-3}$
10 kHz	$25 \cdot 10^{-3}$	$13 \cdot 10^{-3}$	$5 \cdot 10^{-3}$	$0.5 \cdot 10^{-3}$	$1 \cdot 10^{-3}$
Insulation resistance R_{is} Time constant τ (average values)	15000 s	15000 s	25000 s	25000 s	250000 s
Temperature coefficient TC in 10^{-6}/K in the ambient temperature range (typical values)	+600	+250	0	−250	−230
Pulse handling capability (voltage rate of rise V_{pp}/τ) at full voltage amplitude	max. 20 V/μs	max. 1000 V/μs	max. 100 V/μs	max. 1000 V/μs	max. 30 V/μs

4 Constructional design

4.1 Contacting

The large area metalization over the winding face ends ensures good contact between the layers and the connecting elements. Hence, capacitors with low-inductance and low loss characteristics are obtained.

The capacitors in rectangular plastic cases and the epoxy resin sealed types are provided with spacers in order to improve the solderability in the solder bath. These capacitors are thus particularly suited for use on PC boards.

4.2 Dimensions

The main dimensions stated for MK capacitors are maximum dimensions in mm including the insulating sleeve (see individual data sheets).

5 Electrical properties

5.1 Capacitance

5.1.1 Rated capacitance

The capacitance ratings available for the individual capacitor types range from 680 pF to 100 µF. The capacitance values are graded according to the E series. The actually available values of the E series (E6, E12, E24, E48, E96) are contained in the individual data sheets.

5.1.2 Tolerances available

MKL capacitors	±20, ±10%
MKT capacitors	+50/−20%, ±20, ±10, ±5%
MKC capacitors	±20, ±10, ±5%
MKP capacitors	±20%, ±10, ±5%
MKY capacitors	±5, ±2, ±1%

The rated capacitances and appropriate tolerances are indicated on the individual data sheets.

The capacitance tolerances are coded by the following letters (in accordance with IEC recommendation 62:

Code letter	M	K	J	G	F
Capacitance tolerance	±20%	±10%	±5%	±2%	±1%
E series	E6	E12	E24	E48	E96

5.1.3 Temperature dependence

The variation of the capacitance with respect to the permissible temperature range (see climatic category) is not linear, but reversible.

In the range of −20 to +70°C, (−4 to +158°F), however, an approximately linear run of the temperature can be assumed.

Figure 1 shows characteristic curves of the main metalized plastic film capacitors.

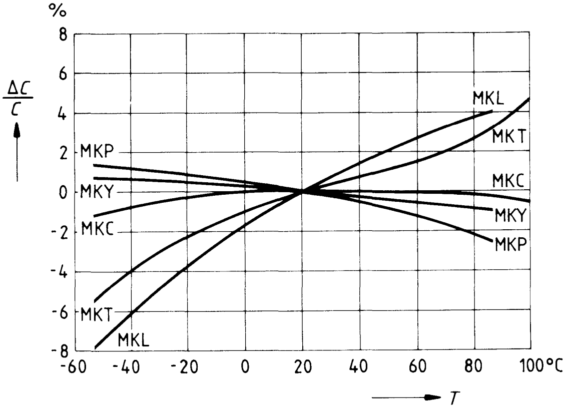


Figure 1
Rel. capacitance change $\frac{\Delta C}{C}$
versus temperature T

5.1.4 Moisture dependence

The capacitance of sealed capacitors is not subject to moisture under environmental climatic conditions.

With non-hermetically sealed capacitors, the operation at high relative humidity causes an increase in capacitance and a decrease in insulation resistance since the capacitor or the layer package has absorbed moisture, particularly when the relative humidity of the permitted climatic category is prolonged. These variations due to moisture are reversible.

5.1.5 Frequency dependence

Since the dielectric constant of the plastic films is frequency dependent, the capacitance decreases with increasing frequency.

An example of this interdependence is shown for MKT capacitors in **figure 2.**

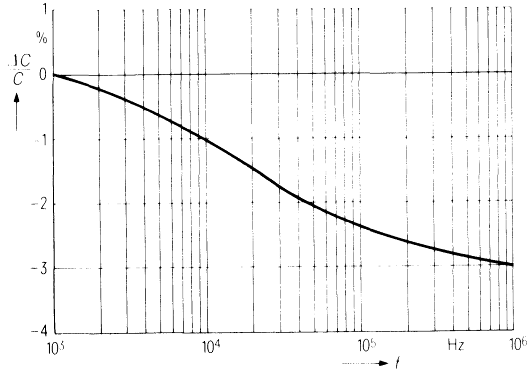


Figure 2
Rel. capacitance change $\frac{\Delta C}{C}$
versus frequency f,
at 20°C/68°F

5.1.6 Capacitance drift i_z

Apart from reversible changes, the capacitance is also subject to irreversible changes which are summarized under the term "maximum capacitance drift i_z". The values refer to +40°C/+104°F and to the load duration stated for each capacitor type on the appropriate data sheets. The values are typical values. For standard type capacitors, the capacitance drift applies to a period of two years. Frequent and large temperature changes within the fringe area of the permissible temperature and relative humidity can cause the stated drift values to rise. In accordance with DIN 44110 typical values for a storage time of two years are also given. The storage conditions stated under para. 3.5.3. are applicable.

5.2 Voltage and current operation

5.2.1 Rated voltage V_R

The rated voltage is the direct operating voltage which may be applied continuously to the terminals of a capacitor at an ambient temperature of 40°C (104°C).

When the capacitor is operated within the permissible climatic category, the following limiting conditions are to be taken into account:

5.2.2 Category voltage V_c (at dc operation)

The category voltage V_c is the maximum dc voltage, which may be applied continuously to the capacitor and is dependent upon the ambient temperature. The resulting voltage derating at higher temperatures is covered by outline drawings in the appropriate data sheet (definition in accordance with DIN 40110).

5.2.3 Category voltage V_c (at ac operation)

The category voltage V_c is referred to 50 Hz which may be applied continuously to the capacitor (see individual data sheets).

When an additional dc voltage is superimposed to the ac voltage, the sum of the applied dc voltage and the amplitude of the ac voltage should not exceed the category voltage V_c.

MK capacitors are generally not intended for technical ac applications. In exceptional cases, references are given to possible operation indicating the permissible rated voltage V_{ac}.

For operation at higher frequencies and for non-sinusoidal ac voltage load see para. 5.2.5.

5.2.4 Peak voltage

The peak voltage is the maximum voltage which may be applied to the capacitor for a short period, e. g. with non-period switchings.

5.2.5 Inherent temperature rise, permissible efficiency

When capacitors are operated at non-sinusoidal ac voltage or at sine voltage load of higher frequency, the inherent temperature rise and the pulse handling capability (see para. 5.2.6) must be taken into account.

In case of sinusoidal voltages, the inherent temperature rise ΔT of the capacitor depends on

- the voltage amplitude $V_p = \hat{V} = V_{rms} \times \sqrt{2}$ and the frequency f
  and in case of pulse-shaped ac voltages on
- double the voltage amplitude V_{pp}, the voltage rate of rise, and the pulse repetition frequency.

For sinusoidal voltages, sawtooth-shaped pulse trains (1 steep edge per cycle) or trapezoidal pulses (2 approximately equally steep edges per cycle), the maximum permissible voltages for an inherent temperature rise of about 10 K can be obtained from the diagrams contained in this book.

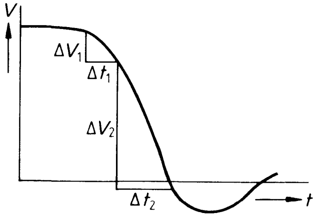
In case of other voltage curves or in ambiguous cases send us a dimensioned voltage/time diagram indicating the maximum voltage rates of rise together with the specification of the ambient temperature and we will give you further information.

5.2.6 Pulse handling capability (current carrying capability)

According to the equation $i = C\frac{dv}{dt}$ pulse-shaped voltages with high voltage rates of rise $\frac{dv}{dt} \approx \frac{V_{pp}}{\tau}$ result in high currents i in the capacitor. The thermal energy dissipated by these currents in the contacts is proportional to $\int i^2 dt$ or $\int \left(\frac{dv}{dt}\right)^2 dt$. To avoid thermal overheating the pulse characteristic, calculated by

$$k_o' = 2\int\left(\frac{dv}{dt}\right)^2 dt \approx 2\left(\frac{\Delta V_1^2}{\Delta t_1} + \frac{\Delta V_2^2}{\Delta t_2} + ...\right)$$

must be lower or at least equal to the k_o value specified for the individual type. ΔV_1, Δt_1 or ΔV_2, Δt_2 etc. represent the correlated voltage portions and periods of the curve of the voltage pulse approximated by a polygonal course.



For pulse-shaped voltages with
straight-line pulse edges (trapezoidal, sawtooth) applies: $k'_o = 2 \times V_{pp}^2/\tau\ [V^2/\mu s]$

For spontaneous and short-circuit like
discharges and charges applies: $k'_o = V_L^2/RC\,[V^2/\mu s]$

The k'_o value determined by the circuit data has to be lower than or at the utmost equal to that k_o value given for the individual capacitor types.
The k_o values refer to ambient temperatures of up to 50°C (122°F).
k_o values for higher temperatures are available on request.

Summary of terms used:

Peak-to-peak voltage (operating voltage)	V_{pp}	[V]
Charging voltage	V_L	[V]
Ohmic resistance in the charging and/or discharging circuit	R	(Ω)
Capacitance of capacitors	C	[μF]
Voltage rise time	τ	[μs]
Permissible pulse characteristic of the capacitor	k_o	[V²/μs]
Pulse characteristic calculated from circuit data	k'_o	[V²/μs]

Calculation example

Known:
Capacitor B 32510, LS 7.5, $V_R = 250$ V dc
The corresponding k_o value is 50,000 V²/μs (refer to page 115).
With a voltage swing of $V_{pp} = 100$ V, the permissible voltage rate of rise is deduced as:

$$\frac{V_{pp}}{\tau} = \frac{k_o}{2 \times V_{pp}} = \frac{50{,}000\ V^2/\mu s}{2 \times 100\ V} = 250\ V/\mu s$$

5.3 Dissipation factor

The dissipation factor tan δ depends on temperature and frequency and rises with increasing frequency and increasing capacitance. It mainly depends on the dielectric losses and the contact resistance of the leads.

The ohmic resistance of the leads is kept especially low and constant due to the contacting method used. For detailed data refer to the individual data sheets.

5.4 Insulation

The insulation of a capacitor is indicated either as a resistance value R_{is} in MΩ or as a time constant τ in seconds = MΩ × µF. It consists of the insulation resistance of the dielectric (layer to layer) and the insulation resistance between layer and case, which is determined by the quality of the insulating material (plastic case, moulding material, lead-throughs etc.) and by the length of the surface leakage paths. Because of the high quality of the insulating materials used for metalized film capacitors, the insulation resistance of the dielectric materials is unaffected.

The insulation resistance is the ratio of dc voltage applied to the current, flowing after a defined period.

The current flowing after a constant dc voltage has been applied, is dependent on temperature, voltage, and time. It is made up from the charging, recharging and leakage currents (definition in accordance with VDE 0560, Part 1, § 11).

In order to determine the limit values, the following conditions are specified: The current shall be measured after the voltage has been applied for 1 minute at 23°C/73.4 °F and a relative humidity $\leq 65\%$.

Measuring voltage for:

Capacitors with V_R	<100 V	≥ 100 V
Measuring voltage	10 V	100 V

The insulation resistance for more than 95% of all capacitors lies far above the stated minimum value at delivery. The average value is, therefore, also indicated in the individual data sheets.

During the service life the insulation resistance can temporarily decrease to about 10% of the values at delivery, especially when the maximum permissible humidity (according to the climatic category) is applied over a longer period or when the capacitor is used continuously in the range of the maximum operating temperature.

5.5 Self inductance and impedance

The self inductance of metalized plastic film capacitors depends on the inductance of their leads and the winding. Because of the large contacting area by which all turns of the winding are connected, the self inductance is especially low. The resonant frequency of a capacitor results from its self-inductance and its capacitance.

Typical impedance characteristics of MK capacitors are shown in **figure 3,** demonstrated on an MKT capacitor. The measuring conditions comply with DIN 41 328, sheet 2, length of leads 3 mm.

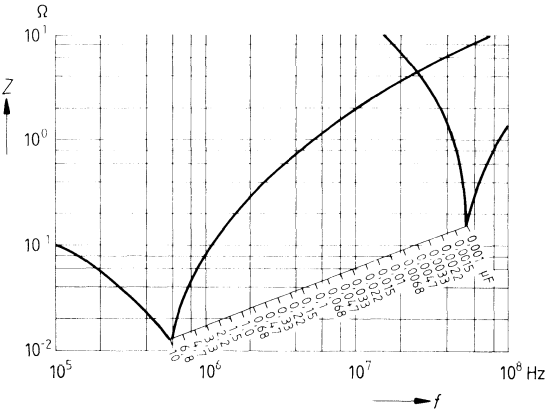


Figure 3
Impedance Z
versus frequency f

6 Climatic and mechanical characteristics

6.1 Permitted temperature and humidity

The permitted temperature and humidity depend on the individual capacitor types and are identified in accordance with DIN 40 040 as follows:

1st code letter	**G**	**F**	–	–
Lower category temperature	–40°C/ –40°F	–55°C –67°F	–	–
2nd code letter	**S**	**P**	**M**	–
Upper category temperature	+70°C/ +158°F	+85°C/ +185°F	+100°C/ +212°F	–
3rd code letter humidity category	**G**	**F(E3))**	**D**	**C**
Average relative humidity per year	≤65%	≤75%	≤80%	≤95%
30 days per year, continuously1)	–	95%	100%	100%
60 days per year, continuously	85%	–	–	–
for the remaining days, occasionally2)	75%	85%	90%	100%

6.1.1 Climatic categories in accordance with DIN IEC 68-1

MK capacitors are graded according to defined climatic categories which result from the climatic conditions according to which the capacitors have been tested. The climatic categories comprise three parameters:

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1) These days should suitably be distributed throughout the year.

2) Keeping the annual average.

3) For humidity category E, rare and slight dew precipitation is additionally permitted, e.g. during short openings of outdoor equipment.

Example:

Climatic category **55/085/56**

Test A: Cold
-55°C/-67°F
(in accordance with DIN IEC 68-2-1)
Test B: Dry heat
+85°C/+185°F
(in accordance with DIN IEC 68-2-2)
Test C: Damp heat (steady state)
56 days
(in accordance with DIN IEC 68-2-3)

6.2 Soldering conditions

As regards solderability and soldering heat resistance tests DIN IEC 68, Part 2-20 applies, unless otherwise specified.
Solder bath temperature: max. 260°C/500°F
Soldering time: 5 s

For soldering capacitors of particularly small volume, such as B 32 560 and B 32 561, the following procedure is recommended:

Maximum heating on the preheating path (flux dry path) up to 80°C/176°F
Solder bath temperature: max. 245°C/473°F
Soldering time: 4 s

Quick cooling, e. g. by a fan, after the actual soldering, to minimize the post-heating effect of the still liquid solder.

6.2.1 Resistance to cleaning agents

Organic solvents consisting of alcohols or certain fluorocarbons or a mixture of both groups are suitable to clean soldered-in capacitors from flux residues and similar residues.

Suitable solvents are, e. g.:
- Ethyl alcohol
- Isopropyl alcohol
- Trifluor trichloroethane
- Mixtures of the above-mentioned components

By no means should solvents or solvent mixtures be used which contain chlorinated carbons or ketones. This type of solvents may attack or corrode the capacitor or its sleeve.

Unprotected capacitors (such as B 32 510 to 513 or B 32 560 to 563) require a drying period if an electrical test is to be carried out successively.

Tables 1 and 2 give a selection of appropriate solvents which are commercially available at present. Table 3 shows a selection of solvents which are not suited for MK capacitors.

Table 1:
Presently available trifluor trichloroethanes (selection)

Designation	Manufacturer
Freon TF	Du Pont
Frigen 113 TR	Hoechst
Arklone P	ICI
Kaltron 113 MDR	Kali-Chemie
Flugene 113	Rhone-Progil

Table 2:
Presently available solvent mixtures of the components ethyl alcohol, isopropyl alcohol, and trifluor trichloroethane (selection)

Designation	Manufacturer
Freon TE; Freon TP 35; Freon TMS; Freon TES	Du Pont
Frigen 113 TR-E; Frigen 113 TR-P; Frigen 113 TR-M	Hoechst
Arklone A; Arklone F; Arklone L; Arklone K	ICI
Kaltron 113 MDA; Kaltron 113 MDI; Kaltron 113 MDM	Kali-Chemie
Flugene 113 E; Flugene 113 IPA; Flugene 113 M	Rhone-Progil

Table 3:
Presently available solvent mixtures of chlorinated carbons and ketones with fluorized carbons (selection) which are not suited for the cleaning of MK capacitors.

Designation	Manufacturer
Freon TMC; Freon TA; Freon TC	Du Pont
Arklone E	ICI
Kaltron 113 MDD; Kaltron 113 MDK	Kali-Chemie
Flugene 113 CM	Rhone-Progil

6.3 Mechanical robustness of terminations

The connecting leads are permitted to be bent at a distance not less than 1 mm from face ends of the capacitor, unless restrictions are indicated on the individual data sheets.

The terminals meet the requirements of DIN IEC 68-2-21.

Test Ua – Tensile	Diameter of wires ≤ 0.8 mm: 10 N[1]) > 0.8 mm: 20 N
Test Ub – Bending	Two bendings through 90° in the opposite direction. The loading weight shall be 5 N at $\leq 0.8\ mm^2$ dia 10 N at $> 0.8\ mm^2$ dia
Test Uc – Torsion of axial wires	Condition 2
Test Ud – Torque of threaded bolts	Condition 1 M 3 $\triangleq$ 0.5 Nm M 4 $\triangleq$ 1.2 Nm M 5 $\triangleq$ 2 Nm

For cube-shaped types with parallel leads, the termination tests Ub and Uc are not applicable.

6.4 Sealing unprotected MKT stacked-film capacitors

The numerous kinds of sealings entail difficulties in indicating the know-how – based on own experiments – for every application. According to our understanding, the following sealing materials are suitable for any application:

Acid-anhydride hardening, non-flexibilized epoxy resins; indifferent, electrically non-conductive hardeners; hardening temperature max. 100°C (212°F).

A sealing, comprising those elements, has stood our tests and has been utilized in the electronics industry.

6.5 Resistance to vibration

The ability of MK capacitors to withstand vibration load complies with the conditions specified in DIN IEC 68, Part 2-6, test Fc.

Frequency range	10 to 55 Hz
Displacement amplitude	0.75 mm
Duration of endurance conditioning	3 × 2 hours
This vibration load is equivalent to a maximum of	98.1 m/s^2 or 10 *g*

Big components have to be fixed by clamps for this test.

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[1]) 10 N = 1 kp

6.6 Low air pressure

MK capacitors feature reliable operation even in high altitudes.
Test in accordance with DIN 40 046, sheet 13 or IEC recommendation 68-2-13 providing a degree condition of severity of 44 hPa.

7 Quality specifications

(Delivery quality, reliability, service life, failure rate)

7.1 Delivery quality

The term delivery quality designates the conformity with agreed data at the time of delivery.

7.1.1 Random samples

The customer may carry out incoming inspections which are to be subject to the sampling inspection plan standards specifying the acceptance or rejection of a delivery lot in conjunction with the fixed AQL (acceptable quality level) values. The scope and maximum permissible number of defects of a random sample is specified in DIN 40080 (identical with MIL Std. 105 D and IEC 410), single sampling inspection plan for normal inspection, inspection level II. The sampling instructions of this standard are such that a delivery lot will most probably be accepted (more than 90%) if the percentage of defective components does not exceed the specified AQL value. Generally, the average defect percentage of our delivered components lies clearly below the AQL value.

7.1.2 Classification of defects

A defect exists if a component characteristic does not correspond to the specifications stated in the data sheets or an agreed delivery contract. Classified are total defects (inoperatives) which generally exclude a functional application of the component, and less important defects.

Total defects are
- open or short circuit
- component, case, leads or encapsulation broken
- missing or incorrect marking
- intermixing with other device types.

Deviations from this list are specified in the relevant data sheets or are agreed upon separately.

The other defects are classified as
- defects in the electrical features (e.g. if a characteristic value exceeds its max. permissible tolerance range)
- defects in the mechanical features (e.g. incorrect dimensions, damaged cases, illegible or incorrect marking, and twisted or bent leads).

7.1.3 AQL values

The following AQL values apply to the specified defects:

– for total defects (electrical and mechanical)	0.1
– for the sum of the electrical defectives	0.4
– for the sum of the mechanical defectives	0.4

The sum values include the related total defects.

7.2 Reliability (in accordance with DIN 40040)

The reliability (operational reliability) of a component is determined by the failures expected out of a sufficiently large batch after a defined period of time.

Data on load duration and failure quota is used for characterization.

7.2.1 Reference reliability of MK capacitors

The reference reliability is the reliability for a particularly defined requirement (reference requirement).

The reference reliability given for MK capacitors, refers to 40°C (104°F) and to the annual average humidity permitted for the particular type. Here, the diagrams of apendix 2, DIN 40040, page 7, are to be taken into account for a reduced relative humidity at temperatures above room temperature.

Electric stress implies operation at rated voltage (direct voltage or permissible superimposed alternating voltage); the sum of direct voltage and amplitude of alternating voltage, however, must not exceed the rated voltage.

Mechanic stress primarily implies resistance to vibration as described in para. 6.5.

7.2.2 Service life

The service life is the sum of:

- Working time
- Intermittent time
- Storage, testing, and checking time at the user
- Transport time

and is identified by the 5th code letter of the climatic category (see DIN 40040)

7.2.3 Failure rate[1])

The failure rate is the ratio of the number of failures and the service life specified. It is indicated in failures per 10^9 component hours and identified by the 4th code letter of the climatic category in accordance with DIN 40040.

Specifications of the component failure rate provides the equipment manufacturer with a basis for reliability forecasts and permits him to estimate the scope of servicing required.

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[1]) In DIN 40040 the failure rate in the ratio to time is designated as failure quota.

If of a large number N of identical components, percentage ΔN fails in time Δt,

$$\lambda = \frac{\Delta N}{N \times \Delta t}$$

expresses the failure rate (averaged over time Δt). It depends on the failure criteria, the stress, and the operating time.

The failure rate is expressed as a reciprocal period. The customary unit is 10^{-9}/h = fit (failures in time).

In case of stress conditions and temperatures which differ from the specifications in para. 7.2.1, the following conversion factors can be used for calculation:

Stress ratio	Conversion factor
100%	1
75%	0.4
50%	0.2
25%	0.06
10%	0.04

Temperature	Conversion factor
≤40°C	1
55°C	2
70°C	5
T_{max}	10

7.2.4 Failure criteria

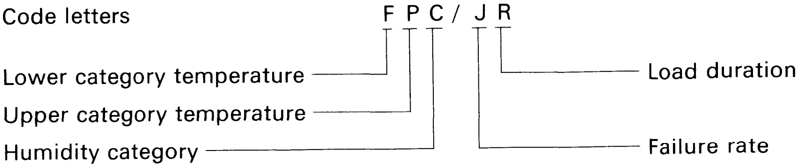
For MK capacitors the following failure criteria are decisive.

Total failure	Short or open circuit
Failure due to variations	exceeding or falling below the limit values given in the data sheets for: – capacitance change $\frac{\Delta C}{C}$ – dissipation factor change Δ tan δ – insulation resistance

Failure due to variation means deviations of electrical values which can generally be considered as being acceptable. In a lot of cases, there will be no functional failure of the unit, even if the capacitor exceeds one or even several of those limits. However, there are no hard-and-fast rules; the crucial factors are the nature and sensitivity of the circuit in question.

The failure criteria for the MK capacitors contained in this book can be found in the individual data sheets.

7.2.5 Example of coding the climatic category and reliability

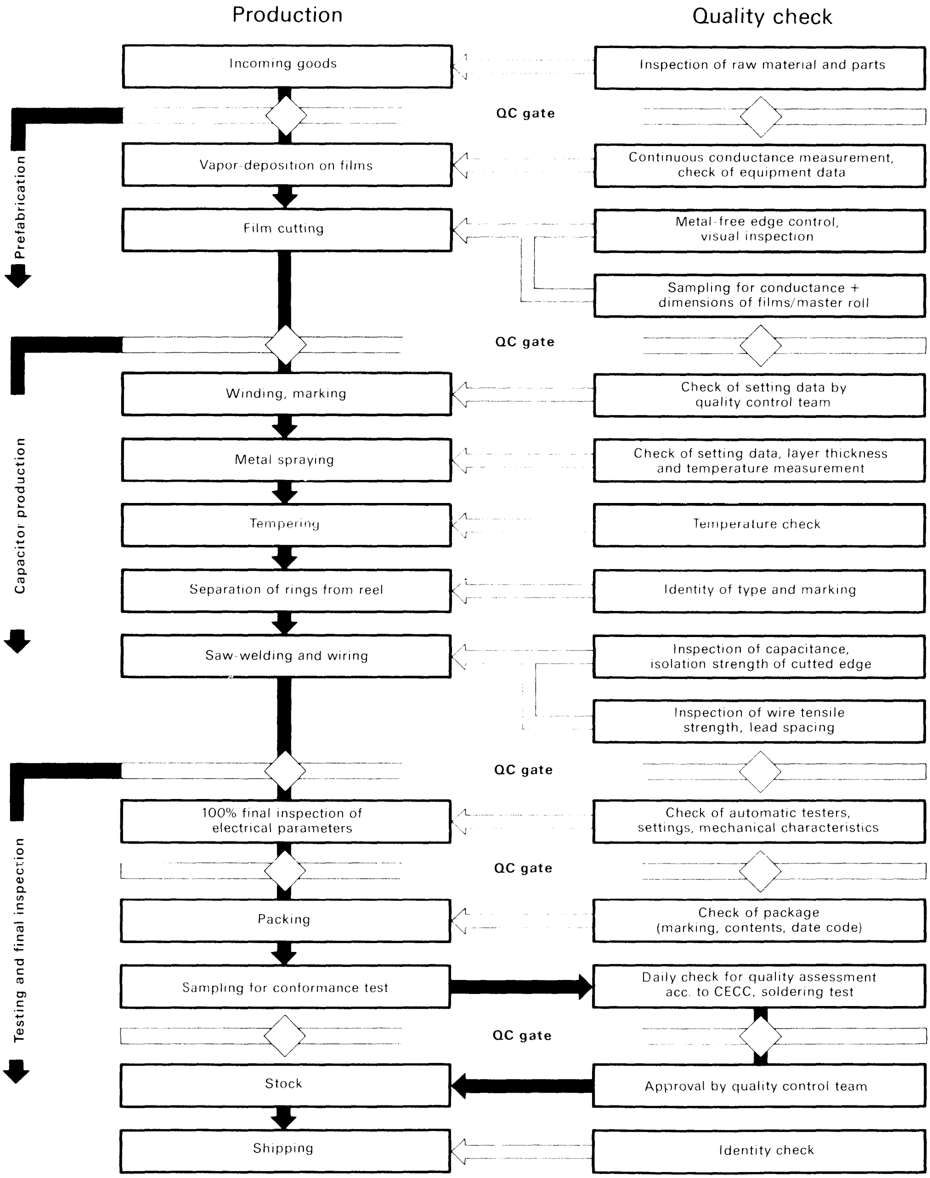


7.3 Supplementary information

Quality data, which always refers to a large number of components, does not assure characteristics in a legal sense. Conversely, an agreement as regards such data does not exclude the possibility of the customer being able to claim replacement for individual defective capacitors within the framework of the terms of delivery. However, we are not able to assume any further liability, in particular as regards the consequences of component failure.

Furthermore, it must be taken into consideration that information on the service life and failure rate refers to an average production situation in each case and that such information must thus be considered as average values (statistical anticipated values) based upon a large number of delivery batches of identical capacitors. They are based upon experience gained during use of the components and on data obtained from a preceding test under normal conditions or more severe conditions (for the purpose of accelerating the test).

7.4 Inspection plan for metalized plastic film capacitors with MKT stacked-film capacitors (B 32 560...563) serving as example



8 Ordering codes

Siemens has introduced part numbers for all its technical products in order to expedite procedures such as ordering and supplying, by means of data processing equipment. These part numbers clearly identify any deliverable component.

The ordering codes (Siemens part numbers) for MK capacitors are contained on every data sheet.

Ordering code example: B 32 520–A3104–K

Type — B 32 520
Revison status — A
Rated voltage 3≙250 V dc — 3
Rated capacitance (104≙10 × 10^4 pF = 0.1 μF) — 104
Capacitance tolerance (K≙±10%) — K

Improvements and technical advance are expressed by changing the code letter for the revision status. It is reserved to deliver MK capacitors with a revision status later than that ordered.

8.1 Marking the capacitors

The capacitance of the capacitors is, in most cases, marked according to DIN 40825.

Example of marking MKT capacitors, can version, LS 5 mm:

68 nF, Cap. tolerance ±20%, 63 V:	§68nM63
0.1 μF, Cap. tolerance ±10%, 63 V:	§μ1K63
1.0 μF, Cap. tolerance ±5%, 50 V:	§1μJ50

The date of manufacture is either marked in clear or as date code according to DIN 41314.

Code for specification of the **year**	
1979	L
1980	M
1981	N
1982	P
1983	R
1984	S
1985	T
1986	U
1987	V
1988	W
1989	X
1990	A

Code for specification of the **month**	
January	1
February	2
March	3
April	4
May	5
June	6
July	7
August	8
September	9
October	O
November	N
December	D

Example of year-month coding: 1984, May: S5
1985, Dec.: TD

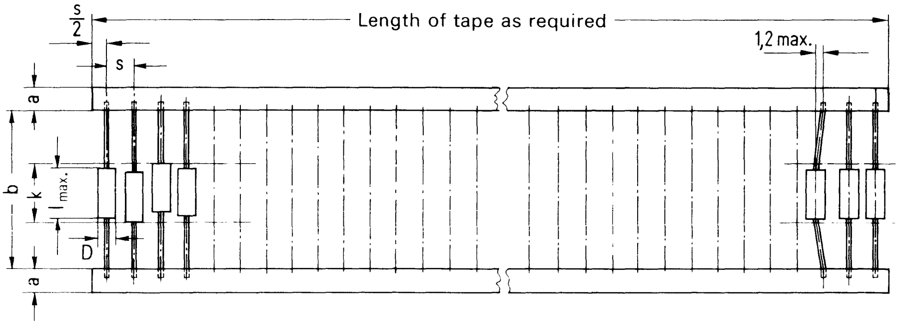
9 Packaging MK capacitors on continuous tapes

We provide taped versions with axial and unidirectional leads tailored to automatic assembly of equipment. Taping of MK capacitors with axial leads is based on DIN IEC 286-1; taping of types with unidirectional leads is done in accordance with DIN IEC 286-2 (at present draft).

Taped MK capacitors with axial leads

Preferably the MKL capacitors B 32110 and B 32112 up to a rated diameter of 18.7 mm are taped for automatic assembly.

Dimensions and tolerances



Dimensions in mm

Diameter *D*	Standard spacings between components *s*	Permissible deviations over 10 spacings	Inner tape spacings *b*		Body location (perm. lateral deviation)
			a = 6±1	a = 9±1	
mm	mm	mm	mm		*k*[1]
5.4 ... 9.4	10 ± 0.5	± 2	96 ± 2	93 ± 2	l_{max}[1]+1.4 mm
10.7 ... 13.7	15 ± 0.75	± 3			
15.7 ... 18.7	20 ± 1	± 4			

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[1] Measurement in acc. with IEC 294 (DIN 41099, sheet 1)

Minimum order quantities for taped MK capacitors with axial leads

Using only small numbers of taped components would be uneconomic as the share of taping and packing expense would increase the costs considerably. Moreover, automatic assembly is only reasonable for larger quantities. We, therefore, determined minimum order quantities for taped MK capacitors, which also correspond to the capacity of the packaging box.

Max. diameter (mm)	Packaging unit (item/cardboard box)	Kind of packing
5.4	1500	AMMO pack
6.4; 7.4	1300	
8.4; 9.4; 10.7	600	
11.7	500	
12.7; 13.7	400	
15.7; 16.7; 17.7; 18.7	300	

Ordering code for taped, axial-leaded MK capacitors

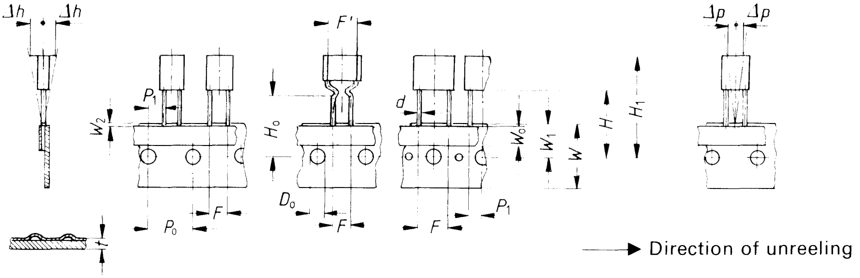
The ordering code (part number) for taped MK capacitors (produced in quantity) is formed by appending a "9" to the code of untaped components.

Example:	untaped capacitor	B 32110-E1105-M
	taped capacitor	B 32110-E1105-M9

Taped MK capacitors with unidirectional leads

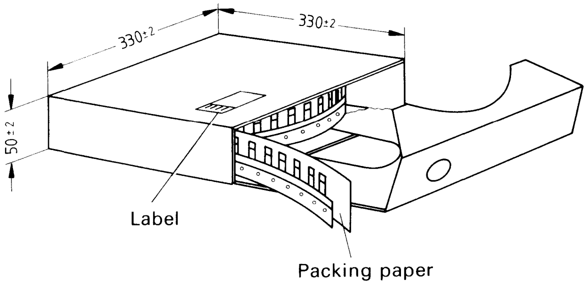
Stacked-film capacitors with lead spacings of LS 5, LS 7.5/5 (leads crimped to LS 5), as well as LS 7.5 are particularly suitable for taping of components with unidirectional leads.

Dimensions and tolerances

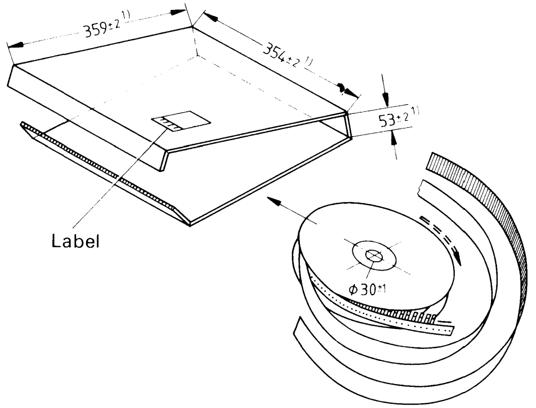


Designation	Symbol	Dimensions at:			Tolerance	Notes:
		LS 5	LS 7.5/5	LS 7.5		
Lead diameter	d	0.5	0.5	0.5	±0.05	
Spacing hole center/ lead center	P_1	3.80	3.80	3.80	±0.65	
Lead spacing (LS)	F	5	5	7.5	+0.6	measured at top of component body
Lead spacing (LS)'	F'		7.5		−0.1	
Pitch of the sprocket holes	P_0	12.7			±0.2	±1 mm/20 × P_0
Slope of capacitors	Δh	0			±2	
Slope of capacitors	Δp	0			±1.3	
Carrier tape width	W	18			±0.5	
Hold-down tape width	W_0	6			±0.5	
Position of sprocket holes	W_1	9			±0.5	
Position of hold-down tape	W_2	0.5 to 3.0				
Spacing hole center/bottom plane of component body	H	18			+2	depending on assembly system
		16.5			±0.3	
Spacing hole center/ start of crimping or bending	H_0	16.0			±0.5	
Spacing hole center/ top of component body	H_1	32.20 max				
Sprocket hole diameter	D_0	4.0			±0.2	
Tape thickness	t	0.7			±0.2	

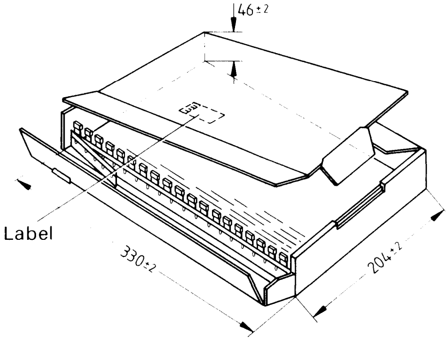
Cassette packing



Reel packing



AMMO pack



Dimensions in mm

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[1] Inner dimensions

Ordering codes

Lead spacing mm	Dimens. H or H_0 mm	Cassette packing	Reel packing	AMMO pack
5	$H = 18$ $H = 16.5$	B32529–A***–+89 B32529–A***–+69	B32529–A***–+189 B32529–A***–+169	B32529–A***–+289 B32529–A***–+269
	$H = 18$ $H = 16.5$	B32539–A***–+89 B32539–A***–+69	B32539–A***–+189 B32539–A***–+169	B32539–A***–+289 B32539–A***–+269
7.5/5	$H_0 = 16$	–	B32510–T105–K159	B32510–T105–K259
	$H_0 = 16$	–	B32520–A****–+159	B32520–A****–+259
	$H_0 = 16$ $H_0 = 16$	– –	B32530–A****–+159 B32550–B****–+159	B32530–A****–+259 B32550–B****–+259
7.5	$H = 18$ $H = 16.5$	–	B32510–T105–K189 B32510–T105–K169	B32510–T105–K289 B32510–T105–K269
	$H = 18$ $H = 16.5$	B32520–A****–+89 B32520–A****–+69	B32520–A****–+189 B32520–A****–+169	B32520–A****–+289 B32520–A****–+269
	$H = 18$ $H = 16.5$	B32530–A****–+89 B32530–A****–+69	B32530–A****–+189 B32530–A****–+169	B32530–A****–+289 B32530–A****–+269
	$H = 18$ $H = 16.5$	B32550–B****–+89 B32550–B****–+69	B32550–B****–+189 B32550–B****–+169	B32550–B****–+289 B32550–B****–+269

The ordering code digits marked by * or + are to be replaced by the appropriate specifications shown on the corresponding data sheets.

Packaging units (minimum order quantities)

Capacitor[1]		Minimum order quantity = packaging unit in items	
C_R	V_R	Cassette and reel packing	AMMO pack
B 32529/B 32539, lead spacing 5 mm			
4700 pF to 0.1 µF	63 Vdc	2000	1700
0.15 µF		1400	1300
0.22 µF		1400	1300
0.33 µF		1100	1000
0.47 µF		1000	900
0.68 µF		1000	900
1.0 µF		800	700

---

[1] For dimensions see individual data sheets

Capacitor1)		Minimum order quantity = packaging unit in items	
C_R	V_R	Cassette and reel packing	AMMO pack
B 32510, lead spacing 7.5/5 or 7.5 mm			
1.0 µF	63 Vdc	800	700
B 32520/B 32530, lead spacing 7.5/5 or 7.5 mm			
1000 pF to 0.010 µF	400 Vdc	1700	1500
0.015 µF		1300	1100
0.022 µF		1300	1100
0.033 µF		1000	900
0.047 µF		800	700
0.015 µF	250 Vdc	1700	1500
0.022 µF		1700	1500
0.033 µF		1700	1500
0.047 µF		1300	1100
0.068 µF		1000	900
0.10 µF		1000	900
0.15 µF		800	700
0.047 µF	100 Vdc	1700	1500
0.068 µF		1700	1500
0.10 µF		1700	1500
0.15 µF		1300	1100
0.22 µF		1000	900
0.33 µF		800	700
0.15 µF	63 Vdc	1700	1500
0.22 µF		1700	1500
0.33 µF		1300	1100
0.47 µF		1000	900
0.68 µF		800	700
B 32550, lead spacing 7.5/5 or 7.5 mm			
1000 pF to 0.033 µF	250 Vdc	1300	1100
0.047 µF		1000	900
0.068 µF		1000	900
0.1 µF		800	700
0.047 µF to 0.1 µF	100 Vdc	1300	1100
0.15 µF		1000	900
0.22 µF		800	700

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1) For dimensions see individual data sheets

MKL (MKU) Capacitors
Metalized Lacquer Film Capacitors

Metalized lacquer film capacitors – high rel version

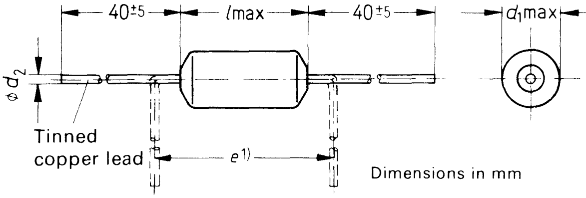
Designation in accordance with DIN 41379: MKU capacitors. Self-healing tubular capacitor winding with cellulose acetate dielectric. Enclosed in metal tube, with insulating sleeve, epoxy resin sealed face ends. Central axial leads.

MKL capacitors with quality assessment

Capacitors of the type series B 32 110 are permitted for space applications (see B 95 020 in section "Qualified Types"). They comply with the regulations SCC 3006 and SCC 3006/009 of ESA (European Space Agency), as well as with the specifications CF 100 and CF 101 of GfW (German Space Agency), and have the electronic test symbol.

Packaging on continuous tapes

Capacitors of this type are also available packaged on continuous tape. For taping instructions and ordering information refer to B 32071, page 46.



l	18.5	21	25	34
e[1])	22.5	25	30	40
d_1	≤7.4	≥8.4		
dia. d_2	0.6	0.8		

Rated dc voltage		25 V[2]	63 V	100 V	160 V	250 V
Rated capacitance µF	Tolerance	Dimensions $d_1 \times l$ Ordering code B 32 110–				
0.1	±20% ≙ M			5.4 × 18.5 -E104-M	6.4 × 18.5 -E1104-M	7.4 × 18.5 -E2104-M
0.15			5.4 × 18.5 -F9154-M	6.4 × 18.5 -E154-M	7.4 × 18.5 -E1154-M	8.4 × 18.5 -E2154-M
0.22			5.4 × 18.5 -F9224-M	6.4 × 18.5 -E224-M	7.4 × 21 -E1224-M	8.4 × 21 -E2224-M
0.33			6.4 × 18.5 -F9334-M	7.4 × 18.5 -E334-M	8.4 × 21 -E1334-M	9.4 × 21 -E2334-M
0.47		5.4 × 18.5 -D3474-M	7.4 × 18.5 -F9474-M	7.4 × 21 -E474-M	9.4 × 21 -E1474-M	10.7 × 21 -E2474-M
0.68		6.4 × 18.5 -D3684-M	7.4 × 18.5 -F9684-M	8.4 × 21 -E684-M	9.4 × 25 -E1684-M	10.7 × 25 -E2684-M
1	(±10 % ≙ K)[3] ±20% ≙ M	7.4 × 18.5 -D3105-M	7.4 × 21 -F9105-M	9.4 × 21 -E105-M	10.7 × 25 -E1105-M	11.7 × 25 -E2105-M
1.5		7.4 × 18.5 -D3155-M	8.4 × 21 -F9155-M	9.4 × 25 -E155-M	12.7 × 25 -E1155-M	13.7 × 25 -E2155-M
2.2		7.4 × 21 -D3225-M	10.7 × 21 -F9225-M	10.7 × 25 -E225-M	11.7 × 34 -E1225-M	12.7 × 34 -E2225-M
3.3		8.4 × 21 -D3335-M	9.4 × 25 -F9335-M	9.4 × 34 -E335-M	13.7 × 34 -E1335-M	15.7 × 34 -E2335-M
4.7		9.4 × 21 -D3475-M	10.7 × 25 -F9475-M	11.7 × 34 -E475-M	15.7 × 34 -E1475-M	17.7 × 34 -E2475-M
6.8		10.7 × 25 -K3685-M	10.7 × 34 -F9685-M	12.7 × 34 -E685-M	18.7 × 34 -E1685-M	20.7 × 34 -E2685-M
10		11.7 × 25 -D3106-M	12.7 × 34 -F9106-M	16.7 × 34 -E106-M	20.7 × 34 -E1106-M	25.9 × 34 -E2106-M

[1] Minimum distance between lead bend and capacitor body: 1 mm.

[2] Only available with a capacitance tolerance ±20 mm ≙ M

[3] Upon request

S All capacitors of this type are preferred types (see page 4).

DIN climatic category in acc. with DIN 40040	**FPE/JR**
Lower category temperature	**F** −55°C/−67°F
Upper category temperature	**P** +85°C/+185°F
Humidity category	**E** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h
Failure criteria Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > {}^{+\,18}_{-\,\;9}\%$ Dissipation factor $\tan \delta$ > 1.5 × upper category values Insulation resistance < 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**
Damp heat test in accordance with DIN IEC 68-2-3	**Conditions** Test temperature +40°C/+104°F Relative humidity $(93\,^{+2}_{-3})$ % Test duration 56 days **Test criteria** Capacitance change $\frac{\Delta C}{C} \leq \pm 5\%$ Dissipation factor change $\Delta \cdot \tan \delta$ $\leq 3 \times 10^{-3}$ at 1 kHz $\leq 5 \times 10^{-3}$ at 10 kHz Insulation resistance ≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 10 *g*) Capacitors with a diameter >15 mm must be fixed by clamps for this test
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the solder joint min. 6 mm Capacitance change $\frac{\Delta C}{C} \leq \pm 3\%$

---

[1] For soldering recommendations also refer to "General Information", para. 6.2.

Capacitance drift i_z

$^{+6}_{-3}\%$

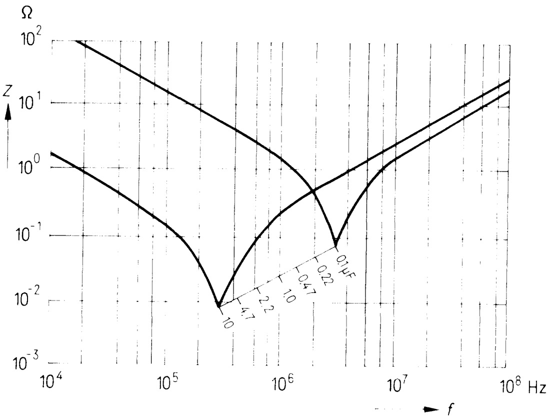
Dissipation factor tan δ measured at 20°C/68°F

	Upper limits	Average production values
at 1 kHz	20×10^{-3} for $C > 1.0$ µF	15×10^{-3} for $C > 1.0$ µF
at 10 kHz	36×10^{-3} for $C \leq 1.0$ µF	25×10^{-3} for $C \leq 1.0$ µF

Self inductance

approx. 20 nH (for 6 mm lead length at both ends)

Impedance Z **versus frequency** f (typical values)



Category voltage V_c

at dc operation: $1.0 \times V_R$

at operation with peak voltage: $1.5 \times V_R$ at 20°C/68°F up to 2000 h, at 85°C/185°F up to 200 h

$2.0 \times V_R$ up to max. 1 h
$2.5 \times V_R$ up to max. 1 min.
$3.0 \times V_R$ up to max. 1 s

for inevitable exceptions only, not for systematic switchings[1])

V_R = rated voltage

Category voltage V_c at ac operation

Rated voltage	$V_{c\ rms}$[2]) perm. Vac at 50 Hz	Peak voltage[3])
25 Vdc	10 Vac	15 Vac
63 Vdc	20 Vac	25 Vac
100 Vdc	35 Vac	50 Vac
160 Vdc	60 Vac	80 Vac
250 Vdc	90 Vac	125 Vac

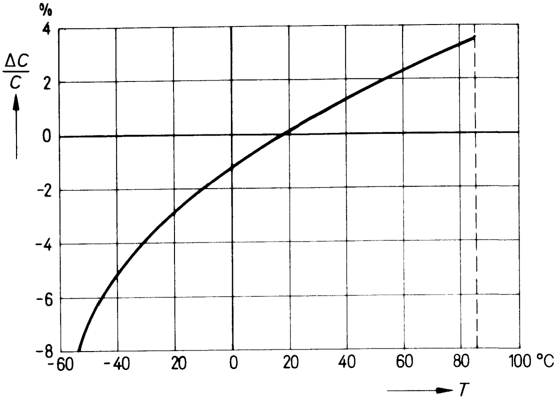
---

[1]) Throughout the entire service life, the times are summed up thereby permitting the electrical values to deviate up to the limit indicated for failures due to variations.

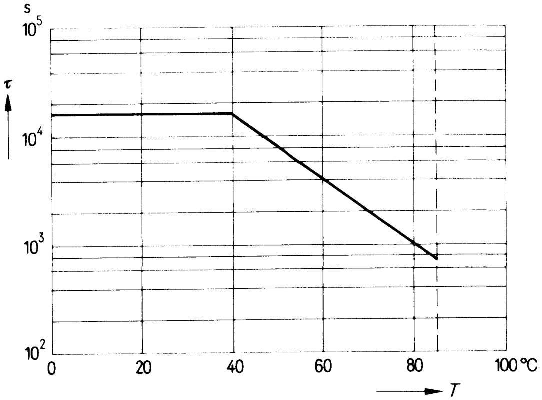
[2]) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

[3]) The peak voltage refers to 2000 hours at +20°C/68°F or 200 hours at +85°C/185°F.

Capacitance change $\frac{\Delta C}{C}$
versus temperature
at 1 kHz (typical values)



Insulation
Time constant τ versus temperature T



Insulation resistance R_{is} and time constant τ	
Minimum value as supplied1)	
for $C \leq 0.33$ µF	15 000 MΩ
for $C > 0.33$ µF	5 000 s
Average value as supplied	>15 000 s

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1) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_o).

Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length 18.5 mm	21 mm	25 mm	34 mm
25 V	V_{pp}/τ k_o	2.5 V/µs 125 V²/µs	1.5 V/µs 75 V²/µs	1.0 V/µs 50 V²/µs	– –
63 V	V_{pp}/τ k_o	4.5 V/µs 570 V²/µs	3.0 V/µs 380 V²/µs	2.0 V/µs 250 V²/µs	1.2 V/µs 150 V²/µs
100 V	V_{pp}/τ k_o	6.5 V/µs 1300 V²/µs	4.5 V/µs 900 V²/µs	3.0 V/µs 600 V²/µs	1.7 V/µs 340 V²/µs
160 V	V_{pp}/τ k_o	10 V/µs 3200 V²/µs	6.0 V/µs 1920 V²/µs	4.0 V/µs 1300 V²/µs	2.3 V/µs 750 V²/µs
250 V	V_{pp}/τ k_o	11.5 V/µs 5750 V²/µs	8.0 V/µs 4000 V²/µs	5.0 V/µs 2500 V²/µs	2.7 V/µs 1400 V²/µs

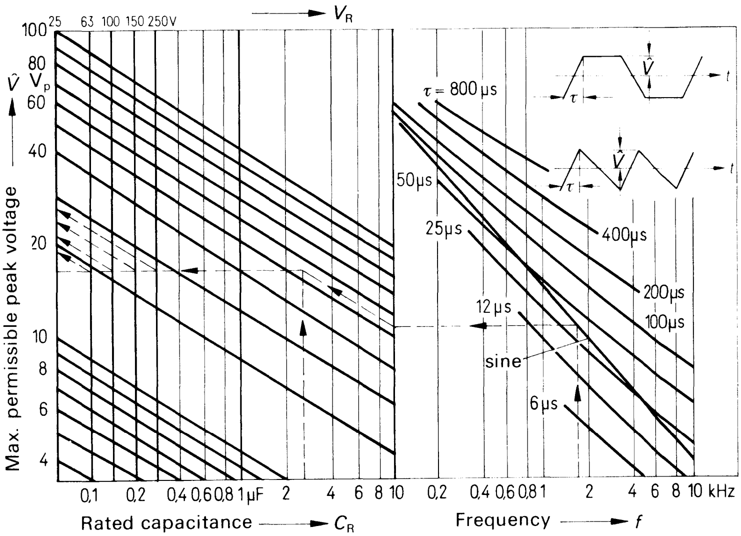
For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para 5.2.6.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram, where the following limits may not be exceeded.

Rated voltage V_R	25 V	63 V	100 V	160 V	250 V
Limit voltage $\hat{V}_l$	14 V	28 V	50 V	80 V	125 V

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature. In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be taken into account.



Example:

f = 1.7 kHz (repetition frequency)
τ = sine (rise time)
C = 2.5 µF (capacitance)

According to the dashed line in the above graph, this results:

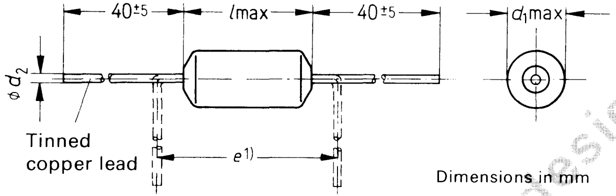
for the 25 Vdc type in a max. peak voltage $\hat{V}$ of approx. 17 V (not permissible)
for the 63 Vdc type in a max. peak voltage $\hat{V}$ of approx. 19 V
for the 100 Vdc type in a max. peak voltage $\hat{V}$ of approx. 21 V
for the 160 Vdc type in a max. peak voltage $\hat{V}$ of approx. 24 V
for the 250 Vdc type in a max. peak voltage $\hat{V}$ of approx. 26 V

Metalized lacquer film capacitors – high rel version

Designation in accordance with DIN 41379: MKU capacitors. Self-healing tubular capacitor winding with cellulose acetate dielectric. In metal tube, with insulating sleeve, epoxy resin sealed face ends. Central axial leads.

MKL capacitors with quality assessment

Capacitors of the type series B 32 111 are permitted for space applications (see B 95 020 in section "Qualified Types"). They comply with the regulations SCC 3006 and SCC 3006/009 of ESA (European Space Agency), as well as with the specifications CF 100 and CF 101 of GfW (German Space Agency), and have the electronic test symbol.



l	e1)	ød2
34	40	0.8
46	52.5	1.0

Dimensions in mm

Rated capacitance µF	Tolerance	Rated dc voltage	Dimensions $d_1 \times l$	Ordering code
22	±10%≙K ±20%≙M	63 V	16.7 × 34	B32111-A9226-+
47			23.7 × 34	B32111-A9476-+
100			25.9 × 46	B32111-A9107-+

+ Insert appropriate code letter for requested capacitance tolerance.

DIN climatic category in acc. with DIN 40040	**F P E / J R**
Lower category temperature	**F** −55°C/−67°F
Upper category temperature	**P** +85°C/+185°F
Humidity category	**E** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h

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[1] Minimum distance between lead bend and capacitor body: 1 mm.

Failure criteria Total failure Failure due to variation	Short or open circuit Capacitance change $\frac{\Delta C}{C} > {}^{+18}_{-\ 9}\%$ Dissipation factor tan δ >1.5 × upper category value Insulation <50 s
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**
Damp heat test in accordance with DIN IEC 68-2-3	**Conditions** Test temperature +40°C/+104°F Relative humidity $(93 {}^{+2}_{-3})\%$ Test duration 56 days **Test criteria** Capacitance change $\frac{\Delta C}{C} \leq \pm 5\%$ Dissipation factor change Δ tan δ $\leq 3 \times 10^{-3}$ at 50 Hz Insulation resistance ≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 10 *g*) For this test the capacitors must be fixed by clamps
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the soldering joint min. 6 mm Capacitance change $\frac{\Delta C}{C} \leq \pm 3\%$
Capacitance drift i_Z	${}^{+6}_{-3}\%$
Dissipation factor tan δ measured at 20°C/68°F and 50 Hz	Upper limit 20×10^{-3} Average production value 15×10^{-3}
Self inductance	approx. 20 nH (for 6 mm lead length at both ends)

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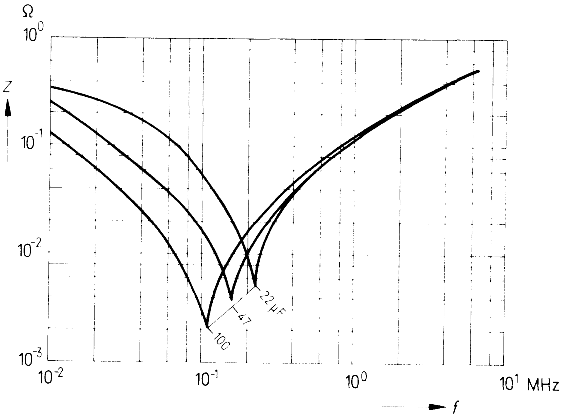
[1] For soldering recommendations also refer to "General Information", para 6.2.

Impedance Z versus frequency f
(typical values)



Category voltage V_C
at dc operation
at operation with peak voltage

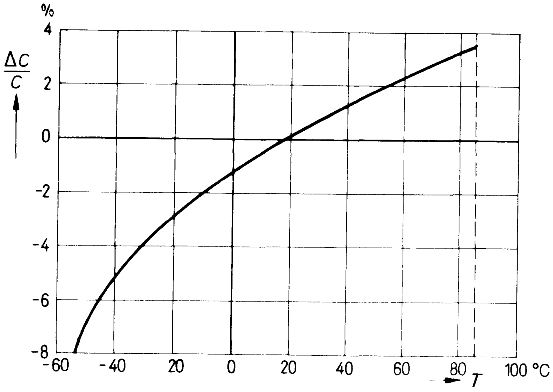
$1.0 \times V_R$
$1.5 \times V_R$ at 20°C/68°F up to 2000 h, at 85°C/185°F up to 200 h
$2.0 \times V_R$ up to max. 1 h
$2.5 \times V_R$ up to max. 1 min.
$3.0 \times V_R$ up to max. 1 s
} for inevitable exceptions only, not for systematic switchings¹)
V_R = rated voltage

Category voltage V_C
at ac operation

perm. Vac_{rms}; 50 Hz²)	Peak voltage³)
20 Vac	25 Vac

$1.5 \times V_C$ for milliseconds (e.g. switchings)

Capacitance change $\frac{\Delta C}{C}$ versus temperature T
at 1 kHz (typical values)



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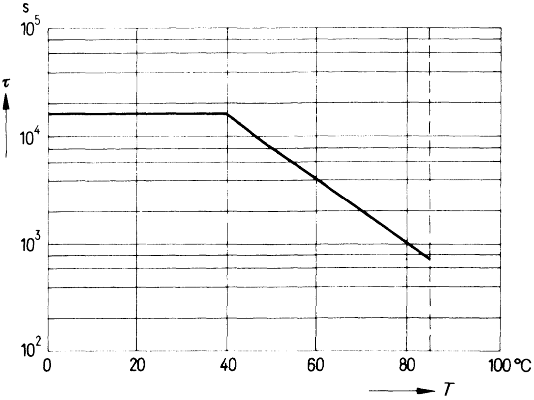
¹) Throughout the entire service life, the times are summed up thereby permitting the electrical values to deviate up to the limit indicated for failures due to variations.

²) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

³) This peak voltage refers to 2,000 hours at +20°C/68°F or 200 hours at +85°C/185°F.

Insulation
Time constant τ versus temperature T



Minimum value as supplied[1]	5000 s
Average value as supplied	>15000 s

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated voltage V_R		Capacitor length 34 mm	46 mm
63 V	V_{pp}/τ	1.5 V/µs	1.0 V/µs
	k_0	190 V²/µs	126 V²/µs

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information" para. 5.2.6.

---

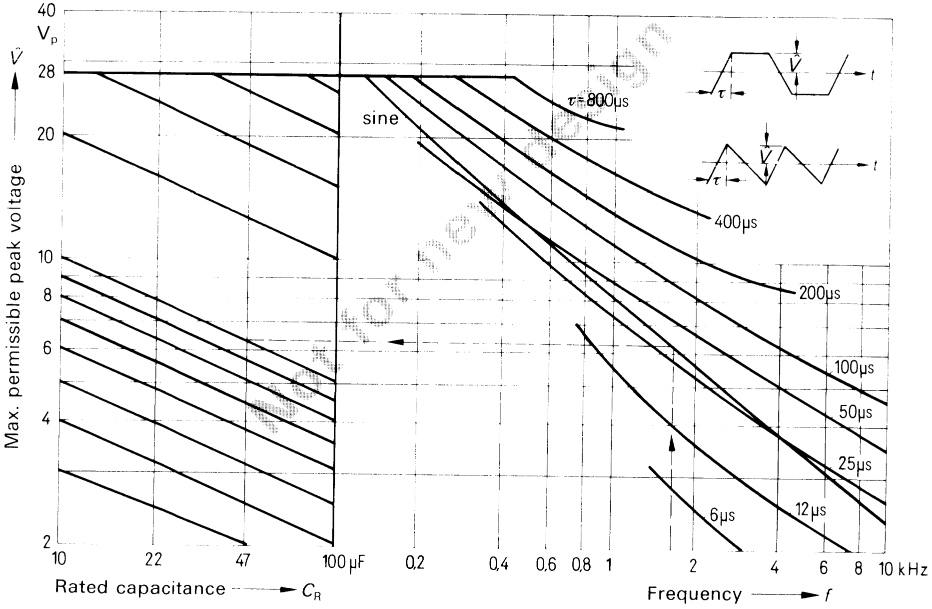
[1] The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram, where the following limit values $\hat{V}_l$ may not be exceeded.

Rated voltage V_R	63 V
Limit voltage $\hat{V}_l$	28.5 V

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature. In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be taken into account.



Example:

f = 1.7 kHz (repetition frequency)
τ = sine (rise time)
C = 47 µF (capacitance)

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 10 V.

Metalized lacquer film capacitors – high rel version

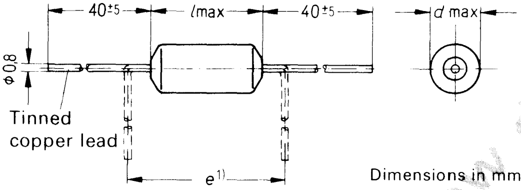
Designation in accordance with DIN 41379: MKU capacitors. Self-healing tubular capacitor winding with cellulose acetate dielectric. Enclosed in metal tube, with insulating sleeve, epoxy-resin sealed face ends. Central axial leads.

MKL capacitors with quality assessment

Capacitors of the type series B 32 112 are permitted for space applications (see B 95 020 in section "Qualified Types"). They comply with the regulations SCC 3006 and SCC 3006/012 of ESA (European Space Agency), as well as with the specifications CF 100 and CF 104 of GfW (German Space Agency), and have the electronic test symbol.

Packaging on continuous tapes

Capacitors of this type are also available packaged on continuous tape.
For taping instructions and ordering information refer to B 32071, page 46.



Dimensions in mm

l	e[1]
18.5	22.5
21	25
25	30
34	40

Rated capacitance µF	Tolerance	Rated dc voltage	Dimensions $d \times l$	Ordering code
0.033	±20%≙M	630 V	8.4×18,5	B32112-A2333-M
0.047			8.4×18,5	B32112-A2473-M
0.068			8.4×21	B32112-A2683-M
0.1			8.4×21	B32112-A2104-M
0.15			9.4×25	B32112-A2154-M
0.22			9.4×25	B32112-A2224-M
0.33			11.7×25	B32112-A2334-M
0.47			12.7×25	B32112-A2474-M
0.68			11.7×34	B32112-A2684-M
1			13.7×34	B32112-A2105-M
1.5			16.7×34	B32112-A2155-M
2.2			18.7×34	B32112-A2225-M
3.3			23.7×34	B32112-A2335-M
4.7			25.9×34	B32112-A2475-M

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[1] Minimum distance between lead bend and capacitor body: 1 mm.

DIN climatic category in acc. with DIN 40040	**F P E / J R**
Lower category temperature	**F** −55°C/−67°F
Upper category temperature	**P** +85°C/+185°F
Humidity category	**E** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > {}^{+\,18}_{-\;\;9}\%$ Dissipation factor tan δ > 1.5 × upper category values Insulation resistance < 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**
Damp heat test in accordance with DIN IEC 68-2-3	**Conditions** Test temperature +40°C/+104°F Relative humidity $(93\,{}^{+2}_{-3})$ % Test duration 56 days **Test criteria** Capacitance change $\frac{\Delta C}{C} \leq \pm 5\%$ Dissipation factor change Δ tan δ ≤3×10^{-3} at 1 kHz ≤5×10^{-3} at 10 kHz Insulation resistance ≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 10 *g*) Capacitors with a diameter >15 mm must be fixed by clamps for this test
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the solder joint min. 6 mm Capacitance change $\frac{\Delta C}{C}$ ≤±3%

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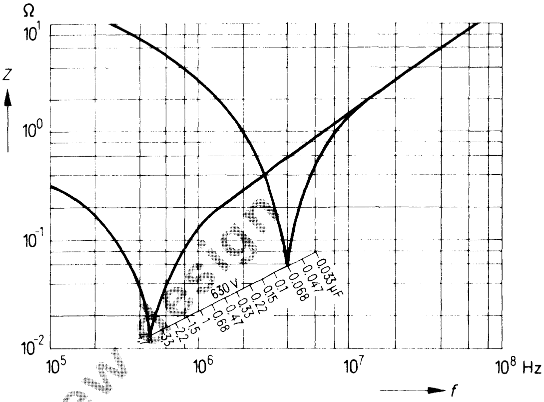
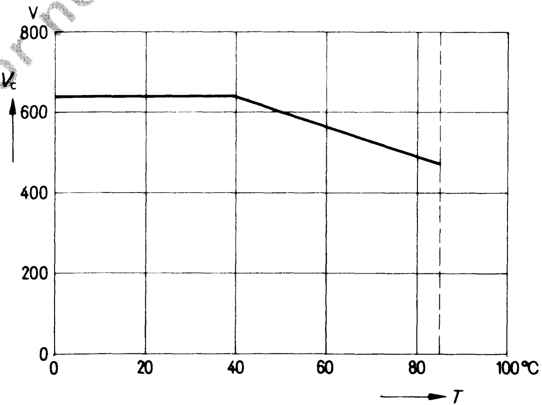
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Capacitance drift i_z	$^{+6}_{-3}\%$	
Dissipation factor tan δ measured at 20°C/68°F	Upper limits	Average production values
at 1 kHz at 10 kHz	15×10^{-3} for $C > 1$ µF 25×10^{-3} for $C \leq 1$ µF	12×10^{-3} for $C > 1$ µF 20×10^{-3} for $C \leq 1$ µF
Self inductance	approx. 20 nH (for 3 mm lead length at both ends)	

Impedance Z
versus frequency f
(typical values)



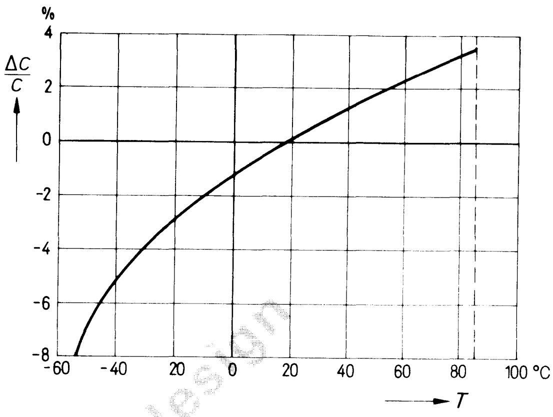
Category voltage V_c
at dc operation



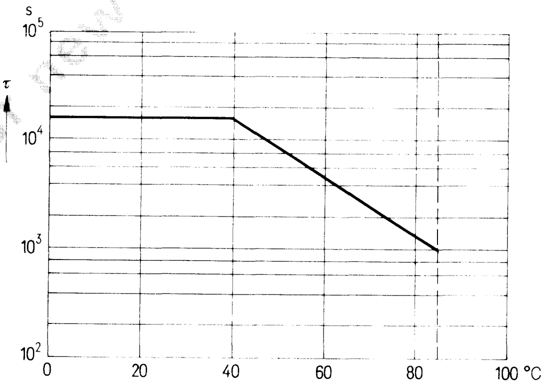
max. 2000 h	$1.10 \times V_c$
max. 1 h	$1.25 \times V_c$
max. 1 min	$1.50 \times V_c$

Category voltage V_c 1) at ac operation for milliseconds (e. g. switchings)	200 Vac (permissible Vac_{rms} at 50 Hz) 1.5 × V_c

Capacitance change $\frac{\Delta C}{C}$ versus temperature T
at 1 kHz (typical values)



Insulation
Time constant τ versus temperature T



Insulation resistance R_{is} and time constant

Minimum value as supplied2) for $C \leq 0.33$ µF	30000 MΩ
for $C > 0.33$ µF	10000 s
Average value as supplied	>20000 s

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1) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

2) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_O). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated voltage		Capacitor length			
V_R		18.5 mm	21 mm	25 mm	34 mm
630 V	V_{pp}/τ	20 V/µs	13 V/µs	9 V/µs	5 V/µs
	k_O	25000 V²/µs	16400 V²/µs	11400 V²/µs	6300 V²/µs

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

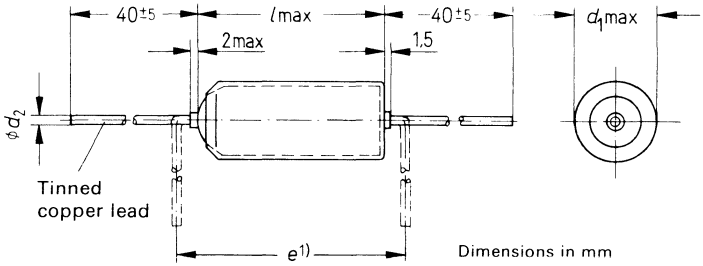
Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

Metalized lacquer film capacitors – high rel version

Designation in accordance with DIN 41 379: MKU capacitors.
Self-healing tubular capacitor winding with plastic films as dielectric. Hermetically sealed in tubular, non-magnetic metal can (cartridge), with insulating sleeve.
Leads: Insulated lead-in wire at one end centrally soldered in cartridge at the other.

MKL capacitors with quality assessment

Capacitors of the type series B 32 120 are also available on request as "quality assessed components" under the ordering code B 95 017 in accordance with VG 95 296, part 4 (refer to section "Qualified Types"). They are subject to quality supervision and have the electronic test symbol.



Dimensions in mm

l	17.5	21.5	25.5	35.5
e[1])	25	30	35	45

d_1	≤8.2	≥11.2
dia. d_2	0.6	0.8

---

[1]) Minimum distance between lead bend and capacitor body: 2 mm.

Rated dc voltage		63 V	100 V	160 V	250 V
Rated capacitance μF	Tolerance	Dimensions d_1 × l (mm) and ordering code			
0.1	±20%≙M	–	S 6.2×17.5 B32120–E104–M	8.2×17.5 B32120–D1104–M	8.2×21.5 B32120–D2104–M
0.15		6.2×17.5 B32120–F9154–M	6.9×17.5 B32120–D154–M	8.2×17.5 B32120–D1154–M	11.2×21.5 B32120–D2154–M
0.22		S 6.2×17.5 B32120–F9224–M	S 6.9×17.5 B32120–D224–M	8.2×21.5 B32120–D1224–M	11.2×21.5 B32120–D2224–M
0.33		S 6.9×17.5 B32120–E9334–M	S 8.2×17.5 B32120–D334–M	8.2×21.5 B32120–D1334–M	11.2×21.5 B32120–D2334–M
0.47		S 8.2×17.5 B32120–E9474–M	S 8.2×21.5 B32120–D474–M	11.2×21.5 B32120–D1474–M	11.2×21.5 B32120–D2474–M
0.68		8.2×17.5 B32120–E9684–M	8.2×21.5 B32120–D684–M	11.2×25.5 B32120–D1684–M	11.2×25.5 B32120–D2684–M
1	(±10%≙K)[1] ±20%≙M	S 8.2×21.5 B32120–E9105–M	S 11.2×21.5 B32120–D105–M	11.2×25.5 B32120–D1105–M	15 ×25.5 B32120–D2105–M
1.5		8.2×21.5 B32120–E9155–M	11.2×25.5 B32120–D155–M	15 × 25.5 B32120–D1155–M	15 ×25.5 B32120–D2155–M
2.2		S 11.2×21.5 B32120–E9225–M	S 11.2×25.5 B32120–D225–M	11.2×35.5 B32120–D1225–M	15 × 35.5 B32120–D2225–M
3.3		S 11.2×25.5 B32120–E9335–M	S 11.2×35.5 B32120–D335–M	15 × 35.5 B32120–D1335–M	16.5×35.5 B32120–D2335–M
4.7		S 11.2×25.5 B32120–E9475–M	S 11.2×35.5 B32120–D475–M	16.5×35.5 B32120–D1475–M	21 × 35.5 B32120–D2475–M
6.8		11.2×35.5 B32120–E9685–M	15 × 35.5 B32120–D685–M	18.2×35.5 B32120–D1685–M	B32120–D2685–M
10		S 15 × 35.5 B32120–E9106–M	S 16.5×35.5 B32120–D106–M	21 × 35.5 B32120–D1106–M	25.8×35.5 B32120–D2106–M

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[1] Upon request

S These capacitors are preferred types (see page 4)

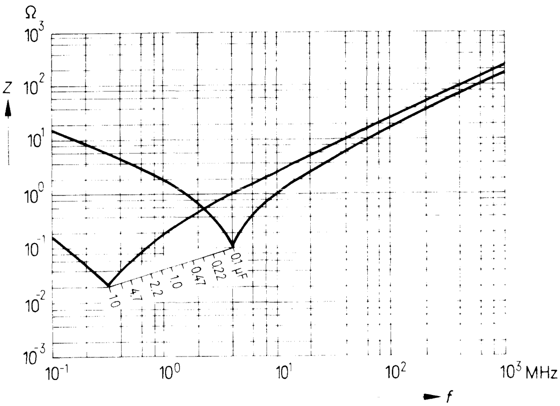
DIN climatic category in acc. with DIN 40040	**F P C / J R**
Lower category temperature	**F** $-55°\mathrm{C}/-67°\mathrm{F}$
Upper category temperature	**P** $+85°\mathrm{C}/+185°\mathrm{F}$
Humidity category	**C** average relative humidity ≤95%; max. value 100%, including dew precipitation
Failure rate (40°C/104°F, V_R)	**J** $30 \times 10^{-9}/\mathrm{h} = 30$ fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > \pm 4\%$ Dissipation factor tan δ > 1.5 × upper category values Insulation resistance < 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**
	Conditions
	Test temperature +40°C/+104°F
Damp heat test in acc. with DIN IEC 68-2-3	Relative humidity $(93 {}^{+2}_{-3})$ % Test duration 56 days
	Test criteria
	Capacitance change $\frac{\Delta C}{C} \leq \pm 2\%$ Dissipation factor change Δ tan δ $\leq 3 \times 10^{-3}$ at 1 kHz $\leq 5 \times 10^{-3}$ at 10 kHz Insulation resistance ≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 98.1 $\mathrm{m/s^2}$ or 10 *g*)
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the solder joint min. 6 mm Capacitance change $\frac{\Delta C}{C}$ ≤±3%

---

[1] For soldering recommendations also refer to "General Information", para. 6.2.

Capacitance drift i_z	±2%	
Dissipation factor tan δ measured at 20°C/68°F	Upper limits	Average production values
at 1 kHz	20×10^{-3} for $C > 1.0$ μF	15×10^{-3} for $C > 1.0$ μF
at 10 kHz	36×10^{-3} for $C \leq 1.0$ μF	25×10^{-3} for $C \leq 1.0$ μF
Self inductance	approx. 20 nH (for 6 mm lead length at both ends)	

Impedance Z versus frequency f
(typical values)



Category voltage V_c	
at dc operation	1.0 × V_R
at operation with peak voltage	1.5 × V_R at 20°C/68°F up to 2000 h, at 85°C/185°F up to 200 h 2.0 × V_R up to max. 1 h 2.5 × V_R up to max. 1 min. 3.0 × V_R up to max. 1 s for inevitable exceptions only, not for systematic switchings[1] V_R = rated voltage

---

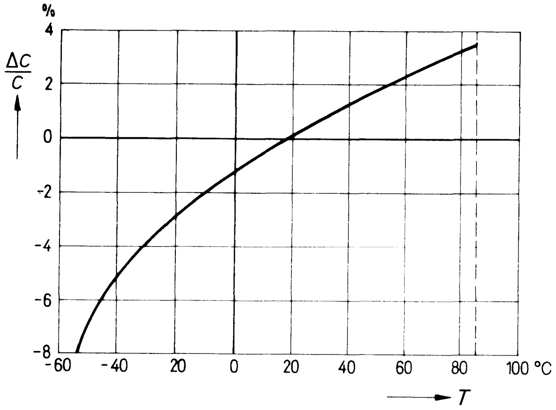
[1] Throughout the entire service life, the times are summed up thereby permitting the electrical values to deviate up to the limit indicated for failures due to variations.

Category voltage V_C[1]
at ac operation

Rated voltage	$V_{c\ rms}$ perm. Vac at 50 Hz	Peak voltage[2]
63 Vdc	20 Vac	25 Vac
100 Vdc	35 Vac	50 Vac
160 Vdc	60 Vac	80 Vac
250 Vdc	90 Vac	125 Vac

1.5 × V_C for milliseconds (e. g. switchings)

Capacitance change $\frac{\Delta C}{C}$
versus temperature T
at 1 kHz (typical values)



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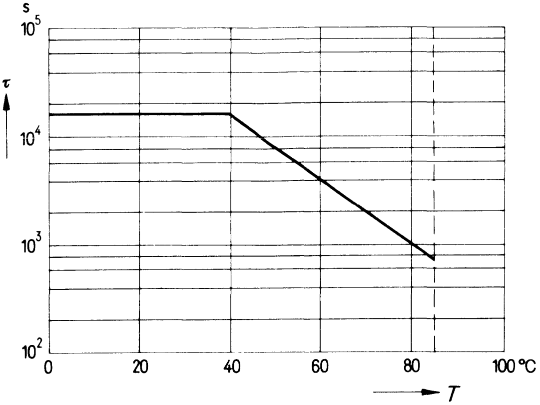
[1] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

[2] The peak voltage refers to 2,000 hours at + 20°C/68°F and 200 hours at + 85°C/185°F

Insulation
Time constant τ versus temperature *T*



Insulation resistance R_{is} and time constant τ

Minimum value as supplied1)	
for $C \leq 0.33$ µF	15000 MΩ
for $C > 0.33$ µF	5000 s
Average value as supplied	>15000 s

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_o). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length			
		17.5 mm	21.5 mm2)	25.5 mm	35.5 mm
63 V	V_{pp}/τ k_o	4.5 V/µs 567 V²/µs	3.0 V/µs 378 V²/µs	2.0 V/µs 252 V²/µs	1.2 V/µs 151 V²/µs
100 V	V_{pp}/τ k_o	6.5 V/µs 1300 V²/µs	4.5 V/µs 900 V²/µs	3.0 V/µs 600 V²/µs	1.7 V/µs 340 V²/µs
160 V	V_{pp}/τ k_o	10.0 V/µs 3200 V²/µs	6.0 V/µs 1920 V²/µs	4.0 V/µs 1280 V²/µs	2.3 V/µs 736 V²/µs
250 V	V_{pp}/τ k_o	–	8.0 V/µs 4000 V²/µs	5.0 V/µs 2500 V²/µs	2.7 V/µs 1350 V²/µs

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

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1) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery if the capacitor is operated close to the upper category temperature.

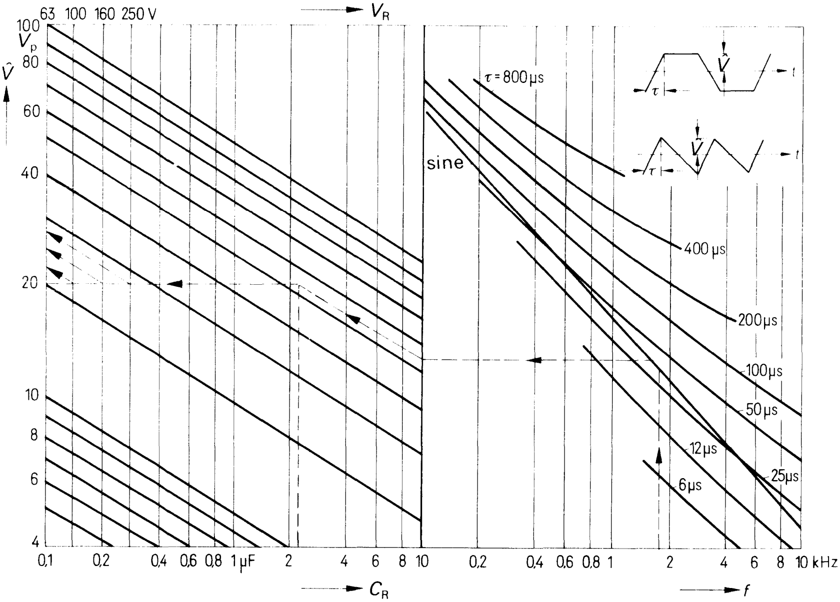
2) The capacitors 0.1 µF, 250 Vdc and 0.15 µF, 250 Vdc may be loaded as 17.5 mm long capacitors, 160 Vdc.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram, where the following limit values $\hat{V}_l$ may not be exceeded.

Rated voltage V_R	63 V	100 V	160 V	250 V
Limit voltage $\hat{V}_l$	28 V	50 V	80 V	125 V

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature. In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be taken into account.



Example:

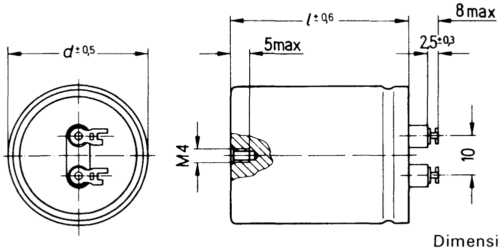
f = 1.7 kHz (repetition frequency)
τ = sine (rise time)
C = 2.2 µF (capacitance)

According to the dashed line in the above graph, this results:

for the 63 Vdc type in a max. peak voltage $\hat{V}$ of approx. 20 V
for the 100 Vdc type in a max. peak voltage $\hat{V}$ of approx. 23 V
for the 160 Vdc type in a max. peak voltage $\hat{V}$ of approx. 25 V
for the 250 Vdc type in a max. peak voltage $\hat{V}$ of approx. 27 V

Metalized lacquer film capacitors – high rel version

Designation in accordance with DIN 41379: MKU capacitors. Self-healing tubular capacitor winding with cellulose acetate dielectric. Hermetically sealed in tubular can, metal cover with ceramic lead-throughs and solder tag connections.

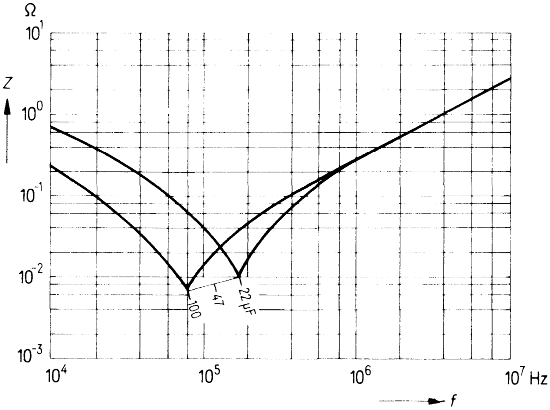


Dimensions in mm

Rated capacitance µF	Tolerance	Rated dc voltage	Dimensions *d* × *l*	Ordering code
22	±20%≙M ±10%≙K	100 V	25 × 38	B32121-J226-+
47			32 × 38	B32121-J476-+
100			40 × 50	B32121-J107-+

+ Insert appropriate code letter for requested capacitance tolerance.

DIN climatic category in acc. with DIN 40040	**F P C / J R**
Lower category temperature	**F** −55°C/−67°F
Upper category temperature	**P** +85°C/+185°F
Humidity category	**C** average relative humidity ≤95%; max. value 100% including dew precipitation
Failure rate (40°C/104°F, V_R)	**J** 30 × 10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** ≥10^5 h
Failure criteria	
Total failure	Short or open circuit
Failure due to variation	Capacitance change $\frac{\Delta C}{C}$ >±4%
	Dissipation factor tan δ >1.5 × upper category value
	Insulation <50 s

IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**	
	Conditions	
Damp heat test in acc. with DIN IEC 68-2-3	Test temperature	+40°C/+104°F
	Relative humidity	$(93 {+2 \atop -3})$ %
	Test duration	56 days
	Test criteria	
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 2\%$
	Dissipation factor change Δ tan δ	$\leq 3 \times 10^{-3}$ (at 50 Hz)
	Insulation resistance	≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10 to 55 Hz
	Displacement amplitude	0.75 mm (conforming to max. 10 *g*)
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 10 s
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 3\%$
Capacitance drift i_z	±2%	
Dissipation factor tan δ measured at 20°C/68°F and 50 Hz	Upper limit 20×10^{-3}	Average production value 15×10^{-3}
Self inductance	approx. 40 nH	
Impedance *Z* **versus frequency** *f* (typical values)		

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[1] For soldering recommendations also refer to "General Information", para. 6.2.

Category voltage V_C
at dc operation
at operation with peak voltage

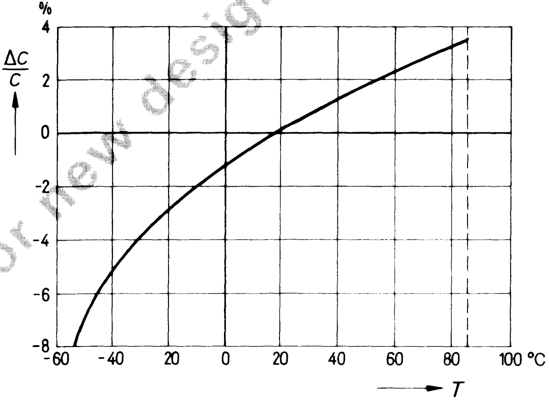
$1.0 \times V_R$
$1.5 \times V_R$ at 20°C/68°F up to 2000 h,
at 85°C/185°F up to 200 h
$2.0 \times V_R$ up to max. 1 h
$2.5 \times V_R$ up to max. 1 min.
$3.0 \times V_R$ up to max. 1 s
} for inevitable exceptions only, not for systematic switchings[1]
(V_R = rated voltage)

Category voltage V_C
at ac operation

Rated voltage	$V_{c\ rms}$ perm. Vac[2] at 50 Hz	Peak voltage[3]
100 Vdc	35 Vac	50 Vac

$1.5 \times V_c$ for milliseconds (e.g. switchings)

Capacitance change $\frac{\Delta C}{C}$
versus temperature T
at 1 kHz (typical values)



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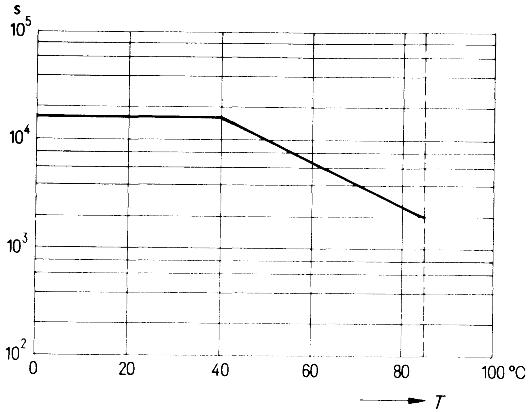
[1] Throughout the entire service life, the times are summed up thereby permitting the electrical values to deviate up to the limit indicated for failures due to variations.

[2] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

[3] The peak voltage refers to 2,000 hours at +20°C/68°F and 200 hours at +85°C/185°F.

Insulation
Time constant τ versus temperature T



Minimum value as supplied[1]	5 000 s
Average value as supplied measured at 20°C/68°F	>15 000 s

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length 38 mm	50 mm
100 V	V_{pp}/τ k_0	2 V/µs 400 V^2/µs	1.2 V/µs 250 V^2/µs

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

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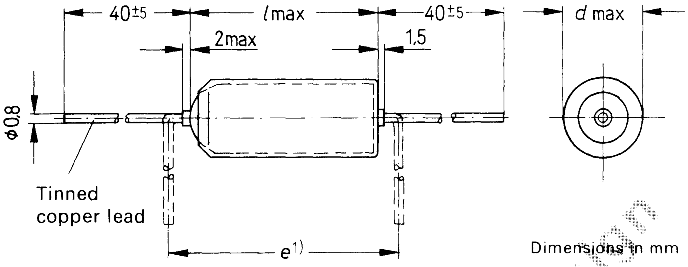
[1] The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, e. g. if the capacitor is operated close to the upper category temperature.

Metalized lacquer film capacitors – high rel version

Designation in accordance with DIN 41 379: MKU capacitors.
Self-healing tubular capacitor winding with plastic film as dielectric. Hermetically sealed in tubular non-magnetic metal can (cartridge), with insulating sleeve. Leads: insulated lead-in wire at one end, centrally soldered in cartridge at the other. For capacitors with a low rated voltage see B 32 120.



Dimensions in mm

l	e1)
21	30
25	35
25.5	35
29	37.5
35.5	45

Rated capacitance µF	Tolerance	Rated dc voltage	Dimensions $d \times l$	Ordering code
0.033	±20% ≙ M	630 V	8.2 × 21	B32122-A2333-M
0.047			8.2 × 21	B32122-A2473-M
0.068			8.2 × 25	B32122-A2683-M
0.1			11.2 × 21	B32122-A2104-M
0.15			11.2 × 29	B32122-A2154-M
0.22			11.2 × 29	B32122-A2224-M
0.33			11.2 × 29	B32122-A2334-M
0.47			15 × 25.5	B32122-A2474-M
0.68			15 × 25.5	B32122-A2684-M
1			15 × 35.5	B32122-A2105-M
1.5			16.5 × 35.5	B32122-A2155-M
2.2			21 × 35.5	B32122-A2225-M
3.3			25.8 × 35.5	B32122-A2335-M

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1) Minimum distance between lead bend and capacitor body: 2 mm.

DIN climatic category in acc. with DIN 40040	**F P C / J R**
Lower category temperature	**F** −55°C/−67°F
Upper category temperature	**P** +85°C/+185°F
Humidity category	**C** average relative humidity ≤95%; max. value 100%, including dew precipitation
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** ≥10^5 h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > \pm 4\%$ Dissipation factor tan δ > 1.5 × upper category values Insulation resistance < 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**
	Conditions
	Test temperature +40°C/+104°F
Damp heat test in acc. with DIN IEC 68-2-3	Relative humidity $(93 {}^{+2}_{-3})$ %
	Test duration 56 days
	Test criteria
	Capacitance change $\frac{\Delta C}{C} \leq \pm 2\%$
	Dissipation factor change Δ tan δ ≤3×10^{-3} at 1 kHz ≤5×10^{-3} at 10 kHz
	Insulation resistance ≥50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 10 g)
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the solder joint min. 6 mm Capacitance change $\frac{\Delta C}{C}$ ≤±3%

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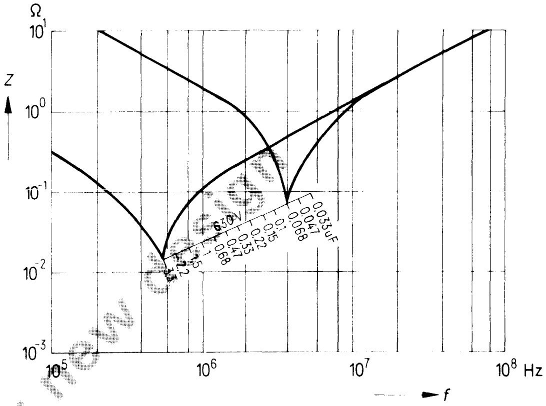
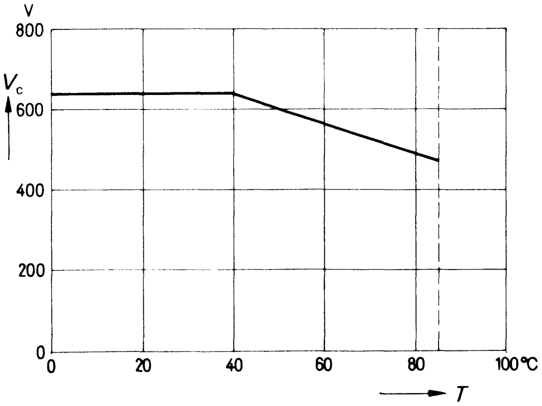
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Capacitance drift i_z	±2%	
Dissipation factor tan δ measured at 20°C/68°F	Upper limits	Average production values
at 1 kHz at 10 kHz	15 × 10^{-3} for $C > 1.0$ µF 25 × 10^{-3} for $C \leq 1.0$ µF	12 × 10^{-3} for $C > 1.0$ µF 20 × 10^{-3} for $C \leq 1.0$ µF
Self inductance	approx. 20 nH (for 3 mm lead length at both ends)	

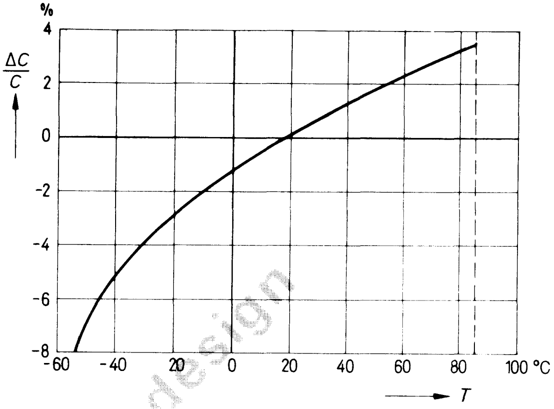
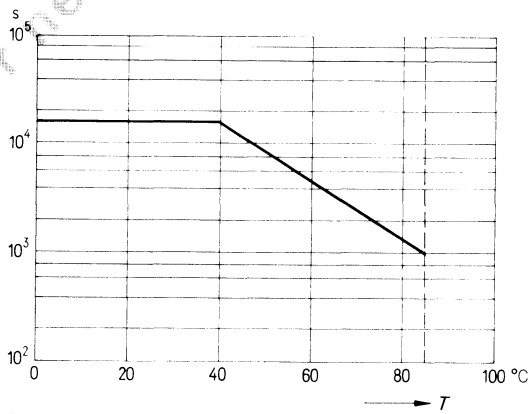
Impedance ***Z***
versus frequency ***f***
(typical values)



Category voltage V_c
versus ambient
temperature T
at dc operation



max. 2000 h	1.10 × V_C
max. 1 h	1.25 × V_C
max. 1 min.	1.50 × V_C

Category voltage V_C1) at ac operation at 50 Hz for milliseconds (e. g. switchings)	 200 Vac 1.5 × V_C
Capacitance change $\frac{\Delta C}{C}$ **versus temperature T** at 1 kHz (typical values)	
Insulation **Time constant τ** **versus temperature T**	
Insulation resistance R_{is} **and time constant τ** Minimum value as supplied2) for $C \leq 0.33$ µF for $C > 0.33$ µF Average value as supplied	 30 000 MΩ 10 000 s >20 000 s

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1) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

2) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, e. g. if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length				
		21 mm	25 mm	25.5 mm	29 mm	35.5 mm
630 V	V_{pp}/τ k_0	20 V/μs 25 000 V^2/μs	9 V/μs 11 400 V^2/μs	9 V/μs 11 400 V^2/μs	9 V/μs 11 400 ^{2}/μs	5 V/μs 6 300 V^2/μs

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

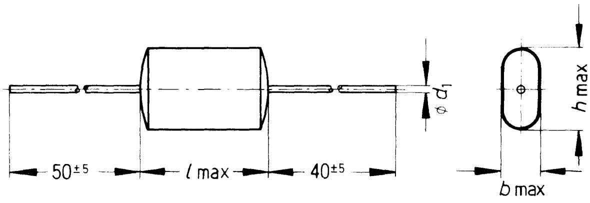
MKT Capacitors
Metalized Polyester Film Capacitors

Metalized polyester film capacitors – high rel version

Self-healing capacitor with insulating sleeve; flat winding with polyethyleneterephthalate dielectric. Epoxy resin sealed face ends. Central axial leads. Larger types are also available with screw connections with thread bolts and flat plugs, as required.

Connections:	Version with leads	B32227-J
	Version with screw connections	B32227-A (see page 89)

Axial-leaded version B 32227-J...



b	≤6	>6 to 10	>10
dia. d_1	0.6	0.8	1.0

Dimensions in mm

Rated voltage		1 kVdc	1.6 kVdc	2.5 kVdc	4 kVdc	6.3 kVdc
Rated capacitance µF	Tolerance	Dimensions $b \times h \times l$ Code				
0.01	±20% ≙M	–	–	–	9.5 × 22 × 33 -J4103-M	9 × 21.5 × 45 -J6103-M
0.025		–	5 × 11.5 × 33 -J1253-M	8.5 × 18 × 33 -J2253-M	10 × 22.5 × 45 -J4253-M	13.5 × 32.5 × 45 -J6253-M
0.05		5.5 × 12 × 33 -J503-M	6 × 16.5 × 33 -J1503-M	12.5 × 25.5 × 33 -J2503-M	12.5 × 31 × 45 -J4503-M	19 × 44 × 45 -J6503-M
0.1		6 × 18.5 × 33 -J104-M	8 × 20 × 33 -J1104-M	10.5 × 26.5 × 45 -J2104-M	16.5 × 42 × 45 -J4104-M	–
0.25		9.5 × 25 × 33 -J254-M	15.5 × 31 × 33 -J1254-M	15.5 × 40.5 × 45 -J2254-M	–	–

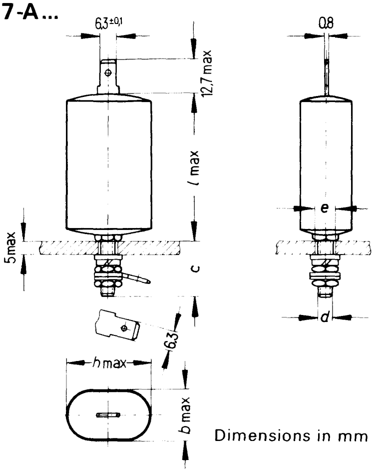
Ordering code example

B32227-J4103-M

Type — B32227

J4103-M — Code according to table

Version with thread bolts and flat plugs B 32227-A...



Dimensions in mm

h	d	c_{-1}	$e^{+0.5}$
25 25.5 26.5	M3	11	3.3
29 31 32.5 40.5	M4	14	4.3
42 44	M5	15	5.3

Rated voltage		1 kVdc	1.6 kVdc	2.5 kVdc	4 kVdc	6.3 kVdc
Rated capacitance µF	Tolerance	Dimensions $b \times h \times l$ Code				
0.025	±20% ≙M	–	–	–	–	13.5 × 32.5 × 46 -A6253-M
0.05		–	–	12.5 × 25.5 × 33 -A2503-M	12.5 × 31 × 46 -A4503-M	19 × 44 × 46 -A6503-M
0.1		–	–	10.5 × 26.5 × 46 -A2104-M	16.5 × 42 × 46 A4104-M	–
0.25		9.5 × 25 × 33 -A254-M	13.5 × 29 × 34 -A1254-M	15.5 × 40.5 × 46 -A2254-M	–	–

Ordering code example

B 32227-A 2503-M

Type (B 32227) — Code according to table (A 2503-M)

DIN climatic category in acc. with DIN 40040	**G M G / K S**	
Lower category temperature	**G**	−40°C/−104°F
Upper category temperature	**M**	+100°C/+212°F
Humidity category	**G**	average relative humidity ≤65%; 85% for 60 days per year continuously; 75% for the remaining days occasionally;
Failure rate (40°C/104°F; V_R)	**K**	100×10^{-9}/h = 100 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**S**	$\geq 3 \times 10^4$ h

Failure criteria		
Total failure	Short or open circuit	
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$	$>\pm 10\%$
	Dissipation factor tan δ	$>2\times$upper category values
	Insulation resistance	<150 MΩ
IEC climatic category in acc. with DIN IEC 68-1	**40/100/21**	
	Conditions	
	Test temperature	+40°C/+104°F
Damp heat test in acc. with DIN IEC 68-2-3	Relative humidity	$(93^{+2}_{-3})\%$
	Test duration	21 days
	Test criteria	
	Capacitance change $\frac{\Delta C}{C}$	$\leq\pm 3\%$ (>0.1 µF) $\leq\pm 5\%$ (≤ 0.1 µF)
	Dissipation factor change Δ tan δ	$\leq 3\times 10^{-3}$ at 1 kHz $\leq 5\times 10^{-3}$ at 10 kHz
	Insulation resistance	$\geq 20\%$ of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10 to 55 Hz
	Displacement amplitude	0.75 mm (conforming to max. 10 *g*)
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 10 s
	Capacitance change $\frac{\Delta C}{C}$	$\leq\pm 2\%$
Capacitance drift i_Z	$\pm 3\%$	
Dissipation factor tan δ measured at 20°C/68°F	Upper limits	Average production values
at 1 kHz	8×10^{-3}	5×10^{-3}
10 kHz	15×10^{-3}	13×10^{-3}

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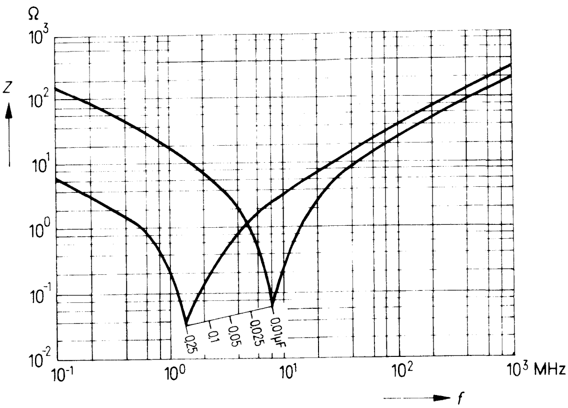
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Self inductance

approx. 30 to 50 nH
(for 3 mm lead length at both ends)

Impedance Z versus frequency f
(typical values)



Category voltage V_C
at dc operation

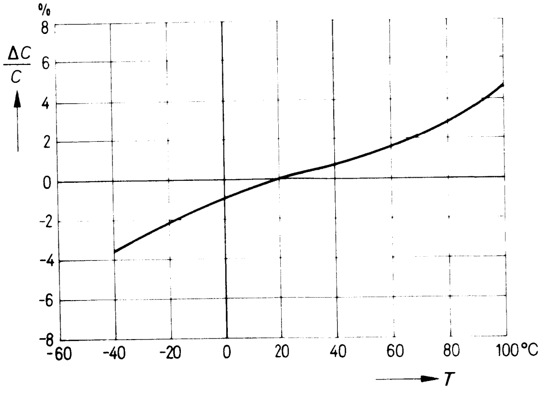
$1.05 \times V_R$ up to 40°C/104°F
$1.04 \times V_R$ up to 50°C/122°F
$1.00 \times V_R$ up to 60°C/140°F
$0.93 \times V_R$ up to 70°C/158°F
$0.64 \times V_R$ >70 up to 85°C/185°F
$0.55 \times V_R$ >85 up to 100°C/212°F

in accordance with VDE 0560, part 11 (V_R = rated voltage)

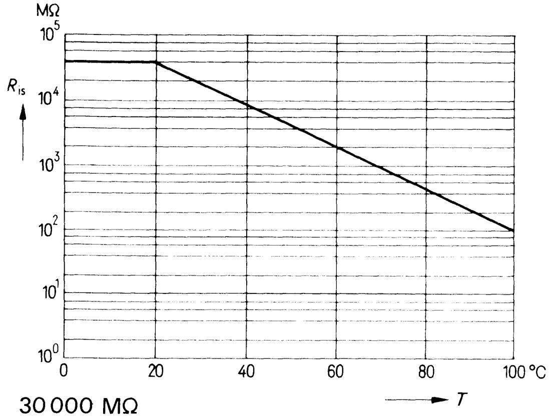
Category voltage V_C
at ac operation

220 Vac up to 70°C/158°F
150 Vac >70 to 100°C/>158 to 212°F
$1.5 \times V_C$ for milliseconds (e.g. switchings)

Capacitance change $\frac{\Delta C}{C}$ versus temperature T
at 1 kHz (typical values)



Insulation resistance R_{is} versus temperature T



Minimum value as supplied[1])	30000 MΩ
Average value as supplied measured at 20°C/68°F 100 Vdc, 1 min	>75000 MΩ

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated voltage V_R		Capacitor length	
		33 mm / 34 mm	45 mm / 46 mm
1.0 kVdc	V_{pp}/τ k_0	10 V/µs 20000 V²/µs	–
1.6 kVdc	V_{pp}/τ k_0	15 V/µs 48000 V²/µs	–
2.5 kVdc	V_{pp}/τ k_0	25 V/µs 125000 V²/µs	12.5 V/µs 62500 V²/µs
4.0 kVdc	V_{pp}/τ k_0	40 V/µs 320000 V²/µs	20 V/µs 160000 V²/µs
6.3 kVdc	V_{pp}/τ k_0	–	40 V/µs 500000 V²/µs

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

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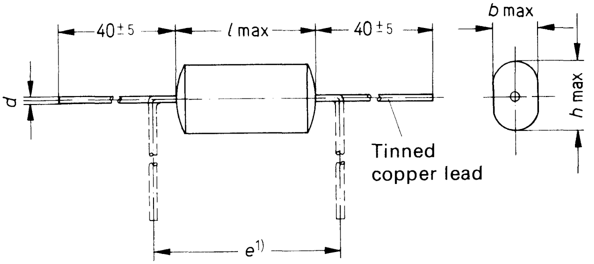
[1]) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 85% of the humidity category G is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Metalized polyester film capacitors in accordance with DIN 44113

Self-healing flat capacitor winding with polyethyleneterephthalate dielectric.
Capacitor winding with insulating sleeve, epoxy resin sealed face ends.
Central axial leads.



l	*e*1)
14	20
19	25
26.5	32.5
32	37.5
44	50

b	*l*	dia. *d*
≤6	–	0.6
>6	–	0.8
–	44	1.0

Dimensions in mm

DIN climatic category in acc. with DIN 40040	**G M G**
Lower category temperature Upper category temperature Humidity category	**G** – 40°C/–104°F **M** +100°C/+212°F **G** average relative humidity ≤65%; 85% for 60 days per year continuously; 75% for the remaining days occasionally
IEC climatic category in acc. with DIN IEC 68-1	**40/100/04 or 40/100/21**2)
Damp heat test in acc. with DIN IEC 68-2-3	**Conditions** Test temperature +40°C/+104°F Relative humidity $(93\,^{+2}_{-3})$ % Test duration 4 days (21 days)2) Capacitance change $\frac{\Delta C}{C}$ ≤±5% Dissipation factor change Δ tan δ ≤5 × 10^{-3} (at 1 kHz) ≤7 × 10^{-3} (at 10 kHz) Insulation resistance ≥50% (≥20%)2) of the minimum value as supplied

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1) Minimum distance between lead bend and capacitor body: 1 mm.
2) The values in parantheses apply to these increased requirements.

Rated dc voltage		100 V	250 V	400 V	630 V
Rated capacitance		Dimensions *b* × *h* × *l* (mm) and ordering code			
µF	Tolerance				
0.01	± 20 % ≙ M (± 10 % ≙ K)1))	–	–	–	4.5 × 8 × 14 B32231–C8103–M
0.015		–	–	–	4.5 × 8 × 14 B32231–C8153–M
0.022		–	–	4.5 × 7.5 × 14 B32231–C6223–M	5 × 8.5 × 14 B32231–C8223–M
0.033		–	–	4.5 × 7.5 × 14 B32231–C6333–M	4.5 × 8 × 19 B32231–C8333–M
0.047		–	4.5 × 8.5 × 14 B32231–A3473–M	4.5 × 8 × 19 B32231–C6473–M	5 × 10.5 × 19 B32231–C8473–M
0.068		–	5.5 × 9 × 14 B32231–A3683–M	4.5 × 8 × 19 B32231–C6683–M	6 × 12 × 19 B32231–C8683–M
0.1		–	4.5 × 8.5 × 14 B32231–A3104–M	5.5 × 8.5 × 19 B32231–C6104–M	5 × 12.5 × 26.5 B32231–C8104–M
0.15		4.5 × 8 × 14 B32231–A1154–M	4 × 8 × 19 B32231–A3154–M	6.5 × 10 × 19 B32231–C6154–M	6.5 × 14 × 26.5 B32231–C8154–M
0.22		5 × 9 × 14 B32231–A1224–M	4.5 × 10 × 19 B32231–A3224–M	5 × 12 × 26.5 B32231–C6224–M	7.5 × 16.5 × 26.5 B32231–C8224–M
0.33		4.5 × 8.5 × 19 B32231–A1334–M	6 × 10.5 × 19 B32231–S3334–M	6 × 13.5 × 26.5 B32231–C6334–M	9 × 16.5 × 32 B32231–J8334–M
0.47		5 × 9 × 19 B32231–A1474–M	4.5 × 11.5 × 26.5 B32231–A3474–M	7 × 16 × 26.5 B32231–C6474–M	11 × 18.5 × 32 B32231–J8474–M
0.68		6 × 10 × 19 B32231–A1684–M	6 × 13 × 26.5 B32231–A3684–M	8 × 15.5 × 32 B32231–J6684–M	–
1		7.5 × 11 × 19 B32231–A1105–M	6.5 × 16 × 26.5 B32231–A3105–M	10.5 × 17.5 × 32 B32231–J6105–M	–
1.5		6 × 13 × 26.5 B32231–A1155–M	8 × 16 × 32 B32231–J3155–M	8.5 × 24 × 44 B32231–C6155–M	–
2.2		7 × 15.5 × 26.5 B32231–A1225–M	9.5 × 18 × 32 B32231–J3225–M	10 × 25.5 × 44 B32231–C6225–M	–
3.3		9.5 × 16.5 × 26.5 B32231–A1335–M	10.5 × 22 × 32 B32231–J3335–M	14 × 29 × 44 B32231–C6335–M	–
4.7		9 × 18 × 32 B32231–A1475–M	10 × 25 × 44 B32231–A3475–M	17.5 × 32.5 × 44 B32231–C6475–M	–
6.8		12.5 × 20 × 32 B32231–A1685–M	12.5 × 27.5 × 44 B32231–A3685–M	–	–
10		13.5 × 25 × 32 B32231–A1106–M	16.5 × 31 × 44 B32231–A3106–M	–	–

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1) Upon request.

Resistance to vibration
Test Fc in acc. with
DIN IEC 68-2-6:
vibration, sinusoidal

Duration of endurance conditioning	6 h
Frequency range	10 to 55 Hz
Displacement amplitude	0.75 mm (conforming to max. 10 *g*)

Resistance to soldering heat[1]
Test Tb in acc. with
DIN IEC 68-2-20

Solder bath temperature	max. 260°C/500°F
Soldering duration	max. 10 s
Distance to the solder joint	min. 6 mm
Capacitance change $\frac{\Delta C}{C}$	≤±2%

Capacitance drift i_Z

±3%

Dissipation factor tan δ in 10^{-3}
measured at 20°C/68°F
(typical values)

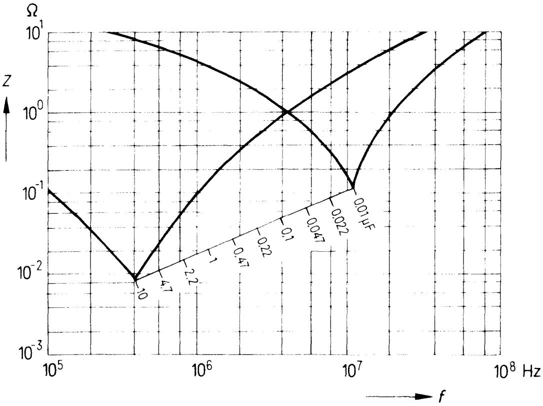
Upper limits/Average production values

	for $C \leq 0.047$ µF	$C > 0.047$ to 1 µF	$C > 1$ µF
at 1 kHz	10/5	10/6	10/7
at 10 kHz	20/15	25/17	–

Self inductance

approx. 10 nH (per cm lead and capacitor length)

Impedance *Z*
versus frequency *f*
(typical values)



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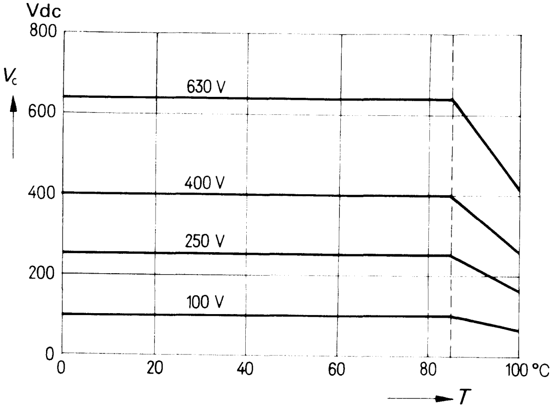
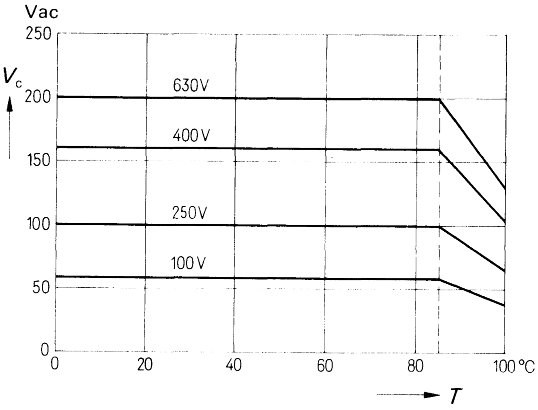
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Category voltage V_C versus ambient temperature T at dc operation



2,000 hours at 85°C/185°F	$1.25 \times V_C$
for milliseconds (e. g. switchings)	$1.5 \times V_C$

Category voltage V_C¹)²) **versus ambient temperature T** at ac operation



for milliseconds (e. g. switchings)	$1.50 \times V_C$

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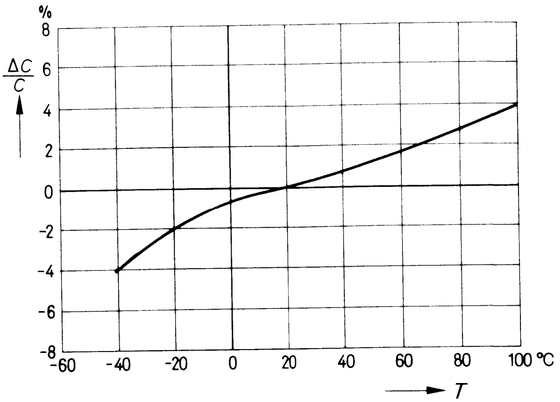
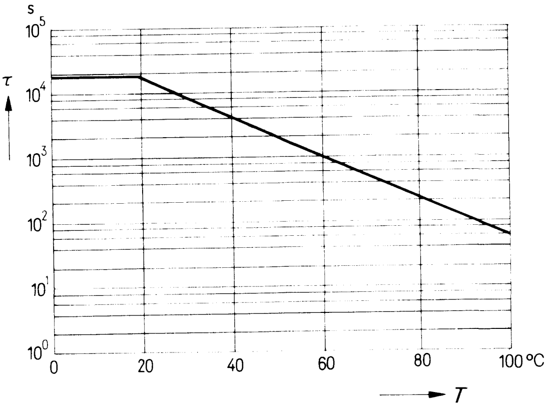
¹) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

²) Capacitors of the 630 Vdc series can be used as 250 Vac line power parallel capacitors if it is ensured that voltage peaks occurring occasionally during operation do not exceed 1000 V.

Capacitance change $\frac{\Delta C}{C}$ versus temperature T
at 1 kHz (typical values)



Insulation
Time constant τ
versus temperature T



Insulation resistance R_{is} and time constant τ

	for V_R = 100 Vdc	for V_R > 100 Vdc
Minimum value as supplied[1]		
$C \leq 0.33$ µF	3000 MΩ	7500 MΩ
$C > 0.33$ µF	1000 s	2500 s
Average value as supplied		
$C \leq 0.33$ µF	>30000 MΩ	>75000 MΩ
$C > 0.33$µF	>10000 s	>25000 s

---

[1] The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 85% of the humidity category G is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length				
		14 mm	19 mm	26.5 mm	32 mm	44 mm
100 V	V_{pp}/τ k_0	6 V/µs 1 200 V^2/µs	3 V/µs 600 V^2/µs	2 V/µs 400 V^2/µs	1.5 V/µs 300 V^2/µs	–
250 V	V_{pp}/τ k_0	10 V/µs 5 000 V^2/µs	5 V/µs 2 500 V^2/µs	3 V/µs 1 500 V^2/µs	2.5 V/µs 1 250 V^2/µs	2 V/µs 1 000 V^2/µs
400 V	V_{pp}/τ k_0	14 V/µs 11 200 V^2/µs	7 V/µs 5 600 V^2/µs	4 V/µs 3 200 V^2/µs	3 V/µs 2 400 V^2/µs	2.5 V/µs 2 000 V^2/µs
630 V	V_{pp}/τ k_0	20 V/µs 25 000 V^2/µs	10 V/µs 12 600 V^2/µs	7 V/µs 8 800 V^2/µs	5 V/µs 6 300 V^2/µs	–

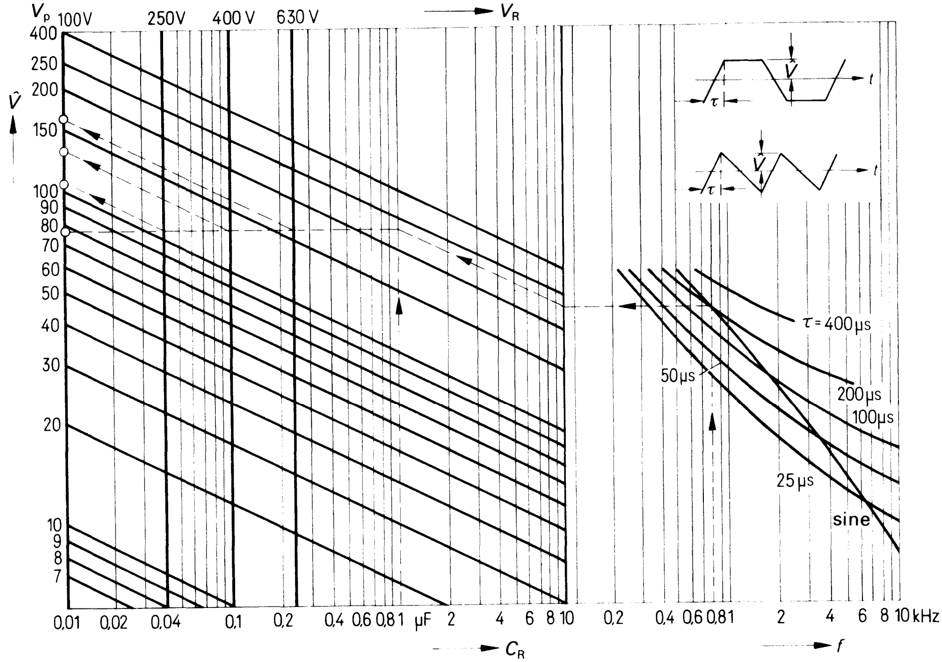
For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram, where the following limit values $\hat{V}_l$ may not be exceeded.

Rated voltage V_R	100 V	250 V	400 V	630 V
Limit voltage $\hat{V}_l$	84 V	140 V	224 V	280 V

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature. In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be taken into account.



Example:

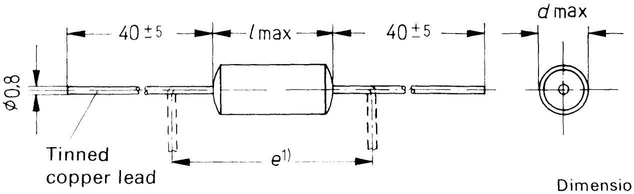
f = 800 Hz (repetition frequency)
τ = 200 µs (rise time)
C = 1 µF (capacitance)

According to the dashed line in the above graph, this results:

for the 100 Vdc type in a max. peak voltage $\hat{V}$ of approx. 75 V
for the 250 Vdc type in a max. peak voltage $\hat{V}$ of approx. 105 V
for the 400 Vdc type in a max. peak voltage $\hat{V}$ of approx. 135 V
for the 630 Vdc type in a max. peak voltage $\hat{V}$ of approx. 160 V

Metalized polyester film capacitors – high rel version

Self healing tubular capacitor winding with polyethyleneterephthalate dielectric. Enclosed in plastic tube, epoxy resin sealed face ends. Central axial leads.



Dimensions in mm

l	*e*[1])
24	30
33	37.5
45	50
56	60

Rated voltage		1 kVdc	1.6 kVdc	2.5 kVdc	4 kVdc	6.3 kVdc	8 kVdc	10 kVdc	12.5 kVdc
Rated capacitance	Tolerance	Dimensions *d* × *l* Code							
680 pF	$^{+50}_{-20}$ % ≙ S ±20 % ≙ M[2])	–	–	–	–	–	–	–	9.5×56 -A3681-S
1000 pF		–	–	–	7.5×33 -A4102-S	8.5×33 -B6102-S	8.5×45 -A8102-S	8.5×56 -A9102-S	10.5×56 -A3102-S
2500 pF		–	–	8.5×33 -J2252-S	8.5×33 -J4252-S	11.5×33 -B6252-S	11.5×45 -B8252-S	11.5×56 -A9252-S	12.5×56 -A3252-S
5000 pF		–	7.5×24 -A1502-S	9.5×33 -J2502-S	10.5×33 -J4502-S	10.5×45 -B6502-S	12.5×45 -A8502-S	13.5×56 -A9502-S	–
0.01 µF		–	10.5×24 -A1103-S	10.5×33 -B2103-S	12.5×33 -B4103-S	13.5×45 -B6103-S	16.5×45 -J8103-S	–	–
0.025 µF		11.5×24 -A253-S	–	16.5×33 -J2253-S	–	–	–	–	–

Ordering code example B32237-J4252-S

Type: B32237

Code according to table: J4252-S

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[1]) Minimum distance between lead bend and capacitor body: 1 mm.

[2]) Upon request.

DIN climatic category in acc. with DIN 40040	**G M G / K S**
Lower category temperature	**G** − 40°C/−104°F
Upper category temperature	**M** +100°C/+212°F
Humidity category	**G** average relative humidity ≤65%; 85% for 60 days per year continuously; 75% for the remaining days occasionally
Failure rate (40°C/104°F, V_R)	**K** 100×10^{-9}/h = 100 fit for conversion tables for other loads and temperatures see page 42.
Load duration	**S** $\geq 3 \times 10^4$ h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$ $>\pm 10\%$ Dissipation factor tan δ > 2 × upper category limits Insulation resistance < 150 MΩ
IEC climatic category in acc. with DIN IEC 68-1	**40/100/21**
Damp heat test in acc. with DIN IEC 68-2-3	**Conditions** Test temperature +40°C/+104°F Relative humidity $(93 {}^{+2}_{-3})$ % Test duration 21 days **Test criteria** Capacitance change $\frac{\Delta C}{C}$ $\leq \pm 5\%$ Dissipation factor change Δ tan δ $\leq 3 \times 10^{-3}$ (at 1 kHz) $\leq 5 \times 10^{-3}$ (at 10 kHz) Insulation resistance ≥20% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning 6 h Frequency range 10 to 55 Hz Displacement amplitude 0.75 mm (conforming to max. 10 *g*) For this test the capacitors must be fixed by clamps
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature max. 260°C/500°F Soldering duration max. 10 s Distance to the solder joint min. 6 mm Capacitance change $\frac{\Delta C}{C}$ $\leq \pm 2\%$

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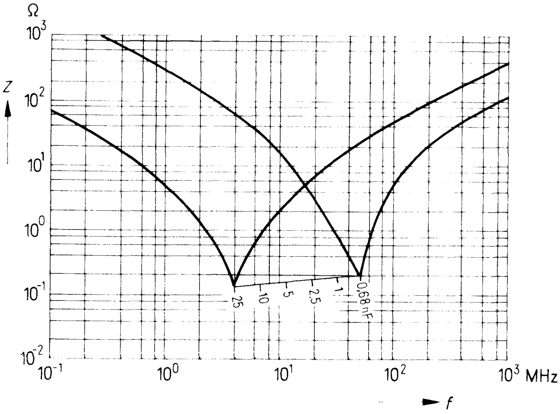
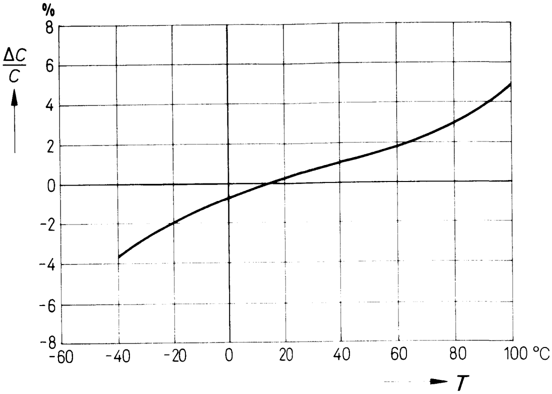
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Capacitance drift i_Z	±3%	
Dissipation factor tan δ measured at 20°C/68°F	Upper limits	Average production values
at 1 kHz	8×10^{-3}	5×10^{-3}
at 10 kHz	15×10^{-3}	13×10^{-3}
Self inductance	approx. 30 to 50 nH (for 3 mm lead length at both ends)	
Impedance *Z* **versus frequency** *f* (typical values)		
Category voltage V_C at dc operation	$1.05 \times V_R$ up to 40°C/104°F $1.04 \times V_R$ up to 50°C/122°F $1.00 \times V_R$ up to 60°C/140°F $0.93 \times V_R$ up to 70°C/158°F $0.64 \times V_R$>70 to 85°C/158 to 185°F $0.55 \times V_R$>85 to 100°C/185 to 212°F	(V_R = rated voltage)
Category voltage V_C[1] at ac operation at 50 Hz	Rated voltage	$V_{C\ rms}$ perm. Vac
	≤1.6 kVdc	200 Vac to 70°C/158°F 150 Vac >70 to 100°C/158 to 212°F
	>2.5 kVdc	450 Vac to 70°C/158°F 200 Vac >70 to 100°C/158 to 212°F
	$1.5 \times V_C$ for milliseconds (e.g. switchings)	

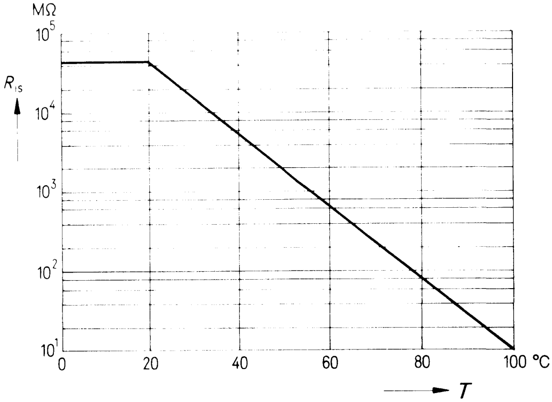
---

[1] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

Capacitance change $\frac{\Delta C}{C}$
versus temperature T
at 1 kHz (typical values)



Insulation resistance R_{is}
versus temperature T



Minimum value as supplied1)	30 000 MΩ
Average value as supplied measured at 20°C/68°F 100 Vdc, 1 min.	>75 000 MΩ

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1) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 85% of the humidity category G is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_O).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated voltage V_R	V_{pp}/τ	k_O
1 kVdc	15 V/µs	3×10^4 V²/µs
1.6 kVdc	25 V/µs	9×10^4 V²/µs
2.5 kVdc	25 V/µs	12.5×10^4 V²/µs
4 kVdc	40 V/µs	3.2×10^5 V²/µs
6.3 kVdc	50 V/µs	6.3×10^5 V²/µs
8 kVdc	50 V/µs	8×10^5 V²/µs
10 kVdc	375 V/µs	7.5×10^5 V²/µs
12.5 kVdc	1000 V/µs	25×10^6 V²/µs

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

Complementary types to version B 32520...523

MKT stacked-film capacitors similar to DIN 44112; with quality assessment according to CECC 30401-007, form B.

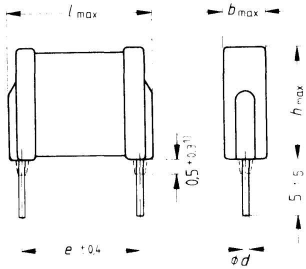
Fields of application: consumer electronics, industrial electronics.

Self-healing capacitor with polyethyleneterephthalate dielectric; resin coated face ends to ensure reliable contacts. The insulation strength to live parts corresponds to 1.5 times the rated dc voltage of the capacitor; it amounts, however, to at least 300 Vdc. Connections: parallel leads, tinned, plug-in, lead spacing 7.5 to 22.5 mm.

Packaging on continuous tapes

Capacitors with 7.5 mm lead spacing and 7.5/5 mm lead spacing (leads crimped to a 5 mm lead spacing) are also available on continuous tapes. For taping instructions and ordering information refer to B 32071, page 46.

Type	Lead spacing *e*	dia. *d*
B 32510	7.5 mm	0.6
B 32511	10 mm	0.6
B 32512	15 mm	0.8
B 32513	22.5 mm	0.8



Dimensions in mm

DIN climatic category in acc. with DIN 40040		**F M E / J R**
Lower category temperature	**F**	– 55°C/– 67°F
Upper category temperature	**M**	+100°C/+212°F
Humidity category	**E**	average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J**	30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R**	$\geq 10^5$ h

Failure criteria		
Total failure	Short or open circuit	
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$	$>\pm 10\%$
	Dissipation factor tan δ	> 2 × max. upper category values
	Insulation resistance	< 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)

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[1] Possible reach of resin coating.

Complementary types to version B 32520...523 (refer to page 108 to 110)

Lead spacing			LS 7.5 mm	LS 10 mm	LS 15 mm	LS 22.5 mm
Rated dc voltage V_R	Rated capacitance C_R	Tolerance	Dimensions $b \times h \times l$ (mm) and ordering code			
			B 32510–	B 32511–	B 32512–	B 32513–
63 V	1.0 µF	± 10 % ≙ K ± 5 % ≙ J[1]	5.7 × 11.5 × 10 –D105–K			
100 V	0.47 µF		7 × 14 × 10 –D1474–K	6.5 × 10 × 12.5 –D1474–K		
	0.68 µF		9.5 × 13 × 10 –D1684–K	7.8 × 11 × 12.5 –D1684–K		
	1.0 µF			10 × 11.5 × 12.5 –D1105–K		
	1.5 µF				8 × 12.5 × 17.5 –E1155–K	
	2.2 µF				9 × 15 × 17.5 –E1225–K	
	4.7 µF					11 × 17.5 × 25 –D1475–K
	6.8 µF					13 × 19.5 × 25 –D1685–K
250 V	0.22 µF			6.0 × 12 × 12.5 –D3224–K		
	0.33 µF			8.5 × 11 × 12.5 –D3334–K		
	0.47 µF			9.5 × 13 × 12.5 –D3474–K	7.5 × 11 × 17.5 –E3474–K	
	0.68 µF				8 × 13 × 17.5 –E3684–K	
	1.0 µF				11 × 13 × 17.5 –E3105–K	
	1.5 µF					9 × 16.5 × 25 –D3155–K
	2.2 µF					11 × 19.5 × 25 –D3225–K
400 V	0.22 µF				8.5 × 10.5 × 17.5 –E6224–K	
	0.33 µF				9.5 × 12.5 × 17.5 –E6334–K	
	0.68 µF					10 × 17 × 25 –D6684–K
	1.0 µF					12 × 19.5 × 25 –D6105–K

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[1] Upon request.

MKT Capacitors

S B 32520
...B 32529

Metalized polyester film capacitors in accordance with DIN 44112

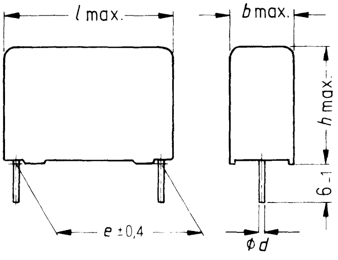
V_R = 63 to 630 Vdc

With quality assessment according to CECC 30401-043, edition 1, June 1983.

Self-healing capacitor with polyethyleneterephthalate dielectric. Encapsulated in a flame-retardant rectangular plastic case (in accordance with UL 94 V-0). Epoxy resin sealed for humidity resistance. For improved solderability, the package is provided with spacers. Connections: parallel leads, tinned, plug-in in the lead spacing. Particularly suited for space-saving assembly at high packing density on any PC board.

Packaging on continuous tapes

Capacitors with 5 mm and 7.5 mm lead spacing, as well as capacitors with a lead spacing of 7.5/5 mm (leads crimped to a lead spacing of 5 mm) are also available on continuous tape. For taping instructions and ordering code information refer to page 46.



l	Lead spacing *e*	dia. *d*
7.5	5	0.5
10	7.5	0.6
13	10	0.6
18	15	0.8
27	22.5	0.8
31.5	27.5	0.8

Dimensions in mm

DIN climatic category in acc. with DIN 40040	**F M E / J R**
Lower category temperature	**F** − 55°C/− 67°F
Upper category temperature	**M** +100°C/+212°F1)
Humidity category	**E** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > \pm 10\%$ Dissipation factor tan δ > 2 × upper category values Insulation resistance < 150 MΩ (≤0.33 μF) < 50 s (>0.33 μF)

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1) Shelf and service life at temperatures >100 ... 125°C/212 ... 257°F, 1000 h max., $V_C = 0.5\ V_R$.

MKT Capacitors

Lead spacing		LS 5 mm	LS 7.5 mm			
Rated dc voltage		63 V	63 V	100 V	250 V	400 V
Rated capacitance			Dimensions $b \times h \times l$ (mm) and ordering code			
C_R	Tolerance	B 32529–	B 32520–			
1000 pF						3 × 8.5 × 10 –A6102–+
1500 pF						3 × 8.5 × 10 –A6152–+
2200 pF						3 × 8.5 × 10 –A6222–+
3300 pF						3 × 8.5 × 10 –A6332–+
4700 pF		2.5 × 6.5 × 7.2 –A472–+				3 × 8.5 × 10 –A6472–+
6800 pF		2.5 × 6.5 × 7.2 –A682–+				3 × 8.5 × 10 –A6682– +
0.01 µF		2.5 × 6.5 × 7.2 –A103–+				3 × 8.5 × 10 –A6103–+
0.015 µF		2.5 × 6.5 × 7.2 –A153–+			3 × 8.5 × 10 –A3153–+	4 × 8.5 × 10 –A6153–+
0.022 µF		2.5 × 6.5 × 7.2 –A223–+			3 × 8.5 × 10 –A3223–+	4 × 8.5 × 10 –A6223–+
0.033 µF	± 20 % ≙ M ± 10 % ≙ K ± 5 % ≙ J	2.5 × 6.5 × 7.2 –A333–+			3 × 8.5 × 10 –A3333–+	5 × 10.5 × 10 –A6333–+
0.047 µF		2.5 × 6.5 × 7.2 –A473–+		3 × 8.5 × 10 –A1473–+	4 × 8.5 × 10 –A3473–+	6 × 12 × 10 –A6473–+
0.068 µF		2.5 × 6.5 × 7.2 –A683–+		3 × 8.5 × 10 –A1683–+	5 × 10.5 × 10 –A3683–+	
0.1 µF		2.5 × 6.5 × 7.2 –A104–+		3 × 8.5 × 10 –A1104–+	5 × 10.5 × 10 –A3104–+	
0.15 µF		3.5 × 9 × 7.2 –A154–+	3 × 8.5 × 10 –A154–+	4 × 8.5 × 10 –A1154–+	6 × 12 × 10 –A3154–+	
0.22 µF		3.5 × 9 × 7.2 –A224–+	3 × 8.5 × 10 –A224–+	5 × 10.5 × 10 –A1224–+		
0.33 µF		4,5 × 9.5 × 7.2 –A334–+	4 × 8.5 × 10 –A334–+	6 × 12 × 10 –A1334–+		
0.47 µF		5 × 10 × 7.2 –A474–+	5 × 10.5 × 10 –A474–+			
0.68 µF		5 × 10 × 7.2 –A684–+	6 × 12 × 10 –A684–+			
1 µF		6 × 10.5 × 7.2 –A105–+				
1.5 µF						
2.2 µF						

\+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors with capacitance tolerance ± 10% (LS 5 mm: ± 10%; ± 20%) are preferred types (refer to page 4). Complementary types to B 32510 ... 512 refer to page 106.

LS 10 mm			LS 15 mm				LS
100 V	250 V	400 V	100 V	250 V	400 V	630 V	V_R
Dimensions *b* × *h* × *l* (mm) and ordering code							
B 32521−			B 32522−				C_R
							1000 pF
							1500 pF
							2200 pF
							3300 pF
							4700 pF
							6800 pF
		4×9×13 −A6103−+					0.01 µF
		4×9×13 −A6153−+					0.015 µF
		4×9×13 −A6223−+					0.022 µF
		4×9×13 −A6333−+				5.5×11×18 −M8333−+	0.033 µF
	4×9×13 −A3473−+	5×11.5×13 −A6473−+			5.5×11×18 −A6473−+	7×13×18 −M8473−+	0.047 µF
	4×9×13 −A3683−+				5.5×11×18 −A6683−+	9×14.5×18 −M8683−+	0.068 µF
4×9×13 −A1104−+	5×11.5×13 −A3104−+			5.5×11×18 −A3104−+	7×13×18 −A6104−+		0.1 µF
4×9×13 −A1154−+	5×11.5×13 −A3154−+			5.5×11×18 −A3154−+	7×13×18 −A6154−+		0.15 µF
4×9×13 −A1224−+				7×13×18 −A3224−+			0.22 µF
5×11.5×13 −A1334−+			5.5×11×18 −A1334−+	7×13×18 −A3334−+			0.33 µF
			5.5×11×18 −A1474−+				0.47 µF
			7×13×18 −A1684−+				0.68 µF
			7×13×18 −A1105−+				1 µF
							1.5 µF
							2.2 µF

MKT Capacitors

Lead spacing		LS 22.5 mm			
Rated dc voltage		100 V	250 V	400 V	630 V
Rated capacitance		Dimensions $b \times h \times l$ (mm) and ordering code			
C_R	Tolerance	B 32523-			
0.1 µF	± 20 % ≙ M ± 10 % ≙ K ± 5 % ≙ J				7.3 × 16.5 × 27 −M8104−
0.15 µF					8.5 × 18.5 × 27 −M8154− +
0.22 µF				7.3 × 16.5 × 27 −M6224−+	10.5 × 19 × 27 −M8224− +
0.33 µF				8.5 × 18.5 × 27 −M6334− +	
0.47 µF			7.3 × 16.5 × 27 −M6474− +	10.5 × 19 × 27 −M3474− +	
0.68 µF			7.3 × 16.5 × 27 −M3684−+		
1 µF			8.5 × 18.5 × 27 −M3105−+		
1.5 µF		7.3 × 16.5 × 27 −M1155−+			
2.2 µF		8.5 × 18.5 × 27 −M1225−+			
3.3 µF		10.5 × 19 × 27 −M1335−+			
4.7 µF					
6.8 µF					
10 µF					

\+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors with capacitance tolerance ± 10% are preferred types (refer to page 4).
For complementary types refer to B 32513, page 106.

LS 27.5 mm				LS
100 V	250 V	400 V	630 V	V_R
Dimensions *b* × *h* × *l* (mm) and ordering code B 32524–				C_R
				0.1 µF
				0.15 µF
				0.22 µF
			11.5 × 21 × 31.5 –M8334–+	0.33 µF
			13.5 × 23 × 31.5 –M8474–+	0.47 µF
		11.5 × 21 × 31.5 –M6684–+	15 × 24.5 × 31.5 –M8684–+	0.68 µF
		11.5 × 21 × 31.5 –M6105–+		1 µF
	11.5 × 21 × 31.5 –M3155–+	13.5 × 23 × 31.5 –M6155–+		1.5 µF
	11.5 × 21 × 31.5 –M3225–+			2.2 µF
	13.5 × 23 × 31.5 –M3335–+			3.3 µF
11.5 × 21 × 31.5 –M1475–+	15 × 24.5 × 31.5 –M3475–+			4.7 µF
13.5 × 23 × 31.5 –M1685–+				6.8 µF
15 × 24.5 × 31.5 –M1106–+				10 µF

Ordering code example

B32523-M6474–+

Code letter for capacitance tolerance (refer to table)

Type

Code according to table

IEC climatic category
in acc. with DIN IEC 68-1

55/100/56

Damp heat test
in acc. with
DIN IEC 68-2-3

Conditions

Test temperature	+40°C/+104°F
Relative humidity	$(93 ^{+2}_{-3})$ %
Test duration	56 days

Test criteria

Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 5\%$
Dissipation factor change $\Delta \tan \delta$ at 1 kHz	$\leq 5 \times 10^{-3}$
Insulation resistance	$\geq$50% of the minimum value as supplied

Resistance to vibration
Test Fc in acc. with
DIN IEC 68-2-6:
vibration, sinusoidal

Duration of endurance conditioning	6 h
Frequency range	10...55 Hz
Displacement amplitude	0.75 mm (conforming to 98.1 m/s^2 max. or to 10 *g*)

At 10 Hz...2 kHz capacitors with LS $\geq$22.5 mm must additionally be fixed at the case.

Resistance to soldering heat[1]
Test Tb in acc. with
DIN IEC 68-2-20

Solder bath temperature	max. 260°C/500°F
Soldering duration	max. 5 s
Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 2\%$

Resistance to cleaning agents

Refer to section "General Information", page 37.

Capacitance drift i_Z

±3%

Self inductance

Lead spacing (mm)	5	7.5	10	15	22.5	27.5
Self inductance (approx. nH)	5	8	9	10	20	20

Dissipation factor tan δ
measured at 20°C/68°F

Upper limits/Average production values

	$C_R < 0.1$ µF	$C_R \geq 0.1 ... < 1$ µF	$C_R \geq 1$ µF
at 1 kHz	$8/\ 5 \times 10^{-3}$	$10/\ 6 \times 10^{-3}$	$10/7 \times 10^{-3}$
at 10 kHz	$15/12 \times 10^{-3}$	$20/15 \times 10^{-3}$	–
at 100 kHz	$30/18 \times 10^{-3}$	–	–

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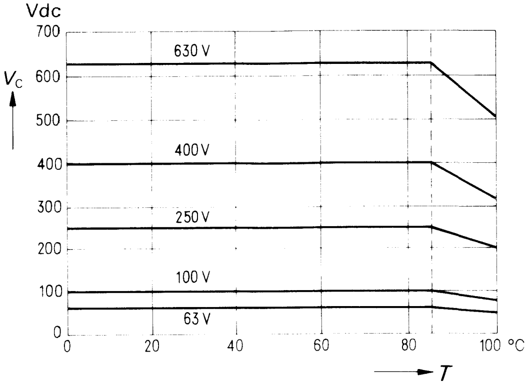
[1] For soldering recommendations also refer to "General Information", para. 6.2.

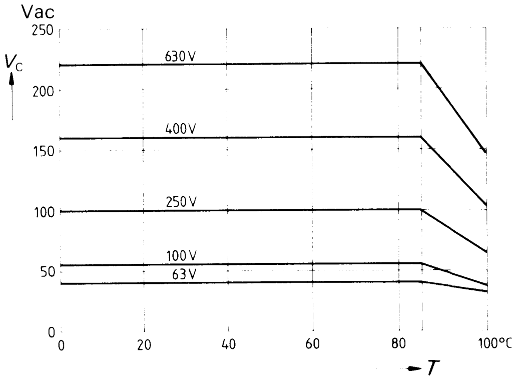
Category voltage V_C versus temperature T
at dc operation

2000 h max.	$1.25 \times V_C$
for milliseconds (e.g. switchings)	$1.50 \times V_C$

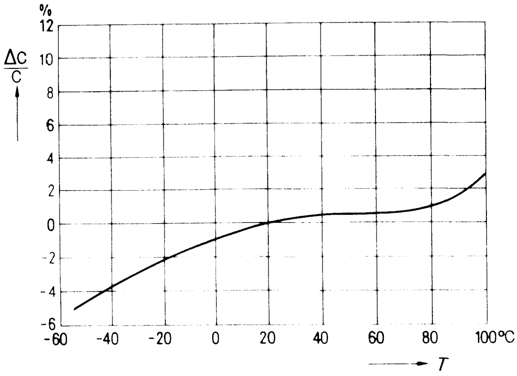


Category voltage V_C[1][2] versus temperature T
at ac operation
at 50 Hz

max. 2000 hours	$1.25 \times V_C$
for milliseconds (e.g. switchings)	$1.50 \times V_C$



Capacitance change $\frac{\Delta C}{C}$ versus temperature T
(typical values, measured at 1 kHz)



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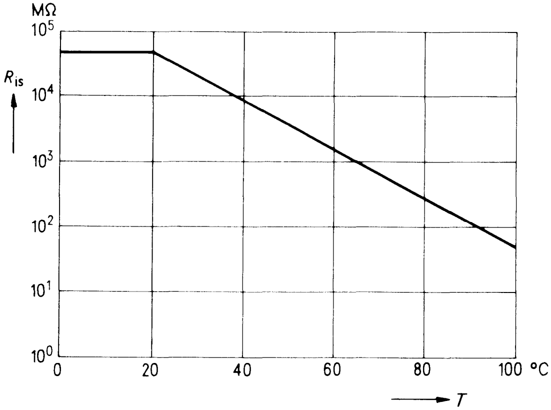
[1] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

[2] Capacitors of the 630 Vdc series can be used as 250 Vac line power parallel capacitors if it is ensured that voltage peaks occurring occasionally during operation do not exceed 1000 V.

Insulation resistance R_{is} versus temperature T



Typical values
measured at 20°C/68°F and a
relative humidity ≤65%

Insulation resistance R_{is} and time constant τ

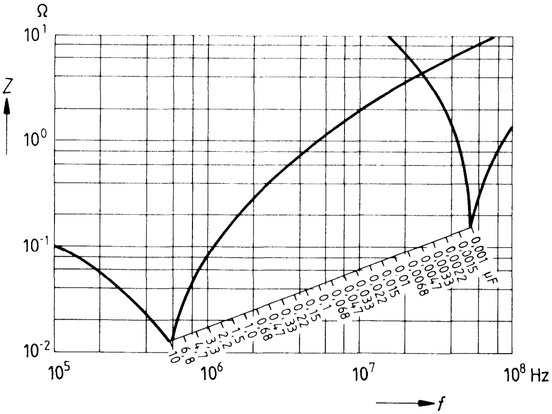
Minimum value as supplied1)

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
≤100 V	3750 MΩ	1250 sec
≥250 V	7500 MΩ	2500 sec

Average value as supplied

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
≤100 V	>30 000 MΩ	>10 000 sec
≥250 V	>75 000 MΩ	>25 000 sec

Impedance Z versus frequency f (typical values)



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1) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		LS 5	LS 7.5	LS 10	LS 15	LS 22.5	LS 27.5
63 V	V_{pp}/τ in V/μs k_0 in V²/μs	80 10000					
100 V	V_{pp}/τ in V/μs k_0 in V²/μs		50 10000	35 7500	25 5000	2 400	1.5 300
250 V	V_{pp}/τ in V/μs k_0 in V²/μs		100 50000	75 35000	50 25000	3 1500	2.5 1250
400 V	V_{pp}/τ in V/μs k_0 in V²/μs		125 100000	90 75000	60 50000	4 3200	3 2400
630 V	V_{pp}/τ in V/μs k_0 in V²/μs				10 12600	7 8800	5 6300

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram.

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature.

The following limits may not be exceeded:

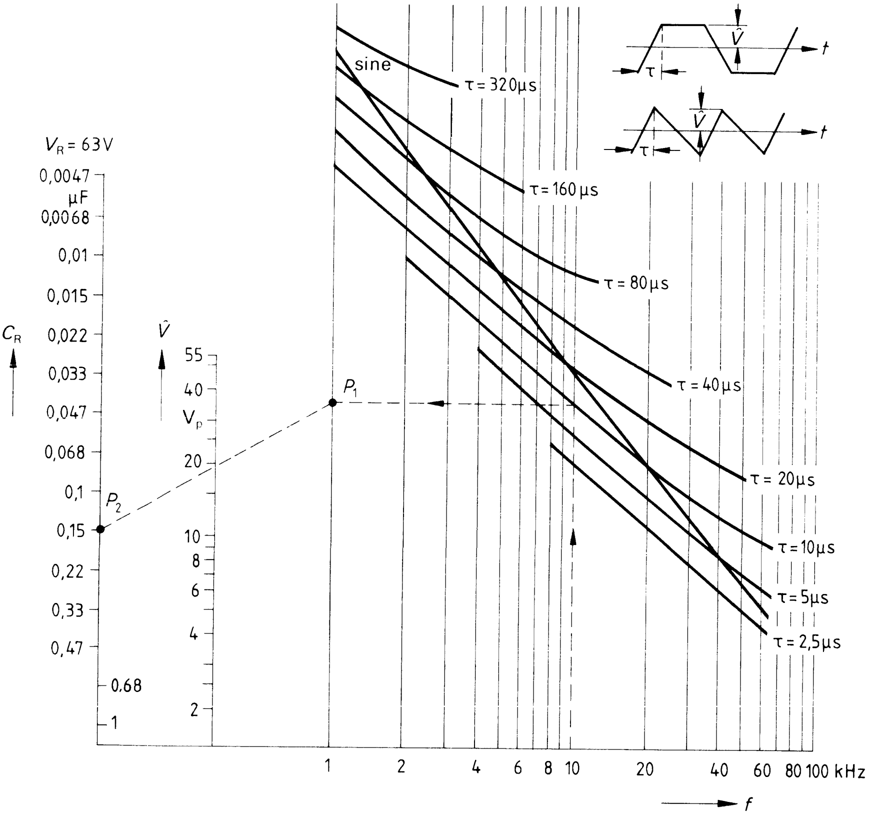
Rated dc voltage V_R	63 V	100 V	250 V	400 V	630 V
Limit voltage $\hat{V}_l$	55 V	85 V	140 V	224 V	280 V

B 32 529, LS 5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz (repetition frequency)
τ = 10 µs (rise time)
} intersection P_1

C_R = 0.15 µF (capacitance)
V_R = 63 V (rated voltage)
} intersection P_2

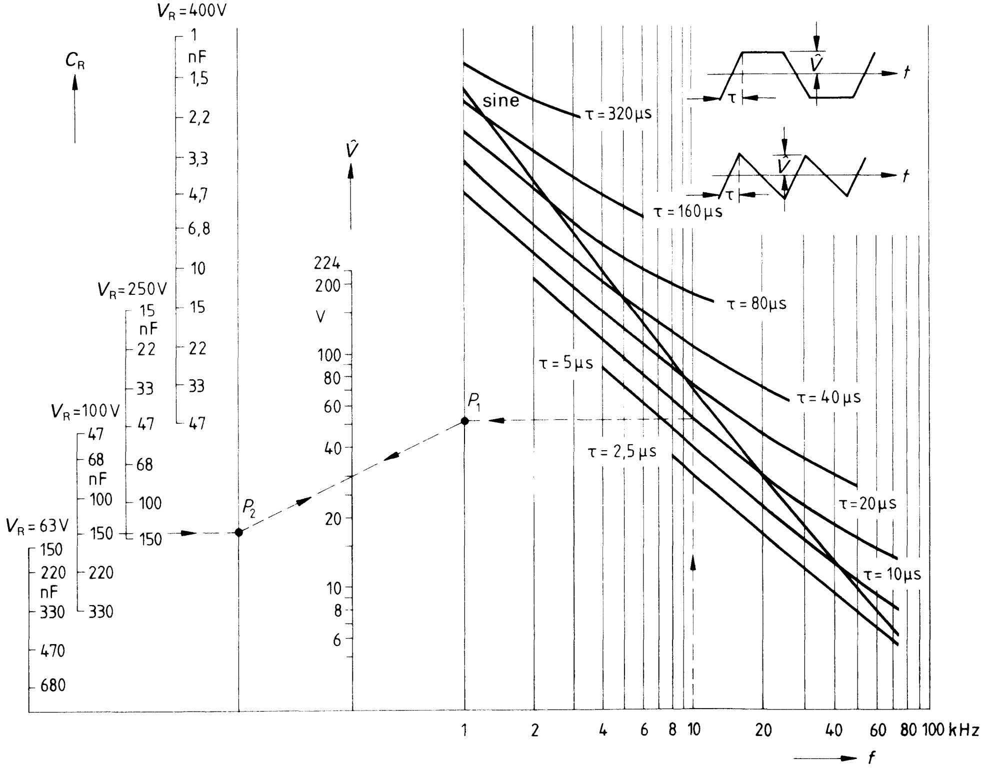
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 19 V.

B 32520, LS 7.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz	(repetition frequency)	}	intersection P_1
τ = 10 µs	(rise time)		
C_R = 150 nF	(capacitance)	}	intersection P_2
V_R = 100 V	(rated voltage)		

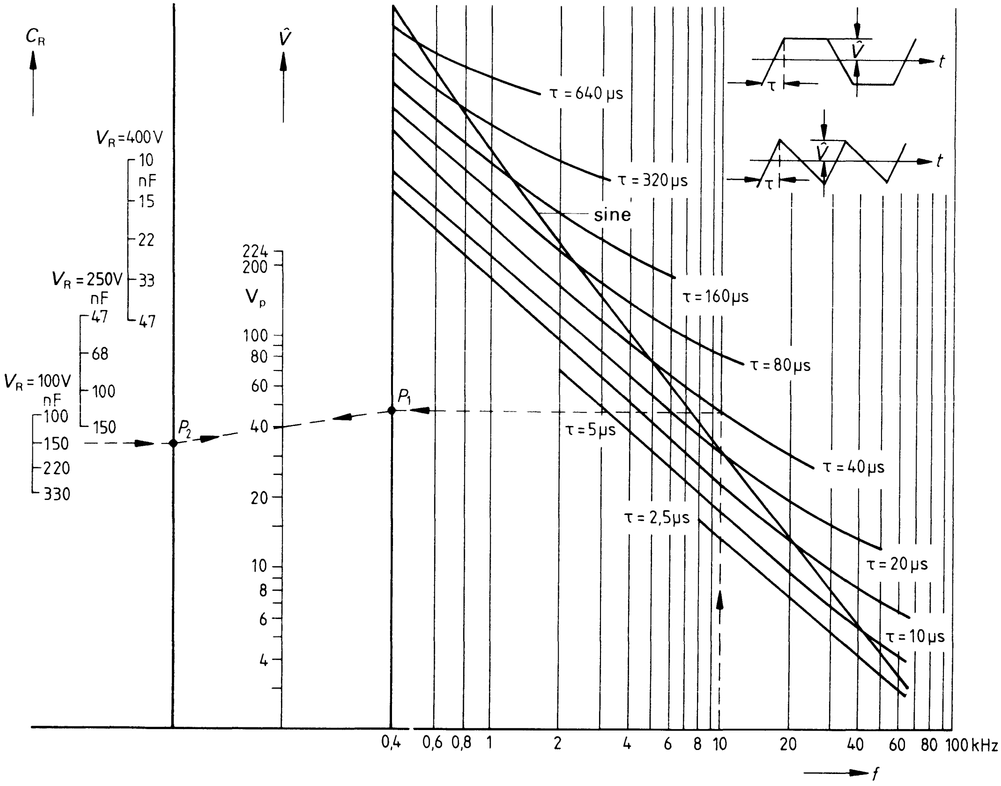
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 30 V.

B 32521, LS 10 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz (repetition frequency)
τ = 40 µs (rise time)
} intersection P_1

C_R = 150 nF (capacitance)
V_R = 100 V (rated voltage)
} intersection P_2

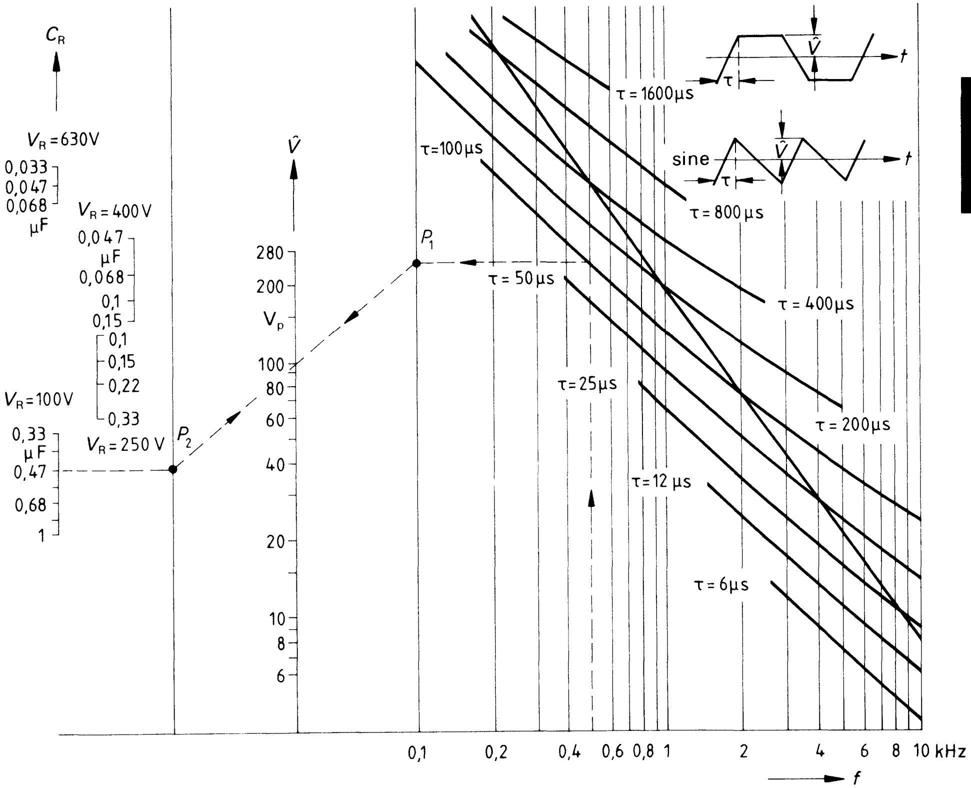
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 40 V.

B 32522, LS 15 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 0.5 kHz (repetition frequency) } intersection P_1
τ = 100 µs (rise time)
C_R = 0.47 µF (capacitance) } intersection P_2
V_R = 100 V (rated voltage)

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 100 V.

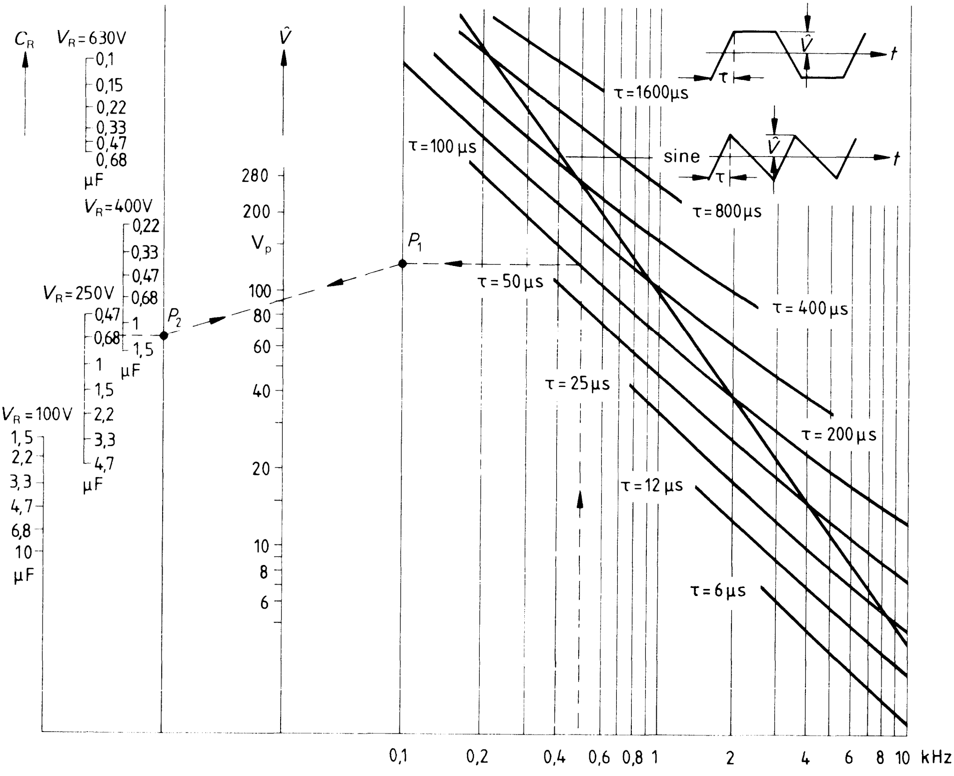
For loads at frequencies > 10 kHz, please contact us.

B 32523, LS 22.5 mm
B 32524, LS 27.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 0.5 kHz (repetition frequency)
τ = 100 µs (rise time)
} intersection P_1

C_R = 0.68 µF (capacitance)
V_R = 250 V (rated voltage)
} intersection P_2

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 90 V.

For loads at frequencies >10 kHz, please contact us.

MKT Capacitors

B 32530 ... B 32539

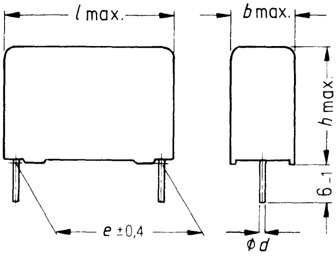
Metalized polyester film capacitors, high rel version, in accordance with DIN 44112
V_R = 63 to 400 Vdc

With quality assessment according to CECC 30401-026, edition 3, May 1983.

Self-healing capacitor with polyethyleneterephthalate dielectric. Encapsulated in a flame-retardant rectangular plastic case (in accordance with UL 94 V-0). Epoxy resin sealed for humidity resistance. For improved solderability, the package is provided with spacers. Connections: parallel leads, tinned, plug-in in the lead spacing. Particularly suited for space-saving assembly at high packing density on any PC board.

Packaging on continuous tapes

Capacitors with 5 mm and 7.5 mm lead spacing, as well as capacitors with a lead spacing of 7.5/5 mm (leads crimped to a lead spacing of 5 mm) are also available on continuous tape. For taping instructions and ordering code information refer to page 46.



l	Lead spacing *e*	dia. *d*
7.2	5	0.5
10	7.5	0.6
13	10	0.6
18	15	0.8
27	22.5	0.8
31.5	27.5	0.8

Dimensions in mm

DIN climatic category in acc. with DIN 40040	**F M E / J R** (LS 5) **F M D / J R** (LS 7.5 to 27.5)
Lower category temperature	**F** − 55°C/− 67°F
Upper category temperature	**M** +100°C/+212°F1)
Humidity category	**E(D)** average relative humidity ≤75% (≤80%); 95% (100%)for 30 days per year continuously; 85% (90%) for the remaining days occasionally
Failure rate (40°C/104°F, V_R)	**J** 30 × 10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 41.
Load duration	**R** ≥10^5 h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$ >±10% Dissipation factor tan δ > 2 × upper category values Insulation resistance < 150 MΩ (≤0.33 μF) < 50 s (>0.33 μF)

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1) Shelf and service life at temperatures >100 ... 125°C/212 ... 257°F, 1000 h max., V_C = 0.5 V_R.

Lead spacing		LS 5 mm	LS 7.5 mm			
Rated dc voltage		63 V	63 V	100 V	250 V	400 V
Rated capacitance		Dimensions *b* × *h* × *l* (mm) and ordering code				
C_R	Tolerance	B 32 539-	B 32 530-			
1000 pF	± 20 % ≙ M ± 10 % ≙ K ± 5 % ≙ J					3 × 8.5 × 10 −A6102−+
1500 pF						3 × 8.5 × 10 −A6152−+
2200 pF						3 × 8.5 × 10 −A6222−+
3300 pF						3 × 8.5 × 10 −A6332−+
4700 pF		2.5 × 6.5 × 7.2 −A472−+				3 × 8.5 × 10 −A6472−+
6800 pF		2.5 × 6.5 × 7.2 −A682−+				3 × 8.5 × 10 −A6682−+
0.01 μF		2.5 × 6.5 × 7.2 −A103−+				3 × 8.5 × 10 −A6103−+
0.015 μF		2.5 × 6.5 × 7.2 −A153−+			3 × 8.5 × 10 −A3153−+	4 × 8.5 × 10 −A6153−+
0.022 μF		2.5 × 6.5 × 7.2 −A223−+			3 × 8.5 × 10 −A3223−+	4 × 8.5 × 10 −A6223−+
0.033 μF		2.5 × 6.5 × 7.2 −A333−+			3 × 8.5 × 10 −A3333−+	5 × 10.5 × 10 −A6333−+
0.047 μF		2.5 × 6.5 × 7.2 −A473−+		3 × 8.5 × 10 −A1473−+	4 × 8.5 × 10 −A3473−+	6 × 12 × 10 −A6473−+
0.068 μF		2.5 × 6.5 × 7.2 −A683−+		3 × 8.5 × 10 −A1683−+	5 × 10.5 × 10 −A3683−+	
0.1 μF		2.5 × 6.5 × 7.2 −A104−+		3 × 8.5 × 10 −A1104−+	5 × 10.5 × 10 −A3104−+	
0.15 μF		3.5 × 9 × 7.2 −A154−+	3 × 8.5 × 10 −A154−+	4 × 8.5 × 10 −A1154−+	6 × 12 × 10 −A3154−+	
0.22 μF		3.5 × 9 × 7.2 −A224−+	3 × 8.5 × 10 −A224−+	5 × 10.5 × 10 −A1224−+		
0.33 μF		4.5 × 9.5 × 7.2 −A334−+	4 × 8.5 × 10 −A334−+	6 × 12 × 10 −A1334−+		
0.47 μF		5 × 10 × 7.2 −A474−+	5 × 10.5 × 10 −A474−+			
0.68 μF		5 × 10 × 7.2 −A684−+	6 × 12 × 10 −A684−+			
1 μF		6 × 10.5 × 7.2 −A105−+				
1.5 μF						
2.2 μF						

\+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors with capacitance tolerance ± 10% are preferred types (refer to page 4).

LS 10 mm			LS 15 mm			LS
100 V	250 V	400 V	100 V	250 V	400 V	V_R
Dimensions $b \times h \times l$ (mm) and ordering code						
B 32531–			B 32532–			C_R
						1000 pF
						1500 pF
						2200 pF
						3300 pF
						4700 pF
						6800 pF
		4×9×13 –A6103–+				0.01 µF
		4×9×13 –A6153–+				0.015 µF
		4×9×13 –A6223–+				0.022 µF
		4×9×13 –A6333–+				0.033 µF
	4×9×13 –A3473–+	5×11.5×13 –A6473–+			5.5×11×18 –A6473–+	0.047 µF
	4×9×13 –A3683–+				5.5×11×18 –A6683–+	0.068 µF
4×9×13 –A1104–+	5×11.5×13 –A3104–+			5,5×11×18 –A3104–+	7×13×18 –A6104– +	0.1 µF
4×9×13 –A1154–+	5×11.5×13 –A3154–+			5,5×11×18 –A3154–+	7×13×18 –A6154– +	0.15 µF
4×9×13 –A1224–+				7×13×18 –A3224–+		0.22 µF
5×11.5×13 –A1334–+			5.5×11×18 –A1334–+	7×13×18 –A3334–+		0.33 µF
			5.5×11×18 –A1474–+			0.47 µF
			7×13×18 –A1684–+			0.68 µF
			7×13×18 –A1105–+			1 µF
						1.5 µF
						2.2 µF

Lead spacing		LS 22.5 mm			LS 27.5 mm		
Rated dc voltage		100 V	250 V	400 V	100 V	250 V	400 V
Rated capacitance		Dimensions *b* × *h* × *l* (mm) and ordering code					
C_R	Tolerance	B 32533–			B 32534–		
0.1 µF	± 20 % ≙ M ± 10 % ≙ K ± 5 % ≙ J						
0.15 µF							
0.22 µF				7.3×16.5×27 –M6224–+			
0.33 µF				8.5×18.5×27 –M6334–+			
0.47 µF			7.3×16.5×27 –M3474–+	10.5×19×27 –M6474–+			
0.68 µF			7.3×16.5×27 –M3684–+				11.5×21×31.5 –M6684–+
1 µF			8.5×18.5×27 –M3105–+				11.5×21×31.5 –M6105–+
1.5 µF		7.3×16.5×27 –M1155–+				11.5×21×31.5 –M3155–+	13.5×23×31.5 –M6155–+
2.2 µF		8.5×18.5×27 –M1225–+				11.5×21×31.5 –M3225–+	
3.3 µF		10.5×19×27 –M1335–+				13.5×23×31.5 –M3335–+	
4.7 µF					11.5×21×31.5 –M1475–+	15×24.5×31.5 –M3475–+	
6.8 µF					13.5×23×31.5 –M1685–+		
10 µF					15×24.5×31.5 –M1106–+		

+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors with capacitance tolerance ± 10% are preferred types (refer to page 4).

Ordering code example

B32533-M6474–+

Code letter for capacitance tolerance (refer to table)

Type

Code according to table

IEC climatic category
in acc. with DIN IEC 68-1

55/100/56

Damp heat test
in acc. with
DIN IEC 68-2-3

Conditions

Test temperature	+40°C/+104°F
Relative humidity	$(93 {}^{+2}_{-3})$ %
Test duration	56 days

Test criteria

Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 5\%$
Dissipation factor change $\Delta \tan \delta$ at 1 kHz	$\leq 5 \times 10^{-3}$
Insulation resistance	$\geq$50% of the minimum value as supplied

Resistance to vibration
Test Fc in acc. with
DIN IEC 68-2-6:
vibration, sinusoidal

Duration of endurance conditioning	6 h
Frequency range	10...55 Hz
Displacement amplitude	0.75 mm (conforming to 98.1 m/s^2 max. or to 10 *g*)

At 10 Hz...2 kHz capacitors with LS $\geq$22.5 mm must additionally be fixed at the case.

Resistance to soldering heat[1]
Test Tb in acc. with
DIN IEC 68-2-20

Solder bath temperature	max. 260°C/500°F
Soldering duration	max. 5 s
Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 2\%$

Resistance to cleaning agents

Refer to section "General Information", page 37.

Capacitance drift i_Z

±3%

Self inductance

Lead spacing (mm)	5	7.5	10	15	22.5	27.5
Self inductance (approx. nH)	5	8	9	10	20	20

Dissipation factor tan δ
measured at 20°C/68°F

Upper limits/Average production values

	C_R<0.1 µF	$C_R\geq$0.1 ...<1 µF	$C_R\geq$1 µF
at 1 kHz	8/ 5 × 10^{-3}	8/ 5 × 10^{-3}	10/6 × 10^{-3}
at 10 kHz	15/12 × 10^{-3}	15/12 × 10^{-3}	–
at 100 kHz	30/18 × 10^{-3}	–	–

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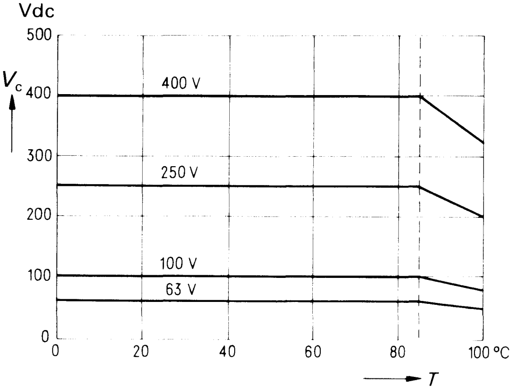
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Category voltage V_C
versus temperature T
at dc operation

max. 2000 hours 1.25 × V_C

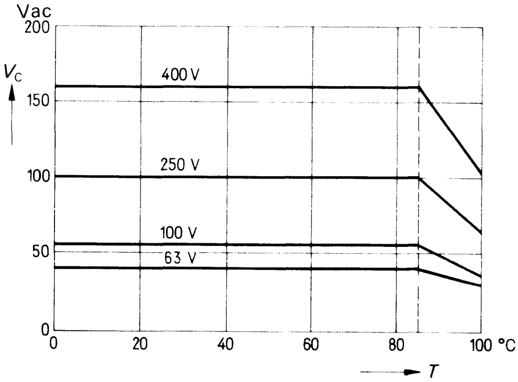
for milliseconds 1.50 × V_C
(e. g. switchings)



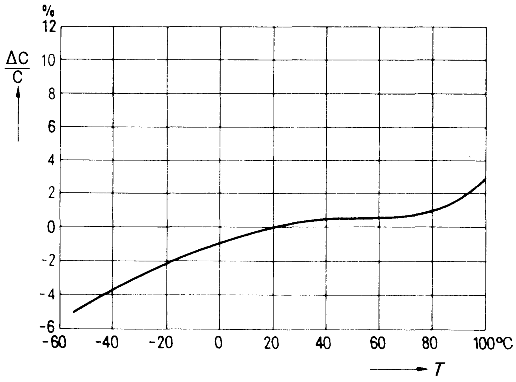
Category voltage V_C[1]
versus temperature T
at ac operation
at 50 Hz

max. 2000 h 1.25 × V_C

for milliseconds 1.50 × V_C
(e. g. switchings)



Capacitance change $\frac{\Delta C}{C}$
versus temperature T
(typical values, measured
at 1 kHz)



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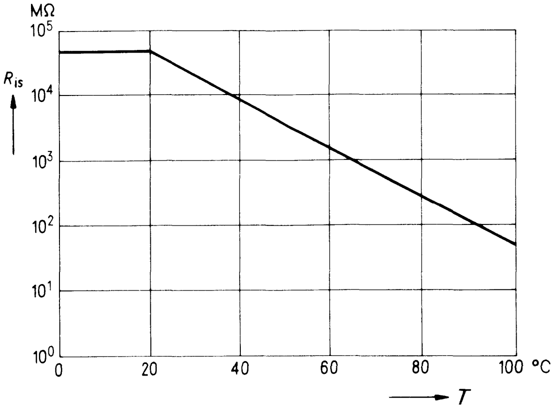
[1] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

Insulation resistance R_{is} versus temperature T



Typical values
measured at 20°C/68°F and a relative humidity ≤65%

Insulation resistance R_{is} and time constant τ

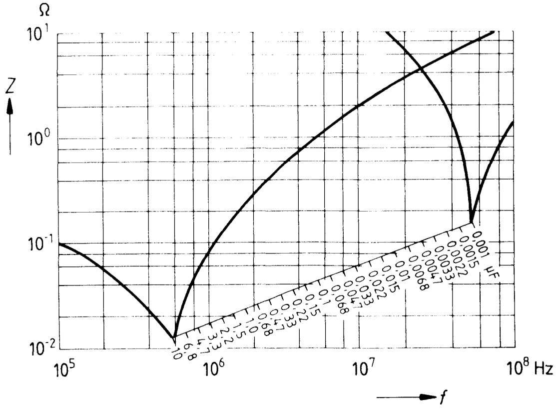
Minimum value as supplied[1]

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
≤100 V	15 000 MΩ	5 000 s
≥250 V	30 000 MΩ	10 000 s

Average value as supplied

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
≤100 V	>30 000 MΩ	>10 000 s
≥250 V	>75 000 MΩ	>25 000 s

Impedance Z versus frequency f
(typical values)



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[1] The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E or 100% of the humidity category D is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		LS 5	LS 7.5	LS 10	LS 15	LS 22.5	LS 27.5
63 V	V_{pp}/τ in V/µs k_0 in V²/µs	80 10000					
100 V	V_{pp}/τ in V/µs k_0 in V²/µs		50 10000	35 7500	25 5000	2 400	1.5 300
250 V	V_{pp}/τ in V/µs k_0 in V²/µs		100 50000	75 35000	50 25000	3 1500	2.5 1250
400 V	V_{pp}/τ in V/µs k_0 in V²/µs		125 100000	90 75000	60 50000	4 3200	3 2400

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram.

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature.

The following limits may not be exceeded:

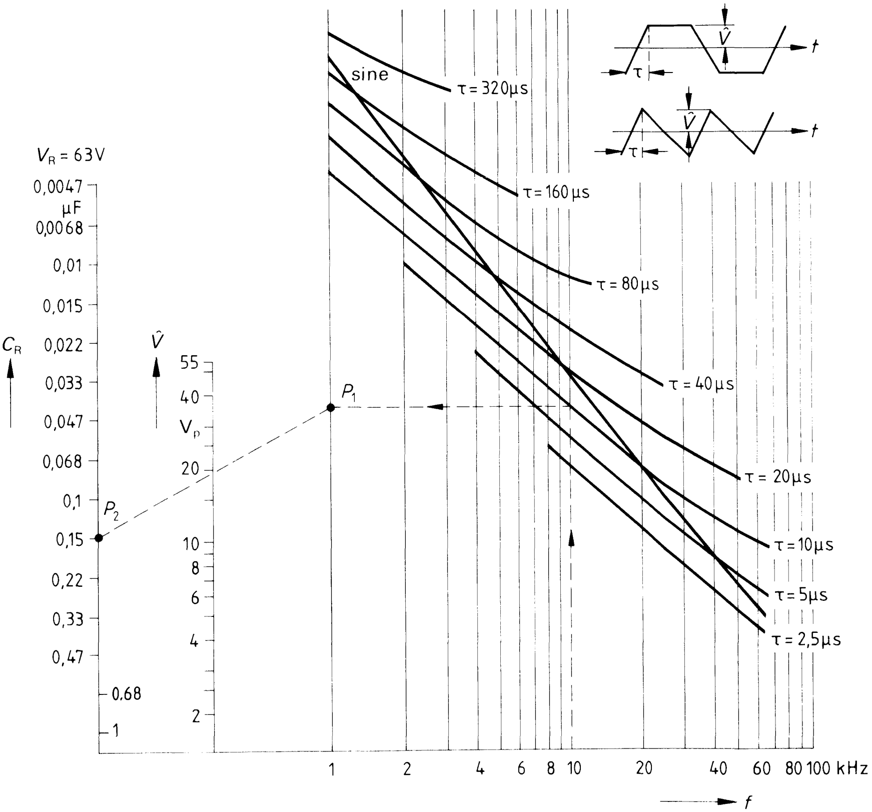
Rated dc voltage V_R	63 V	100 V	250 V	400 V
Limit voltage $\hat{V}_l$	55 V	85 V	140 V	224 V

B 32539, LS 5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz (repetition frequency) }
τ = 10 µs (rise time) } intersection P_1

C_R = 0.15 µF (capacitance) }
V_R = 63 V (rated voltage) } intersection P_2

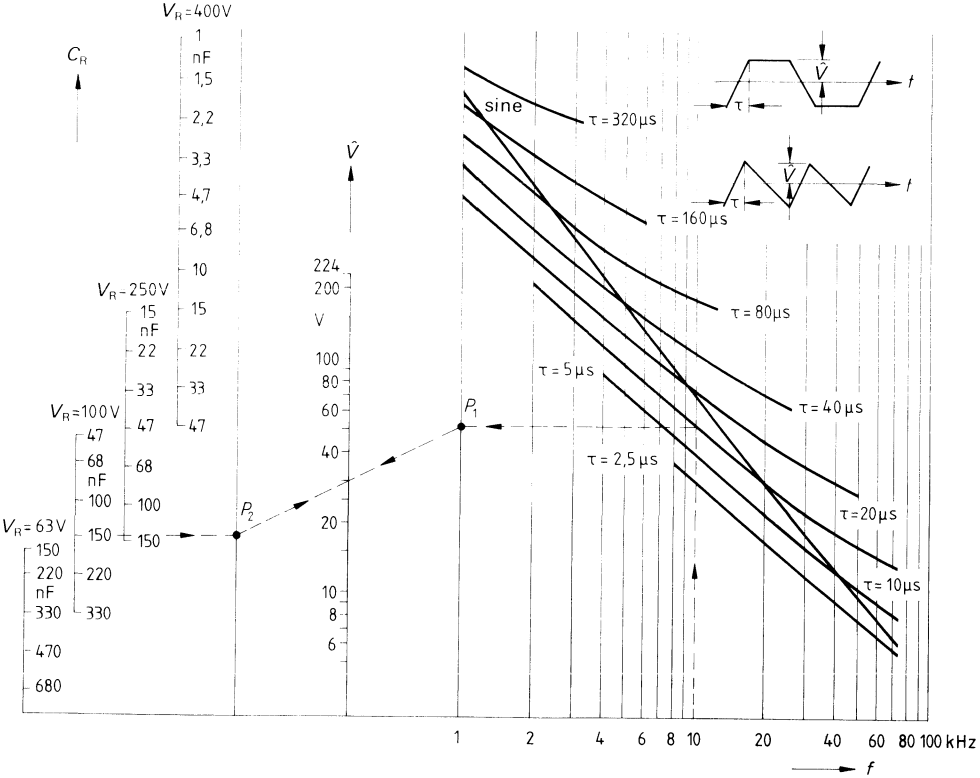
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 19 V.

B 32530, LS 7.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz (repetition frequency)
τ = 10 μs (rise time)
} intersection P_1

C_R = 150 nF (capacitance)
V_R = 100 V (rated voltage)
} intersection P_2

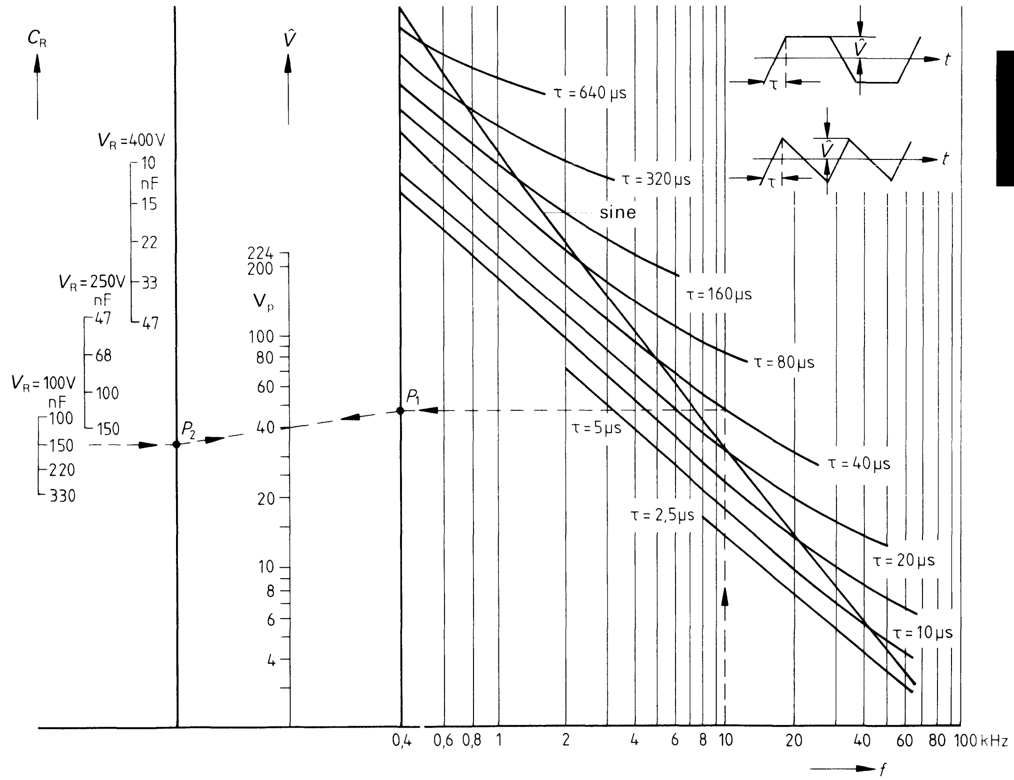
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 30 V.

B 32531, LS 10 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz (repetition frequency) }
τ = 40 µs (rise time) } intersection P_1

C_R = 150 nF (capacitance) }
V_R = 100 V (rated voltage) } intersection P_2

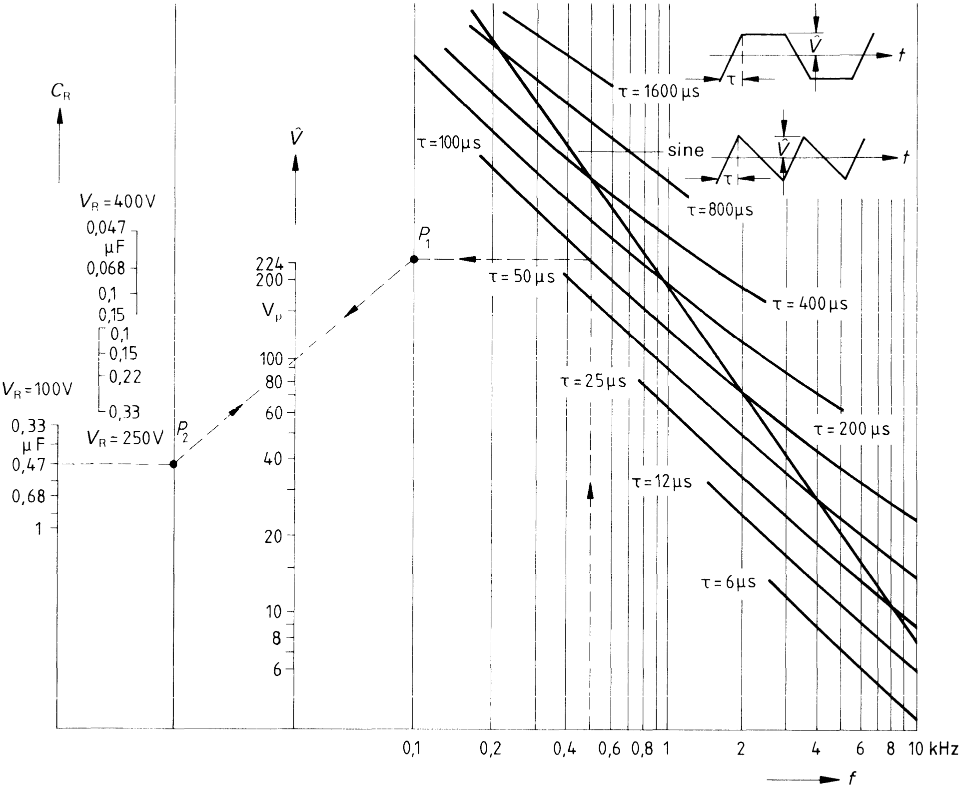
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 40 V.

B 32532, LS 15 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 0.5 kHz (repetition frequency) } intersection P_1
τ = 100 µs (rise time) }
C_R = 0.47 µF (capacitance) } intersection P_2
V_R = 100 V (rated voltage) }

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 100 V.

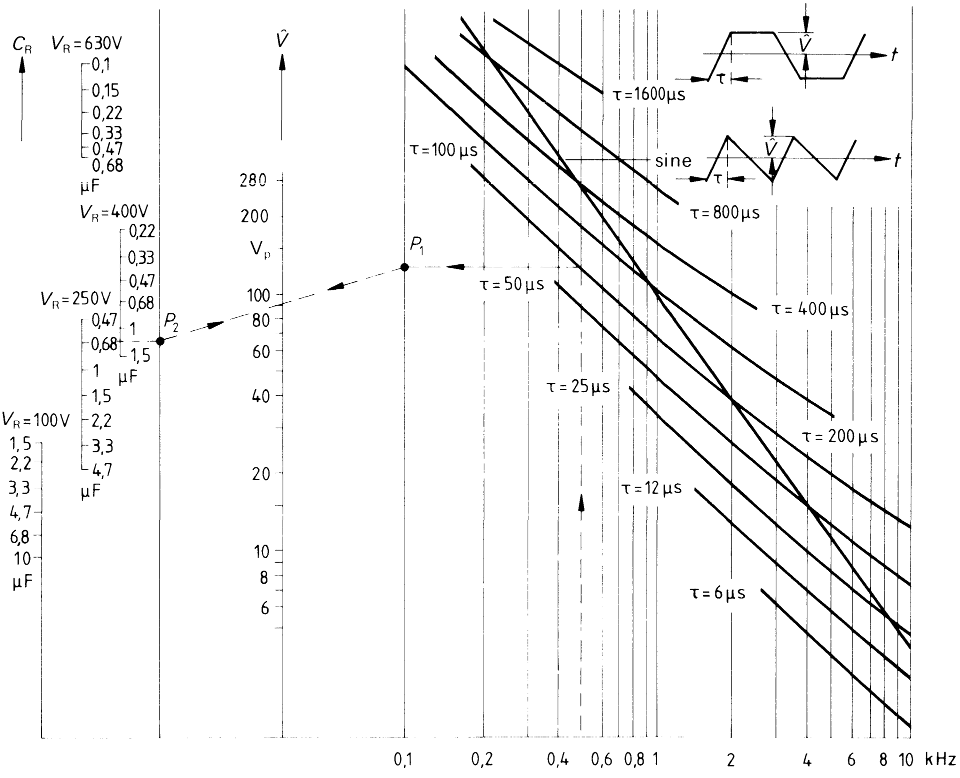
For loads at frequencies > 10 kHz, please contact us.

B 32533, LS 22.5 mm
B 32534, LS 27.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 0.5 kHz	(repetition frequency)	}	intersection P_1
τ = 100 µs	(rise time)		
C_R = 0.68 µF	(capacitance)	}	intersection P_2
V_R = 250 V	(rated voltage)		

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 90 V.

For loads at frequencies >10 kHz, please contact us.

MKT Stacked-Film Capacitors

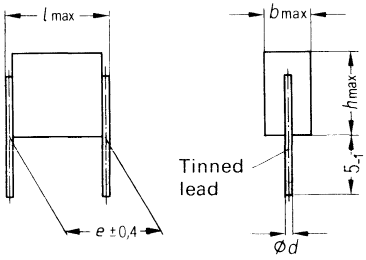
S B 32560 ...B 32563

With quality assessment according to CECC 30401-007, form A

Fields of application: consumer electronics, industrial electronics
B 32560...B 32563 for incorporation in single-clad PC boards
B 32561...B 32563 also suitable for double-clad PC boards

Self-healing capacitor with polyethyleneterephthalate dielectric. When mounting, attention must be given to the surface leakage paths and air paths to adjacent live parts. The insulating strength of the sectional areas to live parts corresponds to 1.5 times the rated dc voltage of the capacitor; it amounts, however, to at least 300 Vdc.
Connections: Parallel leads, tinned, plug-in, lead spacing 7.5 to 22.5 mm.

Type	Lead spacing *e*	dia. *d*
B 32560	7.5 mm	0.6
B 32561	10 mm	0.6
B 32562-D	15 mm	0.6
B 32562-E	15 mm	0.8
B 32563	22.5 mm	0.8



Dimensions in mm

DIN climatic category in acc. with DIN 40040	**F M E / J R**
Lower category temperature	**F** – 55°C/– 67°F
Upper category temperature	**M** +100°C/+212°F
Humidity category	**E** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J** 30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R** $\geq 10^5$ h
Failure criteria	
Total failure	Short or open circuit
Failure due to variations	Capacitance change $\frac{\Delta C}{C} > \pm 10\%$
	Dissipation factor tan δ > 2 × upper category values
	Insulation resistance < 150 MΩ (≤0.33 µF) < 50 s (>0.33 µF)

MKT Stacked-Film Capacitors

Lead spacing		LS 7.5 mm			LS 10 mm		
Rated dc voltage V_R		100 V	250 V	400 V	100 V	250 V	400 V
Rated capacitance		Dimensions $b \times h \times l$ (mm) and ordering code					
C_R	Tolerance	B 32 560–			B 32 561–		
1000 pF				2.4 × 8.2 × 9 −D6102−+			
1500 pF				2.3 × 8.2 × 9 −D6152−+			
2200 pF				2.3 × 8.2 × 9 −D6222−+			
3300 pF				2.3 × 8.2 × 9 −D6332−+			
4700 pF				2.3 × 8.2 × 9 −D6472−+			
6800 pF				2.4 × 7.3 × 9 −D6682−+			
0.01 µF			2.3 × 7.3 × 9 −D3103−+	2.4 × 7.3 × 9 −D6103−+			3.2×6.6×11.5 −D6103−+
0.015 µF			2.3 × 7.3 × 9 −D3153−+	2.7 × 7.3 × 9 −D6153−+			3.2×6.6×11.5 −D6153−+
0.022 µF			2.3 × 7.3 × 9 −D3223−+			3.2×6.6×11.5 −D3223−+	3.2×6.6×11.5 −D6223−+
0.033 µF			2.5 × 7.3 × 9 −D3333−+			3.3×6.6×11.5 D3333−+	3.3×6.6×11.5 −D6333−+
0.047 µF	±5% ≙ J ±10% ≙ K		2.9 × 7.4 × 9 −D3473−+			3.1×6.6×11.5 −D3473−+	3.9×7.2×11.5 −D6473−+
0.068 µF		2.4 × 8.1 × 9 −D1683−+	3.6 × 8.1 × 9 −D3683−+			3.1×6.6×11.5 −D3683−+	
0.1 µF		2.7 × 8.1 × 9 −D1104−+	4 × 10.1 × 9 −D3104−+			3.6×7.4×11.5 −D3104−+	
0.15 µF		3.4 × 8.1 × 9 −D1154−+				4.3×8.5×11.5 −D3154−+	
0.22 µF		4.4 × 8.0 × 9 −D1224−+			3.4×7.2×11,5 −D1224−+	5.0×10.1×11.5 −D3224−+	
0.33 µF		5.5 × 8.8 × 9 −D1334−+			4.2×8.1×11,5 −D1334−+		
0.47 µF		5.5 × 12.5 × 9 −D1474−+			5.4×8.1×11.5 −D1474−+		
0.68 µF		8 × 11.4 × 9 −D1684−+			7.2×8.2×11.5 −D1684−+		
1 µF					8.5×9.8×11.5 −D1105−+		
1.5 µF							
2.2 µF							
3.3 µF							

+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors in lead spacing 7.5 mm, 10 mm, and 15 mm with capacitance tolerance ± 5% are preferred types (refer to page 4).

LS 15 mm			LS 22.5 mm			LS
100 V	250 V	400 V	100 V	250 V	400 V	V_R
Dimensions $b \times h \times l$ (mm) and ordering code						
B 32562–			B 32563–			C_R
						1000 pF
						1500 pF
						2200 pF
						3300 pF
						4700 pF
						6800 pF
						0.01 µF
						0.015 µF
						0.022 µF
						0.033 µF
						0.047 µF
		3.8×6.2×16.5 –D6683–+				0.068 µF
		4.5×7.1×16.5 –D6104–+				0.1 µF
		5,5×8,2×16,5 –E6154–+				0.15 µF
		7.2×8.6×16.5 –E6224–+				0.22 µF
	5.4×7.7×16.5 –D3334–+	8.3×10.9×16.5 –E6334– +				0.33 µF
4×6.9×16.5 –D1474–+	6.1×9.4×16.5 –E3474–+				7.3×12.4×24 –D6474–+	0.47 µF
5×7.3×16.5 –D1684–+	7×11.4×16.5 –E3684–+				8.3×15.4×24 –D6684–+	0.68 µF
5.5×9.2×16.5 –E1105–+	9.6×11.5×16.5 –E3105– +			6.5×11.8×24 –D3105–+	10.4×17.5×24 –D6105–+	1.0 µF
7×10.5×16.5 –E1155–+				7.8×14.4×24 –D3155–+		1.5 µF
8.5×12.3×16.5 –E1225–+			6.4×11.3×24 –D1225–+	9.1×17.5×24 –D3225–+		2.2 µF
			7.7×13.4×24 –D1335–+			3.3 µF

IEC climatic category in acc. with DIN IEC 68-1	**55/100/21**[1]	
Damp heat test in acc. with DIN IEC 68-2-3	**Conditions**	
	Test temperature	+40°C/+104°F
	Relative humidity	$(93 ^{+2}_{-3})$ %
	Test duration	21 days
	Test criteria	
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 5\%$
	Dissipation factor change Δ tan δ	$\leq 3 \times 10^{-3}$ at 1 kHz $\leq 5 \times 10^{-3}$ at 10 kHz
	Insulation resistance	$\geq$50% of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10...55 Hz
	Displacement amplitude	0.75 mm (conforming to 98.1 m/s^2 max. or to 10 *g*)
Resistance to soldering heat[2] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 5 s
	Test criterion: Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 2\%$
Resistance to cleaning agents	Refer to section "General Information", page 37.	
Sealing compound	Refer to para. 6.4 in section "General Information", page 39	
Capacitance drift i_Z	±3%	

Self inductance

Lead spacing (mm)	7.5	10	15	22.5
Self inductance (approx. nH)	5	6	7	9

Dissipation factor tan δ
measured at 20°C/68°F

Upper limits/Average production values

	$C_R < 0.1$ µF	$C_R \geq 0.1$ µF	$C_R > 1$ µF
at 1 kHz	$8/\ 5 \times 10^{-3}$	$8/\ 5 \times 10^{-3}$	$10/6 \times 10^{-3}$
at 10 kHz	$15/12 \times 10^{-3}$	$15/12 \times 10^{-3}$	–
at 100 kHz	$30/18 \times 10^{-3}$	–	–

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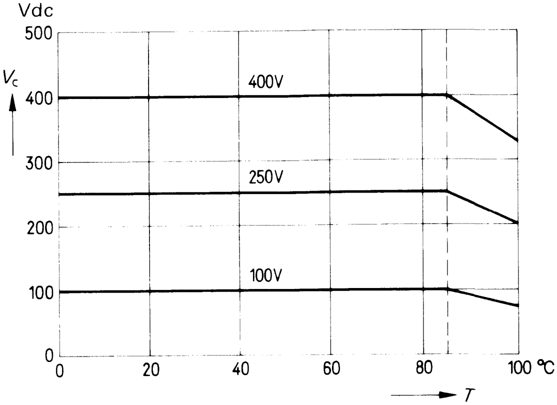
[1] The test criteria are also kept at a humidity stress of 56 days.

[2] For soldering recommendations also refer to "General Information", para. 6.2.

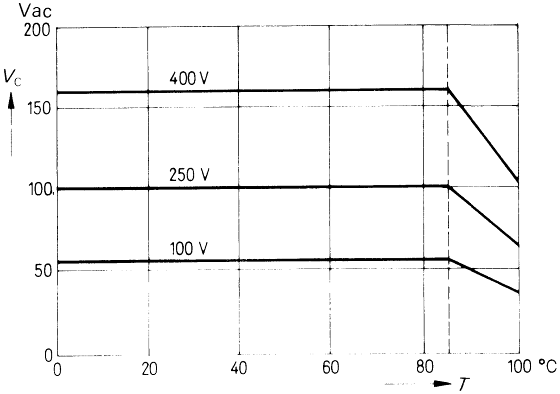
Category voltage V_C versus temperature T
at dc operation

max. 2000 hours	1.25 × V_C
for milliseconds (e.g. switchings)	1.50 × V_C

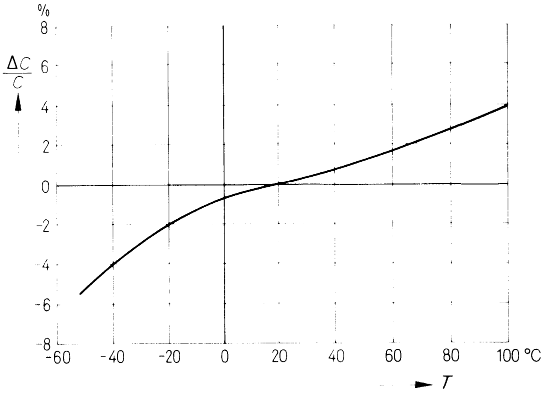


Category voltage V_C[1] versus temperature T
at ac operation
at 50 Hz

max. 2000 h	1.25 × V_C
for milliseconds (e.g. switchings)	1.50 × V_C



Capacitance change $\frac{\Delta C}{C}$ versus temperature T
(typical values, measured at 1 kHz)



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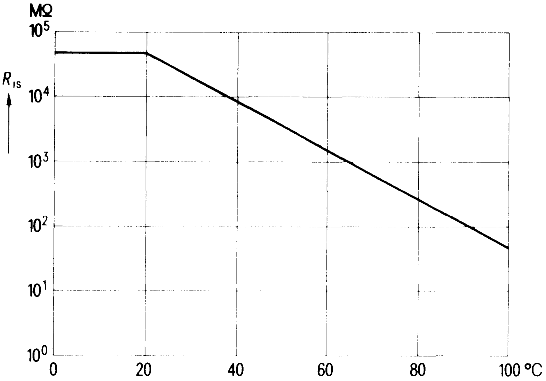
[1] The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

Insulation resistance R_{is} versus temperature T



Insulation resistance R_{is} and time constant τ

Minimum value as supplied[1]

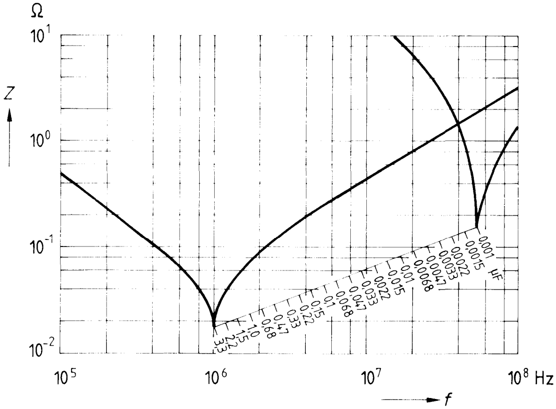
V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
100 V	3750 MΩ	1250 s
≥250 V	7500 MΩ	2500 s

Average value as supplied

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
100 V	>30 000 MΩ	>10 000 s
≥250 V	>75 000 MΩ	>25 000 s

Impedance Z versus frequency f

(typical values)



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[1] The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		LS 7.5	LS 10	LS 15	LS 22.5
100 V	V_{pp}/τ in V/µs k_0 in V²/µs	100 20000	75 15000	50 10000	50 10000
250 V	V_{pp}/τ in V/µs k_0 in V²/µs	200 100000	150 75000	100 50000	100 50000
400 V	V_{pp}/τ in V/µs k_0 in V²/µs	250 200000	175 150000	125 100000	125 100000

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram.

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature.

The following limits may not be exceeded:

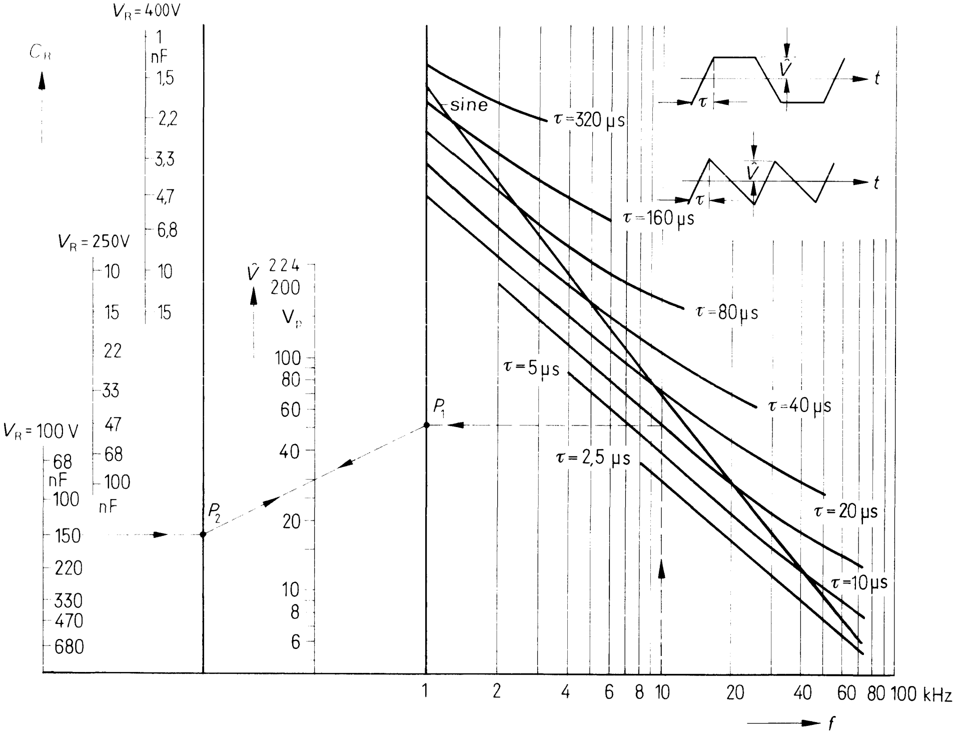
Rated dc voltage V_R	100 V	250 V	400 V
Limit voltage $\hat{V}_l$	85 V	140 V	224 V

B 32560, LS 7.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz	(repetition frequency)	}	Point of intersection P_1
τ = 10 µs	(rise time)	}	
C_R = 150 nF	(capacitance)	}	Point of intersection P_2
V_R = 100 V	(rated voltage)	}	

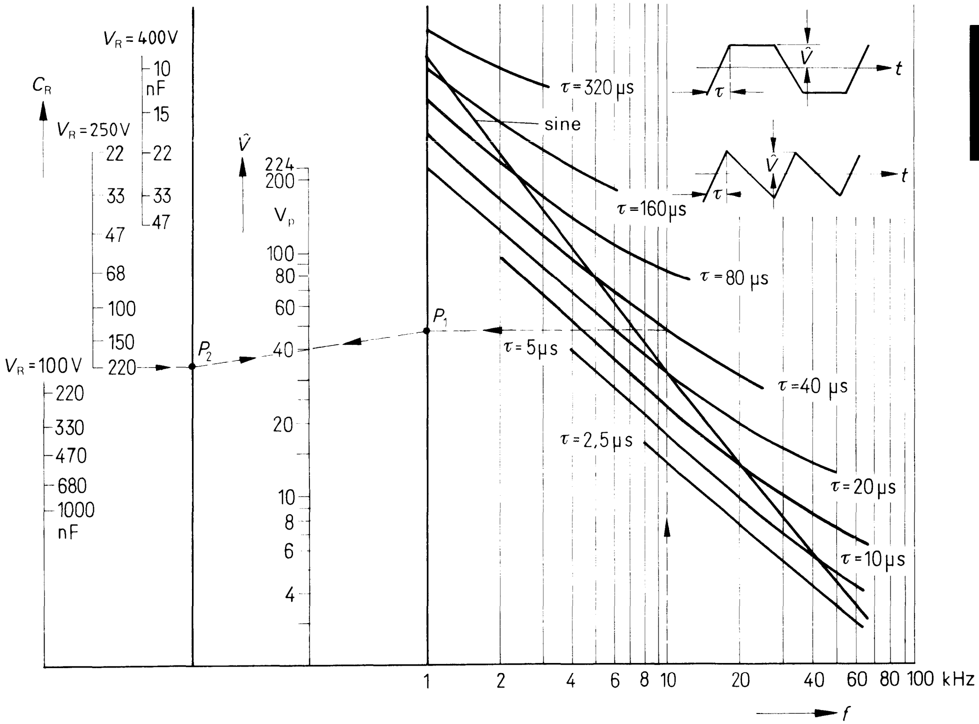
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 30 V.

B 32561, LS 10 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 10 kHz	(repetition frequency)	}	Point of intersection P_1
τ = 40 µs	(rise time)		
C_R = 220 nF	(capacitance)	}	Point of intersection P_2
V_R = 250 V	(rated voltage)		

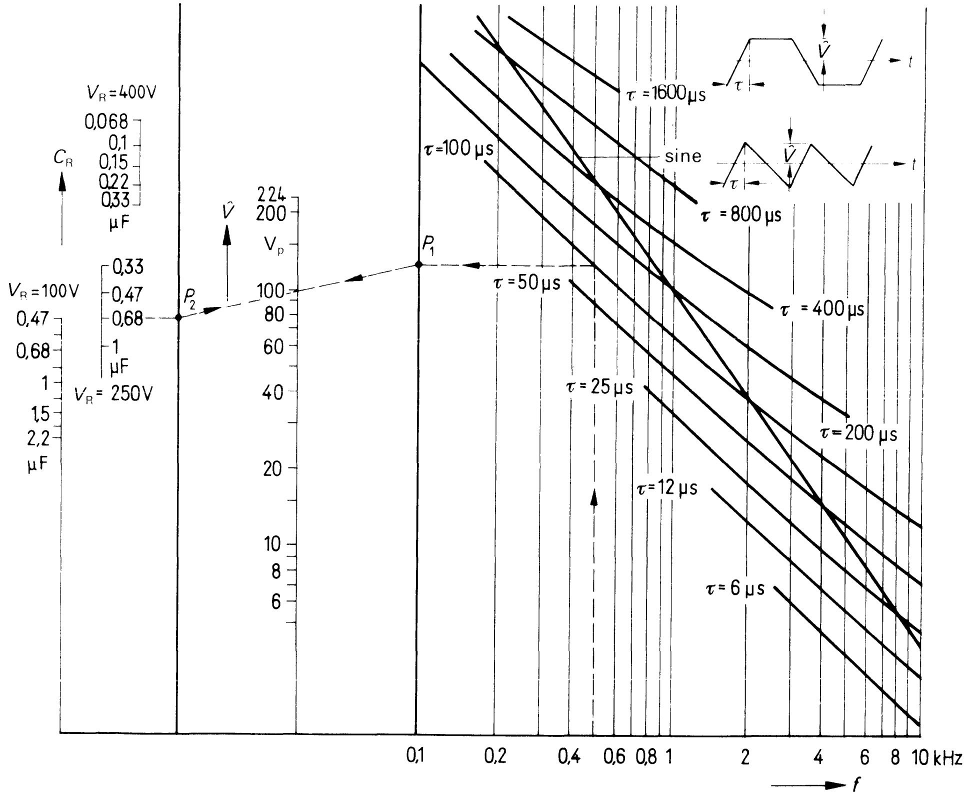
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 40 V.

B 32562, LS 15 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 0.5 kHz (repetition frequency)
τ = 100 µs (rise time)
} Point of intersection P_1

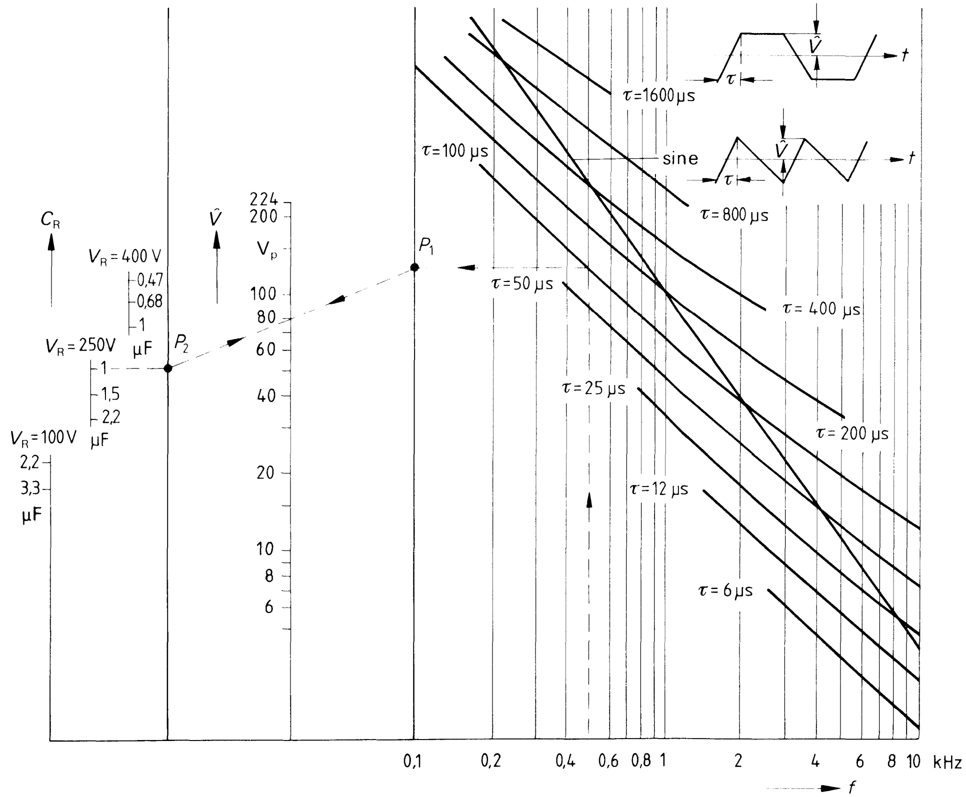
C_R = 0.68 µF (capacitance)
V_R = 250 V (rated voltage)
} Point of intersection P_2

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 100 V.

B 32563, LS 22.5 mm

Nomogram for determining the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the example plotted. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale yields the maximum permissible peak voltage.
In case of trapezoidal voltage load with two steep edges, the second harmonic frequency has to be taken into account. With sinusoidal voltage load the "sine" characteristic applies.



Example:

f = 0.5 kHz (repetition frequency)
τ = 100 µs (rise time)
} Point of intersection P_1
C_R = 1 µF (capacitance)
V_R = 250 V (rated voltage)
} Point of intersection P_2

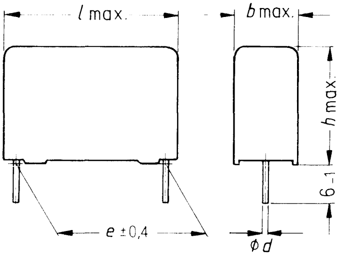
According to the dashed line in the graph above, this results in a max. peak voltage $\hat{V}$ of approx. 80 V.

MKC Capacitors
Metalized Polycarbonate Film Capacitors

Metalized polycarbonate film capacitors, high rel version, in accordance with DIN 44116

V_R = 100 to 250 Vdc

Self-healing capacitor with polycarbonate dielectric. Enclosed in a flame-retardant rectangular plastic case (in accordance with UL 94 V-0). Epoxy resin sealed for humidity resistance. For improved solderability, the package is provided with spacers. Connections: parallel leads, tinned, plug-in in the lead spacing. Particularly suited for space-saving assembly at high packing density on any PC board.



Dimensions in mm

l	Lead spacing e	dia. d
10	7.5	0.6
13	10	0.6
18	15	0.8
27	22.5	0.8

DIN climatic category in acc. with DIN 40040	**F M D / J R**	
Lower category temperature	**F**	− 55°C/− 67°F
Upper category temperature	**M**	+100°C/+212°F[1]
Humidity category	**D**	average relative humidity ≤80% 100% for 30 days per year continuously; 90% for the remaining days occasionally; rare, brief dew precipitation permitted
Failure rate (40°C/104°F, V_R)	**J**	30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R**	$\geq 10^5$ h
Failure criteria		
Total failure		Short or open circuit
Failure due to variations		Capacitance change $\frac{\Delta C}{C} > \pm 10\%$
		Dissipation factor tan δ > 2 × upper category values
		Insulation resistance < 150 MΩ (≤0.33 μF) < 50 s (>0.33 μF)

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[1] Shelf and service life at temperatures >100 ... 125°C/212 ... 257°F, 1000 h max., $V_C = 0.5\ V_R$.

Lead spacing		LS 7.5 mm		LS 10 mm		LS 15 mm	LS 22,5 mm
Rated dc voltage V_R		100 V	250 V	100 V	250 V	160 V	160 V
Rated capacitance		Dimensions $b \times h \times l$ (mm) and ordering code					
C_R	Tolerance	B 32550–		B 32551–		B 32552–	B 32553–
1000 pF	±20 %≙M ±10 %≙K ± 5 %≙J 1)		4 × 8.5 × 10 –B3102–+				
1500 pF			4 × 8.5 × 10 –B3152–+				
2200 pF			4 × 8.5 × 10 –B3222–+				
3300 pF			4 × 8.5 × 10 –B3332–+				
4700 pF			4 × 8.5 × 10 –B3472– +				
6800 pF			4 × 8.5 × 10 –B3682–+				
0.01 µF			4 × 8.5 × 10 –B3103–+		4 × 9 × 13 –B3103–+		
0.015 µF			4 × 8.5 × 10 –B3153–+		4 × 9 × 13 –B3153–+		
0.022 µF			4 × 8.5 × 10 –B3223–+		4 × 9 × 13 –B3223–+		
0.033 µF			4 × 8.5 × 10 –B3333–+		4 × 9 × 13 –B3333–+		
0.047 µF		4 × 8.5 × 10 –B1473–+	5 × 10.5 × 10 –B3473–+		4 × 9 × 13 –B3473–+		
0.068 µF		4 × 8.5 × 10 –B1683–+	5 × 10.5 × 10 –B3683–+	4 × 9 × 13 –B1683–+	5 × 11 × 13 2) –B3683–+		
0.1 µF		4 × 8.5 × 10 –B1104–+	6 × 12 × 10 –B3104–+	4 × 9 × 13 –B1104–+	5 × 11 × 13 2) –B3104–+		
0.15 µF		5 × 10.5 × 10 –B1154–+		5 × 11 × 13 2) –B1154–+		5.5 × 11 × 18 –B2154–+	
0.22 µF		6 × 12 × 10 –B1224–+		5 × 11 × 13 2) –B1224–+		7 × 13 × 18 –B2224–+	
0.33 µF						9 × 14.5 × 18 –B2334–+	
0.47 µF							7.3×16.5×27 –B2474–+
0.68 µF							8.5×18.5×27 –B2684–+
1.0 µF							8.5×18.5×27 –B2105–+

+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors with lead spacing 7.5 mm and 10 mm as well as capacitance tolerance ± 10% are preferred types (see page 4).

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1) Upon request.
2) In preparation. Capacitors, 5 mm × 11.5 mm × 13 mm in size, are available at present.

IEC climatic category in acc. with DIN IEC 68-1	**55/100/56**	
Damp heat test in acc. with DIN IEC 68-2-3	**Conditions**	
	Test temperature	+40°C/+104°F
	Relative humidity	$(93\,{}^{+2}_{-3})$ %
	Test duration	56 days
	Test criteria	
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 5\%$
	Dissipation factor change $\Delta \tan \delta$	$\leq 3 \times 10^{-3}$ at 1 kHz $\leq 5 \times 10^{-3}$ at 10 kHz
	Insulation resistance	$\geq 50\%$ of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10 to 55 Hz
	Displacement amplitude	0.75 mm (conforming to max. 98.1 m/s^2 or 10 *g*)
Resistance to soldering heat[1] Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 5 s
	Test criterion: Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 2\%$
Resistance to cleaning agents	Refer to section "General Information", page 37.	
Capacitance drift i_Z	±3%	

Self inductance	Lead spacing (mm)	7.5	10	15	22.5
	Self inductance (approx. nH)	8	9	10	20

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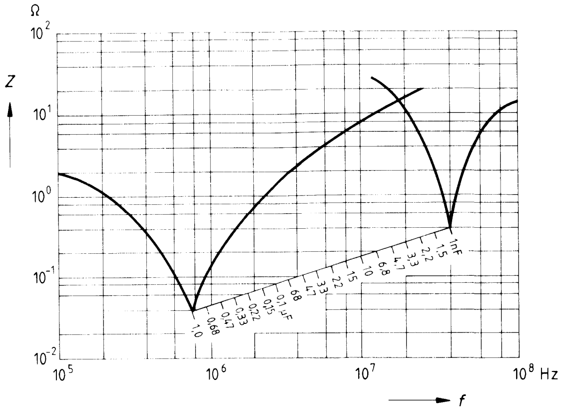
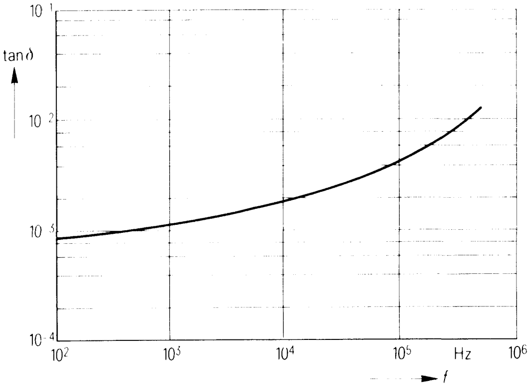
[1] For soldering recommendations also refer to "General Information", para. 6.2.

Impedance Z **versus frequency** f
(typical values)

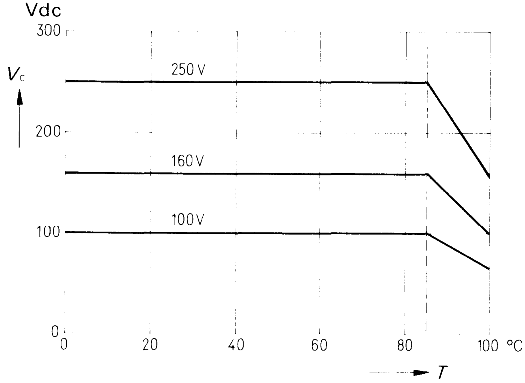


Dissipation factor tan δ **versus frequency** f



Typical values measured at 20°C/68°F	Upper limits/Average production values $C_R \leq 0.1$ µF	$C_R > 0.1$ µF
at 1 kHz	$3/1 \times 10^{-3}$	$5/3 \times 10^{-3}$
10 kHz	$5/2 \times 10^{-3}$	$8/5 \times 10^{-3}$
100 kHz	$10/5 \times 10^{-3}$	–

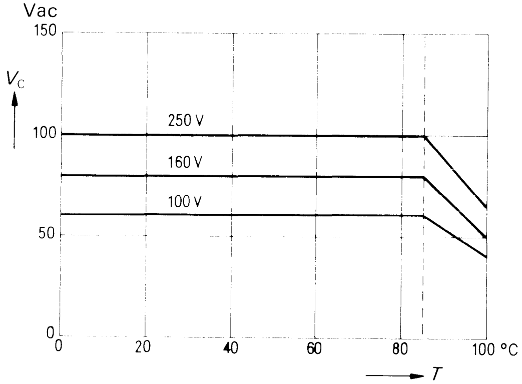
Category voltage V_C versus temperature T
at dc operation



max. 2,000 hours 1.25 × V_C

for milliseconds 1.50 × V_C
(e.g. switchings)

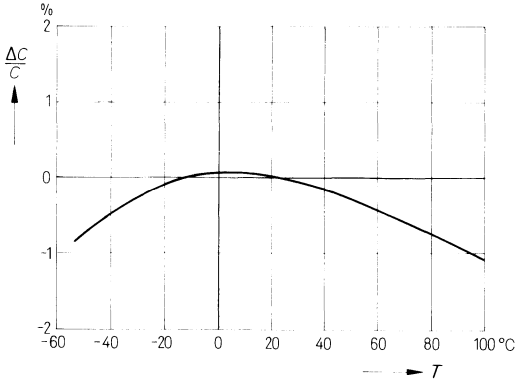
Category voltage V_C[1]) versus temperature T
at ac operation, 50 Hz



max. 2000 hours 1.25 × V_C

for milliseconds 1.50 × V_C
(e.g. switchings)

Capacitance change $\frac{\Delta C}{C}$ versus temperature T
(typical values, measured at 1 kHz)



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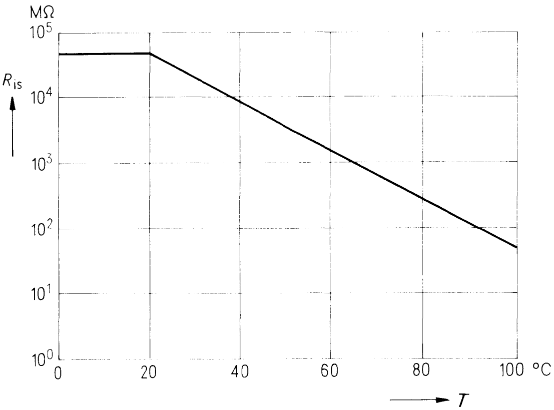
[1]) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

Insulation resistance R_{is} versus temperature T



Typical values
measured at 20°C/68°F and a relative humidity ≤65%

Insulation resistance R_{is} and time constant τ

Minimum value as supplied[1])

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
100 V	15 000 MΩ	5 000 s
>100 V	30 000 MΩ	10 000 s

Average value as supplied

V_R	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF
100 V	>75 000 MΩ	>25 000 s
>100 V	>75 000 MΩ	>25 000 s

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		LS 7.5	LS 10	LS 15	LS 22.5
100 V	V_{pp}/τ in V/µs k_0 in V²/µs	50 10 000	35 7 500	–	–
160 V	V_{pp}/τ in V/µs k_0 in V²/µs	–	–	5 1 600	3 960
250 V	V_{pp}/τ in V/µs k_0 in V²/µs	100 50 000	75 35 000	–	–

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

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[1]) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 100% of the humidity category D is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram.

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature.

The following limits may not be exceeded:

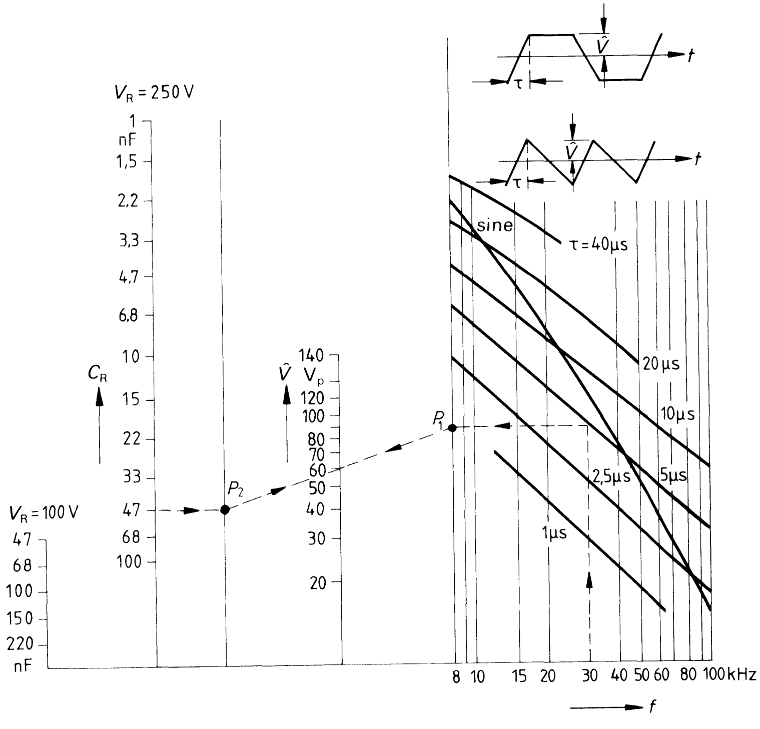
Rated dc voltage V_R	100 V	160 V	250 V
Limit voltage $\hat{V}_l$	85 V	110 V	140 V

B 32550, LS 7.5 mm
B 32551, LS 10 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 30 kHz (repetition frequency)
τ = 5 μs (rise time)
C_R = 47 nF (capacitance)

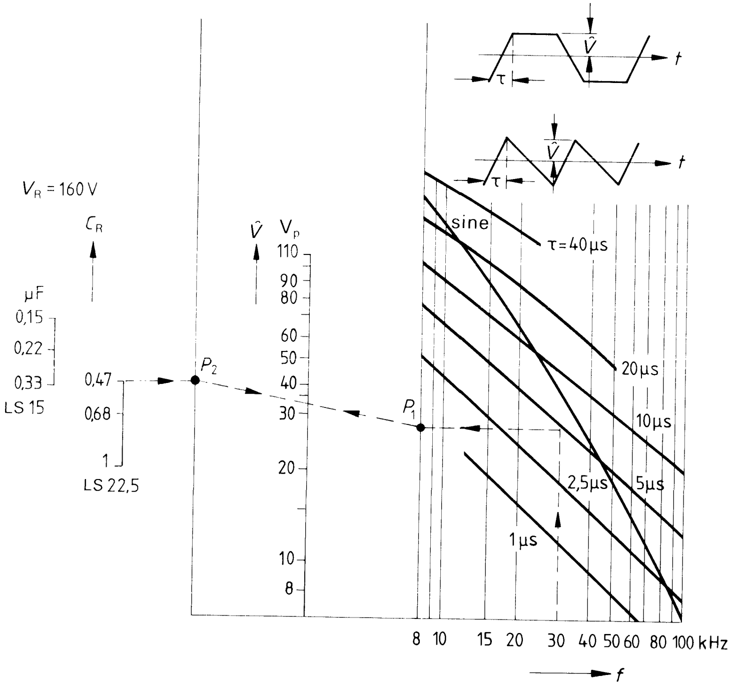
According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 60 V.

B 32552, LS 15 mm
B 32553, LS 22.5 mm

Nomogram to determine the permissible peak voltage $\hat{V}$

Determine the intersections P_1 and P_2 according to the plotted example. The intersection of the line connecting P_1 with P_2 and the $\hat{V}$ scale gives the maximum permissible peak voltage.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be considered. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 30 kHz (repetition frequency) } intersection P_1
τ = 5 μs (rise time)
C_R = 0.47 μF (capacitance) } intersection P_2
V_R = 160 V (rated voltage)
LS 22.5 mm

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 33 V.

MKP Capacitors
Metalized Polypropylene Film Capacitors

MKP Capacitors

B 32650
B 32655
B 32656

Metalized polypropylene film capacitors

Self-healing wound capacitors with face-end contacts and polypropylene dielectric. Encapsulated in a flame-retardant rectangular plastic case. Epoxy resin sealed for humidity resistance. For improved solderability in the solder bath, the capacitors are provided with spacers. Connections: parallel leads, plug-in.

B 32650

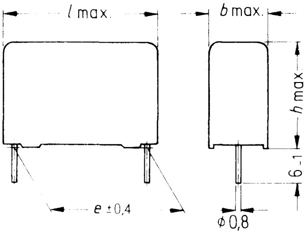
Capacitors of this type series are particularly pulse-proof and therefore suited for use in deflection and high voltage stages of TV sets; e.g. as reservoir and S-correction capacitor (250 V, 400 V series), as commutation capacitor in thyristor deflection circuits (1000 V series) and as line flyback capacitor (1500 V series).

B 32655

These capacitor are suited for use at line ac voltage load with V_R = 250 Vac (up to 1 kHz) and in pulse circuits.

B 32656

Capacitors, high rel version, with V_R = 400 Vac (to 2 kHz) are suited for use at line ac voltage load and in pulse circuits.



l	*e*
18	15
27	22.5
31.5	27.5

Dimensions in mm

	B 32650, B 32655		**B 32656**
IEC climatic category in acc. with DIN IEC 68-1	40/085/56		55/085/56
Damp heat test in acc. with DIN IEC 68-2-3	**Conditions**		
	Test temperature	+40°C/104°F	+40°C/104°F
	Relative humidity	(93^{+2}_{-3}) %	(93^{+2}_{-3}) %
	Test duration	56 days	56 days
	Test criteria		
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 3\%$	$\leq \pm 1\%$
	Dissipation factor change $\Delta \tan \delta$		
	at 1 kHz	$\leq 0.5 \times 10^{-3}$	$\leq 3 \times 10^{-3}$
	at 10 kHz	$\leq 1 \times 10^{-3}$	$\leq 5 \times 10^{-3}$
	Insulation resistance	≥50% of the minimum value as supplied	

MKP Capacitors

Rated dc voltage V_R AC voltage $V_{ac\ pp}$		250 V 300 V	400 V 500 V	1000 V 700 V	1200 V 1200 V	1500 V 1500 V
Rated capacitance C_R		Dimensions $b \times h \times l$ (mm) and ordering code B 32 650–				
1500 pF	± 5 % ≙ J ± 10 % ≙ K					7.3×16.5×27 –K1152–+
2200 pF						7.3×16.5×27 –K1222–+
3300 pF						7.3×16.5×27 –K1332–+
4700 pF						7.3×16.5×27 –K1472–+
6800 pF						8.5×18.5×27 –K1682–+
0.01 µF						10.5×19×27 –K1103–+
0.015 µF						11×20.5×27 –K1153–+
0.022 µF				7×13×18 –K223–+	7.3×16.5×27 –K2223–+	11.5×21×31.5 –K1223–+
0.033 µF				9×14.5×18 –K333–+	8.5×18.5×27 –K2333–+	13.5×23×31.5 –K1333–+
0.047 µF				7.3×16.5×27 –K473–+	10.5×19×27 –K2473–+	
0.068 µF				8.5×18.5×27 –K683–+	11.5×21×31.5 –K2683–+	
0.1 µF			5.5×11×18 –K4104–+	10.5×19×27 –K104–+	13.5×23×31.5 –K2104–+	
0.15 µF			7×13×18 –K4154–+	11×20.5×27 –K154–+	15×24.5×31.5 –K2154–+	
0.22 µF			9×14.5×18 –K4224–+	13.5×23×31.5 –K224–+		
0.33 µF		9×14.5×18 –K3334–+	7.3×16.5×27 –K4334–+	15×24.5×31.5 –K334–+		
0.47 µF		7.3×16.5×27 –K3474–+	8.5×18.5×27 –K4474–+			
0.68 µF		8.5×18.5×27 –K3684–+	10.5×19×27 –K4684–+			
1.0 µF		10.5×19×27 –K3105–+	11.5×21×31.5 –K4105–+			
1.5 µF		11.5×21×31.5 –K3155–+	13.5×23×31.5 –K4155–+			
2.2 µF		13.5×23×31.5 –K3225–+	15×24.5×31.5 –K4225–+			
3.3 µF		18×27.5×31.5 –K3335–+				
4.7 µF		18×27.5×31.5 –K3475–+				

+ Insert appropriate code letter for requested capacitance tolerance (refer to table).

S All capacitors of type B 32650 with capacitance tolerance ± 5% and of type B 32655 with capacitance tolerance ± 10% are preferred types (refer to page 4).

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[1] Rated ac voltage V_R up to 1 kHz.
[2] Rated ac voltage V_R up to 2 kHz.

Rated ac voltage V_R 250 V1) Perm. dc voltage 630 V	400 V2) 1000 V	
Dimensions $b \times h \times l$ (mm) and ordering code B 32655	B 32656	Rated capacitance C_R
		1500 pF
	7.3 × 16.5 × 27 B 32656–K8222–+	2200 pF
	7.3 × 16.5 × 27 B 32656–K8332–+	3300 pF
	7.3 × 16.5 × 27 B 32656–K8472–+	4700 pF
	7.3 × 16.5 × 27 B 32656–K8682–+	6800 pF
	7.3 × 16.5 × 27 B 32656–K8103–+	0.01 μF
	8.5 × 18.5 × 27 B 32656–K8153–+	0.015 μF
	10.5 × 19 × 27 B 32656–K8223–+	0.022 μF
	11 × 20.5 × 27 B 32656–K8333–+	0.033 μF
5.5 × 11 × 18 B 32655–K6473–+	11.5 × 21 × 31.5 B 32656–K8473–+	0.047 μF
7 × 13 × 18 B 32655–K6683–+	13.5 × 23 × 31.5 B 32656–K8683–+	0.068 μF
9 × 14.5 × 18 B 32655–K6104–+	15 × 24.5 × 31.5 B 32656–K8104–+	0.1 μF
9 × 14.5 × 18 B 32655–K6154–+		0.15 μF
8.5 × 18.5 × 27 B 32655–K6224–+		0.22 μF
10.5 × 19 × 27 B 32655–K6334–+		0.33 μF
11 × 20.5 × 27 B 32655–K6474–+		0.47 μF
11.5 × 21 × 31.5 B 32655–K6684–+		0.68 μF
13.5 × 23 × 31.5 B 32655–K6105–+		1.0 μF

DIN climatic category in acc. with DIN 40 040		
B 32 650, B 32 655	**G P E**	
Lower category temperature	**G**	−40°C/−104°F
Upper category temperature	**P**	+85°C/+185°F
Humidity category	**E**	average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally; rare, brief dew precipitation permitted
B 32 656	**F P D / J S**	
Lower category temperature	**F**	−55°C/−67°C
Upper category temperature	**P**	+85°C/+185°F
Humidity category	**D**	average relative humidity ≤80%; 100% for 30 days per year continuously; 90% for the remaining days occasionally;
Failure rate (40°C/104°F; V_R)	**J**	30×10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**S**	$\geq 3 \times 10^4$ h
Reference load		23°C/73.4°F, ≤75% rel. humidity 400 V_{rms}, 10 kHz/for higher load, data upon request
Failure criteria		
Total failure	Short or open circuit	
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$ >±10%	
	Dissipation factor tan δ	> 4 × upper category values
	Insulation resistance	≤ 1500 MΩ
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10 to 55 Hz
	Displacement amplitude	0.75 mm (conforming to max. 98.1 m/s² or 10 *g*)
Resistance to soldering heat[1]) Test Tb in acc. with DIN IEC 68-2-20	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 10 s
	Capacitance change $\frac{\Delta C}{C}$	≤±2%
Capacitance drift i_z	±2%	

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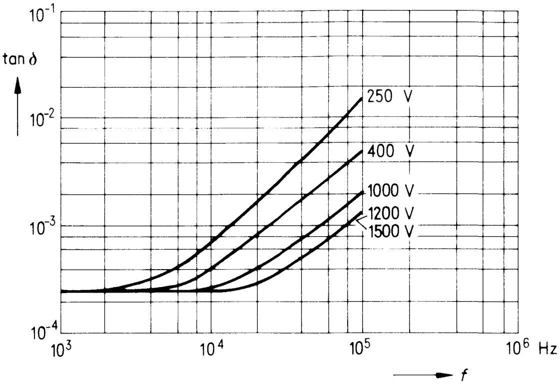
[1]) For soldering recommendations also refer to "General Information", para. 6.2.

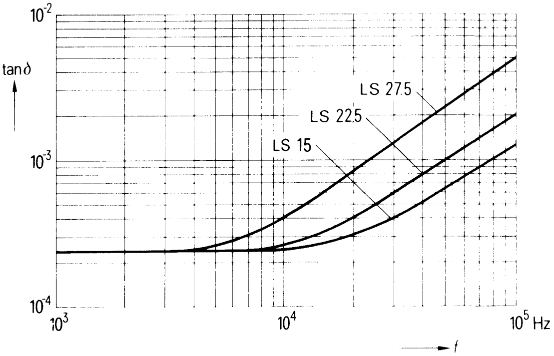
Dissipation factor tan δ versus frequency *f*
(typical values)

B 32650



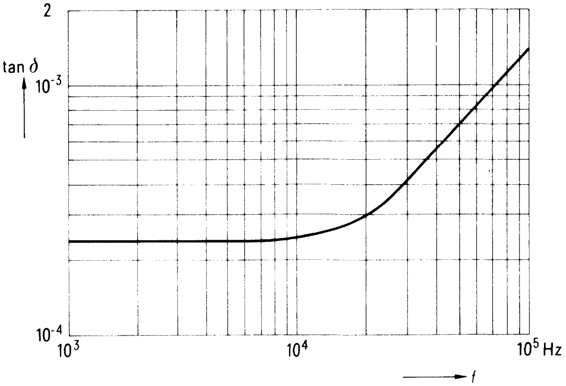
Parameter: Voltage series
Max. lead spacing

B 32655



Parameter: Lead spacing

B 32656



Dissipation factor tan δ
measured at 20°C/68°F

B 32650

	Upper limits		Average production values	
	$C \leq 1$ µF	$C > 1$ µF	$C \leq 1$ µF	$C > 1$ µF
at 1 kHz	0.5×10^{-3}	0.5×10^{-3}	0.25×10^{-3}	0.25×10^{-3}
at 10 kHz	0.8×10^{-3}	1.5×10^{-3}	0.4×10^{-3}	1.0×10^{-3}

B 32655

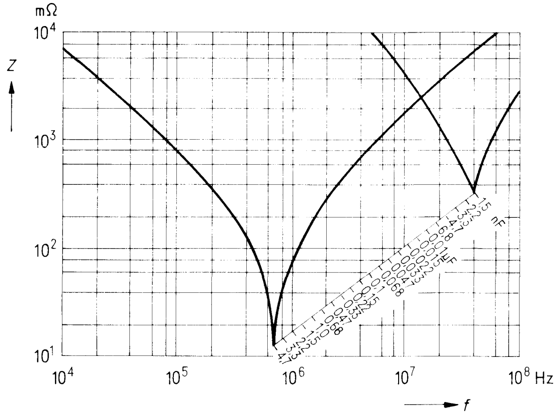
	Upper limits	Average production values
at 1 kHz	0.5×10^{-3}	0.25×10^{-3}
at 10 kHz	1.0×10^{-3}	0.4×10^{-3}

B 32656

	Upper limits
at 1 kHz	0.5×10^{-3}
at 10 kHz	0.5×10^{-3}
at 100 kHz	2.0×10^{-3} (LS 22.5) or 3.0×10^{-3} (LS 27.5)

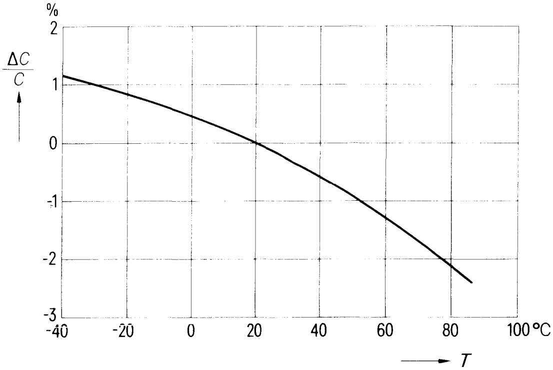
Self inductance approx. 20 nH

Impedance *Z* **versus frequency** *f*
(typical values)

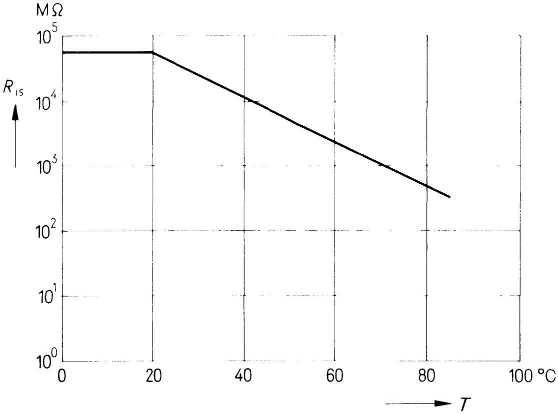


Voltage load		B 32650	B 32655	B 32 656
Test voltage	V_t	$1.5 \times V_R$, 2 s	1200 Vdc, 2 s	2500 Vdc, 2 s
Perm. switching peaks	V_p	–	≤1000 V (occasionally)	–
Category voltage	V_c	$1.0 \times V_R$	250 Vac, 630 Vdc	400 Vac, 1000 Vdc

Capacitance change $\frac{\Delta C}{C}$
versus temperature T
measured at 1 kHz
(typical values)



Insulation resistance R_{is}
versus temperature T



Insulation resistance R_{is}
and time constant τ

Minimum value as supplied1)	
for $C \leq 0.33$ µF	30 000 MΩ
for $C > 0.33$ µF	10 000 s
Average value as supplied	
for $C \leq 0.33$ µF	>75 000 MΩ
for $C > 0.33$ µF	>25 000 s

Inherent heating

Power loss at 10°C/50°F excess temperature of the case (typical values)	90 mW (capacitor length 18 mm) 160 mW (capacitor length 27 mm) 260 mW (capacitor length 31.5 mm)

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1) The indicated values apply at the time of delivery. During the service life, the insulation may temporarily decrease to approx. 10% of the value at the time of delivery, especially if the max. permissible relative humidity of 95% of the humidity category E or 100% of the humidity category D is applied for a longer period, or if the capacitor is operated close to the upper category temperature.

Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_0). Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated voltage V_R	$V_{pp\ perm.}$		Pulse handling capability		
			Capacitor length		
			18 mm	27 mm	31.5 mm
B 32650					
250 Vdc	300 V_{pp}1)	V_{SS}/τ k_0	50 V/µs 0.3 · 10^5 V^2/µs	25 V/µs 0.15 · 10^5 V/µs	20 V/µs 0.12 · 10^5/µs
400 Vdc	500 V_{pp}2)	V_{SS}/τ k_0	50 V/µs 0.5 · 10^5 V^2/µs	30 V/µs 0.3 · 10^5 V^2/µs	20 V/µs 0.2 · $10^5$$V^2$/µs
1000 Vdc	700 V_{pp}	V_{SS}/τ k_0	215 V/µs 3 · 10^5 V^2/µs	115 V/µs 1.6 · 10^5 V^2/µs	90 V/µs 1.25 · $10^5$$V^2$/µs
1200 Vdc	1200 V_{pp}	V_{SS}/τ k_0	– –	250 V/µs 6 · 10^5 V^2/µs	165 V/µs 4 · $10^5$$V^2$/µs
1500 Vdc	1500 V_{pp}	V_{SS}/τ k_0	– –	430 V/µs 13 · 10^5 V^2/µs	330 V/µs 10 · $10^5$$V^2$/µs
B 32655					
250 Vac	700 V_{pp}	V_{SS}/τ k_0	70 V/µs 1 · 10^5 V^2/µs	43 V/µs 0.6 · 10^5 V^2/µs	36 V/µs 0.5 · $10^5$$V^2$/µs
B 32656					
400 Vac	1130 V_{pp}	V_{SS}/τ k_0	– –	350 V/µs 8 · 10^5 V^2/µs	175 V/µs 4 · $10^5$$V^2$/µs

For a voltage deviation of V_{pp} less than V_R the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. See also calculation example in section "General Information", para. 5.2.6.

AC power handling capability at higher frequencies

Values upon request; a voltage/time diagram as well as indication of ambient temperature and other operational conditions are requested. Refer also to para. 5.2.5 "Inherent temperature rise, permissible efficiency", page 33.

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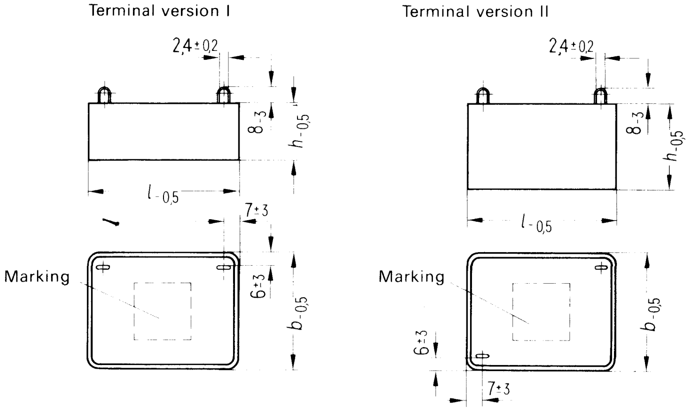
1) With unipolar pulse load $V_{pp\ perm.} = 250\ V_{pp}$
2) With unipolar pulse load $V_{pp\ perm.} = 400\ V_{pp}$

Metalized polypropylene film capacitors

Self-healing capacitor with polypropylene dielectric. Encapsulated in a rectangular, epoxy-resin sealed plastic case which is flame-retardant. Tinned wire tags.



Dimensions in mm

Terminal version		I	II	II: 4 ... 15 kV I: 20 ... 40 kV	II
Rated dc voltage V_R	Perm. ac voltage $V_{ac\,pp}$	Dimensions $l \times b \times h$ (mm) 60×60×30	60×60×45	105×60×45	143×73×43
kV	kV	Rated capacitance C_R[1] Ordering code B32662–	B32662–	B32662–	B32662–
4	2.8	0.22 µF –A1224–+	0.33 µF –A1334–+	0.60 µF –A1604–+	1.2 µF –A1125–+
6	4.2	0.08 µF –A2803–+	0.15 µF –A2154–+	0.25 µF –A2254–+	0.44 µF –A2444–+
10	5.6	0.03 µF –A3303–+	0.06 µF –A3603–+	0.12 µF –A3124–+	0.22 µF –A3224–+
15	8.4	0.01 µF –A4103–+	0.02 µF –A4203–+	0.04 µF –A4403–+	0.09 µF –A4903–+
20	12.6	7500 pF –A5752–+	0.01 µF –A5103–+	0.02 µF –A5203–+	0.04 µF –A5403–+
30	21.0	3300 pF –B6332–+	5700 pF –A6572–+	0.01 µF –A6103–+	0.018 µF –A6183–+
40	21.0	– –	3900 pF –A7392–+	7000 pF –A7702–+	0.012 µF –A7123–+

\+ Insert appropriate code letter for requested capacitance tolerance: J = ± 5%; K = ± 10%; closer tolerances upon request.

[1] Intermediate values upon request.

DIN climatic category		
in acc. with DIN 40040		**G S F**
Lower category temperature		**G** –40°C/–40°F
Upper category temperature		**S** +70°C/158°F
Humidity category		**F** average relative humidity ≤75%; 95% for 30 days per year continuously; 85% for the remaining days occasionally
Electrical characteristics		
Rated capacitance	C_R	0.002 μF to 1.2 μF
Tolerance		±5%, ±10%
Rated voltage	V_R	4 kV to 40 kV
Perm. ac voltage	V_{ac}	2.8 kV to 21 kV (peak-to-peak) 1 kV to 7.4 kV (rms) at sinusoidal load The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage V_R.
Test voltage	V_t	1.2 V_R/2 min
Max. surge current	i_{max} [A]	= (C [μF] × k_O [V²/μs]) / 2 × V [V]
Dissipation factor (10 kHz)		$\leq 1 \times 10^{-3}$
Insulation resistance		≥75 GΩ (500 V/1 min)

Pulse characteristics k_O

Rated voltage V_R kV dc	Perm. ac voltage $V_{ac\,pp}$ kV	Pulse characteristics k_O V²/μs
4	2.8	1.3×10^6
6	4.2	2.2×10^6
10	5.6	5.1×10^6
15	8.4	13×10^6
20	12.6	29×10^6
30	21.0	56×10^6
40	21.0	80×10^6

Note: Due to the recharging effect, high-voltage capacitors are to be short-circuited before forwarding and storing.
It has to be ensured that the max. permissible surge current i_{max} will not be exceeded at the charging and discharging process.

MKY Capacitors
Metalized Polypropylene Film Capacitors

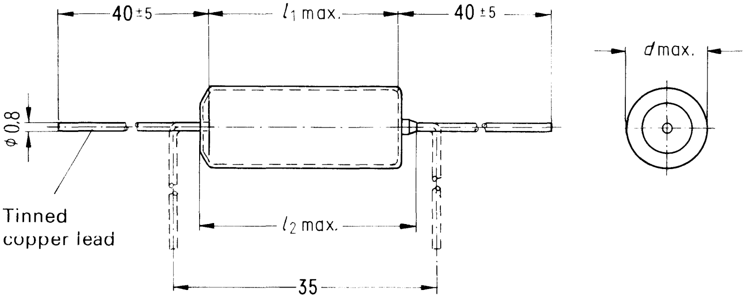
Metalized polypropylene film capacitors – high rel version

Self-healing capacitors with polypropylene dielectric.

Version according to figure 1: Hermetically sealed in small tubular can (cartridge), with insulating sleeve. Leads insulated at one end in low-loss ceramic lead-through, and centrally soldered in cartridge bottom at the other.

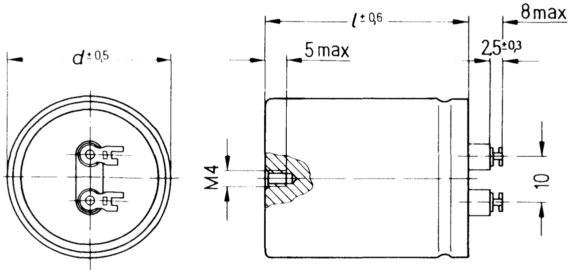
Version according to figure 2: Hermetically sealed in tubular metal can with an inside thread in the case bottom. Closed by a metal cover with low-loss ceramic lead-throughs. Solder tags.

Version according to Fig. 1



Minimum lead bend: 2 mm from face ends.

Version according to Fig. 2



Dimensions in mm

Rated dc voltage		250 V		Figure
Rated capacitance[1]) µF	Tolerance	$d_{max} \times l_{2\ max}$	$d \times l$	
0.10 to 0.15	±5%≙J ±2%≙G ±1%≙F	11.2 × 28		1
>0.15 to 0.30		15.0 × 28		
>0.30 to 0.50		18.2 × 28		
>0.50 to 1.0			25 × 29	2
>1.0 to 1.9			32 × 29	
>1.9 to 3.6			32 × 38	
>3.6 to 6.0			32 × 50	
>6.0 to 10			40 × 50	

Ordering code example B 32355-K2105-G

Type — B 32355

Revision status (here only K) — K

Rated voltage (2 ≙ 250 Vdc) — 2

Rated capacitance (105 ≙ 10 × 10^5 pF = 1 µF) — 105

Capacitance tolerance (G≙±2%) — G

DIN climatic category in acc. with DIN 40040	**F P C / J R**	
Lower category temperature	**F**	−55°C/− 67°F
Upper category temperature	**P**	+85°C/+185°F
Humidity category	**C**	average relative humidity ≤95% Max. value 100%, including dew precipitation
Failure rate (40°C/104°F, V_R)	**J**	30 × 10^{-9}/h = 30 fit for conversion tables for other stresses and temperatures see page 42.
Load duration	**R**	≥10^5 h

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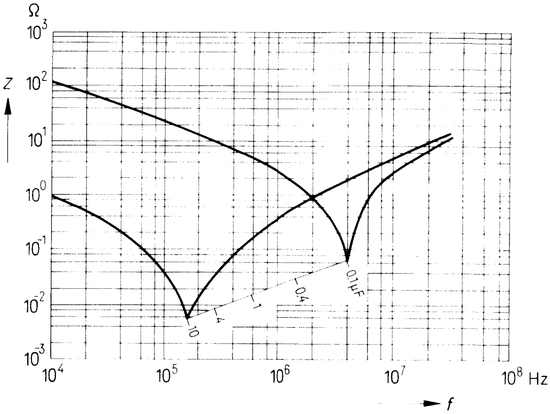
[1]) Series available are: E24, E48, and E96

Failure criteria		
Total failure	Short or open circuit	
Failure due to variations	Capacitance change $\frac{\Delta C}{C}$	$> \pm 3\%$
	Dissipation factor tan δ	$> 2 \times$ upper category values
	Insulation resistance $R_{is} \times C$	< 2500 s
IEC climatic category in acc. with DIN IEC 68-1	**55/085/56**	
	Conditions	
	Test temperature	+40°C/+104°F
Damp heat test in acc. with DIN IEC 68-2-3	Relative humidity	$(93 {}^{+2}_{-3})$ %
	Test duration	56 days
	Test criteria	
	Capacitance change $\frac{\Delta C}{C}$	$\leq \pm 1\%$
	Dissipation factor change Δ tan δ	$\leq 3 \times 10^{-3}$ at 1 kHz $\leq 5 \times 10^{-3}$ at 10 kHz
	Insulation resistance	$\geq 50\%$ of the minimum value as supplied
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6: vibration, sinusoidal	Duration of endurance conditioning	6 h
	Frequency range	10 to 55 Hz
	Displacement amplitude	0.75 mm (conforming to max. 10 *g*)
	Capacitors with a diameter >15 mm must be fixed by clamps for this test	
Capacitance drift i_Z	$\pm 1\%$	

	Upper limits		
Dissipation factor tan δ [1] measured at 20°C/68°F	for $C \leq 1$ µF	$C \leq 3.6$ µF	$C > 3.6$ µF
at 1 kHz	0.5×10^{-3}	0.5×10^{-3}	1×10^{-3}
at 10 kHz	1×10^{-3}	–	–

---

[1] See also diagrams.

Solder conditions		
for cartridge types	Solder bath temperature	max. 260°C/500°F
	Soldering duration	max. 10 s
	Distance to the capacitor	min. 6 mm
for case types	Temperature of the soldering iron	max. 300°C/572°F
	Soldering duration	max. 5 s
Self inductance		
for cartridge types	approx. 20 nH	(for 3 mm lead length
for case types	approx. 30 to 35 nH	at both ends)
Impedance Z versus frequency f		
Category voltage V_c	1.00 × V_R	
at dc operation		
2,000 hours	1.25 × V_R up to +85°C/185°F	
for milliseconds¹)	1.50 × V_R	
Category voltage V_c		
at ac operation²)	100 Vac 50 Hz up to +85°C/185°F	
for milliseconds	1.25 × V_c	

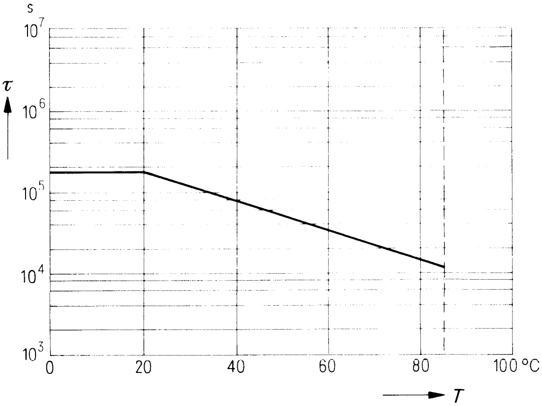
---

¹) Permissible for inevitable exceptions only, not for periodic switchings.

²) The sum of the dc voltage and the peak value of an ac voltage superimposed on the dc voltage may not exceed the rated voltage.

Temperature coefficient *TC* of the capacitance	−230 ±40 × 10^{-6}/K

Time constant τ **versus temperature** T



Insulation resistance R_{is} **and time constant** τ

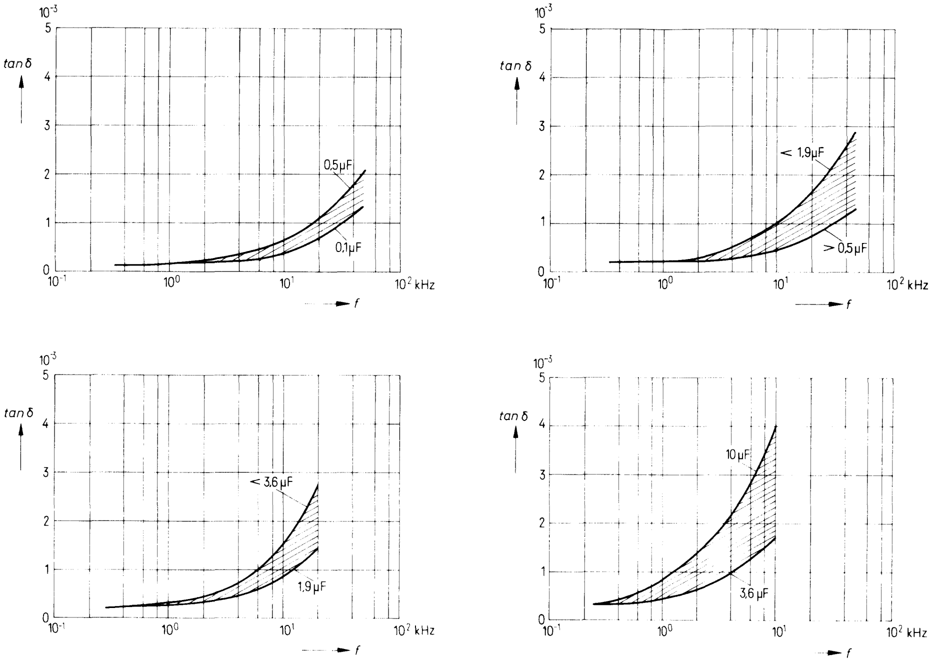
Minimum value as supplied[1]	
for $C \leq 1$ µF	100000 MΩ
for $C > 1$ µF	100000 s
Average value as supplied	>250000 s

---

[1] The indicated values apply at the time of delivery. During the service life, the insulation may decrease to approx. 10% of the value at the time of delivery, e.g. if the capacitor is operated close to the upper category temperature.

Dissipation factor tan δ versus frequency f

Typical values, measured at 20°C/68°F



Pulse handling capability (voltage rate of rise V_{pp}/τ and pulse characteristic k_O).
Maximum permissible voltage change per time unit for non-sinusoidal voltages (pulse, sawtooth).

Rated dc voltage V_R		Capacitor length 29 mm	 38 mm	 50 mm
250 V	V_{pp}/τ k_O	30 V/µs 15 000 V²/µs	16 V/µs 8 000 V²/µs	10 V/µs 5 000 V²/µs

For a voltage deviation of $V_{pp} < V_R$ the value of the permissible voltage rate of rise V_{pp}/τ can be multiplied by the factor V_R/V_{pp}. The data of the nomogram must be considered in case of periodic pulses. See also calculation example in section "General Information", para. 5.2.6.

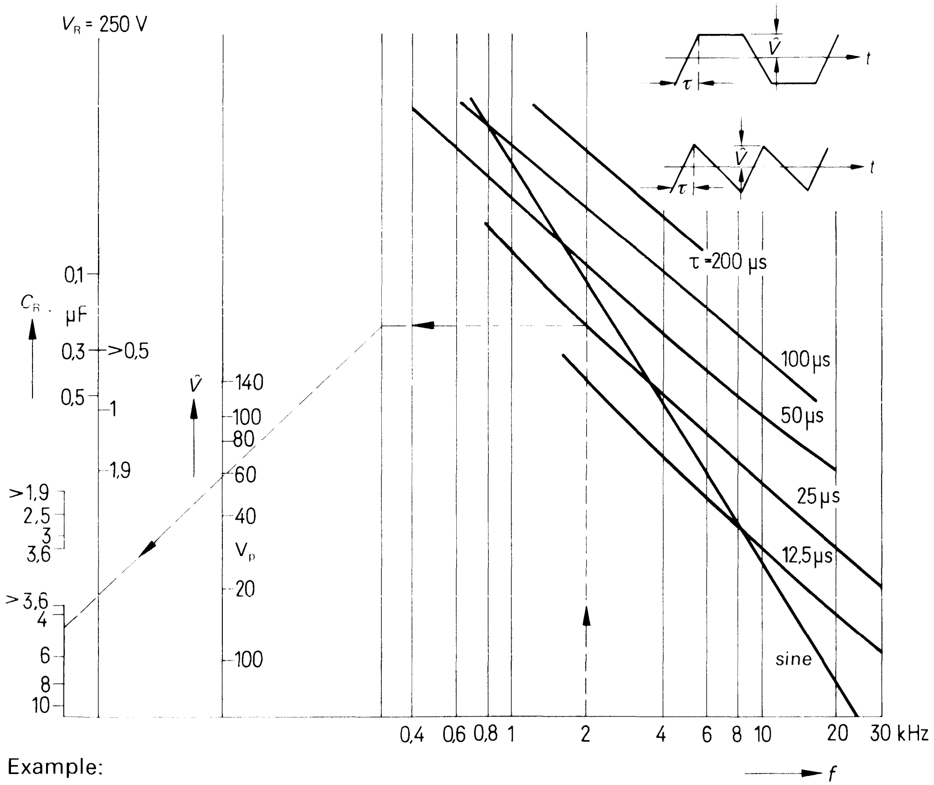
AC power handling capability at higher frequencies

The maximum permissible peak voltage $\hat{V}$ for sinusoidal and non-sinusoidal voltages (pulse, sawtooth, trapezoidal voltages) can be determined from the nomogram, where the following limit value $\hat{V}_l$ may not be exceeded.

Rated voltage V_R	250 V
Limit voltage $\hat{V}_l$	140 V

The nomogram is based on 10°C/50°F inherent temperature rise of the capacitor; this must be considered during operation with regard to the permissible upper category temperature.

In case of a trapezoidal voltage load with two steep edges, the second harmonic frequency must be taken into account. With sinusoidal voltage load, the "sine" characteristic applies.



Example:

f = 2 kHz (repetition frequency)
τ = 25 µs (rise time)
C = 4.3 µF (capacitance)

According to the dashed line in the above graph, this results in a max. peak voltage $\hat{V}$ of approx. 60 V.

Qualified Types
in accordance with ESA, GfW, and
VG Specifications

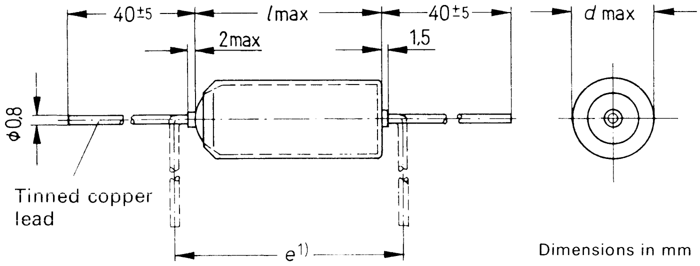
Metalized lacquer film capacitors
Type MKU 04 with quality assessment in accordance with VG 95 296, part 4

Version: Self-healing capacitor with metalized cellulose acetate film dielectric.

Hermetically enclosed in tubular, non-magnetic metal can (cartridge) with insulating sleeve. Leads: Insulated lead-in wire at one end and centrally soldered in cartridge at the other.

MKU capacitors B 95 017 comply with the Siemens MKL types B 32 120, high rel version.

Qualified in accordance with: VG 95 296, part 4 (military type specification for plastic film capacitors, type MKU 04). The capacitors have the electronic test symbol.



Dimensions in mm

l	17.5	21.5	25.5	35.5
e[1]	25	30	35	45

d_1	≤8.2	≥11.2
dia. d_2	0.6	0.8

---

[1] Minimum distance between lead bend and capacitor body: 2 mm.

Type MKU 04 with quality assessment according to VG 95 296, part 4

Rated dc voltage		63 V	100 V	160 V	250 V
Rated capacitance μF	Tolerance	Dimensions d_1 × l (mm) and ordering code			
0.1	± 20 %		6.2 × 17.5 B95017-L202-D	8.2 × 17.5 B95017-L302-D	8.2 × 21.5 B95017-L402-D
0.15	± 20 %	6.2 × 17.5 B95017-L104-D	6.9 × 17.5 B95017-L204-D	8.2 × 17.5 B95017-L304-D	11.2 × 21.5 B95017-L404-D
0.22	± 20 %	6.2 × 17.5 B95017-L106-D	6.9 × 17.5 B95017-L206-D	8.2 × 21.5 B95017-L306-D	11.2 × 21.5 B95017-L406-D
0.33	± 20 %	6.9 × 17.5 B95017-L108-D	8.2 × 17.5 B95017-L208-D	8.2 × 21.5 B95017-L308-D	11.2 × 21.5 B95017-L408-D
0.47	± 20 %	8.2 × 17.5 B95017-L110-D	8.2 × 21.5 B95017-L210-D	11.2 × 21.5 B95017-L310-D	11.2 × 21.5 B95017-L410-D
0,68	± 20 %	8.2 × 17.5 B95017-L112-D	8.2 × 21.5 B95017-L212-D	11.2 × 25.5 B95017-L312-D	11.2 × 25.5 B95017-L412-D
1	± 10 %	8.2 × 21.5 B95017-L113-D	11.2 × 21.5 B95017-L213-D	11.2 × 25.5 B95017-L313-D	15 × 25.5 B95017-L413-D
1	± 20 %	8.2 × 21.5 B95017-L114-D	11.2 × 21.5 B95017-L214-D	11.2 × 25.5 B95017-L314-D	15 × 25.5 B95017-L414-D
1.5	± 10 %	8.2 × 21.5 B95017-L115-D	11.2 × 25.5 B95017-L215-D	15 × 25.5 B95017-L315-D	15 × 25.5 B95017-L415-D
1.5	± 20 %	8.2 × 21.5 B95017-L116-D	11.2 × 25.5 B95017-L216-D	15 × 25.5 B95017-L316-D	15 × 25.5 B95017-L416-D
2.2	± 10 %	11.2 × 21.5 B95017-L117-D	11.2 × 25.5 B95017-L217-D	11.2 × 35.5 B95017-L317-D	15 × 35.5 B95017-L417-D
2.2	± 20 %	11.2 × 21.5 B95017-L118-D	11.2 × 25.5 B95017-L218-D	11.2 × 35.5 B95017-L318-D	15 × 35.5 B95017-L418-D
3.3	± 10 %	11.2 × 25.5 B95017-L119-D	11.2 × 35.5 B95017-L219-D	15 × 35.5 B95017-L319-D	16.5 × 35.5 B95017-L419-D
3.3	± 20 %	11.2 × 25.5 B95017-L120-D	11.2 × 35.5 B95017-L220-D	15 × 35.5 B95017-L320-D	16.5 × 35.5 B95017-L420-D
4.7	± 10 %	11.2 × 25.5 B95017-L121-D	11.2 × 35.5 B95017-L221-D	16.5 × 35.5 B95017-L321-D	21 × 35.5 B95017-L421-D
4.7	± 20 %	11.2 × 25.5 B95017-L122-D	11.2 × 35.5 B95017-L222-D	16.5 × 35.5 B95017-L322-D	21 × 35.5 B95017-L422-D
6.8	± 10 %	11.2 × 35.5 B95017-L123-D	15 × 35.5 B95017-L223-D	18.2 × 35.5 B95017-L323-D	21 × 35.5 B95017-L423-D
6.8	± 20 %	11.2 × 35.5 B95017-L124-D	15 × 35.5 B95017-L224-D	18.2 × 35.5 B95017-L324-D	21 × 35.5 B95017-L424-D
10	± 10 %	15 × 35.5 B95017-L125-D	16.5 × 35.5 B95017-L225-D	21 × 35.5 B95017-L325-D	25.8 × 35.5 B95017-L425-D
10	± 20 %	15 × 35.5 B95017-L126-D	16.5 × 35.5 B95017-L226-D	21 × 35.5 B95017-L326-D	25.8 × 35.5 B95017-L426-D

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1) The counting numbers comply with those of the military specification VG 95 296, part 4.

Metalized lacquer film capacitors with quality assessment in accordance with ESA (European Space Agency) and GfW (German Space Agency) specifications.

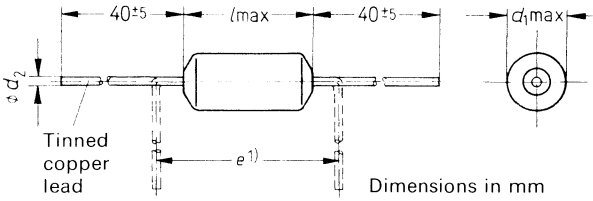
Version: Self-healing tubular capacitor winding with cellulose acetate dielectric. Enclosed in metal tube with insulating sleeve, epoxy resin sealed face ends. Central axial leads.

MKU capacitors B 95 020 comply with the Siemens MKL types B 32 110/B 32 111 (25 to 250 V dc) or B 32 112 (630 V dc, high rel versions.

Qualified in accordance with:

25...250 Vdc: SCC 3006 and SCC 3006/009; GfW specifications CF 100 and CF 101
630 Vdc: SCC 3006 and SCC 3006/012; GfW specifications CF 100 and CF 104.

The capacitors have the electronic test symbol.



Dimensions in mm

l	18.5	21	25	34	46
e 1)	22.5	25	30	40	52.5

d_1	≤7.4	8.4 to 23.7	25.9
dia. d_2	0.6	0.8	1.0

Rated dc voltage		25 V	63 V	100 V	160 V	250 V	630 V
Rated capacitance µF	Tolerance %	Dimensions $d \times l$ (mm) and ordering code					
		B95020–	B95020–	B95020–	B95020–	B95020–	B95020–
0.033	±20	–	–	–	–	–	8.4×18.5 -K*608-D300
0.047	±20	–	–	–	–	–	8.4×18.5 -K*610-D300
0.068	±20	–	–	–	–	–	8.4×21 -K*612-D300
0.1	±20	–	–	5.4×18.5 –K*314-D300	6.4×18.5 -K*414-D300	7.4×18.5 -K*514-D300	8.4×21 -K*614-D300
0.15	±20	–	5.4×18.5 -K*216-D300	6.4×18.5 -K*316-D300	7.4×18,5 -K*416-D300	8.4×18.5 -K*516-D300	9.4×25 -K*616-D300
0.22	±20	–	5.4×18.5 -K*218-D300	6.4×18.5 -K*318-D300	7.4×21 -K*418-D300	8.4×21 -K*518-D300	9.4×25 -K*618-D300
0.33	±20	–	6.4×18.5 -K*220-D300	7.4×18.5 -K*320-D300	8.4×21 -K*420-D300	9.4×21 -K*520-D200	11.7×25 -K*620-D300
0.47	±20	5.4×18.5 -K*122-D300	7.4×18.5 -K*222-D300	7.4×21 -K*322-D300	9.4×21 -K*422-D300	10.7×21 -K*522-D300	12.7×25 -K*622-D300
0.68	±20	6.4×18.5 -K*124-D300	7.4×18.5 -K*224-D300	8.4×21 -K*324-D300	9.4×25 -K*424-D300	10.7×25 -K*524-D300	11.7×34 -K*624-D300
1	±10	–	7.4×21 -K*225-D300	9.4×21 -K*325-D300	10.7×25 -K*425-D300	11.7×25 -K*525-D300	–
1	±20	7.4×18.5 -K*126-D300	7.4×21 -K*226-D300	9.4×21 -K*326-D300	10.7×25 -K*426-D300	11.7×25 -K*526-D300	13.7×34 -K*626-D300

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1) Minimum distance between lead bend and capacitor body: 1 mm.

Rated dc voltage		25 V	63 V	100 V	160 V	250 V	630 V
Rated capacitance µF	Tolerance %	Dimensions d_1 × l (mm) and ordering code					
		B95020–	B95020–	B95020–	B95020–	B95020	B95020
1.5	±10	–	8.4×21 -K*227-D300	9.4×25 -K*327-D300	12.7×25 -K*427-D300	13.7×25 -K*527-D300	–
1.5	±20	7.4×18.5 -K*128-D300	8.4×21 -K*228-D300	9.4×25 -K*328-D300	12.7×25 -K*428-D300	13.7×25 -K*528-D300	16.7×34 -K*628-D300
2.2	±10	–	10.7×21 -K*229-D300	10.7×25 -K*329-D300	11.7×34 -K*429-D300	12.7×34 -K*529-D300	–
2.2	±20	7.4×21 -K*130-D300	10.7×21 -K*230-D300	10.7×25 -K*330-D300	11.7×34 -K*430-D300	12.7×34 -K*530-D300	18.7×34 -K*630-D300
3.3	±10	–	9.4×25 -K*231-D300	9.4×34 -K*331-D300	13.7×34 -K*431-D300	15.7×34 -K*531-D300	–
3.3	±20	8.4×21 -K*132-D300	9.4×25 -K*232-D300	9.4×34 -K*332-D300	13.7×34 -K*432-D300	15.7×34 -K*532-D300	23.7×34 -K*632-D300
4.7	±10	–	10.7×25 -K*233-D300	11.7×34 -K*333-D300	15.7×34 -K*433-D300	17.7×34 -K*533-D300	–
4.7	±20	9.4×21 -K*134-D300	10.7×25 -K*234-D300	11.7×34 -K*334-D300	15.7×34 -K*434-D300	17.7×34 -K*534-D300	25.9×34 -K*634-D300
6.8	±10	–	10.7×34 -K*235-D300	12.7×34 -K*335-D300	18.7×34 -K*435-D300	20.7×34 -K*535-D300	–
6.8	±20	10.7×25 -K*136-D300	10.7×34 -K*236-D300	12.7×34 -K*336-D300	18.7×34 -K*436-D300	20.7×34 -K*536-D300	–
10	±10	–	12.7×34 -K*237-D300	16.7×34 -K*337-D300	20.7×34 -K*437-D300	25.9×34 -K*537-D300	–
10	±20	11.7×25 -K*138-D300	12.7×34 -K*238-D300	16.7×34 -K*338-D300	20.7×34 -K*438-D300	25.9×34 -K*538-D300	–
22	±10	–	16.7×34 -K*239-D300	–	–	–	–
22	±20	–	16.7×34 -K*240-D300	–	–	–	–
47	±10	–	23.7×34 -K*241-D300	–	–	–	–
47	±20	–	23.7×34 -K*242-D300	–	–	–	–
100	±10	–	25.9×46 -K*243-D300	–	–	–	–
100	±20	–	25.9×46 -K*244-D300	–	–	–	–

Ordering code example B95020–K*338–D300

Type ——— ——— Code number (refer to table)

* insert the test category in accordance with ESA specification SCC 3006 and GFW specification CF 100 and the order:

1 for test level A 3 for test level C
2 for test level B 4 for test level D

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