SIEMENS

Tantalum Electrolytic Capacitors

Data Book 1984/85

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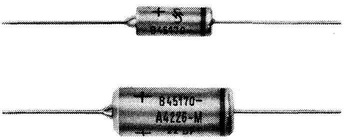
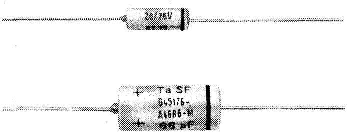
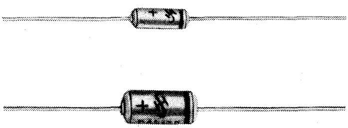
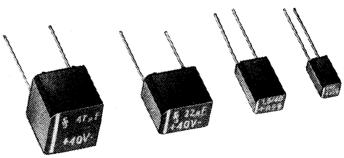
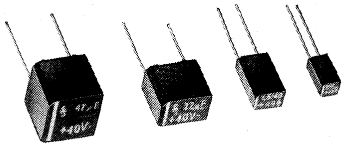
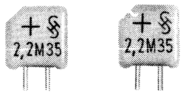
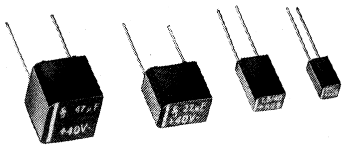
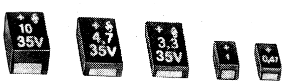
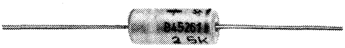
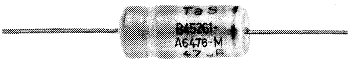
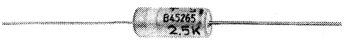
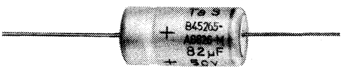
Summary of Types

Type	Rated voltage V_R Vdc	Rated capacitance C_R µF	Dimensions $d \times l$ or $b \times l \times h$ mm
Capacitors with solid electrolyte			
B 45 170 	6,3 to 80	0,1 to 6,8 1,0 to 47 4,7 to 150 15 to 330	3,4 × 7,2 4,7 × 12,0 7,3 × 17,3 8,9 × 20,0
B 45 176 	6,3 to 40	1,5 to 10 10 to 100 33 to 470 68 to 1000	3,4 × 7,2 4,7 × 12,0 7,3 × 17,3 8,9 × 20,0
B 45 179 	6,3 to 50	0,1 to 4,7 0,33 to 15 1,5 to 33 3,3 to 68	2,4 × 6,6 2,8 × 7,4 4,8 × 8,8 4,8 × 11,8
B 45 181; B 45 181-Q 	6,3 to 50	0,1 to 6,8 1,5 to 47 6,8 to 150 22 to 330	4,2 × 4,7 × 7,3 4,8 × 7,3 × 10,0 7,3 × 12,3 × 10,0 12,3 × 12,3 × 10,5

	Temperature range (°C/°F) IEC climatic category	Failure rate (40 °C, V_R, circuit resistance ≥3 Ω/V)	Specifications and qualifications	Features and fields of application	Page
	−55 to +125/ −67 to +257 55/125/56	$1 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350 DIN 44351 **Upon request:** UTE C83-112, part 8 MIL-C-39003/1E (refer to B 95057) CECC 30201-001 CECC 30201-019 CECC 30201-029 DIN 45910, part 144	Hermetically sealed, meeting high environmental requirements	41
	−55 to +125/ −67 to +257 55/125/56	$1 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350	Hermetically sealed, very high volumetric efficiency, meeting high environmental requirements	50
	−55 to +125/ −67 to +257 55/125/56	$2 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350 DIN 44359 DIN 45910, part 148 (CECC 30201-xxx)	Miniature version, metal case with epoxy resin seal at one face (flame retardant)	58
	−55 to +125/ −67 to +257 55/125/56	$3 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350 DIN 44352 **B 45 181-Q:** CECC 30200 CECC 30201-007 CECC 30201-009 UTE C 83-112, part 6	Plastic encapsulated, plug-in, (flame retardant molding material)	68

Type	Rated voltage V_R Vdc	Rated capacitance C_R µF	Dimensions $b \times l \times h$ mm
B 45 182 	6,3 to 50	1,5 to 15 6,8 to 100 22 to 220 47 to 470	4,2 × 4,7 × 7,3 4,8 × 7,3 × 10,0 7,3 × 12,3 × 10,0 12,3 × 12,3 × 10,5
B 45 184 	6,3 to 50	1,5 to 10	2,35 × 7,1 × 7,6
B 45 185 	6,3 to 50	0,1 to 6,8 1,5 to 47 6,8 to 150 22 to 330	4,2 × 4,7 × 7,3 4,8 × 7,3 × 10,0 7,3 × 12,3 × 10,0 12,3 × 12,3 × 10,5
B 45 193 	6,3 to 50	0,1 to 3,3 0,33 to 6,8 0,68 to 22 2,2 to 47 4,7 to 100	2,55 × 4,57 × 1,77 2,55 × 4,57 × 2,57 4,55 × 8,13 × 1,77 4,55 × 8,13 × 2,57 4,55 × 8,13 × 4,97

	Temperature range (° C/° F) IEC climatic category	Failure rate (40 ° C, V_R, circuit resistance ≥ 3 Ω/V)	Specifications and qualifications	Features and fields of application	Page
	−55 to +125/ −67 to +257 55/125/56	$3 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350	Plastic encapsulated, plug-in, (flame retardant molding material), very high volumetric efficiency	76
	−55 to +125/ −67 to +257 55/125/56	$2 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350	Plastic encapsulated (flame retardant), plug-in, safe against thermal overload, very high reliability	84
	−55 to +125/ −67 to +257 55/125/56	$3 \cdot 10^{-8}$/h	IEC 384-15 DIN 44350 DIN 44352 DIN 45910, part 145 (CECC 30201-xxx)	Plastic encapsulated (flame retardant), plug-in; in acc. with B 45181 however additionally safe against thermal overload	91
	−55 to +125/ −67 to +257 55/125/56	$3 \cdot 10^{-8}$/h	IEC 384-3	Chip version, plastic encapsulated (flame retardant). Due to the defined cube-shaped dimension ideally suited for automatic assembly (reflow- and dip-solderable)	100

Type	Rated voltage V_R Vdc	Rated capacitance C_R µF	Dimensions $d \times l$ mm	
Capacitors with liquid electrolyte				
B 45 261  	6,3 to 100	2,2 to 68 6,8 to 220 33 to 470 68 to 1000	5,5 × 13,8 7,9 × 18,6 10,3 × 21,8 10,3 × 27,2	
B 45 265  	6 to 125	1,7 to 68 9 to 270 25 to 560 56 to 1200	5,5 × 13,8 7,9 × 18,6 10,3 × 21,8 10,3 × 27,2	
Quality-assessed types, MIL version				
B 95 057  	6 to 75	0,1 to 6,8 0,82 to 56 5,6 to 180 22 to 330	3,43 × 7,26 4,7 × 12,04 7,34 × 17,2 8,92 × 19,96	

	Temperature range (°C/°F) IEC climatic category	Failure rate (40 °C, V_R)	Specifications and qualifications	Features and fields of application	Page
	−55 to +125/ −67 to +257 55/125/56	$4 \cdot 10^{-8}$/h	IEC 384-15 DIN 44360 DIN 44361	Tubular metal case, elastomer-sealed, capacitance and voltage ratings in acc. with DIN/IEC, very low leakage current	110
	−55 to +125/ −67 to +257 55/125/56	$4 \cdot 10^{-8}$/h	IEC 384-15 DIN 44360	Tubular metal case, elastomer-sealed, capacitance and voltage range in acc. with MIL C 39006/9, style CLR 65, very low leakage current	118
	−55 to +125/ −67 to +257 55/125/56	FR level 1% to 0.001 % per 1000 h at 85 °C (see MIL STD 690)	MIL-C-39003 E MIL-C-39003/1E	Hermetically sealed, meeting high environmental requirements	128

General Information
Ordering Information
Weights and Packaging Units

1 Basic construction

The following explanations relate to capacitors with a sintered body and solid or liquid electrolytes for high reliability (high rel) applications.
The information given in the individual paragraphs including numerical values is of general importance. To certain types often better values apply which are contained in the individual data sheets.

	Sinter capacitors with solid electrolyte	Sinter capacitors with liquid electrolyte
1st layer (anode)	a sintered body of tantalum powder	
Dielectric	tantalum-oxide generated in an electrochemical process by oxidation on the anode	
2nd layer (cathode)	a semiconducting metal oxide (manganese dioxide) applied on the anodic oxide foil.	liquid electrolyte (highly conductive acid), Teflon spacers.
Contacting of the cathode	a graphite and conductive silver foil that is applied on the semiconducting coating and sealed to the case.	fine-silver housing (internally platinum black)

All tantalum electrolytic capacitors dealt with in the individual data sheets are polar capacitors. The dielectric layers of polar electrolytic capacitors are arranged such that the current is blocked in only one direction. It is therefore necessary for operation to consider the polarity indications (positive pole on anode, negative pole on cathode). Incorrect polarization is permitted only up to the values indicated in the individual data sheets, otherwise the capacitor could explosively be damaged.

2 Terms and explanations

2.1 Rated voltage V_R

The rated voltage V_R is the dc voltage indicated upon the capacitor. It determines the dielectric thickness.

2.2 Category voltage V_C

The category voltage V_C is the maximum permissible dc voltage (pure dc) or the peak value of the ripple voltage as the sum of the basic dc voltage + superimposed ac voltage, to which the capacitor can permanently withstand. The category voltage depends on the ambient temperature. The rated voltage and the category voltage are identical for all tantalum electrolytic capacitors over the temperature range −55 °C/−67 °F to +85 °C/185 °F.
The temperature range between +85 °C/185 °F and +125 °C/257 °F requires a linear reduction of V_C to $^2/_3$ V_R. (125 °C).
85 °C/185 °F at V_R and 125 °C/257 °F at $^2/_3$ V_R represent an approximately same load for the capacitor.
Operation below category voltage V_C does not impair the capacitor and has a positive effect upon its service life.

2.3 Operating voltage V_{op}

All unfavorable operating conditions (e.g. possible line overvoltages, unfavorable tolerances of the transformation ratio of the line transformer in the equipment, repeated overvoltages upon turning on, high ambient temperatures etc.) have to be taken into account for determining the voltage occurring at the capacitor during continuous operation, i.e., the operating voltage that is not allowed to exceed the category voltage.

2.4 Peak voltage V_P

The peak voltage V_P is the maximum voltage (peak value) which may be applied to the capacitor for short periods, at the most 5 times up to 1 minute during 1 hour. The peak voltage may not be used for operational periodic charging and discharging purposes.

2.5 Superimposed alternating voltage

The superimposed alternating voltage is the rms alternating voltage that may be applied to a capacitor in additon to a direct voltage. The sum of the direct voltage and the peak value of the superimposed alternating voltage shall not exceed the category voltage. The superimposed alternating voltage must be limited such that no undue incorrect polarization can occur. Corresponding data is available from the individual data sheets. No voltage of reversed polarity, not even temporarily, is allowed to be applied to wet sinter capacitors.
The alternating current flowing through the capacitor or the alternating voltage applied shall not exceed a maximum value determined for each type and the rated capacitance, since otherwise the capacitor could be damaged due to overheating or its service life could be reduced. The value of the permitted superimposed alternating current or the voltage tabulated and plotted corresponds to the inherent heating permitted for each individual capacitor type.

2.6 Polarity reversal voltage (incorrect polarization)

The permissible polarity reversal voltages indicated on the individual data sheets can also appear without any superimposed direct voltage and during continuous operation without causing a decrease in reliability or an increase in instability.
Incorrect polarization of wet sinter capacitors must be avoided in any case, since otherwise the component could be damaged.

2.7 Series back-to-back connection

For applications where higher polarity reversal voltages occur, two solid sinter capacitors of identical rated voltage and identical rated capacitance can be connected in series (back-to-back, i.e. cathode to cathode). Hence a blocking in each polarizing direction is obtained. The non-polar or bipolar type (half the capacitance value) can be operated with voltages up to the rated dc voltage of any polarity or with twice the superimposed ac voltage of that value which is permitted for the individual capacitor. The capacitors connected back-to-back in this way can also be operated at a pure ac voltage. The surface temperature of the capacitor is not allowed to increase by more than max. 10 °C/18 °F, while the upper limit temperature should not be exceeded.
Wet sinter capacitors are not allowed to be connected back-to-back since on the silver cathode (case) of the capacitor just connected in forward direction, gaseous oxygen can arise causing an excess pressure in the case.

2.8 Inherent voltage

Occasionally, inherent voltages can appear in electrolytic capacitors (due to element formation between anode and cathode). Since these inherent voltages are relatively low (less than 0.5 V) with an accordingly high internal resistance (some $10^6\,\Omega$) they are of no importance for most applications.

2.9 Recharging

All usual capacitors with either solid or liquid dielectrics can produce a recharging effect that results at a loaded capacitor after elimination of an outer bridging at its layers in a recharging voltage unidirectional with the charging polarization. This is more or less independent of the capacitance of the capacitors as well as of the thickness of the dielectric and can be considered as a specific feature of the dielectric material. The value of the recharging voltage depends on different factors (type, charge time, discharge time, measuring instant, ambient temperature) and can attain an order of magnitude of 10^{-2} up to some 10^{-1} of the operating voltage.
The lowest recharging effect of all electrolytic capacitors is at present to be found with solid sinter types.

2.10 Voltage-free storage

Tantalum and its oxide are particularly resistant to chemical influences and can only be attacked by very corrosive chemicals. They are resistant to the electrolytes used so that no layer reduction occurs. For this reason the leakage current of wet tantalum electrolytic capacitors doesn't significantly increase even after voltage -free storage for years and at higher storage temperatures. Voltage-free storage of solid sinter capacitors for years at $\leq 40°C/104°F$ has practically no influence on the service life. A voltage-free storage at room temperature is of no and at higher storage temperatures of only little influence on the leakage current.

3 Rated capacitance C_R

The rated capacitance C_R is the value which is indicated upon the capacitor. The actual capacitance of a capacitor can deviate from the rated capacitance up to the full magnitude of the tolerance at delivery.
The capacitance of tantalum electrolytic capacitors is determined at a frequency f of 120 Hz and a temperature of 20° C/68° F as series capacitance on an alternating current bridge (at rms measuring voltages of less than 0.5 V).

3.1 Capacitance tolerance (tolerance at delivery)

The capacitance tolerance (or tolerance at delivery) is the maximum permissible deviation of the actual capacitance value from the rated capacitance.
Capacitance variations because of temperature, frequency and time have to be taken into consideration.

3.2 Temperature dependence of capacitance

The capacitance of a tantalum electrolytic capacitor varies with the temperature (positive temperature coefficient) and also depends on capacitance and rated voltage. Low voltages and high capacitance values cause higher changes than high voltages and low capacitance values.

3.3 Frequency dependence of capacitance

The frequency dependence of the capacitance of a tantalum electrolytic capacitor must be determined by its impedance value Z. The effective capacitance decreases with increasing frequency.

3.4 Capacitance drift

The drift value is the capacitance variation with time throughout the service life and is referred to a temperature of +40°C/104°F. The capacitance drift is higher at low than at high rated voltages. In critical cases it is therefore advisable to use capacitors of a higher rated voltage series. The drift rises with increasing operating temperature as well as with a continuous, full utilization of the permitted alternating current load.

3.5 Dielectric strength (capacitance decrease after 10^8 switchings)

Tantalum electrolytic capacitors for high reliability applications have a surge-proof construction. The permissible capacitance decrease after 10^8 switchings is less than and equal to 3%. This irreversible capacitance decrease must be added to the capacitance drift value.

4 Impedance (absolute value of the ac resistance)

The impedance of tantalum electrolytic capacitors is determined in close approximation by connecting the following individual resistances in series:

1. Effective reactance $1/\omega C$ of the capacitance C.
2. Dielectric losses and the ohmic resistance of the electrolyte of the semiconductor layer (equivalent series resistance = *ESR*).
3. Effective reactance ωL of the inductance of the electrodes and the supply lines.

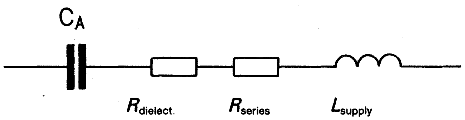


Figure 1
Simplified equivalent circuit diagram of an electrolytic capacitor

The frequency and temperature behavior of these resistances determine the impedance characteristic. The *ESR* includes both the $R_{dielectric}$ and the R_{series} the first of which describes the dielectric losses and decreases with $1/\omega$, whereas the second, mainly representing the electrolytic series resistance, does not depend on the frequency.
From approximately 10 kHz the frequency depending part can be neglected. At low and at higher frequencies the frequency dependence of the impedance is preferably caused by both the effective reactances. The temperature dependence is mainly determined by the electrolytic series resistance.
As tantalum is corrosion-resistant, electrolytes of high conductivity can be used for tantalum electrolytic capacitors thus resulting in a low series resistance. A particularly high conductivity is characteristic of the solid semiconductor layer used for dry sinter types instead of the liquid electrolyte. Hence this capacitor features the lowest series resistance of all electrolytic capacitors. The conductivity of the electrolytes and the semiconductor layer only slightly changes even at low temperatures thus providing a favorable frequency and temperature performance of the impedance.
The following figures (2 and 3) show the typical performance of the impedance of wet and solid tantalum electrolytic capacitors versus frequency and temperature.
The decrease in impedance at low frequencies down to some kHz is determined by the capacitive reactance whereas the following, almost horizontal course of the curve mainly shows the ohmic series resistance. Beyond the natural resonance the inductive reactance increasingly operates so that the curves finally run into straight lines.

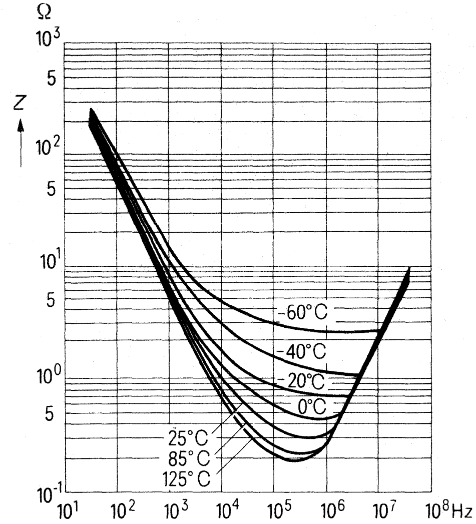


Figure 2
Impedance of a wet sinter capacitor 20 µF/60 V

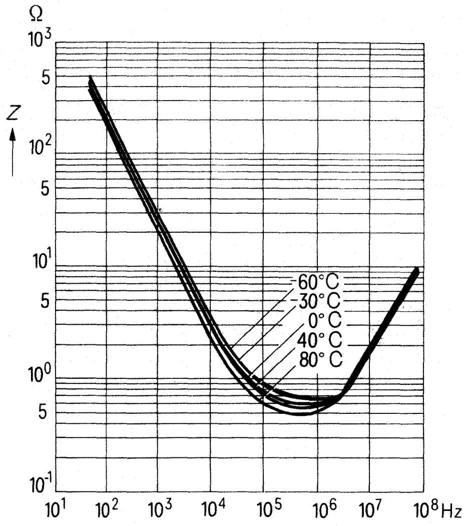


Figure 3
Impedance of a solid sinter capacitor 6.8 µF/35 V

5 Dissipation factor tan δ

The dissipation factor of solid tantalum electrolytic capacitors increases with frequency and tends near the resonance to very high values. The dissipation factors depending on frequency of wet sinter types run similarly to those of solid sinter capacitors. Figure 4 demonstrates the typical frequency response of the dissipation factor at several temperatures, using a solid sinter capacitor as example.

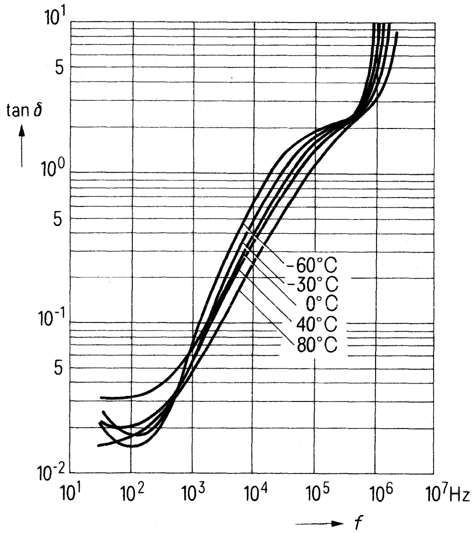


Figure 4
Dissipation factor of a tantalum electrolytic capacitor 1 µF/35 V
with a solid electrolyte

6 Leakage current I_{lk}

When a direct voltage is applied to electrolytic capacitors, a low current steadily flows through every capacitor. This so-called leakage current depends on voltage as well as on temperature (figure 5 and 6). The impurities (nonformable foreign atoms) in the carrier metal (anode) preferably determine the value of the leakage current of an electrolytic capacitor. The use of highly pure tantalum powder results in a low failure density in the dielectric and a consequently low leakage current. Wet tantalum sinter capacitors feature the lowest leakage current value of all electrolytic capacitors. When a voltage is applied the anions existing in the electrolyte additionally maintain the continuous reforming of the dielectric. All wet tantalum capacitors therefore feature a leakage current reduction at applied voltage. The operational leakage current of solid sinter capacitors (with semiconductor contacting instead of a liquid electrolyte) exceeds that of wet types because of a lower reforming capability of the manganese dioxide layer. For this reason also the leakage current increases slightly more with rising temperatures than does that of wet types.

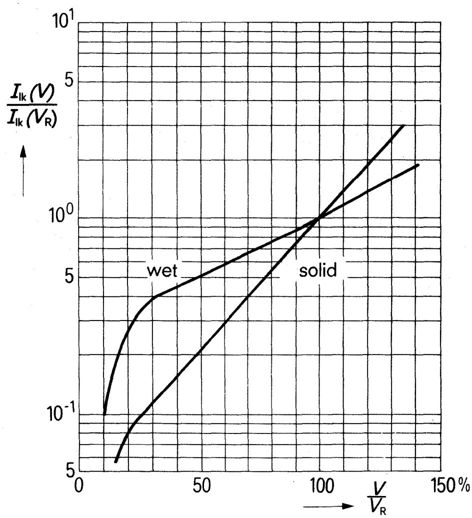


Figure 5
Leakage current versus voltage
(typical values)

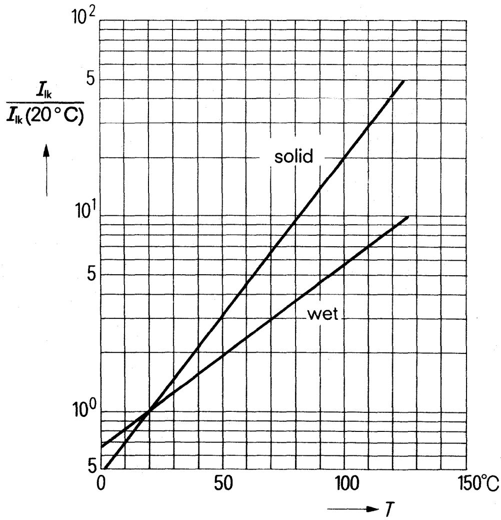


Figure 6
Leakage current versus temperature
(typical values)

7 Temperature range

The temperature range of a capacitor is the range between lower and upper category temperature, throughout which the capacitor may be operated corresponding to its climatic category (see DIN 40 040).
The temperature range for tantalum electrolytic capacitors is −55° C/−67° F to +125° C/257° F. Over the range −55° C/−67° F to +85° C/185° F the category voltage V_C may be identical to the rated voltage V_R, unless any limiting conditions have been given. From +85° C/185° F a voltage derating has to be considered (see data sheets).

7.1 Lower category temperature

The lower temperature limit results from the capacitance decrease permitted for each individual capacitor type or from the increase in impedance due to the reduced conductivity of the electrolyte or the semiconductor layer. Temperatures down to the lower temperature limit don't affect the service life.

7.2 Upper category temperature

The upper temperature limit applies to an operation at a direct voltage and the maximum permissible superimposed alternating currents or ac voltages respectively. The max. temperature limit may only exceed the rated temperature when this is expressly permitted for the type concerned.

7.3 Storage and transport temperatures

The lower storage temperature of wet tantalum electrolytic capacitors is not allowed to fall below −65 °C/−85 °F, for solid tantalum electrolytic capacitors −80 °C/−112 °F are permitted.
The upper storage temperature shall not exceed the rated temperature range. The most favorable storage temperature is around +25 °C/77 °F. Higher temperatures enter into the load duration (see also section 9.2, service life).

8 Humidity conditions

The permissible humidity condition of tantalum electrolytic capacitors is determined in accordance with the DIN climatic category (DIN 40040) or the IEC climatic category (publ. 68—1). Within the permitted limits the influence on the electrical data can be neglected.

9 Quality specifications

(Delivery quality, service life, relative failure rate)

9.1 Delivery quality

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

9.1.1 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 40 080 (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.

9.1.2 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 and/or leads broken
- missing or incorrect marking
- incorrect identification of connections
- intermixing with other device types
- alternating orientation of components in a tube or tape

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

9.1.3 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 includes the related total defects.

9.2 Service life

The term "service life" designates the period until a given failure rate is reached. The failure rate is the ratio of the number of failures to the total number of inspected (identical) components. The service life depends on the failure criteria as well as the load and stress to which the electrolytic capacitors are subjected.

Service life relates to an ambient temperature of 40 °C/104 °F, rated voltage, and in the case of solid tantalum electrolytic capacitors also to a circuit resistance $\geq 3\ \Omega/V$.

At operating temperatures exceeding 40°C/104°F, service life is reduced; operation at voltages below the category voltage V_C, however, has a positive effect. For this reason, the service life is additionally indicated for voltages $< V_R$ (see data sheets).

Service life will increase
- the lower the ambient temperature
- the lower the superimposed ac voltage
- the lower the proportion V_{op}/V_R or the operating dc voltage

In the case of solid tantalum electrolytic capacitors service life increases as a consequence of increasing circuit resistances (R_i) up to $3\ \Omega/V$.

9.2.1 Failure criteria

A failure exists if one or several characteristics of a previously faultless component change inadmissibly.

Differentiated are

— total failures: open or short circuit

— failures due to variation: $\left.\begin{matrix} I_{lk} \\ Z \\ \Delta C \end{matrix}\right\}$ for values see data sheets

This describes 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 electrolytic 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.

9.3 Relative failure rate

Specification 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. 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).

The failure rates contained in the individual data sheets have a confidence coefficient of 60% in accordance with IEC publication 409.

9.3.1 Failure periods

The number of failures, plotted as a function of the time t, would form a step-function curve since only integral changes could occur. If N is a large number this step-curve can be appoximated by a continuous curve with a high degree of accuracy. This offers the advantage that λ can also be specified for any small period of time (in form of a differential quotient $dN/N \times dt$) and can thus be plotted as a function of time. Usually, we differentiate between components with three time ranges (fig. 7).

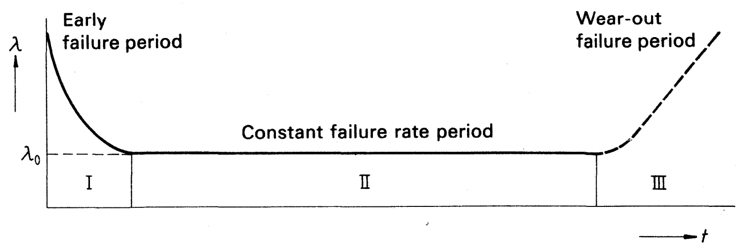


Figure 7
Variation of failure rate with time (schematic)

In the case of tantalum electrolytic capacitors, the service life lies chiefly in range II. For this reason, it is generally adequate to specify the failure rate λ_0 which is (virtually) constant in this range.
As a result of aging during the manufacturing process, the early-failure period (range I) has been minimized.

9.3.2 Reference conditions

Unless other agreements have been reached, the rel failure rate specification for tantalum electrolytic capacitors refers to the conditions stated below. These reference conditions correspond to average conditions occurring in most applications.

Electrical stress

Operation at rated voltage; circuit resistance
for tantalum electrolytic capacitors with solid electrolyte $\geq 3\ \Omega/V$
for tantalum electrolytic capacitors with liquid electrolyte $0\ \Omega/V$

Climatic stress

Ambient temperature 40 °C/104 °F, humidity category in accordance with individual data sheets, no agressive atmosphere.

Mechanical stress Class W in accordance with DIN 40 040

Time range Range II in figure 7

Failure criteria Total failures (short or open circuit) and failures due to variations which, in the majority of applications, will result in a failure of the functional unit.

9.4 Examples for calculating the failure rate

9.4.1 Capacitors with solid electrolyte

Given: Ambient temperature T_{amb} = 70 °C/158 °F
Operating voltage V_{op} = 25 Vdc
Circuit resistance R_i $\leq 0.1\ \Omega/V$

Capacitor used: $\left.\begin{matrix} C_R = 1\ \mu F \\ V_R = 50\ Vdc \end{matrix}\right\}$ e.g. B 45 170

At $\frac{V_{op}}{V_R} = 0.5$ and $T_{amb} = 70\ °C/158\ °F$ a conversion factor of approx. 0.03 can be derived from the diagram.

For $R_i \leq 0.1\ \Omega/V$ a factor 5 can be taken from the table (see B 45 170 for example) for case size A.

Calculated failure rate: $1 \times 10^{-8}/h \times 0.03 \times 5 = 1.5 \times 10^{-9}/h$

9.4.2 Capacitors with liquid electrolyte

Given: Ambient temperature T_{amb} = 90 °C/194 °F
Operating voltage V_{op} = 25 Vdc

Capacitor used: $\left.\begin{matrix} C_R = 10\ \mu F \\ V_R = 100\ Vdc \end{matrix}\right\}$ e.g. B 45 261

At $\frac{V_{op}}{V_R} = 0.25$ and $T_{amb} = 90°C/194°F$ a conversion factor of approx. 4 can be derived from the diagram.

Calculated failure rate: $4.5 \times 10^{-8}/h \times 4 = 18 \times 10^{-8}/h$.

As indicated in the load duration diagram this failure rate applies to a period of 25 000 h.

9.5 Additional information

Quality data which always refers to a large number of components does not assure characteristics in a legal sense. An agreement upon such data does not exclude, however, that the customer may claim replacement for individual defective tantalum electrolytic 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 service life and relative failure rate in each case refers to an average production situation. Such information must thus be considered as average values (statistically expected values), based upon a large number of delivery batches of homogeneous electrolytic 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 purposes of accelerating the test).

10 Ordering information

Siemens has introduced part numbers (ordering codes) for all its technical products in order to rationalize the ordering and supplying procedure by means of data processing equipment. These part numbers are stated for passive components on data sheets, in data books, as well as in short form catalogs, thus clearly indentifying any deliverable components. In the following paragraphs the construction of part numbers and their 15 digits is explained. It will facilitate and speed up the supplying procedure, if the customer properly indicates the part number. All components are supplied only in conformity with the coded part number.

10.1 Construction of the part number

	1	2	3	4	5	6		7	8	9	10	11		12	13	14	15
Digit position	B						–						–				
	1st block							2nd block						3rd block			

In order to facilitate the legibility, the part number comprising 15 digits, has been separated into 3 blocks of 6, 5 and 4 digits, the blocks being joined by a hyphen. Each of the three blocks begins with a letter, whereas all other digits are Arabic figures.

10.2 Digit 1 to 6 (type number)

For passive components, the first block starts with the letter "B". Together with the following 5 figures the first block is to be understood as "type number" or B-number, dividing the passive devices into groups, e.g. electrolytic capacitors, ceramic capacitors, SIFERRIT material etc. The type number range B 45 . . . is used for tantalum electrolytic capacitors.

10.3 Digit 7 (revision status)

The first letter of the second block — the 7th digit of the part number — indicates the revision status, which can be changed for variations into the next following letter of the alphabet.
There are different reasons for changing the revision status code letter: in most cases these are either improved electrical properties (e.g. an extended temperature range) or changed dimensions.
As far as improved electrical properties are concerned, the previous version can always be replaced by the revised one. When the dimensions are subject to changes, the replacement depends on certain conditions. The former applicability will normally not be impaired if the diameter and/or the length are scaled down, provided that the mounting conditions are kept the same. In both cases (properties, size reduction) the previous letter of the revision status is changed into the following, e.g. a version with the code letter A can be replaced by one with the code letter B. For this purpose the letters A to H (1st third of the alphabet) are used.
Quite a different situation is given, when a volume reduction has been attained at the expense of scaled up dimensions (diameter or length) which can be due to reasons of standardization. Here, difficulties in the replacement may arise when the mounting conditions are changed as well. In these cases, the changed component is designated by a letter between J and Q (2nd third of the alphabet). This means that interchangeability is possible as far as the electrical properties are concerned, but the dimensions are to be checked.
The letters S to Z (3rd third of the alphabet) serve to identify special versions. Therefore they are to be found on the data sheets only in particular cases, when a special version advances to standard type.

10.4 Digit 8 (rated voltage)

The meaning of the code figure of the rated voltage is indicated on the individual data sheets.

10.5 Digit 9, 10, 11 and 13 (capacitance value)

In the above mentioned digits of the ordering code the rated capacitance of the electrolytic capacitor has been coded as following:

a) The rated capacitance will be converted into the form $a \times 10^b$ pF; the µF values must be converted into the basic unit "pF". The factor *a* is the unchanged figure sequence of the value, with the decimal point behind the second figure. The exponent *b* of the multiplier 10^b is clearly specified by the position of the decimal point and the basic unit "pF", and can admit values from 0 to 9. The lowest value to be represented is therefore 1 pF, the highest 99 000 µF.

b) The 2 figures before the point are contained in the 9th and 10th digit; thus the decimal point must always be imagined as being behind digit 10.

c) The exponent *b* which designates the number of naughts of the multiplier (see the following code table for capacitance values) is the code number in digit position 11.

Examples:

Coding: →
Decoding: ←

0,22 µF =	220 000 pF =	22×10^4 pF =	– + * 224 – + ***
4,7 µF =	4 700 000 pF =	47×10^5 pF =	– + * 475 – + ***
22 µF =	22 000 000 pF =	22×10^6 pF =	– + * 226 – + ***
470 µF =	470 000 000 pF =	47×10^7 pF =	– + * 477 – + ***
1 000 µF =	1 000 000 000 pF =	10×10^8 pF =	– + * 108 – + ***

10.6 Digit 12 (tolerance)

Code letters in accordance with IEC publication 62/1968 are used to code the tolerances of capacitance values. The relevant tolerances available are contained on the individual data sheets.

Code letter	Capacitance tolerance
A	Tolerances without proper code letter
J	±5 %
K	±10 %
L	±15 %
M	±20 %

10.7 Digits 13, 14, and 15

Tantalum electrolytic capacitors do not require the digits 13 and 14 to identify the "capacitance value behind the decimal point". Digit 15 serves to identify the taped version and the type of packaging (see taping instructions page 32).

10.8 Example for the compiling of part numbers

Ordering code example: B45170-A8226-M9

- B45170 — Type
- Code[1]:
  - A — Revision status
  - 8 — Rated voltage (8 ≙ 25 Vdc)
  - 226 — Rated capacitance ($226 \triangleq 22 \times 10^6$ pF = 22 µF)
- M — Capacitance tolerance (M ≙ ±20%)
- 9 — taped (tape or reel)

The part number can end behind digit position 12 (tolerance); when all subsequent digit positions are "zero". This is generally the case with untaped electrolytic capacitors.

[1]) This code is generally contained in the tables for the individual capacitors.

11 Weights and packaging units (PU)

11.1 Capacitors with solid electrolyte, axial leads (taped)

Type	B 45 170		B 45 176		B 45 179		
Size	Weight [1] per item (g)	PU items	Weight [1] per item (g)	PU items	Size	Weight [1] per item (g)	PU items
A	0,5	5000	0,5	5000	1	0,25	5000
B	1,0	3000	1,2	3000	2	0,3	5000
C	3,0	1000	4,0	1000	3	0,8	3000
D	5,5	800	7,0	800	4	1,1	3000

11.2 Capacitors with solid electrolyte, unidirectional leads (untaped)[2]

Type	B 45 181/182/185		B 45 184	
Size	Weight [1] per item (g)	PU items/box	Weight [1] per item (g)	PU items/box
A	0,35	1000	0,3	1000
B	0,9	500	—	—
C	2,5	200	—	—
D	4,5	100	—	—

11.3 Capacitors with solid electrolyte, leadless (untaped)[2]

Type	B 45 193	
Size	Weight [1] per item (g)	PU items/box
A	0,06	1000
B	0,09	1000
C	0,2	1000
D	0,35	1000
E	0,7	1000

11.4 Capacitors with liquid electrolyte (untaped)

Type	B 45 261/265	
Size	Weight [1] per item (g)	PU items
T 1	1,7	100
T 2	4,5	100
T 3	8,5	60
T 4	15,0	60

[1]) Typical values; deviations up to approx. ± 30 % possible
[2]) For PU for taped capacitors see section "Packaging on continuous tapes"

Packaging on Continuous Tapes

1 General

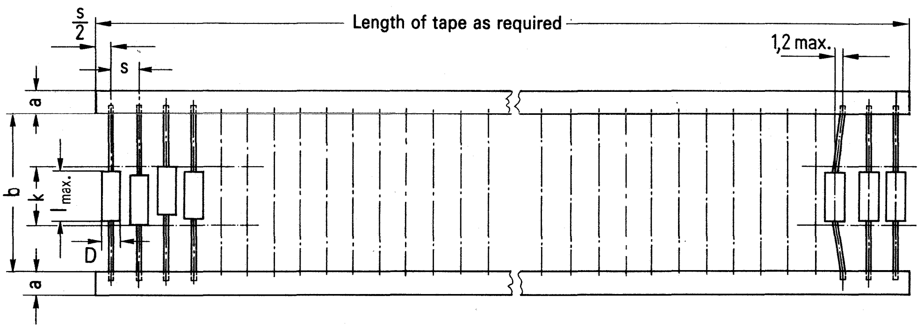
Taped components with axial leads are available for automatic insertion up to the rated diameter 8.9 mm and with unidirectional leads in the case sizes A and B.

Packaging of axial-leaded tantalum electrolytic capacitors on continuous tapes is based on the specifications of IEC publication 286-1 or DIN IEC 286, part 1, while components with unidirectional leads are packaged on continuous tapes in accordance with DIN IEC 286, part 2 (at present only draft).

2 Taping of tantalum electrolytic capacitors with axial leads

The types B 45 170, B 45 176, B 45 179 and B 95 057 are suitable for packaging on continuous tapes.

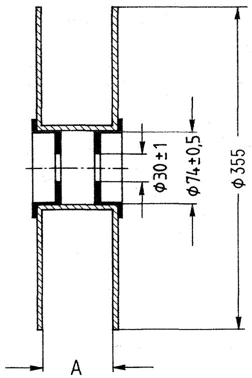
Dimensions and tolerances

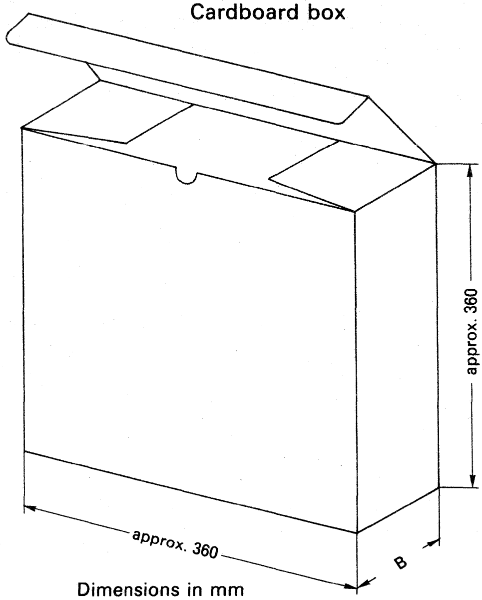


Rated diameter D mm	Standard spacings between components s mm	Permissible deviations over 10 spacings mm	Standard width of tape a mm	Inner tape spacings b mm	Body location (permissible lateral deviation) k[1]	Packing method
2,4 ... 4,8	5 ± 0,5	±2	6 ± 1	63 ± 2	$l_{max.}+1,4$	Reel
7,3 ... 8,9	10 ± 0,5			73 ± 2		

[1]) Measurement in acc. with IEC 294 (DIN 41 099, sheet 1).

Packing





Inner tape spacings b	Coil width A	Box width B
63±2	81	approx. 92
73±2	91	approx. 102

Ordering code and packaging quantities

Axial-leaded tantalum electrolytic capacitors are only available as taped version (depending on the quantity ordered as tapes or reels, packed in cardboard box).
For reel-packing minimum order quantities corresponding to the reel size have been determined.

Rated diameter of the capacitor	Minimum order quantity ≙ packaging unit
≤3,4	5000
4,8; 4,7	3000
7,3	1000
8,9	800

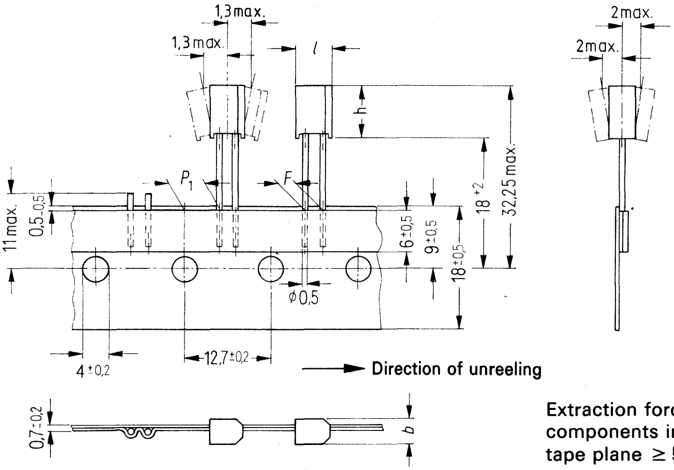
Since axial-leaded tantalum electrolytic capacitors, manufactured in quantity, are only available as taped version, the ordering code in the individual data sheets already includes the "9" identifying the taped version.

3 Taping of tantalum electrolytic capacitors with unidirectional leads

The types B 45 181, B 45 182 and B 45 185 in the case sizes A and B as well as type B 45 184 are ideally suited for packaging on continuous tapes.

Dimensions and tolerances

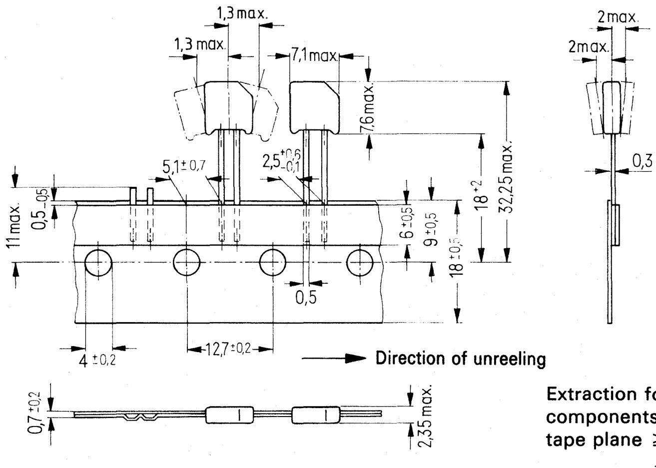
Types B 45 181, B 45 182, B 45 185



Extraction force for components in the tape plane ≥ 5 N

Size	l max	b max	h max	$F^{+0,6}_{-0,1}$	$P_1 \pm 0,7$
A	4,7	4,2	7,3	2,5	5,1
B	7,3	4,8	10,0	5,0	3,85

Type B 45 184

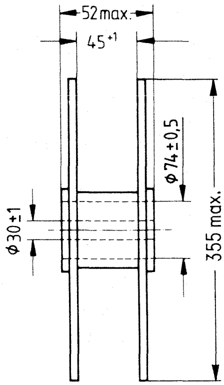


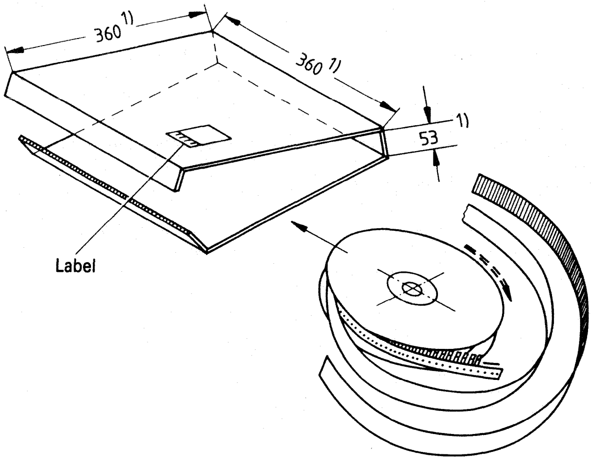
Dimensions in mm

Extraction force for components in the tape plane ≥ 5 N

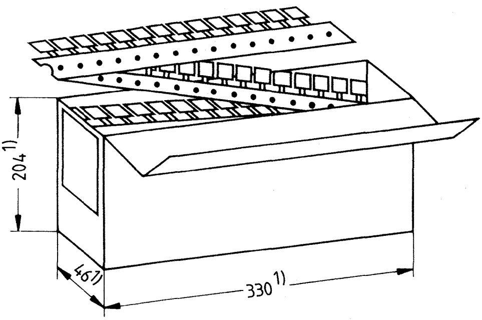
Packing methods

Reel packing





AMMO pack



1) Inner dimensions

Dimensions in mm

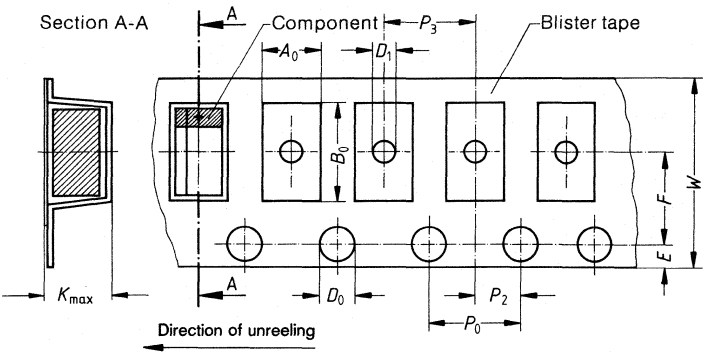
Ordering codes and packaging quantities

Type	Packing method	Ordering code[1]	Minimum order quantity = packaging unit (items/box) Case size of capacitor A	B
B 45181 B 45182 B 45185 (types A and B)	Reel	B45181 – + ✱✱✱✱ – + 9 B45182 – + ✱✱✱✱ – + 9 B45185 – + ✱✱✱✱ – + 9	1700	1400
	AMMO pack	B45181 – + ✱✱✱✱ – + 8 B45182 – + ✱✱✱✱ – + 8 B45185 – + ✱✱✱✱ – + 8	1200	1000
B 45184	Reel	B45184 – + ✱✱✱✱ – + 9	3000	
	AMMO pack	B45184 – + ✱✱✱✱ – + 8	1700	

1) The ordering code digits marked with + or ✱ have to be completed by the data given in the corresponding data sheets.

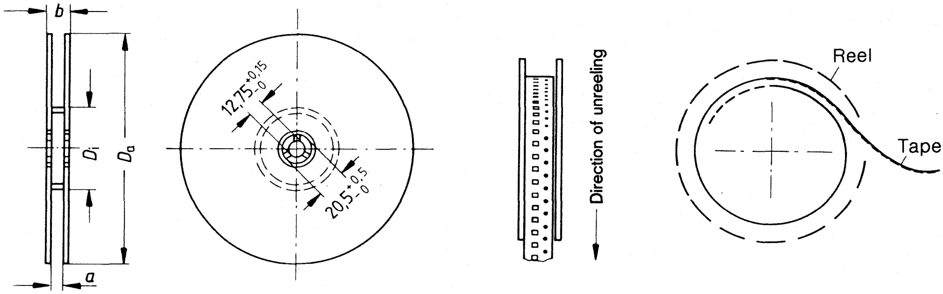
4 Taping of leadless components

Dimensions and tolerances



Dimensions	Case size B 45 193				
	A	B	C	D	E
W	12 ± 0,3		16 ± 0,3		
P_0	4 ± 0,1		8 ± 0,1		
D_0	1,5 + 0,1		1,5 + 0,1		
E	1,75 ± 0,1		1,75 ± 0,1		
F	5,5 ± 0,05		7,5 ± 0,05		
P_2	2 ± 0,05		4 ± 0,05		
P_3	4 ± 0,1		8 ± 0,1		
$K_{max.}$	2,7	3,5	2,7	3,5	5,9
$A_{0\,max.}$	3		5		
$B_{0\,max.}$	5		8,4		
D_1	1,5 + 0,2		1,5 + 0,2		
Reel diameter	180 and 330				

Tapes are supplied on reels as illustrated below



Reel dimensions (mm)

	D_i	D_a
Size 1	60	180
Size 2	100	330

	a	b
dim W[1]) 12 ± 0,3	$12{,}4^{+1{,}5}_{-0}$	$18{,}4_{max.}$
dim W[1]) 16 ± 0,3	$16{,}4^{+1{,}5}_{-0}$	$22{,}4_{max.}$

Packaging units

Size	Packaging unit for reel diameter D_a 180	330
A	2 200	6 000
B	1 600	4 500
C	1 000	3 000
D	800	2 200
E	400	1 000

Ordering code B45193-A∗∗∗∗ – +9

The ordering code digits marked with + or ∗ have to be completed by the data given in the corresponding data sheets.

[1]) refer to table of dimensions on page 37

Capacitors with Solid Electrolyte
Axial Leads

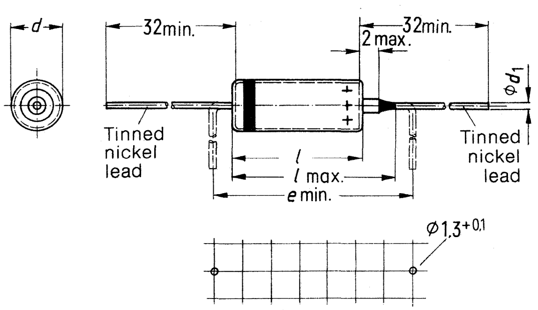
Sinter type with solid electrolyte, hermetically sealed, polar; high rel version

Application features
The capacitors are particularly suitable for use in communications engineering as well as in measuring and control equipment, where apart from high capacitance, a very low leakage current, a low dissipation factor, good temperature and frequency performance, and long service life are required.

DIN climatic category	FKC (DIN 40040)
Lower category temperature	F ≙ −55°C
Upper category temperature	K ≙ +125°C (from +85°C voltage derating)
Humidity category	C ≙ average relative humidity ≤95% 100% for 30 days per year
IEC climatic category	55/125/56
Technical data	IEC 384-15, DIN 44 350, DIN 44 351 B 45 010 (general information)
Qualified in acc. with (upon request)	UTE C 83-112, part 8 (CTS 32) MIL-C-39003/1E (refer to B 95057) CECC 30201-001; CECC 30201-019; CECC 30201-029 DIN 45910, part 144

Packaging on continuous tapes
The capacitors are supplied as taped versions (tape or reel).
For taping instructions refer to B 45 071, page 32.

Basic construction
Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte, in tubular, hermetically sealed metal case **with insulating sleeve.** Axial, tinned nickel leads at both ends.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)			Minimum lead spacing	Lead diameter
	$d \pm 0{,}4$	$l \pm 0{,}8$	l max.	e min.	$d_1 + 0{,}05$
A	3,4	7,2	10,7	12,5	0,5
B	4,7	12,0	15,4	17,5	0,5
C	7,3	17,3	20,8	22,5	0,6
D	8,9	20,0	23,4	25	0,6

Rated voltage V_R up to +85 °C[1])		6.3 Vdc	10 Vdc	16 Vdc	20 Vdc	25 Vdc	Case size
Rated voltage V_R up to +125 °C[1])		4 Vdc	6.3 Vdc	10 Vdc	13 Vdc	16 Vdc	
Rated capacitance µF	Tolerance	Output leakage current I_{lko}[2]) / Impedance Z[3]) Code					
1,5	±20% ≙ M ±10% ≙ K					0,5/17 -A8155- +9 ◥	A
2,2				0,5/12 -E2225- +9	0,5/12 -A3225- +9	0,6/11 -A8225- +9 ◥	B
3,3				0,5/9 -E2335- +9 ◥		0,8/7,5 -A8335- +9	B
4,7			0,5/7,5 -A1475- +9 ◥			1,5/5,5 -A8475- +9	B
6,8		0,5/6 -A685- +9 ◥				2,0/4,2 -A8685- +9	B
10						2,5/3,2 -A8106- +9 ◥	B
15				2,5/2,5 -E2156- +9	3/2,5 -A3156- +9	4/2,2 -A8156- +9 ◥	C
22				3,5/2,1 -E2226- +9 ◥		5,5/1,9 -A8226- +9	C
33			3,5/1,7 -A1336- +9 ◥	5,5/1,5 -E2336- +9		8/1,5 -A8336- +9 ◥	C
47		3/1,5 -A476- +9 ◥		7/1,3 -E2476- +9	9/1,3 -A3476- +9	12/1,1 -A8476- +9 ◥	D
68				10/1,1 -E2686- +9 ◥		17/0,9 -A8686- +9 ◥	D
100			10/1,0 -A1107- +9 ◥	15/0,8 -E2107- +9	20/0,8 -A3107- +9		D
150		9/0,8 -A157- +9		20/0,65 -E2157- +9 ◥			D
220			20/0,55 -A1227- +9 ◥				D
330		15/0,5 -A337- +9 ◥					D

Ordering code example B45170-E2156-+9

Type: B45170 — Code according to table: E2156-+9

\+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%; K ≙ ±10%

For packaging units and weights refer to page 30.

◥ These capacitors with ±20% capacitance tolerance are preferred types **S**, available for prompt delivery via the Siemens Components Service (refer to page 4).

[1]) Peak voltage $V_p = 1.15\ V_R$.
[2]) Output leakage current I_{lko} (µA), measured at 20 °C, and V_R after 5 minutes, limit values.
[3]) Impedance Z (Ω) measured at 10 kHz and 20 °C, limit values.

Rated voltage V_R up to +85°C[1]		40 Vdc	50 Vdc	63 Vdc	80 Vdc	Case size
Rated voltage V_R up to +125°C[1]		25 Vdc	33 Vdc	40 Vdc	50 Vdc	
Rated capacitance µF	Tolerance	Output leakage current I_{lko}[2] / Impedance Z[3] Code				
0,1		0,5/220 -E4104- +9		0,5/220 -A6104- +9	0,5/220 -E7104- +9 ◥	
0,15		0,5/150 -E4154- +9		0,5/150 -A6154- +9	0,5/150 -E7154- +9	
0,22		0,5/100 -E4224- +9		0,5/100 -A6224- +9	0,5/100 -E7224- +9	
0,33		0,5/75 -E4334- +9 ◥		0,5/75 -A6334- +9	0,5/75 -E7334- +9	A
0,47		0,5/50 -E4474- +9 ◥		0,5/50 -A6474- +9	0,5/50 -E7474- +9 ◥	
0,68		0,5/36 -E4684- +9 ◥		0,5/36 -A6684- +9	0,5/36 -E7684- +9	
1,0		0,5/25 -E4105- +9 ◥	0,5/25 -A5105- +9	0,7/25 -A6105- +9	1/25 -E7105- +9 ◥	
1,5		0,7/15 -E4155- +9 ◥		1/15 -A6155- +9	1,5/15 -E7155- +9	
2,2	±20% ≙ M ±10% ≙ K	1/11 -E4225- +9 ◥		1,5/11 -A6225- +9	2/11 -E7225- +9 ◥	B
3,3		1,5/7,5 -E4335- +9 ◥		2,5/7,5 -A6335- +9	3/7,5 -E7335- +9 ◥	
4,7		2/5,5 -E4475- +9 ◥	2,5/5,5 -A5475- +9	3/5,5 -A6475- +9		
6,8		3/4,2 -E4685- +9 ◥		4,5/4,0 -A6685- +9		C
10		4/2,8 -E4106- +9 ◥		6,5/2,8 -A6106- +9		
15		6/2,2 -E4156- +9 ◥		10/2,2 -A6156- +9		
22		9/1,9 -E4226- +9 ◥				D
33		12/1,4 -E4336- +9 ◥				
47		16/1,1 -E4476- +9 ◥				

Ordering code example B45170-A5105-+9

Type ——— B45170   A5105-+9 ——— Code according to table

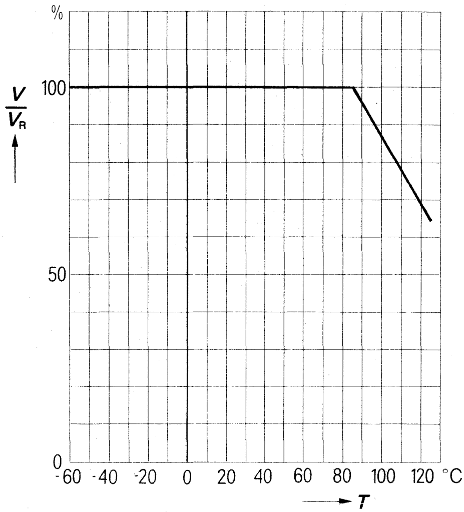
+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%, K ≙ ±10%.

For packaging units and weights refer to page 30.

◥ These capacitors with ±20% capacitance tolerance are preferred types S, available for prompt delivery via the Siemens Components Service (refer to page 4).

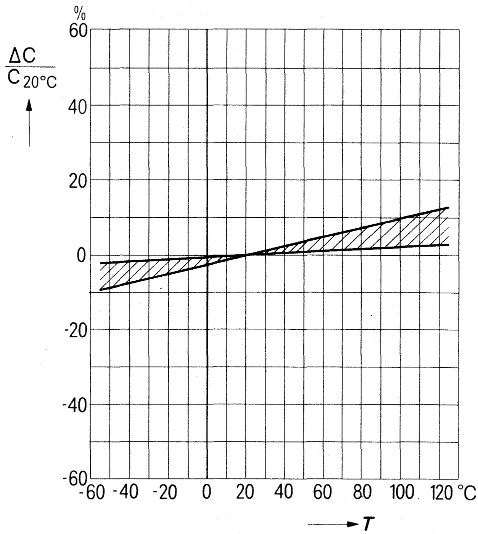
[1]) Peak voltage $V_P = 1.15\ V_R$.
[2]) Output leakage current I_{lko} (µA), measured at 20°C, and V_R after 5 minutes, limit values.
[3]) Impedance Z (Ω) measured at 10 kHz and 20°C, limit values.

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values

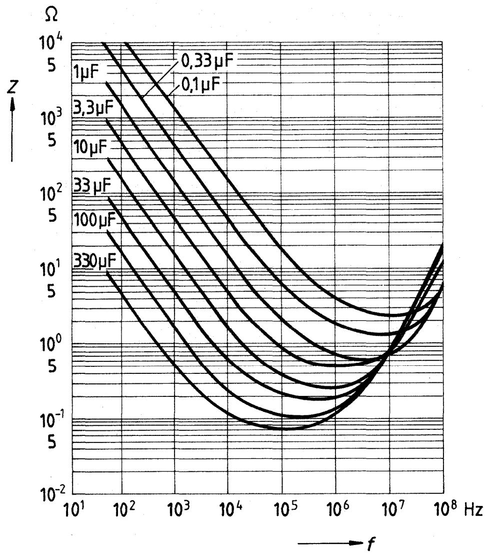


Maximum values

−55° C	+85° C	+125° C
−10%	+8%	+12%

Dissipation factor tan δ at 120 Hz (max. values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 1 μF	0,02	0,02	0,04	0,04
	> 1 ... 5,6 μF	0,04	0,04	0,04	0,04
	> 5,6 ... 100 μF	0,06	0,06	0,06	0,06
	> 100 μF	0,08	0,08	0,08	0,08

Impedance *Z*
versus frequency
(typical values at +20° C)



Impedance *Z*
(limit values at delivery for 10 kHz and +20° C)
see capacitance range

Impedance

versus temperature

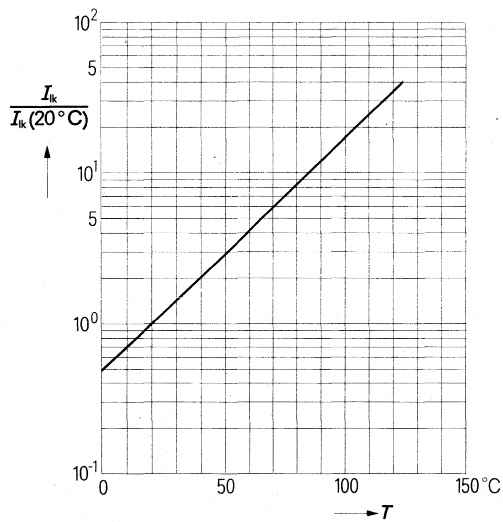
For temperatures deviating from +20 °C the impedance value has to be multiplied by the factors tabulated below:

at		Temperature factors −55° C	−40° C	−20° C	0° C	+20° C	+85° C	+125° C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 μF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 μF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

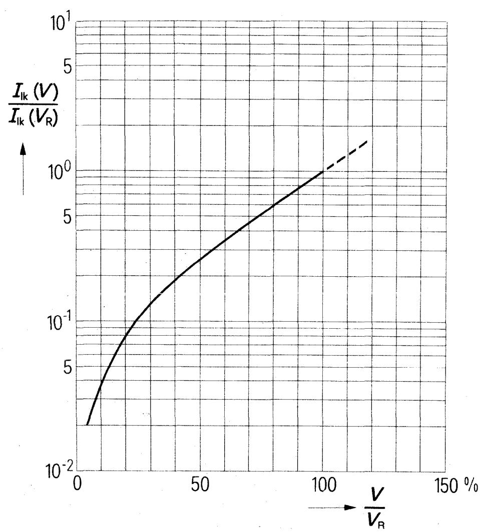
At +20°C the maximum values according to the table apply to the leakage current. The limit values at +85°C amount to 10 times and at +125°C (at voltage derating) to 12.5 times the limit value of the leakage current at +20°C.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible

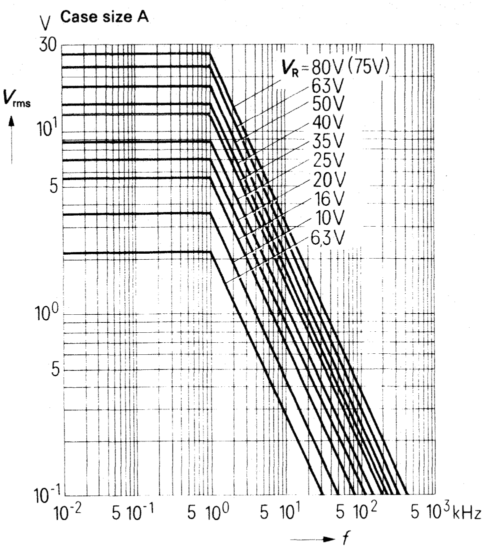
Leakage current, measurement

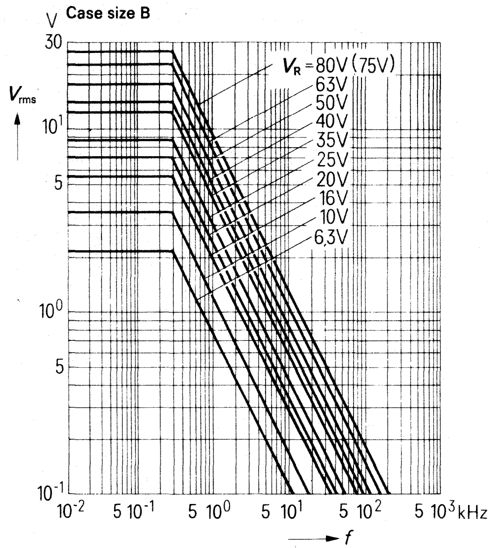
The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

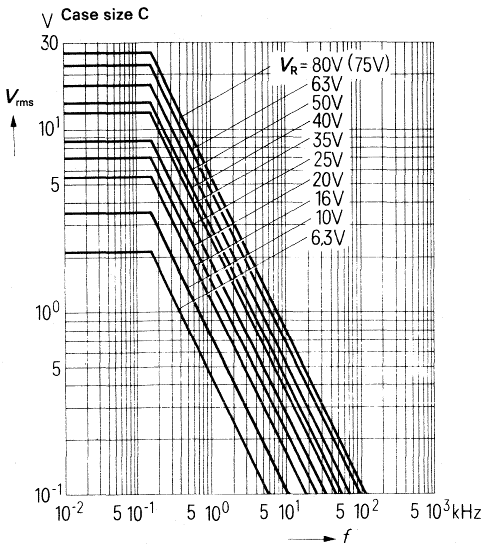
Permissible superimposed AC voltage

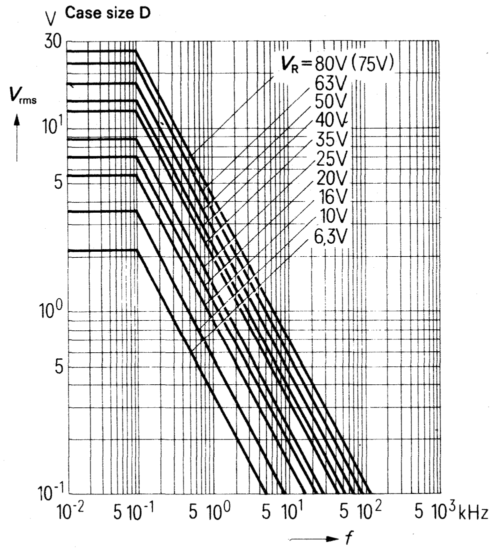
The capacitors can be operated with a superimposed ac voltage, provided that the permissible inherent temperature rise of the capacitor will not be exceeded. For limit values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20°C









At increased temperatures the following factors apply:

+50°C	+85°C	+125°C
0,7	0,5	0,3

The sum of the direct voltage and the peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

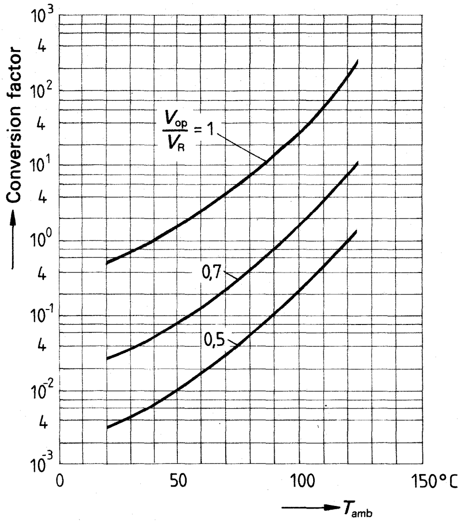
Polarity reversal voltage:	at +20° C: 0.15 × V_R
(intermittently)	at +55° C: 0.1 × V_R
	at +85° C: 0.05 × V_R

Series back-to-back circuit

For a back-to-back circuit (cathode to cathode) containing two capacitors of identical rated capacitance and rated voltage, twice the ac voltage as for a single capacitor is permissible. The frequency and temperature dependence indicated is correspondingly valid.

Life test 2000 h at +85° C or 2000 h at +125° C at voltage derating	ΔC ≤ 10% of the initial value $\tan\delta$ ≤ limit values $I_{lk\,20°C}$ ≤ 1.25 × initial limit values Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.	
Storage test (voltage-free) 5000 h at +85° C	ΔC ≤ 10% of the initial value $\tan\delta$ ≤ 1.5 × limit values $I_{lk\,20°C}$ ≤ limit values	
Capacitance drift	$^{+\ 5}_{-10}$% (typical value)	
Tensile strength of the leads	15 N (1.5 kp), 30 s in axial direction	
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2° C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test *Fc* in acc. with DIN IEC 68-2-6 Virbration, sinusoidal	Frequency range Displacement amplitude Duration	10 to 2000 Hz 1.5 mm (max. 196 m/s² or 20 *g* resp.) 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load	981 m/s² or 100 *g*
Low air pressure in accordance with DIN 40046, sheet 13	Condition 2	20 hP ≙ approx. 26 000 m height

Solder conditions	Temperature of the solder bath max. 270°C Soldering duration max. 2 s The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.
Dielectric strength of the insulating sleeve	2000 Vdc
Service life	> 500 000 h
Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.1% within 100 000 h ≙ 1 × 10^{-8}/h
The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance. For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).	Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥3	1	0,3	≤0,1
Factor for case size A and B	1	2,0	3,5	5,0
Factor for case size C and D	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variations	$I_{lk} > 5 \times I_{lko} + 5\mu A$ $Z >$ 3 times the max. limit value at delivery $\Delta C > 10\%$

[1]) For an example of how to calculate refer to page 26.

Sinter type with solid electrolyte, hermetically sealed, polar; particularly high volumetric efficiency; high rel version

Application features

The capacitors are particularly suitable for use in communications engineering as well as in measuring and control equipment, where apart from very high capacitance a low leakage current, a low dissipation factor, good temperature and frequency performance, and a long service life are required.

DIN climatic category F K C (DIN 40040)

Lower category temperature F ≙ −55°C
Upper category temperature K ≙ +125°C
(from +85°C voltage derating)
Humidity category C ≙ average relative humidity ≤ 95%,
100% for 30 days per year

IEC climatic category 55/125/56

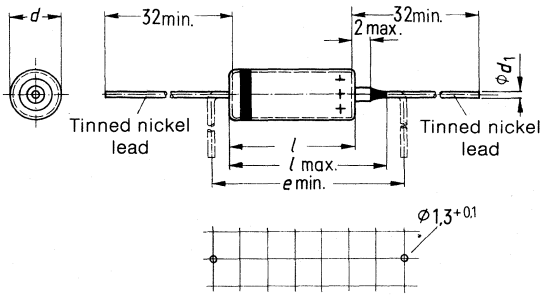
Technical data IEC 384-15
DIN 44 350
B45010 (general information)

Packaging on continuous tapes

The capacitors are supplied as taped versions (tape or reel).
For taping instructions refer to B45071, page 32.

Basic construction

Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte, in tubular, hermetically sealed metal case **with insulating sleeve.** Axial tinned-nickel leads at both ends.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)			Minimum lead spacing	Lead diameter
	$d \pm 0{,}4$	$l \pm 0{,}8$	l max.	e min.	$d_1 + 0{,}05$
A	3,4	7,2	10,7	12,5	0,5
B	4,7	12,0	15,4	17,5	0,5
C	7,3	17,3	20,8	22,5	0,6
D	8,9	20,0	23,4	25	0,6

Rated voltage V_R up to +85 °C[1])		6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	40 Vdc	Case size
Rated voltage V_R up to +125 °C[1])		4 Vdc	6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	
Rated capacitance		Output leakage current I_{lk}[2]) / Impedance Z[3]) Code					
µF	Tolerance						
1,5						0,5/17 -A5155-+9	A
2,2					0,5/12 -A4225-+9		
3,3					0,5/9,0 -A4335-+9		
4,7				0,5/7,5 -A3475-+9			B
6,8			0,5/6,0 -A2685-+9				
10		0,5/5,0 -A1106-+9				2,0/3,2 -A5106-+9	
22					3,0/2,1 -A4226-+9		
33	±20% ≙ M ±10% ≙ K			2,5/1,7 -A3336-+9		7,0/1,5 -A5336-+9	C
47			2,5/1,5 -A2476-+9			10/1,3 -A5476-+9	
68			3,5/1,3 -A2686-+9		8,5/1,1 -A4686-+9	14/0,9 -A5686-+9	
100		3,5/1,2 -A1107-+9		8,0/1,0 -A3107-+9	12,5/1,0 -A4107-+9		
150				12/0,8 -A3157-+9			
220			11/0,7 -A2227-+9	19/0,55 -A3227-+9			D
330		10/0,6 -A1337-+9		26/0,5 -A3337-+9			
470		15/0,55 -A1477-+9	24/0,45 -A2477-+9				
680		22/0,4 -A1687-+9					
1000		30/0,38 -A1108-+9					

Ordering code example B45176-A3107-+9

Type — B45176

Code according to table — A3107-+9

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20% or K ≙ ±10%

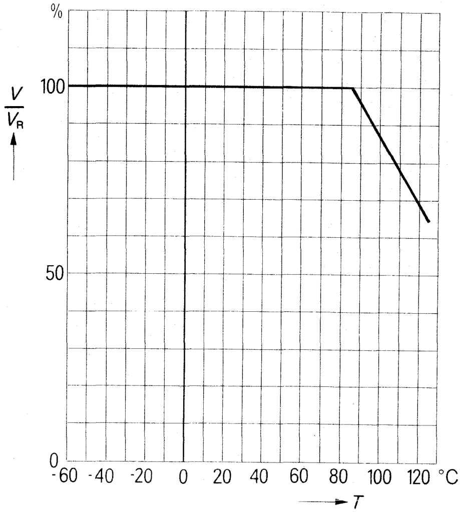
For packaging units and weights refer to page 30.

[1]) Peak voltage $V_P = 1.15\ V_R$.

[2]) Output leakage current I_{lk} (µA), measured at 20 °C/68 °F and V_R after 5 minutes, limit values. Lower leakage current values upon request.

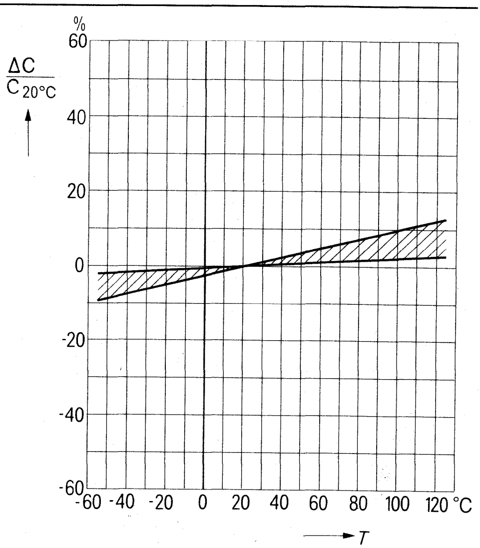
[3]) Impedance Z (Ω) measured at 10 kHz and 20 °C/68 °F, limit values at delivery.

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values



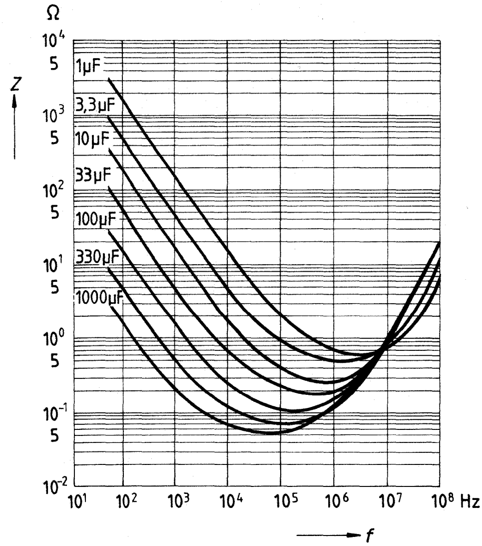
Maximum values

−55 °C	+85 °C	+125 °C
−10 %	+8 %	+12 %

Dissipation factor tan δ at 120 Hz for the entire temperature range (max. values)

Rated voltage 6.3 Vdc		10 Vdc		16 Vdc		25 Vdc		40 Vdc	
C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ
10	0,06	6,8	0,06	4,7	0,06	2,2	0,04	1,5	0,04
100	0,06	47	0,06	33	0,06	3,3	0,04	10	0,06
330	0,08	68	0,06	100	0,08	22	0,06	33	0,06
470	0,08	220	0,08	150	0,08	68	0,06	47	0,06
680	0,10	470	0,10	220	0,10	100	0,06	68	0,06
1000	0,10			330	0,10				

Impedance Z
versus frequency
(typical values at +20° C)



Impedance Z
(limit values at delivery for
10 kHz and +20° C)
see capacitance range

Impedance
versus temperature

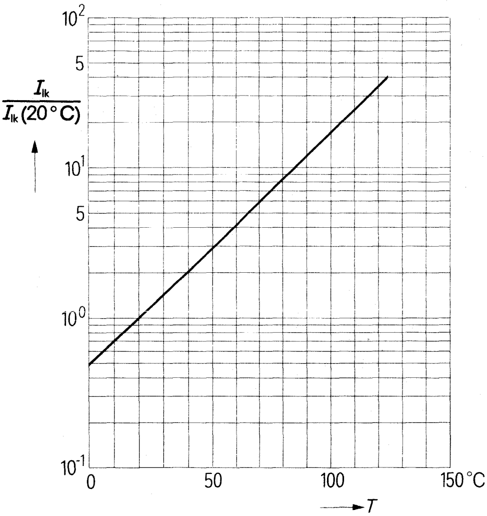
For temperatures deviating from +20° C the impedance has to be multiplied by the factors tabulated below:

at		Temperature factors −55° C	−40° C	−20° C	0° C	+20° C	+85° C	+125° C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 µF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 µF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

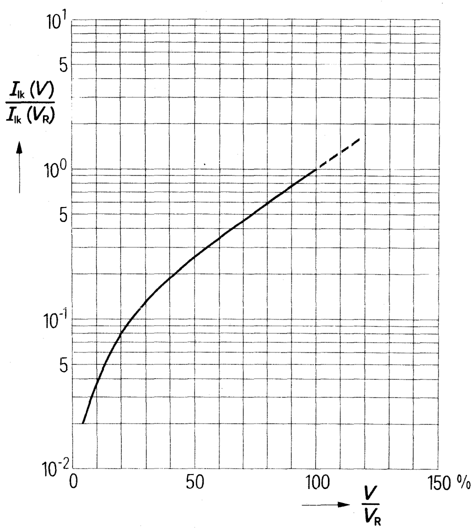
At +20°C the maximum values of the table apply to the leakage current. The limit values at +85°C amount to 10 times and at +125°C (at voltage derating) to 12.5 times the limit value of the leakage current at +20°C.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

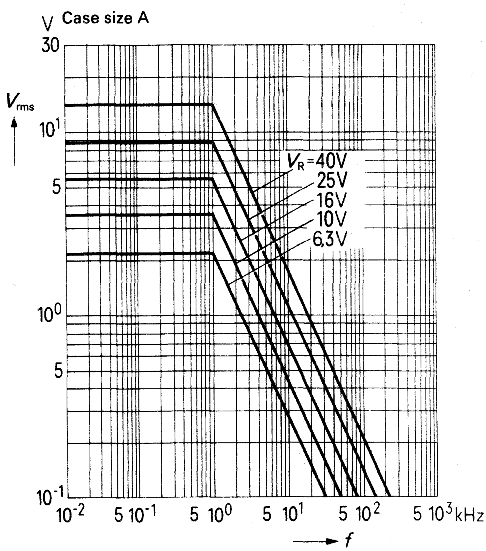
Leakage current, measurement

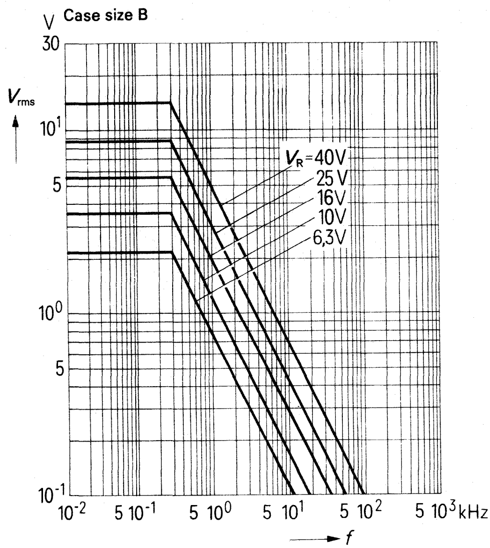
The measurement takes place at 20°C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

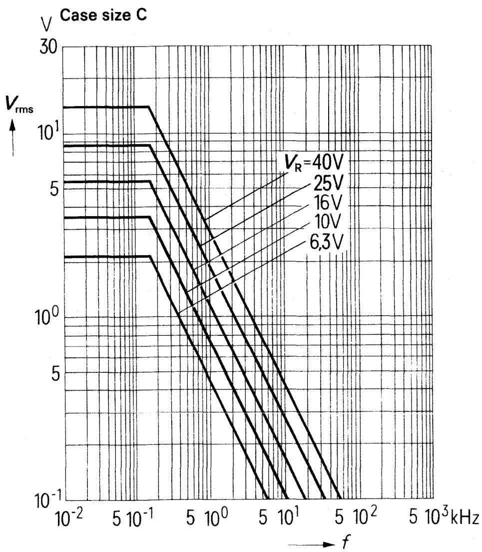
Permissible superimposed AC voltage

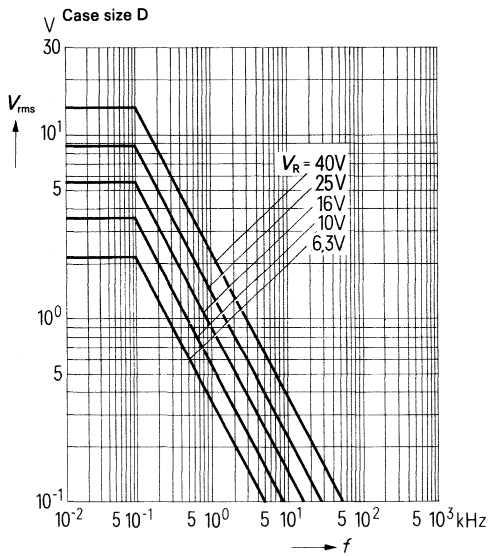
The capacitors can be operated with a superimposed ac voltage provided that the inherent temperature rise of the capacitors will not be exceeded. For limit values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20° C









At increased temperatures the following factors apply:

+50° C	+85° C	+125° C
0,7	0,5	0,3

The sum of direct voltage and peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)	at +20°C: $0.15 \times V_R$
	at +55°C: $0.1 \times V_R$
	at +85°C: $0.05 \times V_R$

Series back-to-back circuit

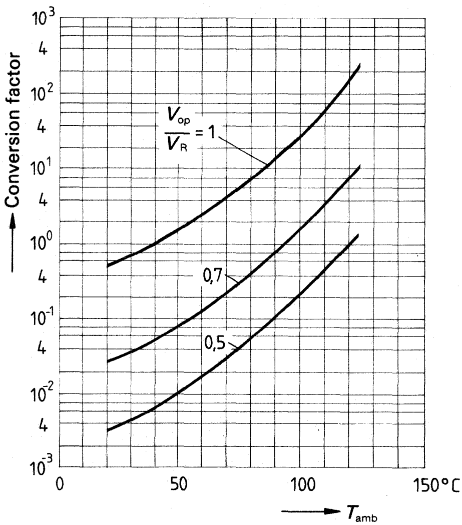
For a back-to-back circuit (cathode to cathode) containing two capacitors of identical rated capacitance and rated voltage, twice the ac voltage as for a single capacitor is permissible. The frequency and temperature dependence indicated is correspondingly valid.

Life test 2000 h at +85°C or 2000 h at +125°C at voltage derating	ΔC $\tan \delta$ $I_{lk\ 20°C}$ Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.	≤ 10% of the initial value ≤ limit values ≤ 1.25 × initial limit value
Storage test (voltage-free) 5000 h at +85°C	ΔC $\tan \delta$ $I_{lk\ 20°C}$	≤ 10% of the initial value ≤ 1.5 × limit values ≤ limit values
Capacitance drift	$^{+\ 5}_{-10}$ % (typical value)	
Tensile strength of the leads	15 N (1.5 kp), 30 s in axial direction	
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2°C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test *Fc* in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range Displacement amplitude Duration	10 to 2000 Hz 1.5 mm (complying with max. 196 m/s^2 or 20 *g* resp.) 6 h
Shock resistance in acc. with DIN 40046, sheet 7	Peak load	981 m/s^2 or 100 *g* resp.
Low air pressure in accordance with DIN 40046, sheet 13	Condition 2	20 hP ≙ approx. 26 000 m height

Solder conditions	Temperature of the solder bath: max. 270° C Soldering duration: max. 2 s The temperature, however, is not allowed — even at a final tinning process of the leads - to exceed 130° C at any point of the capacitor.
Dielectric strength of the insulating sleeve	2000 Vdc
Service life Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	> 500 000 h 0.1% within 100 000 h ≙ 1 × 10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥ 3	1	0,3	≤ 0,1
Factor for case size A and B	1	2,0	3,5	5,0
Factor for case size C and D	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variation	$I_{lk} > 5 \times I_{lko} + 5\ \mu A$ $Z >$ 3 times the max. limit value at delivery $\Delta C >$ 10%

[1]) For an example of how to calculate refer to page 26.

Miniature sinter version (solid electrolyte) in epoxy resin sealed metal case, axial leads, polar.

Fields of application

In communications engineering and data processing systems as well as in measuring and control equipment.

Features

Very high volumetric efficiency, highly compact construction (miniature version), very high resistance to shock and vibration, low leakage current.

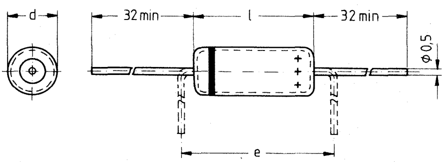
DIN climatic category	FKE (DIN 40040)
Lower category temperature	F ≙ −55°C
Upper category temperature	K ≙ +125°C (from +85°C voltage derating)
Humidity category	E ≙ average relative humidity ≤ 75%, 95% for 30 days per year rare and slight dew precipitation permitted
IEC climatic category	55/125/56
Technical data	IEC 384-15, DIN 44350, DIN 44359 DIN 45910, part 148 (CECC 30301-xxx) B 45010 (general information)

Packaging on continuous tapes

The capacitors are supplied as taped versions (tape or reel).
For taping instructions refer to B 45 071, page 32.

Basic construction

Tantalum capacitor with sintered body as anode and a solid semiconductor electrolyte, in tubular metal case, end-filled with epoxy resin (flame-retardant), and insulating sleeve. Axial, tinned nickel leads at both ends.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)		Minimum lead spacing
	$d \pm 0{,}4$	$l \pm 1$	e min.
1	2,4	6,6	10
2	2,8	7,4	12,5
3	4,8	8,8	12,5
4	4,8	11,8	15

Rated voltage V_R up to +85° C[1]	6.3 Vdc	10 Vdc	16 Vdc	20 Vdc	25 Vdc	35 Vdc	50 Vdc	Case size
Rated voltage V_R up to +125°C[1]	4 Vdc	6.3 Vdc	10 Vdc	13 Vdc	16 Vdc	23 Vdc	33 Vdc	
Rated capacitance µF / Tolerance	Output leakage current I_{lko}[2]/Impedance Z[3] Code							
0,1						0,5/220 -A6104-+9	0,5/220 -A7104-+9	1
0,15						0,5/150 -A6154-+9	0,5/150 -A7154-+9	1
0,22						0,5/100 -A6224-+9	0,5/100 -A7224-+9	1
0,33						0,5/75 -A6334-+9	0,5/75 -A7334-+9	2
0,47					0,5/50 -A5474-+9	0,5/50 -A6474-+9	0,5/50 -A7474-+9	2
0,68					0,5/36 -A5684-+9	0,5/36 -A6684-+9	0,5/36 -A7684-+9	2
1				0,5/25 -A4105-+9	0,5/25 -A5105-+9	0,5/25 -A6105-+9	0,5/25 -A7105-+9	2
1,5			0,5/17 -A3155-+9	0,5/17 -A4155-+9	0,5/15 -A5155-+9	0,5/15 -A6155-+9	0,8/15 -A7155-+9	3
2,2 (±20% ≙ M, ±10% ≙ K)		0,5/12 -A2225-+9	0,5/12 -A3225-+9	0,5/11 -A4225-+9	0,6/11 -A5225-+9	0,8/11 -A6225-+9	1,1/11 -A7225-+9	3
3,3		0,5/9 -A2335-+9	0,5/9 -A3335-+9	0,7/7,5 -A4335-+9	0,8/7,5 -A5335-+9	1,2/7,5 -A6335-+9	1,7/7,5 -A7335-+9	4
4,7	0,5/7,5 -A1475-+9	0,5/7,5 -A2475-+9	0,8/7,5 -A3475-+9	0,9/7,5 -A4475-+9	1,2/5,5 -A5475-+9	1,6/5,5 -A6475-+9	2,4/5,5 -A7475-+9	4
6,8	0,5/6 -A1685-+9	0,7/6 -A2685-+9	1,1/6 -A3685-+9	1,4/4,2 -A4685-+9	1,7/4,2 -A5685-+9	2,4/4,2 -A6685-+9		4
10	0,6/3,2 -A1106-+9	1,0/3,2 -A2106-+9	1,6/3,2 -A3106-+9	2,0/3,2 -A4106-+9	2,5/3,2 -A5106-+9	3,5/2,8 -A6106-+9		4
15	0,9/2,5 -A1156-+9	1,5/2,5 -A2156-+9	2,4/2,5 -A3156-+9	3,0/2,5 -A4156-+9	3,8/2,2 -A5156-+9			4
22	1,4/2,1 -A1226-+9	2,2/2,1 -A2226-+9	3,5/2,1 -A3226-+9	4,4/2,1 -A4226-+9				4
33	2,1/1,7 -A1336-+9	3,3/1,7 -A2336-+9	5,3/1,5 -A3336-+9					4
47	3,0/1,5 -A1476-+9	4,7/1,5 -A2476-+9						4
68	4,3/1,1 -A1686-+9							4

Ordering code example B45179-A3685-+9

Type ——— Code according to table

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ± 20%, K ≙ ± 10%

For packaging units and weights refer to page 30.

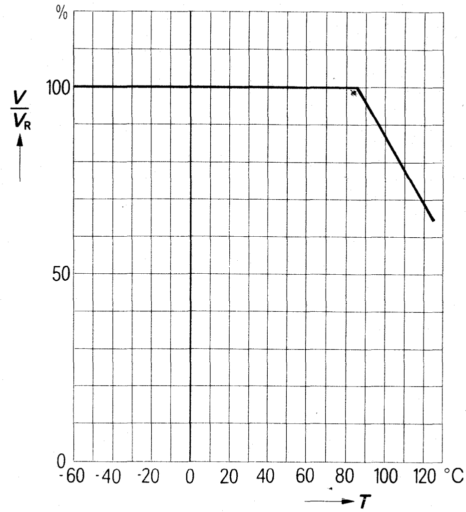
These capacitors with capacitance tolerance ±20% are preferred types S available for prompt delivery via the Siemens Components Service (refer to page 4).

[1]) Peak voltage $V_P = 1.15\ V_R$.

[2]) Output leakage current I_{lko} (µA), measured at 20°C and V_R after 5 minutes, limit values.

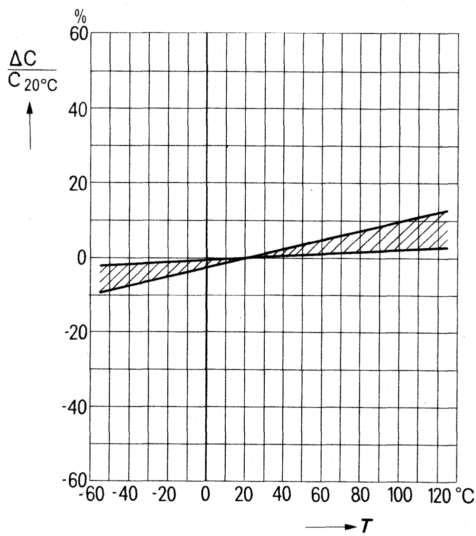
[3]) Impedance Z (Ω) measured at 10 kHz and 20° C, limit values.

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values

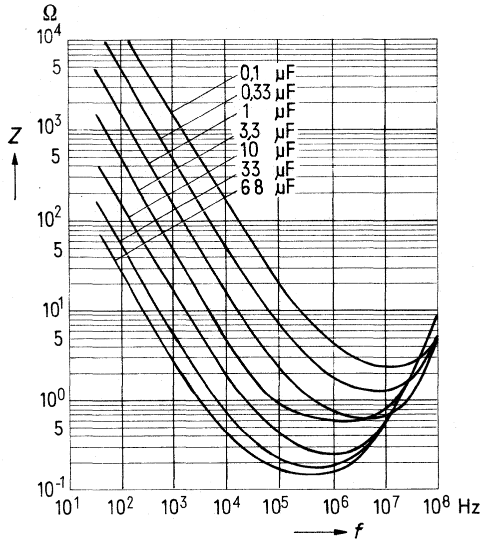


Maximum values

−55° C	+85° C	+125° C
−10%	+8%	+12%

	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
Dissipation factor tan δ at 120 Hz (max. values)	≤4,7 µF	0,04	0,04	0,04	0,04
	6,8 … 68 µF	0,06	0,06	0,06	0,06

Impedance *Z*
versus frequency
(typical values at +20° C)



Impedance *Z*
(limit values at delivery for 10 kHz and +20° C)
see capacitance range

Impedance versus temperature

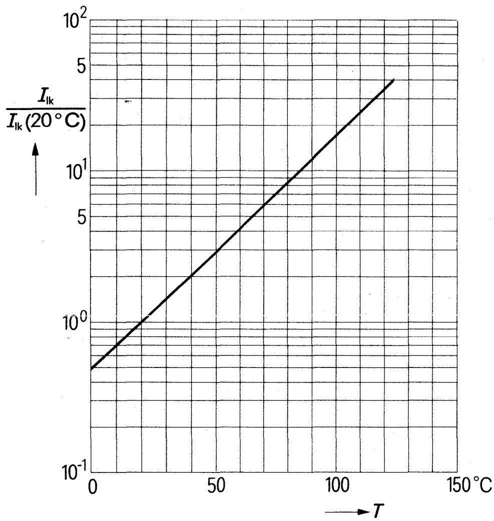
For temperatures deviating from +20° C, the impedance has to be multiplied by the factors tabulated below:

at		Temperature factors −55° C	−40° C	−20° C	0° C	+20° C	+85° C	+125° C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 µF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 µF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

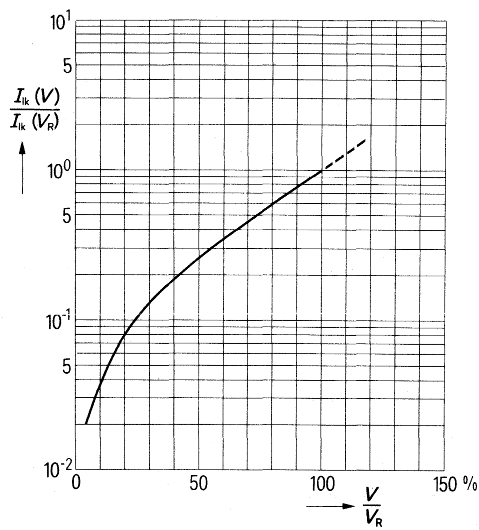
At +20 °C the maximum values of the table apply to the leakage current. The limit values at +85 °C amount to 10 times and at +125 °C (at voltage derating) to 12.5 times the limit value of the leakage current at +20 °C

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

Leakage current, measurement

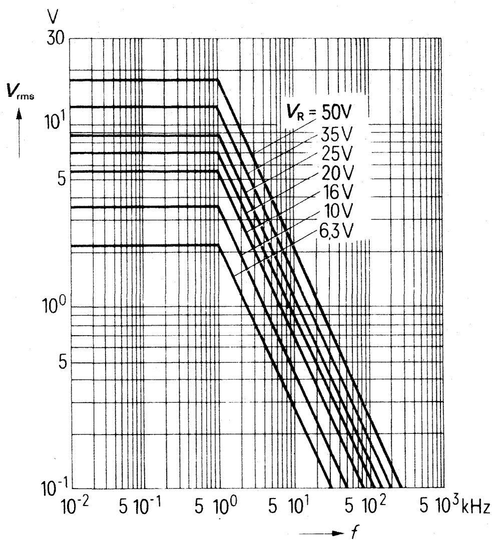
The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

Permissible superimposed AC voltage

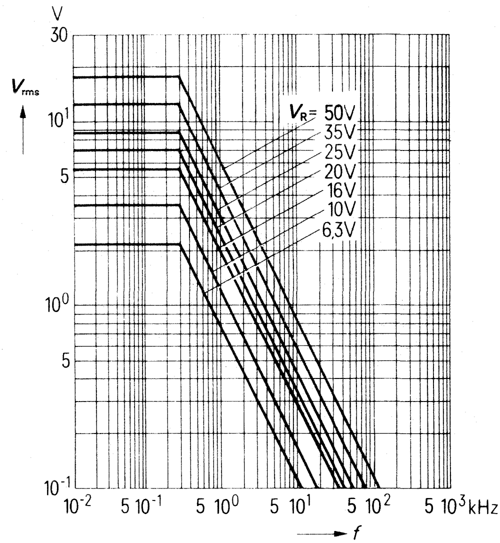
The capacitors can be operated with a superimposed ac voltage provided that the inherent temperature rise of the capacitors will not be exceeded. For maximum values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20 °C

Case size I, II



Case size III, IV



At increasing temperatures the following factors apply:

+50 °C	+85 °C	+125 °C
0,7	0,5	0,3

The sum of direct voltage and peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)
at +20 °C: 0.15 × V_R
at +55 °C: 0.1 × V_R
at +85 °C: 0.05 × V_R

Series back-to-back circuit

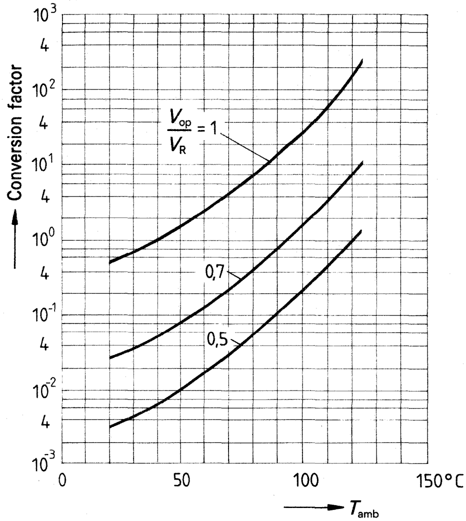
For a back-to-back circuit (cathode to cathode) containing two capacitors of identical rated capacitance and rated voltage, twice the ac voltage as for a single capacitor is permissible. The frequency and temperature dependence indicated is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC ≤ 10% of the initial value tan δ ≤ limit values $I_{\mathrm{lk}\,20\,°\mathrm{C}}$ ≤ 1.25 × initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC ≤ 10% of the initial value tan δ ≤ 1.5 × limit values $I_{\mathrm{lk}\,20\,°\mathrm{C}}$ ≤ limit values
Capacitance drift	$^{+\ 5}_{-10}$ % (typical values)
Tensile strength of the leads	15 N (1.5 kp), 30 s in axial direction
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4: 40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement amplitude: 1.5 mm (complying with max. 196 m/s² or 20 *g* resp.) Duration: 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load: 981 m/s² or 100 *g* resp.
Low air pressure in accordance with DIN 40046, sheet 13	Condition 2: 20 hP ≙ approx. 26 000 m height
Solder conditions	Temperature of the solder bath: max. 270 °C Soldering duration: max. 2 s The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.
Dielectric strength **of the insulating sleeve**	2000 Vdc

Service life	> 500 000 h
Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.20% within 100 000 h ≙ 2×10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥ 3	1	0,3	≤ 0,1
Factor for failure rate	1	2,0	3,5	5,0

Failure criteria	
Total failure	short or open circuit
Failure due to variation	$I_{lk} > 5 \times I_{lko} + 5$ µA $Z >$ 3 times the max. limit value at delivery $\Delta C > 10\%$

[1]) For an example of how to calculate refer to page 26.

Capacitors with Solid Electrolyte
Unidirectional Leads

Sinter type with solid electrolyte, single-ended leads; high rel version; in acc. with DIN 44 352; also with CECC quality assessment

Application features

These capacitors are especially suitable for use on PC boards of low voltage equipment, where apart from high packing density, a low dissipation factor, low leakage current, good temperature and frequency performance, and high reliability are required.
For special applications these capacitors — under supervision of the VDE testing board as national supervising inspectorate — are licensed for the international quality assessment system CECC. They are subject to international quality inspection and can be delivered including test reports.

DIN climatic category	F K E (DIN 40040)
Lower category temperature	F ≙ −55 °C
Upper category temperature	K ≙ +125 °C (from +85 °C voltage derating)
Humidity category	E ≙ average relative humidity ≤ 75%, 95% for 30 days per year, rare and slight dew precipitation permitted
IEC climatic category	55/125/56
Technical data	IEC 384-15, DIN 44 350, DIN 44 352 B 45 010 (general technical information)
Qualified	for capacitors with quality assessment in acc. with CECC 30200, CECC 30201-007, CECC 30201-009 UTE C 83-112, part 6

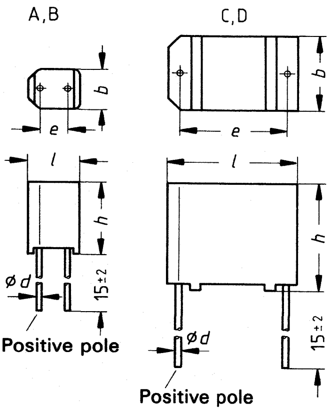
Packaging on continuous tapes

The capacitors of sizes A and B are also available as taped versions. For taping instructions and ordering information refer to B 45071, page 32.

Basic construction

Tantalum capacitors with sintered body as anode and a solid semiconductor electrolyte. Rectangular, epoxy resin encapsulated type (flame-retardant) with single-ended tinned nickel leads. The positive pole is marked by a lateral projection. Values are stamped on the capacitor.

Case sizes



Case size	b max.	l max.	h max.	d¹)	e ±0,2
A	4,2	4,7	7,3	0,5	2,54
B	4,8	7,3	10	0,5	5,08
C	7,3	12,3	10	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

¹) Permissible deviation in accordance with DIN 40815.

Dimensions in mm

Rated voltage V_R up to +85°C[1])		6.3 Vdc	10 Vdc	16 Vdc	20 Vdc	25 Vdc	40 Vdc	50 Vdc	Case size
Rated voltage V_R up to +125°C[1])		4 Vdc	6.3 Vdc	10 Vdc	13 Vdc	16 Vdc	25 Vdc	33 Vdc	
Rated capacitance		Output leakage current I_{lko}[2])/Impedance Z[3]) Code							
µF	Tolerance								
0,1							0,5/220 -C4104-+ ◥	0,5/220 -B6104-+	
0,15							0,5/150 -C4154-+	0,5/150 -B6154-+	
0,22							0,5/100 -C4224-+ ◥	0,5/100 -B6224-+	
0,33							0,5/75 -C4334-+	0,5/75 -B6334-+	A
0,47							0,5/50 -C4474-+ ◥	0,5/50 -B6474-+	
0,68							0,5/36 -C4684-+	0,5/36 -B6684-+	
1							0,5/25 -C4105-+ ◥	0,5/25 -B6105-+	
1,5						0,5/17 -C3155-+ ◥	0,7/15 -C4155-+ ◥	0,9/15 -B6155-+	
2,2					0,5/12 -B7225-+		1,0/11 -C4225-+ ◥	1,7/11 -B6225-+	
3,3				0,5/9 -B2335-+ ◥			1,5/7,5 -C4335-+ ◥	2,0/7,5 -B6335-+	B
4,7	±20% ≙ M ±10% ≙ K		0,5/7,5 -B1475-+ ◥				2,0/5,5 -C4475-+ ◥	2,5/5,5 -B6475-+	
6,8		0,5/6 -B685-+ ◥					3,0/4,2 -C4685-+ ◥	3,5/4,0 -A6685-+	
10						2,5/3,2 -C3106-+ ◥	4,0/2,8 -B4106-+ ◥	5/2,8 -A6106-+	C
15					3/2,5 -B7156-+		6,0/2,2 -B4156-+ ◥	8/2,2 -A6156-+	
22				3,5/2,1 -B2226-+ ◥			9,0/1,9 -B4226-+ ◥	12/1,7 -A6226-+	
33			3,5/1,7 -B1336-+ ◥			8,0/1,5 -B3336-+ ◥	12/1,4 -B4336-+ ◥		
47		3,0/1,5 -B476-+ ◥			9/1,3 -A7476-+	12/1,3 -B3476-+ ◥	16/1,1 -B4476-+ ◥		
68				10/1,1 -A2686-+ ◥		17/0,9 -B3686-+ ◥			D
100			10/1,0 -A1107-+ ◥		20/0,8 -A7107-+				
150		9,0/0,8 -A157-+ ◥		20/0,65 -A2157-+ ◥					
220			20/0,55 -A1227-+ ◥						
330		15/0,5 -A337-+ ◥							

Normal version
Ordering code example B45181-B4336-+

Quality-assessed version[4])
Ordering code example B 45181-Q4336-+

Type: B45181 — Code according to table: B4336-+

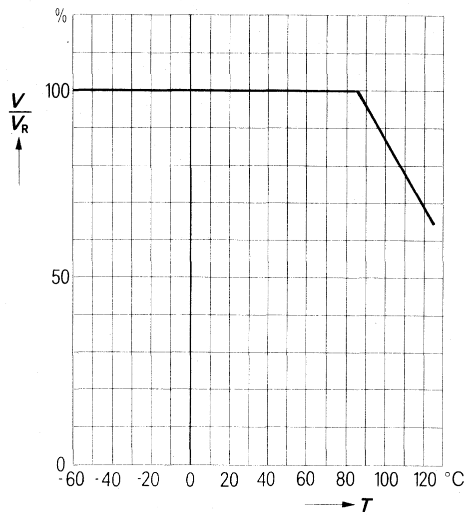
+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ± 20%, K ≙ ± 10%

For packaging units and weights refer to page 30.

◥ These capacitors with capacitance tolerance ±20% are preferred types S available for prompt delivery via the Siemens Components Service (refer to page 4).

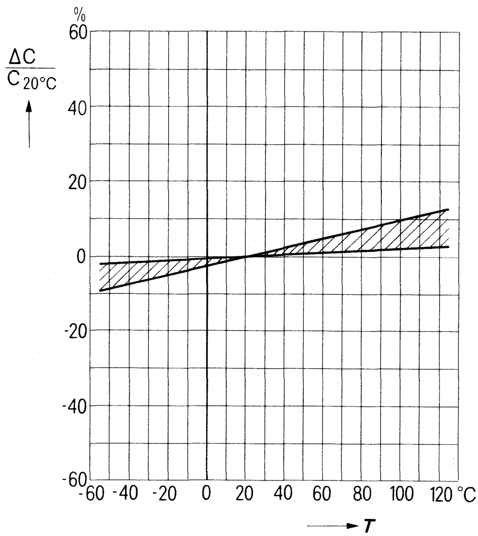
[1]) $V_p = 1.15\ V_R$.
[2]) Output leakage I_{lko} (µA), measured at 20°C and V_R after 5 minutes (limit values).
[3]) Impedance Z (Ω) measured at 10 kHz and 20°C (limit values).
[4]) The quality-assessed version is indicated by a "Q" in the second block of the ordering code.

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values



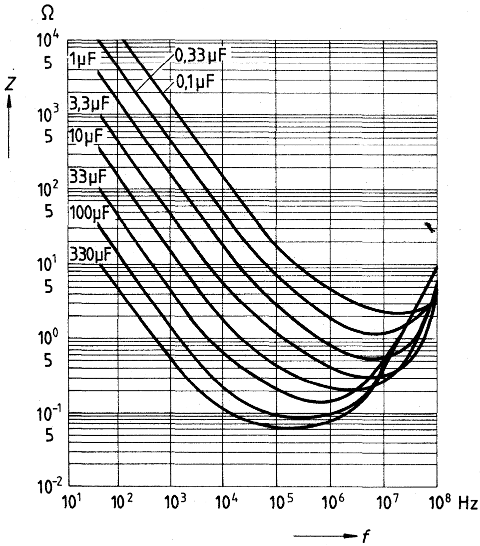
Maximum values

– 55° C	+ 85° C	+ 125° C
– 10 %	+ 8 %	+ 12 %

Dissipation factor tan δ at 120 Hz
(limit values)

Rated capacitance	−55°C	+20°C	+85°C	+125°C
≤ 100 μF	0,06	0,06	0,06	0,06
> 100 μF	0,08	0,08	0,08	0,08

Impedance *Z*
versus frequency
(typical values at +20 °C)



Impedance *Z*
(limit values at delivery for
10 kHz and +20 °C)
see capacitance range

Impedance versus temperature

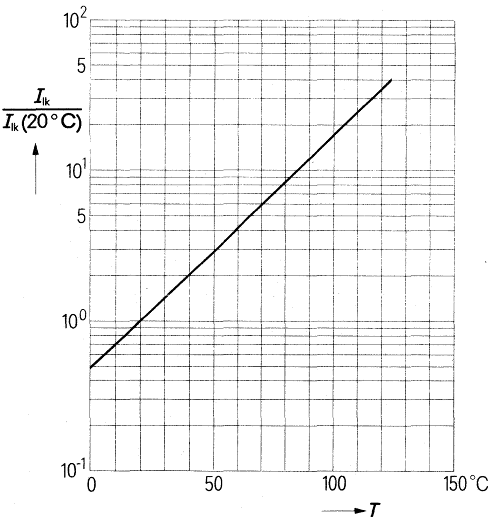
For temperatures deviating from +20 °C, the impedance has to be multiplied by the factors tabulated below:

at		Temperature factors −55°C	−40°C	−20°C	0°C	+20°C	+85°C	+125°C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 μF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 μF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

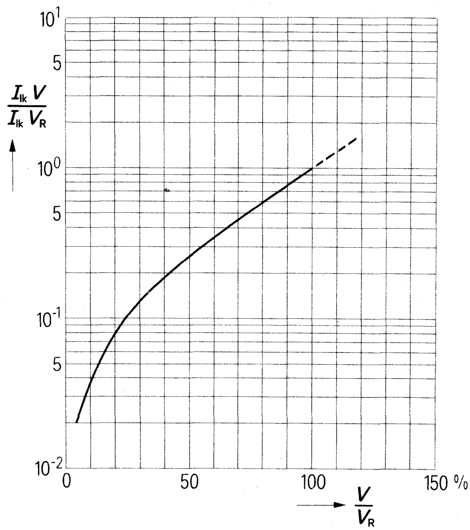
At $+20\,°C$ the maximum values of the table apply to the leakage current. The limit values at $+85\,°C$ amount to 10 times and at $+125\,°C$ (at voltage derating) to 12.5 times the limit value of the leakage current at $+20\,°C$.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

Leakage current, measurement

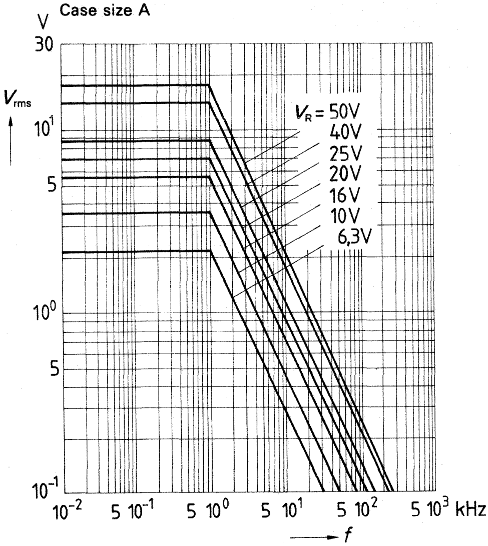
The measurement takes place at $20\,°C$ after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of $1000\ \Omega$ to limit the charging current of the capacitor.
Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

Permissible superimposed AC voltage

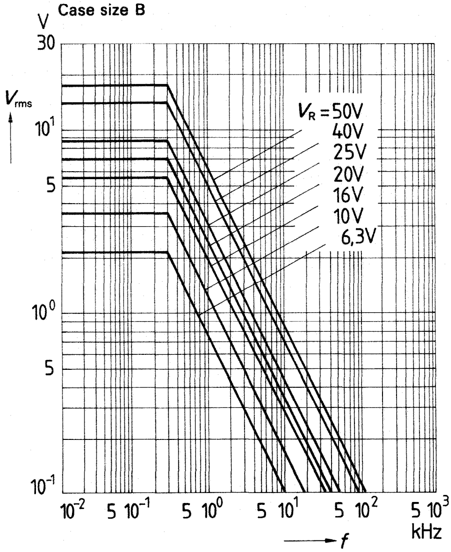
The capacitors can be operated by superimposed ac voltage provided that the inherent temperature rise of the capacitors will not be exceeded. For maximum values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20 °C

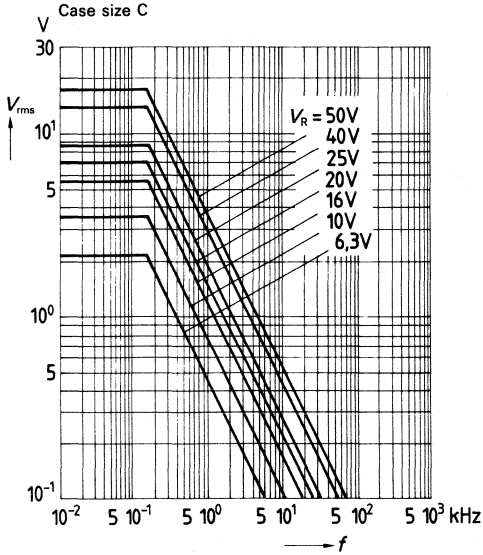
Case size A



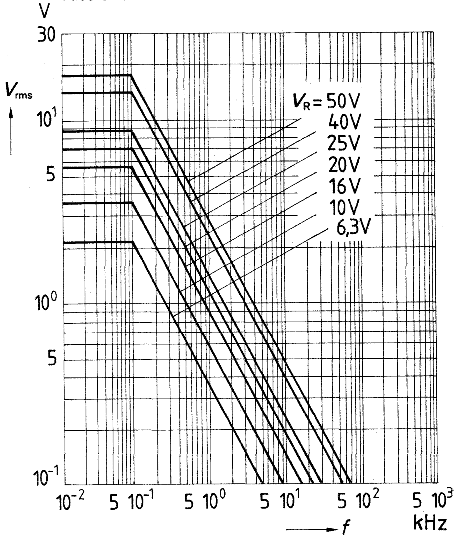
Case size B



Case size C



Case size D



At increased temperatures the following factors apply:

+50 °C	+85 °C	+125 °C
0,7	0,5	0,3

The sum of direct voltage and peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)	at +20 °C: $0.15 \times V_R$ at +55 °C: $0.1 \times V_R$ at +85 °C: $0.05 \times V_R$

Series back-to-back circuit

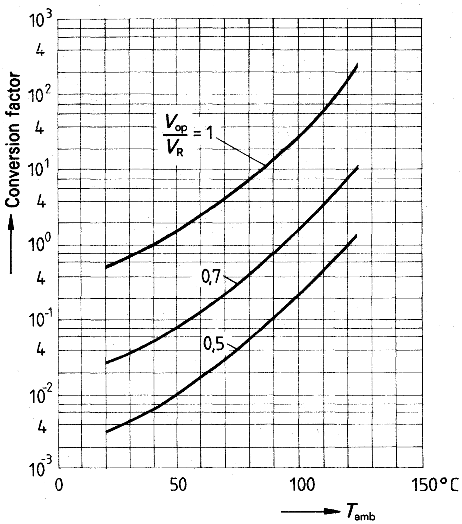
For a back-to-back circuit (cathode to cathode) of two capacitors of identical rated capacitance and rated voltage, twice the ac voltage of a single capacitor is permissible. The indicated frequency and temperature dependence is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC $\tan \delta$ $I_{lk\,20\,°C}$	$\leq$ 10% of the initial value $\leq$ limit values $\leq 1.25 \times$ initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC $\tan \delta$ $I_{lk\,20\,°C}$	$\leq$ 10% of the initial value $\leq 1.5 \times$ limit values $\leq$ limit values
Capacitance drift	$^{+\,5}_{-10}$ % (typical value)	
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range Displacement amplitude Duration	10 to 2000 Hz 1.5 mm (complying with max. 196 m/s² or 20 *g* resp.) 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load	981 m/s² or 100 *g* resp.
Solder conditions	Temperature of the solder bath Soldering duration	max. 270 °C max. 2 s
	The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.	

Service life	> 500 000 h
Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.30% within 100 000 h ≙ 3×10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥3	1	0,3	≤0,1
Factor for case size A and B	1	2,0	3,5	5,0
Factor for case size C and D	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variations	$I_{lk} \geq 5 \times I_{lko} + 5\ \mu A$ $Z \geq 3$ times the max. limit value at delivery ΔC at $V \leq 16$ V: +10 . . . −20% ΔC at $V > 16$ V: +10 . . . −10%

[1]) For an example of how to calculate refer to page 26.

Sinter version with solid electrolyte; very high volumetric efficiency, single-ended leads, high rel version

Fields of application

in communications engineering and data processing systems as well as in measuring and control equipment.

Features

These capacitors are especially suitable for use on PC boards of low voltage equipment, where apart from high packing density, a low dissipation factor, low leakage current, good temperature and frequency performance, and high reliability are required.

DIN climatic category F K E (DIN 40040)

Lower category temperature F ≙ $-55\,°C$
Upper category temperature K ≙ $+125\,°C$ (from $+85\,°C$ voltage derating)
Humidity category E ≙ average relative humidity ≤ 75%, 95% for 30 days per year, rare and slight dew precipitation permitted

IEC climatic category 55/125/56

Technical data IEC 384-15, DIN 44 350
B 45 010 (general technical information)

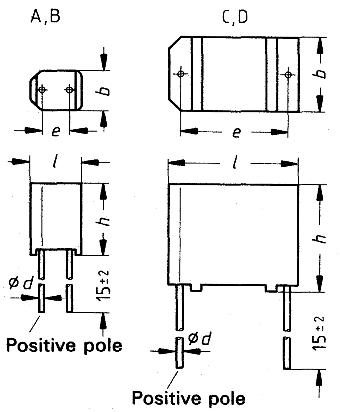
Packaging on continuous tapes

The capacitors of sizes A and B are available as taped versions. For taping instructions and ordering information refer to B 45071, page 32.

Basic construction

Tantalum capacitors with sintered body as anode and a solid semiconductor electrolyte. Rectangular, epoxy resin encapsulated type (flame-retardant) with single-ended tinned nickel leads. The positive pole is marked by a lateral projection. Values are stamped on the capacitor.

Case sizes



Case size	*b* max.	*l* max.	*h* max.	*d*[1])	*e* ±0,2
A	4,2	4,7	7,3	0,5	2,54
B	4,8	7,3	10	0,5	5,08
C	7,3	12,3	10	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

[1]) Permissible deviations in accordance with DIN 40815.

Dimensions in mm

Rated voltage V_R up to +85 °C[1])		6.3 Vdc	10 Vdc	16 Vdc	20 Vdc	25 Vdc	40 Vdc	50 Vdc	Case size
Rated voltage V_R up to +125 °C[1])		4 Vdc	6.3 Vdc	10 Vdc	13 Vdc	16 Vdc	25 Vdc	33 Vdc	
Rated capacitance µF	Tolerance	Output leakage current I_{lko}[2]) / Impedance Z[3]) Code							
1,5								0,8/17 -A7155-+	A
2,2							0,9/12 -A6225-+		
3,3						0,8/9,0 -A5335-+			B
4,7					0,9/7,5 -A4475-+				
6,8				1,1/6,5 -A3685-+				3,4/4,5 -A7685-+	
10	±20% ≙ M +10% ≙ K		1,0/3,5 -A2106-+				4,0/3,2 -A6106-+		
15		0,9/2,8 -A1156-+							C
22						5,5/2,1 -A5226-+		11,0/1,9 -A7226-+	
33					6,6/1,7 -A4336-+		13,0/1,6 -A6336-+		D
47				7,5/1,5 -A3476-+		12,0/1,4 -A5476		24,0/1,3 -A7476-+	
68			6,8/1,3 -A2686-+		14,0/1,1 -A4686-+		27,0/1,2 -A6686-+		
100		6,3/1,2 -A1107-+		16,0/1,0 -A3107-+		25,0/1,0 -A5107-+			
150			15,0/0,7 -A2157-+		30,0/0,9 -A4157-+				
220		14,0/0,6 -A1227-+		35,0/0,7 -A3227-+					
330			33,0/0,6 -A2337-+						
470		30,0/0,55 -A1477-+							

Ordering code example B45182-A6106-+

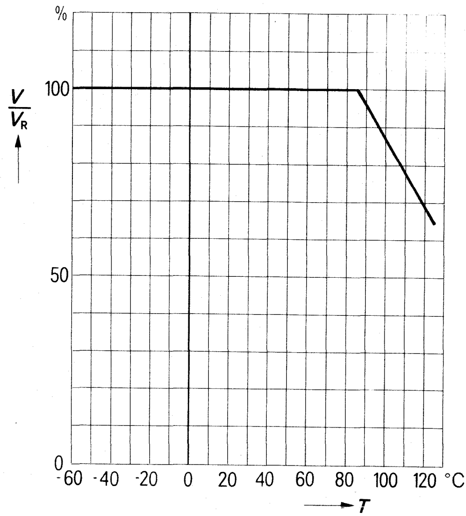
Type —— Code according to table

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%, K ≙ ±10%

For packaging units and weights refer to page 30.

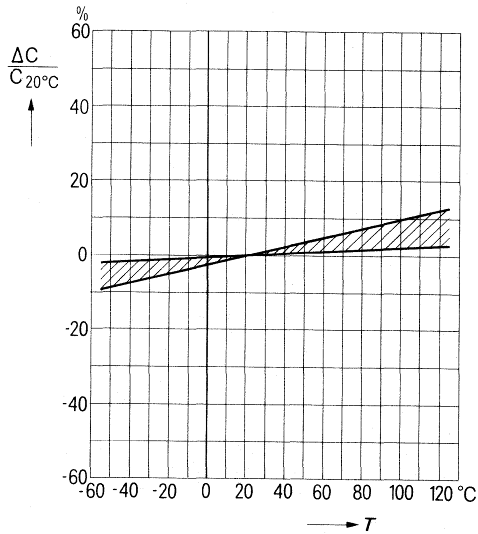
[1]) Peak voltage $V_P = 1.15\ V_R$.
[2]) Leakage current I_{lko} (µA) at 20 °C and V_R after 5 minutes (limit values).
[3]) Impedance $Z(\Omega)$ at 10 kHz and 20 °C (limit values).

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values

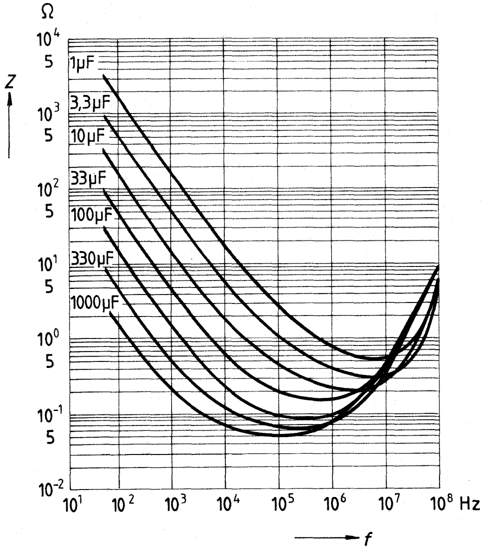


Maximum values

−55 °C	+85 °C	+125 °C
−10 %	+8 %	+12 %

Dissipation factor tan δ at 120 Hz (limit values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 100 µF	0,08	0,06	0,08	0,08
	> 100 µF	0,10	0,08	0,10	0,10

Impedance Z
versus frequency
(typical values at +20 °C)



Impedance Z
(limit values at delivery for
10 kHz and +20 °C)
see capacitance range

Impedance versus temperature

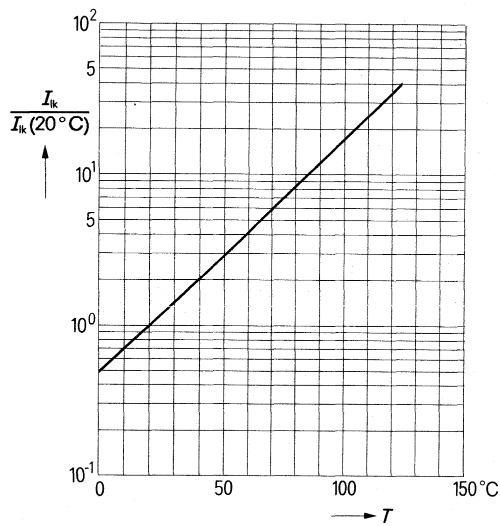
For temperatures deviating from +20 °C, the impedance has to be multiplied by the factors tabulated below:

at		Temperature factors −55 °C	−40 °C	−20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 µF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 µF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

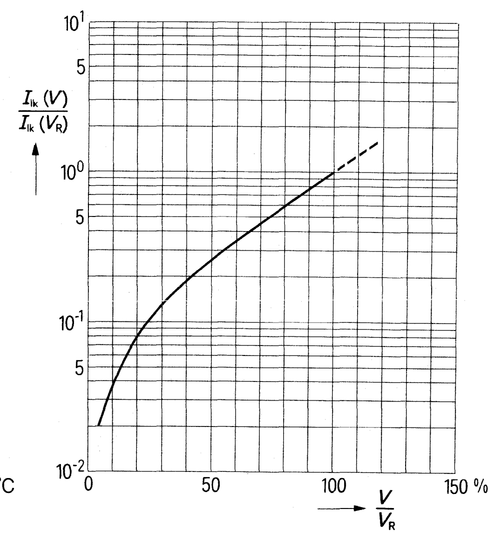
At $+20\,^\circ C$ the maximum values according to the table are valid for the leakage current. The limit values at $+85\,^\circ C$ amount to 10 times and at $+125\,^\circ C$ (at voltage derating) to 12.5 times the limit value of the leakage current at $+20\,^\circ C$.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

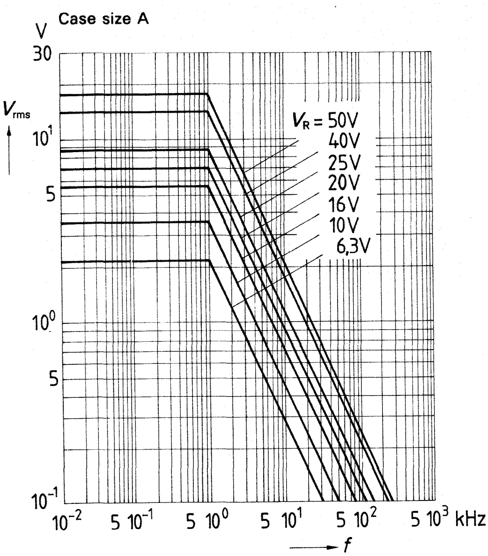
Leakage current, measurement

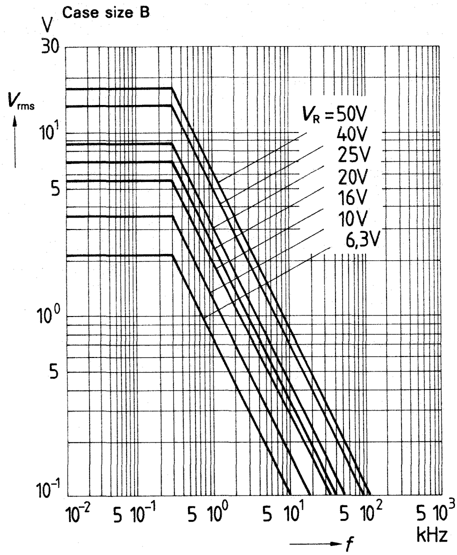
The measurement takes place at $20\,^\circ C$ after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistor of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied, the capacitor must be stabilized for 30 minutes at rated temperature.

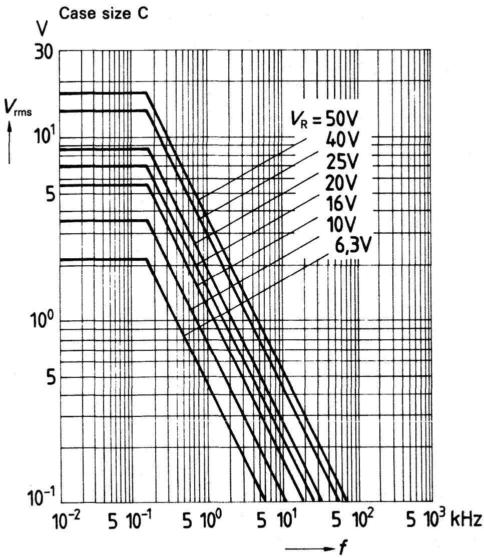
Permissible superimposed AC voltage

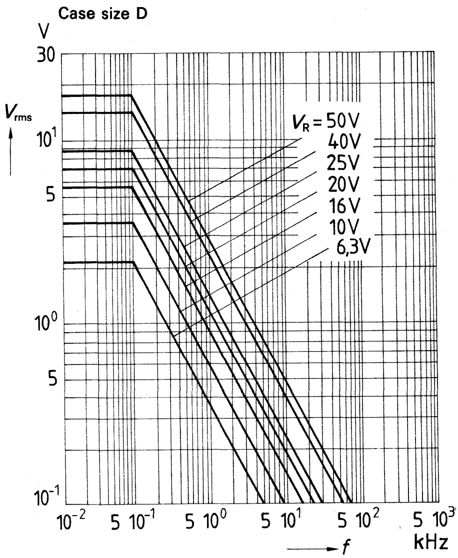
The capacitors can be operated at superimposed ac voltage provided that the permissible inherent temperature rise of the capacitor is not exceeded. For limit values of superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20 °C









At increased temperatures the following factors apply:

+50 °C	+85 °C	+125 °C
0,7	0,5	0,3

The sum of direct voltage and peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)
at +20 °C: $0.15 \times V_R$
at +55 °C: $0.1 \times V_R$
at +85 °C: $0.05 \times V_R$

Series back-to-back circuit

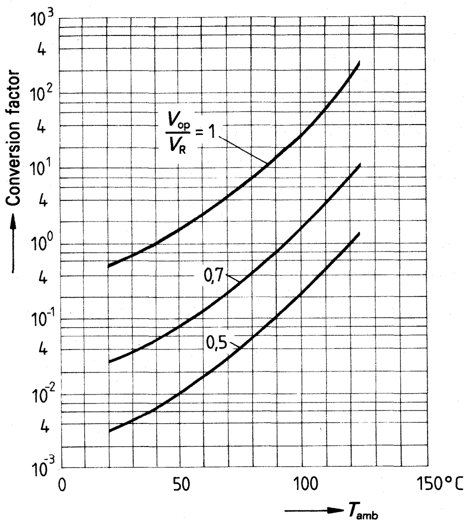
For a back-to-back circuit (cathode to cathode) of two capacitors of identical rated capacitance and rated voltage, twice the ac voltage of a single capacitor is permissible. The indicated frequency and temperature dependence is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC ≤ 10% of the initial value $\tan\delta$ ≤ limit values $I_{lk\,20\,°C}$ ≤ 1.25 × initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC ≤ 10% of the initial value $\tan\delta$ ≤ 1.5 × limit values $I_{lk\,20\,°C}$ ≤ limit values
Capacitance drift	$^{+\,5}_{-10}$ % (typical value)
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4: 40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement amplitude: 1.5 mm (complying with max. 196 m/s² or 20 *g* resp.) Duration: 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load: 981 m/s² or 100 *g* resp.
Solder conditions	Temperature of the solder bath: max. 270 °C Soldering duration: max. 2 s The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.

Service life	> 500 000 h
Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.30% within 100 000 h ≙ 3×10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥ 3	1	0,3	≤ 0,1
Factor for case size A and B	1	2,0	3,5	5,0
Factor for case size C and D	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variations	$I_{lk} \geq 5 \times I_{lko} + 5\ \mu A$ $Z \geq 3$ times the max. limit value at delivery ΔC at $V \leq 16$ V: +10 . . . −20% ΔC at $V > 16$ V: +10 . . . −10%

[1]) For an example of how to calculate the total failure rate see page 26.

Sinter version with solid electrolyte, plug-in, high rel version, incorporated overload protector

Application features

These capacitors are particularly suitable for use on PC boards in communications engineering and in measuring and control equipment, where apart from **high packing density**, a low dissipation factor, low leakage current, good temperature and frequency performance as well as very high reliability are required.

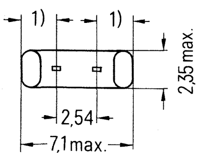
DIN climatic category	F K F (DIN 40040)
Lower category temperature	F ≙ −55 °C
Upper category temperature	K ≙ +125 °C (from +85 °C voltage derating)
Humidity category	F ≙ average relative humidity ≤ 75%, 95% for 30 days per year
Storage temperature range	−55 °C to +125 °C
IEC climatic category	55/125/56
Technical data	IEC 384-15 DIN 44 350 B 45 010 (general information)

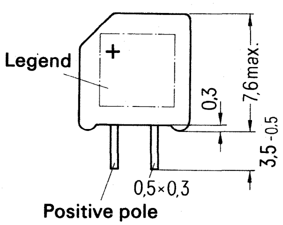
Packaging on continuous tapes

The capacitors are also available as taped version. For taping instructions and ordering information refer to B 45071, page 32.

Basic construction

Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte. Rectangular, plastic coated version (flame-retardant) with single-ended leads in the lead spacing. A built-in thermal overload protector prevents inflammation by self-ignition in case of electrical overload.





Dimensions in mm

[1]) Permissible difference 0.2.

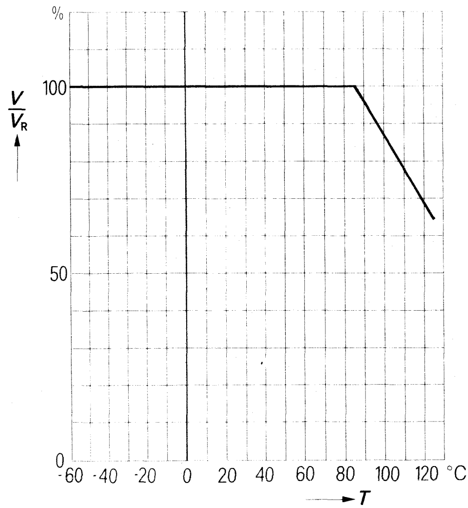
Rated voltage V_R up to +85 °C 1)		6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	35 Vdc	50 Vdc
Rated voltage V_R up to +125 °C 1)		4 Vdc	6.3 Vdc	10 Vdc	16 Vdc	23 Vdc	33 Vdc
Rated capacitance µF	Tolerance	Output leakage current I_{lko} 2) / Impedance Z 3) Code					
1,5	±20 % ≙ M						0,8/15 -B6155-M
2,2	±20 % ≙ M					0,8/11 -B5225-M	
3,3	±20 % ≙ M				0,8/7,5 -B4335-M		
4,7	±20 % ≙ M			0,8/5,5 -B3475-M			
6,8	±20 % ≙ M		0,7/4,2 -B2685-M				
10	±20 % ≙ M	0,6/3,2 -B1106-M					

Ordering code example B45184-B4335-M

Type — B45184; Code according to table — B4335

For packaging units and weights refer to page 30.

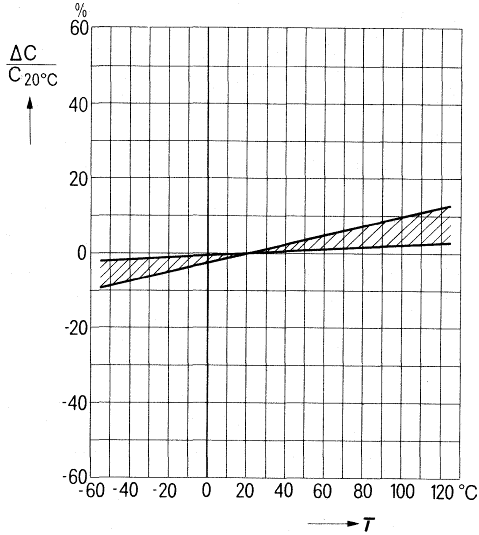
Maximum permissible operating voltage versus temperature



1) Peak voltage $V_P = 1.15\ V_R$.
2) Output leakage current I_{lko} (µA), at 20 °C and V_R after 5 minutes (limit values).
3) Impedance Z (Ω) measured at 10 kHz and 20 °C (limit values).

Capacitance change versus temperature

Typical values



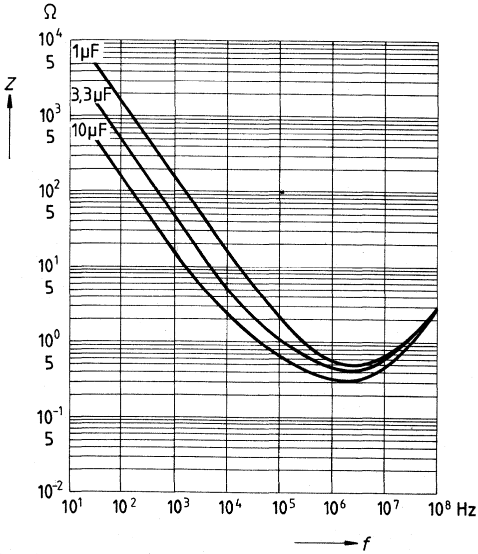
Maximum values

−55° C	+85° C	+125° C
−10 %	+ 8 %	+12 %

Dissipation factor tan δ at 120 Hz
(max. values)

−55° C	+20° C	+85° C	+125° C
0,06	0,06	0,06	0,06

Impedance *Z*
versus frequency
(typical values at +20 °C)



Impedance *Z*
(Limit values at delivery for
10 kHz and +20 °C)
see capacitance range

Impedance
versus temperature

For temperatures deviating from +20 °C the impedance value has to be multiplied by the temperature factors as tabulated below.

at	Temperature factors −55 °C	−40 °C	−20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz	1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz	1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz	1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	1,5	1,3	1,3	1,1	1	0,85	0,82

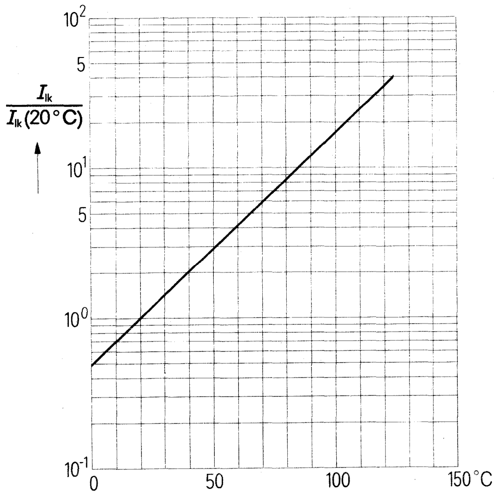
Leakage current

At +20 °C the maximum values as tabulated above apply to the leakage current. The limit values at +85 °C amount to 10 times and at +125 °C (at voltage derating) to 12.5 times the limit value of the leakage current at +20 °C.

Leakage current, measurement

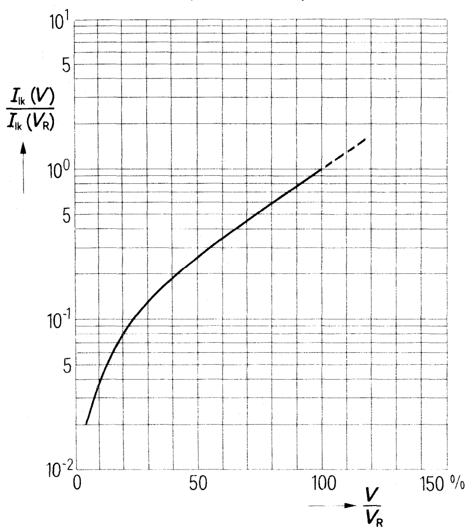
The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistor of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied, the capacitor must be stabilized for 30 minutes at rated temperature.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)

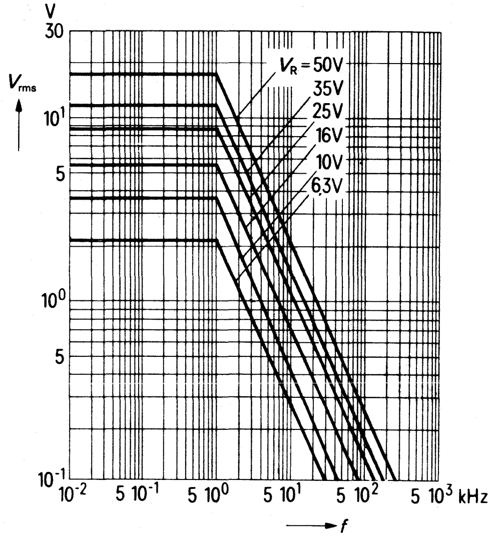


Operating voltage > V_R are not permissible!

Permissible superimposed AC voltage

The capacitors can be operated at superimposed ac voltage provided that the permissible inherent temperature rise of the capacitor is not exceeded. For limit values of superimposed ac voltage see the following diagram.

AC voltage derating
(max. values)
superimposed ac voltage versus frequency at 20 °C



At increased temperatures, the following factors apply:

+50 °C	+85 °C	+125 °C
0.7	0.5	0.3

The sum of direct voltage and peak value of the superimposed alternating voltage shall not exceed the rated voltage.
The sum of direct voltage and the portion of negative alternating voltage may cause a polarity reversal only conforming to the permissible reversal voltage.

Polarity reversal voltage (intermittently)
at +20 °C: 0.15 × V_R
at +55 °C: 0.1 × V_R
at +85 °C: 0.05 × V_R

Series back-to-back circuit

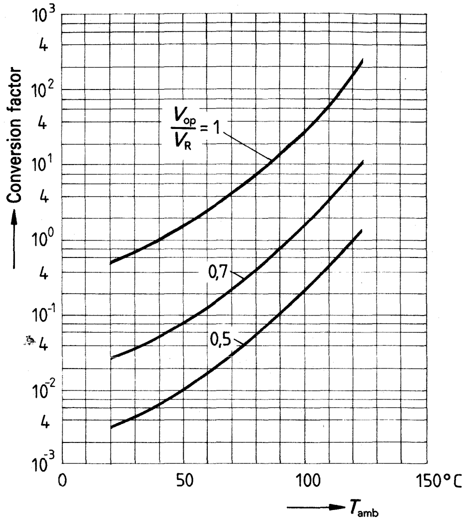
For a back-to-back circuit (cathode to cathode) of two capacitors of identical rated capacitance and rated voltage, twice the ac voltage of a single capacitor is permissible. The indicated frequency and temperature dependence is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC ≤ 10% of the initial value tan δ ≤ limit values $I_{lk\,20\,°C}$ ≤ 1.25 × initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC ≤ 15% of the initial value tan δ ≤ 1.5 × limit values $I_{lk\,20\,°C}$ ≤ limit values
Capacitance drift	$^{+5}_{-10}$ % (typical value)
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4 — 40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement amplitude: 1.5 mm (complying with max. 196 m/s² or 20 *g* resp.) Duration: 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load: 981 m/s² or 100 *g* resp.
Solder conditions	Temperature of the solder bath: max. 270 °C Soldering duration: max. 2 s The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.

Service life	> 500 000 h
Failure rate[1] (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.2% within 100 000 h ≙ 2 × 10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥3	1	0,3	≤0,1
Factor for case size A and B	1	2,0	3,5	5,0
Failure criteria Total failure Failure due to variations	short or open circuit $I_{lk} \geq 5 \times I_{lko} + 5\ \mu A$ $Z \geq$ 3 times the max. limit value at delivery ΔC at $V_R \leq 16$ V: +10 . . . −20% ΔC at $V_R > 16$ V: +10 . . . −10%			

[1]) For an example of how to calculate the total failure rate refer to page 26.

Sinter version with solid electrolyte, incorporated overload protection; single-ended leads; high rel version

Fields of application

in communications engineering and data processing systems and in measuring and control equipment.

Features

The capacitors ensure very high protection against thermal overload due to an incorporated safety unit which automatically disconnects in case of internal thermal overload. They are particularly suitable for use in circuits of industrial electronics, where apart from high packing density, a low dissipation factor, low leakage current, good temperature and frequency performance as well as high operational reliability are required.

DIN climatic category	F K E (DIN 40040)
Lower category temperature	F ≙ −55 °C
Upper category temperature	K ≙ +125 °C (from +85 °C voltage derating)
Humidity category	E ≙ average relative humidity ≤ 75%, 95% for 30 days per year, rare and slight dew precipitation permitted
IEC climatic category	55/125/56
Technical data	IEC 384-15, DIN 44 350, DIN 44 352 DIN 45 910, part 145 (CECC 30201-xxx) B 45 010 (general technical information)

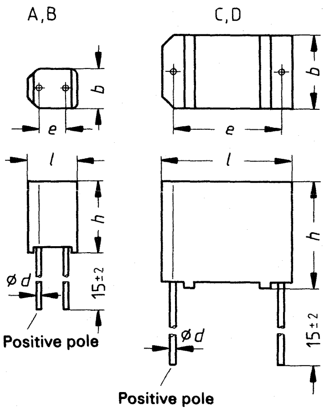
Packaging on continuous tapes

The capacitors A and B are also available as taped versions. For taping instructions and ordering information refer to B 45071, page 32.

Basic construction

Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte. Rectangular, epoxy resin encapsulated type (flame-retardant) with single-ended tinned nickel leads. An incorporated thermal overload protection prevents inflammation as a result of spontaneous inflammability at electrical overload. The positive pole is marked by a lateral projection at the case. The values are stamped upon the component.

Case size



Case size	*b* max.	*l* max.	*h* max.	*d*[1])	*e* ±0,2
A	4,2	4,7	7,3	0,5	2,54
B	4,8	7,3	10	0,5	5,08
C	7,3	12,3	10	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

[1]) Permissible deviations in acc. with DIN 40 815

To distinguish these capacitors from type B 45 181, they have a colored stamp.

Dimensions in mm

Rated voltage V_R up to +85 °C[1])		6.3 Vdc	10 Vdc	16 Vdc	20 Vdc	25 Vdc	40 Vdc	50 Vdc	Case size
Rated voltage V_R up to +125 °C[1])		4 Vdc	6.3 Vdc	10 Vdc	13 Vdc	16 Vdc	25 Vdc	33 Vdc	
Rated capacitance µF	Tolerance	Output leakage current I_{lko}[2])/Impedance Z[3]) Code							
0,1							0,5/220 -A6104-+	0,5/220 -A7104-+	
0,15							0,5/150 -A6154-+	0,5/150 -A7154-+	
0,22							0,5/100 -A6224-+	0,5/100 -A7224-+	
0,33							0,5/75 -A6334-+	0,5/75 -A7334-+	A
0,47							0,5/50 -A6474-+	0,5/50 -A7474-+	
0,68							0,5/36 -A6684-+	0,5/36 -A7684-+	
1							0,5/25 -A6105-+	0,5/25 -A7105-+	
1,5						0,5/17 -A5155-+	0,7/15 -A6155-+	0,9/15 -A7155-+	
2,2					0,5/12 -A4225-+		1,0/11 -A6225-+	1,7/11 -A7225-+	
3,3				0,5/9 -A3335-+			1,5/7,5 -A6335-+	2,0/7,5 -A7335-+	B
4,7	±20% ≙ M		0,5/7,5 -A2475-+				2,0/5,5 -A6475-+	2,5/5,5 -A7475-+	
6,8	±10% ≙ K	0,5/6 -A1685-+					3,0/4,2 -A6685-+	3,5/4,0 -A7685-+	
10						2,5/3,2 -A5106-+	4,0/2,8 -A6106-+	5/2,8 -A7106-+	C
15					3/2,5 -A4156-+		6,0/2,2 -A6156-+	8/2,2 -A7156-+	
22				3,5/2,1 -A3226-+			9,0/1,9 -A6226-+	12/1,7 -A7226-+	
33			3,5/1,7 -A2336-+			8,0/1,5 -A5336-+	12/1,4 -A6336-+		
47		3,0/1,5 -A1476-+			9/1,3 -A4476-+	12/1,3 -A5476-+	16/1,1 -A6476-+		
68				10/1,1 -A3686-+		17/0,9 -A5686-+			D
100			10/1,0 -A2107-+		20/0,8 -A4107-+				
150		9,0/0,8 -A1157-+		20/0,65 -A3157-+					
220			20/0,55 -A2227-+						
330		15/0,5 -A1337-+							

Ordering code example B45185-A6336-+

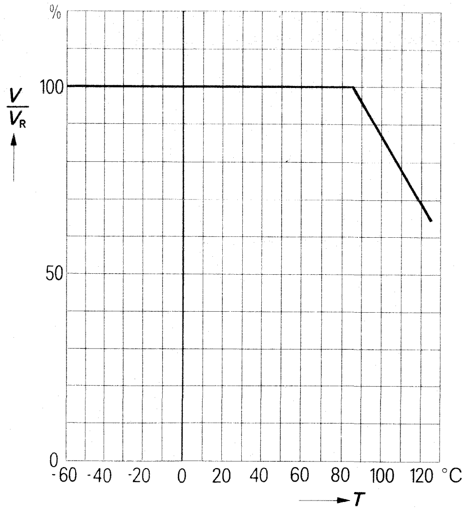
Type: B45185 — Code according to table: A6336-+

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%, K ≙ ±10%

For packaging units and weights refer to page 30.

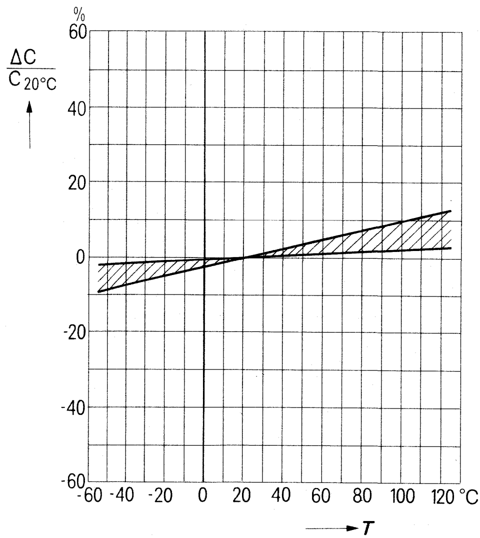
[1]) Peak voltage $V_P = 1.15\ V_R$.
[2]) Leakage current I_{lko} (µA), measured at 20 °C and V_R after 5 minutes (limit values).
[3]) Impedance Z (Ω) measured at 10 kHz and 20 °C (limit values).

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values

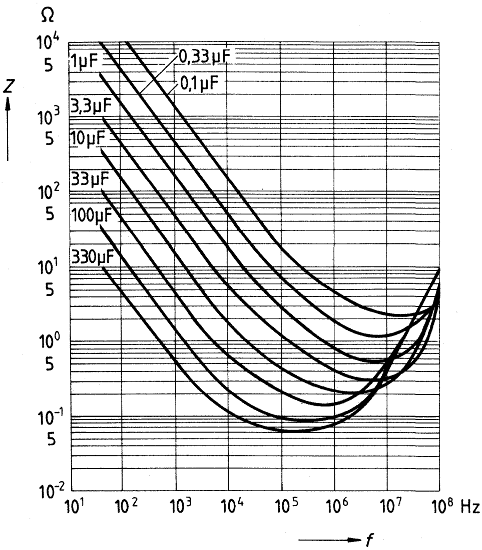


Maximum values

−55° C	+85° C	+125° C
−10 %	+8 %	+12 %

Dissipation factor tan δ at 120 Hz (limit values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 100 µF	0,06	0,06	0,06	0,06
	> 100 µF	0,08	0,08	0,08	0,08

Impedance Z
versus frequency
(typical values at +20 °C)



Impedance Z
(limit values at delivery for
10 kHz and +20 °C)
see capacitance range

Impedance versus temperature

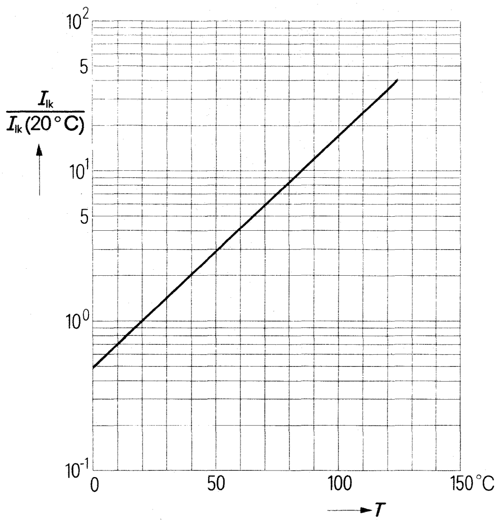
For temperatures deviating from +20 °C, the impedance has to be multiplied by the factors tabulated below:

at		Temperature factors −55 °C	−40 °C	−20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 µF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 µF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

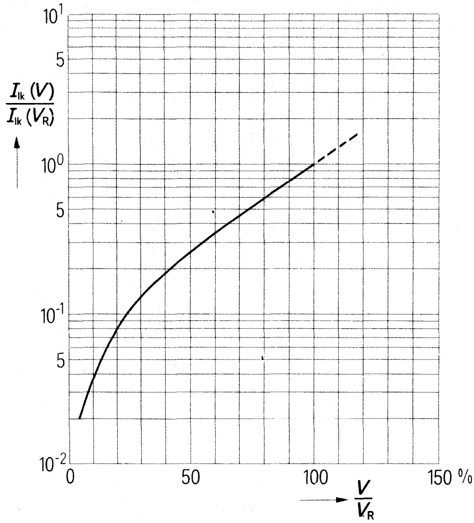
At +20 °C the maximum values of the table apply to the leakage current. The limit values at +85 °C amount to 10 times and at +125 °C (at voltage derating) to 12.5 times the limit value of the leakage current at +20 °C.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

Leakage current, measurement

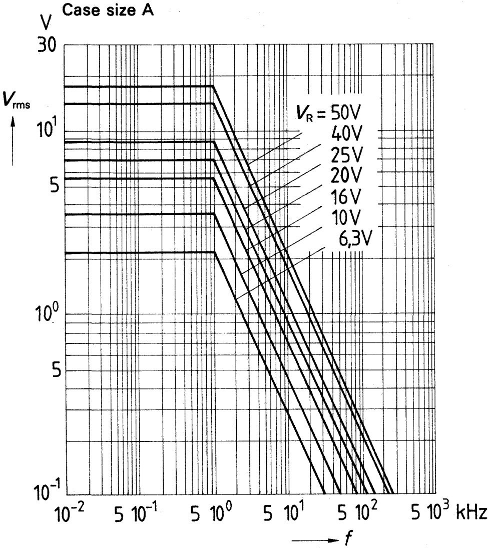
The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied, the capacitor must be stabilized for 30 minutes at rated temperature.

Permissible superimposed AC voltage

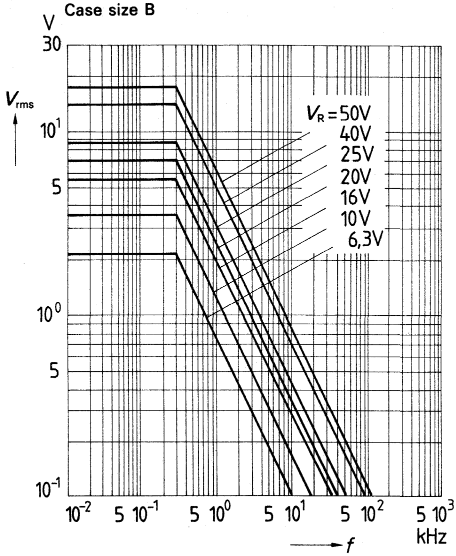
The capacitors can be operated with a superimposed ac voltage provided that the inherent temperature rise of the capacitors will not be exceeded. For maximum values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20 °C

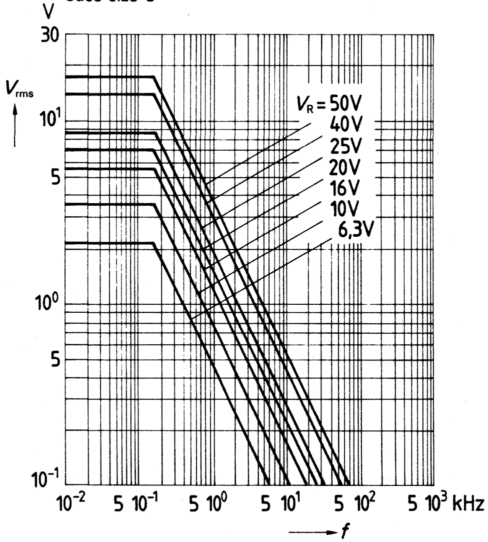
Case size A



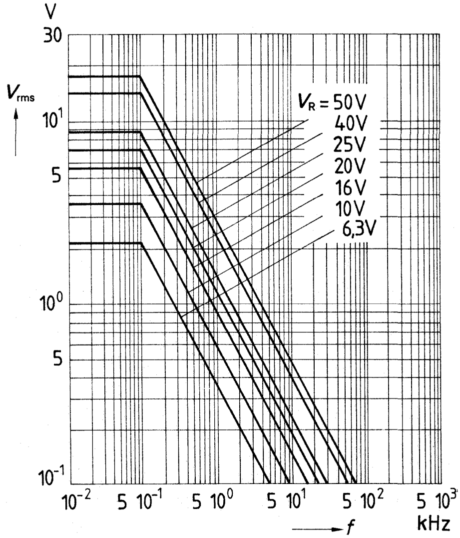
Case size B



Case size C



Case size D



At increasing temperatures the following factors apply:

+50 °C	+85 °C	+125 °C
0,7	0,5	0,3

The sum of direct voltage and peak value of the superimposed alternating voltage is not allowed to exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)	at +20 °C: 0.15 × V_R at +55 °C: 0.1 × V_R at +85 °C: 0.05 × V_R

Series back-to-back circuit

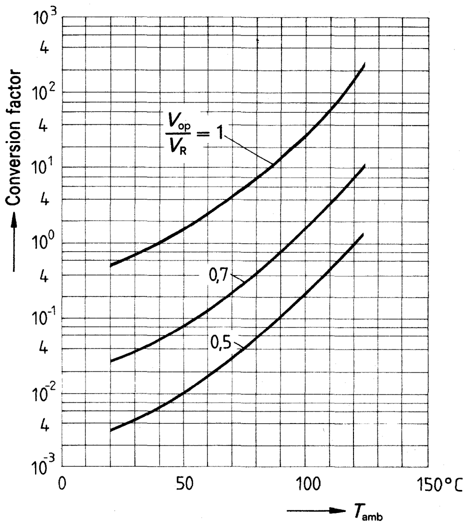
For a back-to-back circuit (cathode to cathode) of two capacitors of identical rated capacitance and rated voltage, twice the ac voltage of a single capacitor is permissible. The indicated frequency and temperature dependence is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC $\tan \delta$ $I_{lk\,20\,°C}$	≤ 10% of the initial value ≤ limit values ≤ 1.25 × initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC $\tan \delta$ $I_{lk\,20\,°C}$	≤ 10% of the initial value ≤ 1.5 × limit values ≤ limit values
Capacitance drift	$^{+\ 5}_{-10}$ % (typical value)	
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range Displacement amplitude Duration	10 to 2000 Hz 1.5 mm (complying with max. 196 m/s² or 20 *g* resp.) 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load	981 m/s² or 100 *g* resp.
Solder conditions	Temperature of the solder bath Soldering duration	max. 270 °C max. 2 s
	The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.	

Service life	> 500 000 h
Failure rate[1]) (typ. value, at 40° C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.3% within 100 000 h ≙ 3×10^{-8}/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table[1]):

R_i in Ω/V	≥ 3	1	0,3	≤ 0,1
Factor for case size A and B	1	2,0	3,5	5,0
Factor for case size C and D	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variations	$I_{lk} \geq 5 \times I_{lko} + 5\ \mu A$ $Z \geq 3$ times the max. limit value at delivery ΔC at $V \leq 16$ V: +10 ... −20% ΔC at $V > 16$ V: +10 ... −10%

[1]) For an example of how to calculate the total failure rate refer to page 26.

Capacitors with Solid Electrolyte
Leadless Version

Leadless version, particularly suitable for automatic assembly; polar, high rel version

Application
in communications engineering and data processing systems as well as in measuring and control equipment.

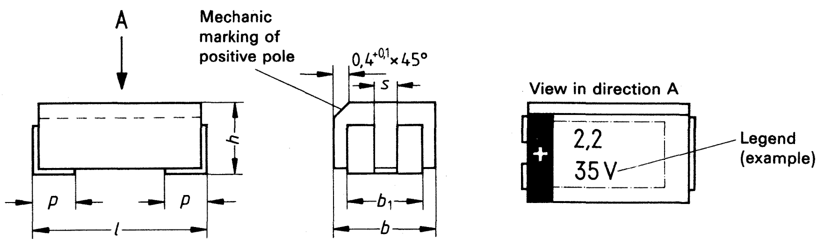
Features

- high charge per unit volume
- very high resistance to shock and vibration
- low leakage current
- precise geometric dimensions
- particularly suitable for automatic assembly
- dip- and reflow-solderable, also on PCBs

DIN climatic category	FKE (DIN 40 040)
Lower category temperature	F ≙ −55 °C
Upper category temperature	K ≙ +125 °C (from +85 °C voltage derating)
Humidity category	E ≙ average relative humidity ≤ 75%, 95% for 30 days per year rare and slight dew precipitation permitted
IEC climatic category	55/125/56
Technical data	IEC 384-3 B 45 010 (general technical information)

Design
Tantalum electrolytic capacitors with a sintered body as anode (solid) in rectangular plastic case, polar, high rel version.

Packaging on continuous tapes
These capacitors are also available as taped versions. For taping instructions and ordering information refer to B 45 071, page 32.



Dimensions in mm

Case size	Dimensions (mm)					
	$l \pm 0{,}13$	$b \pm 0{,}25$	$h \pm 0{,}13$	$p \pm 0{,}25$	b_1 min.	s
A	4,57	2,55	1,77	0,75	1,9	0,6
B	4,57	2,55	2,57	0,75	1,9	0,6
C	8,13	4,55	1,77	1,25	3,3	1,0
D	8,13	4,55	2,57	1,25	3,3	1,0
E	8,13	4,55	4,97	1,25	3,3	1,0

Rated voltage V_R up to +85 °C¹)		6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	35 Vdc	50 Vdc	Case size
Rated voltage V_R up to +125 °C¹)		4 Vdc	6.3 Vdc	10 Vdc	16 Vdc	23 Vdc	33 Vdc	
Rated capacitance µF	Tolerance	Output leakage current I_{lko}²) / Impedance Z³) Code						
0,1						0,5/220 -A6104-+	0,5/220 -A7104-+	
0,15						0,5/150 -A6154-+	0,5/150 -A7154-+	A
0,22						0,5/100 -A6224-+	0,5/100 -A7224-+	
0,33						0,5/75 -A6334-+	0,5/75 -A7334-+	B
0,47						0,5/50 -A6474-+	0,5/50 -A7474-+	
0,68					0,5/36 -A5684-+	0,5/36 -A6684-+	0,5/36 -A7684-+	
1				0,5/25 -A3105-+	0,5/25 -A5105-+	0,5/25 -A6105-+	0,5/25 -A7105-+	C
1,5			0,5/17 -A2155-+		0,5/17 -A5155-+	0,5/15 -A6155-+	0,8/15 -A7155-+	
2,2	±20% ≙ M ±10% ≙ K		0,5/12 -A2225-+	0,5/12 -A3225-+	0,6/11 -A5225-+	0,8/11 -A6225-+	1,1/11 -A7225-+	D
3,3		0,5/9 -A1335-+	0,5/9 -A2335-+		0,8/7,5 -A5335-+	1,2/7,5 -A6335-+	1,7/7,5 -A7335-+	
4,7			0,5/7,5 -A2475-+		1,2/5,5 -A5475-+	1,6/5,5 -A6475-+	2,4/5,5 -A7475-+	
6,8		0,5/6 -A1685-+		1,1/6 -A3685-+	1,7/4,2 -A5685-+	2,4/4,2 -A6685-+		
10			1,0/3,2 -A2106-+		2,5/3,2 -A5106-+	3,5/2,8 -A6106-+		
15			1,5/2,5 -A2156-+	2,4/2,5 -A3156-+	3,8/2,2 -A5156-+			
22		1,4/2,1 -A1226-+	2,2/2,1 -A2226-+		5,5/1,9 -A5226-+			E
33			3,3/1,7 -A2336-+	5,3/1,5 -A3336-+				
47		3,0/1,5 -A1476-+	4,7/1,5 -A2476-+					
68			6,8/1,1 -A2686-+					
100		6,3/1,0 -A1107-+						

Ordering code example B45193-A3685-+

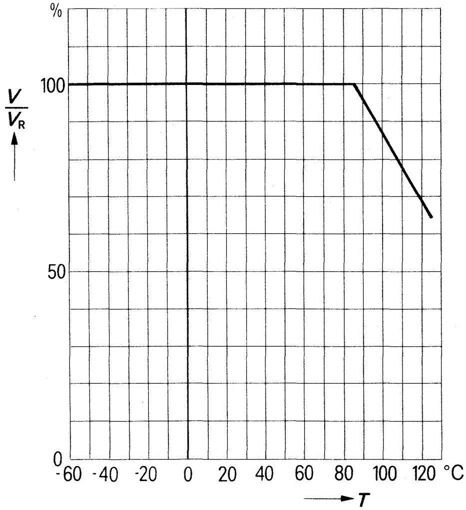
Type ——— Code according to table

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ± 20%, K ≙ ± 10%

For weights and packaging units refer to page 30.

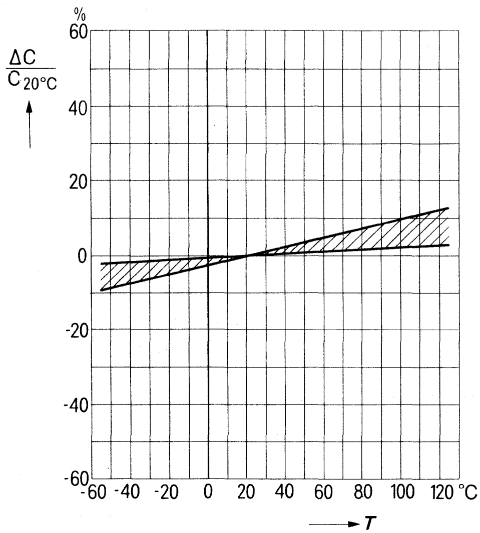
¹) Peak voltage $V_P = 1.15\ V_R$. ²) Output leakage current I_{lko} (µA), measured at 20 °C and V_R after 5 minutes, limit values.
³) Impedance $Z(\Omega)$ measured at 10 kHz and 20 °C, limit values.

Maximum permissible operating voltage versus temperature



Capacitance change versus temperature

Typical values

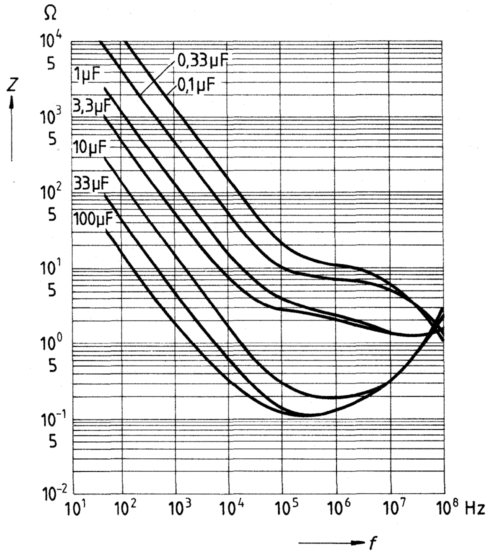


Maximum values

−55° C	+85° C	+125° C
−12%	+8%	+12%

Dissipation factor tan δ at 120 Hz, 20 °C	≤10 V	≤6,8 µF	>6,8 µF
		0,06	0,08
	>10 V	0,06	

Impedance Z
versus frequency
(typical values at +20 °C)



Impedance Z
(limit values at delivery for 10 kHz and +20 °C)
see capacitance range

Impedance versus temperature

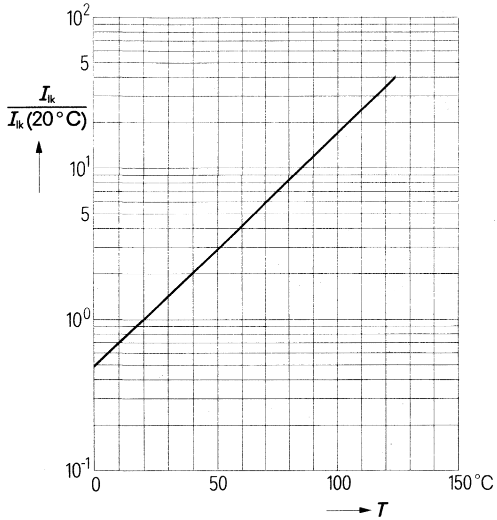
For temperatures deviating from +20 °C, the impedance value has to be multiplied by the factors tabulated below:

at		Temperature factors						
		–55 °C	–40 °C	–20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz		1,3	1,2	1,1	1,05	1	0,95	0,92
1 kHz		1,3	1,3	1,2	1,1	1	0,9	0,87
10 kHz		1,5	1,3	1,2	1,1	1	0,85	0,82
100 kHz	≤ 50 µF	1,5	1,3	1,3	1,1	1	0,85	0,82
	> 50 µF	1,8	1,6	1,3	1,15	1	0,8	0,78

Leakage current

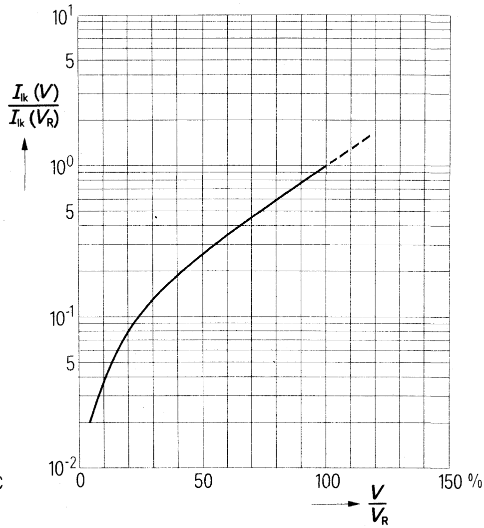
At +20 °C the maximum values according to the table apply to the leakage current. The limit values at +85 °C amount to 10 times and at +125 °C (at voltage derating) to 12.5 times the limit value of the leakage current at +20 °C.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into account!

Leakage current
versus voltage (typical values)



Operating voltages > V_R are not permissible!

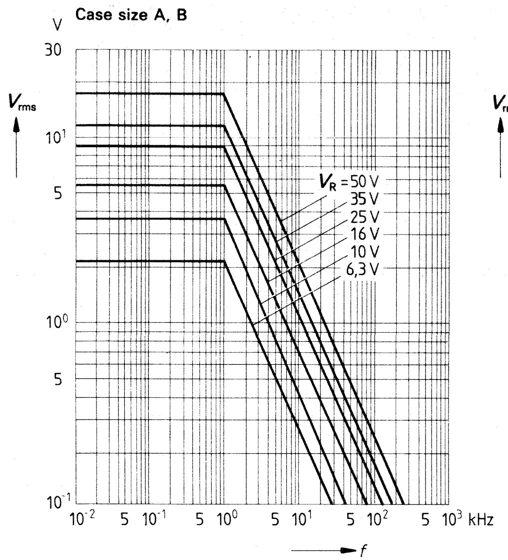
Leakage current, measurement

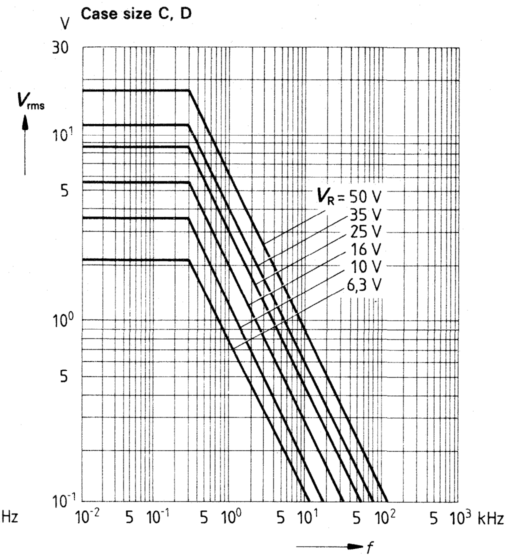
The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor.
Before the voltage is applied, the capacitor must be stabilized for 30 minutes at rated temperature.

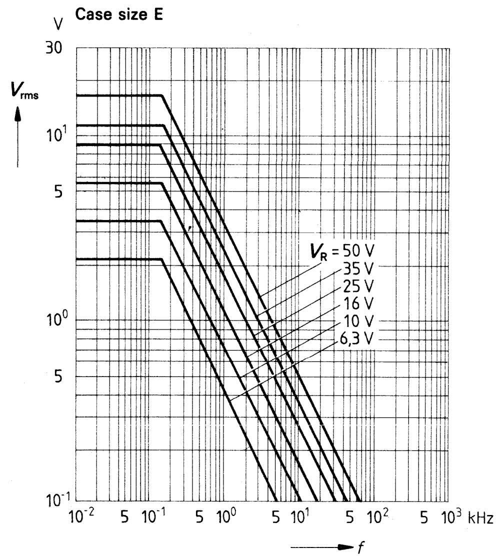
Permissible superimposed AC voltage

The capacitors can be operated with a superimposed ac voltage, provided that the permissible inherent temperature rise of the capacitor will not be exceeded. For limit values for the superimposed ac voltage see the following diagrams.

AC voltage derating (max. values)
superimposed ac voltage versus frequency at 20 °C







At increasing temperatures the following factors apply:

+50° C	+85° C	+125° C
0.7	0.5	0.3

The sum of direct voltage and peak value of the superimposed alternating voltage shall not exceed the rated voltage.
The sum of direct voltage and negative alternating voltage portions may cause a polarity reversal only according to the permissible reversal voltage.

Polarity reversal voltage (intermittently)
at +20 °C: 0.15 × V_R
at +55 °C: 0.1 × V_R
at +85 °C: 0.05 × V_R

Series back-to-back circuit

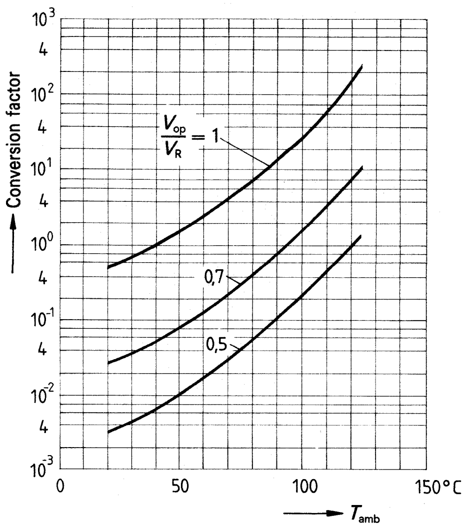
For a back-to-back circuit (cathode to cathode) containing two capacitors of identical rated capacitance and rated voltage, twice the ac voltage as for a single capacitor is permissible. The indicated frequency and temperature dependence is correspondingly valid.

Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC tan δ $I_{lk\,20\,°C}$	≤ 10% of the initial value ≤ limit values ≤ 1.25 × initial limit value
	Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.	
Storage test (voltage-free) 5000 h at +85 °C	ΔC tan δ $I_{lk\,20\,°C}$	≤ 10% of the initial value ≤ 1.5 × limit values ≤ limit values
Capacitance drift	$^{+\;5}_{-10}$ % (typical value)	
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range Displacement amplitude Duration	10 to 2000 Hz 1.5 mm (max. 196 m/s² or 20 *g* resp.) 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load	981 m/s² or 100 *g* resp.
Solder conditions	Temperature of the solder bath Soldering duration	max. 260 °C max. 10 s

Service life	$> 500\,000$ h
Failure rate¹) (typ. value, at 40°C, an operating voltage of less than or equal to rated voltage and a circuit resistance of greater than or equal to 3 Ω/V).	0.3% within 100 000 h $\triangleq 3 \times 10^{-8}$/h

The failure rate depends on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. It increases with increasing ambient temperature, and decreases with decreasing ratio V_{op}/V_R and increasing circuit resistance.
For the dependence of failure rate on ambient temperature and operating voltage throughout the period of operation, conversion factors are given in the adjacent graph (typical values).

Conversion factors for the failure rate



Failure rate and service life are referred to circuit resistances of greater than or equal to 3 Ω/V. For circuits at lower internal resistances (R_i) an increase in failure rates (referred to the leakage current rise) can be expected in accordance with the following table¹):

R_i in Ω/V	≥3	1	0,3	≤0,1
Factor for size A to D	1	2,0	3,5	5,0
Factor for size E	1	2,8	6,1	12

Failure criteria	
Total failure	short or open circuit
Failure due to variations	$I_{lk} \geq 5 \times I_{lko} + 5\ \mu A$ $Z \geq 3$ times the max. limit value at delivery ΔC at $V \leq 16$ V: +10 ... −20% ΔC at $V > 16$ V: +10 ... −10%

¹) For an example of how to calculate the total failure rate refer to page 26.

Capacitors with Liquid Electrolyte
Axial Leads

Sinter type with liquid electrolyte in accordance with DIN/IEC, polar; high rel version

Features

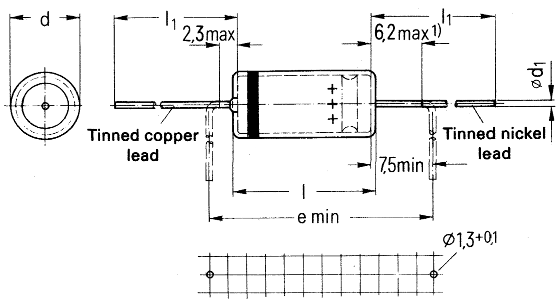
Very low leakage currents, high specific charge, wide temperature range, insensitive to operation at low-resistance voltage sources, high reliability and long service life.

DIN climatic category	F K C (DIN 40040)
Lower category temperature	F ≙ −55 °C (storage down to −65 °C)
Upper category temperature	K ≙ +125 °C (from +85 °C voltage derating)
Humidity category	C ≙ average relative humidity ≤95%, 100% for 30 days per year
IEC climatic category	55/125/56
Technical data	IEC 384-15 DIN 44 360, DIN 44 361, version S, type I B 45 010 (general information)

Basic construction

Tantalum capacitors with a sintered body as anode and a liquid electrolyte in tubular silver case **with insulating sleeve;** sealed with temperature and aging resistant materials. Welded central axial leads ensure reliable contact.

Attention! Incorrect polarization must be avoided by all means. The electrolyte has etching and metal corroding characteristics. Caution, when opening the capacitor.



Dimensions in mm

Case size²)	Dimensions		$l_1 \pm 4$	Minimum lead spacing e min.	d_1
	$d_{-0,7}$	$l_{-2,0}$			
T1	5,5	13,8	40	25	dia $0.6^{+0.05}$
T2	7,9	18,6	55	30	
T3	10,3	21,8		32,5	
T4	10,3	27,2		40	dia $0.8^{\pm 0.03}$

¹) Tantalum lead not solderable. Bending at the welded joint not permitted.
²) Case size T1 to T4 in accordance with MIL-C-39006/9. Style CLR 65.

Rated voltage V_R up to +85 °C[1])		6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	40 Vdc	63 Vdc	80 Vdc	100 Vdc	Case size
Rated voltage V_R up to +125 °C[1])		4 Vdc	6.3 Vdc	10 Vdc	16 Vdc	25 Vdc	40 Vdc	50 Vdc	63 Vdc	
Rated capacitance µF	Tolerance			Output leakage current I_{lko}[2]) Code						
2,2									1 -A8225-+	
3,3									1 -A8335-+	T1
4,7									1 -A8475-+	
6,8								1 -A7685-+	1 -A8685-+	
10							1 -A6106-+		1 -A8106-+	
15						1 -A5156-+			1 -A8156-+	T2
22					1 -A4226-+				1,1 -A8226-+	
33				1 -A3336-+				1,3 -A7336-+	1,7 -A8336-+	
47	±20% ≙ M ±10% ≙ K		1 -A2476-+				1,5 -A6476-+	1,9 -A7476-+		T3
68		1 -A1686-+				1,4 -A5686-+	2,2 -A6686-+		3,5 -B8686-+	
100					1,3 -A4107-+	2 -A5107-+		4 -B7107-+		
150			1 -A2157-+		1,9 -A4157-+		4,8 -B6157-+			
220		1 -A1227-+		1,8 -A3227-+		4,4 -B5227-+				
330			1,7 -A2337-+		4,2 -B4337-+					T4
470		1,5 -A1477-+		3,8 -B3477-+						
680			3,5 -B2687-+							
1000		3 -B1108-+								

Ordering code example B45261-A4107-+

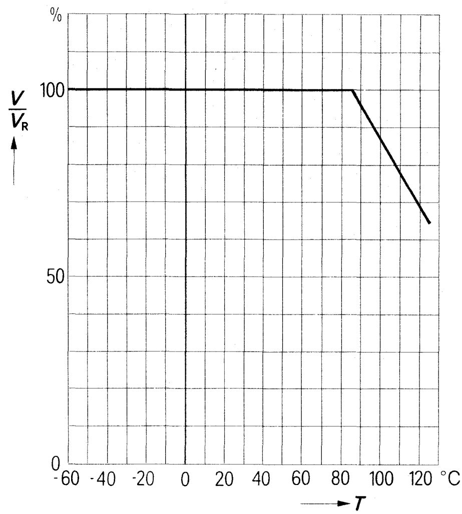
Type ——— B45261 ——— Code according to table ——— A4107

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ± 20%, K ≙ ± 10%

For packaging units and weights refer to page 30.

[1]) Peak voltage $V_P = 1.15\ V_R$.
[2]) Output leakage current I_{lko} (µA), measured at 20 °C (limit values).

Maximum permissible operating voltage versus temperature



Capacitance change in % at −55 °C and 120 Hz (max. values)

Rated capacitance µF	Rated dc voltage 6,3 V	10 V	16 V	25 V	40 V	63 V	80 V	100 V
2,2								−16
3,3								−16
4,7								−16
6,8							−20	−16
10						−20		−16
15					−20			−16
22				−25				−20
33			−25				−20	−20
47		−35				−25	−20	
68	−35				−25	−25		−25
100				−35	−25		−35	
150		−50		−35		−45		
220	−55		−35		−60			
330		−55		−70				
470	−65		−80					
680		−80						
1000	−80							

Capacitance change in % at +85 °C and 120 Hz (max. values)

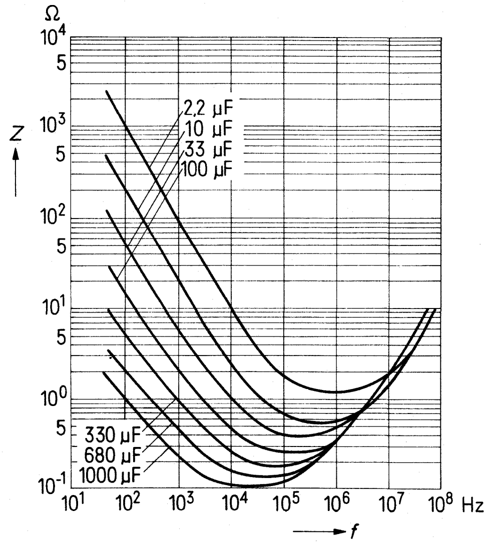
Rated capacitance µF	Rated dc voltage 6,3 V	10 V	16 V	25 V	40 V	63 V	80 V	100 V
2,2								+7,5
3,3								+7,5
4,7							+10	+7,5
6,8						+10		+7,5
10						+12		+7,5
15					+12			+7,5
22				+12				+7,5
33			+15				+12	+10
47		+15				+12		
68	+15				+15	+12		+13
100				+15	+15		+17,5	
150		+15		+15		+17,5		
220	+17,5		+17,5		+22			
330		+17,5		+22				
470	+17,5		+22					
680		+22						
1000	+22							

Capacitance change in % at +125 °C and 120 Hz (max. values)

Rated capacitance µF	Category voltage 4 V	6,3 V	10 V	16 V	25 V	40 V	50 V	63 V
2,2								+10
3,3								+10
4,7								+12
6,8							+14	+15
10						+14		+15
15					+14			+16
22				+15				+16
33			+18				+16	+18
47		+18				+16	+18	
68	+18				+18	+18		+18
100				+18	+18		+20	
150		+18		+18		+20		
220	+20		+20		+25			
330		+20		+25				
470	+20		+25					
680		+25						
1000	+25							

Dissipation factor tan δ max. values at 120 Hz	V_R (Vdc)	≤10	≤40	>40
	tan δ	≤0,4	≤0,3	≤0,2

Impedance *Z*
versus frequency
(typical values at 20 °C)



Impedance
versus temperature

For temperatures deviating from +20 °C, the impedance *Z* has to be multiplied by the factors tabulated below.

at		Temperature factors −55 °C	−40 °C	−20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz	≤30 V	1,6	1,3	1,1	1,02	1	0,9	0,85
	>30 V	1,1	1,06	1,04	1,02	1	0,95	0,9
1 kHz	≤30 V	3	2,5	1,9	1,2	1	0,85	0,8
	>30 V	1,8	1,3	1,1	1,03	1	0,9	0,85
10 kHz	≤30 V	6	3,7	2,6	1,8	1	0,7	0,65
	>30 V	4	3	2,1	1,2	1	0,85	0,8

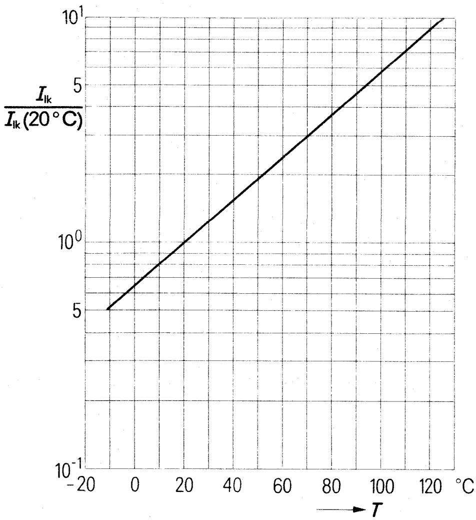
Impedance in Ω at −55 °C and 120 Hz (max. values)

C_R (μF)	2,2	3,3	4,7	6,8	10	15	22	33	47
Z (Ω)	1000	700	500	350	250	175	140	100	80
C_R (μF)	68	100	150	220	330	470	680	1000	
Z (Ω)	60	50	40	30	28	25	23	21	

Leakage current

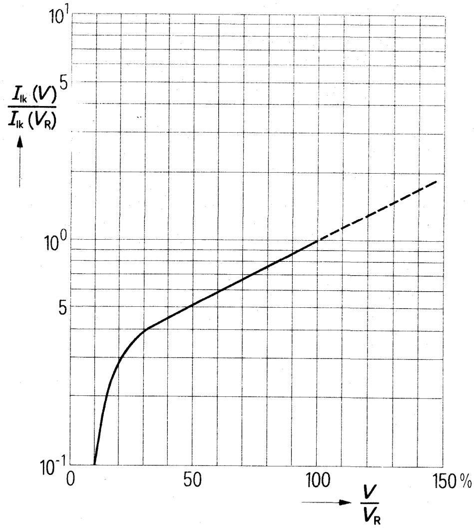
At 20 °C the tabulated maximum values apply to the leakage current. The maximum values at 85 °C amount to 5 times, at 125 °C (at voltage derating) to 8 times the maximum leakage current value at 20 °C.

Leakage current
versus temperature (typical values)



Voltage derating must be taken into consideration!

Leakage current
versus voltage (typical values)



Operating voltage > V_R not permitted!

Leakage current, measurement	The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor. Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

Maximum permissible ac current I_{rms} in mA for the frequency range ≥50 Hz

Case size	+25 … +85 °C mA	> +85 … +125 °C mA
T1	50	40
T2	250	200
T3	400	320
T4	600	480

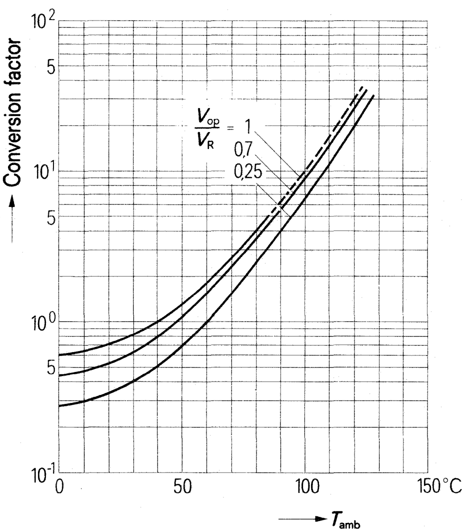
The sum of direct voltage and peak value of the superimposed alternating voltage applied to the capacitor is not allowed to exceed the permissible category voltage. Moreover, care must be taken that the peak value of the superimposed alternating voltage is always lower than the applied direct voltage in order to avoid incorrect polarization of the capacitor.

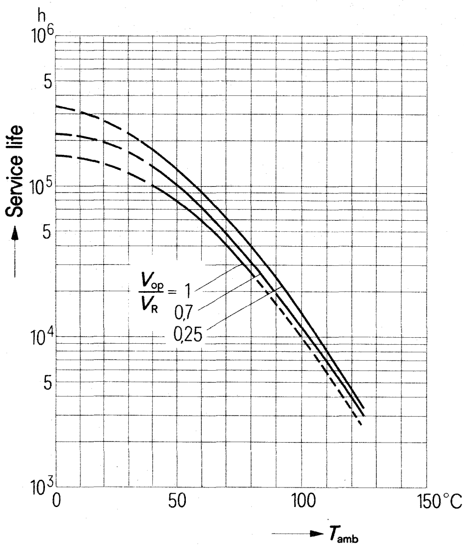
Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC ≤ 10% of the initial value tan δ ≤ limit values $I_{lk\,20\,°C}$ ≤ initial limit value Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Storage test (voltage-free) 5000 h at +85 °C	ΔC ≤ 10% of the initial value tan δ ≤ 1.5 × limit values $I_{lk\,20\,°C}$ ≤ limit values
Capacitance drift	±10% (typical value)
Mechanical strength of the leads Tensile load Number of bendings	 10 N, 30 s, in axial direction 2 (bending at the welded joint not permitted)
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4: 40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days
Resistance to vibration Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement amplitude: 1 mm (complying with max. 147 m/s² or 15 *g* resp.) Duration: 6 h
Shock resistance in accordance with DIN 40046, sheet 7	Peak load: 981 m/s² or 100 *g* resp.
Low air pressure in accordance with DIN 40046, sheet 13	Condition 2: 20 hP ≙ approx. 26 000 m height
Solder conditions	Temperature of the solder bath: max. 270 °C Soldering duration: max. 2 s Distance to the soldering joint Cathode side: ≥2.3 mm Anode side: ≥6.3 mm The temperature, however, is not allowed – even at a final tinning process of the leads – to exceed 130 °C at any point of the capacitor.
Dielectric strength of the insulating sleeve	2000 Vdc

Service life	100 000 h
Failure rate[1]) (typical value, at 40 °C and rated voltage)	0.4% within 100 000 h ≙ 4×10^{-8}/h

The failure rate depends on the ambient temperature and the ratio V_{op}/V_R. It grows with rising ambient temperature and falls with decreasing ratio V_{op}/V_R. For the dependence of failure rate on ambient temperature and operating voltage throughout the service life, conversion factors are given in the following graphs (typical values)[1]).

Conversion factors for relative failure rate and service life





Failure criteria	
Total failure	Short or open circuit
Failure due to variation	$\frac{\Delta C}{C} \geq 20\%$
	$Z_{10\,kHz} \geq 3$ times the typical impedance value (see graph for impedance versus frequency),
	$I_{lk} \geq 0.01$ µA/µF × V

[1]) For an example of how to calculate the total failure rate refer to page 26.

Sinter type with liquid electrolyte, polar; characteristics similar to MIL-C-39006/9, style CLR 65*); high rel version

Features

Very low leakage currents, high specific charge, wide temperature range, insensitivity to operation at low-ohmic voltage sources, high reliability and long service life.

DIN climatic category F K C (DIN 40040)

Lower category temperature F ≙ −55 °C (storage down to −65 °C)
Upper category temperature K ≙ +125 °C (from +85 °C voltage derating)
Humidity category C ≙ average relative humidity ≤95%, 100% 30 days per year

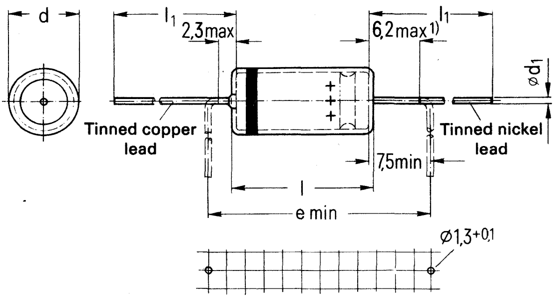
IEC climatic category 55/125/56

Technical data IEC 384-15
DIN 44 360, DIN 44 361, version S, type I
B 45 010 (general information)
MIL-C-39006/9, style CLR 65

Basic construction

Tantalum capacitor with a sintered body as anode and a liquid electrolyte in tubular silver case **with insulating sleeve**; sealed by temperature and aging-resistant materials. Welded central axial leads ensure reliable contact.

Attention! Incorrect polarization has to be avoided by all means. The electrolyte has etching and metal corroding characteristics. Caution, when opening the capacitor.



Dimensions in mm

Case size²)	Dimensions $d_{-0,7}$	$l_{-2,0}$	$l_1 \pm 4$	Minimum lead spacing *e* min.	d_1
T1	5,5	13,8	40	25	dia $0.6^{+0.05}$
T2	7,9	18,6	55	30	
T3	10,3	21,8		32,5	
T4	10,3	27,2		40	dia $0.8^{\pm 0.03}$

*) Capacitors with test certificate to MIL specification upon request.
[1]) Tantalum lead not solderable. Bending at the welded joint not permitted.
[2]) Case size T1 to T4 in accordance with MIL-C-39006/9, style CLR 65.

Rated capacitance	Rated voltage¹)		Max. leakage current at		Case size	Ordering code
	up to +85 °C	up to +125 °C	+20 °C	+85 °C and +125 °C		
µF	Vdc	Vdc	µA	µA		
30	6	4	1	2	T1	B45265-A306-+
68			1	2	T1	B45265-A686-+
140			1	3	T2	B45265-A147-+
270			1	7	T2	B45265-A277-+
330			2	8	T3	B45265-A337-+
560			2	13	T3	B45265-A567-+
1200			3	14	T4	B45265-B128-+
25	8	5	1	2	T1	B45265-A1256-+
56			1	2	T1	B45265-A1566-+
220			1	7	T2	B45265-A1227-+
430			2	14	T3	B45265-A1437-+
850			4	16	T4	B45265-B1857-+
20	10	7	1	2	T1	B45265-A2206-+
47			1	2	T1	B45265-A2476-+
100			1	4	T2	B45265-A2107-+
180			1	7	T2	B45265-A2187-+
250			2	10	T3	B45265-A2257-+
390			2	16	T3	B45265-A2397-+
750			4	16	T4	B45265-B2757-+
15	15	10	1	2	T1	B45265-A3156-+
33			1	2	T1	B45265-A3336-+
70			1	4	T2	B45265-A3706-+
120			1	7	T2	B45265-A3127-+
170			2	10	T3	B45265-A3177-+
270			2	16	T3	B45265-A3277-+
540			6	24	T4	B45265-B3547-+
10	25	15	1	2	T1	B45265-A4106-+
22			1	2	T1	B45265-A4226-+
100			1	10	T2	B45265-A4107-+
180			2	18	T3	B45265-A4187-+
350			7	28	T4	B45265-B4357-+
8	30	20	1	2	T1	B45265-A5805-+
15			1	2	T1	B45265-A5156-+
40			1	5	T2	B45265-A5406-+
68			1	8	T2	B45265-A5686-+
100			2	12	T3	B45265-A5107-+
150			2	18	T3	B45265-A5157-+
300			8	32	T4	B45265-B5307-+

\+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%, K ≙ ±10%, J ≙ ±5%.

¹) Peak voltage $V_p = 1.15\ V_N$.

For packaging units and weights refer to page 30.

Rated capacitance	Rated voltage[1]		Max. leakage current at		Case size	**Ordering code**
	up to +85 °C	up to +125 °C	+20 °C	+85 °C and +125 °C		
µF	Vdc	Vdc	µA	µA		
5			1	2	T1	B45265-A6505-+
10			1	2	T1	B45265-A6106-+
25			1	5	T2	B45265-A6256-+
47	50	30	1	9	T2	B45265-A6476-+
60			2	12	T3	B45265-A6606-+
82			2	16	T3	B45265-A6826-+
160			8	32	T4	B45265-B6167-+
4			1	2	T1	B45265-A7405-+
8,2			1	2	T1	B45265-A7825-+
20			1	5	T2	B45265-A7206-+
39	60	40	1	9	T2	B45265-A7396-+
50			2	12	T3	B45265-A7506-+
68			2	16	T3	B45265-A7686-+
140			8	32	T4	B45265-B7147-+
3,5			1	2	T1	B45265-A8355-+
6,8			1	2	T1	B45265-A8685-+
15			1	5	T2	B45265-A8156-+
33	75	50	1	10	T2	B45265-A8336-+
40			2	12	T3	B45265-A8406-+
56			2	17	T3	B45265-A8566-+
110			9	36	T4	B45265-B8117-+
2,5			1	2	T1	B45265-A9255-+
4,7			1	2	T1	B45265-A9475-+
11			1	4	T2	B45265-A9116-+
22	100	70	1	9	T2	B45265-A9226-+
30			2	12	T3	B45265-A9306-+
43			2	17	T3	B45265-A9436-+
86			9	36	T4	B45265-B9866-+
1,7			1	2	T1	B45265-A175-+1
3,6			1	2	T1	B45265-A365-+1
9			1	5	T2	B45265-A905-+1
14	125	85	1	7	T2	B45265-A146-+1
25			2	13	T3	B45265-A256-+1
56			10	40	T4	B45265-B566-+1

+ Insert appropriate code letter for requested capacitance tolerance: M ≙ ±20%, K ≙ ±10%, J ≙ ±5%.

For packaging units and weights refer to page 30.

[1]) Peak voltage $V_p = 1.15\ V_R$.

tan $\delta_{max.}$ = Maximum dissipation factor at 120 Hz in % (value at delivery)

$Z_{max.}$ = Maximum impedance at −55 °C and 120 Hz in Ω

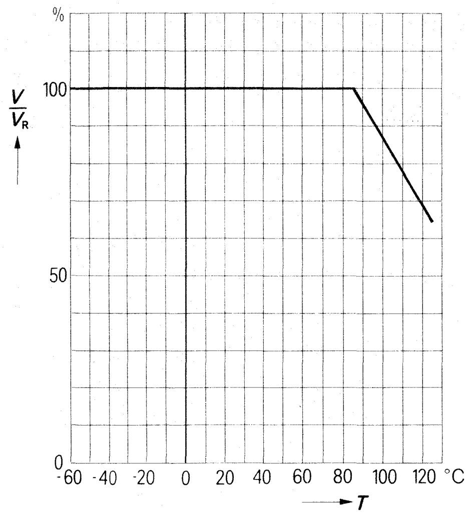
ESR = Equivalent series resistance at +20 °C and 120 Hz in Ω ($ESR = \frac{\tan \delta}{\omega C}$)

$\Delta C_{max.}/C_{20}$ = Maximum capacitance drift referred to +20 °C in % at 120 Hz

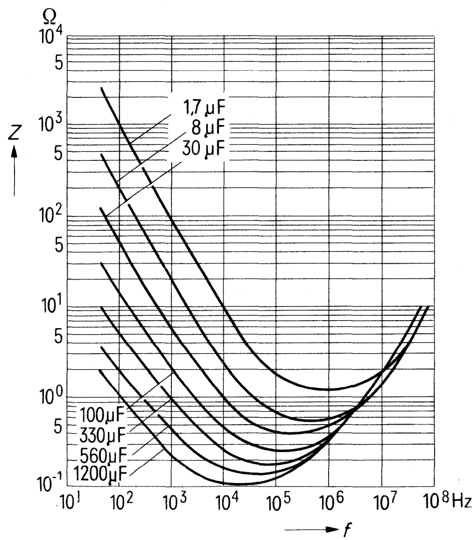
Case size	C_R µF	V_R Vdc	tan $\delta_{max.}$ %	$Z_{max.}$ Ω	ESR Ω	$\Delta C_{max.}/C_{20}$ in % −55 °C	+85 °C	+125 °C
T1	30 68	6	9,1 20,4	100 60	4	−40	+10,5 +14	+12 +16
	25 56	8	7,6 17,0	100 59		−40	+10,5 +14	+12 +16
	20 47	10	6,1 18,1	175 100	4 5	−32 −36	+10,5 +14	+12 +16
	15 33	15	5,7 12,5	155 90	5	−24 −28	+10,5 +14	+12 +16
	10 22	25	4,6 8,3	220 140	6 5	−16 −20	+ 8 +10,5	+ 9 +12
	8 15	30	4,5 9,1	275 175	7,5 8	−16 −20	+ 8 +10,5	+12
	5 10	50	3,4 6,0	400 250	9 8	−16 −24	+ 5 + 8,5	+ 6 + 9
	4 8,2	60	3,0 5,0	550 275	10 8	−16 −24	+ 5 + 8	+ 6 + 9
	3,5 6,8	75	2,5 4,1	650 300	10 8	−16 −20	+ 5 + 8	+ 6 + 9
	2,5 4,7	100	5,0 3,6	950 500	10	−16	+ 3 + 5	+ 4 + 6
	1,7 3,6	125	7,0 4,1	1250 600	15	−16	+ 3 + 4	+ 4 + 5
T2	140 270	6	21,3 81,8	40 25	2 4	−40 −44	+14 +17,5	+16 +20
	220	8	66,4	30	4	−44	+17,5	+20
	100 180	10	15,2 54,4	60 40	2 4	−36	+14	+16
	70 120	15	13,1 36,8	75 50	2,5 4	−28	+14 +17,5	+16 +20
	100	25	31,4	50	4	−28	+13	+15
	40 68	30	12,2 31,0	65 60	4 6	−24	+10,5 +13	+12 +15
	25 47	50	11,2 21,4	95 70	6	−20 −28	+10,5 +13	+12 +15
	20 39	60	7,6 20,7	105 90	5 7	−16 −28	+10,5	+12
	15 33	75	7,5 17,5	150 90	6,5 7	−16 −24	+ 8 +10,5	+ 9 +15

Case size	C_R µF	V_R Vdc	tan $\delta_{max.}$ %	$Z_{max.}$ Ω	*ESR* Ω	$\Delta C_{max.}/C_{20}$ in % −55°C	+85°C	+125°C
T2	11 22	100	5,0 11,8	200 100	6 7	−16	+ 5	+ 6
	9 14	125	10,2 12,7	240 167	15 12			+ 6 + 7
T3	330 560	6	49,6 128,0	20 25	2 3	−44 −64	+14 +17,5	+16 +20
	430	8	91,5	25	3	−64	+17,5	+20
	250 390	10	37,8 87,6	30 25	2 3	−40 −64	+14 +17,5	+16 +20
	170 270	15	25,4 60,9	35 30	2 3	−32 −56	+14 +17,5	+16 +20
	180	25	54,3	32	4	−48	+13	+15
	100 150	30	19,0 46,0	40 35	2,5 4	−28 −48	+10,5 +13	+12 +15
	60 82	50	13,6 24,9	45	3 4	−16 −32	+10,5 +13	+12 +15
	50 68	60	15,3 30,7	50	4 6	−16 −32	+10,5	+12
	40 56	75	15,2 26,0	60	5 6	−16 −28		+12 +15
	30 43	100	9,1 19,7	80 70	4 6	−16 −20	+ 7	+ 8
	25	125	19,0	93	10	−16	+ 8	+10
T4	1200	6	144,4	20	1	−80	+22	+25
	850	8	65,8	22	1	−80	+22	+25
	750	10	56,5	23	1	−80	+22	+25
	540	15	49,0	23	1,2	−80	+22	+25
	350	25	35,0	24	1,3	−70	+22	+25
	300	30	35,0	25	1,5	−60	+22	+25
	160	50	25,7	27	1,8	−50	+22	+25
	140	60	25,7	28	2	−40	+17,5	+20
	110	75	25,7	29	2,6	−35	+17,5	+20
	86	100	20,7	30	3	−25	+13	+15
	56	125	17,5	32	4	−25	+13	+15

Maximum permissible operating voltage
versus temperature



Impedance
versus frequency
(typical values at 20 °C)

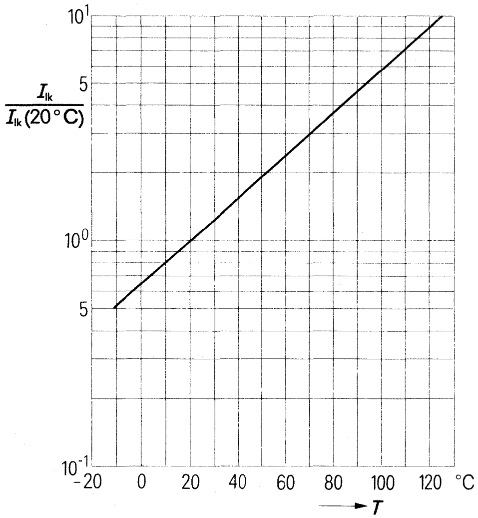


Impedance versus temperature

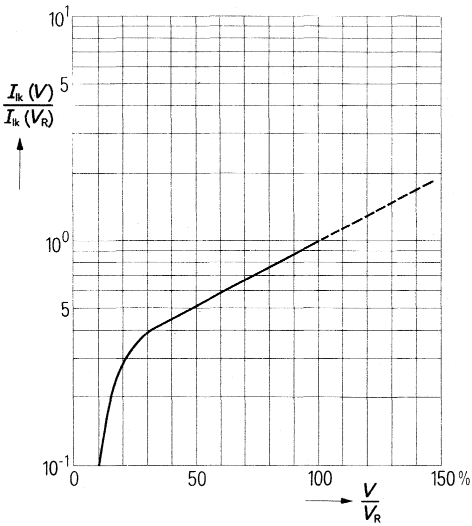
For temperatures deviating from +20 °C, the impedance Z has to be multiplied by the factors tabulated below.

at		Temperature factors −55 °C	−40 °C	−20 °C	0 °C	+20 °C	+85 °C	+125 °C
100 Hz	≤30 V	1,6	1,3	1,1	1,02	1	0,9	0,85
	>30 V	1,1	1,06	1,04	1,02	1	0,95	0,9
1 kHz	≤30 V	3	2,5	1,9	1,2	1	0,85	0,8
	>30 V	1,8	1,3	1,1	1,03	1	0,9	0,85
10 kHz	≤30 V	6	3,7	2,6	1,8	1	0,7	0,65
	>30 V	4	3	2,1	1,2	1	0,85	0,8

Leakage current
versus temperature (typical values)



Leakage current
versus voltage (typical values)



Leakage current, measurement

The measurement takes place at 20 °C after the rated voltage has been applied to the capacitor for 5 minutes, using a constant voltage source and a series resistance of 1000 Ω to limit the charging current of the capacitor. Before the voltage is applied the capacitor must be stabilized for 30 minutes at rated temperature.

AC voltage derating

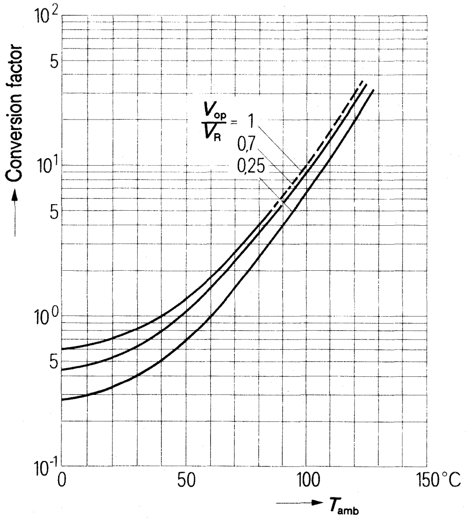
The sum of direct voltage and peak value of the superimposed alternating voltage applied to the capacitor shall not exceed the rated voltage. Moreover care must be taken that the peak value of the superimposed alternating voltage is always lower than the applied dc voltage in order to avoid incorrect polarization of the capacitor.

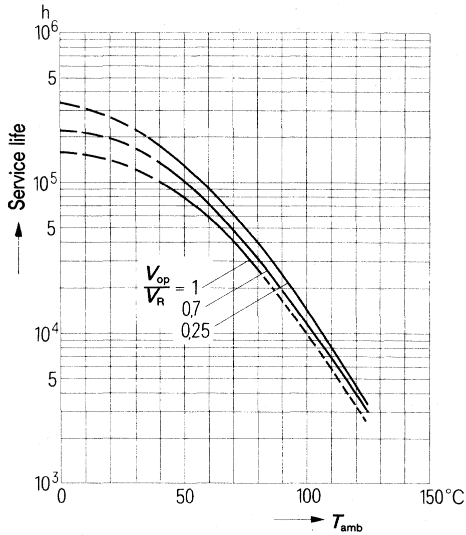
Maximum permissible ac current I (rms) for frequencies ≥ 50 Hz	Case size	+25 to +85 °C mA	> +85 to +125 °C mA
	T1	50	40
	T2	250	200
	T3	400	320
	T4	600	480
Life test 2000 h at +85 °C or 2000 h at +125 °C at voltage derating	ΔC ≤ 10% of the initial value tan δ ≤ max. values acc. to table $I_{lk\ 20\,°C}$ ≤ max. values acc. to table Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.		
Storage test (voltage-free) 5000 h at +85 °C	ΔC ≤ 10% of the initial value tan δ ≤ 1.5 × limit values $I_{lk\ 20\,°C}$ ≤ limit values		
Capacitance drift	± 10% (typical value)		
Mechanical strength of the leads Tensile load Number of bendings	 10 N, 30 s, in axial direction 2 (bending at the welded joint not permitted)		
Permissible damp heat test in accordance with DIN IEC 68-2-3	Condition 4	40 ± 2 °C; 93^{+2}_{-3}% relative humidity Duration: 56 days	
Resistance to vibration	The capacitors meet all requirements of the vibration test in accordance with MIL-C-39006/9 (MIL-STD 202, method 204, condition D).		
Shock resistance in accordance with DIN 40046, sheet 7	Peak load	981 m/s² or 100 g	
Low air pressure in accordance with DIN 40046, sheet 13	Condition 2	20 hP ≙ approx. 26 000 m height	
Dielectric strength of the insulating sleeve	2000 Vdc		

Solder conditions	Temperature of the solder bath max. 270 °C Soldering duration max. 2 s Distance to the soldering joint Cathode side ≥ 2.3 mm Anode side ≥ 6.3 mm The temperature, however, is not allowed — even at a final tinning process of the leads — to exceed 130 °C at any point of the capacitor.
Service life	100 000 h
Failure rate[1] (typical value, at 40 °C and rated voltage)	0.4% within 100 000 h ≙ 4×10^{-8}/h

The failure rate depends on the ambient temperature and the ratio V_{op}/V_R. It grows with rising ambient temperature and falls with decreasing ratio V_{op}/V_R. For the dependence of failure rate on ambient temperature and operating voltage throughout the service life, conversion factors are given in the following graphs (typical values)[1].

Conversion factors for relative failure rate and service life





Failure criteria	
Total failure	Short or open circuit
Failure due to variation	$\frac{\Delta C}{C} \geq 20\%$ $Z_{10\ kHz}$ ≥ 3 times the typical impedance value (see graph for impedance versus frequency) $I_{lk} \geq 0.01\ \mu A/\mu F \times V$

[1]) For an example of how to calculate the total failure rate refer to page 26.

Quality-Assessed Types
MIL Version

Characteristics

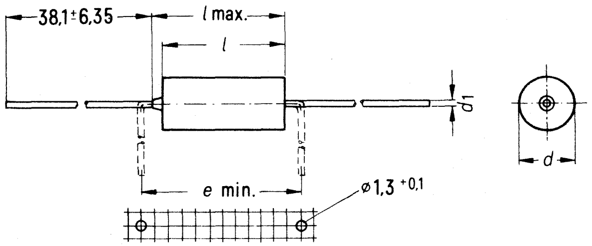
The capacitors fully comply with the MIL-C-39003E standard, sheet of specification 39003/1E, and are supplied with quality assessment and established reliability.

In the USA the CS 13 types in accordance with MIL-C-26655 (type B95001) are not for new design. They are replaced by the types CSR 13 complying with MIL-C-39003 (type B95057) with established reliability. Capacitors according to style CS 13 are available for the future under the designation B95001-X∗∗∗∗-X∗∗∗.

Construction

Tantalum capacitors with a sintered body as anode and solid semiconductor as electrolyte in tubular, hermetically sealed metal case with insulating sleeve. Axial, tinned-nickel leads at both ends.

For technical information refer to MIL-C-39003/1E



Dimensions in mm

Case size	Dimensions with insulating sleeve $d^{+0,41}_{-0,38}$	$l \pm 0{,}79$	l max.	Min. lead spacing e min.	Lead diameter $d_1 \pm 0{,}05$
A	3,43	7,26	10,72	12,5	0,51
B	4,70	12,04	14,49	17,5	0,51
C	7,34	17,20	20,88	22,5	0,64
D	8,92	19,96	23,42	19,05	0,64

Ordering code example B 95057-A∗∗∗∗-B100

Type (CSR 13) — B 95057
Revision status — A
Code No. for failure rate (refer to page 129) — ∗∗∗∗
Component in acc. with MIL STD permitted — B100

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M=1%	P=0,1%	R=0,01%[1]	S=0,001%[1]
V_R up to 85 °C: 6 V; V_R up to 125 °C: 4 V									
5,6	5	A	0,3	6,0	7,5	5001	5201	5401	5601
5,6	10	A	0,3	6,0	7,5	2241	2481	2721	2961
6,8	5	A	0,3	6,0	7,5	5002	5202	5402	5602
6,8	10	A	0,3	6,0	7,5	2242	2482	2722	2962
6,8	20	A	0,3	6,0	7,5	2243	2483	2723	2963
47,0	5	B	1,5	24,0	30,0	5003	5203	5403	5603
47,0	10	B	1,5	24,0	30,0	2244	2484	2724	2964
47,0	20	B	1,5	24,0	30,0	2245	2485	2725	2965
56,0	5	B	1,5	24,0	30,0	5004	5204	5404	5604
56,0	10	B	1,5	24,0	30,0	2246	2486	2726	2966
150,0	5	C	4,5	90,0	113,0	5005	5205	5405	5605
150,0	10	C	4,5	90,0	113,0	2247	2487	2727	2967
150,0	20	C	4,5	90,0	113,0	2248	2488	2728	2968
180,0	5	C	5,5	110,0	138,0	5006	5206	5406	5606
180,0	10	C	5,5	110,0	138,0	2249	2489	2729	2969
270,0	5	D	6,5	130,0	163,0	5007	5207	5407	5607
270,0	10	D	6,5	130,0	163,0	2250	2490	2730	2970
330,0	5	D	7,5	150,0	188,0	5008	5208	5408	5608
330,0	10	D	7,5	150,0	188,0	2251	2491	2731	2971
330,0	20	D	7,5	150,0	188,0	2252	2492	2732	2972
V_R up to 85 °C: 10 V; V_R up to 125 °C: 7 V									
3,9	5	A	0,3	6,0	7,5	5009	5209	5409	5609
3,9	10	A	0,3	6,0	7,5	2253	2493	2733	2973
4,7	5	A	0,4	7,0	8,8	5010	5210	5410	5610
4,7	10	A	0,4	7,0	8,8	2254	2494	2734	2974
4,7	20	A	0,4	7,0	8,8	2255	2495	2735	2975
27,0	5	B	2,0	40,0	50,0	5011	5211	5411	5611
27,0	10	B	2,0	40,0	50,0	2256	2496	2736	2976
33,0	5	B	2,5	50,0	63,0	5012	5212	5412	5612
33,0	10	B	2,5	50,0	63,0	2257	2497	2737	2977
33,0	20	B	2,5	50,0	63,0	2258	2498	2738	2978
39,0	5	B	2,5	50,0	63,0	5013	5213	5413	5613
39,0	10	B	2,5	50,0	63,0	2259	2499	2739	2979
82,0	5	C	4,0	80,0	100,0	5014	5214	5414	5614
82,0	10	C	4,0	80,0	100,0	2260	2500	2740	2980
100,0	5	C	5,0	100,0	125,0	5015	5215	5415	5615
100,0	10	C	5,0	100,0	125,0	2261	2501	2741	2981
100,0	20	C	5,0	100,0	125,0	2262	2502	2742	2982
120,0	5	C	6,0	120,0	150,0	5016	5216	5416	5616
120,0	10	C	6,0	120,0	150,0	2263	2503	2743	2983
180,0	5	D	9,0	180,0	226,0	5017	5217	5417	5617
180,0	10	D	9,0	180,0	226,0	2264	2504	2744	2984
220,0	5	D	10,0	200,0	250,0	5018	5218	5418	5618
220,0	10	D	10,0	200,0	250,0	2265	2505	2745	2985
220,0	20	D	10,0	200,0	250,0	2266	2506	2746	2986

[1]) upon request

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M = 1%	P = 0,1%	R = 0,01%[1]	S = 0,001%[1]
V_R up to 85 °C: 15 V; V_R up to 125 °C: 10 V									
2,7	5	A	0,3	6,0	7,5	5019	5219	5419	5619
2,7	10	A	0,3	6,0	7,5	2267	2507	2747	2987
3,3	5	A	0,4	8,0	10,0	5020	5220	5420	5620
3,3	10	A	0,4	8,0	10,0	2268	2508	2748	2988
3,3	20	A	0,4	8,0	10,0	2269	2509	2749	2989
18,0	5	B	2,0	35,0	44,0	5021	5221	5421	5621
18,0	10	B	2,0	35,0	44,0	2270	2510	2750	2990
22,0	5	B	2,0	40,0	50,0	5022	5222	5422	5622
22,0	10	B	2,0	40,0	50,0	2271	2511	2751	2991
22,0	20	B	2,0	40,0	50,0	2272	2512	2752	2992
56,0	5	C	4,0	80,0	100,0	5023	5223	5423	5623
56,0	10	C	4,0	80,0	100,0	2273	2513	2753	2993
68,0	5	C	5,0	100,0	125,0	5024	5224	5424	5624
68,0	10	C	5,0	100,0	125,0	2274	2514	2754	2994
68,0	20	C	5,0	100,0	125,0	2275	2515	2755	2995
120,0	5	D	9,0	180,0	226,0	5025	5225	5425	5625
120,0	10	D	9,0	180,0	226,0	2276	2516	2756	2996
150,0	5	D	10,0	200,0	250,0	5026	5226	5426	5626
150,0	10	D	10,0	200,0	250,0	2277	2517	2757	2997
150,0	20	D	10,0	200,0	250,0	2278	2518	2758	2998
V_R up to 85 °C: 20 V; V_R up to 125 °C: 13 V									
1,2	5	A	0,3	6,0	7,5	5027	5227	5427	5627
1,2	10	A	0,3	6,0	7,5	2279	2519	2759	2999
1,5	5	A	0,3	6,0	7,5	5028	5228	5428	5628
1,5	10	A	0,3	6,0	7,5	2280	2520	2760	3000
1,5	20	A	0,3	6,0	7,5	2281	2521	2761	3001
1,8	5	A	0,3	6,0	7,5	5029	5229	5429	5629
1,8	10	A	0,3	6,0	7,5	2282	2522	2762	3002
2,2	5	A	0,4	8,0	10,0	5030	5230	5430	5630
2,2	10	A	0,4	8,0	10,0	2283	2523	2763	3003
2,2	20	A	0,4	8,0	20,0	2284	2524	2764	3004
8,2	5	B	1,0	20,0	25,0	5031	5231	5431	5631
8,2	10	B	1,0	20,0	25,0	2285	2525	2765	3005
10,0	5	B	1,5	30,0	38,0	5032	5232	5432	5632
10,0	10	B	1,5	30,0	38,0	2286	2526	2766	3006
10,0	20	B	1,5	30,0	38,0	2287	2527	2767	3007
12,0	5	B	1,8	35,0	44,0	5033	5233	5433	5633
12,0	10	B	1,8	35,0	44,0	2288	2528	2768	3008
15,0	5	B	2,0	40,0	50,0	5034	5234	5434	5634
15,0	10	B	2,0	40,0	50,0	2289	2529	2769	3009
15,0	20	B	2,0	40,0	50,0	2290	2530	2770	3010
27,0	5	C	2,5	50,0	63,0	5035	5235	5435	5635
27,0	10	C	2,5	50,0	63,0	2291	2531	2771	3011
33,0	5	C	3,5	70,0	88,0	5036	5236	5436	5636
33,0	10	C	3,5	70,0	88,0	2292	2532	2772	3012
33,0	20	C	3,5	70,0	88,0	2293	2533	2773	3013

[1]) upon request

Rated capaci-tance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M = 1%	P = 0,1%	R = 0,01% [1]	S = 0,001% [1]
V_R up to 85 °C: 20 V;	V_R up to 125 °C: 13 V								
39,0	5	C	4,0	80,0	100,0	5037	5237	5437	5637
39,0	10	C	4,0	80,0	100,0	2294	2534	2774	3014
47,0	5	C	4,5	90,0	113,0	5038	5238	5438	5638
47,0	10	C	4,5	90,0	113,0	2295	2535	2775	3015
47,0	20	C	4,5	90,0	113,0	2296	2536	2776	3016
56,0	5	D	5,5	110,0	138,0	5039	5239	5439	5639
56,0	10	D	5,5	110,0	138,0	2297	2537	2777	3017
68,0	5	D	7,0	140,0	175,0	5040	5240	5440	5640
68,0	10	D	7,0	140,0	175,0	2298	2538	2778	3018
68,0	20	D	7,0	140,0	175,0	2299	2539	2779	3019
82,0	5	D	8,0	160,0	200,0	5041	5241	5441	5641
82,0	10	D	8,0	160,0	200,0	2300	2540	2780	3020
100,0	5	D	10,0	200,0	250,0	5042	5242	5442	5643
100,0	10	D	10,0	200,0	250,0	2301	2541	2781	3021
100,0	20	D	10,0	200,0	250,0	2302	2542	2782	3022
V_R up to 85 °C: 35 V;	V_R up to 125 °C: 23 V								
5,6	5	B	1,3	25,0	32,0	5043	5243	5443	5643
5,6	10	B	1,3	25,0	32,0	2303	2543	2783	3023
6,8	5	B	1,5	30,0	38,0	5044	5244	5444	5644
6,8	10	B	1,5	30,0	38,0	2304	2544	2784	3024
6,8	20	B	1,5	30,0	38,0	2305	2545	2785	3025
22,0	5	C	4,0	80,0	100,0	5045	5245	5445	5645
22,0	10	C	4,0	80,0	100,0	2306	2546	2786	3026
22,0	20	C	4,0	80,0	100,0	2307	2547	2787	3027
27,0	5	D	4,5	90,0	113,0	5046	5246	5446	5646
27,0	10	D	4,5	90,0	113,0	2308	2548	2788	3028
33,0	5	D	5,5	110,0	138,0	5047	5247	5447	5647
33,0	10	D	5,5	110,0	138,0	2309	2549	2789	3029
33,0	20	D	5,5	110,0	138,0	2310	2550	2790	3030
39,0	5	D	7,0	140,0	175,0	5048	5248	5448	5648
39,0	10	D	7,0	140,0	175,0	2311	2551	2791	3031
47,0	5	D	8,0	160,0	200,0	5049	5249	5449	5649
47,0	10	D	8,0	160,0	200,0	2312	2552	2792	3032
47,0	20	D	8,0	160,0	200,0	2313	2553	2793	3033

[1]) upon request

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M = 1%	P = 0,1%	R = 0,01%[1]	S = 0,001%[1]
V_R up to 85 °C: 50 V; V_R up to 125 °C: 33 V									
0,1	5	A	0,3	5,0	6,3	5066	5266	5466	5666
0,1	10	A	0,3	5,0	6,3	2338	2578	2818	3058
0,1	20	A	0,3	5,0	6,3	2339	2579	2819	3059
0,12	5	A	0,3	5,0	6,3	5067	5267	5467	5667
0,12	10	A	0,3	5,0	6,3	2340	2580	2820	3060
0,15	5	A	0,3	5,0	6,3	5068	5268	5468	5668
0,15	10	A	0,3	5,0	6,3	2341	2581	2821	3061
0,15	20	A	0,3	5,0	6,3	2342	2582	2822	3062
0,18	5	A	0,3	5,0	6,3	5069	5269	5469	5669
0,18	10	A	0,3	5,0	6,3	2343	2583	2823	3063
0,22	5	A	0,3	5,0	6,3	5070	5270	5470	5670
0,22	10	A	0,3	5,0	6,3	2344	2584	2824	3064
0,22	20	A	0,3	5,0	6,3	2345	2585	2825	3065
0,27	5	A	0,3	5,0	6,3	5071	5271	5471	5671
0,27	10	A	0,3	5,0	6,3	2346	2586	2826	3066
0,33	5	A	0,3	5,0	6,3	5072	5272	5472	5672
0,33	10	A	0,3	5,0	6,3	2347	2587	2827	3067
0,33	20	A	0,3	5,0	6,3	2348	2588	2828	3068
0,39	5	A	0,3	5,0	6,3	5073	5273	5473	5673
0,39	10	A	0,3	5,0	6,3	2349	2589	2829	3069
0,47	5	A	0,3	5,0	6,3	5074	5274	5474	5674
0,47	10	A	0,3	5,0	6,3	2350	2590	2830	3070
0,47	20	A	0,3	5,0	6,3	2351	2591	2831	3071
0,56	5	A	0,3	5,0	6,3	5075	5275	5475	5675
0,56	10	A	0,3	5,0	6,3	2352	2592	2832	3072
0,68	5	A	0,3	5,0	6,3	5076	5276	5476	5676
0,68	10	A	0,3	5,0	6,3	2353	2593	2833	3073
0,68	20	A	0,3	5,0	6,3	2354	2594	2834	3074
0,82	5	A	0,3	5,0	6,3	5077	5277	5477	5677
0,82	10	A	0,3	5,0	6,3	2355	2595	2835	3075
1,0	5	A	0,4	8,0	10,0	5078	5278	5478	5678
1,0	10	A	0,4	8,0	10,0	2356	2596	2836	3076
1,0	20	A	0,4	8,0	10,0	2357	2597	2837	3077
1,2	5	B	0,4	9,0	11,0	5079	5279	5479	5679
1,2	10	B	0,4	9,0	11,0	2358	2598	2838	3078
1,5	5	B	0,6	12,0	15,0	5080	5280	5480	5680
1,5	10	B	0,6	12,0	15,0	2359	2599	2839	3079
1,5	20	B	0,6	12,0	15,0	2360	2600	2840	3080
1,8	5	B	0,7	14,0	18,0	5081	5281	5481	5681
1,8	10	B	0,7	14,0	18,0	2361	2601	2841	3081
2,2	5	B	0,8	17,0	22,0	5082	5282	5482	5682
2,2	10	B	0,8	17,0	22,0	2362	2602	2842	3082
2,2	20	B	0,8	17,0	22,0	2363	2603	2843	3083
2,7	5	B	1,0	20,0	25,0	5083	5283	5483	5683
2,7	10	B	1,0	20,0	25,0	2364	2604	2844	3084
3,3	5	B	1,2	25,0	32,0	5084	5284	5484	5684
3,3	10	B	1,2	25,0	32,0	2365	2605	2845	3085

[1]) upon request

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M=1%	P=0,1%	R=0,01%[1]	S=0,001%[1]
V_R up to 85 °C: 50 V; V_R up to 125 °C: 33 V									
3,3	20	B	1,2	25,0	32,0	2366	2606	2846	3086
3,9	5	B	1,5	30,0	38,0	5085	5285	5485	5685
3,9	10	B	1,5	30,0	38,0	2367	2607	2847	3087
4,7	5	B	1,7	35,0	44,0	5086	5286	5486	5686
4,7	10	B	1,7	35,0	44,0	2368	2608	2848	3088
4,7	20	B	1,7	35,0	44,0	2369	2609	2849	3089
5,6	5	C	2,2	45,0	56,0	5087	5287	5487	5687
5,6	10	C	2,2	45,0	56,0	2370	2610	2850	3090
6,8	5	C	2,2	45,0	56,0	5088	5288	5488	5688
6,8	10	C	2,2	45,0	56,0	2371	2611	2851	3091
6,8	20	C	2,2	45,0	56,0	2372	2612	2852	3092
8,2	5	C	2,5	50,0	63,0	5089	5289	5489	5689
8,2	10	C	2,5	50,0	63,0	2373	2613	2853	3093
10,0	5	C	2,5	50,0	63,0	5090	5290	5490	5690
10,0	10	C	2,5	50,0	63,0	2374	2614	2854	3094
10,0	20	C	2,5	50,0	63,0	2375	2615	2855	3095
12,0	5	C	3,0	60,0	75,0	5091	5291	5491	5691
12,0	10	C	3,0	60,0	75,0	2376	2616	2856	3096
15,0	5	C	4,0	80,0	100,0	5092	5292	5492	5692
15,0	10	C	4,0	80,0	100,0	2377	2617	2857	3097
15,0	20	C	4,0	80,0	100,0	2378	2618	2858	3098
18,0	5	C	4,5	90,0	113,0	5093	5293	5493	5693
18,0	10	C	4,5	90,0	113,0	2379	2619	2859	3099
22,0	5	D	5,5	110,0	138,0	5094	5294	5494	5694
22,0	10	D	5,5	110,0	138,0	2380	2620	2860	3100
22,0	20	D	5,5	110,0	138,0	2381	2621	2861	3101
V_R up to 85 °C: 75 V; V_R up to 125 °C: 50 V									
0,1	5	A	0,3	5,0	6,3	5095	5295	5495	5695
0,1	10	A	0,3	5,0	6,3	2382	2622	2862	3102
0,1	20	A	0,3	5,0	6,3	2383	2623	2863	3103
0,12	5	A	0,3	5,0	6,3	5096	5296	5496	5696
0,12	10	A	0,3	5,0	6,3	2384	2624	2864	3104
0,15	5	A	0,3	5,0	6,3	5097	5297	5497	5697
0,15	10	A	0,3	5,0	6,3	2385	2625	2865	3105
0,15	20	A	0,3	5,0	6,3	2386	2626	2866	3106
0,18	5	A	0,3	5,0	6,3	5098	5298	5498	5698
0,18	10	A	0,3	5,0	6,3	2387	2627	2867	3107
0,22	5	A	0,3	5,0	6,3	5099	5299	5499	5699
0,22	10	A	0,3	5,0	6,3	2388	2628	2868	3108
0,22	20	A	0,3	5,0	6,3	2389	2629	2869	3109
0,27	5	A	0,3	5,0	6,3	5100	5300	5500	5700
0,27	10	A	0,3	5,0	6,3	2390	2630	2870	3110
0,33	5	A	0,3	5,0	6,3	5101	5301	5501	5701
0,33	10	A	0,3	5,0	6,3	2391	2631	2871	3111
0,33	20	A	0,3	5,0	6,3	2392	2632	2872	3112
0,39	5	A	0,3	5,0	6,3	5102	5302	5502	5702

[1]) upon request

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code No. for failure rate (%/1000 h) M = 1%	P = 0,1%	R = 0,01%[1]	S = 0,001%[1]
V_R up to 85 °C: 75 V; V_R up to 125 °C: 50 V									
0,39	10	A	0,3	5,0	6,3	2393	2633	2873	3113
0,47	5	A	0,3	5,0	6,3	5103	5303	5503	5703
0,47	10	A	0,3	5,0	6,3	2394	2634	2874	3114
0,47	20	A	0,3	5,0	6,3	2395	2635	2875	3115
0,56	5	A	0,3	5,0	6,3	5104	5304	5504	5704
0,56	10	A	0,3	5,0	6,3	2396	2636	2876	3116
0,68	5	A	0,3	5,0	6,3	5105	5305	5505	5705
0,68	10	A	0,3	5,0	6,3	2397	2637	2877	3117
0,68	20	A	0,3	5,0	6,3	2398	2638	2878	3118
0,82	5	B	0,3	5,0	6,3	5106	5306	5506	5706
0,82	10	B	0,3	5,0	6,3	2399	2639	2879	3119
1,0	5	B	0,4	5,0	6,3	5107	5307	5507	5707
1,0	10	B	0,4	5,0	6,3	2400	2640	2880	3120
1,0	20	B	0,4	5,0	6,3	2401	2641	2881	3121
1,2	5	B	0,4	5,0	6,3	5108	5308	5508	5708
1,2	10	B	0,4	5,0	6,3	2402	2642	2882	3122
1,5	5	B	0,6	10,0	13,0	5109	5309	5509	5709
1,5	10	B	0,6	10,0	13,0	2403	2643	2883	3123
1,5	20	B	0,6	10,0	13,0	2404	2644	2884	3124
1,8	5	B	0,7	10,0	13,0	5110	5310	5510	5710
1,8	10	B	0,7	10,0	13,0	2405	2645	2885	3125
2,2	5	B	0,8	15,0	19,0	5111	5311	5511	5711
2,2	10	B	0,8	15,0	19,0	2406	2646	2886	3126
2,2	20	B	0,8	15,0	19,0	2407	2647	2887	3127
2,7	5	B	1,0	15,0	19,0	5112	5312	5512	5712
2,7	10	B	1,0	15,0	19,0	2408	2648	2888	3128
3,3	5	B	1,2	20,0	25,0	5113	5313	5513	5713
3,3	10	B	1,2	20,0	25,0	2409	2649	2889	3129
3,3	20	B	1,2	20,0	25,0	2410	2650	2890	3130
3,9	5	B	1,5	20,0	25,0	5114	5314	5514	5714
3,9	10	B	1,5	20,0	25,0	2411	2651	2891	3131

Dissipation factor tan δ at 120 Hz

Rated capacitance	−55 °C to +20 °C	+85 °C to +125 °C
≤ 1,0 µF	0,02	0,04
1,2 . . . 5,6 µF	0,04	0,04
6,8 . . . 82 µF	0,06	0,06
≥ 100 µF	0,08	0,08

[1]) upon request

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