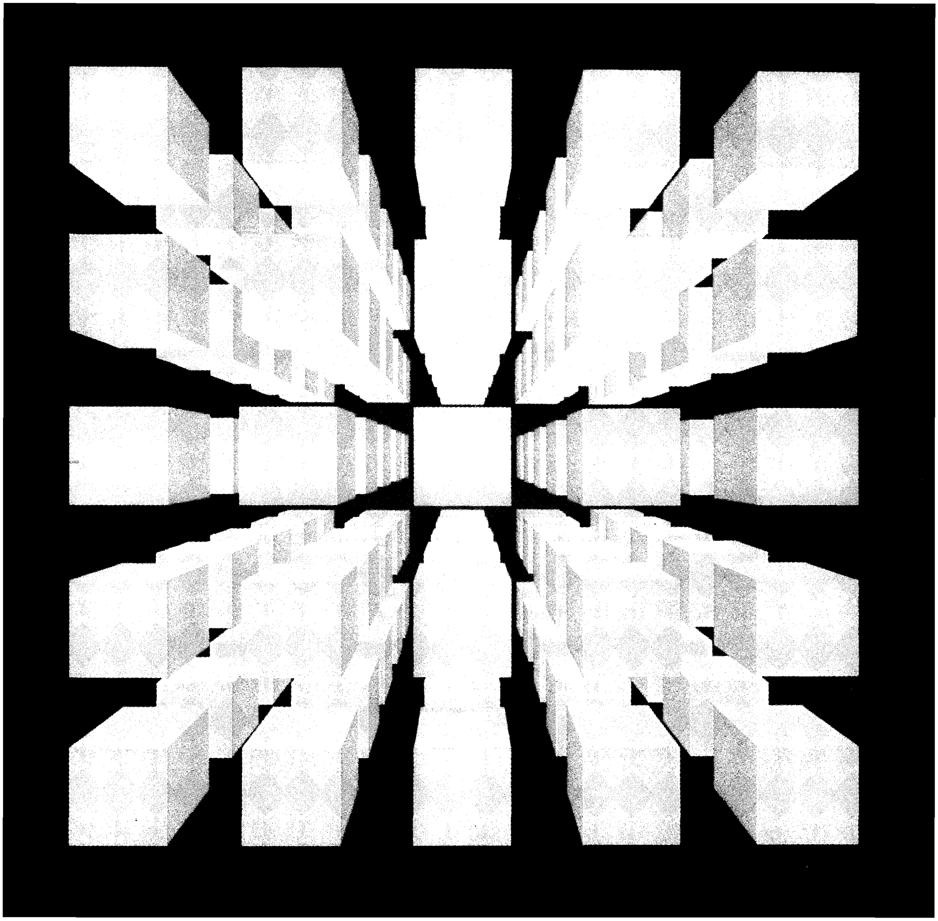
SIEMENS

Aluminum and Tantalum Electrolytic Capacitors

Data Book 1989/90



Aluminum and Tantalum Electrolytic Capacitors

Data Book 1989/90

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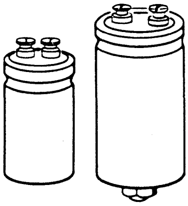
Screw terminals 	B 41455	136	B 41564	126	B 41431	97
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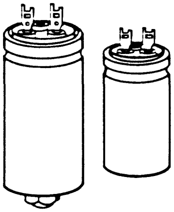
Solder tags 	B 41070	197	–		–	
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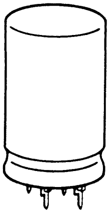
Solder pins 	B 41306	190	B 41507	183	–	
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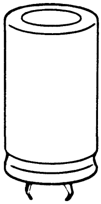
Snap-in 	B 41303	175	B 41503	167	–	
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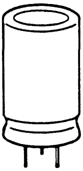
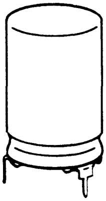
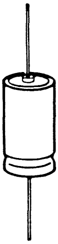
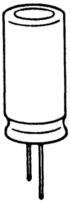
3-pin 	–		B 41336 B 41534 B 43534	161 154	–	
Soldering star 	B 41293 B 43293	233	B 41593 B 43593	214	B 41592 B 43592	113 120
Axial 	B 41283 B 41010 B 43283 B 43050	223	B 41588 B 43588	205	B 41590 B 43590	101 107
Single-ended 	B 41326 B 43326	243	–		–	

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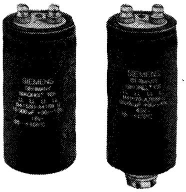
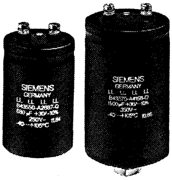
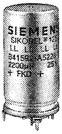
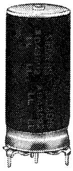
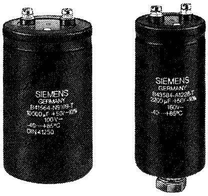
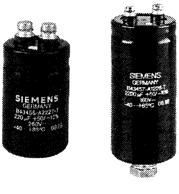
Selector Guide

Type	Rated capacitance C_R µF	Rated voltage V_R V dc	Dimensions $d_{max} \times l_{max}$ mm	
SIKOREL® and high-performance capacitors				
 B 41554 SIKOREL 125	1000 to 150000	16 to 100	35,7 × 56,7 to 76,9 × 145,6	
 B 41550 B 41570 SIKOREL 105	1000 to 150000	16 to 100	35,7 × 56,7 to 76,9 × 145,6	
 B 43550 B 43570 High-performance	150 to 15000	160 to 400	35,7 × 56,7 to 76,9 × 221,8	
 B 41431 SIKOREL SMPS	2800 to 46000	5 to 55	35,7 × 56,7 to 35,7 × 107,5	
 B 41590 SIKOREL 125	4,7 to 4700	10 to 100	7,0 × 19 to 25,5 × 41,5	

	Temperature range (°C) IEC climatic category	Service life 40 °C, V_R, I_{acR} h	Standards and specifications	Features and applications	Page
	−55 to +125 55/125/56	> 500 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 DIN 41 249	Very wide temperature range, very long service life, high ripple current capability, outstanding reliability. For highly professional power supplies.	76
	−55 to +105 55/105/56	> 500 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 Dimensions in acc. with DIN 41 249	Very long service life, high ripple current capability, wide temperature range, high reliability. For highly professional power supplies.	83
	−40 to +105 for $V_R \leq 350$ V dc −40 to +85 for $V_R > 350$ V dc 40/105/56 or 40/085/56	> 180 000 or > 360 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 Dimensions in acc. with DIN 41 248	High reliability, wide temperature range, high contact reliability. For highly professional switch-mode power supplies.	90
	−55 to +105 55/105/56	> 180 000	DIN IEC 384 Part 4 DIN 45 910 Part 12	Very high ripple current capability, low *ESR*, even at high frequencies, long service life, wide temperature range, high reliability. Particularly suitable for switch-mode power supplies.	97
	−55 to +125 (+145) 55/125/56	> 500 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 DIN 41 257	Very wide temperature range (dia. ≤ 18 mm: at 0.6 V_R up to 145 °C), very long service life, outstanding reliability. For highly professional applications.	101

Type	Rated capaci-tance C_R µF	Rated voltage V_R V dc	Dimensions $d_{max} \times l_{max}$ mm	
SIKOREL® and high-performance capacitors				
B 43590  High-performance	1 to 220	160 to 350	9,0 × 19 to 25,5 × 41,5	
B 41592  SIKOREL 125	47 to 4700	10 to 100	13,5 × 33 to 26,5 × 42	
B 43592  High-performance	1 to 220	160 to 350	13,5 × 33 to 26,5 × 42	
Can-type capacitors, LL and GP grade				
B 41564 B 43564 B 41584 B 43584  LL grade	220 to 220000	16 to 400	35,7 × 56,7 to 76,9 × 221,8	
B 41455 B 43455 B 41457 B 43457  GP grade	220 to 150000	16 to 400	35,7 × 56,7 to 76,9 × 221,8	

	Temperature range (°C) IEC climatic category	Service life 40 °C, V_R, I_{acR} h	Standards and specifications	Features and applications	Page
	−40 to +105 40/105/56	> 260000 or >360000	DIN IEC 384 Part 4 DIN 45910 Part 12 Dimensions in acc. with DIN 41257	Wide temperature range, long service life, excellent electrical data. For high rel equipment; automotive electronics.	107
	−55 to +125 (+145) 55/125/56	> 500000	DIN IEC 384 Part 4 DIN 45910 Part 12 Dimensions in acc. with DIN 41267	Very wide temperature range (dia. ≤ 18 mm: at 0.6 V_R up to 145 °C) high vibration resistance, pinning ensures correct insertion, very long service life, outstanding reliability. For professional applications and automotive electronics.	113
	−40 to +105 40/105/56	> 360000	DIN IEC 384 Part 4 DIN 45910 Part 12 Dimensions in acc. with DIN 41267	Wide temperature range, long service life, excellent electrical data, pinning ensures correct insertion, high vibration resistance. For professional applications and automotive electronics.	120
	−40 to +85 40/085/56	B 41564, B 41584: > 180000 B 43564, B 43584: > 130000	DIN IEC 384 Part 4 DIN 45910 Part 12 DIN 41248	Professional DIN types with long service life, high reliability and ripple current capability. For application in industrial electronics and professional power supplies.	126
	−40 to +85 40/085/56	B 41455, B 41457: > 110000 B 43455, B 43457: > 70000	DIN IEC 384 Part 4 DIN 45910 Part 12 DIN 41250	DIN standard types. General-purpose application.	136

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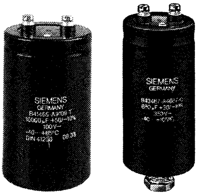
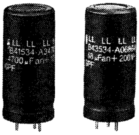
Type	Rated capacitance C_R µF	Rated voltage V_R V dc	Dimensions $d_{max} \times l_{max}$ mm
Can-type capacitors, LL and GP grade			
B 41465/B 43465 B 41467/B 43467 B 41481/B 43481  GP grade	170 to 850000	10 to 450	35,7 × 56,7 to 76,9 × 221,8
B 41534 B 43534  LL grade	47 to 15000	6,3 to 385	18,8 × 30,5 to 25,8 × 40,5
B 41336  LL grade	100 to 15000	6,3 to 100	18,8 × 30,0 to 25,8 × 40,5
B 41503 B 43503  LL grade	47 to 33000	10 to 400	22 × 25 to 30 × 50
B 41303 B 43303  GP grade	68 to 47000	10 to 385	22 × 25 to 30 × 50

	Temperature range (°C) IEC climatic category	Service life 40 °C, V_R, $I_{ac\,R}$ h	Standards and specifications	Features and applications	Page
	−40 to +85 40/085/56	> 90000	DIN IEC 384 Part 4 Construction in acc. with DIN 41248	Series featuring long service life and high ripple current capability, high volumetric efficiency; screw terminals with UNF or metric thread. For professional power supplies and application in power electronics, e.g. power converters.	146
	−40 to +85 40/085/56	> 180000	DIN IEC 384 Part 4 DIN 45910 Part 12	Low *ESR*, high ripple current capability, long service life, high reliability. For compact professional switch-mode power supplies.	154
	−40 to +85 40/085/56	> 180000	DIN IEC 384 Part 4 DIN 45910 Part 12	Low self-inductance, low *ESR*, high ripple current capability, long service life, high reliability. Particularly suitable for switch-mode power supplies with high clock frequencies.	161
	−40 to +105 40/105/56	> 220000	DIN IEC 384 Part 4 DIN 45910 Part 12	LL version with outstanding reliability, high ripple current capability at small dimensions, low *ESR*. For professional switch-mode power supplies in industrial electronics and data processing systems.	167
	−40 to +85 40/085/56	> 40000	DIN IEC 384 Part 4 DIN 45910 Part 12	Very small size, low *ESR*, high ripple current capability. For switch-mode power supplies in entertainment electronics.	175

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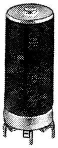
Type	Rated capaci-tance C_R µF	Rated voltage V_R V dc	Dimensions $d_{max} \times l_{max}$ mm
Can-type capacitors, LL and GP grade			
  B 41507 B 43507 LL grade	100 to 100000	10 to 385	25,8 × 34 to 40,8 × 104
 B 41306 B 43306 GP grade	100 to 47000	16 to 385	25,8 × 34 to 40,8 × 104
  B 41070 B 41072 GP grade	470 to 47000	16 to 100	25 × 45 to 40 × 105
Small capacitors, axial, upright, single-ended			
 B 41588 B 43588 LL grade	1 to 4700	10 to 350	7,0 × 19 to 25,5 × 41,5
 B 41593 B 43593 LL grade	10 to 4700	10 to 350	13,5 × 33 to 26,5 × 42

	Temperature range (°C) IEC climatic category	Service life 40 °C, V_R, $I_{ac\,R}$ h	Standards and specifications	Features and applications	Page
	– 40 to + 85 40/085/56	> 110 000 or > 230 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 Dimensions in acc. with DIN 41 268	Can be flow-soldered directly on PCB, for high rel requirements, high ripple current capability, high volumetric efficiency. For professional switch-mode power supplies in industrial and consumer electronics.	183
	– 40 to + 85 40/085/56	> 70 000 or > 90 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 DIN 41 238	Standard version with high ripple current capability, solder pins can be flow-soldered directly on PCB. For switch-mode power supplies in entertainment electronics.	190
	– 40 to + 85 40/085/56	> 45 000	DIN IEC 384 Part 1 DIN 45 910 Part 12 DIN 41 238	Not for new design! Can with solder tags, for general-purpose application, conventional connection by wire or litz wire.	197
	– 40 to + 85 (+ 105) 40/085/56	B 41 588 $d_R \leq 8{,}5$: > 135 000 $d_R \geq 10$: > 220 000 B 43 588 $d_R \leq 8{,}5$: > 135 000 $d_R \geq 10$: > 180 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 DIN 41 257	DIN type for high rel requirements, long service life, low *ESR*. For application in all kinds of electronic equipment and systems.	205
	– 40 to + 85 (+ 105) 40/085/56	B 41 593: > 220 000 B 43 593: > 180 000	DIN IEC 384 Part 4 DIN 45 910 Part 12 DIN 41 267	Welded-on soldering star ensures stable, vibration-resistant mounting, DIN type for high rel requirements, long service life, low *ESR*. For application in automotive and industrial electronics.	214

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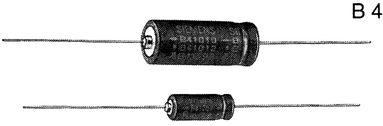
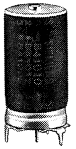
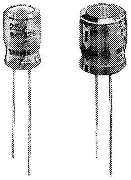
Type	Rated capaci-tance C_R µF	Rated voltage V_R V dc	Dimensions $d_{max} \times l_{max}$ mm
Small capacitors, axial, upright, single-ended			
B 41283 B 41010 B 43283 B 43050  GP grade	1 to 10000	6,3 to 350	7,0 × 19 to 25,5 × 41,5
B 41293 B 43293  GP grade	10 to 4700	10 to 385	13,5 × 33 to 26,5 × 47
B 41326 B 43326  GP grade	0,47 to 4700	6,3 to 250	5,5 × 12 to 18,5 × 32,5
Capacitors for photoflash applications			
B 43405  B 43405 B 43406  B 43407	approx. 120 to approx. 4000	310 to 510	22,5 × 30,5 to 40,5 × 80,5
B 43406	approx. 500 to approx. 3000	330 to 500	35,5 × 60,5 to 40,5 × 80,5
B 43407	approx. 1500	350 V	51,6 × 107,5

	Temperature range (°C) IEC climatic category	Service life 40 °C, V_R, $I_{ac\,R}$ h	Standards and specifications	Features and applications	Page
	−40 to +85 (+105) 40/085/56	B 41283: > 70000 B 41010: > 90000 B 43283: > 70000 B 43050: > 70000	DIN IEC 384 Part 4 DIN 45910 Part 12 DIN 41316	Standard version with small dimensions, operation up to +105°C, high ripple current capability and favorable electrical values. General-purpose use, e.g. in entertainment electronics and for semiprofessional applications.	223
	−40 to +85 (+105) 40/085/56	B 41293: > 90000 B 43293: > 70000	DIN IEC 384 Part 4 DIN 45910 Part 12 DIN 41253	Stable, vibration-resistant construction, operation up to 105°C. For application in automotive, entertainment and industrial electronics as well as in switch-mode power supplies.	233
	−40 to +85 (+105) 40/085/56	$d_R = 5$ mm: >45000 $d_R \geq 6{,}3$ mm: >70000	DIN IEC 384 Part 4 DIN 45910 Part 12 DIN 41259 (draft)	Single-ended version for high-density PCBs, operation up to 105°C. Particularly suitable for automatic PCB assembly and mass production, available on tape.	243
	−25 to +70	≥ 5000 flash discharges	–	Photoflash electrolytic capacitor for amateur equipment, solid solder tags for reliable connection by wire or litz wire.	255
	−25 to +70	≥ 30000 flash discharges	–	Photoflash electrolytic capacitor for portable professional equipment.	256
	−25 to +70	≥ 100000 flash discharges	–	Photoflash electrolytic capacitor for studio equipment.	257

Aluminum Electrolytic Capacitors

General Technical Information

Symbols and terms

Symbols	Description
C	Capacitance
C_R	Rated capacitance
C_s	Series capacitance
$C_{s,T}$	Series capacitance at temperature T
C_T	Capacitance at temperature T
C_f	Capacitance at frequency f
V	Voltage
V_R	Rated voltage, dc voltage
V_p	Peak voltage
V_C	Category voltage
V_{op}	Operating voltage
I	Current
I_{ac}	Alternating current, ripple current
$I_{ac\,f}$	Ripple current at frequency f
$I_{ac\,R}$	Rated ripple current
$I_{ac\,R,\,UC}$	Rated ripple current at upper category temperature
I_{lk}	Leakage current
I_{lko}	Output leakage current
I_{lkop}	Operational leakage current
R	Resistance
ESR	Equivalent series resistance
ESR_f	Equivalent series resistance at frequency f
ESR_T	Equivalent series resistance at temperature T
R_{ins}	Insulation resistance
R_{symm}	Balancing resistance
Z	Impedance
Z_T	Impedance at temperature T
T	Temperature
T_A	Ambient temperature
T_{UC}	Upper category temperature
T_{LC}	Lower category temperature
t	Time
Δt	Period of time
t_B	Service life
λ	Failure rate (1 fit = $1 \cdot 10^{-9}$/h)
d	Diameter of the capacitor
l	Case length of the capacitor
ESL	Self-inductance of the capacitor
$\tan\delta$	Dissipation factor
ε_r	Relative dielectric constant
f	Frequency
ω	Angular frequency; $2 \cdot \pi \cdot f$

I Basic construction

Metals the oxides of which are capable of blocking the current flow in one direction and of passing it in the other are called valve metals. The metals aluminum and tantalum have gained practical importance. Operation of electrolytic capacitors is based on the the effect of their oxides.

The electrolytic capacitor assumes an exceptional position among the numerous kinds of capacitors since its operating characteristic is partly based on electrochemical processes. In order to understand its properties, it is advisable to take a closer look at its construction. In the following the aluminum electrolytic capacitor will be discussed.

Generally, each capacitor consists of two electrically conducting layers with the dielectric in between. The aluminum electrolytic capacitor is also composed of these three components. Contrary to other capacitors, where the electrodes are formed of metal layers, the cathode of aluminum electrolytic capacitors is formed by a conducting liquid, the operational electrolyte. The anode is an aluminum body (in wound capacitors an aluminum foil). On its surface an aluminum oxide layer (the dielectric) is generated by electrochemical processes. The aluminum that has not been exploited for oxidation (starting metal) forms the necessary positive layer.

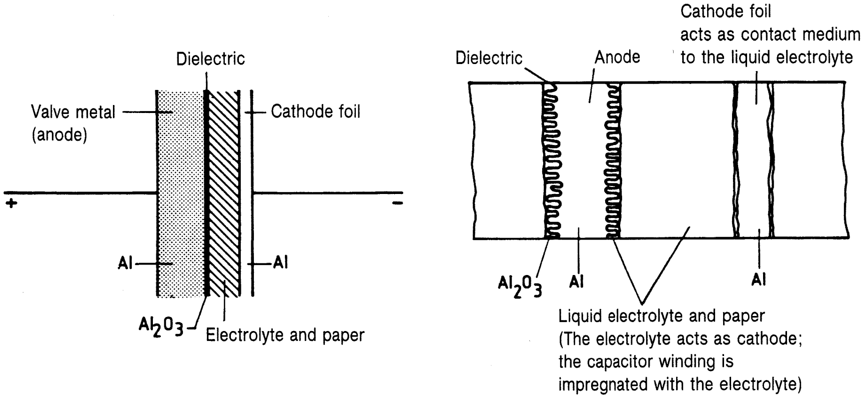


Figure 1
Basic construction of an electrolytic capacitor

The advantages that have led to the widespread application of electrolytic capacitors are their high volumetric efficiency (capacitance per unit volume), which permits the production of capacitors up to 1 Farad, and the excellent price/performance ratio.

As is the case with other capacitors, the capacitance is directly proportional to the effective surface and the relative dielectric constant ε_r of the dielectric and inversely proportional to the distance between the two layers which, in the case of electrolytic capacitors, is determined by the thickness of the oxide layer. At approximately 10, the ε_r value of the aluminum oxide is relatively high (paper dielectrics have a value of approx. 5). In addition, aluminum oxide affords the particular advantage that it can be designed a great deal thinner than other dielectrics owing to its unusually high permissible operating field strength of approx. 800 MV/m. Its thickness can be matched precisely to the operating conditions of the capacitor.

The aluminum oxide film is generated by anodic oxidation (anodization). The thickness of the film grows practically proportionally to the applied forming voltage. For safety reasons, the final forming voltage is chosen higher than the rated or peak voltage values.

The film thickness is approx. 1.2 nm/V, i.e. even with high-voltage capacitors, a layer distance of only 0.7 µm can be expected. This is one of the reasons for the high capacitance per unit volume. (The minimum thickness of a paper dielectric for example is 6 to 8 µm.)

In addition, the electrode surface is considerably enlarged by an electrochemical etching process (see figure 2). Since one of the layers of electrolytic capacitors is liquid (operational electrolyte), its surface ideally fits to the anode. During anodization of etched foils, the fine etching pits partially incrust. This phenomenon intensifies with increasing forming voltage and layer thickness. With different etching processes the magnitude of the pores can be matched to the required voltage.

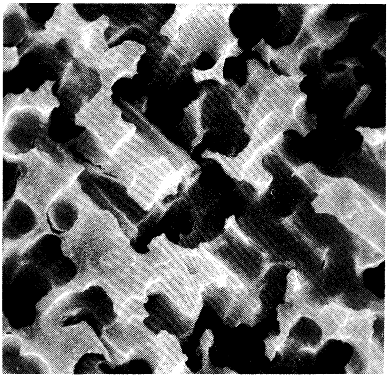


Figure 2
Etched aluminum foil in a scanning electron micrograph. Enlargement: 2500 times.

As the oxide layer constitutes a voltage-dependent resistance, the current rises more than proportionally to the applied voltage, as can be seen from figure 3.

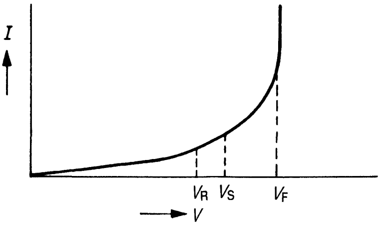


Figure 3
Current dependence on voltage of al electrolytic capacitors.

When the forming voltage has been reached, a further forming process starts generating large amounts of gas and heat. The same effect, yet on a smaller scale can already be observed in the strongly curved part of the characteristic. In order to avoid damage to the capacitor, the rated voltage should be applied where the characteristic has its less curved part. The difference between the forming voltage and the operating voltage, the so-called over-anodization, thus substantially determines the operational reliability of the capacitors. High over-anodization offers the possibility of building capacitors with high operational reliability (long-life grade "LL" in acc. with IEC 384-1 or previous designation "type I" in acc. with DIN 41 240).

As already mentioned, al electrolytic capacitors with liquid electrolyte are today almost exclusively produced with wound construction. The winding contains, in addition to the already described anode, a second aluminum foil, at least equal in size, but not anodized. It serves as a large area current supply for the electrolyte and is normally called "cathode" in spite of the fact that with respect to its function the proper cathode is represented by the electrolyte.

Both foils are separated from each other by paper layers. The paper has to meet different requirements. It serves as carrying agent for the electrolyte – the electrolyte is stored in the pores of the absorbent paper – and as space-keeping agent in order to avoid short circuits and to achieve the necessary voltage strength between anode and "cathode".

II Terms, technical data, explanations

All data given in the following including numerical values, is of general importance. To certain types often better values apply which are given in the individual data sheets.

1 Plain and etched

Due to their small dimensions, aluminum electrolytic capacitors with etched, and thus surface enlarged foils are today nearly exclusively demanded. Electrolytic capacitors with non-etched foils (plain) partly feature better electrical ratings but are on the other hand considerably larger. They are only used for particular applications.

2 Polar and non-polar

The electrolytic capacitor designed as described above, consisting of an anodized aluminum foil on which the dielectric film is applied, a second aluminum foil and the electrolyte being between both foils, can only function correctly when the positive pole is connected to the anodized aluminum foil (anode) and the negative pole to the other (cathode). A reversed polarization would cause an electrolytic process and a dielectric film would be generated on the cathode foil as well as on the anode. Thus, heavy internal heating and gas formation would arise which could possibly destroy the capacitor. The total capacitance would also be reduced by the increasing thickness of the oxide film which reduces the capacitance of the cathode in series with the capacitance of the anode. Due to its basic design the electrolytic capacitor is therefore only suitable for dc voltage applications. This direct voltage may also be a ripple voltage, i.e., a direct voltage with a superimposed alternating voltage with the positive pole connected to the anode. This is understood as the *polar* version, which is suitable for most applications. The requirement of correct polarizing for the polar capacitor types is valid with the only exception that incorrect polarization is permitted up to 2 V for short periods, since the damaging anodization of the cathode as described above only begins to rise at voltages of this magnitude. (The cathode foil is covered by an air-oxide layer which corresponds to an anodically generated layer with a blocking voltage of about 2 V.)

Non-polar (bipolar) electrolytic capacitors are also available. In addition to the anode foil they have a second foil which is anodized during the production process and its capacitance value is of the same range as that of the anode. This construction allows for operation at direct voltage ratings and either polarization, as well as at pure alternating voltage ratings. Since the latter causes inherent heating, the alternating voltage must be kept considerably below the direct voltage rating. Due to series-connection of the two capacitor elements the total capacitance amounts only to half the individual capacitance values. A non-polar electrolytic capacitor, compared with a polar one, needs therefore up to twice the volume for the same total capacitance at the same construction. Moreover, twice the leakage current has to be expected.

3 "LL Grade" and "GP Grade" electrolytic capacitors

Al electrolytic capacitors are generally divided into two basic reliability categories: capacitors for high-reliability applications and capacitors for general-purpose applications. This differentiation has also been adopted in the relevant standards (IEC and CECC internationally and DIN in the Federal Republic of Germany).

In IEC publications al electrolytic capacitors for high rel requirements are identified as "Long Life Grade" capacitors; the previous DIN designation was "Type I". The abbreviation "LL" is stamped on the capacitors. In addition to the over-anodization described in section I, other measures are taken to enhance their reliability. The materials used for the construction of LL grade capacitors are carefully selected and have to satisfy particularly high requirements as to their purity. These efforts influence the case size as well as the price.

Capacitors identified as "General-Purpose Grade" or "GP" capacitors in IEC publications (previous DIN designation "Type II") are intended for less strict reliability requirements. Their most important feature is small size. During the last years a steady size reduction has been obtained, mainly resulting from an increased etching effect. However, this cannot be permanently continued as a reduction of the foil area brings about increased losses. Up to now this drawback could be compensated to a large extent by using highly conductive electrolytes.

4 Specifications

The international specifications for aluminum electrolytic capacitors are given in IEC publication 384-4, which is also available in German as DIN-IEC 384, part 4 (at present only draft). In the future, German specs will be adapted to these IEC specs or will brought into line with the DIN standard 45910, part 12, which has the same technical contents as CECC 30300.

In addition to the sectional DIN specs there are type specs that apply only to a specific type (e.g. axial-lead electrolytic capacitors). The values contained in the type specifications are frequently better than those of the sectional standards. The type specs also include the maximum permissible dimensions in correlation with capacitance and rated voltage.

In recent specifications capacitance ratings in accordance with the E3 or E6 series are given. The rated voltage values are standardized according to the R5 series, in exceptional cases the voltage has been standardized with regard to requirements.

The number of the type specification, if there is any, is given on the individual data sheets. The capacitors are marked with this number as well, if allowed for by the case size. If there is no type specification available (as yet), the capacitors are marked with the number of the fundamental spec. The capacitance/voltage range given on the individual data sheets is not always equal to that of the type specs. It is more or less wide, as required.

Some of the specifications given by DIN have been included in the individual data sheets for completion.

A DIN specification for non-polar electrolytic capacitors is not available, since there is only little demand for these types. Photoflash electrolytic capacitors are produced in large quantities, however, they are at present not subject to standardization due to the multitude of types requested.

Listed below are the most important DIN type specs and the corresponding Siemens types:

Type specification	Related type specification for quality assessment DIN 45910	Corresponding Siemens type complying with the specification	Corresponding Siemens type in addition to the specification
DIN 41 257	Part 123	B 41 588 B 43 588	B 41 590 B 43 590
DIN 41 259	Part 124	–	B 41 326 B 43 326
DIN 41 316	Part 126	B 41 010 B 43 050 B 41 283 B 43 283	–
DIN 41 248	Part 128	B 41 564 B 43 564 B 41 584 B 43 584	B 43 550 B 43 570
DIN 41 238	Part 129	B 41 070 B 41 072 B 41 306 B 43 306	–
DIN 41 253	Part 1210	B 41 293 B 43 293	–
DIN 41 250	–	B 41 455 B 43 455 B 41 457 B 43 457	–
DIN 41 267	Part 1211	B 41 593 B 43 593	B 41 592 B 43 592
DIN 41 249	Part 1212	B 41 554	B 41 550 B 41 570
DIN 41 268	Part 1213	–	B 41 507 B 43 507

5 Electrical ratings

5.1 Rated voltage V_R

The rated voltage V_R is the operating voltage which is indicated upon the capacitor. It is a dc voltage. The ratings are based on an R5 series; voltages of 350 V, 385 V and 450 V have additionally been included.

	Low-voltage (LV) ratings							High-voltage (HV) ratings					
V_R in Volts	6.3	10	16	25	40	63	100	160	250	350	385	400	450

Not each of the type specs and not all Siemens data sheets comprise all voltage ratings; the actual demand is covered.

5.2 Operating voltage V_{op}

Siemens al electrolytic capacitors can be operated up to the upper category temperature at full rated voltage (incl. superimposed ac voltages). Exceptions are stated in the individual data sheets. The rated voltage may also be exceeded for short periods of time (see 5.3, peak voltage V_p).

Operation at reduced voltage (voltage derating) slows down the processes which decrease the capacitor's life time. Particularly at high temperatures, however, the service life is also influenced by other factors that do not depend on the operating voltage, such as diffusion processes and material fatigue. For this reason, the advantages to be expected for service life due to voltage derating come only partly to bearing in practice (see page 61, failure rate).

5.3 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 only, e. g. up to 5 times for 1 minute during 1 hour, but is not allowed to be exceeded during this period. The peak voltage must not be employed for operational periodic charging and discharging purposes. In accordance with IEC 384-4 the following applies:

for $V_R \leq 315$ V: $V_p = 1.15 \cdot V_R$
for $V_R > 315$ V: $V_p = 1.1 \cdot V_R$

Some of the Siemens al electrolytic capacitors can be loaded with considerably higher peak voltage. In this case, details are given in the individual data sheets.

The reduced operating voltage V_{op} instead of V_R has to be applied to capacitors for which a derating at ambient temperatures > 85 °C is required (refer to individual data sheets).

5.4 Superimposed alternating voltage

This is the rms value of the alternating voltage which may be applied to the capacitor in addition to the direct voltage. The peak value of the resulting ripple voltage should not exceed the rated voltage. Voltages of reversed polarity with a peak value greater than 2 V are not permitted.

5.5 Ripple current

The term ripple current means the rms value of the alternating current with which a capacitor is loaded. The maximum permissible value depends on the ambient temperature, the capacitor surface (cooling area), the dissipation factor $\tan\delta$ (or the equivalent series resistance *ESR*) and, to a certain extent, on the ac frequency.

Since the expected service life of an al electrolytic capacitor depends to a large extent on the thermal stress, the dissipation heat generated by ripple current loading is important when considering the service life. Diagrams showing the service life as a function of the ambient temperature T_A are given in the individual data sheets. (Refer to 5.5.4 for an explanation of how to use these diagrams.)

This implies that under certain circumstances a capacitor with a higher voltage rating or higher capacitance rating than the application necessitates has to be selected.

5.5.1 Frequency dependence of the ripple current

The dissipation factor (or the equivalent series resistance) of al electrolytic capacitors depends to a certain extent on the frequency. This means that the ripple current is dependent on frequency without effecting the temperature conditions. The ripple current capability of the individual capacitors is generally referred to a frequency of 100 Hz and in certain cases to 20 kHz. Conversion factors for other operating frequencies are specified for each individual type.

5.5.2 Temperature dependence of the ripple current

In accordance with DIN IEC 384, part 4, the permissible ripple current rating at upper category temperature is generally determined such that the dissipation heat produced in the capacitor causes an overtemperature of 3 K on the capacitor surface¹). The resultant ripple current is specified for each capacitor in the individual data sheets.

If the electrolytic capacitor is operated at lower ambient temperatures, it may be loaded with a higher ripple current. In accordance with standard recommendations, the following typical values apply to current conversion factors:

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¹) Types B 41 550/570 and B 41 507 for which a higher overtemperature is permitted at upper category temperature are an exception to this rule.

Ambient temperature	Upper category temperature							
	High rel						General purpose	
	125 °C/257 °F		105 °C/221 °F		85 °C/185 °F		85 °C/185 °F	
T_A in °C/°F	T_O (°C/°F)	F	T_O (°C/°F)	F	T_O (°C/°F)	F	T_O (°C/°F)	F
40/104	55/131.0	2.24	55/131.0	2.24	50/122.0	1.83	55/131.0	2.24
45/113	59/138.2	2.18	59/138.2	2.15	55/131.0	1.75	59/138.2	2.13
50/122	64/147.2	2.13	63/145.4	2.10	59/138.2	1.68	63/145.4	2.03
55/131	68/154.4	2.07	67/152.6	2.00	63/145.4	1.60	67/152.6	1.91
60/140	72/161.6	2.01	71/159.8	1.95	67/152.6	1.52	70/158.0	1.80
65/149	76/168.8	1.96	75/167.0	1.85	71/159.8	1.43	74/165.2	1.67
70/158	81/177.8	1.89	79/174.2	1.80	75/167.0	1.33	77/170.6	1.53
75/167	85/185.0	1.83	84/183.2	1.70	80/176.0	1.23	81/177.8	1.37
80/176	89/192.2	1.77	88/190.4	1.60	84/183.2	1.12	84/183.2	1.2
85/185	94/201.2	1.70	92/197.6	1.50	88/190.4	1.0	88/190.4	1.0
90/194	98/208.4	1.63	96/204.8	1.40		0.9		0.9
95/203	102/215.6	1.55	100/212.0	1.25		0.8		0.8
100/212	106/222.8	1.48	104/219.2	1.15		0.7		0.7
105/221	111/231.8	1.39	108/226.4	1.0		0.6		0.6
110/230	115/239.0	1.33						
115/239	119/246.2	1.21						
120/248	124/237.2	1.11						
125/257	128/262.4	1.0						

T_O: Surface temperature of capacitor
F: Reproductive factor of ripple current referred to upper category temperature

Higher maximum permissible ripple current ratings apply to Siemens electrolytic capacitors. The ratings are specified in the individual data sheets. The table of the individual electrical data lists the maximum permissible ripple current at an ambient temperature of + 40 °C and at upper category temperature for each capacitor. The maximum ripple current ratings at 85 °C have also been included for types having a higher category temperature than + 85 °C, in order to permit the user to compare the values. A diagram for the relevant type specifies the continuous load limit for operation at other ambient temperatures and other ripple current values. This diagram also permits the expected service life under given operating conditions to be estimated.

5.5.3 Loading with non-clearly defined currents and frequencies

If the current or frequency on the capacitor is not clearly defined, the surface temperature must not exceed the capacitor's upper category temperature at any point of the case (according to table under 5.5.2).

5.5.4 Determining the service life at ripple current operation

The tables of the individual data sheets specify the rated current ($I_{\mathrm{ac\,R,UC}}$) at an upper category temperature of + 85 °C, + 105 °C or + 125 °C. With given ripple current and ambient temperature the service life is determined on the basis of the service life curves as follows:

Determine the quotient $\frac{I\text{ac}}{I\text{ac}_{\text{R,UC}}}$ using the required ripple current at a specific ambient temperature and the rated ripple current at upper category temperature. The service life can be read at the point of intersection of the ambient temperature and the current quotient or can be estimated, if it does not directly lie on one of the service life curves. The dependence of the ripple current on the frequency has not yet been taken into consideration. It is included in the calculation in the form of a further factor. The table below specifies typical values for the related conversion factors. More precise, specific values can be taken from the characteristic curves in the individual data sheets.

Frequency in Hz	50	100	400	800	1000	≥ 2000
Conversion factor	0.8	1.0	1.2	1.3	1.35	1.4

As an example, consider a clocked battery charging unit with 50 A rated output current at 24 V. The output capacitance is to be determined, assuming the following conditions:

- $C_R \geq 4700$ µF and $V_R \geq 24$ V
- 12 A ripple current at 20 kHz
- ambient temperature ≤ 65 °C
- service life at least 5 years, i. e. 43000 h
- total capacitor height max. 120 mm.

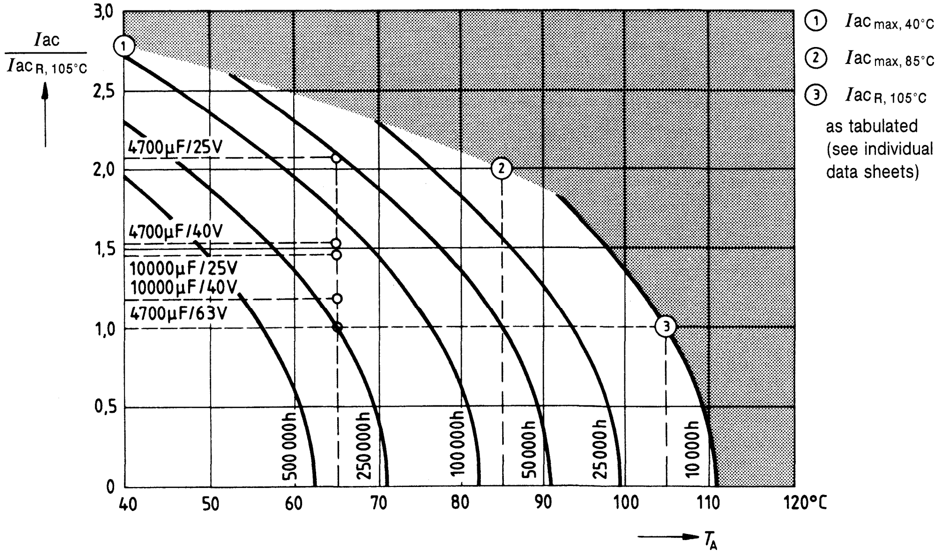

Figure 4
Service life at ripple current operation, types B 41550, B 41570, SIKOREL 105, small diameters.

In order to estimate whether these requirements can be met at all with one single capacitor, we shall consider in further detail the power supply electrolytic capacitors B 41 550 or B 41 570 of the "SIKOREL 105" quality category. From figure 4 it can be seen immediately that at $T_A = 65\,°C$ the service life "reserve" is fully adequate. With a current factor $\frac{I\text{ac}_{65\,°C}}{I\text{ac}_{R\,105\,°C}} = 2.1$, approx. 50 000 h, i.e. more than 5 years, can be expected and with a current factor $\frac{I\text{ac}_{65\,°C}}{I\text{ac}_{R\,105\,°C}} = 1.0$, approx. 250 000 h which is approx. equal to 30 years.

Determining the service life of single capacitors of types B 41 550, B 41 570 at $T_A = 65\,°C$ and ripple current operation

C_R/V_R µF/V	Dimensions $d \times l$ mm × mm	Current factor $\frac{I\text{ac}_{65\,°C,\ 20\,kHz}}{I\text{ac}_{R,\ 105\,°C,\ 100\,Hz} \cdot \text{frequency factor}}$	Service life $t_{op\ 65\,°C,\ 12\,A,\ 20\,kHz}$
4 700/25	35 × 57	$\frac{12}{5.2 \cdot 1.1} = 2.10$	≈ 50 000 h ≈ 6 years
10 000/25	35 × 82	$\frac{12}{7.5 \cdot 1.1} = 1.45$	≈ 160 000 h ≈ 18 years
4 700/40	35 × 82	$\frac{12}{7.2 \cdot 1.1} = 1.52$	≈ 120 000 h ≈ 14 years
10 000/40	35 × 107	$\frac{12}{9.5 \cdot 1.1} = 1.15$	≈ 200 000 h ≈ 23 years
4 700/63	35 × 107	$\frac{12}{8.7 \cdot 1.15} = 1.20$	

Extract from the data sheet specifications for the above-mentioned capacitor types

V_R	C_R	Dimensions		$I\text{ac}_{max}$	$I\text{ac}_{max}$	$I\text{ac}_R$
		d_{max}	l_{max}	40 °C/100 Hz	85 °C/100 Hz	105 °C/100 Hz
V dc	µF	mm	mm	A	A	A
25	4 700	35.7	56.7	14	10	5.2
	10 000	35.7	82.1	21	15	7.5
	15 000	35.7	107.5	26	19	9.4
40	4 700	35.7	82.1	20	14	7.2
	10 000	35.7	107.5	26	19	9.4
63	4 700	35.7	107.5	24	17	8.7

5.5.5 Service life and ripple current with forced cooling

The details on service life apply generally to electrolytic capacitors which dissipate the heat arising in the winding through the capacitor case to the air which is not force ventilated. With additional means of cooling (heat sink, water cooling, air ventilation) the service life or the permissible ripple current can be increased. Similarly, impediments to cooling (closely packed capacitor banks, thermally insulating sealing material, vacuum) will reduce the service life.

In order to lower the thermal resistance between the winding and the case, Siemens can-type versions have an additional metal thermal bridge from the capacitor winding to the can bottom. With the heavy flow of heat through the can bottom, the use of a heatsink on the bottom is the most effective method. Therefore, some of the Siemens versions have a threaded stud in this region for fastening a heatsink.

Only the thermal resistance between the case and the ambient air, which is larger without forced cooling than the value between the winding and the case, is affected by the arrangement of the capacitor. It is proportional to the temperature difference ΔT. This temperature difference ($T_{\mathrm{case}} - T_{\mathrm{ambient}}$) can be measured for the same ripple current load by the user under normal conditions (ΔT) and with forced cooling (ΔT^*). From the degree of forced cooling $\Delta T^*/\Delta T$ the relative reduction or increase in the thermal resistance between the case and the ambient can be determined and therefore also the ripple current factor $I^*\mathrm{ac}/I\mathrm{ac}$. This states by which factor the ripple current can be increased by the use of forced cooling, without having to restrict the service life. In the diagram in figure 5 the effect of the degree of forced cooling determined by measurement on the ripple current factor $I^*\mathrm{ac}/I\mathrm{ac}$ is shown for various case dimensions. Here the service life of the cooled capacitor (ripple current load: $I^*\mathrm{ac}$) is the same as the service life of the electrolytic capacitor in normal operation (ripple current load: $I\mathrm{ac}$).

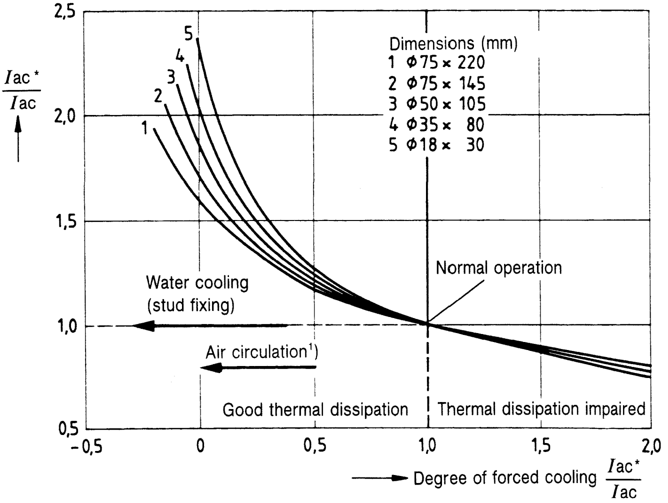

Figure 5
Al electrolytic capacitor
Influence of forced cooling on ripple current capability

ΔT Temperature difference $\Delta T = T_{\mathrm{case}} - T_{\mathrm{ambient}}$
$I\mathrm{ac}$ Permissible ripple current for normal operation
* Values for forced cooling

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[1] For an al electrolytic capacitor with the case size 75 dia. × 220 it can be assumed that a current factor $I^*\mathrm{ac}/I\mathrm{ac}$ of 1.4 is obtained with forced cooling and an air flow rate of 2 m/s.

The same applies for capacitors whose thermal dissipation is impaired; the ripple current capability I^*ac is then smaller than Iac.

When using a cooling medium that is colder than the ambient temperature (e.g. water, oil), the degree of forced cooling can become zero or negative. On account of the limited capability for heat absorption of these media, the linear laws assumed in the use of thermal resistances no longer apply to the cooling process. The degree of forced cooling is in such cases dependent on the power dissipated in the capacitor. Therefore, with this means of cooling it should be determined for the maximum thermal load. This is not necessary when just using heatsinks and forced air.

5.6 Capacitance

5.6.1 Rated capacitance C_R

The rated capacitance is the capacitance on the basis of which the capacitor is designated and refers to the measuring procedure established in the relevant regulations, e.g. IEC 384-1 and IEC 384-4. The actual capacitance value may deviate from this value within the delivery tolerance range specified in the individual data sheets.

5.6.2 A and D capacitance

The capacitance of the capacitor can be determined on the basis of its impedance (allowing for the magnitude and phase) or on the basis of its storage capacity when charged with dc voltage. Both measuring methods produce slightly different results. As a general rule it can be stated that measurements on the basis of the dc voltage method (D capacitance) provide higher values than the alternating current method. The factors are approx. 1.1 to 1.5 and maximum deviations occur with capacitors for low voltage ratings.

In line with the most frequent applications (e.g. smoothing and coupling capacitors), the A capacitance is generally determined for electrolytic capacitors. For this purpose, the capacitive component of the equivalent series circuit (the series capacitance C_S) is determined with an ac voltage ≤ 0.5 V. The A capacitance depends on the frequency. For this reason a specific measuring frequency must be agreed upon. IEC 384-4 prescribes 100 Hz or 120 Hz.

There are also applications (e.g. discharge circuits and timing elements) where the dc capacitance (D capacitance) is decisive. Despite this, capacitors the capacitance of which has been determined on the basis of the ac method, are also used conventionally in such applications and the difference between the two measuring methods is taken into consideration accordingly. However, in exceptional cases, it may be necessary to determine the D capacitance. The IEC regulations specify no information in this respect. For this reason a separate DIN standard has been created for this purpose. This standard, DIN 41 328, part 4 "Measurement of the dc capacitance" describes a measuring method involving non-recurring charging or discharging of the capacitor.

5.6.3 Temperature dependence of the capacitance

The capacitance of an electrolytic capacitor is not a constant magnitude that remains unchanged under all operating conditions. The temperature is of great influence. The viscosity of the electrolyte increases with decreasing temperatures, thus reducing its conductivity. A typical behavior is shown in fig. 6, where the capacitance at 20 °C is the reference value.

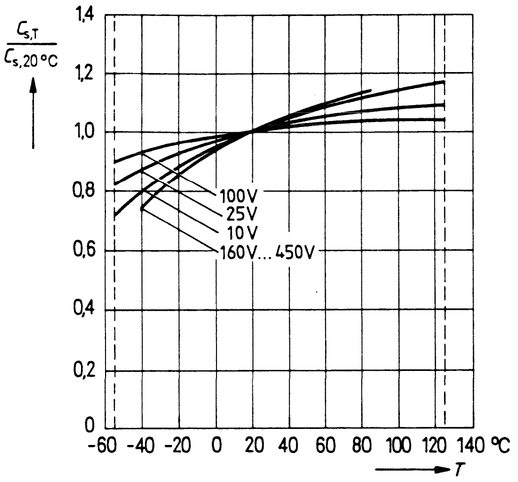

Figure 6
Series capacitance C_S versus temperature. Typical behavior.

The lower the rated voltage is and the more the foils are etched at otherwise the same conditions (low voltage or high voltage) the steeper are the characteristic curves. The favorable flat shape of the curve shown in fig. 6 was obtained by using special electrolytes, and thus the capacitors are capable of operating even at temperatures far below zero. The shape of the curves is subject to strong variations, depending on whether the temperature dependence of the ac or dc capacitance is determined. A dc capacitance attains a more favorable and thus flatter shape of the curve.

5.6.4 Frequency dependence of the capacitance

The A capacitance depends not only on the temperature but also on the measuring frequency. It decreases with increasing frequency. If there is no particular data in the individual data sheets, typical values for the effective capacitance can be obtained from the impedance characteristic:

$$C = \frac{1}{2 \cdot \pi \cdot f \cdot Z}$$

5.6.5 Dielectric strength

A capacitance decrease can also result from frequent discharges. Due to a special structure, Siemens al electrolytic capacitors have a high dielectric strength. After 10^6 switching operations their capacitance decrease is less than 10%. Generally a switching stress as specified in DIN IEC 384-4 for LL grade capacitors can be assumed.

5.7 Dissipation factor tan δ

The dissipation factor δ is the ratio of equivalent series resistance to capacitive reactance in the equivalent circuit or the ratio of effective power to reactive power at sinusoidal voltages. It is measured with the same set-up as the series capacitance C_S. IEC publication 384-4 specifies the following maximum values:

Rated voltage (V)	> 4 to ≤ 10	> 10 to ≤ 25	> 25 to ≤ 63	> 63
IEC maximum value for the 100 Hz dissipation factor	0.5	0.35	0.25	0.20

These IEC maximum values apply to capacitors with a maximum charge of 100 000 microcoulomb. With capacitors featuring higher charges correspondigly higher dissipation factors may occur.

Without exception, Siemens al electrolytic capacitors have better dissipation factor characteristics than required by IEC 384-4. The individual data sheets specify the relevant values.

5.7.1 Frequency and temperature dependence of the dissipation factor

Like the capacitance the dissipation factor depends on temperature and frequency. Figures 5 to 9 show this interdependence, taking the example of frequently used low-voltage and high-voltage capacitors.

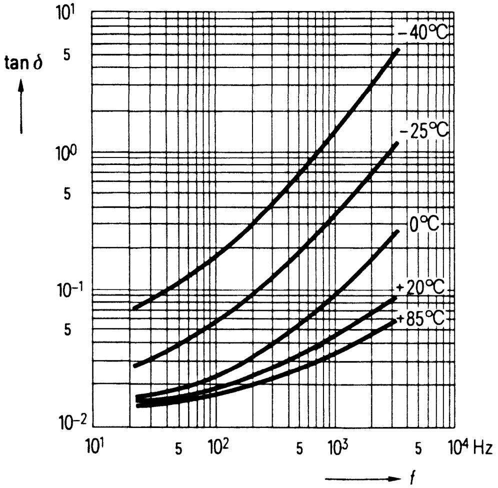

Figure 7
Low-voltage electrolytic capacitor
(example 100 µF/63 V)

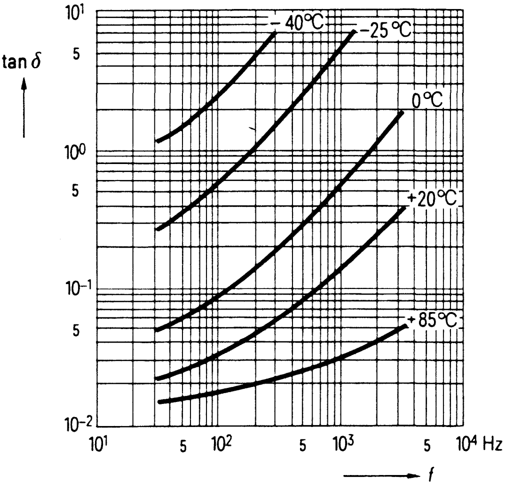

Figure 8
High-voltage electrolytic capacitor
(example 47 µF/350 V)

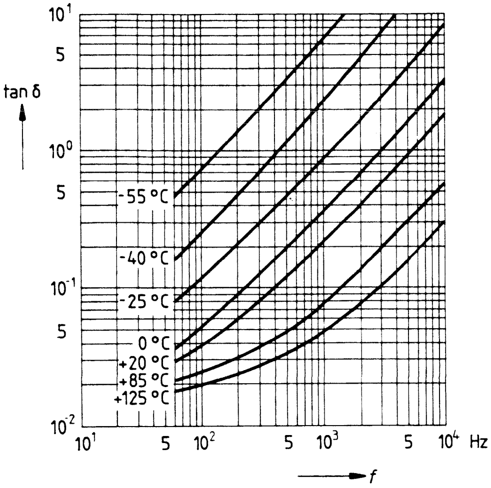

Figure 9
Low-voltage electrolytic capacitor "SIKOREL 125", B41590 (example 220 µF/40 V)

5.8 Equivalent series resistance *ESR*

This is the resistive component of the equivalent circuit. Like the dissipation factor the *ESR* value depends on temperature and frequency. It is related to the dissipation factor tan δ by the formula

$$ESR = \frac{\tan\delta}{\omega \cdot C}$$

The following *ESR* limit values for 1 µF and 20 °C can be calculated on the basis of the maximum tan δ values specified in IEC 384-4 (see 5.7). A permissible minimum capacitance amounting to 90 % of the rated capacitance has been taken into account.

Rated voltage (V)	> 4 to ≤ 10	> 10 to ≤ 25	> 25 to ≤ 63	> 63
Max. *ESR* referred to capacitance at 100 Hz in Ω · µF in acc. with DIN IEC 384-4	880	620	440	350

The equivalent series resistance of an aluminum electrolytic capacitor is obtained by dividing the above-stated tabular values by the rated capacitance C_R. The minimum *ESR* value which can be obtained in practice is restricted by the resistive component of the contact connections and by the foil resistances. For this reason computed values below 0.05 Ω cannot be implemented in all cases.

These IEC maximum values apply to capacitors with maximum charges of 100000 microcoulomb. With capacitors featuring higher charges, higher series resistance values may occur.

Lower *ESR* values apply to Siemens electrolytic capacitors. The individual data sheets specify further details.

5.9 Impedance *Z*

The impedance of an electrolytic capacitor is principally determined from the series connection of the following individual resistances (fig. 10):

1. Effective reactance $1/\omega C$ of the capacitance C
2. Dielectric losses and ohmic resistance of the electrolytes and the terminals *(ESR)*
3. Effective reactance ωL of the inductance of the winding and the terminals

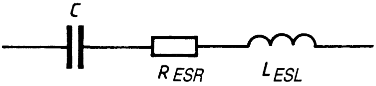

Figure 10
Equivalent circuit diagram of an electrolytic capacitor

The effective reactances, $1/\omega C$ and ωL are actually only dependent on frequency, whereas the electrolytic resistance is mainly temperature-dependent and increases considerably with decreasing temperature.

These characteristics of the individual resistances determine the development of the total resistance of an electrolytic capacitor in dependence on frequency and operating temperature. The graphs in figure 11 and 12 serve as examples. It is evident that the capacitive resistance is preponderant at low frequencies and decreases with $X_C = 1/\omega C$ as the frequency increases, until it reaches the order of magnitude of the electrolytic resistance. The relatively constant electrolytic resistance is the deciding factor at further increasing frequencies and unchanged temperatures (see the 20 °C curve). At still higher frequencies a resonance minimum is formed, especially at low capacitance values and low temperatures. The inductive reactance of the winding and the terminals then becomes operational and results in an increase in impedance ($X_L = \omega L$).

The electrolytic resistance increases with falling temperatures and thus shifts the impedance curves towards higher values. With low temperatures this influence becomes already effective at low frequencies. Figures 11 and 12 show the typical frequency and temperature behavior of al electrolytic capacitors. Specific values can be found in the individual data sheets.

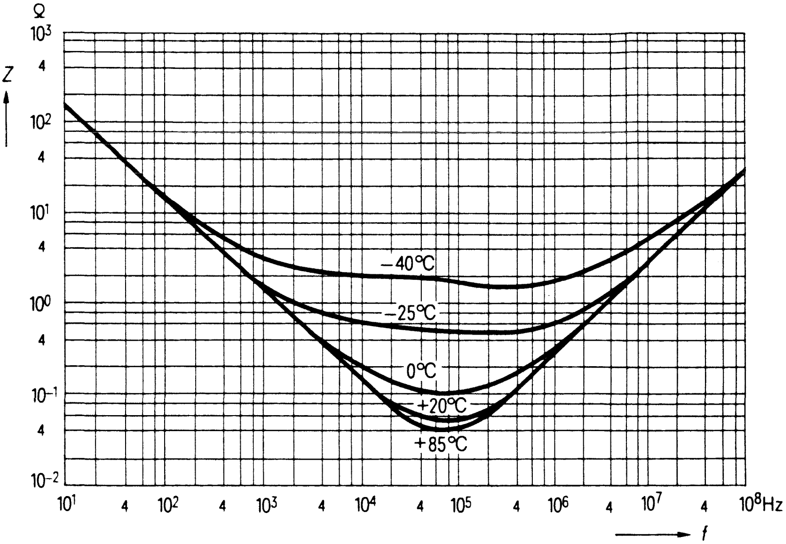

Figure 11
Impedance of a low-voltage electrolytic capacitor versus frequency and temperature (example 100 µF/63 V, simplified diagram)

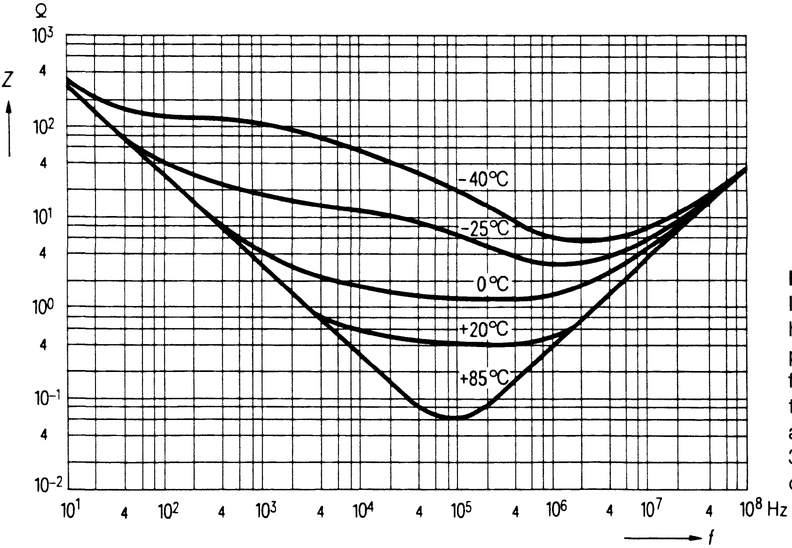

Figure 12
Impedance of a high-voltage capacitor versus frequency and temperature (example 47 µF/350 V, simplified diagram)

5.10 Leakage current

Due to the special features of the aluminum oxide layer serving as dielectric, a small current, the so-called leakage current, flows even after applying dc voltage for a longer period. A low leakage current value is the criterion of a well designed dielectric. The leakage current can thus be considered as a measure for the quality of the capacitor. (Here it should be noted that due to physical reasons about twice the leakage current values occur in non-polar capacitors.)

5.10.1 Time dependence of the leakage current

After having applied a voltage, the leakage current at first is high (starting current), particularly after prolonged voltage-free storage, then it decreases rapidly with increasing operating time and attains at last an almost constant final value (see fig. 13).

5.10.2 Temperature dependence of the leakage current

The temperature dependence of the leakage current is shown in figure 14, taking the example of a capacitor with 85 °C category temperature.

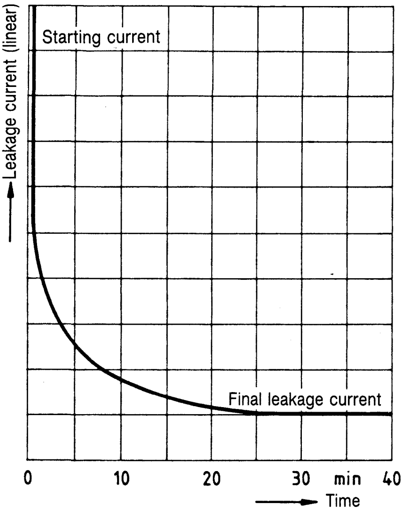

Figure 13
Leakage current versus starting time

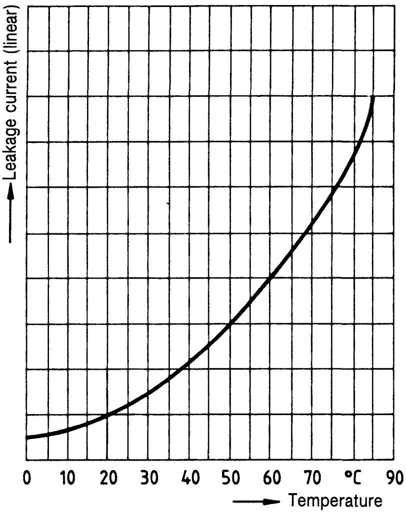

Figure 14
Leakage current versus temperature

5.10.3 Voltage dependence of the leakage current

The voltage dependence is illustrated in figure 3, chapter I. A constant temperature has been assumed.

5.10.4 Operational leakage current

The operational leakage current is the final current that appears after a prolonged operating times (see 5.10.1 and figure 13). In accordance with DIN 41 240 and DIN 41 332 typical values in µA can be calculated with the following equations:

LL grade:

$$I_{\mathrm{lk\,op}} = \frac{0.005\ \mu\mathrm{A}}{\mu\mathrm{F} \cdot \mathrm{V}} \cdot C_{\mathrm{R}} \cdot V_{\mathrm{R}} \text{ or } 1\ \mu\mathrm{A} \text{ (the higher values applies)}$$

GP grade:

$$I_{\text{lk op}} = \frac{0.02\ \mu\text{A}}{\mu\text{F} \cdot \text{V}} \cdot C_R \cdot V_R + 3\ \mu\text{A}$$

Siemens al electrolytic capacitors feature lower operational leakage currents; for this reason use the following equations:

LL grade:

$$I_{\text{lk op}} = \frac{0.001\ \mu\text{A}}{\mu\text{F} \cdot \text{V}} \cdot C_R \cdot V_R + 1\ \mu\text{A}$$

GP grade:

$$I_{\text{lk op}} = \frac{0.002\ \mu\text{A}}{\mu\text{F} \cdot \text{V}} \cdot C_R \cdot V_R + 3\ \mu\text{A}$$

(For non-polar capacitors the values are twice as high.)

The results refer to V_R and 20 °C.

To allow for the temperature dependence, the 20 °C-results have to be multiplied by the following factors (in acc. with DIN 41 240 and DIN 41 332):

Temperature °C/°F	0/32	20/68	50/122	60/140	70/158	85/185	125/257
Factor (typical value)	0.5	1	4	5	6	10	12.5[1])

Siemens "SIKOREL" types are an exception to this rule. The factors specified in the following table apply to these types:

Temperature °C/°F	0/32	20/68	55/131	70/158	85/185	105/221	125/257
Factor (typical value)	0.7	1	2	3	4	5	8

Operation below the rated voltage results in a substantially lower operational leakage current.

Operating voltage in % of the rated voltage	20	30	40	50	60	70	80	90	100
Typical values in % of the operational leakage current $I_{\text{lk op}}$	8	9	10	12	15	20	30	50	100

5.10.5 Output leakage current

Because of the dependence on time and temperature it is necessary to determine reference values for time and temperature when testing the leakage current. In accordance with the relevant specifications the leakage current is to be measured after 5 min with rated voltage. The reference temperature is 20 °C. The maximum values for the output leakage current in µA are calculated by means of the following equations:

In accordance with DIN IEC 384-4 (LL grade):

For $C_R \cdot V_R \leq 1000$ microcoulomb:

$$I_{\text{lko}} = \frac{0.01\ \mu\text{A}}{\mu\text{F} \cdot \text{V}} \cdot C_R \cdot V_R \text{ or } 1\ \mu\text{A (the higher value applies)}$$

---

[1]) At voltage derating (see individual data sheets)

For $C_R \cdot V_R > 1000$ microcoulomb:

$$I_{lko} = \frac{0.006\ \mu A}{\mu F \cdot V} \cdot C_R \cdot V_R + 4\ \mu A$$

In accordance with DIN IEC 384-4 (GP grade):

For $C_R \cdot V_R \leq 1000$ microcoulomb:

$$I_{lko} = \frac{0.05\ \mu A}{\mu F \cdot V} \cdot C_R \cdot V_R \text{ or } 5\ \mu A \text{ (the higher value applies)}$$

For $C_R \cdot V_R > 1000$ microcoulomb:

$$I_{lko} = \frac{0.03\ \mu A}{\mu F \cdot V} \cdot C_R \cdot V_R + 20\ \mu A$$

Siemens al electrolytic capacitors show better results; generally the following equations apply (exact values are quoted in the individual data sheets):

LL grade:

$$I_{lko} \leq \frac{0.002\ \mu A}{\mu F \cdot V} \cdot C_R \cdot V_R + 4\ \mu A$$

GP grade:

$$I_{lko} \leq \frac{0.004\ \mu A}{\mu F \cdot V} \cdot C_R \cdot V_R + 20\ \mu A$$

(For non-polar capacitors the values are twice as high.)

The output leakage current can be tested within the temperature range 15 to 35 °C. The permissible limit values calculated for 20 °C are then multiplied by the following conversion factors:

Temperature °C/°F	15/59	20/68	25/77	30/86	35/95
Factor	0.8	1	1.5	2	2.5

Prior to the measuring procedure, which might be carried out to assess the capacitor or to compare different products, a re-anodization is necessary in order to obtain the same starting conditions. For this purpose the capacitor is for one hour connected to rated voltage via a series resistance of about 100 Ω for $V_R \leq 100$ V and about 1000 Ω for $V_R > 100$ V. Subsequently the capacitors are stored voltage-free for 12 to 48 hours at a temperature of 15 to 35 °C. The leakage current is measured during this storage period. If the capacitor meets the leakage current requirements without re-anodization process, it can be omitted.

5.10.6 Leakage current behavior at voltage free-storage

The oxide film may be impaired during voltage-free storage (especially at high storage temperatures). Since there is no leakage current carrying oxygen ions to the anode, a regeneration of the oxide film is not possible. Consequently, upon applying a voltage after prolonged storage, the leakage current will at first increase. With the oxide film being restored, however, it will gradually decrease to its normal level.

The capacitors can be stored voltage-free for at least 2 years and SIKOREL types even for 10 years without any reduction of their reliability (for storage temperature see 6.3). If these storage periods have not been exceeded, the capacitors can be operated at rated voltage directly afterwards; the re-anodization described under 5.11.5 is not necessarily required. However, during the first minutes of the switching-on period the current values can be up to 100 times higher than normal. This has to be taken into account when designing the circuit.

5.11 Dielectric strength of the insulating sleeve

Siemens al electrolytic capacitors are provided with an outer insulating sleeve. The dielectric strength is at least 1500 Vac or 2000 Vdc. DIN IEC 384-4 refers to test methods that can be used to verify the dielectric strength. To ensure full dielectric strength, care must be taken not to damage the insulating sleeve by improper handling, particularly when using mounting clips.

5.12 Insulation resistance of the insulating sleeve

The insulation resistance of the insulating sleeve of Siemens capacitors amounts to min. 100 MΩ. An appropriate test method is described in DIN IEC 384-4.

6 Climatic conditions

The climatic stress on the al electrolytic capacitor has to be limited, partly for reasons of reliability and partly due to the temperature dependence of the electrical parameters. It is, therefore, important to observe the permissible minimum and maximum temperatures as well as the humidity conditions specified by the DIN and IEC climatic categories (explanation of coding under 6.6.1 and 6.6.2).

6.1 Upper operating temperature limit

The upper operating temperature is the maximum ambient temperature for which the capacitors are designed to be operated continuously. Exceeding this temperature limit may result in early failure of the capacitor. With many type series, however, exceeding the upper operating temperature for a short period of time is permitted. Details are given in the individual data sheets.

As explained in the next chapter on quality, service life and reliability depend to a large extent on the capacitor's temperature. Operation at the lowest possible temperature will increase both service life and reliability. For this reason it is advisable to install the capacitor at a position of low ambient temperature.

6.2 Lower operating temperature limit

With decreasing temperature the conductivity of the electrolyte diminishes and causes an increase in the capacitor's real resistance. This, in turn, leads to increased impedances and dissipation factors (or equivalent series resistances). For most applications these increases are only permissible up to a certain maximum value and it is therefore reasonable to determine a lower temperature limit.

It should be emphasized that operation below this limit temperature will not damage the capacitor. In fact, there are numerous applications where the equipment nevertheless remains fully operable. This is particularly the case, when the ac current flowing due to the increased equivalent series resistance heats the capacitor to such an extent that its capacitive properties are sufficient to maintain the equipment's operability.

6.3 Upper storage temperature

Al electrolytic capacitors can be stored voltage-free at temperatures ranging up to the upper operating temperature. However, it has to be considered that leakage current stability, service life and reliability decrease with increasing temperatures. In order not to degrade these qualities unnecessarily, the storage temperature should not exceed +40 °C and ideally lie between 0 °C and +25 °C.

6.4 Lower storage temperature

The DIN specifications for al electrolytic capacitors relate a lower storage temperature to the lower category temperature. Siemens al electrolytic capacitors withstand the lowest storage temperature specified, i.e. −65 °C, without being damaged.

6.5 Humidity conditions

A distinction has to be made between al electrolytic capacitors which have been especially protected against infiltrating humidity by constructional measures and versions with a humidity protection sufficient for usual applications. The especially humidity resistant versions allow dew precipitation and are coded "D". The DIN specs assign the code letter "F" to to standard versions that do not permit any dew precipitation. The corresponding Siemens capacitors, however, also comply with the test requirements of humidity category "E" according to which rare and minor dew precipitation, as often cannot be avoided (e.g. short opening of equipment installed outdoors), is permissible.

6.6 Climatic categories

For the purpose of describing and marking the capacitors, specification of temperature and humidity in clear text would be too complicated and too long. For this reason the climatic conditions have been coded in the form of climatic categories in DIN 40 040 and IEC 68-1. These DIN and IEC categories are quoted in the data sheets and, when required and possible, included in the capacitor marking.

6.6.1 DIN climatic categories

In accordance with DIN 40040 the climatic categories for al electrolytic capacitors consist of three code letters. The first one indicates the lower category temperature, the second one the upper category temperature and the third one the permitted humidity.

1st letter	F	G	H
lower category temperature	– 55 °C – 67 °F	– 40 °C – 40 °F	– 25 °C – 13 °F

2nd letter	K	P	S
upper category temperature	+ 125 °C + 257 °F	+ 85 °C 185 °F	+ 70 °C + 158 °F

3rd letter	C	D	E	F
rel. humidity, annual average	≤ 95 %	≤ 80 %	≤ 75 %	≤ 75 %
up to 30 days per annum	100 %	100 %	95 %	95 %
occasionally	100 %	90 %	85 %	85 %
dew precipitation permissible	yes	yes	yes[1]	no

6.6.2 IEC climatic categories

In accordance with IEC publication 68-1, appendix A, the climatic categories are composed of three groups of numbers, which are decoded as shown in the following example:

lower category temperature: – 40 °C/ – 40 °F

upper category temperature: + 85 °C/ + 185 °F

duration of the IEC test "damp heat": 56 days

40/085/56

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[1] In contrast to humidity category F, a rare and minor dew precipitation is permitted for humidity category E (e.g. when opening equipment installed outdoors).

7 Application notes

The specification DIN 57 560, part 15/VDE 0560, part 15, contains application notes for al electrolytic capacitors. The most important subjects dealt with are safety requirements, protective measures, installation in equipment characterized by inherent heating, destruction as a result of overpressure, fire hazard, parallel and series connection.

7.1 Working positions for can-type capacitors

During capacitor operation a leakage current flows that on the one hand restores the dielectric due to the electrolytic refining process, and on the other hand causes hydrogen to be released from the electrolyte. The result may be a slow increase in pressure.

Appropriate overpressure vents ensure that the gas is evacuated when the pressure has reached a certain level. To prevent electrolyte from leaking out during venting, the capacitor should be mounted in the positions recommended by DIN 41 248, 41 250, 41 238. All of these mounting positions are intended to avoid the upside down arrangement of the vents.

Example from DIN 41 238:

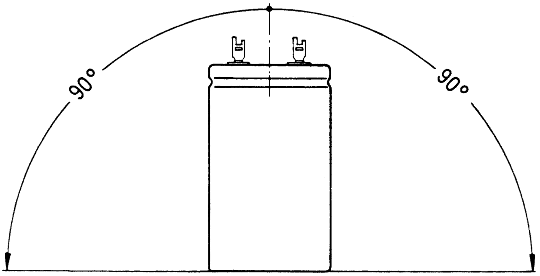


Figure 15
Recommended range of working positions

For horizontal mounting it is recommended to arrange the safety vents in a "12 o'clock position".

Upright mounting can be regarded as ideal, particularly when the capacitors are fixed by their solder terminals, by a threaded stud or mounting socket.

It has to be emphasized, however, that another mounting position will not cause any damage to the capacitor. The only effect may be a minor contamination of the equipment by electrolyte leaking out of the safety vent.

7.2 Capacitor banks

Certain applications require more than one electrolytic capacitor for the following reasons:

- The electrical load required is too high to be accommadated in one capacitor.
- The voltage load is higher than can be covered with feasible permissible operating voltages (normally 500 V max.).
- The switching and ripple current load results in a dissipation heat high enough to overheat a single capacitor.

- The requirements made on the electrical characteristics (e.g. equivalent resistance and inductance) are so high that it would be too complicated or virtually impossible to use a single capacitor.

In these cases it is advisable to establish banks of capacitors connected in parallel or series or in combined parallel and series connection. To prevent overloading of the individual capacitors, the capacitance tolerance has to be taken into account when determining the maximum ac current. Furthermore, no negative voltages are permitted to be applied to the capacitor during discharge. VDE regulation 0560, part 15 (at present draft) provides important information on the dimensioning and circuit configuration of capacitor banks. In the following these circuit configurations will be described in detail.

7.2.1 Parallel connection

If one of the capacitors in a parallel circuit fails as a result of short circuit, the entire bank is discharged through the defective capacitor. In case of large banks with high energy content this may lead to extremely abrupt and severe discharge phenomena. It is therefore advisable to take measures to prevent or limit the discharge current. In smoothing capacitor banks, for example, this is achived by individual fusing; the principle is shown in figure 16.

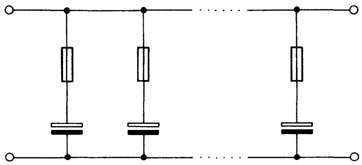


Figure 16

This principle is not suitable for capacitor banks designed for pulse discharges. Here, the capacitors should be mutually fused by means of appropriate charging resistors. The parallel connection is then provided directly before the discharge as shown in figure 17.

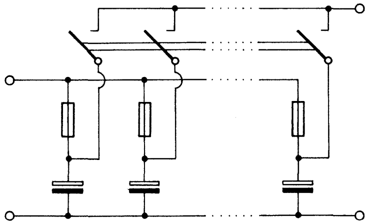


Figure 17

7.2.2 Series connection

In series circuits it has to be ensured that the load on the individual capacitor does not exceed the permissible voltage. It must be considered that the total dc voltage applied is distributed proportional to the insulation resistances. Since the insulation resistance of the individual capacitors may differ substantially, non-uniform voltage distribution and thus voltage overload of the individual capacitors may occur. For this reason forced balancing of the voltage distribution is recommended. The most reliable method is to use electrically isolated voltage sources for the individual capacitors as shown in figure 19.

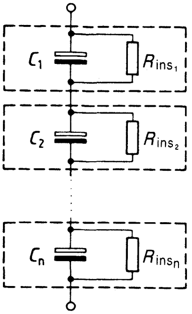


Figure 18

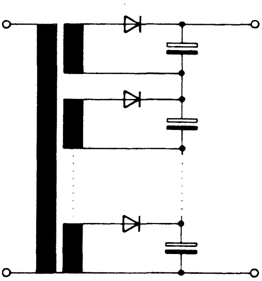


Figure 19

If this is not possible, balancing resistors (R_{symm}, figure 20) can be externally connected to the individual capacitors. The balancing resistances must be equal and lower than the insulation resistance of the capacitor.

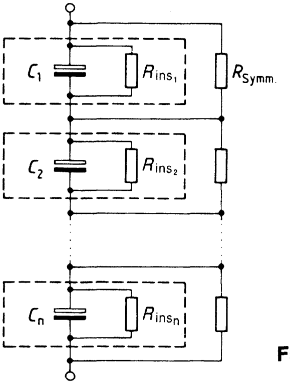


Figure 20

A proven method is to design the balancing resistors such that a current approximately amounting to 10 times the leakage current flows through them. The equation

$$R_{\text{symm}} = 50\ \text{M}\Omega \cdot \mu\text{F} \cdot \frac{1}{C_\text{R}}$$

can be used for dimensioning. In case the total voltage is substantially lower than the value calculated for the rated voltage, the balancing resistors can be omitted.

Experience has shown that this is possible for n single capacitors without any considerable risk, if the total voltage does not exceed 0.8 · n · V_R. However, this solution can only be implemented when the series circuit consists of identical capacitors (same type, same capacitance). Only by identical capacitors it can be ensured that the insulation resistances that determine the voltage distribution will not differ excessively.

7.2.3 Combined parallel and series connection

The recommendations given above apply analogously to combined parallel/series connection. When using balancing resistors, it is advisable to assign each capacitor its own resistor (figure 21).

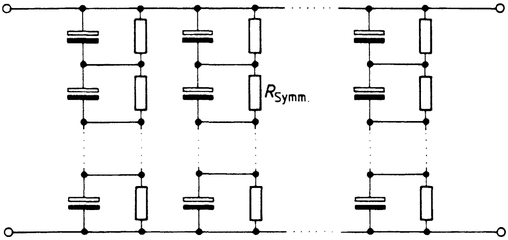


Figure 21

The other solution, i.e. the use of parallel connection within the series circuit and group balancing (figure 22), is, admittedly, less complex yet it is characterized by a crucial disadvantage:

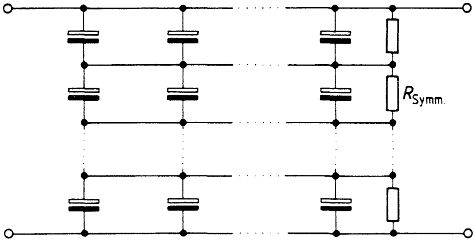


Figure 22

If a capacitor in the series circuit fails as a result of short circuit, the applied voltage is distributed among the remaining capacitors of the series circuit. This results in voltage overload and possibly in destruction of the remaining capacitors. In the balancing arrangement shown in figure 21 only one series branch is subject to this risk, whereas with the more simple configuration shown in figure 22 the voltage overload affects all series branches due to the internal parallel connections and causes more severe damage. For the same reason, internal parallel connections should not be used without balancing resistors in combined parallel/series connection.

7.3 Resistance to vibration

Unless otherwise specified in the individual data sheets, the capacitors comply with IEC publication 68-2-6 (1970), test Fc with 5 *g*, endurance conditioning 1.5 h, frequency range 10 to 55 Hz, displacement amplitude 0.35 mm.

7.4 Cleaning agents

Halogenated hydrocarbons may cause serious damage to al electrolytic capacitors if applied directly. The insulating film may be decomposed or corroded, thus reducing the insulating properties to an impermissibly low level. The seals of the capacitors may swell substantially, thus even causing solvents to enter the inside of the electrolytic capacitor. This may result in premature failure of the component.

The following list contains a selection of critical halogenated hydrocarbons partially in pure form, partially in compound with other solvents, that are frequently used as cleaning agents in electrical industry.

Trichlorotriethane fluoride (trade name e. g. Freon, Kaltron, Frigene)
Trichloroethylene
Trichloroethane (trade name e. g. Chlorothene, Wacker 3 × 1)
Tetrachloroethylene (trade name e.g. Per)
Methylene chloride
Chloroform
Carbon tetrachloride
Acetone
Methyl ethyl ketone
Ethyl acetate
Butyl acetate

When cleaning PC boards after soldering in components or when removing flux residues with halogenated solvents, care must be taken that the electrolytic capacitors do not come into direct contact with the cleaning agent. If wetting of the capacitor with cleaning agent cannot be avoided, halogen-free solvents must be used in order to eliminate the possibility of damage.

Halogen-free solvents

Methanol
Ethanol (alcohol)
Propanol
Isopropanol
Isobutanol
Petroleum ether

For the cleaning of PC boards equipment is available that, although operating with halogenated cleaning agents (ultrasonic cleaning with the 4-chamber method), permits optimum cleaning within the shortest possible time. Furthermore, virtually no residues of cleaning agent are left on the cleaned parts.

Owing to this fact, the general warning against the use of halogenated cleaning agents for al electrolytic capacitors can be restricted if the following points are observed:

1. The cleaning time per chamber must not exceed 1 minute.
2. The last cleaning step must always be performed during the vapor phase. The temperature must be equal to or less than 50 °C.

3. Directly after cleaning the parts must be adequately dried in order to ensure that all condensate residues are able to evaporate.
4. Contaminated cleaning agent must be regularly replaced as specified by the manufacturer.

7.5 Electrolytes

Care is taken during the manufacture of electrolytes that no materials are used which are regarded in law as hazardous materials or products and that no materials are used which give rise to hazardous materials or products when in operation.

However in exceptional cases, for chemical and/or physical reasons, these types of materials must be used to achieve certain physical characteristics if there is no substitute available. Their content in our products has for a long time been restricted to the absolute minimum. Irrespective of this, the following should be observed in using al electrolytic capacitors:

a) Any escaping electrolyte should not come into contact with the skin or the eyes.
b) Parts of the skin wetted with electrolyte should be thoroughly washed under flowing water. Eyes should be rinsed for 10 minutes with plenty of water. If symptoms persist, a doctor should give treatment.
c) Breathing of electrolyte vapors or mist should be avoided. Ventilate the working area and rooms well.
d) Clothing contaminated with electrolyte should be removed and washed with water.

7.6 Taking capacitors out of service

Electrolytic capacitors may contain materials which are a danger to the environment and must therefore be diposed as special waste according to the national requirements. In the Federal Republic of Germany the laws of refuse apply; the preliminary code number 35399 has been allocated to capacitors. Further information can be obtained from our sales offices stating the relevant type.

8 Mounting instructions

When mounting the capacitor types contained in this data book, the following torques for screw terminals and studs must not be exceeded:

Size of thread	Maximum torque
M 5	2 Nm
M 6	2.5 Nm
M 8	4 Nm
M12	10 Nm

Aluminum Electrolytic Capacitors

Quality Assurance

1 Introduction

To meet the high technical requirements in an open international market the Siemens Division "Passive Components" provides various specific quality assurance systems. The individual systems are matched to general-purpose or high rel requirements as specified in the CECC/IECQ standards for quality assessment.

The Siemens system of quality assurance is laid down in the quality assurance manuals of the plants.

2 Sequence of quality assurance measures

The quality department tested and released the capacitors described in this data book taking into account the criteria compliance with type specification, long-term reliability, process capability of production equipment as well as measuring and test methods and equipment.

To ensure a constantly high quality level the following tests were carried out:

2.1 Incoming inspection

In the incoming inspection the parts and materials required for production are checked for dimensional accuracy and material properties in a prescribed sequence. The results are stored and evaluated by an EDP system.

2.2 Product assurance

All important manufacturing stages are subject to routine monitoring. Each manufacturing stage is followed by a socalled "quality control gate", i.e. the product is only relased for the next stage after passing a corresponding test. The test results are constantly monitored and evaluated and are then used to assess the quality of the manufacturing process itself.

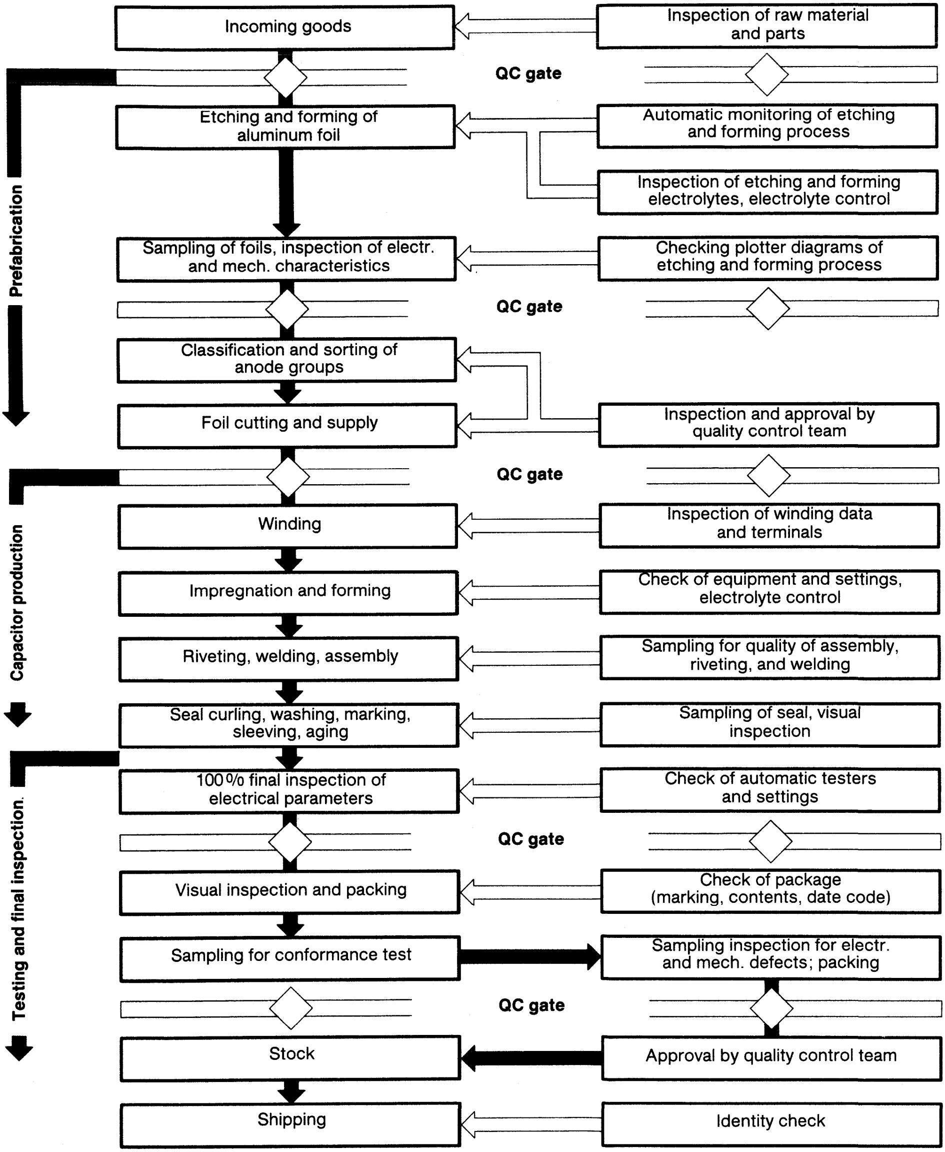
2.3 Final inspection

All capacitors are subjected to a final inspection in accordance with the relevant specification, where they are checked for capacitance tolerance, dissipation factor, leakage current, equivalent series resistance, impedance and finish.

2.4 Product monitoring

During standard production random sampling inspections are periodically carried out to check climatic resistance, operational reliability as well as solderability and resistance to soldering heat in accordance with DIN, CECC and IEC specifications.

Figure 1
Manufacturing processes and quality assurance for al electrolytic capacitors



3 Delivery quality

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

3.1 Random sampling

The given AQL values (AQL = acceptable quality level) are based on the sampling inspection regulation DIN 40080 (contents correspond to MIL-STD 105 D and IEC 410), single sampling plan for normal inspection, inspection level II. The sampling instructions of this standard are such that a delivered lot will be accepted with a probability of higher than 90% if the percentage of defectives does not exceed the specified AQL level.

Generally, the percentage of defectives delivered lies significantly below the AQL value.

3.2 Classification of defects

A defect exists if a component characteristic does not correspond to the specifications stated in the data sheets or in an agreed delivery specification. Defects which generally exclude the functional use of the component (inoperatives) are classified separately from less significant defects.

Inoperatives:

- short circuit or open circuit
- encapsulation or leads broken
- missing or incorrect marking of rated capacitance, rated voltage or type number
- incorrect identification of terminals
- mixing with other types
- alternating orientation of components on tape

Other defects:

- exceeding of limiting values of electrical parameters
- mechanical defects, e.g. incorrect dimensions, damaged housing, illegible marking, bent leads

3.3 AQL values

The following AQL values apply to the quoted defects:

– for inoperatives (electrical and mechanical)	0.065
– for the total number of electrical defectives	0.25
– for the total number of mechanical defectives	0.25

The values for the total number of defectives include related inoperatives.

3.4 Sampling inspection plan

A sampling inspection plan is the basis for acceptance or rejection of a delivery lot. The employed inspection methods must be agreed between the customer and the supplier.

The following information is required for the assessment of possible claims: test circuit, sample size, quantity of defectives found, sample defectives and packing slip.

Single sampling plan for normal inspection – inspection level II
(Extract from DIN 40080)

Sampling plan N = Lot size	AQL 0.065	AQL 0.10	AQL 0.15	AQL 0.25
2 ... 50	N	N	N	N
51 ... 90	N	N	N or 80-0	50-0
91 ... 150	N	N or 125-0	80-0	50-0
151 ... 280	N or 200-0	125-0	80-0	50-0
281 ... 500	200-0	125-0	80-0	50-0
501 ... 1200	200-0	125-0	80-0	50-0
1201 ... 3200	200-0	125-0	80-0	200-1
3201 ... 10000	200-0	125-0	315-1	200-1
10001 ... 35000	200-0	500-1	315-1	315-2
35001 ... 150000	800-1	500-1	500-2	500-3
150001 ... 500000	800-1	800-2	800-3	800-5
> 500000	1250-2	1250-3	1250-5	1250-7

Columns 2 to 5: left figure = sample size
right figure = admissible defects
Classification of defects: see para. 3.2.

4 Service life

The term service life designates the period until a given fraction failure is reached. The fraction failure 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 on the load and stress to which the electrolytic capacitor is subjected.

4.1 Failure criteria

A failure exists if one or several characteristics of a previously faultless component change inadmissibly. A distinction is made between:
- total failures: short or open circuit
- failures due to variation: deviations in characteristics exceeding a specified limit

Unless otherwise specified, the following criteria apply to failures due to variation:

	High rel	General-purpose
Increase in the tan δ values to the adjacent factor of the initial limit value	3	
Falling below the rated capacitance		
at V_R up to 6.3 V by	40 %	50 %
at V_R from 10 to 25 V by	30 %	40 %
at V_R from 40 to 100 V by	25 %	30 %
at V_R from 160 to 450 V by	20 %	30 %
Exceeding the rated capacitance	1.5 × plus tolerance	
Increase of the impedance to the adjacent factor of the initial limit value:		
at $V_R \leq 25$ V by the factor	4	
at $V_R > 25$ V by the factor	3	
Leakage current	The initial limit value must not be exceeded.	

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 capacitor exceeds one or several of those limits. There are, however, no general rules; the decisive factor is the sensitivity of the circuit used.

4.2 Operating conditions

The service life of electrolytic capacitors is substantially influenced by the ambient temperature, the dc voltage load and the inherent heating caused by the ripple current. The influence of these conditions is continuously checked and recorded in accelerated endurance tests. The results are summarized in the form of a service life curve, which is included in the individual data sheets. These graphs show the service life as function of ambient temperature and ripple current load. The specifications refer to full rated dc voltage V_R. Unless otherwise specified, the following conditions apply to climatic and mechanical stress (as per DIN 40040):

Climatic conditions:	humidity category F no corrosive atmosphere
Mechanical stress:	category W

5 Reliability

Data on long-term reliability under severe or moderate operating conditions are gained from continuously performed endurance tests. Basis are the failures registered under a defined load. The long-term reliability of the individual types tested is based on a confidence level of 60 %. Our reliability data results from a large number of component hours.

5.1 Failure rate (long-term failure rate)

The failure rate is the fraction failure divided by the specified time of duty. The failure rate is expressed in fit (failures in 10^9 component hours) or in percentage of failure in 1000 hours.

1 fit = $1 \cdot 10^{-9}$/h (fit = **f**ailure **i**n **t**ime)

Example for a failure rate λ_{test} determined in a service life test:

1) Number of tested components N = 8000
2) Test duration t_b = 25 000 h
3) Number of failures n = 2

$$\lambda_{test} = \frac{n}{N} \cdot \frac{1}{t_b} = \frac{2}{8000} \cdot \frac{1}{25000\ h} = 10\ \text{fit} = 0.001\ \%/1000\ h$$

Failure rate specifications have to include the failure criteria and the operating and ambient conditions.

The failure rate curve for components can be represented by an idealized graph comprising three periods of time:

I Early failure period
II Service period
III Wear-out period

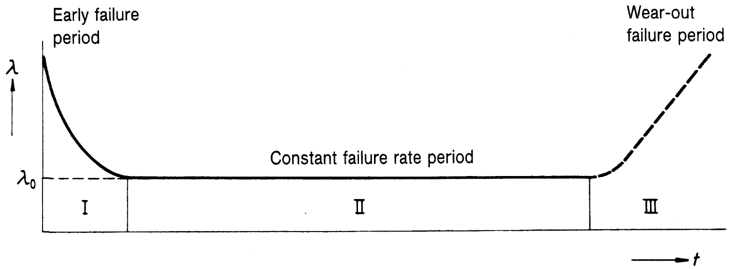


Figure 2
Component failure periods versus time

Unless otherwise specified, the failure rate refers to the service period (II). During this period an approximately constant failure rate λ_0 can be assumed.

5.2 Conversion factors

The failure rate for each type is given in the individual data sheets.

The data sheet values are based on rated voltage load, negligible ac heating, an ambient temperature of 40 °C and climatic conditions in accordance with DIN 40040.

In case of other load conditions and temperatures the following conversion factors apply as per DIN 40039 (draft May 88):

Rated voltage load	Conversion factor
100%	1
75%	0.7
50%	0.5
25%	0.4
10%	0.3

Temperature °C/°F	Conversion factor
≤ 40/104	1
55/131	3
70/158	8
85/185	20
105/221	90[1])
125/257	350[1])

5.3 Typical failure rate (field experience)

Years of experience have shown that electrolytic capacitors can be combined to groups with identical failure rate:

λ in fit for LL grade (high rel)		λ in fit for GP grade (general-purpose)
SIKOREL	other capacitors	
2	5	10

These values refer to loading with half the rated voltage and to an ambient temperature of 40 °C.

6 Supplementary information

Quality data which always refers to a large number of components does not assure characteristics in a legal sense. Conversely, an agreement as regards such data does not exclude the possibility of the customer being able to claim replacement for individual defective al 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 the service life and relative failure rate refers to an average production situation in each case and that such information must thus be considered as average values (statistical anticipated values) based upon a large number of delivery batches of identical 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).

7 Reference literature

The following publications on the subject of quality are available from the Siemens Components Group:

Quality Assurance for Capacitors (ordering no. B/3111-101)
Quality Terms for Electronic Components (ordering no. B9-B3466-X-X-7600)
Components – Assured Quality for the Benefit of the User (ordering no. B9-B3583-X-X-7600)

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[1]) Not contained in DIN 40039 (draft May 88)

Aluminum Electrolytic Capacitors

Tape Packaging, Packaging Units
Ordering Codes

General information

Al electrolytic capacitors with axial and radial leads are available on tape for automatic insertion. The taping complies with DIN IEC regulations.

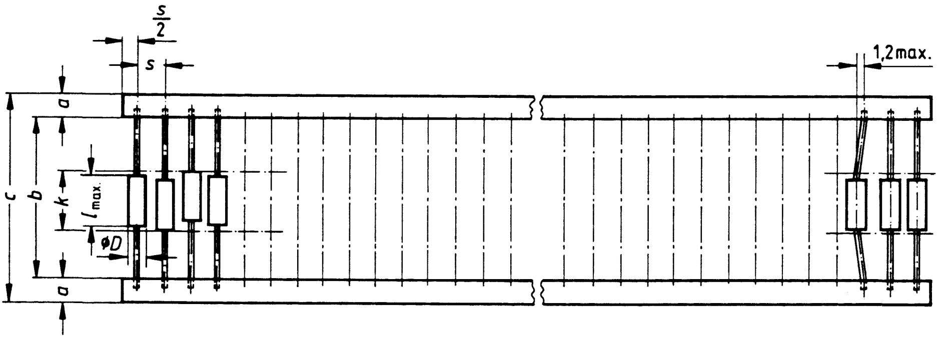
The capacitors are uniformly oriented, i. e. identical poles point to the same tape side/direction. The tape on the cathode side of axial-lead capacitors is blue to facilitate identification of the polarity.

Depending on your order the tapes are supplied on reels or in AMMO packs.

1 Taping of capacitors with axial leads

- Tape packaging in accordance with DIN IEC 286, part 1
- Types with a rated diameter of up to 16 mm

1.1 Dimensions and tolerances



To obtain a uniform tape width, the capacitor leads have been clipped down to the suitable length. The wire ends do not project beyond the tape.

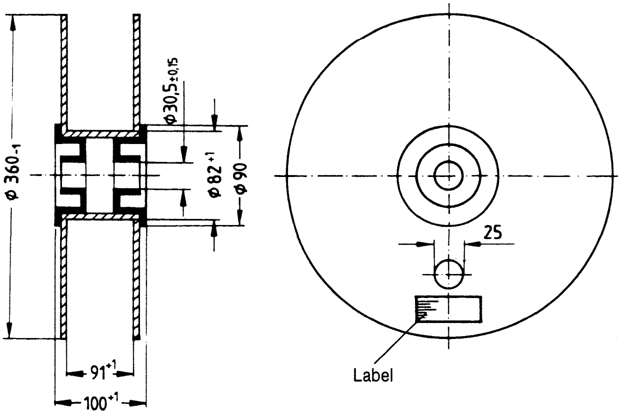
Rated diameter D mm	Spacing Spacing s mm	 Tolerance over 10 spacings Δs mm	Body location k (perm. lateral deviation) mm	Tape width a mm	Inner tape spacing b mm	Tape width c mm
6.5 ... 8.5	10 ± 0.5	± 2	l_{max}[1]) + 1.4	6 ± 1	73 ± 2	85 ± 5
10 ... 14	15 ± 0.5	± 3				
16	20 ± 1	± 4				

---

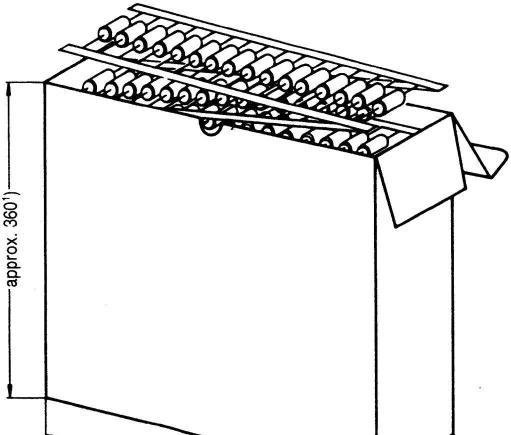
[1]) Measured in accordance with DIN 41 099, sheet 1 and IEC 294.

1.2 Modes of packing

Reel packing
(tape wound on reel
with separation paper
between the layers)



AMMO pack
(meander-shaped
packing in
cardboard box)



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[1]) Outline dimensions

Dimensions in mm

1.3 Packaging units and minimum order quantities

The use of taped components in small quantities would not be economical, since the share of the taping and packing costs would then be too high. Therefore, minimum quantities for ordering electrolytic capacitors have been determined, corresponding to the size of the reel or the box.

Rated diameter of the capacitor mm	Packaging units/Minimum order quantities Reel packing Items per reel	AMMO pack Items per box
6.5	1300	1000
8.5	1000	800
10	600	700
12	450	600
14	350	500
16	250	350

1.4 Types available and ordering codes

The following types are suitable for tape packaging:

B 41010	B 43050
B 41283	B 43283
B 41588	B 43588
B 41590	B 43590

For reels with axial-lead, mass-produced electrolytic capacitors append a "9" to the ordering code, for AMMO packs an "8", respectively.

Ordering code example for taped version

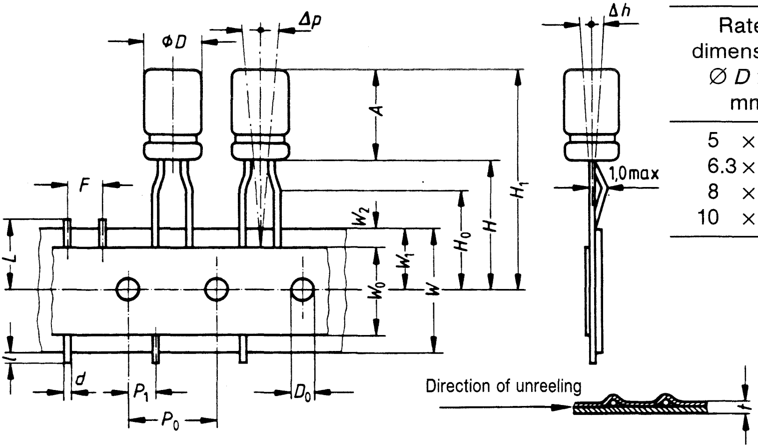
B41590-A****-T*

Type — B41590
Code according to data sheet — A****
Code number for mode of packing — T*
9 ≙ Reel packing
8 ≙ AMMO pack

2 Taping of capacitors with radial leads

- Tape packaging in accordance with DIN IEC 286, part 2
- Type series B 41326/B 43326 (single-ended), 11 and 12.5 mm capacitor height

2.1 Dimensions and tolerances

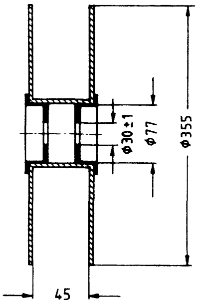


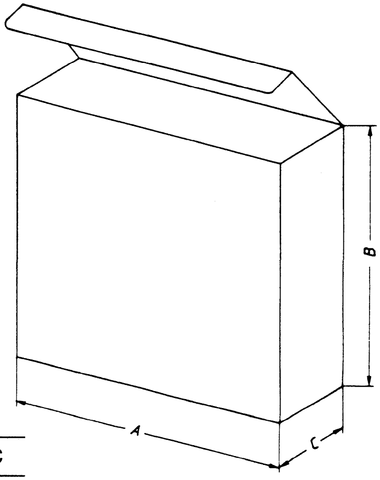
Rated dimensions $\varnothing D \times A$ mm	Lead diameter d mm
5 × 11	0.5
6.3 × 11	0.5
8 × 12.5	0.5
10 × 12.5	0.6

Designation	Symbol	Dimensions (mm)		Remarks
		Value	Tolerance	
Capacitor diameter	D	see table above	max.	
Capacitor height	A		max.	
Lead diameter	d		± 0.05	
Pitch of sprocket holes	P_0	12.7	± 0.3	± 1 mm/20 hole pitches
Distance hole center to lead center	P_1	3.81	± 0.7	
Lead spacing	F	5	+ 0.6/ − 0.1	
Slope of capacitor	Δh	0	± 2.0	measured at top of component body
Slope of capacitor	Δp	0	± 1.3	
Carrier tape width	W	18	+ 1/ − 0.5	
Hold-down tape width	W_0	12	min.	Peel force ≥ 5 N
Position of sprocket holes	W_1	9	+ 0.75/ − 0.5	
Position of hold-down tape	W_2	3	max.	
Distance hole center to kink	H_0	16	± 0.5	
Distance hole center to top of component body	H_1	32.2	max.	
Sprocket hole diameter	D_0	4	± 0.2	
Tape thickness	t	0.7	+ 0.2	
Projecting length of leads	l	2	max.	
Length of clipped leads	L	11	max.	

Modes of packing

Taped capacitors of type series B 41 326/B 43 326 are available on reel or in AMMO pack. Cardboard box as illustrated below.





	A	B	C
Reel packing	355	355	50
AMMO pack	330	330	47

Ordering codes and packaging quantities

Mode of packing	Case size	Capacitor dimensions $d_R \times l_R$ mm	Minimum order quantity ≙ packaging unit items/box
Reel packing	1	5 × 11	1400
	2	6.3 × 11	1100
	3	8 × 12.5	800
	4	10 × 12.5	600
AMMO pack	1	5 × 11	2000
	2	6.3 × 11	1750
	3	8 × 12.5	1250
	4	10 × 12.5	1000

Ordering code example for taped version

B 41 326-A****-T*

Type

Code according to data sheet

Code number for mode of packing
9 ≙ Reel packing
8 ≙ AMMO pack

Weights and packaging units (PU)

(Packing in cardboard box, capacitors not taped; PU for taped capacitors are listed under section "Tape Packaging")

a) Can-type capacitors

Rated dimensions $d \times l$ (mm)	Weight[1] g	PU items
22 × 25	9	384
22 × 30	12	384
22 × 35	15	384
22 × 40	18	256
25 × 25	13	384
25 × 30	17	384
25 × 35	19	384
25 × 40	22	256
25 × 45	28	256
30 × 25	17	240
30 × 30	23	240
30 × 35	29	240
30 × 40	36	240
30 × 45	41	160
30 × 50	46	160
30 × 55 (53)	48	200
30 × 73	58	100
35 × 45 (43)	48	160
35 × 55 (53)	57	80
35 × 75 (73)	78	80
35 × 80	105	80
35 × 105	135	80
40 × 55 (53)	75	60
40 × 75 (73)	100	60
40 × 105 (103)	150	60
50 × 80	170	35
50 × 105	210	35
65 × 105	360	25
75 × 105	480	20
75 × 140	640	20
75 × 220	1100	20

b) Small capacitors

Rated dimensions $d \times l$ (mm)	Weight[1] g	PU items
6.5 × 17.5	1.1	5000
8.5 × 17.5	1.8	5000
10 × 20	2.6	2500
10 × 25	3.2	2500
12 × 30	5.4	1500
14 × 30	7.5	1000
16 × 30	9.3	1000
18 × 39.5	14	500
21 × 40	18	500
22 × 40	18	500
25 × 40	26	350
25 × 45	30	300

c) Single-ended capacitors

B 41 326; B 43 326

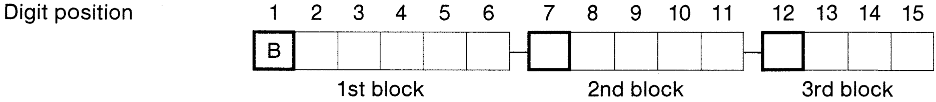
Rated dimensions $d \times l$ (mm)	Weight[1] g	PU items
5 × 11	0.5	2500
6.3 × 11	0.6	2500
8 × 12.5	0.9	1000
10 × 12.5	1.3	1000
10 × 20	2.3	500
12.5 × 25	4.2	250
16 × 25	6.5	250
16 × 31.5	8.7	200
18 × 31.5	11.0	100

[1] Typical values; deviation up to approx. ± 30 % possible.

1 Part number, ordering code

Siemens has introduced part numbers for all its technical products in order to expedite procedures such as ordering and supplying, by means of data processing equipment. These part numbers are stated in data sheets and data books, as well as in short form catalogs, thus clearly identifying any deliverable component. Orders can be settled easier and faster, when the customer indicates the part number.
The coding system is dealt with in the following sections.
Should, however, the coding system remain unclear, it is better to place the order uncoded (clear text). Since the coded designation is necessary for the internal settlement, the coding will then be performed by Siemens, so that all types are supplied according to a coded part number.

2 Construction of the part number



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 linked by a hyphen. Each of the three blocks begins with a letter, whereas all other digits are Arabic figures.

2.1 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. aluminum electrolytic capacitors have the B number group B40*** to B445**.

2.2 Digit 7 (revision status)

The first letter of the second block – the 7th digit position of the type number – indicates the revision status. Upon variation of the revision status, the code letter can be changed 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 enhanced electrical characteristics (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. If 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 remain 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, if a volume reduction has been attained at the expense of scaled up dimensions (diameter or length) which may be necessary for 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 R (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 indicated in the data sheets only in particular cases, when a special version advances to standard type.

2.3 Digit 8 (rated voltage)

The meaning of the code figure of the rated voltage is indicated in the individual data sheets. The code figures for the voltage ratings of electrolytic capacitors are mostly systematized.

2.4 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 $a \cdot 10^b$ 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 99990 µF. Higher values are subject to special regulations, which are described later. For capacitors with several partial capacitances the total of the individual values is coded in this manner.

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.

d) In case the calculation according to para. a) has shown a figure behind the decimal point, this figure will be inserted in digit 13.

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-****
2 200 µF = 2 200 000 000 pF = 22 · 10^8 pF = -**228-****
68 500 µF = 68 500 000 000 pF = 68,5 · 10^9 pF = -**689-*5**

This system allows the coding of rated capacitances up to 99 900 µF only. The technical progress, however, enabled also the production of electrolytic capacitors with higher capacitance, for which the following system was chosen:

Coding: →
Decoding: ←
150 000 µF = 150 000 000 000 pF = 15 · 10^{10} pF = -**150-****
1 000 000 µF = 1 000 000 000 000 pF = 10 · 10^{11} pF = -**101-****

In this code number only the last figure of the exponent, now containing two digits, is quoted. It is, however, impossible to get mixed up with the capacitance values 15 pF, 100 pF, respectively, resulting from the decoding formula $a \times 10^b$, as such small rated capacitances are far below the electrolytic capacitor range.

2.5 Digit 12 (tolerance)

Code letters in accordance with IEC publication 62/1968 are used to code the tolerances of capacitance values.

Code letter	Capacitance tolerance	Code letter	Capacitance tolerance
A	Tolerances without proper code letter	M	± 20 %
J	± 5 %	Q	+ 30 % − 10 %
K	± 10 %	T	+ 50 % − 10 %

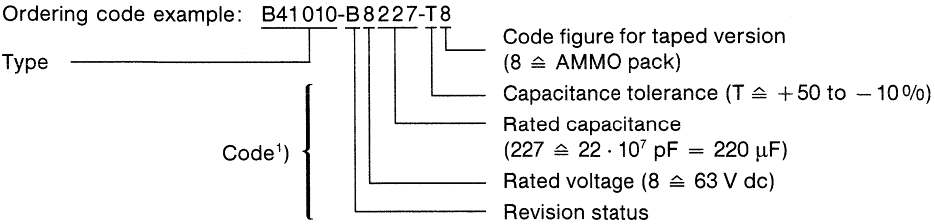
The relevant tolerances available are contained in the individual data sheets.

2.6 Digit 14 and 15 ("counting digits")

There exist electrolytic capacitors for which no difference in the ordering code can be determined when using the coding described above. This, for example, can happen for two dual capacitors of identical design with partial capacitances of 150 µF + 150 µF, 200 µF + 100 µF, respectively. But nevertheless the ordering codes of both capacitors have to differ. For this purpose the digits 14 and 15 are used, into which differing "counting digits" will be inserted, if necessary.

Digit 15 also serves to identify the taped version and the type of packaging in the case of small capacitors.
Code figure 9 ≙ taped, reel packing
Code figure 8 ≙ taped, AMMO pack

3 Example for the compiling of part numbers



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

Exception: taped versions, multiple capacitances and special versions.

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[1] This code is generally contained in the tables of the individual data sheets.

Aluminum Electrolytic Capacitors

SIKOREL® and High-Performance Capacitors

Can-type and small

Siemens Aktiengesellschaft

Al Electrolytic Capacitors SIKOREL® 125
16 to 100 V dc LL Grade
B 41 554

1000 to 150 000 µF; 35.7 mm to 76.9 mm dia.

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Poles brought out to M 5 screw terminals
- Mounting with ring clips

Features

- Outstanding reliability and very long service life
- Wide temperature range
- Good thermal characteristics
- High ripple current capability
- Up to 10 years shelf life
- CECC quality approval in preparation
- All-welded construction ensures reliable contacting

Application

- Highly professional power supplies

Accessories

- Included in delivery (loosely):
  cylindrical screws M 5 × 8 DIN 84-4.8;
  toothed washers A5.1 DIN 6797
- Not included in delivery:
  ring clips B 44 030, page 263

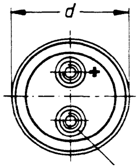
Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 249
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKD (−55 to +125 °C, humidity category D) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

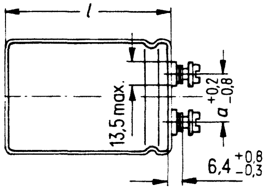
Service life

Operating conditions	dia. ≤ 51.6 mm	dia. ≥ 64.3 mm
40 °C; V_R; $I_{ac\,R}$	> 500 000 h	> 500 000 h
85 °C; V_R; $I_{ac\,max}$	> 15 000 h	> 25 000 h
125 °C; V_R; $I_{ac\,R}$	> 2 500 h	> 5 000 h

Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 20 fit (≤ $20 \cdot 10^{-9}$/h)



Min. reach of screw: 8 mm



Dimensions in mm

Marking of positive pole: +

Dimensions (mm)			Approx. weight g
$d_{max} \times l_{max}$ (with insulating sleeve)	$d_{min} \times l_{min}$ (with insulating sleeve)	Dimension *a*	
35,7 × 56,7	34,9 × 53,5	12,7	65
35,7 × 82,1	34,9 × 78,9	12,7	105
35,7 × 107,5	34,9 × 104,3	12,7	135
51,6 × 82,1	50,8 × 78,9	22,2	220
51,6 × 107,5	50,8 × 104,3	22,2	280
64,3 × 107,5	63,5 × 104,3	28,5	440
76,9 × 107,5	76,2 × 104,3	31,7	540
76,9 × 145,6	76,2 × 142,4	31,7	840

Rated voltage V_R1)		16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Dimensions $d_{max} \times l_{max}$ Code				
1 000	$^{-10}_{+30}$ % ≙ Q					35,7 × 56,7 -B9108-Q
2 200					35,7 × 56,7 -B8228-Q	35,7 × 82,1 -B9228-Q
3 300					35,7 × 82,1 2) -B8338-Q	51,6 × 82,1 -B9338-Q
4 700			35,7 × 56,7 -B5478-Q	35,7 × 82,1 -B7478-Q	35,7 × 107,5 -B8478-Q	51,6 × 107,5 -B9478-Q
6 800					51,6 × 82,1 -B8688-Q	64,3 × 107,5 -B9688-Q
10 000		35,7 × 56,7 -B4109-Q	35,7 × 82,1 -B5109-Q	35,7 × 107,5 -B7109-Q	51,6 × 107,5 -B8109-Q	76,9 × 107,5 3) -B9109-Q
15 000		35,7 × 82,1 -B4159-Q	35,7 × 107,5 -B5159-Q	51,6 × 82,1 -B7159-Q	64,3 × 107,5 -B8159-Q	76,9 × 145,6 -B9159-Q
22 000		35,7 × 107,5 -B4229-Q	51,6 × 82,1 -B5229-Q	51,6 × 107,5 -B7229-Q	76,9 × 107,5 -B8229-Q	
33 000		51,6 × 82,1 -B4339-Q	51,6 × 107,5 -B5339-Q	64,3 × 107,5 -B7339-Q	76,9 × 145,6 -B8339-Q	
47 000		51,6 × 107,5 -B4479-Q	64,3 × 107,5 -B5479-Q	76,9 × 107,5 -B7479-Q		
68 000		64,3 × 107,5 -B4689-Q	76,9 × 107,5 -B5689-Q	76,9 × 145,6 -B7689-Q		
100 000		76,9 × 107,5 -B4100-Q	76,9 × 145,6 -B5100-Q			
150 000		76,9 × 145,6 -B4150-Q				

Example for the compiling of ordering codes

$$\text{B41554-}\underbrace{\text{B4479-Q}}_{\text{Code according to table}}$$

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

---

1) Peak voltage $V_p = 1.15\ V_R$

2) Not quoted in DIN 41 249

3) Dimensions deviating from DIN 41 249

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 20 kHz 20 °C mΩ	$I_{r,max}$ 5 min 20 °C mA	$I_{ac\,max}$1) 100 Hz 40 °C A	$I_{ac\,max}$1) 100 Hz 85 °C A	$I_{ac\,R}$1) 100 Hz 125 °C A	ESL approx. nH
10000	16	15	38	26	0,32	17	12	4,5	10
15000		12	26	21	0,48	23	16	5,8	10
22000		9	21	18	0,71	29	21	7,5	10
33000		7	17	15	1,1	30	24	8,7	15
47000		5	13	13	1,5	30	30	11	15
68000		5	13	11	2,2	40	38	14	20
100000		4	10	9	3,2	40	39	14	20
150000		4	10	8	4,0	40	40	16	20
4700	25	22	40	31	0,24	14	10	3,7	10
10000		14	28	21	0,50	21	15	5,4	10
15000		11	24	17	0,75	26	19	6,8	10
22000		8	20	15	1,1	30	22	8,1	15
33000		6	15	12	1,7	30	29	10	15
47000		5	13	11	2,4	40	34	12	20
68000		5	11	9	3,4	40	35	13	20
100000		4	9	8	4,0	40	39	15	20
4700	40	15	35	25	0,38	20	14	5,2	10
10000		11	27	17	0,80	26	19	6,8	10
15000		8	20	14	1,2	30	22	8,1	15
22000		6	15	12	1,8	30	29	10	15
33000		5	13	10	2,6	40	34	12	20
47000		5	12	9	3,8	40	35	13	20
68000		4	9	8	4,0	40	39	15	20
2200	63	26	60	30	0,28	13	9,4	3,4	10
3300		17	39	24	0,42	19	14	4,9	10
4700		13	31	20	0,60	24	17	6,2	10
6800		10	23	17	0,86	28	20	7,2	15
10000		7	18	14	1,3	30	27	9,6	15
15000		6	15	11	1,9	40	31	11	20
22000		5	12	9	2,8	40	35	13	20
33000		4	9	8	4,0	40	39	15	20
1000	100	55	120	48	0,20	9,9	6,9	2,5	10
2200		26	57	30	0,44	17	12	4,2	10
3300		17	37	24	0,66	21	15	5,4	15
4700		13	29	20	0,94	29	20	7,2	15
6800		8	22	17	1,4	36	25	9,1	20
10000		7	15	14	2,0	40	30	11	20
15000		6	13	11	3,0	40	36	13	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

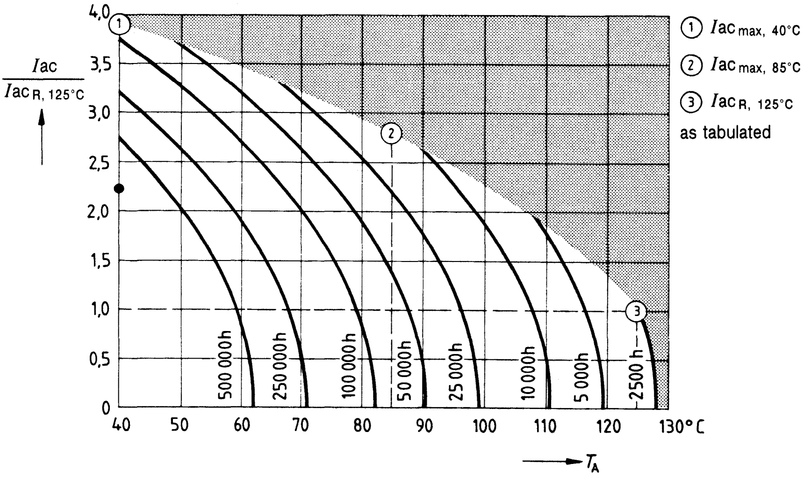
---

1) The current load on the contact elements must not ecxeed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm : 30 A
Capacitor diameter > 51.6 mm : 40 A

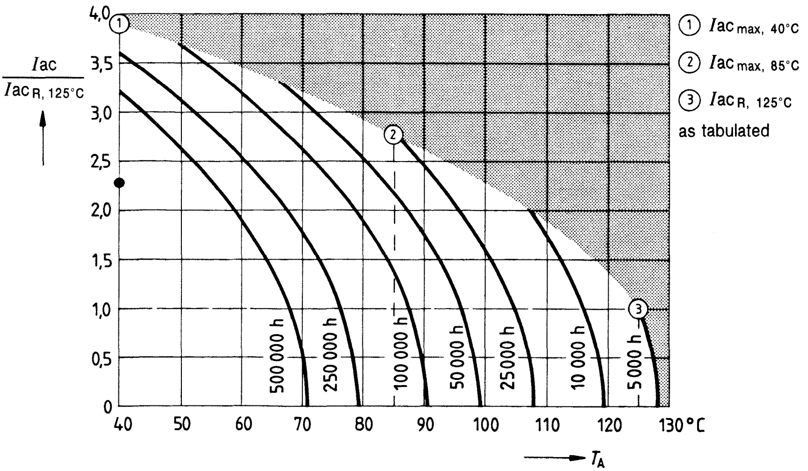
Service life¹)

versus ambient temperature T_A at ripple current operation

for ≤ 51.6 mm dia.



for ≥ 64.3 mm dia.



● $I\text{ac}_R$ at 40 °C = 2.24 · $I\text{ac}_R$ at 125 °C

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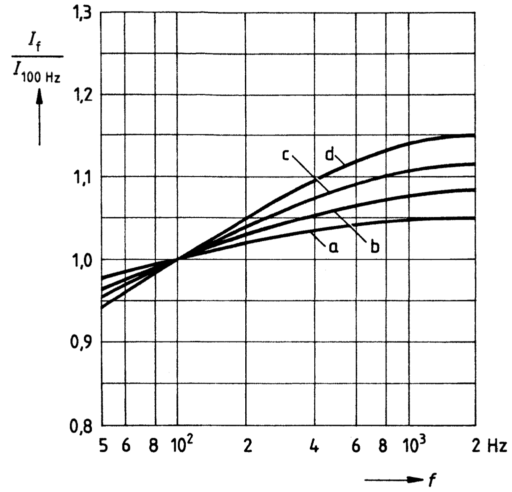
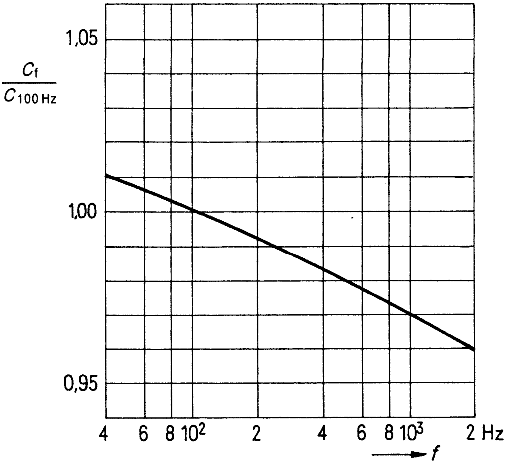
¹) For details on service life curve refer to page 32.

Permissible ripple current Iac
versus frequency *f*

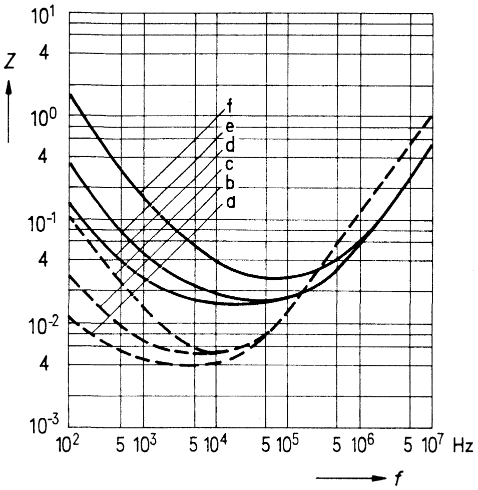


V_R V dc	d_{max} (mm) 35,7	 51,6	 64,3	 76,9
16; 25	b	a	a	a
40	c	b	a	a
63	d	c	c	b
100	d	c	c	c

Capacitance C
versus frequency *f*
Typical behavior

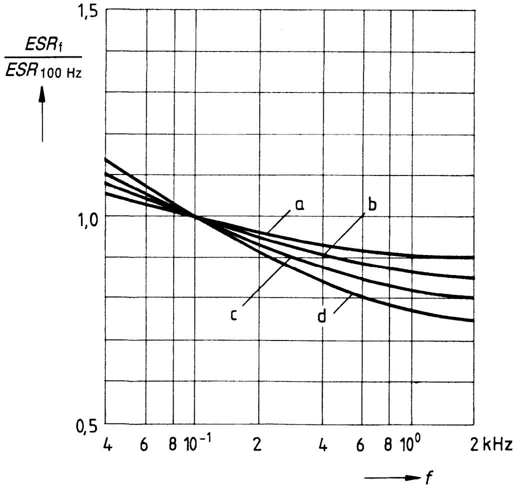


Impedance *Z*
versus frequency *f*
Typical behavior



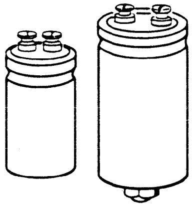
C_R µF	V_R V dc	d_{max} mm	Curve
150 000	16	76,9	a
68 000	40		b
15 000	100		c
10 000	16	35,7	d
4 700	40		e
1 000	100		f

Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior



V_R V dc	d_{max} (mm) 35,7	 51,6	 64,3	 76,9
16; 25	b	a	a	a
40	c	b	a	a
63	d	c	c	b
100	d	c	c	c

1000 to 150 000 μF; 35.7 mm to 76.9 mm dia.; applicable up to 125 °C[1])



B 41 550 B 41 570

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Poles brought out to M 5 screw terminals
- Mounting with ring clips (B 41 550) or with threaded stud (B 41 570)

Features

- High reliability and long service life
- Wide temperature range
- High ripple current capability
- All-welded construction ensures reliable contacting
- Up to 10 years shelf life

Application

- All professional power supplies

Accessories

- Included in delivery (loosely):
  cylindrical screws M 5 × 8 DIN 84-4.8;
  toothed washers A5.1 DIN 6797
- Not included in delivery:
  ring clips B 44 030, page 263 (for type B 41 550)
  insulating parts B 44 020, page 260 (for type B 41 570)

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41 249
IEC climatic category	55/105/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	−55 to +105 °C[1])
Humidity category	D in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	dia. ≤ 51.6 mm	dia. ≥ 64.3 mm
40 °C; V_R; $I\text{ac}_R$	> 500 000 h	> 500 000 h
85 °C; V_R; $I\text{ac}_{max}$	> 15 000 h	> 25 000 h
105 °C; V_R; $I\text{ac}_R$	> 10 000 h	> 20 000 h

Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 20 fit (≤ 20 · 10^{-9}/h)

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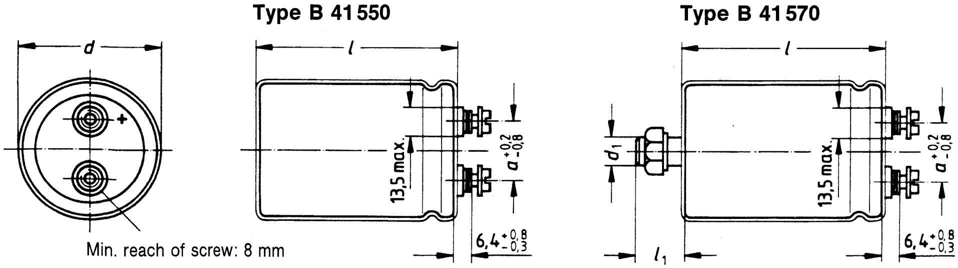
[1]) After having removed the insulating sleeve, operation up to 125°C is permitted: for dia. ≤ 51.6 mm: 2500 h; for dia. ≥ 64.3 mm: 5000 h



Dimensions in mm

Marking of positive pole: +

Dimensions (mm)					Approx. weight g
$d_{max} \times l_{max}$ (with insulating sleeve)	$d_{min} \times l_{min}$ (with insulating sleeve)	d_1	l_{1-1}	Dimension a	
35,7 × 56,7	34,9 × 53,5	M8	13	12,7	65
35,7 × 82,1	34,9 × 78,9	M8	13	12,7	105
35,7 × 107,5	34,9 × 104,3	M8	13	12,7	135
51,6 × 82,1	50,8 × 78,9	M12	17	22,2	220
51,6 × 107,5	50,8 × 104,3	M12	17	22,2	280
64,3 × 107,5	63,5 × 104,3	M12	17	28,5	440
76,9 × 107,5	76,2 × 104,3	M12	17	31,7	540
76,9 × 145,6	76,2 × 142,4	M12	17	31,7	840

Rated voltage V_R 1)		16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Dimensions $d_{max} \times l_{max}$ Code				
1 000	$^{-10}_{+30}$ % ≙ Q					35,7 × 56,7 ◥ -A9108-Q
2 200					35,7 × 56,7 ◥ -A8228-Q	35,7 × 82,1 ◥ -A9228-Q
3 300					35,7 × 82,1 2) -A8338-Q	51,6 × 82,1 -A9338-Q
4 700			35,7 × 56,7 -A5478-Q	35,7 × 82,1 ◥ -A7478-Q	35,7 × 107,5 ◥ -A8478-Q	51,6 × 107,5 ◥ -A9478-Q
6 800					51,6 × 82,1 -A8688-Q	64,3 × 107,5 -A9688-Q
10 000		35,7 × 56,7 ◥ -A4109-Q	35,7 × 82,1 -A5109-Q	35,7 × 107,5 ◥ -A7109-Q	51,6 × 107,5 ◥ -A8109-Q	76,9 × 107,5 3) ◥ -A9109-Q
15 000		35,7 × 82,1 -A4159-Q	35,7 × 107,5 -A5159-Q	51,6 × 82,1 -A7159-Q	64,3 × 107,5 -A8159-Q	76,9 × 145,6 -A9159-Q
22 000		35,7 × 107,5 ◥ -A4229-Q	51,6 × 82,1 -A5229-Q	51,6 × 107,5 ◥ -A7229-Q	76,9 × 107,5 -A8229-Q	
33 000		51,6 × 82,1 -A4339-Q	51,6 × 107,5 -A5339-Q	64,3 × 107,5 -A7339-Q	76,9 × 145,6 -A8339-Q	
47 000		51,6 × 107,5 -A4479-Q	64,3 × 107,5 -A5479-Q	76,9 × 107,5 -A7479-Q		
68 000		64,3 × 107,5 -A4689-Q	76,9 × 107,5 -A5689-Q	76,9 × 145,6 -A7689-Q		
100 000		76,9 × 107,5 -A4100-Q	76,9 × 145,6 -A5100-Q			
150 000		76,9 × 145,6 -A4150-Q				

Example for the compiling of ordering codes

for ring clip mounting
B41550-A4479-Q
└── Code according to table

for threaded stud mounting
B41570-A4479-Q
└── Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.
◥ These capacitors are preferred types **S** (refer to page 4).

---

1) Peak voltage $V_p = 1.15\ V_R$
2) Not quoted in DIN 41 249
3) Dimensions deviating from DIN 41 249

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 20 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$ 1) 100 Hz 40 °C A	$I_{ac\,max}$ 1) 100 Hz 85 °C A	$I_{ac\,R}$ 1) 100 Hz 105 °C A	ESL approx. nH
◥ 10 000	16	15	38	26	0,32	17	12	6,2	10
15 000		12	26	21	0,48	23	16	8,1	10
◥ 22 000		9	21	18	0,71	29	21	10	10
33 000		7	17	15	1,1	30	24	12	15
47 000		5	13	13	1,5	30	30	16	15
68 000		5	13	11	2,2	40	34	17	20
100 000		4	10	9	3,2	40	39	19	20
150 000		4	10	8	4,0	40	40	22	20
4 700	25	22	40	31	0,24	14	10	5,2	10
10 000		14	28	21	0,50	21	15	7,5	10
15 000		11	24	17	0,75	26	19	9,4	10
22 000		8	20	15	1,1	30	22	11	15
33 000		6	15	12	1,7	30	29	15	15
47 000		5	13	11	2,4	40	34	17	20
68 000		5	11	9	3,4	40	35	17	20
100 000		4	9	8	4,0	40	39	21	20
◥ 4 700	40	15	35	25	0,38	20	14	7,2	10
◥ 10 000		11	27	17	0,80	26	19	9,4	10
15 000		8	20	14	1,2	30	22	11	15
◥ 22 000		6	15	12	1,8	30	29	15	15
33 000		5	13	10	2,6	40	34	17	20
47 000		5	12	9	3,8	40	35	17	20
68 000		4	9	8	4,0	40	39	21	20
◥ 2 200	63	26	60	30	0,28	13	9,4	4,7	10
3 300		17	39	24	0,42	19	14	6,8	10
◥ 4 700		13	31	20	0,60	24	17	8,7	10
6 800		10	23	17	0,86	28	20	10	15
◥ 10 000		7	18	14	1,3	30	27	13	15
15 000		6	15	11	1,9	40	31	15	20
22 000		5	12	9	2,8	40	35	17	20
33 000		4	9	8	4,0	40	39	21	20
◥ 1 000	100	55	120	48	0,20	9,8	7	3,5	10
◥ 2 200		26	57	30	0,44	16	12	5,9	10
3 300		17	37	24	0,66	22	16	8,0	15
◥ 4 700		13	29	20	0,94	28	20	10	15
6 800		10	22	17	1,4	36	26	13	20
◥ 10 000		7	15	14	2,0	40	32	16	20
15 000		6	13	11	3,0	40	36	18	20

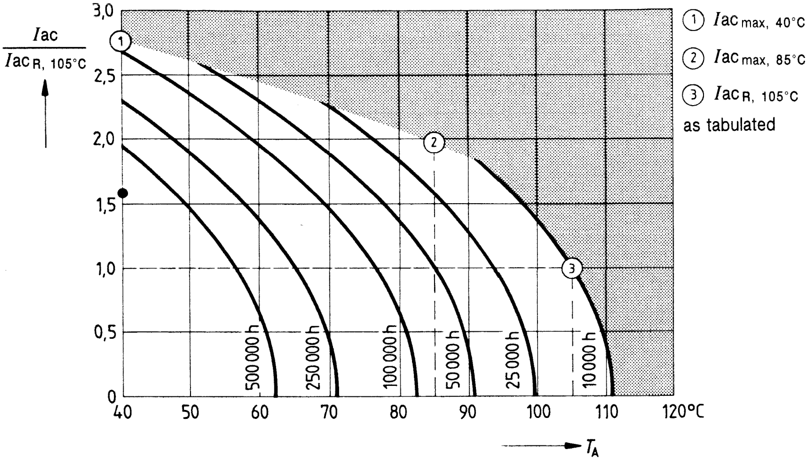
Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.
◥ These capacitors are preferred types S (refer to page 4).

---

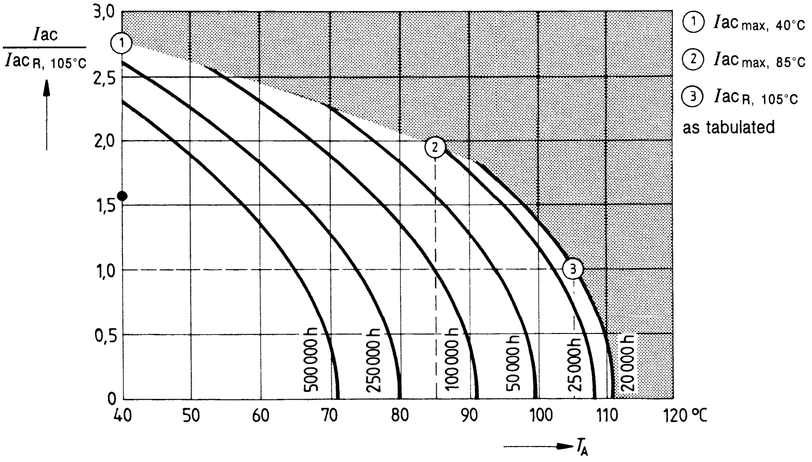
1) The current load on the contact elements must not ecxeed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm : 30 A
Capacitor diameter > 51.6 mm : 40 A

Service life[1]
versus ambient temperature T_A at ripple current operation

for ≤ 51.6 mm dia.



for ≥ 64.3 mm dia.



● $I_{ac\,R}$ at 40 °C = 1.60 · $I_{ac\,R}$ at 105 °C

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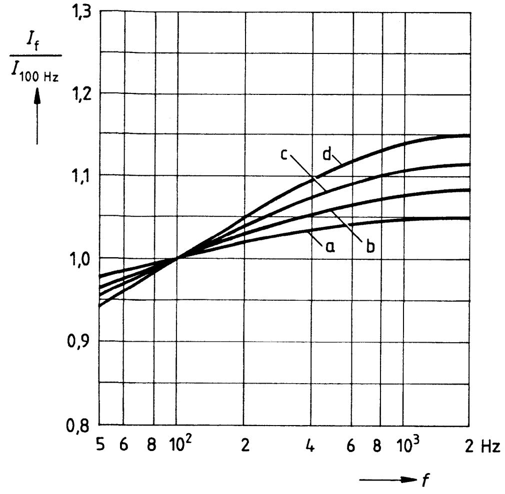
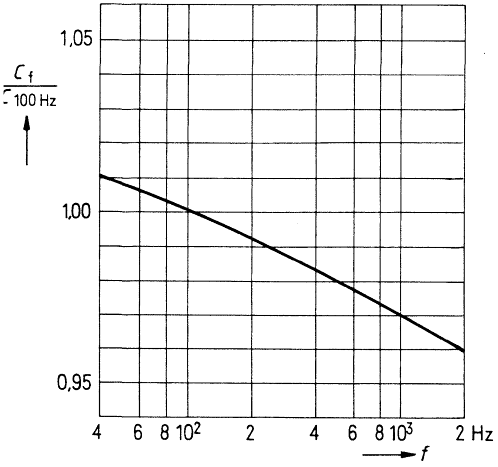
[1] For details on service life curve refer to page 32.

Permissible ripple current Iac
versus frequency f

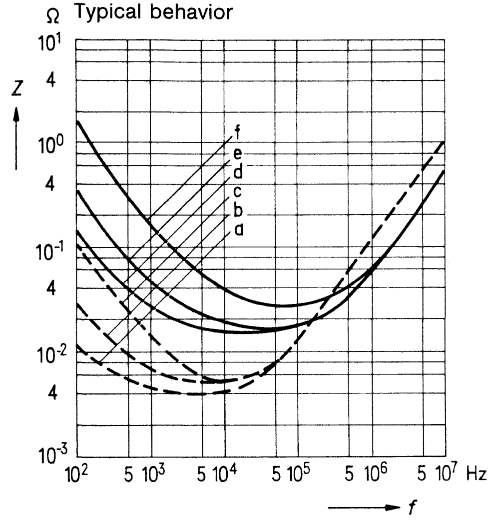


V_R V dc	d_{max} (mm) 35,7	 51,6	 64,3	 76,9
16; 25	b	a	a	a
40	c	b	a	a
63	d	c	c	b
100	d	c	c	c

Capacitance C
versus frequency f
Typical behavior

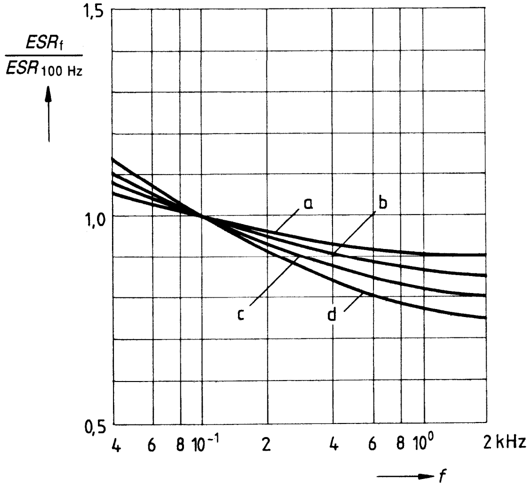


Impedance *Z*
versus frequency *f*
Typical behavior



C_R µF	V_R V dc	d_{max} mm	Curve
150 000	16		a
68 000	40	76,9	b
15 000	100		c
10 000	16		d
4 700	40	35,7	e
1 000	100		f

Equivalent series resistance ***ESR***
versus frequency *f*
Typical behavior



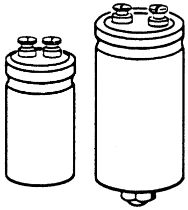
V_R V dc	d_{max} (mm) 35,7	51,6	64,3	76,9
16; 25	b	a	a	a
40	c	b	a	a
63	d	c	c	b
100	d	c	c	c

Al Electrolytic Capacitors High-Performance Version

160 to 400 V dc LL Grade

B 43550 B 43570

150 to 15000 µF; 35.7 mm to 76.9 mm dia.



B 43550 B 43570

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Poles brought out to M 5 screw terminals, with 76.9 mm dia. to M 6 screw terminals
- Mounting with ring clips (B 43550) or with threaded stud (B 43570)

Features

- High reliability
- Wide temperature range
- High ripple current capability
- All-welded construction ensures reliable contacting

Application

- Highly professional power supplies
- Power electronics, e.g. capacitor banks in power converters

Accessories

- Included in delivery (loosely):
  for 35.7 to 64.3 dia.: cylindrical screws M 5 × 8 DIN 84-4.8;
  toothed washers A 5.1 DIN 6797
  for 76.9 dia.: cylindrical screws M 6 × 12 DIN 85-4.8;
  toothed washers A 6.4 DIN 6797
- Not included in delivery:
  ring clips B 44030, page 263 (for type B 43550)
  insulating parts B 44020, page 260 (for type B 43570)

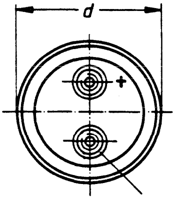
Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41248
IEC climatic category	≤ 350 V dc: 40/105/56 > 350 V dc: 40/085/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	≤ 350 V dc: −40 to +105 °C > 350 V dc: −40 to + 85 °C
Humidity category	D in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

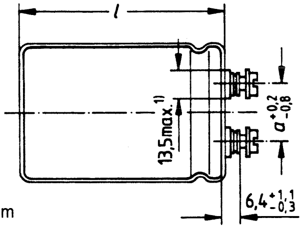
Service life

Operating conditions	$V_R \leq 350$ V dc	$V_R \geq 385$ V dc
40 °C; V_R; $I_{ac\,R}$	> 360000 h	> 180000 h
85 °C; V_R; $I_{ac\,max}$	> 10000 h	> 8000 h
105 °C; V_R; $I_{ac\,R}$	> 4000 h	–

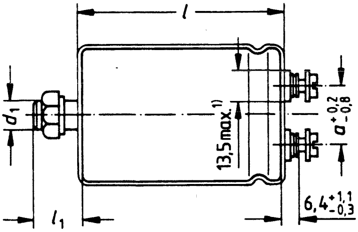
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)



Type B 43 550



Type B 43 570



M5: Min. reach of screw: 8 mm
M6: Min. reach of screw: 12 mm

Dimensions in mm

Marking of positive pole: +

Dimensions (mm)					Approx.
$d_{max} \times l_{max}$ (with insulating sleeve)	$d_{min} \times l_{min}$ (with insulating sleeve)	d_1	l_{1-1}	Dimension *a*	weight g
35,7 × 56,7	34,9 × 53,5	M8	13	12,7	65
35,7 × 82,1	34,9 × 78,9	M8	13	12,7	105
35,7 × 107,5	34,9 × 104,3	M8	13	12,7	135
51,6 × 82,1	50,8 × 78,9	M12	17	22,2	220
51,6 × 107,5	50,8 × 104,3	M12	17	22,2	280
64,3 × 107,5	63,5 × 104,3	M12	17	28,5	440
76,9 × 107,5	76,2 × 107,5	M12	17	31,7	540
76,9 × 145,6	76,2 × 142,4	M12	17	31,7	840
76,9 × 221,8	76,2 × 218,6	M12	17	31,7	1300

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[1] Max. 17.7 mm for M6 screw terminals

Rated voltage V_R[1]		160 V dc	250 V dc	350 V dc	400 V dc[2]
Rated capacitance µF	Tolerance	Dimensions $d_{\max} \times l_{\max}$ Code			
150	$^{-10}_{+30}$ % ≙ Q			35,7 × 56,7 -A4157-Q	35,7 × 56,7 -E157-Q
220			35,7 × 56,7 -A2227-Q	35,7 × 82,1 -A4227-Q	35,7 × 82,1 -E227-Q
330		35,7 × 56,7 -A1337-Q	35,7 × 82,1 -A2337-Q	35,7 × 107,5 -A4337-Q	35,7 × 107,5 -E337-Q
470		35,7 × 56,7 -A1477-Q	35,7 × 107,5 -A2477-Q	51,6 × 82,1 -A4477-Q	51,6 × 82,1 -E477-Q
680		35,7 × 82,1 -A1687-Q	51,6 × 82,1 -A2687-Q	51,6 × 107,5 -A4687-Q	51,6 × 107,5 -E687-Q
1 000		35,7 × 107,5 -A1108-Q	51,6 × 107,5 -A2108-Q	64,3 × 107,5 -A4108-Q	64,3 × 107,5 -E108-Q
1 500		51,6 × 82,1 -A1158-Q	64,3 × 107,5 -A2158-Q	64,3 × 107,5 -A4158-Q	64,3 × 107,5 -E158-Q
2 200		51,6 × 107,5 -A1228-Q	64,3 × 107,5 -A2228-Q	76,9 × 107,5 -B4228-Q	76,9 × 107,5 -F228-Q
3 300		64,3 × 107,5 -A1338-Q	76,9 × 107,5 -B2338-Q	76,9 × 145,6 -B4338-Q	76,9 × 145,6 -F338-Q
4 700		64,3 × 107,5 -A1478-Q	76,9 × 145,6 -B2478-Q	76,9 × 221,8 -B4478-Q	76,9 × 221,8 -F478-Q
6 000				76,9 × 221,8 -B4608-Q	
6 800		76,9 × 107,5 -B1688-Q	76,9 × 221,8 -B2688-Q		
10 000		76,9 × 145,6 -B1109-Q			
15 000		76,9 × 221,8 -B1159-Q			

Example for the compiling of ordering codes

without threaded stud	with threaded stud
B43550-A1337-Q	B43570-A1337-Q
└── Code according to table	└── Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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[1] Peak voltage $V_p = 1.15 \cdot V_R$ (160, 250 V dc); 1.1 V_R (350 and 400 V dc)

[2] 385 V version available upon request.

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$ 1) 100 Hz 40 °C A	$I_{ac\,max}$ 1) 100 Hz 85 °C A	$I_{ac\,R}$ 1) 100 Hz 105 °C A	ESL approx. nH
330	160	210	450	290	0,11	4,1	2,5	1,2	10
470		150	240	200	0,15	4,8	2,9	1,4	10
680		100	140	130	0,22	6,8	4,2	2,0	10
1 000		70	100	98	0,32	8,8	5,5	2,6	10
1 500		47	68	67	0,48	11,0	6,7	3,2	15
2 200		33	50	49	0,71	14,0	8,8	4,2	15
3 300		22	35	34	1,1	19,0	12,0	5,7	20
4 700		16	27	26	1,5	23,0	14,0	6,8	20
6 800		12	24	23	2,2	27,0	16,0	7,8	20
10 000		9	18	17	3,2	34,0	21,0	10,0	20
15 000		7	17	16	4,8	48,0	29,0	14,0	20
220	250	220	440	330	0,11	4,1	2,5	1,2	10
330		150	300	220	0,17	5,4	3,4	1,6	10
470		100	190	160	0,24	7,5	4,6	2,2	10
680		73	140	110	0,34	8,8	5,5	2,6	15
1 000		50	100	82	0,50	12,0	7,1	3,4	15
1 500		34	62	59	0,75	16,0	9,7	4,6	20
2 200		24	45	44	1,1	18,0	11,0	5,4	20
3 300		17	33	32	1,7	22,0	14,0	6,5	20
4 700		12	27	26	2,4	30,0	18,0	8,8	20
6 800		9	23	22	3,4	41,0	25,0	12,0	20
150	350	270	600	410	0,11	3,7	2,3	1,1	10
220		180	420	280	0,16	5,1	3,2	1,5	10
330		120	280	190	0,24	6,8	4,2	2,0	10
470		87	190	140	0,33	7,8	4,8	2,3	15
680		60	130	100	0,48	11,0	6,5	3,1	15
1 000		42	90	72	0,70	14,0	8,6	4,1	20
1 500		29	60	52	1,1	17,0	11,0	5,0	20
2 200		20	45	40	1,5	20,0	13,0	6,0	20
3 300		14	30	29	2,3	28,0	17,0	8,1	20
4 700		11	24	23	3,3	37,0	23,0	11,0	20
6 000		9	20	19	4,2	41,0	25,0	12,0	20

cont'd on page 94

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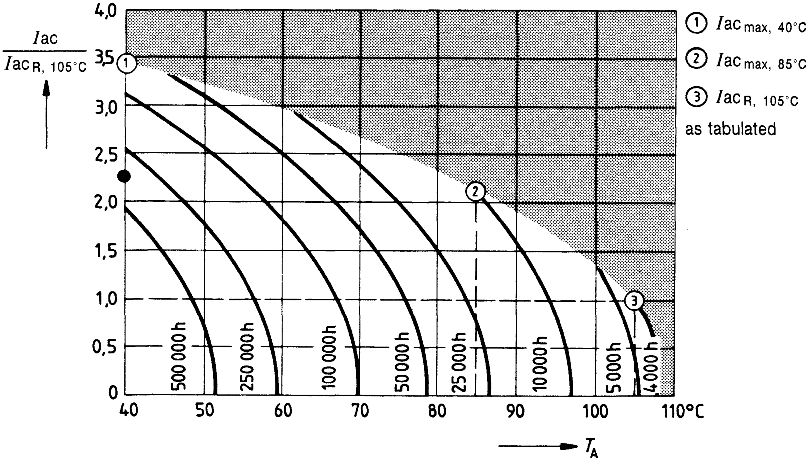
1) The current load on the contact elements must not ecxeed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm: 50 A

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	Iac_{max}[1] 100 Hz 40 °C A	Iac_R[1] 100 Hz 85 °C A	ESL approx. nH
150	400	270	600	410	0,12	3,3	1,4	10
220		180	420	280	0,18	4,5	1,9	10
330		120	280	190	0,26	5,9	2,5	10
470		87	190	140	0,38	7,1	3,0	15
680		60	130	100	0,54	9,4	4,0	15
1 000		42	90	72	0,8	12,0	5,3	20
1 500		29	60	52	1,2	15,0	6,5	20
2 200		20	45	40	1,8	18,0	7,8	20
3 300		14	30	29	2,6	24,0	10,0	20
4 700		11	24	23	3,8	33,0	14,0	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

Service life[2]**)**
versus ambient temperature T_A at ripple current operation

for V_R = 160 to 350 V dc



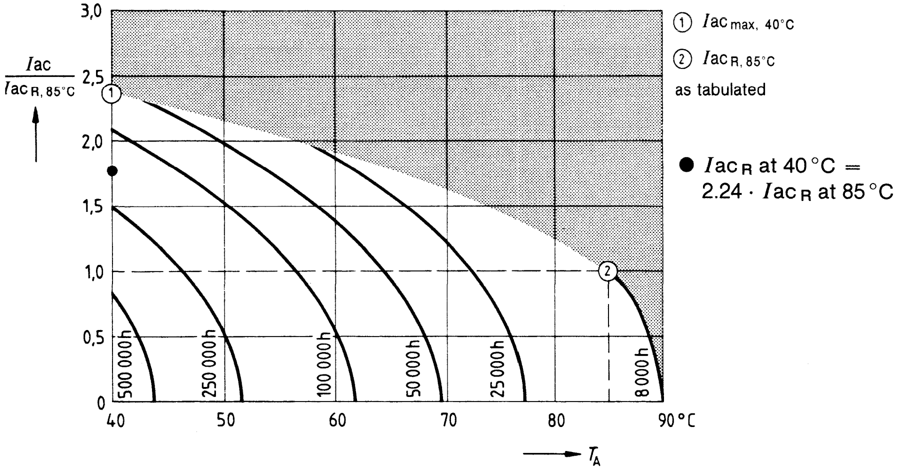
● Iac_R at 40 °C = 2.24 · Iac_R at 105 °C

---

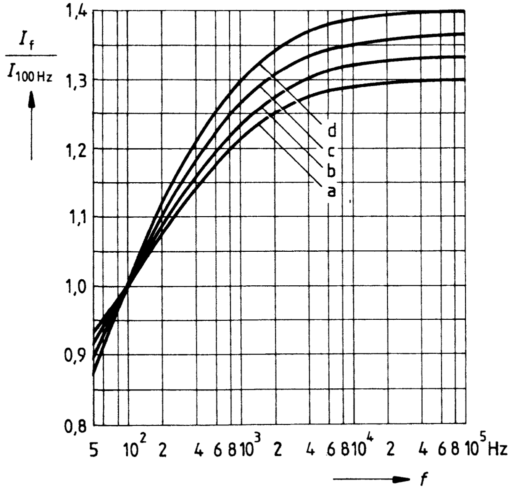
[1] The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm: 50 A

[2] For details on service life curve refer to page 32.

Service life[1])
versus ambient temperature T_A at ripple current operation
for $V_R > 350$ V

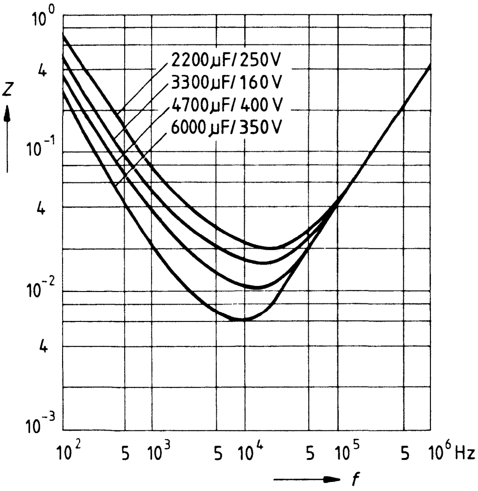


Permissible ripple current I_{ac}
versus frequency f



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

Impedance *Z*
versus frequency f
Typical behavior



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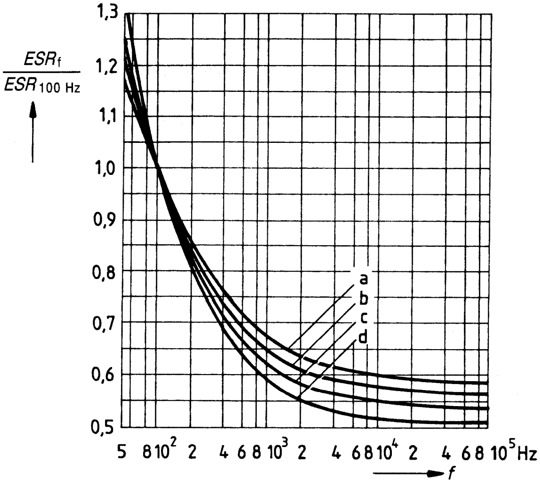
[1]) For details on service life curve refer to page 32.

Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

2800 to 46 000 µF; 35.7 mm dia.

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- All-welded construction ensures reliable contacting
- Poles brought out to heavy duty screw terminals with UNF thread
- Mounting with ring clips

Features

- Particularly low impedance throughout wide temperature range
- Good thermal characteristics
- High ripple current capability
- Low ohmic losses
- Long service life
- Up to 10 years shelf life

Application

- Professional switch-mode power supplies with high clock frequencies

Accessories

- Included in delivery (loosely):
  Screws 10–32 UNF-2 A × 9.5; toothed washers A 5.1 DIN 6797
- Not included in delivery:
  ring clips B 44 030, page 263

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
IEC climatic category	55/105/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	– 55 to + 105 °C
Humidity category	F[1]) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h
Service life	40 °C; V_R; $I\text{ac}_R$: > 180 000 h 85 °C; V_R; $I\text{ac}_{\text{max}}$: > 4 500 h 105 °C; V_R; $I\text{ac}_R$: > 2 000 h
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 40 fit ($\leq 40 \cdot 10^{-9}$/h)

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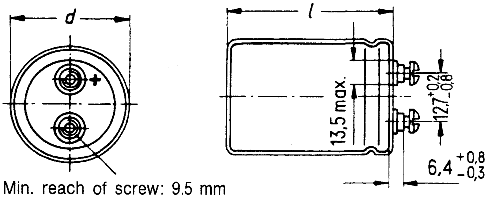
[1]) These capacitors also comply with the test conditions of humidity category E in acc. with DIN 40 040.



Min. reach of screw: 9.5 mm

Dimensions in mm

Marking of positive pole: +

Case size	Dimensions (mm) $d_{max} \times l_{max}$ (with insulating sleeve)	Dimensions (mm) $d_{min} \times l_{min}$ (with insulating sleeve)	Approx. weight g	*ESL* approx. nH
AA	35,7 × 56,7	34,9 × 53,5	60	10
AB	35,7 × 82,1	34,9 × 78,9	95	10
AC	35,7 × 107,5	34,9 × 104,3	120	10

C_R[1]) µF	V_R[2]) V dc	ESR_{typ} 20 kHz 20 °C mΩ	ESR_{max} 20 kHz 20 °C mΩ	$I_{r, max}$ 5 min 20 °C mA	$I_{ac\,max}$[3]) 20 kHz 40 °C A	$I_{ac\,max}$[3]) 20 kHz 85 °C A	$I_{ac\,R}$[3]) 20 kHz 105 °C A	Case size	Ordering code B41431-
18000	5	5,8	7,6	0,18	26,6	16,1	7,7	AA	-A189-M
32000		4,5	5,9	0,32	30,0	21,2	10,2	AB	-A329-M
46000		3,8	5,0	0,46	30,0	25,8	12,4	AC	-A469-M
◥ 15000	7,5	6,0	7,8	0,23	26,2	15,8	7,6	AA	-D159-M
◥ 27000		4,6	6,0	0,41	30,0	20,9	10,1	AB	-D279-M
39000		3,9	5,1	0,59	30,0	25,4	12,2	AC	-D399-M
◥ 10000	16	6,4	8,4	0,32	25,3	15,3	7,4	AA	-A4109-M
◥ 18000		4,9	6,4	0,58	30,0	20,3	9,7	AB	-A4189-M
26000		4,0	5,2	0,84	30,0	25,1	12,1	AC	-A4269-M
8800	20	6,6	8,6	0,36	25,0	15,1	7,3	AA	-G888-M
16000		5,0	6,5	0,64	30,0	20,1	9,7	AB	-G169-M
22000		4,1	5,4	0,88	30,0	24,8	11,9	AC	-G229-M
◥ 6300	28	7,1	9,3	0,36	24,1	14,5	7,0	AA	-K638-M
◥ 11000		5,3	6,9	0,62	30,0	19,4	9,4	AB	-K119-M
16000		4,3	5,6	0,90	30,0	24,2	11,7	AC	-K169-M
◥ 4500	35	7,5	9,8	0,32	23,1	14,0	6,7	AA	-A7458-M
◥ 8100		5,5	7,2	0,57	30,0	19,1	9,2	AB	-A7818-M
12000		4,5	5,9	0,84	30,0	23,7	11,4	AC	-A7129-M
◥ 2800	55	8,7	11,3	0,31	21,7	13,1	6,3	AA	-N288-M
◥ 5000		6,3	8,2	0,55	29,6	17,9	8,6	AB	-N508-M
7300		5,0	6,5	0,81	30,0	22,5	10,8	AC	-N738-M

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.
Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.
◥ These capacitors are preferred types S (refer to page 4).

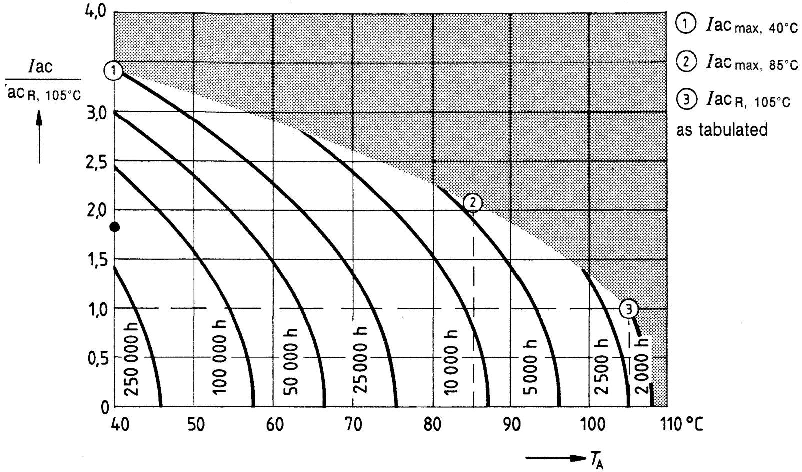
---

[1]) Capacitance tolerance ± 20%

[2]) Peak voltage $V_P = 1.15\ V_R$

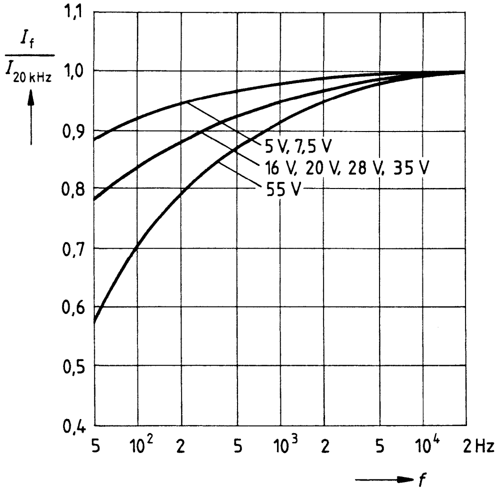
[3]) The current load on the contact elements must not exceed the limit of 30 A, even when frequency and temperature factors have been taken into account.

Service life[1]
versus ambient temperature T_A at ripple current operation

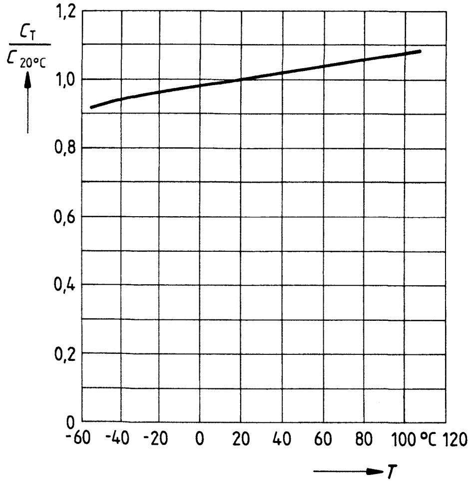


● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 105 °C

Permissible ripple current Iac
versus frequency f



Series capacitance C_S
versus temperature T (f = 100 Hz)
Typical behavior



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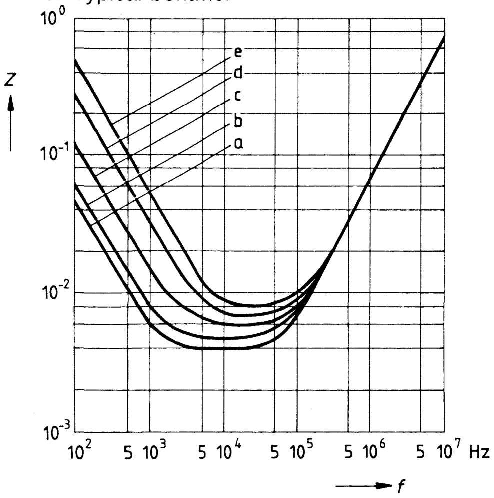
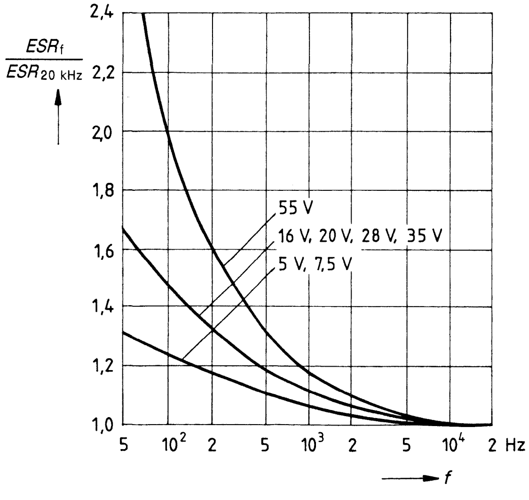
[1] For details on service life curve refer to page 32.

Impedance *Z*
versus frequency *f*
Typical behavior



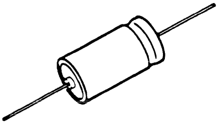
C_R µF	V_R V dc	Curve
39 000	7,5	a
27 000	7,5	b
15 000	7,5	c
5 000	55	d
2 800	55	e

Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior



Al Electrolytic Capacitors SIKOREL® 125 — 10 to 100 V dc LL Grade — B 41 590

4.7 to 4700 µF; 7.0 mm to 25.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Negative pole connected to case
- Axial leads; welded terminal connections ensure reliable contacting

Features

- Outstanding reliability and very long service life
- Wide temperature range
- Excellent parametric stability
- High ripple current capability
- Up to 10 years shelf life

Application

- High rel equipment in industrial electronics
- Automotive electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41257
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKD (−55 to +125 °C[1]), humidity category D) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	dia. ≤ 10 mm, dia. 21 mm, dia. 25 mm	dia. ≥ 12 mm to dia. 18 mm
40 °C; V_R; $I_{ac\,R}$	> 500000 h	> 500000 h
85 °C; V_R; $I_{ac\,max}$	> 10000 h	> 15000 h
125 °C; V_R; $I_{ac\,R}$	> 2000 h	> 3000 h

Fraction failure	≤ 0.5 % (during service life)
Failure rate	≤ 10 fit (≤ $10 \cdot 10^{-9}$/h)
Taping	Capacitors with 6.5 mm to 16 mm dia. are also available on tape. For information on tape packaging and ordering code example refer to pages 64 to 66.

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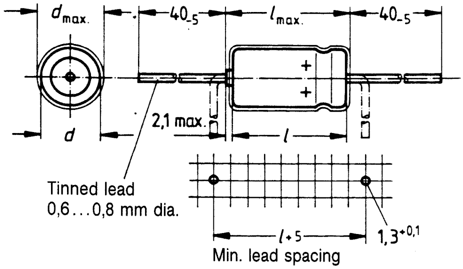
[1] For ≤ 18 mm dia.: operation at 145 °C and ≤ 0.6 · V_R permissible for 500 h



Dimensions in mm

Dimensions (mm) $d \times l$ (rated dimensions)	$d_{max} \times l_{max}$ (with insulating sleeve)	Lead dia.	Approx. weight g
6,5 × 17,5	7,0 × 19	0,6	1,1
8,5 × 17,5	9,0 × 19		1,8
10 × 20	10,5 × 21,5		2,6
10 × 25	10,5 × 26,5		3,2
12 × 30	12,5 × 32	0,8	5,4
14 × 30	14,5 × 32		7,5
16 × 30	16,5 × 32		9,3
18 × 39,5	18,5 × 41,5		14
21 × 40	21,5 × 41,5		18
25 × 40	25,5 × 41,5		26

Rated voltage V_R¹)		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code					
4,7	−10 +50 % ≙ T					▨ 6,5 × 17,5 -A8475-T	▨ 8,5 × 17,5 -A9475-T
10					▨ 6,5 × 17,5 -A7106-T	▨ 8,5 × 17,5 -A8106-T	▨ 8,5 × 17,5 -A9106-T
22					▨ 8,5 × 17,5 -A7226-T	▨ 8,5 × 17,5 -A8226-T	▨ 10 × 25 -A9226-T
47		▨ 6,5 × 17,5 -A3476-T	▨ 8,5 × 17,5 -A4476-T	▨ 8,5 × 17,5 -A5476-T	▨ 8,5 × 17,5 -A7476-T	▨ 10 × 25 -A8476-T	▨ 12 × 30 -A9476-T
100		▨ 8,5 × 17,5 -A3107-T	▨ 8,5 × 17,5 -A4107-T	▨ 10 × 20 -A5107-T	▨ 10 × 25 -A7107-T	▨ 12 × 30 -A8107-T	▨ 16 × 30 -A9107-T
220		▨ 10 × 20 -A3227-T	▨ 10 × 25 -A4227-T	▨ 12 × 30 -A5227-T	▨ 12 × 30 -A7227-T	▨ 16 × 30 -A8227-T	18 × 39,5 -A9227-T
470		▨ 12 × 30 -A3477-T	▨ 12 × 30 -A4477-T	▨ 14 × 30 -A5477-T	▨ 16 × 30 -A7477-T	18 × 39,5 -A8477-T	25 × 40 -A9477-T
1000		▨ 14 × 30 -A3108-T	▨ 16 × 30 -A4108-T	18 × 39,5 -A5108-T	21 × 40 -A7108-T	25 × 40 -A8108-T	
2200		18 × 39,5 -A3228-T	18 × 39,5 -A4228-T	21 × 40 -A5228-T	25 × 40 -A7228-T		
4700		25 × 40 -A3478-T	25 × 40 -A4478-T				

▨ Capacitors available on tape

Example for the compiling of ordering codes

B41590-A8107-T

└── Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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¹) Peak voltage $V_P = 1.15\ V_R$

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,\ max}$ 5 min 20 °C µA	$I_{ac\ max}$[1] 100 Hz 40 °C A	$I_{ac\ max}$[1] 100 Hz 85 °C A	$I_{ac\ R}$[1] 100 Hz 125 °C A	ESL approx. nH
47	10	0,15	2,90	5,60	1,76	5	0,32	0,22	0,08	14
100		0,15	1,40	2,60	0,86	6	0,52	0,36	0,13	17
220		0,15	0,63	1,20	0,42	8	0,96	0,67	0,24	31
470		0,15	0,29	0,56	0,22	13	1,80	1,30	0,45	37
1 000		0,15	0,14	0,26	0,14	24	2,80	1,90	0,69	38
2 200		0,15	0,06	0,12	0,10	48	5,60	3,90	1,40	57
4 700		0,18	0,04	0,07	0,07	98	8,00	5,60	2,00	34
47	16	0,13	2,50	4,80	1,64	6	0,40	0,28	0,10	17
100		0,13	1,20	2,30	0,80	7	0,60	0,42	0,15	17
220		0,13	0,53	1,00	0,40	11	1,10	0,78	0,28	35
470		0,13	0,25	0,48	0,22	19	2,00	1,40	0,49	37
1 000		0,13	0,12	0,23	0,12	36	3,20	2,20	0,80	45
2 200		0,13	0,06	0,10	0,10	74	5,60	3,90	1,40	57
4 700		0,15	0,04	0,06	0,06	154	8,00	5,60	2,00	34
47	25	0,10	2,00	3,70	1,56	6	0,44	0,31	0,11	17
100		0,10	0,95	1,80	0,76	9	0,76	0,53	0,19	31
220		0,10	0,41	0,79	0,38	15	1,50	1,10	0,38	37
470		0,10	0,20	0,37	0,20	27	2,30	1,60	0,58	38
1 000		0,10	0,10	0,18	0,12	54	4,00	2,80	1,00	57
2 200		0,13	0,05	0,10	0,10	114	6,40	4,50	1,60	30
10	40	0,08	7,40	14,00	6,60	5	0,20	0,14	0,05	14
22		0,08	3,40	6,40	3,00	6	0,36	0,25	0,09	17
47		0,08	1,60	3,00	1,44	8	0,52	0,36	0,13	17
100		0,08	0,74	1,40	0,72	12	0,92	0,64	0,23	35
220		0,08	0,34	0,64	0,36	22	1,70	1,20	0,42	37
470		0,08	0,16	0,30	0,20	42	2,80	1,90	0,69	45
1 000		0,09	0,08	0,16	0,12	84	5,20	3,60	1,30	30
2 200		0,10	0,04	0,08	0,08	180	8,00	5,60	2,00	34
4,7	63	0,07	14,00	26,00	13,00	5	0,16	0,11	0,04	14
10		0,07	6,50	12,30	6,20	5	0,24	0,17	0,06	17
22		0,07	2,90	5,60	2,80	7	0,36	0,25	0,09	17
47		0,07	1,40	2,60	1,34	10	0,68	0,48	0,17	35
100		0,07	0,63	1,20	0,66	17	1,20	0,87	0,31	37
220		0,07	0,31	0,56	0,34	32	2,00	1,40	0,50	45
470		0,07	0,14	0,26	0,18	63	3,50	2,50	0,88	57
1 000		0,08	0,08	0,14	0,12	130	5,60	3,90	1,40	34
4,7	100	0,09	18,00	33,60	18,00	5	0,16	0,11	0,04	17
10		0,09	8,30	15,70	8,40	6	0,24	0,17	0,06	17
22		0,09	3,80	7,20	3,90	8	0,40	0,28	0,10	35
47		0,09	1,80	3,40	1,90	13	0,72	0,50	0,18	37
100		0,09	0,79	1,50	0,90	24	1,20	0,87	0,31	45
220		0,09	0,38	0,72	0,50	48	2,20	1,50	0,54	57
470		0,10	0,20	0,38	0,30	98	3,50	2,50	0,88	34

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

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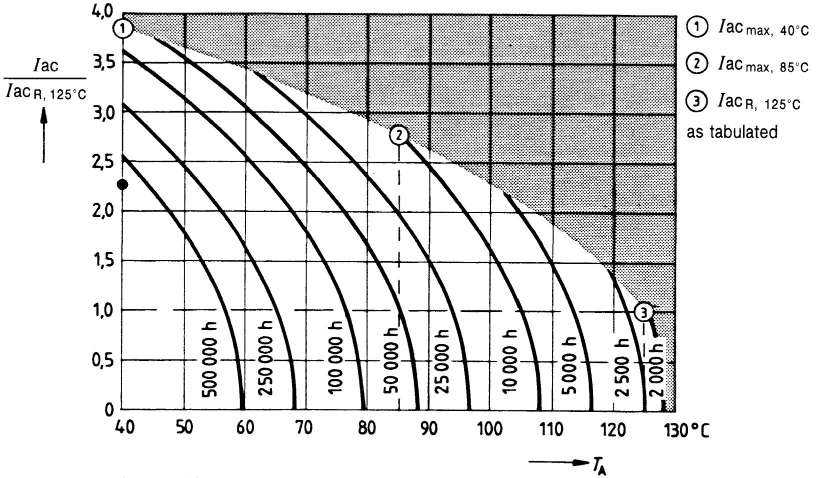
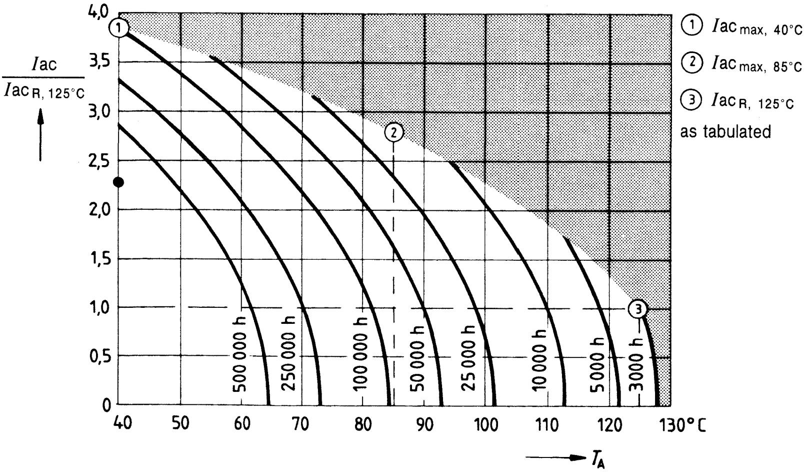
[1] Low-cost version with reduced current handling capability upon request.

Service life[1])
versus ambient temperature T_A at ripple current operation

for ≤ 10 mm dia., 21 mm and 25 mm dia.



for ≥ 12 mm to 18 mm dia.



● $I\mathrm{ac}_R$ at 40 °C = 2.24 · $I\mathrm{ac}_R$ at 125 °C

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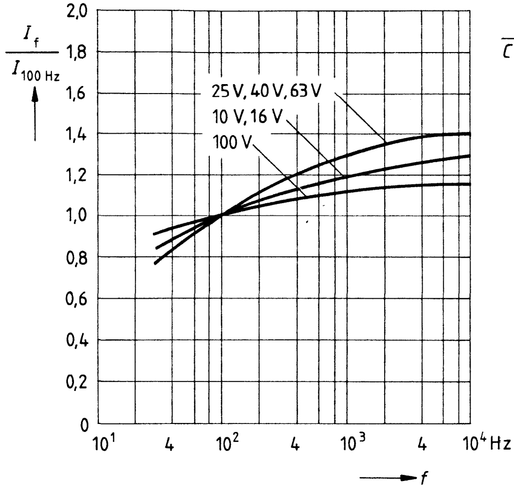
[1]) For details on service life curve refer to page 32.

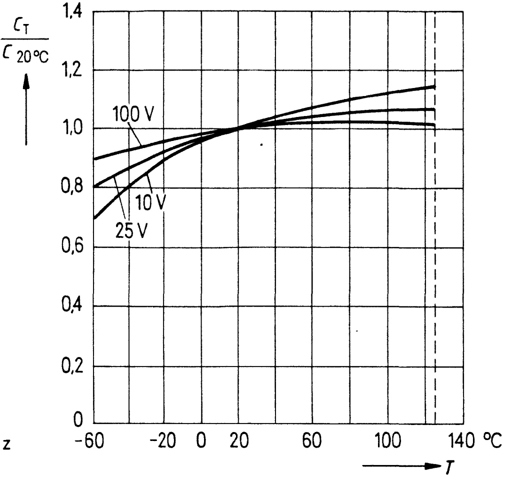
Permissible ripple current I_{ac}

versus frequency f



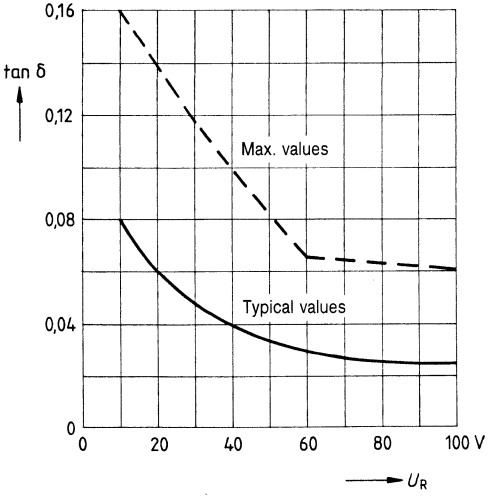
Series capacitance C_s

versus temperature T (f = 100 Hz)
Typical behavior



Dissipation factor tan δ

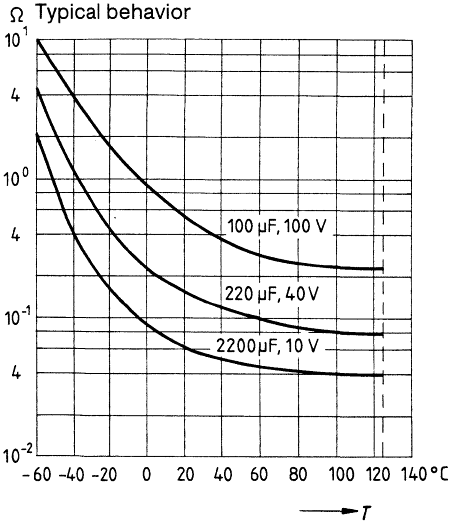
versus rated voltage V_R
(at T = 20 °C and f = 100 Hz)



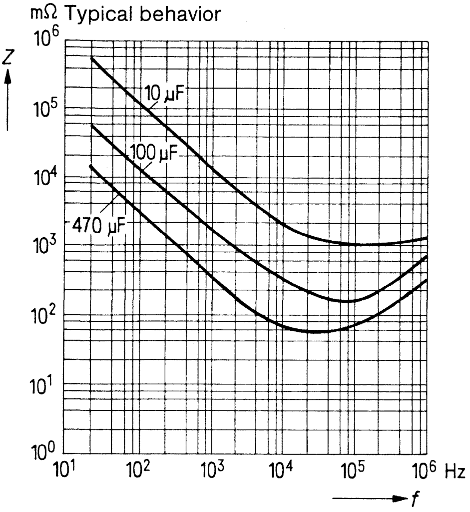
The maximum values are in accordance
with DIN 45910, part 123, and apply to $C_R \leq 1000\ \mu F$.
The values increase by 0.02 per 1000 µF.

Impedance Z

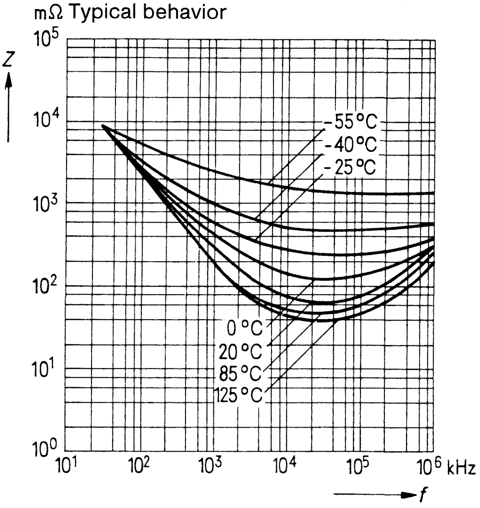
versus temperature T (f = 10 kHz)
Typical behavior



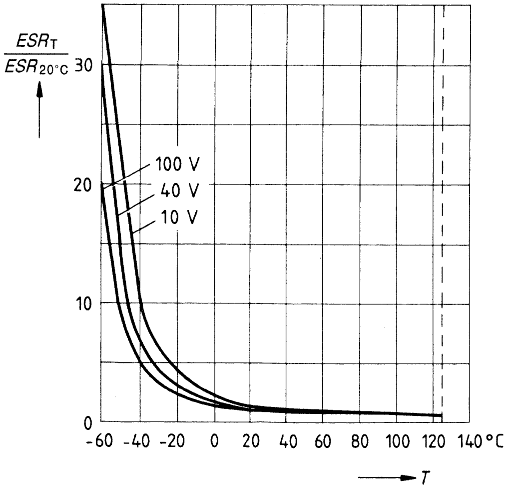
Impedance *Z*
versus frequency *f*
for $V_R = 40$ V, at 20 °C
Typical behavior



Impedance *Z*
versus frequency *f*
and temperature for 470 µF/40 V
Typical behavior



Equivalent series resistance *ESR*
versus temperature *T* (at $f = 100$ Hz)
Typical behavior

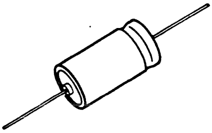


Al Electrolytic Capacitors High-Performance Version

160 to 350 V dc LL Grade

B 43 590

2.2 to 220 μF; 8.5 mm to 25 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Negative pole connected to case
- Axial leads; welded terminal connections ensure reliable contacting

Features

- Outstanding reliability and very long service life
- Wide temperature range
- Excellent electrical data
- High ripple current capability

Application

- High rel equipment in industrial electronics
- Automotive electronics

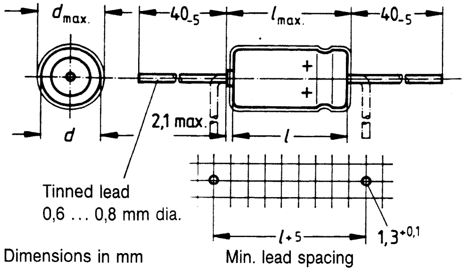
Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41 257
IEC climatic category	40/105/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	− 40 to + 105 °C
Humidity category	D in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	$d_R \leq 10$ mm	$d_R \geq 12$ mm
40 °C; V_R; $I_{\mathrm{ac\,R}}$	> 260 000 h	> 360 000 h
85 °C; V_R; $I_{\mathrm{ac\,max}}$	> 7 500 h	> 10 000 h
105 °C; V_R; $I_{\mathrm{ac\,R}}$	> 3 000 h	> 4 000 h

Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)
Taping	Capacitors with 8.5 mm to 16 mm dia. are also available on tape. For information on tape packaging and ordering code example refer to pages 64 to 66.



Dimensions in mm

Dimensions (mm) $d \times l$ (rated dimensions)	$d_{max} \times l_{max}$ (with insulating sleeve)	Lead dia.	Approx. weight g
8,5 × 17,5	9,0 × 19	0,6	1,8
10 × 20	10,5 × 21,5		2,6
10 × 25	10,5 × 26,5		3,2
12 × 30	12,5 × 32	0,8	5,4
14 × 30	14,5 × 32		7,5
16 × 30	16,5 × 32		9,3
18 × 39,5	18,5 × 41,5		14
25 × 40	25,5 × 41,5		26

Rated voltage V_R¹)		160 V dc	250 V dc	350 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code		
2,2	$^{-10}_{+50}\,\% \mathrel{\hat{=}} \text{T}$		▨ 8,5 × 17,5 -A2225-T	▨ 8,5 × 17,5 -A4225-T
4,7		▨ 8,5 × 17,5 -A1475-T	▨ 10 × 20 -A2475-T	▨ 10 × 25 -A4475-T
10		▨ 10 × 25 -A1106-T	▨ 12 × 30 -A2106-T	▨ 12 × 30 -A4106-T
22		▨ 12 × 30 -A1226-T	▨ 14 × 30 -A2226-T	▨ 16 × 30 -A4226-T
47		▨ 16 × 30 -A1476-T	18 × 39,5 -A2476-T	18 × 39,5 -A4476-T
100		18 × 39,5 -A1107-T	25 × 40 -A2107-T	25 × 40 -A4107-T
220		25 × 40 -A1227-T		

▨ Capacitors available on tape

Example for the compiling of ordering codes

B43590-A1475-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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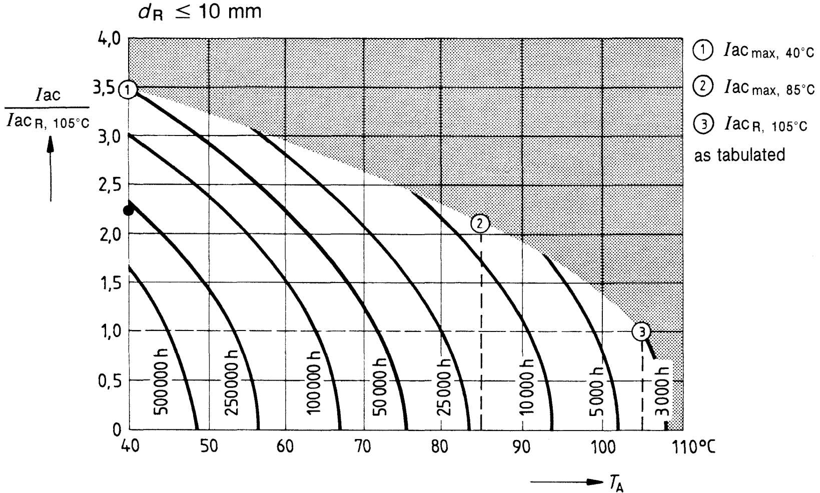
¹) Peak voltage $V_P = 1.15 \cdot V_R$ for 160, 250 V dc; $1.1 \cdot V_R$ for 350 V dc.

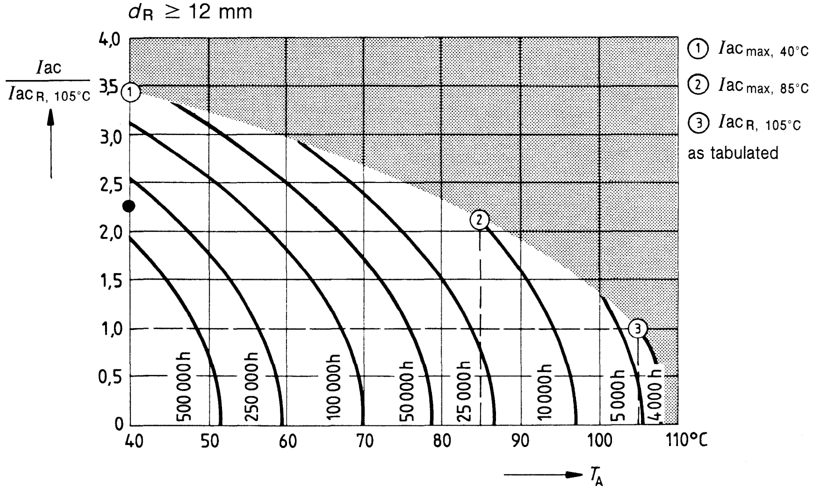
C_R µF	V_R V dc	ESR_typ 100 Hz 20 °C Ω	ESR_max 100 Hz 20 °C Ω	Z_max 10 kHz 20 °C Ω	$I_\mathrm{r\,max}$ 5 min 20 °C µA	$I_\mathrm{ac\,max}$ 100 Hz 40 °C mA	$I_\mathrm{ac\,max}$ 100 Hz 85 °C mA	$I_\mathrm{ac\,R}$ 100 Hz 105 °C mA	ESL approx. nH
4,7	160	14	34	14	6	140	88	42	20
10		6,8	16	6,8	7	260	160	75	30
22		3	7,2	3,1	11	480	290	140	40
47		1,4	3,4	1,5	19	820	500	240	40
100		0,7	1,6	0,71	36	1 400	840	400	60
220		0,3	0,7	0,33	74	2 400	1 500	720	60
2,2	250	25	63	29	5	110	67	32	20
4,7		12	30	13	6	180	110	53	30
10		5	13	6,5	9	370	230	110	40
22		2,5	6,4	2,9	15	540	340	160	40
47		1,2	3,0	1,4	28	1 000	630	300	40
100		0,54	1,4	0,7	54	1 800	1 100	530	60
2,2	350	19	48	28	6	120	76	36	20
4,7		8,5	21	13	7	230	150	69	30
10		4,1	10	6,1	11	400	250	120	40
22		1,9	4,8	2,8	19	680	420	200	40
47		0,85	2,1	1,3	37	1 200	760	360	60
100		0,41	1,0	0,64	74	2 100	1 300	620	60

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

Service life[1])
versus ambient temperature T_A at ripple current operation



● Iac_R at 40 °C = 2.24 · Iac_R at 105 °C



● Iac_R at 40 °C = 2.24 · Iac_R at 105 °C

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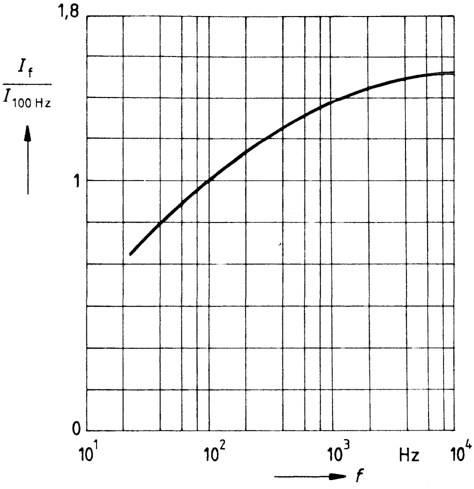
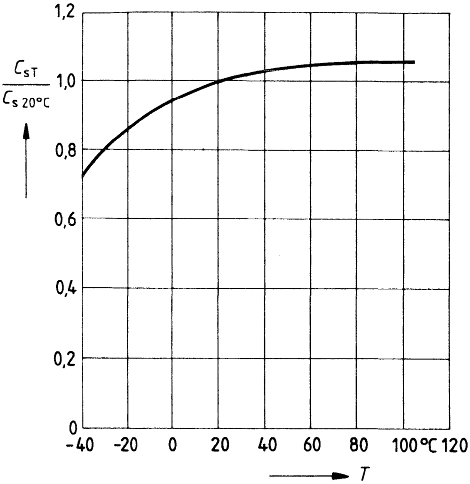
[1]) For details on service life curve refer to page 32.

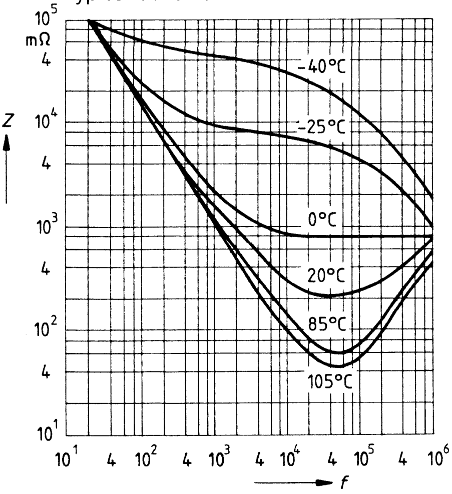
Permissible ripple current Iac
versus frequency f



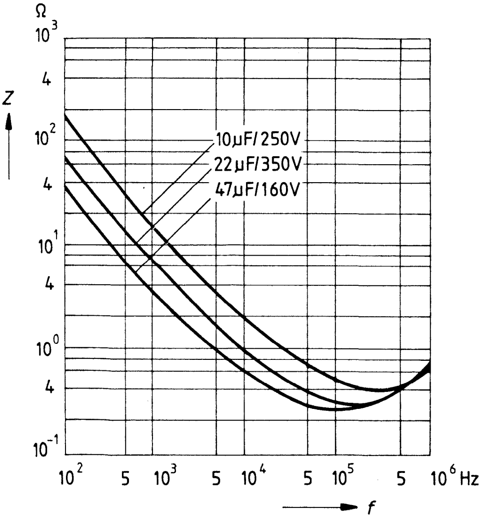
Series capacitance C_s
versus temperature T (f = 100 Hz)
Typical behavior



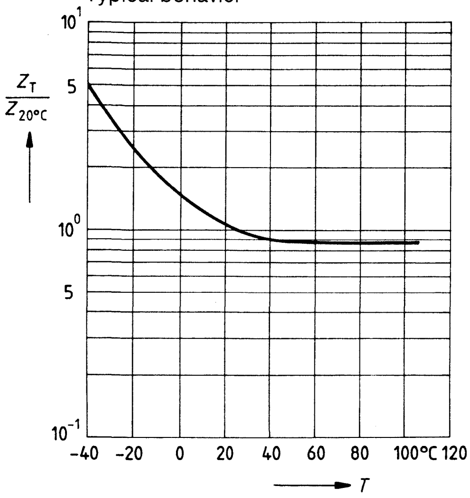
Impedance Z
versus frequency f
and temperature for 100 µF/250 V
Typical behavior



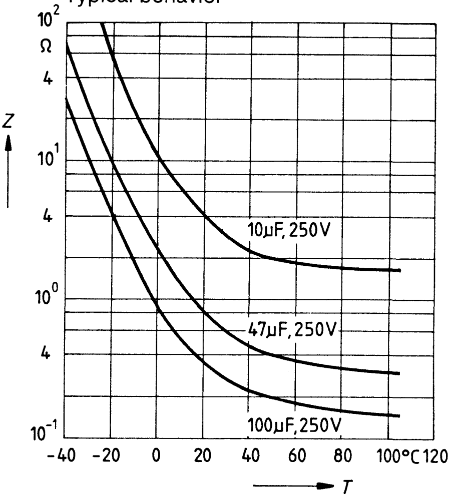
Impedance Z
versus frequency f
Typical behavior at 20 °C



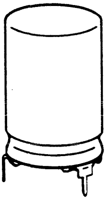
Impedance *Z*
versus temperature *T* (*f* = 100 Hz)
Typical behavior



Impedance *Z*
versus temperature *T* (*f* = 10 kHz)
Typical behavior



47 to 4700 µF; 13.5 mm to 26.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Solder pins; welded mounting socket ensures reliable contacting
- Positive pole brought out central-axially
- Negative pole at the 2 or 3 solder pins of the mounting socket

Features

- Outstanding reliability and very long service life
- Very wide temperature range
- Excellent parametric stability
- High ripple current capability
- Up to 10 years shelf life
- Pinning ensures correct insertion

Application

- High rel equipment in industrial electronics
- Automotive electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41267
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKD (−55 to +125 °C[1]), humidity category D) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	dia. ≤ 12 to 18 mm	dia. 21 mm and 25 mm
40 °C; V_R; $I_{ac\,R}$	> 500000 h	> 500000 h
85 °C; V_R; $I_{ac\,max}$	> 15000 h	> 10000 h
125 °C; V_R; $I_{ac\,R}$	> 3000 h	> 2000 h

Fraction failure	≤ 0.5 % (during service life)
Failure rate	≤ 10 fit (≤ $10 \cdot 10^{-9}$/h)

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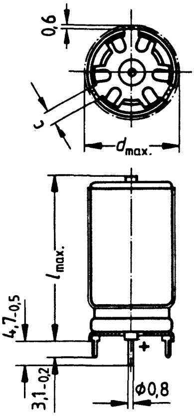
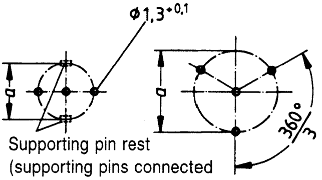
[1]) For ≤ 18 mm dia.: operation at 145 °C and ≤ 0.6 · V_R permissible for 500 h.



Dimensions in mm

Mounting holes

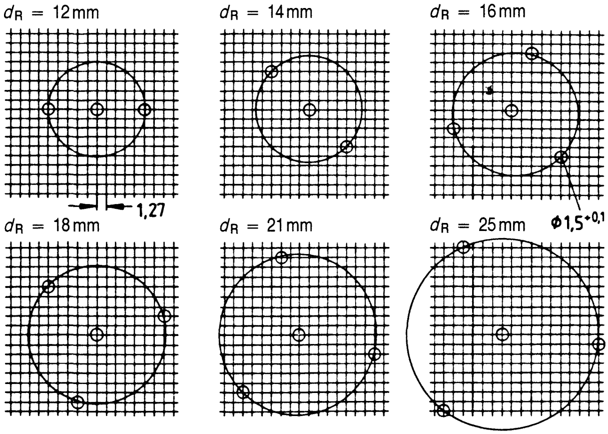
d_R 12 and 14 d_R 16 to 25



Supporting pin rest
(supporting pins connected
to negative pole)

Dimensions (mm) $d_R \times l_R$	$d_{max} \times l_{max}$	$a \pm 0,1$	$c \pm 0,1$	Approx. weight g
12 × 30	13,5 × 33	12,5	3	5,4
14 × 30	15,5 × 33	14,5		7,5
16 × 30	17,5 × 33	16,5		9,3
18 × 39,5	19,5 × 42	18,5		14
21 × 40	22,5 × 42	21,5	3,5	18
25 × 40	26,5 × 42	25,5		26

The PC board mounting holes given above refer to partial circles. However, it is often necessary to arrange the mounting holes in a standard lead spacing, especially for the production of small quantities. Generally, this is achieved with sufficient accuracy at a spacing of 1.27 mm ($^1/_{20}$″) if the positions are chosen as follows:



Rated voltage V_{R}1)		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d_{\text{R}} \times l_{\text{R}}$ Code					
47	$^{-10}_{+50}$ % ≙ T						12 × 30 -A9476-T
100						12 × 30 -A8107-T	16 × 30 -A9107-T
220				12 × 30 -A5227-T	12 × 30 -A7227-T	16 × 30 -A8227-T	18 × 39,5 -A9227-T
470		12 × 30 -A3477-T	12 × 30 -A4477-T	14 × 30 -A5477-T	16 × 30 -A7477-T	18 × 39,5 -A8477-T	25 × 40 -A9477-T
1 000		14 × 30 -A3108-T	16 × 30 -A4108-T	18 × 39,5 -A5108-T	21 × 40 -A7108-T	25 × 40 -A8108-T	
2 200		18 × 39,5 -A3228-T	18 × 39,5 -A4228-T	21 × 40 -A5228-T	25 × 40 -A7228-T		
4 700		25 × 40 -A3478-T	25 × 40 -A4478-T				

Example for the compiling of ordering codes

B41592-A5227-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

C_{R} µF	V_{R} V dc	tan $\delta_{\max}$ 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	$ESR_{\max}$ 100 Hz 20 °C Ω	$Z_{\max}$ 10 kHz 20 °C Ω	$I_{\text{r, max}}$ 5 min 20 °C µA	$I_{\text{ac max}}$ 100 Hz 40 °C A	$I_{\text{ac max}}$ 100 Hz 85 °C A	$I_{\text{ac R}}$ 100 Hz 125 °C A	ESL approx. nH
470	10	0,15	0,29	0,56	0,22	13	1,8	1,3	0,45	23
1 000		0,15	0,14	0,26	0,14	24	2,8	1,9	0,69	37
2 200		0,15	0,06	0,12	0,10	48	5,6	3,9	1,4	37
4 700		0,18	0,04	0,07	0,07	98	8	5,6	2	17
470	16	0,13	0,25	0,48	0,22	19	2	1,4	0,49	23
1 000		0,13	0,12	0,23	0,12	36	3,2	2,2	0,8	37
2 200		0,13	0,06	0,10	0,10	74	5,6	3,9	1,4	37
4 700		0,15	0,04	0,06	0,06	154	8	5,6	2	17
220	25	0,10	0,41	0,79	0,38	15	1,5	1,1	0,38	23
470		0,10	0,20	0,37	0,20	28	2,3	1,6	0,58	37
1 000		0,10	0,10	0,18	0,12	54	4	2,8	1	37
2 200		0,13	0,05	0,10	0,10	114	6,4	4,5	1,6	17

cont'd on page 116

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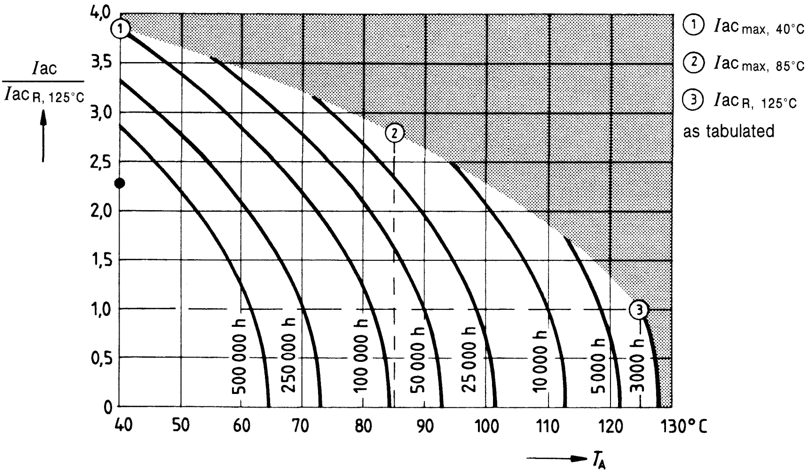
1) Peak voltage $V_{\text{p}} = 1.15\ V_{\text{R}}$

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r, max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,max}$ 100 Hz 85 °C A	$I_{ac\,R}$ 100 Hz 125 °C A	ESL approx. nH
220	40	0,08	0,34	0,64	0,36	22	1,7	1,2	0,42	23
470		0,08	0,16	0,30	0,20	42	2,8	1,9	0,69	37
1000		0,09	0,08	0,16	0,12	84	5,2	3,6	1,3	17
2200		0,10	0,04	0,08	0,08	180	8	5,6	2	17
100	63	0,07	0,63	1,20	0,66	17	1,2	0,87	0,31	23
220		0,07	0,31	0,56	0,34	32	2	1,4	0,5	37
470		0,07	0,14	0,26	0,18	63	3,5	2,5	0,88	37
1000		0,08	0,08	0,14	0,12	130	5,6	3,9	1,4	17
47	100	0,09	1,8	3,40	1,90	13	0,72	0,5	0,18	23
100		0,09	0,79	1,50	0,90	24	1,2	0,87	0,31	37
220		0,09	0,38	0,72	0,50	48	2,2	1,5	0,54	37
470		0,10	0,20	0,38	0,30	98	3,5	2,5	0,88	17

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuos operation may only lie within the range between rated voltage and −2 V.

Service life1)
versus ambient temperature T_A at ripple current operation

d_R = 12 mm to 18 mm

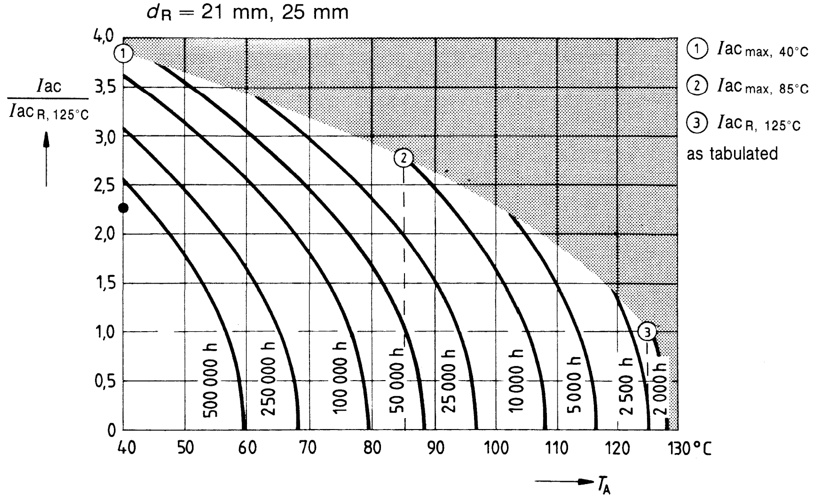


● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 125 °C

---

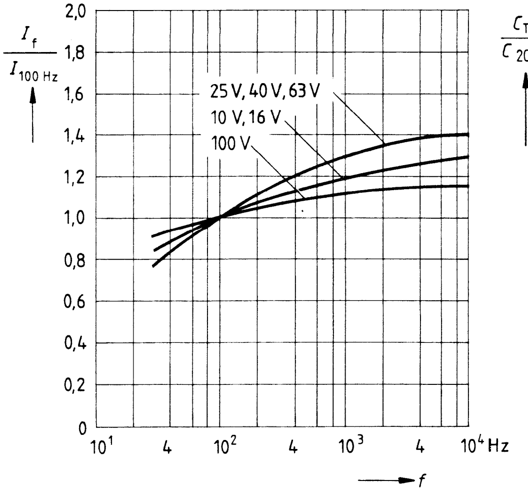
1) For details on service life curve refer to page 32.

Service life[1])
versus ambient temperature T_A at ripple current operation

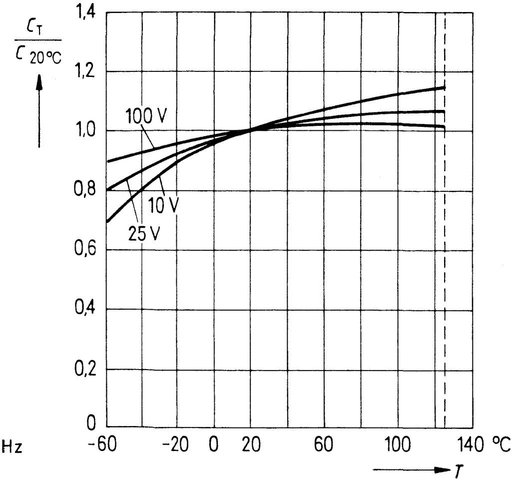


● $I\text{ac}_R$ at 40 °C = 2.24 · $I\text{ac}_R$ at 125 °C

Permissible ripple current Iac
versus frequency f



Series capacitance C_S
versus temperature T (f = 100 Hz)
Typical behavior



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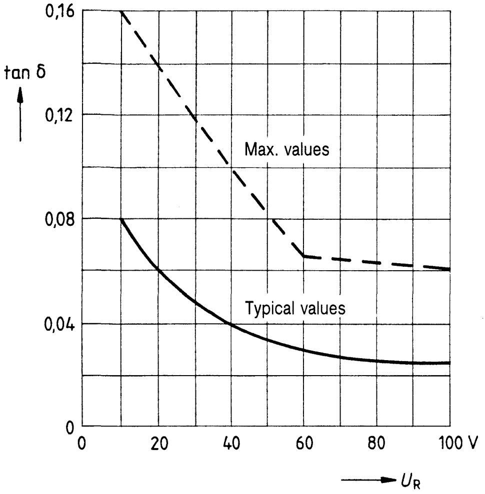
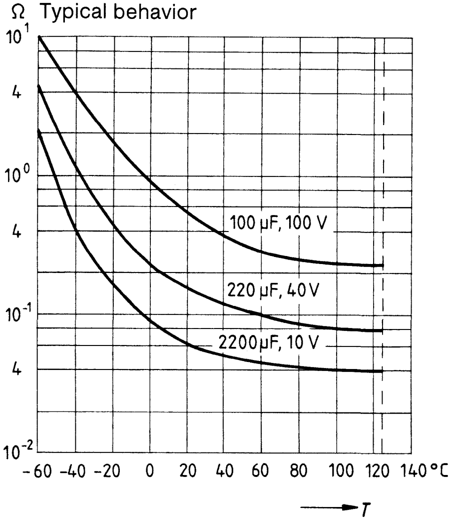
[1]) For details on service life curve refer to page 32.

Dissipation factor tan δ
versus rated voltage V_R
(at $T = 20°C$ and $f = 100$ Hz)

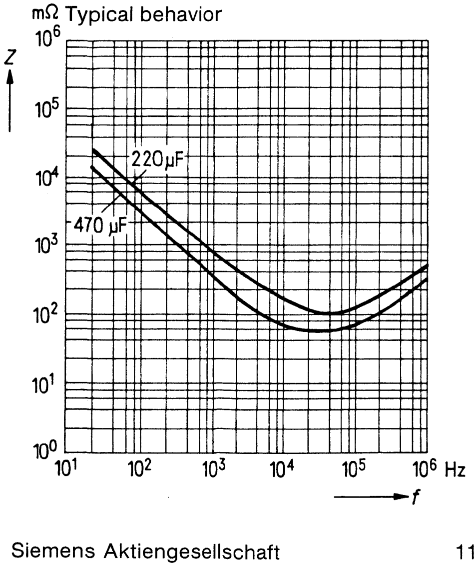


The maximum values are in accordance
with DIN 45910, part 123 and apply to $C_R \leq 1000$ µF.
The values increase by 0.02 per 1000 µF.

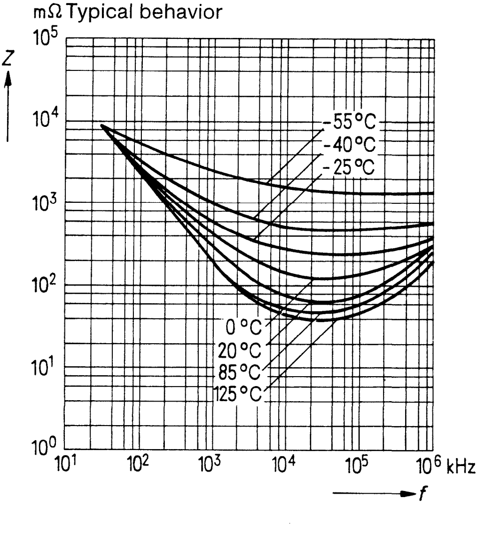
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior



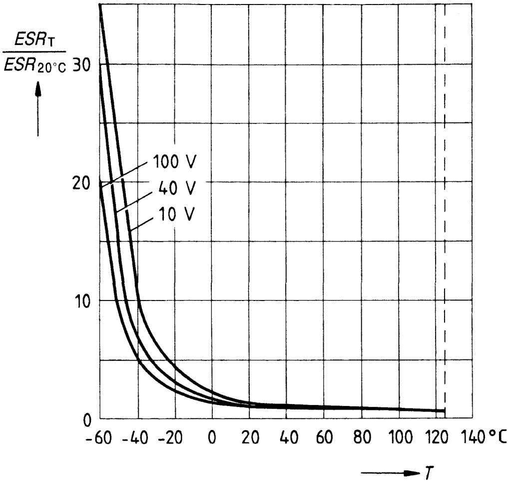
Impedance Z
versus frequency f
for $V_R = 40$ V, at 20 °C
Typical behavior



Impedance Z
versus frequency f
and temperature for 470 µF/40 V
Typical behavior

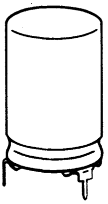


Equivalent series resistance *ESR*
versus temperature T (at $f = 100$ Hz)
Typical behavior



Al Electrolytic Capacitors High-Performance Version
160 to 350 V dc LL Grade
B 43 592

10 to 220 µF; 12 mm to 25 mm dia.



Construction

- Surge-proof electrolytic capacitor in tubular aluminum case with insulating sleeve
- Solder pins; welded mounting socket ensures reliable contacting
- Positive pole brought out central-axially
- Negative pole at the 2 or 3 solder pins of the mounting socket

Features

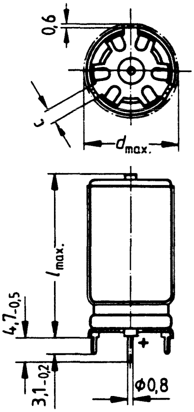
- High reliability and long service life
- Wide temperature range
- Excellent electrical data
- High ripple current capability
- Pinning ensures correct insertion
- High vibration resistance

Application

- High rel equipment in industrial electronics
- Automotive electronics

Specifications and characteristics in brief

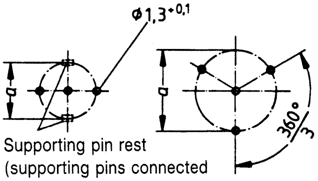
Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41 257
IEC climatic category	40/105/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	−40 to +105 °C
Humidity category	D in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h
Service life	40 °C; V_R; $I_{ac\,R}$: > 360 000 h 85 °C; V_R; $I_{ac\,max}$: > 10 000 h 105 °C; V_R; $I_{ac\,R}$: > 4 000 h
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)



Dimensions in mm

Mounting holes

d_R 12 and 14 d_R 16 to 25

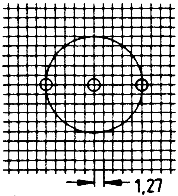


Supporting pin rest
(supporting pins connected
to negative pole)

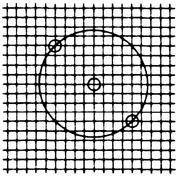
Dimensions (mm) $d_R \times l_R$	$d_{max} \times l_{max}$	$a \pm 0,1$	$c \pm 0,1$	Approx. weight g
12 × 30	13,5 × 33	12,5	3	5,4
14 × 30	15,5 × 33	14,5		7,5
16 × 30	17,5 × 33	16,5		9,3
18 × 39,5	19,5 × 42	18,5		14
25 × 40	26,5 × 42	25,5	3,5	26

The PC board mounting holes given above refer to partial circles. However, it is often necessary to arrange the mounting holes in a standard lead spacing, especially for the production of small quantities. Generally, this is achieved with sufficient accuracy at a spacing of 1.27 mm ($^1/_{20}''$) if the positions are chosen as follows:

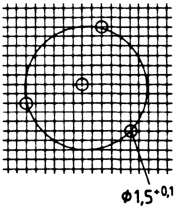
d_R = 12mm



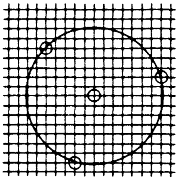
d_R = 14mm



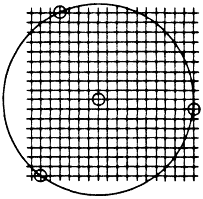
d_R = 16mm



d_R = 18mm



d_R = 25mm



Rated voltage V_{R}1)		160 V dc	250 V dc	350 V dc
Rated capacitance		Rated dimensions $d_{\mathrm{R}} \times l_{\mathrm{R}}$ Code		
µF	Tolerance			
10	$^{-10}_{+50}$ % ≙ T		12 × 30 -A2106-T	12 × 30 -A4106-T
22		12 × 30 -A1226-T	14 × 30 -A2226-T	16 × 30 -A4226-T
47		16 × 30 -A1476-T	18 × 39,5 -A2476-T	18 × 39,5 -A4476-T
100		18 × 39,5 -A1107-T	25 × 40 -A2107-T	25 × 40 -A4107-T
220		25 × 40 -A1227-T		

Example for the compiling of ordering codes

B43592-A1476-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

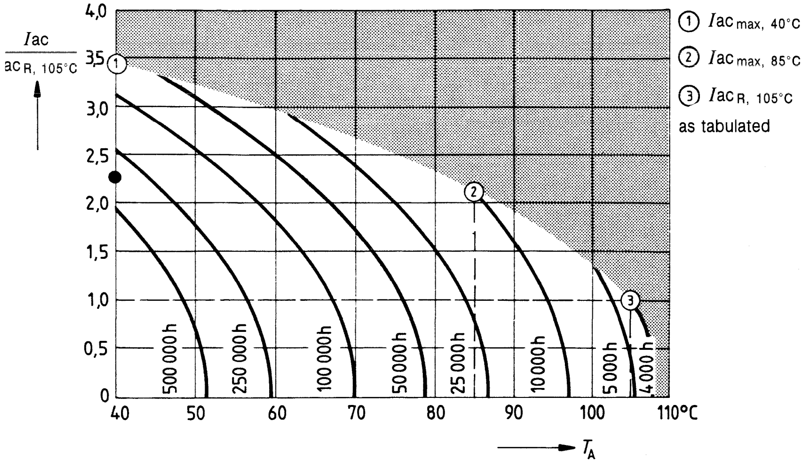
C_{R} µF	V_{R} V dc	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{\mathrm{r,\,max}}$ 5 min 20 °C µA	$I_{\mathrm{ac\,max}}$ 100 Hz 40 °C mA	$I_{\mathrm{ac\,max}}$ 100 Hz 85 °C mA	$I_{\mathrm{ac\,R}}$ 100 Hz 105 °C mA	ESL approx. nH
22	160	3	7,2	3,1	11	480	290	140	20
47		1,4	3,4	1,5	19	820	500	240	40
100		0,7	1,6	0,71	36	1400	840	400	40
220		0,3	0,7	0,33	74	2400	1500	720	20
10	250	5	13	6,5	9	370	230	110	20
22		2,5	6,4	2,9	15	540	340	160	40
47		1,2	3,0	1,4	28	1000	630	300	40
100		0,54	1,4	0,7	54	1800	1100	530	20
10	350	4,1	10	6,1	11	400	250	120	20
22		1,9	4,8	2,8	19	680	420	200	40
47		0,85	2,1	1,3	37	1200	760	360	40
100		0,41	1,0	0,64	74	2100	1300	620	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

---

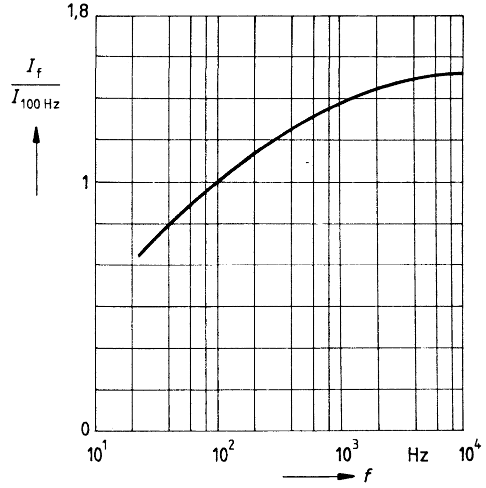
1) Peak voltage $V_{\mathrm{P}} = 1.15 \cdot V_{\mathrm{R}}$ for 160, 250 V dc; $1.1 \cdot V_{\mathrm{R}}$ for 350 V dc.

Service life[1]**)**
versus ambient temperature T_A at ripple current operation

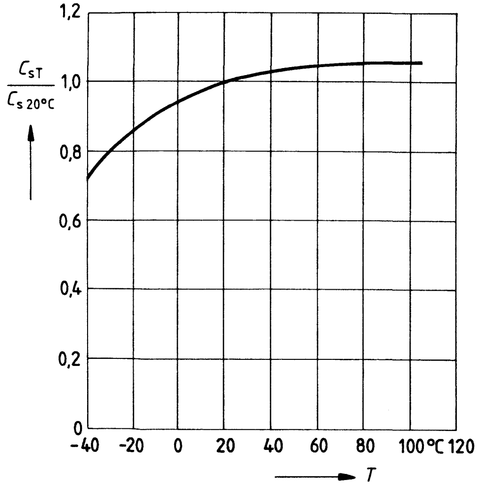


● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 105 °C

Permissible ripple current I_{ac}
versus frequency f



Series capacitance C_S
versus temperature T ($f = 100$ Hz)
Typical behavior



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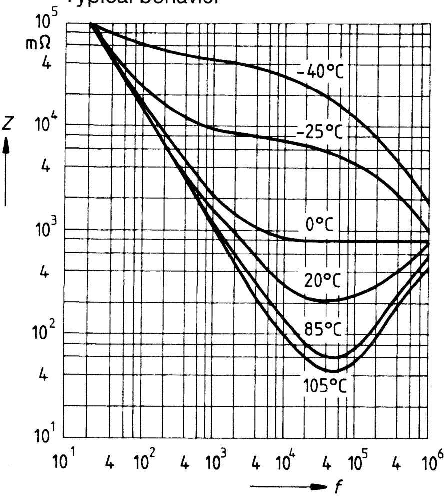
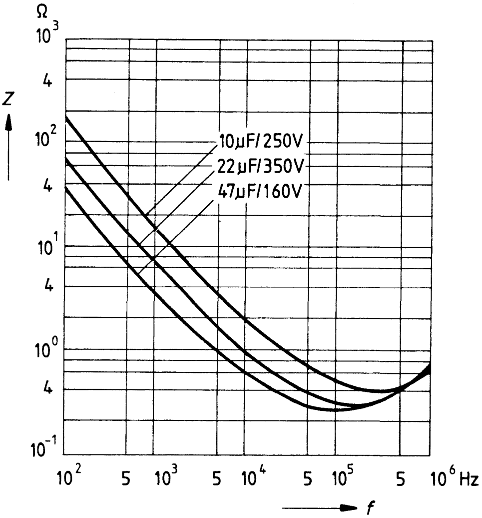
[1]) For details on service life curve refer to page 32.

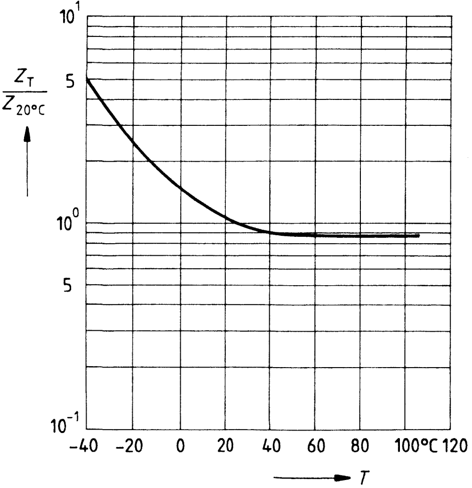
Impedance *Z*
versus frequency *f*
and temperature for 100 µF/250 V
Typical behavior



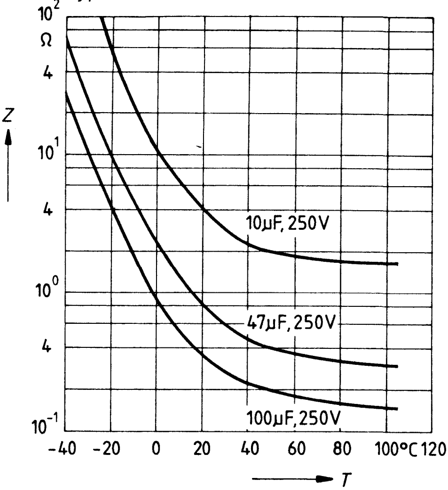
Impedance *Z*
versus frequency *f*
Typical values at 20 °C



Impedance *Z*
versus temperature *T* (*f* = 100 Hz)
Typical behavior



Impedance *Z*
versus temperature *T* (*f* = 10 kHz)
Typical behavior



Aluminum Electrolytic Capacitors

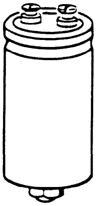
Can-Type Capacitors, LL and GP Grade

Al Electrolytic Capacitors 16 to 400 V dc LL Grade

B 41 564
B 43 564
B 41 584
B 43 584

220 to 220 000 µF; 35.7 mm to 76.9 mm dia.

B 41 564
B 43 564



B 41 584
B 43 584

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Poles brought out to M 5 screw terminals, with 76.9 mm dia. to M 6 screw terminals
- Mounting with ring clips (B 41 564, B 43 564) or with threaded stud (B 41 584, B 43 584)

Features

- High reliability (Long Life Grade)
- Excellent electrical data at small dimensions
- High ripple current capability

Application

- In industrial electronics
- Professional switch-mode power supplies

Accessories

- Included in delivery (loosely):
  for 35.7 to 64.3 dia.: cylindrical screws M 5 × 8 DIN 84-4.8;
  toothed washers A5.1 DIN 6797
  for 76.9 dia.: cylindrical screws M 6 × 12 DIN 85-4.8;
  toothed washers A6.4 DIN 6797
- Not included in delivery:
  ring clips B 44 030, page 263 (for type B 41 564, B 43 564)
  insulating parts B 44 020, page 260 (for type B 41 584, B 43 584)

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 248
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (– 40 to + 85 °C, humidity category F[1])) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

	Operating conditions	B 41 564; B 41 584	B 43 564; B 43 584
Service life	40 °C; V_R; $I_{ac\,R}$ 85 °C; V_R; $I_{ac\,R}$	> 180 000 h > 8 000 h	> 130 000 h > 6 000 h
Fraction failure	(during service life)	≤ 0.5 %	≤ 1 %
Failure rate		≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)	≤ 40 fit ($\leq 40 \cdot 10^{-9}$/h)

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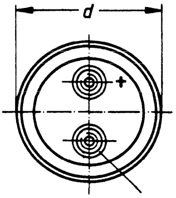
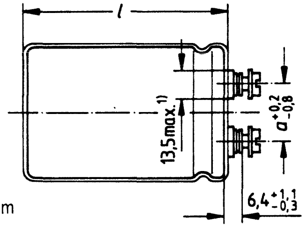
[1]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.

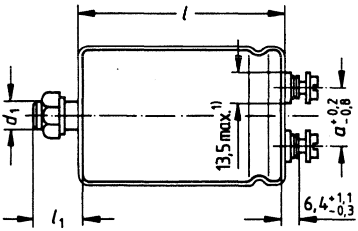
Types B 41 564, B 43 564



M5: Min. reach of screw: 8 mm
M6: Min. reach of screw: 12 mm



Types B 41 584, B 43 584



Dimensions in mm

Marking of positive pole: +

Dimensions (mm)					Approx.
$d_{\max} \times l_{\max}$ (with insulating sleeve)	$d_{\min} \times l_{\min}$ (with insulating sleeve)	d_1	l_{1-1}	Dimension a	weight g
35,7 × 56,7	34,9 × 53,5	M8	13	12,7	65
35,7 × 82,1	34,9 × 78,9	M8	13	12,7	105
35,7 × 107,5	34,9 × 104,3	M8	13	12,7	135
51,6 × 82,1	50,8 × 78,9	M12	17	22,2	220
51,6 × 107,5	50,8 × 104,3	M12	17	22,2	280
64,3 × 107,5	63,5 × 104,3	M12	17	28,5	440
76,9 × 107,5	76,2 × 104,3	M12	17	31,7	540
76,9 × 145,6	76,2 × 142,4	M12	17	31,7	840
76,9 × 221,8	76,2 × 218,6	M12	17	31,7	1 300

---

[1] Max. 17.7 mm with reinforced screw terminals M6

Low-voltage series

Rated voltage V_R¹)		16 V dc	25 V dc	40 V dc	63 V dc	
Rated capacitance µF	Tolerance	Dimensions $d_{max} \times l_{max}$ and code **B 41 564- and B 41 584-**				
220						
470						
1 000						
1 500						
2 200					35,7 × 56,7 -A8228-Q ◥	
3 300						
4 700			35,7 × 56,7 -A5478-Q	35,7 × 82,1 -A7478-Q ◥	35,7 × 107,5 -A8478-Q ◥	
6 800					51,6 × 82,1 -A8688-Q	
10 000	$^{-10}_{+30}$ % ≙ Q	35,7 × 56,7 -A4109-Q ◥	35,7 × 82,1 -A5109-Q	35,7 × 107,5 -A7109-Q ◥	51,6 × 82,1 -B8109-Q ◥	
15 000		35,7 × 82,1 -A4159-Q	35,7 × 107,5 -A5159-Q	51,6 × 82,1 -A7159-Q	51,6 × 107,5 -J8159-Q	
22 000		35,7 × 82,1 -B4229-Q ◥	51,6 × 82,1 -A5229-Q	51,6 × 107,5 -A7229-Q ◥	64,3 × 107,5 -J8229-Q ◥	
33 000		35,7 × 107,5 -J4339-Q	51,6 × 82,1 -B5339-Q	64,3 × 107,5 -A7339-Q	76,9 × 107,5 -B8339-Q	
47 000		51,6 × 82,1 -B4479-Q	64,3 × 107,5 -A5479-Q ◥	76,9 × 107,5 -B7479-Q ◥	76,9 × 145,6 -B8479-Q	
68 000		51,6 × 107,5 -J4689-Q	64,3 × 107,5 -J5689-Q	76,9 × 145,6 -B7689-Q	76,9 × 221,8³) -B8689-Q	
100 000		64,3 × 107,5 -J4100-Q	76,9 × 107,5 -B5100-Q	76,9 × 221,8³) -B7100-Q		
150 000		76,9 × 107,5 -B4150-Q	76,9 × 145,6 -B5150-Q			
220 000		76,9 × 145,6 -B4220-Q				

		High-voltage series			
	100 V dc	160 V dc	250 V dc	350 V dc	400 V dc[2]
		Dimensions $d_{max} \times l_{max}$ and code **B 43 564- and B 43 584-**			
				35,7 × 82,1 -A4227-Q	35,7 × 82,1 -E227-Q
		35,7 × 56,7 -A1477-Q	35,7 × 82,1 -A2477-Q	51,6 × 82,1 -A4477-Q	51,6 × 82,1 -E477-Q
	35,7 × 56,7 -A9108-Q ◥	35,7 × 82,1 -B1108-Q	51,6 × 82,1 -A2108-Q	51,6 × 107,5 -A4108-Q	51,6 × 107,5 -E108-Q
		35,7 × 107,5 -J1158-Q	51,6 × 107,5 -A2158-Q	64,3 × 107,5 -A4158-Q	64,3 × 107,5 -E158-Q
	35,7 × 82,1 -A9228-Q ◥	51,6 × 82,1 -B1228-Q	64,3 × 107,5 -A2228-Q	64,3 × 107,5 -J4228-Q	76,9 × 107,5 -E228-Q
	51,6 × 82,1 -A9338-Q	51,6 × 107,5 -J1338-Q	64,3 × 107,5 -J2338-Q	76,9 × 107,5 -B4338-Q	76,9 × 145,6 -E338-Q
	51,6 × 107,5 -A9478-Q ◥	64,3 × 107,5 -J1478-Q	76,9 × 107,5 -B2478-Q	76,9 × 145,6 -B4478-Q	76,9 × 221,8[3] -E478-Q
	64,3 × 107,5 -A9688-Q	76,9 × 107,5 -B1688-Q	76,9 × 145,6 -B2688-Q	76,9 × 221,8[3][4] -S4608-Q5	76,9 × 221,8[3][4] -T608-Q1
	64,3 × 107,5 -A9109-Q ◥	76,9 × 145,6 -B1109-Q			
	76,9 × 145,6 -B9159-Q	76,9 × 221,8[3] -B1159-Q			
	76,9 × 145,6 -B9229-Q				
	76,9 × 221,8[3] -B9339-Q				

Example for the compiling of ordering codes

for ring clip mounting	for threaded stud mounting
B41564-B8479-Q	B41584-B8479-Q

Code according to table — Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

◥ These capacitors are preferred types S (refer to page 4).

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[1] Peak voltage $V_p = 1.15 \cdot V_R$ for 16 to 250 V dc; $1.1 \cdot V_R$ for 350 and 400 V dc

[2] 385 V versions available upon request

[3] Only for ring clip mounting

[4] Special version, supplied with $C_R = 6000$ µF

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$ 1) 100 Hz 40 °C A	$I_{ac\,R}$ 1) 100 Hz 85 °C A	$I_{ac\,max}$ 1) 100 Hz 85 °C A	ESL approx. nH
◥ 10 000	16	27	42	40	0,32	9,9	3,4	5,4	20
15 000		20	32	32	0,48	13	4,4	7,0	20
◥ 22 000		17	26	26	0,71	14	4,8	7,7	20
33 000		14	21	23	1,1	17	5,8	9,3	20
47 000		12	18	20	1,5	18	6,3	10	20
68 000		11	16	19	2,2	21	7,2	12	20
100 000		10	15	18	3,2	24	8,4	13	20
150 000		9	14	17	4,0	26	9,0	14	20
220 000		9	13	15	4,0	29	10	16	20
4 700	25	35	65	60	0,24	9	3,0	5	20
10 000		21	37	36	0,50	13	4,3	7,2	20
15 000		16	29	29	0,75	16	5,4	8,6	20
22 000		13	23	25	1,1	18	6,1	9,8	20
33 000		11	20	21	1,7	19	6,6	11	20
◥ 47 000		10	17	19	2,4	24	8,4	13	20
68 000		10	16	18	3,4	24	8,4	13	20
100 000		9	15	17	4,0	26	9,0	14	20
150 000		9	14	15	4,0	29	10	16	20
◥ 4 700	40	30	57	51	0,38	11	3,5	6,1	20
◥ 10 000		18	33	32	0,80	16	5,1	9,0	20
15 000		14	26	26	1,2	17	5,8	9,3	20
◥ 22 000		10	22	23	1,8	22	7,6	12	20
33 000		9	18	20	2,6	26	8,9	14	20
◥ 47 000		8	17	19	3,8	28	9,5	15	20
68 000		7	15	18	4,0	35	12	19	20
100 000		7	13	18	4,0	41	14	22	20
◥ 2 200	63	44	92	83	0,28	7,8	2,7	4,3	20
◥ 4 700		24	49	47	0,60	13	4,4	7,0	20
6 800		18	38	37	0,86	15	5,1	8,2	20
◥ 10 000		14	30	30	1,3	17	5,8	9,3	20
15 000		12	24	25	1,9	20	6,9	11	20
◥ 22 000		10	20	22	2,8	24	8,4	13	20
33 000		9	17	20	4,0	26	9,0	14	20
47 000		8	16	18	4,0	32	11	18	20
68 000		7	15	18	4,0	41	14	22	20
◥ 1 000	100	51	128	115	0,20	7,3	2,5	4,0	20
◥ 2 200		27	68	61	0,44	11	3,8	6,1	20
3 300		20	50	45	0,66	14	4,9	7,8	20
◥ 4 700		16	40	39	0,94	17	6,0	9,6	20
6 800		13	33	33	1,4	21	7,4	12	20
◥ 10 000		11	27	27	2,0	23	8,0	16	20
15 000		10	22	23	3,0	28	9,6	15	20
22 000		9	18	20	4,0	29	10	16	20
33 000		8	16	18	4,0	38	13	21	20

◥ These capacitors are preferred types **S** (refer to page 4).

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r, max}$ 5 min 20 °C mA	$I_{ac\,max}$ 1) 100 Hz 40 °C A	$I_{ac\,R}$ 1) 100 Hz 85 °C A	$I_{ac\,max}$ 1) 100 Hz 85 °C A	ESL approx. nH
470	160	89	220	200	0,15	5,5	1,9	3,9	20
1 000		45	110	100	0,32	8,4	2,9	4,6	20
1 500		32	80	72	0,48	11	3,8	6,1	20
2 200		24	60	55	0,71	13	4,5	7,2	20
3 300		18	45	42	1,1	16	5,6	9,0	20
4 700		14	35	33	1,5	21	7,1	11	20
6 800		12	30	30	2,2	23	7,8	12	20
10 000		10	24	24	3,2	28	9,6	15	20
15 000		9	20	20	4,0	35	12	19	20
470	250	74	190	170	0,24	6,7	2,3	3,7	20
1 000		37	93	84	0,50	10	3,6	5,8	20
1 500		26	65	59	0,75	14	4,7	7,5	20
2 200		19	48	46	1,1	18	6,1	9,8	20
3 300		14	35	33	1,7	21	7,1	11	20
4 700		11	28	28	2,4	23	8,1	13	20
6 800		9	23	23	3,4	29	10	16	20
220	350	140	350	300	0,16	4,9	1,7	2,7	20
470		68	170	150	0,35	7,5	2,6	4,2	20
1 000		34	85	76	0,70	12	4,1	6,6	20
1 500		24	54	54	1,1	16	5,4	8,6	20
2 200		18	45	41	1,5	18	6,3	10	20
3 300		13	33	32	2,3	22	7,5	12	20
4 700		10	25	25	3,3	28	9,6	15	20
6 000		9	21	21	4,0	35	12	19	20
220	400	170	420	360	0,18	4,4	1,5		20
470		82	200	180	0,38	7,0	2,4		20
1 000		41	100	90	0,80	11	3,7		20
1 500		29	72	65	1,2	15	5,0		20
2 200		22	55	49	1,8	17	5,7		20
3 300		16	40	38	2,6	22	7,6		20
4 700		12	30	30	3,8	29	10		20
6 000		11	28	28	4,8	32	11		20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

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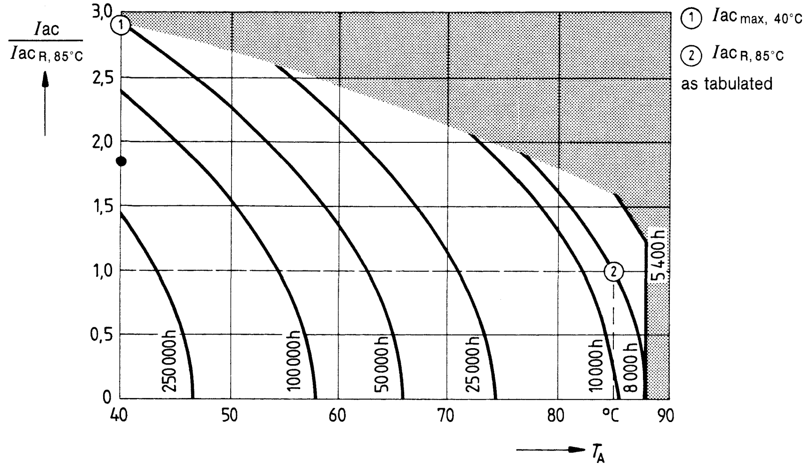
1) The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm: 50 A

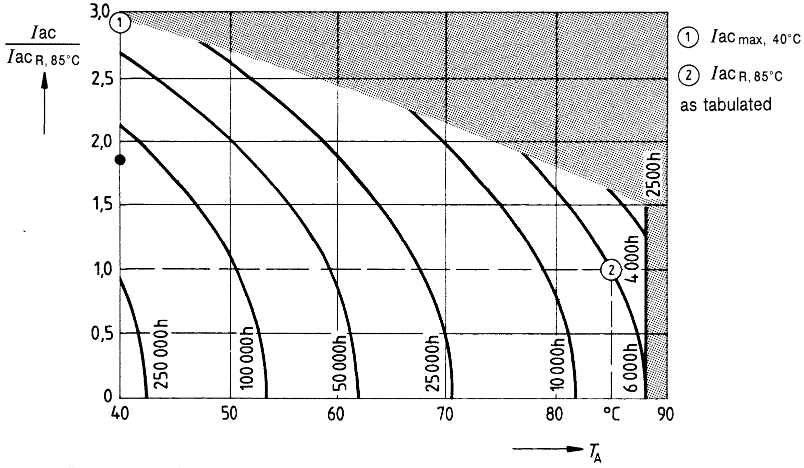
Service life[1])
versus ambient temperature T_A at ripple current operation

Low-voltage series B 41 564 and B 41 584



- ● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

High-voltage series 160 V dc to 350 V dc (B 43 564 and B 43 584)



- ● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

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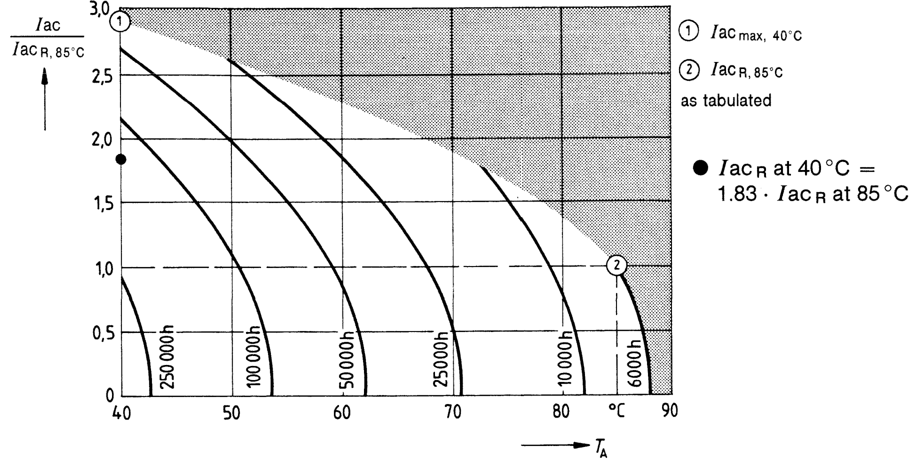
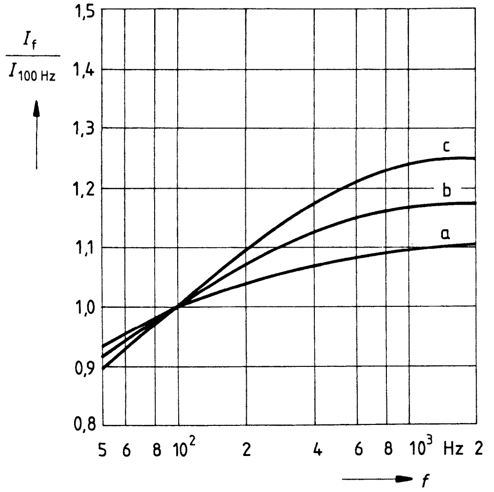
[1]) For details on service life curve refer to page 32.

Service life1)

versus ambient temperature T_A at ripple current operation
High-voltage series > 350 V dc (B 43 564 and B 43 584)

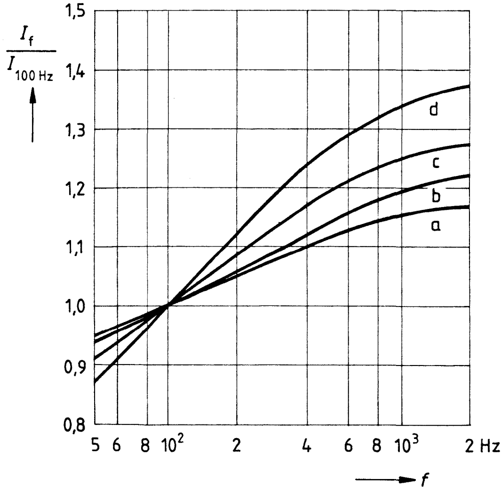


Permissible ripple current I_{ac}
versus frequency f
$V_R \leq 100$ V



V_R (V dc)	16	25; 40	63	100
$d_{max} = 35{,}7$	a	a	b	c
$d_{max} \geq 51{,}6$	a	a	a	a

Permissible ripple current I_{ac}
versus frequency f
$V_R \geq 160$ V



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

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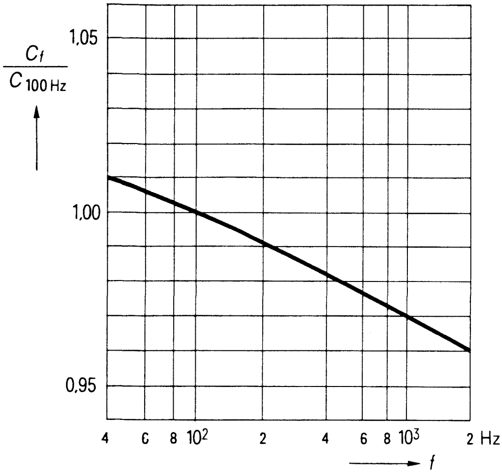
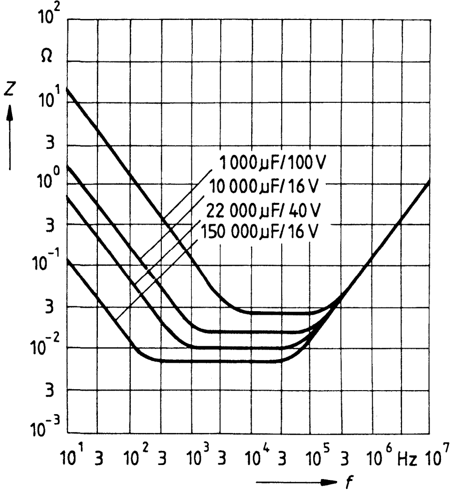
1) For details on service life curve refer to page 32.

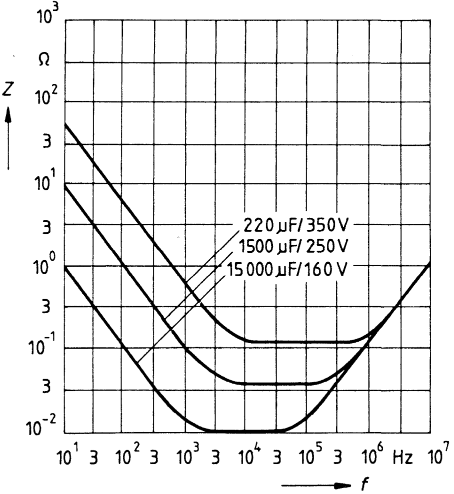
Capacitance *C*
versus frequency *f*
Typical behavior



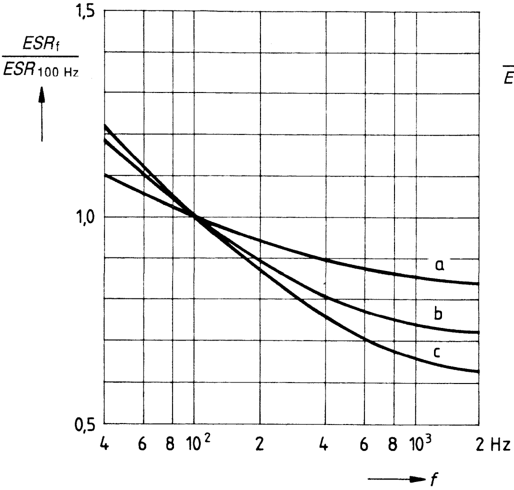
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 160$ V

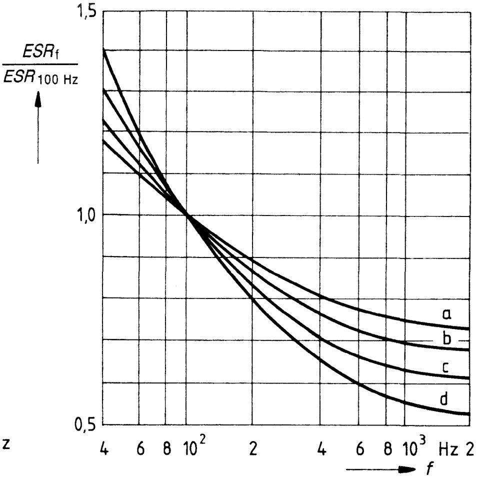


Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



V_R (V)	16	25; 40	63	100
$d_{max} = 35{,}7$	a	a	b	c
$d_{max} \geq 51{,}6$	a	a	a	a

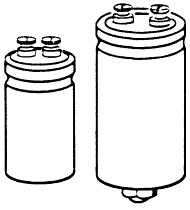
Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \geq 160$ V



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

Al Electrolytic Capacitors 16 to 400 V dc GP Grade B 41455 B 43455 B 41457 B 43457

220 to 150000 µF; 35.7 mm to 76.9 mm dia.



B 41455 B 41457
B 43455 B 43457

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Poles brought out to M5 screw terminals, with 76.9 mm dia. to M6 screw terminals
- Mounting with ring clips (B 41455, B 43455) or with threaded stud (B 41457, B 43457)

Features

- Very small size, i.e. high CV product
- All-welded construction ensures reliable contacting
- High reliability and ripple current capability

Application

- Professional power supplies
- Switch-mode power supplies in industrial electronics

Accessories

- Included in delivery (loosely):
  for 35.7 to 64.3 dia.: cylindrical screws M5 × 8 DIN 84-4.8;
  toothed washers A5.1 DIN 6797
  for 76.9 dia.: cylindrical screws M6 × 12 DIN 85-4.8;
  toothed washers A6.4 DIN 6797
- Not included in delivery:
  ring clips B 44030, page 263 (for type B 41455, B 43455)
  insulating parts B 44020, page 260 (for type B 41457, B 43457)

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4[1]) DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	DIN 41250
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C, humidity category F[2])) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

	Operating conditions	B 41455; B 41457	B 43455; B 43457
Service life	40 °C; V_R; I_{acR} 85 °C; V_R; I_{acR}	> 110000 h > 5000 h	> 70000 h > 3000 h
Fraction failure	≤ 1 % (during service life)		
Failure rate		≤ 40 fit (≤ 40 · 10^{-9}/h)	≤ 100 fit (≤ 100 · 10^{-9}/h)

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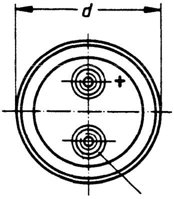
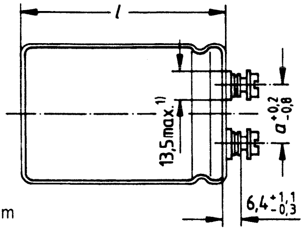
[1]) These capacitors comply with the test requirements for Long Life Grade (LL).

[2]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.

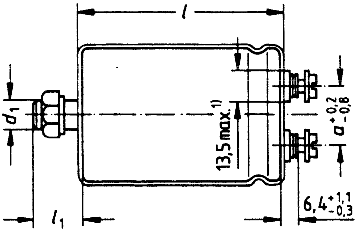
Types B 41 455, B 43 455





M5: Min. reach of screw: 8 mm
M6: Min. reach of screw: 12 mm

Types B 41 457, B 43 457



Dimensions in mm

Marking of positive pole: +

Dimensions (mm)					Approx. weight g
$d_{max} \times l_{max}$ (with insulating sleeve)	$d_{min} \times l_{min}$ (with insulating sleeve)	d_1	l_{1-1}	Dimension a	
35,7 × 56,7	34,9 × 53,5	M8	13	12,7	65
35,7 × 82,1	34,9 × 78,9	M8	13	12,7	105
35,7 × 107,5	34,9 × 104,3	M8	13	12,7	135
51,6 × 82,1	50,8 × 78,9	M12	17	22,2	220
51,6 × 107,5	50,8 × 104,3	M12	17	22,2	280
64,3 × 107,5	63,5 × 104,3	M12	17	28,5	440
76,9 × 107,5	76,2 × 104,3	M12	17	31,7	540
76,9 × 145,6	76,2 × 142,4	M12	17	31,7	840
76,9 × 221,8	76,2 × 218,6	M12	17	31,7	1 300

---

[1] Max. 17.7 mm with screw terminals M6

Low-voltage series

Rated voltage V_R¹)		16 V dc	25 V dc	40 V dc	63 V dc
Rated capacitance µF	Tolerance	Dimensions $d_{max} \times l_{max}$ and code **B 41 455- and B 41 457-**			
220	$^{-10}_{+50}$ % ≙ T				
470					
1 000					
1 500					
2 200					35,7 × 56,7 -N8228-T ◥
3 300				35,7 × 56,7 -N7338-T	35,7 × 56,7 -P8338-T
4 700				35,7 × 56,7 -N7478-T ◥	35,7 × 82,1 -P8478-T ◥
6 800			35,7 × 56,7 -N5688-T	35,7 × 82,1 -N7688-T	51,6 × 82,1 -N8688-T
10 000		35,7 × 56,7 -N4109-T ◥	35,7 × 82,1 -N5109-T	35,7 × 82,1 -P7109-T ◥	51,6 × 82,1 -P8109-T ◥
15 000		35,7 × 56,7 -P4159-T	35,7 × 82,1 -P5159-T	51,6 × 82,1 -N7159-T	64,3 × 82,1 -P8159-T
22 000		35,7 × 82,1 -P4229-T ◥	51,6 × 82,1 -N5229-T	51,6 × 82,1 -P7229-T ◥	64,3 × 107,5 -N8229-T ◥
33 000		51,6 × 82,1 -N4339-T	51,6 × 82,1 -P5339-T	64,3 × 82,1 -P7339-T	76,9 × 107,5 -P8339-T
47 000		51,6 × 82,1 -P4479-T ◥	64,3 × 82,1 -P5479-T	64,3 × 107,5 -P7479-T ◥	
68 000		51,6 × 82,1 -P4689-T	64,3 × 107,5 -N5689-T	76,9 × 107,5 -P7689-T	
100 000		64,3 × 82,1 -P4100-T ◥	76,9 × 107,5 -P5100-T		
150 000		64,3 × 107,5 -P4150-T			

		High-voltage series			
	100 V dc	160 V dc	250 V dc	350 V dc	400 V dc[2]
		Dimensions $d_{\text{max}} \times l_{\text{max}}$ and code **B 43455- and B 43457-**			
			35,7 × 56,7 -A2227-T	35,7 × 82,1 -A4227-T	35,7 × 82,1 -E227-T
		35,7 × 56,7 -A1477-T	35,7 × 82,1 -A2477-T	51,6 × 82,1 -A4477-T	51,6 × 82,1 -E477-T
	35,7 × 56,7 ◥ -N9108-T	35,7 × 82,1 -A1108-T	51,6 × 82,1 -A2108-T	51,6 × 107,5 -A4108-T	51,6 × 107,5 -E108-T
	35,7 × 56,7 -N9158-T	51,6 × 82,1 -A1158-T	51,6 × 82,1 -B2158-T	64,3 × 107,5 -A4158-T	64,3 × 107,5 -E158-T
	35,7 × 82,1 ◥ -N9228-T	51,6 × 82,1 -B1228-T	64,3 × 107,5 -A2228-T	64,3 × 107,5 -J4228-T	76,9 × 107,5 -E228-T
	51,6 × 82,1 -N9338-T	51,6 × 107,5 -J1338-T	64,3 × 107,5 -J2338-T	76,9 × 107,5 -B4338-T	76,9 × 145,6 -E338-T
	51,6 × 82,1 ◥ -P9478-T	64,3 × 107,5 -J1478-T	76,9 × 107,5 -B2478-T		
	64,3 × 82,1 -P9688-T	76,9 × 107,5 -B1688-T		76,9 × 145,6[3] -S4608-T5	76,9 × 221,8[3] -T608-T1
	64,3 × 107,5 ◥ -N9109-T				
	76,9 × 107,5 -P9159-T				

Example for the compiling of ordering codes

	for ring clip mounting	for threaded stud mounting	
	B41455-N7159-T	B41457-N7159-T	
Code according to table			Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

◥ These capacitors are preferred types S (refer to page 4).

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[1] Peak voltage $V_P = 1.15\ V_R$ for $V_R = 16$ to 250 V dc; 1.1 V_R for $V_R = 350$ and 400 V dc

[2] 385 V versions available upon request

[3] Special version, supplied with $C_R = 6000\ \mu F$

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$1) 100 Hz 40 °C A	$I_{ac\,R}$1) 100 Hz 85 °C A	$I_{ac\,max}$1) 100 Hz 85 °C A	ESL approx. nH
◥ 10 000	16	31	78	60	0,66	9,3	3,2	4,2	20
15 000		23	58	44	0,98	11	3,7	4,8	20
◥ 22 000		20	50	34	1,4	13	4,4	5,7	20
33 000		16	40	27	2,1	16	5,5	7,2	20
◥ 47 000		14	33	23	3,0	17	5,8	7,5	20
68 000		13	26	20	4,4	18	6,1	7,9	20
◥ 100 000		12	21	17	6,0	21	7,1	9,2	20
150 000		10	16	15	6,0	24	8,4	11	20
6 800	25	34	85	62	0,7	8,7	3,0	3,9	20
10 000		24	60	46	1,0	12	4,0	5,2	20
15 000		18	45	35	1,5	13	4,6	6,0	20
22 000		15	38	28	2,2	16	5,6	7,3	20
33 000		13	33	23	3,3	17	6,0	7,8	20
47 000		12	27	20	4,7	21	7,1	9,2	20
68 000		11	22	18	6,0	23	8,0	10	20
100 000		10	18	16	6,0	25	8,5	11	20
3 300	40	40	100	85	0,55	8,1	2,8	3,6	20
◥ 4 700		30	75	64	0,77	9,3	3,2	4,2	20
6 800		25	63	48	1,1	11	3,9	5,1	20
◥ 10 000		20	50	36	1,6	13	4,4	5,7	20
15 000		16	40	28	2,4	16	5,5	7,2	20
◥ 22 000		12	30	23	3,5	18	6,3	8,2	20
33 000		10	25	20	5,3	22	7,7	10	20
◥ 47 000		9	23	18	6,0	26	8,9	12	20
68 000		8	20	16	6,0	28	9,5	12	20
◥ 2 200	63	51	130	90	0,6	7,3	2,5	3,3	20
3 300		37	93	64	0,9	8,4	2,9	3,8	20
◥ 4 700		28	70	49	1,2	11	3,7	4,8	20
6 800		21	53	37	1,7	14	4,8	6,2	20
◥ 10 000		16	40	29	2,5	16	5,5	7,2	20
15 000		14	35	24	3,8	19	6,5	8,5	20
◥ 22 000		12	30	20	5,6	22	7,7	10	20
33 000		10	25	18	6,0	25	8,5	11	20
◥ 1 000	100	55	140	120	0,4	7,0	2,4	3,1	20
1 500		40	100	85	0,6	8,1	2,8	3,6	20
◥ 2 200		30	75	65	0,9	10	3,6	4,7	20
3 300		23	58	47	1,3	13	4,5	5,9	20
◥ 4 700		18	45	38	1,9	15	5,1	6,6	20
6 800		15	38	30	2,7	18	6,3	8,2	20
◥ 10 000		12	30	24	4,0	22	7,7	10	20
15 000		10	25	20	6,0	25	8,5	11	20

cont'd on the next page

◥ These capacitors are preferred types S (refer to page 4).

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$1) 100 Hz 40 °C A	$I_{ac\,R}$1) 100 Hz 85 °C A	$I_{ac\,max}$1) 100 Hz 85 °C A	ESL approx. nH
470	160	100	250	230	0,32	5,2	1,8	2,3	20
1 000		52	130	120	0,60	7,8	2,7	3,5	20
1 500		37	93	79	0,98	10	3,6	4,7	20
2 200		28	70	58	1,4	12	4,1	5,3	20
3 300		21	53	43	2,1	15	5,2	6,8	20
4 700		16	40	34	3,0	19	6,7	8,7	20
6 800		12	30	27	4,4	23	7,8	10	20
220	250	170	430	380	0,24	3,8	1,3	1,7	20
470		85	210	190	0,49	6,1	2,1	2,7	20
1 000		43	110	92	1,0	9,6	3,3	4,3	20
1 500		30	75	66	1,5	12	4,0	5,2	20
2 200		22	55	49	2,2	17	5,7	7,4	20
3 300		16	40	37	3,3	19	6,7	8,7	20
4 700		13	33	30	4,7	22	7,5	9,8	20
220	350	160	400	310	0,33	4,4	1,5	2,0	20
470		78	200	160	0,68	7,3	2,5	3,3	20
1 000		39	98	77	1,4	11	3,8	4,9	20
1 500		28	70	56	2,1	15	5,0	6,5	20
2 200		21	53	42	3,1	17	5,8	7,5	20
3 300		15	38	32	4,6	20	7,0	9,1	20
6 000		12	30	21	6,0	26	8,8	11	20
220	400	190	480	310	0,35	4,1	1,4		20
470		94	240	160	0,75	6,4	2,2		20
1 000		47	120	77	1,6	10	3,5		20
1 500		34	85	56	2,4	13	4,6		20
2 200		25	63	42	3,5	16	5,4		20
3 300		18	45	32	5,3	21	7,2		20
6 000		14	35	21	9,6	28	9,7		20

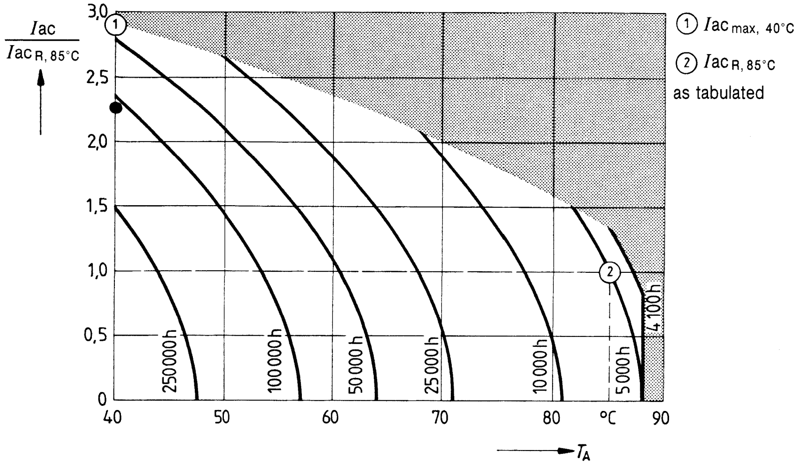
Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

---

1) The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm: 50 A

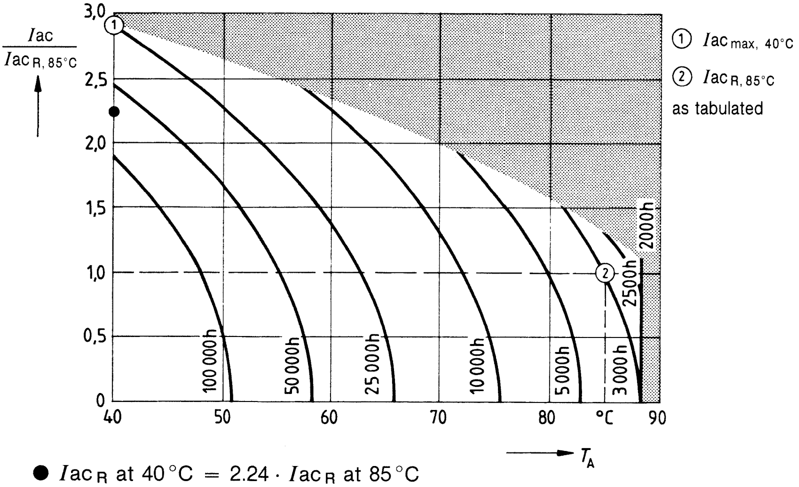
Service life[1])
versus ambient temperature T_A at ripple current operation

Low-voltage series B 41 455 and B 41 457



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

High-voltage series 160 V dc to 350 V dc (B 43 455 and B 43 457)



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

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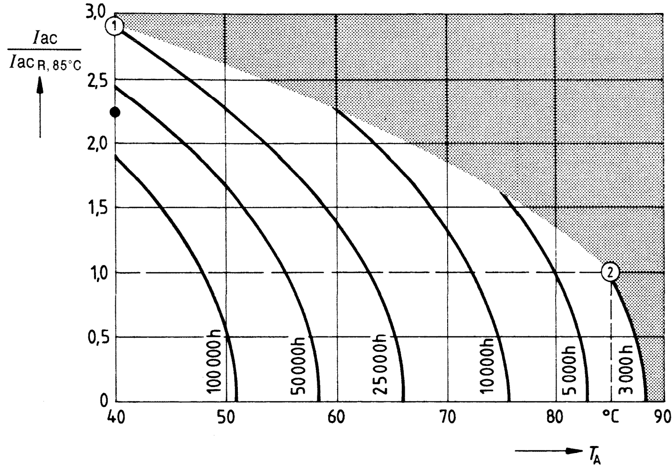
[1]) For details on service life curve refer to page 32.

Service life[1])

versus ambient temperature T_A at ripple current operation
High-voltage series > 350 V dc (B 43 455 and B 43 457)



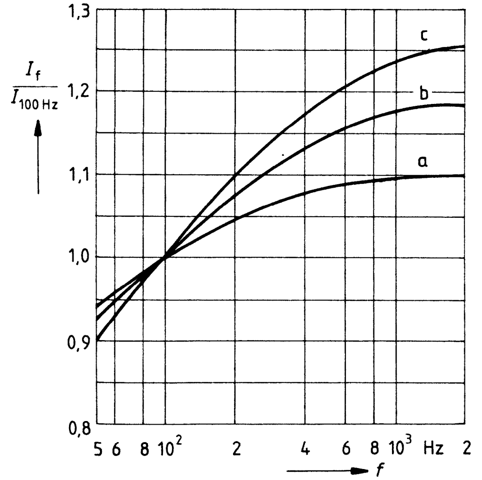
① $I\text{ac}_{\text{max, 40°C}}$

② $I\text{ac}_{R,85°C}$
as tabulated

● $I\text{ac}_R$ at 40 °C = 2.24 · $I\text{ac}_R$ at 85 °C

Permissible ripple current Iac

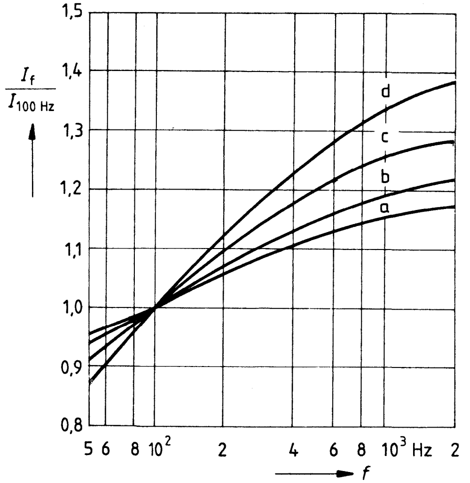
versus frequency f
$V_R \leq 100$ V



V_R (V)	16	25; 40	63	100
$d_{max} = 35,7$	a	a	b	c
$d_{max} \geq 51,6$	a	a	a	a

Permissible ripple current Iac

versus frequency f
$V_R \geq 160$ V



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

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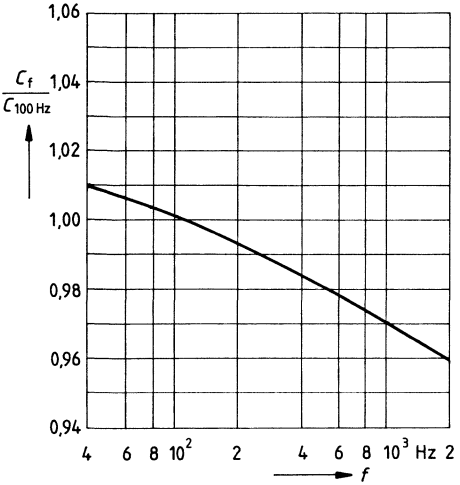
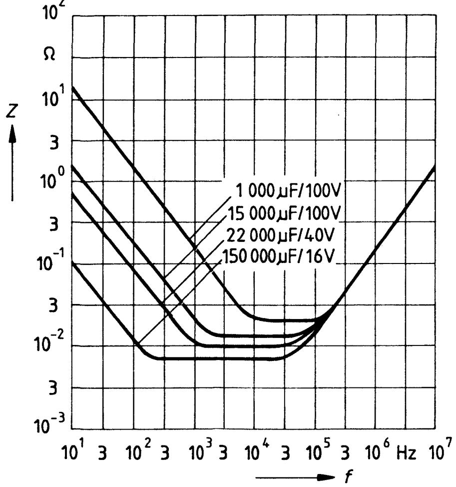
[1]) For details on service life curve refer to page 32.

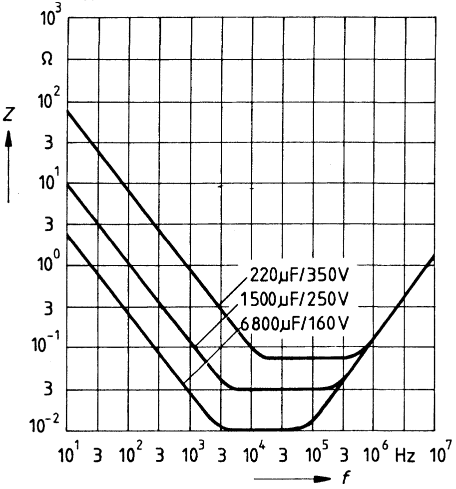
Capacitance *C*
versus frequency *f*
Typical behavior



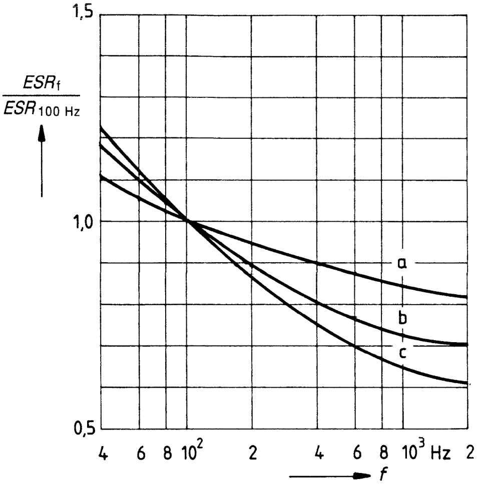
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 160$ V

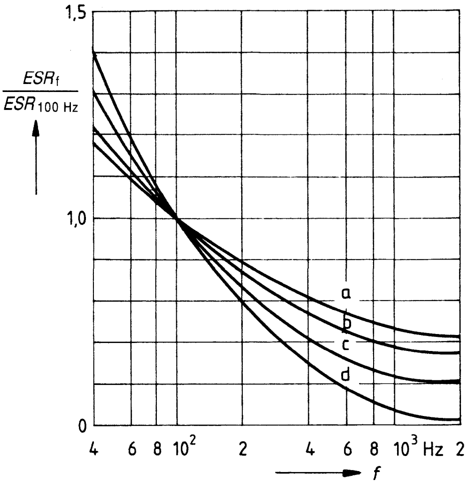


Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



V_R (V)	16	25; 40	63	100
$d_{max} = 35,7$ $d_{max} \geq 51,6$	a a	a a	b a	c a

Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \geq 160$ V



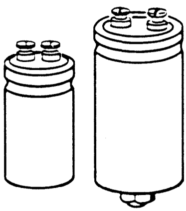
d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

Al Electrolytic Capacitors

10 to 450 V dc
GP Grade

B 41 465, B 43 465
B 41 467, B 43 467
B 41 481, B 43 481

170 to 850 000 µF; 35.7 mm to 76.9 mm dia.



B 4*465 B 4*467
B 4*481

The following range of capacitors features a high CV product and is designed for application in power supplies and in power electronics. This summary of capacitors is intended to give a general survey. Please inform us about your requirements and we will provide an appropriate solution.

Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- All-welded construction ensures reliable contacting
- Poles brought out to heavy duty screw terminals
- Mounting with ring clips or with threaded stud

Features

- High volumetric efficiency
- High ripple current capability (up to 50 A)
- Excellent electrical data

Application

- Professional power supplies
- Power electronics, e.g. capacitor banks in power converters

Mounting versions

The capacitors are available in various mounting versions:

- B 41 465 and B 43 465 for ring clip mounting, with metric threads
- B 41 467 and B 43 467 for threaded stud mounting, with metric threads
- B 41 481 and B 43 481 for ring clip mounting, with UNF thread

Accessories

- Included in delivery (loosely):
  cylindrical screws M 5 × 8 DIN 84-4.8 and toothed washers A5.1 DIN 6797 for B 41 465, B 41 467, B 43 465 and B 43 467

  cylindrical screws 10-32 UNF-2 A × 9.5 and toothed washers A5.1 DIN 6797 for B 41 481 and B 43 481

  hex nuts and toothed washers (for threaded stud, if required) for B 41 467 and B 43 467
- Not included in delivery:
  ring clips B 44 030, page 263 for B 41 465, B 41 481, B 43 465 and B 43 481

  insulating parts B 44 020, page 260 for insulated mounting of threaded-stud types B 41 467 and B 43 467

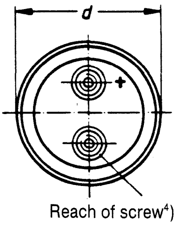
Reinforced threads

Capacitors with 76.9 mm diameter can be supplied with reinforced threads for applications where the capacitor is subjected to high mechanical stress or high electrical load.

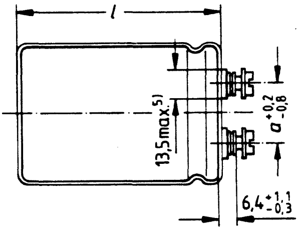
- Screws M6 × 12 DIN 84-4.8 for B 41465, B 41467, B 43465 and B 43467
- Screws 25-28 UNF-2A × 12.5 for B 41481 and B 43481

Specifications and characteristics in brief

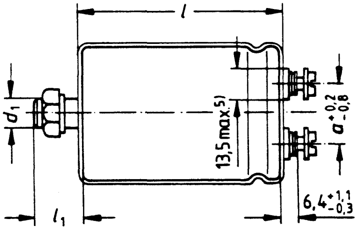
Sectional specifications	DIN IEC 384, part 4[1])
Type specification	Construction in acc. with DIN 41248
IEC climatic category	40/085/56[2]) in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C, humidity category F[2])[3])) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h
Service life	40 °C; V_R; $I_{\mathrm{ac}\,R}$: > 90000 h 85 °C; V_R; $I_{\mathrm{ac}\,R}$: > 4000 h
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 100 fit (≤ 100 · 10^{-9}/h)



B 41465, B 43465
B 41481, B 43481



B 41467, B 43467



Dimensions (mm)						Approx. weight g
Case size	$d_{\max} \times l_{\max}$ (with insulating sleeve)	$d_{\min} \times l_{\min}$ (with insulating sleeve)	d_1	l_{1-1}	Dimension *a*	
AA	35,7 × 56,7	34,9 × 53,5	M8	13	12,7	65
AB	35,7 × 82,1	34,9 × 78,9	M8	13	12,7	105
AC	35,7 × 107,5	34,9 × 104,3	M8	13	12,7	135
BB	51,6 × 82,1	50,8 × 78,9	M12	17	22,2	220
BC	51,6 × 107,5	50,8 × 104,3	M12	17	22,2	280
CC	64,3 × 107,5	63,5 × 104,3	M12	17	28,5	440
DC	76,9 × 107,5	76,2 × 104,3	M12	17	31,7	540
DF	76,9 × 145,6	76,2 × 142,4	M12	17	31,7	840
DJ	76,9 × 221,8	76,2 × 218,6	M12	17	31,7	1300

[1]) These capacitors comply with the test requirements for Long Life Grade (LL).

[2]) For rated voltages > 400 V: 25/085/56 or HPF (−25 to +85 °C).

[3]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.

[4]) Min. 8.0 mm for B 41465, B 41467, B 43465 and B 43467
Min. 9.5 mm for B 41481 and B 43481
Min. 12.0 mm with reinforced screw terminals

[5]) Max. 17.7 mm with reinforced screw terminals

Maximum capacitances and corresponding ratings

V_R[1] V dc	C_R[2] µF	Case size	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$[3] 100 Hz 40 °C A	$I_{ac\,R}$[3] 100 Hz 85 °C A	$I_{ac\,max}$[3] 100 Hz 85 °C A
10	26 000	AA	31	46	34	1,1	9,5	3,7	4,8
	44 000	AB	19	29	22	1,8	13	5,1	6,7
	64 000	AC	14	21	17	2,6	17	6,7	8,7
	100 000	BB	10	15	12	4,0	21	8,0	10
	150 000	BC	7	11	10	6,0	27	10	13
	230 000	CC	6	9	8	6,0	33	13	16
	350 000	DC	4	7	7	6,0	37	14	19
	510 000	DF	4	6	6	6,0	40/47	18	23
	850 000	DJ	3	5	5	6,0	40/50	23	30
16	18 000	AA	28	42	37	1,2	10	3,8	5,0
	30 000	AB	18	27	24	1,9	14	5,3	6,9
	44 000	AC	13	19	18	2,8	18	7,0	9,1
	70 000	BB	9	14	13	4,5	21	8,2	11
	100 000	BC	7	11	10	6,0	27	10	13
	160 000	CC	5	8	8	6,0	35	13	17
	240 000	DC	4	7	7	6,0	37	14	19
	350 000	DF	4	6	6	6,0	40/47	18	23
	580 000	DJ	3	5	5	6,0	40/50	23	30
25	11 000	AA	30	45	36	1,1	9,6	3,7	4,8
	18 000	AB	19	29	24	1,8	13	5,1	6,7
	26 000	AC	14	21	18	2,6	17	6,7	8,7
	42 000	BB	10	15	13	4,2	21	8,0	10
	62 000	BC	7	11	10	6,0	27	10	13
	98 000	CC	5	8	8	6,0	35	13	17
	140 000	DC	5	7	7	6,0	37	14	19
	210 000	DF	4	6	6	6,0	40/47	18	23
	350 000	DJ	3	5	5	6,0	40/50	23	30
40	6 300	AA	33	50	42	1,0	9,1	3,5	4,6
	10 000	AB	22	33	28	1,6	13	4,8	6,3
	15 000	AC	15	23	20	2,4	17	6,4	8,3
	24 000	BB	10	16	14	3,9	20	7,7	10
	36 000	BC	8	12	11	5,8	25	9,8	13
	57 000	CC	6	9	9	6,0	33	13	16
	85 000	DC	5	7	7	6,0	37	14	19
	120 000	DF	4	6	6	6,0	40/47	18	23
	200 000	DJ	3	5	5	6,0	40/50	23	30
63	3 300	AA	41	61	41	0,85	8,3	3,2	4,1
	5 500	AB	25	38	27	1,4	12	4,5	5,8
	8 000	AC	18	27	20	2,0	15	5,9	7,6
	12 000	BB	13	19	15	3,0	18	7,1	9,2
	19 000	BC	9	14	11	4,8	24	9,1	12
	29 000	CC	7	10	9	6,0	31	12	16
	43 000	DC	5	8	7	6,0	35	13	18
	65 000	DF	4	6	6	6,0	40/47	18	23
	100 000	DJ	4	5	5	6,0	40/50	23	30

cont'd on the next page

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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

[2] Capacitance tolerance −10/+30%

[3] The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm with screws M5: 40 A; M6: 50 A (applies also to UNF threads)

V_R 1) V dc	C_R 2) µF	Case size	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{\mathrm{r,\,max}}$ 5 min 20 °C mA	$I_{\mathrm{ac\,max}}$ 3) 100 Hz 40 °C A	$I_{\mathrm{ac\,R}}$ 3) 100 Hz 85 °C A	$I_{\mathrm{ac\,max}}$ 3) 100 Hz 85 °C A
100	1200	AA	69	100	43	0,50	6,5	2,5	3,2
	2300	AB	37	56	25	0,95	9,6	3,7	4,8
	3400	AC	26	39	19	1,4	13	4,9	6,4
	4700	BB	19	29	15	1,9	15	5,7	7,4
	7000	BC	14	21	12	2,8	19	7,4	9,6
	12000	CC	9	14	9	4,8	26	10	13
	17000	DC	7	11	8	6,0	30	11	15
	26000	DF	5	8	7	6,0	39	15	20
	44000	DJ	4	6	6	6,0	40/50	21	27
160	780	AA	130	200	140	0,52	4,6	1,8	2,3
	1300	AB	80	120	87	0,85	6,6	2,5	3,3
	1900	AC	56	84	62	1,2	8,7	3,3	4,3
	3000	BB	37	55	41	1,9	11	4,2	5,4
	4400	BC	26	39	30	2,8	14	5,4	7,1
	7000	CC	18	26	22	4,5	19	7,4	9,6
	10000	DC	13	20	17	6,0	22	8,5	11
	15000	DF	10	15	14	6,0	29	11	14
	25000	DJ	7	11	11	6,0	39	15	20
250	540	AA	150	230	160	0,56	4,3	1,6	2,1
	900	AB	92	140	99	0,92	6,1	2,3	3,0
	1300	AC	65	97	71	1,3	8,1	3,1	4,0
	2100	BB	41	62	46	2,1	10	3,9	5,1
	3000	BC	30	45	35	3,0	13	5,1	6,6
	4800	CC	20	30	24	4,8	18	6,9	9,0
	7200	DC	14	22	19	6,0	21	8,1	11
	10000	DF	11	17	15	6,0	27	10	14
	17000	DJ	8	12	12	6,0	39	15	19
350	300	AA	230	340	230	0,44	3,5	1,3	1,8
	500	AB	140	210	140	0,72	5,0	1,9	2,5
	740	AC	93	140	98	1,1	6,7	2,6	3,4
	1100	BB	64	96	69	1,6	8,2	3,1	4,1
	1700	BC	43	64	47	2,4	11	4,2	5,5
	2700	CC	28	42	33	3,8	15	5,8	7,6
	4000	DC	20	30	25	5,6	18	7,0	9,0
	6000	DF	14	22	19	6,0	24	9,2	12
	9900	DJ	10	15	15	6,0	34	13	17
400	260	AA	260	390	260	0,44	3,3	1,3	1,6
	430	AB	160	240	160	0,71	4,7	1,8	2,3
	630	AC	110	160	110	1,0	6,3	2,4	3,1
	1000	BB	70	110	75	1,6	7,6	2,9	3,8
	1400	BC	51	76	56	2,3	10	3,9	5,1
	2300	CC	32	48	38	3,7	14	5,4	7,1
	3400	DC	23	34	28	5,5	17	6,5	8,5
	5100	DF	16	25	22	6,0	22	8,6	11
	8400	DJ	11	17	17	6,0	32	12	16

cont'd on the next page

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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1) Peak voltage $V_p = 1.15 \cdot V_R$ for $V_R \leq 315$ V dc or $V_p = 1.1\ V_R$ for $V_R > 315$ V dc

2) Capacitance tolerance $-10/+30$ %

3) The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm with screws M5: 40 A; M6: 50 A (applies also to UNF threads)

V_R[1]) V dc	C_R[2]) µF	Case size	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r, max}$ 5 min 20 °C mA	$I_{ac\,max}$[3]) 100 Hz 40 °C A	$I_{ac\,R}$[3]) 100 Hz 85 °C A	$I_{ac\,max}$[3]) 100 Hz 85 °C A
450	170	AA	790	1200	750	0,33	1,9	0,72	0,93
	290	AB	460	690	440	0,54	2,7	1,1	1,4
	430	AC	310	470	300	0,79	3,7	1,4	1,8
	700	BB	190	290	190	1,3	4,7	1,8	2,4
	1 000	BC	140	210	140	1,8	6,1	2,3	3,0
	1 600	CC	87	130	89	2,9	8,6	3,3	4,3
	2 400	DC	59	88	63	4,3	11	4,1	5,3
	3 500	DF	41	62	46	6,0	14	5,5	7,1
	5 800	DJ	26	39	32	6,0	21	8,2	1,1

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

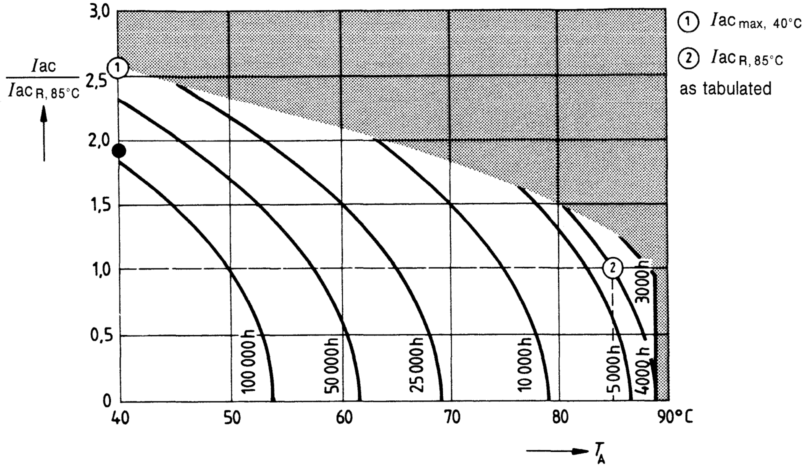
---

[1]) Peak voltage $V_p = 1.1\ V_R$

[2]) Capacitance tolerance −10/+30 %

[3]) The current load on the contact elements must not exceed the following limits, even when frequency and temperature factors have been taken into account.
Capacitor diameter ≤ 51.6 mm: 30 A
Capacitor diameter 64.3 mm: 40 A
Capacitor diameter 76.9 mm with screws M5: 40 A; M6: 50 A (applies also to UNF threads)

Service life[1]
versus ambient temperature T_A at ripple current operation

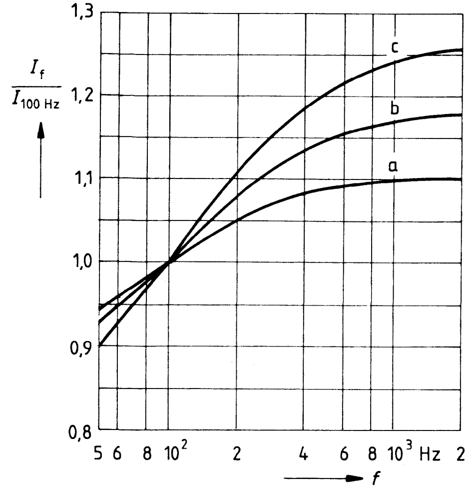


● I_{acR} at 40 °C = 1.94 · I_{acR} at 85 °C

---

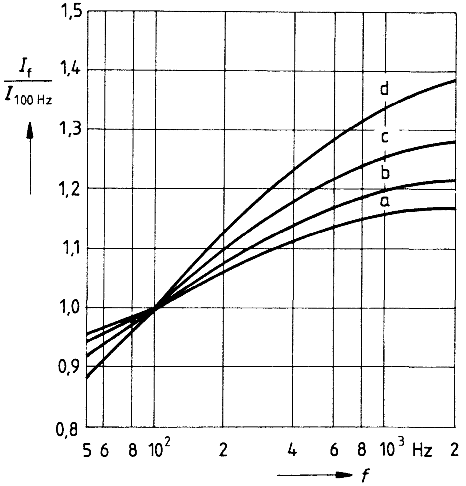
[1] For details on service life curve refer to page 32.

Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



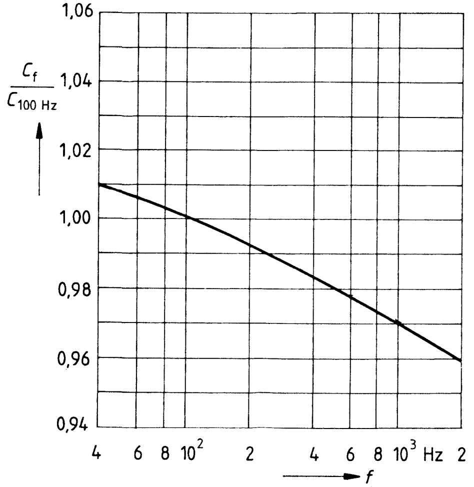
V_R (V)	10; 16	25; 40	63	100
$d_{max} = 35,7$	a	a	b	c
$d_{max} \geq 51,6$	a	a	a	a

Permissible ripple current Iac
versus frequency f
$V_R \geq 160$ V

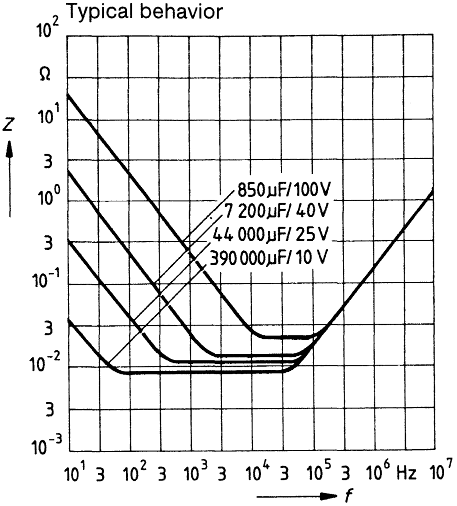


d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

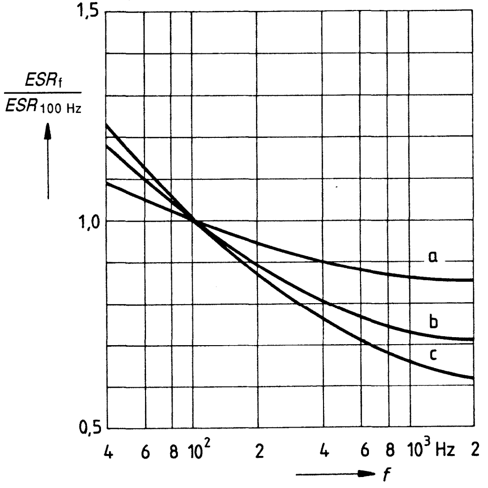
Capacitance C
versus frequency f
Typical behavior



Impedance Z
versus frequency f
Typical behavior

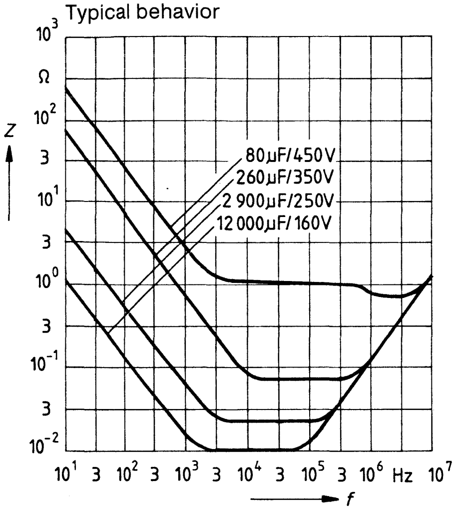


Equivalent series resistance ESR
versus frequency f
Typical behavior
$V_R \leq 100$ V

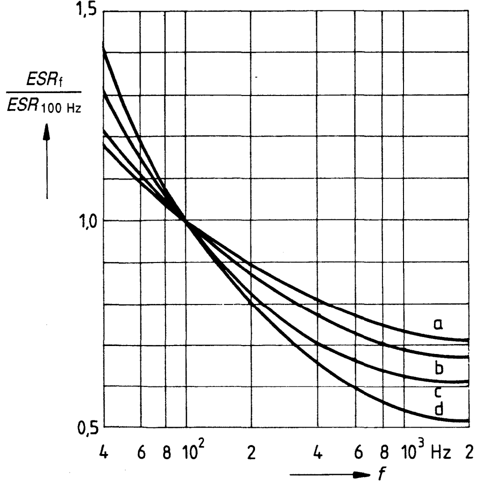


V_R (V)	10 to 40	63	100
$d_{max} = 35{,}7$ $d_{max} \geq 51{,}6$	a a	b a	c a

Impedance Z
versus frequency f
Typical behavior



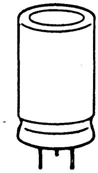
Equivalent series resistance ESR
versus frequency f
Typical behavior
$V_R \geq 160$ V



d_{max}	35,7	51,6	64,3	76,9
Curve	d	c	b	a

Al Electrolytic Capacitors — 6.3 to 385 V dc LL Grade — B 41 534 B 43 534

47 to 15 000 µF; 18.8 mm to 25.8 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Solder pins, single-ended design
- The negative potential can be applied to the third pin, which, however, does not serve as negative pole

Features

- Very low equivalent series resistance
- High ripple current capability at small dimensions
- Long service life
- Operation at 105 °C permissible for 1000 h
- Asymmetric pinning ensures against incorrect insertion

Application

- For compact professional switch-mode power supplies
- Industrial electronics, communications engineering, data processing systems

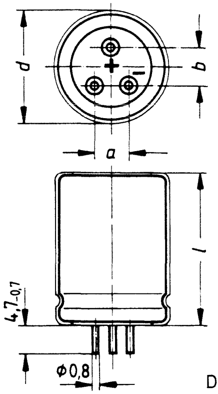
Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[2])), in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h
Service life	40 °C; V_R; I_{acR}: > 180 000 h 85 °C; V_R; I_{acR}: > 8 000 h
Fraction failure	≤ 0.5 % (during service life)
Failure rate	≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)

---

[1]) Operation at 105 °C permissible for 1000 h.

[2]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.



Dimensions in mm

Dimensions (mm)				Approx. weight g
$d \times l$ (rated dimensions)	$d_{max} \times l_{max}$ (with insulating sleeve)	$a^{+0,4}_{-0,2}$	$b^{+0,4}_{-0,2}$	
18 × 30	18,8 × 30,5	5	7,5	11
18 × 40¹)	18,8 × 40,5	5	7,5	14
22 × 40²)	22,8 × 40,5	7,5	10	18
25 × 40	25,8 × 40,5	7,5	10	26

---

¹) Optionally available with dia. 22 × 30; ordering code: B 41 534-**J******-M or
B 43 534-**J*****-M (200 V dc)
B 43 534-**N*****-M (385 V dc)

²) Optionally available with dia. 25 × 30; ordering code: B 41 534-**J******-M or
B 43 534-**J*****-M (200 V dc)
B 43 534-**N*****-M (385 V dc)

Low-voltage series B 41 534

Rated voltage V_R1)		6,3 V dc	10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance μF	Tolerance	Rated dimensions $d \times l$ (mm) Code						
100	± 20 % ≙ M							18 × 30 -A9107-M
150								18 × 30 -A9157-M
220							18 × 30 -A8227-M	18 × 40 -A9227-M
330							18 × 30 -A8337-M	22 × 40 -A9337-M
470						18 × 30 -A7477-M	18 × 40 -A8477-M	25 × 40 -A9477-M
680						18 × 30 -A7687-M	22 × 40 -A8687-M	
1 000					18 × 30 -A5108-M	18 × 40 -A7108-M	25 × 40 -A8108-M	
1 500				18 × 30 -A4158-M	18 × 40 -A5158-M	22 × 40 -A7158-M		
2 200				18 × 30 -A4228-M	22 × 40 -A5228-M	25 × 40 -A7228-M		
3 300			18 × 30 -A3338-M	18 × 40 -A4338-M	25 × 40 -A5338-M			
4 700		18 × 30 -A2478-M	18 × 40 -A3478-M	22 × 40 -A4478-M	25 × 40 -A5478-M			
6 800		18 × 40 -A2688-M	22 × 40 -A3688-M	25 × 40 -A4688-M				
10 000		22 × 40 -A2109-M	25 × 40 -A3109-M					
15 000		25 × 40 -A2159-M						

Example for the compiling of ordering codes

B41534-$\underbrace{\text{A5228-M}}$

Code according to table

---

1) Peak voltage $V_p = 1.15\ V_R$

High-voltage series B 43 534

Rated voltage V_R[1]		200 V dc	385 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ (mm) Code	
47	± 20 % ≙ M	18 × 30 -A476-M	18 × 40 -E476-M
68		18 × 40 -A686-M	22 × 40 -E686-M
100		22 × 40 -A107-M	25 × 40 -E107-M
150		22 × 40 -A157-M	25 × 40 -E157-M
220		25 × 40 -A227-M	

Example for the compiling of ordering codes

B43534-A476-M

└── Code according to table

---

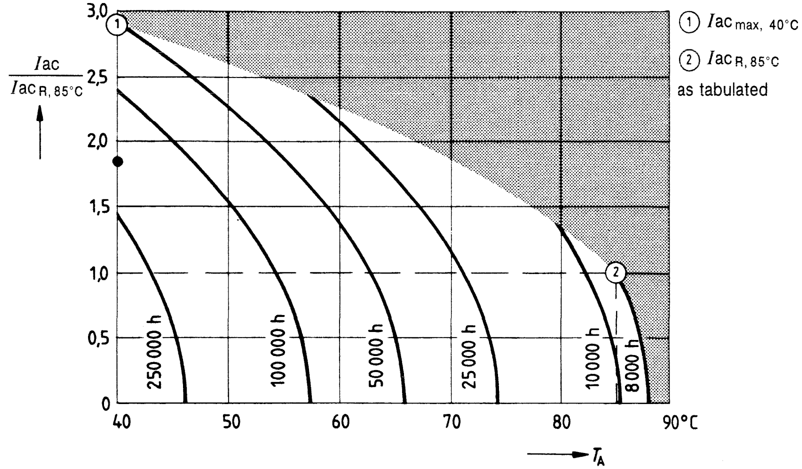
[1] Peak voltage $V_p = 1.15\ V_R$ for 200 V dc; 1.1 V_R for 385 V dc

C_R µF	V_R V dc	ESR_{typ} 20 kHz 20 °C mΩ	ESR_{max} 20 kHz 20 °C mΩ	Z_{max} 200 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 20 kHz 40 °C A	$I_{ac\,R}$ 20 kHz 85 °C A	ESL approx. nH
4700	6,3	27	31	30	63	6,3	2,2	10
6800		22	26	26	90	7,7	2,6	10
10000		19	23	24	130	9,0	3,1	10
15000		17	20	22	190	10,0	3,6	10
3300	10	27	32	30	70	6,2	2,1	10
4700		23	27	27	98	7,6	2,6	10
6800		19	23	24	140	9,0	3,1	10
10000		17	21	22	200	10,0	3,5	10
1500	16	35	41	37	52	5,5	1,8	10
2200		28	33	31	74	6,1	2,1	10
3300		23	27	26	110	7,6	2,6	10
4700		19	23	24	150	9,0	3,1	10
6800		17	21	22	220	10,0	3,5	10
1000	25	32	37	36	54	5,8	2,0	10
1500		25	30	30	79	7,2	2,4	10
2200		21	25	26	110	8,6	3,0	10
3300		18	22	23	170	9,9	3,4	10
4700		16	20	22	240	10,0	3,6	10
470	40	44	50	44	42	5,0	1,7	10
680		34	39	36	58	5,6	1,9	10
1000		27	32	30	84	7,0	2,4	10
1500		22	26	26	120	8,5	2,9	10
2200		19	23	23	180	9,7	3,3	10
220	63	57	65	54	32	4,4	1,5	10
330		42	48	42	46	5,1	1,7	10
470		33	38	35	63	6,4	2,2	10
680		27	31	30	90	7,7	2,7	10
1000		22	26	26	130	9,1	3,1	10
100	100	90	115	85	24	2,9	1,0	10
150		65	77	62	34	3,5	1,2	10
220		48	55	48	48	4,4	1,5	10
330		36	40	37	70	5,2	1,8	10
470		28	32	31	98	7,0	2,4	10
47	200	520	1300	1100	23	1,1	0,36	10
68		360	900	780	31	1,6	0,55	10
100		250	630	540	44	2,1	0,71	10
150		170	430	360	64	2,5	0,86	10
220		120	300	250	92	3,5	1,2	10
47	385	440	1100	950	40	1,5	0,51	10
68		310	780	670	56	1,9	0,63	10
100		210	530	460	81	2,6	0,89	10
150		150	380	310	120	3,1	1,1	10

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and –2 V.

Service life[1])

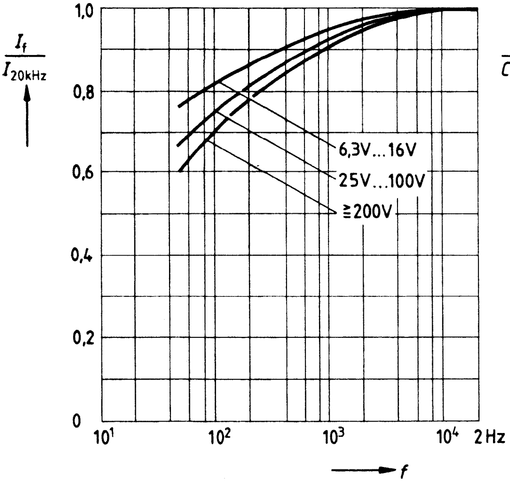
versus ambient temperature T_A at ripple current operation



● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

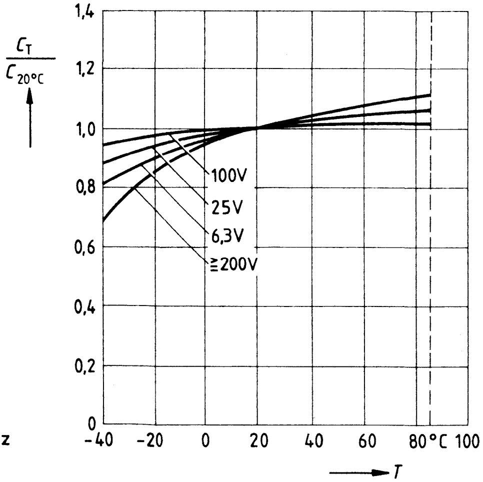
Permissible ripple current Iac

versus frequency f



Series capacitance C_S

versus temperature T (f = 100 Hz)
Typical behavior



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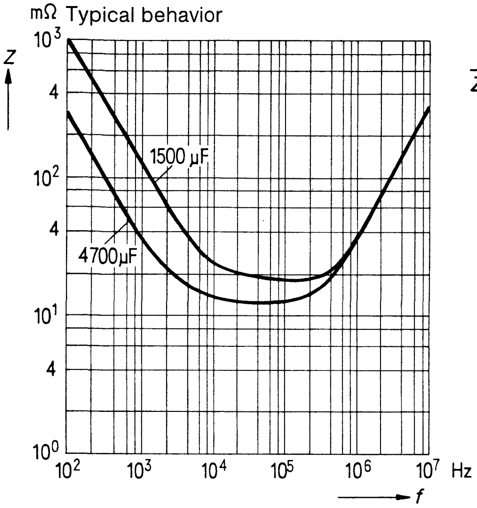
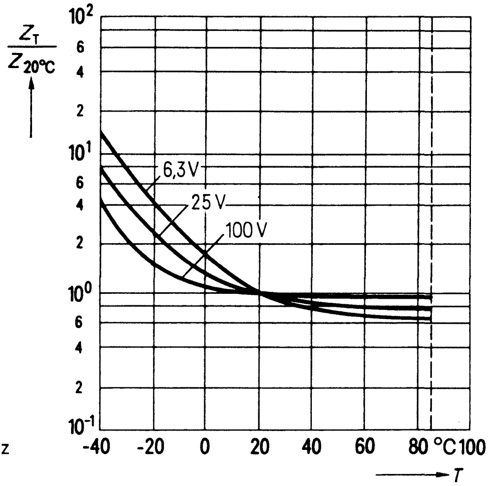
[1]) For details on service life curve refer to page 32.

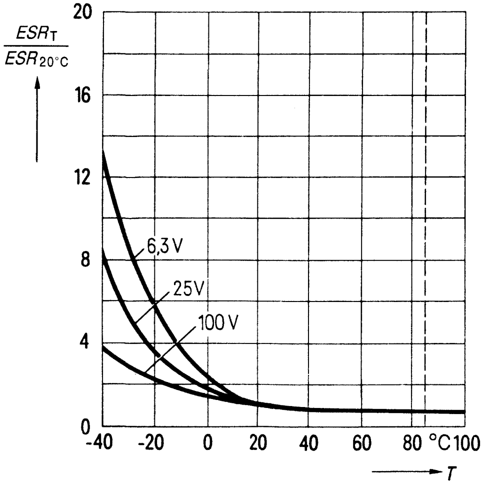
Impedance *Z*
versus frequency *f*
for $V_R = 25$ V at 20 °C
Typical behavior



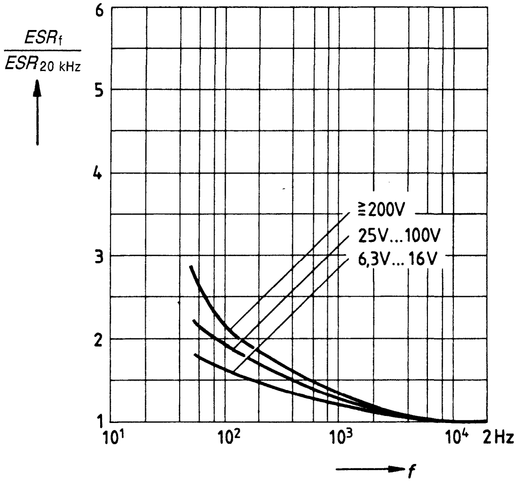
Impedance *Z*
versus temperature *T* ($f = 20$ kHz)
Typical behavior



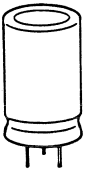
Equivalent series resistance *ESR*
versus temperature *T* ($f = 100$ Hz)
Typical behavior



Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior



100 to 15000 μF; 18.8 mm to 25.8 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can with insulating sleeve
- Solder pins, single-ended design
- The negative potential can be applied to the third pin, which, however, does not serve as negative pole

Features

- Very low equivalent series resistance
- Very low self-inductance
- High ripple current capability at small dimensions
- Long service life
- Operation at 105 °C permissible for 1000 h
- Asymmetric pinning ensures against incorrect insertion

Application

- Excellently suitable for switch-mode power supplies with high clock frequencies
- Equipment with high operating frequencies

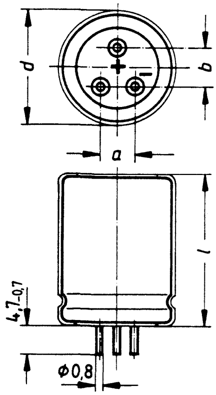
Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[2]) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h
Service life	40 °C; V_R; I_{acR}: > 180000 h 85 °C; V_R; I_{acR}: > 8000 h
Fraction failure	≤ 0.5 % (during service life)
Failure rate	≤ 20 fit (≤ $20 \cdot 10^{-9}$/h)

---

[1]) Operation at 105 °C permissible for 1000 h.

[2]) These capacitors also comply with the test requirements of humidity categorie E in accordance with DIN 40040.



Dimensions in mm

Dimensions (mm)				Approx. weight g
$d \times l$ (rated dimensions)	$d_{max} \times l_{max}$ (with insulating sleeve)	$a^{+0,4}_{-0,2}$	$b^{+0,4}_{-0,2}$	
18 × 30	18,8 × 30,5	5	7,5	11
18 × 40[1])	18,8 × 40,5	5	7,5	14
22 × 40[2])	22,8 × 40,5	7,5	10	18
25 × 40	25,8 × 40,5	7,5	10	26

---

[1]) Optionally available with dia. 22 × 30; ordering code: B 41 336-**J******-T

[2]) Optionally available with dia. 25 × 30; ordering code: B 41 336-**J******-T
The electrical values may slightly differ from those specified here.

Rated voltage V_R1)		6,3 V dc	10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions *d* × *l* Code						
100	$\begin{smallmatrix}-10\\+50\end{smallmatrix}$ % ≙ T							18 × 30 ◥ -A9107-T
150								18 × 30 ◥ -A9157-T
220							18 × 30 ◥ -A8227-T	18 × 40 ◥ -A9227-T
330							18 × 30 ◥ -A8337-T	22 × 40 ◥ -A9337-T
470						18 × 30 ◥ -A7477-T	18 × 40 ◥ -A8477-T	25 × 40 ◥ -A9477-T
680						18 × 30 ◥ -A7687-T	22 × 40 ◥ -A8687-T	
1 000					18 × 30 ◥ -A5108-T	18 × 40 ◥ -A7108-T	25 × 40 ◥ -A8108-T	
1 500				18 × 30 ◥ -A4158-T	18 × 40 ◥ -A5158-T	22 × 40 ◥ -A7158-T		
2 200				18 × 30 ◥ -A4228-T	22 × 40 ◥ -A5228-T	25 × 40 ◥ -A7228-T		
3 300			18 × 30 ◥ -A3338-T	18 × 40 ◥ -A4338-T	25 × 40 ◥ -A5338-T			
4 700		18 × 30 ◥ -A2478-T	18 × 40 ◥ -A3478-T	22 × 40 ◥ -A4478-T	25 × 40 ◥ -A5478-T			
6 800		18 × 40 ◥ -A2688-T	22 × 40 ◥ -A3688-T	25 × 40 ◥ -A4688-T				
10 000		22 × 40 ◥ -A2109-T	25 × 40 ◥ -A3109-T					
15 000		25 × 40 ◥ -A2159-T						

Example for the compiling of ordering codes

B41336-A5228-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

◥ These capacitors are preferred types S (refer to page 4).

---

1) Peak voltage $V_p = 1.15\ V_R$

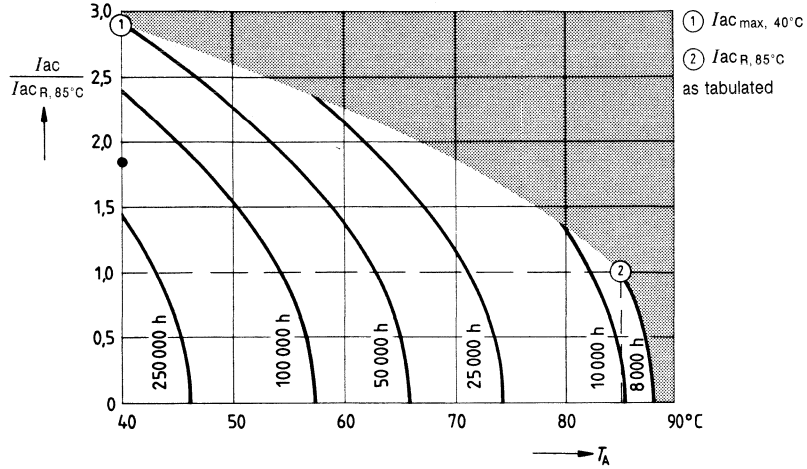
C_R µF	V_R V dc	ESR_{typ} 20 kHz 20 °C mΩ	ESR_{max} 20 kHz 20 °C mΩ	Z_{max} 200 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 20 kHz 40 °C A	$I_{ac\,R}$ 20 kHz 85 °C A	ESL approx. nH
◥ 4700	6,3	26	30	30	63	6,7	2,3	5
◥ 6800		22	25	25	90	7,9	2,7	5
◥ 10000		18	20	22	130	9,7	3,3	5
◥ 15000		16	18	20	193	11,0	3,8	5
◥ 3300	10	26	31	30	70	6,4	2,2	5
◥ 4700		23	26	25	98	7,7	2,6	5
◥ 6800		18	21	22	140	9,4	3,2	5
◥ 10000		17	19	20	204	10,7	3,7	5
◥ 1500	16	34	40	36	52	5,8	2,0	5
◥ 2200		27	32	30	74	6,4	2,2	5
◥ 3300		23	27	25	110	7,6	2,6	5
◥ 4700		19	22	22	154	9,2	3,2	5
◥ 6800		17	19	20	222	10,7	3,7	5
◥ 1000	25	31	36	35	54	6,1	2,1	5
◥ 1500		25	29	26	79	7,3	2,5	5
◥ 2200		20	23	22	114	9,0	3,1	5
◥ 3300		18	22	22	169	9,9	3,4	5
◥ 4700		16	20	21	239	10,4	3,6	5
◥ 470	40	43	49	43	42	5,2	1,8	5
◥ 680		33	38	35	58	5,8	2,0	5
◥ 1000		27	31	26	84	7,1	2,4	5
◥ 1500		22	25	23	124	8,6	3,0	5
◥ 2200		19	22	21	180	9,9	3,4	5
◥ 220	63	56	64	53	32	4,4	1,5	5
◥ 330		41	47	40	46	5,2	1,8	5
◥ 470		33	38	30	63	6,4	2,2	5
◥ 680		27	30	26	90	7,9	2,7	5
◥ 1000		22	26	25	130	9,1	3,1	5
◥ 100	100	98	220	180	24	2,8	0,95	5
◥ 150		69	160	130	34	3,2	1,1	5
◥ 220		53	120	100	48	4,1	1,4	5
◥ 330		39	88	78	70	5,2	1,8	5
◥ 470		31	71	66	98	6,4	2,2	5

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

◥ These capacitors are preferred types S (refer to page 4).

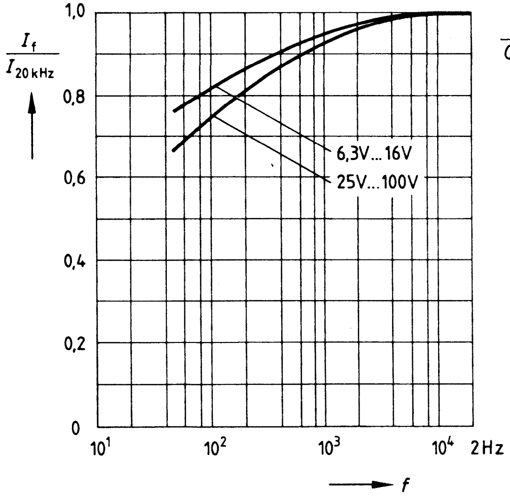
Service life[1])

versus ambient temperature T_A at ripple current operation

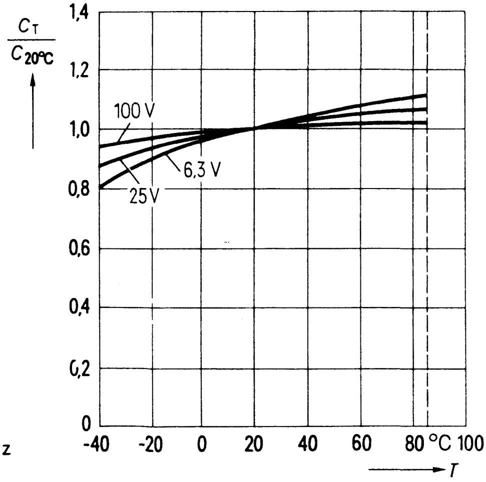


● $I_{ac\,R}$ at 40 °C = 1.83 · $I_{ac\,R}$ at 85 °C

Permissible ripple current I_{ac}
versus frequency f



Series capacitance C_S
versus temperature T (f = 100 Hz)
Typical behavior



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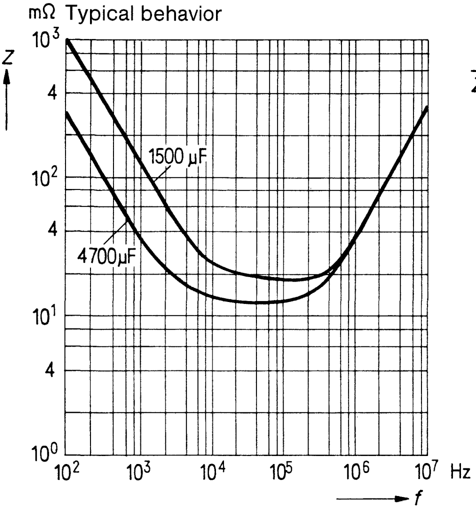
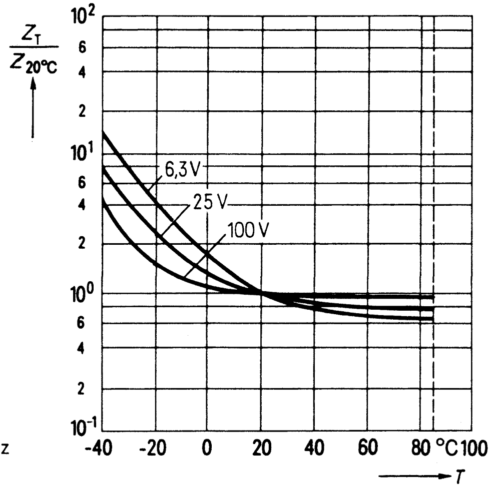
[1]) For details on service life curve refer to page 32.

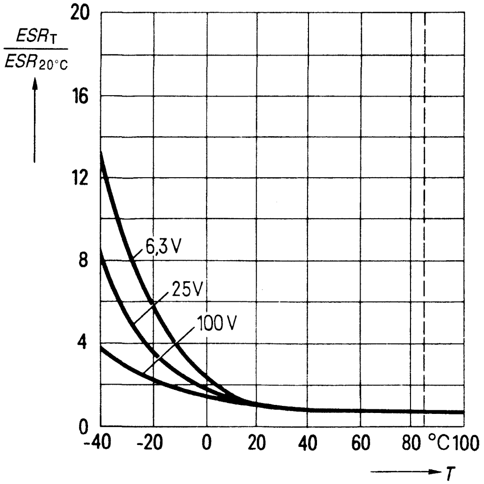
Impedance *Z*
versus frequency *f*
for V_R = 25 V at 20 °C
Typical behavior



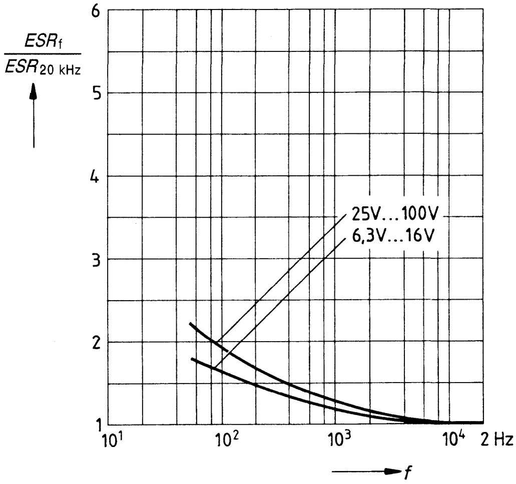
Impedance *Z*
versus temperature *T* (*f* = 20 kHz)
Typical behavior



Equivalent series resistance *ESR*
versus temperature *T* (*f* = 100 Hz)
Typical behavior

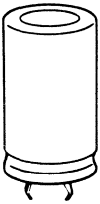


Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior



Al Electrolytic Capacitors 10 to 400 V dc LL Grade B 41 503 B 43 503

47 to 33 000 µF; 22 mm to 30 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can, fully insulated
- Snap-in solder pins provide secure locking to PC board
- Marking of negative pole on can
- Negative pole not insulated from case
- All-welded construction

Features

- Outstanding reliability (Long Life Grade)
- High ripple current capability at small dimensions
- Very wide temperature range
- Low equivalent series resistance
- Two different case dimensions available for each capacitance value

Application

- Professional switch-mode power supplies in industrial electronics and data processing systems
- Switch-mode power supplies in entertainment electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
IEC climatic category	40/105/56 in acc. with DIN IEC 68, part 1
Permissible operating temperature	-40 to $+105$ °C
Humidity category	F[1]) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h
Service life	40 °C; V_R; $I\mathrm{ac}_R$: > 220 000 h 85 °C; V_R; $I\mathrm{ac}_{\mathrm{max}}$: > 4000 h 105 °C; V_R; $I\mathrm{ac}_R$: > 2500 h
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 40 fit ($\leq 40 \cdot 10^{-9}$/h)

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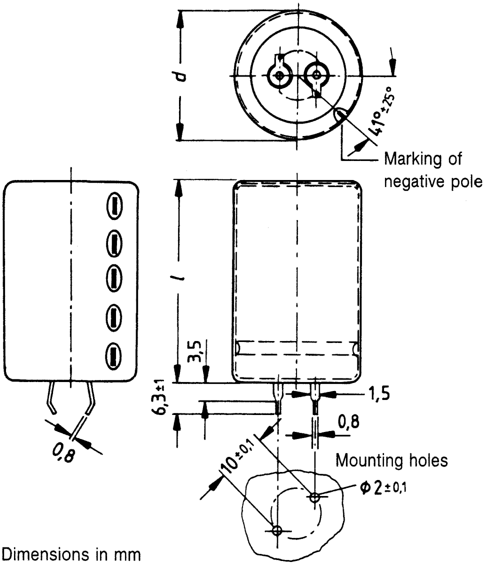
[1]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.



Dimensions in mm

Dimensions		Approx. weight g
$d + 1$ mm	$l \pm 2$ mm	
22	25	9
22	30	12
22	35	15
22	40	18
25	25	13
25	30	17
25	35	19
25	40	22
30	30	23
30	35	29
30	40	36
30	45	41
30	50	46

Low-voltage series B 41 503

Rated voltage V_R[1])		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance C_R µF	Tolerance	Rated dimensions $d \times l$ Code					
470	± 20 % ≙ M						22 × 30 -A9477-M
							25 × 25 -J9477-M
680							22 × 35 -B9687-M
							25 × 30 -J9687-M
1 000						22 × 30 -A8108-M	25 × 35 -B9108-M
						25 × 25 -J8108-M	30 × 30 -J9108-M
1 500						22 × 35 -B8158-M	30 × 35 -B9158-M
						25 × 30 -J8158-M	
2 200					22 × 30 -A7228-M	25 × 35 -B8228-M	30 × 45 -B9228-M
					25 × 25 -J7228-M	30 × 30 -J8228-M	
3 300				22 × 30 -A5338-M	22 × 40 -A7338-M	30 × 40 -A8338-M	
				25 × 25 -J5338-M	25 × 30 -J7338-M		
4 700			22 × 30 -A4478-M	22 × 35 -B5478-M	25 × 40 -A7478-M	30 × 45 -B8478-M	
			25 × 25 -J4478-M	25 × 30 -J5478-M	30 × 30 -J7478-M		
6 800		22 × 30 -A3688-M	22 × 35 -B4688-M	25 × 35 -B5688-M	30 × 35 -B7688-M		
		25 × 25 -J3688-M	25 × 30 -J4688-M	30 × 30 -J5688-M			
10 000		22 × 35 -B3109-M	25 × 35 -B4109-M	30 × 35 -B5109-M	30 × 50 -A7109-M		
		25 × 30 -J3109-M	30 × 30 -J4109-M				
15 000		25 × 35 -B3159-M	30 × 35 -B4159-M	30 × 45 -B5159-M			
		30 × 30 -J3159-M					
22 000		30 × 35 -B3229-M	30 × 45 -B4229-M				
33 000		30 × 45 -B3339-M					

---

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

High-voltage series B 43 503

Rated voltage V_R[1]		200 V dc[2]	400 V dc
Rated capacitance C_R µF	Tolerance	Rated dimensions $d \times l$ Code	
47	±20 % ≙ M		22 × 25 -F476-M
68			22 × 30 -F686-M
			25 × 25 -P686-M
100			22 × 35 -F107-M
			25 × 30 -P107-M
150		22 × 25 -B157-M	25 × 40 -F157-M
			30 × 30 -N157-M
220		22 × 30 -B227-M	30 × 40 -F227-M
		25 × 25 -K227-M	
330		22 × 35 -B337-M	30 × 50 -E337-M
		25 × 30 -K337-M	
470		25 × 40 -B477-M	
		30 × 30 -J477-M	
680		30 × 35 -B687-M	

Example for the compiling of ordering codes

Low-voltage series B 41 503	High-voltage series B 43 503
B41503-A4478-M	B43503-F476-M
Code according to table	Code according to table

Special dimensions as well as other capacitance and voltage values upon request.

For packaging units refer to page 69.

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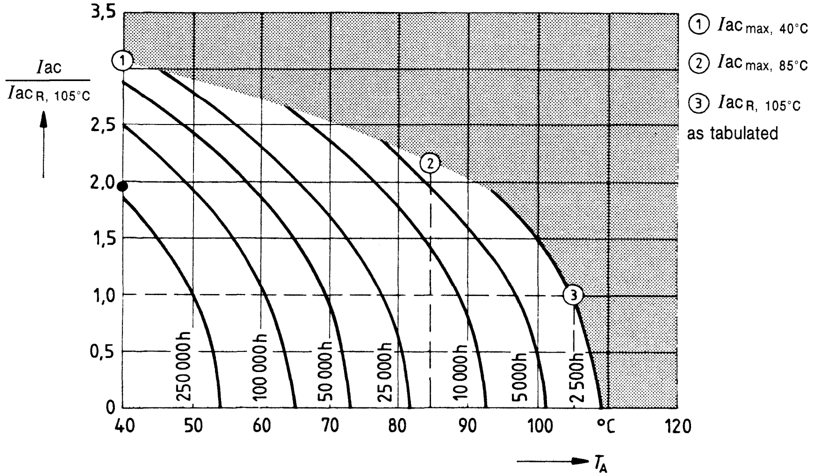
[1] Peak voltage $V_p = 1.15\ V_R$ for $V_R = 200$ V dc; 1.1 V_R for $V_R = 400$ V dc

[2] Capacitors with $V_R = 250$ V dc available upon request.

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,max}$ 100 Hz 85 °C A	$I_{ac\,R}$ 100 Hz 105 °C A	ESL approx. nH
6800	10	55	83	72	0,14	4,9	3,5	1,6	20
10000		44	66	59	0,20	5,9	4,2	1,9	20
15000		36	54	49	0,30	6,8	4,8	2,2	20
22000		31	46	43	0,44	8,1	5,7	2,6	20
33000		27	41	39	0,66	9,6	6,8	3,1	20
4700	16	60	90	78	0,15	4,7	3,5	1,6	20
6800		47	71	63	0,22	5,6	4,0	1,8	20
10000		39	58	52	0,32	6,8	4,8	2,2	20
15000		32	49	45	0,48	8,1	5,7	2,6	20
22000		28	43	40	0,71	9,3	6,6	3,0	20
3300	25	64	97	83	0,17	4,6	3,3	1,5	20
4700		51	77	67	0,24	5,3	3,7	1,7	20
6800		42	62	56	0,34	6,5	4,6	2,1	20
10000		35	52	48	0,50	7,8	5,5	2,5	20
15000		30	45	42	0,75	9,0	6,4	2,9	20
2200	40	72	110	92	0,18	4,3	3,1	1,4	20
3300		54	82	71	0,27	5,4	3,9	1,8	20
4700		44	66	59	0,38	6,2	4,8	2,2	20
6800		37	55	50	0,55	7,4	5,3	2,4	20
10000		31	47	44	0,80	9,2	6,5	3,0	20
1000	63	110	160	130	0,13	3,6	2,6	1,2	20
1500		78	120	100	0,19	4,3	3,1	1,4	20
2200		59	89	77	0,28	5,6	4,0	1,8	20
3300		46	69	62	0,42	7,0	5,0	2,3	20
4700		38	58	52	0,60	8,1	5,7	2,6	20
470	100	160	240	200	0,10	2,9	2,1	0,96	20
680		120	180	150	0,14	3,4	2,4	1,1	20
1000		87	130	110	0,20	4,6	3,1	1,4	20
1500		64	97	83	0,30	5,6	4,0	1,8	20
2200		50	75	66	0,44	7,1	5,1	2,3	20
150	200	390	580	470	0,07	1,7	1,3	0,56	20
220		270	400	330	0,10	2,2	1,6	0,72	20
330		190	280	230	0,14	2,8	2,0	0,90	20
470		140	210	170	0,19	3,7	2,7	1,2	20
680		100	150	130	0,28	4,7	3,4	1,5	20
47	400	1200	1700	1400	0,05	1,0	0,72	0,32	20
68		830	1200	1000	0,07	1,3	0,92	0,41	20
100		570	860	690	0,09	1,6	1,2	0,52	20
150		390	580	470	0,12	2,2	1,6	0,71	20
220		270	400	330	0,18	3,2	2,3	1,0	20
330		190	280	230	0,27	3,7	2,7	1,2	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and –2 V.

Service life[1])
versus ambient temperature T_A at ripple current operation



● Iac_R at 40 °C = 1.94 · Iac_R at 105 °C

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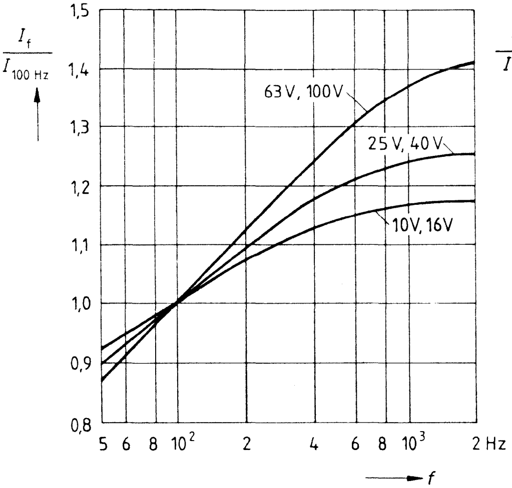
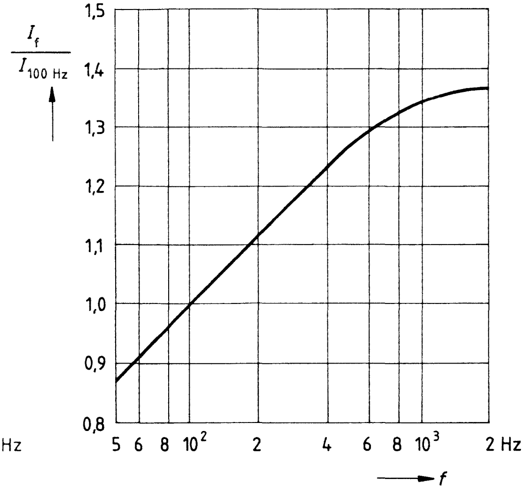
[1]) For details on service life curve refer to page 32.

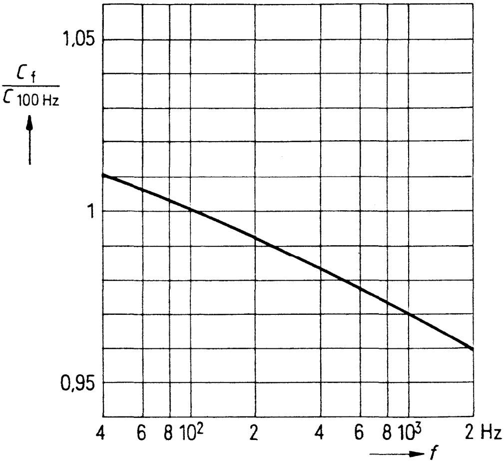
Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



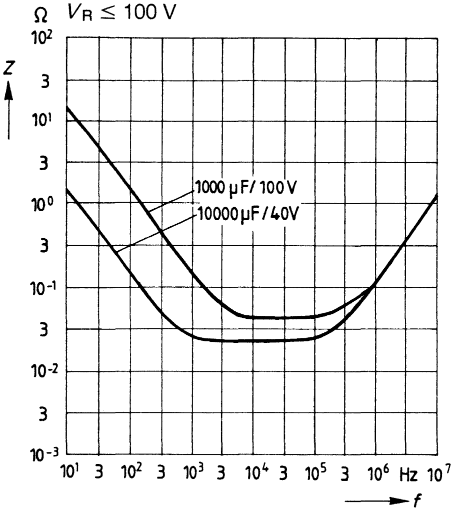
Permissible ripple current Iac
versus frequency f
$V_R \geq 200$ V



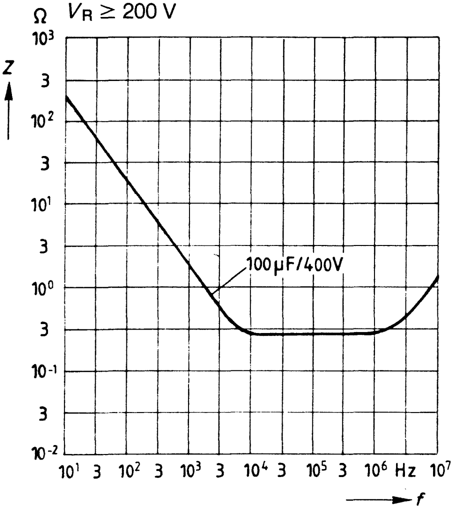
Capacitance C
versus frequency f
Typical behavior



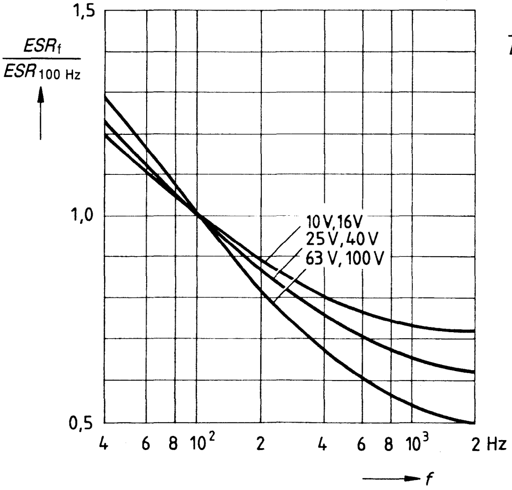
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



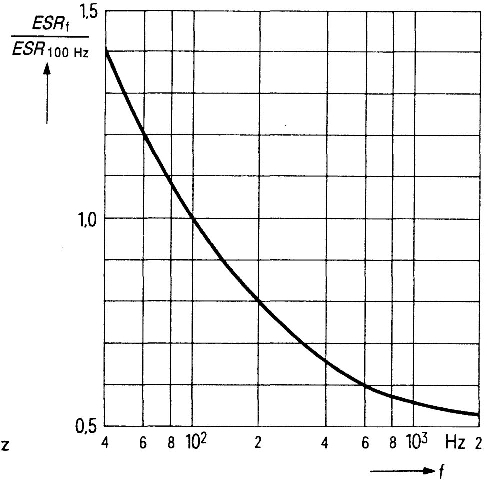
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 200$ V



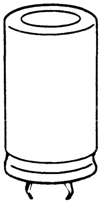
Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \geq 200$ V



68 to 47 000 µF; 22 mm to 30 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can, fully insulated
- Snap-in solder pins provide secure locking to PC board
- Marking of negative pole on can
- Negative pole not insulated from case
- All-welded construction

Features

- Low equivalent series resistance
- High ripple current capability
- Very small size, i.e. high CV product
- Two different case dimensions available for each capacitance value

Application

- Switch-mode power supplies in industrial and entertainment electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (-40 to $+85$ °C, humidity category F[1]) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h
Service life	40 °C; V_R; I_{acR}: > 40 000 h 85 °C; V_R; I_{acR}: > 2 000 h
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 100 fit ($\leq 100 \cdot 10^{-9}$/h)

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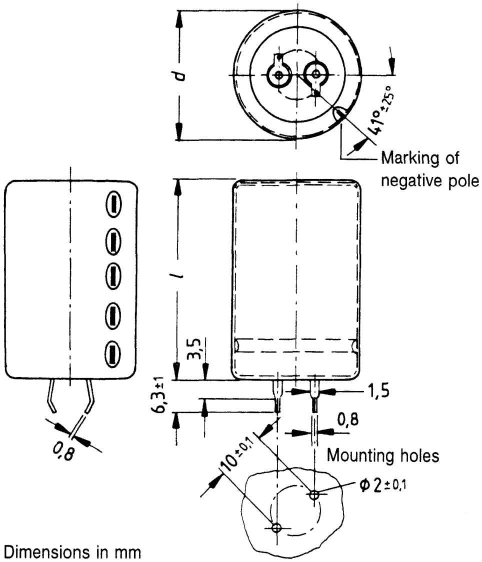
[1] These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.



Dimensions in mm

Dimensions		Approx. weight
d + 1 mm	l ± 2 mm	g
22	25	9
22	30	12
22	35	15
22	40	18
25	25	13
25	30	17
25	35	19
25	40	22
30	25	17
30	30	23
30	35	29
30	45	41
30	50	46

Low-voltage series B 41 303

Rated voltage V_R[1])		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance C_R		Rated dimensions $d \times l$ Code					
µF	Tolerance						
680	± 20 % ≙ M						22 × 30 -A9687-M
							25 × 25 -J9687-M
1 000							22 × 35 -B9108-M
							25 × 30 -J9108-M
1 500						22 × 30 -A8158-M	25 × 35 -B9158-M
						25 × 25 -J8158-M	30 × 30 -J9158-M
2 200						22 × 35 -B8228-M	30 × 35 -B9228-M
						25 × 30 -J8228-M	
3 300					22 × 30 -A7338-M	25 × 35 -B8338-M	30 × 45 -B9338-M
					25 × 25 -J7338-M	30 × 30 -J8338-M	
4 700				22 × 30 -A5478-M	22 × 35 -B7478-M	30 × 35 -B8478-M	
				25 × 25 -J5478-M	25 × 30 -J7478-M		
6 800			22 × 30 -A4688-M	22 × 35 -B5688-M	25 × 40 -A7688-M	30 × 45 -B8688-M	
			25 × 25 -J4688-M	25 × 30 -J5688-M	30 × 30 -J7688-M		
10 000		22 × 30 -A3109-M	22 × 35 -B4109-M	25 × 35 -B5109-M	30 × 35 -B7109-M		
		25 × 25 -J3109-M	25 × 30 -J4109-M	30 × 30 -J5109-M			
15 000		22 × 35 -B3159-M	25 × 40 -A4159-M	30 × 35 -B5159-M	30 × 50 -A7159-M		
		25 × 30 -J3159-M	30 × 30 -J4159-M				
22 000		25 × 40 -A3229-M	30 × 35 -B4229-M	30 × 45 -B5229-M			
		30 × 30 -J3229-M					
33 000		30 × 35 -B3339-M	30 × 45 -B4339-M				
47 000		30 × 45 -B3479-M					

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

High-voltage series B 43 303

Rated voltage V_R1)		200 V dc2)	385 V dc
Rated capacitance C_R μF	Tolerance	Rated dimensions $d \times l$ Code	
68	±20 % ≙ M		22 × 25 -F686-M
100			22 × 30 -F107-M
			25 × 25 -P107-M
150			22 × 40 -F157-M
			25 × 30 -P157-M
220		22 × 25 -B227-M	25 × 40 -F227-M
			30 × 35 -N227-M
330		22 × 30 -B337-M	30 × 45 -F337-M
		25 × 25 -K337-M	
470		22 × 40 -B477-M	
		30 × 25 -K477-M	
680		25 × 40 -B687-M	
		30 × 35 -J687-M	
1 000		30 × 45 -B108-M	

Example for the compiling of ordering codes

Low-voltage series B 41 303	High-voltage series B 43 303
B41303-A3109-M	B43303-B227-M
Code according to table	Code according to table

Special dimensions as well as other capacitance and voltage values upon request.

For packaging units refer to page 69.

---

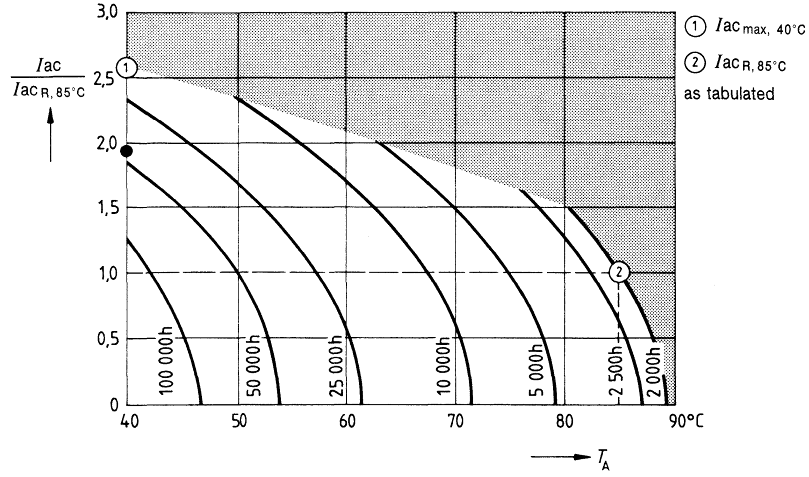
1) Peak voltage $V_p = 1.15\ V_R$ for $V_R = 200$ V dc; 1.1 V_R for $V_R = 385$ V dc

2) Capacitors with $V_R = 250$ V dc available upon request

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,max}$ 5 min 20 °C mA	$I_{ac max}$ 100 Hz 40 °C A	I_{acR} 100 Hz 85 °C A	ESL approx. nH
10 000	10	44	66	59	0,42	4,7	1,8	20
15 000		36	54	49	0,62	5,6	2,2	20
22 000		31	46	43	0,90	6,7	2,6	20
33 000		27	41	39	1,34	7,3	2,8	20
47 000		25	38	36	1,90	8,3	3,2	20
6 800	16	47	71	59	0,46	4,5	1,8	20
10 000		39	58	52	0,66	5,2	2,0	20
15 000		32	49	45	0,98	6,4	2,5	20
22 000		28	43	40	1,43	7,3	2,8	20
33 000		26	39	37	2,13	8,1	3,1	20
4 700	25	51	77	67	0,49	4,4	1,7	20
6 800		42	62	56	0,70	4,9	1,9	20
10 000		35	52	48	1,02	5,5	2,3	20
15 000		30	45	42	1,52	7,0	2,7	20
22 000		27	40	38	2,22	8,1	3,1	20
3 300	40	54	77	71	0,55	4,4	1,7	20
4 700		44	66	59	0,77	4,9	1,9	20
6 800		37	55	50	1,11	6,1	2,4	20
10 000		31	47	44	1,62	6,8	2,6	20
15 000		28	41	39	2,42	8,4	3,3	20
1 500	63	78	120	100	0,40	3,5	1,4	20
2 200		59	89	77	0,57	4,2	1,6	20
3 300		46	69	62	0,85	5,2	2,0	20
4 700		38	58	52	1,20	6,2	2,4	20
6 800		33	49	45	1,73	7,3	2,8	20
680	100	120	180	150	0,29	2,9	1,1	20
1 000		87	130	110	0,42	3,4	1,3	20
1 500		64	97	83	0,62	4,4	1,7	20
2 200		50	75	66	0,90	5,5	2,1	20
3 300		40	60	54	1,34	6,5	2,5	20
220	200	270	400	330	0,20	1,7	0,67	20
330		190	280	230	0,28	2,2	0,85	20
470		140	210	170	0,40	2,9	1,1	20
680		100	150	130	0,56	3,6	1,4	20
1 000		75	110	96	0,82	4,7	1,8	20
68	385	830	1200	1000	0,12	0,98	0,38	20
100		570	860	690	0,17	1,3	0,49	20
150		390	580	470	0,25	1,7	0,65	20
220		270	400	330	0,36	2,2	0,86	20
330		190	280	230	0,53	3,2	1,2	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and –2 V.

Service life[1])
versus ambient temperature T_A at ripple current operation

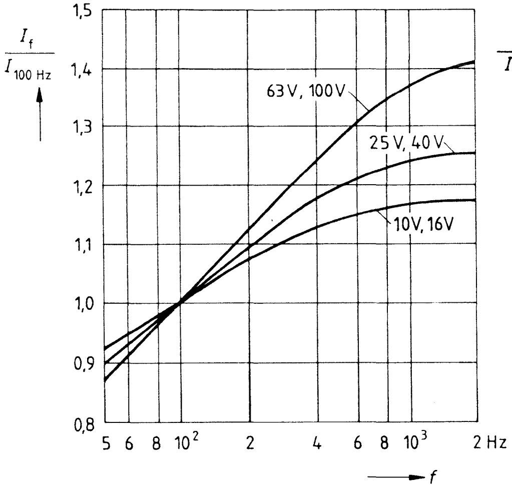


● $I\text{ac}_R$ at 40 °C = 1.94 · $I\text{ac}_R$ at 85 °C

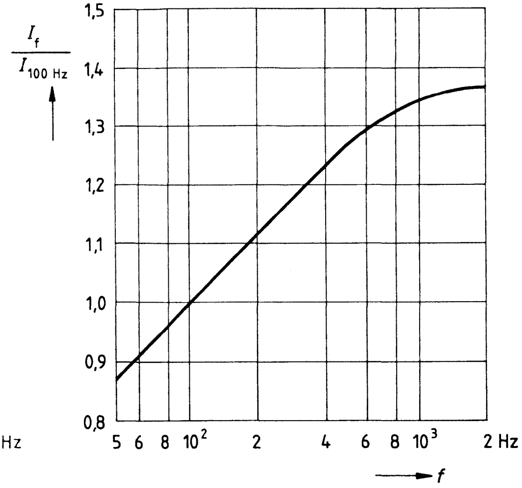
---

[1]) For details on service life curve refer to page 32.

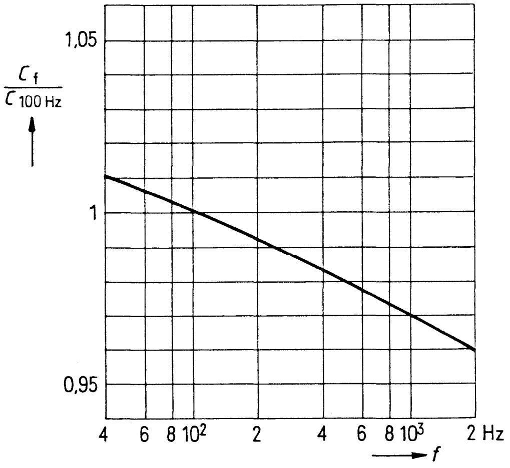
Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



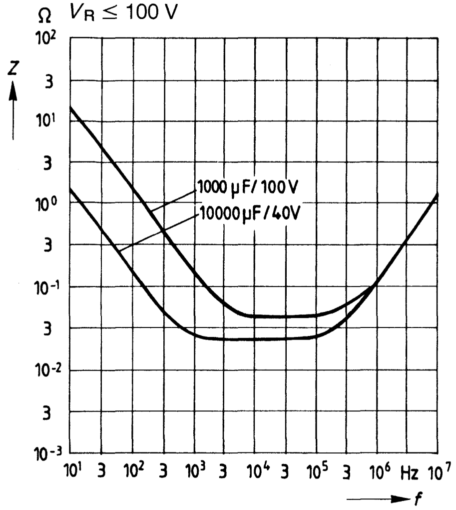
Permissible ripple current Iac
versus frequency f
$V_R \geq 200$ V



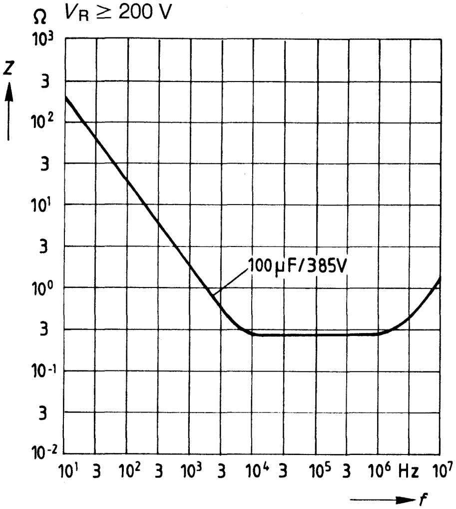
Capacitance C
versus frequency f
Typical behavior



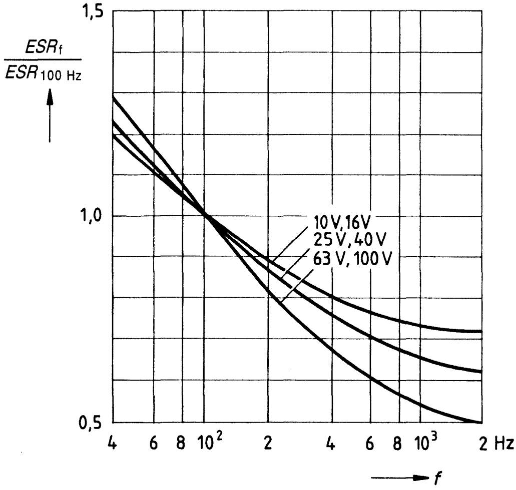
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



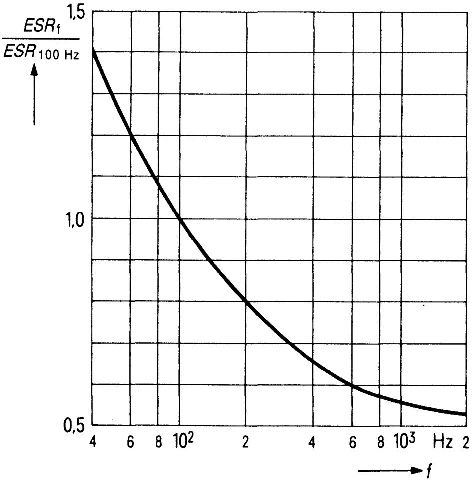
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 200$ V



Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V

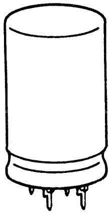


Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \geq 200$ V



Al Electrolytic Capacitors 10 to 385 V dc LL Grade B 41507 B 43507

100 to 100000 µF; 25.8 mm to 40.8 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can, fully insulated
- Solder pins brought out to fit standardized lead spacing
- Surge protection by preset breaking point in case shell
- Negative pole brought out to solder pin, but not insulated from case

Features

- High reliability and high ripple current capability
- Very small size, i.e. high volumetric efficiency
- Low series resistance and low self-inductance
- Pinning ensures correct insertion

Application

- Switch-mode power supplies in industrial and consumer electronics
- Professional switch-mode power supplies with long service life

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	Dimensions in acc. with DIN 41268
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C, humidity category F[1]) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: frequency range 10 to 55 Hz, acceleration max. 10 *g* for 25 mm dia. and max. 5 *g* for ≥ 30 mm dia., duration 3 × 2 h.

	Operating conditions	$V_R \le 63$ V	$V_R > 63$ V
Service life	40 °C; V_R; I_{acR}	> 230000 h	> 110000 h
	85 °C; V_R; I_{acR}	> 10000 h	> 5000 h
Fraction failure	≤ 1 % (during service life)		
Failure rate		≤ 40 fit ($\le 40 \cdot 10^{-9}$/h)	≤ 100 fit ($\le 100 \cdot 10^{-9}$/h)

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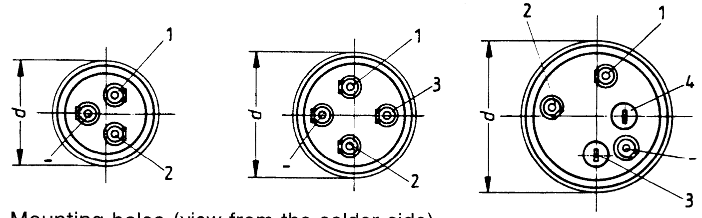
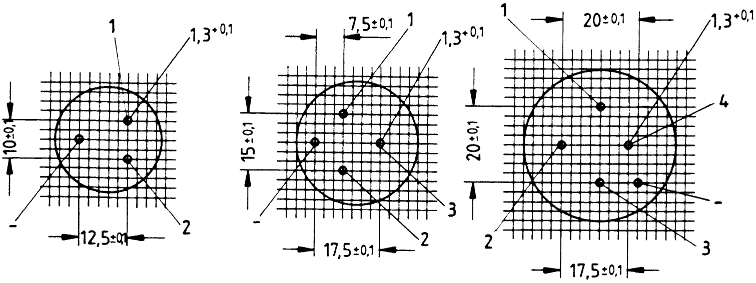
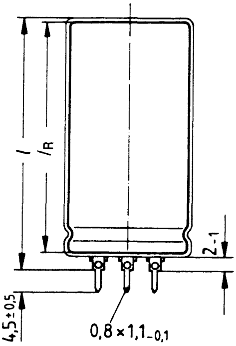
[1] These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.

25 mm dia. 30 and 35 mm dia. 40 mm dia.



Mounting holes (view from the solder side)





Dimensions in mm

Marking of positive pole: 1
negative pole: –

All drill holes should be provided since the undefined solder pins serve as support. These pins must be soldered-in either potential-free or with the same potential as the negative pole.

d_{max} (mm)	25,8	25,8	25,8	30,8	30,8	35,8	35,8	40,8	40,8	40,8
l_{max} (mm)	34	39	44	44	49	44	54	54	74	104
d_R (mm)	25	25	25	30	30	35	35	40	40	40
l_R (mm)	30	35	40	40	45	40	50	50	70	100
Approx. weight g	22	22	29	36	36	48	59	76	103	153

Low-voltage series B 41 507

Rated voltage V_R[1])		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code					
1 000	±20 % ≙ M						25 × 40 -B9108-M
2 200						25 × 35 -A8228-M	35 × 40 -B9228-M
4 700				25 × 30 -B5478-M	25 × 40 -B7478-M	30 × 45 -A8478-M	40 × 50 -B9478-M
10 000		25 × 30 -B3109-M	25 × 40 -B4109-M	30 × 40 -B5109-M	35 × 40 -B7109-M	35 × 50 -B8109-M	40 × 100 -B9109-M
22 000		30 × 40 -B3229-M	35 × 40 -B4229-M	35 × 50 -B5229-M	40 × 50 -B7229-M	40 × 100 -B8229-M	
47 000		35 × 50 -B3479-M	40 × 50 -B4479-M	40 × 70 -B5479-M	40 × 100 -B7479-M		
100 000		40 × 70 -B3100-M	40 × 100 -B4100-M				

Example for the compiling of ordering codes

B41507-B3100-M

Code according to table

High-voltage series B 43 507

Rated voltage V_R[1])		200 V dc[2])	385 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code	
100	±20 % ≙ M		25 × 40 -F107-M
150			30 × 40 -F157-M
220		25 × 40 -B227-M	35 × 40 -F227-M
470		35 × 40 -B477-M	40 × 50 -F477-M
680		35 × 50 -B687-M	40 × 70 -F687-M
1 000		40 × 50 -B108-M	40 × 100 -F108-M
2 200		40 × 100 -B228-M	

Example for the compiling of ordering codes

B43507-F107-M

Code according to table

Special dimensions as well as other capacitance and voltage values available upon request.
For packaging units refer to page 69.

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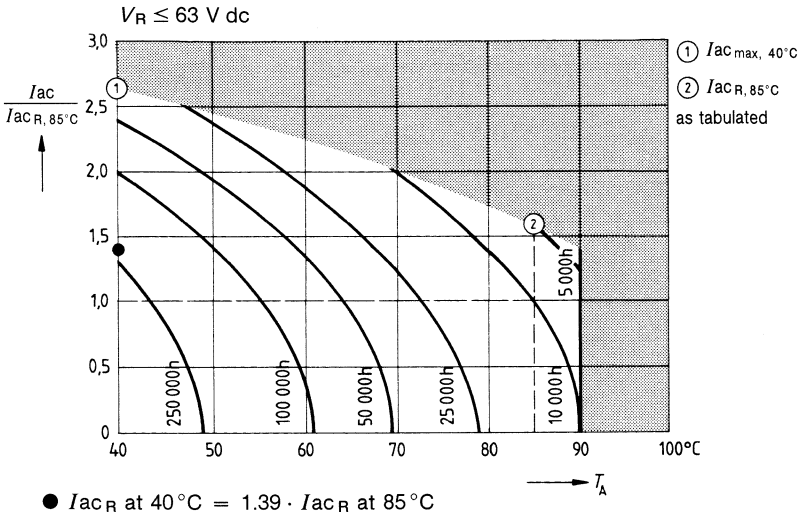
[1]) Peak voltage $V_p = 1.15\ V_R$ for 10 to 200 V dc; 1.1 V_R for 385 V dc

[2]) Capacitors with $V_R = 250$ V dc available upon request.

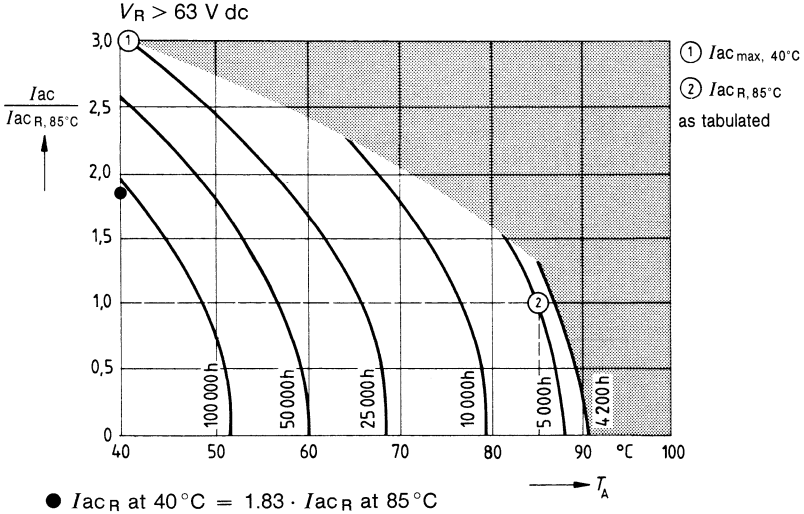
C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r, max}$ 5 min 20 °C mA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	$I_{ac\,max}$ 100 Hz 85 °C A	ESL approx. nH
10 000	10	46	98	81	0,20	6,5	2,5	4,0	10
22 000		30	51	46	0,44	9,4	3,6	5,8	10
47 000		20	35	32	0,94	13	5,1	8,2	10
100 000		17	34	21	2,0	17	6,4	10	10
10 000	16	36	62	56	0,32	7,8	3,0	4,8	10
22 000		24	44	42	0,71	12	4,6	7,4	10
47 000		17	35	28	1,5	15	5,8	9,3	10
100 000		13	20	16	3,2	22	8,4	13	10
4 700	25	46	87	84	0,24	6,5	2,5	4	10
10 000		28	48	46	0,50	9,6	3,7	5,9	10
22 000		20	33	32	1,1	13	5,1	8,2	10
47 000		14	24	23	2,4	18	7,0	11	10
4 700	40	36	60	59	0,38	7,8	3,0	4,8	10
10 000		24	42	41	0,80	12	4,6	7,4	10
22 000		18	35	34	1,8	15	5,6	9,0	10
47 000		13	20	19	3,8	22	8,4	13	10
2 200	63	45	87	84	0,28	6,5	2,5	4,0	10
4 700		30	50	49	0,60	9,4	3,6	5,8	10
10 000		20	36	33	1,3	13	5,1	8,2	10
22 000		13	20	18	2,8	22	8,4	13	10
1 000	100	58	110	88	0,20	7,2	2,4	3,3	10
2 200		31	60	48	0,44	12	4,1	5,3	10
4 700		20	36	31	0,94	16	5,3	7,6	10
10 000		13	25	22	2,0	24	8,1	12	10
220	200	220	410	350	0,09	2,7	0,9	1,2	10
470		100	200	170	0,19	5,4	1,8	2,3	10
680		77	140	120	0,28	6,0	2,0	2,6	10
1 000		55	100	88	0,40	7,5	2,5	3,3	10
2 200		30	55	48	0,88	12	4,1	5,3	10
100	385	480	890	750	0,08	1,8	0,6	0,8	10
150		320	600	500	0,12	2,4	0,8	1,0	10
220		220	410	350	0,17	3,6	1,2	1,6	10
470		100	200	170	0,37	5,4	1,8	2,3	10
680		77	140	120	0,53	6,9	2,3	3,0	10
1 000		55	100	88	0,77	9,0	3,0	3,9	10

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

Service life[1]**)**
versus ambient temperature T_A at ripple current operation



● $I_{ac\,R}$ at 40 °C = 1.39 · $I_{ac\,R}$ at 85 °C



● $I_{ac\,R}$ at 40 °C = 1.83 · $I_{ac\,R}$ at 85 °C

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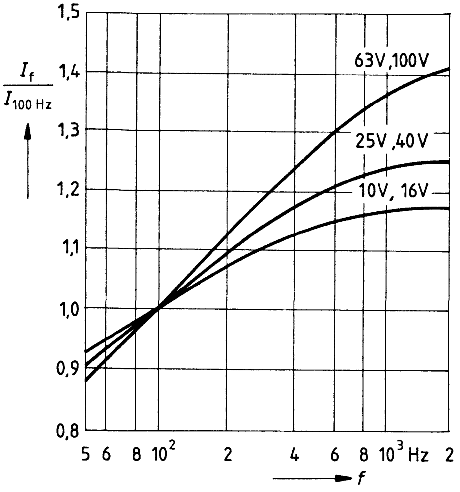
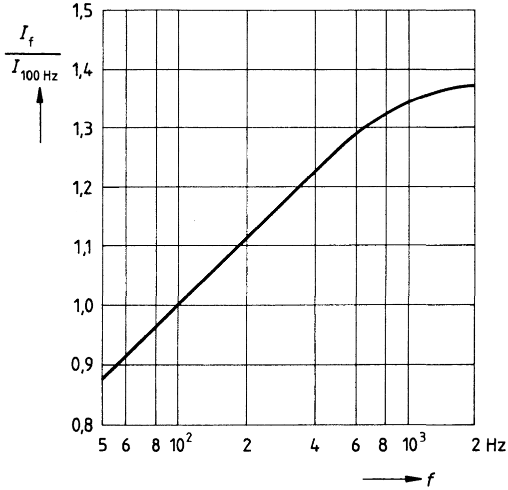
[1]) For details on service life curve refer to page 32.

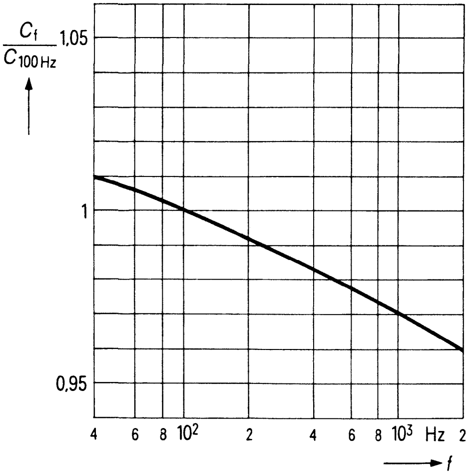
Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



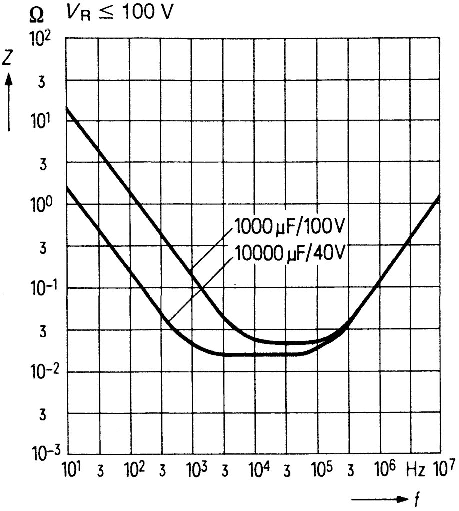
Permissible ripple current Iac
versus frequency f
$V_R \geq 200$ V



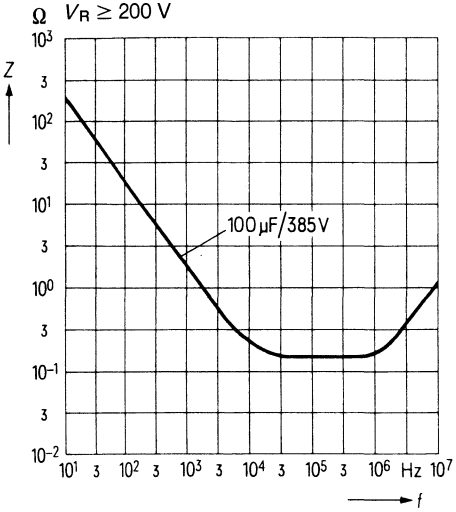
Capacitance C
versus frequency f
Typical behavior



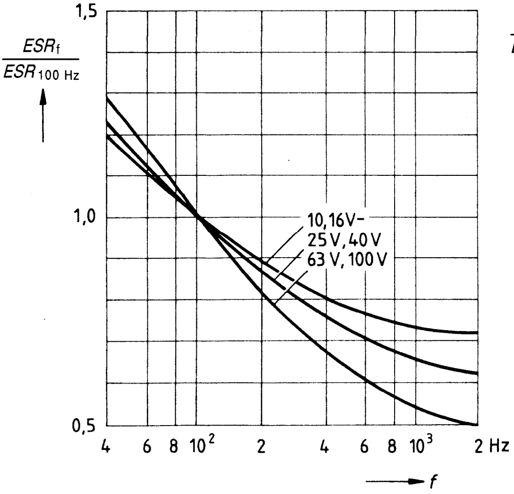
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



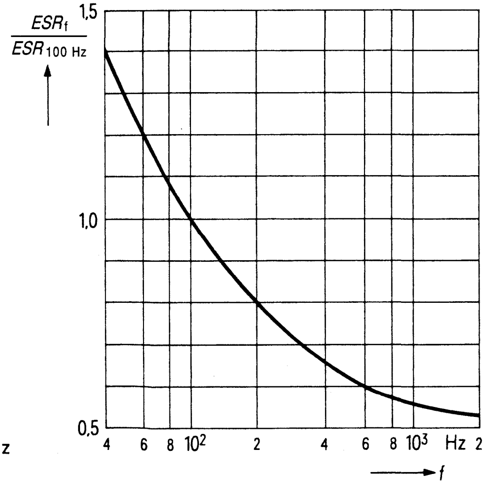
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 200$ V



Equivalent series resistance ***ESR***
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



Equivalent series resistance ***ESR***
versus frequency *f*
Typical behavior
$V_R \geq 200$ V

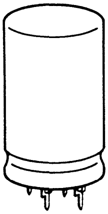


Al Electrolytic Capacitors

16 to 385 V dc
GP Grade

B 41 306
B 43 306

100 to 47 000 µF; 25.8 mm to 40.8 mm dia.



Construction

- Surge-proof electrolytic capacitor in aluminum can, fully insulated
- Solder pins brought out to fit standardized lead spacing
- Surge protection by preset breaking point in the case shell
- Negative pole brought out to solder pin, but not insulated from case

Features

- Standard version with high ripple current capability
- Welded terminal connections ensure reliable contacting
- Low series resistance and low self-inductance
- Pinning ensures correct insertion

Application

- Particularly suitable for switch-mode power supplies in consumer electroncis
- Industrial applications, e.g. in control systems

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4[1] DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 238
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C, humidity category F[2]) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: frequency range 10 to 55 Hz, acceleration max. 10 *g* for 25 mm dia. and max. 5 *g* for ≥ 30 mm dia., duration 3 × 2 h

Service life	Operating conditions	$V_R \leq 100$ V	$V_R \geq 100$ V
	40 °C; V_R; $I_{ac\,R}$	> 90 000 h	> 70 000 h
	85 °C; V_R; $I_{ac\,R}$	> 4 000 h	> 3 000 h
Fraction failure	≤ 1 % (during service life)		
Failure rate		≤ 40 fit ($\leq 40 \cdot 10^{-9}$/h)	≤ 100 fit ($\leq 100 \cdot 10^{-9}$/h)

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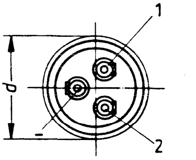
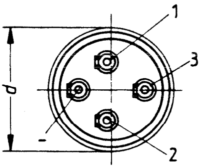
[1] These capacitors comply with the test requirements for Long Life Grade.

[2] These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.

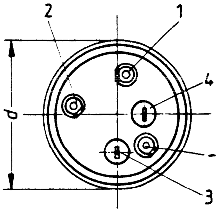
25 mm dia.



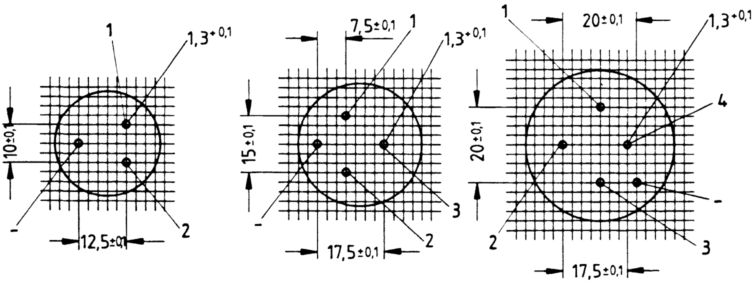
30 and 35 mm dia.

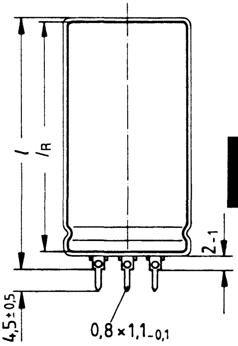


40 mm dia.



Mounting holes (view from the solder side)





Dimensions in mm

Marking of positive pole: 1
negative pole: –

All drill holes should be provided since the undefined solder pins serve as support. These pins must be soldered-in either potential-free or with the same potential as the negative pole.

d_{max}	(mm)	25,8	25,8	30,8	30,8	30,8	35,8	35,8	40,8	40,8
l_{max}	(mm)	34	44	44	54	74	54	74	54	74
d_R	(mm)	25	25	30	30	30	35	35	40	40
l_R	(mm)	30	40	40	50	70	50	70	50	70
Approx. weight g		20	28	34	42	58	57	78	73	100

Low-voltage series B 41 306

Rated voltage V_R 1)		16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance		Rated dimensions $d \times l$				
μF	Tolerance	Code				
470	$^{-10}_{+50}\,\% \mathrel{\hat{=}} \mathrm{T}$					25 × 40 -E9477-T
1 000					25 × 40 ◥ -E8108-T	30 × 40 -E9108-T
2 200			25 × 30 -F5228-T	30 × 40 ◥ -E7228-T	30 × 40 ◥ -E8228-T	35 × 50 -E9228-T
4 700		25 × 30 ◥ -F4478-T	30 × 40 -E5478-T	30 × 40 ◥ -E7478-T	35 × 50 ◥ -E8478-T	40 × 70 -E9478-T
10 000		30 × 40 ◥ -E4109-T	30 × 50 -E5109-T	30 × 50 ◥ -F7109-T	40 × 70 -F8109-T	
22 000		30 × 70 ◥ -E4229-T	40 × 70 -E5229-T			
47 000		40 × 70 -E4479-T				

Example for the compiling of ordering codes

B41306-E7228-T

Code according to table

High-voltage series B 43 306

Rated voltage V_R 1)		250 V dc	350 V dc	385 V dc
Rated capacitance		Rated dimensions $d \times l$		
μF	Tolerance	Code		
100	$^{-10}_{+50}\,\% \mathrel{\hat{=}} \mathrm{T}$	25 × 40 -E2107-T	30 × 40 ◥ -E4107-T	30 × 40 -E107-T
150				30 × 40 ◥ -E157-T
220		30 × 40 -E2227-T	30 × 50 ◥ -E4227-T	30 × 50 ◥ -E227-T
470		30 × 50 -F2477-T	40 × 50 -E4477-T	40 × 70 -E477-T
1 000		40 × 70 -E2108-T		

Example for the compiling of ordering codes

B43306-E4227-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

◥ These capacitors are preferred types S (refer to page 4).

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1) Peak voltage $V_\mathrm{P} = 1.15\ V_\mathrm{R}$ for 16 to 250 V dc; 1.1 V_R for 350 V dc and 385 V dc

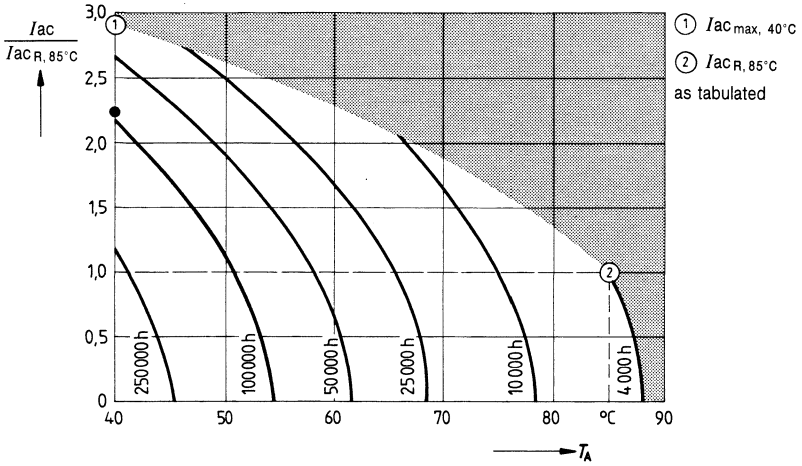
C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r,\,max}$ 5 min 20 °C mA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
◥ 4700	16	48	95	81	0,32	5,5	1,9	10
◥ 10000		34	63	54	0,66	7,5	2,6	10
◥ 22000		24	41	36	1,4	11	3,7	10
47000		17	30	27	3,0	15	5,0	10
2200	25	60	112	90	0,24	4,9	1,7	10
4700		39	68	54	0,49	7,0	2,4	10
10000		26	47	36	1,0	9,3	3,2	10
22000		19	32	27	2,2	14	4,7	10
◥ 2200	40	48	86	72	0,37	6,4	2,2	10
◥ 4700		30	54	45	0,77	8,1	2,8	10
◥ 10000		20	36	31	1,6	12	3,2	10
◥ 1000	63	75	135	83	0,27	4,6	1,6	10
◥ 2200		44	77	54	0,57	6,7	2,3	10
◥ 4700		27	49	36	1,2	9,9	3,4	10
10000		19	32	27	2,5	15	4,4	10
470	100	110	234	108	0,21	3,8	1,3	10
1000		67	126	63	0,42	5,2	1,8	10
2200		38	72	40	0,90	8,4	2,9	10
4700		24	45	27	1,9	12	4,2	10
100	250	540	1350	1100	0,12	1,7	0,6	10
220		250	630	500	0,24	2,9	1,0	10
470		120	300	240	0,49	3,8	1,3	10
1000		54	160	120	1,0	8,1	2,8	10
◥ 100	350	470	1180	920	0,16	2,0	0,7	10
◥ 220		220	550	470	0,33	3,2	1,1	10
470		100	250	210	0,68	5,2	1,8	10
100	385	470	1180	900	0,17	2,0	0,7	10
◥ 150		320	800	600	0,25	2,3	0,8	10
◥ 220		220	550	410	0,36	3,2	1,1	10
470		100	250	190	0,74	5,8	2,0	10

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

◥ These capacitors are preferred types **S** (refer to page 4).

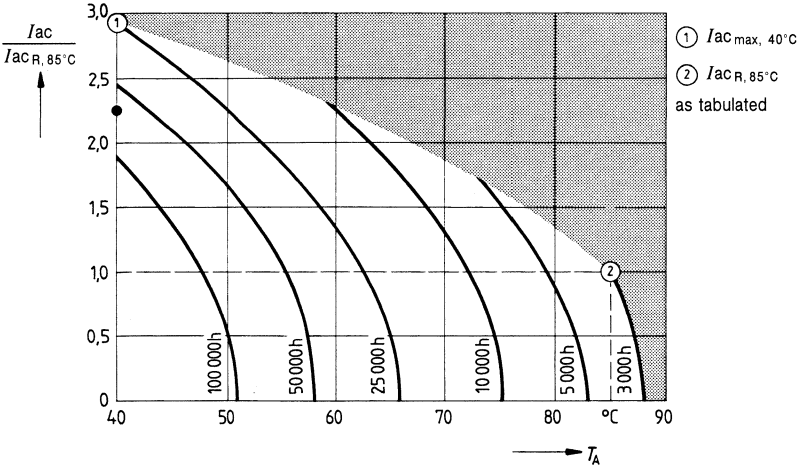
Service life[1])
versus ambient temperature T_A at ripple current operation

Type B 41 306 ($V_R \leq 100$ V)



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

Type B 43 306 ($V_R > 100$ V)



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

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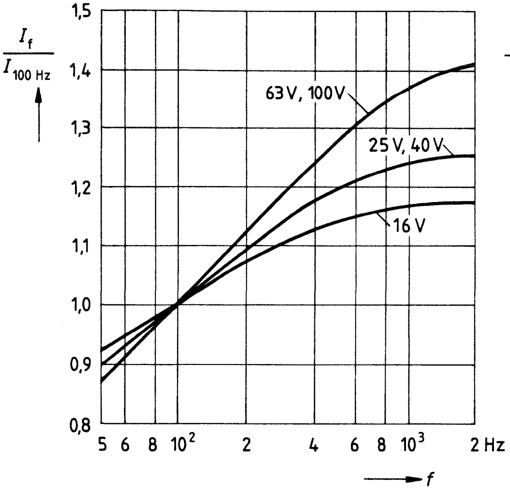
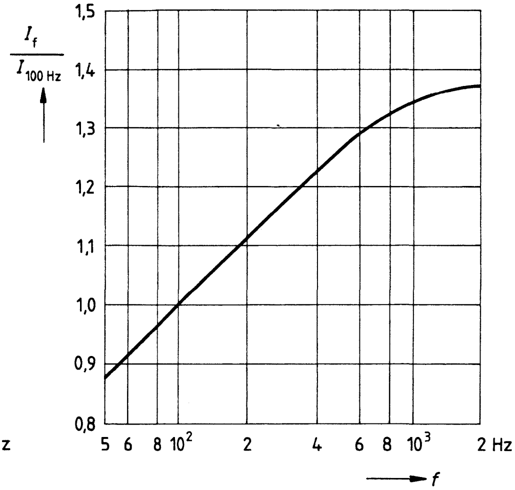
[1]) For details on service life curve refer to page 32.

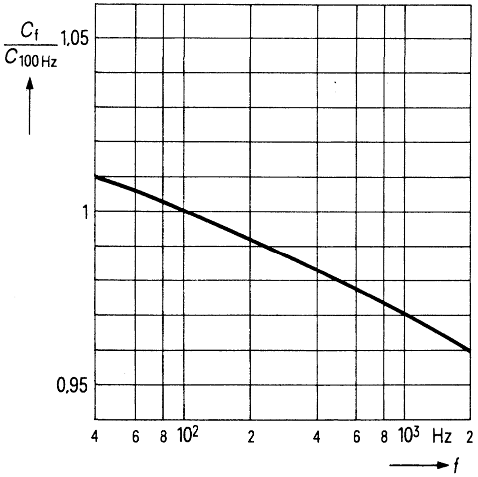
Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



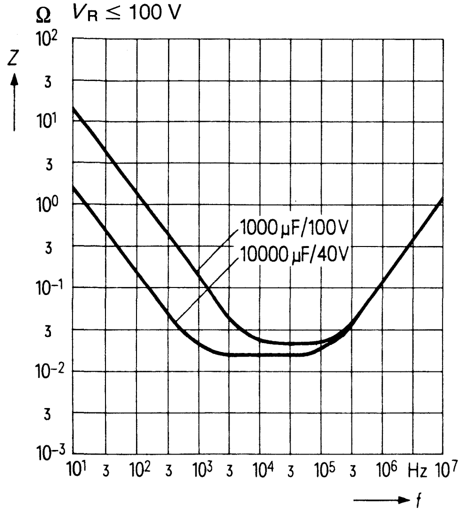
Permissible ripple current Iac
versus frequency f
$V_R \geq 250$ V



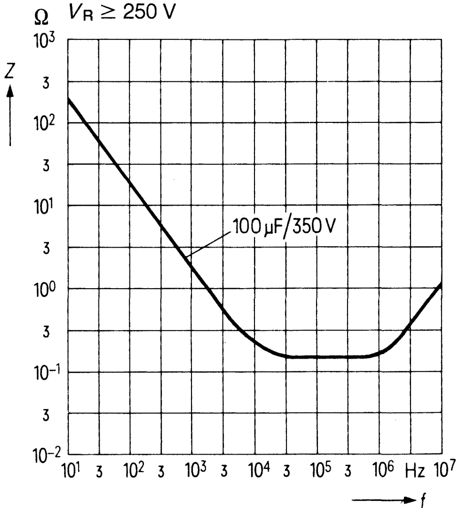
Capacitance C
versus frequency f
Typical behavior



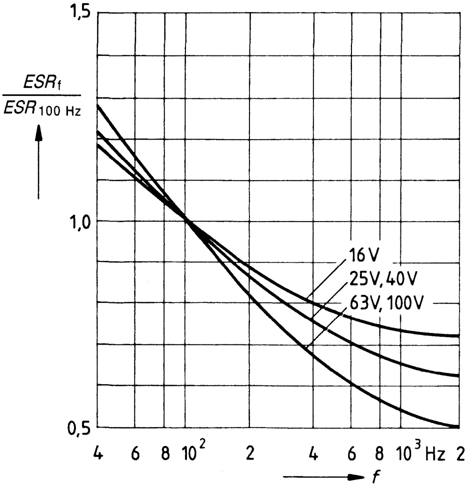
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V



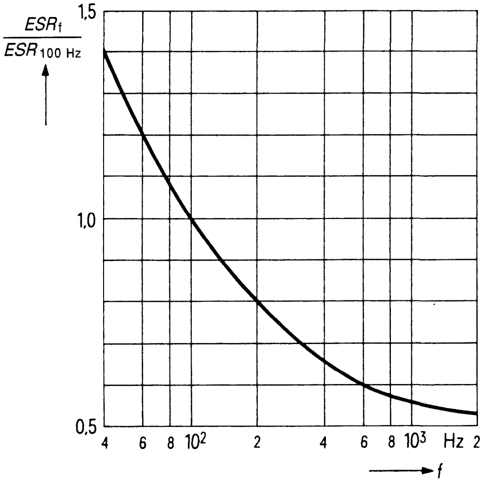
Impedance *Z*
versus frequency *f*
Typical behavior
$V_R \geq 250$ V



Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \leq 100$ V

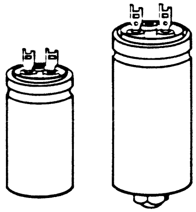


Equivalent series resistance *ESR*
versus frequency *f*
Typical behavior
$V_R \geq 250$ V



Al Electrolytic Capacitors 16 to 100 V dc GP Grade B 41 070 B 41 072

470 to 47 000 µF; 25 mm to 40 mm dia.



B 41 070 B 41 072

Construction

- Surge-proof electrolytic capacitor in aluminum can without insulating sleeve
- Poles brought out to solid solder tags
- Negative pole not insulated from case
- Mounting with ring clips (B 41 070) or with threaded stud (B 41 072)

Features

- Solder tags for conventional connection by wire or litz wire
- Particularly suitable for production in small quantities

Application

- Switch-mode power supplies in consumer and industrial electronics

Accessories

- Included in delivery (loosely):
  hex nut, toothed washers (for B 41 072)
- Not included in delivery:
  ring clips, insulating strips B 44 030, page 263
  (for B 41 070)
  insulating parts for insulated mounting B 44 020, page 260
  (for B 41 072)

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 238
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C, humidity category F[1]) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h
Service life	40 °C; V_R; $I_{\mathrm{ac\,R}}$: > 45 000 h 85 °C; V_R; $I_{\mathrm{ac\,R}}$: > 2 000 h
Fraction failure	≤ 2 % (during service life)
Failure rate	≤ 400 fit ($\leq 400 \cdot 10^{-9}$/h)

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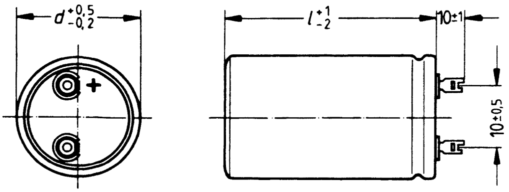
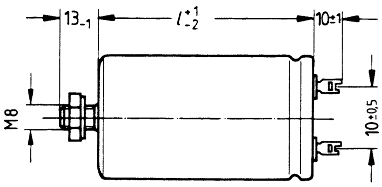
[1] These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.

Type B 41 070



Type B 41 072



Dimensions in mm

d_{R} (mm)	25	30	30	35	35	40	40
l_{R} (mm)	45	45	55	55	75	75	105
Approx. weight g	28	34	42	57	78	100	150

Type B 41 070

Rated voltage V_{R}1)		16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code				
470	-10 $+50$ % ≙ T					25 × 45 -B9477-T
1 000					25 × 45 -B8108-T	30 × 45 -C9108-T
2 200			25 × 45 -A5228-T	30 × 45 -B7228-T	30 × 45 -C8228-T	35 × 55 -L9228-T
4 700		25 × 45 -B4478-T	30 × 45 -B5478-T	30 × 55 -J7478-T	35 × 55 -K8478-T	40 × 75 -C9478-T
10 000		30 × 45 -C4109-T	35 × 55 -B5109-T	35 × 75 -K7109-T	40 × 105 -B8109-T	
22 000		35 × 75 -K4229-T	40 × 75 -L5229-T			
47 000		40 × 105 -B4479-T				

Example for the compiling of ordering codes

B41070-B5478-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

---

1) Peak voltage $V_{\mathrm{P}} = 1.15\ V_{\mathrm{R}}$

Type B 41 072

Rated voltage V_R[1]		16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance μF	Tolerance	Rated dimensions $d \times l$ Code				
470	$^{-10}_{+50}$ % ≙ T					25 × 45 -B9477-T
1 000					25 × 45 -B8108-T	30 × 45 -C9108-T
2 200			25 × 45 -A5228-T	30 × 45 -B7228-T	30 × 45 -C8228-T	35 × 55 -L9228-T
4 700		25 × 45 -B4478-T	30 × 45 -B5478-T	30 × 55 -C7478-T	35 × 55 -L8478-T	40 × 75 -C9478-T
10 000		30 × 45 -C4109-T	35 × 55 -B5109-T	35 × 75 -K7109-T	40 × 105 -B8109-T	
22 000		35 × 75 -K4229-T	40 × 75 -L5229-T			
47 000		40 × 105 -B4479-T				

Example for the compiling of ordering codes

B41072-B5478-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

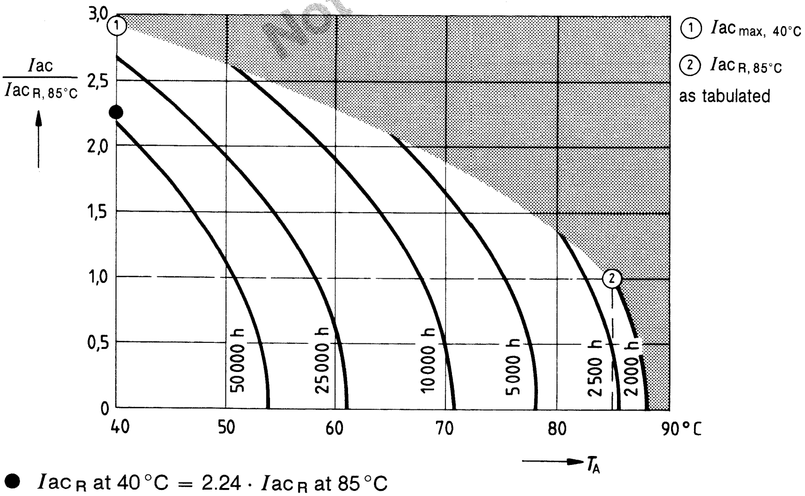
---

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

C_R µF	V_R V dc	ESR_{typ} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz 20 °C mΩ	Z_{max} 10 kHz 20 °C mΩ	$I_{r, max}$ 5 min 20 °C mA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
4700	16	48	94	93	0,32	5,8	2,0	20
10000		34	62	51	0,66	7,5	2,6	20
22000		24	44	31	1,4	12	4,0	20
47000		17	31	22	3,0	16	5,5	20
2200	25	60	150	140	0,24	5,2	1,8	20
4700		39	83	70	0,49	7,0	2,4	20
10000		26	53	40	1,0	9,9	3,4	20
22000		19	40	25	2,2	14	4,7	20
2200	40	48	120	120	0,37	6,4	2,2	20
4700		30	75	63	0,77	8,4	2,9	20
10000		20	48	37	1,6	13	4,4	20
1000	63	75	190	190	0,27	4,6	1,6	20
2200		44	110	91	0,57	6,7	2,3	20
4700		27	68	53	1,2	9,9	3,4	20
10000		19	44	31	2,5	15	5,2	20
470	100	110	280	260	0,21	3,8	1,3	20
1000		67	170	140	0,42	5,2	1,8	20
2200		38	95	76	0,90	8,4	2,9	20
4700		24	60	44	1,9	12	4,2	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

Service life[1])
versus ambient temperature T_A at ripple current operation



● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 85 °C

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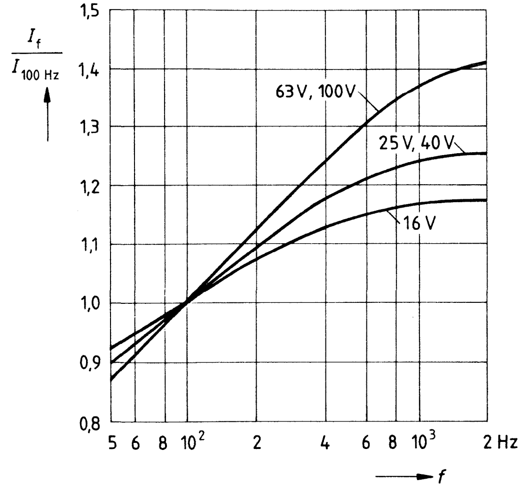
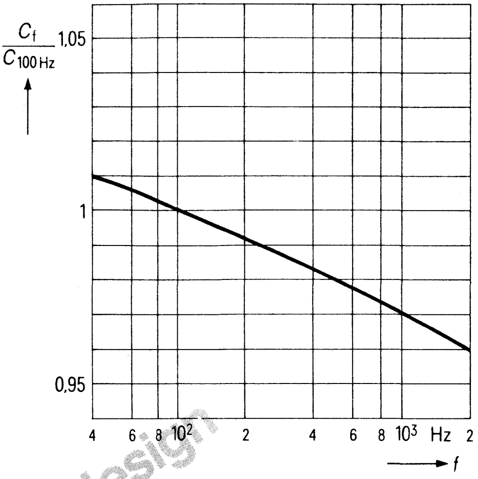
[1]) For details on service life curve refer to page 32.

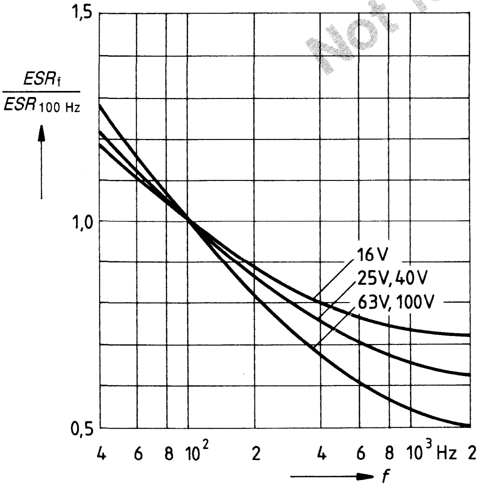
Permissible ripple current I_{ac}
versus frequency f



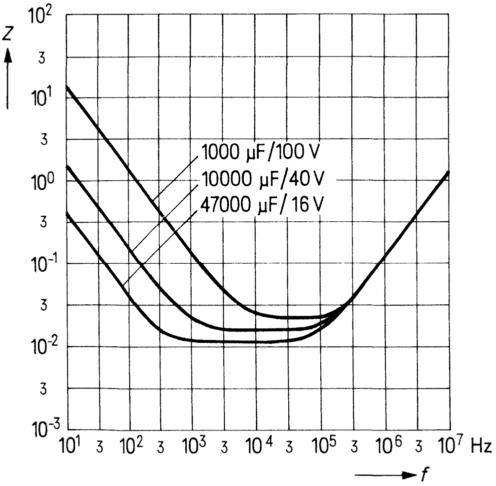
Capacitance C
versus frequency f
Typical behavior



Equivalent series resistance ESR
versus frequency f
Typical behavior



Impedance Z
versus frequency f
Typical behavior



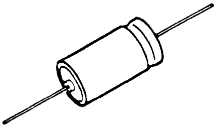
Aluminum Electrolytic Capacitors

Small Capacitors, LL and GP Grade

Axial, upright, single-ended

Al Electrolytic Capacitors 10 to 350 V dc LL Grade B 41588 B 43588

1 to 4700 µF; 7.0 mm to 25.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Negative pole connected to case
- Axial leads; welded terminal connections ensure reliable contacting

Features

- High reliability and long service life
- Operation up to 105 °C[1]) permissible
- High parametric stability
- High ripple current capability

Application

- Professional equipment in industrial electronics
- Filtering, coupling and pulse circuits
- Automotive electroncis

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	DIN 41257
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[2])) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 x 2 h

Service life

Operating conditions	B 41588 B 43588 dia. ≤ 8.5 mm	B 41588 dia. ≥ 10 mm	B 43588 dia. ≥ 10 mm
40 °C; V_R; I_{acR}	> 135000 h	> 220000 h	> 180000 h
85 °C; V_R; I_{acR}	> 6000 h	> 10000 h	> 8000 h

Fraction failure ≤0.5 % (during service life)

Failure rate

	≤ 50 fit (≤ 50 · 10^{-9}/h)	≤ 20 fit (≤ 20 · 10^{-9}/h)	≤ 20 fit (≤ 20 · 10^{-9}/h)

Taping: Capacitors with 6.5 to 16 mm dia. are also available on tape. For information on tape packaging and ordering example see chapter "Tape Packaging", page 64.

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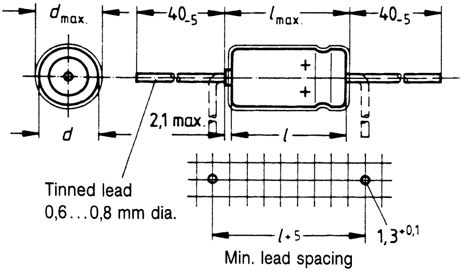
[1]) Operation at 105 °C with 0.6 $I_{ac\,max\,85\,°C}$ permissible for a total of 1500 h for dia. ≤ 8.5 mm; 2500 h permissible for dia. ≥ 10 mm, respectively.

[2]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.



Dimensions in mm

Dimensions (mm) $d \times l$ (rated dimensions)	$d_{max} \times l_{max}$ (with insulating sleeve)	Lead dia.	Approx. weight g
6,5 × 17,5	7,0 × 19	0,6	1,1
8,5 × 17,5	9,0 × 19		1,8
10 × 20	10,5 × 21,5		2,6
10 × 25	10,5 × 26,5		3,2
12 × 30	12,5 × 32	0,8	5,4
14 × 30	14,5 × 32		7,5
16 × 30	16,5 × 32		9,3
18 × 39,5	18,5 × 41,5		14
21 × 40	21,5 × 41,5		18
25 × 40	25,5 × 41,5		26

Low-voltage series B 41 588

Rated voltage V_R¹)		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code					
4,7	$^{-10}_{+50}$ % ≙ T					▨ 6,5 × 17,5 ◥ -J8475-T	▨ 8,5 × 17,5 ◥ -B9475-T
10					▨ 6,5 × 17,5 ◥ -C7106-T	▨ 8,5 × 17,5 ◥ -J8106-T	▨ 8,5 × 17,5 ◥ -C9106-T
22					▨ 8,5 × 17,5 ◥ -C7226-T	▨ 8,5 × 17,5 ◥ -J8226-T	▨ 10 × 25 ◥ -C9226-T
47		▨ 6,5 × 17,5 ◥ -C3476-T	▨ 8,5 × 17,5 ◥ -B4476-T	▨ 8,5 × 17,5 ◥ -C5476-T	▨ 8,5 × 17,5 ◥ -D7476-T	▨ 10 × 25 ◥ -J8476-T	▨ 12 × 30 ◥ -D9476-T
100		▨ 8,5 × 17,5 -C3107-T	▨ 8,5 × 17,5 ◥ -C4107-T	▨ 10 × 20 ◥ -D5107-T	▨ 10 × 25 ◥ -D7107-T	▨ 12 × 30 ◥ -J8107-T	▨ 16 × 30 ◥ -E9107-T
220		▨ 10 × 20 ◥ -D3227-T	▨ 10 × 25 ◥ -C4227-T	▨ 12 × 30 ◥ -L5227-T	▨ 12 × 30 ◥ -D7227-T	▨ 16 × 30 ◥ -B8227-T	18 × 39,5 ◥ -D9227-T
470		▨ 12 × 30 -C3477-T	▨ 12 × 30 ◥ -D4477-T	▨ 14 × 30 ◥ -E5477-T	▨ 16 × 30 ◥ -M7477-T	21 × 40 ◥ -J8477-T	25 × 40 ◥ -A9477-T
1000		▨ 14 × 30 -E3108-T	▨ 16 × 30 ◥ -M4108-T	18 × 39,5 ◥ -D5108-T	21 × 40 ◥ -D7108-T	25 × 40 -A8108-T	
2200		18 × 39,5 -C3228-T	18 × 39,5 ◥ -D4228-T	21 × 40 -A5228-T	25 × 40 -A7228-T		
4700		25 × 40 -A3478-T	25 × 40 -A4478-T				

▨ Capacitors available on tape

Example for the compiling of ordering codes

B41588-J8107-T

└── Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.
◥ These capacitors are preferred types S (refer to page 4).

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¹) Peak voltage $V_p = 1.15\ V_R$

High-voltage series B 43 588

Rated voltage V_R[1]		160 V dc	250 V dc	350 V dc
Rated capacitance		Rated dimensions $d \times l$ Code		
µF	Tolerance			
1	$\begin{matrix}-10\\+50\end{matrix}$ % ≙ T			▨ 6,5 × 17,5 -C4105-T ◥
2,2		▨ 6,5 × 17,5 -B1225-T	▨ 8,5 × 17,5 -B2225-T ◥	▨ 8,5 × 17,5 -C4225-T ◥
4,7		▨ 8,5 × 17,5 -C1475-T	▨ 10 × 20 -B2475-T ◥	▨ 10 × 20 -C4475-T ◥
10		▨ 10 × 20 -C1106-T	▨ 10 × 25 -C2106-T ◥	▨ 12 × 30 -D4106-T ◥
22		▨ 12 × 30 -C1226-T	▨ 14 × 30 -D2226-T ◥	▨ 14 × 30 -E4226-T ◥
47		▨ 14 × 30 -D1476-T	▨ 16 × 30 -M2476-T ◥	18 × 39,5 -D4476-T ◥
100		18 × 39,5 -D1107-T	21 × 40 -D2107-T ◥	25 × 40 -A4107-T
220		25 × 40 -A1227-T		

Example for the compiling of ordering codes B43588-C4105-T

Code according to table (C4105-T)

▨ Capacitors available on tape

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
◥ 47	10	0,16	2,00	5,0	0,88	5	0,29	0,10	14
100		0,16	0,95	2,4	0,43	6	0,49	0,17	17
◥ 220		0,16	0,43	1,1	0,21	8	0,83	0,28	31
470		0,16	0,20	0,5	0,11	13	1,59	0,55	37
1 000		0,16	0,10	0,25	0,07	24	2,47	0,85	38
2 200		0,17	0,06	0,14	0,05	48	4,13	1,42	57
4 700		0,18	0,05	0,07	0,05	98	5,48	1,88	34
◥ 47	16	0,14	1,6	4,0	0,82	6	0,34	0,12	17
◥ 100		0,14	0,75	1,9	0,40	7	0,52	0,18	17
◥ 220		0,14	0,36	0,9	0,20	11	0,96	0,33	35
◥ 470		0,14	0,18	0,45	0,11	19	1,7	0,57	37
◥ 1 000		0,14	0,10	0,25	0,06	36	2,7	0,92	45
◥ 2 200		0,15	0,06	0,12	0,05	74	4,1	1,42	57
4 700		0,15	0,05	0,06	0,05	154	5,5	1,88	34
◥ 47	25	0,11	1,3	3,3	0,78	6	0,41	0,14	17
◥ 100		0,11	0,60	1,5	0,38	9	0,70	0,24	31
◥ 220		0,11	0,28	0,70	0,19	15	1,3	0,46	37
◥ 470		0,11	0,16	0,40	0,10	28	1,9	0,64	38
◥ 1 000		0,11	0,10	0,19	0,06	54	3,2	1,11	57
2 200		0,13	0,06	0,10	0,05	114	4,5	1,55	30

◥ These capacitors are preferred types S (refer to page 4).

cont'd on page 208

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[1] Peak voltage $V_p = 1.15\ V_R$ for 160 and 250 V dc; 1.1 V_R for 350 V dc

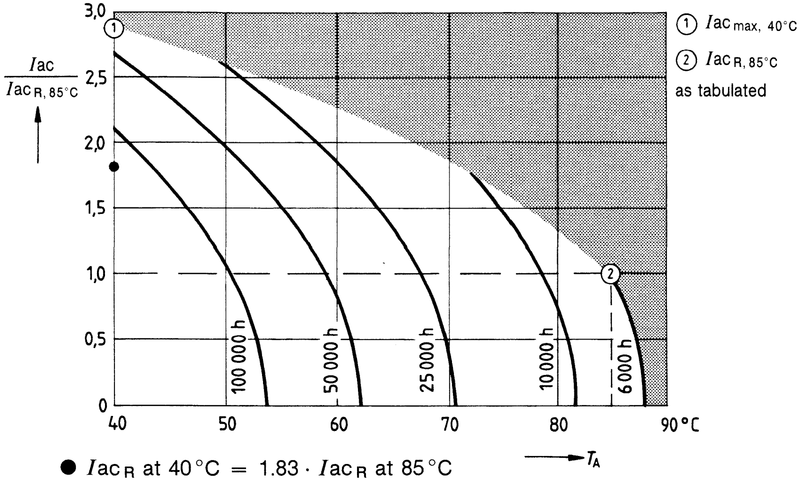
C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r, max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
◥ 10	40	0,09	5,00	13,00	3,30	5	0,17	0,06	14
◥ 22		0,09	2,20	5,50	1,50	6	0,32	0,11	17
◥ 47		0,09	1,00	2,50	0,72	8	0,46	0,16	17
◥ 100		0,09	0,50	1,25	0,36	12	0,81	0,28	35
◥ 220		0,09	0,25	0,63	0,18	22	1,40	0,49	37
◥ 470		0,09	0,13	0,33	0,10	42	2,20	0,77	45
◥ 1000		0,09	0,07	0,16	0,06	84	4,00	1,39	30
2200		0,10	0,04	0,08	0,05	180	5,90	2,00	34
◥ 4,7	63	0,07	9,50	24,00	6,50	5	0,15	0,05	14
◥ 10		0,07	4,00	10,00	3,10	5	0,23	0,08	17
◥ 22		0,07	1,80	4,50	1,40	7	0,35	0,12	17
◥ 47		0,07	0,80	2,00	0,67	10	0,64	0,22	35
◥ 100		0,07	0,40	1,00	0,33	17	1,10	0,38	37
◥ 220		0,07	0,18	0,45	0,17	32	1,90	0,65	45
◥ 470		0,07	0,10	0,25	0,09	63	3,30	1,13	30
1000		0,07	0,05	0,12	0,06	130	5,30	1,80	34
◥ 4,7	100	0,06	7,00	18,00	6,00	5	0,17	0,06	17
◥ 10		0,06	3,00	7,50	2,80	6	0,26	0,09	17
◥ 22		0,06	1,30	3,30	1,30	8	0,52	0,18	35
◥ 47		0,06	0,60	1,50	0,62	13	0,90	0,31	37
◥ 100		0,06	0,32	0,80	0,31	24	1,40	0,49	45
◥ 220		0,06	0,16	0,40	0,15	48	2,40	0,83	57
◥ 470		0,06	0,09	0,23	0,09	98	4,10	1,39	34
2,2	160	0,10	36,00	80,00	33,00	5	0,07	0,02	14
4,7		0,10	17,00	38,00	15,00	6	0,12	0,04	17
10		0,10	8,00	18,00	7,20	7	0,19	0,07	31
22		0,10	3,60	8,00	3,30	11	0,38	0,13	37
47		0,10	1,70	3,80	1,60	19	0,59	0,20	38
100		0,10	0,80	1,80	0,75	36	1,11	0,38	57
220		0,10	0,40	0,80	0,35	74	1,97	0,68	34
◥ 2,2	250	0,09	29,00	72,00	31,00	5	0,09	0,03	17
◥ 4,7		0,09	14,00	34,00	14,00	6	0,15	0,05	31
◥ 10		0,09	6,40	16,00	6,80	9	0,24	0,08	35
◥ 22		0,09	2,90	7,20	3,10	15	0,45	0,15	38
◥ 47		0,09	1,40	3,40	1,50	28	0,70	0,24	45
◥ 100		0,09	0,60	1,50	0,70	54	1,37	0,47	30
◥ 1	350	0,08	48,00	120,00	64,00	5	0,06	0,02	14
◥ 2,2		0,08	22,00	55,00	29,00	6	0,10	0,04	17
◥ 4,7		0,08	10,00	25,00	14,00	7	0,17	0,06	31
◥ 10		0,08	4,80	12,00	6,40	11	0,33	0,11	37
◥ 22		0,08	2,20	5,50	2,90	19	0,51	0,18	38
◥ 47		0,08	1,00	2,50	1,40	37	1,00	0,34	57
100		0,08	0,50	1,30	0,67	74	1,71	0,59	34

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and –2 V.

◥ These capacitors are preferred types S (refer to page 4).

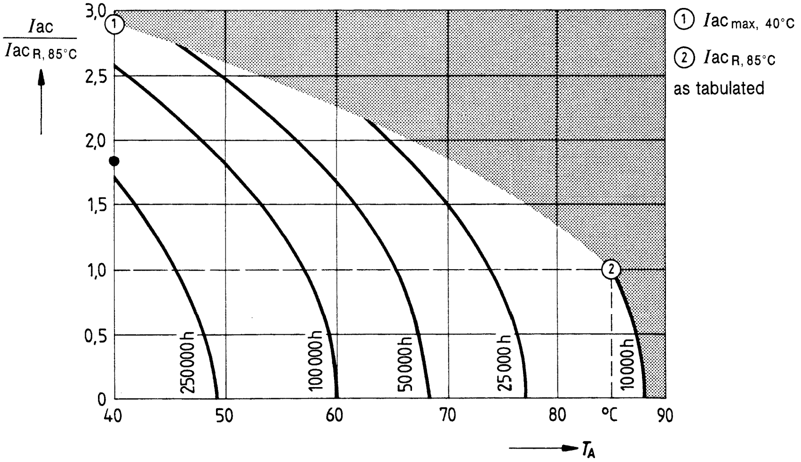
Service life[1])
versus ambient temperature T_A at ripple current operation

Type B 41 588, $d_R \leq 8.5$ mm
Type B 43 588, $d_R \leq 8.5$ mm



● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

Type B 41 588, $d_R \geq 10$ mm



● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

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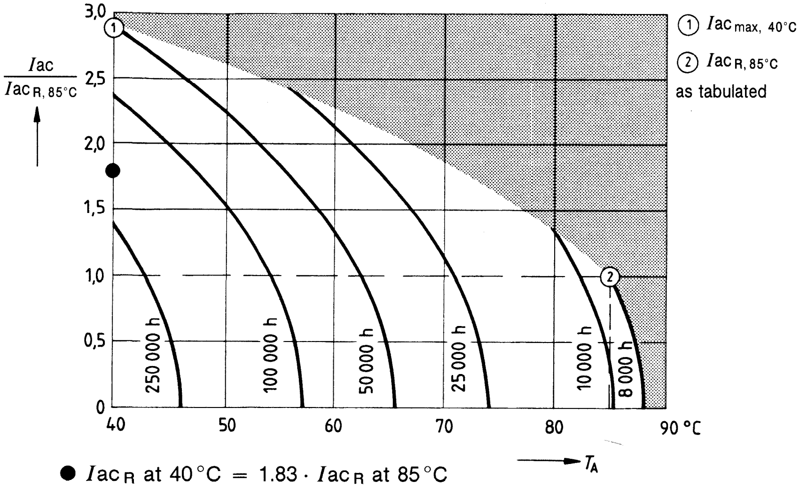
[1]) For details on service life curve refer to page 32.

Service life¹)

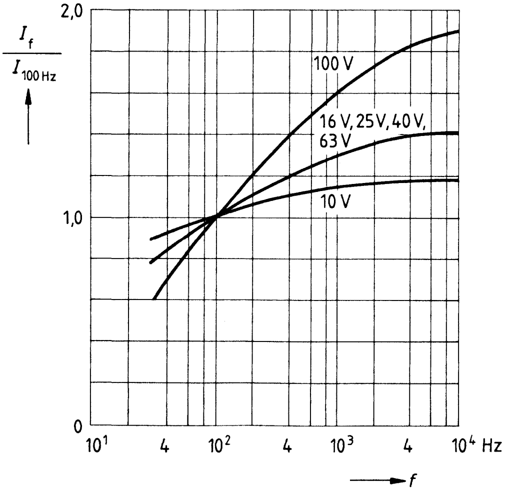
versus ambient temperature T_A at ripple current operation

Type B 43 588, $d_R \geq 10$ mm

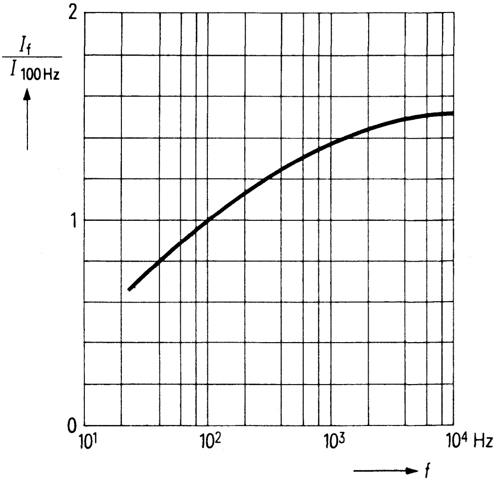


● $I\text{ac}_R$ at 40 °C = 1.83 · $I\text{ac}_R$ at 85 °C

Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



Permissible ripple current Iac
versus frequency f
$V_R \geq 160$ V



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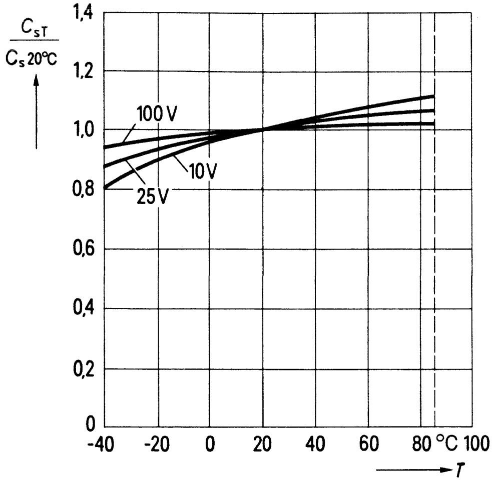
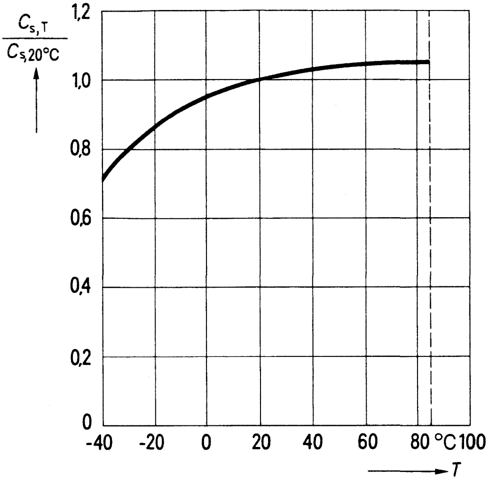
¹) For details on service life curve refer to page 32.

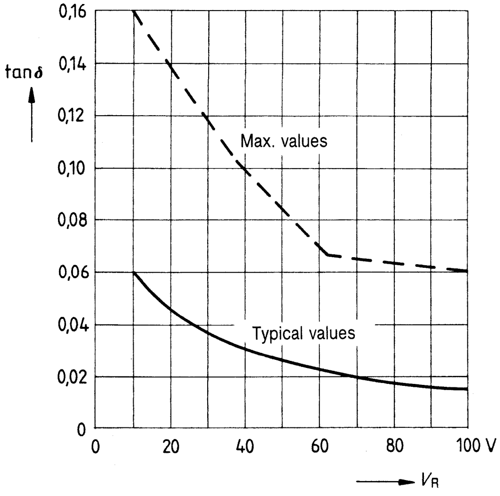
Series capacitance C_s
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \leq 100$ V



Series capacitance C_s
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \geq 160$ V

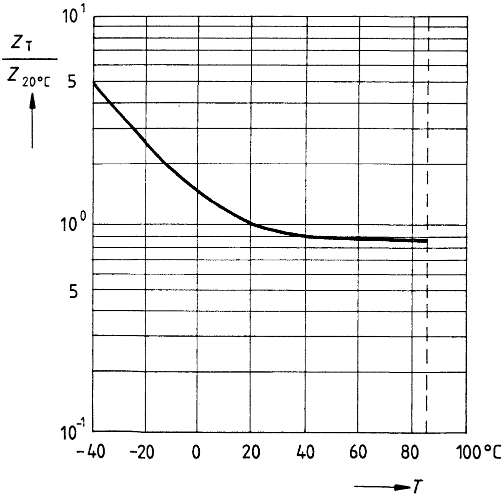


Dissipation factor tan δ
versus rated voltage V_R
($T = 20$°C and $f = 100$ Hz)
$V_R \leq 100$ V

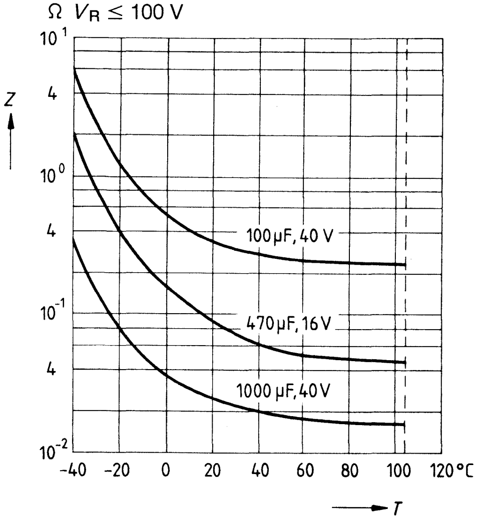


The maximum values are in accordance with DIN 45910, part 123, and apply to $C_R \leq 1000$ µF.
The values increase by 0.02 per 1000 µF.

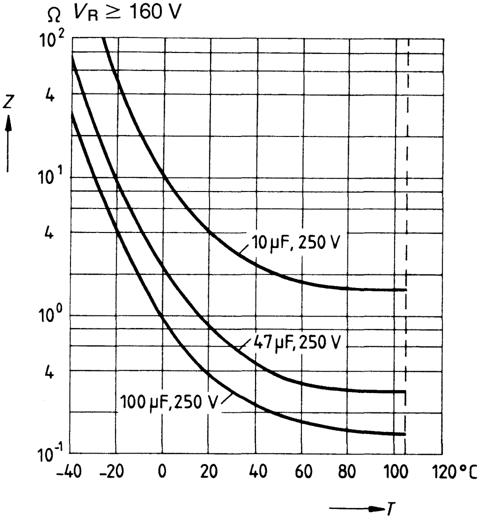
Impedance Z
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \geq 160$ V



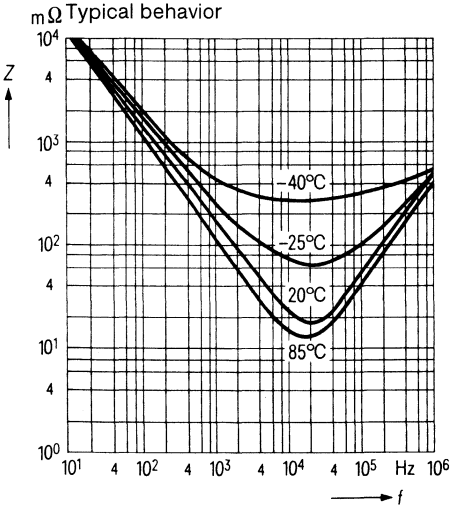
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior



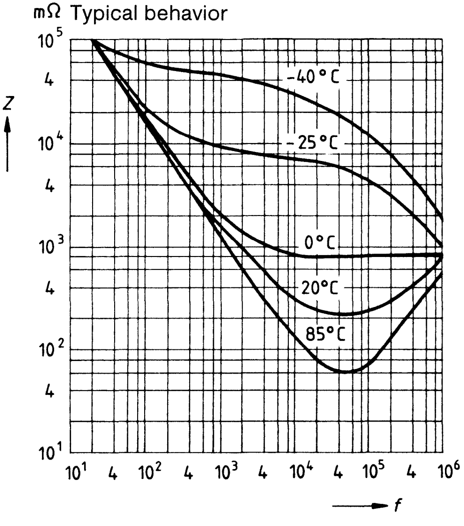
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior



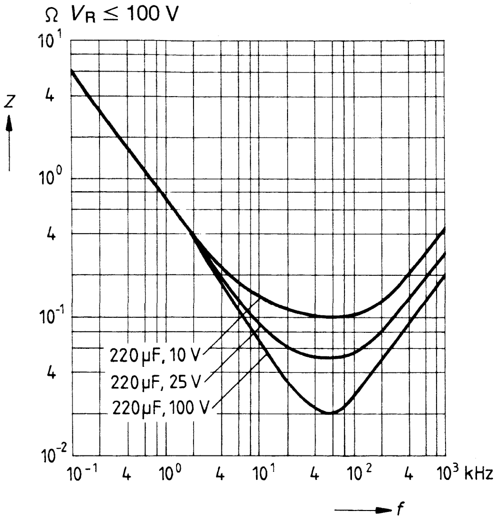
Impedance Z
versus frequency f
and temperature for 1000 µF/40 V
Typical behavior



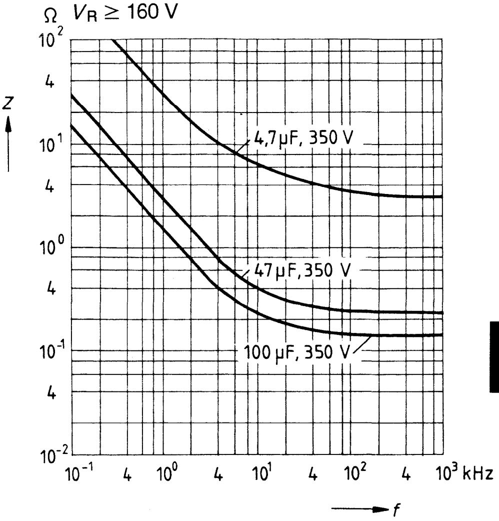
Impedance Z
versus frequency f
and temperature for 100 µF/250 V
Typical behavior



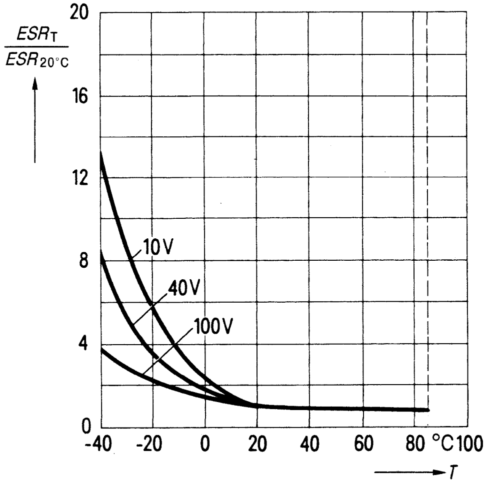
Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \leq 100$ V



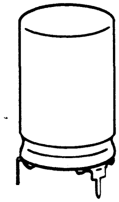
Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \geq 160$ V



Equivalent series resistance *ESR*
versus temperature *T* ($f = 100$ Hz)
Typical behavior
$V_R \leq 100$ V



10 to 4700 µF; 13.5 mm to 26.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Solder pins; welded mounting socket ensures reliable contacting
- Positive pole brought out central-axially
- Negative pole at the 2 or 3 solder pins of the mounting socket

Features

- High reliability and long service life
- Operation up to 105 °C[1]) permissible
- High parametric stability
- High vibration resistance
- Pinning ensures correct insertion

Application

- Professional equipment in industrial electronics
- Filtering, coupling and pulse circuits
- Automotive electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45910, part 12 B 40010 "General Technical Information"
Type specification	DIN 41267
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[2])) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz, acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	≤ 100 V (B 41593)	≥ 160 V (B 43593)
40 °C; V_R; $I\text{ac}_R$	> 220000 h	> 180000 h
85 °C; V_R; $I\text{ac}_R$	> 10000 h	> 8000 h

Fraction failure	≤ 0.5 % (during service life)
Failure rate	≤ 20 fit (≤ 20 · 10^{-9}/h)

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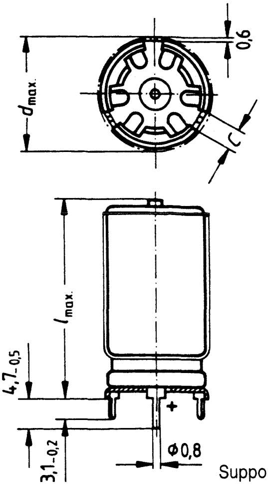
[1]) Operation at 105 °C with 0.6 $I\text{ac}_{\text{max, 85 °C}}$ permissible for a total of 2500 h.

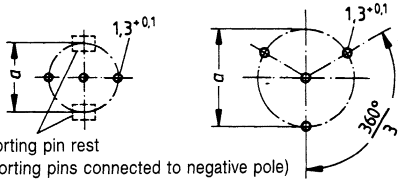
[2]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.



Dimensions in mm

Mounting holes

d_R 12 and 14 d_R 16 to 25

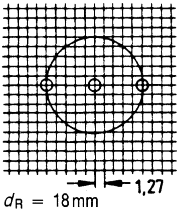


Supporting pin rest
(supporting pins connected to negative pole)

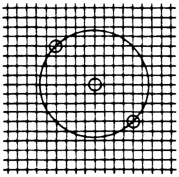
Dimensions (mm)				Approx.
$d_R \times l_R$	$d_{max} \times l_{max}$	$a \pm 0,1$	$c \pm 0,1$	weight g
12 × 30	13,5 × 33	12,5	3	5,7
14 × 30	15,5 × 33	14,5		7,9
16 × 30	17,5 × 33	16,5		9,8
18 × 39,5	19,5 × 42	18,5		15
21 × 40	22,5 × 42	21,5	3,5	19
25 × 40	26,5 × 42	25,5		27

The PC board mounting holes given above refer to partial circles. However, it is often necessary to arrange the mounting holes in a standard lead spacing, especially for the production of small quantities. Generally, this is achieved with sufficient accuracy at a spacing of 1.27 mm (1/20″) if the positions are chosen as follows:

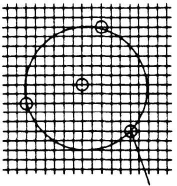
d_R = 12mm



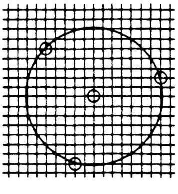
d_R = 14mm



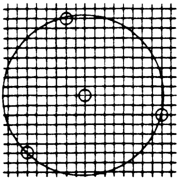
d_R = 16mm



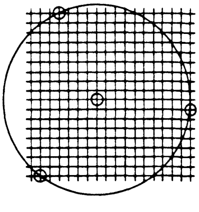
d_R = 18mm



d_R = 21mm



d_R = 25mm



Low-voltage series B 41 593

Rated voltage V_R 1)		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code					
47	$^{-10}_{+50}\,\% \mathrel{\hat=} \mathrm{T}$						12 × 30 -A9476-T
100						12 × 30 -J8107-T	16 × 30 -A9107-T
220				12 × 30 -A5227-T	12 × 30 -J7227-T	16 × 30 -J8227-T	18 × 39,5 -J9227-T
470		12 × 30 -A3477-T	12 × 30 -J4477-T	14 × 30 -J5477-T	16 × 30 -J7477-T	21 × 40 -J8477-T	25 × 40 -A9477-T
1 000		14 × 30 -J3108-T	16 × 30 -A4108-T	18 × 39,5 -J5108-T	21 × 40 -J7108-T	25 × 40 -A8108-T	
2 200		18 × 39,5 -A3228-T	18 × 39,5 -J4228-T	21 × 40 -A5228-T	25 × 40 -A7228-T		
4 700		25 × 40 -A3478-T	25 × 40 -A4478-T				

Example for the compiling of ordering codes

B41593-A4478-T

Code according to table

High-voltage series B 43 593

Rated voltage V_R 1)		160 V dc	250 V dc	350 V dc
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code		
10	$^{-10}_{+50}\,\% \mathrel{\hat=} \mathrm{T}$			12 × 30 -A4106-T
22		12 × 30 -A1226-T	14 × 30 -A2226-T	14 × 30 -A4226-T
47		14 × 30 -A1476-T	16 × 30 -A2476-T	18 × 39,5 -A4476-T
100		18 × 39,5 -A1107-T	21 × 40 -A2107-T	25 × 40 -A4107-T
220		25 × 40 -A1227-T		

Example for the compiling of ordering codes

B43593-A4106-T

Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

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1) Peak voltage $V_p = 1.15\ V_R$ for 16 to 250 V dc; 1.1 V_R for 350 V dc

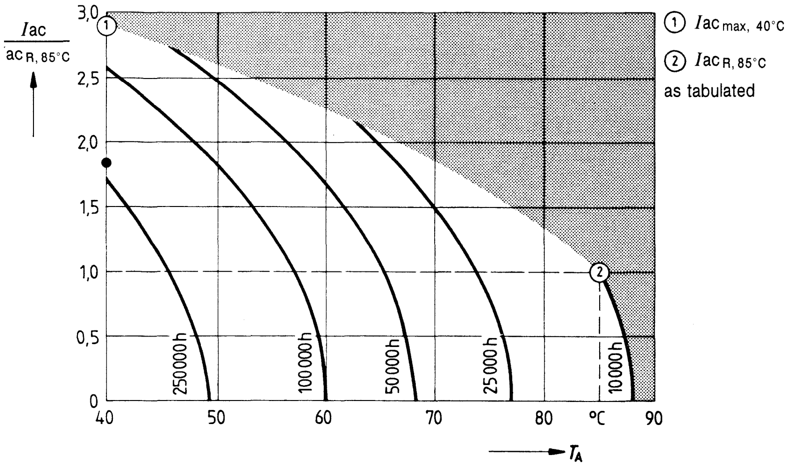
C_R µF	V_R V dc	$\tan \delta_{max}$ 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
470	10	0,16	0,20	0,50	0,11	13	1,59	0,55	23
1000		0,16	0,10	0,25	0,07	24	2,40	0,85	37
2200		0,17	0,06	0,14	0,05	48	4,13	1,42	37
4700		0,18	0,05	0,07	0,05	98	5,48	1,88	17
470	16	0,14	0,18	0,45	0,11	19	1,70	0,57	23
1000		0,14	0,10	0,25	0,06	36	2,70	0,92	38
2200		0,15	0,06	0,12	0,05	74	4,10	1,42	37
4700		0,15	0,05	0,06	0,05	154	5,50	1,88	17
220	25	0,11	0,28	0,70	0,19	15	1,30	0,46	23
470		0,11	0,16	0,40	0,10	28	1,90	0,64	37
1000		0,11	0,10	0,19	0,06	54	3,20	1,11	37
2200		0,13	0,06	0,10	0,05	114	4,50	1,55	17
220	40	0,09	0,25	0,63	0,18	22	1,40	0,49	23
470		0,09	0,13	0,33	0,10	42	2,20	0,77	38
1000		0,09	0,07	0,16	0,06	84	4,00	1,39	17
2200		0,10	0,04	0,08	0,05	180	5,90	2,00	17
100	63	0,07	0,40	1,00	0,33	17	1,10	0,38	23
220		0,07	0,18	0,45	0,17	32	1,90	0,65	38
470		0,07	0,10	0,25	0,09	63	3,30	1,13	17
1000		0,07	0,05	0,12	0,06	130	5,30	1,80	17
47	100	0,06	0,60	1,50	0,62	13	0,90	0,31	23
100		0,06	0,32	0,80	0,31	24	1,40	0,49	38
220		0,06	0,16	0,40	0,15	48	2,40	0,83	37
470		0,06	0,09	0,23	0,09	98	4,10	1,39	17
22	160	0,10	3,60	8,00	3,30	11	0,38	0,13	23
47		0,10	1,70	3,80	1,60	19	0,58	0,20	37
100		0,10	0,80	1,80	0,75	36	1,11	0,38	37
220		0,10	0,36	0,80	0,35	74	1,97	0,68	17
22	250	0,09	2,90	7,20	3,10	15	0,45	0,15	37
47		0,09	1,40	3,40	1,50	27	0,70	0,24	38
100		0,09	0,64	1,50	0,70	54	1,37	0,47	17
10	350	0,08	4,80	12,00	6,40	11	0,33	0,11	23
22		0,08	2,20	5,50	2,90	19	0,51	0,18	37
47		0,08	1,00	2,50	1,40	37	1,00	0,34	37
100		0,08	0,48	1,30	0,67	74	1,71	0,59	17

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and –2 V.

Service life[1])

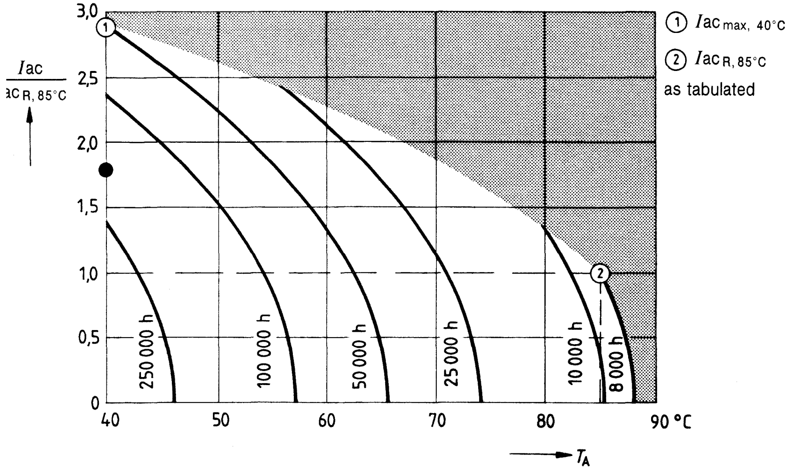
versus ambient temperature T_A at ripple current operation

Low-voltage series B 41 593



● $I_{ac\,R}$ at 40 °C = 1.83 · $I_{ac\,R}$ at 85 °C

High-voltage series B 43 593



● $I_{ac\,R}$ at 40 °C = 1.83 · $I_{ac\,R}$ at 85 °C

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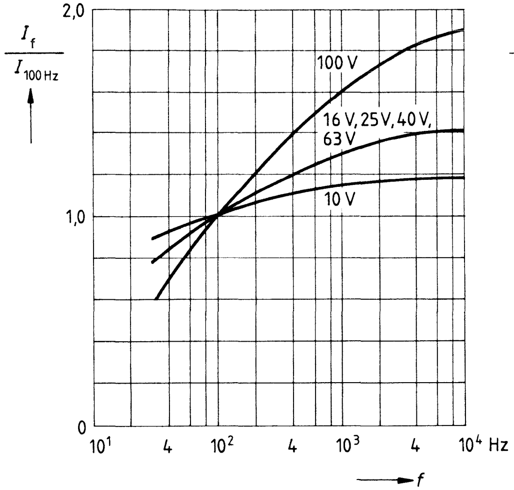
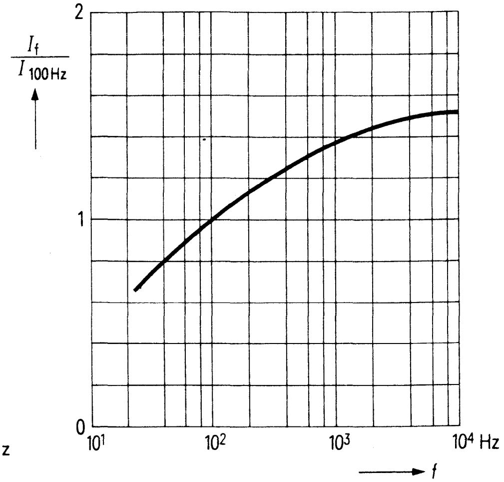
[1]) For details on service life curve refer to page 32.

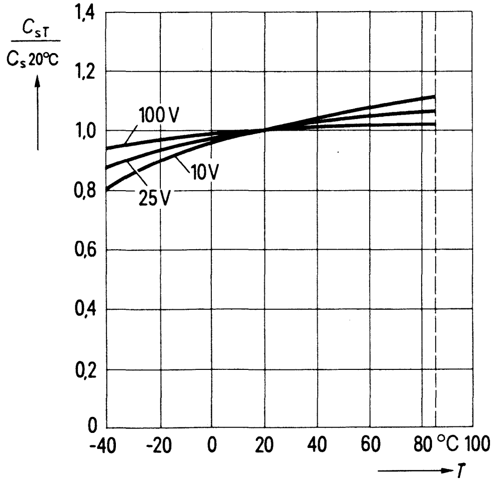
Permissible ripple current Iac
versus frequency f
$V_R \leq 100$ V



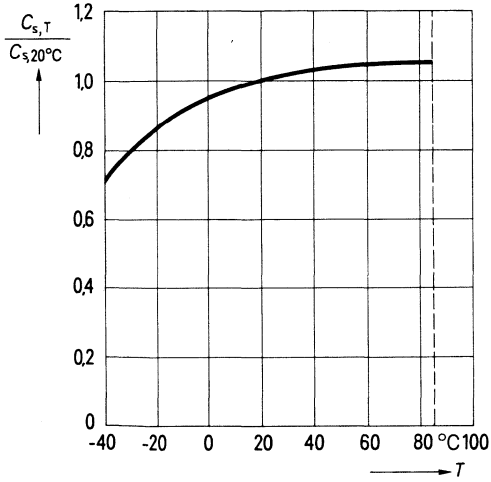
Permissible ripple current Iac
versus frequency f
$V_R \geq 160$ V



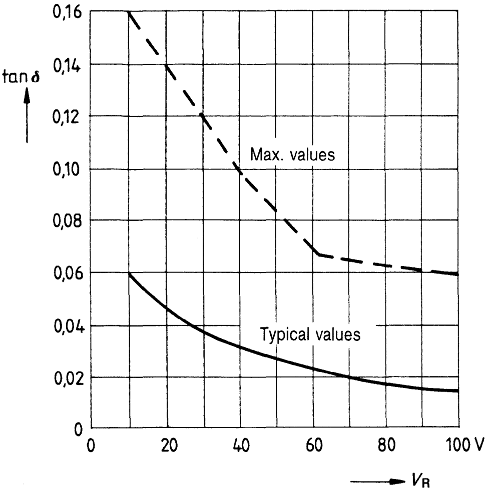
Series capacitance C_s
versus temperature T (f = 100 Hz)
Typical behavior
$V_R \leq 100$ V



Series capacitance C_s
versus temperature T (f = 100 Hz)
Typical behavior
$V_R \geq 160$ V

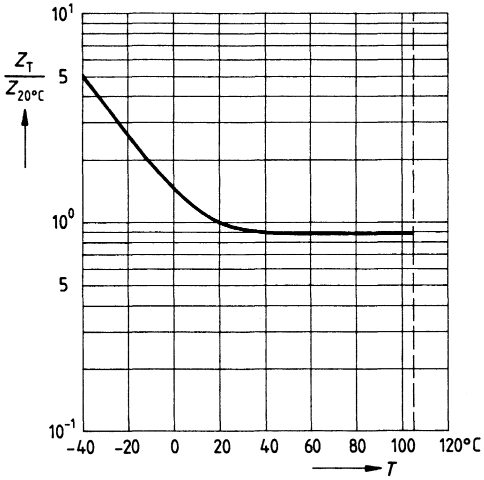


Dissipation factor tan δ
versus rated voltage V_R
(at $T = 20°C$ and $f = 100$ Hz)
$V_R \leq 100$ V

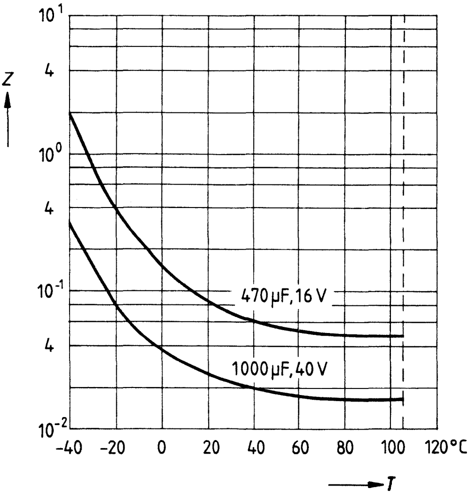


The maximum values are in accordance with DIN 45 910, part 123, and apply to $C_R \leq 1000$ µF.
The values increase by 0.02 per 1000 µF.

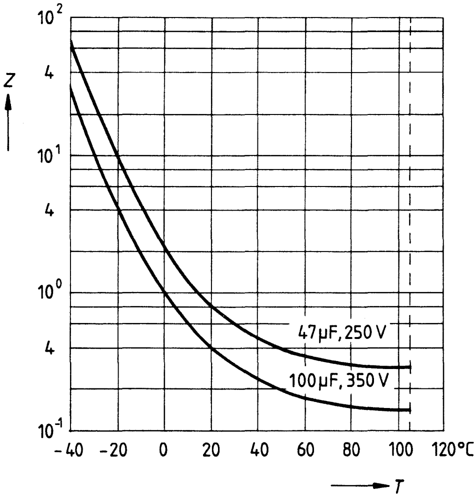
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
$V_R \geq 160$ V



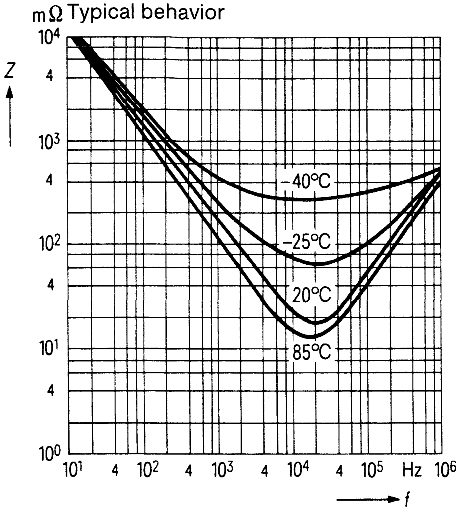
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
Ω $V_R \leq 100$ V



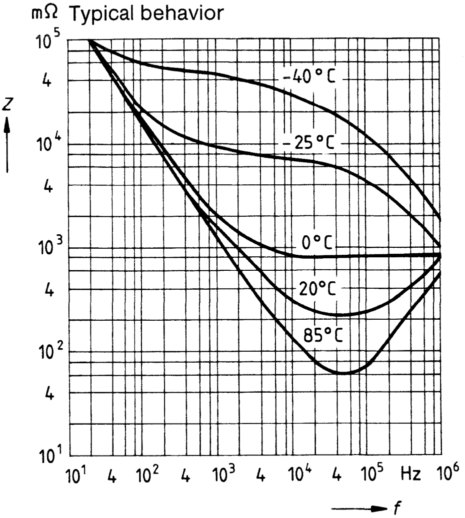
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
Ω $V_R \geq 160$ V



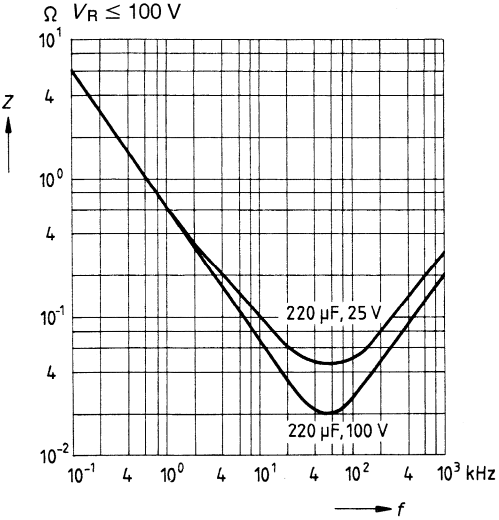
Impedance Z
versus frequency f
and temperature for 1000 µF/40 V
Typical behavior



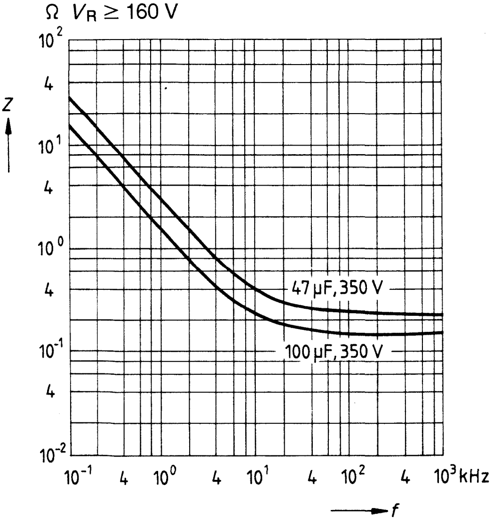
Impedance Z
versus frequency f
and temperature for 100 µF/250 V
Typical behavior



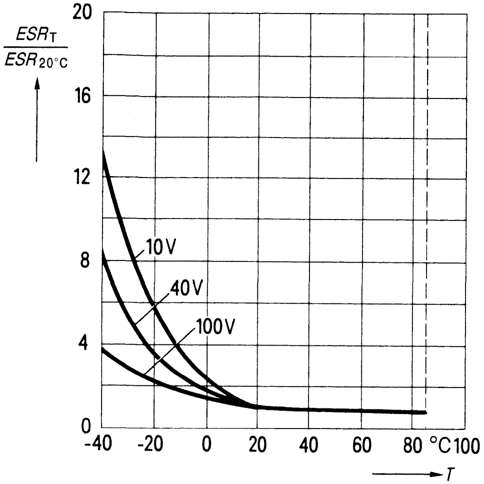
Impedance Z
versus frequency f
Typical values at 20 °C
$V_R \leq 100$ V



Impedance Z
versus frequency f
Typical values at 20 °C
$V_R \geq 160$ V



Equivalent series resistance *ESR*
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \leq 100$ V

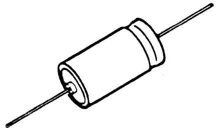


Al Electrolytic Capacitors

6.3 to 350 V dc
GP Grade

B 41283
B 41010
B 43283
B 43050

1 to 10000 μF; 7.0 mm to 25.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Negative pole connected to case
- Axial leads; welded terminal connections ensure reliable contacting

Features

- Standard version with small dimensions
- Operation up to 105 °C[1] permissible
- Favorable electrical values
- High ripple current capability

Application

- General-purpose applications in entertainment electronics
- Semiprofessional to professional applications
- For filtering, coupling and pulse circuits

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4[2] DIN 45910, part 12 B 40010 „General Technical Information"
Type specification	DIN 41316
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[3]) in acc. with DIN 40040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz, acceleration max. 5 *g*, duration 3 × 2 h

Service life

Operating conditions	B 41283 dia. ≤ 10 mm	B 41010 dia. ≥ 12 mm	B 43283 B 43050 dia. 6.5 mm to 25 mm
40 °C; V_R; I_{acR}	≥ 70000 h	≥ 90000 h	≥ 70000 h
85 °C; V_R; I_{acR}	≥ 3000 h	≥ 4000 h	≥ 3000 h

Fraction failure ≤ 1 % (during service life)

Failure rate

	≤ 100 fit (≤ 100 · 10^{-9}/h)	≤ 40 fit (≤ 40 · 10^{-9}/h)	≤ 100 fit (≤ 100 · 10^{-9}/h)

Taping: Capacitors with 6.5 to 16 mm dia. are also available on tape.
For information on tape packaging and ordering example see chapter "Tape Packaging", page 64.

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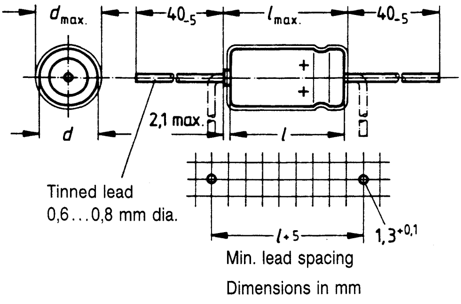
[1] Operation at 105 °C with 0.6 $I_{ac\,max\,85\,°C}$ permissible for a total of 1500 h for dia. ≤ 8.5 mm; 2500 h permissible for dia. ≥ 10 mm, respectively.

[2] These capacitors comply with the test requirements for Long Life Grade (LL).

[3] The capacitors also comply with the test requirements of humidity category E in accordance with DIN 40040.

Low-voltage series B 41 283, B 41 010
Capacitance tolerance −10/+50 % ≙ T

Rated voltage V_R1)		6,3 V dc	10 V dc	16 V dc	25 V dc	40 V dc	
Rated capacitance µF	Type	Rated dimensions $d \times l$ Code					
1	B 41 283-						
2,2							
4,7							
10							
22						6,5 × 17,5 -B7226-T	
47					6,5 × 17,5 -B5476-T	8,5 × 17,5 -D7476-T	
100			6,5 × 17,5 -B3107-T	8,5 × 17,5 -B4107-T	8,5 × 17,5 -B5107-T	10 × 20 -B7107-T	
220			8,5 × 17,5 -C3227-T	8,5 × 17,5 -B4227-T	10 × 20 -B5227-T	10 × 25 -A7227-T	
470		8,5 × 17,5 -C2477-T	10 × 20 -A3477-T	10 × 25 -A4477-T	12 × 30 -B5477-T	12 × 30 -B7477-T	
1 000		10 × 25 -A2108-T	12 × 30 -A3108-T	12 × 30 -B4108-T	14 × 30 -C5108-T	16 × 30 -E7108-T	
2 200	B 41 010-	12 × 30 -B2228-T	14 × 30 -C3228-T	16 × 30 -E4228-T	18 × 39,5 -C5228-T	21 × 40 -C7228-T	
4 700		16 × 30 -E2478-T	18 × 39,5 -C3478-T	21 × 40 -C4478-T	25 × 40 -C5478-T		
10 000			25 × 40 -C3109-T				



Dimensions (mm)		Lead dia.	Approx. weight g
$d \times l$ (rated dimensions)	$d_\mathrm{max} \times l_\mathrm{max}$ (with insulating sleeve)		
6,5 × 17,5	7,0 × 19	0,6	1,1
8,5 × 17,5	9,0 × 19		1,8
10 × 20	10,5 × 21,5		2,6
10 × 25	10,5 × 26,5		3,2
12 × 30	12,5 × 32	0,8	5,4
14 × 30	14,5 × 32		7,5
16 × 30	16,5 × 32		9,3
18 × 39,5	18,5 × 41,5		14
21 × 40	21,5 × 41,5		18
25 × 40	25,5 × 41,5		26

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1) Peak voltage $V_\mathrm{p} = 1.15\ V_\mathrm{R}$ for 6.3 to 250 Vdc; V_R for 350 Vdc.

High-voltage series B 43 283, B 43 050
Capacitance tolerance −10/+50 % ≙ T

	63 V dc	100 V dc		160 V dc	250 V dc	350 V dc
			Type	Rated dimensions *d* × *l* Code		
			B 43 283-			▨ 6,5 × 17,5 -E4105-T ◥
						▨ 8,5 × 17,5 -C4225-T ◥
		▨ 6,5 × 17,5 -A9475-T ◥		▨ 8,5 × 17,5 -B1475-T	▨ 8,5 × 17,5 -C2475-T	▨ 10 × 20 -C4475-T ◥
	▨ 6,5 × 17,5 -A8106-T ◥	▨ 8,5 × 17,5 -J9106-T ◥		▨ 10 × 20 -B1106-T ◥	▨ 10 × 25 -B2106-T	▨ 12 × 30 -B4106-T ◥
	▨ 8,5 × 17,5 -C8226-T ◥	▨ 8,5 × 17,5 -C9226-T ◥	B 43 050-	▨ 12 × 30 -B1226-T	▨ 12 × 30 -C2226-T ◥	▨ 14 × 30 -D4226-T ◥
	▨ 8,5 × 17,5 -C8476-T ◥	▨ 10 × 25 -A9476-T ◥		▨ 14 × 30 -C1476-T ◥	▨ 16 × 30 -D2476-T ◥	18 × 39,5 -C4476-T ◥
	▨ 10 × 25 -A8107-T ◥	▨ 12 × 30 -B9107-T ◥		18 × 39,5 -E1107-T ◥	21 × 40 -B2107-T	25 × 40 -B4107-T
	▨ 12 × 30 -B8227-T ◥	▨ 16 × 30 -E9227-T ◥		25 × 40 -B1227-T		
	▨ 16 × 30 -D8477-T ◥	21 × 40 -B9477-T ◥				
	21 × 40 -B8108-T ◥					

▨ Capacitors available on tape

Example for the compiling of ordering codes

Low-voltage series	High-voltage series
B41283-B3107-T and	B43283-B1475-T and
B41010-B2228-T	B43050-B1226-T
Code according to table	Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.
◥ These capacitors are preferred types S (refer to page 4).

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,\,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
◥ 470	6,3	0,20	0,44	0,75	0,46	32	0,73	0,25	17
◥ 1 000		0,20	0,24	0,35	0,22	45	1,2	0,42	35
◥ 2 200		0,24	0,12	0,19	0,10	75	2,1	0,71	37
◥ 4 700		0,28	0,08	0,11	0,05	138	3,2	1,1	45
◥ 100	10	0,18	1,5	3,2	1,7	24	0,35	0,12	14
◥ 220		0,18	0,65	1,4	0,79	29	0,61	0,21	17
◥ 470		0,18	0,32	0,68	0,37	39	1,0	0,36	31
◥ 1 000		0,18	0,18	0,32	0,16	60	1,7	0,57	37
◥ 2 200		0,22	0,10	0,18	0,08	108	2,3	0,81	38
◥ 4 700		0,26	0,06	0,10	0,05	208	4,1	1,4	57
◥ 10 000		0,36	0,05	0,07	0,05	420	5,5	1,9	34
◥ 100	16	0,16	1,3	2,8	1,4	26	0,41	0,14	17
◥ 220		0,16	0,58	1,3	0,65	34	0,61	0,21	17
◥ 470		0,16	0,27	0,60	0,30	50	1,1	0,39	35
◥ 1 000		0,16	0,15	0,28	0,13	84	1,8	0,63	37
◥ 2 200		0,20	0,09	0,16	0,06	161	2,7	0,93	45
◥ 4 700		0,24	0,06	0,09	0,05	321	4,4	1,5	30
◥ 47	25	0,14	2,4	5,3	2,1	25	0,26	0,09	14
◥ 100		0,14	1,0	2,5	1,0	30	0,46	0,16	17
◥ 220		0,14	0,44	1,1	0,45	42	0,81	0,28	31
◥ 470		0,14	0,21	0,53	0,19	67	1,5	0,53	37
◥ 1 000		0,14	0,12	0,25	0,09	120	2,1	0,74	38
◥ 2 200		0,18	0,07	0,14	0,05	240	3,8	1,3	57
◥ 4 700		0,22	0,05	0,09	0,05	490	5,2	1,8	34
◥ 22	40	0,10	4,0	8,0	3,6	24	0,20	0,07	14
◥ 47		0,10	1,5	3,8	1,7	28	0,38	0,13	17
◥ 100		0,10	0,70	1,8	0,80	36	0,64	0,22	31
◥ 220		0,10	0,36	0,80	0,36	55	0,96	0,33	35
◥ 470		0,10	0,18	0,38	0,15	95	1,7	0,57	37
◥ 1 000		0,10	0,1	0,18	0,08	180	2,6	0,88	45
◥ 2 200		0,14	0,07	0,11	0,05	372	4,1	1,4	30
◥ 10	63	0,08	5,0	13	6,0	23	0,17	0,06	14
◥ 22		0,08	2,5	6,3	2,7	26	0,29	0,10	17
◥ 47		0,08	1,2	3,0	1,2	32	0,44	0,15	17
◥ 100		0,08	0,55	1,4	0,60	45	0,78	0,27	35
◥ 220		0,08	0,30	0,64	0,25	75	1,3	0,44	37
◥ 470		0,08	0,14	0,30	0,12	138	2,1	0,74	45
◥ 1 000		0,08	0,08	0,14	0,06	272	3,8	1,3	30
◥ 4,7	100	0,07	9,5	24	10	22	0,15	0,05	14
◥ 10		0,07	4,0	10	5,0	24	0,23	0,08	17
◥ 22		0,07	1,8	4,5	2,2	29	0,35	0,12	17
◥ 47		0,07	0,85	2,1	1,0	39	0,64	0,22	35
◥ 100		0,07	0,40	1,0	0,45	60	1,1	0,38	37
◥ 220		0,07	0,22	0,55	0,20	108	1,7	0,59	45
◥ 470		0,07	0,12	0,26	0,10	208	2,9	1,0	30

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
4,7	160	0,11	17	41	33	23	0,12	0,04	17
◥ 10		0,11	8,0	19	15	26	0,19	0,07	31
22		0,11	4,0	8,8	6,8	34	0,36	0,12	37
◥ 47		0,11	1,9	4,1	3,3	50	0,55	0,19	38
◥ 100		0,11	0,95	1,9	1,5	84	1,02	0,35	57
220		0,11	0,43	0,9	0,7	160	1,81	0,62	34
4,7	250	0,10	14	35	33	25	0,13	0,0,4	17
10		0,10	6,0	15	15	30	0,24	0,08	35
◥ 22		0,10	3,3	8,3	6,8	42	0,39	0,13	37
◥ 47		0,10	1,5	3,8	3,3	67	0,67	0,23	45
100		0,10	0,72	1,8	1,5	120	1,3	0,44	30
◥ 1	350	0,08	48	120	100	21	0,06	0,02	14
◥ 2,2		0,08	22	55	44	23	0,10	0,04	17
◥ 4,7		0,08	10	25	20	27	0,17	0,06	31
◥ 10		0,08	5,6	14	12	34	0,30	0,10	37
◥ 22		0,08	2,5	6,3	5,5	51	0,48	0,17	38
◥ 47		0,08	1,2	3,0	2,7	86	0,91	0,31	57
100		0,08	0,56	1,4	1,2	160	1,6	0,54	34

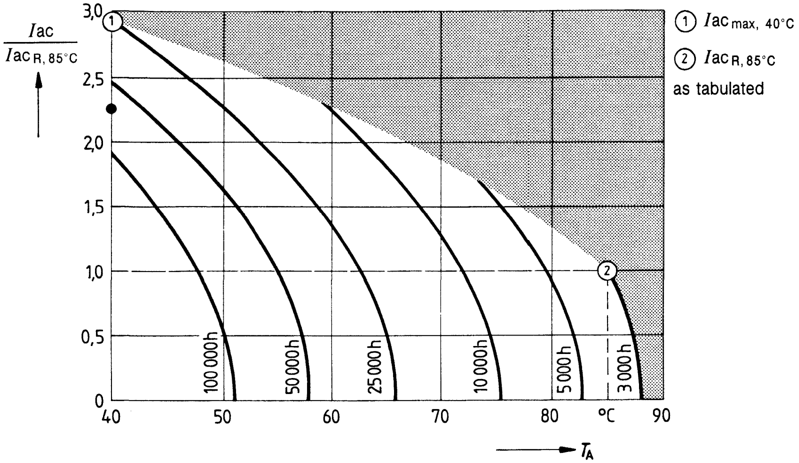
Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

◥ These capacitors are preferred types S (refer to page 4).

Service life[1])

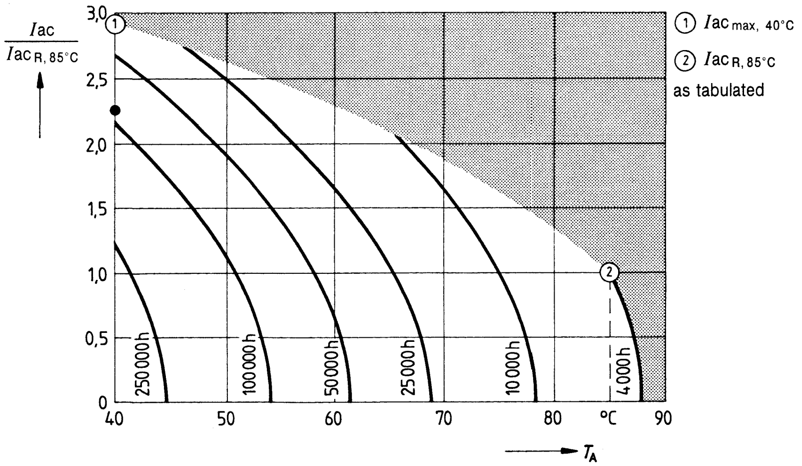
versus ambient temperature T_A at ripple current operation

Type B 41 283, $d_R \leq 10$ mm



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

Type B 41 010, $d_R \geq 12$ mm



● Iac_R at 40 °C = 2.24 · Iac_R at 85 °C

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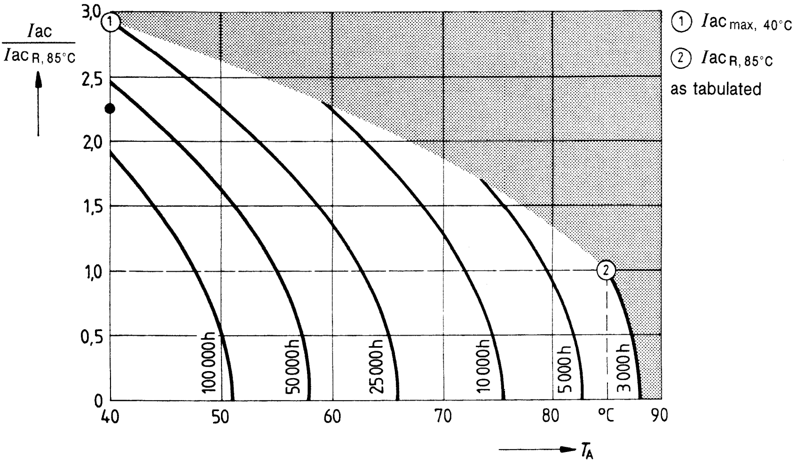
[1]) For details on service life curve refer to page 32.

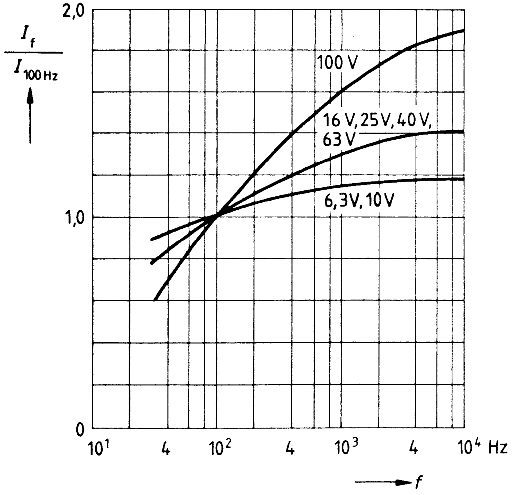
Service life[1])
versus ambient temperature T_A at ripple current operation

Type B 43283, $d_R \leq 10$ mm
Type B 43050, $d_R \geq 12$ mm

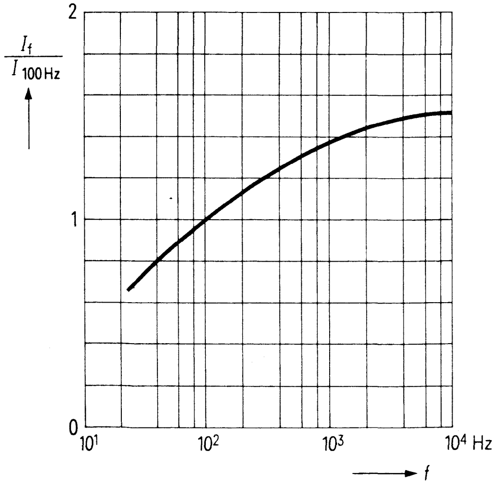


● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 85 °C

Permissible ripple current I_{ac}
versus frequency f
$V_R \leq 100$ V



Permissible ripple current I_{ac}
versus frequency f
$V_R \geq 160$ V



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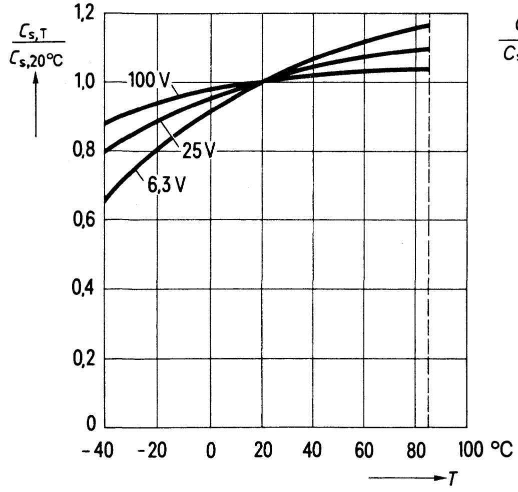
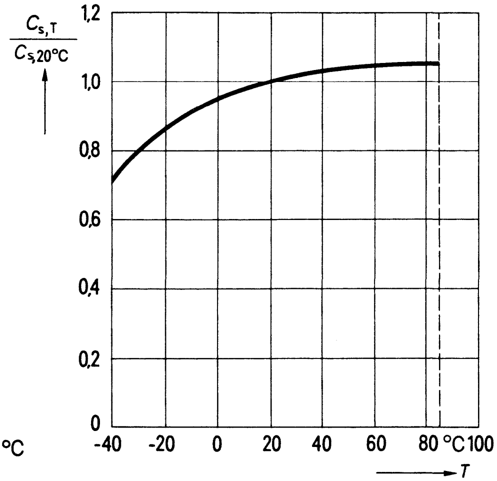
[1]) For details on service life curve refer to page 32.

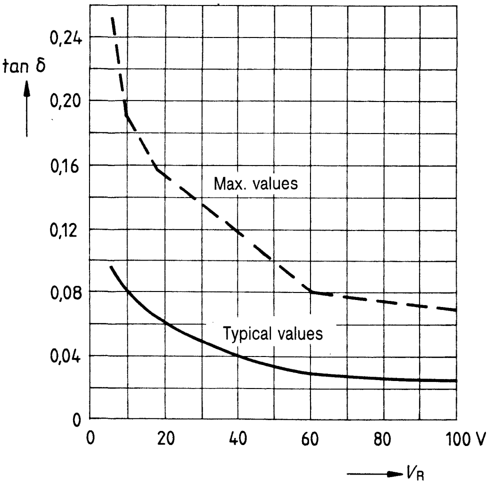
Series capacitance C_S
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \leq 100$ V



Series capacitance C_S
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \geq 160$ V



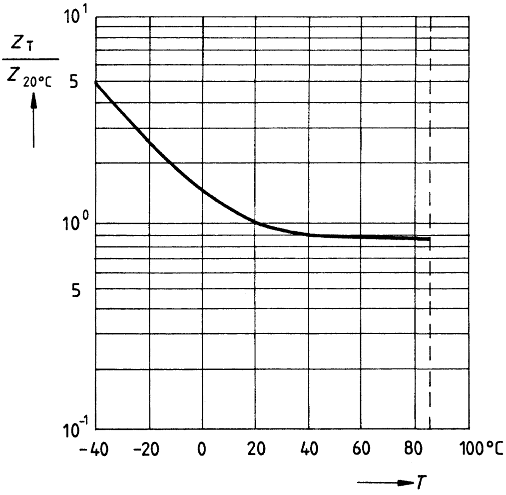
Dissipation factor tan δ
versus rated voltage V_R
(at $T = 20$ °C and $f = 100$ Hz)
$V_R \leq 100$ V



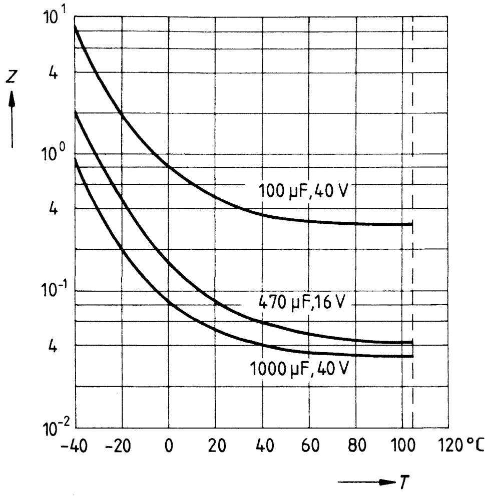
The maximum values are in accordance with DIN 45910, part 126, sheet 1 and apply to $C_R \leq 1000$ µF.
The values increase by 0.02 per 1000 µF.

Impedance Z
versus temperature T ($f = 100$ Hz)

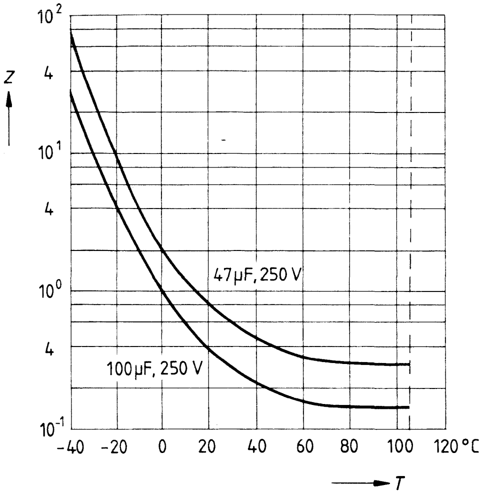
$V_R \geq 160$ V



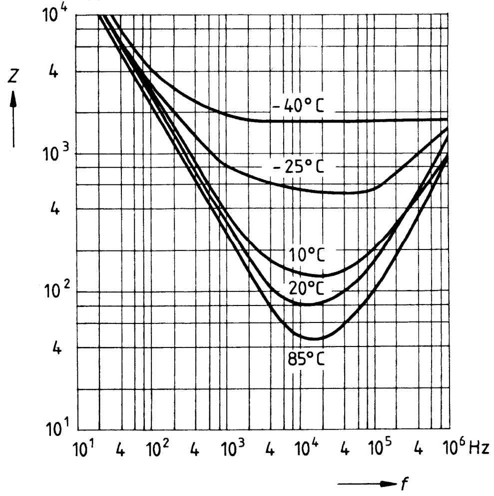
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
Ω $V_R \leq 100$ V



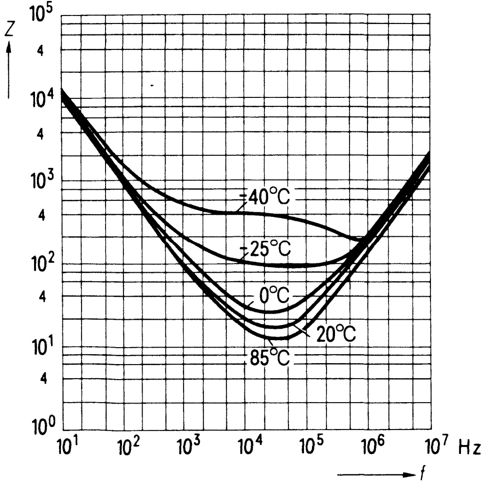
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
Ω $V_R \geq 160$ V



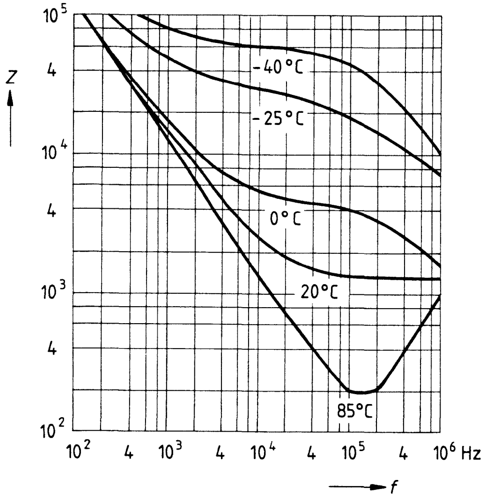
Impedance Z
versus frequency f
and temperature for 470 µF/16 V
mΩ Typical behavior



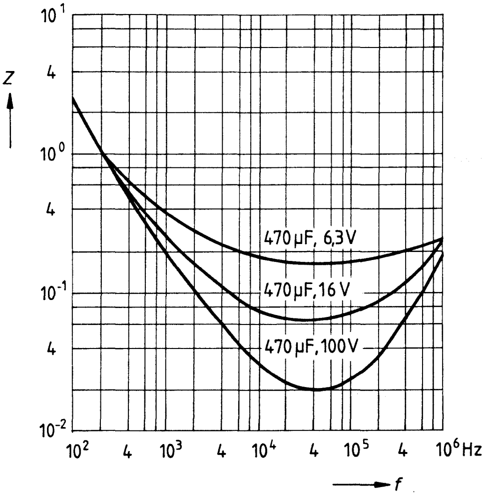
Impedance Z
versus frequency f
and temperature for 1000 µF/40 V
mΩ Typical behavior



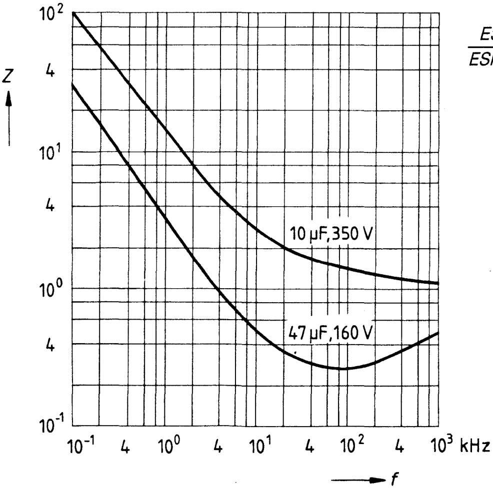
Impedance *Z*
versus frequency *f*
and temperature for 10 µF/250 V
Typical behavior



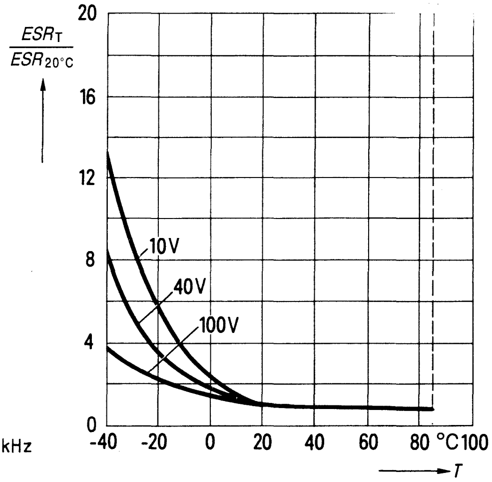
Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \leq 100$ V



Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \geq 160$ V



Equivalent series resistance *ESR*
versus temperature *T* (*f* = 100 Hz)
Typical behavior
$V_R \leq 100$ V



Al Electrolytic Capacitors

10 to 385 V dc
GP Grade

B 41 293
B 43 293

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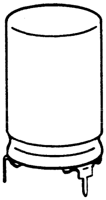
10 to 4700 µF; 13.5 mm to 26.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Solder pins; welded mounting socket ensures reliable contacting
- Positive pole brought out central-axially
- Negative pole at the 2 or 3 solder pins of the mounting socket

Features

- Stable, vibration-resistant construction
- Operation up to 105 °C[1]) permissible
- High parametric stability
- Pinning ensures correct insertion

Application

- Standard version for entertainment and industrial electronics
- Filtering, coupling and pulse circuits
- Automotive electronics

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4[2]) DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 253
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C[1]), humidity category F[3])) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.75 mm, frequency range 10 to 55 Hz acceleration max. 10 *g*, duration 3 × 2 h

Service life

Operating conditions	≤ 100 V (B 41 293)	≥ 100 V (B 43 293)
40 °C; V_R; $I\text{ac}_R$ 85 °C; V_R; $I\text{ac}_R$	> 90 000 h > 4 000 h	> 70 000 h > 3 000 h

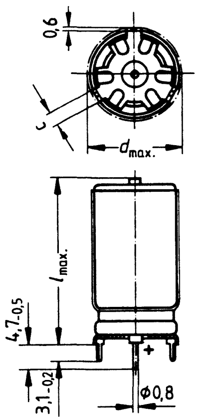
Fraction failure	≤ 1 % (during service life)
Failure rate	≤ 100 fit (≤ 100 · 10^{-9}/h)

---

[1]) Operation at 105 °C with 0.6 $I\text{ac}_{\text{max, 85 °C}}$ permissible for a total of 1000 h.

[2]) These capacitors comply with the test requirements for Long Life Grade (LL).

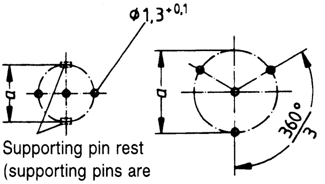
[3]) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.



Dimensions in mm

Mounting holes

d_R 12 and 14 d_R 16 to 25

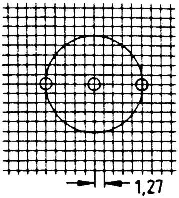


Supporting pin rest
(supporting pins are
connected to negative pole)

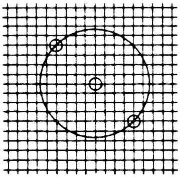
Dimensions (mm)				Approx. weight g
$d_R \times l_R$	$d_{max} \times l_{max}$	$a \pm 0,1$	$c \pm 0,1$	
12 × 30	13,5 × 33	12,5	3	5,7
14 × 30	15,5 × 33	14,5		7,9
16 × 30	17,5 × 33	16,5		9,8
18 × 39,5	19,5 × 42	18,5		15
21 × 40	22,5 × 42	21,5	3,5	19
25 × 40	26,5 × 42	25,5		27
25 × 45	26,5 × 47	25,5		27

The PC board mounting holes given opposite refer to partial circles. However, it is often necessary to arrange the mounting holes in a standard lead spacing, especially for the production of small quantities. Generally, this is achieved with sufficient accuracy at a spacing of 1.27 mm ($^1/_{20}''$) if the positions are chosen as follows:

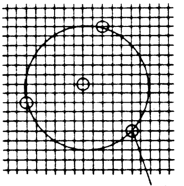
d_R = 12 mm



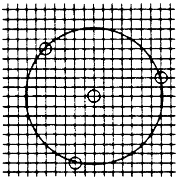
d_R = 14 mm



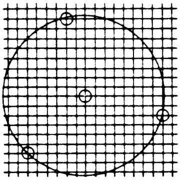
d_R = 16 mm



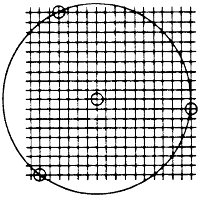
d_R = 18 mm



d_R = 21 mm



d_R = 25 mm



Low-voltage series B 41 293

Rated voltage V_R[1])		10 V dc	16 V dc	25 V dc	40 V dc	63 V dc	100 V dc
Rated capacitance		Rated dimensions $d \times l$					
μF	Tolerance	Code					
100	$^{-10}_{+50}$ % ≙ T						12 × 30 -B9107-T
220						12 × 30 ◥ -J8227-T	16 × 30 -B9227-T
470				12 × 30 ◥ -A5477-T	12 × 30 ◥ -J7477-T	16 × 30 ◥ -B8477-T	21 × 40 -B9477-T
1 000		12 × 30 -A3108-T	12 × 30 -J4108-T	14 × 30 ◥ -J5108-T	16 × 30 ◥ -B7108-T	21 × 40 ◥ -A8108-T	
2 200		14 × 30 -J3228-T	16 × 30 ◥ -B4228-T	18 × 39,5 ◥ -J5228-T	21 × 40 ◥ -B7228-T		
4 700		18 × 39,5 -J3478-T	21 × 40 ◥ -A4478-T	25 × 40 ◥ -B5478-T			

Example for the compiling of ordering codes

B41293-J8227-T

└── Code according to table

High-voltage series B 43 293

Rated voltage V_R[1])		160 V dc	250 V dc	350 V dc	385 V dc
Rated capacitance		Rated dimensions $d \times l$			
μF	Tolerance	Code			
10	$^{-10}_{+50}$ % ≙ T			12 × 30 -A4106-T	
22		12 × 30 -A1226-T	12 × 30 -A2226-T	14 × 30 -A4226-T	
47		14 × 30 -A1476-T	16 × 30 -A2476-T	18 × 40 -A4476-T	
100		18 × 40 -A1107-T	21 × 40 -A2107-T	25 × 40 -A4107-T	25 × 40 -A107-T
150					25 × 45 -A157-T
220		25 × 40 -A1227-T			

Example for the compiling of odering codes

B43293-A4106-T

└── Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.
◥ These capacitors are preferred types S (refer to page 4).

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[1]) Peak voltage $V_P = 1.15\ V_R$ for 10 to 250 V dc; 1.1 V_R for 350 V dc and 385 V dc

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r, max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C A	$I_{ac\,R}$ 100 Hz 85 °C A	ESL approx. nH
1 000	10	0,18	0,18	0,32	0,16	60	1,7	0,57	23
2 200		0,22	0,10	0,18	0,08	108	2,3	0,81	38
4 700		0,26	0,06	0,10	0,05	210	4,1	1,4	37
1 000	16	0,16	0,15	0,28	0,13	84	1,8	0,63	37
◥ 2 200		0,20	0,09	0,16	0,06	160	2,7	0,93	38
◥ 4 700		0,24	0,06	0,09	0,05	320	4,4	1,5	17
◥ 470	25	0,14	0,21	0,53	0,19	67	1,5	0,53	23
◥ 1 000		0,14	0,12	0,25	0,09	120	2,1	0,74	38
◥ 2 200		0,18	0,07	0,14	0,05	240	3,8	1,3	37
◥ 4 700		0,22	0,05	0,09	0,05	490	5,2	1,8	17
◥ 470	40	0,10	0,18	0,38	0,15	95	1,7	0,57	37
◥ 1 000		0,10	0,10	0,18	0,05	180	2,6	0,88	38
◥ 2 200		0,10	0,07	0,11	0,05	370	4,1	1,4	17
◥ 220	63	0,08	0,30	0,64	0,25	75	1,3	0,44	37
◥ 470		0,08	0,14	0,30	0,12	140	2,1	0,74	38
◥ 1 000		0,08	0,08	0,14	0,06	270	3,8	1,3	17
100	100	0,07	0,40	1,0	0,45	60	1,1	0,38	23
220		0,07	0,22	0,55	0,20	110	1,7	0,59	38
470		0,07	0,12	0,26	0,10	210	2,9	1,0	17
22	160	0,11	4,0	8,8	6,8	34	0,36	0,12	23
47		0,11	1,9	4,1	3,3	50	0,55	0,19	37
100		0,11	0,95	1,9	1,5	84	1,02	0,35	37
220		0,11	0,43	0,88	0,68	160	1,81	0,62	17
22	250	0,11	3,3	8,8	6,8	42	0,39	0,13	23
47		0,11	1,5	4,1	3,3	67	0,67	0,23	38
100		0,11	0,72	1,9	1,5	120	1,3	0,44	17
10	350	0,11	5,6	19	15	34	0,30	0,10	23
22		0,11	2,5	8,8	6,8	51	0,48	0,17	37
47		0,11	1,2	4,1	3,3	86	0,91	0,31	37
100		0,11	0,56	1,9	1,5	160	1,6	0,54	17
100	385	0,11	0,56	1,9	1,5	174	1,6	0,54	34
150		0,11	0,37	1,3	1,0	250	2,0	0,70	40

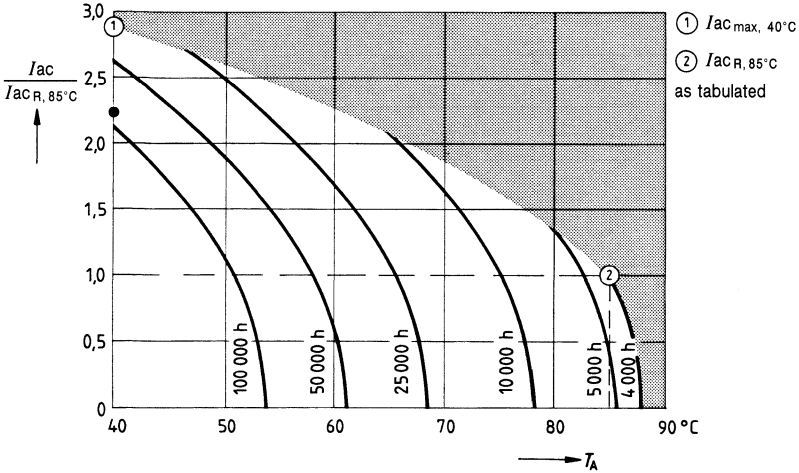
Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

◥ These capacitors are preferred types S (refer to page 4).

Service life[1])

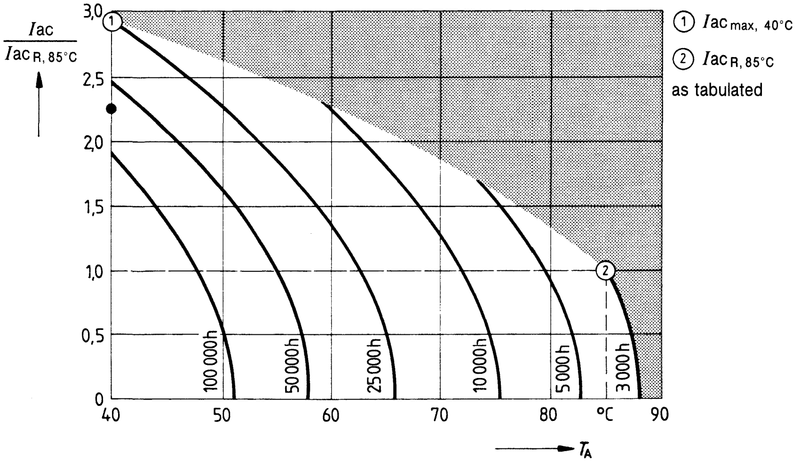
versus ambient temperature T_A at ripple current operation

Low-voltage series B 41 293



● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 85 °C

High-voltage series B 43 293



● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 85 °C

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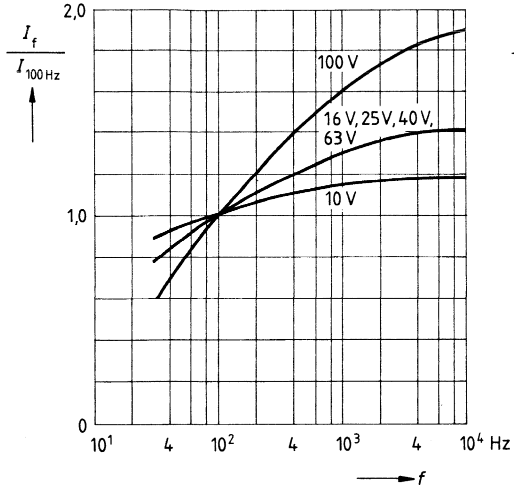
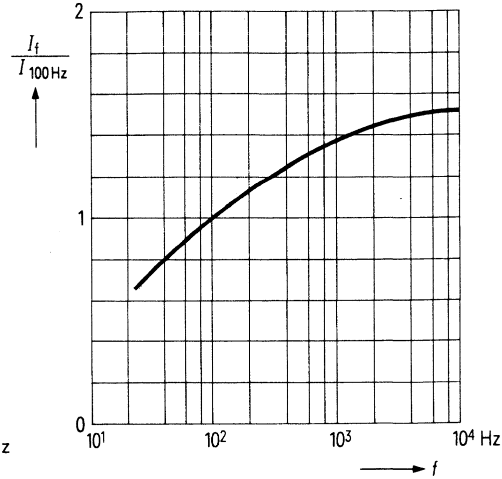
[1]) For details on service life curve refer to page 32.

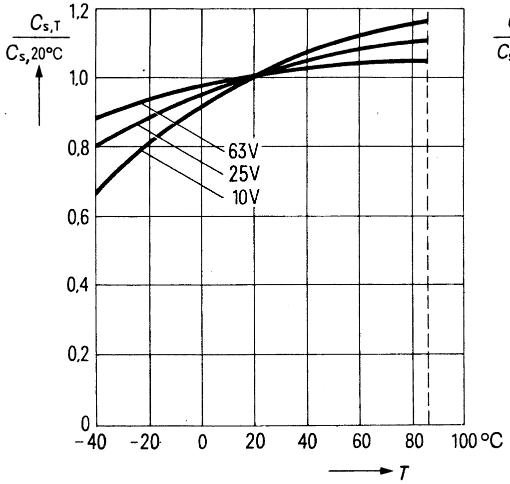
Permissible ripple current I_{ac}
versus frequency f
$V_R \leq 100$ V



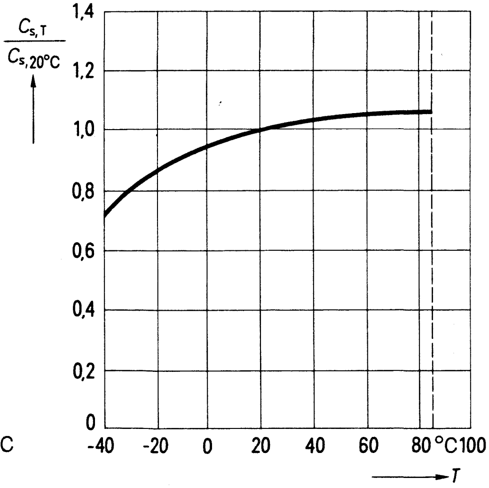
Permissible ripple current I_{ac}
versus frequency f
$V_R \geq 160$ V



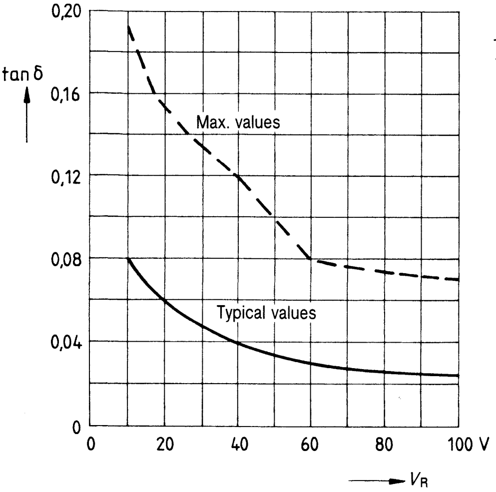
Series capacitance C_s
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \leq 100$ V



Series capacitance C_s
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \geq 160$ V

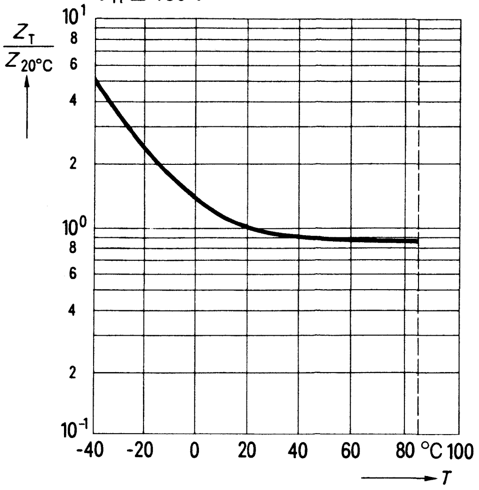


Dissipation factor tan δ
versus rated voltage V_R
(at $T = 20°C$ and $f = 100$ Hz)
$V_R \le 100$ V

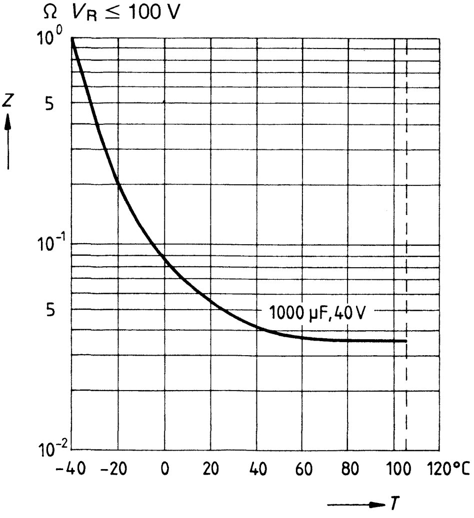


The maximum values are in accordance with DIN 45 910, part 126, sheet 1 and apply to $C_R \le 1000$ µF.
The values increase by 0.02 per 1000 µF.

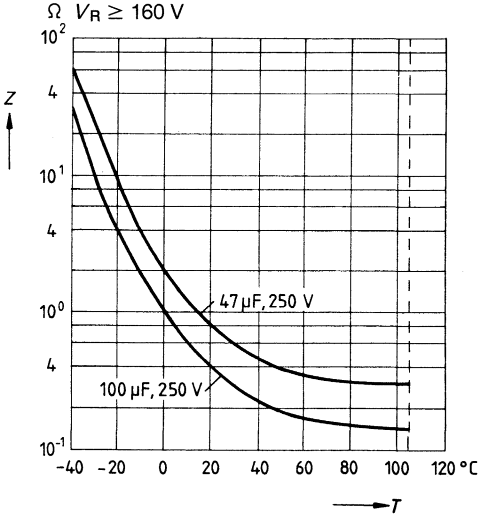
Impedance Z
versus temperature T ($f = 100$ Hz)
Typical behavior
$V_R \ge 160$ V



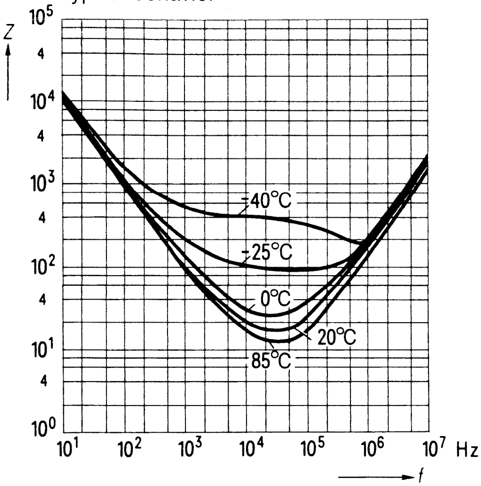
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
$V_R \le 100$ V



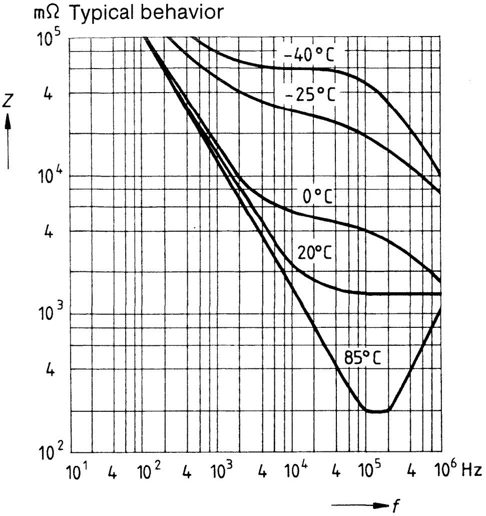
Impedance Z
versus temperature T ($f = 10$ kHz)
Typical behavior
$V_R \ge 160$ V



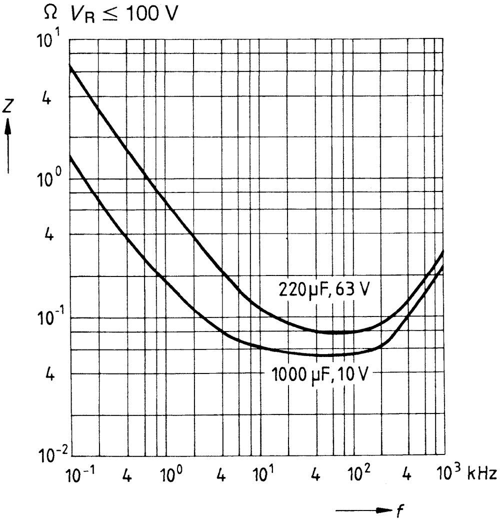
Impedance *Z*
versus frequency *f* and
temperature for 1000 µF/40 V
Typical behavior



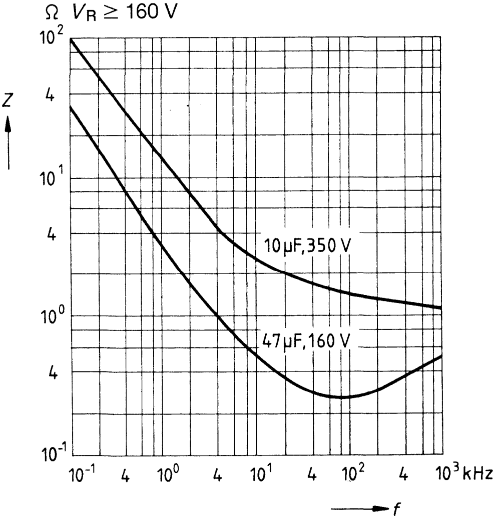
Impedance *Z*
versus frequency *f* and
temperature for 22 µF/250 V
Typical behavior



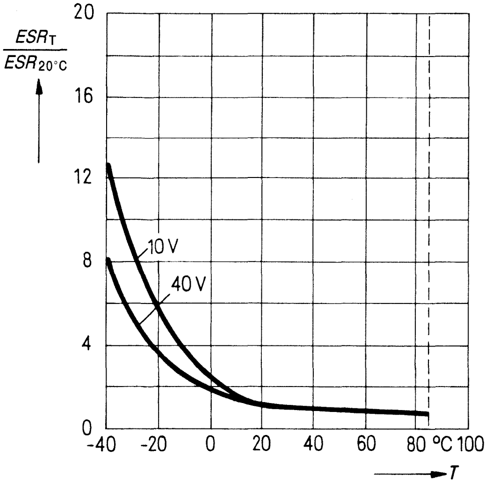
Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \leq 100$ V



Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \geq 160$ V



Equivalent series resistance *ESR*
versus temperature T ($f = 100$ Hz)
Typical behavior

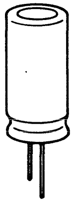


Al Electrolytic Capacitors

6.3 to 250 V dc
GP Grade

B 41 326
B 43 326

0.47 to 4700 µF; 5.5 mm to 18.5 mm dia.



Construction

- Surge-proof electrolytic capacitor, polar, in tubular aluminum case with insulating sleeve
- Single-ended design
- Positive pole marked by longer lead
- Negative pole marked on case

Features

- For vertical mounting on high-density PCBs
- Particularly suitable for automatic PCB assembly and mass production
- Operation up to 105 °C1) permissible

Application

- General-purpose applications in entertainment electronics
- Industrial electronics
- Filtering, coupling and pulse circuits, RC networks

Specifications and characteristics in brief

Sectional specifications	DIN IEC 384, part 4 DIN 45 910, part 12 B 40 010 "General Technical Information"
Type specification	DIN 41 259
IEC climatic category	40/085/56 in acc. with DIN IEC 68, part 1
DIN climatic category	GPF (−40 to +85 °C1), humidity category F2)) in acc. with DIN 40 040
Vibration resistance	In acc. with DIN IEC 68, part 2–6, test Fc: displacement amplitude 0.35 mm, frequency range 10 to 55 Hz acceleration max. 5 *g*, duration 3 × 2 h

	Operating conditions	$d_R \geq 6.3$ mm	$d_R = 5$ mm
Service live	40 °C; V_R; I_{acR} 85 °C; V_R; I_{acR}	> 70 000 h > 3 000 h	> 45 000 h > 2 000 h
Fraction failure	≤ 1 % (during service life)		
Failure rate		≤ 200 fit (≤ $200 \cdot 10^{-9}$/h)	≤ 200 fit (≤ $200 \cdot 10^{-9}$/h)

Taping	Types with rated dimensions 5 × 11 mm to 10 × 12.5 mm are also available on tape. The lead spacing „e" is here always 5 mm. For information on tape packaging and ordering code example refer to page 67.

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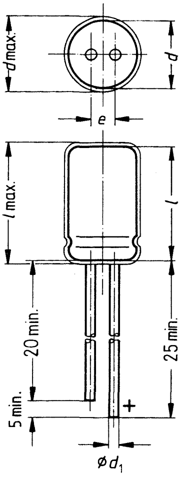
1) Operation at 105 °C with 0.6 $I_{ac\,max\,85\,°C}$ permissible for a total of 750 h for B 41 326; 500 h permissible for B 43 326, respectively.

2) These capacitors also comply with the test requirements of humidity category E in accordance with DIN 40 040.

Low-voltage series B 41 326

Rated voltage V_R[1]		6,3 V dc	10 V dc	16 V dc	25 V dc	
Rated capacitance µF	Tolerance	Rated dimensions $d \times l$ Code				
0,47	$^{-10}_{+50}\,\% \mathrel{\hat{=}} \mathrm{T}$					
1						
2,2						
4,7						
10					5 × 11 -A5106-T	
22				5 × 11 -A4226-T	6,3 × 11 -A5226-T	
47		5 × 11 -A2476-T		6,3 × 11 -A4476-T	8 × 12,5 -A5476-T	
100		6,3 × 11 -A2107-T		8 × 12,5 -A4107-T	10 × 12,5 -A5107-T	
220		8 × 12,5 -A2227-T		10 × 12,5 -A4227-T	10 × 20 -A5227-T	
470		10 × 12,5 -A2477-T		10 × 20 -A4477-T	12,5 × 25 -A5477-T	
1000		10 × 20 -A2108-T		12,5 × 25 -A4108-T	16 × 25 -A5108-T	
2200		12,5 × 25 -A2228-T	16 × 25 -A3228-T	16 × 31,5 -A4228-T	18 × 31,5 -A5228-T	
4700		16 × 31,5 -A2478-T	18 × 31,5 -A3478-T			



Dimensions (mm)				Approx. weight g
$d \times l$ (rated dimensions)	$d_{max} \times l_{max}$	d_1	e	
5 × 11	5,5 × 12	0,5	2	0,5
6,3 × 11	6,8 × 12		2,5	0,6
8 × 12,5	8,5 × 13,5		3,5	0,9
10 × 12,5	10,5 × 13,5	0,6	5	1,3
10 × 20	10,5 × 21		5	2,3
12,5 × 25	13,0 × 26		5	4,2
16 × 25	16,5 × 26	0,8	7,5	6,5
16 × 31,5	16,5 × 32,5		7,5	8,7
18 × 31,5	18,5 × 32,5		7,5	11,0

---

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

				High-voltage series B 43 326	
	40 V dc	63 V dc	100 V dc	160 V dc	250 V dc
				Rated dimensions *d* × *l* Code	
			5 × 11 -A9474-T ◥ ▨	6,3 × 11 -A1474-T ▨	8 × 12,5 -A2474-T ▨
			5 × 11 -A9105-T ◥ ▨	6,3 × 11 -A1105-T ▨	8 × 12,5 -A2105-T ▨
		5 × 11 -A8225-T ◥ ▨	6,3 × 11 -A9225-T ◥ ▨	8 × 12,5 -A1225-T ▨	10 × 12,5 -A2225-T ▨
	5 × 11 -A7475-T ▨	6,3 × 11 -A8475-T ◥ ▨	8 × 12,5 -A9475-T ◥ ▨	10 × 12,5 -A1475-T ▨	10 × 20 -A2475-T
	6,3 × 11 -A7106-T ▨	8 × 12,5 -A8106-T ◥ ▨	10 × 12,5 -A9106-T ◥ ▨	10 × 20 -A1106-T	12,5 × 25 -A2106-T
	8 × 12,5 -A7226-T ◥ ▨	10 × 12,5 -A8226-T ◥ ▨	10 × 20 -A9226-T ◥	12,5 × 25 -A1226-T	16 × 25 -A2226-T
	10 × 12,5 -A7476-T ◥ ▨		10 × 20 -A9476-T ◥	16 × 25 -A1476-T	18 × 31,5 -A2476-T
		10 × 20 -A8107-T ◥	12,5 × 25 -A9107-T ◥		
		12,5 × 25 -A8227-T ◥	16 × 31,5 -A9227-T ◥		
	16 × 25 -A7477-T ◥	16 × 31,5 -A8477-T			
	16 × 31,5 -A7108-T				

▨ Capacitors available on tape

Example for the compiling of ordering codes

Low-voltage series	High-voltage series
B41326-A4477-T	B43326-A2106-T
Code according to table	Code according to table

Special dimensions as well as other capacitance and voltage values upon request.
For packaging units refer to page 69.

◥ These capacitors are preferred types S (refer to page 4).

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C mA	$I_{ac\,R}$ 100 Hz 85 °C mA	ESL approx. nH
47	6,3	0,25	6,27	9,40	4,30	21	120	39	15
◥ 100		0,25	2,95	4,40	2,00	23	200	70	15
◥ 220		0,25	1,34	2,00	0,90	26	350	120	15
◥ 470		0,25	0,63	0,94	0,43	32	570	200	20
◥ 1 000		0,25	0,30	0,44	0,20	45	1 000	340	20
2 200		0,27	0,15	0,21	0,09	75	1 800	620	20
4 700		0,31	0,08	0,12	0,05	140	3 000	1 000	20
2 200	10	0,22	0,12	0,18	0,07	110	2 200	760	20
4 700		0,26	0,07	0,10	0,05	210	3 500	1 200	20
22	16	0,16	8,57	13,00	5,50	21	98	34	15
◥ 47		0,16	4,01	6,00	2,60	23	170	60	15
◥ 100		0,16	1,87	2,80	1,20	26	290	100	15
◥ 220		0,16	0,86	1,30	0,55	34	490	170	20
◥ 470		0,16	0,40	0,62	0,26	50	860	290	20
◥ 1 000		0,16	0,19	0,28	0,12	84	1 600	540	20
2 200		0,18	0,10	0,14	0,06	160	2 800	950	20
10	25	0,14	16,51	24,00	9,00	21	72	25	15
22		0,14	7,50	11,00	4,10	22	130	44	15
47		0,14	3,51	5,30	2,00	25	210	74	15
◥ 100		0,14	1,65	2,50	0,90	30	350	120	15
◥ 220		0,14	0,75	1,10	0,41	42	630	220	20
◥ 470		0,14	0,35	0,53	0,20	70	1 100	390	20
1 000		0,14	0,17	0,25	0,09	120	1 900	650	20
2 200		0,16	0,09	0,13	0,05	240	3 100	1 100	20
4,7	40	0,12	30,10	45,00	15,00	21	53	18	15
10		0,12	14,15	21,00	7,00	22	93	32	15
◥ 22		0,12	6,43	9,60	3,20	24	160	55	15
◥ 47		0,12	3,01	4,50	1,50	28	260	90	15
◥ 470		0,12	0,30	0,45	0,15	95	1 400	480	20
1 000		0,12	0,14	0,21	0,07	180	2 300	770	20
◥ 2,2	63	0,08	42,87	64,00	25,00	21	44	15	15
◥ 4,7		0,08	20,07	30,00	12,00	21	78	27	15
◥ 10		0,08	9,43	14,00	5,50	23	130	45	15
◥ 22		0,08	4,29	6,40	2,50	26	220	75	15
◥ 100		0,08	0,94	1,40	0,55	45	560	190	20
◥ 220		0,08	0,43	0,64	0,25	75	1 000	360	20
470		0,08	0,20	0,30	0,12	140	1 900	650	20
◥ 0,47	100	0,08	200,67	300,00	90,00	20	20	7	15
◥ 1,0		0,08	94,31	140,00	50,00	20	30	10	15
◥ 2,2		0,08	42,87	64,00	23,00	21	53	18	15
◥ 4,7		0,08	20,07	30,00	10,00	22	90	31	15
◥ 10		0,08	9,43	14,00	4,90	24	150	51	15
◥ 22		0,08	4,29	6,40	2,20	30	260	90	20
◥ 47		0,08	2,00	3,00	1,00	40	380	130	20
◥ 100		0,08	0,94	1,40	0,50	60	700	240	20
◥ 220		0,08	0,43	0,64	0,23	110	1 300	440	20

Cont'd on the next page

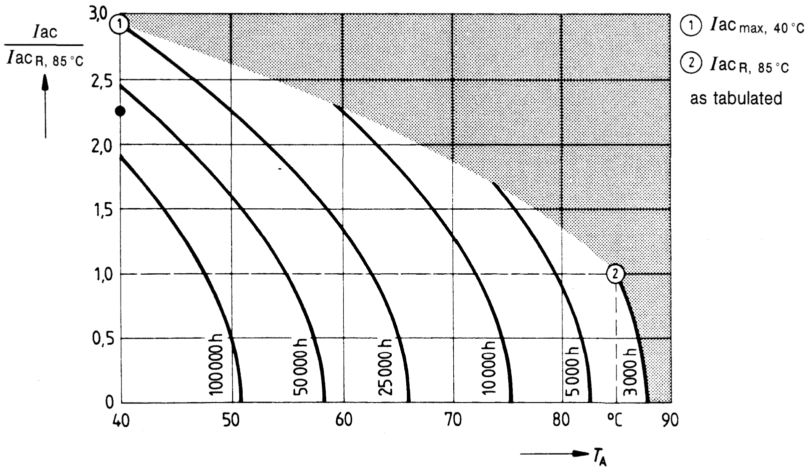
◥ These capacitors are preferred types S (refer to page 4).

C_R µF	V_R V dc	tan δ_{max} 100 Hz 20 °C	ESR_{typ} 100 Hz 20 °C Ω	ESR_{max} 100 Hz 20 °C Ω	Z_{max} 10 kHz 20 °C Ω	$I_{r,\,max}$ 5 min 20 °C µA	$I_{ac\,max}$ 100 Hz 40 °C mA	$I_{ac\,R}$ 100 Hz 85 °C mA	ESL approx. nH
0,47	160	0,17	426,42	640,0	320,0	20	17	6	15
1,0		0,17	200,42	300,0	150,0	21	25	9	15
2,2		0,17	91,10	140,0	68,0	21	45	15	15
4,7		0,17	42,64	64,0	32,0	23	74	25	15
10		0,17	20,04	30,0	15,0	26	130	44	20
22		0,17	9,11	14,0	6,8	34	230	80	20
47		0,17	4,26	6,4	3,2	50	390	130	20
0,47	250	0,17	426,42	640,0	320,0	20	21	7	15
1,0		0,17	200,42	300,0	150,0	21	30	10	15
2,2		0,17	91,10	140,0	68,0	22	50	17	20
4,7		0,17	42,64	64,0	32,0	25	87	30	20
10		0,17	20,04	30,0	15,0	30	160	54	20
22		0,17	9,11	14,0	6,8	42	260	90	20
47		0,17	4,26	6,4	3,2	67	450	150	20

Details on deviating frequencies and temperatures are shown in the following curves.
Any voltage occurring during continuous operation may only lie within the range between rated voltage and −2 V.

Service life[1]
versus ambient temperature T_A at ripple current operation

$d_R \geq 6.3$ mm



● $I_{ac\,R}$ at 40 °C = 2.24 · $I_{ac\,R}$ at 85 °C

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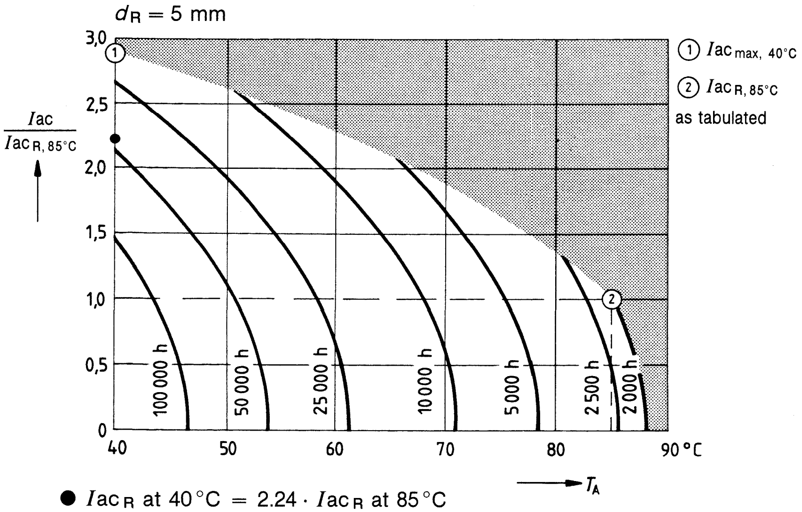
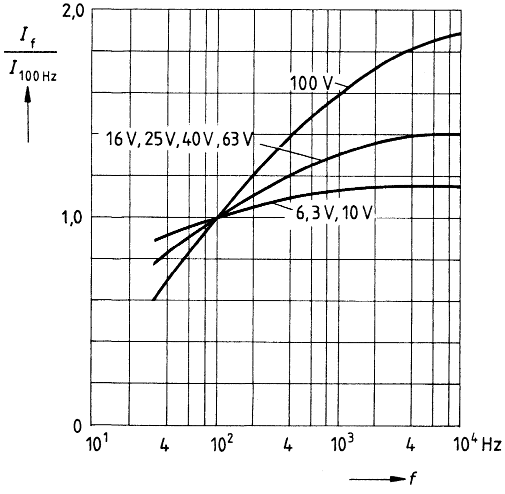
[1] For details on service life curves refer to page 32.

Service life[1])
versus ambient temperature T_A at ripple current operation

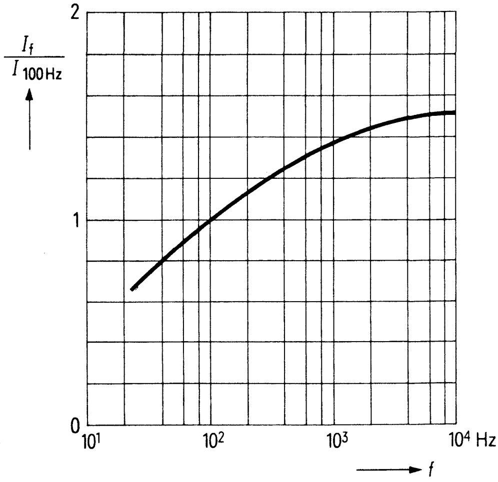


● $I\text{ac}_R$ at 40 °C = 2.24 · $I\text{ac}_R$ at 85 °C

Permissible ripple current Iac
versus frequency *f*
$V_R \leq 100$ V



Permissible ripple current Iac
versus frequency *f*
$V_R \geq 160$ V



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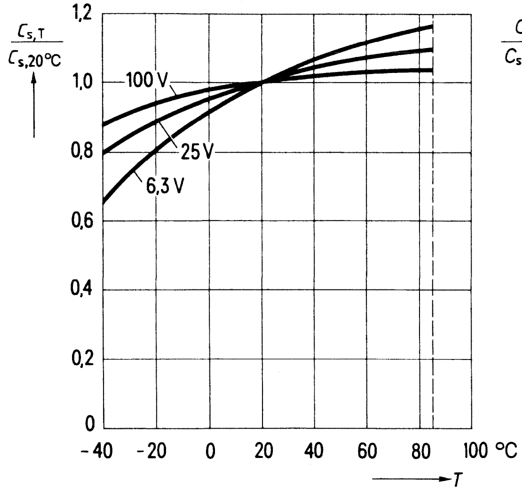
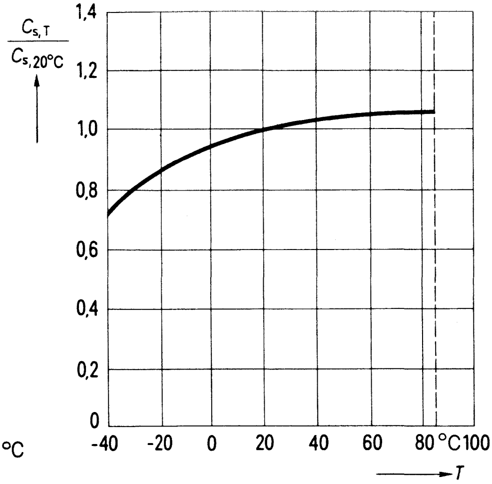
[1]) For details on service life curve refer to page 32.

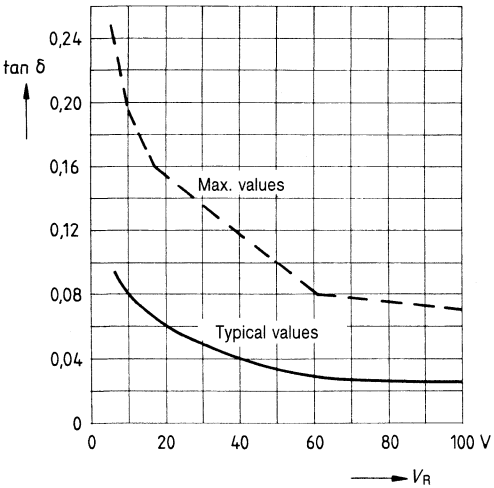
Series capacitance C_S
versus temperature T (f = 100 Hz)
Typical behavior
$V_R \leq 100$ V



Series capacitance C_S
versus temperature T (f = 100 Hz)
Typical behavior
$V_R \geq 160$ V

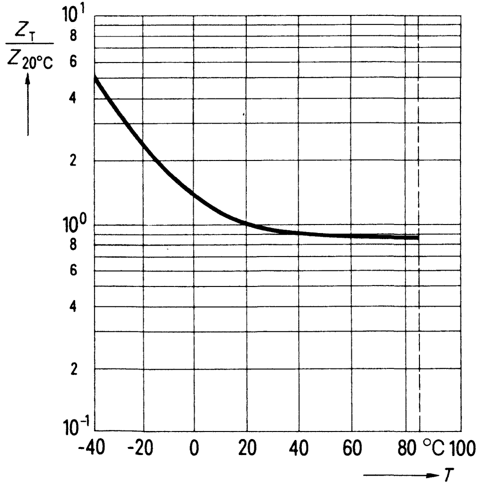


Dissipation factor tan δ
versus rated voltage V_R
(at T = 20°C and f = 100 Hz)
$V_R \leq 100$ V

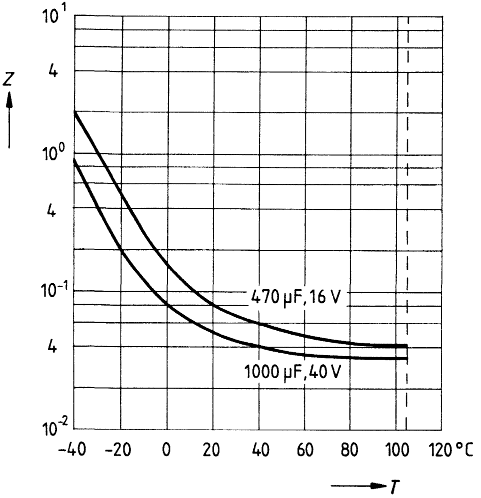


The maximum values are in accordance with DIN 45910/124
and apply to $C_R \leq 1000$ µF.
The values increase by 0.02 per 1000 µF.

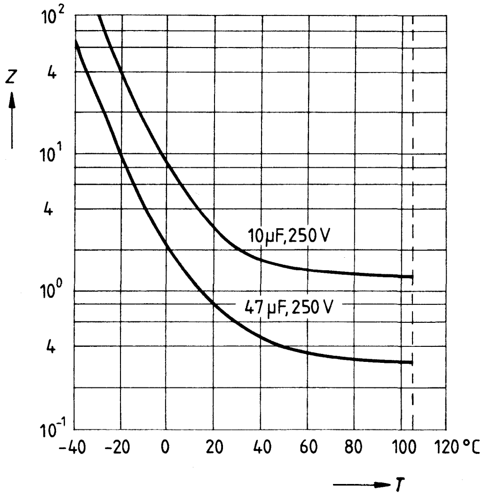
Impedance Z
versus temperature T (f = 100 Hz)
Typical behavior
$V_R \geq 160$ V



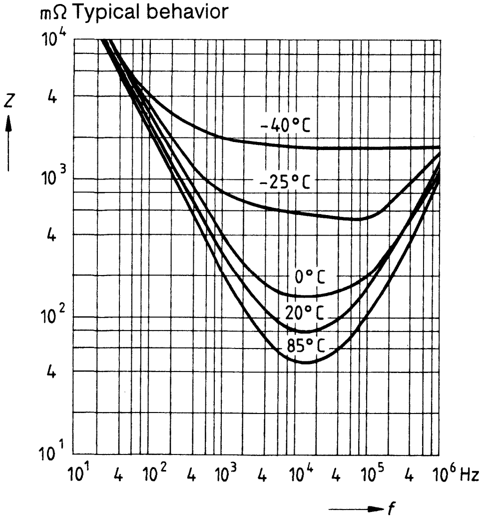
Impedance *Z*
versus temperature T ($f = 10$ kHz)
Typical behavior
$V_R \leq 100$ V



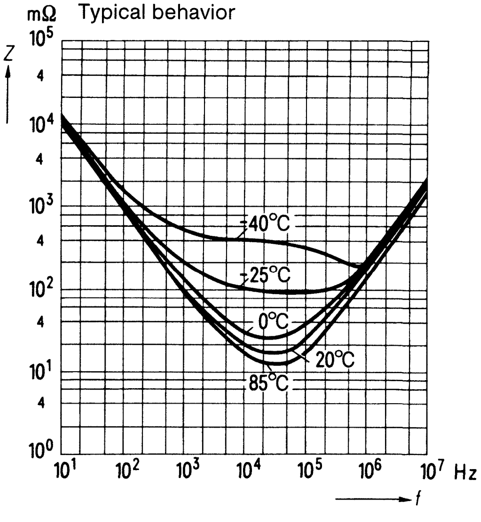
Impedance *Z*
versus temperature T ($f = 10$ kHz)
Typical behavior
$V_R \geq 160$ V



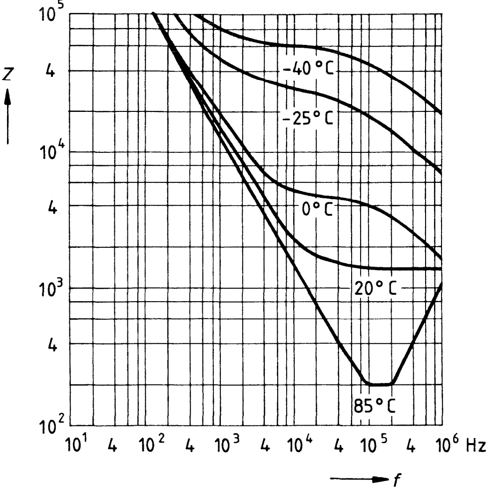
Impedance *Z*
versus frequency f and
temperature for 470 µF/16 V
Typical behavior



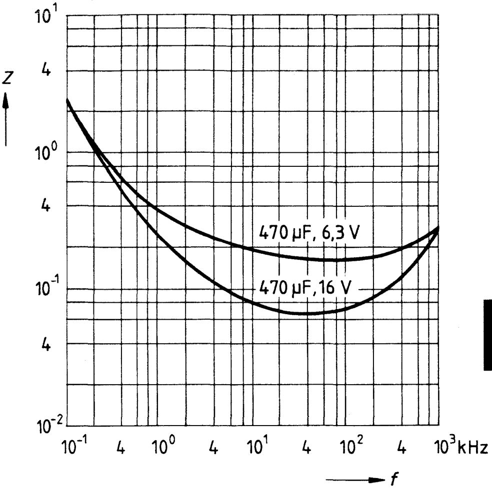
Impedance *Z*
versus frequency f and
temperature for 1000 µF/40 V
Typical behavior



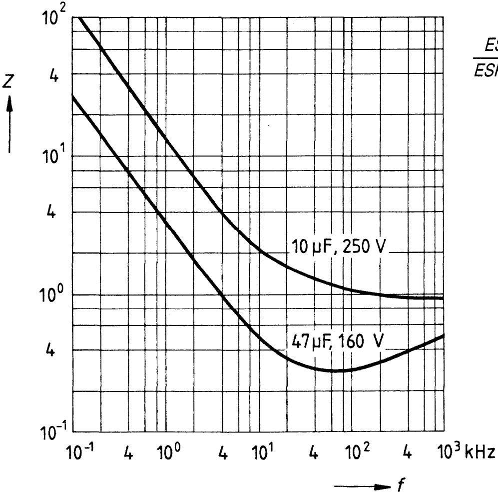
Impedance *Z*
versus frequency *f* and
temperature for 10 µF/250 V
Typical values



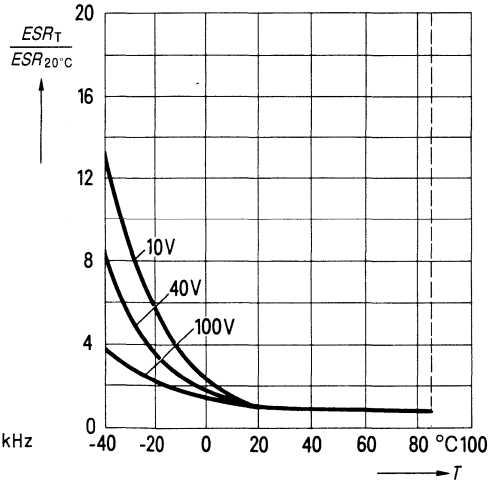
Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \leq 100$ V



Impedance *Z*
versus frequency *f*
Typical values at 20 °C
$V_R \geq 100$ V



Equivalent series resistance *ESR*
versus temperature *T* (*f* = 100 Hz)
Typical values
$V_R \leq 100$ V



Aluminum Electrolytic Capacitors

Capacitors for Photoflash Applications

Al Electrolytic Capacitors for Photoflash Applications

B 43 405 ... B 43 407

General information

The widely varying demands made on photoflash devices have to be taken into account when selecting an appropriate aluminum electrolytic capacitor. In the following only the essential data from the relevant short form catalog will be quoted. For further information contact your nearest Siemens office. The most important selection criteria are listed in the questionnaire on page 258.

Features

Design and characteristics of Siemens photoflash capacitors excellently match the various operating conditions.

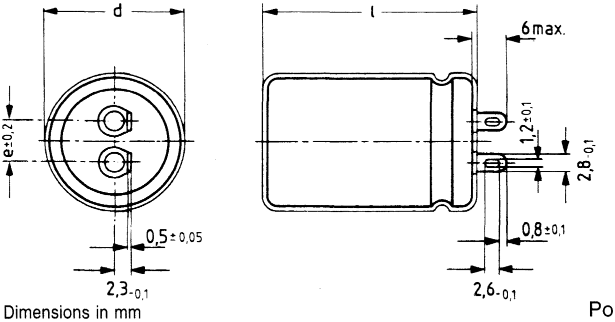
- Stable capacitance for a high number of flashes, even with short flash repetition intervals, ensures a constant flash factor.
- Low leakage currents, even after long idle periods, guarantee a high number of flashes per battery charge and permit employment in exclusively battery-operated equipment.
- Small dimensions with given voltage and capacitance allow small equipment size.
- With capacitor and flash tube correctly matched, low internal resistances ensure optimum light efficiency.

Summary

Type series	Description	Rated capacitance	Rated voltage	Page
B43405	Photoflash electrolytic capacitor with solder tags for amateur equipment	approx. 120 µF to 4000 µF	310 V dc to 510 V dc	255
B43406	Photoflash electrolytic capacitor with solder tags for professional portable photoflash devices	approx. 500 µF to 3000 µF	330 V dc to 500 V dc	256
B43407	Photoflash electrolytic capacitor with screw terminals for studio photoflash equipment	approx. 1500 µF	350 V dc	257

Al electrolytic capacitor for photoflash application; 22.5 mm to 40.5 mm dia.; with insulating sleeve; particularly suitable for use in amateur equipment.
Single-anode version with a particularly low dissipation factor.
Double-anode version with particularly small dimensions.

Type B 43 405, solder tags



Dimensions in mm

Polarity marking: +

Rated capacitance	Tolerance	Rated voltage
approx. 120 to 4000 µF	+30/−10 %	310 to 510 V dc

Preferred dimensions

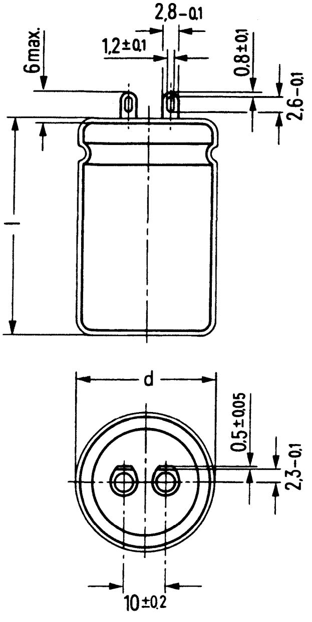
*d*max (mm) with insulating sleeve	*e* (mm)	*l*max (mm) with insulating sleeve 30,5	40,5	50,5	60,5	70,5	80,5
22,5	7	×	×	×			
25,5	10		×	×	×		
26,5	10		×	×	×		
30,5	10			×	×	×	
35,5	10			×	×	×	
40,5	10				×	×	×

Other dimensions as well as other terminal versions upon request.

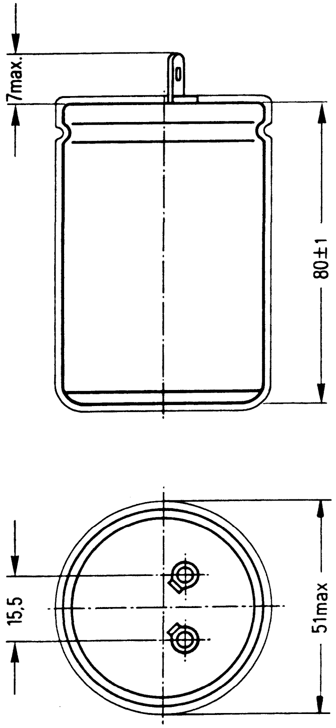
Al electrolytic capacitor for photoflash application; 35.5 mm to 51 mm dia.; due to high load capacity particularly suitable for use in professional equipment.

Type B 43 406, double-anode version

Outline drawing I



Outline drawing II



Dimensions in mm

Rated capacitance	Tolerance	Rated voltage
approx. 500 to 3000 µF	+ 30/ – 10 %	330 to 500 V dc

If intermediate values or higher energy are required, we recommend to connect an appropriate number of capacitors in parallel.

Preferred dimensions for outline drawing I

$d_{max} \times l_{max}$ (with insulating sleeve)

35,5 × 60,5
35,5 × 80,5
40,5 × 80,5

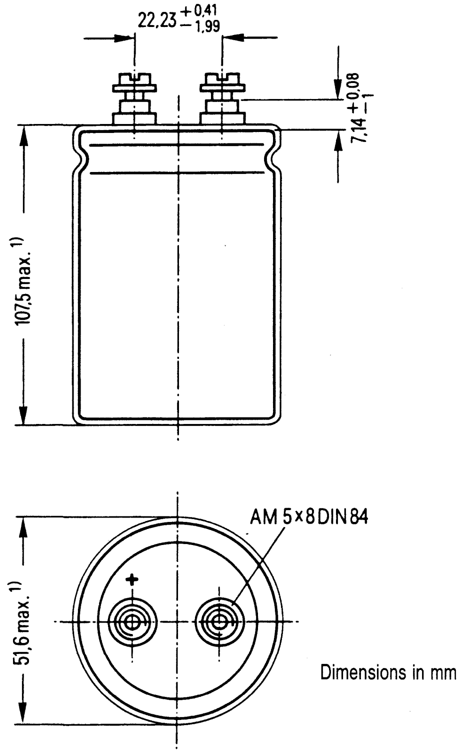
Other dimensions as well as other terminal versions upon request.

Al electrolytic capacitor for photoflash application; 51.6 mm dia. (with insulating sleeve); due to outstanding load capacity and operational reliability particularly suitable for use in studio equipment.

Type B 43 407

With regard to heat dissipation the capacitance level of each capacitor has been limited to 1500 µF.

If higher energy is required, we recommend to connect an appropriate number of capacitors in parallel. In case of series connection, the circuit should be designed such that the load on the individual capacitors will not exceed the permissible voltage range ($\leq V_R$).



Dimensions in mm

Rated capacitance	Tolerance	Rated voltage
approx. 1500 µF	+20/−10 %	350 V dc

Cylindrical screws and toothed washers are included in delivery (loosely). Ring clips have to be ordered separately; refer to B 44 030, page 263.

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[1] with insulating sleeve

The characteristic data compiled in the questionnaire below are required for dimensioning photoflash electrolytic capacitors.

Please use the questionnaire for your request, as the data will enable us to ideally fit the capacitor to your particular application.

Furthermore, it should be taken into consideration that photoflash electrolytic capacitors can only be produced in economically reasonably minimum quantities.

Questionnaire

Rated capacitance ______________________ µF

Rated voltage ______________________ Vdc

Required dimensions: diameter ______________________ mm

length ______________________ mm

Terminals ______________________

Ambient temperature ______________________ °C

Discharge conditions

Internal resistance of the discharge tube ______________________ Ω

Charging resistance (series resistance) ______________________ Ω

Sequence of flashes ______________________

Intermittent periods ______________________

Service life expectancy ______________________

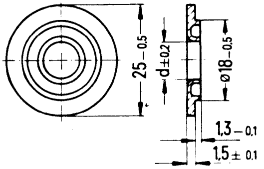
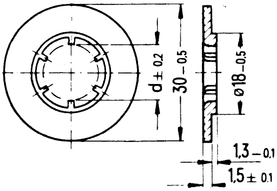
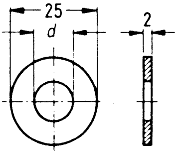
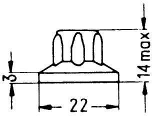
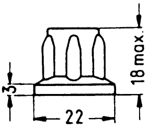
Number of items, annually ______________________

Aluminum Electrolytic Capacitors

Accessories

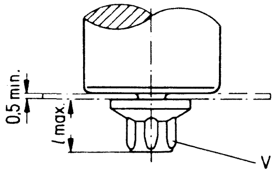
Mounting and insulating parts

Accessories in accordance with DIN 41331 for capacitors with threaded-stud base

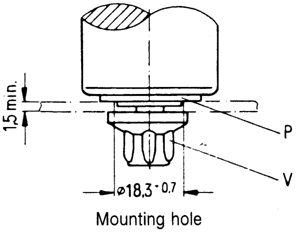
Capacitor diameter	Outline drawing	Diameter *d*	Ordering code
Insulating connecting washer "P"			
25...40		8,5	B44020-B1-B25 ◥
50...75		12,5	B44020-B2-B30 ◥
Insulating washer "N"			
25...40		8,4	B44020-A1-B25 ◥
50...75		13	B44020-A2-B25 ◥
Plastic cap nut "V"			
25...40	**for thread M8** width across flats 13 		B44020-B5-B8 ◥
50...75	**for thread M12** width across flats 17 		B44020-A5-B12 ◥

◥ These accessories are preferred types S (refer to page 4).

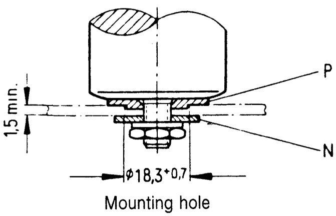
Accessories in accordance with DIN 41 331 for capacitors with threaded-stud base



Uninsulated mounting with cap nut

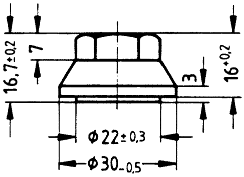
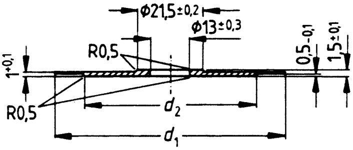
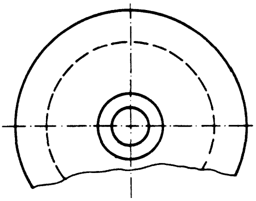


Insulated mounting with cap nut

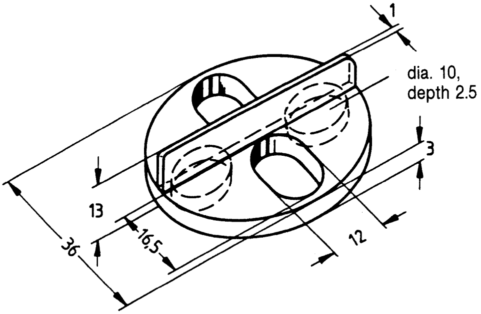


Insulated mounting with hex nut DIN 439

Special accessories for capacitors with screw terminals and threaded studs

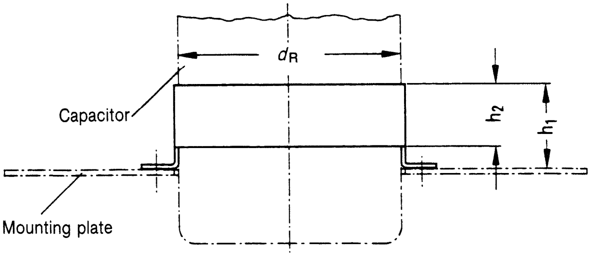
<table>
<tr><th>Capacitor diameter</th><th>Outline drawing</th><th>Ordering code</th></tr>
<tr><td>50 ... 75 mm</td><td>Reinforced cap nut made of nylon
for thread M 12
width across flats 19 mm
 </td><td>B44020-J6-B12</td></tr>
<tr><td>50 mm
75 mm</td><td>Hostalen insulating washer
 

$d_{1-0,5}$	$d_{2-0,5}$
51	31
76	56

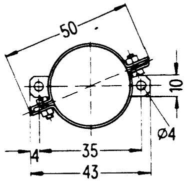
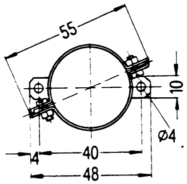
</td><td>B44020-B6-B51
B44020-B6-B76</td></tr>
<tr><td>35 mm
45 mm
50 mm</td><td>Insulating part to increase the
clearance between the terminals
 </td><td>B44020-B7-B35
B44020-B7-B45
B44020-B7-B50</td></tr>
</table>

Ring clips for cans with 25 mm to 75 mm diameter

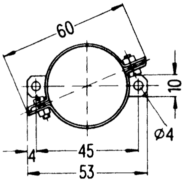
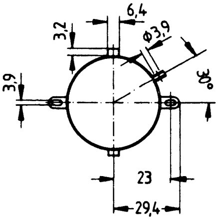
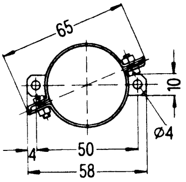
Ring clips are used for upright mounting of can-type capacitors. The refined clip surface is protected against corrosion.



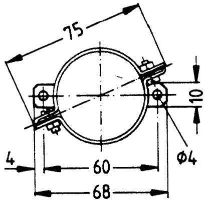
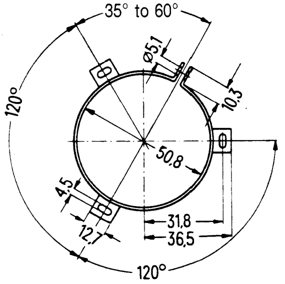
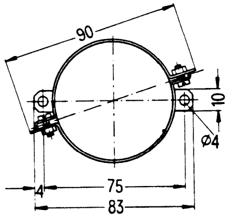
Various ring clip versions are available for al electrolytic capacitors. Some types are delivered with tightening screws AM 3 × 10 DIN 84 and nuts DIN 934. The ring clips require 30 mm wide plastic strips, which are inserted for – possibly additional – insulation between ring clip and capacitor. Please observe the relevant VDE regulations.

d_R	h_1	h_2	Ring clip version	**Ordering code** without	with
	mm			insulating strips	
25	19	15	 Tightening screws and nuts are included in delivery.	◥ B44030-A25	◥ B44030-J25 (Length of insulating strip: 170 mm)
30	19	15	 Tightening screws and nuts are included in delivery.	◥ B44030-A30	◥ B44030-J30 (Length of insulating strip: 200 mm)

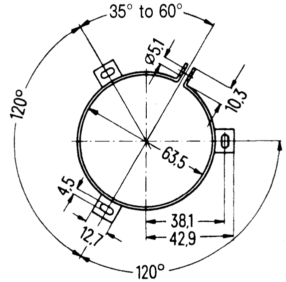
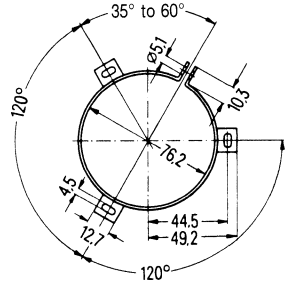
◥ These accessories are preferred products S (refer to page 4).

d_R	h_1	h_2	Ring clip version	**Ordering code** without	with
	mm			insulating strips	
35	19	15	 Tightening screws and nuts are included in delivery.	B44030-A35 ◥	B44030-J35 ◥ (Length of insulating strip: 230 mm)
	19	14		B44030-A36 ◥	B44030-J36 (Length of insulating strip: 230 mm)
40	19	15	 Tightening screws and nuts are included in delivery.	B44030-A40 ◥	B44030-J40 ◥ (Length of insulating strip: 260 mm)

◥ These accessories are preferred products S (refer to page 4).

d_R	h_1	h_2	Ring clip version	**Ordering code** without	with
	mm			insulating strips	
50	19	15	 Tightening screws and nuts are included in delivery.	B44030-A50 ◥	B44030-J50 ◥ (Length of insulating strip: 325 mm)
	29	19		B44030-A51 ◥	B44030-J51 (Length of insulating strip: 325 mm)
65	26	22	 Tightening screws and nuts are included in delivery.	B44030-A65	B44030-J65 (Length of insulating strip: 420 mm)

◥ These accessories are preferred products S (refer to page 4).

d_R	h_1	h_2	Ring clip version	**Ordering code** without	with
	mm			insulating strips	
65	29	19		B44030-A64	◥ B44030-J64 (Length of insulating strip: 420 mm)
75	29	19		B44030-A75	◥ B44030-J75 (Length of insulating strip: 495 mm)

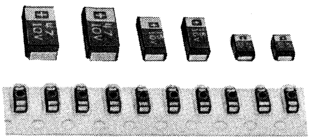
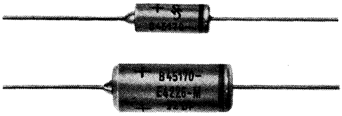
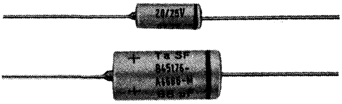
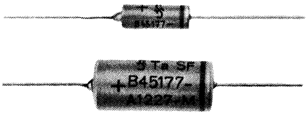
◥ These accessories are preferred products S (refer to page 4).

Tantalum Electrolytic Capacitors

Survey

Tantalum Electrolytic Capacitors

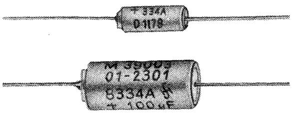
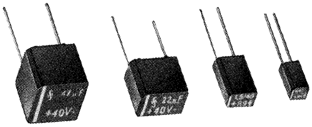
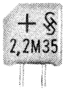
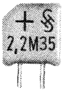
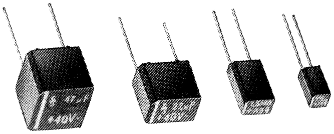
Selector Guide

Type	Rated voltage V_R V dc	Rated capacitance C_R µF	Dimensions $d \times l$ or $W \times L \times H$ mm	
SMD chip capacitors				
B 45 196 	6,3 to 35	0,10 to 3,3 0,47 to 6,8 1,5 to 22 3,3 to 68	$W \times L \times H$ 1,6 × 3,2 × 1,6 2,8 × 3,5 × 1,9 3,2 × 6,0 × 2,5 4,3 × 7,3 × 2,8	
Axial capacitors				
B 45 170 CECC 	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 45 177 	6,3 to 50	4,7 to 47 6,8 to 150 22 to 330	4,7 × 12,0 7,3 × 17,3 8,9 × 20,0	

	Temperature range (°C) IEC climatic category	Failure rate (40 °C, V_R, circuit resistance $\geq 3 \Omega/V$)	Standards and qualifications	Features and applications	Page
	−55 to +125 55/125/56	≤ 70 fit ($\leq 70 \cdot 10^{-9}$/h)	IEC 384-3 IECQ-QC300801/US0001	Chip version, particularly suitable for automatic placement, reflow and wave solderable; only available on tape.	299
	−55 to +125 55/125/56	≤ 5 fit ($\leq 5 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350 DIN 44351 CECC 30201-001 CECC 30201-019 CECC 30201-029 DIN 45910, part 144 UTE C 83-112, part 8	Hermetically sealed, for high climatic stress; only available on tape.	309
	−55 to +125 55/125/56	≤ 5 fit ($\leq 5 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350	Hermetically sealed, very high volumetric efficiency, for high climatic stress; only available on tape.	315
	−55 to +125 55/125/56	≤ 5 fit ($\leq 5 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350 CECC 30201-040	Extremely low *ESR*! Hermetically sealed, for high climatic stress; particularly suitable for switch-mode power supplies with very high clock frequencies; only available on tape.	320

Tantalum Electrolytic Capacitors

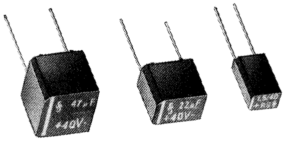
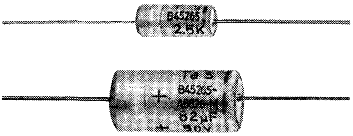
Selector Guide

Type	Rated voltage V_R V dc	Rated capacitance C_R µF	Dimensions $d \times l$ or $b \times l \times h$ mm	
Axial capacitors, 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 4,70 × 12,04 7,34 × 17,20 8,92 × 19,96	
Radial capacitors				
B 45 181 CECC 	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 45 184  	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	

	Temperature range (°C) IEC climatic category	Failure rate (40 °C, V_R, circuit resistance $\geq 3\,\Omega/V$)	Standards and qualifications	Features and applications	Page
	−55 to +125 55/125/56	FR level 1 % to 0,001 % per 1000 h at 85 °C (refer to MIL-STD-690)	MIL-C-39003 E MIL-C-39003/1 E	Hermetically sealed, for high climatic stress.	327
	−55 to +125 55/125/56	$\leq$ 15 fit ($\leq 15 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350 DIN 44352 CECC 30200 CECC 30201-007 CECC 30201-009 UTE C 83-112, part 6	Flame-retardant epoxy encapsulation, plug-in.	336
	−55 to +125 55/125/56	$\leq$ 15 fit ($\leq 15 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350	Flame-retardant epoxy encapsulation, plug-in, high reliability. **Thermal-overload protection.**	341
	−55 to +125 55/125/56	$\leq$ 15 fit ($\leq 15 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350 DIN 44352 DIN 45910, part 145 (CECC 30201-xxx)	Flame-retardant epoxy encapsulation, plug-in. **Thermal overload protection.**	346

Tantalum Electrolytic Capacitors

Selector Guide

Type	Rated voltage V_R V dc	Rated capacitance C_R µF	Dimensions $d \times l$ or $b \times l \times h$ mm
B 45 187 	6,3 to 50	4,7 to 47 6,8 to 150 22 to 330	4,8 × 7,3 × 10,0 7,3 × 12,3 × 10,0 12,3 × 12,3 × 10,5
Axial capacitors with liquid electrolyte			
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

Temperature range (°C) IEC climatic category	Failure rate (40 °C, V_R, circuit resistance ≥ 3 Ω/V)	Standards and qualifications	Features and applications	Page
−55 to +125 55/125/56	≤ 15 fit (≤ $15 \cdot 10^{-9}$/h)	IEC 384-15 DIN 44350	Extremely low *ESR*! Flame-retardant epoxy encapsulation, plug-in. **Thermal overload protection.**	351
−55 to +125 55/125/56	≤ 20 fit (≤ $20 \cdot 10^{-9}$/h) without circuit resistance	IEC 384-15 DIN 44360	Tubular metal case, elastomer-sealed, capacitance and voltage range in accordance with MIL-C 39006/9, Style CLR 65, extremely low leakage current.	358

Tantalum Electrolytic Capacitors

General Technical Information
Tape Packaging, Packaging Units

1 Basic construction

The following explanations relate to capacitors with a sintered body and solid or liquid electrolytes for high reliability 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 soldered to the case or the terminals	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 important to pay attention to the polarity marking (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.
Siemens capacitors with built-in fuse (B 45 184, B 45 185, B 45 187) are protected against these failures.

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 within the temperature range $-55\,°C$ to $+85\,°C$.
The temperature range between $+85\,°C$ and $+125\,°C$ requires a linear reduction of V_C to $^2/_3\ V_R$ (125 °C). 85 °C at V_R and 125 °C at $^2/_3\ V_R$ represent approximately the same load for the capacitor. Operation below category voltage V_C does not impair the capacitor and has a positive effect on 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.

2.3.1 Max. permissible operating voltage

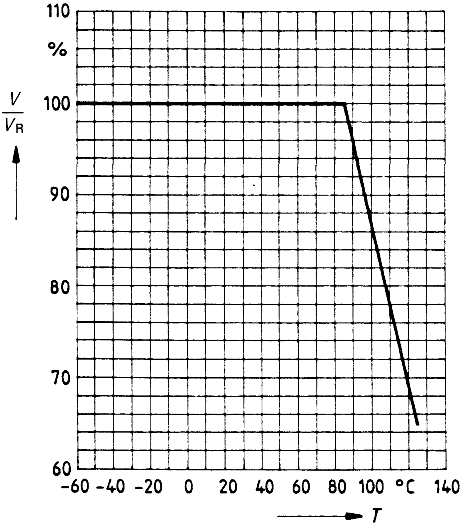


Figure 1
Max. permissible operating voltage versus temperature

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 must 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 addition 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. 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 corresponding 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.

Ripple voltage capability (maximum values)

Superimposed alternating voltage versus frequency at 20 °C.
The following diagrams are valid for all types except for B 45 196 and B 45 265; the data for these types are included in the relevant data sheets.

Figure 2
Case size A

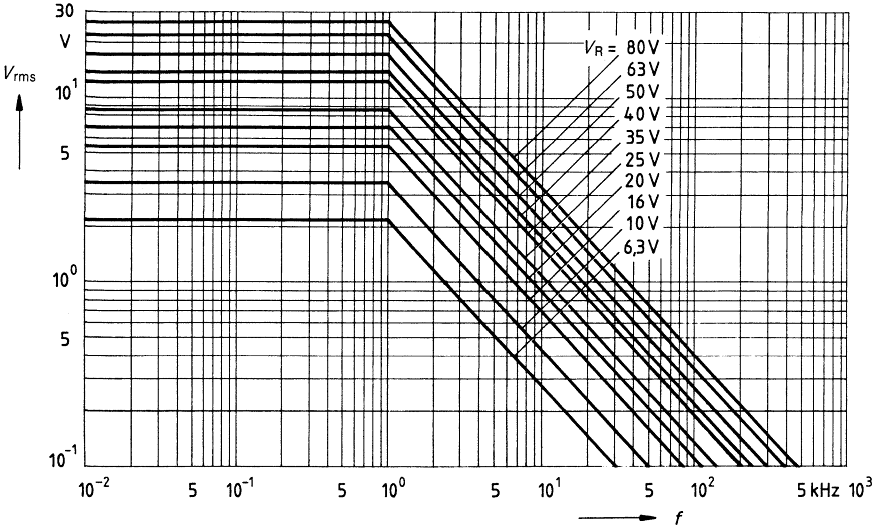


Figure 3
Case size B

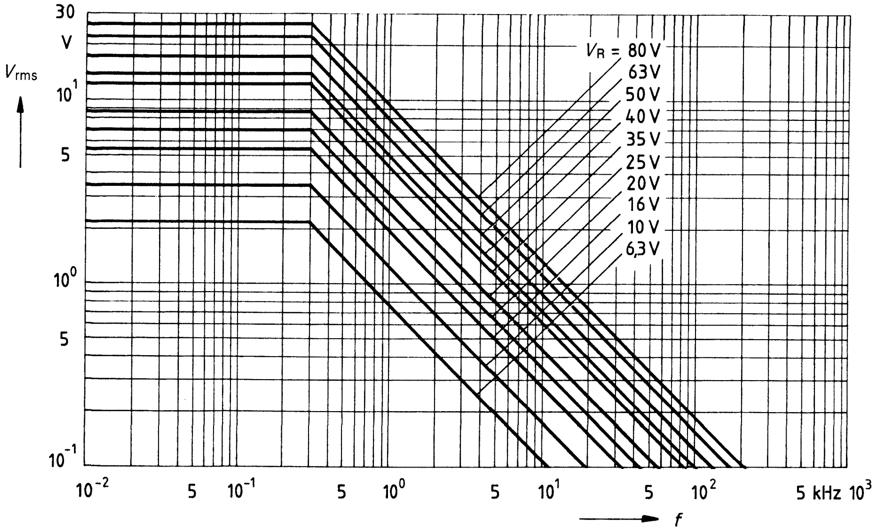


Figure 4

Case size C

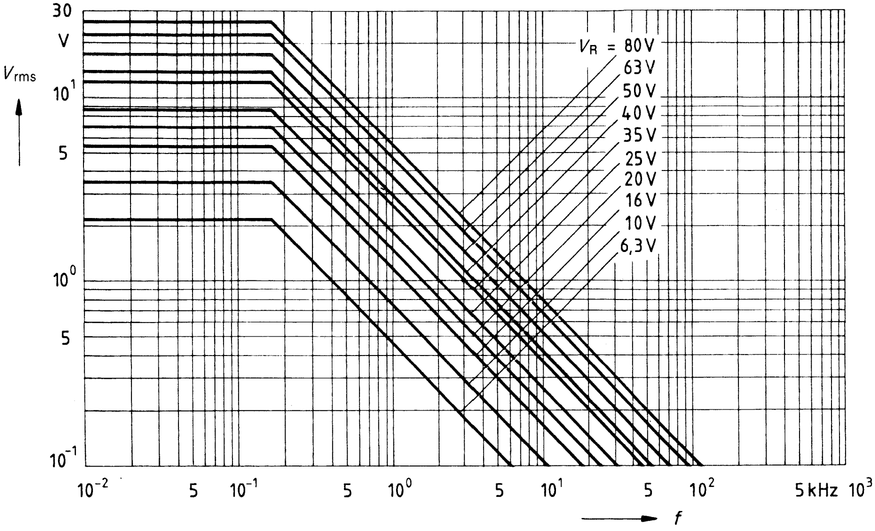
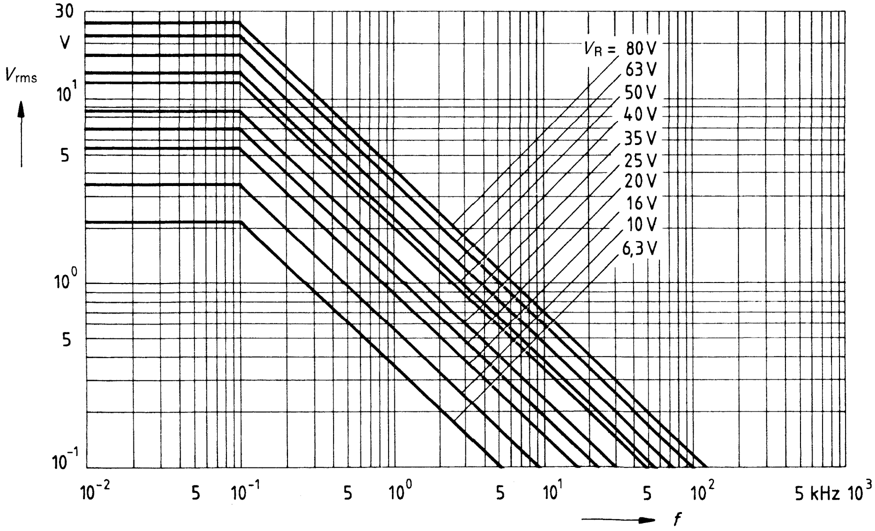


Figure 5

Case size D



At higher temperatures the following temperature factors apply:

+50 °C	+85 °C	+125 °C
0.7	0.5	0.3

2.6 Polarity reversal voltage (incorrect polarization)

The permissible polarity reversal voltages indicated in the individual data sheets can appear for short periods of time 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 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, while the upper limit temperature should not be exceeded.

Wet sinter capacitors are not allowed to be connected back-to-back, since gaseous oxygen, which causes excessive pressure in the case, can form on the silver cathode of the capacitor which is at that time connected in forward direction.

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

In all conventional capacitors a recharging effect may occur. After elimination of an external bridging at its layers, this recharging effect causes a charged capacitor to generate a recharging voltage that is unidirectional to the charging polarization. The recharging voltage 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 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 does not significantly increase even after voltage-free storage for years and at relatively high storage temperatures. Voltage-free storage of solid sinter capacitors for years at $\leq 40\,^\circ C$ has practically no influence on the service life. A voltage-free storage at room temperature has no influence on the leakage current and at higher storage temperatures the influence is only small. Tantalum electrolytic capacitors can be stored for at least 10 years without requiring any subsequent conditioning.

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 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.

3.2 Temperature dependence of the capacitance

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

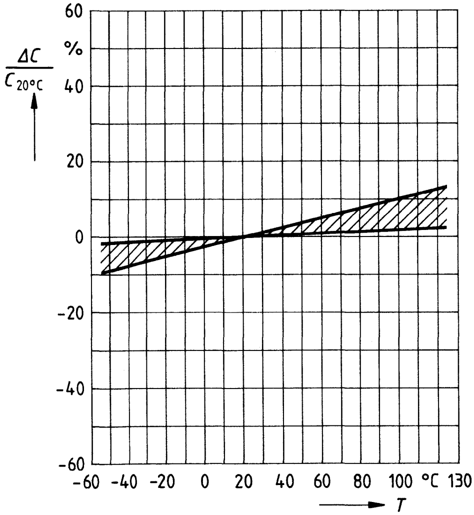


Figure 6
Capacitance change versus temperature (typical values)

Maximum values

−55 °C	+85 °C	+125 °C
−10%	+8%	+12%

For tantalum chip capacitors B 45196 and wet sinter capacitors B 45265 the values given in the data sheets apply.

3.3 Frequency dependence of the 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 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 or the semiconductor layer (equivalent series resistance = *ESR*);
3. Effective reactance ωL of the inductance of the electrodes and the terminals.

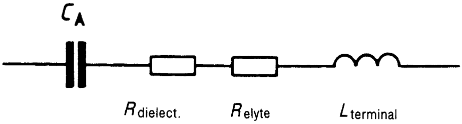


Figure 7
Simplified equivalent circuit diagram of an electrolytic capacitor

The frequency and temperature behavior of these resistances determine the impedance characteristic. The *ESR* includes both $R_{\text{dielectric}}$ and R_{elyte} 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 mainly caused by both the effective reactances. The temperature dependence is mainly determined by the resistance of the electrolyte.

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.

Figures 8 to 10 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.

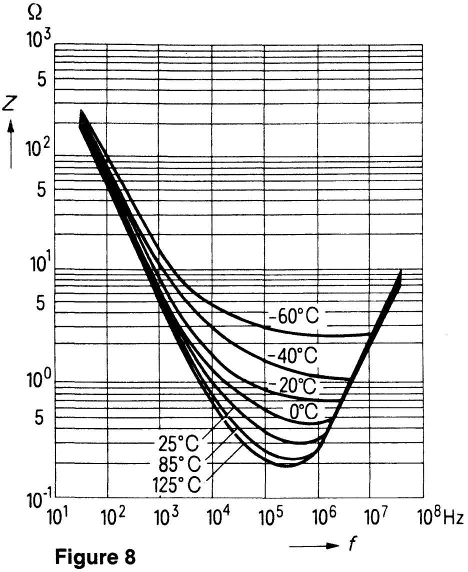


Figure 8
Impedance of a wet
sinter capacitor 20 µF/60 V

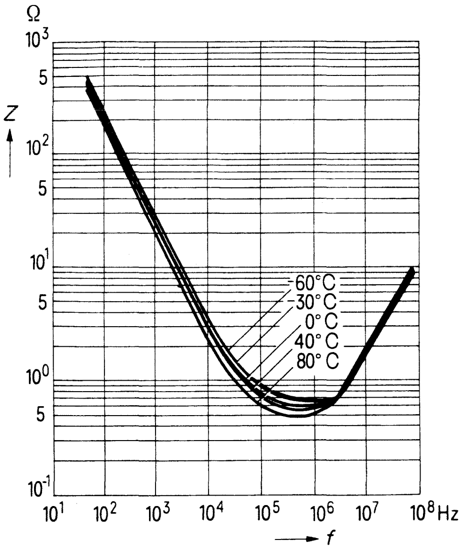


Figure 9
Impedance of a solid
sinter capacitor 6.8 µF/35 V

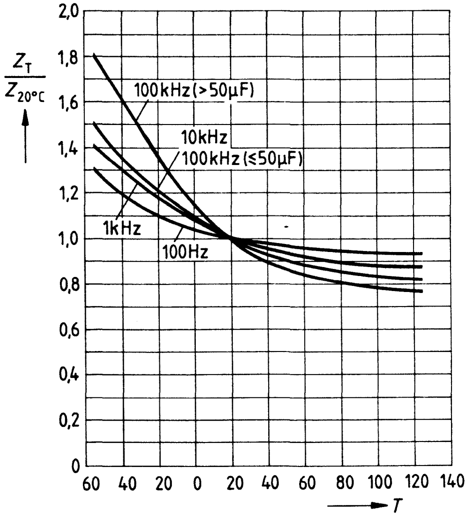


Figure 10
Impedance versus temperature
with solid sinter capacitors
(typical values)

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 factor as a function of frequency shows a similar curve for wet and solid sinter capacitors. Figure 11 demonstrates the typical frequency response of the dissipation factor at several temperatures, using a solid sinter capacitor as example.

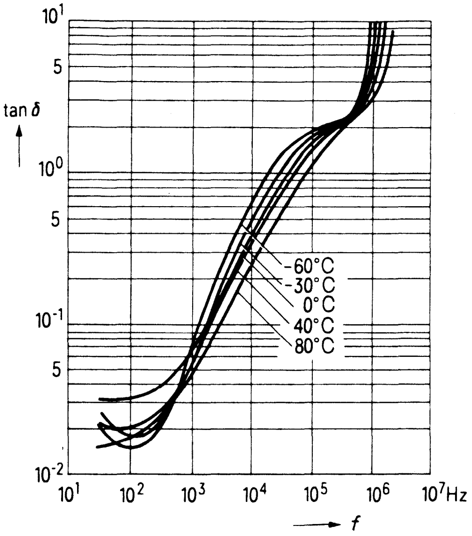


Figure 11
Dissipation factor of a tantalum electrolytic capacitor 1 µF/35 V with solid electrolyte

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 the voltage as well as on the temperature (figures 12 to 15). 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 the leakage current increases slightly more with rising temperatures than does that of wet types.

Leakage current measurement

The leakage current is measured at 20 °C, 5 minutes after having connected the capacitor to rated voltage. A stable power supply and a series resistance of 1000 Ω to limit the charging current are required for measurement.
Prior to connecting the voltage, the capacitors have to be stabilized at rated temperature for 30 minutes.

6.1 Voltage and temperature dependence of the leakage current with solid tantalum electrolytic capacitors

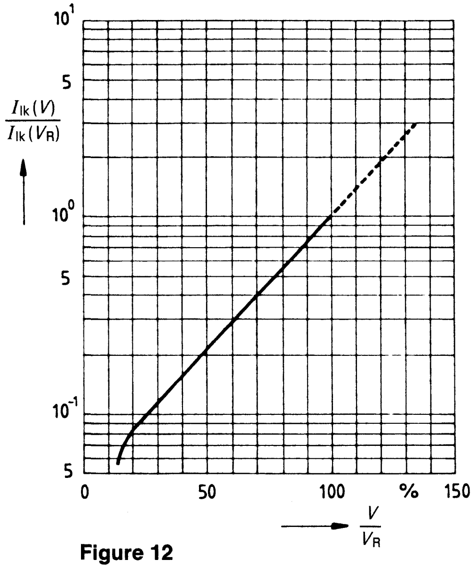


Figure 12
Leakage current versus voltage
(typical values)

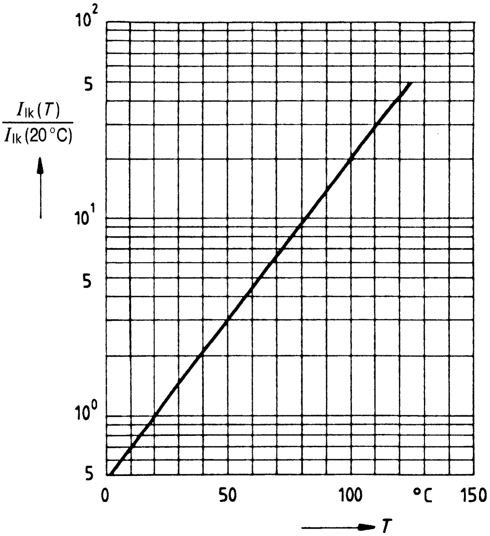


Figure 13
Leakage current versus temperature
(typical values)

6.2 Voltage and temperature dependence of the leakage current with wet tantalum electrolytic capacitors

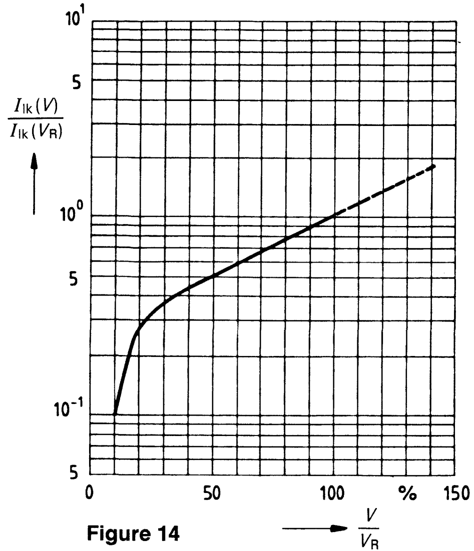


Figure 14
Leakage current versus voltage
(typical values)

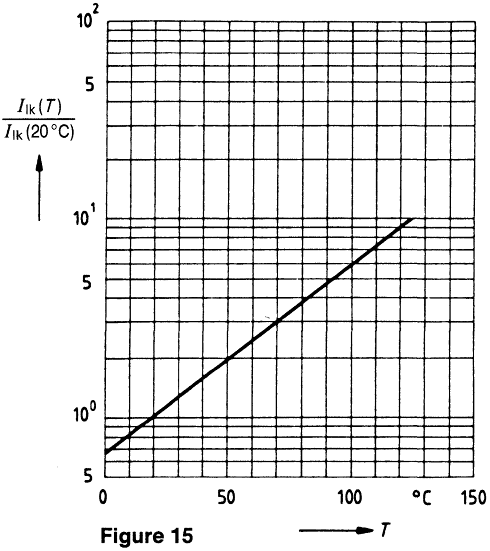


Figure 15
Leakage current versus temperature
(typical values)

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 40040).

The temperature for tantalum electrolytic capacitors is −55 °C to +125 °C. Throughout the range −55 °C to +85 °C the category voltage V_C may be identical to the rated voltage V_R, unless otherwise specified. From +85 °C a voltage derating has to be taken into account (see 2.3.1).

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 do not affect the service life.

7.2 Upper category temperature

The upper temperature limit applies to operation at direct voltage and at the maximum permissible superimposed alternating currents or voltages. 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, for solid tantalum electrolytic capacitors −80 °C are permitted.

The upper storage temperature shall not exceed the rated temperature range. The most favorable storage temperature is around +25 °C. Higher temperatures affect the service life (see also section 9.1).

8 Humidity conditions

The permissible humidity conditions for tantalum electrolytic capacitors are specified by the climatic categories in accordance with DIN 40040 and IEC 68-1. Within the permitted limits the influence on the electrical data can be neglected.

9 Quality

Delivery quality, AQL values, failure rate
For detailed information refer to chapter "Quality Assurance", page 56.
The following applies in particular to tantalum electrolytic capacitors:

9.1 Service life

The term service life designates the period until a given fraction failure is reached. The fraction failure is the ratio of the number of failures to the total number of inspected (identical) components. The service life depends on the failure criteria and on the load and stress to which the tantalum electrolytic capacitor is subjected.

The service life is referred to an ambient temperature of 40 °C, rated voltage and, in the case of solid capacitors, to a circuit resistance of $\geq 3\,\Omega/\text{V}$.

Operating voltages exceeding 40 °C reduce the service life, whereas operation at voltages lower than the category voltage increases the capacitor's life time. For this reason the service life is also specified for voltages $< V_R$ in the individual data sheets.

The lower the ambient temperatures, the lower the superimposed ac voltage and the smaller the ratio V_{op}/V_p or the operating voltage, the longer is the service life.

With solid tantalum electrolytic capacitors, increasing circuit resistances R_i up to $3\,\Omega/\text{V}$ result in a longer service life.

9.2 Reference conditions for the failure rate

Unless other terms have been agreed upon, the failure rate specifications for tantalum electrolytic capacitors refer to the following conditions, which correspond to average conditions found with most applications.

Electrical load

Operation at rated voltage; circuit resistance

for tantalum electrolytic capacitors with solid electrolyte	$\geq 3\,\Omega/\text{V}$
for tantalum electrolytic capacitors with liquid electrolyte	$0\,\Omega/\text{V}$

Climatic stress

Ambient temperature 40 °C, humidity category as specified in the data sheets, no corrosive atmosphere.

Mechanical stress

Class W in accordance with DIN 40040.

Period of time

Period II as shown in figure 2 on page 61.

Failure criteria

Total failures (short or open circuit) as well as failures due to variation which, in the majority of applications, will result in a failure of the functional unit.

9.3 Examples for calculating the failure rate

9.3.1 Capacitors with solid electrolyte

Given: Ambient temperature $T_A = 70\,°C$
Operating voltage $V_{op} = 25$ V dc
Circuit resistance $R_i \leq 0.1\,\Omega/V$

Capacitor used: $\left.\begin{array}{l} C_R = 1\,\mu F \\ V_R = 50 \text{ V dc} \end{array}\right\}$ e.g. B 45170.

At $\frac{V_{op}}{V_R} = 0.5$ and $T_A = 70\,°C$ a conversion factor of approx. 0.03 can be derived from the diagram (e.g. page 314).

For $R_i \leq 0.1\,\Omega/V$ a factor 5 can be taken from the table (see B 45170 for example) for case size A.

Calculated failure rate: $5 \cdot 10^{-9}/h \cdot 0.03 \cdot 5 = 0.75 \cdot 10^{-9}/h = 0.75$ fit

9.3.2 Capacitors with liquid electrolyte

Given: Ambient temperature $T_A = 90\,°C$
Operating voltage $V_{op} = 25$ V dc

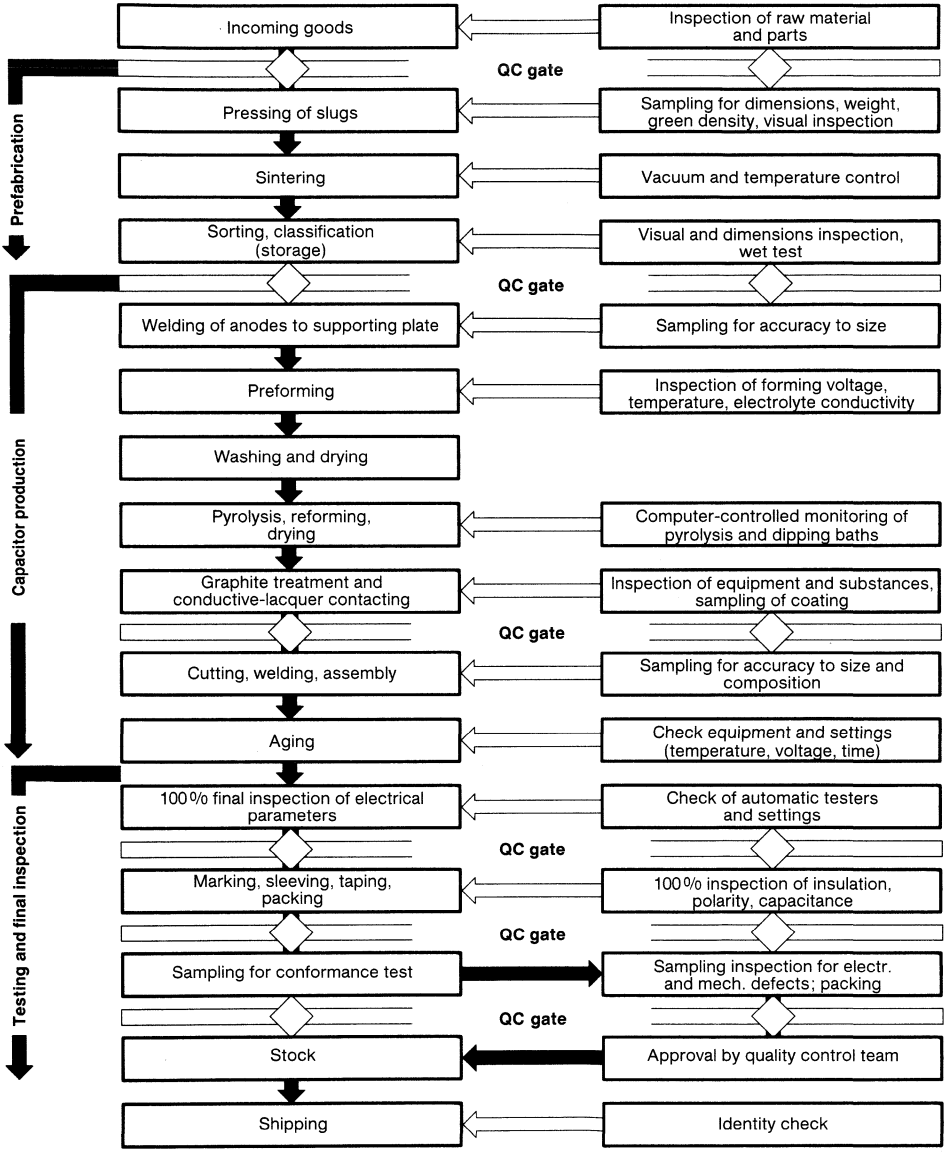
Capacitor used: $\left.\begin{array}{l} C_R = 11\,\mu F \\ V_R = 100 \text{ V dc} \end{array}\right\}$ e.g. B 45265.

At $\frac{V_{op}}{V_R} = 0.25$ and $T_A = 90\,°C$ a conversion factor of approx. 4 can be derived from the diagram on page 365.

Calculated failure rate: $2 \cdot 10^{-9}/h \cdot 4 = 80 \cdot 10^{-9}/h = 80$ fit.

As indicated in the service life diagram this failure rate applies to a period of 25000 h.

9.4 Manufacturing processes and quality assurance for tantalum electrolytic capacitors



The following capacitor series are available on tape for automatic insertion/placement:

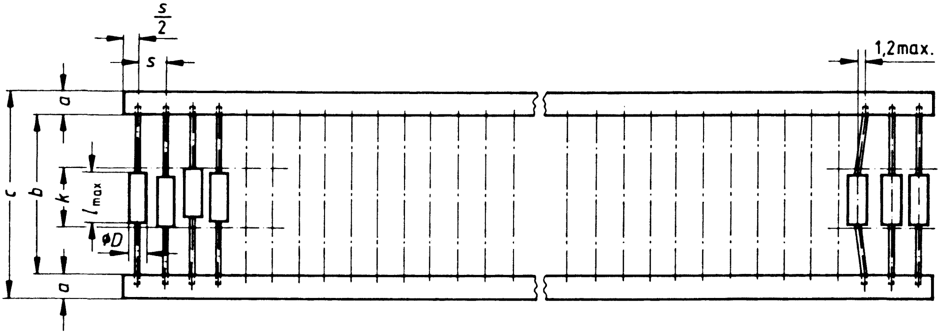
- Solid capacitors with axial leads in all sizes
- Capacitors with radial leads in sizes A and B
- Chip capacitors in all sizes

The tape dimensions are in accordance with DIN IEC regulations. Wet sinter capacitors are not available on tape.

1 Taping of tantalum electrolytic capacitors with axial leads

- Tape packaging in accordance with DIN IEC 286, part 1
- Types B 45 170, B 45 176, B 45 177 and B 95 057

1.1 Dimensions and tolerances



Rated diameter D	Spacing		Body location k[1] (perm. lateral deviation)	Bandwidth a	Inner tape spacing b	Tape width c
	Spacing s	Tolerance over 10 spacings Δs				
2.4 ... 4.8	5 ± 0.5	± 2	$l_{max} + 1.4$	6 ± 1	63 ± 2	75 ± 5
7.3 ... 8.9	10 ± 0.5				73 ± 2	85 ± 5

The capacitors are uniformly oriented, i. e. identical poles point to the same tape side/direction. The tape on the cathode side of axial-lead capacitors is blue to facilitate identification of the polarity.

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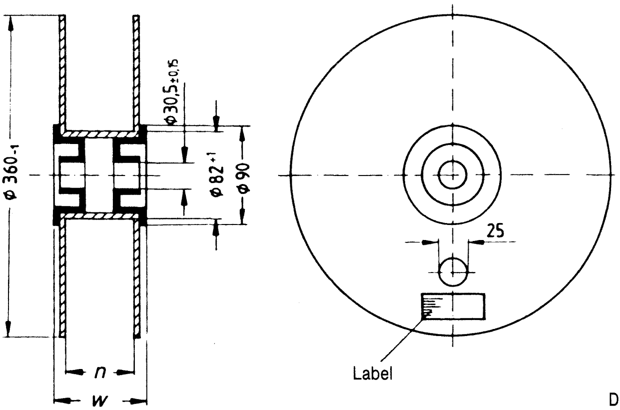
[1] Measured in accordance with IEC 294 (DIN 41 099, sheet 1).

1.2 Packing

The tape is wound on a reel with separation paper between the individual layers.



Dimensions in mm

Tape width c	Dimension n	Dimension w
75±5	81^{+1}	90^{+1}
85±5	91^{+1}	100^{+1}

1.3 Packaging units/minium order quantities

The use of taped components in small quantities would not be economical, since the share of the taping and packing cost would be too high. Therefore, minimum quantities for ordering tantalum electrolytic capacitors have been determined, corresponding to the size of the reel or the box.

Rated diameter of the capacitor	Packaging units (minimum order quantities)
3.4	5500
4.8; 4.7	3500
7.3	1200
8.9	1000

1.4 Ordering code

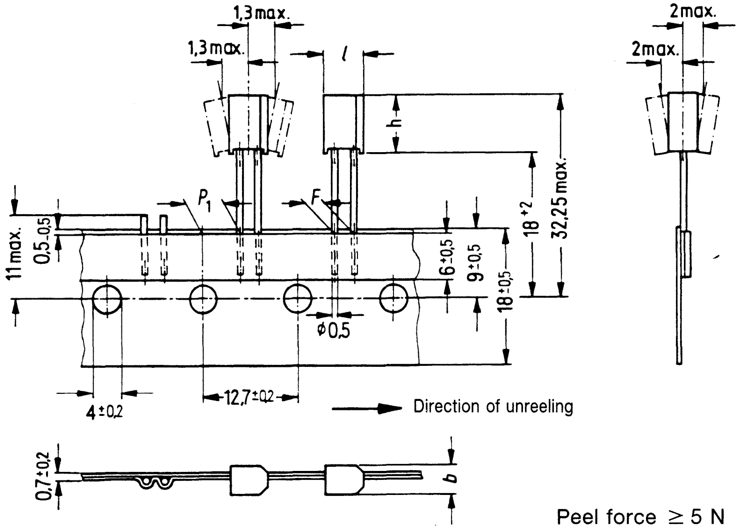
Mass-produced tantalum electrolytic capacitors with axial leads are only supplied on tape. The ordering code can be found in the relevant data sheets B 45170, B 45176, B 45177, B 95057.

2 Taping of tantalum electrolytic capacitors with radial leads

- Tape packaging in accordance with DIN IEC 286, part 2
- Types B 45 181, B 45 185 (sizes A and B), B 45 187 (size B) and B 45 184

2.1 Dimensions and tolerances

Types B 45 181, B 45 185, B 45 187

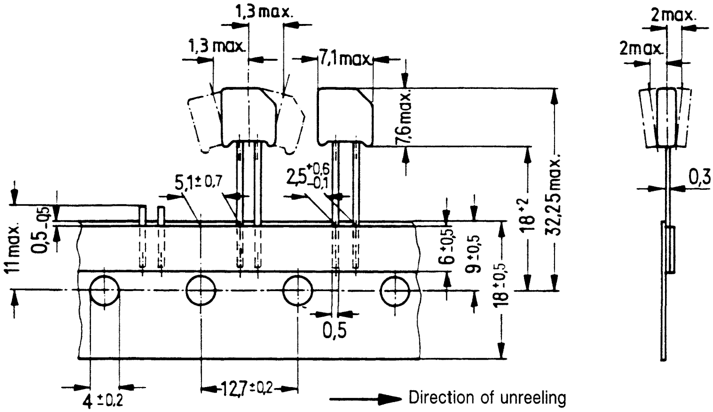


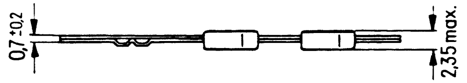
Peel force ≥ 5 N

Dimensions in mm

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



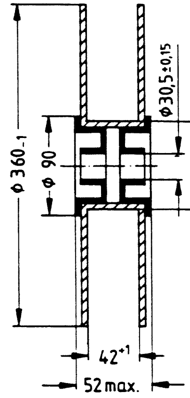


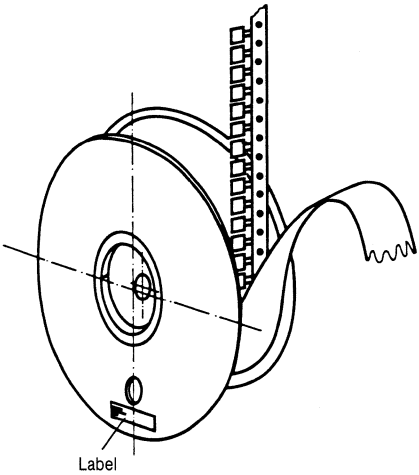
Peel force ≥ 5 N

Dimensions in mm

2.2 Modes of packing

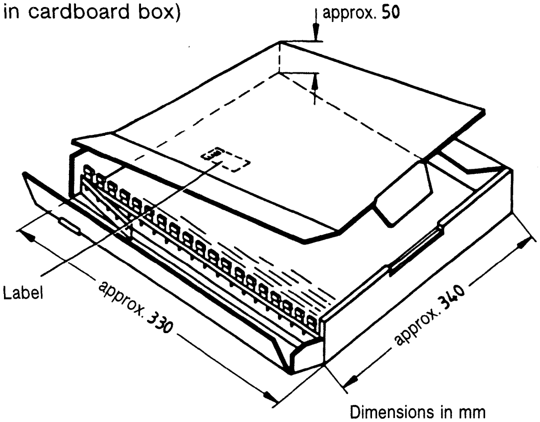
Reel packing
(tape wound on reel
with separation paper
between the layers)





Dimensions in mm

AMMO pack
(meander-shaped packing
in cardboard box)



Dimensions in mm

2.3 Packaging units/minimum order quantities

The use of taped components in small quantities would not be economical, since the share of the taping and packing cost would be too high. Therefore, minimum quantities for ordering tantalum electrolytic capacitors have been determined, corresponding to the size of the reel or the box.

Size	Mode of packing	Ordering code[1]	Packaging units/ minimum order quantities (Items/reel or box)	
			Size A	Size B
B 45 181 B 45 185 B 45 187	Reel	B 45 181-+ ****-+9 B 45 185-+ ****-+9	1700	1400
	AMMO pack	B 45 181-+ ****-+8 B 45 185-+ ****-+8	1900	1600
B 45 184	Reel	B 45 184-+ ****-+9	3200	
	AMMO pack	B 45 184-+ ****-+8	2700	

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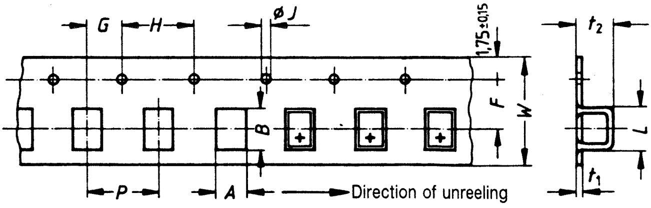
[1] Digits marked with + or * have to be completed by the codes given in the relevant data sheets.

3 Tantalum chip capacitors packaged in blister tape

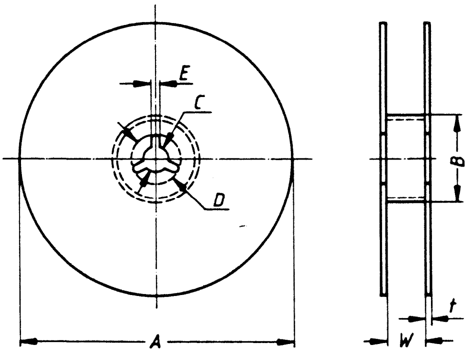
Size A and B capacitors are packaged in 8-mm tape, size C and D capacitors in 12-mm tape, respectively. Taping is in accordance with DIN IEC 286-3. The position of the positive pole is illustrated below.

Carrier tape



Dimensions and tolerances

Dimension	Size A	Size B	Size C	Size D
A	1.9 ± 0.2	3.3 ± 0.2	3.7 ± 0.2	4.7 ± 0.2
B	3.5 ± 0.2	3.8 ± 0.2	6.4 ± 0.2	7.7 ± 0.2
W	8.0 ± 0.3	8.0 ± 0.3	12.0 ± 0.3	12.0 ± 0.3
F	3.5 ± 0.1	3.5 ± 0.1	5.5 ± 0.1	5.5 ± 0.1
L	4.0 max.	4.2 max.	7.3 max.	8.4 max.
P	4.0 ± 0.1	4.0 ± 0.1	8.0 ± 0.1	8.0 ± 0.1
G	2.0 ± 0.05			
H	4.0 ± 0.1			
Ø*J*	$1.5^{+0.1}_{-0}$			
t_1	0.2		0.3	
t_2	1.9 ± 0.2	2.1 ± 0.2	3.0 ± 0.2	3.3 ± 0.2
Carrier tape	embossed plastic film			
Cover tape	polyester			



The tapes are supplied on reels.

Packaging units	
Sizes A, B	2000 items/reel
Sizes C, D	750 items/reel

Tape width	dia. *A* ± 2	dia. *B* min.	*C* ± 0.5	*D* ± 0.8	*E* ± 0.5	*W* ± 1.5	*t* ± 0.5
8 mm	178	50	13.0	21.0	2.0	10.0	2.0
12 mm	178	50	13.0	21.0	2.0	14.0	2.0

Weights and packaging units (PU)

1 Capacitors with solid electrolyte, axial leads, taped

Type	B 45170		B 45176		B 45177	
Case size	Weight 1) per item (g)	PU Items/reel	Weight 1) per item (g)	PU Items/reel	Weight 1) per item (g)	PU Items/reel
A	0.5	5500	0.5	5500	–	–
B	1.0	3500	1.2	3500	1.0	3500
C	3.0	1200	4.0	1200	3.0	1200
D	5.5	1000	7.0	1000	5.5	1000

2 Capacitors with solid electrolyte, radial leads, untaped

Type	B 45181, B 45185		B 45187		B 45184	
Size	Weight 1) per item (g)	PU Items/box	Weight 1) per item (g)	PU Items/box	Weight 1) per item (g)	PU Items/box
A	0.35	2000	–	–	0.3	2000
B	0.9	1000	0.9	1000	–	–
C	2.5	400	2.5	400	–	–
D	4.5	250	4.5	250	–	–

3 Capacitors with solid electrolyte, radial leads, taped

Type	B 45181, B 45185			B 45187			B 45184		
Size	Weight 1) per item (g)	PU		Weight 1) per item (g)	PU		Weight 1) per item (g)	PU	
		Reel	AMMO pack		Reel	AMMO pack		Reel	AMMO pack
A	0.35	1700	1900	–	–	–	0.3	3200	2700
B	0.9	1400	1600	0.9	1400	1600	–	–	–

4 Tantalum chip capacitors, taped

Type	B 45196	
Size	Weight 1) per item (g)	PU Items/reel
A	0.06	2000
B	0.09	2000
C	0.2	750
D	0.35	750

5 Wet sinter capacitors, untaped

Type	B 45265	
Size	Weight 1) per item (g)	PU Items
T1	1.7	100
T2	4.5	100
T3	8.5	60
T4	15.0	60

---

1) Typical values, deviation up to approx. ± 30% possible.

Tantalum Electrolytic Capacitors

SMD Chip Capacitors

Tantalum Chip Capacitors SMD Version — 6.3 to 35 V dc — B 45196

0.10 to 68 µF

Construction

Tantalum capacitors with a sintered body as anode (solid) in rectangular plastic case, polar, for high rel requirements.
Chip version for SMD assemblies, suitable for automatic placement.

Application

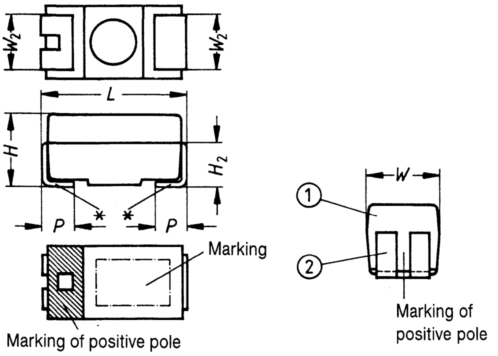
Communications and data processing systems, measuring and control equipment.

Features

- High volumetric efficiency
- High resistance to shock and vibration, e.g. in automotive electronics
- Low leakage current
- High dimensional accuracy
- Low self-inductance
- Suitable for wave soldering, vapor phase soldering and other reflow methods

Specifications and characteristics in brief

Sectional specifications	IEC 384-3 B 45010 "General Technical Information"
Type specification	IECQ-QC 300801/US0001
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKE (-55 to $+125$ °C, humidity category E) in acc. with DIN 40040
Service life	$>$ 500000 h
Failure rate	≤ 70 fit ($\leq 70 \cdot 10^{-9}$/h)
Taping	Chip capacitors are only available on tape. For information on tape packaging refer to B 45071, page 295.



* Soldering area

① Encapsulation: epoxy mold

② Bd Ni; surface Sn 60/Pb 40

Size	Dimensions (mm)						
	$L \pm 0{,}2$	L_2 typ.	$W \pm 0{,}2$	$W_2 \pm 0{,}1$	$H \pm 0{,}2$	H_2 typ.	$p \pm 0{,}3$
A	3,2	3,0	1,6	1,2	1,6	1,0	0,8
B	3,5	3,3	2,8	2,2	1,9	1,2	0,8
C	6,0	5,8	3,2	2,2	2,5	1,5	1,3
D	7,3	7,1	4,3	2,4	2,8	1,6	1,3

Rated voltage V_R up to + 85 °C 1)		6,3 V dc	10 V dc	16 V dc	20 V dc	25 V dc	35 V dc	Case size
Rated capacitance C_R µF	Tolerance	Output leakage current I_{lko} 2)/Impedance Z 3) Code						
0,10	± 20 % ≙ M ± 10 % ≙ K						0,5/28,0 -B6104-+9	B
0,15							0,5/23,0 -B6154-+9	
0,22							0,5/19,0 -B6224-+9	
0,33							0,5/15,0 -B6334-+9	
0,47						0,5/13,0 -B5474-+9	0,5/11,0 -B6474-+9	B
0,68					0,5/12,0 -B4684-+9		0,5/9,0 -B6684-+9	
1,0				0,5/10,0 -B3105-+9			0,5/7,0 -B6105-+9	
1,5				0,5/8,0 -B3155-+9		0,5/7,0 -B5155-+9	0,6/6,0 -B6155-+9	C
2,2			0,5/7,0 -B2225-+9		0,5/6,0 -B4225-+9		0,8/4,0 -B6225-+9	
3,3		0,5/7,0 -B1335-+9		0,6/5,2 -B3335-+9		0,9/4,0 -B5335-+9	1,2/3,0 -B6335-+9	D
4,7			0,5/4,5 -B2475-+9		1,0/3,0 -B4475-+9		1,7/1,8 -B6475-+9	
6,8		0,5/4,5 -B1685-+9			1,4/2,4 -B4685-+9		2,4/1,5 -B6685-+9	
10				1,6/2,5 -B3106-+9		2,5/1,5 -B5106-+9		
15			1,5/2,5 -B2156-+9		3,0/1,5 -B4156-+9			
22		1,4/2,4 -B1226-+9		3,6/1,5 -B3226-+9				
33			3,3/1,5 -B2336-+9	5,3/1,2 -B3336-+9				
47		3,0/1,4 -B1476-+9	4,7/1,0 -B2476-+9					
68		4,3/1,0 -B1686-+9						

Ordering code example: B45196 - B3106-+9

Type —— Code according to table

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

For packaging units and weights refer to page 296.

S All capacitors with ± 20 % cap. tolerance are preferred types (refer to page 4).

---

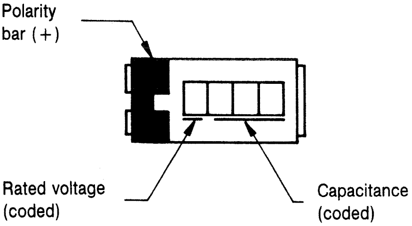
1) Peak voltage $V_p = 1.3\ V_R$

2) I_{lko} (µA) measured at 20 °C, V_R measured after 5 minutes (limit values)

3) Impedance Z (Ω) measured at 100 kHz and 25 °C (typical values)

Marking

Case size A



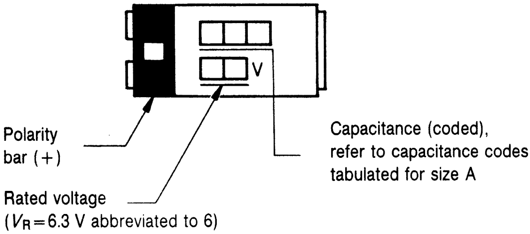
Rated voltage code

Rated voltage (V dc)	6.3	10	16	20	25	35
Code letter	J	A	C	D	E	V

Capacitance code

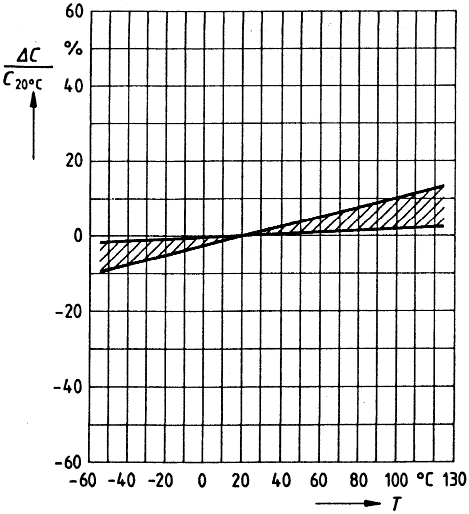
First two numbers	Capacitance values in pF
Third number	Multiplier 5 ≙ 10^5 pF 6 ≙ 10^6 pF 7 ≙ 10^7 pF

Case sizes B, C, D



Capacitance change versus temperature

Typical values

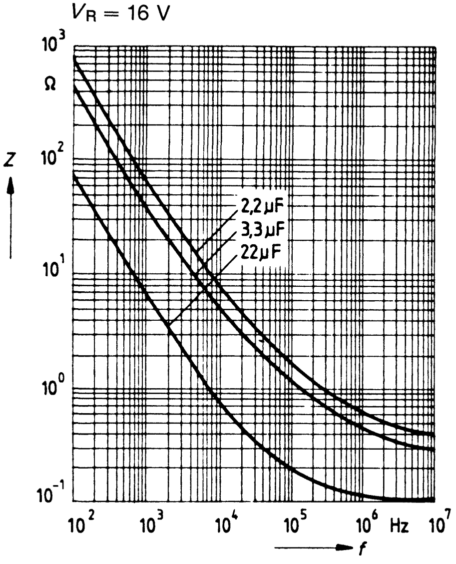


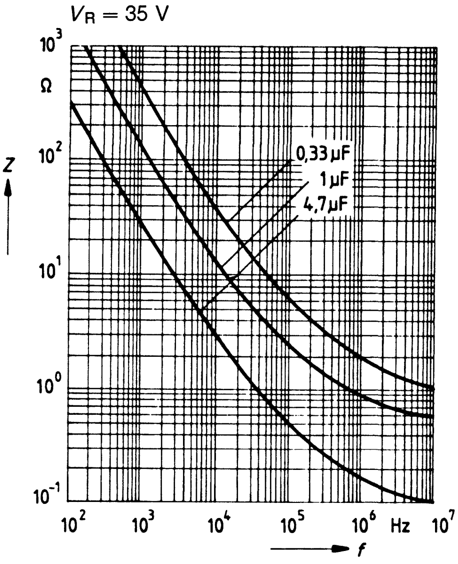
Maximum values

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

	< 4,7 µF	≥ 4,7 µF
Dissipation factor tan δ at 120 Hz, 20 °C	0,04	0,06

Impedance Z
versus frequency (typical values at +20 °C)
Limit values at delivery for 100 kHz and +20 °C, see capacitance range.

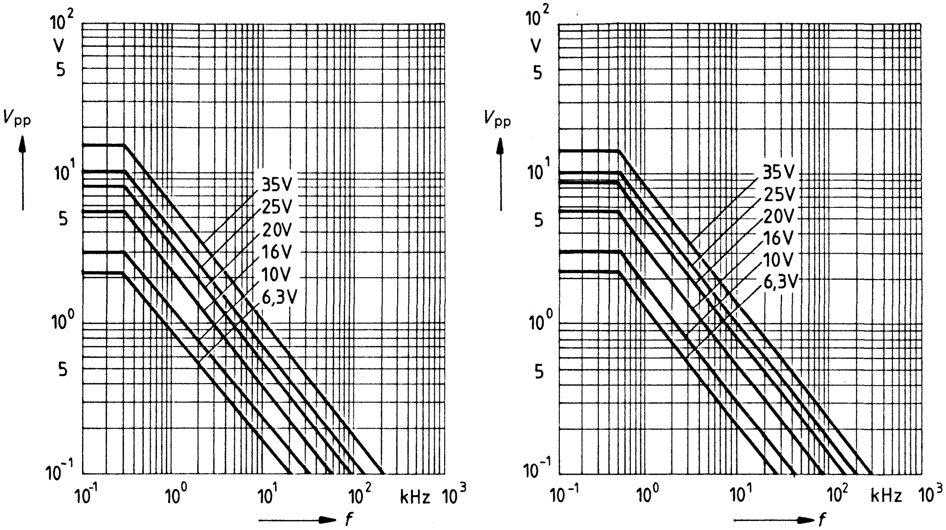




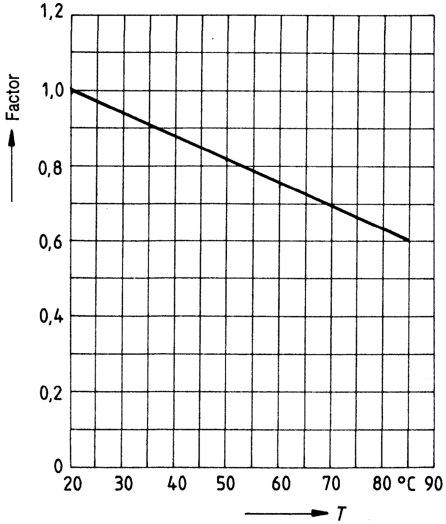
Permissible superimposed ac voltage

The capacitors can be operated at superimposed ac voltage, provided that the permissible inherent temperature rise of the capacitor will not be exceeded. The limit values for the individual $C_R \cdot V_R$ ranges are shown in the following diagrams.

Permissible superimposed ac voltage versus frequency at 20 °C



In case of higher temperatures the temperature factors of the following curve apply to the permissible superimposed ac voltage.



Polarity reversal voltage

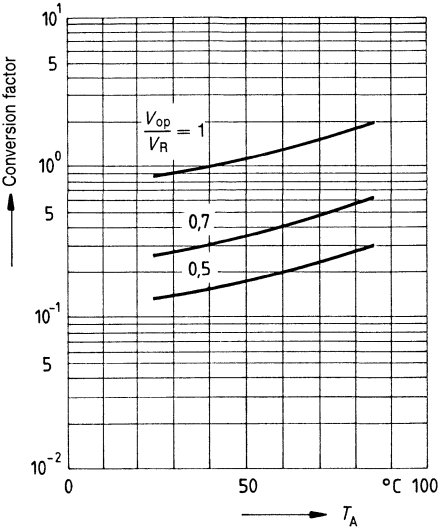
The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage (intermittent)
at +20 °C: 0.10 · V_R or 2 V max.: the lower value is applicable
at +85 °C: 0.05 · V_R or 1 V max.: the lower value is applicable

Test conditions

<table>
<tr><td>Life test
2000 h at +85 °C
or
2000 h at +125 °C
with voltage derating
$R_i = 1 \Omega/V$</td><td>ΔC ≤ 10 % of the initial value
tan δ ≤ 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.</td></tr>
<tr><td>Shelf life test
5000 h at +85 °C</td><td>ΔC ≤ 10 % of the initial value
tan δ ≤ 1.5 · limit values
$I_{lk\ 20\ °C}$ ≤ limit values</td></tr>
<tr><td>Capacitance drift</td><td>$^{+\ 5}_{-10}$ % (typical value)</td></tr>
<tr><td>Permissible damp heat test
in acc. with DIN IEC 68-2-3</td><td>Severity 4: 40 ± 2 °C; 93^{+2}_{-3} % relative humidity; duration: 1000 h</td></tr>
<tr><td>Vibration resistance
Test Fc in acc. with DIN IEC 68-2-6
Vibration, sinusoidal</td><td>Frequency range: 10 to 2000 Hz
Displacement : 1.5 mm (max. 196 m/s^2 or 20 *g*)
Duration: 6 h</td></tr>
<tr><td>Shock resistance
in acc. with DIN 40046, sheet 7</td><td>Peak load: 981 m/s^2 or 100 *g*</td></tr>
<tr><td>Wettability test
in acc. with DIN IEC 68-2-20
Preconditioning:
Immersion in F-SW 32 flux
Test criterion: wetting of terminations ≥ 95 %</td><td><table><tr><th>Solder</th><th>Bath temperature
°C</th><th>Dwell time
s</th></tr><tr><td>SnPb 60/40</td><td>235 ± 5</td><td>2</td></tr><tr><td>SnPb 60/40</td><td>215 ± 5</td><td>6</td></tr></table></td></tr>
<tr><td>Resistance to soldering heat
in acc. with DIN IEC 68-2-20
Preconditioning:
Immersion in F-SW 32 flux
Test criterion: no leaching of contacts</td><td><table><tr><th>Solder</th><th>Bath temperature
°C</th><th>Dwell time
s</th></tr><tr><td>SnPb 60/40</td><td>260 ± 5</td><td>10</td></tr></table></td></tr>
</table>

Reliability

Service life	> 500000 h
Fraction failure[1]	$\leq 0.7\%$ during 100000 h
Failure rate[1]	≤ 70 fit ($\leq 70 \cdot 10^{-9}$/h) These values apply to 40 °C, $\leq V_R$, $R_i \geq 3\,\Omega/V$
Conversion factors for the failure rate: Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance. The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).	

The table below shows the increase in the failure rate (referred to leakage current rise) that can be expected for circuits with lower internal resistances R_i).

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for sizes A to D	1	2.9	10	14

Failure criteria

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

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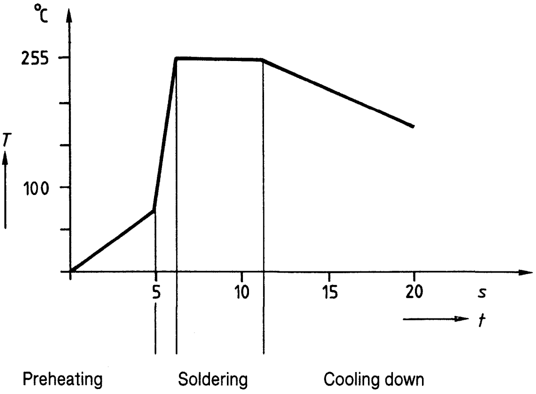
[1] For calculation example see page 288

Mounting instructions for tantalum chip capacitors

Wave soldering:

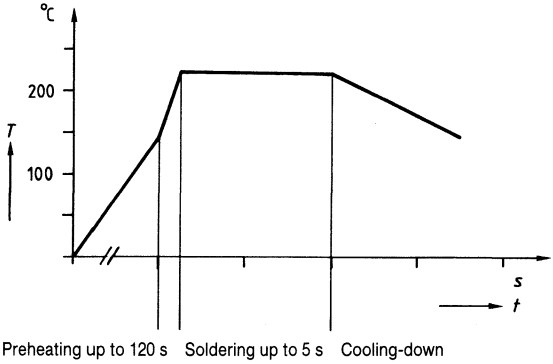
A widely used and well-proven technique is dual wave soldering. The first turbulent wave ensures proper wetting and soldering of the component, while the second laminar wave removes the excess solder.



Temperature/time diagram for wave soldering

Reflow soldering:

In a continuous-type or reflow oven the components on the assembled PCB are gradually heated up to a temperature of 200 °C.



Temperature/time diagram for reflow soldering

Tantalum Electrolytic Capacitors

Axial Capacitors
MIL Version

Tantalum Electrolytic Capacitors 6.3 to 80 V dc B 45 170

0.1 to 330 μF

Construction

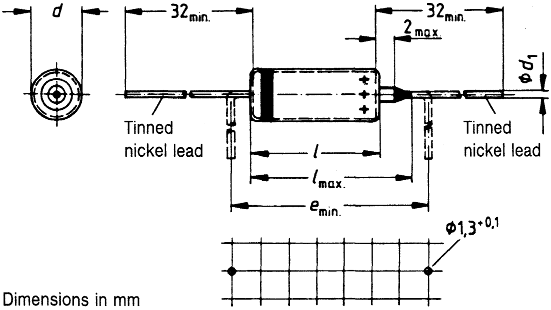
Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte, in tubular, hermetically sealed metal case with insulating sleeve. Axial tinned nickel leads on both ends.

Application

These capacitors are particularly suitable for use in communications systems as well as in measuring and control equipment, where very low leakage current, low dissipation factor, good temperature and frequency performance and long service life are required.
Under supervision of the national VDE inspection agency the capacitors have qualified for the CECC international system of quality assessment. The components are thus subject to international quality surveillance. All B 45 170 capacitors have the CECC quality approval.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15; DIN 44 350; CECC 30 200 B 45 010 "General Technical Information"
Type specification	DIN 44 351
Qualifications	CECC 30201-001; CECC 30201-029 DIN 45 910, part 144 CECC 30201-019 } with special mark "CTS 32" UTE C 83-112, part 8 }
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKC (– 55 to + 125 °C, humidity category C) in acc. with DIN 40 040
Service life	> 500 000 h
Failure rate	≤ 5 fit (≤ $5 \cdot 10^{-9}$/h)
Taping	The capacitors are only available on tape. For information on tape packaging refer to B 45 071, page 290.



Dimensions in mm

Mounting holes $1.3^{+0.1}$ mm dia.

Case size	Dimensions (with insulating sleeve) $d \pm 0{,}4$	$l \pm 0{,}8$	l_{max}	Min. lead spacing e_{min}	Lead diameter $d_1 \pm 0{,}05$
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	0,6
Special sizes					
A1	3,4	5,4	7,4	12,5	0,5
B1	4,9	8,6	9,9	15,0	0,5

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

Ordering code example: B45170-E2156-+9

Type: B45170

Code according to table: -E2156-+9

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

For packaging units and weights refer to page 296.

◥ All capacitors with ±20 % cap. tolerance are preferred types S (refer to page 4).

---

[1] Peak voltage $V_p = 1.3\ V_R$

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

[3] Impedance Z (Ω) measured at 100 kHz and 20 °C (limit values)

Rated voltage V_R up to +85 °C[1]		40 V dc	50 V dc	63 V dc	80 V dc	Case size
Rated capacitance C_R		Output leakage current I_{lko}[2]/Impedance Z[3] Code				
µF	Tolerance					
0,10	±20 % ≙ M ±10 % ≙ K	0,5/30 -E4104-+9		0,5/30 -A6104-+9	0,5/30 -E7104-+9	A
0,15		0,5/24 -E4154-+9		0,5/24 -A6154-+9	0,5/24 -E7154-+9	
0,22		0,5/18 -E4224-+9		0,5/18 -A6224-+9	0,5/18 -E7224-+9	
0,33		0,5/14 -E4334-+9		0,5/14 -A6334-+9	0,5/14 -E7334-+9	
0,47		0,5/11 -E4474-+9		0,5/11 -A6474-+9	0,5/11 -E7474-+9	
0,68		0,5/8 -E4684-+9		0,5/8 -A6684-+9	0,5/8 -E7684-+9	
1,0		0,5/6 -E4105-+9	0,5/6 -A5105-+9	0,7/6 -A6105-+9	1/6 -E7105-+9	B
1,5		0,7/5,2 -E4155-+9		1/5,2 -A6155-+9	1,5/5,2 -E7155-+9	
2,2		1/4 -E4225-+9		1,5/4 -A6225-+9	2/4 -E7225-+9	
3,3		1,5/2,8 -E4335-+9		2,5/2,8 -A6335-+9	3/2,8 -E7335-+9	
4,7		2/2 -E4475-+9	2,5/2 -A5475-+9	3/2 -A6475-+9		C
6,8		3/1,6 -E4685-+9		4,5/1,6 -A6685-+9		
10		4/1,3 -E4106-+9		6,5/1,3 -A6106-+9		
15		6/1 -E4156-+9		10/1 -A6156-+9		D
22		9/0,8 -E4226-+9				
33		12/0,6 -E4336-+9				
47		16/0,5 -E4476-+9				

Ordering code example for capacitors with special mark (CTS 32):

B45170-S2156-+039

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

Other capacitance and voltage values upon request.

Special cases A1 and B1 can be supplied upon request (replacement for case size A and B).

---

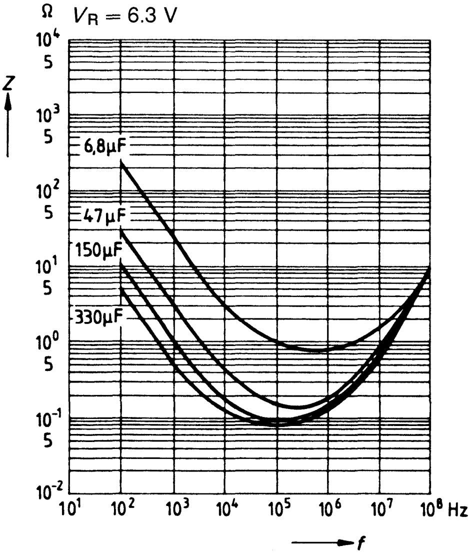
[1] Peak voltage $V_P = 1.3\ V_R$

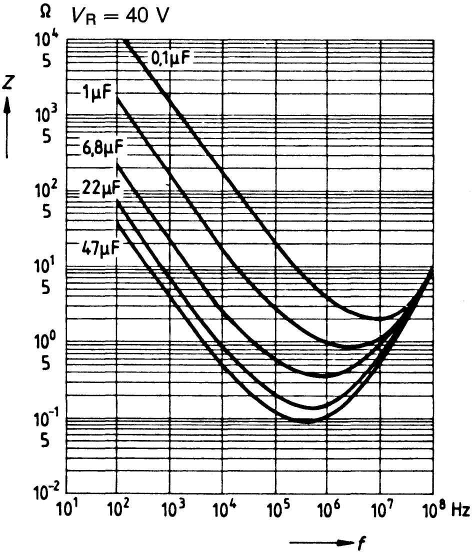
[2] I_{lko} (µA) measured at 20 °C and V_R measured after 5 minutes (limit values)
Lower leakage current values upon request.

[3] Impedance Z (Ω) measured at 100 kHz and 20 °C (limit values)

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)
Limit values at delivery for 100 kHz and + 20 °C, see capacitance range





Polarity reversal voltage

The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage (intermittent)
at + 20 °C: 0.15 · V_R
at + 55 °C: 0.10 · V_R
at + 85 °C: 0.05 · V_R

Test conditions

Life test 2000 h at +85 °C or 2000 h at +125 °C with voltage derating	ΔC ≤ 10 % of the initial value tan δ ≤ limit values $I_{\text{lk } 20\,°\text{C}}$ ≤ 1.25 · initial limit values Out of 25 specimens tested only 1 capacitor ist allowed to exceed the values indicated.
Shelf life test 5000 h at +85 °C	ΔC ≤ 10 % of the initial value tan δ ≤ 1.5 · limit values $I_{\text{lk } 20\,°\text{C}}$ ≤ limit values
Capacitance drift	$^{+5}_{-10}$ % (typical value)
Tensile strength of the leads	15 N, 30 s in axial direction
Permissible damp heat test in acc. with DIN IEC 68-2-3	Severity 4: 40 ± 2 °C; 93^{+2}_{-3} % relative humidity Duration: 56 days
Vibration resistance Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement: 1.5 mm (max. 196 m/s² or 20 *g*) Duration: 6 h
Shock resistance in acc. with DIN 40046, sheet 7	Peak load: 981 m/s² or 100 *g*
Low air pressure in acc. with DIN 40046, sheet 13	Severity 2: 20 hP ≙ approx. 26000 m height
Resistance to soldering heat	Temperature of wave bath: max. 270 °C Soldering time: max. 2 s The temperature must not exceed 130 °C at any point of the capacitor, also in case of a final tinning process of the leads.
Dielectric strength of the insulating sleeve	2000 V dc

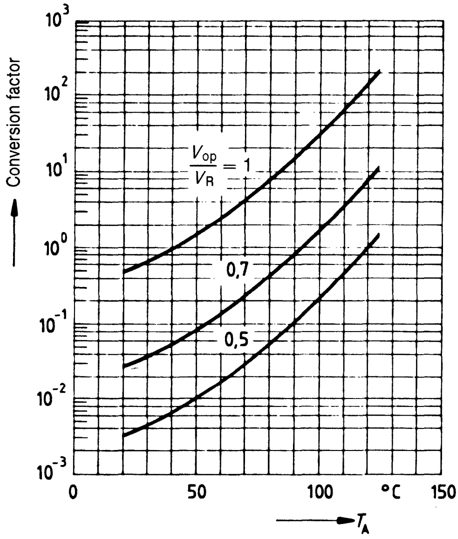
Reliability

Service life	> 500000 h
Fraction failure[1]	≤ 0.05% during 100000 h
Failure rate[1]	≤ 5 fit (≤ $5 \cdot 10^{-9}$/h) These values apply to 40 °C, ≤ V_R, R_i ≥ 3 Ω/V

Conversions factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1].

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case sizes A and B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

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

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[1] For calculation example see page 288

Tantalum Electrolytic Capacitors 6.3 to 40 V dc B 45176

1.5 to 1000 µF

Construction

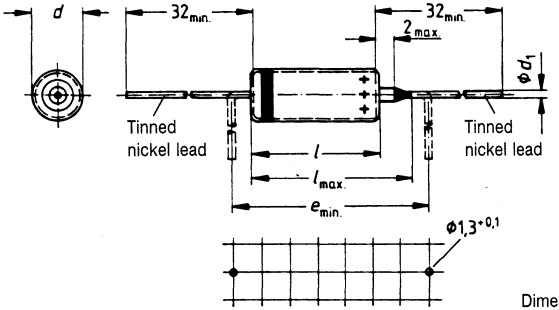
Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte, in tubular, hermetically sealed metal case with insulating sleeve. Axial tinned nickel leads on both ends.

Application

These capacitors are particularly suitable for use in communications systems as well as in measuring and control equipment, where very low leakage current, low dissipation factor, good temperature and frequency performance and long service life are required.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15 DIN 44350 B 45010 "General Technical Information"
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKC (−55 to +125 °C, humidity category C) in acc. with DIN 40040
Service life	> 500000 h
Failure rate	≤ 5 fit (≤ $5 \cdot 10^{-9}$/h)
Taping	The capacitors are only available on tape. For information on tape packaging refer to B 45071, page 290.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)			Min. lead spacing	Lead diameter
	$d \pm 0{,}4$	$l \pm 0{,}8$	l_{max}	e_{min}	$d_1 \pm 0{,}05$
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 V dc	10 V dc	16 V dc	25 V dc	40 V dc	Case size
Rated capacitance C_R µF	Tolerance	Output leakage current I_{lko}[2]/Impedance Z[3] Code					
1,5	±20 % ≙ M ±10 % ≙ K					0,5/5,2 -A5155-+9	A
2,2					0,5/4,5 -A4225-+9		B
3,3					0,5/3,5 -A4335-+9		
4,7				0,5/3,1 -A3475-+9			
6,8			0,5/3,1 -A2685-+9				
10		0,5/3,1 -A1106-+9				2,0/1,3 -A5106-+9	
22					3,0/1 -A4226-+9		C
33				2,5/1 -A3336-+9		7,1/0,6 -A5336-+9	
47			2,5/1 -A2476-+9			10/0,5 -A5476-+9	
68			3,5/1 -A2686-+9		8,5/0,5 -A4686-+9	14/0,4 -A5686-+9	D
100		3,5/0,8 -A1107-+9		8,0/0,5 -A3107-+9	12,5/0,4 A4107-+9		
150				12/0,4 -A3157-+9			
220			11/0,4 -A2227-+9	19/0,3 -A3227-+9			
330		10/0,4 -A1337-+9		26/0,25 -A3337-+9			
470		15/0,3 -A1477-+9	24/0,25 -A2477-+9				
680		22/0,25 -A1687-+9					
1000		30/0,2 -A1108-+9					

Ordering code example: B45176-A3107-+9

Code according to table

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

For packaging units and weights refer to page 296.

---

[1] Peak voltage $V_p = 1.3\ V_R$

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

[3] Impedance Z (Ω) at 100 kHz and 20 °C (limit values)

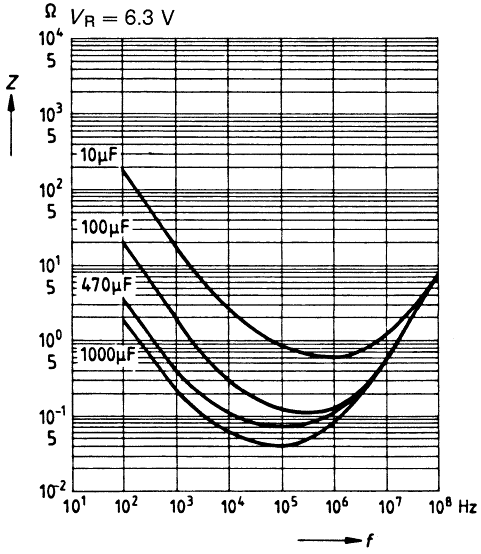
Dissipation factor tan δ at 120 Hz for the entire temperature range (limit values)

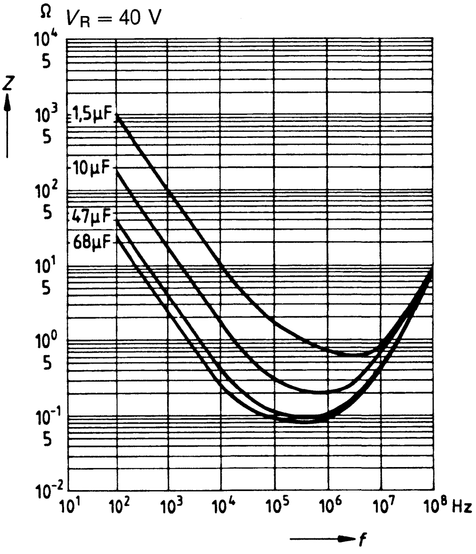
Rated voltage 6,3 V dc		10 V dc		16 V dc		25 V dc		40 V dc	
C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ	C_R (µF)	tan δ
10	0,06	6,8	0,06	4,7	0,06	2,2	0,04	1,5	0,04
100	0,06	47	0,06	33	0,06	3,3	0,04	10	0,06
330	0,08	68	0,06	100	0,08	22	0,06	33	0,06
470	0,08	220	0,08	150	0,08	68	0,06	47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

Limit values at delivery for 100 kHz and +25 °C, see capacitance range





Polarity reversal voltage

The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage: at +20 °C: 0.15 · V_R
(intermittent) at +55 °C: 0.10 · V_R
at +85 °C: 0.05 · V_R

Test conditions

Life test 2000 h at +85 °C or 2000 h at +125 °C with voltage derating	ΔC ≤ 10 % of the initial value tan δ ≤ limit values $I_{\text{lk } 20\,°\text{C}}$ ≤ 1.25 · initial limit values Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Shelf life test 5000 h at +85 °C	ΔC ≤ 10 % of the initial value tan δ ≤ 1.5 · limit values $I_{\text{lk } 20\,°\text{C}}$ ≤ limit values
Capacitance drift	$^{+\ 5}_{-10}$ % (typical value)
Tensile strength of the leads	15 N, 30 s in axial direction
Permissible damp heat test in acc. with DIN IEC 68-2-3	Severity 4: 40 ± 2 °C; 93^{+2}_{-3} % relative humidity Duration: 56 days
Vibration resistance Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement: 1.5 mm (max. 196 m/s^2 or 20 *g*) Duration: 6 h
Shock resistance in acc. with DIN 40046, sheet 7	Peak load: 981 m/s^2 or 100 *g*
Low air pressure in acc. with DIN 40046, sheet 13	Severity 2: 20 hP ≙ approx. 26000 m height
Resistance to soldering heat	Temperature of wave bath: max. 270 °C Soldering time: max. 2 s The temperature must not exceed 130 °C at any point of the capacitor, also in case of a final tinning process of the leads.
Dielectric strength of the insulating sleeve	2000 V dc

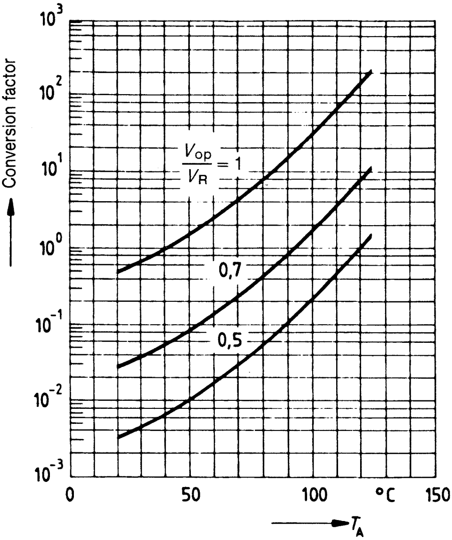
Reliability

Service life	> 500 000 h
Fraction failure[1])	≤ 0.05% during 100 000 h
Failure rate[1])	≤ 5 fit ($\leq 5 \cdot 10^{-9}$/h) These values apply to 40 °C, ≤ V_R, $R_i \geq 3\,\Omega$/V

Conversion factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values)[1]).



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1]).

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case sizes A and B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

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

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[1]) For calculation example see page 288

Tantalum Electrolytic Capacitors 6.3 to 50 V dc B 45177

Extremely low *ESR*

4.7 to 330 μF

Construction

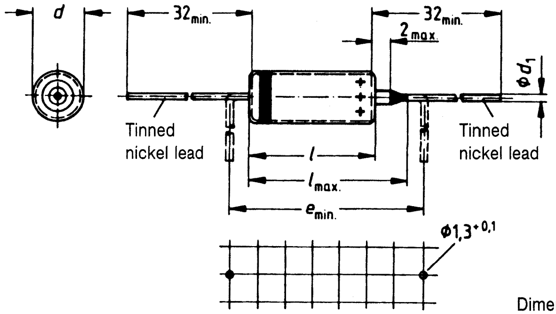
Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte, in tubular, hermetically sealed metal case with insulating sleeve. Axial tinned nickel leads on both ends.

Application

These capacitors are particularly suitable for use in switch-mode power supplies with high clock frequencies (e.g. 300 kHz) and DC/DC converters, where high ripple current capability and low *ESR* are required.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15; DIN 44350 B 45010 "General Technical Information"
Type specification	CECC 30201-040 MIL-C39003/9(CSR21)
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKC (−55 to +125 °C, humidity category C) in acc. with DIN 40040
Service life	> 500000 h
Failure rate	≤ 5 fit (≤ $5 \cdot 10^{-9}$/h)
Taping	The capacitors are only available on tape. For information on tape packaging refer to B 45071, page 290.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)			Min. lead spacing	Lead diameter
	$d \pm 0{,}4$	$l \pm 0{,}8$	l_{max}	e_{min}	$d_1 \pm 0{,}05$
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 °C¹)		6,3 V dc	10 V dc	16 V dc	20 V dc	Case size
Rated capacitance C_R µF	Tolerance	Code				
15	± 20 % ≙ M ± 10 % ≙ K				-A3156-+9	B
22				-A2226-+9		C
33			-A1336-+9			
47		-A476-+9			-A3476-+9	
68				-A2686-+9		D
100			-A1107-+9		-A3107-+9	
150		-A157-+9		-A2157-+9		
220			-A1227-+9			
330		-A337-+9				

cont'd on page 322

Ordering code example: B45177-A3156-+9

Type — B45177; Code according to table — A3156-+9

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

For packaging units and weights refer to page 296.

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[1] Peak voltage $V_p = 1.3\ V_R$

Rated voltage V_R up to +85 °C1)		25 V dc	40 V dc	50 V dc	Case size
Rated capacitance C_R µF	Tolerance	Code			
4,7	± 20 % ≙ M ± 10 % ≙ K			-A5475- + 9	B
6,8			-A4685- + 9	-A5685- + 9	C
10		-A8106- + 9	-A4106- + 9	-A5106- + 9	
15		-A8156- + 9	-A4156- + 9	-A5156- + 9	
22		-A8226- + 9	-A4226- + 9	-A5226- + 9	D
33		-A8336- + 9	-A4336- + 9		
47		-A8476- + 9	-A4476- + 9		
68		-A8686- + 9			

Ordering code example: B45177-A5106- + 9

Type — Code according to table

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

For packaging units and weights refer to page 296.

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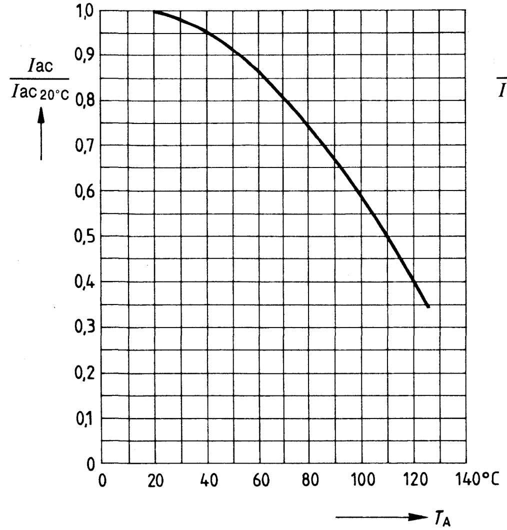
1) Peak voltage $V_p = 1.3\ V_R$

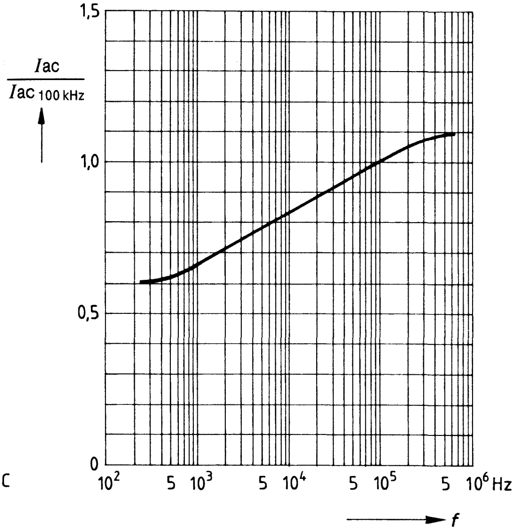
C_R µF	V_R V dc	Case size	$I_{lko, max}$ V_R/5 min. 20 °C µA	tan δ_{max} 1 kHz 20 °C %	ESR_{max} 100 kHz 20 °C mΩ	$I_{ac\ max}$ 100 kHz 20 °C A	ESL approx. nH
47	6,3	B	3	6	110	1,8	15
150		C	9	10	65	3,5	18
330		D	15	12	45	4,6	20
33	10	B	3,5	5	130	1,7	15
100		C	10	8	75	3,2	18
220		D	20	10	55	4,2	20
22	16	B	3,5	5	160	1,5	15
68		C	10	6	95	2,9	18
150		D	20	8	65	3,9	20
15	20	B	3	4	190	1,4	15
47		C	9	6	110	2,7	18
100		D	20	8	75	3,6	20
10	25	B	2,5	4	230	1,3	15
15		C	4	4	190	2,0	18
22		C	5,5	5	160	2,2	18
33		C	8	5	130	2,5	18
47		D	12	6	110	3,0	20
68		D	17	6	95	3,2	20
6,8	40	B	3	3	275	1,2	15
10		C	4	3	230	1,8	18
15		C	6	3	190	2,0	18
22		C	9	4	160	2,2	18
33		D	12	5	130	2,7	20
47		D	16	5	110	3,0	20
4,7	50	B	2,5	3	330	1,1	15
6,8		C	3,5	3	275	1,7	18
10		C	5	3	230	1,8	18
15		C	8	3	190	2,0	18
22		D	12	4	160	2,5	20

Dissipation factor tan δ at 120 Hz (max. values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 100 µF	0,03	0,03	0,03	0,03
	> 100 µF	0,04	0,04	0,04	0,04

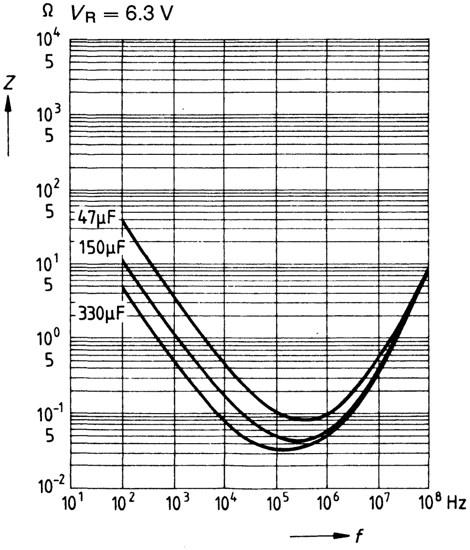
Permissible ripple current *I*ac
versus ambient temperature T_A



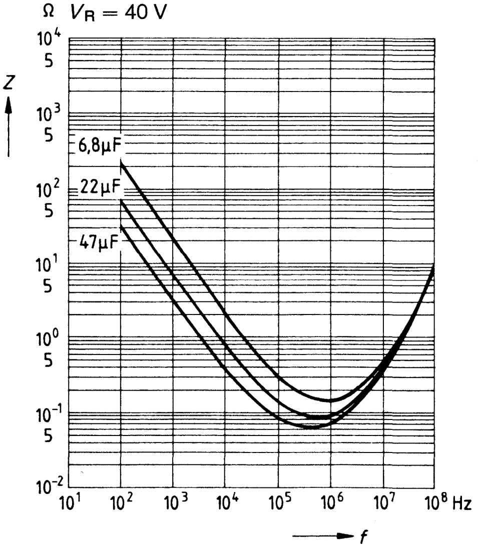
Permissible ripple current *I*ac
versus frequency *f*



Impedance *Z*
versus frequency *f*
(typical values at +20 °C)
$V_R = 6.3$ V



Impedance *Z*
versus frequency *f*
(typical values at +20 °C)
$V_R = 40$ V



Polarity reversal voltage
The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage (intermittent)
at +20 °C: $0.15 \cdot V_R$
at +55 °C: $0.10 \cdot V_R$
at +85 °C: $0.05 \cdot V_R$

Test conditions

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

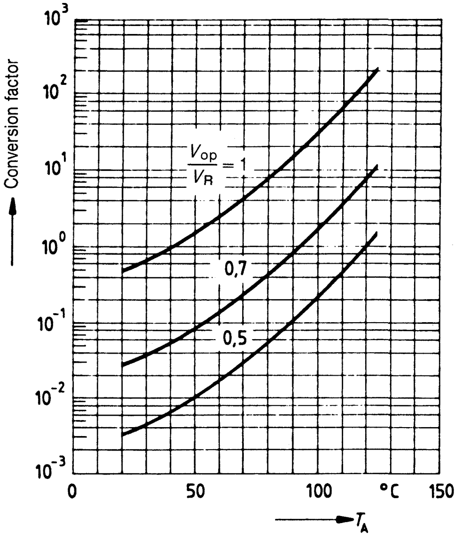
Reliability

Service life	> 500 000 h
Fraction failure[1]	≤ 0.05 % during 100 000 h
Failure rate[1]	≤ 5 fit (≤ $5 \cdot 10^{-9}$/h) These values apply to 40 °C, ≤ V_R, R_i ≥ 3 Ω/V

Conversion factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values)[1].



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1].

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case size B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

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

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[1] For calculation example see page 288

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 on both ends.

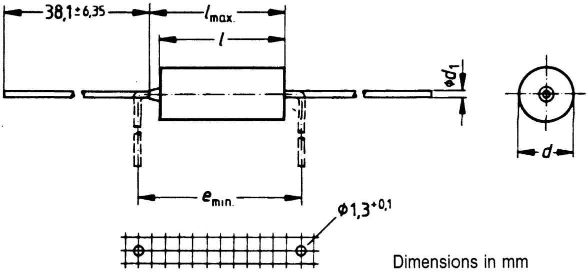
Application

For all applications that require capacitors complying with MIL-C-39003 (CSR 13).

Specifications and characteristics in brief

These capacitors fully comply with MIL-C-39003E standard, specification sheet 39003/1E and are supplied with quality assessment and defined reliability.

For technical specifications refer to MIL-C-39003/1E.



Dimensions in mm

Case size	Dimensions (with insulating sleeve)			Min. lead spacing	Lead diameter
	$d^{+0,41}_{-0,38}$	$l \pm 0,79$	l_{max}	e_{min}	$d_1 \pm 0,05$
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	25,0	0,64

Ordering code example: B95057-A****-B100

Type (CSR13)
Revision status
Code no. for failure rate
(see following tables)
MIL qualification

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk}			Code number for failure rate (%/1000 h)			
			25 °C µA	85 °C µA	125 °C µA	M = 1 %	P = 0,1 %	R = 0,01 %	S = 0,001 %
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

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk}			Code number for failure rate (%/1000 h)			
			25 °C µA	85 °C µA	125 °C µA	M = 1 %	P = 0,1 %	R = 0,01 %	S = 0,001 %
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

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk}			Code number for failure rate (%/1000 h)			
			25 °C µA	85 °C µA	125 °C µA	M = 1 %	P = 0,1 %	R = 0,01 %	S = 0,001 %
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	5642
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

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25°C µA	85°C µA	125°C µA	Code number for failure rate (%/1000 h) M = 1%	P = 0,1%	R = 0,01%	S = 0,001%
V_R up to 85°C: 50 V; V_R up to 125°C: 33 V									
0,10	5	A	0,3	5,0	6,3	5066	5266	5466	5666
0,10	10	A	0,3	5,0	6,3	2338	2578	2818	3058
0,10	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

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk} 25 °C µA	85 °C µA	125 °C µA	Code number for failure rate (%/1000 h) M = 1 %	P = 0,1 %	R = 0,01 %	S = 0,001 %
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

Rated capacitance µF	Cap. tolerance %	Case size	Leakage current I_{lk}			Code number for failure rate (%/1000 h)			
			25 °C µA	85 °C µA	125 °C µA	M = 1 %	P = 0,1 %	R = 0,01 %	S = 0,001 %
V_R up to 85 °C: 75 V; V_R up to 125 °C									
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

Tantalum Electrolytic Capacitors

Radial Capacitors

0.1 to 330 µF

Construction

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

Application

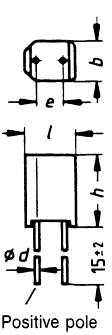
These capacitors are particularly suitable for use on PCBs for low-voltage equipment, where high packing density, low dissipation factor, low leakage current, good temperature and frequency performance as well as high reliability are required.
Under supervision of the national VDE inspection agency the capacitors have qualified for the CECC international system of quality assessment. The components are thus subject to international quality surveillance. All B 45181 capacitors have the CECC quality approval.

Specifications and characteristics in brief

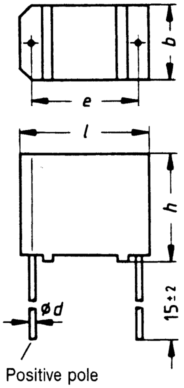
Sectional specifications	IEC 384-15, DIN 44350, CECC 30200 B 45010 "General Technical Information"
Type specification	DIN 44352
Qualifications	CECC 30201-007, CECC 30201-009 UTE C 83-112, part 6
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKE (−55 to +125 °C, humidity category E) in acc. with DIN 40040
Service life	> 500000 h
Failure rate	≤ 15 fit (≤ $15 \cdot 10^{-9}$/h)
Taping	Case sizes A and B are also available on tape. For information on tape packaging refer to B 45071, page 292.

Case sizes

A,B



C,D



Case size	b max.	l max.	h max.	Ød ±0,05	e ±0,2
A	4,2	4,7	7,3	0,5	2,54
B	4,8	7,3	10,0	0,5	5,08
C	7,3	12,3	10,0	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

Dimensions in mm

Rated voltage V_R up to +85 °C[1])		6,3 V dc	10 V dc	16 V dc	20 V dc	25 V dc	40 V dc	50 V dc	Case size
Rated capacitance C_R µF	Tolerance	Output leakage current I_{lko}[2])/Impedance Z[3]) Code							
0,10	±20 % ≙ M ±10 % ≙ K						0,5/30 ◥ -C4104-+	0,5/30 -B6104-+	A
0,15							0,5/24 -C4154-+	0,5/24 -B6154-+	
0,22							0,5/18 ◥ -C4224-+	0,5/18 -B6224-+	
0,33							0,5/14 -C4334-+	0,5/14 -B6334-+	
0,47							0,5/11 ◥ -C4474-+	0,5/11 -B6474-+	
0,68							0,5/8 -C4684-+	0,5/8 -B6684-+	
1,0							0,5/6,5 ◥ -C4105-+	0,5/6,5 -B6105-+	
1,5						0,5/6 ◥ -C3155-+	0,7/5,2 ◥ -C4155-+	0,9/5,2 -B6155-+	B
2,2					0,5/5,5 -B7225-+		1,0/4 ◥ -C4225-+	1,7/4 -B6225-+	
3,3				0,5/4,4 ◥ -B2335-+			1,5/2,8 ◥ -C4335-+	2,0/2,8 -B6335-+	
4,7			0,5/4 ◥ -B1475-+				2,0/2 ◥ -C4475-+	2,5/2 -B6475-+	
6,8		0,5/4 ◥ -B685-+					3,0/1,6 ◥ -C4685-+	3,5/1,6 -A6685-+	C
10						2,5/1,6 ◥ -C3106-+	4,0/1,3 ◥ -B4106-+	5/1,3 -A6106-+	
15					3/1,5 -B7156-+		6,0/1 ◥ -B4156-+	8/1 -A6156-+	
22				3,5/1,3 ◥ -B2226-+			9,0/0,8 ◥ -B4226-+	12/0,8 -A6226-+	D
33			3,5/1,3 ◥ -B1336-+			8,0/0,8 ◥ -B3336-+	12/0,6 ◥ -B4336-+		
47		3,0/1,3 ◥ -B476-+			9/0,7 -A7476-+	12/0,6 ◥ -B3476-+	16/0,5 ◥ -B4476-+		
68				10/0,6 ◥ -A2686-+		17/0,5 ◥ -B3686-+			
100			10/0,6 ◥ -A1107-+		20/0,5 -A7107-+				
150		9,0/0,6 ◥ -A157-+		20/0,4 ◥ -A2157-+					
220			20/0,4 ◥ -A1227-+						
330		15/0,4 ◥ -A337-+							

Standard version

Ordering code example: B45181-B4336-+

Type — B45181; Code according to table — B4336

With special mark CTS 27

Ordering code example: B45181-Q4336-+

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

For packaging units and weights refer to page 296.

◥ All capacitors with ±20 % cap. tolerance are preferred types S (refer to page 4).

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[1]) $V_P = 1.3\ V_R$

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

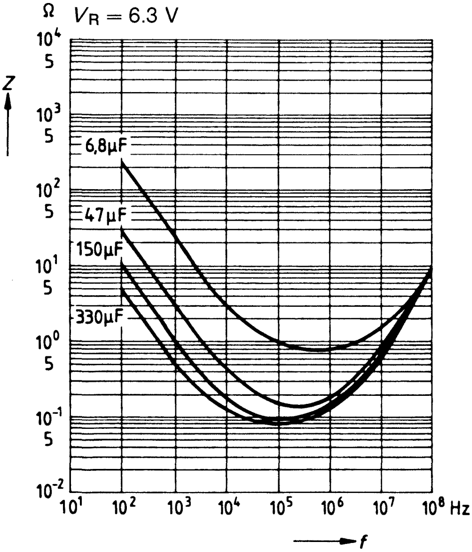
[3]) Impedance Z (Ω) at 100 kHz and 20 °C (limit values)

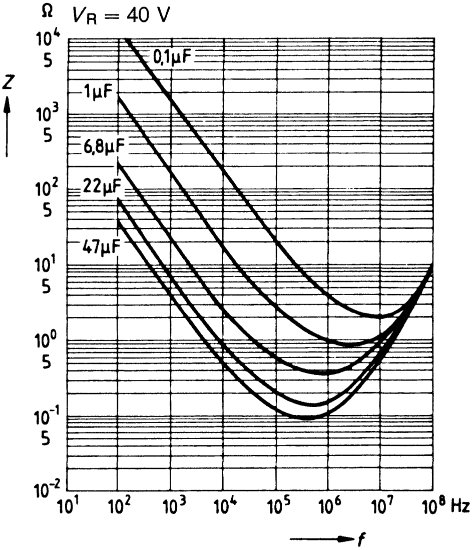
Dissipation factor tan δ at 120 Hz (limit values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 100 µF	0,06	0,06	0,06	0,06
	> 100 µF	0,08	0,08	0,08	0,08

Impedance *Z*

versus frequency (typical values at +20 °C)

Limit values at delivery for 100 kHz and +20 °C, see capacitance range





Polarity reversal voltage

The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage (intermittent)	at +20 °C: 0.15 · V_R at +55 °C: 0.10 · V_R at +85 °C: 0.05 · V_R

Test conditions

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

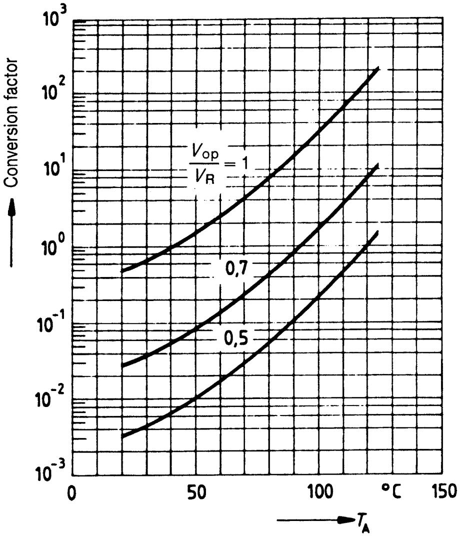
Reliability

Service life	> 500 000 h
Fraction failure[1])	0.15 % during 100 000 h
Failure rate[1])	≤ 15 fit ($\leq 15 \cdot 10^{-9}$/h) These values apply to 40 °C, $\leq V_R$, $R_i \geq 3\,\Omega$/V

Conversion factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1]).

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case sizes A and B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

Total failure	Short or open circuit
Failure due to variations	$I_{lk} \geq 5 \cdot I_{lko} + 5\ \mu$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 %

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[1]) For calculation example see page 288

Tantalum Electrolytic Capacitors 6.3 to 50 V dc B 45184

With Overload Protection

1.5 to 10 µF

Construction

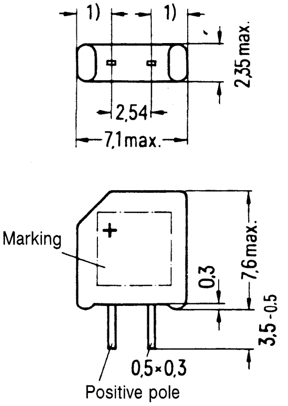
Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte. Rectangular encapsulation (flame-retardant), single-ended design, leads brought out to fit standardized lead spacing. A built-in thermal overload protector prevents inflammation by self-ignition in case of electrical overload.

Application

These capacitors are particularly suitable for use on PCBs for communications systems and measuring and control equipment, where high packing density, low dissipation factor, low leakage current, good temperature and frequency performance as well as high reliability are required.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15 DIN 44350 B 45010 "General Technical Information"
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKF (−55 to +125 °C, humidity category F) in acc. with DIN 40040
Service life	$>$ 500000 h
Failure rate	$\leq$ 15 fit ($\leq 15 \cdot 10^{-9}$/h)
Taping	The capacitors are also available on tape. For information on tape packaging refer to B 45071, page 292.



Dimensions in mm

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1) Permissible deviation 0.2 mm

Rated voltage V_R up to +85 °C[1]		6,3 V dc	10 V dc	16 V dc	25 V dc	35 V dc	50 V dc
Rated capacitance C_R		Output leakage current I_{lko}[2]/Impedance Z[3] Code					
µF	Tolerance						
1,5	± 20 % ≙ M						0,8/5,2 -B6155-M
2,2						0,8/4,0 -B5225-M	
3,3					0,8/3,5 -B4335-M		
4,7				0,8/3,1 -B3475-M			
6,8			0,7/3,1 -B2685-M				
10		0,6/3,1 -B1106-M					

Ordering code example: B45184-B4335-M

Type: B45184

Code according to table: B4335-M

For packaging units and weights refer to page 296.

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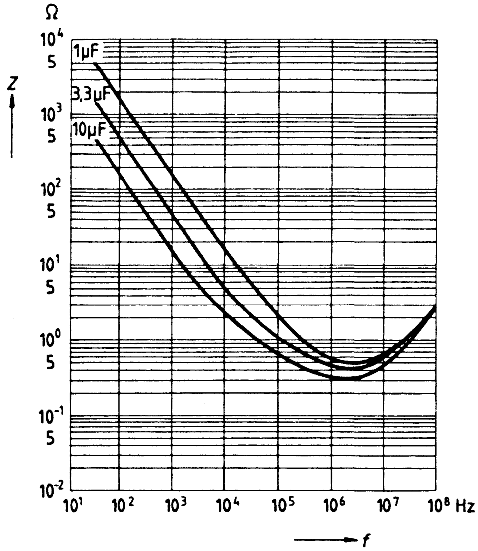
[1] Peak voltage $V_p = 1.3\ V_R$

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

[3] Impedance Z (Ω) at 100 kHz and 20 °C (limit values)

	−55 °C	+20 °C	+85 °C	+125 °C
Dissipation factor tan δ at 120 Hz (limit values)	0,06	0,06	0,06	0,06

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



Impedance Z
Limit values at delivery
for 100 kHz and +20 °C,
see capacitance range

Polarity reversal voltage

The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage at +20 °C: $0.15 \cdot V_R$
(intermittent) at +55 °C: $0.10 \cdot V_R$
at +85 °C: $0.05 \cdot V_R$

Test conditions

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

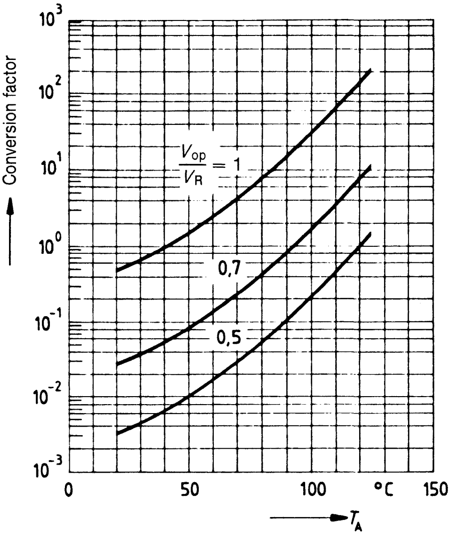
Reliability

Service life	$> 500\,000$ h
Fraction failure[1]	$\leq 0.15\%$ during 100 000 h
Failure rate[1]	≤ 15 fit ($\leq 15 \cdot 10^{-9}$/h) These values apply to 40 °C, $\leq V_R$, $R_i \geq 3\,\Omega/V$

Conversion factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1].

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case sizes A and B	1	2.0	3.5	5.0

Failure criteria

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

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[1] For calculation example see page 288

Tantalum Electrolytic Capacitors 6.3 to 50 V dc B 45185

With Overload Protection

0.10 to 330 µF

Construction

Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte. Rectangular epoxy encapsulation (flame-retardant), single-ended design with tinned nickel leads. A built-in thermal overload protector prevents inflammation by self-ignition in case of electrical overload. The positive pole is marked by a lateral projection. Values are stamped on the capacitor.

Application

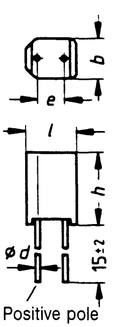
For communication and data processing systems as well as measuring and control equipment. These capacitors are particularly suitable for circuits in industrial electronics, where high packing density, low dissipation factor, low leakage current, good temperature and frequency performance as well as high reliability are required.

Specifications and characteristics in brief

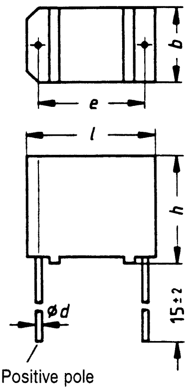
Sectional specification	IEC 384-15; DIN 44350; DIN 44352 B 45010 "General Technical Information"
Type specification	DIN 45910, part 145 (CECC 30201-xxx)
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKE (−55 to +125 °C, humidity category E) in acc. with DIN 40040
Service life	> 500000 h
Failure rate	≤ 15 fit (≤ 15 · 10^{-9}/h)
Taping	Case sizes A and B are also available on tape. For information on tape packaging refer to B 45071, page 292.

Case sizes

A,B



C,D



Case size	b max.	l max.	h max.	Ø d ±0,05	e ±0,2
A	4,2	4,7	7,3	0,5	2,54
B	4,8	7,3	10,0	0,5	5,08
C	7,3	12,3	10,0	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

To distinguish type series B 45181 from B 45185, the latter is marked with a colored stamp.

Dimensions in mm

Rated voltage V_R up to +85 °C[1])		6,3 V dc	10 V dc	16 V dc	20 V dc	25 V dc	40 V dc	50 V dc	Case size
Rated capacitance C_R µF	Tolerance	Output leakage current I_{lko}[2])/Impedance Z[3]) Code							
0,10	±20 % ≙ M ±10 % ≙ K						0,5/30 -A6104-+	0,5/30 -A7104-+	A
0,15							0,5/24 -A6154-+	0,5/24 -A7154-+	
0,22							0,5/18 -A6224-+	0,5/18 -A7224-+	
0,33							0,5/14 -A6334-+	0,5/14 -A7334-+	
0,47							0,5/11 -A6474-+	0,5/11 -A7474-+	
0,68							0,5/8 -A6684-+	0,5/8 -A7684-+	
1,0							0,5/6,5 -A6105-+	0,5/6,5 -A7105-+	
1,5						0,5/6 -A5155-+	0,7/5,2 -A6155-+	0,9/5,2 -A7155-+	B
2,2					0,5/5,5 -A4225-+		1,0/4 -A6225-+	1,7/4 -A7225-+	
3,3				0,5/4,4 -A3335-+			1,5/2,8 -A6335-+	2,0/2,8 -A7335-+	
4,7			0,5/4,0 -A2475-+				2,0/2 -A6475-+	2,5/2 -A7475-+	
6,8		0,5/4 -A1685-+					3,0/1,6 -A6685-+	3,5/1,6 -A7685-+	C
10						2,5/1,6 -A5106-+	4,0/1,3 -A6106-+	5/1,3 -A7106-+	
15					3/1,5 -A4156-+		6,0/1 -A6156-+	8/1 -A7156-+	
22				3,5/1,3 -A3226-+			9,0/0,8 -A6226-+	12/0,8 -A7226-+	D
33			3,5/1,3 -A2336-+			8,0/0,8 -A5336-+	12/0,6 -A6336-+		
47		3,0/1,3 -A1476-+			9/0,7 -A4476-+	12/0,6 -A5476-+	16/0,5 -A6476-+		
68				10/0,6 -A3686-+		17/0,5 -A5686-+			
100			10/0,6 -A2107-+		20/0,5 -A4107-+				
150		9,0/0,6 -A1157-+		20/0,4 -A3157-+					
220			20/0,4 -A2227-+						
330		15/0,4 -A1337-+							

Ordering code example: B45185-A6336-+

Type —— B45185

A6336-+ —— Code according to table

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

For packaging units and weights refer to page 296.

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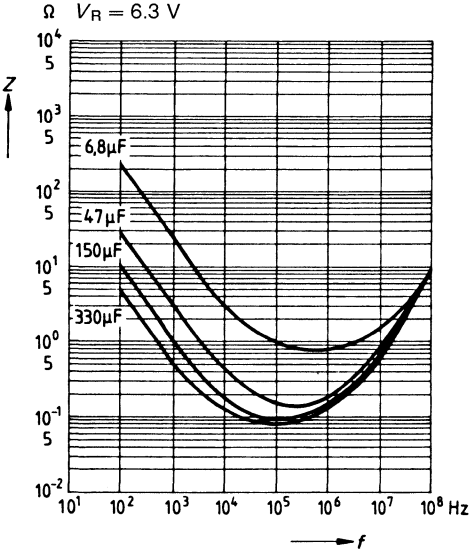
[1]) $V_P = 1.3\ V_R$

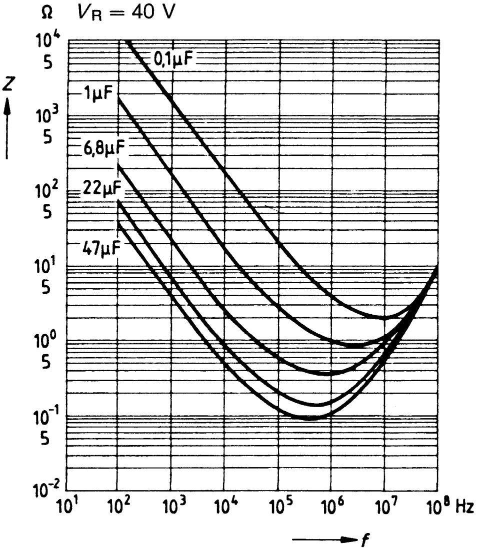
[2]) I_{lko} (µA) measured at 20 °C, V_R measured after 5 minutes (limit values)

[3]) Impedance Z (Ω) at 100 kHz and 20 °C (limit values)

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)
Limit values at delivery for 100 kHz and +20 °C; see capacitance range





Polarity reversal voltage

The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage (intermittent)	at +20 °C: $0.15 \cdot V_R$ at +55 °C: $0.10 \cdot V_R$ at +85 °C: $0.05 \cdot V_R$

Test conditions

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

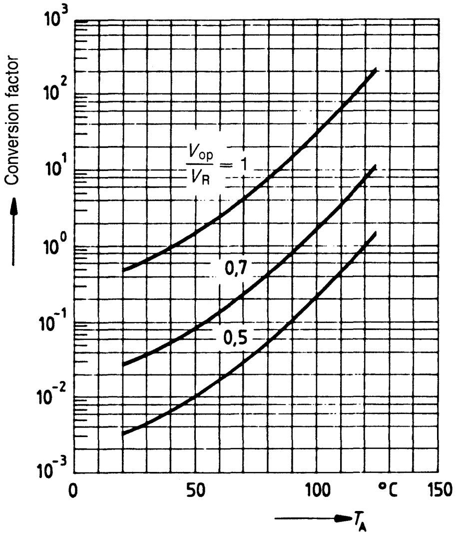
Reliability

Service life	> 500000 h
Fraction failure[1]	≤ 0.15 % during 100000 h
Failure rate[1]	≤ 15 fit (≤ $15 \cdot 10^{-9}$/h) These values apply to 40 °C, ≤ V_R, R_i ≥ 3 Ω/V

Conversion factors for the failure rate:

Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance.

The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).



The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1].

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case sizes A and B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

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

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[1] For calculation example see page 288

Tantalum Electrolytic Capacitors 6.3 to 50 V dc B 45187

Extremely Low *ESR*; Overload Protection

4.7 to 330 µF

Construction

Tantalum capacitors with a sintered body as anode and a solid semiconductor electrolyte. Rectangular epoxy encapsulation (flame-retardant), single-ended design with tinned nickel leads. A built-in thermal overload protector prevents inflammation by self-ignition in case of electrical overload. The positive pole is marked by a lateral projection. Values are stamped on the capacitor.

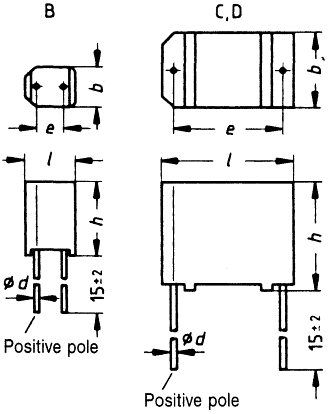
Application

These capacitors are particularly suitable for use in switch-mode power supplies with very high clock frequencies (e.g. 300 kHz) and DC/DC converters, where high ripple current capability and low *ESR* are required.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15, DIN 44350 B 45010 "General Technical Information"
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKE (−55 to +125 °C humidity category E) in acc. with DIN 40040
Service life	> 500000 h
Failure rate	≤ 15 fit ($\leq 15 \cdot 10^{-9}$/h)
Taping	Case size B is also available on tape. For information on tape packaging refer to B 45071, page 292.

Case sizes



Dimensions in mm

Case size	*b* max.	*l* max.	*h* max.	Ø*d* ±0,05	*e* ±0,2
B	4,8	7,3	10,0	0,5	5,08
C	7,3	12,3	10,0	0,63	10,16
D	12,3	12,3	10,5	0,63	10,16

To distinguish type series B 45181 from B 45187, the latter is marked with a colored stamp.

Rated voltage V_R up to +85 °C1)		6,3 V dc	10 V dc	16 V dc	20 V dc	25 V dc	40 V dc	50 V dc	Case size
Rated capacitance C_R		Code							
µF	Tolerance								
4,7	±20 % ≙ M ±10 % ≙ K							-A7475-+	B
6,8							-A6685-+	-A7685-+	C
10						-A5106-+	-A6106-+	-A7106-+	
15					-A4156-+		-A6156-+	-A7156-+	
22				-A3226-+			-A6226-+	-A7226-+	D
33			-A2336-+			-A5336-+	-A6336-+		
47		-A1476-+			-A4476-+	-A5476-+	-A6476-+		
68				-A3686-+		-A5686-+			
100			-A2107-+		-A4107-+				
150		-A1157-+		-A3157-+					
220			-A2227-+						
330		-A1337-+							

Ordering code example: B45187-A6336-+

Type: B45187 — Code according to table: A6336-+

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

For packaging units and weights refer to page 296.

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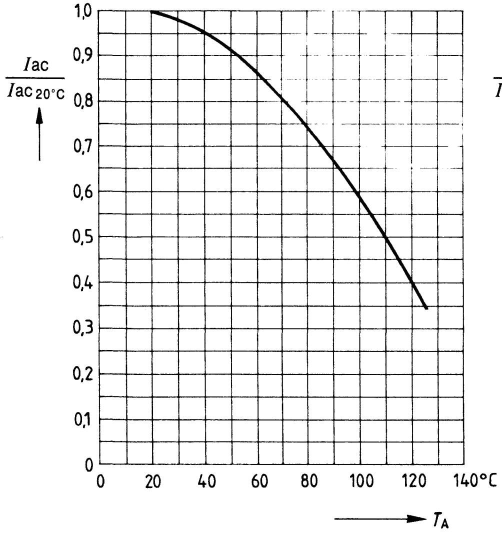
1) $V_p = 1.3\ V_R$

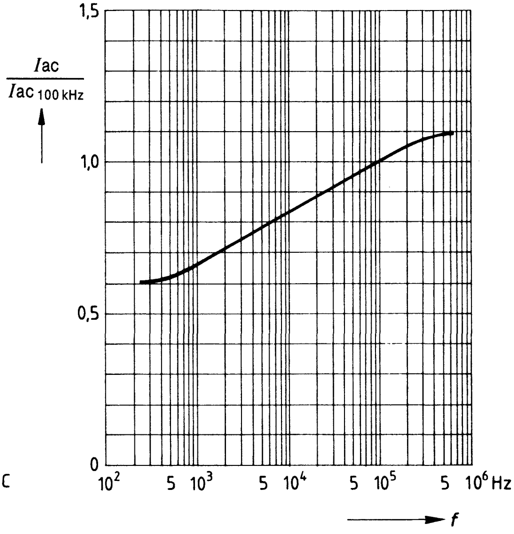
C_R µF	V_R V dc	Case size	$I_{lko, max}$ V_R/5 min 20 °C µA	tan δ_{max} 1 kHz 20 °C %	ESR_{max} 100 kHz 20 °C mΩ	$I_{ac\,max}$ 100 kHz 20 °C A	ESL approx. nH
47	6,3	B	3	8	110	1,8	10
150		C	9	12	65	3,5	10
330		D	15	14	45	4,6	10
33	10	B	3,5	6	130	1,7	10
100		C	10	10	75	3,2	10
220		D	20	12	55	4,2	10
22	16	B	3,5	6	160	1,5	10
68		C	10	8	95	2,9	10
150		D	20	10	65	3,9	10
15	20	B	3	5	199	1,4	10
47		C	9	8	110	2,7	10
100		D	20	10	75	3,6	10
10	25	B	2,5	5	230	1,3	10
33		C	8	6	130	2,5	10
47		D	12	8	110	3,0	10
68		D	17	8	95	3,2	10
6,8	40	B	3	4	275	1,2	10
10		C	4	4	230	1,8	10
15		C	6	4	190	2,0	10
22		C	9	5	160	2,2	10
33		D	12	6	130	2,7	10
47		D	16	6	110	3,0	10
4,7	50	B	2,5	4	330	1,1	10
6,8		C	3,5	4	275	1,7	10
10		C	5	4	230	1,8	10
15		C	8	4	190	2,0	10
22		D	12	5	160	2,5	10

Dissipation factor tan δ at 120 Hz (max. values)	Rated capacitance	−55 °C	+20 °C	+85 °C	+125 °C
	≤ 100 µF	0,03	0,03	0,03	0,03
	> 100 µF	0,04	0,04	0,04	0,04

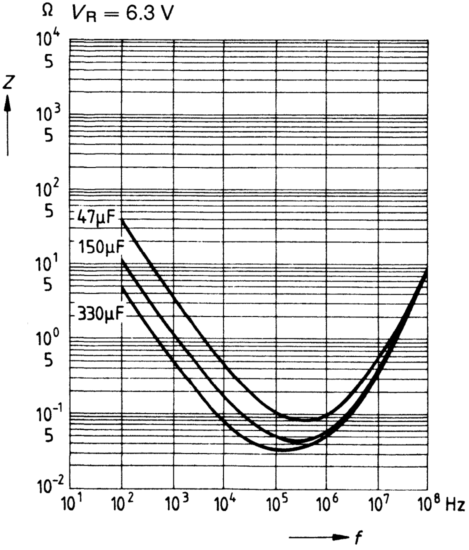
Permissible ripple current I_{ac}
versus ambient temperature T_A



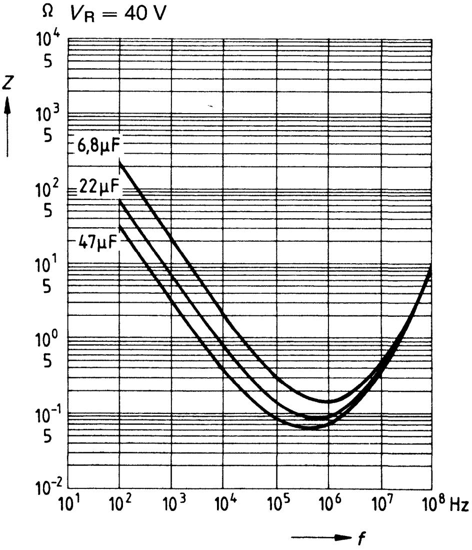
Permissible ripple current I_{ac}
versus frequency f



Impedance Z
versus frequency f
(typical values at +20 °C)
$V_R = 6.3\ \text{V}$



Impedance Z
versus frequency f
(typical values at +20 °C)
$V_R = 40\ \text{V}$



Polarity reversal voltage

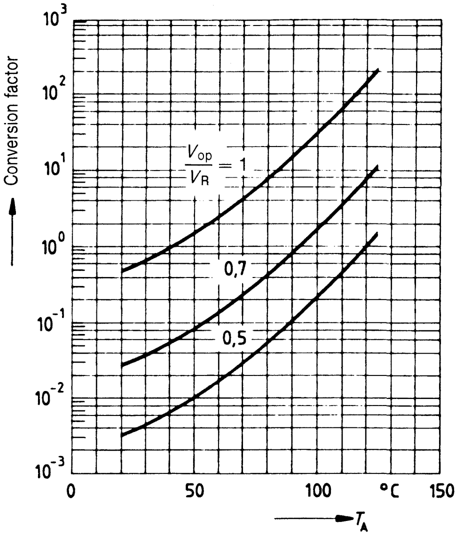
The sum of dc voltage and negative ac voltage portions may only cause a polarity reversal within the range of the permissible reversal voltage.

Polarity reversal voltage at +20 °C: $0.15 \cdot V_R$
(intermittent) at +55 °C: $0.10 \cdot V_R$
at +85 °C: $0.05 \cdot V_R$

Test conditions

Life test 2000 h at +85 °C or 2000 h at +125 °C with voltage derating	ΔC ≤ 10 % ot the initial value tan δ ≤ limit values $I_{\mathrm{lk}\ 20\,°\mathrm{C}}$ ≤ 1.25 · initial limit values Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Shelf life test 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 value)
Permissible damp heat test in acc. with DIN IEC 68-2-3	Severity 4: 40 ± 2 °C; 93^{+2}_{-3} % relative humidity Duration: 56 days
Vibration resistance Test Fc in acc. with DIN IEC 68-2-6 Vibration, sinusoidal	Frequency range: 10 to 2000 Hz Displacement: 1.5 mm (max. 196 m/s^2 or 20 g) Duration: 6 h
Shock resistance in acc. with DIN 40046, sheet 7	Peak load: 981 m/s^2 or 100 g
Resistance to soldering heat	Temperature of wave bath: max. 270 °C Soldering time: max. 2 s The temperature must not exceed 130 °C at any point of the capacitor, also in case of a final tinning process of the leads.

Reliability

Service life	> 500 000 h
Fraction failure[1]	≤ 0.15 % during 100 000 h
Failure rate[1]	≤ 15 fit (≤ 15 · 10^{-9}/h) These values apply to 40 °C, ≤ V_R, R_i ≥ 3 Ω/V
Conversion factors for the failure rate: Fraction failure and failure rate depend on the ambient temperature, the ratio V_{op}/V_R and the circuit resistance. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio and rising circuit resistance. The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the opposite graph (typical values).	

The table below shows the increase in the failure rate that can be expected for circuits with lower internal resistances R_i[1].

R_i in Ω/V	≥ 3	1	0.3	≤ 0.1
Factor for case size B	1	2.0	3.5	5.0
Factor for case sizes C and D	1	2.8	6.1	12

Failure criteria

Total failure	Short or open circuit
Failure due to variations	$I_{lk} \geq 5 \cdot I_{lko} + 5\ \mu A$ $Z \geq$ 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 %

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[1] For calculation example see page 288

Tantalum Electrolytic Capacitors

Axial Capacitors with Liquid Electrolyte

Tantalum Electrolytic Capacitors 6 to 125 V dc B 45265

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 material. Central-axial leads, welded terminal connections ensure reliable contacting.

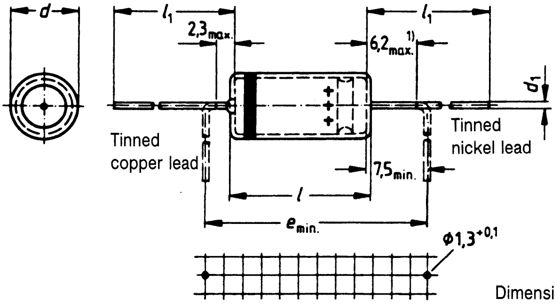
Attention! Incorrect polarization has to be avoided by all means. The electrolyte has etching and metal-corroding characteristics. Caution, when opening the capacitor.

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.

Specifications and characteristics in brief

Sectional specifications	IEC 384-15 B 45010 "General Technical Information"
Type specification	DIN 44360 (at present draft), version S, type I MIL-C-39006/9, style CLR 65*)
IEC climatic category	55/125/56 in acc. with DIN IEC 68, part 1
DIN climatic category	FKC (− 55 to + 125 °C, humidity category C) in acc. with DIN 40040
Service life	> 100000 h
Failure rate	≤ 20 fit ($\leq 20 \cdot 10^{-9}$/h)



Dimensions in mm

Case size²)	Dimensions		$l_1 \pm 4$	Min. lead spacing	Lead diameter
	$d_{-0,7}$	$l_{-2,0}$		e_{min}	d_1
T1	5,5	13,8	40	25	0,6 ±0,05
T2	7,9	18,6	55	30	
T3	10,3	21,8		32,5	
T4	10,3	27,2		40	0,8 ±0,05

*) Capacitors with MIL certificate upon request.

[1]) Tantalum lead not solderable. Bending at the welded joint not permitted.

[2]) Case sizes T1 to T4 are 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	V dc	V dc	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-+
100	40	25	2	12	T3	B45265-A107-+2
220			4	32	T4	B45265-B227-+2

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

For packaging units and weights refer to page 296.

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1) Peak voltage $V_P = 1.15\ V_R$

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	V dc	V dc	µA	µA		
5	50	30	1	2	T1	B45265-A6505-+
10			1	2	T1	B45265-A6106-+
25			1	5	T2	B45265-A6256-+
47			1	9	T2	B45265-A6476-+
60			2	12	T3	B45265-A6606-+
82			2	16	T3	B45265-A6826-+
160			8	32	T4	B45265-B6167-+
4	60	40	1	2	T1	B45265-A7405-+
8,2			1	2	T1	B45265-A7825-+
20			1	5	T2	B45265-A7206-+
39			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	75	50	1	2	T1	B45265-A8355-+
6,8			1	2	T1	B45265-A8685-+
15			1	5	T2	B45265-A8156-+
33			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	100	70	1	2	T1	B45265-A9255-+
4,7			1	2	T1	B45265-A9475-+
11			1	4	T2	B45265-A9116-+
22			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	125	85	1	2	T1	B45265-A175-+1
3,6			1	2	T1	B45265-A365-+1
9			1	5	T2	B45265-A905-+1
14			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 the required capacitance tolerance: M ≙ ± 20 %, K ≙ ± 10 % or J ≙ ± 5 %.

For packaging units and weights refer to page 296.

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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

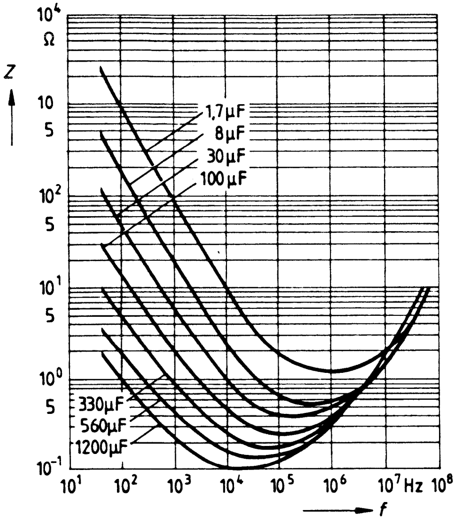
ESR = Equivalent series resistance at +20 °C and 120 Hz in Ω $\left(ESR = \frac{\tan\delta}{\omega C}\right)$

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

Case size	C_R µF	V_R V dc	$\tan\delta_{max}$ %	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 V dc	tan δ_{max} %	Z_{max} Ω	*ESR* Ω	$\Delta C_{max}/C_{20}$ in %		
						−55 °C	+85 °C	+125 °C
T2	11	100	5,0	200	6	−16	+ 5	+ 6
	22		11,8	100	7			
	9	125	10,2	240	15			+ 6
	14		12,7	167	12			+ 7
T3	330	6	49,6	20	2	−44	+14	+16
	560		128,0	25	3	−64	+17,5	+20
	430	8	91,5	25	3	−64	+17,5	+20
	250	10	37,8	30	2	−40	+14	+16
	390		87,6	25	3	−64	+17,5	+20
	170	15	25,4	35	2	−32	+14	+16
	270		60,9	30	3	−56	+17,5	+20
	180	25	54,3	32	4	−48	+13	+15
	100	30	19,0	40	2,5	−28	+10,5	+12
	150		46,0	35	4	−48	+13	+15
	100	40	25,0	50	3	−25	+15	+18
	60	50	13,6	45	3	−16	+10,5	+12
	82		24,9		4	−32	+13	+15
	50	60	15,3	50	4	−16	+10,5	+12
	68		30,7		6	−32		
	40	75	15,2	60	5	−16		+12
	56		26,0		6	−28		+15
	30	100	9,1	80	4	−16	+ 7	+ 8
	43		19,7	70	6	−20		
	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
	220	40	30,0	30	4	−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

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



Ripple voltage capability

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

Max. permissible ripple current Iac for frequencies ≥ 50 Hz	Case size	+25 … +85 °C mA	> +85 … +125 °C mA
	T1	50	40
	T2	250	200
	T3	400	320
	T4	600	480

Test conditions

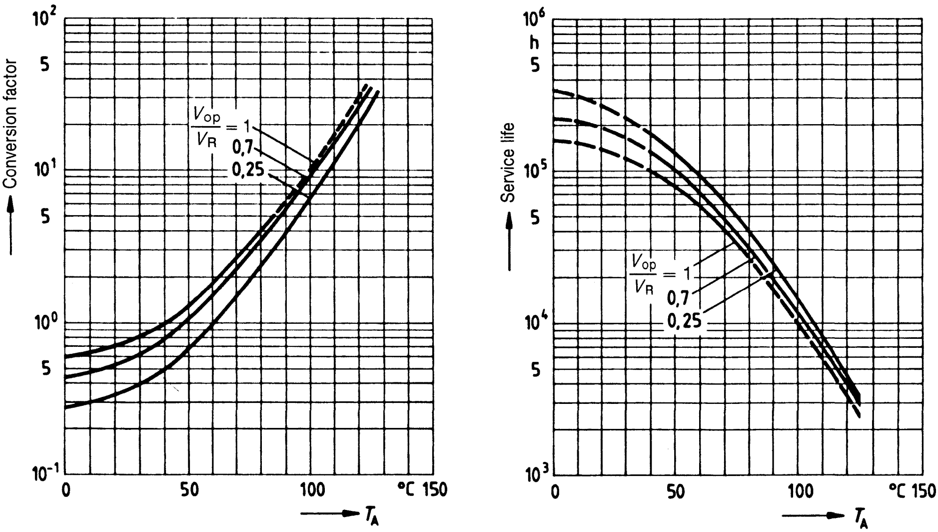
Life test 2000 h at +85 °C or 2000 h at +125 °C with voltage derating	ΔC ≤ 10 % of the initial value $\tan \delta$ ≤ limit values according to table $I_{\mathrm{lk}\ 20\ °\mathrm{C}}$ ≤ limit values according to table Out of 25 specimens tested only 1 capacitor is allowed to exceed the values indicated.
Shelf life test 5000 h at +85 °C	ΔC ≤ 10 % of the initial value $\tan \delta$ ≤ 1.5 · limit values $I_{\mathrm{lk}\ 20\ °\mathrm{C}}$ ≤ limit values
Capacitance drift	± 10 % (typical value)
Mechanical strength of the leads Tensile strength Number of bendings	10 N, 30 s in axial direction 2 (bending at the welded joint not permitted)
Permissible damp heat test in acc. with DIN IEC 68-2-3	Severity 4: 40 ± 2 °C; 93^{+2}_{-3} % relative humidity Duration: 56 days
Vibration resistance	The capacitors meet all requirements of the vibration test in acc. with MIL-C-39006/9 (MIL-STD 202, method 204, severity D).
Shock resistance in acc. with DIN 40046, sheet 7	Peak load: 981 m/s^2 or 100 g
Low air pressure in acc. with DIN 40046, sheet 13	Severity 2: 20 hP ≙ approx. 26 000 m height
Dielectric strength of the insulating sleeve	2000 V dc
Resistance to soldering heat	Temperature of wave bath: max. 270 °C Soldering time: max. 2 s Distance cap. body – solder joint: Anode side ≥ 2.3 mm Cathode side ≥ 6.3 mm The temperature must not exceed 130 °C at any point of the capacitor, also in case of a final tinning process of the leads.

Reliability

Service life	> 100 000 h
Fraction failure	≤ 0.2 % during 100 000 h
Failure rate	≤ 20 fit (≤ 20 · 10^{-9}/h) These values apply to 40 °C and V_R

Fraction failure and failure rate depend on the ambient temperature and the ratio V_{op}/V_R. They increase with rising ambient temperature and decrease with falling V_{op}/V_R ratio. The conversion factors for the dependence of the failure rate on ambient temperature and operating voltage during service life are given in the graph below (typical values)[1].

Conversion factors for fraction failure and service life



Failure criteria

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

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[1] For calculation example see page 288

Siemens Worldwide (Addresses)

Siemens AG, Bereich Passive Bauelemente und Röhren
Balanstraße 73, Postfach 801709, **D-8000 München 80**
☎ (089) 4144-0 Tx 52108-0 sie d FAX (089) 4144-2689

Siemens Worldwide

Federal Republic of Germany and Berlin (West)

Siemens AG
Salzufer 6–8
1000 Berlin 10
☎ (030) 3939-1, Tx 18100-278
FAX (030) 3939-2630
Ttx 308190 = sieznb

Siemens AG
Lahnweg 10
Postfach 1115
4000 Düsseldorf 1
☎ (0211) 399-0, Tx 21134401
FAX (0211) 399-2506

Siemens AG
Rödelheimer Landstraße 5–9
Postfach 111733
6000 Frankfurt 1
☎ (069) 797-0, Tx 414131-0
FAX (069) 797-2253

Siemens AG
Lindenplatz 2
Postfach 105609
2000 Hamburg 1
☎ (040) 282-1, Tx 215584-0
FAX (040) 282-2210

Siemens AG **Hannover**
Hildesheimer Str. 7
Postfach 110551
3014 Laatzen
☎ (0511) 877-0, Tx 922333
FAX (0511) 877-2799

Siemens AG
Richard-Strauss-Straße 76
Postfach 202109
8000 München
☎ (089) 9221-4380
Tx 529421-19
FAX (089) 9221-4390
Ttx 8985061

Siemens AG
Von-der-Tann-Straße 30
Postfach 4844
8500 Nürnberg 1
☎ (0911) 654-0, Tx 622251
FAX (0911) 654-4064

Siemens AG
Geschwister-Scholl-Straße 24
Postfach 120
7000 Stuttgart 1
☎ (0711) 2076-0, Tx 723941
FAX (0711) 2076-3706

EUROPE

Austria

Siemens Aktiengesellschaft
Österreich
Postfach 326
A-1031 Wien
☎ (0222) 71711-0, Tx 1372-0

Belgium

Siemens S.A.
chaussée de Charleroi 116
B-1060 Bruxelles
☎ (02) 536-2111, Tx 21347

Denmark

Siemens A/S
Borupvang 3
DK-2750 Ballerup
☎ (02) 656565, Tx 35313

Finland

Siemens Osakeyhtiö
PL 8
SF-00101 Helsinki 10
☎ (80) 1626-1, Tx 124465

France

Siemens S.A.
39/47, Bd. Ornano
F-93527 Saint-Denis CEDEX 2
☎ (1) 49223100, Tx 620853

Great Britain

Siemens Ltd.
Siemens House
Windmill Road
GB-Sunbury-on-Thames
Middlesex TW 16 7HS
☎ (09327) 85691, Tx 8951091

Greece

Siemens AE
Paradissou & Artemidos
P.O.B. 61011
GR-15110 Amaroussio
☎ (01) 6864 111

Ireland

Siemens Ltd.
Unit 8–11 Slaney Road
Dublin Industrial Estate
Finglas Road
Dublin 11
☎ (01) 302855, Tx 32547

Italy

Siemens Elettra S.p.A.
Via Fabio Filzi, 25/A
Casella Postale 10388
I-20100 Milano
☎ (02) 6248, Tx 330261

Netherlands

Siemens Nederland N.V.
Postb. 16068
NL-2500 BB Den Haag
☎ (070) 782782, Tx 31373

Norway

Siemens A/S
Østre Aker vei 90
Postboks 10, Veitvet
N-0518 Oslo 5
☎ (02) 633000, Tx 78477

Portugal

Siemens S.A.R.L.
Avenida Almirante Reis, 65
Apartado 1380
P-1100 Lisboa-1
☎ (01) 538805, Tx 12563

Spain

Siemens S.A.
Orense, 2
Apartado 155
E-28080 Madrid
☎ (01) 4552500, Tx 27247

Sweden

Siemens AB
Hälsingegatan 40
Box 23141
S-10435 Stockholm
☎ (08) 7281000, Tx 19880

Switzerland

Siemens-Albis AG
Freilagerstraße 28
Postfach
CH-8047 Zürich
☎ (01) 495-3111, Tx 823781

Turkey
ETMAŞ Elektrik Tesisati ve
Mühendislik A.Ş.
Meclisi Mebusan Caddesi 55/35
Findikli
P.K. 1001 Karakoey
Istanbul
☎ (01) 1 51 09 00, Tx 24 233

AFRICA

South African Republic
Siemens Limited
Siemens House,
P.O.B. 4583
2000 Johannesburg
☎ (011) 407-4111, Tx 4-22524

AMERICA

Argentina
Siemens S.A.
Avenida Pte. Julio A. Roca 516
Casilla Correo Central 1232
RA-1000 Buenos Aires
☎ (01) 00541/300411, Tx 21812

Brazil
Icotron S.A.
Indústria de Componentes
Eletronicos
Caixa Postal 1375,
01051 São Paulo-SP
☎ (011) 833-2211
Tx (011) 81001

Canada
Siemens Electric Limited
Electronic Components Division
1180 Courtney Park Drive
Mississauga, Ontario L5T 1P2
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