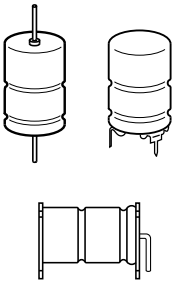
Aluminum electrolytic capacitors

Axial-lead and soldering star capacitors

Series/Type: **B41696, B41796**

Date: November 2012

EPCOS AG is a TDK Group Company.



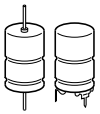
Applications
- Automotive electronics

Features
- Very low ESR at temperature down to −55 °C
- Compact design
- High ripple current capability
- High vibration stability
- Shelf life up to 15 years at storage temperatures up to 40 °C. To ensure solderability, the capacitors should be built into the application within one year of delivery. After a total of two years' storage, the operating voltage must be applied for one hour to ensure the specified leakage current.
- RoHS-compatible

Construction
- Charge/discharge-proof, polar
- Aluminum case with insulating sleeve
- Negative pole connected to case

Terminals
- Axial leads, welded to ensure perfect electrical contact
- Soldering star for upright mounting on PCB available
- Alternative axial-lead design with double-sided plates for horizontal mounting available upon request

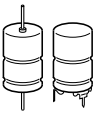
Taping and packing
- Axial-lead capacitors will be delivered in pallet package Capacitors with $d \times l \leq 16 \times 30$ mm are also available taped on reel
- Soldering star capacitors are packed in cardboard



Specifications and characteristics in brief

Rated voltage V_R	25 and 40 V DC						
Surge voltage V_S	1.15 · V_R						
Rated capacitance C_R	470 ... 6800 µF						
Capacitance tolerance	−10/+30% ≙ Q						
Leakage current I_{leak} (5 min, 20 °C)	$I_{leak} \leq 0.006\ \mu A \cdot \left(\frac{C_R}{\mu F} \cdot \frac{V_R}{V}\right) + 4\ \mu A$						
Self-inductance ESL[1]	Diameter d (mm)		12	14	16	18	20/21
	Terminals	Length l (mm)	Approx. ESL (nH)				
	axial	25	–	22	–	30	–
		29	–	–	–	–	38
		30	21	24	29	34	–
		35	–	–	31	–	–
		39	–	–	33	38	45
		49	–	–	–	–	50
	soldering star	25	–	6	–	8	–
		30	6	7	8	10	–
		35	–	–	9	–	–
		39	–	–	9	11	13
		49	–	–	–	–	14
Useful life[2]			Requirements:				
125 °C; V_R; $I_{AC,R}$	> 3000 h		ΔC/C	≤ ±30% of initial value			
85 °C; V_R; $I_{AC,max}$	> 15000 h		ESR	≤ 3 times initial specified limit[3]			
40 °C; V_R; 2.9 · $I_{AC,R}$	> 200000 h		I_{leak}	≤ initial specified limit			
Voltage endurance test			Post test requirements:				
125 °C; V_R	2000 h		ΔC/C	≤ ±10% of initial value			
			ESR	≤ 1.3% initial specified limit[3]			
			I_{leak}	≤ initial specified limit			
Vibration resistance test	To IEC 60068-2-6, test Fc: Frequency range 10 Hz ... 2 kHz, displacement amplitude max. 1.5 mm, acceleration max. 20 *g*, duration 3 × 2 h. Capacitor mounted by its wire leads at a distance of (6 ±1) mm from the case and additionally clamped by the case.						
IEC climatic category	To IEC 60068-1: 55/125/56 (−55 °C/+125 °C/56 days damp heat test)						
Detail specification Sectional specification	Similar to CECC 30301-802 IEC 60384-4						

1) If optimum circuit design is used, the values are lower by 30%.
2) Refer to chapter "General technical information, 5 Useful life" on how to interpret useful life.
3) ESR_{max} at 100 Hz, 20 °C

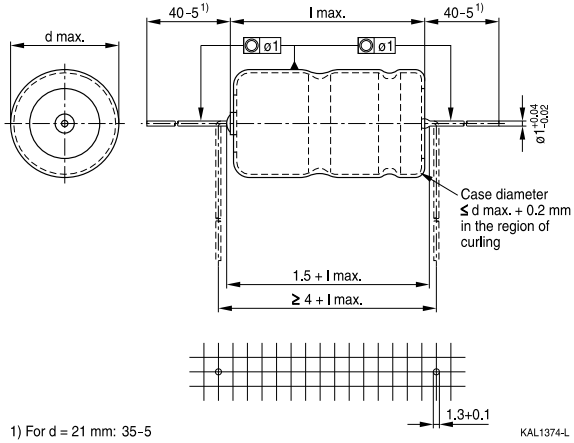


B41696, B41796

Very low ESR – 125 °C

B41696, Axial-lead capacitors

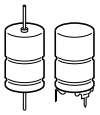
Dimensional drawing



1) For d = 21 mm: 35–5

Dimensions, weights and packing units

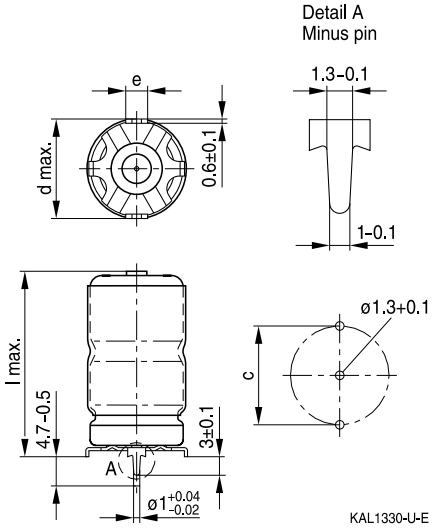
d × l	$d_{max} \times l_{max}$	Approx. weight	Packing units (pcs.)	
mm	mm	g	Pallet	Reel
12 × 30	12.5 × 30.5	5.1	288	450
14 × 25	14.5 × 25.5	5.7	200	350
14 × 30	14.5 × 30.5	6.8	200	350
16 × 30	16.5 × 30.5	8.9	180	250
16 × 35	16.5 × 35.5	10.4	180	–
16 × 39	16.5 × 40	11.7	180	–
18 × 25	18.5 × 25.5	9.3	160	–
18 × 30	18.5 × 30.5	11.1	160	–
18 × 39	18.5 × 40	14.7	160	–
20 × 29	20.5 × 29.5	13.5	140	–
21 × 39	21.5 × 40	20.0	140	–
21 × 49	21.5 × 50	25.0	110	–



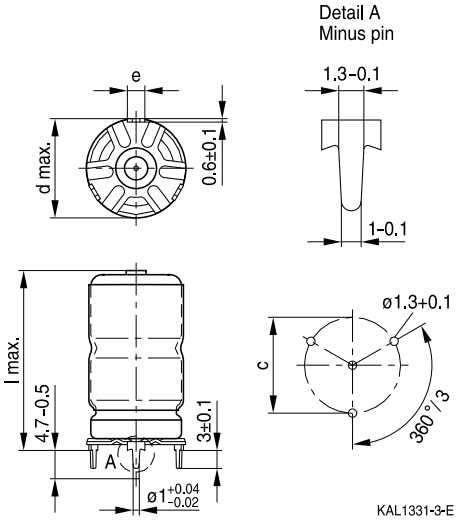
B41796, Soldering star capacitors

Dimensional drawings

Mounting holes d = 12 mm ... 14 mm

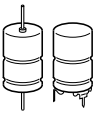


Mounting holes d = 16 mm ... 21 mm



Dimensions, weights and packing units

d × l mm	$d_{max} \times l_{max}$ mm	c ±0.1 mm	e ±0.1 mm	Approx. weight g	Packing units pcs.
12 × 30	13.5 × 32	12.5	3.0	5.4	480
14 × 25	15.5 × 27	14.5	3.0	6.1	480
14 × 30	15.5 × 32	14.5	3.0	7.2	480
16 × 30	17.5 × 32	16.5	3.0	9.4	300
16 × 35	17.5 × 37	16.5	3.0	10.9	200
16 × 39	17.5 × 41.5	16.5	3.0	12.2	200
18 × 25	19.5 × 27	18.5	3.0	9.9	300
18 × 30	19.5 × 32	18.5	3.0	11.8	300
18 × 39	19.5 × 41.5	18.5	3.0	15.4	200
21 × 39	22.5 × 41.5	21.5	3.5	21.0	324
21 × 49	22.5 × 51.5	21.5	3.5	26.0	264



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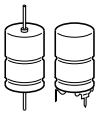
Very low ESR – 125 °C

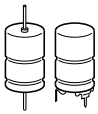
Overview of available types

V_R (V DC)	25	40
	Case dimensions d × l (mm)	
C_R (µF)		
470		12 × 30
680	12 × 30	14 × 30
1000	14 × 25	16 × 30
1200		16 × 35
1500	16 × 30	16 × 39 18 × 30
1800	18 × 25	
2200	18 × 30	18 × 39 20 × 29
3300	18 × 39 20 × 29	21 × 39
4400		21 × 49
5000	21 × 39	
6800	21 × 49	



Case dimensions and ordering codes

V_R	C_R 100 Hz 20 °C	Case dimensions d × l	Ordering code Axial pallet	Ordering code Axial reel	Ordering code Soldering star
V DC	µF	mm			
25	680	12 × 30	B41696A5687Q001	B41696A5687Q003	B41796A5687Q001
	1000	14 × 25	B41696A5108Q001	B41696A5108Q003	B41796A5108Q001
	1500	16 × 30	B41696A5158Q001	B41696A5158Q003	B41796A5158Q001
	1800	18 × 25	B41696A5188Q001		B41796A5188Q001
	2200	18 × 30	B41696B5228Q001		B41796B5228Q001
	3300	18 × 39	B41696B5338Q001		B41796B5338Q001
	3300	20 × 29	B41696C5338Q001		
	5000	21 × 39	B41696A5508Q001		B41796A5508Q001
	6800	21 × 49	B41696A5688Q001		B41796A5688Q001
40	470	12 × 30	B41696A7477Q001	B41696A7477Q003	B41796A7477Q001
	680	14 × 30	B41696A7687Q001	B41696A7687Q003	B41796A7687Q001
	1000	16 × 30	B41696A7108Q001	B41696A7108Q003	B41796A7108Q001
	1200	16 × 35	B41696A7128Q001		B41796A7128Q001
	1500	16 × 39	B41696A7158Q001		B41796A7158Q001
	1500	18 × 30	B41696B7158Q001		B41796B7158Q001
	2200	18 × 39	B41696B7228Q001		B41796B7228Q001
	2200	20 × 29	B41696C7228Q001		
	3300	21 × 39	B41696A7338Q001		B41796A7338Q001
	4400	21 × 49	B41696A7448Q001		B41796A7448Q001

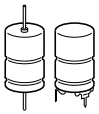


B41696, B41796

Very low ESR – 125 °C

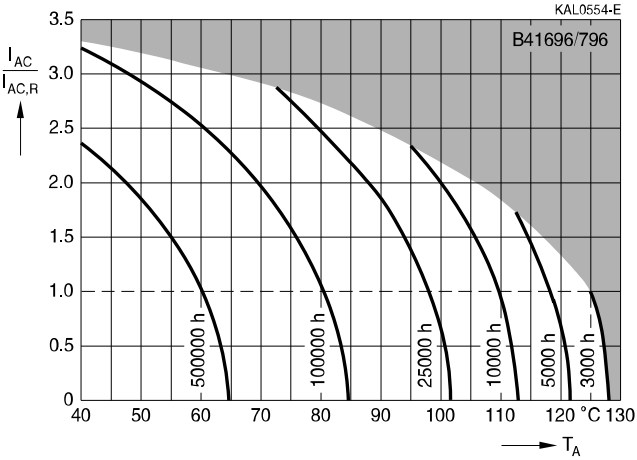
Technical data

C_R 100 Hz 20 °C µF	Case dimensions d × l mm	ESR_{max} 100 Hz 20 °C mΩ	ESR_{max} 100 Hz −40 °C mΩ	ESR_{max} 10 kHz 20 °C mΩ	Z_{max} 100 kHz 20 °C mΩ	$I_{AC,max}$ 10 kHz 40 °C A	$I_{AC,max}$ 10 kHz 105 °C A	$I_{AC,R}$ 10 kHz 125 °C A	$I_{AC,max}$ 10 kHz 125 °C A
V_R = 25 V DC									
680	12 × 30	160	1000	85	80	5.6	3.4	1.7	1.7
1000	14 × 25	115	650	65	62	5.8	3.5	1.75	1.75
1500	16 × 30	80	450	45	43	7.4	4.5	2.25	2.25
1800	18 × 25	65	380	36	34	9.0	5.5	2.7	2.7
2200	18 × 30	55	300	28	27	11.0	6.7	3.4	3.4
3300	18 × 39	36	200	19	18	15.2	9.3	4.6	4.6
3300	20 × 29	38	200	22	21	12.3	7.5	3.7	3.7
5000	21 × 39	25	150	15	15	17.2	10.5	5.3	5.3
6800	21 × 49	19	110	11	11	22.0	13.5	6.7	6.7
V_R = 40 V DC									
470	12 × 30	170	1000	70	68	6.0	3.6	1.8	1.8
680	14 × 30	135	600	53	51	7.1	4.3	2.2	2.2
1000	16 × 30	85	450	42	40	8.0	4.8	2.45	2.45
1200	16 × 35	70	370	35	33	9.5	5.8	2.9	2.9
1500	16 × 39	58	300	29	28	11.0	6.7	3.35	3.35
1500	18 × 30	54	300	25	24	11.5	7.0	3.5	3.5
2200	18 × 39	38	200	17	16	15.7	9.6	4.8	4.8
2200	20 × 29	40	200	20	20	12.4	7.6	3.8	3.8
3300	21 × 39	27	140	14	14	17.3	10.5	5.3	5.3
4400	21 × 49	21	110	11	11	21.5	13.2	6.6	6.6



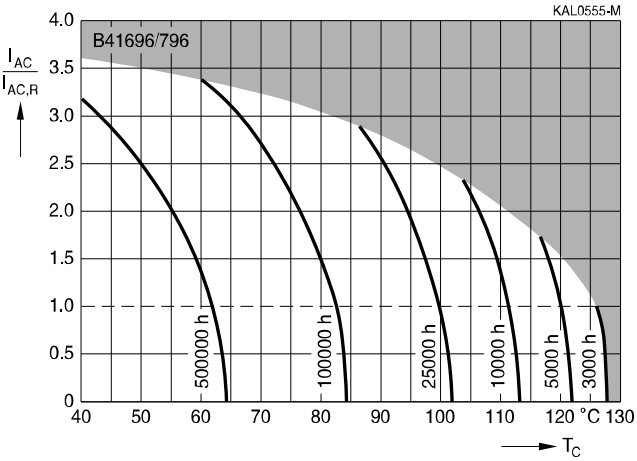
Useful life[1)]

depending on ambient temperature T_A under ripple current operating conditions at V_R

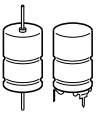


Useful life[1)]

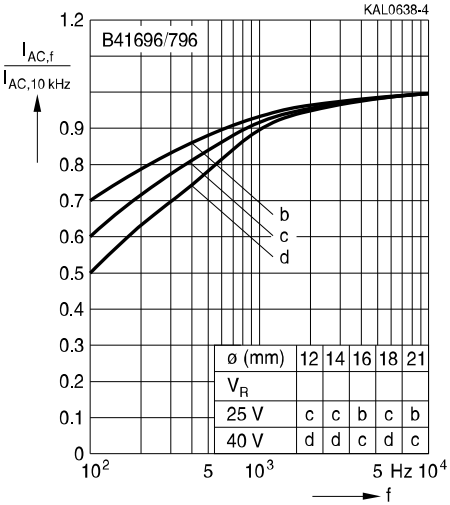
depending on case temperature T_C under ripple current operating conditions at V_R



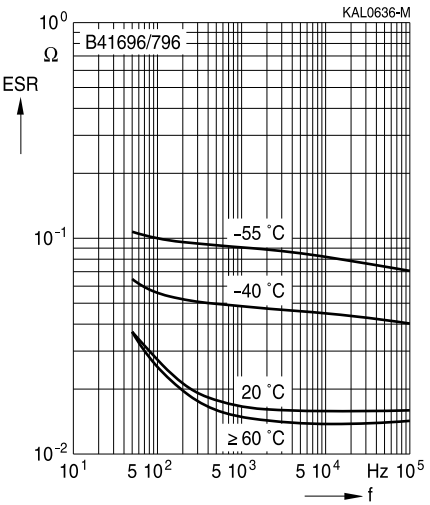
1) Refer to chapter "General technical information, 5 Useful life" on how to interpret useful life.



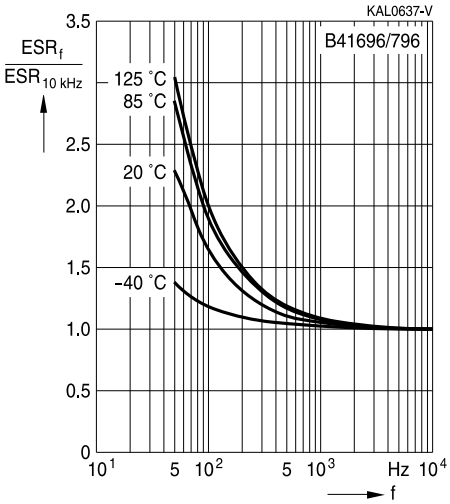
Frequency factor of permissible ripple current I_{AC} versus frequency f



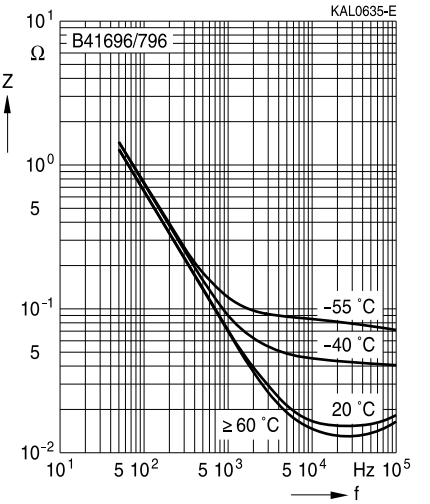
Frequency characteristics of ESR
Typical behavior

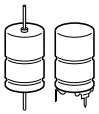


Equivalent series resistance ESR versus frequency f
Typical behavior for 2200 µF/40 V



Impedance Z versus frequency f
Typical behavior for 2200 µF/40 V





Cautions and warnings

Personal safety

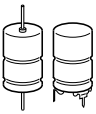
The electrolytes used by EPCOS have been optimized both with a view to the intended application and with regard to health and environmental compatibility. They do not contain any solvents that are detrimental to health, e.g. dimethyl formamide (DMF) or dimethyl acetamide (DMAC).
Furthermore, some of the high-voltage electrolytes used by EPCOS are self-extinguishing.

As far as possible, EPCOS does not use any dangerous chemicals or compounds to produce operating electrolytes. However, in exceptional cases, such materials must be used in order to achieve specific physical and electrical properties because no alternative materials are currently known. However, the amount of dangerous materials used in our products is limited to an absolute minimum.

Materials and chemicals used in EPCOS aluminum electrolytic capacitors are continuously adapted in compliance with the EPCOS Corporate Environmental Policy and the latest EU regulations and guidelines such as RoHS, REACH/SVHC, GADSL, and ELV.

MDS (Material Data Sheets) are available on the EPCOS website for all types listed in the data book. MDS for customer specific capacitors are available upon request.
MSDS (Material Safety Data Sheets) are available for all of our electrolytes upon request.

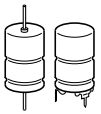
Nevertheless, the following rules should be observed when handling aluminum electrolytic capacitors: No electrolyte should come into contact with eyes or skin. If electrolyte does come into contact with the skin, wash the affected areas immediately with running water. If the eyes are affected, rinse them for 10 minutes with plenty of water. If symptoms persist, seek medical treatment. Avoid inhaling electrolyte vapor or mists. Workplaces and other affected areas should be well ventilated. Clothing that has been contaminated by electrolyte must be changed and rinsed in water.



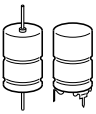
Product safety

The table below summarizes the safety instructions that must be observed without fail. A detailed description can be found in the relevant sections of chapter "General technical information".

Topic	Safety information	Reference chapter "General technical information"
Polarity	Make sure that polar capacitors are connected with the right polarity.	1 "Basic construction of aluminum electrolytic capacitors"
Reverse voltage	Voltages polarity classes should be prevented by connecting a diode.	3.1.6 "Reverse voltage"
Mounting position of screw-terminal capacitors	Do not mount the capacitor with the terminals (safety vent) upside down.	11.1. "Mounting positions of capacitors with screw terminals"
Robustness of terminals	The following maximum tightening torques must not be exceeded when connecting screw terminals: M5: 2.5 Nm M6: 4.0 Nm	11.3 "Mounting torques"
Mounting of single-ended capacitors	The internal structure of single-ended capacitors might be damaged if excessive force is applied to the lead wires. Avoid any compressive, tensile or flexural stress. Do not move the capacitor after soldering to PC board. Do not pick up the PC board by the soldered capacitor. Do not insert the capacitor on the PC board with a hole space different to the lead space specified.	11.4 "Mounting considerations for single-ended capacitors"
Soldering	Do not exceed the specified time or temperature limits during soldering.	11.5 "Soldering"
Soldering, cleaning agents	Do not allow halogenated hydrocarbons to come into contact with aluminum electrolytic capacitors.	11.6 "Cleaning agents"
Upper category temperature	Do not exceed the upper category temperature.	7.2 "Maximum permissible operating temperature"
Passive flammability	Avoid external energy, such as fire or electricity.	8.1 "Passive flammability"

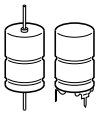


Topic	Safety information	Reference chapter "General technical information"
Active flammability	Avoid overload of the capacitors.	8.2 "Active flammability"
Maintenance	Make periodic inspections of the capacitors. Before the inspection, make sure that the power supply is turned off and carefully discharge the electricity of the capacitors. Do not apply any mechanical stress to the capacitor terminals.	10 "Maintenance"
Storage	Do not store capacitors at high temperatures or high humidity. Capacitors should be stored at +5 to +35 °C and a relative humidity of ≤ 75%.	7.3 Storage conditions
		Reference chapter "Capacitors with screw terminals"
Breakdown strength of insulating sleeves	Do not damage the insulating sleeve, especially when ring clips are used for mounting.	"Screw terminals – accessories"



Symbols and terms

Symbol	English	German
C	Capacitance	Kapazität
C_R	Rated capacitance	Nennkapazität
C_S	Series capacitance	Serienkapazität
$C_{S,T}$	Series capacitance at temperature T	Serienkapazität bei Temperatur T
C_f	Capacitance at frequency f	Kapazität bei Frequenz f
d	Case diameter, nominal dimension	Gehäusedurchmesser, Nennmaß
d_{max}	Maximum case diameter	Maximaler Gehäusedurchmesser
ESL	Self-inductance	Eigeninduktivität
ESR	Equivalent series resistance	Ersatzserienwiderstand
ESR_f	Equivalent series resistance at frequency f	Ersatzserienwiderstand bei Frequenz f
ESR_T	Equivalent series resistance at temperature T	Ersatzserienwiderstand bei Temperatur T
f	Frequency	Frequenz
I	Current	Strom
I_{AC}	Alternating current (ripple current)	Wechselstrom
$I_{AC,rms}$	Root-mean-square value of alternating current	Wechselstrom, Effektivwert
$I_{AC,f}$	Ripple current at frequency f	Wechselstrom bei Frequenz f
$I_{AC,max}$	Maximum permissible ripple current	Maximal zulässiger Wechselstrom
$I_{AC,R}$	Rated ripple current	Nennwechselstrom
$I_{AC,R}$ (B)	Rated ripple current for base cooling	Nennwechselstromstrom für Bodenkühlung
I_{leak}	Leakage current	Reststrom
$I_{leak,op}$	Operating leakage current	Betriebsreststrom
l	Case length, nominal dimension	Gehäuselänge, Nennmaß
l_{max}	Maximum case length (without terminals and mounting stud)	Maximale Gehäuselänge (ohne Anschlüsse und Gewindebolzen)
R	Resistance	Widerstand
R_{ins}	Insulation resistance	Isolationswiderstand
R_{symm}	Balancing resistance	Symmetrierwiderstand
T	Temperature	Temperatur
ΔT	Temperature difference	Temperaturdifferenz
T_A	Ambient temperature	Umgebungstemperatur
T_C	Case temperature	Gehäusetemperatur
T_B	Capacitor base temperature	Temperatur des Becherbodens
t	Time	Zeit
Δt	Period	Zeitraum
t_b	Service life (operating hours)	Brauchbarkeitsdauer (Betriebszeit)



Symbol	English	German
V	Voltage	Spannung
V_F	Forming voltage	Formierspannung
V_{op}	Operating voltage	Betriebsspannung
V_R	Rated voltage, DC voltage	Nennspannung, Gleichspannung
V_S	Surge voltage	Spitzenspannung
X_C	Capacitive reactance	Kapazitiver Blindwiderstand
X_L	Inductive reactance	Induktiver Blindwiderstand
Z	Impedance	Scheinwiderstand
Z_T	Impedance at temperature T	Scheinwiderstand bei Temperatur T
tan δ	Dissipation factor	Verlustfaktor
λ	Failure rate	Ausfallrate
ε_0	Absolute permittivity	Elektrische Feldkonstante
ε_r	Relative permittivity	Dielektrizitätszahl
ω	Angular velocity; $2 \cdot \pi \cdot f$	Kreisfrequenz; $2 \cdot \pi \cdot f$

Note

All dimensions are given in mm.

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