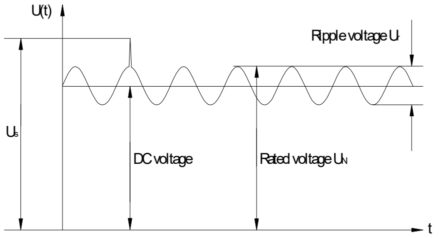
1. Technical Terms and Definitions

1.1 Rated Capacitance Cn
The rated capacitance measured at 20±5°C, 1 KHz .

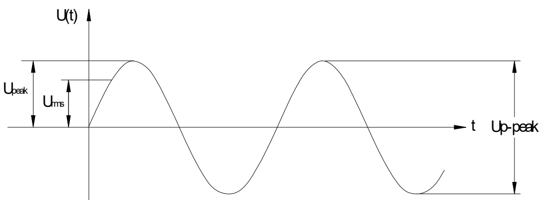
1.2 Rated Voltage Un
The maximum or peak voltage of either polarity of a reversing or non-reversing type wave form for which the capacitor has been designed and rated.



1.3 Non Repetitive Peak (non-recurrent surge) Voltage Us
Voltages beyond the rated voltage induced by switching or faults of the system or any part of it. Maximum count 1000 times with the duration of not more than 50 ms each.

1.4 Ripple Voltage Ur
The peak-to-peak alternating component of the unidirectional voltage

1.5 Rated A.C Voltage Urms
Root mean square of the max. permissible value of sinusoidal AC voltage in continuous operation



1.6 Rated A.C peak voltage Upeak
Rated A.C peak voltage, permissible A.C peak voltage in continuous operation.

1.7 Voltage Rise Time du/dt
This value shows the maximum voltage rise or fall time, it is expressed in volts per microsecond, and cannot overcome.

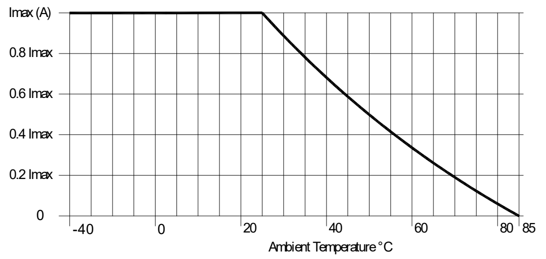
1.8 Maximum non-repetitive rate of voltage rise (du/dt)s
Peak rate of voltage rise that may occur non-repetitively and briefly in the event of a fault.

1.9 Voltage Test between terminals Ut-t
Routine test of all capacitors conducted at room temperature, prior to delivery. A further test with 80% of the test voltage stated in the data sheet may be carried out once at the user's location.

1.10 Voltage Test between terminals and case Ut-c
Routine test of all capacitors between short-circuited terminals and case, conducted at room temperature. May be repeated at the user's location.

1.11 Peak Current Ipeak
Maximum permitted repetitive current amplitude during continuous operation
Ipeak = Cn x (du/dt)

1.12 Maximum Current Imax
Maximum rms value of permissible current in continuous operation. The values given in the data sheets are related to either the specified maximum power dissipation or the current limits of the connection terminals



Irms vs ambient temperature

1.13 Non-repetitive Peak Current (surge) Is

Maximum current that may occur non-repetitively and briefly in the event of a fault. Maximum count 1000 times with the duration of not more than 50 ms each.

$$Is = Cn \times (du / dt)\ s$$

1.14 Equivalent Series Resistance ESR

Equivalent resistance representing the sum of all Ohmic resistances occurring inside the capacitor. Essential for calculation of the current dependent losses.

1.15 Self-inductance Ls

Represents the sum of all inductive elements which are, for mechanical and construction reasons, contained in any capacitor.

1.16 Insulation Resistance I.R.

The insulation resistance between terminals is expressed by meaning of the discharge time constant R.C. Measured for 1 minute at 100 Vdc and at 25±5°C. The time constant (s) of a capacitor is the product of IR and capacitance:

$$s = M\Omega \times \mu F$$

1.17 Resonant Frequency Fr

The capacitance and self-inductance of any capacitor form a series resonant circuit. Above the resonant frequency, the inductive part of this LC-circuit prevails. The capacitor would then behave as an inductor.

$$Fr = \frac{1}{2\pi\sqrt{Cn \times Ls}}$$

1.18 Dielectric Dissipation Factor tanδ0

Constant dissipation factor of the dielectric material for all capacitors in their rated frequency.

1.19 Dissipation Factor tanδ

Dissipation factor calculated as: $\tan\delta = \tan\delta_0 + 2 \times \pi \times f \times Cn \times ESR$

1.20 Thermal Resistance Rth

The thermal resistance indicates by how many degrees the capacitor temperature at the hotspot rises in relation to the dissipation losses.

1.21 Maximum Power Dissipation Pmax

Maximum permitted power dissipation for the capacitor’s operation.

$$Pmax = \frac{Ths - Te}{Rth}$$

1.22 Ambient Temperature Te

Temperature of the surrounding air, measured 10 cm away and at 2/3 of the case height of the capacitor.

1.23 Hotspot Temperature Ths

Temperature at hottest spot inside the capacitor

1.24 Lower Category Temperature Tmin

Lowest permissible ambient temperature at which a capacitor may be used.

1.25 Upper Category Temperature Tmax

Highest permissible capacitor temperature during operation, i.e. temperature at the hottest point of the case.

1.26 Rated Energy Contents Wn

Energy stored in the capacitor when charged at rated voltage.

$$Wn = 1/2 \times Cn \times (Un)^2$$

1.27 Clearance in air L

The shortest distance between conducting parts of the terminals or between terminals and case.

1.28 Creepage distance K

The shortest distance along an insulated surface between conducting parts of the terminals or between terminals and case.

1.29 Altitude

The maximum allowable altitude is 2000 meters. As the barometric pressure decreases, the terminal arc-over susceptibility increases. Heat cannot be properly dissipated operating at high altitude and can result in high losses and eventual failure.

1.30 Storing Temperature

The range over which the capacitor can be stored without any applied voltage, with no degradation is - 40 to + 85 ˚C.

1.31 Life Expectancy Le

Above all, the expected life of the capacitors depends on the internal temperature during operation, and the field strength in its dielectric.

Life expectancy versus voltage

$$Le = Ln \times (Un/Uw)^8$$

Le = Life expectancy at operating voltage (h)
Ln = Life expectancy at nominal voltage (h)
Un = Nominal voltage (v)
Uw = Operating voltage (v)

Life expectancy versus temperature

$$Le = LTo \times 2^{(To-Ths)/7}$$

Le = Life expectancy at operating temperature (h)
LTo= Life expectancy at 70˚C (h)
To = Reference temperature (70˚C)
Ths = Hot spot case temperature (≤ 70˚C)

2. Mounting and Operating Instructions

2.1 Overpressure Disconnector

When mounting capacitors with overpressure disconnectors, make sure that the elastic elements of the fuse are not impeded.

This means:

- The connecting leads must be sufficiently elastic.
- There must be enough space left for expansion above the terminals of aluminum-cased capacitors (stated for the individual type).
- The folded crimps must not be held by retaining clamps.
- The elastic bottom of capacitors in round steel cases must be free to move.

2.2 Mounting position

Capacitors can be mounted in any position except SMA series (Capacitors of SMA series can only be mounted upright, i.e. terminals on top). But the following exceptions to the rule are possible:

- Capacitors in aluminum cases with voltage ratings up to 3600 V and capacitors in rectangular steel cases may also be positioned horizontally.
- At higher voltages or for capacitors in round steel cases, horizontal positioning is also permissible. But consult the manufacturer first.

2.3 Mounting

The threaded bolt on the bottom of aluminum cases with a diameter of ≤60 mm and a height of ≤160 mm may be used for attachment if vibration stress does not exceed 5 g. For larger dimensions and vibration of > 5 g, the capacitors should be mounted by clamps, rings, etc.

Mounting with threaded bolt:

Threaded bolt	**Mounting hole**	**Maximum torque**
M10	12mm	6Nm
M12	16mm	8Nm

2.4 Terminals

For terminal bolt and nut tightening torques, refer to the individual datasheets.
The terminal torque must not act upon the ceramic. So the lead should be locked between two nuts.

Internal thread(female terminal)	**Maximum torque(N*m)**
M5*8	2.5
M6*8	4.5
M8*8	8.5

2.4.1 Minimum terminal connection cross-sections in accordance with VDE/DIN 0100 part 523 and 430,group 2.

For the electrical terminals on ceramic lead-throughs only flexible leads should be used so that these lead-throughs are guarded against mechanical stress.
The outer leads of the capacitor should be dimensioned so that no heat is conducted into the component. You are advised to scale these leads so that heat is conducted away from capacitor terminals.

2.5 Grounding

Either a threaded bolt or a strap serves for grounding to VDE 0100. Grounding is omitted for single-pole and fully insulated capacitors. The layer of varnish beneath the clamp should be removed when grounding with a metal clamp.

2.6 Safety precautions

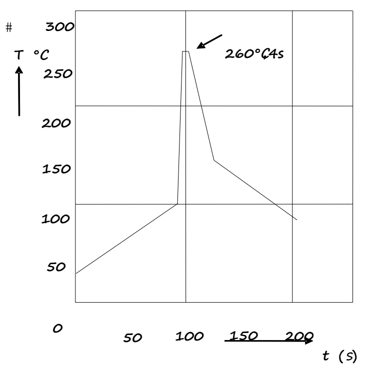
Observe appropriate safety precautions in use (self-recharging phenomena and the high energy contained in capacitors).

2.7 Solder conditions for radial and axial units on PCB

The soldering temperature must be set to keep the temperature inside the capacitors below the following general limits:
Solder bath temperature 260 ±5˚C, Soldering time 4s for radial units with leads pitch P>10mm.
When soldering the leads, make sure the capacitors are not damaged through excessive heat.

This means:

- Lead wires with a cross-section of > 1.5 mm^2 should not be soldered but clamped (soldering would require too much heat).
- Do not solder at spots where heat concentrates, otherwise there is a risk that the solder joint of the tags melts.



3 Application

3.1 Capacitor for a DC-Link application

The rated voltage of the capacitor must be equal to or bigger than the applied DC voltage plus ripple voltage:

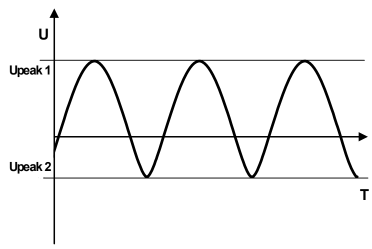
$$Un \geq Udc + Ur/2$$

According to the data sheets of values, you should find a capacitor with required capacitance Cn and voltage Un is recommended. You must also verify that the maximum r.m.s. current for continuous operation can be accepted by the capacitor: Imax depends on the terminal or specified on the sheets.

These capacitors may be subjected to the following surge voltages without any significant reduction in lifetime expectancy.

Repetitive surge voltage	Maximum duration voltage
1.1 × Un	30% of the service period
1.15 × Un	30 min/d
2.0 × Un	5 min/d
1.3 × Un	1 min/d
1.5 × Un	100 ms no more than 1000 times

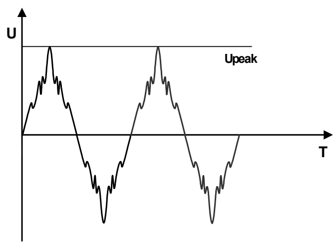
3.2 Capacitor for a AC application



The rated voltage of the capacitor must be equal to or bigger than the highter one on the two Upeak1 and Upeak2.
According to the data sheets of values, you should find a capacitor with required capacitance Cn and voltage Un is recommended. You must also verify that the maximum r.m.s. current for continuous operation can be accepted by the capacitor: Imax depends on the terminal or specified on the sheets.

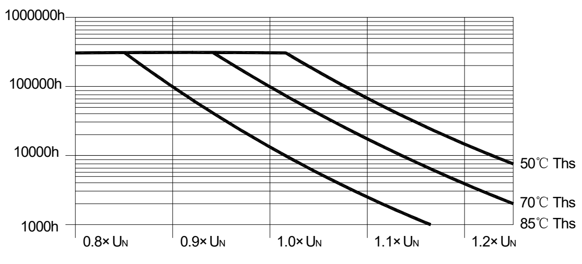
3.3 Capacitor for AC filter

For AC filter capacitors, the AC voltage rating Un AC is not determined by the rms value Urms, but by the peak value of the resulting voltage (as measured by an oscilloscope or calculated from available harmonic data).
In any case, the rated voltage must be bigger than the applied peak voltage.



3.4 Operating life

The operating life of the capacitors depends on the internal temperature during operation, and the field strength in its dielectric. The capacitors have been designed for an average service life of 100,000h (permitted failure rate 3%). These values are rated for the hotspot temperatures specified in the selection charts. The following diagram demonstrates the correlation between service life, temperature, and operating voltage.



Uw/Un vs Lifetime expectancy