



Dear Partner,

Let us introduce ourselves.

Itelcond has over 45 years of experience in the design and production of aluminium electrolytic capacitors.

Our production range covers any application where a high-quality capacitor is required. Our products are found in industrial products, such as UPS, inverter, solar, wind, e-mobility, automation, railways, welders, drives and medical.

An electrolytic capacitor represents many trade-offs in performance, price and lifetime. It is only through experienced understanding that the full benefits can be harnessed to deliver a long service life. At Itelcond, we have that experienced understanding along with state-of-the-art manufacturing facility using European sourced materials in order to specify and deliver a long-life product.

Please find the latest updates on our website.

www.itelcond.it

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Screw Terminal Series

| Series | Capacitance Range [μF] | Voltage range [V] | Temperature range [°C] | Case DxH [mm] | Expected lifetime [hrs] | Applications |
|-----------|---------------------------|----------------------|---|------------------|----------------------------|--|
| <u>AR</u> | 100 47.0000 | 40 – 450 | -40° + 85° Self-extinguishing construction and electrolyte | 35x56/76x145 | 5.000hrs | Industrial applications |
| <u>AY</u> | 1.000-100.0000 | 40 – 500 | -40° + 85° Self-extinguishing construction and electrolyte | 51x105/90x220 | 10.000hrs | High reliability Energy storage |
| <u>AD</u> | 2.200 – 22.000 | 350 – 450 | - 55°+ 85° | 51x80/90x220 | 10.000hrs | High Ripple High reliability Heavy transient Energy storage |
| <u>AP</u> | 1.000-15.000 | 350 – 500 | -40° + 85° Self-extinguishing construction and electrolyte | 64x105/90x220 | 12.000hrs | High Ripple Heavy transient Energy storage Solar and wind application |
| <u>AS</u> | 150-330.000 | 25 - 500 | -40° + 85° Self-extinguishing construction and electrolyte | 35x56/90x220 | 15.000hrs | Long life High reliability Telecom, Railways applications |
| <u>AF</u> | 1.000-15.000 | 350-500 | -40° + 85° | 64x105/90x220 | 20.000hrs | Extra Long life Energy storage Railways applications |
| <u>AZ</u> | 1.000-15.000 | 160-450 | -40°+ 105° | 51x105/90x220 | 5.000hrs | Wide temperature range Long life High reliability |
| <u>AT</u> | 100–10.000 | 350–450 | -55°+ 105° | 64x105/90x220 | 8.000hrs | Wide temperature range Very High reliability Very Long Life |

Solder Pin Series

| Series | Capacitance Range [μF] | Voltage range [V] | Temperature range [°C] | Case $\Phi \times H$ [mm] | Expected lifetime [hrs] | Applications |
|----------------|---------------------------|-------------------------|---|------------------------------|-------------------------------|---|
| <u>ARC/S</u> | 100-3.300 | 200 | -40° + 85° Self-extinguishing construction and electrolyte | 30x40/45x100 | 2.000 | Solder pin mounting Industrial application High reliability 2-4 pins configuration |
| <u>AKS</u> | 100- 47.000 | 40-450 | -40° + 85° Self-extinguishing construction and electrolyte | 30x40/40x100 | 5.000 | Solder pin mounting Industrial applications |
| <u>ACC ACS</u> | 150- 33.000 | 25 - 500 | -40° + 85° Self-extinguishing construction and electrolyte | 30x40/50x100 | 5.000 | Snap-in type, Industrial application High reliability 2-4 pins configuration |
| <u>AZK</u> | 100 – 2.200 | 200 450 | -40° +105° | 30x40/40x100 | 5.000 | Solder pin mounting Solar and wind application Energy Storage |
| <u>AZC AZS</u> | 100 – 4.700 | 200 450 | -40°+ 105° | 30x40/50x100 | 5.000 | Solder pin mounting Industrial applications |
| <u>ATC ATS</u> | 100 – 1.500 | 200 450 | -55°+ 105° | 30x40/50x100 | 8.000 | Very Long life Low ESR Solar and wind application |
| <u>ATK</u> | 100 – 2.200 | 160 450 | -55°+ 105° | 30x40/40x100 | 8.000 | Long life Low ESR Solar and wind application |



Construction

A capacitor is made up of 2 metal plates, separated by a dielectric. The surface areas of the metal plates, the dielectric and the gap between the plates all go towards determining the characteristic of the capacitor. See figure 1.

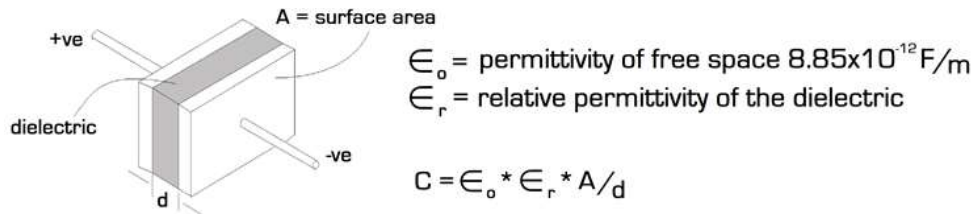


Figure 1

This is the theory. In practice, the metal plates are aluminium foil and the dielectric is an oxide layer on the anode. The cathode is a chemical soaked in paper with the cathode foil acting as a terminal plate. As can be seen in figure 2, the foils and papers are rolled into a cylinder to minimise volume. Interconnecting tabs connect the winding to the terminals mounted on the deck of the capacitor. The winding is fitted into an aluminium can. The interconnecting tabs are welded to the terminal pads on the underside of the terminal deck. The terminal deck is secured down and sealed to the can with a gasket.

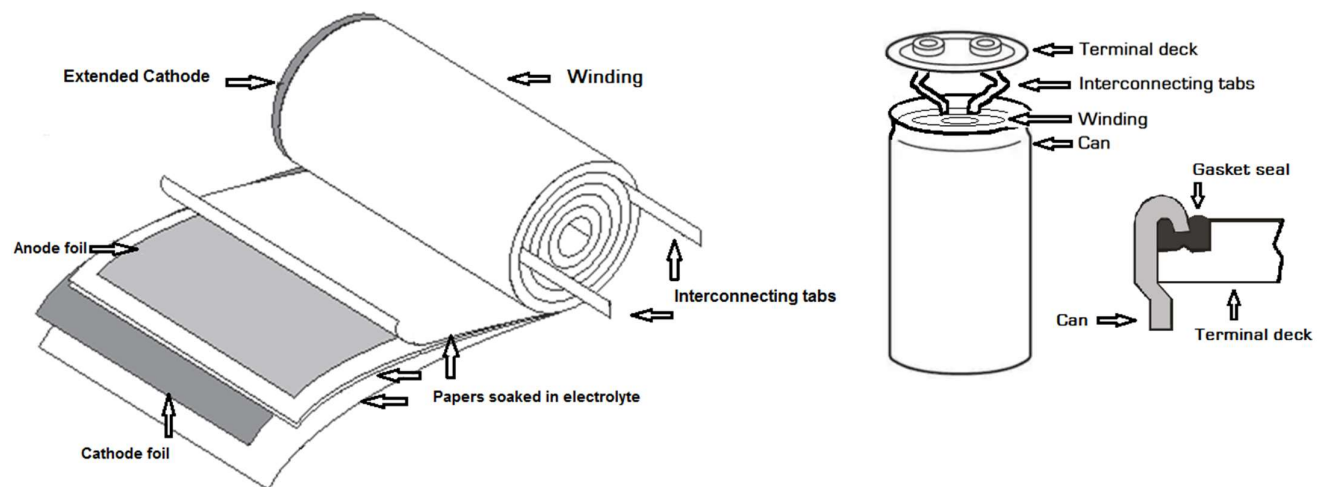


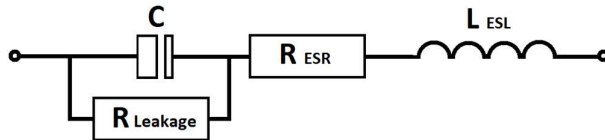
Figure 2



Electrical Characteristics

Capacitance

The DC equivalent circuit of an aluminium electrolytic capacitor is shown in Figure 3.



Where:

- R Leakage is DC leakage current I_L
- C is the capacitance
- R ESR is the equivalent series resistance
- L ESL is the equivalent series inductance

Figure 3

The capacitance of a capacitor is the number of Coulomb/Volt that a capacitor can store. This value is normally expressed in microfarads ($1\mu F = 10^{-6} F$) and the rated value is marked on the capacitor. The capacitance value depends on the ambient temperature in which the capacitor shall operate: the possible variations for every ITELCOND type are indicated in the graphs of individual data sheets: the largest deviations are at low temperature while at high temperature they are negligible.

It should be mentioned that the capacitance varies not only according to the temperature and frequency but even to the operational life of the capacitor: during the service life of the capacitor capacitance shows a regular decay determined by a series of simultaneous causes; such drift is less marked if the operational voltage decreases.

The percent values of capacitance drift for ITELCOND capacitors, after life tests of 2000/5000/10000hrs according to the type, are largely within the tolerance limits indicated in our catalogue and they are definitely lower than stated by DIN or CECC specifications.

Measurement shall be made at frequency of 100Hz and at a temperature of $25^\circ C \pm 2^\circ C$.

Equivalent Series Resistance (ESR)

The equivalent series resistance of a capacitor is the resistance seen by the alternating current and it is this $I^2 R$ that causes a capacitor to warm up. Figure 4 shows a set of ESR curves for a typical electrolytic capacitor.

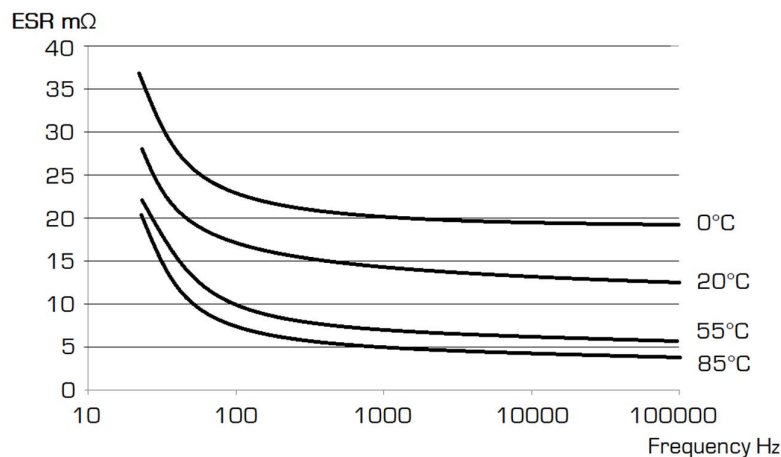


Figure 4



Dissipation Factor (DF)

Dissipation factor ($\tan\delta$) or DF is the ratio of the equivalent series resistance (ESR) to the capacitive reactance (X_c);

$$DF = \tan\delta = ESR/X_c$$

The capacitive reactance (X_c) can be expressed in terms of frequency (f) and capacitance (C):

$$X_c = 1/(2*\pi*f*C)$$

Combining the two equations expresses dissipation factor ($\tan\delta$) or DF in terms of frequency (f), capacitance (C) and equivalent series resistance (ESR): $DF = \tan\delta = 2*\pi*f*C*ESR$

Measurements are made at frequency of 100Hz and at a temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$

Equivalent Series Inductance (ESL)

Equivalent series inductance (ESL) is the inductance seen by the alternating current. Generally, the larger the physical size of a capacitor, the larger the ESL. ESL is made up of the physical aspects of the capacitor such as leads and terminals, are deemed parasitic inductances, and are not ideal, but they have to be taken into account as inductive reactance (X_l). The inductive reactance can be expressed in terms of frequency (f) and equivalent series inductance (ESL): $X_l = 2*\pi*f*ESL$

Impedance (Z)

Impedance (Z) is the total resistance to the alternating currents and includes both resistive and inductive components. The impedance of an electrolytic capacitor depends on the equivalent series resistance (ESR), the capacitive reactance (X_c) and inductive reactance (X_l):

$$Z = \sqrt{(ESR^2 + (X_c - X_l)^2)}$$

Self-Resonant Frequency (Fr)

When the inductive reactance (X_l) and the capacitive reactance (X_c) are equal the self-resonant frequency (F_r) of the capacitor is reached and can be expressed in terms of equivalent series inductance (ESL) and capacitance (C):

$F_r = 1/(2*\pi*\sqrt{ESL*C})$. Figure 5 shows the relationship between the equivalent series resistance (ESR), capacitive reactance (X_c), inductive reactance (X_l) and impedance (Z).

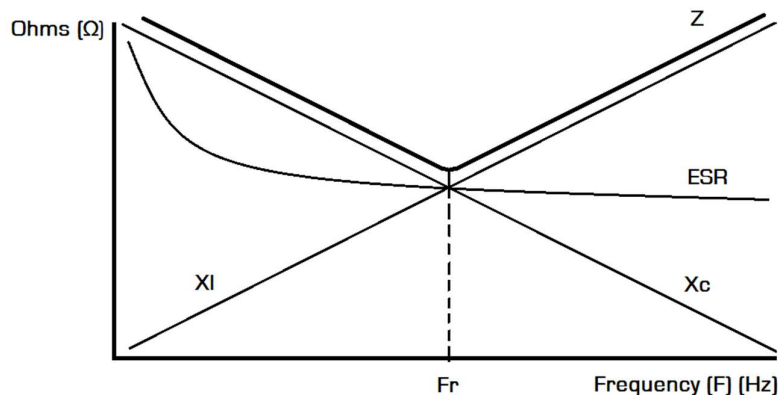


Figure 5



As can be seen from figure 5, the self-resonant frequency (F_p) is when the inductive reactance (X_L) and the capacitive reactance (X_C) are equal. At this point, the impedance (Z) and equivalent series resistance (ESR) converge. Below the self-resonant point (F_p) the capacitive reactance (X_C) is the strongest aspect and the capacitor performs like a capacitor. Above the self-resonant point (F_p) the inductive reactance (X_L) is the strongest aspect, and the capacitor performs like an inductor.

Voltage

The various voltage terminologies are shown in figure 6.

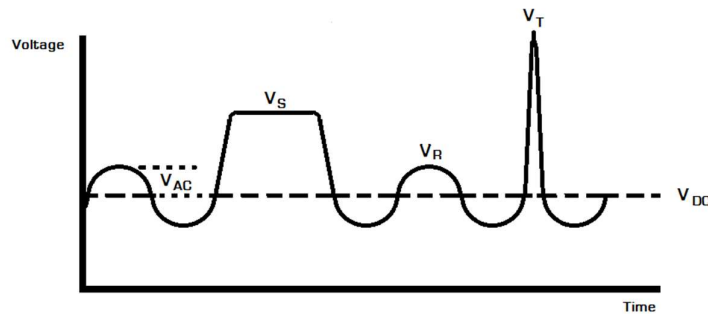


Figure 6

V_R is the rated voltage of the capacitor. The maximum peak voltage of any ripple voltage component must not exceed the rated voltage.

V_{DC} is the mean value of the applied DC voltage.

V_{AC} is the maximum superimposed ripple voltage.

V_S is the surge voltage. A surge voltage is caused by disturbances, such as switching and the values are stated for each capacitor range. The limitations are a maximum of 1000 random occurrences during the life of the capacitor with a load period of 30s and no load period of 330s. The RC time constant equals 0.1s.

V_T is the transient voltage. Transients are application specific and there are no stated values. However, a typical transient could have a rise time ranging from a few hundred μs to several ms. Contact Itelcond if your application involves transients.

Reverse voltage not exceeding 1.5 Volts may be applied to the capacitors without significant change in normal performance characteristics.

Leakage Current and Shelf Life

Figure 3 described the $R_{Leakage}$ component as the DC Leakage current I_L . Leakage current is the residual current that flows once a capacitor has been fully charged. During the manufacture of an electrolytic capacitor the leakage current is managed down to the level specified in the range data. Figure 7 shows this process. Leakage current is specified at 20°C temperature.



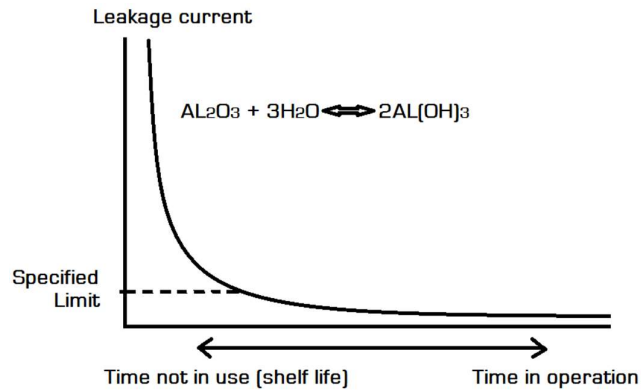


Figure 7

In operation, the leakage current will continue to gradually reduce and settle to a level somewhat less than the specified level. The time to settle will vary depending on the size of the capacitor but can typically take several hundred hours for a screw terminal capacitor.

Leakage Current Multipliers

The leakage current value of an aluminium electrolytic capacitor is influenced by ambient temperature and by ratio of working voltage to rated voltage. Figure 8 gives some indication of the multipliers that can be generally applied to each series.

| Tamb [°C] | AR-AY-AKS-ACC-ACS | AS | AP | AZ | AT |
|-----------|-------------------|------|------|-----|-----|
| 25 | 1 | 1 | 1 | 1 | 1 |
| 35 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| 45 | 1.4 | 1.4 | 1.2 | 1.4 | 1.4 |
| 55 | 1.8 | 1.8 | 1.6 | 1.8 | 1.8 |
| 65 | 2.5 | 2.4 | 2.2 | 2.4 | 2.4 |
| 75 | 3.5 | 3.0 | 2.8 | 3.0 | 3.0 |
| 85 | 5.0 | 4.0 | 3.9 | 4.5 | 4.5 |
| 95 | N.A. | N.A. | N.A. | 6.8 | 6.2 |
| 105 | N.A. | N.A. | N.A. | 9.0 | 8.3 |

Figure 8

Leakage current decrease Vs. Voltage derating

If the voltage applied to the capacitor is lower than the rated voltage, the leakage current decreases accordingly and the approximate reduction factor is shown in Figure 9

| Vapplied/Vrated | 1 | 0,9 | 0,8 | 0,7 | 0,6 | 0,5 | 0,4 |
|-----------------|---|------|------|------|------|------|------|
| Multiplier | 1 | 0,75 | 0,70 | 0,55 | 0,45 | 0,30 | 0,20 |

Figure 9



Shelf life

Shelf life is where the electrolytic capacitor is stored dormant, either within equipment, or individually. Time, humidity and temperature will have an effect on a dormant capacitor where the leakage current will slowly increase over time without voltage present. A reversal of the aging process will occur as a chemical change will occur. As such, re-aging will be required before use. For how long you can leave a capacitor on the shelf at what temperature is shown in figure 10.

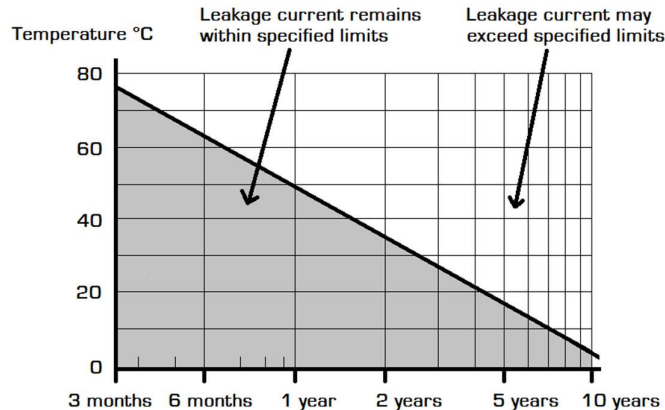


Figure 10

In a typical warehouse, the shelf life should be a minimum of 2 years. Beyond this, the leakage current may exceed the limits. If re-aging is required then this needs to be completed at room temperature. Connect a voltage supply equal to the rated voltage, but current limited to a value equal to the specified leakage limit of the capacitor. Anything from 1 to 4 hours may be required to re-age depending on the initial condition. Care should be taken when re-aging with high voltages.

Voltage Deration

Voltage deration is the operation of an electrolytic capacitor below its rated voltage. This may occur through personal choice based on 'best practise' or through mandated requirements of the end market. How voltage deration works is shown in Figure 11.

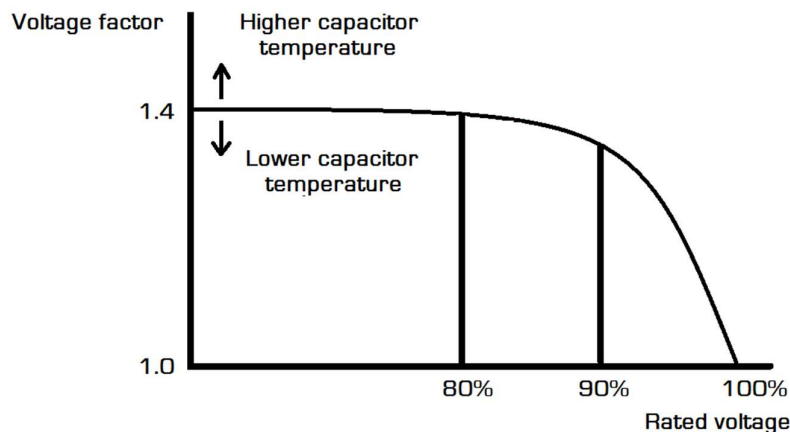


Figure 11

From the figure 11, you can see that you do not gain any further benefit from derating the capacitor below 80% of the rated voltage. Voltage factor has more effect at higher capacitor temperatures and is a parameter that is included in an expected life calculation. The 1.4 value represents a 40% increase in expected life.



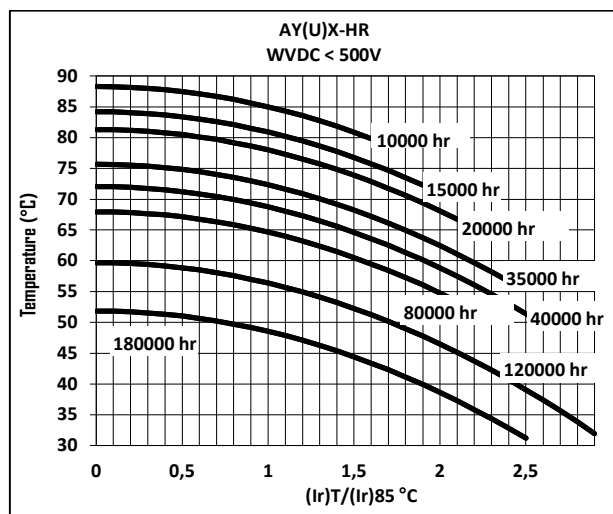
Useful Life Calculation

The useful life of a capacitor is calculated in accordance with the tables of expected life per each series. The rated ripple current at upper category is listed in the data sheets, while the ripple current at different temperature can be calculated using the tables shown on each series.

To know the useful life proceed as follows:

- calculate the ratio $(I_R) / (I_{R85^\circ C})$ or $(I_R) / (I_{105^\circ C})$
- find on to the table the crossing between the working temperature and the calculated ratio
- on top of the table it appears the useful life in hours

The example does not consider the frequency dependence of ripple current: the corresponding factor listed on each type must be used as an additional factor.



Example 1:

- Capacitor AY(U)X-HR472M350DF1
- Working conditions: $I_{Ripple} = 25A@100Hz$
- Ambient temperature = $70^\circ C$

VN=350V

| Capacitance | Case | Tan δ | ESRmax/typ | | Zmax | Iripple55°C/85°C | | Ordering Code |
|-------------------|------|--------------|---------------------|----|---------------------|------------------|-----------|-----------------------|
| [μF]@100Hz | | [%]@100Hz | [m Ω]@100Hz | | [m Ω]@10KHz | [A]@100Hz | [A]@100Hz | (U) for mounting stud |
| 4700 | DF | 0,08 | 27 | 22 | 20 | 22,8 | 16,3 | AF(U)X-HR472M350DF1 |

$$1. \frac{I_{Ripple}}{I_{Ripple@85^\circ C}} = \frac{25}{16,3} = 1,53$$

a. Crossing 1,53 and $T=70^\circ C$ expected life is about 30.000 hours

Example 2:

- Capacitor AY(U)X-HR472M350DF1
- Working conditions: $I_{Ripple} = 25A@500Hz$
- Ambient temperature = $70^\circ C$

VN=350V



| Capacitance | Case | Tan δ | ESRmax/typ | | Zmax | Iripple55°C/85°C | | Ordering Code |
|------------------|------|--------------|---------------------|----|---------------------|------------------|-----------|-----------------------|
| [μ F]@100Hz | | [%]@100Hz | [m Ω]@100Hz | | [m Ω]@10KHz | [A]@100Hz | [A]@100Hz | (U) for mounting stud |
| 4700 | DF | 0,08 | 27 | 22 | 20 | 24,5 | 16,3 | AF(U)X-HR472M350DF1 |
| | | | | | | | | |

$$1. I_{Ripple} = \frac{25}{1,32} = 18,9$$

$$2. \frac{I_{Ripple}}{I_{Ripple@85^{\circ}C}} = \frac{18,9}{16,3} = 1,16$$

a. Crossing 1,16 and T = 70 °C expected life is about 36000 hours

Example 3:

- Capacitor AY(U)X-HR472M350DF1
- Working conditions: IRipple = 25A@500Hz
- Ambient temperature = 60°C

VN=350V

| Capacitance | Case | Tan δ | ESRmax/typ | | Zmax | Iripple55°C/85°C | | Ordering Code |
|------------------|------|--------------|---------------------|----|---------------------|------------------|-----------|-----------------------|
| [μ F]@100Hz | | [%]@100Hz | [m Ω]@100Hz | | [m Ω]@10KHz | [A]@100Hz | [A]@100Hz | (U) for mounting stud |
| 4700 | DF | 0,08 | 27 | 20 | 17 | 23,9 | 17,1 | AY(U)X-HR472M350DF1 |
| | | | | | | | | |

$$3. I_{Ripple} = \frac{25}{1,32} = 18,9$$

$$4. \frac{I_{Ripple}}{I_{Ripple@85^{\circ}C}} = \frac{18,9}{16,3} = 1,16$$

a. Crossing 1,10 and T = 60 °C expected life is about 120000 hours



Waveforms

All of the above examples assume a sine wave ripple current profile. Variations to a sine wave are shown in figure 12 along with the formula to calculate the equivalent sine wave ripple current.

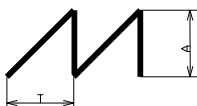
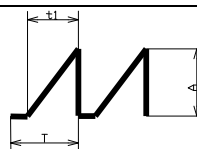
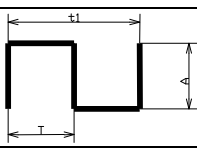
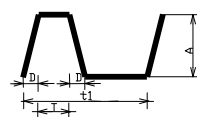
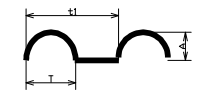
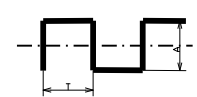
| Waveform | r.m.s. value | Waveform | r.m.s. value |
|---|---|--|---|
|  | $A \cdot \sqrt{\frac{T}{3}}$ |  | $A \cdot \sqrt{\frac{t1}{(3 \cdot T)}}$ |
|  | $A \cdot \sqrt{\frac{T}{t1}}$ |  | $A \cdot \sqrt{\frac{(2 \cdot D + 3 \cdot T)}{(t1)}}$ |
|  | $A \cdot \sqrt{\frac{T}{(2 \cdot t1)}}$ |  | A |

Figure 12

Capacitors in Series – Balancing Resistors

When aluminium electrolytic capacitors are connected as a bank of capacitors where there are multiple parallel branches of series capacitors, the need for balancing resistors is diminished due to the averaging effect of the number of capacitors where individual leakage current values become less critical. However, in the case of just two capacitors connected in series it is advisable to use balancing resistors in order to control the voltage sharing across each device due to imbalances in individual capacitor leakage currents. Figure 13 shows two capacitors in series along with balancing resistors.

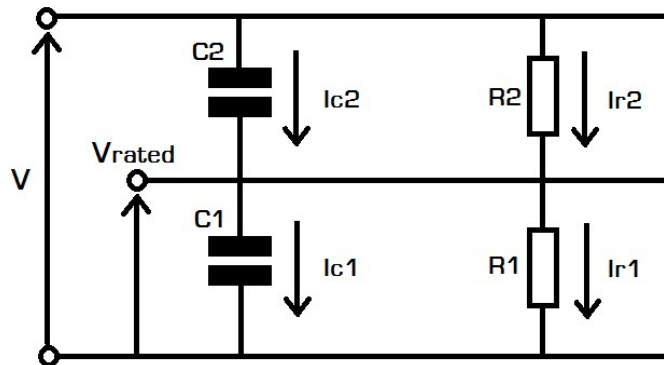


Figure 13

Trying to calculate individual leakage current values is impractical in a production environment and so an estimation based on experience can be made in order to calculate the differences in leakage currents between two capacitors in series. In figure 12 the individual leakage currents are I_{c1} and I_{c2} .

The estimation for the leakage current difference between I_{c1} and I_{c2} is:

$$\text{Difference, mA} = (0.0015 \cdot C \cdot V) / 2000$$





where C is the value of the individual capacitors in μF and V is the voltage across both capacitors in series.

Next, to calculate the value for balancing resistors, the equation is:

$$R \Omega = ((2 * V_{\text{rated}}) - V) / I_{\text{difference}}$$

where V_{rated} is the individual capacitor rated voltage and V is the voltage across both capacitors in series.

Next to calculate the power rating of the resistors, we firstly require the current through the balancing resistor and then the power. The current through the balancing resistor is:

$$I, \text{mA} = (V/2)/R$$

where V is the voltage across both capacitors in series and R is the value of a balancing resistor.

The power, P, $W = I^2 R$.

Example: $V = 940\text{v}$, $V_{\text{rated}} = 500\text{v}$, $C = 1800\mu\text{F}$

$I_{\text{difference}} = 2.538\text{mA}$

$R = 23.64\text{k} \Omega$

$I = 19.881\text{mA} = 0.019881\text{A}$

$P = 9.34\text{W}$

Altitude

Itelcond electrolytic capacitors can be operated at altitude or in a vacuum. The safety vents in electrolytic capacitors will operate at approximately 110 psi/760kPa/7.5bar. At altitude in a vacuum, these values will be reduced by 14.7psi/101kPa/1bar. So, at altitude, the capacitor must be operated in a less demanding arrangement.

Another factor is that there will be no natural convection to carry heat away in a vacuum. As such, there must be further derating of the demands on the capacitor.



Terminals

Screw Terminal

The terminals on a screw terminal capacitor are 99.9% aluminium. The layout is shown in figure 14.

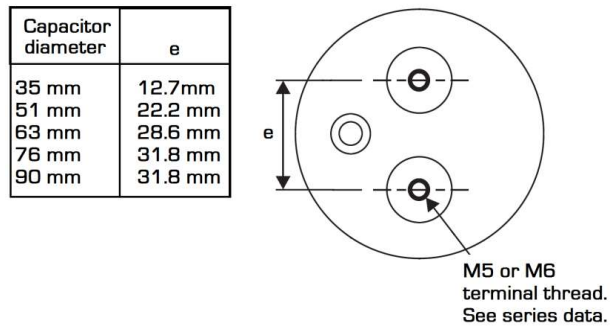


Figure 14

Snap in and DIN pin

The terminals on a snap-in or DIN pin capacitor are base steel, flashed with copper, then plated in tin. So the terminal finish is tin.

Snap in pin layout is shown in figure 15.

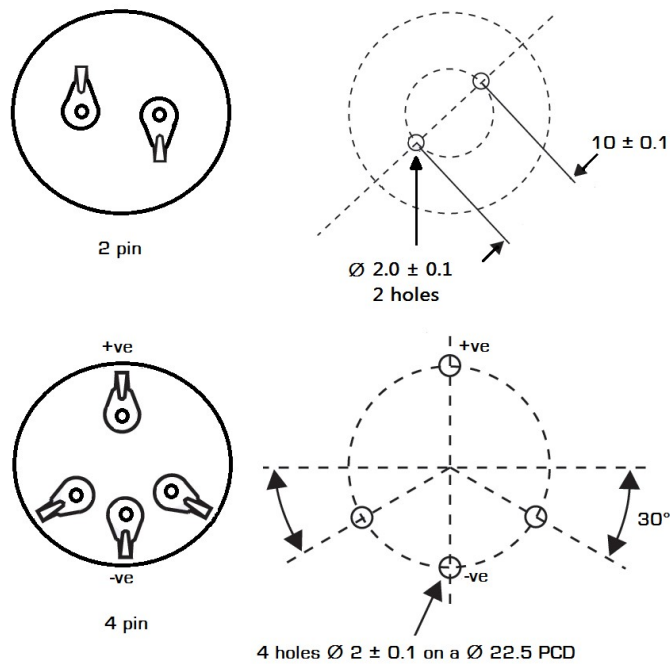


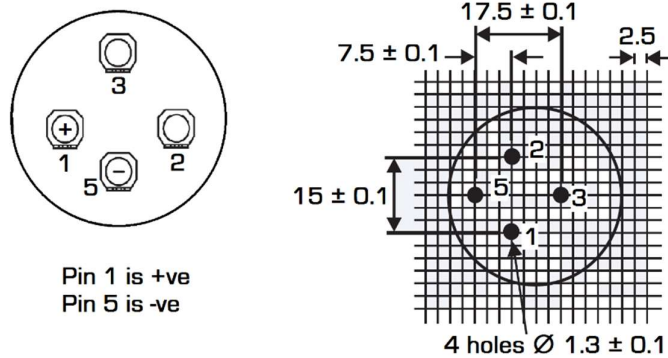
Figure 15



With a 4 pins snap in, two of the pins are unassigned. They are intended for mechanical stability. It is recommended that they are soldered to the printed circuit board. These unassigned pins are at the negative potential but they must not be used in place of the negative connection. As such they should be connected to the same potential as the negative pin or left electrically isolated.

DIN pin layout is shown in figure 16.

35mm diameter 4 pins



40mm and 45mm diameter 5 pins

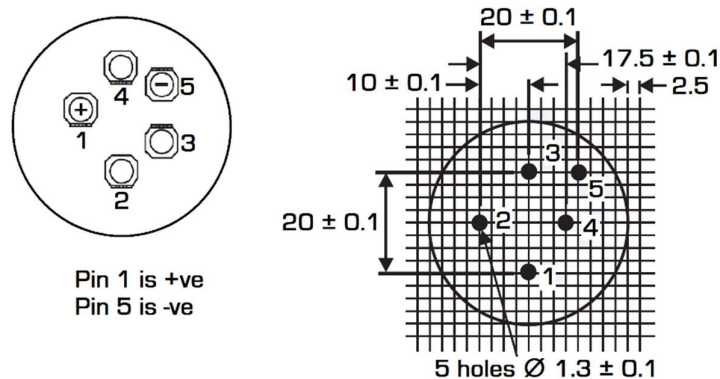


Figure 16

With the DIN pin layout, pin 1 is the positive connection and pins 5 is the negative connection. The spare pins are unassigned. They are intended for mechanical stability. It is recommended that they are soldered to the printed circuit board. These unassigned pins are at the negative potential but they must not be used in place of the negative connection. As such they should be connected to the same potential as the negative pin or left electrically isolated.

IEC – Climatic Category

The permissible climatic stress on an aluminium electrolytic capacitor is given by the respective IEC climatic category. Following IEC 60068-1, the climatic category is composed by 3 groups of numbers, separated by slashes.

Example 40/85/56.



1st group: Lower category temperature (temperature limit) denoting the test temperature for test A (cold) to IEC 60068-2-1

2nd group: Upper category temperature (temperature limit) denoting the test temperature for test B (dry heat) to IEC 60068-2-2

3rd group: Number of days, the duration of test C (damp heat, steady state) at a relative humidity of 93 +2/-3% and an ambient temperature of 40°C, to IEC 60068-2-78.

Reliability

Given an operating condition and expected life, the reliability of an Itelcond capacitor can be defined as the probability that it will operate correctly. The expected life is the period of time in which a capacitor reaches the maximum accepted values of modification of its electrical parameters.

Naturally it is impossible to predict exactly when a capacitor will fail and so probability theory is used. To forecast the probability that a capacitor will operate correctly, MIL-STD-690 specifications with a "confidence level" of 60% is utilised. Reliability is linked to capacitor temperature, applied voltage and time in use.

Reliability as a function of time, Rel (time), is normally expressed as $Rel (time) = e^{-\lambda t}$ where Rel (time) is the probability that the capacitor will work correctly and λ is the failure rate.

The failure rate of many electronic components follows a characteristic 'bath tub' pattern as shown in figure 17.

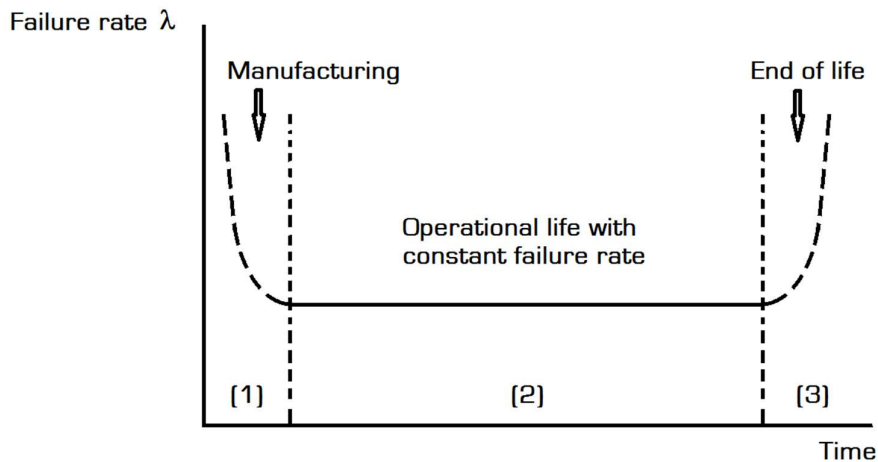


Figure 17

(1) is the period during manufacturing.

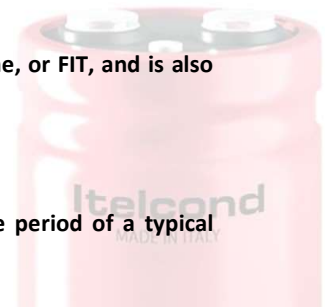
(2) is the operational life, where the failure rate is invariably constant.

(3) is where the end of life has been reached. The failure rate will rapidly increase.

The failure rate, λ , is defined as 1×10^{-9} failures per hour, and is also known as Failure in Time, or FIT, and is also expressed as a percentage of failures per 1000 hours.

For example, $10FIT = 1 \times 10^{-8}$ failures per hour = 0.01%/1000 hours.

Years of experience have shown that values could be considered, during the intrinsic failure period of a typical bathtub statistical curve. The values of FIT are typical at 60°C.



| ITELCOND series | Voltage | FIT | ITELCOND series | Voltage | FIT |
|-----------------|--------------|-----|-----------------|--------------|-----|
| AR,AY | <150 Vdc | 40 | AZK | <150 Vdc | 50 |
| | ≥150 Vdc | 70 | | ≥150 Vdc | 80 |
| AS | <150 Vdc | 45 | ATK | <150 Vdc | 40 |
| | ≥150 Vdc | 45 | | ≥150 Vdc | 70 |
| AP | ALL VOLTAGES | 45 | ACC | ALL VOLTAGES | 50 |
| AF | ALL VOLTAGES | 45 | AZC | <150 Vdc | 50 |
| AT | ALL VOLTAGES | 20 | | ≥150 Vdc | 80 |
| | | | ATC | <150 Vdc | 40 |
| AKS | <150 Vdc | 50 | | ≥150 Vdc | 70 |

Figure 18

Figure 19 shows a typical FIT vs temperature graph.

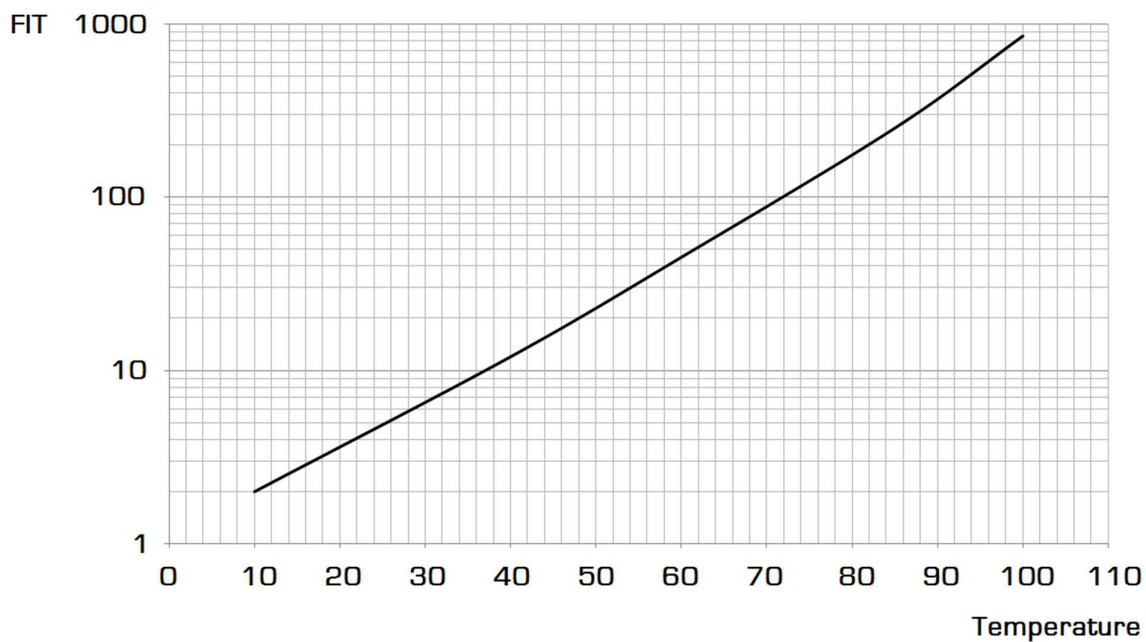


Figure 19

Applied voltage in relation to the capacitor rated voltage also has an effect on reliability. Figure 20 shows the effect of having the applied voltage less than the rated voltage as a percentage.



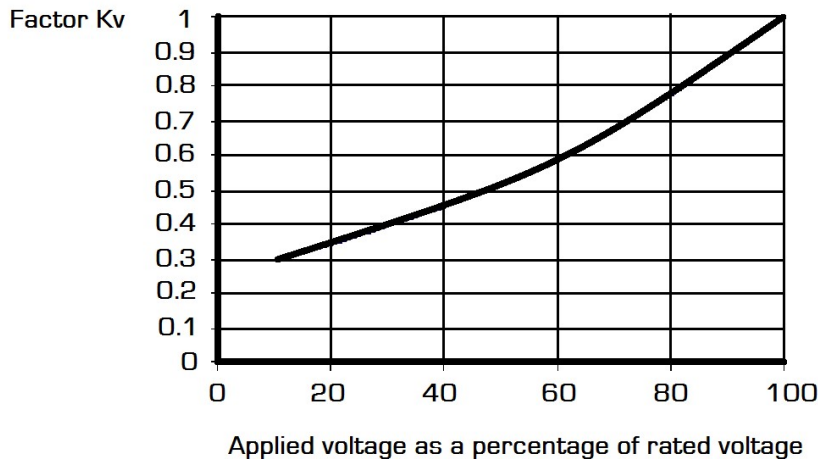


Figure 20

The failure rate during the operational life, λ_{op} , is the FIT value from figure 17 multiplied by the Kv value from figure 20:

$$\lambda_{op} = \text{FIT} \times K_v$$

The mean time before failures (MTBF) is the inverse of the failure rate: $\text{MTBF} = 1 / \lambda_{op}$

Vibration Test

Screw Terminals

To IEC 60068-1:

Frequency range 10 Hz / 55 Hz, displacement amplitude 0.75 mm, acceleration max 10 g, duration 3 x 2h.

Capacitor mounted by its body which is rigidly clamped to the work surface.

Solder pins

To IEC 60068-2-6, test Fc:

Frequency range 10 Hz / 55 Hz, displacement amplitude 0.35 mm, acceleration max 5 g, duration 3 x 2 h.

Capacitor mounted by its body which is rigidly clamped to the work surface.

Sealing Test

The capacitors shall be tested for seal tightness in accordance with IEC 68-2-17.

Insulation Strength

-Insulation resistance @100V, 60°C between terminals and mounting hardware >100 MΩ.

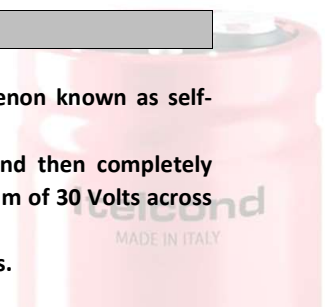
-Dielectric strength of the sleeve >2500Vdc.

Self-recharging (Dielectric Absorption)

It is important to take note that Aluminium Electrolytic Capacitors undergo to the phenomenon known as self-recharging or dielectric absorption.

It is a phenomenon that is impossible to predict. A capacitor, which has been charged and then completely discharged, may appear to re-charge itself, if left open circuit. Itelcond has observed a maximum of 30 Volts across the terminals but sometimes the value could be higher.

It is therefore suggested to discharge the capacitors before touching or connecting the terminals.



Cleaning Agents

Halogenated solvents are not recommended for use in cleaning capacitors, while many solvents such as alcohol are suitable. It must be remembered that many solvents given, as chemically stable in the most varied conditions may on the contrary be electrochemically dissociated, producing chemical products extremely dangerous to the capacitor life. The following list contains critical halogenated solvents (unsafe) used as cleaning agents in electrical industry:

Trichloroethane (ex. Chlorotene)

- Freon
- Trichloroethylene
- Tetrachloroethylene
- Chloroform
- Methylene chloride
- Methyl ethyl Ketone
- Acetone

In case of wetting capacitors with those solvents, a safe cleaning agent must be used to eliminate residues of non-safe agents.

List of solvents without halogen (safe):

Methanol

Propanol

Isobutanol

Electrolytes

Electrolytes used in aluminium capacitors manufacturing are produced in accordance with Itelcond internal specifications.

Since its foundation ITELCOND has never used in its electrolytes formulations that are dangerous or potentially poisonous chemicals. So all electrolytes are free from:

Dimethylformamide (DMF)

Dimethylacetamide (DMAC)

Polychlorinated biphenyl (PCB)

Materials

The aluminium electrolytic capacitors manufactured by Itelcond comply with:

Directive 2002/95/EC -January 2003

Directive 2003/11/EC –February 2003

Amendment of Directive 2002/95/EC -August 2005

Directive 2006/122/EC -December 2006

Itelcond certifies that during designing and manufacturing of aluminium electrolytic capacitors there is no :

Asbestos

Lead (Pb)

Polychlorinated Triphenyl (PCT)

Polybrominated Biphenyl (PBB)

Mercury (Hg),

Dimethylacetamide (DMAC)



Dimethylformamide (DMF)
 Polychlorinated Biphenyl (PCB)
 Polybrominated Diphenyl (PBD)
 Chromium VI (Cr^{VI})
 Polybrominated Diphenyl Ethers (PBDE)
 PentaBDE / OctaBDE / DecaBDE

Materials currently listed as carcinogenic / mutagenic / teratogenic are not intentionally added or used.
 Itelcond has written assurance from suppliers that they do not use the above chemicals or substances in the manufacture of materials Itelcond are currently employs to produce its own capacitors.

Non Flammable Materials

ITELCOND capacitors are manufactured with raw materials that meet UL specifications. This is shown in figures 21 and 22.

Raw Materials for Screw Terminal

| Component | Material | UL rating |
|------------------------|---------------|-----------|
| Cover / deck | Thermosetting | V0 |
| Plastic sleeve | PVC | V0 |
| Bottom insulating disk | PVC | V0 |
| Plastic washers | Thermoplastic | V0 |
| Hex nut | Thermoplastic | V0 |

Figure 21

Raw Materials for Solder Pin Types

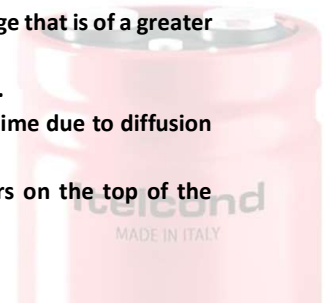
| Component | Material | UL rating |
|------------------------|-----------------|-----------|
| Cover | Rubber-Bakelite | HB |
| Plastic sleeve | PVC | V0 |
| Bottom insulating disk | PVC | V0 |

Figure 22

Precautions

When using aluminium electrolytic capacitors a number of precautions must be taken:

- Operating temperature, ripple current and working voltage must be within the specified limits.
- Do not exceed 1.5V reverse voltage.
- Do not apply an AC only voltage. Any AC voltage must be superimposed onto a DC voltage that is of a greater value than the AC voltage swing, so to avoid any reverse voltage conditions.
- The DC voltage plus AC component cannot exceed the working voltage of the capacitor.
- Capacitors used in areas where harmful gases are present may undergo a reduced lifetime due to diffusion through the sealing gasket into the inside of the capacitor, causing damage.
- When a capacitor is used in a highly dusty area check that the level of dust powders on the top of the capacitor does not reach the terminals to avoid possible short circuit.
- Moisture or salt spray can penetrate into the capacitor and cause short circuit.





- When mounting snap in capacitor with a solder iron, the hot tip cannot come into contact with the can, deck or insulating sleeve.
 - When units are mounted in series – parallel combinations use homogeneous date codes.
 - Take care when handling capacitors. Any physical damage could render the capacitor bad and it should not be used,
 - Capacitors should not be stored under direct sun light.
 - Be aware of the risk posed by dielectric absorption.
 - When a capacitor is operated at a low voltage for a prolonged time and is then operated at a higher voltage an increase in temperature must be expected.
 - When a snap in capacitor is fixed to the printed circuit board by means of a fixing material be sure that the fixing compound does not contain chloride or chemicals that can deliver chlorine.
 - Cleaning the printed circuit board must be achieved with non-hazardous chemicals.
-
- A hazardous voltage, especially on very high capacitance units, is present for up to 60 minutes after removal of power.
 - Do not use capacitors having a standard design in circuits where the charge and discharge cycles have a high repetition rate; specific capacitors can be designed for this application.
 - When the safety vent operates a gas at high temperature is emitted: the gas may contain electrolyte that could damage the printed circuit board or connecting bars if not properly insulated from chemical attack.
 - When a capacitor in bank fails replace all the capacitors: do not replace the failed capacitor only.

Marking

ITELCOND capacitors shall be marked as shown in figure 23.

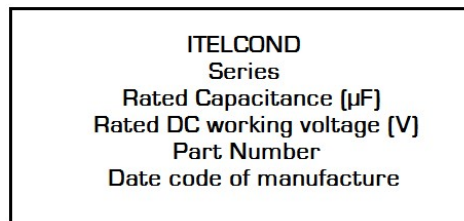
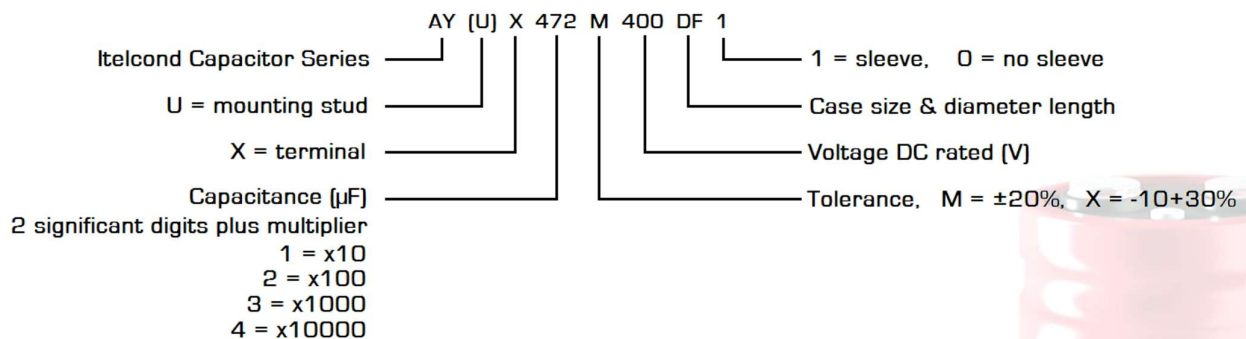


Figure 23

Capacitor Ordering Code



Packaging

Units are packed in carton boxes and the number of units per box is shown in figure 24. Carton boxes for larger shipments are packed onto Euro dimensioned wooden pallets (plastic on request).

| Series | Diameter | Length | Pcs/Box | Weight/Box [kg] |
|----------------|-----------|---------|---------|-----------------|
| Screw terminal | A 35mm | A=55mm | 50/100 | 4-7 |
| | | B=80mm | 50 | 4-6 |
| | | C=105mm | 50 | 6-8 |
| | B 51mm | B=80mm | 30 | 5-7 |
| | | C=105mm | 30 | 6-9 |
| | C 63mm | C=105mm | 20 | 6-8 |
| | | F=145mm | 20 | 9-10 |
| | D 76mm | C=105mm | 12 | 5-7 |
| | | F=145mm | 12 | 6-14 |
| | | K=165mm | 12 | 6-14 |
| | | J=222mm | 8 | 9-11 |
| | E 90mm | C=105mm | 6 | 7-9 |
| | | F=145mm | 6 | 9-11 |
| | | J=222mm | 6 | 8-12 |
| | | L=240mm | 6 | 9-13 |

| Series | Diameter | Length | Pcs/Box | Weight/Box [kg] |
|-------------|-----------|---------|---------|-----------------|
| Solder pins | M 30mm | B=40mm | 254 | 6-15 |
| | | C=50mm | 254 | 6-15 |
| | | | | |
| | N 35mm | B=40mm | 100 | 6-8 |
| | | C=50mm | 100 | 6-8 |
| | | N=60mm | 100 | 5-7 |
| | | E=75mm | 50 | 6-8 |
| | P 40mm | B=40 mm | 126 | 9-10 |
| | | C=50mm | 126 | 9-10 |
| | | E=75mm | 63 | 10-11 |
| | | G=100mm | 63 | 10-11 |
| | Q 45mm | C=50mm | 96 | 18-21 |
| | | N=60mm | 48 | 16-20 |
| | | E=75mm | 48 | 13-18 |
| | | G=100mm | 48 | 16-20 |
| | | H=105mm | 48 | 16-20 |
| | R 50mm | E=75mm | 48 | 13-18 |
| | | H=105mm | 48 | 16-20 |

Figure 24

The shown weight values depend on the type of unit packed into the box: the weight of capacitors is a function of the capacitance value of the capacitor (e.g. into the same can size a capacitor having a capacitance of 2200 μF differs substantially from one having a capacitance of 10.000 μF .).



Mounting Hardware

MOUNTING HARDWARE

CLIP Ring – for flat base

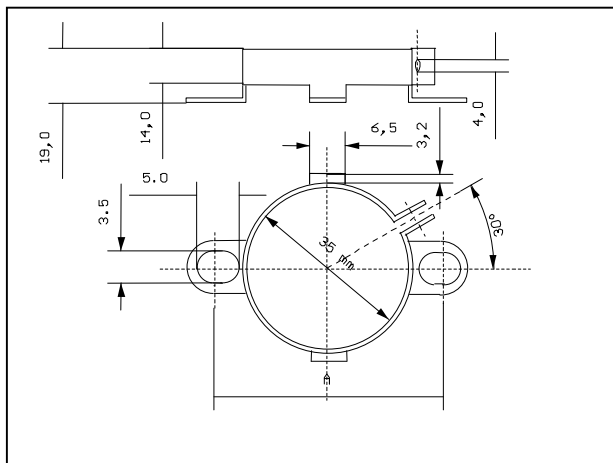


Figure 1

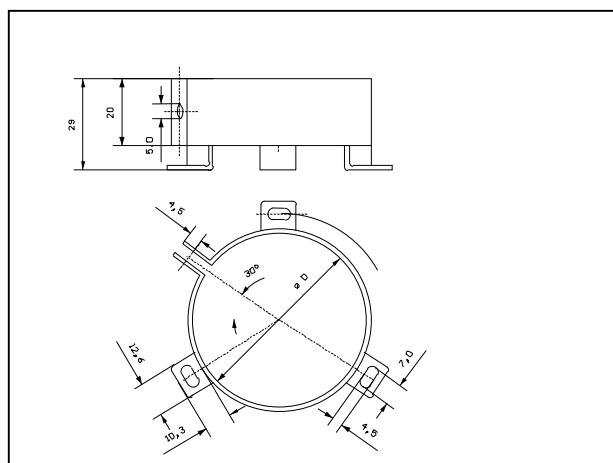


Figure 2

| Ring clip code | D | A |
|----------------|----|------|
| ZAF - A | 35 | 46 |
| ZAF - B | 51 | 63,5 |
| ZAF - C | 63 | 76 |
| ZAF - D | 76 | 89 |
| ZAF - E | 90 | 106 |



MOUNTING HARDWARE

Metal or Plastic - nuts and washers

SCREW

INSULATED WASHERS

| A | C |
|----|----|
| 8 | 25 |
| 12 | 35 |

| A | B | C |
|----|----|----|
| 8 | 18 | 25 |
| 12 | 18 | 35 |

METAL NUTS

| P/N | Th | A | Ch |
|------|-----|----|----|
| 1121 | M8 | 18 | 17 |
| 1277 | M12 | 18 | 19 |

PLASTIC HEX NUTS (ON REQUEST)

| P/N | Th | B | D | H | Ch |
|------|-----|------|----|----|----|
| 1210 | M8 | 18 | 25 | 15 | 17 |
| 1126 | M12 | 18 | 30 | 20 | 19 |
| 1502 | M12 | 22,5 | 30 | 18 | 19 |
| 1508 | M12 | 30 | 38 | 18 | 19 |



Terms and Conditions

1. The general conditions presently in force are applicable to all purchases effected by the Client (Buyer) from Itelcond S.r.l. (Seller). These general conditions must not be exceeded, modified, deferred or, in any other way, altered, except if an official document is underwritten and signed by the Seller. Under no circumstances the general conditions adopted by the Buyer, printed on his purchase orders or any other document, will be deemed applicable to none of the purchase orders placed with the Seller. The execution, also partial, of the Buyer's order, or any other fulfilment from the Seller's side towards the Buyer, will not be valid and therefore not interpreted as tacit or implicit acceptance of any general condition decided by the Buyer, unless specifically agreed upon the Seller's legal representative.
2. The products manufactured or sold by the Seller are not designed to be used into devices or equipment's to be inserted surgically into the human body or, in other words, suitable to examine or preserve the human life, or used in devices or systems for the nuclear applications. If the Buyer intends to utilise the Seller's products for its application in medical, nuclear, military and/or Aerospaziale fields, he may do so only with prior request and receipt of a document signed by the Seller's managing director, certifying that these products are suitable to be applied in the above fields,
3. The Seller will accept purchase orders only after written confirmation of the order, sent to the Buyer.
4. Delivery dates shown in the confirmation order are only indicative and not binding. The Seller will do his utmost in order to respect the confirmed delivery date but, at the same time, does not take any responsibility for the eventual non-observance of the date. The delivery is linked to the payment of eventual amounts which are due and are related to previous supplies. Likewise, also prices indicated in the confirmation order might vary according to increases in the energy or raw materials prices or changes in currency rates.
5. In absence of written agreements, orders are considered fulfilled with a tolerance of plus/minus 3% or plus/minus 5 pieces.
6. The technical specifications of the Seller's products are those contained in his last "Data Book" and are also traceable on his Web Site: www.itelcond.it. The technical specifications may also be those agreed upon between Seller and Buyer.
7. Seller's products will be free from vices and will be guaranteed for a period of 12 months from delivery date to the Buyer. The law decree No.24 of 02/02/2002 will not be enforced as these products are not considered as consumer goods. The warranty is effective exclusively towards the Seller's direct Buyer. Damages claimed by third parties, although if requested by Seller's direct Buyer, will be turned down.
8. The warranty does not cover products which are used incorrectly. Certain types of electric products, designed and manufactured to be used as basic components to be inserted in other electric devices, are anyway such that their performance is widely related to the way they are integrated in the final product and by its general characteristics. In the range of these basic components are included both active and passive components and notably the electrolytic capacitors.
9. Eventual defects or vices of goods will be promptly notified in writing and anyhow not after 8 days from the date of receipt of goods. In case of hidden defects, the above timing will start from the date of the discovery of these defects. In case of vices ascertained and reported in due time, defects or lack in quantity or quality of products, the Seller is entitled to the sole substitution of such products, repair or writing back of such products at his choice. In line with the most ample applicability of the law, any different and further responsibility is excluded for damages occurring to the buyer or third parties with regard to the utilization of the Seller's products. Samples, prototypes and products in development, will be delivered as they are and uncovered from warranty.
10. In case of missed and damaged products and units considered not in line with the technical specifications, the Buyer is entitled to inform immediately the Seller, who will decide how to proceed about the matter. No rejected goods will be accepted, unless previously authorized by the Seller. If an authorization number for the rejection (RMA) has been notified to the Buyer, such a number must be reported both on packaging and on documents accompanying the units rejected to the Seller. Products, travelling at Buyer's risk and danger, must be returned complete, not tampered with, non-welded, with their eventual accessories and adequately packed and delivered free factory of Seller. The assignment of the authorization number for rejection does not allow the Buyer to obtain the substitution of products, the credit of their value, and whatsoever responsibility on the Seller's side is not admitted. The Buyer is obliged to comply with the rules related to the re-exportation of the products to clients or countries, if the Italian law forbids export and sale towards them.
11. Goods are sold free factory of Seller and therefore the transportation risk is at total Buyer's charge. The delivery of products will be considered in every respect accomplished once the products are collected by the carrier or by the same Buyer at the Seller's warehouse.
12. The sold products will remain property of the Seller until totally paid by the Buyer. In case of delayed or missed payment the Seller may, at his discretion, request to re-enter into possession of unpaid products.
13. The Seller will not be liable if events, not due to his will, will prevent him to accomplish, partially or totally, the contractual obligations undertaken. The Seller will not assume responsibility for his products after the same are assembled on Buyer's equipments. The Seller will not be liable, no limitations admitted, for damages caused by the loss of warranty, contracts, or other legal matters, including loss of value, profit, capital, or expenses for the substitution of equipments.
14. Any dispute will be submitted to the law-court of Milan (Italy). Under any circumstance the contract will be exclusively governed by the Italian law.





This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

