ARCOTRONICS NISSEI GROUP

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Aluminum electrolytic capacitors catalogue

2003

Aluminum Electrolytic Capacitors

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GENERAL INFORMATION

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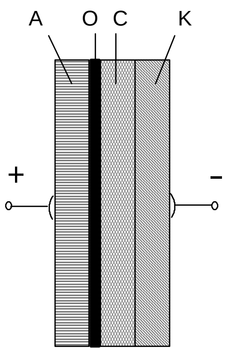
GENERAL INFORMATION

INTRODUCTION

The aluminum electrolytic capacitors are suitable to be used when a great capacitance value is required in a very small size. The volume of an electrolytic capacitor is more than ten times less than a film one considering the same rated capacitance and voltage.
The cost per µF of an electrolytic capacitor is less when compared with all the other capacitor types.

1- BASIC DESIGN

The construction of an aluminum electrolytic capacitor is the following:



Construction scheme

A = ANODE (Al 99.99%)
O = DIELECTRIC Aluminum Oxide
C = ELECTROLYTE + PAPER
K = CATHODE (Al 98%)

The anode (A)

The anode is formed by an aluminum foil of extreme purity . The effective surface area of the foil is greatly enlarged (by a factor of up to 200) by electrochemical etching in order to achieve the maximum possible capacitance values.

The dielectric (O)

The aluminum foil (A) is covered by a very thin oxidized layer of aluminum oxide (O = Al_2O_3). This oxide is obtained by means of an electrochemical process. The thickness is related to the applied voltage (**forming voltage**): 1.2nm/V.
The oxide withstands a high electric field strength and it has a high relative dielectric constant. Aluminum oxide is therefore well suited as a capacitor dielectric in a polar capacitor.
The Al_2O_3, has a high insulation resistance for voltages lower than the forming voltage.
The oxide layer constitutes a non-linear voltage-dependent resistance: the current increases more steeply as the voltage increases.

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The electrolyte-paper-cathode (C,K)

The negative electrode is a liquid electrolyte absorbed in paper. The paper also acts as a spacer between the positive foil carrying the dielectric layer and the opposite Al-foil (the negative foil) acting as a contact medium to the electrolyte. The cathode foil serves as a large contact area for passing current to the operating electrolyte.
The aluminum electrolytic capacitors with a liquid electrolyte are designed as “wet” or “non-solid” capacitors.
Terminations are welded on the foils. The positive foil, the paper and the negative foil are rolled to a winding.
This winding is impregnated with the electrolyte, encapsulated in an Al-case and sealed with a rubber disk.
An aluminum electrolytic capacitor constructed in the way described above, inserted in an electrical circuit, will only operate correctly if the positive pole is connected to the formed Al foil (anode) and the negative one to the cathode.
If the opposite polarity were to be applied, this would cause an electrolytic process resulting in the formation of a dielectric layer an the cathode foil: an internal heat generation and gas emission may destroy the capacitor. In addition, the increase of the thickness of the oxide on the cathode will reduce its capacitance and thus the overall capacitance of the capacitor.
The electrolytic capacitor above described is a polarized capacitor: it is suitable for D.C. operation only.
The D.C. voltage may also be a direct voltage with a superimposed alternating voltage
Bipolar electrolytic capacitors are also available. In this design the anode and the cathode foils are anodized in the production process and thus have the same capacitance rating.
A direct voltage of either the polarity or an alternating voltage may be applied to a bipolar capacitor.
The size of the bipolar type will be double the polarized one with the same rated capacitance and voltage.

2 - STANDARDS

The international standard for the aluminum electrolytic capacitors is IEC 384-4.

3 - TECHNICAL TERMS EXPLANATION

Rated capacitance
The rated capacitance is the capacitance value for which the capacitor has been designed and which is indicated upon it.

Capacitance tolerance
The capacitance tolerance is the range within which the actual capacitance may deviate from the specific rated capacitance.

Rated voltage V_R
Maximum operating peak voltage of a non-reversing type wave-form for which the capacitor has been designed and which is indicated upon it.

Surge voltage V_S
A peak voltage induced by a switching or any other disturbance of the system which is allowed for a limited number of times (as per IEC 384-4)

Forming voltage V_F
The voltage applied to the anode foil during the forming process.
It is higher than surge voltage V_S.

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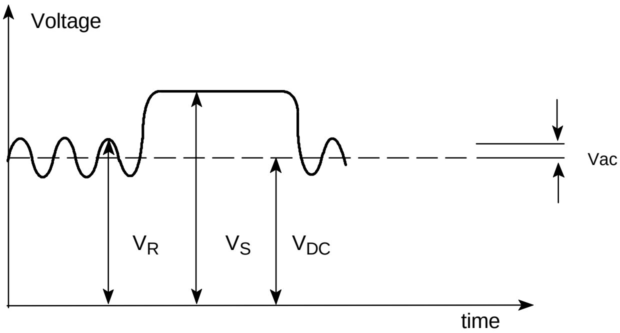
Superimposed AC, ripple voltage

A superimposed alternating voltage, or ripple voltage, may be applied to aluminum electrolytic capacitors, provided that:
- the sum of the direct voltage and superimposed alternating voltage does not exceed the rated voltage;
- the rated ripple current is not exceeded;
- no polarity reversal will occur.



Ripple current

The ripple current is the rms value of the alternating current that flows through the capacitor as a result of any ripple voltage.

Rated ripple current

The maximum permissible current allowed at a certain temperature and frequency.

Maximum permissible operating temperature (upper category temperature)

The upper category temperature is the maximum permissible temperature at which the capacitor may be operated, measured on the can. It is listed in the data sheets for each series.
If the above limit is trespassed the capacitor may fail prematurely.

Minimum permissible operating temperature (lower category temperature)

The minimum category temperature is the minimum permissible temperature at which the capacitor may be operated, measured on the can.
The conductivity of the electrolyte reduces with decreasing temperature, causing electrolyte resistance, impedance and ESR increasing. For this reason, minimum permissible operating temperature are specified for aluminum electrolytic capacitors.

Storage temperature

Storage at high temperature (e.g. upper category temperature) will reduce leakage current stability, life and reliability of electrolytic capacitors. Store capacitors at a temperature of 5 to 35°C and a humidity 75% maximum.

IEC climatic category

In accordance with the IEC 68-1, the climatic category comprises
1 - Lower category temperature: the test temperature for test A (cold) in accordance with IEC 68-2-1.
2 - Upper category temperature: the test temperature for test B (dry heat) in accordance with IEC 68-2-2
3 - Number of days of the duration of the test Ca (damp heat, steady state) according to IEC 68-2-3.

Safety vent

An overpressure device (safety vent) ensuring that the gas can escape when the pressure reaches a certain value.

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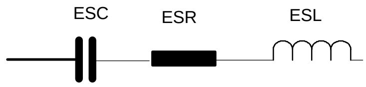
4 - ELECTRICAL RATINGS

4.1 - Capacitance (E.S.C.)



Simplified equivalent circuit diagram of an electrolytic capacitor

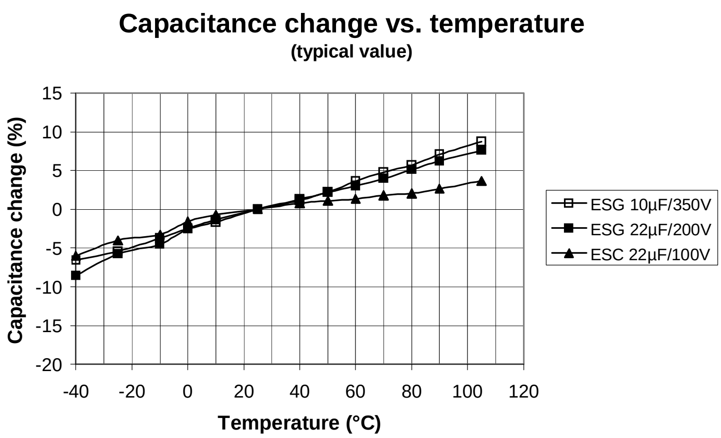
The capacitive component of the equivalent series circuit (equivalent series capacitance ESC) is determined by applying an alternate voltage of $\leq$0,5V at a frequency of 120 or 100Hz and 20°C (IEC 384-1, 384-4)

Temperature dependence of the capacitance

The capacitance of an electrolytic capacitor depends on the temperature: with decreasing temperature, the viscosity of the electrolyte increases reducing its conductivity.

The capacitance will decrease if the temperature decreases.

Furthermore temperature drifts cause armature dilatation and therefore capacitance changes (up to 20%, depending on the series considered, from 0 to 80 °C).This phenomenon is more evident for electrolytic capacitors than for other types.

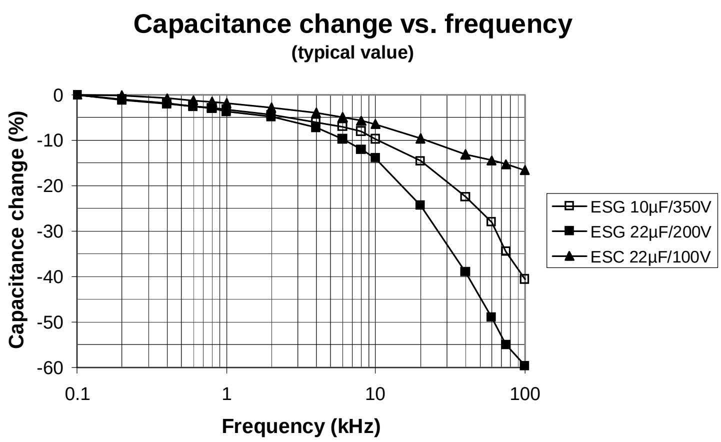


Frequency dependence of the capacitance

The effective capacitance value is derived from the impedance curve, as long as the impedance is still in the range where the capacitance component is dominant.

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

C = Capacitance (F)
f = Frequency (Hz)
Z = Impedance (Ω)



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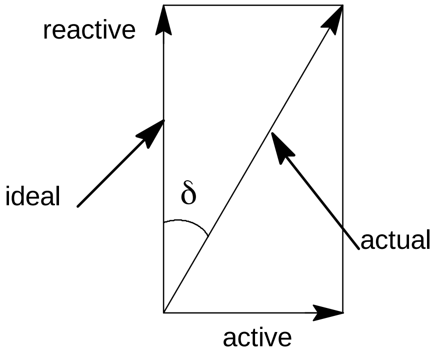
4.2 - Dissipation factor tgδ (D.F.)

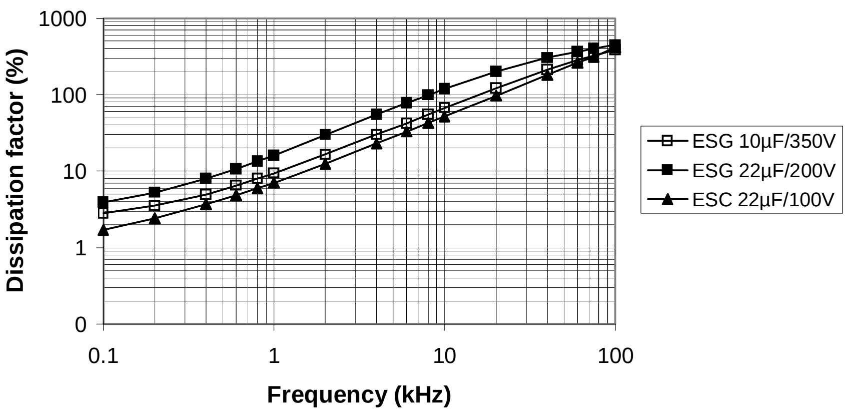
The dissipation factor tgδ is the ratio between the active and the reactive power for a sinusoidal waveform voltage. It can be thought as a measurement of the gap between an actual and an ideal capacitor.



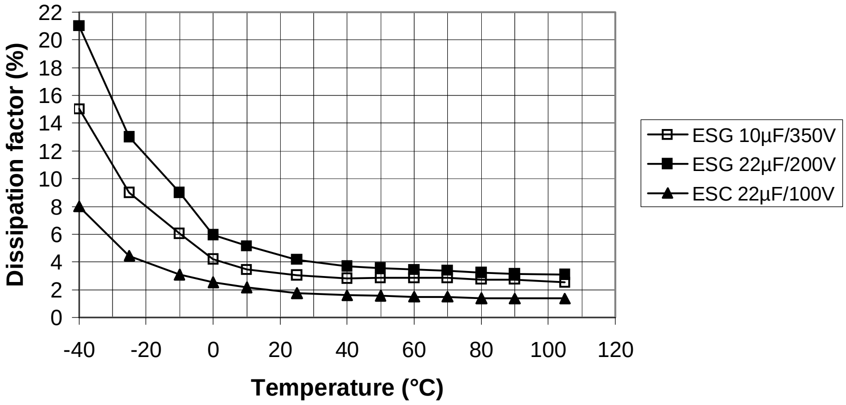
The tgδ is measured with the same set up as for the series capacitance ESC.

tgδ = ω x ESC x ESR where: ESC = Equivalent Series Capacitance
ESR = Equivalent Series Resistance

Dissipation factor vs. frequency
(typical value)



Dissipation factor vs. temperature
(typical value)



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4.3 - Self inductance (E.S.L.)

The self inductance or equivalent series inductance results from the terminal configuration and the internal design of the capacitor (see equivalent series circuit page 5).

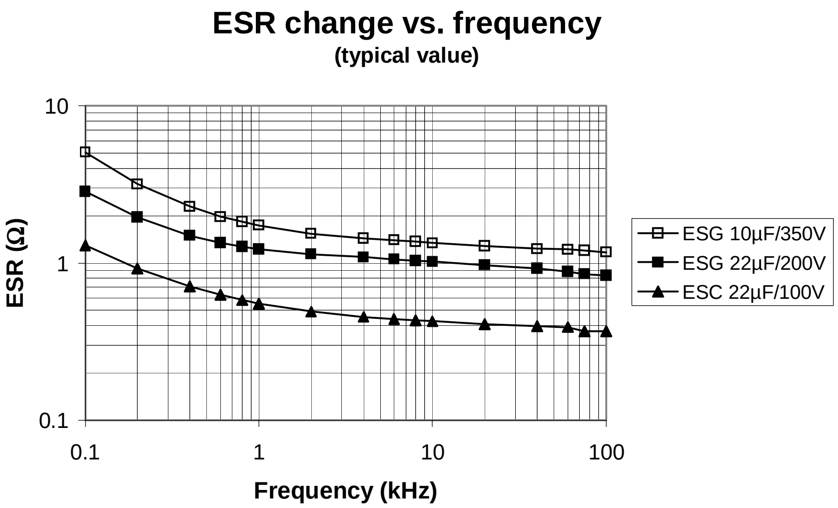
4.4 - Equivalent series resistance (E.S.R.)

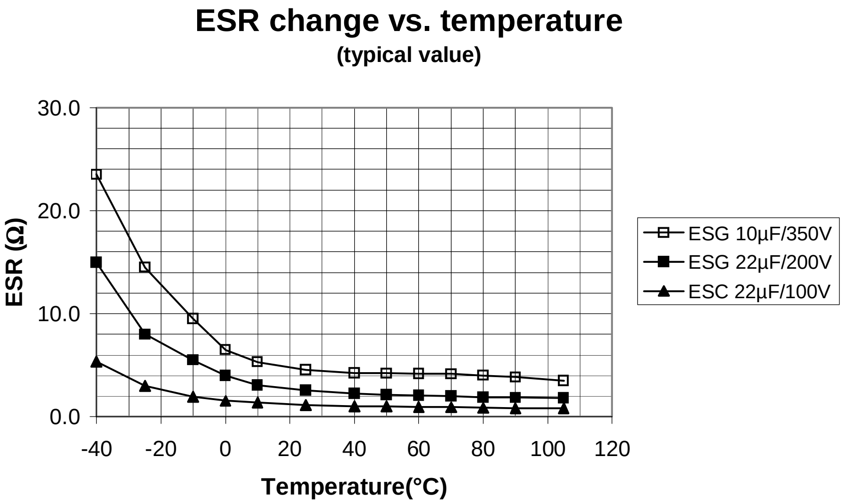
The equivalent series resistance is the resistive component of the equivalent series circuit. The ESR value depends on frequency and temperature and is related to the tgδ by the following equation:

$$ESR = \frac{tg\delta}{2\pi f\ ESC}$$

ESR = Equivalent Series Resistance (Ω)
tgδ = Dissipation Factor
ESC = Equivalent Series Capacitance (F)
f = Frequency (Hz)

The tolerance limits of the rated capacitance must be taken into account when calculating this value.





The resistance of the electrolyte decreases strongly with increasing temperature.

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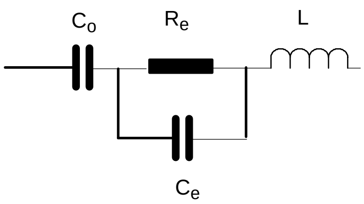
4.5 - Impedance (Z)

The impedance of an electrolytic capacitor results from here below circuit formed by the following individual equivalent series components:



C_o = Aluminum oxide capacitance (surface and thickness of the dielectric)

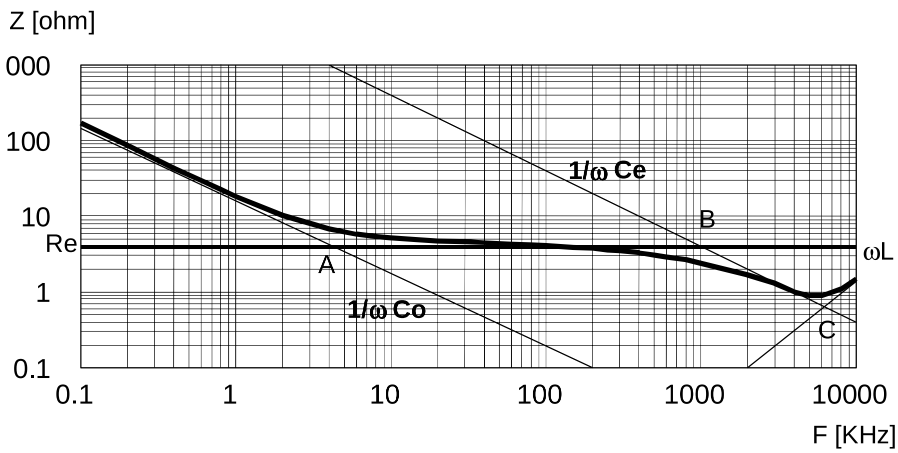
R_e = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, and so on)

C_e = Electrolyte soaked paper capacitance

L = Inductive reactance of the capacitor winding and terminals.

The impedance of an electrolytic capacitor is not a constant quantity that retains its value under all the conditions: it changes depending on the frequency and the temperature.

The impedance as a function of frequency (sinusoidal waveform) for a certain temperature can be represented as follows:



- Capacitive reactance predominates at low frequencies
- With increasing frequency, the capacitive reactance $Xc=1/\omega C_o$ decreases until it reaches the order of magnitude of the electrolyte resistance R_e (A)
- At even higher frequencies, the resistance of the electrolyte predominates: $Z= R_e$ (A - B)
- When the capacitor's resonance frequency is reached (ω_0), capacitive and inductive reactance mutually cancel each other $1/ \omega C_e = \omega L$, ω_0=SQR($1/LC_e$) (C).
- Above this frequency, the inductive reactance of the winding and its terminals (XL=Z=ωL) becomes effective and leads to an increase in impedance.

Generally speaking it can be estimated that $C_e \simeq 0{,}01\ C_o$.

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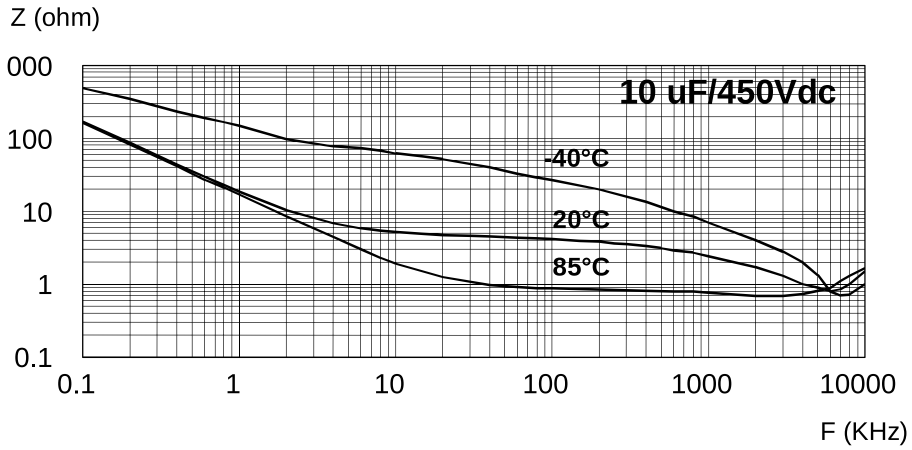
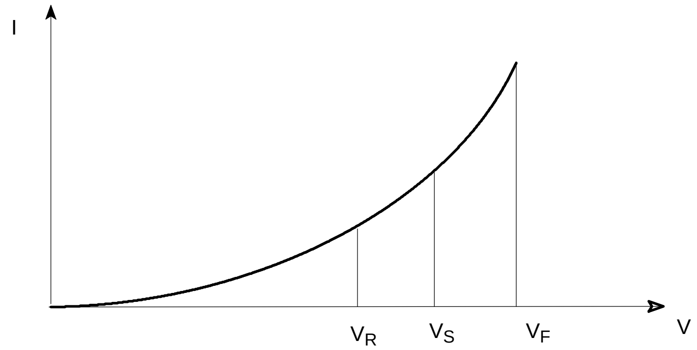
The impedance as a function of frequency (sinusoidal waveform) for different temperature values can be represented as follows (typical values):



R_e is the most temperature dependant component of electrolytic capacitor equivalent circuit. The electrolyte resistivity will decrease if the temperature rises.
In order to obtain a low impedance value all over the temperature range, R_e must be as little as possible, but too low R_e values means a very aggressive electrolyte and then a shorter life of the electrolytic capacitor at the high temperatures. A compromise must be reached.

4.6 - Leakage current (L.C.)

Due to the aluminum oxide layer that serves as a dielectric, a small current will continue to flow even after a DC voltage has been applied for long periods. This current is called leakage current.
A high leakage current flows after applying a voltage to the capacitor and then decreases in few minutes (e.g. after a prolonged storage without any applied voltage). In the course of the continuous operation, the leakage current will decrease and reach an almost constant value.
After a voltage free storage the oxide layer may deteriorate, especially at high temperature. Since there are no leakage current to transport oxygen ions to the anode, the oxide layer is not regenerated. The result is that a higher than normal leakage current will flow when a voltage is applied after prolonged storage. As the oxide layer is regenerated in use, the leakage current will gradually decrease to its normal level.
The relationship between the leakage current and the voltage applied at constant temperature can be shown schematically as follows:



Where:
V_F = **Forming voltage**
If this level is exceeded a large quantity of heat and gas will be generated and the capacitor could be damaged.
V_R = **Rated Voltage**
This level represents the top of the linear part of the curve.
V_S = **Surge voltage**
It lies between V_R and V_F: the capacitor can be subjected to V_S for short periods only.

In accordance with the IEC 384-4, electrolytic capacitors have to be subjected to a reforming process before acceptance testing. The purpose of this preconditioning is to ensure that the same initial conditions are maintained when comparing different products.

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4.7 - Ripple current (R.C.)

The maximum ripple current value depends on:
- ambient temperature
- surface area of the capacitor (heat dissipation area)
- tgδ or ESR
- frequency

The capacitor's life depends on the thermal stress.

Frequency dependence of the ripple current

The ESR and thus the tgδ depend on the frequency of the applied voltage. It means that the allowed ripple current is a function of the frequency too.

Temperature dependence of the ripple current

The data sheet specifies the maximum ripple current at the upper category temperature for each capacitor.

4.8 - Expected Life Calculation Chart

Expected Life depends on Operating Temperature according to the following formula:

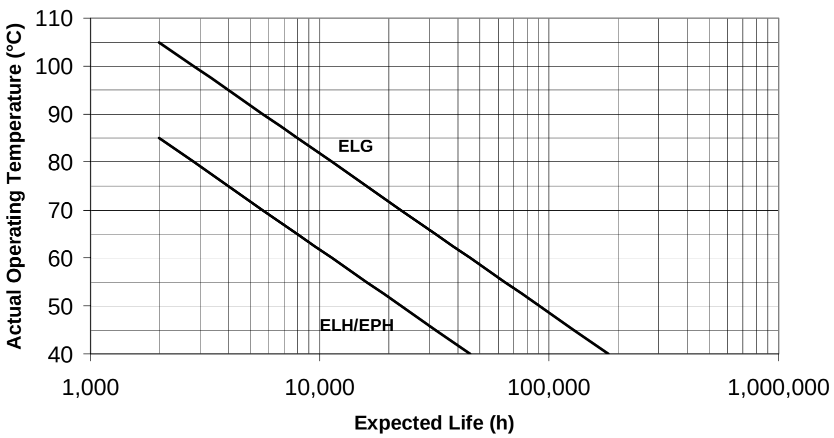
$$L = Lo \times 2^{(To-T)/10}$$

Where:

L: Expected Life
Lo: Load Life at Maximum Permissible Operating Temperature
T: Actual Operating Temperature
To: Maximum Permissible Operating Temperature

This formula is applicable between 40°C and To.

Expected Life Calculation Chart



4.9 - Mounting positions (safety vent)

In operation, electrolytic capacitors will always conduct a leakage current which causes electrolysis. The oxygen produced by electrolysis will regenerate the dielectric layer but, at the same time, the hydrogen released may cause the internal pressure of the capacitor to increase.

The overpressure vent (safety vent) ensures that the gas can escape when the pressure reach a certain value. All the mounting position must allow the safety vent to work properly.

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5- GUIDE AND PRECAUTIONS

The aim of this guide is to minimize the risks of failure due to bad applications and provide some important information and precautions on the specific peculiarities of the component.

5.1 - Polarity

Electrolytic capacitors for D.C. applications require polarization. Polarity is clearly indicated on the capacitors and it's better checked both in circuit design and in mounting. For very short period a limited reverse voltage less than 1 V is permitted. Exceeding the specified reverse voltage can induce damage, overheating, over pressure, open or short circuit conditions and the destruction of the capacitor. For this reason the electrolytic capacitors are equipped (see detailed specifications in any series) with a specific pressure device "safety vent" which opens at a given pressure and limits the risk of explosions due to overpressure.
For special purposes, no polarized capacitors, so-called bipolar capacitors, may be provided. This type of capacitor is used for a circuit where the polarity is occasionally reversed but must not be used for AC voltage applications.

5.2- Voltage

Do not apply a DC voltage exceeding the rated voltage (V_R). It's possible to apply the surge voltage (V_S) only for little time . Exceeding the capacitors specified voltage limits may cause premature damage and even destruction of the capacitor may be the consequence.

5.3- Temperature range

The capacitors must be used within specified temperature range. In any case the general principle is: the lower the ambient temperature, the longer the life. According to Arrhenius' rule, the lifetime is approximately halved with each 10°C of the ambient temperature increasing.

5.4- Ripple current

The sum of D.C. voltage and the maximum amplitude of ripple voltage shall remain within rated voltage (V_R) and 0 V.
The useful life of the capacitors is a function of the r.m.s. ripple current because ripple current induces overheating and over pressure and therefore reduces the life.
For different ripple frequencies, the ripple current must be calculated by correction factors shown for each product and each frequency. In case of many frequencies, the following calculation shall be done:

$$I_R = \sqrt{\left[\sum_{i_1}^{N} \left(\frac{Irms_i}{F_i} \right)^2 \right]}$$

Where:
I_R = ripple current according to the frequency of the rated ripple current.
N = number of significant harmonics.
Irmsi = rms current of the ith harmonic.
F_i = correction factor of the ith harmonic.

5.5- Charge and discharge

Do not use polarized capacitors in circuit where heavy charge and discharge cycles are frequently repeated. If you use the capacitors in this situation, capacitance could decrease and capacitors could be damaged due to generated heating and internal pressure.
Specified capacitors are designed to meet the requirements of charging and discharging cycles.

5.6- Storage

Capacitors should be stored at room temperature, normal atmospheric pressure, low humidity, and in manufacturers packaging. We recommended to store the capacitors indoors at a temperature of 5 to 35°C and humidity less than 75% RH in places free from salt water, toxic gases, ultraviolet rays radiation, etc.

5.7- Self-recharge phenomenon

Even if the aluminium electrolytic capacitors are totally discharged, these components may afterwards develop some voltage without external influence. This phenomenon depending on the capacitor type and its designed voltage, such self-recharge may result in values (sometimes around 10-15 volt) which could represent some risk : damage semiconductor devices, sparking by-pass terminal and so on.
It is recommended, for instance, to keep the terminal shorter or repeat the discharge before mounting them.

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5.8 - Electrolytes

Ethyl Glycol is used for main solvent and Organic Acids for main solute.
Quaternary ammonium salts are not used.
Nevertheless the following rules should be observed when handling electrolytic capacitors:

- Any escaping electrolyte should not come into contact with eyes or skin.
- If electrolyte comes into contact with the skin, wash the affected part 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 breathing in electrolyte vapor or mists. Workplace and other affected areas should be well ventilated.
- Clothing that has been contaminated by electrolyte must be changed or rinsed in water.

5.9 - Installing

- A general principle is that lower use temperatures result in a longer useful life of the capacitor. For this reason it should be ensured that electrolytic capacitors are placed away from heat emitting components. Adequate space should be allowed between components for cooling air circulate, particularly when high ripple current loads are applied. In any case the max category temperature must not be exceeded.
- Do not deform the case of capacitors or use capacitors with deformed case.
- Verify that the connections of the capacitors are able to insert on the board without excessive mechanical force.
- For capacitors with screw terminals apply the correct permissible torque.
- If the capacitors have to be mounted with additional means, the mounting accessories recommended shall be used.
- Verify the correct polarization of the capacitor on the board.
- Verify that the space around pressure relief device is according to the following guideline:

Case diameter	Space around safety vent
$\leqslant$16 mm	$>$2 mm
$>$16 to $\leqslant$40 mm	$>$3 mm
$>$40 mm	$>$5 mm

  It is recommended that capacitors are always mounted with the safety device uppermost or in the upper part of the capacitors.

- If the capacitors are stored for long time, the leakage current must be verified and, if the leakage current is superior to the value listed in this catalogue, capacitors must be reformed.
  In this case, they can be reformed by application of the rated voltage through a series resistor approximately 1 kΩ for capacitors with $V_R \leqslant 160$ V (5W resistor) and 10 kΩ for the other rated voltages.

5.10 - Soldering

In case of small sized of electrolytic capacitors nothing abnormal will occur if dipping is performed at less than 260°C for less than 10 seconds (for SMD type refer to “SMD reflow soldering conditions”).

5.11 - Cleaning agents

Halogen hydrocarbons may cause serious damage if allowed to come into contact with aluminum electrolytic capacitors. These solvents may dissolve or decompose the insulating film and reduce the insulating properties. The capacitor seals may be affected and swell, and the solvents may penetrate them. This will lead to premature component failure.

GENERAL INFORMATION

6 - PRODUCT CODE SYSTEM

6.1 Part number digits

1 2 3 . 4 5 6 . 7 . 8 9 10 . 11 . 12 13 . 14 . 15

Series (E**)
Rated Capacitance
Capacitance tolerance
Rated Voltage
Electrical parameters
Size D x L
Packaging specification
Internal use

6.2 Digits explanation

6.2.1 1st, 2nd, 3rd, digit - (Series)

ES5 =	Super miniature L= 5 mm	1000 h - 105 °C	Single Ended - Leaded
ESS =	Miniature L= 7 mm	1000 h - 105 °C	Single Ended - Leaded
ESK =	General purpose	2000 h - 85 °C	Single Ended - Leaded
ESE =	General purpose	1000 h - 105 °C	Single Ended - Leaded
ESH =	General purpose	2000 h - 105 °C	Single Ended - Leaded
ESB =	Low leakage current	1000 h - 105 °C	Single Ended - Leaded
ESX =	Low impedance	2000-5000 h - 105 °C	Single Ended - Leaded
ESC =	Low impedance	2000-3000 h - 105 °C	Single Ended - Leaded
ESY =	Low impedance	1000-5000 h - 105 °C	Single Ended - Leaded
ESG =	Low impedance	5000 h - 105 °C	Single Ended - Leaded
ESN =	General purpose bi-polar	2000 h - 105 °C	Single Ended - Leaded
EHD =	General purpose	2000 h - 85 °C	Snap-in (4 pins)
ELH =	General purpose	2000 h - 85 °C	Snap-in
ELG =	General purpose	2000 h - 105 °C	Snap-in
EPH =	General purpose	2000 h - 85 °C	Screw Terminal
EPG =	General purpose	2000 h - 105 °C	Screw Terminal
EDK =	General purpose	2000 h - 85 °C	SMD
EDE =	General purpose	1000 h - 105 °C	SMD
EDC =	Low impedance	1000 h - 105 °C	SMD
EDH =	Long life	2000 h - 105 °C	SMD
EDL =	Long life	3000-5000 h - 85 °C	SMD
EDN =	General purpose bi-polar	1000 h - 85 °C	SMD

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6.2.2 4th, 5th, 6th Digit - (Rated capacitance)

Rated capacitance is expressed by an exponential code, where the digits 4 and 5 represent the first two numbers of the rated capacitance value. Digit 6 is the exponent to apply at base 10 to obtain the capacitance in pF.

0,47 μF	= 470.000 pF	47 x 10.000	**474**
1 μF	= 1.000.000 pF	10 x 100.000	**105**
47 μF	= 47.000.000 pF	47 x 1.000.000	**476**
470 μF	= 470.000.000 pF	47 x 10.000.000	**477**
470.000 μF	= 470.000.000.000 pF	47 x 10.000.000.000	**47K**
1.000.000 μF	= 1.000.000.000.000 pF	10 x 100.000.000.000	**10L**

Special rated capacitance values will be evaluated upon request.

For instance: 1360 mF = **1Z1**
For instance: 1380 mF = **1Z2**

6.2.3 7th Digit - (Capacitance tolerance)

J = ±5% **K** = ±10% **M** = ±20% **X** = -10% +30%
Z = Special capacitance tolerance. When this digit has been chosen, it must be clearly defined.

6.2.4 8th, 9th, 10th Digit - (Rated voltage)

6R3 = 6,3 Vdc **063** = 63 Vdc **100** = 100 Vdc **450** = 450 Vdc

6.2.5 11th Digit - (Electrical parameters)

This digit outlines the special electric parameter of a special capacitor version.

A = STANDARD
B = Low D.F. (tand)
C = Low E.S.R. (Equivalent Series Resistance)
D = Low Z (Impedance)
E = High ripple current
F = Low leakage current
G = Formed cathode

6.2.6 12th, 13th Digit - (Size D x L)

SMD

Size	3x5,4	4x5,4	5x5,4	6,3x5,4	8x6,2	8x10,2	10x10,2
Code	**9A**	**9B**	**9D**	**9G**	**9L**	**9M**	**9P**

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Single ended , snap-in and screw terminal

Size	**Code**	Size	**Code**	Size	**Code**	Size	**Code**	Size	**Code**	Size	**Code**
3x5	**A1**	10x12	**H1**	16X26	**M1**	22X25	**Q1**	30X25	**S1**	40X81	**V1**
		10x15	**H2**	16X32	**M2**	22X30	**Q2**	30X30	**S2**	40X96	**V2**
4x5	**B1**	10x17	**H3**	16X36	**M3**	22X35	**Q3**	30X35	**S3**		
4x7	**B2**	10x19	**H4**	16X40	**M4**	22X40	**Q4**	30X40	**S4**	51X60	**W1**
		10x25	**H5**	16X20	**M5**	22X45	**Q5**	30X45	**S5**	51X79	**W2**
5x5	**C1**	10x30	**H6**	16X15	**M6**	22X50	**Q6**	30X50	**S6**	51X105	**W3**
5x7	**C2**			16X25	**M7**	22X20	**Q7**			51X118	**W4**
5x11	**C3**	12x25	**K1**					35X25	**T1**		
		12x30	**K2**	18X32	**N1**	25X25	**R1**	35X30	**T2**	63X105	**X1**
6x5	**E1**	12x35	**K3**	18X36	**N2**	25X30	**R2**	35X35	**T3**	63X130	**X2**
6x7	**E2**	12x40	**K4**	18X40	**N3**	25X35	**R3**	35X40	**T4**		
6x11	**E3**	12x20	**K5**	18X20	**N4**	25X40	**R4**	35X45	**T5**	76X105	**Y1**
				18X25	**N5**	25X45	**R5**	35X50	**T6**	76X130	**Y2**
8x7	**G1**	13x13	**L1**	18X16	**N6**	25X50	**R6**	35X51	**T7**	76X143	**Y3**
8x9	**G2**	13x16	**L2**			25X20	**R7**	35X60	**T8**	76X150	**Y4**
8x11	**G3**	13x20	**L3**					35X79	**T9**	76X222	**Y5**
8x15	**G4**	13x25	**L4**					35X105	**TA**		
8x5	**G5**	13x32	**L5**							91X170	**Z5**
8x20	**G6**	13x36	**L6**							91X222	**Z6**
8x14	**G7**	13x40	**L7**							91X230	**Z7**
8x16	**G8**	13x30	**L8**								

6.2.7 14th Digit - (Packaging)

A = STANDARD:
SMD = Reel
Single ended = Loose (standard leads)
Snap-in = Loose
Screw terminal = Loose (screw insulation can - ∅ = 11mm)

D = Ammopack - pitch 5 mm for diameters < 10 mm
E = Ammopack - straight leads for diameters 4~18 mm
F = Ammopack - formed leads with pitch 2,5 mm for diameters 4~5 mm

J = Reel - pitch 5mm for diameters < 10 mm
K = Reel - straight leads for diameters 4 ~ 16 mm
L = Reel - formed leads with pitch 2,5 mm for diameters 4 ~ 5 mm

P = Straight cut leads — Shape A (Arcotronics Catalogue)
Special packaging - loose with bee hive cells for diameter ⩾10 mm
R = Straight cut leads — Shape A (Arcotronics Catalogue)
S = Cut and formed leads — Shape B (Arcotronics Catalogue)
T = Crimped cut and formed leads — Shape C (Arcotronics Catalogue)
U = Straight cut and crimped leads — Shape D (Arcotronics Catalogue)

X = Screw terminals (screw insulation can - ∅ = 18.5mm)

The leads length must be fixed by the 15th Digit when **P** or **R** or **S** or **T** or **U** has been chosen.

6.2.8 15th Digit - (INTERNAL USE)

A = Standard leads length for loose version or standard taping

B = Double label.

C = Double label and special sealing rubber for single ended only, it avoids soldering problems. Stand-off rubber, it prevents the capacitor to be directly attached to the P.C.B.

R = Special sealing rubber for single ended only, it avoids soldering problems.
Stand-off rubber, it prevents the capacitor to be directly attached to the P.C.B.

S = Case with stud system mounting, for screw terminals only.

When **P** or **R** or **S** or **T** or **U** has been chosen as digit 14th, the digit 15th get the following meanings:

1 = Leads length 3,1 ±0,2 mm (Shape A, B, C, D)

2 = Leads length 3,3 ±0,2 mm (Shape A, B, C, D)

3 = Leads length 3,7 ±0,2 mm (Shape A, B, C, D)

4 = Leads length 4,2 ±0,2 mm (Shape A, B, C, D)

9 = Leads length 5,0 ±0,5 mm (Shape A, B, C, D)

6.3 Part number example

ELG 157 M 450 A S2 A A

ELG	Series (ELG)
157	Rated Capacitance (150 µF)
M	Capacitance tolerance (± 20%)
450	Rated Voltage (450 Vdc)
A	Electrical parameters (Standard)
S2	Size D x L (30x30 mm)
A	Packaging specification (Loose)
A	Internal use

PACKING QUANTITY

ES5, ESS, ESK, ESE, ESH, ESB ESX, ESC, ESY, ESG, ESN Series
(Single ended types)

D (mm)	L (mm)	BULK Inner box	TAPED ammopack	reel	LEAD CUTTING Inner box
		pcs	pcs	pcs	pcs
4	5	10000	2500	1500	15000
5	5	10000	2000	1300	15000
6	5	10000	2000	1100	15000
4	7	10000	2500	1500	15000
5	7	10000	2000	1300	15000
6	7	10000	2000	1100	15000
5	11	10000	2000	1300	15000
6	11	10000	2000	1100	15000
8	7	6000	1000	750	8000
8	11	6000	1000	750	8000
8	15	5000	1000	750	5000
8	20	4000	1000	750	4000
10	12	4000	700	600	4000
10	15	3000	700	600	4000
10	16	3000	700	600	4000
10	19	2400	700	600	3000
10	25	2400	500		2400
10	27	2000	500		2000
10	30	2000	500		2000
12	20	2000	500		2000
12	25	2000	500		2000
12	30	1600	500		1600
12	35	1000	500		500
12	40	1000	500		500
13	20	2000	500		2000
13	25	1600	500		1600
13	40	1000	500		500
16	20	1000	300		500
16	25	1000	300		500
16	32	800			500
16	36	600			500
16	40	600			500
18	20	800			1000
18	25	800			500
18	32	500			500
18	36	500			500
18	40	500			500
22	40	300			400

EPH Series
(Screw terminals type)

SIZE ∅d (mm)	Qty/box	Box dimensions (cm)
35 x 51	60	36 x 25 x 6
35 x 60	60	36 x 25 x 8
35 x 79	60	36 x 25 x 8
51 x 60	42	38.5 x 38.5 x 14
51 x 79	42	38.5 x 38.5 x 14
51 x 105	42	38.5 x 38.5 x 14
51 x 143	42	38.5 x 38.5 x 18
63 x 60	25	38.5 x 38.5 x 14
63 x 79	25	38.5 x 38.5 x 14
63 x 105	25	38.5 x 38.5 x 14
63 x 143	25	38.5 x 38.5 x 18
76 x 79	16	38.5 x 38.5 x 14
76 x 105	16	38.5 x 38.5 x 14
76 x 120	16	38.5 x 38.5 x 18
76 x 130	16	38.5 x 38.5 x 18
76 x 143	16	38.5 x 38.5 x 18
76 x 222	16	38.5 x 38.5 x 25
91 x 79	9	38.5 x 38.5 x 14
91 x 222	9	38.5 x 38.5 x 25
91 x 230	9	38.5 x 38.5 x 25

ELH, ELG Series
(Snap-in types)

D (mm)	L (mm)	pcs / Inner box Bulk
22	25	400
22	30	400
22	35	400
22	40	400
22	45	400

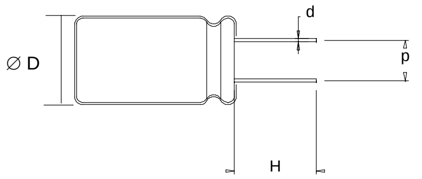
D (mm)	L (mm)	pcs / Inner box Bulk
25	25	200
25	30	200
25	35	200
25	40	200
25	45	200
25	50	200

D (mm)	L (mm)	pcs / Inner box Bulk
30	25	200
30	30	200
30	35	200
30	40	200
30	45	200
30	50	200

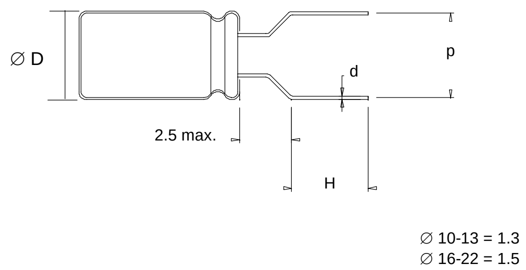
D (mm)	L (mm)	pcs / Inner box Bulk
35	30	200
35	35	200
35	40	200
35	45	200
35	50	200

Radial leads cutting, forming and crimping

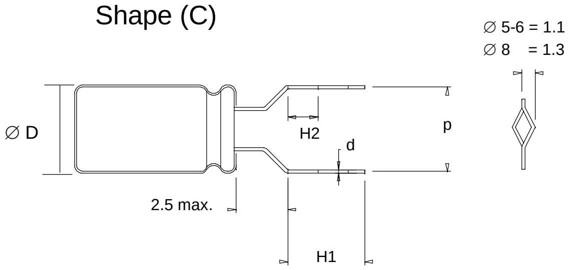
Shape (A)



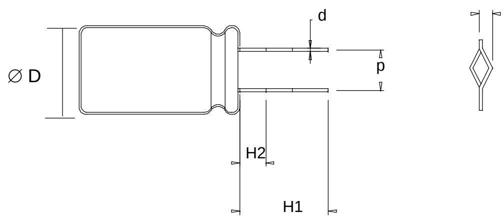
Shape (B)



Shape (C)



Shape (D)



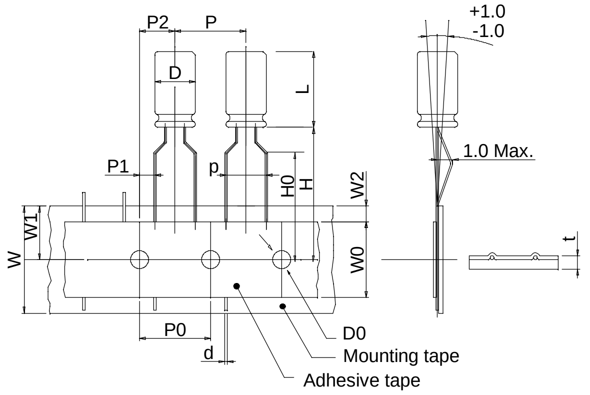
Stand off rubber available upon request for loose and taped versions

(Unit = mm)

Shape	Cutting forming and crimping methods	D ∅	5 ∅	6.3 ∅	8 ∅	10 ∅	12, 13 ∅	16 ∅	18 ∅	22 ∅
A	Leads cut only	p ±0.5	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0
		H ±0.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		d ±0.05	0.5	0.5	0.5	0.6	0.6	0.8	0.8	0.8
B	Leads cut and formed	p ±0.5	5.0	5.0	5.0					
		H ±0.5	5.0	5.0	5.0					
		d ±0.05	0.5	0.5	0.5					
C	Leads cut, crimped and formed	p ±0.5	5.0	5.0	5.0					
		H1 ±0.5	5.0	5.0	5.0					
		H2 ±0.1	2.5	2.5	2.5					
		d ±0.05	0.5	0.5	0.5					
D	Leads cut and crimped	p ±0.5				5.0	5.0	7.5	7.5	10.0
		H1 ±0.5				5.0	5.0	5.0	5.0	5.0
		H2 ±0.1				2.5	2.5	2.5	2.5	2.5
		d ±0.05				0.6	0.6	0.8	0.8	0.8

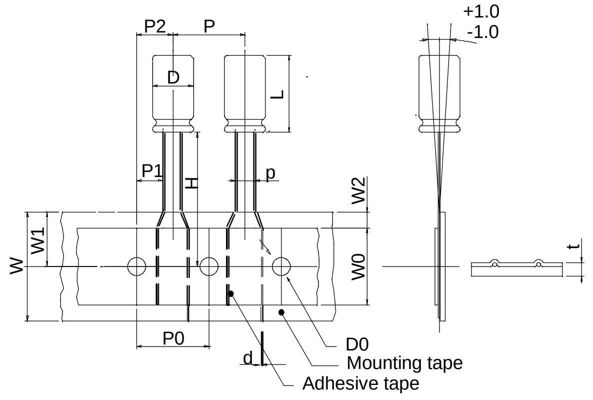
Lead taping for automatic insertion machines

Fig.1



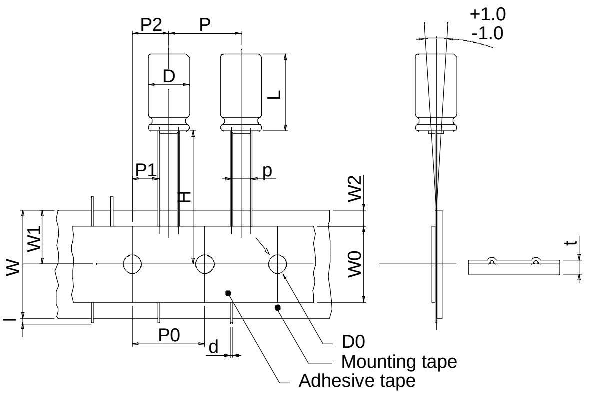
Taping pitch 5 mm formed leads

Fig.2



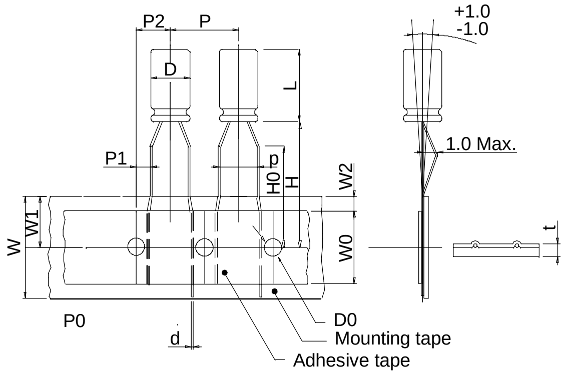
Taping straight leads ∅D 4 to ∅D8 mm

Fig.3



Taping straight leads ∅D >8 mm

Fig.4



Taping pitch 2.5 mm

For dimensions see following page.

Aluminum Electrolytic Capacitors

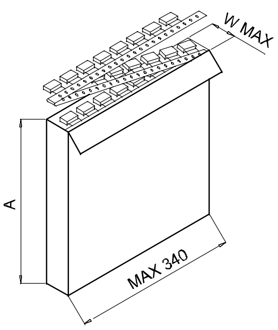
Lead taping for automatic insertion machines

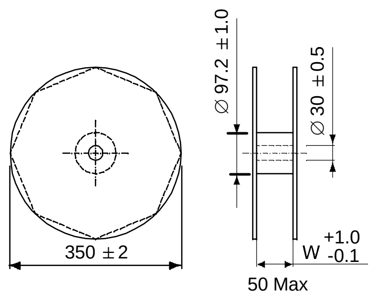
Diagram of dimensions for lead taping
(Unit = mm)

Dimensions		ØD	L	p	d	P	P0	P1	P2	W	W0	W1	W2	H	H0	I	D0	t
Tolerance		+0.5 -0		+0.8 -0.2	±0.05	±1.0	±0.3	±0.7	±1.3	+1.0 -0.5	±0.5	Max	Max	±0.75	±0.5	Max	±0.2	±0.2
Figures	4	4	5-7	2.5	0.45	12.7	12.7	5.1	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
		5	≤7	2.5	0.45	12.7	12.7	5.1	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
			>7	2.5	0.5	12.7	12.7	5.1	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
	1	4	5-7	5.0	0.45	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
		5	≤7	5.0	0.45	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
			>7	5.0	0.5	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
		6	≤7	5.0	0.5	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
			>7	5.0	0.5	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
		8	≤7	5.0	0.5	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
			>7	5.0	0.5	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	16.0	-	4.0	0.7
	2	4	5-7	1.5	0.45	12.7	12.7	5.6	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
		5	≤7	2.0	0.45	12.7	12.7	5.35	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
			>7	2.0	0.5	12.7	12.7	5.35	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
		6	≤7	2.5	0.5	12.7	12.7	5.1	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
			>7	2.5	0.5	12.7	12.7	5.1	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
		8	≤7	3.5	0.5	12.7	12.7	4.6	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
			>7	3.5	0.5	12.7	12.7	4.6	6.35	18.0	12.0	11.0	3.0	18.5	-	-	4.0	0.7
	3	10	12-25	5.0	0.6	12.7	12.7	3.85	6.35	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1
		12	15-25	5.0	0.6	15.0	15.0	3.85	7.5	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1
		13	15-25	5.0	0.6	15.0	15.0	3.85	7.5	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1
			15-25	5.0	0.6	15.0	15.0	3.85	7.5	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1
		16	15-25	7.5	0.8	30.0	30.0	3.75	7.5	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1
		18	15-25	7.5	0.8	30.0	30.0	3.75	7.5	18.0	12.0	11.0	3.0	18.5	-	1.0	4.0	1

Packing quantity (Unit = mm)

Case Diameter (mm)	Ammopack Style		Reel Style
	A	W	D
4	275	50	4
5	275	50	5
6	275	50	6
8	275	50	8
10 (12L)	275	50	10x12
10 (15 - 30L)	285	60	10x15
12 - 13	285	60	-
16	285	60	-
8x14 - 20	285	60	-



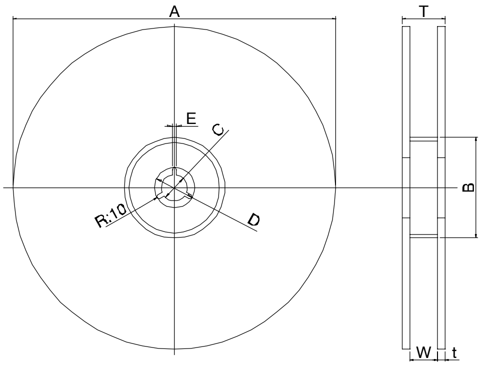


SMD - Designed for surface mount technology

■ Packaging specification

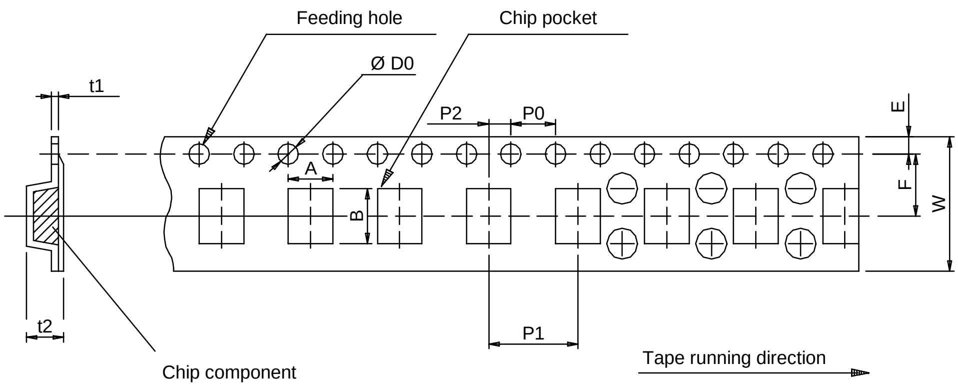
Reel dimensions (Units = mm)

Size Ø DxL	$A_{\pm0.2}$	B_{min}	$C_{\pm0.5}$	$D_{\pm0.8}$	$E_{\pm0.5}$	$W_{\pm1}$	$T_{\pm1}$	t
4.0 to 5.0	380	50	13	21	2	14	20	3
6.3 to 8.0 (L=6.2)	380	50	13	21	2	18	24	3
8.0 (L=10.2) to 10.0	380	50	13	21	2	26	32	3



- Taping dimensions (Units = mm)

Size Ø DxL	W	A	B	$P_{0\pm0.1}$	$P_{1\pm0.1}$	$P_{2\pm0.1}$	F	$ØD_{0\pm0.1/-0}$	E	t1	t2
4.0 x 5.4	12	4.7	4.7	4	8	2	5.5	1.5	1.75	0.4	5.8
5.0 x 5.4	12	5.7	5.7	4	12	2	5.5	1.5	1.75	0.4	5.8
6.3 x 5.4	16	7.0	7.0	4	12	2	7.5	1.5	1.75	0.4	5.8
8.0 x 6.2	16	8.7	8.7	4	12	2	7.5	1.5	1.75	0.4	6.8
8.0 x 10.2	24	8.7	8.7	4	16	2	11.5	1.5	1.75	0.4	11.0
10.0 x 10.2	24	10.7	10.7	4	16	2	11.5	1.5	1.75	0.4	11.0



- Packing quantity

Size Ø DxL (mm)	Quantity per reel	Inner carton / dimensions (mm)		Outer carton / dimensions (mm)	
4.0 x 5.4	2000	20000	390 x 195 x 395	40000	420 x 410 x 414
5.0 x 5.4	1000	10000	390 x 195 x 395	20000	420 x 410 x 414
6.3 x 5.4	1000	10000	390 x 235 x 405	20000	420 x 410 x 492
8.0 x 6.2	1000	10000	390 x 235 x 405	20000	420 x 410 x 492
8.0 x 10.2	500	4000	390 x 255 x 405	8000	420 x 410 x 530
10.0 x 10.2	500	4000	390 x 255 x 405	8000	420 x 410 x 530

■ Storage conditions

- Avoid to store the aluminum electrolytic capacitors in place where the conditions differ from the following:

  - the suitable environment temperature is between 5°C and 35°C and less than 75% of relative humidity.
  - the storage time must be ≤24 months from the date marked on the label glued to the package.
    After this period, please contact Arcotronics Technical Service before using them in your applications.