# ALUMINUM ELECTROLYTIC CAPACITORS

## ■ TECHNICAL NOTE

**1.General Description of Aluminum Electrolytic Capacitors**

1-1 The Principle of Capacitor

The principle of capacitance can be presented by the principle drawing as Fig.1-1.

When a voltage is applied between the metal electrodes placed opposite on the surfaces of a dielectric. electric charge can be stored proportional to the voltage.

Q=CV

Q: Quantity of electricity(C)

V: Voltage (V)

C: Capacitance (F)

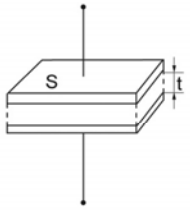


Fig. 1-1

C. called the capacitance of capacitor, is expressed by the following expression with the electrode area S [m²], the electrode spacing t [m] and the dielectric constant of dielectric" ε " :

$$C[F]= \varepsilon_0 \cdot \varepsilon \cdot S/t$$

$\varepsilon_0$: Dielectric constant in vacuum (=8.85x10$^{-12}$ F/M)

The dielectric constant of an aluminum oxide film is 7 to 8. Larger capacitances can be obtained by enlarging the electrode area S or reducing t.

Table 1-1 shows the dielectric constants of typical dielectrics used in the capacitor. In many cases, capacitor names are determined by the dielectric material used, for example, aluminum electrolytic capacitor, tantalum capacitor, etc.

Table 1

| Dielectric | Dielectric Constant | Dielectric | Dielectric Constant |
|---|---|---|---|
| Aluminum oxide film | 7 to 8 | Porcelain(ceramic) | 10 to 120 |
| Mylar | 3.2 | Polystyrene | 2.5 |
| Mica | 6 to 8 | Tantalum oxide film | 10 to 20 |

Although the aluminum electrolytic capacitor is small, it has a large capacitance. It is because the electrode area is roughened by electrochemical etching, enlarging the electrode area and also because the dielectric is very thin.

The schematic cross section of the aluminum electrolytic capacitor is as in Fig. 1-2

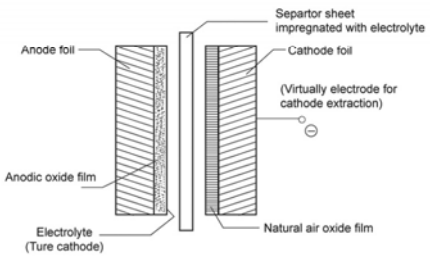


Fig. 1-2

## ■ TECHNICAL NOTE

Structure of aluminum electrolytic capacitors

The aluminum electrolytic capacitor is mainly composed of a inside element, which is made up of an anode foil, a cathode foil and separator paper wound together and impregnated with an electrolyte, external terminals, which are connected to tabs drawn from anode and cathode foils, a can and sealing materials.

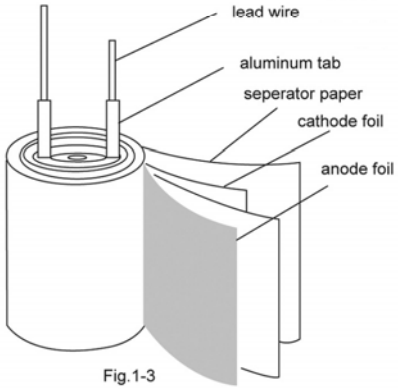


Fig.1-3

1-2 Equivalent Circuit of the Capacitor

The electrical equivalent circuit of the aluminum electrolytic capacitor is as presented in Fig.1-4

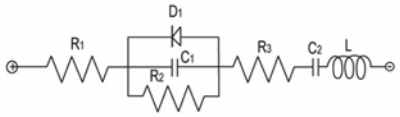


Fig. 1-4

$R_1$: Resistance of terminal and electrode

$R_2$: Resistance of anode oxide film and electrolyte

$R_3$: Insulation resistance because of defective anodic oxide film

$D_1$: Oxide semiconductor of anode foil

$C_1$: Capacity of anode foil

$C_2$: Capacity of cathode foil

L: Inductance caused by terminals, electrodes, etc.

1-3 Basic Electrical Characteristics

1-3-1 Capacitance:

The capacitance of capacitor is determined as AC capacitance by measuring its impedance. As the AC capacitance depends on frequency, voltage and other measuring methods. The capacitance of an aluminum electrolytic capacitor shows smaller values as a measuring frequency increases.

Measuring temperature as well as frequency effects the capacitance. As the measuring temperature decreases, the capacitance shows smaller values.

On the other hand, DC capacitance, which can be determined by measuring the charge when a DC voltage is applied, shows a slightly larger value than AC capacitance at a normal temperature and has the flatter characteristic over the temperature range.