GIHOU No.15-106
Jun 16,2015
Nichicon Corporation

Method of Setting the Balance Resistance in a Series Connection

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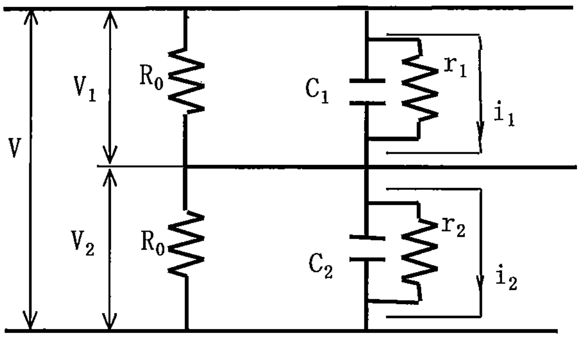
1． item

Type	Rated	Size
LGW2G221MELA35	400V / 220 μF	ϕ 25×35L

2． Method of Setting the Balance Resistance

2－1． Equivalent Circuit and Leakage Current

The relationship between the balance resistance and leakage current resistance of aluminum electrolytic capacitors used in a series circuit, expressed in an equivalent circuit, is shown in Fig. 1.



C_1 : Aluminum Electrolytic Capacitor No. 1
C_2 : Aluminum Electrolytic Capacitor No. 2
r_1 : Leakage Current resistance of Capacitor No. 1
r_2 : Leakage Current resistance of Capacitor No. 2
V_1 : Voltage between terminals in Capacitor No. 1
V_2 : Voltage between terminals in Capacitor No. 2
R_0 : Balance Resistance
V_0 : Line Voltage

Fig 1

If the leakage current of C_1 and C_2 are expressed as i_1 and i_2.

$$i_1 = \frac{V_1}{r_1} \qquad i_2 = \frac{V_2}{r_2}$$

$(V_1 > V_2)$

If the voltage of V_1 and V_2 are expressed as V_1 and V_2.

$$V_0 = V_1 + V_2$$

$$R_0 = \frac{V_1 - V_2}{i_2 - i_1} \qquad V_1 - V_2 = R_0(i_2 - i_1)$$

2－2．Leakage Current of the Aluminum Electrolytic Capacitor

If the rated voltage is expressed as V (V) and the capacitance as C (μF) variation of the leakage current at room temperature can be generally expressed by the following equation:

$$i_{\max} - i_{\min} = \frac{3}{10}\sqrt{C \times V}(\mu\ \mathrm{A})$$

The leakage current of aluminum electrolytic capacitors increases as the temperature rises. Generally if the leakage current at 20℃ is referred to as 1, it becomes 3 times at 65℃, 5 times at 85℃ and 10 times at 105℃. The leakage current also differentiates depending on the applied voltage and storage conditions, so it is necessary to multiply the leakage current variation coefficient to give a little leeway.

2－3．Setting the Balance Resistance

- Type：LGW2G221MELA35 (400V/220μF φ25×35L)
- Temperature coefficient for leakage current at 105℃:10
- Voltage balance rate:20%
- Coefficient for variation of leakage current:1.4
- Vo:545V
- Connection method of capacitor:2 series

Range of leakage current variation:

$$i_{\max} - i_{\min} = \frac{3}{10}\sqrt{C \times V} \times 10 \times 1.4 = \frac{3}{10}\sqrt{220 \times 400} \times 10 \times 1.4 = 1245.9(\mu\ \mathrm{A})$$

Voltage balance

$$\mathrm{V}_1 - \mathrm{V}_2 = \Delta V = 80(\mathrm{V})$$

$$\therefore R_O = \frac{80}{1245.9 \times 10^{-6}} \approx 64209 \quad \cdots \quad 64.2(\mathrm{k\Omega})$$

The maximum voltage impressed to a capacitor:V_1=400(V)

$$P = I \times V = \frac{V}{R} \times V = \frac{400}{64.2 \times 10^3} \times 400 \approx 2.5(W)$$

Balance Resistance:64.2 [kΩ] or less/2.5 [W] or more at 105℃.

In the same way as above mentioned method, the calculation at 65℃ and 85℃ are shown below.

[at 65℃]

Range of leakage current variation:

$$i_{\max} - i_{\min} = \frac{3}{10}\sqrt{C \times V} \times 3 \times 1.4 = \frac{3}{10}\sqrt{220 \times 400} \times 3 \times 1.4 = 373.8(\mu\ \mathrm{A})$$

…Temperature coefficient for leakage current at 65℃:3

Voltage balance

$$\mathrm{V}_1 - \mathrm{V}_2 = \Delta V = 80(\mathrm{V})$$

$$\therefore R_O = \frac{80}{373.8 \times 10^{-6}} \approx 214031 \quad \cdot\cdot\cdot\ 214(\mathrm{k\Omega})$$

The maximum voltage impressed to a capacitor: V_1=400(V)

$$P = I \times V = \frac{V}{R} \times V = \frac{400}{214 \times 10^3} \times 400 \approx 0.75(W)$$

Balance Resistance:214 [kΩ] or less/0.75 [W] or more at 65℃.

[at 85℃]

Range of leakage current variation:

$$i_{\max} - i_{\min} = \frac{3}{10}\sqrt{C \times V} \times 5 \times 1.4 = \frac{3}{10}\sqrt{220 \times 400} \times 5 \times 1.4 = 623.0(\mu\ \mathrm{A})$$

…Temperature coefficient for leakage current at 85℃:5

Voltage balance

$$\mathrm{V}_1 - \mathrm{V}_2 = \Delta V = 80(\mathrm{V})$$

$$\therefore R_O = \frac{80}{623.0 \times 10^{-6}} \approx 128419 \quad \cdot\cdot\cdot\ 128.4(\mathrm{k\Omega})$$

The maximum voltage impressed to a capacitor: V_1=400(V)

$$P = I \times V = \frac{V}{R} \times V = \frac{400}{128.4 \times 10^3} \times 400 \approx 1.25(W)$$

Balance Resistance:128.4 [kΩ] or less/1.25 [W] or more at 85℃.

When setting the balance resistance, we recommend consideration of the method that is currently used as well.

Your kindly review would be appreciated.