Output Voltage Holding Time

■General Description

Power circuits hold the output voltage for some time even when power supplied at the input block from an external source is interrupted. This duration is referred to as the "output voltage holding time."
Backup circuits used with microcomputers or RAM are also voltage-holding circuits. A large-size capacitor, lithium battery, or the like is used for this purpose depending on the length of time required to hold voltage. In the case of a capacitor, its capacitance is greatly related to the length of backup time.
This paper explains the relationship between output voltage holding time and the capacitance of a capacitor.

■Principle

Holding an output voltage is achieved by energy stored in the output capacitor. However, if a load is connected to the output, energy stored in the output capacitor is always discharged as a load current. Discharge characteristics determined by the time constant of the RC circuit exert an influence on the voltage holding time.
If, in a booster circuit, a short output voltage holding time and drop in the output voltage do not constitute a matter of concern, the capacitance of the output capacitor can be increased as a simple method.
If a drop in the output voltage should be avoided, the capacitance of the input capacitor can be increased. As the input capacitor serves as a power source if power supplied from an external source stops, the circuits continue to operate normally without producing any drop in the output voltage.
Energy stored in a capacitor within a unit time is expressed by the following equation.

$$W_C = \frac{1}{2} \times C \times V^2 \times \frac{1}{t} \,[W]$$

This equation expresses that the stored energy depends highly on the voltage applied to the capacitor and the capacitance of the capacitor.

■Calculation Example

Set input and output conditions as shown in the figure below.

V_{IN}=5.0V, V_{OUT}=3.3V, I_{OUT}=0.15A, η=0.8
Output Voltage holding time (t):0.07s

First, determine the output power (W_{OUT}).

$$W_{OUT} = V_{OUT} \times I_{OUT} = 3.3 \times 0.15 = 0.495\,[W]$$

Next, obtain the input power (W_{IN}) required to hold W_{OUT} = 0.495 [W].

$$W_{IN} = W_{OUT} \div \eta = 0.495 \div 0.8 = 0.61875 \fallingdotseq 0.62\,[W]$$

The capacitance of the input capacitor (C_{IN}) meeting this input power requirement is determined by the following equation.

$$W_{IN} = \frac{1}{2} \times C_{IN} \times (V_{IN} - V_{OUT})^2 \times \frac{1}{t}$$

$$C_{IN} = \frac{2 \times W_{IN} \times t}{(V_{IN} - V_{OUT})^2}$$

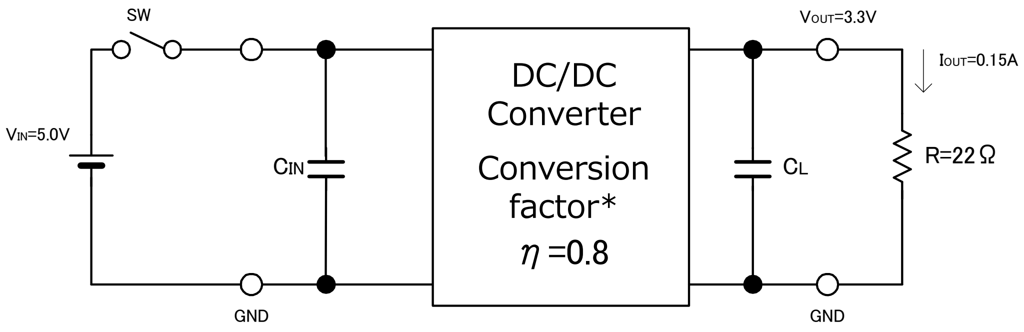
Substituting VIN = 5.0 [V], WIN = 0.62 [W], and t = 0.07 [s] in this equation, we obtain:

$$C_{IN} = \frac{2 \times 0.62 \times 0.07}{(5.0 - 3.3)^2} = 0.030034\,[F] = 30\,[mF]$$

Hence, if CIN = 30 [mF] or higher, it is possible to hold the output voltage even when power supplied from an output source stops for 0.07[s].

Note: Regarding the capacitance of a capacitor, the lower tolerance derived from the nominal value should be taken into account.

■Circuit Example



* The conversion factor is determined by dividing the rated-load efficiency by 100.