DEKI
Film Capacitor Solutions

Film Capacitors
in Capacitive Power Supply

A major challenge faced by many circuit designers today is to obtain a low voltage by reducing the incoming voltage from mains. This low voltage is required to power their circuit. Conventionally a step-down transformer is used to reduce the incoming 230 volts AC to the desired low level AC voltage. But there exists a simple, cost effective and space saving method to perform the same task. This is through the use of a Voltage Dropping Capacitor in series with the phase line.

Selection of the dropping capacitor and the circuit design requires some technical knowledge to get the desired voltage and current. An ordinary capacitor will not do the job since the device will be destroyed by the rushing current from the mains. Mains spikes will create holes in the dielectric and the capacitor will fail to work. AC-rated capacitor specified for the use in AC mains is required for reducing voltage level.

Some of the most common capacitive power supply based applications include smart meters, switch gears and relays, LED drivers, etc.

Any circuit being used today will be subjected to high temperature and high humidity conditions during its service life. It is extremely important that even under worst environmental conditions, these circuits continue to operate without failure. Deki has conducted extensive research and trials to design a specific series of High Stability capacitor which will perform even under worst conditions. This ensures that the circuit will not cease to operate even when the climatic conditions are extreme.

The design methodology of both the transformer and capacitor based system involves five stages as shown in Fig.1 and Fig.2.

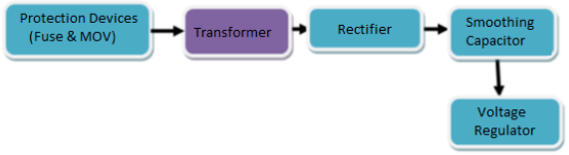


Fig.1: Flow Diagram of transformer based DC Power Supply

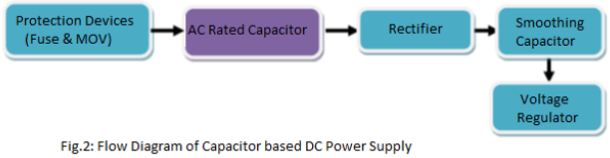
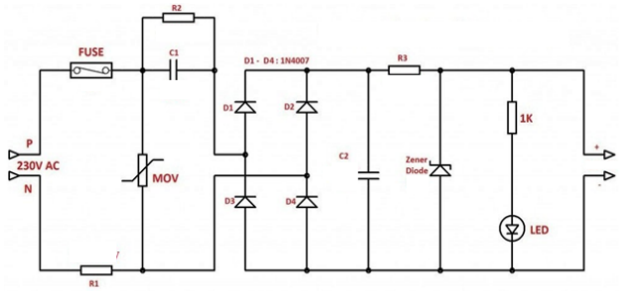


Fig.2: Flow Diagram of Capacitor based DC Power Supply

Before selecting the dropping capacitor, it is necessary to understand the working principle and the operation of the dropping capacitor. The AC rated capacitor is designed for 275, 310, 440 VAC. Higher voltage versions are also available. The Effective Impedance (Z), Reactance (Xc) and the mains frequency (50 – 60 Hz) are the important parameters to be considered while selecting the capacitor. The reactance (Xc) of the capacitor (C) in the mains frequency (f) can be calculated using the formula: $Xc = 1/(2\pi f\ C)$

For example the reactance of a 2.2µF capacitor running in the mains frequency 50Hz will be:



$Xc = 1/\{2\ \pi \times 50 \times 2.2 \times (1/1{,}000{,}000)\} = 1447.5976$ Ohms Or 1.44 Kilo Ohms.

Reactance of the capacitor 2.2 uF is calculated as $Xc = 1/(2\pi f\ C)$

Where f is the 50 Hz frequency of mains and C is the value of capacitor(C1) in Farads. That is 1 microfarad is 1/1,000,000 farads. Hence 2.2 microfarad is 2.2 x 1/1,000,000 farads. Therefore the reactance of the capacitor appears as 1447.597 Ohms or 1.44 K Ohms. To get current "I" divide mains Volts by the reactance in kilo ohm. That is 230 / 1.44 = 159 mA.

Effective impedance (Z) of the capacitor is determined by taking the load resistance (R) as an important parameter. Impedance can be calculated using the formula: $Z = \sqrt{(R^2 + Xc^2)}$

Suppose the current in the circuit is I and Mains voltage is V then the equation appears like: $I = V / Xc$.

The final equation thus becomes: I=230 V/1.44 =159 mA.

Current values for a 230 V/50 Hz supply for different capacitors

Capacitor	Current
0.10 µF	7.20 mA
0.33 µF	23.84 mA
0.47 µF	33.95 mA
0.68 µF	49.14 mA
1.00 µF	72.25 mA
2.20 µF	159.00 mA

Advantages of capacitive power supply

Significantly smaller than transformer-based power supply.

Less harmonics as compared to transformer based power supply

More cost-effective than transformer-based or switch-based power supply.

Power supply more efficient than resistive transformer less power supply.

Disadvantages of capacitive power supply

There is no galvanic isolation between the high volt AC and the DC load. So failure of the power supply may destroy the circuit.