Murata Power Solutions

Output Holdup and Ridethrough for PF600-1

In this application note, you will find information on output holdup and ridethrough for the PF600-1. Additional information on the PF600-1, including features and complete specifications can be found on our website at http://www.murata-ps.com.

Output Holdup and Ridethrough for PF600-1

Calculation of Bulk Capacitor Size

ENERGY REQUIREMENT

The reservoir capacitor (alias bulk capacitor or storage capacitor) supplies power when none or insufficient is available from the input source. It does this through every zero-crossing of the mains, and continues to support the output for a short time after the mains have failed or been switched off. Its energy is restored near the peaks of the mains cycle, when the power into the capacitor is as high as the output power, so the total input is doubled. It must be large enough to provide this storage with an acceptable voltage change, and to pass the necessary current (charge flowing in and out) without overheating.

Calculations of holdup and ride-through are determined by the relationship:

$$P*T=½C*(V_{start}^2-V_{end}^2)$$

Where: **P** is the total power, expressed in Watts, taken from the capacitor;

T is the time, expressed in seconds, for which holdup occurs;

C is the capacitance, expressed in Farads, as seen from the output.

For the PF600-1, we can use a constant that allows for the losses (about 6%) and turns ratio (22/3). To relate marked capacitor value to minimum holdup time, allow for –20% tolerance. V_{start} and V_{end} are the output voltages at the beginning and end of the holdup time.

Then:

$$P_{output}*T_{holdup(min)}=20.3*C_{nom}*(V_{start}^2-V_{end}^2)$$

If the output voltage begins at 48V and is considered to have failed at 36V, a capacitor of say 330µF will support full power of 600W for at least 11.25ms or 300W for 22.5ms. Similarly, a 470µF capacitor would provide holdup of 16ms or 32ms respectively.

If using the Output Monitor to switch off loads when the supply is low, V_{end} would be represented by the maximum trip voltage, which is 39.5V, and the holdup time would be correspondingly reduced.

If the initial voltage differs from 48V due to loading, the corrected value should be used there also. A small ripple voltage is present at the output during normal operation. For the most accurate (worst-case) calculation, use the voltage at the lowest point of this ripple.

Note: At low mains voltages, particularly when the load is light, it will be found that the undervoltage detector causes the output to fail earlier than predicted by the above formula. At 92V input, this effect typically limits holdup to 10ms, at 100V to 14ms, but at 120V or higher to more than 25ms.

RIPPLE VOLTAGE

The low-frequency ripple at the output is ideally:

$$V_{ripple(pp)}=\frac{I_{load}}{2\pi fC}$$

where: $\mathbf{V}_{ripple}$ is the peak-to-peak value at double supply frequency, $\mathbf{I}_{load}$ is the dc load from the capacitor, f is the supply frequency, in Hz, **C** is the actual reservoir capacitance referred to the output.

For the PF600-1, again allowing for practical factors, the predicted ripple is:

$$V_{ripple(pp)}=\frac{I_{out}}{344fC}$$

where: $\mathbf{I}_{out}$ is the module output current, and the factor **344** incorporates the transformer ratio.

If the capacitor is at its nominal value of 330µF, the 100Hz ripple at full load on a 50Hz supply would be 12.5/(344*50*330µ) = 2.2V_{pp}, reducing to 1.84V_{pp} at 60Hz.

RIPPLE RATING

At full load and minimum input voltage, the capacitor current is about 3Arms. It comprises a mixture of 300kHz and double-mains frequency. It will be found that this is enough to significantly heat the capacitor, and parts unable to handle the current at the prevailing conditions will suffer a reduced life and increased risk of thermal runaway (when self-heating reaches the point at which electrolyte begins to be ejected, further increasing the internal resistance). This effect places a practical lower limit on capacitance, since a small, low-value capacitor will be unlikely to handle the ripple current.

Ripple rating is related to permissible working temperature. Since the capacitor must be close to the module (as detailed in the following section), it will be close to the heatsink, and therefore in a hot environment. Use capacitors of 105ºC or higher rating rather than 85ºC types.

LOCATION

The 300kHz component of the ripple will see the capacitor connecting wires or tracks as a significant inductance. To reduce EMC and minimize the stress on the small internal decoupling capacitors, these leads should be kept as short as possible. A total conductor length of 100mm seems to be acceptable (e.g. 50mm each side). Use leads or tracks that are wide and thick, and keep them as close together as possible. Allow for the presence of 400Vdc between these conductors, and the fact that they are both at a hazardous voltage and must be insulated accordingly to meet safety standards.

Murata Power Solutions

Murata Power Solutions, Inc.
11 Cabot Boulevard, Mansfield, MA 02048-1151 U.S.A.
Tel: (508) 339-3000 (800) 233-2765 Fax: (508) 339-6356
www.murata-ps.com email: sales@murata-ps.com ISO 9001 REGISTERED
01/15/09

USA: Mansfield (MA), Tel: (508) 339-3000, email: sales@murata-ps.com
Canada: Toronto, Tel: (866) 740-1232, email: toronto@murata-ps.com
UK: Milton Keynes, Tel: +44 (0)1908 615232, email: mk@murata-ps.com
France: Montigny Le Bretonneux, Tel: +33 (0)1 34 60 01 01, email: france@murata-ps.com
Germany: München, Tel: +49 (0)89-544334-0, email: munich@murata-ps.com
Japan: Tokyo, Tel: 3-3779-1031, email: sales_tokyo@murata-ps.com
Osaka, Tel: 6-6354-2025, email: sales_osaka@murata-ps.com
China: Shanghai, Tel: +86 215 027 3678, email: shanghai@murata-ps.com
Guangzhou, Tel: +86 208 221 8066, email: guangzhou@murata-ps.com
Singapore: Parkway Centre, Tel: +65 6348 9096, email: singapore@murata-ps.com