Power Supply Hold-Up Considerations

General Description

Hold-Up Time: The amount of time (in milliseconds) that a power supply can maintain output within the specified voltage range after a loss of input power. This enables your system to continue running without resetting or rebooting if a brief interruption of input power occurs. Values of 15–50 milliseconds are often required for today's power supply systems. For instance, the MIL-STD-704A specification calls for 50ms hold-up time for critical applications. Hold-up time is a function of energy storage and load.

When the power system application under consideration requires the ability to continue operation for a period of time following an input power interruption, additional capacitance can be used to permit the power supply module(s) to continue operation. Since the hold-up time requirement of a power supply system can vary depending on the end-use and overall system requirements, hold-up capacitance is usually not designed into the modules. The added size and weight, which may or may not be required, is more appropriately designed into the system. DC-DC power supply modules readily accept power from external hold-up capacitance. AC input systems may also take advantage of external hold-up capacitance circuitry.

Calculation of Required Capacitance

Calculations for the hold-up capacitance for DC-DC converters, such as Rantec's High Density Modules (HDM product lines), are very straightforward. For AC-DC systems, the external hold-up circuitry interfaces with the internal DC bus of the power supply. Information about the power supply rectification and the DC bus is required to make these capacitance calculations.

The amount of capacitance required, for DC-DC converters, or at the DC bus level for AC-DC systems, is given by the following equation:

$$C_{holdup} \geq \frac{2 \times P_{LOAD} \times t_{HOLDUP}}{\eta \times \left((V_{NOM})^2 - (V_{DROPOUT})^2 \right)}$$

Where
C_{holdup} = Total hold-up capacitance
P_{load}= Output Power Requirement: The total delivered power to the load(s) in Watts
t_{holdup}= Desired holdup time in seconds
V_{nom}= The nominal DC input or DC bus voltage, of the power supply at time of input power loss (for example, for modules connected to a boost converter, this is the nominal boost output voltage)
$V_{dropout}$= The low-line, or dropout voltage, of the DC portion of the power supply (see Table 1)
η = Efficiency of the power supply

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Calculation of Hold-Up For Capacitance

Alternatively, a computation of hold-up time based on an existing hold-up capacitance can be done, as follows:

$$t_{holdup\ \max} = \frac{\eta \times \left((V_{NOM})^2 - (V_{DROPOUT})^2 \right) \times C_{HOLDUP}}{2 \times P_{LOAD}}$$

Implementing the Storage Capacitor

In selecting the storage capacitor or capacitors, use only low ESR types with high ripple current ratings. Where relatively high voltage is involved, it may be necessary to use two or more capacitors in series or series-parallel configuration to accomplish the desired total capacitance. Also pay attention to the operating temperature range of the power supply, as most capacitors, especially electrolytics, will lose a significant percentage of their capacity at low temperatures.

Voltage bleeding resistors and reverse polarity protection diodes may also be required to prevent possible injury from stored charge, and to protect the capacitors from damage at turn-on and turn-off (see Fig. 1).

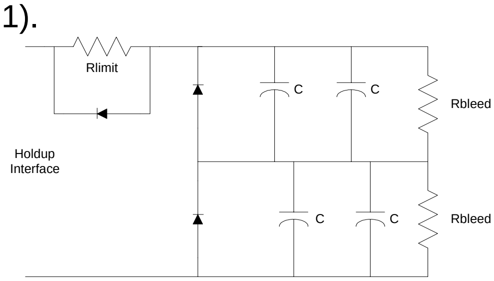

Figure 1 - Sample hold-up circuit

This sample hold-up circuit shows sets of series/parallel capacitors, to achieve the required capacitance and provide a design margin for the capacitor breakdown voltage of a 300Vin DC-DC converter or DC bus system. For this example circuit using four capacitors of the same value, the resulting holdup capacitance, C_{holdup} would be equal to the total value of C. In addition, consideration is given to in-rush current limiting during hold-up capacitor charging, by using resistor R_{limit}.

Boost Module Considerations

For implementations using Rantec's HDM-BT boost modules, Figure 1 attaches in parallel to the output of the boost module, and the input of the DC-DC converter(s). R_{limit} provides the in-rush current limiting needed for charging the hold-up capacitors. Depending on the application, approx-imately 30 ohms is sufficient.

AC Input Power Supply Considerations

For 3 phase input AC-DC systems, such as Rantec's VME or MIL HD power supplies, the external hold-up circuitry interfaces with the internal DC bus of the power supply. The DC bus voltage, V_{nom} in the equation on page 1, is the rectified 3 phase AC input voltage. Both Rantec's VME and MIL HD power supplies can provide interfaces for hold-up (across the internal DC bus). A series resistor/diode combination should be used in the circuit, as shown in Figure 1, between the input/output of the hold-up capacitors and the +hold-up pin of the

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power supply. This resistor is used to limit inrush current. The diode is used to bypass the resistor during an actual bus dropout. This minimizes the holdup voltage droop, during the time that current is flowing out of the holdup circuit and into the power supply.

Single phase AC input systems, such as those using Rantec's HDA series PFC, have the hold-up capacitance added between the PFC and the DC-DC converter module(s). The application would be similar to what was described for a 3 phase system, except that the inrush resistor/diode combination is not used. For more information, see Rantec's Application Note HDMA-107.

Dropout Voltage

For Rantec's standard HDM DC-DC models, the typical dropout values are shown in Table 1. Custom modified models may have higher or lower input ranges, and therefore different dropout voltages.

Model	Input	Input Range	$V_{dropout}$ Typical (2)	Efficiency Typical (3)
HDM DC-DC Converters				
HDM 28V Single	28V DC	20-32V DC	20V DC	80%
HDM 28V Triple	28V DC	16-32V DC	16V DC	70%
HDM 48V Single	48V DC	36-72V DC	32V DC	78%
HDM 300V (1)	300V DC	220-400V DC	220V DC	82%
AC-DC Power Supplies/Systems				
VME 6U Series	200V AC_{L-L}	160-270V AC_{L-L}	216V DC	75%
MIL HD Series	200V AC_{L-L} or 270V DC	185-215V AC_{L-L} 250-290V DC	187V DC	75%
DC-DC Power Supplies/Systems DC				
ATR/VME Series	28V DC	16-28V DC	16V DC	75%

(1) All 300V input HDM modules.
(2) For full specifications, use input range minimum voltage as $V_{dropout}$ in calculations
(3) See individual data sheets for specific model efficiencies

Table 1 – Sample $V_{dropout}$ Levels

Please consult factory for more information.

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