CALCULATING AC LINE CURRENT

APP Note 502

invensys LAMBDA

AC Line Current

AC line current is an important parameter for system installations. It is simple to calculate the AC current drawn given a few operating parameters for the supply and the AC line conditions.

AC line current draw is determined by a number of power supply and system parameters which are explained below;

$P_{average}$ (average output power) is the average output power consumed by the power supply load circuit. A higher average power results in a higher AC line current draw.

V_L (AC line voltage) is the RMS voltage measured at the input terminals of the power supply. A lower value for AC line voltage results in a higher input current for a given power supply and load conditions.

PF (power factor) is a decimal fraction between 0 and 1, and the ratio of real power consumed and the RMS power consumed. A higher value for PF results in a lower AC line current draw for given line and load conditions. PF is normally quoted for power supplies operating with nominal AC line and full output power. The following tables show typical power factor for single phase and three phase products. Note: Models 500A, 102A, 152A, and 202A include figures for optional electronic power factor correction circuit which results in a PF close to 1.

Model	500A	102A	152A	202A
Non PFC	0.65	0.65	0.65	-
Active PFC	0.98	0.98	0.98	0.98

Power Factor for single phase units

Model	402	802	XR802	LC1202	203	303
PF	0.85	0.85	0.85	0.9	0.85	0.85

Power Factor for three phase units

Eff (efficiency) is a decimal fraction between 0 and 1. Efficiency is the ratio of input power to output power. A typical value for the efficiency a switchmode supply is 0.85 or 85%. A higher efficiency results in a lower AC line current draw.

AC Line Current in a Single Phase Supply

For power supplies operating from a single line the following relationship can be used to determine the AC line current drawn.

$$I_L = \frac{P_{average}}{V_L \times PF \times Eff} \quad \text{.......................... equation 1}$$

Where;
I_L is the RMS line current in Amps
$P_{average}$ is the average output power in Watts
V_L is the AC line voltage in Volts
PF is the input power factor
Eff is the efficiency of the supply

Example:

What is the AC line current for a 152A power supply operating from a 190VAC line without the active PFC option, delivering an average output power of 1200W?

$$I_L = \frac{1200}{190 \times 0.65 \times 0.85} = 11.5\text{A RMS}$$

Active Power factor Correction

Active PFC is available as an option on single phase input power supplies. Active PFC improves the power factor of a single phase switchmode supply from a typical figure of 0.65 to 0.98. If the active PF of 0.98 is used in the line current calculation shown, the RMS line current would be reduced from 11.5A (PF=0.65) to 7.6A (PF=0.98) for the same output power and line voltage. This is a reduction of almost 4A or 34% in line current. See APP Note 513 for a more detailed description of active PFC. Note: Active PFC is only available with a single phase AC input. Power supplies with three phase AC input feature passive PFC which results in a typical PF between 0.8 and 0.9.

AC Line Current in a Three Phase Supply

For power supplies operating from a three phase line the following relationship can be used to determine the AC line current drawn. Note: active PFC is not available on three phase supplies.

$$I_L = \frac{P_{average}}{\sqrt{3} \times V_L \times PF \times Eff} \quad \text{........................ equation 2}$$

Where;
I_L is the RMS line current in Amps
$P_{average}$ is the average output power in Watts
V_L is the AC line to line voltage in Volts
PF is the input power factor
Eff is the efficiency of the supply

Example:

What is the AC line current for an LC1202 power supply operating from a 208VAC line option, delivering an average output power of 11000W.

$$I_L = \frac{11000}{\sqrt{3} \times 208 \times 0.9 \times 0.85} = 40\text{A RMS}$$

Determining the Maximum AC Line Current

Maximum AC line current occurs when the power supply is operated with the lowest acceptable AC line input. It is good practice to allow for the maximum line current when determining the size and rating of the AC conductors. The low AC line figures are given on the individual product data sheets, and it is recommended these are used to calculate maximum line current.

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