



## APPLICATION NOTES FOR USE WITH SPELLMAN HIGH VOLTAGE POWER SUPPLIES

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### How to Calculate Maximum AC Input Current

Knowing a power supplies maximum input current can be helpful in selecting electrical service requirements, circuit breaker selection, AC input cable and connector selection and even picking an isolation transformer in floating applications. Calculating the maximum input current is fairly easy knowing a few basic parameters and some simple math.

#### High Voltage Power Supply Power Rating

All of Spellman's power supplies have an advertised maximum power rating, in watts. This is the first parameter we'll need and it can be obtained from the product data sheet. Most of Spellman's power supplies have the maximum power rating right in the model number. Like for this example an SL30P300/115 is a 30kV, positive polarity unit that can provide 300 watts, maximum; operated from 115Vac input line.

#### Power Supply Efficiency

The power supplies efficiency is the ratio of input power to output power. Efficiency is typically stated as a percentage or a decimal less than 1, like 80% or 0.8. To figure out the input power we take the stated maximum output power and divide by the efficiency:

$$300 \text{ watts} / 0.8 = 375 \text{ watts}$$

#### Power Factor

Power factor is the ratio of the real power to apparent power utilized. It is typically expressed as a decimal number less than 1. Real power is expressed in watts while apparent power is expressed in VA (volt-amperes). Single phase uncorrected switching power supplies typically have fairly poor power factor, like 0.65. Three phase uncorrected switching power supplies have a higher power factor, like 0.85. Units with active power factor correction circuitry can have very good power factor like 0.98. In our example above the supply is an uncorrected unit, powered by a single phase line so:

$$375 \text{ watts} / 0.65 = 577 \text{ VA}$$

#### Input Line Voltage

We need to know the AC input voltage the unit is designed to be powered from. In the example above the AC input voltage is 115Vac. This is the nominal voltage, in reality the input voltage is specified at  $\pm 10\%$ . We need to subtract 10% to account for the worst case, low line condition:

$$115\text{Vac} - 10\% = 103.5\text{Vac}$$

### **Maximum AC Input Current**

If we take the 577 VA and divide it by 103.5Vac we get:

$$577 \text{ VA} / 103.5\text{Vac} = 5.57 \text{ amps}$$

If our AC input voltage is single phase, then we have our answer, 5.57 amps.

### **Three Phase Input Voltage**

Units with three phase input voltage are powered by three phases, hence they have a better power factor number than single phase units. Also due to the presence of three phases powering the unit, phase currents will be less. To obtain the input current per phase we divide our input current calculation by  $\sqrt{3}$  (1.73).

Let's calculate this example: STR10N6/208. From the STR data sheet we find out the maximum power is 6000 watts, the efficiency is 90% and the power factor is 0.85. Although the STR will operate down to 180Vac by design, in this example it will be powered via 208Vac, 3 phase. We obtain the maximum input current per phase as follows:

Power Supply Efficiency

$$6000 \text{ watts} / .9 = 6666 \text{ watts}$$

Power Factor

$$6666 \text{ watts} / .85 = 7843 \text{ VA}$$

Input Line Voltage

$$208\text{Vac} - 10\% = 187\text{Vac}$$

Maximum AC Input Current

$$7843 \text{ VA} / 187\text{Vac} = 41.94 \text{ amps (if it was single phase)}$$

Correction for Three Phase Input

$$41.94 \text{ amps} / \sqrt{3} (1.73) = 24.21 \text{ amps per phase}$$

So we have two equations, one for single phase inputs and one for three phase inputs:

### **Single Phase Maximum Input Current Equation**

$$\text{Input Current} = \text{Maximum Power} / (\text{Efficiency})(\text{Power Factor})(\text{Minimum Input Voltage})$$

### **Three Phase Maximum Input Current Equation**

$$\text{Input Current} = \text{Maximum Power} / (\text{Efficiency})(\text{Power Factor})(\text{Minimum Input Voltage})(\sqrt{3})$$

These input current calculations are for the worst case: assuming the unit is running at maximum power, operating at a low line condition and taking efficiency and power factor into account.