Writing Sample B

Abstract: The goal of this project is to design and build a circuit for improving the power factor of an existing variable frequency drive(VFD) designed and built by Lenze. This circuit will be a Boost Converter controlled by a prebuilt IC (ICE3PCS01G). We will use passive rectification to convert the AC into pulsating DC. This Power Factor Correction (PFC) circuit will allow for greater efficiency which is important for Lenze to stay competitive as well as saving costs for their customers. The PFC circuit is to take 120VAC and get an output of 325VDC with a power factor of 0.95 with a max continuous power of 1472 watts or about 2.0 hp. This circuit will feed into one of their VFDs and will appear as a near resistive load to the grid.

Background

In an AC electrical system, power can be identified in two distinct classes, real power, and reactive power. Real power is that which is consumed by resistive loads. This power is absorbed into the system and is used to either do work or generate heat. Reactive power is power which is not consumed by the system, but rather drawn from the system and then fed back into it as is the case of inductors. Reactive power is represented as an imaginary number, 90° out of phase with the real power. These powers combine to form the apparent power which can be found using the following equation:

$$S = \sqrt{P^2 + Q^2} \qquad (1)$$

The apparent power is not representative of the real power absorbed, but it does represent the load that is applied to the power grid. The ratio of real to reactive power is represented by displacement power factor, which can be found using the following equation:

$$displacement\ power\ factor = cos\varphi = \frac{P}{S} \qquad (2)$$

In addition to Displacement Power Factor, the distortion of the current waveform must also be considered. The Distortion Power Factor can be related to the total harmonic distortion by the following equation:

$$distortion\ power\ factor = \frac{1}{\sqrt{1+THD^2}} \qquad (3)$$

The Displacement Power Factor and the Distortion Power Factor combine together to form the True Power Factor using the following equation:…

$$TruePF = displacement\ PF * distortion\ PF \qquad (4)$$

A power factor correction circuit added to the VFD will reduce losses associated with needless reactive power flow as well as reducing the maximum inrush current, allowing for more powerflow using smaller conductors and lower rated circuit breakers. Our circuit will make use of semiconductor devices, such as transistors and diodes as well as passive components such as capacitors and inductors. The use of these devices will allow us to bring the input power factor close to 1, appearing as a nearly resistive load to the grid.