Alternating Current Power Factor Monitoring and Correction:
Functional Requirements List and Performance Specifications

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Introduction

This project will utilize power factor correction to improve efficiency and reduce power company surcharges in an electrical distribution system. A single phase alternating current (AC) load will be used with a source voltage of up to 120 [VAC]. Connected to this load will be a power factor correction device that will be controlled by the same EMAC 80C535 microcontroller used to measure the system voltage, current, and the active and apparent powers. Since the microcontroller is limited to 0-5V on its inputs, a voltage-to-voltage converter and a current-to-voltage converter will be used to measure the voltage and current. The goal of this project is to obtain a power factor as close to one as the system permits to obtain increased efficiency and reduce customer costs.

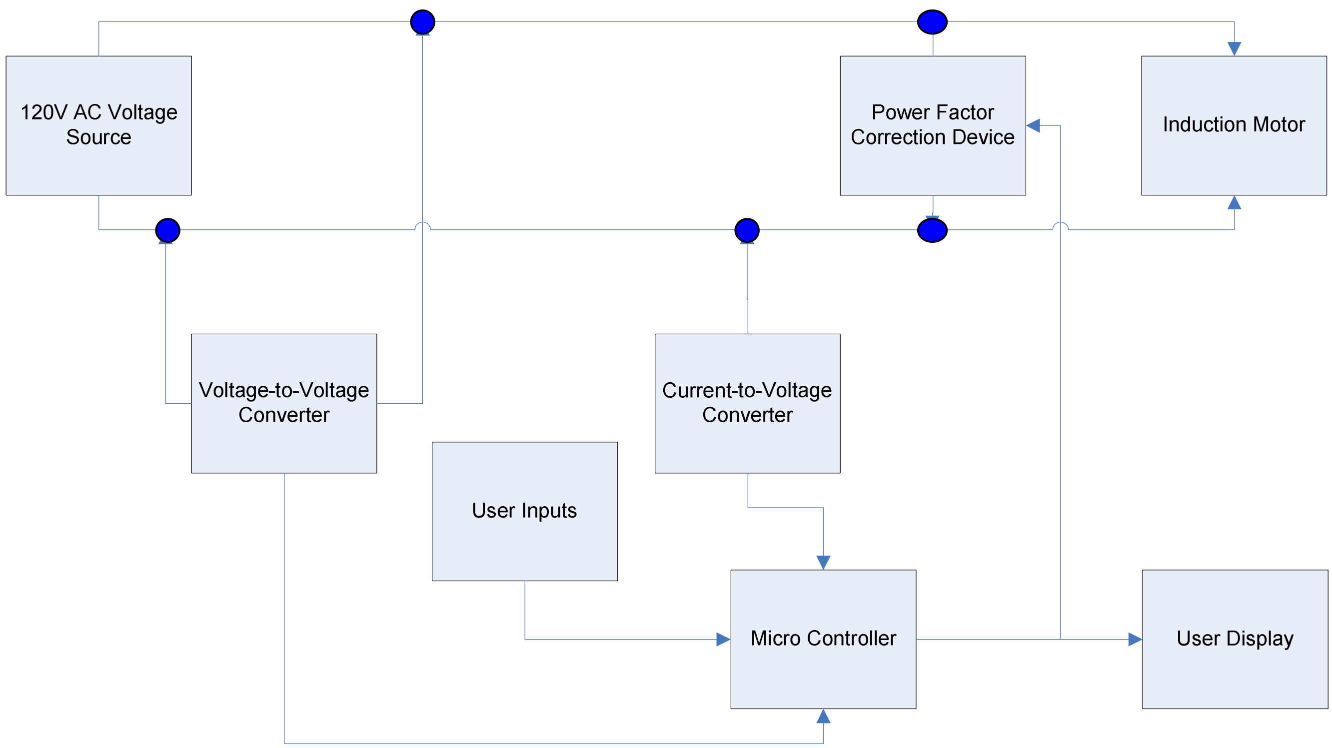

Figure 2-1, High Level System Block Diagram

A 120 [VAC] source will be used to power an inductive load, since the load power factor can easily be altered by adjusting the load inductance, as seen in Figure 2-1. The voltage-to-voltage converter will consist of a voltage isolation transformer and a voltage divider to reduce the voltage to a magnitude that will not damage the microcontroller. The current-to-voltage converter will be a Hall Effect current sensor that will convert the current signal to a voltage signal since the microcontroller can only measure voltages. The microcontroller will be an EMAC 80C535 and will process the voltage inputs via its A/D converter to measure the system voltage and current. The current and voltage measurements will be used to compute output control signals for the power factor correction device.

Functional Description

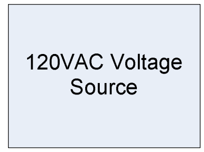

Figure 3-1, AC Voltage Source

Figure 3-1 represents the voltage source for the system. The voltage can be varied within the range of 0-120 [VAC] with the voltage never to exceed 120 [VAC] for this project's specifications.

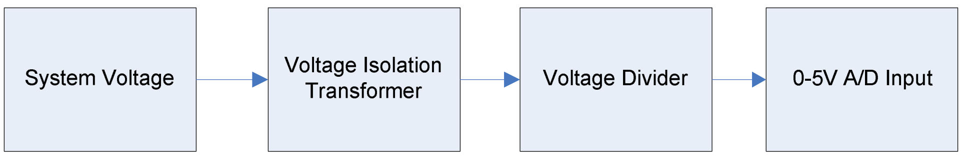

Figure 3-2, Voltage-to-Voltage Converter

The voltage-to-voltage converter shown in figure 3-2 will step down the system voltage to the 0-5 [VDC] range that is acceptable to the microcontroller. Since the microcontroller can only measure voltages in this small range, this converter will allow the microcontroller to measure the voltage without damaging the microcontroller due to excessive voltage. The conversion will make use of a small, lower power isolation transformer. There will be no need to account for phase differences between the input and output of the isolation transformer as the primary and secondary currents will be nearly zero.

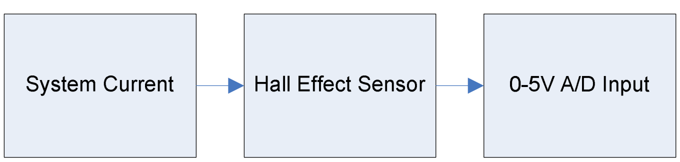

Figure 3-3, Current-to-Voltage Converter

The current-to-voltage converter shown in figure 3-3, using a Hall Effect current sensor, will convert the system current to a voltage that the microcontroller will be able to process. Once the current and voltage values are obtained, the system power factor will be calculated. The needed control signals can then be sent to the power factor correction unit to obtain the desired power factor.

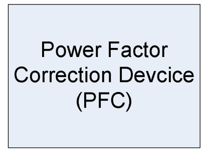

Figure 4-1, PDC Unit

The power factor correction device shown in figure 4-1 will utilize one of several possibilities to adjust some aspect of the system in the hopes of increasing system efficiency and reduce cost to the customer. The specific method of power factor correction has not yet been determined, but one possibility is by placing fixed or variable capacitor banks parallel with the circuit. Whichever method is used, the microcontroller will provide the command signals.

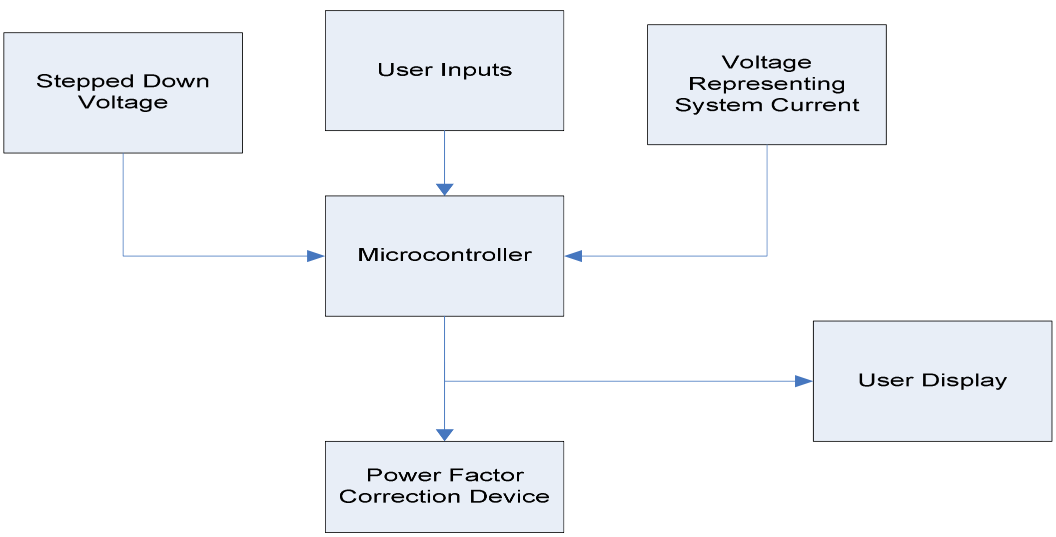

Figure 4-2, Microcontroller

The subsystem of figure 4-2 will be used to send the voltage and current measurements to the EMAC 80C535 microcontroller that will be used for the project. Using these measurements, command signals will be generated and sent to the power factor correction device in the system.

Software

In the program code, the measurements for the voltages obtained from the converters will be obtained from the micro controller's built-in A/D converters. This will provide the reduced voltages that can be used for calculating the power factor. Since the ratio used to step down the voltage will be known, the micro controller can be used to send the correct signals to the power factor correction unit. This process is shown in figure 5-1. The output(s) of the micro controller cannot yet be discussed as the method of power factor correction has not yet been determined. All that can be said is that the micro controller will control the power factor correction unit in some way to improve the power factor of the system.

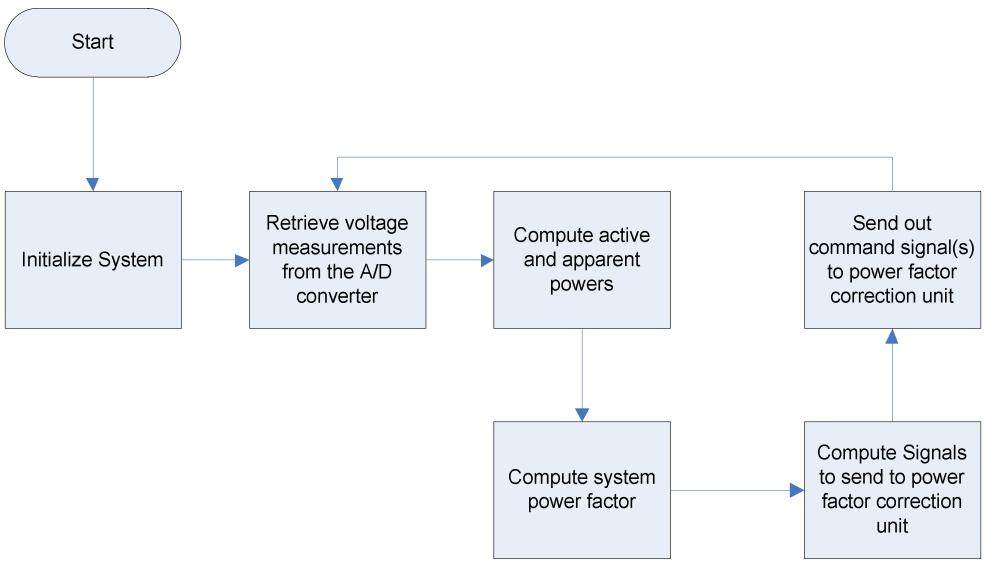

Figure 5-1, Software Flowchart

Functional Requirements

- The Power Factor of the system shall not fall below 0.9.
- The microcontroller shall compute and display the system active power and system power factor in an appropriate amount of time.
- The microcontroller shall be able to accept command inputs with at most one decimal point.
- The voltage isolation transformers will step down the voltage with a ratio of 30:1 into the microcontroller.
- A over voltage protection circuit will be connected to the A/D converter.
- The input current and voltage into the load shall not exceed 1.4A and 220V.
- The input voltage shall not exceed 120 [VAC].

References

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