Project: Harmonic Control of Power Line Current

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Abstract

The main objective of this project is to test a new control method, developed in the Ben-Gurion University of the Negev, to control the current harmonies consumed from the AC line. To test this approach, a 1KW PWM power stage was built and the new control method implementation was tested in a closed loop using a DSP unit with the minimum use of classic analog components.

Overview

In recent years, power factor has become a mandatory standard not only for very high power consumption products but also for all electrical products above 75w (European standard IEC-1000-3).

The demand for “green” power and minimization of line interference caused by low power factors to and from electric products, encouraged researchers to look for a variety of solutions to correct the power factor problem.

Our project incorporates a new method of programming the input current without the need of directly sampling the input voltage, which is necessary in other methods. The project uses a 1KW boost converter with universal input voltage and a regulated 380V-output voltage. The control loop uses an average current sense from the input stage, which is obtained by the currents flowing in the switch and in the diode of the power stage. This enables control of the input current shape by varying the duty cycle. The output voltage is also kept regulated at the required value as a function of load and input voltage change. The ability to work with high switching frequencies (100KHz in the prototype) was realized by using high-speed power MOSFET, an ultra fast rectifier, and a high-speed driver.

Closing the control loop is based on a DSP device from Texas Instruments – TMS320F240 – that is especially designed for control applications. The control system on the prototype consists of an evaluation board for the DSP and an interface board connecting the DSP to the power stage. Software development was accomplished by means of a development kit, which consists of an assembly compiler that runs on a PC computer and an emulator that allows real–time software debugging.

Results

The prototype was tested with a variety of loads and input voltages, and several output voltages including the nominal output voltage. The results were more than satisfying and proved the validity of the approach. It was found that the feedback systems may become unstable under certain load ranges.

An analytical study, backed by simulation, was carried out to explain this instability and to define the boundaries for safe operation.

Figure 1 shows the input current versus the input voltage; picture 1 shows the prototype itself.

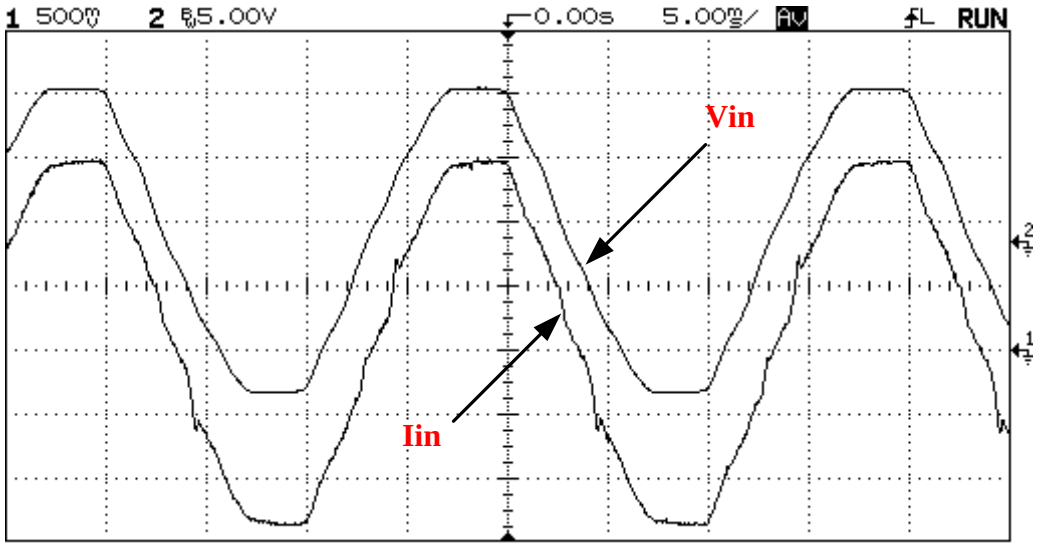
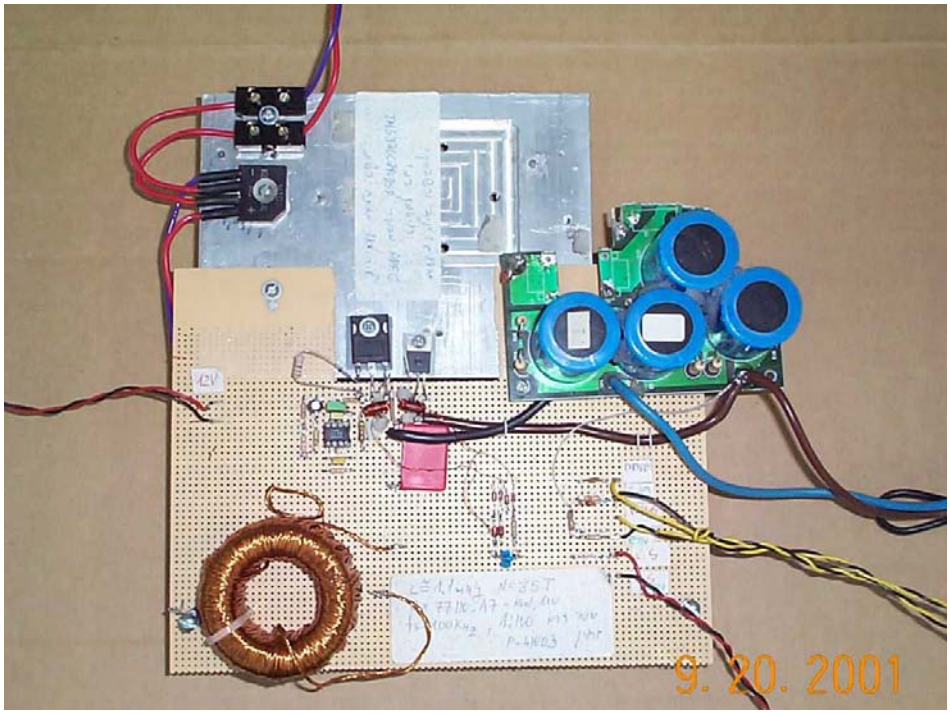


Figure 1



Picture 1