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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The project is to develop a power supply system consisting of
(1) a singlephase Pre-requlator power factor corrector (ac0dc converter) and
(2) a dc-dc converter.

15. SUBJECT TERMS
Dc Power Supply, Power Factor Corrector, DC-DC Converter, Zero Voltage Switching

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HIGH PERFORMANCE POWER SUPPLY FOR THE MORE ELECTRIC AIRCRAFT

Abstract

The project is to develop a power supply system consisting of
(1) a single-phase Pre-regulator power factor corrector (ac-dc converter) and
(2) a dc-dc converter.

A. Significant Results:

1. *AC-DC Converter*

Two different methods for minimizing the input current distortion have been developed. They were applied on a boost converter operating with a discontinuous inductor current. The input voltage of the converter was 120Vac at 60Hz as well as 400Hz. The output of the experimental converter built was 270V, 300W.

In one method, a small portion of the rectified ac voltage was used to modulate the duty cycle of the switch. The second harmonic component present in the rectified voltage was found to reduce the third harmonic distortion and the total harmonic distortion (THD) in the input current. The control technique works well with 60 Hz ac input as well as 400 Hz ac input that is used in an aircraft.

In the second method, the input current distortion was minimized by shaping the input current to be sinusoidal using equal energy criterion. In this method, the peak inductor current was made to follow a reference waveform made up of a fundamental and a third harmonic component. A simple circuit to generate the third harmonic component was also developed as part of the project. The electromagnetic interference (EMI) caused by the switching converter was minimized using a randomly varying switching frequency instead a fixed switching frequency.

An electronic load for testing the ac-dc converter was also developed. The load uses linear Power MOSFETs working in the constant current region. It is possible to test power supplies of different voltage and current ratings.

2. *DC-DC Converter*

The dc-dc converter converts 270V dc to a lower voltage (24V to 48V) which is used to drive the subsystems in an aircraft. A full-bridge converter with zero voltage switching (ZVS) was developed. A phase-shift controller IC (UC 3879) provides the control pulses to the MOSFET switches in the bridge. The ZVS condition for the switches in the lagging leg was provided using a saturable core inductor. The switching frequency of the converter has to be matched to the input voltage so that commutation pulses of proper amplitude and shape are generated. The output voltage of the dc-dc converter is regulated through feedback. The phase-shift input of the IC is controlled through feedback. The converter provides a constant output voltage for a wide range of input voltages.

An experimental converter capable of providing an output of 250W was designed and built. The efficiency of the converter and the losses in different sections of the converter are accurately measured using a Yokagawa power analyzer. The efficiency is around 92%. Methods of increasing the efficiency and soft starting schemes are currently being investigated.

B. Papers Published/Accepted for Publication

1. T. Cannon, B. Csongradi, and S. Yuvarajan, "A harmonic-modulated power factor corrector operating from 400 Hz ac mains," Proc. of Power systems World International Conference, Chicago, IL, Nov. 1999.

2. S. Yuvarajan and Dongsheng Zhang, "Distortion Minimization in a single phase power factor corrector using a novel control circuit." Presented at Power Systems World International Conference, Boston, October 2000.

3. Rahul Patil and S. Yuvarajan, "A dc-dc converter with a variable input voltage and variable output voltage." Presented at Power Systems World International Conference, Boston, October 2000.

C. Students Trained

1. Todd Cannon and Bill Csongradi worked for their Undergraduate Senior Design Project. They graduated in December 2000.
2. Dongsheng Zhang completed his M.S. thesis entitled "Design of Single-phase Power Factor Corrector with reduced input current distortion and EMI." He joined in September 1998 graduated in May 2000.
3. Jing He completed her M.S. thesis entitled, "Microcontroller-based Single-phase Power Factor Corrector," and graduated in January 2001.
4. Rahul Patil has completed his M.S. thesis and will graduate in May 2002
5. Shanguang Xu has joined as a Ph.D. student in January 2000 and he is continuing his work.

D. Research Equipment Acquired (With support from ND EPSCoR and ECE Dept)

1. Yokagawa 3-Phase Digital Power Meter.
2. Personal Computer with GAGE data acquisition cards.