Stroboscope Controller for Imaging Helicopter Rotors

This unit can be programmed to operate in a variety of configurations.

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A versatile electronic timing-and-control unit, denoted a rotorcraft strobe controller, has been developed for use in controlling stroboscopes, lasers, video cameras, and other instruments for capturing still images of rotating machine parts — especially helicopter rotors. This unit is designed to be compatible with a variety of sources of input shaft-angle or timing signals and to be capable of generating a variety of output signals suitable for triggering instruments characterized by different input-signal specifications. It is also designed to be flexible and reconfigurable in that it can be modified and updated through changes in its control software, without need to change its hardware.

Figure 1 is a block diagram of the rotorcraft strobe controller. The control processor is a high-density complementary metal oxide semiconductor, single-chip, 8-bit microcontroller. It is connected to a 32K × 8 nonvolatile static random-access memory (RAM) module. Also connected to the control processor is a 32K × 8 electrically programmable read-only-memory (EPROM) module, which is used to store the control software. Digital logic support circuitry is implemented in a field-programmable gate array (FPGA). A 240 × 128-dot, 40-character × 16-line liquid-crystal display (LCD) module serves as a graphical user interface; the user provides input through a 16-key keypad mounted next to the LCD. A 12-bit digital-to-analog converter (DAC) generates a 0-to-10-V ramp output signal used as part of a rotor-blade monitoring system, while the control processor generates all the appropriate strobing signals. Optocouplers are used to isolate all input and output digital signals, and optoisolators are used to isolate all analog signals.

The unit is designed to fit inside a 19-in. (≈48-cm) rack-mount enclosure. Electronic components are mounted on a custom printed-circuit board (see Figure 2). Two power-conversion modules on the printed-circuit board convert AC power to +5 VDC and ±15 VDC, respectively. Located on the back of the unit are 16 bayonet connectors used for input and output. There are 14 outputs: 10 analog voltage ramp waveforms, a once-per-revolution pulse, an n-times-per-revolution (where n is an integer selectable by the user) pulse, a transistor/transistor logic (TTL) digital strobe signal, and an open-collector digital strobe signal. There are two input connectors which accept a TTL once-per-revolution and an n-per-revo-
The control software was written in the C language. The main functions of the software are to read data present on the control-processor ports, generate the strobe signals, generate the ramp information used to monitor rotor-blade parameters by writing to the 12-bit DAC, save and retrieve configuration settings to and from the nonvolatile RAM, communicate with the FPGA, accept keypad input, and control and update the LCD by paging through appropriate user selections and menus. The user can gain access to several menus to set such parameters as the number of blades to track, the blade-offset angle, and the number of pulses per revolution.

This work was completed for Jon Lautenschlager of the U.S. Army Aviation and Missile Command by Scott Jensen, John Marmie, and Nghia Mai of Ames Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14966.