Automation of Microwave Configuration Control

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Hardware is being developed for the purpose of permitting computer control of a portion of the DSS 14 configuration control group. The configuration control group is part of the antenna microwave subsystem.

I. Introduction

Within the antenna microwave subsystem, there are numerous waveguide and coaxial radio-frequency switches which are used to establish various configurations by selecting the appropriate feed cone, low-noise amplifier, transmitter, etc. Manually operated, illuminated pushbuttons provide the only means of controlling and monitoring switch position at this time.

The goal of the present effort is to provide the hardware necessary to interface with a DSN standard minicomputer in order to permit the computer to control and monitor the position of switches within the antenna microwave subsystem.

II. Design Requirements

There are many design requirements placed upon equipment which is to be used at a deep space station. Three requirements are described here because they affect the design noticeably.

(1) The hardware must be installed and tested in an operating deep space station. The station must continue to perform its duty of communicating with spacecraft in spite of problems encountered in the development hardware. Therefore, the digital interface equipment must work in parallel with the existing manual control panel.

(2) Low cost is another important restriction. Where it is practical and performance requirements can be met, existing equipment must be utilized.

(3) Because ease of maintenance is important, the new equipment must be designed so that its digital interface is electrically and functionally compatible with the DSN standard, 14-line interface.

III. Design Detail

Figure 1 is a block diagram which shows where the digital equipment ties into one bay of the existing five-bay configuration control group. With the exception of the 14-line interface test fixture, all of the logic shown

by the function blocks is packaged in a single card file. The 14-line interface is fully compatible with the DSN standard both electrically and functionally. It double strobes the control lines and includes the capability of handling command and status byte interrupts. The 14-line interface logic is designed to be independent of this particular application so that it may be easily used as the digital interface for other assemblies of the microwave subsystem.

Figure 2 is a photograph of the card file. Figure 3 is a photograph of the 14-line interface test fixture. The test fixture contains a full capability 14-line interface which is controlled by toggle switches and is monitored by light-emitting diodes.

Figure 4 is a photograph of a relay assembly which is used for testing. It simulates the function of the relay assemblies existing at the deep space stations.

Figure 5 provides the detail of the electrical connection of the computer-controlled equipment to the existing configuration control equipment. The control connection is a wire "or" which permits operation using the manual control panel whether the interface adapter is operating or not.

The optical isolators provide a convenient means of reducing the 24-volt indicator level to the 5-volt logic level. However, they are expensive and, because of the quantity involved, account for a significant portion of the cost of the control logic. Ground loop problems do not exist because the control and indicator lines are isolated from ground to the antenna end of the line. While isolators were provided for the first tests, it is anticipated that they will not be required for noise rejection. If this proves to be the case, the level shift will be accomplished with low-cost zener diodes (80% savings).

Position control is accomplished with an 8-bit word which is decoded and used to actuate the relays. The 8 bits are received in parallel as one command byte in a 14-line interface transfer. Actually, only 5 bits are used at this time.

Position monitoring is accomplished with an 8-bit word which is returned to the computer as a status byte through the 14-line interface. Whenever data are requested by the computer, the multiplexer clocks through all 32 addresses. The clocking is accomplished by the asynchronous interlock signals which occur within the 14-line interface.

With the exception of the 14-line interface and the relay drivers, the logic is constructed using complementary symmetry metal-oxide semiconductor (CMOS) digital integrated circuits. If these devices prove to be durable enough to withstand the field environment, they will provide a significant reduction in power consumption when compared to standard transistor-transistor logic (TTL) devices.

IV. Progress and Plans

Both test fixtures (Figs. 2 and 3) and most of the logic cards for the cage have been fabricated and tested in the lab. The 14-line interface card is being revised to incorporate recent changes in the standard interface protocol. Some of the other cards are also being revised in order to simplify the logic. The plan is to complete all of the changes and lab testing by the end of June 1974. The control logic assembly will then be taken to Goldstone for testing using the 14-line interface test fixture. After tests at Goldstone are completed, the logic assembly will be returned to JPL for integration into the hardware and software package which is being developed for the FY 76 automation demonstration.

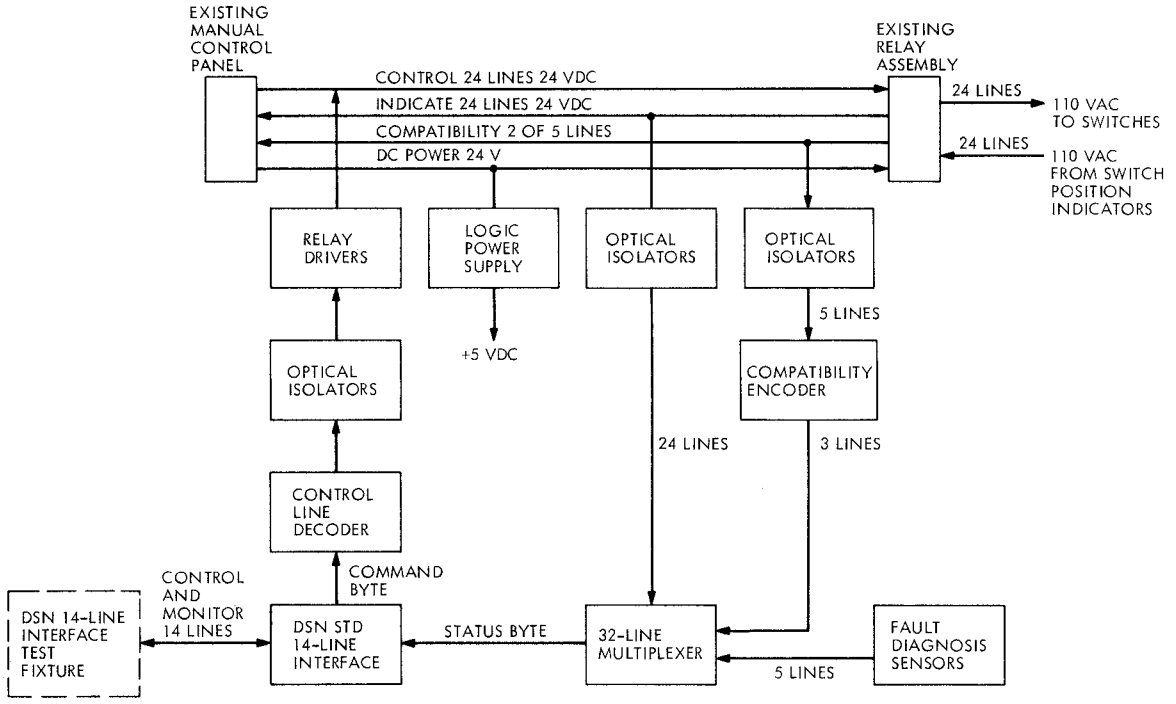

Fig. 1. Automation block diagram of configuration control group, single bay

Fig. 2. Logic card cage

Fig. 3. 14-line interface test fixture

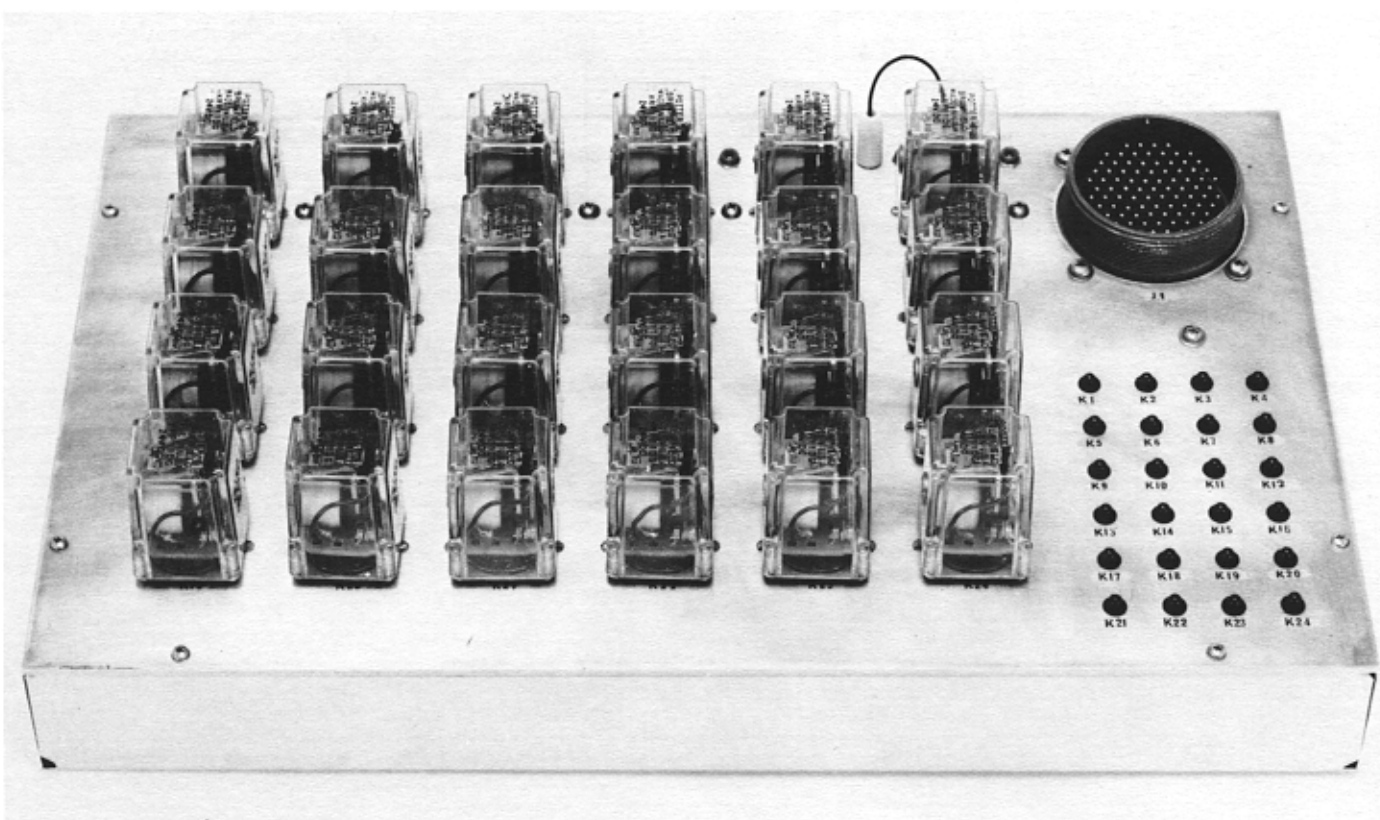

Fig. 4. Configuration control relay simulator

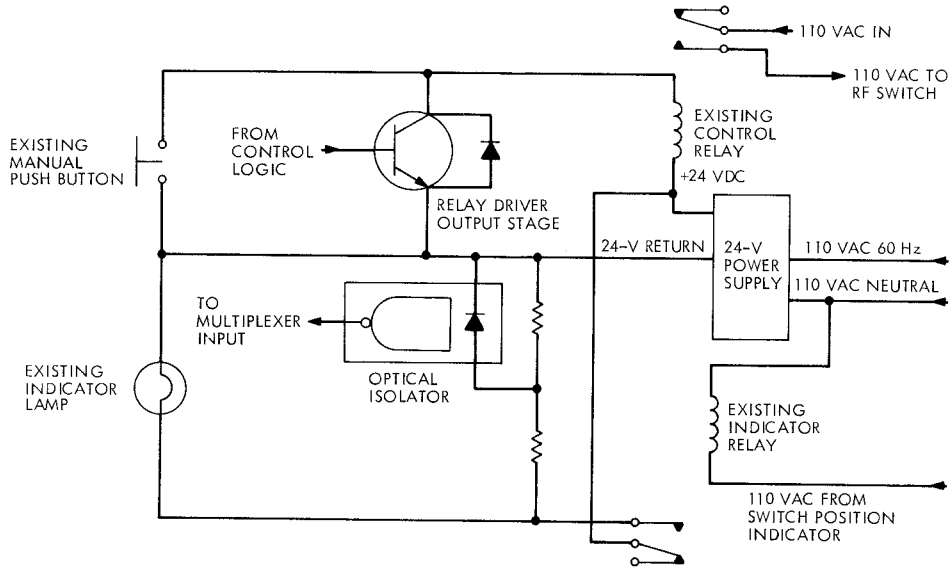

Fig. 5. Electrical connection of computer interface hardware to existing configuration control hardware