Multiple-Mission Command System

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The Multiple-Mission Command System (MMCS) Project was established in January 1969 to design, test, and install throughout the Deep Space Network (DSN) a command system capable of supporting all foreseeable spacecraft with a single command system. In order to provide support for the Mariner Mars 1971 (MM '71) Mission the equipment was required by early Fall of 1970. These objectives have all been met. All DSN stations considered prime for the MM '71 Mission have been implemented with the dual MMCS capability, including the PN sync units required for the MM '71 Mission. The DSN stations considered as backup stations for MM '71 have been implemented with dual MMCSs; however, only one PN sync unit per station was provided.

I. Introduction

The Multiple-Mission Command System (MMCS) Project was established in January 1969 to design, test, and install throughout the DSN a command system capable of supporting all foreseeable spacecraft with a single command system. In order to provide support for the *Mariner*-Mars 1971 (MM '71) Mission the equipment was required by early Fall of 1970. These objectives have all been met. All DSN stations considered prime for the MM '71 Mission have been implemented with the dual MMCS capability, including the PN Sync units required for the MM '71 Mission. The DSN stations considered as backup stations for MM '71 have been implemented with dual MMCSs, however, only one PN sync unit per station was provided.

II. System Verification Test

As an integral part of the MMCS implementation effort, system verification tests were conducted. These tests were designed to establish a means of evaluating the system's performance characteristics. The system was divided into three subsystem or assembly groups for individual evaluation and then combined for total system evaluation. These are as follows:

(1) Transmitter subsystem

(2) Exciter assembly

(3) Telemetry and command processor and command modulator assemblies

A. The Transmitter Subsystem

Performance measurements of the transmitter subsystem were made to evaluate the RF bandwidth, modulation distortion and modulation bandwidth. These measurements were made on both 10 and 20-kW transmitters.

B. Exciter Assembly

Performance measurements of the exciter assembly were made to evaluate the RF bandwidth, modulation distortion, and modulation bandwidth. These exciter measurements are applicable to DSS 71 and CTA 21, which do not have transmitters.

C. TCP and Command Modulator Assemblies

The TCP and command modulator assemblies were evaluated using a special program referred to as the MMCS demonstration test program (Ref. 1). This program was designed to evaluate the operation of the TCP and command modulator assemblies in all of its various operational capabilities, i.e., bit rate, subcarrier frequencies, modulation index, synchronous or nonsynchronous symbol clock, subcarrier frequency verification, etc. The program also contains functions for verifying the system interface such as exciter status and confirmation loop check, transmitter status checks and system monitor and control interface checks.

All of the prime MM '71 deep space stations have been fully tested and have been transferred to DSIF operations. The MM '71 backup DSSs have been implemented and tested; however, they will not be transferred to DSIF operation until the Fall of 1971 due to extensive reconfiguration effort required at these DSSs.

III. Command Modulator Assembly (CMA)

The CMA implementation was completed in the DSIF with the DSS 14 installation in December 1970. Because of subsequent problems encountered during *Mariner* Mars '71 operational support testing, three engineering modifications have been made to the CMA. These modifications were required to: (1) generate the PSK-PN modulated output waveform independent of the phase relation between the subcarrier and twice subcarrier signals; (2) provide better interface on long circuits between the CMA and the exciter; and (3) improve command transmission reliability. The description of each modification is as follows:

A. PSK-PN Output Modification

Inverted PSK-PN modulated output waveform (data "1" waveform for data "0" or vice versa) could be generated in the CMA dependent on the relative phase adjustment between the fundamental subcarrier and twice subcarrier signals that drive the PN generator. The modification consisting of logic changes ensures that the pseudo-Manchester coder and decoder start at the proper state independent of the phase relation between the two subcarrier frequencies.

B. CMA-Exciter Interface Modification

Long and unterminated signal wires from the exciter caused intermittent false sampling in the CMA. Pull-up resistor and capacitor networks were installed in the Verification buffer to maintain the input lines at positive voltage whenever they are switched to open state.

C. Command Transmission Reliability Modification

Negative spikes (below ground level) resulting from ringing on long interassembly wiring in the CMA caused unwanted circuit response to occur. The modification, consisting of diodes clamped to ground and a capacitive filter, were installed in the data input lines of the command register to protect against spikes which carried them below ground. Additional diodes clamped to ground were installed in the parallel output (POT) buffer for the input lines from the TCP.

A TCP/CMA interface study is presently in progress in order to improve the input interface signal characteristics. Future changes are expected to result from this study.

Reference

1. Crow, R., et al., "DSIF Multiple-Mission Command System," in *The Deep Space Network*, Space Programs Summary 37-63, Vol. II, pp. 78-79. Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1970.