For Network Personnel Only

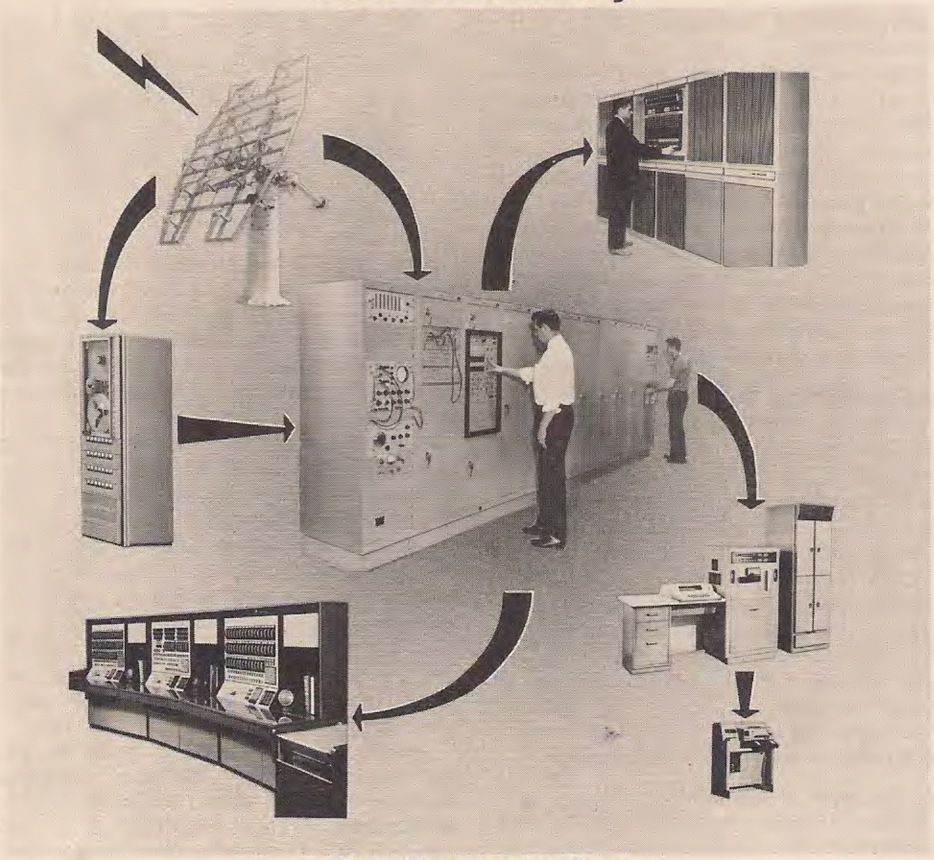
TECHNICAL INFORMATION BULLETIN

MANNED SPACE FLIGHT NETWORK

GODDARD SPACE FLIGHT CENTER, GREENBELT, MARYLAND

Vol. 3, No. 1 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION January 8, 1965

PCM Telemetry



PCM telemetry data flow.

As the Gemini and Agena spacecraft whirl about the earth, ground stations will monitor the condition of the astronauts and spacecraft by means of telemetered scientific, vehicle status, and biomedical data. Located at each ground station are two PCM (pulse code modulation) telemetry systems which will receive this data and convert it to forms suitable for transmission, display, and computation.

Telemetry data flow is as follows: Within the spacecraft, transducers sense various parameters such as temperature, light, acceleration, radioactivity, liquid level, etc., and convert them to proportionate electrical signals which are sent to a multiplexer where they are sampled, one at a time, and channeled to a programmer. The programmer accepts these analog signals, as well as digital signals from the on-board computer, command receiver, etc., encodes the analog inputs to digital, and multiplexes both the encoded and direct digital samples into a continuous serial bit stream. A synchronizer in the programmer provides signals which aid the ground station to synchronize with the airborne equipment. The output of the programmer modulates a real-time transmitter which converts the signal into PCM signals for transmission to the ground stations. Between passes, the programmer output is channeled to a tape recorder/reproducer where it is recorded and, upon command, dumped at high speed into a dump transmitter for transmission to the ground stations.

At the ground stations, the telemetry data is received by the PCM equipment where it is synchronized, decoded, and converted to binary, binary-coded-decimal (BCD), or analog forms. The various kinds of data words are then decommutated and channeled to their respective destinations, i.e., GSFC computers, graphic recorders, flight control consoles, etc.

The PCM system is a programmed data processor composed of ten subsystems, the functions of which are described in the following paragraphs.

INPUT SUBSYSTEM

The input subsystem accepts PCM data directly from a space vehicle through a receiver or from the tape recorder/reproducer, parallel digital data from the tape recorder/reproducer, or test signals from the auxiliary subsystem and reconstructs it into noise-free serial form. The incoming format can contain the MSB (most significant bit) first, or the LSB (least significant bit) first, and up to ten variable wordlengths within a frame, if the wordlengths are constant from frame to frame. The bit rates accepted range from 10 to 1,000,000 bits per second.

The reconstruction process includes acquiring bit-synchronization when the format is not accompanied by bit-timing pulses and reducing the effects of noise in the transmission link. Subsystem inputs may be switch selected. Test NRZC (non-return zero common) inputs from the auxiliary subsystem are selected only when it is desired to evaluate system performance. Regardless of the source selected, reconstructed serial PCM in NRZC form and bit-timing pulses are supplied to the serial-to-parallel conversion (SPC), digital synchronization, and parity subsystems. When it is desired to evaluate input subsystem performance, conditioned NRZC or parallel-to-serial converted NRZC is applied to the auxiliary subsystem for monitoring purposes. During normal mission operations when the incoming format is reconstructed to reduce the effects of noise, the input subsystem also supplies conditioned NRZC and NRZM (non-return zero mark) and associated bit-timing pulses to the distribution subsystem for application to external equipment.

SERIAL-TO-PARALLEL CONVERSION SUBSYSTEM

The SPC subsystem converts the reconstructed serial NRZC output of the input subsystem to parallel binary and binary-coded-decimal (BCD) forms. The converted outputs are applied to the binary and decimal displays subsystem for visual monitoring and to the distribution subsystem for application to external equipment. Serial NRZC from the input subsystem can be in MSB first or LSB first format; however, the outputs supplied to the binary and decimal displays subsystem and the distribution subsystem are scaled from MSB to LSB, with the MSB occurring first. The SPC subsystem also supplies parallel binary inputs to the digital synchronization subsystem which are used to synchronize the incoming format.

BINARY AND DECIMAL DISPLAYS SUBSYSTEMS

The binary and decimal displays subsystem provides visual indication of selected words in both the parallel binary and BCD outputs of the SPC subsystem. The binary output is displayed in binary form while the BCD output is displayed in decimal form. The binary and decimal displays subsystem is capable of displaying both the binary and BCD multiplexes for any single word of any single frame at sub-decommutation ratios up to 200:1, or for any single word during every frame.

(Continued on next page)

PARITY SUBSYSTEM

The parity subsystem monitors the reconstructed serial NRZC output of the input subsystem for transmission dropout when the incoming format contains parity information, or generates parity when the incoming format does not contain parity information. The subsystem can check for even or odd parity, or it can generate even or odd parity with both operations restricted to the data and parity content of words only. When checking for parity, the number of errors accumulated for a selected number of frames is displayed where the display feature is also used to monitor outputs of the auxiliary subsystem during certain system evaluation operations. During the parity check or generation operation, the subsystem provides a parity output to the distribution subsystem for application to external equipment.

DIGITAL SYNCHRONIZATION SUBSYSTEM

The digital synchronization subsystem generates timing signals that synchronize the operation of the PCM system with the incoming PCM format. These timing signals identify bits, words, frames, and subframes. Generation of the timing signals is based on recognition of sync information contained within the PCM format which the digital synchronization subsystem is preprogrammed to recognize. The timing signals are applied to various subsystems to ensure that operations are performed at the proper time. Since words, frames, and subframes are identified, the digital synchronization subsystem permits specific data within the PCM format to be selected for application to external equipment. Internal logic decisions (sync status) indicating the confidence level of timing signals generated by the subsystems are visually monitored at the word, frame, and subframe levels. Word, frame, and subframe sync status outputs are also supplied to the distribution subsystem for application to external equipments. Bits/word, words/frame, and frame/subframe timing pulses are used within the subsystems to generate output timing signals. Readout commands and word, frame, and subframe numbering (identification) signals are also made available as system outputs.

FORMAT SELECTION AND DISPLAYS SUBSYSTEM

The format selection and displays subsystem provides the means of selecting the program that corresponds to the incoming format and also identifies the program selected. Format selection is performed by electronic switching.

ACQUISITION PATCHBOARD SUBSYSTEM

The acquisition patchboard subsystem provides the capability of preprogramming the PCM system for different formats. Four patchboards contained within the acquisition patchboard subsystem are preprogrammed to comply with mission formats that the system may encounter; however, only one format is processed at a given time. The subsystem supplies inputs to the input subsystem, parity subsystem, SPC subsystem, and portions of the digital synchronization subsystem.

DISTRIBUTION PATCHBOARD SUBSYSTEM

The distribution patchboard subsystem programs the PCM system for the various decommutation functions. This subsystem contains four patchboards preprogrammed for different decommutation functions; however, only one preprogrammed board is used at a time. Selected transfer commands and binary data applied to the distribution subsystem determine what data within the incoming format is decommutated for application to external equipment.

DISTRIBUTION SUBSYSTEM

The distribution subsystem supplies system outputs to the proper external equipment. It also converts the eight most significant bits of binary data from the SPC subsystem into analog form. On/off data is derived from the selected binary data inputs from the distribution patchboard subsystem. With the exception of the analog, on/off, and decommutated BCD data outputs, system outputs are available at all times. Analog, on/off, and decommutated BCD data are available only upon command from the distribution patchboard subsystem.

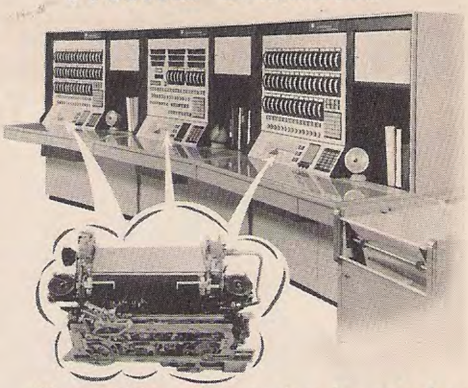
AUXILIARY SUBSYSTEM

The auxiliary subsystem contains all equipment that is not directly related to decommutation and display of data. It includes the self-check function of the system, a PCM simulator, various test equipment used for calibration and maintenance purposes, system power supplies and blowers, and power distribution equipment. During the system evaluation operation, the self-check function supplies the test signals inserted into the system through the input subsystem. Simulated PCM formats in the form of test signals can also be inserted into the system through the input subsystem. Through the use of the test equipment supplied, waveforms can be observed, pulse-repetition rates can be determined, analog output voltages can be measured, test configurations for any part of the system can be set up, and a malfunction can be isolated to a stage on a printed-circuit card. The dc power output of the auxiliary subsystem can be raised or lowered to determine which circuits may fail under these marginal conditions.

Correction

Under the About Documentation Column in the December 25 issue of TIB, DST-503A-2 DRUL should have read DST-503A-1 DRED.

Console RO Paper-Feed Problem Evaluated



The MFOD engineering branch has completed an extensive evaluation of the paper-feed problem that stations have been experiencing with the display console RO's and has concluded that the primary problem is maintenance procedures.

Since the display console RO's differ from the standard RO in that they employ a sprocket-drive paper feed and are housed in a different console, their alignment procedures are slightly different. The peculiarities in the alignment procedures are outlined in EM-39, Peculiar Adjustment Procedures for Display Console RO Teletypes, which, when used in conjunction with ME-520 to align the RO's, should eliminate any paper-feed problems.

An EI will be issued soon to modify the display console RO's by replacing the 9-inch platen with a standard 8-1/2-inch platen. This modification is not intended to improve the paper-feed mechanism but it will allow standard size paper to be used in the RO's.

About EI's

The following Engineering Instructions were issued during the past two weeks:

- EI 877A (TWX follow-up) Display System Retrofit (MSCC, RKV, CYI, CSQ, HAW, GYM, TEX, WLP, CRO)
- EI 891 Interim FR100 Recorder Mod (CSQ)
- EI 962 RF Command Radiation Safety Switch (BDA, RKV, CYI, CSQ, HAW, TEX, WLP, CRO)
- EI 968 Meter Alarm Test and Mode Select Switch (MSCC, RKV, CYI, CSQ, HAW, GYM, TEX, WLP, CRO)

The *Technical Information Bulletin* is published biweekly by the Manned Flight Operations Division for network personnel only. Since information contained herein may not have been released outside the project organization, it is to be considered privileged. Release of this information to others must be approved by the Public Information Office, GSFC. Address other communications to TIB Editor, NASA, Goddard Space Flight Center, Code 552, Greenbelt, Maryland 20771, or use the MSFN teletype facilities.