HIGH RATE PCM DATA
RECEIVING, RECORDING AND RELAYING

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ABSTRACT

This paper discusses the specific applications at White Sands Missile Range to certify the airborne telemetry packages, to receive, relay, and record Pulse Code Modulation (PCM) telemetry data.

One of the most critical areas of data transmission throughout the Range is that of telemetry data. As digital data transmission becomes more commonplace, it becomes necessary to develop new methods for receiving, relaying, and recording digital telemetry data. A recent requirement to support reception, relay, record, and processing of a ten-megabit PCM telemetry signal drove the development of the system described in this paper. New receiving equipment was procured in order to handle the high bandwidth.

Two new methods are now being used at White Sands Missile Range to relay high rate PCM data.

- One is the Lightwave Fiber System. There are four telemetry lightwave links presently being used at WSMR: a multiple fiber link from the Master Relay Control Station (Jig-56) to the Telemetry Data Center (TDC), a duplex link between Jig-56 and Launch Complex 37, a simplex link from Chin Site to Jig-56 and a simplex link at Holloman Air Development Center.

- The second method is the Digital Microwave Links from a TransportableTelemetry Acquisition and Relay System (TTARS) to Jig-67 and from Jig-67 to Jig-56.

AIRBORNE TELEMETRY SYSTEM

All airborne telemetry systems must be tested and certified by White Sands Missile Range in accordance with WSMR Regulations 105-10 and 105-11. The telemeter shall then be certified by the Telemetry Branch to ensure compliance with the IRIG Telemetry Standards. Telemetry Branch personnel will assist the Projects in setting the proper carrier deviation and certify that the telemetry package is compatible with the Range Relay System. A portable RF test rack is used at the missile assembly buildings to test and certify the airborne telemetry packages.

TRACKING SYSTEMS

The systems described below are all located on the forty-by-one-hundred-mile White Sands Missile Range. Jig-56 is located at the extreme south end of the forty-mile east-west expanse. Jig-67 is located at Alamo Peak just outside the eastern boundary of the Range. Jig-10 is located on Atom Peak near North Oscura Peak at the north end of the range.

Jig-56 uses a 15-foot parabolic antenna to cover all of the South Range launch areas. Jig-67 and Jig-10 use 24-foot parabolic antennas to cover the mid-trajectory and terminal phases of a missile test (Figure 1). Seven Transportable Telemetry Acquisition Systems (TTAS) are used throughout the Range to support multiple object test scenarios or to provide redundant coverage. These data are microwave relayed from several sites on and off the Range to (Jig-56) and then to (TDC).

RECEIVING SYSTEMS

All of the telemetry receiving systems consist of right and left circular polarization RF channels which are fed into a diversity combiner (Figure 2). The combined signal is tape recorded in pre-detection and video composite form. The combiners' ten-megahertz IF signal is applied to the Telemetry Acquisition Relay System (TARS) for relaying to (TDC). PCM data is "conditioned" using a PCM bit synchronizer whose output can be applied to a digital multiplexer and relayed over the digital microwave system. The bit synchronizer output can also be directly modulated onto the TARS microwave baseband along with other data channels. The telemetry receivers are the latest model microprocessor-controlled state-of-the-art receivers. The standard configuration consists of two receive channels (left hand circular and right hand circular polarizations) and an optimal ratio combiner. Wideband receivers with Intermediate Filter (IF) bandwidths of 15 and 20-megahertz are also available.

RELAY SYSTEMS

Three different methods are used at White Sands Missile Range to relay high rate PCM data.

- The Telemetry Acquisition and Relay System (TARS) accommodates NRZ-L PCM data rates from 100-kilobits per second to five-megabits per second in addition to several IF converted signals on the TARS baseband channels.

- The Digital Microwave Radio System (DMRS) is used to relay two high rate PCM data streams to Jig-56. The highest rate is 11.5-megabits per second. As many as twenty data streams at one-megabit rates can be relayed on the DMRS by applying ten PCM data streams to the inputs of two intelligent multiplexers (Figure 3). The intelligent multiplexers will accept from one to ten data streams with an aggregate rate not to exceed 11.5-megabits per second. Digital microwave equipment is installed at Jig-10 and equipment is available for the prototype mobile relay link into Jig-56. The DMRS RF bandwidth is twenty-megahertz. The capacity of the DMRS is forty-five megabits per second. This is accomplished by using eight level Phase Shift Keying (8PSK) modulation.

- The Telemetry Lightwave System (TLS) can accept PCM data rates of 100-kilo- bits per second to forty-five megabits per second. The single mode fibers can accomodate five hundred and twenty-five megabits of digital data. The limitation of forty-five megabits per second is due to the input conditioning circuitry of the transmitter and receiver modules. The laser diodes used in the TLS operate on an emission wavelength of 1300 nano meters and can handle from one megabit per second to five hundred megabits per second. The TLS consists of four fibers between Chin Site and Jig-56, two fibers between Launch Complex 37 and Jig-56, two fibers between Elephant Mountain and Jig-56, and six fibers between the Range Control Center and Jig-56 (Figure 4).

Most t of the light wavelinks are used in a simplex mode (one-way). Some are used in a duplex mode (two-way). The duplex links provide a means of “loop-back” quality assurance testing, and tape recordings to prove that the lightwave links were transparent during a Range test.

AUTOMATIC SYSTEM CALIBRATOR

For link verification, the Automatic System Calibrator (ASC) is used to simulate the missile telemeter. The ASC is modulated with an IRIG Standard Psuedo Random Bit Stream (PRBS). The transmitted ASC signal is received by all of the tracking and receiving sites, and relayed to the TDC. A “loop-back” channel from TDC to Jig-56 is used to measure the Pit Error Rate (BER) performance of each acquisition/receiving/

relaying site. The BER test performed before the missile firing verifies that all systems are configured and working properly and that the analog, digital, and lightwave relay systems are transparent.

HIGH DENSITY DIGITAL RECORDING

Recording High Rate PCM Data -- IRIG Standard wideband, magnetic tape recorders are used to record the PCM data. Up to six megabits of randomized NRZ-L data can be direct recorded at 240 inches per second. Higher data rates are recorded using parallel high density digital recording formatters. Data rates up to 20 megabits per second can be recorded using the existing high density digital formatters. The extensive use of encrypted telemetry data required implementation of new procedures to ensure that the telemetry receiving and relaying links are transparent.

New procedures have been implemented to produce high quality magnetic tape recordings of PCM signals. The procedures include conditioning the magnetic tape and recording a PCM tape signature.

LIST OF ILLUSTRATIONS

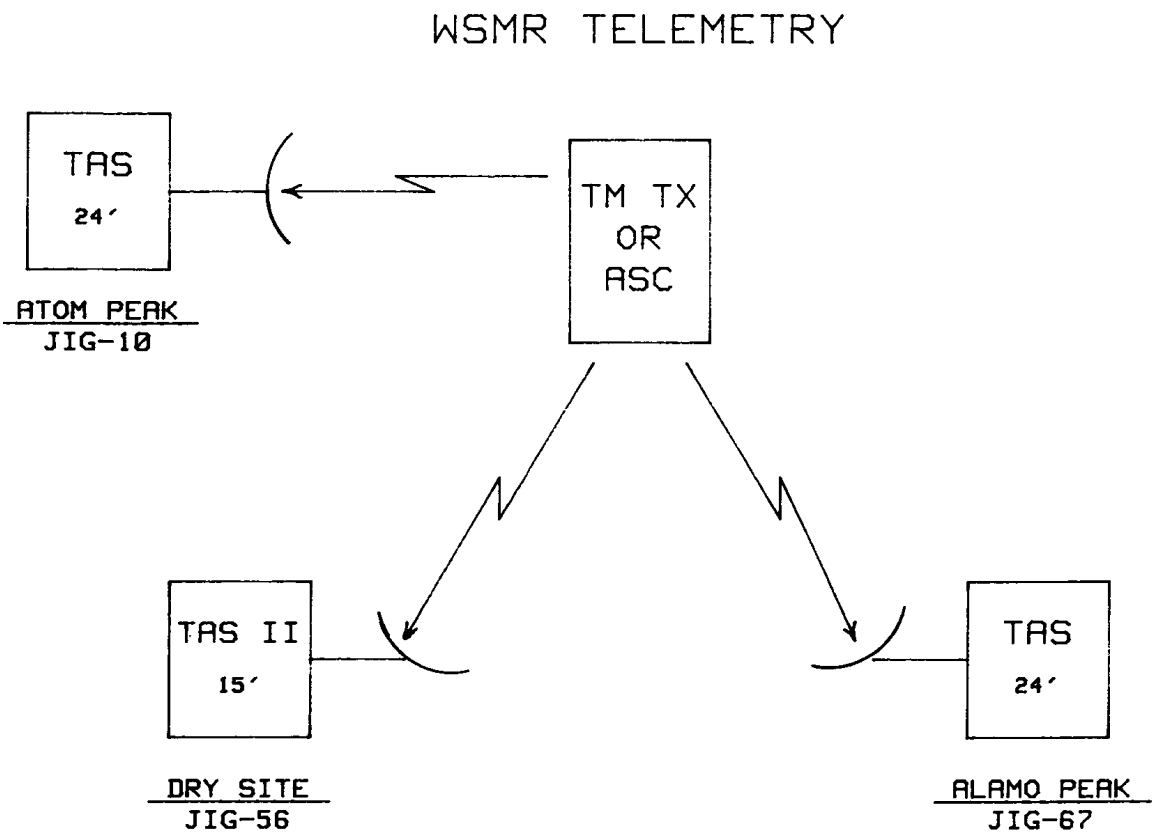

FIGURE 1

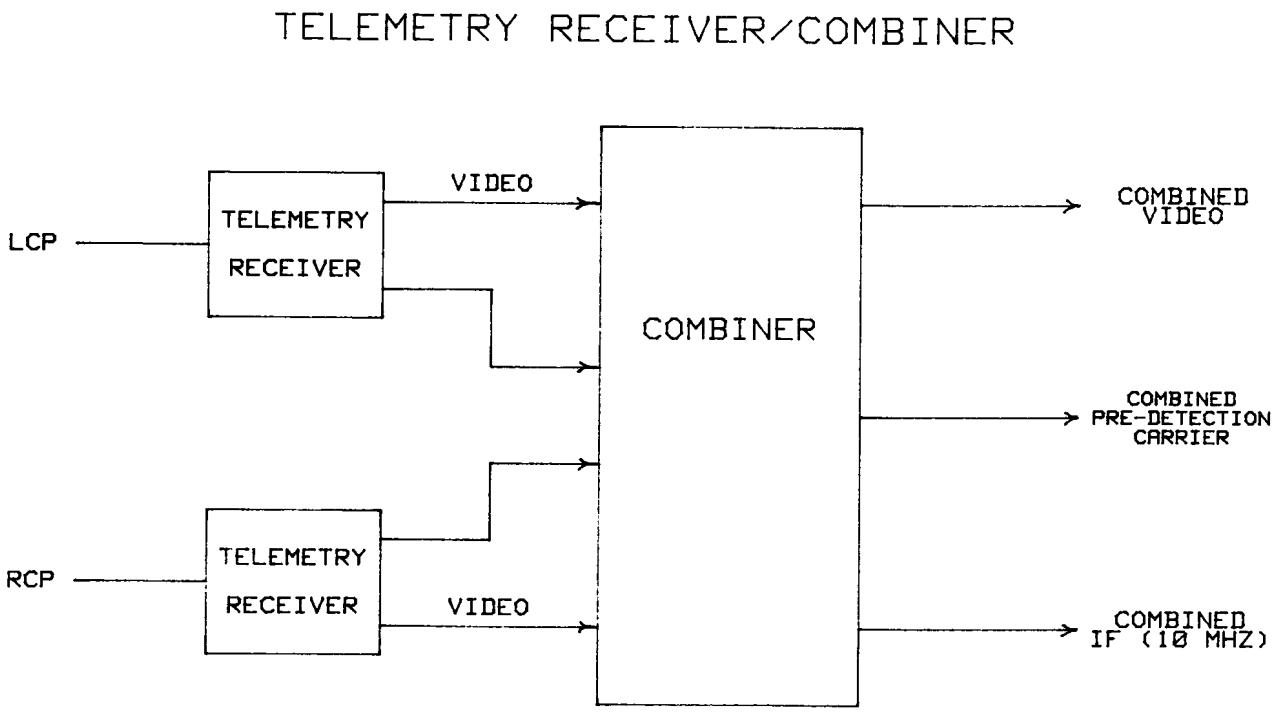

FIGURE 2

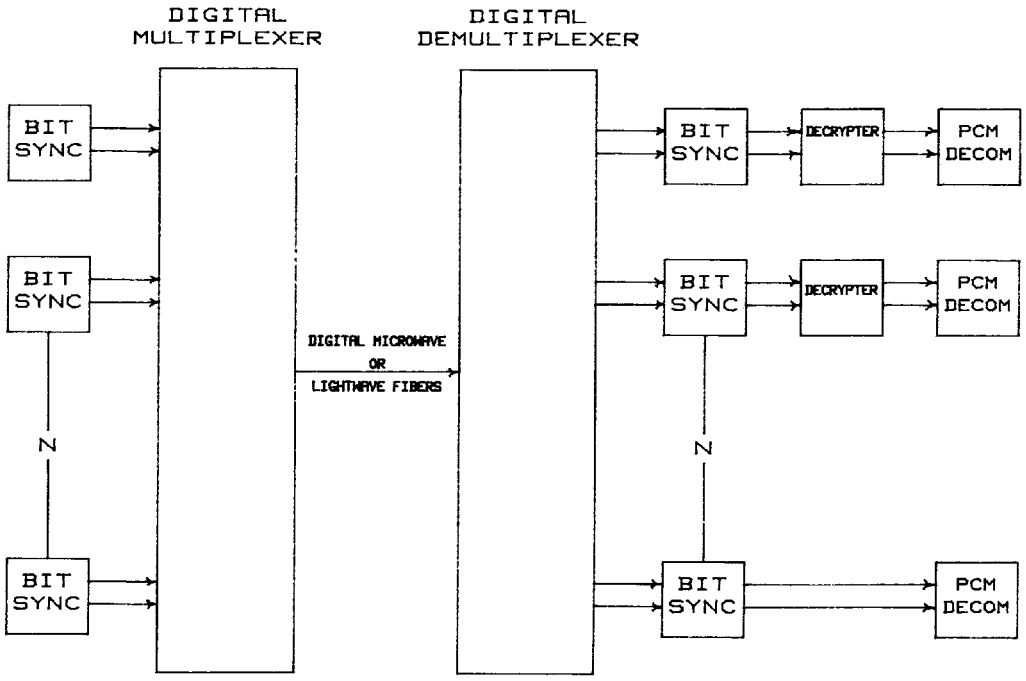

FIGURE 3

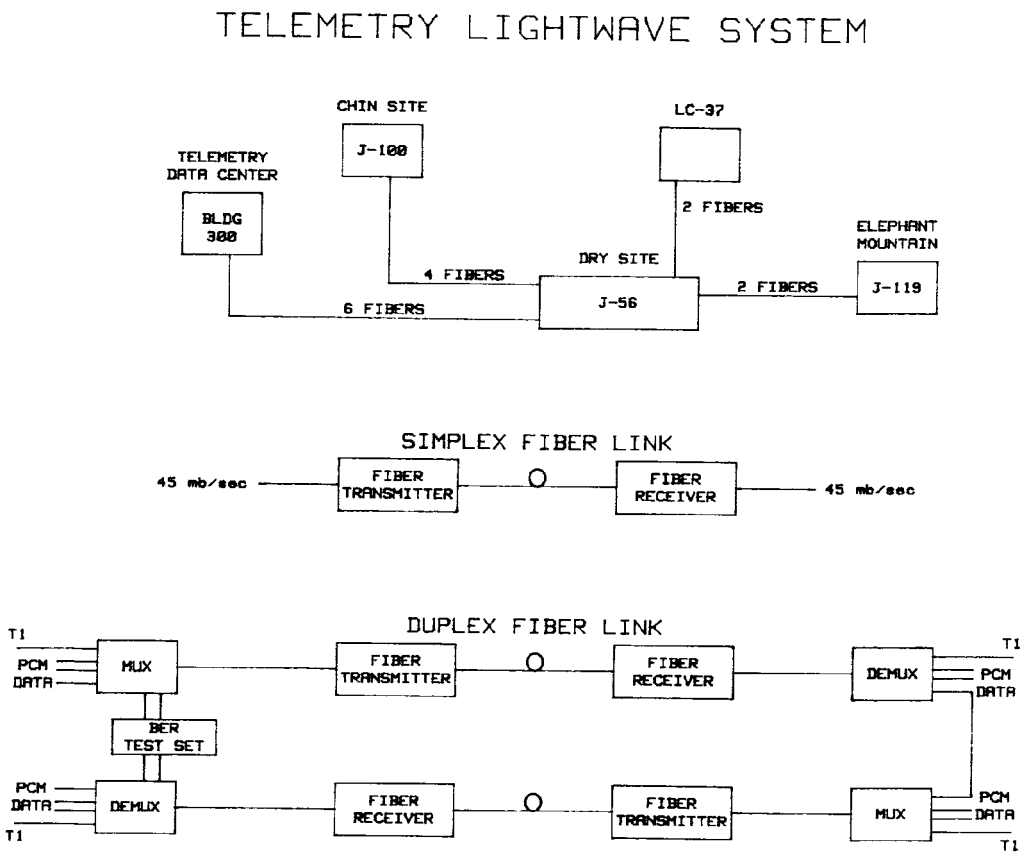

FIGURE 4