PUTTS II PORTABLE UHF TELEMETERING TEST SET NATO INTERNATIONAL TELEMETERING SYSTEM

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With the change in Missile Telemetry frequencies from the VHF band to the UHF band in 1972, the requirement for a new high frequency portable TLM RF receiving set was apparent.

Since a new common modulating format had been standardized, PAM/FM/FM combined with FM/FM, it was apparent a full new receiving ground station on a portable basis could be assembled around new, commercially produced hardware.

Inasmuch as the first of the test firings for Point Defense Missile would be in early 1972, Naval Ship Weapon Systems Engineering Station (NSWSES) was tasked by Point Defense to design and assemble one Portable TLM system around commercial hardware, with system design and final assembly accomplished by NSWSES. This system must be able to be hand carried, hand loaded and be installed as a portable TLM system on any of the smaller Point Defense equipped ships.

Figure #1 shows the original PUTTS system as designed and assembled utilizing standard commercial hardware in the period of October 1971 through January 1972. The basic system weighed less than 600 pounds.

This original system has been used since 1972 both on United States and Foreign ships with highly successful results. However, due to the basic design of commercial hardware - non-ruggidized, further system assembly was delayed until MTBF and hardware problems could be assessed - after two years of operation - with no hardware failures - it appeared that standard, well-built commercial hardware could be used for portable fleet monitoring without hardware failure.

In October 1974 the NATO SEASPARROW group in Washington, DC, advised it would like to purchase five new updated systems for Belgium, Denmark, Netherlands, Norway and Italy. This system to be updated to the latest state of the commercial art circa 1975.

PHYSICAL DESCRIPTION

The complete PUTTS II system consists of six separate units, Auto-Track Antenna/ Receiver Group, Data Processing Section, Magnetic Tape Unit, Spectrum Analyzer, CRT Visicorder, and Dynamic Test Set. All units operate from 110/120 VAC 50/60 Hz power.

The RF Assembly (Figure #2) measures approximately 24" x 12" x 20" plus the radome of 18" diameter and 15" high, (4 element array) or 24" diameter and 15" high (12 element array) for a volume of 7.5cubic feet. Its approximate weight is pounds. It consumes approximately 110 watts of power. Its removable, fiberglass dome protects the Auto-Track Antenna array. A plexiglass front door a-lows access to power switches, manual tracking controls, receiver tuning, and remote control unit which is stored in the base. A side door allows access to control circuits and cabling.

The Remote Control unit can be removed from the antenna base and connected to the antenna through a cable for use. It consumes less than 10 watts of power which it receives from the Antenna-Receiver Group by way of the cable. Controls include: Local-Remote control switch, Manual-Automatic mode switch, Clockwise-Counterclockwise manual antenna rotation switch, Nanual antenna rotation velocity adjustment potentiometer. Displays include a 1:1 servo antenna position pointer and a servo error indicator. These controls and indicators are identical to those of the Antenna-Receiver Group Control Unit in placement and function.

The Data Processing Section (Figure #3) measures approximately 20" x 22" x 36" for a volume of 9.2 cubic feet. Its approximate weight is 200 pounds. It consumes approximately 325 watts of power. The data processing section has front and back removable protective covers exposing all controls and connectors. Five distinct sub-units comprising the section are: A Time Code Generator/Reader, the Master Control Panel, PAM/PDM Synchronizer, Demultiplexer, Discriminator Bank, and Detranslator.

The Magnetic Tape Unit (Figure #4) measures approximately 26" high x 17.5" wide x 16" deep for a volume of 4.25 cubic foot. Its approximate weight is 150 pounds. It consumes approximately 500 watts of power. A protective, front, transparent door exposes the tape deck, 10 1/2 inch tape reels and head assembly. Also on the front panel, but outside the door, are power and operate controls, mode switches and Record/Reproduce level indicators.

The Spectrum Analyzer unit (Figure #5) measures approximately 5 1/4" high x 16 7/8" wide x 16 7/8" deep for a volume of approximately .86 cubic foot. Its approximate weight is 31 pounds. It consumes approximately 160 watts of power.

The Oscillograph Recorder (Figure #6) unit measures 9.4" high x 17.1" wide x 21" deep for a volume of approximately 1.95 cubic feet. Its approximate weight is 75 pounds. It consumes approximately 150 watts of power. The unit is a standard eighteen channel fiber-optic cathode ray tube oscillograph speeds using 8" wide paper. Included is an ultra violet paper developer.

BOX 1 RF ASSEMBLY

The antenna differs from the conventional tracking system in that it tracks in the azimuth plane only. The majority of telemetry tracking operations are relatively short range missions and the antenna has a relatively broad beam width which can be satisfied by auto-tracking the aximuth motion of the test vehicle.

Elimination of the elevation tracking axis reduces antenna size and weight, improves reliability, and minimizes multipath problems which can cause loss of track and loss of telemetered data.

Two basic antenna subsystems have been developed for use in a portable telemetry receiving system. The antenna subassembly consists of a 4 or 12 element array, (Figure #7) polarization hybrids, monopulse hybrids, compaator and scan converter. These antennas are a four element, in-line cross dipole array with an extremely broad elevation beam width and a twelve element cross dipole array in a two element high by six element wide configuration. Either array can be mounted on the same base and can be interchanged.

All components are stripline to minimize loss and to enhance reliability. The received energy is converted into sum and difference signals in the 90° comparator hybrids and processed into a composite RF signal which contains both data and error information in the stripline converter.

The purpose of the pedestal is to support and position the antenna. The pedestal consists of a rectangular cabinet type base which houses the servo, the rotator, the local controller, two telemetry receivers and provides storage space for the remote controller. The rotator is mounted to the upper surface of the cabinet.

The rotator consists of a servo drive motor coupled through precision spur gears to the antenna mounting flange. Positioning data is provided by a synchro torque transmitter which is coupled through antibacklash gearing.

To permit continuous rotation of the antenna, slip rings and a rotary joint are included in the rotator subassembly. Slip rings are used to transfer the drive signal to the scan converter power to the preamplifier.

The servo system is a high performance linear d-c solid state design. Type II configuration is used in the auto-track mode and a variable rate velocity loop is used in the manual mode.

TELEMETRY/TRACKING RECEIVERS (Figure #8)

The demodulated FM information and AM tracking signals are supplied by two FM/AM Telemetry/Tracking Receivers. The small, horizontal space provided by the antenna/RF pedestal necessitated the design of these receivers to fit the available space. They have been designed so that two receivers may be placed in a single 19-inch rack side by side (for other applications or may be placed one on top of the other as is done in the PUTTS system where a limited amount of horizontal space is available.

The design concept of the receiver was to utilize existing front panel plug-in RF tuning units (including the Remote Tuning versions), and existing internal modules from a commercial/telemetry Receiver which is an industry standard. As such, the concept of front panel plug-in IF bandwidths and demodulator types were sacrificed to provide a single bandwidth FM/AM only receiver. IF bandwidth and FM demodulator bandwidth may be changed in the field by changing internal removeable modules. The full reange of IF bandwidths (10 kHz to 6 MHz) and FM demodulator bandwidths (narrow, intermediate, and wide) are available. A single cuttoff-frequency video filter is provided in lieu of the switch selectable multiple filters.

The use of circuitry from an existing receiver provided a maximum of reliability in the field, while the modular construction provides ease of maintenance on a modular basis.

RF TUNING UNIT

The Tuning Unit covers the required 2200 to 2300 MHz tuning range. The noise figure of the tuning unit is 10.0 dB which, with a 1.0 MHz bandwidth, will provide tracking data to -98 dBm input (6 dB IF S/N ratio) and FM data to -92 dBm (12 dB IF S/N ratio).

The RF Tuning Unit may be remotely or locally tuned in the VFO mode with the frequency of operation displayed on a front panel digital readout counter. The counter has an accuracy of ±10 kHz. A ten-turn conductive film potentiometer is provided on the front panel to set the tuned frequency. There are no mechanically tuned elements in the tuning unit other than the ten-turn tuning potentiometer. All tuning is done electronically.

IF FILTER/AMPLIFIER

A high performance 1.0 MHz 3 dB bandwidth 2nd IF Amplifier/Filter is provided in the receiver. The replaceable module has a 60 dB to 6 dB bandwidth ratio of 3.0 maximum and phase linearity of ±8 degrees over 80% of the 3 dB bandwidth. FM intermodulation due to delay distortion is thus kept to a minimum

The module utilized FET active devices to provide a very linear gain control curve (dB gain vs. control voltage). This is desirable to prevent changes in AGC loop gain which causes attendand changes in AGC time constant. Changes in AGC time constant may affect the tracking performance of the receiver.

FM DEMODULATOR

The standard wideband FM Demodulator was repackaged in a smaller internal module. It has a 1.2 MHz ±3 dB video response and a linearity of 1% over the 1 MHz IF bandwidth. A limiter with 50 dB of overdrive is incorporated in the FM Demodulator to provide good AM rejection when receiving signals having large level variations due to signal dropouts which may be too fast for the AGC system to follow. The limiter also rejects the AM tracking signal superimposed on the RF Carrier.

VIDEO FILTER

A single bandwidth, 500 kHz 3 dB cutoff frequency, video filter is supplied as standard. The relatively wide bandwidth is required since the system must pass a video doppler carrier which may range up to 350 kHz. There is also a 276 kHz ±15% subcarrier. The video filter may be changed to other bandwidths for system optimization by changing the video filter module.

BOX 2 - DATA PROCESSOR

The demultiplexer contains a master control panel or system integration, a PAM decommutator, a bank of automatic calibrating subcarrier discriminators and a time-code generator/reader. The individual units are modular in construction.

MASTER CONTROL PANEL

The Master Control. Panel (Figure #9) contains relay logic and switches for routing telemetry data and various signals to the data processing equipment and records for in-flight recordings, playback and system testing. The front panel controls are divided into two groups: the left side for testing and the right side for operations.

The Master Control Selector switch is divided into three modes of operation: Real Time, Playback and Testing. In the real time mode, Telemetry 1 (TM1) or Telemetry 2 (TM2), PAM or wideband FM functions are selected for in-flight (real time) readout on the oscillograph, along with timing signals and video doppler data. All data are recorded on magnetic tape in the real time operating mode.

During the playback mode of operation, TM1, TM2, wideband FM or scoring data may be recorded on the CRT visicorder with timing signals. The video signals may be played back at a reduced tape speed for video doppler rolloff display on the missilizer.

PAM or FM signals are routed to the decommutator and discriminators for system test and alignment during the test mode of operation.

The test point on the left side of the MCP may be used to monitor selected signals during operations or system testing. Selector switches are used to monitor the seven input and output tracks of the tape recorder, discriminator output, decommutator input, selected decommuteted channel output, IRIG “B” or IRIG “E” timing signal.

Other front panel controls include a master circuit breaker for system power, power switches to rear panel receptacles for receiver, missilizer and demultiplexer system, tape recorder remote controls, and manual event marker. Jacks are also included for a microphone and headset for voice annotation.

There are three output signals routed to the MCP from the receivers: two video signals containing the telemetered data and the AGC signal from the tracking receiver. The video and AGC signals are routed to the MCP for additional processing and distribution.

The AGC signal from the tracking receiver is routed to the modulator/demodulator in the MCP and is used to modulate a 14.5 kHz voltage controlled oscillator (VCO). The output of the VCO is mixed with other data: Voice, Timing (IRIG “E”), Event, and 100 kHz tape speed reference tone. The composite signal is then recorded on magnetic tape.

The video signal is routed to a selector switch: NSS (NATO SEASPARROW)/TTS (TERRIER, TARTAR, STANDARD MISSILE). Other missile systems are acceptable although not listed. In the NSS position, the signal is routed through a combination high pass/low pass filter. The output of the high pass filter (200 kHz) is the 240 kHz subcarrier oscillator modulated by the PAM signal. Both outputs are recorded on magnetic tape. Either output may be selected for display on the CRT visicorder. The video doppler information is recorded on the CRT visicorder in real time or may be played back at a reduced tape speed at a later time.

With the NSS/TTS selector switch in the TTS position, the video signal is routed through a combination high pass/low pass filter. The output of the low pass filter (75 kHz) is the PAM signal. The output of the high pass filter (100 kHz) is a video dopplcr signal if applicable. The PAM signal from the log pass filter modulates a 450 kHz VCO. The output of the VCO is recorded on magnetic tape and is routed through a 450 kHz discriminator to the decommutator for analog readout on a CRT visicorder. The output of the high pass filter is recorded on magnetic tape for playback at a later time.

IRIG "B" (modulated carrier) timing is also recorded on the magnetic tape.

Although the composite signal (timing, voice, AGC, reference tone and event) recorded on the magnetic tape is primarily for use by data analysis personnel at a land base site, it can be used during playback operations at the recording site. Timing, voi-e and event are readily available through the demodulator unit. AGC and the 100 kHz reference tone can be obtained by routing the signals through appropriate discriminators and filters.

DECOMMUTATOR

The PAM decommutator provided signal conditioning, synchronization, and data conversion for a broad range of pulse-ainplitude-modulated (APM) signals. The unit accepts either PAM-NRZ (non-return-to-zero) and PAM-RZ (return-to-zero) signals at channel rates between 10 channels per second to 100,000 channels per second (limited to 50,000 channels per second in (PAM-RZ mode). After synchronization, each channel of the serial input pulse train is converted to a ten-bit parallel binary word which is available as an output on the rear panel. The signal is further processed and compared against "zero" and "full scale" reference levels and then converted back to an analog signal for recording on the CRT visicorder.

The input signal to the decommutator may be either "real-tine" (in flight) or "playback" (post flight) from a magnetic tape recorder.

The analog readout data is selected from a diode matrix program board. Up to twelve channels can be programmed in any combination for simultaneous display on the strip-chart recorder. Super-commutated channels of one function count as one read-out channel.

Pre-program boards are offered to facilitate operations. Up to four readout formats can be pre-selected and the boards interchanged for real time or playback readout on the strip-chart recorder.

DISCRIMINATORS

The sub-carrier discriminators are used to separate FM/FM data for recording on the strip-chart recorder. The units offered were selected for use with the various SEASPARROW Exercise Heads. Other frequencies are available and can be interchanged in the discriminator housing.

The PAM signal from TERRIER, TARTAR, STANDARD is used to modulate a 450 kHz subcarrier oscillator prior to recording on a direct track on the magnetic tape in lieu of using a FM track on the tape recorder. The 450 kHz discriminator is used to recover the PAM signal for decommutation. This discriminator is also used to recover the PAM signal when an AN/SKQ-2 or AN/SKQ-3 magnetic tape is played back through the PUTTS system.

The discriminators contain an automatic self-calibration feature. Each discriminator can be calibrated individually from the front panel or all can be calibrated simultaneously from the master control panel.

When a CAL COMMAND signal is received, the discriminator’s input is automatically switched to a crystal frequency oscillator and the discriminator’s output is adjusted to 0 V with an error of less then ±10 mV. Upon completion or the ZERO calibration, the discriminator’s input is automatically switched to an upper bandedge crystal oscillator and the discriminator’s gain is automatically adjusted to give an output of ±10V with an error of less than ±20 mV. (Other output voltages are avaiTable.) The calibration time is less than 2 seconds.

The logic, comparators and precision voltage references required for automatic calibration are a part of the discriminator main frame. The center and upper bandedge frequency crystal oscillators (referenced to internal crystal oscillators which are accurate to within .001%) and switching logic are a part of the channel selector. This allows complete freedom in system configuration by eliminating the need for external logic, voltage or frequency references. The front panel “zero” and “gain” controls are eliminated with the auto-cal feature. Thus the possibility of operator error is eliminated.

TIME CODE GENERATOR-READER

The time code generator is capable of generating a modified IRIG “B” and a modified IRIG “E” timing signal. The signal is coded for hours, minutes, and seconds. The time can be preset for hours and minutes and then placed in a run or generate mode of operation.

The Unit may also be used to read the timing signal from a magnetic tape during playback operations.

DETRANSLATOR

The detranslator is a two-speed unit for use during real time or playback of video doppler information. The video signal is translated up in the missile to the frequency range 205 to 350 kHz which is received and recorded on magnetic tape. The video signal is routed through the detranslator and returned to a base band of 50 to 150 kHz. Reduce tape recorder playback speed further reduces the frequency range by an identical factor of reduction.

BOX 3 - MAGNETIC TAPE RECORDER/RE-PRODUCER

The magnetic tape recorder/reproducer is a standard 7 track, 7 speed portable instrument using 1/2 inch tape on coaxial reels. The transport is a closed loop system using dual capstans for constant tape tension and bead isolation. An optical tachometer and a servo amplifier drive the capstans at a constant speed. An optical tape sensor control by compliance arms maintain constant tape tension on the supply and takeup reels.

The record and reproduce amplifiers are designed for wideband Group II operation in the direct mode. In the record mode the maching has 7 electronically switchable speeds from 1 7/8 inches per second to 120 inches per second. The playback mode, 6 speeds are electronically switchable.

BOX 4 - CRT VISICORDER

The CRT visicorder is a multichannel, direct recording instrument which uses the light from a fiber-optic cathode ray tube (FO-CRT) to produce a visible record on a photosensitiver paper. All signals are presented to the CRT in the form of an unblanking signal. A 50 Mz rate sweep is unblanked by the incoming signal to give an instantaneous position of each trace.

The Plug-in signal-conditioning modules accept an analog-voltage input. The modules contain an analog-voltage-to-time converter which produces a pulse, with a duration in proportion to the amplitude of the incoming signal. These pulses unblank the CRT sweep for data recording. An internal clock is generated to synchronize the signal conditioning modules with the CRT beam.

The CRT visicorder as used in PUTTS contains 16 medium gain differential amplifiers for telemetry data and a special interface module which includes the ability to intensity modulate the oscilloscope from the video doppler signals from the spectrum analyzer. The module also provides the capability of selecting either a positive or negative Video Doppler trace on the CRT visicorder.

The output of the plug-in modules is a series of dots for static or slow moving components of the signal and, a series of dashes for fast moving components. The dots and dashes are further processed by a video amplifier in the basic recorder. The output of the video amplifier is displayed on the CRT for recording on the photographic paper.

BOX 5 - SPECTRUM ANALYZER

The spectrum analyzer operates in a time compression manner. In its simplest form, the unit consists of two components, recirculating memory and Heterodyne Analyser. The signal enters the memory at one rate and because of the recirculation, exits at a faster rate. The speed-up obtained by this procedure permits a much faster analysis than would have been possiible at the original frequency range.

The Spectrum Analyzer operates with an input frequency bandwidth of 50 kHz (0-50 kHz) including 500 Hz frequency discrimination.

The purpose of the Spectrum Analyzer in the PUTTS is to generate spectra of a video doppler signal for recording in time versus frequency domain in order to analyze performance and to determine miss-distance between a missile and target in flight.

The input to the spectrum analyzer is through an input attenuator to an antialiasing filter. The output of the filter is amplified and then sampled in a Sample and Hold. Each sample is converted to an eight bit binary work, of which only six bits are used. The synchronizing clock is derived from a 12 mHz oscillator.

The memory elements are shift registers which introduce the time compression. Each piece of the digitized data held in storage is continuously updated and reconstructed. The memory contains 396 digitized samples which are recirculated at a rate of 12M word/s. As they rotate, each digitized sample is applied to a Digital to Analog converter where the applied signal represented in the digitized form is reconstructed at a rate corresponding to 12ms/s.

When a new sample is to be entered into the memory, it is placed in an update buffer to await rotation of the recirculating memory. When the oldest entry is opposite the update buffer, the memory is updated. If there is no new entry waiting, the memory continues to recirculate.

From the Digital to Analog Converter, the reconstructed signal is first entered into a 4 mHz low pass filter and then presented to a Heterodyne filtering system consisting of a mixer and a narrow band filter. The mixer oscillator is swept by a 3.6 ms ramp. The output of the narrow band filter is a 3.6 ms scan of the spectral content which is passed to an Intermediate Frequency stage and again mixed down.

In order to obtain discrete data values, the scanned signal is gated to a high Q LC circuit 109 times during the 3.6 ms sweep time. The gating action is synchronized with the recirculation of the memory. After amplification, this gated output of the sampled value becomes the output of the spectrum analyzer.

The output of the spectrum analyzer drives an Intensity-Modulated Display Interface Module in the Fiber-Optic oscillograph recorder. The 3.6 ms sweep from the spectrum analyzer deflects the marking beam to generate a roster across the chart paper. The video output of the spectrum analyzer blanks and unblanks the marking beam to present a trace of the video spectrum with the amplitude of the trace representing the frequency scale and the distance versus paper speed, the time scale.

BOX 6 - RF TEST BOX

The RF Test Box (Figure #10) is a single frequency S-Band Source designed for testing the total system.

The main carrier frequency is 2252.2 mHz, which is available from the front panel for antenna connection. The VCO's have center frequencies and deviations of 240 kHz ±15% and 275 kHz ±75 kHz, which are individually energized by a front panel switch. Controls for adjustment of center frequency, input level, and output level, as well as test points for monitoring, are provided for each VCO.

The Function Generator has two outputs: square wave and switch-selectable sine or triangle wave. The output frequency can be adjusted from 2 Hz to 200 kHz in 5 switchable ranges; (2-20, 20-200, 200-2kHz, 2 kHz-20 kHz, 20 kHz-200 kHz) with a vernier frequency potentiometer. The square wave output is fixed 0 to 5 volts. The sine/triangle output is adjustable offset control to provide 0 to ±5 DC shift.

The mixer/amplifier has two inputs available. The gain is adjustable by means of a front panel potentiometer. The amplifier output drives the transmitter modulation input.

The PAM Clock Source provides a front panel, switch selectable, external clock source for the PAM Commutator. By means of this switch, channel ranges of 5, 10 and 25 KCH/SEC can be selected.

A BNC connector on the front panel is available to externally modulate the transmitter, VCO's or PAM Commutator.

Based on system requirement, the configuration of modulation needed is interfaced on the patch panel. Upon modulating the transmitter, the multiplex proceeds through a 2 dB pad directional coupler which provides voltage to the power meter, a 60 dB attenuator, and the antenna input.

PAM/PDM SIGNAL SIMULATOR

The PAM/PDM Simulator has an adjustable channel rate from 10 to 100,000 channels per second and adjustable frame lengths from 10 to 199 channels. All parameters (channel rate, mode and code, frame-sync patterns, unique channel locations, unique and odd/even channels' data selection, DC offset, output level, and polarity) are front-panel programmable. The unit is self-contained and is designed for rack or portable instrument case installation.

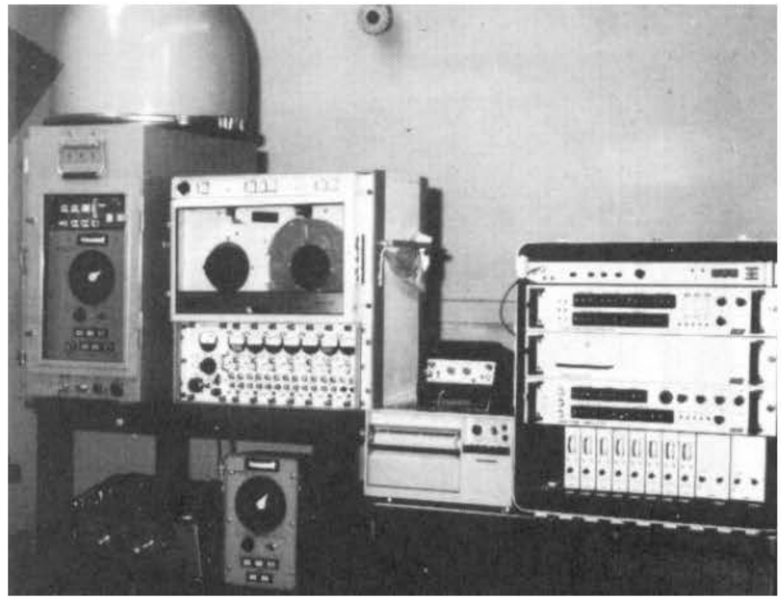
The VCO and Clock Generator circuits generate the channel rate as adjusted by front-panel switches. The Channel Counter and Output Logic circuits establish the frame length, the frame-sync pattern location unique channels 1 and 2 location, and common odd and even channels' location. Front-panel switches operate in conjunction with the Output Logic to select the data channels' and frame-sync channels' patterns.

The PAM Generator is both a multiplexer and PAM generator which converts parallel pattern and channel command inputs into a serial PAM output. Internal voltage sources provide the 0%, 50%, 100% and RZ baseline voltages. Unique channel 1 data is continuously variable as established by a front-panel potentiometer in conjunction with the 0% and 100% voltage sources' outputs. Unique channel 2 and common odd/even channel data can be 0%, 50%, or 100%, or can contain data as established by external inputs to the unit.

Output level and offset control are accomplished in the Output Amplifier which also permits the summing of noise or other inputs into the serial PAM or PDM output. A front-panel switch controls the mixing of the external signals with the data output. Another external input is provided to the simulator which may be routed directly to the simulator output instead of the normal serial PAM or PDM data output. A front-panel switch selects the signal output.

A power supply and regulator network is provided in the simulator. This network operates from a primary AC power input and generates all regulated voltages for operation of the simulator.

Figure #1
FIRST PUTTS SYSTEM
BUILT IN DEC 1971



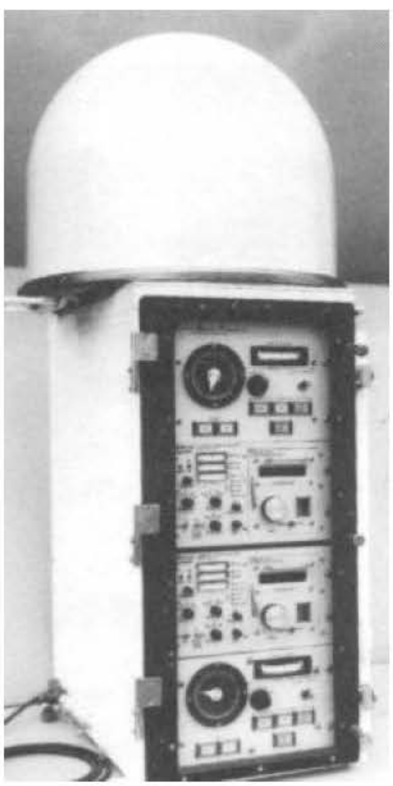


FIGURE #2
PUTTS II - RF ASSEMBLY
Box 1 OF SYSTEM

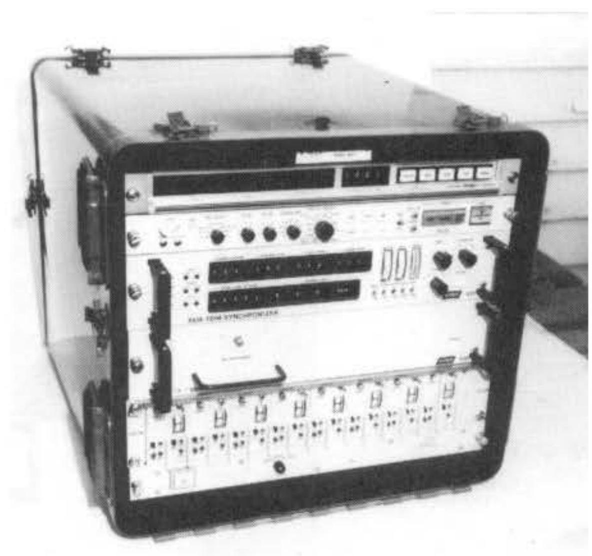


FIGURE #3
DATA PROCESSING SECTION
BOX 2 OF SYSTEM

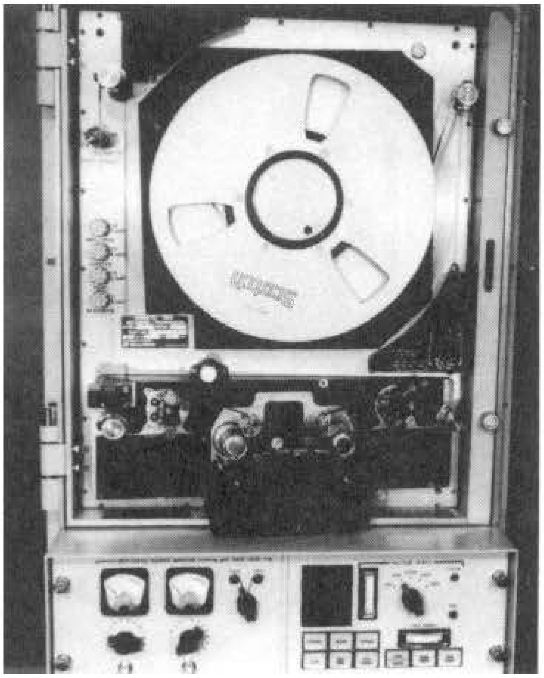


FIGURE #4
MAGNETIC TAPE UNIT - 7 CHANNEL D.R.
BOX 3 OF SYSTEM

FIGURE #5
SPECTRUM ANALYZER–
VIDEO DOPPLER IN-
MISS DISTANCE OUT-

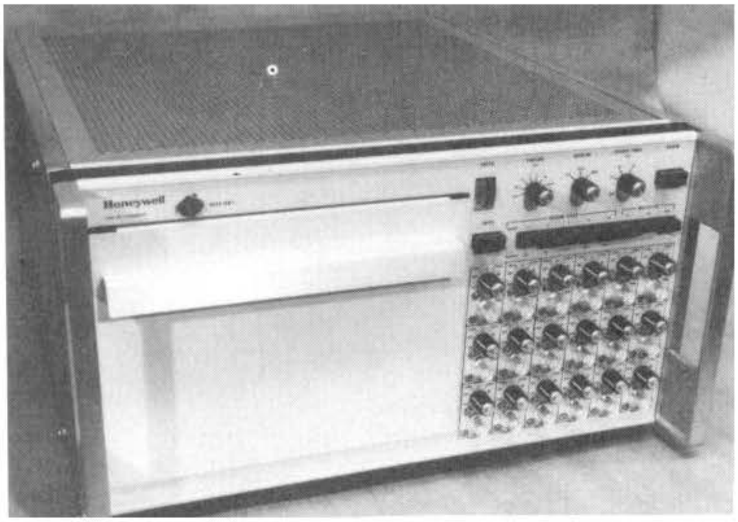
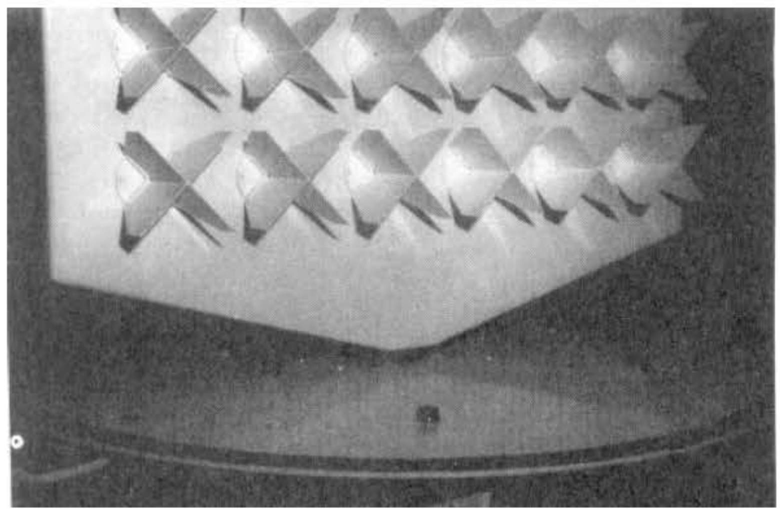


FIGURE #6
FIBER OPTIC OSCILLOGRAPH-
RECORDER
BOX 5 OF SYSTEM

FIGURE #7
6 X 12 = 12 ELEMENT
AZMUTH - SEARCH ARRAY



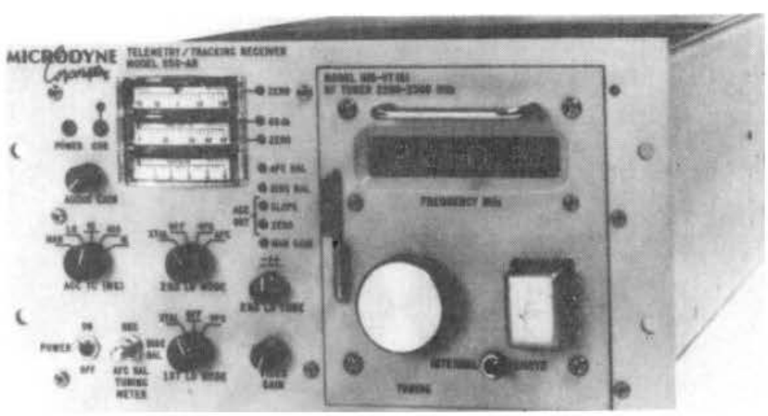
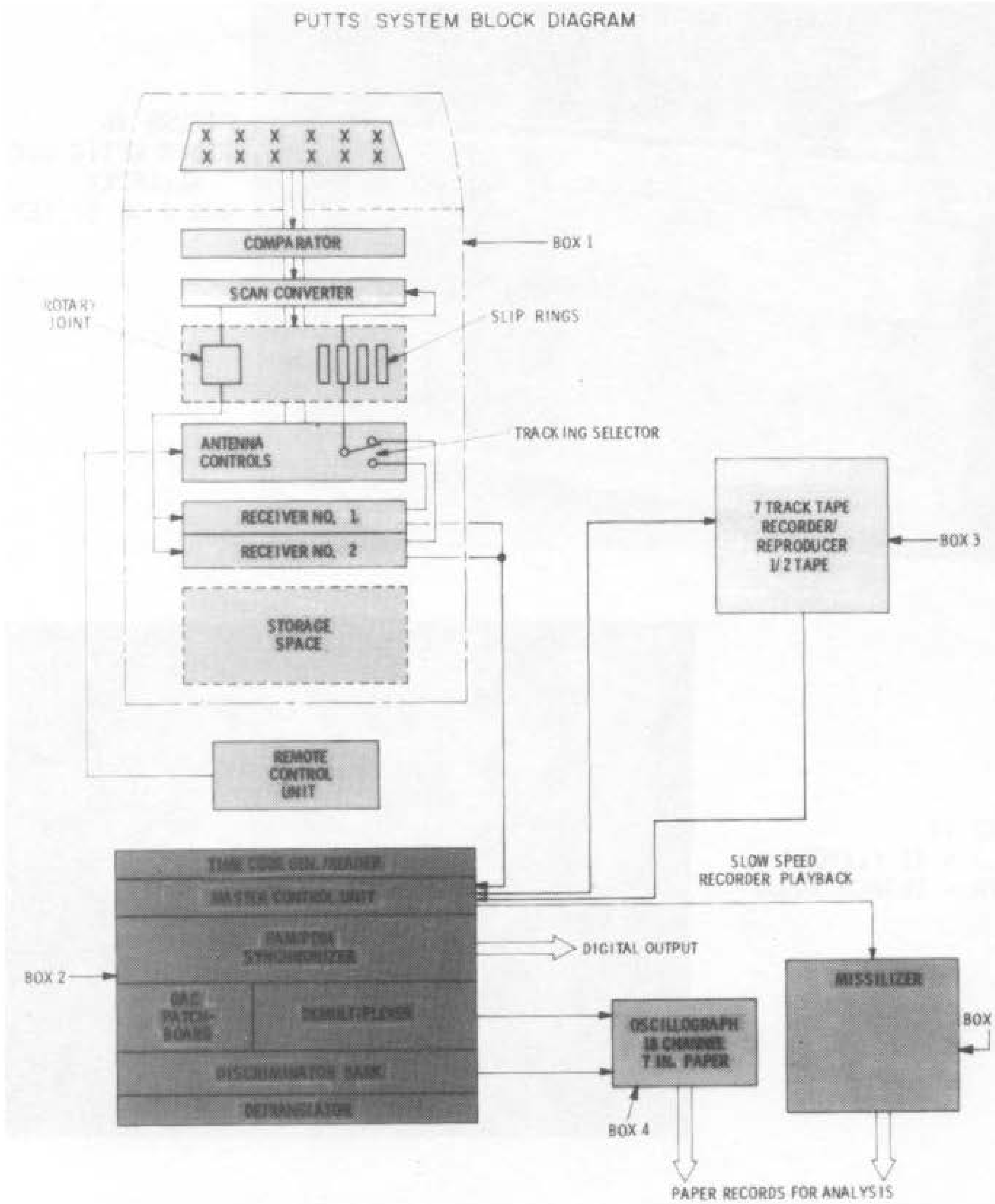


FIGURE #8
2200-2300 - DATA RECEIVER
DIGITAL READOUT-
XTAL OR VFO
TUNEABLE



GENERAL SPECIFICATIONS

	MODEL NO.	POWER	WEIGHT	SIZE	COST
ANTENNA-RECEIVER GROUP		200W	78.5 Kg	51 X 51 X 86 CM	
REMOTE CONTROL UNIT		—	2.3 Kg	13 X 13 X 30 CM	
DEMUX/DECOM BOX		325W	90.7 Kg	51 X 56 X 91 CM	
TAPE RECORDER					
OSCILLOGRAPH		400W	28.0 Kg	33 X 20 X 46 CM	
MISSILIZER		100W	52.2 Kg	53 X 56 X 71 CM	

FIGURE #9
SYSTEM INTERFACE
MASTER CONTROL PANEL

FIGURE #10
RF TEST BOX - MISSILE TLM
DYNAMIC TEST SET - CAN SIMULATE
MISSILE TLM FROM BIRD IN FLIGHT