MISSION 7161
(MULTI-GROUP I)

OBJECTIVE:

To locate ground emitters by intercepting ground signal emissions, analyzing and recording certain critical characteristics of these data while on orbit. This payload contains a digital recorder and a 6 mc analog data storage unit (DSU) for recording electronic emissions. The DSU will permit fine grain measurement of specific signals of interest. These data are retrieved by transmission in digital and wideband analog form via the data links upon command.

SYSTEM DESCRIPTION

This payload is an electronic reconnaissance system that intercepts pulsed electronic emissions from ground radiations. Analog video signals from the receivers are recorded on wideband recording system. Digital data expressing frequency, time, and operating mode information, are compiled periodically and recorded on an AR-400 tape recorder. Emitter parameters, such as frequency, pulse repetition frequency, pulse width and pulse amplitude are also recorded. The signals recorded on the wide-band system (DSU) will be read out, or transmitted, to a ground station via a narrow-band VHF data link.

Major Components: The Multi-Group payload consists of the following eight major components:

1. Antenna
2. Receiver(s)
3. Payload Control
4. Data Handler
5. Tape Recorder(s)
6. Vernier Location Module
7. Wide Pulse Recognizer
8. Predetection Module

1. Antennas. Two log-spiral antennas are used to cover the four frequency bands. One covers Bands 2 and 3 and is an unfurlable structure of mylar and aluminum. It is stored in a hermetically sealed canister and mounted on the end of a 15 foot boom. The boom is extended after the vehicle is in orbit and the antenna is inflated shortly thereafter.

The other antenna is a fixed cone covering Bands 4 and 5 which is exposed for use after nose cone separation.

The antenna radiation patterns develop a coverage cone by the difference between the amplitude of the signals received by the signal and inhibit antenna pair. The size of the coverage cone angle is mainly influenced by (1) the signal and inhibit channel gain settings, (2) the payload altitude and ground speed, and (3) is set to be consistent with the scanning rates of the receiver. A cone angle of 30 degrees at 275 N. mi. orbital altitude produces a circular coverage area of 150 N. mi. diameter.

2. Receivers: The frequency range of the multigroup payload is 125 Mc to 2100 Mc and is divided into four receiver bands: Band 2 - 125 to 260 Mc, Band 3 - 260 to 530 Mc, Band 4 - 530 to 1060 Mc, and Band 5 - 1060 to 2100 Mc. Each band utilizes a complete receiver consisting of an RF front end, an IF/video section, and an amplitude comparator.

Sum and difference mode signals from the antenna forming the signal and inhibit channels, respectively, are amplified, mixed, amplified again, detected and routed to an amplitude comparator. The amplitude comparator examines these signals for relative amplitude difference, and determines whether they came from an emitter within the desired circle of coverage. If so, an accept pulse is generated within the comparator and sent to the Data Handler (DH) and the signal is processed. An in-band detector inhibits the generation of an accept pulse for an off-channel response (those signals appearing from detuned signals outside the IF passband). A discriminator receives the limited IF output from the signal log IF amplifier and delivers a discriminator video output to the payload control (PLC).

3. Payload Control (PLC): The payload control component receives interface commands and converts them into a form that provides the controls for payload operation. It provides:

a. Storage, interpretation, or distribution of nearly all interface commands as necessary to control the payload in its various modes of operation.

b. Recorder controls for the digital recorder.

c. Protection to the analog recorder by proper voltage control to prevent destruction of the tape.

d. Receiver scan voltage generation with back-up capability (the back-up generator does not provide a quadrant select capability).

Bands (2 3 5 4)

e. Payload sequencing and scan controls. The bays are sequenced 1, 2, 3, 4, 1, 2, 3, 4, regardless of which receivers are located in the bays. Any bay disabled will not be included in the sequence, and no delay will be encountered in scanning through a disabled bay (any disabled quadrant or quadrants cannot be by-passed, however, without some delay).

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4. Data Handler (DH): The data handler receives, measures, digitizes, and stores the electrical description of the electromagnetic signal detected by the payload. The following information is processed:

a. Pulse Repetition Interval (PRI). The PRI circuit receives the accept pulses from the receiver, digitizes and stores the interval between them and determines the basic time for which the data handler operates on an input signal before generating a data word.

b. Pulse Width (PW). The PW circuit receives, digitizes, and stores the PW information contained in the accept gate input to the data handler. This circuit digitizes PW's from 0.25 usec to 379.75 usec.
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c. Pulse Amplitude (PA). The PA circuit digitizes and stores signal channel PA information from the receivers. This circuit digitizes PA's over a range of 52 db.

d. Pulse Amplitude Difference (PAD). The PAD circuit measures, digitizes, and stores the PAD between the signal and inhibit amplitude gate inputs. The PAD compares and subtracts the inhibit pulse amplitude from the signal pulse amplitude when the pulses are coincident. If the inhibit amplitude gate width is greater than the signal amplitude gate width, the PAD circuit inputs are blanked since no accept pulses will be received by the data handler under this condition.

e. Band Code, Frequency, and Time are other characteristics that are processed through the data handler.

The data handler also originates the record actuate signal through a record control circuit to the tape recorders after the electrical characteristics of the intercept have been analyzed and digitized in the data handler.

This record control circuit synchronizes the proper operation for start-stop words when either recorder is turned ON or OFF and steers all forms of digital words to the proper recorder.

5. Tape Recorders: The digital tape recorder records digital information in a start-stop fashion on magnetic tape and, on command, plays back this information continuously in either a forward or reverse direction. The tape recorder stores the processed digital data from the DH during an intercept. During readout, the stored data are read out to the DH for reprocessing. The following is a summary of the digital tape recorder characteristics:

Number of tracks	Four (two for information and two for synchronization)
Steady-state recording speed	22.5 ips
Steady-state readout speed	22.5 ips
Start time	6.8 ± 0.4 milliseconds
Record time	9.6 ± 0.5 milliseconds
Time beyond word	3.3 ± 0.3 milliseconds
Bit density	444 bits per inch (nominal)
Tape capacity	Sufficient for 6200 recorded words minimum

The Analog recorder records analog and digital information and operates in a steady state condition. On command, playback is obtained continuously in a reverse direction, with the last recorded information being readout first.

Analog tape recorder characteristics:

Recording time - 40 min.
1:1 readin/readout 6 MC pre-detection
Number of channels - 1 video and 1 digital

6. Vernier Location Module (VLM). The VLM is an add-on module that provides azimuthal location of emitters within the cone of coverage. It is designed to operate with the antennas for Bands 2, 3, 4, and 5. As a component, the VLM is concerned only with measuring the electrical phase difference angle between certain combinations of the conical spiral antenna windings so as to yield azimuthal location information. It samples the signal and inhibit channels in the receiver and measures the phase difference over a 360° range to within ± 40°. The azimuth angle of incoming signals shall be coded in 5 bits. The VLM will be ON and operational whenever the payload is ON during readin and calibrate.

7. Wide Pulse Recognizer (WPR). The WPR is an add-on module that provides recognition of an emitter pulse greater than 75 usec with a signal channel input power greater than - 65 dbm. It is designed to operate in the frequency range of 158-162 Mc. The digitized output is inserted in the payload digital data word as 1 identification bit.

Each time a wide pulse in the specified frequency is received, the WPR produces command outputs that stop receiver scanning, starts the data storage unit (DSU) for recording the analog and digital signal outputs. The receiver resumes scanning after the target signal fades. The WPR will be enabled ON and OFF by real-time commands.

8. Predetection Module (PDM). The predetection module is an add-on module that processes and shapes received signals for analog recording before detection. It is designed to operate within all the receiver bands, PW's and RRI's. The PDM receives power and combined IF pulsel signals from the VLM. However, the PDM and VLM may be operated separately or simultaneously because of their interconnection with the PLC.

The PDM will be turned ON and OFF by real-time command.

PAYLOAD CHARACTERISTICS

	Receiver Bands			
Item	2	3	~~4~~ 4	5
Frequency range (Mc) (Spec. limits)	125-260	260-530	530-1060	1060-2100
Bandwidth (Mc)	2.0	4.0	4.0	5.0
Scan time (normal) (Sec.) (no intercepts)	4.1	4.1	4.1	4.1
Scan time (Alternate rate) (Sec.)	16.4	16.4	16.4	16.4
PRF, minimum (PPS) (verified)	10	10	10	10
PRF, maximum	10,000	10,000	10,000	10,000
Minimum PW (usec)	0.8	0.5	0.3	0.3
Maximum PW (msec)	3.8	3.8	3.8	3.8
Sensitivity (dbm) without antenna gain	-75	-85	-75	-83
Antenna gain	-1.5	-2.5	-2.0	-3.0
Ground coverage area (diameter)	150 nmi with a cone angle of 30 degrees ± 15 at 275 nmi orbital altitude			

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OPERATIONAL CONCEPT:

The Agena will be launched by a Thorad booster to a nominal 275 n mi 75° inclination circular orbit with a mission lifetime of 30-60 days. The digital recorder will be programmed on from border to border, the analog recorder and payload modes will be pre-programmed for operation over specific locations according to COMOR guidelines. All data will be dumped and recorded at ZI facilities. The digital material will be sent electronically to the processors and the analog data will be forwarded by courier. Location accuracies will be + 35 n mi for one intercept and less for multiple intercept.

The basic operating functions of the payload are readin, calibrate, and readout. A simplified explanation of these operating conditions is given below.

Readin: With respect to receiver operation, the basic readin modes of operation are scan and lock-on. A payload command for these basic operating modes turns on power to the DH and PLC and starts the programmed receivers in their scanning sequence. Any combination of receivers can be selected for operation. A scan generator in the PLC programs each enabled receiver on as its turn comes in the sequence. All receivers are scanned from low to high frequency, and the receivers are scanned from Bay 1 through Bay 4.

Signal and inhibit antenna outputs are fed into separate receiving channels having the same gain characteristics. An amplitude comparison is performed on the outputs of these two channels. When the amplitude of the signal channel exceeds that of the inhibit channel by the desired amount, an identifying tag (accept gate) is generated that locates the signal (if the amplitude of the signal channel is not greater than the inhibit channel, a tag is not generated and the signal is not processed).

Upon receipt of a signal from the coverage area, an accept gate is generated within the receiver, initiating DH operation. The DH signals the PLC to stop the receiver scan for up to three more accept gates. At least two accept gates are required to generate a data word, although four are required for a complete word. If a second gate is not received within the maximum PRI for the band, the DH is reset, scan resumes, and in the normal scan mode, no data word is produced. When the fourth accept gate is received, the DH will have completed 3 PRI, 2 PW, 2 PA, PAD, frequency and time measurements, and will transfer the data word to the recorders. The DH then initiates the actuate signals to the recorder that is programmed on. The timing at this point is a function of the mode programmed and the recorder being used. In the normal scan mode, the scan remains stopped only long enough to obtain up to four accept gates and generate a data word. In the lock-on mode, the scan remains stopped for 10 seconds to permit recording on the DSU, but data words are generated and can be recorded on the digital recorder. The number of data words recorded is limited to ten.

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Four different types of 96-bit digital words are generated: (1) the data word just mentioned, which is generated for each time verified incoming signal within the coverage area; (2) the start word which is generated when either tape recorder is turned on in a write mode, and the stop word which is generated as each recorder is turned off at the end of a write period; (3) the status word which is generated between the frequency scan of Bay 4 and Bay 1 and (4) the marker word which is generated and permit interpolation of a signal's frequency. If a record signal should be received during the generation of a marker word, the data word will override the marker word.

Calibrate Mode: In the calibrate mode, known signals are transmitted to the payload and the data are transmitted to a tracking station in real time. Program 770 ASTROPHYSICAL RESEARCH VEHICLE's are utilized to transmit signals of known parameters from predetermined sites inside the Vandenburg area of tracking coverage to the payload.

Readout: In the readout mode, the stored digital data and pertinent payload monitor points information are transmitted to the station. When the payload receives the digital readout command, the DIGITAL tape recorder reads out the data in reverse order to the DH. The DH reprocesses the data for transmission by the command and control subsystem. Transmission is automatically stopped when front-of-tape is reached.

The analog recorder records on one side of the tape while the tape moves in one direction, and on the other side while the tape moves in the opposite direction. When the Analog Readout ON command is given, the recorder will read out in the reverse direction from which it reads in, with the last recorded information being read out first.

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MISSION 7229

(SETTER IA)

OBJECTIVE: The SETTER IA payload is an electronic reconnaissance system which locates ground-based S-Band emitters by making relative phase measurements on the received RF signal. The SETTER IA is capable of working in dense signal environments using emitter frequency and geoposition as parameters for sorting the pulse trains. The payload processes and records the intercept information in digital form and converts the recorded information into a form suitable for transmission to the ground.

SYSTEM: SETTER IA is integrally mounted with the prime payload (in this case Mission 7161) on a fully stabilized AGENA vehicle. It is a 6 channel-90 dbm sensitivity system using six circular horn antennas arranged in an interferometric array feeding six superheterodyne receivers each tuned in 256 steps 2960.5 to 3215 MC with 1.5 mc bandwidth. The dwell time on each step is 25.42 msec to 100 msec depending on signal density. During this time the 120 x 340 mi field of view is scanned and the radio frequency, pulse width and repetition interval of received pulses are digitized and stored. The SETTER data is recorded and dumped on the same type of 10,000 bit/sec equipment as is the Mission 7161 data. Two 96 bit words are used for each intercept; 6550 intercepts can be stored and the total dump time is only 165 sec. The SETTER IA payload has three fundamental functional modes of operation: a reconnaissance mode (read-in), and two real-time modes (readout, and calibrate and record).

Read-In

The readin or reconnaissance mode may be further subdivided into 5 operational modes: The normal mode and 4 alternate modes. In the normal mode, 4 successive pulses may be analyzed from the same emitter, but only 2 are needed to confirm the intercept and print two descriptive 96 bit digital words onto the associated AR-200 tape recorder. All basic intercept parameters, together with other necessary data, are recorded in 2 data words. The digital data word contains 96 bits with a 3 millisecond interword spacing. The first data word contains parameters of the first two pulses, and the second data word contains parameters of the third and fourth pulses. In any operational mode, 2 start-stop words are generated at both the beginning and the end of an observation period. These words contain system time, vehicle attitude, and payload operational configuration. Also, 2 time attitude words are generated once every 16 seconds during an observation period. The 4 alternate modes are provided to permit continued limited system performance in the event of certain malfunctions. All modes are discussed below:

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Normal Mode. The normal mode utilizes a Space Window concept of sorting phase (geoposition) information of emitter signals for the logic decision to process or reject. The normal mode permits de-interleaving during a single dwell period. All of the following inhibit-confirm parameters are also analyzed in the normal mode of read-in:

a. Within phase field-of-view (FOV)

b. Real and not a spurious signal

c. Amplitude within dynamic range

d. PW PW min (0.5 usec)

e. Within frequency process band of $\pm$ 0.75 Mc.

Alternate Mode I. Alternate Mode I disables the intra-step core memory so that individual emitters may be repetitively processed during a fly-by, but only one emitter is processed per dwell period. The emitter is accepted or rejected in this mode on the basis of first come, first serve. Subsequent pulses are compared to the first pulse for acceptance on the basis of DF information.

Alternate Mode II. Alternate Mode II disables the Space Window logic and processes 2 pulses per emitter. The system immediately changes frequency after 2 pulses per emitter are processed. (Four pulses are processed in the normal mode if SI pulses occur within the required time intervals.) Two emitters operating at the same frequency but separated within the FOV may be processed as one emitter within a dwell period, since the absence of SW logic prevents emitter DF sorting.

Alternate Mode III. In this mode, the following inhibit, frequency confirm, Tmin. and Tmax. The intra-step core memory and space window logic is maintained.

Alternate Mode IV. This mode is the same as Alternate Mode II except the phase FOV inhibit function is removed.

Readout

In the readout mode, the data which was stored in NRZ-Mark form is readout through the IBU to the data link in 3 level RZ code. The digital tape recorder is the same type as that used with the 7161 payload.

Calibrate and Record

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In the calibrate and record mode, known signals are transmitted to the payload and the digital data are transmitted to a tracking station in real-time at the same time the data are recorded. Program 770 Astro Physical Research Vehicle's are utilized to transmit signals of known parameters from predetermined sites inside the Vandenberg area of tracking coverage to the payload.

Location accuracy of SETTER is $\pm$ 7.5 n mi on a single intercept with even increased confidence and minimized system errors possible from multiple hits. Rf measurement accuracy is $\pm$ 0.03%, pulse width quantization levels are 1.43, 2.86, and 5.62 microsec, pulse repetition interval is measured $\pm$ 15 microsec for prfs 390 to 33,000 pps and pulse amplitude is measured $\pm$ 2.5 db over a 45 db dynamic range.

SETTER IA is an advanced all-solid state system using electronically tuned frequency synthesized stripline receivers and a magnetic core data handler.

EXPECTED LIFETIME: 30-60 days.

SCHEDULED LAUNCH DATE: 19 Dec 1966

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SETTER IA PAYLOAD CHARACTERISTICS

Frequency coverage	2960.5 ± 1 Mc to 3215.5 ± 1 Mc
Scan time (entire freq. range)	7.02 ± .5 sec. (no intercept) to 32 sec. (max. dwell at each 1 Mc step)
Dwell time (time at one discrete frequency)	25.4 mx ± 2.5 or 100 ms depending on whether an intercept is processed.
Dynamic range (referenced to antenna input)	-45 dbm to -90 dbm
Pulse repetition interval	
PRI min.	30.52 usec (32730 PPS)
PRI max.	23.5 millisec
Pulse width (PW)	0.75 PW 1.43 usec 1.43 PW 2.86 usec 2.86 PW 5.62 usec 5.62 PW (no max. PW inhibit)
Absolute pulse amplitude	Encoded in a 2.5 db increments, 7.5 db (bottom increment)
Space coverage	A rectangle approximately 120 n.m. wide and 340 n. m. long (at 275 n. m. alt.) (The width dimension is along the flight path)
DF Accuracy	CPE of 1.5° (1/2 angle) cone about the line of sight to the emitter (payload only) (Equiv. to 0.6745 σ).

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