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32 Pages Copy No. 2 of 5

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Control System

BYE-15792-63

[redacted]

TECHNICAL DESCRIPTION
NEW JERSEY
RECONNAISSANCE SYSTEM

EXCLUDED FROM AUTOMATIC
REGRADING. DOD DIR 5200.10
DOES NOT APPLY

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CONTENTS

[redacted]

[illegible]

[illegible]: Three units have been built and delivered, of which two have been expended on missions. It is planned that the third unit will have one channel modified to provide voice recognition and recording at predetermined spot carrier frequencies. It will be necessary to encipher the recorded voice traffic prior to transmission. Depending on availability of launch vehicles, the third unit will probably be orbited in November, 1963.

Contractor: Lockheed Missiles and Space Company for Agena vehicle and reconnaissance system support equipment.

[illegible] contract [illegible] for reconnaissance receivers.

[illegible]-Sanger [illegible] engineering equipment.

[illegible] Research for reconnaissance antennas.

[illegible]

[illegible] lower limits. [illegible] 100 to 1[illegible] [illegible] lock on, and [illegible] 100 to 200 [illegible] acquisition criteria.

[illegible] is sampled by one side of a two-pole commutator [illegible] voltages between zero and five volts. Each [illegible] output is frequency-modulated on one track of a dual-track recorder which plays back, at eight times recording speed, on appropriate subcarrier channels of an FM telemetry link. The data are recorded, together with other telemetry information, on standard instrumentation tape recorders at the tracking stations.

The unit is normally programmed by the vehicle orbital timer. A "Zombie" mode is available, however, for use after the primary mission is accomplished. On this mode real-time commands initiate time delays which program the unit relative to a reference latitude.

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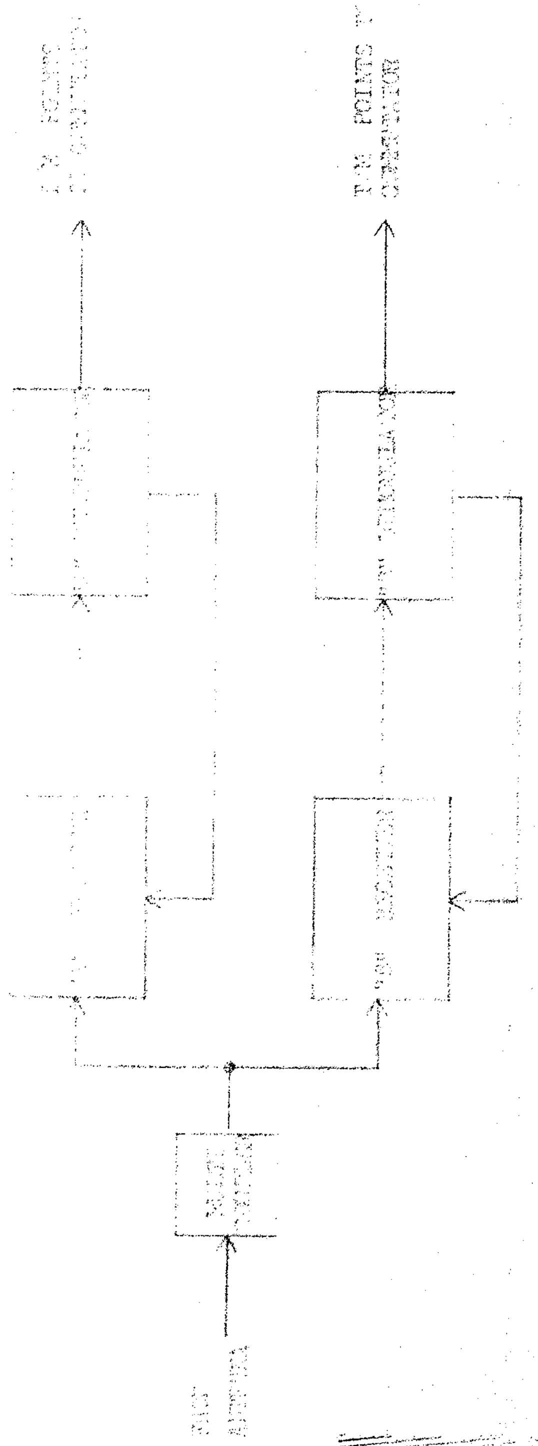

FIGURE 1

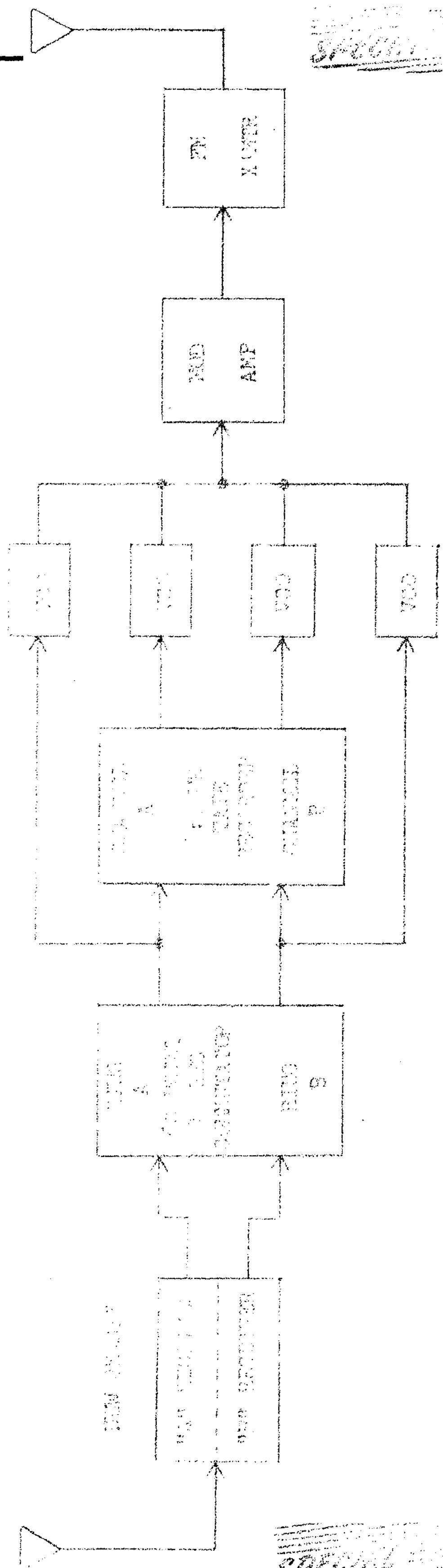

FIGURE 2

~~SECRET~~

[redacted]

[illegible] Characteristics

1. Antenna: The antenna is a planar [illegible] spiral [illegible] circularly polarized, single lobe perpendicular to the plane of the antenna, directed downward from the satellite platform. When used with a non-stabilized vehicle, the antenna can be [illegible] from the vehicle so that near-omnidirectional coverage is [illegible].

The fixed antenna has a loss of four to eight db with respect to isotropic due to cavity restrictions at low frequencies. When unfolded, the gain is nominally isotropic. Future plans include an unfolding antenna whether or not the vehicle is operated in a stabilized mode.

Patterns and impedance are essentially independent of frequency. The half-power beamwidth varies from 100° to 120°, practically a horizon to horizon coverage.

One antenna is used to supply both channels of the receiver through a coupling network.

~~SECRET~~ SPECIAL HANDLING [redacted]

1. Receiver Description

a. "A" Receiver

The "A" receiver scans the 110-150 mc band searching for carriers which are amplitude modulated by one of five discrete audio tones. The receiver locks onto any signal in the band that is 10 db above the average noise. When the 10 db threshold is exceeded, the sweep is stopped for 10 milliseconds, the automatic frequency control (AFC) loop is activated, and test circuitry in the demodulator is activated. The signal is then checked to see if the frequency components of the amplitude modulated envelope of the carrier fall within a specific band of frequencies. If the signal meets this test the receiver is held in the "lock" mode for an additional [illegible] milliseconds while another test is made. The signal is checked further to see if the detected frequency components of the amplitude modulated envelope of the carrier consists of discrete audio tones which fall within specific narrow bands of frequency. If this last test is met the receiver is retained in the "lock" mode until the signal disappears or the tone content disappears.

The "A" receiver provides the following information:

- Carrier frequency
- Carrier doppler frequency shift
- Audio tone identification
- Audio tone duration
- Signal level
- Short baud indication
- Temperature
- Power supply status voltages
- Clock

[illegible] signal to the [illegible] receiver comes from the antenna through [illegible] a voltage tuned R.F. amplifier, see Figure 3. The [illegible] center frequency of the R.F. amplifier and the frequency of the voltage controlled oscillator are offset by a fixed frequency of 70mc. The output of the R.F. amplifier and voltage controlled oscillator are combined in the first mixer. The output of the first mixer passes through the first intermediate frequency amplifier (70mc) to the second mixer where the signal is combined with the output of the crystal local oscillator ([illegible].7mc). The output of the second mixer is passed through a 10kc crystal band pass filter whose center frequency is 10.7mc. The output of the band pass filter is applied to the second intermediate frequency amplifier (10.7mc). The second I.F. has four outputs.

1. Signal level - a telemetry point
2. Video out - goes to demodulator
3. AFC loop
4. Threshold loop

The output of the second I.F. to the threshold loop is operated on in the threshold gate to verify that the carrier power is greater than 10db above the average noise level. If the carrier power meets the threshold requirements a 20 millisecond "short hold" is developed and sent to the demodulator to enable the "medium hold" test circuitry, the sweep circuit is disabled, the AFC loop is enabled and causes the voltage controlled oscillator to track the signal carrier as it undergoes a doppler frequency shift. The threshold circuit also enables the circuitry which gives a measure of the rate of change of the doppler frequency shift.

The doppler frequency shift measurement is accomplished in the following manner. The output of the voltage controlled oscillator is mixed with the output of a fixed 1[illegible]5mc crystal oscillator in a broad-bandmixer. The output of the mixer is sampled by a 100kc switch or synchronous detector. This sampled signal is then low pass filtered, amplified and limited in the 50kc amplifier and limiter. The output of the 50kc amplifier is then counted for 40 milliseconds by three ten-step, linear staircase counters and stored until read out, which occurs every 80 milliseconds. The three ten-step frequency counters readout frequency in quantized steps of 25 cps, 250 cps and 2.5k cps.

e. [illegible] Demodulator

With the receiver locked and a "short hold" [illegible] generated in the receiver and sent to the demodulator to activate the "medium hold" [illegible] circuitry, the video output from the second IF amplifier enters the demodulator section and is low-pass filtered, amplified, and limited (see Figure 4). The output of the limiter feeds a bank of five narrow-band filters and full wave rectifiers. The center frequencies of the filters are those of the five discrete audio tones mentioned earlier. The filter outputs are "OR" gated, and fed to a Schmitt trigger during the "short hold" interval. The output of the Schmitt trigger, enabled by the "short hold" gate, generates a 40 millisecond "medium hold" gate which maintains the receiver in the locked mode. Each of the filters feeds a separate threshold gate. The five threshold gates outputs are "OR" gated to give a "long hold" which maintains the receiver in a locked mode for an indefinite period. The output of each threshold gate is also fed into a differentiating circuit. The five differentiating circuit outputs are "OR" gated into circuitry which measures the duration of each audio tone and gives a "short bit" indication when a tone is less than the prescribed length. The output of this "OR" gate also initiates an eight second timer which keeps the receiver in the "lock" mode during signal fades.

[illegible] 2. Sweep Circuit

The sweep voltage for the voltage controlled oscillator (VCO) and the voltage tuned R.F. amplifier is obtained in the following manner: A 218 cps clock feeds an eight stage binary staircase generator. The staircase generator provides a staircase input to the shaping circuit which compensates for the inherently non-linear voltage-frequency characteristic of the VCO. The shaping circuit provides the sweep to the VCO and the R.F. amplifier.

The "A" receiver continues to sweep as long as the sweep clock is free running. The sweep is stopped to lock onto a signal by a sweep clock inhibit circuit. In order to provide frequency information when the sweep stops the eight binary counters of the staircase generator are arranged in three groups, consisting of two groups of three binaries and one group of two which, with the digital to analog conversion, provides two eight-step and one four-step frequency readouts in quantized steps of 195kc, 1.56mc and 12.5mc respectively.

b. "B" Receiver

The "B" receiver scans the [illegible]-200mc band, also scanning for carriers which are amplitude modulated by one of five discrete audio tones. The receiver pauses or temporarily locks onto any signal in the band that is 10 db above the average noise. When the 10 db threshold is exceeded the sweep is stopped for 10 milliseconds. The automatic frequency control (AFC) loop is activated, and the hold circuitry in the demodulator is enabled. The signal is then checked to see if the detected frequency components of the amplitude modulated envelope of the carrier consist of discrete tones which fall within specific narrow bands of frequency. If the last test is met the receiver is retained in the "lock" mode until the receiver output data have been read out; the receiver then returns to the search mode.

The "B" receiver provides the following output data:

- Carrier frequency
- Signal level
- Temperature
- Power supply status voltages
- Clock

A highly accurate crystal clock provides part of the output of both the "A" and "B" receivers. The clock output consists of three octally coded readouts in quantized time steps of 0.5, 4.0, and 32.0 seconds. The clock provides a four minute, 16 second (256 sec.) time vernier for the vehicle time.

The input to the "B" receiver comes in through the antenna and is coupled to a voltage tuned radio frequency amplifier, see Figure [illegible]. The passband center frequency of the R.F. amplifier and the frequency of the voltage controlled oscillator are offset by a frequency of 70mc. The outputs of the R.F. amplifier and the voltage controlled oscillator are combined in the first mixer. The output of the first mixer passes through the first intermediate frequency amplifier (70mc). The output of the first intermediate amplifier is combined with the output of the crystal local oscillator (80.7mc) in the second mixer. The output of the second mixer is filtered by a 10kc crystal bandpass filter whose center frequency is 10.7mc. The filter output feeds the logarithmic intermediate frequency amplifier.

The log IF amplifier has four outputs:

1. Video - goes to demodulator
2. Signal level - telemetry point
3. AFC loop
4. Threshold loop

The output of the log IF amplifier is operated upon in the threshold gate to verify that the carrier power is 10db above the average noise. If the carrier power meets the threshold requirements a 20 millisecond "short hold" is developed. The "short hold" disables the sweep, enables the automatic frequency control (AFC) loop and enables test circuitry in the demodulator.

[illegible] Demodulator

The video input to the demodulator is low pass filtered and limited, see Figure 6. The limiter feeds a bank of five narrow-band filters whose center frequencies are those of the five discrete audio tones. The filter outputs are rectified by a full wave rectifier and then "OR" gated. The "OR" gate drives a Schmitt trigger and provides the input to the threshold gate. The Schmitt trigger resets the threshold gate for each input as it is received. The output of the threshold gate and the "short hold" from the receiver are "OR" gated to "set" the bistable circuit which provides the "long hold" that maintains the receiver in the "lock" mode. The output of the threshold gate also disables the limiter via the two bistables and the "and" gate to prevent spurious readings.

Every 100 milliseconds a "read control" pulse is developed in the read control circuitry by having F-1 connected to commutator segments approximately every 100 milliseconds apart. If these "read control" pulses are not inhibited they will reset the "long hold" gate and permit the receiver to return to the swept frequency search mode. The "short hold" triggers a 155 millisecond monostable that activates an inhibit gate to keep the "read control" pulses from resetting the "long hold" gate for 155 milliseconds. The phase between the "short hold" gate and the "read control" pulse is random. Consequently, the receiver can remain locked in frequency for between 115 - 200 milliseconds.

f. Sweep Circuit

The sweep voltage for the voltage controlled oscillator (VCO) and the voltage tuned R.F. amplifier is obtained in the following manner. A [illegible] cps clock feeds a nine stage binary staircase generator. The staircase generator provides a staircase input to the shaping circuit which provides the sweep to the VCO and the R.F. amplifier. In order to provide frequency information when the sweep stops, the nine binary counters of the staircase generator are arranged in three groups of three binaries each. The digital to analog conversion results in three eight-step frequency readouts in quantized frequency steps of 195kc, 1.56mc and 12.5mc.

[illegible] calibration data [illegible] consists of two portions. The first is the instrumentation schedule which identifies the data, their position in the sampling sequence, and their sampled frequency. In the "A" data, the input processor output contains the intelligence, and it is sampled [illegible] times per second, one sample being sacrificed to make up the synchronizing pulse. The remaining data are [illegible] sampled according to the relative significance that they contribute to the end product. A few "status" points are monitored once per second, this being the lowest sampling rate. In the "B" data, the more significant parameters are frequency, input processor outputs, and signal level. Accordingly, these are sampled nine times per second, the tenth time being sacrificed for calibration and synchronizing purposes.

A list of these points appears in the routine telemetry schedule released by LMSC with each vehicle, with the exception that literal-numerical designations are substituted for the functional descriptions contained in this report. A correlating document is prepared and submitted to the appropriate analysis group as required.

The other portion of the calibration consists of a tabulation (or analog curve) of the voltage output versus the datum parameter variation. Included for reference purposes are the tabulated calibrations for Unit No. 4. These are typical to show the general behavior of the receivers. For analysis purposes, specific curves should be used for each mission, and such curves are supplied after the final calibration prior to launch.

[illegible] frames [illegible] "Coarse" refer to the significance [illegible] distinguished, but combined to yield more digits [illegible] point. The use of maximum 1/2 volt steps gives good [illegible] with little danger of ambiguity in reading the results.

1	[illegible]
2	F_1 = Carrier Freq
3	I
4	F_2 = Carrier Freq
5	I
6	F_3 = Carrier Freq
7	I
8	ΔF_1 = Doppler Freq Shift
9	I
10	ΔF_2 = Doppler Freq Shift
11	I
12	ΔF_3 = Doppler Freq Shift
13	I
14	Sig. Level
15	I
16	CL_1 = Clock #1
17	I
18	CL_2 = Clock #2
19	I
20	CL_3 = Clock #3
21	I
22	Temp
23	I
24	± 12 V Pwr Supply Monitor
25	I
26	+ [illegible] V Pwr Supply Monitor
27	I
28	+ 40 V Operate Pwr Supply Monitor
29	I
30	+ 40 V Standby Pwr Supply Monitor
31	I
32	F_1
33	I
34	F_2
35	I
36	F_3
37	I
38	ΔF_1
39	I
40	ΔF_2
41	I
42	ΔF_3
43	I
44	Sig. Level
45	I
46	CL_1
47	I
48	CL_2
49	I
50	CL_3

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
58	[illegible]
59	[illegible]
60	[illegible]

[illegible]		[illegible]		[illegible]	
1	F_1 = [illegible] Freq	26	S.L.	51	F_2
2	[illegible]	27	F_2	52	F_3
3	[illegible] = Carrier Freq	28	F_3	53	Temp
4	[illegible] = Carrier Freq	29	[illegible] V P.S. Monitor	54	I
5	F_3 = [illegible]	30	I	55	CAL Z
6	[illegible] = [illegible] Processor	31	F_1	56	CAL +
7	F_1	32	S.L.	57	CAL ½
8	S.L.	33	F_2	58	SYNC
9	F_2	34	F_3	59	SYNC
10	F_3	35	CL_1	60	SYNC
11	CL_2 = Clock [illegible]	36	I		
12	I	37	F_1		
13	F_1	38	S.L.		
14	S.L.	39	F_2		
15	F_2	40	F_3		
16	F_3	41	CL_3		
17	± 12 V P.S. Monitor	42	I		
18	I	43	F_1		
19	F_1	44	S.L.		
20	S.L.	45	F_2		
21	F_2	46	F_3		
22	F_3	47	CAL Z		
23	+ 6 V P.S. Monitor	48	I		
24	I	49	F_1		
25	F_1	50	S.L.		

[illegible]	[illegible]	[illegible]	[illegible]	80	[illegible]
-1[illegible]	[illegible] - [illegible]	0.2 - 0.8	[illegible] - [illegible]	0 - [illegible]	0 - 1.65
-[illegible]	[illegible] - 1.2	[illegible] - 1.8	[illegible] - 1.6	0.0[illegible] - 1.[illegible]	0 - 1.55
-9[illegible]	1.[illegible] - [illegible]	[illegible] - [illegible]	[illegible] - 1.7	[illegible] - [illegible]	[illegible] - [illegible]
-[illegible]	[illegible] - [illegible].05	[illegible] - [illegible]	1.9 - [illegible]	[illegible] - [illegible]	[illegible] - [illegible]
-[illegible]	[illegible] - 2.6	1.[illegible] - 2.7	2.[illegible] - 2.[illegible]	[illegible] - [illegible].9	0.[illegible] - 3.0
-[illegible]0	[illegible] - 3.0	2.4 - 3.05	2.2 - [illegible]	[illegible] - 3.[illegible]	1.3 - [illegible]
-[illegible]	[illegible].05 - [illegible]	2.35 - 3.7	2.[illegible] - 3.2	[illegible] - [illegible].9	1.7 - 3.25

[illegible] SYSTEM - ΔF

Least ΔF1		ΔF2		Most ΔF3	
STEP	VOLTS	STEP	VOLTS	STEP	VOLTS
1	1.5	1	0.33	1	0.55
2	1.95	2	0.9	2	1.1
3	2.3	3	1.33	3	1.65
4	2.77	4	1.85	4	2.2
5	3.25	5	2.45	5	2.65
6	3.73	6	3.05	6	3.2
7	4.1	7	3.5	7	3.9
8	4.55	8	4.05	8	4.45

[illegible]

[redacted] AW-18

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CALIBRATION SHEET

[illegible] UNIT #4

[illegible]	[illegible] VOLTS	[illegible] VOLTS
F_1	[illegible]	3.2
F_2	1.5	2.3
F_3	1.75	2.0
F_4	1.15	1.4
F_5	2.15	2.55
[illegible] HOLD	1.55	
SHORT HOLD	4.1	
NO HOLD	1.1	

[illegible]	[illegible]
[illegible]	1.5
[illegible]	1.75
[illegible]	[illegible]
[illegible]	[illegible]

"A" SYSTEM

Least F_1 STEP	Least F_1 VOLTAGE	F_2 STEP	F_2 VOLTAGE	Most F_3 STEP	Most F_3 VOLTAGE
1	0.45	1	0.5	1	0.6
2	1.05	2	1.05	2	1.25
3	1.55	3	1.5	3	1.9
4	2.2	4	2.1	4	2.5
5	2.8	5	2.7		
6	3.45	6	3.3		
7	3.95	7	3.8		
8	4.6	8	4.4		

~~SECRET~~ SPECIAL HANDLING [redacted]

[illegible] [redacted] AW-[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.9	4.[illegible]	[illegible].45
[illegible]	1.9	[illegible]	1.45
[illegible]	1.25	3.5	1.55
[illegible]	0.[illegible]	[illegible]	1.55

"B" SYSTEM

FREQ	MOST F_3	F_2	LEAST F_1
110	4.3	3.6	---
120	4.3	2.6	---
140	4.3	1.0	---
160	3.75	1.0	---
180	2.5	3.15	---
200	2.05	1.0	---
205	0.4	3.6	---

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1 AUGUST 2015

AW-186

~~[illegible]~~

[redacted]

[illegible]

[illegible]	[illegible]
[illegible]	1.1
[illegible]	2.0
[illegible]	3.0

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	0.9
[illegible]	3.5
[illegible]	[illegible]

Least CLOCK 1

STEP	VOLTAGE
1	1.1
2	1.55
3	2.05
4	2.55
5	2.9
6	3.4
7	3.85
8	4.35

CLOCK 2

STEP	VOLTAGE
1	1.1
2	1.55
3	2.0
4	2.5
5	3.0
6	3.45
7	3.9
8	4.35

Last CLOCK 3

STEP	VOLTAGE
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	3.0
6	3.15
7	3.35
8	4.35

~~SECRET~~ SPECIAL HANDLING [redacted]

[illegible] Recorder. The tape recorder/reproducer [illegible] P/M [illegible] is capable of recording [illegible] pps [illegible] data and reproducing [illegible]. The [illegible] noise amplitude for the P/M channel is not [illegible] 30% below 5 volts. The record time is [illegible] 1 minutes and the reproduce time is approximately 3 minutes, resulting in [illegible] speed ratio of the two modes of operation.

The unit will read in when power is applied to the record terminals, provided that the unit is not stopped at the end of the record cycle or that the unit is not in the reproduce mode.

The unit will play back when power is applied to the reproduce terminals provided that the unit is not at the end of the reproduce cycle.

The reproduce command overrides the record command. When both commands are given, and the unit is reading out or has stopped at the end of the readout cycle, removing the reproduce command will allow the unit to enter the record mode of operation.

When the end of the tape is reached in either the record or the reproduce modes of operation the unit automatically shuts off.

[illegible]

[illegible] stations contain all necessary equipment for [illegible] of [illegible] New Jersey data on conventional FM/FM [illegible] track on [illegible] inch tape [illegible] four [illegible] are used for data, and [illegible]. However, for use with [illegible] data, [illegible] stations, Coso, Pole and Base, are being equipped with [illegible] wide-band recorders. These recorders will permit F.M. recording of the [illegible], thus minimizing degradation of the [illegible] bit stream.

4. Data Processing: Data processing at [illegible] results chiefly in two types of output for the New Jersey data. One consists in stripping irrelevant information from the composite telemetry signal, and making a high quality re-recording. The other consists of producing a visual record of the sampled wave train on a paper record large enough to permit analysis by hand measurement methods. Since the presence of activity is readily distinguishable by eye when viewed in this fashion, it is practical to utilize this method for engineering evaluation of equipment performance. This method also lends itself to documentation from which signal analysis may be performed.

[illegible]. Estimate of Equipment Performance

The two New Jersey missions which have been orbited have obtained mixed results. In the first mission the "A" receiver remained operative during the life of the mission. Some traffic was observed, and the doppler measurements yielded portions of excellent data. The clock failed early in the mission, but resumed normal operation after four days. Indications are that some malfunction occurred in the "B" receiver prior to orbit injection since it showed no activity during the mission. The recorder and telemetry link operated normally for the life of the mission. It is estimated that fifty percent of the reconnaissance equipment operated properly and performed its mission.

Attempts to perform real-time calibration revealed radio interference problems due to both data links transmitting simultaneously. It was noted that on a specific calibration pass a short segment of calibration data was observed when one telemetry transmitter was turned off prior to that which was transmitting New Jersey information. The calibration procedure can be revised to avoid this difficulty.

The second mission showed both receivers and clock operating to conclusion of the mission. No obvious traffic was noted on these records examined. Recorder and telemetry link operation was normal. These records are still being examined in detail, and it is not possible to place a relative figure of merit on the equipment.

The quality of the data retrieved from these two missions was good, and a high degree of confidence can be placed on the measured values of the data points.