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NATIONAL RECONNAISSANCE OFFICE

SATELLITE OPERATIONS CENTER

DESCRIPTION OF SIGINT MISSION 7340

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SIGINT MISSION 7340 MISSION DESCRIPTION

1. GENERAL INFORMATION

Mission 7340 is a reconnaissance receiver and data system directed against tropospheric-scatter communication signals operating in the 450-1000 MHz frequency range and other signals. The purpose of the mission is to provide geopositioning data of the transmitting antennas within accuracy limits of [redacted] analyze the target emitter signal characteristics and sample the signal information content. A simplified functional block diagram of the system is shown in Figure 1.1. 25X1

The mission description contains discussion of the following:

a. Antenna Subsystem

b. Receiver Subsystem

c. Recognizer Subsystem

d. Signal Measurement Subsustem

e. Tape Recorders

f. Summary of System Characteristics

2. ANTENNA SUBSYSTEM (Figure 2.1)

Signals are received via two antenna arrays; one array pointing south and the other north. Each array consists of two antennas mounted approximately 40 inches apart in a plane perpendicular to the spin axis; only one array at a time is selected for input. Each antenna is a conical spiral having approximately 3-db gain on axis, decreasing to approximately -8 db at 80 degrees off axis. The location of target emitters, in terms of angle about spin axis and angle to spin axis, is based upon the phase difference measured between antenna outputs as the satellite spins.

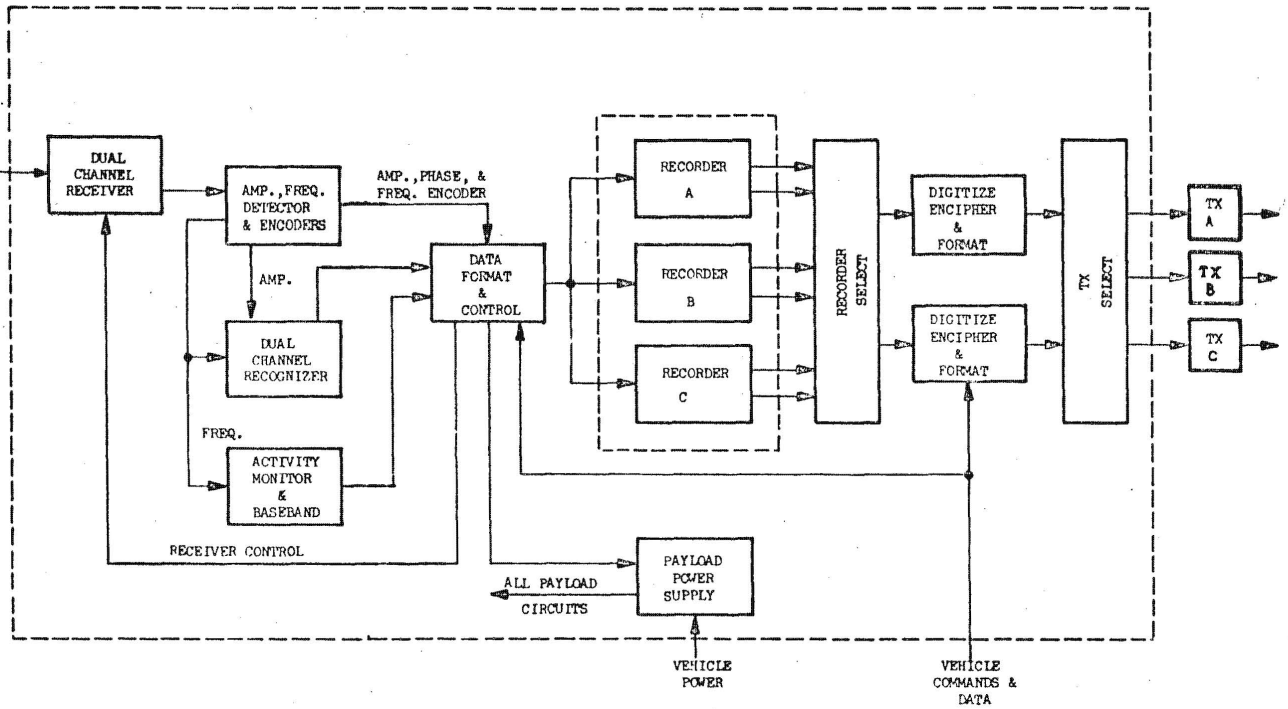

Figure 1.1 Simplified Functional Block Diagram

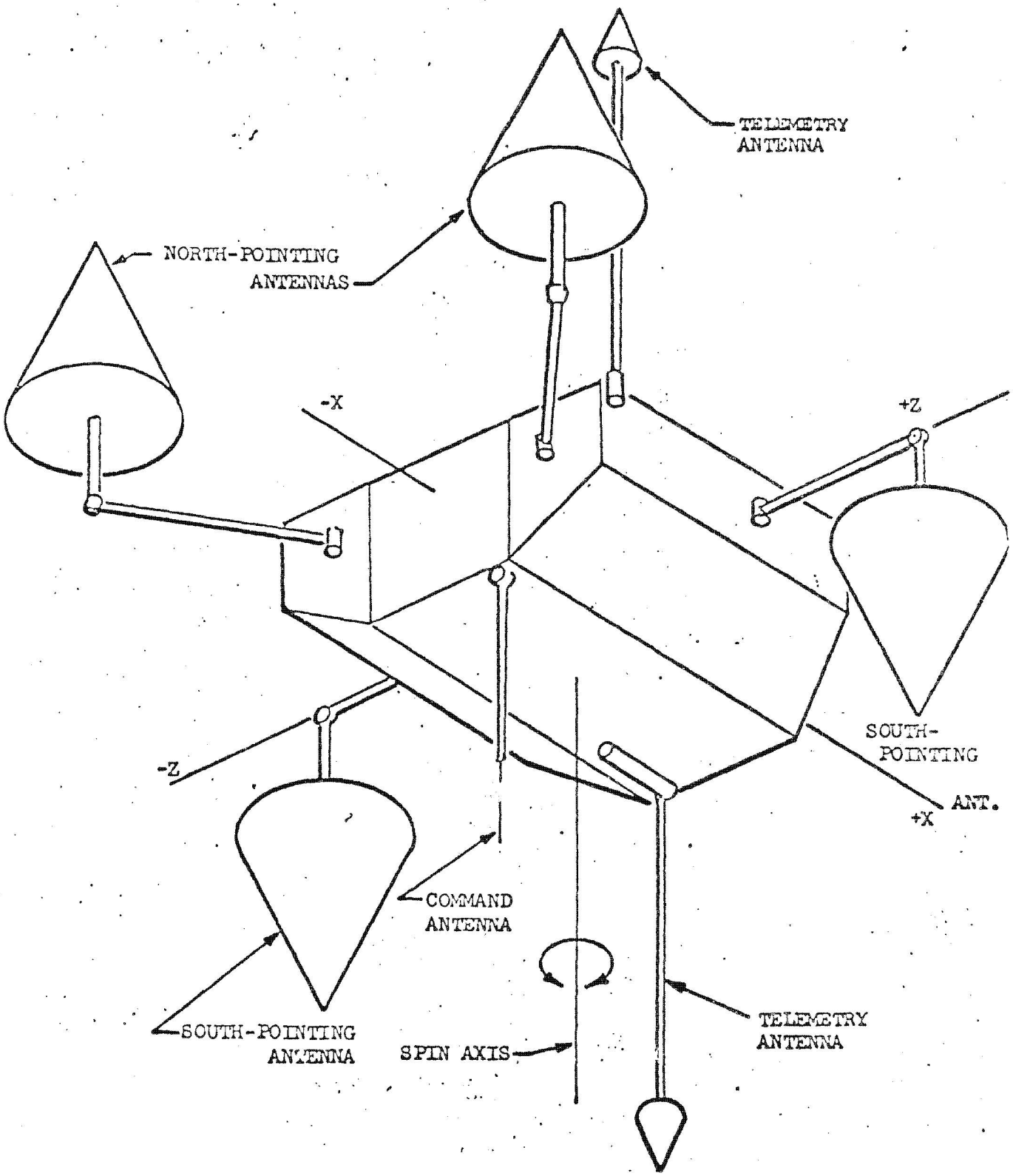

Figure 2-1 Antenna Subsystem

3. RECEIVER SUBSYSTEM

The payload contains a dual-channel receiver (DCR) that can detect the sidelobes of a target antenna. In addition, the DCR contains a commandable fixed-tuned receiver (FTR) mode.

3.1 Dual-Channel Receiver.

The DCR may search for either FDM or FSK type signals, but not both simultaneously. The DCR may be tuned in steps of 545 KHz from 450 to 1000 MHz. The receiver may be commanded to either a discrete frequency step or to scan a selected band segment. As in Mission 7334, there are three separate frequency segments designated A, B and C. Segment C in Mission 7340 can only use the FSK recognizer. With no frequency segments nor discrete steps selected, the receiver steps across the entire frequency band. The DCR will function properly for any in-band signal in the range from -95 to -30 dbm. This range of signals is accommodated by the DCR by adjusting the gain of the receiver front end for signals above -55 dbm. The noise figure of the DCR is 8 db or less. The DCR recognizer ignores signals below the receiver threshold, which is normally a noise-riding threshold. The actual threshold can be set to any level between 7 and 28 db above noise in steps of 3 db by ground command. Additionally, the DCR threshold can be set to any level between -95 and -74 dbm by ground command in steps of 3 db.

3.2 DCR Operating Modes.

Mission 7340 has three basic operating modes: search, recognize and copy.

3.2.1 DCR Search Mode.

In the search mode, the DCR steps across its tuning range, taking one step of approximately 545 KHz every 560 usec. The DCR searches with one channel monitoring a north-looking antenna and the other channel monitoring a south-looking antenna, unless an antenna pair has been selected by ground command. At each step, the DCR measures its own noise level and sets a threshold the proper amount (per ground command) above this noise level. The DCR then determines whether it is receiving a signal, apparently CW, which is above this threshold. If so, the DCR selects the antenna pair that will provide the strongest signal and transfers to the recognize mode; if not, the DCR continues to search.

3.2.2 DCR/FTR Mode.

In the fixed-tuned receiver (FTR) mode, the DCR is commanded to a 34 KHz RF step within the 450-1000 MHz range. The FSK recognizer is configured to recognize FSK signals having a frequency shift of 10 to 20 KHz. Normal mode recognition flags for tones, bandwidth and TV shall be operable but shall not cause any inhibit action to be generated. The DCR sensitivity will be increased to approximately -108 dbm because of the narrow bandwidths employed. Once commanded to this mode, the payload will remain at the commanded frequency step during the entire read-in.

3.2.3 DCR Recognize Mode.

In the recognize mode, the DCR first tests to determine whether the signal received is located within the current frequency step. If so, the signal present flag is raised, and recognition is continued; if not, the DCR reverts to the search mode. At the same time, tests are initiated to determine the proper IF bandwidth for the signal and to determine the AM and FM signal characteristics. The results of at least some of these tests are used if the signal present flag is up to determine whether the DCR should transfer to its copy mode. If the signal is accepted, the DCR transfers to its copy mode immediately. If the signal

is rejected, but the signal present flag is up, the recognize mode terminates only after the results of all pertinent recognizer tests have been delivered to the output data formatter.

3.2.4 DCR Copy Mode.

In the copy mode for a qualified FDM signal, the DCR measures and reports the differential phase between its two inputs once each 2.24 msec at a time consistent with the output data formatter requirements. The DCR also performs a spectral analysis of the FM baseband and measures the actual received signal frequency. The DCR continues to perform the TV and pilot tone tests, the results of which are sent to the data formatter.

When the DCR is dwelling on an FSK signal, the detected baud pattern will be recorded in two different frequency locations on the spacecraft recorder, i.e., from 200 cycles to 8 KHz and from 12 to 60 KHz. Recordings of the detected signal within the higher frequency range will eliminate tape recorder degradation. When in the FTR mode, the FSK signal will be recorded from 12 to 72 KHz in a predetection mode on the spacecraft recorder.

The copy mode terminates at the completion of a dwell period as established by ground command. The last 20 msec of the copy mode are used to calibrate the DCR. To minimize signal loss, the RF calibrator will be inhibited at the end of a dwell period for the FTR mode.

4. RECOGNIZER SUBSYSTEM

Mission 7340 is required to recognize signals from an environment containing many interfering signals of relatively high field strength. The DCR contains two signal recognizers; one for FDM-type signals and one for FSK-type signals. The FTR recognizer is a

modified FSK type. Table 4.1 lists the signal characteristics that each recognizer measures. Once a signal is recognized as a target, additional data are acquired for ground evaluation. A TV test may be enabled upon command for both recognizers. The FM bandwidth and pilot tone tests are used only to identify FDM type signals. The frequency in-band confirm, amplitude and duration tests are checked after 1104 usec to determine if the signal present marker is justified. When pilot tones are required, and all other requirements have been satisfied, recognition continues until the tones are detected or until 20 msec have passed to assure detection of any pilot tones present. The DCR recognition mode terminates when the signal is either accepted or rejected.

4.1 Signal Environment.

The target emitters transmit 3 to 5 kilowatt, frequency modulated/frequency division-multiplex (FM/FDM) signals in 12, 24, 60 or 120 channel formats. Figures 4.1 and 4.2 show these formats. Emitters operating between 450 and 700 MHz use 10 meter diameter, open mesh dish antennas, and emitters operating between 700 and 1000 MHz use 60 by 60 foot and 100 by 100 foot antennas. Figure 4.3 shows the signal levels that will be received versus distance (on the ground) of the emitter from the nadir point.

Table 4.2 summarizes the characteristics of specific known interference sources. The sources will, in large part, be capable of generating field strengths equal to or greater than those produced by the target signal emitters.

Mission 7340 will search for FSK (frequency shift keyed) type emitters in addition to FDM emitters. The characteristics of the FSK emitters of interest are as follows:

Table 4.1

Available Recognition Criteria

Amplitude and CW*	Signal must exceed selected threshold level throughout a 60-usec period.
In-Band Confirm*	Signal center frequency must fall within selected frequency step center ±375 KHz.
Not TV	Must not contain typical TV horizontal retrace pulses (AM).
FM Bandwidth	Must be FM at rates above 12 KHz; must not be FM at rates above 552 KHz.
Pilot Tones (20-msec test)	Must be FM with an 8 KHz pilot tone; must be FM with 8 or 304 KHz pilot tones; must be FM with an 8 and a 304 or 500 KHz pilot tones.
FSK	Must be FSK with frequency shift deviations from ±10 to ±100 KHz, and keying rates from 50 baud/sec to 15 Kbaud/sec.
FSK/FTR	Must be FSK with a peak-to-peak frequency shift deviation within +10 KHz to +20 KHz, and keying rates from 500 baud/sec to 4 Kbaud/sec.

*Signals not satisfying these tests are ignored. Signals satisfying these tests are described by the low-speed PCM data train.

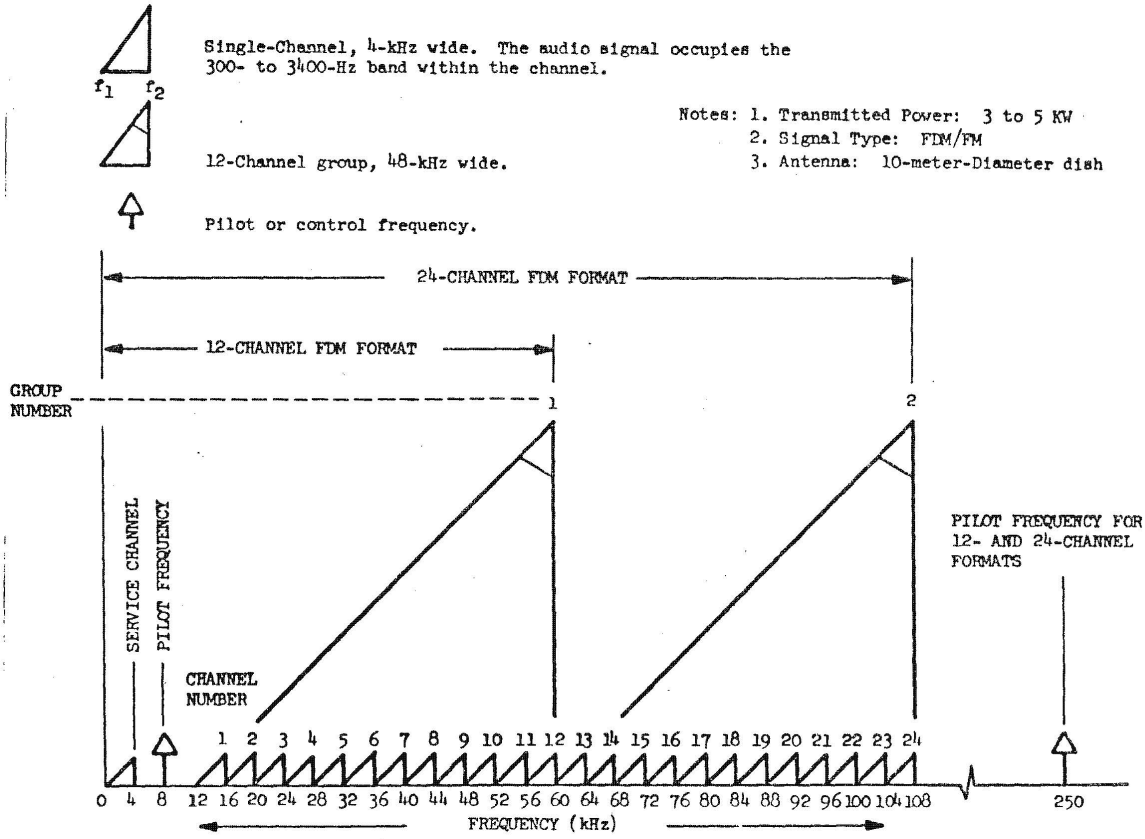

Figure 4.1 12- and 24-Channel FDM Format in the 450- to 700-MHz Band

Single-Channel, 4-kHz wide. The audio signal occupies the 300- to 3400-Hz band within the channel.

12-Channel group, 48-kHz wide.

Pilot or control frequency.

Notes: 1. Signal type: FDM/FM
2. Transmitter Power: 3 to 5 kW
3. Antenna: 60 x 60 ft or 100 x 100 ft billboard
4. FM BW: 1.6 and 2.1 MHz

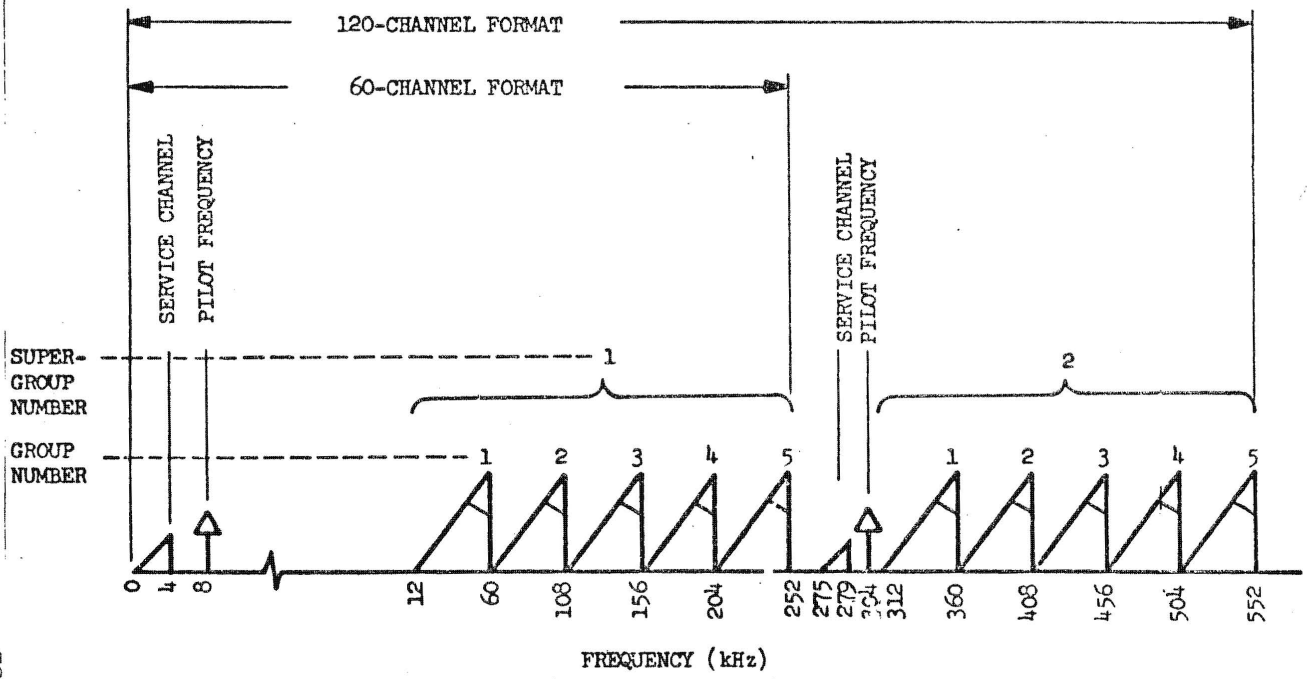

Figure 4.2 120-Channel FDM Format in the 700- to 1000-MHz Band

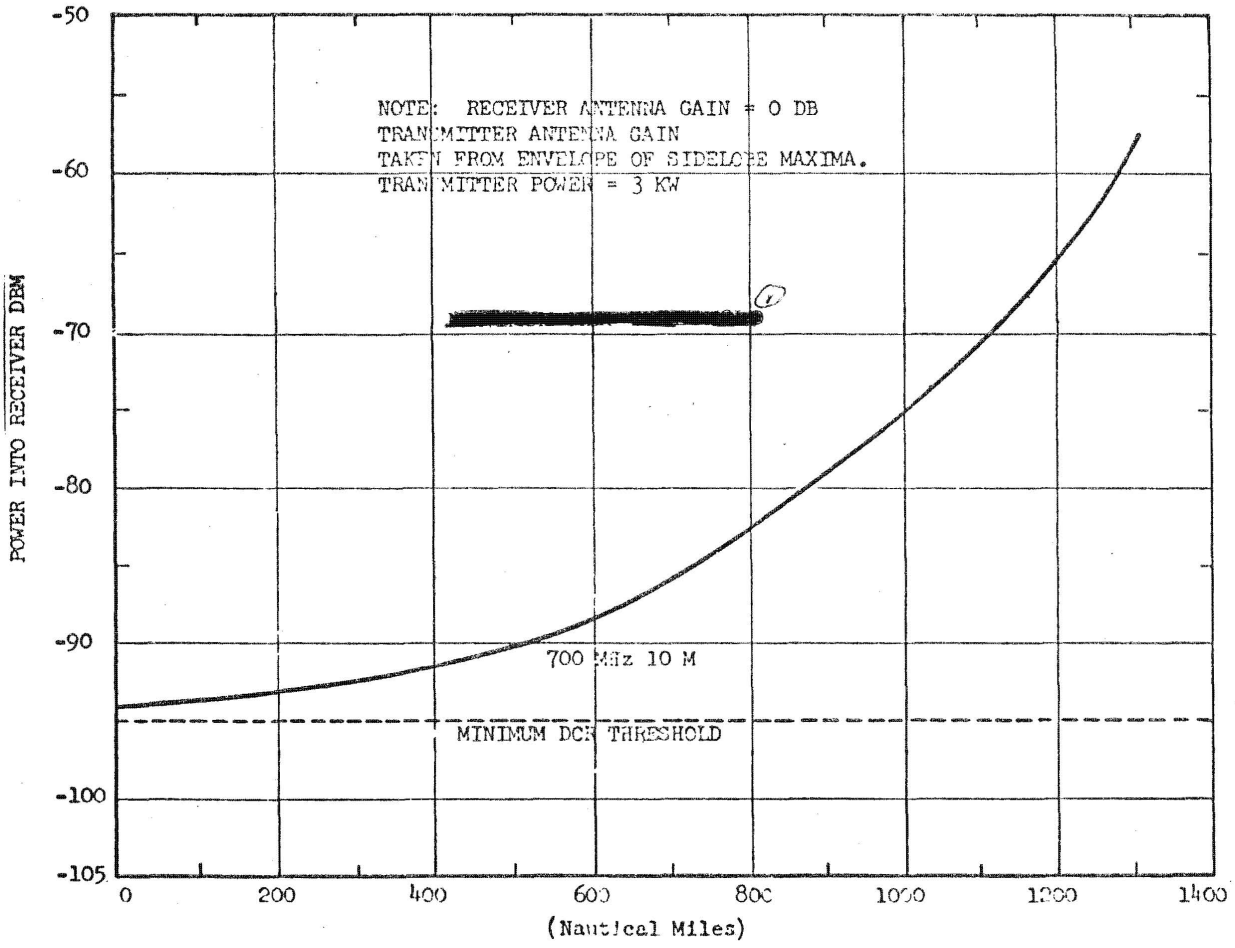

Figure 4.3 Input power vs distance from NADIR

Signal	Frequency Shift	Band Rate	Estimated Power
1	±80 KHz	14.925 Kbaud to 15.950 Kbaud	
2	±20 KHz	73 baud/S	3 to 5 KW
3	+13 KHz	500 baud/S and 4 Kbaud/S	20 to 200 W

4.2 Recognizer Tests.

The following specified tests (summarized in Table 4.1) are performed by the recognizer.

TV Test. This test determines whether the characteristic horizontal retrace pulses of a TV video signal are present. If such pulses are present, the signal has failed the TV test. When commanded to the standard or adaptive FSK modes and the TV recognizer has been set, blanking of the associated TV audio frequency step will take place. The blanked steps will consist of a frequency band 5.5 to 6.5 MHz from the frequency at which the TV flag was set. When in the FTR mode, presence of the TV video signal 5.5 to 6.5 MHz below the fixed FTR frequency step will be recognized by setting the TV flag. No inhibiting action will be taken.

FM Bandwidth Test. This test determines the spectral distribution of the FM baseband energy and categorizes signals as being narrowband, the desired 12 to 552 KHz normal band, or wideband. Non FM and TV audio signals are considered to be narrowband signals; FM and TV signals are considered to be wideband signals. The recognizer can be commanded to reject either narrowband or wideband signals or both. This test is replaced by the spectrum analysis test in the DCR during the copy phase.

Table 4.2

INTERFERENCE SUMMARY

Signal Type	Modulation Type AM	Modulation Type FM	Distinguishing Characteristics
CW	--	--	No Modulation
P2, P3, P9	x	--	Audio frequencies modulating the pulsewidth, amplitude or position
[redacted]	x	--	[redacted]
F30, F39	--	x	Low ERP
FM TV Video (F5)	--	x	Baseband above 552 KHz
FM TV Sound	--	x	No baseband above 15 KHz
AM TV Sound	x	--	Amplitude modulation only
AM TV Video	x	--	Line sync pulses

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Pilot Tone Test. This test determines the presence of certain tones and combinations thereof in the FDM spectrum. The tones tested for are 8,304 and 500 KHz. The commandable combinations necessary to satisfy this test are as follows:

a. No tones

b. 8 and 304 or 500 KHz

c. 8 KHz

d. 8 or 304 KHz

FSK Test. This test evaluates FSK signals having baud rates from 50 baud/sec to 15 Kbaud/sec and having the correct frequency shift. When commanded to the FTR mode, the modified FSK recognizer is enabled. FSK signals satisfying this mode will have frequency shift level between 10 and 20 KHz, with a baud rate of 500 to 4 Kbauds per second. The in-band, amplitude, and signal duration requirements are still necessary for setting the signal present flag. A sampling period of 17 msec is used for setting the signal accept and FSK flags.

Accept/Reject Test. The FDM recognizer is configured to consider only those tests that have been selected by ground command. It accepts any signal presented to it that satisfies all the selected tests. If both the bandwidth and pilot tone tests are selected, the recognizer can be commanded to accept a signal that fails either one, but not both of these tests. The FSK recognizer criteria are satisfied by the repeated presence of the same frequency shift level.

DCR Bandwidth Test. The DCR recognizer also performs an added bandwidth test on the received signal. When commanded to its adaptive bandwidth mode, the DCR selects the proper DCR IF bandwidth according to the outcome of this test. This test is not part of the accept/reject decision and is not performed in the DCR copy mode.

5. SIGNAL MEASUREMENT SUBSYSTEM

5.1 DCR Signal Measurements.

The following are measured by the DCR, and are incorporated into the low-speed PCM data stream:

a. DCR Threshold. The DCR threshold level is measured once every 6.72 msec at time intervals compatible with the output data formatter requirements. Threshold level is reported with a resolution of 1 DB or better.

b. DCR Signal Amplitude. The amplitude of all signals received by the DCR is measured once every 6.72 msec at times compatible with the output data formatter requirements. DCR amplitude is reported with a resolution of 0.8 DB.

c. DCR Step Frequency. Center frequency is reported each time the DCR signal amplitude is reported. The stability of the DCR is such that no step drifts more than 20 KHz during a 15-minute read-in period in a fixed external environment.

d. DCR Fine Frequency. The average frequency of each signal accepted by the DCR is measured and reported with an accuracy of ±100 KHz for signals in the central half of the reportable range of frequencies, i.e., for signals within 1/2 step of the DCR center frequency. This measurement is performed once per subframe cycle so long as the DCR is in the copy mode. Resolution of the report is 8.516 KHz (128 levels for ±545 KHz).

e. DCR Recognizer. The results of DCR recognizer tests are reported each time the DCR amplitude is reported. If the DCR is in its search mode at the time of the report, this report should be ignored since there may be no signal applied to the recognizer.

f. DCR Spectral Analysis. The FM baseband of a signal received by the DCR in its copy mode is subjected to a spectral analysis that consists of the measurement of the activity of a 12 channel group. Each of 10 such groups is evaluated and the results reported during each subframe cycle.

g. DCR Phase. The phase difference between the two channels of the DCR is measured and reported once every 2.24 msec while the DCR is in its copy mode.

6. TAPE RECORDERS

Mission 7340 is equipped with three magnetic tape recorders for storage of payload data; one of the tape recorders is for backup. Each of the three 150 KHz tape recorders has a read-in/read-out ratio of 1:1. Read-in time capability is approximately 6.25 minutes. Read-in and read-out tape speeds are 40 inches/second. The tape recorders are automatically stopped at read-in and read-out end-of-tape (EOT). Two tape recorders can be read in serially and then read out in parallel. The mission cannot be operated in a transpond mode, i.e.; data must be recorded and dumped.

7. SUMMARY OF SYSTEM CHARACTERISTICS

A summary of pertinent system characteristics is contained in Table 7.1.

Table 7.1

MISSION 7340 SYSTEM CHARACTERISTICS

	Dual-Channel Receiver
Frequency Coverage	446.5-1004 MHz
Number of Steps	1024
Step Spacing (nominal)	545 KHz
Step Size	750 KHz
Noise Figure	8 db
Dynamic Range	
High-Gain Configuration	-95 to -55 dbm
Low-Gain Configuration	-70 to -30 dbm
Threshold Level	
(8 Command Options)	-95 to -74 dbm
Spurious Rejection	55 db
Accuracy	
Step Frequency Signal Frequency	±100 KHz
Band Scan Time	
No Contacts*	573.44 msec
False Alarm Every Step*	
TV, FM Station	6.881 sec
Worst Case	20.644 sec

*Scan speed limited by data channel capacity.