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BIF003W/2-020212-70
Series B
Revision A
[redacted] 50X1
70 Mar 16
P-114
No. of Pages ~~87~~ 92

TECHNICAL DESCRIPTION

TOPHAT INTERCEPT SYSTEM ~~(S)~~

(Spacecraft 4423)

Prepared by [redacted]
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Approved: for [redacted] 50X1
Advanced Techniques

Approved: [redacted] 50X1
Manager and Chief Systems Engineer

Approved [redacted] 50X1
Program Manager

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FOREWORD

This document has been prepared in accordance with the requirements of Sequence No. 005 of DD1423 (exhibit A to Contract [redacted] 50X1

REVISION RECORD

Revision	Document: Spacecraft 4423/TOPHAT Technical Description	Date
Change pages	Changes have been incorporated to reflect the effects of design modifications. Appendix C has been added to define the subcommutated data format.	69 Sept 8
A	This revision incorporates changes made to reflect the final system configuration.	70 Mar 16
Change pages	Changes have been incorporated to rectify certain errors and to include final modifications	70 Jun 26

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Section 1

INTRODUCTION

This technical description describes the TOPHAT Intercept System and includes a brief description of the signals that may be encountered during the system mission as well as the criteria by which the system selects desired signals and rejects interfering signals.

This document also describes the data formats used to compile and report information acquired and the command capabilities and format used to control the payload so as to acquire specific desired data.

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Section 2

SUMMARY

2.1 SYSTEM MISSION

The TOPHAT reconnaissance system is directed against [redacted] 25X1 communication links operating in the 450- to 1000-MHz frequency range. The purpose of the mission is as follows:

a. Determine the geographic locations of the transmitting antennas

b. Determine the antenna pointing directions

c. Analyze the transmitted signal characteristics

d. Sample the signal information content.

2.2 SIGNAL ENVIRONMENT

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Table 2-1

Sidelobe Signal Duration, Overhead Pass

Frequency (MHz)	Antenna Dimensions	3-dB Sidelobe Dimension (degrees)	Flying Time (seconds)
450	10 meters	3.0	65.0
700	10 meters	1.7	36.8
700	60 feet	1.0	21.6
700	100 feet	0.6	13.0
1000	100 feet	0.4	8.6

Table 2-2

Main-Lobe Signal Duration, Pass Perpendicular To Main Lobe

Frequency (MHz)	Antenna Dimensions	Main Lobe Dimension (degrees)	Flying Time (seconds)
450	10 meters	4.50	26.8
700	10 meters	3.00	17.9
700	60 feet	1.53	9.1
1000	100 feet	0.64	3.8

Table 2-3

Interference Summary

Signal Type	Modulation Type AM	FM	Distinguishing Characteristics
CW	--	--	No modulation
P2, P3, P9	x	--	Audio frequencies modulating the pulse-width, amplitude, or position
Short-Pulse Radars	x	--	Pulsewidths less than 60 usec
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

Table 2-4

Principal TV Standards

Standard	Synch PW (usec)	Blanking Pedestal Width (usec)	Horizontal Retrace Interval (usec)
		Black Positive	
USA	4.0-5.7	9.6-12.0	63.5
Russia	4.4-5.5	11.6-12.75	64.0
CCIR	4.3-5.3	11.6-12.70	64.0
		White Positive	
Belgium	4.5-4.9	11.8-12.2	64.00
Belgium	3.3-3.9	9.1- 9.7	48.84
France	2.3-2.7	9.0-10.0	48.84

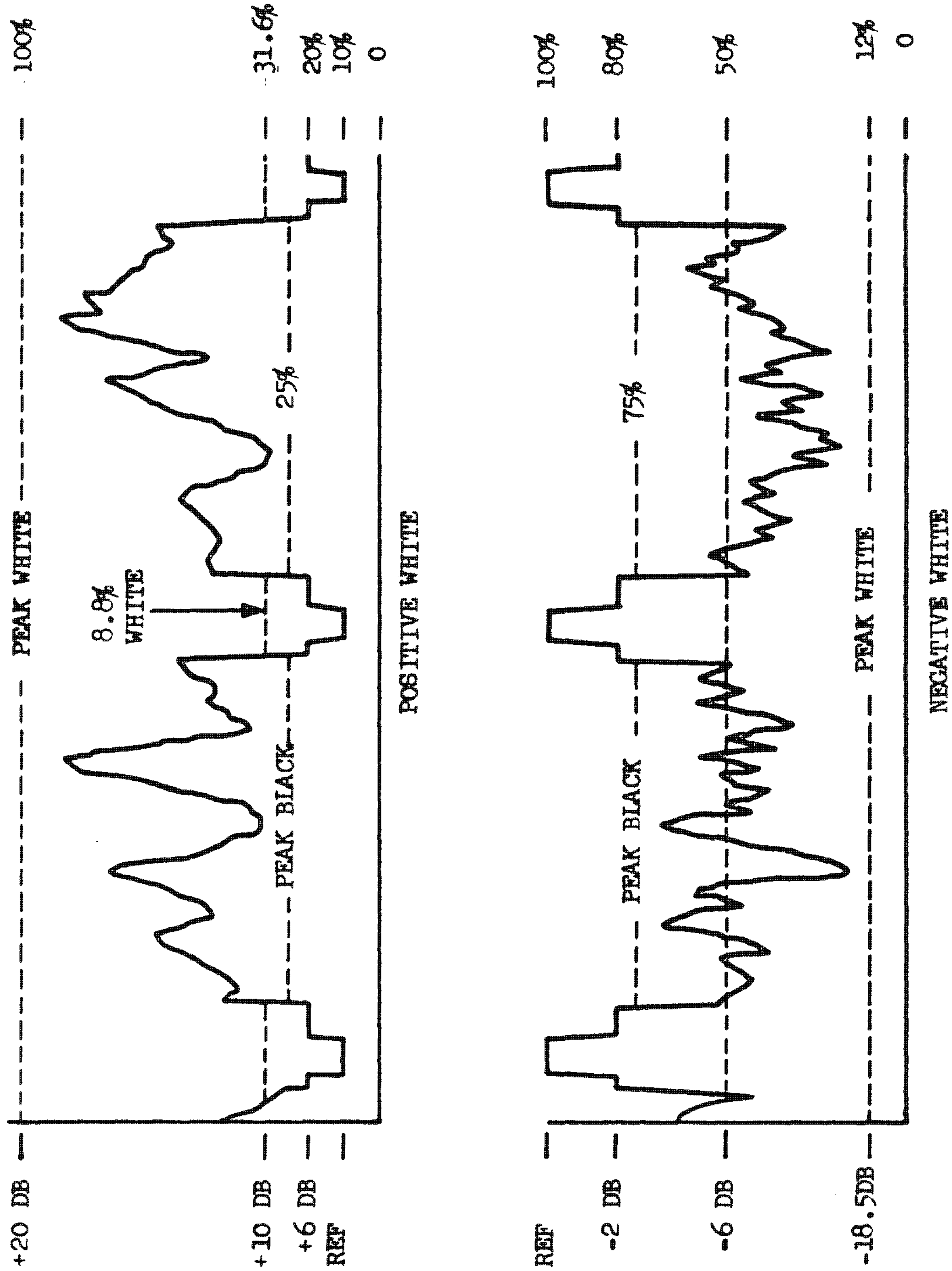

Figure 2-3A Typical TV Video Waveforms

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2.3 SPACECRAFT ORBIT AND SPIN

The TOPHAT system will be installed in a Program 989 spacecraft and launched into a circular orbit at an initial altitude of 275 n.m. The spacecraft will spin at an initial rate of 60 rpm about an axis parallel to the earth axis.

2.4 ANTENNA CONFIGURATION

Signals are received on 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, as shown in figure 2-4. Each antenna is a conical spiral having approximately 3-dB gain on axis, decreasing to approximately -8 dB at 80 degrees off axis. [redacted] 25X1

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[redacted] 25X1 Figures 2-5 and 2-6 show the expected antenna patterns.

2.5 TOPHAT CONFIGURATION

The TOPHAT incorporates the functions shown in the block diagram of figure 2-7. All items and functions shown within the dashed-line box are payload items or functions. Items shown in figure 2-7 that are spacecraft equipment include the antennas, horizon sensor, sun sensor, three 150-kHz tape recorders, spacecraft status commutator and VCO, two transmitters, multicoupler, and the telemetry antenna.

The (1) symbols in the figure indicate those areas or functions where ground commands are required to select various modes of operation. However, commands are not limited to just the areas indicated. Table 2-5 summarizes the TOPHAT system characteristics.

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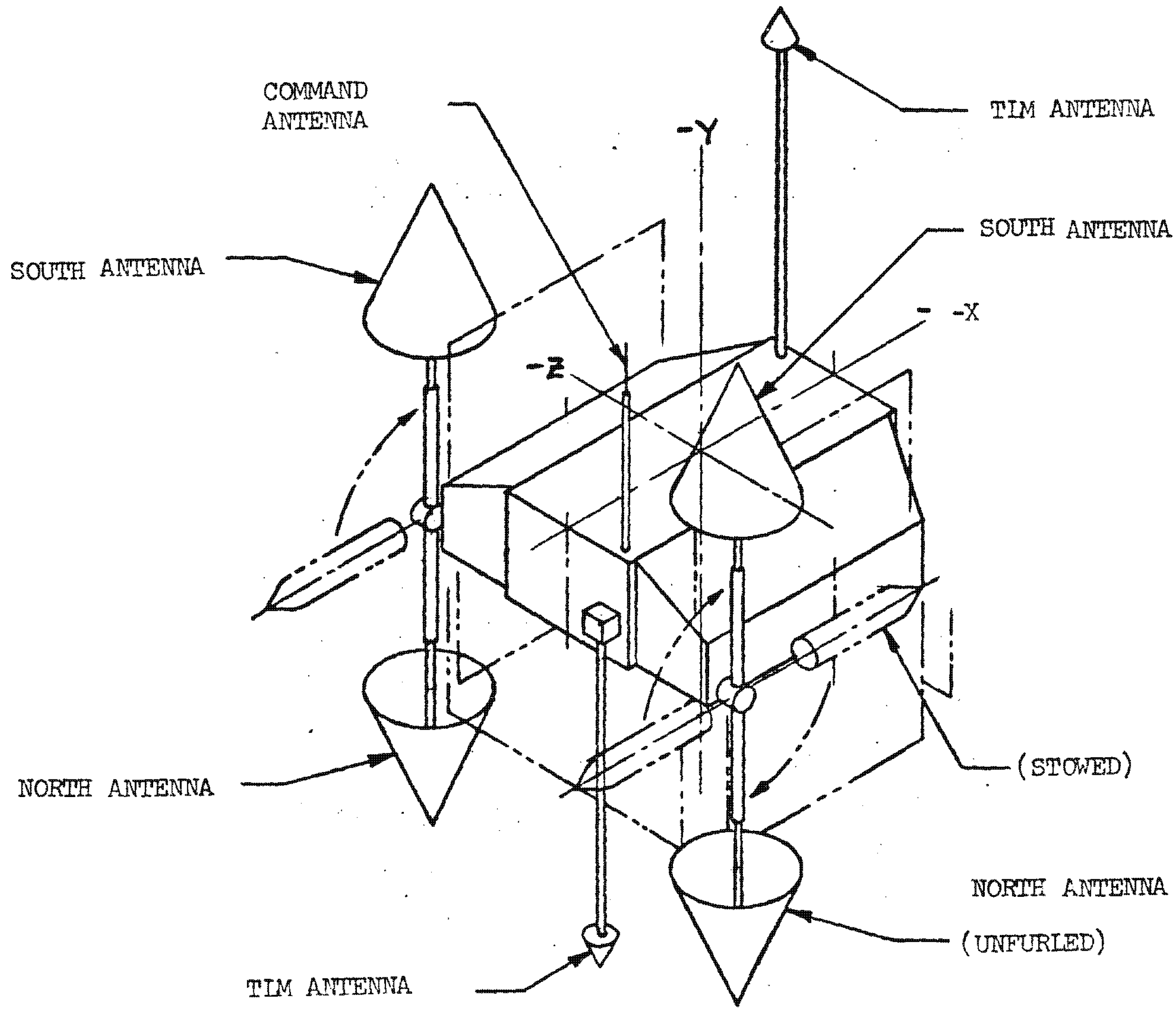

Figure 2-4 Spacecraft 4423 Configuration

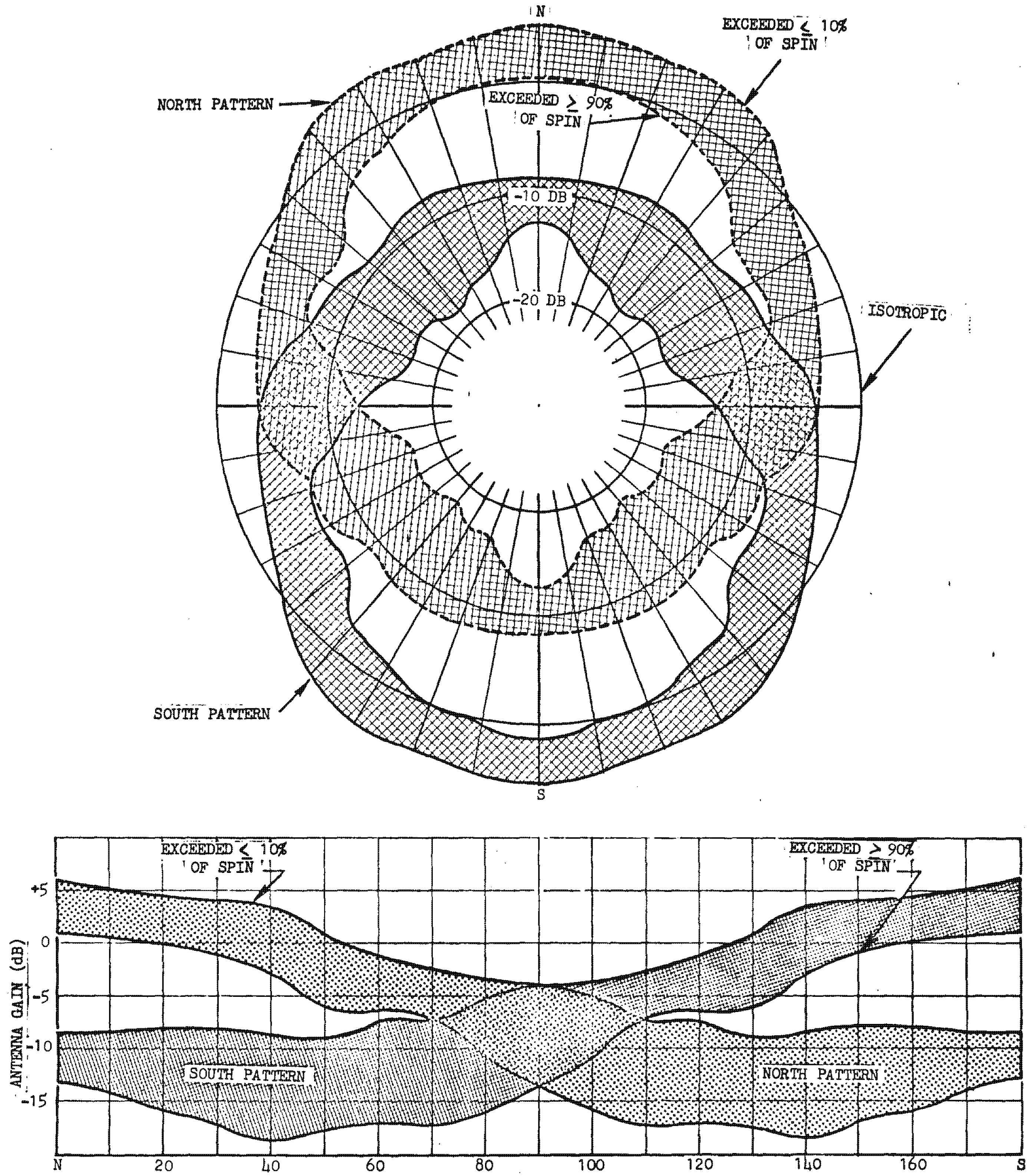

Figure 2-5 Antenna Pattern at 450 MHz, Spin Average

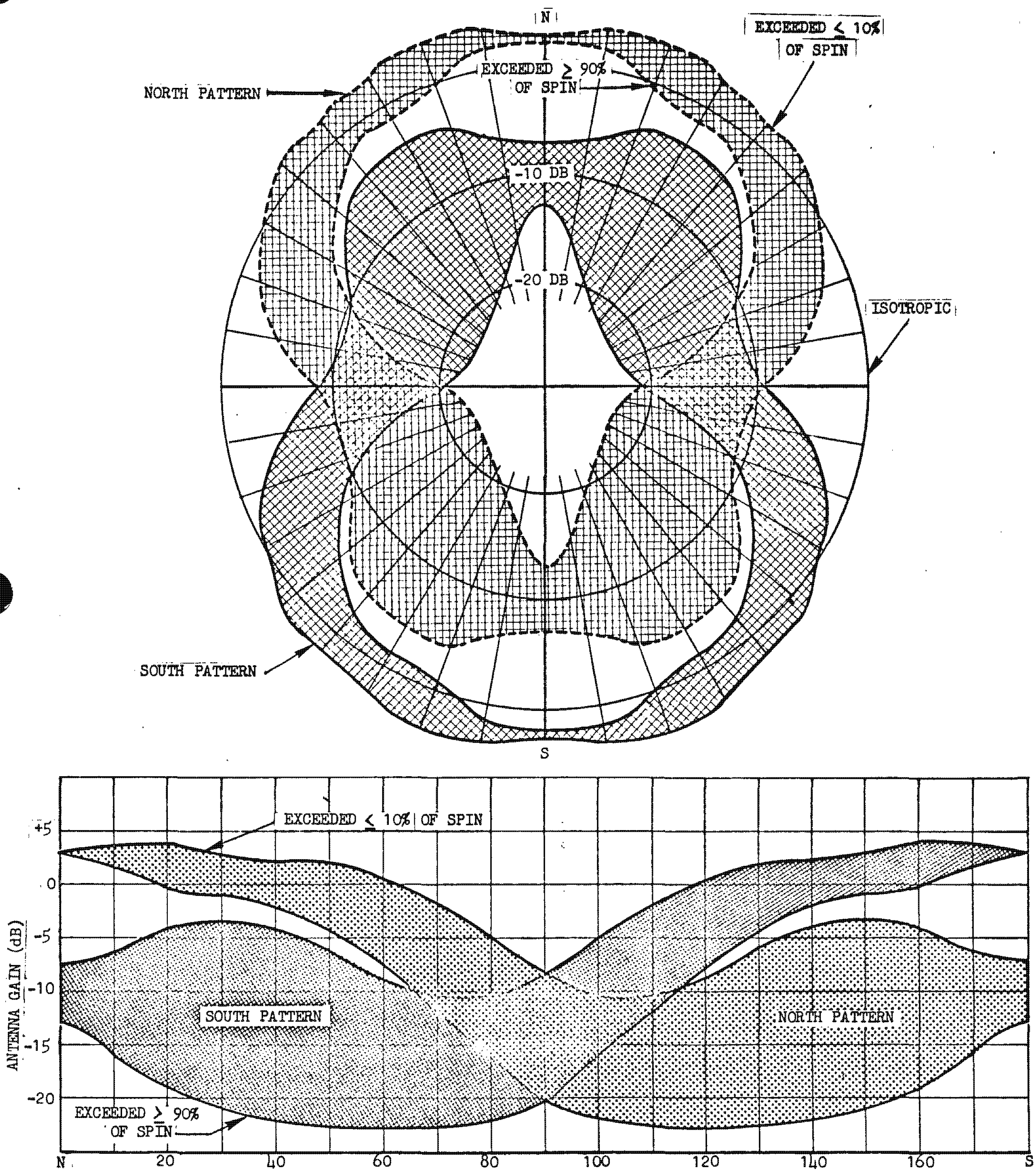

Figure 2-6 Antenna Pattern at 1000 MHz, Spin Average

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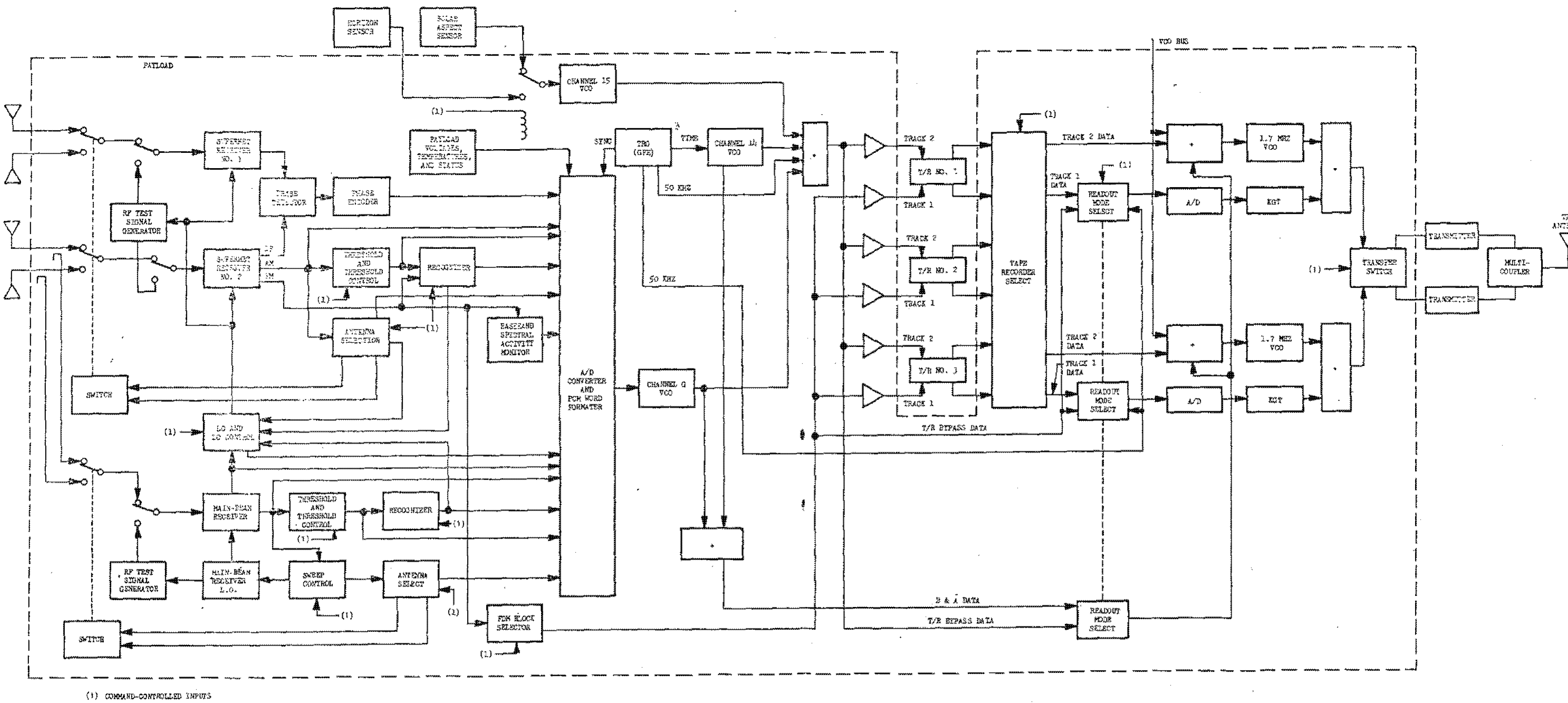

Figure 2-7 Spacecraft 4423 Simplified Block Diagram

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Table 2-5

TOPHAT SYSTEM CHARACTERISTICS

	Dual-Channel Receiver	Main-Beam Receiver
Frequency Coverage	446.5-1004 MHz	450-1000 MHz
Number of Steps	1024	512
Step Spacing (Nominal)	545 kHz	1.09 MHz
Step Size	750 kHz	1.80 MHz
Noise Figure	8 dB	27 dB
Dynamic Range		
High-Gain Configuration	-95 to -55 dBm	
Low-Gain Configuration	-70 to -30 dBm	-70 to -30 dBm
Threshold Level		
(8 Command Options)	-95 to -74 dBm	-70 to -49 dBm
Spurious Rejection	55 dB	55 dB
Accuracy:		
Step Frequency		±5 MHz
Signal Frequency	±100 kHz	
Band Scan Time		
No Contacts	573.44 msec	240 msec
False Alarm Every Step*		
TV, FM Station	6.881 sec	3.441 sec
Worst Case	20.644 sec	10.322 sec

*Scan speed limited by data channel capacity.

2.5.1 Functional Configuration

The TOPHAT system consists of two receivers plus a data interface network. The first receiver is a single-channel, low-sensitivity receiver that detects and identifies the main antenna lobe from target stations. This receiver is called the main-beam receiver (MBR) in this document. When the MBR encounters and identifies a main-beam signal from a target station, it issues an alarm to the second receiver so that both receivers can extract data from the signal, if desired.

The second receiver is a dual-channel receiver (DCR) capable of detecting the sidelobes of a target antenna. The DCR searches for and extracts data from such sidelobes except when called by the MBR to read a main-lobe signal. The DCR is used to determine target locations, operating frequency, and signal content.

The data interface circuitry formats data as it is acquired for storage on a spacecraft tape recorder. Later, on command, the contents of the tape recorders are played back to the data interface so that they can be reformatted for transmission to a ground station.

2.5.2 Target Locating

Direction to the target is determined using a rotating interferometer. The difference in phase at two antennas, both receiving the same signal, is determined by the separation of the antennas (40 inches), the operating frequency, and the angle between the line joining the antenna pair and the line-of-sight to the signal source. When this angle is 90 degrees, the phase difference is zero. Because the spacecraft is spinning, this angle varies, thus varying the phase (unless the target is on the spin axis). The minimum angle (which can be calculated from the measured phase data) gives the largest phase difference. The minimum angle, together with the time that it occurs, defines the line of sight from the target to the spacecraft. The spacecraft location is readily computed, knowing the time of contact and the spacecraft orbit. Thus, the target is also located.

2.5.3 Target Antenna Aiming Determination

Target antenna aiming is determined from amplitude data taken while the spacecraft is crossing the main radiated beam from a target emitter. These data can come from either receiver (in slave, DCR data are probably best). The data identify the moment the spacecraft is closest to the center of the radiated beam. Spacecraft location is computed, using the known orbit parameters, to give one point near the center of the main radiated beam. The target location is, of course, the second point needed to define the target antenna aiming.

2.5.4 Signal Evaluation

Each receiver contains a recognizer that evaluates detected signals to determine whether they are the desired type of signal. Table 2-6 lists the signal characteristics that each recognizer measures. The recognizers can be configured (by command) to ignore any of these tests except the first two (marked with asterisks) in determining which signals to accept. Every signal satisfying these two tests is reported, at least briefly, since it is possible to configure the recognizer to accept such signals.

Once a signal is recognized as a target, additional data are acquired for ground evaluation. These include a precise measurement of the signal frequency, the results of a spectral analysis of the FM baseband, and samples of the FM baseband.

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Table 2-6

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 step (center ±375 kHz for DCR, ±950 kHz for MBR).
Not TV	Must not contain typical TV horizontal retrace pulses. (AM)
FM Bandwidth (2 tests)	Must be FM at rates above 16 kHz. Must not be FM at rates above 552 kHz.
Pilot Tones (20-msec test) (2 tests)	Must be FM with an 8-kHz pilot tone Must be FM with a pilot tone at 248, at 250, or at 304 kHz.

*Signals not satisfying these tests are ignored.

Signals satisfying these tests are described by the low-speed PCM data train.

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SECTION 3

PAYLOAD CHARACTERISTICS

3.1 RF CHARACTERISTICS

3.1.1 Dual-Channel Receiver (DCR)

3.1.1.1 DCR Frequency Range. The DCR is capable of tuning from 446.5 to 1004-MHz in steps of 545 kHz. It is also capable of restricting its tuning range to any one, two, or three of the three frequency segments defined by the payload command memory. The DCR uses the 10 most significant bits (MSB) of the words defining the selected segment(s) to provide 1024 possible frequencies for each starting and ending point. Each end point must be equal to or greater than the corresponding starting point.

If no frequency segments are selected, the DCR scans the entire frequency range; if more than one frequency segment is selected, the DCR scans the selected segments in rotation.

3.1.1.2 Stability. The short-term stability of the DCR local oscillators is such that incidental FM is less than 1.0 kHz peak at or below 10 Hz. Above 10 Hz, the peak deviation is reduced at 6 dB per octave from 10 Hz to 10 kHz. FM rates above 10 kHz are less than 1.0 Hz peak.

3.1.1.3 Amplitude Range. The DCR functions correctly 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. Noise figure of the DCR is 8 dB or less.

The DCR recognizer (see section 3.3) ignores signals below the receiver threshold, which is normally a noise-riding threshold. As 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. In addition, the DCR threshold can be set to any level between -95 and -74 dBm by ground command in steps of 3 dB.

3.1.1.4 Spurious Responses. With the DCR configured for high-level signals, spurious responses (to signals more than 10 MHz from the DCR tuned frequency) are below -85 dBm for signals below -30 dBm. In the normal configuration, spurious responses will be below -100 dBm for signals below -50 dBm. (-30 dBm signals may produce spurious responses as strong as -60 dBm.)

3.1.2 Main Beam Receiver (MBR)

3.1.2.1 MBR Frequency Range. The MBR can tune across the [redacted] 25X1
band in steps of approximately [redacted] MHz. Also, its tuning range can be restricted to any one, two, or three of the three frequency segments defined by the payload command memory. The 9 MSB of the words defining the selected segments are used to provide [redacted] possible frequencies for each starting and ending point. If no frequency segments are selected, the MBR will scan its entire frequency range. If more than one frequency segment is selected, the MBR will scan the selected segments in rotation. 25X1 25X1

3.1.2.2 Stability. The MBR local oscillators have a repeatable (and, thus, calibrateable) operating frequency for a given step and temperature. The calibrated frequency accuracy of the MBR is ± 5 MHz or better. The tuned frequency is within 14 MHz of nominal (defined as DCR frequency at same step) for any temperature between 20 and 100°F.

3.1.2.3 Amplitude Range. The MBR functions correctly for any in-band signal in the range from -70 to -30 dBm. The noise figure of the MBR is 27 dB or better. The MBR recognizer ignores signals below the MBR threshold, which is capable of being set to any level from -70 to -49 dBm in steps of 3 dB by ground command.

3.1.2.4 Spurious Responses. Spurious responses (to signals more than 10 MHz from the MBR tuned frequency) are below -85 dBm for signals below -30 dBm.

3.2 READ-IN MODES

The TOPHAT payload waits five seconds at the start of a read-in to allow the tape recorders to come up to speed. The next three seconds are devoted to calibration (see section 3.2.4). The two receivers then start to scan, starting at the lowest step in the band (full-band scan) or at the first step of the first segment enabled (segment scan).

3.2.1 <u>Signal Acquisition</u>

The MBR and the DCR search independently for signals; when either acquires a potential signal-of-interest, that receiver evaluates the signal.

Acceptance of a signal by the DCR has no effect on the MBR. However, acceptance of a signal by the MBR results in a DCR call-up if the slave mode has been selected. In the slave mode, the DCR responds to a call-up by first storing a record of its current operating frequency and then transferring to the approximate operating frequency of the MBR. All this is done within 6.72 msec.

The DCR is switched to its low-gain mode, and its threshold is set 3 dB below the MBR threshold. The DCR searches from 26 steps low (or bottom of band) to 26 steps high (or top of band). All signals detected are analyzed by the DCR recognizer, and the first acceptable signal is considered to be the correct signal.

If, after one search of the possible area, the DCR cannot locate an acceptable signal at the approximate location indicated by the MBR, it terminates the call-up and returns to search at the frequency stored in its register, with its original threshold and sensitivity levels. In this case, the MBR also abandons the signal. No MBR calibration is provided.

After the DCR recognizer accepts a signal during a call-up, the MBR and DCR remain in the copy mode until the DCR terminates its copy mode. The DCR returns to normal sensitivity and threshold when the signal fails its elevated threshold.

Termination of copy by the MBR occurs in the independent mode when the signal drops below the MBR threshold. The copy period can be limited to 30 seconds by ground command. In the slave mode, both MBR and DCR terminate copy when the signal drops below the DCR threshold, or after a maximum of 30 seconds if so commanded. The DCR threshold may be set at normal level or slightly below the MBR threshold.

3.2.2 <u>DCR Operating Modes</u>

a. <u>DCR Search Mode</u>. 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.* 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.

b. <u>DCR Recognize Mode</u>. 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

*Unless an antenna pair has been selected by ground command.

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.

c. <u>DCR Copy Mode</u>. In the copy mode 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. These tests cannot cause an accepted contact to be rejected.

In addition to the above, the DCR translates a 48-kHz section of the FM baseband into the region from 12 to 60 kHz, translates the portion between 275 and 279 kHz down to the region from 68 to 72 kHz, and delivers these - along with the portion of the original baseband below 8 kHz - to the interface circuitry for recording on one track of a tape 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. An exception to the above is made when the

DCR is slaved to the MBR and the MBR calls-up the DCR. In this case, the DCR terminates the copy mode (without a calibration period) at the next time that the DCR data are delivered to the output formatter after the call-up. In any case, the DCR reverts to the search mode at the end of the copy mode. Dwell can be set to 1.5, 3, 10, or 60 seconds. Alternatively, the dwell can continue as long as the signal is satisfactory (recognition rechecked every 3, 10, or 60 seconds).

3.2.3 MBR Operating Modes

a. MBR Search Mode. In the search mode, the MBR steps across its tuning range, taking one step of approximately 1.09 MHz every 448 usec. During the first half of this step period, the MBR is connected to a south-looking antenna* and determines whether this antenna provides a signal that is (1) above the (ground-commanded) MBR threshold, (2) appears to be CW, and (3) is centered within the current frequency step. If any of these criteria are failed, the MBR repeats this test with a north-looking antenna for the second half of the step-period. (If ground commands have specified one antenna, the time assigned to the other antenna is used to recheck the specified antenna. The MBR pauses for approximately 10 msec on the first step of each scan. When scanning two or more sectors, it pauses on the first step of each sector.

The MBR remains in the search mode until the above test is satisfied, at which time the MBR raises its SIGNAL PRESENT flag and transfers to the recognize mode.

*Unless the antenna to be used is specified by ground command.

b. MBR Recognize Mode. In the recognize mode, the MBR tests the AM and FM characteristics of the received signal. The results of some of these tests (possibly all) are used to determine whether the received signal is acceptable for copy. (See section 3.3.4). In either case, the recognize mode terminates as soon as the results of the tests, plus a report on the signal level and identifications of the frequency step and antenna, are delivered to the output data formatter. If the signal is rejected, the MBR reverts to the search mode; if the signal is accepted, the MBR transfers to the copy mode. Also, if the signal is accepted, the MBR issues a call-up to the DCR. The DCR responds to this call-up only if it is slaved to the MBR.

c. MBR Copy Mode. In the copy mode, the MBR repeats all the tests required in the recognize mode, except for the actual accept/reject test. It performs these tests, measures the input signal level, and reports the results once every 6.72 msec throughout the copy mode duration. The selected frequency step and the selected antenna are identified in these reports (although they cannot change).

The MBR copy mode continues for a time period determined by ground command. The last 20 msec of copy mode are used to calibrate the MBR. At the end of the copy mode, the MBR reverts to the search mode. This search mode begins with the MBR testing the south antenna at the next frequency step.

3.2.4 Calibration

Each receiver contains an RF test signal generator. In addition, the payload contains video calibrators for the A/D (analog-to-digital) converters used to generate the high- and low-speed PCM bit streams.

3.2.4.1 RF Test Signals. Each test signal is an FM signal located at the center of the frequency step to which the receiver is tuned. The test-signal is injected at the front-end transfer switch (used to select the desired antennas).

The DCR test signal is at about -65 dBm during the first part of its period, and the MBR test signal is at about -40 dBm during the first part of its period. Each test signal is reduced (by about 20 dB) after half the period has passed. Each test signal is frequency modulated ±0.5 MHz with a 10-kHz sawtooth signal.

3.2.4.2 Video Calibrators. The high-speed PCM video calibrator consists of a 50-KHz tone having an amplitude 80 ±10 percent of the maximum amplitude capability of the high-speed PCM A/D converters. The low-speed PCM video calibrator is a 16-level stairstep wave, the range of which is from zero to the maximum amplitude capability of the A/D converters involved.

3.2.4.3 Timing. The low-speed PCM video calibrator signal is inserted into the A/D converters at the beginning of each read-in, starting five seconds after read-in is initiated and continuing for 1.5 seconds (3 cycles).

The high-speed PCM video calibrator signal is inserted into the two A/D converters (that provide the high-speed PCM) during the B&A T/R R/O (before and after tape recorder readout) periods.

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Both RF test signals are injected at the beginning of each read-in, starting at the end of the initial video calibrate period, and ending 1.5 seconds later.

Each RF test signal is injected during the last 20 msec of a commanded dwell in the copy mode. In the indefinite dwell period modes, an RF test period occurs before each requalification (every 3, 10, or 60 seconds as commanded). The DCR terminates a copy mode without an RF test period only if the termination is in response to a slaved call-up. The MBR terminates a copy mode without an RF test period only if a slave call-up has been rejected by the DCR.

3.3 RECOGNIZER

Each receiver contains a recognizer that performs three tests on the incoming signal and accepts or rejects the signal depending on the results of those tests as selected by ground command. The three tests are described below.

3.3.1 TV Tests

The first 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. This test is performed at the output of an AM detector.

3.3.2 FM Bandwidth Test

The second test determines the spectral distribution of the FM baseband energy. This test categorizes signals as narrowband, normal-band, and wideband signals. Non-FM and TV audio signals are considered to be narrowband signals, and FM-TV video 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.

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3.3.3 Pilot Tone Test

The third test determines whether the FM baseband contains certain tones. This test may be configured to require a tone at 8 kHz. It may, independently, require a tone at one of the following three frequencies: 248, 250 or 304 kHz. The presence of any one of these frequencies will satisfy this part of the test.

3.3.4 Accept/Reject Decision

The 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. In addition, if both the second and third tests are selected, the recognizer can be commanded to accept a signal that fails either one, but not both, of these tests.

3.3.5 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.

3.3.6 Timing

The recognizers are synchronized to the low-speed PCM bit stream. (See appendix A.)

3.3.6.1 <u>DCR Recognizer.</u> The DCR recognizer performs each test once during a recognition phase. In-band confirm, and the amplitude and duration (A & D) test are checked after 1104 usec to determine if the signal present marker is justified. When pilot tones are required, and all other requirements are satisfied, recognition continues until the tones are detected, or 20 msec have passed. This assures detection of any pilot tones present. The DCR recognition mode terminates when the signal is accepted or rejected.

A fixed 20-msec recognition period can be commanded (this allows tone tests to be performed on nonqualified contacts without requiring tones - an exploratory mode). In this case, the FM bandwidth test is repeated for a total of six times. These tests are combined as follows: for narrowband reject, all must report "narrow band"; for wide-band reject, at least one must report "wide band".

3.3.6.2 <u>MBR Recognizer</u>. The MBR recognizer performs each test once during a recognition mode period. The TV test can be satisfied in as little as 100 usec. The FM BW test requires 528 usec to perform. If pilot tones are required, and all other requirements are satisfied, recognition continues until tones are detected or until 20 msec have passed. The MBR recognition mode terminates when the signal is accepted or rejected.

A fixed 20-msec recognition period can be commanded. In this case a full tone test, and six FM bandwidth scans will be performed, even on nonqualified signals. Like the DCR recognizer, the MBR recognizer considers a signal narrow band only if all six scans report "narrow-band signal". Any one "wide-band signal" report will characterize that signal as wide band.

3.4 SIGNAL MEASUREMENTS

3.4.1 DCR Data

The following quantities 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. A reading of 10 represents the normal level of the lowest available threshold setting. The reported amplitude is derived equally from the two channels, i.e., if one channel were to loose the signal, the output number would be divided by two.

c. DCR Step Frequency. The DCR 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 $\pm$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 $\pm$545 kHz). This output is not valid until the DCR has been in the copy mode for at least two frames (40 msec) and, preferably, for at least five frames (100 msec).

e. DCR Recognizer. The results of the DCR recognizer tests described in section 3.3.1 thru 3.3.4 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 Miscellaneous Data. The DCR miscellaneous data bits are reported each time the DCR amplitude is reported. (See 3.5.1.1.)

g. 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.

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

3.4.2 MBR Data

The following quantities are measured by the MBR and the results are incorporated into the low-speed PCM data stream.

a. MBR Signal Amplitude. The amplitude of all signals received by the MBR is measured and reported on the average of once each 6.72 msec. Resolution is 1.0 dB nominal.

b. MBR Step Frequency. The MBR center frequency is reported each time the MBR signal amplitude is reported. This frequency is accurate within ±5 MHz after compensation for predictable variations using any calibration tables or charts provided with the payload.

c. MBR Recognizer. The results of the MBR recognizer tests (section 3.3.1 thru 3.3.4) are reported each time the MBR signal amplitude is reported. If the MBR is in its search mode at the time data are delivered to the data formatter, this output is considered to be invalid.

d. MBR Miscellaneous Data. The MBR miscellaneous data bits are reported each time the MBR signal amplitude is reported. (See 3.5.1.1.)

3.4.3 High-Speed PCM

The high-speed PCM data streams describe the signals recorded on track 1 of each tape recorder. There are two such data streams, one for each recorder readout. Each track-1 signal consists of the received FM baseband from near DC to 8 kHz (limited by the tape recorder low-frequency response), one 48-kHz segment of the FM baseband (frequency translated to the 12- to 60-kHz band), plus the 275 to 279 kHz segment of the baseband translated to the band from 68 to 72 kHz. An AGC circuit stabilizes the level at the input to the tape recorders.

3.4.4 Payload Status and Memory

Critical temperatures and voltages are monitored and reported once each subframe cycle. Contents of the payload memory are read out once each subframe cycle. This readout includes both discrete commands and the contents of the memory matrix. The payload status monitoring and memory readout is performed during the read-in interval and also during the before-and-after tape recorder readout intervals.

Temperatures are reported with a resolution of 3° F or better over a range of 0 to 160°F or greater. Reported temperatures are accurate to within ±3°F, disregarding the quantizing error.

Voltages are reported with at least one potential level outside the normal operating range (of the voltage in question) on either end. Resolution of voltage reports is 10 percent of nominal or better.

Payload status and memory data are formatted in 7-bit words, MSB first.

The state of all functions controlled by RTC's (see section 3.7.1) is also reported to the spacecraft in the form of analog voltages as follows:

Analog Line	Volts (DC)	Function
1	1.0	Memory Bank 1 selected
	2.0	Memory Bank 2 selected
	3.0	Memory Bank 3 selected
	4.0	Memory Bank 4 selected
2	1.0	Transmitters normal
	4.0	Transmitters interchanged
3	1.0	CAL enabled, B/U osc. disabled
	2.0	CAL disabled, B/U osc. disabled
	3.0	CAL enabled, B/U osc. enabled
	4.0	CAL disabled, B/U osc. enabled
4	Line voltage	P/L power bus

3.5 DATA FORMAT

3.5.1 Low-Speed PCM

The low-speed PCM is a 17.857 kbps, NRZ-L data stream formatted as follows:

1 bit	=			56.00 usec
1 word	=	8 bits*	=	448.00 usec
1 group	=	15 words	= 120 bits =	6.72 msec
1 frame	=	3 groups	= 360 bits =	20.16 msec
1 subframe cycle	=	24 frames	= 8640 bits =	483.84 msec

*Data are formatted MSB first.

3.5.1.1 Data Assignments. The low-speed PCM words have the following data assignments in each group of 15 words (see figure 3-1):

Words	Assignment
1, 2 and 3	Commutated data
4	DCR threshold
5, 10, 15	DCR phase
6	DCR recognizer
7	DCR misc plus 2 MSB's of step frequency
8	DCR 8 LSB's of step frequency

SECRET/

50X1

SYNC PATTERN (words 1–3)

1st GROUP

1	2	3	4	5
11011101	11101111	10111111	DCR THRESHOLD 00	PHASE

6	7	8	9	10
DCR RECOGNIZER 00	DCR MISC.	DCR STEP FREQ	DCR AMPLITUDE 00	PHASE

11	12	13	14	15
MBR RECOGNIZER 00	MBR MISC.	MBR STEP FREQ 0	MBR AMPLITUDE 00	PHASE

2nd GROUP

1	2	3	4	5
SUBFRAME 000 ID	COMMUTATED "A" 0	0 COMMUTATED "B"	DCR THRESHOLD 00	PHASE

6	7	8	9	10
DCR RECOGNIZER 00	DCR MISC.	DCR STEP FREQ	DCR AMPLITUDE 00	PHASE

11	12	13	14	15
MBR RECOGNIZER 00	MBR MISC.	MBR STEP FREQ 0	MBR AMPLITUDE 00	PHASE

3rd GROUP

1	2	3	4	5
SUBFRAME 000 ID	COMMUTATED "C" 0	0 COMMUTATED "D"	DCR THRESHOLD 00	PHASE

6	7	8	9	10
DCR RECOGNIZER 00	DCR MISC.	DCR STEP FREQ	DCR AMPLITUDE 00	PHASE

11	12	13	14	15
MBR RECOGNIZER 00	MBR MISC.	MBR STEP FREQ 0	MBR AMPLITUDE 00	PHASE

Note: 6.72 ms/group
20.16 ms/frame

Figure 3-1 Low-Speed PCM Data (One Frame)

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CONTROL SYSTEM ONLY

50X1

Words	Assignment
9	DCR amplitude
11	MBR recognizer
12	MBR misc plus MSB's of step frequency
13	MBR 7 LSB's of step frequency
14	MBR amplitude

These data assignments are described in the following sections.

Commutated Data. The first three words in each group are assigned to commutated data. These data are inserted in the second and third words of the second and third group of each frame, leaving the remaining words for frame and subframe sync.

DCR Threshold. The fourth word in each group reports the DCR threshold. The reportable range is -97 to -71 dB, nominal, (0.75-dB steps) in the high-gain mode, and -72 to -67 dB in the low-gain mode.

DCR Phase. The fifth, tenth, and 15th words in each group report the phase difference between the two channels of the DCR. These reports use 8 bits to cover the range from -180 to +179 degrees. These words are valid only when the DCR is in the copy mode. Table 3-1 shows typical phase words and their meaning.

DCR Recognizer. The sixth word in each group reports the results of the DCR recognizer tests. The bits in this word are assigned as follows:

Bit 1 (MSB)	304-kHz tone present
2	248- or 250-kHz tone present
3	8-kHz tone present
4, 5	FM BW report: 00 = no FM detected 01 = activity in supergroup 1 only 10 = activity in supergroups 1 and 2 only 11 = activity above supergroup 2
6	TV-type signal present
7, 8	Not used (fixed zeros)

This report is not valid when the DCR is in the search mode.

Table 3-1

Typical Phase Words

MSB 1	2	3	4	5	6	7	LSB 8	Phase Angle (degrees)
0	0	0	0	0	0	0	0	-180
0	0	0	0	0	0	0	1	-178.6
0	0	0	0	0	0	1	0	-177.2
				.				.
				.				.
0	0	1	0	0	0	0	0	-135
				.				.
				.				.
0	1	0	0	0	0	0	0	-90
				.				.
				.				.
0	1	1	0	0	0	0	0	-45
				.				.
				.				.
1	0	0	0	0	0	0	0	+0
				.				.
				.				.
1	0	1	0	0	0	0	0	+45
				.				.
				.				.
1	1	0	0	0	0	0	0	+90
				.				.
				.				.
1	1	1	0	0	0	0	0	+135
				.				.
				.				.
1	1	1	1	1	1	1	0	+177.2
1	1	1	1	1	1	1	1	+178.6

DCR Miscellaneous. The seventh word in each group reports miscellaneous data from the DCR. The bits in this word are assigned as follows:

Bit 1	(MSB)	Signal present flag
2		Accept flag
3		Antenna selection
4		DCR sensitivity (HI/LO range)
5		DCR bandwidth
6		Cal flag
7, 8		Two MSB's of DCR step frequency.

DCR Step Frequency. The eighth word in each group reports the eight LSB's of the DCR step frequency. (See table 3-2.)

DCR Amplitude. The ninth word in each group reports the signal amplitude received by the DCR. This amplitude is measured at the point where this level is compared to the DCR threshold level, and reported with a resolution of 0.8 dB, using the 6 MSB's of this word. The 2 LSB's of this word are zeros. (See table 3-4.)

MBR Recognizer. The 11th word in each group reports the results of the MBR recognizer tests. Bit assignments are identical to those of the sixth word.

MBR Miscellaneous. The 12th word in each group reports miscellaneous data from the MBR. Bit assignments in this word are as follows:

Bit 1	(MSB)	Signal present flag
2		Accept flag
3		CAL flag
4		Antenna selection
5, 6		Not used
7, 8		Two MSB's of MBR step frequency.

MBR Step Frequency. The 13th word in each group reports the 7 LSB's of the MBR step frequency. The LSB of the word is a zero. (See table 3-4.)

MBR Amplitude. The 14th word in each group reports the signal amplitude received by the MBR with a resolution of 1 dB, using the 6 MSB's of this word. The 2 LSB's of this word are zeros. (See table 3-5.)

Table 3-2

DCR STEP FREQUENCY (8th WORD)

MSB 7*	8*	1	2	3	4	5	6	7	LSB 8	Step Number	Step Frequency (nominal)
0	0	0	0	0	0	0	0	0	0	1	446.520
0	0	0	0	0	0	0	0	0	1	2	447.065
0	0	0	0	0	0	0	0	1	1	4	448.155
0	0	0	0	0	0	0	1	1	1	8	450.335
0	0	0	0	0	0	1	1	1	1	16	454.695
0	0	0	0	0	1	1	1	1	1	32	463.415
0	0	0	0	1	1	1	1	1	1	64	480.885
0	0	0	1	1	1	1	1	1	1	128	515.735
0	0	1	1	1	1	1	1	1	1	256	585.495
0	1	1	1	1	1	1	1	1	1	512	725.015
1	1	1	1	1	1	1	1	1	1	1,024	1,004.055

*These words are in the preceding (misc.) word.

Table 3-3

DCR AMPLITUDE (9th WORD)

MSB 1	2	3	4	5	LSB 6	7*	8*	Nominal Amplitude (dB) High gain	Nominal Amplitude (dB) Low Gain
0	0	0	0	0	0	0	0	Under-102.2**	
0	0	0	0	0	1	0	0	-101.8	
0	0	0	0	1	0	0	0	-101.0	
0	0	0	1	0	0	0	0	-99.4	
0	0	1	0	0	0	0	0	-96.2	
0	1	0	0	0	0	0	0	-89.8	
0	1	0	0	1	1	0	0	-87.4	Under-62
1	0	0	0	0	0	0	0	-77.0	-52
1	1	0	0	0	0	0	0	-64.2	-39.2
1	1	1	1	1	1	0	0	Over-52.6	Over-27.6

*Forced zeros.
**Below expected receiver noise level.

Table 3-4

MBR STEP FREQUENCY (13th WORD)

MSB 7*	8*	1	2	3	4	5	6	LSB 7	8**	Step Number	Step Frequency (nominal)
0	0	0	0	0	0	0	0	0	0	1	450
0	0	0	0	0	0	0	0	1	0	2	451
0	0	0	0	0	0	0	1	1	0	4	453
0	0	0	0	0	0	1	1	1	0	8	457
0	0	0	0	0	1	1	1	1	0	16	466
0	0	0	0	1	1	1	1	1	0	32	483
0	0	0	1	1	1	1	1	1	0	64	518
0	0	1	1	1	1	1	1	1	0	128	587
0	1	1	1	1	1	1	1	1	0	256	725
1	1	1	1	1	1	1	1	1	0	512	1,000

*These words are in the preceding (misc.) word.
**Forced zeros.

Table 3-5

MBR AMPLITUDE (14th WORD)

MSB 1	2	3	4	5	LSB 6	7*	8*	Nominal Amplitude (dB)
0	0	0	0	0	0	0	0	-90**
0	0	0	0	0	1	0	0	-89
0	0	0	0	1	1	0	0	-87
0	0	0	1	1	1	0	0	-83
0	0	1	1	1	1	0	0	-75
0	1	1	1	1	1	0	0	-59
1	1	1	1	1	1	0	0	-27

*Forced zeros.
**Below expected receiver noise level.

3.5.2 High-Speed PCM

The high-speed PCM is a 1.0-Mbps, NRZ data stream consisting of [redacted] at [redacted]. A [redacted] code is substituted for the data every [redacted] words to allow the ground equipment to synchronize to the data stream.* 25X1 25X1

3.5.3 Output Data Format

The output data applied to each telemetry transmitter is formatted as shown in figure 3-2. The encrypted PCM is low-pass filtered with a 3-dB point of [redacted] kHz. 25X1
This low-pass filter provides 20 dB of attenuation to frequencies above [redacted] MHz. 25X1
The [redacted] MHz VCO is bandpass filtered, with the 3-dB points at [redacted] and [redacted] MHz. 25X1
This bandpass filter provides 17 dB of attenuation to frequencies below [redacted] MHz. 25X1
Thus, the two components can be readily separated on the ground.

[redacted] 25X1

Figure 3-2 Output Data Format

Figure 3-3A shows the data input to track 2 (of each tape recorder), figure 3-3B shows the track 1 data, figure 3-3C shows the (real time) data on each 1.7-MHz VCO during the before-and-after tape recorder readout intervals, and figure 3-3D shows the data format to these VCOs during tape recorder readout and during the tape recorder bypass test mode.

[redacted] 25X1

TRACK 2 INPUT

[redacted] 25X1

(A)

[redacted] 25X1

(B)

[redacted] 25X1

(C)

[redacted] 25X1

Frequency (KHZ)

*Signals supplied by spacecraft (real time data) on VCO bus.

Figure 3-3 Tape Recorder Data Readout Format

3.6 INTERFACE CIRCUITS (See figures 3-4, 3-5, and 3-6)

The payload contains interface circuits to perform the following functions:

a. Drive three 2-track, type 24 tape recorders during read-in.

b. Select the output of any one of these tape recorders for each of two channels, simultaneously.

c. Process the selected data during readout and drive two type 10, S-band transmitters with the resulting signals.

d. Process real time data during B&A T/R R/O periods and drive the transmitters with the resulting signals.

e. Process real time data during bypass and drive a transmitter with the resulting signal.

3.6.1 <u>Read-In Interface Circuits</u>

The read-in interface circuitry contains the following VCO's:

a. Channel 14, modulated with the time code from the TRG

b. Channel 15, modulated with the output of the earth sensor or the solar aspect sensor (as commanded)

c. Channel G, modulated with the low-speed PCM bit stream.

The relative level of the signals from the VCO's can be set by screwdriver adjustments. Controls to independently set the level of the signals to each track of each of the three tape recorders are also provided. These controls are accessible thru an access door when the payload is completely assembled.

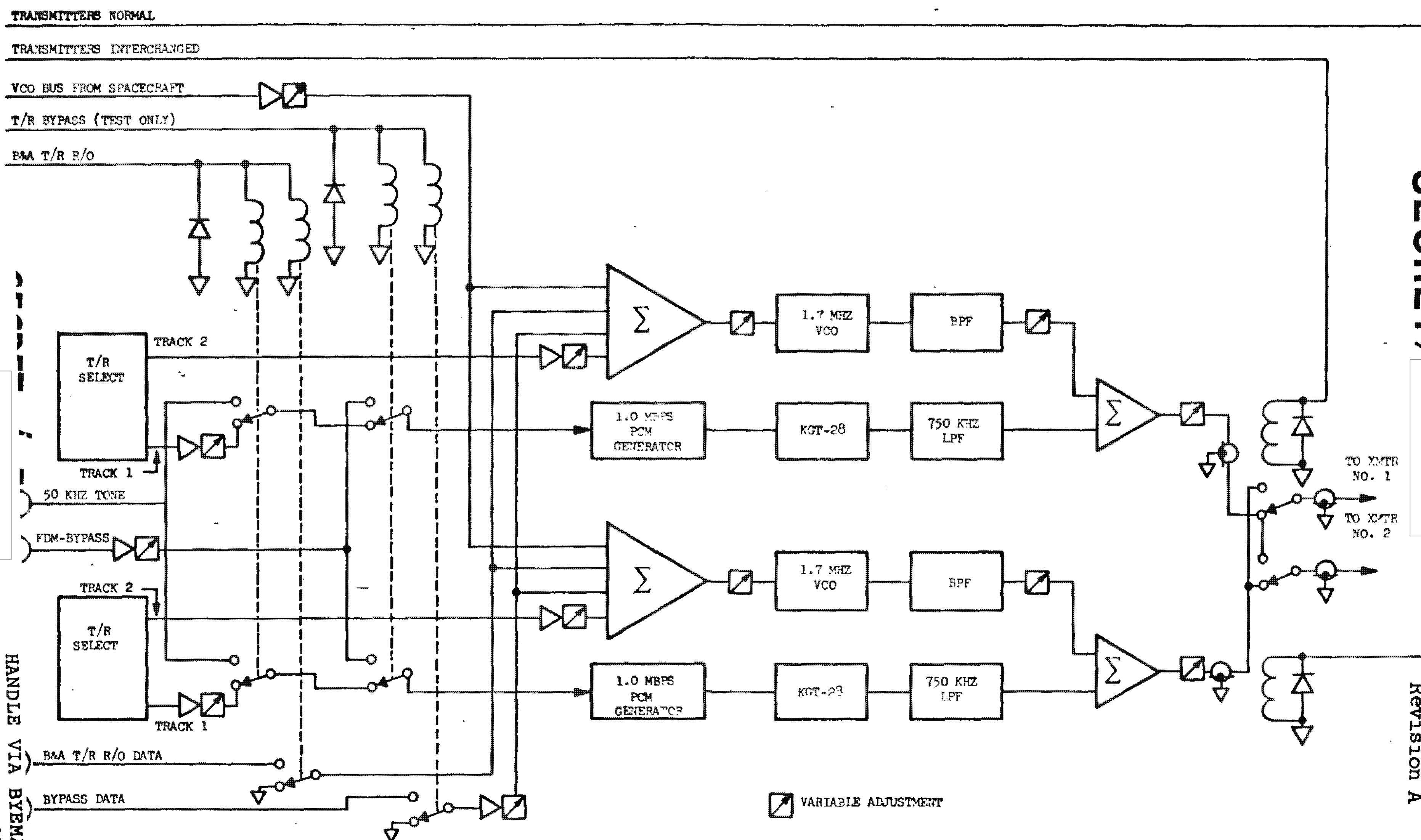


Figure 3-4 Telemetry - On Circuit

25X1

[redacted]

Figure 3-5 Tape Recorder Read-In Circuits

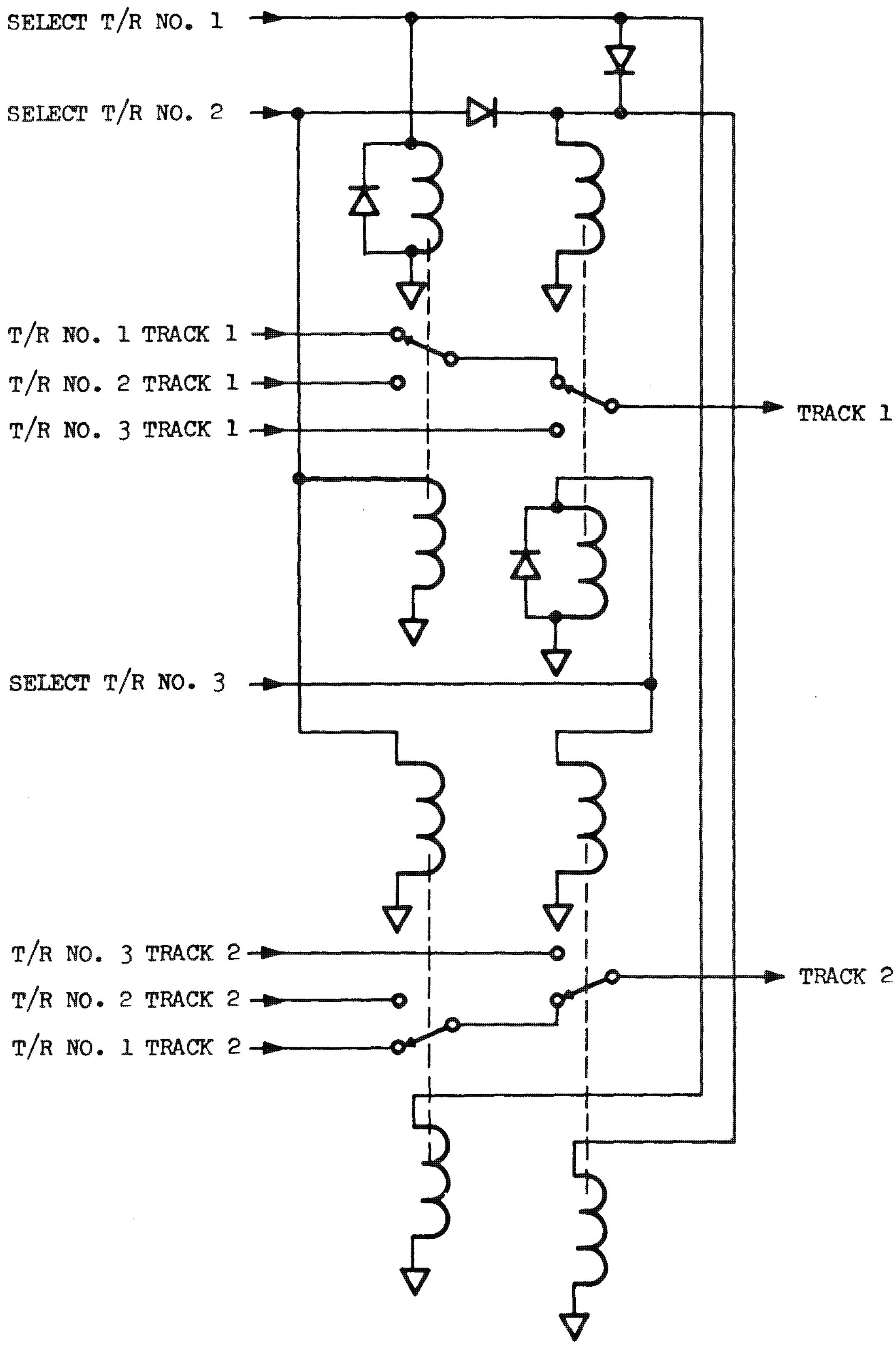


Figure 3-6 Tape Recorder Select Circuit

3.6.2 Readout Interface Circuits

The readout interface circuitry contains latching relays capable of simultaneously selecting the output of any one tape recorder for each transmitter. The same recorder may be selected for both transmitters, if so desired. The circuitry also contains, for each transmitter, the following:

a. A 5-bit A/D converter operating at 1.0 Mbps

b. A KGT-28 (GFE) to process the output of the above converter

c. A 1.7-MHz VCO, modulated by the lower frequency VCO's (including the real time signal on the VCO bus)

d. Filters to restrict the bandwidth of the above signals, plus a summing device to combine them.

A 1.0-MHz clock controls items (a) and (b) above. Screwdriver adjustable controls are provided to set the relative levels of the two inputs (tape recorder and VCO bus) to each 1.7-MHz VCO, the levels of the two inputs to each summer, and, finally, the levels of the composite signals to each transmitter. These controls are accessible thru an access door when the payload is completely assembled.

Each recorder carries 6 minutes of data when filled (recorders are operated at 1:1 R/I to R/O ratio). A 6 minute T/R R/O can cover a total of up to 12 minutes of R/I data, since two recorders can be loaded in sequence then read out in parallel.

3.6.3 Real Time Data Processing Circuitry

The interface circuitry also processes real time data during the B&A T/R R/O periods and during tape recorder bypass.

During tape recorder bypass, the interface circuitry applies the signals generated during a normal read-in plus a channel 18 VCO signal from the vehicle VCO bus to the readout circuitry for both transmitters. Controls are provided to set the levels of each read-in signal. These controls are accessible when the payload is completely assembled. This bypass mode is not available in flight.

During B&A T/R R/O, the interface circuitry operates the same as during tape recorder bypass, except that the real-time signals include vehicle VCO's. Also, the payload channel 15 VCO and 50-kHz reference tone are turned off. The interface circuitry also provides the calibrate tone (see section 3.2.4) to the two KGT-28's.

3.7 PAYLOAD MEMORY

The payload memory consists of a set of discrete memory cells, a memory matrix, and the necessary additional circuitry to select, control, monitor, and use the various cells of the memory.

The inputs to the memory consist of real time commands (RTC's), command address commands (CAC's), and function bits from the P-114 spacecraft digital command system. The memory responds correctly to inputs meeting the following specifications:

a. RTC's and CAC's

Duration	400 to 550 msec
True Level	+20 to +28 VDC
False Level	0 to +0.5 VDC
Rise Time	1 msec max
Fall Time	5 msec max
Maximum Allowed Load	250 ma

b. Function Bits

Duration	Same as the associated CAC
True Level	+4.4 to +5.0 VDC
False Level	0 to 0.25 VDC
Output Impedance	10 K ohm max

In addition, the P-114 spacecraft command system matrixes three commands addressed to it and then passes on the results of this action to the payload on six separate lines. The payload controls latching relays in accordance with the pulses on these lines, for pulses satisfying the following conditions:

Duration	400 to 550 msec
True Level	+22 to +28 VDC
False Level	0 to +0.5 VDC
Maximum allowed load	250 ma

3.7.1 Discrete Memory Cells

The payload memory contains discrete memory cells controlled by the following RTC's:

RTC	Function
1	Select transmitters normal
16	Disable RF and video calibrator
17	Select back-up oscillator
18	Reset RTC's 16 and 17
19	Select bank A of memory matrix
20	Select bank B of memory matrix
21	Select bank C of memory matrix
22	Select bank D of memory matrix
29	Select transmitters interchanged

The payload also provides latching relays capable of selecting any one tape recorder for each transmitter.

3.7.2 Memory Matrix

The payload memory contains a memory matrix consisting of a maximum of 12 words, each containing no more than 11 bits. The matrix is organized into four banks for control purposes. Only one word may be addressed at one time. The bank to be addressed is selected by an RTC, and the word within this bank is selected by a CAC. The CAC does not control any latching devices. At the exact time that a

CAC is received, the P-114 spacecraft digital command system energizes 11 bit lines. The bits in the selected word are set to match the pattern on these 11 lines. The state of a line for which there is no corresponding bit cell in the matrix may be ignored.

Memory Matrix Banks

The first bank contains words one, two, and three as follows:

a. The first word consists of 10 bits defining the first step of the first frequency segment. The MBR uses the nine MSB's of this word to define this step for the MBR.

b. The second word consists of 10 bits defining the last step of the first segment. The MBR uses the nine MSB's of this word to define this step for the MBR, while the DCR uses all 10 MSB's.

c. The third word consists of seven bits to configure the DCR recognizer plus three bits to select segments for the DCR to search. Bit assignments are as follows:

5 bits	Select recognizer acceptance test criteria
1 bit	Tones and/or FM bandwidth choice
1 bit	Select long time constant for FM BW tests
3 bits	Select segments.

The second bank contains words four, five, and six. These are the same as words one, two, and three, respectively, except that words four and five define the second segment, and word six controls the MBR recognizer and segment scan. Also, bit two of word six disables the DCR dwell timer (fixed dwell modes) so that the dwell terminates at once when the signal disappears.

The third bank contains words seven, eight, and nine as follows:

a. Words seven and eight are the same as words one and two, respectively, except that they define the third segment.

b. Word 9 determines the DCR mode. Bit assignments for word 9 are as follows:

3 bits	Threshold offset (3-dB steps)
1 bit	Limit copy dwell at 30 seconds
1 bit	Use DCR threshold (slave only) to terminate copy dwell
1 bit	DCR slaved/independent

The fourth bank contains words 10, 11, and 12. Word 10 determines the portions of the FM baseband to be selected, translated, and reported by the high-speed PCM data stream. The MBR mode is determined as follows:

4 bits	Select one of 10 groups (12 to 60 kHz)
1 bit	Enable second service channel (68 to 72 kHz)
4 bits	Not used
1 bit	Select adaptive selection
1 bit	Select channel for discriminator

Bit assignments for word 11 are as follows:

3 bits	Threshold offset (3 dB steps)
3 bits	Copy dwell (1.5-, 3-, 10-, 5-sec dropout)

Word 12 specifies the following data:

3 bits	Spares
1 bit	Select ES or SAS
1 bit	Enable DCR noise-riding threshold
2 bits	Select MBR antenna (N-S-adaptive)
2 bits	Select DCR antenna (N-S-adaptive)
2 bits	Select DCR bandwidth (1.4 MHz - 2.6 MHz - adaptive)

3.8 GOVERNMENT FURNISHED EQUIPMENT (GFE)

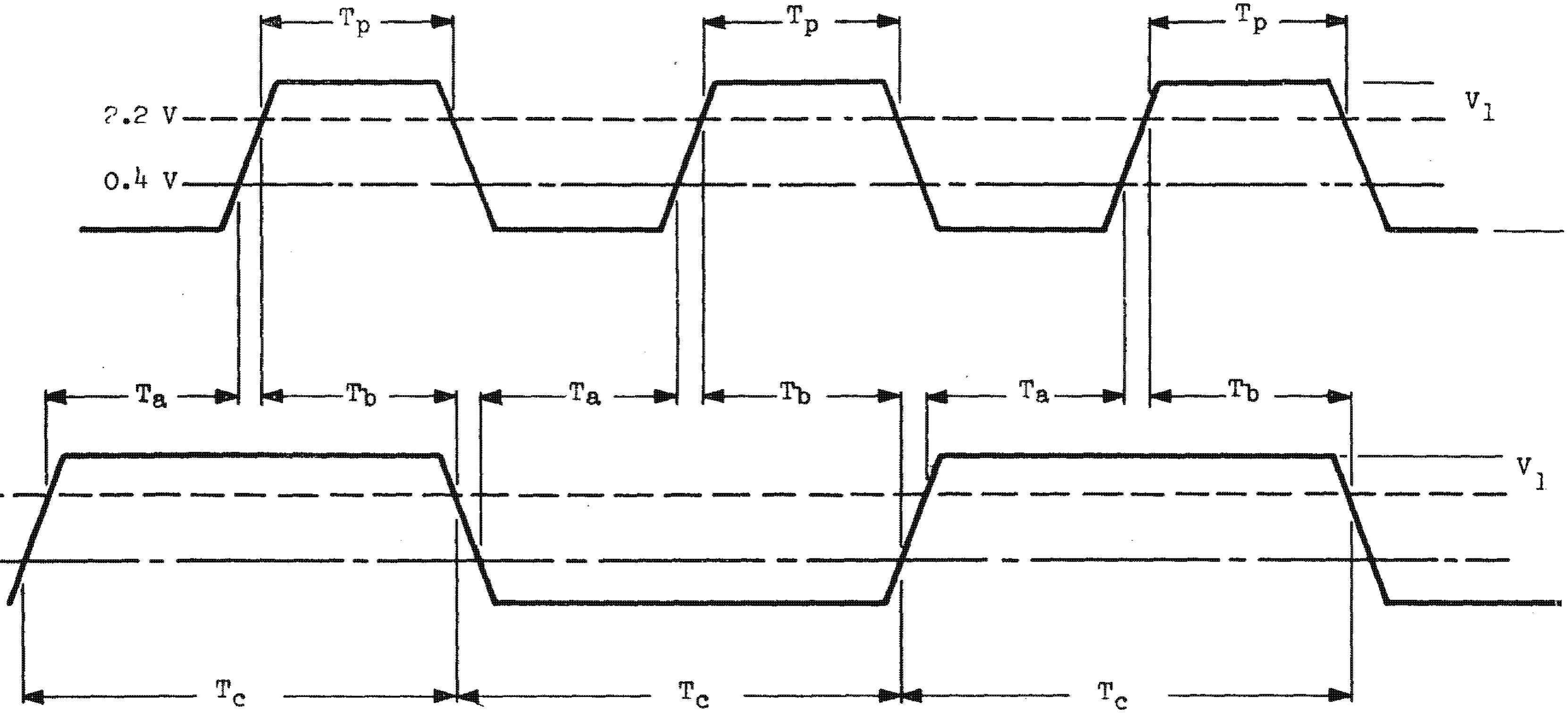
The following items are furnished as GFE to be integrated into the payload system:

a. A time reference generator (TRG), series 2

b. Two KGT-28 (V-2)/TSEC transmit telemetry security equipment.

The TRG is used as a primary timing source for the payload. TRG outputs are as described in 2P24048. The AN/GSQ-53A time code output is used to modulate a VCO. This VCO signal plus the 50-kHz tone from the TRG are incorporated into the signal being recorded during tape-recorder read-in.

Figure 3-7 shows the clock/data timing relationship.



T_p = Clock pulsewidth = 490 ±20 nsec
T_a = Data to clock delay = 490 ±20 nsec
T_b = Data remaining after clock = 490 ±20 nsec
T_c = 1 bit period = 1000 ±20 nsec
V_1 = 2.8 ±0.6 V
V_2 = 0.3 ±0.7 V
T_r = T_f = Rise and fall times = 30 nsec, 10 to 90 percent points, max.

Notes

1. Ringing on clock and data cannot exceed 300 mv. This ringing shall not cause the signal to fall below 2.2 V.

2. Overshoot cannot exceed 600 mv.

Figure 3-7 Clock/Data Timing Relationships

SECRET/

Approved for Release: 2024/08/06 C05098831

25X1

APPENDIX A

RECEIVER TIMING SCHEDULE

A.1 MAIN-BEAM RECEIVER (MBR) TIMING SCHEDULE

The MBR frequency scan is synchronized to the low-speed PCM bit stream. The MBR searches at one frequency step every 448 usec (8 bits); thus, the MBR can scan up to 15 steps between reports (6.72 msec). All 512 MBR frequency steps can be monitored in 229.376 msec if no signals are detected.

Figure A-1 shows the MBR schedule when the amplitude and duration (A&D) test is not satisfied or the in-band confirm fails. These tests together define signal present (SP). Reports are made through the low-speed PCM data stream of every contact satisfying these tests.

Figure A-2 shows the MBR schedule when the SP flag is set by a contact. This schedule starts at the point where the MBR transfers to the antenna receiving the contact.

The result of each test is stored as soon as a positive finding occurs - as yes, this is TV, or yes, there is activity in supergroup 2. Recognition is terminated at point A unless a 20-msec dwell is required. When pilot tones are required, recognition will be automatically extended only if all other acceptance criteria are satisfied. Thus, a belated recognition of TV could cause termination at any of the tic marks in the figure from A to B while waiting for completion of the tone tests.

The A&D, in-band confirm, and TV tests run continuously to assist in monitoring signals that have been accepted. Acceptance is based on the contents of the

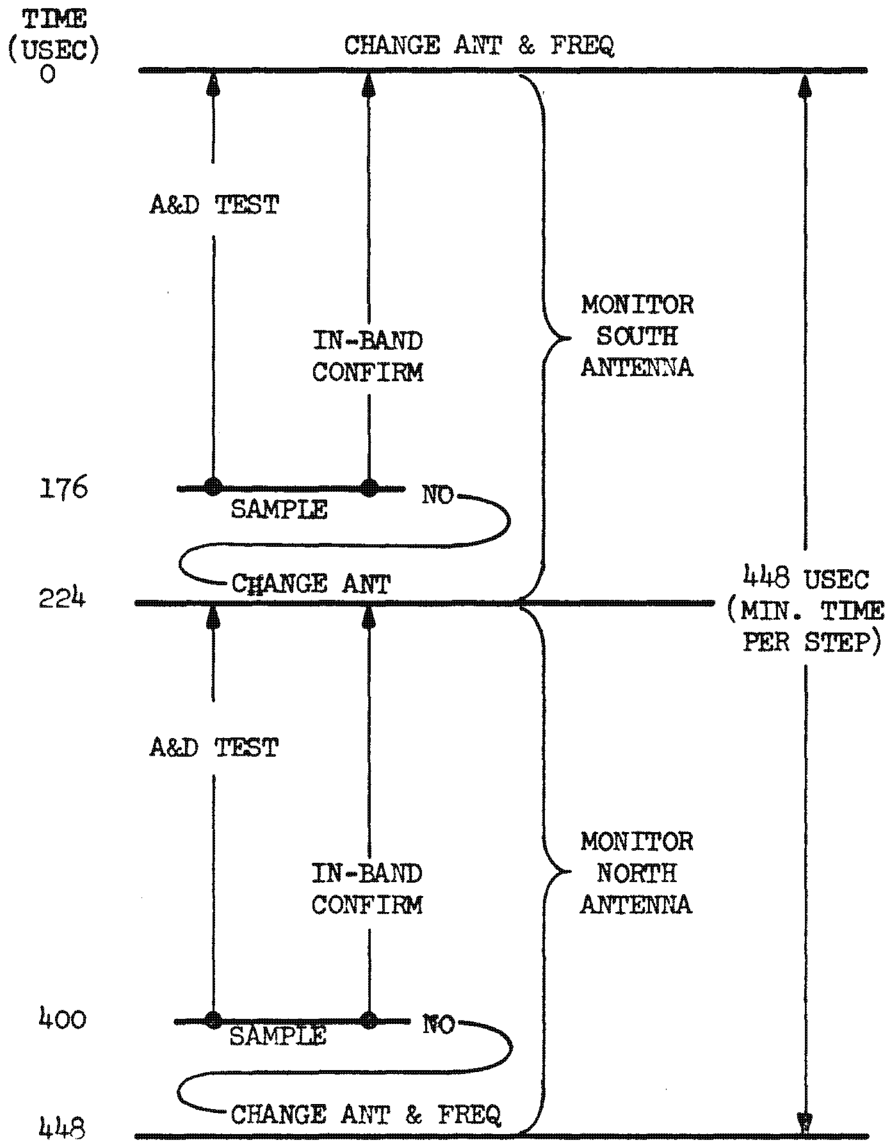


Figure A-1 Main-Beam Receiver Timing : No Contacts

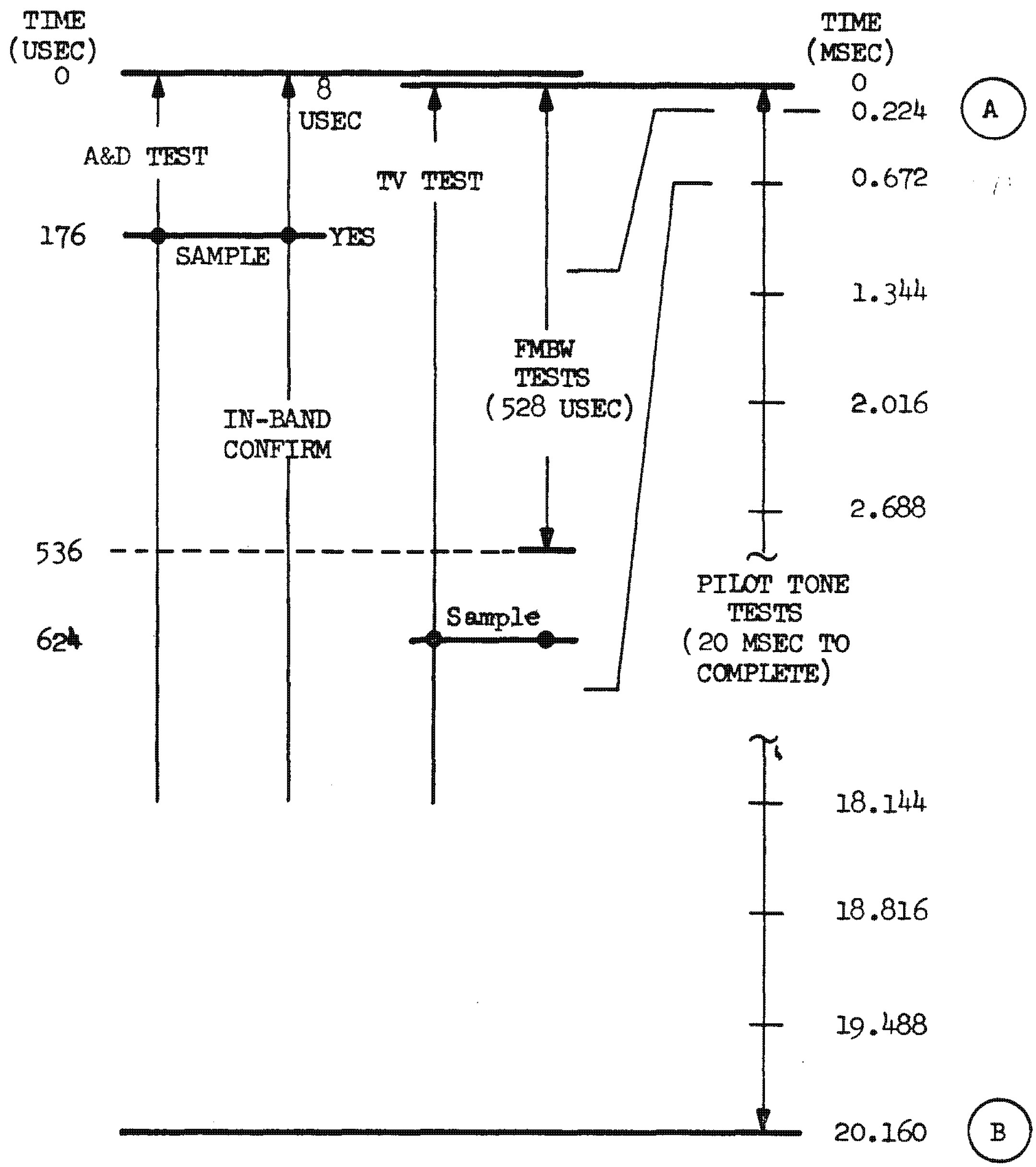


Figure A-2 Main-Beam Receiver Timing : Contact storage cells (at sample time), so the recognizer cannot be made to dither between accept and reject by a signal with varying characteristics. These storage cells are reset only at the times the MBR changes antennas or frequency. The MBR attempts to accept/reject at (624 + 672 n) usec. Once a signal is accepted, the MBR proceeds to the copy phase.

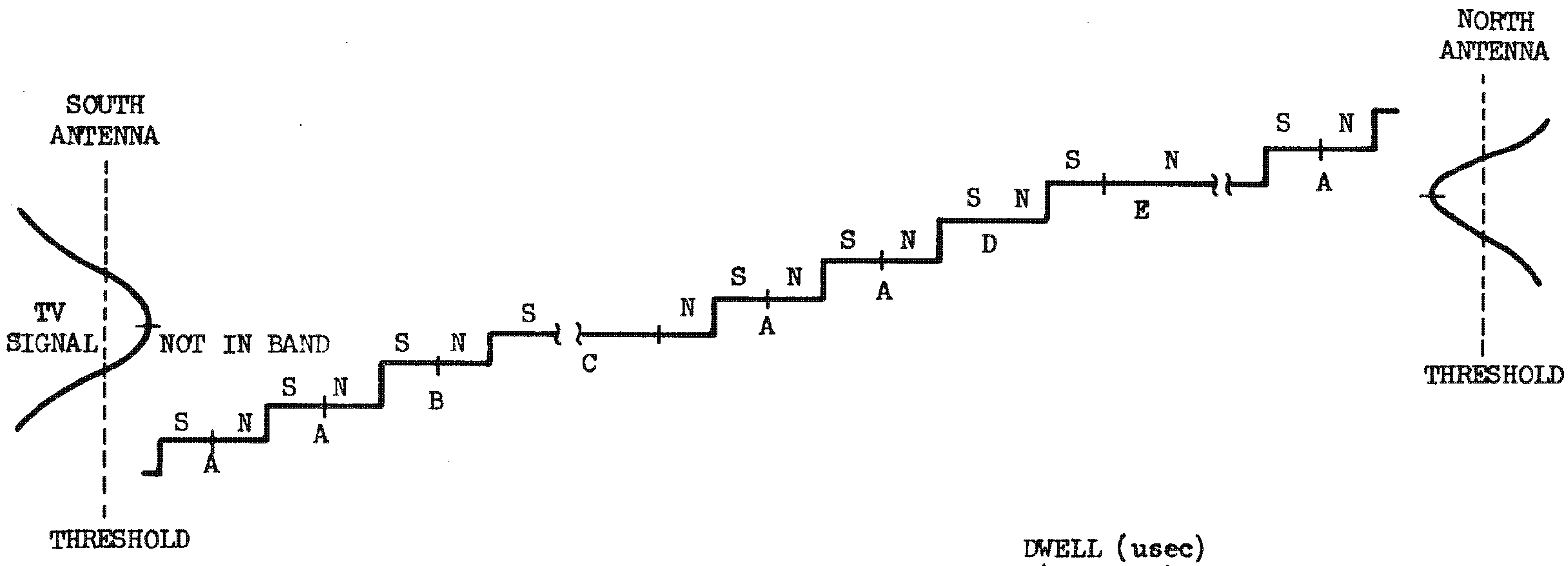
The north antenna is ignored on any step producing a target signal from the south antenna. If a false alarm is received from the south antenna, the MBR will not change frequency until the north antenna has been checked. When n, above, is odd, a 224-usec delay is required to get back into synchronism with the "change antenna" clock pulses.

Figure A-3 illustrates the normal MBR frequency scan. This scan is slowed each time the SP flag is set, with a minimum delay of 448 usec. The MBR has a data buffer register, so there is no waiting for the output PCM to accept the acquired data unless two contacts occur close together. The maximum delay per false alarm is 20.16 msec unless contact is made on both the north and the south antennas.

Figure A-3 does not show contact with a target signal. Such a contact will usually result in a dwell of several seconds while the signal is being analyzed.

A.2 DUAL-CHANNEL RECEIVER (DCR) TIMING SCHEDULE

The DCR frequency scan is also synchronized to the low-speed PCM bit stream. The DCR searches at one frequency step every 560 usec (10 bits); thus, the DCR can scan up to 12 steps between reports. All 1024 DCR steps can be monitored in 573.44 msec if no CW signals are detected.



			DWELL (usec)
A:	NO SIGNALS		224 S + 224 N
B:	OUT-OF-BAND ON SOUTH		224 S + 224 N
C:	FALSE ALARM ON SOUTH	NO SIGNAL NORTH	672 to 20160 S + 224 N
D:	OUT-OF-BAND ON NORTH	NO SIGNAL SOUTH	224 S + 224 N
E:	FALSE ALARM ON NORTH	NO SIGNAL SOUTH	224 S + 672 to 19936 N

ACCEPTED SIGNALS WILL RESULT IN AN EXTENDED DWELL.

Figure A-3 Typical MBR Frequency Scan Pattern

25X1

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Figure A-4 illustrates the DCR timing schedule. In the absence of signals that satisfy the A&D test, only the portion of figure A-4 from A to B applies - instead of selecting an antenna pair, the DCR then takes another step and tries again.

When the A&D test is satisfied, the DCR selects the antenna pair providing the strongest signal. This allows FM tests to be performed - there is no assurance that the discriminator could see the signal before. The TV test is started at this point (B) also. About 560 usec later, all tests are sampled. Both the A&D test and the in-band confirm must be satisfied, or the DCR will discard all acquired data on the signal and take a step in frequency at point C.

If these tests are satisfied, the DCR sets its SP flag. The acquired data now must be retained (up to 6.72 msec) until they have been inserted in the output data stream. If the TV and FMBW tests are sufficient to accept or reject the contact, a final decision is made at point C. (Assuming a fixed 20-msec recognition period has not been selected.)

If the pilot tone test results are needed, the recognition phase is continued for up to 20 msec. During this time, only the TV test is meaningful - if the signal is belatedly recognized as TV (and the recognizer is instructed to reject all TV) during the tone tests, the contact will be rejected at the next tic mark (between C and D). If pilot tones have not been recognized by point D, contact will be rejected - tones may be recognized as early as 13 msec, but marginal cases could require the full 20-msec period. Thus, the recognition procedure can stop at any of the tick marks from C to D, with the DCR making either a false alarm report or an accept report on the signal.

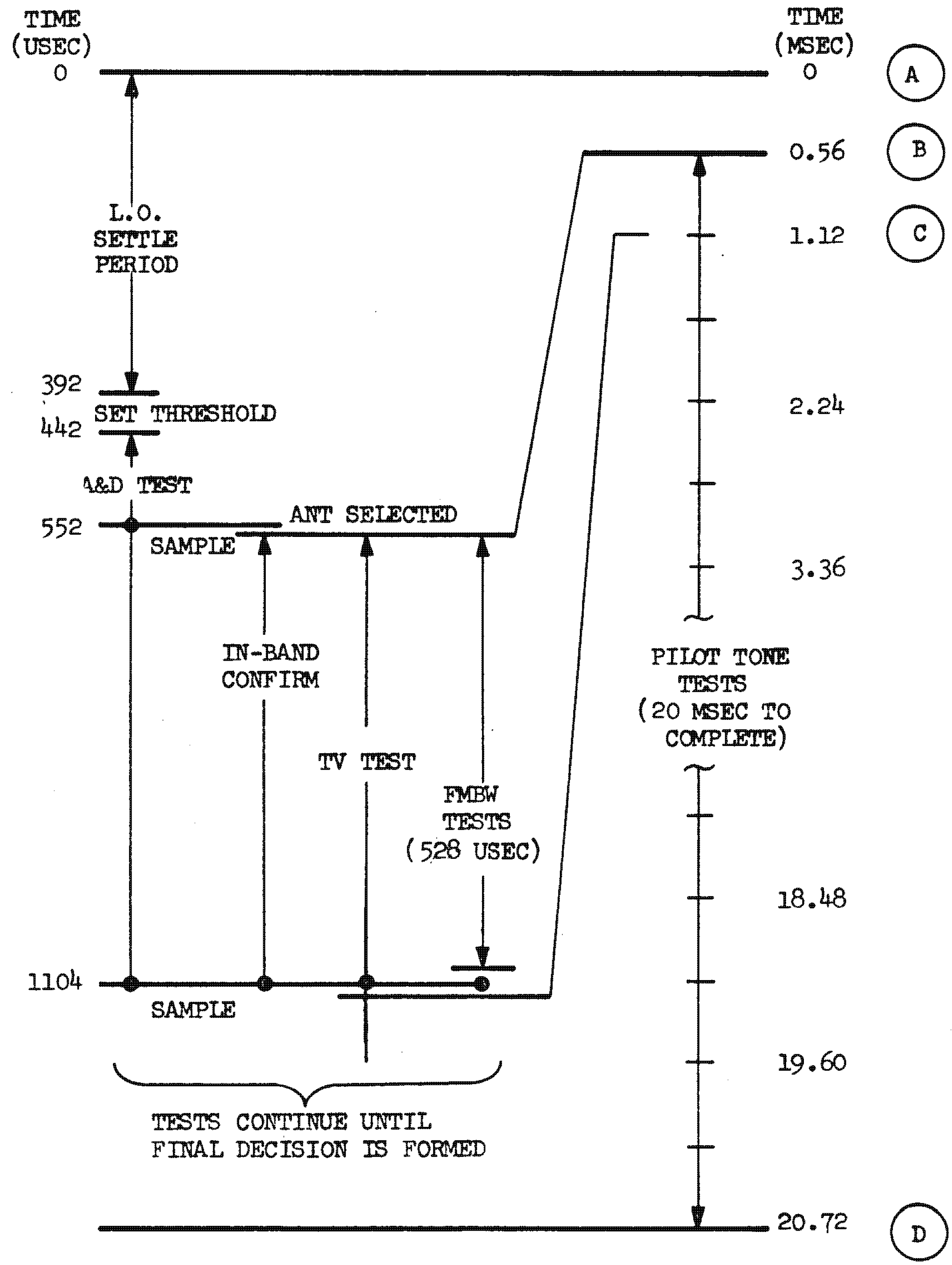
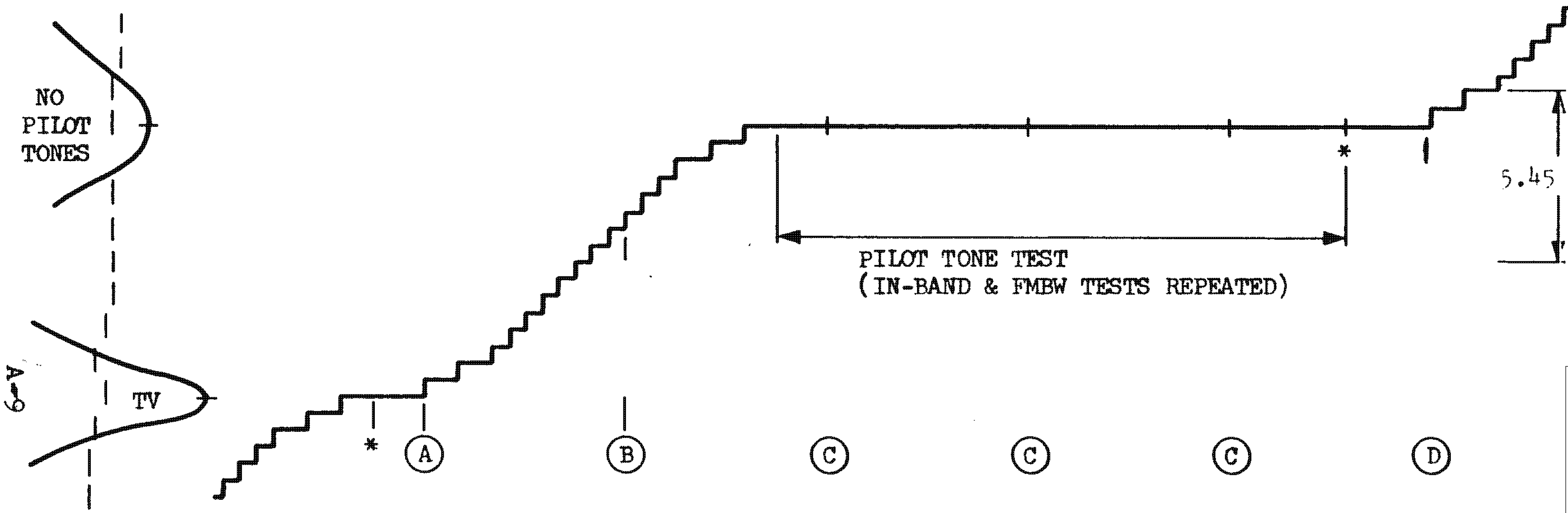


Figure A-4 Dual-Channel Receiver Timing : Contact

Figure A-5 illustrates the DCR frequency scan. Notice that the DCR has to wait with a false alarm report until the PCM data stream accepts the report. No delay is required for sweep reports - data are taken "on the fly" for these. (The threshold reported actually applies to a step already past.)



A: FALSE ALARM (TV)
B: NO CONTACT: SWEEP REPORT
C: INTERIM REPORT (PILOT TONE TEST IN PROGRESS)
D: FALSE ALARM (NO TONES)

*REPORT READY - WAIT FOR PCM REGISTER TO EMPTY

NOTE: IF TARGET SIGNAL IS RECOGNIZED, DWELL ON STEP WILL BE EXTENDED 1.5 SEC OR MORE.

Figure A-5 Typical DCR Frequency Scan Pattern

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APPENDIX B

ERROR BUDGETS

Tables B-1 and B-2 present the estimated error budgets for the phase and amplitude data. It should be noted that these tables refer to errors in a single report. A DF computation uses from 440 to 670 phase reports. Fixed offsets (RF errors in table B-1) can be eliminated by the computer. Random errors, on the other hand, are theoretically reduced by the square root of the number of reports used to obtain a single datum. Thus, the phase error could be reduced to around 0.2 degree if the more complicated computations required are acceptable.

Table B-2 also refers to a single report (147 amplitude reports are made per second). This represents a change of only 40 seconds of arc per report, (assuming that the target is on the horizon) or 1 degree per 90 reports. Thus, postdetection filtering could be used to reduce the relative amplitude error by a factor of 10; thus, refining the measurement of target antenna aiming angles. The accuracy indicated by table B-1 applies mainly when determining absolute, rather than relative, power levels.

Table B-1

PHASE ERROR BUDGET*

Error Source	Error	
	Peak Degrees	RMS Degrees
1. R F Error		
20 dB coupler	±0.3	0.173
North-south switch	±0.7	0.404
Ch. Reversing switch	±1.4	0.808
2. Phase Detector Nonlinearity	±1.5	0.860
3. A/D Converter Error	±1.0	0.577
4. Quantizing Error	±0.703	0.406
Systematic Error		1.447
5. Thermal Noise 20 dB S/N; t = 50 usec		0.98
6. Signal Modulation		0.40
7. Interference (20 dB S/I)		0.98
Total error: 1 sigma		2.06
2 sigma		4.11

*Note: Phase characteristics of the antennas are not included in this table.

Table B-2

AMPLITUDE ERROR BUDGET *

Error Source	Peak (dB)	RMS (dB)
1. RF ERROR		
20-dB Coupler	±0.2	0.115
North-South Switch	±0.2	0.115
Channel Reverse Switch	±0.2	0.115
PRF Selector	±1.5	0.866
RF Attenuator	±0.2	0.115
RF Amplifier	±1.0	0.577
1st Mixer	±0.5	0.289
Filter	±0.1	0.058
2nd Mixer	±0.1	0.058
IF Preamp	±0.1	0.058
2. IF ERROR		
Log-IF Linearity	±1.0	0.577
Summer & Detector	±0.5	0.289
3. A/D ERROR	±0.25	0.144
4. QUANTIZING ERROR	±0.39	0.225
Total Systematic Error Temp Range: 0°F to 130°F		1.31
5. NOISE ERROR (S/N = 20 dB) Sample Time = 100 usec		0.16
Total 1 Sigma Error		1.32
Total 2 Sigma Error		2.64

*Note: Amplitude characteristics of the antennas are not included in this table.

APPENDIX C

SUBCOMMUTATED DATA

C.1 SYNCHRONIZATION CODES

The frame sync code is as follows (MSB first):

11011101 - 11101111 - 10111111 (221-239-191 in decimal)

The subframe sync codes are as follows:

Frame	Code MSB							LSB
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1
3	0	0	0	0	0	0	1	1
4	0	0	0	0	0	1	1	1
5	0	0	0	0	0	1	1	0
6	0	0	0	0	0	1	0	0
7	0	0	0	0	1	0	0	0
8	0	0	0	0	1	0	0	1
9	0	0	0	0	1	0	1	1
10	0	0	0	0	1	1	1	1
11	0	0	0	0	1	1	1	0
12	0	0	0	0	1	1	0	0
13	0	0	0	1	0	0	0	0
14	0	0	0	1	0	0	0	1
15	0	0	0	1	0	0	1	1
16	0	0	0	1	0	1	1	1
17	0	0	0	1	0	1	1	0
18	0	0	0	1	0	1	0	0
19	0	0	0	1	1	0	0	0
20	0	0	0	1	1	0	0	1
21	0	0	0	1	1	0	1	1
22	0	0	0	1	1	1	1	1
23	0	0	0	1	1	1	1	0
24	0	0	0	1	1	1	0	0

C.2 WORD A DATA

Each A word is seven bits long, since a terminal zero is required to prevent false sync. Words are formatted MSB first.

A1 = spectral analysis - 12-60 kHz

A2 = dual-channel fine frequency (see calibration book)

A3 = spectral analysis - 60-108 kHz

A4 = FDM group being copied

A5 = spectral analysis - 108-156 kHz

A6 = not used

A7 = spectral analysis 156-204 kHz

A8 = not used

A9 = spectral analysis - 204-252 kHz

A10 = not used

A11 = spectral analysis - 312-360 kHz

A12 = not used

A13 = spectral analysis - 360-408 kHz

A14 = not used

A15 = spectral analysis - 408-456 kHz

A16 = not used

A17 = spectral analysis - 456-504 kHz

A18 = not used

A19 = spectral analysis - 504-552 kHz

A20 = not used

A21 = all zeros

A22 = not used

A23 = all zeros

A24 = not used

C.3 WORD B DATA

Each of the 24 B words is 7 bits long, since a leading zero is required to prevent false sync. The B words report data as follows (a "1" has meaning indicated after that bit):

a. B1 through B5 report contents of memory bank A

b. B6 through B10 report contents of memory bank B

c. B11 through B15 report contents of memory bank C

d. B16 through B20 report contents of memory bank D

e. B21 reports on the discrete commands

Bit 1 Memory bank A addressable
2 Memory bank B addressable
3 Memory bank C addressable
4 Memory bank D addressable
5 Payload calibrators disabled
6 Backup 1-MHz oscillator selected
7 TLM transmitters not interchanged

f. B22 reports tape recorder selections (a "0" has meaning indicated after that bit for B22 only)

Bit 1 Tape recorder No. 1 for 1st R/I
2 Tape recorder No. 2 for 1st R/I
3 Tape recorder No. 3 for 1st R/I
4 Tape recorder No. 1 for 2nd R/I
5 Tape recorder No. 2 for 2nd R/I
6 Tape recorder No. 3 for 2nd R/I
7 Zero

g. B23 and B24 are not used (all zeros).

Listed below are the twelve words stored in the memory, their bit assignments (the meaning of a "1" in each bit), and the location (word and bit) of the report on the status of each such bit as stored in the memory:

Command Word 1: 10 bits, segment A starting point

MSB	at B1,	bit no. 1
2	B2,	1
3	B3,	1
4	B4,	1
5	B5,	1
6	B1,	4
7	B2,	4
8	B3,	4
9	B4,	4
10	B5,	4

Command Word 2: 10 bits, segment A stop point

MSB	at B1,	bit no. 2
2	B2,	2
3	B3,	2
4	B4,	2
5	B5,	2
6	B1,	5
7	B2	5
8	B3	5
9	B4	5
10	B5	5

Command Word 3: 11 bits, DCR recognizer and scan control

MSB	(Reject TV)	at B1,	bit no. 3
2	Not used	B2,	3
3	(Reject wideband FM)	B3,	3
4	(Reject narrowband FM)	B4,	3
5	(20 msec. recognition dwell)	B5,	3
6	*	B1,	6
7	*	B2,	6
8	(Accept: FMBW or tone tests good)	B3,	6
9	Use C segment for DCR	B4,	6
10	Use B segment for DCR	B5,	6
11	Use A segment for DCR	B3,	7

*bit 6	7		
0	0	=	No tones required
0	1	=	8 KHz tone required
1	1	=	tone required: 248, 250, or 304 KHz
1	0	=	8 KHz tone plus tone at 248, 250, or 304 KHz req'd.

Command Word 4: 10 bits, segment B starting point

MSB	at B6,	bit no. 1
2	B7,	1
3	B8,	1
4	B9,	1
5	B10,	1
6	B6,	4
7	B7,	4
8	B8,	4
9	B9,	4
10	B10,	4

Command Word 5: 10 bits, segment B stop point

MSB	at B6,	bit no. 2
2	B7,	2
3	B8,	2
4	B9,	2
5	B10,	2
6	B6,	5
7	B7,	5
8	B8,	5
9	B9,	5
10	B10,	5

Command Word 6: 11 bits, MBR recognizer and scan control

MSB	(Reject TV)	at B6,	bit no. 3
2	Disable DCR dwell timer	B7,	3
3	(Reject wideband FM)	B8,	3
4	(Reject narrowband FM)	B9,	3
5	(20 msec recognition dwell)	B10,	3
6	*	B6,	6
7	*	B7,	6
8	(Accept: FMBW or tone tests good)	B8,	6
9	Use C segment for MBR	B9,	6
10	Use B segment for MBR	B10,	6
11	Use A segment for MBR	B8,	7

*bit 6	7		
0	0	=	No tones required
0	1	=	8 KHz tone required
1	1	=	tone required: 248, 250, or 304 KHz
1	0	=	8 KHz tone pluse tone at 248, 250, or 304 KHz req'd.

Command Word 7: 10 bits, segment C starting point

MSB	at B11,	bit no. 1
2	B12,	1
3	B13,	1
4	B14,	1
5	B15,	1
6	B11,	4
7	B12,	4
8	B13,	4
9	B14,	4
10	B15,	4

Command Word 8: 10 bits, segment C stop point

MSB	at B11,	bit no. 2
2	B12,	2
3	B13,	2
4	B14,	2
5	B15,	2
6	B11,	5
7	B12,	5
8	B13,	5
9	B14,	5
10	B15,	5

Command Word 9: 6 bits, MBR threshold and dwell

MSB	(Raise MBR threshold 12 dB)	at B11,	bit no. 3
2	(Raise MBR threshold 6 dB)	B12,	3
3	(Raise MBR threshold 3 dB)	B13,	3
4	(Limit MBR dwell at 30 sec.)	B14,	3
5	(Use mode B in slave)	B15,	3
6	Operate independent	B11,	6

Command Word 10: 11 bits, FDM group select

MSB)	(Supergroup 2)	at B16,	bit no. 1
2)	Select FDM sample	B17,	1
3)	1-5 + supergroup)	B18,	1
4)		B19,	1
5	Enable second service channel	B20.	1
6)		B16,	4
7)	Not used	B17,	4
8)		B18,	4
9)		B19,	4
10	Adapt selection to BW	B20,	4
11	Use channel 2 for discriminator	B16,	7

Note: bits 2 + 3 + 4 should form numbers from 1 to 5. A 6 will be interpreted as a 2, a 7 as a 3, and a 0 as a 4, except that group 6 of supergroup 2 represents the band from 275 to 323 kHz.

Command Word 11: 6 bits, DCR threshold and dwell control

MSB	(Raise DCR threshold 12 dB)	at B16, bit no.	2
2	(Raise DCR threshold 6 dB)	B17,	2
3	(Raise DCR threshold 3 dB)	B18,	2
4)		B19,	2
5)	Select DCR dwell*	B20,	2
6)		B16,	5

*4	5	6		
0	0	0	= 1.5 sec.	
0	0	1	= 3.0 "	
0	1	0	= 10 "	
0	1	1	= 60 "	
1	0	0	= Requal ea. 60 sec.)	
1	0	1	= " " 3 "	)Dwell till requal fails,
1	1	0	= " " 10 "	)or 5 sec. below threshold
1	1	1	= " " 60 "	)

Command Word 12: 11 bits

MSB	Spare	at B16, bit no.	3
2	Spare	B17,	3
3	DCR use noise riding threshold	B18,	3
4 }	MBR antenna selection*	B19,	3
5 }		B20,	3
6 }	DCR antenna selection**	B16,	6
7 }		B17,	6
8	DCR = use 2.6 MHz IF BW	B18,	6
9	DCR = use 1.4 MHz IF BW	B19,	6
10	Spare	B20,	6
11	Use sun sensor	B18,	7

* 4	5	MBR ANT	** 6	7	DCR ANT
0	0	S	0	0	Check both
0	1	N	0	1	N
1	0	Check both	1	0	S
1	1	Check both	1	1	Check both

Each command word is transmitted as an 11-bit command. Bit 11 of command words 1, 2, 4, 5, 7, and 8, plus bits 7 through 11 of command words 9 and 11 are not used. No notice is taken of the state of bits for these locations.

C.4 WORD C DATA

Each C word is 7 bits long, since a terminal zero is required to prevent false sync. Words are formatted MSB first.

C1 through C10 report temperatures in payload as follows:

C1	synthesizer crystal oscillator
C2	phase detector
C3	log IF
C4	power supply - power transistor
C5	power supply - regulator
C6	main beam local oscillator
C7	card file
C8	crystal oscillator (spectrum analyzer)
C9	KGT mounting plate
C10	record/playback circuitry

C11 through C20 report payload voltages (VDC) as follows:

C11	+4.1 (readout only)
C12	+8.0
C13	+12.0
C14	+4.9
C15	+24.0
C16	+6.0 (read-in only)
C17	-8.0 (read-in only)
C18	-12.0
C19	-5.4 (read-in only)
C20	-20.0

C21 through C24 are not used.

C.5 WORD D DATA

All D words are unused (all zeros).

APPENDIX D

PAYLOAD COMMANDING

The TOPHAT payload is configured by commands sent to the spacecraft command system. The payload uses nine RTC's (real time commands) plus three CAC's (command address commands). In addition, the spacecraft processes certain commands and instructs the payload accordingly. (See figure D-1).

D.1 REAL TIME COMMANDS

The nine RTC's accepted by the payload have the following functions:

RTC	Function
1	Resets RTC-29 (also used by spacecraft)
16	Disables payload calibrators
17	Selects backup 1-MHz oscillator (TRG failure mode)
18	Resets RTC-16 and RTC-17
19	Selects memory bank A
20	Selects memory bank B
21	Selects memory bank C
22	Selects memory bank D
29	Selects TLM transmitters interchanged.

D.2 MEMORY MATRIX

The payload configuration is, for the most part, established by the state of a 107-bit memory matrix. This matrix is ordered in four banks: A (30 bits), B (30 bits), C (26 bits), and D (21bits). Only one bank can be altered at any given time, with the selected bank being determined by the latest sent, bank-select RTC. The matrix is altered by sending a CAC-5, a CAC-6, or a CAC-7 command with the proper time label pulse (TLP) bits. The payload must be in its TLM-ON mode to accept matrix changes.

Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RTC	Spacecraft Address					0	0	0	LSB				MSB	These 6 bits are not evaluated					
CAC						Command Address			LSB	Time Label Pulses (TLP)									M

Figure D-1 Command Word Format

BIF003W/2-020212-70
Series B
Revision A

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Approved for Release: 2024/08/06 C05098831

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D.2.1 Memory Bank A

Memory bank A contains 30 active bits plus one blank, for a total of 31 bits. When bank A is eligible for alteration, transmitting a CA-5 command will cause the first 10 bits of bank A to match the 10 MSB (most significant bits) of the 11 TLP bits accompanying the CA-5 command. These 10 bits form the 10-bit word that determines the starting step of scan segment A (word 1 on page C-4). (See table D-1.)

Transmitting a CA-6 command will similarly establish the condition of bits 11 through 20 in bank A. These 10 bits form the 10-bit word that determines the last step in scan segment A (word 2 on page C-4).

Transmitting a CA-7 command will likewise establish the condition of the last 11 (10 active plus 1 blank) bits in bank A.

These 11 bits have the following meanings (bits 1 (MSB) through 8 configure the DCR recognizer*):

Bit	Function
1	1 = Reject TV
2	Not used
3	1 = Reject wideband FM
4	1 = Reject narrowband FM
5	1 = Extend recognition dwell to 20 msec
6, 7	00 = No tones required
	01 = 8-kHz tone required
	11 = Tone required at 248, 250, or 304 kHz
	10 = 8-kHz plus one of 248, 250, or 304 kHz tone required
8	1 = Accept if either tone or FM bandwidth tests are satisfied

*Bit 1 is command bit 19, bit 11 is command bit 9 since commands are transmitted MSB last (see figure D-1).

Table D-1

SWEEP SEGMENT STARTING/LAST STEP COMMAND CODES

Command Bits										Frequency Step	
MSB 19	18	17	16	15	14	13	12	11	LSB 10	MBR	DCR
0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	1	1	2
0	0	0	0	0	0	0	0	1	0	2	3
0	0	0	0	0	0	0	0	1	1	2	4
0	0	0	0	0	1	1	1	1	1	16	32
0	0	1	1	1	1	1	1	1	1	128	256
1	0	1	1	1	1	1	1	1	1	384	768
1	1	1	1	1	1	1	1	1	1	512	1,024

Bits 9 through 11 determine the DCR search strategy (see section 3.1.1.1 on page 3-1):

Bit	Function
9	1 = Include segment C in search
10	1 = Include segment B in search
11	1 = Include segment A in search

D.2.2 Memory Bank B

Memory bank B contains 31 active bits. When bank B is eligible for alteration, transmitting a CA-5 command will cause the first 10 bits of bank B to match the 10 MSB (most significant bits) of the 11 TLP bits accompanying the CA-5 command. These 10 bits form the 10-bit word that determines the starting step of scan segment B (word 4 on page C-5).

Transmitting a CA-6 command will similarly establish the condition of bits 11 through 20 in bank B. These 10 bits form the 10-bit word that determines the last step in scan segment B (word 5 on page C-5).

Transmitting a CA-7 command will likewise establish the condition of the last 11 bits in bank B.

These 11 bits have the following meanings: Bits 1 (MSB) through 8 configure the MBR recognizer*.

Bit	Function
1	1 = Reject TV
2	1 = Disable DCR dwell timer
3	1 = Reject wideband FM
4	1 = Reject narrowband FM
5	1 = Extend recognition dwell to 20 msec
6, 7	00 = No tones required
	01 = 8 kHz tone required
	10 = Tone required at 248, 250, or 304 kHz
	11 = 8 kHz + one of 248, 250, 304 kHz tones required
8	1 = Accept if either tone or FM bandwidth tests are satisfied

Bits 9 through 11 determine the MBR search strategy (see section 3.1.2.1 on page 3-2).

Bit	Function
9	1 = Include segment C in search
10	1 = Include segment B in search
11	1 = Include segment A in search

D.2.3 Memory Bank C

Memory bank C contains 26 active bits. When bank C is eligible for alteration, transmitting a CA-5 command will cause the first 10 bits of bank C to match the 10 MSB (most significant bits) of the 11 TLP bits accompanying the CA-5 command. These 10 bits form the 10-bit word that determines the starting step of scan segment C (word 7 on page C-6).

---

*Bit 1 is command bit 19, bit 11 is command bit 9, since commands are transmitted MSB last (see figure D-1).

Transmitting a CA-6 command will similarly establish the condition of bits 11 through 20 in bank C. These 10 bits form the 10-bit word that determines the last step in scan segment C (word 8 on page C-6).

Transmitting a CA-7 command will likewise establish the condition of the last six bits in bank C. These six bits have the following meanings (see word 9 on page C-6*). Bits 1 (MSB), 2, and 3 set the MBR threshold.

Bits	Function
1, 2, 3	000 = -70 dBm MBR threshold
	001 = -67 dBm MBR threshold
	010 = -64 dBm MBR threshold
	011 = -61 dBm MBR threshold
	100 = -58 dBm MBR threshold
	101 = -55 dBm MBR threshold
	110 = -52 dBm MBR threshold
	111 = -49 dBm MBR threshold
4	1 = Limit dwell of MBR (and DCR if slaved) at 30 seconds
5	1 = MBR and DCR (in slave) hold common contact till signal fails DCR threshold or in-band test (slave mode B)
6	1 = MBR and DCR operate independently

D.2.4 Memory Bank D

Memory bank D contains 21 active bits plus 7 blanks, for a total of 28 bits. When bank D is eligible for alteration, transmitting a CA-5 command will cause the first 11 bits of bank D (7 active plus 4 blanks) to match the 11 TLP bits accompanying the CA-5 command. These bits have the following meanings (word 10 on page C-6).

*Bit 1 is command bit 19 and bit 6 is command bit 14 since commands are transmitted MSB last (see figure D-1).

Bits 1 (MSB) through 4 determine the portion of the FM modulation copied by the payload for later evaluation. (See figure 2-2, page 2-3).

Bit	Code	Frequency Segment (kHz)	
1, 2, 3, 4	0000*	156-204	SG 1
	0001	12-60	
	0010	60-108	
	0011	108-156	
	0100	156-204	
	0101	204-252	
	0110*	60-108	
	0111*	108-156	
	1000*	456-504	SG 2
	1001	312-360	
	1010	360-408	
	1011	408-456	
	1100	456-504	
	1101	504-552	
	1110	275-323	
	1111*	408-456	

Bit	Code	Function
5	1	Copy 275 to 279 kHz. Store at 68 to 72 kHz
6, 7, 8, 9	—	Blanks
10	1	Treat bit no. 1 as a "0" when there is no modulation detected in SG-2
	0	Use actual value of bit no. 1
11	1	Connect DCR discriminator to channel 2 (not to channel 1).

Transmitting a CA-6 command will cause the 12th through 17th bits of bank D to match the 6 MSB's of the TLP bits accompanying the CA-6 command. These 6 bits have the following meanings (word 11 on page C-7):

*Not normally used.

Bits 1 (MSB), 2, and 3 set the DCR threshold. (Bits 1 and 2 are treated as zeros when the DCR is in the low-gain mode to assure acceptance of strong signals.)

Bits	Code	DCR Threshold
1, 2, 3	000	-95 dBm, or 7 dB above noise
	001	-92 dBm, or 10 dB above noise
	010	-89 dBm, or 13 dB above noise
	011	-86 dBm, or 16 dB above noise
	100	-83 dBm, or 19 dB above noise
	101	-80 dBm, or 22 dB above noise
	110	-77 dBm, or 25 dB above noise
	111	-74 dBm, or 28 dB above noise

Bits 4, 5, and 6 set the DCR copy dwell (except slaved call-up):

Bits	Code	Dwell	
4, 5, 6	000	1.5 second	Fixed dwell
	001	3.0 second	
	010	10.0 second	
	011	60.0 second	
	100	Requalify each 60 seconds	Indefinite dwell periods*
	101	Requalify each 3 seconds	
	110	Requalify each 10 seconds	
	111	Requalify each 60 seconds	

*Dwell until signal fails to qualify or until signal is below threshold or out of band for five continuous seconds.

Transmitting a CA-7 command will cause the last 11 bits of bank D (10 active plus 1 blank) to match the 11 TLP bits accompanying the CA-7 command*. These bits have the following meanings (word 12 on page C-7):

Bit	Function
1, 2	Not used
3	1 = DCR use noise-riding threshold
4,5	10 or 11 = MBR check both N and S
	01 = MBR check north antenna only
	00 = MBR check south antenna only
6, 7	00 = DCR check both N and S
	01 or 11 = DCR check north pair only
	10 = DCR check south pair only
8, 9	00 = DCR adapt IF BW to signal BW
	01 = DCR use 1.4-MHz IF BW
	10 or 11 = DCR use 2.6-MHz IF BW
10	Not used
11	1 = Use sun sensor (not earth sensor)

D.3 CONTROL SIGNALS FROM SPACECRAFT

Besides establishing the time and duration of each T/R read-in, T/R readout and B & A T/R R/O period, the spacecraft instructs the payload as to which tape recorders are to be read out, using 6 lines. These lines are ordered as two sets of 3 to select one of three tape recorders for each telemetry link. (See spacecraft command list.) The payload connects the output of the tape recorder selected to receive the first R/I (next pass) to transmitter 1, and the output of the tape recorder selected to receive the second R/I to transmitter 2. Thus, this selection should not be changed until the tape recorder R/O has been completed.

*Bit 1 (MSB) is command bit 19, bit 11 (LSB) is command bit 9 (see figure D-1).

D.4 COMMAND CONSTRAINTS

The recommended commanding procedure is to re-command the entire memory matrix each time any part of memory is altered.

Unused sectors should be set to start at the bottom of the band and end at the top. This is the equivalent of full-band sweep, in case the sector is accidentally selected. It also assures added data transitions (in case other data are all zeros) to help maintain synchronization to the 18 kbps signal.

Under no circumstances may the starting point of a segment in use exceed the end-point of that segment. The payload will not accept such a segment (if this is the only segment enabled for a receiver, the receiver will not function properly). In addition, should the MBR be used in segment scan, the selected segment must exceed five (MBR) steps in size. It should exceed 26 steps to guarantee coverage of a single desired frequency.

Both the DCR and the MBR recognizers must be configured to require that the FMBW tests <u>and</u> the pilot tone tests be satisfied, except when neither test is required - or when the OR function is specifically desired.