~~TOP SECRET~~
EARPOP

K-8

19

HANDLE VIA BYEMAN
CONTROL CHANNELS

COPY ________
BYE-1265-68
SORS 11./24
16 April 1968

4

UNITED STATES INTELLIGENCE BOARD

SIGINT COMMITTEE

SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

MEMORANDUM FOR MEMBERS OF THE SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

SUBJECT: Technical Mission Description of VAMPAN SIGINT Mission 7325

The Mission Description for VAMPAN - 7325 has been provided to the SORS by the NRO and is forwarded for your information.

[redacted] (b)(1) (b)(3)

EXECUTIVE SECRETARY
SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

Attachment:
a/s

EARPOP
~~TOP SECRET~~

GROUP 1
Excluded from automatic downgrading and declassification

80416024

~~TOP SECRET~~

HANDLE VIA BYEMAN CONTROL SYSTEM

EARPOP

~~TSL~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

ATTACHMENT:

THE NRO STAFF

BYE-1265-68
SORS 11./24
16 April 1968

MEMORANDUM FOR THE CHAIRMAN, SORS

SUBJECT: Mission Description of SIGINT Mission 7325 (VAMPAN)

The mission description for Mission 7325 is forwarded as an attachment to this correspondence. This Elint Reconnaissance System is designed to meet the requirements of USIB D 41.14/246, USIB D 41.14/303 and current attachments thereto.

Mission 7325 is contained in a spin stabilized P-11 subsatellite which is scheduled to be launched into a nominal 270 mile circular orbit by a Thorad Agena booster. It is designed to intercept and record signals in the 100-1000 MHz band and will receive and record signals of interest with sufficient bandwidth to permit measurement of such parameters as frequency, [redacted] power, pulse repetition (b)(1)
frequency, and geopositions of the emitter. (b)(3)

The planned launch date, predicated on the launch of the primary payload, is October 1968. Mission life is expected to be 9 months. A nominal 6 to 11 collection revs per day should be available. Under worst case power conditions, it would appear that a minimum of six operations per day can be sustained.

Edwin P. Sweeney
for HENRY C. HOWARD
Colonel, USAF
Deputy Director for
Satellite Operations
NRO Staff

Attachment
As Stated

HANDLE VIA BYEMAN CONTROL SYSTEM EARPOP

~~TOP SECRET~~
EXCLUDED FROM AUTOMATIC REGRADING
DOD DIRECTIVE 5200.10 DOES NOT APPLY

80416024

BYE-1265-68

MISSION DESCRIPTION

MISSION 7325 (VAMPAN)

1.1 GENERAL.

The VAMPAN reconnaissance system comprises the payload receiving antennas, the payload receivers, a data storage and transmission subsystem, a command subsystem, and ancillary equipment. The payload receivers consist of a high-band receiver unit covering the frequency range from 400 to 1000 MHz and a low-band receiver unit covering the frequency range from 100 to 400 MHz. Each receiver unit contains a matched pair of superheterodyne receivers and a crystal video receiver. The superheterodyne receivers provide pulse amplitude, pulsewidth, carrier frequency, and geoposition measurements. Phase difference measurements of pulse signals are obtained using the superheterodyne receivers in pairs. The crystal video receiver provides scan rate, antenna pattern, PRF, [redacted] and signal power measurements. The two receiver units are independent of each other and may be considered as separate payloads. (b)(1) (b)(3)

1.2 PAYLOAD ANTENNAS.

The VAMPAN reconnaissance system uses two pairs of planar spiral circularly polarized antennas for reception of signals of interest: one pair for low-band (100 to 400 MHz) reception and one pair for high-band (400 to 1000 MHz) reception. The spiral elements are formed by a gold deposition process on dacron mesh sheets and are made as nearly omni-directional as possible. Both of the high-band and one of the low-band spirals are formed on a 4 ft. x 8 ft. dacron sheet; the remaining low-band spiral is formed on a separate 4 ft. x 4 ft. dacron sheet. Diagram 1 shows the antennas mounted on the P-11 subsatellite.

The antennas pairs use a phase measurement system embodying basic interferometer principles for target geopositioning. Phase measurement consists of determining the phase differential of an incident RF wavefront striking two antennas that are spatially displaced

Handle Via BYEMAN
Control System

BYE-1265-68

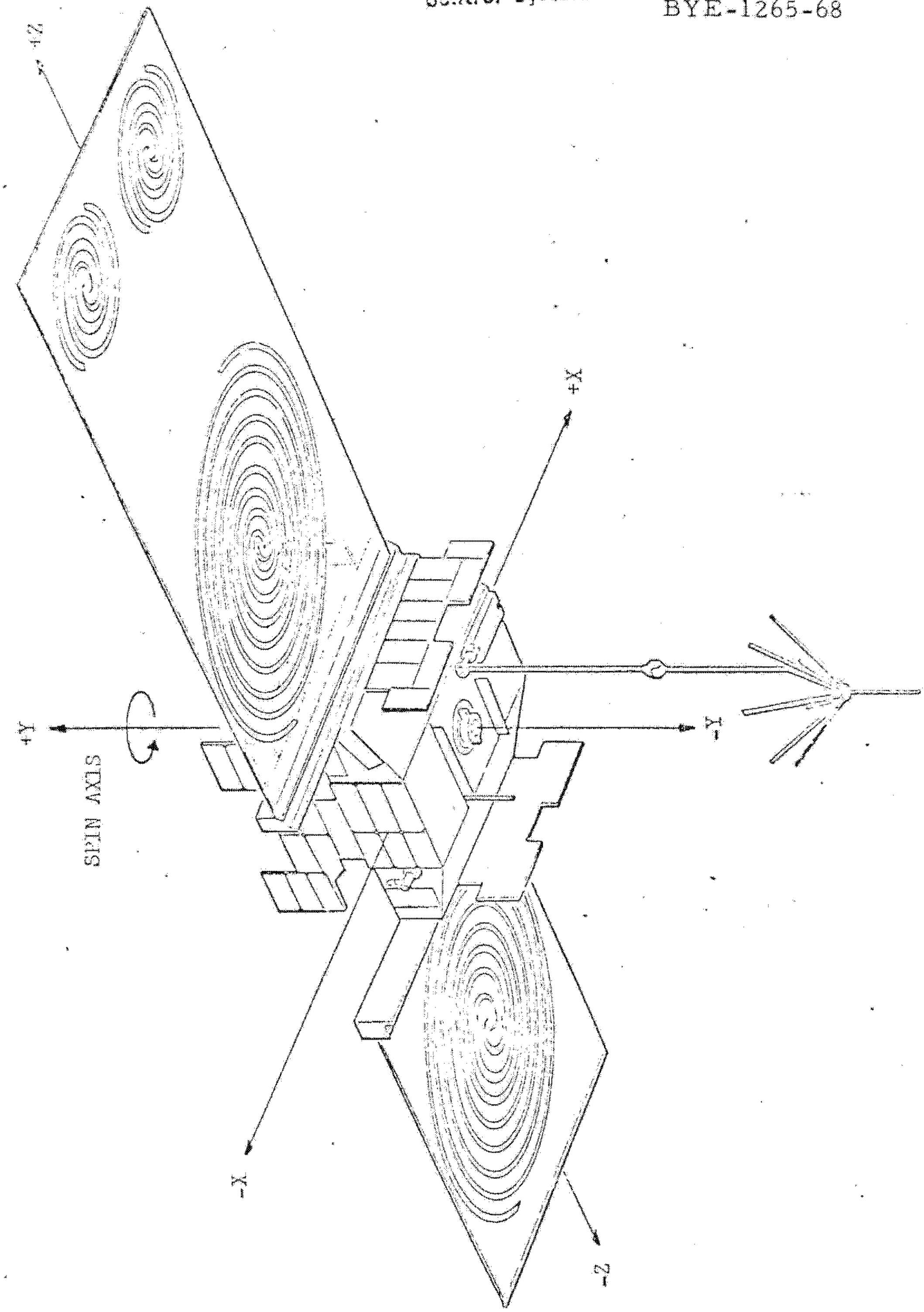


DIAGRAM 1. VAMPAN Receiver Antennas Mounted on P-11 Spacecraft

relative to the wavefront. The phase differential in the two arms of the antenna system is proportional to the difference in travel time from the emitter source to the two receiving antennas and is, therefore proportional to the difference between the two transmission path lengths. Since the physical separation of the antennas is small compared to the path lengths, the path difference is directly proportional to the direction cosine (with respect to the antenna baseline) of a vector pointing to the signal source. The direction cosine varies as the antennas rotate, thus allowing this angle to be resolved into an elevation angle plus an azimuth angle. The vehicle coordinate system is defined with respect to ground coordinates based on vehicle ephemeris data and earth sensor signals. Diagram 2 shows the phase measurement geometry.

1.3 PAYLOAD RECEIVERS.

The payload receiver subsystem contains six receivers: a low-band (100 to 400 MHz) crystal video receiver, a pair of low-band sweeping superheterodyne receivers, a high-band (400 to 1000 MHz) crystal video receiver and a pair of high-band superheterodyne receivers. Diagram 3 is a block diagram of the high-band receiver unit, and Table 1 summarizes the primary receiver characteristics.

1.3.1 High-Band Receiver Unit.

The high-band receiver unit contains a broadband, 400 to 1000 MHz crystal video receiver, a pair of sweeping superheterodyne receivers covering the 400 to 1000 MHz band, a time reference generator (TRG), and a payload status commutator.

1.3.1.1 Crystal Video Receiver.

The RF input to the crystal video receiver is coupled from the same antenna used by one of the superheterodyne receivers passed through a 400 to 1000 MHz bandpass filter to a wideband RF amplifier, and applied to a crystal detector/amplifier. The video amplifier following the crystal detector has a pseudolog output. A 40 db input to the detector is compressed into a 20 db range. The compressed output pulses are then applied via a threshold control circuit to a 200 usec pulse stretcher that frequency modulates a voltage control oscillator (VCO). The crystal detector video output pulse must exceed

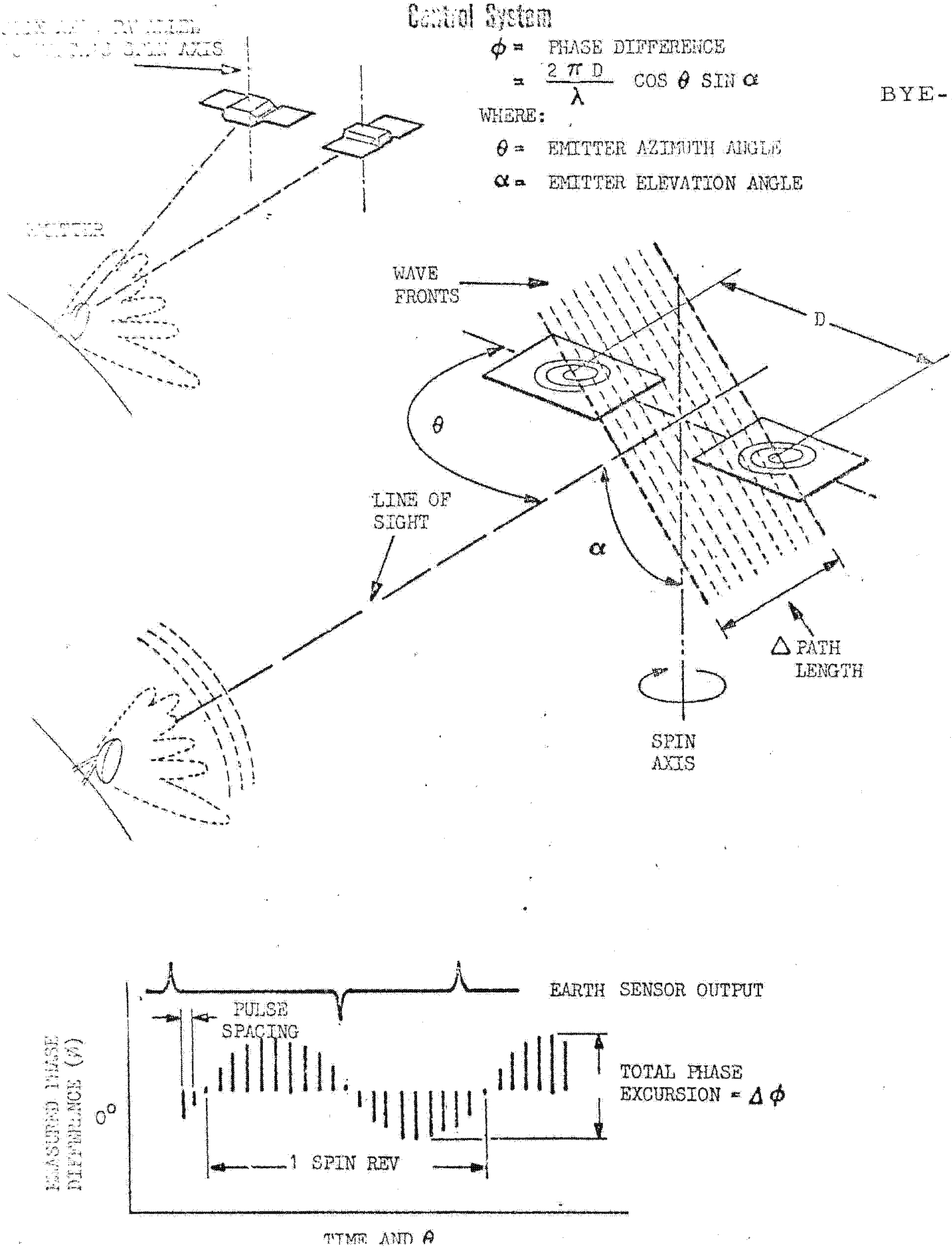


DIAGRAM 2. Phase Measurement Geometry

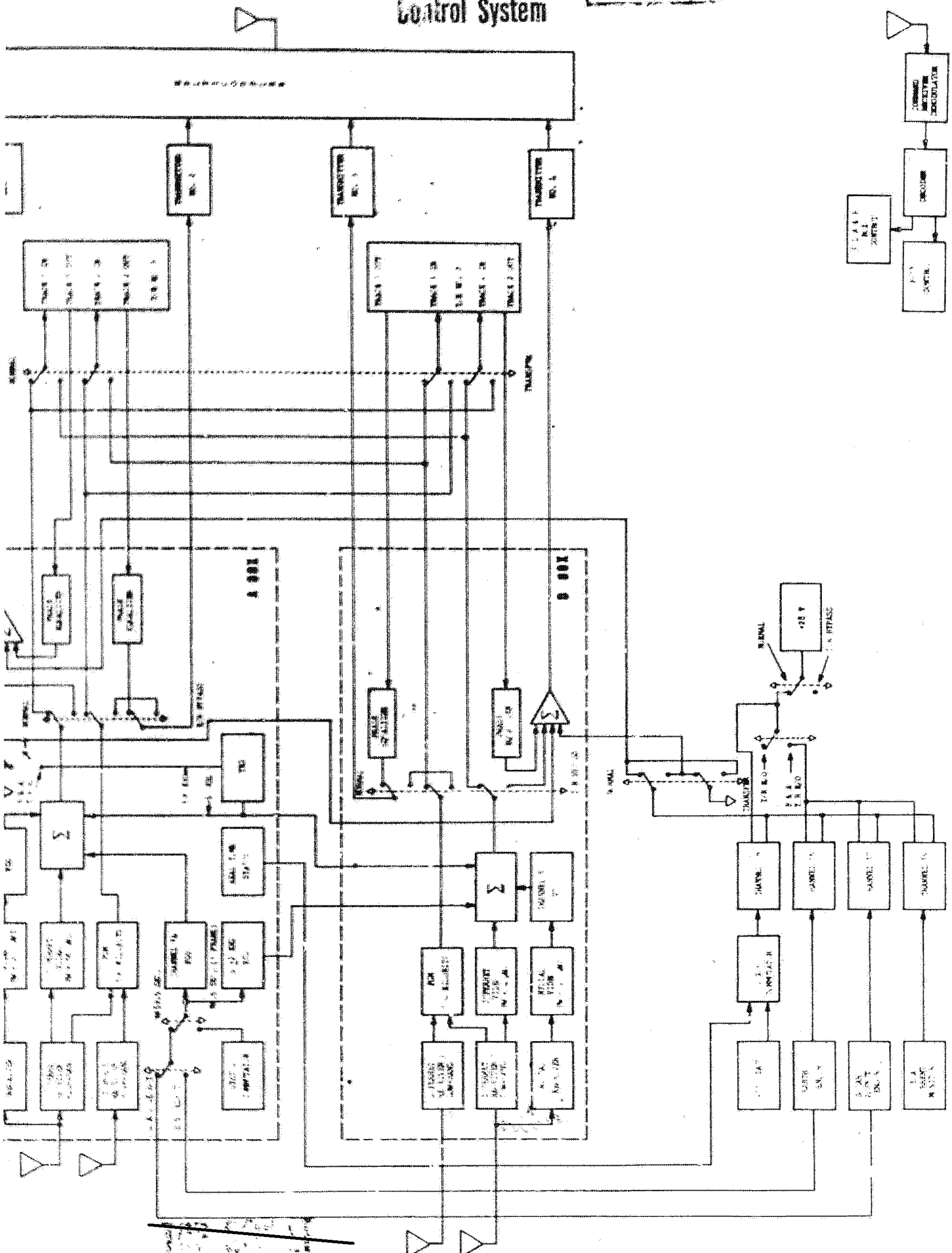

A BOX
B BOX
+28 V

TABLE I

SUMMARY OF RECEIVER SUBSYSTEM CHARACTERISTICS

Receiver Subsystem

Total receiver frequency coverage:	100 to 1000 MHz
Individual receiver frequency coverage:	
Low-band sweeping superhets	100 to 400 MHz in 600 kHz steps
Low-band crystal video	100 to 400 MHz
High-band sweeping superhets	400 to 1000 MHz in 1.2 MHz steps
High-band crystal video	400 to 1000 MHz
Receiver Sensitivity (S/N $\approx$ 1)	
Low-band sweeping superhets:	
100 to 200 MHz	-92 dbm
200 to 400 MHz	-99 dbm
Low-band crystal video:	-54 dbm
High-band sweeping superhets:	
400 to 700 MHz	-99 dbm
700 to 1000 MHz	-98 dbm

a preset threshold for approximately 2 usec before a 200 usec pulse is generated. The amplitude of the generated pulse is proportional to the amplitude of signals received during the 10 usec period after the present threshold has been exceeded. Successive 200 usec stretched pulses are generated as long as the amplitude of the video pulse is above the present threshold. This condition would exist when a pulse longer than 202 usec was intercepted.

1.3.1.2 Superheterodyne Receivers.

The high-band superheterodyne receiver pair nominally sweeps through the 400 to 1000 MHz band in 512 steps of 1.2 MHZ each. The two single-conversion superheterodyne receivers are tuned by common voltage-tuned oscillators (VTO). One VTO covers the 400 to 700 MHz band and a second VTO covers the 700 to 1000 MHz band. Each receiver contains two preselectors that are tuned to the selected frequency step by the same sweep generator that controls the VTO's. The tunable preselectors consist of voltage-tuned filters (VTF) coupled to wideband amplifiers. The 3 db bandwidth of the VTF is approximately 10 percent of the lowest frequency over which the filters are tuned.

IF Amplifiers.

Each receiver has two parallel IF channels, each having a center frequency of 105 MHz. The first IF amplifier is a linear amplifier having a bandwidth of 2 MHz. The output of this amplifier is limited and applied to one input of a phase detector. (The second input to the phase detector is from a matched linear IF amplifier in the other receiver.) The second IF amplifier is a log amplifier having a bandwidth of 1.8 MHz. The output of this amplifier is envelope detected and applied to the data processor section.

Phase Detector.

The phase detector produces an analog output proportional to the phase difference of an RF carrier intercepted by each of the high-band antennas. The two receivers are phase balanced; therefore, the phase difference voltage at the output of the phase detector is a function of the time of arrival of the incident RF wavefront at the antennas. The phase detector analog output is converted to a digital word if the received signal qualifies in the log IF data processor section.

Threshold Circuits.

The log IF envelope detector output is applied to a threshold circuit and to a 66 usec pulse stretcher. The threshold circuit criteria must be met before any measurements of an incoming pulse can be conditioned for data storage and/or transmission.

Tuning Modes.

The data processor section contains the circuits that control the receivers and condition the video outputs for data storage and/or transmission. The logic circuits can be commanded to program one of three tuning modes: the first mode (band scan) consists of 1.2 MHz frequency steps that cover the 400 to 700 MHz band, the 700 to 1000 MHz band, or the 400 to 1000 MHz band. The frequency tuning rate is 10 steps per second unless a signal is intercepted that satisfies a preset threshold requirement. If a qualifying signal is intercepted, the frequency step is held for 1.5 seconds. The second mode (fixed frequency) allows the VTO to be programmed to a discrete frequency step and held there until commanded to another step or to another mode. The third mode (incremental scan) consists of stepping the VTO across any five successive frequency steps in the 400 to 1000 MHz range.

PCM Frame Word.

At the start of every target search period, a bipolar, binary frame word is generated at a 100 kilobit-per-second rate. The frame word consists of a 15 bit frame sync word, a 9 bit frequency step word, and a 5 bit threshold setting word. The search interval normally extends for 90 msec after the 10 msec frame word interval; however, when a signal that meets the threshold requirements is intercepted, the search time is extended to 1.5 seconds. In the frequency sweeping modes, a frequency step occurs with the start of every frame word. In the fixed frequency mode, the search logic is the same as in the frequency sweeping modes except that the same frequency step is selected. In all three tuning modes, the threshold setting word is generated 9950 usec after the start of the sync word to permit the signal environment to be sampled and the threshold to be set when in the adaptive threshold mode.

PCM Data Word.

A bipolar, binary data word is generated at a 100 kilobit-per-second rate for each signal pulse that meets the threshold requirements. The data word consists of a 2 bit sync word, an 8 bit phase measurement word, a [redacted] measurement word, and a 1 bit end of word bit. Phase measurement resolution is 1.41 electrical degrees per bit, and [redacted] is as follows:

a. [redacted]

b.

c.

d.

(b)(1)
(b)(3)

[redacted]

1.3.1.3 Data Outputs. (See Diagram 4)

Two channels of data are generated in the payload during readin. One channel consists of a 3-level, bipolar nonreturn-to-zero (NRZ) digital frame and data words generated at a 100 kilobit rate. The second channel is a multiplexed signal consisting of the following:

a. Superheterodyne video pulses stretched to 66 usec.

b. A VCO modulated by the sun/earth sensors or the payload status commutator.

c. 50 kHz reference tone modulated by the AN/GSQ 53 time word.

d. A VCO modulated by the high-band, 200 usec stretched crystal video pulses.

1.3.2 Low-Band Receiver Unit.

The low-band receiver unit contains a broadband, 100 to 400 MHz crystal video receiver and a pair of sweeping superheterodyne receivers covering the 100 to 400 MHz band.

1.3.2.1 Crystal Video Receiver.

The low-band crystal video receiver is similar to the high-band unit except for the frequency coverage.

1.3.2.2 Superheterodyne Receivers.

The low-band superheterodyne receivers are basically similar to the high-band units, with the following differences:

a. Band Coverage.

100 to 400 MHz in 512 steps of 0.6 MHz.

One VTO covers the 100 to 200 MHz band.

One VTO covers the 200 to 400 MHz band.

b. IF Channels.

Linear IF BW = 1 MHz, f_o = 40 MHz.

Log IF BW = 0.8 MHz, f_o = 40 MHz.

[redacted]

(b)(1)
(b)(3)

d. Tuning Modes.

The same as high-band except for frequency range.

e. Data Outputs.

The PCM output contains the same data word types as the high-band receiver.

The multiplexed output channel to the tape recorder during readin is as follows (see Diagram 4):

(1) Superheterodyne video pulses stretched to 40 usec.

(2) A VCO modulated by the sun/earth sensors or the payload status commutator (redundant data).

(3) 50 kHz reference tone modulated by the AN/GSQ-53 time word.

(4) A VCO modulated by the low-band 200 usec stretched crystal video pulses.

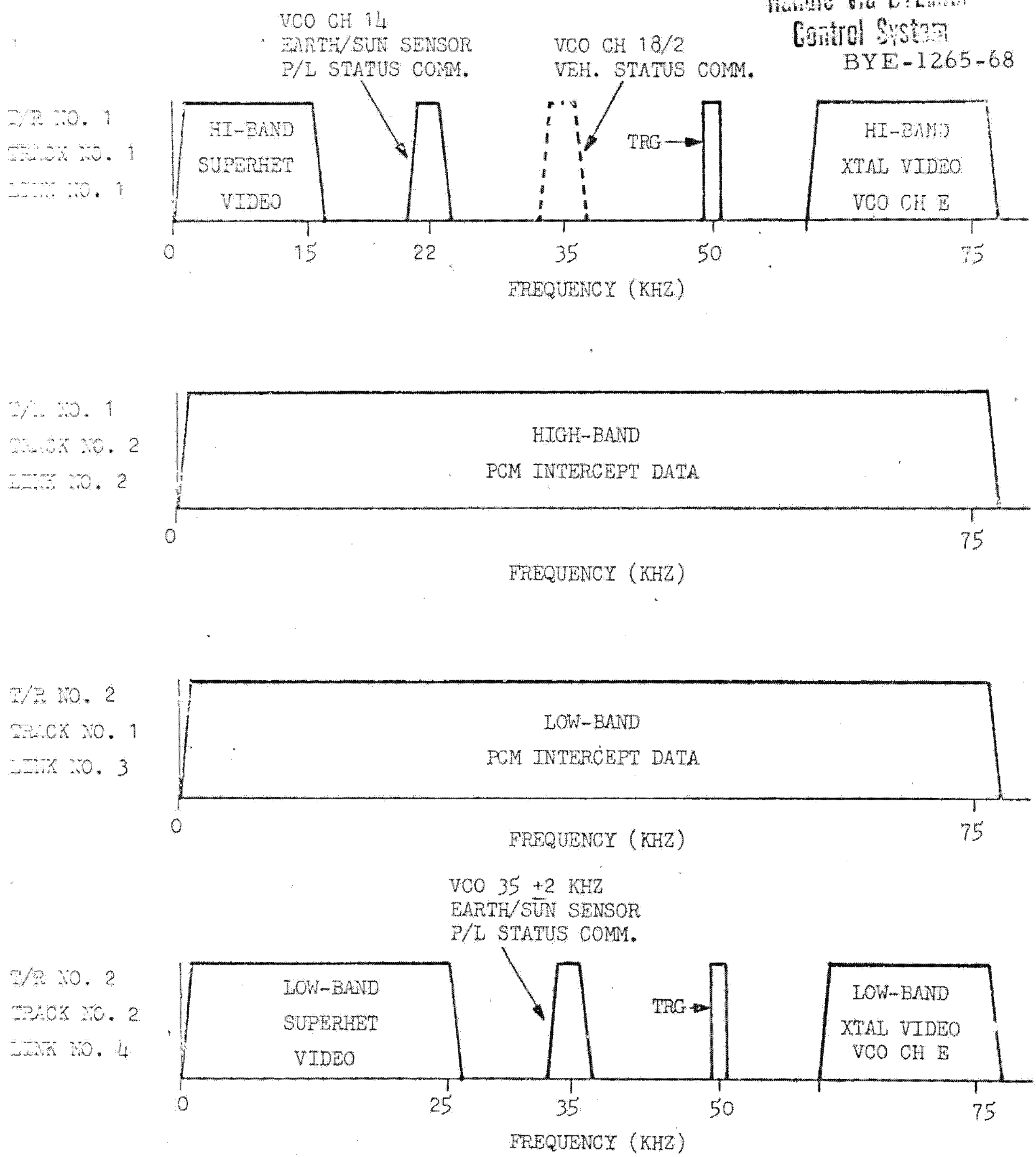
1.4 DATA RECORDING AND TRANSMISSION SUBSYSTEM.

1.4.1 Tape Recorders.

Two dual-track, magnetic tape recorders are used to store the payload and earth/sun sensor data during payload readin. Tape recorder readin time is a nominal 12 minutes with a frequency response of ± 3 db over the 300 Hz to 75 kHz range. The dynamic range is 25 db with a linear input/output response. Readout tape speed is double the readin speed; therefore, the nominal readout time is 6 minutes and the readin frequencies are doubled. A 50 kHz reference tone is applied to one track of each recorder during readin to permit tape speed compensation during ground data processing. The tape recorder track assignments for the payload data during the normal tape recorder mode are as follows:

Handle Via BYEMAN Control System

BYE-1265-68



NOTES:
1. Readin format of 2:1 speed ratio tape recorders shown. Readout format is two times frequencies shown.
2. Ch 18 VCO is read out in real time. It is shown at half frequency to indicate its position in the readin spectrum of the T/R.
3. Tape recorder input transfer mode interchanges T/R 1 track 1 with T/R 2 track 2 and T/R 1 track 2 with T/R 2 track 1.

DIAGRAM 4. Tape Recorder Input Data Format

T/R No.	Track No.	Data
1	1	High-band multiplex signal (66 usec pulses, IRIG chan 14 VCO, 50 kHz reference tone).
1	2	High-band PCM data.
2	1	Low-band PCM data.
2	2	Low-band multiplex signal (40 usec pulses, 35 ± 2 kHz VCO, 50 kHz reference tone).

Tape recorder inputs can be transferred by real time command to interchange T/R No. 1 track No. 1 with T/R No. 2 track No. 2 and T/R No. 1 track No. 2 with T/R No. 2 track No. 1. The tape recorder can also be bypassed by real time command. In the tape recorder bypass mode, the payload outputs that normally go to the tape recorder inputs are applied directly to the telemetry transmitters.

1.4.2 Data Transmission.

Each transmitter is rated at two watts minimum power output. The output of each transmitter is applied via a multicoupler to a common telemetry antenna.

The telemetry antenna is a VHF monopole having extended radial elements to provide a good ground plane. The location of the telemetry antenna on the spacecraft is shown in Diagram 1.

1.5 GROUND SUPPORT EQUIPMENT.

1.5.1 Tracking Stations.

The existing United States Air Force command and tracking network contains the required equipment for generating and transmitting commands to the spacecraft and for recording the readout of the intercepted data.

1.6 DATA PROCESSING.

Data processing includes shipment of recordings from the collection site to the West Coast facilities, performing engineering evaluation of demultiplexed payload status data, and delivery of ELINT intercepts to NSA for exploitation.