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MISSION 7300

SIGINT SATELLITE SYSTEM

USERS MANUAL

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MISSION 7300 DESCRIPTION

OVERVIEW

The Mission 7300 SIGINT Satellite program, conceived in the overhead reconnaissance program as a means of performing selected high-priority directed search missions, has evolved into a flexible, multi-mission surveillance system capable of a wide range of SIGINT tasks. Today, Mission 7300 series SIGINT satellites provide repetitive worldwide surveillance of foreign radar, communications, and satellite uplink signals across the 2 GHz to 18 GHz radiofrequency spectrum. Intelligence missions derived from this capability include the following:

Directed Surveillance --	Support of National Security Council Decisions; Time-Critical intelligence support to SAC for SIOP flight planning; Support to U. S. Operational forces, worldwide; "Hotspot" Indications & Warning (I & W).
Directed Search --	Support of Foreign Weapons System Analyses; Collection of Technical Intelligence from foreign electronics development facilities and system test ranges.
General Search --	Collection of Technical Intelligence, Worldwide, to discover new or unusual signals, and new or unusual operational uses of known signals.
General Surveillance --	Intelligence support of indications and warning analysis; Order of Battle maintenance

Unique among the U. S. Surveillance satellite systems in several aspects, Mission 7300 provides a combination of worldwide access, [redacted] 25X1
25X1
25X1
Current Mission 7300 payloads provide adequate target intercept probabilities by intercepting sidelobe energy through high-gain, narrowbeam antennas which are scanned horizon-to-horizon; and mainbeam energy through omnidirectional antennas.

In summary, the Mission 7300 SIGINT Satellite System has made and continues to make significant contributions to this country's understanding of foreign weapons systems through the collection and analysis of weapons-associated signals. Further, Mission 7300 has greatly facilitated determination of the locations and activity of foreign microwave, troposcatter, and satellite communications links; and developed operational associations of foreign satellite command uplinks. Today, Mission 7300 satellites provide a continuing and unique capability to survey the earth's signal environment daily, while providing essential technical intelligence against new, unusual, and other high-interest signals worldwide.

Omni-directional intercept antennas on the satellite provide a lower sensitivity over the entire area to the horizon. These omni search antennas intercept primarily mainbeams and strong sidelobes. Mainbeam collection occurs, for example, when the satellite passes through the beam pattern of a horizon search radar. As the spacecraft rises above the horizon and the radar beam points (or scans) in the direction of the satellite, power and frequency profiles of the radar beams are recorded. In this manner, signal parameters, beam scan characteristics, and radiated power levels are measured for technical analysis of foreign weapon system capabilities and vulnerability to jamming.

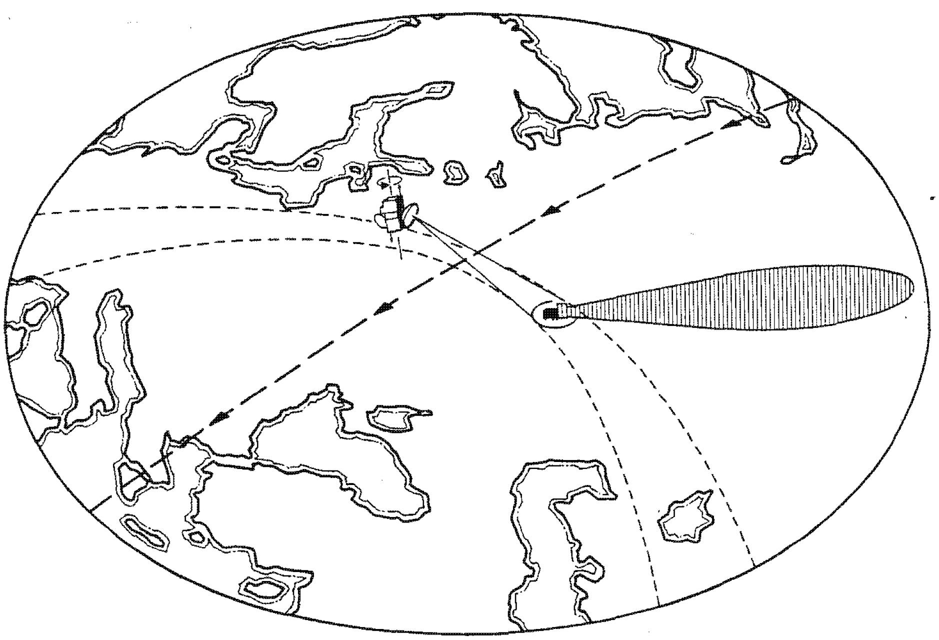
Low power, highly directive signals such as microwave communication transmissions generally require the satellite to pass through the target emitter beam for detection to occur. Mission 7300 low altitude non-repetitive groundtrack orbits afford numerous intercept opportunities against such [redacted] targets as [redacted] 25X1
for which a portion of the communications antenna beam "spills over" the tower reflector plate and points vertically up from the earth.

[redacted] 25X1

SIGNAL INTERCEPT CONCEPT

The Mission 7300 spacecraft has been developed to maximize combined geographic and frequency (or geofrequency) coverage. This is, a 2 GHz instantaneous bandwidth jumped in frequency in synchronism with each antenna as it begins a scan of the earth to provide segmented or contiguous coverage of up to 14 GHz of the spectrum. Low-altitude earth orbits give mission 7300 satellites access to virtually every point on the earth at least once a day, and most areas several times each day. Thus, each satellite searches for emitters operating over any 8 to 14 GHz segment of the 2-18 GHz radiofrequency spectrum, and maps their locations over many millions of square nautical miles during each day of operation.

Mission 7300 satellites have two intercept modes: sidelobe intercept and mainbeam intercept. High-gain dish antennas scan the earth horizon-to-horizon with sufficient sensitivity to intercept sidelobe radiation from most radars, and signals from a variety of communications systems. The high sensitivity of the sweeping antenna system is designed to provide a high probability of detecting and locating emitters from unintentional radiation. Thus, the probability of intercept is relatively independent of the beam pointing direction of target emitter. Sidelobe collection occurs when the satellite intercept antenna points toward an emitter operating in the receiver collection band, as illustrated below.



Receivers are of three types: a pulse receiver, which intercepts and extracts parameters from pulsed signals; continuous wave (CW) receiver, which makes measurements on non-pulsed or very high data rate signals; and the Technical Intelligence (TI) receiver, which can either record up to 10 MHz of predetection signal bandwidth directly (rather than measuring signal parameters on-board), or perform a spectral analysis of a 13 MHz segment of the spectrum. Each spacecraft has three recorders for redundant storage of digital intercept data from pulse and CW receivers, and compressed bandwidth analog or spectrum analysis data from the TI receiver. Recorders are commanded to replay data through the downlink to a network of remote ground stations. Electrical power is provided by solar cell arrays, with batteries providing power during periods when the satellite is eclipsed by the earth. The satellite is spin stabilized with its spin axis parallel to the spin axis of the earth, and fine control of the spin axis is maintained by a magnetic attitude control system. Small solid rockets mounted on the periphery of the vehicle spin the satellite after launch. A magnetic spin rate control system maintains a near constant spin rate.

Spin stabilization serves also as the mechanism for moving the intercept swath across the earth, scanning the high-gain antenna beam across the earth from horizon-to-horizon as the spacecraft moves along its orbital trajectory. The high-gain antenna's footprint moves across the earth, intercepting signals from emitters within the intercept swath, as illustrated above. The next sweep of the antenna beam overlaps the first to give continuous coverage of the surface from the rotational motion of the antenna and the orbital motion of the satellite until virtually the entire earth is mapped during the period of one day.

TRACKING, COMMAND AND CONTROL

Telemetry, tracking, and command is provided by a standard S-band space-ground link system (SGLS). Both digital and analog data readout is through a wideband downlink and relayed from remote ground stations [redacted] via the Defense Satellite Communication System (DSCS) or other satellite relay. The remote tracking stations also monitor satellite telemetry status [redacted] 25X1

TASKING

General intelligence collection guidance is provided by the National Foreign Intelligence Board (NFIB) through the SIGINT Overhead Reconnaissance Subcommittee (SORS) to the Director of NRO. Detailed tasking is developed within the NRO Detachment, Ft. Meade (NDF) component of the National Reconnaissance Office. Specific guidance from the NDF and the National Security Agency (NSA) as well as the general guidance from SORS is used [redacted] for developing a daily tasking plan. 25X1

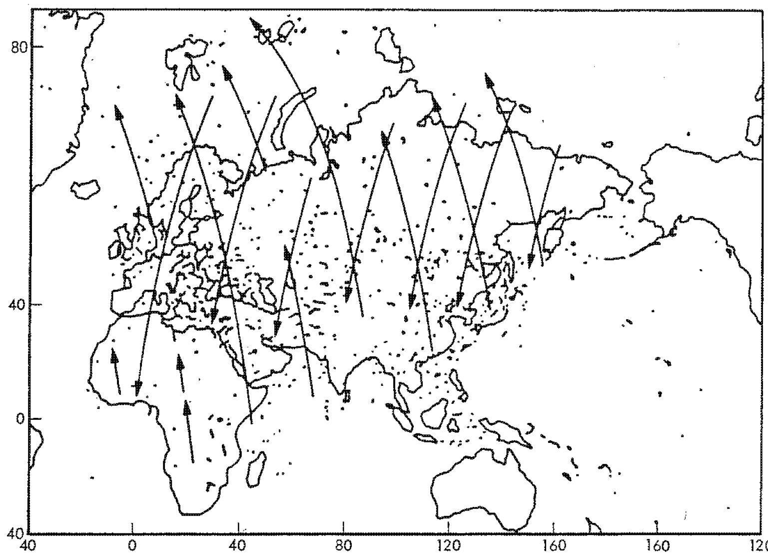
Tasking is relatively insensitive to geographic priorities (as compared to some collection systems) because antenna pointing does not have to be decided on a priority basis. Rather, primary tasking is in the selection of broad geographic areas and frequency bands to be searched. Currently operational satellites are capable of accepting intercept segment tasking in any four of the five bands over which they operate. 7346 and up can be tasked on each intercept segment to search any seven of eight (2 GHz) bands within its operating frequency span of 2 to 18 GHz.

25X1

The daily tasking plan is converted to a series of satellite commands [redacted] Intercept and downlink commands are transmitted via relay satellite to selected remote tracking stations for retransmission to the satellites when they come into view.

INTERCEPT

Whenever the satellite payload is commanded to activate, receivers tune to selected frequency bands and recorders are activated. Intercept segment lengths are varied to optimize collection and processing under constraints of the time-criticality of reports from the area being accessed, remote ground station locations, spacecraft power consumption, [redacted]. Typical intercept segments for one day's operation of a Mission 7300 satellite is shown below. Solid lines indicate the portion of the orbit trace over which the payload was activated.



DATA RETURN

Signals intercepted by the satellite payload are either transponded, or recorded and stored on-board until the spacecraft passes in view of a remote tracking station. When the tracking station commands a data readout, on-board recorders dump stored data through a wideband downlink. Data is then relayed from the ground site [redacted] Transponded data can also be transmitted to Tactical Elint Processing (TEP) Vans for direct tactical exploitation.

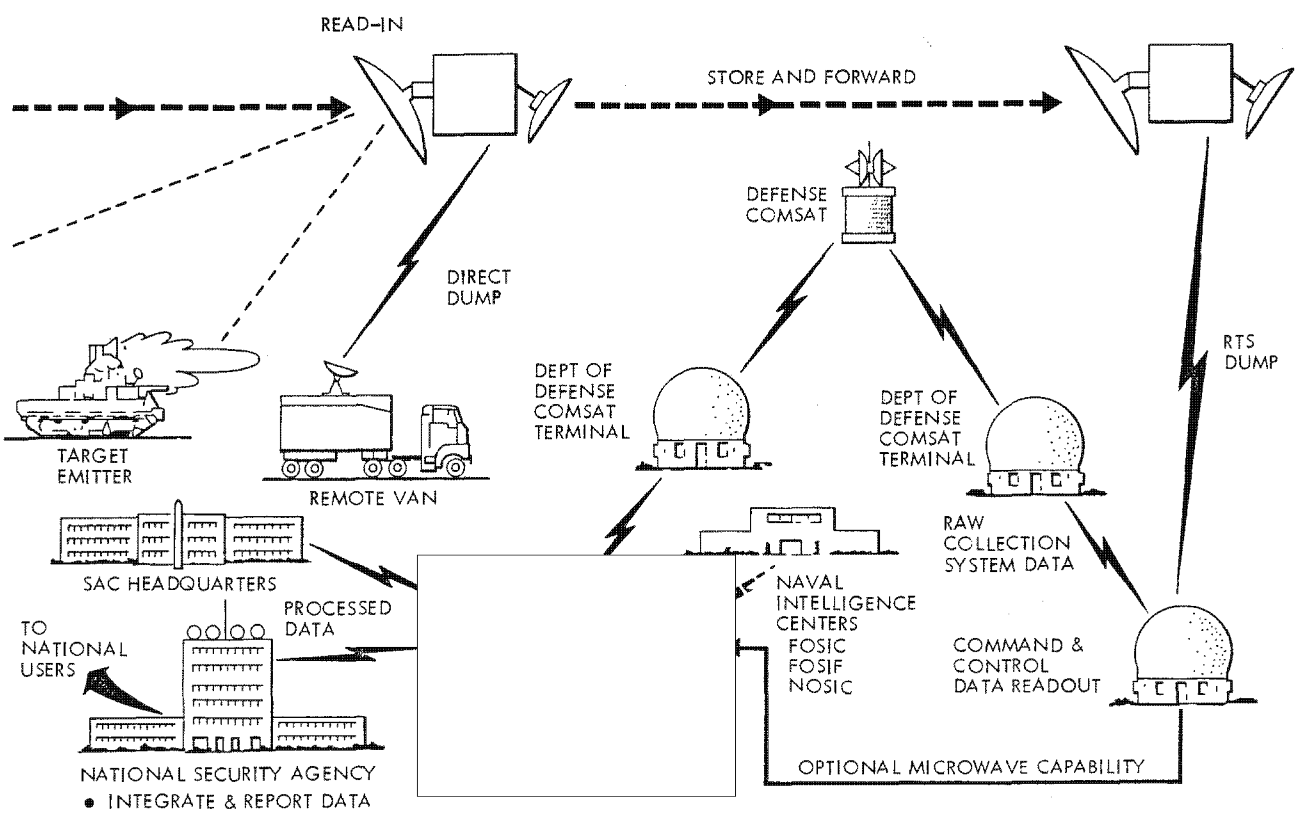
25X1

PROCESSING AND REPORTING

[redacted] Both time-critical and routine reports are transmitted directly to Strategic Air Command (SAC) headquarters in Omaha, Nebraska, to NSOC at Fort Meade, Maryland, and the Defense Intelligence Agency (DIA) in Washington, D. C.

25X1

The National SIGINT Operations Center (NSOC) merges intercepts from Mission 7300 with data from other sources for reporting to operational forces, worldwide; to NSA for signal analysis; to CIA for general intelligence analysis; or to the services' Foreign Technology Centers for detailed weapons system analysis; and other users. [redacted]



25X1

Technical capabilities of the system include coverage of the RF spectrum from 2 to 18 GHz with up to 14 GHz of the total range accessable on each intercept segment; adequate sensitivity for sidelobe intercept and location of most radars; narrowband sensitivity adequate for intercept and location of a variety of communications and uplink signals; access to virtually every point on earth at least once each day, with more than 4 daily accesses to the Soviet Union, Europe and the Middle East assuming two operational satellites are maintained on orbit continuously.

MISSION 7344 DESCRIPTION

1. GENERAL INFORMATION

SIGINT Mission 7344 is a satellite ELINT intercept system which performs general search for pulsed and continuous wave (CW) emitters; and electronic order of battle collection for pulsed emitters in the 2 to 12 GHz frequency range. The intercept system is mounted on a spacecraft placed in a 340 N.M. circular orbit. The measurements made on each intercepted radar pulse include the [redacted] 25X1
[redacted] measurements are accomplished for detected CW signals. The block diagram is Figure 1. 25X1

This mission description discusses the following:

A. Antenna Subsystem
B. Receiver Subsystem
   (1) Pulse Receiver Characteristics
   (2) CW Receiver Characteristics
C. Data Storage and Transmission

INTERCEPT SYSTEM BLOCK DIAGRAM

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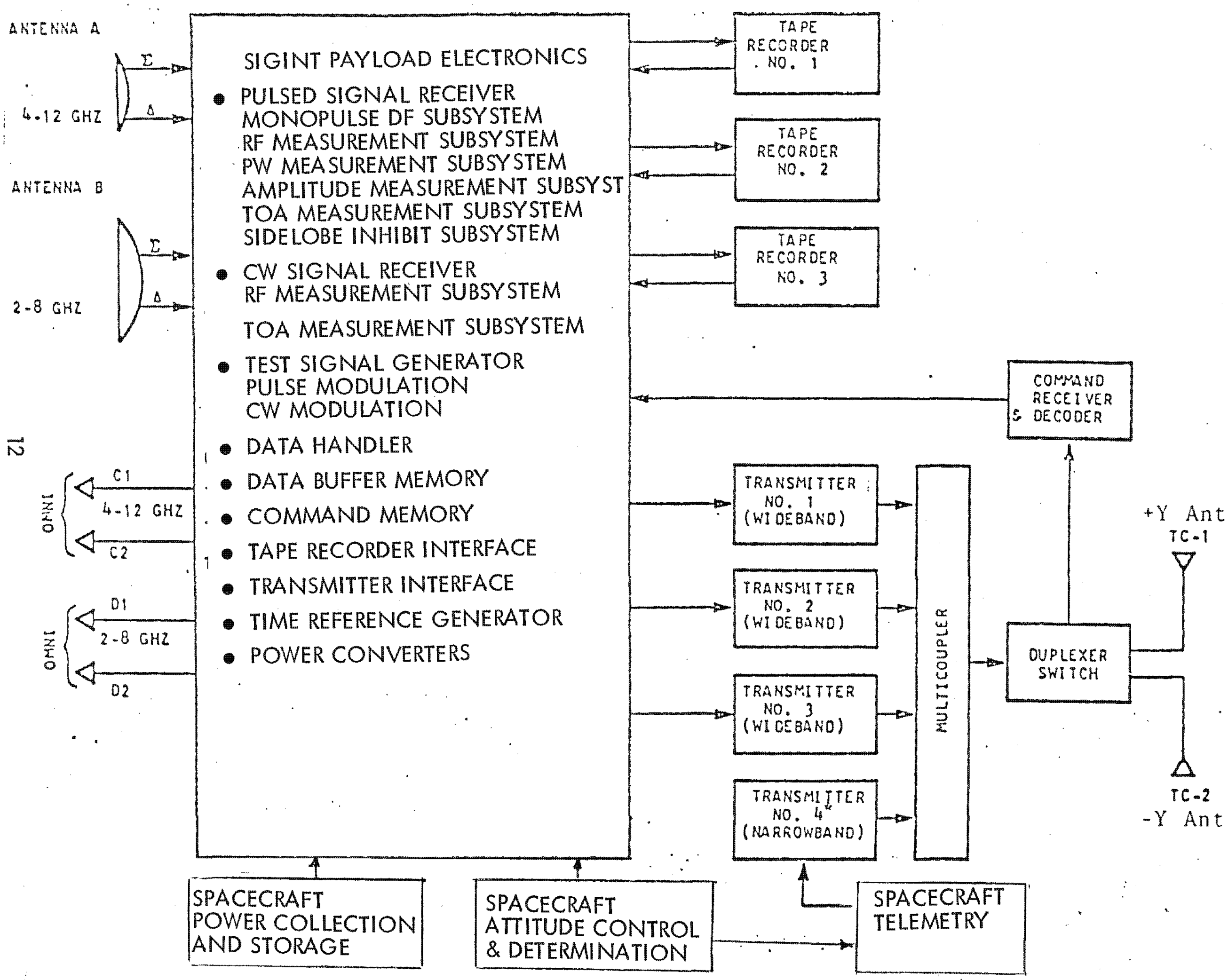

Figure 1.

2. ANTENNA SYSTEM

Mission 7344 uses two antenna systems, one for intercept and one for command and telemetry.

2.1 Intercept Antennas.

A total of seven antennas are used for signal intercept in the 2-12 GHz range: two high-gain pencil-beam antennas for target emitter sidelobe intercept and geopositioning, and five omni-directional antennas that provide inhibit protection for the high-gain antennas.

The two high-gain antennas cover the 2 to 8 GHz band, and the 4 to 12 GHz band. The feeds for these dishes are four-arm spirals whose arms are connected to a beam-forming network (see Fig. 2.) that produces the sum and the difference signals. The amplitude ratio and the relative phase of these [redacted] 25X1 25X1

The signals from the wide beam antennas are combined in the payload to provide the equivalent of two sidelobe inhibit antennas, one covering the 2-8 GHz band and the second covering the 4-12 GHz band. The inhibit signal is used to reject signals received via all but the main lobes of the high-gain antennas.

The omni inhibit antennas are positioned on three deployable booms so that their amplitude patterns cover the side lobes and back lobes of the high gain antennas. On two of the booms, one antenna covers the band from 2 to 8 GHz and the other antenna covers the band from 4 to 12 GHz. The antenna on the third boom reduces close-in side lobe poke-through to the 4 to 12 GHz antenna.

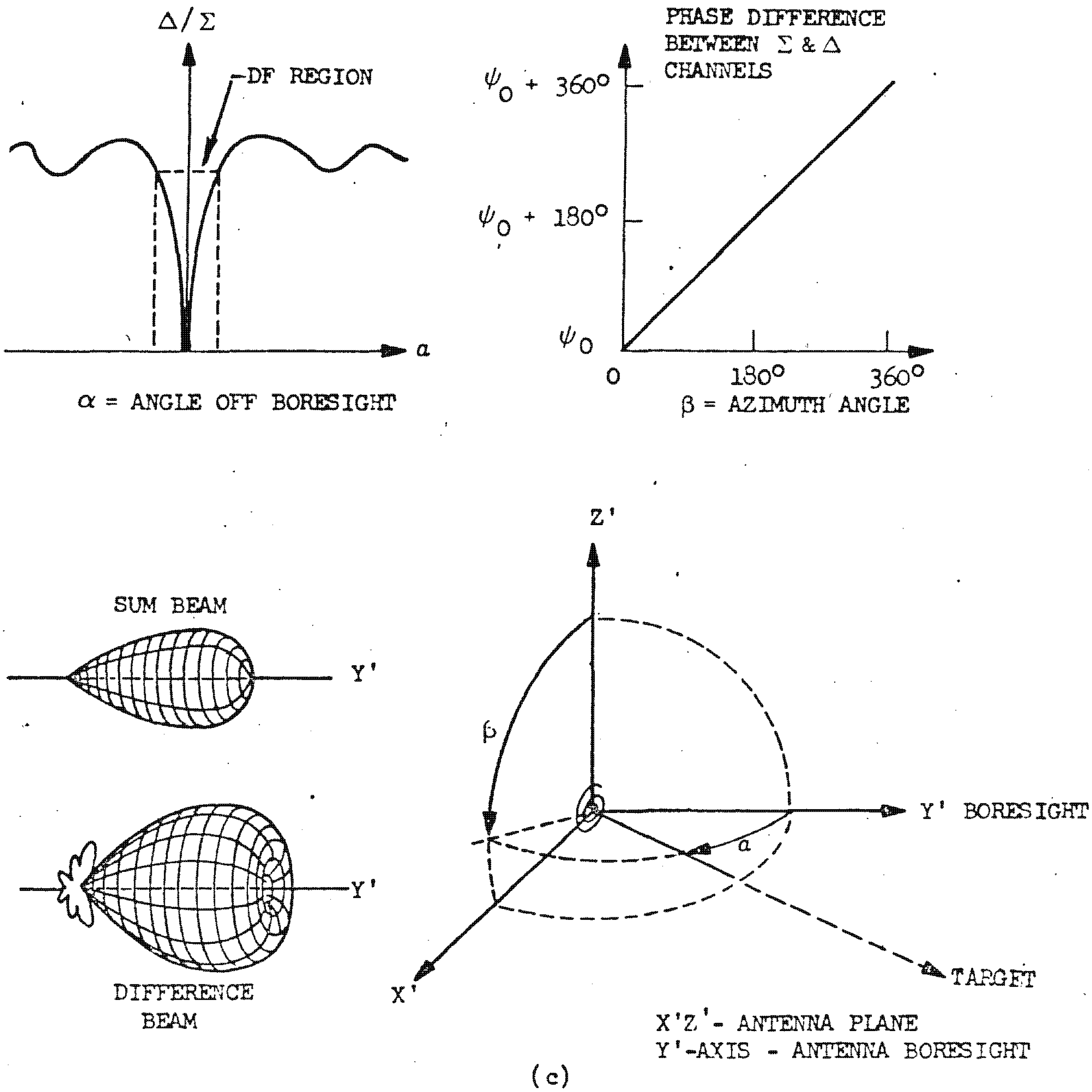

Fig. 2. Sum and Difference DF Beam Relationship

3. RECEIVER SYSTEM

3.1 Pulse Receiver

3.1.1 Frequency Coverage. Mission 7344 provides selectable frequency coverage over the RF range of 2 to 12 GHz using the five contiguous bands defined in Table 1. In a given collection mode, either bands 2A and3B (normal configuration) or bands 2B and 3A (alternate configuration) may be selected, while bands 1, 4 and 5 are available for use at all times. The entire 2-GHz frequency range of a selected band is collected simultaneously.

TABLE I

FREQUENCY COVERAGE BANDS

Band	Frequency Coverage (GHz)
1	2-4
2A	4-6
2B	4-6
3A	6-8
3B	6-8
4	8-10
5	10-12

3.1.2 Frequency Measurement.

3.1.2.1 Coarse Pulse Frequency Measurement. The frequency of pulsed emitters is measured on a single-pulse basis to an accuracy of ±18.6 MHz with a resolution of 31.56 MHz by the coarse pulse frequency measurement subsystem. Frequency measurement is possible whenever the received peak pulse power is greater than the sum channel threshold.

Up to three simultaneous frequencies from a multiple-frequency emitter can be recorded, provided they are separated by a minimum of 64 MHz and all are within the selected 2 GHz band. The system indicates which frequency has the highest received power, how much of the total power was carried by each frequency, and whether the number of frequencies detected is 1, 2, 3 or more.

3.1.2.2 Fine Pulse Frequency Measurement. The fine pulse frequency measurement provides the first pulse report on a pulse intercept with a vernier on the frequency. This measurement is reported with a resolution of 2.1 MHz and an accuracy of ± 2.5 MHz. The strongest frequency component must contain at least 75 percent of the total pulse energy to attain this accuracy.

3.1.3 Pulsewidth Measurement. The system measures pulsewidth to an accuracy of ±0.1 usec or ±10 percent of the pulsewidth, whichever is greater, for pulsewidths from 0.1 to 100 usec. Pulsewidth measurements are performed on the sum channel.

3.1.4 Time-of-Arrival Measurement. The system can determine and digitally encode the time-of-arrival of a pulse to a resolution of 1 usec.

3.1.5 Peak Power Measurement. Received peak pulse power in the sum channel is measured to an accuracy of ±3 dB with 95 percent confidence over the specified receiver dynamic range. On multiple-frequency signals, the peak power measurement represents the total received power and not that of the individual frequencies.

3.1.6 Receiver Sensitivity and Dynamic Range. All system requirements are met over an input dynamic range of 35 dB. System requirements include data accuracy, all inhibit functions, and spurious reponses.

The probability of detecting a pulse is 0.5 with a false alarm rate of one per second for a received peak power of −69 dBm or better.

3.1.7 Pulse Rate Handling Capability. The system can meet all specifications on any pulse provided that the minimum interval between pulses is 15 usec and that the buffer memory is not full. In this context, the minimum interval between pulses is defined as the time between the trailing edge of one pulse and the leading edge of the following pulse.

3.1.8 Geopositioning Accuracy. Geopositioning data is produced on the first and each subsequent intercepted pulse originating from an emitter located within the pencil-beam of the high-gain antennas. Location accuracy varies as a function of emitter position relative to the satellite subvehicle point. For targets located within 250 N.M. east or west of ground track the semi-major axis of the confidence elipse is less than [redacted] 25X1

3.2 CW Receiver Characteristics.

3.2.1 CW Frequency Coverage. The system can be tasked for coverage within the RF band from 2 to 12 GHz. Each frequency within the instantaneous 2 GHz band used for pulse intercept is searched once every 3.3 msec.

3.2.2 CW Frequency Measurement. The system provides frequency measurement of CW emitters over the instantaneous 2 GHz band selected. The frequency measurement subsystem has an accuracy of ±15 MHz anywhere within a 2 GHz band.

3.2.3 CW Sensitivity and Dynamic Range. The requirements of the CW frequency measurement are met over a sum channel input dynamic range of 40 dB. Frequency measurement requirements include data accuracy and pulsed signal rejection.

The CW channel has the following sensitivity for each of the input RF bands:

RF Band	Sensitivity (dBm + 2 dB)
1, 2, 3	-93
4, 5	-94

With this input power, the probability of detection is 0.5, and the false alarm rate is less than than one per second.

3.2.4 Pulsed Signal Rejection. The CW system rejects any single pulse which has a pulsewidth of 7 usec or less.

4. DATA STORAGE AND TRANSMISSION

Signal frequency, intercept time, emitter angle-of-arrival, pulsewidth and pulse amplitude are recorded in Pulse Code Modulation digital format. These data are subsequently readout at a 4:1 ratio at the remote tracking stations. The system includes three recorders. Each recorder can store a total of 22 minutes of intercept data prior to readout.

4.1 <u>Data Transmission System.</u> The transmitter subsystem is responsible for sending telemetry and data to the remote tracking stations. Data is normally read out on an on-board tape recorder, or (in the case of a transpond operation) routed to the transmitter directly from the SIGINT Payload. The capability also exists to record the transpond operation for later readout at a ground station contact. One transmitter is reserved for spacecraft telemetry, and the usual practice is to have two transmitters dedicated to sending payload data from two tape recorder/DIU combinations. A fourth transmitter is available as a spare. Digital mission data is encrypted on-board the spacecraft prior to transmission.

MISSION 7345 DESCRIPTION

1. GENERAL INFORMATION

Mission 7345 is a low altitude SIGINT spacecraft that performs technical intelligence (TI), general search (GS), electronic order of battle (EOB), and operational support missions from a 346 NM circular orbit. The satellite receives both pulse and CW signals by intercepting the main beam or side-lobe radiation from transmitting antennas operating in the 4 GHz to 18 GHz frequency range. [redacted] 25X1

[redacted] 25X1

[redacted] Carrier modulation characteristics both in time and frequency domains will be determined. 25X1

This mission description will discuss the following:

- A. Antenna System
  - (1) Intercept Antenna System
  - (2) Command and Telemetry Antennas
- B. Receiver System
  - (1) Pulse Receiver Characteristics
  - (2) CW Receiver Characteristics
  - (3) Technical Intelligence Receiver Characteristics
- C. Data Storage and Transmission
  - (1) Tape Recorder Interface
  - (2) Data Transmission System

2. ANTENNA SYSTEM

Mission 7345 uses two antenna systems, one for target signal intercept and one for command and telemetry.

2.1 Intercept Antennas.

Each set of collection antennas consist of a high-gain, circularly polarized antenna with a parabolic reflector and a pair of low gain omni antennas. One set of each is provided in the following bands: 1) 4 GHz to 8 GHz, 2) 8 GHz to 12 GHz, 3) 12 GHz to 18 GHz.

The high gain antennas are used to detect and geoposition emitters through intercept of sidelobe emissions. The low gain antennas are used for collection of emitter mainbeams and for the inhibit of the high gain DF antennas sidelobes. These three antennas permit target location determination via a time-amplitude centroiding method used on previous missions of the 7300 type. The three sets of omni antennas are mounted on deployable booms and are positioned so that their amplitude patterns provide omnidirectional coverage of the sidelobes of the high-gain antennas.

2.2 Command and Telemetry Antennas.

The telemetry and command antennas are configured to provide Remote Tracking Station (RTS) satellite contact regardless of spacecraft orientation. Both command and data transmission operations can be conducted simultaneously.

3. RECEIVER SYSTEM

3.1 Pulse Receiver Characteristics.

The pulse receiver (Fig. 3) includes three channels - one channel is connected to the DF antennas and one channel is connected to each of the low gain mainbeam/inhibit antennas, all via appropriate down converters and switches. The pulse receiver monitors one of the seven 2 GHz bands between 4 and 18 GHz with an instantaneous bandwidth of 2 GHz.

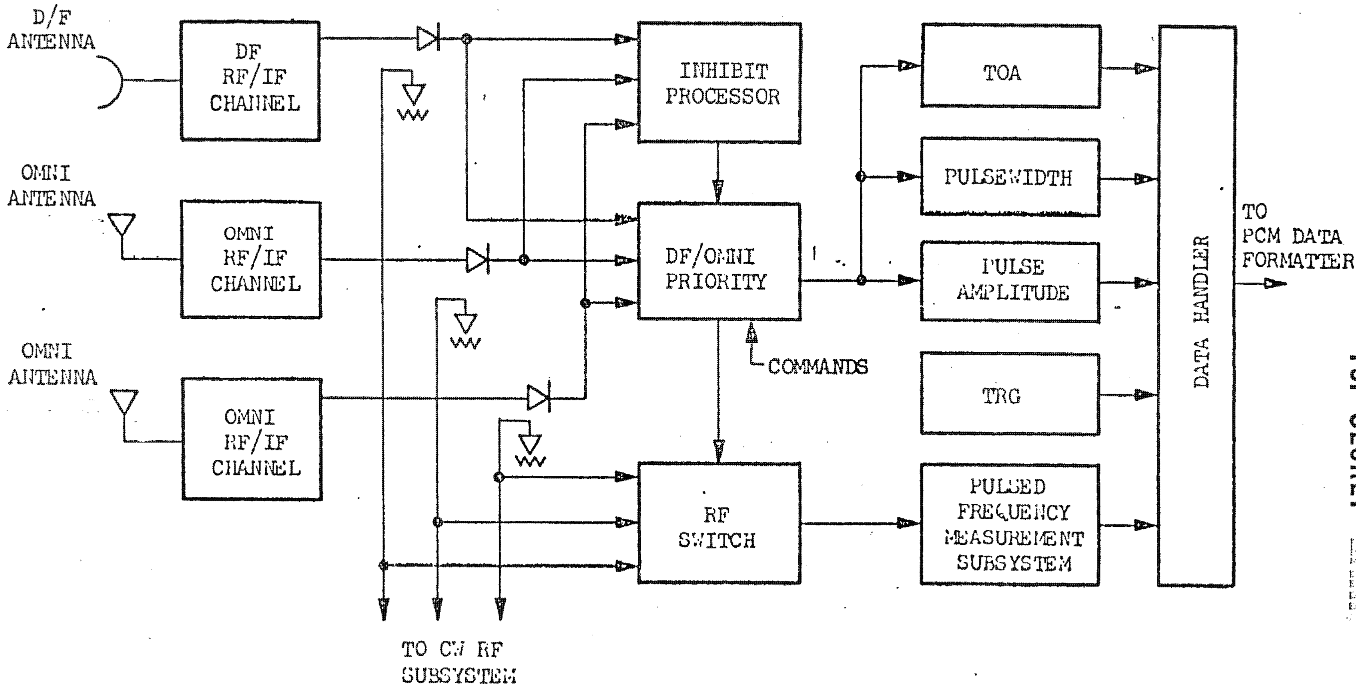

Fig. 3 Pulse Receiver Simplified Block Diagram

3.1.1 Frequency Coverage.

The pulse receiver system provides coverage of the entire RF band from 4 to 18 GHz. Instantaneous frequency coverage is a 2 GHz block of any of seven contiguous bands provided: 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, or 16 to 18 GHz. The band to be used at any given time is selectable by command.

3.1.2 Frequency Measurement.

The frequency of pulsed emitters is measured on a single-pulse basis to an accuracy of ±32 MHz with a resolution of 50 MHz anywhere within the 2 GHz instantaneous band being used. If an intercepted pulse contains more than one carrier frequency, the measurement system will record the frequency of the highest amplitude carrier.

3.1.3 Pulsewidth Measurement.

The pulse receiver system will measure pulsewidth over the range of 0.1 to 12.7 usec to an accuracy of ±0.1 usec with a resolution of 0.1 usec. Signals having a pulsewidth 12.7 usec or greater will be recorded as having a pulsewidth of 12.7 usec.

3.1.4 Time-of-Arrival (TOA).

The time-of-arrival of the leading edge of pulses received in the DF or omni channels is measured to a resolution of 1.0 usec. The system is capable of measuring time-of-arrival from either DF or omni channels.

3.1.5 Peak Power Measurement.

Received peak pulse power in the DF channel or either omni channel is measured to an accuracy of ±6 dB over the specified receiver dynamic range. The ±6 dB accuracy is independent of frequency.

3.1.6 Pulsed Receiver Sensitivity and Dynamic Range.

In both the DF and Omni channels, the probability of detecting a pulse is 0.5 with a false alarm rate of one per second for a received peak power of -74 dBm at the input point, with the exception of the 12 to 14 GHz band where the minimum received power is -73.5 dBm. The system dynamic range is from -74 to -42 dBm received peak power at the input point for either channel.

3.2 Continuous Wave (CW) Receiver Characteristics.

The CW search receiver (Fig. 4) is also a three-channel receiver with one channel connected to the DF antennas and one channel connected to each of the low gain main beam/inhibit antennas via appropriate downconverters and switches. The CW receiver is tunable to any 2 GHz band between 4 and 18 GHz, except that whenever the CW and the pulse receivers are both tuned above 12 GHz, or both tuned below 12 GHz, they must be tuned to the same 2 GHz band.

The CW search receiver can either scan the full selected 2 GHz band, or may scan a 1 GHz, or a 0.5 GHz segment of that band. The selected segment starts at a frequency that is commandable with a resolution of 80 MHz. The receiver scans from that frequency toward the lower edge of the selected band. The CW search receiver is capable of detecting both modulated and unmodulated CW carriers.

3.2.1 Frequency Coverage. The search receiver provides coverage of the entire RF band from 4 to 18 GHz in command-selectable bands. Between 12 and 18 GHz the band selected must be the same as that selected for the pulse receiver.

Sweep Range, Rate, and Period

The sweep range, sweep rate, and sweep period for the search receiver is command-selectable from the following options:

Sweep Range (GHz)	Sweep Rate (MHz/usec)	Sweep Period (Msec)
2.0	1.2	1.875
1.0	0.6	1.875
0.5	0.3	1.875

Each sweep range begins at a selectable multiple integer of 80 MHz.

3.2.2 Frequency Measurement. The radio frequency of CW emitters is measured by the search receiver to an accuracy of ±10 MHz and with a resolution of 10 MHz.

3.2.1.3 DF and Omni Channel Sensitivity and Dynamic Range. The following input signal levels will provide a probability of detection in both the search receiver omni and DF channels of 0.5 with a false alarm rate of one per second:

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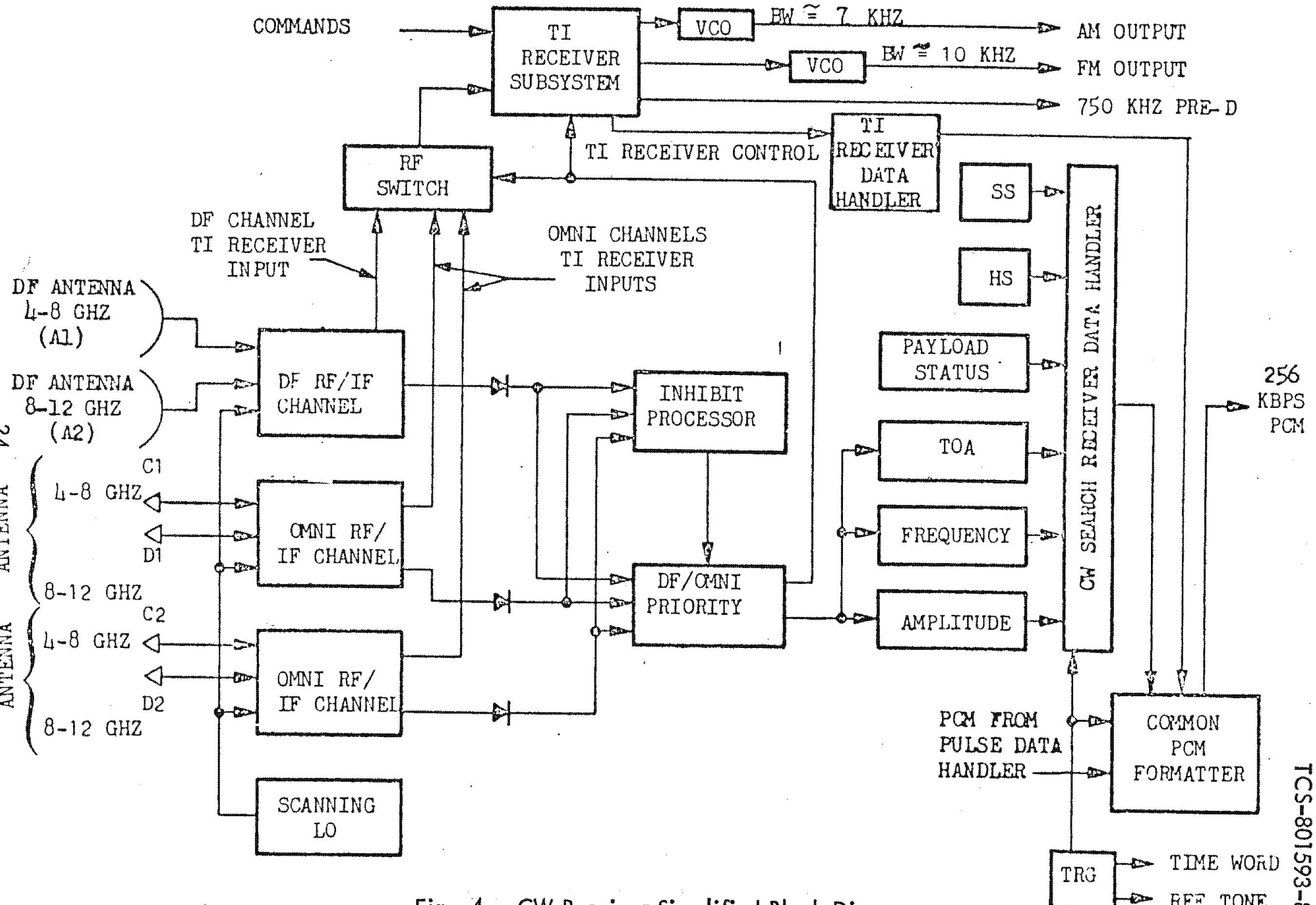

Fig. 4. CW Receiver Simplified Block Diagram

Search Range (GHz)	Input Signal Level for 0.5 Detection Probability
2.0	-94.0 dBm
1.0	-95.5 dBm
0.5	-97.0 dBm

From 13.5 to 14.0 GHz, the above sensitivity is reduced by 3 dB. All system requirements are maintained over a dynamic range of 40 dB.

3.2.4 Peak Power Measurement. Received power in the DF or omni channels can be measured to an accuracy of ±6 dB over the dynamic range.

3.3 Technical Intelligence (TI) Receiver.

The TI receiver (Fig. 5) is a single channel receiver that provides both digital measurements and analog samples of signals appearing within its bandwidth. It operates in the same 2 GHz band as the CW search receiver and can be made to tune adaptively to signals detected by the CW search receiver in any of its three channels or to operate independently (frequency and intercept antenna pre-selected by command).

The purpose of the TI receiver is to permit intelligence to be collected concerning the carrier modulation of CW signals or high duty cycle pulse emitters. The predetection output of the TI receiver has a bandwidth of 750 kHz.

3.3.1 Frequency Coverage. The TI receiver provides coverage of the 4-18 GHz band in command-selectable bands. The band selected for the TI receiver is the same as that selected for the CW search receiver.

3.3.2 Instantaneous Bandwidth. The TI receiver provides two instantaneous bandwidths for the detailed analysis of signals. Post detection outputs (both AM and FM) are provided from an IF bandwidth of 13 MHz, and a predetection output is provided from an IF bandwidth of 0.75 MHz (see section 3.3.5).

3.3.3 TI Receiver Sensitivity. The TI receiver has the same sensitivity capabilities as the search receiver.

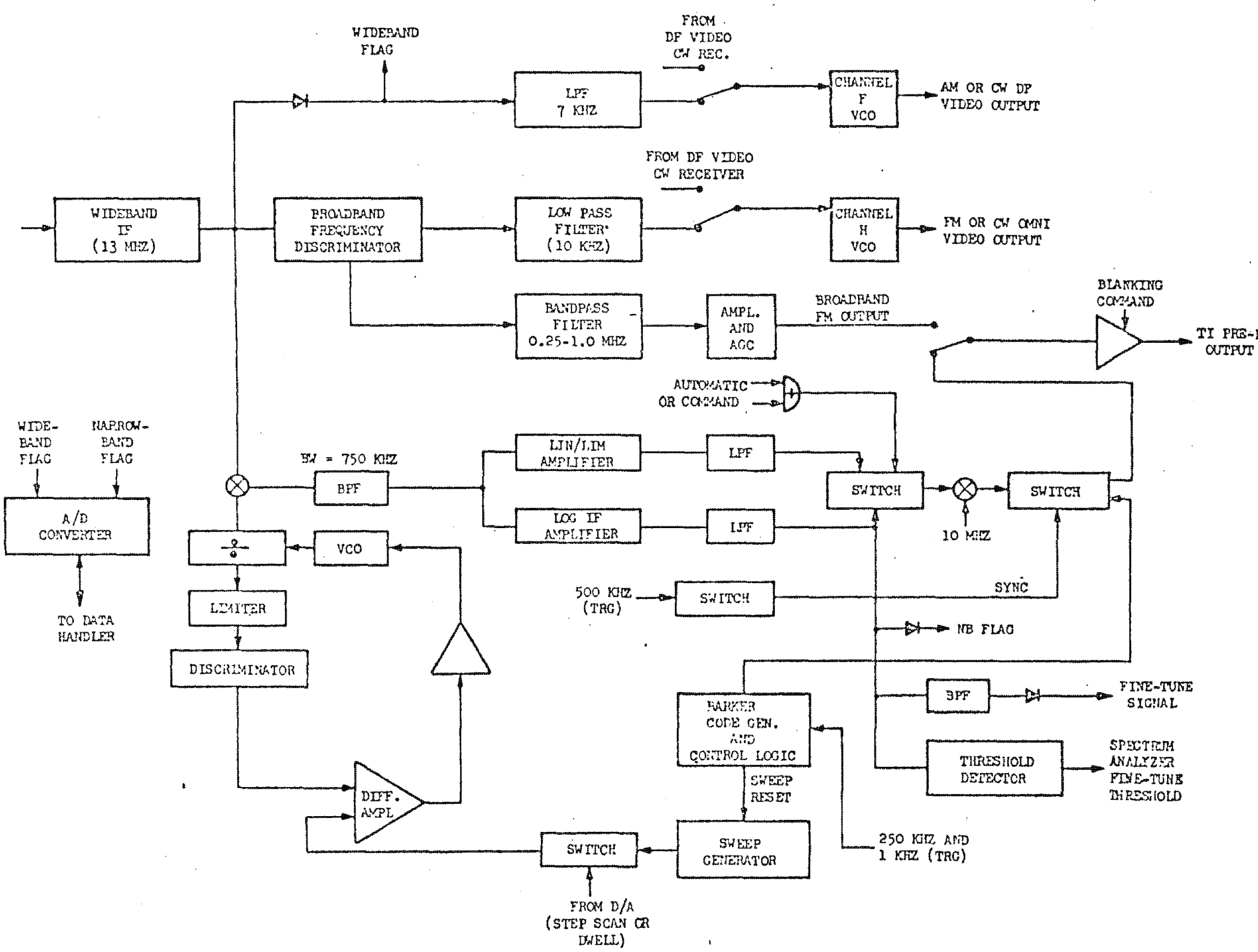

Fig. 5. TI Receiver Simplified Block Diagram

3.3.4 <u>TI Receiver Tuning</u>. The TI receiver is tuned by command (manual mode) or by slaving to the search receiver. The 13 MHz IF bandpass is tuned in 10 MHz steps with an accuracy of ±200 kHz. After the 13 MHz has been tuned to the desired 10 MHz step, the 0.75 MHz IF scans across the 13 MHz window and acquires the signal. The granularity with which the 0.75 MHz IF can stop is 100 kHz or less. Tuning of the narrowband IF is accomplished via a narrowband VCO which has the following commandable options:

a. Spectrum Analysis mode (continuous scan).

b. Search/Lock mode.

(1) Programmed number of scans

(2) After completing scans:

(a) tune to center frequency, or

(b) Go to spectrum analysis mode, or

(c) Abort.

3.3.5 <u>TI Receiver Outputs</u>. The TI receiver has the following analog outputs:

a. Predetected from the 0.75 MHz IF.

b. DC-coupled from a frequency discriminator on the 13 MHz IF which is low-pass filtered at 10 kHz for low modulation rate signals.

c. AC-coupled from a frequency discriminator on the 13 MHz IF which is post detection filtered from 0.25 to 1.0 MHz for high-frequency modulation rates.

The TI receiver also generates digital words every 5.120 msecs whenever the 13 MHz IF is dwelling on a signal and the signal level threshold is exceeded.

3.3.6 <u>TI Receiver Frequency Accept/Reject Band Capability</u>. An option is available wherein the TI receiver can reject RF signals over a commandable range of the search receiver sweep. The frequency increment requirement at which the frequency rejection in the TI receiver starts or ends is 40 MHz. This will allow the 2 GHz sweep range to be reduced or divided into two segments. The number of 40 MHz consecutive increments to be rejected is selectable by command. The frequency range rejected in the TI receiver must always be equal to or less than and compatible with the frequency range swept by the search receiver in order to have handoffs occur. An option also exists to have the TI receiver only accept RF signals over the commanded range of the search sweep in 40 MHz increments.

4. DATA STORAGE AND TRANSMISSION

4.1 Data Storage.

Three tape recorders each provide two tracks having a frequency response from 1 KHz to 1000 KHz at 100 ips. At this speed each tape recorder provides 5.5 minutes of read-in (intercept) time.

Each recorder can be operated at one quarter speed to provide 22 minutes of read-in, but the frequency response is then 250 Hz to 250 KHz. Read-out (downlink) is always accomplished in 5.5 minutes at full speed. The tape recorders are loaded with intercept data from the receivers, and then dumped via downlink transmitters to a ground site.

Figure 6 shows the signal flow from the payload to the tape recorder during read-in and through the tape recorder selection logic, baseband assembly units, and transmitter selection logic during read-out.

4.2 Data Transmission System.

The transmitter subsystem is responsible for sending telemetry and data to the ground station. Data is normally read out of an on-board tape recorder, or (in the case of a transpond operation) routed to the transmitter directly from the SIGINT Payload. The capability also exists to record the transpond operation for later readout at a ground station contact. One transmitter is reserved for spacecraft telemetry, and the usual practice is to have two transmitters dedicated to sending payload data from two tape recorder/DIU combinations. A fourth transmitter is available as a spare.

TALENT-KEYHOLE

TOP SECRET

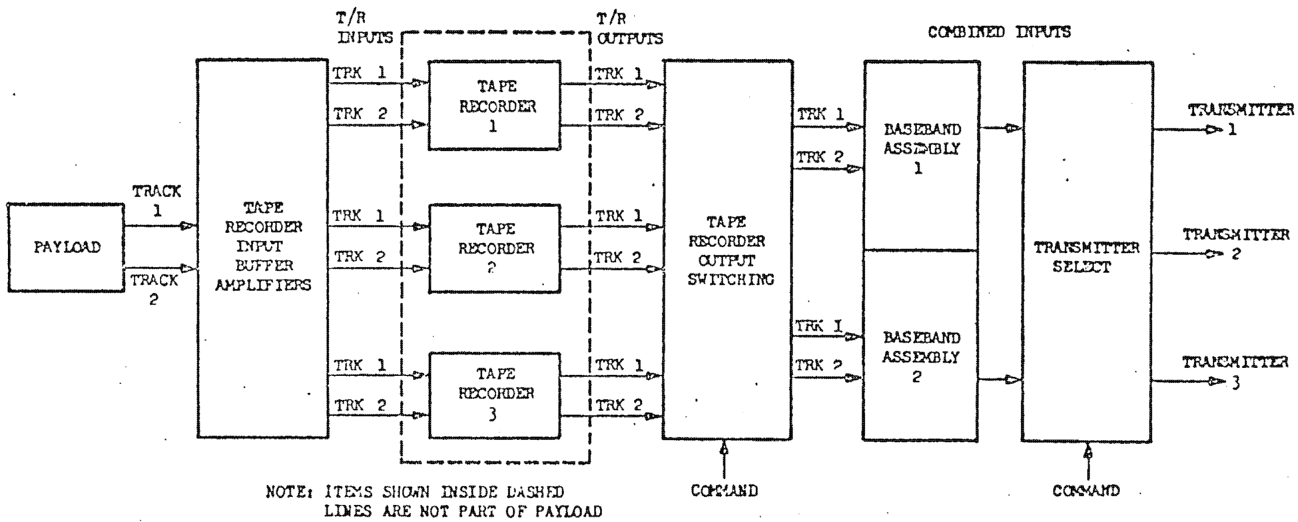

Fig. 6. Payload Data Flow

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TOP SECRET

TALENT-KEYHOLE

MISSION 7346/47 DESCRIPTION

1. GENERAL INFORMATION

SIGINT Missions 7346 and 7347 are nominally identical satellite ELINT intercept systems which perform general search and electronic order of battle collection for pulsed and continuous wave (CW) emitters in the 2 to 18 GHz radio frequency (RF) range. The intercept system is mounted on a spacecraft which is spin stabilized in a 382 N.M. circular orbit. The measurements made on each pencil beam intercepted pulse and CW signal include monopulse angle of arrival, frequency, and amplitude. Additional radar pulse measurements include pulsewidth and time of arrival of each pulse. The spin axis has a North-South alignment and the nominal spin rate is 45 RPM. The high gain (pencil beam) antennas are 120° apart in spin azimuth and the collection system switches between them each one-third spin. This configuration provides coverage of a different 2 GHz RF range over a wide collection swath each one-third spacecraft spin. The block diagram is Fig. 7.

This mission description discussed the following:

A. Antenna Subsystem
B. Receiver Subsystem
  (1) Pulse Receiver Characteristics
  (2) CW Receiver Characteristics
  (3) Main Beam Receiver Characteristics
  (4) TI Receiver Characteristics
C. Data Storage and Transmission

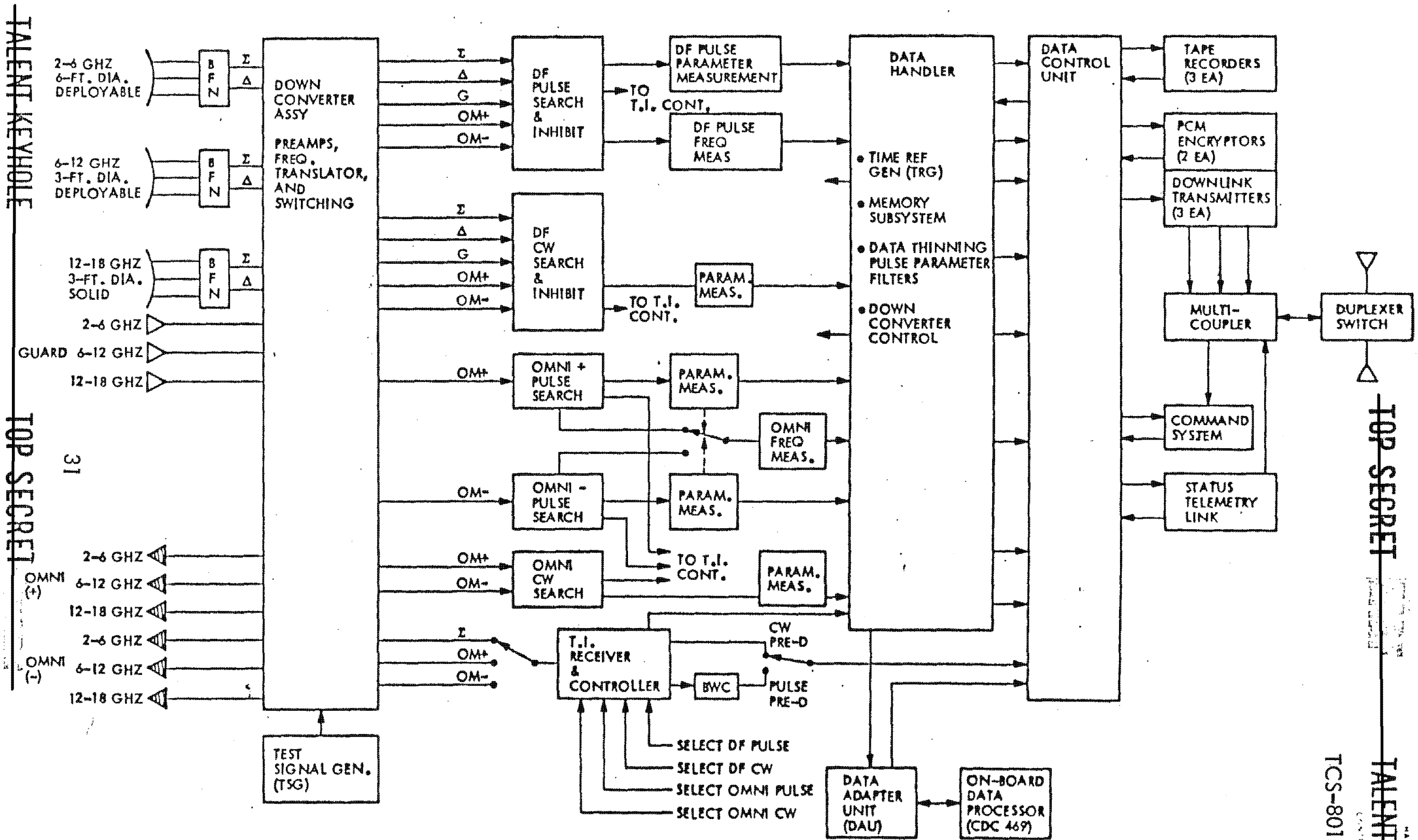

Fig. 7. Intercept System Block Diagram

2. ANTENNA SYSTEM

Missions 7346 and 7347 use two antenna systems, one for intercept and one for command and telemetry.

2.1 Intercept Antennas.

A total of twelve antennas are used for signal intercept in the 2-18 GHz range: three high-gain pencil-beam antennas for target emitter sidelobe intercept and geopositioning, six omni-directional antennas that provide emitter main beam collection and inhibit protection for the high-gain antennas, and three moderate gain guard antennas for inhibit of the foreward lobes of the high gain antennas.

The three high-gain antennas cover the 2 to 6 GHz band, the 6 to 12 GHz band, and the 12 to 18 GHz band. The feeds for these dishes are four-arm spirals whose arms are connected to a beam-forming network (see Fig. 8.) that produces the sum and the difference signals. The amplitude ratio and the relative phase of these two signals [redacted] 25X1 25X1 The signals from the guard antenna and the back-to-back wide beam antennas are combined in the payload to provide the equivalent' of three sidelobe inhibit antennas, one set covering the 2-6 GHz band, a second set covering the 6-12 GHz band, and a third set covering the 12 to 18 GHz band. The inhibit signal is used to reject signals received via all but the main lobes of the high-gain antennas. In addition, the wide beam (omni) antennas are used for emitter main beam intercept measurements.

The omni inhibit antennas are positioned on deployable booms so that their amplitude patterns over the side lobes and back lobes of the high gain antennas. On two of the booms, one antenna pair covers the band from 2 to 6 GHz and the other antenna pair covers the band from 6 to 12 GHz. A third omni antenna pair covers the band from 12 to 18 GHz.

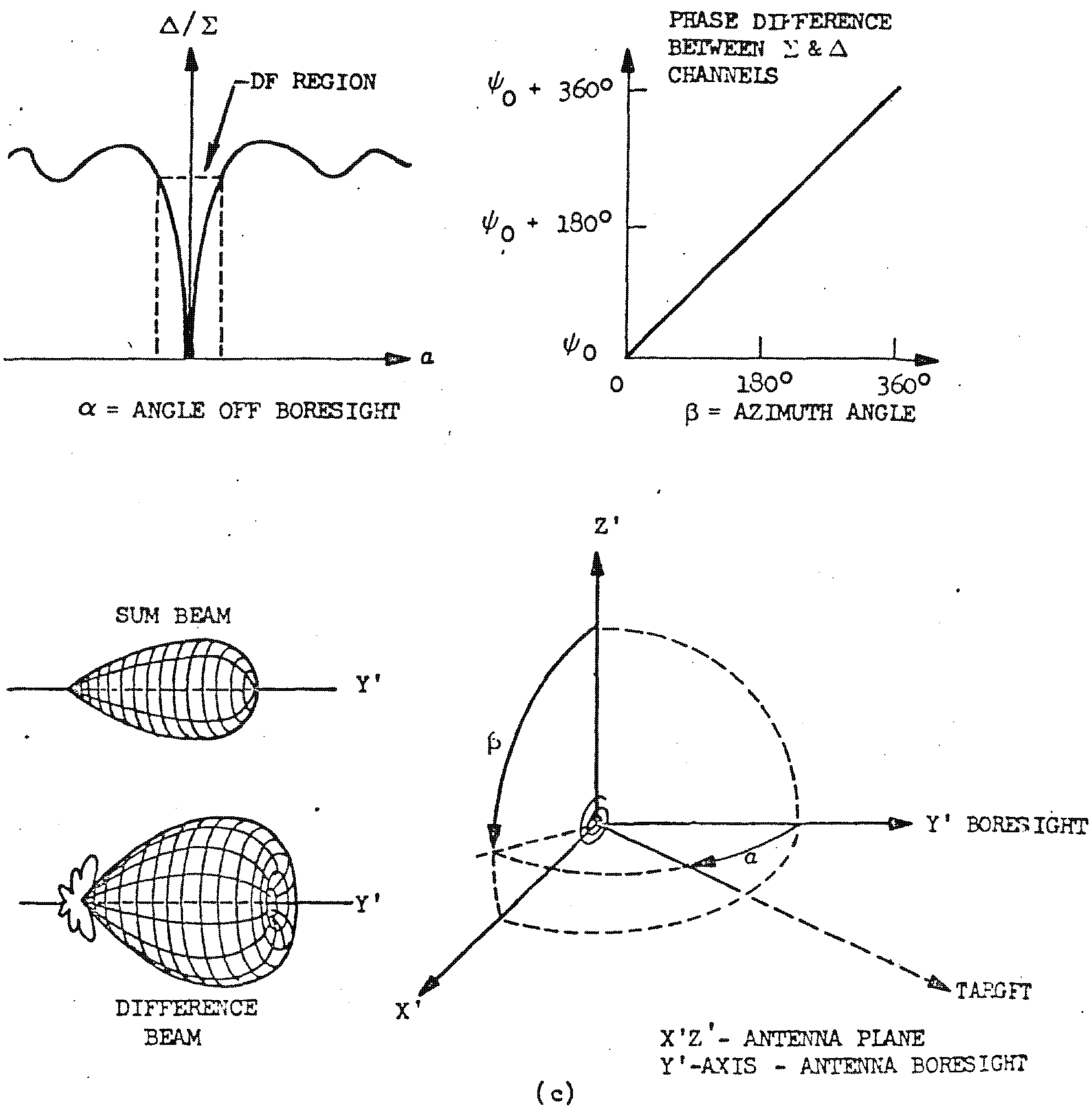

Fig. 8. Sum and Difference DF Beam Relationship

3. RECEIVER SYSTEM

3.1 Pulse Receiver.

3.1.1 Frequency Coverage. Mission 7346 and 7347 provide selectable frequency coverage over the RF range of 2 to 18 GHz using the eight contiguous bands defined in Table II. The entire 2 GHz frequency range of a selected band is collected simultaneously.

TABLE II.

FREQUENCY COVERAGE BANDS

Band	Frequency Coverage (GHz)
1	2-4
2	4-6
3	6-8
4	8-10
5	10-12
6	12-14
7	14-16
8	16-18

3.1.2 Pulse Frequency Measurement. The frequency of pulsed emitters is measured on a single-pulse basis to an accuracy of ±1.56 MHz with a resolution of 1.0 MHz by the pulse frequency measurement subsystem. Frequency measurement is possible whenever the received peak pulse power is greater than the sum channel threshold.

Up to three simultaneous frequencies from a multiple-frequency emitter can be recorded, provided they are separated by a minimum of 64 MHz and all are within the selected 2 GHz band. The system indicates which frequency has the highest received power, how much of the total power was carried by each frequency, and whether the number of frequencies detected is 1, 2, 3 or more.

3.1.3 Pulsewidth. The system measures pulsewidth to an accuracy of ±0.1 us or ±10 percent of the pulsewidth, whichever is greater, for pulsewidths from 0.1 to 100 usec. Pulsewidth measurements are performed on the sum channel.

3.1.4 Dynamic Range. All system requirements are met over an input dynamic range of 35 dB. System requirements include data accuracy. all inhibit functions, and spurious responses.

3.1.5 Peak Power Measurement. Received peak pulse power in the sum channel is measured to an accuracy of ±6 dB with 95% confidence over the specified receiver dynamic range. On multiple-frequency signals, the peak power measurement represents the total received power and not that of individual frequencies.

3.1.6 Time-of-Arrival Measurement. The system can determine and digitally encode the time-of-arrival of a pulse to a resolution of 61 nsec.

3.1.7 Pulse Rate Handling Capability. The system can meet all specifications on any pulse provided that the minimum interval between pulses is 2.3 usec and that the buffer memory is not full. In this context, the minimum interval between pulses is defined as the time between the trailing edge of one pulse and the leading edge of the following pulse.

[redacted] 25X1

25X1

3.2 CW Receiver.

3.2.1 CW Frequency Coverage. The system can be tasked for coverage within the RF band from 2 to 18 GHz. Each frequency within the instantaneous 2 GHz band used for pulse intercept is searched once every 3.3 msec.

3.2.2 CW Frequency Measurement. The system provides frequency measurement of CW emitters over the instantaneous 2 GHz band selected. The frequency measurement subsystem has an accuracy of ±4.4 MHz anywhere within a 2 GHz band.

3.2.3 <u>CW Amplitude</u>. The CW receivers report the amplitude of CW signals with a resolution of 0.75 dB over a range of 47.25 dB.

3.2.4 <u>CW Dynamic Range</u>. The requirements of the CW frequency measurement are met over a sum channel input dynamic range of 40 dB. Frequency measurement requirements include data accuracy and pulsed signal rejection.

3.3 <u>Main Beam Receiver</u>.

In addition to the sidelobe inhibit receiver, a separate 2 GHz omni antenna receiver can be commanded to one of the eight RF bands for main beam parameter measurement. The parameters measured are the pulse and CW signal amplitude and frequency plus pulse width and time of arrival.

3.4 <u>Technical Intelligence (TI) Receiver</u>.

The TI receiver provides spectrum analysis over a 13 MHz RF range and 0.75 MHz predetection signal recording. It has a direct recording mode for narrowband (CW) signals and a bandwidth compression mode to provide 250 usec samples of 10 MHz predetection bandwidth. It receives its input from the pencil beam sum channel or one of the two omni antennas in the commanded RF range.

The TI receiver uses a commandable priority table to select a signal handover when a receiver intercepts a candidate signal. It can also be commanded to dwell at a fixed frequency.

4.0 DATA STORAGE AND TRANSMISSION

4.1 <u>Data Storage</u>.

Three tape recorders each provide two tracks having a frequency response from 1 KHz to 1000 KHz at 100 ips. At this speed each tape recorder provides 5.5 minutes of read-in (intercept) time.

Each recorder can be operated at one quarter speed to provide 22 minutes of read-in, but the frequency response is then 250 Hz to 250 KHz. Read-out (downlink) is always accomplished in 5.5 minutes at full speed. The tape recorders are loaded with intercept data from the receivers, and then dumped via downlink transmitters to a ground site.

4.2 Data Transmission System.

The transmitter subsystem is responsible for sending telemetry and data to the ground station. Data is normally read out of an on-board tape recorder, or (in the case of a transpond operation) routed to the transmitter directly from the SIGINT Payload. The capability also exists to record the transpond operation for later readout at a ground station contact. One transmitter is reserved for spacecraft telemetry, and the usual practice is to have two transmitters dedicated to sending payload data from two tape recorder/DIU combinations. A fourth transmitter is available as a spare. Digital mission data is encrypted on-board the spacecraft prior to transmission.