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FINAL

# FARRAH II INTERCEPT SYSTEM

# GENERAL SYSTEM SPECIFICATION

[redacted]

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The following additions, revisions, or errata corrections, shall be incorporated into the document identified above. This Report Change Record sheet should be inserted as the first page of the affected document following the title page.

| ADDENDUM PAGE | REVISION REMOVE PAGE | REVISION INSERT PAGE | ERRATA INSERT PAGE | REVISION OR ERRATA CORRECTION (CORRECT IN INK) |
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FOREWORD

This document has been prepared in accordance with the requirements of Sequence No. A008 of the CDRL to [redacted] 25X1

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ILLUSTRATIONS



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TABLES

# ABBREVIATIONS AND GLOSSARY

| | |
|---|---|
| ACS | Attitude control system |
| AFSCF | Air Force Satellite Control Facility |
| ARV | Astrophysical research vehicle |
| ASC | Advanced spacecraft computer |
| ASGLS | Advanced Space Ground Link Subsystem |
| B&A | Before and after mode |
| BER | Bit error rate |
| BWC | Bandwidth compressor |
| Biphase-M (BiØ-M) | Biphase-mark PCM code |
| CW | Continuous wave |
| DAU | Data adapter unit |
| DDT | Direct data transmission system |
| DF | Direction finding |
| DIU | Digital interface unit |
| DOA | Direction of arrival |
| DS | Directed surveillance |
| ELINT | Electronic intelligence |
| ELO | Electrically transmitted NSDR message (operational information) |
| ELT | Electrically transmitted NSDR message (technical information) |
| EOB | Electronic order of battle |
| EPL | Emitter parameter list |
| ERP | Effective radiated power |
| FM | Frequency modulation |
| FSK | Frequency shift keying |
| GDPS | Ground data processing system |
| GMT | Greenwich Mean Time |
| GRABAG | Output data collection/retrieval system |
| GRI | Group repetition interval |

ABBREVIATIONS AND GLOSSARY (Cont)

| | |
|---|---|
| GS | General search |
| ICD | Interface control document |
| IWG | Intercept word group. A PCM word group containing target signal description |
| K | Scalar constant |
| LSB | Least significant bit |
| MMD | Mean Mission Duration |
| NB | Narrow bandwidth |
| NRZ-L | Nonreturn to zero-level PCM code |
| NRZ-S | Nonreturn to zero-space PCM code |
| PA | Pulse amplitude as measured at the receiver |
| PAM | Pulse amplitude modulation |
| PCM | Pulse code modulation |
| PCM Word Group | 16 to 96-bit word group |
| PE | Programmable event |
| PFM | Pulse frequency measurement |
| PM | Phase modulation |
| PRI | Pulse repetition interval |
| PRN | Pseudorandom noise |
| PW | Pulsewidth |
| Pre-D | Predetection |
| RAM | Random access memory |
| RF | Radio frequency |
| RFB | Radio frequency band |
| ROM | Read only memory |
| RTS | Remote tracking station |
| Residue | Pulse or CW recognitions not associated into signals |
| SA | Spectrum analysis |
| SAR | Type of NSDR report |
| SAS | Solar aspect sensor |
| SCF | Satellite Control Facility |

ABBREVIATIONS AND GLOSSARY (Cont)

| | |
|---|---|
| SDB | Secondary data base |
| SDR | Type of NSDR report (in greater detail than SAR) |
| SGLS | Space-to-ground link subsystem |
| [redacted] | |
| SNR | Signal-to-noise ratio |
| SOCOMM | Special operations communications |
| SPC | Stored program command |
| SPLA | Support panel and launcher assembly |
| SRCS | Spin rate control subsystem |
| STC | Satellite Test Center |
| TAP | Time/attitude/program word |
| TAW | Time/attitude word |
| TC Antenna | Telemetry and command antenna |
| TCR | Time critical reporting |
| TEL | Telecommunications reports |
| TI | Technical intelligence |
| [redacted] | [redacted] |
| TOI | Time of intercept |
| TOM | Time of measurement |
| TRG | Time reference generator |
| TSG | Test signal generator |
| TT&C | Telemetry, tracking, and command |
| Two sigma ($2\sigma$) | Accuracy of 95 percent of independent parameter measurements (e.g., radio frequency, location, amplitude, temperature, etc.) |

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# Section 1

# SCOPE

This specification establishes the performance, design, development, and test requirements for the FARRAH II Satellite Collection System.

# Section 2

## APPLICABLE DOCUMENTS

Requirements of the following documents in effect on the date of this specification form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and the contents of Section 3 and 4, the detail requirements of Section 3 and 4 shall have precedence.

Government Documents

| | |
|---|---|
| MIL-E-6051D | Electromagnetic Compatibility Requirements, System, 5 July 1968 |

LMSC Documents

| | |
|---|---|
| BIF003W/2-156657-80 | Detail Specification and Statement of Work for Spacecraft 4433/FARRAH II Antenna Subsystem |
| BIF003W/2-013588-73 | Satellite Vehicle/Subsatellite Interface Control Document, Rev B |
| BIF003W/2-156594-80 | Spacecraft System Requirements Document |
| BIF003W/2-076446-73 | Astrophysical Research Vehicles, Rev A, 17 September 1973 |
| BIF003W/2-156595-80 | FARRAH II, Program Test Plan |
| BIF003W/2-236117-82 | Payload Technical Specification |
| 2P14885 | Environment Specification, Subsystem and Equipment |
| 2P24356 | Advanced Spacecraft Computer, Detail Specification |
| BIF003W/2-TBD | GDPS Validation Plan |
| BIF003W/2-TBD | GDPS Verification Plan |
| BIF003W/2-136102-81 | GDPS Specification |
| 2P24380 | TEMPEST Control Plan for FARRAH II Spacecraft |
| BIF003W/2-135885-79 | MPOSS Ground Segment Interface Control Document |

## Section 3

## GENERAL SYSTEM MISSION REQUIREMENTS

The FARRAH II SIGINT Collection System shall be capable of collecting, process- ing, analyzing, and reporting signals from pulse and CW emitters in the 2-GHz to 18-GHz frequency range to satisfy the following primary mission objectives:

1. General Search (GS) - Search for new or unusual signals from new or modified weapons systems over wide ranges of frequency and broad geographical areas.

2. Technical Intelligence (TI) - Determine the operational characteristics and performance capabilities of foreign weapons systems at specific frequencies and locations.

3. General Surveillance/Electronic Order of Battle (EOB) - Monitor the operational status and deployment of emitters associated with weapons systems over wide ranges of frequency and broad geographical areas.

4. Directed Surveillance (DS) - Monitor the operational status and deployment of emitters associated with weapons systems involved in tactical operations at specific frequencies and specific crisis situations.

The FARRAH II system (see Fig. 3-1) shall comprise a space segment and a ground segment. The Space Segment shall consist of the spacecraft with its associated collection antennas and receivers and its electrical power, data handling, data storage, data transmission, command and control, attitude sensing, and attitude control equipment. The Ground Segment shall consist of the Satellite Control Facility (SCF) with its associated communications, command and control, and its data transmission links through the Satellite Test Center (STC) [redacted]

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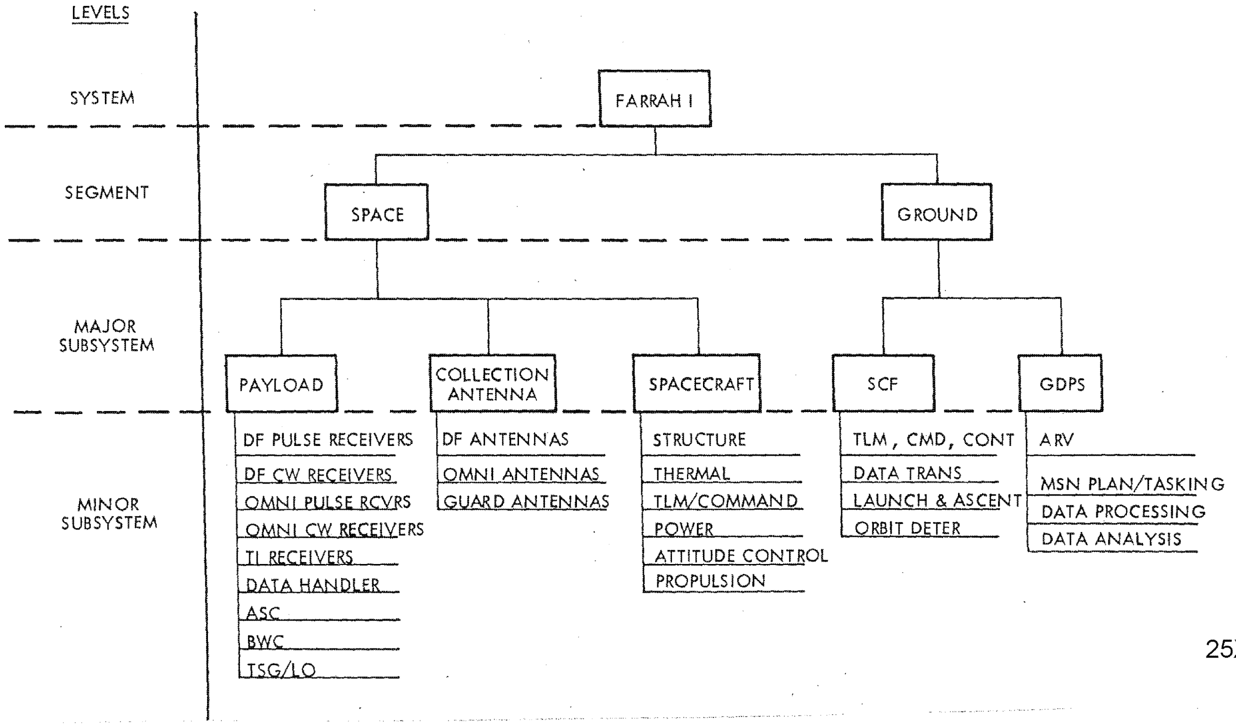


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Fig. 3-1 FARRAH II System Elements

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## 3.1 GENERAL SYSTEM PERFORMANCE REQUIREMENTS

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The FARRAH II System peculiarization of a basic P-989 spacecraft shall permit the collection, measurement, processing, and reporting of intercepted pulsed and CW signals in the 2- to 18-GHz range. The spacecraft segment shall be carried into low-altitude orbit on a host vehicle. The spacecraft shall separate from the host vehicle, spin up, and fire orbital boost rockets to achieve a circular orbit at a nominal altitude of 382 nautical miles. Solar arrays and antenna subsystems shall be deployed to provide power for the spacecraft, collection of emitter signals, and communication to and from ground stations.

The FARRAH II spacecraft segment shall operate on orbit with a spinning, high-gain antenna subsystem capable of providing sidelobe intercept of emitters, and with a low-gain antenna subsystem having near horizon-to-horizon coverage capable of providing intercepts of emitter main beams. The antenna subsystems shall consist of arrays that make the RF spectrum from 2 to 18 GHz available to a receiver subsystem that measures the parameters of pulse and continuous wave (CW) emitters. The arrays shall consist of three high-gain, parabolic antennas that intercept target sidelobes, three medium-gain guard antennas, and six low-gain antennas that together provide inhibit protection of the sidelobes of the parabolic antennas. The six low-gain antennas shall also be used to intercept target emitter main beams.

Pulse and CW signals collected by the high-gain antennas shall be measured for amplitude, frequency, and direction of arrival (DOA); the pulsewidth and [redacted] 25X1
[redacted] of pulse signals shall also be measured, as shall the time of measurement of CW signals. Pulse and CW signals collected by the low-gain antennas shall have the same measurements made except for DOA. A predetection analog output shall make available information on carrier modulation (frequency and/or phase) and other possible unique characteristics of either CW signals or pulsed signals. 25X1

The collected predetection and digital measurement data shall be stored in a tape recorder for later readout to supporting SCF network ground stations. The spacecraft shall also be capable of realtime transponding time-critical intercept data to properly configured ground sites. An onboard computer shall provide the capability of processing selected signal types for transpond output over a narrow bandwidth data link. The SCF stations will provide command capability and furnish spacecraft status and health information for all spacecraft operating modes.

The intercept data from the spacecraft will be forwarded by the SCF to the [redacted]

[redacted] 25X1

The following timeliness requirements shall apply:

- [redacted] Periodic averaging shall be use to determine that this timeliness requirement is satisfied.

- [redacted] 25X1

[redacted]

The results of processing and analysis shall be incorporated into data transmission messages, ELINT technical reports (ELT), ELINT operational reports (ELO), telecommunications reports (TEL), tech memos, signal analysis reports (SAR), signal development reports (SDR), etc.

The system shall be designed to meet simultaneously the requirements in the following sections.

3.1.1 System Accuracy (95 Percent Confidence) and Resolution

System accuracy for any measured or derived parameter shall be defined as the uncertainty in the reported value of that parameter caused by all sources of error in the system. It shall be exceeded by no more than five percent of the time when averaged over all measurements or derivations. All accuracies stated in the following sections shall be the 95 percent confidence accuracy.

The minimum quantum size at which any measured or derived parameter can be reported is the system reporting resolution.

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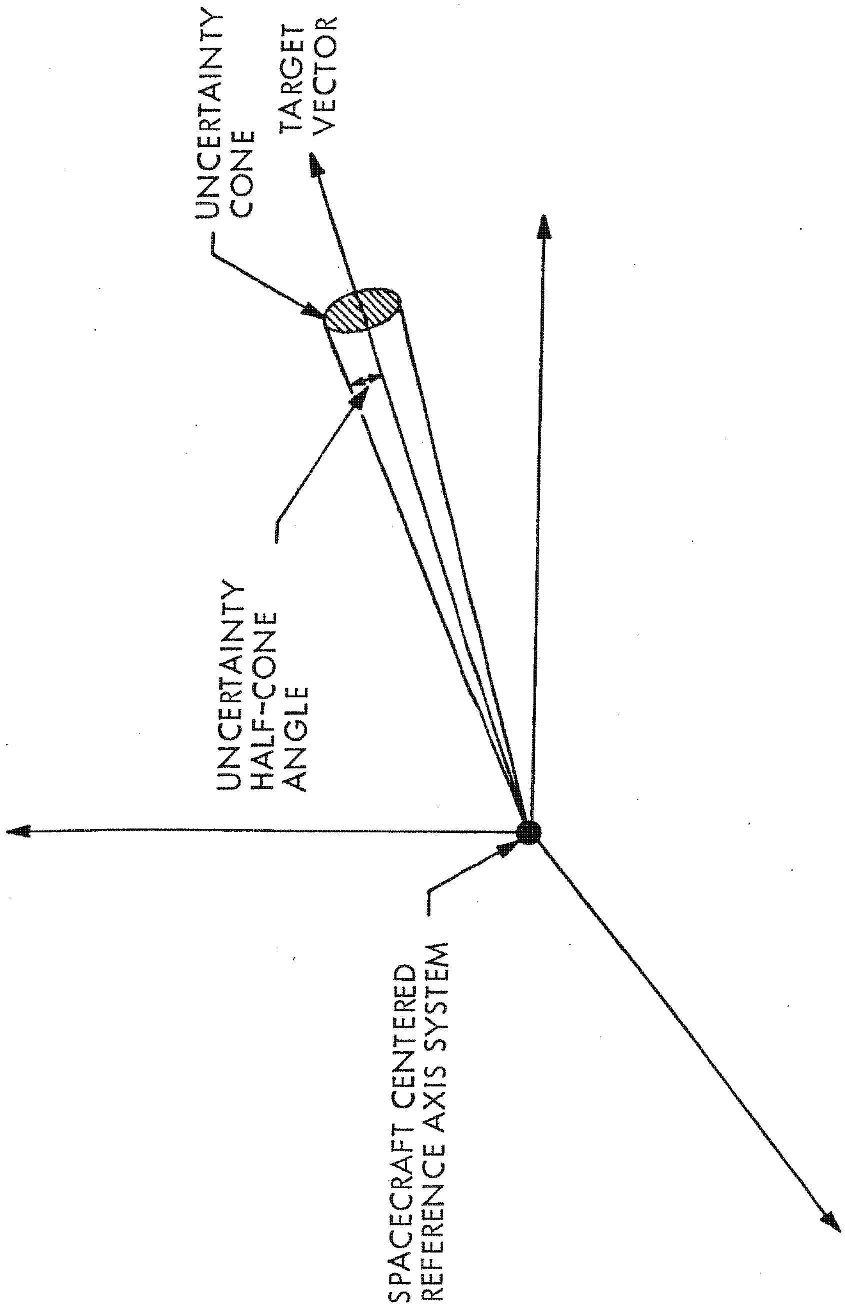
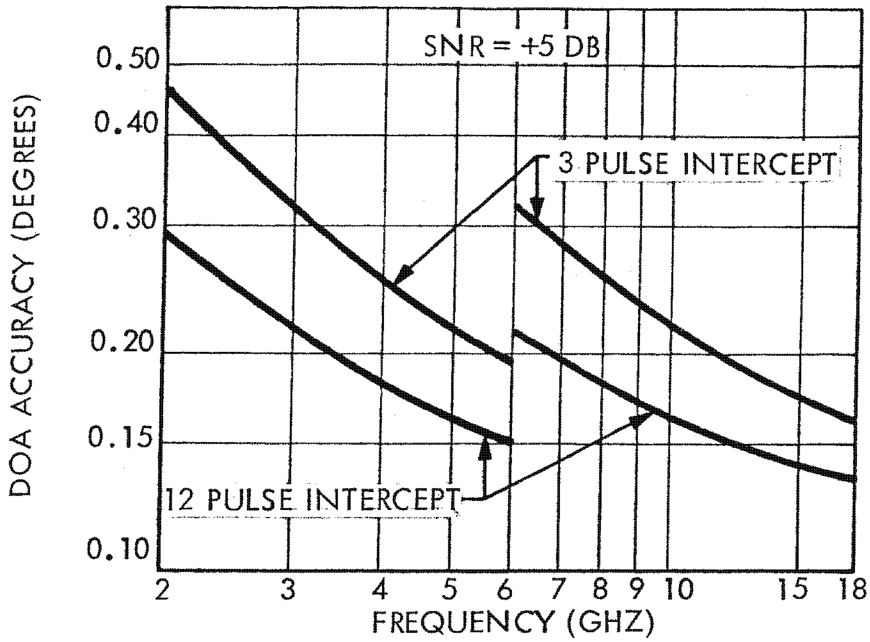
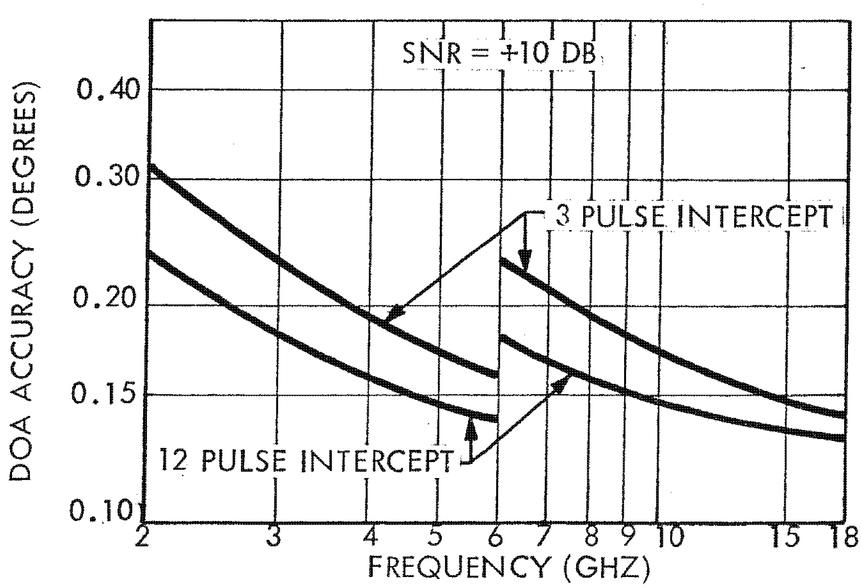


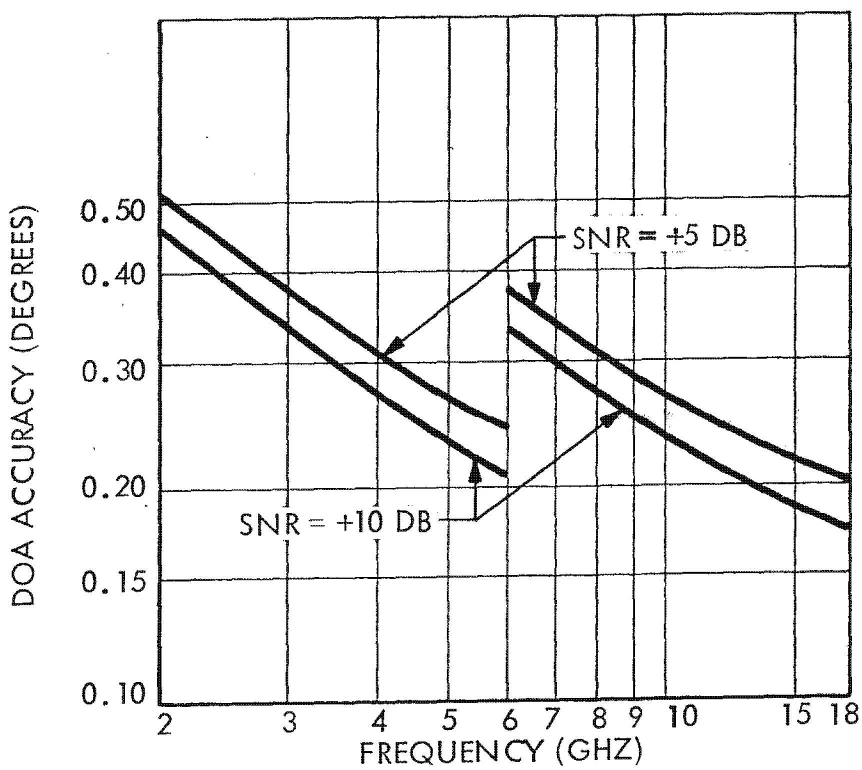

Fig. 3-2 Direction of Arrival (DOA) Uncertainty Cone




NOTE: SNR = −2.2 DB AT THRESHOLD

Fig. 3-3 Pulse System Direction of Arrival Accuracy




NOTE: SNR = -2.2 DB AT THRESHOLD

Fig. 3-4 CW System Direction of Arrival Accuracy

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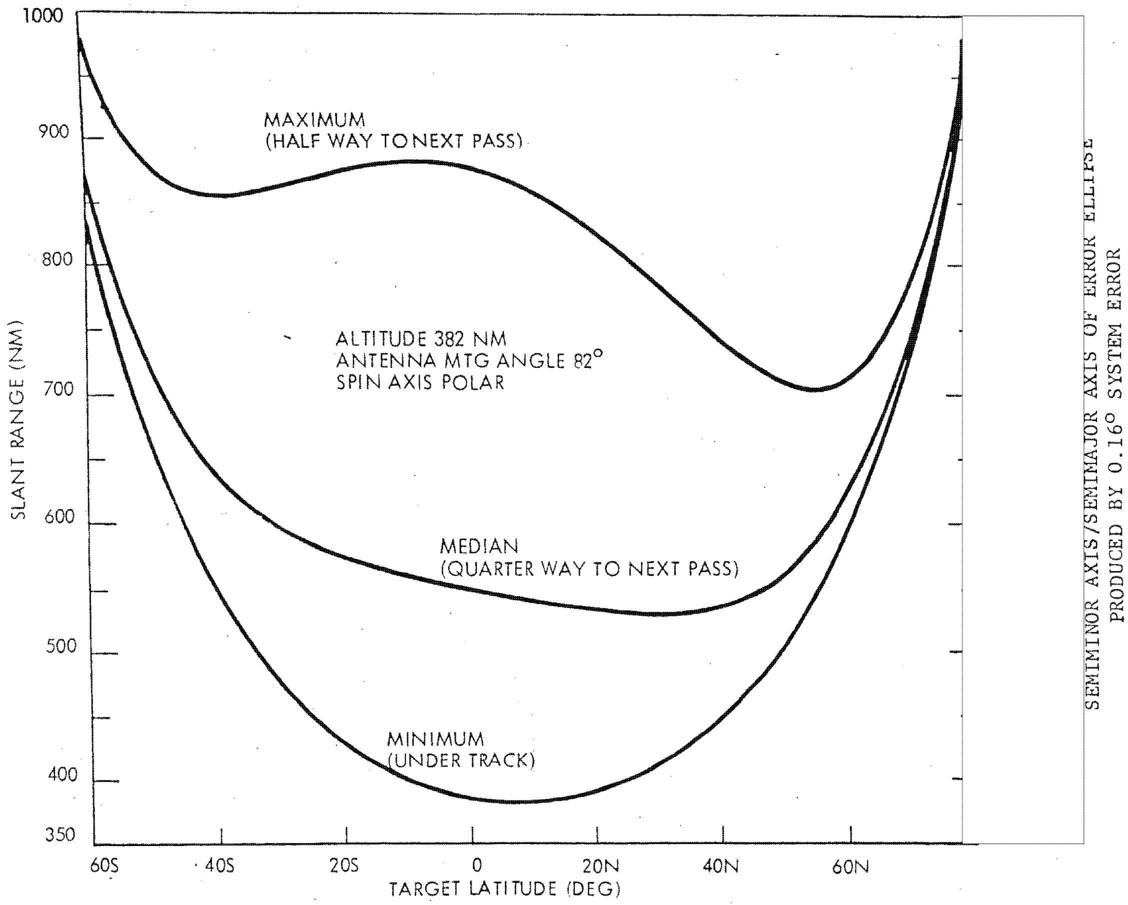


Fig. 3-6 Slant Range and Error Ellipse Size vs Target Latitude

Table 3-1

AMPLITUDE MEASUREMENT ACCURACY

| Antenna | θ (Degrees)[1] | Accuracy (dB) |
|---|---|---|
| A2/A3 | 0 - 30<br>180 - 150 | ± 4.9 |
| | 30 - 60<br>150 - 120 | ± 5.2 |
| | 60 - 90<br>120 - 90 | ± 6.2 |
| B2/B3 | 0 - 20<br>180 - 160 | ± 4.9 |
| | 20 - 45<br>160 - 135 | ± 5.7 |
| | 45 - 70<br>135 - 110 | ± 6.9 |
| | 70 - 90<br>110 - 90 | ± 8.3 |
| C2/C3 | 60 - 90<br>90 - 120 | ± 4.9 |
| | 45 - 60<br>120 - 135 | ± 5.7 |
| | 25 - 45<br>135 - 155 | ± 12.0 |

NOTE:

1. θ angles refer to spacecraft coordinates (refers to figure 3-11)

   Top Range = -Y axis coverage antennas
   Bottom Range = +Y axis coverage antennas

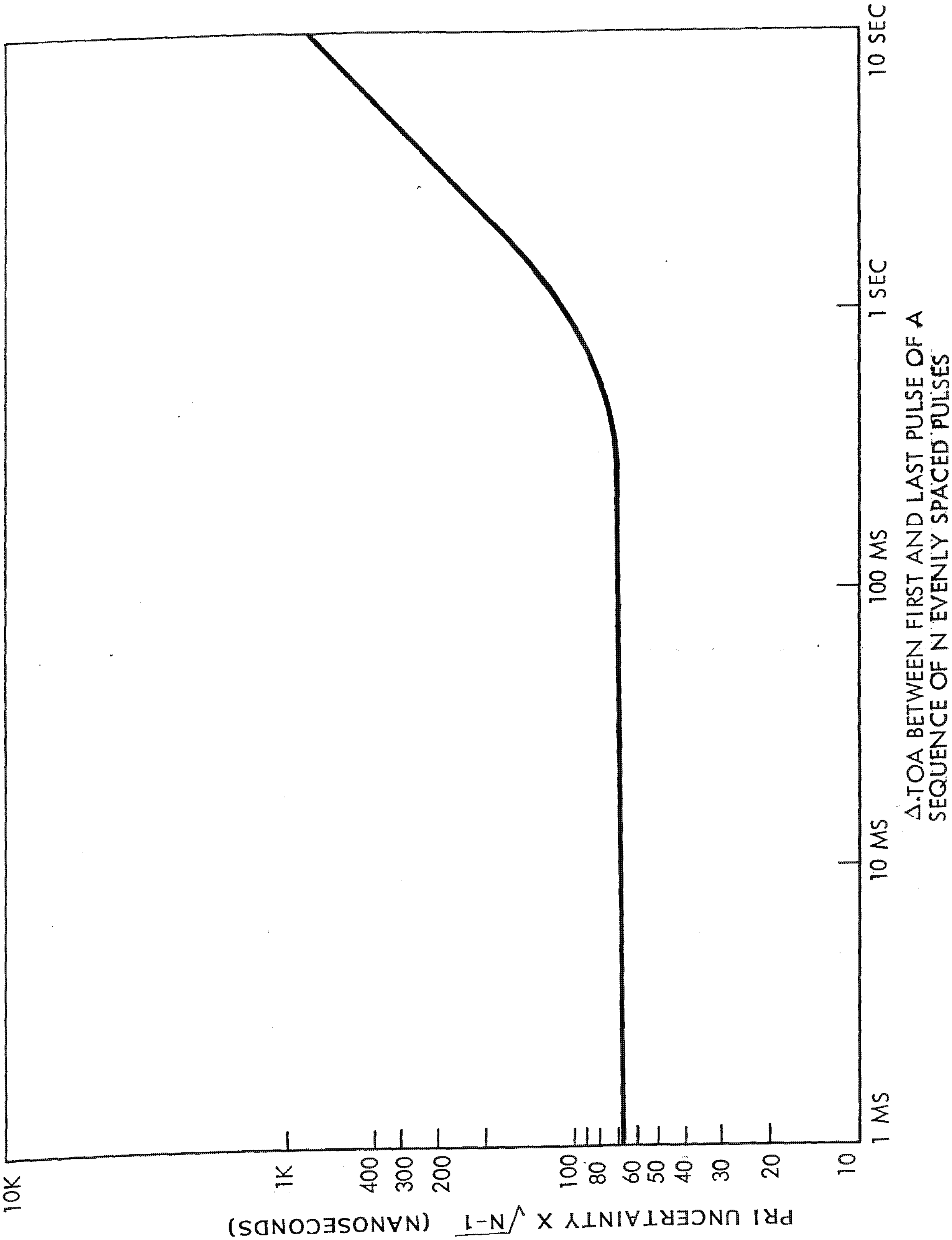


Fig. 3-7 PRI Measurement Accuracy

3.1.1.5 Accuracy of Apparent Scan Period. The system shall be capable of determining and reporting the apparent scan period of an emitter with an accuracy as shown in Fig. 3-8. The apparent emitter scan period shall be defined as the time between the first peak amplitude reports of two successive illuminations of the spacecraft (see Fig. 3-9).

3.1.1.6 Radio Frequency Accuracy and Resolution. The system shall measure and report the frequency of intercepted emitters with the accuracies listed in Table 3-2 for the various conditions shown.

3.1.1.7 Pulsewidth Accuracy. The pulse system shall measure and report pulsewidth of intercepted pulse signals whose rise and fall times are less than 35 nanoseconds with an accuracy of $\pm$0.1 usec or 10 percent of the pulsewidth, whichever is greater. See Fig. 3-10 for the definition of pulsewidth.

3.1.1.8 System Dynamic Range. The system shall meet all requirements over the following dynamic ranges:

| | |
|---|---|
| Pulse Receiver | 35 dB |
| CW Receiver | 45 dB |
| TI Receiver Digital | |
| Fixed Frequency Mode | 45 dB |
| Frequency Handover Mode | 45 dB |
| TI Receiver Analog | |
| Pre-D Linear Output | 20 dB |
| Pre-D Logarithmic Output | 45 dB |
| Pre-D Hardlimited Output | 45 dB |
| BWC Output | 33 dB |
| FM Discriminator Output | 33 dB |

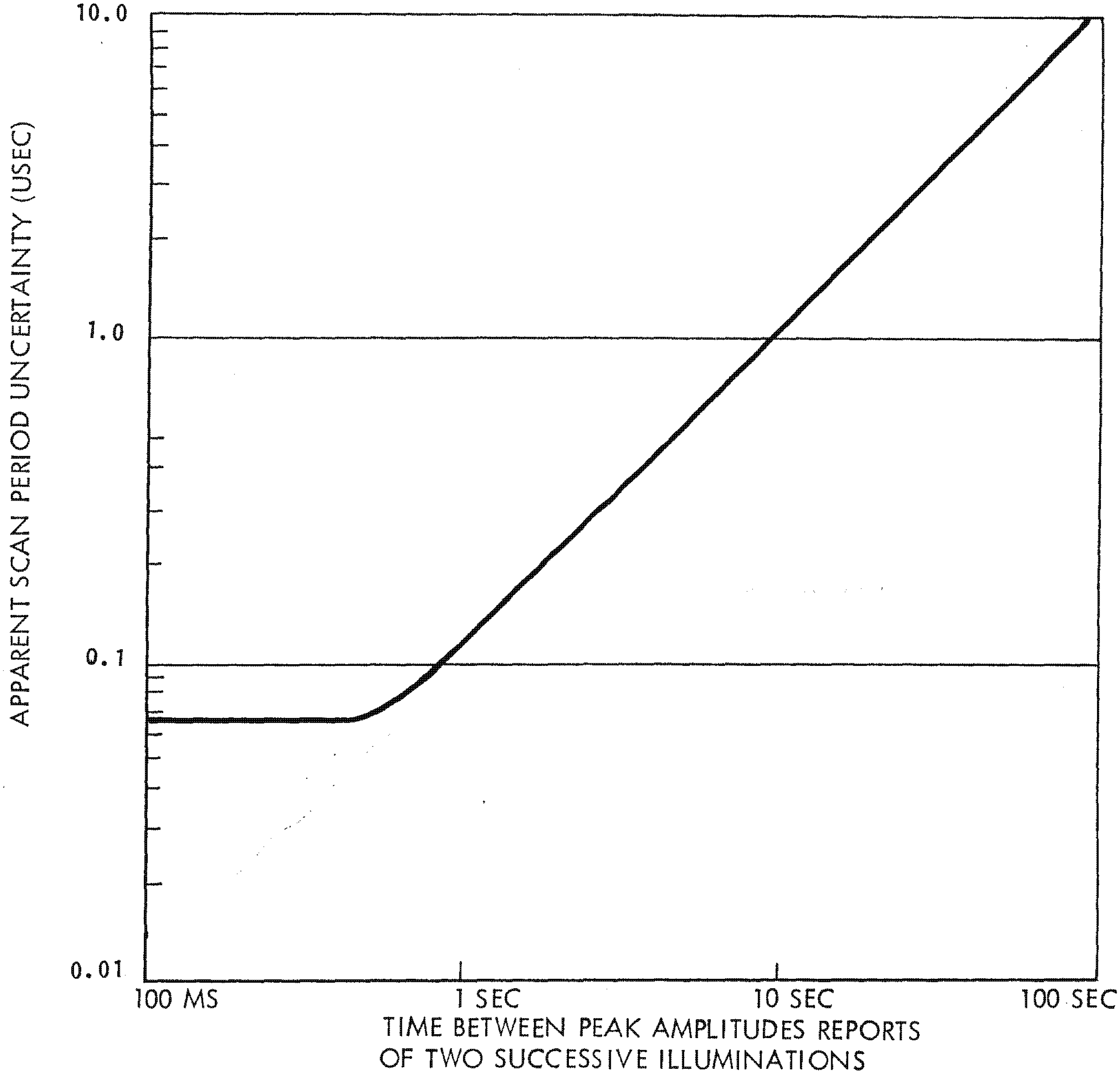


Fig. 3-8 Apparent Scan Period Accuracy

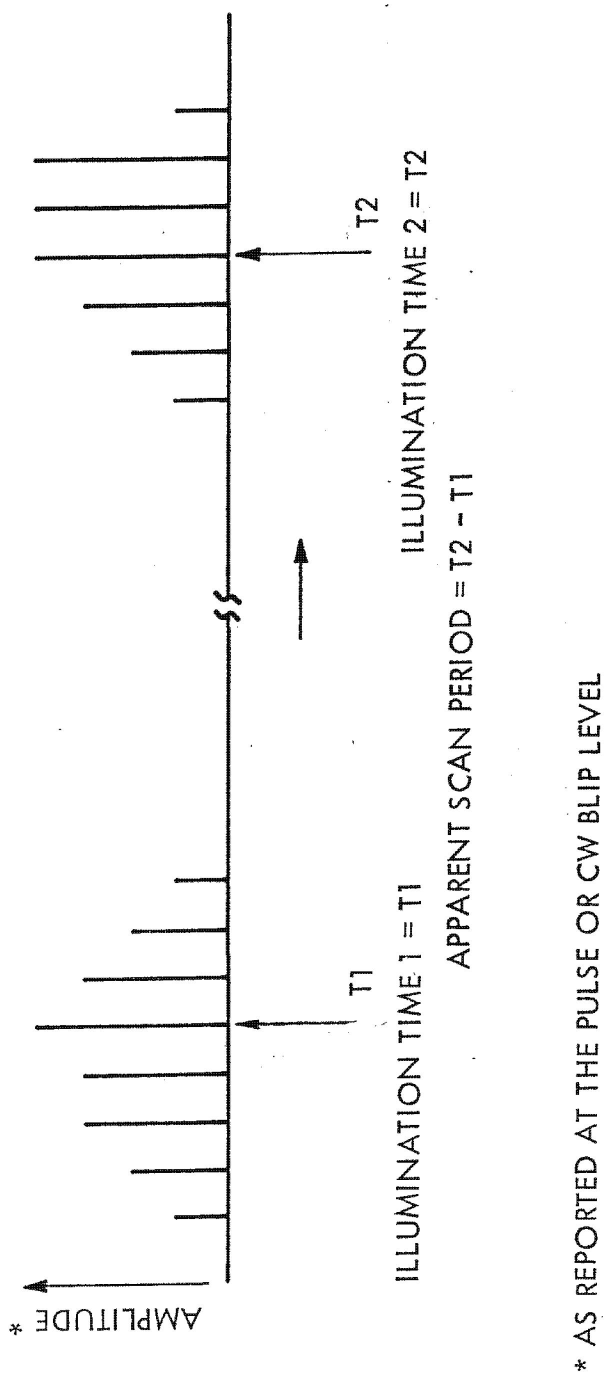


Fig. 3-9 Apparent Scan Period

Table 3-2

RADIO FREQUENCY MEASUREMENT ACCURACY AND RESOLUTION

| Measurement Type | Accuracy* | Resolution | Remarks |
|---|---|---|---|
| Pulsed Emitters | | | |
| Digital Report | $\pm$1.56 MHz | 1 MHz | Accuracy will be achieved at digital processing threshold on a single pulse that does not contain two or more simultaneous frequencies closer than 64 MHz to each other |
| BWC Report | $\pm$136 kHz | NA | Accuracy will be achieved at digital processing threshold **P.W. $\geq$ 1 microsecond |
| CW Emitters | | | |
| Digital Report | $\pm$4.4 MHz | 4.0 MHz | Accuracy will be achieved at digital processing threshold |
| Narrowband Dwell Report | $\pm$86 kHz | NA | |
| Spectrum Analysis Report | $\pm$86 kHz | NA | |
| BWC Report | $\pm$136 kHz | NA | |

* Presumes known emitter location in order to apply doppler correction.

** The required BWC RF accuracy is as noted for input (to the BWC) pulse widths of 1 microsecond or greater. Pulse widths of less than 1 microsecond and greater than 0.2 microseconds result in RF accuracies of $\pm$1 MHz.

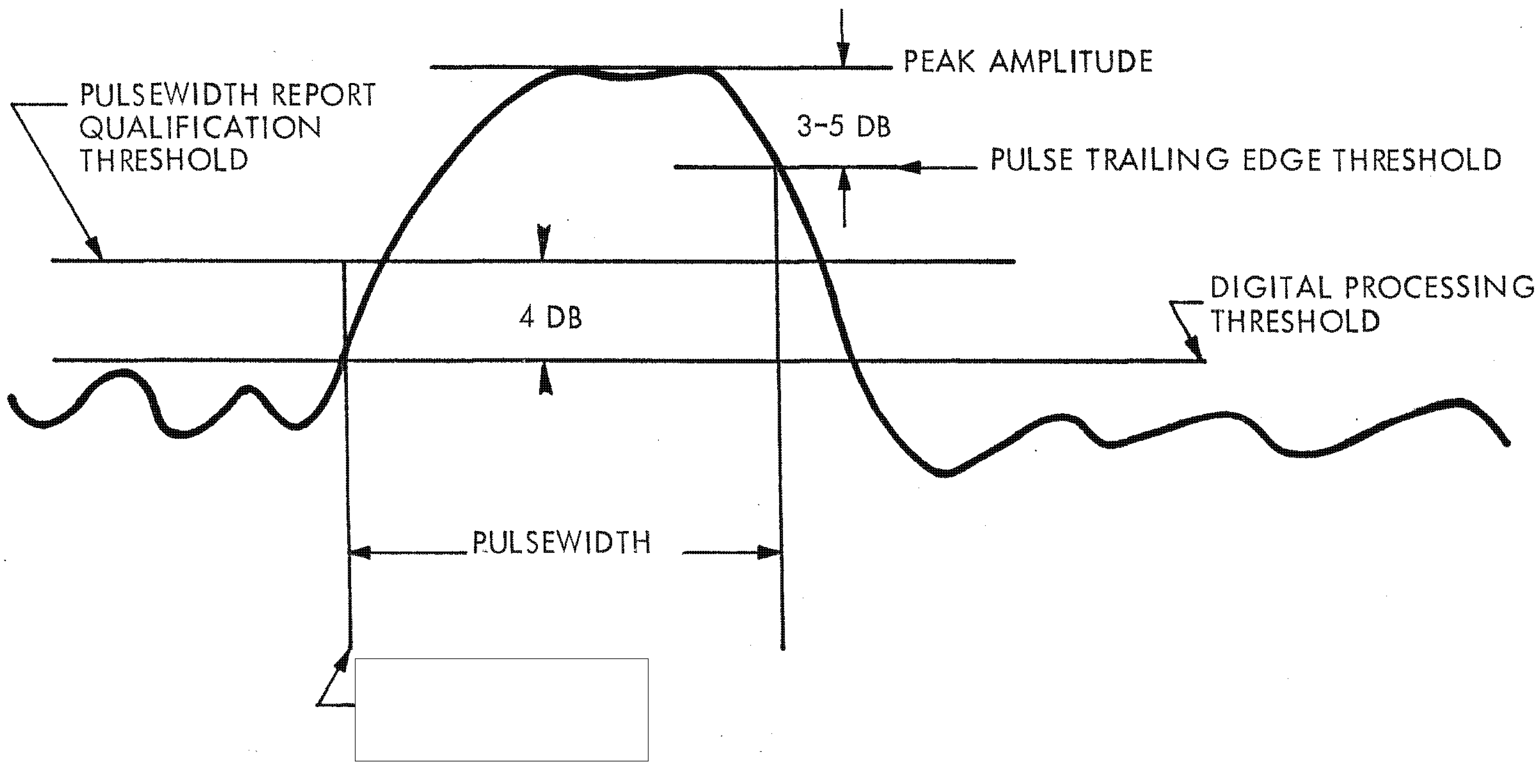


Fig. 3-10 Definition of Pulse Width and TOA

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3.1.2 System Capacity

3.1.2.1 <u>Collection Geometry and Coverage</u>. The three high-gain collection antennas will be installed on the spacecraft with their boresight approximately 82 degrees from the -Y spin axis. This, together with an altitude of 382 nmi and a spin axis orientation that is parallel to the earth's axis, will permit twice daily coverage of all targets between 35$^{\circ}$S and 75$^{\circ}$N latitude. Figure 3-11 illustrates the ground coverage provided by one of the high gain antennas during one-third of a spin when the spacecraft is located at 45$^{\circ}$N.

The low-gain collection antennas shall intercept emitter main beam signals from the horizon. Figure 3-12 defines the spacecraft angle convention.

3.1.2.2 <u>System Tasking Capacity</u>. The system shall be designed to meet the tasking requirements of Table 3-3 under all conditions of percent sun and solar energy incidence angles ranging from 67 to 113 degrees relative to the south-pointing spin axis.

3.1.2.3 <u>System Collection Capacity</u>. The Space Segment shall be capable of collecting bursts of 2,000 pulse, CW, and/or TI measurements whose spacing meets the processing time requirement of 2.7 usec and there is no conflict with other data inputs to the buffer memory. The system shall be capable of sustained average rate of 2.6K pulse, CW, and/or TI measurements per second. The collection capacity of the system when using the Advanced Spacecraft Computer (ASC) shall satisfy the requirements of paragraph 3.2.2.2.9.1.

3.1.2.4 <u>System Processing Capacity</u>. The ground data processing system (GDPS) shall be capable of processing an average of 972,000 intercept word groups within a 24-hour period assuming that omni intercept word groups are limited to 467,000. Of this total, the GDPS shall be capable of time critical processing, certifying, and reporting 140,000 intercept word groups within an elapsed time of one hour per 25,000 intercept word groups.

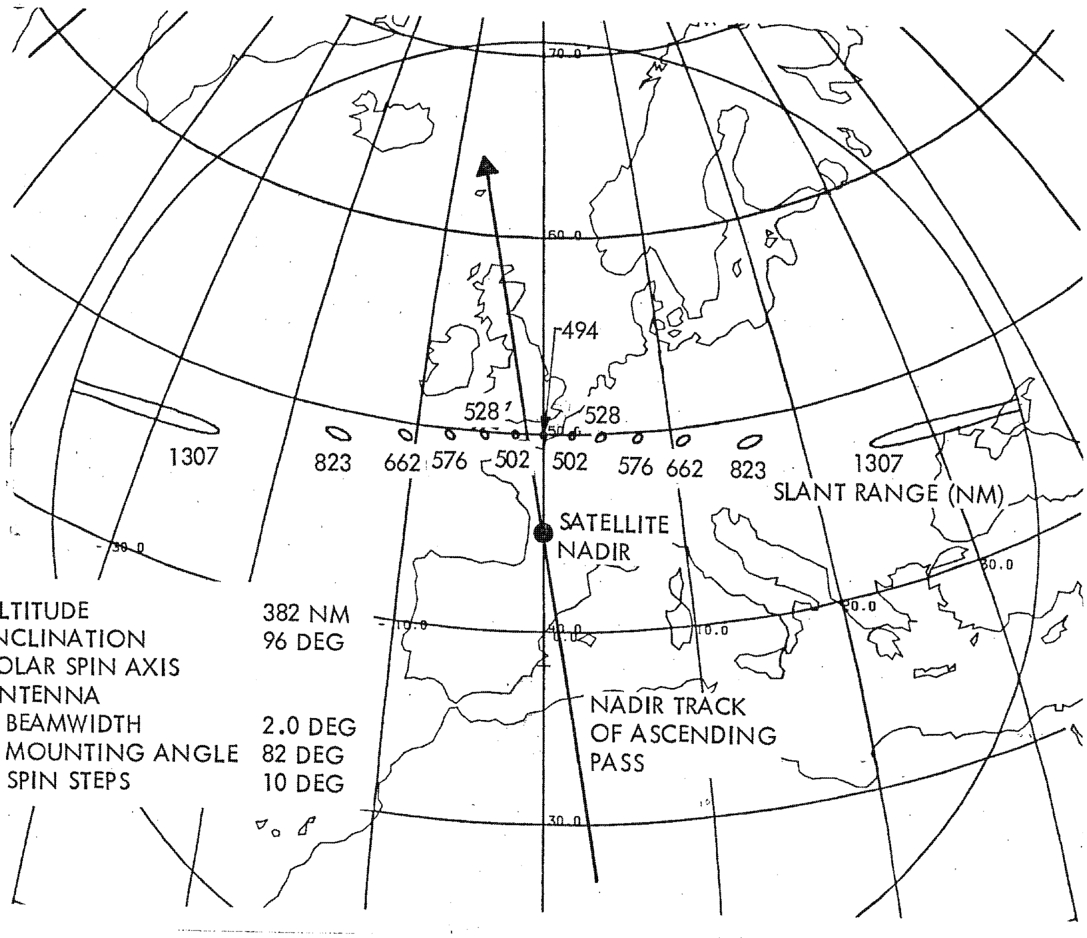


Fig. 3-11 Ground Coverage of High-Gain Antenna

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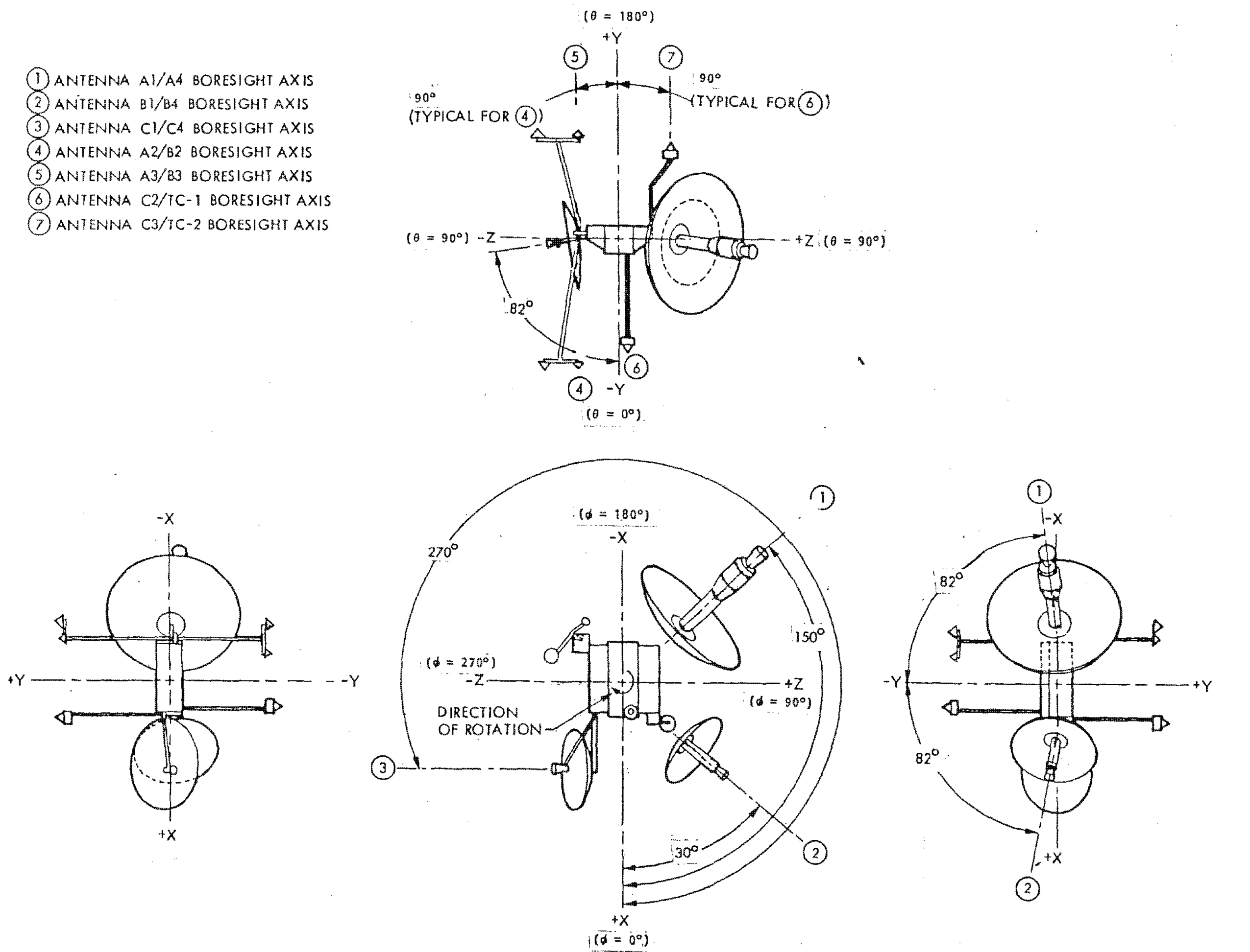


Fig. 3-12 Spacecraft Angle Convention







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Table 3-3

SYSTEM TASKING MODEL

| Read-in/Transpond | Tape Speed (IPS) | Min/Day |
|---|---|---|
| Search and EOB | 25 | 132 |
| TI Receiver OFF<br>BWC OFF<br>ASC OFF | | |
| Tactical* | | |
| TI Receiver OFF<br>BWC OFF<br>ASC ON | 25 | 40 |
| TI Configuration A | 100 | 24 |
| TI Receiver ON<br>BWC OFF<br>ASC OFF | | |
| TI Configuration B | 100 | 12 |
| TI Receiver ON<br>BWC ON<br>ASC OFF | | |
| | Total Read-In | 208 |

*The system will transpond while reading in the tape recorder

### 3.1.3 Target Environment

The system shall be designed to collect, process, and report both pulse and CW (unmodulated and modulated) emitters in the frequency range from 2 GHz to 18 GHz. Emphasis shall be placed on the collection of radar signals but the system design shall provide flexibility for collection of other classes of signals such as jammers, communications systems, and data transmission systems.

3.1.3.1 System Sensitivity. The system sensitivity to pulsed signals in both the DF channel and the omni channels shall be as listed in Table 3-4.

The system sensitivity to CW signals in both the DF channel and the omni channel shall be as listed in Table 3-5. The TI receiver sensitivity shall be as listed in Table 3-6.

### 3.1.4 Orbit Parameters

The space segment shall be placed at an orbital altitude of 382 $\pm$10 nmi, with an orbit inclination ranging from 82 to 110 degrees.

### 3.1.5 Spacecraft General Requirements

The FARRAH II Space Segment shall provide the basic spacecraft structure and subsystems to house and operate the collection subsystem, the propulsion subsystem to achieve orbit, and a support and launcher subsystem to assure reliable and safe separation from the host vehicle.

The spacecraft shall provide a physical support structure for the payload equipment and associated antennas; the power generation, control, and storage equipment, and a command and data transmission subsystem. Auxiliary spacecraft subsystems shall provide attitude sensing and control capability, spin rate control capability, and passive thermal control. The telemetry, tracking, and command (TT&C) subsystem, plus the data transmission equipment shall be compatible with the Satellite Control Facility to provide the necessary communication link.

Table 3-4

PULSE SYSTEM DIGITAL PROCESSING SENSITIVITY

| Band | Freq (GHz) | DF Channel (dBm) | Omni Channel (dBm) |
|---|---|---|---|
| 1 | 3 | -102.4 | -76.6 |
| 2 | 5 | -104.5 | -74.7 |
| 3 | 7 | -101.9 | -74.5 |
| 4 | 9 | -103.2 | -73.9 |
| 5 | 11 | -104.2 | -73.0 |
| 6 | 13 | -110.5 | -75.9 |
| 7 | 15 | -111.2 | -76.4 |
| 8 | 17 | -110.6 | -75.9 |

Conditions:

1. Center frequency of each band
2. Matched circular polarization
3. At antenna boresight
4. 0.1 usec pulsewidth
5. 50 percent probability of detection
6. 1 false alarm per second
7. Sensitivity may vary ±3 dB as a function of temperature and frequency within any band
8. A decrease of 4.5 dB in sensitivity shall be allowed at the crossover between bands 1 and 2 (3.9 GHz to 4.1 GHz) where duplexers are used.

NOTES:

1) Signal power must be raised 4 dB above the indicated level for the digital report to include a pulsewidth measurement per the requirements of paragraph 3.1.1.7.

2) Signal power must be raised 7.5 dB above the indicated level for the DF digital report to include DOA per the requirements of 3.1.1.1.

Table 3-5

CW SYSTEM DIGITAL PROCESSING SENSITIVITY

| Band | Freq (GHz) | DF Channel (dBm) | Omni Channel (dBm) |
|---|---|---|---|
| 1 | 3 | -122.4 | -96.6 |
| 2 | 5 | -124.5 | -94.7 |
| 3 | 7 | -121.9 | -94.5 |
| 4 | 9 | -123.2 | -93.9 |
| 5 | 11 | -124.2 | -93.0 |
| 6 | 13 | -130.5 | -95.9 |
| 7 | 15 | -131.2 | -96.4 |
| 8 | 17 | -130.6 | -95.9 |

Conditions:

1. Center frequency of each band
2. Matched circular polarization
3. At antenna boresight
4. 50 percent probability of detection
5. 1 false alarm per second
6. Sensitivity may vary $\pm 3$ dB as a function of temperature and frequency within any band
7. A decrease of 4.6 dB in sensitivity shall be allowed at the crossover between bands 1 and 2 (3.9 GHz to 4.1 GHz) where duplexers are used.

NOTES:

1) Signal power must be raised 7.5 dB above the indicated level for the DF digital report to include DOA per the requirements of 3.1.1.1.

Table 3-6

TI RECEIVER SENSITIVITY

| Condition | Sensitivity Improvement |
|---|---|
| Narrowband Search and Dwell | 2 dB |
| Spectrum Analysis Mode | 2 dB |
| BWC Mode | 2 dB |
| Fixed Frequency | 6 dB |

NOTE: In order for the TI receiver to automatically acquire a signal that has been handed over from the pulse or CW receiver the signal level must equal or exceed the pulse receiver or CW receiver digital processing threshold. After the TI receiver has acquired the handed over signal it has a sensitivity improvement over the pulse or CW receiver. It is this advantage that is listed in this table.

The deployment subsystems for the antenna and power panels shall be part of the spacecraft and shall deploy the necessary attachments and solar arrays using suitable timers and real time commands.

3.1.6 Collection Subsystem General Requirements

The collection payload subsystem shall consist of a five-channel DF pulse signal receiver, a five-channel DF CW receiver, a two-channel omni pulse signal receiver, a two-channel omni CW receiver, and a single-channel TI receiver with a bandwidth compressor. The five-channel DF receivers shall each consist of two channels that are connected to one of three high-gain monopulse antennas and associated sum-difference beam forming networks, plus three inhibit channels. The inhibit channels shall include one guard receiver connected to one of three medium gain inhibit antennas and two receivers connected to one of three pairs of low gain omni antennas. The low gain antennas shall also be used with the omni pulse and CW receivers.

Signals intercepted in the DF pulse receiver shall be measured, and the frequency, pulsewidth, amplitude, [redacted] and three DOA parameters ($\Sigma/\Delta$, A/B, C/D) 25X1 shall be reported unless one of the three inhibit receivers has indicated that the intercept is via a sidelobe of the DF antenna. Signals intercepted in the DF CW receiver shall be measured, and the frequency, amplitude, TOM, and three parameters associated with the DOA shall be reported unless one of the three inhibit receivers has indicated that the intercept is via a sidelobe of the DF antenna.

Signals intercepted in either the omni pulse or omni CW receivers shall also be measured, and all but the DOA parameters described above shall be reported.

The TI receiver shall be switchable to the DF channel or to either omnidirectional channel. The TI receiver shall output a 750 kHz pre-D analog output and digital intercept word groups. The 750 kHz pre-D shall result from a dwell at a particular frequency against narrowband CW signals (narrowband search and dwell mode), or from a repetitive scan of a 750 kHz bandwidth filter across a 13-MHz bandwidth against wideband CW signals (spectrum analysis mode), or from a dwell at a given frequency against wideband CW signals or pulsed signals (bandwidth compressor mode).

The payload outputs shall be transponded in real time and/or recorded on tape recorders for later transmission to a remote tracking station. The collection subsystem payload and associated antennas shall satisfy the performance requirements specified in Section 3.2.

The payload shall also include a general purpose computer to perform data processing onboard the spacecraft in order to compact selected DF pulse and DF CW data for transmission to the ground over a narrow bandwidth data link.

3.1.7 Data Processing General Requirements

The data processing segment shall process pulse code modulation (PCM) and analog data received from the Space Segment to produce reports on intercepted emitter signals in support of the FARRAH missions defined in Section 3. The data processing segment shall produce measured and computed parameter values for intercepted signals by in-line digital processing, in-line analog processing, off-line analog processing, or by special (existing) [redacted] off-line processing and analysis. 25X1

In-line digital processing functions shall be applied to PCM data from readins including calibration readins. These functions shall include conversion of PCM serial bit stream to computer words, separation of readins from a single readout, conversion of measurements from telemetry units to engineering units, reconstruction of intercepted signals based upon reports received from each payload receiver, geolocation and identification, selection/filtering of data automatically and/or by manual interaction based on prior knowledge, storage of selected data in history, printing of in-line digital processing results, summarization of receiver activity, and summarization of payload health.

Off-line processing functions shall be applied to analog data, including calibration readins, for determination of signals of interest and their position on the tape, and for generation of records for analysis use. Other data, including PCM data, on a tape shall be processed as necessary to support and augment the processing of analog data, and to determine quality of the recording.

Off-line processing and analysis functions shall be provided to support technical intelligence analysis. This shall include reprocessing of data utilizing the in-line digital processing capabilities and retrieval and manipulation of intercept and tasking history data. Initiation of in-line digital reprocessing and selection of data to be processed will be available from a graphics terminal.

A real time processing capability shall be provided to process narrowband compacted data from the spacecraft minicomputer (ASC), geoposition burst and series data, and format the results for CRT display of printer listings.

### 3.1.8 Satellite Control Facility

The Satellite Control Facility will provide the necessary tracking, command, control, and data readout and processing capability to support the spacecraft on orbit. Suitable SCF software shall exist to process and transmit the necessary spacecraft status and health, plus associated payload data over existing facilities to effectively operate the spacecraft on orbit.

### 3.1.9 Launch and Ascent

The FARRAH II spacecraft shall be designed for installation on a host vehicle and shall be designed to be stowed in the envelope defined in the Satellite Vehicle/Subsatellite Interface Control Document, BIF003W/2-013588-73, Rev B, which also defines the interface of the spacecraft and launcher assembly with the host vehicle structure. The host shall provide the boost capability to lift the spacecraft into an initial orbit from which the spacecraft propulsion subsystem is capable of achieving the final desired orbit.

3.1.10 Data Transmission and Processing Performance

Within 60 days after the spacecraft is on orbit, payload data forwarded from SCF to [redacted] and through the hardware preprocessor shall provide a first-time processing success rate of greater than 90 percent when averaged over a seven-day period as measured at the point of readin file generation. 25X1

3.1.11 On-Orbit Performance Verification

The FARRAH II/spacecraft performance shall be verified on orbit. This verification shall be accomplished by an onboard test signal generator (TSG) by known radiations from the astrophysical research vehicles (ARV) and by known radiations from selected sites in the secondary data base (SDB). The purpose of the on-orbit verifications shall be to demonstrate nominal operation of the FARRAH II spacecraft as defined in Section 3.1.1, to perform geopositioning bias analysis, to perform processing segment verification, and to perform anomaly evaluation.

3.1.11.1 <u>Test Signal Generator (TSG)</u>. The TSG shall be part of the payload subsystem and shall provide pulse and CW signals over the frequency range from 2 to 18 GHz. These test signals shall provide functional verification of all receivers, all parameter encoders, and the IWG encoders within the data handler.

3.1.11.2 <u>ARV Signals</u>. The contractor will provide on-orbit calibration from an ARV as described in <u>Astrophysical Research Vehicle</u>, BIF003W/076446-73. The functions of the ARV on-orbit calibration are to verify the correct operation of the system, provide data for bias analysis, determine geopositioning accuracy, and aid in anomaly analysis.

The ARV will be capable of generating pulsed and CW signals to verify the proper operation of the system. These signals (both pulse and CW) will have an adequate effective radiated power (ERP) to calibrate at least 15 dB above the DF receiver threshold on at least one frequency in each RF band at a slant range of 600 nmi. The pulse signals used to calibrate the main beam receiver channels will exceed threshold by 5 dB on at least one frequency in each RF band (except 12 to 14 GHz) at a slant range of 600 nmi. The CW signals used to calibrate the omni receiver channels will exceed threshold by 5 dB on at least one frequency in each RF band from 4 to 12 GHz at a slant range of 600 nmi. No requirement will exist for omni channel pulse signals from 12 to 14 GHz and omni channel CW siganls from 12 to 18 GHZ. The ARV will be capable of generating either pulsed or CW signals with parameter accuracies sufficient to verify the operation of each measurement subsystem.

3.1.11.3 Secondary Data Base Signals. The data processing segment will have the capability to utilize data from SDB sites as appropriate to supplement the calibration data base over that which can be obtained from the ARVs alone.

## 3.2 SPACE SEGMENT REQUIREMENTS

The FARRAH II space segment shall be comprised of the spacecraft, payload, and collection antenna subsystems.

### 3.2.1 Spacecraft Subsystems

A standard P-989 spacecraft assembly (Spacecraft 4433) shall be modified to satisfy the requirements of the Spacecraft System Requirements Document BIF003W/2-156594-80. The power, propulsion, attitude control and determination, and TT&C subsystems shall be used to support the payload and collection antenna subsystems operation. A support panel/launcher assembly (SPLA) compatible with a host vehicle shall provide ascent support and launch/separation capability.

3.2.1.1 Mass Properties. the spacecraft assembly weight shall not exceed 850 pounds, and the stowed configuration moments of inertia shall comply with the requirements of ICD 1420289B, paragraph 3.5.

3.2.1.2 Spacecraft Attitude

3.2.1.2.1 Initial Attitude. The initial orientation of the spacecraft axis relative to inertial space, which is controlled by specifying host vehicle attitude and point of spacecraft separation, shall be determined only after the actual host orbit parameters are known. Following separation, rocket burns, and deployment, the pointing direction of the spin axis shall be controllable via the attitude control system.

3.2.1.2.2 Mission Attitude. The nominal spacecraft spin axis shall be parallel to the earth's axis. If other attitudes are chosen, the attitude shall be further constrained to keep the solar aspect angle (gamma) within the limits of 67 to 113 degrees.

3.2.1.3 <u>Attitude Determination</u>. The spacecraft spin axis attitude relative to an inertial space coordinate system shall be determined by the ground data processing segment (GDPS) utilizing horizion sensor and solar aspect sensor data from the spacecraft.

3.2.1.3.1 <u>Horizon Sensor</u>. The horizon sensor shall be capable of detecting the earth-space transition to within 0.15°. There shall be a standby redundant horizon sensor.

3.2.1.3.2 <u>Solar Aspect Sensor</u>. The solar aspect sensor shall be capable of measuring the angle between the spin axis and the spacecraft sun line to within 0.1°. There shall be four sensors with an angular range of ±32° and two associated shift registers, one of which is to be in standby redundancy.

3.2.1.4 <u>Attitude Control Subsystem (ACS)</u>. An attitude control subsystem shall be provided which will permit orientation of the spacecraft spin axis to any location in inertial space within the constraints of available power. Maximum gain shall not exceed 3°/hour in any direction normal to the orbit plane. A low gain mode shall be provided for operation in conditions of low incident solar energy. Redundancy shall be provided.

3.2.1.5 <u>Spin Rate Control Subsystem (SRCS)</u>. Two fully redundant spin rate control subsystems shall be included. The subsystem will be used either to increase or decrease the spin rate to arrive at the optimum which shall be in the range of 45 to 55 rpm. The subsystems shall be used thereafter to periodically restore the spin rate after the environmental torques produce a particular decay. The duty cycle required to offset the decay shall not exceed 1 in 4 for each subsystem. The spin rate control subsystem shall be capable of maintaining the spin rate within 0.5 rpm over the range of 34 rpm to 55 rpm.

3.2.1.6 Telemetry, Tracking, and Control (TT&C) Subsystem. The spacecraft shall incorporate a TT&C subsystem that is compatible with the standard Space-to-Ground Link Subsystem (SGLS) communications system of the Air Force Satellite Control Facility (AFSCF). This TT&C subsystem shall provide the capabilities of:

a. Commanding (realtime and stored programmed)
b. Ranging (noncoherent pseudo random noise (PRN) turnaround ranging only)
c. Status telemetry data
d. Payload data (realtime and stored data)
e. Payload data storage and signal conditioning

3.2.1.6.1 Telemetry and Command (TC) Antennas. The TT&C subsystem shall employ an antenna set consisting of two near omni-directional conical spiral TC antennas to permit commanding, ranging, status telemetry readout, and payload data readout at any spacecraft attitude while the spacecraft is within range of a designated Remote Tracking Station (RTS) of the AFSCF. The minimum gain of the TC antennas, associated with their respective receivers and transmitters, shall be sufficient to permit closure of the RF uplinks and downlinks at 5° above the RTS horizon or greater, with a calculated margin of 0 dB minimum except for the payload analog downlink mode. The analog downlink mode shall provide for a 22.6 dB SNR in the Pre-D bandwidth for 24° and 10° above the RTS horizon for the 60 ft and 46 ft ground antennas, respectively. The operating frequency ranges for each TC antenna shall be [redacted] and [redacted] In addition, the TC antennas shall be connected to the respective spacecraft receivers and transmitters to allow the simultaneous use of one TC antenna for both receiving and transmitting of RF energy. 25X1

3.2.1.6.2 Command and Ranging. The command subsystem shall be capable of receiving, decoding, and processing from two different RF uplink carriers (SGLS channels 1 and 14). It shall have the capability of being programmed to execute stored program commands at preselected times. The types of commands available inlcude:

a. Realtime command functions having magnitude commands for program and event time loading, and basic commands for discrete actions.

b. Stored program command functions provided by a timer and a stored command sequencer.

The spacecraft command receivers shall be capable of detecting a PRN ranging code transmitted simultaneously with command messages, retransmitting it on the SGLS downlink carrier for subsequent range measurements at the RTS.

3.2.1.6.3 Status Telemeter. The TT&C subsystem shall employ equipment that is capable of accepting transducer output signals in analog, discrete, and digital form applied to their respective input gates, multiplex these signals into a suitable frame format and output these in form of a NRZ-L PCM wave train at a bit rate of 8.0 kbps that phase modulates either one of two 1.024 MHz subcarrier oscillators. Each subcarrier oscillator output along with the PRN turnaround signals of 1000 kbps shall be multiplexed to phase modulate the RF TLM downlink carrier. RF telemetry downlink transmissions shall be accomplished via a 2-W transmitter at a frequency of [redacted] (ASGLS channel 1) or in the backup mode via a 10-W transmitter at a frequency of [redacted] (ASGLS channel 7). The 8-kbps status data shall not be encrypted. 25X1

3.2.1.6.4 Payload Data. The TT&C subsystem shall employ equipment that is capable of multiplexing digital and analog payload data into suitable baseband signals and transmitting them via the ASGLS narrowband (NB-PM) and wideband (WB-FM) RF downlinks to remote tracking stations.

In the NB-PM mode payload data shall be transmitted to the RTS at data rates of 4.0, 32.0, and 256.0 kbps. The NB data, in BiØ-M format, shall be code converted to an NRZ-L format for encryption, and code converted again to a BiØ-M format prior to being phase modulated onto either one of three downlink carriers at frequencies of [redacted] ASGLS channel 12), or [redacted] (ASGLS channel 17). 25X1

The three transmitters to be provided for these services shall have two inputs--one PM input and one FM input. Each transmitter shall have an RF output power of 10 W minimum. If required, the channel 7 transmitter shall be capable of accepting inputs of either payload NB-PM data or 8-kbps status data that are selected by a realtime command. The transmitter outputs, in turn, shall be suitably combined to permit utilization of one TC antenna for all payload downlink transmissions.

In the WB-FM mode, payload data shall be transmitted to the RTS at data rates of 128.0, and 1024.0 kbps in BiØ-M format, or 256.0 kbps in BiO-M format and either 4.0 or 32.0 kbps PCM in BiØ-M format modulating a 1.7 MHz subcarrier oscillator, or analog data and 256.0 kbps PCM data in BiØ-M format modulating a 1.7 MHz subcarrier oscillator. The analog data shall consist of a channel 14 subcarrier oscillator, a 51.2 kHz reference tone, a channel F subcarrier oscillator, and 750 kHz pre-D in the transpond mode and the 1:1 WB mode. In the before and after (B&A) mode the analog data shall consist of three tones at 250 kHz, 500 kHz, and 1.0 MHz. The analog data in the above modes shall not be encrypted for payload downlink transmissions.

The PCM data shall be code converted to an NRZ-L format for encryption. The encrypted PCM data, in turn, shall again be code converted to a BiØ-M format prior to either being multiplexed, first with another encrypted BiØ-M format PCM digital data signal or with an analog data signal, or being frequency modulated directly onto either one of three downlink carriers at the frequencies stated above. The same three transmitters shall be used for payload WB downlink transmissions as for payload NB downlink transmissions, except that each transmitter shall operate only in either the WB-FM or the NB-PM mode.

3.2.1.6.5 Payload Data Storage and Conditioning. The TT&C subsystem shall employ three magnetic tape recorders for recording and reproducing of analog and/or digital payload data in the frequency band of 1 kHz to 1 MHz, and two digital interface units (DIU) for conditioning the reproduced tape recorded digital data.

Each tape recorder shall be capable of recording digital (PCM) data at bit rates of 32 and/or 256 kbps in Bio-M format and/or analog data, ranging from 1 kHz to 1 MHz. Each tape recorder shall be capable of reproducing these data at a single speed and recording the data at one of two different speeds (1X or 1/4X reproduce speed). The record speeds shall be selected by command.

The two digital interface units, one associated with each of the two baseband assembly units of the payload data control unit shall be capable of:

a. Accepting PCM bit rates of 128, 256, and 1024 kbps in BiØ-M format

b. Providing compatibility with the PSK-modems which are part of the DSIS at the remote tracking stations

c. Providing clock pulses coincident with the DIU output data at bit rates of 128 kbps, 256 kbps, or 1024 kbps to a BiØ-M to NRZ-L code converter for subsequent encryption in KG-46 units

d. Enhancing the quality of the reproduced PCM data from the tape recorders throughout the normal operating life of the tape recorder. The peak-to-peak jitter frequencies from 0.5 Hz to 10 kHz shall be less than 1 percent. The overall bit error rate (BER) of the DIU and any tape recorder shall be $2 \times 10^{-6}$ or smaller.

3.2.1.7 Payload Data Outputs. The various data outputs from the payload and the tape recorder/DIUs shall be suitably processed and switched by command in the payload data control unit to permit code conversion and encryption of the digital data and multiplexing of digital and/or analog data into various baseband formats. This unit shall also provide the necessary switch logic to select any of the PM or FM outputs to the three WB transmitters delineated in paragraph 3.2.1.6.5.

The baseband spectra for the required payload data modes shall be as shown in Figs. 3-13 through 3-20 and summarized in Table 3-7.

3.2.1.8 Electromagnetic Compatibility and System TEMPEST Requirements

3.2.1.8.1 Electromagnetic Compatibility Requirements. The spacecraft shall satisfy the requirements of Electromagnetic Compatibility Requirements, System, MIL-E-6051D and applicable sections of the Satellite Vehicle/ Subsatellite Interface Control Document, BIF003W/2-013588-73.

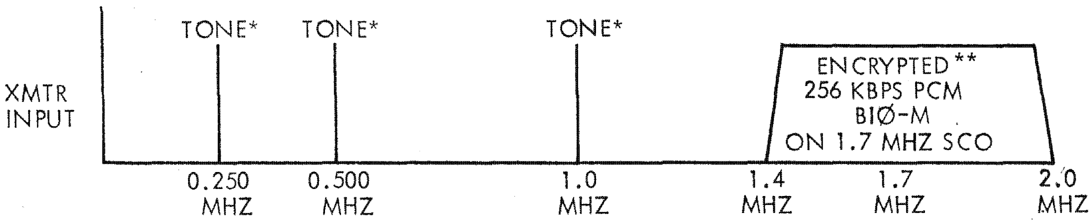
3.2.1.8.2 TEMPEST Requirements. The Space Segment subsystems including the payload shall be designed such that any compromising emanations are reduced to levels where unauthorized interested observers are unable to extract extraneous energy related to the classified payload data being processed and transmitted to designated ground stations. The design and verification of TEMPEST requirements will be accomplished in accordance with the approved Program TEMPEST control plan.

3.2.1.9 Mean Mission Duration Requirements. The spacecraft equipped with three type 38 recorders shall have a Mean Mission Duration (MMD) of at least 36 months when based upon the following:

a. 208 readin minutes per day, average
b. 19 tape recorder cycles per day average
c. 50 percent confidence level.

The ground test life shall be at least 24 months or 975 cycles on a single tape recorder.

3.2.1.10 Spacecraft Environment Requirements. The spacecraft system shall be capable of withstanding the environments of ground handling/test, launch and ascent on a host vehicle, and operate in the on-orbit environments generated by the requirements of Subsystems and Equipment Environment Specification 2P14885E.

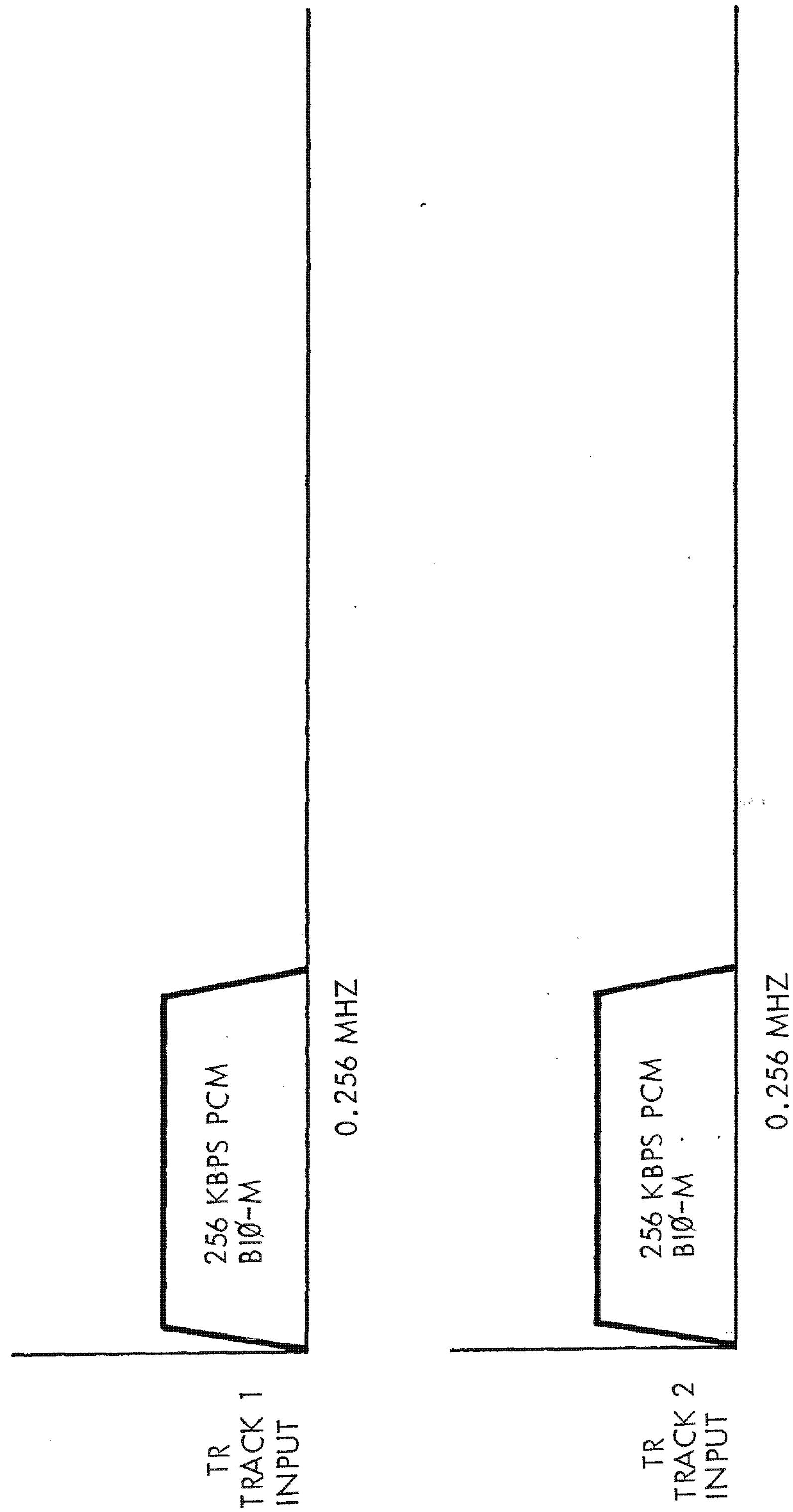



* 0.250 MHZ TONE HAS HIGH AND LOW LEVEL AND 0.500 MHZ AND 1.0 MHZ TONES ARE AT LOW LEVELS. THE TONES ARE SEQUENCED THROUGH AT 10 MSEC EACH FOLLOWED BY A 10 MSEC NO-TONE PERIOD.

** DATA PRESENT ONLY IF PL DATA HANDLER IS ON. HOWEVER, THE SPECTRUM WITHOUT DATA WILL LOOK VERY MUCH LIKE THAT WITH DATA DUE TO PHASE LOCK LOOP AHEAD OF KG.

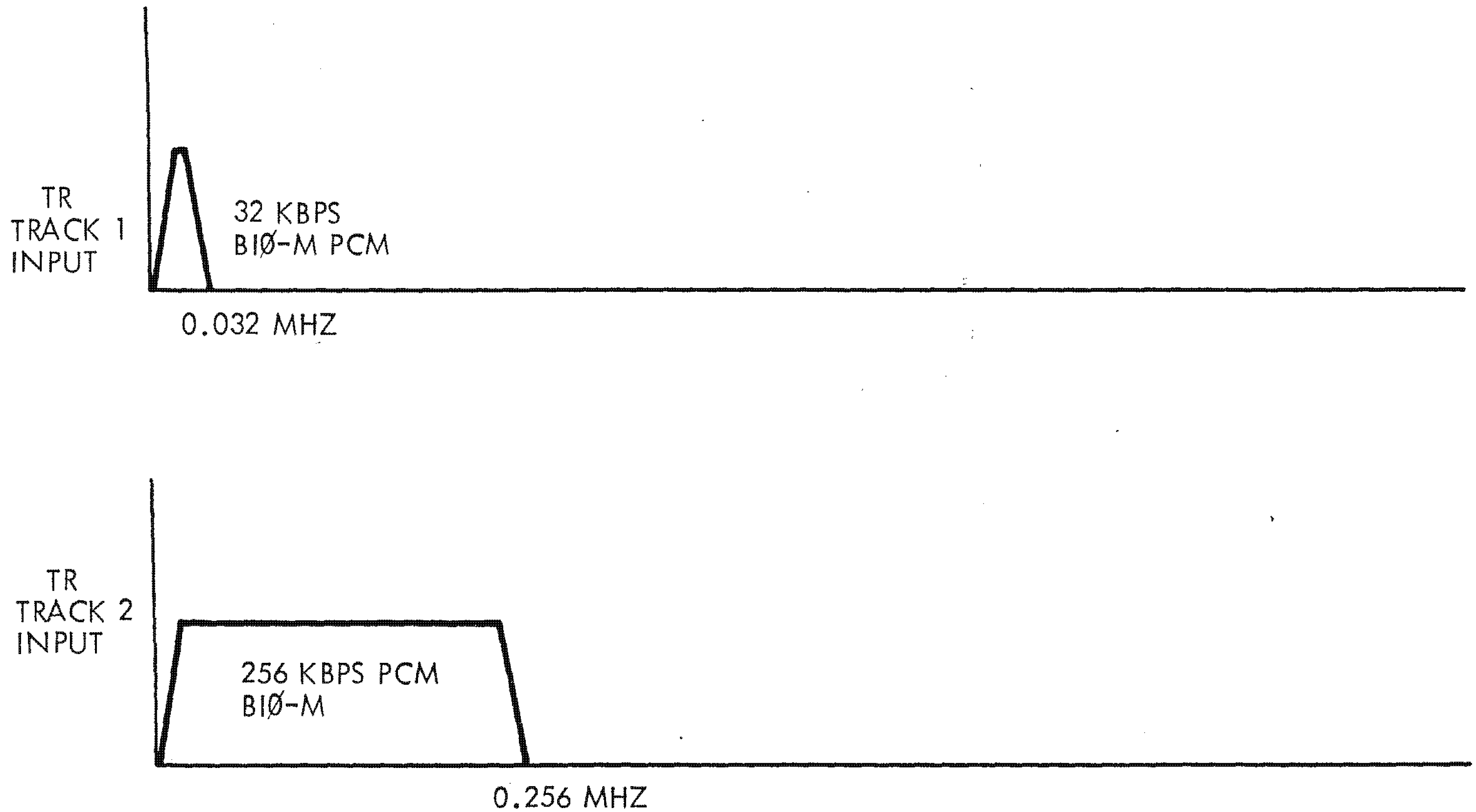
25X1

Fig. 3-13 Payload Downlink Spectrum
Before and After Mode



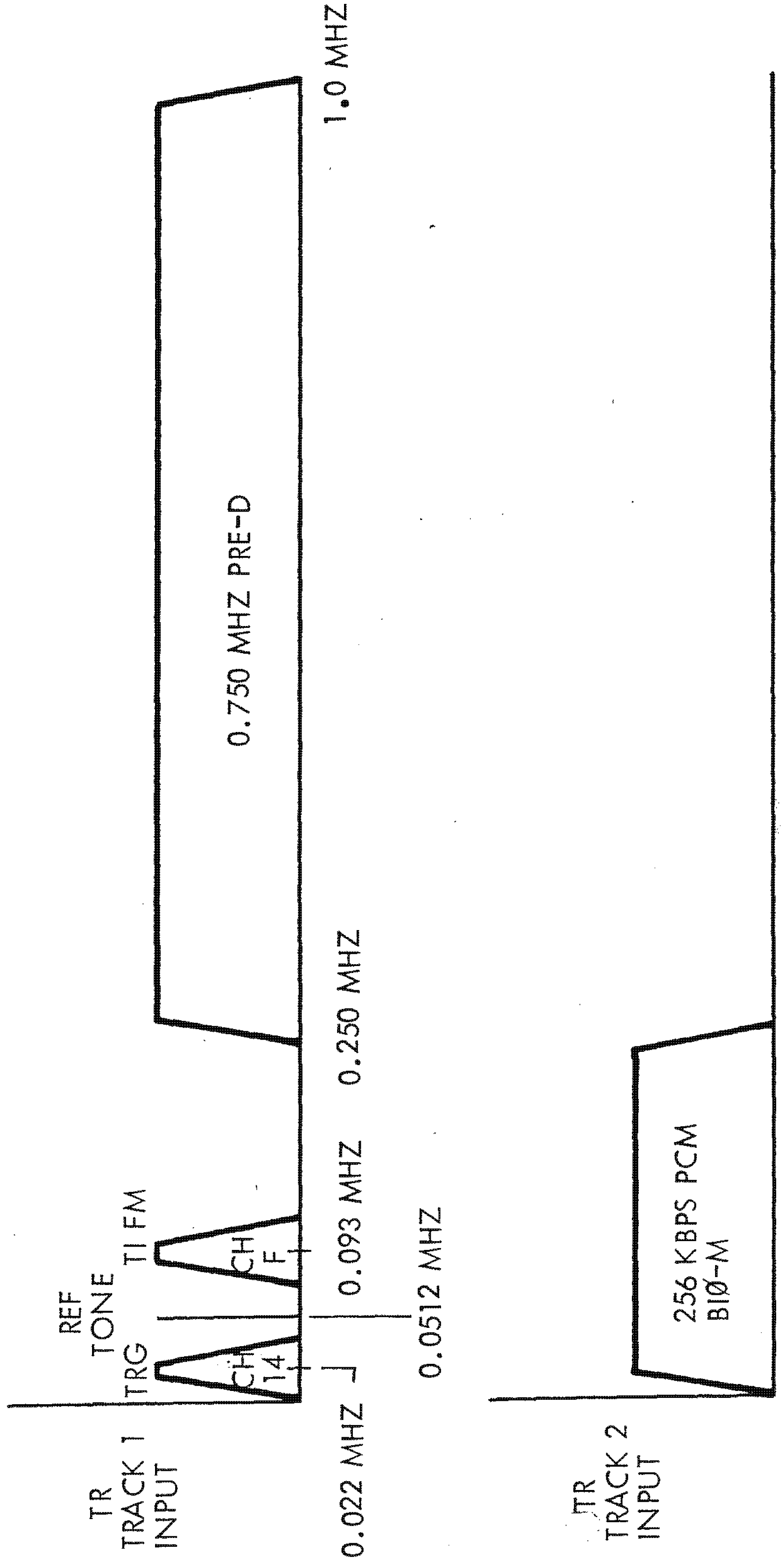

NOTE: MODE 1 RECORD EOB (256/256 AT 4:1)

Fig. 3-14 Single Operation Mode 1




NOTE: MODE 2 – RECORD OBPS TAC (256/4 x 8 AT 4:1) OR
MODE 3 – RECORD OBPS ENGRG (256/32 AT 4:1)

Fig. 3-15 Single Operation Modes 2 and 3




NOTE: MODE 4 – RECORD TI (A/256 AT 1:1)

Fig. 3-16 Single Operation Mode 4

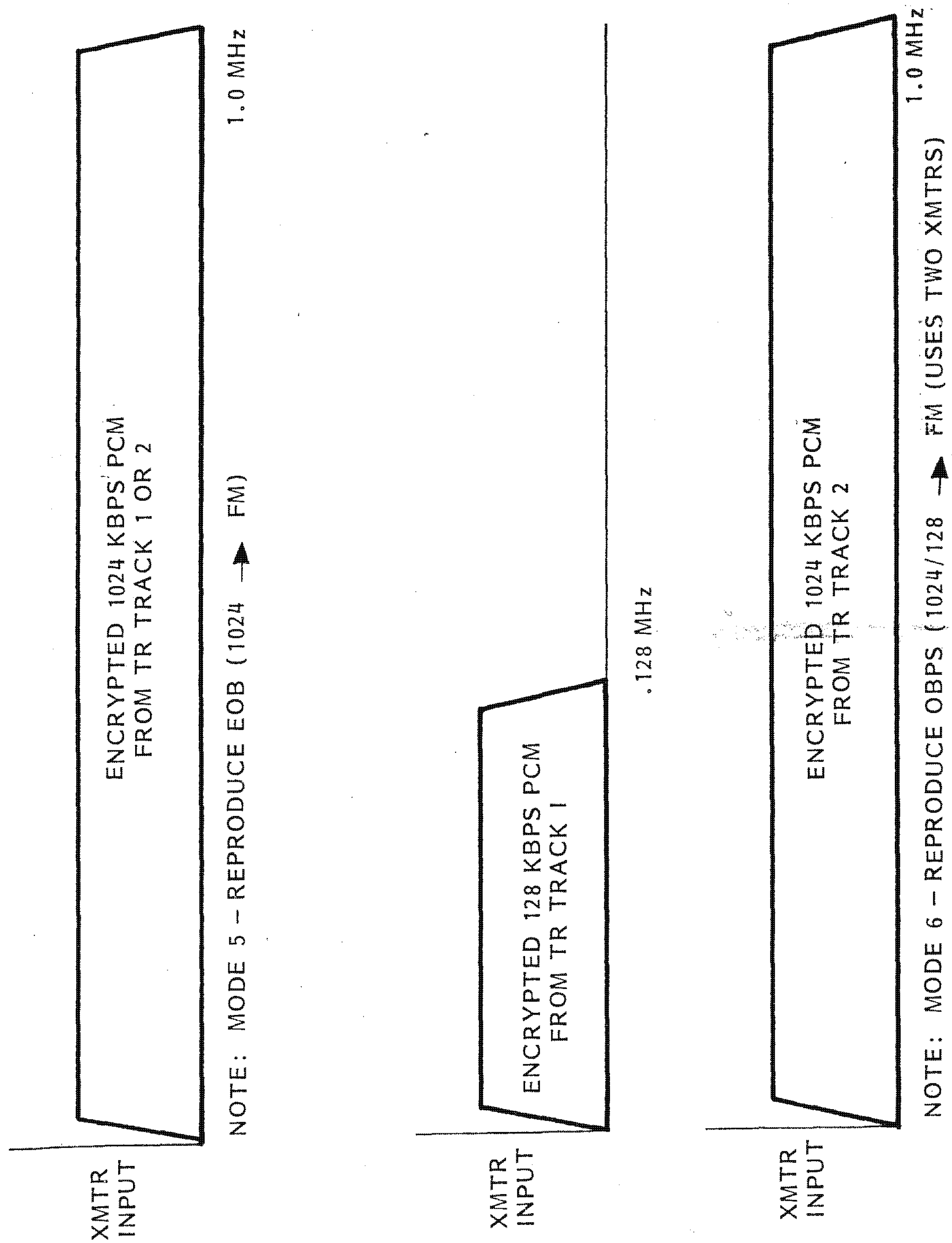
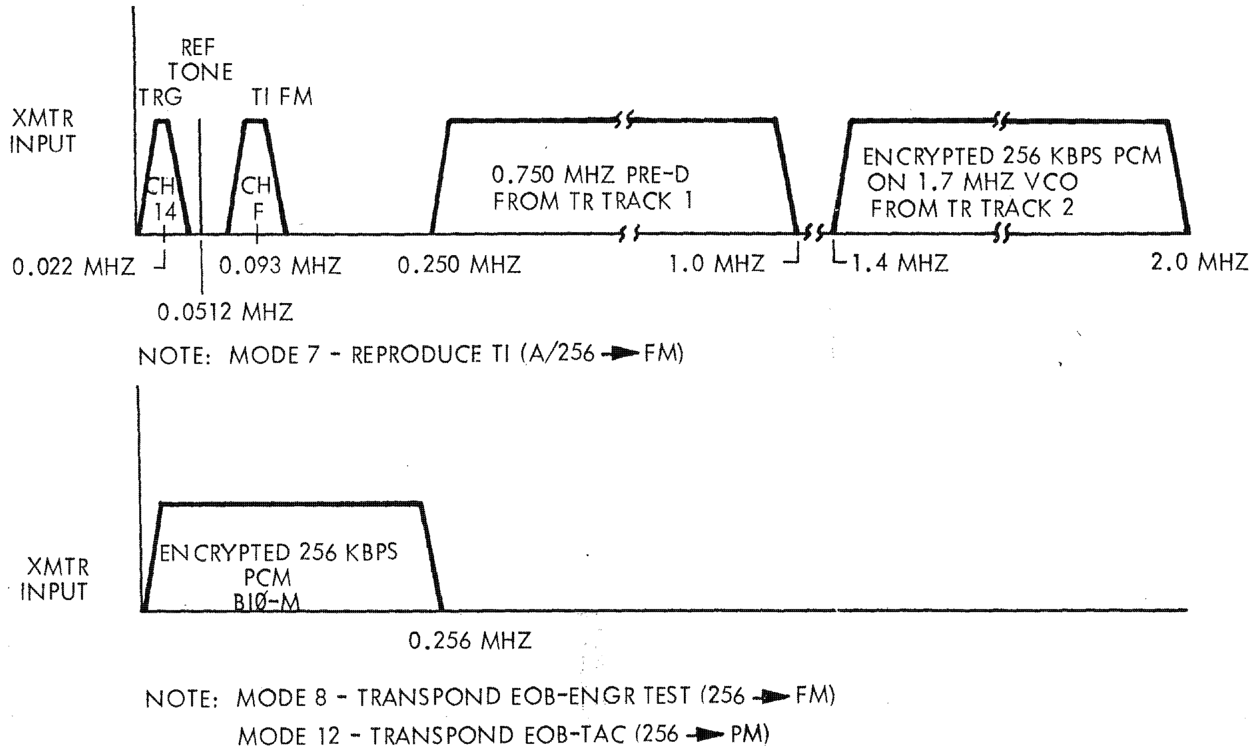
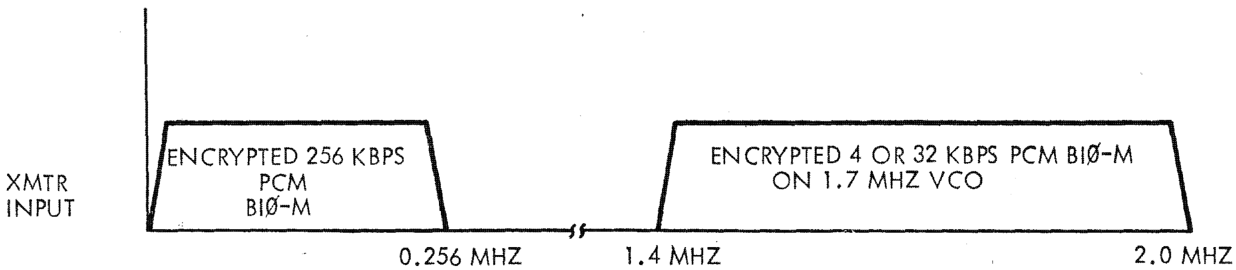



Fig. 3-17 Single Operation Mode 5 and 6

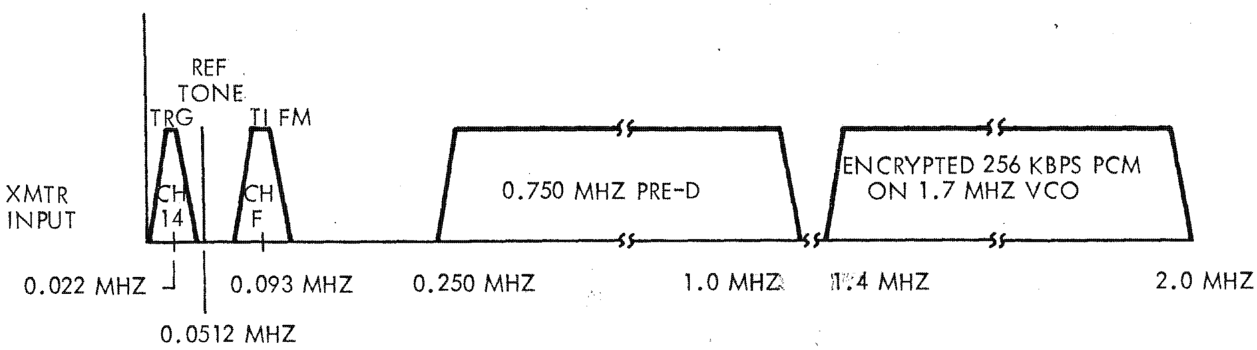



25X1

Fig. 3-18 Single Operation Modes 7, 8, and 12




NOTE: MODE 9 - TRANSPOND OBPS TAC-ENGRG TEST (256/4 → FM)
MODE 10 - TRANSPOND OBPS ENGRG-ENGRG TEST (256/32 → FM)




NOTE: MODE 11 - TRANSPOND TI-ENGR TEST (A/256 → FM)

25X1

Fig. 3-19 Single Operation Modes 9, 10, and 11

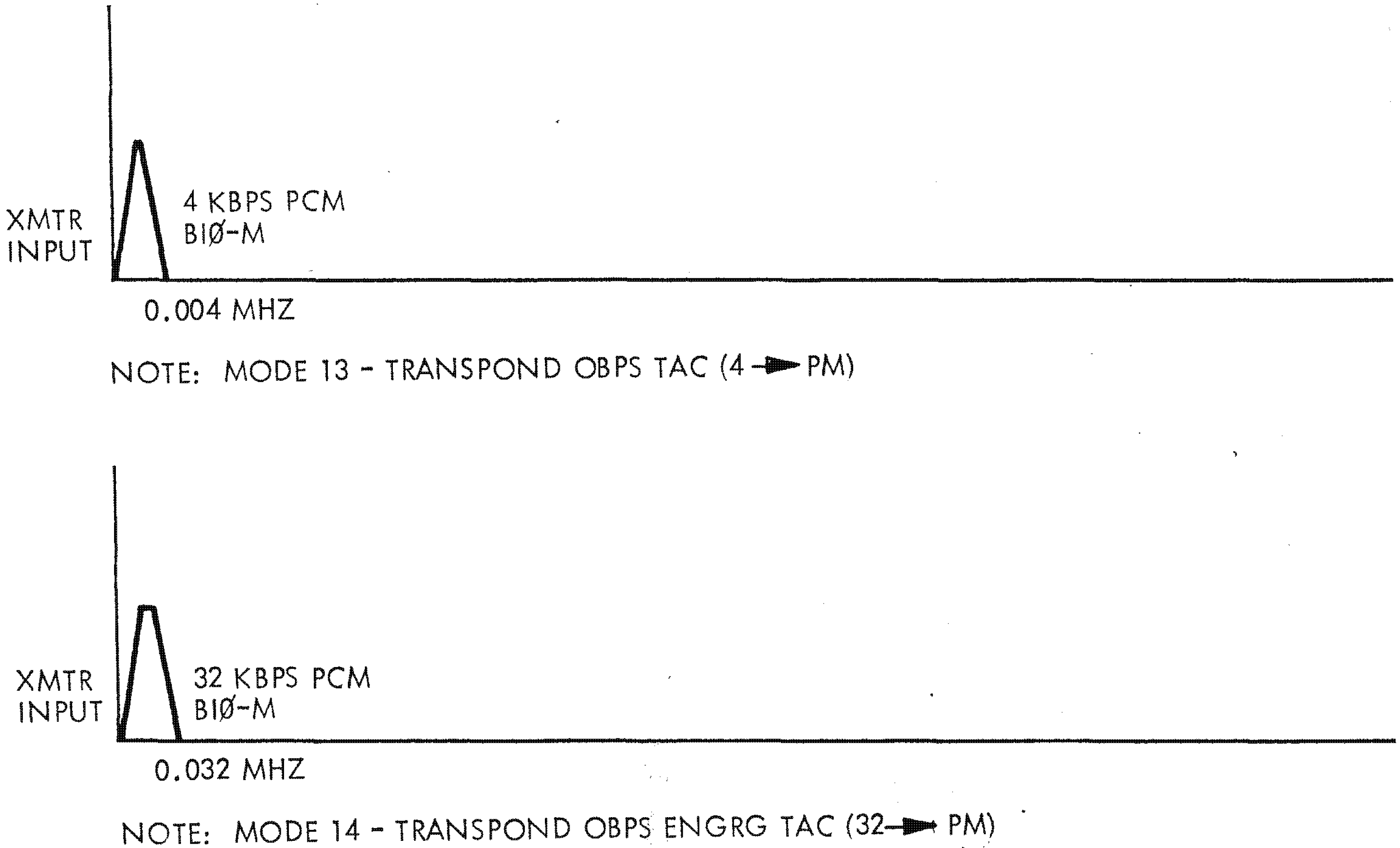



Fig. 3-20 Single Operation Modes 13 and 14

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Table 3-7

DATA COLLECTION AND TRANSMISSION MODES

| | SINGLE OPERATIONS | | MULTIPLE SIMULTANEOUS OPERATIONS | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
| 1. | READIN EOB | (256/256 @ 4:1) | X | | | X | | | | | | | | | | | | | X | | |
| 2. | READIN OBPS TAC | (256/4x8 @ 4:1) | | X | | | X | | | | | | | | | | | | | X | |
| 3. | READIN OBPS ENGRG | (256/32 @ 4:1) | | | X | | | X | | | | | | | | | | | | | X |
| 4. | READIN TI | (A/256 @ 1:1) | X | X | X | | | | | | | | | | | | | | X | X | X |
| 5. | READOUT EOB | (1024 - FM) | | | | | | | X | X | X | * | | | | | | | | | |
| 6. | READOUT OBPS | (1024/128 - FM)** | | | | | | | | | | | | | | | | | | | |
| 7. | READOUT TI | (A/256 - FM) | | | | | | | | | X | | X | X | * | | | | | | |
| 8. | TRANSPOND EOB ENGR TEST | (256 - FM) | | | | | | | X | | | | X | | | X | X | X | | | |
| 9. | TRANSPOND OBPS TAC ENGR TEST | (256/4 - FM) | | | | | | | | | | | | | | | | | | | |
| 10. | TRANSPOND OBPS ENGR TEST | (256/32 - FM) | | | | | | | | | | | | | | | | | | | |
| 11. | TRANSPOND TI ENGR TEST | (A/256 - FM) | | | | | | | | X | | | | X | | | | | | | |
| 12. | TRANSPOND EOB TAC | (256 - PM) | | | | X | | | | | | | | | | X | | | X | | |
| 13. | TRANSPOND OBPS TAC | (4 - PM) | | | | | X | | | | | | | | | | X | | | X | |
| 14. | TRANSPOND OBPS ENGR TAC | (32 - PM) | | | | | | X | | | | | | | | | | X | | | X |

THE FOLLOWING OPTIONS ARE REQUIRED WITH ANY MODE OF OPERATION:

1. TR REWIND (except dual RI or RO modes)
2. STATUS (8KBPS) DATA
3. B&A

* TWO SEPARATE TR RC'S OF THIS MODE

** REQUIRES USE OF TWO TRANSMITTERS FOR THIS MODE

25X1

3-47



BIF003W/B-15661-84

3.2.2 Collection Subsystem

The FARRAH II System, Space Segment Collection Subsystem shall consist of the Signal Intercept Collection Antenna Subsystem BIF003W/2-156657-80, plus the Payload Subsystem BIF003W/2-236117-82.

3.2.2.1 Collection Antenna Subsystem. The collection antennas shall consist of three groups of payload antennas. The antenna groups shall cover the 2 to 6 GHz (low), 6 to 12 GHz (mid), and 12 to 18 GHz (high) collection bands, respectively. Each group shall consist of one high-gain antenna for direction finding and one guard antenna for near-in sidelobe suppression. Additional sidelobe suppression shall be provided by two each omni-directional antennas covering the low, mid, and high bands. The omni-directional antennas shall also be designed for use in collecting signals from horizon-located main beams. The antennas are defined to include the beam-forming networks, coaxial cables, waveguides, and connectors up to the payload interface.

3.2.2.1.1 Payload Antenna A1 (Low-Band). Payload antenna A1 shall consist of a 6-foot diameter, unfurlable parabola fed by a multimode planar log spiral and a beam-forming network. The antenna output shall consist of two channels -- the sum ($\Sigma$) channel and the difference ($\Delta$) channel. These two outputs are fed into the payload. Payload antenna A1 shall operate in the frequency range of 2 to 6 GHz. The sum and difference patterns, taken at the payload/antenna interface shall exhibit a VSWR of 2.0 or less. Payload antenna A1 shall exhibit the nominal characteristics for its sum pattern, gain, and beamwidth as shown in Table 3-8 and shall be such as to permit realization of the system geolocation accuracy of paragraph 3.1.1.1.

3.2.2.1.2 Payload Antenna B1 (Mid-Band). Payload antenna B1 shall consist of a 3-foot-diameter, unfurlable parabola fed by a multimode planar log spiral and a beam-forming network. The antenna output shall consist of two channels, the sum ($\Sigma$) channel and the difference ($\Delta$) channel. These two outputs are fed into the payload. Payload antenna B1 shall operate in the frequency range of 6 to 12 GHz. The sum and difference patterns taken at the payload/antenna interface shall exhibit a VSWR of 2.0 or less. Payload antenna B1 shall exhibit the nominal characteristics for its sum pattern, gain, and beamwidth as shown in Table 3-8 and shall be such as to permit realization of the system geoplocation accuracy of paragraph 3.1.1.1.

3.2.2.1.3 Payload Antenna C1 (High-Band). Payload antenna C1 shall consist of a 3-foot diameter, solid parabola fed by a multimode planar log spiral and a beam-forming network. The antenna output shall consist of two channels -- the sum ($\Sigma$) channel and the difference ($\Delta$) channel. These two outputs are fed into the payload. Payload antenna C1 shall operate in the frequency range of 12 to 18 GHz. The sum and difference patterns taken at the payload/antenna interface shall exhibit a VSWR of 2.0 or less. Payload antenna C1 shall exhibit the nominal characteristics for its sum pattern, gain, and beamwidth as shown in Table 3-8 and shall be such as to permit the realization of the system geolocation accuracy of paragraph 3.1.1.1.

3.2.2.1.4 Payload Omni Antennas A2/A3, B2/B3, and C2/C3. The functions of the payload omni-directional antennas A2/A3, B2/B3, and C2/C3 shall be to protect the high-gain, pencil-beam antennas from intercepts through their own sidelobes and to collect signals from horizon-located main beams.

The payload omni antennas shall consist of four conical spiral antennas A2/B2 and A3/B3, and two biconical horn antennas C2 and C3. The characteristics of the payload omni antenna shall be as shown in Table 3-9 and 3-10.

3.2.2.1.5 Payload Guard Antennas A4, B4, C4. The primary function of the guard antennas shall be to protect the high-gain antennas A1, B1, and C1 from intercepts through their own close-in sidelobes. The absolute gain of each guard antenna shall be sufficient to cover the associated first-order sidelobes. The characteristics of the guard antennas shall be as shown in Table 3-11.

3.2.2.2 Collection Payload Subsystem. The payload shall contain a DF pulse receiver, a DF CW receiver, an omni pulse receiver, an omni CW receiver, a TI receiver, a data handler, a TSG, and a general purpose minicomputer (ASC).

Table 3-8

HIGH-GAIN ANTENNA SUM PATTERN PARAMETERS

| ANTENNA | COLLECTION BAND | | FREQUENCY RANGE (GHz) | MINIMUM ANTENNA GAIN AT PAYLOAD INTERFACE* (dBi)** | MINIMUM HALF POWER BEAMWIDTH** (DEG) |
|---|---|---|---|---|---|
| A1 | LOW | 1 | 2 TO 4 | 25.4 | 3.5 |
| | | 2 | 4 TO 6 | 28.5 | 2.1 |
| B1 | MID | 3 | 6 TO 8 | 25.9 | 3.0 |
| | | 4 | 8 TO 10 | 27.2 | 2.3 |
| | | 5 | 10 TO 12 | 28.2 | 1.9 |
| C1 | HIGH | 6 | 12 TO 14 | 35.5 | 1.6 |
| | | 7 | 14 TO 16 | 36.2 | 1.4 |
| | | 8 | 16 TO 18 | 36.6 | 1.2 |

* GAIN TO MATCHED POLARIZATION

** AS MEASURED AT MID-BAND

Table 3-9

LOW-GAIN OMNI ANTENNA PATTERN PARAMETERS

| ANTENNA | COLLECTION BAND | | FREQUENCY RANGE (GHz) | MINIMUM ANTENNA GAIN AT PAYLOAD INTERFACE (dBi)* | MINIMUM HALF POWER BEAMWIDTH |
|---|---|---|---|---|---|
| A2/A3 | LOW | 1 | 2 TO 4 | -0.4 | |
| | | 2 | 4 TO 6 | -1.3 | 150° AT 6 GHz |
| B2/B3 | MID | 3 | 6 TO 8 | -1.5 | |
| | | 4 | 8 TO 10 | -2.1 | |
| | | 5 | 10 TO 12 | -3.0 | |
| C2 | HIGH | 6 | 12 TO 14 | +0.9 | 40° AT 12 GHz |
| | | 7 | 14 TO 16 | +1.4 | |
| | | 8 | 16 TO 18 | +1.9 | |
| C3 | HIGH | 6 | 12 TO 14 | +1.1 | |
| | | 7 | 14 TO 16 | +1.6 | 40° AT 12 GHz |
| | | 8 | 16 TO 18 | +2.1 | |

* GAIN MEASURED AT MID-BAND TO MATCHED POLARIZATION

Table 3-10

LOW-GAIN ANTENNA AXIAL RATIOS

| FREQ GHZ | A2/A3 ANTENNA θ (DEGREES) | | | | | |
|---|---|---|---|---|---|---|
| | 0-30 | 30-60 | 60-90 | 90-120 | 120-150 | 150-180 |
| 2 TO 6 | 2 | 3 | 5 | 5 | 3 | 2 |

| FREQ GHZ | B2/B3 θ (DEGREES) | | | | | |
|---|---|---|---|---|---|---|
| | 0-30 | 30-60 | 60-90 | 90-120 | 120-150 | 150-180 |
| 6 | 2 | 3 | 5 | 5 | 3 | 2 |

| FREQ GHZ | B2/B3 θ (DEGREES) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-20 | 20-45 | 45-70 | 70-80 | 80-100 | 100-110 | 110-135 | 135-160 | 160-180 |
| 12 | 2 | 4 | 6 | 8 | 10 | 8 | 6 | 4 | 2 |

| FREQ GHZ | C2/C3 θ (DEGREES) | | | | |
|---|---|---|---|---|---|
| | 25-35 | 35-55 | 55-125 | 125-145 | 145-155 |
| 12 | 10 | 4 | 2 | 4 | 10 |
| | 25-45 | 45-60 | 60-120 | 120-135 | 135-155 |
| 18 | 13 | 4 | 2 | 4 | 13 |

25X1

Table 3-11

GUARD ANTENNA PATTERN PARAMETERS

| ANTENNA | COLLECTION BAND | | FREQUENCY RANGE (GHz) | MINIMUM ANTENNA GAIN AT PAYLOAD INTERFACE* (dBi) | HALF POWER BEAMWIDTH (DEG)** |
|---|---|---|---|---|---|
| A4 | LOW | 1 | 2 TO 4 | 12.8 | 30 |
| | | 2 | 4 TO 6 | 16.1 | 18 |
| B4 | MID | 3 | 6 TO 8 | 13.5 | 26 |
| | | 4 | 8 TO 10 | 15.1 | 20 |
| | | 5 | 10 TO 12 | 16.3 | 16.5 |
| C4 | HIGH | 6 | 12 TO 14 | 19.0 | 16 |
| | | 7 | 14 TO 16 | 19.9 | 14 |
| | | 8 | 16 TO 18 | 20.8 | 12 |

* GAIN TO MATCHED POLARIZATION AND GAIN MEASURED AT MID-BAND

** AS MEASURED AT MID-BAND

Each of the receivers shall provide coverage of the entire frequency range from 2 to 18 GHz. Instantaneous frequency coverage shall be nominally 2 GHz, and there shall be no frequency coverage gaps between adjacent bands. The DF pulse/CW receivers shall cover the same 2-GHz band. The omni pulse/CW receivers shall cover the same 2-GHz band and shall be independent of the DF receivers.

3.2.2.2.1 Pulse Receivers. The DF pulse receiver shall consist of five RF/IF channels - two DF (sum and difference) channels plus three inhibit (guard, omni M, and omni P) channels. The omni pulse receiver shall consist of two RF/IF channels (omni M and omni P). The following specifications shall apply to both the DF pulse receiver and the omni pulse receiver unless otherwise specified.

3.2.2.2.1.1 Frequency Measurement. The frequency of pulsed signals shall be measured unambiguously on a single-pulse basis to an accuracy of ±1.56 MHz, and with a resolution of 1 MHz over the entire 2-GHz instantaneous bandwidth. The pulse frequency measurement (PFM) subsystem shall be capable of measuring frequencies of emitters that transmit pulses simultaneously* on one or more frequencies. Up to and including three frequencies for DF and two frequencies for OMNI from a simultaneous-frequency emitter shall be detected, provided that the minimum frequency separation between adjacent signals is 65 MHz, and also provided that the power at each frequency is within 10 dB of the total received peak pulse power.

The 2-GHz instantaneous IF bandwidth shall be divided into sixty-four 31.25-MHz intervals which can be independently enabled or disabled in each of the eight DF bands and each of the two omni program steps.

3.2.2.2.1.2 Sensitivity. The 50 percent probability of detection at a false alarm rate of less than one per second for a 0.1 usec pulse shall be as indicated in Table 3-12.

* In this context, simultaneous refers to pulses whose leading and trailing edges are time coincident.

Table 3-12

PULSE RECEIVER SENSITIVITY (4)

| Band | DF Pulse Sensitivity Maximum | (1) | Omni M&P Pulse Sensitivity (2) Maximum |
|---|---|---|---|
| 1 (3) | -77 | -70 | -77 |
| 2 (3) | -76 | -69 | -76 |
| 3 | -76 | -69 | -76 |
| 4 | -76 | -69 | -76 |
| 5 | -76 | -69 | -76 |
| 6 | -75 | -68 | -75 |
| 7 | -75 | -68 | -75 |
| 8 | -74 | -67 | -74 |

(1) Sensitivity with enhanced inhibit commanded

(2) The omni sensitivity shall be adjustable on a program step basis in three 7-dB steps

(3) A decrease of 4.5 dB in sensitivity shall be allowed at the crossover where diplexers are used between bands 1 and 2 in the frequency range from 3.9 to 4.1 GHz.

(4) dBm at PW = 0.1usec

3.2.2.2.1.3 Power Amplitude (PA). The pulse receivers shall measure the total power in a 2-GHz bandwidth associated with intercepted signals over a 35-dB range with a resolution of 0.6 dB. The reported amplitude shall be accurate within ±2.9 dB over the first 15 dB of dynamic range and within ±1.52 dB for signals greater than or equal to 15 dB above threshold.

[redacted]



3.2.2.2.1.5 Pulsewidth (PW) Measurement. The subsystem will measure pulsewidth to an accuracy of ±0.1 usec or ±10 percent of the pulsewidth, whichever is greater. This specification shall be met for all pulsewidths from 0.1 to 100 usec provided that the subsystem pulsewidth threshold has been exceeded. Pulses longer than 100 usec shall be reported as having a pulsewidth exceeding 100 usec.

3.2.2.2.1.6 Dynamic Range. Except as specifically noted, the subsystem will meet all requirements throughout an input signal dynamic range of 35 dB. For each band, the lower limit of dynamic range is established by the poorest sensitivity point in each band. The subsystem must be capable of meeting measurement requirements for the following measurements within the above dynamic range:

a. Peak power measurement
b. Pulse [redacted]
c. Pulse frequency measurement
d. Pulsewidth (may have 4 dB less dynamic range)
e. DF parameters (except as noted in paragraph 3.2.2.2.1.8)*



The subsystem shall also meet all inhibit function and spurious signal rejection requirements over the specified dynamic range.

* DF parameter, applies to DF channel only

3.2.2.2.1.7 Minimum Pulse Spacing Requirements. The intercept subsystem shall be capable of meeting all measurement specifications on every pulse which meets inhibit and/or threshold criteria, provided that the minimum interval between pulses is 2.3 usec and there is no conflict with other data inputs to the buffer memory. The minimum interval between pulses is defined herein as the time between the trailing edge of one pulse and the leading edge of the following pulse. The measurements required are as follows:

a. Power amplitude (PA)
b. [redacted] 25X1
c. Pulsewidth (PW)
d. Pulse frequency
e. RF band (RFB)
f. Log ($\Sigma/\Delta$)*
g. Log (A/B)*
h. Log (C/D)*
i. Data flags (RT1, etc.)*

3.2.2.2.1.8 DF Requirements

a. DF Antenna Sidelobe Inhibits

(1) Omni Inhibit. The DF subsystem shall totally inhibit the processing of signals for which the postdetection amplitude in the sum channel does not exceed $K_p$ times the individual postdetection amplitudes of the two omni channels. Two values for $K_p$ shall be provided for each of the omni outputs (omni M and omni P). The value assigned to $K_p$ shall be commandable on a per band basis.

(2) Guard Inhibit. The DF subsystem shall totally inhibit the processing of signals for which the postdetection amplitude in

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* DF Parameter, applies to DF channel only

the sum channel does not exceed $G_p$ times the postdetection amplitude in the guard channel. Two values for $G_p$ shall be provided. The value assigned to $G_p$ shall be commandable on a per band basis.

b. Monopulse Direction Finding. The DF subsystem shall be capable of reporting three direction-finding measurements on each detected pulse: $\log \Sigma/\Delta$, $\log A/B$, and $\log C/D$. Log $\Sigma/\Delta$ shall be determined by amplitude comparison of the sum and difference channels. The A, B, C, and D channels shall be obtained by combining the sum and difference signals prior to detection according to the following relationships:

$$A = K \ (\Sigma + \Delta)$$
$$B = K \ (\Sigma - \Delta)$$
$$C = K \ (\Sigma - j\Delta)$$
$$D = K \ (-j\Sigma + \Delta)$$

Where $(\Sigma)$ and $(\Delta)$ indicate phasor notation, j is the complex operator, and K is a scalar constant.

c. DF Signal Measurement Accuracy. The mean reported values of the A/B C/D, and $\Sigma/\Delta$ ratios for an arbitrary, fixed phase and $\Sigma/\Delta$ ratio shall vary no more than $\pm 0.5$ dB over the dynamic range specified, provided that:

(1) A and B (or C and D) are both above their threshold, log A/B (or log C/D ) is less than 16 dB, $\Sigma/\Delta$ ratio is greater than +2 dB.

(2) $\Delta$ is above threshold, the $\Sigma/\Delta$ ratio is between +2 dB and +28 dB.

3.2.2.2.1.9 Outputs. The pulse receiver outputs shall be digitized with quantum steps sufficient to meet all specifications defined in Section 3.2.2.2.1.

3.2.2.2.1.10 TI Pulse Receiver Handover. The subsystem shall have the capability of generating or inhibiting pulse handovers within any one of three command-selectable frequency ranges. The frequency range shall be independently commanded within the selected 2-GHz frequency band for the eight DF pulse or two omni program steps. In addition, a commandable pulsewidth range shall further accept or reject signals within the accept frequency intervals. Upon encoding a valid pulse intercept that meets the TI receiver recognition criteria, a frequency word shall be reported to the TI receiver.

3.2.2.2.2 CW Receivers. The DF CW receiver shall consist of five RF/IF channels, two DF (sum and difference) channels, plus three inhibit (guard, omni M, and omni P) channels. The omni CW receivers shall consist of two RF/IF channels (omni M and omni P). The selected 2-GHz band in each receiver shall be searched bidirectionally three times every 5 milliseconds (maximum).

The following specifications shall apply to both the DF CW receiver and the omni CW receiver unless otherwise specified:

3.2.2.2.2.1 CW Frequency Measurement. The frequency of CW emitters shall be measured to an accuracy of 4.4 MHz and a resolution of 4.0 MHz anywhere within the 2-GHz RF band being searched.

3.2.2.2.2.2 Sensitivity. The 50 percent probability of detection at a false alarm rate of less than one per second shall be as indicated in Table 3-13.

3.2.2.2.2.3 Power Amplitude (PA). Received CW amplitude in the sum channel shall be measured to an accuracy of ±3.26 dB over the first 15 dB of the dynamic range, and to ±1.96 dB for signals greater than or equal to 15 dB above threshold. The nominal resolution shall be 0.75 dB.

3.2.2.2.2.4 Time of Measurement (TOM). The time at which a CW signal is detected shall be measured to an accuracy of ±10 usec or better and reported at a resolution of 1 usec.

Table 3-13

CW SENSITIVITY

| Band | DF CW Sensitivity (dBm) | Omni M & P CW Sensitivity (dBm) |
|---|---|---|
| 1 (1) | -97 | -97 |
| 2 (1) | -96 | -96 |
| 3 | -96 | -96 |
| 4 | -96 | -96 |
| 5 | -96 | -96 |
| 6 | -95 | -95 |
| 7 | -95 | -95 |
| 8 | -94 | -94 |

(1) A decrease of 4.5 dB in sensitivity shall be allowed at the crossover where diplexers are used between bands 1 and 2 in the frequency range from 3.9 - 4.1 GHz.

3.2.2.2.2.5 Rejection of Pulse Signals. The CW receiver shall search the 2-GHz IF bandwidth in approximately 1.5 msec. Pulse signals with pulsewidths less than 4.0 microseconds shall not be recognized. Signals which have been recognized with pulsewidths less than 4.0 microseconds shall be inhibited. The pulsewidth inhibit may be deleted by command.

3.2.2.2.2.6 Dynamic Range. The requirements of the CW frequency, TOM, and power amplitude measurements shall be met over a sum channel input dynamic range of 45 dB. For each band, the lower limit on dynamic range shall be established by the minimum sensitivity in each band.

3.2.2.2.2.7 DF Requirements

a. DF Antenna Sidelobe Inhibits

(1) Omni Inhibit. The DF CW subsystem shall totally inhibit the processing of signals for which the post detection amplitude in the sum channel power does not exceed $K_c$ times the combined amplitude, after detection, in the two omni channels. Two values for $K_c$ shall be provided. The value assigned to $K_c$ shall be commandable on a per band basis.

(2) Guard Inhibit. The DF CW subsystem shall totally inhibit the processing of signals for which the post detection amplitude in the sum channel power does not exceed $G_c$ times the post detection amplitude in the guard channel. Two values of $G_c$ shall be provided. The value assigned to $G_c$ shall be commandable on a per band basis.

b. Monopulse DF. The DF subsystem shall be capable of reporting three DF measurements on each detected signal: log $\Sigma/\Delta$, log A/B and log C/D. Log $\Sigma/\Delta$ shall be determined by amplitude comparison of the sum and difference channels. Measurements shall be made in the narrowband CW IF. The A, B, C, and D channels shall be obtained by combining the sum difference signals prior to detection according to the following relationships:

$$A = K\ (\Sigma + \Delta)$$
$$B = K\ (\Sigma - \Delta)$$
$$C = K\ (\Sigma - j\Delta)$$
$$D = K\ (-j\Sigma + \Delta)$$

where ( $\Sigma$ ) and ( $\Delta$ ) indicate phasor notation, j is the complex operator, and K is a scalar constant.

c. <u>DF Signal Measurement Accuracy</u>. The mean reported values of the A/B, C/D, and $\Sigma/\Delta$ ratios for any arbitrary, fixed phase and $\Sigma/\Delta$ ratio shall vary no more than $\pm 1$ dB over the dynamic range specified, provided that:

(1) A and B (or C and D) are both above their threshold, log A/B (or log C/D ) is less than 16 dB, $\Sigma/\Delta$ ratio is greater than +2 dB.

(2) $\Delta$ is above threshold, the $\Sigma/\Delta$ ratio is between +2 dB and 28 dB.

3.2.2.2.2.8 <u>CW Data Control</u>. The CW receiver shall have the capability of accepting or rejecting signals within any one of five command-selectable frequency ranges. The frequency ranges shall be independently commanded within the 2-GHz frequency range for the eight DF CW or omni CW frequency bands. Regions designated as the accept regions shall also be capable of either generating or inhibiting frequency handovers to the TI receiver. This option shall be commandable in each of the eight DF bands and each of the two omni program steps.

3.2.2.2.2.9 <u>Outputs</u>. The CW receiver outputs shall be digitized with quantum steps sufficient to meet all specifications defined in Section 3.2.2.2.2.

3.2.2.2.2.10 TI CW Receiver Handover. Upon encoding a valid CW intercept that meets the TI receiver handover criteria, a frequency word shall be reported to the TI receiver.

3.2.2.2.3 TI Receiver. The TI receiver subsystem shall provide predetection information on either CW signals in a 750-kHz instantaneous bandwidth or on CW/pulsed signals in a 10-MHz bandwidth by a bandwidth/time exchange technique in which a high-speed analog-to-digital conversion of the input signal is stored in memory; then a low-speed digital to analog conversion is filtered and output in a 750-kHz bandwidth. In its primary mode of operation, the TI receiver shall be directly linked through a downconverter to either the DF antenna or one of the omni antennas. This source selection shall be controlled by the DF CW, DF pulse, omni CW, or omni pulse subsystem in a frequency-handover mode. The TI receiver shall also be operable in an independent mode called the fixed-frequency-assignment mode. The relative priority of the TI receiver for use on pulse or CW signals shall be determined by command and shall apply for a command execute interval.

3.2.2.2.3.1 TI Receiver Operational Configuration. The assignment of the TI receiver for signals in the handover mode to process CW and/or pulse signals in the DF and/or omni channels shall be determined by command memory load. The selectable handover options shall be as indicated in Table 3-14. Omni processing shall be accomplished on signals in the omni channel (omni M or omni P) containing the highest amplitude at the time the handover occurs. If the TI receiver is currently processing a signal, a handover of higher priority (as described in Table 3-15) shall cause an immediate pre-empting of a lower priority signal.

The antenna/receiver source assignment for the TI receiver in the fixed-frequency assignment mode and during periods of no activity in the frequency handover mode (priority 5 in Table 3-14) shall be determined by command memory loads. The selectable options for the antenna/receiver shall be as indicated in Table 3-15.

Table 3-14

HANDOVER OPTIONS

| | Priority | | | | |
|---|---|---|---|---|---|
| Option | DF Pulse | DF CW | Omni Pulse | Omni CW | Fixed Freq Assignment |
| 1 | 1 | 2 | 3 | 4 | 5 |
| 2 | 2 | 1 | 4 | 3 | 5 |
| 3 | 3 | 4 | 1 | 2 | 5 |
| 4 | 4 | 3 | 2 | 1 | 5 |
| 5 | 1 | 2 | None | None | 3 |
| 6 | 2 | 1 | None | None | 3 |
| 7 | None | None | 1 | 2 | 3 |
| 8 | None | None | 2 | 1 | 3 |
| 9* | None | None | None | None | 1 |

* Fixed Frequency Assignment Mode

Table 3-15

FIXED FREQUENCY MODE

| Option* | Channel | Signal Type |
|---|---|---|
| 1 | DF | Pulse |
| 2 | DF | CW |
| 3 | Omni | Pulse |
| 4 | Omni | CW |
| 5 | DF | Pulse |
| 6 | DF | CW |
| 7 | Omni | Pulse |
| 8 | Omni | CW |
| 9A | DF | Pulse |
| 9B | DF | CW |
| 9C | Omni | Pulse |
| 9D | Omni | CW |

* Handover Option from Table 3-14

3.2.2.2.3.1.1 Fixed-Frequency Assignment Mode/State. The coarse frequency step to which the TI receiver tunes in the fixed-frequency assignment mode or during periods of no activity in the frequency handover mode shall be set by command memory. The available coarse frequency steps shall be spaced at 1-MHz increments across the 2-GHz frequency range in each of the eight DF bands and each of two omni program steps. Once the receiver has been coarse-tuned to the commanded frequency the receiver shall proceed to the IF sweep state.

The TI receiver shall be fixed-tuned to the commanded frequency in the band, which is assigned to the current DF program step if the TI source is commanded to the DF antenna or fixed-tuned to the commanded frequency in the band which is assigned to the current omni program step is the source is commanded to either the omni M or the omni P antenna.

3.2.2.2.3.1.2 Frequency Handover Mode/CW Tuning Procedure. In the frequency handover mode of operation the TI receiver shall respond directly to frequency and antenna data handed over from the DF pulse, DF CW, omni pulse, or omni CW receiver. Frequencies shall be handed over in the form of a digital code that represents the frequency of the intercepted signal. The handover shall be tested by logic within the receiver that determines if the receiver can accept that particular handover based upon its priority. If the receiver is already busy processing another signal at the moment, it shall not accept the new handover signal unless the new signal has priority over the signals currently being processed. CW handovers which pass these tests shall be accepted for coarse tuning. Pulse handovers which pass these tests shall be tuned directly to the handover frequency with no further tuning and shall proceed to the wideband analysis state.

a. Coarse Tuning State

Coarse tuning to an accepted handover shall be accomplished by tuning a 13-MHz bandwidth to the handover frequency, then $\pm 4.0$ MHz about the handover frequency. The receiver shall then tune to the step with the highest signal amplitude above the wideband threshold ($TH_{WB}$).

If the signal is also above the counter threshold ($TH_{CNT}$) the digital counter shall be enabled. The counter output shall be referred to as $C_{OUT}$. Signals which have been tuned and are above the wideband threshold shall proceed to the IF sweep state. If the handover signal fails to exceed the wideband threshold, the receiver shall terminate and return to the fixed frequency assignment state. Upon leaving the coarse tuning state an INITIALIZATION IWG shall be output.

b. <u>IF Sweep State</u>

In the IF sweep state, the receiver shall step across the 13-MHz bandwidth in 100-kHz increments in approximately 1 msec. At each step of the sweep the narrowband threshold ($TH_{NB}$) output shall be monitored. The first and last step in which the narrowband threshold is exceeded shall be noted. The frequency associated with the first threshold crossing shall be referred to as $F_{MIN}$ and the frequency associated with the last threshold crossing $F_{MAX}$, $(F_{MAX} - F_{MIN})/2$ shall be referred to as $F_{AVG}$. When $(F_{MAX} - F_{MIN})$ 700 kHz and $F_{AVG} - C_{OUT}$ 200 kHz or $C_{OUT}$ is not available the receiver shall proceed to one of three states: the fixed-tune state, the wideband analysis state, or the fixed frequency assignment state. This selection shall be set by command memory for a memory execute interval. When $F_{MAX} - F_{MIN}$ 700 kHz or $F_{AVE} - C_{OUT}$ 200 kHz the receiver shall proceed to the wideband analysis state.

When none of the steps exceed the narrowband threshold, the receiver shall output an end of DWELL IWG and either initiate a dwell timer and continue to search for a signal in the IF sweep rate for the dwell period before returning to the fixed-frequency assignment state, or return to the fixed-frequency assignment state immediately. This option shall be set by command memory for a memory execute interval.

The TI receiver shall be capable of processing two DF signals per program step with a maximum of six signals. The only restriction shall be that the intercepted signals be from different parts of the spin with no more than two in the period associated with every third program step. The band, priority, frequency, and receiver state shall be stored in the dwell memory. The receiver shall then return to the frequency and receiver state directly on each spin for four spins. This process shall be referred to as a dwell chain. Upon completion of a dwell the receiver shall return to the fixed frequency assignment state. A chain shall be broken if another overlapping chain has been established by a higher priority signal, or if the chain is established by a higher priority signal and no dwell timers are available. The DF dwell period shall be 40 msec.

Omni handover which progress to either the wideband analysis state or the fixed tune state shall dwell for a period of two seconds if the signal remains above $TH_{NB}$ or until the signal is below $TH_{NB}$ for two consecutive sample periods (4 msec). The omni dwell shall be foreshortened by a higher priority handover or an omni program step.

c. Wideband Analysis State

(1) Pulse Signals. Pulsed signals which exceed the TI pulse threshold $TH_{TIP}$ shall be bandwidth compressed, then readout to the data control unit (DCU). The input sample duration of the bandwidth compressor shall be determined by command memory in each of the eight DF bands and each of the two omni program steps if the maximum input sample duration is designated as $S_{MAX}$, then $S_{MAX}$ shall be greater than or equal to 250 microsecond. The readin sample increments shall be $S_{MAX}/(2)^N$, where N = 0 through 7.

The minimum cycle time for the bandwidth compressor shall be approximately 162 + (readin duration x 14.3) microseconds. The TI receiver shall output a PULSE DWELL IWG at the beginning of each readin cycle. The bandwidth compressor shall continue to sample pulses which exceed $TH_{TIP}$ for the entire dwell period if not pre-empted by a higher priority signal.

(2) CW Signals. CW signals shall have two optional techniques for wideband analysis, either bandwidth compressor (BWC) or spectrum analysis. The analysis technique shall be determined by command and shall remain constant during a memory execute interval.

The BWC shall provide the capability to sample the 10-MHz BW video signal output from the TI receiver at a 32.768-mega-sample-per-second rate. Sampling shall be done using a 6-bit analog-to-digital converter (with sample and hold). Samples shall be stored in a memory of 32K words. Readout of the memory shall be at a 2.458-mega word-per-second rate achieving a 16 to 1 data bandwidth compression ratio. The output words shall be converted to a 64-level pulse amplitude modulation (PAM) signal, band limited from 0.25 to 1 MHz.

Spectrum analysis of a CW signal shall be accomplished by a continuous linear sweep of the 13-MHz IF bandwidth at a 1-msec rate during the entire dwell period if not pre-empted by a higher priority signal. The system shall output a CW DWELL IWG if $TH_{NB}$ has been exceeded in any two sweep periods (approximately two msec). If the CW BWC analysis technique is selected, the CW signal will be sampled for $S_{MAX}$ usec and then read out to the DCU. The read/write cycle shall continue for the entire dwell period if not pre-empted by a higher priority signal. The system shall output a CW DWELL IWG at the beginning of each readin cycle.

Upon completion of dwell of either CW or pulsed signals, the receiver shall output an END OF DWELL IWG and return to the fixed-frequency assignment state if the system has been commanded to the frequency handover mode, or to the IF sweep state if the system has been commanded to the fixed-frequency mode.

d. Fixed Tune State

The TI receiver shall tune to $F_{AVG}$ and initiate a timer which causes the signal to be sampled, and data for a CW DWELL IWG to be output every 2 msec if the signal is above narrowband threshold ($TH_{NB}$). The receiver shall remain in this state for one dwell period if not pre-empted by a higher priority signal. Upon completion of the dwell, the receiver shall output an END OF DWELL IWG and return to the fixed-frequency assignment state if the system has been commanded to the frequency handover mode, or the IF sweep state if the system has been commanded to the fixed-frequency mode.

3.2.2.2.3.2 TI Outputs. The TI analog outputs shall be as follows:

a. The TI predetection (pre-D) output from the TI receiver shall be the 0.75-MHz bandwidth output of the receiver in fixed-tuned or spectrum analysis state, or the 0.75-MHz bandwidth output of the bandwidth compressor (0.25 to 1 MHz).

b. A time reference generator shall modulate an IRIG channel 14 voltage-controlled oscillator.

c. A 51.2 kHz reference tone

d. A 20-bit, 256-kbps sync code shall be provided after each sweep of the TI receiver in the spectrum analysis state and a 41-bit, 256-kbps sync code at the end of each bandwidth compressor cycle. The 256-kbps sync code and the 51.2-kHz reference tone shall be coherent.

e. A DC-coupled output from a frequency discriminator on the 13-MHz IF which is low-pass filtered (postdetection) at 10 kHz shall modulate an IRIG channel F voltage-controlled oscillator. This output is a command option.

f. The TI receiver shall provide digitized word group information to the data handler.

3.2.2.2.3.3 Specifications. TI subsystems shall be as specified below.

a. Frequency Coverage. The TI receiver shall provide coverage of the entire RF range from 2 to 18 GHz. It shall be capable of operating on a different 2-GHz band than either the DF subsystem or the omni subsystem.

b. Dynamic Range Analog Outputs

| | |
|---|---|
| (1) Pre-D linear output | 20 dB |
| (2) Pre-D logarithim output | 45 dB |
| (3) Pre-D hard-limited output | 45 dB |
| (4) BWC output | 33 dB |
| (5) FM discriminator output | 35 dB |

c. Dynamic Range of Digital Outputs

| | |
|---|---|
| (1) Fixed-frequency mode | 55 dB |
| (2) Frequency handover mode | 45 dB |

d. Sensitivity. The 50 percent probability of detection at a false alarm rate of less than one per second in the frequency handover mode shall be as indicated in table 3-16 and in the fixed-frequency assignment mode shall be as indicated in table 3-17. The BWC threshold ($TH_{TIP}$) shall be the sensitivity for a 0.1-microsecond pulse.

Table 3-16

FREQUENCY HANDOVER SENSITIVITIES

| Band | $TH_{WB}$ (dBm) | $TH_{CNT}$ (dBm) | $TH_{NB}$ (dBm) | $TH_{TIP}$ (dBm) | CW Analog SN @ $TH_{NB}$ | BWC SN @ $TH_{TIP}$ |
|---|---|---|---|---|---|---|
| 1 | -99.0 | -90.0 | -99.0 | -79.0 | 33 dB | 22 dB |
| 2 | -98.0 | -90.0 | -98.0 | -78.0 | 33 dB | 22 dB |
| 3 | -98.0 | -90.0 | -98.0 | -78.0 | 33 dB | 22 dB |
| 4 | -98.0 | -90.0 | -98.0 | -78.0 | 33 dB | 22 dB |
| 5 | -98.0 | -90.0 | -98.0 | -78.0 | 33 dB | 22 dB |
| 6 | -97.0 | -88.0 | -97.0 | -77.0 | 33 dB | 22 dB |
| 7 | -97.0 | -88.0 | -97.0 | -77.0 | 33 dB | 22 dB |
| 8 | -96.0 | -88.0 | -96.0 | -76.0 | 33 dB | 22 dB |

Table 3-17

FIXED FREQUENCY ASSIGNMENT SENSITIVITIES

| Band | $TH_{WB}$ | $TH_{CNT}$ (dBm) | $TH_{NB}$ (dBm) | $TH_{TIP}$ (dBm) | Analog SN @ $TH_{TIP}$ | BWC SN @ $TH_{TIP}$ |
|---|---|---|---|---|---|---|
| 1 | N/A | -91.5 | -107.5 | -85.5 | 27 dB | 16 dB |
| 2 | N/A | -91.5 | -107.5 | -85.5 | 27 dB | 16 dB |
| 3 | N/A | -90.0 | -106.0 | -84.0 | 27 dB | 16 dB |
| 4 | N/A | -90.0 | -106.0 | -84.0 | 27 dB | 16 dB |
| 5 | N/A | -90.0 | -106.0 | -84.0 | 27 dB | 16 dB |
| 6 | N/A | -88.0 | -104.0 | -82.0 | 27 dB | 16 dB |
| 7 | N/A | -88.0 | -104.0 | -82.0 | 27 dB | 16 dB |
| 8 | N/A | -88.0 | -104.0 | -82.0 | 27 dB | 16 dB |

e. Frequency Measurement

(1) Resolution

| | |
|---|---|
| CW signals | ±4 kHz |

(2) Accuracy

| | |
|---|---|
| CW signals with S/N in 13 MHz bandwidth > 8 dB | ±50 kHz |
| CW signals with S/N in 13 MHz bandwidth < 8 dB | ±100 kHz |

f. Linear Sweep Characteristics

| | | |
|---|---|---|
| (1) | Linearity | ±1% |
| (2) | Sweep time | 948 usec |
| (3) | Sweep rate | 13.29 kHz/usec |
| (4) | Flyback time | 52 usec |

g. Bandwidth Compressor Characteristics

| | | |
|---|---|---|
| (1) | Input bandwidth | 10 MHz |
| (2) | Input sample rate | 32.768 mega samples/sec |
| (3) | Readout rate | 2.048 mega samples/sec |
| (4) | Sample resolution | 6 bits |
| (5) | Maximum readin duration | 250 usec |
| (6) | Output bandwidths | 750 kHz |

3.2.2.2.4 Data Handler. The data handler shall convert a number of analog and digital inputs into a continuous PCM output. The inputs from the data measurement and conversion unit shall be converted as required to constitute an organized PCM format. The data handler shall also provide the following functions:

a. Buffer storage for 2048 96-bit intercept word group

b. Synchronization of the PCM format to the time reference generator (TRG) pulse. BiØ-M coding shall be used, and the PCM bit rate shall be 256 kbps.

The data handler shall format the PCM into variable length word group types. The frame synchronization word group shall be inserted at the output of the data buffer; the remaining word group types shall flow through the buffer. The data handler shall not accept intercept reports when the buffer contains room for less than 24 more word groups. This will always assure space in the buffer for time, attitude, and program step word groups.

3.2.2.2.4.1 <u>PCM Structure</u>. PCM data shall be organized in one of the variable length word group types listed below:

a. Frame sync word group
b. No-data word group
c. Filler word group
d. DF pulse word group (2 types)
e. DF CW word group
f. Omni CW word group
g. Omni CW word group
h. Program step word groups
i. TI word group (4 types)
j. Time/attitude/program (TAP) step word group (4 types)

Table 3-18 summarized the ID code assignments and the number of bits required for each word type.

3.2.2.2.4.2 <u>PCM Word Group Buffer</u>. A buffer memory capable of storing approximately 2048 96-bit word groups shall be provided. The buffer shall be used as temporary storage for pulse intercepts, CW intercepts, TI intercepts, or TAPs. The buffer shall be a first-in/first-out type, so that the sequence of buffer input and output word groups is identical.

Table 3-18

PCM ID CODES ASSIGNED

| | MAJOR CATEGORY | MINOR CATEGORY | SUBCODE | NO OF BITS |
|---|---|---|---|---|
| HOUSEKEEPING | 00 | 00 | -- | -- |
| FRAME SYNC | 00 | 00 | -- | 96 |
| NO DATA | 00 | 01 | -- | 80 |
| FILLER | 00 | 10 | -- | 16 |
| TAP | 00 | 11 | -- | -- |
| TRG | 00 | 11 | 00 | 48 |
| HS | 00 | 11 | 01 | 48 |
| SAS | 00 | 11 | 10 | 48 |
| PROGRAM STEP | 00 | 11 | 11 | 48 |
| TI RECEIVER | 01 | -- | -- | -- |
| INITIALIZE | 01 | 00 | -- | 64 |
| CW SEARCH/DWELL | 01 | 01 | -- | 64 |
| PULSE DWELL | 01 | 10 | -- | 48 |
| END DWELL | 01 | 11 | -- | 64 |
| DF RECEIVER | 10 | -- | -- | -- |
| CW | 10 | 00 | -- | 80 |
| PLS FIRST RF | 10 | 01 | -- | 96 |
| PLS SECOND AND THIRD RF | 10 | 10 | -- | 48 |
| OMNI RECEIVER | 11 | -- | -- | -- |
| CW | 11 | 00 | -- | 48 |
| PLS FIRST RF | 11 | 01 | -- | 80 |
| PLS SECOND AND THIRD RF | 11 | 10 | -- | 48 |

3.2.2.2.4.3 Intercept Data Rate Control. The following options shall be provided to reduce the instantaneous data rate and also to reduce the probability of buffer overflow and subsequent loss of information in dense signal environments:

a. Swath Reduction. The data handler shall have the capability of processing signals arriving from targets that are located only within programmable time windows. One time window shall be established relative to the spacecraft horizon sensor output for each program step. A programmable $N_i$ x 8-msec inhibit shall be applied symmetrically to the beginning and end of each program step. The value of $N_i$ shall range between 0 and 31, shall be controlled by command memory, and shall be programmable in each of the 18 DF program steps. During this inhibit interval all DF pulses and DF CW data shall be inhibited.

b. DF Pulse Difference Channel Inhibit. The data handler shall totally inhibit the processing of signals for which the post detection amplitude in the sum channel does not exceed $D_p$ times the post detection amplitude in the difference channel. Two values of $D_p$ shall be provided. The value assigned to $D_p$ shall be commandable on a per band basis.

c. DF CW Difference Channel Inhibit. The data handler shall totally inhibit the processing of signals for which the post detection amplitude in the sum channel does not exceed $D_c$ times the post detection amplitude in the difference channel. Two values of $D_c$ shall be provided. The value of $D_c$ shall be commandable of a per band basis.

d. Rejection of CW Intercepts. The data handler shall provide the capability for inhibiting the processing of DF CW or omni CW intercepts.

e. Multiple-Frequency Signals. The data handler shall provide the capability of inhibiting the reporting of all but the strongest components of multiple-frequency signals in the DF pulse receiver or the omni pulse receiver.

f. Pulse Parameter Filters. The data handler shall provide one programmable pulse parameter filter for the DF pulse receiver and one for the omni pulse receiver. Each of these filters shall be programmable for a range of PRIs. Criteria for qualification as a valid pulse train shall include programmable upper and lower limits for pulsewidths. The circuit shall include a programmable window for valid PRIs. The DF pulse parameter filter shall be programmable on an RF band basis and the omni pulse parameter filter shall be programmable on program step basis.

g. Processing Sensitivity Control. The pulse DF and omni receivers shall have processing sensitivities as shown in table 3-12. Options a through f above shall each be selectable by ground command for a memory execute period as enabled, disabled, or adaptive to buffer level. The values of $D_p$ and $D_c$ shall be selectable by ground command independently for each DF band tasked during a memory execute period.

3.2.2.2.4.4 Payload Command Memory. The data handler shall provide for storage of two complete readin programs each of which will be loaded into the data handler by the stored command sequencer (external to the payload) before its use is required. The two program memories shall be used by the data handler as selected by external stored program commands (SPCs).

3.2.2.2.4.5 Payload Event Counters. The payload shall include a primary and a redundant readin counter and a minimum of four task counters to count events within a readin.

a. Readin Counter. The readin counter shall sequentially count payload ON-to-OFF cycles to a minimum capacity of 256 counts before recycling. The primary or redundant readin counter shall be selectable by command.

b. Task Counters. The task counters shall each have a minimum capacity of 16 counts. These counters shall reset to zero at the beginning of a readin and shall individually increment at the time of command memory execute if so indicated by the setting of bits in the command memory corresponding to each of the counters.

3.2.2.2.5 Test Signal Generation Subsystem. The payload shall contain an onboard test signal generator (TSG) that shall generate and insert pulsed and CW test signals into the sum, difference, guard, and two omni channel inputs. The TSG shall provide the following capabilities:

a. Verify the predetection amplitude and phase imbalance of the sum and difference channels.

b. Verify the post detection amplitude imbalance of the post-detection channel pairs (A & B, C & D, $\Sigma$ & $\Delta$).

c. Verify operation of the pulsed signal frequency measurement subsystem for the DF and omni channels.

d. Verify operation of the pulsewidth measurement subsystem for DF and omni channels.

e. Verify the amplitude inhibit operation of the guard and omni channels for both pulse and CW signals.

f. Verify the amplitude inhibit operation of the difference channel for both pulse and CW signals.

g. Verify the operation of the CW frequency measurement subsystem for both DF and omni channels.

h. Verify proper CW handover and pulse handover to the TI receiver for both DF and omni channels.

i. Verify operation of the TI receiver in both fixed frequency assignment mode and frequency handover mode.

3.2.2.2.6 Rejection of Undesired Signals

a. Out-of-Band Signals. Pulsed and CW signals which are out of the selected RF bands of 2 to 4, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 by 500 MHz or more shall be rejected by 50 dB or more.

b. In-RF-Band Signals. All image frequencies, spurious frequencies, cross-modulation frequencies mixed and/or local oscillator by-products, and other undesirable signals caused by CW or pulse signals in the selected 2-GHz RF band selected by the DF pulse/CW or TI receivers shall be rejected when such signals are anywhere within the system dynamic range.

c. In RF-Range/Out-of-RF Band. An intermodulation product which lies within the RF range but outside of the 2-GHz RF band selected shall not be reported when such signals are anywhere within the dynamic system ranges.

3.2.2.2.7 Program Step Sequence. During any given memory execute interval, the payload shall provide the following RF band/antenna combinations.

a. 2- to 6-GHz Antenna. Bands 1 and 2 selected for the DF receivers. Omni receiver selection can be any one of the eight bands.

b. 6- to 12-GHz Antenna. Bands 3 or 4 or 5 selected for DF receivers. Omni selection can be any one of the eight bands.

c. 12- to 18-GHz Antenna. Bands 6 or 7 or 8 selected for the DF receiver. Omni receiver selection can be any one of the eight bands.

Any sequence of bands within the DF pulse/CW subsystem shall be programmed via the command memory on a program step basis over a total sequence length of 18. Program step commands for bandswitching shall be generated from horizon sensor transitions. The system shall provide the capability for deriving the proper timing for the band-switch bands from the horizon sensor transitions. A reference midprogram step time shall be established relative to the center of the earth-contact period of the spacecraft horizon sensor. If the time between positive going transitions of the horizon sensor is referred to as $T_{spin}$ and the reference midprogram step times for the $i^{th}$ program step, calculated by the system, is referred to as $T_{ref\ i}$ the time at which the $i^{th}$ program step begins shall be: $[T_{ref}\ i + 34 + (8xN)\ msec - (1/6\ T_{spin})]$ and the time which the $i^{th}$ program step ends shall be $[T_{ref}\ i + 34 + (8xN)\ msec + (1/6\ T_{spin})]$ the value for N shall range between 0 and 63, shall be controlled by command memory and shall remain constant during a memory execute interval. If no horizon sensor transitions occur, the DF subsystem program steps shall occur every two seconds. The omni pulse/CW subsystems shall be programmed via the command memory on a program step basis over a total sequence length of two and shall switch every fourth DF program step.

3.2.2.2.8 Band 1 SGLS Rejection. The payload shall provide the capability for rejection of band 1 signals in the frequency range of 2.2 to 2.3 GHz. This capability shall be selectable by command memory for a memory execute interval. Signals in the range of 2.2 to 2.3 GHz shall be rejected by a minimum of 75 dB. Signals in the range of 2.6 to 4.0 GHz shall be attenuated by no more than 3 dB. The selectable reject capabilities shall be provided in all five RF/IF channels. Amplitude and phase matching requirements shall be met in the 2.6-4.0 GHz range when the system is in this reject mode.

3.2.2.2.9 General Purpose Computer (ASC). The payload shall include a general purpose minicomputer known as the Advanced Spacecraft Computer (ASC), Detail Specification 2P24356. The ASC shall be interfaced with the data handler by a data adapter unit (DAU) and shall permit the compaction of payload digital data in realtime for narrowband transmission to suitably equipped ground stations. This hardware and the ASC software shall comprise the satellite portion of the realtime ASC processing subsystem.

3.2.2.2.9.1 Subsystem Capabilities

a. The ASC shall be capable of receiving and processing intercept and time/attitude data from the payload data handler at rates of up to 400 pulses per second.

b. The ASC shall be capable of receiving and utilizing data sent to it via the ground data processing system's (GDPS) command system.

c. The ASC program shall be capable of reconstructing signals from the DF pulsed and DF CW data intercepted by the payload to produce bursts (a collection of pulsed or CW data from the same emitter) and series (a collection of bursts from the same emitter).

d. The ASC shall be capable of executing self-diagnostic programs and transmitting the results to the DAU for relay to the ground based subsystem.

e. The DAU shall be capable, on command from the command subsystem, of suppressing input data on the basis of signature (intercept word group type), RF range and band/antenna number.

f. The ASC shall be capable, on command of the command subsystem or in response to critical data densities, of selectively discarding data or suppressing execution of sections of the data processing program.

g. The DAU shall be capable of accepting data from the ASC, creating a serial PCM bit stream of 4 kbps or 32 kbps by adding frame synchronization and no-data words, and directing the data, as commanded by the command subsystem, to the vehicle transmitter and/or the payload tape recorder.

3.2.2.2.9.2 ASC/DAU Command and Control. The ASC/DAU subsystem shall be activated by the payload data handler when commanded to do so by the command subsystem; they shall not be activated automatically when the payload is activated.

The command subsystem shall specify to the payload data handler which collection segments the ASC/DAU shall be activated to process. The command subsystem shall also be capable of directing the DAU to activate the ASC service program, to initiate an ASC memory bank swap, or to reload the ASC bootstrap program from the read only memory (ROM). The bootstrap program shall permit reloading of the complete ASC program via the commanding subsystem in case the ASC program should, for some reason, become inoperative.

The command subsystem shall also be used to send support data to the ASC. Support data shall incude ephemeris, spin axis, TRG to GMT clock correlation, and a status block which shall be used to send messages to the site where the ground-based subsystem is located. Support data shall not be used directly by the ASC but shall be reformatted and included in the ASC output to be used by the ground-based subsystem for geopositioning and formatting the data received from the onboard subsystem.

The command subsystem shall be used to change the contents of ASC memory. The changes shall incude program modification, algorithm parameter changes, and flag settings. The flag settings may be used to control the operation of the ASC programs. For example, the flag settings will tell the ASC service program when it should execute a specific diagnostic program.

3.2.2.2.9.3 <u>Advanced Spacecraft Computer (ASC).</u> The ASC shall be CDC 469R$^2$ minicomputer with 16K, 16-bit words of CMOS memory. A low voltage shall be continuously applied to a sectionof memory to prevent loss of the stored program during periods of no operation. The ASC shall contain two independent programs -- the service program and the payload data processing program.

If the stored program does become degraded, the DAU can, on command from the command subsystem, load a bootstrap program into the ASC memory using the ASC DIRECT EXECUTE feature. This shall permit reloading of the data processing and service program by the command subsystem. A section of memory shall be protected (writing into it shall be inhibited) but this feature can be disabled by the DAU when necessary.

3.2.2.2.9.4 <u>Data Adapter Unit (DAU).</u> The DAU shall consist of logic cards and a power converter module. The DAU power module shall accept +28 VDC of unregulated power from the spacecraft's primary power source and convert it to the various regulated voltages required by the ASC and the DAU circuitry.

The DAU shall be responsible for operating the ASC. It shall, when appropriate, execute a startup sequence which shall include turning on power, activating the MASTER CLEAR signal, releasing the STOP INPUT state, and sending a signal which shall select one of two starting addresses, one being for the ASC service program and the other for the data processing program. The DAU shall initiate the ASC data processing program at the start of every collection segment which the command subsystem designates as a realtime processing segment. It shall initiate the ASC service program whenever the command subsystem has data involving the ASC.

The DAU shall also be responsible for halting the ASC. This shall include setting the STOP INPUT state and shutting off power to the ASC. The ASC shal have a standby low voltage keep-alive circuit which shall protect the sectionof the ASC's volatile CMOS memory which contains the stored program. The DAU shall also, on command from the command subsystem, reload the ASC bootstrap program from the read only memory (ROM). The DAU shall use the ASC

DIRECT EXECUTE feature for writing the bootstrap program to the ASC. This shall be the only use that will be made of the DIRECT EXECUTE feature in the ASC.

3.2.2.2.9.5 <u>The ASC Service Program</u>. The ASC service program shall be capable of performing a number of support functions under control of the command subsystem and the DAU. Communication will be by means of data sent via the command subsystem. Each data type shall contain an identification code. The service program shall be capable of receiving support data as described n 3.3.2.9.3 and storing it in memory for later use by the data processing program. The service program shall be capable of accepting data to be stored in specified locations in memory. This capability may be used to modify an ASC program, change parameters used in algorithms, or to set flags controlling the ASC service or data processing programs. The service program shall, when the appropriate flags are set, perform diagnostic routines and return the results via the DAU.

3.2.2.2.9.6 <u>The Payload Data Processing Program</u>. The payload data processing program will accept DF pulsed first, second and third frequency intercept word groups, DF CW intercept word groups and time-attitude program (TAP) step word groups originating in the payload data handler. The data processing program shall form bursts and series to represent the emitters from which the intercepted signals originated.

The first step in the burst formation routine shall be to deinterleave related DF pulses on the basis of [redacted] interval, commonly referred to as pulse repetition interval (PRI) as a first criterion and RF consistency as a second criterion. This process may be repeated several times, the tolerances being relaxed on each iteration. The second step in the deinterleaving process shall be to correlate the DF pulses which were not correlated on the first step, the residue on the basis of matching RF as the first criterion and PRI consistency as a second criteria. At the end of the program step an attempt shall be made to combine discrete bursts formed during the spin which represent signals from the same emitter. This shall be done by means of har- 25X1 monic analysis and by identifying and compensating for PRI stagger and jitter. The last step shall be an attempt to correlate the new bursts with the active series formed on previous spins and to create new series by correlating the unmatched bursts with the active unmatched bursts from previous spins. The criteria used shall be centroid time, relative to the start of the spin, as the primary criterion and PRI and RF consistency as secondary criteria.

The DAU shall be responsible for activating, on command from the command subsystem, the memory BANK SWAP feature of the ASC. This feature swaps the addresses of the two 8K banks comprising the ASC's 16K memory. This feature is useful if a section of memory fails. The DAU shall act as an interface, transmitting data from the payload data handler to the ASC and from the ASC to the payload data control unit which shall pass it to the vehicle transmitter and/or tape recorder, as commanded by the command subsytem. Before sending the data to the baseband assembly unit the DAU shall convert the data to a 4-kbps or 32-kbps PCM stream by adding frame synchronization and no-data fill words to create the appropriate rate.

Two types of data will be received by the DAU -- payload data and data from the command subsystem. The command data shall be type coded. Certain data types shall be passed to the ASC, others shall be used by the DAU. All data intended for the ASC, whether payload or command, shall be sent to the ASC, one 16-bit word at a time, via the ASC input bus under ASC interrupt control. Data from the payload shall be analyzed by the DAU and only those word groups which meet the data type and RF criteria for the given collection segment and program step shall be passed to the ASC.

The DAU shall have input buffering for word groups. Output data from the ASC shall be sent to the DAU via the ASC output bus under ASC interrupt control. Output data may be routed to the vehicle tape recorder, the vehicle transmitter, or both, as directed by the command subsystem.

Processing of CW intercepts shall be similar in concept to pulse processing except that PRI is not used, since it is not relevant to CW deinterleaving. The ASC program shall also process time/attitude word groups and output timing, spacecraft rotation, and activity and status information at the end of each program step. Support data shall be output at approximately 60-second intervals.

An option, which may be invoked via the tasking subsystem, shall be to suppress the burst-to-burst association and series formation functions in the ASC and perform them in the ground-based subsystem. When this option is commanded the output data rate from the DAU shall be 32 kbps.

### 3.3 GROUND SEGMENT REQUIREMENTS

The FARRAH II Ground Segment shall be composed of the Satellite Control Facility [redacted] 25X1

### 3.3.1 Satellite Control Facility

The RF uplink and downlink services for FARRAH II, including the payload narrowband link, shall be compatible with the Air Force Satellite Control Facility for commanding, ranging, and telemetry readout of spacecraft status data and encrypted and plain text payload data. Standard SGLS and ASGLS communication links shall be utilized for these services. The designated remote tracking stations will have the following capabilities:

a. Transmit plain text command messages via frequency-shift keying (FSK), combined with a pseudorandom noise (PRN) ranging code into composite signals, to the spacecraft by phase modulating the uplink RF carrier.

b. Receive the PRN code multiplexed with the plain text status TLM data, and the cypher text or plain text payload data on standard downlink RF carriers from the spacecraft. At the remote tracking stations the received telemetry data and payload data will be recorded and processed for transmission to the STC.

Data transmissions from the remote tracking stations to the STC will be accomplished via the SCF wideband communications segment extent for the Program 989 facilities on January 1, 1981.

The SCF will perform the following functions:

a. Determine the orbit of the spacecraft and generate actual and predicted ephemeris data

b. Generate specific command messages to satisfy detailed tasking plan

c. On special request, revise the command messages for a given station pass

d. Identify and resolve conflicts between SCF resources.

3.3.2 Data Processing Performance

[redacted] 25X1

[redacted] 25X1

[redacted] 25X1

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## Section 4
## VERIFICATION PROVISIONS

System requirements specified in section 3 shall be formally verified by the provisions of this section. Formal verification of these requirements (delineated in table 4-1) establishes acceptance of design, development, and operation of the system. The system consists of a Space Segment and a Ground Segment.

### 4.1 SYSTEM VERIFICATION

System level requirements of section 3 shall be verified in two basic phases: prelaunch and postlaunch. The developmental and preflight verification phases shall, to the maximum extent possible, verify that the elements of the overall system will perform to satisfy the subsystem and interface specifications. The postlaunch test shall verify those items that cannot be tested prior to launch, confirm preflight verification results, and in conjunction with prelaunch test results, verify the capability of the system to satisfy mission objectives. For the purposes of this section, the following verification method definitions shall apply:*

a. Inspection. Verified by observing the design of the hardware, the hardware proper, and software formats/listings

b. Test Demonstration. Verified by demonstrating the equipment during a test

c. Test/Analysis. Verified by analysis based on test results

d. Analysis. Verified by analysis of existing data

*These definitions also appear in table 4-1 keyed to the respective alpha designator.

e. Operations/Demonstration. Verified in the normnal course of mission operations

f. Operations/Analysis. Verified by analysis based on normal mission operations data.

4.1.1 Prelaunch Verification

The prelaunch verification shall verify to the maximum extent possible that the entire system is in a state of readiness prior to launch. The Space Segment shall be operated to simulate on-orbit collection sequences and to exercise the spacecraft subsystems. The Ground Segment, including the data processing facility and SCF, shall be exercised in sequences and combinations to demonstrate system compatibility. The test results which form the basis of verification by test/analysis shall be derived from tests performed on final system elements during formal unit or subsystem qualificatin and acceptance test phases. In general, the highest level of testing which best verifies the parameter shall be used for the verification. The highest level of testing refers to the completeness of assembly at the time the test is performed, when in the schedule the test is performed, and the quality of data collected. When two tests have been performed at the same level of assembly, the test performed last is considered a higher level of testing.

4.1.2 Postlaunch Verification

On-orbit verification shall demonstrate to the maximum extent possible all system level requirements of section 3.1. The postlaunch period shall commence at the time of launch and shall continue until completion of section 3.1 verification.

## 4.2 SUBSYSTEM AND INTERFACE VERIFICATION REQUIREMENTS

The system-level requirements of section 3 shall be apportioned to subsystem or interface specifications for formal prelaunch verification. These shall be verified during the process of design, development, fabrication, and checkout of each applicable subsystem segment and interface. The requirements shall be verified prior to launch in accordance with each subsystem's test program.

### 4.2.1 Space Segment Verification

The spacecraft preflight test program shall consist of the following three categories of tests:

a. Development

b. Qualification

c. Acceptance

These tests shall be performed in accordance with the requirements of the FARRAH II, Space Segment Test Plan.

4.2.1.1 Subsystem Development Tests. Development tests shall be conducted on critical, new subsystem designs.

4.2.1.2 Subsystem Qualification Tests. The qualification tests shall be conducted to qualify previously unqualified designs and will be to conditions more severe than the mission environment.

4.2.1.3 Subsystem Acceptance Tests. Acceptance tests shall be conducted on all flight hardware and spares to disclose workmanship defects and to verify proper performance. The environmental test levels shall be for the expected or predicted mission levels. Acceptance tests include ambient, vibration, thermal/vacuum and the necessary calibrations.

4.2.2 Ground Segment Verification

The data processing prelaunch test program consists of the following three categories:

a. Development
b. Acceptance
c. Validation

The tests shall be performed in accordance with the requirements of the GDPS Verificatin Plan.

4.2.2.1 Data Processing Development Tests. Development tests shall be conducted on all new and/or nonvalidated subprograms, including modifications of previously validated programs, to verify that they meet their design requirements.

4.2.2.2 Data Processing Acceptance Tests. Acceptance tests shall be conducted on all new and/or nonvalidated subprograms including modifications of previously validated programs to verify that they meet their design requirements.

4.2.2.3 Data Processing Validation Tests. Data processing validation tests in accordance with the GDPS Validation Plan shall be conducted in a representative system environment to verify interface and system performance. Validation tests encompass analog and digital ground equipment and software. Only those portions of the ground data processing system which are applicable to FARRAH II shall be validated; that is, those areas that are common to the overall processing system and those areas that are applicable only to the FARRAH II system.

Table 4-1

SYSTEM VERIFICATION

LEGEND

The letters A through F shall have meaning as defined in para 4.1.

The numerical entries in the Remarks Column shall have the following meanings:

4.1 To be demonstrated by ARV and/or SDB site tests under conditions producing comparable data

4-2 By similarity to FARRAH-I

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3. | GENERAL SYSTEM MISSION REQUIREMENTS | | | N/A |
| 3.1 | General System Performance Requirements | | F* | |
| 3.1.1 | System Accuracy and Resolution | | | N/A |
| 3.1.1.1 | System Geolocation Accuracy | | C | 4-1 |
| 3.1.1.2 | Power Amplitude Measurement | | C | 4-1 |
| 3.1.1.3 | [redacted] Measurement Accuracy and Resolution | | | |
| 3.1.1.4 | PRI Measurement Accuracy | | C | 4-1 |
| 3.1.1.5 | Accuracy of Apparent Scan Period | | F | |
| 3.1.1.6 | RF Accuracy and Resolution | | C | 4-1 |
| 3.1.1.7 | PW Accuracy | | C | 4-1 |
| 3.1.1.8 | System Dynamic Range | | C | 4-1 |
| 3.1.2 | System Capacity | | | N/A |

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*Alpha designations in this column refer to the definitions listed in section 4.1.

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Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3.1.2.1 | Collection Geometry and Coverage | A + D | | |
| 3.1.2.2 | System Tasking Capacity | | E | |
| 3.1.2.3 | System Collection Capacity | | E | |
| 3.1.2.4 | System Processing Capacity | | E | |
| 3.1.3 | Target Environment | | | N/A |
| 3.1.3.1 | System Sensitivity | | C | |
| 3.1.4 | Orbit Parameters | | E | |
| 3.1.5 | Spacecraft General Requirements | | | N/A |
| 3.1.6 | Collection Subsystem General Requirements | | | N/A |
| 3.1.7 | Data Processing General Requirements | | | N/A |
| 3.1.8 | Satellite Control Facility | D | E | |
| 3.1.9 | Launch and Ascent | D | | |
| 3.1.10 | Data Transmission and Processing Performance | | E | |
| 3.1.11 | On-Orbit Performance Verification | | | |
| 3.1.11.1 | Test Signal Generator | C | | |
| 3.1.11.2 | ARV Signals | D | | |
| 3.1.11.3 | Secondary Data Base Signals | | E | 4-2 |
| 3.2 | Spacecraft Segment Requirements | | | N/A |
| 3.2.1 | Spacecraft Subsystems | | | |
| 3.2.1.1 | Mass Properties | C | | |
| 3.2.1.2 | Spacecraft Attitude | | | N/A |
| 3.2.1.2.1 | Initial Attitude | | F | |
| 3.2.1.2.2 | Mission Attitude | | F | |
| 3.2.1.3 | Attitude Determination | | F | |
| 3.2.1.3.1 | Horizon Sensor | B & A | | |
| 3.2.1.3.2 | Solar Aspect Sensor | B & A | | |
| 3.2.1.4 | Attitude Control Subsystem | C & A | E | |
| 3.2.1.5 | Spin Rate Control Subsystem | A & C | E | |
| 3.2.1.6 | Telemetry, Tracking, and Control Subsystem | B | | |

Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3.2.1.6.1 | Telemetry and Command Antennas | C | | |
| 3.2.1.6.2 | Commanding and Ranging | B & C | | |
| 3.2.1.6.3 | Status Telemeter | B | | |
| 3.2.1.6.4 | Payload Data | B | | |
| 3.2.1.6.5 | Payload Data Storage and Conditioning | B | | |
| 3.2.1.7 | Payload Data Outputs | B | | |
| 3.2.1.8 | Electromagnetic Compatibility and System TEMPEST Requirements | | | N/A |
| 3.2.1.8.1 | Electromagnetic Compatibility Requirements | C & D | | |
| 3.2.1.8.2 | TEMPEST Requirements | B | | |
| 3.2.1.9 | Operational Life Requirements | D | | |
| 3.2.1.10 | Spacecraft Environmental Requirements | B | | |
| 3.2.2 | Collection Subsystem | | | N/A |
| 3.2.2.1 | Collection Antenna Subsystem | B | | |
| 3.2.2.1.1 | Payload Antenna A1 (Low Band) | B & C | | |
| 3.2.2.1.2 | Payload Antenna B1 (Mid-Band) | B & C | | |
| 3.2.2.1.3 | Payload Antenna C1 (High-Band) | B & C | | |
| 3.2.2.1.4 | Payload Omni Antennas A2/A3, B2/B3, C2/C3 | B & C | | |
| 3.2.2.1.5 | Payload Guard Antennas A4, B7 and C4 | B & C | | |
| 3.2.2.2 | Collection Payload Subsystem | B | | |
| 3.2.2.2.1 | Pulse Receivers | B | | |
| 3.2.2.2.1.1 | Frequency Measurement | C | | |
| 3.2.2.2.1.2 | Pulse Sensitivity | C | | |
| 3.2.2.2.1.3 | Pulse Amplitude | C | | |
| 3.2.2.2.1.4 | [redacted] Measurement | C | | |
| 3.2.2.2.1.5 | Pulsewidth Measurement | C | | |
| 3.2.2.2.1.6 | Dynamic Range | C | | |
| 3.2.2.2.1.7 | Minimum Pulse Spacing Requirements | | | |

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Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3.2.2.2.1.8 | DF Requirements | C | | |
| a. | DF Antenna Sidelobe Inhibits | C | | |
| | 1. Omni & Guard Inhibits | | | |
| | 2. Difference Channel Inhibit | | | |
| b. | Monopulse Direction Finding | C | | |
| c. | DF Signal Measurement Accuracy | C | | |
| 3.2.2.2.1.9 | Outputs | C | | |
| 3.2.2.2.1.10 | TI Pulse Receiver Handover | C | | |
| 3.2.2.2.2 | CW Receivers | B | | |
| 3.2.2.2.2.1 | CW Frequency Measurement | C | | |
| 3.2.2.2.2.2 | CW Sensitivity | C | | |
| 3.2.2.2.2.3 | CW Power Amplitude (PA) | C | | |
| 3.2.2.2.2.4 | Time of Measurement (TOM) | C | | |
| 3.2.2.2.2.5 | Rejection of Pulse Signals | C | | |
| 3.2.2.2.2.6 | CW Dynamic Range | C | | |
| 3.2.2.2.2.7 | DF Requirements | C | | |
| a. | DF Antenna Sidelobe Inhibits | C | | |
| | 1. DF Sidelobe Inhibits (Omni & Guard) | | | |
| | 2. DF Sidelobe Inhibits (Difference Channel) | | | |
| b. | Monopulse DF | C | | |
| c. | DF Signal Measurement Accuracy | C | | |
| 3.2.2.2.2.8 | CW Data Control | C | | |
| 3.2.2.2.2.9 | Outputs | C | | |
| 3.2.2.2.2.10 | TI CW Receiver Handover | C | | |
| 3.2.2.2.3 | TI Receiver | B | | |
| 3.2.2.2.3.1 | TI Receiver Operational Configuration | C | | |
| 3.2.2.2.3.1.1 | Fixed Frequency Assignment Mode/State | C | | |
| 3.2.2.2.3.1.2 | Frequency Handover Mode/CW Tuning Procedure | C | | |

RWA

Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| a. | Coarse Tuning State | C | | |
| b. | IF Sweep State | C | | |
| c. | Wideband Analysis State | C | | |
| | 1. Pulsed Signals | C | | |
| | 2. CW Signals | C | | |
| d. | Fixed Tune State | C | | |
| 3.2.2.2.3.2 | TI Outputs | C | | |
| 3.2.2.2.3.3 | Specifications | C | | |
| a. | Frequency Coverage | C | | |
| b. | Dynamic Range Analog Outputs | C | | |
| c. | Dynamic Range of Digital Outputs | C | | |
| d. | Sensitivity | C | | |
| e. | Frequency Measurement | C | | |
| f. | Linear Sweep Characteristics | C | | |
| g. | Bandwidth Compressor Characteristics | C | | |
| 3.2.2.2.4 | Data Handler | B | | |
| 3.2.2.2.4.1 | PCM Structure | C | | |
| 3.2.2.2.4.2 | PCM Word Group Buffer | C | | |
| 3.2.2.2.4.3 | Intercept Data Rate Control | C | | |
| a. | Swath Reduction | C | | |
| b. | DF Pulse Difference Channel Inhibit | C | | |
| c. | DF CW Difference Channel Inhibit | C | | |
| d. | Rejection of CW Intercepts | C | | |
| e. | Multiple-Frequency Signals | C | | |
| f. | PRI Rejection | C | | |
| g. | Processing Sensitivity Control | C | | |
| 3.2.2.2.4.4 | Payload Command Memory | B | | |
| 3.2.2.2.4.5 | Payload Task Counters | | | |
| 3.2.2.2.5 | Test Signal Generation Subsystem | C | | |
| 3.2.2.2.6 | Rejection of Undesired Signals | B | | |
| a. | Out-of-Band Signals | C | | |
| b. | In-RF-Band Signals | C | | |
| c. | In RF Range/Out-of-RF Band | C | | |

Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3.2.2.2.7 | Program Step Sequence | B | | |
| a. | 2- to 6-GHz Antenna | C | | |
| b. | 6- to 12-GHz Antenna | C | | |
| c. | 12- to 18-GHz Antenna | C | | |
| 3.2.2.2.8 | Band 1 SGLS Rejection | B | | |
| 3.2.2.2.9 | General Purpose Computer (ASC) | B | | |
| 3.2.2.2.9.1 | Subsystem Capabilities | C | | |
| 3.2.2.2.9.2 | ASC/DAU Command and Control | C | | |
| 3.2.2.2.9.3 | Advanced Spacecraft Computer (ASC) | C | | |
| 3.2.2.2.9.4 | Data Adapter Unit (DAU) | C | | |
| 3.2.2.2.9.5 | The ASC Service Program | C | | |
| 3.2.2.2.9.6 | The Payload Data Processing Program | C | | |
| 3.3 | Ground Segment | | | |
| 3.3.1 | Satellite Control Facility | B & D | E & F | |
| 3.3.2 | Data Processing Facility | B | | |
| 3.3.2.1 | Prelaunch Processing | | | N/A |
| 3.3.2.1.1 | Preflight Calibration Data | C | F | |
| | Processing | B | | 4-2 |
| 3.3.2.1.2 | Prelaunch Validation Data Prep. | | | |
| 3.3.2.1.3 | Spacecraft/Payload Test Data Processing | B | | |
| 3.3.2.2 | Mission Planning/Tasking | B | E | |
| 3.3.2.2.1 | Target Opportunities | B | E | |
| 3.3.2.2.2 | Tasking Selection and Constraints | B | E | |
| 3.3.2.2.3 | Tasking Parameter Values | B | E | |
| 3.3.2.2.4 | Commanding Interface | B | E | |
| 3.3.2.2.5 | Command Sequence Configuration | B | E | |
| 3.3.2.2.6 | Tasking Response Time | B | E | |
| 3.3.2.2.7 | Data Processing System Interface | B | E | |
| 3.3.2.2.8 | Tasking History | B | E | |

Table 4-1

SYSTEM VERIFICATION (Cont.)

| | | Pre-Launch | Post-Launch | Remarks |
|---|---|---|---|---|
| 3.3.2.3 | Data Processing Inputs | | | N/A |
| 3.3.2.3.1 | Payload PCM Inputs | B & C | | |
| 3.3.2.3.2 | Payload Analog Data | B & C | | |
| 3.3.2.3.3 | Government Inputs | B | | 4-2 |
| 3.3.2.3.4 | Satellite Control Facility (SCF) Inputs | B & C | E | 4-2 |
| 3.3.2.4 | In-Line Digital Processing | B | | |
| 3.3.2.4.1 | General | B & C | | |
| 3.3.2.4.2 | Pre-Processing Functions | B & C | | |
| 3.3.2.4.3 | Special Position/Attitude Determination | B | | 4-2 |
| 3.3.2.4.4 | Signal Processing | B & C | | 4-2 |
| 3.3.2.4.5 | Signal Editing | B | | 4-2 |
| 3.3.2.4.6 | Digital History | B | | 4-2 |
| 3.3.2.4.7 | List Outputs | B | | 4-2 |
| 3.3.2.4.8 | Tape Output | B | | 4-2 |
| 3.3.2.4.9 | On-Orbit Calibration Data | B | | 4-2 |
| 3.3.2.4.10 | Performance Standards | C | | 4-2 |
| 3.3.2.5 | Off-Line Digital Processing | A,B,C | | 4-2 |
| 3.3.2.6 | In-Line Analog Processing | B | | |
| 3.3.2.7 | Off-Line Analog Processing | A | | |
| 3.3.2.7.1 | General | A & B | | |
| 3.3.2.7.2 | Time Domain Processing | A & B | | |
| 3.3.2.7.3 | Frequency Domain Processing | A & B | | |
| 3.3.2.8 | Data Processing/Analysis Outputs | A | | |
| 3.3.2.9 | Ground-Based Portion of the ASC Realtime Processing Subsystem | A | A | |
| 3.3.2.9.1 | Software Description | B | E | |
| 3.3.2.9.2 | Preflight Validation | C | | |
| 3.3.2.9.3 | On-Orbit Validation | | C | |
| 3.3.2.9.4 | Performance Standards | B | B | |
| a. | Probability of Detection | | C | |
| b. | Misrepresentation | | C | |
| c. | Fragmentation | | C | |
| d. | Signal Parameter Characterization Success | | C | |