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SPACECRAFT 4431/URSALA IV
SPACECRAFT SYSTEMS REQUIREMENTS DOCUMENT

[redacted]

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Prepared by [redacted]
Systems Engineer

Approved by [redacted]
Chief Systems Engineer

Prepared by [redacted]
Systems Engineer

Approved by [redacted]
Program Manager

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Foreword

This document has been prepared in accordance with the requirements of sequence no. A010 of DD 1423 (exhibit A to contract [redacted] 25X1

REVISION RECORD

Revision	Document: SPACECRAFT 4431/URSALA IV SPACECRAFT SYSTEMS REQUIREMENTS DOCUMENT ~~(S)~~	Date
--	Basic Issue	73 Mar 21
A	This revision incorporates the following changes: a. Changes relative to mission requirements, orbit parameters, separation, and horizon sensor depression angle. b. Update of solar module installing drawings, spin motor alignment requirements, temperature sensor requirements, current monitor part numbers, separation relay logic, and wording of LVCO select command titles. c. Add octal form of uplink address and added requirements for new antenna C3. d. Update of power summary, weight summary, termination commands, and termination sequence. e. Added timer reset to deployment sequence.	73 Jul 5
B	This revision incorporates the following a. Changes tape recorder from 150 kHz to 1 MHz. b. Removes detailed test requirements. c. Updates launch sequence requirements. d. Changes functions of commands 0.01-4F and -4T. e. Changes wording of PE-3B and BME-1. f. Clarifies clocking angle of payload antenna A. g. Changes mission requirements statement. h. Adds antenna B tiedown EED.	74 Feb 5
C	This revision incorporates the following changes: a. Changes command assignment for switching between phase 1 and phase 2 monitors. b. Clarifies overlapping read-in requirement. c. Deletes remote mode change from the operational capabilities requirements. d. Updates power summary using latest payload levels.	74 May 1
C Change pages	These pages incorporate minor changes to the document	74 Nov 21 RTW

Note: Changes incorporated into the current revision are indicated by change bars affixed to the right margin of affected pages.

REVISION RECORD

Revision	Document: Spacecraft 4431/URSALA IV Spacecraft Systems Requirements Document	Date
C Change pages	Pages have been changed to reflect changes in the spacecraft weight and power summary and to add a TRG command selection restriction. Carriers 4 and 5 pre-emphasis has been changed.	
C Change pages	Pages have been changed to show an increase in on-orbit altitude and to update power available and tasking.	75 Sep 10
C Change pages	Pages have been changed to update power information and to correct wideband transmitter power and frequency requirements.	76 Dec 8
D	This revision incorporates various modifications to the payload and vehicle.	78 Apr 15
E	This revision incorporates an update to the power summary and clarifies some command functions and the wording of section 6.3.1.	78 Dec 20

Note: Changes incorporated into the current revision are indicated by change bars affixed to the right margin of affected pages.

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List of Illustrations

Section 1

INTRODUCTION

This document describes the total spacecraft 4431/URSALA IV operating system from mission to data product.* It provides the justification for the system configuration as well as references to all top system documentation. The format of this document has been organized to provide the following:

a. Description of mission objectives in terms of target emitter characteristics (section 2)

b. Description of payload requirements to meet the above objectives (section 3)

c. Description of subsystems required to support the payload (section 4)

d. Resultant system configuration (section 5)

e. Resultant test and flight operation requirements (section 6)

f. Data processing requirements (section 7)

g. List of applicable documentation (section 8)

*As modified by LCP 78

Section 2

MISSION REQUIREMENTS

The mission objective of the Spacecraft 4431/URSALA IV intercept system is to provide electronic order of battle (EOB) and general search (GS) intercept capability against pulsed and CW emitters over the radio frequency range of 2 to 12 GHz. The requirements for the intercept system against pulsed emitters are as follows:

a. Locate targets by means of sidelobe intercepts to an accuracy corresponding to a half-cone angle at the satellite of no more [redacted] 25X1

b. Measure the following parameters on a pulse-by-pulse basis:

1. Pulsewidth
2. Pulse amplitude
3. Pulse time-of-arrival
4. Radio frequency.

The requirements for the intercept system against CW emitters are as follows:

a. Locate targets by means of centroiding

b. Measure the radio frequency of [redacted]. 25X1

All sidelobe intercept data are to be digitized into a single, serial, PCM bit stream. The intercept system shall have a minimum on-orbit lifetime of 24 months.

Section 3

PAYLOAD REQUIREMENTS

The requirements of the URSALA IV system payload to accomplish mission objectives are presented in this section.

3.1 PULSED SIGNAL RECEIVER

The pulsed-signal (or pulse) receiver shall provide coverage of the entire radio frequency range from 2 to 12 GHz. Instantaneous frequency coverage shall nominally be 2 GHz. There shall be no frequency coverage gaps between adjacent bands.

Four RF/IF channels shall be provided: sum, difference, and two omni inhibit channels. Each channel shall be provided with two input ports: one port (B port) will cover the frequency range from 2 to 8 GHz, and the other port (A port) will cover the frequency range from 4 to 12 GHz. The system shall be capable of selecting any of the following frequency band/RF port combinations:

Band	Frequency Range (GHZ)	Port
1	2 to 4	B
2A	4 to 6	A
3A	6 to 8	A
2B	4 to 6	B
3B	6 to 8	B
4	8 to 10	A
5	10 to 12	A

The system must be capable of meeting measurement requirements for the following measurements over its dynamic range.

a. Peak power measurement

b. Pulse time-of-arrival

c. Pulse frequency measurement (coarse and fine)

d. Pulsewidth (may have 4 dB less dynamic range)

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

The system shall perform an omni inhibit function by comparing the signal power received by the sum channel with the total signal power received by the two omni channels. The two omni channels shall be combined after detection.

The system shall also perform a difference-channel inhibit function via post-detection amplitude comparison of the sum and difference channels. When the amplitude of the signal in the difference channel exceeds the amplitude of the signal in the sum channel, the reporting of the monopulse direction-finding signals (Σ/Δ, A/B, C/D) shall always be suppressed. It shall also be possible, by command option, to suppress the reporting of the entire pulse intercept word group and the sum video output. This option shall be commandable on a half-spin basis.

A small-signal inhibit function shall be provided wherein the maximum increase in either omni channel or difference channel input power required to go from a 10-percent pulse inhibit condition to a 90-percent pulse inhibit condition shall be 4 dB.

3.2 CW SIGNAL RECEIVER

The CW signal (or CW) receiver shall provide coverage of the entire RF band from 2 to 12 GHz. Each frequency within the 2-GHz band used for pulse intercept must be searched in a period of 3.3 msec, maximum.

The intercept system shall provide frequency measurement of CW emitters over the instantaneous 2-GHz band selected. The frequency measurement subsystem shall have a resolution of 8 MHz and an accuracy of ± 15 MHz (with calibration) anywhere within the 2-GHz band being searched.

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

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

The following subsystems shall be part of the CW receiving system:

a. RF measurement subsystem

b. Amplitude measurement subsystem

c. TOA measurement subsystem

d. Sidelobe inhibit subsystem (optional).

3.3 CALIBRATION SUBSYSTEMS

A set of on-board calibration subsystems shall be provided to check the performance of the pulse receiver system and the CW receiver system. A set of test signal generators (TSG) shall generate and insert signals into the DF and omni channels at the system inputs to verify proper payload operation. The intercept system shall provide the following four calibration modes.

Mode	Function
1. Start of read-in calibration	Calibrate all five possible bands for pulse signals and calibrate CW
2. Repeat calibration	Calibrate bands selected by two program steps for pulse signals and calibrate CW
3. Continuous calibration	Calibrate system for pulse signals continuously
4. No calibration	Calibration disabled.

Mode 1 shall be performed at the beginning of each read-in period. Mode 2 shall repeat the calibration sequence at approximately 3-minute intervals for the duration of a read-in period and shall cover only those bands programmed for that particular read-in period. Mode 3 shall provide a continuous pulse and CW calibration sequence. The calibration mode for each read-in period shall be selected by ground command. A commandable override of the horizon sensor shall be provided to enable the payload to switch bands every two seconds.

3.4 DATA MEASUREMENT AND CONVERSION UNIT

The data measurement and conversion unit (DMCU) shall provide pulse signal measurement, CW signal measurement, and miscellaneous data. The miscellaneous data shall include the following:

a. Horizon sensor data
b. Solar aspect sensor (eye and word) data
c. Payload status data
d. Time reference generator data
e. Day counter (up to 256 days)
f. Read-in counter to count each time (up to 256 times) read-in power is applied
g. Spacecraft number
h. Timing synchronized to the TRG.

The data conversion portion of the DMCU will convert a number of analog and digital inputs into a continuous PCM output. It will also provide a buffer storage for a minimum of 512 intercept word groups as well as synchronization of the PCM to the TRG. The bit rate shall be 128 kbps with revised biphase-mark coding. Typical structure shall be 8 bits per word (or 80 bits in a line or word group) and 800 word groups per ½ sec (approximately 750 word groups per ½ sec. available for data pulses and 50 word groups for time, attitude, sync, and subcomm data).

3.5 SYSTEM COMMANDING

A command storage subsystem and a programmer shall provide logical control of the operation of the URSALA IV subsystem. The payload command memory shall be controlled by the 11 function bits of magnitude commands 5, 6, and 7. The first three function bits shall be used to steer the last eight function bits to as many as eight registers for each magnitude command. Each register shall contain as many as eight bits of memory. The memory shall be read out in the payload subcomm and spacecraft telemetry in 8-bit bytes related directly to individual magnitude commands.

3.6 DATA INTERFACE SUBSYSTEM

A data interface subsystem shall provide signal processing and tape recorder and transmitter selection. Figure 3-1 is a simplified block diagram showing the payload read-in and readout signal flow.

3.7 TIME REFERENCE GENERATOR

The time reference generator (TRG) identifies the exact time of data acquisition and generates reference tones. The word output shall be in the AN/GSQ-53A time code format.

3.8 REDUNDANCY REQUIREMENTS

The intercept system shall include the following redundancy provisions:

a. Time Reference Generator (TRG)

   To be supplied by the contractor and incorporated into the system by the subcontractor. The redundant TRG shall be used on orbit in an unpowered, standby redundancy mode. The subcontractor shall provide the necessary circuitry for switching power and selecting the TRG output.

b. Sum Channel IF Backup

   The intercept system shall provide mechanical switches to allow the difference channel IF amplifier to be switched in in place of the sum channel IF amplifier.

c. Redundant Local Oscillators

   The system shall provide redundant local oscillators for bands 2, 3, 4 and 5. The redundant local oscillators are to be used on orbit in an unpowered, standby redundancy mode. The subcontractor shall provide the necessary circuitry for switching power and selecting the local oscillator output.

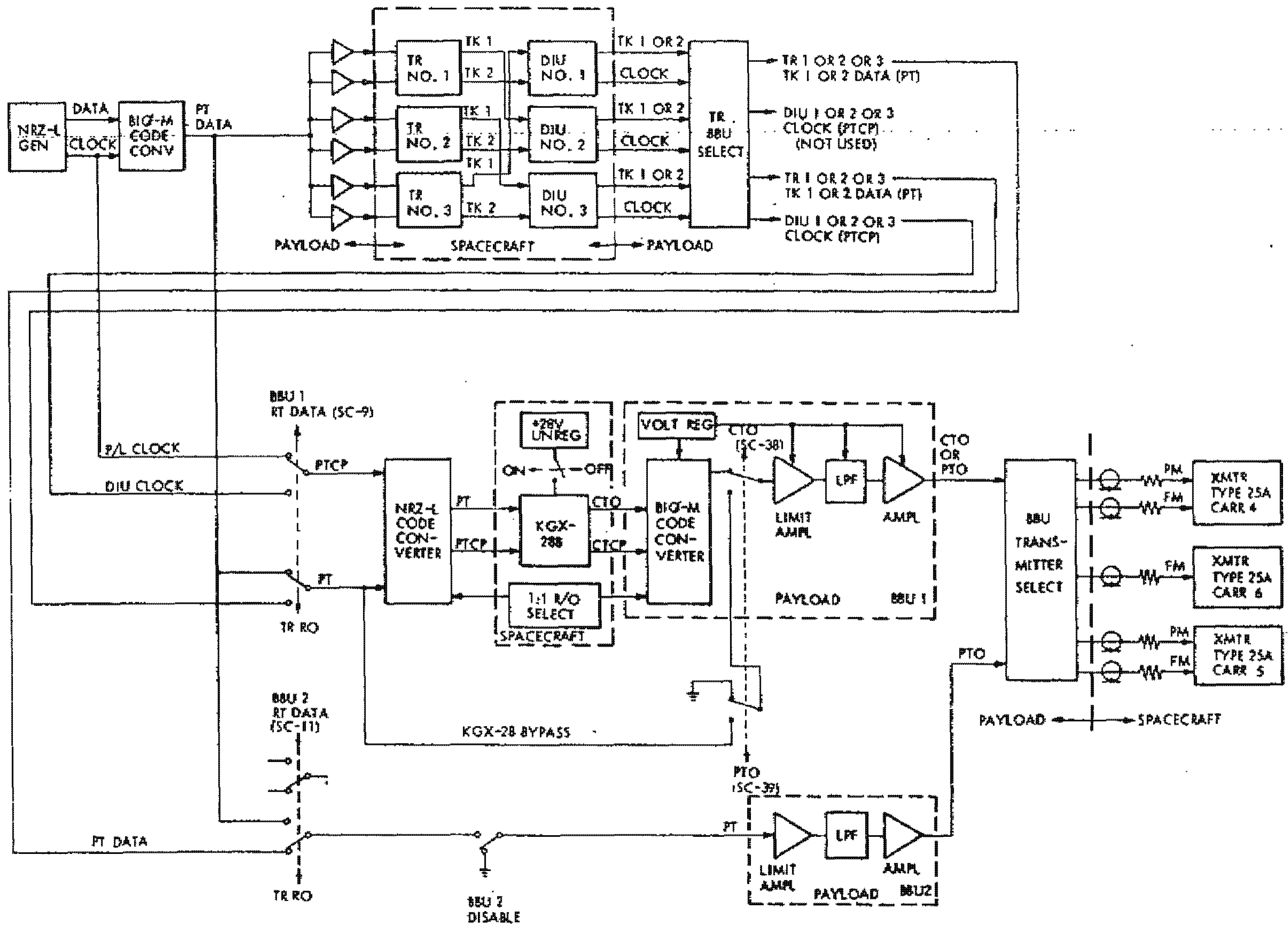

Figure 3-1 Payload Read-In and Readout Signal Flow

d. Redundant Memory

A redundant memory shall be provided which shall perform the functions of command storage and payload data buffering. The memory shall be used in an unpowered, standby redundancy mode. The subcontractor shall provide the necessary circuitry for switching power and memory inputs and outputs.

c. Power Converters

The system shall provide redundant power converters. The redundant power converters are to be used on orbit in an unpowered, standby redundancy mode. The subcontractor shall provide the necessary circuitry for switching power into and out of the power converters.

Section 4

SUPPORTING SYSTEM REQUIREMENTS

4.1 PAYLOAD ANTENNAS

Signals of interest will be collected by seven antennas: two high-gain antennas to intercept target sidelobes and four omnidirectional antennas to provide inhibit protection for the high-gain antennas. The high-gain antennas are 6-foot-diameter and 3-foot-diameter parabolic reflectors. The 6-foot-diameter antenna (antenna B) covers the 2- to 8-GHz band, and the 3-foot-diameter antenna (antenna A) covers the 4- to 12-GHz band; thus providing overlapping coverage of C-band (4- to 8-GHz). Each antenna has a four-arm Archimedean spiral feed and associated beam-forming network (BFN). The BFN generates sum and difference patterns simultaneously; the sum and difference channels are used in the system to develop monopulse direction-finding error signals. The axes of both antennas are at an angle of approximately 55 degrees with respect to the spacecraft spin axis (the -Y axis).

Four omni antennas are circularly polarized, conical logarithmic spirals mounted on deployable booms (two antennas per boom) and positioned so that their amplitude patterns "cover" the sidelobes and backlobes of the high-gain antennas. One antenna on each boom covers the band from 2 to 8 GHz, and the other antenna covers the band from 4 to 12 GHz. Signal amplitudes received on the high-gain and omni antennas are compared to reject signals outside of the high-gain antenna main beams. The fifth omni antenna (antenna C3) is a circularly polarized waveguide horn, which was added to reduce poke-through of close-in sidelobes of the A antenna.

The principal characteristics of the various antennas are listed in table 4-1.

Table 4-1

PRINCIPAL ANTENNA CHARACTERISTICS

Antenna Designation	Frequency (GHz)	Function	Type	Location
A	4 to 12	Sidelobe Intercept and Location	3-ft diameter flexible rib reflector with dual-mode spiral feed	On -X side
B	2 to 8	Sidelobe Intercept and Location	6-ft diameter flexible rib reflector with dual-mode spiral feed	On +X side
C1	4 to 12	Omni and Inhibit	Conical log spiral	On -Y side
C2	4 to 12	Omni and Inhibit	Conical log spiral	On +Y side
C3	4 to 12	Omni and Inhibit	Waveguide horn	On -Y side
D1	2 to 8	Omni and Inhibit	Conical log spiral	On -Y side
D2	2 to 8	Omni and Inhibit	Conical log spiral	On +Y side
T/C-1	1.7 to 2.3	Intercept Data Transmission and Ranging, TLM and Command	Conical log spiral	On -Y side
T/C-2	1.7 to 2.3	Intercept Data Transmission and Ranging, TLM and Command	Conical log spiral	On +Y side

4.2 PAYLOAD/SPACECRAFT INTERFACE REQUIREMENTS

This section describes the necessary interface requirements between the spacecraft and the payload. These requirements allow the payload and spacecraft to function together to achieve mission objectives.

4.2.1 Mechanical Interface

4.2.1.1 Physical Location. Payload A shall be installed in the -Z wing of the spacecraft, and payload B shall be installed in the +Z wing. (See Spacecraft 4431/URSALA IV Configuration Drawing, (2P24256).

4.2.1.2 Payload Antenna/Spacecraft Interface. The mechanical requirements for this interface are defined in section 5. The payload antenna installations are shown in figure 5-2.

4.2.1.3 Payload Envelope. Payload A shall be sized to be installed within the envelope defined by Envelope Drawing - Payload A, 2P24224-5; Payload B shall be sized to be installed within the envelope defined by Envelope Drawing - Payload B, 2P24224-7.

Payload Downlink Encryptor. A GFE, KGX-28B Encryptor shall be installed on the -X,+Z wing bulkhead and shall encrypt downlink payload data. The mechanical interface shall be as shown in figure 4-1.

4.2.1.4 Weight and Center of Gravity. The maximum combined weight of the payloads plus any interconnecting cabling shall not exceed 157 pounds, unless authorized by the chief systems engineer. The individual weight of each payload shall be evenly matched, within ± 5 pounds, with the center of gravity of each unit being maintained as closely as possible to the -X end of the payload structure and as closely as possible to the spacecraft X-Y plane. Compliance with these requirements shall be confirmed by actual weighing of the payloads and by measuring their centers of gravity in all three axes as soon as practicable. These data shall be submitted to the chief systems engineer's office.

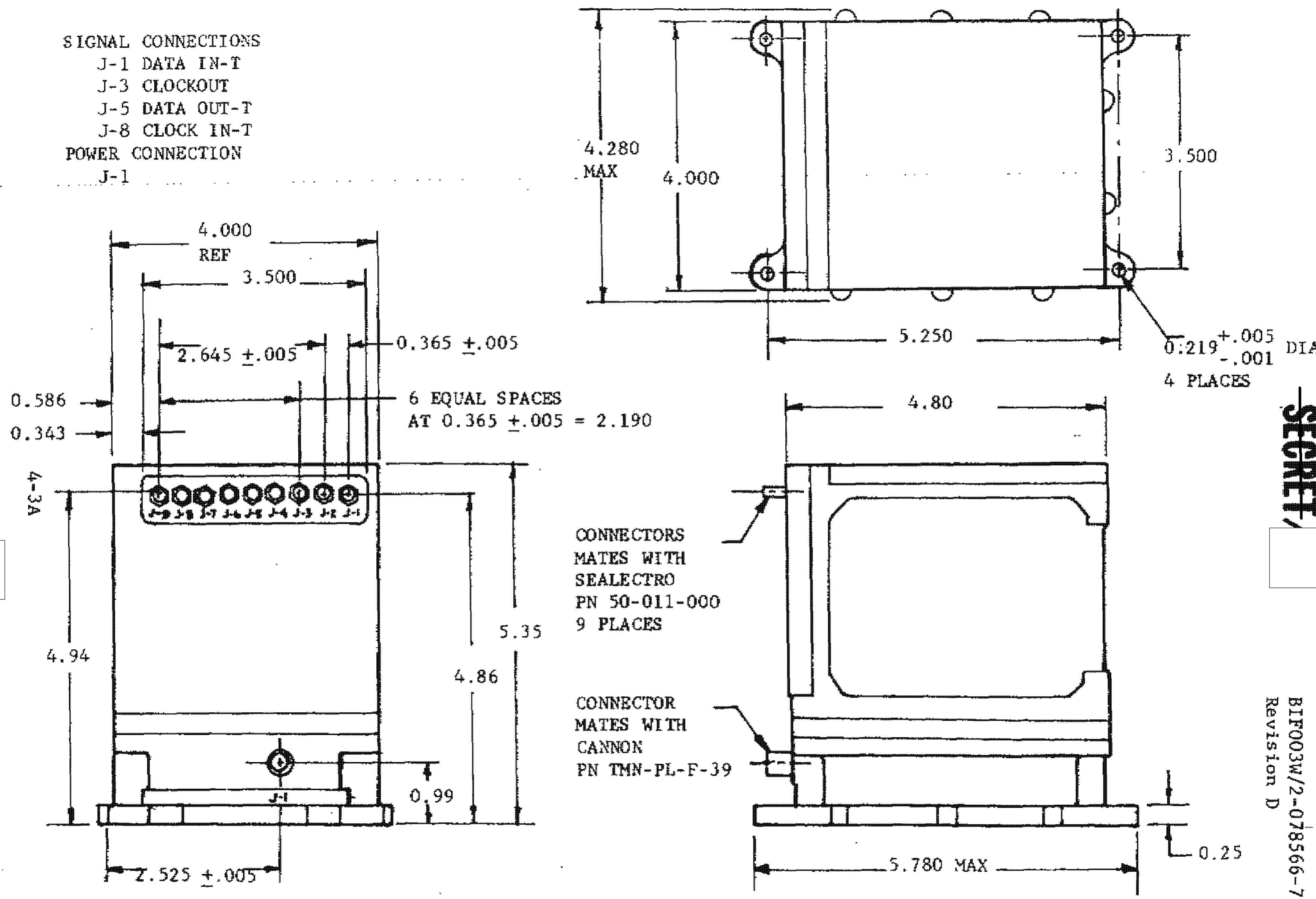

Figure 4-1 KGX-28B Encryptor

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4.2.2 Electrical Interface

The spacecraft/payload electrical interface is defined in and controlled by the Interface Control Document, BIF003W/2-063285-72.

4.3 PAYLOAD COMMAND REQUIREMENTS

Four command types are required to support the URSALA IV system. These commands shall be supplied by the spacecraft command receiver/decoder/timer subsystem. The commands are as follows:

a. Magnitude Commands. Magnitude commands (with 11 associated function bits) and basic commands shall be used to select the payload configuration and to program the frequency band switching sequences.

b. Basic Commands. Basic commands shall be provided to satisfy the requirement of transmitter switching, tape recorder selection, data switching, etc.

c. Programmable Events (PE's). Since the target areas are not within range of tracking and command stations, four programmable events are provided so that the URSALA IV system can be activated over the target area. Associated with this turn-on event is a programmable companion event (CE) which is used to turn the system OFF.

d. Single Events. The single events are fixed time delay outputs provided by the timer. One event (SE-1) is started by the TLM ON command and is used to turn off the TLM data at the end of a station acquisition. The second event (SE-2) is started by a "primary event" (PE) and provides a delay prior to the read-in of the tape recorder and payload-on that is used to allow the horizon sensor to warm up.

The signal characteristics of the above commands shall be as follows:

Command	Voltage (vdc)	Duration (msec)	Maximum Current Capability (ma)
Magnitude	+20.0 to +30.0	50 (min.)	50.0
Basic	+20.0 to +30.0	50 (min.)	50.0
Function Bit	+4.0 to +5.25	50 (min.)	0.4
CE, PE, SE	+18.5 to +30.0	100 $\pm$30	50.0

4.4 PAYLOAD POWER REQUIREMENTS

Four discrete unregulated power modes are required for the URSALA IV system from the spacecraft power control unit. The power modes are as follows:

Power Mode	Worst-Case Current
Continuous Power	55 ma
Read-In Power	5.65 amp
Telemetry ON Power (TR ON or OFF)	1.00 amp
Transpond (Bypass) Power	5.42 amp

4.5 DATA STORAGE AND TRANSMISSION

The payload system will combine its digital data output signals, along with specific spacecraft-generated signals, into a form suitable for recording on a two-channel spacecraft tape recorder and for transmission to ground on an S-band telemetry transmitter. The payload data shall digitize the systems output into a serial bit stream. The tape recorders will have a normal read-in/readout ratio of 4:1 and will have a 500 kHz bandwidth for readout through a digital interface unit (DIU). One track of a tape recorder will be selected to read out through a DIU to accomplish a dejitter function and to provide both data and clock outputs. These data will be encrypted by a KGX-28B encryptor and transmitted via one UHF transmitter to the ground.

The other track of a tape recorder can be read-out through another DIU in the event of a DIU failure. Using this arrangement, tape recorder data can be read out dejittered from any tape recorder via two DIUs. Also, a 1:1 tape recorder read-in/readout ratio is available which can be handled on a narrowband, FM-modulated data link.

In addition, two other tape recorder and DIU combinations will be installed and will be interwired with the other 2 tape recorder/DIU combinations. One spare transmitter will also be available that can be interchanged with either of the other two payload data transmitters (or the spacecraft status transmitter.) The complete tape recorder data format and spectrum are detailed in section 7.3.

To summarize, the system is redundant to the extent of having three tape recorders, three DIUs, and three transmitters, all capable of accepting payload data. One tasking is defined as one tape recorder wholly or partially read in and read out.

4.6 UHF DATA LINK REQUIREMENT

Any tape recorder may be selected to readout over any of the three type 25A UHF transmitters selected. Two transmitters can be turned on at one time so that two tape recorder/DIU combinations can be read out simultaneously. This capability will permit fewer acquisitions for a given number of read-in operations. Both the transmitter and tape recorder/DIU transfer capability shall be incorporated in the payload logic. The UHF transmitter shall have a minimum input modulation bandwidth of 2 MHz and shall be capable of $\pm$2.1 MHz deviation of the output.

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Section 6

OPERATIONS

6.1 COMMAND CAPABILITIES AND LIMITATIONS

Command capabilities and limitations for the spacecraft shall be according to the Spacecraft 4431 Command Capabilities and Limitations Document, BIF003W/2-071095-78.

6.2 CONTOUR PLOTS

Contour plots used for readout and antenna switching criteria shall be according to the Spacecraft 4431 Signal Contour Plots (to be published).

6.3 DATA AND TRANSMISSION SYSTEM (See Figure 6-1)

6.3.1 Characteristics

6.3.1.1 Uplink Characteristics. The frequency of channel 1 is [redacted] ±0.002 percent, and the frequency of channel 14 is [redacted] ±0.002 percent. 25X1
The modulation indexes of the SGLS transmitters are as follows:

a. PRN: 0.125

b. Command Tone: 0.3

6.3.1.2 Downlink Characteristics.

SGLS Carrier 1. The modulation indexes of the services on carrier 1 are as follows:

a. 1.024 MHz VCO 1.4

b. 500 kHz PRN: 0.180 ±10%, Primary Configuration
0.180 ±30%, Alternate Configuration

c. Command Tones:* 0.3

The peak phase deviation capability of the phase modulated status transmitter (carrier 1) is three radians. Output power of the type 24 transmitter is two watts, minimum, and the output frequency is [redacted] ±0.003 percent.

*Command tones are not removed from the downlink PRN spectrum.

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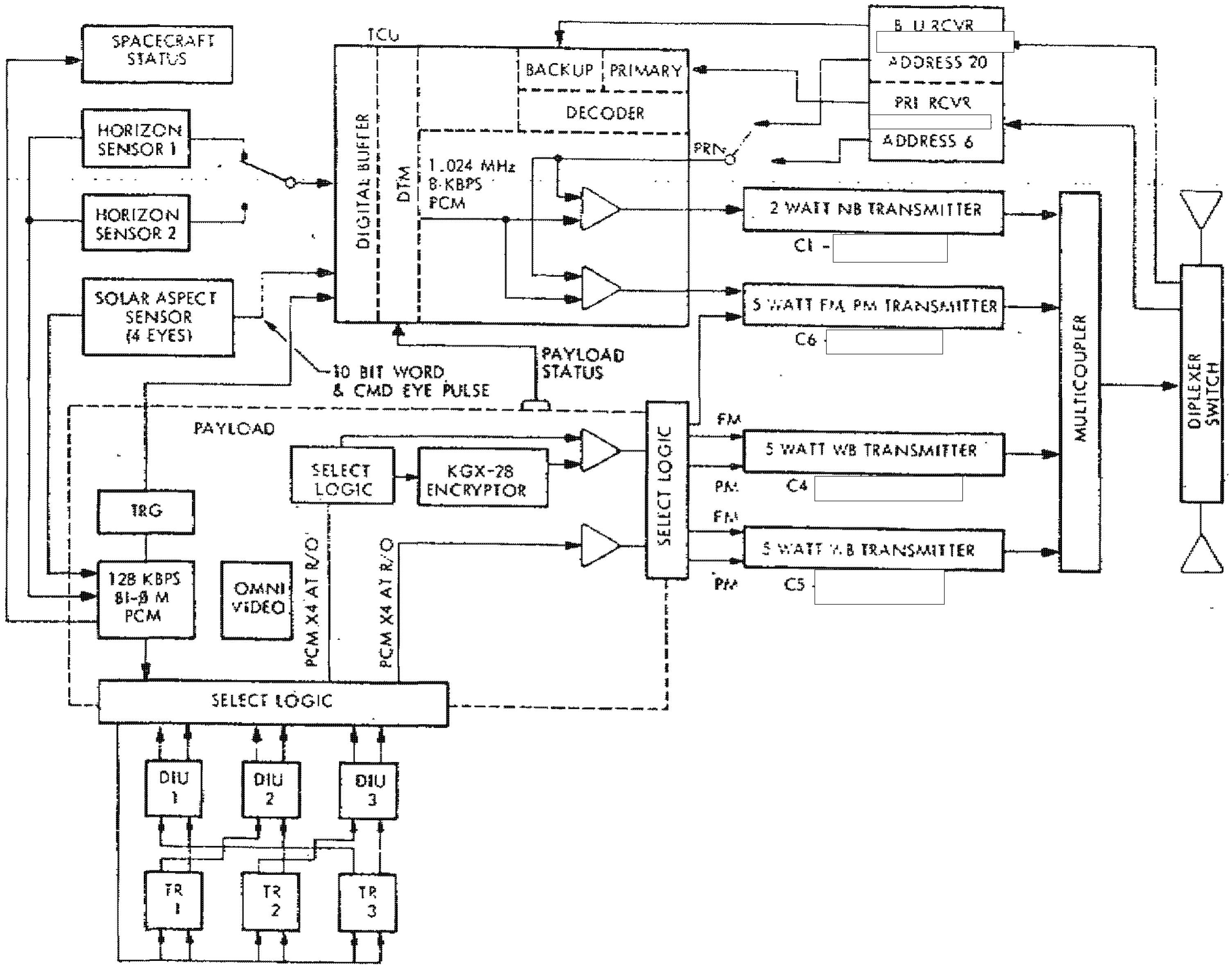

Figure 6-1 Data Transmission System Block Diagram

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SGLS Carriers 4 and 5. The transmitter deviation for various data rates and modulation modes on URSALA IV are as follows:

a. 512 kbps PCM data from a tape recorder via a DIU shall be limited to produce a deviation of ±2.1 MHz, ±10 percent in the wideband FM mode.

b. 128 kbps PCM data from a payload transpond shall be limited to deviate the transmitter with a modulation index of 1.25 radians ±5 percent in the PM mode.

Output power requirements for carriers 4 and 5 is five watts, minimum, and the output frequencies are [redacted] for carrier 4 and [redacted] for carrier 5. The frequency tolerance for the type 25 transmitters is 0.05 percent and 0.003 percent in the FM mode. 25X1

SGLS Carrier 6. Carrier 6 may be selected to back up carrier 1 or carriers 4 or 5. The deviation and pre-emphasis requirements will be the same as those carriers listed above. Output power is five watts, minimum, and the output frequency is [redacted] The frequency tolerance of the type 25 transmitter is ±0.05 percent in the FM mode and 0.003 percent in the PM mode.

6.3.2 Spacecraft Tape Recorder/DIU and S-Band Transmitter Operations

One tasking is defined as a tape recorder wholly or partially read in and read out. There shall be three type 38 tape recorder/digital interface unit (DIU) combinations and three wideband, type 25 transmitters in the downlink system. The DIU's are to be added to URSALA IV for data enhancement and data clocking purposes. The downlink system shall be divided into two separately controlled channels: one to be cypher text, the other plain text. Encryption shall be provided by the on-board KGX-28 encryption unit, with the necessary clock signal provided by the DIU's. The encryption equipment shall be capable of being bypassed when it is disabled.

The T/R's shall be used to store the P/L-generated data during the R/I cycle. The PCM data are to be recorded on both tracks of any one of the available recorders (selected by S/C command). Multiple relay contacts shall be provided in the T/R R/I power-on design to eliminate single-point failure possibility. Two tape recorder read-in modes shall be available: a 4:1 mode for normal operation and a 1:1 mode where readout is desired at a narrowband tracking station. During the readout cycle, the PCM data from track 2 of a tape recorder shall be passed through its associated DIU where it will be dejittered, reshaped, and reclocked. The PCM data recorded on track 1 of a tape recorder shall be connected to another DIU's track 1 input and shall be available if necessary. Logic switching shall be provided to allow a tape recorder to read out through this alternate DIU in the event of a failure in its associated DIU. In either case, the reclocked data shall be converted from biphase mark to NRZ-L in the payload and encrypted via the KGX-28B. The encrypted NRZ-L data shall be reconverted to biphase mark in the payload, and any plain text modulation are to be removed before the PCM data are modulated onto a transmitter.

The transmitter select logic should allow the encyphered PCM data to be transmitted on any one of the three S-band telemetry transmitters. Two of these transmitters shall be operable at one time to allow two tape recorders to be read out in parallel. One readout is to be encyphered, the other not. Both channels could be plain text as a backup mode. The existing tape recorder readout select logic design allows any one tape recorder to read out over both channels simultaneously. When only one tape recorder is read out, in the cypher text, provisions shall be made to automatically disconnect the PCM data from the input of the plain text channel 2 baseband unit (BBU). The input to BBU 2 should be switched to ground to prevent any extraneous plain-text data modulations.

The payload system shall provide the buffering and switching circuits for the tape recorders, the encryption equipment bypass, and the transmitter selection. The payload system shall also provide the independent channel switching circuits to connect the PCM data directly to a transmitter (transpond or bypass mode). Provisions shall be made to allow only cypher text or only plain text transpond data (not both) to modulate a transmitter. The independent switching of the two channels shall allow simultaneous tape recorder readouts via the encyphered link and transpond operations via the plain-text link, or vise-versa. The commands which select the realtime data modes for channels 1 and 2 shall be the same commands used to select the backup transmitter (carrier 6) to these channels. The normal transmitter-select command must be issued subsequently to restore normal operation.

6.3.3 <u>Digital Interface Unit (DIU)</u>

A DIU shall be provided at the output of each tape recorder to reshape the tape recorder data to remove the effects of jitter. The DIU shall have two inputs and outputs: the inputs shall be selectable to a buffer timing circuit (BTC), the output of which will be 3 volts ± 0.1 peak-to-peak and will remain in specification when driving a load a 5 K ohms to 50 K ohms shunted by 50 pf maximum at the end of six feet of RG-188/U coaxial cable. The second will be a clock signal. This clock signal will have a true level of 2.5 VDC minimum, a false level of 0.0 VDC ± 0.4 VDC, and output impedence of 250 ohms maximum and a time base instability of 1 percent peak-to-peak maximum.

6.3.4 <u>Transmitter Selection Logic</u>

The two payload data links are connected to two of the transmitters in one of six selectable configurations by use of command 0.06 backed up by command 0.31 and its six function bits. This feature combined with the transmitter transfer capability will permit any combination of transmitter-to-link selections. During acquisitions, the selected transmitter may be turned on by command 0.01 (backed up by command 0.36).

6.3.5 <u>Before-and-After Tape Recorder Readout Mode</u>

Before and after the tape recorder is read out over the ground tracking and recording site, the spacecraft S-band transmitters are operational, and a PCM data signal modulates any one or both the wideband transmitters in plain text only.

6.4 READ-IN OPERATION CAPABILITIES

Programmed payload and tape recorder read-ins shall be initiated via the PE commands of the dual timer. Timer CE commands shall terminate these read-ins, and the timer SE-2 command shall be used to delay the payload-on for 32 seconds (if it was in the off state) to allow for the horizon sensor stabilize. Once the payload has been turned on in a read-in mode, subsequent PE commands shall result in incrementing the payload read-in counter at the time of the PE as well as selecting other tape recorders to begin reading in. Remote transpond operations shall be initiated and terminated using the dual timer in exactly the same manner as read-in modes. Tape recorder read-in during a transpond mode shall be provided. Provisions to switch the TC antenna from the +Y to -Y or -Y to +Y positions via stored PE commands shall be available in the transpond mode. A PE shall be dedicated to the antenna switching and shall not turn on the payload or tape recorder.

A mixture of payload read-in and transpond operations shall be provided where the transpond mode can accommodate a TC antenna switch. PE-1 shall be devoted to transpond-mode-on in the mixed mode. PE's 3 and 4 shall initiate normal read-ins and, PE-2 shall switch the antenna. Real time commands to initiate and terminate the payload and tape recorder read-ins shall be provided. Read-in operations shall <u>not</u> be terminated with the downlink-off or ALL-OFF function; however, real time transpond operations shall be terminated with downlink-off or (ALL-OFF).

Real-time read-in operations initiated to start remote tasking must be preceded by a valid timer load and starting sequence to insure subsequent payload and tape recorder read-in termination by CE command unless real time control is available after tasking.

6.4.1 Option I: Single Read-In, Single Recorder

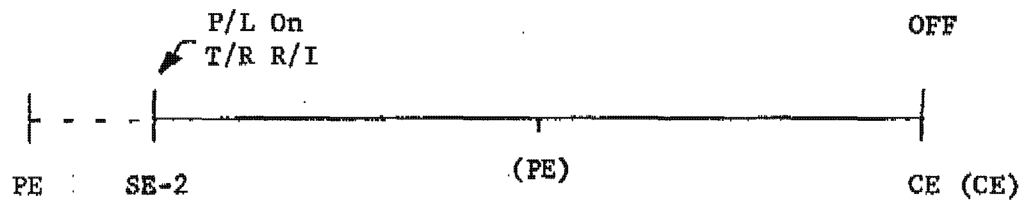
a. Single read-in or transpond operation.

b. Partial or full tape.

c. Single tape recorder, TR 1 or TR 2 or TR 3

d. No remote payload mode change capability.

e. Remote mid-pass antenna switching available with use of second (PE) and (CE) set.



6.4.2 Option II: Multiple Read-Ins, Single Recorder

a. Split read-in variable durations.

b. Partial or full tape.

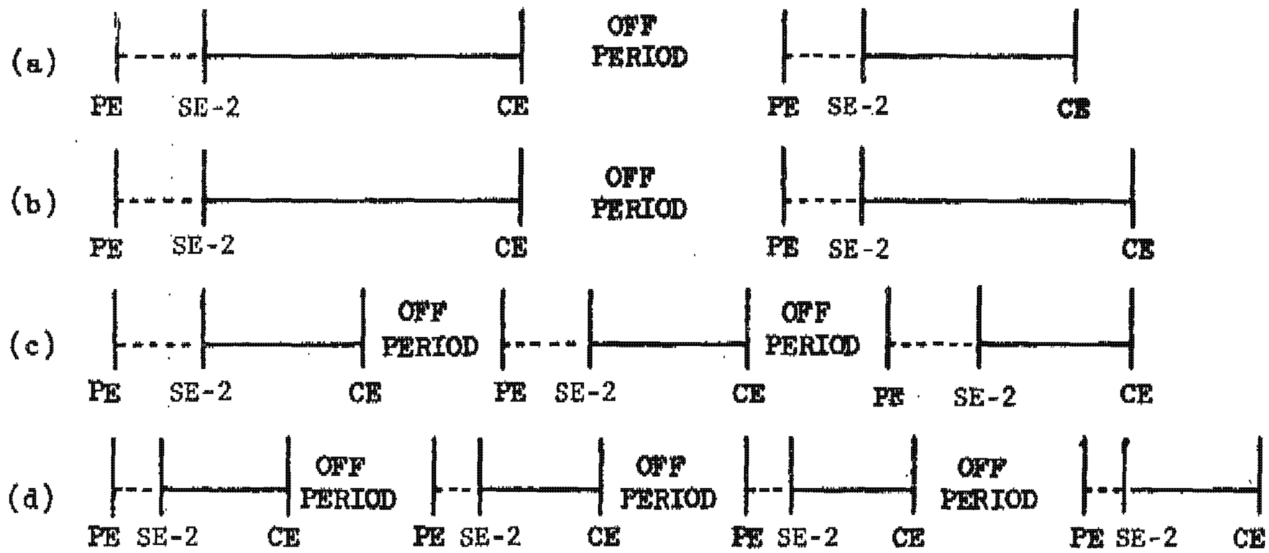
c. Single tape recorder, TR 1 or TR 2 or TR 3.

d. No remote payload mode change capability.

e. Controlled by any combination and sequence of PE's.

f. Off-period variable from 16 seconds to 5.7 orbits.

g. Any one read-in could be a transpond operation with antenna switching in the mixed mode of operation. This operation would require an additional PE and CE (not shown).



NOTE: In configuration (d) above, the first read-in period could be a transpond with antenna switching in the mixed mode of operation if the initial payload and tape recorder read-in-on is handled via real time command. The antenna switching could be done midpass with a PE, and its associated CE would terminate the transpond operation.

6.4.3 Option III: Multiple Read-Ins, Two Recorders

a. Two read-ins.

b. Partial or full tapes.

c. Any two tape recorders.

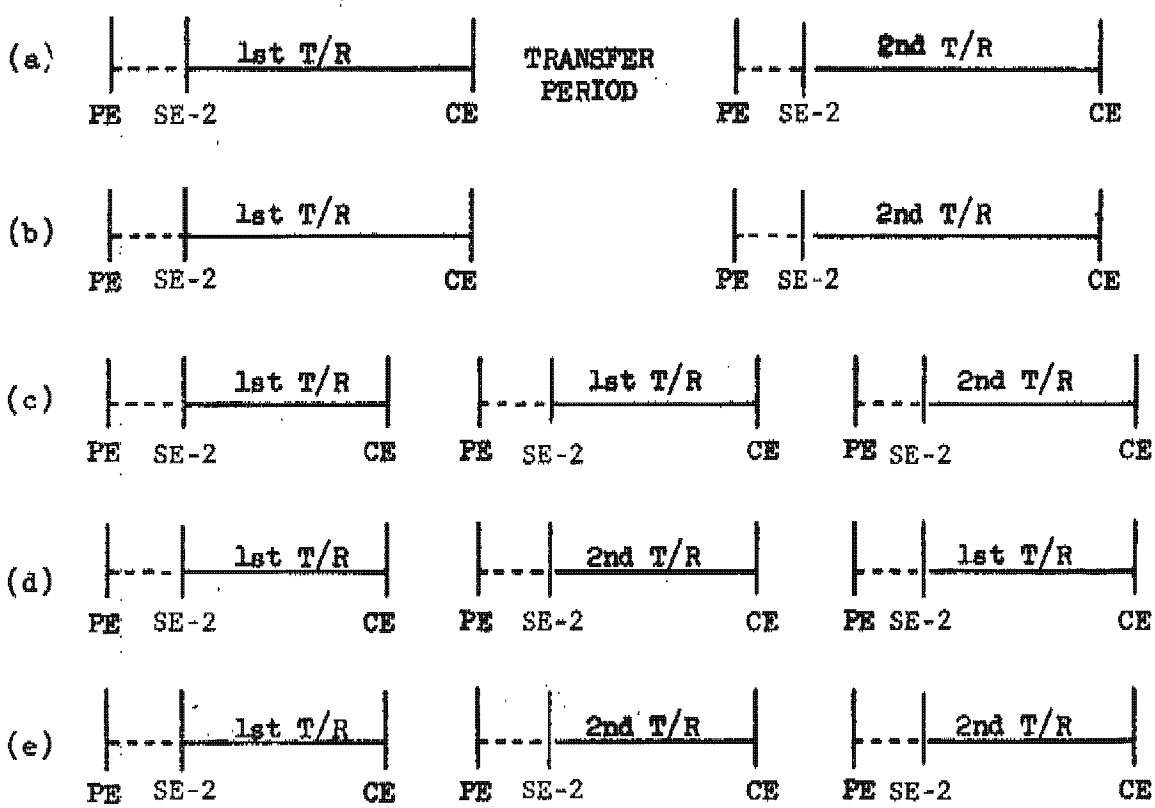
d. Any combination of tape recorders.

e. No remote payload mode change capability.

f. Controlled by any combination and sequence of PE's,

g. Transfer period variable from 16 seconds to 5.7 orbits.

h. Any one read-in could be a transpond operation with antenna switching in the mixed mode. This operation would require the use of an additional PE and CE (not shown).



(f) Combinations of four split read-ins with four PE/CE's and two T/R's.

NOTE: The first read-in of four split read-ins could be a transpond with antenna switching, providing the read-in initiation is via real time command.

25X1

6.4.4 Option IV: Data Overlap Between Recorders

a. Two read-ins

b. Partial or full tapes (two full tapes are longer than the longest CE delay)

c. Any two tape recorders

d. Any combination of tape recorders

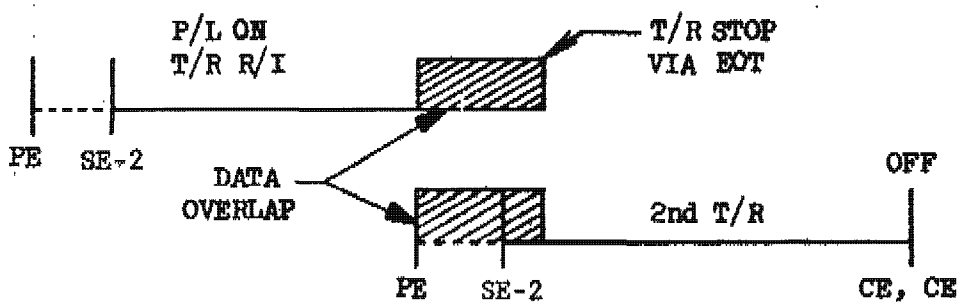
e. Controlled by any sequence of PE's

f. Data overlap during transfer period

g. First "CE" must come after second recorder stop

h. No remote payload mode change capability

i. The first T/R starts with the SE-2; the second with the second PE



Note: Second SE-2 does nothing. Payload burst counter update with second PE.

25X1

6.5 EVALUATION PHASE

During the first 60 to 75 orbits of the spacecraft, evaluation phase command exercises are implemented.

Approximately one week before launch, a planning meeting is held at the STC to merge a nominal predict ephemeris and station acquisition times with the proposed command exercises. Normal tasking of the payload is integrated with the evaluation phase exercises, subject to approval of the Technical Advisor and MD. Selection of specific passes for specific command exercises is subject to change in order to optimize SCF capability in terms of spacecraft demonstrated performance and actual orbital characteristics (e.g., such factors as multiops conflicts, availability of microwave facilities, and availability of tracking station receivers, antennas, and other equipment are taken into consideration).

Upon completion of the evaluation phase, [redacted] will forward a formal letter to the [redacted] transferring the spacecraft to the latter organization for operations, reporting completion of the phase and, if appropriate, operating restrictions to be observed. 25X1

6.6 BATTERY CONDITIONING EXERCISES

During orbital operations, the battery may be subjected to a reconditioning exercise as specified by and under the direction of the CSE.

6.7 ACS MANEUVERING

Once the spacecraft attitude has been determined, the ACS capability will be used to place and maintain the spacecraft in the mission-required attitude, i.e., parallel to the earth's axis.

6.8 POWER SUMMARY

The power calculations in the following summary are based on a spacecraft voltage of +25 VDC.

6.8.1 Equipment Power

			Measured Current (ma)	Power (Watts)	Watt-Hours per day
a. Continuous					
During read-in (PM Mode)			353	8.83	212
During read-in (FM Mode)			345	8.63	207
During readout (FM Mode)			464	11.6	278.4
b. PL Read-in	Mode	Band			Watt-Hours per min
With TR 2	4:1	B 2-5	5920	148.0	2.46
	4:1	B 1	5520	138.0	2.30
	1:1	B 2-5	6000	150.0	2.50
	1:1	B 1	5600	140.0	2.33
c. TIM On (Dual WB Links)					
Links 1-4 and 5, FM mode			7250	181.3	3.02
Add two TRs in readout (dual). Two TRs and DIUs in readout, CTO			9920	248.0	4.13
Or add transpond and readout. Real time transpond; one TR-DIU readout, CTO			12090	302.3	5.04
d. TIM On (Single)					
Links 1 and 4, FM			4960	124.0	2.07
Add readout (single). One TR and DIU in R/O CTO (TR 2)			6500	162.5	2.71
Or add transpond only. Real time transpond, CTO, no TR read-in			8780	219.5	3.66

		Actual Current (ma)	Power (Watts)	Watt-Hours per min
e. Transpond				
Transpond with TR read-in 4:1, CTO, link 4 only, PM	(B1)	9150	228.8	3.81
	(B2-5)	9550	239.0	3.98
Transpond with no TR read-in, CTO, link 4 only, PM	(B1)	8110	202.8	3.38
	(B2-5)	8510	212.8	3.55

6.8.2 Power Consumed During Tasking

Assumptions: Read-in time equals four times readout time equals four times TLM on without readout.

a. Dual Readouts

Read-In (1 T/R)	2.50	W/Hrs per min.
1/4, 1/2 TLM On	0.38	W/Hrs per min.
1/4, 1/2 Readout	0.52	W/Hrs per min.
Total	3.40	W/Hrs per min.

b. Single Readout

Read-In (1 T/R)	2.50	W/Hrs per min.
1/4 TLM On	0.52	W/Hrs per min.
1/4 Readout	0.68	W/Hrs per min.
Total	3.70	W/Hrs per min.

6.8.3 Power Available

a. Best case gamma, best case power
(gamma angle = 100°, 100% sun): 1098 watt-hrs per day

Less continuous power: 207 watt-hrs per day

Total 891 watt-hrs per day

b. Best case gamma, worst case power
(gamma angle = 100°, 62% sun) 681 watt-hrs per day

Less continuous power: 207 watt-hrs per day

Total 474 watt-hrs per day

6.8.4 Tasking Capability

a. Dual readout (best case gamma, best case power)

$$\frac{891}{3.40} = 262 \text{ minutes of tasking per day}$$

b. Single readout (best case gamma, best case power)

$$\frac{891}{3.70} = 241 \text{ minutes of tasking per day}$$

c. Dual readout (best case gamma, worst case power)

$$\frac{474}{3.40} = 139 \text{ minutes of tasking per day}$$

d. Single readout (best case gamma, worst case power)

$$\frac{474}{3.70} = 128 \text{ minutes of tasking per day}$$

6.8.5 Individual Equipment - Mfg. Suggested Current Drains at +25 V

a. Continuous Equipment

Continuous Equipment		Current (ma.)
Command Systems (2)	Passive	80
Command Systems (1)	Active	235
Primary Timer		7
PSCA		75
TCU	Passive	20
Payload TRG	Passive	50
Tape Recorders (3)	Passive	35

b. Read-in & Transpond

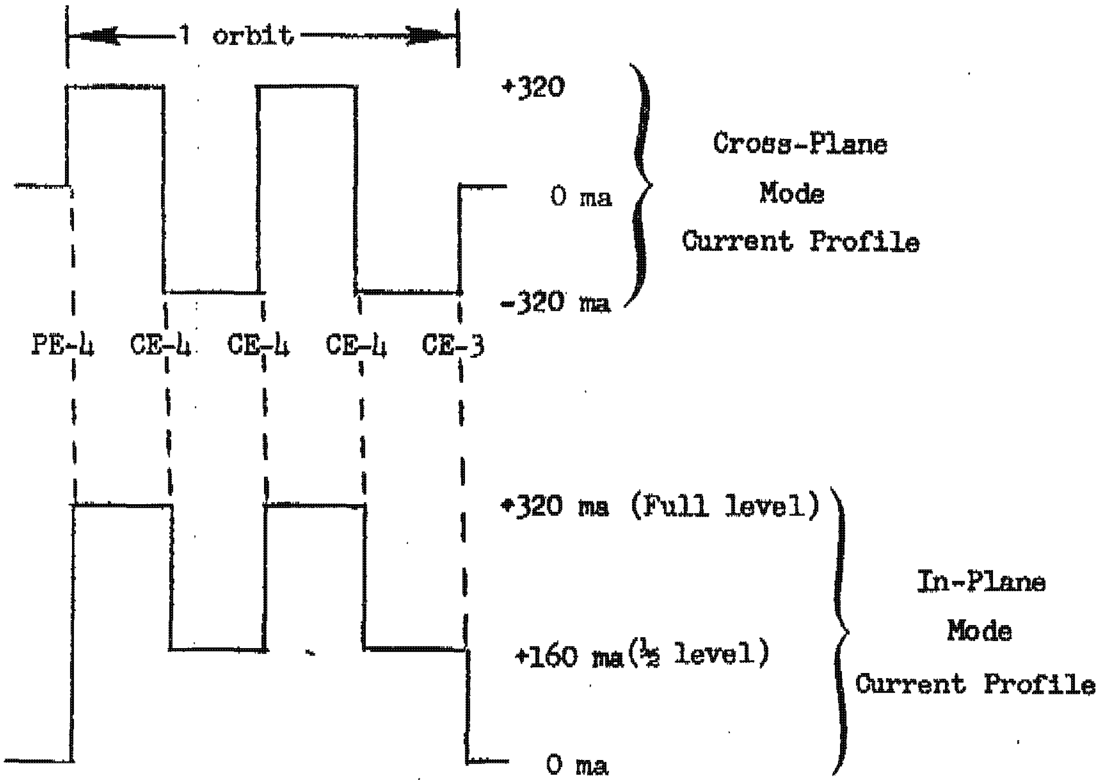
Payload Band 1	on	3900
Payload Band 2-5	on	4300
Horizon Sensor (1)		35
Solar Aspect Sensor (1)		8
Tape Recorder 4:1		840
Tape Recorder 1:1		970
Encryptor		255
WB Transmitter FM		2625
TC Antennas (2)		150

c. TLM on (Dual) RO - RO Transpond

Payload Status (920) + B&A		1020
Command System (1)	Active	235
Horizon Sensor (1)		35
Solar Aspect Sensor (1)		8
PSCA	Active	165
TCU	Active	210
TC Antennas (2)		150
Status Transmitter		950
WB Transmitters (2) (FM)		5230
RF Switches (at 1/2 value)		75
DIU's in RO (2)		620
Tape Recorders in RO (2)		1960
Payload in Transpond B1		3900
Payload in Transpond B2-5		4300
Encryptor		255

d. TLM On (Single) 1 TR RO

Item		Current (ma.)
Payload Status (920) + B&A		1020
Command System (1)	Active	235
Horizon Sensor (1)		35
Solar Aspect Sensor (1)		8
PSCA	Active	165
TCU	Active	210
TC Antennas (2)		150
Status Transmitter		950
WB Transmitter (1) (FM)		2615
RF Switch (at 1/2 value)		75
DIU in RO (1)		310
Tape Recorder in RO (1)		980
Encryptor		255



6.8.6 Attitude Control Subsystem (ACS) Power Summary

The ACS will be used on a noninterference basis with normal operations, and, therefore, will not affect the power summary given in the previous section.

The length of operation in any given mode is to be determined.

	ACS Mode	Current (ma)	Power (Watt Hrs/Orbit)
a.	Cross-Plane, High Gain	320	13.0
b.	In-Plane, High Gain	340	9.7

Values for the figures and tables above should be doubled when both systems are in operation.

6.9 SPACECRAFT TERMINATION MODE

A means has been provided to terminate the spacecraft's operational capability when it is no longer desired to task with normal operations. The termination sequence shall be implemented at the direction of the technical advisor and is as follows:

Command	Spacecraft Termination
0.14-1T & 2F & 3T	Enable termination
0.04-2T	Enable termination (Trickle Charge B1)
0.17-2T	Enable termination (Trickle Charge B2)
0.14-1T & 2F & 3F	Terminate (If enabled) Disconnect solar array from PSCA.

The continuous current load of the spacecraft (approximately 300 ma.) will discharge the battery. To reset the spacecraft out of the termination mode, send the following command:

Command	
0.04-2F	Enable reset (Normal Charge B1)
0.17-2F	Enable reset (Normal Charge B2)
0.14-1F & 2T & 3T	Reset termination Connect solar array to PSCA Disable terminate command.

Section 7

DATA PROCESSING

7.1 TEST DATA PROCESSING

Experimental Programs Test (0/76-40) is responsible for all test data processing and analyses for status carrier data (except payload subcomm data). Payload engineering (0/65-24) is responsible for all payload carrier test data (and payload subcomm data) processing and analyses. Results of analyses and associated discrepancies shall be forwarded to cognizant organizations. Systems Engineering (0/65-21) will be responsible for dispositioning all systems-level discrepancies.

7.2 FLIGHT DATA PROCESSING

0/60-90 will utilize computers and data processing facilities available in [redacted] for preparation of final data output to be forwarded to the user as specified in the DAHOPS plan (BIF003W/2-079057-78) if and as contracted. 25X1

7.3 DATA FREQUENCY SPECTRA

Figures 7-1, 7-2, and 7-3 illustrate the frequency spectra and data content formats for the different modes described in section 6.

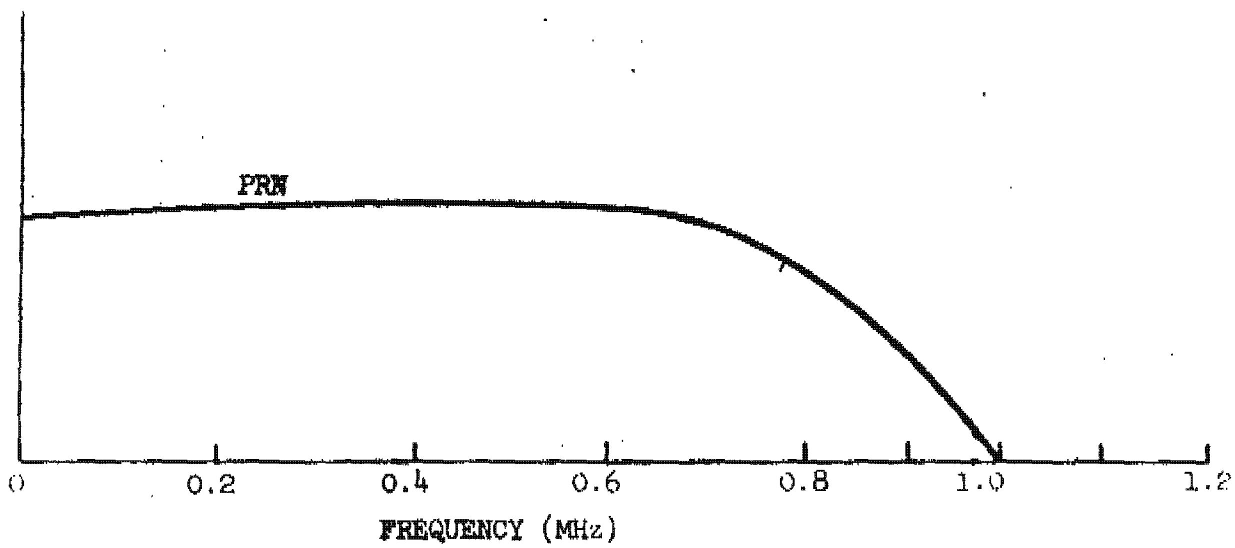


Figure 7-1 Narrowband FM Status Transmitter Format

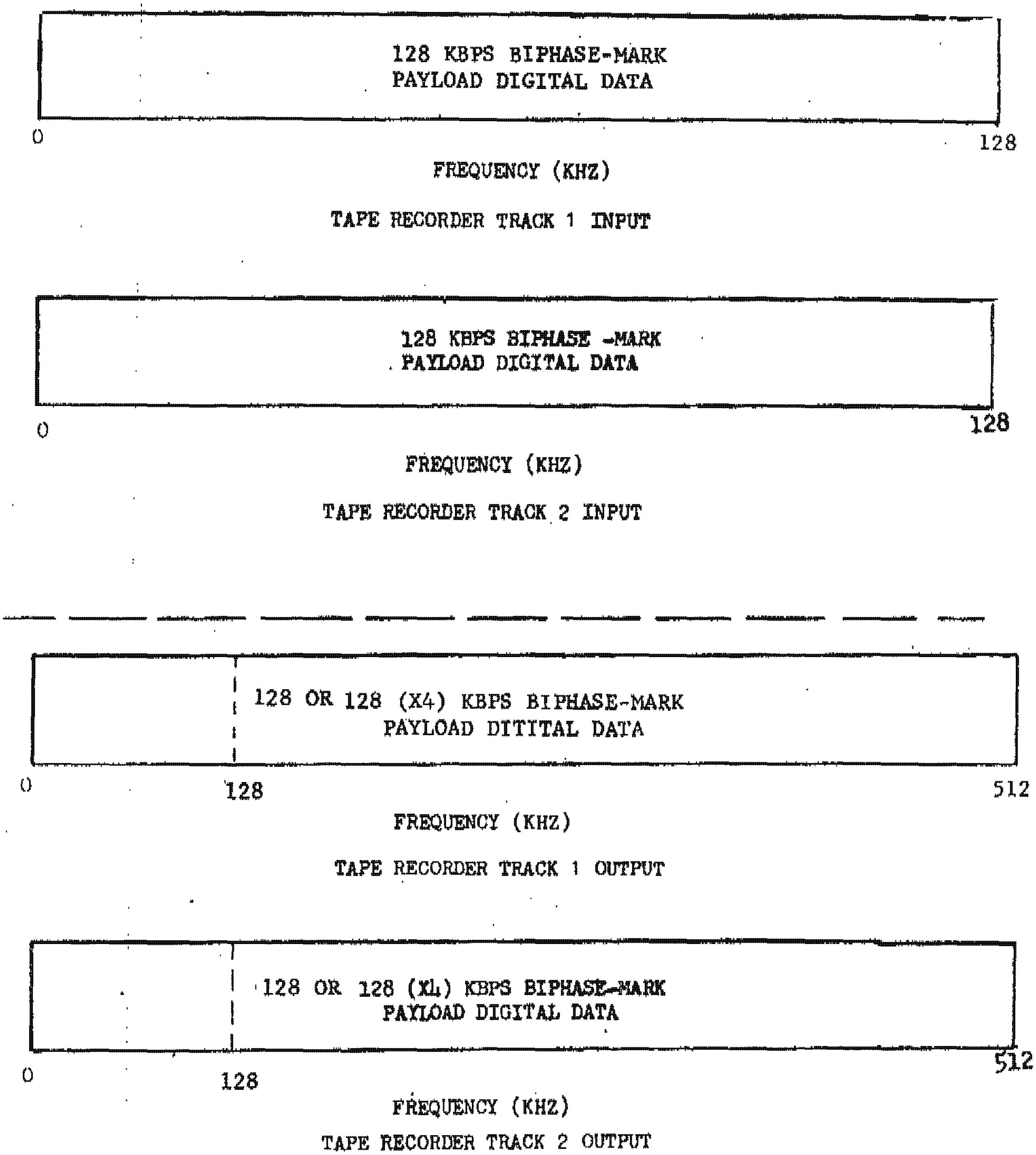
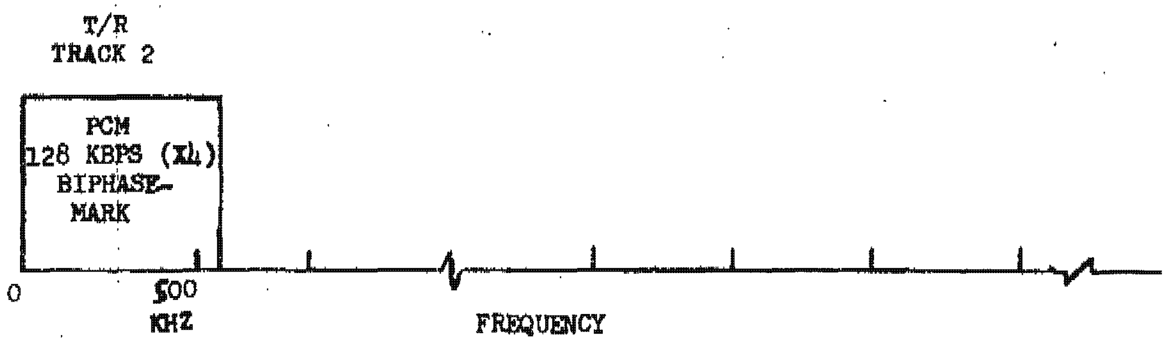
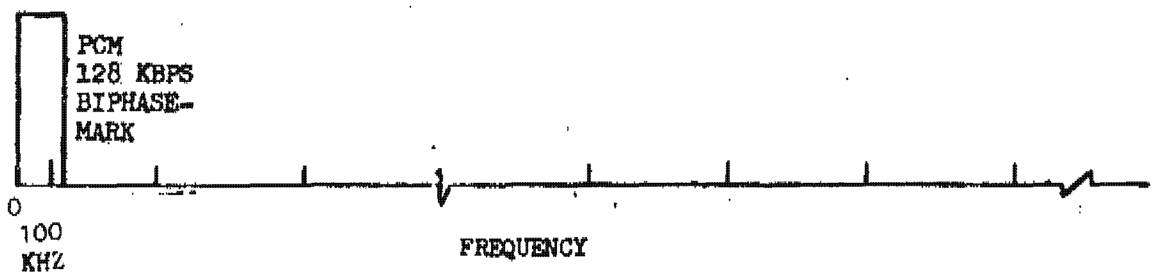


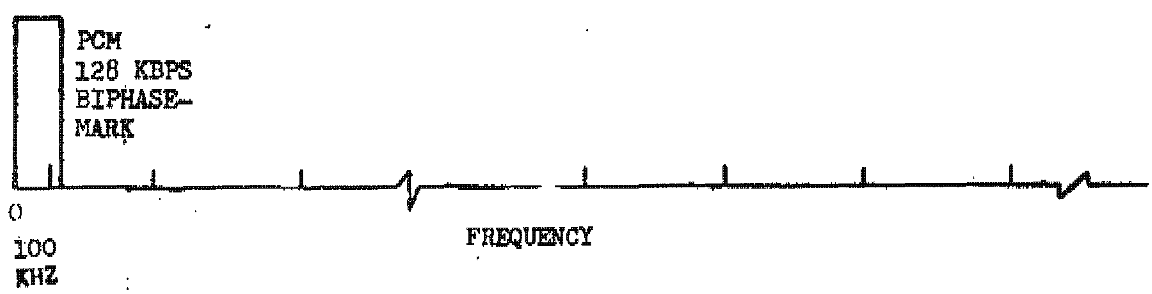
Figure 7-2 Tape Recorder Input and Output Data Formats



Wideband FM Transmitter Input, 4:1 Tape Recorder Readout



WB-FM or NB-PM Transmitter Input, Transpond Mode or 1:1 Tape Recorder Readout



WB-FM or NB-PM Transmitter Input, Before and After Tape Recorder Readout Mode

Figure 7-3 Transmitter Input Data Formats

Section 8

APPLICABLE DOCUMENTS

Document No.	Title
2P14752	Detailed Specification, Advanced Structure Subsystem
2P14885	Environmental Specification, Subsystems and Equipment
2P24041	Detailed Specifications for New Host Vehicle Support Panel
2P24050	Thermodynamic Requirements, Launcher Support Panel, New Host Vehicle
2P24224-5	Envelope Drawing, Payload A
2P24224-7	Envelope Drawing, Payload B
2P24231	Mission Peculiar Thermal Finish Requirements, Unit 31
2P24227	Enlarged Wing Design and Development Requirements Specification
2P24237	Augmented Power Subsystem Requirements
2P24241	Thermodynamic Requirements for Thermal/Vacuum Systems Test, Unit 31
2P24256	Spacecraft 4431/URSALA IV Configuration Drawing
BIF003W/2-013588-73	Satellite Vehicle/Subsatellite Interface Control Document
BIF003W/2-022448-69	Subsatellite System Design Requirements
BIF003W/2-022721-70	Test Plan for Subsatellite/New Host Vehicle Interface
BIF003W/2-022744-69	P-114/P-95 Electromagnetic Compatibility Plan, Rev. A
BIF003W/2-062619-76	Program Test Plan
BIF003W/2-071095-78	Spacecraft 4431/URSALA IV Command Capabilities and Limitations Document
BIF003W/2-079479-78	Spacecraft 4431/URSALA IV Instrumentation Schedule
BIF003W/2-079057-78	Data Handling Operations Procedures (DAHOPS)
(To be published)	Spacecraft 4431/URSALA IV Signal Contour Plots

Document No.	Title
BIF003W/2-063285-72	Interface Control Document
8103363	Cleanliness Requirements