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SPACECRAFT 4430/URSALA III

COMMAND CAPABILITIES AND LIMITATIONS DOCUMENT (S)

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Section 1

INTRODUCTION

This document describes the operational capabilities of Spacecraft 4430 and the URSALA III reconnaissance receiving system, and establishes guidelines for the collection and recovery of spacecraft and payload data. Special features, constraints, and limitations of the spacecraft and payload systems are provided to establish on-orbit operational criteria for the spacecraft.

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Section 2

GENERAL SYSTEM DESCRIPTION

The URSALA III intercept system is a 2- to 12-GHz monopulse, direction-finding, electronic order of battle (EOB), reconnaissance receiving system, which is mounted on a spin-stabilized spacecraft orbiting in a 340-nm circular orbit at a spin rate of approximately 55 rpm. (See figure 2-1.) The system uses two parabolic pencil-beam antennas plus five omni/inhibit antennas to provide omnidirectional coverage. The parabolic antennas are mounted such that each antenna views the earth during one-half of each spacecraft spin. Switching between antennas and switching of RF bands maximizes the coverage time and, thus, the probability of intercept. The intercept system measures the [redacted] of a target signal on a pulse-by-pulse basis. The system also detects CW signals and measures CW frequency.

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The spacecraft contains an attitude control system, a spin-rate control system, and an attitude sensing system that consists of four solar aspect sensors, two shift registers (one spare), and two horizon sensors (one spare).

A simplified block diagram of the spacecraft/payload system is shown in figure 2-2. The logic is configured so that one transmitter will transmit simultaneously both tracks of a dual-track tape recorder. This is accomplished by translating the frequency of one track via a 1.7-MHz VCO. Three tape recorders are available, with each one having a read-in/readout ratio of 4:1.

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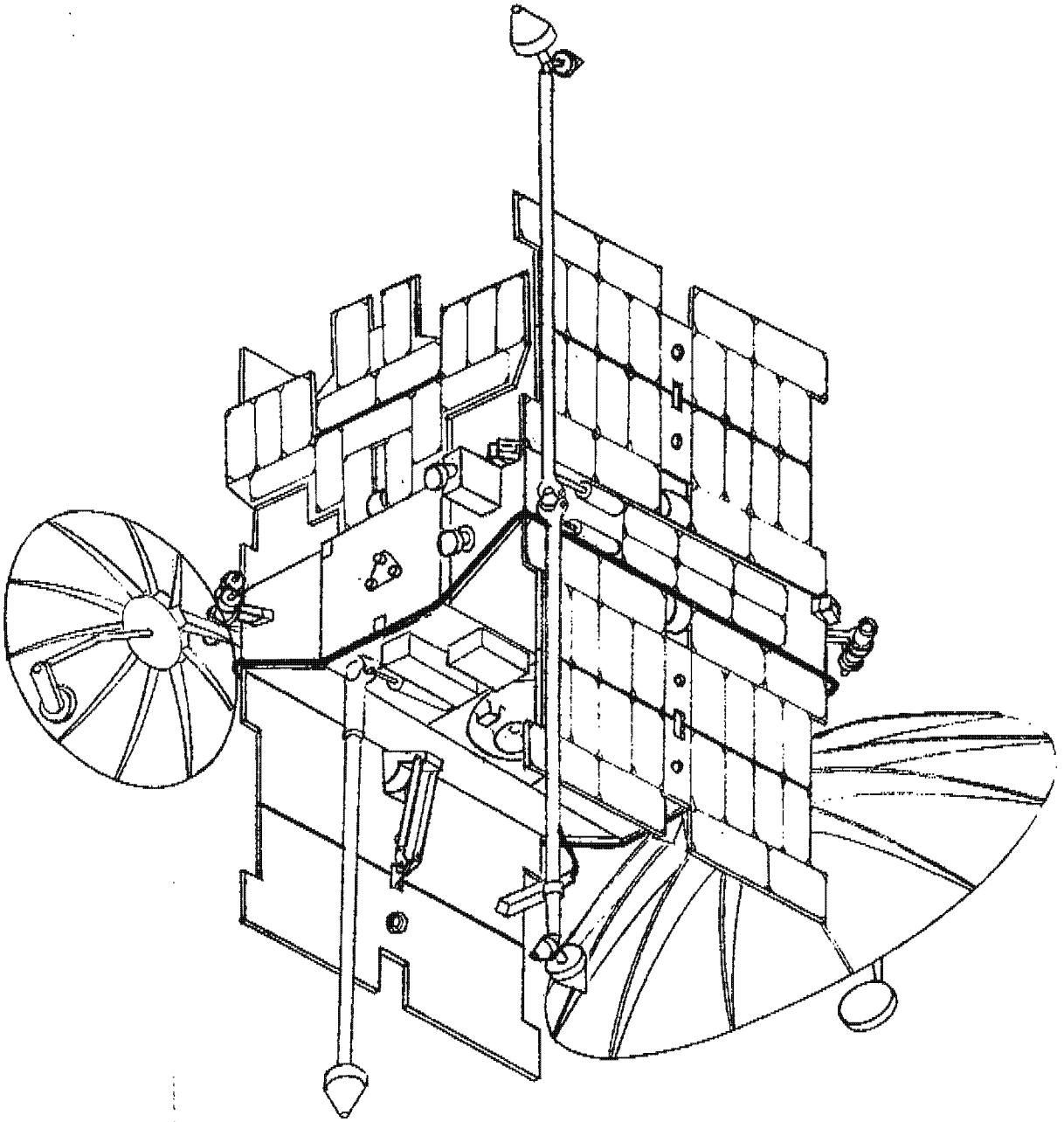

Figure 2-1 Spacecraft 4430/URSALA III On-Orbit Configuration

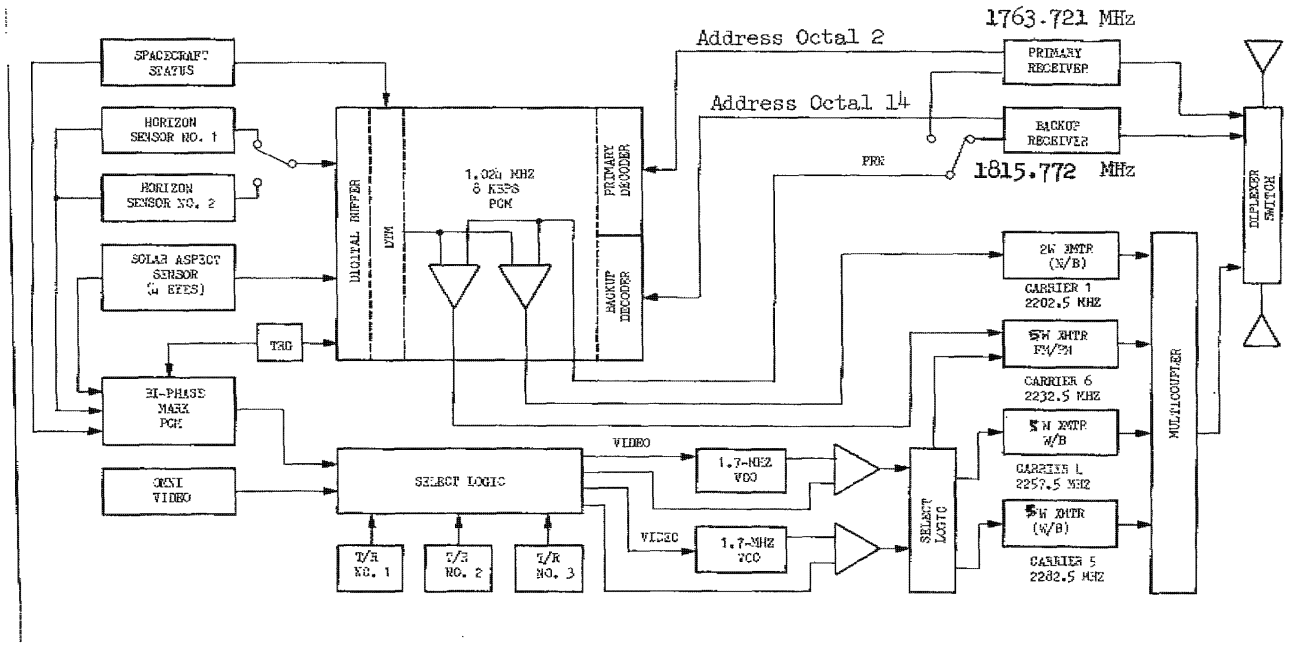

Figure 2-2 Spacecraft 4430/URSALA III Simplified Block Diagram

Section 3

REAL TIME CONTROL AND DATA RECOVERY

3.1 INTRODUCTION

This section describes the commands and functions associated with data recovery. Spacecraft 4430/URSALA III Systems Requirements Document, BIF003W/2-075479-73, provides a detailed description of all spacecraft commands, and Spacecraft 4430/URSALA III Intercept System Technical Description, BIF003W/2-077876-73, delineates payload mode selection commanding.

3.2 TRANSMITTER OPERATION

3.2.1 Transmitter Selection Logic

Spacecraft 4430 contains the four transmitters that perform the following functions:

a. Carrier 1 Transmitter. Normally transmits spacecraft status data
b. Carrier 4 Transmitter. Normally transmits payload channel 1 data *
c. Carrier 5 Transmitter. Normally transmits payload channel 2 data *
d. Carrier 6 Transmitter. Backup transmitter for carriers 1, 4, or 5* transmitters.

Carriers 2 and 3 are reserved for standard SGLS downlink data, and are not used.

Power output of the carrier 1 transmitter is two watts, minimum, and power output of the other transmitters is seven watts, minimum. The selection of a given transmitter to be used for a given function is accomplished via primary command 0.06XX or backup command 0.31XX. The possible transmitter/function configurations available are shown in table 3-1.

*NOTE: The system is redundant to the extent that only one transmitter is needed for status (i.e. either Carrier 1 or 6) and only one tape recorder (of 3) and one transmitter (i.e. either Carrier 4 or 5 or 6) is needed for payload information.

Table 3-1

TRANSMITTER/FUNCTION CONFIGURATIONS

(See pages 8-2 and 8-3 for details of this table.)

Primary Command (0.06XX)	Backup Command (0.31XX)	Configuration Selected
1F	1T	Select carrier 4 for P/L channel 1 data (command 8 to payload)
1T	1F	Select carrier 6 for P/L channel 1 data (command 9 to payload)
2F	2T	Select carrier 5 for P/L channel 2 data (command 10 to payload)
2T	2F	Select carrier 6 for P/L channel 2 data (command 11 to payload)
3F	3T	P/L channel 1 & 2 transfer reset (command 12 to payload)
3T	3F	P/L channel 1 & 2 transfer (command 13 to payload)
4F	4T	Status baseband no. 1 and no. 2 transfer reset (normal mode)
4T	4F	Status baseband no. 1 and no. 2 transfer
5F	5T	Select carrier 1 for spacecraft status (carrier 6 to FM mode)
5T	5F	Select carrier 6 for spacecraft status (carrier 6 to PM mode)

Once the desired transmitter configuration has been selected, it need not be repeated for every acquisition, since it will remain the same until deliberately changed.

3.2.2 Transmitter Turn On

The transmitters are turned on via primary command 0.01XX or backup command 0.36XX as shown in table 3-2. A "channel" rather than a "carrier"* is turned on by bits 1, 2, or 3. LVCO Reset/Override will occur with each 0.01, i.e., override if below the LVCO voltage region; reset if above.

*I.e., the channel is a "selectable" carrier.

If bit 4 is false, SE-1 will start and will clock out at 808 +4, -0 seconds. The function of SE-1 is to turn off the transmitters and terminate the acquisition should, for some reason, the tracking station be unable to transmit real time termination commands. Bit 5 is used for antenna selection, and bit 6 is used for selection of primary or backup receiver PRN.

Table 3-2

TELEMETRY-ON COMMANDS

Primary Command (0.01XX)	Backup Command (0.36XX)	Telemetry-On Configuration LVCO Reset/Override
1F	1T	Spare
1T	1F	Status channel ON Carrier 1 or 6 ON, as selected Bus and T/R current monitors ON, Status monitors ON Command 1 to payload (50 ma) DTM, HS and SAS ON
2F	2T	Spare
2T	2F	Channel 1 ON Carrier 4 or 6 ON as selected Command 2a to payload (50 ma)
3F	3T	Spare
3T	3F	Channel 2 ON Carrier 5 or 6 ON as selected Command 2b to payload (50 ma)
4F	4T	Start SE-1
4T	4F	Spare
5F	5T	Select -Y antenna (uplink and downlink)
5T	5F	Select +Y antenna (uplink and downlink)
6F	6T	Select receiver 1 PRN, disable receiver 2 PRN
6T	6F	Select receiver 2 PRN, disable receiver 1 PRN

To conserve power, a channel should be turned on only if it is to be used to transmit desired data.

3.2.3 Transmitter Turn Off

Primary command 0.02XX or 0.35XX (or SE-1*) are used to turn off the transmitters at the end of a pass. Bits are assigned to transmitters rather than to channels.

If a read-in mode is started by a PE and an SE-2 before the TLM OFF command, bit 6 is disabled from stopping the tape recorder. The enable for this is the read-in off command CE. (Only a CE pulse resets the payload read-in mode.)

The TLM OFF command selects the downlink via the -Y antenna and the uplink via both the -Y and +Y antennas. Table 3-3 shows the various TLM OFF command functions.

Table 3-3

TELEMETRY-OFF COMMANDS

Primary Command (0.02XX)	Backup Command (0.35XX)	TLM OFF Configuration
1F	1T	Command 7 to payload (50 ma)
1T	1F	Spare
2F	2T	Carrier 1 transmitter OFF
		If FM mode is selected for carrier 6: DTM, H/S & SAS OFF; Bus & T/R current monitors OFF; Command 7a to payload (50 ma); Reset cmnd/TLM antenna
2T	2F	Spare
3F	3T	Carrier 4 transmitter OFF Command 7b to payload (50 ma)
3T	3F	Spare
4F	4T	Carrier 5 transmitter OFF Command 7c to payload (50 ma)
4T	4F	Spare
5F	5T	Carrier 6 transmitter OFF
		If PM mode is selected for carrier 6: DTM, H/S and SAS OFF; Bus & T/R current monitors OFF; Command 7a to payload; Reset cmnd/TLM antenna
5T	5F	Spare
6F	6T	T/R's R/O stop (enabled by CE, & disabled by SE-2) Command 6 to payload (50 ma)
6T	6F	Spare

*The term SE (single event) supersedes the term BME (base module event)

3.3 UPLINK AND DOWNLINK ANTENNAS

As stated previously, one bit of the TLM ON command is used to select the uplink and downlink via the -Y or +Y antenna. Real time switching of the antennas once per pass is necessary to maintain the required signal strengths at the tracking station throughout the pass. A data loss in the order of 10 msec (maximum) can be expected during antenna switching. The TLM OFF command resets the uplink to both the -Y and +Y antennas and the downlink to the -Y antenna.

Primary command 0.13XX or backup command 0.24XX are used to set up the logic required to select which downlink antenna shall be used during bypass.

3.4 TAPE RECORDER OPERATION

The three tape recorders have a read-in/readout ratio of 4:1, read-in time capacity is 1130 seconds minimum with no roll-back.* Measured roll-back worst-case read-in is 1124 seconds, minimum. Normally, only one recorder at a time should be read in (i.e., in series, but not in parallel) except for the "overlap" at the end of one tape recorder and start of a second tape recorder. Two recorders may be read out at the same time.

3.4.1 Tape Recorder Readout

The tape recorder readout is initiated by primary command 0.03XX or backup command 0.34XX as shown in table 3-4.

The commands shown in table 3-4 will change the payload mode from "before-and-after tape recorder readout" to "tape recorder readout." Note that the false states of bits 1, 2, and 3 are tape recorder readout stop commands. Therefore, care must be exercised in selecting the proper bit state. For example, if tape recorder 1 is started first, followed by the start of tape recorder 2 before tape recorder 1 has reached end-of-tape, bit state selection would be 0.03-1T, -2F, -3F for start of tape recorder 1 and 0.03-1T, -2T, -3F (not 0.03-1F, -2T, -3F) for start of tape recorder 2.

* Derivation of the read-in time interval is as follows: 1160 seconds ±2% speed variation ±0.5 speed ratio tolerance equals 1130 seconds. Roll-back at read-in EOT may result in some loss of data. The largest such roll-back measured to date is 80 read-in seconds (see section 3.8 for details).

Table 3-4

TAPE RECORDER READOUT COMMANDS

Primary Command (0.03XX)	Backup Command (0.34XX)	Tape Recorder Readout Control
1F	1T	T/R 1 R/O stop
1T	1F	T/R 1 R/O Command 3 to payload
2F	2T	T/R 2 R/O stop
2T	2F	T/R 2 R/O Command 4 to payload
3F	3T	T/R 3 R/O stop
3T	3F	T/R 3 R/O Command 5 to payload
4F	4T	Monitors to phase 2
4T	4F	Monitors to phase 1
5F	5T	Spare
5T	5F	Pyro power on, solar array motor power on, enable launch logic
6F	6T	Spare
6T	6F	Solar array motors off

The selection of which of the two transmitter links a tape recorder will read out on is accomplished automatically by spacecraft payload logic as shown in table 3-5.

3.5 PROGRAMMED COMMANDS

The system timer capability has four independent PE's and four CE's. The total amount of time delay possible is 9.1 hours. Hence, up to 6 revs (at 90 minutes per rev) can be tasked at one time. For example, four 12-minute read-ins can be programmed within a 6-rev time interval (this requires using tape recorders in sequence). Simultaneous readouts of two recorders at 4 times read-in speed results in read out of all data within six minutes. Doubling the total time delay has reduced the command timing resolution from 8 to 16 seconds for the PE's. CE's still have the 8-second resolution. Zero load for the PE's is 16 seconds and for the CE's, it is eight seconds.

3.6 READ-IN CONTROL LIMITATIONS

Programmed commands PE-3/CE-3 and PE-4/CE-4 control both read-in selection and operation of the attitude control system (ACS) via common relays. Therefore, these commands may not be used for read-in on/off control while the ACS is in operation.

3.7 TAPE RECORDER BYPASS MODE

In the tape recorder bypass mode, the payload is in the read-in mode, but the data are routed directly to the transmitters; thus, "real time" operation of the payload results. In a normal bypass, no tape recorder read-in occurs; in a joint bypass/read-in, both real time payload data and the recording of that data are available.

Both payload baseband units will be turned on during bypass (the same as a normal TLM ON). Only one payload transmitter is usually needed.

The bypass mode is controlled via primary command 0.13XX or backup command 0.24XX as shown in table 3-7. Turn on or off of the spacecraft in the bypass mode is via the usual PE/CE method of read-in control.

Section 4

PAYLOAD OPERATIONAL CONTROL

Details of the payload features are presented in Spacecraft 4430/URSALA III Intercept System Technical Description, BIF003W/2-077876-73. This section deals only with a delineation of the actual operational control of the payload.

4.1 READ-IN OPTIONS AVAILABLE

The payload read-in mode can be programmed during a real time acquisition only. Any one of the four PE/CE combinations can be programmed to initiate a partial or full read-in on any of the three recorders. During any acquisition, as many as four read-ins can be programmed with delays up to six orbits. Any sequence or combination of tape recorders can be selected for this programming.

4.2 PAYLOAD READ-IN ON

The start of SE-2 and, thus, payload read-in is controlled by the PE's. SE times are +4, -0 seconds of their programmed times (plus 0.03 percent, minus 0.01 percent). Thus, SE-2 will occur between 32 and 36 seconds. The PE accuracy is +0, -1 second $^{+0.03}_{-0.01}$ percent of the programmed delays. PE delays can be programmed in 16-second increments to occur from a minimum of 16 seconds to a maximum of 32,752 seconds. The time delays must be reprogrammed for each read-in. Magnitude commands MC -1, -2, -3 and -4 load primary events PE-1, -2, -3, and -4, respectively. This is accomplished following an 0.05-5T or 0.32-5F command. Following an 0.05-5F or 0.32-5T command, the MC's load the CE delay. PE-3 and -4 are used for payload-on (via SE-2) only after commands 0.07-3F and -4F or 0.30-3T and -4T. Commands 0.07-3T or 0.30-3F enable ACS no. 1, and commands 0.07-4T or 0.30-4F enable ACS no. 2. Thus, if the ACS is to be used, PE-3 and -4 cannot be used for payload tasking.

4.3 PAYLOAD READ-IN OFF

Each PE in the timer has an associated companion event (CE) that is initiated with the occurrence of its respective PE. CE-1, -2, -3, and -4 can be orbit programmed in 8-second increments from 8 to 2040 seconds. The CE will occur within +0.03, -0.01 percent of the programmed time.