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This document is now released under Class 1 Configuration Management Control per MMAS document 2308226, Configuration Management Plan for TIROS.

GSFC TIROS Deputy Project Manager

Martin Marietta Astro Space
Director, TIROS Program

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1.0 SCOPE

This document is not a spacecraft, or Ground Station, requirements document. The purpose of this document is to describe the spacecraft transmitted data streams available and the various spacecraft to ground interfaces. Predicated on spacecraft requirements, and the availability and correctness of ground station information, this document describes/predicts the link performance with the two NOAA/NESDIS CDA ground stations (Wallops Island, VA and Fairbanks, AK). Data users and system developers must consult the appropriate Performance Specification listed under Section 2.0 to obtain requirements for design applications.

2.0 APPLICABLE DOCUMENTS

The specifications listed below form a part of this document. In the event of conflict between this document and any listed specification, the applicable specification shall govern.

ASD

PS-2284374	Performance Specification - TIROS Information Processor (TIP)
PS-3267403	Performance Specification - AMSU Information Processor (AIP)
PS-2284391	Performance Specification - Manipulated Information Rate Processor (MIRP)
PS-2284379	Performance Specification - Cross Strap Unit (XSU)
PS-2285211	Performance Specification - Communication Subsystem
PS-2629937	Performance Specification - GSTDN Command Receiver (GRD)
PS-2285212	Performance Specification - Command Subsystem
PS-2280287	Performance Specification - VHF Real-Time Antenna (VRA)
PS-20038448	Performance Specification - S-Band Data Antenna (SBA)
PS-3288057	Performance Specification - UHF Data Collection System
PS-2280284	Performance Specification - VHF Beacon/Command Antenna (BDA)
PS-3265453	Performance Specification - S-Band Data Transmitters (STX)
PS-3288236	Performance Specification - Search & Rescue Antenna (SRA)
PS-2288274	Performance Specification - S-Band Omni Antennule (SOA-1,2)
PS-2628492	Performance Specification - S-Band Omni Antennule (SOA-3,4)
PS-3284970	Performance Specification - S-Band Omni Antennule (SOA-5,6)
PS-2297967	Performance Specification - Search & Rescue L-Band Ant (SLA)
3267701,	RF Cabling (RFC) Control Drawing
200225 17	NOAA - K, L, M Telemetry List

NASA/GSFC

GSFC-S-480-25	Performance Specification for the NOAA-K through M Satellites

3.0 SPACECRAFT/GROUND INTERFACE PERFORMANCE

3.1 Spacecraft Data Transmissions/Formats

There are eight separate data types that the spacecraft is capable of transmitting. Some of these data types are transmitted real-time, with the other data types transmitted as 'playback' data. A description of each of these data types follows. A summary of these data types is listed in Table 3.1.

TABLE 3.1
Transmitter Data Type Summary

Transmitter / Data Rate	Modulation Format	Data '0'	Data '1'
STX-1, 2, or 3	Phase Modulated		
8.32 Kbps (Real-time TIP Data)	split Phase	+ 67° / - 67°	- 67° / + 67°
16.64 Kbps (Real-time TIP Boost Data)	split Phase	+ 67° / - 67°	- 67° / + 67°
16.64 Kbps (Real-time AIP Data)	split Phase	+ 67° / - 67	- 67° / + 67
332 Kbps (TIP Playback Data)	split Phase	+ 67° / - 67°	- 67° / + 67
665 Kbps (Real-time HRPT Data)	split Phase	+ 67° / -67	- 67° / + 67
1.33 Mbps (LAC Playback Data)	split Phase	+ 67° / - 67°	- 67° / + 67°
2.66 Mbps (LAC/GAC Playback Data)	NRZ - L	-67°	+ 67°
STX - 4 (see note)	Phase Modulated		
8.32 Kbps (Real-time TIP Data)	split Phase	+ 67° / - 67°	- 67° / + 67
16.64 Kbps (Real-time TIP Boost Data)	split Phase	+ 67° / - 67°	- 67° / + 67°
BTX - 1 2	Phase Modulated		
8.32 Kbps (Real-time TIP Data)	split Phase	- 67° / +67	+ 67° / - 67°
VTX - 1, 2	FM modulated by	N / A	N / A
± 17 Khz (APT Data)	2.4 Khz subcarrier	Analog	Analog

Note: STX-4 is capable of transmitting the data streams as noted for STX-1, 2, 3 but, as the ascent transmitter, will not normally be used to do so.

3.1.1 Real Time TIP Data Format.

The TIROS Information Processor (TIP) Format contains a multiplex of analog housekeeping data, digital housekeeping data, and low rate instrument data. The TIP format is based on a major frame which contains 320 minor frames. The major frame permits low rate sampling of many analog and digital housekeeping data points in conjunction with 550 words per second of operational payload data. The TIP data is transmitted as a 8.32 Kbps split phase signal in real time over one of the two selectable Beacon transmitters (BTX) and it is simultaneously recorded on one of the five spacecraft tape recorders as an NRZ-L signal. The parameters of the real time TIP orbital mode format are contained in Table 3.1.1-1

TABLE 3.1.1-1
Real Tii TIP Orbital Mode Parameters

Major Frame	
Rate	1 Major frame every 32 sec.
Number of Minor Frames	320 per major frame
Minor Frame	
Rate	10 minor frames per sec.
Number of words	104 words per minor frame
Format	See Table 3.1.1-2
Word Parameters	
Rate	1040 words per sec.
Number of bits/word	8
Order	bit 1 = MSB / bit 8 = LSB
Bit Parameters	
Rate	8320 bps
Format	Split phase
Data 0	-67° / + 67°
Data 1	+ 67° / -67°

TABLE 3.1.1-2
TIP MINOR FRAME FORMAT

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8 Plus Word Code & Meaning
Frame Sync & S/C ID	3	0 1 2	11101101 See Note 2 1 1 1 0 0 0 1 0 0 0 0 0 A A A A See Note 1
status	1-	3	Bit 1: Cmd Verification Status ; 1 = Cv update word present in frame; 0 = no Cv update in frame. Bits 2&3 TIP status; 00 = orbital mode, 10 = CPU memory Dump Mode, 01 = Dwell Mode; 11 Boost Mode. Bits 4-6: Major Frame Count: 000 = Major Frame 0 111 = Major Frame 7; MSB first; Counter incremented every 320 minor frames.
Dwell Mode Address	1+	3 4	Bits 7&8 9 bit Dwell mode address of analog channel Bits 1-7 that is being monitored continuously 0 0 0 0 0 0 0 0 0 = Analog chan 0 See Note 2 11 11 11 11 1 = Analog chan 511
Minor Frame counter	1+	4 5	Bit8 0 0 0 0 0 0 0 0 0 = Minor Frame 0 See Note 2 Bits 1-8 10 0 111111 = Minor Frame 319
Command Verification	2	6 7	Bits 9 thru 24 of each valid received or stored command word are placed in the 16 bit slots of telemetry words 6 and 7 on a one-for-one basis. See Note 3
Time Code	5	8 9 9 9,10,11 12	9 bits of Binary Day Count, MSB first bits 2-5: 0 1 0 1, Spare bits 27 bits of Binary millisec of Day Count, MSB first Time code is inserted in word location 8-12 only in minor frame 0 of every major frame. The data inserted is referenced to the beginning of the first bit of the minor frame sync word of minor frame 0 within ±1 millisecond.
Digital B Subcom-1	1	8	A subcommutation of Discrete Inputs collected to form 8 bit words. 256 Discrete inputs (32 words) can be accommodated. It takes 32 minor frames to sample all inputs once (sampling rate = once per 3.2 sec). A Major frame contains 10 complete Digital B subcommuted frames.
32 Sec Analog subcom	1	9	A subcommutation of up to 191 analog points sampled once every 32 seconds plus 64 analog points sampled twice every 32 seconds (once every 16 seconds). Bit 1 of each word represents 2560 mV while Bit 8 represents 20 mV.

TABLE 3.1.1-2
TIP MINOR FRAME FORMAT (cont.)

16 Secon	No. of Wards	wad Position	Bit No. 1 2 3 4 5 6 7 8 Plus Word Code & Meaning
Analog Subcom-1		10	This subcomm is controlled by a PROM located in the TIP and contains 160 word locations with 128 analog channels sampled once every 16 seconds..
1 Sec Analog Subcom	1	11	This subcom is controlled by a PROM located in the TIP and contains 10 analog channels sampled once every 1 second. Word 0 of this subcom is filled with data from an analog point selected by command. The selected analog point may be any of the 512 analog points available to the TIP. Bit 1 of each word represents 2560 mV while Bit 8 represents 20 mV.
Dig B subcom-2	1	12	A subcommutation of discrete inputs collected to form 8 Bit words. 256 discrete inputs (32 words) can be accommodated. It takes 32 minor frames to sample all inputs once (sampling rate = once per 3.2 sec). A major frame contains 10 complete Digital B subcommuted frames. 64 of these Bit locations corresponding to TIP minor frames 24-31 form the XSU Digital A data. The XSU generates an 8 word subcom which is read out at the rate of one word per minor frame. The XSU subcom is synchronized with its word 1 in minor frame 24.
16 Sec Analog subcom-2	1	1 3	This subcomm is controlled by a PROM located in the TIP and contains 160 word location with 128 analog channels sampled once every 16 seconds. The remaining 32 word locations contain data from the Solar Array Telemetry Commutator Unit (SATCU). The SATCU receives inputs from 16 sources on the solar array, commutates them and presents this output to the TIP on channel 282. The TIP formats this stream and presents it in the last 32 word locations. The 32 words represent two successive passes through the SATCU subcom.
DAU-1	1	14	8 Bit Housekeeping Telemetry words are formed by the DAU-1 and read out by the telemetry system at an average rate of 10 words per second.
DAU-2	1	15	8 Bit Housekeeping Telemetry words are famed by the DAU-2 and read out by the telemetry system at an average rate of 10 words per second.
HIRS/3	36	16, 17, 22, 23, 42: 26, 27, 30, 31, 43: 54, 55, 34, 35, 38, 39. 58. 59, 62, 63, 66, 67, 70, 71, 74, 75, 78, 79, 82, 83, 84, 85, 88, 89, 92, 93	8 Bit words are formed by the HIRS/3 experiment and are read out by the telemetry system at an average rate of 360 words per second.

TABLE 3.1.1-2
TIP MINOR **FRAME** FORMAT **(cont.)**

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8 Plus Word Code & Meaning
SEM	2	20,21	8 bit words are formed by the SEM sensor and read out by the telemetry system at an average rate of 20 words per second.
DCS-2	32	18,19,24,25,28 29,32,33,40,41 44,45,52,53,56 57,60,61,64,65 68,69,72,73,76 77,86,87,90,91 94,95	8 bit words are formed by the DCS experiment and read out by the telemetry system at an average rate of 320 words per second.
SBUV/2	4	36, 37, 80, 81	8 Bit words are formed by the SBUV/2 experiment and read out by the telemetry system at an average rate of 40 words per second.
CPU A TLM	6	46, 47, 48, 49, 50, 51	A block of three 16 Bit CPU words read out by the telemetry system every minor frame.
CPU B TLM	6	96, 97, 98, 99, 100, 101	A second block of three 16 Bit CPU words read out by the telemetry system every minor frame.
CPU Data Status	1-	103	Bits 1&2: 00 = All CPU data received 01 = All CPU-A data received; CPU-B incomplete 10 = All CPU-B data received; CPU-A incomplete 11 = Both CPU-A and CPU-B incomplete
Parity	1-	103	Bit 3: Even parity check on words 2 thru 18 Bit 4: Even parity check on words 19 thru 35 Bit 5: Even parity check on words 36 thru 52 Bit 6: Even parity check on words 53 thru 69 Bit 7: Even parity check on words 70 thru 86 Bit 8: Even parity check on words 87 thru bit 7 of word 103

Notes

1] The last 4 bits of word 2 are used for spacecraft ID

2] MSB is first

3] A complete explanation of command verification error messages is contained in Paragraphs 3.2.1.2.3.2.6 and 3.2.1.2.3.2.7 of PS-2285212.

3.1.2 Real Time AIP Data Format

The AIP Format contains a multiplex of TIP and AIP data. The AIP format is based on a major frame which contains 80 minor frames merged, frame for frame, with TIP and provides four major frames for each TIP major frame. The AIP data may be transmitted as a split phase signal in real time over any of the L / S Band transmitters (STX). The key parameters of the real time AIP orbital mode format are contained in Table 3.1.2-I

TABLE 3.1.2-1
Real Time AIP Orbital Mode Parameters

Major Frame	
Rate	1 Major frame every 8 sec.
Number of Minor Frames	80 per major frame
Minor Frame	
Rate	10 minor frames per sec.
Number of words	208 words per minor frame
Format	See Table 3.1.2-2
Word Parameters	
Rate	2080 words per sec.
Number of bits/word	8
Order	bit 1 = MSB / bit 8 = LSB
Bit Parameters	
Rate	16,640
Format	Split phase
Data 0	-67° / + 67°
Data 1	+ 67° / -67°

3.1.3 Playback TIP Data Format

The playback TIROS Information Processor (TIP) format is a speeded up, time reversed replica of the real-time TIP data The data is transmitted at 0.332 Mbps which is approximately 40 times the recorded bit rate. On playback, the recorded NRZ-L data is transformed into a split phase data stream and then used to modulate an STX. The key parameters of the playback TIP format are contained in Table 3.1.3

3.1.4 Playback AIP Data Format

The playback AMSU Information Processor (AIP) format is a speeded up, time reversed replica of the real-time AIP data. The data is transmitted at 0.332 Mbps which is approximately 20 times the recorded bit rate. On playback, the recorded NRZ-L data is transformed into a split phase data stream and then used to modulate an STX. The key parameters of the playback AIP format are contained in Table 3.1.4

TABLE 3.1.2-2.
AIP MINOR FRAME FORMAT

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8	Plus Word Code & Meaning
Frame Sync	3	0	1 1 1 1 0 0 1 1	
		1	0 1 1 0 1 0 1 0	
		2	0 0 0 0 0 0 0 0	See Note
Spare	1	3	0 1 0 1 0 1 0 1	
Minor Frame Counter	1	4	0 0 0 0 0 0 0 0	Represents Minor Frame 0
			0 1 0 0 1 1 1 1	Represents Minor Frame 79
			MSB is First	
Major Frame Counter	1	5	First six Bits are 0 0 0 0 0 0. Last two Bits are major (8-sec) frame counter. The major frame counter is incremented every 80 minor frames. Bits 7 and 8 of minor frame 5 will count 8-second intervals, the count overflowing to 0 synchronous with the TIP 32-second major frame pulse.	
Spare	2	6	0 1 0 1 0 1 0 1	
		7	0 1 0 1 0 1 0 1	
AMSU-A1	26	8 thru 33	8 Bit words are formed by the AMSU-A1 experiment and are read out by the AMSU Information Processor at an average rate of 260 words per second.	
AMSU-A2	14	34 thru 47	8 Bit words are formed by the AMSU-A2 experiment and are read out by the AMSU Information Processor at an average rate of 140 words per second.	
AMSU-B	50	48 thru 97	8 Bit words are formed by the AMSU-B experiment and are read out by the AMSU Information Processor at an average rate of 500 words per second.	
Spare	4	98 thru 101	0 1 0 1 0 1 0 1	
			0 1 0 1 0 1 0 1	
AMSU Parity	1	102	Bit 1: 0 Bit 2: 1 Bit 3: Even parity check on words 2 through 18 Bit 4: Even parity check on words 19 through 35 Bit 5: Even parity check on words 36 through 52 Bit 6: Even parity check on words 53 through 69 Bit 7: Even parity check on words 70 through 86 Bit 8: Even parity check on words 87 through Bit 7 of Word 102	
TIP Data	104	103 thru 206	Identical to TIP minor frame format contained in Table 3.2.3-3.	

TABLE 3.1.2-2.
AIP MINOR FRAME FORMAT (cont.)

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8 Plus Word Code & Meaning
TIP Parity	1	207	Bit 1: 0 Bit 2: 1 Bit 3: Even parity check on words 105 through 121 Bit 4: Even parity check on words 122 through 138 Bit 5: Even parity check on words 139 through 155 Bit 6: Even parity check on words 156 through 172 Bit 7: Even parity check on words 173 through 189 Bit 8: Even parity check on words 190 through Bit 7 of Word 206 This parity word amounts to an AIP recalculation of the TIP parity which was calculated by the the TIP in TIP word 103 (AIP word 206).

Note: Frame sync is first 22 bits. Last 2 bits of word 2 are: 00.

TABLE 3.1.3
Playback TIP Orbital Mode Parameters

Major Frame Rate Number of Minor Frames	 1.25 X (3327 / 3328) major frames/sec 320
Minor Frame Rate Number of words Format	 400 minor frames/sec (approx.) 104 Time reversed image of format in Table 3.1.1-2
Word Parameters Rate Number of bits/word Order	 41600 words/sec (approx.) 8 Bit 1 = MSB / Bit 8 = LSB
Bit Parameters Rate Format Data 0 Data 1	 332700 Bits/sec. Split phase + 67° / - 67° - 67° / +67°

TABLE 3.1.4
Playback AIP Orbital Mode Parameters

Major Frame	
Rate	2.5 X (3327 / 3328) major frames/sec
Number of Minor Frames	80
Minor Frame	
Rate	200 minor frames/sec (approx.)
Number of words	208
Format	Time reversed image of format in Table 3.1.1-2
Word Parameters	
Rate	41600 words/sec (approx.)
Number of bits/word	8
Order	Bit 1 = MSB / Bit 8 = LSB
Bit Parameters	
Rate	332700 Bits/sec.
Format	Split phase
Data 0	+ 67° / - 67°
Data 1	- 67° / +67°

3.1.5 HRPT Format

The High Rate Picture Transmission (HRPT) Format provides a major frame which is made up of 3 minor frames. TIP and AMSU data are updated at the major frame rate. That is, the three minor frames which make up a major frame will contain TIP data in the first minor frame, backfill in the second minor frame, and AMSU data in the third minor frame. The HRPT is provided in a split phase format to the S-Band Transmitter. The split phase data '0' is defined as being +67° phase during the first half of the bit period and -67° phase during the second half of the bit period. The split phase data '1' is defined as being -67° phase during the first half of the bit period and +67° phase during the second half of the bit period. The time code contained in each minor frame indicates the spacecraft time 1.13 ± 0.5 milliseconds before the beginning of bit 1 of word 1. The HRPT parameters are given in Table 3.15-l and the HRPT minor frame format is shown in Table 3.1.5-2

TABLE 3.1.5-1
HRPT Parameters

Major Frame	
Rate	2 major frames/sec
Number of Minor Frames/ major Frame	3
Minor Frame	
Rate	6 minor frames/sec
Number of words	11090
Format	See Table 3.1.5-2
Word Parameters	
Rate	66540 words/sec
Number of bits/word	10
Order	Bit 1 = MSB / Bit 10 = LSB
Bit Parameters	
Rate	665400 Bits/sec.
Format	Split phase
Data 0	+ 67° / - 67°
Data 1	- 67° / +67°

TABLE 3.1.5-2.
HRPT MINOR FRAME FORMAT

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8 9 1 0 Plus Word Code & Meaning
Frame Sync	6	1	1 0 1 0 0 0 0 1 0 0
		2	0 1 0 1 1 0 1 1 1 1
		3	1 1 0 1 0 1 1 1 0 0 See Note 1
		4	0 1 1 0 0 1 1 1 0 1
		5	1 0 0 0 0 0 1 1 1 1
		6	0 0 1 0 0 1 0 1 0 1
ID	2	7	Bit 1; 0 = Internal Sync; 1 = AVHRR Sync Bits 2 & 3; 00 = Not an HRPT frame but a GAC Frame; 01 = Minor Frame #1; 10 = Minor Frame #2, 11 = Minor Frame #3 Bits 4-7; Spacecraft Addresses; Bit 4 = MSB, Bit 7 = LSB Bit 8; 0 = Frame Stable; 1 = Frame Resync Occurred Bit 9; 1 = Normal AVHRR input; 0 = PN AVHRR input Bit 10; 0 = AVHRR CH3A, 1 = AVHRR CH3B
		8	Bits 1-10; Spare - undefined
Time Code	4	9	Bits 1-9; Binary day count; Bit 1 = MSB; Bit 9 = LSB Bit 10; 0; spare
		10	Bit 1-3; 101, spare Bits 4-10; Part of Binary msec of day count; Bit 4 = MSB
		11	Bit 1-10; Part of Binary msec of day count;
		12	Bit 1-10; Remainder of Binary msec of day count; Bit 10 = LSB
Telemetry	10	13	Ramp Calibration AVHRR Channel #1
		14	Ramp Calibration AVHRR Channel #2
		15	Ramp Calibration AVHRR Channel #3
		16	Ramp Calibration AVHRR Channel #4
		17	Ramp Calibration AVHRR Channel #5
		18	AVHRR Chan #3 Target Temp.
		19	AVHRR Chan #4 Target Temp.
		20	AVHRR Chan #5 Target Temp. See Note 2
		21	Channel 3 patch Temp.
		22	Spare - Undefined
Back Scan	30	23 thru 52	10 words of back scan data from each AVHRR channel 3, 4, and 5. These data are time multiplexed as chan 3 (word 1), chan 4 (word 1), chan 5 (word 1), chan 3 (word 2), chan 4 (word 2), chan 5 (word 2), etc.
Space Data	50	53 thru 102	10 words of space scan data from each AVHRR channel 1, 2, 3, 4, and 5. These data are time multiplexed as chan 1 (word 1), chan 2 (word 1), chan 3 (word 1), chan 4 (word 1), chan 5 (word 1), chan 1 (word 2), chan 2 (word 2), chan 3 (word 2), chan 4 (word 2), chan 5 (word 2), etc.
Sync Delta	1	103	Bit 1; 0 = AVHRR sync early; 1 = AVHRR sync late, Bits 2-10; 9 bit binary count of 0.9984 MHz periods; Bit 2 = MSB, Bit 10 - LSB

TABLE 3.1.5-2
HRPT MINOR FRAME FORMAT (cm.)

Function	No. of Words	Word Position	Bit No. 1 2 3 4 5 6 7 8 9 1 0. Plus Word Code & Meaning
Data Words	520	104 thru 623	3 sets of data corresponding to three HRPT minor frames per HRPT major frame. First HRPT minor frame: The 520 words contain 5 TIP minor frames of TI P data (104 TIP data words per TIP minor frame) Bits 1-8: Exact format as generated by TIP. Bit 9: Even parity check over Bits l-8. Bit 10: Inverted Bit 1. Second HRPT minor frame: The 520 words shall consist of five frames (104 words per frame) of spare data in the same form as spare wads 624-750. Third HRPT minor frame: The 520 words shall consist of five frames (104 words per frame) of AMSU data from the AIP. Bits 1-8: Exact format as generated by AIP. Bit 9: Even parity check over Bits 1-8. Bit 10: Inverted Bit 1. See Note 3
		624	
Spare Words	127	625	1 0 1 0 0 0 1 1 1 0
			1 1 1 0 0 0 1 0 1 1
		626	0 0 0 0 1 0 1 1 1 1
		627	1 0 1 1 0 0 0 1 1 1
		628	1 1 0 1 0 1 0 0 1 0
			See Note 4
		748	1 0 0 1 0 1 1 0 1 0
		749	1 1 0 0 1 0 0 0 1 0
		750	1 0 0 0 0 0 0 0 0 0
Earth Data	10,240	751	Chan 1 - Sample 1
		752	Chan 2 - Sample 1
		753	Chan 3 - Sample 1
		754	Chan 4 - Sample 1
		755	Chan 5 - Sample 1
		756	Chan 1 - Sample 2
			See Note 5
		10,985	Chan 5 - Sample 2047
		10,986	Chan 1 - Sample 2048
		10,987	Chan 2 - Sample 2048
		10.988	Chan 3 - Sample 2048
		10,989	Chan 4 - Sample 2048
		10,990	Chan 5 - Sample 2048

TABLE 3.1.5-2
HRPT MINOR FRAME FORMAT (cont.)

Function	No. of Words	Wad Position	Bii No. 1 2 3 5 6 8 9 10	Plus Word Code & Meaning
Auxiliary Sync	100	10,991	1 1 1 1 1 0 0 0 1 0	
		10992	1 1 1 1 1 1 0 0 1 1	
		10993	0 1 1 0 1 1 0 1 0 1	
		10,994	1 0 1 0 1 1 1 1 0 1	
				See Note 6
		11,089	0 1 1 1 1 1 0 0 0 0	
		11.090	1 1 1 1 0 0 1 1 0 0	

Notes:

1] First 60 bits from a 63 bit PN generator started in the all 'l's state. The generatorpolynominal is X6 + X^5 + X^2 + X +1

2] Each of these words is a 5 channel subcom; 4 words of IR data plus subcom sync (10 'o's)

3] The 104th word of each AMSU data frame to the MIRP contains 1110110100.

4] Derived by inverting the output of a 1023 Bit PN sequence provided by a feedback shift register generating the polynominal:

$$X^{10} + X^5 + X^2 + X + 1$$

The generator is started in all 1's state at the beginning of word 7 of each minor frame.

5] Each minor frame contains the data obtained during one Earth scan of the AVHRR sensor. The data from the five sensor channels of the AVHRR are time multiplexed as indicated,

6] Derived from the non-inverted output of a 1023 bit PN sequence provided by a feedback shift register generating the polynominal:

$$X^{10} + X^5 + x2 + X + 1$$

The generator is started in the all l's state at the beginning of word 10,991

3.1.6 **LAC Format.**

Local Area Coverage (LAC) data is recorded on one of the five spacecraft tape recorders and then played back through an STX. The LAC Format parameters are shown in Table 3.1.6. The LAC Minor Frame Format is identical to that described in Table 3.1.5-2 (HRPT) except as delineated in Item 4. The time code contained in each minor frame indicates the actual spacecraft time 1.13 ± 0.5 milliseconds before the beginning of bit 1 of word 1. The following summarizes the major aspects of LAC data.

1. The LAC bit rate is 1.33 Mbps or 2.66 Mbps as determined by the selected tape recorder's playback speed.

2. The LAC bit Format is NRZ-L if the playback bit rate is 2.66 Mbps or split phase if the playback bit rate is 1.33 Mbps.

3. The LAC Format is time inverted. The MSB is transmitted last and the LSB is transmitted first; the 6 word frame sync is transmitted last and the 100 word auxiliary sync is transmitted first.

4. The 127 span words axe Data '0' before randomizing.

5. The LAC minor frame is randomized. The randomization methodology is shown in Figure 3.1.5. The same 10th degree polynominal ($X^{10} + X^5 + X^2 + X+1$) generator used to provide the auxiliary sync is used to randomize the data. The complimented output of the PN generator shift register is modulo 2 added on a bit-by-bit basis to the minor frame data.

TABLE 3.1.6
LAC Playback Parameters

Major Frame		
Rate	4 or 8 major frames/sec	
Number of Minor Frames/ Major Frame	3	
Minor Frame		
Rate	12 or 24 minor frames/sec	
Number of words	11090	
Format	Time inverted version of HRPT format	
Word Parameters		
Rate	133080 or 266160 words/sec	
Number of bits/word	10	
Order	Bit 1 = MSB / Bit 10 = LSB	
Bit Parameters		
Rate	1.33 MBits/sec.	2.66 MBits/sec
Format	split phase	NRZ - L
Data 0	+ 67° / - 67°	- 67°
Data 1	- 67° / +67°	+ 67°

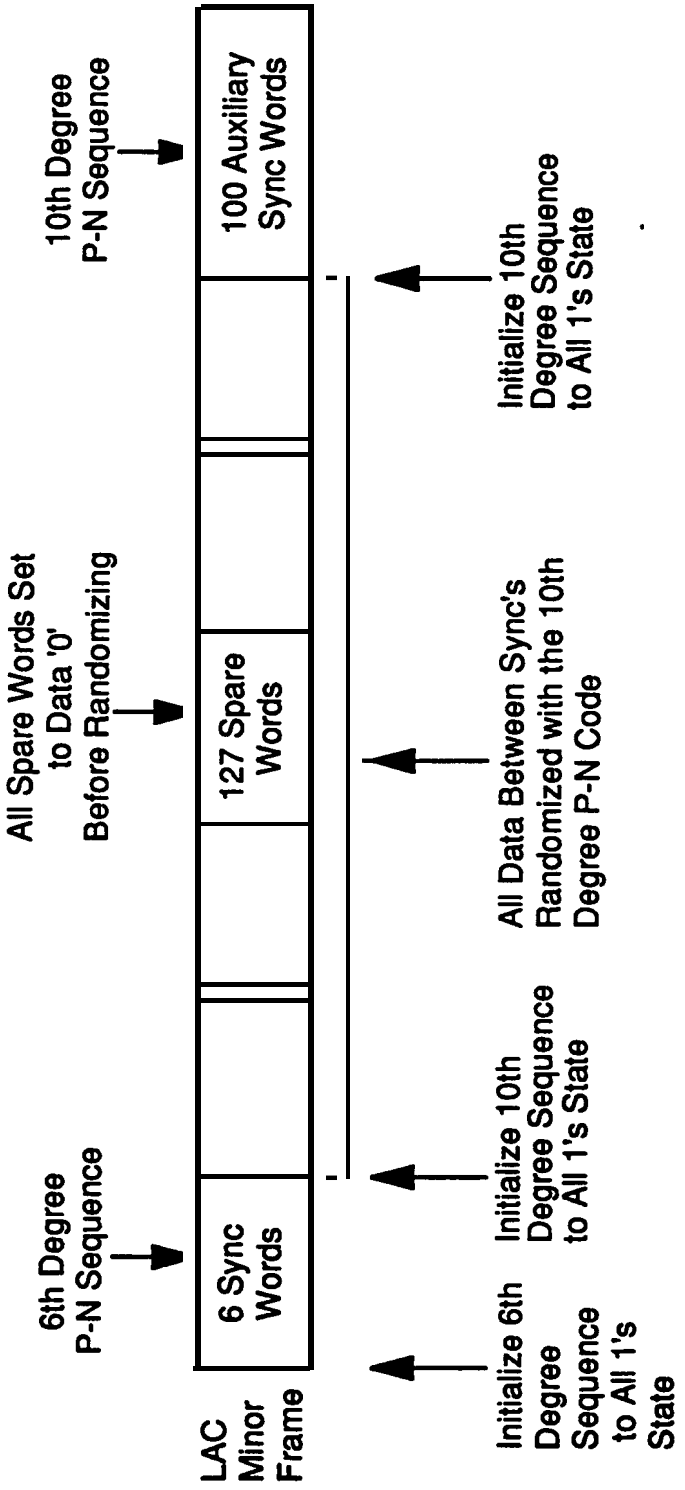


FIGURE 3.1.6
LAC MINOR FRAME RANDOMIZATION METHODOLOGY

3.1.7 GAC Format

The Global Area Coverage (GAC) Format parameters are given in Table 3.1.7-1 and Table 3.1.7-2. Like LAC, GAC data is recorded and then played back through an STX.

1. The GAC bit rate is 1.33 Mbps or 2.66 Mbps as determined by the selected tape recorder's playback speed.

2. The GAC bit Format is NRZ-L if the playback bit rate is 2.66 Mbps or split phase if the playback bit rate is 1.33 Mbps.

3. The GAC Format is time inverted. The MSB is transmitted last and the LSB is transmitted first; the 6 word frame sync is transmitted last and the 100 word auxiliary sync is transmitted first.

4) The GAC frame is randomized. The randomization methodology is shown in Figure 3.1.7. The same 10th degree polynominal ($X^{10} + X^5 + X2 + X + 1$) generator used to provide the auxiliary sync is used to randomize the data. The complimented output of the PN generating shift register is modulo 2 added on a bit-by-bit basis to the GAC.

5) The time code contained in each GAC Frame indicates the actual spacecraft time 1.13 ± 0.5 milliseconds before the beginning of bit 1 byword 1.

TABLE 3.1.7-l
GAC Playback Parameters

Frame		
Rate	40 or 80 frames/sec	
Number of words	3327	
Format	Time inverted version of GAC format	
Word Parameters		
Rate	133,080 or 266,160 words/sec	
Number of bits/word	10	
Order	Bit 1 = MSB / Bit 10 = LSB	
Bit Parameters		
Rate	1.33 MBits/sec.	2.66 MBits/sec
Format	Split phase	NRZ - L
Data 0	+ 67° / - 67°	- 67°
Data 1	- 67° / +67°	+ 67°

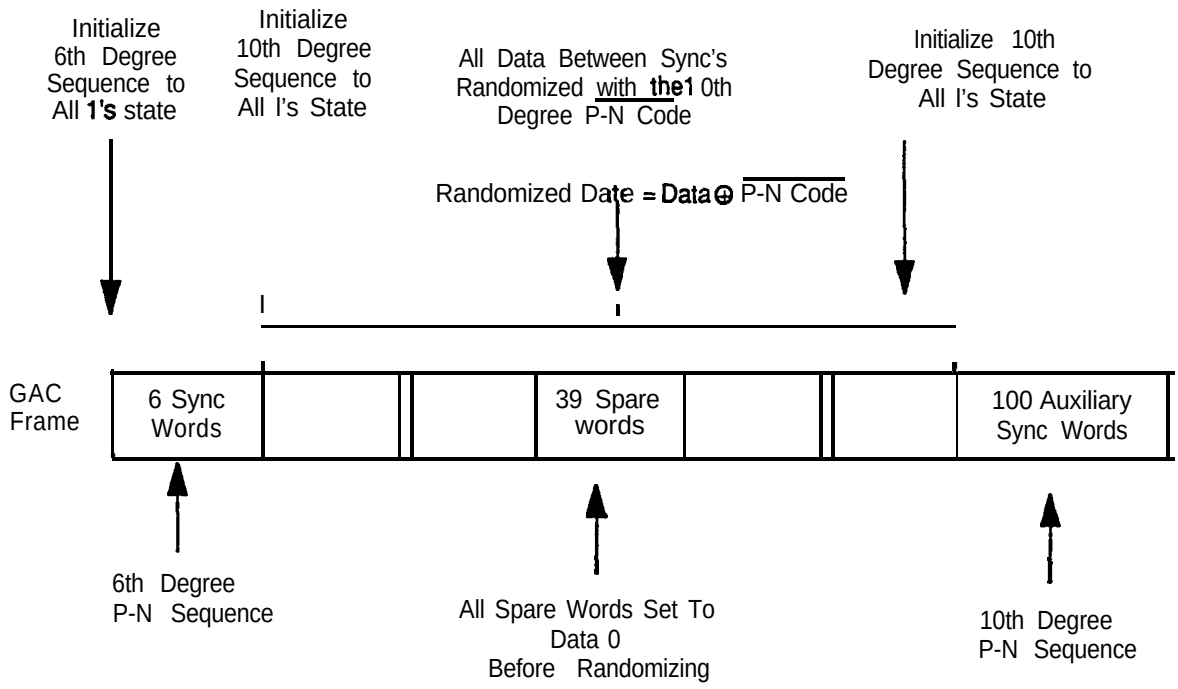


FIGURE 3.1.7
GAC FRAME RANDOMIZATION METHODOLOGY

TABLE 3.1.7-2
GAC **FRAME FORMAT**

Function	No.of Words	wad Position	Bit No. 1 2 3 4 5 6 7 8 9 1 0 Plus Word Code & Meaning
Frame Sync	6	1 2 3 5 6	1 0 1 0 0 0 0 1 0 0 0 1 0 1 1 0 1 1 1 1 1101011100 See Note 1 0 1 1 0 0 1 1 1 0 1 0010010101 1000001111
ID	2	7 8	Bit 1; 0 = Internal Sync; 1 - AVHRR Sync Bits 2 & 3; 00 = Identifies Frame as GAC Frame Bits 4-7; Spacecraft Address; Bit 4 = MSB, Bit 7 = LSB Bit 8; 0 = Frame Stable; 1 = Frame Resync Occurred Bit 9; 1 = Normal AVHRR input; 0 = PN AVHRR input Bit 10; 0 = AVHRR CH3A, 1 = AVHRR CH3B Bits 1-10; Spare - undefined
Time Code	4	9 10 11 12	Bits 1-9; Binary day count; Bit 1 = MSB; Bit 9 = LSB Bit 10; 0; spare Bit 1-3; 101, spare Bits 4-10; Part of Binary msec of day count; Bit 4 = MSB Bit 1-10; Part of Binary msec of day count; Bit 1-10; Remainder of Binary msec of day count; Bit 10 = LSB
Telemetry	10	13 14 15 16 17 18 19 20 21 22	Ramp Calibration AVHRR Channel #1 Ramp Calibration AVHRR Channel #2 Ramp Calibration AVHRR Channel #3 Ramp Calibration AVHRR Channel #4 Ramp Calibration AVHRR Channel #5 AVHRR Chan #3 Target Temp. AVHRR Chan #4 Target Temp. See Note 2 AVHRR Chan #5 Target Temp. Channel 3 patch Temp. Spare - undefined
Back Scan	30	23 thru 52	10 words of back scan data from each AVHRR channel 3, 4, and 5. These data are time multiplexed as chan 3 (word 1), chan 4 (word 1), chan 5 (word 1), chan 3 (word 2), chan 4 (word 2), chan 5 (word 2), etc.
Space Data	50	53 thru 102	10 words of space scan data from each AVHRR channel 1, 2, 3, 4, and 5. These data are time multiplexed as chan 1 (word 1), chan 2 (word 1), chan 3 (word 1), chan 4 (word 1), chan 5 (word 1), chan 1 (word 2), chan 2 (word 2), chan 3 (word 2), chan 4 (word 2), chan 5 (word 2), etc.

TABLE 3.1.7-2
GAC FRAME FORMAT (cont.)

Function	No. of Words	Wad Position	Bit No. 1 2 3 4 5 6 7 8 9 1 0 Plus Word Code & Meaning
'sync Delta	1	103	Bit 1; 0 = AVHRR sync Early; 1 = AVHRR sync Late Bit 2-10; 9 bit binary count of 0.9984 MHz periods; Bit 2 = MSB, Bit 10 = LSB
Tip Data	520	thru 623	The 520 words contain 5 minor frames of TIP data (104 TIP data words/frame) Bits 1-8: exact format as generated by TIP Bit 9: even parity check over bits 1-8 Bit 10: = Bit 1
Data Words	520 Words AMSU Data	624-1143	The 520 words shall consist of five frames (104 words per frame) of AMSU data from the AIP. Bits 1-8: Exact format as generatd by AIP. Bit 9: Evenparitycbeck over Bits 1-8. Bit 10: Inverted Bit 1. See Note 3
	39 wards Spare Data	1144-1182	1 0 1 0 0 0 1 1 1 0 1 1 1 0 0 0 1 0 1 1 0 0 0 0 1 0 1 1 1 1 1 0 1 1 0 0 0 1 1 1 1 1 0 1 0 1 0 0 1 0 thru 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 1 1 0 0 1 0 1 See Note 4
Processed Earth Data	2045	1183 1184 1185 1186 1187 1188 thru 3222 3223 3224 3225 3226 3227	Chan 1 - avg sample 1 Chan 2 - avg sample 1 Chan 3 - avg sample 1 Chan 4 - avg sample 1 Chan 5 - avg sample 1 Chan 1 - avg sample 2 thru Chan 5 - avg sample 408 Chan 1 - avg sample 409 Chan 2 - avg sample 409 Chan 3 - avg sample 409 Chan 4 - avg sample 409 Chan 5 - avg sample 409 See Note 5

TABLE 3.1.7-2
GAC FRAME FORMAT (cont.)

Function	No. of Words	Word Po:3228	Bit No. 1 2 3 4 5 6 7 8 9 1 0	Plus Word Code & Meaning
Auxiliary Sync	100	3229	1111110011 1111100010	
		3230	0 1 1 0 1 1 0 1 0 1	
		3231	1 0 1 0 1 1 1 1 0 1	
		thru		See Note 6
		3 %	0 1 1 1 1 1 0 0 0 0	
		3327	1 1 1 1 0 0 1 1 0 0	

Notes:

1] 1st 60 bits from a 63 bit PN generator started in the all 1's state. The generator polynominal is $X^6 + X^5 + X^2 + X + 1$

2] Each of these words is a 5 channel subcom; 4 words of IR data plus subcom sync (10 'o's)

3] The 104th word of each AMSU data frame to the MIRP contains 1110110100.

4] Derived by inverting the output of a 1023 Bit PN sequence provided by a feedback shift register generating the polynominal: $x10 + X^5 + x2 + X + 1$ The generator is started in the all 1's state at the beginning of word 7 of each minor frame.

5] Each GAC frame contains processed data which is obtained from every 3rd earth scan of the AVHRR sensor. Each "avg sample" is the average of 4 contiguous samples obtained during each 5 sample interval for each AVHRR sensor channel. The "avg samples" are time multiplexed as indicated.

6] Derived from the non-inverted output of a 1023 Bit PN sequence provided by a feedback shift register generating the polynominal: $X10 + X^5 + X^2 + X + 1$ The generator is started in the l's state at the beginning of word 3228.

3.1.8 APT Data Format

The Automatic Picture Transmission (APT) Format is defined in Table 3.1.8 and Figure 3.1.8-1, and Figure 3.1.8-2. The APT provides a time multiplex of geometrically corrected data from any two selected AVHRR sensor channels and includes calibrations and telemetry data associated with the selected sensor channel. After digital formatting, the MIRP D/A converts the APT data, low pass filters the D/A output, and then A.M. modulates a 2400 Hz subcarrier. The subcanier modulation sense is defined as; gray scale wedge #8 produces a maximum modulation index of 87% +5%. The AM modulated subcarrier is subsequently used to FM modulate the VTX transmitter.

TABLE 3.1.8
APT Format Parameters

Frame	
Rate	1 frame per 64 sec.
Length	128 lines
Format	See Figure 3.1.8-1
Line Parameters	
Rate	2 lines/sec
Number of words	2080
Number of sensor channels	any 2 of 6 AVHRR channels (selectable)
Number of words/sensor channel	909
Format	See Figure 3.1.8-2
Line sync format	See Figure 3.1.8-3
WordParameters	
Rate	4160 words/sec.
D/A conversion accuracy	The 8 MSB's of each 10 bit word

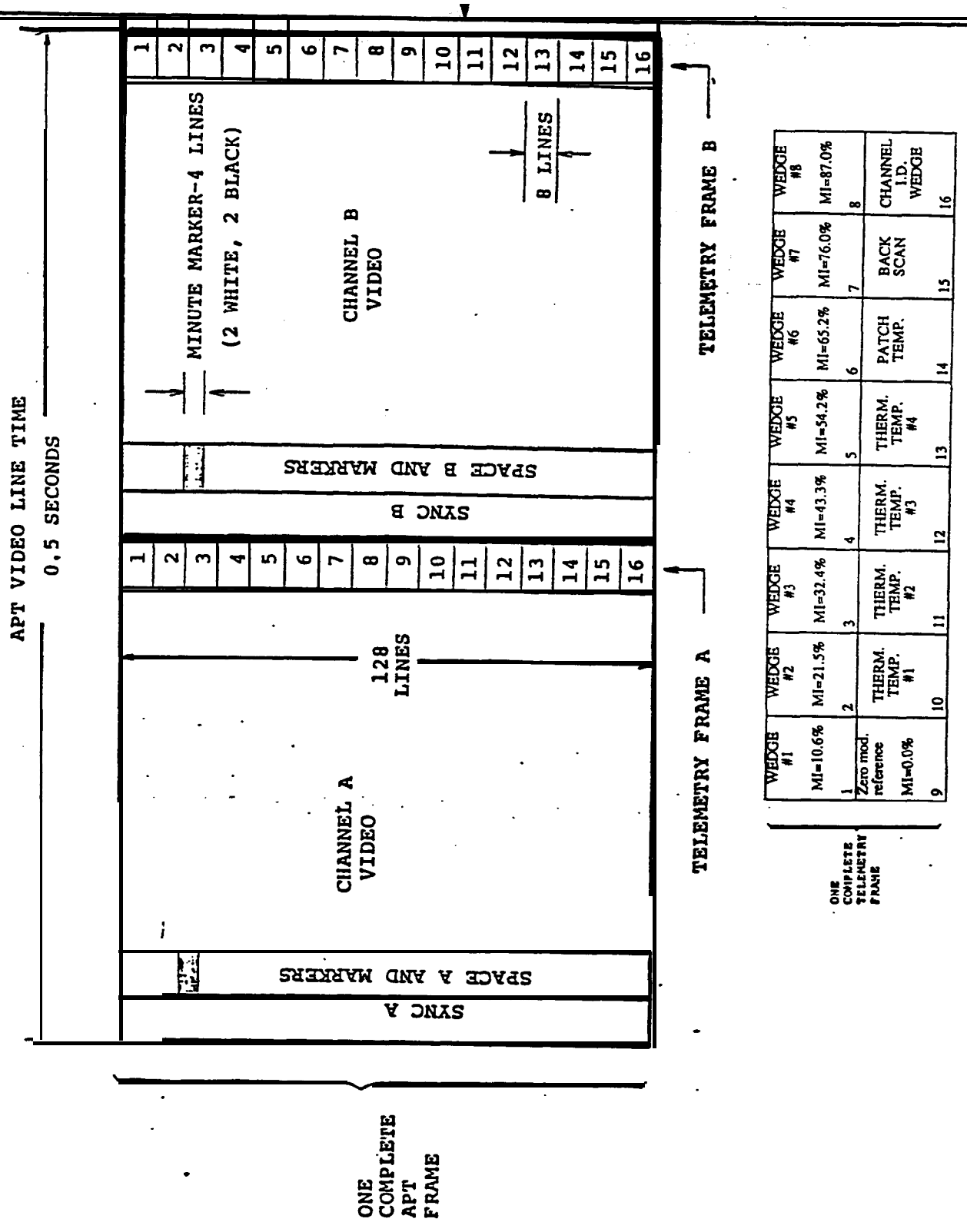
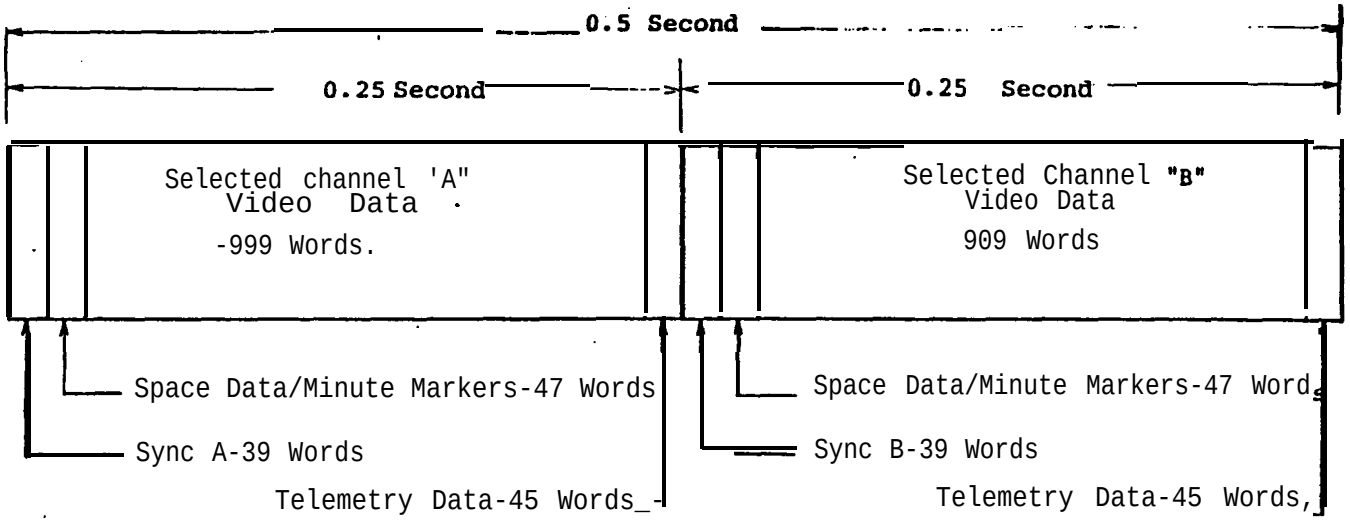


Figure 3.1.8-l
APT Frame Format

Size	Code Ident No.	
A	18713	IS3278200
		Sheet 29

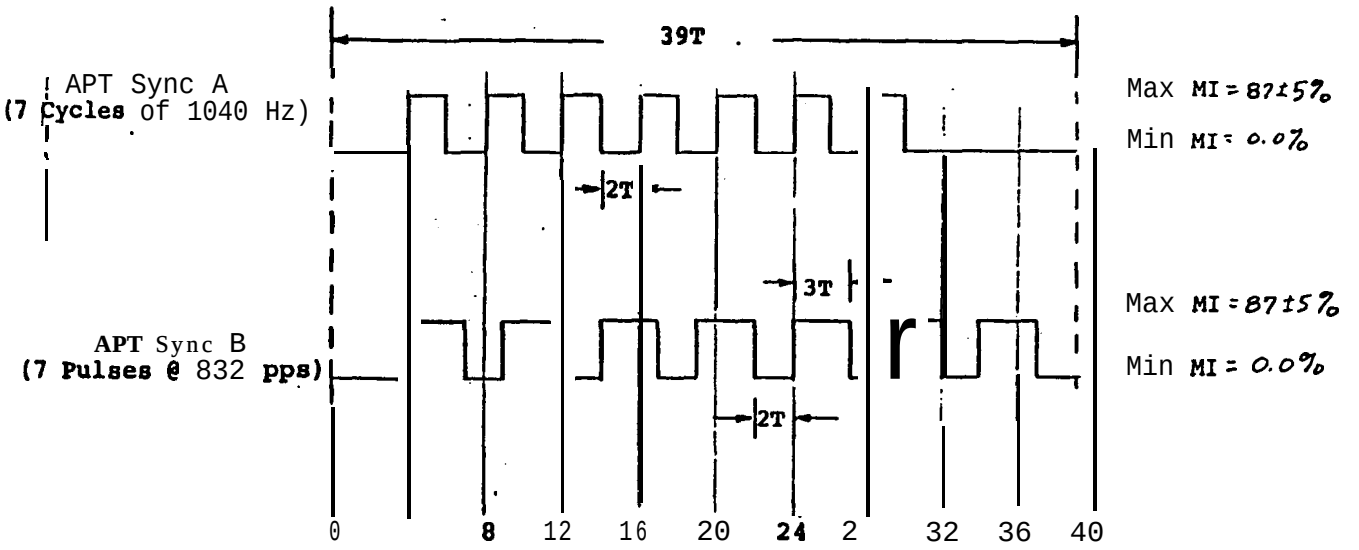
A 772 5/70



Notes:

1) Equivalent Output Digital Data Rate is 4160 Words/Second.
2) Video Line Rate - 2 Lines/Second.
3) APT Frame Size - 128 Lines.
4) Any two of the six AVHRR channels may be selected for use.
5) Sync A is a 1040-Hz square wave - 7 Cycles.
6) Sync B is a 832-pps pulse train - 7 Pulses.
7) Each of 16 telemetry points are repeated on 8 successive lines.
8) Minute markers are repeated on 4 successive lines, with 2 lines Black and 2 lines white.

FIGURE 3.1.8-2
APT VIDEO LINE FORMAT



Notes:

1) $T = \frac{1}{4160} = 0.24038$ millisecond.
2) Sync-A precedes Channel A data.
3) Sync B precedes Channel B data.

FIGURE 3.1.8-3
APT SYNC DETAILS

Size	Code Ident No.	
A	18713	63278200
		Sheet 31

A 7725/70

3.2 **Spacecraft Parameters**

The following sections list the general parameters of the individual spacecraft transmitters and receivers.

3.2.1 **Real Time VHF Beacon Transmitter Parameters**

The spacecraft contains two VHF Real Time Beacon Transmitters (BTX). Each transmitter operates at a unique frequency; BTX-1 opemes at 137.35 MHz and BTX-2 operates at 137.77 MHz. Only one BTX transmitter is selected for operation at any time, and is mission dependant. TABLE 32.1 summarizes the BTX transmission parameters.

3.2.2 **Real Time VHF APT Transmitter Parameters**

The spacecraft contains two VHF Real Time Transmitters (VTX). Eachtransmitter opemes at a unique frequency; VTX-1 operates at 137.5 MHz and VTX-2 operates at 137.62 MHz. Only one VTX transmitter is selected for operation at any time and is mission dependant. TABLE 3.2.2 summarizes the APT transmission parameters.

3.2.3 **L/S-Band Transmitter Parameters**

There are three L-band data transmitters (STX-1, STX-2, STX-3) and one S-band data transmitter (STX-4) on the spacecraft. The STX transmitters are the primary source of spacecraft data transmissions. The four transmitters are capable of simultaneous operation. The STX-2 transmitter's antenna is orthogonally polarized relative to the STX-1 and SIX-3 transmitters to enhance adjacent channel isolation. The RF parameters of the four STX transmitters aboard the spacecraft is [redacted]e d in Table 3.2.3.

TABLE 3.2.1
Beacon DataTransmitter (BTX) Parameters

Transmitter Frequency (Mhz, ± 0.002 %)	137.35 / 137.77
Modulation Index (rad pk-pk, ± 5 %)	2.35
Modulation (Kbps)	8.32
Modulation Type	Phase Mod. / Split Phase
Modulation Sense Data 0: Data 1:	 -67 °/+67° +67°/-67°
Premodulation Filter (Type/3 dB BW)	7 Pole LPF/16 Khz
Antenna Polarization	Linear
BTX Output Power (dBm)	30.0 (EOL minimum)
Radiated Power (dBm)	≥ 9.5 (Over 90 % of sphere)

TABLE 3.2.2

VHF APT Data **Transmitter (VTX) Parameters**

Transmitter Frequency (Mhz, ± 0.002 **%)**	**137.50 /** 137.62 **(VTX-1/VTX-2)**
Modulation **(AM/FM) [1]**	**± 17 KHz**
Premodulator Bandwidth **(Khz)**	0.1 to 4.8
Modulation Sense	See Note 1
Antenna Polarization	RCP
Antenna Gain **(dBic)**	-0.3 **(@** 63 ●)
VTX Output Power **(dBm) [2]**	37.0
S/C Losses **(dB)**	2.2
Radiated **Power (dBm)**	34.5 **(@** 63 **°)**

Notes: **1] A 2.4 KHZ subcarrier is AM modulated** by a low pass **filtered** analog signal which subsequently FM modulates **the VTX transmitter's carrier.** The **subcarrier's** peak index of 87 **% ±** 5% **corresponds** to a **#8 grey scale wedge.** A positive voltage swing of the 2.4 Khz **subcarrier** induces a negative frequency shift of the transmitter.

2] Transmitter output power is End **Of Life (EOL)** minimum.

TABLE 3.2.3
L / S - Band Data Transmitter (STX) Parameters

Parameter	STX-1	STX - 2	STX - 3	STX-4
Transmitter Frequency (Mhz, ± 0.002 %)	1698.0	1702.5	1707.0	2247.5
Modulation Index (rad pk-pk, ± 5 %)	2.35	2.35	2.35	2.35
Antenna Coverage (°) [1]	± 63	± 63/± 90	± 63	± 90
Antenna Polarization	RCP	LCP / [3]	RCP	RCP
Antenna Ellipticity (dB)	6.0	6.0	6.0	N/A
STX Output Power (dBm) [2]	38.0	38.0	38.0	38.0
S/C Losses (dB)	0.9	1.8	0.8	5.2
S/C Antenna Gain (dBic, @ 63°)	2.1	2.1	12.1	0.0
Radiated Power (dBm, @ 63")	39.2	38.3 / [4]	39.3	32.8 / [4]

Notes:

1] STX-1, STX-2, STX-3 are typically connected to directional antennas. STX-4 is connected to two omni-directional antennas via a hybrid splitter with one omni positioned in the NADIR axis and one omni positioned in the anti-NADIR axis (both omni antennas are RCP polarized).

2] Transmitter output power is End Of Life (EOL) minimum

3] Transmitter STX-2 can be connected to two omni directional antennas via an RF switch and a hybrid splitter arangement. The NADIR omni antenna is RCP polarized and the anti-NADIR omni antenna is LCP polarized.

4] EIRP (for omni directional configuration) is ≥ 24 dBm over 90% of a sphere for STX-2 and 95% of sphere for STX-4.

3.2.4 GSTDN Command Receiver/Demodulator Parameters

The spacecraft contains two GSTDN compatible S-Band Command Receiver/Demodulators which are cross-strapped. Both receivers and demodulators are operated simultaneously. The parameters of the spacecraft receivers are summarized in Table 3.2.4.

TABLE 3.2.4
GSTDN Command Receiver Parameters

Center Frequency (Mhz)	2026.0
Frequency stability (%)	± 0.002
Subcarrier (Khz)	16.0
Modulation Index (Rad.)	1.0 ± 0.1
Modulationtype	Phase modulated
Receiver Type	Phase Lock Loop
Received Power (dBm)	-118.0 (minimum)

3.2.5 Data Collection System (DCS) Receiver Parameters

The Spacecraft contains a Data Collection System (DCS) receiver. Platforms (bouys, free floating balloons and remote weather stations) collect relevant data and transmit them to the spacecraft. The onboard DCS receives the incoming signal, measures both the frequency and relative time of occurrence of each transmission and the spacecraft retransmits these data via the CDA stations. The performance characteristics of the DCS receiver are summarized in Table 3.2.5.

TABLE 3.2.5
DCS Receiver Parameters

Receiver Frequency (Mhz)	401.65
Modulation Type	Phase Mod
Dynamic Range (dBm)	-109 to -128
Receiver Losses (dB)	1.0
Antenna Polarization	RCP

3.2.6 **Search and Rescue Processor (SARP) Parameters**

The spacecraft contains a Search and Rescue Processor (SARP) receiver. The performance characteristics of the SARP receiver are summarized in Table 3.2.6.

TABLE 3.2.6
SARP - 2 Parameters

Receiver Center Frequency (Mhz)	406.050
Receiver 1 dB Bandwidth (Khz)	
Model	27
Mode2	40
Mode 3	80
Receiver Dynamic Range (dBm)	-131 to -108
Doppler Measurement Error (Hz RMS)	0.35
Bit Errror Rate	1 in 1010
Output Data Rate (bps) [see note]	2409.0
Memory Capacity (Kbits)	400

Note: Output data of the SARP (24 Khz) is fed to the mudulatorof the SARR Transmitter.

3.2.7 **Search and Rescue Repeater (SARR) Parameters**

The spacecraft contains a Search and Rescue Repeater (SARR). The SARR consists of redundant pairs of receivers and transmitters. Each 'side' of the SARR (Side A/Side B) consists of three separate receivers and a transmitter. The performance characteristics of the SARR receivers and transmitter are summarized in Table 3.2.7-l and Table 3.2.7-2

TABLE 3.2.7-l
SARR Receiver Parameters

121.5 Mhz Receiver	
Center Frequency (Mhz)	121.5 ± 12.5 Khz
Dynamic Range (dBm)	-148.9 to -107.9
1 dB Bandwidth (Khz)	25
Translated Receiver Frequency (Khz)	47.0
Receiver Noise (K°)	600
Maximum Input Power (dBm)	-20
Backround Noise (K°)	6000 (nominal) 10,000 (maximum)
243 Mhz Receiver	
Center Frequency(Mhz)	243.0 ± 23.0 Khz
Dynamic Range (dBm)	-151.8 to -119.9
1 dB Bandwidth (Khz)	46
Translated Receiver Frequency (Khz)	94.0
Receiver Noise (k°)	350
Maximum Input Power (dBm)	-20
Backround Noise (K°)	3000 (nominal)
406 Mhz Receiver	
Center Frequency (Mhz)	406.05 ± 40.0 Khz
Dynamic Range (dBm)	-134.3 to -107.2
1 dB Bandwidth (Khz)	80
Translated Receiver Frequency (Khz)	170.0
Receiver Noise (K°)	350
Maximum Input Power (dBm)	-20
Backround Noise (K°)	1000 (nominal)

TABLE 3.2.7-2
SARRTransmitter Parameters

Frequency (Mhz)	1544.5
Long Term Frequency Stability (Khz)	± 3.2
Output Power (dBm)	38.6 (min Beginning of Life (BOL))
Incidental AM (max)	≤ 5 %
Phase Jitter (max)	10° rms

3.3 Ground System Parameters

The following sections describe the Ground Stations/Platforms that the spacecraft supports or that support the operation of the spacecraft.

3.3.1 Standard Direct Readout TIP Station Parameters

'The Standard Direct Readout TIP Station receives the VHF beacon transmission which is modulated with TIP data. The TIP data is transmitted at 8.32 Kbps, at 137.35 MHz or 137.77 MHz as selected by spacecraft command. The characteristics of the Standard Readout TIP Station are given in Table 3.3.1.

TABLE 3.3.1
Standard Direct Readout TIP Station

Received Signal	TIP
Modulation type	split phase / Phase modulation
Bit Rate (Kbps)	8.32
Received Frequency (Mhz)	137.35 or 137.77 (selectable)
Antenna polarization	Linear
Antenna Gain (dBi)	16.0

3.3.2 **European TIP Dump Station Parameters**

The European TIP Dump Station receives the programmed playback of stored TIP data The stored data is transmitted at 0.33 Mpbs, at 1698 MHz; 1702.5 MHz; or 1707 MHz, depending upon the spacecraft's operating configuration. The characteristics of the European TIP Station are given in Table 3.3.2.

TABLE 3.3.2
European TIP Station Parameters

Received Signal	TIP Playback
Modulation type	split phase / Phase modulation
Data rate (Mbps)	0.332
Received Frequency (Mhz)	1698.0 / 1702.5 / 1707.0
Antenna Polarization	RCP / LCP
Antenna Gain (dBi)	32.0
System Noise (K°)	290

3.3.3 **Standard HRPT Station Parameters**

The Standard HRPT Station receives the real-time transmission of five, time - multiplexed AVHRR sensor channels. The HRPT data is transmitted at 665.4 Kpbs, at either 1698 MHz or 1707 MHz as determined by mission characteristics. The characteristics of the Standard HRPT Station are given in Table 3.3.3.

TABLE 3.3.3
Local user HRPT Station

Frequency (Mhz)	1698.0 / 1707.0
Antenna Polarization	RCP
Modulation Tvpe	Phase Modulation
Bit Rate (Kbps)	665.4
Antenna Gain (dBci)	31.0
System Noise (K°)	280

3.3.4 Standard APT Station Parameters

The Standard Automatic Picture Transmission (APT) Station receives the VHF real-time transmission which is modulated with any selected two of the five AVHRR sensor channels. The two selected channels are processed in the spacecraft to produce a nearly constant ground resolution signal and are time multiplexed on a line-by-line basis. The APT data is transmitted by one of two selectable VHF (137.50 MHz or 137.62 MHz) FM transmitters. The characteristics of the standard APT station are given in Table 3.3.4.

TABLE 3.3.4
Standard APT Local User Station

Frequency (Mhz)	137.50 or 137.62
Antenna Polarization	RCP
Modulation Type	AM/PM
subcarrier (Khz)	2.4
Antenna Gain (dBci)	10.0
System Noise (K°)	3460

3.3.5 Standard DCS Platform Parameters

The 401.65 MHz UHF bad is used far Data Collection System (DCS) transmission. The Standard DCS Platform typically transmits for 390 milliseconds every 20 to 30 seconds.The characteristics of the Standard DSC Platform are summarized in Table 3.3.5.

3.3.6 Standard SARP/SARR 406 Beacon Parameters

The 406.05 MHz UHF band is used for SARP/SARR transmission. The Standard UHF Emergency Position Indicating Radio Beacon (EPIRB) used on marine vehicles, and the Emergency Location Transmitter (ELT) used on aircraft, have the identical characteristics. The SARP/SARR Platform typically transmits for 440 milliseconds every 50 seconds.The characteristics of the Standard SARP/SARR Platform are summarized in Table 3.3.6.

3.3.7 Standard SARR 121/243 Platform Parameters

The 121.5 Mhz/243.0 Mhz VHF band is used for SARR transmission. The Standard 121.5 Mhz/243 Mhz SARR Platforms typically transmits continuously. The characteristics of the Standard SARR Platform are summarized in Table 3.3.7.

3.3.8 Standard SARR LUT Reception Parameters

The standard Search and Rescue Local User Terminal (LUT) receives the L-Band real time search and rescue signal transmitted from the spacecraft. The received signal is processed by the LUT to determine the location and identification of marine and aircraft vessels in distress. The characteristics of the standard LUT are summarized in Table 3.3.8.

3.3.9 NOAA CDA Station Parameters

There are two NOAA Command and Data Acquisition (CDA) stations; Wallops Island, Virginia and Fairbanks, Alaska. The CDA stations receive stored LAC/GAC data, Real Time HRPT data, real time TIP data and transmit commands. The CDA ground system receiving parameters are listed in Table 3.3.9-l and transmitting parameters in Table 3.3.9-2. Each CDA is capable of full duplex operation with its command transmissions and any or all data receivers. On those orbits when a spacecraft is simultaneously in view of both CDAs, normal operations protocol shall prevent that spacecraft fiom being illuminated simultaneously by RF uplink transmissions from the two CDA stations. Figures 3.3.9-1, 3.3.9-2, 3.3.9-3 and 3.3.9-4 show the antenna coverage including mechanical limits and terrain limitations for the Wallops Island and Fairbanks CDAs.

TABLE 3.3.5
Standard DCS Platform Parameters

Frequency (Mhz)	401.65 ± 0.012
Accuracy (Khz over 5 yr.)	± 4.0
Short-term Stability (Hz)	± 0.4
Max. rate of change (Hz/min)	± 0.2 (location type 'A' platform)
Carrier Modulation	PSK
Positive phase shift	63° ± 5.73°
Negative phase shift	63° ± 5.73°
Transistion time (microseconds)	100 ≤ t ≤ 250
Data Modulation	Split phase (Manchester code)
Bit period (msec)	2.5
Data 1	+phaseshiftatbitcenter
Data 0	- phase shift at bit center
Asymmetry of 1/0 message	± 1 %
Asymmetry of all 1 or 0 message	± 1.25 %
Data Rate (bps)	400
Long-term stability (bps per 1 yr.)	± 5
Short-term stability (bps per 0.2 sec period)	± 0.4
Message Format	
Precursor	68 bit times (at 0° carrier phase shift)
Bit sync	15 bits, all 1's
Frame sync	9 bits (000101111)
Data	56 bits (no constraints)
Transmitter Power (dBw)	3.0 ± 1
Transmitter Line Loss (dB)	0.5
Antenna Gain	See Figure 3.3.5
Antenna Feed Losses (dB)	1.0
Antenna Polarization	Linear and RCP
Transmitted Signal	Phase Modulated / Split phase

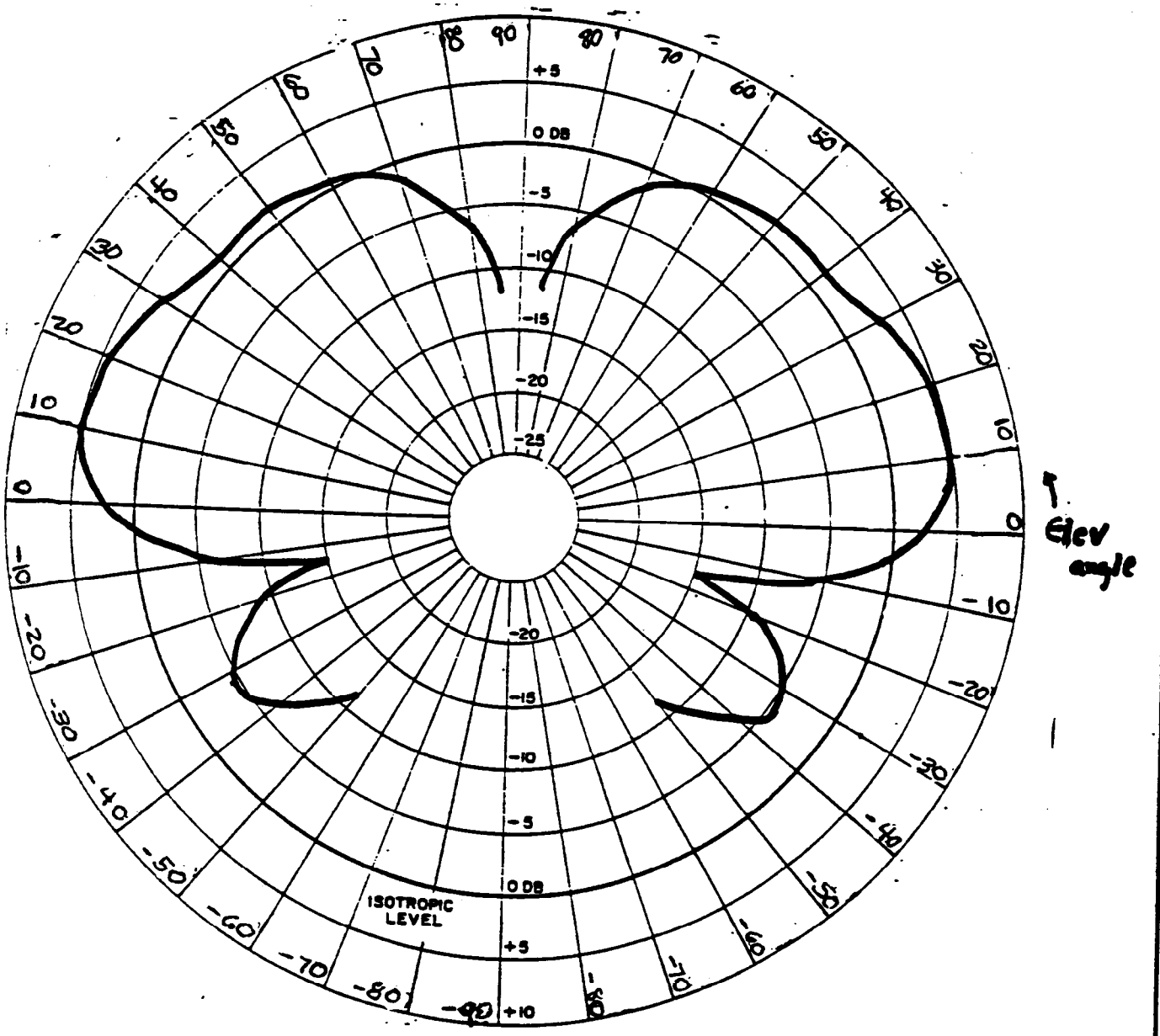


FIGURE 3.35
Standard DCS Platform Antenna Gain

Size	Code Ident No.	
A	18713	183278200
		Sheet 43

A 772 5/70

TABLE 3.3.6

Standard SARP/SARR (406) Beacon Parameters

Frequency (Mhz)	406.025 ± 2 Khz
Accuracy (Khz over 5 yr.)	± 5.0
Short-term Stability (over 100 ms)	≤ 2 parts in 109
Mid-tam stability (over 15 min.)	≤ 1 part in 10^9 (per minute)
Carrier Modulation	PSK
Positive phase shift	1.1 ± 0.1 radian
Negative phase shift	1.1 ± 0.1 radian
Data Modulation	Biphase - L
Bit period (msec)	2.5
Data 1	+ phase shift at bit center
Data 0	- phase shift at bit center
Data Rate (bps)	400 ± 1%
Message Format	
CW Preamble	160 ms of unmodulated carrier
Bit sync	15 bits, all l's
Frame sync	9 bits (000101111)
Data	112 bits standard mode 144 bits optional mode
Transmitter Power (dBw)	7.0 ± 2
Antennahlalization	Linear or RCP
Antenna Gain	Hemispherical pattern between -3 dBi and 4 dBi over 90% of region

TABLE 3.3.7
Standard Search and Rescue Beacon (121/243) Parameters

Frequency (Mhz)	121.5 ± 0.005% / 243.0 ± 0.005%
Beacon Output Power (dBm)	15.74
Antenna Polarization	Linear
Modulation Characteristics	
Emmission Type	Amplitude-
Modulation Type	10096 Square Wave Swept Tone
Modulation Index	≥ 0.85%
Modulation Duty Cycle	≥ 33.3 %
Ocupied Bandwidth	≤ 25 Khz

TABLE 3.3.8
Standard Search and Rescue LUT Parameters

Frequency (Mhz)	1544.5 ± 0.5
Received Signal	Phase Modulated
Modulation Index (rad. rms)	0.7 (composite mod.)
Polarization	LCP
G /T (dB/K)	3.0
Receiver Characteristics	
IF Bandwidth (Khz)	1000
- Baseband	
121.5 Mhz Ch. BW (Khz)	25
243.0 Mhz Ch. BW (Khz)	46
406.0 Mhz Ch. BW (Khz)	80
Processed Data Ch. BW (Khz)	5
Location Processor Type	Doppler Correlator

TABLE 3.3.9-1
CDA Receiving Antenna Parameters

Antenna Site		Wallops Island, VA	
Antenna Size		26 Meter	
Antenna Mount		XY	
Antenna Type		Parabolic	
Antenna Feed		Prime	
Frequency (MHz)	136 - 138	1670 - 1710	2200 - 2300
Antenna Polarity	LINX/LINY	RCP / LCP	RCP / LCP
Gain (dBi)	27.4	43.8 / 43.6	48.7 / 48.9
3 dB Beamwidth (°)	6.7	0.54	0.34
System Noise (°K)	Unknown	343.7 / 362.7	289.8 / 323.4
G / T (dB)	Unknown	18.5 / 18.0	24.0 / 23.8

Antenna Site		Wallops Island, VA	
Antenna Size		14.2 Meter	
Antenna Mount		XY	
Antenna Type		Parabolic	
Antenna Feed		Prime	
Frequency (MHz)	136 - 138	1670 - 1710	m - 2 3 0 0
Antenna Polarity	RCP / LCP	RCP / LCP	RCP / LCP
Gain (dBi)	22.41	44.3 143.9	46.5 / 46.7
3 dB Beamwidth (°)	11.23	0.91	0.68
System Noise (°K)	unknown	144.5 / 1422	157.0 / 173.0
G / T (dB)	unknown	22.7 / 22.4	24.5 / 24.3

TABLE 3.3.9-1
CDA Receiving Antenna Parameters (cont.)

Antenna Site		Fairbanks, AK	
Antenna Size		26 Meter	
Antenna Mount		XY	
Antenna Type		Parabolic	
Antenna Feed		Prime	
Frequency (MHz)	136 - 138	1670 - 1710	2200 - 2300
Antenna Polarity	LINX/LINY	RCP / LCP	RCP / LCP
Gain (dBi)	27.4	48.7	51.8
3 dB Beamwidth (°)	6.7	0.54	0.34
System Noise (°K)	unknown	275.4	257.0
G / T (dB)	unknown	24.3	27.7

Antenna Site		Fairbanks, AK	
Antenna Size		12.0 Meter	
Antenna Mount		XY	
Antenna Type		Parabolic	
Antenna Feed		Prime	
Frequency (MHz)	136 - 138	1670 - 1710	2200 - 2300
Antenna Polarity	LINX/LINY	RCP / LCP	RCP / LCP
Gain (dBi)	16.0	43.7	46.0
3 dB Beamwidth (°)	13.0	1.0	0.8
System Noise (°K)	unknown	813.0	426.6
G / T (dB)	Unknown	14.6	19.7

TABLE 3.3.9-2
CDA Transmiting Antenna Parameters

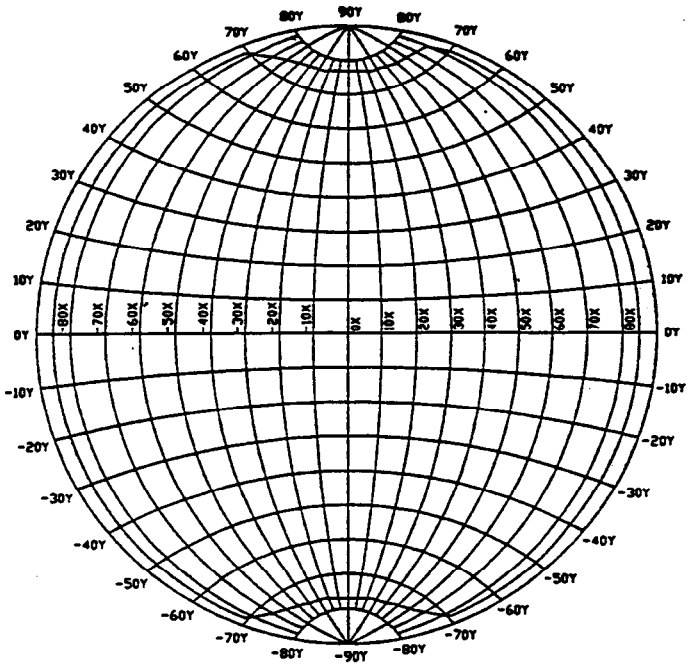
Antenna Site	Wallops Island, VA
Antenna Size	4.0 Meter
Antenna Mount	AZ/EL
Antenna Type	Parabolic
Antenna Feed	Rime
Frequency (MHz)	2024 - 2110
Antenna Polarity	RCP
Gain (dBi)	34.0
3 dB Beamwidth (°)	3.0
Transmitter Power (KW)	2.0
EIRP (dBm)	97.0

Antenna Site	Wallops, VA
Antenna Size	142 Meter
Antenna Mount	XY
Antenna Type	Parabolic
Antenna Feed	Rime
Frequency (MHz)	2020-2120
Antenna Polarity	RCP
Gain (dBi)	46.8
3 dB Beamwidth (°)	0.76
Transmitter Power (KW)	2.0
EIRP (dBm)	110.0

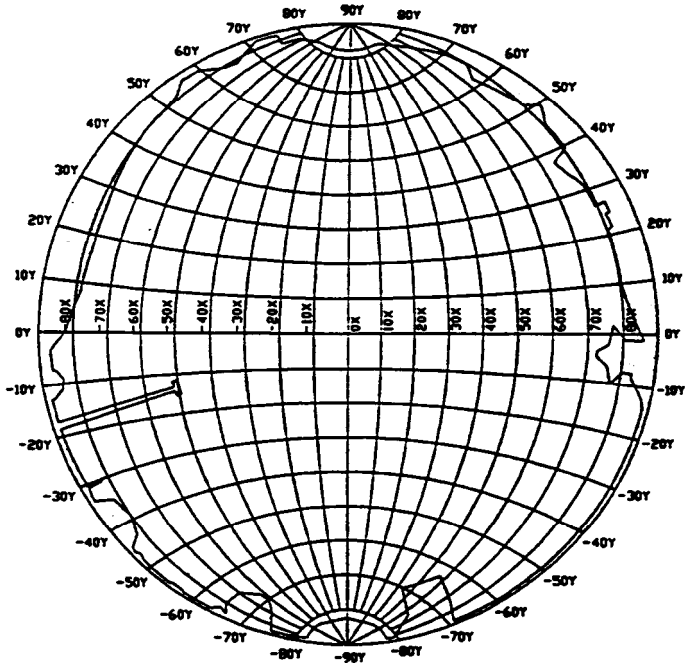
TABLE 3.3.9-2
CDA Transmiting Antenna Parameters (cont.)

Antenna Site	Fairbanks, AK
Antenna Size	4.0 Meter
Antenna Mount	AZ/EL
Antenna Type	Parabolic
Antenna Feed	Prime
Frequency (MHz)	2024 - 2110
Antenna Polarity	RCP
Gain (dBi)	34.0
3 dB Beamwidth (°)	3.0
Transmitter Power (KW)	2.0
EIRP (dBm)	97.0

Antenna Site	Fairbanks, AK
Antenna Size	6.0 Meter
Antenna Mount	XY
Antenna Type	Parabolic
Antenna Feed	Rime
Frequency (MHZ)	2025 - 2120
Antenna Polarity	RCP / LCP
Gain (dBi)	39.0
3 dB Beamwidth (°)	1.7
Transmitter Power (KW)	2.0
EIRP (dBm)	102.0

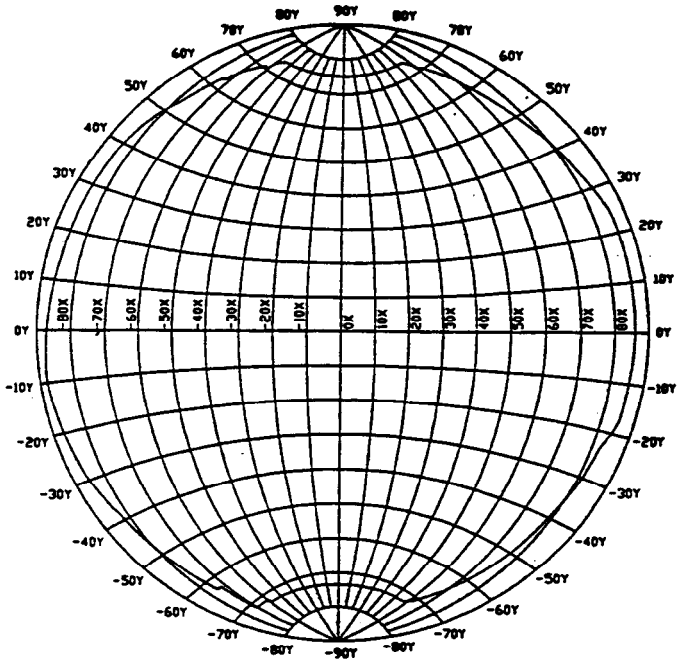


Wallops 26 Meter Antenna Horizon Profile

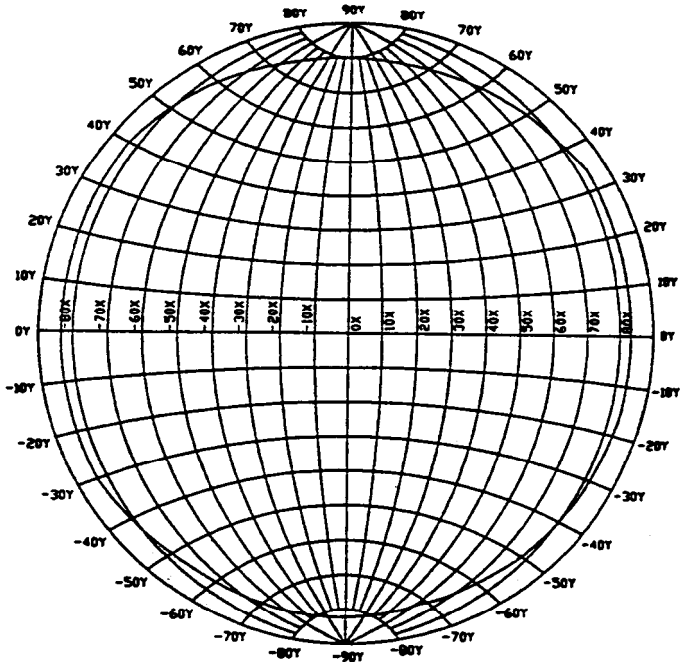


Wallops 14.2 Meter Antenna Horizon Profile

FIGURE 3.3.9-1
Wallops Receive Antenna's Horizon Profile

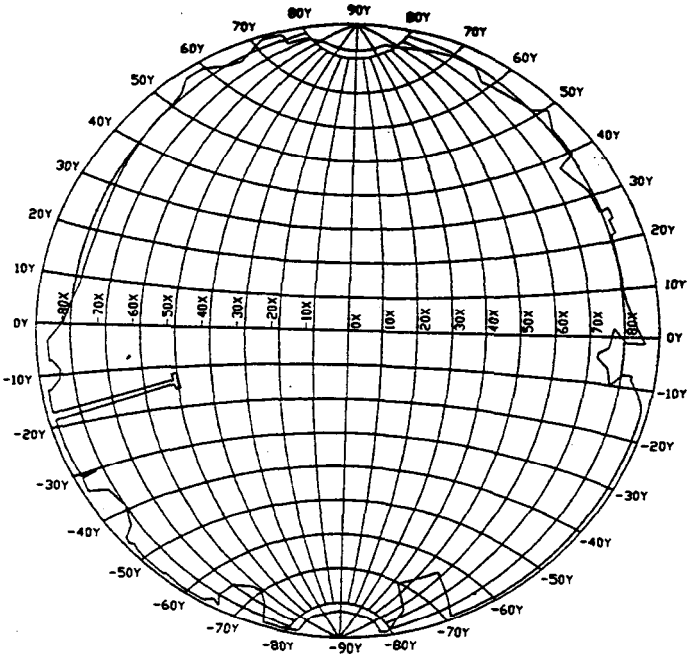


Fairbanks 26 Meter W Antenna Horizon Profile

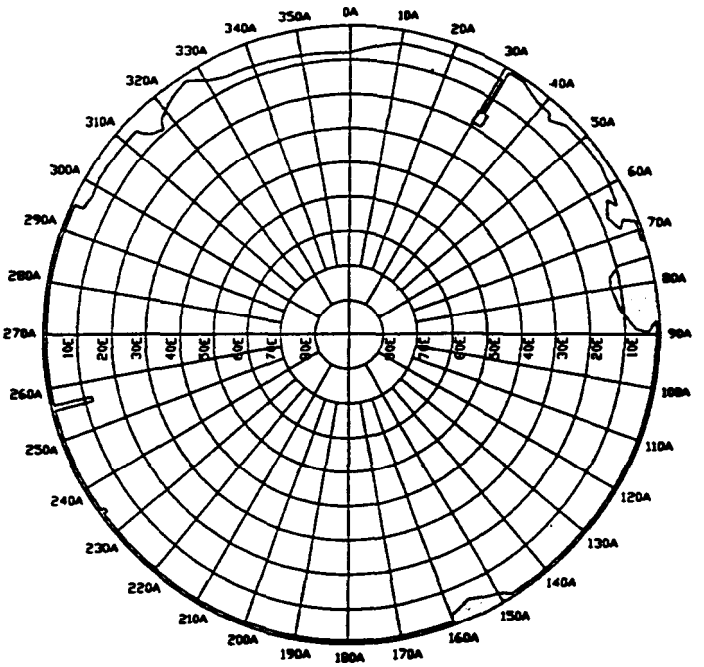


Fairbanks 12 Meter (C) Antenna Horizon Profile

FIGURE 3.3.9-2
Fairbanks Receive Antenna's Horizon Profile

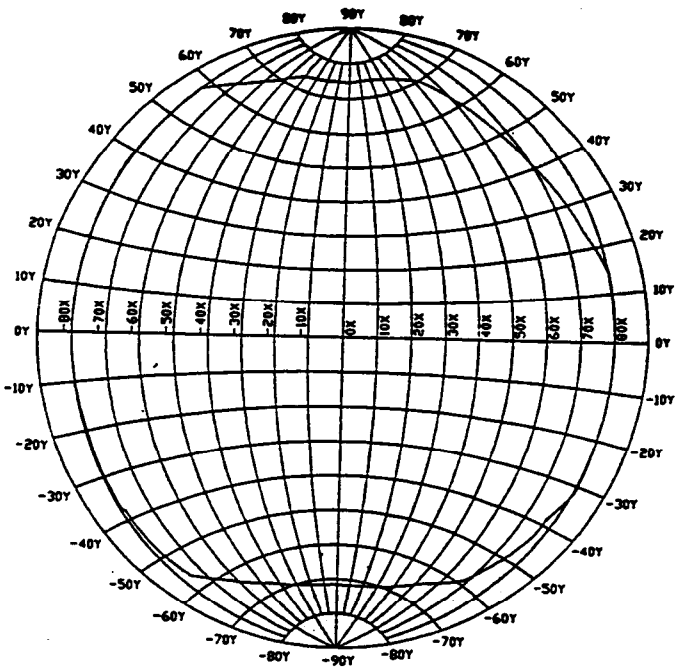


Wallop0 14.2 **Meter Antenna Horizon Profile**

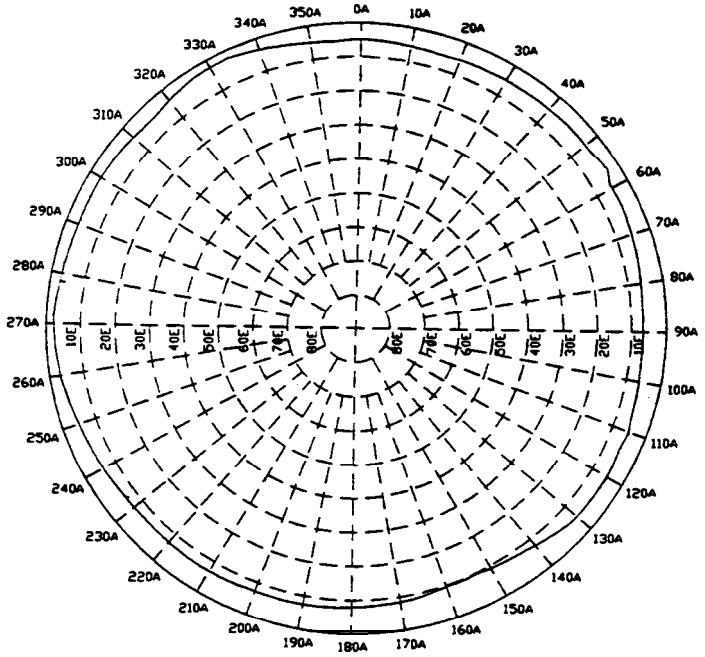


Wallops 4 Meter Antenna Horizon Profile

FIGURE 3.3.9-3
Wallops Transmitting Antenna's Horizon Profile



Fairbanks 6 Meter Antenna Horizon Profile



Fairbanks 4 Meter Antenna Horizon Profile

FIGURE **3.3.9-4**
Fairbanks Transmitting Antenna's Horizon Profile

3.4 Link Calculations

The following sections present the predicted performance of the various spacecraft to ground receive and transmit links.

3.4.1 Predicted Direct Readout TIP Station Performance

Table 3.4.1 shows the predicted performance of the Direct Readout TIP station. Tk predicted performance was calculated using the worst case BTX output power and maximum path loss (63° spacecraft antenna angle).

TABLE 3.4.1
Direct Readout TIP Station Predicted Performance

Spacecraft Radiated Power at 63° (dBm)	9.5
Path Loss at 63° (dB)	145.8
Polarization Loss (dB)	0.2
Modulation Loss (dB)	0.7
Ground Antenna Gain (dB)	16.0
Demodulator Loss (dB)	3.0
Received Level (dBm)	-124.2
Bit-Rate Bandwidth (dB-Hz)	39.2
Noise Density (dBm/Hz)	-165.7
Eb/No Required (dB), 10^{-6} BER	10.5
Eb/No Margin (dB)	-8.2

3.4.2 Predicted European TIP Dump Station Performance

Table 3.4.2 shows the predicted performance of the European TIP Playback station. The predicted performance was calculated using the worst case STX output power and maximum path loss (63° spacecraft antenna angle).

TABLE 3.4.2
European TIP Predicted Performance

Spacecraft Radiated Power at 63° (dBm)	38.3
Path Loss at 63° (dB)	167.7
Polarization Loss (dB)	0.2
Modulation Loss (dB)	0.7
Ground Antenna Gain (dB)	32.0
Demodulator Loss (dB)	3.0
Received Level (dBm)	-101.3
Bit-Rate Bandwidth (dB-Hz)	55.2
Noise Density (dBm/Hz)	-173.9
Eb/No Required (dB), 10-6 BER	10.5
Eb/No Margin (dB)	6.9

3.4.3 Predicted Standard APT Station Performance

Table 3.4.3 shows the predicted performance of theStandard APT Station. The predicted performance was calculated using the worst case VTX output power and maximum path loss (63° spacecraft antenna angle).

3.4.4 Predicted Standard HRPT Station Performance

Table 3.4.4 shows the predicted performance of the Standard HRPT Station. The predicted performance was calculated using the worst case STX output power and maximum path loss (63° spacecraft antenna angle).

3.4.5 Predicted Standard DCS Platform Performance

Table 3.4.5 shows the predicted performance of the Standard DCS Platform reception. The predicted performance was calculated using maximum path loss (63° spacecraft antenna angle).

TABLE 3.4.3
Standard APT Station Predicted Performance

Radiated Power at 63° (dBm)	34.5
Path Loss at 63°	145.8
Polarization Loss (dB)	0.2
Ground Antenna Gain (dB)	10.0
Received Level (dBm)	-101.5
IF Bandwidth (dB-Hz)	47.8
Noise Density (dBm/Hz)	-163.2
CNR Required (dB)	12.0
CNR Margin (dB)	1.9

TABLE 3.4.4
Standard HRPT Station Predicted Performance

Radiated Power at 63° (dBm)	39.2
Path Loss at 63" (dB)	167.7
Polarization Loss (dB)	0.2
Modulation Loss (dB)	0.7
Ground Antenna Gain (dB)	31.0
Demodulator Loss (dB)	3.0
Received Level (dBm)	-101.4
Bit-Rate Bandwidth (dB-Hz)	58.2
Noise Density (dBm/Hz)	-174.1
Eb/No Required (dB), 10^{-6} BER	10.5
Eb/No Margin (dB)	4.0

TABLE 3.4.5
Predicted Platform/DCS Performance

DCS Platform Output Power (dBm)	32.0
cable Loss (dB)	0.5
Platfcxm Feed Loss (dB)	1.0
Platform Antenna Gain (dB)	2.5
Path Loss (dB)	155.2
S/C Antenna Gain (dB)	-4.5 (@ 63')
Insertion/VSWR Loss (dB)	1.7
Required Receiver Power Min (dBm)	-128.0
Margin (dB)	-0.4

3.4.6 Predicted SARP Link Performance

Table 3.4.6 shows the predicted performance of the Standard SARP Platform reception. The predicted performance was calculated using maximum path loss (63° spacecraft antenna angle).

TABLE 3.4.6
Predicted Platform/SARP Performance

SARP Platform Output Power (dBm)	37.0
Multipath Loss (dB)	1.0
Platform Antenna Gain (dB)	2.5
Path Loss (dB)	155.2
S/C Antenna Gain (dB)	-4.5 (@ 63')
Insertion/VSWR Loss (dB)	2.2
Required Receiver Power Min (dBm)	-131.0
Margin (dB)	7.6

3.4.7 Predicted SARR Link Performance

Tabk 3.4.7-l shows the predicted performance of the three SARR uplinks (1215 Mhz, 243.0 Mhz and 406.05 Mhz) calculated for a 0° elevation angle. Table 3.4.7-2 shows the predicted performance of the SARR's L-Band (1544.5 Mhz) downlink calculated for a 5° elevation and a single nominal uplink signal.

TABLE 3.4.7-l
Predicted SARR Uplink Parameters

	121 Mhz Beacon	243 Mhz Beacon	406 Mhz Beacon
ELT / EPIRB Radiated Power (dBm)	15.74	15.74	37.0
Multipath Loss (dB)	4.0	1.0	1.0
Noise Density (dBm/Hz)	-158.6	-163.8	-168.6
Path Loss at 0° Elevation (dB)	144.8	150.8	155.2
Spacecraft Ant. Gain at 63 . (dBci) [see note]	-9.0	-6.0	-10.0
Spacecraft Losses (dB)	2.0	1.9	1.5
Received Signal Level (dBm)	-144.0	-144.0	-130.7
Received Signal - to - Noise Ratio (dB Hz)	12.5	17.9	39.4

Note: RCP antenna as measured with a linearlly polarized source.

TABLE 3.4.7-2
Predicted SARR Downlink Power Budget
(for a single nominal uplink signal)

	121 Mhz Relay	243 Mhz Relay	406 Mhz Relay	PDS Data
Required Signal-to-Noise Min. (dB-Hz)	50.0	46.0	52.2	47.0
Path Loss at 5° Elevation (dB)	165.4	165.4	165.4	165.4
LUT G / T (dB / K°)	3.0	3.0	3.0	3.0
Boltzmann's Constant (dBm / K° / Hz)	-198.6	-198.6	-198.6	-198.6
Spacecraft Antenna Gain (dB)	1.0	-1.0	-1.0	-1.0
Required Transmitter Power (dBm)	i4.8	10.8	17.0	11.8
Transmitter Power Min (dBm)	38.6	38.6	38.6	38.6
Spacecraft Losses (dB)	1.6	1.6	1.6	1.6
Link Margin (dB)	22.2	26.2	20.0	25.2

3.4.8 Predicted CDA Link Performance

Tables 3.4.8-l to 3.4.8-8 presents the predicted VHF, L-Band and S-Band received power at the CDA stations for LAC, GAC, HRPT, stored TIP and Boost Mode telemetry Playback transmissions as calculated at a 63° spacecraft antenna angle. Additionally, Figure 3.4.8-I to Figure 3.4.8-10 presents the predicted CDA reception, of the various data streams, as a function of antenna angle.

TABLE 3.4.8-l
Beacon CDA Sensitivity
137.35 Mhz - 137.77 MHz
(Wallops)

Parameter	26 Meter Antenna	14.2 Meter Antenna
Polarization Loss (dB)	0.2	0.2
Modulation Loss (dB)	0.7	0.7
Ground Antenna Gain (dB)	27.4	22.4 1
Bit-Rate Bandwidth (dB-Hz)	39.2	39.2
Noise Density (dBm/Hz)	-169.5	-1695
Demodulator Loss (dB)	3.0	3.0
Eb/No Required (dB), 10^{-6} BER	1 0 . 5	10.5
CDA Sensitivity (dBm)	-143.7	-138.7

TABLE 3.4.8-2
Beacon CDA Sensitivity
137.35 Mhz - 137.77 Mhz
(Fairbanks)

Parameter	26 Meter Antenna	12 Meter Antenna
Polarization Loss (dB)	0.2	0.2
Modulation Loss (dB)	0.7	0.7
Ground Antenna Gain (dB)	27.4	16.0
Bit-Rate Bandwidth (dB-Hz)	39.2	39.2
Noise Density (dBm/Hz)	-169.5	-169.5
Demodulator Loss (dB)	3.0	3.0
Eb/No Required (dB), 10-6 BER	10.5	10.5
CDA Sensitivity (dBm)	-143.7	-132.3

TABLE 3.4.8-3
L - Band CDA Sensitivity
1698.0 Mhz - 1707.0 Mhz
(Wallops 26 Meter Antenna)

Parameter	Type of Data Transmission: LAC/GAC (2.66 Mbps)	LAC/GAC (1.33 Mbps)	HRPT (0.66 Mbps)	Stored TIP (0.33 Mbps)
Polarization Loss (dB)	1.5	1.5	1.5	1.5
Premodulator Loss (dB)	1.2	0.8	0.4	0.2
Modulation Loss (dB)	0.7	0.7	0.7	0.7
Rain Fade Loss (dB)	0.4	0.4	0.4	0.4
Adjacent Channel Loss (dB)	10.8	10.6	8.5	15.1
Ground Antenna Gain (dB)	43.6	43.6	43.6	43.6
Bit-Rate Bandwidth (dB-Hz)	64.2	61.2	58.2	I55.2
Noise Density (dBm/Hz)	-173.2	-173.2	-173.2	I-173.2
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required (dB), 10^{-6} BER	10.5	10.5	10.5	10.5
CDA Sensitivity (dBm)	I-124.5	I-128.1	-133.6	I-140.2

TABLE 3.4.8-4
L - Band CDA Sensitivity
1698.0 MHz - 1707.0 MHz
(Wallops 142 Meter Antenna)

Parameter	Type of Data Transmission			
	LAC/GAC (2.66 Mbps)	LAC/GAC (1.33 Mbps)	HRPT (0.66 Mbps)	Stored TIP (0.33 Mbps)
Polarization Loss (dB)	1.5	1.5	1.5	1.5
Premodulator Loss (dB)	1.2	0.8	0.4	0.2
Modulation Loss (dB)	0.7	0.7	0.7	0.7
Rain Fade Loss (dB)	0.4	0.4	0.4	0.4
Adjacent Channel Loss (dB)	10.8	10.6	8.5	5.1
Ground Antenna Gain (dB)	43.9	43.9	43.9	43.9
Bit-Rate Bandwidth (dB-Hz)	64.2	61.2	58.2	55.2
Noise Density (dBm/Hz)	-177.1	-177.1	-177.1	-177.1
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required (dB), 10^{-6} BER	10.5	10.5	10.5	10.5
CDA Sensitivity (dBm)	-128.7	-132.3	-137.8	-144.4

TABLE 3.4.8-5
L - Band CDA Sensitivity
1698.0 Mhz - 1707.0 MHz
(Fairbanks 26 Meter Antenna)

Parameter	Type of Data Transmission			
	LAC/GAC (2.66 Mbps)	LAC/GAC (1.33 Mbps)	HRPT (0.66 Mbps)	Stored TIP (0.33 Mbps)
Polarization Loss (dB)	1.5	1.5	1.5	1.5
Premodulator Loss (dB)	1.2	0.8	0.4	0.2
Modulation Loss (dB)	0.7	0.7	0.7	0.7
Rain Fade Loss (dB)	0.4	0.4	0.4	0.4
Adjacent Channel Loss (dB)	10.8	10.6	8.5	5.1
Ground Antenna Gain (dB)	48.7	48.7	48.7	48.7
Bit-Rate Bandwidth (dB-Hz)	64.2	61.2	58.2	55.2
Noise Density (dBm/Hz)	-174.2	-174.2	-174.2	-174.2
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required (dB), 10^{-6} BER	10.5	10.5	10.5	10.5
CDA Sensitivity (dBm)	-130.6	-134.2	-139.7	-146.3

TABLE 3.4.8-6
L - Band CDA **Sensitivity**
1698.0 Mhz - 1707.0 MHz
(Fairbanks 12 Meter Antenna)

	Type of Data Transmission			
Parameter	**LAC/GAC** (2.66 Mbps)	**LAC/GAC** (1.33 Mbps)	**HRPT** (0.66 **Mbps)**	**Stored TIP** (0.33 **Mbps)**
polarization Loss **(dB)**	1.5	1 . 5	1.5	1.5
Premodulator Loss **(dB)**	1.2	**0.8**	0.4	0.2
Modulation Loss **(dB)**	**0.7**	0.7	0.7	0.7
Rain Fade **Loss (dB)**	0 . 4	0.4	0.4	0.4
Adjacent Channel Loss **(dB)**	10.8	10.6	8.5	**5.1**
Ground Antenna Gain (dB)	43.7	43.7	43.7	**43.7**
Bit-Rate Bandwidth **(dB-Hz)**	64.2	61.2	58.2	55.2
Noise **Density (dBm/Hz)**	**-169.5**	-169.5	-169.5	-169.5
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required **(dB),** 10-6 BER	10.5	10.5	10.5	10.5
CDA Sensitivitv **(dBm)**	I-120.9	-124.5	-130.0	-136.6

TABLE 3.4.8-7
L / S - Band CDA Sensitivity
1702.5 Mhz / 2247.5 Mhz
(Wallops CDA)

	26 Meter Antenna		14.2 Meter Antenna	
Parameter	1702.5 MHz	2247.5 MHz	1702.5 MHZ	2247.5 MHz
Polarization Loss (dB)	1.5	1.5	1.5	1.5
Modulation Loss (dB)	0.7	0.7	0.7	0.7
Rain Fade Loss (dB)	0.4	0.4	0.4	0.4
Ground Antenna Gain (dB)	43.6	48.7	43.9	46.5
Bit-Rate Bandwidth (dB-Hz)	39.2	39.2	39.2	39.2
Noise Density (dBm/Hz)	- 173.2	-173.5	-177.0	-176.2
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required (dB), 10^{-6} BER	10.5	10.5	10.5	10.5
CDA Sensitivity (dBm)	-161.5	-166.9	-165.6	-167.4

TABLE 3.4.8-8
L / S - Band CDA Sensitivity
1702.5 Mhz / 2247.5 Mhz
(Fairbanks CDA)

	26 Mete Antenna		12.0 Meter Antenna	
Parameter	1702.5 **MHz**	2247.5 **MHz**	**1702.5 MHz**	12247.5 MHZ
Polarization Loss **(dB)**	1.5	1.5	1.5	1.5
Modulation **Loss (dB)**	0.7	**0.7**	**0.7**	**0.7**
Rain Fade **Loss (dB)**	0.4	**0.4**	**0.4**	**0.4**
Ground Antenna Gain (dB)	48.7	**51.8**	**43.7**	**46.0**
Bit-Rate Bandwidth **(dB-Hz)**	**39.2**	**39.2**	**39.2**	**39.2**
Noise **Density (dBm/Hz)**	-174.2	-174.5	l-169.5	**-172.3**
Demodulator Loss (dB)	3.0	3.0	3.0	3.0
Eb/No Required **(dB),** 10^{-6} BER	10.5	10.5	10.5	10.5
CDA Sensitivity **(dBm)**	-167.6	-171.0'	-157.9	-163.9

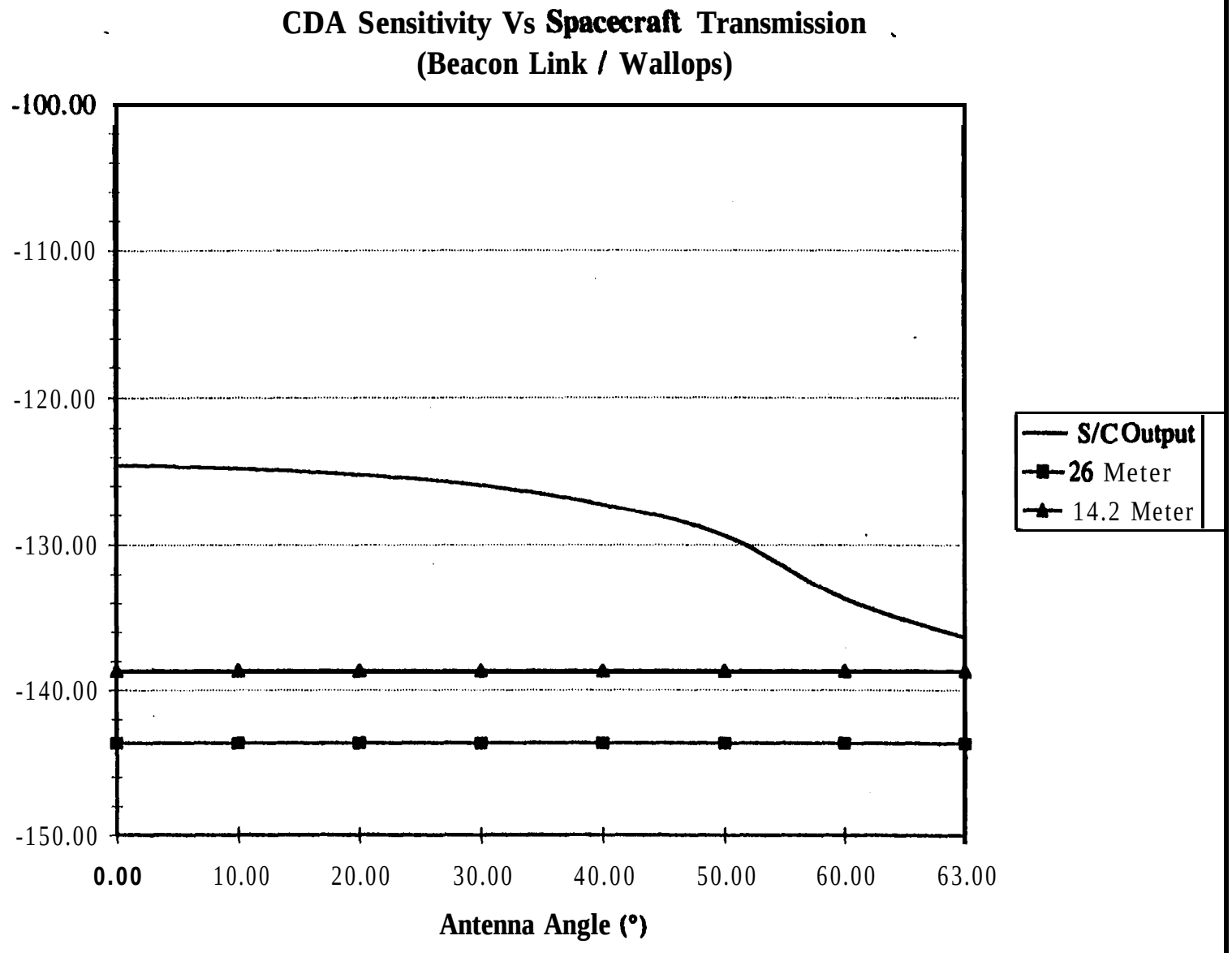


FIGURE 3.4.8-1

Size	Code Ident No.		Sheet
A	18713	IS3278200	67

A 772570

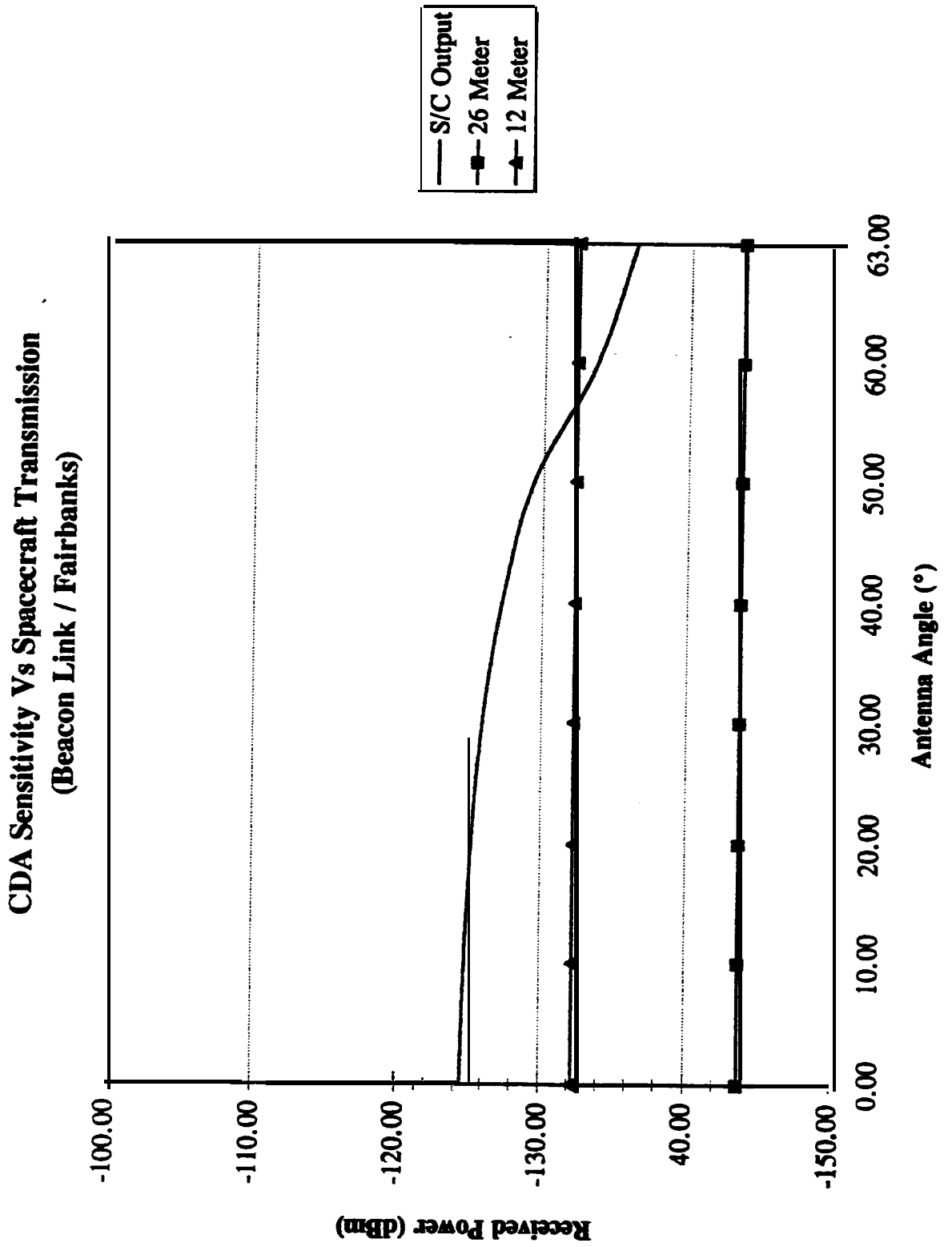

CDA Sensitivity Vs Spacecraft Transmission
(Beacon Link / Fairbanks)
S/C Output
26 Meter
12 Meter
Received Power (dBm)
-100.00
-110.00
-120.00
-130.00
40.00
-150.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
63.00
Antenna Angle (°)

FIGURE 3.4.8-2

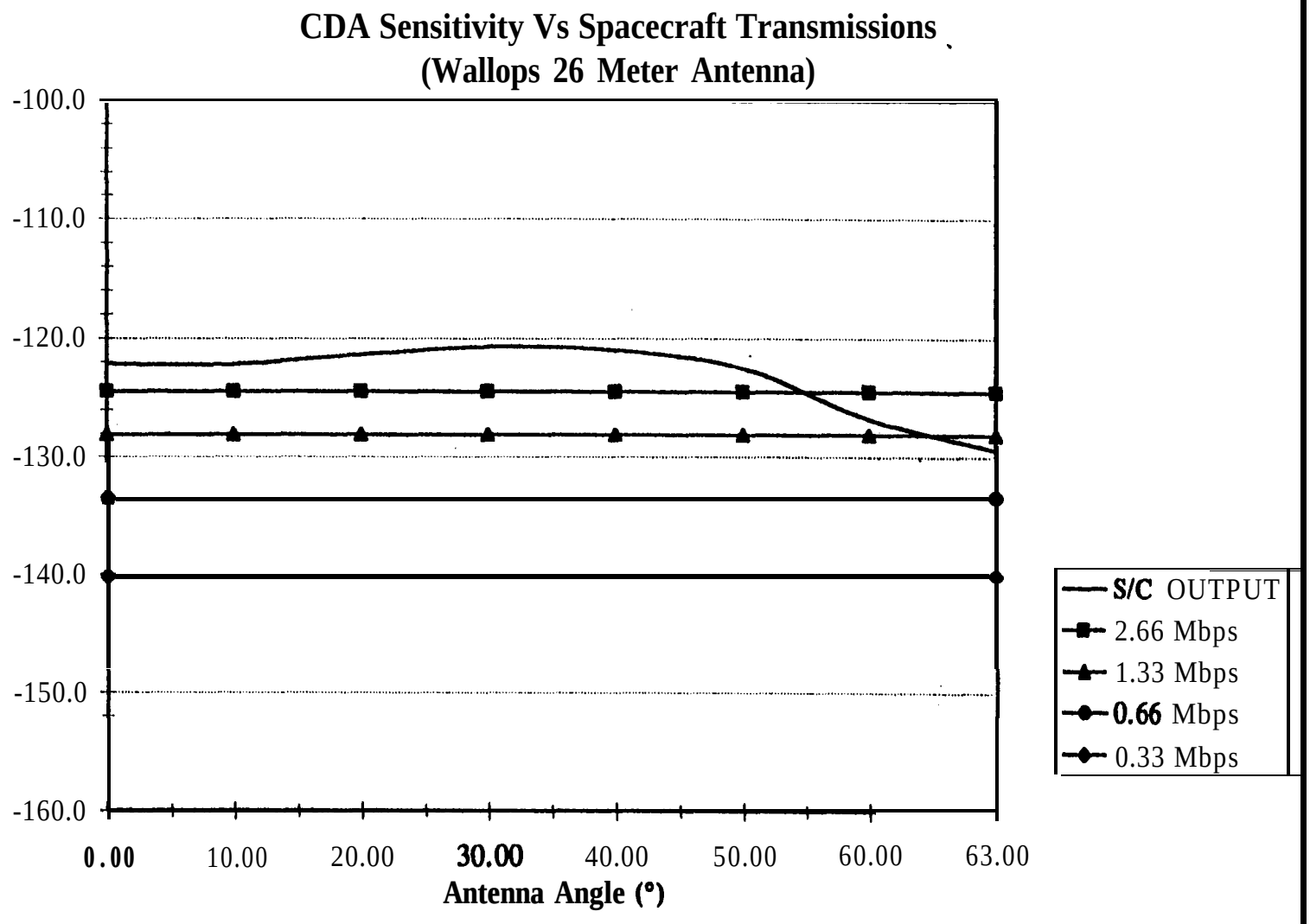


FIGURE 3.4.8-3
L-BAND CDA SENSITIVITY

Size	Code Ident No.	
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		Sheet 09

A 772570

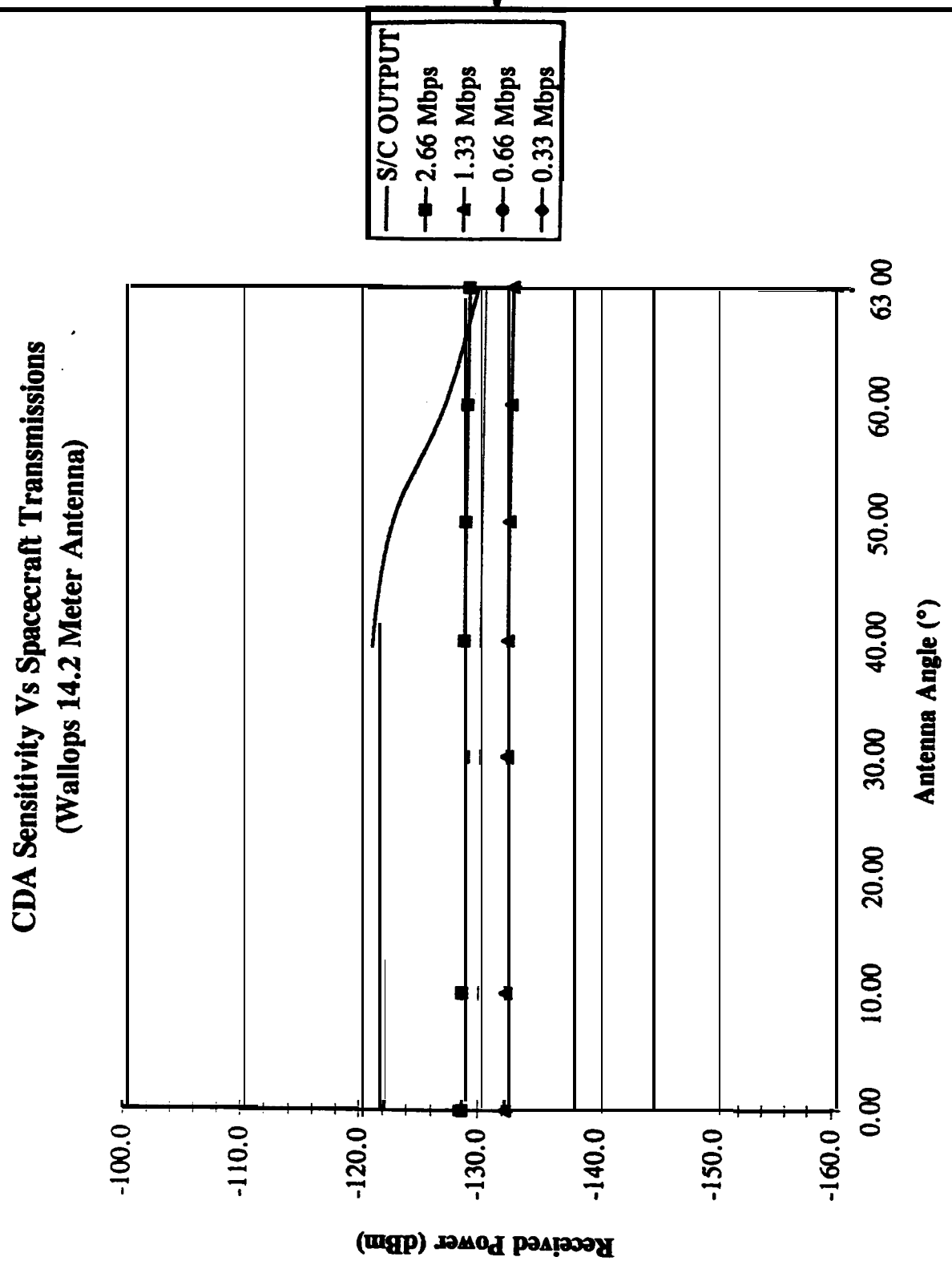

FIGURE 3.4.8-4
L-BAND CDA SENSITIVITY

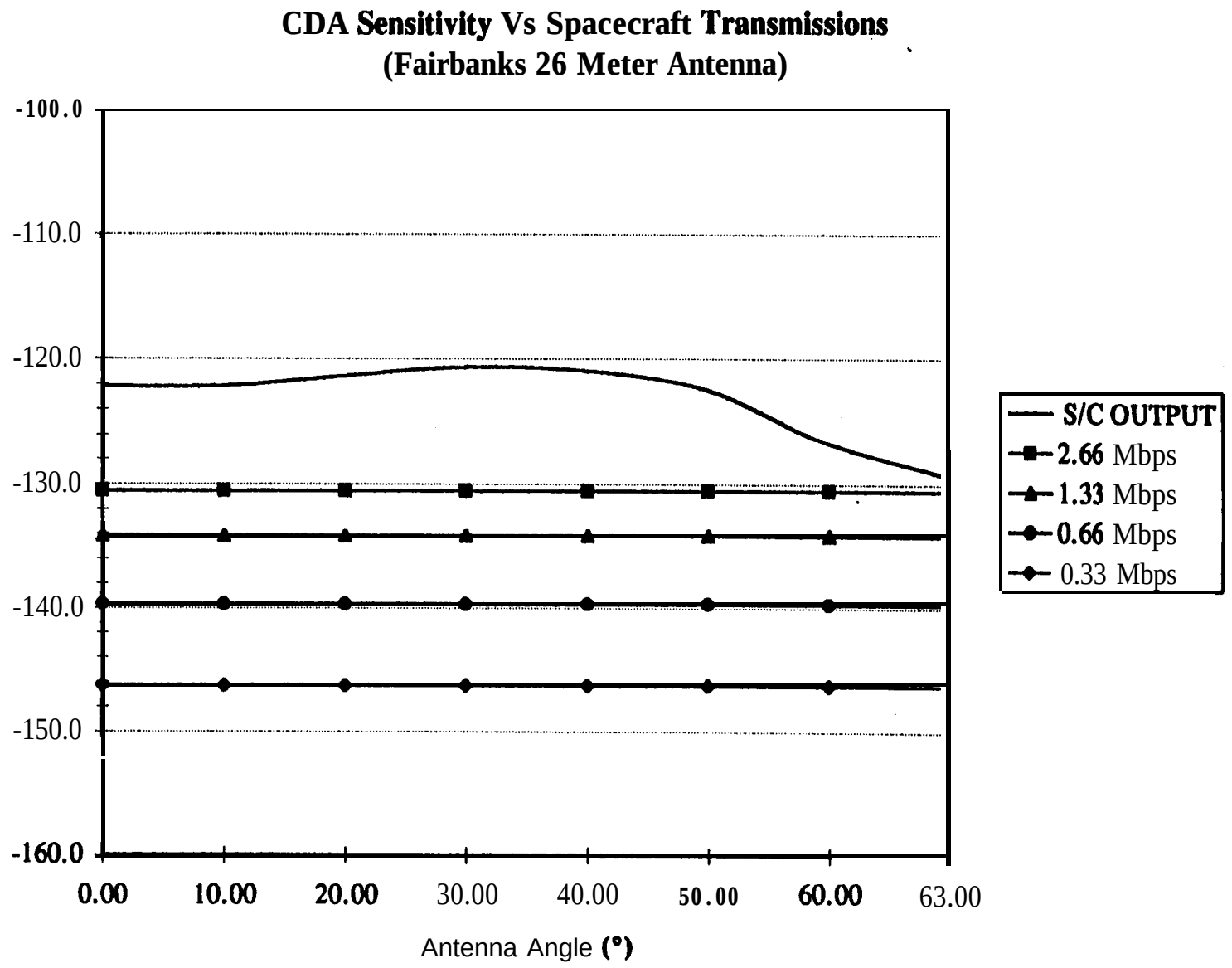

FIGURE 3.4.8-5
L-BAND CDA SENSITIVITY

Size	Code Ident No.	
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		Sheet 71

A 772 570

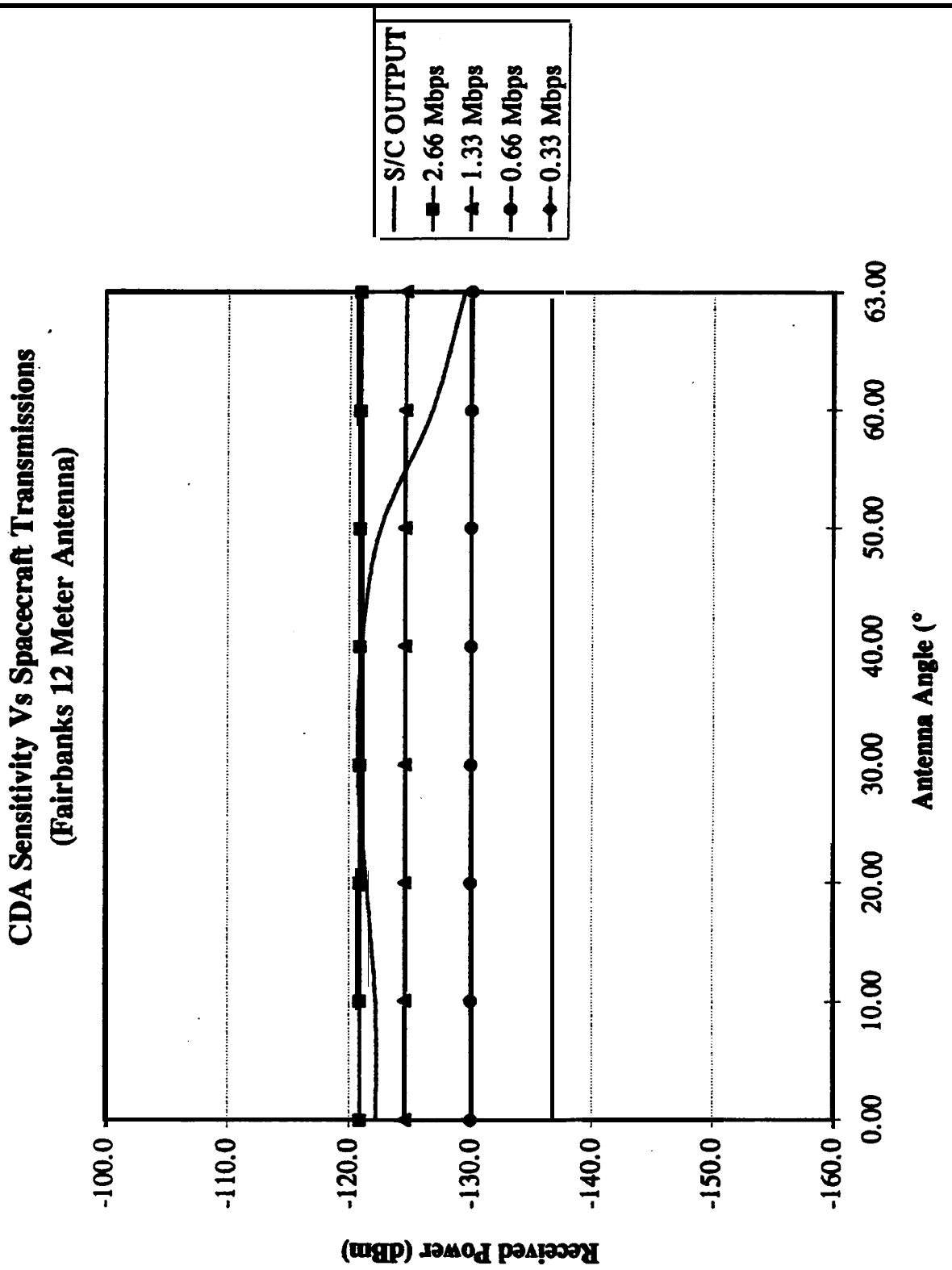


FIGURE 3.4.8-6
L-BANDCDASENSITMTY

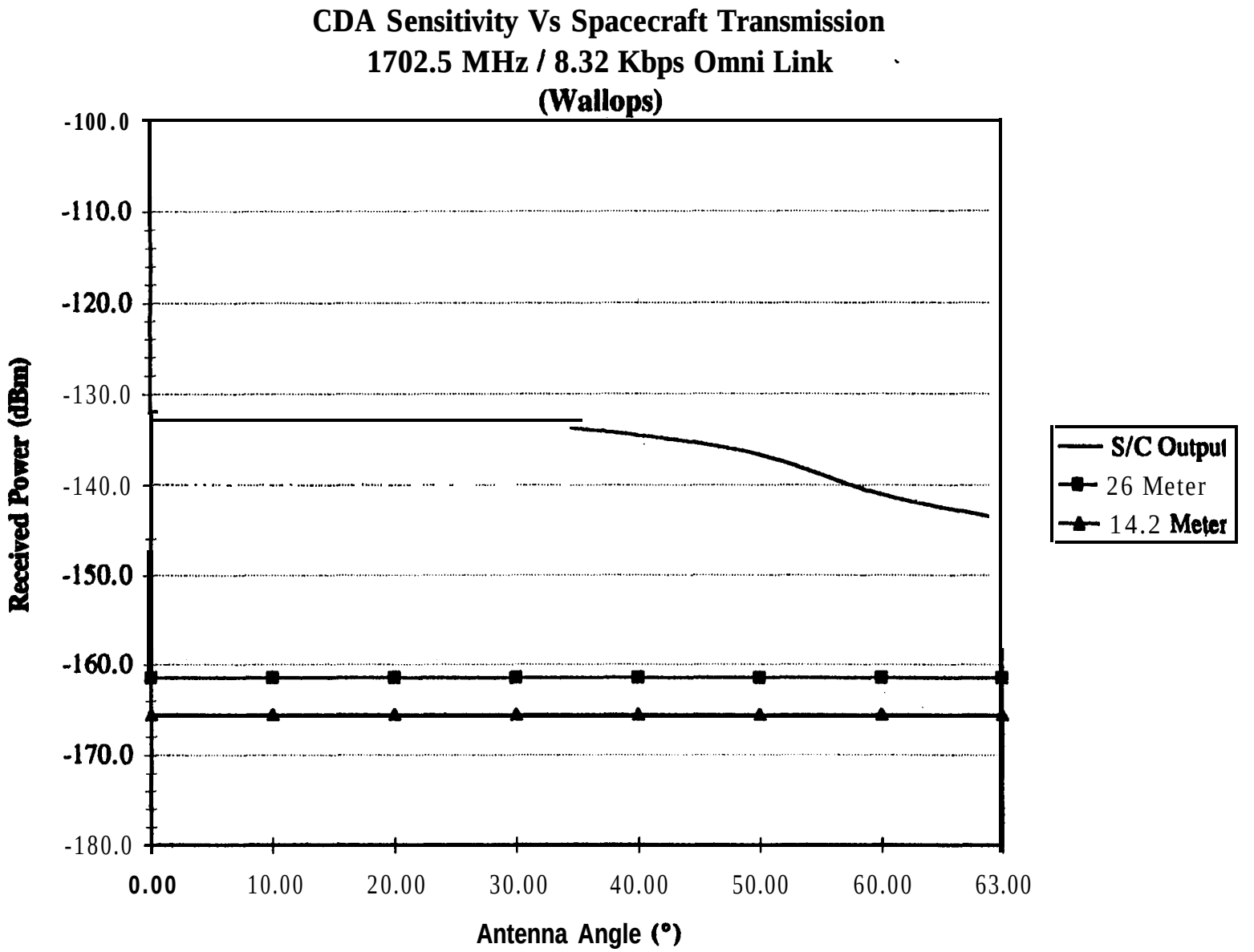


FIGURE 3.4.8-7

Size A | Code Ident No. 18713 | S3278200

Sheet 73

A 772 5/70

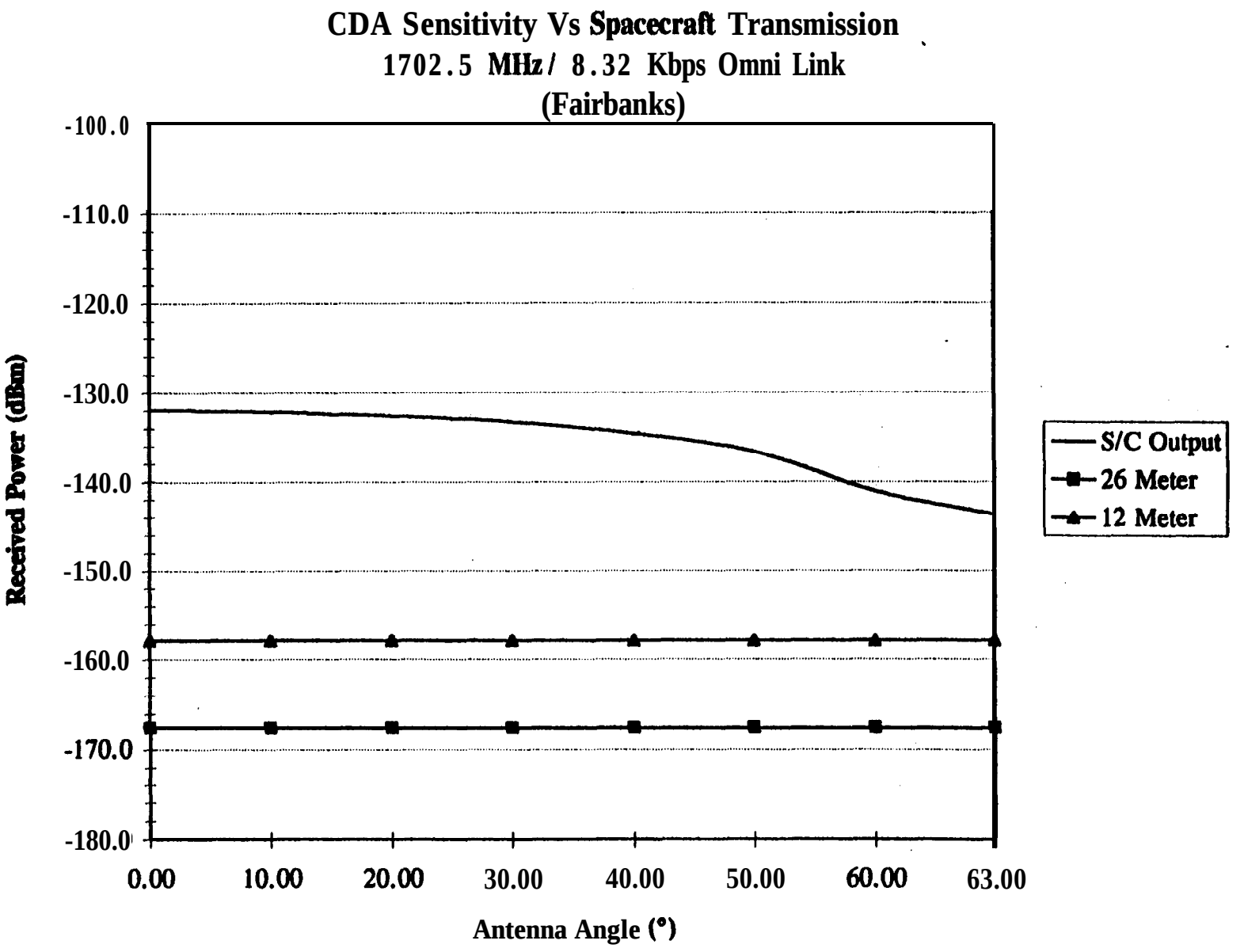


FIGURE 3.4.8-8

Size	Code Ident No.	
A	18713	IS3278200
		Sheet 7/4

A 772 570

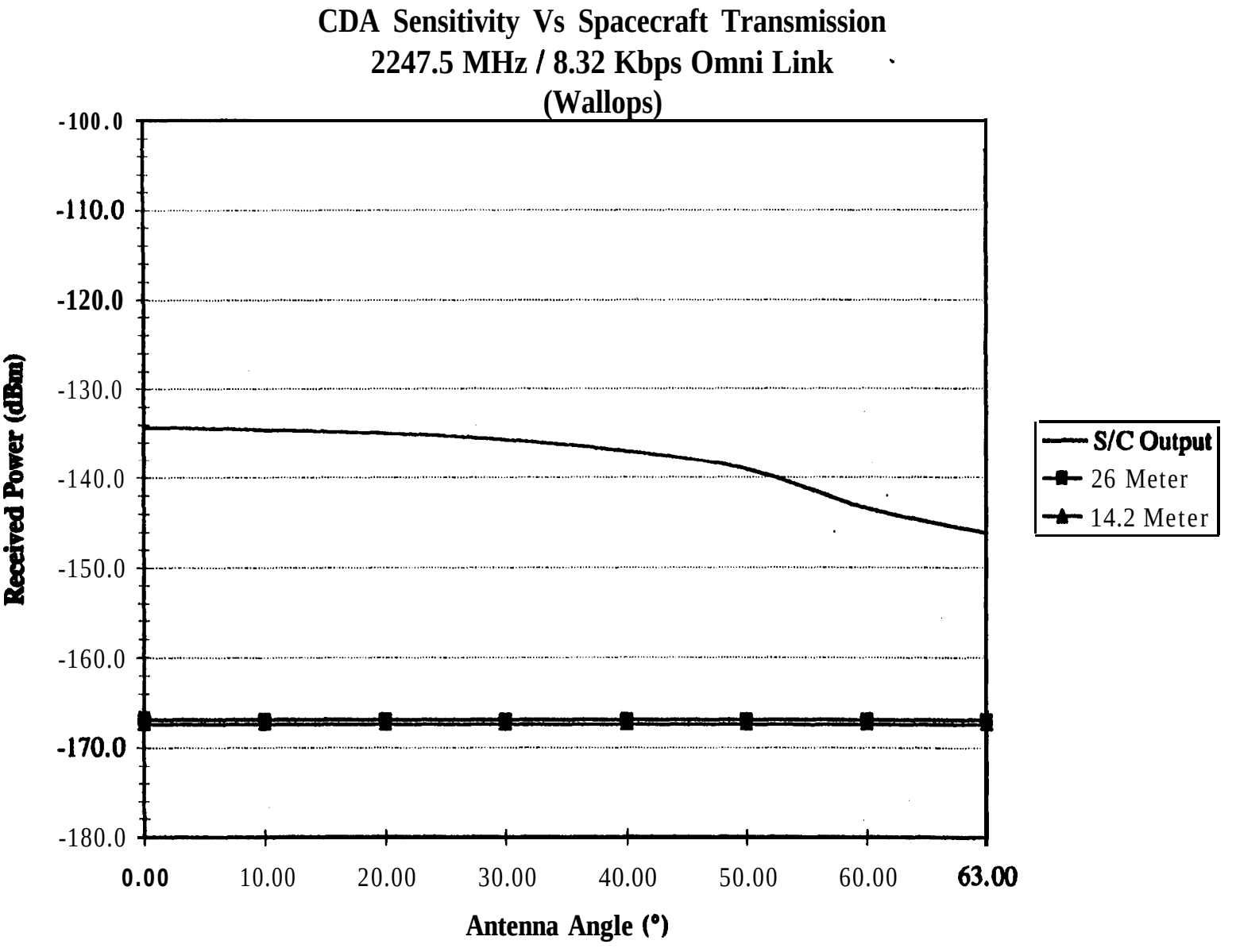


FIGURE 3.4.8-9

A 772 570

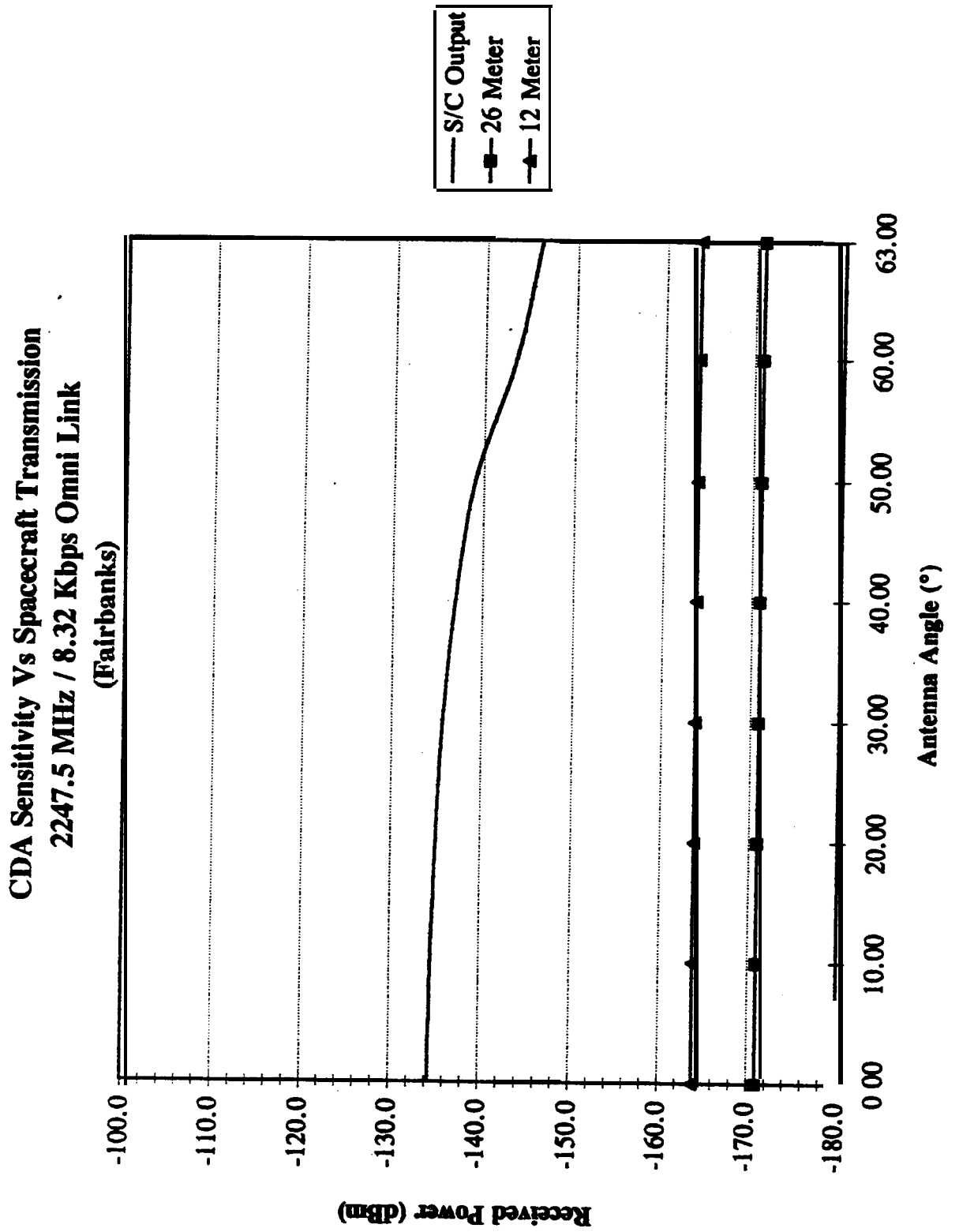


FIGURE 3.4.8-10

3.4.9 CDA Command Transmission

The predicted performance of the CDA Command Transmissions, as seen by the spacecraft, as calculated for a 63' spacecraft antenna angle is shown in Table 3.4.9-1 and Table 3.4.9-2. Additionally, the predicted link performancee as a function af antenna angle is shown in Figure 3.4.9-l and Figure 3.4.9-2.

TABLE 3.4.9-l
Predicted Wallops CDA Command Transmissions

	Wallops 14.2 Meter Ant.	Wallops 4 Meter Ant.
GRD Sensitivity (dBm)	-118.0	-118.0
Spacecraft Losses (dB)	6.0	6.0
S/C Antenna Gain (dBci)	0.0 (@ 63')	0.0 (@ 63')
Polarization Loss (dB)	0.2	0.2
Path Loss (dB, 63')	169.2	169.2
Min Required GRD Received Power (dBm)	57.4	57.4
CDA Transmitter EIRP (dBm)	110.0	97.0
Link Margin (dB)	52.6	39.6

TABLE 3.4.9-2
Predicted Fairbanks CDA Command Transmissions

	Fairbanks 6 Meter Ant.	Fairbanks 4 Meter Ant.
GRD Sensitivity (dBm)	-118.0	-118.0
Spacecraft Losses (dB)	6.0	6.0
S/C Antenna Gain (dBci)	0.0 (@ 63°)	0.0 (@ 63°)
Polarization Loss (dB)	0.2	0.2
Path Loss (dB, 63°)	169.2	169.2
Min Required GRD Received Power (dBm)	57.4	57.4
CDA Transmitter EIRP (dBm)	102.0	97.0
Link Margin (dB)	44.6	39.6

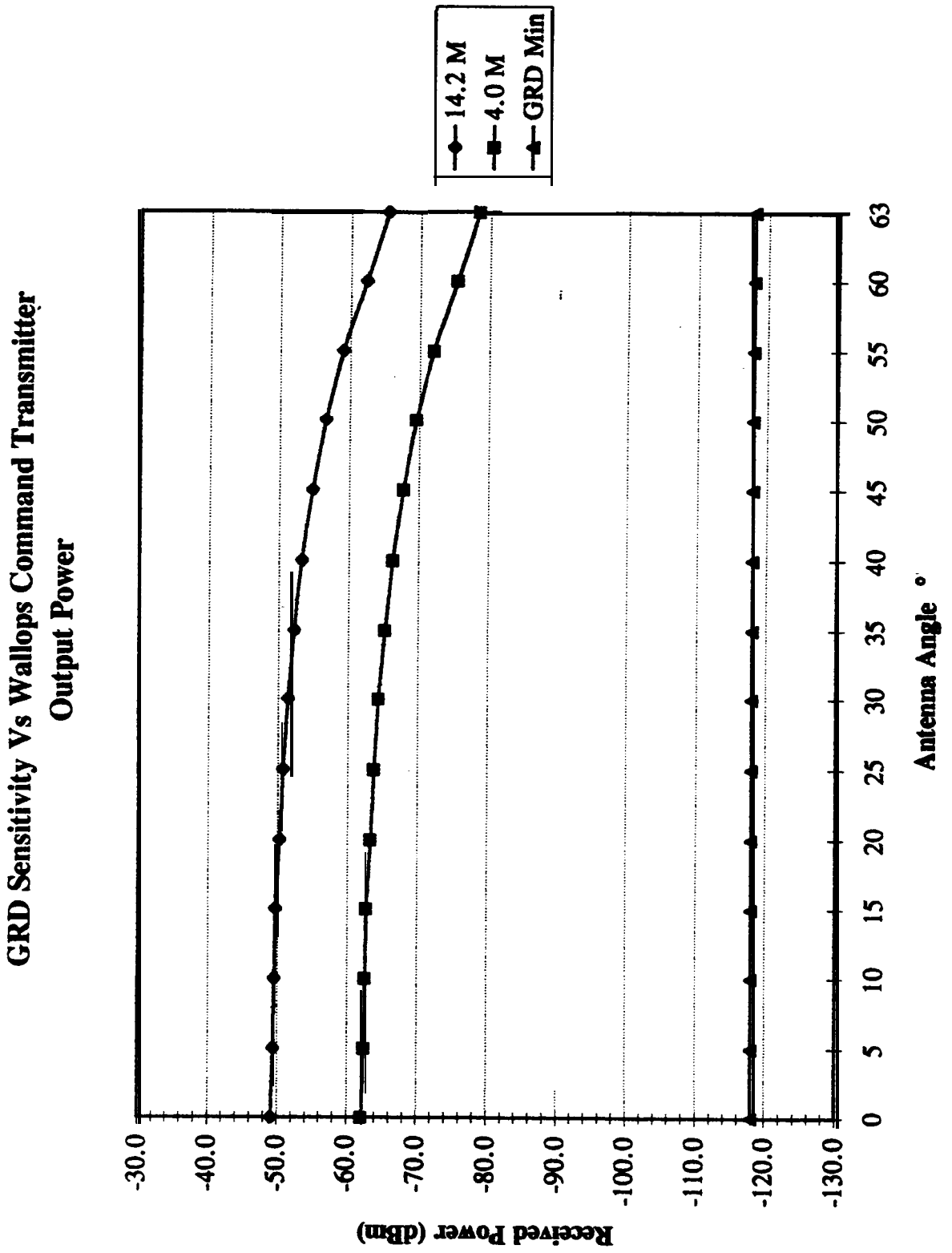

GRD Sensitivity Vs Wallops Command Transmitter Output Power
14.2 M
4.0 M
GRD Min
Received Power (dBm)
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-110.0
-120.0
-130.0
Antenna Angle °
0
5
10
15
20
25
30
35
40
45
50
55
60
63

FIGURE 3.4.9-1

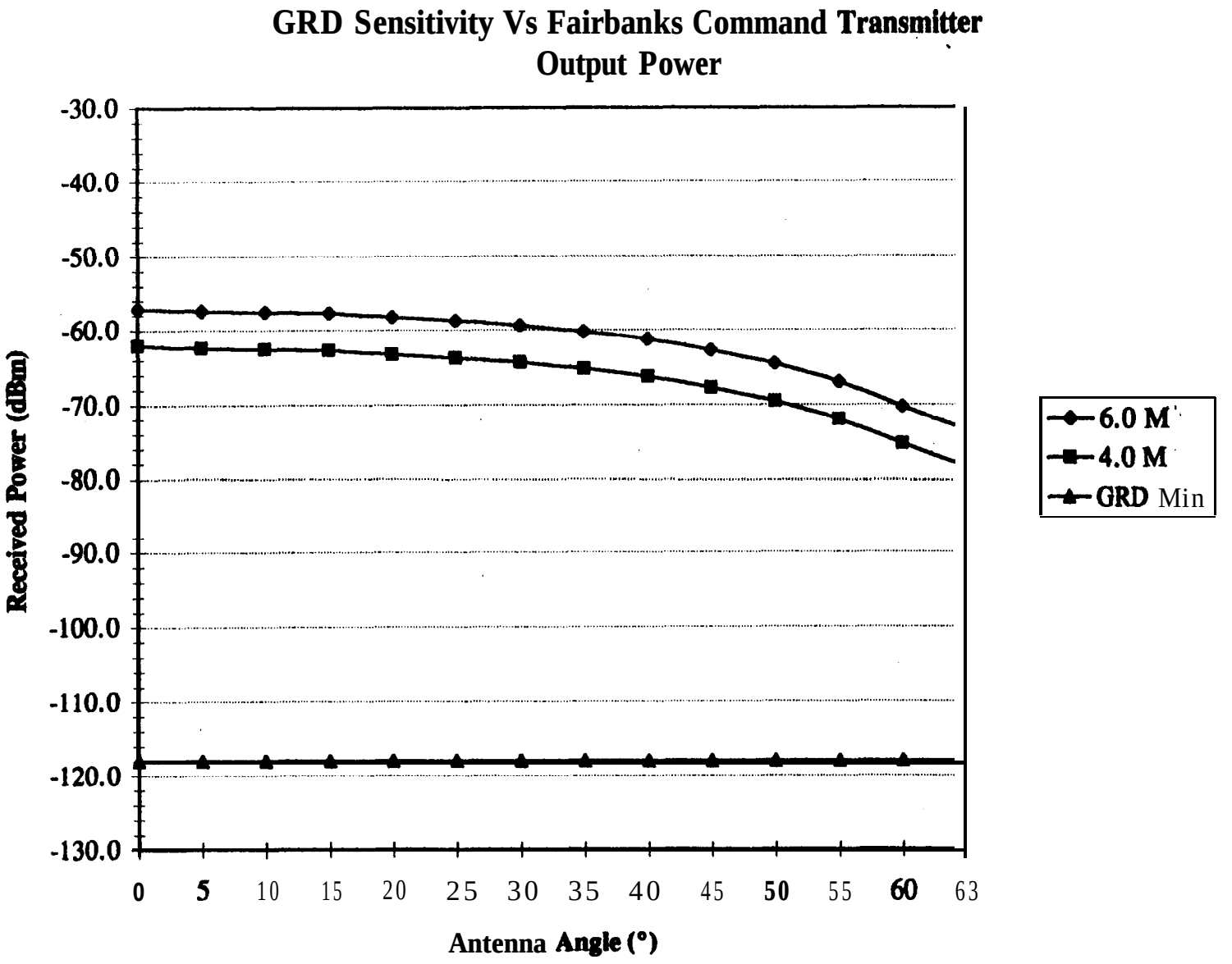


FIGURE 3.4.9-2

Size	Code Ident No.	
A	18713	IS3278200
		Sheet 9

A 772 970

APPENDIX A
Path Loss Information

TABLE A-l

Path Loss (dB) Vs Frequency (MHz)
Spacecraft Transmitter Frequencies

Antenna Angle (°)	2247.5	17079	1544.5	137.77	137.62
0	158.29	155.90	155.04	134.04	134.03
5	158.52	156.13	155.26	134.27	134.26
10	158.55	156.16	155.30	134.30	134.29
15	158.61	156.22	155.35	134.36	134.35
20	158.98	156.59	155.73	134.73	134.72
25	159.26	156.87	156.00	135.01	135.00
30	159.69	157.30	156.43	135.44	135.43
35	160.35	157.96	157.10	136.10	136.09
40	161.01	158.62	157.76	136.76	136.75
45	161.99	159.60	158.74	137.74	137.73
50	163.11	160.72	159.86	138.86	138.85
55	164.74	162.35	161.49	140.49	140.48
60	167.43	165.04	164.17	143.18	143.19
61	168.51	166.12	165.26	144.26	144.25
62	170.10	167.7 1	166.85	145.85	145.84

Note: Path Loss calculations were performed utilizing the following equation :
L = 36.6 + 20 Log (MHz) + 20 Log (mi)

TABLE A-2

Path Loss (dB) Vs Frequency (MHz)
Spacecraft Receiver Frequencies

Antenna Angle (°)	2026.0	406.05	401.65	243.0	121.5
0	157.39	143.43	143.34	138.97	132.95
5	157.62	143.65	143.57	139.19	133.17
10	157.65	143.69	143.60	139.23	133.21
15	157.71	143.7s	143.66	139.29	133.27
20	158.08	144.12	144.03	139.66	133.64
25	158.36	144.40	144.31	139.94	133.92
30	158.79	144.82	144.74	140.36	134.34
35	159.45	145.49	145.40	141.03	135.01
40	160.11	146.1s	146.06	141.69	135.67
45	161.09	147.13	147.04	142.67	136.65
50	162.21	148.25	148.16	143.79	137.77
55	163.84	149.88	149.79	145.42	139.40
60	166.53	152.56	152.48	148.10	142.08
61	167.61	153.65	153.56	149.19	143.17
62	169.20	155.24	155. 1s	150.78	144.76

Note: Path Loss calculations were performed utilizing the following equation :
L = 36.6 + 20 Log (MHz) + 20 Log (mi)

TABLE A-3

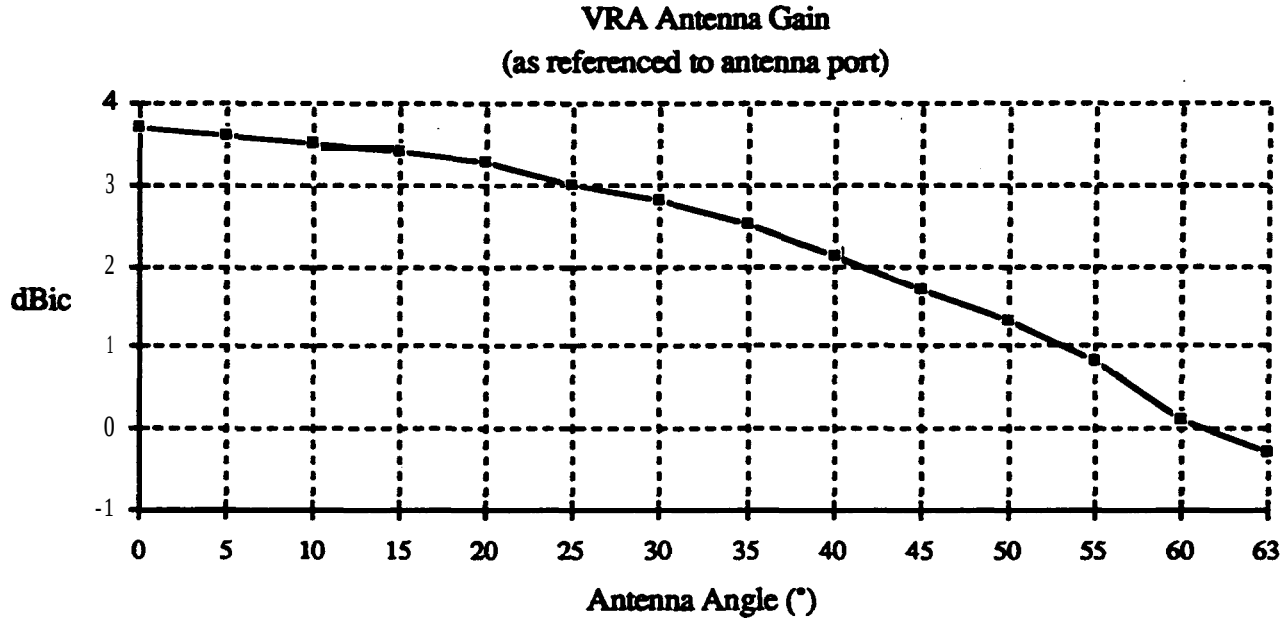
Spacecraft Distance Vs Antenna Angle / Ground Elevation

Antenna Angle (°)	Elevation (°)	Distance (mi)
0	90.0	540.8
5	84.3	555.0
10	78.6	557:o
15	72.9	561.0
20	67.1	585.6
25	61.3	604.5
30	55.4	635.0
35	49.3	685.5
40	43.1	740.0
45	36.5	827.6
50	29.5	941.8
55	21.4	1136.5
60	10.2	1548.5
61	6.2	1754.1
62	0.0	2105.0

Note: The following parameters were utilized in the calculation of Spacecraft Elevation and Spacecraft Distance:
Earth Radius = 3959.0 mi.
Spacecraft Orbit = 540.8 mi.

APPENDIX B
S/C Antenna Gain Information

FIGURE B - 1



FIGUREB-2

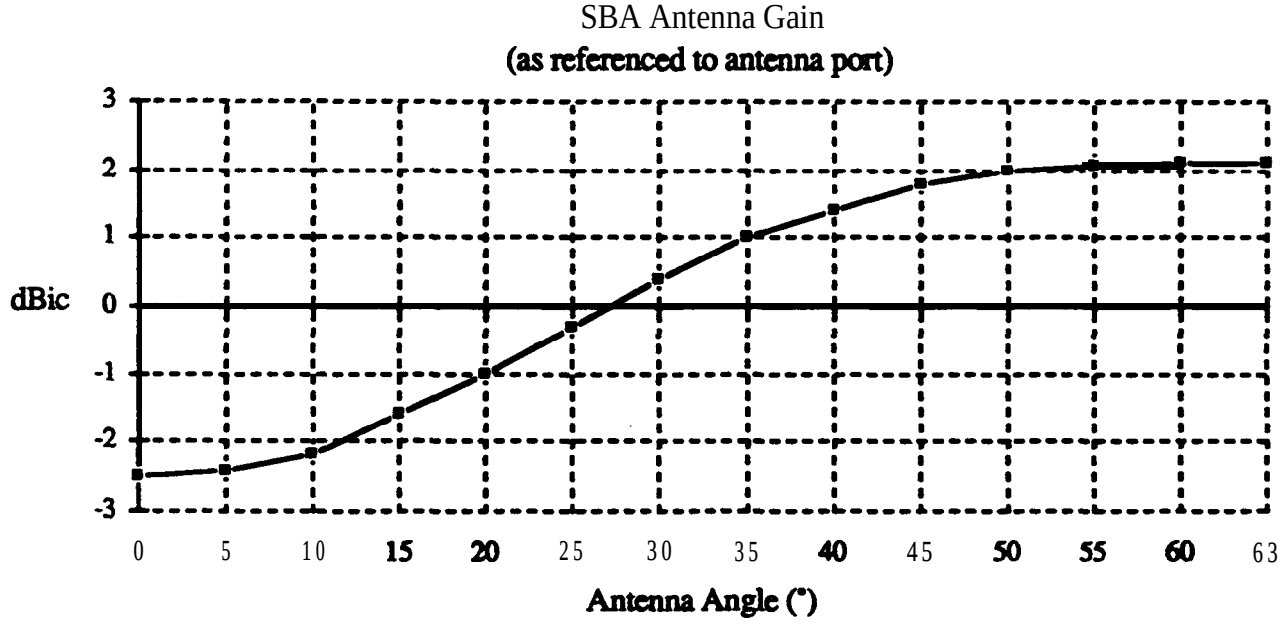
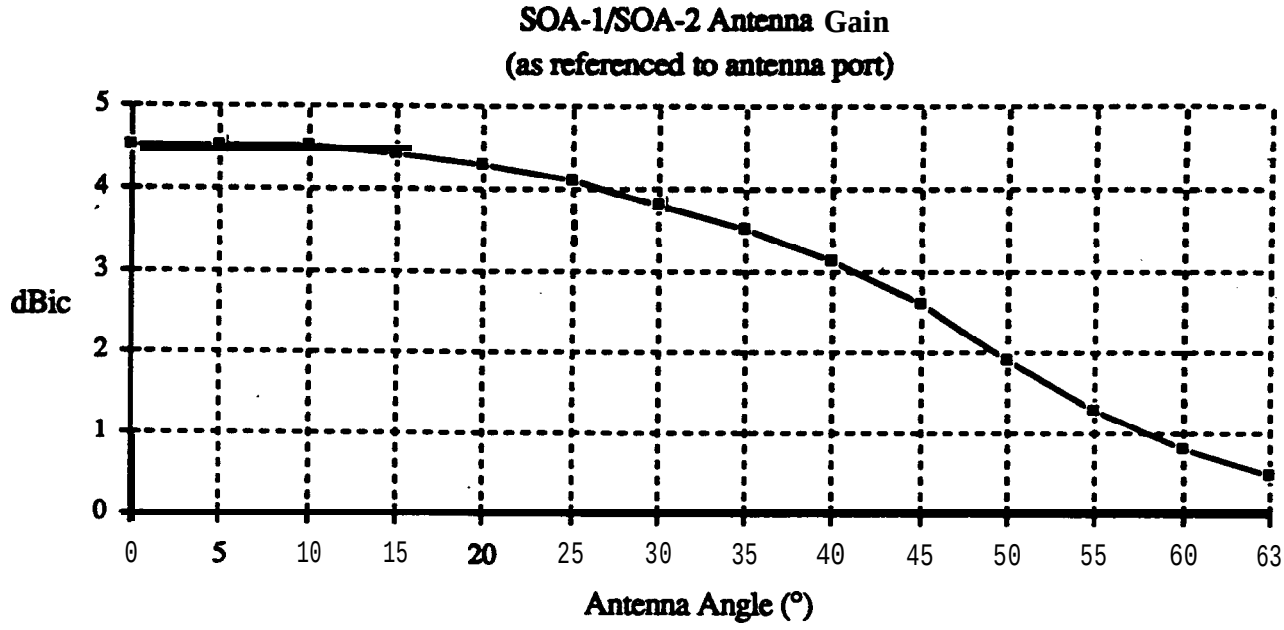


FIGURE B - 3



'FIGUREB-4

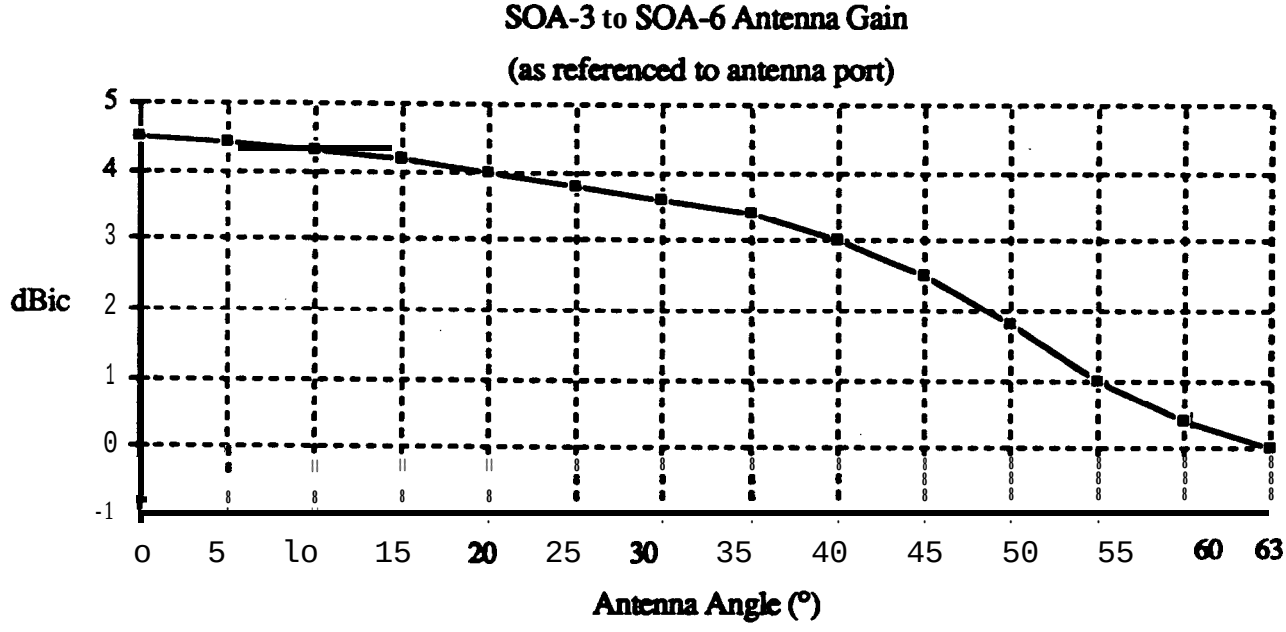
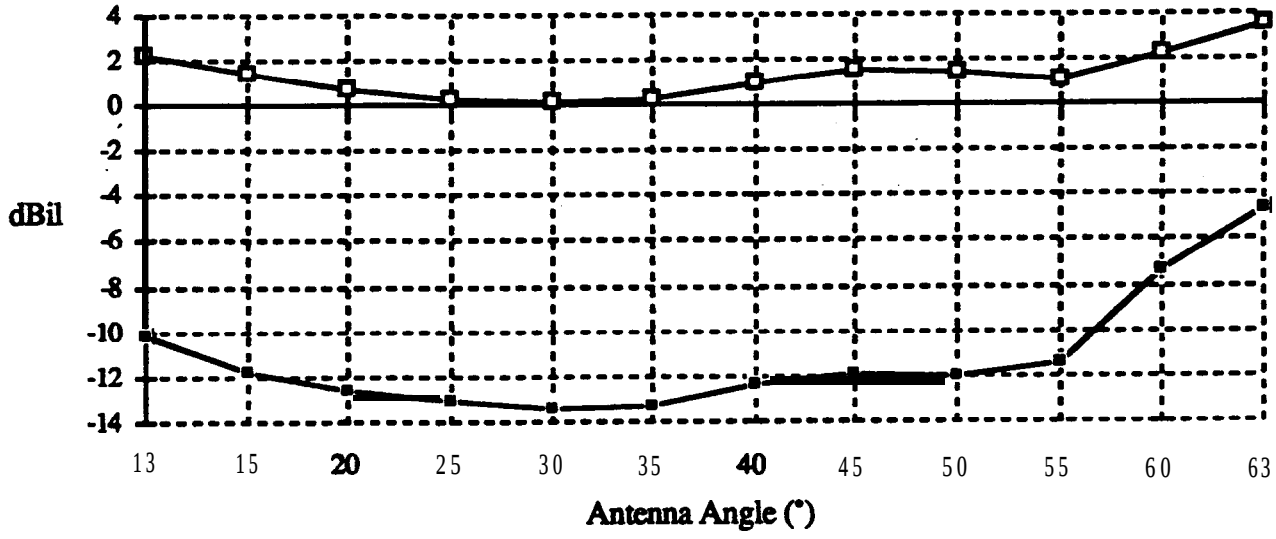


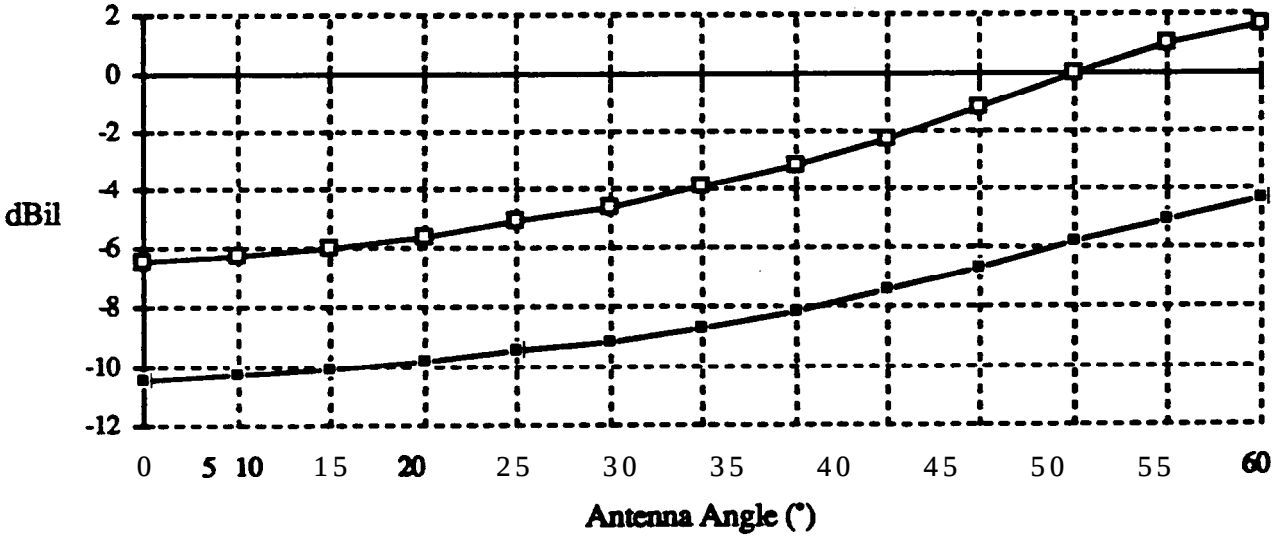
FIGURE B - 5

UDA Antenna Gain (DCS - 401.65 Mhz)
(as referenced to DCS receiver input port)



FIGUREB-6

UDA Antenna Gain (SARP - 406.05 Mhz)
(as referenced to SARP input port)



Size	Code Ident No.	
A	18713	183278200

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FIGURE B - 7

SRA 121.5 Mhz Antenna Gain
(as referenced to SARR input port)

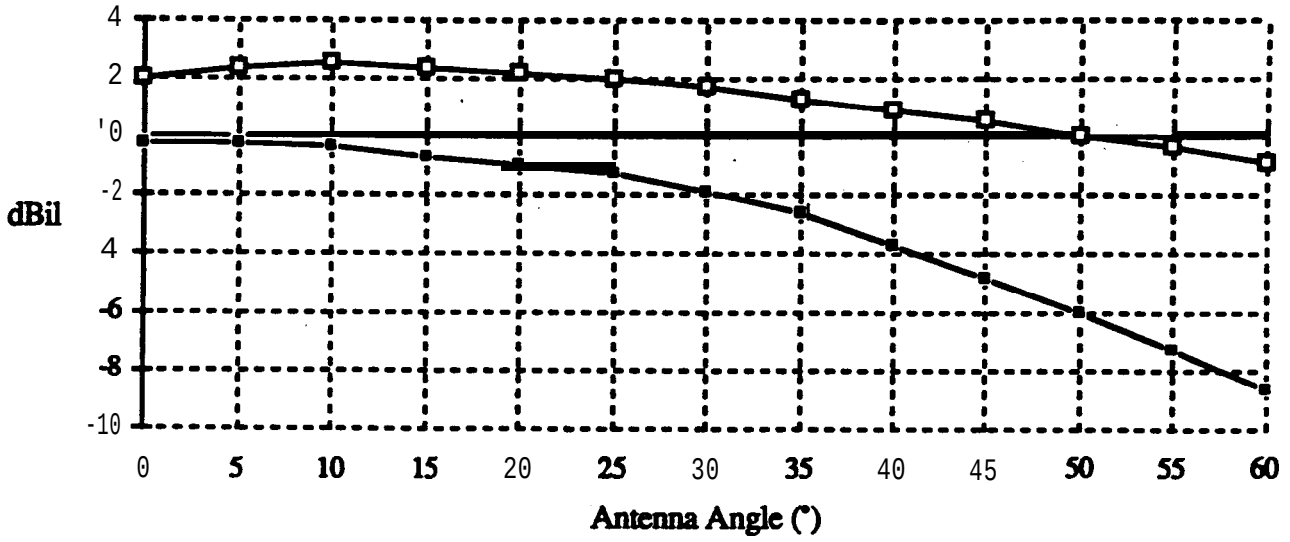
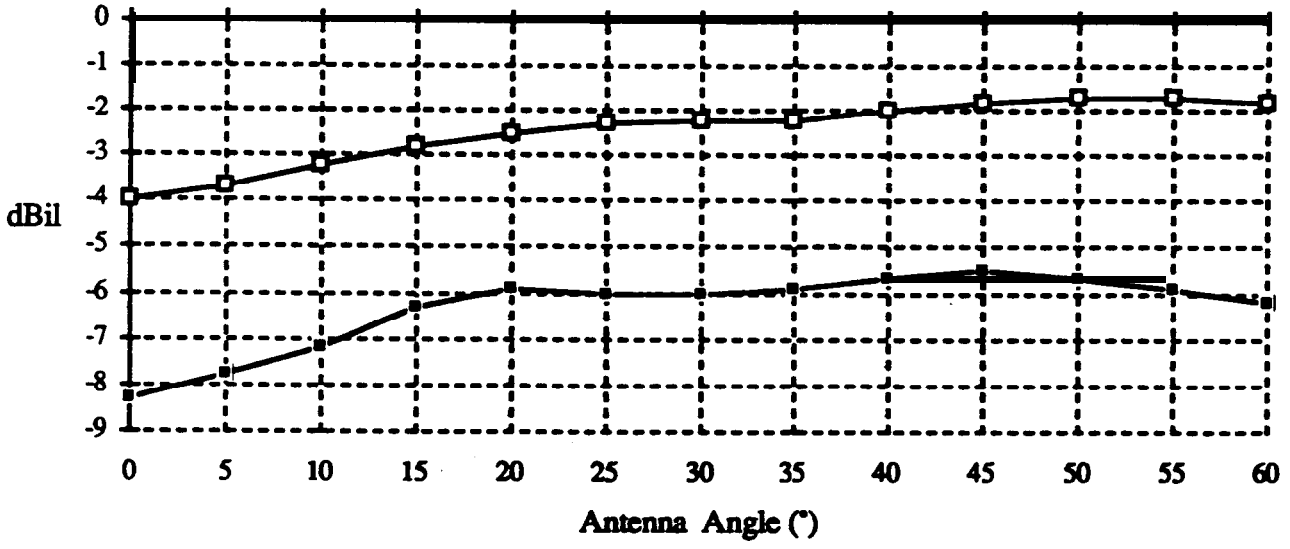


FIGURE B - 8

SRA 243 Mhz Antenna Gain
(as referenced to SARR input port)



Size	Code Ident No.	
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FIGUREB-9

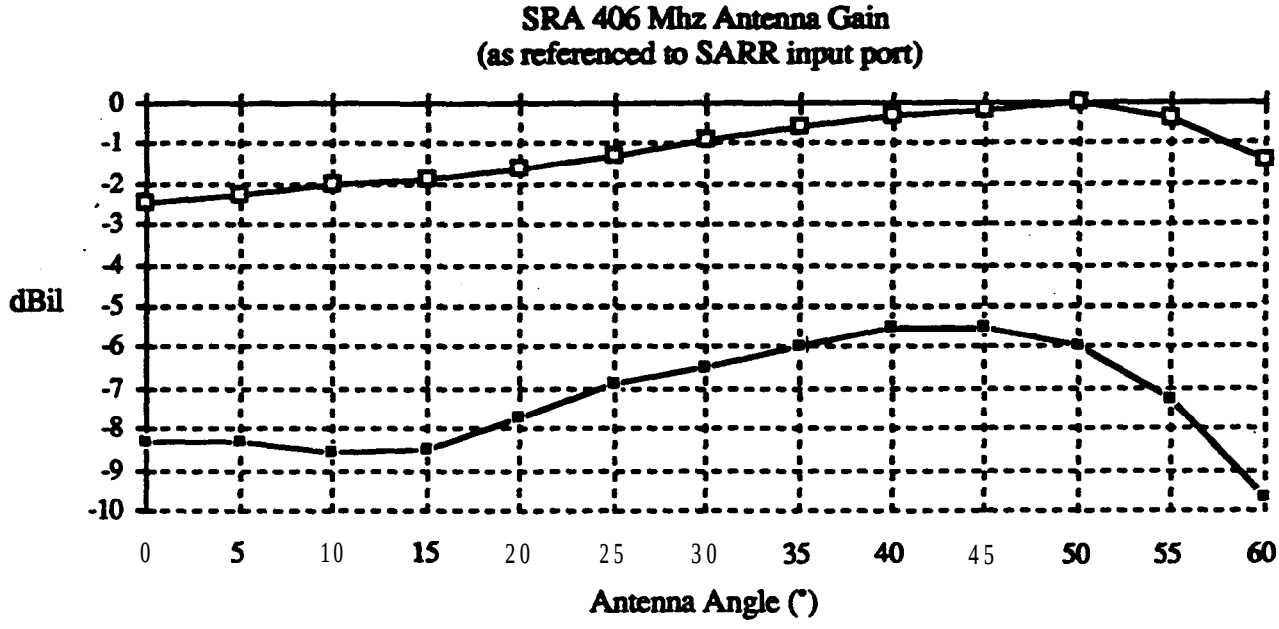
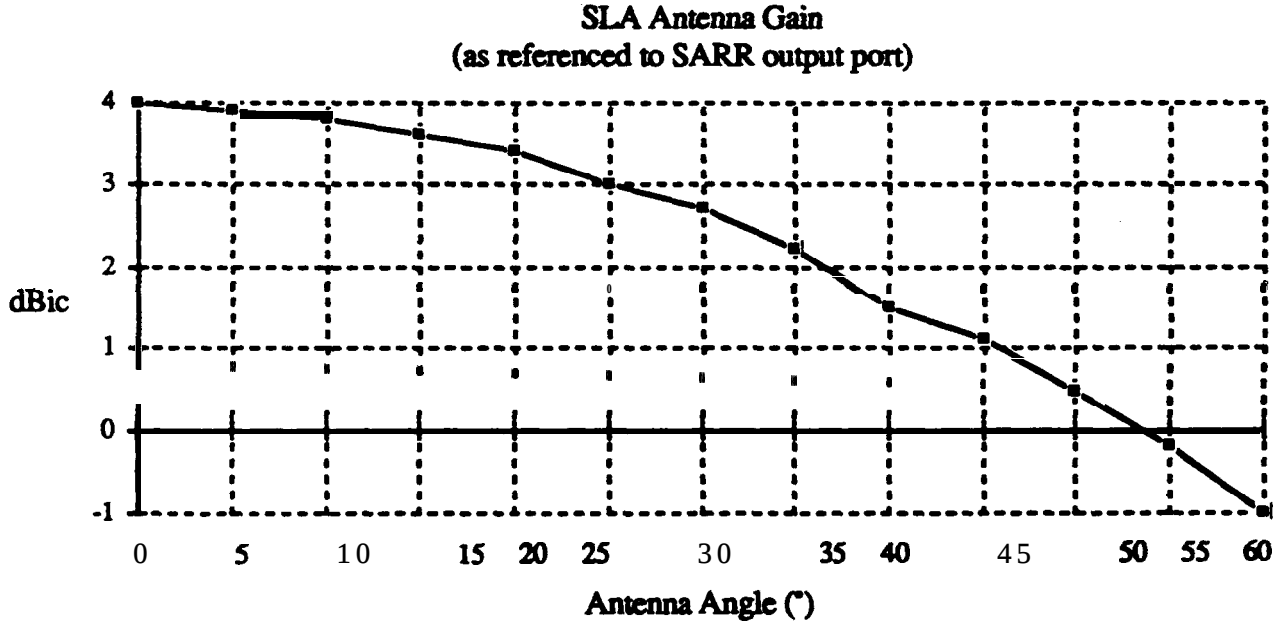
FIGURE B - 10