Cm#: FAST-TEV-072

PRELIMINARY

COMPATIBILITY TEST PLAN

FOR THE

FAST AURAL SNAPSHOT EXPLORER

(FAST)

FEBRUARY 1993

GODDARD SPACEFLIGHT CENTER

GREENBELT, MARYLAND

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1.0 GENERAL

The purpose of this test plan is to serve as a guide for the compatibility tests between the Fast Auroral Snapshot Explorer (FAST) and the Spacecraft Tracking and Data Network (STDN) station equipment. The Engineering Test Unit (ETU) test will be conducted at Goddard Space Flight Center/Building 5, Greenbelt, Maryland in October 1993. FAST spacecraft testing will be conducted in Building 5 in February 1994.

This document presents the anticipated equipment configuration to be utilized for the compatiblity tests and also lists the individual tests to be performed.

2.0 PURPOSE OF COMPATIBILITY TESTING

STDN RF Compatibility tests assure that the spacecraft tracking, telemetry and command interfaces and procedures are adequate for the intended mission requirements. In addition, spacecraft performance data and magnetic tape recordings obtained from these tests are used to prepare all participating organizations for the operational support of the spacecraft.

The specific objectives of compatibility testing are to:

A. Determine spacecraft-to-STDN tracking, telemetry and command interface compatibility.

B. Assure compliance with certain aspects of Aerospace Data System Standards (ADSS).

C. Verify interface and support equipment configuration parameters.

D. Provide all participating organizations with advance experience with the spacecraft under controlled conditions.

E. Produce magnetic tapes and other data, as applicable, for verifying the mission support requirements.

3.0 METHODS OF TESTING

NASA-GSFC document, STDN No. 408.1, STDN Spacecraft RF Compatibility Test Procedures and Data Sheets, Rev. 2, will be utilized for most of the compatibility tests. This document contains the purpose, description, method and procedural steps for the majority of the tests to be performed.

The test modes are listed in Table 1. The anticipated

compatibility tests to be performed are presented in Table 2A. Table 2B identifies the compatibility tests vs test modes.

General link characteristics are provided in Tables 3 and 4. The actual order of performing the test will be that most convenient to the test conductor and the spacecraft personnel.

4.0 EQUIPMENT CONFIGURATION

The equipment configuration for testing the FAST spacecraft shown in Figure 1. The configuration and parameters were determined by the Compatibility Test Section based on information contained in the Preliminary Compatibility Test Plan for the Fast Auroral Snapshot Explorer (FAST), dated July 1993, which was prepared by Ken Dearth of NASA/GSFC in Greenbelt, Maryland. The equipment to be utilized during the test duplicates the equipment at the STDN station.

The test van will interface with the spacecraft via coaxial cables (hard-wired) to reduce outside RF interference. The cable runs should be of minimum length to assure a signal of -70 dBm at the test van. Cables will be supplied by the test van unless special routing or extreme lengths are required.

It is requested that an extension of local telephone lines and intercom capability to the van be provided. The van has built-in local telephone, SCAMA voice (4-wire) and intercom (2-wire) equipment. Normally only the line extensions are required to complete these communication capabilities.

The test van should be located near the spacecraft area to minimize RF interface losses and to utilize van-supplied cables. The power and space requirements for the test van are as follows:

A. Physical Dimensions of the Compatibility Test Van

(1)	Highway Configuration		
	(A)	Length	45 feet
	(B)	Width	8 feet
	(C)	Height	12 feet, 6 in.
	(D)	Weight	50,000 lbs. (Approx)
	(e)	Clearance	15 inches under trailer
(2)	Required Operating Area (Figure 3)		
	(A)	With antenna ext.	57-19-22.5 ft. (L-W-H)
	(B)	No antenna	57-19-13.5 ft. (L-W-H)

B. Power requirements

(1) Utility Bus	120/208 VAC, 3-phase with neutral. 100 Amp/phase, 4 wire service
Utility Power Connection	Phases A, B, and C should be in a 1,2, and 3, sequence, respectively
(2) Technical Bus	120/208 VAC, 3-phase with neutral. 70 Amp/phase, 4 wire service
Technical Power Connection	Phases A, B, and C should be in a 1, 2, and 3 sequence, respectively
(3) Power Cables Supplied	Two 70 foot, four-conductor cables with Russel and Stoll 3138W-72 type power plug (facility may use Russell & Stoll 3134W-72 receptacle as a counterpart). In addition, 4 adapter cables (two pair) are provided, each 8 feet in length. One pair of these adapter cables have Russel and Stoll 3238W type receptacles (Compatible with 3138W plug on power cable) on one end and approximately 6 inch pigtails on the other end. The other pair of adapters have the 3238W type receptacles on one end and Crouse Hinds type APJ-10455 power plugs on the other end.

*Phase connections of power can be determined from phase lights inside the van for both utility and technical power.

(4) Ground Cable Supplied	A separate ground cable is used to connect the van Ground to the local ground plane (75 feet in length)

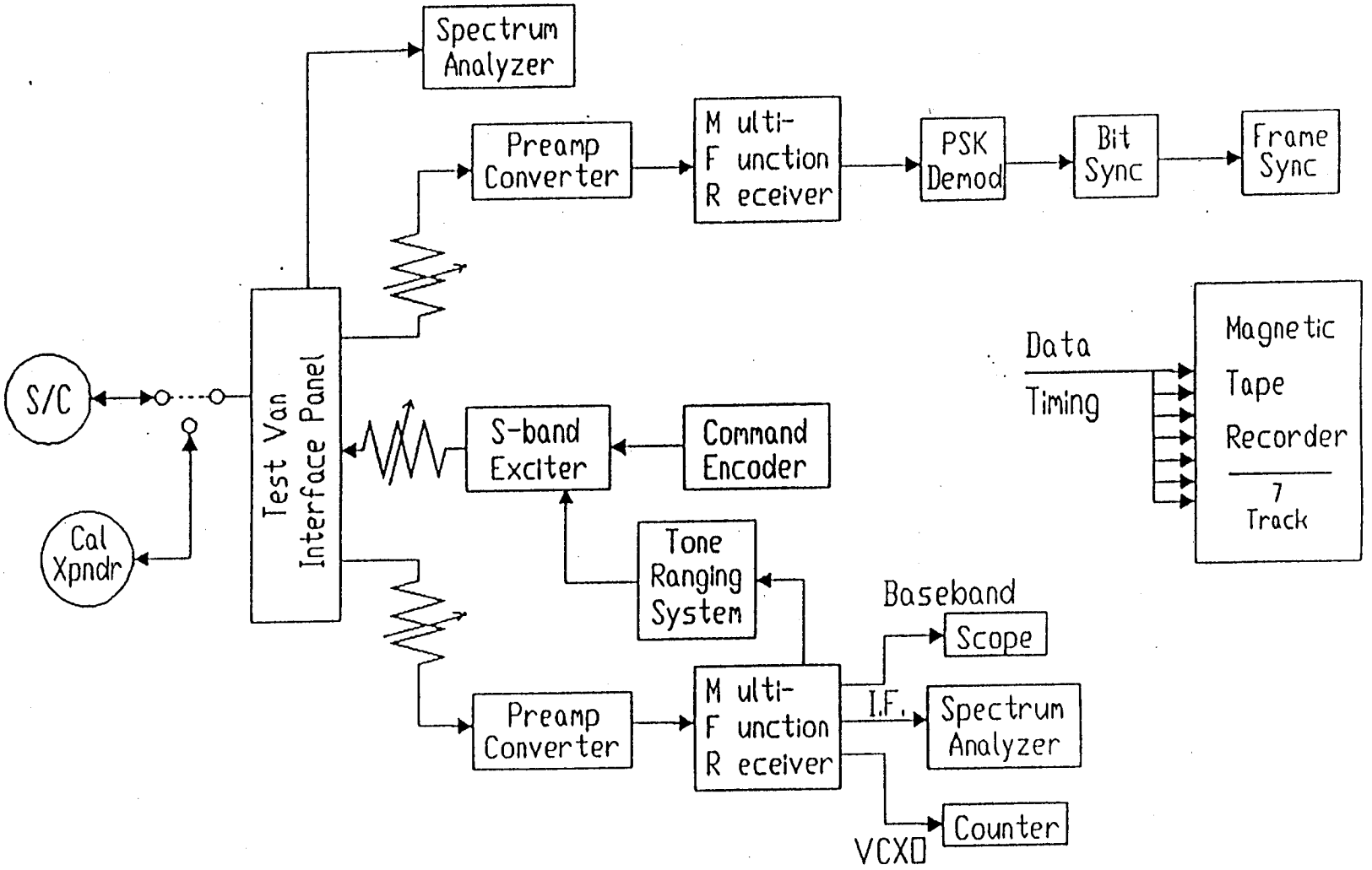

FIGURE 1. GN COMPATIBILITY TEST EQUIPMENT CONFIGURATION

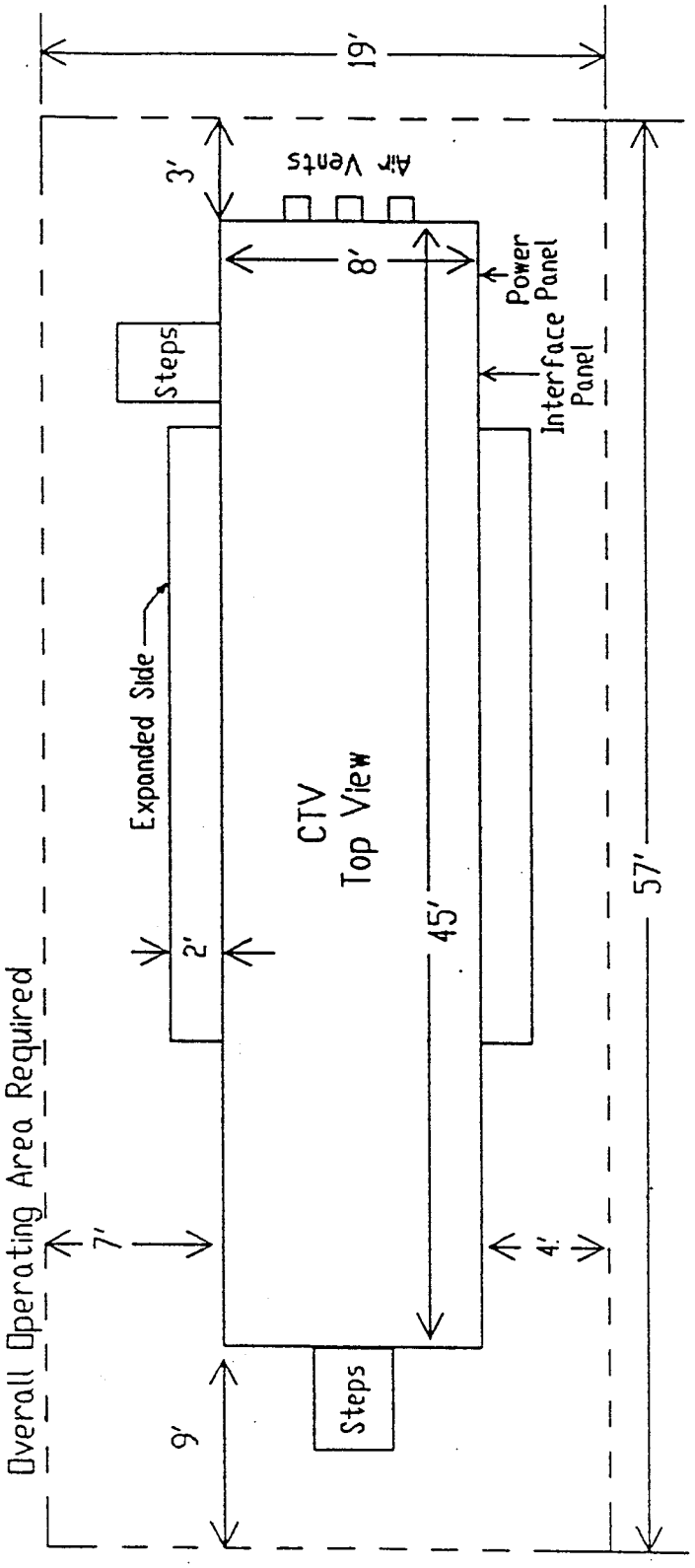

FIGURE 2. CTV OPERATING CONFIGURATION

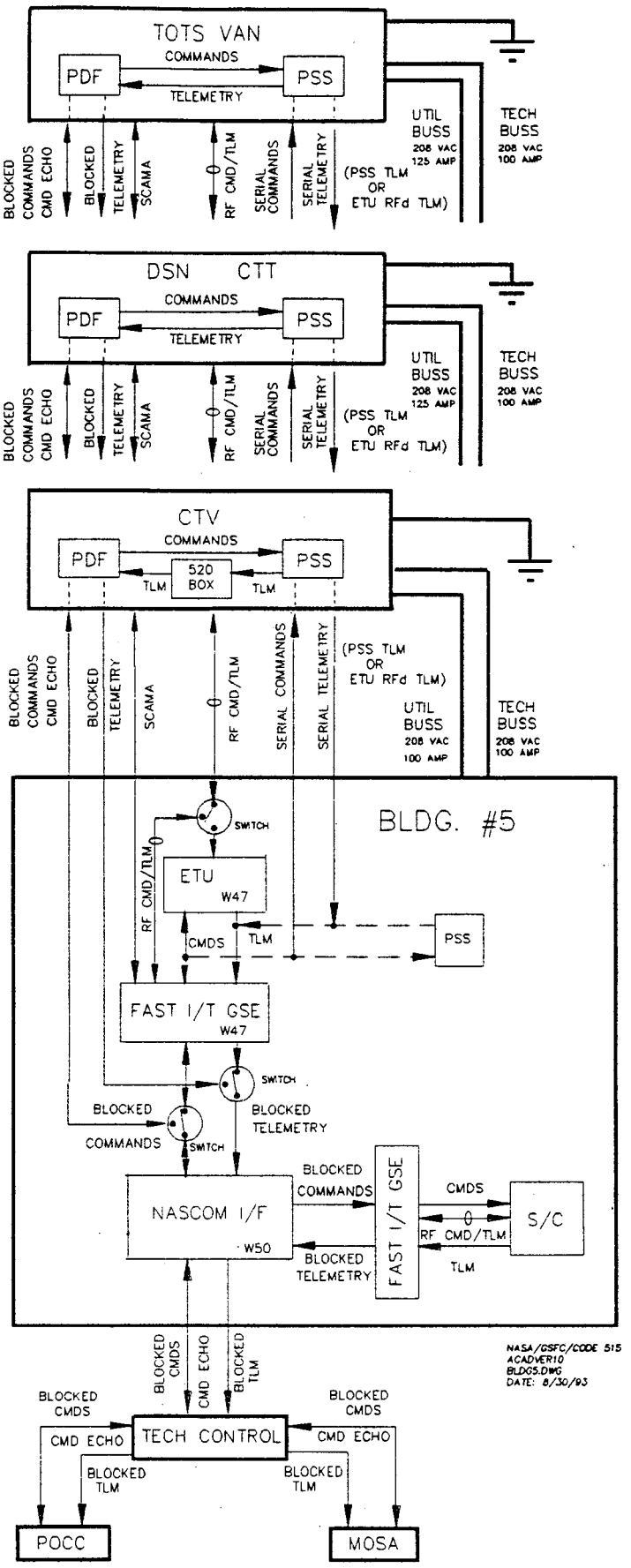
TOTS VAN
COMMANDS
PDF
PSS
TELEMETRY
UTIL BUSS
208 VAC
125 AMP
TECH BUSS
208 VAC
100 AMP
BLOCKED COMMANDS CMD ECHO
BLOCKED TELEMETRY
SCAMA
RF CMD/TLM
SERIAL COMMANDS
SERIAL TELEMETRY
(PSS TLM OR ETU RFd TLM)
DSN CTT
COMMANDS
PDF
PSS
TELEMETRY
UTIL BUSS
208 VAC
125 AMP
TECH BUSS
208 VAC
100 AMP
BLOCKED COMMANDS CMD ECHO
BLOCKED TELEMETRY
SCAMA
RF CMD/TLM
SERIAL COMMANDS
SERIAL TELEMETRY
(PSS TLM OR ETU RFd TLM)
CTV
COMMANDS
PDF
520 BOX
PSS
TLM
TLM
BLOCKED COMMANDS CMD ECHO
BLOCKED TELEMETRY
SCAMA
RF CMD/TLM
SERIAL COMMANDS
SERIAL TELEMETRY
(PSS TLM OR ETU RFd TLM)
UTIL BUSS
208 VAC
100 AMP
TECH BUSS
208 VAC
100 AMP
BLDG. #5
SWITCH
ETU
W47
RF CMD/TLM
CMDS
TLM
PSS
FAST I/T GSE
W47
SWITCH
BLOCKED COMMANDS
SWITCH
BLOCKED TELEMETRY
NASCOM I/F
W50
BLOCKED COMMANDS
BLOCKED TELEMETRY
FAST I/T GSE
CMDS
RF CMD/TLM
TLM
S/C
NASA/GSFC/CODE 515
ACADVER10
BLDG5.DWG
DATE: 8/30/93
BLOCKED CMDS
CMD ECHO
BLOCKED TLM
BLOCKED CMDS
CMD ECHO
TECH CONTROL
BLOCKED TLM
BLOCKED CMDS
CMD ECHO
BLOCKED TLM
POCC
MOSA

TABLE 1A: FAST DOWNLINK MODES OF OPERATION

Test Mode	Function	Modulation Type	Data Type	PSK Subcarrier (kHz)		Frequency (kHz) Data Rate (kbps)	Modulation Index (rad)	Carrier Suppression (db)	First Sideband to Carrier (db)	Modulation Loss (dB)
GCAL	Carrier Wave Only	None	N/A	N/A		N/A	N/A	N/A	N/A	N/A
GT-1	Real Time Telemetry	PCM(R1/2)/ Bi0-L/PM	NRZ-L	N/A		4.096	1.1	-6.87	+1.93	-1.00
GT-x	Play Back Telemetry	PCM(R1/2)/ PM	NRZ-L	N/A	(x=2)	900.000	1.1	-6.87	+1.93	-1.00
					(x=3)	1500.000				
					(x=4)	2250.000				
GR-1	Ranging	Tone /PM	SINE	N/A		100.000	0.4	-7.22	-13.80	-18.01
	Real Time Telemetry	PCM(R1/2)/ BI0-L/PM	NRZ-L	N/A		4.096	1.1		+1.93	-1.35
	Ranging (2 Tones)	Tones/PM	SINE	N/A		MJRT	0.4	-7.57	-13.80	-18.36
			SINE	N/A		MIRT	0.4		-13.80	-18.36
	Real Time Telemetry	PCM(R1/2)/ BI0-L/PM	NRZ-L	N/A		4.096	1.1		+1.93	-1.70

MJRT = Major Range Tone
MIRT = Minor Range Tone

TABLE 1A: FAST DOWNLINK MODES OF OPERATION

Test Mode	Function	Modulation Type	Data Type	PSK Subcarrier (kHz)		Frequency (kHz) Data Rate (kbps)	Modulation Index (rad)	Carrier Suppression (db)	First Sideband to Carrier (dB)	Modulation Loss (dB)
GR-x	Ranging	Tone /PM	SINE	N/A		100.000	0.4	-7.22	-13.80	-18.01
	Play Back Telemetry	PCM(R1/2)/ PM	NRZ-L	N/A	(x=2)	900.000	1.1		+1.93	-1.35
					(x=3)	1500.000				
					(x=4)	2250.000				
	Ranging (2 Tones)	Tones/PM	SINE	N/A		MJRT	0.4	-7.57	-13.80	-18.36
			SINE	N/A		MIRT	0.4		-13.80	-18.36
	Play Back Telemetry	PCM(R1/2)/ PM	NRZ-L	N/A	(x=2)	900.000	1.1		+1.93	-1.70
					(x=3)	1500.000				
					(x=4)	2250.000				
GCR-1	Ranging	Tone /PM	SINE	N/A		100.000	0.4	-7.57	-13.80	-18.36
	Command	PCM/PSK/PM	NRZ-L	16.000		2.000	0.4		-13.80	-18.36
	Real Time Telemetry	PCM(R1/2)/ BIO-L/PM	NRZ-L	N/A		4.096	1.1		+1.93	-1.70
	Ranging (2 Tones)	Tones/PM	SINE	N/A		MJRT	0.4	-7.92	-13.80	-18.71
			SINE	N/A		MIRT	0.4		-13.80	-18.71
	Command	PCM/PSK/PM	NRZ-L	16.000		2.000	0.4		-13.80	-18.71
	Real Time	PCM(R1/2)/ Telemetry	NRZ-L BIO-L/PM	N/A		4.096	1.1		+1.93	-2.05

MJRT = Major Range Tone
MIRT = Minor Range Tone

TABLE 1A: FAST DOWNLINK MODES OF OPERATION

Test Mode	Function	Modulation Type	Data Type	PSK Subcarrier (kHz)	Frequency (kHz) Data Rate (kbps)	Modulation Index (rad)	Carrier Suppression (db)	First Sideband to Carrier (dB)	Modulation Loss (dB)
GCR-x	Ranging	Tone /PM	SINE	N/A	100.000	0.4	-7.57	-13.80	-18.36
	Command	PCM/PSK/PM	NRZ-L	16.000	2.000	0.4		-13.80	-18.36
	Play Back Telemetry	PCM(R1/2)/ PM	NRZ-L	N/A (x=2)	900.000	1.1		+1.93	-1.70
				(x=3)	1500.000				
				(x=4)	2250.000				
	Ranging (2 Tones)	Tones/PM	SINE	N/A	MJRT	0.4	-7.92	-13.80	-18.71
			SINE	N/A	MIRT	0.4		-13.80	-18.71
	Command	PCM/PSK/PM	NRZ-L	16.000	2.000	0.4		-13.80	-18.71
	Play Back Telemetry	PCM(R1/2)/ PM	NRZ-L	N/A (x=2)	900.000	1.1		+1.93	-2.05
				(x=3)	1500.000				
				(x=4)	2250.000				

MJRT = Major Range Tone
MIRT = Minor Range Tone

TABLE 1B: FAST UPLINK MODES OF OPERATION

Test Mode	Function	Modulation Type	Data Type	PSK Subcarrier (kHz)	Frequency (kHz) Data Rate (kbps)	Modulation Index (rad)	Carrier Suppression (dB)	First Sideband to Carrier (dB)	Modulation Loss (dB)
GCMD	Command	PCM/PSK/PM	NRZ-L	16.000	2.000	0.5	-0.55	-11.76	-9.30
GR-x	Ranging (1 Tone)	Tone /PM	SINE	N/A	100.0	0.7	-1.10	-8.56	-6.65
	Ranging (2 Tones)	Tones/PM	SINE	N/A	MJRT	0.7	-2.20	-8.56	-7.75
			SINE	N/A	MIRT	0.7		-8.56	-7.75
GCR-x	Command + Ranging (1 Tone)	PCM/PSK/PM	NRZ-L	16.000	2.000	0.5	-1.65	-11.76	-10.40
		Tone /PM	SINE	N/A	100.0	0.7		-8.56	-7.20
	Command + Ranging (2 Tones)	PCM/PSK/PM	NRZ-L	16.000	2.000	0.5	-2.75	-11.76	-11.50
		Tones/PM	SINE	N/A	MJRT	0.7		-8.56	-8.30
			SINE	N/A	MIRT	0.7		-8.56	-8.30

MJRT = Major Range Tone
MIRT = Minor Range Tone
x = 1, 2, 3, or 4.

TABLE 2: FAST COMPATIBLITY TESTS

Calibration Tests

101	Input/Output Level Calibration
103	Ranging System Calibration
104	Spacecraft Transponder AGC vs. Uplink Power

Spacecraft Transponder Carrier Tests

211	Frequency Stability and Offset
212	Coherent Turnaround Frequency
221	Phase Stability
230	Spectrum Analysis
245	Phase Modulation Index
251	Power Output

Telemetry Tests

311	Phase-Lock Demodulator Threshold
330	PCM Conditioner Threshold
331	PCM Data Quality Analysis

Command Signal Tests

411	Command Receiver Sensitivity and Correct Commands
422	Command Desensitization
425	Command System Phase Modulation Sensitivity
431	Command Receiver Bandpass
433	Command Subcarrier Bandpass

Command Security Checks

511	Command Receiver Spurious Carrier Immunity
521	Command Response to False Address

Recordings

611	Steady-Level Magnetic Tape Recording
631	Baseband Photograph

Ranging and Acquistion Tests

701	Ranging Group Delay
702	Turnaround Index Vs. Uplink Index
703.1	Ranging Threshold
703.2	Delay Vs. Signal Level
704	Delay Vs. Simulated Doppler
705	Tone Phase Shift
706	Transponder Acquisition Threshold
707	Transponder Acquisition Rate
708T	Doppler Extractor Calibration and Verification Test

Table 2A. GN Compatibility Tests for FAST

TEST No.	TEST MODES (Gxxx)												
	GCAL	GT1	GT2	GT3	GT4	GCMD	GR1	GR2	GR3	GR4	GCR1	GCR2	GCR3	GCR4
101	Xcw													
103	X													
104	X				X		X			X				
211		Xn												
212		Xc												
221		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
230		Xc	Xc	Xc	Xc	Xt	Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
245		Xc	Xc	Xc	Xc	Xt	Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
251	Xcw													
311		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
330		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
331		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
411						Xbi					Xbi			
422						Xbi								
425						Xbi					Xbi			
433						Xbi					Xbi			
511						X					X			
521						X								
611		X	X	X	X		X	X	X	X	X	X	X	X
631		X	X	X	X		X	X	X	X	X	X	X	X
701							Xo	X	X	X	Xo	X	X	X
702							X			X	X			X
703.1							X			X	X			X
703.2							X			X	X			X
704							X			X	X			X
705							X			X	X			X
706		X			X		X			X				
707		X			X		X			X				

X = Required test.
Xbi = NCPS in burst and idle modes.
Xc = Coherent mode only.
Xcw = Carrier wave only.
Xe = Coherent and noncoherent required tests.
Xo = Telemetry on and telemetry off.
Xn = Noncoherent mode only. (For test 211, cold start).
Xt = Signal turnaround.
101, 103 tests should be done pre- and post-cal.
Number of tests = 186.

Table 2B. GN TOTS Compatibility Tests for FAST*

TEST No.	TEST MODES (Gxxx)												
	GCAL	GT1	GT2	GT3	GT4	GCMD	GR1	GR2	GR3	GR4	GCR1	GCR2	GCR3	GCR4
101	Xcw													
103T	X													
221T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
311T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
330T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
331T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
411T						X					X			
422T						X								
425T						X					X			
433T						X					X			
511T						X					X			
521T						X								
611T		X	X	X	X		X	X	X	X	X	X	X	X
631		X	X	X	X		X	X	X	X	X	X	X	X
701T							Xo	X	X	X	Xo	X	X	X
706T		X			X		X			X				
707T		X			X		X			X				
708T							X			X	X			X

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*This matrix assumes GN compatibility testing was done first.
T = TOTS test procedure.
101, 103 tests should be done pre- and post-cal.
Number of tests = 132.

X = Required test.
Xc = Coherent mode only.
Xcw = Carrier wave only.
Xe = Coherent and noncoherent required tests.
Xo = Telemetry on and telemetry off.
Xn = Noncoherent mode only. (For test 211, cold start).
Xt = Signal turnaround.

Table 2B. GN TOTS Compatibility Tests for FAST

TEST No.	TEST MODES (Gxxx)												
	GCAL	GT1	GT2	GT3	GT4	GCMD	GR1	GR2	GR3	GR4	GCR1	GCR2	GCR3	GCR4
101	Xcw													
103T	X													
104T*	X				X		X			X				
211T*		Xn												
212T*		Xc												
221T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
230T*		Xc	Xc	Xc	Xc	Xt	Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
245T*		Xc	Xc	Xc	Xc	Xt	Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
251T*	Xcw													
311T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
330T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
331T		Xc	Xc	Xc	Xc		Xc	Xc	Xc	Xc	Xe	Xe	Xe	Xe
411T						Xbi					Xbi			
422T						Xbi								
425T						Xbi					Xbi			
433T						Xbi					Xbi			
511T						X					X			
521T						X								
611T		X	X	X	X		X	X	X	X	X	X	X	X
631		X	X	X	X		X	X	X	X	X	X	X	X
701T							Xo	X	X	X	Xo	X	X	X
702T							X			X	X			X
706T		X			X		X			X				
707T		X			X		X			X				
708T		X			X		X			X				

*These tests should be performed if the GN compatibility testing was not done first. Number of tests = 170.
101, 103 tests should be done pre- and post-cal.

T = TOTS test procedure.
X = Required test.
Xbi = NCPS in burst and idle modes.
Xc = Coherent mode only.
Xcw = Carrier wave only.
Xe = Coherent and noncoherent required tests.
Xo = Telemetry on and telemetry off.
Xn = Noncoherent mode only. (For test 211, cold start).
Xt = Signal turnaround.

Table 2C. GN ETU Tests for FAST

TEST MODES (Gxxx)

TEST No.	GCAL	GT1	GT2	GT3	GT4	GCMD	GR1	GR2	GR3	GR4	GCR1	GCR2	GCR3	GCR4
101	X													
103	X													
230		X	X	X	X		X	O	O	O	X	O	O	O
245		X	X	X	X		X	O	O	X	X	O	O	X
251	X													
331		X	X	X	X		X	O	O	X	X	O	O	X
411						X*								
611		X	X	X	X	X	X				O			
701							X			X	X			X
706							X							
707							X							

O = Optional test.
X = Required test.
Number of tests = 52 (37 required).

*Only the Command Threshold portion of this test will be performed.

Note: Where possible, JPL will perform 4 kb & 900 kb telemetry tests, and CTV will perform 1.5 Mb & 2.25 Mb tests.

TABLE 3: FAST DOWNLINK SIGNAL CHARACTERISTICS

Carrier Frequency:	2215.0 MHz
Transmitter Power:	5.0 Watts (36.99 dBm)
RANGING (turnaround)	
Bandwidth:	10.0 MHz
Modulation:	Sine Wave
Major Tone:	100.0 kHz
Mod. Index, Major Tone:	0.4 radian
Mod. Index, Major Tone: + Minor Tone:	0.4 radian 0.4 radian
TELEMETRY	
Bandwidth:	10.0 MHz
Modulation, 4.096 kpbs:	NRZ-L / R(1/2) / BI0-L / PM
Modulation, 900 kbps, 1.5 Mbps, 2.25 Mbps:	NRZ-L / R1/2 / PM
Convolutional Coding:	K = 7, R = 1/2 G1 = 1111001 G2 = 1011011 (inverted)
Phase Mod. Index:	1.1 radian
CCSDS Transfer Frame	
Bits / Transfer Frame	8608
Bytes / Transfer Frame	1076
Bit Format	NRZ-L
Transfer Frame Sync Pattern	1ACFFC1D (HEX)
Frame Sync Word Length	32 bits

TELEMETRY (Con'd)

TAPE RECORDER

Model: Kodak Datatape 3700J

Data Rate (kbps)	Symbol Rate (kbps)	Tape Speed (ips)
4.096	8.192	7 1/2
900.000	1800.000	120
1500.000	3000.000	120
2250.000	4500.000	240

Track	Amplifier	Contents	From
1	Direct	Commands	NCPS
2	Direct	Internal Reference	
3	Direct	Convolutionally Encoded Data	MFR Video
4	Direct	Viterbi Decoded Data	Viterbi
5	Direct	Reconditioned Coded Data	Bit Sync
6	FM	Reconditioned Decoded Real Time Data (4 kpbs only)	Bit Sync
7	FM	BCDT/ 1 kHz	Timing

TABLE 4: FAST UPLINK SIGNAL CHARACTERISTICS

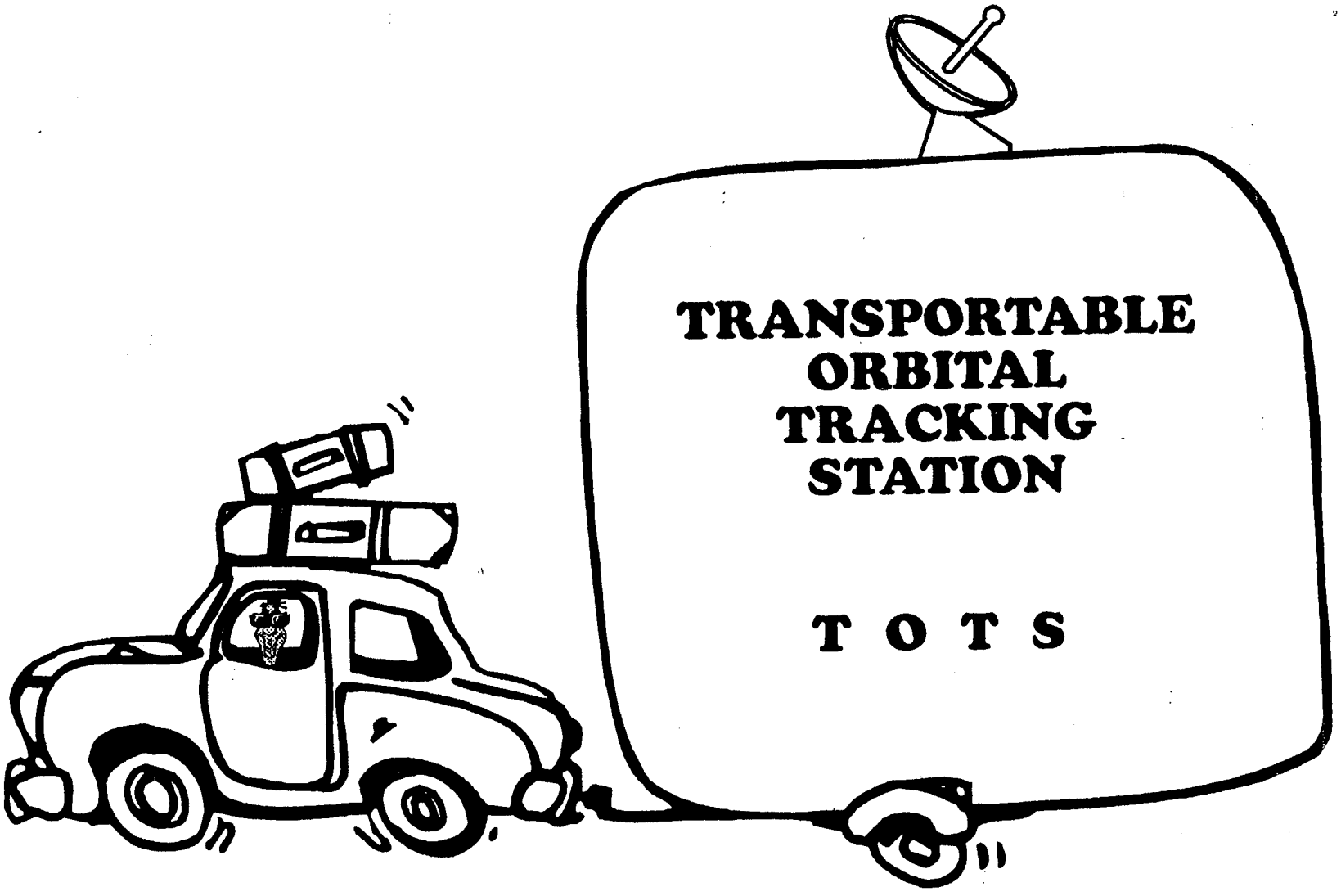
Uplink Frequency:	2039.645833 MHz
Dynamic Range:	-50 dBm to -137* dBm
COMMAND	
Bandwidth:	2.0 MHz
PCM Format:	NRZ-L
Modulation:	PCM(NRZ-L)/BPSK/PM
Modulation Index:	0.5 radian
PSK Subcarrier:	16.000 kHz
Command Bit Rate:	2000 bps
Command Link Transfer Unit (CLTU)	
CLTU Start Sequence:	EB90 (HEX)
Bits / Codeblock:	64
Bits / CLTU:	Less than 4600 (575 bytes) (132 acquisition sequence, 16 CLTU start sequence, + 64 tail sequence) & 64 bits/command code block
Transfer Frames / CLTU:	1 to 19
Bytes / Transfer Frame:	6 to 256
Spacecraft ID:	0010110011 (179 (base 10))
ACQUISITION	
Sweep Rate (CW):	25.0 kHz/sec*
Sweep Range:	± 120 kHz
Acquistion Threshold:	-137 dBm*

*Per DSN ETU testing in October, 1993.

TABLE 4: FAST UPLINK SIGNAL CHARACTERISTICS

RANGING

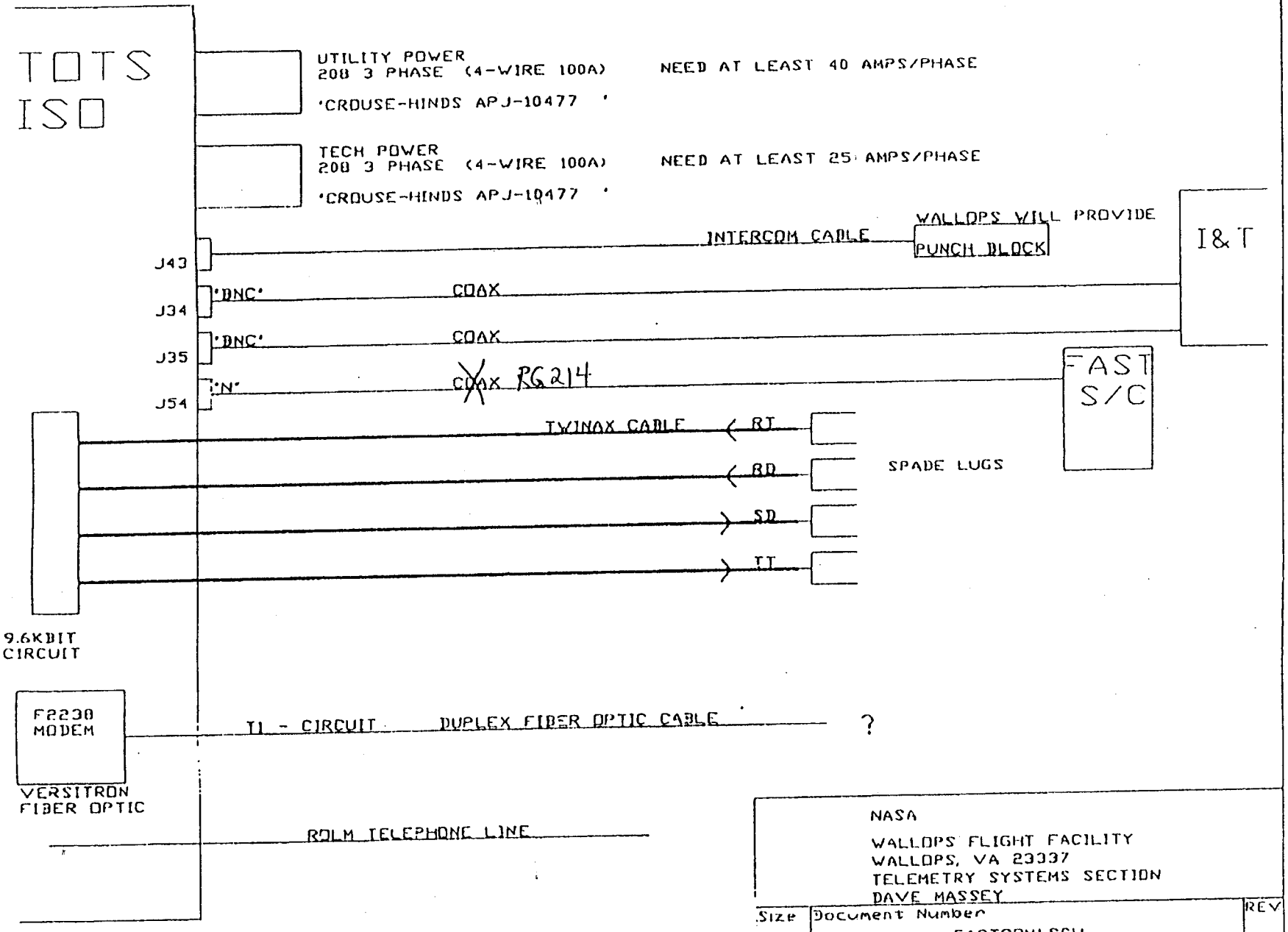
Bandwidth:	2.0 MHz
Modulation:	Tone/PM
Major Tone:	100.0 kHz
Mod. Index, Major Tone:	0.7 radian
Mod. Index, Major Tone: + Minor Tone:	0.7 radian


TRANSPORTABLE
ORBITAL
TRACKING
STATION
T O T S

TOTS COMPATABILITY EQUIPMENT

	EIA Height	Depth
1. Scientific-Atlanta 930 RCVR	7"	22"
2. Scientific-Atlanta 934 Combiner	7"	22"
3. DSI 7710 Bit Sync	5.25"	21"
4. CCSDS Front End	21"	19"
5. Doppler Carrier Measurement System (CDMS)	10.5"	23"
6. Tracking Data Formatter	7"	23"
7. Command Processing System (TCPS)	7"	19"
8. GDP PSK Modulator	3.5"	18"
9. HP 8780A Vector Signal Gen	7"	23"
10. Barker Code Time Capture Unit	1.75"	12"
11. GPS Receiver/Clock	5.25"	20"
12. TTL to RS422 Converter	3.5"	18"
13. GDP Block Error Detector	8.75"	18"
14. Keyboard and Monitor for TCPS (TCPS computer can also be used to control HP8780A sweep acquisition)	1.75" (Keyboard) 17" (Monitor)	17"

FAST/TOTS CONTAINER INTERFACE

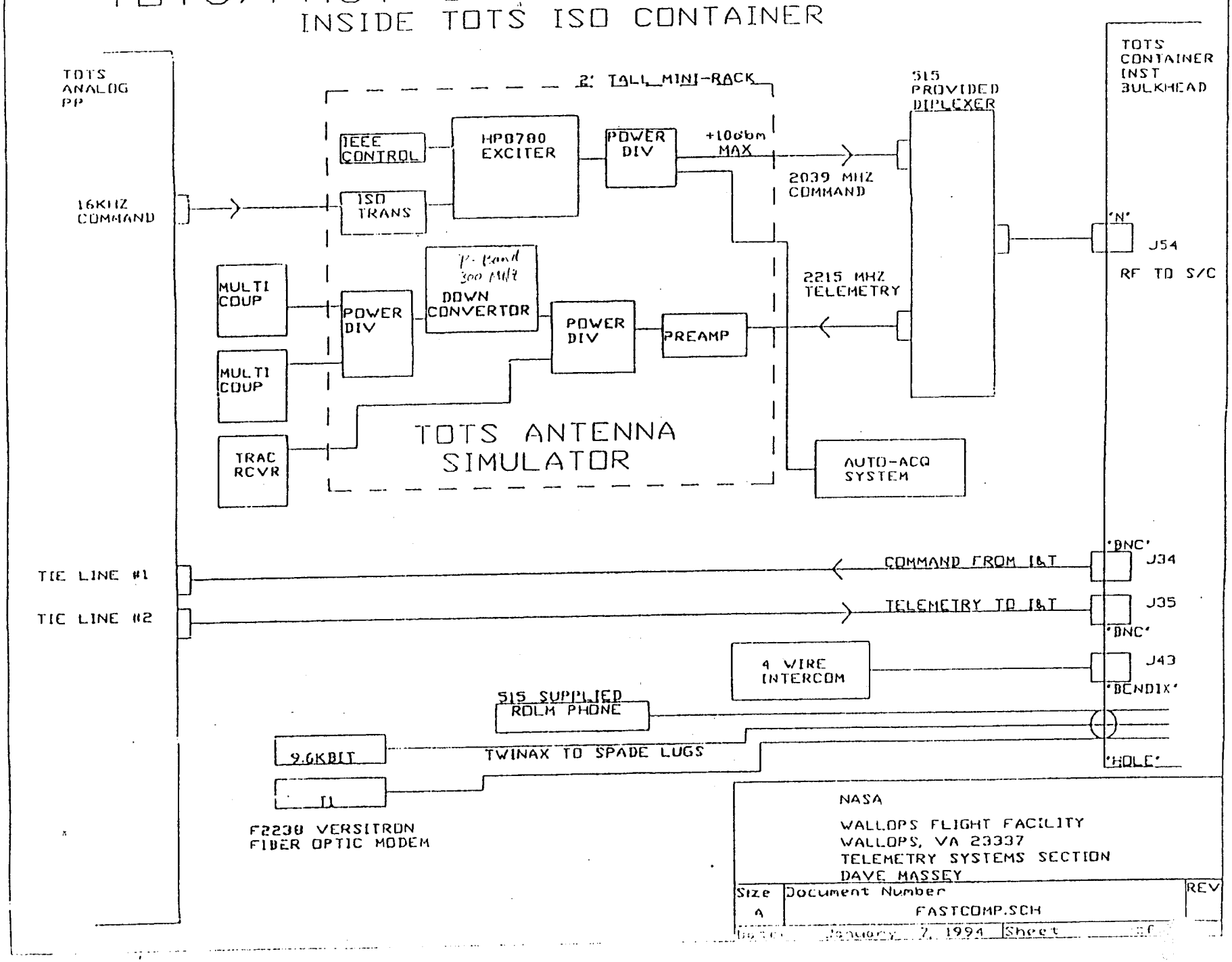


NASA
WALLOPS FLIGHT FACILITY
WALLOPS, VA 23337
TELEMETRY SYSTEMS SECTION
DAVE MASSEY

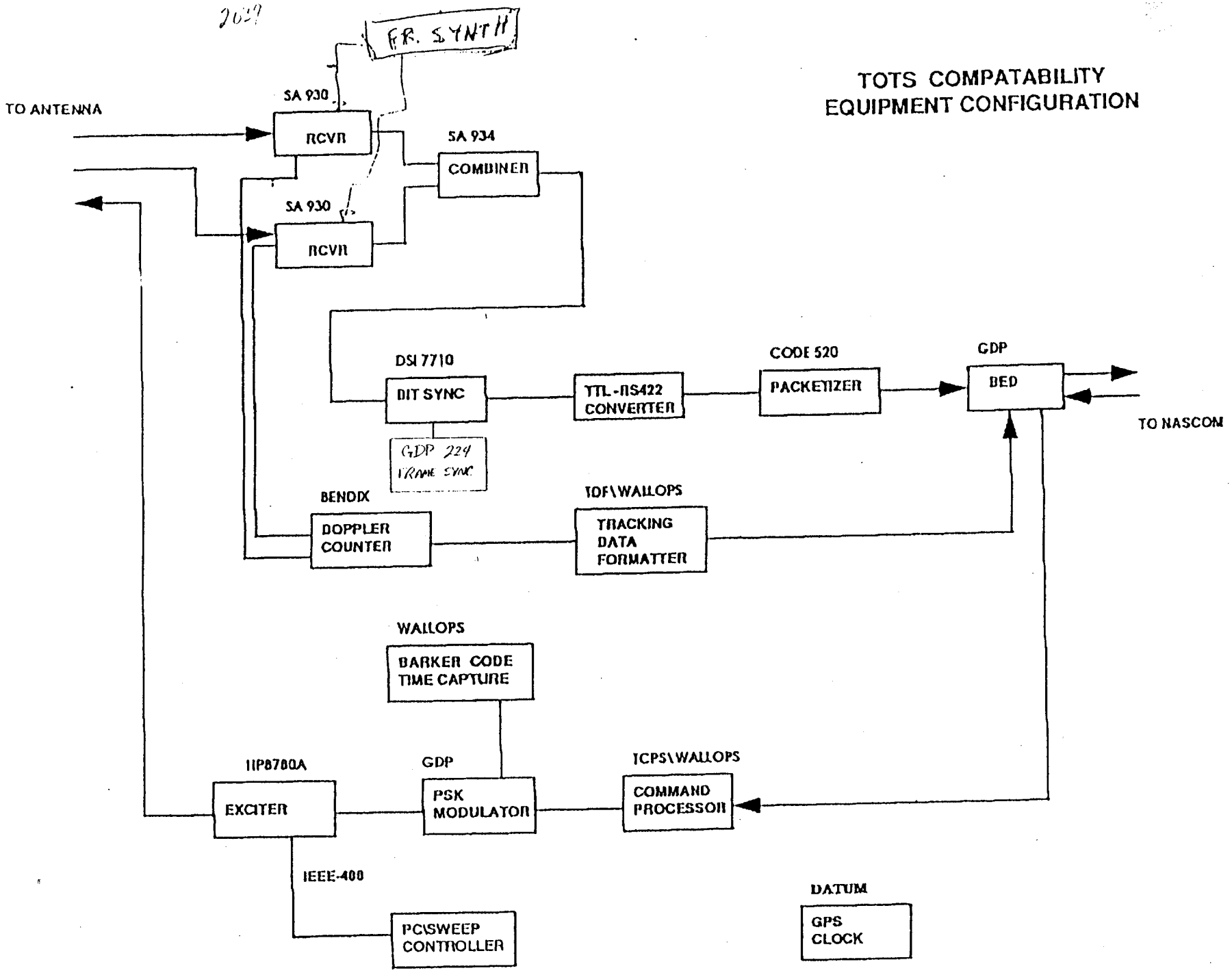
Size	Document Number	REV
A	FASTCOMI.SCH	

Date: JANUARY 7, 1994 Sheet

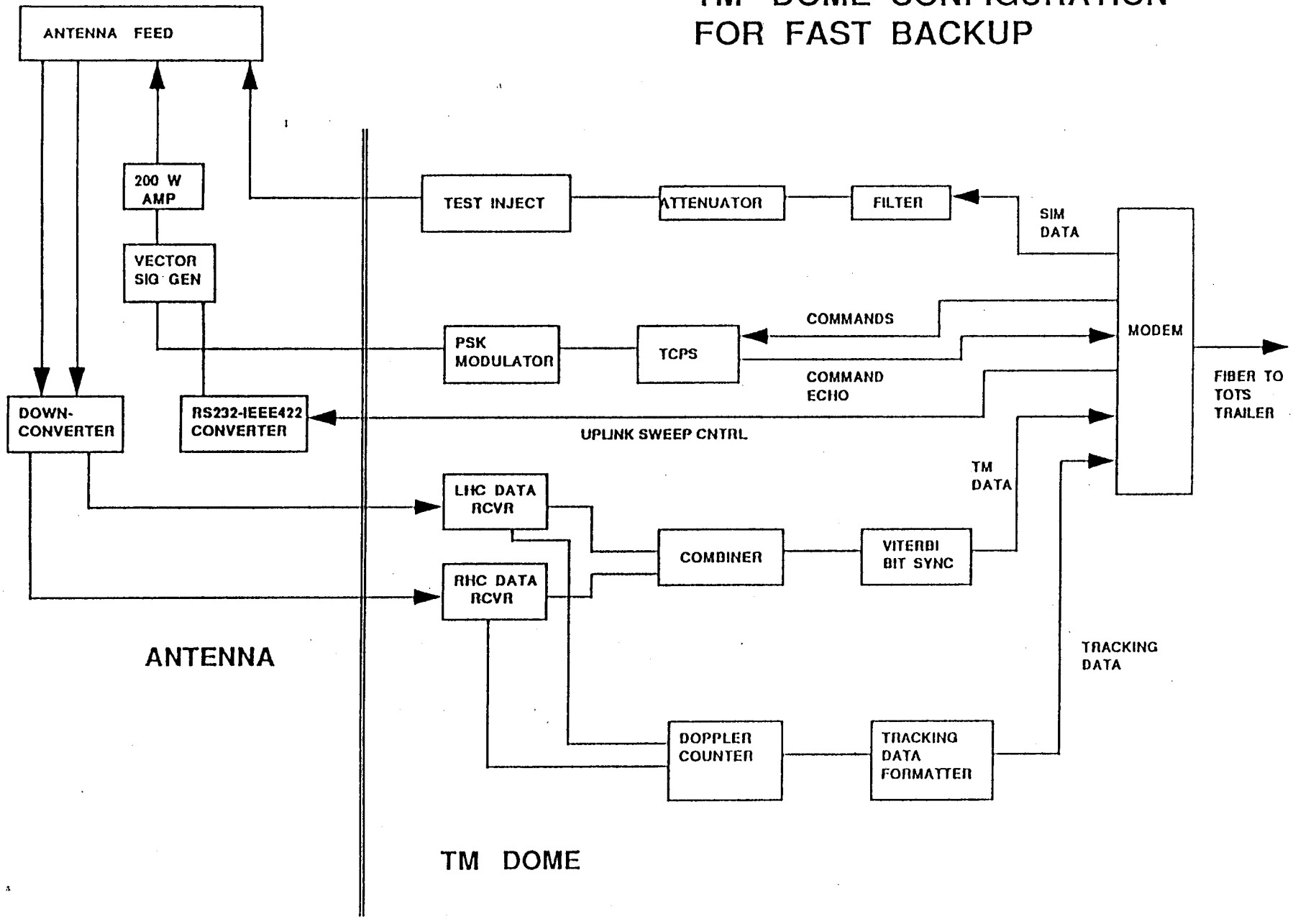
TOTS/FAST COMPATIBILITY TESTS
INSIDE TOTS ISO CONTAINER



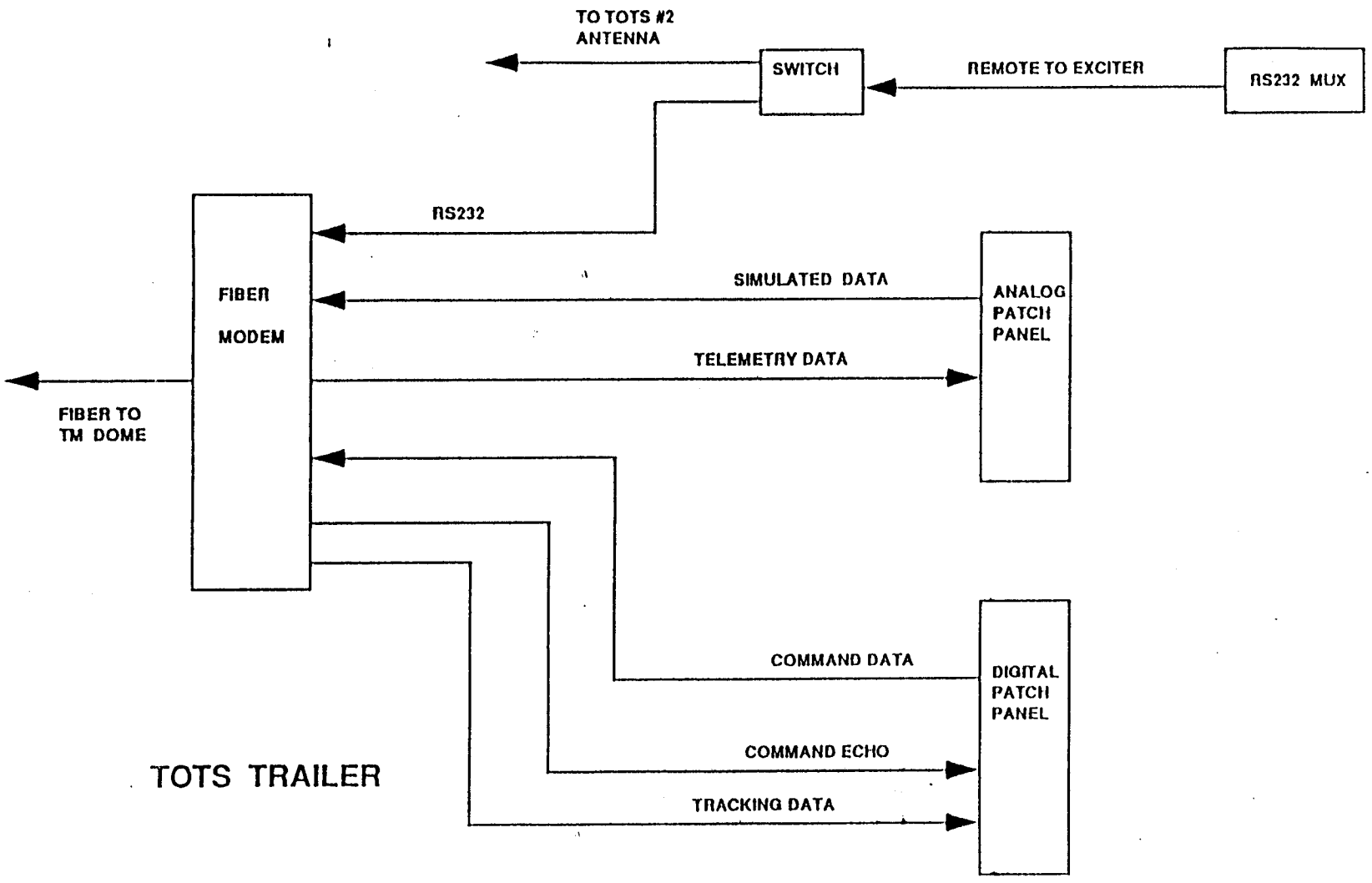
TOTS COMPATABILITY EQUIPMENT CONFIGURATION



TM DOME CONFIGURATION FOR FAST BACKUP



PFRR TOTS INTERFACE TO TM DOME



NASCOM CIRCUITS REQUIRED

ONLY 2-9.6 KBPS

- One 9.6 Kbit full duplex for command/echo line switched into the CP
- One 9.6 Kbit full duplex for tracking data/ephemeris data line switched into the CP
- One 9.6 Kbit full duplex command generate circuit from PFSOC to CMS/GSFC
- ~~One~~ TWO voice grade circuit to the POCC
- ~~One~~ TWO T1 or higher for data circuit switched to GSFC/POCC/
- Backup circuits TBD

Table of Contents

Table of Figures

Section 1
Introduction

1.1 Purpose

This document defines the detailed procedures for the Small Explorer (SMEX) Fast Auroral Snapshot Explorer (FAST)/DSN compatibility tests as established in the FAST Compatibility Test Plan. The primary objective of these tests is to confirm FAST/DSN RF telecommunications system interface compatibility.

1.2 Scope

Compatibility testing is defined as verification of ground telecommunications and spacecraft system interfaces. Compatibility tests assure that flight and ground systems tracking, telemetry and command parameters, equipment configuration and operational procedures can adequately satisfy intended mission requirements. In addition, spacecraft performance data obtained are used to prepare the flight project and DSN for support of the flight mission.

1.3 Applicable Documents

The following documents are considered applicable to the extent utilized in the procedures:

(1) FAST/DSN RF Compatibility Test Plan

1.4 Reference Documents

(1) JPL 810-8 DSN Compatibility Test Design Handbook

1.5 Precautions

Receiver specifications require operation over input levels of -50 dBm to threshold, and NO DAMAGE BY UPLINK CARRIER LEVELS UP TO TBD dBm. The test configuration should limit receiver input levels to -50 dBm maximum.

1.6 Test Configuration

The FAST project equiment configuration includes the FAST Engineering Test Unit (ETU), supported by the FAST Integration and Test (I&T) Ground Support Equipment (GSE). FAST will be located in Building 5 at the Goddard Space Flight Center. The DSN equipment configuration consists of the DSN Compatibility Test Trailer, which will be located adjacent to Building 5. The RF interface will be via coaxial connection.

The CTT equipment is functionally similar to the DSN 26 meter stations except for its higher effective system temperature. The essential characteristics of the CTT equipment are:

(1) S-band system noise temperature 400 degrees Kelvin.

(2) Test configuration is shown in Figure 1-1.

1.7 Test Sequence

1.7.1 Day 1

Test Number	Test Time	Operation
	1 Hour	Equipment Warmup and Test Briefing
RF1	1.5 Hours	Carrier Threshold, AGC Calibration
RF7	1.5 Hours	D/L Receiver Threshold

1.7.2 Day 2

Test Number	Test Time	Operation
	1 Hour	Equipment Warmup and Test Briefing
TLM2	7 Hours	Telemetry Performance

1.7.3 Day 3

Test Number	Test Time	Operation
	1 Hour	Equipment Warmup and Test Briefing
CMD1	6 Hours	Command Performance

Post-test critique, summary report

1.8 Support Test Equipment Requirements

1.8.1 Support test equipment for FAST

none

1.8.2 Support test equipment for CTT

(1) Spectrum Analyzer - Model HP 8566B

(2) Power Meter - Model HP 436A

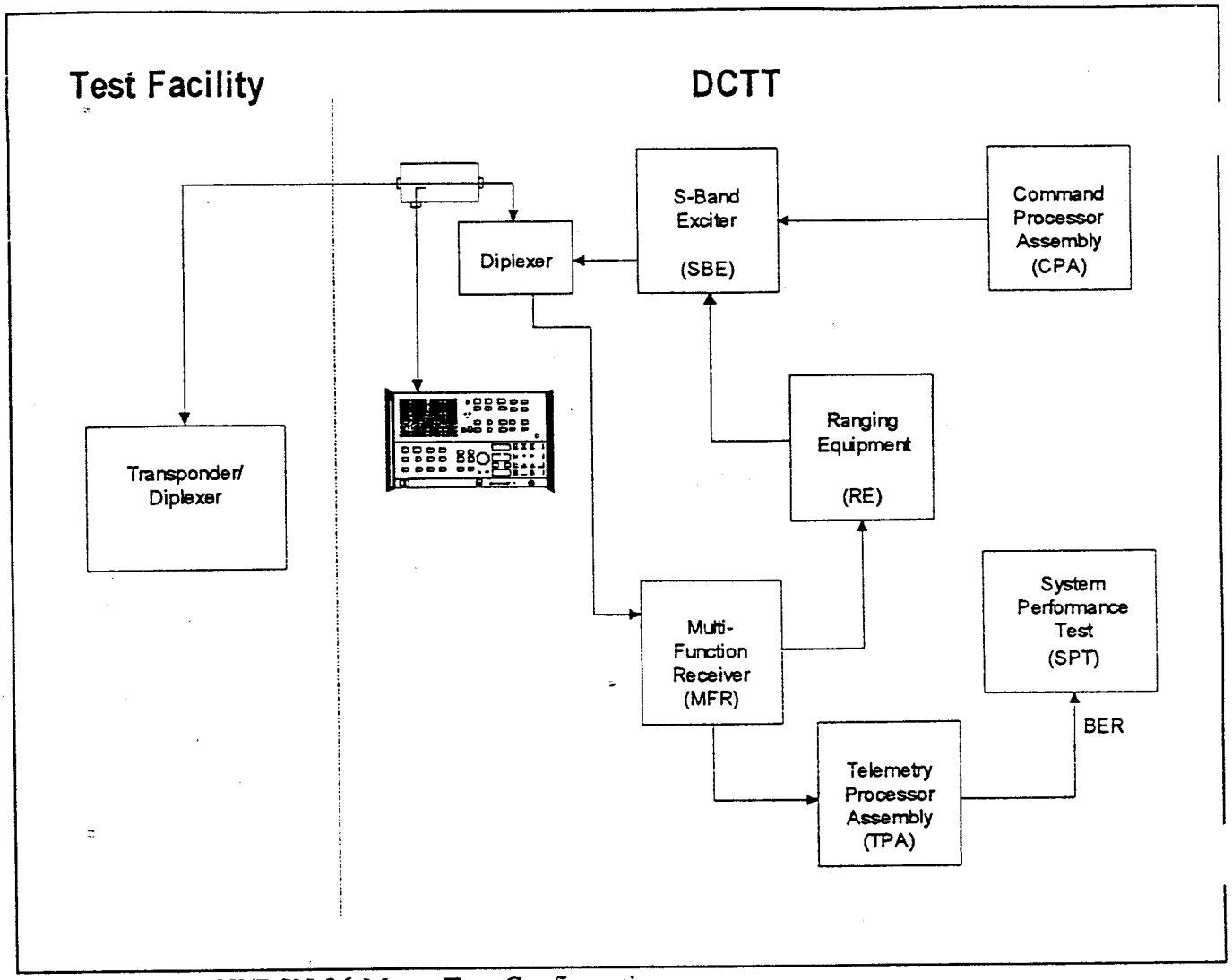


Figure 1-1 FAST/DSN 26 Meter Test Configuration

Section 2
Compatibility Tests

2.1 RF1 - Uplink Receiver Threshold and AGC Calibration

Step	Operation
1	Configure project and DSN equipment per attached table.
2	Tune exciter to the table-specified frequency.
3	Adjust the uplink power per test data sheet using the uplink RF attenuators.
4	Turn the exciter on. Acquire the uplink receiver, ramping the exciter if required.
5	Record the uplink receiver AGC voltage on the test data sheet.[1]
6	Reduce the uplink power per table, holding at each point until the uplink receiver AGC voltage is reported. Continue until the uplink receiver drops phase lock. Record the AGC voltage at each point and threshold point on the test data sheet.
7	Turn exciter off.
8	Reconfigure per table and repeat steps 2 - 7 for each test condition.

[1]AGC calibration may be deleted if not applicable.

TABLE

RF1 - Uplink Receiver Threshold and AGC Calibration

Project: FAST

Uplink nominal frequency (MHz): 2039.645833
Expected receiver threshold (dBm): -118
Maximum uplink power (dBm): -50 dBm

Test No.	Uplink MI (rad)		Downlink MI (rad)			Remarks
	CMD	RNG	CMD	RNG	TLM	
RF1-1	0.5	0.7	0.3	0.35	1.0 (4 kb/s)	U/L = channel center frequency
RF1-2	0.5	0.7	0.3	0.35	1.0 (4 kb/s)	U/L = center frequency + 120 kHz
RF1-3	0.5	0.7	0.3	0.35	1.0 (4 kb/s)	U/L = center frequency - 120 kHz

TEST DATA SHEET

RF1 - Uplink Receiver Threshold and AGC Calibration

Project: FAST

Test date: 10/6/93
Test number: RF1-1

Uplink P_c (dBm)	RCV AGC (volts)	Remarks
-70	-5.77	
-80	-5.92	
-90	-5.91	
-100	-6.08	
-110	-6.26	
-115	-6.48	
-120	-6.61	
-121	-6.74	
-122	-6.78	
-123	-6.82	
-124	-6.86	
-125	-6.89	
-126	-6.91	
-127	-6.98	
-128	-7.02	
-129	-7.09	
-130	-7.14	
-131	-7.22	
-132	-7.28	
-133	-7.37	
-134	-7.69	
-135	drop lock	

TEST DATA SHEET

RF1 - Uplink Receiver Threshold and AGC Calibration

Project: FAST

Test date: 10/6/93
Test number: RF1-2

Uplink P_c (dBm)	RCV AGC (volts)	Remarks
-137	drop lock	drop-lock point verification only

Test date: 10/6/93
Test number: RF1-3

Uplink P_c (dBm)	RCV AGC (volts)	Remarks
-137	drop lock	drop-lock verification only

2.2 *RF7 - Ground Receiver Threshold Test*

Step	Operation
1	Configure project and DSN equipment per attached table.
2	If one way test, go to step 6.
3	Turn exciter on ramp if necessary to acquire receiver.
4	Verify uplink power with spacecraft and record value on the test data sheet.
5	Turn uplink modulation on, as required.
6	Acquire downlink carrier.
7	Adjust downlink signal level per table.
8	Record downlink frequency, and signal level on the test data sheet.
9	Adjust downlink signal level to value 5 dB above expected threshold.
10	Decrease downlink signal by adjusting the RF attenuator 1 dB per minute until the ground receiver loses carrier phase lock.
11	Record threshold value on the test data sheet.
12	Repeat test for all elements of table.

TABLE

RF7 - Ground Receiver Threshold Test

Project: FAST

Uplink nominal frequency (MHz): 2039.645833
Maximum uplink power (dBm): -50
Downlink nominal frequency (MHz): 2215.0000
DSN Receiver (26m) $2B_{Lo}$ (Hz): 200

Test No.	Uplink			Downlink	
	P_C (dBm)	CMD	RNG	TLM Rate (b/s)	RNG
RF7-1	n/a	n/a	n/a	4k	off

TEST DATA SHEET

Test date: 10/6/93

Test No.	Threshold (dBm)		Remarks
	Expected	Tested	
RF7-1	-149	-147	

2.3 *RNG1 - Station Range Delay Calibration*

Step	Operation
1	Configure zero delay device (ZDD) and DSN equipment per attached table.
2	When using crystal as ZDD, go to step 7.
3	Measure total delay using a crystal detector at a strong signal level.
4	Insert the ZDD in place of the crystal and measure the range delay.
5	Difference the two measurements and convert range units (RU) to nanoseconds (ns).
6	Record the difference (ZDD calibration) on the test data sheet.
7	Insert the ZDD in place of the transponder under test.
	The zero delay device must be connected to the same interface point as the transponder under test for valid path range delay calibration.
8	Using test conditions per table, perform the path range delay calibrations.
9	Take the average of 10 or more range acquisitions and convert RU to ns. Record results on the test data sheet.

TABLE

RNG1 - Station Range Delay Calibration

Project: FAST

Uplink nominal frequency (MHz): 2039.645833
RE major range tone (kHz): 100
DSN receiver $2B_{Lo}$ (Hz): 200 (LBW=100)

Test No.	Upllink MI (rad)		Carrier P_T (dBm)		Remarks
	CMD	RNG	U/L	D/L	
RNG1-1		0.7	-50	-90	

TEST DATA SHEET

Test date: 10/7/93
ZDD calibration (ns): 0

Test No.	Total Range Delay		Range SNR		Remarks
	Avg. (ns)	std. dev. (ns)	Avg. (dB)	std. dev.	
RNG1-1	13666	n/a	n/a	n/a	station delay = total delay in ns - ZDD calibration

2.4 *RNG2 - Transponder Range Delay*

Step	Operation
1	Configure project and DSN equipment per attached table.
2	Set exciter frequency per table.
3	Set uplink power per table.
4	Turn exciter on.
5	Acquire uplink receiver.
6	Acquire downlink carrier.
7	Adjust downlink signal level per table.
8	Turn range modulation on.
9	Set uplink range modulation carrier suppression per table.
10	Measure and record downlink range carrier suppression on the test data sheet.
11	Perform range delay measurements per attached table.
12	Verify ranging turn-around polarity and record results on the test data sheet.
13	Take the average of 10 range acquisitions, convert RU to ns, and record results on the test data sheet.
14	Repeat range delay measurements for each element of table.

TABLE

RNG2 - Transponder Range Delay

Project: FAST

Uplink nominal frequency (MHz): 2039.645833
RE major tone (kHz): 100
DSN receiver $2B_{Lo}$ (Hz): 200 (LBW=100)

Test No.	RNG MI (rad)	Carrier P_T (dBm)		Remarks
		U/L	D/L	
RNG2-1	0.7	-80	-90	D/L TLM 4 kb/s, U/L CMD = OFF

TEST DATA SHEET

RNG2 - Transponder Range Delay

Project: FAST

Test date: 10/7/93
Range polarity: normal

Test No.	Total Range Delay		Remarks
	Avg. (ns)	std. dev.	
RNG2-1	14416	n/a	14416-13666 = 750 ns transponder delay

2.5 *TLM2 - Telemetry Performance*

Step	Operation
1	Configure project and DSN equipment per attached table.
2	If one way mode, go to step 8.
3	Set uplink power per table.
4	Tune exciter to best lock frequency.
5	Turn exciter on, ramp if necessary to acquire uplink receiver.
6	Verify uplink power level.
7	Turn uplink modulation on, if required.
8	Acquire downlink carrier.
9	Calculate Y-factor using appropriate modulation index values.
10	Configure the DSN telemetry subsystem per table.
11	Verify telemetry system operation and data flow.
12	To adjust downlink power for Y-factor, follow steps 13 - 20.
13	Turn spacecraft telemetry off.
14	Remove downlink carrier from ground receiver input.
15	Measure noise reference level, add Y-factor.
16	Turn carrier on.
17	Lock ground receiver to downlink carrier.
18	Adjust downlink power level for the Y-factor setting from step 15.
19	Turn telemetry subcarrier and data on.
20	Record test results on data sheet.
21	Repeat test for all elements from table.

TABLE

TLM2 - Telemetry Performance

Project: FAST

Uplink nominal frequency (MHz): 2039.645833
Uplink power (dBm): -50
Downlink nominal frequency (MHz): 2215.0000
DSN Receiver $2B_{Lo}$ (Hz): 200 (LBW=100)

Test No.	Uplink			Downlink		BSNR in (Y-factor)/BSNR out (from bit-error-rate, dB)		
	Coh	RNG	CMD	TLM Rate (b/s)	RNG	Point 1	Point 2	Point 3
TLM2-1				4 k		5.0/1.6	only one point taken	
TLM2-2				900 k		3.0/2.5	4.0/3.4	5.0/4.3
TLM2-3	*	*	*	900 k	*	5.0/1.9	6.0/2.7	7.0/3.5
TLM2-4	*	*	*	4 k	*	6.0/0.7	6.5/1.4	7.0/1.5
TLM2-5				900 k		5.0/2.3	6.0/3.2	7.0/4.1
TLM2-6				4 k		6.0/0.7	6.5/1.3	7.0/2.1

note: TLM2-1 and 2-2 used Demodulator Synchronizer Assembly (DSA) for performance comparison; all other tests used Aydin Model 335 Bit Synchronizer.

System 34
Receiver
Demod Loss

DSN → 50 MHz IF measure Power
10 kHz crystal

2.6 *CMD1 - Command Performance Test*

Step	Operation
1	Configure project and DSN equipment per attached table.
2	Set the uplink power to value from table.
3	Turn exciter for uplink receiver best lock frequency.
4	Turn exciter on, ramp if necessary to acquire uplink receiver.
5	Adjust the uplink power per table.
6	Verify the uplink power level.
7	Transmit ten test commands.
8	Record number of commands received on data sheet.
9	If all commands transmitted were received, reduce uplink power by one dB and repeat step 8 until the number of commands received is less than the number of commands transmitted.
10	Repeat steps 5 - 9 for each row of the table.

TABLE

CMD1 - Command Performance Test

Project: FAST

Test No.	Uplink			Downlink	
	P_T (dBm)	CMD	RNG	TLM Rate (b/s)	RNG
CMD1-1	-115	*	*	4 k	*
CMD1-4	-115	*	*	900 k	*

Test Data Sheet

Test date: 10/8/93

Test No.	Uplink P_T at which commands are first rejected (dBm)	Remarks
CMD1-1	-114	point at which at least one command is rejected (all commands accepted at -113 dBm)
CMD1-2		test not run, 900 kb/s not available