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MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Advanced Composition Explorer (ACE) Deep Space Network (DSN) Communications Compatibility Test Plan

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ACE DSN Communications Compatibility Test Plan

Prepared By:

William Gray

William Gray, JHU/APL

Gabrielle Griffith, Omitron Inc.

Approved By:

Frank Snow 5/6/97

Frank Snow
ACE Ground System Project Manager

William B. Cross 4/24/97

William Cross
ACE Systems Manager

John P. Thurber 4/22/97

John Thurber
ACE Observatory Manager

Mary C. Chiu 4/29/97

Mary Chiu
APL Program Manager for ACE

Allen Berman

Allen Berman
ACE Telecommunications and Mission Services Manager

Table of Contents

Table of Contents (continued)

Tables

Figures

1.0 INTRODUCTION

This Test Plan documents the approach to the Advanced Composition Explorer (ACE) Radio Frequency (RF) Compatibility Testing. The RF Compatibility Testing will be performed to validate the compatibility between the ACE spacecraft RF communications subsystem and the Deep Space Network (DSN).

1.1 Purpose

The purpose of this plan is to identify the ACE RF Compatibility testing requirements, schedule, and documentation required to validate compatibility between the spacecraft RF communications subsystem and the DSN. This document will define the process for the RF compatibility testing.

1.2 Scope

This test plan identifies the tests required to accomplish ACE spacecraft RF compatibility and end to end command and telemetry verification. It identifies the test objectives, required equipment, test data, test modes, test criteria necessary to support testing, and a schedule of activities. This plan also assigns the responsibilities for planning, scheduling, documentation, and logistics to facilitate coordination between the involved agencies.

2.0 APPLICABLE DOCUMENTS

The following documents are applicable to the ACE Compatibility Test Plan to the extent specified herein. In the event of conflict between this document and the referenced documents, the order of precedence will be as follows: (1) DSN Design and Test Facility (DTF)-21 Test Procedure, (2) this document, and (3) other referenced documents.

2.1 ACE Documents

Document Number	Title
GSFC-410-ACE-017	ACE Detailed Mission Requirements
GSFC-410-ACE-019	ACE Project Test Plan

2.2 Jet Propulsion Laboratory (JPL) Documents

Document Number	Title
DSN 810-5	DSN Flight Project Interface Design Handbook
870-324 (D12639)	DSN Compatibility Test Program for ACE (contains DTF-21 Test Procedures)

3.0 REQUIREMENTS

3.1 Compatibility Test Prerequisites

Prerequisite calibration data required to perform the ACE DSN compatibility tests are specified by the JPL DSN Compatibility Test Manager (CTM) and the ACE Telecommunications Systems Verifications Engineer (TVE). These data are supplied by the DTF-21 and the ACE TVE. Measurements must be performed within one month prior to the start date of the test to ensure the validity of these data at the time of test.

3.1.1 DSN Supplied Data (DSN Calibrations and Performance Data)

The following data will be supplied by the JPL DSN CTM:

a) Y-Factor Filter noise bandwidth and uplink and down link attenuator calibrations,
b) Downlink receiver carrier threshold and AGC (ground receiver) calibrations,
c) Telemetry System loss measurements at selected ACE rates,
d) Zero-delay range calibrations,
e) Uplink RF spectra,
f) Command performance at specified ACE data rates and frequencies,
g) Operating constraints,
h) Test procedures.

3.1.2 Spacecraft Supplied Data

The following data will be supplied by the ACE TVE:

a) Expected uplink and downlink P_T/N_0 levels,
b) Rest frequency for the spacecraft receivers,
c) Transponder Auxiliary oscillator frequency,
d) Receiver calibration curves,
e) Receiver threshold,
f) Receiver pull-in range,
g) Receiver acquisition rates (max.),
h) Receiver maximum tracking rates and ranges,
i) Transponder ranging delay measurements,
j) Downlink telemetry modulation indices for telemetry,
k) Uplink command modulation indices to be used,
l) RF channel assignments,
m) RF downlink spectrum plots for all ACE modes and data rates,
n) RF downlink spurious and harmonic outputs,
o) CDU acquisition and de-acquisition times in bits,
p) Listings for any non-standard equipment required,
q) Diagrams of any special test configurations required,
r) Operating constraints.

3.2 Compatibility Test Readiness Review

At least two weeks prior to the test, a readiness review will be conducted by the ACE Ground System Project Manager. The DSN CTM and a Johns Hopkins University/Applied Physics Laboratory (JHU/APL) representative will co-chair the meeting. This review will verify that all pre-requisite data have been obtained or are properly scheduled so that all conflicts in scheduling or test conditions can be resolved. Availability, compatibility, and calibration of all test equipment shall be verified at this time.

3.3 Responsibilities

The Mission Readiness Manager (MRM) is responsible for scheduling all test resources and sending out briefing messages. The Test Director will coordinate with the MRM to ensure all supporting elements are configured properly for each test. The Test Director has the overall responsibility for test execution and will conduct pre-test briefings and the post-test debrief. The MRM and Test Conductor are responsible for procedure development, test execution, post test analysis, and the post test reports.

Following is a list of organizational responsibility for each test. Briefing messages are required for the JPL/Compatibility Test Trailer (CTT) Compatibility Test #2 and the Launch Site Test.

Test Title	Test Director	Test Conductor
Transponder Tests	JHU/APL	DSN
JPL/CTT Compatibility Test #1	JHU/APL	DSN
JPL/CTT Compatibility Test #2		
RF Testing	JHU/APL	DSN
Observatory/IMOC Tests	Project	DSN
Launch Site Test		
RF Testing	JHU/APL	DSN
Observatory/IMOC Tests	Project	DSN

3.4 Schedule

The testing dates defined in this document are to be used for planning purposes only. Official test schedules will be maintained by the ACE Project.

The DSN Compatibility Testing has been broken down into the following tests:

Test Title	Planned Date
Transponder Tests	March 1996
JPL/CTT Compatibility Test #1	July 1996
JPL/CTT Compatibility Test #2	May 1997
Launch Site Test	July/August 1997

3.5 Test Procedures and Reports

3.5.1 Test Procedures

All tests must have approved test procedures prior to the start of the compatibility testing. The DSN test procedure will be the controlling test document. Approval of the test procedures is required by the DSN CTM or his representative, ACE Telecommunications System Lead Engineer (TSE) or his representative, and the ACE TVE. Deviations from the procedures will be allowed in the event of unforeseen constraints or station equipment failures if approval is obtained from the DSN CTM and the ACE TVE or their designated representatives. Deviations to the test plan will be recorded in an engineering notebook and documented in published test reports.

Generation of the DSN test procedures and test parameters/criteria shall be the responsibility of the DSN CTM in consultation with the ACE TSE and TVE. JHU/APL shall review and approve the test procedures to assure safety of the Flight Equipment.

3.5.2 Preliminary Test Report

Within 10 working days after completion of the ACE DSN compatibility test, a preliminary test report providing the qualitative results of each test shall be issued. Any liens against the compatibility tests shall be listed and recommendations for removal of the lien shall be given. The preparation of this report shall be the responsibility of the DSN Compatibility Test Engineer (CTE) in consultation with the ACE TSE and TVE. Approval of this report will be the DSN CTM, ACE TSE, and ACE TVE.

3.5.3 Final Test Report

Within 90 days after completion of the ACE DSN compatibility test, a final test report shall be issued. This report will provide a comparison of the actual test results with the test criteria, state liens (if any) against the compatibility testing, and provide a plan for removal of these liens. The preparation of this report shall be the responsibility of the DSN CTE. This plan will be developed by the DSN CTE in collaboration with JHU/APL and the ACE Project. Approval of this report will be the DSN CTM, ACE TSE, and ACE TVE.

3.5.4 Test Documentation

All test plans, procedures, reports, printouts, photographs, and magnetic tape records containing test results shall be maintained by the DSN CTE until the end of the ACE mission. Copies of these data shall be made available upon request.

4.0 COMPATIBILITY TESTS

ACE telecommunications system operating modes are defined in Tables 4-1.1, 4-1.2 and 4-1.3. The tests required are shown in Table 4-2. Test configurations are defined in Tables 4-3, 4-4, 4-5 and 4-6.

4.1 Transponder Tests

The ACE spacecraft RF communication subsystem tests will tentatively be performed in March 1996 at the Jet Propulsion Laboratory, Compatibility Area (DTF 21). These tests will involve a flight Transponder, flight Pre-Modulation Conditioner (PMC), and Command and Data Handling (C&DH) component simulator. The purpose of these compatibility tests are to ensure that the ACE Spacecraft design for the RF Communications Subsystem and C&DH Subsystem is compatible with the DSN and to detect possible causes of reduced performance or non-compatibility. JPL personnel will perform these tests with APL I&T team support.

The specific tests are as indicated in Table 4-2. Block diagrams are shown in Figures 4.1 thru 4.3.

4.2 JPL/CTT Compatibility Test #1

Objective
The objective of the JPL/CTT Compatibility Test #1 is to verify RF compatibility between the ACE spacecraft and the JPL CTT and to perform various signal level measurements while the ACE spacecraft is located at APL.

Description
This test will consist of establishing a command and telemetry interface between the ACE spacecraft and the ITOCC. The JPL CTT will interface with the ACE spacecraft to verify RF compatibility. The JPL CTT will provide either an interface to the ITOCC or special test equipment to generate the ACE command bit pattern. When a spacecraft configuration change is required, the APL I&T team will reconfigure the spacecraft using their companion procedures. Figure 4.4 depicts the proposed test configuration. This test is tentatively scheduled to be performed in July 1996. The exact test sequence will be defined when the test procedure outline is completed.

Modes
This test will be performed in both the non coherent and coherent mode, with and without ranging, with and without spin doppler, using different uplink carrier levels, and at all spacecraft telemetry bit rates. The telemetry data will be Reed-Solomon and Convolutional encoded. The specific tests are as indicated in Table 4-2.

Test Participants
APL I&T team
JPL/DSN
FOT personnel
MRM, TE

Resources Required
ACE Spacecraft
ITOCC
JPL CTT
NASCOM

4.3 JPL/CTT Compatibility Test #2

Objective
There are two major objectives to the tests with the ACE Observatory and the JPL Compatibility Test Trailer (CTT) while the Observatory is located in the thermal vacuum chamber at GSFC. One objective is to demonstrate end-to-end compatibility between the ACE Observatory and the IMOC and all of the communications paths that interconnect them. The second objective is to demonstrate RF compatibility between the ACE Observatory and the DSN ground stations as represented by the CTT.

Description
This test will consist of establishing a command and telemetry interface between the ACE Observatory and the IMOC and performing an end-to-end command and telemetry data flow through the network interfaces. Figure 4.5 depicts the proposed test configuration. An interface between the ACE Observatory and the ITOCC will be provided as a backup for command and telemetry. In the event a spacecraft configuration change is required and the interface between the IMOC and ACE Observatory is down, the APL I&T team will reconfigure the spacecraft using their companion procedures.

The JPL CTT will interface with the ACE Observaotry to verify RF compatibility. Figure 4.6 depicts the proposed test configuration. Interfaces required between the CTT and ITOCC for RF testing include coaxial cables for baseband commands and CTT receiver baseband plus a network connection to the ISIS Fanout Unit to retrieve telemetry. Additionally, an Exabyte tape unit will serve as backup for capturing Observatory recorder playback data. The CTT will also have a series of commands that will be transmitted during command receiver tests.

This test is tentatively scheduled to be performed in May 1997. The exact test sequence will be defined when the test procedure outline is completed.

Modes
This test will be performed at high and low Observatory telemetry bit rates. The telemetry data will be Reed-Solomon and Convolutionally encoded. Specific tests are as indicated in Table 4-2.

Test Participants
FOT
IMOC support
APL I&T team
JPL/DSN
MRM, TE
FDF
ACE Science Center

Resources Required
IMOC
ACE Spacecraft
JPL CTT
NOCC
ITOCC
ASC
FDF
NASCOM

4.4 Launch Site Test

Objective
There are two major objectives of the Launch Site Test. One objective is to verify the end-to-end data flow between the IMOC at GSFC and the ACE Observatory on the launch pad using MIL-71. The second objective is to verify RF compatibility between the ACE Observatory and the DSN ground stations as represented by MIL-71 while the Observatory is in the Launch Site Integration Facility.

Description
This test will consist of establishing a command and telemtery interface between the ACE Observatory at the launch site and the IMOC using MIL-71 and performing an end-to-end command and telemetry data flow through the network interfaces. Figure 4.7 depicts the proposed test configuration. An interface between the ACE Observatory and the ITOCC will be provided as a backup for command and telemetry. In the event, a spacecraft configuration change is required and the interface between the IMOC and the ACE spacecraft is down, the APL I&T team will reconfigure the spacecraft using their companion procedures.

The ITOCC will interface with the ACE Observatory using MIL-71 to verify RF compatibility. The ITOCC will establish a command and telemetry interface using MIL-71. The proposed test configuration is depicted in Figure 4.7.

This test is tentatively scheduled to be performed July/August 1997. The exact test sequence will be defined when the test procedure outline is completed.

Modes
This test will be performed in both the non-coherent and coherent mode, with and without ranging, using different uplink carrier levels, and at all spacecraft telemetry bit rates. The telemetry data will be Reed-Solomon and Convolutional encoded. Specific tests are indicated in Table 4-2.

Test Participants
FOT
IMOC support
APL I&T team
JPL/DSN
MRM, TE

Resources Required
ACE Spacecraft
IMOC
ITOCC
NOCC
MIL-71
NASCOM

Table 4-1.1
ACE Downlink Modes and Data Rates

Mode	Data Rate (bps)	Symbol Rate R/S & Convol (SPS)	Convolutional Coding*	Modulation	Nominal Modulation Index
Low rate data. With simultaneous ranging and cmds	434	996	r=1/2,k=7	Bi-phase-L direct on carrier	**0.70 radian peak
Real time data. With simultaneous ranging and cmds.	6944	15936	r=1/2,k=7	Bi-phase-L direct on carrier	1.25 radian peak
Playback data. With simultaneous ranging and cmds.	76,384	175,296	r=1/2,k=7	Bi-phase-L direct on carrier	1.25 radian peak
Ranging. DSN Squarewave.	Ranging clock = 512kHz			Sequential squarewave components(5-17)	0.28 radian peak

* In all cases, the convolutional code (r=1/2,k=7) is concatenated with an I=4, (255,223) Reed Solomon codeblock with 28 symbols (bytes) of virtual fill. This can also be stated as an I=4, (248,216) shortened codeblock.
**Transponder Low Modulation Sensitivity mode.

Table 4-1.2
ACE Uplink Data Rates

Data Rate (bps)	Modulation	Nominal Modulation Index
1000	NRZ-L on 16 KHz sine wave subcarrier (coherent)	0.868 radians peak

Note: Uplink subcarrier to be present only when actively sending commands.

Table 4-1.3
ACE Uplink Squarewave Ranging

Ranging Clock kHz	Modulation	Nominal Modulation Index
512	Squarewave clock chopped with components 5 thru 17. PM modulated direct on carrier.	0.40 radians peak

Table 4-2
ACE DSN Communications Compatibility Tests

Tests	Trans-ponder (1)	JPL-CTT #1			JPL-CTT #2	Launch Site
		26m system	34m system	Transponder Serial #	CTT System, Blk V Receiver S/C Transponder 101 & 102	MIL-71 System, S/C Transponder 101 & 102
RF-1	√	P1 & P4	P1w/s & P4w/s	101 & 102	P1 & P4	P1 & P4
RF-2 a	√	P1a, P1c, P1e	X	101 & 102	P1a, P1e, P2b	P1a, P1e, P2b
RF-2 b	√	√	X	101 & 102	√	√
RF-3	√	P2b	X	101 & 102	P2b	P2b
RF-4	√	√	X	101	√	√
RF-6 a	√	P1, P5, P7, P9	X	101	P1, P5, P7, P9	X
RF-6 b	√	P1, P6, P8, P10	X	101	P1, P6, P8, P10	X
RF-6 c	√	√	X	101	√	√
RF-7 a	√	P1, P2, P4, P6	P1, P6	101	P1, P2, P4, P6	P1, P2, P6
RF-7 b	√	X	√	101	P2	√
RF-7 c	√	P1, P2, P4, P6	P1, P6	101	P1, P2, P6	P1, P2, P6
CMD-1	√	√	√	101 & 102	√	√
ST-1	√	X	X		X	X
TLM-2 a	√	X	X		X	X
TLM-2 b	√	High & Low Rate Threshold, ?BER if possible?	Low Rate Threshold, ?BER if possible?	101	BER @ (0.434, 6.9, 76.4) kbps	BER @ (0.434, 76.4) kbps
TLM-2 b Special		X	X		BER @ 76kbps (closed loop)	X
TLM-2 c	√	High & Low Rate Threshold, ?BER if possible?	Low Rate Threshold, ?BER if possible?	101	BER @ (0.434, 6.9, 76.4) kbps	BER @ (76.4) kbps
RNG-2	√	P3A,3C	P3A	101 & 102	P3	P3
ST-2	√	High & Low Rate Data	Low Rate Data	101 & 102	X	X

Note: P# indicates perform select tests
w/s indicates test with spin modulation;
U/L only: 2.1 Hz peak @ 0.083 Hz rate
Combined U/L and D/L: 4.4 Hz peak @ 0.083 Hz rate
√ indicates perform test
X indicates do not perform test

Table 4-3
Test Parameters and Success Criterion for Flight RF Receiver/Transmitter Tests

Test No.	Test Title	Success Criterion	Conditions
RF-1	Uplink Receiver carrier drop-lock threshold. Perform with and without spin* modulation.	Lock maintained for uplink power, referenced to spacecraft antenna port. Pc≤-136dBm(-130 accept.)	At Rcvr best lock frequency, with transmitter on: 1) U/L Carrier only. 2) Carr. w/commands. 3) Carr. w/ranging. 4) Carr. w/cmds & ranging
RF-2 a	Uplink Receiver sweep acquisition. At maximum and minimum sweep rates.	Successful acq. at uplink power between -50dBm and -120dBm referenced to spacecraft antenna port port. Reduced sweep rates acceptable for E and F. Reduced sweep rates acceptable for B and C.	Unmodulated. Sweeping over frequency range of ±120kHz about center freq. 1) Sweep rate = 25kHz/sec A) P_{T-UP} = -70dBm B) P_{T-UP} = -90dBm C) P_{T-UP} = -105Bm D) P_{T-UP} = -115dBm E) P_{T-UP} = -120dBm F) P_{T-UP} = -130dBm 2) Sweep rate = 1kHz/sec. A) P_{T-UP} = -70dBm B) P_{T-UP} = -120dBm C) P_{T-UP} = -130dBm
RF-2 b	Uplink Receiver sweep acquisition.	Sweep rate between 10kHz and 25kHz. Successful Acq. on ten successive tries at specified rate about best lock frequency.	Total sig. level = -120dBm Unmodulated. Level referenced to spacecraft antenna port, triangular sweep pattern.
RF-3	Uplink Receiver Tracking Range	Receiver shall maintain lock.	Unmodulated uplink. Sweeping over frequency range of ±150kHz about best lock freq. Transmitter on. 1) Sweep rate =35kHz/sec A) P_{T-UP} = -70dBm B) P_{T-UP} = -90dBm 2) Sweep rate =25kHz/sec A) P_{T-UP} = -115dBm B) P_{T-UP} = -120dBm 3) Sweep rate = 10kHz/sec A) P_{T-UP} = -130dBm

Table 4-3 (Continued)
Test Parameters and Success Criterion for Flight RF Receiver/Transmitter Tests

Test No.	Test Title	Success Criterion	Conditions
RF-4	Downlink RF Power.	Information Only. 5Watts minimum.	At spacecraft antenna port output. Performed in non-coherent mode only.
RF-6 a	Downlink Spectrum Analysis. Non-coherent	1) Plot f_C ±500kHz 2) Plot f_C ±500kHz 3) Plot f_C ±800kHz 4) Plot f_C ±800kHz 5) Plot f_C ±10kHz 6) Plot f_C ±800kHz 7) Plot f_C ±100kHz 8) Plot f_C ±800kHz 9) Plot f_C ±350kHz 10) Plot f_C ±800kHz Each condition will also be measured at ±.5, ±5, and ±50kHz.	1) Carrier Only. 2) Carrier with U/L cmds. 3) Carrier with U/L ranging. 4) Carrier with cmds & Rng. 5) Telemetry @ 434bps** 6) 434bps + cmds +rng 7) Telemetry @ 6944bps 8) 6944bps + cmds +rng 9) Telemetry @ 76,384bps 10) 76,384 +cmds + rng
RF-6 b	Downlink Spectrum Analysis. Coherent	1) Plot f_C ±500kHz 2) Plot f_C ±500kHz 3) Plot f_C ±800kHz 4) Plot f_C ±800kHz 5) Plot f_C ±10kHz 6) Plot f_C ±800kHz 7) Plot f_C ±100kHz 8) Plot f_C ±800kHz 9) Plot f_C ±350kHz 10) Plot f_C ±800kHz Each condition will also be measured at ±.5, ±5, and ±50kHz.	1) Carrier Only. 2) Carrier with U/L cmds. 3) Carrier with U/L ranging. 4) Carrier with cmds & Rng. 5) Telemetry @ 434bps** 6) 434bps + cmds +rng 7) Telemetry @ 6944bps 8) 6944bps + cmds +rng 9) Telemetry @ 76,384bps 10) 76,384 +cmds + rng
RF-6 c	Downlink Signal Modulation Indices	Telemetry Mod. Indices = 1.25radians ± 10% for Playback and Realtime Modes, 0.70radians ±10% for Low Rate Mode. Ranging M. I. = 0.28radians ± 10%	Tlm = 76,384bps Tlm = 6,944bps Tlm = 434bps** 512kHz clock $P_{T\text{-}UP}$ = -70dbm

Table 4-3 (Continued)
Test Parameters and Success Criterion for Flight RF Receiver/Transmitter Tests

Test No.	Test Title	Success Criterion	Conditions
RF-7 a	Weak Signal Downlink Threshold. Coherent mode. W/O spin mod.	P_{T-DN} = -123dBm ±2dB P_{T-DN} = -133dBm ±2dB P_{T-DN} = -142dBm ±2dB	1) Carrier only. 2) W/76,384bps Tlm. 3) Carrier only. 4) W/6,944bps Tlm. 5) Carrier only. 6) W/434bps** Tlm.
RF-7 b	Weak Signal Downlink Threshold. Coherent mode. With spin mod.	P_{T-DN} = -142dBm ±2dB	1) Carrier only. 2) W/434bps** Tlm.
RF-7 c	Weak Signal Downlink Threshold. Aux Osc. mode. W/O spin mod.	P_{T-DN} = -123dBm ±2dB P_{T-DN} = -133dBm ±2dB P_{T-DN} = -142dBm ±2dB	1) Carrier only. 2) W/76,384bps Tlm. 3) Carrier only. 4) W/6,944bps Tlm. 5) Carrier only. 6) W/434bps Tlm.

* S/C spin modulation = 2.1Hz peak offset. Rate = 1.4Hz/sec.
**Transponder Low Modulation Sensitivity mode.

Table 4-4
Test Parameters and Success Criterion for Command Tests

Test No.	Test Title	Success Criterion	Conditions
CMD-1	System Command Recpt Verification	Successful receipt of typical ACE command within the preamble bit interval on 10 seperate trials.	Single ACE commands at 1000bps.Uplink P_T= -115dBm to start. P_T is lowered after ten successful trials until command is rejected.
ST-1	Bit error rate. Coherent mode	BER = $\leq 10^{-6}$	Mod index = .868 rad. peak. $\Delta f = 0$, Max string of ones or zeros = 56 bits. Min. of 2 transitions for every 64 bits. CMD rate = 1000bps. Transmitter on. $P_{T\text{-}UP}$ = -117dBm Without spin modulation. A) Commands only. B) Cmds. with ranging.

Note 1: APL special test equipment will monitor telecommunications system command output to verify command reception.
Note 2: JPL will determine the Bit Error Rate (BER) for Special Test (ST) 1.

Table 4-5
Test Parameters and Success Criterion for Telemetry Tests

Test No.	Test Title	Success Criterion	Conditions
TLM-2 a	Telemetry BER Performance. Coherent mode. Convolutional code only. *Symbol rates: 152,768sps (76,384bps) 13,888sps (6,944bps) 868sps (434bps)**	1) BER < 2×10^{-7} for Eb/No=5.6 dB. 2) BER < 1×10^{-3} for Eb/No=3.5 dB.	Data is conv. encoded (r=1/2,k=7). Coh. mode downlink. Uplink Pt. referenced to spacecraft antenna port. With cmds and ranging. Uplink P_T -83dBm -104dBm
TLM-2 b	Telemetry BER Performance. Coherent. Concatenated codes. *Symbol rates: 175,296sps (76,384bps) 15,936sps (6,944bps) 996sps (434bps)** Special test @ 76kbps	1) Block V Receiver (Eb/No)in/(Eb/No)out≤2.0 dB 2) MFR/SSA;Blk V (Eb/No)in/(Eb/No)out≤3.2 dB TBD	Concatenated coding R/S(216,248). Convol(r=1/2,k=7). Coherent mode downlink. Uplink Pt referenced to spacecraft antenna port. With ranging and commands. Uplink P_T -83dBm -104dBm (Eb/No)in=(3.0,4.0,5.0)dB Closed loop BER Test.
TLM-2 c	Telemetry BER Performance. Aux Osc. mode. Concatenated codes. *Symbol rates: 175,296sps (76,384bps) 15,936sps (6,944bps) 996sps (434bps)**	1) Block V Receiver (Eb/No)in/(Eb/No)out≤2.0 dB 2) MFR/SSA;Blk V (Eb/No)in/(Eb/No)out≤3.2 dB	Concatenated coding R/S & Convol(r=1/2,k=7). Aux Osc mode downlink. (Eb/No)in=(3.0,4.0,5.0)dB

* PN data generated by DTF-21.
** Transponder Low Modulation Sensitivity mode.

Table 4-6
Test Parameters and Success Criterion for Sequential Ranging Tests

Test No.	Test Title	Success Criterion	Conditions
RNG-2	Range Delay Calibration W/O spin modulation	Transponder only. Delay = <1400nsec delay variation = ±30 nsec	Uplink Ranging mod index = 0.4rad. pk. Coherent. Cables calibrated out of measurement. P_{T-DN} = -115dBm P_{T-UP}, referenced to spacecraft antenna port. 1) Ranging only. P_{T-UP} = -90dBm 2) Ranging + Telemetry P_{T-UP} = -100dBm A) 434bps** B) 6,944bps C) 76,384bps 3) Ranging + Telemetry P_{T-UP} = -110dBm A) 434bps** B) 6,944bps C) 76,384bps 4) Ranging + Telemetry P_{T-UP} = -120dBm A) 434bps** B) 6,944bps C) 76,384bps
ST-2	Range measurement		Normal carrier suppression. Simultaneous commands & telemetry at all three rates. P_{Tup} = -84dBm. T1= 5sec, Pr/No = 19dB-Hz Symbol rates: 175,296sps (76,384bps) 15,936sps (6,944bps) P_{Tup} = -104dBm. T1 = 50sec, Pr/No = 9dB-Hz Symbol rate: 996sps (434bps**)

** Transponder Low Modulation Sensivity mode.

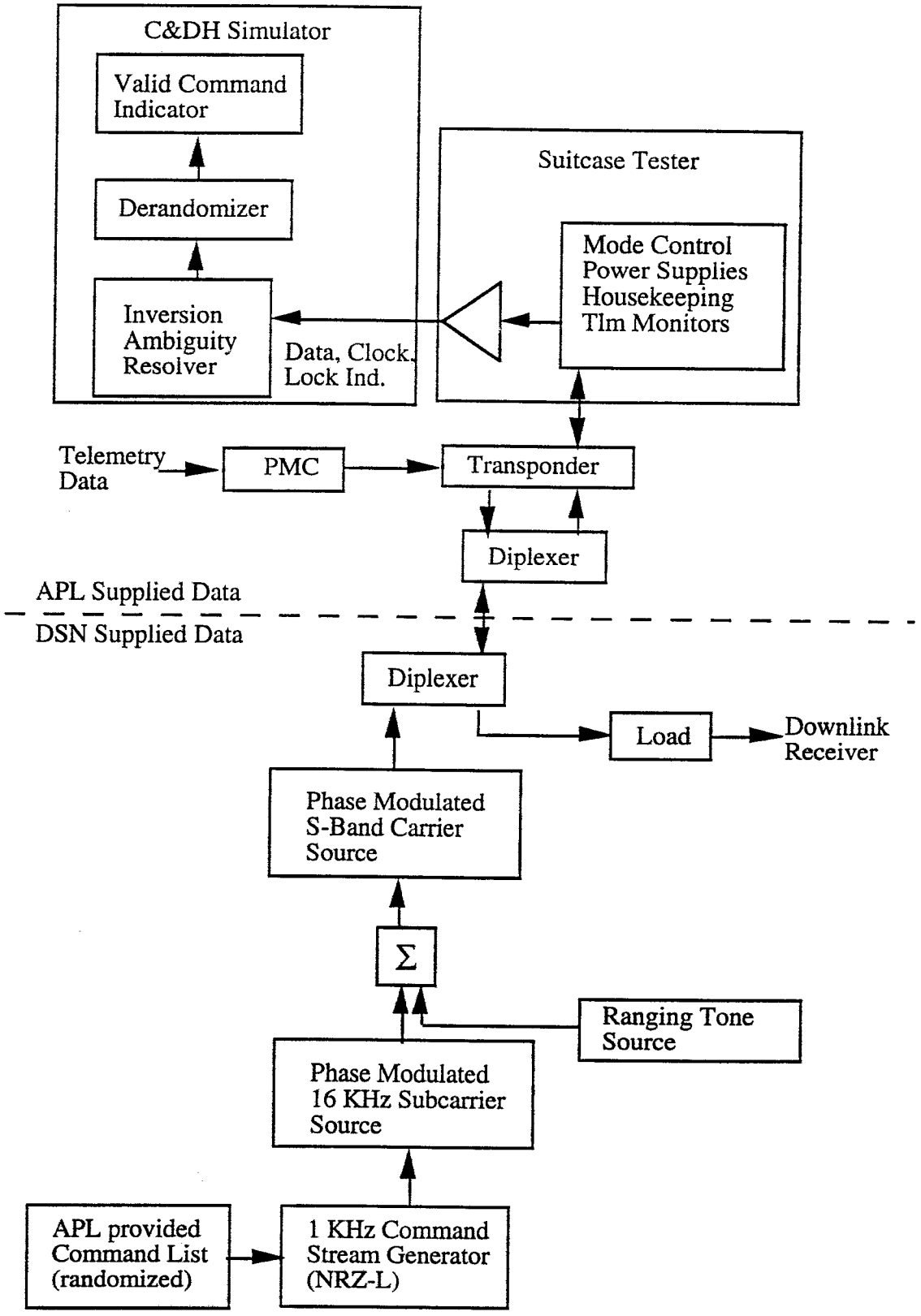

Figure 4.1 Transponder Uplink Performance Test Configuration (Test CMD-1)

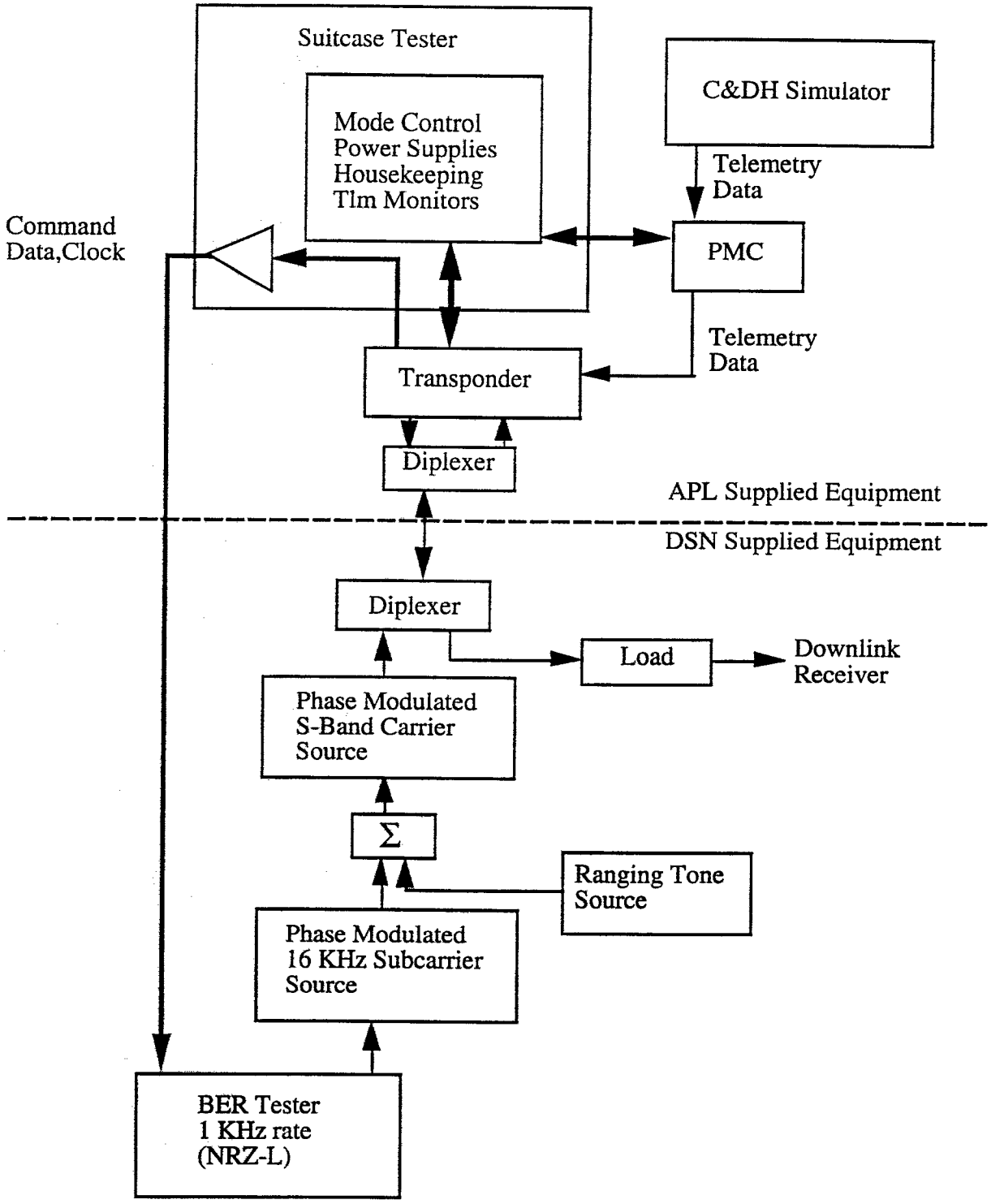

Figure 4.2 Transponder Uplink Bit Error Rate Test (Test ST-1)

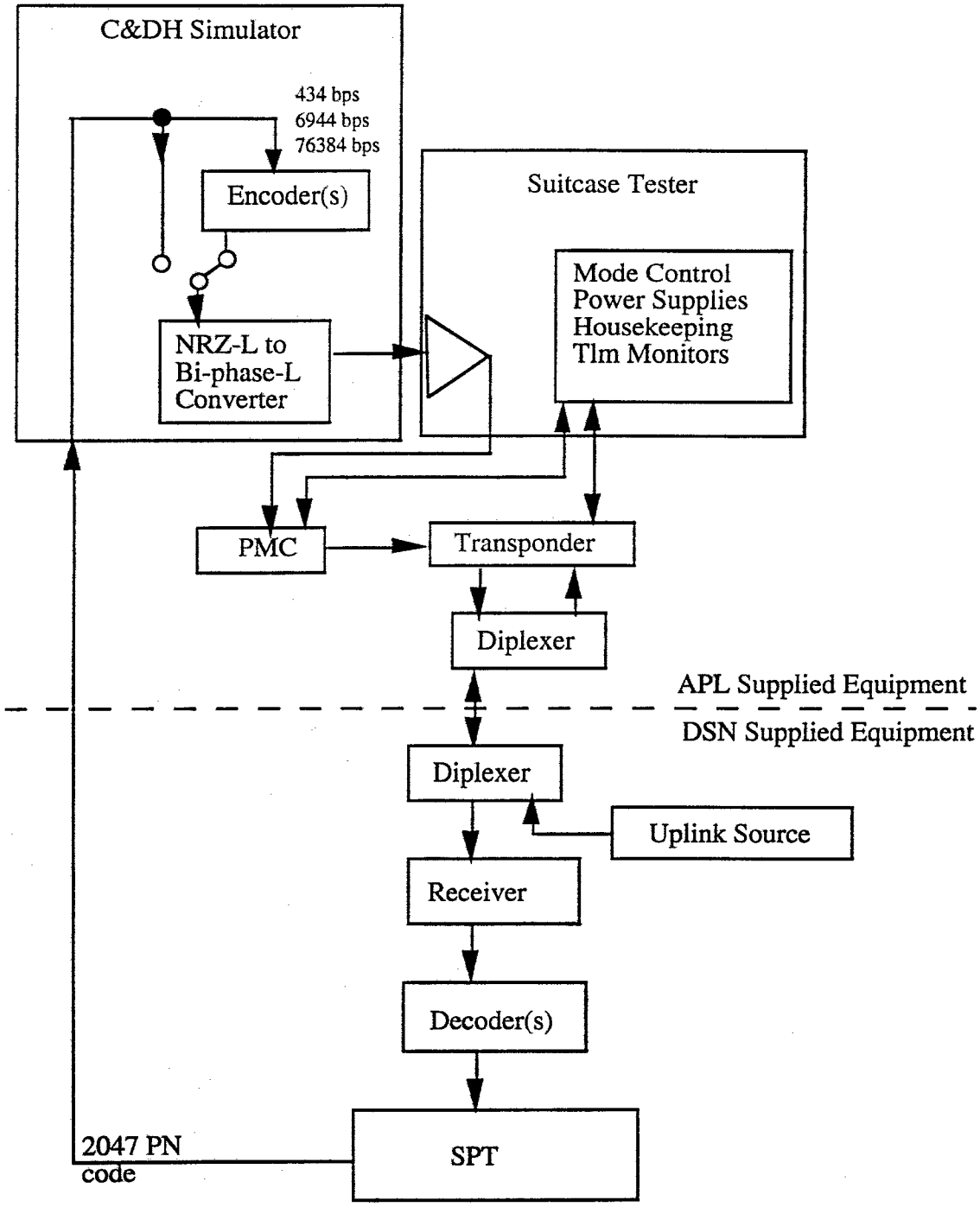

Figure 4.3 Transponder Downlink Telemetry Performance Test Configuration (Test TLM-2)

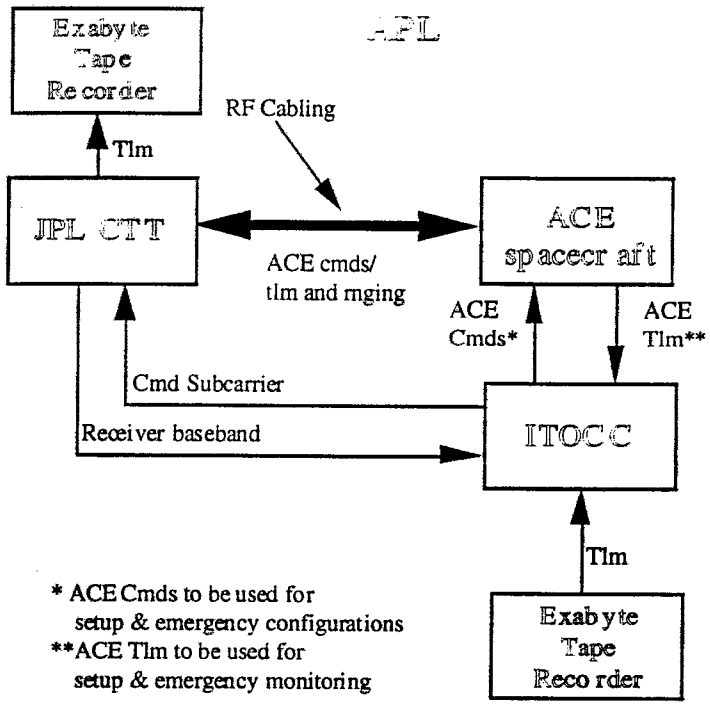

Figure 4.4 JPL/CTT Compatibility Test #1 Configuration

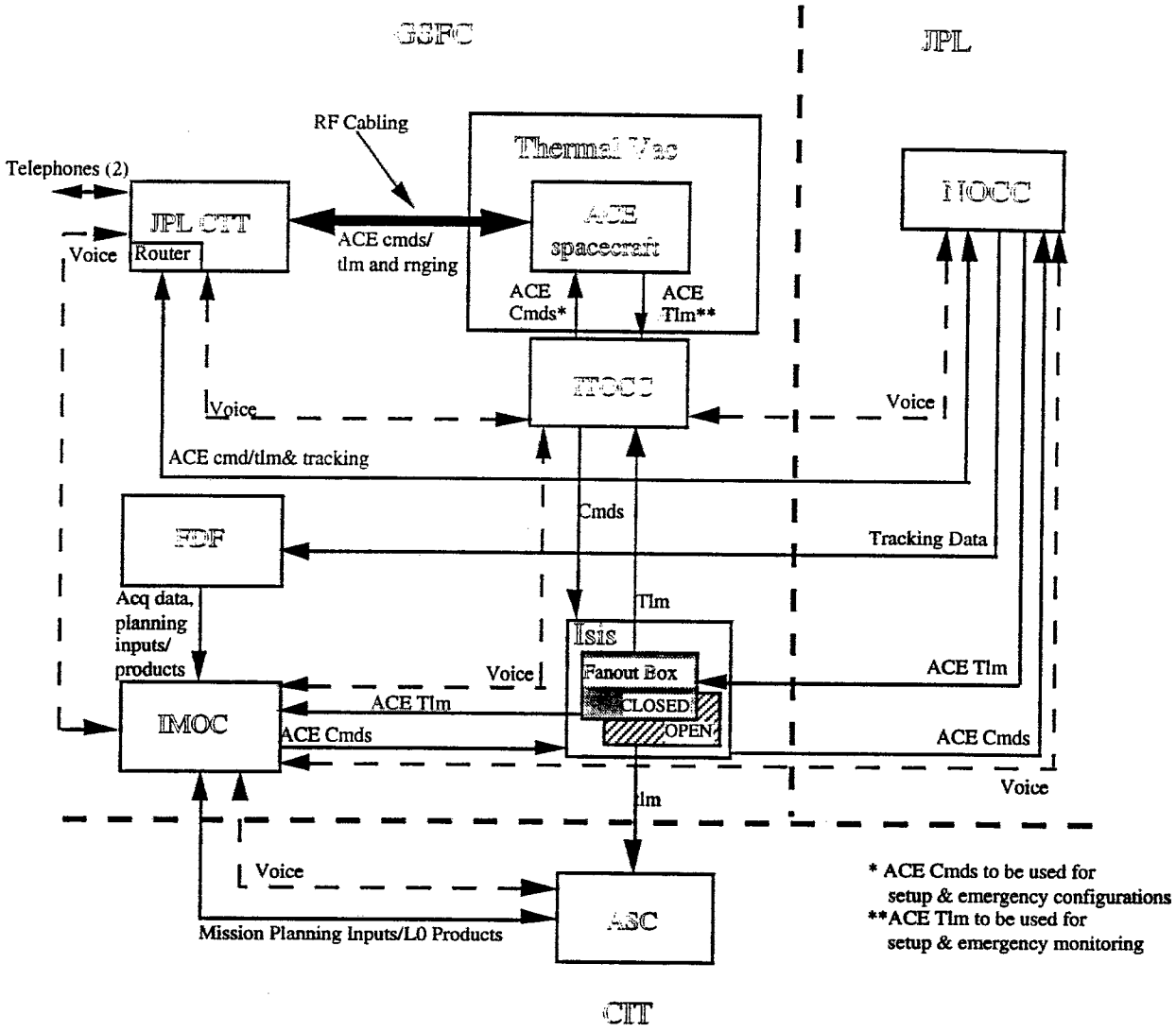

Figure 4.5 JPL/CTT Compatibility Test #2 Configuration for IMOC Tests

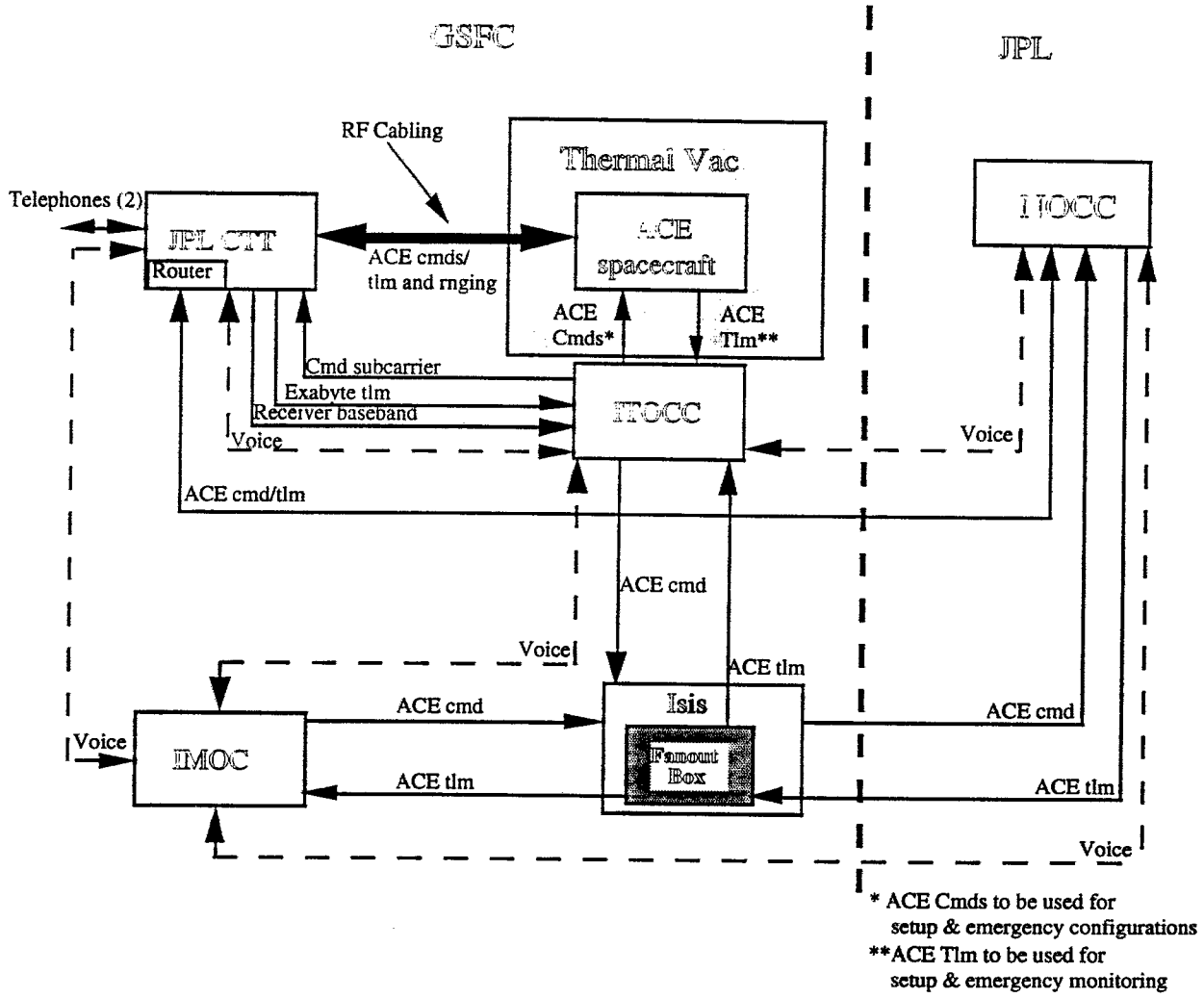

Figure 4.6 JPL/CTT Compatibility Test #2 Configuration for RF Tests

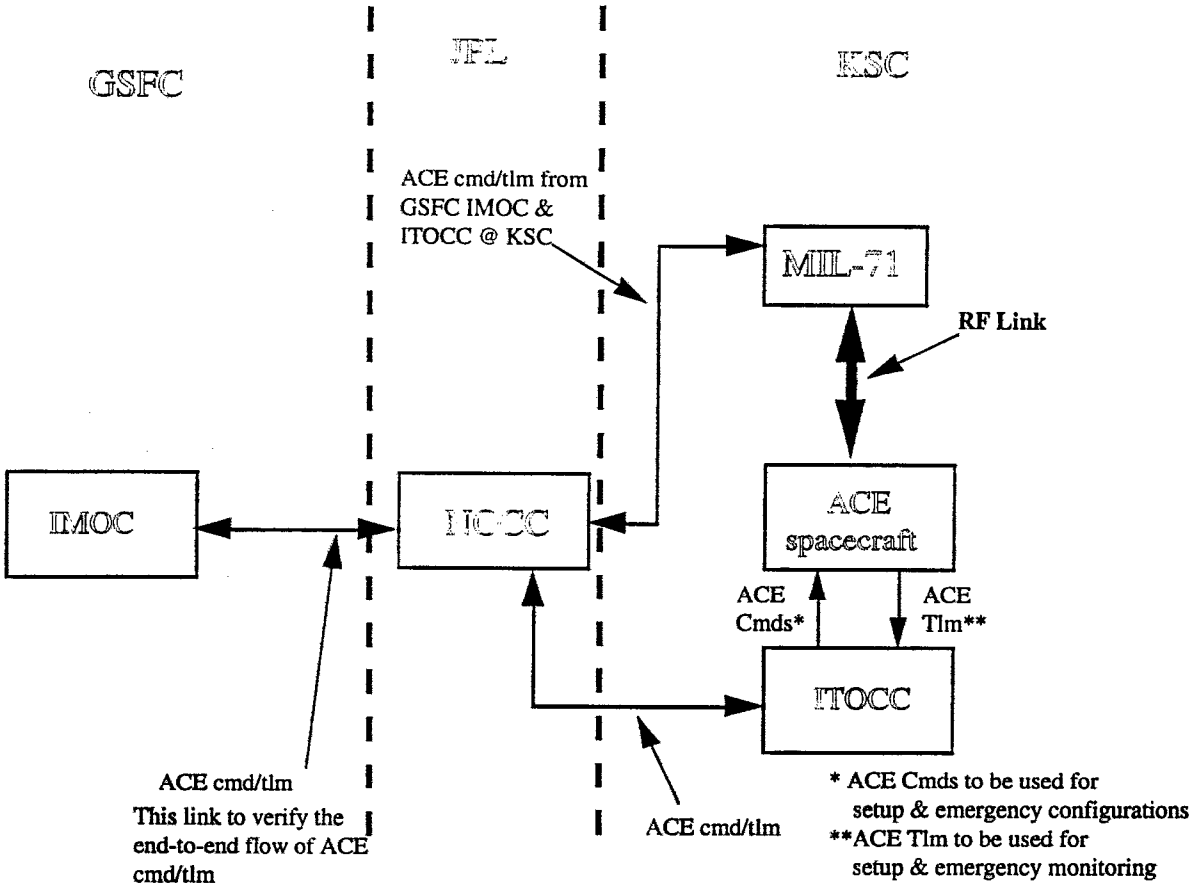

Figure 4.7 Launch Site Test Configuration

5.0 ACRONYMS AND ABBREVIATIONS

ACE	Advanced Composition Explorer
AGC	Automated Gain Control
APL	Applied Physics Laboratory
ASC	ACE Science Center
C&DH	Command and Data Handling
CDU	Command Data Unit
CIT	California Institue of Technology
CTE	DSN Compatibility Test Engineer
CTM	DSN Compatibility Test Manager
CTT	Compatibility Test Trailer
DSN	Deep Space Network
DSOPM	Data System Operations Project Manager
DTF-21	Design and Test Facility 21
FDF	Flight Dynamics Facility
FOT	Flight Operations Team
GDS	Ground Data System
GSFC	Goddard Space Flight Center
I&T	Integration & Test
IMOC	Integrated Mission Operations Center
ITOCC	Integration & Test Operations Control Center
JHU	Johns Hopkins University
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
MFR	Multi-Function Receiver
MIL-71	JPL Radio Frequency Facility at Merritt Island
MOT	Mission Operations Team
MRM	Mission Readiness Manager
MRTT	Mission Readiness Test Team
NASCOM	NASA Communications
NOCC	JPL Network Operations Control Center
PI	Principle Investigator
PMC	Pre-Modulation Conditioner
RF	Radio Frequency
S/C	Spacecraft

SOC	Science Operations Center
ST	Special Test
TE	Test Engineer
TPOCC	Transportable Operations Control Center
TSE	ACE Telecommunications System Lead Engineer
TVE	ACE Telecommunications Systems Verification Engineer