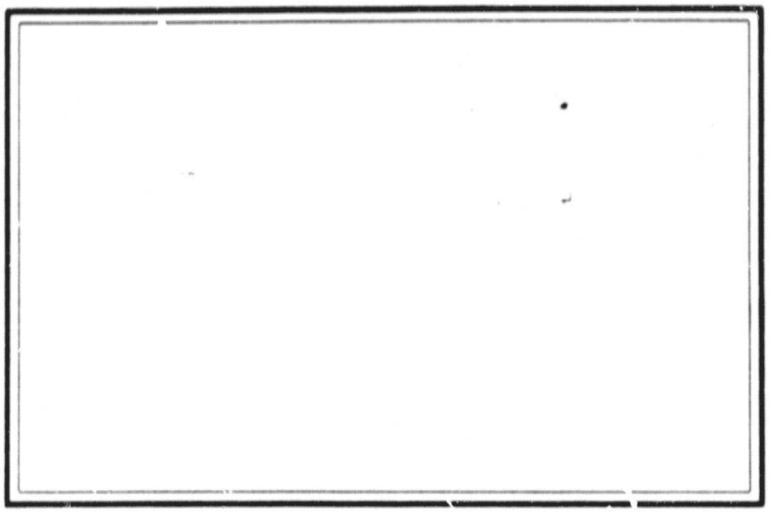

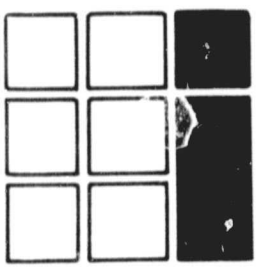

INTERMETRICS

INTERMETRICS, INC.

IMCS REFLIGHT CERTIFICATION REQUIREMENTS AND DESIGN SPECIFICATIONS

IR-AL-016

10 JANUARY 1984

PREPARED FOR: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
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12/15/83	Review Copy Release		
01/10/84	Final Copy Release		Incorporation of approved RID's RID's 1-12

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PREFACE

This document contains the IMCS Reflight Software Requirements and Design Specifications.

This document was prepared for the Information and Electronics Laboratory of the Marshall Space Flight Center under NASA Contract NAS8-33825.

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ACRONYMS

A/D	Analog to Digital
AST	Astros Star Tracker
AST1	Astros Star Tracker Interface
CDR	Critical Design Review
CPD	Cruciform Power Distribution
DDU	Data Display Unit
DEP	Dedicated Experiment Processor
DIOI	Discrete Input/Output Interface
DRIRU	Dry Rotor Inertial Reference Unit
EA	Electronics Assembly
EC	Experiment Computer
ECIO	Experiment Computer Input-Output
ECAS	Experiment Computer Application Software
ECOS	Experiment Computer Operating System
GEMS	Generalized Experiment Monitor Systems
GIRD	Ground Interface Requirement Document
GML	General Measurement Loop
GSE	Ground Support Equipment
HITS	HRM Input/Output Test System
HRM	High Rate Multiplexor
HRMI	High Rate Multiplexor Interface
ID	Identifier
I/O	Input/Output
IMC	Image Motion Compensation
IMCE	Image Motion Compensation Electronics
IMCS	Image Motion Compensation System
IPS	Inertial Pointing System
ITF	Integrated Test Facility
KSC	Kennedy Space Center

ACRONYMS
(CONTINUED)

LED	Light Emitting Device
MMU	Mass Memory Unit
O&C	Operations and Checkout
PCC	Programmable Crate Controller
PDSS	Payload Development Support System
PWR	Power
RAU	Remote Access Unit
RAUI	Remote Access Unit Interface
RFC	Reflight Certification
SA	Subsystem Assembly
SEID	Spacelab Experiment Interface Device
SPSME	Spacelab Payload Standard Modular Electronics
STSW	Serial Transaction Specification Word
TEC	Thermo-electric Cooler
TMI	Time Interface
UIT	Ultraviolet Imaging Telescope
WUPPE	Wisconsin Ultraviolet Photo-Polarimeter Experiment

1.1 Scope

The scope of this document is to establish the requirements for Reflight Certification. Software requirements encompass the software programs that are resident in the PCC, DEP, PDSS, EC, or any related GSE.

This document also recommends a design approach for the reflight software packages. These designs will be of sufficient detail to permit the implementation of reflight software.

The PDSS/IMC Reflight Certififcation system provides the tools and mechanisms for the user to perform the Reflight Certification test procedures, test data capture, test data display, and test data analysis. The system as defined will be structured to permit maximum automation of Reflight Certification procedures and test data analysis.

Special test equipment designed by the instrument builders may be available for detailed analysis of IMCS problems or failures. This special support test equipment is not addressed in this document except to identify the existence and potential use of that equipment to perform detailed testing. The instrument builder will be responsible for defining the requirements for special tests should that be required. The special test equipment is not part of the Reflight Certification proper but is to be used for diagnostic and detailed testing of the various components.

1.2 Applicable Documents

The following documents are applicable.

ASTROS

[1] Technical Description for Astros Star Tracker (AST)
8 November 1983

[2] Detail Specification for an Advanced STAR/TARGET Reference Optical Sensor (ASTROS)
ES 513218 (Rev. C)
8 November 1983

[3] AST Real Time Telemetry Data Requirement Technical Memo
Jet Propulsion Laboratory
Harvey H. Horiuchi
10 May 1983

[4] Astro-1 Software Requirements Document
MDC G9827B
MDTSCO/IBM
November 1983

DRIRU-II

[5] DRIRU-II Inertial Reference Unit Component Interface Specification for ASPS Gimbal System (AGS)
Contract No. NAS8-34367, Job No. 8088, CDRL Seq. No. 12
Teledyne Systems Company
February 1982

[6] ASPS Gimbal System Dry Rotor Inertial Reference Unit (DRIRU-II) Specification
MSFC-SPEC-565, Revision C
Appendix B
April 1981

GENERAL

[7] Spacelab Payload Accommodations Handbook (SPAH)
SLP 2104, Appendix A
Spacelab Program Software Users Guide
MDC G68544
McDonnell Douglas Corporation

[8] Software Users Guide
Appendix B
DEP Users Guide
TM No. A90-ACIS-81182
Revision 3
McDonnell Douglas Corporation and IBM
1 March 1983

[9] RAUI Operation and Maintenance Manual
15M30124
George C. Marshall Space Flight Center
9 February 1983

[10] RAUS Operation and Maintenance Manual
15M30123
George C. Marshall Space Flight Center
9 February 1983

[11] MSFC Software Management and Development Requirements
MA-001-006-2H
Revised
George C. Marshall Space Flight Center
January 1983

[12] GSFC Specification Standard Telemetry and Command Components
(STACC) Remote Interface Unit (RIU) and Expander Unit (EU)
GSFC-S-714-11, Revision D
Goddard Space Flight Center
March 1979

IMCE

[13] RAUI Operation & Maintenance Manual
15M30/24

[14] RAUS Operation & Maintenance Manual
15M30123

[15] Functional Specification for the IMCE/SPSME Analog to Digital Converter Module (A/D)
96M87411
29 June 1983

[16] Functional Specification for the IMCE/SPSME Remote Acquisition Unit Simulator Module (RAUS)
96M87413
29 June 1983

[17] Functional Specification for the IMCE/SPSME Dedicated Experiment Interface Module (DEI)
96M87414
29 June 1983

[18] Functional Specification for the IMCE/SPSME Discrete Input/Output Interface Module (DIOI)
96M87415
29 June 1983

[19] Functional Specification for the IMCE/SPSME Time Module Interface (TMI)
96M87408
6/29/83

[20] Functional Specification for the IMCE/SPSME Dedicated Experiment Processor Module (DEP)
96M87412
6/29/83

[21] Functional Specification for the IMCE/SPSME Remote Acquisition Interface Module (RAUI)
96M87409
6/29/83

[22] Functional Specification for the IMCE/SPSME High Rate Multiplexer Interface Module (HRMI)
96M87410
6/29/83

[23] Functional Specification for the IMCE/SPSME Programmable Crate Controller Module (PCC)
96M87806
6/29/83

[24] Functional Spec for the IMCE/SPSME Power Supply Module
96M87405
14 Sheets
June 1983

IMCS

[25] Image Motion Compensation System
Project Requirements Document ASTRO-1 Mission
MSFC-RQMT-906
George C. Marshall Space Flight Center
System Analysis and Integration Laboratory
March 1983

[26] IMCS Flight Software Requirements Specifications
MSFC-RQMT-933
MSFC, S&E
December 5, 1983

[27] Image Motion Compensation System
Flight Software Development Plan
MSFC-Plan-966
MSFC, S&E, IESL
December 5, 1983

[28] Image Motion Compensation System
Flight Software Verification & Validation Plan
MSFC-Plan-967
MSFC, S&E, IESL
December 5, 1983

[29] ASTRO-1 Software Requirements
MDC-G9827
McDonnell Douglas

[30] Image Motion Compensation System
Flight Software Preliminary Design
MSFC-Doc-968
MSFC, S&E, IESL
December 5, 1983

[31] PDSS/IMC Software Design Specification
IR-AL-013
Intermetrics, Inc.
1 July 1983

[32] Design and Performance Specification for IMCE
96M8740
George C. Marshall Space Flight Center

PDSS/SEID

[33] PDSS User's Manual
IR-AL-001
Intermetrics, Inc.
1 December 1983

[34] PDSS Design Specification
IR-AL-006
Intermetrics, Inc.
1 December 1983

[35] SEID II Specification
IR-AL-007
Intermetrics, Inc.
1 April 1983

[36] PDSS Configuration Control Plan & Procedures
IR-AL-003
Intermetrics, Inc.
1 January 1983

[37] Payload Development Support System Image Motion Compensator Requirements
George C. Marshall Space Flight Center
23 March 1983

2.0 REQUIREMENTS

The requirements contained herein provide for a PDSS/IMC system to be used for Reflight Certification.

The IMCS Reflight Certification criteria are:

1. To certify the IMCS interfaces - IMCE/WUPPE, IMCE/AST, IMCE/UIT, IMCE/DRIRU, IMCE/HRM, and IMCE/RAU. The interfaces will be certified for format, rate, protocol, and content.

   The interfaces will be certified to be flight operational; i.e., the interfaces meet all flight requirements.

   The interfaces' operations (initialization, command, data, failure detection, failure recovery, and low/normal/high traffic loads) will be certified.

2. To certify the IMCE operational status - Each component (PCC, DEP, RAUI, TMI, AMM, DEI, ASTI, A/D, DIOI, HRMI, MEM, PS) of IMCE will be certified to be in flight operational health.

3. To certify the IMCE software to be operational - All modes of the ICME flight software will be certified.

The "Reflight Certification Test Procedures" (being developed by MSFC) will detail the following:

- Test Setup
- Test Input Data
- Test Procedures
- Test Steps
- Test Output Data
- Test Analysis Process
- Pass/Fail Criteria
- Retest Procedures

The "Reflight Certification Test Procedures" will establish the detailed Reflight Certification criteria.

2.1 IMCS Reflight Certification Overview

A system requirement levied for IMCS is that IMCS shall be designed to provide Reflight Certification without requiring an IMCS dismount and requiring minimum physical disconnects. Reflight Certification is to mean the performance of a set of tests on the IMCS which certify that the system is flight ready. The Reflight Certification is to simplify the flight preparation process and to minimize Level IV Integration.

Figure 2-1 depicts the Astro-1 CDMS Block Diagram. Relative to the IMCS, the primary components (see Figure 2-2) include the IMCE subsystem, DRIRU-II, UIT, WUPPE, AST, and Spacelab RAU and HRM interfaces. Figure 2-3 depicts the PDSS/IMC GSE configuration that is to be used during development testing and is shown for reference only. The Reflight Certification requirements verify the correct operation and health of the IMCS.

The general assumptions that pertain to establishing the Reflight Certification requirements are listed below.

1. The IMCS will remain mounted on the Spacelab pallet upon completion of the Astros mission. the Astro pallet will be unmated from the Shuttle/Spacelab and will be stored in the O & C building at KSC. Reflight testing will be performed in this configuration.

2. The IMCS Reflight Certification tests will be conducted in the O & C building at KSC.

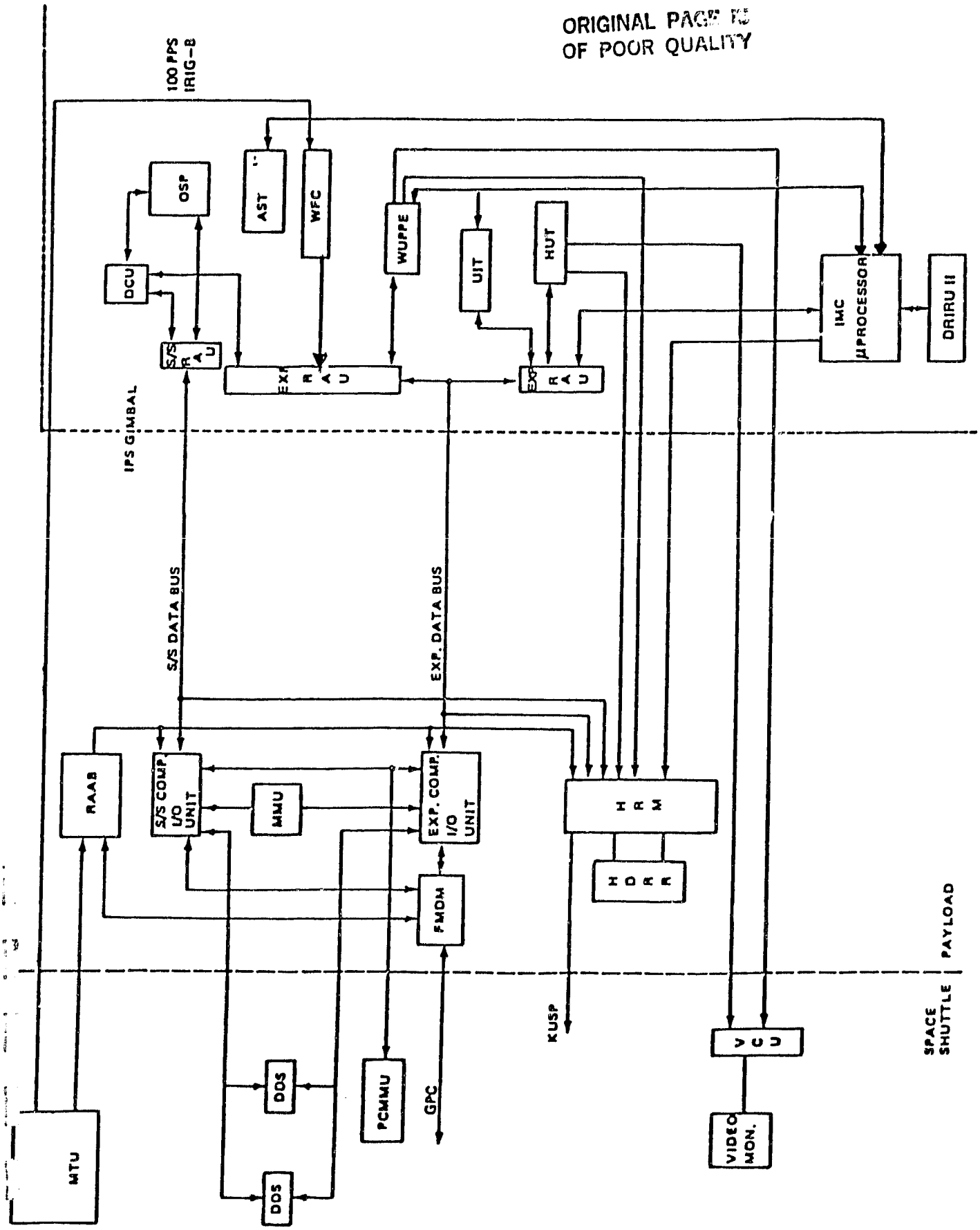


FIGURE 2-1: ASTRO-1 CDMS BLOCK DIAGRAM

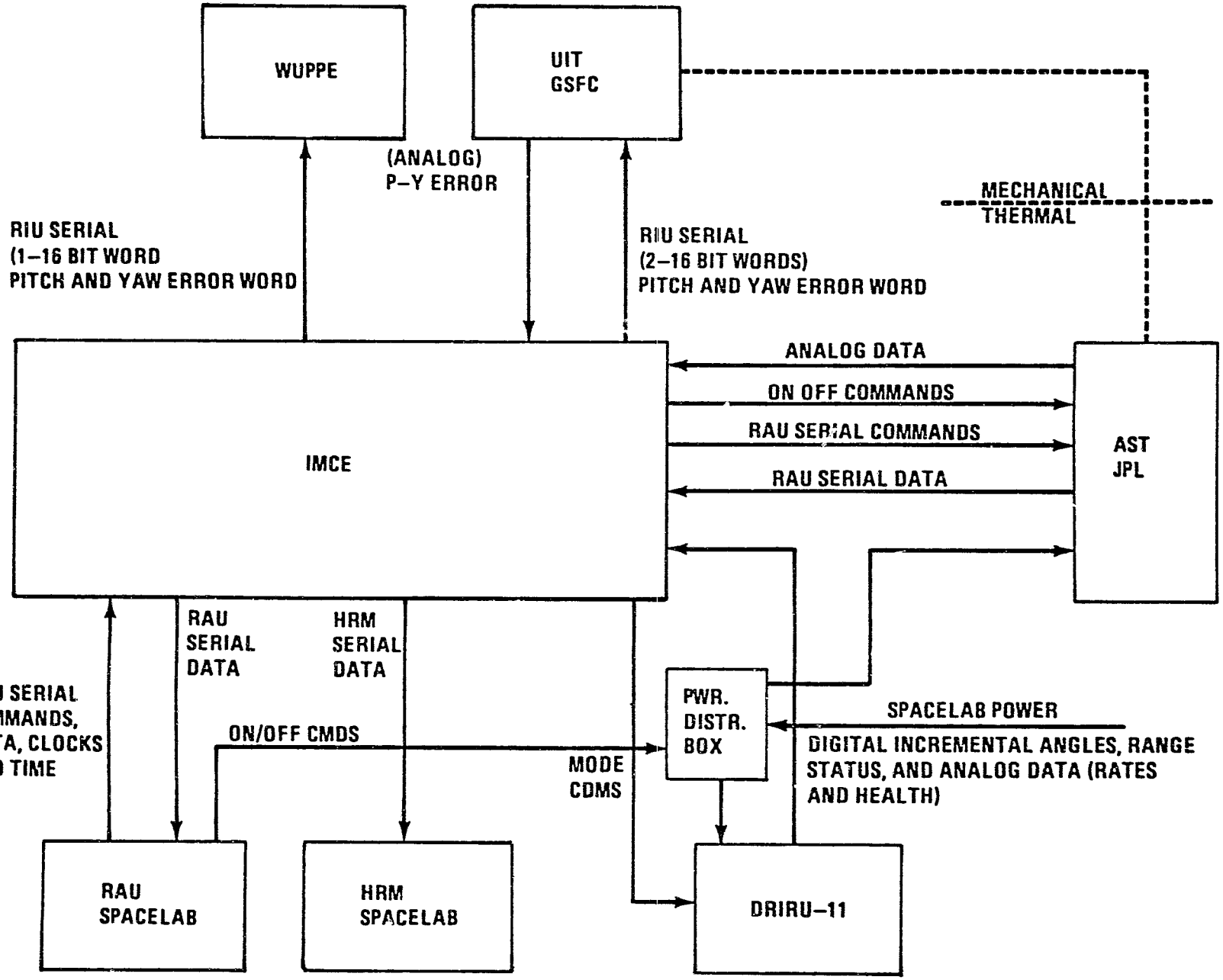


FIGURE 2-2: IMAGE MOTION COMPENSATION SYSTEM

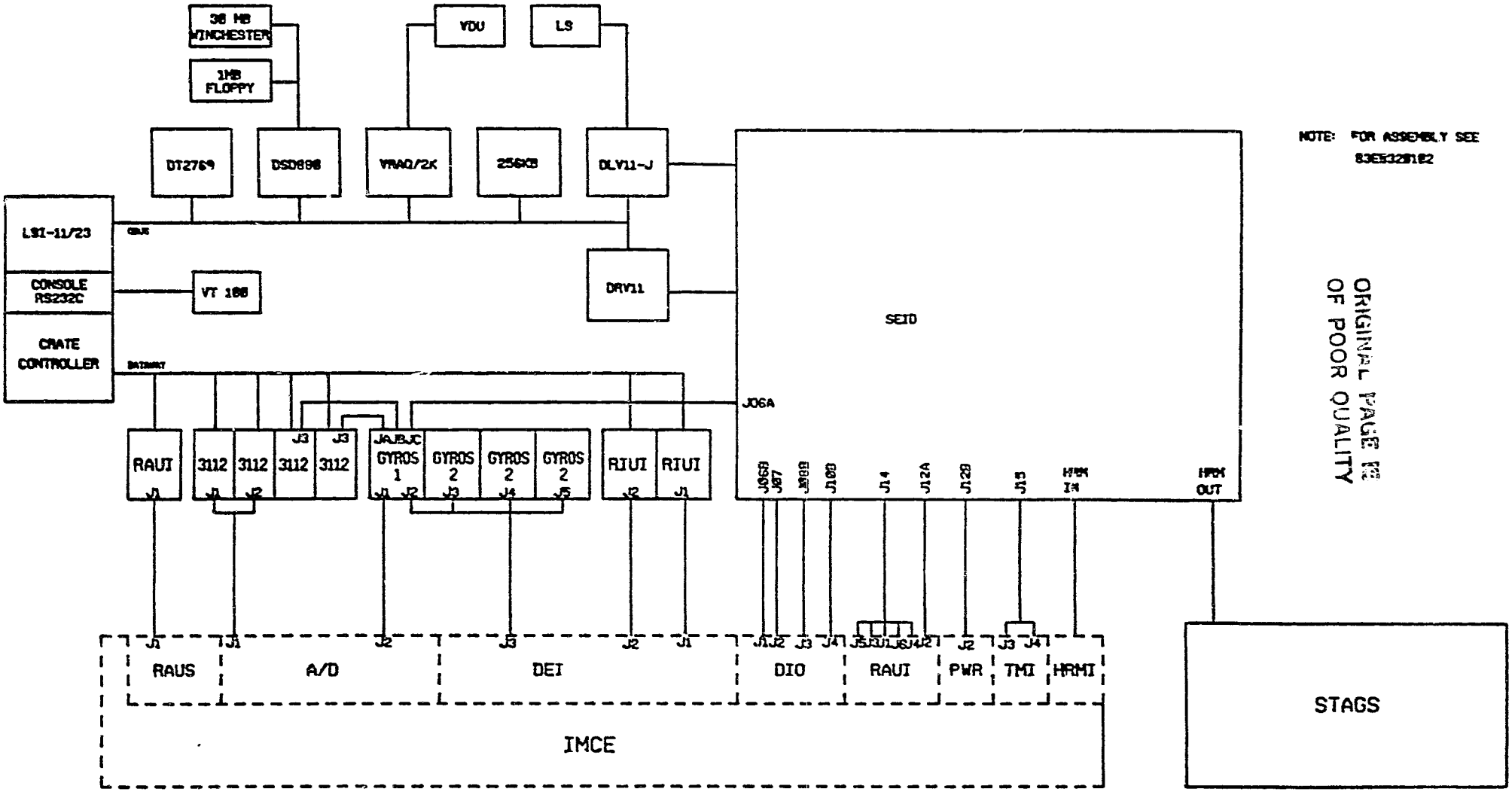


FIGURE 2-3: PDSS/IMC GSE DIAGRAM

3. The Reflight Certification tests will be performed using the PDSS/IMC system to replace the RAU and ECOS/ECAS functions. The disconnect of the RAU for interfacing the IMCE to the SEID is mandatory. The IMCE to RAU interface will be verified at Level III/II/I tests. Figure 2-4 depicts the anticipated configuration for Reflight Certification tests.

4. The HITS/GEMS ground support equipment will be available for testing and data analysis during the Reflight Certification tests. Utilization of the HITS/GEMS system must be included in the GIRD.

5. The Reflight Certification operational procedures for the Astros instruments will be patterned after the flight procedures. The general procedure is for the crew to maneuver the Orbiter to the appropriate attitude, command IPS to point to the target, and then begin the instrument operational sequences. The Reflight Certification will utilize the operational plan as a basis for developing the certification procedures. Procedures similar to the Level IV Mission Sequence Test are envisioned for Reflight Certification.

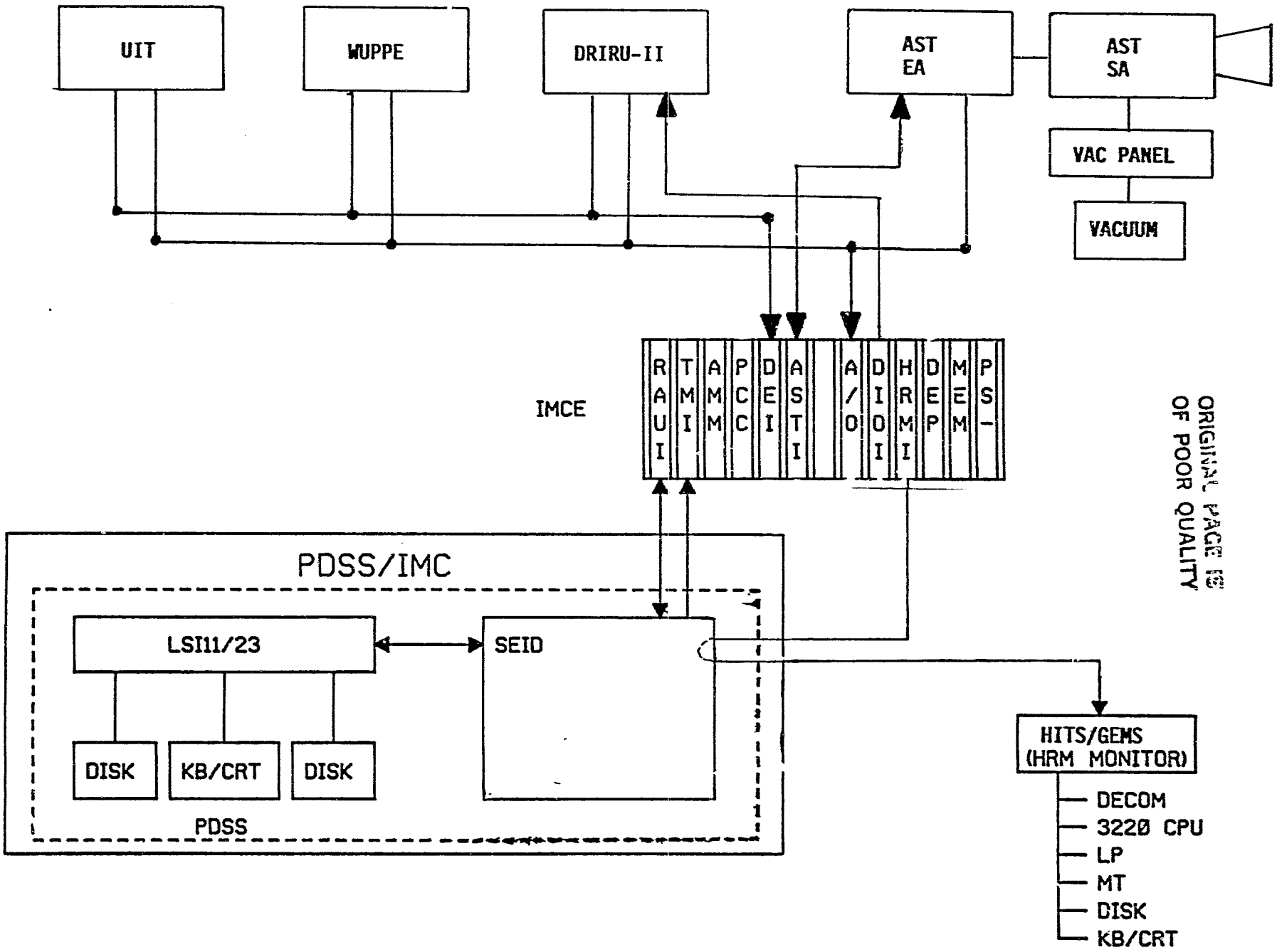


FIGURE 2-4: REFLIGHT CERTIFICATION CONFIGURATION

6. The Reflight Certification requirements were developed with the intent of using the IMCE DEP Flight Software without placing any new requirements.

7. The IPS will not be moved during Reflight Certification nor is there a requirement for IPS movement. (Special structures and equipment would be required for IPS movement.)

8. There is no requirement for the PDSS/IMC to provide any of the Spacelab subsystem RAU I/O functions.

9. The Reflight Certification software package will be verified at the Integrated Test Facility (ITF) using the actual flight IMCE and flight software. The Reflight Certification package will also be used for the IMCS system validation and acceptance testing performed at the ITF.

The following sections present the requirements for Reflight Certification.

2.2 IMCE Reflight Certification Requirements

The IMCE Reflight Certification requirements insure the flight readiness of the IMCE subsystem.

The IMCE Reflight Certification will verify the operation of the IMCE subsystem. The operational status of the IMCE components (i.e., ASTI, A/D, DEI, DIO, RAUI, PWR, TMI, HRMI, DEP (i8086), and PCC) will be verified. The Reflight Certification will verify the interfaces from the IMCE to AST, DRIRU-II, WUPPE, HRM, and Spacelab RAU.

Each IMCE interface will be tested to certify the interface performance.

The IMCE HRM interface will be certified by testing the format, content, and rate of the PCC HRM output. The HITS/GEMS ground support equipment will be used to record, display, and analyze the PCC HRM output. The Reflight Certification PCC HRM data stream will have the same format and rate as the IMCE HRM flight data stream. The requirement is to verify the IMCE HRM data stream only once during reflight certificaion. The HITS/GEMS GSE will be scheduled through the GIRD to support Reflight Certification tests.

Reflight Certification will verify that the IMCE will operate in each of the defined modes:

- Self Test
- Boot
- Standby
- Calibrate
- Operate
    - Operate Acquisition
    - Operate Execute
    - Operate DRIRU Only
    - Operate Comet Track

Reflight Certification will command the IMCE to operate in these modes and will verify the operational status. The valid mode transition (see Figure 2-5) will be commanded and verified.

RFC will verify the rate, format, and data content of all IMCE interfaces.

The IMCE interfaces will be operated at the normal flight rates as specified in MSFC-RQMT-933 (i.e., the flight software interface drivers are to be used). The output data (RIU serial) to the UIT and WUPPE (pitch and yaw error words) are to be controlled by the flight software. The flight software will provide the capability to output predetermined commands to the experiment actuators. These commands are to be loaded from MMU with the standard MMU load and can be updated in RAM via DEP protocol DEP memory load. The command data parameters are.

- NULL-UIT Pitch and Yaw for UIT
- NULL-WUPPE Pitch and Yaw for WUPPE

The flight software will output the fixed value to UIT (NULL-UIT) and WUPPE (NULL-WUPPE) unless the calibrate mode has been commanded. The values NULL-WUPPE and NULL-UIT are null command values that are issued when in STANDBY.

The flight software control logic is:

```
CASE IMCS-MODE

   STANDBY:    OUTPUT NULL-UIT TO UIT
               OUTPUT NULL-WUPPE TO WUPPE
   CALIBRATE:  OUTPUT TRIANGULAR WAVEFORM TO UIT AND
               WUPPE
      .
      .
      .
```

RFC will verify the IMCE DEP capability for inflight loading of DEP RAM memory from the Spacelab MMU.

RFC will verify the IMCE DEP and PCC capability for memory dump of selectable memory locations.

RFC will verify the IMCE DEP initial boot function and the capability for the crew to command the IMCE to reboot.

RFC will verify the IMCE DEP capability to perform self-test on crew command.

RFC will verify the rate and format of the WUPPE and UIT interfaces to IMCE from status data provided by the flight software.

A special piece of Ground Support Equipment will be provided by NASA/MSFC to be used for diagnostic tests and DEP monitor as deemed necessary to support special testing during Reflight Certification. This GSE is a Hewlett Packard test set that connects to the DEP's 8086 test connector and provides the capability to load, patch, and display registers and memory. This GSE will be used for trouble shooting the IMCE DEP and is not part of Reflight Certificatior proper.

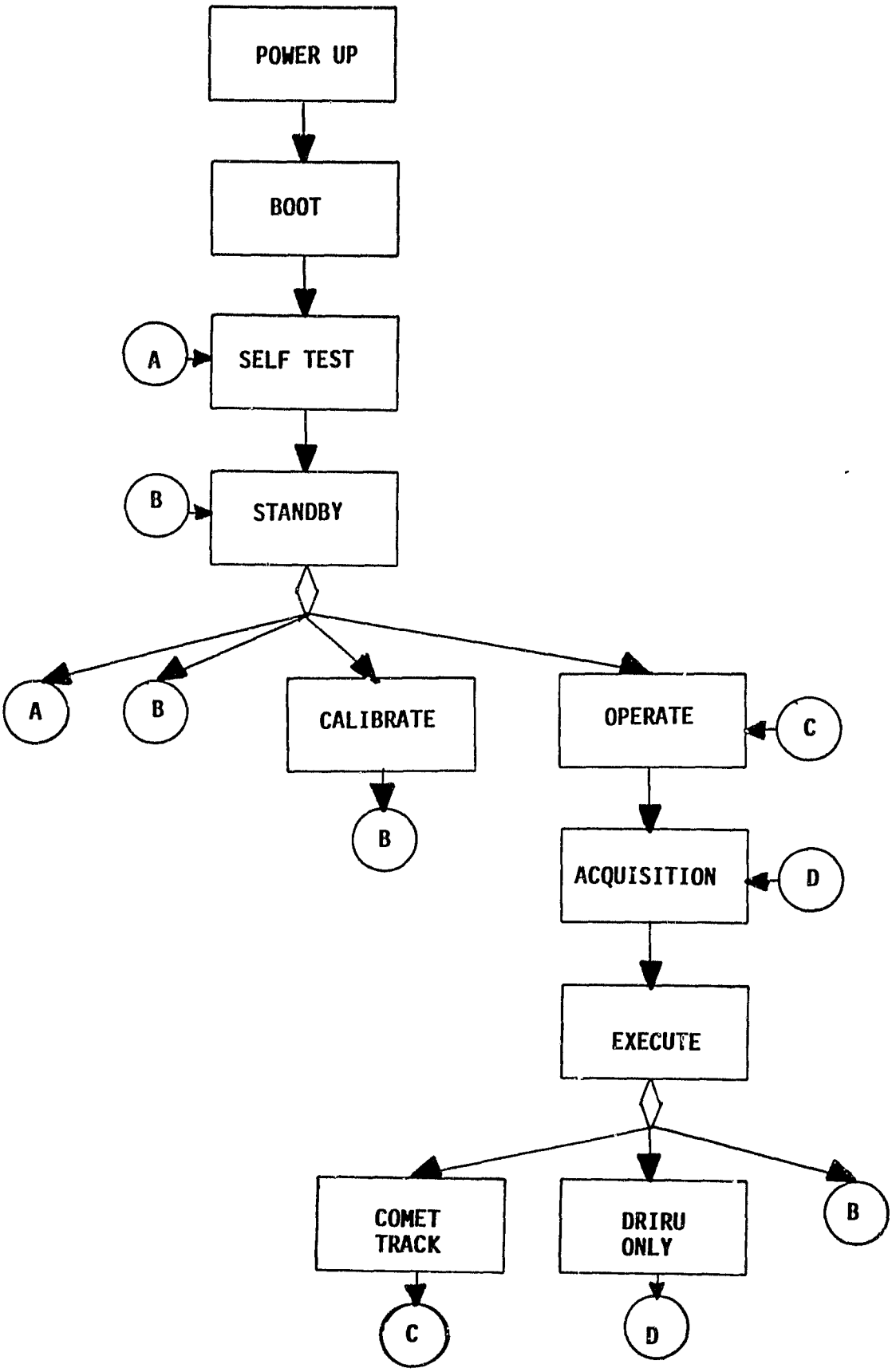


FIGURE 2-5: IMCE MODE TRANSITIONS

2.3 DRIRU-II Reflight Certification Requirements

The DRIRU-II Reflight Certification requirements are to demonstrate the health of the DRIRU interfaces and internal operations.

The DRIRU will be powered up through the IMC Power Distribution system through PDSS/SEID RAU Discrete commands.

The PDSS/IMC will read the incremental position data for all axes. The PDSS/IMC will compute earth's rate components for each axis and will compare the actuals with computed earth rate. PDSS/IMC will display the accumulated DRIRU gyro data, the earth's rate components, and will display error differences.

The PDSS/IMC will read, record, and display all DRIRU health data.

There is no requirement that the DRIRU be positioned to where gyro data about all axes are non zero. The certification test criteria should note that zero gyro readouts indicate a problem to be verified. Due to normal seismic and thermal disturbances, internal noise and null offsets, zero gyro outputs are not realistic even when the DRIRU is positioned for perfect alignment to siderial axis (i.e., zero rates).

Reflight Certification will verify the capability of IMCE to issue command data to DRIRU-II.

These commands are the 12 HIGH/LOW (Electrical Interface Mode Commands).

The Reflight Certification will verify the rate and contents of data transferred from DRIRU-II to IMCE. The data includes:

1. 12 Incremental Angle Pulses
2. 12 Electrical Interface Mode Commands
3. 6 Analog Rate Telemetry Output
4. 6 Range Status Telemetry Output
5. 3 Gyro Temperatures
6. 3 Torque Motor Currents

2.4 AST Requirements

The purpose of the AST reflight requirements is to verify the operational status of the AST.

2.4.1 Assumptions/Equipment

The following general assumptions are made for these tests:

1. There are no significant differences between the Level IV and recertification tests in terms of support equipment and software.

2. The test connector on the Sensor Assembly will be accessed to provide full frame views of the CCD. The test connector on the Electronic Assembly will only be accessed if an anomalous condition is detected.

3. The thermoelectric cooler must be operating to provide checkout capability.

4. The baffle will be covered providing a totally dark environment for the AST to view. In the event that a dark environment cannot be provided (e.g., the baffle is removed), a light tight lens cap must be installed on the AST optics. (Note that the AST baffle cover must be removed shortly before launch -- "Red tag" item.)

5. The power, command and data interfaces with the AST are fully supported with flight hardware or systems checkout equipment (Figure 2-6). Further, power can be supplied independently to any and all of the three AST power circuits (Electronics power, Sensor Assembly heaters, Electronics Assembly heaters).

6. Should detailed AST testing be deemed necessary based on Reflight Certification tests or mission performance analysis, the AST developer will provide a test computer, similar to that used with the AST engineering model (PDP 11/34 or 11/23). The test computer will provide command entry, data gathering and display functions and will acquire frames of CCD data through the SA test-connector interface.

   The AST test set (Figure 2-7) can be connected to the power and command/data interfaces of the AST in place of the PDSS/IMC. This test set provides a standalone capability for checking out AST performance and does not require support from the PDSS/IMC.

   The use of the AST test set is not part of the Reflight Certification proper.

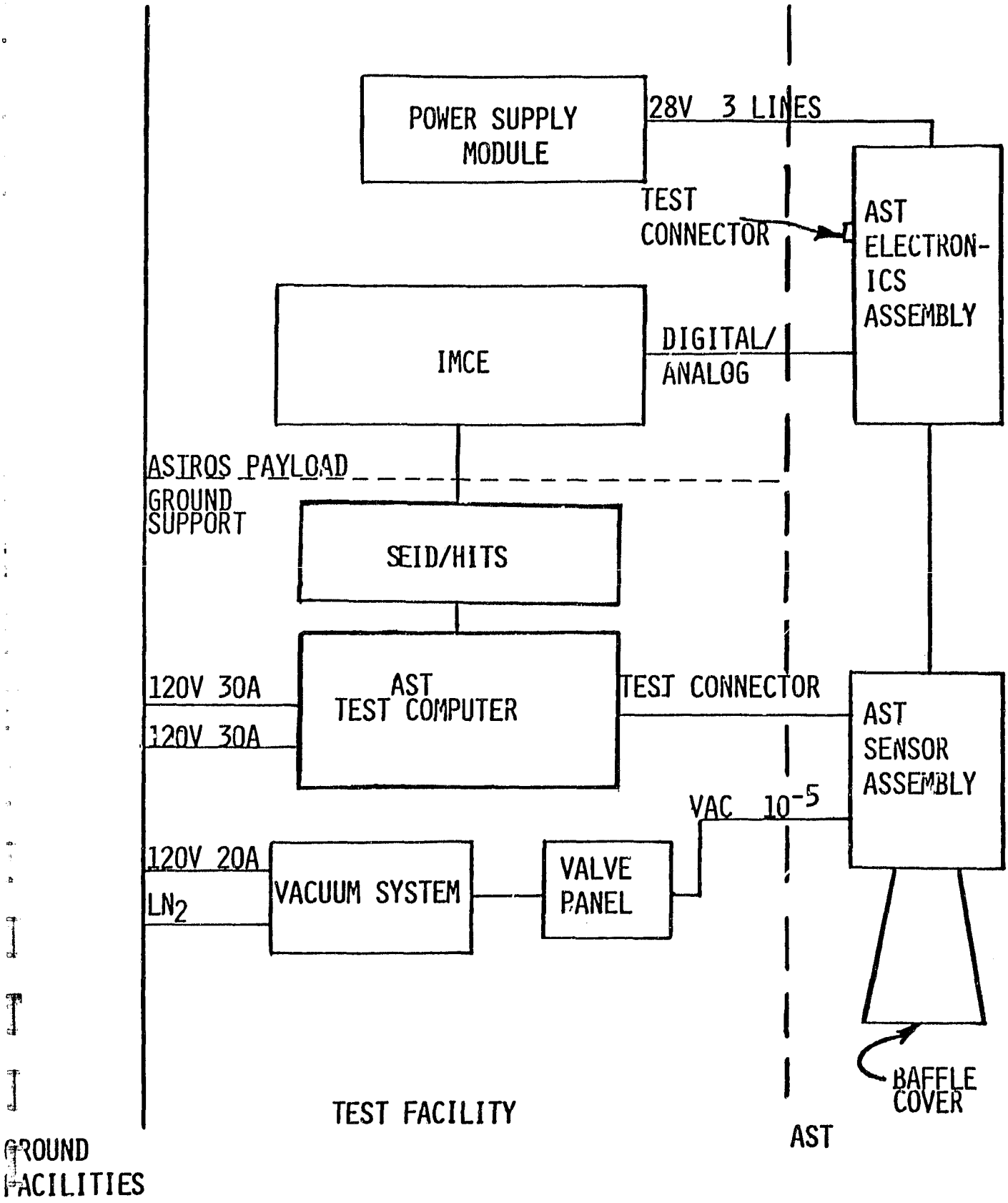


FIGURE 2-6: LEVEL IV/RECERTIFICATION INTERFACES

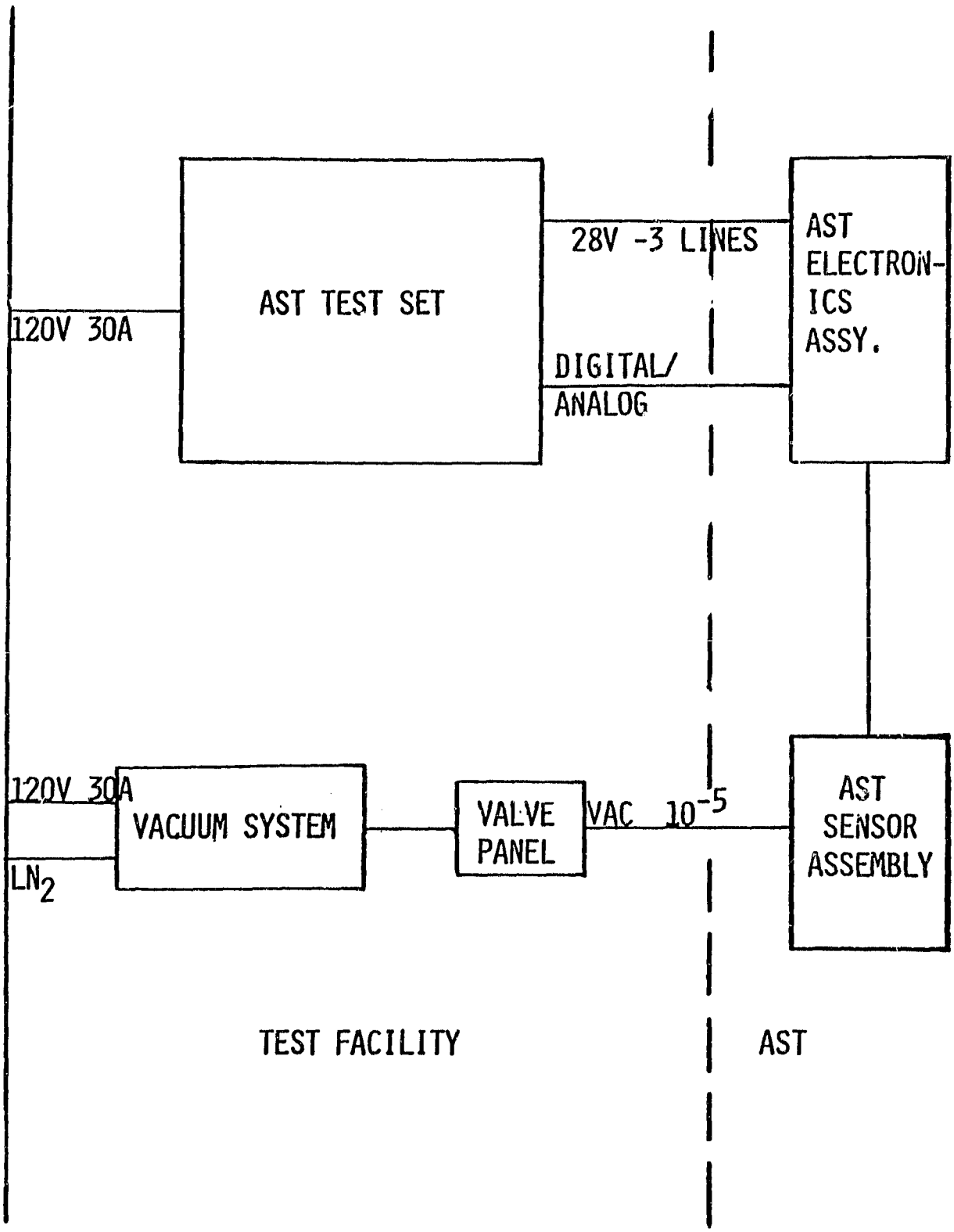


FIGURE 2-7: LEVEL IV OFF-LINE GROUND INTERFACE

2.4.2 Test/Commands

The following performance characteristics, using the AST flight command set and the LED self-test star source (as appropriate), will be measured . All status data output by the AST (digital, analog, bilevel) can be acquired by PDSS/IMC. Each of the AST flight commands will be issued and verified.

1. Acquisition
2. Track
    a. NEA
    b. Nominal Response
3. Search for Defects (Self-Test Star Off)
4. Flat Field Response Check (Light Flood)
5. Commands:
    a. Memory Dump
    b. Self-Test LED On/Off
    c. Light-Flood LED On/Off
    d. Add Defect Coordinates
    e. Reset Defect Map
    f. Frame Start
    g. Specify Update Interval

    ON/OFF Commands:
    a. TEC Power
    b. Master Reset
6. Analog Telemetry Checks

In addition to flight commands, a number of test commands (Table 2-2) will be supported. Other than the test connector interface, none of these commands requires any change to the command and data formats implemented for the flight command set.

PDSS/IMC will provide the capability to issue the AST test commands in addition to the AST flight commands. The baselined PDSS/IMC will not provide the "Frame Grabber" test connection.

2.5 PDSS/IMC Reflight Certification Requirements

The PDSS/IMC Reflight Certification package will provide the test commands, data acquisition and storage, and test data analysis to determine Reflight Certification acceptance criteria.

PDSS/IMC will provide the following functional capabilities for Reflight Certification:

- ECOS DEP Services
- MMU Loads
- IMCS Display Page
- IMCS Item Entry & Type Commands
- IMCS Timeline
- Ground/Test Commands
- IMCS ECIO Data Acquisition
- ECIO Data Display
- IMCS Reflight Certification Models
- IMCS Reflight Certification Analysis

Figure 2-8 depicts a functional block diagram of these functions.

PDSS/IMC will provide a PDSS/IMC MMU Data Set for loading IMCS during boot operation. The Data Set will consist of control system parameters for the Kalman Filter. The Flight/Reflight Flag will be set for reflight mode.

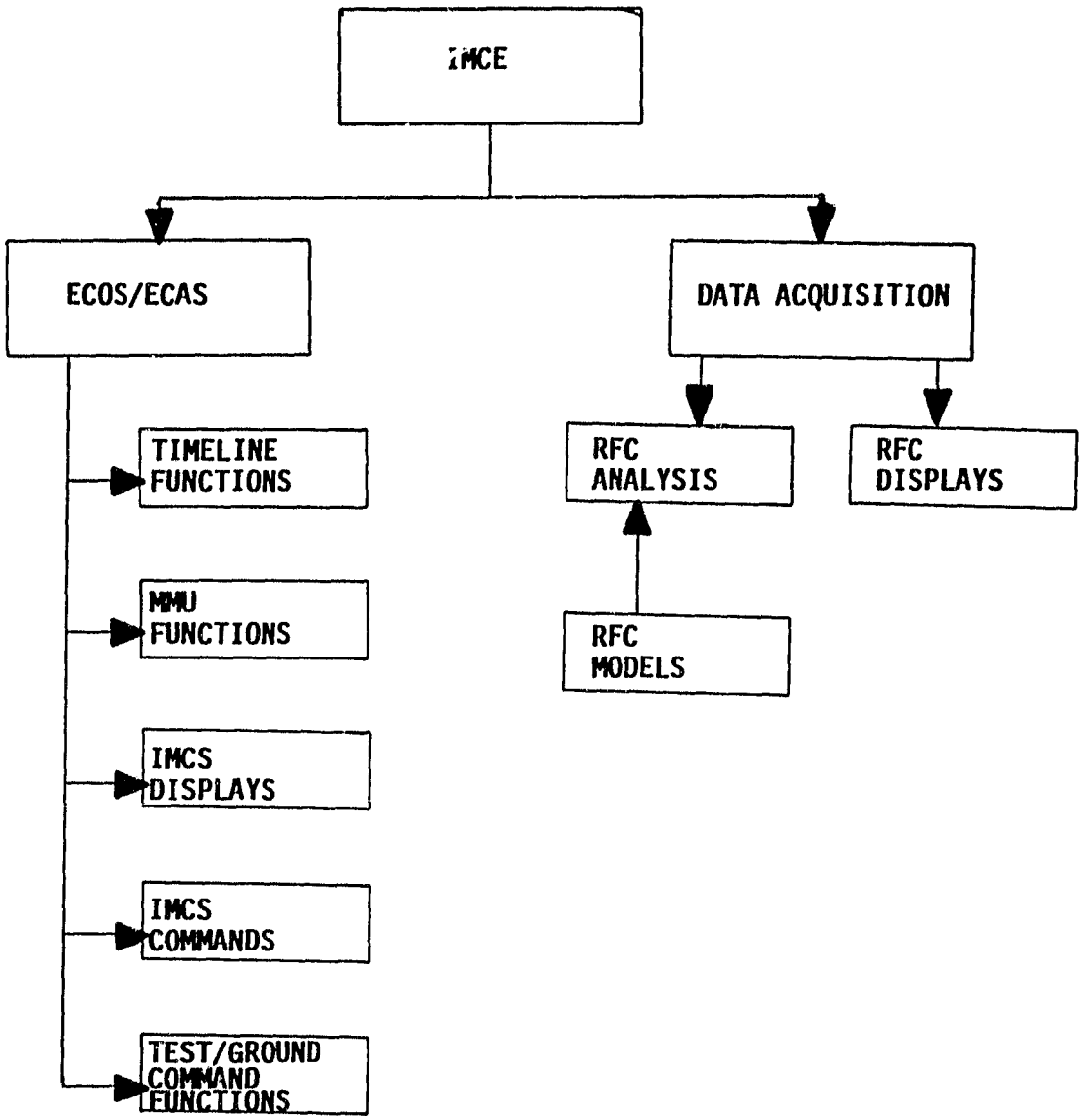


FIGURE 2-8: PDSS/IMC RFC FUNCTIONS

PDSS/IMC will provide the RAU serial channel logic to support the DEP protocol and the SPSME protocol commands and data acquisition required for IMCS. Most of the IMCS commands are initiated from the IMC Spacelab Display (Figure 2-9) or crew DDU type commands. PDSS/IMC will provide the IMCS display page and the associated crew commands.

The SPSME protocol commands are summarized in Table 2-1 and the DEP protocol commands are summarized in Table 2-2.

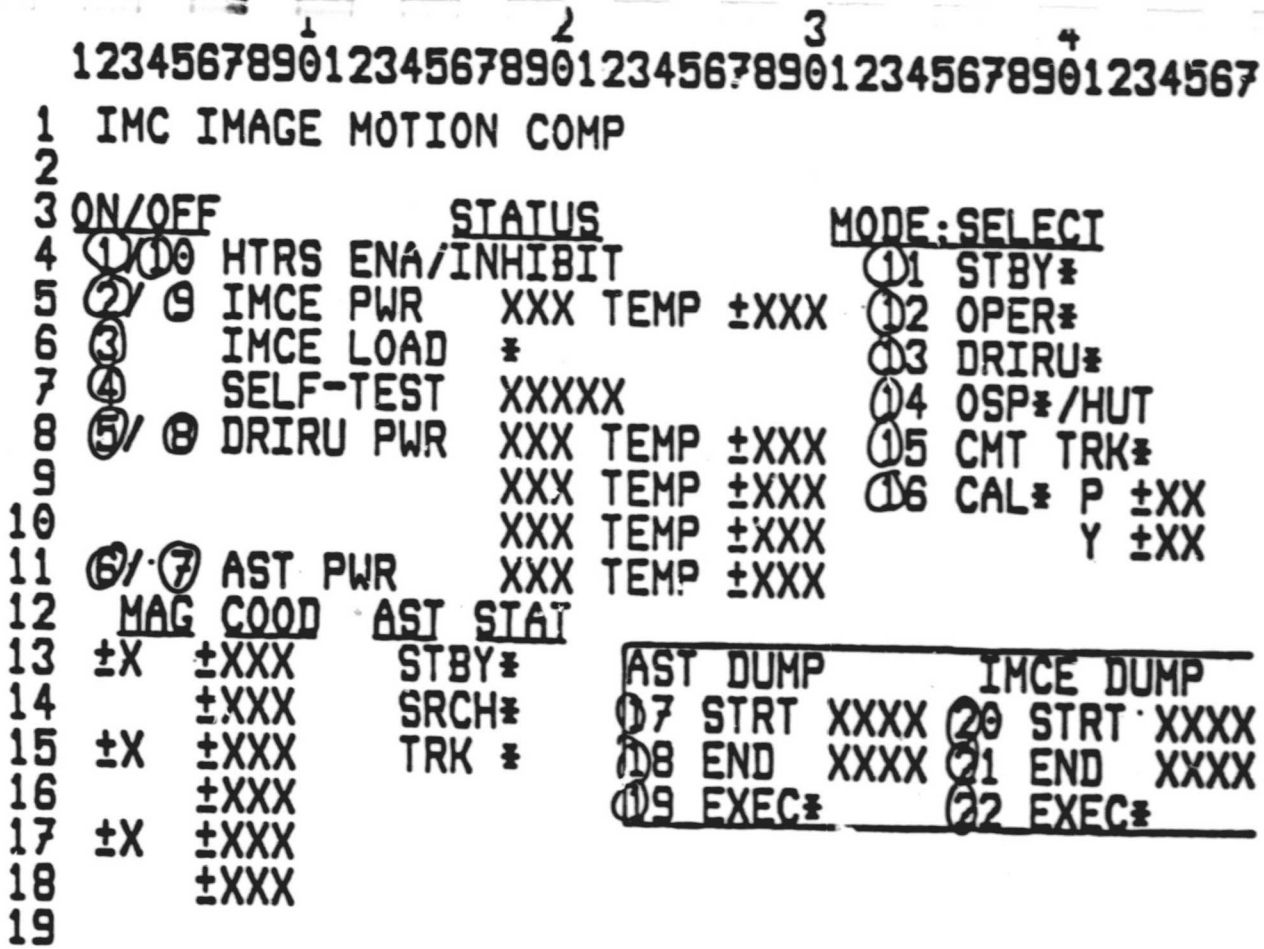


FIGURE 2-9: IMC DISPLAY FORMAT

MDC G 9827B
NOV 1983

TABLE 2-1: IMC SPSME PROTOCOL COMMANDS

COMMAND	DESCRIPTION	INITIATION*
IMCE LOAD	REQUEST IMCE MMU DATA BASE LOAD	I/E 3
SET GMT	RESET INTERNAL GMT	TYPE
TEST	PERFORM PCC AND DEP SELF TESTS	I/E 4
STANDBY	PLACE IMCE INTO STANDBY MODE	I/E 11
OPERATE	PLACE IMCE INTO OPERATE MODE	I/E 12
CALIBRATE	PLACE IMCE INTO CALIBRATE MODE	I/E 16
DRIRU ONLY	CONFIGURE IMCE FOR DRIRU ONLY MODE	I/E 13
COMET TRACK	CONFIGURE IMCE FOR COMET TRACK MODE	I/E 15
REBOOT IMCE	REBOOT PCC AND DEP	
GYRO XA YB ZA	SELECT GYRO CHANNEL XA YB ZA	
GYRO XA YB ZC	SELECT GYRO CHANNEL XA YB ZC	
GYRO XA YC ZA	SELECT GYRO CHANNEL XA YC ZA	
GYRO XA YC ZC	SELECT GYRO CHANNEL XA YC ZC	
GYRO XB YB ZA	SELECT GYRO CHANNEL XB YB ZA	
GYRO XB YB ZC	SELECT GYRO CHANNEL XB YB ZC	
GYRO XB YC ZA	SELECT GYRO CHANNEL XB YC ZA	
GYRO XB YC ZC	SELECT GYRO CHANNEL XB YC ZC	
AST STANDBY	PLACE AST IN STANDBY MODE	
FRAME SEARCH (LFOV)	AST ACQUISITION LIMITED FIELD OF VIEW	
FRAME SEARCH (FFOV) (FULL FOV)	AST ACQUISITION FULL FIELD OF VIEW	
RESET DEFECT MAP	RETURN TO DEFAULT DEFECT COORDINATES	
SELF-TEST LED ON	AST SELF-TEST LED ON	
SELF-TEST LED OFF	AST SELF-TEST LED OFF	
LIGHT FLOOD ON	AST LIGHT FLOOD ON	
LIGHT FLOOD OFF	AST LIGHT FLOOD OFF	
FRAME START	START TRACKING NEW FRAME OF DATA	

* I/E = ITEM ENTRY

TABLE 2-2: IMC DEP PROTOCOL COMMANDS

COMMAND	DESCRIPTION	INITIATION*
IMCE DEP DUMP	DUMP DEP MEMORY	I/E 20,21,22
IMCE PCC DUMP	DUMP PCC MEMORY	I/E TBD
AST DUMP	DUMP AST MEMORY	I/E 17,18,19
ADD DEFECT COORD	ADD DEFECTS TO AST DEFECT MAP	
SPECIFY UPDATE INT	SPECIFY INTERVAL BETWEEN AST UPDATES	
AST MAP MODE	SCANS CCD	
AST WINDOW MODE	ACQUIRES 5X5 PIXEL DATA	
AST DIAGNOSTIC MODE	PERFORM DIAGNOSTIC	

I/E = ITEM ENTRY

2.6 IMCS Flight Software Reflight Certification Requirements

The IMCS Reflight Certification requirements are designed to utilize the IMCE flight software package as defined per the IMCS Flight Software Requirements Specification (MSFC-RQMT-933).

The IMCS flight software will exhibit the following capabilities for IMC Reflight Certification.

1. The IMCS HRM format (PCC multitask HRM generation) will be the same for reflight as for flight. IMCS reflight will use the variable buffer for outputting any unique reflight data.

2. The IMCS flight software boot, selftest, and memory load operations will be performed for reflight operations. The IMCS Memory Load (flight = from Spacelab MMU upon command by crew from DDU, RFC = from PDSS/IMC upon command by operator from DDU) will contain a flag (data cell) that indicates the IMCS is to enter Reflight Certification mode rather than flight mode.

3. IMCE flight software will communicate with PDSS/IMC over a serial PCM channel employing a maximum of 32 words (16 bit) per message using the Spacelab DEP protocol.

4. The IMCS flight software will provide the capability to issue all AST flight and test commands. These commands will be sent from the PDSS/IMC SEID RAU interface to the IMCE. Upon receipt of the AST commands, the IMCS will issue the serial command to the ASTROS.

5. The IMCS flight software will provide the capability to read and accumulate DRIRU-II gyro data. Reflight Certification requires the capability to acquire gyro data from IMCE on the SPSME RAU serial channel.

The flight software will provide status and data via the SPSME serial channel. The data is identified in Tables 2-3 and 2-4. The format of the ECIO data will be defined by the flight software prior to CDR.

The ECIO data stream includes:

- 33 Analogs (8 bits)
- TBD Analog Spares
- 56 Discretes
- TBD Discrete Spares

The ECIO data will be acquired by the PDSS/IMC simulation of the Generalized Measurement Loop (GML). The GML will acquire ECIO data from the RAUI serial interface once per second. The two primary RAUI serial transaction commands to be used are:

STSW/ID	TRANSACTION
AA--	Read Serial Analog Inputs (Groups)
CC--	Read Serial Discrete Inputs (Groups)

Each Read Serial Analog Input reads 1 to 4 blocks - a block is 16 analog (8 bits) data values.

Each Read Serial Discrete Input reads 1 to 8 discrete words - a discrete word is 16 discretes (16 bits).

The number of serial transactions are determined by the ECIO format; i.e., the embedded format of the analogs and discretes in the RAUI buffers.

TABLE 2-3: PCC TO EXPERIMENT COMPUTER DATA
(ANALOG)

DESCRIPTION	SAMPLE RATE	SIZE (bits)	RAUI* BLOCK, ID
A GYRO Temperature	1	8	
B GYRO Temperature	1	8	
C GYRO Temperature	1	8	
A GYRO Motor Current	1	8	
B GYRO Motor Current	1	8	
C GYRO Motor Current	1	8	
X Axis Rate A	1	8	
X Axis Rate B	1	8	
Y Axis Rate B	1	8	
Y Axis Rate C	1	8	
Z Axis Rate A	1	8	
Z Axis Rate C	1	8	
AST CCD Temperature	1	8	
AST Heat Sink Temperature	1	8	
AST Optics Temperature	1	8	
AST EA Temperature	1	8	
AST CCD Cooler Volt	1	8	
AST Heater 1 Volt	1	8	
AST Heater 2 Volt	1	8	
AST Heater 3 Volt	1	8	
AST SA Electronics Temperature	1	8	
AST Baseplate Temperature	1	8	
AST +5 Volts	1	8	
AST +8 Volts	1	8	
AST +18 Volts	1	8	
AST -18 Volts	1	8	
IMCE Temperature	1	8	
Magnetic Vector 1	1	8	
Magnetic Vector 2	1	8	
Magnetic Vector 3	1	8	
Pitch CAL	1	8	
YAW CAL	1	8	

* RAUI Block, Id are to be defined by flight software.

TABLE 2-4: PCC TO EXPERIMENT COMPUTER DATA
(DISCRETE)

DESCRIPTION		SAMPLE RATE	SIZE (bits)	RAUI* WORD [BITS]
DRI Range Status XA DI		1	1	
DRI Range Status XB DI		1	1	
DRI Range Status YB DI		1	1	
DRI Range Status YC DI		1	1	
DRI Range Status ZA DI		1	1	
DRI Range Status ZC DI		1	1	
DRI Mode CMD HI Rate 1A DO		1	1	
DRI Mode CMD HI Rate 2A DO		1	1	
DRI Mode CMD LO Rate 1A DO		1	1	
DRI Mode CMD LO Rate 2A DO		1	1	
DRI Mode CMD HI Rate 1B DO		1	1	
DRI Mode CMD HI Rate 2B DO		1	1	
DRI Mode CMD LO Rate 1B DO		1	1	
DRI Mode CMD LO Rate 2B DO		1	1	
DRI Mode CMD HI Rate 1C DO		1	1	
DRI Mode CMD HI Rate 2C DO		1	1	
DRI Mode CMD LO Rate 1C DO		1	1	
DRI Mode CMD LO Rate 2C DO		1	1	
AST Master Clock Status		1	1	
AST T/E Cooler Power On/Off DO		1	1	
AST Spare		1	1	
AST Master Reset DO		1	1	
RAU RAUI Status DO		1	1	
Load MMU On/Off	DEP1	1	1	
Load OK Y/N	DEP2	1	1	
Test GO/NOGO	DEP3	1	1	
DRI Mode HI/LO	DEP4	1	1	
STBY On/Off	DEP5	1	1	
Oper On/Off	DEP6	1	1	
DRI (Only) On/Off	DEP7	1	1	
CMT On/Off	DEP9	1	1	
CAL On/Off	DEP10	1	1	
AST STBY Y/N	DEP11	1	1	
AST SRC11 Y/N	DEP12	1	1	
AST TRK Y/N	DEP13	1	1	
XA YB ZA On/Off	DEP 2-01	1	1	
XA YB ZC On/Off	DEP 2-02	1	1	
XA YC ZA On/Off	DEP 2-03	1	1	
XA YC ZC On/Off	DEP 2-04	1	1	
XB YB ZA On/Off	DEP 2-05	1	1	
XB YB ZC On/OFF	DEP 2-06	1	1	
XB YC ZA On/OFF	DEP 2-07	1	1	
XB YC ZC On/Off	DEP 2-08	1	1	

* RAUI Word, Bit are to be defined by flight software.

TABLE 2-4: PCC TO EXPERIMENT COMPUTER DATA (DISCRETE)

DESCRIPTION		SAMPLE RATE	SIZE (bits)	RAUI* WORD [BITS]
Telemetry On/Off	PCC 01	1	1	
RAU Data On/Off	PCC 02	1	1	
DEP Test On/Off	PCC 03	1	1	
AST Test On/Off	PCC 04	1	1	
Operate On/Off	PCC 06	1	1	
Comet On/Off	PCC 07	1	1	
DEP Dump On/Off	PCC 08	1	1	
AST Dump On/Off	PCC 09	1	1	
STBY On/Off	PCC 10	1	1	
Acquisition On/Off	PCC 11	1	1	
Execute On/Off	PCC 12	1	1	
Boot On/Off	PCC 13	1	1	
PCC Dump On/Off	PCC 14	1	1	

* RAUI Word, Bit are to be defined by flight software.

3.0 Interfaces

PDSS/IMC will provide the interfaces from IMCE to the SEID as detailed in Tables 3-1 to 3-3. PDSS/IMC will acquire the data at a rate of once per second. Commands to the IMCE will be issued on request.

Tables 3-4 and 3-5 detail the PDSS/IMC cabling.

Figure 3-1 depicts the data flow for PDSS/IMC.

TABLE 3-1: RAU/SEID DO COMMANDS

COMMAND			IMCE		SEID	
DRIRU	RSTO	RSTX1A	DI	101	DO	00
		SPARE	DI	102	DO	01
		RSTX1B	DI	103	DO	02
		SPARE	DI	104	DO	03
		RSTY1B	DI	105	DO	04
		SPARE	DI	106	DO	05
		RSTY1C	DI	107	DO	06
		SPARE	DI	108	DO	07
		RSTZ1A	DI	109	DO	08
		SPARE	DI	110	DO	09
		RSTZ1C	DI	111	DO	10
		SPARE	DI	112	DO	11
CPD	DRIRU	X POWER ON			DO	48
	DRIRU	X POWER OFF			DO	49
	DRIRU	Y POWER ON			DO	50
	DRIRU	Y POWER OFF			DO	51
	DRIRU	Z POWER ON			DO	52
	DRIRU	Z POWER OFF			DO	53
	DRIRU	HEATER POWER ON			DO	54
	DRIRU	HEATER POWER OFF			DO	55
	IMCE	POWER ON			DO	56
	IMCE	POWER OFF			DO	57
	IMCE	HEATER ON			DO	58
	IMCE	HEATER OFF			DO	59
	AST	POWER ON			DO	60
	AST	POWER OFF			DO	61
	EA	HEATER ON			DO	62
	EA	HEATER OFF			DO	63
	SA	HEATER ON			DO	32
	SA	HEATER OFF			DO	33

TABLE 3-2: RAU/SEID FI COMMANDS

COMMAND			IMCE		SEID	
AST	COOL	PWR ON/OFF	DO	1	FI	.6
AST	SPARE		DO	2	FI	17
AST	MASTER	RESET	DO	3	FI	18
DRIRU	EIMC	RRH1A	DO	-	FI	00
		RRH2A	DO	-	FI	01
		RRL1A	DO	-	FI	02
		RRL2A	DO	-	FI	03
		RRH1B	DO	-	FI	04
		RRH2B	DO	-	FI	05
		RRL1B	DO	-	FI	06
		RRL2B	DO	-	FI	07
		RRH1C	DO	-	FI	08
		RRH2C	DO	-	FI	09
		RRL1C	DO	-	FI	10
		RRL2C	DO	-	FI	11
POWER	+5V		AO	-	FI	32
	+15V		AO	-	FI	33
	-15V		AO	-	FI	34
	TEMP		AO	-	FI	35

TABLE 3-3: RAU/SEID SI-SO DATA

DATA		IMCE	SEID
RAUI	DEP	RAUI	CH 0
RAUI	SPSME	RAUI	CH 0

TABLE 3-4: PDSS/IMC CABLING

PDSS/IMC		CPD		
J8	2	DRIRU 11	X POWER ON	(48)
	3	RTN		
	4	SLD		
	5	DRIRU 11	X POWER OFF	(49)
	6	RTN		
	7	SLD		
	8	DRIRU 11	Y POWER ON	(50)
	9	RTN		
	10	SLD		
	11	DRIRU 11	Y POWER OFF	(51)
	12	RTN		
	13	SLD		
	14	DRIRU 11	Z POWER ON	(52)
	15	RTN		
	16	SLD		
	18	DRIRU 11	Z POWER OFF	(53)
	19	RTN		
	20	SLD		
	21	DRIRU 11	HEATER POWER ON	(54)
	22	RTN		
	23	SLD		
	24	DRIRU 11	HEATER POWER OFF	(55)
	25	RTN		
	17	SLD		
	26	IMCE	POWER ON	(56)
	27	RTN		
	28	SLD		
	29	IMCE	POWER OFF	(57)
	30	RTN		
	31	SLD		
	32	IMCE	HEATER ON	(58)
	33	RTN		
	41	SLD		

TABLE 3-4: PDSS/IMC CABLING
(CONTINUED)

	35	IMCE	HEATER OFF	(59)
	36	RTN		
	37	SLD		
	38	AST	POWER ON	(60)
	39	RTN		
	40	SLD		
	34	AST	POWER OFF	(61)
	42	RTN		
	43	SLD		
	44	EA	HEATER ON	(62)
	45	RTN		
	46	SLD		
	47	EA	HEATER OFF	(63)
	48	RTN		
	54	SLD		
J7	2	SA	HEATER ON	(32)
	3	RTN		
	4	SLD		
	5	SA	HEATER OFF	
	6	RTN		
	7	SLD		

PDSS/IMC-RAUI

J10	16	SERIAL IN REQUEST
	21	GND
	22	SLD
	23	SERIAL IN DATA (TRUE)
	18	SERIAL IN DATA (FALSE)
	17	SLD
	27	SERIAL IN CLOCK (TRUE)
	28	SERIAL IN CLOCK (FALSE)
	24	SLD
	6	SERIAL PCM COMMAND (TRUE)
	12	SERIAL PCM COMMAND (FALSE)
	11	SLD

TABLE 3-4: PDSS/IMC CABLING
(CONTINUED)

	2	SERIAL PCM CLOCK (TRUE)
	3	SERIAL PCM CLOCK (FALSE)
	7	SLD

PDSS/IMC-TMI

J11	8	UTC (TRUE)
	14	UTC (FALSE)
	13	SLD
	25	UTC UPDATE (TRUE)
	20	UTC UPDATE (FALSE)
	19	SLD

PDSS/IMC-HRMI

J9	2	HRM DATA (TRUE)
	4	HRM DATA (FALSE)
	3	SHIELD
	5	HRM CLOCK (TRUE)
	7	HRM CLOCK (FALSE)
	6	SHIELD

TABLE 3-5: PDSS/IMC CONNECTORS

CONNECTION	TYPE
J7	2064-37-1 AMP
J8	2064-37-1 AMP
J10	206039-1 AMP
J11	206039-1 AMP
J9	DE9P AMP

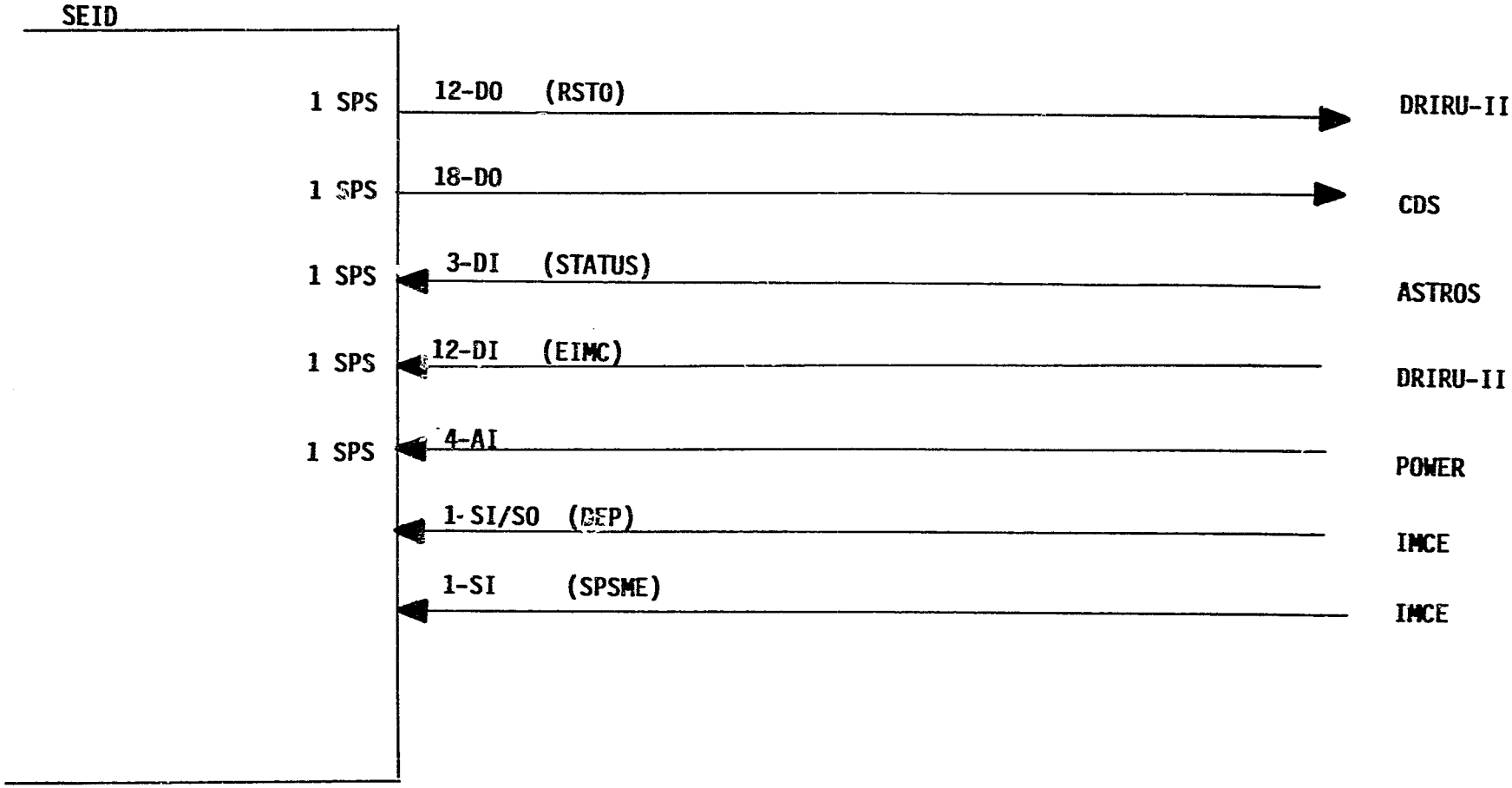


FIGURE 3-1: RFC DATA FLOW

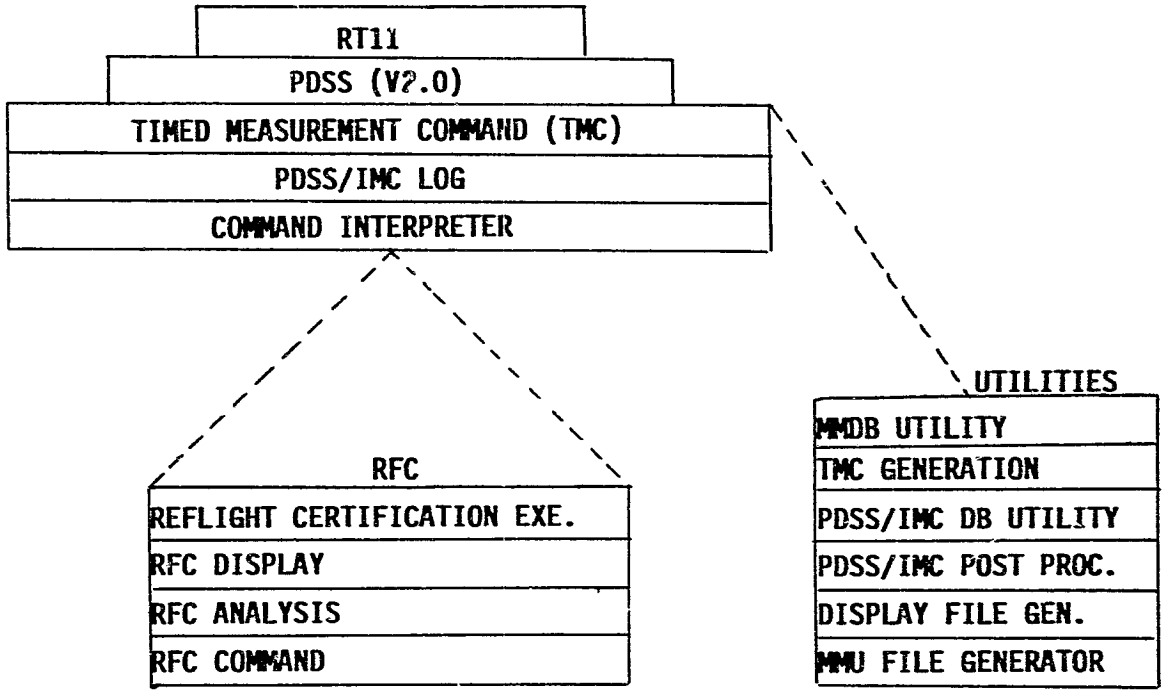
4.0 ACCEPTANCE CRITERIA

The PDSS/IMC reflight software acceptance criteria will be the installation and performance of the package on the ITF. The PDSS/IMC will perform in accordance with this requirement document, the design specifications, and the PDSS/IMC Reflight Software User's Document.

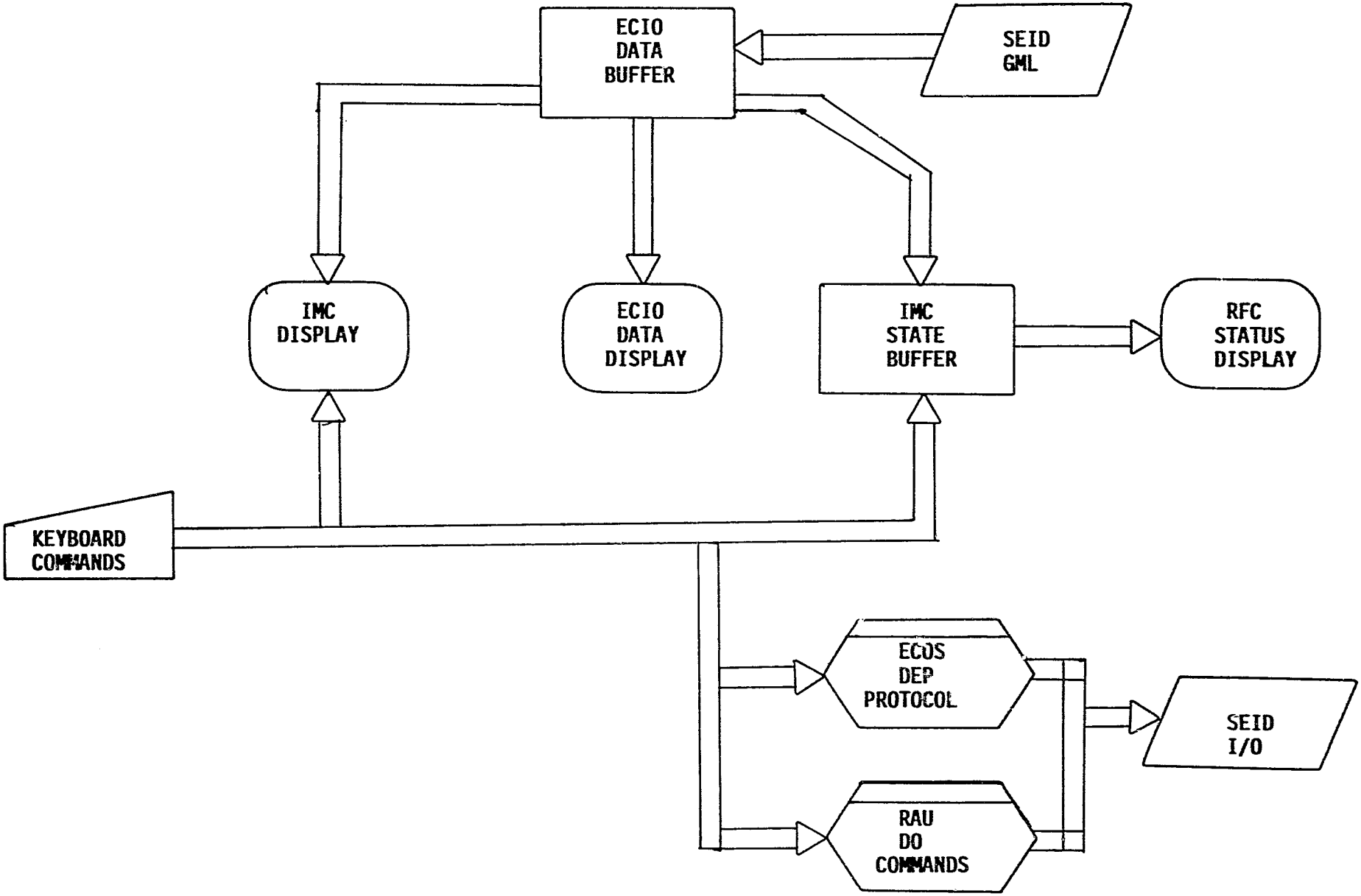
A test plan will also be prepared for integrated testing of the PDSS/IMC reflight software on the ITF. The plan will specify the tests to be performed including test setup, test procedures, test data, and test evaluation parameters. Performance in accordance with this plan will be required before general use of the package.

5.0 DESIGN SPECIFICATION

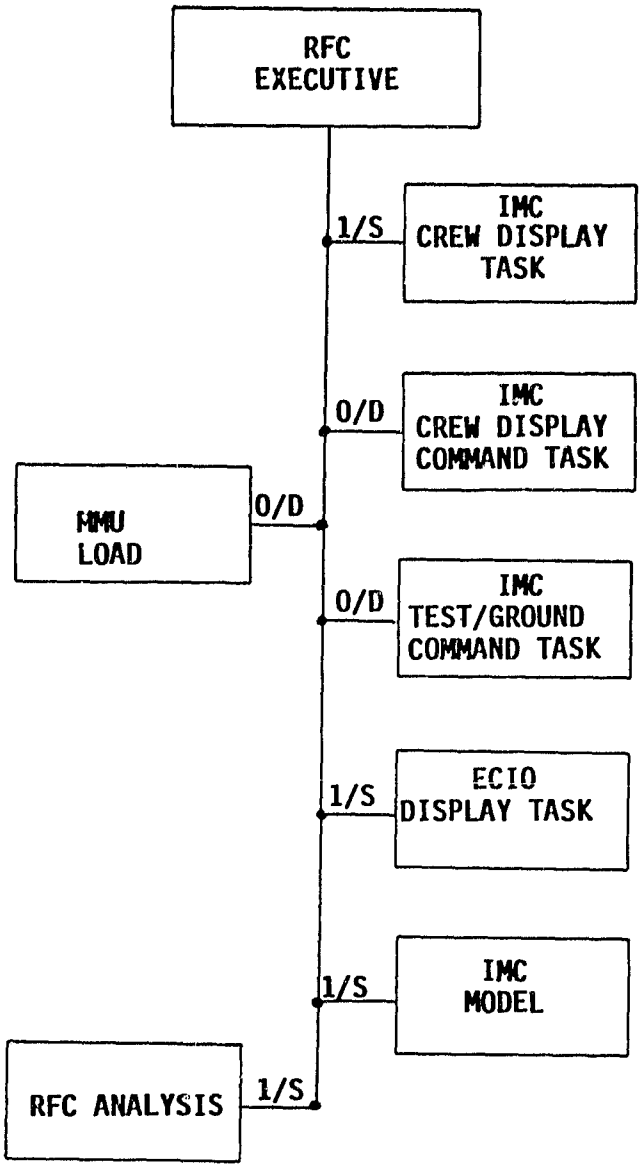
This section contains the functional design specifications of the PDSS/IMC reflight software.



PDSS/IMC REFLIGHT SOFTWARE



PDSS/IMC RFC DATA FLOW



PDSS/IMC REFLIGHT SOFTWARE TASKS

MODULE: RFC EXECUTIVE		
	PROCEDURE RFC-EXECUTIVE	
PDSS DISK	LOAD IMC DISPLAY PAGE	VDU
PDSS DISK	LOAD & INITIATE IMC GML	SEID
PDSS DISK	LOAD & REFRESH IMC ECIO PAGE	VDC
PDSS DISK	LOAD & INITIATE IMC TIMELINE	
	DO UNTIL "STOP"	
	SCHEDULE RFC TASKS	
	ENDDO	
	PRINT ECIO DATA	
	PRINT RFC DATA	
	STOP	
	END	

MODULE: MMU LOAD		
DDU/KB	ON ITEM ENTRY 3 PERFORM MMU-LOAD MMU-LOAD	
PDSS DISK	FETCH MMU LOAD FILE DO UNTIL FILE EXHAUSTED ISSUE DEP LOAD COMMAND ENDDO END	

MODULE: CREW-DISPLAY

	CREW-DISPLAY	
	IF BG NOT LOADED	
	THEN	
PDSS DISK	FETCH IMC DISPLAY FILE	
	MOVE BACKGROUND DATA TO DISPLAY	VRA-2K
	SET BG AS LOADED	
	ENDIF	
	DO UNTIL ALL FIELDS UPDATED	
	FETCH FIELD DATA FROM ECIO BUFFER	
	CONVERT TO DISPLAYABLE FORMAT	
	MOVE DATA TO DISPALY	VRA-2K
	ENDDO	
	END	

MODULE: CREW-COMMAND

PDSS/KB	ON KB CREW COMMAND ENTRY PERFORM
	CREW-COMMAND
	
	CREW-TASK
	IF KB ENTRY IS "ITEM ENTRY"
	THEN
	GENERATE SPSME DISCRETE OUTPUT#
	ISSUE SPSME DISCRETE
	ELSE
	SEND DEP USER'S MESSAGE
	ENDIF
	
	MARK RFC DATA COMMAND COMPLETED
	
	END
		SEID SO
		SEID SO

MODULE: TEST/GROUND-COMMAND		
PDSS/KB	ON KB ENTRY ("=") PERFORM T/G-COMMAND	
	T/G-COMMAND	
	GENERATE DEP USER'S MESSAGE	
	ISSUE DEP MESSAGE	SEID SO
	READ BACK DEP RESPONSE MESSAGE	SEID SI
	DISPLAY DEP COMMAND & RESPONSE	
	MARK RFC DATA COMMANDS COMPLETE	
	END	

MODULE: ECIO-DISPLAY

	ECIO-DISPLAY
	  DO FOR ALL ECIO DATA ITEMS
	  FETCH DATA FROM ECIO BUFFER
	  CONVERT TO DISPLAYABLE FORMAT
	  MOVE TO DISPLAY AREA
	  ENDDO
	END
		VRA-2K

MODULE: IMC-MODEL		
	IMC-MODEL FETCH GMT CALCULATE DT SINCE TEST BEGAN FETCH GYRO DRIFT DATA COMPUTE EARTH'S RATE END IMC-MODEL	SEID

MODULE: RFC-ANALYSIS

```
RFC-ANALYSIS
  VERIFY DRIRU DRIFT RATE
  VERIFY DRIRU STATE
  VERIFY ASTROS STATE
  VERIFY ASTROS DATA
  VERIFY UIT INTERFACE
  VERIFY WUPPE INTERFACE
  VERIFY IMCE STATUS
END
```