SH 1

DWG. NO. 99-343-0006

CAGE NO. 0P0N7

DASH NO. REV STATUS					REVISIONS			
DASH	-01	-02	-03	-04	REV	DESCRIPTION	DATE	APPROVED
REV					-	INITIAL RELEASE	05/11/11	K. SEARS

Notes:

1. Engineering Drawing Practices in accordance with ISO 128.

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN mm

THIRD ANGLE
PROJECTION

DWN	D. YORK	04/03/10
CHK	C. EMMONS	04/03/10
ORIG	J. DELGADILLO	04/03/10
PROD MGR	F. COLE	04/03/10
CE MGR		

THIS DOCUMENT IS FOR REFERENCE ONLY AND MAY NOT BE INCORPORATED INTO A DESIGN OR USED FOR MANUFACTURE OR PROCUREMENT FROM SOURCES OTHER THAN GENERAL DYNAMICS C4 SYSTEMS VERTEXRSI THE CONTENTS OF THIS DOCUMENT MAY BE DISCLOSED ONLY TO CUSTOMERS HAVING INTERFACE, OPERATION OR MAINTENANCE REQUIREMENTS SPECIFIC TO THIS EQUIPMENT.

Vertex RSI®
GENERAL DYNAMICS

DWG TITLE

VISTA MCS, INTEGRATED TEST PROCEDURE

SIZE	CAGE NO.	DWG NO.	REV
A4	0P0N7	99-343-0006	-

VIS - PRO - VER - 01001-9008

SCALE NONE | WEIGHT: | SHEET 1 OF 125

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

1.0 SCOPE/INTRODUCTION

This procedure details the tests, measurements, and performance criteria for the Integrated Acceptance Test of the Vista Optical Telescope Mount Control System.

1.1 EQUIPMENT CONFIGURATION

The system components provided by General Dynamics C4 Systems VertexRSI (VRSI), Richardson Controls Facility are interconnected per the System Schematic 99-343-0002 (VPO Dwg. No. VIS-DWG-VER-01001-9002).

The MCU and the PMU are not part of the system being delivered to meet the requirements of the Tech. Spec and the SOW, and thus can be considered as test equipment. For this reason, the units testing have been placed in Appendixes.

1.2 TEST CONDITIONS

All tests will be performed under ambient conditions of temperature, atmospheric pressure, and humidity. All heating and air conditioning equipment intended to provide a controlled environment must be installed and operating.

1.3 TEST DATA

This document provides for the recording of test data. Test steps followed by the word "Record" require a measurable value to be recorded in the space provided. Test steps followed by the word "Check" require a mark (✓) to be made in the space provided upon successful completion of the observation or function. Any additional data generated during the performance of this test (recordings, notes, calculations, etc.) are considered to be part of this test procedure and shall be attached hereto.

1.4 ACCEPTANCE/REJECT CRITERIA

Most individual test measurements have tolerance limits specified in this procedure. The basis for acceptance of the equipment is:

a. All measurements are within the tolerance allowed.

b. All test functions or observations are successfully completed.

1.5 ACRONYMS

The following acronyms may appear in this test procedure.

AZ	Azimuth Axis
AZ/ALT PDU	Azimuth/Altitude Power Drive Unit
CCU	Central Control Unit
CCW	Counter Clockwise
CW	Clockwise
DAQ	Data Acquisition Unit
DVM	Digital Volt Meter
ALT	Altitude Axis
FOG	Fiber Optic Gyroscope
MCU	Mount Control Unit
CASS PDU	Cassegrain Power Drive Unit
PMU	Portable Maintenance Unit
MCS	Mount Control System
CASS C.W.	Cassegrain Cablewrap
LVDT	Linear Variable Differential Transformer

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this Test Procedure to the extent specified herein.

VIS-SPE-ATC-01000-0006 ISSUE 4.0 (Record)

3.0 TEST EQUIPMENT

The following items are required for the performance of this testing:

3.1 COMMERCIAL TEST EQUIPMENT

a. Dynamic Signal Analyzer

Manufacture/Model No. HP 35670A (Record)

Serial No. T-234 (Record)

Calibration Due Date 5/5/06 (Record)

b. Function Generator

Manufacture/Model No. LEADER LG1301 (Record)

Serial No. T-360 (Record)

Calibration Due Date None Required (Record)

c. Strip Chart Recorder
Manufacture/Model No. ASTROMED DASH IV (Record)
Serial No. T-362 (Record)
Calibration Due Date 2/25/06 (Record)

d. Digital Volt Meter
Manufacture/Model No. FLUKE 179 (Record)
Serial No. T-605 (Record)
Calibration Due Date 5/18/06 (Record)

e. DC Power Supply
Manufacture/Model No. TENMA 72-6628 (Record)
Serial No. T-589 (Record)
Calibration Due Date None Required

f. Temperature Sensor
Manufacture/Model No. __________ (Record)
Serial No. __________ (Record)
Calibration Due Date __________ (Record)

g. True-RMS Data Acquistions Instrument
Manufacture/Model No. IOTECH DAQBOOK 216 (Record)
Serial No. T-511 (Record)
Calibration Due Date 12/21/05 (Record)

3.2 VERTEXRSI SUPPLIED SPECIAL TEST EQUIPMENT

a. Three Phase Isolation Transformer

b. Data Acquisition Unit Host Computer

c. Anemometer Host Computer

3.3 EQUIPMENT UNDER TEST

	P/N	**S/N**
Mount Control Unit (MCU)	99-343-1100-01	326
AZ/ALT Power Drive Unit (AZ/ALT PDU)	99-343-2000-01	001
CASS Power Drive Unit (CASS PDU)	99-343-2010-01	001

	P/N	**S/N**
Regeneration Cabinet	99-343-2050-01	001
Portable Maintenance Unit (PMU)	99-343-3000-01	149
AZ Drive Motor #1	99-343-3500-01	—
AZ Drive Motor #2	99-343-3500-01	—
AZ Drive Motor #3	99-343-3500-01	—
AZ Drive Motor #4	99-343-3500-01	—
CASS Drive Motor #1	99-343-3500-02	—
CASS Drive Motor #2	99-343-3500-02	—
CASS Cablewrap Drive Motor	99-343-3500-02	—
Data Acquisition Unit	99-343-3300-01	
ALT FOG		
Anemometer #1	1086M	577
Anemometer #2	1086M	579
Anemometer #3	—	—
ALT Drive Motor #1	99-343-3501-01	—
ALT Drive Motor #2	99-343-3501-01	—
Isolation Transformer	99-343-4500-01	—

Record the revision and date of the MCU and AZ/ALT and CASS CCU Software as observed on the Self-Test Screen at the MCU.

MCU Software Revision 1.86.7.7 (Record)

Date 2005/9/30 (Record)

AZ/ALT CCU Software Revision 1.277.5.5 (Record)

Date 2005/10/14 (Record)

CASS CCU Software Revision 1.277.6.6 (Record)

Date 2005/11/08 (Record)

4.0 FUNCTIONAL TEST

The following tests will verify the functional operation of the servo system equipment. In general, the tests will be performed in the order listed; however, they may be performed in any order desired.

4.1 POWER UP/SETUP

4.1.1 Power Up

4.1.1.1 Verify that the equipment is configured per the System Schematic.

✓ (Check)

NOTE: **A test transformer is used for conducting the Integrated Acceptance Test due to unavailability of 400 VAC, 3∅ Utility Power at Mexia, Texas.**

4.1.1.2 Verify that the customer interfaces are as shown below.

Input 3Ø to AZ/ALT PDU 230 VAC ± 10%

✓ (Check)

Input 1Ø Utility Power to CASS PDU 230 VAC ± 10%

✓ (Check)

Input 1Ø to AZ/ALT PDU, CASS PDU, DAQ, and MCU 230 VAC ± 10%.

✓ (Check)

4.1.1.3 Verify power is applied to all system equipment under test.

✓ (Check)

4.1.1.4 Verify that the MCU powers up in the LCU Mode.

✓ (Check)

4.1.1.5 Enter Stop Mode at the MCU.

✓ (Check)

4.2 BRAKE FAULT

The PDU contains circuitry which will disable the motor drive if the brake fails to enable. A fault message will be displayed if the brake fails to energize or if remains enabled after the axis is disabled.

4.2.1 Enter an active mode and verify that the brakes are energized and motors are enabled.

✓ (Check)

4.2.2 Verify proper AZ Brake Released indication to LCU per Table 1.

✓ (Check)

4.2.3 Create a brake fault by temporarily disconnecting the brake pressure switch cable from the AZ/ALT PDU (J61). Enter an active mode and verify that the axis attempts to enable for about 1 sec and then disables the axis and issues a AZ BRAKE Fault Message. Verify proper AZ BRAKE FLT indication to LCU per Table 6.

AZ 1 Disconnect J61 ✓ (Check)

Active Mode ✓ (Check)

Axis Disables ✓ (Check)

Fault Reporting ✓ (Check)

NOTE: **Brake faults are latching faults that require cycling of the enable command to clear them.**

4.2.4 Reconnect the J61 Cable and clear faults.

✓ (Check)

4.2.5 Repeat 4.2.1 through 4.2.4 for AZ #2, AZ #3 and AZ #4 brakes.

Active Mode ✓ (Check)

AZ LCU Brake Released Stat ✓ (Check)

AZ2 Disconnect J62 ✓ (Check)

Active Mode ✓ (Check)

AZ #2 Brake Fault ✓ (Check)

AZ LCU Brake Fault ✓ (Check)

Reconnect J62 & Clear Faults ✓ (Check)

Active Mode ✓ (Check)

AZ LCU Brake Released Stat ✓ (Check)

AZ3 Disconnect J63 ✓ (Check)

Active Mode ✓ (Check)

AZ #3 Brake Fault ✓ (Check)

AZ LCU Brake Fault ✓ (Check)

Reconnect J63 & Clear Faults ✓ (Check)

Active Mode ✓ (Check)

AZ LCU Brake Released Stat ✓ (Check)

AZ4 Disconnect J64 ✓ (Check)

Active Mode ✓ (Check)

AZ #4 Brake Fault ✓ (Check)

AZ LCU Brake Fault ✓ (Check)

Reconnect J64 & Clear Faults ✓ (Check)

4.2.6 With the AZ Axis disabled, temporarily bypass the AZ Brake Status Switches to simulate released brakes (apply +24 VDC to A1A9P44-11). Verify that the "AZ BRAKE FAULT" Message is displayed at the MCU and to the AZ LCU.

✓ (Check)

4.2.7 Repeat 4.2.1 through 4.2.6 for Altitude Axis.

Active Mode ✓ (Check)

ALT LCU Brake Released Stat ✓ (Check)

ALT1, 3 Disconnect a Wire from TB3-72 ✓ (Check)

Active Mode ✓ (Check)

ALT #1,3 Brake Fault ✓ (Check)

ALT LCU Brake FLT per Table 7 ✓ (Check)

Reconnect Wire & Clear Faults ✓ (Check)

Active Mode ✓ (Check)

ALT LCU Brake Released Stat ✓ (Check)

ALT2, 4 Disconnect the other Wire from TB3-72 ✓ (Check)

Active Mode ✓ (Check)

ALT #2, 4 Brake Fault ✓ (Check)

ALT LCU Brake FLT per Table 7 ✓ (Check)

Reconnect Wire & Clear Faults ✓ (Check)

Δ1N9P44-10

Bypass ALT Brake Status Switches ✓ (Check)

ALT Brake Fault ✓ (Check)

ALT LCU Brake FLT per Table 7 ✓ (Check)

4.2.8 Repeat 4.2.1 through 4.2.6 for Cassegrain Axis.

Active Mode ✓ (Check)

CASS LCU Brake Released Stat ✓ (Check)

CASS1 Disconnect J52 ✓ (Check)

Active Mode ✓ (Check)

CASS #1 Brake Fault ✓ (Check)

CASS LCU Brake FLT per Table 8 ✓ (Check)

Reconnect J52 & Clear Faults ✓ (Check)

Active Mode ✓ (Check)

CASS LCU Brake Released Stat ✓ (Check)

CASS2 Disconnect J53 ✓ (Check)

Active Mode ✓ (Check)

CASS #2 Brake Fault ✓ (Check)

CASS LCU Brake FLT per Table 8 ✓ (Check)

Reconnect J53 & Clear Faults ✓ (Check)

Active Mode ✓ (Check)

CASS LCU Brake Released Stat ✓ (Check)

CASS C.W. Disconnect J54 ✓ (Check)

Active Mode ✓ (Check)

CASS Cablewrap Brake Fault ✓ (Check)

CASS LCU Brake FLT per Table 8 ✓ (Check)

Reconnect J54 & Clear Faults ✓ (Check)

A1A9P44-11

Bypass CASS Brake Status Switches ✓ (Check)

CASS Brake Fault ✓ (Check)

CASS LCU Brake FLT per Table 8 ✓ (Check)

4.3 LOOP TESTS

Each loop will be tested to verify its bandwidth and step response. The testing will start with Rate Loop and proceed to the Position Loop (Appendix B). In each case, the input to the loop will be removed and replaced with a controlled signal. The loop feedback will be monitored for acceptable performance.

4.3.1 Running Current

The following test will measure the current required to move the telescope mount at a constant velocity. This will be used as a baseline record of current mount performance to be used for comparison against future tests.

The following test will cause the mount to slowly accelerate to full speed and then to reverse full speed. The total distance traveled during the sweep is determined by the equation below:

$d = \frac{1}{2} at^2$ for acceleration.

$d = at^2$ for acceleration and deceleration.

f = Frequency of input triangle waveform.

$$a = \frac{Vmax}{t}$$

$$d = Vmax\ t$$

$$t = (\tfrac{1}{4})(\frac{1}{f})$$

$$d = (Vmax)(\tfrac{1}{4})(\frac{1}{f})$$

$$\text{For AZ and ALT} = (2°/\text{sec})(\tfrac{1}{4})(\frac{1\text{sec}}{0.02}) = 25°$$

For CASS = $(3.6°/\sec)(¼)(\frac{1\sec}{0.02}) = 45.0°$

4.3.1.1 Before starting this test, place the mount axes at a position which will allow the appropriate range of travel and record.

AZ Position 0.0° (Record)

ALT Position 45.0° (Record)

CASS Position 0.0° (Record)

4.3.1.2

a. Switch off the normal rate command input to the Rate Loop Board (AZ, CASS A14-1 (+) A14-2 (-) ALT C3-3 (+) C3-4 (-)) and connect the function generator. Set the function generator to ±10V peak, 0.02 Hz triangle wave. This provides a rate command of full velocity.

b. Verify that Channel 1 of the strip chart recorder is connected to the function generator.

c. Connect Channel 2 of the chart recorder to AZ, CASS (ALT, CASS C.W.). Rate Loop Board A25-8 (C25-8), to monitor axis current command (10V = Max overload motor current).

d. Using the PMU in the High Rate Mode, enable the axis under test and set the chart recorder to convenient settings and record.

Channel 1 ±12.5V (Record)

Channel 2 ± 12.5 V (Record)

Chart Speed — (Record)

4.3.1.3 Record one cycle of the triangle wave on the strip chart. Record the peak current using the following scale factor. Record the approximate AZ, ALT and CASS midpoint angle. Midpoint angle is the average of the two extreme angles. Extreme angles are the angles where the axis changes direction.

AZ 10V = 11.9A

ALT 10V = 20.4A

CASS 10V = 2.67A

CASS CW 10V = 1.73A

AZ Motor Rated Current 27.2 Amps

A1 Plot AZ Running Current POS 6.66 NEG -5.93 Amps (Record)

ALT Motor Rated Current 20.0 Amps

A2 Plot ALT Running Current POS 6.32 NEG -6.39 Amps (Record)

CASS Motor Rated Current 5.3 Amps

A 3 Plot CASS Running Current POS 1.15 NEG -1.16 Amps (Record)

CASS C.W. Motor Rated Current 5.3 Amps

A3 Plot CASS C.W. Running Current POS 1.05 NEG -1.20 Amps (Record)

AZ Angle 0.0° (Record)

ALT Angle 45.0° (Record)

CASS Angle 0.0° (Record)

4.3.1.4 The running currents will be measured over the entire range of travel to characterize the balance and/or friction. Remove the signal generator and switch on the normal rate command inputs.

✓ (Check)

4.3.1.5 Using the PMU in full LO Rate Mode, drive the mount 360° in the NEG direction with the strip chart recording the current command (AZ, CASS A25-8, ALT, CASS C.W. C25-8) with PMU in full low rate. Mark angles every 10° on the strip chart recording. Record the average current below. Repeat in the opposite direction.

A4 Plot AZ NEG Avg Current -1.27A (Record)

A5 Plot AZ POS Avg Current 1.2A (Record)

A6 Plot ALT NEG Avg Current -4.8A (Record)

A6 Plot ALT POS Avg Current ~~0.41A~~ 2.8A (Record)

A7 Plot CASS POS Avg Current 0.49A (Record)

A8 Plot CASS NEG Avg Current -0.41A (Record)

A7 Plot CASS CW POS Avg Current 0.58A (Record)

A8 plot CASS CW NEG Avg Current -0.48A (Record)

4.3.2 Rate Loop

The Rate Loop is tested for bandwidth, step response, acceleration and Locked Rotor Resonance.

4.3.2.1 Rate Loop Bandwidth and Locked Rotor Resonance

This test demonstrates the Rate Loop's Bandwidth defined as the frequency at which the feedback is 70% of the initial value.

4.3.2.1.1 **a.** Replace the normal rate command with the function generator by switching off the normal rate command input to the rate loop (A22-8 for AZ, CASS) (C22-8 for ALT, CASS CW). Connect the function generator to the above inputs and set to 0.22V peak-to-peak with a 0.1 VDC offset, 0.5 Hz, sine wave.

b. Connect Channel 1 of the chart recorder to the function generator. Connect the axis rate feedback at the Rate Loop Board A10-1 (AZ), B5-8 (CASS), C1-14 (ALT), C1-1 (CASS CW) to Channel 2 of the chart recorder to monitor rate feedback. Record settings.

Channel 1 Gain — (Record)

Channel 2 Gain — (Record)

Chart Speed — (Record)

c. Using the PMU, enable the axis and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the rate signals.

A9 Plot

d. Slowly increase the function generator frequency up through 100 Hz, while marking convenient frequencies as they occur. Appropriate personnel shall be stationed on the mount to monitor the mount structure while going through the resonant frequency.

e. A Dynamic Signal Analyzer may be used for this test. Attach the analyzer's test set-up printout to this procedure.

4.3.2.1.2 Drive ALT Axis to 45.0°. Record the frequency at which the feedback peak-to-peak voltage is 70% of the initial value.

A10, A11 Plot AZ 3 dB Bandwidth 26.9 Hz (Record)

4.3.2.1.3 Repeat Sections 4.3.2.1.1 and 4.3.2.1.2 for the ALT, CASS and CASS C.W. Axis and record the results below.

A12, A13 Plot ALT 3 dB Bandwidth 11.5 Hz (Record)

A14, A15 Plot CASS 3 dB Bandwidth 33.1 Hz (Record)

A16, A17 Plot CASS C.W. 3 dB Bandwidth 22.5 Hz (Record)

4.3.2.1.4 Verify that the 3 dB Bandwidths are >5 Hz.

✓ (Check)

4.3.2.1.5 Determine the Locked Rotor Resonance of the axis by looking for a definable dip in the response recording. Record the function generator output frequency at this point.

A10 Plot AZ Locked Rotor Resonance 9.8 Hz (Record)

(ALT = 45°)

A12 Plot ALT Locked Rotor Resonance COULD NOT BE MEASURED DUE TO LOOSE M|SIMULATOR Hz (Record)

A14 Plot CASS Locked Rotor Resonance NOT DETECTED Hz (Record)

A16 Plot CASS CW Locked Rotor Resonance NOT DETECTED Hz (Record)

4.3.2.1.6 Repeat 4.3.2.1.5 in Azimuth for an Altitude look angle of 90° and 0°.

A18 Plot AZ Locked Rotor Resonance 10.0 Hz (Record)

(ALT = 90°)

A19 Plot AZ Locked Rotor Resonance 9.8 Hz (Record)

(ALT = 0°)

4.3.2.2 Rate Loop Step Response

This test demonstrates the Rate Loop's ability to respond to a step change in commanded rate.

$$\text{Overshoot} = \left(\frac{\text{Max Value}}{\text{Final Value}} - 1 \right) * 100\%$$

Settling Time = (Start Time) - (Time at which the feedback is within 5% of the final value)

4.3.2.2.1

a. Drive the ALT Axis to 0° when performing this test.

b. With the setup unchanged from the bandwidth test, set the function generator to 0.5V peak-to-peak, 0.05 Hz, square wave.

c. Enable the axis using the PMU and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the rate signals and record.

Channel 1 Gain ±0.50V (Record)

Channel 2 Gain ±0.50 V (Record)

Chart Speed — (Record)

4.3.2.2.2 Record the percent of overshoot.

A21, A20 Plot AZ Overshoot 13 % (Record)

4.3.2.2.3 Repeat Sections 4.3.2.2.1 and 4.3.2.2.2 for the ALT, CASS and CASS C.W. Axis and record the results below.

A22, A23 Plot ALT Overshoot 25.5 % (Record)

A24, A25 Plot CASS Overshoot 7.3% (Record)

A26, A27 Plot CASS C.W. Overshoot 0 % (Record)

4.3.2.2.4 Verify all overshoots are < 45%, and that the 5% settling time is <1 sec.

✓ (Check)

4.3.2.2.5 Reconnect the normal rate loop inputs.

✓ (Check)

4.3.3 Maximum Rate Loop Acceleration

This test will demonstrate the loop's maximum acceleration capability, with the acceleration limiter circuit, by commanding the motors from full rate one direction to full rate the opposite direction.

4.3.3.1 Enable the axis using the PMU and command full rate in the POS direction, then in the NEG direction, and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the rate signals and record. Connect the strip chart recorder to the Rate Loop Board A10-1 (AZ), C1-14 (ALT), B5-8 (CASS).

Channel 1 Gain ±12.5V (Record)

Chart Speed — (Record)

4.3.3.2 Record the acceleration.

A28 Plot

AZ POSAcceleration 1.35 Deg/sec^2 (Record)

AZ NEG Acceleration 1.22 Deg/sec^2 (Record)

4.3.3.3 Repeat 4.3.3.1 and 4.3.3.2 for the Altitude Axis.

Channel 1 Gain ±12.5V (Record)

Chart Speed — (Record)

A29 Plot

ALT POS Acceleration 1.32 °/sec^2 (Record)

ALT NEG Acceleration 1.18 °/sec^2 (Record)

4.3.3.4 Verify the AZ and ALT acceleration values are equal to 1.0 deg/sec^2 + 40%, -0%.

✓ (Check)

4.3.3.5 Enable the CASS Axis using the PMU and command full rate in the UP direction, then in the DN direction. Record the acceleration.

CASS POS Acceleration 3.7 Deg/sec^2 (Record)

A30 Plot

CASS NEG Acceleration 3.4 Deg/sec^2 (Record)

4.3.3.6 Verify the acceleration values are equal to 2.5 deg/sec^2 + ~~40%~~, -0%.

50%

✓ (Check)

4.3.3.7 Verify that the CASS Cablewrap remained synchronized (didn't get CASS C.W. Divergence fault) with the CASS Axis during the acceleration tests.

✓ (Check)

4.4 TRAVEL RANGE/LIMITS

The following tests will verify the Travel Range of the mount and demonstrate the hardware travel limit operation. The Azimuth Axis is capable of a minimum of 460° of travel (Refer to Figure 1). The Cassegrain axis is capable of a minimum of 556° of travel (Refer to Figure 2). This results in an Azimuth overlap of 100° and a Cassegrain overlap of 196°. To avoid uncertainty in the overlapping area, an indication of POS/NEG zone operation is provided to the LCU and MCU. The mount will have limit switches mounted at the extremes of travel in both axes. In addition, Software Limits will prevent the mount from driving beyond the Travel Range during MCU Position Loop operations.

Software Limit:	The Software Limit is set at the MCU. The MCU monitors commands and position feedback, initiating an alarm if either exceeds the Software Limit. The Software Limits are tested in Appendix B.
Velocity Limits:	Axis slew speed is limited to 0.5°/sec of full capacity near extremes of travel. Bi-directional control remains available from MCU, PMU or LCU.
Vicinity Limit:	The Vicinity Limit will be checked to verify that when activated, the motors are inhibited from further travel into the limit and automatically backs out of the Vicinity Limit Region.
Pre Interlock:	The Pre-Interlock Limits will be checked to verify that, when activated, the brakes are set, the motors disabled. This condition can be overridden by depressing the Manual Override Button at the PDU.
Interlock Limit:	The Interlock Limits will be checked to verify that when activated, the Interlock Chain is broken which results in motor controller power removal.

Figure 1, Azimuth Travel

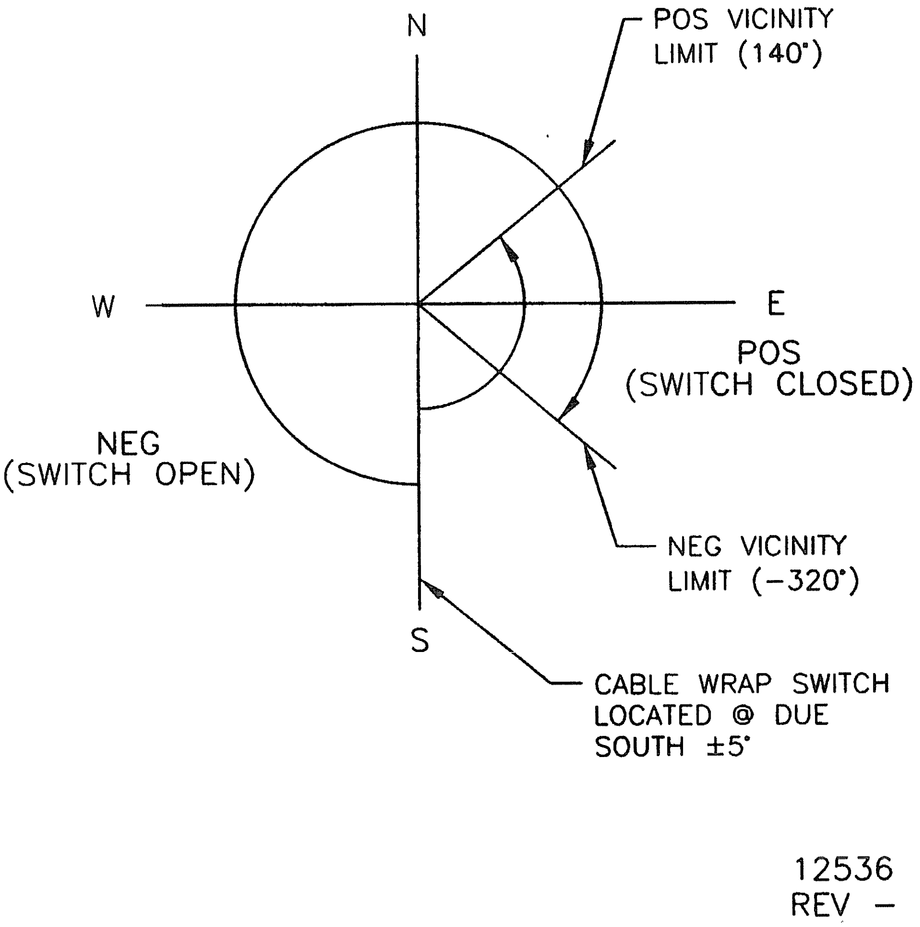
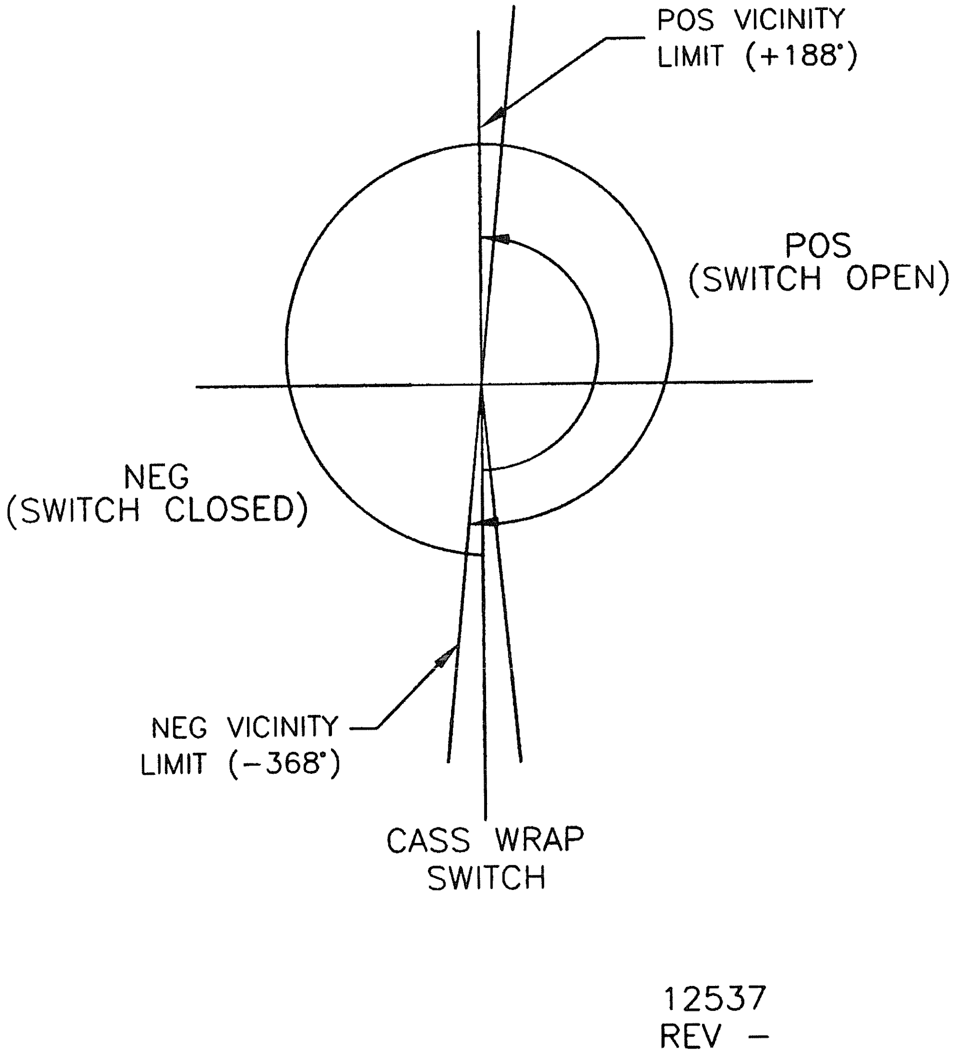


Figure 2, Cassegrain Travel



SIZE	CAGE NO.	DWG NO.	REV
A4	0P0N7	99-343-0006	-
VPO DWG. NO. VIS-PRO-VER-01001-9008			
SCALE NONE	WEIGHT:	SHEET 23 OF 125	

4.4.1 AZ/ALT Limits - Hardware

4.4.1.1 Place the system in a Maintenance Mode and slowly drive POS into the AZ POS Vicinity Limit.

✓ (Check)

4.4.1.2 Record the angle at which POS motion stops. Verify that the axis automatically drives out of limit.

AZ (ALT) POS Vicinity Limit 142.85 (Record)

4.4.1.3 Verify that commands do not allow further POS motion into the Vicinity Limit.

✓ (Check)

4.4.1.4 Verify that the fault message, "AZ (ALT) POS VICINITY LIMIT", is displayed.

✓ (Check)

4.4.1.5 Verify proper AZ (ALT) POS VICINITY LIMIT indication to LCU per Table 1.

✓ (Check)

4.4.1.6 Drive the mount out of the limit by at least 5°. Using the PMU, command full speed in the POS direction. Verify that only the POS Vicinity Limit is activated.

✓ (Check)

4.4.1.7 Bypass the POS Vicinity Limit and slowly drive the axis to the AZ (ALT) POS Pre-Interlock Limit. Record the AZ (ALT) POS Pre-INTLK Limit Position. Verify that the brakes are set and the motors disabled.

AZ POS Pre-INTLK Limit 143.25° (Record)

Motors Disabled ✓ (Check)

4.4.1.8 Verify that commands do not enable the motors.

✓ (Check)

4.4.1.9 Verify that the fault message, "AZ (ALT) POS PRE-INTERLOCK LIMIT", is displayed and the green LED next to the AZ (ALT) Limit Override Switch is ON.

✓ (Check)

4.4.1.10 Verify proper AZ (ALT) POS Pre-Interlock Limit indication to LCU per Table 1.

✓ (Check)

4.4.1.11 Press the AZ (ALT) Limit Override Switch and verify that the red LED is now ON, the green LED is OFF, the fault message clears and the motor will enable from the PMU.

✓ (Check)

4.4.1.12 With the motor enabled, release the AZ (ALT) Limit Override Switch and verify that the motor disables, the green LED next to the override switch is ON, the red LED is OFF and the fault message is displayed.

✓ (Check)

4.4.1.13 Press the AZ (ALT) Limit Override Switch again and enable the motor. Verify that the motor will drive out of the POS Pre-Interlock Limit.

✓ (Check)

4.4.1.14 After clearing the POS Pre-Interlock Limit, verify that releasing the override switch does not cause an axis fault.

✓ (Check)

4.4.1.15 Bypass the Pre-Interlock Limit and slowly drive POS to the POS/NEG Interlock Limit. Record the POS Interlock Limit Position. Verify that the AZ Interlock chain is broken and 3∅ power is removed from the AZ Motor Controllers.

POS INTLK Limit N/A (Record)

INTLK Chain Broken ✓ (Check)

4.4.1.16 Verify that the fault message, "AZ NEG/POS Interlock", is displayed and proper LCU indication per Table 1.

✓ (Check)

4.4.1.17 Bypass the AZ POS/NEG Interlock Limit and reset CBs. Slowly drive to the mechanical buffer. Record the point at which the structure contacts the buffer.

POS Buffer Position N/A (Record)

4.4.1.18 Clear all limits and remove all bypass jumpers.

✓ (Check)

4.4.1.19 Complete the following table for AZ NEG, ALT POS and NEG Travel Limits. Follow instructions in the preceding paragraphs.

		AZ NEG	**ALT POS**	**ALT NEG**	
4.4.1.1)	Activate Vicinity Limit	✓	✓	✓	(Check)
4.4.1.2a)	Vicinity Limit Position	36.57°	91.3°	-1.5°	(Record)
4.4.1.2b)	System Drives Out of Vicinity Limit	✓	✓	✓	(Check)
4.4.1.3	Commands into Limit Disabled	✓	✓	✓	(Check)

		AZ NEG	ALT POS	ALT NEG	
4.4.1.4	Fault Message and Alarms	✓	✓	✓	(Check)
4.4.1.5	Fault Reported to LCU	✓	✓	✓	(Check)
4.4.1.6	Full Speed Into Vicinity Limit	✓	✓	✓	(Check)
4.4.1.7a)	Bypass Vicinity Limit	✓	✓	✓	(Check)
4.4.1.7b)	Pre-Interlock Limit Position	33.955	92.567	-1.655	(Record)
4.4.1.7c)	Brakes Set, Motors Disabled	✓	✓	✓	(Check)
4.4.1.8	Commands Disabled	✓	✓	✓	(Check)
4.4.1.9	Fault Message, Alarms and Green LED ON	✓	✓	✓	(Check)
4.4.1.10	LCU Fault Indication	✓	✓	✓	(Check)
4.4.1.11a)	Press Limit Override Switch	✓	✓	✓	(Check)
4.4.1.11b)	Red LED ON, Green LED OFF	✓	✓	✓	(Check)
4.4.1.11c)	Fault Message Clears and Motor Enables	✓	✓	✓	(Check)
4.4.1.12a)	Release Switch and Motor Disables	✓	✓	✓	(Check)
4.4.1.12b)	Green LED ON, Red LED OFF, and Fault Message	✓	✓	✓	(Check)
4.4.1.13	Press Limit Override Switch and Drives Out	✓	✓	✓	(Check)
4.4.1.14a)	Clear Limit Switch	✓	✓	✓	(Check)
4.4.1.14b)	Release Override Switch and No Faults	✓	✓	✓	(Check)
4.4.1.15a)	Bypass Pre-Interlock Limit	–	–	–	(Check)
4.4.1.15b)	Activate INTERLOCK Limit	✓	✓	✓	(Check)
4.4.1.15c)	Interlock Limit Position	N/A	N/A	N/A	(Record)
4.4.1.15d)	Interlock Chain Broken	✓	✓	✓	(Check)
4.4.1.15e)	Motor Controller Power Removed	✓	✓	✓	(Check)
4.4.1.16	Verify Fault indication @ MCU & @ LCU	✓	✓	✓	(Check)

		AZ NEG	ALT POS	ALT NEG	
4.4.1.17a)	Bypass Interlock Limit	N/A	—	—	(Check)
4.4.1.17b)	Mechanical Buffer Position	N/A	—	—	(Record)
4.4.1.18	Clear Limits & Remove Jumpers	✓	—	—	(Check)

4.4.1.20 Verify that as AZ axis passes through zero from POS direction, cable wrap indicating changes to NEG.

✓ (Check)

4.4.1.21 Verify proper AZ cablewrap indication to LCU per Table 1.

✓ (Check)

4.4.2 Cassegrain/Limits - Hardware

4.4.2.1 Complete the following table for Cassegrain travel limits. Follows instructions in the preceding paragraphs.

		CASS POS	CASS NEG	
4.4.1.1	Activate Vicinity Limit	✓	✓	(Check)
4.4.1.2a)	Vicinity Limit Position	189°	352.7°	(Record)
4.4.1.2b)	System Drives Out of Vicinity Limit	✓	✓	(Check)
4.4.1.3	Commands into Limit Disabled	✓	✓	(Check)
4.4.1.4	Fault Message and Alarms	✓	✓	(Check)
4.4.1.5	LCU Fault Indication			(Check)
4.4.1.6	Full Speed Into Vicinity Limit	✓	✓	(Check)
4.4.1.7a)	Bypass Vicinity Limit	✓	✓	(Check)
4.4.1.7b)	Pre-Interlock Limit Position	191.99°	346.61°	(Record)
4.4.1.7c)	Brakes Set, Motors Disabled	✓	✓	(Check)
4.4.1.8	Commands Disabled	✓	✓	(Check)
4.4.1.9	Fault Message, Alarms and Green LED ON	✓	✓	(Check)
4.4.1.10	LCU Fault Indication	✓		(Check)
4.4.1.11a)	Press Limit Override Switch	✓	✓	(Check)
4.4.1.11b)	Red LED ON, Green LED OFF	✓	✓	(Check)
4.4.1.11c)	Fault Message Clears and Motor Enables	✓	✓	(Check)

		CASS POS	CASS NEG	
4.4.1.12a)	Release Switch and Motor Disables	✓	✓	(Check)
4.4.1.12b)	Green LED ON, Red LED OFF, and Fault Message	✓	✓	(Check)
4.4.1.13	Press Limit Override Switch and Drives Out	✓	✓	(Check)
4.4.1.14a)	Clear Limit Switch	✓	✓	(Check)
4.4.1.14b)	Release Override Switch and No Faults	✓	✓	(Check)
4.4.1.15a)	Bypass Pre-Interlock Limit	✓	✓	(Check)
4.4.1.15b)	Activate INTERLOCK Limit	✓	✓	(Check)
4.4.1.15c)	Interlock Limit Position	195.54	342.42	(Record)
4.4.1.15d)	Interlock Chain Broken	✓	✓	(Check)
4.4.1.15e)	Motor Controller Power Removed	✓	✓	(Check)
4.4.1.16	Verify Fault indication @ MCU & @ LCU	✓	✓	(Check)
4.4.1.17a)	Bypass Interlock Limit	N/A	N/A	(Check)
4.4.1.17b)	Mechanical Buffer Position	N/A	N/A	(Record)
4.4.1.18	Clear Limits & Remove Jumpers	✓	✓	(Check)

4.4.2.2 Verify that as CASS Axis passes through zero from POS direction, the cablewrap indication changes to NEG.

✓ (Check)

4.4.2.3 Verify proper cablewrap indication to LCU per Table 3.

✓ (Check)

4.4.3 Cassegrain - Cablewrap Divergence Limit

4.4.3.1 Simulate an LVDT Fault that will result in a POS CASS Cablewrap Divergence Limit. Verify that the CASS Interlock chain is broken and motor controller power is removed to the two CASS motor controllers and to the CASS C.W. Motor Controller.

REMOVED BJ1-25, -26
JUMPER ON CASS RLB

✓ (Check)

4.4.3.2 Verify that the fault message, "CASS CABLEWRAP DIVERGENCE LIMIT", gets reported at the MCU.

✓ (Check)

4.4.3.3 Verify proper CASS CABLEWRAP DIVERGENCE INTLK indication to LCU per Table 3.

✓ (Check)

4.4.3.4 Clear fault and reset Motor Controller circuit breakers.

✓ (Check)

4.4.3.5 Simulate an LVDT fault that will result in a NEG CASS Cablewrap Divergence Limit. Verify that the CASS Interlock chain is broken and motor controller power is removed.

✓ (Check)

4.4.3.6 Verify that the fault message, "CASS CABLEWRAP DIVERGENCE LIMIT", gets reported to the MCU and to the CASS LCU.

✓ (Check)

4.4.4 Velocity Limits

Velocity Limits add another level of protection to the mount by reducing its velocity near the travel extremes. The maximum limited velocity was verified in the factory to be approximately 0.5°/sec. This test verifies proper switch activation and responses.

4.4.4.1 Drive the mount in AZ POS direction until the Velocity Switch is activated. Verify the status message, "AZ VELOCITY LIMIT", appears at the MCU.

✓ (Check)

4.4.4.2 Verify proper AZ Velocity Limit indication to LCU per Table 1.

✓ (Check)

4.4.4.3 Record the angle of POS activation.

AZ POS Velocity Limit 126.8° (Record)

4.4.4.4 Repeat Section 4.4.4.1 for the AZ NEG direction.

✓ (Check)

4.4.4.5 Record the angle of NEG activation.

AZ NEG Velocity Limit 44.5° (Record)

4.4.4.6 Repeat Sections 4.4.4.1 through 4.4.4.5 for ALT and CASS.

4.4.4.1a) Drive ALT Axis POS to VEL Limit ✓ (Check)

4.4.4.1b) "ALT VELOCITY LIMIT" message @ MCU ✓ (Check)

4.4.4.2 LCU Limit Indication Per Table 2 ✓ (Check)

4.4.4.3 ALT POS Velocity Limit 87.2° ~~20.4~~ °(Record)

4.4.4.4a) Drive ALT Axis NEG to VEL Limit ✓ (Check)

4.4.4.4b) "ALT VELOCITY LIMIT" message @ MCU ✓ (Check)

4.4.4.5 ALT NEG Velocity Limit 20.4 °(Record

4.4.4.1a) Drive CASS Axis POS to VEL Limit ✓ (Check)

4.4.4.1b) "CASS VELOCITY LIMIT" message @ MCU ✓ (Check)

4.4.4.2 LCU Limit Indication Per Table 3 ✓ (Check)

4.4.4.3 CASS Pos Velocity Limit 178.5° °(Record)

4.4.4.4a) Drive CASS Axis NEG to VEL Limit ✓ (Check)

4.4.4.4b) CASS VELOCITY LIMIT" message @ MCU ✓ (Check)

4.4.4.5 CASS NEG Velocity Limit 357° °(Record)

4.5 WARNING HORN ACTIVATION

The Warning Horn provides a 5 second delay before Azimuth, Altitude or CASS Axis movement to provide personnel safety.

4.5.1 Place the Warning Horn Switch in the ON position on the AZ/ALT Control Board. Place the Warning Horn Switch in the OFF position on the CASS Control Board.

✓ (Check)

4.5.2 From the STOP Mode, enter any active AZ/ALT Mode and verify that the Warning Horn sounds for approximately 5 seconds and the motors are not enabled until after the 5 second delay.

✓ (Check)

4.5.3 Enter STOP Mode. Enter any active CASS Mode and verify that the Warning Horn is not sounded and the motors enable immediately.

✓ (Check)

4.5.4 Enter the Maintenance or LCU Mode, activate the PMU or LCU, enable AZ or ALT Axis, verify that the Warning Horn is activated and control is available after the horn delay.

✓ (Check)

4.5.5 Disable the PMU or the LCU and place the MCU in the STOP Mode. Verify that the Warning Horn is activated indicating a change of the control state.

✓ (Check)

4.5.6 Place the AZ/ALT Warning Horn Switch in the OFF position. Enter any active AZ/ALT Mode and verify that the Warning Horn is not sounded and the motors enable immediately.

✓ (Check)

4.5.7 Enter the Maintenance or LCU Mode, activate the PMU or LCU and enable AZ or ALT Axis, verify that the Warning Horn is not activated and control is available immediately.

✓ (Check)

4.5.8 Place the Warning Horn Switch in the ON position on the CASS Control Board.

✓ (Check)

4.5.9 From the STOP Mode enter any active CASS Mode and verify that the Warning Horn sounds for approximately 5 seconds and the motors are not enabled until after the 5 second delay.

✓ (Check)

4.5.10 Enter STOP Mode. Enter any active AZ/ALT Mode and verify that the Warning Horn is not sounded and the motors enable immediately.

✓ (Check)

4.5.11 Enter the Maintenance or LCU Mode, activate the PMU or LCU, select CASS control and enable the CASS Axis, verify that the Warning Horn is activated and control is available after the horn delay.

✓ (Check)

4.5.12 Disable the PMU or LCU and place the MCU in STOP Mode. Verify that the Warning Horn is activated indicating a change of the control state.

✓ (Check)

4.5.13 Place the CASS Warning Horn Switch in the OFF position. Enter any active CASS Mode and verify that the Warning Horn is not sounded and the motors enable immediately.

✓ (Check)

4.5.14 Enter the Maintenance or LCU Mode, activate the PMU and enable the CASS Axis, verify that the Warning Horn is not activated and control is available immediately.

✓ (Check)

4.6 ALT OVERSPEED DETECTION

The Overspeed Detection System is totally independent from the Mount Control System. It provides Altitude overspeed protection by disabling the motors via dry contact closure to the AZ/ALT PDU when axis velocities exceed 125% of slew speeds. The AZ/CASS motor controller overspeed detection function was tested at the factory. The ALT Velocity trip point was verified at the factory. This test verifies proper activation and responses.

4.6.1 On MCU, set faults to latched.

✓ (Check)

4.6.2 Drive ALT axis to 45°.

✓ (Check)

4.6.3 Remove CI IC from ALT RLB to simulate open rate loop condition.

✓ (Check)

4.6.4 Set the PMU rate knob to fully ~~CW~~ POS position and enable the ALT axis. Verify that the ALT INTLK Chain is broken and the ALT motors are disabled, and the fault, "ALT OVERSPEED INTLK", is displayed at the MCU.

✓ (Check)

4.6.5 Verify proper ALT overspeed INTLK indication to LCU per Table 2.

✓ (Check)

4.6.6 Verify that the ALT motors remain disabled after the mount has come to a stop. Verify that the fault message, "ALT OVERSPEED INTLK", has cleared at the MCU and at the LCU.

✓ (Check)

4.6.7 Reset the ALT Motor Controller Circuit Breakers.

✓ (Check)

4.6.8 Set the PMU rate knob to fully ~~CCW~~ NEG position and enable the ALT Axis. Verify that the ALT INTLK chain is broken and the ALT motors are disabled and the fault message, "ALT OVERSPEED INTLK", is displayed at the MCU.

✓ (Check)

4.6.9 Verify proper ALT OVERSPEED INTLK indication to LCU per Table 2.

✓ (Check)

4.6.10 Verify that the ALT motors remain disabled after the mount came to a stop. Verify that the fault message, "ALT OVERSPEED INTLK", has cleared at the MCU and at the LCU.

✓ (Check)

4.6.11 Reset the ALT Motor Controller circuit breakers and reinstall ALT RLB CI IC.

__✓__ (Check)

5.0 LCU INTERFACE TESTING

The Interface between the AZ/ALT PDU and the CASS PDU will be verified in this section. The following tests will be performed to verify that the interfaces are per the customer's specifications.

1. Verification of the Handshaking between VertexRSI equipment and LCU
2. Verification of LCU Rate Demands/Feedback
3. LCU Status Monitoring
4. Verification of LCU (AZ, ALT and CASS) Interlock Limit Command
5. Verification of dual rate command

A test fixture will be used to verify the rate demands and feedback signals. Refer to Figure 3 for a schematic diagram of the LCU Test Fixture.

5.1 AZ LCU INTERFACE VERIFICATION

5.1.1 Connect LCU test fixture to A6A cable and verify that Switch 1, Axis Enable Cmd is in the UP position.

__✓__ (Check)

5.1.2 Verify that Switch 2, LCU INTLK Cmd is not in the INTLK position.

__✓__ (Check)

5.1.3 Verify that Switch 4, Track/Slew Cmd is set to the Slew position. Verify that an open exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

__✓__ (Check)

5.1.4 Verify that no axis fault is present by measuring across TP8 (Axis Summary Flt) and TP13 (Status Common) with an ohm-meter and verifying continuity between TPs.

__✓__ (Check)

5.1.5 With an Ohm meter, measure across TP13 (Status Common) and TP12 (LCU Available). Verify that continuity exists between TPs.

__✓__ (Check)

5.1.6 Cycle power to the MCU and verify that the MCU powers up in the LCU Mode.

__✓__ (Check)

5.1.7 Verify that the LCU is enabled by measuring a short across TP11 (LCU Enabled) and TP13 (Status Common).

__✓__ (Check)

5.1.8 With the AZ LCU not in Active Condition, verify that there exists an open across TP10 (LCU Active) and TP13 (Status Common).

✓ (Check)

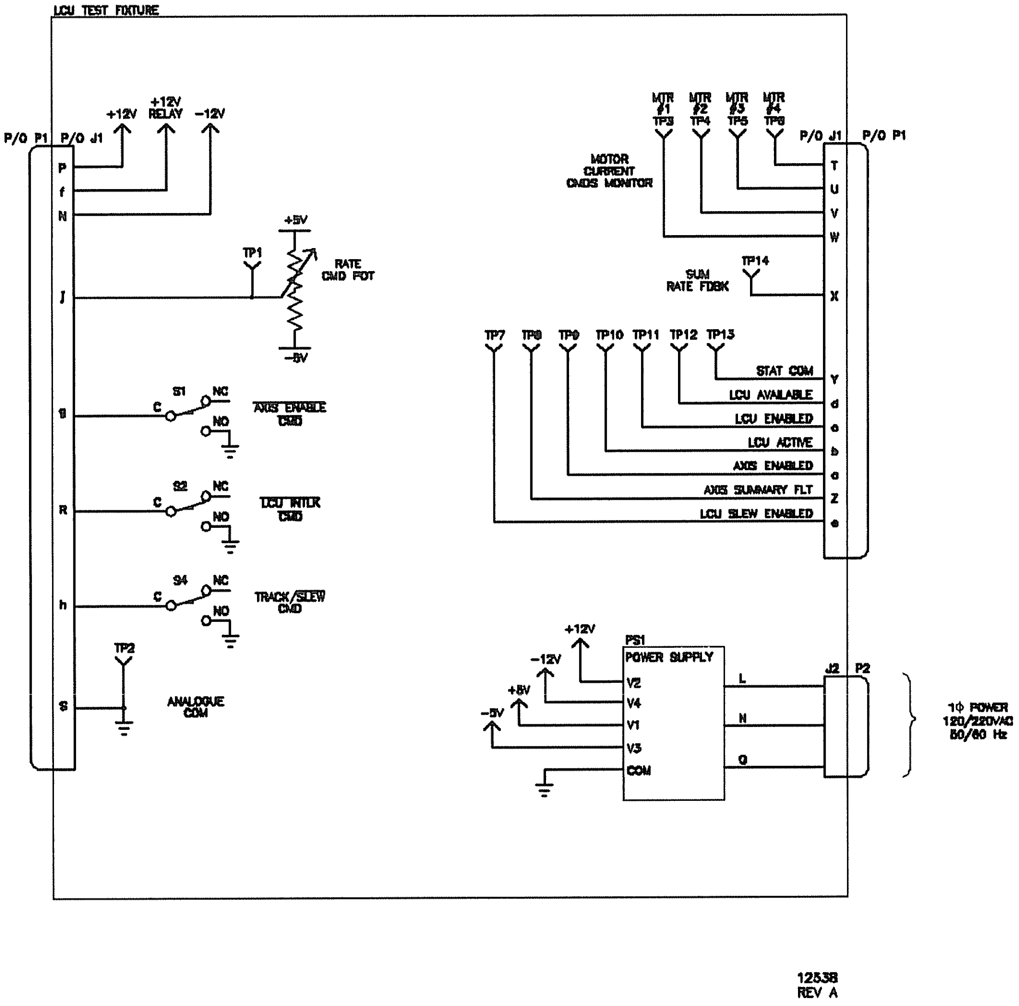
5.1.9 Depress the AZ/ALT LCU Active Switch inside the AZ/ALT PDU. Verify that now there exists a short across TP10 (LCU Active) and TP13 (Status Common).

✓ (Check)

5.1.10 Verify that LCU Test Fixture rate demands are not accepted by the AZ/ALT PDU.

✓ (Check)

Figure 3, LCU Test Fixture



5.1.11 Issue an Axis Enable Cmd by ~~tagging~~ toggling (DN position, UP Position) the S1 switch, verify that short exists across TP9 (Axis Enabled) and TP13 (Status Common) and that the Azimuth motors become enabled.

✓ (Check)

5.1.12 Verify that the velocity and direction of the Azimuth motors can now be controlled from the Rate Demand Pot.

✓ (Check)

5.1.13 Measure the bi-direction full speed of the motors. With the motors rotating at full speed, record the travel over a 30 second period and calculate the axis velocity.

A31 Plot

AZ POS DIR 2.09 °/sec (Record)

AZ NEG DIR 2.02 °/sec (Record)

5.1.14 Verify that the axis velocities are ±2.0°/sec ±10%.

✓ (Check)

5.1.15 With the motors running at full velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is +5 VDC ±10% going in the NEG direction, and -5 VDC ±10% going in the POS direction.

✓ (Check)

5.1.16 Toggle S1 Switch to Disable the AZ axis.

✓ (Check)

5.1.17 Place Switch 4, Track/Slew Cmd to the Track position. Verify that continuity exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

✓ (Check)

5.1.18 Enable axis and measure the bi-directional full track speed of the motors. With the motors rotating at full track speed, record the travel over a 30 second period and calculate the axis velocity.

A32 Plot

AZ POS DIR 0.23 °/sec (Record)

AZ NEG DIR 0.20 °/sec (Record)

5.1.19 Verify that the axis velocities are ±0.2°/sec ± 10%.

✓ (Check)

5.1.20 With the motors running at full track velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is +0.5 VDC ± 10% going in NEG direction, and -0.5 VDC ± 10% going in the POS direction.

✓ (Check)

5.1.21 Disable the Axis. Place Switch 2, LCU INTLK Cmd to the INTLK position. Verify that the AZ Interlock chain is broken which results in the removal of motor controller 3∅ power.

✓ (Check)

5.1.22 Verify that an open exists between TP8 (Axis Summary Fault) and TP13 (Status Common).

✓ (Check)

5.1.23 Place Switch 2 not in the INTLK Position and reset AZ Motor Controller CB's.

✓ (Check)

5.1.24 Simulate an LCU power failure by turning off the LCU simulator power switch. Verify that the AZ Interlock chain is broken resulting in removal of motor controller 3∅ power.

✓ (Check)

5.2 AZ LCU MONITORING SIGNAL TESTING

5.2.1 Table 1 depicts the faults/status that are reported to the AZ LCU. It will be verified that the appropriate contact action occurs per Table 1 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

✓ (Check)

Table 1, Azimuth LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A6C-L AND:	VERIFICATION (✓)
1	AZ NEG VICINITY LIMIT	A6C-U	✓
2	AZ POS VICINITY LIMIT	A6C-T	✓
3	AZ NEG PRE-INTLK LIMIT	A6C-S	✓
4	AZ POS PRE -INTLK LIMIT	A6C-R	✓
5	AZ CABLEWRAP-NEG DIRECTION	A6C-N	✓
6	AZ VELOCITY LIMIT	A6C-P	✓
7	AZ PARKED	A6C-M	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A6C-V AND:	VERIFICATION (✓)
8	DOME CRANE AZ INTLK	A6C-W	✓
9	AZ BRAKES RELEASED	A6C-b	✓
10	AZ/ALT CCU OFF	A6C-Z	✓
11	YOKE ACCESS HATCH OPEN INTLK	A6C-Y	✓
12	AZ STOW PIN ENGAGED INTLK	A6C-X	✓
13	AZ NEG/POS INTLK LIMIT	A6C-a	✓
14	PIER ACCESS INTLK	A6C-K	✓
15	MOBILE PLATFORM INTLK	A6C-J	✓

5.3 ALT LCU INTERFACE VERIFICATION

5.3.1 Connect LCU test fixture to A7A cable and verify that Switch 1, Axis Enable Cmd is in the UP position.

___✓___ (Check)

5.3.2 Verify that Switch 2, LCU INTLK Cmd is not in the INTLK position.

___✓___ (Check)

5.3.3 Verify that Switch 4, Track/Slew Cmd is set to the Slew position. Verify that an open exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

___✓___ (Check)

5.3.4 Verify that no axis fault is present by measuring across TP8 (Axis Summary Flt) and TP13 (Status Common) with an Ohm Meter and verifying continuity between TPs.

___✓___ (Check)

5.3.5 With a Ohm Meter, measure across TP13 (Status Common) and TP12 (LCU Available). Verify that continuity exists between TPs.

___✓___ (Check)

5.3.6 Cycle power to the MCU and verify that the MCU powers up in the LCU Mode.

___✓___ (Check)

5.3.7 Verify that the LCU is Enabled by measuring a short across TP11 (LCU Enabled) and TP13 (Status Common).

___✓___ (Check)

5.3.8 With the LCU not in Active Condition, verify that there exists an open across TP10 (LCU Active) and TP13 (Status Common).

___✓___ (Check)

5.3.9 Depress the AZ/ALT LCU Active Switch inside the AZ/ALT PDU. Verify that now there exists a short across TP10 (LCU Active) and TP13 (Status Common).

___✓___ (Check)

5.3.10 Verify that LCU Test Fixture rate demands are not accepted by the AZ/ALT PDU.

✓ (Check)

5.3.11 Issue an Axis Enable Cmd by toggling the S1 Switch, verify that a short exists across TP9 (Axis Enabled) and TP13 (Status Common) and that the Altitude motors become enabled.

✓ (Check)

5.3.12 Verify that the velocity and direction of the Altitude motors can now be controlled from the Rate Demand Pot.

✓ (Check)

5.3.13 Measure the bi-directional full speed of the motors. With the motors rotating at full speed, record the travel over a 30 second period and calculate the axis velocity.

A33 Plot

ALT POS DIR 2.03 °/sec (Record)

ALT NEG DIR 2.00 °/sec (Record)

5.3.14 Verify that the axis velocities are ±2.0°/sec ± 10%.

✓ (Check)

5.3.15 With the motors running at full velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is +5 VDC ± 10% going in the NEG direction and -5 VDC ± 10% going in the POS direction.

✓ (Check)

5.3.16 Toggle S1 Switch to disable the ALT Axis.

✓ (Check)

5.3.17 Place Switch 4, Track/Slew Cmd to the Track position. Verify that continuity exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

✓ (Check)

5.3.18 Measure the bi-directional full track speed of the motors. With the motors rotating at full track speed, record the travel over a 30 second period and calculate the axis velocity.

A34 Plot

ALT POS DIR 0.22 °/sec (Record)

ALT NEG DIR 0.19 °/sec (Record)

5.3.19 Verify that the axis velocities are ±0.2°/sec ± 10%.

✓ (Check)

5.3.20 With the motors running at full track velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is +0.5 VDC ± 10% going in the NEG direction and -0.5 VDC ± 10% going in the POS direction.

✓ (Check)

5.3.21 Disable the Alt Axis.

✓ (Check)

5.3.22 Place the Switch 2, LCU INTLK Cmd to the INTLK position. Verify that the ALT Interlock chain is broken which results in the removal of motor controller 3∅ power.

✓ (Check)

5.3.23 Verify that an open exists between TP8 (Axis Summary Fault) and TP13 (Status Common).

✓ (Check)

5.3.24 Place Switch 2 not in the INTLK position and reset ALT motor controller CB's.

✓ (Check)

5.3.25 Simulate an LCU power failure by turning off the LCU simulator power supply. Verify that the ALT Interlock chain is broken resulting in removal of motor controller 3∅ power.

✓ (Check)

5.4 ALT LCU MONITOR SIGNAL TESTING

5.4.1 Table 2 depicts the faults/status that are reported to the ALT LCU. It will be verified that the appropriate contact action occurs per Table 2 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

Table 2, Altitude LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A7C-L AND:	VERIFICATION (✓)
01	ALT NEG VICINITY LIMIT	A7C-U	✓
02	ALT POS VICINITY LIMIT	A7C-T	✓
03	ALT NEG PRE-INTLK LIMIT	A7C-S	✓
04	ALT POS PRE -INTLK LIMIT	A7C-R	✓
05	ALT VELOCITY LIMIT	A7C-P	✓
06	ALT PARKED	A7C-M	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A7C-V AND:	VERIFICATION (✓)
07	DOME CRANE ALT INTLK	A7C-W	✓
08	ALT BRAKES RELEASED	A7C-b	✓
09	AZ/ALT CCU OFF	A7C-Z	✓
10	ALT STOW PIN ENGAGED INTLK	A7C-X	✓
11	ALT NEG/POS INTLK LIMIT	A7C-a	✓
12	ALT OVERSPEED INTLK	A7C-J	✓
13	ALT AUX DRIVE ENABLED INTLK	A7C-K	✓

5.5 CASS LCU INTERFACE VERIFICATION

5.5.1 Connect LCU test fixture to A8A cable and verify that Switch 1, Axis Enable Cmd is in the UP position.

✓ (Check)

5.5.2 Verify that Switch S2, LCU INTLK Cmd is not in the INTLK position.

✓ (Check)

5.5.3 Verify that Switch 4, Track/Slew Cmd is set to the Slew position. Verify that an open exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

✓ (Check)

5.5.4 Verify that no axis fault is present by measuring across TP8 (Axis Summary Flt) and TP13 (Status Common) with an Ohm Meter and verifying continuity between TPs.

✓ (Check)

5.5.5 With an Ohm Meter, measure across TP13 (Status Common) and TP12 (LCU Available). Verify that continuity exists between TPs.

✓ (Check)

5.5.6 Cycle power to the MCU and verify that the MCU powers up in the LCU Mode.

✓ (Check)

5.5.7 Verify that the LCU is Enabled by measuring a short across TP11 (LCU Enabled) and TP13 (Status Common).

✓ (Check)

5.5.8 With the LCU not in Active condition, verify that there exists an open across TP10 (LCU Active) and TP13 (Status Common).

✓ (Check)

5.5.9 Depress the CASS LCU Active Switch inside the CASS PDU. Verify that now there exists a short across TP10 (LCU Active) and TP13 (Status Common).

✓ (Check)

5.5.10 Verify that LCU Test Fixture rate demands are not accepted by the CASS PDU.

✓ (Check)

5.5.11 Issue an Axis Enable Cmd by toggling the S1 switch, verify that a short exists across TP9 (Axis Enabled) and TP13 (Status Common) and that the Cassegrain motors become enabled.

✓ (Check)

5.5.12 Verify that the velocity and direction of the Cassegrain motors can now be controlled from the Rate Demand Pot.

✓ (Check)

5.5.13 Measure the bi-directional full speed of the motors. With the motors rotating at full speed, record the travel over a 30 second period and calculate the axis velocity.

A35 Plot

CASS POS DIR 3.79 °/sec (Record)

CASS NEG DIR 3.79 °/sec (Record)

5.5.14 Verify that the axis velocities are ±3.6°/sec ± 10%.

✓ (Check)

5.5.15 With the motors running a full velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is ~~+5~~ -5 VDC ± 10% going in the POS direction and ~~5~~ +5 VDC ± 10% going in the NEG direction.

✓ (Check)

5.5.16 Place Switch 4, Track/Slew Cmd to the Track position. Verify that continuity exists across TP7 (LCU Slew Enabled) and TP13 (Status Common).

✓ (Check)

5.5.17 Measure the bi-directional full track speed of the motors. With the motors rotating at full track speed, record the travel over a 30 second period and calculate the axis velocity.

A36 Plot

CASS POS DIR 0.38 °/sec (Record)

CASS NEG DIR 0.36 °/sec (Record)

5.5.18 Verify that the axis velocities are ±0.36°/sec ± 10%.

✓ (Check)

5.5.19 With the motors running at full track velocity, measure across TP14 (Sum Rate Feedback) and TP2 (Analogue Common) and verify that the voltage reading is ~~+0.5~~ -.5 VDC ±10% going in the POS direction and ~~-0.5~~ +0.5 VDC ± 10% going in the NEG direction.

✓ (Check)

5.5.20 Disable the axis.

✓ (Check)

5.5.21 Place Switch 2, LCU INTLK Cmd to the INTLK position. Verify that the CASS Interlock chain is broken which results in the removal of motor controller power.

✓ (Check)

5.5.22 Verify that an open exists between TP8 (Axis Summary Fault) and TP13 (Status Common).

✓ (Check)

5.5.23 Place Switch 2 not in the INTLK position and reset CASS Motor Controller CB's.

✓ (Check)

5.5.24 Simulate an LCU power failure by turning off the LCU Simulator power supply. Verify that the CASS Interlock chain is broken resulting in removal of motor controller power.

✓ (Check)

5.6 CASS LCU MONITOR SIGNAL TESTING

5.6.1 Table 3 depicts the fault/status that are reported to the CASS LCU. It will be verified that the appropriate contact action occurs per Table 3 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

Table 3, Cassegrain LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A8C-L AND:	VERIFICATION (✓)
1	CASS NEG VICINITY LIMIT	A8C-U	✓
2	CASS POS VICINITY LIMIT	A8C-T	✓
3	CASS NEG PRE-INTLK LIMIT	A8C-S	✓
4	CASS POS PRE -INTLK LIMIT	A8C-R	✓
5	CASS CABLEWRAP-NEG DIRECTION	A8C-N	✓
6	CASS VELOCITY LIMIT	A8C-P	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A8C-V AND:	VERIFICATION (✓)
7	CASS BRAKES RELEASED	A8C-b	✓
8	CASS CCU OFF	A8C-Z	✓
9	CASS STOW PIN ENGAGED INTLK	A8C-X	✓
10	CASS NEG/POS INTLK LIMIT	A8C-a	✓
11	CASS CABLEWRAP DIVERGENCE INTLK	A8C-W	✓

5.7 DATA ACQUISTION UNIT

The Data Acquisition Unit (DAQ) interfaces to 34 Resistance Temperature Detectors (RTDs), 6 LVDTs and 6 analogue test points. The data Acquisition Unit signal conditions the RTDs, Analogue and the LVDT signals and makes the sensor readings available over a CanOpen Interface to a Host Computer. Three (3) analogue test points are received from the AZ/ALT PDU and the remaining three are received from the CASS PDU via selection from the MCU Signal Meters.

The Signal Meter readings by the DAQ will be tested in the MCU Signal Meter section of this test procedure.

5.7.1 Verify that the DAQ Host Computer has been loaded with the TWINCAT PLC Application Software. Record the version information.

____________ (Record)

5.7.2 Annotate the BK5120 Coupler Network Address and baud rate setting below. DIP Switches 1-6 are used to set up the coupler's node ID. DIP Switches 7 and 8 are used to set up the coupler's baud rate.

Switch 1 ____________ (Record)

Switch 2 ____________ (Record)

Switch 3 ____________ (Record)

Switch 4 ____________ (Record)

Switch 5 ____________ (Record)

Switch 6 ____________ (Record)

Switch 7 ____________ (Record)

Switch 8 ____________ (Record)

5.7.3 Verify that the BK5120 Coupler Network Address and baud rate annotated above is entered at the TWINCAT PLC application software.

_____ (Check)

5.7.4 Verify that the Data Acquisition Unit Can Open Port (J41) is connected to the Host Computer Can Open Port.

_____ (Check)

5.7.5 Verify that the Host Computer has established communication with the DAQ.

_____ (Check)

5.7.6 Configure the Host Computer TWINCAT PLC Software to be able to retrieve data information for the Beckhoff modules interfaced to the 34 RTD's, 6 LVDT's and 6 Analogue Test Points.

_____ (Check)

5.7.7 Out of the possible thirty-four (34) RTD input ports, randomly select five (5) to be tested. Annotate the ones chosen for testing.

DAQ Port

RTD 1 ____________ (Record)

RTD 2 ____________ (Record)

RTD 3 ____________ (Record)

RTD 4 ____________ (Record)

RTD 5 ____________ (Record)

5.7.8 For the five (5) selected RTD input ports, connect the RTD to the appropriate DAQ rear panel port.

_____ (Check)

5.7.9 From the DAQ Host Computer, obtain the RTD measured temperature and record below. The scale factor for the RTD measurement is 100 bits/deg C reported on the Beckhoff Twincat program.

RTD 1 ____________ °C (Record)

RTD 2 ____________ °C (Record)

RTD 3 ____________ °C (Record)

RTD 4 ____________ °C (Record)

RTD 5 ____________ °C (Record)

5.7.10 Alter the temperature sensed by the RTDs and verify that the temperature displayed changes accordingly. Record the new temperature.

RTD 1 ____________ °C (Record)

RTD 2 ____________ °C (Record)

RTD 3 ____________ °C (Record)

RTD 4 ____________ °C (Record)

RTD 5 ____________ °C (Record)

5.7.11 If a secondary temperature sensor is available, record the measured temperatures for the five RTDs selected.

RTD 1 ____________ °C (Record)

RTD 2 ____________ °C (Record)

RTD 3 ____________ °C (Record)

RTD 4 ____________ °C (Record)

RTD 5 ____________ °C (Record)

5.7.12 If available, verify that the secondary temperature readings agree within ±0.4°C with those displayed on the Host Computer.

RTD 1 _____ (Check

RTD 2 _____ (Check

RTD 3 _____ (Check

RTD 4 _____ (Check

RTD 5 _____ (Check

5.7.13 Connect the LVDTs to the DAQ.

_____ (Check)

5.7.14 Put the LVDTs at a nominal position and record below the Host Computer measured nominal displacement for the LVDTs using the following scale factors:

LVDT Input: 15Vpp = 5.3 V_{rms}

OSC/DEM Output: $\frac{\pm 0.8347 \text{ VDC}}{\text{mm}}$

A/D Output: $\frac{\pm 3{,}276.8 \text{ bits}}{\text{VDC}}$

Displayed Output: $\frac{\pm 2{,}734.97 \text{ bits}}{\text{mm}}$

LVDT 1 ____________mm (Record)

LVDT 2 ____________mm (Record)

LVDT 3 ____________mm (Record)

LVDT 4 ____________mm (Record)

LVDT 5 ____________mm (Record)

LVDT 6 ____________mm (Record)

5.7.15 Change the LVDT position and record the new Host Computer measured displacement for the LVDTs.

LVDT 1 ____________mm (Record)

LVDT 2 ____________mm (Record)

LVDT 3 ____________mm (Record)

LVDT 4 ____________mm (Record)

LVDT 5 ____________mm (Record)

LVDT 6 ____________mm (Record)

5.7.16 Verify that the reported displacements changed accordingly.

LVDT 1 _____ (Check)

LVDT 2 _____ (Check)

LVDT 3 _____ (Check)

LVDT 4 _____ (Check)

LVDT 5 _____ (Check)

LVDT 6 _____ (Check)

5.8 ANEMOMETER TESTING

Three anemometers will be located on strategic locations on the mount for the monitoring of the wind by the M1 Mirror Support Local Control Unit (CFE). The anemometers will be serially connected (RS-422) to a Host Computer to retrieve the anemometer's wind velocity information.

5.8.1 Load the utility software provided with the anemometer or Hyperterminal to a host computer.

__✓__ (Check)

5.8.2 Using a RS-422 cable, connect anemometer #1 to the host computer.

✓ (Check)

5.8.3 Verify that a communication link has been established between anemometer #1 and host computer.

✓ (Check)

5.8.4 Place a fan directly in front of anemometer #1.

Plot A37, A38

✓ (Check)

5.8.5 Record the wind information from the host computer with the fan turned off.

≈ 0.53 KPH (~~Check~~) R

5.8.6 Turn on the fan. Set it to low. Record the wind information from the host computer.

≈ 6 KPH (Record

5.8.7 Verify that the wind measurement changed accordingly.

✓ (Check)

5.8.8 Set the fan to Hi. Record the wind information from the host computer.

≈ 10 KPH (Record)

5.8.9 Verify that the wind measurement increased from previous measurement.

✓ (Check)

5.8.10 Repeat Sections 5.8.2 - 5.8.9 for Anemometer #2 and #3.

Plot A39 - A41

Connect Anemometer #2 to Host Computer ✓ (Check)

Communication Established ✓ (Check)

Place Fan in front of Anemometer ✓ (Check)

Wind information with Fan Off ≈ 0.5 KPH (Record)

Wind information with Fan set to Low ≈ 16 KPH (Record)

Reported Wind Speed Increased ✓ (Check)

Wind information with Fan set to Hi ≈ 25 KPH (Record)

Reported Wind Speed Increased ✓ (Check)

Connect Anemometer #3 to Host Computer _____ (Check)

VPO HAS 3rd ANEMOMETER

Communication Established _____ (Check)

Place Fan in front of Anemometer _____ (Check)

Wind information with Fan Off ___________ (Record)

Wind Information with Fan set to Low ___________ (Record)

Reported Wind Speed Increased _____ (Check)

Wind information with Fan set to Hi ___________ (Record)

Reported Wind Speed Increased _____ (Check)

5.9 BRAKE DECELERATION

This test will demonstrate the brake's deceleration capability.

5.9.1 Set the strip chart recorder channels to convenient settings for the peak excursions of the rate signals and record. Connect the strip chart recorder to the Rate Loop Board A1-1 (AZ), C1-1 (ALT) and A1-1 (CASS).

Channel 1 Gain ±15V (Record)

Channel 1 Speed — (Record)

5.9.2 Enable the axis using the PMU and command AZ full rate in the POS direction.

✓ (Check)

5.9.3 While the AZ axis running at full velocity, create an Axis fault that would cause the brakes to be set immediately.

✓ (Check)

5.9.4 From the strip chart recording, calculate the brake deceleration by dividing the axis velocity by the time elapsed to bring the axis to a complete stop. Annotate the calculated brake deceleration value.

A42 Plot AZ Brake Deceleration 8.56 deg/sec^2 (Record)

5.9.5 Verify that the AZ Brake deceleration is between 4 to 60 deg/sec^2.

✓ (Check)

5.9.6 Repeat Paragraph 5.9.1 through 5.9.5 tests for the Altitude axis.

Channel 1 Gain ±15V (Record)

Chart Speed — (Record)

Enable Axis and Cmd Full Rate ✓ (Check)

Create Axis Fault ✓ (Check)

A43 Plot ALT Brake Deceleration 3.5 deg/sec^2 (Record)

ALT Brake Deceleration between 8 to 60 deg/sec^2 _____ (Check)

5.9.7 Repeat the above tests for the Cassegrain Rotator axis.

Channel 1 Gain ±15V (Record)

Chart Speed — (Record)

Enable Axis and Cmd Full Rate ✓ (Check)

Create Axis Fault ✓ (Check)

A44 Plot CASS Brake Deceleration 13.5 deg/sec^2 (Record)

CASS Brake Deceleration between 16 to 120 deg/sec^2 _____ (Check)

5.10 M1 MIRROR RESTRAINING SYSTEM TEST

The M1 Mirror Support System implements a scheme where the M1 Mirror is restrained when the ALT axis is below 20 degrees. For redundancy, two sets of redundant switches monitor the position of the ALT axis. If it is detected that the ALT axis is below 19 deg and the restraining system hasn't clamped the M1 mirror, the Altitude axis is Interlocked.

5.10.1 Position the ALT axis to 25 degrees.

_____ (Check)

5.10.2 With the PMU in HI rate mode, drive the ALT axis in the NEG direction.

_____ (Check)

5.10.3 Verify that as the axis passes 20 degrees, the ALT Velocity Limit is ON and slows down the axis velocity and the Restraint System is activated.

ALT Velocity Limit ON _____ (Check)

Restraint System activated _____ (Check)

5.10.4 Continue driving in the NEG direction past 19 degrees.

_____ (Check)

5.10.5 Verify that the M1 Mirror restraint system is fully activated and a M1 Mirror Restraint Failure didn't occur.

_____ (Check)

5.10.6 Using the PMU, drive in the POS direction to 30 degrees.

_____ (Check)

5.10.7 Verify that the M1 Mirror Restraint System is no longer restraining the M1 Mirror.

_____ (Check)

5.10.8 Simulate a failure of the restraining system (actuator command originating from FCC cabinet, actuator, or with any of the eight clamps that restrain the M1 Mirror) by disconnecting the J18 cable to the Altitude junction-box coming from the Maintenance Restraint distribution box. The J18 cable carries the feedback signal from the eight clamps that are wired in series that provides positive indication that the M1 Mirror Restraint system is working properly.

Disconnect J18 Cable _____ (Check)

5.10.9 Using the PMU, drive the axis in the NEG direction between 20 and 19 degrees.

_____ (Check)

5.10.10 Verify that the M1 Mirror Restraint system has been activated.

_____ (Check)

5.10.11 Continue driving in the NEG direction. Verify that as the axis drives below 19 degrees, the ALT Interlock Chain is broken causing the removal of a 3-Phase ALT motor amplifier power.

_____ (Check)

5.10.12 Verify that an M1 Mirror Restrained Failure fault is issued to the MCU and to the ALT LCU (Table 7).

_____ (Check)

5.10.13 Reconnect the J18 connector to the ALT junction-box and reset the ALT motor controller circuit breakers.

_____ (Check)

5.10.14 Drive the ALT axis to 30 degrees and verify that the M1 Mirror Restraint system is no longer restraining the M1 Mirror.

_____ (Check)

APPENDIX A

PORTABLE MAINTENANCE UNIT

APPENDIX A CONTENTS

5.11 PORTABLE MAINTENANCE UNIT

The Portable Maintenance Unit (PMU) can be selected to drive the AZ/ALT Axes or the CASS Axes. It can be plugged in at either PDU or at the dedicated PMU J-Boxes. The PMU can be enabled through the Maintenance MCU Screen or when the MCU is not powered up.

Plug in the PMU at the AZ/ALT PDU and give control to the AZ/ALT Axes (CASS Control LED not lit).

✓ (Check)

5.11.1 Place the MCU in the STOP Mode. Verify that the POWER ON LED is illuminated on the PMU and verify the status message, "AZ/ALT PMU AVAILABLE", is present at the MCU.

✓ (Check)

5.11.2 PMU Operations-AZ/ALT Axes

5.11.2.1 Enable the PMU through the MCU by executing the Maintenance Mode. Verify that the ENABLE LED is illuminated on the PMU and that the CASS CONTROL LED is not lit.

✓ (Check)

5.11.2.2 Take control with the PMU by pressing the ACTIVE Button and verify the ACTIVE LED is lit and status message, "AZ/ALT PMU IN CONTROL", appears at the MCU.

✓ (Check)

5.11.2.3 Verify proper AZ/ALT PMU IN CONTROL indication to AZ and ALT LCU per Table 6 and Table 7.

✓ (Check)

5.11.2.4 Select the HI Rate. Verify that the HI LED is lit and AZ and ALT do not display a fault condition.

✓ (Check)

5.11.2.5 Enable the AZ and then the ALT Axis by pressing the Axis Enable Button at the PMU and measure the bi-directional full speed of the motor. With the motor rotating at full speed, record the travel over approximately a 50-60° travel region and calculate the axis velocity.

	LENGTH OF TEST (Secs)	TRAVEL (deg)	AXIS VELOCITY (deg/sec)	
Δ45 AZ POS	28.08	60°	2.14	(Record)
PLOT AZ NEG	29.58	60°	2.03	(Record)

		LENGTH OF TEST (Secs)	TRAVEL (deg)	AXIS VELOCITY (deg/sec)	
A46	ALT POS	19.22	40°	2.08	(Record)
PLOT	ALT NEG	20.03	40°	2.00	(Record)

5.11.2.6 Verify the full speed is equal or greater than the desired speed.

AZ Desired Speed 2°/sec

ALT Desired Speed 2°/sec

AZ ✓ (Check)

ALT ✓ (Check)

5.11.2.7 Simulate an axis fault (limit, brake) for each axis and verify the PMU AXIS FAULT LED is lit and only the corresponding axis is inhibited.

AZ ✓ (Check)

ALT ✓ (Check)

5.11.2.8 Clear the fault and select the LO Rate and verify the LO LED is lit.

✓ (Check)

5.11.2.9 Enable each axis and measure the bi-directional full speed of the axis.

		LENGTH OF TEST (Secs)	TRAVEL (deg)	AXIS VELOCITY (deg/sec)	
A47	AZ POS	56.52	30°	0.53	(Record)
PLOT	AZ NEG	59.72	30°	0.50	(Record)
A48	ALT POS	37.87	20°	0.53	(Record)
Plot	ALT NEG	40.24	20°	0.50	(Record)

5.11.2.10 Verify the full speed is 20% to 30% of the speeds recorded in the HI Rate Mode.

AZ ✓ (Check)

ALT ✓ (Check)

5.11.2.11 Attempt to change modes at the MCU or attempt to take control with the AZ and ALT LCU and verify that the PMU remains in control.

✓ (Check)

5.11.2.12 Disable the PMU, verify the ACTIVE LED is OFF and the MCU status message, "AZ/ALT PMU IN CONTROL", clears.

✓ (Check)

5.11.3 PMU Operation-CASS Axis

5.11.3.1 Press the CASS Control Button at the PMU and verify that the CASS CONTROL LED is lit, the "AZ/ALT PMU AVAILABLE" message clears and the "CASS PMU AVAILABLE" message is displayed at the MCU.

✓ (Check)

5.11.3.2 Depress the ACTIVE Button at the Portable Maintenance Unit (PMU) and verify the ACTIVE LED is lit and the status message, "CASS PMU IN CONTROL", appears at the MCU.

✓ (Check)

5.11.3.3 Verify proper CASS PMU IN CONTROL indication to CASS LCU per Table 8.

✓ (Check)

5.11.3.4 Repeat Sections 5.11.2.4 through 5.11.2.10 for the CASS Axis and record results below. Verify that CASS Cablewrap axis velocity follows the axis motors' velocity.

5.11.2.4 HI Rate ✓ (Check)

5.11.2.5 Record Speed

A49 PLOT

80°/21.22 sec CASS POS 3.77 °/sec (Record)

CASS NEG 3.62 °/sec (Record)

80°/22.08 sec

CASS Desired Speed 3.6°/sec

5.11.2.6 Verify Axis Velocity ✓ (Check)

5.11.2.7 Fault LED ✓ (Check)

5.11.2.8 LO LED ✓ (Check)

5.11.2.9 Record Speed

CASS POS 0.53 °/sec (Record)

30°/56.58 sec

A50 PLOT

30°/59.35sec CASS NEG 0.51 °/sec (Record)

5.11.2.10 Verify Speed (10% to 20% of Slew Speed) ✓ (Check)

5.11.3.5 Verify that for all of the CASS Velocity tests above, the CASS Cablewrap remained synchronized with the CASS axis.

✓ (Check)

5.11.3.6 Attempt to enter a new mode at the MCU or attempt to take control with the CASS LCU and verify that the PMU remains in control.

✓ (Check)

5.11.4 Alternate PMU Connection Point

5.11.4.1 Connect the PMU at the CASS PDU and give control to the AZ/ALT axes. Verify that the CASS Control LED is not lit.

✓ (Check)

5.11.4.2 Repeat Sections through 5.11.1 through 5.11.2.4 and record the results below.

5.11.1 Messages ✓ (Check)

5.11.2.1 Maintenance Mode ✓ (Check)

5.11.2.2 PMU in Control ✓ (Check)

5.11.2.4 HI Rate ✓ (Check)

5.11.4.3 Enable the AZ and then the ALT Axis by pressing the Axis Enable Button and verify that bi-directional full speed of the motor is achieved.

AZ ✓ (Check)

ALT ✓ (Check)

5.11.4.4 Simulate an axis fault (limit, brake) for each axis and verify the PMU Axis FAULT LED is lit and only the corresponding axis is disabled.

AZ ✓ (Check)

ALT ✓ (Check)

5.11.4.5 Clear the fault and select the LO Rate and verify the LO Rate LED is lit.

✓ (Check)

5.11.4.6 Enable each axis and verify that bi-directional speed control of the motor is achieved.

AZ ✓ (Check)

ALT ✓ (Check)

5.11.4.7 Disable the AZ and ALT Axis.

✓ (Check)

5.11.4.8 Press the CASS Control Button at the PMU and verify that the CASS Control LED is lit, the "AZ/ALT PMU AVAILABLE" message clears and the "CASS PMU AVAILABLE" message is displayed.

✓ (Check)

5.11.4.9 Depress the ACTIVE Button and verify the ACTIVE LED is lit and the status message, "CASS PMU IN CONTROL", appears at the MCU.

✓ (Check)

5.11.4.10 Select the HI Rate. Verify that the HI LED is lit and CASS does not display a fault condition.

✓ (Check)

5.11.4.11 Repeat Sections 5.11.4.3 through 5.11.4.7 for the CASS Axis and record the results below.

5.11.4.3 Bi-directional Speed Control ✓ (Check)

5.11.4.4 Axis Fault ✓ (Check)

5.11.4.5 LO LED ✓ (Check)

5.11.4.6 LO Rate ✓ (Check)

5.11.4.7 Disable the CASS Axis ✓ (Check)

5.11.4.12 Connect PMU at PMU J-Box No. 1 and verify that the PMU has complete control and status capability.

✓ (Check)

5.11.4.13 Connect PMU at PMU J-Box No. 2 and verify that the PMU has complete control and status capability.

✓ (Check)

5.11.5 Power OFF Control

5.11.5.1 Power OFF the MCU and verify the PMU remains enabled and has complete control and status capabilities.

✓ (Check)

5.11.5.2 Power up the MCU and verify PMU remains in control.

✓ (Check)

5.11.5.3 Allow the MCU to take control and put the system in Stop Mode.

✓ (Check)

5.11.5.4 At the PMU, select the AZ/ALT Axes, disconnect the MCU-AZ/ALT CCU Data Link (MCU cable A2J21), verify the fault message, "MCU-AZ/ALT CCU LINK DOWN", and verify that the ENABLED indicator at the PMU is illuminated and AZ/ALT control is available at the PMU and at the AZ/ALT LCU. & AZ/ALT LCU

✓ (Check)

5.11.5.5 Reconnect the MCU-AZ/ALT CCU Data Link.

✓ (Check)

5.11.5.6 At the PMU, select the CASS Axes by pressing the CASS Control Button. Verify that the CASS Control LED is lit. Put the system in Stop Mode.

✓ (Check)

5.11.5.7 Disconnect the MCU-CASS CCU Data Link (MCU Cable J4), verify the fault message, "MCU-CASS CCU Link Down", and verify that the ENABLED indicator at the PMU is illuminated and CASS control is available at the PMU and at the CASS LCU. & CASS LCU

✓ (Check)

5.11.5.8 Reconnect the MCU-CASS CCU Data Link cable.

✓ (Check)

5.11.6 PMU Display

The PMU 2-line LCD displays AZ, ALT and CASS position angles as well as hardware generated faults and status message. When the PMU display is set to display faults/messages, the top line is dedicated for AZ/ALT and the bottom line is dedicated for CASS.

5.11.6.1 At the MCU, turn all error corrections OFF. Verify that the PMU Display axes angle readout agrees with the MCU readout.

✓ (Check)

5.11.6.2 Enable the AZ Axis with the LO Rate selected, drive POS and NEG, verify that the PMU Display follows the MCU readout.

✓ (Check)

Repeat 5.11.6.2 for the ALT and CASS Axes.

ALT ✓ (Check)

CASS ✓ (Check)

5.11.6.3 Depress the Rate Selection/Display Control Membrane Switch for approximately 5 seconds. Verify that the display readout changes to Status/Fault Messages.

✓ (Check)

5.11.6.4 Verify that the messages being scrolled on the PMU Display agree with the MCU Status and Fault Windows. Note that only hardware generated faults will appear at the PMU Display.

✓ (Check)

5.11.6.5 Create a new fault and verify that the new message is being reported at the PMU display and the MCU.

✓ (Check)

5.11.6.6 Reset the fault and verify that the message clears at the MCU and PMU display.

✓ (Check)

5.11.6.7 Disconnect the AZ/ALT CCU - CASS CCU PMU Display Link (AZ/ALT CCU A7COM1). Verify the fault message, "PMU-PMU LINK DOWN", is displayed at the MCU and on the PMU display.

✓ (Check)

5.11.6.8 Create any CASS fault and verify that fault is reported to the MCU and not to the PMU display.

✓ (Check)

5.11.6.9 Reconnect the AZ/ALT CCU - CASS CCU PMU Display Link Cable.

✓ (Check)

APPENDIX B

MOUNT CONTROL UNIT

APPENDIX B CONTENTS

5.12 FAULTS AND STATUS

Fault and status messages are displayed at the MCU and to the appropriate LCU (via contact closure). Fault messages will flash and cause the audible alarm to sound until they are acknowledged. Status messages remain steady state (not flashing) as they occur.

Appropriate contact action verification to the LCU will be verified by Table 1 through Table 3 and Table 6 through Table 8 (Appendix C). Additional fault and status sequences are detailed in the following paragraphs.

5.12.1 MCU Latching Faults

5.12.1.1 On the Site/Setup Screen, set latched faults ON.

✓ (Check)

5.12.1.2 Clear all fault conditions. While in an active mode, activate any system fault condition (Emergency Stop) and verify the system is disabled, the flashing fault indicator appears in top portion of screen, flashing message appears in the Fault Screen, and audible alarm at MCU is active.

✓ (Check)

5.12.1.3 Acknowledge the fault. Verify that both the fault message and the fault indicator in the top portion of the screen return to normal video (not flashing), and the audible alarm is OFF.

✓ (Check)

5.12.1.4 Activate a second emergency condition and verify the new message and the fault indicator on the top portion of the screen are flashing, the existing message is not flashing and the audible alarm is active.

✓ (Check)

5.12.1.5 Clear both fault conditions (and reset motor controller circuit breakers) and verify that the first fault message clears and the second remains.

✓ (Check)

5.12.1.6 Acknowledge the second fault message, verify that the fault message clears and the system remains disabled.

after entering stop mode.

✓ (Check)

5.12.1.7 Enter an active mode. Verify that the axes reenable.

✓ (Check)

5.12.1.8 Execute the STOP Mode. On the Site/Setup Screen, set latched faults OFF.

✓ (Check)

5.12.1.9 Repeat 5.12.1.2 through 5.12.1.4.

5.12.1.2 Activate Fault ✓ (Check)

5.12.1.3 Acknowledge Fault ✓ (Check)

5.12.1.4 Activate Second Fault ✓ (Check)

5.12.1.10 Clear both faults, verify that the fault messages are no longer displayed and the system is disabled.

✓ (Check)

5.12.1.11 Change the mode to an active mode after entering stop mode. Verify that the axes reenable.

✓ (Check)

5.12.2 Faults

5.12.2.1 Fault Table

All fault messages shall be tested with the system in an active mode. The following table lists the fault messages that will be activated with the appropriate disabling/interlock action that should take place. Each test shall activate the appropriate switch or mechanism. At the MCU, verify the appropriate disable state and verify that the proper message is displayed. At the LCU Interface, verify that the appropriate contact action occurs per Table 1 and Table 6 (AZ LCU), Table 2 and Table 7 (ALT LCU) and Table 3 and Table 8 (CASS LCU). Place a check (✓) in the verification column upon proper operation. Some fault conditions cause additional messages to appear.

SYSTEM DISABLING/INTLK DEFINITION:

Motor Level:	Disables affected motor. Brakes are not set and non-disabled motor continues to operate. Status message, "AZ, ALT or CASS SINGLE MOTOR", appears when only one motor is active for that axis.
Axis Level:	Brakes are set and motors disabled in affected axis only. Other axes continues to function in selected mode. Status message, "AZ, ALT or CASS DISABLED", appears.
Axis Interlock:	Breaks the appropriate axis interlock chain which results in motor controller power removed and immediate setting of axis brakes.
Non Disabling:	All motors continue to function.

Table 4, Fault Table

FAULT MESSAGE	FAULT LOCATION	SYSTEM INTERLOCK			(✓) VERIFICATION @ MCU & @ LCU INTERFACE
		MOTOR LEVEL DISABLE	AXIS LEVEL DISABLE	AXIS INTERLOCK	
EQUIPMENT ROOM EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
CONE EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
AZ MOTOR #1/#2 EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
AZ MOTOR #3/#4 EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
ALT MOTOR #1 EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
ALT MOTOR #2 EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
ALT PIER EMERGENCY	Activate E-Stop			X (AZ/ALT/CASS)	✓
M1 MIRROR RESTRAINT FAILURE	Activate Switch			X (ALT)	✓
ALT AUX DRIVE EN INTLK	Remove Handcrank from cradle			X (ALT)	✓
CASS INSTRUMENT NOT INSTALLED	Activate Switch			X (ALT)	✓
AZ/ALT REGEN OVERTEMP FLT	Remove Regen Cabinet J7 Cable		X (AZ/ALT)		✓
CASS REGEN OVERTEMP FLT	Remove Regen Cabinet J8 Cable		X (CASS ONLY)		✓
AZ MOT 1 3-PHASE OFF AZ MOTOR CONTROL 1 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
AZ MOT 2 3-PHASE OFF AZ MOTOR CONTROL 2 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
AZ MOT 3 3-PHASE OFF AZ MOTOR CONTROL 3 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
AZ MOT 4 3-PHASE OFF AZ MOTOR CONTROL 4 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
ALT MOT 1 3-PHASE OFF ALT MOTOR CONTROL 1 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
ALT MOT 2 3-PHASE OFF ALT MOTOR CONTROL 2 FAULT	AZ/ALT PDU Motor Disconnect	X			✓
AZ LUBE OVERFLOW	Disconnect AZ/ALT PDU J70 Cable		X		✓
DOME CRANE INTLK	Activate Switch			X (AZ/ALT)	✓
AZ LUBE PUMP CB OFF	AZ/ALT PDU CB		X		✓
AZ MOTOR 1 OVERTEMP	Disconnect A2P17-1 Wire	X			✓
AZ MOTOR 2 OVERTEMP	Disconnect A2P17-5 Wire	X			✓
AZ MOTOR 3 OVERTEMP	Disconnect A2P17-9 Wire	X			✓
AZ MOTOR 4 OVERTEMP	Disconnect A2P17-10 Wire	X			✓
ALT MOTOR 1 OVERTEMP	Disconnect A2P18-1 Wire	X			✓
ALT MOTOR 2 OVERTEMP	Disconnect A2P18-5 Wire	X			✓
M2 UNIT NOT INSTALLED	Activate Switch			X (ALT)	✓
OSS NOT INSTALLED	Activate Switch			X (ALT)	✓
YOKE ACCESS HATCH INTLK	Activate Switch			X (AZ)	✓
AZ LUBE PUMP PRESSURE LOW	Turn OFF Pump Motor		X		✓

SIZE	CAGE NO.	DWG NO.	REV
A4	0P0N7	99-343-0006	-

VPO DWG. NO.
VIS-PRO-VER-01001-9008

SCALE NONE | WEIGHT: | SHEET 66 OF 125

FAULT MESSAGE	FAULT LOCATION	SYSTEM INTERLOCK			(✓) VERIFICATION @ MCU & @ LCU INTERFACE
		MOTOR LEVEL DISABLE	AXIS LEVEL DISABLE	AXIS INTERLOCK	
DSP BOOT FAILURE	DSP BD		X (ALT)		✓
CASS MOTOR 1 POWER OFF CASS MOTOR CONTROL 1 FAULT	CASS PDU Motor Disconnect	X			✓
CASS MOTOR 2 POWER OFF CASS MOTOR CONTROL 2 FAULT	CASS PDU Motor Disconnect	X			✓
CASS CABLEWRAP MTR POWER OFF CASS CABLEWRAP M/C FLT	CASS PDU Motor Disconnect		X		✓
CASS MOT 1 OVERTEMP	Disconnect A2P17-1 Wire	X			✓
CASS MOT 2 OVERTEMP	Disconnect A2P17-5 Wire	X			✓
CASS CABLEWRAP MTR OVERTEMP	Disconnect A2P17-2 Wire		X		✓
PIER ACCESS INTLK	Activate Switch			X (AZ)	✓
MOBILE PLATFORM INTLK	Activate Switch			X (AZ/ALT)	✓
AZ FLOOR ACCESS INTLK	Activate Switch			X (ALT)	✓

5.12.3 Status

The following table lists the externally generated status messages. (Status messages that are generated internally are tested with the applicable test in the procedure). At the MCU, verify that the proper message is displayed. At the LCU interface, verify that the appropriate contact action occurs per Table 1 through Table 3, and Table 6 through Table 8. Place a (✓) in the verification column upon proper operation.

Table 5, Status Table

STATUS MESSAGE	STATUS LOCATION	VERIFICATION (✓) @ MCU AND @ LCU INTERFACE
AZ Single Motor	AZ Motor Disconnect	✓
ALT Single Motor	ALT Motor Disconnect	✓
CASS Single Motor	CASS Motor Disconnect	✓
AZ Preload OFF	AZ ~~Motor Disconnect~~ Axis during Accel	✓
CASS Preload OFF	CASS ~~Motor Disconnect~~ Axis during Accel	✓
AZ Cablewrap Neg Dir	AZ Cablewrap in NEG Wrap	✓
CASS Cablewrap Neg Dir	CASS Cablewrap in NEG Wrap	✓
ALT Imbalance Pin Extended	Activate Switch	—
*AZ Parked	Activate Switch	✓
*ALT Parked	Activate Switch	✓
*AZ/ALT CCU OFF	CCU Power Switch	✓
*CASS CCU OFF	CCU Power Switch	✓

* Status/Fault reported only to LCU.

5.13 POSITION LOOP TESTS

The Position Loop is tested for bandwidth and step response.

5.13.1 Record the Position Loop Parameters located on the Axis Loop Parameter Screen via the Site/Setup Screen.

TYPE II

	AZ SINGLE	AZ DUAL	ALT SINGLE	ALT DUAL	CASS SINGLE	CASS DUAL	
Max Velocity	2.0	2.0	2.0	2.0	3.6	3.6	(Record)
Deadband	0.0	0.0	0.0	0.0	0.0	0.0	(Record)
Hysteresis	1.5	1.5	1.5	1.5	1.5	1.5	(Record)
Lag Break 1	0.035	0.0	0.001	0.0	0.05	0.0	(Record)
Lead Break	0.05	0.24	0.05	0.24	0.05	0.30	(Record)
Crossover Freq.	0.13	1.00	0.125	1.00	0.25	1.25	(Record)
Lag Break 2	0.90	10.0	0.90	10.0	4.50	10.0	(Record)
Sqrt Trans Pt	0.044	0.015	0.044	0.044	0.044	0.044	(Record)
Trans Pt Hyst	1.50	5.00	1.50	1.50	1.50	1.50	(Record)
Max Accel	0.50	0.50	0.50	0.50	0.50	1.80	(Record)
Scan Accel	1.00	0.50	1.00	0.50	—	—	(Record)

✓ (Check)

5.13.2 Position Loop Bandwidth

This test demonstrates the Position Loop's Bandwidth defined as the frequency at which the feedback is 70% of the initial value.

a. Connect a function generator set at 2V peak-to-peak (±1V), 0.05 Hz, Sine Wave to A4TP4 at the appropriate PDU and to Channel 1 of the chart recorder.

b. Connect the position feedback, A4TP1 at the appropriate PDU to Channel 2 of the chart recorder.

c. At the MCU, select the Signal Meters Screen; select the Position FB output for the axis under test. Verify that the range is set to ±0.05° about the commanded angle.

d. Select the Test Function Screen and, from there, select the Position Loop Test Screen. Set the scale factor to .01°/V (this creates ±0.010° movement) and select Execute.

e. Verify that all error corrections are OFF.

f. Enable the axis to be tested and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the position signals and record.

NOTE: **Disable all axes not currently being tested.**

Channel 1 Gain — (Record)

Channel 2 Gain — (Record)

Chart Speed — (Record)

AS1 PLOT

g. Slowly increase the function generator frequency up through 10 Hz while marking convenient frequencies as they occur.

h. A dynamic signal analyzer may be used for this test. Attach the analyzer's test set-up printout to this procedure.

5.13.3 Record the frequency at which the feedback peak-to-peak voltage is 70% of the initial value.

AS2, AS3 PLOT AZ 3 dB Bandwidth 2.0 Hz (Record)

5.13.4 Repeat Section 5.13.3 for the ALT and then for the CASS Axis and record the results below.

AS4, AS5 PLOT ALT 3 dB Bandwidth 2.5 Hz (Record)

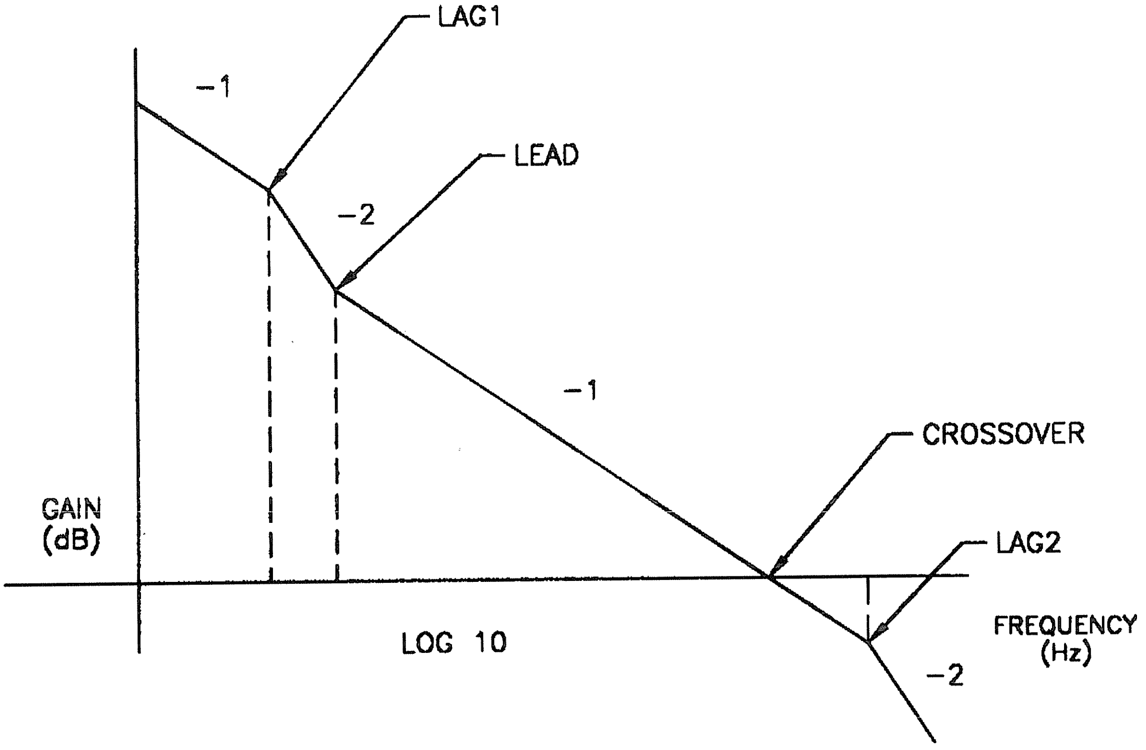
AS6, AS7 PLOT CASS 3 dB Bandwidth 1.5 Hz (Record)

5.13.5 Verify that the bandwidths are >0.8 Hz and <2.5 Hz.

✓ (Check)

NOTE: **If the recorded AZ, ALT and CASS Position Loop Bandwidths are lower than 1.4 Hz, the Vista Telescope Control System Simulation will need to be re-examined with the measured Position Loop BW data.**

Figure 4, Position Loop Filter
Type II



11168
REV -

SIZE	CAGE NO.	DWG NO.	REV
A4	0P0N7	99-343-0006	-
VPO DWG. NO.	VIS-PRO-VER-01001-9008		
SCALE NONE	WEIGHT:	SHEET 70 OF 125	

5.13.6 Position Loop Step Response

This test demonstrates the Position Loop's ability to respond to a step change in commanded rate.

In the following tests:

$$\text{Overshoot} = \left(\frac{\text{MAX VALUE}}{\text{FINAL VALUE}} - 1\right) * 100\%$$

Settling time = (Start time) - (Time at which the feedback is within 5% of the final value)

5.13.6.1 **a.** With the setup unchanged from the bandwidth test, set the function generator to 4V peak-to-peak (±2V), 0.02 Hz square wave. This creates ±0.02° position loop steps.

b. Enable the axis to be tested and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the position signals and record.

NOTE: **Disable all axes not currently under test.**

Channel 1 Gain ±5V (Record)

Channel 2 Gain ±5V (Record)

Chart Speed – (Record)

5.13.6.2 Record the percentage of overshoot.

A58 PLOT AZ Overshoot 26% (Record)

5.13.6.3 Repeat Section 5.13.6.2 for the ALT and the CASS Axis and record the results below.

A59 PLOT ALT Overshoot 35.6% (Record)

A60 PLOT CASS Overshoot 27.3% (Record)

5.13.6.4 Verify that overshoots are <40% and that the 5% settling time is <4 sec.

✓ (Check)

5.13.6.5 Set the function generator to 4V peak-to-peak (±2V), 0.02 Hz square wave and the Pos Loop Scale Factor to 0.2°/V. This creates ±0.4° position loop steps. At the Signal Meters Screen, set the Position FB output range to ±0.6° about the commanded angle.

✓ (Check)

5.13.6.6 Enable the axis to be tested and set the chart recorder channels to convenient settings for the peak-to-peak excursions of the position signals and record.

Channel 1 Gain ±5V (Record)

Channel 2 Gain ±5V (Record)

Chart Speed — (Record)

5.13.6.7 Record the percentage of overshoot.

A61 PLOT AZ Overshoot 1% (Record)

5.13.6.8 Repeat Section 5.13.6.7 for the ALT and CASS Axis and record the results below.

A62 PLOT ALT Overshoot 1% (Record)

A63 PLOT CASS Overshoot 1% (Record)

5.13.6.9 Verify that overshoots are <40% and that the 5% settling time is <6 secs.

✓ (Check)

5.13.6.10 Set the function generator to 1V peak-to-peak (±0.5V), 0.02 Hz square wave and the Position Loop Scale Factor to 0.001°/V. This creates ±0.0005° position loop steps. At the Signal Meters Screen, set the Position FB output range to ±0.002° about the commanded angle.

✓ (Check)

5.13.6.11 Enable the axis to be tested and set the chart recorder to convenient settings for the peak-to-peak excursions of the position signals and record.

Channel 1 Gain ±1V (Record)

Channel 2 Gain ±2V (Record)

Chart Speed ~ (Record)

5.13.6.12 Record the percentage of overshoot.

A64 PLOT AZ Overshoot 18.3% (Record)

5.13.6.13 Repeat Section 5.13.6.12 for the ALT and CASS. Record the results below.

A65 PLOT ALT Overshoot 14.6% (Record)

A66 PLOT CASS Overshoot 23.5% (Record)

5.13.6.14 Verify the overshoots are <40% and that the 5% settling time is <3 secs.

✓ (Check)

5.13.6.15 Disable the Position Loop Test.

✓ (Check)

5.14 POINTING REPEATABILITY/ENCODER RE-REFERENCING

Due to a lack of a boresight tower or other forms of obtaining positive position feedback verification (due to absence of optics), other means of measuring pointing performance were sought. Pointing repeatability will be tested, using high precision measuring devices that establish a mechanical reference point. After the mechanical reference point has been established, the axis is driven away from the reference point positions and then commanded back to the reference point, using the MCU Position Designate Mode. It will be verified that the axis drives precisely back to the mechanical reference position.

The Azimuth, Altitude and Cassegrain encoders are pseudo-absolute encoders that have an incremental track and a reference track. Upon CCU power-up, in order to ensure that the absolute position of the axis has not been lost (due to possible axis movement while the PDU CCU was powered down), an encoder referencing procedure occurs where the axis is manually slowly driven through three reference pulses and the absolute position is then calculated and registered.

5.14.1 Azimuth Pointing Repeatability

5.14.1.1 Record below the measuring device to be used for this test.

Measuring Device Type LASER (Record)

L-719

Manufacturer/Model No. HAMAR (Record)

.0001" @ 325.2677"

Device Resolution rad (Record)

= .063 arc-sec/.0001

Serial No. 97063086 (Record)

Calibration Due Date ____________ (Record)

5.14.1.2 Lock down the measuring device on a stationary surface in such a way that good consistent measurements can be obtained when the rotating axis is driven to this reference position.

✓ (Check)

5.14.1.3 Record the Azimuth reference position.

AZ Ref Position 253.750° (Record)

5.14.1.4 Using the PMU or the MCU, drive approximately 1.0° from the reference position.

✓ (Check)

5.14.1.5 Allow the MCU to take control of the MCS. Record the Azimuth Position.

254.750° (Record)

5.14.1.6 Using the appropriate EN/DIS Function of the MCU, disable the axes not under test.

✓ (Check)

5.14.1.7 Using the Position Designate Mode, command the AZ Axis to the reference position annotated above.

✓ (Check)

5.14.1.8 Verify that the AZ Axis is driven back to the reference position and once it reaches the reference position it holds position.

✓ (Check)

5.14.1.9 Verify that the axis was driven back to the mechanical reference position within 0.28 arc-sec pk (0.2 arc-sec rms).

0.0002''
Pointing Repeatability ≈0.126 arc-sec (Record)

Pointing Repeatability w/i 0.28 arc-sec pk ✓ (Check)

5.14.1.10 Using the PMU, drive approximately 60° away from the reference position.

✓ (Check)

5.14.1.11 Allow the MCU to take control of the MCS. Record the Azimuth Position.

200.00 ° (Record)

5.14.1.12 With the MCU in control, using the Position Designate Mode, command the AZ Axis to the reference position noted above.

✓ (Check)

5.14.1.13 Verify that the AZ Axis is driven back to the reference position and once it reaches the reference position it holds position.

✓ (Check)

5.14.1.14 Verify that the axis was driven back to the mechanical reference position within 2.8 arc-sec pk (2 arc-sec rms).

.0003''
Pointing Repeatability 0.189 arc-sec (Record)

Pointing Repeatability w/i 2.8 arc-sec pk ✓ (Check)

5.14.2 Azimuth Pointing Accuracy

Within the high precision measuring device field of view, the axis will be commanded from the MCU to small incremental positions from the reference point. It will be verified that the axis moves by the commanded amount by comparing the MCU encoder position delta to the angular displacement of the hig precision measuring device.

5.14.2.1 With the measuring device locked down per the Azimuth Pointing Repeatability test, record the Azimuth reference position.

AZ Ref Position 252.738° (Record)

5.14.2.2 Using the MCU, command the axis 0.17° from the AZ Ref Position. Verify that the measuring device is still within its field of view, if not, command the MCU to a smaller delta position. Record the delta position commanded.

MCU Commanded AZ Delta Position 0.005° (Record)

5.14.2.3 Verify that the AZ is holding position.

✓ (Check)

5.14.2.4 Record the measuring device delta position. Convert the position change to axis angular displacement from the mechanical reference position.

NOTE: COULD NOT GET INDMAR USSEN ON AXIS

Measuring Device AZ Position 308 Hh" 19.404 arc-sec (Record)

Measuring Device AZ Axis Angular Displacement .00539° (Record)

5.14.2.5 Calculate the AZ axis Pointing Accuracy by subtracting the MCU Commanded Delta Position from the Measuring Device Axis Angular Displacement.

AZ Pointing Accuracy 0.00037° (Record)

5.14.2.6 Convert the AZ Pointing Accuracy to XALT Pointing Accuracy by multiplying by COS (ALT angle). Use ALT angle of 20° which is the lowest ALT operational angle.

XALT Pointing Accuracy 0.00035° (Record)

5.14.2.7 The above AZ Pointing Accuracy error will be used to calculate the overall Beam Radial Error (BRE) for AZ and ALT.

_____ (Check)

5.14.3 Azimuth Encoder Re-referencing Procedure

5.14.3.1 Lock down the Measuring Device on a stationary surface as done in Paragraph 5.14.1.2.

✓ (Check)

5.14.3.2 Record the Azimuth reference position.

AZ Ref Position 252.738° (Record)

5.14.3.3 Power down the AZ/ALT PDU Central Control Unit (CCU).

✓ (Check)

5.14.3.4 From the PMU, drive the AZ Axis approximately 20° POS from the reference position.

✓ (Check)

5.14.3.5 Power Up the AZ/ALT CCU.

✓ (Check)

5.14.3.6 Verify that the MCU issues an AZ and ALT TAPE UNREFERENCED FAULT, indicating that encoder re-referencing is necessary.

✓ (Check)

5.14.3.7 From the PMU, re-reference the AZ Encoder. Verify that the AZ TAPE UNREFERENCED FAULT clears.

CALIBRATED
@ 285°

✓ (Check)

5.14.3.8 After the AZ Axis Encoder calibrates, drive to the previously recorded mechanical reference position using the Position Designate mode of operation.

✓ (Check)

5.14.3.9 Verify that the axis has precisely driven back to the reference position.

.0019" = 1.197 arc-sec (Check)

5.14.4 Altitude Pointing Repeatability

5.14.4.1 Repeat Paragraphs 5.14.1.1 through 5.14.1.14 for the Altitude Axis.

5.14.1.1 Measuring Device Type ____________ (Record)

Mfg/Model No. ____________ (Record)

Device Resolution ____________ (Record)

Serial No. ____________ (Record)

Cal Due Date ____________ (Record)

5.14.1.2 Lock Down Meas Device _____ (Check)

5.14.1.3 ALT Ref Position ____________° (Record)

5.14.1.4 Drive 1.0° off _____ (Check)

5.14.1.5 (a.) MCU Takes Control _____ (Check)

5.14.1.5 (b.) ALT Position __________° (Record)

5.14.1.6 Disable Axes not under test _____ (Check)

5.14.1.7 Commanded to ALT Ref Pos _____ (Check)

5.14.1.8 (a.) Drives to Ref Pos _____ (Check)

5.14.1.8 (b.) Holds Position _____ (Check)

5.14.1.9 (a.) Pointing Repeatability __________ (Record)

5.14.1.9 (b.) Pointing Repeatability w/i 0.28 arc-sec pk _____ (Check)

5.14.1.10 Drive 20° off _____ (Check)

5.14.1.11 (a.) MCU Takes Control _____ (Check)

5.14.1.11 (b.) ALT Position __________° (Record)

5.14.1.12 Command to ALT Ref Pos _____ (Check)

5.14.1.13 (a.) Drives to Ref Pos _____ (Check)

5.14.1.13 (b.) Holds Position _____ (Check)

5.14.1.14 (a.) Pointing Repeatability __________ (Record)

5.14.1.14 (b.) Pointing Repeatability w/i 2.8 arc-sec pk _____ (Check)

5.14.5 <u>Altitude Pointing Accuracy</u>

5.14.5.1 Repeat Paragraphs 5.14.2.1 through 5.14.2.7 for the Altitude Axis.

5.14.2.1 ALT Ref Position __________° (Record)

5.14.2.2 MCU Cmd ALT Delta Pos __________° (Record)

5.14.2.3 ALT Holding Position _____ (Check)

5.14.2.4 (a.) Meas Device ALT delta pos ____________ (Record)

5.14.2.4 (b.) Meas Device ALT Ang. Displ ____________ (Record)

5.14.2.5 ALT Pointing Accuracy ____________ (Record)

5.14.5.2 Calculate the Beam Radial Error (BRE) of the XALT and ALT Pointing Errors.

BRE Pointing Error = $(\text{XALT Error}^2 + \text{ALT Error}^2)^{1/2}$ ____________ (Record)

5.14.5.3 Verify that the BRE Pointing Error is ≤ 0.14 arc sec pk.

_____ (Check)

5.14.6 Altitude Encoder Re-Referencing Procedure

5.14.6.1 Repeat Paragraphs 5.14.3.1 through 5.14.3.9 for the Altitude Axis.

5.14.3.1 Lock-down Measuring Device _____ (Check)

5.14.3.2 Alt Ref Position ____________° (Record)

5.14.3.3 Power-down CCU _____ (Check)

5.14.3.4 Drive 20° POS _____ (Check)

5.14.3.5 Power UP CCU _____ (Check)

5.14.3.6 AZ and ALT TAPE UNREFERENCED FAULT issued. _____ (Check)

5.14.3.7 Re-reference ALT Encoder _____ (Check)

5.14.3.8 Drive to Ref Position _____ (Check)

5.14.3.9 Axis Drives Precisely to Ref Position _____ (Check)

5.14.7 Cassegrain Pointing Repeatability

5.14.7.1 Repeat Paragraphs 5.14.1.1 through 5.14.2.7 for the Cassegrain Axis.

5.14.1.1 Measuring Device Type Dial Indicator (Record)

Mfg/Model No. Westward / Starret (Record)

Device Resolution 0.001" @ 0.83 m (Record)
rad = 6.3 arc sec/.001"

	Serial No.	—	(Record)
	Cal Due Date	—	(Record)
5.14.1.2	Lock Down Meas Device	✓	(Check)
5.14.1.3	CASS Ref Position	213.000 °	(Record)
5.14.1.4	Drive 1.0° off	✓	(Check)
5.14.1.5	(a.) MCU Takes Control	✓	(Check)
5.14.1.5	(b.) CASS Position	214.59 °	(Record)
5.14.1.6	Disable Axes not under test	✓	(Check)
5.14.1.7	Commanded to CASS Ref Pos	✓	(Check)
5.14.1.8	(a.) Drives to Ref Pos	✓	(Check)
5.14.1.8	(b.) Holds Position	✓	(Check)
5.14.1.9	(a.) Pointing Repeatability	0 arc-sec	(Record)
5.14.1.10	Drive 60° off	✓	(Check)
5.14.1.11	(a.) MCU Takes Control	✓	(Check)
5.14.1.11	(b.) CASS Position	260.82 °	(Record)
5.14.1.12	Command to CASS Ref Pos	✓	(Check)
5.14.1.13	(a.) Drives to Ref Pos	✓	(Check)
5.14.1.13	(b.) Holds Position	✓	(Check)
5.14.1.14	Pointing Repeatability	3/4 of 1 tth = 4.7arc-sec	(Record)

5.14.8 Cassegrain Pointing Accuracy

5.14.8.1 Repeat Paragraphs 5.14.2.1 through 5.14.2.5 for the CASS axis.

5.14.2.1 CASS Ref Position 213.000 ° (Record)

5.14.2.2 MCU Cmd Cass Delta Pos 0.036 ° (Record)

5.14.2.3 CASS Holding POS ✓ (Check)

5.14.2.4 (a.) Meas Device CASS delta Pos 20.944h (Record)
131.67 arc-sec

5.14.2.4 (b.) Meas Device CASS Ang. Displ ≈ 0.0365 (Record)

5.14.2.5 CASS Pointing Accuracy 0.000575° (Record)
≈ 2.07 arc-sec

5.14.9 CASS Encoder Re-Referencing Procedure

5.14.9.1 Repeat Paragraphs 5.14.3.1 through 5.14.3.9 for the CASS Axis.

5.14.3.1 Lock-down Measuring Device ✓ (Check)

5.14.3.2 CASS Ref Position 213.000 (Record)

5.14.3.3 Power-down CCU ✓ (Check)

5.14.3.4 Drive 20° off ✓ (Check)

5.14.3.5 Power UP CCU ✓ (Check)

5.14.3.6 CASS TAPE UNREFERENCED FAULT issued. ✓ (Check)

5.14.3.7 Re-reference CASS Encoder 280.55° ✓ (Check)

5.14.3.8 Drive to Ref Position ✓ (Check)

5.14.3.9 Axis Drives Precisely to Ref Position ✓ (Check)
0 arc-sec

5.15 TRACKING ACCURACY

The following test will verify the tracking accuracy (or jitter) while the MCS is in the MCU Velocity Test Mode of Operation. The AZ, ALT and CASS Position Loop error signals from the Signal Meter will be used to measure the position loop tracking error or jitter. Since the Velocity Test does not allow for independent velocities between the axes, individual Velocity tests will be run. The Axes Position Loop errors will be captured with true-RMS Data Acquisition Instrument and with a strip chart recorder (for Reference only). The data will be analyzed to determine the tracking error or jitter. The Cassegrain position errors will be mapped (converted) from the Cassegrain error to the On-Sky absolute pointing errors as described on the Pointing and Tracking Analysis Report. The Azimuth errors will be converted to be On-Sky (cross-altitude) errors by multiplying the Azimuth errors by the cosine of the Altitude angle. The strip chart recorder captured peak position errors will be converted to rms assuming a 3-Sigma Gaussian distribution. The Beam Radial Error (BRE) will be computed from the three (3) axis errors by performing an RSS calculation. It will be verified that the open loop tracking will be accurate to within 0.1 arc-sec rms over 15 seconds of tracking and to within 0.2 arc-sec rms over 5 minutes of tracking.

The Cassegrain Rotator axis position loop error data captured will be reduced. It will be verified that the CASS tracking is accurate to within 31 arc-sec rms.

5.15.1 Tracking Accuracy Test #1

This test measured the Tracking Accuracy (over 15 seconds) when AZ, CASS are traveling at maximum tracking velocity (0.133°/sec) while ALT is holding position.

5.15.1.1 Connect true RMS data acquisition instrument Channel 1 input to A4TP1 of the AZ/ALT PDU. Connect Channel 2 of the input to A4TP2 of the AZ/ALT PDU. Connect Channel 3 of the input to A4TP1 of the CASS PDU.

✓ (Check)

5.15.1.2 At the MCU, select the Signal Meters Screen, select the AZ Position Error output for Signal Meter #1, ALT Position Error output for Signal Meter #2 and CASS Position Error output for Signal Meter #4. Set the range of the signal meters selected to ±0.001°.

✓ (Check)

5.15.1.3 Set the recorder to convenient settings and record.

Channel 1 Gain ± 3V (Record)

Channel 2 Gain ± 1V (Record)

Channel 3 Gain ± 4V (Record)

Chart Speed — (Record)

5.15.1.4 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.067
Length of Test	30 sec
AZ Axis Enable/Dir	POS
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.1.5 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.134	0.134	0.241	deg/sec
Travel	4.02	0.00	0.00	deg

✓ (Check)

5.15.1.6 Record the Altitude starting angle.

88.2 ° (Record)

5.15.1.7 Execute the test mode and record the Azimuth and Altitude position errors on the strip chart recorder and on the true-RMS Data Acquisition Instrument.

✓ (Check)

5.15.1.8 Record the AZ and the ALT Position Errors from the true-RMS Data Acquisition Instrument.

PLOT A67

AZ Position Error 0.000114 Deg rms (Record)

ALT Position Error 0.000006 Deg rms (Record)

5.15.1.9 Convert the position errors to arc-secs by multiplying by 3600. Convert the AZ position error to XALT position error by multiplying by Cos (ALT angle).

AZ Position Error 0.4104 arc-sec rms (Record)

ALT Position Error 0.0216 arc-sec rms (Record)

XALT Position Error 0.013 arc-sec rms (Record)

5.15.1.10 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.037
Length of Test	30 sec
AZ Axis Enable/Dir	OFF
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	POS

✓ (Check)

5.15.1.11 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	**ALT**	**CASS**	
Velocity	0.074	0.074	0.133	deg/sec
Travel	0.00	0.00	4.00	deg

✓ (Check)

5.15.1.12 Execute the test mode and record the Cassegrain position errors on the true-RMS Data Acquisition Instrument.

✓ (Check)

5.15.1.13 Record the CASS Position Error from the true-RMS Data Acquisition Instrument.

CASS Position Error 0.000144 Deg rms (Record)

5.15.1.14 Convert the CASS Position Error to arc-secs by multiplying by 3600. Convert the CASS Position Error to the On-Sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-RMS rotary error. Finally, convert time-RMS rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error 0.5184 arc-sec time rms (Record)

PLOTA58

On-Sky CASS Position Error 0.009512 arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error 0.004 arc-sec time & space rms (Record)

5.15.1.15 Verify that the CASS Position Error above is less than 31 arc-sec rms.

✓ (Check)

5.15.1.16 Calculate the Beam Radial Error (BRE).

BRE = $((\text{XALT Error})^2 + (\text{ALT Error})^2 + (\text{On-Sky Focal Plane CASS Error})^2)^{1/2}$ 0.026 arc-sec rms (Record)

5.15.1.17 Verify that the BRE error is less than 0.1 arc-sec rms.

✓ (Check)

5.15.2 Tracking Accuracy Test #2

This test measures the Tracking Accuracy (over 15 seconds) when AZ, CASS are traveling at half their maximum tracking velocity (0.067°/sec) while ALT is traveling at half its maximum tacking velocity (0.0024°/sec).

5.15.2.1 Connect the True-RMS Data Acquisition Instrument Channel 1 input to A4TP1 of the AZ/ALT PDU, connect Channel 2 of the recorder input to A4TP2 of the AZ/ALT PDU, and connect Channel 3 of the recorder input to A4TP1 of the CASS PDU.

✓ (Check)

5.15.2.2 At the MCU, select the Signal Meters Screen, select the AZ Position Error Output for Signal Meter #1, ALT Position Error output for Signal Meter #2 and CASS Position Error output for Signal Meter #4. Set the range of the signal meters selected to ±0.001°.

✓ (Check)

5.15.2.3 Set the recorder to convenient settings and record.

Channel 1 Gain ±30 (Record)

Channel 2 Gain ±10 (Record)

Channel 3 Gain ±40 (Record)

Chart Speed — (Record)

5.15.2.4 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.034
Length of Test	30 sec
AZ Axis Enable/Dir	POS
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.2.5 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.068	0.068	0.122	deg/sec
Travel	2.04	0.00	0.00	deg

✓ (Check)

5.15.2.6 Record the Altitude starting angle. 86.48 ° (Record)

5.15.2.7 Execute the test mode and record the Azimuth position errors on the true-RMS Data Acquisition Instrument.

✓ (Check)

5.15.2.8 Record the AZ position error from the true-RMS Data Acquistion Instrument.

PLOT A69 AZ Position Error 0.000058 Deg rms (Record)

5.15.2.9 Convert the position error to arc-secs by multiplying by 3600. Convert the AZ position error to XALT position error by multiplying by Cos (ALT angle).

AZ Position Error 0.2088 arc-sec rms (Record)

XALT Position Error 0.0128 arc-sec rms (Record)

5.15.2.10 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.001
Length of Test	30 sec
AZ Axis Enable/Dir	OFF
ALT Axis Enable/Dir	POS
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.2.11 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.002	0.002	0.004	deg/sec
Travel	0.00	0.06	0.00	deg

✓ (Check)

5.15.2.12 Execute the test mode and record the Altitude position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.2.13 Record the ALT position error from the true-RMS Data Acquistion Instrument.

PLOT A70 ALT Position Error 0.000006 Deg rms (Record)

5.15.2.14 Convert the position error to arc-secs by multiplying by 3600.

ALT Position Error 0.046 arc-sec rms (Record)

5.15.2.15 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.019
Length of Test	30 sec
AZ Axis Enable/Dir	OFF
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	POS

✓ (Check)

5.15.2.16 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.038	0.038	0.068	deg/sec
Travel	0.00	0.00	2.04	deg

✓ (Check)

5.15.2.17 Execute the test mode and record the Cassegrain position errors on the true-RMS Data Acquisition Instrument.

✓ (Check)

5.15.2.18 Record the CASS position error from the true-RMS Data Acquisition Instrument.

PLOT A71 CASS Position Error 0.000092 Deg rms (Record)

5.15.2.19 Convert the CASS position error to arc-secs by multiplying by 3600. Convert the CASS position error to the On-sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-RMS rotary error. Finally, convert time-RMS rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error 0.331 arc-sec time rms (Record)

On-Sky CASS Position Error 0.006 arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error 0.0025 arc-sec time & space rms (Record)

5.15.2.20 Verify that the CASS Position Error above is less than 31 arc-sec rms.

✓ (Check

5.15.2.21 Calculate the Beam Radial Error (BRE).

BRE = $((\text{XALT Error})^2 + (\text{ALT Error})^2 + (\text{On-Sky Focal Plane CASS Error})^2)^{1/2}$ 0.025 arc-sec rms (Record)

5.15.2.22 Verify that the BRE error is less than 0.1 arc-sec rms.

✓ (Check)

5.15.3 Tracking Accuracy Test #3

This test measures the Tracking Accuracy (over 6 minutes ~~15 seconds~~) when AZ,CASS are holding position while ALT is traveling at maximum tracking velocity (0.0047°/sec).

5.15.3.1 Connect true-RMS Data Acquisition Instrument Channel 1 input to A4TP1 of the AZ/ALT PDU, Connect Channel 2 of the recorder input to A4TP2 of the AZ/ALT PDU, and Connect Channel 3 of the recorder input to A4TP1 of the CASS PDU.

✓ (Check)

5.15.3.2 At the MCU, select the Signal Meters Screen, select the AZ Position Error output for Signal Meter #1, ALT Position Error output for Signal Meter #2 and CASS Position Error output for Signal Meter #4. Set the range of the signal meters selected to ±0.001°.

✓ (Check)

5.15.3.3 Set the recorder to convenient settings and record.

Channel 1 Gain ± 3V (Record)

Channel 2 Gain ± 1V (Record)

Channel 3 Gain ± 4V (Record)

Chart Speed — (Record)

5.15.3.4 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.0024
Length of Test	30 sec
AZ Axis Enable/Dir	POS
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.3.5 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.0048	0.0048	0.0086	deg/sec
Travel	0.00	0.144	0.00	deg

✓ (Check)

5.15.3.6 Record the Altitude starting angle.

88.4 ° (Record)

5.15.3.7 Execute the test mode and record the Azimuth, Altitude and CASS position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.3.8 Record the AZ and ALT position errors from the true-rms Data Acquisition Instrument.

AZ Position Error 0.000004 Deg rms (Record)

PLOT A72

ALT Position Error 0.000018 Deg rms (Record)

5.15.3.9 Convert the position errors to arc-secs by multiplying by 3600. Convert the AZ position error to XALT positioin error by multiplying by Cos (ALT angle).

AZ Position Error 0.0144 arc-sec rms (Record)

ALT Position Error 0.0648 arc-sec rms (Record)

XALT Position Error 0.0004 arc-sec rms (Record)

5.15.3.10 Record the CASS position error from the true-rms Data Acquisition Instrument.

CASS Position Error ___—___ Deg rms (Record)

5.15.3.11 Convert the CASS position error to arc-secs by multiplying by 3600. Convert the CASS position error to the On-Sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-rms rotary error. Finally, convert time-rms rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error ___—___ arc-sec time rms (Record)

On-Sky CASS Position Error ___—___ arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error ___—___ arc-sec time & space rms (Record)

5.15.3.12 Verify that the CASS Position Error above is less than 31 arcsec rms.

___—___ (Check)

5.15.3.13 Calculate the Beam Radial Error (BRE).

$$BRE = ((\text{XALT Error})^2 + (\text{ALT Error})^2 + (\text{On-Sky Focal Plane CASS Error})^2)^{1/2}$$

___0.0648___ arc-sec rms (Record)

5.15.3.14 Verify that the axis BRE error is less than 0.1 arc-sec rms.

___✓___ (Check)

5.15.4 Tracking Accuracy Test #4

This test measures the Tracking Accuracy (over 5 minutes) when AZ,CASS are traveling at half their maximum tracking velocity (0.067°/sec) while ALT is traveling at half its maximum tracking velocity (0.0024°/sec).

5.15.4.1 Connect the true-RMS Data Acquisition Instrument Channel 1 input to A4TP1 of the AZ/ALT PDU, connect Channel 2 of the recorder input to A4TP2 of the AZ/ALT PDU, and connect Channel 3 of the recorder input to A4TP1 of the CASS PDU.

___✓___ (Check)

5.15.4.2 At the MCU, select the Signal Meters Screen, select the AZ Position Error output for Signal Meter #1, ALT Position Error output for Signal Meter #2 and CASS Position Error output for Signal Meter #4. Set the range of the signal meters selected to ±0.001°.

___✓___(Check)

5.15.4.3 Set the recorder to convenient settings and record.

Channel 1 Gain ± 3v (Record)

Channel 2 Gain ± 1v (Record)

Channel 3 Gain ±4V (Record)

Chart Speed — (Record)

5.15.4.4 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.034
Length of Test	360 sec
AZ Axis Enable/Dir	POS
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.4.5 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	<u>AZ</u>	<u>ALT</u>	<u>CASS</u>	
Velocity	0.068	0.068	0.122	deg/sec
Travel	24.48	0.00	0.00	deg

✓ (Check)

5.15.4.6 Record the Altitude starting angle.

86.48 (Record)

5.15.4.7 Execute the test mode and record the Azimuth position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.4.8 Record the AZ position errors from the true-rms Data Acquisition Instrument.

PLOT A73 AZ Position Error 0.00007 Deg rms (Record)

5.15.4.9 Convert the position errors to arc-secs by multiplying by 3600. Convert the AZ position error to XALT position error by multiplying by Cos (ALT angle).

AZ Position Error 0.252 arc-sec time rms (Record)

XALT Position Error 0.0155 arc-sec time rms (Record)

5.15.4.10 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.001
Length of Test	360 sec
AZ Axis Enable/Dir	OFF
ALT Axis Enable/Dir	NEG
CASS Axis Enable/Dir	OFF

✓ (Check)

5.15.4.11 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.002	0.002	0.004	deg/sec
Travel	0.00	-0.72	0.00	deg

✓ (Check)

5.15.4.12 Execute the test mode and record the Altitude position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.4.13 Record the ALT position error from the true-rms Data Acquisition Instrument.

PLOT A74

ALT Position Error 0.000006 Deg rms (Record)

5.15.4.14 Convert the position error to arc-secs by multiplying by 3600.

ALT Position Error 0.0216 arc-sec rms (Record)

5.15.4.15 Select the Velocity Test Screen from the Test Functions Menu Screen. Set the parameter to the following values and store.

% of Max Velocity	0.019
Length of Test	360 sec
AZ Axis Enable/Dir	OFF
ALT Axis Enable/Dir	OFF
CASS Axis Enable/Dir	POS

✓ (Check)

5.15.4.16 Execute the preview at the bottom of the Velocity Test Screen. Verify that the following values are calculated.

	AZ	ALT	CASS	
Velocity	0.038	0.038	0.068	deg/sec
Travel	0.00	0.00	24.62	deg

✓ (Check)

5.15.4.17 Execute the test mode and record the Cassegrain position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.4.18 Record the CASS position error from the true-rms Data Acquisition Instrument.

PLOT A75 CASS Position Error 0.00009 Deg rms (Record)

5.15.4.19 Convert the CASS position error to arc-secs by multiplying by 3600. Convert the CASS position error to the On-Sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-rms rotary error. Finally, convert time-rms rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error 0.324 arc-sec time rms (Record)

On-Sky CASS Position Error 0.0059 arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error 0.00243 arc-sec time & space rms (Record)

5.15.4.20 Verify that the CASS Position Error above is less than 31 arc-sec rms.

✓ (Check)

5.15.4.21 Calculate the Beam Radial Error (BRE).

$$BRE = ((\text{XALT Error})^2 + (\text{ALT Error})^2 + (\text{On-Sky focal plane CASS Error})^2)^{1/2}$$

0.0267 arc-sec rms (Record)

5.15.4.22 Verify that the BRE error is less than 0.1 arc-secs rms.

✓ (Check)

5.15.5 Tracking Accuracy Test #5

This test measures the Tracking Accuracy when the AZ, ALT and CASS axes are position commanded to follow a triangular wave of ±0.02° having a 0.02 Hz frequency. This test demonstrates the tracking performance at very low tracking rates and through direction reversals for each axis.

Set up the tests as follows:

a. Connect a function generator set at 4V peak-to-peak (±2V), 0.02 Hz, triangular wave to AZ/ALT PDU and CASS PDU A4TP4 and to Channel 1 of the chart recorder.

b. Connect the AZ Position Error, A4TP1 at the AZ/ALT PDU to Channel 2 of the chart recorder.

c. Connect the ALT Position Error, A4TP2 at the AZ/ALT PDU to Channel 3 of the chart recorder.

d. Connect the CASS Position Error, A4TP1 at the CASS PDU to Channel 4 of the chart recorder.

e. At the MCU, select the Signal Meters screen. Select AZ Position Error for Meter No. 1, ALT Position Error for Meter No. 2 and CASS Position Error for Meter No. 4. Set the range of the signal meters selected to ±0.001°.

f. Select the Test Function Screen, and from there, select the Position Loop Test Screen. Set the scale factor to 0.01°/V (this creates ±0.020° movement) and select Execute.

g. Verify that all error corrections are OFF.

h. Set the chart recorder channels to convenient settings for the peak-to-peak excursions of the position signals and record.

Channel 1 Gain ±3V (Record)

Channel 2 Gain ±1V (Record)

Channel 3 Gain ±0.5V (Record)

Channel 4 Gain ±5V (Record)

Chart Speed – (Record)

5.15.5.1 Record the Altitude starting angle.

45° (Record)

5.15.5.2 Enable the axes and record the Azimuth, Altitude and Cassegrain Position errors on the true-rms Data Acquisition Instrument.

✓ (Check)

5.15.5.3 Record the AZ and ALT position errors from the true-rms Data Acquisition Instrument.

PLOT A76, A77

AZ Position Error 0.000018 Deg rms (Record)

ALT Position Error 0.000008 Deg rms (Record)

5.15.5.4 Convert the position errors to arc-secs by multiplying by 3600. Convert the AZ position error to XALT position error by multiplying by Cos (ALT angle).

AZ Position Error 0.0648 arc-sec time rms (Record)

ALT Position Error 0.0288 arc-sec time rms (Record)

XALT Position Error 0.0458 arc-sec time rms (Record)

5.15.5.5 Record the CASS Position Error from the true-RMS Data Acquisition Instrument.

PLOT A76, A77

CASS Position Error 0.000036 Deg rms (Record)

5.15.5.6 Convert the CASS Position Error to arc-secs by multiplying by 3600. Convert the CASS Position Error to the On-Sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-RMS rotary error. Finally, convert time-RMS rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error 0.1296 arc-sec time rms (Record)

On-Sky CASS Position Error 0.0024 arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error 0.00097 arc-sec time & space rms (Record)

5.15.5.7 Verify that the CASS Position Error above is less than 31 arc-sec rms.

✓ (Check)

5.15.5.8 Calculate the Beam Radial Error (BRE).

BRE = ((XALT Error)^2 + (ALT Error)^2 + (On-Sky Focal Plane CASS Error)^2)$^{1/2}$

0.054 arc-sec rms (Record)

5.15.5.9 Verify that the BRE error is less than 0.1 arc-sec rms.

✓ (Check)

5.16 TRACKING TEST #6 - STAR TRACK MODE

The Star Track Mode of Operation generates pointing angles based upon:

1. Stored parameters describing targets
2. Real Time
3. Location of station

The MCU has the capability to store up to 10 Star Track data sets. The data for 10 common radio-source stars is loaded in the MCU as default. Different pointing trajectories can be defined by changing the Right Ascension and Declination parameter values.

5.16.1 Connect the true-RMS Data Acquisition Instrument recorder Channel 1 input to A4TP1 of the AZ/ALT PDU, connect Channel 2 of the recorder input to A4TP2 of the AZ/ALT PDU, and connect Channel 3 of the recorder to A4TP1 of the CASS PDU.

✓ (Check)

5.16.2 At the MCU, select the Signal Meters Screen, select the AZ Position Error output for Signal Meter #1, the ALT Position Error output for Signal Meter #2 and the CASS Position Error output for Signal Meter #4. Set the range of the signal meters selected to ±0.001°(AZ/ALT), CASS ±0.01°

✓ (Check)

5.16.3 Set the recorder to convenient settings and record.

Channel 1 Gain ±1V (Record)

Channel 2 Gain ±0.5V (Record)

Channel 3 Gain ±2V (Record)

Chart Speed — (Record)

5.16.4 Select Star Track Set #1, enter and record below the appropriate Right Ascension and Declination values that would result in a trajectory traveling at approximately half sidereal rate for the Azimuth and Altitude Axes.

Right Ascension 186.6379 (Record)

Declination 2.3275 (Record)

Epoch J1950.0 (Record)

5.16.5 Set the appropriate site location values needed for being able to track on the star.

Latitude -30.00 (Record)

Longitude 70.00 (Record)

Altitude 2700 (Record)

5.16.6 Select the Self-Test Function and set and record the Real Time Clock to the appropriate time and date for conducting this test.

Time 00:18:20 (Record)

Date 11/13/05 (Record)

5.16.7 Execute the Preview Function and verify that the star is visible for the current MCU time.

✓ (Check)

5.16.8 From the previewed information, calculate the approximate AZ and ALT axis velocities for the selected trajectory. Record below.

AZ Target Velocity 0.0026 °/sec (Record)

ALT Target Velocity 0.00345 °/sec (Record)

5.16.9 On the Slave Screen, turn on Slaving for Cassegrain. Enter a Slave Reference Position for CASS to the starting AZ angle position for the Star Track Test.

_____ (Check)

5.16.10 Execute the Star Track Test and record the Azimuth, ALT and CASS position errors on the strip chart recorder and on the true-rms Data Acquisition Instrument. Run the test for approximately 10 minutes. Record the position at the start and at the end of the test. Calculate the amount traveled and the axis velocities.

	AZ	**ALT**	**CASS**		
Start Position	71.585 ~~71.935~~	25.150 ~~24.692~~	165.12	°	(Record)
End Position	70.123°	27.004°	166.99	°	(Record)
Travel	1.462	1.854	1.87	°	(Record)
Test Time	555	555	555	sec	(Record)
Velocity	0.0026	0.0033	0.0037	°/sec	(Record)

5.16.10.1 Record the AZ and the ALT Position Errors from the true-RMS Data Acquisition Instrument.

AZ Position Error 0.00002 Deg rms (Record)

ALT Position Error 0.000014 Deg rms (Record)

5.16.10.2 Convert the position errors to arc-secs by multiplying by 3600. Convert the AZ position error to XALT position error by multiplying by Cos (ALT angle).

PLOT A78

ALT @ 26°

AZ Position Error 0.072 arc-sec rms (Record)

ALT Position Error 0.0504 arc-sec rms (Record)

XALT Position Error 0.0647 arc-sec rms (Record)

5.16.10.3 Record the CASS Position Error from the true-RMS Data Acquisition Instrument.

CASS Position Error 0.0006 Deg rms (Record)

5.16.10.4 Convert the CASS Position Error to arc-secs by multiplying by 3600. Convert the CASS Position Error to the On-Sky pointing error by dividing the position error by 54.5, giving the peak focal plane error to the time-RMS rotary error. Finally, convert time-RMS rotary error to RMS focal plane error by multiplying by $(1/6)^{1/2}$.

CASS Position Error 2.232 arc-sec time rms (Record)

On-Sky CASS Position Error 0.041 arc-sec time rms (Record)

On-Sky Entire Focal Plane Position Error 0.0167 arc-sec time & space rms (Record)

5.16.11 Calculate the Beam Radial Error (BRE).

$$\text{BRE} = ((\text{XALT Error})^2 + (\text{ALT Error})^2 + (\text{On-Sky Focal Plane CASS Error})^2)^{1/2}$$

0.084 arc-sec rms(Record)

5.16.12 Verify that the axis BRE error is less than 0.1 arc-sec rms.

✓ (Check)

6.0 Ka MEASUREMENT

The following tests will measure the Ka of the MCU Position Loop with and without velocity feed forward. The Ka of the system determines the amount of steady state error present when following a constantly accelerating target. The test will be performed at or above the maximum tracking velocities and accelerations (AZ, CASS 0.133°/sec, 0.00275°/sec^2, ALT 0.0047°/sec, 0.000143°/sec^2).

6.1 Ka MEASUREMENT SET-UP

a. Connect Channel 1 of the strip chart recorder to AZ/ALT PDU A4TP1 and connect Channel 2 to A4TP2 and record the settings.

Channel 1 Gain ±2.5V (Record)

Channel 2 Gain ±2.5V (Record)

Chart Speed — (Record)

b. At the MCU, select the axis velocity (Rate CMD) and Position Error to be output on Signal Meters 1 and 2 and record the settings.

CHANNEL	**SIGNAL**	**MINIMUM**	**MAXIMUM**	
1	AZ Rate CMD	-15%	+15%	(Record)
2	AZ Pos Error	-0.001°	+0.001°	(Record)

6.1.1 At the MCU, select the Acceleration Test with the % Max Accel to 0.003 (0.003°/sec^2), 90% Velocity Feed Forward (VFF) and % Max Velocity of 0.067 (0.134°/sec). Record the velocity and position error on the strip chart recorder.

✓ (Check)

6.1.2 Record the steady state error.

PLOT A79 0.000042 (Record)

6.1.3 Calculate the Ka using the following formula and record.

Ka = Acceleration / Error

Ka = 71 (Record)

6.1.4 Verify that the Ka is greater than 60.

Ka > 60 ✓ (Check)

6.1.5 Repeat the Ka test set without Velocity Feed forward and record the results below.

1. Set Up Rate CMD ±15% (Record)
   POS Error ±0.001° (Record)
2. 0% VFF ✓ (Check)
3. PLOT A80 Steady State Error 0.000298 (Record)
4. Ka 10.1 (Record)
5. Ka > 6 ✓ (Check)

6.1.6 Repeat the Ka Tests for the Altitude axis.

With 90% Velocity Feed Forward

1. Set Up — Rate CMD ± 15% (Record)
   POS Error ± 0.001° (Record)
2. Ka Test at 90% VFF
   % Max Accel .006 (0.003°/s^2)
   % Max Vel .067 (0.134°/sec) ✓ (Check)
3. PLOT A81 — Steady State Error 0.000024 (Record)
4. Ka 125 (Record)
5. Ka > 60 ✓ (Check)

With 0% Velocity Feed Forward

1. Set Up — Rate CMD ± 15% (Record)
   POS Error ± 0.001° (Record)
2. Ka Test at 0% VFF
   % Max Accel .006 (0.003°/s^2)
   % Max Vel .067 (0.134°/sec) ✓ (Check)
3. PLOT A82 — Steady State Error 0.00032 (Record)
4. Ka 9.4 (Record)
5. Ka > 6 ✓ (Check)

6.1.7 Repeat the Ka Tests for the Cassegrain axis.

With 90% Velocity Feed Forward

1. Set Up — Rate CMD ± 10% (Record)
   POS Error ± 0.001° (Record)
2. Ka Test at 90% VFF
   % Max Accel .0.002(0.036°/s^2)
   % Max Vel 0.037 (0.133°/sec) ✓ (Check)
3. PLOT A83 — Steady State Error 0.000048° (Record)

4. Ka 62.5 (Record)

5. Ka > 60 ✓ (Check)

With 0% Velocity Feed Forward

1. Set Up
   Rate CMD ±10% (Record)
   POS Error ±0.001° (Record)

2. Ka Test at 0% VFF
   % Max Accel .002 (0.036°/s^2)
   % Max Vel .037 (0.133°/sec)
   ✓ (Check)

PLOT A84

3. Steady State Error 0.000276 (Record)

4. Ka 11 (Record)

5. Ka > 6 ✓ (Check)

6.2 MANUAL POSITION MODE

The Manual Position Mode is a Closed Position Loop Mode, with the means to adjust the position incrementally. The amount of a movement produced by each keystroke can be adjusted by the increment parameters. The operator has the capabilities of four independently adjustable increment steps.

6.2.1 AZ/ALT Axes

6.2.1.1 Enter the Manual Position Mode and verify that the commanded position is equal to the current position ±0.001°. Record the commanded position.

Command = Current ± 0.001° ✓ (Check)

AZ Command 228.052° (Record)

ALT Command 68.304° (Record)

6.2.1.2 Command the Azimuth Axis POS 0.100° using the AZ "+" Increment Function and verify that the axis drives to the initial command plus 0.100° and that the total AZ Offset is 0.1000°.

✓ (Check)

6.2.1.3 Command the Azimuth Axis NEG 0.200° by first changing any increment step size to 0.2000° and using the AZ "-" Function.

✓ (Check)

6.2.1.4 Verify that the Azimuth Axis drives to -0.100° from the initial position and that the total AZ Offset is -0.1000°.

✓ (Check)

6.2.1.5 Execute the Manual Offset Store Function and verify that the stored offset is -0.1000°.

✓ (Check)

6.2.1.6 Command the Azimuth Axis POS 1.000° using the AZ "+" Function and verify that the axis drives to + 0.900 from the initial position, the total offset is 0.9000° and the stored offset remains -0.1000°.

✓ (Check)

6.2.1.7 Execute the Recall Stored Function. Verify that the axis drives to -0.100° from the initial position, the total offset is -0.1000° and the stored offset remains -0.1000°.

✓ (Check)

6.2.1.8 Enter 0.000° into the Azimuth Total Offset. Verify that the axis drives to the initial position and that the stored offset remains -0.1000°.

✓ (Check)

6.2.1.9 Execute the Manual Offset Store Function. Verify that the stored offset now reads 0.000°.

✓ (Check)

6.2.1.10 Repeat Paragraphs 6.2.1.2 through 6.2.1.9 for the Altitude Axis.

6.2.1.2 ✓ (Check)

6.2.1.3 ✓ (Check)

6.2.1.4 ✓ (Check)

6.2.1.5 ✓ (Check)

6.2.1.6 ✓ (Check)

6.2.1.7 ✓ (Check)

6.2.1.8 ✓ (Check)

6.2.1.9 ✓ (Check)

6.2.2 CASS Axes

6.2.2.1 Enter the Manual Position Mode and verify that the commanded position is equal to the current position ±0.01°. Record the commanded position.

Command = Current ± 0.01° ✓ (Check)

CASS Command 118.83 (Record)

6.2.2.2 Command the CASS ~~1~~ Axis POS 0.10° using the CASS "+" Increment Function and verify that the axis drives to the initial command plus 0.10° and that the total CASS Offset is 0.1000°.

✓ (Check)

6.2.2.3 Command the CASS Axis NEG 0.20° by first changing any increment step size to 0.2000° and using the CASS "-" Function.

✓ (Check)

6.2.2.4 Verify that the CASS Axis drives to -0.10° from the initial position and that the total CASS Offset is -0.1000°.

✓ (Check)

6.2.2.5 Execute the Manual Offset Store Function and verify that the stored offset is -0.1000°.

✓ (Check)

6.2.2.6 Command the CASS Axis POS 1.00° using the CASS "+" Function and verify that the axis drives to +0.90° from the initial position, the total offset is 0.9000° and the stored offset remains -0.1000°.

✓ (Check)

6.2.2.7 Execute the Recall Stored Function. Verify that the axis drives to -0.10° from the initial position, the total offset is -0.1000° and the stored offset remains -0.1000°.

✓ (Check)

6.2.2.8 Enter 0.000° into the CASS Total Offset. Verify that the axis drives to the initial position and that the stored offset remains -0.1000°.

✓ (Check)

6.2.2.9 Execute the Manual Offset Store Function. Verify that the stored offset now reads 0.000°.

✓ (Check)

6.3 PRESET POSITION MODE

The Preset Position Mode has the capability for storing the position coordinates for forty pointing angles. These pointing angles are normally the locations of frequently used signal sources.

Use of the Preset Position Detail allows the user to modify and store the position coordinates and name each individual position.

6.3.1 AZ/ALT Axes

6.3.1.1 Select the Preset Position Function detail and randomly choose any position(s) (1 - 40). Enter and store position coordinates for the Azimuth and Altitude Axes and input a name for the selected position.

✓ (Check)

6.3.1.2 Select AZ/ALT Axis in the Preset Position Detail Screen. Execute the chosen Preset Position(s) and verify that the system drives to the stored position coordinate and that the names were stored. Record the information as follows:

Pos. No.	Pos. Name	AZ Preset	ALT Preset		Drives To Preset ±0.001°	
1	FCC/LCU ACCESS	228.545°	75.000°	(Record)	✓	(Check)
5	REAR GATE	316.138°	20.000°	(Record)	✓	(Check)
10	Test 3	300.000°	88.000°	(Record)	✓	(Check)
15	Test 4	180.000°	10.000°	(Record)	✓	(Check)

6.3.1.3 Recall the Manual Offset Screen.

✓ (Check)

6.3.1.4 Verify that offsets may be added to the base mode.

✓ (Check)

6.3.2 CASS Axes

6.3.2.1 Select the Preset Position Function detail and randomly choose any position(s) (1 - 40). Enter and store position coordinates for the CASS Axes and input a name for the selected position.

✓ (Check)

6.3.2.2 Select CASS Axis in the Preset Position Detail Screen. Execute the chosen Preset Position(s) and verify that the system drives to the stored position coordinate and that the names were stored. Record the information below:

Pos. No.	**Pos. Name**	**CASS Preset**		**Drives To Preset ±0.01°**	
2 ~~CASS Test 1~~	CASS Test 1	25.00°	(Record)	✓	(Check)
6	Cass Test 2	80.00°	(Record)	✓	(Check)
11	Cass Test 3	0.00°	(Record)	✓	(Check)
14	Cass Test 4	50.00°	(Record)	✓	(Check)

6.3.2.3 Recall the Manual Offset Screen.

✓ (Check)

6.3.2.4 Verify that offsets may be added to the base mode.

✓ (Check)

6.4 STOW MODE/ALT MANUAL BRAKE RELEASE

The Stow Mode is another form of Preset Positioning. Four stow positions are available.

6.4.1 Stow Mode Functional Test

6.4.1.1 Select the Stow Detail Window and enter position coordinates and names for the four stow positions.

	NAME	**AZ**	**ALT**	**CASS**	
No. 1	Stow 1	225.386°	89.801°	0.000°	(Record)
No. 2	Stow 2	225.000°	89°	10°	(Record)
No. 3	Stow 3	220.000°	90°	20°	(Record)
No. 4	Stow 4	225.000°	90.5°	30°	(Record)

6.4.1.2 Select AZ/ALT/CASS Axis in the Stow 1 Detail Window. Execute Stow No. 1 and verify the AZ, ALT and CASS Axes drive towards the stored coordinates.

✓ (Check)

6.4.1.3 Verify that when the axes reach the stored position the brakes are set.

✓ (Check)

6.4.1.4 Depress the Manual Brake Released Button and verify that the ALT Brakes are not disengaged.

✓ (Check)

6.4.1.5 Remove the Azimuth stow pin from its cradle and verify the fault message, "AZ STOW PIN ENGAGED INTLK", is displayed, and that the AZ INTLK chain is broken. Verify that the AZ INTLK chain cannot be reestablished with the AZ Stow Pin Extended INTLK Fault present.

✓ (Check)

6.4.1.6 Verify proper AZ STOW PIN ENGAGED fault indication to LCU per Table 1.

✓ (Check)

6.4.1.7 Remove either Altitude stow pin from its cradle and verify the fault message, "ALT STOW PIN ENGAGED INTLK", is displayed, and that the ALT INTLK chain is broken.

✓ (Check)

6.4.1.8 Verify that the ALT INTLK chain cannot be reestablished with the ALT Stow Pin extended INTLK Fault present.

✓ (Check)

6.4.1.9 Depress the Manual Brake Released Button and verify that the ALT Brakes disengage.

✓ (Check)

6.4.1.10 Verify that the message, ALT MANUAL BRAKE RELEASED, is displayed at the MCU and reported to the LCU per Table 2. 7

✓ (Check)

6.4.1.11 Verify proper ALT STOW PIN ENGAGED fault indication to LCU per Table 2.

✓ (Check)

6.4.1.12 Activate the CASS stow pin and verify that the fault message, "CASS STOW PIN ENGAGED INTLK", is displayed, and that the CASS INTLK chain is broken.

✓ (Check)

6.4.1.13 Verify that the CASS INTLK chain cannot be reestablished with the CASS Stow Pin Extended INTLK Fault present.

✓ (Check)

6.4.1.14 Verify proper CASS STOW PIN ENGAGED Fault indication to LCU per Table 3.

✓ (Check)

6.4.1.15 Verify that the status message, "AZ STOWED", is issued to the MCU and to the CASS LCU (per Table 8).

✓ (Check)

6.4.1.16 Execute STOP Mode. Enter Position Designate Mode, command AZ, ALT and CASS Axes to another position. Verify axes remain disabled. Execute STOP Mode.

✓ (Check)

6.4.1.17 Insert the AZ and ALT Stow Pins in the stowed position and verify the status messages, "AZ STOWED" and "ALT STOWED", are issued.

AZ ✓ (Check)

ALT ✓ (Check)

6.4.1.18 Verify proper AZ and ALT Stowed message indication to LCUs per Table 6 and Table 7, appropriately.

AZ ✓ (Check)

ALT ✓ (Check)

6.4.1.19 Remove the Stow Pin from their stowed position and verify the status messages, "AZ STOWED" and "ALT STOWED", clear.

AZ ✓ (Check)

ALT ✓ (Check)

6.4.1.20 Return the AZ, ALT and CASS Stow Pins to their cradle and verify that the messages, "AZ STOW PIN ENGAGED INTLK", "ALT STOW PIN ENGAGED INTLK", and "CASS STOW PIN ENGAGED INTLK" clear.

✓ (Check)

6.4.1.21 Verify that the AZ, ALT and CASS Interlock chain can now be reestablished. Reset the motor controller CBs.

✓ (Check)

6.4.1.22 Verify that the CASS STOWED message clears.

✓ (Check)

6.4.1.23 Enter Position Designate Mode and command the axes to another position. Verify that the mount drives to this new position. Execute STOP Mode.

✓ (Check)

6.4.2 <u>Stow No. 2, 3, 4</u>

6.4.2.1 Select AZ/ALT/CASS axis in the Stow 2 Detail Window. Execute Stow No. 2 and verify that the mount drives to the stored position coordinates, sets the brakes and disables the motors.

✓ (Check)

6.4.2.2 Repeat 6.4.2.1 for Stow No. 3 and Stow No. 4.

✓ (Check)

6.5 POSITION DESIGNATE MODE

The Position Designate Mode provides closed position loop operation on axis pointing angles as they are received.

6.5.1 AZ/ALT Axes

6.5.1.1 Select AZ/ALT Axis. Execute the Position Designate Mode and verify that the mount is driven to the commanded position ±0.001°.

✓ (Check)

6.5.1.2 Verify that after reaching the commanded position, the motors remain enabled.

✓ (Check)

6.5.1.3 Recall the Manual Offset Screen.

✓ (Check)

6.5.1.4 Verify that offsets may be added to the base mode.

✓ (Check)

6.5.2 CASS Axes

6.5.2.1 Select CASS Axis. Execute the Position Designate Mode and verify that the mount is driven to the commanded position ±0.01°.

✓ (Check)

6.5.2.2 Verify that after reaching the commanded position, the motors remain enabled.

✓ (Check)

6.5.2.3 Recall the Manual Offset Screen.

✓ (Check)

6.5.2.4 Verify that offsets may be added to the base mode.

✓ (Check)

6.6 SOFT STOP MODE

The STOP Mode disables the drives and sets the brakes after a controlled deceleration.

6.6.1 Select AZ/ALT/CASS Axis. Execute any active mode (such as Position Designate) which will cause the motors to drive at full velocity.

✓ (Check)

6.6.2 While the motors are rotating at full velocity execute the STOP Mode. Verify that the motors decelerate, the brakes are set and the motor controller is disabled after the deceleration period.

AZ ✓ (Check)

ALT ✓ (Check)

CASS ✓ (Check)

PLOT A85

6.7 SIGNAL METERS

The MCU can display eight signals simultaneously in a bar graph format. Each signal has a minimum and maximum range selection. The first three signals are output to the AZ/ALT PDU analog test points located on the PMU bracket. The 4th, 5th and 6th signals are output to the CASS PDU analog test points located on the PMU bracket. The outputs are limited to ±5 VDC. The Data Acquisition Unit interfaces to the 3 AZ/ALT and to the 3 CASS PDU Analogue test points and makes the information available over the DAQ's Can Open interface. The scale factor for the DAQ's Analogue test points is ±10V = ±32,768 bits reported on the Beckhoff Twincat program.

6.7.1 At the Signal Meter Detail Window, select the following available signals and store the data below.

NOTE: **Only AZ/ALT signals may be output to the AZ/ALT PDU test points and only CASS signals may be output to the CASS test points.**

SIGNAL NAME	STORE AS	MIN.	MAX.	TWINCAT VAR
AZ Rate Command	1	-100	100	Box 2, Var 74
ALT Rate Command	2	-100	100	Box 2, Var 73
AZ Position FB	3	10.000	50.000	Box 2, Var 72
CASS Rate Command	4	-100	100	Box 2, Var 71
+15V (CASS CCU)	5	0	20	Box 2, Var 70
CASS Position FB	6	50	90	Box 2, Var 69
-15V (AZ/ALT CCU)	7	-20	0	-
ALT Position FB	8	40.000	80.000	-

6.7.2 Using the Position Designate Mode, drive AZ Axis full speed in the POS direction and verify that the AZ Rate Command Meter displays the commanded rate of +100% ± 5% and the voltage at AZ/ALT TP1 and at the DAQ Host Computer is +5V ± 0.2V. Reverse the direction and verify that the meter reads -100% ± 5% and the voltage is -5V ± 0.2V.

AZ Rate Cmd Meter _____ (Check)

Voltage at AZ/ALT TP1 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.3 Repeat Section 6.7.2 with ALT, measuring the voltages at TP2 in the AZ/ALT PDU and the voltage reported to DAQ Host Computer.

ALT Rate Cmd Meter _____ (Check)

Voltage at AZ/ALT TP2 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.4 Repeat Paragraph 6.7.2 with CASS, measuring the voltages at TP1 in the CASS PDU and the voltage reported to DAQ Host Computer.

CASS Rate Cmd Meter _____ (Check)

Voltage at CASS TP1 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.5 Verify that +15V meter registers 75% ± 5% toward the right and the voltage at TP2 in the CASS PDU and the voltage reported to DAQ Host Computer is +2.5V ± 0.2V.

+15V Meter _____ (Check)

Voltage at CASS TP2 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.6 Using the Position Designate Mode drive the mount to AZ = 40.000°, ALT = 50.000°, CASS = 80.000°.

_____ (Check)

6.7.7 Verify the AZ Position meter registers 75% ± 5% towards the right and the voltage at TP3 in the AZ/ALT PDU and the reported voltage at the DAQ Host Computer is 2.5V ± 0.2V.

AZ Position Meter _____ (Check)

Voltage at AZ/ALT TP3 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.8 Verify the CASS Position meter registers 75% ± 5% towards the right and the voltage at TP3 in the CASS PDU and the reported voltage at the DAQ Host Computer is 2.5V ± 0.2V.

CASS Position Meter _____ (Check)

Voltage at CASS TP3 _____ (Check)

Reported Voltage at DAQ Host Computer _____ (Check)

6.7.9 Verify that the AZ/ALT CCU -15V meter registers 25% ± 5% towards the left from center.

_____ (Check)

6.7.10 Verify the ALT Position meter registers 25% ± 5% towards the right.

_____ (Check)

6.8 TEST TRAJECTORIES-AZ/ALT

The MCU has the following three test trajectory algorithms.

1. Acceleration
2. Velocity
3. Flyby

These test trajectories screens are accessed via the Test Functions menu selection. The Acceleration and Velocity Tests have been performed on other sections of this test procedure.

6.8.1 Flyby Trajectory Test

The Flyby Trajectory Test simulates a target trajectory which causes the mount to point at high Altitude angles. This test the mount's capability to continue tracking a target as it passes near keyhole, requiring high Azimuth velocities.

This test is used to demonstrate near zenith passes, so it will be tested at the upper limit.

6.8.1.1 For the following test, select the Azimuth rate feedback and the Altitude rate feedback to be output on AZ/ALT PDU Analog Test Points 1 and 2. Setup the strip chart recorder to monitor TP1/TP2. Record the following meter signal parameters and strip chart settings.

	TP1 (AZ Sum Rate)	**TP2** (ALT Sum Rate)	
Signal Min	-50	-50	(Record)
Signal Max	+50	+50	(Record)
Strip Chart Scale	2V/cm	2V/cm	(Record)
Strip Chart Speed	250 mm/min	250 mm/min	(Record)

6.8.1.2 Select the Flyby Test Screen. Set the parameters to the following values and store.

Max EL (at t = 0)	86.000°
Range AT Max EL	15,000 km
Target Velocity	10 km/sec
Length of Test	100 sec
% Feed Forward Vel	1.0
AZ Axis Enable/Dir	POS
ALT Axis Enable	ON

_____ (Check)

6.8.1.3 Execute the Preview Function at the bottom of the Flyby Test Screen. Verify that the following values are calculated for velocity and acceleration. Record the values for Azimuth travel and the minimum Altitude angle.

	AZ	ALT	
Max Velocity	0.548	0.016	_____(Check)
Max Acceleration	0.003	0.000	_____(Check)

Travel 51.082°

Min ALT 85.568°

6.8.1.4 Drive the mount to the Altitude angle 10° below the minimum Altitude calculated in the preview menu. Drive Azimuth to an angle which will allow the full travel required for the test and record.

_____ (Check)

Starting Azimuth __________ (Record)

6.8.1.5 Place the system in the STOP Mode and execute the Flyby Trajectory Test. Verify that the mount is driven to the minimum Altitude angle while holding the current Azimuth position. Record the time at which the minimum Altitude angle is reached.

Drives to Min ALT, Holds AZ _____ (Check)

Time of Min ALT __________ (Record)

6.8.1.6 Allow the system to run through the test. Verify that the system goes to the maximum Altitude angle and returns to the minimum ALT angle and stops. Record the maximum Altitude angle and the time at which the minimum Altitude angle is returned to. Record the final Azimuth position.

Max ALT Angle __________ (Record)

Min ALT Time __________ (Record)

Min ALT & Stop _____ (Check)

Final AZ __________ (Record)

6.8.1.7 From the strip chart recordings, calculate the peak velocity and acceleration and record below.

AZ Max Velocity __________ (Record)

AZ Max Acceleration __________ (Record)

6.8.1.8 Calculate the test time by taking the differences between the time at the two minimum Altitude points. Calculate Azimuth travel.

Test Time __________ (Record)

AZ Travel __________ (Record)

6.8.1.9 Verify that the following parameters meet the predicted value within the tolerance specified.

AZ Max Velocity ± 0.1°/sec _____ (Check)

AZ Max Acceleration ± 0.005°/sec2 _____ (Check)

AZ Travel ± 3.0° _____ (Check)

Test Time ± 10 sec _____ (Check)

6.9 IMAGE JITTER

The Image Jitter compensates for Azimuth induced rotary jitter by feeding the Azimuth error signal into the active Cassegrain Axis to counter rotate the image.

6.9.1 With the MCU in control, using the Position Designate Mode, command AZ to 125°, ALT to 45°, and CASS to 50°. Enter STOP Mode. Disable AZ Motors #1, #2, and #3.

✓ (Check)

6.9.2 Verify that the Image Jitter correction is enabled.

✓ (Check)

6.9.3 Place the MCU in Manual Position Mode.

✓ (Check)

6.9.4 While in Manual Position Mode, disable the Azimuth Axis by removing AZ #4 Motor Controller enable command, C3-8.

✓ (Check)

6.9.5 Command the Azimuth Axis POS 0.100° using the AZ "+" Increment Function.

✓ (Check)

6.9.6 Verify that the CASS position command changes to 49.93°.

✓ (Check)

6.9.7 Command the Azimuth Axis NEG –0.200° from the present position.

✓ (Check)

6.9.8 Verify that the CASS position command changes to 50.07°.

✓ (Check)

6.9.9 Reenable the Azimuth Axis by reconnecting the motor controller enable command wire.

✓ (Check)

6.9.10 Verify that the CASS position command now becomes 50.000°.

✓ (Check)

6.9.11 Enter STOP Mode. Command the ALT Axis UP 10.000° using the Position Designate Mode.

✓ (Check)

6.9.12 Enter STOP Mode. Place the MCU in Manual Position Mode. Verify that the CASS position command remains at 50.000°.

✓ (Check)

6.9.13 While in Manual Position Mode, disable the Azimuth Axis by removing motor controller enable command wire.

✓ (Check)

6.9.14 Command the Azimuth Axis POS 0.200° using the AZ "+" Increment Function.

✓ (Check)

6.9.15 Verify that the CASS position command changes to 49.89°.

✓ (Check)

6.9.16 Command the Azimuth Axis NEG 0.400° from the present position.

✓ (Check)

6.9.17 Verify that the CASS position command changes to 50.12°.

✓ (Check)

6.9.18 Reenable the Azimuth Axis by reconnecting the motor controller enable command wire.

_____ (Check)

6.9.19 Verify that the CASS position command now becomes 50.000°.

✓ (Check)

6.9.20 Disable the Image Jitter correction.

✓ (Check)

6.10 CASSEGRAIN SLAVE MODE

In the Slave Mode, the CASS Axis motion is generated based on the Azimuth and Altitude Trajectories.

NOTE: Slave Mode is disabled when executing STOP Mode.

6.10.1 On the Slave screen, verify that slaving for Cassegrain is OFF.

✓ (Check)

6.10.2 Using the Position Designate Mode, command AZ to 160°, ALT to 25° and CASS to 100°.

✓ (Check)

6.10.3 On the Slave Screen, turn on slaving for Cassegrain. Enter a Slave Reference Position for CASS to an Azimuth position of 160°.

✓ (Check)

6.10.4 Using the Position Designate Mode, command AZ to 160° and ALT to 25°. Verify that CASS position remains at 100°.

✓ (Check)

6.10.5 Command AZ to 165° and ALT to 20°.

✓ (Check)

6.10.6 Verify that the CASS Axis drives from 100° to 95.30° as the Azimuth and Altitude Axes reach their commanded position.

✓ (Check)

6.10.7 Enter Stop Mode.

✓ (Check)

6.10.8 In the Preset Detail Window, configure a Preset to AZ 135.5° and ALT 55.8°. Enter the Preset Position Mode and execute the slave mode.

✓ (Check)

6.10.9 Verify that the CASS Axis drives from 95.30° to 109.07° as the Azimuth and Altitude Axes reach their commanded positions.

✓ (Check)

6.10.10 Enter Stop Mode.

✓ (Check)

6.11 SOFTWARE TRAVEL LIMITS

The MCU Monitors commands and position feedback, initiating an alarm if either exceeds the software limit. The hardware travel limit testing is done at another section of this test procedure.

6.11.1 AZ POS Limits - Software

6.11.1.1 Set the Software Limits to 0.1° beyond the specified travel range as follows:

AZ POS 136.1°

AZ NEG 43.9° (-316.1°)

ALT POS 91.1°

ALT NEG -1.1°

CASS POS 188.1°

CASS NEG 11.0° (-349.0°)

✓ (Check)

6.11.1.2 Use the Position Designate Mode, command the Azimuth Position to the POS Travel Limit (136.0° POS). Verify that the mount drives to the commanded position and indication is POS. The Software Limit may appear due to position overshoot. Clear the fault message if it appears.

✓ (Check)

6.11.1.3 Command 0.001° past the POS Software Limit (136.101° POS) and verify that the brakes are set and the fault message, "COMMAND > REGION AZ+", appears.

✓ (Check)

6.11.1.4 Enter Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "AZ + SOFTWARE LIMIT", appears as the position passes through the Software Limit (136.1°).

✓ (Check)

6.11.1.5 With the axis in the limit condition, enter the Position Designate Mode and verify that commands out of the limit are executed.

✓ (Check)

6.11.2 AZ NEG Limits - Software

6.11.2.1 Using the Position Designate Mode, command the Azimuth Position to the NEG Travel Limit (44° NEG) and verify the command is executed and the position display changes in 0.001° increments.

✓ (Check)

6.11.2.2 Command 0.001° past the Software Limit (43.899° NEG) and verify that the brakes are set and the fault message, "COMMAND>REGION AZ-", appears.

✓ (Check)

6.11.2.3 Enter Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "AZ - SOFTWARE LIMIT", appears as the position passes through the NEG Software Limit (43.9°).

✓ (Check)

6.11.2.4 Verify that commands out of the limit are accepted.

✓ (Check)

6.11.3 ALT NEG Limits - Software

6.11.3.1 Using the Position Designate Mode, command the Altitude Position to the NEG Travel Limit (-1.0°). Verify that the mount drives to the commanded position. The Software Limit may appear due to position overshoot. Clear the fault if it appears.

✓ (Check)

6.11.3.2 Execute a command of 0.001° past the NEG Software Limit (-1.101°) and verify that the brakes are set and the fault message, "COMMAND > REGION ALT-", appears.

✓ (Check)

6.11.3.3 Enter the Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "ALT - SOFTWARE LIMIT", appears as the position passes through the Software Limit (-1.10°).

✓ (Check)

6.11.3.4 With the mount in the Software Limit condition, enter the Position Designate Mode and verify that commands out of the limit are executed.

✓ (Check)

6.11.4 ALT POS Limits - Software

6.11.4.1 Using the Position Designate Mode, command the mount to the POS Travel Limit (91.0°). Verify that the mount drives to the commanded position. Verify that the Altitude Display increments from -1.0° to 91° with 0.001° resolution.

✓ (Check)

6.11.4.2 Execute a command of 0.001° past the POS Software Limit (91.101°) and verify that the brakes are set and the fault message, "COMMAND > REGION ALT+", appears.

_____✓ (Check)

6.11.4.3 Enter the Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "ALT + SOFTWARE LIMIT", appears as the position passes through the Software Limit (91.1°).

_____✓ (Check)

6.11.4.4 With the mount in the limit condition, enter the Position Designate Mode and verify that commands out of the limit are executed.

_____✓ (Check)

6.11.5 CASS NEG Limits - Software

6.11.5.1 Using the Position Designate Mode, command the CASS Position to the NEG Travel Limit (11.1° NEG). Verify that the mount drives to the commanded position. The Software Limit may appear due to position overshoot. Clear the fault if it appears.

_____✓ (Check)

6.11.5.2 Execute a command of 0.01° past the NEG Software Limit (10.99° NEG) and verify that the brakes are set and the fault message, "COMMAND > REGION CASS-", appears.

_____✓ (Check)

6.11.5.3 Enter the Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "CASS - SOFTWARE LIMIT", appears as the position passes through the Software Limit (11.0° NEG).

_____✓ (Check)

6.11.5.4 With the mount in the Software Limit condition, enter the Position Designate Mode and verify that commands out of the limit are executed.

_____✓ (Check)

6.11.6 CASS POS Limits - Software

6.11.6.1 Using the Position Designate Mode, command the CASS Position to the POS Travel Limit (188° POS). Verify that the mount drives to the commanded position. Verify that the CASS Display increments with 0.01° resolution.

_____✓ (Check)

6.11.6.2 Execute a command of 0.01° past the POS Software Limit (188.11° POS) and verify that the brakes are set and the fault message, "COMMAND > REGION CASS+", appears.

✓ (Check)

6.11.6.3 Enter the Maintenance Mode and slowly drive the mount into the Software Limit. Verify that the fault message, "CASS + SOFTWARE LIMIT", appears as the position passes through the Software Limit (188.1° POS).

✓ (Check)

6.11.6.4 With the mount in the limit condition, enter the Position Designate Mode and verify that commands out of the limit are executed.

✓ (Check)

6.12 AXIS DISABLE

The MCU has three commands which will allow the operator to disable an individual axis without affecting the other axis.

6.12.1 Enter any active mode and verify that motors are enabled and the brakes released.

✓ (Check)

6.12.2 Select the AZ EN/DIS Function at the MCU. Verify that the Azimuth Axis is disabled and the status messages, "DISABLE AZ KEY DEPRESSED" and "AZ DISABLED", are displayed.

✓ (Check)

6.12.3 Verify proper AZ DISABLED indication to LCU per Table 6.

✓ (Check)

6.12.4 Select the AZ EN/DIS Function again and verify that the axis is enabled and the messages clear.

✓ (Check)

6.12.5 Select the ALT EN/DIS Function at the MCU and verify that the Altitude Axis is disabled and the status messages, "DISABLE ALT KEY DEPRESSED" and "ALT DISABLED", are displayed.

✓ (Check)

6.12.6 Verify proper ALT DISABLED indication to LCU per Table 7.

✓ (Check)

6.12.7 Select the ALT EN/DIS Function again and verify that the axis is enabled and the messages clear.

✓ (Check)

6.12.8 Select the CASS EN/DIS Function at the MCU. Verify that the Cassegrain Axis is disabled and the fault message, "DISABLE CASS KEY DEPRESSED", and the status message, "CASS DISABLED", are displayed.

✓ (Check)

6.12.9 Verify proper CASS DISABLED indication to LCU per Table 8.

✓ (Check)

6.12.10 Select the CASS EN/DIS Function again and verify that the axis is enabled and the messages clear.

✓ (Check)

6.12.11 Verify that each time the Axis Disable Function was executed the other axes were not affected and the current mode remained active.

✓ (Check)

6.13 PARAMETER STORAGE

6.13.1 Store the data base parameters to a floppy disk and attach to this document.

_____ (Check)

APPENDIX C

LCU MONITORING SIGNALS

APPENDIX C CONTENTS

6.14 AZ LCU MONITORING SIGNAL TESTING

6.14.1 Table 6 depicts the faults/status that are reported to the AZ LCU via the CCU Relay Board. It will be verified that the appropriate contact action occurs per Table 6 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

✓ (Check)

Table 6, Azimuth LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A6B-H AND:	VERIFICATION (✓)
1	AZ CURRENT CLAMPED	A6B-s	
2	AZ SINGLE MOTOR	A6B-b	✓
3	AZ MOTOR CONTROLLER 1 FAULT	A6B-p	✓
4	AZ MOTOR CONTROLLER 2 FAULT	A6B-n	✓
5	AZ MOTOR CONTROLLER 3 FAULT	A6B-m	✓
6	AZ MOTOR CONTROLLER 4 FAULT	A6B-k	✓
7	AZ MOTOR CONTROLLER 1 3∅ OFF	A6B-f	✓
8	AZ MOTOR CONTROLLER 2 3∅ OFF	A6B-e	✓
9	AZ MOTOR CONTROLLER 3 3∅ OFF	A6B-d	✓
10	AZ MOTOR CONTROLLER 4 3∅ OFF	A6B-c	✓
11	AZ MOTOR 1 OVERTEMP	A6B-j	✓
12	AZ MOTOR 2 OVERTEMP	A6B-i	✓
13	AZ MOTOR 3 OVERTEMP	A6B-h	✓
14	AZ MOTOR 4 OVERTEMP	A6B-g	✓
15	AZ LUBE OVERFLOW	A6B-Y	✓
16	AZ DISABLED	A6B-X	✓
17	AZ BRAKE FAULT	A6B-t	✓
18	AZ PRELOAD OFF	A6B-r	✓
19	AZ LUBE PUMP CB OFF	A6B-a	✓
20	AZ LUBE PUMP PRESSURE LO	A6B-Z	✓
21	AZ STOWED	A6B-W	✓
22	*AZ/ALT CONTROL BD FAULT	A6B-V	✓
23	**AZ/ALT STATUS BD FAULT	A6B-U	✓
24	AZ/ALT PMU IN CONTROL	A6B-T	✓
25	AZ/ALT REGEN OVERTEMP FAULT	A6B-S	✓
26	AZ MOTOR 1 / 2 E-STOP	A6B-R	✓
27	AZ MOTOR 3 / 4 E-STOP	A6B-P	✓
28	ALT MOTOR 1 E-STOP	A6B-N	✓
29	ALT MOTOR 2 E-STOP	A6B-M	✓
30	ALT PIER E-STOP	A6B-L	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A6B-H AND:	VERIFICATION (✓)
31	EQUIPMENT ROOM E-STOP	A6B-K	✓
32	CONE E-STOP	A6B-J	✓

*RemoveU102 on Control Board and create a PLD fault (i.e. AZ Lube Pump CB off).
**Remove U16 on Status Board.

6.15 ALT LCU MONITOR SIGNAL TESTING

6.15.1 Table 7 depicts the faults/status that are reported to the ALT LCU. It will be verified that the appropriate contact action occurs per Table 7 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

Table 7, Altitude LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A7B-H AND:	VERIFICATION (✓)
1	ALT CURRENT CLAMPED	A7B-s	✓
2	ALT SINGLE MOTOR	A7B-b	✓
3	ALT MOTOR CONTROLLER 1 FAULT	A7B-p	✓
4	ALT MOTOR CONTROLLER 2 FAULT	A7B-n	✓
5	ALT MOTOR CONTROLLER 1 3Ø OFF	A7B-f	✓
6	ALT MOTOR CONTROLLER 2 3Ø OFF	A7B-e	✓
7	ALT MOTOR 1 OVERTEMP	A7B-j	✓
8	ALT MOTOR 2 OVERTEMP	A7B-i	✓
9	ALT DISABLED	A7B-X	✓
10	ALT BRAKE FAULT	A7B-t	✓
11	ALT STOWED	A7B-W	✓
12	DSP BOOT FAILURE	A7B-D	✓
13	M1 MIRROR RESTRAINT FAILURE	A7B-A	✓
14	M2 UNIT NOT INSTALLED	A7B-F	✓
15	CASS INSTRUMENT NOT INSTALLED	A7B-E	✓
16	ALT IMBALANCE PIN CRADLE	A7B-C	—
17	ALT MANUAL BRAKE RELEASED	A7B-G	✓
18	*AZ/ALT CONTROL BD FAULT	A7B-V	✓
19	**AZ/ALT STATUS BD FAULT	A7B-U	✓
20	AZ/ALT PMU IN CONTROL	A7B-T	✓
21	AZ/ALT REGEN OVERTEMP FAULT	A7B-S	✓
22	AZ MOTOR 1 / 2 E-STOP	A7B-R	✓
23	AZ MOTOR 3 / 4 E-STOP	A7B-P	✓
24	ALT MOTOR 1 E-STOP	A7B-N	✓
25	ALT MOTOR 2 E-STOP	A7B-M	✓
26	ALT PIER E-STOP	A7B-L	✓
27	EQUIPMENT ROOM E-STOP	A7B-K	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A7B-H AND:	VERIFICATION (✓)
28	CONE E-STOP	A7B-J	✓
29	OSS NOT INSTALLED	A7B-B	✓
30	AZ FLOOR ACCESS INTLK	A7B-Y	✓
31	MOBILE ACCESS PLATFORM INTLK	A7B-Z	✓
32	SPARE 4		—

6.16 CASS LCU MONITOR SIGNAL TESTING

6.16.1 Table 8 depicts the fault/status that are reported to the CASS LCU. It will be verified that the appropriate contact action occurs per Table 8 when the fault/status is simulated per other sections of this test procedure. Place a check (✓) in the verification column upon proper operation.

Table 8, Cassegrain LCU Monitor Signals

SIGNAL #	FAULT/STATUS	OPEN ACROSS A8B-H AND:	VERIFICATION (✓)
1	CASS CURRENT CLAMPED	A8B-s	✓
2	CASS SINGLE MOTOR	A8B-b	✓
3	CASS MOTOR CONTROLLER 1 FAULT	A8B-p	✓
4	CASS MOTOR CONTROLLER 2 FAULT	A8B-n	✓
5	CABLEWRAP MOTOR CONTROLLER FAULT	A8B-a	✓
6	CASS MOTOR CONTROLLER 1 1∅ OFF	A8B-f	✓
7	CASS MOTOR CONTROLLER 2 1∅ OFF	A8B-e	✓
8	CASS CABLEWRAP MOTOR CONTROLLER 1∅ OFF	A8B-c	✓
9	CASS MOTOR 1 OVERTEMP	A8B-j	✓
10	CASS MOTOR 2 OVERTEMP	A8B-i	✓
11	CASS CABLEWRAP MOTOR OVERTEMP	A8B-d	✓
12	CASS DISABLED	A8B-X	✓
13	CASS BRAKE FAULT	A8B-t	✓
14	CASS PRELOAD OFF	A8B-r	✓
15	CASS STOWED	A8B-W	✓
16	*CASS CONTROL BD FAULT	A8B-V	✓
17	**CASS STATUS BD FAULT	A8B-U	✓
18	CASS PMU IN CONTROL	A8B-T	✓
19	CASS REGEN OVERTEMP FAULT	A8B-S	✓
20	AZ MOTOR 1 /2 E-STOP	A8B-R	✓
21	AZ MOTOR 3 / 4 E-STOP	A8B-P	✓
22	ALT MOTOR 1 E-STOP	A8B-N	✓
23	ALT MOTOR 2 E-STOP	A8B-M	✓
24	ALT PIER E-STOP	A8B-L	✓
25	EQUIPMENT ROOM E-STOP	A8B-K	✓
26	CONE E-STOP	A8B-J	✓

SIGNAL #	FAULT/STATUS	OPEN ACROSS A8B-H AND:	VERIFICATION (✓)
27	SPARE 1		—
28	SPARE 2		—
29	SPARE 3		—
30	SPARE 4		—
31	SPARE 5		—
32	SPARE 6		—

* Remove U102 on Control Board and create a PLD fault (ie, CASS POS/NEG INTLK Limit)

** Remove U16 on Status Board.

NOTES

SIZE	CAGE NO.	DWG NO.	REV
A4	0P0N7	99-343-0006	-

VPO DWG. NO.
VIS-PRO-VER-01001-9008

SCALE NONE	WEIGHT:	SHEET 124 OF 125

SIGNATURE OF WITNESS

______________________ FOR: ______________________ DATE: ________________

______________________ FOR: ______________________ DATE: ________________

______________________ FOR: ______________________ DATE: ________________