

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER:05-3A-ADC1 -X

SUBSYSTEM NAME: MULTIFUNCTION ELECTRONIC DISPLAY SUBSYSTEM
REVISION: 1 12/05/97

PART DATA

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : CONVERTER, ANALOG-TO-DIGITAL	MC409-0185-003X

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
 CONVERTER, ANALOG-TO-DIGITAL, (ADC 1A, & ADC 1B), "MPS, OMS, SPI"

REFERENCE DESIGNATORS: 30V73A181A1
 30V73A181A2

QUANTITY OF LIKE ITEMS: 2
 TWO

FUNCTION:
 ACCEPTS SUBSYSTEM PARAMETERS FROM THE SUBSYSTEM AND/OR MDM. PERFORMS ANALOG TO DIGITAL CONVERSION, STORES CONVERTED SIGNALS INTERNALLY, AND TRANSMITS TO ASSOCIATED INTEGRATED DISPLAY PROCESSORS (IDP) UPON REQUEST VIA THE MEDS 1553B DATABUSES. AFTER PROCESSING THE DATA RECEIVED FROM THE ADC'S, THE ASSOCIATED IDP'S OUTPUT FORMATTED DISPLAY DATA TO THE APPROPRIATE MULTIFUNCTION DISPLAY UNITS (MDU'S).

THE FOLLOWING IS THE INFORMATION THAT IS PROCESSED BY THE ADC'S AND IDP'S PRIOR TO DISPLAY ON THE MDU'S:

MAIN PROPULSION SYSTEM (MPS) - LEFT/CENTER/RIGHT SSME CHAMBER PRESSURE, LO2/LH2 MPS MANIFOLD PRESSURE, AND MPS HELIUM PRESSURE (TANK SUPPLY OR REGULATOR OUTLET PRESSURE FOR PNEUMATIC/LEFT/CENTER/ RIGHT HELIUM SYSTEMS)

ORBITAL MANEUVERING SYSTEM (OMS) - LEFT/RIGHT OMS CHAMBER PRESSURE, LEFT/RIGHT NITROGEN (N2) TANK PRESSURE, AND LEFT/RIGHT HELIUM (HE) TANK PRESSURE.

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SURFACE POSITION INDICATOR (SPI) - PROVIDES THE ACTUAL AND COMMANDED POSITIONS OF THE SPEED BRAKE, AND PROVIDES THE ACTUAL POSITIONS OF THE ELEVONS, BODY FLAPS, RUDDER, AILERON.

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LRU: CONVERTER, ANALOG-TO-DIGITAL

CRITICALITY OF THIS

ITEM NAME: CONVERTER, ANALOG-TO-DIGITAL

FAILURE MODE: 1R3

FAILURE MODE:

ERRONEOUS OUTPUT

MISSION PHASE:LO LIFT-OFF
OO ON-ORBIT**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR**CAUSE:**

PIECE-PART FAILURE (MECHANICAL STRESS, VIBRATION), CONTAMINATION, ELECTRICAL STRESS, THERMAL STRESS, PROCESSING ANOMALY, RADIATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? NO

REDUNDANCY SCREENA) PASS
B) FAIL
C) PASS**PASS/FAIL RATIONALE:**

A)

B)

FAILS SCREEN B BECAUSE TIME REQUIRED TO DETERMINE VALIDITY OF DISPLAYED DATA MAY EXCEED TIME AVAILABLE FOR CORRECTIVE ACTION.

C)

- FAILURE EFFECTS -**(A) SUBSYSTEM:**

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INACCURATE INDICATION OF LO2/LH2 MANIFOLD PRESSURE OR MAIN ENGINE HELIUM PRESSURE.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT FIRST FAILURE

(C) MISSION:

NO EFFECT FIRST FAILURE

(D) CREW, VEHICLE, AND ELEMENT(S):

NO EFFECT FIRST FAILURE

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

- FIRST FAILURE - INCOMPLETE MPS DUMP AND VACUUM INERT, I.E. LH2 INBOARD FILL AND DRAIN VALVE (PV12) FAILS TO OPEN
- SECOND FAILURE - LH2 MANIFOLD RELIEF SYSTEM FAILS TO RELIEVE
- THIRD FAILURE - ERRONEOUS OUTPUT OF THE ADC LEADING TO INACCURATE LH2 MPS MANIFOLD PRESSURE READING

CREW USES THE DISPLAYED DATA TO DETERMINE WHICH PROPELLANT MANIFOLD REQUIRES A SECOND VACUUM INERTING. INACCURATE DISPLAY COULD DELAY OR PREVENT TIMELY CORRECTIVE ACTION. PRESSURE BUILDUP DUE TO RELIEF SYSTEM FAILURE WILL CAUSE MANIFOLD RUPTURE RESULTING IN LEAKAGE OF PROPELLANT INTO THE AFT COMPARTMENT. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYOGENIC EXPOSURE. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

- FIRST FAILURE - FA MDM FAILS. SOFTWARE CAUTION & WARNING, CRT MESSAGE, AND MCC MONITORING CAPABILITY FOR ASSOCIATED HELIUM ENGINE SYSTEM DEGRADED.
- SECOND FAILURE - LEAK IN ASSOCIATED ENGINE HELIUM SYSTEM.
- THIRD FAILURE - ERRONEOUS OUTPUT OF THE ADC PROVIDING ERRONEOUS INDICATION (SHIFTED HIGH). LOSS OF HELIUM LEAK CUES PREVENTS PNEUMATIC SYSTEM INTERCONNECT AND RESULTS IN EARLIER THAN NECESSARY ENGINE SHUTDOWN.
- FOURTH FAILURE - ONE OF THE REMAINING ENGINES EXCEEDS A REDLINE.

CREW DOES NOT INTERCONNECT PNEUMATIC HELIUM SUPPLY TO LEAKING ENGINE AT PROPER TIME SINCE DISPLAYED METER SHIFT IS MASKING THE PROPER INTERCONNECT ACTION LEVEL. THE LEAKING ENGINE WILL SHUTDOWN EARLIER THAN NECESSARY DUE TO INTERMEDIATE SEAL PURGE REDLINE. AT THIS TIME, THE REMAINING ENGINE LIMITS WILL BE INHIBITED BY VEHICLE SOFTWARE. THE EARLY FIRST ENGINE SHUTDOWN WILL DELAY SINGLE ENGINE CAPABILITY AND THE MANUAL REENABLING OF ENGINE LIMITS. IF A SECOND ENGINE EXCEEDS A REDLINE DURING

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THE EXTENDED LIMIT INHIBIT PERIOD, UNCONTAINED ENGINE FAILURE WILL RESULT.
POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

ALL PARTS USED IN THE DESIGN AND FABRICATION OF THE ADC ARE SELECTED FROM MF0004-400 ORBITER PROJECT PARTS LIST (OPPL), EXCEPT WHERE THE USE OF NON-OPPL PARTS OR "OFF THE SHELF" HARDWARE HAD BEEN AUTHORIZED. OPPL PARTS UTILIZATION ARE BASED UPON SELECTION OF QUALIFIED PARTS, PROPER DERATING, AND MINIMIZING THE NUMBER OF PART TYPES. FOR THE USE OF PARTS WHICH ARE NOT IN THE OPPL AND DO NOT MEET THE OPPL REQUIREMENTS, A NON-OPPL PART APPROVAL REQUEST (NOPAR) FORM MUST BE SUBMITTED FOR APPROVAL ON OR BEFORE THE CRITICAL DESIGN REVIEW AND PRIOR TO PART PROCUREMENT FOR THE PROPOSED DESIGN. APPROVAL OF NOPAR PARTS ARE ALSO BASED ON CIRCUIT APPLICATION AND CRITICALITY. "OFF THE SHELF" HARDWARE ARE COMPARED, ANALYZED, OR TESTED TO MEET SPECIFIED REQUIREMENTS BEFORE BEING AUTHORIZED, OR TESTED TO MEET SPECIFIED REQUIREMENTS BEFORE BEING AUTHORIZED FOR USE. THE APPLICABLE FAULT TOLERANCE ARE BEING ACHIEVED AT THE LRU LEVEL.

THE ADC DESIGN UTILIZED ERROR DETECTION AND CORRECTION CIRCUITRY, CYCLIC PROCESSING, AND/OR RADIATION TOLERANT EEE PARTS TO PRECLUDE ADVERSE EFFECTS DUE TO RADIATION INDUCED SINGLE EVENT UPSETS OR RADIATION INDUCED LATCHUP.

THERE ARE VARIOUS BUILT-IN-TEST-EQUIPMENT (BITE) SELF-TEST CAPABILITY FOR THE ADC. OPERATIONAL BITE IN THE ADC IS PERFORMED CONTINUOUSLY WHILE THE COMPONENT IS OPERATING. POWER ON SELF TEST (POST) IN THE ADC IS USED TO VERIFY SYSTEM INTEGRITY BEFORE RESUMING OPERATION AFTER A POWER INTERRUPTION OR CYCLE.

(B) TEST:

ACCEPTANCE REQUIREMENTS INCLUDE:

EXAMINATION OF PRODUCT
FUNCTIONAL AND PERFORMANCE
ACCEPTANCE THERMAL TEST
ACCEPTANCE VIBRATION TEST
FUNCTIONAL AND PERFORMANCE RECHECK.

AVT

20 TO 80 HZ

PLUS 3 DB/OCTAVE

80 TO 350 HZ

0.04 G²/HZ

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350 TO 2000 HZ

MINUS 3 DB/OCTAVE

ATT

THE ADC SHALL BE THERMAL CYCLED FROM 70 F TO 120 F, TO 20 F, TO PLUS 120 F, AND TO 70 F WITH CONTINUITY MONITORED THROUGHOUT. RATE OF CHANGE SHALL NOT EXCEED 240 F PER HOUR, NOR BE LESS THAN 60 F PER HOUR. DWELL AT EACH LIMIT TEMPERATURE SHALL BE A MINIMUM OF 60 MINUTES AFTER THERMAL STABILIZATION OF THE TEST ARTICLE. SELECTED PERFORMANCE TEST AT EACH HIGH TEMPERATURE EXTREME AND LOW TEMPERATURE EXTREME.

QUALIFICATION REQUIREMENTS INCLUDE:

ACCEPTANCE TEST
PERFORMANCE TESTS
POWER TEST
EMC TEST
LIGHTNING
CABIN ATMOSPHERE
HUMIDITY
SALT FOG
SAND AND DUST
ACCELERATION
OPERATING LIFE TEST
AUDIBLE NOISE TEST
QUALIFICATION ACCEPTANCE VIBRATION TEST
THERMAL VACUUM TEST
THERMAL CYCLE TEST
LIFE
SHOCK
POST PERFORMANCE TESTS
PACKAGE QUALIFICATION TEST

QAVT

20 TO 80

PLUS 3 DB/OCTAVE TO .067 G²/HZ

80 TO 350 HZ

CONSTANT .067 G²/HZ

350 TO 2000 HZ

MINUS 3 DB/OCTAVE FROM .067 G²/HZ

DURATION

5 TIMES AVT

ACCELERATION

ACCELERATION TEST REQUIREMENT SHALL BE MET BY ANALYSIS.

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

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(C) INSPECTION:

RECEIVING INSPECTION

CERTIFICATIONS & SOURCE INSPECTION TEST REPORTS ARE ON FILE. CASES AND FLATPACKS ARE SCREENED FOR LOOSE PARTICLE DETECTION IN RECEIVING INSPECTION. ALL HYBRID COMPONENTS ARE LOT SAMPLED IN RECEIVING INSPECTION.

CONTAMINATION CONTROL

LRU'S SHALL BE CLEANED TO LEVEL GC (GENERALLY CLEAN) OF MA0110-301.

ASSEMBLY/INSTALLATION

VISUAL INSPECTION IS PERFORMED AT KIT RELEASE. PRINTED WIRING BOARD MICROSECTION ANALYSIS IS PERFORMED AND MONITORED BY INSPECTION FOR EACH LOT OF PWB'S. QUALITY CONTROL VERIFIES AND WITNESSES TORQUE OPERATIONS. QUALITY CONTROL VERIFIES SOLDERED CONNECTIONS AND ASSEMBLY OF PARTS. TOOL CERTIFICATIONS ARE MAINTAINED. QUALITY CONTROL PERFORMS PRE-CAP VISUAL INSPECTION FOR CLEANLINESS. QUALITY CONTROL VERIFIES CONVEYOR FURNACE PROFILE/TEMPERATURE EVERY 90 DAYS. POPULATED PWB'S WILL BE PURGED OF IONIC CONTAMINATION PRIOR TO CONFORMAL COAT.

CRITICAL PROCESSES

INSPECTION VERIFIES CRIMPING OPERATIONS AND CERTIFICATION. SOLDERING REQUIREMENTS PER NHB5300.4(3A) AND MIL-STD-2000 ARE VERIFIED BY INSPECTION.

TESTING

ATP IS OBSERVED AND VERIFIED BY QUALITY CONTROL, INCLUDING AVT AND ATT.

HANDLING/PACKAGING

PROPER GROUNDING OF ELECTRICALLY STATIC SENSITIVE DEVICES WHEN HANDLING IS PERFORMED. PACKAGING AND PROTECTION VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

CREW CAN VERIFY THE DISPLAY'S INTEGRITY BY SELECTING THE SAME DISPLAY FORMAT ON THE OTHER ADC. ADC POWER CYCLE MAY RECOVER ADC FUNCTION.

- APPROVALS -

PAE MANAGER	: P.A. STENGER-NGUYEN	<i>P.A. Stenger-Nguyen 5/16/98</i>
PRODUCT ASSURANCE ENGR.	: N.D. NGUYEN	<i>N.D. Nguyen 5/17/98</i>
DPS SYSTEM	: G.L. PRICE	<i>G.L. Price 5/18/98</i>
MEDS SYSTEM	: M.B. WARNER	<i>M.B. Warner 5/17/98</i>

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MEDS HARDWARE : R.M. SITAPARA
NASA SSMA :
NASA SUBSYSTEM MANAGER :
NASA MOD :

: Ramin Sitapara 5/8/98
: Cheryl M. Yokoyama 5/20/98
: James Newson 5/20/98
: Michelle McCord 5/20/98