SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :INSTRUMENTATION FMEA NO 05-4 -321300-1 REV:05/24/88

ASSEMBLY :FORWARD AVIONICS BAY 1
P/N RI :MC476-0136
P/N VENDOR:
QUANTITY :1
:ONE
:

CRIT. FUNC: 2
CRIT. HDW: 2

VEHICLE EFFECTIVITY:	102	103	104
	X	X	X

PHASE(S): PL X LO X OO X DO X LS X

REDUNDANCY SCREEN: A- N/A B- N/A C- N/A

PREPARED BY:
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APPROVED BY:
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ITEM:
PAYLOAD DATA INTERLEAVER(PDI)

FUNCTION:
ACCEPTS DATA FROM UP TO 5 ATTACHED PAYLOADS AND 1 DETACHED PAYLOAD SIMULTANEOUSLY, DECOMMUTATES AND REFORMATS SELECTED DATA FROM FOUR PAYLOADS, AND PROVIDES STORAGE OF, AND ACCESS TO THAT DATA BY THE GENERAL PURPOSE COMPUTER(GPC) AND THE PULSE CODE MODULATION MASTER UNITS (PCMMU) ~~(PCMMU)~~ REFERENCE DESIGNATOR: 81V75A8.

FAILURE MODE:
LOSS OF OUTPUT, ERRONEOUS OUTPUT

CAUSE(S):
PIECE PART FAILURE, VIBRATION, THERMAL STRESS, MECHANICAL SHOCK, CONTAMINATION.

EFFECT(S) ON:
(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A) ERRONEOUS DATA OR LOSS OF DATA TO PCMMU AND PAYLOAD RECORDER.

(B) ERRONEOUS DATA OR LOSS OF PAYLOAD DATA TO COMMUNICATION AND TRACKING(C&T).

(C) ERRONEOUS DATA OR LOSS OF DATA MAY CAUSE LOSS OF MISSION OBJECTIVES.

(D) NO EFFECT.

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DISPOSITION & RATIONALE:
(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN
THE PDI CONSISTS OF THREE DIGITAL DATA BUS INTERFACES (GPC, PCMMU 1 AND PCMMU 2), 5 ATTACHED PAYLOADS INTERFACES AND TWO INTERFACES FOR DETACHED PAYLOADS. THE PDI PERFORMS BIT SYNC, WORD SYNC AND FRAME SYNC, DATA STORAGE, AND DATA TRANSMISSION TO THE PCMMU'S. THE PDI CONTAINS INTERNAL BITE CAPABILITY TO TEST AND REPORT FAILURES VIA THE DATA BUS PORTS. THIS BUILT-IN-TEST CAPABILITY IN CONJUNCTION WITH THE INTGRATED AVIONICS SHALL PROVIDE THE MEANS FOR ACCOMPLISHING FUNCTIONAL PATH FAILURE DETECTION DURING FLIGHT ALONG WITH THE NECESSARY LRU FAULT ISOLATION TO SUPPORT GROUND TURNAROUND REQUIREMENTS.
EEE PARTS ARE SELECTED FROM OR IN ACCORDANCE WITH MF0004-400(OPPL) REQUIREMENT. THE PDI SHALL HAVE A MINIMUM DESIGN LIFE OF 24,000 HOURS, WHICH ARE EQUIVALENT TO 100 ORBITAL MISSIONS IN A 10 YEAR PERIOD.

(B) TEST

ACCEPTANCE REQUIREMENTS: EACH PDI IS SUBJECTED TO THE FOLLOWING: EXAMINATION OF PRODUCT, FUNCTIONAL AND PERFORMANCE TESTS, ACCEPTANCE VIBRATION TEST(AVT), ACCEPTANCE THERMAL TEST(ATT).

QUALIFICATION TESTS INCLUDE:
ACCEPTANCE TEST, EMC, POWER, VIBRATION ACCELERATION, THERMAL CYCLE, THERMAL VACUUM, CABIN ATMOSPHERE, SHOCK, LIFE.

GROUND TURNAROUND TESTS
PDI OUTPUT AND INTERFACE VERIFICATION PERFORMED EVERY FLIGHT.

(C) INSPECTION

RECEIVING INSPECTION
ALL INCOMING PARTS ARE INSPECTED VISUALLLY TO VERIFY CONFORMANCE TO PURCHASE ORDER AND DRAWING SPEC.

CONTAMINATION CONTROL
QUALITY CONTROL VERIFIES REQUIRED PROCEDURES AND SHOP PRACTICES. PRODUCTION UNITS ARE MAINTAINED TO CLEANLINESS LEVEL BY SPEC.

ASSEMBLY/INSTALLATION
ON-LINE INSPECTION POINTS ARE VERIFIED. TORQUE FORCES APPLIED ON PRINTED WIRE BOARDS (P.W.B.) MOUNTING HARDWARE ARE VERIFIED. ANTI-STATIC PROCESS IS VERIFIED THROUGHOUT ASSEMBLY/INSTALLATION/SHIPPING PROCESSES. MICROSCOPIC EXAMINATIONS ARE UTILIZED TO INSPECT PARTS AND P.W.B. TO ENSURE ACCEPTABILITY OF ALL PLATING CONTACTS PRIOR TO NEXT ASSEMBLY. WIRE INSULATION IS INSPECTED TO SURFACE ANY EXPOSED WIRE. MERCURY CONTAMINATION INSPECTIONS ARE CONDUCTED AT BOARD LEVEL.

CRITICAL PROCESSES
ALL BONDING, WIRE SOLDERING, SEALING, P.W.B. COATING, SWAGING AND SHIELDING ON COMPONENTS AND CONTACTS ARE VERIFIED IN COMPLIANCE WITH QUALITY SPECIFICATIONS. OTHER OPTIONAL PROCESSES, SUCH AS, REFLOW SOLDER TECHNIQUE, ARE VERIFIED TO ENSURE CONFORMANCE.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
ALL PARTS ARE PACKAGED AND PROTECTED FROM DAMAGE AND CONTAMINATION.

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(D) FAILURE HISTORY

(1) CAR# AC3095, SAIL, 5-13-82, PDI S/N 3. During TEST AT SAIL, the PDI EXHIBITED AN ERRONEOUS IRIG-B STATUS REGISTER OUTPUT BY SKIPPING THE 20 SECOND MARK, GOING FROM 19 TO 00 TO 21 SECONDS. SUPPLIER ANALYSIS FOUND LSI CHIPS, U64, U66, AND U71, LOCATED ON THE TIMING AND IRIG MODULE, P/N 5651528, WERE WIRED INCORRECTLY. CERTAIN PINS WERE CONNECTED TO LOGIC "HIGH" (5VDC) WHERE LOGIC "LOW"(GROUND) WAS REQUIRED TO ENSURE A CORRECT COUNTING SEQUENCE. THIS DESIGN ERROR AFFECTED THE TENS COLUMN OF DAYS. ECDP BY THE SUPPLIER WAS REJECTED BY CCB BECAUSE OF COST AND ACCEPTABLE RISK (I.E. USE AS IS). REDESIGN WAS APPROVED BY A LATER CCB, EFFECTIVE ON ALL PDI'S.

(2) CAR# AC3921, Supplier 8-24-82, PDI S/N 013. THE PDI RECEIVER DISTORTS THE 1.152 MHZ TIMING SIGNAL FROM THE PCM AND OCCASIONALLY CAUSES THE "PDI 1.152 MHZ GOOD" BSR BIT TO CYCLE ON AND OFF. THE JITTER WAS DISCOVERED AT THE SUPPLIER'S FACILITY WHEN PCM #013 WAS INTERFACED WITH PDI #003 FOR TROUBLESHOOTING. THE CAUSE WAS TRACED TO A SLOW RESPONSE TIME IN THE LH2111D COMPARATOR (U4) ON TIMING AND IRIG CARD ASSEMBLY (P/N 561528), AS NOTED ON LOGIC DIAGRAM #622148. FAILURE RESULTED ~~THEREFORE~~ FROM MARGINAL DESIGN. ~~ERROR~~ EDCP #G041-392-220-45, SUBMITTED BY THE SUPPLIER, PROPOSED THAT U4 BE REPLACED WITH AN LM119J AND FOUR NEW DIODES FOR INPUT PROTECTION. THIS CHANGE WOULD PROVIDE A FASTER RESPONSE AND PREVENT 1.152 MHZ CLOCK JITTER. THE EDCP, WAS APPROVED. THIS CIRCUIT HAS BEEN REDESIGNED TO ELIMINATE THIS PROBLEM.

(3) CAR# AC2558, Palmdale OV-103, 3-9-83, PDI S/N 7. DURING SUBSYSTEM TEST ON OV103 AT PALMDALE, PDI PORT J2 TO PCM-1 FAILED TO COMMUNICATE VIA BUS PI-1. FAILURE RESULTED FROM OPEN SOLDER JOINTS IN PDI-7 BETWEEN MAG WIRE AND PIN 45 OF LSI-U4 ON I/O BUFFER CARD. ALL OTHER JOINTS INSPECTED OK. the problem was ISOLATED TO ~~CAGE OPEN~~ INADVERTENT WORKMANSHIP ERROR. NO TREND OR GENERIC PROBLEM INDICATED.

(4) CAR# AD0357, Class KSC OV-104, 9-06-85, S/N 4. DURING OV-104 VEHICLE TESTING (PRE-FRF) AT KSC, A FAIL STATE IN WORD #2 (#V75M6420P), BIT #15 (PCM 1.152 MHZ GOOD) OF THE PDI BITE STATUS REGISTER WAS INDICATED. TROUBLESHOOTING ISOLATED THE PROBLEM TO DUAL COMPARATOR U4 (P/N LH2111D), IN THE 1.152 MHZ CIRCUITRY. ALL TESTING, HOWEVER, INDICATED THAT U4 HAD NOT FAILED. RATHER, THE COMPARATOR'S PROPAGATION DELAY TIME LIMIT (DETERMINED BY ANALYTICAL ANALYSIS) REQUIRED BY THE 1.152 MHZ CIRCUITRY. AN ENGINEERING CHANGE HAS BEEN SUBMITTED FOR ALL UNITS TO CORRECT THIS FAILURE MODE. CORRECTIVE ACTION PER EDCP-39 HAS BEEN APPROVED AND IS BEING IMPLEMENTED ON ALL UNITS BY HARRIS CORPORATION. REWORK WILL CONSIST OF REPLACING U4 WITH A NEW PART (P/N LM119J; RESPONSE TIME LESS THAN 100NS), AND ADDING MAG WIRES AND FOUR DIODES. THIS CORRECTIVE ACTION IS PART OF THE -0005 CONFIGURATION HARDWARE CHANGES AS APPROVED BY MCR 11837. ALL UNITS WILL BE RETROFITTED PRIOR TO THEIR RESPECTIVE FLIGHTS.

"No output" and "erroneous output" failures will be addressed on this CIL.

05-4-19

(5) KSC OV-099 CAR# AD0683, 1-09-86, PDI S/N 7. PCMMU BITE 10, MEAS. #V75X2130D (VALID DATA INPUT), AND PDI DYNAMIC WRAPAROUND, MEAS. #V75X4007D (PCMMU BITE TEST WORD #7) WERE INTERMITTENT DURING POWER-ON CHECKS OF OV099 AT KSC. FAILURE CAUSE WAS ISOLATED TO A HARRIS CMOS CUSTOM LSI U4 (PN 128240, LDC 8022) UNIQUE TO THE PDI AND PCMMU. A FULL ELECTRICAL FUNCTIONAL TEST, WHICH INCLUDED MICROPROBING, REVEALED A 100 OHM SHORT TO GROUND IN CELL 163. FURTHER INVESTIGATION DID NOT SPECIFICALLY REVEAL THE CAUSE OF THE ANOMALY: HOWEVER, THE SUSPECTED CAUSE WAS THOUGHT TO BE A DIFFUSION DEFECT PRESENT FROM THE ORIGINAL PROCESSING. THIS MAY HAVE ALLOWED THE GROWTH OF A DIFFUSION SPIKE. OTHER INVESTIGATIONS INCLUDED RADIOGRAPHIC, HERMETICITY, AND FIND TESTS. NONE OF THESE CHECKS, HOWEVER, REVEALED ANY DEFECTS. THIS FAILURE MODE WAS AN ISOLATED CASE. TWO OTHER U4 FAILURES HAVE BEEN PREVIOUSLY REPORTED, BUT BOTH FAILURES RESULTED FROM POOR WORKMANSHIP. NO C/A WAS DEEMED NECESSARY AT TIME OF PROBLEM CLOSURE BASED ON A FIRST OCCURRENCE.

(6) KSC OV-103 CAR #AD1149, 5-29-86, PDI S/N 4. DURING TEST ON OV103 AT KSC, DATA TRANSMISSION PROBLEMS OCCURRED ON PORT #2 RESULTING IN PCCMU BITE BIT #10 SHOWING FAIL. SUPPLIER [redacted] TEST AT AMBIENT SHOWED NO FAILURE. RETEST AT TEMPERATURES, HOWEVER, DID REPEAT THE REPORTED ANOMALY. LOCALIZED HEATING TECHNIQUES LATER ISOLATED THE PROBLEM TO THE PART #2 MIA. FURTHER TEST BY THE MIA SUPPLIER (SINGER) COULD NOT DUPLICATE THE ANOMALY. MIA TESTING WAS BASED ON EXTENSIVE COMMUNICATION BETWEEN SINGER, HARRIS, ROCKWELL AND NASA. FINALLY LSI U2 ON THE SUSPECT MIA WAS REMOVED FOR DETAILED ANALYSIS AS THE SUSPECT MOST PROBABLE CAUSE. SEM ANALYSIS REVEALED SOME MINOR UNSATISFACTORY CONDITIONS IN U2, BUT NONE WOULD EXPLAIN THE SUBJECT ANOMALY. THE CAR WAS "EXPLAINED" AS "UA" WITH NO FURTHER ACTION REQUIRED BASED ON FIRST OCCURRENCE. NO TREND OR GENERIC PROBLEM IS INDICATED. PROBLEM IS DETECTABLE IN FLIGHT BY PCMMU BITE BIT #10. FLIGHT CREW WOULD SELECT ALTERNATE PCMMU AS A WORKAROUND. (PDI HAS A PART FOR EACH PCMMU AND ONE FOR THE GPC BUS). FAILURE PRIOR TO FLIGHT WOULD RESULT IN A LAUNCH DELAY TO REPLACE THE PDI.

(7) KSC OV104 CAR #AD1835, 9-8-87, PDI S/N 8. DURING TEST ON OV104 AT KSC, INTERMITTENT MTU IRIG BITE FAILURES WERE INDICATED. PROBLEM WAS ISOLATED TO PDI-8. SUPPLIER TEST COULD NOT DETERMINE THE FAILURE CAUSE. TESTING INCLUDED AMBIENT AND THERMAL STRESS PLUS SWITCHING ALL THREE I/O B CARDS THRU ALL THREE SLOTS. THE CAR WAS "EXPLAINED" AS "UA". THE MOST PROBABLE CAUSE WAS A MOMENTARY GLITCH IN THE VERIFICATION CIRCUIT IN THE A2 CARD (CONTROL TIMING AND IRIG). THIS ANOMALY IS A FIRST OCCURRENCE AND NO TREND OR GENERIC PROBLEM IS INDICATED. IN THE WORST CASE, IF THE MTU IRIG "B" SIGNAL WAS LOST DURING FLIGHT, SOME TIMING INFORMATION WOULD BE LOST, BUT COULD BE RECOVERED PAST FLIGHT. NO IMPACT IS FORESEEN FOR ANY FLIGHT AND NO FURTHER ACTION WAS TAKEN. ~~EXCEPT [redacted] FUTURE ANOMALIES FOR POSSIBLE REPEAT OF THIS ANOMALY.~~

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51-F OV-099

(g) CAR #26F006, 7-85, PDI S/N 5. THE PDI WOULD NOT RESPOND TO EITHER PCM2MU JUST PRIOR TO LAUNCH OF 51-F (OV099). ALTHOUGH THE PDI FLEW 51-F, IT WAS NOT REQUIRED BECAUSE 51-F WAS A SPACELAB MISSION. IT WAS REMOVED AFTER 51-F. SUPPLIER ANALYSIS ISOLATED THE PROBLEM TO A SHORTED CERAMIC CAPACITOR IN THE POWER SUPPLY (C30, CKR06). TEARDOWN OF C30 REVEALED A PUNCTURE THROUGH THE CERAMIC DIELECTRIC WHICH PREVENTED FURTHER ANALYSIS (I.E., ANY EVIDENCE THAT WOULD EXPLAIN THE FAILURE CAUSE, SUCH AS CRACKS, VOIDS, AND CONTAMINATION WAS DESTROYED BY THE PUNCTURE). THE CAUSE OF FAILURE WAS NOT DETERMINED, BUT THE MOST PROBABLE FAILURE CAUSE WAS AN ISOLATED CASE OF A MANUFACTURING DEFECT IN C30. NO TREND OR GENERIC PROBLEM IS INDICATED. REPAIR WAS MADE BY REPLACING C30 & OVERSTRESSED PARTS IN THE ASSOCIATED CIRCUITRY (RESISTOR, TRANSISTOR, & 2 DIODES). PDI S/N 5 WAS SUCCESSFULLY ACCEPTANCE TESTED AND WAS RETURNED TO THE FIELD FOR UNRESTRICTED USE.

(E) OPERATIONAL USE
NONE.