SPAR - BRAMPTON (SSS)
9445 AIRPORT RD

BRAMPTON ONTARIO L6S4J3

Critical Items List

SRMS

CIL Ref#: 2914

Revision: C FMEA Rev: 1

System: SRMS

Subsystem: ELECTRICAL SUB-SYSTEM

Assembly Desc: Servo Power Amplifier

Part Number(s): S1140F1177-3 S1140F1177-5

Item:

Function: Motor Drive Amplifier Assembly

Provides motor voltage based on demand from tachometer electronics. Commutates the motor drive voltage. Provides hardware current limiting, brake drive, direct drive functions and enables backup drive. Provides BITE circuits and BITE verification for MDA.

Failure Mode: Loss of Commutation FPGA 12.8 MHz or 12.8 MHz derived clocks.

	H/W	Func.	Screen Failures
Criticality:	2	1R	

Mission Phase: Orbit

Cause(s): Motor Drive Amplifier Assembly

Loss of 50 KHz Direct Drive digital filter clock divider.
Loss of all commutation FPGA clocks.

Failure effect on unit/end item:

Clocks to the Direct drive digital filters, Commutator BITE and MDA Over-current BITE circuits are lost. Direct drive may be lost in one or both directions. Commutator BITE and MDA over-current BITE are lost causing the associated verification test to fail. Computer Supported modes still available but 1 failure away from Crit 1.

Worst Case: Unexpected motion. In Direct Drive wrong joint direction or two joints drive. Joint Braking.

Redundant Paths: Backup Drive.

Retention Rationale

Design:

Field Programmable Gate Arrays (FPGA's) and the Error Detection and Correction (EDAC) are semi-custom microcircuits in which the basic design functional elements are designed by the manufacturer. The interconnection of these elements is then customized by Spar to provide the functionality of the completed microcircuit. The design utilizes proven circuit techniques and is implemented using CMOS technology. This technology operates at low power and hence the device does not experience significant operating stresses. The technology is mature, and the basic device reliability is well documented. All stresses are additionally reduced by derating the appropriate parameters in accordance with SPAR-RMS-PA.003 and verified by design review.

The approach has a significant advantage in that it reduces the quantity of discrete parts required in the assembly and also the complexity of the PWB and results in significant weight and volume savings. This type of semi-custom part has been successfully used in other space applications.

The parts are qualified to the requirements of the applicable specification. They are 100% screened and burned in to the requirements of this Spar requirements document.

Prepared: 28Jul97 by Hiltz, Michael

Supersedes: N/A

The SPA board is fabricated using Surface Mount Technology (SMT). This is a PWB assembly technology in which the components are soldered to the solder pads on the surface of the PWB. The significant advantage of this technology is to enable the parts on the board to be more densely packed, to reduce to overall volume and weight of the assembly.

The assembly process is highly automated. The parts are mounted on the boards using a computer controlled "pick and place" machine. The subsequent soldering operation is performed using a belt furnace, in which the time and temperature thermal profile that the PWB assembly is exposed to is tightly controlled and optimized to ensure proper part soldering attachment. The assembly is manufactured under documented procedures and quality controls. These controls are exercised throughout the assembly, inspection and testing of the unit. This inspection includes workmanship, component mounting, soldering, and conformal coating to ensure that it is in accordance with the NHB 5300 standards.

The SMT line used for the SPA PWB assembly has undergone a full qualification program, and assemblies produced on this line are used in other space programs.

The circuit board design has been reviewed to ensure adequate conductor width and separation and to confirm appropriate dimensions of solder pads and of component hold provisions. Parts mounting methods are controlled in accordance with MSFC-STD-154A, MSFC-STD-135 and SASD 2573751. These documents require approved mounting methods, stress relief and component security.

Test:

QUALIFICATION TESTS - The SPA is subjected to the following qualification testing:
VIBRATION: Each axis of the QM is subjected to Flight Acceptance Vibration Test (FAVT), Qualification Acceptance Vibration Test (QAVT), and Qualification Vibration Tests (QVT) in accordance with the SPA Vibration Test Procedure (826586). The level and duration for FAVT is as per Figure 6 and Table 2 of 826586; the level and duration for QAVT is as per Figure 7 and Table 2 of 826586; the level and duration for QVT is as per Figure 8 and Table of 826586. At the end of the three successive random vibration test in each axis, both directions (+/-) of each of the axis is subjected to a shock pulse test as per Figure 9 of 826586.
THERMAL/VACUUM: QM TVAC Test is in accordance with Figure 5 of the SPA TVAC Test Procedure (826588), with full Functional/Parametric Test performed at levels of +60 degrees C and -36 degrees C, and non-operating at -54 degrees C. The Qualification vacuum levels during TVAC is 1X10**-6 torr or less. The total test duration is 7 1/2 cycles. The QM SPA is subjected to a minimum of 1000 hours of life testing and 1000 power On-Off cycles.
EMC: The QM is subjected to EMC Testing (tests CE01/CE03, CE07, CS01, CS02, CS06, RE02, RS02, and RS03) in accordance with the SPA EMC test Procedure (826477) based on MIL-STD-461A.

UNIT FLIGHT ACCEPTANCE TESTS - The FM SPA is subjected to the following acceptance testing:
VIBRATION: FM Acceptance Vibration Test (AVT) in accordance with the SPA Vibration Test Procedure (826585), with level and duration as per Figure 6 and Table 2 of 826586.
THERMAL/VACUUM: FM TVAC Test is in accordance with Figure 6 of the SPA TVAC Test Procedure (826585), with levels of +49 degrees C and -25 degrees C for a duration of 1 1/2 cycles. The vacuum levels during Acceptance TVAC Test is 1X10**-5 torr or less.

JOINT SRU TESTS - The SPA is tested as part of the joints (ambient and vibration tests only). The ambient ATP for the Shoulder Joint, Elbow Joint, and Wrist Joint are as per ATP.2001, ATP.2003, and ATP.2005 respectively. The vibration test for the Shoulder Joint, and Elbow or Wrist Joint are as per ATP.2002, ATP.2004 and ATP.2006 respectively. Through wire function, continuity and electrical isolation tests are performed per TP.283.

MECHANICAL ARM REASSEMBLY - The SPA's/Joints undergo a mechanical arm integration stage where electrical checks are performed per TP.2007.

MECHANICAL ARM TESTING - The outgoing split-arm is configured on the Strongback and the Manipulator Arm Checkout is performed per ATP.1932.

FLIGHT CHECKOUT: PDRS OPS Checkout (all vehicles) JSC 16987.

Inspection:

Units are manufactured under documented quality controls. These controls are exercised throughout design procurement, planning, receiving, processing, fabrication, assembly, testing and shipping of the units. Mandatory inspection points are employed at various stages of fabrication, assembly, and test. Government source inspection is invoked at various control levels.

EEE parts inspection is performed as required by SPAR-RMS-PA.003. Each EEE part is qualified at the part level to the requirements of the applicable specification. All EEE parts are 100% screened and burned-in, as a minimum, as required by SPAR-RMS-PA.003, by the supplier. DPA is performed as required by PA.003 on a randomly selected 5% of parts, maximum 5 pieces, minimum 3 pieces for each lot number/date code of parts received. All cavity devices are subjected to 100% PIND. Wire is procured to specification MIL-W-22759 or MIL-W-81381 and inspected and tested to NASA JSCM8060 Standard Number 95A.

Receiving Inspection verifies that all parts received are as identified in the procurement documents, that no physical damage has occurred to parts during shipment, that the receiving documents provide adequate traceability information and screening data clearly identifies acceptable parts.

Parts are inspected throughout manufacture and assembly as appropriate to the manufacturing stage completed. These inspections include:

Printed circuit board inspection for track separation, damage and adequacy of plated through holes, component mounting inspection for correct soldering, wire looping, strapping, etc. Operators and inspectors are trained and certified to NASA NHB 5300.4(3A-1) Standard. Conformal coating inspection for adequate processing is performed using ultraviolet light techniques. P.C. Board installation inspection includes checks for correct board installation, alignment of boards, proper connector contact mating, wire routing, strapping of wires etc. Post P.C. Board installation inspection includes cleanliness and workmanship (Spar/government rep. mandatory inspection point).

Unit Pre-Acceptance Test inspection, which includes an audit of lower tier inspection completion, as built configuration verification to as design etc (mandatory inspection point). A unit Test Readiness Review (TRR) which includes verification of test personnel, test documents, test equipment calibration/validation status and hardware configuration is convened by QA in conjunction with Engineering, Reliability, Configuration Control, Supplier as applicable, and the government representative, prior to the start of any formal testing (Acceptance or Qualification). Unit level Acceptance Testing (ATP) includes ambient performance, thermal and vibration testing (Spar/government rep. mandatory inspection point).

Integration of unit to Joint SRU - Inspections include grounding checks, connectors for bent or pushback contacts, visual, cleanliness, interconnect wiring and power up test to the appropriate Joint Inspection Test Procedure (ITP). Joint level Pre-Acceptance Test Inspection, includes an audit of lower tier inspection completion, as built configuration verification to as design etc. Joint level Acceptance Testing (ATP) includes ambient and vibration testing (Spar/government rep. mandatory inspection point).

Mechanical Arm Reassembly - the integration of mechanical arm subassemblies to form the assembled arm. Inspections are performed at each phase of integration which includes electrical checks, through wiring checks, wiring routing, interface connectors for bent or pushback contacts etc. Mechanical Arm Testing - Strongback and flat floor ambient performance test (Spar/government rep. mandatory inspection point).

OMRSD Offline: Power-up arm. Verify no BITE errors. Select Drive Drive and verify joint operation in both directions.

OMRSD Online Installation: None.

OMRSD Online Turnaround: Power-up arm. Verify no BITE errors. Select Drive Drive and verify joint attempts to drive in both directions.

Screen Failure: A: Pass
B: Pass
C: Pass

Crew Training: The crew will be trained to always observe whether the arm is responding properly to commands. If it isn't, apply brakes.

Crew Action: Select Backup.

Operational Effect: Loss of direct Drive. For a subsequent failure, when attempting to drive a single joint in Direct Drive, the joint selected plus one other joint will drive. Computer supported modes are available however the system is one failure away from a criticality one. Backup remains available.

Mission Constraints: Operate under vernier rates within approximately 10 ft of structure. The operator must be able to detect that the arm is responding properly to commands via window and/or CCTV views during all arm operations. Auto trajectories must be designed to come no closer than approximately 5 ft from structure.

Approvals:

Functional Group	Name	Position	Telephone	Date Signed	Status
Engineer	Hiltz, Michael	Systems Engineer	4634	15Oct97	Signed
Reliability	Molgaard, Lena	Reliability Engineer	4590	15Oct97	Signed
Program Management Offic	Taplin, Ron	Technical Manager	4766	15Oct97	Signed
Subsystem Manager	Glenn, George	RMS Subsystem Manager	(281) 483-1516	24Mar98	Signed
Technical Manager	Peck, John	Technical Manager (JSC)	713-483-1264	31Mar98	Signed
Safety + Mission Assurance	Carl, David / JSC-NC6	RMS S&MA Engineer	(281) 483-[illegible]	3? APR 98	[signature]