

**SPAR - BRAMPTON (SSS)**  
9445 AIRPORT RD

## Critical Items List

SRMS

BRAMPTON ONTARIO L6S4J3

CIL Ref#: **2641**

Revision: 0

FMEA Rev: 0

**System:** SRMS

**Subsystem:** ELECTRICAL SUB-SYSTEM

**Assembly Desc:** Servo Power Amplifier

**Part Number(s):** 51140F1177-3

51140F1177-5

**Item:**

**Function:** Analog Interface Assembly

Provides Tachometer excitation, SCU signal filtering, Phase Locked Loop and tachometer counter circuits to provide measured motor speed data to inner and outer rate loops. Provides analog to digital conversion of MDA buck output voltage, EPC +5V and reference voltages for BITE.

**Failure Mode:** Loss of A/D data and prime tachometer data to CPU.

H/W Func. Screen Failures

**Criticality:** 2: 1R

**Mission Phase:** Orbit

**Cause(s):** Analog Interface Assembly

Loss of or erroneous A/D and prime tach data to CPU.

**Failure effect on unit/end item:**

Erroneous A/D conversion of MDA demand voltage and reference voltages. Erroneous tach data to CPU. TCO BITE will detect that prime/redundant tachometer data does not agree. Position Encoder BITE will detect that tachometer data is inconsistent with position encoder data. A/D converter bite, MDA demand voltage BITE or motor drive fault detection feedback voltage test may fail due to corrupt A/D data. Direct Drive may be lost.

**Worst Case:** Unexpected motion. Joint runaway. Autobrakes.

**Redundant Paths:** Autobrakes (to Safe the System).

Direct Drive (If Available).

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 components.

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-136 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 2 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  $1 \times 10^{-6}$  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 (826586), 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 (826588), 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  $1 \times 10^{-5}$  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

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 and drive each joint in Single Joint mode. Verify no Position Encoder BITE errors. Also verify joint motion in Direct Drive.

**OMRSD Online:** None.  
**Installation:**

**OMRSD Online Turnaround:** Power-up arm. Verify no Position Encoder BITE errors. Also verify that joint is attempting to drive in Direct Drive.

**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 Direct Drive if available. If D/D not available select Back-up Drive. Single/Direct Drive switch should be pulsed to maintain proper rates.

**Operational Effect:** Cannot use Computer Supported modes. Direct Drive may not be available. Autobrakes. Back-up is available. Arm will not stop automatically if failure of the autobrake system has previously occurred. Brakes can be applied manually.

**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	Hitz, Michael / SPAR-BRAMPTON	Systems Engineer	4634	06Mar98	Signed
Reliability	Molgaard, Lena / SPAR-BRAMPTON	Reliability Engineer	4590	06Mar98	Signed
Program Management Office	Rice, Craig / SPAR-BRAMPTON	Technical Program Manager	4892	06Mar98	Signed
Subsystem Manager	Glenn, George / JSC-ER	RMS Subsystem Manager	(281) 483-1516	30Mar98	Signed
Technical Manager	Alison, Ron / JSC-MV6	RMS Project Engineer JSC	(713) 483-4072	09Apr98	Signed

*20874 + Alison Almond, CAN, DAVID / JSC-MC RMS JSCA ENGINEER (281) 483-1516 17 APR 98 David C. Co*