

System: SRMS

Subsystem: MECHANICAL ARM SUB-SYSTEM

Assembly Desc: MOTOR MODULE

Part Number(s): 51140E1214-1

51140E1214-1

51140E1214-3

51140E1214-5

51140E1214-7

51140E1214-9

Item:

Function: BRAKE ASSEMBLY

PROVIDES MECHANICAL BRAKING FORCE FOR JOINTS.

Failure Mode: Brake will not mechanically release or will only partially disengage.

H/W Func. Screen Failures

Criticality: 1 1

Mission Phase: Orbit

Cause(s): BRAKE ASSEMBLY

Friction Debris Behind the Armature.

Loss of Bearing Preload.

Mechanical Binding.

Failure effect on
unit/end item:

Arm may take an unexpected trajectory (sluggish/frozen). Motor may be able to overdrive brake in Direct or Backup Drive.

Worst Case: Unexpected motion. Frozen Joint. Unannunciated. Crew Action Required

Redundant Paths: Not Applicable.

Retention Rationale

Design:

THE JOINT BRAKE IS A MAJOR BOUGHT-OUT-PART WHICH IS SUPPLIED BY HONEYWELL SPERRY CORPORATION MEETS OR EXCEEDS THE REQUIREMENTS OF SPECIFICATION SPAR-SG.468.

THE FOLLOWING IS A LIST OF DESIGN CHARACTERISTICS THAT LIMIT THE POSSIBILITY OF AN OPEN OR SHORT CIRCUIT IN THE UNIT WINDINGS:

THE INSULATION SYSTEM IS CLASS 185 (185 DEGREES C) OR BETTER AND IS PROVEN THROUGH YEARS OF USE.

THE WIRE USED IN THE UNITS IS HEAVY ML MAGNET WIRE WHICH HAS AN EXTRA COAT OF INSULATION ON THE MAGNET WIRE.

THE WINDINGS ARE PREBAKED AFTER THE WINDINGS ARE FORMED BUT PRIOR TO IMPREGNATION. THIS IS A STRESS RELIEVING OPERATION OF BOTH THE COPPER WIRE AND THE INSULATION, PERFORMED TO MINIMIZE ANY DEGRADATION DURING PROCESSING.

KAPTON TAPE IS APPLIED OVER THE BOBBIN AND WINDINGS O.D. TO PROTECT THE MAGNET WIRE DURING PROCESSING AND INSTALLATION. THE UNIT IS IMPREGNATED WITH 100% SOLID EPOXY THAT IMPROVES THE COIL MECHANICAL PROPERTIES ESPECIALLY DURING VIBRATION AND HELPS THE UNIT RUN COOLER BY INCREASING THE EFFECTIVE THERMAL CONDUCTION WITHIN THE WINDING MASS.

IT SHOULD BE NOTED THAT THE MAGNET WIRE USED IN THE WINDINGS OF THESE UNITS IS SINGLE STRAND. TO LIMIT THE POSSIBILITY OF A LOSS OF INPUT VOLTAGE DUE TO AN OPEN LEAD WIRE ALL SOLDERING IS ACCOMPLISHED BY OPERATORS WHO ARE TRAINED AND CERTIFIED TO NASA NHB 5300.4 (3A) STANDARD, AS MODIFIED BY JSC 08800A. CONNECTORS USED ARE TO GSFC SPECIFICATION S.311.P.4/9.

CONTACTS USED ARE TO GSF SPEC.S.311.P.4/9.

CRIMPING IS CONTROLLED TO SPAR PPS 9:17 WHICH EMBODIES MSC-SPEC-Q-1A.

THE BRAKE USES FOUR PINS PRESS FITTED INTO THE CORE TO HOLD THE ARMATURE FROM ROTATING AND TO ALLOW AXIAL SLIDING FOR ENGAGEMENT AND DISENGAGEMENT. THE FOLLOWING IS A LIST OF CHARACTERISTICS TO LIMIT THE POSSIBILITY OF THE BRAKE HANGING-UP DUE TO MECHANICAL BINDING BETWEEN THE PINS AND THE HOLES.

THE HOLES IN THE ARMATURE AND BRAKE CORE ARE MATCH-BORED (JIG BORED) TO ASSURE GOOD ALIGNMENT.

THE ARMATURE HOLES ARE 0.004 TO 0.005 INCH LARGER THAN THE CORE PINS TO ASSURE ADEQUATE CLEARANCE.

MEASUREMENTS ARE PERFORMED TO CONFIRM A MINIMUM OF 0.002 INCH RADIAL PLAY BETWEEN THE TWO ASSEMBLED PARTS.

THE UNIT IS TESTED A MINIMUM OF SEVEN TIMES DURING ACCEPTANCE TESTING FOR POTENTIAL BINDING. THE TEST CONSISTS OF APPLYING FULL RATED LOAD TORQUE WITH THE UNIT ENGAGED. A VOLTAGE IS THEN APPLIED TO DISENGAGE THE UNIT. THE TIME FROM APPLICATION OF VOLTAGE UNTIL FULL DISENGAGEMENT IS MEASURED. ANY BINDING OF THE ARMATURE WOULD EITHER PREVENT DISENGAGEMENT OR CAUSE AN EXCESSIVE TIME DELAY. THE PINS ARE LUBRICATED WITH MOLYBDENUM DISULFIDE. THE SOLID FILM LUBRICANT SYSTEM USED IS LUBECO 905. THIS COMPRISES A SPRAY AND CURE (400 DEGREES F) APPLICATION OF MOLYBDENUM DISULPHIDE, IN AN IN ORGANIC BINDER APPLIED PER PPS:28:11 AND 28:13. BURNISHING AND RUN IN PER SPAR PPS 28:14. THE LUBRICATED BEARING IS TORQUE TRACED TO ENSURE ACCEPTABILITY PER SPAR PPS:28:14.

THE PRELOAD SPRINGS SUPPLY THE SPECIFIED LOADING FOR THE BRAKE ANGULAR CONTACT BEARING AND LOCATE THE BEARINGS AND SHAFT ASSEMBLY WITHIN THE BRAKE HOUSING. THE BRAKE DESIGN UTILIZES A MULTIPLE ARRANGEMENT OF WAVE WASHERS TO GENERATE THE REQUIRED PRELOAD. THE UNIT PRELOAD IS VERIFIED BY THE END PLAY TEST (SMALLEST APPLIED LOAD) DURING ACCEPTANCE TESTING.

THE HEAVIEST AMOUNT OF FRICTION MATERIAL DEBRIS IS GENERATED DURING THE CALIBRATION RUN-IN OF THE UNIT. THE RUN-IN CONSISTS OF ROTATING THE UNIT IN ONE DIRECTION AT 50 RPM FOR A TOTAL OF 16 HOURS MINIMUM USING A DUTY CYCLE OF 10 SECONDS ENGAGED AND THEN 10 SECONDS DISENGAGED. THE UNITS RECEIVE A VERY LIMITED AMOUNT OF SLIPPING DURING ON MISSION USAGE.

THE AIR GAP OF THE UNIT IS VERIFIED TO MEET A MINIMUM VALUE BY THE END PLAY TEST (LARGEST APPLIED LOAD) DURING ACCEPTANCE TESTING.

THE STRIPDOWN AND INSPECTION OF FLIGHT HARDWARE RETURNED FOR REFURBISHMENT HAS REVEALED THAT A SIGNIFICANT AMOUNT OF FRICTION MATERIAL DEBRIS MAY HAVE ACCUMULATED AT THE UNIT END-OF-LIFE. IT IS VERY UNLIKELY; HOWEVER, THAT SUFFICIENT FRICTION DEBRIS COULD ACCUMULATE BEHIND THE ARMATURE OR BETWEEN THE FRICTION SURFACES, SO AS TO AFFECT THE UNITS PERFORMANCE.

Test:

ACCEPTANCE TESTS - THE JOINTS MOTOR MODULE ASSEMBLY CONSISTS OF THE BRAKE ASSEMBLY, MOTOR ASSEMBLY, TACHOMETER, COMM. SCANNER AND SCU ALL OF WHICH ARE EXPOSED TO AN ACCEPTANCE TEST BY THE VENDOR PRIOR TO ACCEPTANCE BY SPAR. THE MOTOR MODULE ASSEMBLY IS SUBJECT TO THE FOLLOWING ACCEPTANCE ENVIRONMENT: VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8 THERMAL VACUUM: +85 DEGREES C TO -25 DEGREES C (1.5 CYCLES) 1 X 10⁻⁵ TORR

THE MOTOR MODULE IS INSTALLED IN THE JOINTS ASSEMBLY AND AGAIN IS EXPOSED TO ANOTHER ACCEPTANCE TEST, WHICH INCLUDES VIBRATION AND THERMAL VACUUM OF THE SAME APPROXIMATE LEVEL AND DURATION.

QUALIFICATION TESTS - A TYPICAL MOTOR MODULE ASSEMBLY WAS TOTALLY QUALIFIED BY SPAR FOR THE LISTED BELOW ENVIRONMENTS. FURTHER, THE BRAKE ASSEMBLY, MOTOR ASSEMBLY, TACHOMETER AND COMM. SCANNER, ARE SUBJECT TO SOME DEGREE OF QUALIFICATION TESTING BY THE VENDOR. THE MOTOR MODULE TESTS: VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8 THERMAL VACUUM: +96 DEGREE C TO -38 DEGREE C (8 CYCLES) 1 X 10⁻⁶ TORR SHOCK: 20G/11 MS - 3 AXES (6 DIRECTIONS) HUMIDITY: TESTED IN SHOULDER JOINT HUMIDITY TEST EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CS01, CS02, CS06, CE01, RE02(N/B), RS03, RS04). FLIGHT CHECKOUT PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987

Inspection:

UNITS ARE MAJOR BOUGHT OUT PARTS, MANUFACTURED, ASSEMBLED AND TESTED TO SPAR DRAWINGS AND SPECIFICATIONS UNDER DOCUMENTED QUALITY CONTROLS. THESE CONTROLS ARE EXERCISED THROUGHOUT DESIGN PROCUREMENT, PLANNING, PROCESSING, FABRICATION, ASSEMBLY QUALIFICATION AND ACCEPTANCE TESTING. MANDATORY INSPECTION POINTS ARE EMPLOYED AS APPROPRIATE AT VARIOUS LEVELS OF ASSEMBLY AND TEST. SPAR/GOVERNMENT SOURCE INSPECTION IS INVOKED ON THE SUPPLIER.

WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-81381 AND INSPECTED AND TESTED TO NASA JSCM8080 STANDARD NUMBER 95A.

RECEIVING INSPECTION VERIFIES THAT THE HARDWARE RECEIVED IS AS IDENTIFIED IN THE PROCUREMENT DOCUMENTS, THAT NO DAMAGE HAS OCCURRED DURING SHIPMENT, AND THAT APPROPRIATE DATA HAS BEEN RECEIVED WHICH PROVIDES ADEQUATE TRACEABILITY INFORMATION AND IDENTIFIES ACCEPTABLE PARTS.

PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE:

MAGNET WIRE IS PROCURED TO MIL-W-583 AND CHECKED AT INCOMING INSPECTION PER FEDERAL STANDARD J-W-1177 WHICH INCLUDES DIELECTIC, PIN HOLES, BUBBLES, BLISTERS, AND CRACKS IN THE INSULATION.

ALL SOLDERING IS ACCOMPLISHED BY OPERATORS, WHO ARE TRAINED AND CERTIFIED TO NASA NHB5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.

BEARINGS RECEIVE DIMENSIONAL INSPECTION AT THE SUPPLIER AND VERIFICATION BY SPAR RECEIVING INSPECTION. PRE-ASSEMBLY INSPECTION VERIFIES CIRCULARITY OF BALL TRACKS AND INNER/OUTER RACE DIAMETERS. AFTER ASSEMBLY PRIOR TO LUBRICATION, RADIAL CLEARANCE MEASUREMENTS ARE TAKEN. FOLLOWING LUBRICATION, RUN-IN/BURNISHING AND CLEANING OF DRY LUBE BEARINGS, SPECIALIZED BEARING INSPECTION EQUIPMENT AT SPAR IS USED TO VERIFY QUALITY AND STICTION LEVELS THROUGH STRIP CHART RECORDING OF TORQUE TRACES. BEARINGS ARE THEN RETURNED TO THE SUPPLIER FOR FINAL RADIAL CLEARANCE MEASUREMENTS. GOVERNMENT SOURCE INSPECTION IS INVOKED ON ALL BEARING PROCUREMENTS.

UNITS ARE INSPECTED TO THE APPLICABLE SPAR INSPECTION TEST PROCURE (ITP). PRIOR TO MM INTEGRATION, INSPECTIONS INCLUDE CLEANLINESS USING U.V, GENERAL WORKMANSHIP, DIMENSIONAL, SPLINE FOR DRY LUBRICATION, CORRECT INSTALLATION OF BEARING, WIRE LEADS FOR DAMAGE, IDENTIFICATION AND FUNCTIONAL TEST TO VERIFY BRAKE SLIP TORQUE, STICTION, DROPOUT VOLTAGE, PULL-IN VOLTAGE ETC.

INTEGRATION OF UNIT TO MOTOR MODULE - INSPECTIONS INCLUDE GROUNDING CHECKS,CONNECTOR FOR BENT PINS,VISUAL,CLEANLINESS,INTERCONNECT WIRING ETC.
 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 TEST READINESS REVIEW (TRR) WHICH INCLUDES VERIFICATION OF TEST PERSONNEL, TEST DOCUMENTS, TEST EQUIPMENT CALIBRATION/ VALIDATION STATUS AND HARDWARE CONFIGURATION IS CONVENEED BY QUALITY ASSURANCE 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).
 ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL-VAC 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) ETC.
 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, VIBRATION AND THERMAL-VAC TESTING (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT).
 SRMS SYSTEMS INTEGRATION, THE INTEGRATION OF MECHANICAL ARM SUBASSEMBLIES AND THE FLIGHT CABIN EQUIPMENT TO FORM THE SRMS. INSPECTIONS ARE PERFORMED AT EACH PHASE OF INTEGRATION WHICH INCLUDES GROUNDING CHECKS, THRU WIRING CHECKS, WIRING ROUTING, INTERFACE CONNECTORS FOR BENT OR PUSH BACK CONTACTS ETC.
 SRMS SYSTEMS TESTING - STRONGBACK AND FLAT FLOOR AMBIENT PERFORMANCE TEST (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT).

OMRSD Offline: IN DIRECT DRIVE WITH ELBOW DEMATED, VERIFY RATES FOR ALL JOINTS.

OMRSD Online NONE
Installation:

OMRSD Online DRIVE EACH JOINT IN SINGLE MODE. VERIFY TACHOMETER SIGNATURE.
Turnaround:

Screen Failure: A:
B:
C:

Crew Training: THE CREW WILL BE TRAINED: TO ALWAYS OBSERVE WHETHER THE ARM IS RESPONDING PROPERLY TO COMMANDS. IF IT ISNT, APPLY BRAKES.

Crew Action: APPLY BRAKES. USE SINGLE MODE ON OTHER JOINTS TO POSITION ARM FOR JETTISON.

Operational Effect: ONE JOINT STOPS. ARM DOES NOT RESPOND PROPERLY TO COMMANDS. FOR HAND CONTROLLER COMMANDS CREW INHERENTLY COMPENSATE FOR ANY UNDESIREED TRAJECTORIES.

Mission Constraints: OPERATE UNDER VERNIER RATES WITHIN 10 FT OF STRUCTURE. AUTO TRAJECTORIES MUST BE DESIGNED TO COME NO CLOSER THAN 5 FT FROM 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. ARM SHOULD NOT BE MANEUVERED TO POSITION WHERE JETTISON CANNOT BE SAFETY PERFORMED.

Approvals:

Functional Group	Name	Position	Telephone	Date Signed	Status
Engineer	Hiltz, Michael	Systems Engineer	4634	26Aug97	Signed
Reliability	Molgaard, Lena	Reliability Engineer	4590	26Aug97	Signed
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