

BRAMPTON ONTARIO L6S4J3

CIL Ref#: 3341

Revision: 1 FMEA Rev: 0

System: SRMS

Subsystem: ELECTRICAL SUB-SYSTEM

Assembly Desc: EEEU

Part Number(s): 51140F1174-5

Name	Part Number(s)	Qty	Sheet No.	Schematic No.
Item: COMMAND LOGIC		1		2583785
Function: COMMAND LOGIC	RECEIVES INPUT COMMANDS FROM U&C AND COMMANDS MOTOR DRIVE AND BRAKE/CLUTCH ENABLE CIRCUIT.			

Failure Mode: LOSS OF FAILSAFE CIRCUITRY.

	HW	Func.	Screen	Failures
Criticality:	2	1R		B

Mission Phase: Orbit

Cause(s): COMMAND LOGIC	(1) Q4, Q5, Q3 OR Q12, FAIL S/C. U152, U15A OR U18B, FAIL HIGH. U18 C OR D FAIL LOW. U23 A, B, C, D, E OR F, FAIL HIGH. U7D FAILS LOW. U26B AND U26C FAIL HIGH. U18 FAIL HIGH. Q2 FAIL O/C.
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Failure effect on unit/end item: EFEU WILL PROCESS COMMANDS AS NORMAL

Worst Case: LOSS OF MISSION. SUBSEQUENT FAILURE RESULTS IN UNCOMMANDED RELEASE

Redundant Paths: UNCOMMANDED RELEASE.

### Retention Rationale

#### Design:

CMOS DEVICES OPERATE AT LOW POWER AND HENCE DO NOT EXPERIENCE SIGNIFICANT OPERATING STRESSES. THE TECHNOLOGY IS MATURE, AND DEVICE RELIABILITY HISTORY IS WELL DOCUMENTED. ALL STRESSES ARE ADDITIONALLY REDUCED BY DERATING THE APPROPRIATE PARAMETERS IN ACCORDANCE WITH SPAR-RMS-PA.003. SPECIAL HANDLING PRECAUTIONS ARE USED AT ALL STAGES OF MANUFACTURE TO PRECLUDE DAMAGE/STRESS DUE TO ELECTROSTATIC DISCHARGE.

ALL RESISTORS AND CAPACITORS USED IN THE DESIGN ARE SELECTED FROM ESTABLISHED RELIABILITY (ER) TYPES. LIFE EXPECTANCY IS INCREASED BY ENSURING THAT ALL ALLOWABLE STRESS LEVELS ARE DERATED IN ACCORDANCE WITH SPAR-RMS-PA.003. ALL CERAMIC AND ELECTROLYTIC CAPACITORS ARE ROUTINELY SUBJECTED TO RADIOGRAPHIC INSPECTION.

EEE PARTS HAVE BEEN SELECTED AND CONTROLLED IN ACCORDANCE WITH SPAR-RMS-PA.003. THIS DOCUMENT DEFINES THE PROGRAM REQUIREMENTS FOR MONITORING AND CONTROLLING EEE PARTS. THE REQUIREMENTS INCLUDE PART SELECTION TO AT LEAST "ESTABLISHED RELIABILITY" LEVELS, AND ADEQUATE DERATING OF PART STRESS LEVELS. PROCEDURES AND ACTIVITIES ARE SPECIFIED TO ENSURE AT LEAST EQUIVALENT QUALITY FOR NONSTANDARD AND IRREGULAR PARTS. RELIABILITY ANALYSIS HAS CONFIRMED NO PARTS WITH GENERICALLY HIGH FAILURE RATES.

AEROSPACE DESIGN STANDARDS FOR DETAILING ELECTRONIC PARTS PACKAGING, MOUNTING AND STRUCTURAL/MECHANICAL INTEGRITY OF ASSEMBLIES ARE APPLIED. SUCH DESIGN HAS BEEN REVIEWED AND FOUND SATISFACTORY THROUGH THE DESIGN AUDIT PROCESS, INCLUDING THE USE OF RELIABILITY, MAINTAINABILITY AND SAFETY CHECKLISTS. MATERIAL SELECTION AND USAGE CONFORMS TO SPAR-SG.368 WHICH IS EQUIVALENT TO THE NASA MATERIALS USAGE REQUIREMENTS. WORST CASE ANALYSIS HAS BEEN CONDUCTED TO ENSURE THAT PERFORMANCE CAN BE MET UNDER WORST CASE TEMPERATURE AND AGING EFFECTS. EEE PARTS STRESS ANALYSIS HAS BEEN COMPLETED AND CONFIRMS THAT THE PARTS MEET THE DERATING REQUIREMENTS.

PRINTED CIRCUIT BOARD DESIGNS HAVE BEEN REVIEWED TO ENSURE ADEQUATE CIRCUIT PATH WIDTH AND SEPARATION AND TO CONFIRM APPROPRIATE DIMENSIONS OF CIRCUIT SOLDER PADS AND OF COMPONENT HOLE PROVISIONS. PARTS MOUNTING METHODS ARE CONTROLLED IN ACCORDANCE WITH MSFC-STD-136 WHICH DEFINES APPROVED MOUNTING METHODS, STRESS RELIEF, AND COMPONENT SECURITY.

WHERE APPLICABLE, DESIGN DRAWINGS AND DOCUMENTATION GIVE CLEAR IDENTIFICATION OF HANDLING PRECAUTIONS FOR ESD SENSITIVE PARTS.

BOARD ASSEMBLY DRAWINGS INCLUDE THE REQUIREMENTS FOR SOLDERING STANDARDS IN ACCORDANCE WITH IEC 5300.4(3) AND JSC 08800.

**Test:**

ACCEPTANCE TESTS - THE EEEU IS SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING AS AN SRU.  
VIBRATION: LEVEL AND DURATION REFERENCE TABLE 6 THERMAL: +70 DEGREES C TO -25 DEGREES C (1 1/2 CYCLES) THE  
EEEU IS INTEGRATED INTO THE END EFFECTOR AND IS FURTHER EXPOSED TO THE END EFFECTOR ACCEPTANCE TEST  
ENVIRONMENTS (VIBRATION AND THERMAL VACUUM).  
THE END EFFECTOR ASSEMBLY IS PART OF THE INTEGRATED RMS SYSTEM TESTS (TP518 RMS STRONGBACK TEST AND  
TP552 FLAT FLOOR TEST) WHICH VERIFIES THE ABSENCE OF THE FAILURE MODE.  
QUALIFICATION TESTS - THE EEEU IS SUBJECTED TO THE FOLLOWING SRU QUALIFICATION TEST ENVIRONMENTS.  
VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 6 SHOCK: 20G/11MS - 3 AXES (6 DIRECTIONS) THERMAL: +81  
DEGREES C TO -36 DEGREES C (6 CYCLES) 1 X 10<sup>-9</sup> TORR HUMIDITY: TESTED IN THE END EFFECTOR HUMIDITY TEST.  
EMC: MIL STD 161 AS MODIFIED BY SL E 0002 (TESTS CE01, CE03, CS01, CS02, CS06, RE01, RE02 (NB) RS01).  
FLIGHT CHECKOUT PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16887

**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. ADDITIONALLY, EEE PARTS ARE 100% RE-  
SCREENED IN ACCORDANCE WITH REQUIREMENTS, BY AN INDEPENDENT SPAR APPROVED TESTING FACILITY. 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.  
WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-61361 AND INSPECTED AND TESTED TO NASA JSCMR080  
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(3-1) STANDARD.  
CONFORMAL COATING INSPECTION FOR ADEQUATE PROCESSING IS PERFORMED USING ULTRAVIOLET LIGHT TECHNIQUES  
POST P.C. BD. INSTALLATION INSPECTION, CLEANLINESS AND WORKMANSHIP (SPAR/GOVERNMENT REP - MANDATORY  
INSPECTION POINT).  
P.C. BD. INSTALLATION INSPECTION, CHECK FOR CORRECT BOARD INSTALLATION, ALIGNMENT OF BOARDS, PROPER  
CONNECTOR CONTACT MATING, WIRE ROUTING, STRAPPING OF WIRES ETC  
PRE-CLOSURE INSPECTION, WORKMANSHIP AND CLEANLINESS (SPAR/GOVERNMENT REP - MANDATORY INSPECTION  
POINT).  
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 CONVENED 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 PERFORMANCE, THERMAL AND VIBRATION TESTING (SPAR/GOVERNMENT  
REP. - MANDATORY INSPECTION POINT).  
INTEGRATION OF UNIT TO END EFFECTOR ASSY - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTERS FOR BLNT OF  
PUSHBACK CONTACTS, VISUAL, CLEANLINESS, INTERCONNECT WIRING ETC. AND POWER-UP TEST TO SPAR INSPECTION  
TEST PROCEDURE ITP-2510.  
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 THE EE STANDBY MODE MONITOR BRAKE/CLUTCH TEST POINTS

OMRSD Online NONE  
Installation:

OMRSD Online IN THE EE STANDBY MODE MONITOR BRAKE/CLUTCH TEST POINTS.  
Turnaround:

Screen Failure: A: Pass  
B: INDEPENDENT PATHS NOT INSTRUMENTED.  
C: Pass

Crew Training: FOR UNDOCKED OPERATIONS: CREW TO BE TRAINED TO RECOGNIZE OFF NOMINAL OPERATION OF THE EE AND AND TURI MODE SWITCH TO OFF AFTER SPEC TIME AND MANEUVER THE ORBITER AWAY FROM A FREE FLYING PAYLOAD AT ANY TIME DURING ARM OPERATIONS.

Crew Action: NONE. WITH SUBSEQUENT FAILURE THE EE MODE SWITCH SHOULD BE TURNED OFF. CREW SHOULD OBSERVE THE CAPTURE SEQUENCE AND DETERMINE THAT THE GRAPPLE FIXTURE HAS BEEN DRAWN FAR ENOUGH INTO THE EE TO PROHIBIT PAYLOAD ROTATIONS. IF THE INTERFACE DOES NOT APPEAR RIGID, ATTEMPT TO RIGIDIZE IN THE ALTERNATE MODE. IF RIGIDIZE IS UNSUCCESSFUL, ATTEMPT RELEASE USING PRIMARY EE MODE. IF SNARES OPEN, MANEUVER THE ARM AWAY FROM THE PAYLOAD. IF SNARES DON'T OPEN, ATTEMPT TO RELEASE IN BACKUP MODE. IF SNARES OPEN, MANEUVER ARM AWAY FROM PAYLOAD. MANEUVER ORBITER AWAY FROM PAYLOAD (FOR UNDOCKED OPERATIONS ONLY). IF SNARES CANNOT BE OPENED IN ANY MODE, THEN THE ARM/PAYLOAD COMBINATION CAN BE JETTISONED.

Operational Effect: NONE. UNABLE TO RIGIDIZE/DERIGIDIZE WITH SUBSEQUENT FAILURE. IF FAILURE OCCURS DURING RIGIDIZE SEQUENCE, THE CARRIAGE WILL NOT COMPLETELY RIGIDIZE AND ARM WILL REMAIN LIMP IF IN AUTO MODE. OPERATOR WILL DETECT OFF NOMINAL OPERATION OF THE EE.

Mission Constraints: WHEN CAPTURING A FREE FLYING PAYLOAD, THE EE MUST BE FAR ENOUGH AWAY FROM STRUCTURE TO PROHIBIT CONTACT REGARDLESS OF PAYLOAD ROTATIONS.

Approvals:

Functional Group	Name	Position	Telephone	Date Signed	Status
Engineer	Jorgensen, Glenn / MD ROBOTICS	SPAR OEC	(281) 286-9101	26Sep00	Signed
Reliability	Hautot, Rodney / MD ROBOTICS	Product Assurance Manager SRMS	4679	26Sep00	Signed
Program Management Office	Rice, Craig / MD ROBOTICS	Technical Program Manager	-4892	26Sep00	Signed
Technical Manager	Allison, Ron / JSC-MVS	RMS Project Engineer JSC	(281) 433-4072	26Sep00	Signed
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Customer, S&MA	Kokasz, Cheryl / JSC-NS	Engineer / Lead Avionics Engin	(281) 244-1954	26Sep00	Signed