

FMEA NO. 1.1.2CRITICALITY 2/1RSHUTTLE CCTV
CRITICAL ITEMS LISTUNIT Remote Control Unit (RCU)
DWG NO. 2294824-506, 507SHEET 1 OF 8

| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE |
|---|--|--|
| <p>composite sync to a single camera or monitor.</p> <p>causes:</p> <p>1) Sync Amplifier A1, 2294860-502</p> <p>2) Sync Amplifier A2, 2294861-502</p> | <p>Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.</p> <p><u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS stowing.</p> | <p><u>DESIGN FEATURES</u></p> <p>The RCU is a microprocessor-based command and control unit using an RCA 1802 CMOS microprocessor, CMOS RAM, and TTL PROM. Computer I/O circuitry is implemented in CMOS CD4000 series logic to minimize power dissipation. The design incorporates a dual master oscillator (one active, one cold backup). The master oscillator is a Temperature Compensated Crystal Oscillator (TCXO) purchased from Vectron to an RCA specification control drawing (SCD). Decode logic consists of Low Power Schottky TTL, and the sync amplifier design uses monolithic NE5539 wideband op amps.</p> <p>Parts were required to be JAN reliability level parts or their equivalent. Part selection falls into three categories:</p> <ol style="list-style-type: none"> (1) JAN or better parts from the Military QPL, (2) Parts demonstrated to NASA to be equivalent to JAN level via test data (e.g., CD4000/3W series parts), or (3) Parts procured to an RCA spec control drawing which calls out tests and screening to effect JAN equivalency. <p><u>BARE BOARD DESIGN (A1, A2)</u></p> <p>The design for the associated boards A1 and A2 are constructed from laminated copper-clad epoxy glass sheets (NEMA G-10) Grade FR-4), PER MIL-P-55617A. Circuit connections are made through printed traces which run from point to point on the board surfaces. Every trace terminates at an annular ring. The annular ring surrounds the hole in which a component lead or terminal is located. This ring provides a footing for the solder, ensuring good mechanical and electrical performance. Its size and shape are governed by MIL-P-55640 as are trace widths, spacing and routing. These requirements are reiterated specifically in drawing notes to further assure compliance. Variations between the artwork master and the final product (due to irregularities of the etching process) are also controlled by drawing notes. This prevents making defective boards from good artwork. Holes which house no lead or terminal, but serve only to electrically interconnect the different board layers, contain stitch bars for mechanical support and increased reliability.</p> <p>The thru holes are drilled from a drill tape thus eliminating the possibility of human error and allowing tight control over hole and annular ring concentricity, an important reliability criterion. After drilling and etching, All copper cladding is tin-lead plated per MEL-STD-1495. This provides for easy and reliable soldering at the time of board assembly, even after periods of prolonged storage.</p> |

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|---|---|---|
| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE |
| No composite sync to a single camera or monitor. Causes: (1) Sync Amplifier A1, 2294860-502 (2) Sync Amplifier A2, 2294861-502 | Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync. Worst Case: Loss of elbow camera sync signal prevents RMS stowing. | DESIGN FEATURES BOARD ASSEMBLY DESIGN (A1, A2) All components are installed in a manner which assures maximum reliability. Component leads are pre-tinned, allowing total wetting of solder joints. All leads are formed to provide stress relief and the bodies of large components are slaked. Special Mounting and handling instructions are included in each drawing required after final assembly. The board is coated with urethane which protects against humidity and contamination. BOARD PLACEMENT The boards are secured in the electronics assembly by gold-plated beryllium copper card guides. Connections are made to the mother board with blind-mated connectors. Disengagement during launch is prevented by a cover which spans the board's free edge. |

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| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE |
| composite sync to a single camera or monitor. Causes:) Sync Amplifier A1, 2294060-502) Sync Amplifier A2, 2294061-502 | Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync. <u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS stowing. | <u>QUALIFICATION TEST</u> For Qualification Test Flow, see Table 2 located at the front of this book. |

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| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE | | | | | | | | | | | | | | | | |
|--|--|--|----------|---|------------|-------------------------|-------------|---|-----------|--------------------------|------------|---|---------|---|-------|---|---------|---|
| <p>composite sync to a single camera or monitor.</p> <p>uses:</p> <ol style="list-style-type: none"> 1) Sync Amplifier A1, 2294860-502 2) Sync Amplifier A2, 2294861-502 | <p>Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.</p> <p><u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS slowing.</p> | <p><u>ACCEPTANCE TEST</u></p> <p>The CCTV systems' RCU is subjected to the following testing:</p> <ul style="list-style-type: none"> • Vibration: <table border="0"> <tr> <td>20-80Hz:</td> <td>3 dB/Oct-rise from 0.01 G²/Hz to 0.04 G²/Hz</td> </tr> <tr> <td>80-350 Hz:</td> <td>0.04 G²/Hz</td> </tr> <tr> <td>350-750 Hz:</td> <td>3 dB/Oct-Fall to 0.018 G²/Hz</td> </tr> <tr> <td>750-1000:</td> <td>0.018 G²/Hz</td> </tr> <tr> <td>1000-2000:</td> <td>3 dB/Oct-Fall to 0.009 G²/Hz</td> </tr> </table> <p>Test Duration: 1 Minute per Axis Test Level: 6.6 Grms</p> • Thermal: <table border="0"> <tr> <td>100° F:</td> <td>Time to stabilize equipment plus 1 hour</td> </tr> <tr> <td>0° F:</td> <td>Time to stabilize equipment plus 1 hour</td> </tr> <tr> <td>100° F:</td> <td>Time to stabilize equipment plus 1 hour</td> </tr> </table> <p>For Acceptance test flow, see Table I located at the front of this book.</p> <p><u>OPERATIONAL TEST</u></p> <p>In order to verify that CCTV components are operational, a test must verify the health of all the command related components from the PHS (A7A1) panel switch, through the RCU, through the sync lines to the Camera/PTU, to the Camera/PTU command decoder. The test must also verify the camera's ability to produce video, the VSU's ability to route video, and the monitor's ability to display video. A similar test would be performed to verify the MDM command path.</p> <p><u>Pre-launch on Orbiter Test/In-Flight Test</u></p> <ol style="list-style-type: none"> 1. Power CCTV System. 2. Via the PHS panel, select a monitor as destination and the camera under test as source. 3. Send "Camera Power On" command from PHS panel. 4. Select "External Sync" on monitor. 5. Observe video displayed on monitor. Note that if video on monitor is synchronized (i.e., stable raster) then this indicates that the camera is receiving composite sync from the RCU and that the camera is producing synchronized video. 6. Send Pan, Tilt, Focus, Zoom, ALC, AND Gamma commands and visually (either via the monitor or direct observation) verify operation. 7. Select downlink as destination and camera under test as source. 8. Observe video routed to downlink. 9. Send "Camera Power Off" command via PHS panel. 10. Repeat Steps 3 through 9 except issue commands via the MDM command path. This proves that the CCTV equipment is operational. | 20-80Hz: | 3 dB/Oct-rise from 0.01 G ² /Hz to 0.04 G ² /Hz | 80-350 Hz: | 0.04 G ² /Hz | 350-750 Hz: | 3 dB/Oct-Fall to 0.018 G ² /Hz | 750-1000: | 0.018 G ² /Hz | 1000-2000: | 3 dB/Oct-Fall to 0.009 G ² /Hz | 100° F: | Time to stabilize equipment plus 1 hour | 0° F: | Time to stabilize equipment plus 1 hour | 100° F: | Time to stabilize equipment plus 1 hour |
| 20-80Hz: | 3 dB/Oct-rise from 0.01 G ² /Hz to 0.04 G ² /Hz | | | | | | | | | | | | | | | | | |
| 80-350 Hz: | 0.04 G ² /Hz | | | | | | | | | | | | | | | | | |
| 350-750 Hz: | 3 dB/Oct-Fall to 0.018 G ² /Hz | | | | | | | | | | | | | | | | | |
| 750-1000: | 0.018 G ² /Hz | | | | | | | | | | | | | | | | | |
| 1000-2000: | 3 dB/Oct-Fall to 0.009 G ² /Hz | | | | | | | | | | | | | | | | | |
| 100° F: | Time to stabilize equipment plus 1 hour | | | | | | | | | | | | | | | | | |
| 0° F: | Time to stabilize equipment plus 1 hour | | | | | | | | | | | | | | | | | |
| 100° F: | Time to stabilize equipment plus 1 hour | | | | | | | | | | | | | | | | | |

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FAILURE MODE AND
CAUSE

FAILURE EFFECT
ON END ITEM

RAIOWALE FOR ACCEPTANCE

Composite sync to a single camera or monitor.

Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.

QA/INSPECTION

Uses:

-) Sync Amplifier A1, 2294860-502
-) Sync Amplifier A2, 2294861-502

Worst Case:
loss of elbow camera sync signal prevents RMS stowing.

Procurement Control - The RCU EEE parts and hardware items are procured from approved vendors and suppliers, which meet the requirements set forth in the CCTV contract and Quality Plan Work Statement (WS-2593176). Resident DCAS personnel review all procurement documents to establish the need for GSI on selected parts (PAI 517).

Incoming Inspection and Storage - Incoming Quality inspections are made on all received materials and parts. Results are recorded by lot and retained in file by drawing and control numbers for future reference and traceability. All EEE parts are subjected to incoming acceptance tests as called for in PAI 315 - Incoming Inspection Test Instructions. Incoming flight parts are further processed in accordance with RCA 1846684 - Preconditioning and Acceptance Requirements for Electronic Parts, with the exception that DPA and PIND testing is not performed. Mechanical items are inspected per PAI 316 - Incoming Inspection Instructions for Mechanical Items, PAI 305 - Incoming Quality Control Inspection Instruction, and PAI 612 - Procedure for Processing Incoming or Purchased Parts Designated for Flight Use. Accepted items are delivered to Material Controlled Stores and retained under specified conditions until fabrication is required. Nonconforming materials are held for Material Review Board (MRB) disposition. (PAI-307, PAI [QC-531.]

Board Assembly & Test - Prior to the start of RCU board assembly, all items are verified to be correct by stock room personnel, as the items are accumulated to form a kit. The items are verified again by the operator who assembles the kit by checking against the as-built-parts-list (ABPL). DCAS Mandatory Inspection Points are designated for printed circuit, wire wrap and welded wire boards, plus harness connectors for soldering wiring, crimping, solder splices and quality workmanship prior to coating of the component side of boards and sleeving of harnesses. Specific RCU board assembly and test instructions are provided in drawing notes, and applicable documents are called out in the fabrication Procedure and Record (FPR-2294824) and parts list PL-2294824. These include wire connection List 2295901, Process Standard RTV-566 2280881, Process Standard - Bonding Velcro Tape 2280889, Specification Soldering 2280749, Specification Name Plate Application 1960167, Specification - Crimping 2280800, Specification - Bonding and Staking 2280878, Specification - Urethane coating 2280877, Specification - Locking Compound 2026116, Specification Epoxy Adhesive 2010985, Specification - Marking 2280876, Specification - Workmanship 8030035, Specification Bonding and Staking 2280875.

RCU Assembly and Test - An open box test is performed per TP-IT-2294824, and an Acceptance Test per TP-AT-2294824, including vibration and thermal-vacuum. Torques are specified and witnessed, traceability numbers are recorded, and calibrated tools are checked prior to use. RCA Quality and DCAS inspections are performed at the completion of specified FPR operations in accordance with PAI-204, PAI-205, PAI-206, and PAI 217. DCAS personnel witness RCU button-up and critical torquing. RCA and

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| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE |
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| <p>No composite sync to a single camera or monitor.</p> <p>Causes:</p> <p>(1) Sync Amplifier A1, 2294060-502</p> <p>(2) Sync Amplifier A2, 2294861-502</p> | <p>Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.</p> <p><u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS stowing.</p> | <p><u>QA/INSPECTION</u> (Continued)</p> <p>DCAS personnel monitor acceptance tests and review the test data/results. These personnel also inspect for conformance after all repair, rework and retest.</p> <p><u>Preparation for Shipment</u> - The RCU is packaged according to 2280746, Process Standard for Packaging and Handling guidelines. All related documentation including assembly drawings, Parts List, ABPL, Test Data, etc., is gathered and held in a documentation folder assigned specifically to each assembly. This folder is retained for reference. An EIDP is prepared for each RCU in accordance with the requirements of WS-2593176. RCA QC and DCAS personnel witness crating, packaging, packing and marking, and review the EIDP for completeness and accuracy.</p> |

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| FMEA NO. <u>L1.2</u> CRITICALITY <u>2/TR</u> | SHUTTLE CCTV CRITICAL ITEMS LIST | UNIT <u>Remote Control Unit (RCU)</u> DWG NO. <u>2294824-506, 507</u> SHEET <u>7</u> OF <u>8</u> |
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| FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | RATIONALE FOR ACCEPTANCE |
|---|---|---|
| <p>Loss of composite sync to a single camera or monitor.</p> <p>causes:</p> <p>1) Sync Amplifier A1, 2294860-502</p> <p>2) Sync Amplifier A2, 2294861-502</p> | <p>Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.</p> <p><u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS stowing.</p> | <p><u>FAILURE HISTORY</u></p> <p>TDR - W0586, Log #0288, -501 S/N 002</p> <p><u>Description:</u> Acceptance Test Failure, Box Level, Ambient Environment. No sync output.</p> <p><u>Cause:</u> A380 - R113 had loose end cap.</p> <p><u>Corrective Action:</u> R113 removed and replaced with one of the ten samples x-rayed by RCA Q.A. Lab. All tested resistors were normal. This is a random failure.</p> |

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| <p><u>FAILURE MODE AND CAUSE</u></p> <p>1 composite sync to a single camera or monitor.</p> <p>causes:</p> <p>1) Sync Amplifier A1, 2294860-502</p> <p>2) Sync Amplifier A2, 2294861-502</p> | <p><u>FAILURE EFFECT ON END ITEM</u></p> <p>Loss of remote control of single camera and associated PTU (No PTU Motion) or single monitor picture out of lock on external sync.</p> <p><u>Worst Case:</u> Loss of elbow camera sync signal prevents RMS stowing.</p> | <p><u>RATIONALE FOR ACCEPTANCE</u></p> <p><u>OPERATIONAL EFFECTS</u></p> <p>Loss of ability to position the elbow camera. Possible inability to stow the RMS if the elbow camera physically interferes with a payload. If RMS cannot be stowed the port payload bay door cannot be closed. Loss of crew and vehicle.</p> <p><u>CREW ACTIONS</u></p> <p>Perform EVA to reposition the elbow camera, use RMS motion to reposition the camera, or jettison the RMS.</p> <p><u>CREW TRAINING</u></p> <p>Crew should be trained in contingency EVA and RMS operations procedures.</p> <p><u>MISSION CONSTRAINT</u></p> <p>Do not manifest elbow camera for any flight where the payload and the elbow camera can interfere with each other (for any pan or tilt angle). If the camera must be flown do not change the camera position until the interfering payload is deployed.</p> |