FMEA NO. 1.1.5

CRITICALITY 2/1R

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT Remote Control Unit (RCU)
DWG NO. 2294824-506, 507

SHEET 1 OF 8

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
oss of camera commands in omposite sync. auses: 1) D/A Circuitry, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 2) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 2294865-504 3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	DESIGN FEATURES 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. Parts were required to be JAN reliability level parts or their equivalent. Part selection falls into three categories: (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. BARE BOARD DESIGN (A3) The design for the associated board A3 are constructed from laminatedcopper-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. 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 MIL-STD-1495. This provides for easy and reliable soldering at the time of board assembly, even after periods of prolonged storage.

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FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Loss of camera commands in composite sync. Causes: (1) D/A Circuitry, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 (2) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 2294865-504 (3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	DESIGN FEATURES BOARD ASSEMBLY DESIGN (A3) 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 staked. 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. BARE BOARD CONSTRUCTION (A4, A6, A7) The boards are of "welded wire" construction. At the bare board level this does not distinguish it from a normal PC board except that holes which will take weld pins generally are not connected to PC traces. Only those pins which bring power and ground potentials to the ICs are on PCs. An annular ring surrounds the hole in the board where each power and ground pin is located. These pins are then soldered to the trace like any other component lead. Aside from this feature, all design & construction techniques used in PC board layout apply. BOARD ASSEMBLY (A4, A6, A7) The drilled and etched board is populated with several hundred solderable or weldable pins. Power and ground pins, as well as connector pins, are soldered in place. Discreet components (resistors, diodes, capacitors) are attached to bifurcated terminals, where they are soldered. Flatpack ICs are welded, lead-by-lead,to the tops of the weld pins. After welding, extra lead material is trimmed away. Circuit connections are made using #30 AWG nickel weld wire. The wire is welded to the pin surfaces on the board backside. All wire welds are done using a machine which is tape driven, thus eliminating the possibility of miswiring due to operator error. All wiring & circuit performance is tested prior to box-level installation. After successful testing, components are staked as required by drawing notes and the assembly is coated with urethane. The board is inserted in the box on card-edge guides, in the same manner as the other PC boards. 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
oss of camera commands in omposite sync. auses: 1) D/A Circuitory, summing Amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 2) Camera Command Strobe Circuitry on VSU Interface A6, 2592386-501 or 2294865-504 3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	QUALIFICATION TEST For Qualification Test Flow, see Table 2 located at the front of this book.

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UNIT Remote Control Unit (RCU)
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FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
ıss of camera commands in ımposite sync. ıuses: 1) D/A Circuitory, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 2) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 2294865-504 3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	ACCEPTANCE TEST The CCTV systems' RCU is subjected to the following testing: • Vibration: 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^2Hz 750-1000: 0.018 G^2/Hz 1000-2000: 3 dB/Oct-Fall to 0.009 G^2/Hz Test Duration: 1 Minute per Axis Test Level: 6.6 Grms • Thermal: 100° F: Time to stablize equipment plus 1 hour 0° F: Time to stablize equipment plus 1 hour 100° F: Time to stablize equipment plus 1 hour For Acceptance Test Flow, see Table 1 located at the front of this book. OPERATIONAL TEST 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. Pre-Launch on Orbiter Test/In-Flight Test 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.

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FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
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FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Loss of camera commands in composite sync. Causes: (1) D/A Circuitory, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 (2) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 2294865-504 (3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	QA/INSPECTION (Continued) DCAS personnel monitor acceptance tests and review the test data/results. These personnel also inspect for conformance after all repair, rework and retest. Preparation for Shipment - 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-2593476. RCA QC and DCAS personnel witness crating, packaging, packing and marking, and review the EIDP for completeness and accuracy.

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SHEET 7 OF 8

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
ıss of camera commands in ımposite sync. ıuses: 1) D/A Circuitory, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506 2) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 2294865-504 3) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	FAILURE HISTORY TDR - W4307 - Log #505, -501 S/N 004 Description: Prelaunch Test Failure, Box Level, Cold Temperature Environment. Check sum failure at 64°F. Cause: Defective PROM U37-A7BD Corrective Action: U37 PROM replaced per NASA Directive #12. All flight PROMS are to be tested at 40°F and 0°F to check performance. Equipment groups 506 and 507 have been redesigned to use PROM that is less susceptible to temperature failure.

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SHEET 8 OF 8

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
ss of camera commands in nposite sync. uses:) D/A Circuitry, summing amplifier or Pattern Generator A3, 2294862-502 or A4, 2294863-506) Camera command strobe circuitry on VSU Interface A6, 2592386-501 or 229865-504) Microcomputer A7, 2599298-501 or 2294866-504	(1) Loss of command control to all cameras. (2) Same as (1) or loss of specific commands (3) Same as (2) Worst Case: Loss of elbow camera command prevents RMS stowing.	OPERATIONAL EFFECTS 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. CREW ACTIONS Perform EVA to reposition the elbow camera, use RMS motion to reposition the camera, or jettison the RMS. CREW TRAINING Crew should be trained in contingency EVA and RMS operations procedures. MISSION CONSTRAINT 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.