

FMEA NO. 4.2.5

CRITICALITY 2/IR

SHUTTLE CCTV  
CRITICAL ITEMS LISTUNIT TVC/CLA  
DWG NO. 2294819-506, 508/  
2294821-503  
SHEET 1 OF 9FAILURE MODE AND  
CAUSETVC/CLA does not respond to any  
command via the A7 panel on the  
uplink

## TVC

- A1 Command Detector.  
Sync Stripper.  
Clock Divider Chain.  
Sync Generator.  
2294800-504
- A2 Command Decode Logic.  
Command Execution Logic.  
Camera Timing Logic.  
2294881-501
- A3 Sync/CMD Revr.  
2294889-503
- A4 Automatic Light Control.  
2294883-505
- A5 Power On/Off Switching.  
Input Voltage Preregulator.  
Output Voltage Regulators.
- A6 DC-DC Converter Primary  
Oscillator/Driver.  
2294886-503
- A7 Master Oscillator  
2295527-1

FAILURE EFFECT  
ON END ITEM

- (1) No Pan Tilt Motion  
(2) No Lens Motion, i.e.,  
focus, zoom, iris.  
(3) Loss of high or low  
rate of travel for PIU.

Worst Case:  
Unable to command PIU  
motion. Loss of elbow  
PIU control Prevents  
stowing the RMS.

## RATIONALE FOR ACCEPTANCE

## DESIGN FEATURE

The TVC/Lens Assembly is comprised of 16 electrical subassemblies; 13 subassemblies are RCA Astro designed and fabricated using standard printed-circuit board type of construction. The remaining three assemblies, high voltage power supply, oscillator, and stepper motors, are vendor supplied components which have been specified and purchased according to RCA Specification Control Drawings (SCDs) prepared by engineering and reliability assurance. Specifications per the SCD are prepared to establish the design, performance, test, qualification, and acceptance requirements for a procured piece of equipment.

Parts, materials, processes, and design guidelines for the Shuttle CCTV program are specified in accordance with RCA 2295503. This document defines the program requirements for selection and control of EEE parts. To the maximum extent, and consistent with availability, all parts have been selected from military specifications at the JAN level, as a minimum. In addition to the overall selection criteria, a subset of general purpose preferred parts has been defined by this document and the RCA Government Systems Division Standard Parts List. In the case of the CMOS and TTL family of microcircuits, devices are screened and tested to the MIL-STD-883C equivalent and procured under the designations of MI-REL/34Q and SMC 5415 from RCA-SSD and Texas Instruments Corp, respectively. Parts not included in the above documents have been used in the design only after a nonstandard item approval form (NSIAF) has been prepared, submitted to Reliability Assurance Engineering (RAE) and approved for use in the specific application(s) defined in the NSIAF by NASA-JSC.

Worst-Case Circuit Analyses have been performed and documented for all circuit designs to demonstrate that sufficient operating margins exist for all operating conditions. The analysis was worst case-in that the value for each of the variable parameters was set to limits that will drive the output to a maximum (or minimum).

A component application review and analysis was conducted to verify that the applied stress on each piece part by the temperature extremes identified with environmental qualification testing does not exceed the stress derating values identified in RCA 2295503.

In addition, an objective examination of the design was performed through a PDR and CDR to verify that the TVC/Lens assembly met specification and contractual requirements.

FAILURE MODE AND CAUSE		FAILURE EFFECT ON END ITEM	SHUTTLE CCIV CRITICAL ITEMS LIST	UNIT IVC/CIA DWG NO. 2294819-506, 508/ 2294821-503 SHEET 2 OF 9
			RATIONALE FOR ACCEPTANCE	
FMEA NO. 425 CRITICALITY 2/1R IVC/CIA does not respond to any command via the A7 panel on the uplink IVC A1 Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294800-504 A2 Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501 A3 Sync/CMD Rcvr. 2294804-503 A4 Automatic Light Control. 2294803-505 A6 Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators. A7 DC-DC Converter Primary Oscillator/Driver. 2294806-503 A11 Master Oscillator 2294527-1		(1) No Pan/Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PEO. Worst Case: Unable to command PEO motion. Loss of either PEO control Prevents slowing the RMS.	<b>DESIGN FEATURE (Continued)</b> <b>BARE BOARD DESIGN (A1, A4, A5, A6, A7)</b> The design of the associated boards A1, A4, A5, A6, A7 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. 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. <b>BOARD ASSEMBLY DESIGN (A1, A4, A5, A6, A7-A, A7-B)</b> 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.	

IMA NO. <u>4.2.6</u> CRITICALITY <u>2/1R</u>	SIMULTLE CCTV CRITICAL ITEMS LIST	UNIT ... <u>IVC/CIA</u> DWG NO. <u>2294019-506</u> <u>5007</u> <u>2294021-501</u> SHEET <u>3</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>IVC/CIA does not respond to any command via the A7 panel on the uplink</p> <p>IVC                      A1 Command Detector.                      Sync Stripper.                      Clock Divider Chain.                      Sync Generator.                      2294880-504</p> <p>A2 Command Decode Logic.                      Command Execution Logic.                      Camera Timing Logic.                      2294881-501</p> <p>A3 Sync/CMD Rcvr.                      2294884-503</p> <p>A5 Automatic Light Control.                      2294883-505</p> <p>A6 Power On/Off Switching.                      Input Voltage Pre-regulator.                      Output Voltage Regulators.</p> <p>A7 DC-DC Converter Primary Oscillator/Driver.                      2294886-503</p> <p>A11 Master Oscillator                      2295527-1</p>	<p>(1) No Pan Tilt Motion                      (2) No Lens Motion, i.e., focus, zoom, iris.                      (3) Loss of high or low rate of travel for PTU.</p> <p><u>Worst Case:</u>                      Unable to command PTU motion. Loss of elbow PTU control Prevents stowing the RMS.</p>	<p><b>DESIGN FEATURE (Continued)</b></p> <p><b>BARE BOARD CONSTRUCTION (A2)</b></p> <p>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 PCBs. 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 &amp; construction techniques used in PC board layout apply.</p> <p><b>BOARD ASSEMBLY (A2)</b></p> <p>The drilled and etched boards are 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 &amp; 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.</p> <p>The board is inserted in the box on card-edge guides, in the same manner as the other PC boards.</p> <p><b>BOARD PLACEMENT</b></p> <p>The A7-A low voltage power supply board is bolted in place at 6 points around its perimeter. Four of these mounting screws also pass through and tie down the smaller A7-B board. These two boards are mounted face-to-face, separated by the standoffs. Electrical interconnections are achieved by jumper wires between the two boards. The A7-A houses a 34-pin connector which brings in power and signals from outside the module.</p> <p>The A7 module includes these two boards as well as power transistor Q4. The module housing is bent aluminum sheet, comprised of two halves screwed together. The boards and Q4 are secured to the lower half, and wired together. Then the upper half is put in place. By mounting Q4 directly to the aluminum housing, good thermal performance is assured.</p> <p>The A1, A2, A4, A5, A6, 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.</p>

FMEA NO. <u>4.2.5</u> CRITICALITY <u>2/IR</u>		SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u> DWG NO. <u>2294819-506, 508/</u> <u>2294821-503</u> SHEET <u>4</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON CMD ITEM	RATIONALE FOR ACCEPTANCE	
TVC/CLA does not respond to any command via the A7 panel on the omlink  IVC A1 Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504 A2 Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501 A4 Sync/CMD Rcvr. 2294884-503 A5 Automatic Light Control. 2294883-505 A6 Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators. A7 DC-DC Converter Primary Oscillator/Driver. 2294886-501 A11 Master Oscillator 2295522-1	(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PTU.  Worst Case: Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.	The A13 assembly is a temperature compensated voltage controlled crystal oscillator (TCVCO) that is purchased to a specification controlled drawing that establishes the requirements for performance, design, test, and qualification of the unit. The product assurance provisions of the document contain the identical requirements for electronic parts and materials as the Shuttle CCTV program and must receive the approval of RCA and NASA-JSC. Mechanical and electrical integrity of the assembly is confirmed by both analysis (design reviews) and test (qualification and acceptance).  <u>QUALIFICATION TEST</u>  For Qualification test flow, see Table 2 located at the front of this book.	

FMEA NO. 4.2.b

CRITICALITY 2/1R

SHUTTLE CCTV  
CRITICAL ITEMS LISTUNIT TVC/CLA  
DWG NO. 2294819-506, 508/  
2294821-503  
SHEET 5 OF 9

FAILURE MODE AND CAUSE	FAILURE EFFECT OR EMI ITEM	RATIONALE FOR ACCEPTANCE																
TVC/CLA does not respond to any command via the A7 panel on the uplink	(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) loss of high or low rate of travel for PTU.	<u>ACCEPTANCE TEST</u>																
<p>TVC</p> <p>A1 Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504</p> <p>A2 Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p>A3 Sync/CMD Rcvr. 2294884-503</p> <p>A4 Automatic Light Control. 2294885-505</p> <p>A5 Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p>A7 DC-DC Converter Primary Oscillator/Driver. 2294886-503</p> <p>A13 Master Oscillator 2295527-1</p>	<p><u>Worst Case:</u> Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.</p>	<p>The CCTV systems' TVC/CLA is subjected directly, without vibration isolators which might be used in their normal installation, to the following testing:</p> <ul style="list-style-type: none"> <li>* Vibration:           <table border="0" style="margin-left: 20px;"> <tr> <td>20-80Hz:</td> <td>3 dB/Oct-rise from 0.01 G<sup>2</sup>/Hz</td> </tr> <tr> <td>80-350 Hz:</td> <td>0.04 G<sup>2</sup>/Hz</td> </tr> <tr> <td>350-750 Hz:</td> <td>-3 dB/10 Oct-slope</td> </tr> <tr> <td>Test Duration:</td> <td>1 Minute per Axis</td> </tr> <tr> <td>Test Level:</td> <td>6.1 Grms</td> </tr> </table> </li> <li>* Thermal Vacuum: In a pressure of 1X10<sup>-5</sup> Torr, the temperature shall be as follows:           <table border="0" style="margin-left: 20px;"> <tr> <td>125° F:</td> <td>Time to stabilize equipment plus 3 hour</td> </tr> <tr> <td>25° F:</td> <td>Time to stabilize equipment plus 1 hour</td> </tr> <tr> <td>125° F:</td> <td>Time to stabilize equipment plus 1 hour</td> </tr> </table> </li> </ul> <p>The TVC/CLA may not have been subjected to the vacuum condition.</p> <p>For Acceptance Test flow, see Table I located at the front of this book.</p>	20-80Hz:	3 dB/Oct-rise from 0.01 G <sup>2</sup> /Hz	80-350 Hz:	0.04 G <sup>2</sup> /Hz	350-750 Hz:	-3 dB/10 Oct-slope	Test Duration:	1 Minute per Axis	Test Level:	6.1 Grms	125° F:	Time to stabilize equipment plus 3 hour	25° F:	Time to stabilize equipment plus 1 hour	125° F:	Time to stabilize equipment plus 1 hour
20-80Hz:	3 dB/Oct-rise from 0.01 G <sup>2</sup> /Hz																	
80-350 Hz:	0.04 G <sup>2</sup> /Hz																	
350-750 Hz:	-3 dB/10 Oct-slope																	
Test Duration:	1 Minute per Axis																	
Test Level:	6.1 Grms																	
125° F:	Time to stabilize equipment plus 3 hour																	
25° F:	Time to stabilize equipment plus 1 hour																	
125° F:	Time to stabilize equipment plus 1 hour																	
		<p><u>OPERATIONAL TESTS</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> <p>(NOTE: In-Flight testing of the elbow camera/PTU must not be conducted as long as the crit 1/1 interference is present.)</p> <ol style="list-style-type: none"> <li>1. Power CCTV System.</li> <li>2. Via the PHS panel, select a monitor as destination and the camera under test as source.</li> <li>3. Send "Camera Power On" command from PHS panel.</li> <li>4. Select "External Sync" on monitor.</li> <li>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.</li> <li>6. Send Pan, Tilt, Focus, Zoom, ALC, and GAMMA commands and visually (either via the monitor or direct observation) verify operation.</li> <li>7. Select downlink as destination and camera under test as source.</li> <li>8. Observe video routed to downlink.</li> <li>9. Send "Camera Power Off" command via PHS panel.</li> <li>10. Repeat Steps 1 through 9, except issue commands via the MDM command path. This proves that the CCTV equipment is operational.</li> </ol>																

IMEA NO. <u>425</u> CRITICALITY <u>2/1R</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>IVC/CLA</u> DWG NO. <u>2294819-506, 508/</u> <u>2294821-501</u> SHEET <u>6</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
IVC/CLA does not respond to any command via the A7 panel on the uplink  IVC A1 Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294800-504 A2 Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501 A3 Sync/CHD Revr. 2294884-501 A4 Automatic Light Control. 2294883-505 A5 Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators. A6 DC-DC Converter Primary Oscillator/Driver. 2294886-503 A11 Master Oscillator 2295577-1	(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PTU.  Worst Case: Unable to command PTU motion. Loss of elbow PTU control Prevents stowing the RMS.	<p style="text-align: center;"><u>O/A INSPECTION</u></p> <p><u>Procurement Control</u> - The IVC/CLA 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 (MS-2593176). Resident DCAS personnel review all procurement documents to establish the need for GSI on selected parts (PAI 517).</p> <p><u>Incoming Inspection and Storage</u> - 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 1846604 - 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 512 - 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. Non-conforming materials are held for Material Review Board (MRB) disposition. (PAI-307, PAI (QC-521).</p> <p><u>Board Assembly &amp; Test</u> - Prior to the start of IVC or CLA 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 all 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.</p> <p style="text-align: center;"><u>IVC Boards</u></p> <p>Specific IVC board assembly and test instructions are provided in drawing notes, and applicable documents are called out in the Fabrication Procedure and Record (FPR-2294849) and parts list PL2294819. These include shuttle IVC assembly notes 2593660, Process Standard RTV-560 2280881, Process Standard - Bonding Velcro Tape 2280889, Specification Soldering 2280749, Specification Name Plate Application 1960167, Specification - Crimping 2280800, Specification - Bundling and Staking 2280876, Specification - Urethane coating 2280877, Specification - Locking compound 2026116, Specification Epoxy Adhesive 2010485, Specification - Marking 2280876, Specification - Workmanship 8030035, Specification - Bonding and Staking 2280875.</p>

FNCA NO. <u>4.2.5</u> CRITICALITY <u>2/1R</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>IVC/CLA</u> DWG NO. <u>2294819-506 5087</u> <u>2294821-503</u> SHEET <u>7</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CLA does not respond to any command via the A7 panel on the uplink</p> <p>IYC</p> <p>A1 Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504</p> <p>A2 Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p>A3 Sync/CHD Recv. 2294884-503</p> <p>A5 Automatic Light Control. 2294884-505</p> <p>A6 Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p>A7 DC-DC Converter Primary Oscillator/Driver. 2294886-503</p> <p>A12 Master Oscillator 2295527-1</p>	<p>(1) No Pan Tilt Motion (2) No lens Motion, i.e., focus, zoom, iris. (3) loss of high or low rate of travel for PTU.</p> <p><u>Worst Case:</u> Unable to command PTU motion. Loss of elbow PTU control Prevents stowing the RMS.</p>	<p><u>Q/A INSPECTION</u> (Continued)</p> <p><u>IYC Assembly and Test</u> - An open box test is performed per TP-IT-2294819, and an Acceptance Test per TP-AT-2294819, 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 IVC button-up and critical torquing.</p> <p><u>IYC/CLA Assembly and Test</u> - After a IYC and an CLA have has been tested individually, they are mated and a final acceptance test is performed per TP-AI-2294819, including vibration and thermal vacuum environments. RCA and DCAS personnel monitor these tests and review the acceptance test data/results. These personnel also inspect for conformance after all repair, rework and retest.</p> <p><u>Preparation for Shipment</u> - The IYC and CLA are separated prior to shipment after fabrication and testing is complete. Each is packaged according to CCTV Letter 8011 and 2288746, 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 assembly in accordance with the requirements of NS-2593176. RCA QC and DCAS personnel witness crating, packaging, packing, and marking, and review the EIDP for completeness and accuracy.</p>

FMEA NO. <u>4.2.5</u> CRITICALITY <u>2/1R</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>FVC/CIA</u> DWG NO. <u>2294819-506, 508/</u> <u>2294821-503</u> SHEET <u>8</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CIA does not respond to any command via the A7 panel on the uplink</p> <p>FVC</p> <p>A1 Command Detector, Sync Stripper, Clock Divider Chain, Sync Generator, 2294880-504</p> <p>A2 Command Decode Logic, Command Execution Logic, Camera Timing Logic, 2294881-501</p> <p>A1 Sync/CMD Rcvr, 2294882-503</p> <p>A2 Automatic Light Control, 2294883-505</p> <p>A6 Power On/Off Switching, Input Voltage Preregulator, Output Voltage Regulators,</p> <p>A7 DC-DC Converter Primary Oscillator/Driver, 2294886-503</p> <p>A13 Master Oscillator 2294527-1</p>	<p>(1) No Pan Tilt Motion                      (2) No Lens Motion, i.e., focus, zoom, iris.                      (3) loss of high or low rate of travel for PTU.</p> <p>Worst Case:                      Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.</p>	<p><b>FAILURE HISTORY</b></p> <p>TDR - W2644 - Log #0462, TVC S/N F005-502                      TDR - W2640 - Log #0463, TVC S/N F003-502</p> <p><b>Description:</b> Integration testing failure                      Box Level                      Thermal-Vac Hot Environment</p> <p>No video from FVC, +28 volt current at 1.5 Amp limit. (30 minutes into thermal vac hot test cycle -105°F)</p> <p><b>Cause:</b> Short in A7 low voltage power supply. (High voltage winding of transformer)</p> <p><b>Corrective Action:</b> Removed and replaced transformer (sent to vendor for analysis). Short due to a pin-hole in magnet wire insulation. Future transformers to be purchased per revised spec control drawing ECH CCTV 640(B3028).</p> <p>TDR - W2739 - Log #0485 FVC S/N 009 502</p> <p><b>Description:</b> Pre Launch Failure                      Box Level Test                      Ambient Environment</p> <p>Problem report VJCS-201-0093 visual inspection of unit at KSC revealed a recessed pin 31 in the J1 connector.</p> <p><b>Cause:</b> Error in manufacturing of the connector pin. It is 0.035" shorter in length than other pins in connector.</p> <p><b>Corrective Action:</b> Remove and replace pin 31 in J1 connector. Test pins ability to lock into mating connector. Perform contact retention test to insure pin is locking as required. Inspect to insure pin is not pushed out of place.</p> <p>TDR - W2740 - Log #0486 - TVC S/N D08-502</p> <p><b>Description:</b> Pre-Launch Test failure                      Box Level                      Ambient Environment</p> <p>RI: VJCS-2-01 D097 unit returned from KSC. Power was applied to wrong pins. (428VI).</p>



FMEA NO. <u>4.2.5</u> CRITICALITY <u>2/3R</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u> DWG NO. <u>2294819-506, 507</u> <u>2294821-503</u> SHEET <u>BA</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CLA does not respond to any command via the A7 panel on the uplink</p> <p><u>TVC</u></p> <p><u>A1</u> Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504</p> <p><u>A2</u> Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p><u>A3</u> Sync/CHD Revr. 2294884-503</p> <p><u>A4</u> Automatic Light Control. 2294883-505</p> <p><u>A5</u> Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p><u>A7</u> DC-DC Converter Primary Oscillator/Driver. 2294886-503</p> <p><u>A13</u> Master Oscillator 2294821-1</p>	<p>(1) No Pan Tilt Motion (2) No lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PTU.</p> <p><u>Worst Case:</u> Unable to command PTU motion. Loss of elbow PTU control prevents slowing the RMS.</p>	<p><u>FAILURE HISTORY</u></p> <p><u>Cause:</u> Incorrect wiring of shuttle craft harness, put +28V to J1-10 and RTN to J1-9.</p> <p><u>Corrective Action:</u> Wiring of shuttle harness to be repaired by responsible organization. Failure analysis performed and corrective action taken on TVC S/N 008. A6 board-failure analysis indicated the following parts are to be changed. Q3, Q3, Q12, CR3, CR6, and R51 were replaced.</p> <p>TDR - W8024 - Log #0530 - TVC S/N 007-502</p> <p><u>Description:</u> Acceptance Test Failure Box Level Thermal Vac - Hot Environment. TVC drawing excessive current, &gt;1.5A. Failure occurred at +125°F.</p> <p><u>Cause:</u> Capacitor C10 on the A6 board was found to be shorted. A large quantity of solder flowed inside from sleeve thru header.</p> <p><u>Corrective Action:</u> Capacitor C10 removed &amp; replaced, (random part failure).</p> <p>TDR - W823 - Log #558 - TVC S/N 012-502 Y1771 - Log #568 - TVC S/N 009-502 Y1771 - Log #568 - TVC S/N 002-502 Y1771 - Log #568 - TVC S/N 009-502 Y1770 - Log #567 - TVC S/N 014-502 Y1770 - Log #567 - TVC S/N 010-502 Y1770 - Log #568 - TVC S/N 017-502 W1229 - Log #578 - TVC S/N 020-502</p> <p><u>Description:</u> Flight Failure, Spacecraft Level RMS TV Camera circuit breaker popped open during flight mission STS-3.</p> <p><u>Cause:</u> Camera low voltage supply has erratic synchronization mode at low temperature.</p> <p><u>Corrective Action:</u> All flight cameras were returned under CCAS for rework and retest to ECM C-1881. ECM (C-1881) to the low voltage power supplies eliminates the erratic synchronization problem. TVC group part no. has been changed from 2294819-502 to 504 to denote cameras that contain low voltage power supply modification.</p>

INHA NO. <u>4,2,5</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u>
CRITICALITY <u>2/1H</u>		QWG NO. <u>2294819-506 508/</u> <u>2294821-503</u>
		SHEET <u>08</u> OF <u>9</u>

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CLA does not respond to any command via the A7 panel on the link</p> <p>Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504</p> <p>Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p>Sync ZKRD Rcvr. 2294884-503</p> <p>Automatic Light Control. 2294883-505</p> <p>Power On/Off Switching. Input Voltage Pre-regulator. Output Voltage Regulators. In-DC Converter Primary Oscillator/Driver 2294886-503</p> <p>Master Oscillator 2295527-1</p>	<p>(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) loss of high or low rate of travel for PTU.</p> <p>Worst Case: Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.</p>	<p><b>FAILURE HISTORY</b></p> <p>TDR - Y1773 - Log #0570 - TVC S/N 008-502.</p> <p><u>Description:</u> Flight failure Spacecraft Level (STS-3)</p> <p>TVC not synchronized for approximately 30 minutes. This problem occurred at cold temperature. Synchronization was regained at 2°C.</p> <p><u>Cause:</u> Loss of phase lock due to thermal asymmetry of the 3.58 MHz Phase detector.</p> <p><u>Corrective Action:</u> CCA 39 has been issued directing RCA to incorporate the heater and sync modifications (ECN CCT 838) to all flight cameras. TVC 008 was modified accordingly. TVC group number has been updated from group 502 to 506.</p> <p>TDR - Y1779 - Log #576 - TVC S/N 014-502</p> <p><u>Description:</u> Flight failure (STS-3) Spacecraft Level</p> <p>TDR was opened to follow relay K1 - contacts 5 and 8 failure on ass'y 2294805-501 S/N F010.</p> <p><u>Cause:</u> TVC low voltage power supply has erratic synchronization at low temperature. Relay failure result of excessively high current through contacts 5 and 8 during reset command.</p> <p><u>Corrective Action:</u> Removed and replaced K1 on the A6 board. Low voltage power supply was reworked to ECN-C1881. Refer to 1BK H6023 for complete history of erratic synchronization problem.</p> <p>TDR - W0859 - Log #0695 - TVC S/N 024-506</p> <p><u>Description:</u> Pre-launch test failure Box Level Ambient Environment Automatic Iris goes from open to close.</p> <p><u>Cause:</u> Problem could not be duplicated after extensive testing.</p> <p><u>Corrective Action:</u> None - unit returned to KSC.</p>

JHA NO. <u>4.2.5</u> CRITICALITY <u>2/1R</u>		SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u> DWG NO. <u>2294819-506, 508/ 2294821-503</u> SHEET <u>8C</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE	
<p>IVC/CLA does not respond to any command via the A7 panel on the uplink</p> <p><u>IVC</u></p> <p><u>A1</u> Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294880-504</p> <p><u>A2</u> Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p><u>A3</u> Sync/CMD Rcvr. 2294884-503</p> <p><u>A5</u> Automatic Light Control. 2294883-505</p> <p><u>A6</u> Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p><u>A7</u> DC-DC Converter Primary Oscillator/Driver. 2294886-505</p> <p><u>A13</u> Master Oscillator 2295527-1</p>	<p>(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PIU.</p> <p><u>Worst Case:</u> Unable to command PTU motion. Loss of allow PIU control prevents stowing the RMS.</p>	<p><u>FAILURE HISTORY</u></p> <p>TDR - W6870 - Log #0722 - TVC S/N 028-506</p> <p><u>Description:</u> Acceptance Test Failure Ambient Environment Box Level Test</p> <p>Approximately 47 seconds after initial turn on, the iris close command would be generated by IVC.</p> <p><u>Cause:</u> Internal short in the high voltage power supply (S/N 2046), which generated spikes on the POR line.</p> <p><u>Corrective Action:</u> H.V.P.S. removed from TVC and new H.V.P.S. installed. Tests indicated problem solved. Power supply returned to vendor for evaluation. Refer to TDR W1735, log #723.</p> <p>The problem was attributed to improper lead dress of high voltage terminal. These leads have been rerouted and extra insulation added at the HV terminal for all new built units.</p> <p>TDR - W1760 - Log #0838 - TVC S/N 026-506</p> <p><u>Description:</u> Flight failure, Spacecraft Level STS-8</p> <p>During the flight operations, one time when crew turned camera on they had no control of ALC and Gamma functions. Problem resolved itself by recycling power.</p> <p><u>Cause:</u> After numerous operations, the reported condition was duplicated on test set. After initial turn on, camera would not except ALC, and Gamma commands. It was found that the output of U33 Pin 6 CMD I.F. reset on A2 board was set in a high state. This should normally have been reset low by either "POR" or bit count 88 pulses, after initial power turn-on. Suspect devices A2 - U26, U66, U67, and U68.</p> <p><u>Corrective Action:</u> Removed and replaced the following parts on the A2 Board U26, U66, U67, and U68. Lab analysis did not indicated any defect with removed parts. Problem has not recurred after new parts were installed.</p>	

THEA NO. <u>4.2.5</u> CRITICALITY <u>2/IR</u>	SHUTTLE CCIV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u> DWG NO. <u>2294819-506, 508/ 2294821-503</u> SHEET <u>80</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CLA does not respond to any command via the A7 panel on the uplink</p> <p><b>IVC</b></p> <p><b>A1</b> Command Detector. Sync Stripper. Clock Divider Chain. Sync Generator. 2294800-504</p> <p><b>A2</b> Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-503</p> <p><b>A4</b> Sync/FMD Rcvr. 2294884-501</p> <p><b>A5</b> Automatic Light Control. 2294883-505</p> <p><b>A6</b> Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p><b>A7</b> DC-DC Converter Primary Oscillator/Driver. 2294886-503</p> <p><b>A11</b> Master Oscillator 2295527-1</p>	<p>(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PTU.</p> <p><b>Worst Case:</b> Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.</p>	<p><b>FAILURE HISTORY</b></p> <p><b>IDR - A3939 - Log #0954 - IVC S/N 031-506</b></p> <p><b>Description:</b> Flight failure, Spacecraft Level SIS-14 Problem report PV6-004037 No video output</p> <p><b>Cause:</b> Defective Relay K-1 on the A6 Board.</p> <p><b>Corrective Action:</b> Cause due to a foreign conductive particle temporarily lodged between relay leads and board P.C. traces. Relay K-1 sent to product assurance lab for analysis, report #A3909. Numerous discrepancies were found, none of which were critical.</p> <p><b>IDR - B-3523 - Log #1165 - TVC S/N 038-508</b></p> <p><b>Description:</b> Acceptance test failure Box Level Thermal Vac - Hot Environment Excessive supply current, lost all DIR/camera lights and output video information.</p> <p><b>Cause:</b> Shorted capacitor C14 on A6 board.</p> <p><b>Corrective Action:</b> C14 removed and replaced with new capacitor. Product assurance lab could not find a cause for shorted cap. (Report # B5321A) Considered random failure.</p>

FMCA NO. <u>4.2.5</u> CRITICALITY <u>2/1R</u>	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT <u>TVC/CLA</u> DWG NO. <u>2294819-506, 508/ 2294821-503</u> SHEET <u>9</u> OF <u>9</u>
FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
<p>TVC/CLA does not respond to any command via the A7 panel on the uplink</p> <p><u>IVC</u></p> <p><u>A1</u> Command Detector. Sync Stripper. Clock Divider Chain. Sync generator. 2294800-504</p> <p><u>A2</u> Command Decode Logic. Command Execution Logic. Camera Timing Logic. 2294881-501</p> <p><u>A3</u> Syn/CMD Rcvr. 2294884-503</p> <p><u>A4</u> Automatic Light Control. 2294883-505</p> <p><u>A5</u> Power On/Off Switching. Input Voltage Preregulator. Output Voltage Regulators.</p> <p><u>A7</u> DC-DC Converter Primary Oscillator/Driver. 2294886-501</p> <p><u>A13</u> Master Oscillator 2295527-1</p>	<p>(1) No Pan Tilt Motion (2) No Lens Motion, i.e., focus, zoom, iris. (3) Loss of high or low rate of travel for PTU.</p> <p><u>Worst Case:</u> Unable to command PTU motion. Loss of elbow PTU control prevents stowing the RMS.</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>