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DETAILED DESIGN PACKAGE

FOR

DESIGN OF A VIDEO SYSTEM PROVIDING OPTIMAL VISUAL INFORMATION FOR CONTROLLING PAYLOAD AND EXPERIMENT OPERATIONS WITH TELEVISION

(NASA-CR-147778) DETAILED DESIGN PACKAGE FOR DESIGN OF A VIDEO SYSTEM PROVIDING OPTIMAL VISUAL INFORMATION FOR CONTROLLING PAYLOAD AND EXPERIMENT OPERATIONS WITH TELEVISION (RCA Corp., Princeton, N.J.)

Prepared For:
NASA
JOHNSON SPACE CENTER
Houston, Texas

Submitted By:
RCA
ASTRO-ELECTRONICS DIVISION
PRINCETON, N. J.

Contract No. NAS 9-14266
June 30, 1975
DETAILED DESIGN PACKAGE

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Princeton, N. J.

Contract No. NAS 9-14266
June 30, 1975
This Design Package is submitted in accordance with Item 7 of the Data Requirement list of JSC contract NAS 9-14266 by the RCA Astro-Electronics Division (AED). The material contains documentation for the breadboard equipment both as configured for the simulation testing and for the delivered complement. The block diagrams and specification of the recommended system are also provided.
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I. INTRODUCTION AND SUMMARY

The detailed description of the effort performed under contract NAS 9-14266 is contained in two technical reports delivered at the Preliminary Design Review (PDR) and Critical Design Review (CDR), First and Second Engineering Design Reports respectively, and in the Final Report submitted jointly with this design package.

The material contained in the four subsequent sections of this package contains system descriptions, design data, and specifications for the recommended 2-view system. Section II contains diagrams relating to the simulation test configuration of the 2-view system. System III contains descriptions and drawings of the deliverable breadboard equipment. A description of the recommended system is contained in Section IV with equipment specifications in Section V.
II. SIMULATION TEST SET-UP

The simulation test arrangement is shown in Figure II-1. The operator test set-up, located to the right of the curtain partition, is shown in Figure II-2, where the two 17 inch monitors are used for viewing. (The deliverable equipment will consist of two 9 inch monitors, rack mounted.)

The camera, simulation apparatus, and control rack is located on the opposite side of the partition. Photographs of the simulator apparatus are shown in Figure II-3. Figure II-4 contains photographs of the control rack and TV cameras used to provide the two views of the scene. For convenience in test sequencing the color camera (with chrominance off) was used to provide the second view. The interconnection arrangement for the 2-view system is contained in the block diagram of Figure II-5. Note that a second control panel is included to permit repositioning of the test piece during testing. This panel is visible below the frame in the upper photograph of Figure II-3.
Figure II-1. Simulation Test Arrangement

Scale: 3/16 in = 1 FT.
Figure II-2. Operator Test Set-Up
Figure II-3. Simulator Apparatus
NOTES
1. CHROMA SWITCHED OFF ON TK44A CONTROL PANEL
2. ALL TERMINATIONS - 75 OHMS
3. N.T.S.C. INPUTS USED ON COLOR MONITORS, PICTURE SELECT SWITCHED TO 'MONOCROME' OPERATION
4. % DENOTES NON DELIVERABLE HARDWARE - RCA CAPITAL EQUIPMENT

TEST DIRECTOR
CONTROL CONSOLE

ORIGINAL PAGE IS OF POOR QUALITY
Figure II-5. Block Diagram, Two-View System
III. DELIVERABLE EQUIPMENT

The deliverable 2-view breadboard system is shown in functional form in Figure III-1. The major elements consist of the simulation apparatus, the TV cameras, and the control rack.

The simulator apparatus, designed and constructed by AED, is documented mechanically by the engineering sketches listed in Table III-1. Copies of all mechanical sketches are contained in Appendix A. The equipment is self-contained with the exception of six power supplies required to operate the control electronics and motors. These supplies are not included in the list of deliverable items (see Table III-2 for characteristics).

Electrical documentation for the simulator apparatus is listed in Table III-3. Engineering sketches generated by AED are contained in Appendix B; instruction sheets as available will be delivered separately.

Documentation for the deliverable control rack and camera equipments are listed in Table III-4. Engineering sketches listed in the table are contained in Appendix C. Vendor supplied items are described in instruction sheets or operations manuals and will be supplied in a separate package.

Camera and lens instruction manuals are vendor supplied items and will be supplied separately. Interconnection wiring for these items are contained in the rack interconnection diagram.
TABLE III-1. SIMULATOR APPARATUS SKETCHES - MECHANICAL

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Figure III-1. Breadboard Equipment Arrangement
IV. RECOMMENDED EQUIPMENT

The recommended equipment complement, termed a 2-view system, is shown in block form in Figure IV-1. The system is configured assuming a single operations location, and may be expanded to include several locations. For additional locations, one or more additional cameras allowing direct line of sight by 2 cameras offset, in general, by 75 to 90 degrees is assumed.

The cameras will be equipped with zoom lenses with sufficient range to provide an overall perspective of the work area at the short focal length extreme and adequate detail at the long focal length extreme. Detail will generally be adequate when the smallest element of interest is represented by about 3-to-5 picture elements. Travel time between the two extremes should be short so that perspective information is retained by the operator after the close-up view is available.

Iris and focus lens controls are available and, as for the zoom, will be adjustable from the operator control station. Generally, scene illumination should be such that the iris is several f-stops down from maximum to provide good depth of field. Focus adjustment will not be critical, then, and repeated tweaking will not be required.

Changes in light level will be accommodated by the camera with automatic adjustment of the ALC function. Depending on the scene, this function may be operated in the peak mode, to prevent highlight overload, or in the average mode, to permit better visibility of the darker portions of the scene.

Gamma correction is also incorporated in the video channel to improve visibility of darker areas of the scene. This type of circuitry "stretches" blacks and emphasizes noise so that high quality pre-amplifiers are required.
The cameras are mounted on pan/tilt units to permit pointing at the work volume and framing of the area(s) of interest on close-ups. Rates of motion are variable to permit rapid adjustment and accurate settings where alignment aids are used.

All remote adjustments are made by the operator at a control panel. Control signals issued by the operator are encoded and multiplexed with master sync signals in the controller electronics. These are fed to the cameras via a video coax line (one line per camera) where they are separated and decoded for implementation of the control information.

The video signal from the camera is fed via coax line to the processor unit. The processor incorporates the functions of line equalization, video switching and routing, and distribution amplification. In general, a multiplicity of cameras will be used 2 at a time with the appropriate video selected and routed to either of the two monitors.

The monitors are mounted in front of the operator at a distance permitting visual observation with no less than 2 minutes of arc per picture element. At a viewing distance of 20 inches, a 9-inch monitor is employed. Adjustable brightness to at least 100 foot-lamberts is provided, with spot size no larger than 0.7 of the scan line pitch to provide essentially full reproduction of the video signal.

The following section contains the specifications for equipment providing the required characteristics.
Figure IV-1. Two-View System Functional Block Diagram
V. EQUIPMENT SPECIFICATION

SPECIFICATION

FOR

A TELEVISION SYSTEM FOR CONTROLLING PAYLOAD AND EXPERIMENT OPERATIONS
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V. EQUIPMENT SPECIFICATION

1. SCOPE

This Specification is intended to define the characteristics of the TV system recommended for spacecraft use to control payloads and experiments. The specified two-view monochrome system was selected as a result of analyses, tests, and trade-off studies. The specification deals with the major elements of the equipment, including physical characteristics and major electrical interface requirements.

2. GENERAL REQUIREMENTS

The two-view system is intended to provide television coverage of remote operations. Therefore, the equipment shown in block form in Figure IV-1 is divided into local and remote segments. The cameras and pan/tilt units are remote from the operator controlling the operation, while the monitors, control unit and processor are located in the immediate vicinity of the operator. While the general installation may consist of two or more two-view camera set-ups, it is assumed that only the control unit and processing complexity would be affected, and the specified characteristics of this document would be largely unaffected.

3. TV CAMERA

3.1 General. The camera consists of a sensor assembly and a zoom lens, attachable without disassembly of the sensor assembly. The lens contains motors and drive provisions to permit adjustment of focal length (zoom), iris, and focus. The sensor assembly consists of the light sensitive device together with scanning, signal amplifying and processing circuitry; synchronizing, timing, and decoding circuitry; and power supply and conditioning circuits.
3.2 Physical Requirements

3.2.1 Mechanical. The camera, excluding lens, shall occupy a volume no larger than 5 x 7 x 13 inches and shall weigh a maximum of 11 pounds. The lens shall be attachable via a standard "C" mount arrangement; a single electrical connector shall be employed for lens adjust motor drives. The nominal zoom lens is estimated to add no more than 3 pounds and 5 inches to the 13-inch long sensor assembly.

3.2.2 Optical. The zoom lens shall have a focal length range of from 15-to-150 millimeters corresponding to an angular width-of-view of 46-to-4.8 degrees. The open iris lens relative aperture shall be f/2.5 or smaller. A minimum aperture range of 30-to-1 shall be obtainable via the iris adjustment.

3.2.3 Modularity. The camera shall be designed with a high degree of modularity to permit replacement of elements with a minimum of set-up and adjustment. The lens assembly in particular shall be replaceable from the exterior of the camera case and will require no adjustment, other than focus, to achieve normal operation.

3.3 Functional Requirements

3.3.1 Scan

3.3.1.1 Direction. The camera scan will be in a direction such that the scene will be readout top-to-bottom and left-to-right as the scene is viewed.

3.3.1.2 Scan Line Rate. The scan rate (horizontal rate) will be nominally 15,734 scan lines per second. Phase and frequency lock to the externally provided sync signal will be maintained.
3.3.1.3 Field Scan Rate. The field scan rate (vertical rate) will be 1/262.5 of the horizontal rate or about 59.94 fields per second. Phase and frequency lock to the externally provided sync signal will be maintained.

3.3.1.4 Scan Lines. There will be 262.5 scan lines per field resulting in 525 interlaced scan lines per frame, with a frame defined as two successive fields.

3.3.1.5 Aspect Ratio. The total area occupied by the picture will consist of four units of horizontal dimension and three units of vertical dimension, an aspect ratio of 4:3.

3.3.1.6 Scan Rate Tolerance. Refer to Federal Communications Commission standards for synchronization.

3.3.1.7 Blanking Intervals. Refer to waveforms in reference 3.3.1.6.

3.3.2 Camera Video Output

3.3.2.1 Polarity. The video polarity, defined as the potential of a black area of a scene relative to a white area, shall be black negative.

3.3.2.2 Impedance. The standard load impedance on the single-ended video line shall be a nominal 75 ohms. The output impedance of the video line shall be constant to within ±5 percent over the useful video band.

3.3.2.3 Composite Signal. The composite video is the signal resulting from the combination of video and synchronizing (sync) signals. (The location of the combining of the sync to the video signal, internal to the camera or in the processing equipment,
is not constrained by the camera operation. The description of the video level is given with the presumption that the signal is composite at the camera output.)

3.3.2.4 Levels. The blanked picture signal with setup, as measured from blanking-to-peak-white across the standard load impedance, shall be 0.714 ±0.1 volt (100 IRE units). The sync signal shall be 0.286 ±0.05 volt (40 IRE units). The standard setup is 7.5 ±5 IRE units. The composite signal, then, is nominally 140 IRE units from sync-tip to peak-white. (See document 58 IRE 23.51 for method of measurement.)

3.3.3 Controls

3.3.3.1 Camera Identification. The camera identification and control information will be fed to all cameras on the sync line. The camera controls will operate only when the particular camera is addressed. The particular camera code number will be established prior to installation, and after removal may be changed by simple adjustment such as via plug-in board replacement or switch setting.

3.3.3.2 Power. The camera power control ON signal will result in the application of power to the camera (tentatively established as +24 to +33 volts dc). The power OFF signal will result in the removal of dc power and turn the camera off.

3.3.3.3 Automatic Light Control. Three-position control is required. The camera modes resulting from the three-position signal are ALC peak-Mode, ALC Average-Mode, and ALC Disable. The third control signal shall result in disabling the ALC feedback loop and allowing the sensor to operate with maximum sensitivity for any input light level.
3.3.3.4 Focus. Lens focus will be accomplished via this control. The control information will result in the lens focus motor rotating to accomplish a closer or farther focus position of the lens. The rate of focus adjustment will permit complete travel in 20 seconds.

3.3.3.5 Iris. Lens iris adjustment will be accomplished via this control. The control information will result in the lens iris motor rotating to open or close the iris in response to the control information. The rate of iris adjustment will permit complete travel in 10 seconds.

3.3.3.6 Zoom. Lens field-of-view adjustment will be accomplished via this variable rate control. The control information will result in the zoom motor rotating to shorten or lengthen the lens focal length, at rates sufficient to encompass the complete zoom range in from 3-to-15 seconds.

3.3.3.7 Azimuth. This control information will be decoded by the particular camera being addressed and fed to the corresponding azimuth/elevation drive mechanism. The decoded information will contain direction (left or right) and rate information. Power for the azimuth drive circuitry (external to the camera) will be derived from, or controlled by, the camera circuitry and applied in response to the camera ON/OFF control signal.

3.3.3.8 Elevation. This control information will be decoded by the particular camera being addressed and fed to the corresponding azimuth/elevation drive mechanism. The decoded information will contain direction (up or down) and rate information. Power for the elevation drive circuitry, which is external to the camera, will be derived from, or controlled by, the camera circuitry and applied in response to the camera ON/OFF control signal.
3.3.3.9 **Spares.** Three additional control functions are assumed but not yet defined. These may include, for example, test signal ON/OFF or heater power ON/OFF. It is assumed that these signals are bi-level in nature.

3.4 **Performance**

3.4.1 **Sensitivity.** The camera shall be capable of providing an output video signal-to-noise ratio (SNR) of 35 dB when the camera is viewing a scene containing a highlight of 1.0 foot-lamberts. The SNR is defined as the ratio of peak-to-peak signal to rms noise within a 2 MHz bandwidth. For purposes of this measurement, the rms noise may be considered as 1/6 of the peak-to-peak noise. The observation/measurement of noise may exclude any coherent noise in the signal. Aperture compensation required to meet any of the following performance specifications shall be operative for confirming measurements of this and the following performance elements.

3.4.2 **Operating Light Range.** The camera must be capable of operating over a total scene highlight brightness range of 1.0 to 10,000 foot-lamberts. The SNR shall be at least 35 dB over this range.

3.4.3 **Automatic Light Control (ALC).** ALC circuitry shall be incorporated to permit operation over a 1000:1 range of scene illumination. When operative, the circuitry will function on average scene brightness or in a peak mode (5 percent, or more, field-of-view for peak scene brightness).

3.4.4 **Iris Range.** The operating range of the iris shall provide a light range of 900:1. A range of f/2.2 to f/66 may be considered typical.
3.4.5 **Dynamic Range.** With the ALC in peak mode and the camera viewing a static scene, the camera shall be capable of providing an output signal, black-to-white, which encompasses a 32-to-1 range of scene brightness (11 EIA logarithmic shades of gray).

3.4.6 **Signal-to-Noise Ratio (SNR)**

3.4.6.1 **Non-Coherent Noise.** The output snr shall be at least 35 dB for a 2 MHz bandwidth over the operating light range, exclusive of any coherent noise components in the signal.

3.4.6.2 **Coherent Noise.** The ratio of peak-to-peak output signal to peak-to-peak coherent noise in a 2 MHz bandwidth shall be at least 1000. (Compliance may be considered adequate if the noise is not perceptible in a normally adjusted monitor picture.)

3.4.7 **Resolution**

3.4.7.1 **Center Resolution.** The horizontal resolution shall be at least 80 percent at 200 TV lines. (The central vertical stripes on a RETMA chart may be used for the measurement.) The limiting resolution as viewed on a monitor display of a RETMA chart shall be 350 TV lines per picture height for the center horizontal and vertical wedges.

3.4.7.2 **Edge Resolution.** Numerical values shall be 80 percent of the requirements for center resolution. Response at 200 TV lines on the corner wedges shall be 65% and limiting resolution shall be 280 lines per picture height.

3.4.8 **Geometric Distortion.** The displacement of any element in a center, 80% ellipse, shall be no more than 3% of picture height, and no more than 5% for the remaining area. (A design objective shall be less than 2% distortion for the entire raster.)
3.4.9 **Shading.** Black or white shading shall not exceed 10% within the 80% ellipse and shall not exceed 20% for the remainder of the raster. Shading is defined as a percentage of the video signal in the center of the picture for a 300 nanoampere output excursion. The measurement may be made neglecting, or subtracting, the effects of lens produced shading components.

3.4.10 **Power Consumption.** The TV camera shall require no more than 15 watts for operation at +28 volts.

3.5 **Environmental**

3.5.1 **Temperature.** Environmental temperature conditions are not specified. However, it is assumed, however, that an extreme temperature range may be encountered and that heaters and/or coolers may be required to maintain a safe operating temperature range.

3.5.2 **Operating Pressure.** It must be assumed, for camera design and modularization, that for some remote operations, critical pressure will be experienced. Potting materials and interconnection should be designed for operation in any environmental pressure. Approximately normal atmospheric gas content should be assumed.

3.5.3 **Vibration, Shock and Acceleration.** Vibration, shock, and acceleration should tentatively be based on worst case Apollo-camera test values, see RCA Dwg. No. PS-2260580.

3.5.4 **Sun Exposure.** Inadvertent imaging of the sun may occur. The camera performance should recover within one minute following a maximum 30 seconds exposure to the sun, and undegraded performance should then be available.
4. PAN/TILT UNIT

4.1 General. The pan/tilt unit is a remotely controlled azimuth/elevation mount for the TV camera that permits control of camera pointing angle from a remote location. The pan/tilt unit electronics will receive power via the command decode circuitry in the TV camera. The camera will also provide decoded azimuth and elevation signals to the pan/tilt unit.

4.2 Physical Requirements

4.2.1 Mechanical. The form factor of the pan/tilt unit may depend on the available spacecraft volume. A realistic maximum volume of 960 cubic inches is specified as being representative of a typical installation for a form factor of 12-by-10-by-8 inches. The unit weight shall not exceed 10 pounds.

While in orbit maintenance or replacement of a TV camera is not a planned operation, the camera-to-pan/tilt unit interface shall be of simplified design to permit emergency replacement. The camera attachment mechanism shall permit replacement with no more than a single special purpose tool.

4.3 Functional Requirements

4.3.1 Coverage. The pan/tilt unit will be capable of travel adequate to permit camera pointing which will encompass the complete volume for the planned operation or experiment. Limit switches will be employed to restrict the travel to the desired range of elevation and azimuth.

4.3.2 Rates. The typical remote operation will require variable rate operation of the pan/tilt unit. This function may be met with a continuously variable or a series of discrete step rate increments. A range of 5-to-1 in rates is required.
4.3.3 **Interference.** The pan/tilt unit shall generate no radiated or conducted interference that will be visible in the TV picture.

4.3.4 **Drive Quality.** Motion shall be smooth and free from apparent jerkiness as judged by viewing a TV monitor during system test.

4.4 **Performance**

4.4.1 **Azimuth Range.** In response to pan signals with the limit switches adjusted for maximum range, the azimuth angle will be adjustable to $\pm 170^\circ$ from the nominal center (zero) position.

4.4.2 **Elevation Range.** In response to tilt signals with the limit switches adjusted for maximum range, the elevation angle will be adjustable from 60 degrees below-to-90 degrees above the horizontal (zero) position.

4.4.3 **Rates.** Rates of motion for both pan and tilt shall encompass a range of from 2-to-10 degrees per second. If discrete increments are employed to obtain this range, nominal rates shall be 2, 3, 4.5, 6.7, and 10 degrees per second.

4.4.4 **Power.** The pan/tilt unit shall consume no more than 10 watts when the motors are stationary. An additional 5 watts, maximum, may be consumed for a motor drive when a pointing adjustment is being made.

4.5 **Environmental.** The conditions specified in Paragraph 3.5 are applicable to the pan/tilt unit.
5. TV MONITOR

5.1 General. The TV monitor is the functional unit providing the visual display of the remote operation to the monitor. As such it provides the visual interface between the operator and the scene. Therefore, primary emphasis must be given to observer field-of-view, brightness and contrast range. It is assumed for the following paragraphs that the observer viewing distance is in the range of 15-to-30 inches, with a 20 inch nominal distance, and that surround illumination is low, or controllable to a maximum of 25 percent of monitor brightness.

5.2 Physical Requirements

5.2.1 Mechanical. The weight of the TV monitor shall not exceed 15 pounds. The form factor of the monitor will be approximately rectangular in the horizontal and vertical planes and will be contained within a volume of 8-by-8-by-13 inches (width-by-height-by-depth).

5.2.2 Electrical. The monitor will employ an eight inch diagonal, rectangular kinescope with P4 phosphor. The nominal picture format will be 4.8-by-6.4 inches. Normal operation of the monitor will be obtained with a power source of 28 volts, ±10 percent.

5.3 Functional Requirements

5.3.1 Synchronization. The monitor must be capable of precise lock to the synchronization signal. Two switchable operational modes are required. The primary mode will employ a separate 75 ohm coax feed line carrying a composite sync signal to permit monitor phase and frequency lock to the TV signal. The alternate mode requires stripping of the sync signal from the composite video line to effect the same result.
5.3.2 Controls. In addition to the sync mode selector described above, operator accessible controls will include brightness, contrast, and power.

5.3.3 Video. The monitor will be designed to receive the video signal from a 75 ohm coaxial line. The monitor shall provide a 75 ohm termination to the video line. Normal video level on the terminated line is 140 units of composite signal.

5.4 Performance

5.4.1 Brightness. The monitor with implosion shield and any external front surface filter shall provide a highlight brightness of no less than 100 foot-lamberts, termed reference brightness. The brightness level control shall provide an adjustment range of no less than 20-to-1.

5.4.2 Contrast Ratio. The monitor shall provide a contrast ratio of 10-to-1, minimum, at reference highlight brightness with an incident surround light level of 25 foot-candles. The contrast control shall have a minimum range of 20-to-1. At reference highlight, with low surround lighting, the monitor shall be capable of displaying a contrast ratio of 50-to-1 minimum.

5.4.3 Resolution. The horizontal MTF, without aperture compensation, shall be a minimum of 0.8 at a packing density of 75 TV lines per inch. Vertical resolution shall be the same as horizontal (circular spot cross section) except as modified by the scan line process.

5.4.4 Picture Quality. No low frequency streaking shall be observable for a 100 percent video step. Ringing, undershoot or overshoot, shall not be discernible at transitions equivalent to full amplitude at the system resolution of 360 TV lines.
per picture height. With a blank raster spurious background patterns shall be less than 0.05 of reference brightness.

5.4.5 Geometry. Non-linearities in horizontal or vertical directions shall be less than 2 percent of the format.

5.4.6 Video Channel. In addition to the requirements imposed by the previous performance paragraphs, the video channel shall be flat to within 1 dB up to 5 megahertz at any control setting and shall be capable of full kinescope drive at 30 percent video level.

5.5 Environmental

5.5.1 Temperature. The monitor shall operate within specification for an ambient of from 0-to-50 degrees Centigrade.

5.5.2 Operating Pressures. The monitor is intended for operation in a nominal pressure environment. However, exposure to vacuum for extended periods shall not result in degradation. Compliance may be demonstrated by 12 hours exposure at vacuum/temperature extremes of -10 and +60 degrees Centigrade.

5.5.3 Vibration, Shock, and Acceleration. Paragraph 3.5.3 shall apply.
6. CONTROL UNIT

6.1 General. The control unit is the functional segment of the TV system that enables operator control of the TV cameras, generates signals for routing of video information, and master synchronization of the system. Together with a companion processing unit, which it is assumed will share a mounting location, it provides all of the remaining electrical functions not contained in the cameras and monitors.

6.2 Physical Requirements

6.2.1 Mechanical. The control unit will consist of two parts, a control panel and control electronics which may be physically separated. The control panel will contain the switches and potentiometers necessary to provide control information while the control electronics will interpret, format, and encode the information.

The control panel will be contained in a volume of 300 cubic inches or less, consisting of a depth of no more than 2.5 inches and panel dimensions of approximately 10-by-12 inches. Weight shall not exceed 2 pounds.

The control electronics will be contained in a package weighing no more than 6 pounds. The volume of the package will occupy a maximum of 300 cubic inches in a form factor such as 6-by-8-by-6 inches.

6.2.2 Electrical. Normal operation of the control unit will be obtained with a 28 volt, +10 percent, power source. Power consumption will not exceed 8 watts.
6.3 **Functional Requirements**

6.3.1 **Controls and Commands.** Signals generated by activation of controls shall be divided into classes: (1) those signals causing an electronic switch to be activated and thereby affect a video routing or processing change in the processor unit, and (2) those signals which control or activate the TV cameras and their associated pan/tilt units. In the second category, with the exception of the camera power (ON/OFF), all signals will be multiplexed in a format suitable for transmission over a single 75 ohm video line and for efficient decoding at the TV camera locations.

6.3.1.1 **Power.** An individual toggle switch will be employed for each camera to apply or remove power. Power application will be effected by activating a latching relay to complete the power feed circuit to a particular camera.

6.3.1.2 **Video Select.** A separate video select pushbutton or switch closure, shall be provided to enable selection and routing of each video signal for feed to either monitor, to a particular transmitter for earth or other satellite feed, to a particular on-board video tape recorder, or any other as yet undefined equipment segment requiring video information. All video switching shall be accomplished during the vertical blanking interval.

6.3.1.3 **Gamma Correction.** The gamma correction control shall modify the transfer characteristic of the video amplifier(s) in the Processor. The range shall extend from a minimum of at least 0.5 to unity (no correction), and is either continuously variable or will have a minimum of three positions: 0.5, 0.7 and 1.0.
6.3.1.4 **Camera Identification.** A camera identification, assigned to each camera, will be selected via a control panel switch. The camera identification number will serve to activate a particular camera decode system to enable processing of commands addressed to that camera.

6.3.1.5 **Automatic Light Control (ALC).** A three position switch is required to generate the multiplexed command. The command will be issued at least twice and then be inoperative until a change is initiated. After decoding, a latching relay arrangement will establish the appropriate ALC mode: (1) peak, (2) average, or (3) out. Reissuance of the same command will not alter the operation of the camera unless a new mode is ordered.

6.3.1.6 **Focus.** Two commands are required, one to focus the camera lens closer and the other to focus farther. The control will be via a single, return-to-neutral, lever type switch. The command will be encoded and multiplexed with any other simultaneously issued commands and executed at the camera subsequent to decoding.

6.3.1.7 **Iris.** Two commands are required to open or close the iris. Paragraph 6.2.1.6 is otherwise operative.

6.3.1.8 **Zoom.** Two variable rate commands are required, one to shorten and the other to lengthen the lens focal length. Coding for a minimum of 5 rates is required and activation via a joystick control is preferred.

6.3.1.9 **Azimuth and Elevation.** A single joystick control will be employed to effect variable rate positioning of pan/tilt. The amount of joystick deflection, horizontally and vertically will generate information to be encoded and establish the rate of adjustment. The information will be decoded at
the camera location and fed to the associated pan/tilt unit for execution.

6.3.2 Synchronization. The master sync generator is located in the control unit. The composite synchronization information, horizontal and vertical, will be compatible with the requirements of Paragraph 3.3.1. The sync generator output will be time division multiplexed with the command information, with command intervals limited to normal active video time, and routed to each camera via a 75 ohm coaxial line.

6.3.3 Levels. The sync and command information will be combined to provide a normal amplitude composite signal of 140 IRE units. The sync amplitude will have the same 40 units as for the normal video lines (Paragraph 3.3.2.4) with the command information contained in the usual 100 units normally containing video.

6.4 Environmental. Paragraph 5.5 shall apply.
7. **PROCESSOR**

7.1 **General.** The Processor is the functional segment of the TV System that compensates for loss in video lines, switches and routes signals, provides controllable levels of gamma correction, and provides buffer amplification of the video signals for distribution to other locations. Together with the companion Control Unit it provides all of the electrical functions not contained within the cameras and monitors.

7.2 **Physical Requirements**

7.2.1 **Mechanical.** The Processor will consist of an electronics box with connectors for power feed and incoming control/command and video signals, and outgoing video signals. The box will be nominally rectangular in cross-section and have a volume of 250 cubic inches, or less, in a form factor such as 6-by-8-by-5.2 inches. The weight of the box shall not exceed 5 pounds.

7.2.2 **Electrical.** Normal operation of the Processor will be obtained with a 28 volt, ±10 percent, power source. Power consumption will not exceed 5 watts.

7.3 **Functional Requirements**

7.3.1 **Line Equalization.** Termination of each video line (signal) at the processor input shall be provided. Buffer amplification and signal equalization shall be incorporated to normalize the signal amplitude and compensate for any frequency dependent roll-off.
7.3.2 **Switching.** Switching of any video line shall be accomplished in response to a select signal fed from the Control Unit. Switching capability shall permit routing of each video signal to either monitor, to an associated tape recorder, to any operational transmitters, or any undefined equipment segment requiring video information. Interruption and re-routing of a video signal shall take place during the vertical blanking interval.

7.3.3 **Gamma Correction.** The transfer characteristic (gamma) of the video amplifier shall be adjustable in response to operator initiated adjustments. The correction circuitry shall also function to maintain constant amplitude for a video signal extending from black-to-peak white.

7.3.4 **Distribution Amplifiers.** Buffer amplifiers shall be included in the Processor, for each output video line. These amplifiers shall provide 75 ohms sending end impedances for each output signal to be distributed external to the Processor. Each amplifier shall be designed so that a short on one, or more, of the lines shall not affect the remaining amplifiers.

7.4 **Performance.**

7.4.1 **Frequency Response.** The frequency response from a camera output (input to the camera coax line) to the output of the processor shall be flat within $\pm 0.5$ dB to 3.5 MHz and $\pm 1.0$ dB to 5 MHz. Measurements shall normally be made with the gamma control set to unity.

7.4.2 **Waveform Distortion.** Waveform testing and bar (half line and half field) shall be used to establish waveform response from the camera output to the Processor output. Measurements with a $2T$ pulse shall result in an amplitude difference no larger than 1 percent of the half line pulse. Distortion of the
half line bar shall similarly not exceed 1%, overshoot or undershoot, of nominal amplitude.

Distortion of the half field bar shall be no greater than 2 percent. That is flatness shall be adequate to maintain amplitude at leading or trailing edge of the bar to within 2 percent of the center-of-bar value.

7.4.3 Gain. The nominal low frequency gain of the video channel shall be unity, ±0.5 dB, as measured from the camera output to the Processor output. This response shall include the coax cable, line equalizer, gamma, and distribution amplifier elements of the channel. Measurements shall be made with a composite signal containing a full black-to-white transition. Gain shall be maintained for any value of gamma from unity to the lower limit.

7.4.4 Signal-to-Noise Ratio. The signal-to-noise ratio of the video channel (camera output to Processor output) shall be no less than 50 dB, peak-to-peak signal-to-rms noise. Gamma shall be set to unity for this measurement.
APPENDIX A

SIMULATOR MECHANICAL SKETCHES
NOTES:
1. OUTSIDE TYPICAL, ALL ANGLE ITEMS BOLTED.
2. SEATING AREA OF ITEMS 1 & 2 TO BE ENTIRELY FREE OF HIELD MATERIAL, MOIST SPOTTER, ETC.
3. APPLY ITEMS 3, 7 FROM TIGHT 316 SS, HEADING OPERATIONS, & BEFORE TIGHT COATING.
4. APPLY ITEM 3 (COMPRESS, PLAIN BLOCK) AFTER ASSEMBLY.
5. ASSEMBLY MUST NEVER BE SUBJECTED TO FIELD BEND, BOLT HEADS WOULD BE DAMAGED.

(cont'd)
6. UNIT TO BE SUPPLIED WITH EX/ADDITIONAL ITEMS 6 & 7. PIECES TO BE 50# Cs. STAINLESS STEEL, C36000.
7. FIELD RIGGING, SHEET 2, TYP: (M & F) PIERCES TO BE FINISHED SEE ITEM 17 WHEN TIGHTENED.
8. MOUNTING BOLT (11) 1/2-13, 3/4 INCH, 1/4 IN 7-1/2 INCH, (5) ITEMS 6 & 7.
9. (2) SETS/24#.
10. ALL ANGLES ABOVE ARE KNOWN AS ITEM 19.)
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**DIMENSIONS AND TOLERANCES**

**MATERIAL:**

**ALUM ALLOY CHANNEL 6063-T5**

2.00 X 1.00 X 1.25 (2010769-968)

**SKETCH**

**RCA COMMODITY CODE**

**RADIO CORPORATION OF AMERICA**

**ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT**

**DRAWN BY**

**Y. H.**

**DESIGN ACTIVITY APPE**

**R. STRUCKLAND**

**SCALE**

**49671**

**49671**

**SK-2273452**

**FIRST APPLICATION**

**NEXT ASSY USED ON**

**ANGULAR DIMENSIONS ± 1/2"**

**MATERIAL: SEE TABLE**

**RCA COMMODITY CODE**

**RADIO CORPORATION OF AMERICA**

**ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT**

**DRAWN BY**

**Y. H.**

**DESIGN ACTIVITY APPE**

**R. STRUCKLAND**

**SCALE**

**49671**

**49671**

**SK-2273452**

**FIRST APPLICATION**

**NEXT ASSY USED ON**

**ANGULAR DIMENSIONS ± 1/2"**

**MATERIAL: SEE TABLE**
Heli-Coil Insert MS 21209-F1-20

Block Assembly: Scale 1:1
Material: Alum Bar 1.50 x 1.50
Finish: Chemical treatment for Alum & Alum Alloys 1980135-2

Flanged Block Assy Scale 1:1
Material: Alum Alloy Plate 6061-T4
Finish: Chemical treatment for Alum & Alum Alloys 1980135-2

Bear Housing Assy Scale 2:1

Unless otherwise specified, the surface finish of machined parts shall not exceed a maximum reading 10/6 per ANSI and ISO 160.1—1962

Interpret dimensions and tolerances per ANSI Y14.5-66

RCA Commodity Code

Design Activity: D 49671 SK 2288013
MOTOR & BEARING SUPPORT

SCALE: 1:2

MATERIAL: ALUM ALLOY 6061-T6
.500 THK 2010590-993
FINISH: CHEMICAL TREATMENT FOR
ALUM & ALUM ALLOYS
1980136-2

CUT LAST TWO THREADS TO THE
MINOR DIA.

IDLER SHAFT

MATERIAL: STN STL 1.00 HEX BAR TYP 303
2010521-304
FINISH: PASSIVATING DIP FOR STN STL
1980032-1

ORIGINALLY PAGE IS
OF POOR QUALITY
MATERIAL: ALUM ALLOY 6063-T5
1.50 X 0.50 X 1.25 ANGLE 2010769-

THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9
SECURITY CLASSIFICATION
UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINE PARTS SHALL NOT EXCEED A MAX READING OF .025 PER MIL-STD-10
DIMENSIONS AND TOLERANCES PER MIL-STD-8
RCA COMMODITY CODE

CONTRACT NO. NAS8-19246
SHOP ORDER NO. FEG000
DRAWN BY JAMMEDRINE
DESIGN ACTIVITY APPD STICKLAND

ANGLE STRUT

RCA CORPORATION OF AMERICA
NEW YORK, N.Y.
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT

AED 739-1 3/66

AED 27273451
<table>
<thead>
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<th>FINISH</th>
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<td>AL-ALY 2024-T4 .500 HEX ROD *</td>
<td>750 HEX ROD</td>
<td>2010637 - 288</td>
<td>- 296</td>
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<td>2</td>
<td>HELICOIL INSERT, 10 - 32 X 2D</td>
<td>.375 - 24 X 1% D</td>
<td>MS21207F1-20</td>
<td>- FG-15</td>
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<td>SPEC., MFG., HELICOIL INSERT</td>
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<td>4</td>
<td>WORKMANSCHIP, 503002X</td>
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NOTES:
1. Produce as matched set/length, ± .001.

SKETCH
**SKETCH**

**DIMENSIONS AND TOLERANCES**

- **Basic Dimensions:** [Dimensions details are not legible]
- **Tolerances:** [Tolerances details are not legible]

**MATERIAL:**

- **STN 8TL BHR .500 DIN**
- **2010 STN-60**

**RCA COMMODITY CODE:**

- **First Application**
- **Used On Next Assy**

**CONTRACT NO.:**

- **M859-14266**
- **F16000**

**DRAWN BY:**

- **J. ZEMANDLAK**

**DATE:**

- **6-24-72**

**ASSY USED ON:**

- **2010**

**REVISIONS:**

- **HNBK H28 AND MIL-STD-9**

**FINISH:**

- **UNLESS OTHERWISE SPECIFIED**

**SPECIFICATION:**

- **UNLESS OTHERWISE SPECIFIED**

**DESCRIPTION:**

- **OF POOR QUALITY**

**SPECIFICATION TABLE**

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**MIN**

| 1.000 | .002 | .505 |

**TYP**

| 1.10 | 2.500 | 3.000 DIH |

**NYLON**

**SKETCH**

**THD DATA TO BE INTERPRETED USING HNDbk HSB AND MIL-STD-9**

**SECURITY CLASSIFICATION**

**UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINE PARTS SHALL NOT EXCEED A MAX. READING OF 1.0 Per MIL-STD-10**

**DIMENSIONS AND TOLERANCES PER MIL-STD-8**

**CONTRACT NO.**

<table>
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**RADIO CORPORATION OF AMERICA**

**NEW YORK, N.Y.**

**ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT**

**DRAWN BY**

**IDLER WHEEL**

**ID**

**CODE IDENT NO.**

| B | 49671 | SK273455 |

**SCALE**

| SHEET | 10F1 |

**RCA COMMODITY CODE**

<p>| RCA 739-1 3/69. |</p>
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<tr>
<td>1</td>
<td>AL ALY 2024-T4. BAR X 3.000 DIA</td>
<td>QQ-A-225/6C</td>
<td>2021031</td>
<td>SEE NOTES 1-3</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>MEDIUM HARD URETHANE (60A)</td>
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NOTES:
1. PREPARE (URETHANE) MATL. PER SPEC., PARA. 3.2.2.
2. PREPARE SUBSTRATE PER SPEC., PARA. 3.2.1.
3. BOND PER SPEC., PARA. 3.2.3., USING PRIMER, ADHESIVE, NOTED THEREIN.

THD DATA TO BE INTERPRETED USING HNDK H2B AND MIL-STD-9
RCA COMMODITY CODE

NOTES:
2.500 ± .0002 DIA; .500 DIA C'FORE, X .437 DEEP

SKETCH
# DASH SPECIFICATION TABLE

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<th>NO.</th>
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<td>SEE NOTES 1-3</td>
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## Diagram

1. PREPARE (URETHANE) MATL. PER SPEC, PARA. 3.3.2.
2. PREPARE SUBSTRATE PER SPEC, PARA. 3.1.2.1.
3. BOND PER SPEC, PARA. 3.1.3.3, USING PRIMER & ADHESIVE, NOTED THEREIN.

## Specifications

- .505 ± .002 Dia.
- .062 Ref.
- 2.50 Dia (1T. 2)
- .200
- .400
- .500
- .125
- Diameter 2.375 Dia.
- .505 ± .002 Dia.
- .062 Ref.
- #4 (112)-40 -3B THD: .125 W x .062 DEEP KEYWAY

## Notes

- THD DATA TO BE INTERPRETED USING HNDSK H28 AND MIL-STD-9
- SECURITY CLASSIFICATION
- UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF .125 PER MIL-STD-10
- DIMENSIONS AND TOLERANCES PER MIL-STD-8
- CONTRACT NO: NAS 9-14266
- RADIO CORP. OF AMERICA

## Sketch

**SKETCH**

**RCA COMMODITY CODE**

**NEXT ASSY USED ON**

**FIRST APPLICATION**

**DRIVE WHEEL, FREE END**

**AS STATED ON**

**FREE END**

**DESCRIPTION**

**PRODUCT DESCRIPT**

**PRESENTATION**

**MATERIAL:** SEE TABLE

**RCA DISTR**
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</table>

**SKETCH**

Material: STN: STL BAR .328 Dia
2010521-36

4- REQD.
SKETCH

1.25W x 0.0312 DP
x 6.25 LG KJY

1.138 - 32 TFD

1.220

1.220

1.138 - 32 TFD

7.50

1.000 DIA

5.005 + 0.005 DIA

-0.000

15.00"
# Rotation Drive

**List Title:** Rotation Drive

**Prepared By:**

**Date:** 10 Dec 74

**Checked By:**

**Date:**

**Design Activity Appd Date:**

**Contract No.:** NAS 9-14266

## Revisions

<table>
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<tr>
<th>LTR</th>
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<th>Approved</th>
<th>LTR</th>
<th>Description</th>
<th>Date</th>
<th>Approved</th>
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## Units of Measure (UM)

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<th>Units of Measure</th>
<th>Quantities</th>
<th>Symbol</th>
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<tbody>
<tr>
<td>A - Inches</td>
<td>X - Applicable document</td>
<td>U - Govt or customer</td>
</tr>
<tr>
<td>B - Feet</td>
<td>O - For ref only</td>
<td>G - Gallons</td>
</tr>
<tr>
<td>C - Yards</td>
<td></td>
<td>K - Govt or customer</td>
</tr>
<tr>
<td>D - Ounces</td>
<td></td>
<td>H - Box, Case</td>
</tr>
<tr>
<td>E - Pints</td>
<td></td>
<td>F - Roll</td>
</tr>
<tr>
<td>F - Quarts</td>
<td></td>
<td>P - Roll</td>
</tr>
</tbody>
</table>

**Interpret Symbols Used As Follows:**

- **A**: Inches
- **B**: Feet
- **C**: Yards
- **D**: Ounces
- **E**: Pints
- **F**: Quarts
- **G**: Gallons
- **H**: Box, Case
- **X**: Applicable document
- **U**: Govt or customer furnished
- **G**: Gallons
- **K**: Govt or customer furnished and installed
- **O**: For ref only
- **V**: Vendor item, See specification or source control drawing.
- **P**: Roll
- **R**: Box, Case
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<th>Assembly Number</th>
<th>Quantity</th>
<th>Description</th>
<th>Part Number</th>
<th>Notes</th>
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<td>PLATE, MOTOR</td>
<td>SK2288000-1</td>
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<tr>
<td>L</td>
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<td>OUTPUT</td>
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<td>L</td>
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<tr>
<td>L</td>
<td>1</td>
<td>MOUNT</td>
<td></td>
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<tr>
<td>L</td>
<td>1</td>
<td>ADAPTER</td>
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<tr>
<td>L</td>
<td>1</td>
<td>HOLDER</td>
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**Notes:***
- SK2288000-1: Plate, Motor
- SK2288000-2: Output
- SK2288000-3: Spacer
- SK2288000-4: Mount
- SK2288000-5: Adapter
- SK2288000-6: Holder
THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9

SECURITY CLASSIFICATION
UNLESS OTHERWISE SPECIFIED
THE SURF. FIN. OF MACHINED
PARTS SHALL NOT EXCEED A
MAX READING OF 15° PER
MIL-STD-10

DIMENSIONS AND TOLERANCES
PER MIL-STD-9

RCA COMMODITY CODE
NEXT ASSY
USED ON
FIRST APPLICATION

CONTRACT NO.
SHOP ORDER NO.
FE-6000

DEPARTMENT OF DEFENSE
MILITARY SPECIFICATIONS

RADIO CORPORATION OF AMERICA
NEW YORK, N.Y.
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT

Y-AXIS IDLER

DIMENSIONS AND TOLERANCES
PER MIL-STD-9

ANGULAR DIMENSIONS ± 1/2°

MATERIAL: SEE TABLE

FOR REVISIONS ONLY

DRAWN BY
DATE

CONTRACT ACTIVITY APPR
DATE

SIZE
CODE IDENT NO.
B 49671

SCALE
WEIGHT
SHEET
1 OF 1

AED 739-1 3/66

SKETCH
SKETCH

Y-AXIS CARRIAGE

DIMENSIONS AND TOLERANCES

TOLERANCES ON
- BASIC
- 2 PLACE JEEKALS
- 3 PLACE DECIMALS

UNDER 6:
- TIGHT +0.005
- ABOVE 6:
- TIGHT +0.010
- LOOSE +0.015

ANGULAR DIMENSIONS:
- 1/16

THIS DATA TO BE INTERPRETED USING NSN 750-3502 AND MIL-STD-10

SECURITY CLASSIFICATION

UNLESS OTHERWISE SPECIFIED
THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX INCHES OF 1" PER MIL-STD-10

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

CONTRACT NO.

SHOP ORDER NO.

DESIGN NO.

RADIO CORPORATION OF AMERICA
NEW YORK, N.Y.
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

Y-AXIS CARRIAGE

C 49671 SK-2282467
**TABLE OF SPECIFICATIONS**

<table>
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<tr>
<td>1</td>
<td>AL ALY 2024-T4</td>
<td>BAR</td>
<td>1000 DIA</td>
<td>QQ-A-225/6C</td>
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</table>

**DIMENSIONS AND Tolerances**

- Slip fit with .625 nom. dia hole and gear, supplied.
- Slip fit with .2500 nom. dia (pot) shaft.
- #2 (.086)-56 Thd thru 7 bore, 2 holes 90° apart (random orientation with respect to CSK holes in flge).
- .219, typ-2 flats, 90° apart.

**SKETCH**

- Pot. driver, hub-taps
- Pot. shaft, set screw flats

**RADIO CORPORATION OF AMERICA**

New York, N.Y.
Astro-Electronics Division, Princeton, N.J., Plant

**CONTRACT NO.**

NAS 9-14266

**SHOP ORDER NO.**

FEG000

**POT MOUNTING DETAILS**

**DIMENSIONS AND TOLERANCES PER MIL-STD-8**

**RCA COMMODITY CODE**

AED 729-1 3/65
O.D. = .180 (REF)
I.D. = .116

DIRECTION OF WIND: OPTIONAL.

ENDS: SQUARED & GROUND.

NO./TURNS: 6

SOLID LENGTH: .19 (REF)

FREE LENGTH: .31

RATE: 122 LBS/INCH. (REF)

LOAD @ SOLID LENGTH: 12.5 LBS (REF)
PART #1
QUAN. 1
MATT (1A) 3/4 DIA. .049 WALL THK STNSTL TUBING
(16) 32 PITCH SPUR GEAR RACK
Boston Gear No. 4-32

Note:
1. BOND RACK PT# 1B TO SHAFT PT# 1A
   WITH APPLY PRESSURE
   OVER ENTIRE LENGTH OF RACK IN ORDER
   THAT PARALLELISM IS MAINTAINED WHILE CURRING.
**PART #1**
**QUAN 2**
**MAT'L: OIOLITE BRONZE**
**BOSTON GEAR NO. CB1024**

---

**PART #2**
**QUAN 2**
**MAT'L: STN STL**

---

**PART #3**
**QUAN 4**
**MAT'L: BARDEN BR5**
**NO. 5R255**

---

**PART #4**
**QUAN 4**
**MAT'L:**

---

**RADIO CORPORATION OF AMERICA**
**ASTRO ELECTRONICS DIVISION**

**SKETCH**
**Z AXIS**
**(DETAILED PARTS)**

---

S.O. NO. 60000
CONT. NO. MA5-4268
DRAWN BY: JONES
DATE: JAN 19, 1975

---

B SK2273448
**PART #5**

**QUAN 2**

**MAT'L: .375 SQ KEY STOCK**

**PART #7**

**QUAN 2**

**MAT'L: STURDY SQUARE**

**PART #8**

**QUAN 4**

**MAT'L: STN STL**

**PART #6**

**QUAN 2**

**MAT'L: .375 SQ KEY STOCK**

**PART #4**

**MAT'L: S2 BEARING**

**PART #3**

**MAT'L: .375 SQ KEY STOCK**
### Specification Table

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#### Revisions

- **#7 Drill Thru 2-Holes**
  - 2.00
  - 1.38

- **.25 R TYP.**
  - .84
  - .31

- **44x45° Chamfer**
  - .84
  - .31

- **.62**

- **1.25-16 THD Thru**
  - 1.00 Width to Fit PT# SK2273445-1

---

**SKETCH**

**THD Data to Be Interpreted Using HNDBK H28 and MIL-STD-9**

**Security Classification**

Unless otherwise specified, the surf. fin. of machined parts shall not exceed a max reading of 125 per MIL-STD-10.

**Dimensions and Tolerances**

<table>
<thead>
<tr>
<th>Basic Dimensions</th>
<th>2 Places Tolerances</th>
<th>3 Places Tolerances</th>
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<tbody>
<tr>
<td>Up to 6</td>
<td>± .01</td>
<td>± .000</td>
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<td>Above 6 to 24</td>
<td>± .02</td>
<td>± .005</td>
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<tr>
<td>Above 24</td>
<td>± .03</td>
<td>± .015</td>
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**Angled Dimensions ± .012**

**Material:** See Table

---

**RCA Commodity Code**

**Next Assy Used On**

**First Application**

**next Application**

**Shop Order No.**

**Contract No.**

**Radio Corporation of America**

**New York, N.Y.**

**Astro-Electronics Division, Princeton, N.J., Plant**

**Ball Nut Adaptor**
<table>
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**Dash Specification Table**

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<td>1.25-16 TH'D THRU</td>
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<td>STN ST'L</td>
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</table>

**Sketch**


No. 49671

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT

Contract No. KEG000

Radio Corporation of America

New York, N.Y.

As of 13/3/66

RCA Commodities Code

Next Assy. Used On

First Application

Material: See Table

Scale: 1/2

Weight: 10

Sheet: 1 of 1

RCA D1018
NOTES
1. MATERIAL: DASH 1 & 2: ALUM ANGLE COG3-T5
   RCA 2010749-918 Q-Q A-200/9
   FINISH: CHEMICAL TREATMENT FOR ALUM AND
   ALUM ALLOYS
2. WORKMANSHIP SHALL CONFORM TO ITEM 22
3. PRIOR TO ASSEMBLE PAINT ITEM 1 (MASK ALL MTG
   HOLES, THREADS, BEARIGS), ITEM 2 (MASK ALL MTG
   HOLES & BEARING) AND ITEM 3 WITH ITEM 20.
4. AFTER ASSEMBLE PAINT REMAINING ITEMS
   EXCEPT ITEMS 5, 6, 7, 10, 11.
5. MARK WITH .12 STD CHARACTERS IN
   APPROXIMATE LOCATION "49671 ASSY
   2282450-501 PER. ITEMS, USING ITEM 25.
6. STAKE SET SCREW OF ITEM 10 & 11
   AFTER INSTALLATION WITH ITEM 23.

FOR PARTS LIST SEE PL SK2282450

Z AXIS DRIVE

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED
THE SURFACE FINISH OF
MACHINED PARTS SHALL NOT
EXCEED A MAXIMUM READING
UP TO 6 "006" X 16R 1662

TOLERANCE ON
INTERPRET Dimensions AND
TOLERANCES PER ANSI Y14.5

TYP 0-6 = .002 .003 .010
TYP 6-24 = .003 .015
TYP ABOVE 24 = .006 .020

UNLESS OTHERWISE SPECIFIED
Dimensions ARE IN INCHES AND
INCLUDE ThICKNESS OF PLATING

CONTRACT NO. 11440-6-1264

DESIGN ACTIVITY APPROVED
DATE

RCA CORPORATION - NEW YORK, N.Y.

PLANT

Z AXIS DRIVE

RCA COMMODITY CODE

SIZE CODE IDENT NO.

scale 06 weight 0

sheet 1 of 2
# UNIT OF MEASURE (UM) QUANTITIES SYMBOL

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<th>Barrels</th>
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<tr>
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<td>R</td>
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**X** - Applicable document

**U** - Govt or customer furnished

**O** - For ref only

**K** - Govt or customer furnished and installed

**V** - Vendor item. See specification or source control drawing.
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<td>16995-16</td>
<td>SCREW SOCKET HEAD</td>
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<td>4</td>
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### SKETCH

1. PREPARE (ETHANE) MATL. PER SPEC, PARA 3.3.2.
2. PREPARE SUBSTITUTE PER SPEC, PARA 3.3.2
3. BOND PER SPEC, PARA 3.2.3.3 USING PRIMER & ADHESIVE NOTED THEREIN
4. DRILL & TAP #8-32, TWO HOLES APPROXIMATELY 90° APART

**NOTES:**
- THD DATA TO BE INTERPRETED USING HNDbk H28 AND MIL-STD-9
- SECURITY CLASSIFICATION
- UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 0.005" PER MIL-STD-10
- UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
- CONTRACT NO. NAS9-14266
- SHOP ORDER NO. PAS-212.06
- DRAWN BY: Y. DIMENSIONS AND TOLERANCES PER MIL-STD-8
- MATERIAL: SEE TABLE

**SKETCH**

DRIVE WHEEL2
Y AXIS

RADIO CORPORATION OF AMERICA
NEW YORK, N.Y.
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT

**DRAWN BY:** Y. DIMENSIONS AND TOLERANCES PER MIL-STD-8

**MATERIAL:** SEE TABLE

**SHOP ORDER NO.:** PAS-212.06

**CONTRACT NO.:** NAS9-14266

**THD DATA TO BE INTERPRETED USING HNDbk H28 AND MIL-STD-9**

**RCA COMMODITY CODE:** 49671

**CODE IDENT NO.:** SK227347

**DATE:** 5/5

**DRAWN BY:** Y.

**SCALE:** 1/1

**WEIGHT:** N

**SHEET:** 1/OF1

**NOTE:** FOR REVISIONS ONLY

**NOTE:** PREPARE (ETHANE) MATL. PER SPEC, PARA 3.3.2.

**NOTE:** PREPARE SUBSTITUTE PER SPEC, PARA 3.3.2.

**NOTE:** BOND PER SPEC, PARA 3.2.3.3 USING PRIMER & ADHESIVE NOTED THEREIN.

**NOTE:** DRILL & TAP #8-32, TWO HOLES APPROXIMATELY 90° APART.
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<td>BOSTON GEAR G-182 (64T, 32 DP)</td>
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<td>2</td>
<td>BOSTON GEAR G-185 (96T, 32 DP)</td>
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**NOTES:**

THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9

THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9

SECURITY CLASSIFICATION

UNLESS OTHERWISE SPECIFIED
THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 125, PER MIL-STD-10

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

DIMENSIONS AND TOLERANCES
PER MIL-STD-9

SHOP ORDER NO.

CONTRACT NO.

RADIO CORPORATION OF AMERICA

NEW YORK, N.Y.

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J., PLANT

GEAR, MODIFIED

SKETCH

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PER MIL-STD-9

SHOP ORDER NO.

CONTRACT NO.

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NEW YORK, N.Y.

GEAR, MODIFIED

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CONTRACT NO.

RADIO CORPORATION OF AMERICA

NEW YORK, N.Y.

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NEW YORK, N.Y.

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PER MIL-STD-9

SHOP ORDER NO.

CONTRACT NO.

RADIO CORPORATION OF AMERICA

NEW YORK, N.Y.

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NEW YORK, N.Y.

GEAR, MODIFIED

SKETCH

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DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

DIMENSIONS AND TOLERANCES
PER MIL-STD-9

SHOP ORDER NO.

CONTRACT NO.

RADIO CORPORATION OF AMERICA

NEW YORK, N.Y.

RADIO CORPORATION OF AMERICA

NEW YORK, N.Y.
1. MATERIAL, ALUM ANGLE, 1.25 x 3.5 x 0.125
2. "A" & "B" HOLES MATCH DRILL IN ITEMS 1 & 2
APPENDIX B

SIMULATOR APPARATUS ELECTRICAL SKETCHES
NOTES:
1. SI, S2, S3, S4, S5, S6, S7, S8, ARE ALCO TYPE MSPN-206R WITH RS BUTTON
2. CONNECTOR PI IS CANNON TYPE DGM-25P
3. CONNECTOR P2 IS CANNON TYPE DGM-25S
4. SWITCHES SHOWN IN NORMALLY CLOSED POSITION. LAMP TERMINALS NOT USED
5. CABLE IS HEWLETT PACKARD LOW VOLTAGE COMPUTER CABLE. CABLE APPROX. 12 FT.
NOTES:  
1. ALL RESISTORS IN OHMS, 1/4 W, ± 5%  
2. ALL CAPACITORS IN MICROFARADS  
3. ALL DIODES ARE TYPE IN446  
4. U1, U2, U3, U4, U5, U6, U7, U8, ARE TYPE SN7400N  
5. U9 IS TYPE SN7400N  
6. U10 IS TYPE SN7401N  
7. U16, U15 ARE TYPE SN7424N  
8. U6, U11, U5 ARE TYPE SN74121N  
9. U8, U12, U4 ARE TYPE SN74121N  
10. K1, K3, K5, ARE LATCHING RELAYS  
TELEDYNE TYPE 422  
11. K2, K4, K6, ARE TYPE 5822IC-2  
12. ADJUST KG FOR 100MS PULSE AT PIN 1 OF UB  
13. ADJUST RS FOR 100MS PULSE AT PIN 1 OF UB  
14. ADJUST K11 FOR 100MS PULSE AT PIN 1 OF UB  
15. DIRECTION CONTROL SWITCHES PART OF SIMULATOR CONTROL SK 226270  
16. LIMIT SWITCHES PART OF SIMULATOR  

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### Revision Status

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### THD Data to Be Interpreted Using NBS HDBK H28 and MIL-STD-9

| Interpret Dimensions and Tolerances Per ANSI Y14.5-66 |

### Unless Otherwise Specified

The surface finish of machined parts shall not exceed a maximum reading of 125/PER ANSI STD B46.1 — 1962

### RCA Commodity Code:

RCA 2417-3 (4:71)

### First Application

NEXT ASSY USED ON

FIRST APPLICATION

QTY REQ'D PER DASH NO.
### MATERIALS AND SPECIFICATIONS

**UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING**

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<th>2 PLACE DECIMALS</th>
<th>3 PLACE DECIMALS</th>
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<td>BASIC DIMENSIONS</td>
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<td>UP TO 6</td>
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<tr>
<td>ABOVE 6 TO 24</td>
<td>± .03</td>
<td>± .015</td>
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<tr>
<td>ABOVE 24</td>
<td>± .06</td>
<td>± .020</td>
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**DESIGN ACTIVITY APPD DATE**

**DRAWN BY**

**CHECKED BY**

**CONTRACT NO.**

**CODE IDENT NO.**

**SIZE**

**SCALE**

**WEIGHT**

**DESCRIPTION**

**SPECIFICATION**

---

**REVISIONS**

**DESCRIPTION**

**DATE**

**APPROVED**

---

**K1, K3, K5 DETAIL**

---

**FOLDOUT FRAG**
APPENDIX C

BREADBOARD TV SYSTEM DOCUMENTATION
### REVISIONS

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**MATERIALS AND SPECIFICATIONS**

*Unless otherwise specified, the surface finish of machined parts shall not exceed a maximum reading of 1.6 per ANSI Std 846.1—1962.*

**TOLERANCES ON**

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<td>UP TO 6</td>
<td>±0.02</td>
<td>±0.010</td>
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<tr>
<td>ABOVE 24</td>
<td>±0.06</td>
<td>±0.020</td>
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**ANGULAR DIMENSIONS**

±0.15°

**COMMENTS**

- Design activity appd.
- Materials and specifications unless otherwise specified.
- Dimensions are in inches and include thickness of plating.
- Interact with the dimensions and tolerances per ANSI Y14.3-66.

**NOTE:**

- The data is to be interpreted using NBS Handbook H28 and MIL-STD-9.
NOTES
1. CONNECTIONS TO J11 ARE AS FOLLOWS
   J11-A: GROUND
   J11-B: -12.5 VOLTS
   J11-C: +12.5 VOLTS
FRONT PANEL
(REAR VIEW)

NOTES

1. • DENOTES CONNECTION TO GROUND
   PLANE
NOTES:
1. S1, S3, S3, S4, shown in center-off position.
2. S1, S3, S3, S4 are Switchcraft type 7312 with 5327 cutchene plate.
3. J1 is Cannon type DBM-25.
4. DS1, DS2, DS3, DS4, are part of S1, S3, S3, S4, respectively.

### MATERIALS AND SPECIFICATIONS

- **Contract No.** NAS9-14766
- **Drawn by** F.G. Hubit 5-16-73
- **RCA Commodity Code:** SK2282792
- **Design Activity Appl.** J-30, LLA-X 5-14-15

#### UNLESS OTHERWISE SPECIFIED
- **Dimensions are in inches and include thickness of plating.**
- **Tolerances:**
  - Basic Dimensions: ±0.02
  - 2 Place Decimals: ±0.002
  - 3 Place Decimals: ±0.001
- **Angular Dimensions:** ±5°

#### UNLESS OTHERWISE SPECIFIED
- **Tolerances on Interpreted Dimensions and Tolerances:**
  - Up to 5: ±0.02
  - 6 to 19: ±0.03
  - Above 20: ±0.06
- **Angular Dimensions:** ±5°

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**REVISIONS**

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**DATE:** 11-15-73

**SCALE:** 1:1

**Sheet:** 1 of 1

**YEAR:** 1973
NOTES:
1. ± DENOTES CHASSIS GROUND
2. CBI IS WOOD ELECTRIC CIRCUIT BREAKER TYPE 511-215-101
3. DS1 IS DIALCO 32-4001-431-302
   LAMP IS TYPE 656, 115V.
### MATERIALS AND SPECIFICATIONS

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### BASIC DIMENSIONS

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### DESIGN ACTIVITY APP'D

- **DRAWN BY:**
- **CHECKED:**
- **APPROVED:**

### RCA COMMODITY CODE

- **RCA COMMODITY CODE:**

### RCA CORPORATION

- **NEW YORK, N.Y.**

### CONTRACT NO.

- **CONTRACT NO.:**

### DRAWN DATE

- **DRAWN DATE:**

### CHECKED DATE

- **CHECKED DATE:**

### DESIGNED DATE

- **DESIGNED DATE:**

### SCALE

- **SCALE:**

### WEIGHT

- **WEIGHT:**

### SHEET 1 OF

- **SHEET 1 OF:**

---

**NOTE:**

- Unless otherwise specified, dimensions are in inches and include thickness of plating, tolerances per ANSI Y14.5M.

---

**SPECIFICATIONS:**

1. The surface finish of machine parts shall not exceed a maximum reading of 15.5 per Std B46.1—1962.

2. Maximum reading of machine part surfaces shall not exceed 15.5 per ANSI Y14.5M.