

SECTION 16  
CLOSED CIRCUIT TELEVISION

16.1 CLOSED CIRCUIT TELEVISION OVERVIEW

The closed circuit television (CCTV) system is a general purpose circuit TV system which meets U.S. broadcast standards (RS170), with the exception of color. Field-sequential color or black and white is provided, although the system is fully compatible with National Television System Committee (NTSC) color with the exception of the split-screen multiplexer (MUX). All cameras operate in master sync with all switching and motor movement done during the vertical interval to avoid any interference problem. All cameras are identical, though some have different accessories; i.e., color lens assemblies (CLA's) or monochrome lens assemblies (MLA's), and/or pan tilt units (PTU's). Cameras are remotely commandable via commands multiplexed on the sync line. (The cameras also have local control switches on them.) Commanding is done by an onboard crew and/or the ground. Both may command simultaneously. Telemetry is included in the operational instrumentation (OI) link and interleaved in the video. A single digital audio channel is also interleaved in the video.

This brief will address the operation of the CCTV from a ground point of view. For thoroughness, some onboard operation is included. Reference should be made to Space Shuttle System Handbook (SSSH) drawings 16.1-4 (CCTV OV), 16.12 (CCTV Control), and 16.13 (CCTV Camera and Monitor).

16.1.1 Video Control Unit

The video control unit (VCU) is the heart of the CCTV system. It consists of two separate line replaceable units (LRU's), the remote control unit (RCU), and the video switching unit (VSU).

16.1.1.1 RCU Overview

The RCU performs the following functions:

- A. Receive and process commands from the crew switch panel (panel A7) and from the payload forward 2 (PF 2) multiplexer/demultiplexer (MDM) (commands from the Mission Control Center (MCC)).
- B. Turn power on to the cameras by furnishing a power on discrete to each camera.
- C. Send camera configuration commands issued by the crew or by the ground out to the camera as part of the "sync" signal.

- D. Generate the test pattern (used to check out the system or adjust a crew monitor) and the sync signal which is sent out to each camera. This sync signal carries commands to the camera and allows the camera video to be synched to the VCU.
- E. Drive the talkbacks on the crew switch panel (A7).
- F. Send outputs to the OI MDM OF 4 for downlink to the MCC and use by the systems management (SM) computer (the camera overtemp alert).

#### 16.1.1.2 Interfaces and Block Diagram

The interfaces are summarized in figure 16-1.

##### RCU Inputs

#### A. Panel A7 Switch Inputs

The switches on panel A7 are all wired to the RCU. When a switch is pressed the state of the switch is latched in a flip-flop and stored until the RCU microprocessor reads the flip-flop. The switches are shown on the systems handbook drawing.

#### B. MDM Commands

Commands are received from the PF 2 MDM as 14 parallel inputs. (The bits are described in figure 16-7.) The commands are listed in table 16-I.

#### C. MDM Command Enable

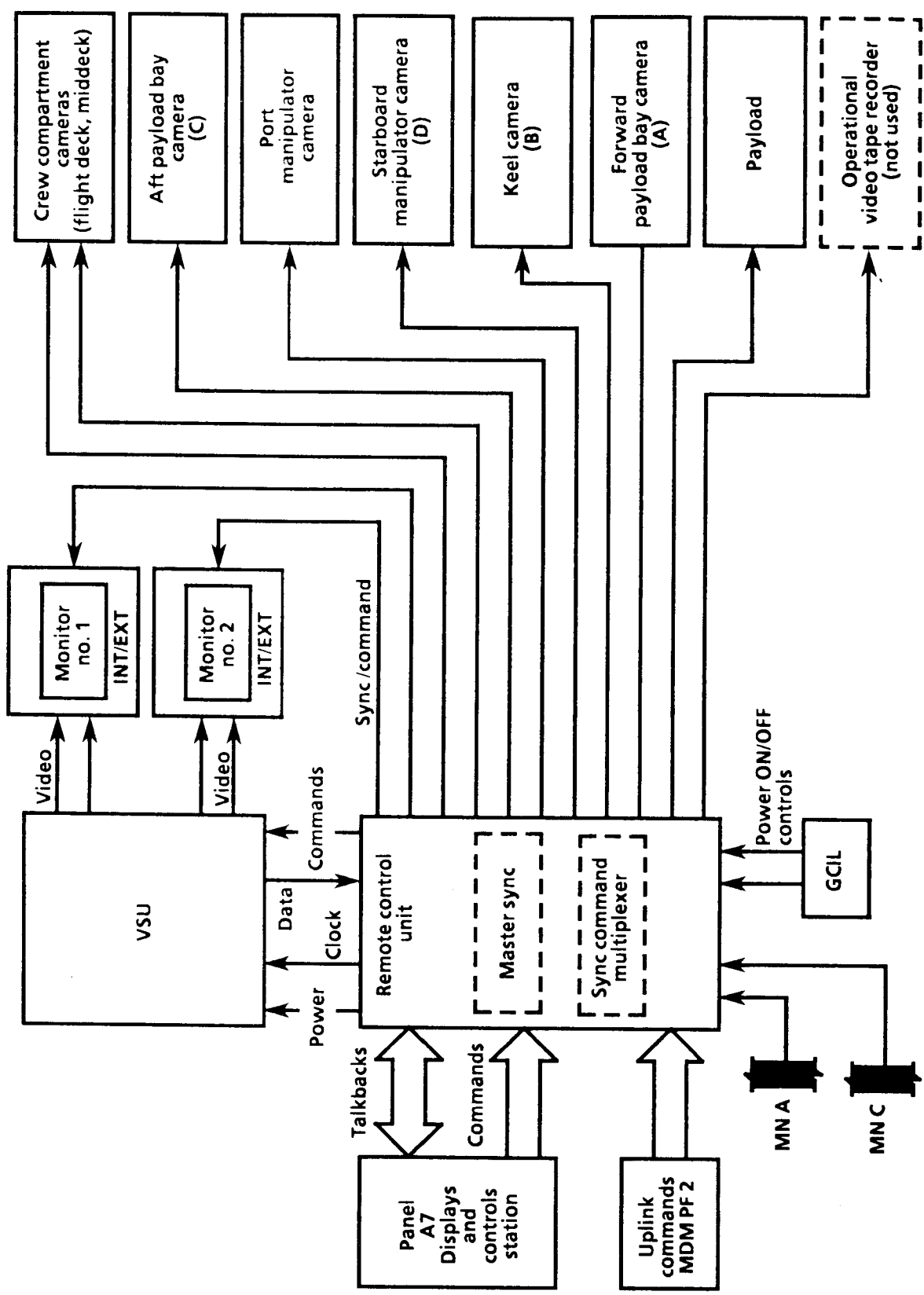
A single line from the ground control interface logic (GCIL) TV control switch (the MNC side) on panel A7 is routed to the RCU and used to enable the MDM commands. If this discrete is low (switch in PANEL position) then the RCU will not process any MDM commands.

#### D. Power

Power is received from Main A R15 and Main B R15. Circuit breakers for each power source are on panel R15. The RCU switches the power on based on GCIL power control discrettes.

#### E. GCIL Power Control Discrettes

The GCIL furnishes power control discrettes to the RCU for power on/off. The two discrettes are for MNA power on and MNB power on. The GCIL interlocks the two so both cannot be on at the same time. (The RCU also interlocks the two.) Control buses AB1 and BC1 provide GCIL control power for MNA and MNB, respectively.



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Figure 16-1.- Remote control unit overview.

### RCU Outputs

#### A. Sync/Command Lines

This is a standard TV signal with the video scene "black" and commands encoded on lines 11 or 13. This is routed to all cameras and to the payload interface so the cameras can run in sync with the RCU and receive commands from the RCU. The commands are summarized in table 16-I.

#### B. Clock

This is a 2.045-MHz clock routed to the VSU for timing. There is also an oddframe start pulse sent to the VSU for timing.

#### C. Panel A7 Talkbacks

The RCU furnishes 28-volt discretes for all the A7 panel talkbacks. Some of these run to the annunciator control assembly (which controls the brightness of the indicator lights) and some go directly to the panel. These are all shown on the systems handbook drawing 16.12.

#### D. Camera Power ON Discretes

The RCU furnishes 28-volt discretes to all cameras for camera power on control. The camera senses the state of its control discrete and "turns itself on" when the discrete is high. There is no positive feedback to the RCU that the camera came on. Thus the camera power talkbacks on panel A7 and telemetry actually indicate the RCU has set the camera power on discrete high.

#### E. MDM Telemetry

The RCU furnishes 28-volt discretes to MDM OF 4 for ground telemetry and crew alert for camera overtemp. The telemetry is summarized in the telemetry section of this brief.

### 16.1.1.3 VSU

The VSU performs the following functions:

- A. Receives video from all cameras, VTR, and payload sources and routes it to crew monitors and the downlink (S-band FM and Ku-band systems). The instructions on what to send where are received from the RCU (which receives them from the crew panel or the PF 2 MDM).
- B. Adds timetags to the video signal received from the cameras. The time information is received from the master timing unit.
- C. Provides two "split screen" multiplexers. These allow two scenes to be viewed together, one on the left and one on the right.

- D. Decodes telemetry received from the cameras, displays the data on the crew monitors, and sends the data to the RCU for display on the A7 panel and for downlink to the MCC. A switch is provided on the monitor to enable/disable the display of camera data.
- E. Limit-senses the temperature of each camera (the temperature is encoded in the video by each camera) and alerts the crew and the ground if an overtemp is sensed. This is done by displaying the temperature on the crew monitor, sending a signal to the RCU which sets a discrete to an OI MDM (which is downlinked to the MCC and used to set off an alert by the SM computer) and inserting a flag into the downlink video which causes the temperature data on the INCO ground monitor to "flash".

#### 16.1.1.4 Interfaces

The interfaces for the VSU are shown in figure 16-2.

#### 16.1.2 Electrical Description of RCU and VSU

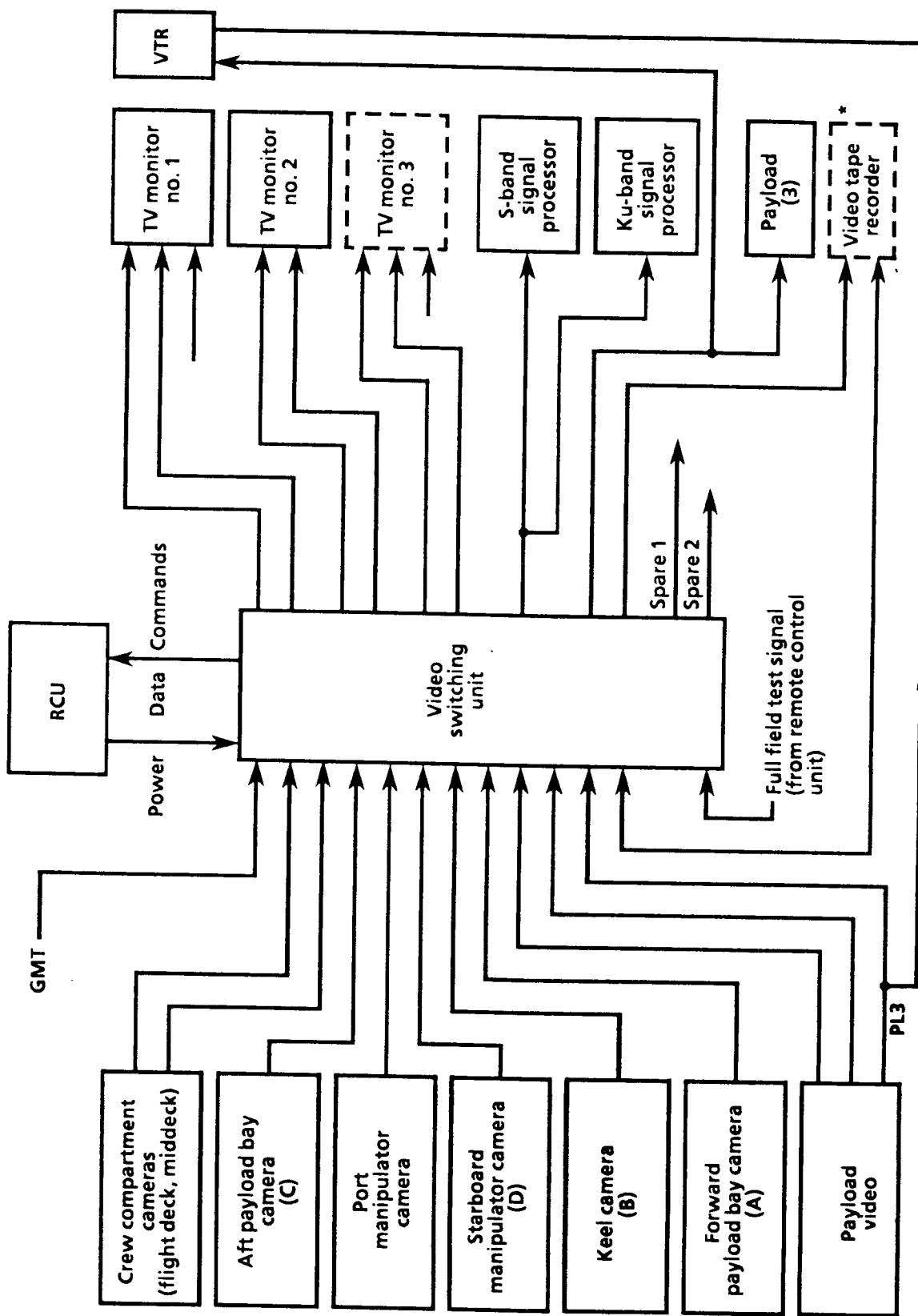
##### 16.1.2.1 RCU

The RCU consists of four major components.

16.1.2.1.1 Power supply.- The power supply switches at the horizontal line rate to avoid interference and supplies power to all RCU and VSU circuits. Power is delivered to the RCU from MNA or MNB, but not both. There is no automatic switchover in case of power loss.

16.1.2.1.2 Sync generator and timing circuits.- The sync generator has redundant 14.318180 MHz oscillators. There is no automatic failover. Oscillator A runs when MNA is powering the RCU, and oscillator B runs when MNB is powering the RCU. The crew can reverse this with the TV-SYNC switch. The timing circuits generate the line count and subline count which control data clocking to cameras and to and from the VSU. During line 11 and 13, command data is clocked from data buffers (where the microprocessor stored it), and multiplexed on the composite sync routed to all cameras. Also during line 11, data is clocked from the RCU to the VSU. The timing circuits furnish a 2.045-MHz timing signal and an odd field start signal to the VSU so the VSU can sync with the RCU. The timing circuits also generate the vertical interval test signal (VITS) and the full field test signal (FFTS).

16.1.2.1.3 Microprocessor.- The RCU is controlled by RCA 1802 CMOS microprocessor with 4k bytes of programmable read-only memory (PROM) and 256 bytes of random access memory (RAM). The microprocessor runs through its program and idles until a line 1 interrupt is issued by the timing circuits. It then runs through the same program again. This will be discussed further in section 16.3.



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\* Not planned

Figure 16-2.- Video switching unit.

16.1.2.1.4 Input/output storage buffers.- There are several buffers which store data until the timing circuits clock the data out (as is the case for camera commands) or until the microprocessor reads the contents (via an 8-bit data bus). The output buffers are loaded by the microprocessor or by a direct memory addressing scheme. Many of the output buffers have relays associated with them to furnish 28-V discretes to the OI MDM or to the A7 panel talkbacks.

16.1.2.1.5 Power use.- The RCU draws 46 watts of power. This includes the power supplied to the VSU. The power for all elements of the CCTV system is shown on table 16-II.

#### 16.1.2.2 VSU

The VSU is also microprocessor-based. It can be split into three major parts.

16.1.2.2.1 Microprocessor.- The microprocessor uses 2k bytes of PROM and 256 bytes of RAM. The VSU microprocessor program also runs once every video field. The microprocessor also interfaces with two 32-byte RAM's used for control of the alphanumeric/character generators. The alphanumeric are displayed on an onboard monitor when enabled by the monitor data switches. The character generators are driven by the timing circuits and use the data stored by the microprocessor in the 32-byte RAM.

16.1.2.2.2 Timing circuits.- These circuits use the 2.045-MHz clock and the odd field signal from the RCU to generate line counts and subline counts. These are used to clock in the RCU data, clock out the camera data to the RCU, and control the data acquisition from the cameras. The logic sequences through the 12 possible cameras, sampling each camera for three fields (to wait on a field sequential color sync signal so temperature can be read). Thus, any camera is sampled every 39 fields or 650 msec.

16.1.2.2.3 Video matrix.- This is simply a matrix of field effect transistor (FET) switches which allow any input to be connected to any output (also called a crossbar). The matrix is controlled from the input shift register. The microprocessor does not control the matrix.

#### 16.1.3 RCU, VCU Installation

The RCU and VCU are installed in the crew cabin on the starboard side of the flight deck. They are both forced-air cooled by cabin air.

### 16.2 TELEVISION CAMERA

All television cameras (TVC's) are identical and interchangeable. Each functions as a basic monochrome television system utilizing a silicon intensified target (SIT) tube. Commands and synchronization are received from the RCU, and video is output to view finder monitor (VFM) and VSU. The

lens assembly is interchangeable for field-sequential color or monochrome. External controls are on the lens assembly and rear of camera. Camera locations in the payload bay are shown in figure 16-3.

#### 16.2.1 Camera Location Code

Each camera commanded by the RCU must have a unique address. The address is determined by the location where the camera is connected (i.e., FWD BAY). This is accomplished by a hardwired 5-bit code in the bulkhead connector (selected pins are shorted to common). Thus, any camera can be connected by any input and will respond to the location address.

#### 16.2.2 Power Switching

All dc power required by the TVC, CLA/MLA, VFM, and PTU is located in the power supply module of the camera. A power ON/OFF enable command, which is a voltage level change to +28 V, is received from the RCU. The circuit is configured to be initially OFF when +28 V main bus is applied.

#### 16.2.3 Automatic Light Control

The automatic light control (ALC) circuits control the voltage applied to the image intensifier on the vidicon, the gain of the video circuits, and the position of the iris. There are two types of CCTV cameras for the CCTV System. The 506 cameras have been used since STS-1. These cameras will generate a blooming effect picture when pointed at targets with high light reflection. The 508 cameras have been modified to eliminate the blooming effect. The 508 cameras are flown presently, but the 506's are still available for certain applications. The 506 cameras have two light control modes: (1) full auto mode initiated by an ALC CMD either NORM, PEAK or AVERAGE and (2) semi-manual mode initiated by an open or close iris CMD. For these two modes the voltage gain of the tube is varied from its normal operating point to handle the changes in light levels thus protecting the tube from target damage. The 508 cameras have the same two modes plus one. The new mode is the FULL MANUAL mode in which the voltage gain is fixed and the light entering the tube is controlled by the opening and closing of the iris manually. It should be pointed out that target damage is most likely to occur in an unattended camera while in full manual. In an attended and correctly operating camera, the overexposure of a small spot will usually bloom to an unusable degree before a damage level is reached.

Operation of the 508 camera is as follows:

- (1) CMD GAMMA white or black.
- (2) CMD IRIS open or close commands as needed. This selects a fixed voltage for full MANUAL MODE



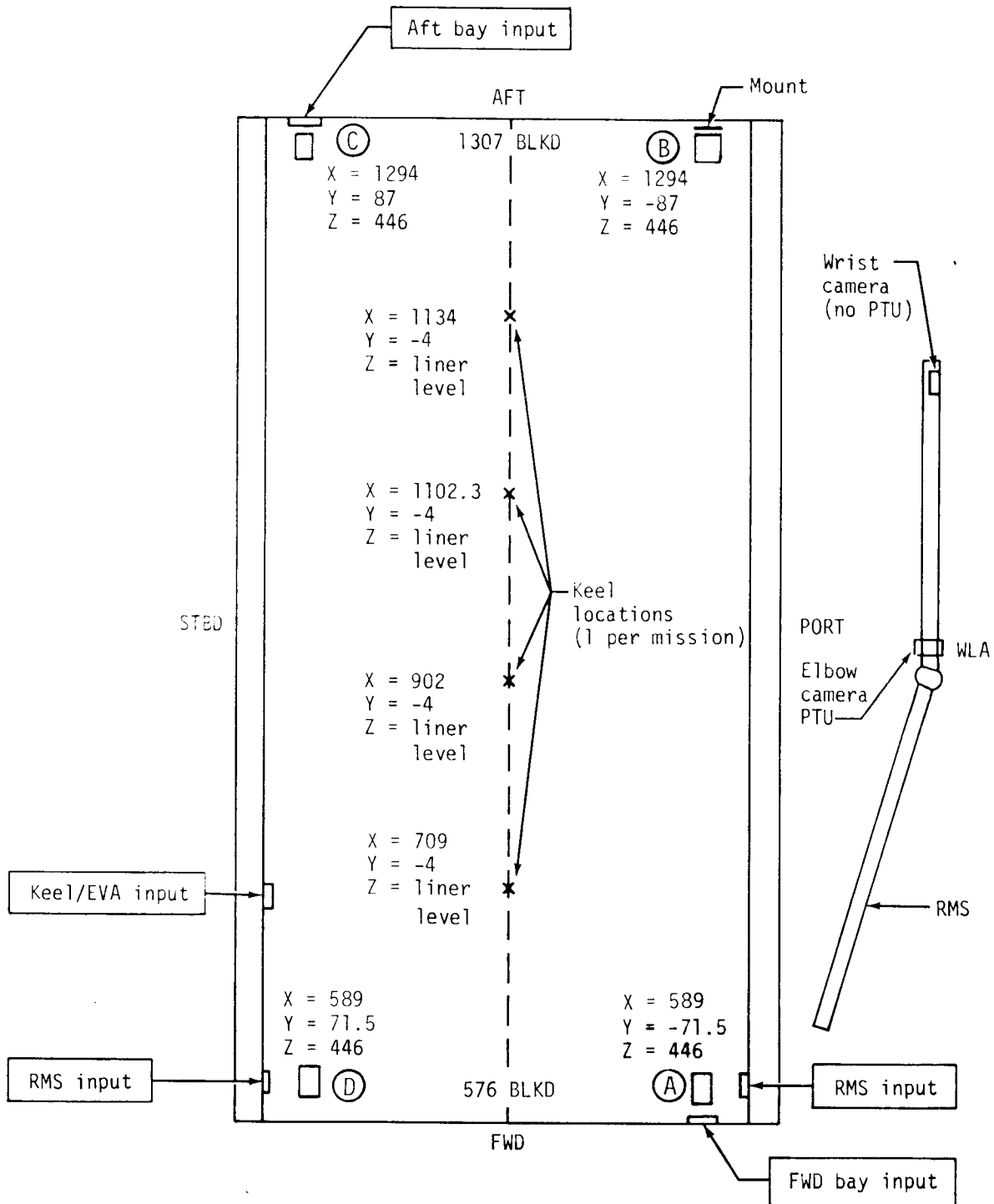


Figure 16-3.- CCTV camera locations.

To disable full manual mode:

(1) CMD GAMMA NORM - This selects the SEMI-MANUAL mode

or

(2) CMD ALC PEAK, NORM or AVG which selects FULL AUTO MODE (fig. 16-4).

Manual operation of the lens functions will be controlled by momentary switches located on the rear and side of the camera. These will override any input command received from the RCU.

Note: The iris takes less than 4 seconds to close in the auto mode, 12 seconds in the manual mode, and 2 seconds for power off.

#### 16.2.4 Color Wheel Electronics

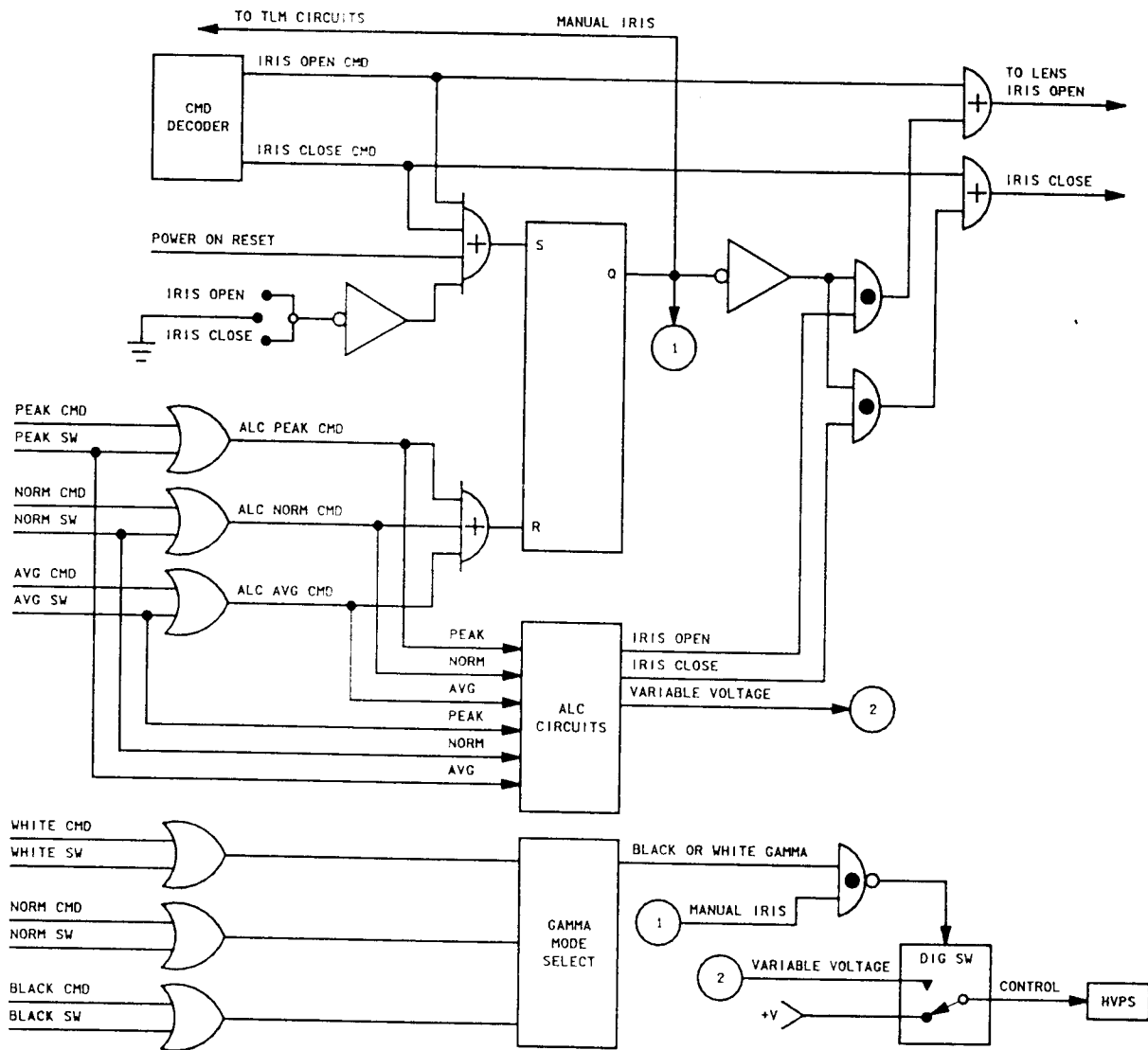
Phase lock loop color wheel circuitry ensures precise phasing of the wheel position to the color sync generator in the decoder (20 Hz = 1/3 vertical sync frequency). The assembly provides a field-sequential color picture with a six-aperture color filter wheel that rotates at 600 rpm. Wheel position is sensed by a magnetic pickup and compared to incoming 20 Hz signal. Additional circuitry provides starting of the motor 1 second after power turnon.

#### 16.2.5 Pan Tilt Unit Description

The PTU is a remotely controlled azimuth/elevation mount for a TVC located on the forward and aft bulkheads and on the remote manipulator system (RMS) elbow of the Orbiter. The power supply cable routing is from bulkhead to PTU and from PTU to TVC.

The pan and tilt motions are provided upon TVC command at 1.2° per second (slow command) or 12° per second (fast command) over a total range of 340° ( $\pm 170^\circ$  from nominal "zero" position). The tilt limit ranges on the wide-angle camera are reduced 20°. Total range for these cameras is 300°.

Pan/tilt limit indicators are incorporated into the drive mechanism in the clutch housing area to interrupt electrical power to the motor drives, thereby limiting the motion to a preset panning and tilting range. The limit range is preflight adjustable. In case of failure of indicators, the unit will pan/tilt 3° until it reaches a mechanical hard stop to prevent further motion. The clutch slips to prevent damage to the motor and gear train.



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Figure 16-4.- Auto/manual iris circuitry.

#### 16.2.6 Stepper Motors

The PTU uses two identical stepper drive circuits, while the MLA/CLA uses three. The iris clock has three rates: 20 Hz is the manual rate, 60 Hz is the auto iris rate, and 120 Hz closes the iris when powering down the camera. The PTU has two rates: 6 Hz for slow and 60 Hz for fast. The stepper logic receives the command and generates the two-phase drive for the stepper motors.

#### 16.2.7 TVC and PTU Heaters

Each TVC and PTU assembly has a heater which is thermostatically controlled to be ON between 0° and 8° C. Possible effects of going above 55° C may result in breakage of image tube, mechanical failure of motor and lens, and cracking of electronic boards and components. Each circuit is activated by enabling individual circuit breakers located on panel R15. There are no temperature sensors on the PTU. A temperature signal is transmitted via the video downlink and is available in real time.

#### 16.2.8 Remote Video Switcher Description

The remote video switcher (RVS) unit is mounted on the RMS elbow PTU. It selects either the elbow or wrist RMS camera as a video source by using three DPDT latching relays to switch camera ON, SYNC, and VIDEO signals. Note that, although the +28 V camera power is routed through the RVS, it is not switched in that unit.

The RMS can be mounted on either the port or starboard side of the Shuttle; therefore, a toggle switch is included on the RVS to allow selection of the proper camera location code.

#### 16.2.9 External Switches

Three switches are located on the lens assembly. These are momentary, with center position OFF. They control the iris, zoom, and focus functions.

On the rear of the camera, there are momentary (push maintain) switches which control ALC (peak, normal, avg) and GAMMA (white, normal, black). See figure 16-5.

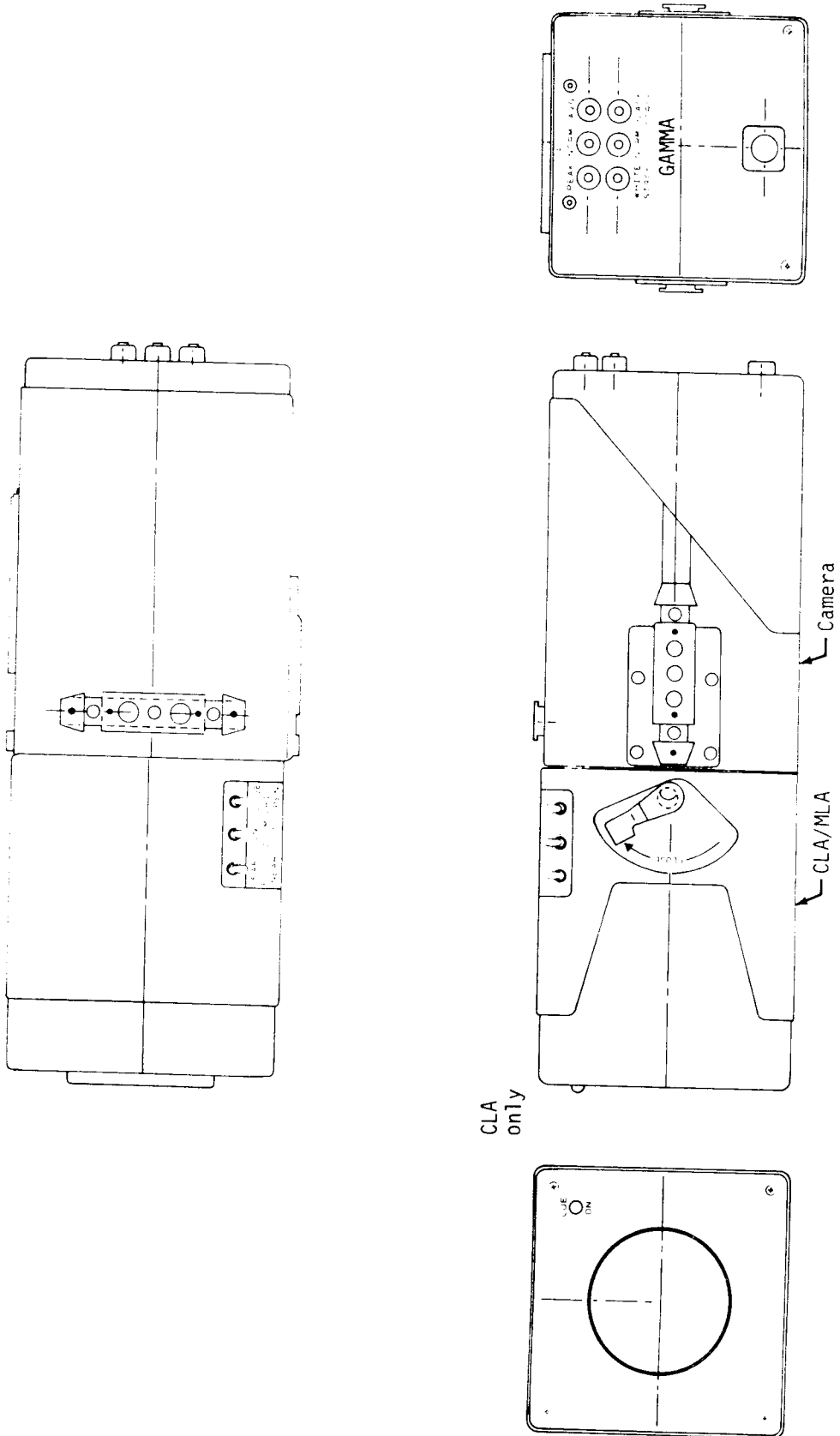


Figure 16-5.- TV camera.

## 16.3 CCTV SYSTEM OPERATION

### 16.3.1 Command

Commands are received by the RCU from the A7 panel and the PF 2 MDM. The RCU is controlled by an RCA 1802 microprocessor which is running a cyclic program. The RCU processing starts at the beginning of a video field and is completed by the end of the field (fig. 16-6). The crew switches are momentary and sampled every vertical field. The inputs are processed and commands sent to the cameras via the sync lines or to the VSU via a dedicated line. Commands from the MDM are only sampled once. For a command to be read, all zeros must be present on bits 7 to 13 of the command word (fig. 16-7). When any bits 7 to 13 go high, the RCU waits 200  $\mu$ sec, then loads the input register and sets a flag telling the microprocessor an uplink command is present (fig. 16-8). Another command will not be read from the MDM until the microprocessor reads the present command and resets the flag. Thus, commands are processed only once and can be received no faster than the processor cycle, which is 59.99 times per second or every 16 msec. Camera motion commands (PAN, TILT, FOCUS, ZOOM, IRIS) are latched in the RCU and sent every field until any one of the following occurs:

- A stop command is received.
- An uplink command with a different camera address is processed.
- The crew issues a motion command which conflicts with the uplink motion command.
- The uplink commands motion in the opposite direction.
- The TV POWER CONTROL switch is placed in PNL.

Commands are sent to the cameras on lines 11 and 13 of the composite sync. Line 11 is used for crew commands, and line 13 for the uplink commands; thus, both can operate independently. If the crew and uplink commands conflict, a single command is output on line 11. The formats of the camera command are shown in figure 16-9 and all commands are listed in table 16-I. The bit length is two periods of the 2.045-MHz clock (130 times the horizontal line rate). The first eight bits are a 11110000 sync pattern. The sync pattern is always present, even if no command is present. The next eight bits consist of a camera address with a single bit for odd parity. The final 32 bits are the function code. The command is routed to all cameras, with only the addressed camera responding. All camera commanding is done over the sync lines, except camera power on/off, which is commanded by a 28 V discrete signal (one for each camera).

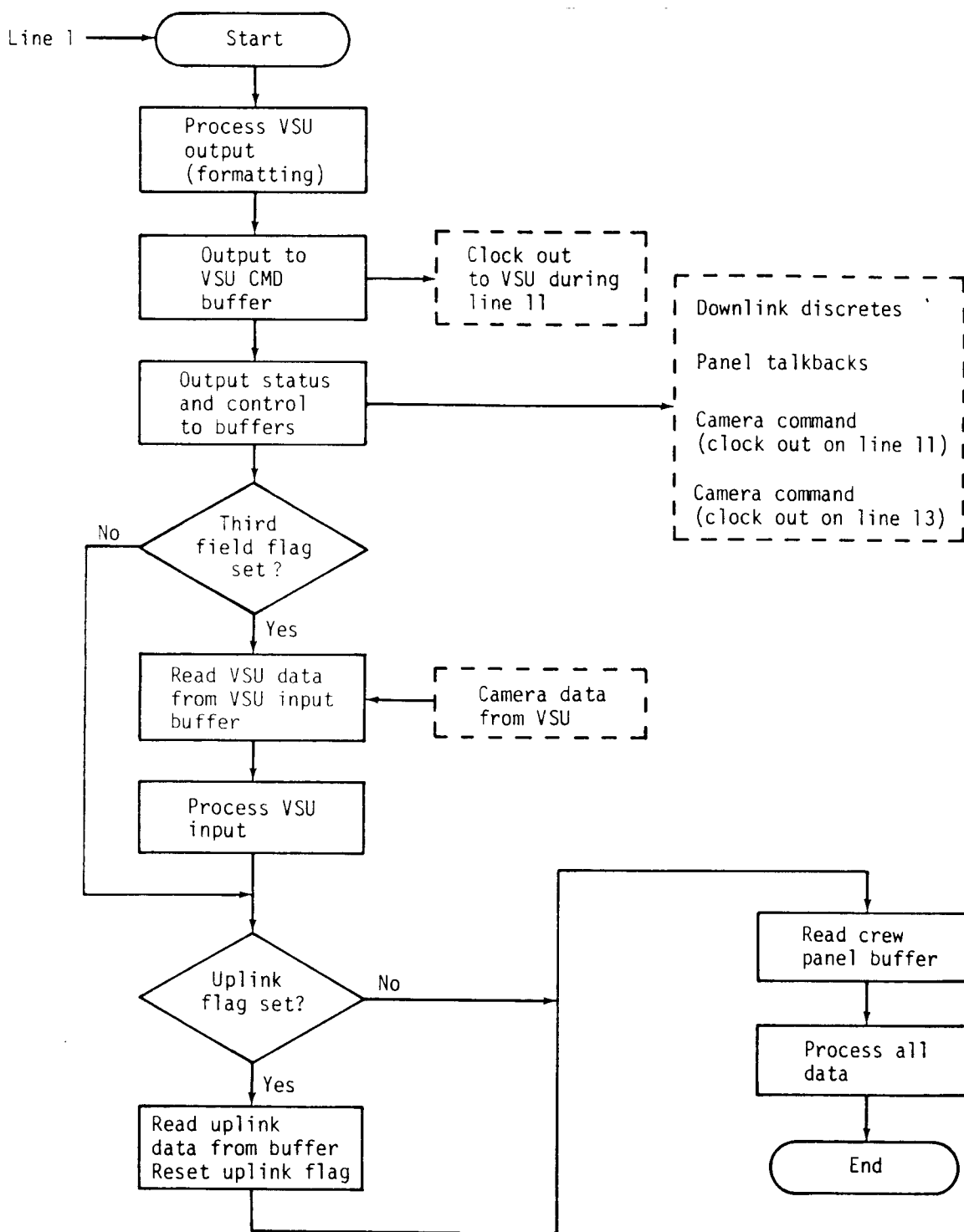
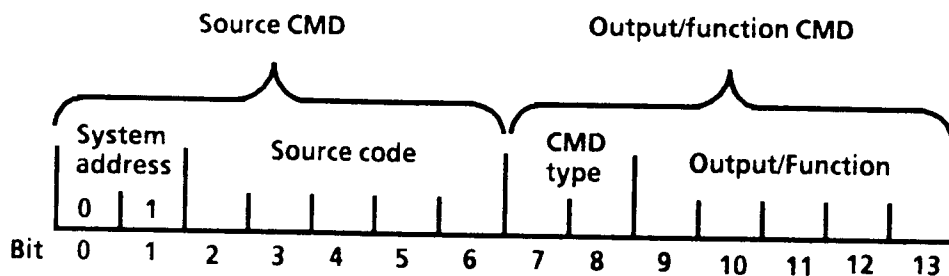


Figure 16-6.- RCU flow chart.



System address - 01 = CCTV

CMD type 01 Camera control command  
(output on sync line)

00 VCU command  
(not output on sync line)

Each command must be preceded by all zeros in bits 7 to 13. Bits 0 to 6 may remain static for many commands.

NOTE: Bits 14 and 15 on the MDM card are assigned to a different (non-comm) system.

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Figure 16-7.- CCTV command structure.



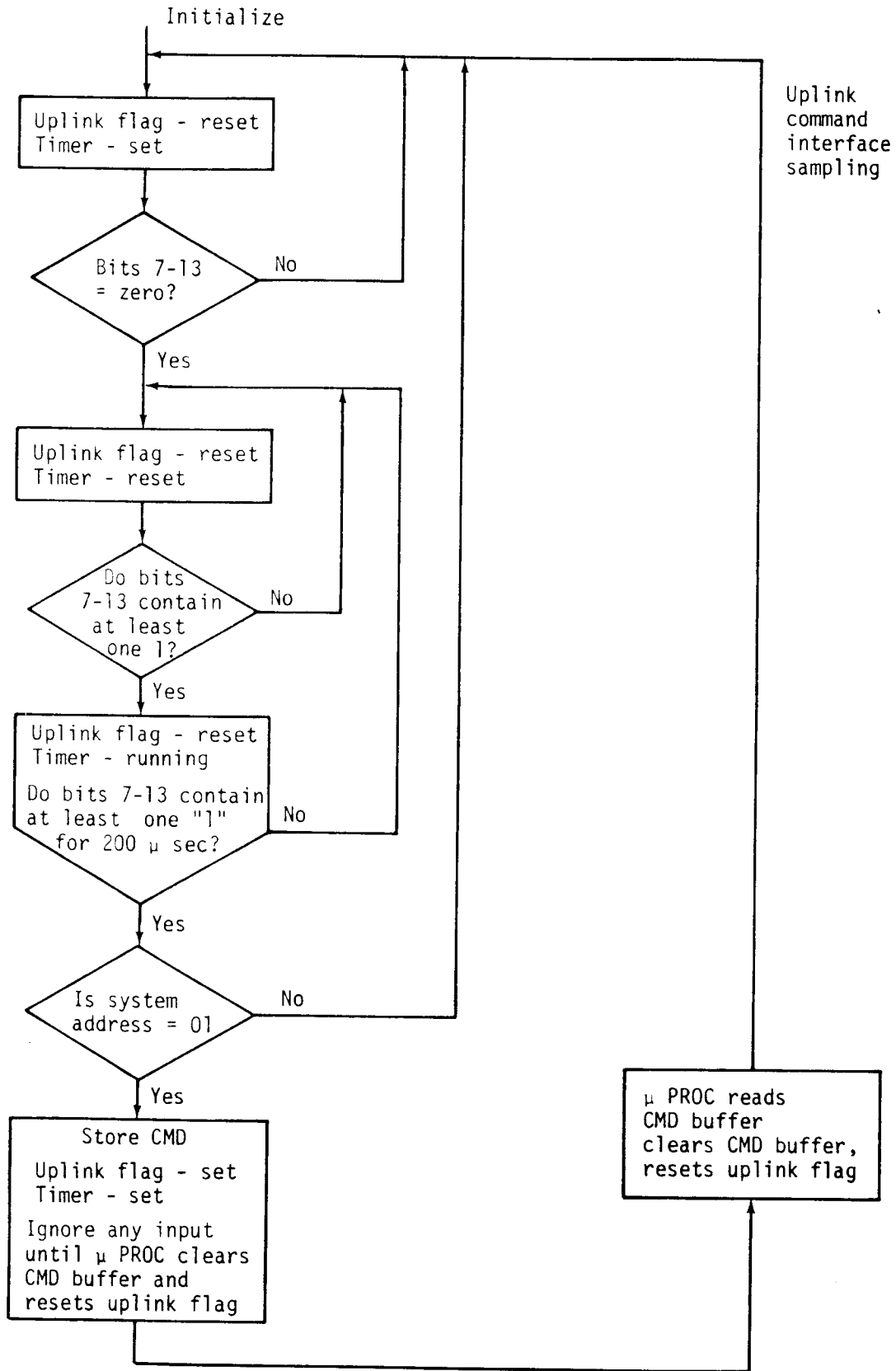


Figure 16-8.- Uplink command interface sampling.

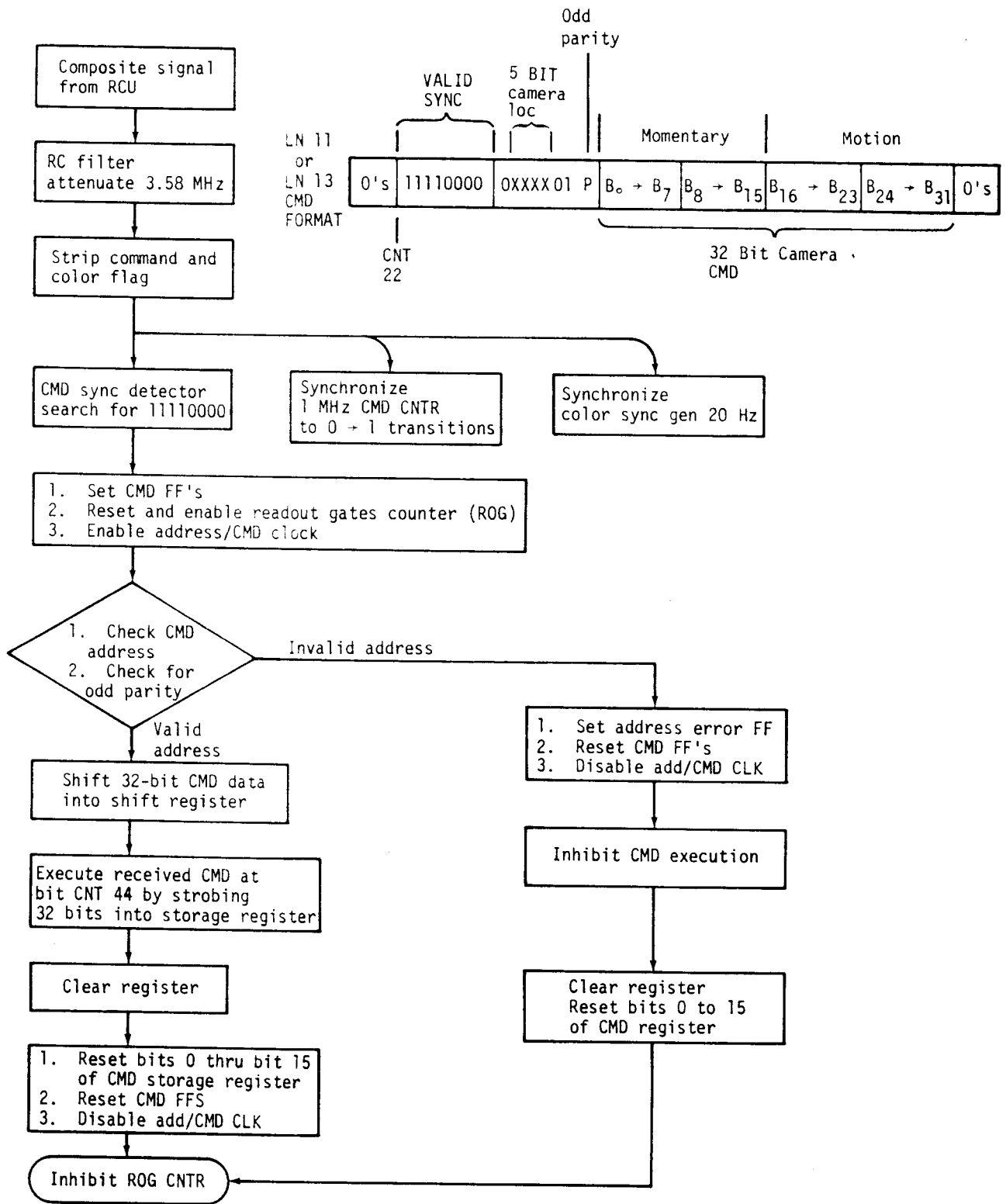


Figure 16-9.- Camera command detection/execution.

### 16.3.2 Telemetry

The RCU also drives 28 V discrete signals for talkbacks on the A7 panel and telemetry to MDM OF 4. The telemetry and talkback parameters, with the exception of camera status (ALC, GAMMA, MAN/AUTO IRIS, CAM OVERTEMP), are from the RCU command logic. The camera parameters come from the VSU, which obtains the data from the camera video. All camera telemetry is interleaved in the video by the camera and can be detected on the ground (during a TV pass), as well as onboard. The VSU samples a camera every third field; thus, data is updated every 39th field (12 cameras) or every 650 msec. The temperature is limit-sensed by the VSU. If any camera temperature reads greater than 45° C, the following occurs:

- An overtemperature flag is inserted on line 16 of the downlink video.
- An overtemperature flag discrete is set to OI MDM OF 4. This bit will be limit-sensed by the GPC (SM OPS 2) and will result in an SM ALERT when high.
- The VSU will enable the display of temperature on the onboard monitors. Normally, camera temperature is not part of the alphanumeric; it is only present when a camera is overtemperature (fig. 16-10). The data switch on the monitor must be ON for the temperature to be displayed.

When the overtemperature condition goes away, all of the above are reset. Note that there is no N count. A false reading could result in the overtemperature condition being present for one sampling cycle or 650 msec. (Systems Management (SM) fault detection and annunciation (FDA) has an N count of 15 before an SM alert will be sounded.)

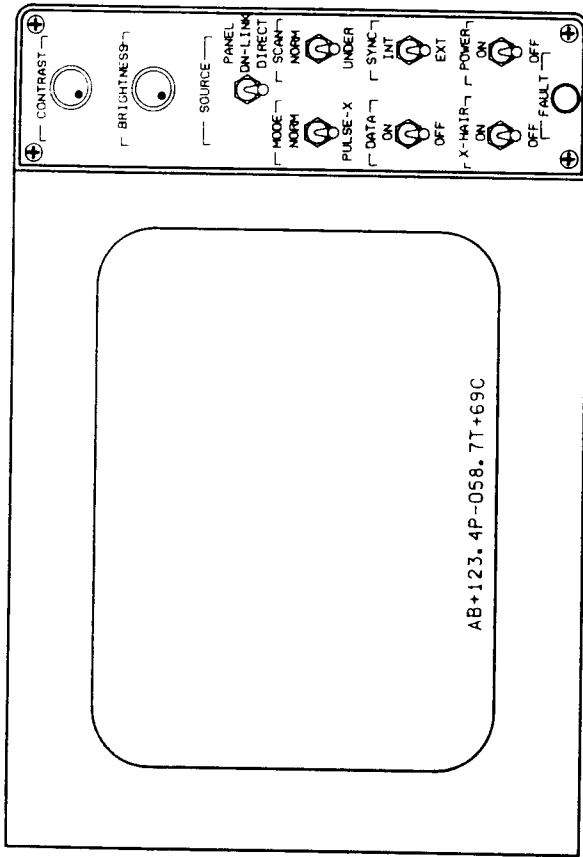
The information format on the video is shown in figure 16-11. The camera command on lines 11 and 13 is present only on the sync line (and on the FFTS). All other information is present in the downlinked video.

### 16.3.3 Camera Powerup

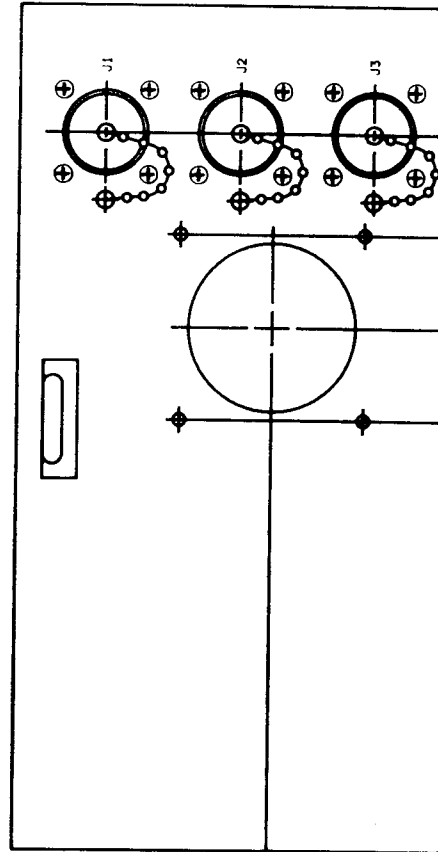
In general, ground operation of the CCTV system is different than onboard operation. The main area where it is the same is for initial camera powerup.

When a camera is first powered, it comes up in the following configuration:

IRIS FULLY CLOSED  
MANUAL IRIS MODE  
ALC - PEAK  
GAMMA - NORM  
PAN/TILT ANGLES - ZERO



TV CAMERA MONITOR



PIN ALLOCATION FOR CONNECTORS ON CCTV MONITOR

PIN NO	FUNCTION T1	J2	J3
1	+28 VDC POWER	VIDEO C IN POS	SPARE
2	DATA CROSSHAIR RETURN	SPARE	SPARE
3	SPARE	VIDEO C IN	SPARE
4	+28 VDC RETURN	SPARE	VIDEO A OUT POS
5	DATA DISABLE	SPARE	SPARE
6	CROSSHAIR DISABLE	SPARE	VIDEO A OUT
7	SPARE		
8			
9			
10			
11			
12			
13			
14			
15	SPARE		
16	VIDEO A IN, POSITIVE		
17	VIDEO A IN		
18	SYNC POSITIVE		
19	SYNC		
20	VIDEO B IN, POSITIVE		
21	VIDEO B IN		
22	SPARE		

Figure 16-10.- TV camera monitor.

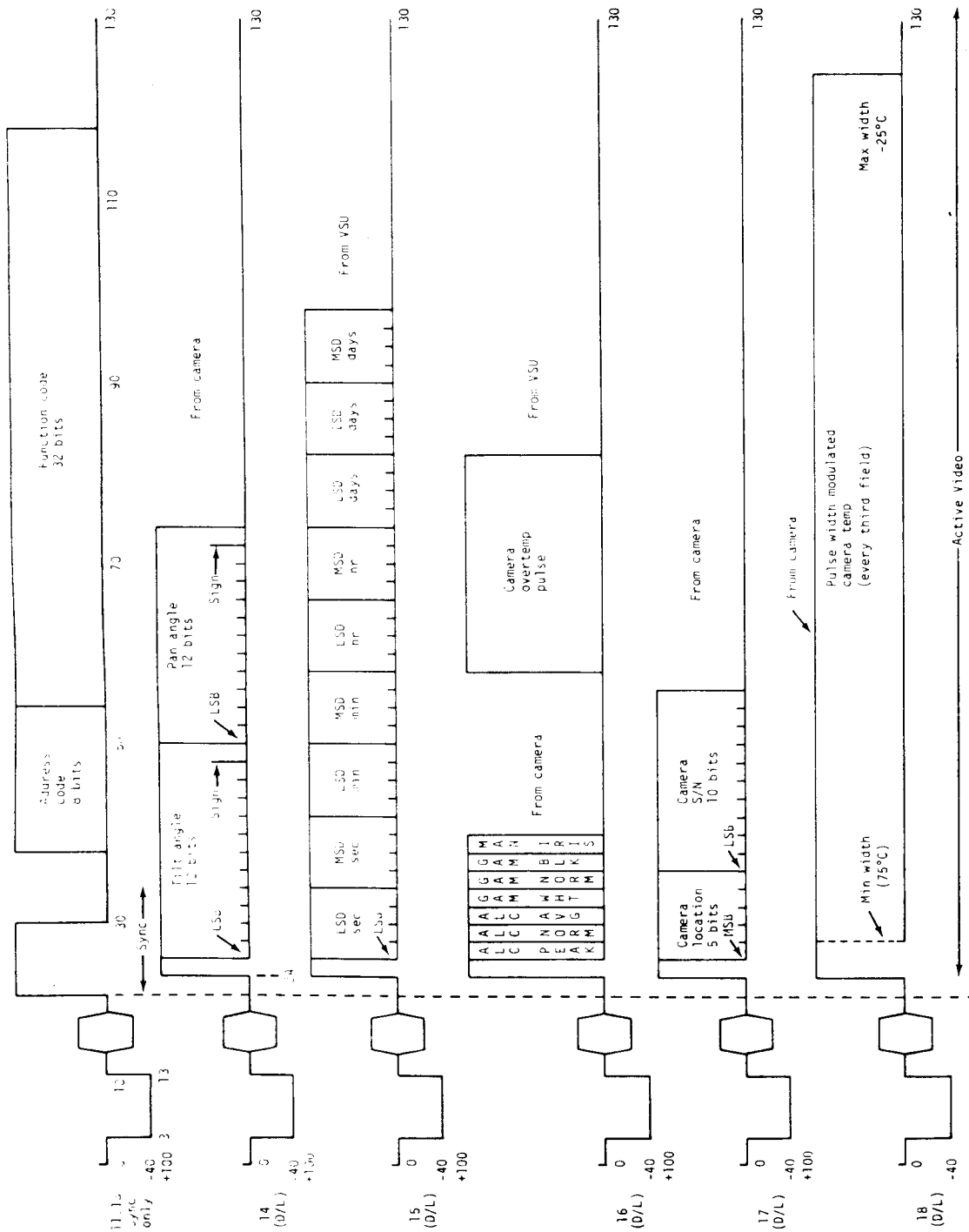


Figure 16-11.- Vertical interval data (sheet 1 of 2).

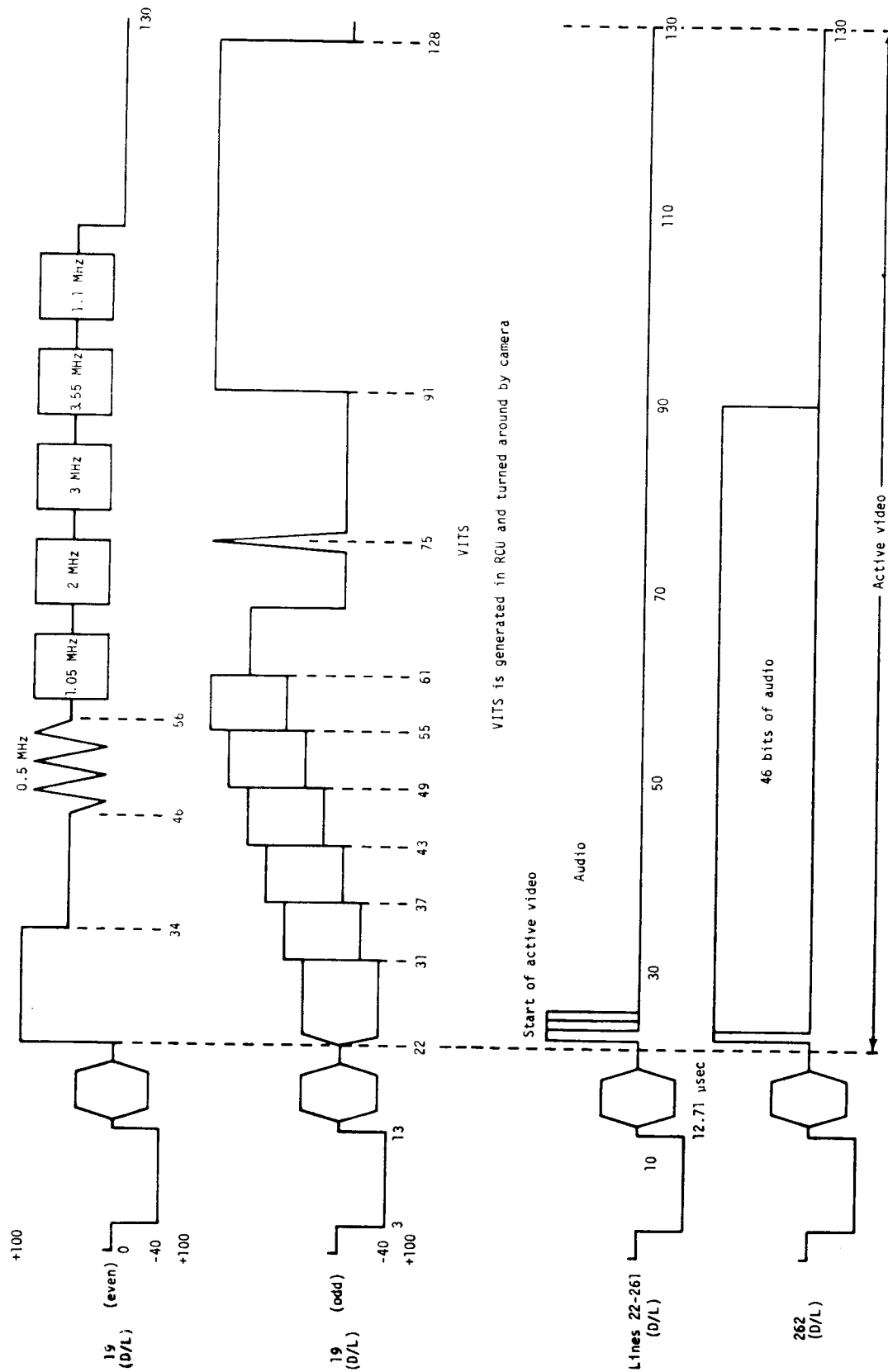


Figure 16-11.- Vertical interval data (sheet 2 of 2).

Since the iris is closed, no picture is received. Sending an ALC command will place the camera in the automatic iris mode, and the iris will open to the proper setting. For a payload bay camera, the plans are to use ALC PEAK on the initial setting (even though the camera is in peak, sending peak again will put the iris control in AUTO). When a camera is powered down, there is a 4-second delay before power is actually removed to allow the iris to fully close (this is done automatically). This is important because the Sun can damage the camera even when off. In the case of a cabin camera, the iris will not automatically close if the camera is turned off via crew switches on panels 019 and M058F. Since these cameras are in the cabin, this normally will cause no problem. However, if a cabin camera is to be used for EVA, the iris should be fully closed before the camera is taken EVA.

#### 16.3.4 Ground Camera Selection

Ground commanding is accomplished via a 14-bit parallel word set on MDM PF 2. The 14-bit command word is partitioned as shown in figure 16-7. As explained earlier, the RCU will respond to a command after a reset/set mask is sent to bits 7 to 13. Commands affecting bits 0 to 6 will not cause any RCU response. Commands are split into two basic categories, source commands (affecting bits 0 to 6) and output/function commands (affecting bits 7 to 13). In effect, a ground operator builds a command onboard using this feature; the source is loaded and an output/function will cause the RCU to execute the command. There is a third type of command called a standalone command. This is a command which does not require a source command, as all required information is contained in the standalone command. The source, output/function, and standalone commands are listed in table 16-I. It should be noted that a source command may be followed by as many output/function commands as required. Since bit 1 must be one for the proper system address, if the set mask of a source command was not received, the RCU will not respond to any output/function command. If the reset mask was not received, the RCU will respond to the OR'ed combination of two source commands. There is no way to confirm that a source command was received, except by sending an output/function command and looking for the correct response.

The PAN/TILT FAST/SLOW commands (4276/4277) control the pan/tilt rate for the currently selected source (camera). Whenever the source is changed and any output/function command is received, the pan/tilt rate will revert to FAST. When panning or tilting in SLOW and it is desirable to change cameras with pan or tilt in SLOW, the PAN/TILT SLOW command must precede the PAN or TILT command.

The following series of commands would assign the forward bay camera to the downlink and zoom it:

```
4232 TV FWD BAY CAM-SEL
4249 TV DOWNLINK
4264 TV ZOOM OUT
4255 TV ZOOM STOP
```

Since the ground has to issue a single RTC, all motion commands (FOCUS, IRIS, ZOOM, PAN, TILT) will start when the command is received and continue to move until a STOP command is received, a command with a different camera address is processed, a conflict occurs, or the TV POWER CONTR switch is placed in PNL. End of travel does not cancel the motion command. No damage will result, but a STOP should be sent as soon as possible.

A split screen MUX is programmed in the same fashion as a single source. Note that the left or right sides of a MUX are outputs, and the MUX itself is an input. The following command sequence will assign the forward bay and aft bay cameras to the left and right sides of MUX 1 and downlink them (both cameras must be on):

4232 TV FWD BAY CAM - SEL  
4245 TV MUX 1 LEFT

4234 TV AFT BAY CAM - SEL  
4246 TV MUX 1 RIGHT

4240 TV MUX 1 - SEL  
4249 TV DOWNLINK

A complete procedure is shown in table 16-III.

### 16.3.5 Onboard Camera Selection

The CCTV system is operated onboard from the switches on the panel A7 (fig. 16-12), and switches on the cameras themselves. A few switches on panel A7 require some explanation. The TV POWER CONTROL switch does not operate the same as the other GCIL control switches. The only GCIL function in the CCTV is the power on/off.

In the PANEL position, the control switch activates the panel drivers, thus giving the crew control over power on/off. It also removes the signal which enables the RCU to receive commands from the MDM. Therefore, in the PANEL position, only the crew has control over any aspect of the CCTV. When the switch is placed in the COMMAND position, the GCIL command drivers become active, giving the ground control over CCTV power on/off. In addition, the RCU is enabled to receive commands from the MDM. Therefore, in the COMMAND position, the ground has control over power on/off, but both ground and crew can command the rest of the CCTV system.

The TV SYNC switch has two positions, NORMAL and REVERSE. In NORMAL, sync generator A operates when the VCU is powered from MNA, and sync generator B operates when the VCU is powered from MNB. In the REVERSE position, sync generators A and B are reversed. The crew can thus easily and quickly change sync generators. The ground does not have this command and must change power buses to change sync generators.





The functioning of the VIDEO INPUT, VIDEO OUTPUT, and CAMERA COMMAND switches will now be explained. The VIDEO INPUT, VIDEO OUTPUT, and the ALC and GAMMA switches are pushbutton indicators (PBI's) which illuminate to display certain status information during operation. The function of each will be explained separately, and then an operational example will be given.

#### 16.3.5.1 Video Output

When a VIDEO OUTPUT PBI is depressed, it will illuminate, and any other VIDEO OUTPUT PBI which was illuminated will go out. Also, the VIDEO INPUT PBI corresponding to the video input connected to the selected video output will illuminate. If no input was previously connected to the selected video output, no VIDEO INPUT PBI will illuminate. If the previous video input was an RCA camera, the ALC and GAMMA PBI's will illuminate to indicate the current modes of the camera ALC and GAMMA circuits. Depressing a VIDEO OUTPUT PBI does not change the VSU configuration or issue any camera command. It only reads out status and prepares the system for the next command.

#### 16.3.5.2 Video Input

When a VIDEO INPUT PBI is depressed, it will illuminate, and a command will be issued to the VSU to assign the selected input to the output represented by the illuminated VIDEO OUTPUT PBI. Any other VIDEO INPUT PBI which was illuminated will go out. Also, if the selected input is an RCA camera, the ALC and GAMMA PBI's will indicate the current camera ALC and GAMMA modes. The only time depressing a VIDEO INPUT PBI does not send a VSU command is when no VIDEO OUTPUT PBI is illuminated. There is always one VIDEO OUTPUT PBI illuminated, except immediately following VCU powerup, before depressing any VIDEO OUTPUT PBI's.

#### 16.3.5.3 Camera Command

The CAMERA COMMAND PBI's and toggle switches issue commands to the video input (camera) represented by the illuminated VIDEO INPUT PBI. The ALC and GAMMA PBI's allow selection of the appropriate mode and function as talk-backs. The ALC PBI's indicate the ALC mode and manual/auto iris mode. In the auto iris mode (iris controlled by ALC circuits), the ALC mode is indicated by the single PBI which is illuminated. In the manual iris mode (iris not controlled by ALC circuits, but set by command), the ALC mode is indicated by the PBI which is not illuminated (two will be on, one off). The auto iris mode is entered when an ALC command is sent. The manual iris mode is entered when an iris command (open or close) is sent.

The typical command sequence is VIDEO OUTPUT, VIDEO INPUT, CAMERA COMMAND. As an example, to assign the forward bay camera to monitor 1 and zoom it out:

A7 VIDEO OUTPUT - MON 1  
VIDEO INPUT - FWD BAY  
CAMR CMD ZOOM - OUT

The MUX's are programmed in the same fashion as single cameras. Each side of the MUX is an output, and the MUX as a whole is an input. The following is an example with the forward bay camera and the aft bay camera assigned to the left and right sides of MUX 1 and displayed on monitor 1:

VIDEO OUTPUT - MON 1  
VIDEO INPUT - MUX 1  
VIDEO OUTPUT - MUX 1 L  
VIDEO INPUT - FWD BAY  
VIDEO OUTPUT - MUX 1 R  
VIDEO INPUT - AFT BAY

Note that since the MUX was assigned to the monitor first, each camera could be viewed and camera commands sent to it as it was assigned to the MUX. (This works since the monitor gets sync from the RCU.) If the monitor sync switch is in INTERNAL, the problem described in 16.3.8 (loss of sync) would occur.

#### 16.3.6 Conflict Resolution Between Ground and Onboard Commanding

When in the command mode the onboard camera motion commands are acted on only when the camera motion switches change. The onboard commands have the same priority as the ground commands. The VCU will respond to the last command change, be it from the ground or onboard.

<u>Action</u>	<u>Response</u>
Crewmember presses and holds the PAN switch in left position	Camera pans left
Ground sends PAN RIGHT	Camera pans right
Crewmember releases the PAN switch	Camera stops

The changes are sensed, not the actual switch positions. The camera functions subject to these limits are PAN, TILT, ZOOM, FOCUS, and IRIS.

In the above case the pan or tilt rate could have been different. Another conflict can arise when the ground commands PAN at one rate and the onboard commands TILT at the other rate (to the same camera). In this case both PAN and TILT will be at the rate selected by the command last received. For instance, the crewmember was panning at the slow rate when an uplink command to TILT up fast was received (same camera), both the PAN and TILT would run in fast. If the crewmember released his pan, the PAN would stop and the TILT would continue at the high rate. If the PAN switch were pressed again, the PAN and TILT would run at the SLOW rate. If the crewmember released his PAN switch, the pan would stop and the TILT would continue but at the SLOW rate. Any subsequent uplink, PAN or TILT, would run at FAST, or a PAN/TILT FAST command could be sent which would cause the TILT to go back to FAST.

When command changes from both ground and onboard are sampled together (in commands in the same vertical field interval), the onboard overrides the ground.

Note: Since the RCU responds to switch changes when in the CMD mode (POWER CONTR switch in CMD), the PAN/TILT rate switch is ineffective until a camera motion switch is changed; i.e., if a PAN is in progress and the rate switch is moved, no rate change will occur until the PAN is stopped and restarted or some other PAN/TILT motion is started.

Nonsimultaneous commands (occurring during different video fields) are executed independently.

### 16.3.7 Voice Interleaver and Asynchronous Mode (Ground Only)

The standalone commands control the operation of the voice interleaver and the asynchronous video mode. These commands operate in a straightforward fashion. Whenever an asynchronous source is being downlinked (i.e., a VTR dump), the asynchronous mode must be entered, and the voice interleaver **must** be turned off.

Note that there are no crew switches for these functions.

#### 16.3.7.1 Asynchronous Mode

The VSU samples camera video synchronously. Therefore, a nonsynchronous source may result in false readings. In addition, the VSU inserts a Greenwich mean time (GMT) time code on line 15 of all video inputs; and, if a camera overtemperature is sensed, an overtemperature flag is inserted on line 16 of the downlink. This is also done synchronously, so an asynchronous source would have the timecode and/or overtemperature flag (and interleaved audio, should that be turned on) inserted in the wrong places. A more serious problem is that a false temperature reading (from the asynchronous source) could result in a false SM ALERT. To prevent this, the asynchronous mode (async mode) is entered via MDM command. In the async mode, the VSU is inhibited from all camera sampling except pan/tilt angles. This is a hardware inhibit and the VSU microprocessor does not know it is inhibited, so it will read zeros for all parameters. Also, GMT insertion is inhibited. The audio interleaver is not inhibited. This will cause the ALC and GAMMA telemetry on panel A7 and on downlink to freeze, possibly in a random configuration. No camera temperatures are sensed so an overtemperature alert will not occur.

#### 16.3.7.2 Onboard Effects of Async Mode

Since the async mode inhibits VSU sampling of camera temperature, the VSU limit-sensing of camera temperature is disabled, the SM alert for camera overtemperature is disabled, and camera temperatures will not be available to the crew. Pan and tilt angles are sensed, so the crew alphanumeric display (on the TV monitors) will read correctly. ALC and GAMMA settings are not sensed, so the ALC and GAMMA PBI's on panel A7 will freeze (possibly in a random state). The crew can still command ALC and GAMMA, and the camera will respond, but the talkbacks will not work. Note that this applies to all cameras, not just the asynchronous source.

#### 16.3.7.3 Ground Effects of Async Mode

The only effect on the ground operations is that the OI telemetry parameters for ALC and GAMMA are static (possibly in a random state), and the GMT is not inserted in the video. If a real-time source is being downlinked, the GMT readout on the TV monitor will be static. If a VTR is being dumped, the TV monitor display will show the data of the recorded source; i.e., the GMT when the recording was made. Since the VTR is the only source normally downlinked in the async mode, our operations are not impacted.

#### 16.3.7.4 Audio Interleaving

The VSU has the capability to interleave a single delta modulated voice channel in the downlink video. The channel can be either ICOM A, ICOM B, or both mixed together. The audio is routed from the payload bay intercom channels. The format of the bits is shown in figure 16-11. Lines 22 to 261 contain a leading "one" for sync and two data bits. Line 262 contains 46 bits. The voice is delta modulated in the VSU at a 31.6 kHz rate (2 X horizontal line rate). Note that the interleaved audio goes only to the downlink channel. The interleaved audio is used on some Spacelab flights; however, on non-Spacelab flights it is not used because of lip sync problems when retrieving the video for playback by the ground.

#### 16.3.7.5 Limit on Split-Screen OPS

Split screen operation with a nonoperating (off or failed) or nonexistent camera will cause loss of video synchronization on the ground. This will propagate throughout the video system (and to the commercial broadcasters if they are broadcasting our video). This occurs because a nonoperating or nonexistent camera will output zero volts, sync tip level (fig. 16-13). When commanding a split screen, make sure both cameras are on before the split screen is downlinked.

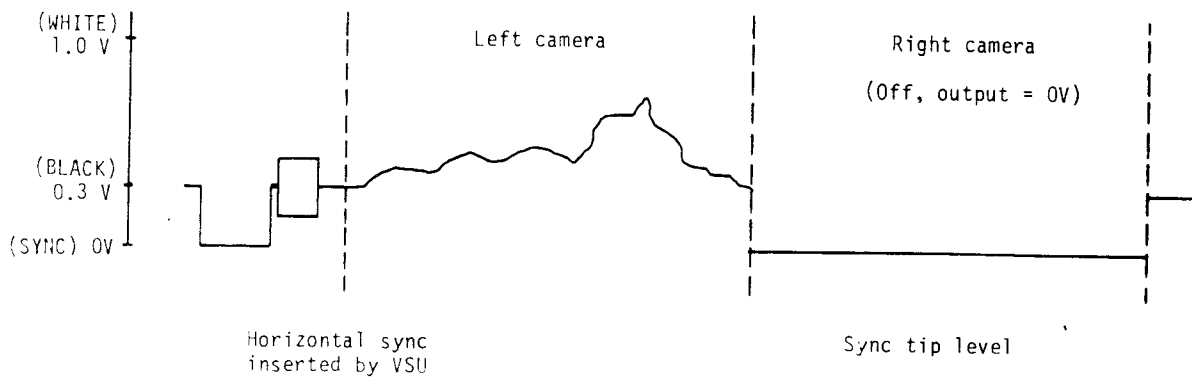


Figure 16-13.- Output of the MUX when one source is inactive.

### 16.3.8 Suggested Techniques for TV OPS

Note: Get permission from the crew before using any cameras. This is especially important for the cabin cameras and for the payload bay cameras when the crew is doing some sort of payload bay OPS.

#### Payload Bay OPS

- A. Lighting is the big problem. Try using ALC-Peak and Gamma NORM. Use the GAMMA white and black to try and bring out detail in a light or dark area if desired. The best technique is to pan and tilt in order to get the bright spots out of the view.
- B. When trying to see a small bright object against a dark background (like space) the only way to do much good is to use the manual ALC options. Go to GAMMA white and use the manual iris to get good contrast on the object. Remember not to leave the camera this way unattended. It is very susceptible to Sun damage while in manual ALC control.
- C. Zoom out before panning or tilting. Otherwise, it is easy to "get lost" in the payload bay.
- D. Use pan tilt in the slow rate. The fast rate is too fast usually for operation from the ground because of the delay in TDRS transmission.

Use fast only when you have a long way to go and not much time to get there.

- E. Use the zoom selectively. When shooting PAO shots, start wide, zoom in on an area of interest, then go back out wide. Try to make smooth transitions from one zoom setting to another. Do not "step" the zoom setting. Get a good idea of the shot wanted and go after it.

#### Inside the Cabin TV OPS

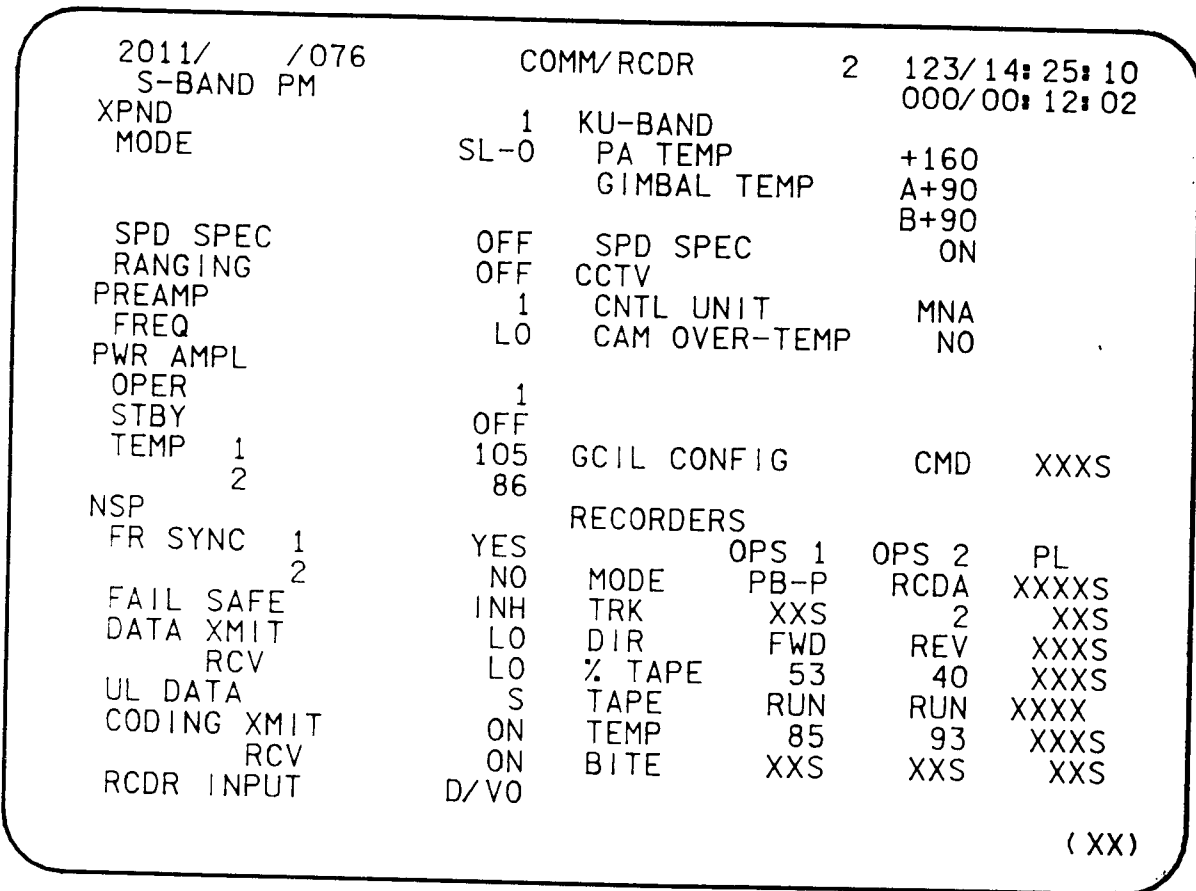
- A. Lighting is still the big item. Try to get bright lights out of the view by using the zoom.
- B. ALC - NORM and GAMMA - NORM gives the best color performance. (PAO' likes good color). This is due to the setup of the color converter in building 8.
- C. Again do not use short jumpy zooms. Decide on the view wanted, go there, and stay for a minute. Start wide, zoom in on an area of interest (if possible), then go back wide. When adjusting the ALC and GAMMA for best picture, get one that is fairly good and leave it alone. The most common mistake is continually "fooling with" the camera settings. Better is the enemy of good.

#### 16.3.9 Telemetry

The OI Telemetry is listed in table 16-IV. There is some additional data presented to the crew.

A set of alphanumerics is displayed on either of the onboard monitors (fig. 16-7). It can be removed by placing the data switch in the OFF position. Electronically generated crosshairs are also available. The alphanumerics show the camera location, the pan and tilt angles, and, if an overtemperature camera has been detected by the VSU, the temperature of the displayed camera. The temperature will not be present unless one of the cameras is overtemperature (not necessarily the one on the monitor). An overtemperature condition will also set off an SM alert. The alert will issue the standard S76 COMM message. The crew will have to call up the COMM RCDR display to check if a TV camera is overtemperature (fig. 16-14).

The MCC also has a unit which decodes the data from the video. This is called the vertical interval data deinterleaver (VIDD). The data detected by the VIDD is displayed on the INCO/Comm Supt TV monitor. The display is illustrated in figure 16-15 and explained in table 16-V.



(XX)

186111605. ART, 3

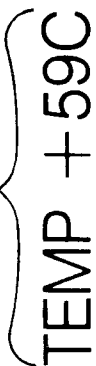
Figure 16-14.- COMM/RCDR display.



Appears only  
when audio is  
detected



TEMP blinks  
when overtemp  
pulse detected



KEEL ALC P<sup>A</sup> PAN -162.3 GMT 365 23 59 59  
999 GAM N TLT +000.6

Indicates  
AUTO IRIS



(VERTICALLY POSITIONABLE)

Figure 16-15.- MCC monitor data display.

16.4 SPECIAL TM COMPS

M01I0603R CCTV D/L SELECT

<u>Comp measure-</u> <u>ment name</u>	<u>Input parameters and logic</u>											<u>DTE TXT</u> <u>output</u>	<u>Comp name</u>
M01I0603R	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0		TV CAMERA DOWNLINK SELECT
	78	77	78	77	78	77	78	78	78	77	77		
	42	49	42	49	42	49	42	42	43	49	49		
	X5	X5	X6	X6	X7	X7	X8	X9	X0	X8	X9		
	-E	-E	-E	-E	-E	-E	-E	-E	-E	-E	-E		
	1	0	0	0	0	0	0	0	0	0	0	FWD	
	0	1	0	0	0	0	0	0	0	0	0	PL1	
	0	0	1	0	0	0	0	0	0	0	0	KEEL	
	0	0	0	1	0	0	0	0	0	0	0	PL2	
	0	0	0	0	1	0	0	0	0	0	0	AFT	
	0	0	0	0	0	1	0	0	0	0	0	PL3	
	0	0	0	0	0	0	1	0	0	0	0	SRMS	
	0	0	0	0	0	0	0	1	0	0	0	PRMS	
	0	0	0	0	0	0	0	0	1	0	0	FLT	
	0	0	0	0	0	0	0	0	0	1	0	MID	
	0	0	0	0	0	0	0	0	0	0	1	CAB3	
	0	0	0	0	0	0	0	0	0	0	0	"BLANK"	
	Any other combination output											INVL	
<u>M09I0603R</u>	<u>V74X0843E</u>	<u>V74X0844E</u>	<u>V74X0845E</u>										TV ALC SELECT
	1	0	0										
	0	1	0										
	0	0	1										
	0	1	1										
	1	0	1										
	1	1	0										
	0	0	0										
	1	1	1										
<u>M10I0603R</u>	<u>V74X0846E</u>	<u>V74X0848E</u>											TV GAMMA
	1	0											
	0	1											
	0	0											
	1	1											