COHU, INC. Electronics Division

Installation and Operation Instructions

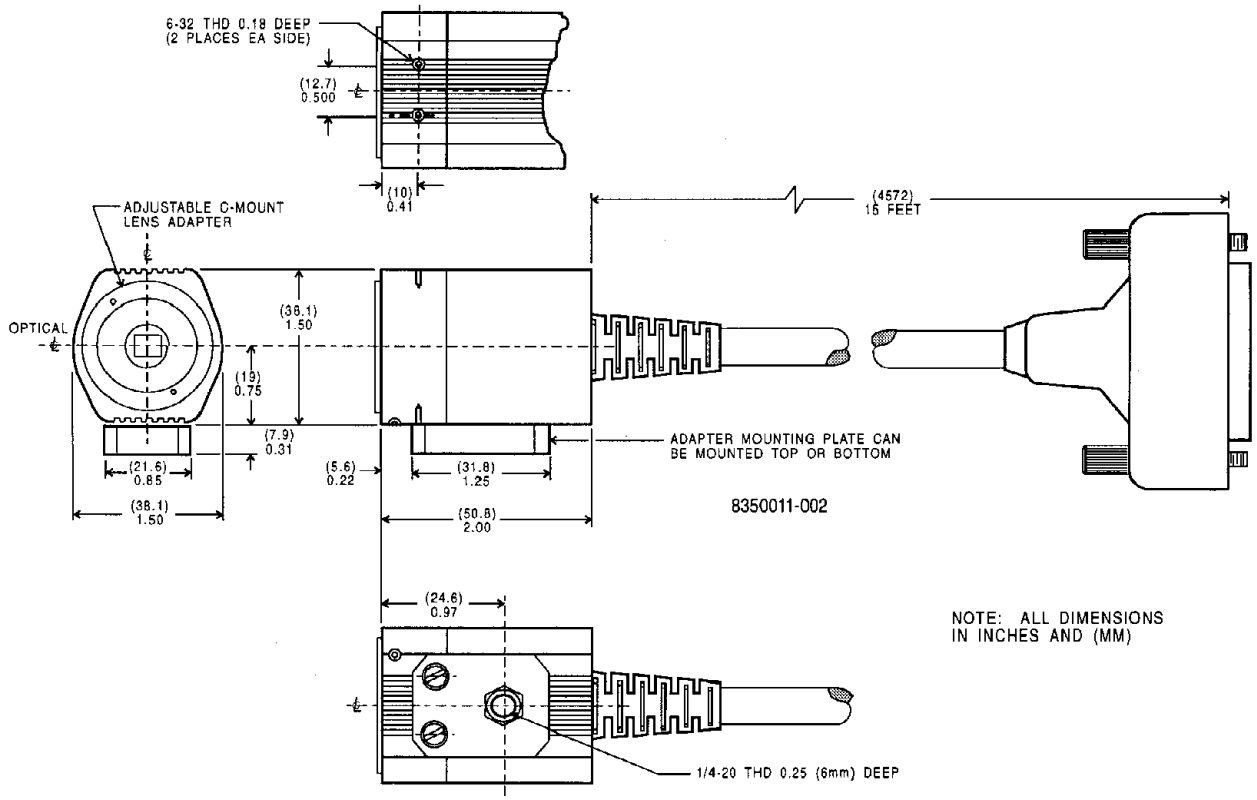


Fig. 1. Dimensions, Camera Head

4990 SERIES
RS-170 AND CCIR
REMOTE HEAD CCD CAMERAS

3912 CALLE FORTUNADA SAN DIEGO, CA. 92123-1827
PHONE 619-277-6700 FAX 619-277-0221 EMAIL INFO@COHU.COM
COHU
Cohu, Inc./Electronics Division

1.0 ELECTRICAL CHARACTERISTICS

The 4990 monochrome Camera consists of a small camera head connected by a 15 foot (4.6 meter) cable to a camera control unit.

This camera uses a 1/2-inch format HAD interline transfer sensor. This sensor offers lower dark current, image lag, and blooming than other types of sensors. It also has improved dynamic range and spectral characteristics. A 1000:1 overload capacity prevents bright incidental light in a scene from deteriorating the video. The agc has a 20-dB range. See **table 1** for a complete list of specifications.

Field transfer is the normal operating mode but frame transfer can be selected with an internal repositionable jumper. Section 13 describes differences between these two operating modes.

The Camera is available in RS-170 and CCIR versions. See **table 2** for a model number interpretation chart.

When an RS-170 version of the Camera operates with the internal crystal as the sync reference source, its field rate is 59.94 Hz. This is consistent with RS-170(A) specifications, making the Camera compatible with field and line rates for color systems. When genlocked, the Camera operates at whatever field rate the input pulse supplies.

A line-locked RS-170 version of the Camera operates at a 60-Hz field rate; a line-locked CCIR version operates at 50 Hz.

On the rear panel of the CCU, a screwdriver adjustment for line-lock PHASE provides 180-degree control range. If additional adjustment range is required, the low-voltage ac power input leads to the rear panel can be reversed to provide an additional 180-degree phase shift.

A top-panel CONTROL ACCESS cover plate can be removed to access seven recessed controls and switches.

An optional electronic iris automatically operates the electronic shutter through a light control range from 1/60 (1/50) to 1/10,000 second, a seven-stop range. About four seconds is required to go from one end of range to the other. This option is used with a manual iris lens so that an auto-iris lens is not required. The electronic iris can be switched on and off with the top panel ELECT IRIS switch.

When the ELECT IRIS switch is OFF, the iris is manually controllable by another top-panel switch. This switch can be set to any of eight positions from OFF (1/60, 1/50) to 1/10,000 second.

Integration is controlled by application of a control pulse input on the rear panel AUX (auxiliary) connector. Two other pins of this connector provide a complementary grab-pulse output.

When internal jumpers are positioned to the reset mode (not to the normal/genlock mode), the Camera can be asynchronously reset at any time by application of a reset pulse to the AUX connector at pin 6. This initiates a vertical-blanking interval 2.5 microseconds later. Video output from the BNC connector then follows the vertical blanking interval, which, for RS-170, is about 1.2 milliseconds (19 to 21 lines) wide. For CCIR, vertical blanking is about 1.6 milliseconds wide (25 lines). This first field of video will most likely be of reduced video level because the reset pulse will have cut the sensor integration period short. Subsequent fields will have a normal video level.

If in frame mode, the first two fields making up an interlaced frame will likely be of reduced (and different) video levels. Subsequent fields making up the frames, though, will be of normal video level.

2.0 MECHANICAL CHARACTERISTICS

2.1 Camera Head

See **figure 1** for dimensions of the camera head.

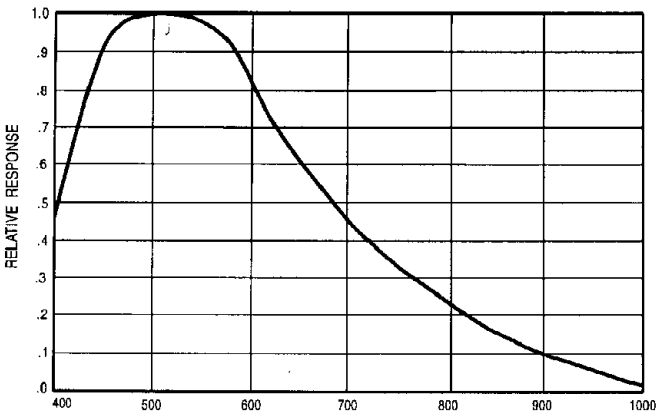
Two circuit boards mount inside the camera head. At the rear is a driver board, at the front a sensor board. Between the sensor and the lens opening is either a permanently attached glass plate or the optional IR blocking filter. The response of this IR filter appears in a chart accompanying the specifications in table 1.

The circular opening at the front of this casting is threaded to accept a 1.250-32 UNS-2A lens mount adapter. The Camera is supplied with an adapter of a width intended to provide 17.5 mm back spacing for use directly with C-mount type lenses. A CS-mount cannot be used.

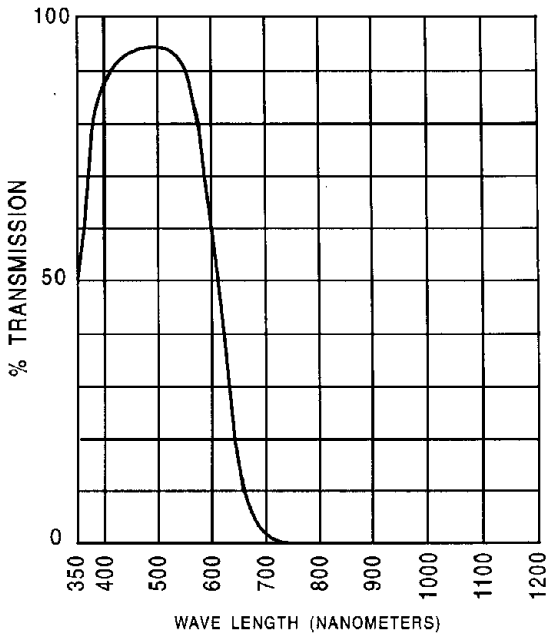
Opposite each other at the top and bottom of the camera head casting are threaded holes, two on top and two on the bottom. A mounting adapter plate supplied with the camera head can be fastened at either of these locations. It fastens to the camera head with a pair of 6-32 × 5/16 fillister head screws. This plate contains a pressed in swage nut with threads to accept a standard 1/4-20 UNC mounting bolt for securing the camera head to a mounting device.

Table 1. Specifications

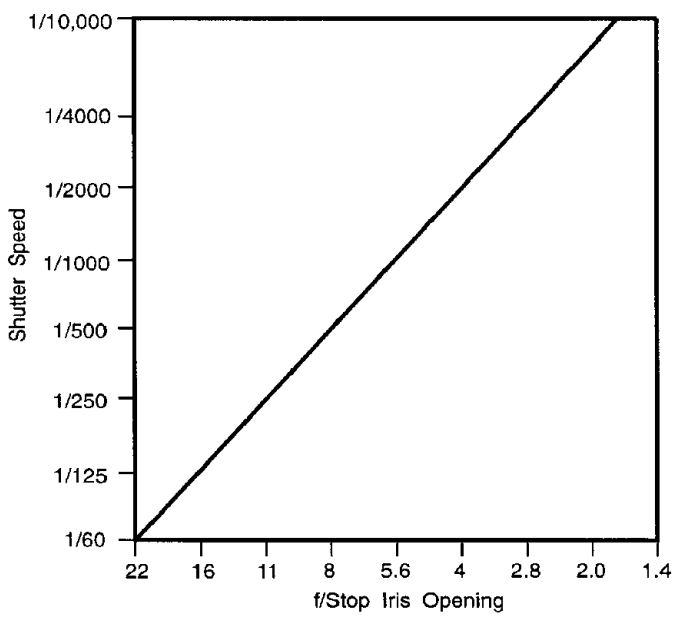
ELECTRICAL	
Image Area	6.4 x 4.8 mm (corresponding to a 1/2-in. image tube)
Active Picture Elements	RS-170 768 (H) x 494 (V) CCIR 752 (H) x 582 (V)
Imager Type	HAD interline transfer CCD
Cell Size	RS-170 8.4 (H) x 9.8 (V) microns CCIR 8.6 (H) x 8.3 (V) microns
Resolution (TV lines)	RS-170 580 horizontal, 350 vertical CCIR 560 horizontal, 450 vertical
Sensitivity, 2854 K (Faceplate)	See table 1a
Electronic Shutter	Eight steps. OFF (1/60, 1/50), 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/10,000 second
Integration	Field (1/60, 1/50) or frame (1/30, 1/25), internally jumper selectable Controllable period through external input pulse Grab pulse output provided
Video output	1.0 V p-p, 75 ohm, unbalanced
Gamma	Continuously variable 0.45 to 1.0
Agc	26 dB
Signal-to-Noise Ratio	56 dB, gamma 1, gain 0 dB 38 dB, gamma 1, agc maximum gain
Auto Lens	Separate lens video output eliminates agc/auto-iris lens interaction (peak/average adjustable) Lens power output +15 V dc, 35 mA maximum
Sync	Genlock, revert to variable phase line lock, zero crossing detector (Includes H and V Drive Inputs) Genlock, revert to crystal (Includes H and V Drive Inputs) Asynchronous reset Internal clock: 28.6363 MHz RS-170(A) or 28.375 MHz CCIR
Input Power	12 V ac/dc (standard) 24 V ac/dc optional 115 V ac, 60 Hz (optional on RS-170 models. Wall transformer with cable provides 12 V ac to Camera) 230 V ac, 50 Hz (optional on CCIR models. Wall transformer with cable provides 12 V ac to Camera) 4.2 watts dc power consumption Green LED power indicator
MECHANICAL	
Dimensions	See figures 1 (camera head) and 2 (CCU)
Weight	Camera Head, less lens and cable: 4 ounce (113 grams) 15 foot (4.6 meter) Remote Cable: 17 ounce (483 grams) CCU: Less than 30 ounces (850 grams)
Lens Attachment	C-mount, provides 17.5 mm back spacing
Camera Head Mounting	1/4-20 threaded hole on adapter plate (provided) that mounts to top or bottom of camera head (See fig. 1)
ENVIRONMENTAL	
Ambient Temperature Limits	Operating: -20 to 60 °C (4 to 140 °F) Storage: -30 to 70 °C (-22 to 158 °F)
Relative Humidity	Up to 95%, noncondensing
Vibration	Sine vibration from 5 to 60 Hz with 0.082 inch total excursion (15 g's at 60 Hz) Random vibration from 60 to 1,000 Hz, 5 g's rms (0.027 g^2 /Hz) without damage
Shock	Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6
Cohu reserves the right to change specifications without notice	



SENSOR SPECTRAL RESPONSE



IR BLOCKING FILTER RESPONSE



Reference Level Set at 1/60 f/22

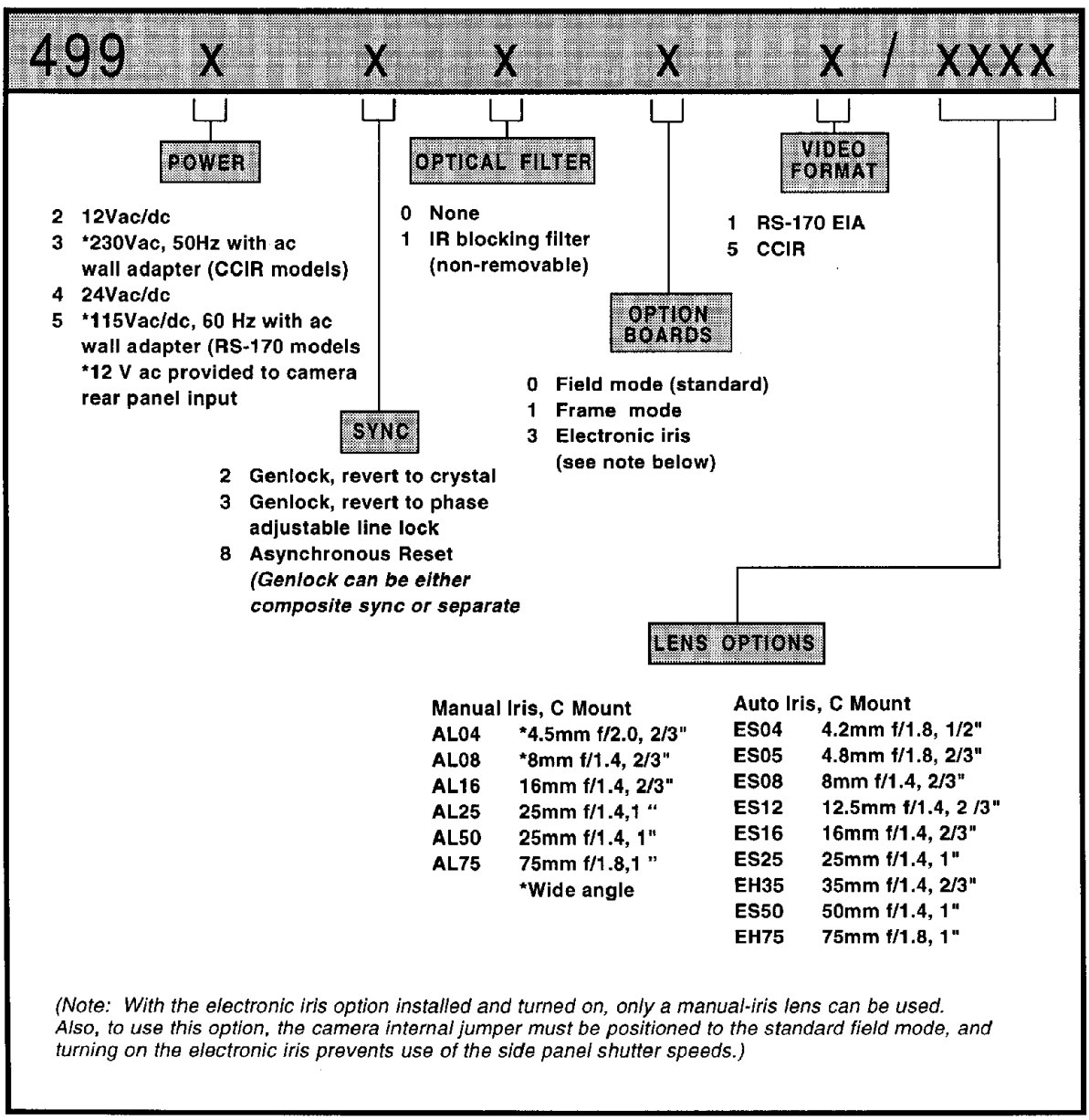
TYPICAL f/STOP VS. SHUTTER SPEED FOR EQUIVALENT LIGHT AT SENSOR FACEPLATE

Table 1a. Faceplate Sensitivity

Sensitivity	Full Spectrum	With IR Blocking Filter
Full Video, No Agc	0.65 lux (0.065 fc)	2.5 lux (0.25 fc)
80% Video, Agc On (20 dB)	0.02 lux (0.002 fc)	0.2 lux (0.02 fc)
30% Video, Agc On	0.016 lux (0.0016 fc)	0.03 lux (0.003 fc)

Note: Sensitivity in the non-interlaced frame mode will be one-half the values given in the table

Table 2. Model Number Interpretation



(Note: With the electronic iris option installed and turned on, only a manual-iris lens can be used. Also, to use this option, the camera internal jumper must be positioned to the standard field mode, and turning on the electronic iris prevents use of the side panel shutter speeds.)

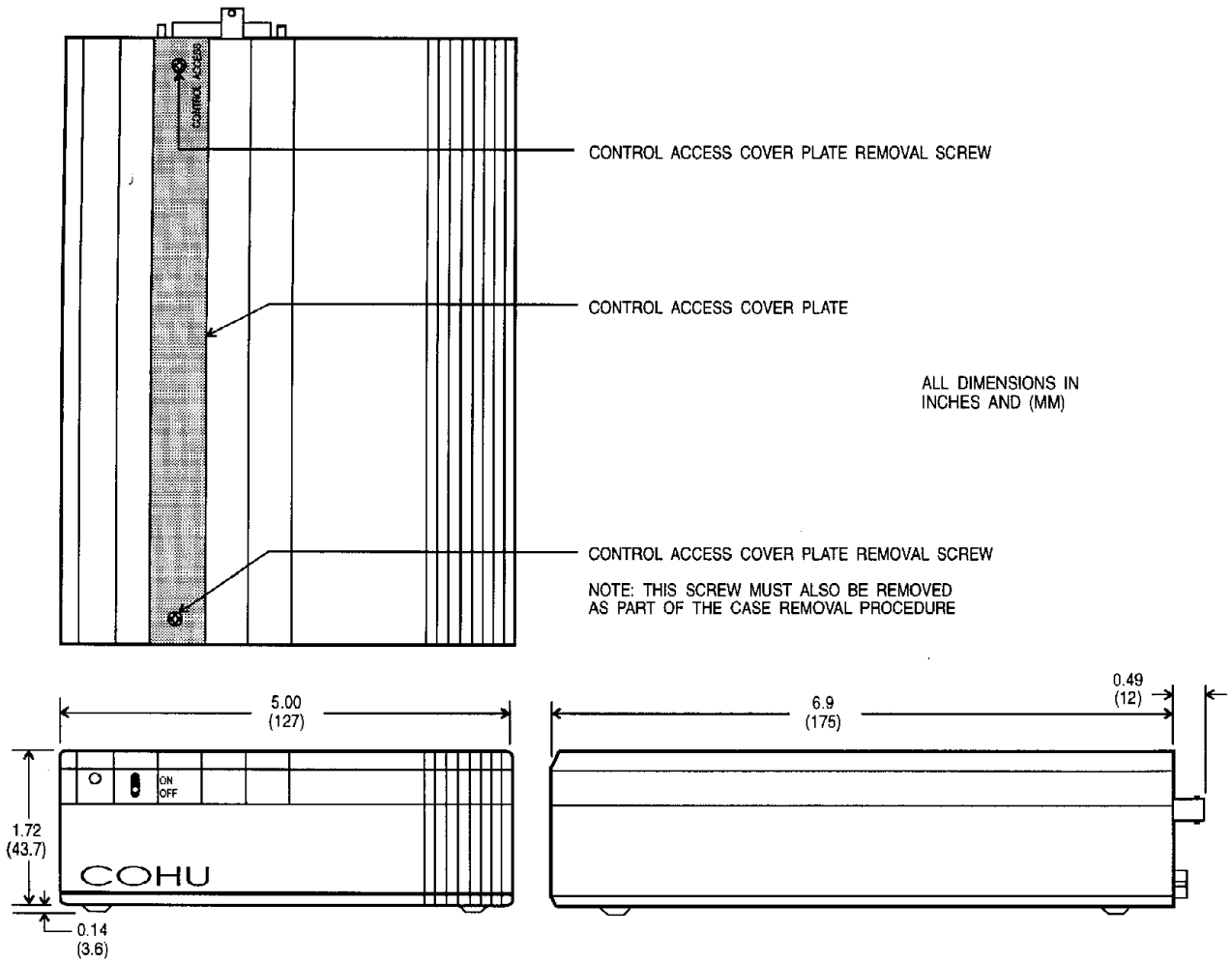


Fig. 2. Dimensions, CCU

2.2 Camera Control Unit (CCU)

See **figure 2** for a dimensional drawing of the CCU.

The majority of circuits for the Camera mount on two circuit boards plugged into an interface board at the front. The two boards are secured along each side by guide rails. A cable connects this interface board to the camera head connector on the rear panel of the CCU.

When the optional electronic iris circuit board is installed, it mounts to two connectors on the video/sync board.

The top of the case has seven holes down its length for access to certain switches and adjustments on the video/sync board. A decorative, protective CONTROL ACCESS cover plate, held in place by two 2-56 × 1/8 flathead screws, covers these holes when access is not required.

All interconnections are made on the rear panel of the CCU. **Table 3** lists part numbers for each of these rear panel connectors and also supplies part numbers for the mating cable connectors. Both the factory part number and a part number from an alternate source are given. This alternate number is either the part number from a manufacturer of that connector or the part number from an alternate supply source such as a distributor or importer.

3.0 POWER REQUIREMENTS

Input power is applied to the CCU rear panel. From this input, it routes through the on/off switch to filtering and then to a bridge rectifier.

Optoisolators and a flyback transformer in the CCU isolate power input circuits from other circuits in the Camera. This has the same effect as an isolation transformer on the input. The advantage to this isolation is that it allows multiple Cameras to be operated from a single 12 V ac source without interference or other problems.

Power input to a standard version of the Camera is 12 V ac or +12 V dc. (A 24-volt option is available.) With ac input to the rear panel, an RS-170 version must receive 60-Hz power, a CCIR version 50 Hz. Power leads for dc power can be applied to either input without regard to polarity. (When setting up operation in the line-lock mode, it is sometimes necessary to switch the two leads at the rear panel so that the ac input is reversed 180 degrees in phase. See section 11.0.)

If a 12-volt version of the Camera is to be operated from ac line power, optional plug-in wall transformers are available to step down the line voltage to 12 V ac. Both 115-V ac 60-Hz and 230-V ac 50-Hz plug-in wall transformers are available for use with corresponding versions of the Camera.

If the Camera is to operate from a 12-V ac or dc power supply, the supply leads must have a 1/2-amp time-lag fuse in series.

If a Camera with the 24-V ac/dc option is to operate from a 24 volt power supply, the power lead must have a 1/4-amp time-lag fuse in series.

A front panel lamp illuminates to indicate when the adjacent power switch is set to on with power applied.

4.0 EQUIPMENT SUPPLIED

The following list does not include any optional or special-request items. A lens ordered with the Camera will either be installed on or packed with the Camera. The connector for an auto iris lens will be attached to its cable.

1. Camera, 4990 series
2. Manual, Installation and Operation (6X-947)
3. Adapter, C-mount, part No. 8350008-001
4. Plug, auxiliary connector (for J21 on rear panel)
5. Plug, lens connector (for J37 on rear panel)
6. Tool, Alignment, part No. 9710032-001
7. Wrench, Allen, L-type, 5/64 inch, part No. 9710010-012

5.0 EQUIPMENT REQUIRED BUT NOT SUPPLIED

The first two items are the minimum required to make use of the Camera. These items are listed in the model breakdown for the Camera and are typically ordered and supplied at the time of purchase. Items 3 and 4 are optional items required to take advantage of Camera capabilities.

An asynchronous sync reset source is required only if the camera vertical interval must be timed to some external event.

The frame grabber is required to use the integration feature. To make use of integration, a start/stop pulse must be supplied to the Camera. The Camera then provides as an output a grab-pulse for use by the frame grabber.

Table 3. Rear Panel Interfacing Connectors

NAME	CAMERA REAR PANEL CONNECTOR		MATING CONNECTOR FOR CABLE	
AUX (J21)	1310373-008 8 Pin Mini DIN Jack	Singatron MDJ-102-8PS	1310373-108 8 Pin Mini DIN Plug	TRW-Cinch MD-8P
LENS (J37)	1310375-003 3 Pin Mini DIN Jack	Hosiden TCS7537-01-201	1310373-103 3 Pin Mini DIN Plug	TRW-Cinch MD-3P
POWER (J25)	1310378-001	Weco 180-A-111/02	N/A - Requires Stripped Wire Ends	—
VIDEO (J32)	BNC Jack	—	BNC Plug	—
CAMERA (J12)	1310370-115 D-15 Male	Amp 747833-5	*D-15 Female	AMP HDE-20 15 pin

#For extender cable and lens, see fig. 9.

**Part of a cable assembly*

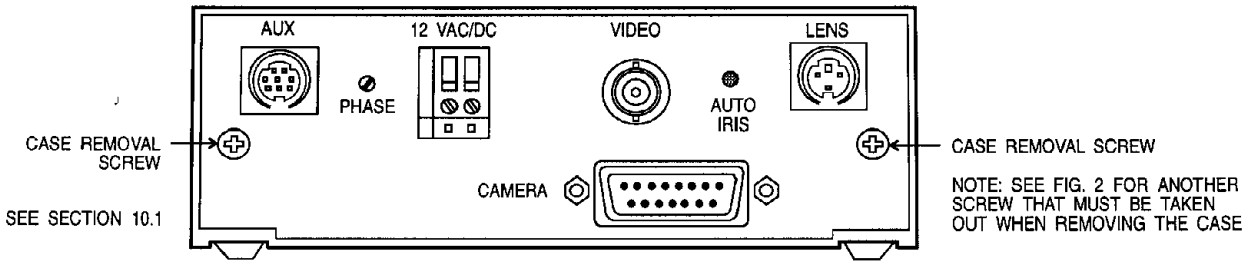


Fig. 3. Rear Panel, CCU

1. Lens, TV type, C-mount (When using the optional electronic iris circuit, a manual iris lens is required)
2. Power supply, ac or dc
3. Sync reset source, asynchronous
4. Frame grabber, with integrate start/stop pulse output and grab-pulse input

6.0 UNPACKING AND RECEIVING INSPECTION

Carefully inspect the shipping container for damage. Contact the shipping agent is any is noted. Otherwise, unpack the camera and inspect the internal contents for any damage, again contacting the shipping agent if any damage is noted. To return the product to the factory for service, please contact the Customer Service Department for a Return Authorization Number.

7.0 STATIC DISCHARGE PROTECTION

Components used in modern electronic equipment, especially solid state devices, are susceptible to damage from static discharge. Use all appropriate precautions to prevent damage to the Camera.

8.0 INSTALLATION PROCEDURE

This summary of the installation procedure assumes that the Camera may not be properly set up for the intended application. Internal jumpers may have to be repositioned and top panel controls may require new settings. The Camera is then turned on so that back focus (C-mount adjustment) can be checked out before mounting at its permanent location. If the Camera is known to be properly set up for the intended application, only steps 8 through 11 need be performed.

Additional information about these procedures follows this summary of the installation procedure. Do not begin the installation without referencing the subsequent sections that provide detailed instructions about the installation. This list is merely a summary of the installation procedure. **Figure 3** shows the CCU rear panel, where all interconnections are made.

Read the following 11 steps to obtain a general overview of installing the Camera. A typical installation consists of:

1. Installing the required power, video, and auxiliary connector cables between the CCU location and the operator's console or equipment room

2. Removing the case and setting up internal jumpers for the desired operating conditions

3. Installing the lens (and, for an auto iris lens, connecting the lens video cable)

4. Connecting power and video (and, if required, sync)

5. Checking back focus and adjusting the lens C-mount adapter if necessary

6. Setting up top panel controls for the intended application (if required)

7. Removing power, video, and sync cables

8. Mounting the Camera at its location

9. Connecting power, video, and any other required cables

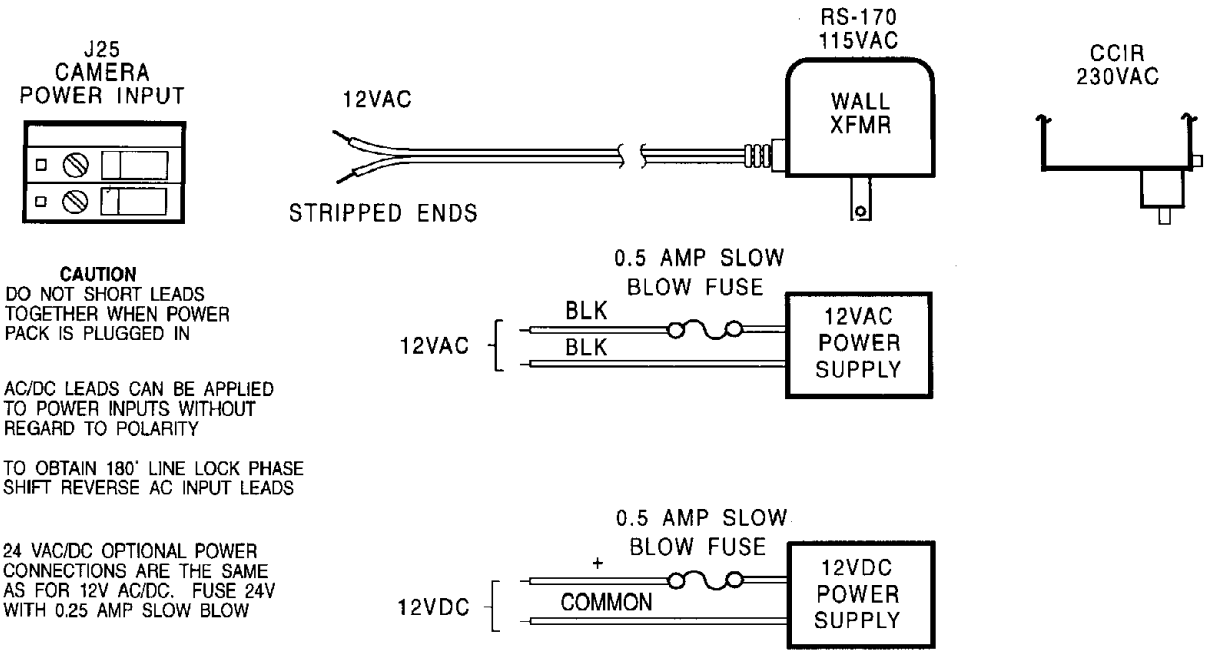


Fig. 4. Power Supply

10. Adjusting the Camera and lens to view the scene of interest

11. Making any required final adjustments to top panel controls, the rear-panel line-lock PHASE adjustment, and the manual-iris lens if the electronic iris option is being used

8.1 Power Connections

CAUTION

Do not apply voltage outside the recommended operating range of the Camera (12 V ac/dc ±10%, or 24 V ac/dc ±10%, depending on the option.)

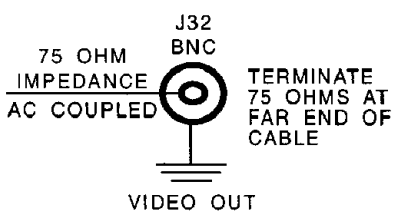


Fig. 5. Video Output Connector (J32)

The Camera requires either 12 V ac/dc or optionally 24 V ac/dc ±10%. A 12-volt version of the Camera operates from 115 V ac, 60 Hz (or 230 V, 50 Hz) power by using an optional external plug-in wall transformer (**figure 4**). If the Camera is to operate from a power supply other than the optional wall transformers, use a 0.5-amp time-lag fuse (0.25-amp time-lag fuse with the 24-volt version of the Camera).

8.2 Video Connections

Standard 1-volt peak-to-peak composite video is available at the rear panel BNC connector (**figure 5**). This is a standard 75-ohm ac coupled video output. Use 75-ohm coaxial cable. A 75-ohm termination must be used at the equipment connected to this cable. When multiple equipment is connected to the video output in a loop-through arrangement, only the last item of equipment at the end of the cable should be terminated. All other equipment must present a high impedance to the cable.

8.3 Genlock Inputs

Applying composite sync (sync containing both horizontal sync and vertical sync pulses) to pin 2 of the AUX connector (**figure 6**) takes control of the Camera away from the internal sync reference. (The internal reference is either the crystal or the line-lock reference. Line lock can be used only if the

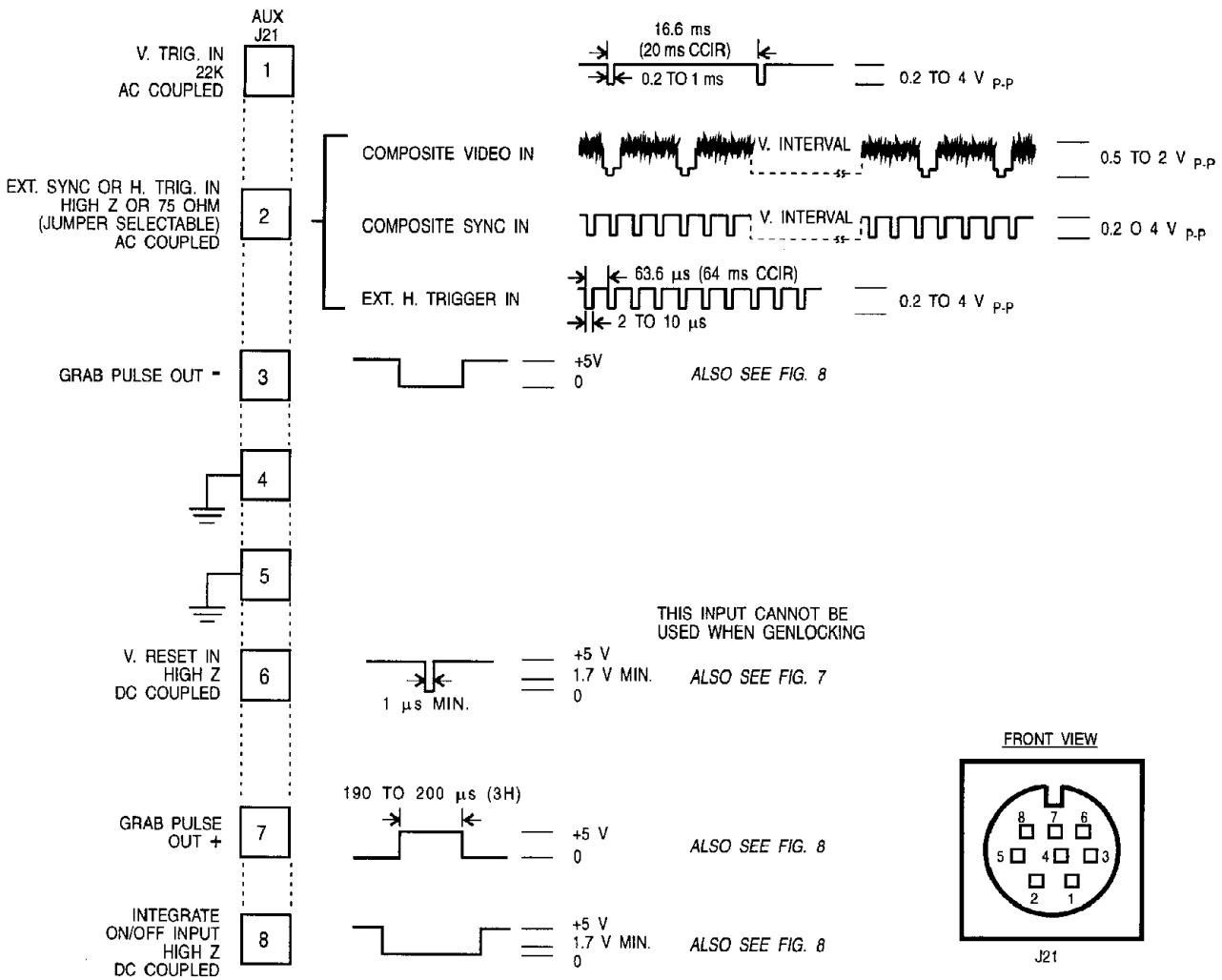


Fig. 6. Auxiliary Connector (J21)

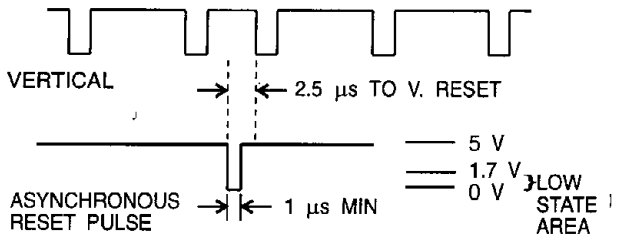


Fig. 7. Timing Diagram, Asynchronous Vertical Reset Delay

Camera is operating from low voltage ac at the rear panel.)

When the Camera genlock input is on a cable with other Cameras (or video equipment), only the Camera or equipment at the end of the cable away from the sync source can have its internal 75-ohm termination selected. If the Camera is mid-cable in such an arrangement, be sure that jumper JB80 on the genlock/power-supply board is removed. Removing the jumper allows the input to become a high impedance instead of 75-ohms. This jumper can be stored by plugging it onto only one of the two pin.

The Camera can also be connected to a sync reference consisting of horizontal-trigger pulses applied to pin 2 on the AUX connector and vertical triggering pulses applied to pin 1.

8.4 Asynchronous Input

Repositionable jumpers on the video/sync board must be positioned to RST (reset) when the asynchronous reset feature to be used. It cannot be used if the jumpers are positioned to the NOR (normal) mode, which is genlock.

An asynchronous reset is initiated when pin 6 of the AUX connector is pulled low (below 1.7 volt). The vertical interval of the Camera then resets 2.5 microseconds later (**figure 7**). Note that the minimum allowable width of the reset pulse is 1 microsecond.

Since application of the reset pulse most likely interrupts the sensor before the end of an integration period, the first field of video out of the Camera following reset will be of a reduced video level. (If operating in the interlaced frame mode, the second field will also have a reduced level.) Subsequent fields would then be of normal video levels.

8.4.1 Strobing with Asynchronous Input

To capture rapidly moving or periodic events, a strobe light can be used in conjunction with an asynchronously reset.

The camera should be operated in frame mode so that both fields are produced by the strobe. See section 13 for a description of field and frame modes.

This strobe can occur during either of two periods (**figure 8**) following application of the reset pulse:

1. Beginning 2.5 µs after application of the reset pulse and throughout a 9 Horizontal line interval (14.5 H for CCIR) until a transfer gate occurs. This is a strobing window of about 572 (928) microseconds.

2. Beginning 9.5 H (15 H for CCIR) after the vertical drive is reset and continuing throughout a full vertical interval — 1/60 (1/50) second — until the next transfer gate occurs.

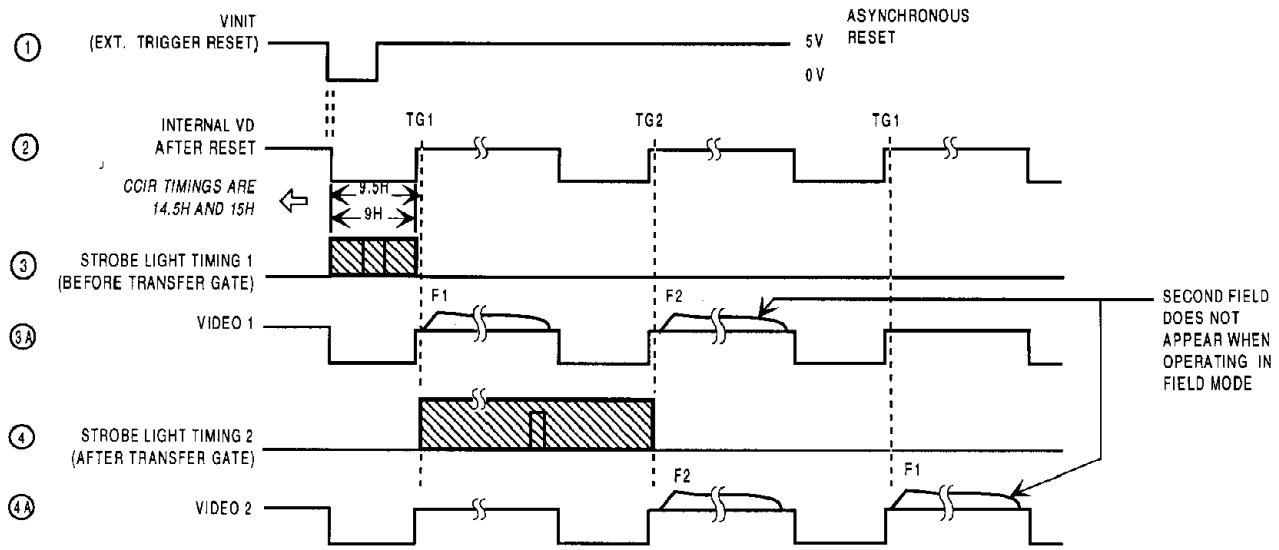
Figure 8 also shows the related fields of video produced by a strobe during either of these two strobe periods.

Captions accompanying the waveform in figure 8 more fully describe their relationships. For a detailed view of the 2.5 µs delay between application of the asynchronous reset pulse and the start of a new vertical drive see figure 7. It expands this timing area to show both the 2.5 µs delay and the required 1 µs minimum duration for the asynchronous reset pulse.

Ambient Light Considerations

When planning to use a strobe light with the camera, some consideration should be given to ambient lighting on the scene and to the setting of the lens iris. When the camera is asynchronously reset, any image integrated on the sensor up to that time becomes part of the video output. This will be both fields if in frame mode and a single field if in field mode.

Ideally the camera should not produce any picture unless the strobe is triggered. This would require a nearly dark scene. As a practical matter, it is likely that some picture can be allowed to appear before it produces unacceptable interference with the strobe light image. A few tests will determine whether the image generated by ambient light produces unacceptable interference with the desired strobe light image.



NOTE: The following descriptions assume operation in frame mode. Since frame mode integrates both the odd and even fields simultaneously, a strobe of light produces a complete frame of video. (In field mode, however, odd and even fields are produced during separate vertical intervals; only a single field of video can result from a strobe.)

① *ASYNCHRONOUS RESET PULSE When this pulse is applied to pin 6 of J21, on the camera rear panel, the camera internal vertical drive resets. See waveform 2. (Though not detailed on this figure, a delay of 2.5* µs occurs between application of the reset pulse and internal vertical drive being reset. See fig. 7 for an expanded view.)

② *CAMERA INTERNAL VERTICAL DRIVE RESET. When the camera internal vertical drive is reset, two time periods follow during which a strobe light may be triggered to illuminate the scene. In frame mode, both fields will be integrated by the sensor when this strobe occurs during either period.*

The first period starts 2.5 µs after reset and continues for 9 H (14.5 H for CCIR) lines. The shaded area in waveform 3 shows this first period.

A transfer gate occurs in the interval reserved from 9 to 9.5 lines (14.5 to 15 lines for CCIR). This gate (TG1) initiates transfer of field 1 and then a second gate (TG2) initiates transfer of field 2 from the sensor to become video at the Camera rear panel BNC connector, J32. This is shown in waveform 3A. Be aware that ambient light on the scene may produce sufficient video to interfere with the image produced by the strobe.

The second period starts 9.5 H lines (15 H lines for CCIR) after reset and continues for a full vertical interval of 1/60 (1/50) second. See waveform 4. The transfer gate at the end of this vertical interval then initiates movement of field 2 from the sensor to become video at the Camera rear panel BNC connector, J32. A second gate initiates movement of field 1 to this output. Waveform 4A shows field 2 followed by field 1. Vertical intervals and transfer gates then repeat until another asynchronous reset pulse is applied at pin J21-6.

③ *FIRST STROBE PERIOD. After application of the asynchronous reset pulse and throughout an interval of 9 H lines (14.5 H lines for CCIR), the strobe light may be triggered to light the scene. Field 1 and field 2 are integrated simultaneously by the sensor. This results in the outputs shown in Waveform 3A.*

③A *OUTPUT FROM FIRST STROBE PERIOD. Both fields are integrated by the sensor when the strobe is triggered during the first 9 H intervals (14.5 H intervals for CCIR) after asynchronous reset. TG1 transfers out field F1 and TG2 transfers out field F2 to provide video at the camera rear panel. Both fields may have residual image from ambient light.*

④ *SECOND STROBE PERIOD. This period begins 9.5 H intervals (15 H intervals for CCIR) after asynchronous reset and continues throughout a full vertical period of 1/60 (1/50) second. A strobe light triggered anytime during this period produces both fields on the sensor simultaneously. Waveform 4A shows the video outputs derived from the sensor as a result of a strobe light being triggered during this second period.*

④A *OUTPUT FROM SECOND STROBE PERIOD. When the scene is strobed with light during the second strobe period, the first video out of the camera is field F2 — followed by field F1. Both fields may have residual image from ambient light.*

Fig. 8. Timing Diagram, Asynchronous Reset with Strobe Light Intervals

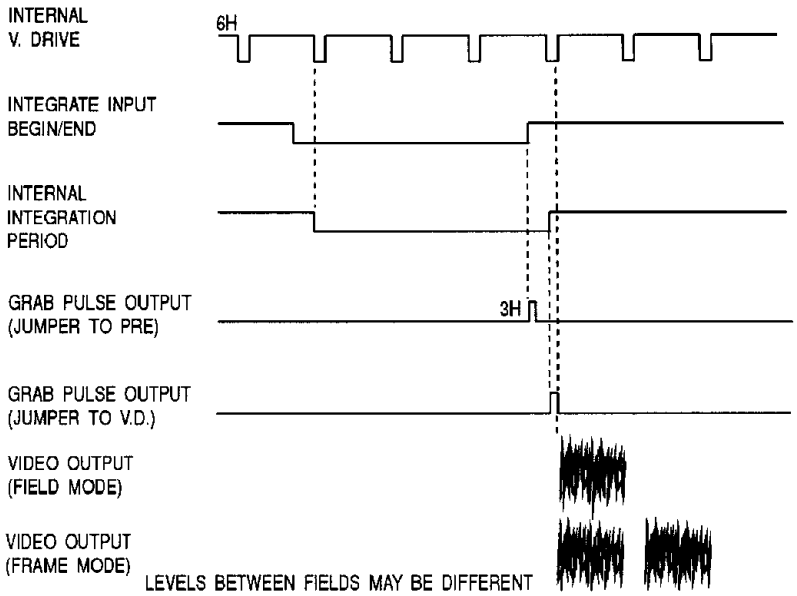


Fig. 9. Timing Diagram, Integration

8.5 Integration Input and Output

When pin 8 of the AUX connector is pulled low, integration begins with the next vertical blanking pulse. When the input is allowed to go high again, integration ends with the next vertical blanking pulse. Note in **figure 9** that integration begins and ends with the vertical blanking interval — not at the exact time of application and removal of the integration pulse. The minimum integration period is two fields. The maximum period is about four to six seconds, limited by deterioration of picture quality caused by dark current. It is best to perform tests to determine acceptable picture quality vs. integration period for an intended application.

For applications requiring longer integration periods, maintaining the Camera (sensor) at reduced temperatures will enhance picture quality by reducing noise.

8.6 Lens Installation

1. Remove the protective plastic plug or seal from the lens mount adapter opening.

2. Clean the lens and the window in front of the image sensor. Use methyl alcohol or a commercially prepared optical-quality solution and a cotton swab. Never rub an optical surface with a dry swab.

NOTE

The window in front of the sensor faceplate is out of the focal plane of the Camera. Thus small contaminants on this surface will most likely not show up in the picture. Even so, pressurized dry air should be used to remove any contaminants on the window or IR blocking filter.

3. Check the setscrew (8-32 × 15/64, socket head, nylon tipped) and make sure it is snugged down. Be careful not to over-tighten. Use a 5/64-inch Allen wrench.

4. Screw the lens into the adapter. Snug down so the two will turn as one unit when the setscrew is loosened for focus adjustments.

5. If an auto lens is used, plug the lens cable (P37) into the extender cable and then that cable into the lens connector (J37) on the rear panel (**figure 10**)

8.7 Back Focus Adjustment

Back focus adjustment establishes proper distance between the back of the lens and the sensor. This ensures that the lens projects its image exactly on the surface (focal plane) of the sensor and not slightly in front of or behind the surface.

This distance is set by observing for sharp focus on a picture monitor. The lens focusing first

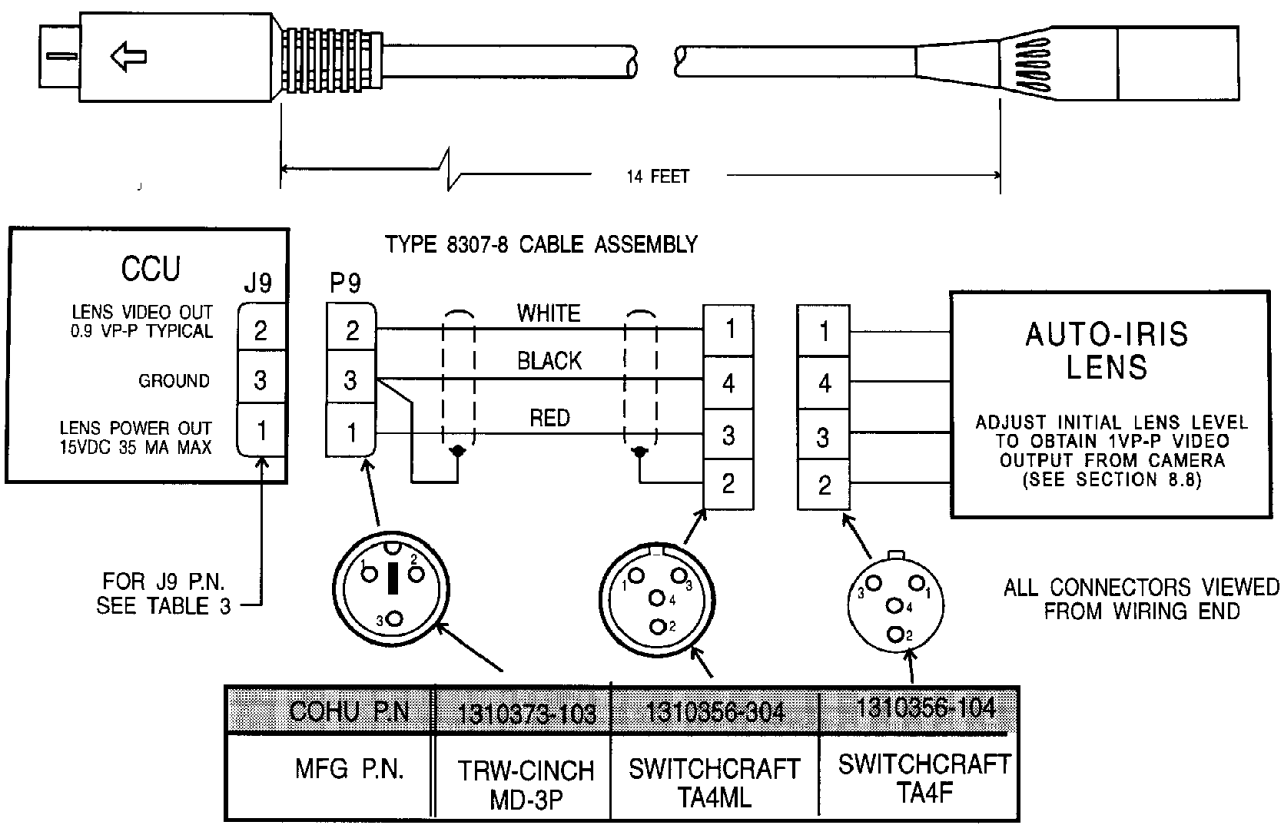


Fig. 10. Auto Iris Output (J9)

must be set to infinity and the iris fully opened to establish minimum depth of field.

Once back focus is set, it should be possible to change between most lens types without any further setting of back focus.

The first four steps determine whether any adjustment is required. Proceed as follows.

1. Set the lens focusing ring to infinity.

2. Point the Camera at a distant scene well into the infinity focusing distance of the lens.

3. Place sufficient neutral density (ND) filters in front of the lens so the lens iris is fully open with normal video output.

4. Note whether the scene is in sharp focus. If it is, no adjustment is required.

5. If the scene is out of focus, loosen the setscrew with a 5/64-inch hex wrench and rotate the lens and adapter as a unit in and out of the Camera Head until the scene is in focus.

6. Snug down the setscrew. Do not over-tighten.

7. Verify that sharp focus is still maintained.

8.8 Auto Iris Lens Level Adjustment

If an auto iris lens is used and the scene on a picture monitor has too much or too little contrast (or pulsates/hunts) under bright lighting conditions, the LEVEL control on the lens may require adjustment. To adjust this control, proceed as follows:

1. Set the top panel AGC switch to ON.

2. Set the PK/AVG (peak/average) control on the auto iris lens fully toward AVG.

3. Point the Camera at a brightly lighted scene having a full range of white and black levels.

4. Adjust the LEVEL control on the lens to obtain a normal picture on the picture monitor. When this control is properly set, video output at J32 to the monitor should be 1 Vp-p. (Virtually all lens manufacturers label this control LEVEL. If a lens is being used that does not have a control labeled LEVEL, adjust the control with a name similar to this function.)

5. Vary light level into the camera by placing a hand in front of the lens and taking it away. Do this several times while observing the picture monitor.

6. Note whether the light level of the scene on the picture monitor pulsates or hunts after the hand has been taken away. If pulsating/hunting is noted, proceed to step 7 for adjustment. If scene lighting remains stable, proceed to step 9.

7. Adjust the PK/AVG control on the auto iris lens slightly toward PK and repeat steps 5 and 6 until the pulsating/hunting stops. If it persists after several slight adjustments to the PK/AVG control, proceed to step 8.

8. Repeat steps 2 through 7. Make a slightly different adjustment to the LEVEL control in step 4 while maintaining a good picture on the picture monitor. After all conditions in these steps have been met, proceed to step 9.

9. Test the camera under actual operating conditions, if desired, and after verifying proper operation return it to service.

9.0 TOP PANEL ADJUSTMENTS

Four adjustments and three switches appear under a CONTROL ACCESS panel on top of the Camera Control Unit (See fig. 2). They are described in **table 4**. Cameras are shipped with these controls set either for operation under typical conditions or as requested by the user. Black level would typically be set for the industry standard 7.5 IRE units above blanking. For special situations, this can be changed to provide the desired picture from the Camera under actual operating conditions.

10.0 INTERNAL ADJUSTMENTS

Six repositionable jumpers are accessible when the case is removed from the CCU. **Table 5** lists these jumpers and describes their functions. Their locations on the video/sync and genlock/power-supply boards are shown in **figures 11 and 12**.

Do not make any adjustments to components on the circuit boards when the CCU case has been removed to reposition a jumper. Performing internal setup adjustments requires test instruments and detailed step-by-step procedures. Such procedures appear in section V of the Installation, Operation, and Maintenance Manual (6X-948). Perform internal setup adjustments only when the step-by-step procedures in that manual are being followed. Be aware that adjusting anything electrical or mechanical without the proper procedure may void the warranty of a new Camera. Refer to the last page of this manual for the warranty.

10.1 CCU Case Removal

Perform the case removal procedure and all subsequent work on the CCU circuit boards only at a static dissipating work station.

1. Remove the front screw on the top panel CONTROL ACCESS plate (See fig. 2).

2. Remove the two screws holding the rear panel plate on (See fig. 3).

3. Tilt the top of the rear panel away and down from the CCU. (The CAMERA D-15 connector mounts to the panel. All other connectors mount only to circuit boards inside the CCU and do not connect to the rear panel.)

4. Slide the CCU case off the circuit boards. Note that the boards slide in plastic grooves at the sides and at the top middle of the case.

5. Place the CCU circuit board chassis assembly in an anti-static bag if it is not to be worked on immediately.

10.2 CCU Case Installation

Do not handle the CCU circuit board assembly unless working at a static dissipating work station.

1. Verify that the front screw on the top panel of the CCU CONTROL ACCESS cover plate is not installed. See figure 2. Remove this screw if it is in place.

2. Position the CCU case so that the CONTROL ACCESS cover plate lines up with the adjustable controls on the video/sync circuit board. This positions the CONTROL ACCESS cover plate on the same side of the chassis as the AUTO IRIS indicator and the power ON OFF switch

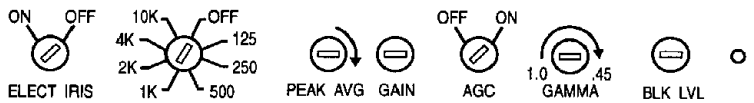
3. Align the circuit boards with the plastic guide slots on the top and sides of the CCU case, then slide them into slots.

4. Position the rear panel plate over the connectors and align the screw holes with the threaded fasteners inside the housing.

5. Install the two screws at the rear panel (fig. 3).

6. Install the front screw on the CONTROL ACCESS plate on top the CCU. (See fig. 2.) If the

Table 4. Top Panel Adjustments



CONTROL NAME	NORMAL SETTING	FUNCTION
ELECT IRIS ON/OFF (Requires the optional electronic iris board and a manual-iris lens)	ON	When turned ON, the electronic iris board provides automatic control of camera sensitivity to scene lighting through a range of about seven f/stops. It does this by electronically shuttering the sensor in the camera through a continuous range from 1/60 (1/50) second to 1/10,000 second. The iris on the manual-iris lens must be properly set. See section 12.0 for this adjustment. When the ELECT IRIS switch is set to ON, the eight-position shutter speed switch to the right is deactivated.
Shutter Speed Switch	As desired	Sets the shutter speed of the camera to any of its eight settings: from 1/60 (1/50) up to 1/10,000 second. Active only when ELECT IRIS switch at left is set to OFF
PEAK/AVG	Midrange	When the related AGC ON/OFF switch is set to ON, this peak/average control determines whether the automatic gain control circuits respond more to peaks (highlights) of light in the scene or to the overall average light level. When this control is rotated toward the PEAK position, the agc holds the peaks in the video to a maximum of 100 IRE units. When adjusted to the AVG position, the agc averages the video to the 100-unit level.
GAIN	Midrange	When the related AGC ON/OFF switch is set to OFF, this control can provide an additional 20-dB gain for the camera. To minimize noise in the video, keep this control toward ccw. To increase gain (sensitivity to light), rotate this control clockwise. Noise increases as the control is rotated cw for more gain.
AGC ON/OFF	ON	Setting this switch to ON provides automatic gain control. Agc range is 20 dB. Setting the switch to OFF activates the related manual GAIN control.
GAMMA 1.0/.45	.45 for viewing 1.0 for measurement	Rotated fully cw to .45, this control provides a nonlinear video output that favors black areas of the scene at the expense of white areas. This setting compensates for a nonlinear characteristic common to all vacuum-type picture tubes used in standard monitors. Picture tubes favor whites over blacks. The net effect is that blacks and whites in the scene are accurately represented visually. This gamma control can be used to change tonal variations between blacks and whites when viewing scenes on a monitor. As the control is rotated ccw, away from the .45 position, the camera video output becomes less and less nonlinear. At the full ccw position (1.0) the video output is linear. Blacks and whites are represented electronically exactly as they appear in the scene. This is the setting to use for measurement purposes. Use 1.0 when connecting a frame grabber to the video output.
BLK LVL	7.5 IRE	This control sets the reference level (setup) for black in the video signal and thus the overall relationship of black and white for the camera. The industry standard setting is 7.5 IRE units (53 mV) above blanking. Adjusting setup to 7.5 units requires that the lens be capped and an oscilloscope or waveform monitor be connected to the video output. If this calibrated black-level reference is not require, the control can be adjusted wherever desired to obtain the desired tonal range of black and white in the scene.

Table 5. Repositionable Jumpers, Video/Sync Board

JUMPER	PURPOSE
	VIDEO/SYNC BOARD
JB1 XTAL/LL	Jumper position determines whether the default internal sync source is the internal crystal (RS-170(A) or CCIR) or the low voltage ac input power. Input power at the Camera rear panel connector must be ac for line lock to be used. A Camera operating with a genlock sync source will revert to either crystal or line lock (with ac input power) upon removal of the genlock input.
JB2, JB3 NOR/ RESET	Positioning JB2 to NORmal selects genlock as the external sync source by activating pins 1 and 2 of the rear panel AUX connector. Positioning JB2 to RST activates the asynchronous vertical reset input (pin 6) of the rear panel AUX connector. In asynchronous mode, the Camera can be reset at any time by pulling pin 6 low. The Camera then provides video output immediately following a vertical blanking interval. Jumper JB3 is typically set to RST at all times. If desired it can be positioned to NOR when JB2 is set to NOR.
JB4 FRAME/ FIELD	FIELD mode is the normal mode. In FIELD mode the sensor integrates for 1/60 (1/50) second. Two lines are summed and read out at a time until all pixels are read out. Although this reduces vertical resolution, it also minimizes lag and improves sensitivity. In FRAME mode, the sensor integrates for 1/30 (1/25) second and readout is the same as for a tube Camera. One row of pixels is read out for each horizontal line. FRAME mode gives the highest resolution, but lag and sensitivity are somewhat degraded.
	GENLOCK/POWER SUPPLY BOARD
JB60 VD/PRE	This jumper position determines where the integration grab-pulse output begins. See figure 9. When positioned to PRE, the grab pulse starts at the same time the integration start/stop pulse goes low to end integration. Note in figure 9 that the integrated output from the Camera begins with the first vertical interval after leading edge of the grab pulse. When the jumper is positioned to V.D. (vertical drive), the grab pulse starts at the same time actual integration is ended. The grab pulse is coincident with the vertical-drive pulse at the end of integration.
JB80 75 Ohm Sync Sel.	With this jumper installed, the external sync/horizontal-trigger input (pin 2 of the AUX connector) is terminated with 75 ohms. This jumper should be removed only when the Camera is to be installed in a genlock cable with other Cameras. In this situation, only the last Camera (or other type of equipment) at the far end of the cable is terminated with 75 ohms. The disconnected jumper can be stored by installing it on only one pin of JB80.

CONTROL ACCESS plate was completely removed, it will have to be set in place and both screws installed.

11.0 REAR PANEL LINE-LOCK PHASE ADJUSTMENT

Multiple Cameras operating from 12 (or the optional 24) V ac input power can have their vertical intervals locked together by using the power line frequency as a reference. The internal crystal/line-lock (XTAL/LL) jumper on the video/sync board of all Cameras must be positioned to LL to use this feature.

Several situations can cause cameras not to have their vertical intervals occurring at the same time when all are locked to the ac input power at the Camera rear panel.

1. Power input at the Camera rear panel may be 180 degrees out-of-phase relative to the Camera chosen as the reference. This is because the two leads at the power input connector are reversed in relation to the reference Camera.

2. Some Cameras may be operating off different phases of the main power line. This could position

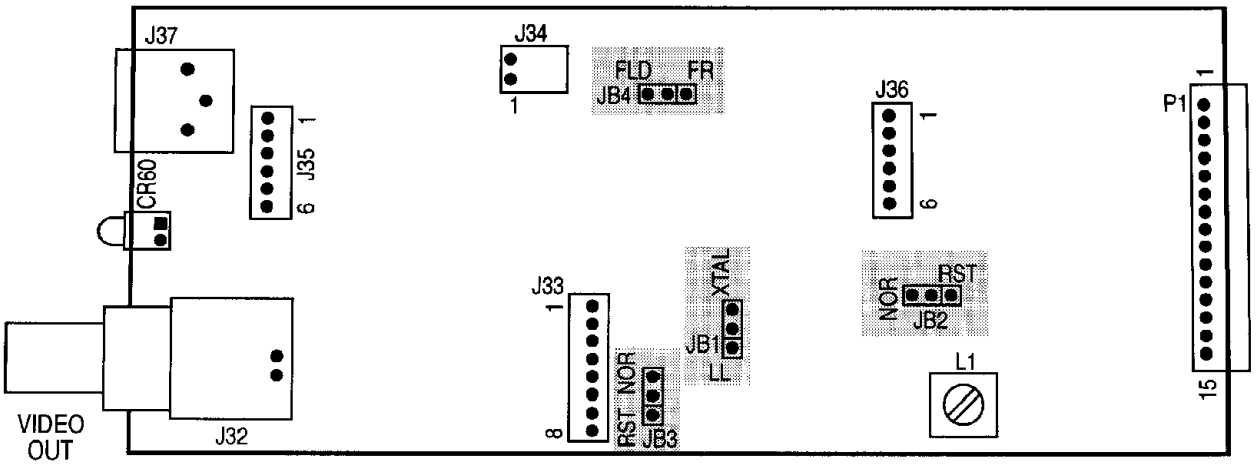


Fig. 11. Jumper Locations, Video/Sync Board

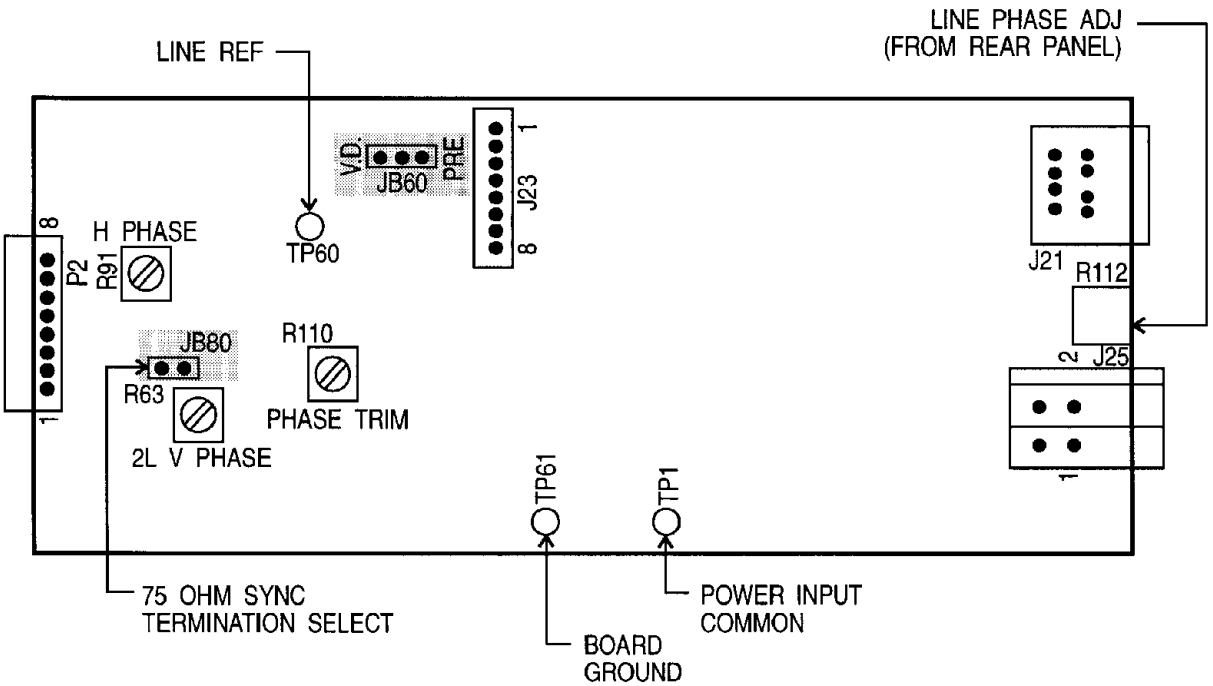


Fig. 12. Jumper Location, Genlock/P.S. Board

vertical intervals out-of-phase by, for example, 180 degrees or even 120 or 240 degrees relative to the power line.

3. Other phase shifts in power distribution equipment may be significant enough to cause problems in some applications.

Two actions can be performed at each Camera to put its vertical interval in phase with the vertical interval chosen as reference. (1) The rear panel PHASE control can be adjusted to provide up to 180 degrees of control. (2) If more than 180 degrees is required, the two power input leads can be reversed for a 180-degree phase shift. Then adjust the rear panel PHASE control for the final amount required.

The adjustment is generally done by observing video at the switcher where all the video cables converge. Use a dual-channel oscilloscope.

Video from one Camera is selected as the reference. Then the input power leads and PHASE controls on all other Cameras are changed as necessary to bring their vertical intervals into alignment with the reference Camera.

In summary, then:

1. Adjust the rear panel PHASE control for up to 180 degrees of control

2. Switch the two power leads at the rear panel when more than 180 degrees of control is required. Then make a final adjustment with the PHASE control.

12.0 ELECTRONIC-IRIS/ MANUAL-IRIS-LENS SETUP

When turned ON, the optional electronic iris board provides automatic control of Camera sensitivity to scene lighting through a range of about seven f/stops. It does this by electronically shuttering the sensor in the Camera through a continuous range from 1/10,000 second (scene very bright) to 1/60 (1/50) second (scene not well lighted). The full range can be covered in about four seconds. The manual-iris lens must be set to bring the light handling capability of the electronic iris within range of the sensor.

For indoor use where scene lighting typically is not extremely bright and does not vary more than seven f/stops, the iris on the manual lens can usually be set wide open.

If fluorescent lights are present, the camera should be line locked to prevent interaction between this type of lighting and the electronic iris circuit.

For viewing a scene where the light is extremely bright and can vary more than seven f/stops (such as an outdoor scene), the iris on the manual lens must be stopped down somewhat. This is to bring the light reaching the sensor into a range that the electronic iris can handle. Proceed as follows the make this setting:

1. Verify that the Camera is viewing the scene of interest and that no further positioning adjustments are required.

2. Wait for the brightest time of day on the scene being viewed by the Camera.

3. Open the manual iris fully while observing the AUTO IRIS indicator lamp on the rear panel (fig. 3). As the lens is opened this lamp should go out at some point, indicating that the electronic iris has run out of range (and thus is at 1/10,000 s).

4. Slowly close the lens iris until the rear panel AUTO IRIS indicator just comes on again. This is the proper setting for the manual iris lens.

If blooming is observed on the picture monitor while using the electronic iris feature, it is likely that scene lighting has become too bright for the E.I. circuit.

13.0 OPERATING MODES

The four basic scanning modes are:

Frame mode, interlaced
Frame mode, non-interlaced
Field mode, interlaced
Field mode, non-interlaced

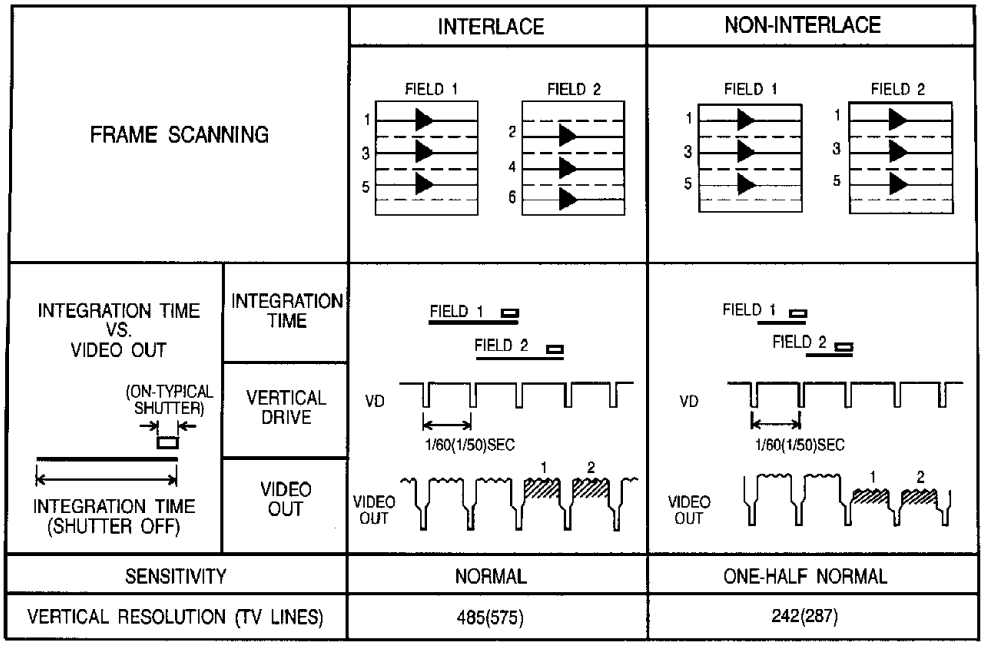
The Camera can be operated with non-interlaced scanning only under control of externally applied horizontal and vertical drive.

Timings appear first as RS-170 followed by CCIR timings in parenthesis.

Note in the two illustrations that a shutter interval is shown together with the integration time for fields 1 and 2. The long line is the integration time without shuttering. The boxed portion at the end of the long integration line is a representative integration period for shutter mode. The key point is that shuttering occurs near the end of a vertical interval.

13.1 Frame Mode — Interlaced

Refer to **figure 13**. In the interlaced frame mode, the sensor integrates each field for 1/30 (1/25) second — spanning two vertical intervals. Note that field-2 begins integrating midway through the integration of field-1.



NOTE: WHEN ASYNCHRONOUSLY RESETTING WITH THE SHUTTER ON IN FRAME MODE, VIDEO OUTPUT OCCURS IN 1/60(1/50) SECOND.

Fig. 13. Frame Integration Mode

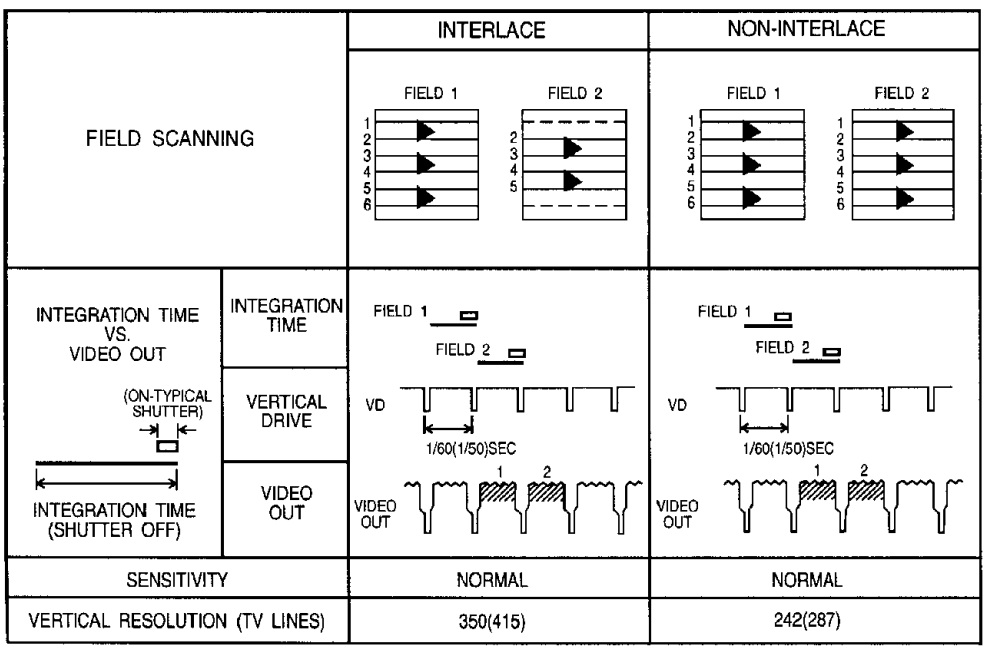


Fig. 14. Field Integration Mode

Field-1 is comprised of odd lines, field-2 of even lines. In this mode pixels are not paired to form lines. Thus the maximum vertical resolution of about 485 (575) tv lines is available.

Since this mode integrates each field for 1/30 (1/25) second it is more prone to problems with relative movement between the Camera and scene.

13.2 Frame Mode — Non-interlaced

Refer to figure 13. Each field is scanned for 1/60 (1/50) second. Each field is integrated on the sensor during its own interval.

Only the odd lines are used. Vertical resolution is about 242 (287) tv lines. This is about one-half that available with the frame interlaced mode.

This mode has about one-half the sensitivity of the other three modes. Reduced sensitivity results due to the combination of integration occurring for 1/60 (1/50) second and pixels not being combine.

In the other three sensor operating modes, normal specified sensitivity is maintained due either to 1/30 second integration or to two lines of pixels being combined to form a single line.

13.3 Field Mode — Interlaced

Refer to **figure 14**. In the interlaced field mode, the sensor integrates for 1/60 (1/50) second and combines two rows of pixels to form the lines.

Note that to form field-1, pixels in lines one and two are combined. Then to form field-2 pixels in lines two and three are combined.

Because two lines of pixels are being combined to form each line, this mode provides the normal specified sensitivity, but it has less vertical resolution than the interlaced frame mode.

This mode has less lag than the interlaced frame mode because of its 1/60 (1/50) second rate.

13.4 Field Mode — Non-interlaced

Refer to figure 14. In the non-interlaced field mode, the Camera operates at a 1/60 (1/50) second rate. The same two rows of pixels are combined to produce each line for both fields. This results in the lower vertical resolution of 242 (287) tv lines. Because two lines of pixels are combined to form each line, though, normal specified sensitivity is obtained.

14.0 PREPARATION FOR SHIPMENT AND STORAGE

Maintain the Camera storage environment within a range of -30 to 70 °C (-22 to 158 °F).

For shipping the camera back to the factory by Common Carrier, use:
3912 Calle Fortunada, San Diego, CA 92123-1827
as the address. Please contact the Customer Service Department for a Return Authorization (RA) number before sending any shipments to the factory.

WARRANTY

Cohu, Inc., Electronics Division, warrants equipment manufactured to be free from defects of material and workmanship. Any part or parts will be repaired or replaced when proven by Cohu examination to have been defective within two years from date of shipment to the original purchaser for standard CCD cameras and one year from date of shipment to the original purchaser for intensified CCD cameras and all other Cohu manufactured products.

All warranty repairs will be performed at the factory or as otherwise authorized by Cohu in writing. Transportation charges to Cohu shall be prepaid by purchaser.

This warranty does not extend to Cohu equipment subjected to misuse, accident, neglect, or improper application, nor repaired or altered by other than Cohu or those authorized by Cohu in writing. **Television image pickup tubes, image intensifiers, lenses, and products manufactured by companies other than Cohu are warranted by the original manufacturer.** This warranty is in lieu of all other warranties expressed or implied. Cohu shall not be liable for collateral or consequential damages.

A Return Authorization (RA) number must be obtained from Cohu prior to returning any item for warranty repairs or replacement.

COHU
Cohu, Inc./Electronics Division

September 9, 1992
Revision 1 January 22, 1993
Revision 2 March 3, 1995
Revision 3 August 1, 1995
Revision 4 July 6, 2000