PULNiX

# TMC-74 / TMC-76
# HIGH RESOLUTION
# CCD COLOR CAMERA

## OPERATIONS &
## MAINTENANCE MANUAL

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## SECTION 1: OPERATION

### 1.1 OUTLINE

The TMC-74 (NTSC model) / TMC-76 (PAL model) is a compact, lightweight color video camera which uses a high resolution solid state image sensor - the Charge Coupled Device (CCD). This camera module is designed to operate with both internal and external sync systems. The CCD camera produces less geometrical distortion and has higher resistance to vibration and shock when compared with a camera using a pickup tube. These features make the camera suitable for both industrial and CCTV surveillance applications. It is also suitable as an input device in an image processing system since the TMC-74 series takes external VBS, VS, HD and VD sync.

The TMC-74 series cameras feature separate outputs for the RGB signals and Y/C output on top of standard VBS output. Y/C and VBS can output negative color pictures as an option.

All models have external switches to enable or disable the AGC, and auto-white balance or external adjustment for color hues. The TMC-74 series uses complementary stripe color filters of Cy, Gr, Ye to generate all color variations. The complementary color has the advantage of better sensitivity than the primary color of R, G, B.

All models use C-mount lenses and have a back focus adjustment and auto iris output. The remote imager option is designed with a mini- bayonet lens mount to achieve a tiny remote color camera with changeable lenses. Remote capability up to 2 meters is available.

### 1.2 SPECIAL CHARACTERISTICS OF A CCD

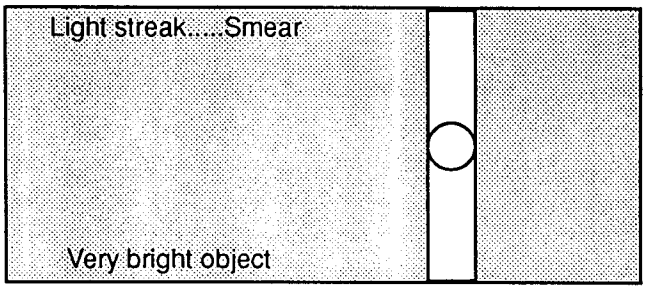
#### Smear phenomenon

This phenomenon occurs when shooting a very bright object (such as electronic light, fluorescent lamp, the sun or a strong reflection.) Due to the interline-transfer organization of the CCD image sensors (Refer to the "The Interline-transfer Organization of the CCD Image Sensors", Section 3.3), this phenomenon is caused by electronic charges generated beneath the photosensors by a light with a long wavelength, such as an infrared light.

NOTE: PULNiX color cameras contain a filter to minimize smear. Smear should only occur under extremely bright, and point light source conditions.

#### Patterned noise on the picture at high temperatures

Dark current (thermal noise) is inherent in semiconductors. At room temperature, the amount of dark current in all photosensors is very close. However, as the temperature rises, the amount of dark current increases. As a result, the relative difference between the dark current of each photosensor increases. This difference also causes the patterned noise on the picture.



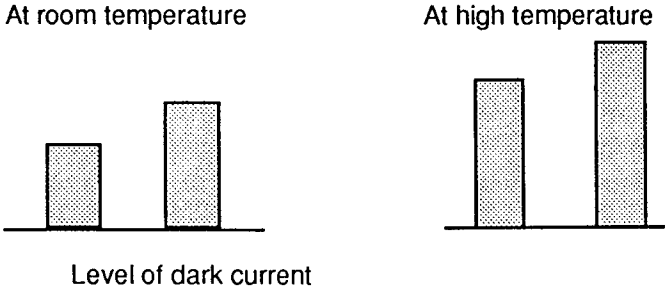

#### False signal

When vertical stripes or straight lines are shot, they may look wavy ( Moire effect ).

#### Blemishes

The photosensor elements generate electronic charges which ultimately produce horizontal and vertical rows in the CCD image sensor. Thus, any malfunctioning photosensor element will eventually cause a blemish on the monitor screen.

Consult the specifications in "Comprehensive Specifications" for details on the blemishes of the TMC-74/TMC-76.



## SECTION 2: COMPREHENSIVE SPECIFICATIONS

| TMC-74/TMC-76 SPECIFICATIONS | | |
|---|---|---|
| | **TMC-74** | **TMC-76** |
| **Imager** | 2/3" interline transfer CCD | |
| **Pixels** | 768 (H) x 493(V) | 756 (H) x 581(V) |
| **Color filter** | Ye, G, Cy stripe color filter | |
| **Scanning** | 525 lines (NTSC) | 625 lines (PAL) |
| | fHD = 15.734 KHz, fVd = 59.94Hz | fHD = 15.625KHz, fVd = 50.0 Hz |
| **Ext. sync** | VBS (color burst lock): 1.0 Vp-p, | Vs (Black Video): 1.0 Vp-p or TTL |
| | fHD = 15.734 KHz ± 0.01% (NTSC), | fHD = 15.625 KHz ± 0.01% (PAL) |
| | HD, VD, Interlace or non-interlace (optional) | |
| | VBS, subcarrier phase adjustable | |
| **TV resolution** | 330(H) x 500(V) lines | |
| **Minimum illumination** | 5 lux at F=1.4 3200°K | |
| **S/N ratio** | 50dB (AGC - OFF) | |
| **Video output** | NTSC 1.0V p-p (75 ohm) R/G/B 0.7V p-p (75 ohm) Sync 0.3V p-p or TTL | |
| | PAL 1.0V p-p (75 ohm) B/W (or Y) 1.0V p-p Chroma 285 mV p-p | |
| **Color balance** | Through-the-lens auto white balance (memory) and manual hue adjustment | |
| **Gamma** | 0.45 or 1 adjustable | |
| **AGC** | On - off, manual gain adjustable | |
| **Shutter** | Variable (1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/10000 sec.) | |
| **Lens mount** | C-mount | |
| **Power supply** | 12VDC, 420mA | |
| **Operating temperature** | -10°C to +50°C | |
| **Vibration and shock** | Vibration 7G (11 Hz to 200 Hz), Shock 70G | |
| **Size** | 51(W) x 44(H) x 159mm(L), 2.0"(W) x 1.73"(H) x 6.3"(L) | |
| **Weight** | 360 grams (13 oz.) | |
| | **Due to ongoing product improvements, specifications may change without notice.** | |

## SECTION 3: THEORY OF OPERATION

### 3.1 OPERATION PRINCIPLES OF THE CCD

A CCD (Charge Coupled Device) consists of MOS (Metal Oxide-Silicon) capacitors arranged in a regular array. It performs three functions connected with handling electrical charges:

#### Photoelectric conversion (photo sensor)

Incandescent light generates electrical charges on the MOS capacitors, with the quantity of charge being proportional to the brightness.

#### Accumulation of electrical charges

When voltage is applied to the electrodes of the CCD, an electrical potential well is formed in the silicon layer. The electrical charge is accumulated in this well.

#### Transmission of electrical charge

When high voltage is applied to the electrodes, a deeper well is formed. When low voltage is applied, a shallower well is formed. In the CCD, this property is used to transmit electrical charge. When a high voltage is applied to the electrodes, a deep electric potential well is formed and electrical charge flows in from the neighboring wells. When this is repeated over and over among the regularly arranged electrodes, the electrical charge is transferred from one MOS capacitor to another. This is the principle of CCD electrical charge transmission.

## 3.2 MECHANISM OF CCD ELECTRICAL CHARGE TRANSMISSION

The TMC-74 uses a 4-phase drive method CCD. For simplicity, a 2-phase drive method CCD is explained below.

Figure 1 shows an example of the changes which can occur in potential wells in successive time intervals.

At t1, the electrode voltages are fH1>fH2, so the potential wells are deeper toward the electrode at the higher voltage fH1. Electrical charge accumulates in these deep wells.

At t2, the clock voltages fH1 and fH2 are reversed; now the wells toward the electrode at voltage fH2 become deeper while those toward the electrode at fH1 become shallower. So the wells at fH2 are deeper than those at fH1 and the signal charge flows toward the deeper wells.

At t3, the electrode voltages have not changed since t2, so the signal charge flows into the wells toward the electrode at fH2. One transmission of electrical charge is completed. This action is repeated over and over to execute the horizontal transmissions.

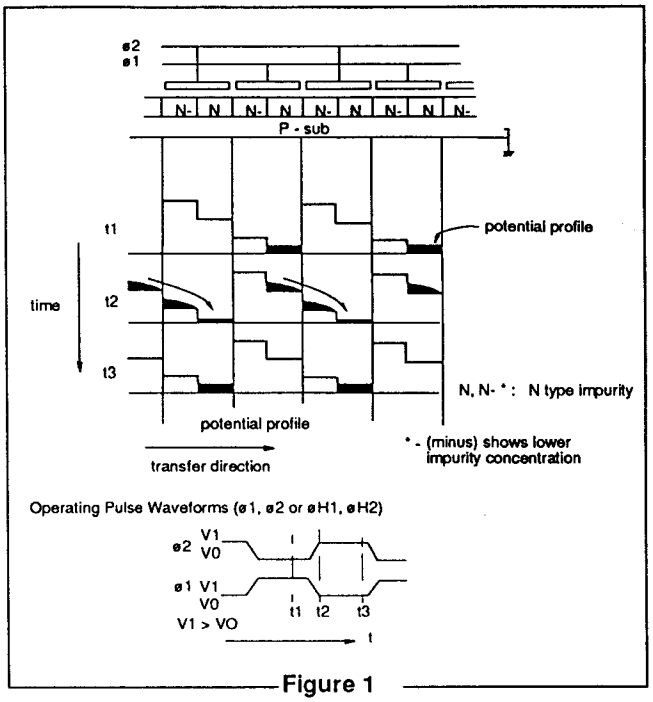



Figure 1

### Vertical transfer

The vertical shift register transfers charges using a four-phase drive mode. Figure 2 shows an example of the changes which can occur in potential wells in successive time intervals. At tO, the electrode voltages are (V1 = V2)>(V3 = V4), so the potential wells are deeper toward the electrode at the higher voltages V1 and V2. Charges accumulate in these deep wells.

At t1, the electrode voltages are (V1 = V2 = V3)>(V4), so the charges accumulate in the wells toward the electrode at V1, V2 and V3.

At t2, the electrode voltages are (V2 = V3)>(V4 = V1), so the charges accumulate in the wells toward the electrode at V2 and V3. Electrode voltage states at t3 and after are shown below.

t3(V2 = V3 = V4)>(V1)
t4(V3 = V4)>(V1 = V2)
t5(V4>(V1 = V2 = V3)
t6(V4 = V1)>(V2 = V3)
t7(V4 = V1 = V2)>(V3)
t8(V1 = V2)>(V3 = V4) (Initial state)

These operations are repeated to execute the vertical transfer.

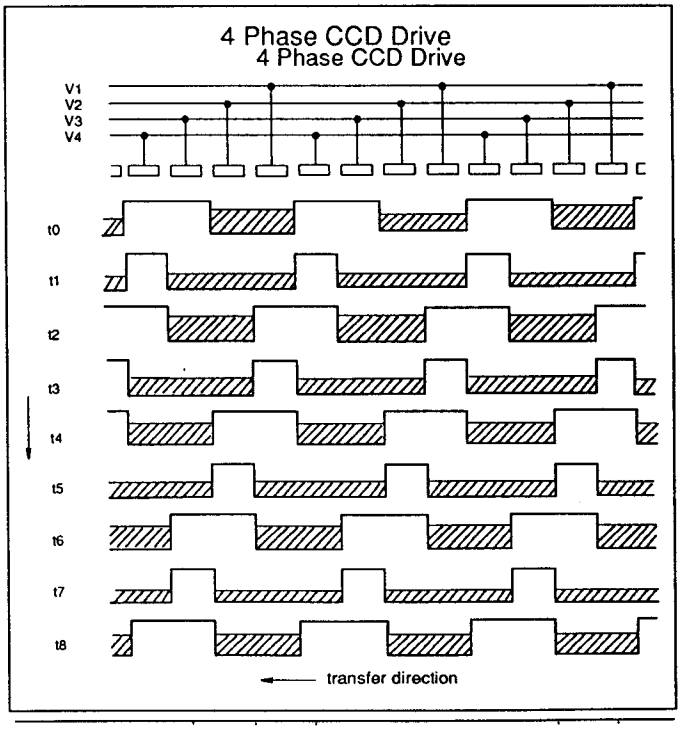
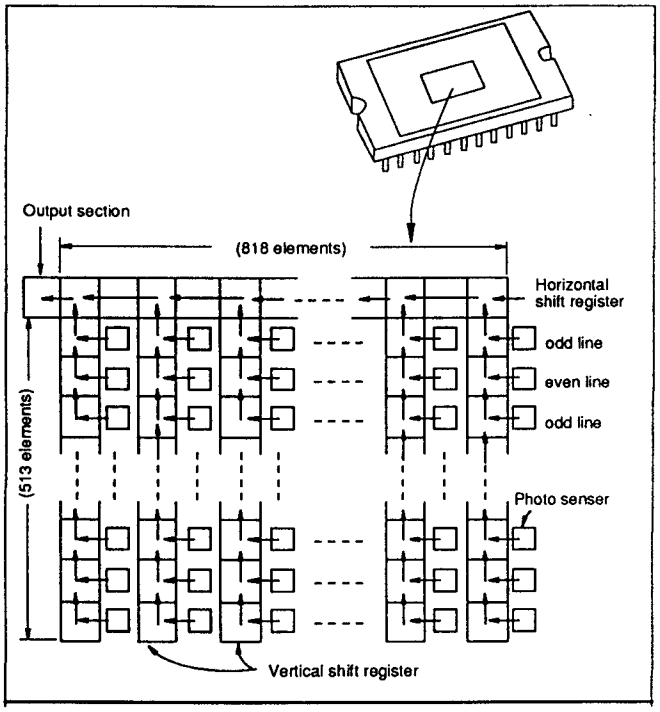



Figure 2

## 3.3 THE INTERLINE-TRANSFER ORGANIZATION OF THE CCD IMAGE SENSORS

The TMC-74 CCD video camera module adopts an interline-transfer organization in which the precisely aligned photosensor and vertical transmission section are arrayed interlinearly.

A horizontal shift register links up with the vertical transmission section. Light variations are sensed by the photosensors which generate electronic charges proportional to the light intensity. The generated charges are fed into the vertical shift registers all at once. The charges are then transferred from the vertical transmission section to the horizontal shift registers successively and finally reach the output amplifier to be read out successively.




## 3.4 INSTRUCTIONS FOR POWERING THE TMC-74/TMC-76

### Connectors

The TMC-74 requires 12 V DC (500 mA). Power is obtained through the 12-pin connector located at the rear of the camera. PULNiX offers a 4-conductor power cable with mating connector (model# C-10). For RGB or Y/C output, use a 12-pin connector to supply power.

Pin #6 is used for sync input option or HD, VD input option.

### Optional output

Each pin has to be designated for various options such as Y/C output, integration control, HD and VD sync input. The customer will be required to assign option numbers.

### *Warning*

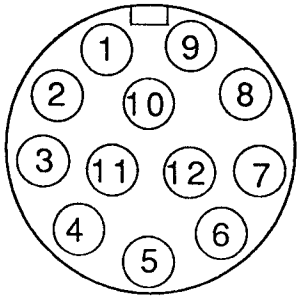
The TMC-74 must use either the 12P Series or C-10 cable. When applying power to the camera, make sure that none of the exposed leads on the multiple conductor cable are touching. This may cause damage to the camera. Besides the power connector, there is a standard BNC video connector as well as a color adjustment on the rear of the camera.

### 3.4.1 12-Pin Connector and Cables

**12-Pin Connector**

| TMC-74/TMC-76 | Options | 12P-02 Cable |
|---|---|---|
| 1. GND | | Gray |
| 2. +12V DC In | | Yellow |
| 3. GND | | Red Shield |
| 4. Video Out (VBS) | (Integ Cont.) | Red Coax Signal |
| 5. GND | (HD In) | Orange Shield |
| 6. Sync Out | (Sync In, VD In) | Orange Coax Signal |
| 7. R Out | (Y Out) | Black Coax Signal |
| 8. GND | | White Shield |
| 9. G Out | (C Out) | White Coax Signal |
| 10. GND | | Brown |
| 11. B Out | | Blue |
| 12. GND | | Black Shield |

**12-Pin Figure Power Connector**

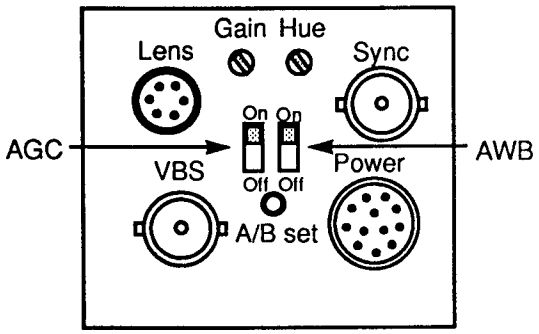


**12P Series cables available:**

12P-02 2 meters
12P-05 5 meters
12P-10 10 meters
12P-15 15 meters
12P-25 25 meters
12P-X Custom length

### 3.4.2 C-10 Color Cable

12P-02 8-conductor cable for RGB
12P-02MF RGB separator cable (for use with CCA-5 Signal Separator only)




Back Panel Assembly

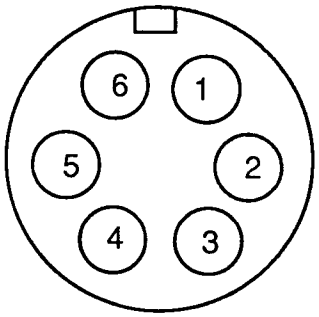
### 3.4.3 Color Balance Adjustment

Automatic white balance is built in and memorizes the color balance as long as power is applied. When a new balance is required, push the switch on the back of the camera while focusing on a general scene or white paper. Do not saturate the input light.

In order to achieve the best color balance for various lighting conditions, the red and blue color hues can be manually adjusted. Color is factory balanced at 3200°K. Move the potentiometer slightly clockwise or counterclockwise to obtain the best color rendition.

### 3.4.4 Auto Iris Connector

The TMC-74 has a 6-pin auto iris connector located on the back of the camera. A mating 6-pin connector (PC-6P) may be obtained from PULNIX. The lens mount of the camera is a standard 2/3" C-mount, and most standard auto iris lenses may be used with the TMC-74/TMC-76.




6-Pin Connector (Auto Iris Lens connector)

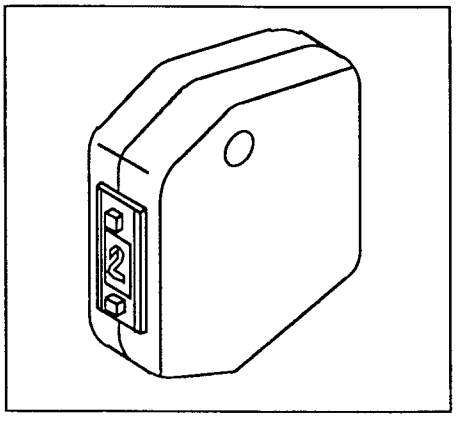
1. D2
2. GND is available for RGB models
3. Video
4. +12V DC out
5. D0
6. D1

D0, D1, D2 are used for shutter speed control and SC-745 can be adapted for easy control.

***Warning:***
Do not unplug the auto iris lens from the camera while the camera is powered. This may damage the lens.

### 3.4.5 SC-745 Shutter Control

The SC-745 is the shutter speed controller for the shutter speed. It connects to the 6-pin connector of the TM-745/TM-765.

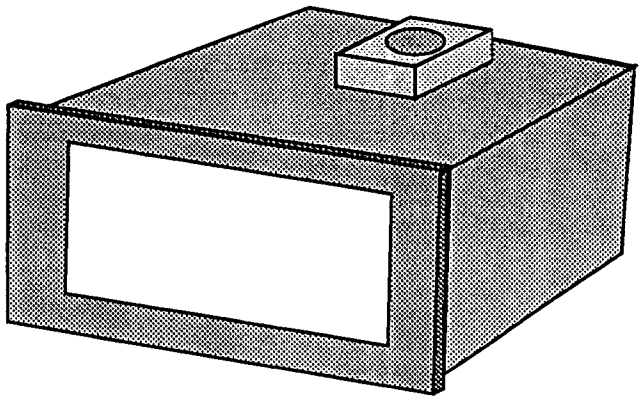


| Controller Setting | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Shutter Speed (sec.) | 1/60 | 1/125 | 1/250 | 1/500 | 1/1000 | 1/2000 | 1/4000 | 1/10000 |
| $D_0$ | L | H | L | H | L | H | L | H |
| $D_2$ | L | L | L | L | H | H | H | H |
| $D_1$ | L | L | H | H | L | L | H | H |

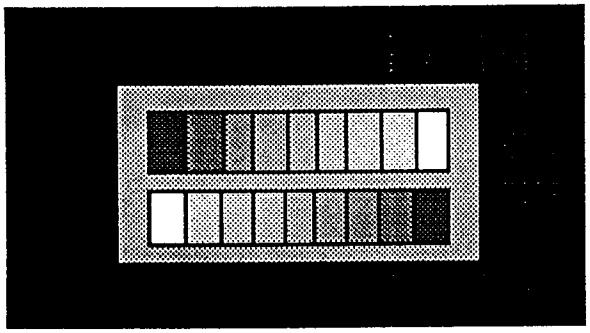
## SECTION 4 : ALIGNMENT AND ADJUSTMENT

### 4.1 EQUIPMENT

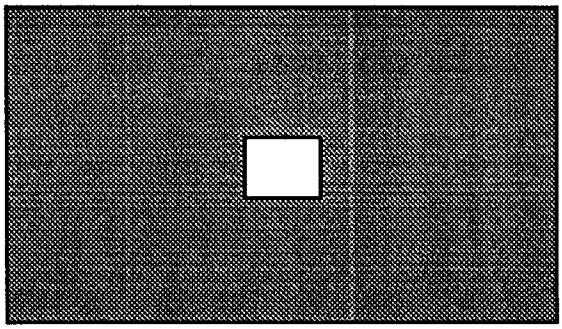
1. Light source for test chart.
   Pattern Box PTB-100 (90-130V)
   PTB-220 (190-240V)



2. For video level and gamma adjustment.

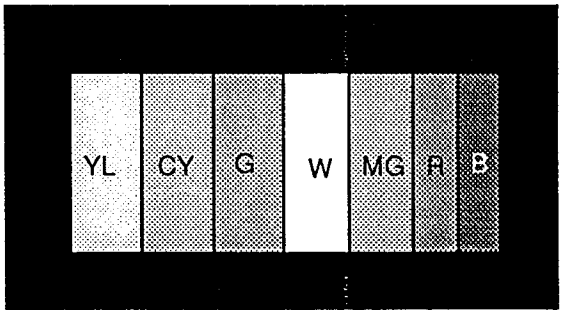


Grayscale Chart



White Window Chart

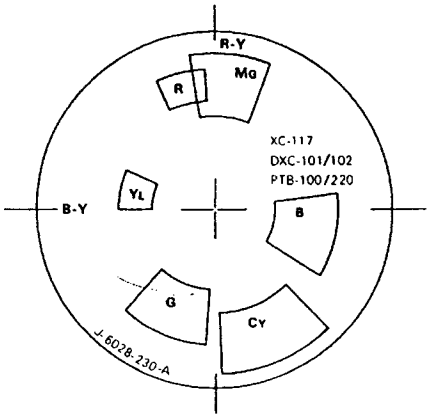
3. For color adjustment.
   (Use color bar chart)




Color Bar Chart

4. For signal adjustment.
   Vectorscope
   Waveform monitor
   Oscilloscope

5. Standard Pattern Frame



## 4.2 PREPARATION

### 4.2.1 Mechanical Back Focus Adjustment

Subject: Resolution chart

1. Mount the manual lens (i.e. Cosmicar 25mm, F=1.4).

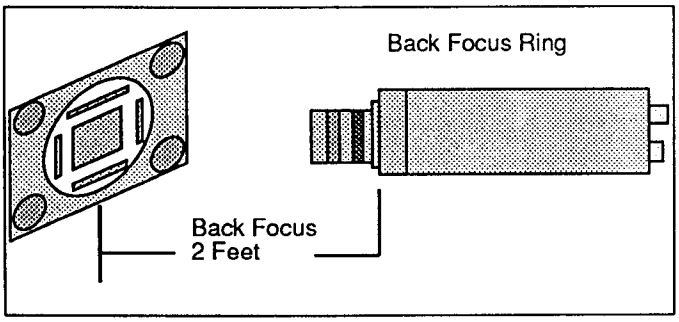
2. Open the lens iris completely and set lens focal length to minimum for the lens used (e.g. 2 ft.).

3. If image is not focused properly, set back focus as follows.

4. Unscrew the M2x3 hex screws on the Front Panel until the ring is loose.

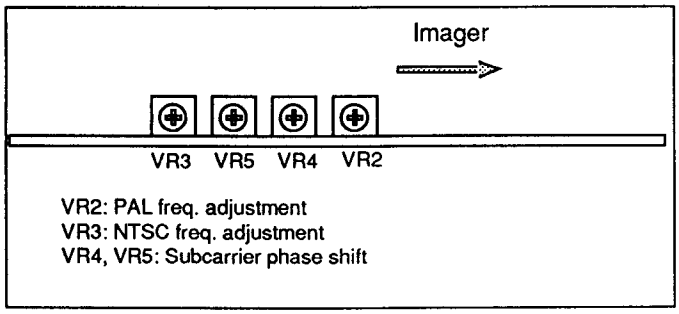
5. Adjust the silver back focus ring until the image is focused.

6. Repeat steps 4 and 5 if needed.




### 4.2.2 Oscilloscope Adjustment

Adjust the clock oscillation frequency VR3 of the driver board by comparing the video signal and the ED-255 horizontal sync which is monitored with a frequency counter. fH=15.7340 Khz (NTSC), fH= 15.6250 KHz (PAL).

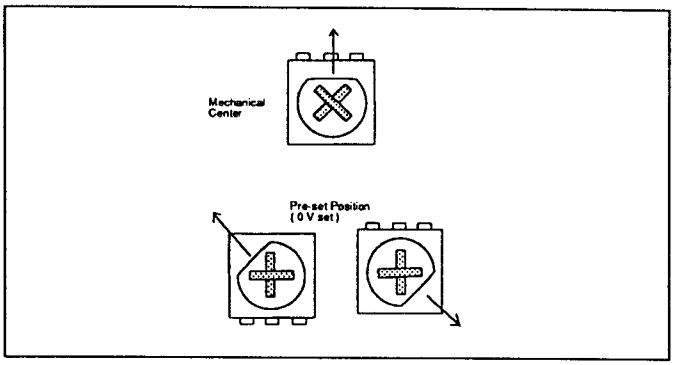


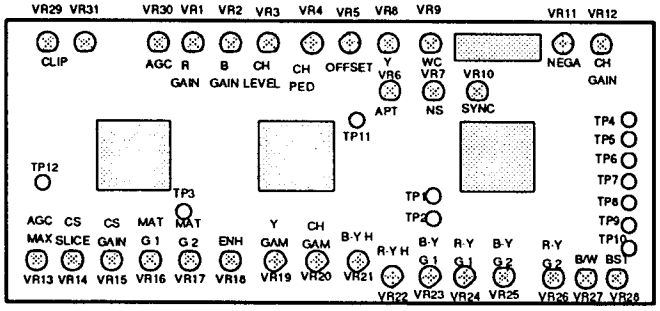

## 4.3 TMC-74/76 ADJUSTMENT PROCEDURES

### 4.3.1 Initial Set-up

Set (Preset) all potentiometers shown below.

Set VR3, VR4, VR5, VR11, VR19, VR20, VR21,VR22, VR23, and VR24 at preset position, and all others at mechanical center as shown.




TMC-74 Signal Board

### 4.3.2. Rear plate

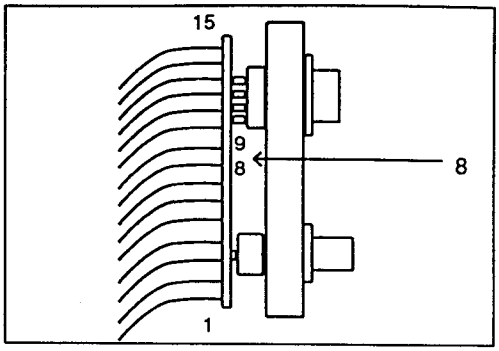
Set AGC Off.
W/B Manual.

1. Adjust Vsub to specified voltage (see value of CCD).

2. Probe pin#8 of CXA1337 and adjust VR13 to 3.5V (AGC Max).

3. Adjust R Cont, B Cont to 1.5V (at connector pin 8).

4. VR5 Offset Control to GND (Preset).



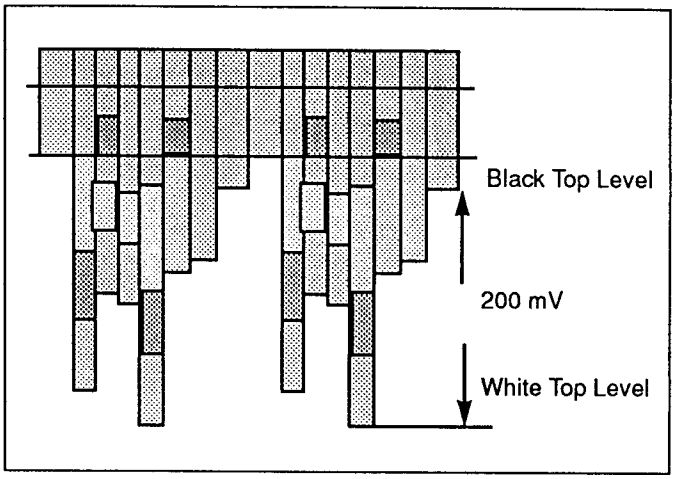

### 4.3.3 Color bar chart

Use color bar chart at 3200°K and adjust the following:
**1. CCD Out**

Adjust lens iris so that TP12 is 200mVp-p. Normally F=8.

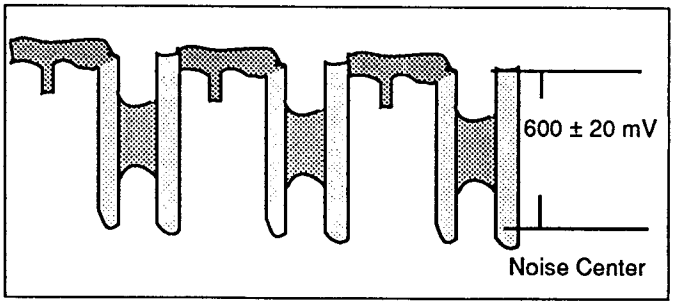
**2. At F=8**

Adjust Manual Gain Control (rear panel) to 600mV at Ye (F1 or S2).
Switch AGC On.
Set VR30 to 600mVp-p at Ye (F1).




**3. OFFSET Cont**

VR5 GND (Set to AGC:OFF).
Use Oscilloscope and see TP11.
G out to 350 mVp-p.
Adjust VR3 (C level) to 2.0V (AGC OFF).
Set VR1 (R Gain), VR2 (B Gain) to mechanical center.
Use Oscilloscope and clip as follows:
CH1 R-Y (TP1).
CH2 B-Y (TP2).
Adjust Mat Gain 1(VR16) and Mat Gain 2 (VR17 to 400mVp-p (see picture).

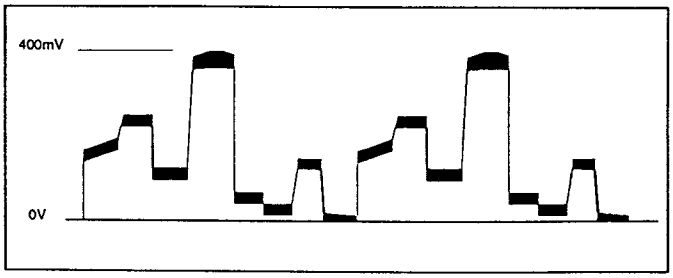



**4. Burst Level**

Use Vectorscope. Set the level to 75%.

**5. White Balance**

Use Vectorscope.
Adjust VR5 (OFFSET) at center of the pot to 3.5V.
Move VR1 (RGain), VR2 (BGain) to set white spot at the center.

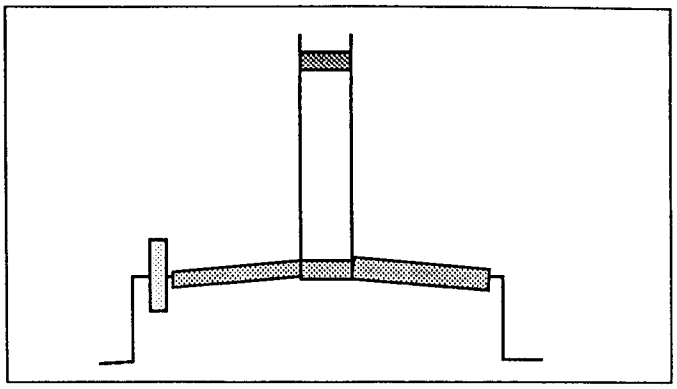



**6. Y Level and Sync Level**

Use Waveform monitor.
Set VR9 (W/C) to max.
Set VR8 (Y Level) at 100 IRE.
Set VR10 (Sync) at 40 IRE.x

**7. Open the Lens Completely**

Adjust VR14 (CS) and Vsub until the smear and green color at the bright spot disappears.



**8. White Clip**

Use Waveform Monitor.
Open Iris. Set 120 IRE for top peak.

**9. Set Lens F-Stop to 8**

VR15 (CS Gain) to see Yellow max.

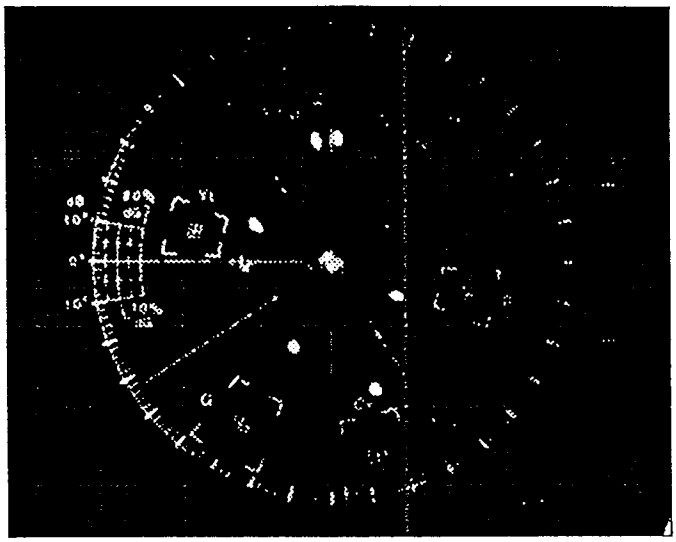
**10. Vector Adjustment**

Adjust following to move all spots on vector scope into specified region.

| R-Y Gain | B-Y Gain |
|---|---|
| (VR23) | (VR24) |

**11. Hue**

| R-Y Hue | B-Y Hue |
|---|---|
| (VR21) | (VR22) |



## 4.4 FUNCTION CHECK

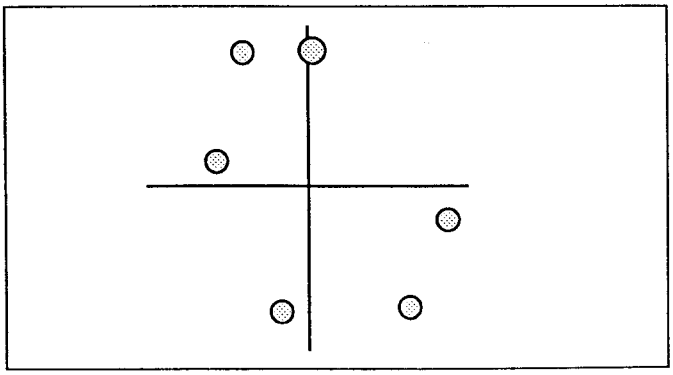
Check all functions specified.
AGC ON.
A/W ON. Push switch to check for Auto White Balance.
Adjust VR3 (Chroma Level) to minimum noise level.

### 4.4.1 Aperture and Noise Slice Adjustment

Adjust VR6 and VR7 to optimize aperture level.

### 4.4.2 RGB Adjustment

VR27 for B/W (Y).
VR26 for Red.
VR25 for B.
Adjust Gain to 700mV.



### 4.4.3 Y/C Adjustment (Optional)

Check the VR12 (Chroma Level) to 285mV.

### 4.4.4 Check the External Sync

### 4.4.5 Check the Shutter Control

### 4.4.6 Check Negative Video By Turning VR11

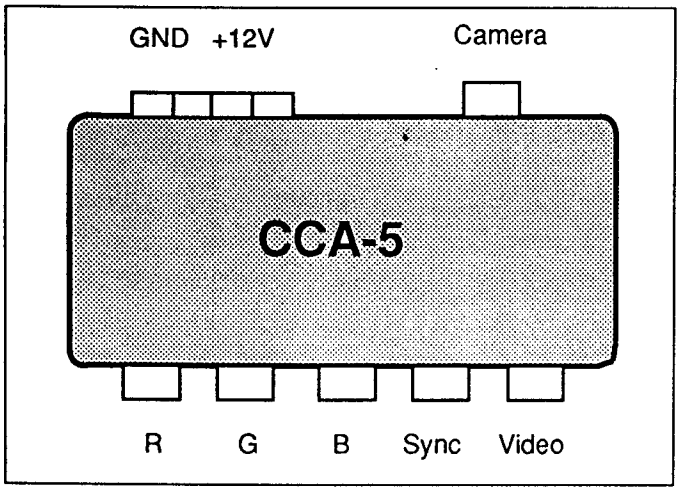
### 4.4.7 Check the Integration Function (Optional)

### 4.4.8 Check Vinit Function (Optional)

## SECTION 5: RGB OPERATION

### 5.1 CCA-5 RGB "BREAKOUT" MODULE

CCA-5 is a compact device designed to accept camera outputs via the 12P-02MF (2 - meter) cable from the camera, and then output the signals (R, G, B, Sync, and Video) via standard BNC connectors. It also accepts 12V DC input via a terminal for power.




### 5.2 RGB ADJUSTMENT

The colors can be corrected by adjusting the three potentiometers located inside the camera (VR25, VR26, VR27). A color bar chart with a light box is needed to adjust the colors. Starting from the right, the order of the potentiometers is: Gain, Blue, and Red. RGB adjustment can be done by the following:

1. Mount the manual lens (i.e. Cosmicar 25mm, F=1.4).

2. Set the f-stop at 8 and focus until the color bar chart is clear.

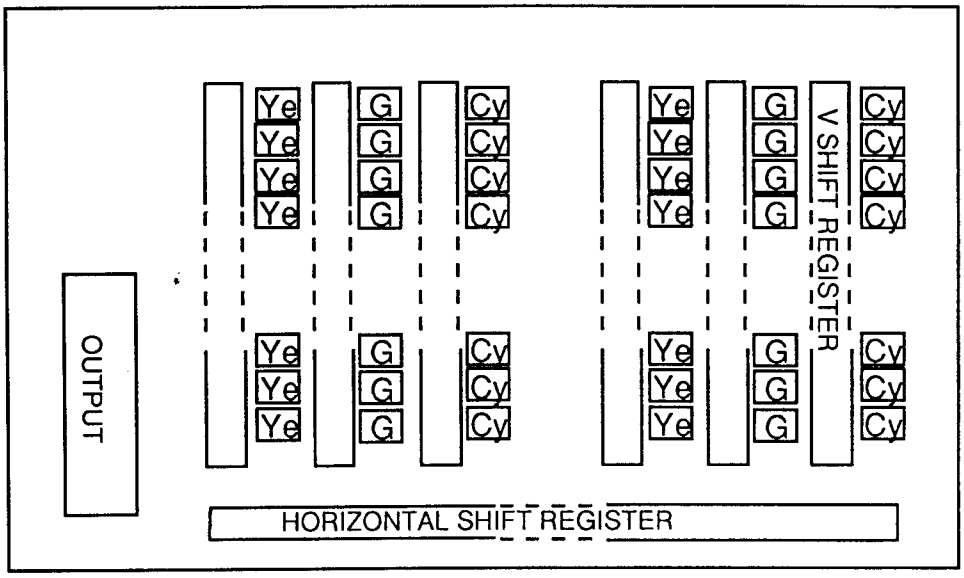
3. Adjust the R, G, B potentiometers until you get the appropriate colors on the monitor.

Note: Make sure the monitor is set for NTSC (Line A) when adjusting the colors.

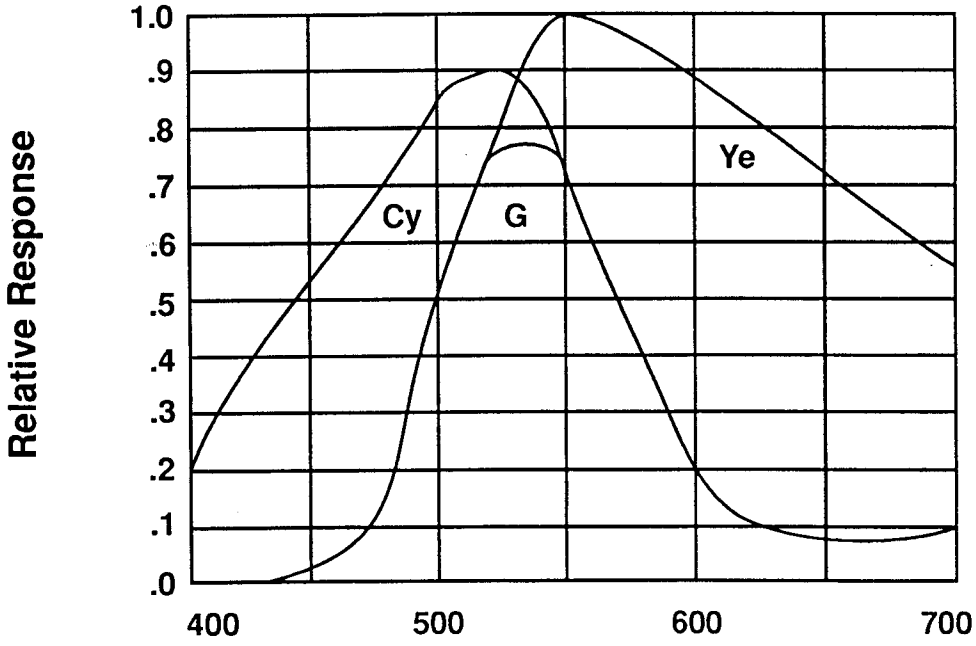
## SECTION 6: IMAGER COLOR FILTERS

### 6.1 DIAGRAM OF COMPLEMENTARY STRIPE FILTER

COMPLEMENTARY STRIPE FILTER



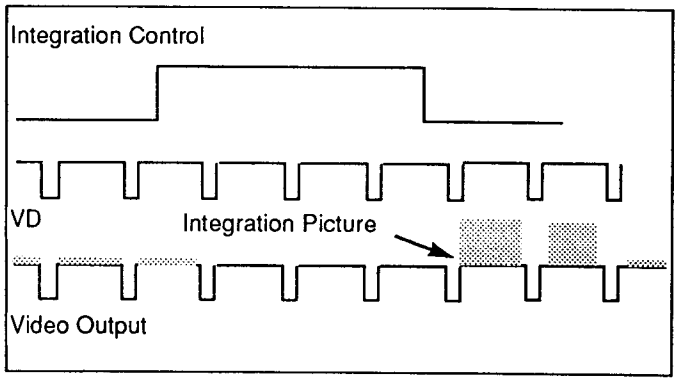

### 6.2 SPECTRAL RESPONSE WITH OPTICAL FILTER (IR CUT FILTER)



## SECTION 7: SPECIAL FUNCTIONS

### 7.1 INTEGRATION CONTROL

TTL level integration control pulse can be applied to pin-4 (Normal option). For integration, the level is Low (ov). When the pulse is returned to High (5V), the next one or two fields of video are integrated signals. In order to capture full frame resolution, an internal jumper must be set to FRAME MODE. The normal factory setting is FIELD MODE for shutter and vertical moire suppression advantages. The integrated video can be NTSC, PAL, Y/C or RGB.

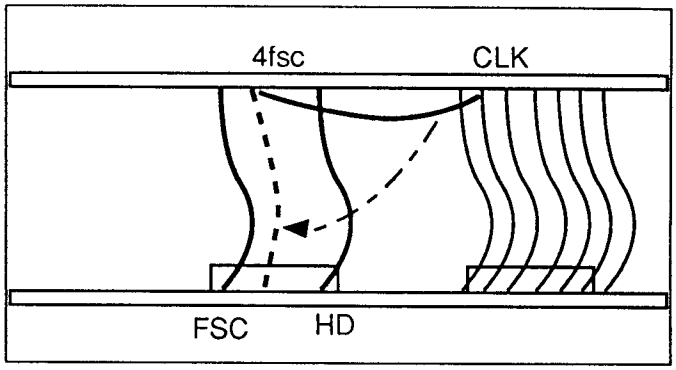



### 7.2 NEGATIVE COLOR

By adjusting VR11, the TMC-74/TMC-76 will output a negative color signal. VR11 is for Black level adjustment (Black becomes white in a negative picture and the level is normally 100 IRE or 700 mV). For external control, pin #11 is normally used. The negative color output is only available in NTSC, PAL, and Y/C (Not RGB). For color reproduction, a blue filter may be required for a negative picture.

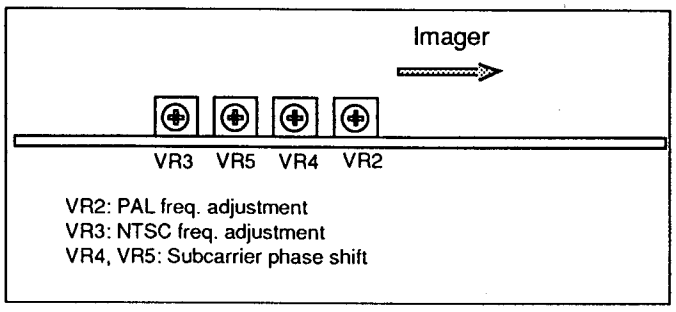
### 7.3 ASYNCHRONOUS RESET

The TMC-74/TMC-76 can reset asynchronously by controlling VINIT input. By accepting the leading edge of VINIT, it can reset the horizontal and vertical sync in less than 1 µsec. No external sync is applied for this mode and a special asynchronous frame grabber will be required for image capturing. In general, strobe lighting should follow after the async reset for clean images. FRAME MODE will be required for the application in order to capture full vertical resolution.

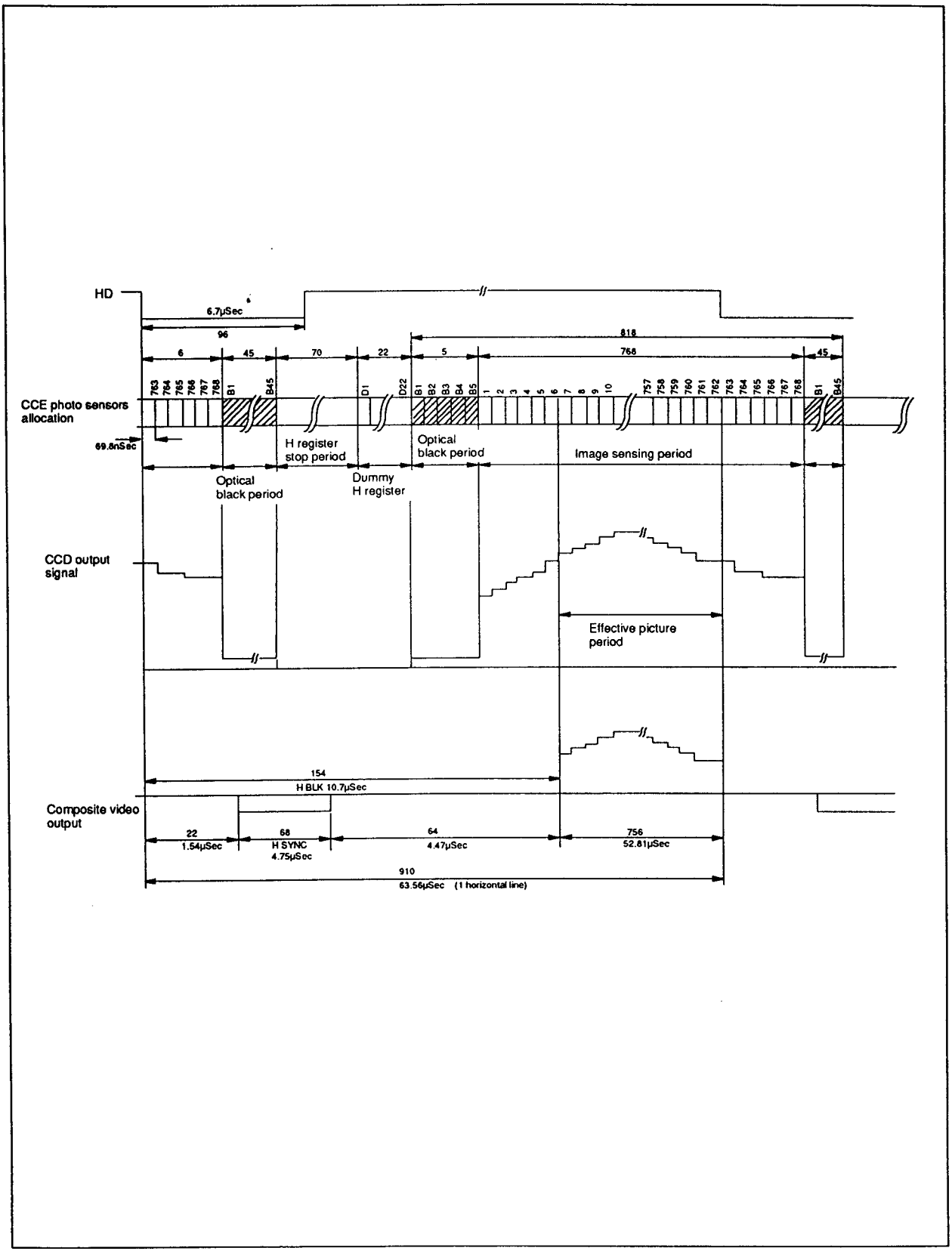


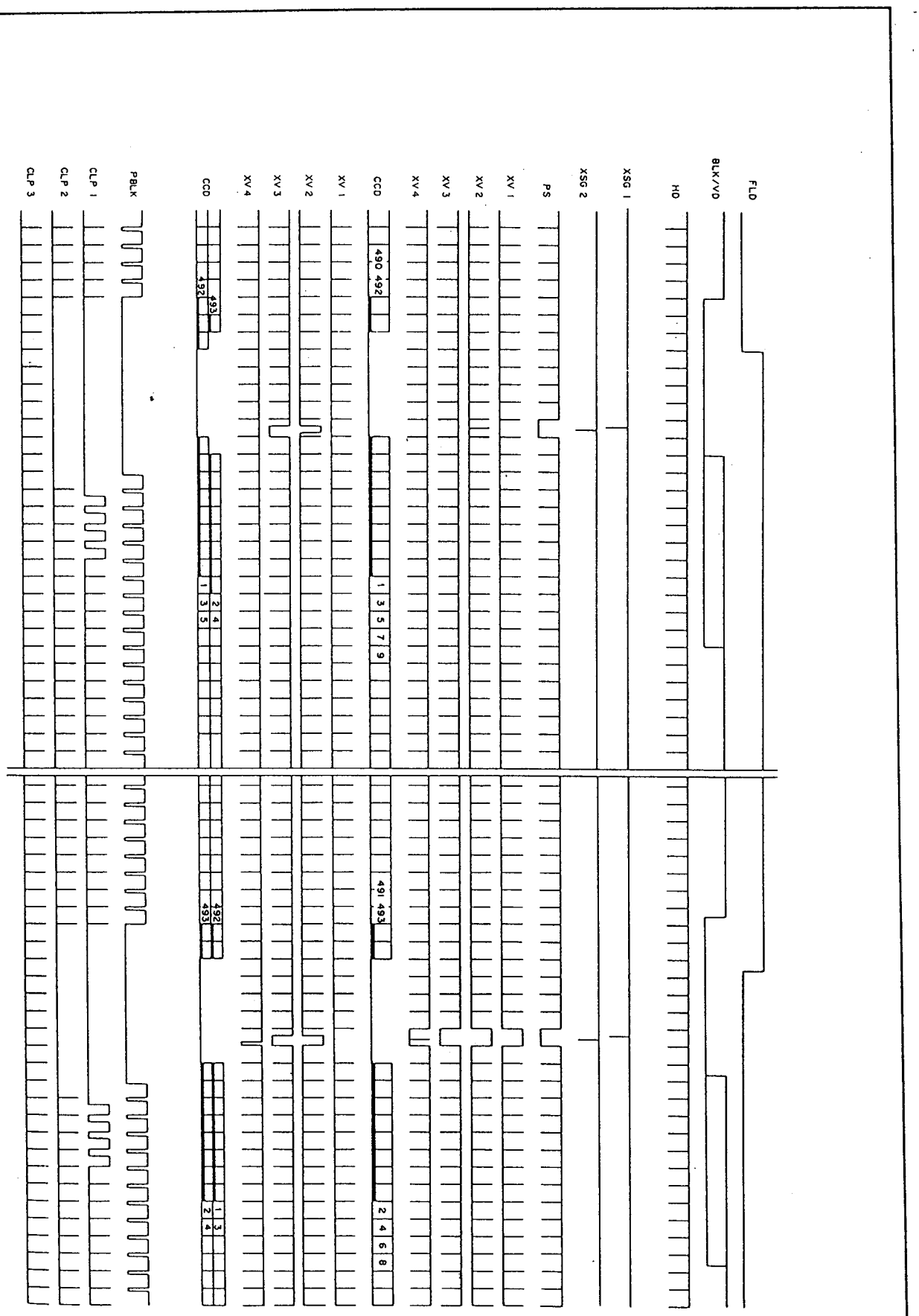

### 7.4 SUBCARRIER EXTERNAL LOCKING

Standard NTSC format (TMC-74) is VS or composite sync locking. VBS or subcarrier locking is available as a simple modification since it has a built in subcarrier VCO and phase adjustment circuit. If subcarrier external locking is required, 4fsc signal wiring is moved from CLK to VCO 4fsc. When this change is done, it is neccessary to feed external sync all the time as internal subcarrier may not be synchronous as master clock. PAL does not need this modification.

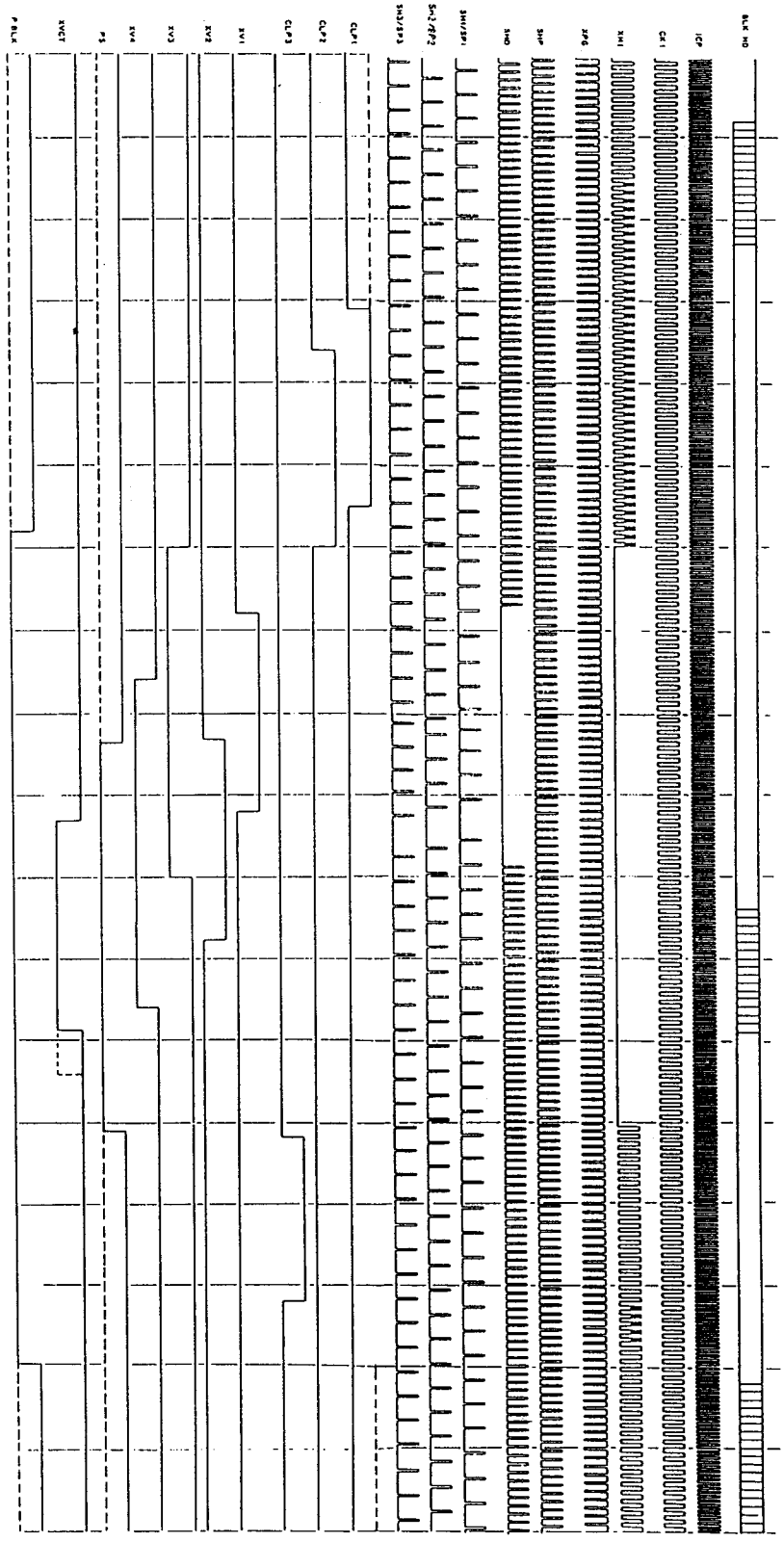


## SECTION 8: TIMING CHART FOR TMC-74/TMC-76

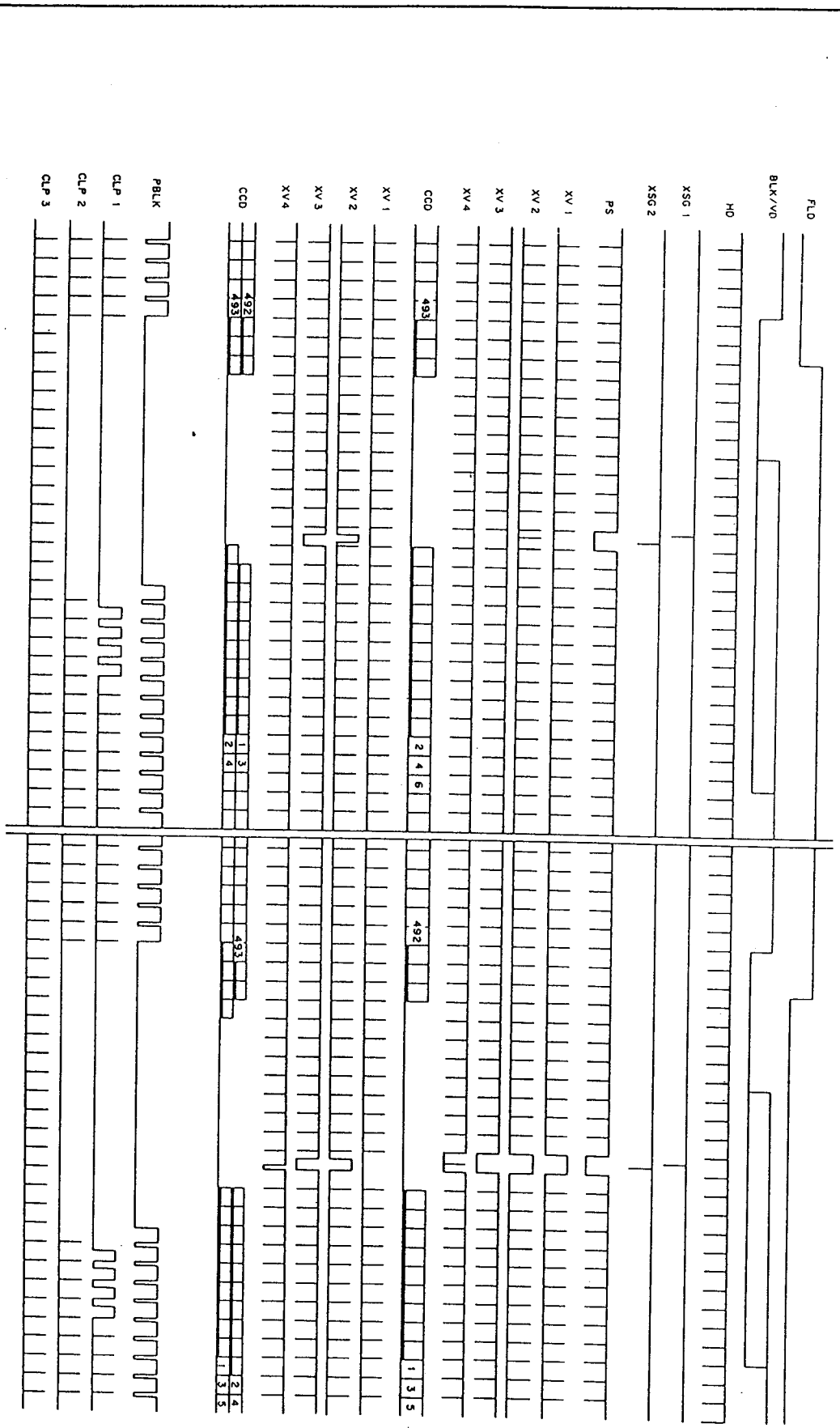




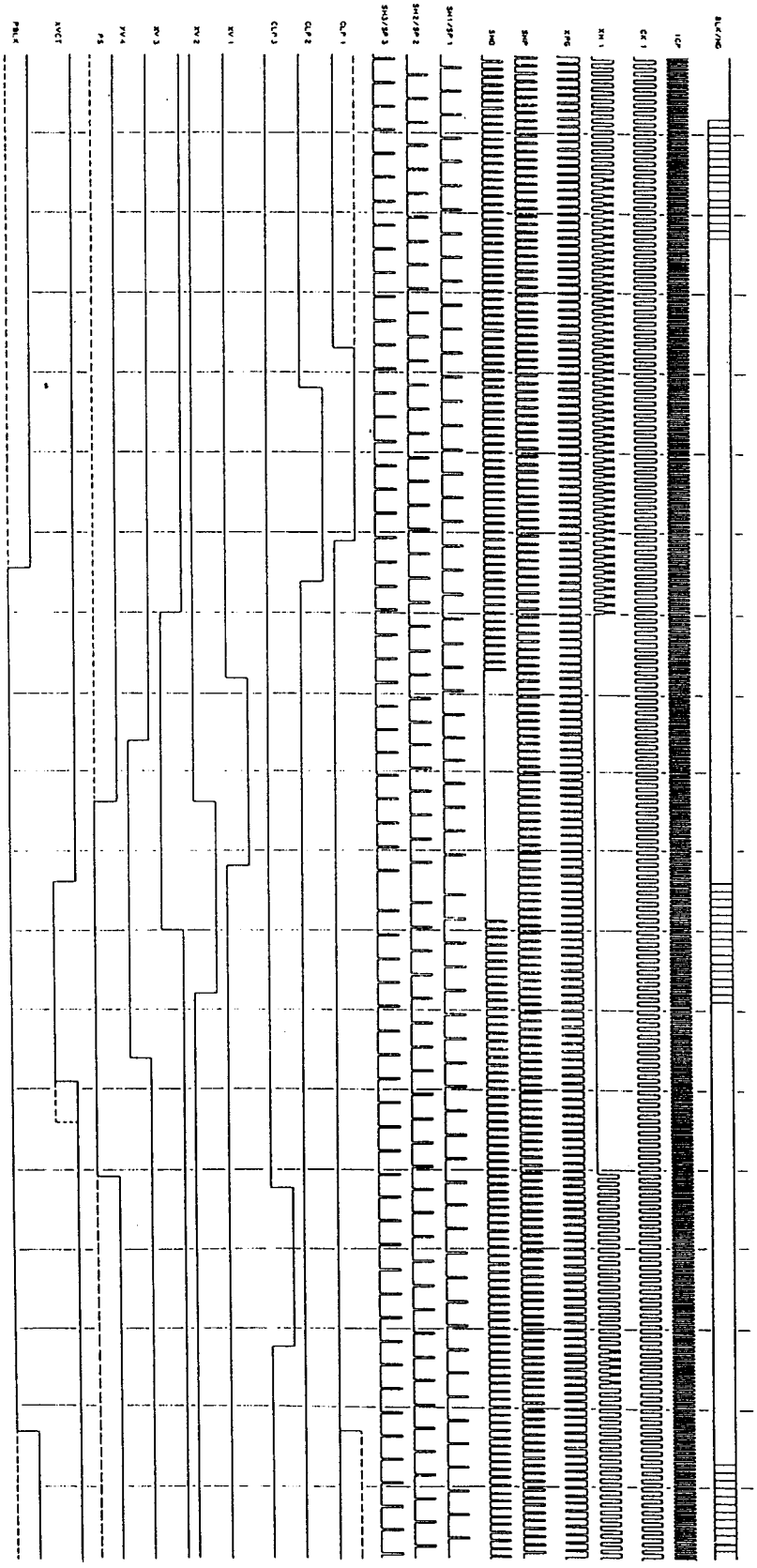

NTSC Vertical Pulse Drawing



NTSC Horizontal Pulse Drawing



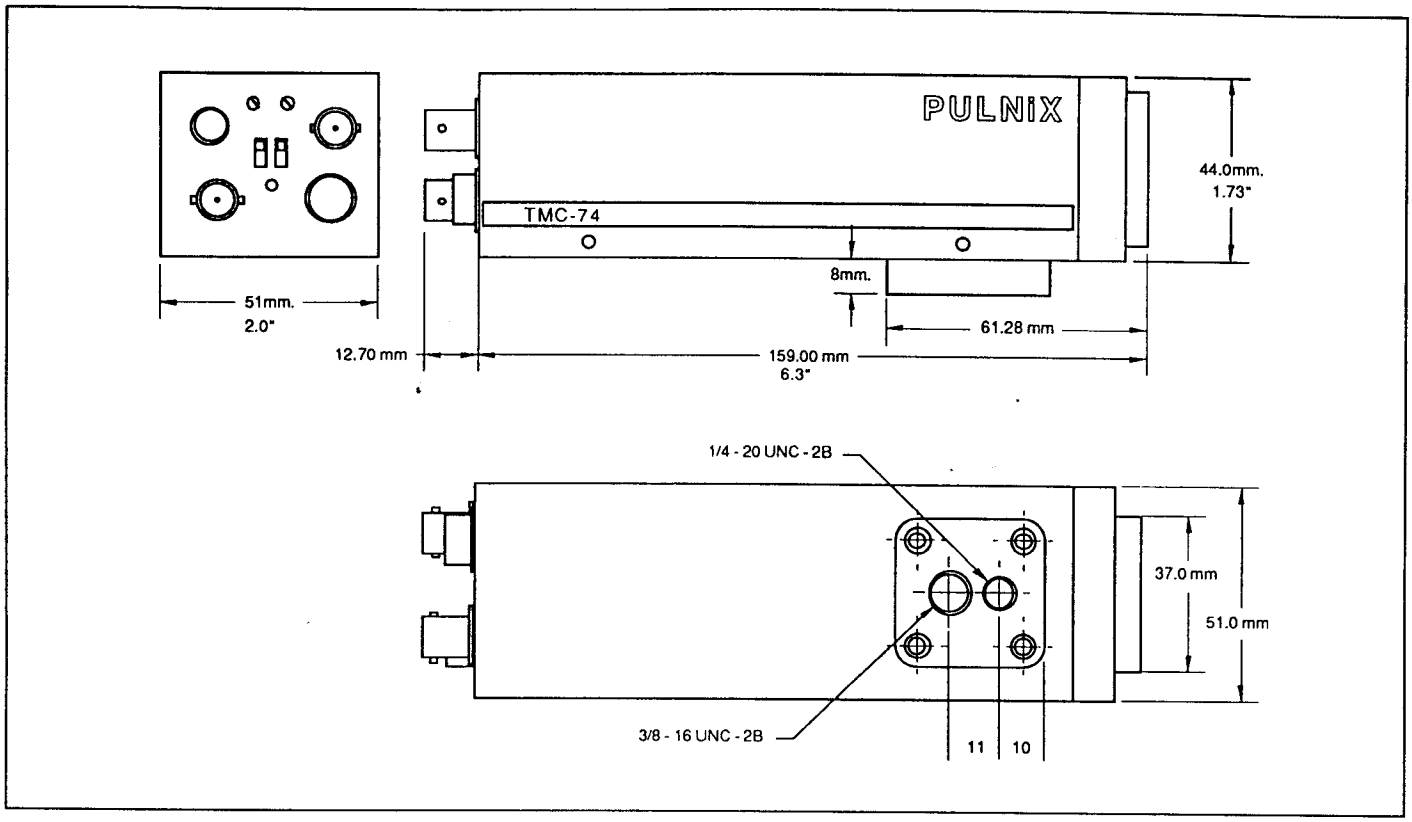

PAL Vertical Pulse Drawing



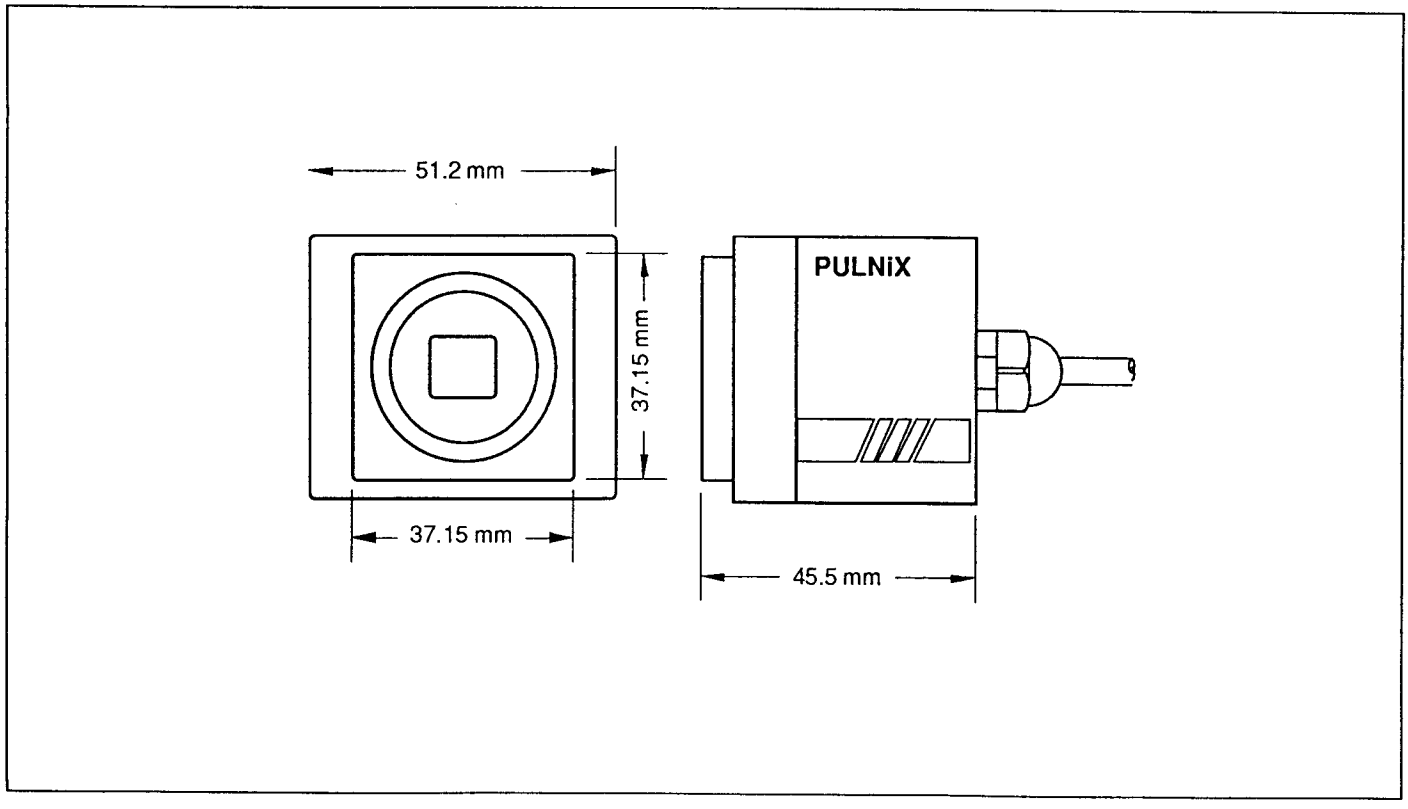
PAL Horizontal Pulse Drawing

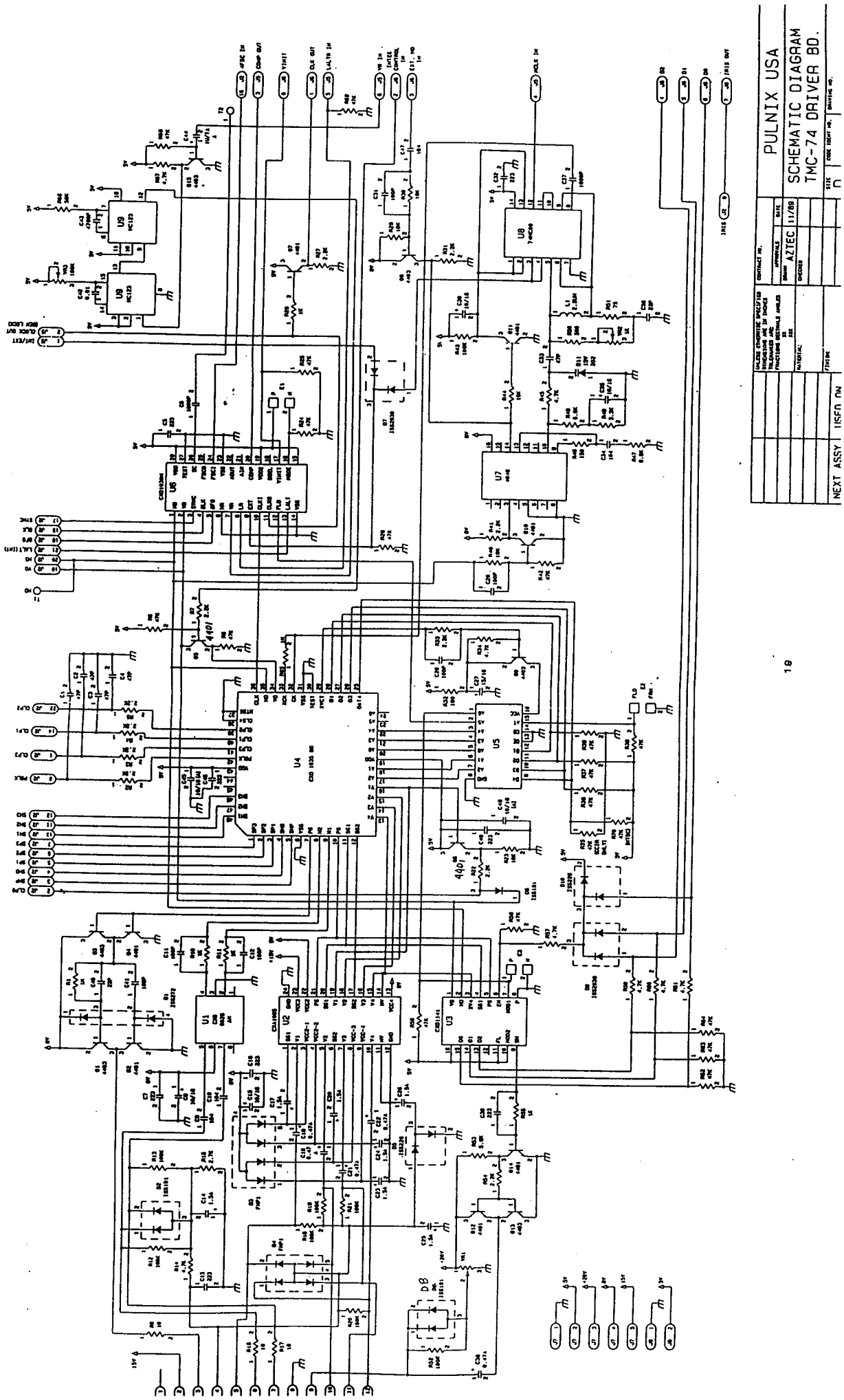
## SECTION 9: MECHANICAL DRAWINGS

### 9.1 STANDARD CONFIGURATION




### 9.2 REMOTE HEAD CONFIGURATION

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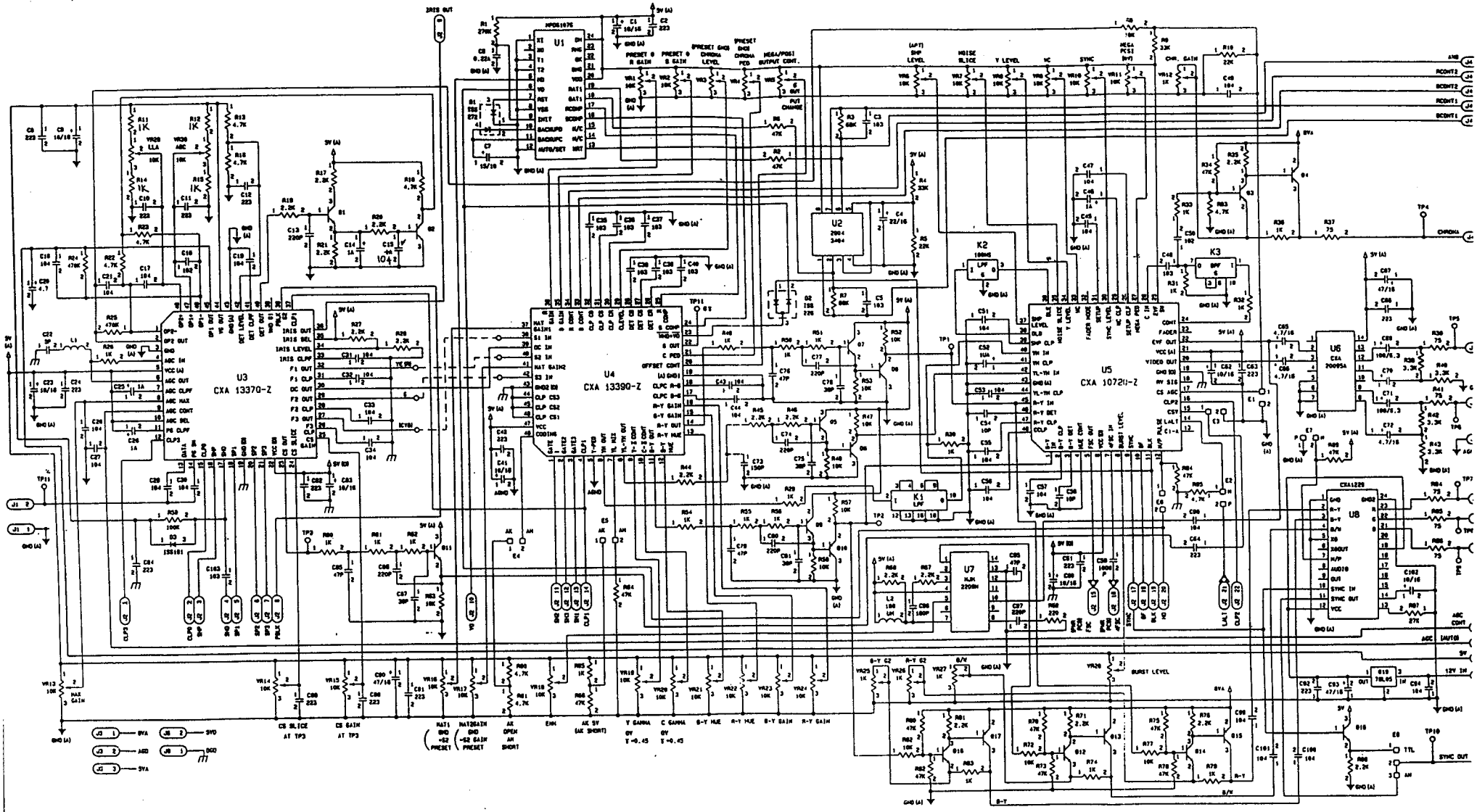


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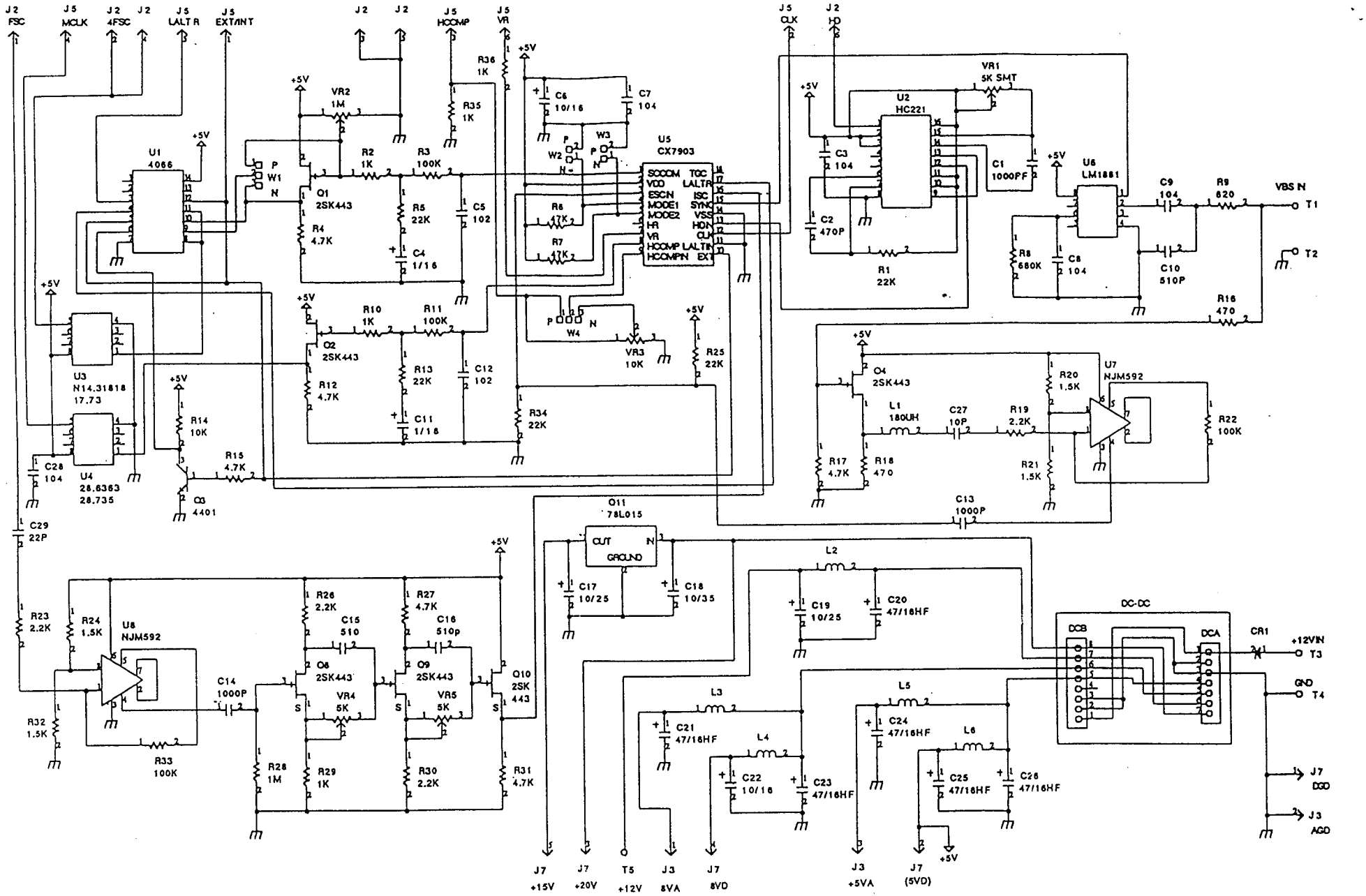


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| MATERIAL | DRAWN TRINH 3-29-90 | SCHEMATIC DIAGRAM TMC-74 POWER BD. |
| UNIT: Inches | ENGR | |
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## NOTICE

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## WARRANTY

All our solid state cameras have a full three year warranty. If any such product proves defective during this warranty period, Pulnix America, Inc. will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product. This warranty shall not apply to any damage, defect or failure caused by improper use or inadequate maintenance and use.

Revised Printing: September 1995

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