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PULNiX

TM-440 (EIA) / TM-460 (CCIR)
CCD CAMERA

OPERATIONS &
MAINTENANCE MANUAL

1. Introduction

The TM-440/460 are compact and high quality monochrome video cameras using a CCD image device. The TM-440 is the EIA (NTSC) system, and TM-460 is the CCIR (PAL) system.

- 1/1000 Second Electronic Shutter Function (TM-440S/TM-460S)
- 310 TV Lines Horizontal Resolution
- 2 External Sync Functions
- Non-Interlaced Scanning Capable
- AGC: ON/OFF, Gamma: ON/OFF Switchable
- Auto-Iris Function

2. Specifications

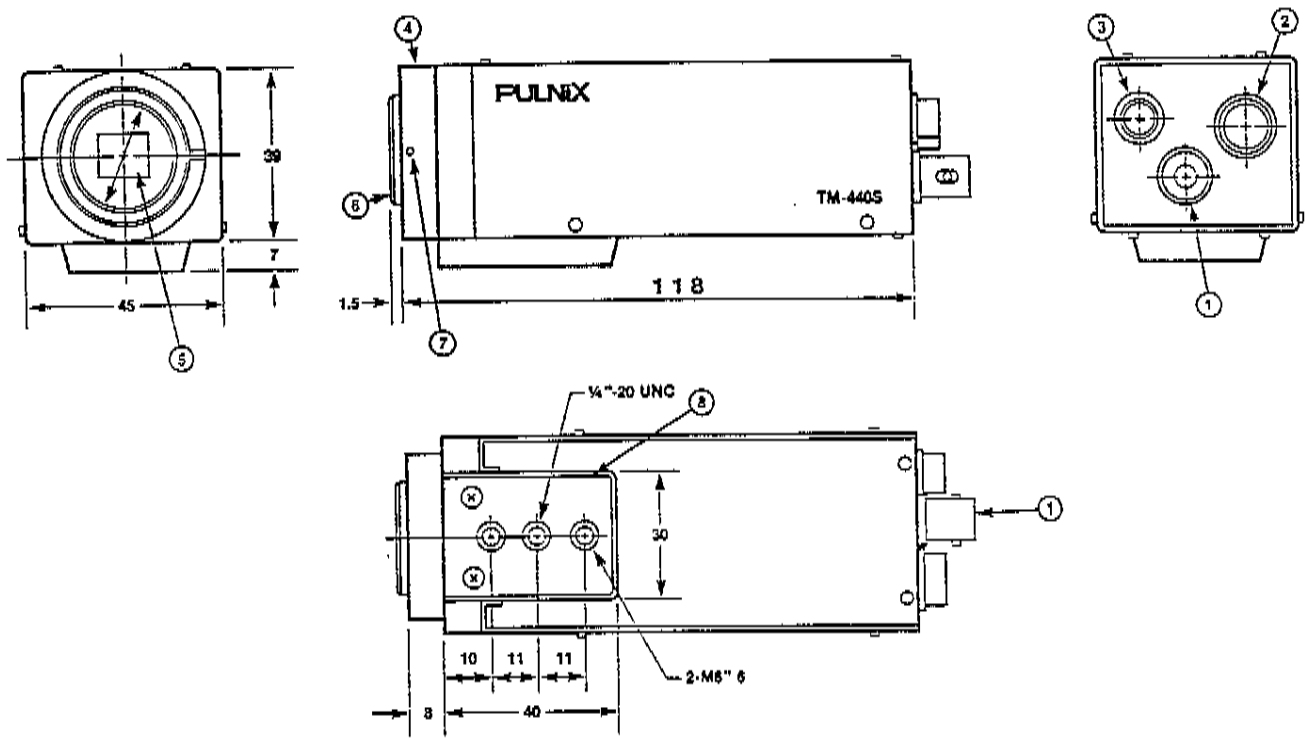
1. TM-440/460

	TM-440 (EIA)	TM-460 (CCIR)
Image Sensor	MN3734SK Interline transfer CCD Field storage mode Pixel···422(H) x 489(V) Pixel size··· 15.2(H) x 10.0(V) μm Area ···6.41 (H) x 4.89 (V) mm (1/2-inch tube size)	MN3740SK Interline transfer CCD Field storage mode Pixel···422(H) x 579(V) Pixel size··· 15.2(H) x 8.3(V) μm Area ···6.41(H) x 4.79 (V) mm (1/2-inch tube size)
Charge Storage Time (Shutter Speed)	1/60 or 1/1000 sec (Internal Switch/External Control)	1/50 or 1/1000 sec (Internal Switch/External Control)
Scanning System	EIA standards 525 lines, 30 flames/sec 2:1 interlace or non-interlace (switchable)	CCIR standards 625 lines, 25 flames/sec 2:1 interlace or psuedo-interlace (switchable)
Sync System	Internal/External sync	Internal/External sync
Sync Frequency	Horizontal···15.734 kHz Vertical ···59.9 Hz	Horizontal···15.625 kHz Vertical ···50.0 Hz
External Sync	HD.VD. EXT IN HD···15.734 kHz ± 1.0% 4Vp-p ± 1.0V (negative logic) VD···59.9 Hz ± 1.0% 4Vp-p ± 1.0V (negative logic) Composite EXT IN 4Vp-p ± 1.0V (negative logic)	HD.VD EXT IN HD···15.625 kHz ± 1.0% 4Vp-p ± 1.0V (negative logic) VD···50.0 Hz ± 1.0% 4Vp-p ± 1.0V (negative logic) Composite EXT IN 4Vp-p ± 1.0V (negative logic)
Resolution	310 TV Lines (H) 350 TV Lines (V)	310 TV Lines (H) 420 TV Lines (V)
S/N	50 dB typ	50 dB typ
Standard Illumination	50 lux (F1.4, without IR cut filter)	50 lux (F1.4, without IR cut filter)
Minimum Illumination	3 lux (F1.4, without IR cut filter)	3 lux (F1.4, without IR cut filter)
Video Output	Composite Video Signal 1.0Vpp/75Ω	Composite Video Signal 1.0Vpp/75Ω
Gamma Character	$\partial \cong 1.0$ or $\partial \cong 0.6$ (Switchable)	$\partial \cong 1.0$ or $\partial \cong 0.6$ (Switchable)
AGC	OFF (+0dB) or ON(+10dB) (Switchable)	OFF (+0dB) or ON(+10dB) (Switchable)
Power Voltage	DC 11~16V	DC 11~16V
Power Current	240mA typ (DC 12.0V)	240mA typ (DC 12.0V)
Lens Mount	C-mount	C-mount
Dimensions	39(H)x45(W)x118(L)mm	39(H)x45(W)x118(L)mm
Weight	300g typ	300g typ

Note: All specification values are taken with the standard metallic case and the standard lens as the camera module unit.

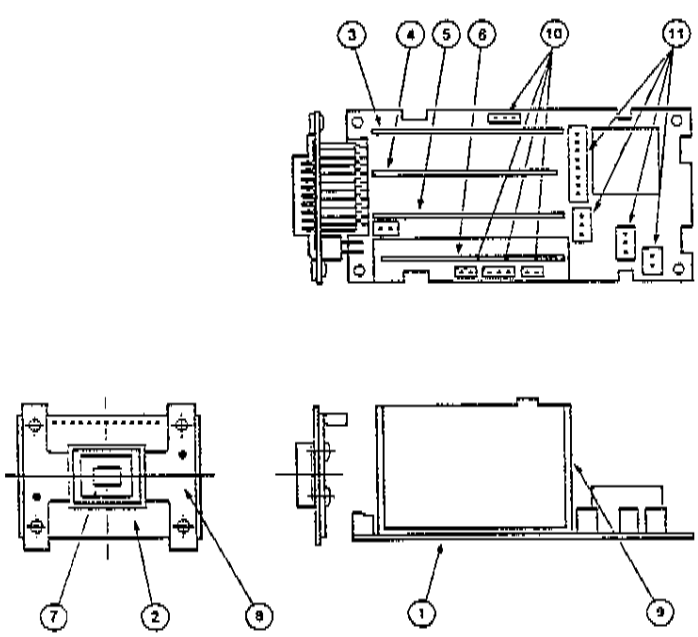
3. Name of Parts

1. TM-440/460



1. Video Signal Connector
2. Power/Ext Sync Input Connector
3. ALC Connector
4. Front-end Panel
5. Installation for IR cut Filter
6. Lens Mounting Screw (C-Mount)
7. Lens Fastening Screw
8. Tripod Adapter

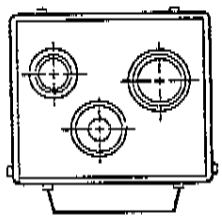
2. Inside PCB Assembly



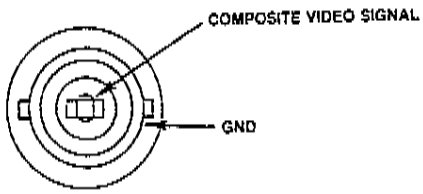
1. MB Board
2. IDN/IDP Board
3. LDN/LDP Board
4. PL2-N/PL2-P Board
5. PL1 Board
6. PS Board
7. CCD Image Device
8. Fixing Plate
9. Shield Plate
10. Switches
11. Connectors

4. Connectors

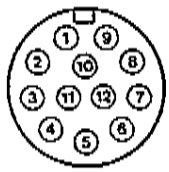
TM-440/460



• Video Signal Connector

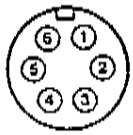


• Power/Ext Sync Input Connector



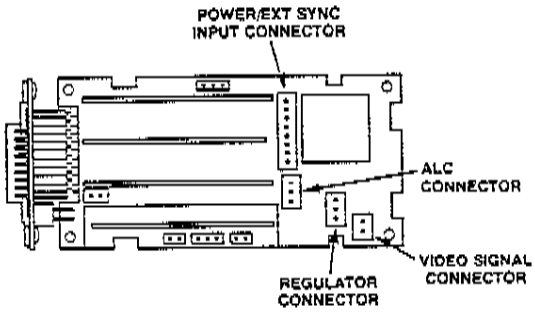
1. GND
2. + 12V DC
3. GND (video)
4. Video out
5. GND (C. sync)
6. Composite sync in
7. V_D in
8. GND (H_D)
9. H_D in
10. Shutter GND
11. Shutter control
12. GND (V_D)

• ALC Connector



1. N/C
2. GND
3. Video out
4. + 12V
5. N/C
6. N/C

TM-440/460

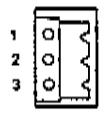


• Video Signal Connector



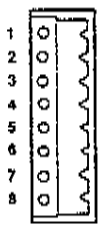
1. Composite Video Signal
2. GND

• Regulator Connector



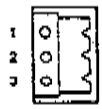
1. DC11~16V
2. GND
3. DC9V

• Power/Ext Sync Input Connector



1. DC11~16V IN
2. GND
3. VD EXT IN
4. CS EXT IN
5. HD EXT IN
6. SH EXT IN
7. L/I IN
8. GND

• ALC Connector

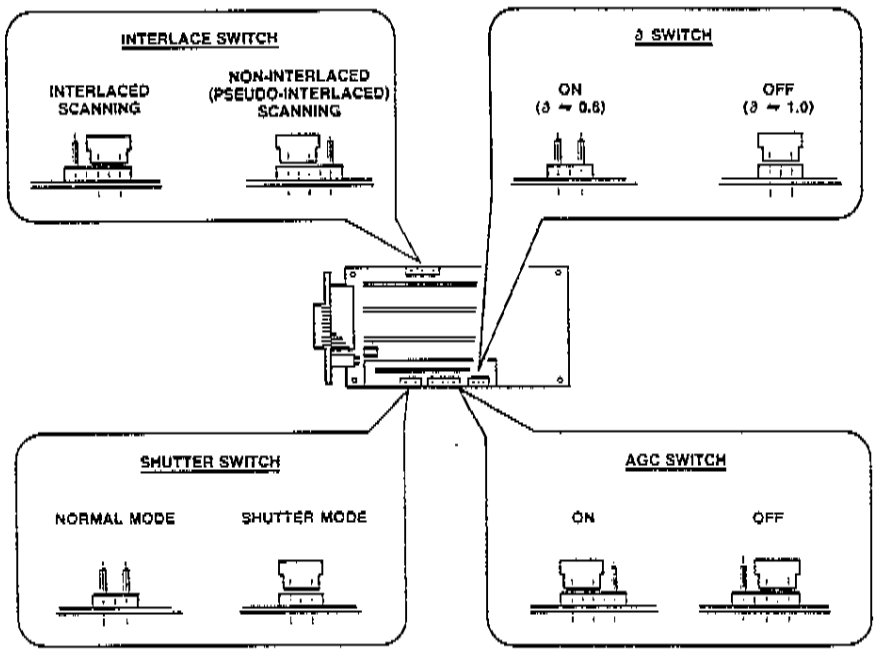


1. GND
2. DC11~16V
3. ALC OUT

5. Switches

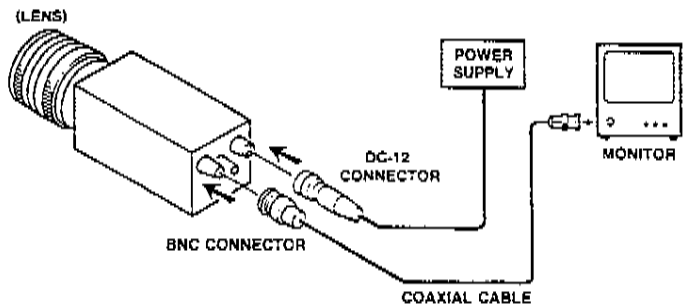
Initially, the switches on MB board are set as follows.

Switch	Setting	Jumper Connector
Interlace	2:1 Interlaced	Installed
AGC	ON	Installed
∂	ON (∂ ≅0.6)	Not installed
Shutter	OFF (Normal mode)	Not installed

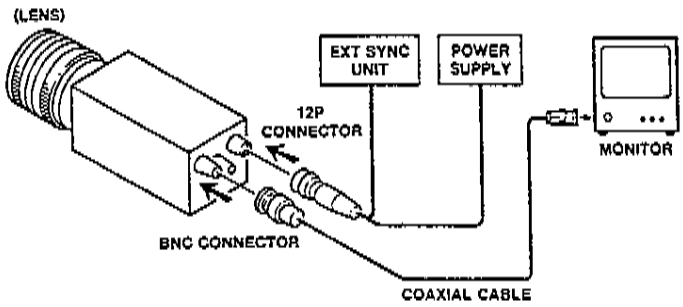


6. Connection

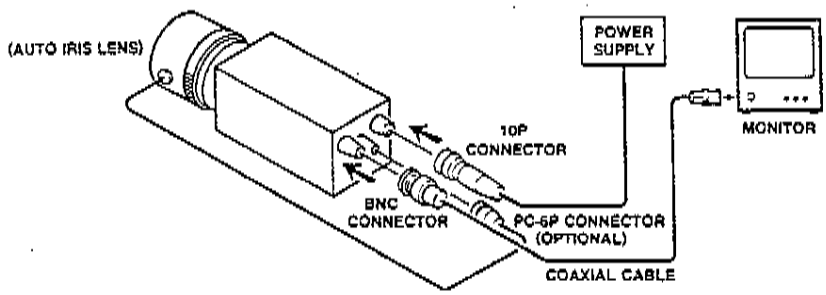
- **Internal Sync Mode**
  Connect the power/ext sync input connector and video signal connector to their respective receptacle connectors. Provide the power voltage through the power/ext sync input connector.



- **External Sync Mode**
  Connect the connectors the same as internal sync mode, and provide the power voltage and the external sync signal.

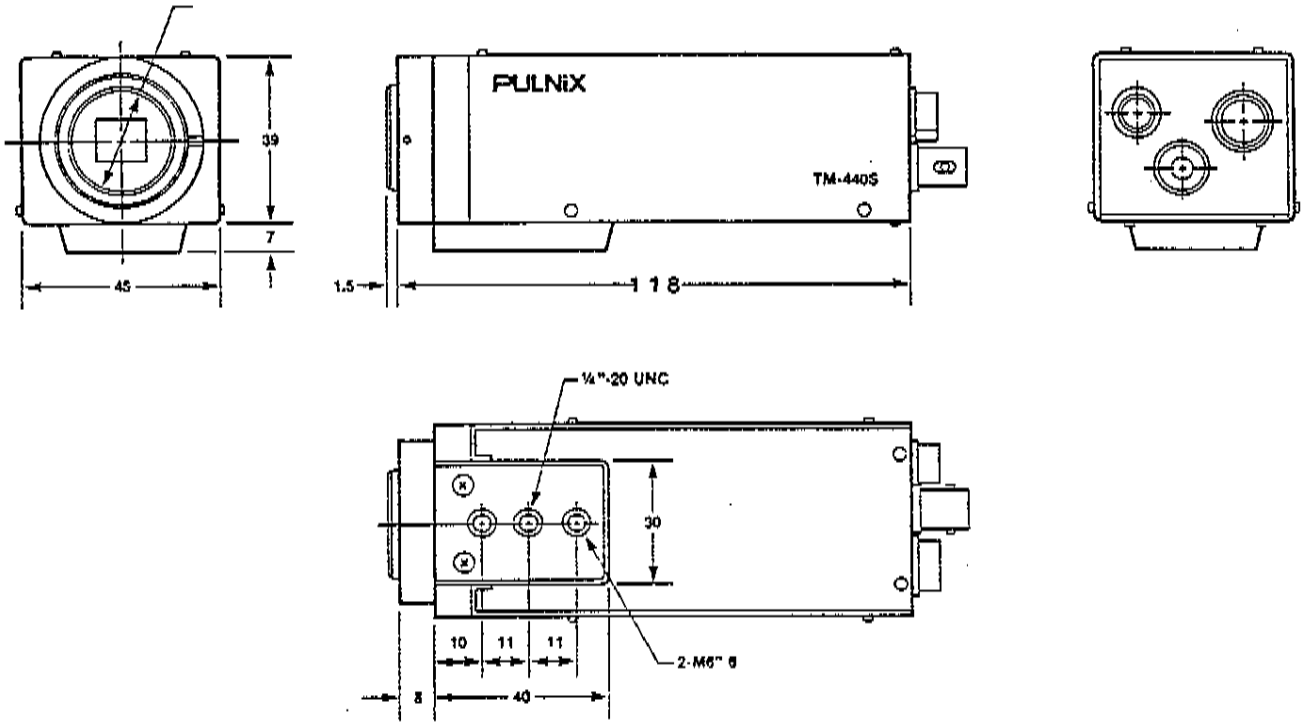


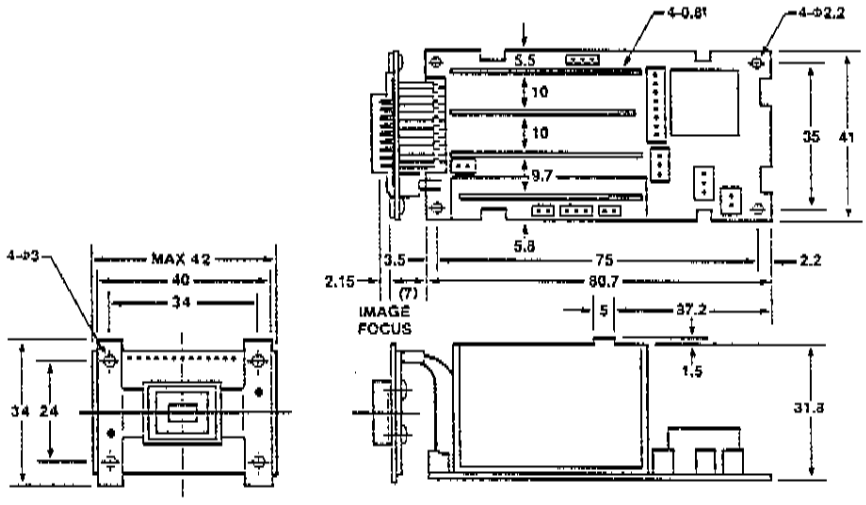
- **When Using Auto-Iris Lens (Internal Sync Mode)**
  Connect the connectors the same as internal sync mode, and connect the ALC connector to its receptacle connector.



Note: Please attach the connectors firmly. Don't pull the cable to take off the connector. It may break the wire.

7. Dimensions





8. Basic Operation

1. Construction

The TM-440/460 has 6 printed-circuit boards. They are as follow:

Name/Type	TM-440	TM-460
Ext Sync Circuit	PL1	PL1
Sync Signal Generator Circuit	PL2-N	PL2-P
CCD Drive Circuit	LDN	LDP
Optical-Electronic Exchange Circuit	IDN	IDP
Signal Process Circuit	PS	PS
Mother Board	MB	MB

2. Function of Each Board

1. EXT SYNC Circuit (PL1 board)

   EXT SYNC CIRCUIT (PL1 board) is the external sync signal (HD_{EXT}, VD_{EXT}, CS_{EXT} interface circuit. When the input is the external sync signals (HD_{EXT}, VD_{EXT}), PL1 sends out the HD, VD signals. However, if the input is the CS_{EXT} signal, PL1 board sends out the HD, VD and COMP signals.

   And PL1 board has two other functions:

   - Level shift function of WHD and VP signal
   - Interface function of shutter mode control signal (SH_{EXT})

2. SYNC SIGNAL GENERATOR CIRCUIT (PL2-N/PL2-P board)

   1. INTERNAL SYNC MODE ((): means PL2-P)
      IC206 (IC402) generates the standard clock signal for the sync signal generator (IC204 (IC406)).

      The sync signal generator (IC204 (IC406)) devides the standard clock signal frequency. This sync signal (WHD, VP, C-SYNC, CP1, CP2, C-BLK) is then sent out to the CCD DRIVE CIRCUIT.

   2. EXTERNAL SYNC MODE
      When the external sync signals (HD_{EXT}, VD_{EXT} or CS_{EXT}) are received, the sync signals (HD, VD or HD, VD, COMP) communicate with the SYNC SIGNAL GENERATOR CIRCUIT and the sync mode is automatically switched to the "EXTERNAL SYNC MODE".

      In the external sync mode, phase comparator circuit (IC201 (IC404)), low-pass filter (IC202 (IC405)), voltage controlled oscillater (VCO) (IC206 (IC402)) and sync signal generator circuit (IC204 (IC406)) form the PLL (Phase Locked Loop). PLL only operates in the external sync mode.

      Phase comparator circuit (IC201 (IC404)) compares the phase of the WHD sync signal (CP1 in composite sync mode) and the HD sync signal. Where the WHD sync signal is from the sync signal generator and the HD sync signal is from the EXT SYNC CIRCUIT (PL1). Phase comparator circuit also controls the standard clock signal frequency of VCO (14.31818/4.40625 MHz) for the synchronization of the two sync signals.

      The sync signal generator circuit (IC204 (IC406)) divides the standard clock signal frequency of VCO (IC204 (IC406)). This sync signal (WHD, VP, C-SYNC, CP1, CP2, C-BLK) is sent out to the CCD DRIVE CIRCUIT and SIGNAL PROCESS CIRCUIT.

3. CCD DRIVE CIRCUIT (LDN/LDP board)
   Using the WHD and VP from SYNC SIGNAL GENERATOR (PL2-N/PL2-P), CCD DRIVE CIRCUIT (LDN/LDP) sends out the sampling pulses (DS1, DS2), CCD horizontal transfer pulses (H_{12}, H_{34}, R) and vertical transfer pulses (V1, V2, V3, V4).

   Sampling pulses (DS1, DS2) are then sent to CDS block of the SIGNAL PROCESS CIRCUIT. And the CCD horizontal transfer pulses and vertical transfer pulses are sent to the CCD of the OPTICAL-ELECTRONIC EXCHANGE CIRCUIT.

4. OPTICAL-ELECTRONIC EXCHANGE CIRCUIT (IDN/IDP board)
   The CCD image sensor is made of the photo-diodes for optical-electronic exchange, the vertical CCD and the horizontal CCD. The optical information exchange process is as follows:

   1. Photo-diode converts the light rays into electric charge.
   2. Reads this charge out to the respective vertical CCD.
   3. Vertical transfer pulse then transfer the respective columns of charges from the vertical CCD to the horizontal CCD.

4. The horizontal CCD then send the signal charges to the output terminal.

   In normal mode, charge storage time of photo-diode for optical-electronic exchange is 1/60 (CCIR SYSTEM: 1/50) sec. On the other hand, the charge storage time for the shutter' mode is 1/1000 sec. So sensitivity in shutter mode with be 1/16.7 (1/20) in comparison with that of in normal mode.

5. SIGNAL PROCESS CIRCUIT (PS board)
   In the CDS circuit (IC501), two sampling pulses (DS1, DS2) first sample the input video signal from the OPTICAL-ELECTRONIC EXCHANGE CIRCUIT, and then output the sampled signal to IC502.

   Pedestal level, gamma (∂) character and AGC function are added to video signal in IC502. And the output signal band width from IC502 is limited by low-pass filter (3MHz, −3dB), and then put into IC503. The sync signal will then be mixed to video signal in IC503 as a composite video signal output.

6. MOTHER BOARD (MB board)
   MOTHER BOARD (MB board) generates voltages of +16, +9, +6, +5, −8V from DC voltage input source (11∼16V) for the respective circuits.

   IC601∼604 are the voltage regulators of +9, +5, +6, +5V.
   Tr601∼603 are parts of DC-DC converter for +16 and −8V.

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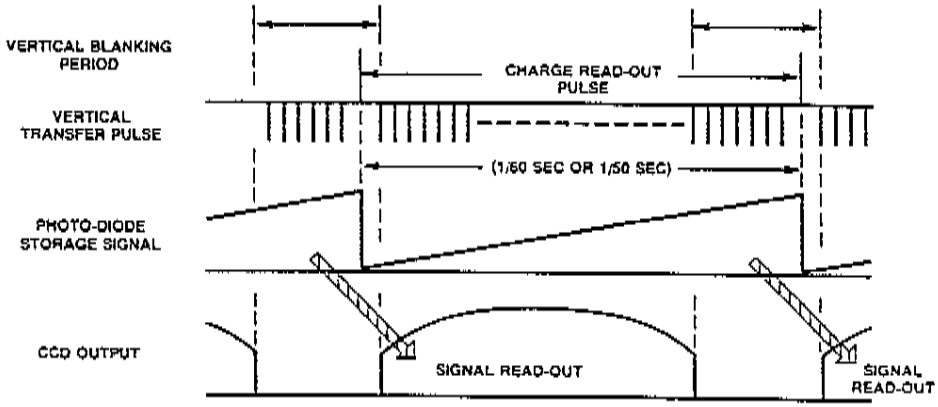
3. SHUTTER MODE (TM-440S/460S ONLY)

1. NORMAL MODE
   Usually charge storage time of the field storage mode CCD is 1/60 sec (EIA) TV SYSTEM) or 1/50 sec (CCIR TV SYSTEM).

   Fig. 1 show the function of this mode. Charges which are storaged in the photo-diode of the image sensor will be read-out by the charge read-out pulse in the vertical blanking period.

   Photo-diode starts to store the charge at the moment when read-out has ended for 1/60 (1/50) sec until the next charge read-out pulse is sensed.

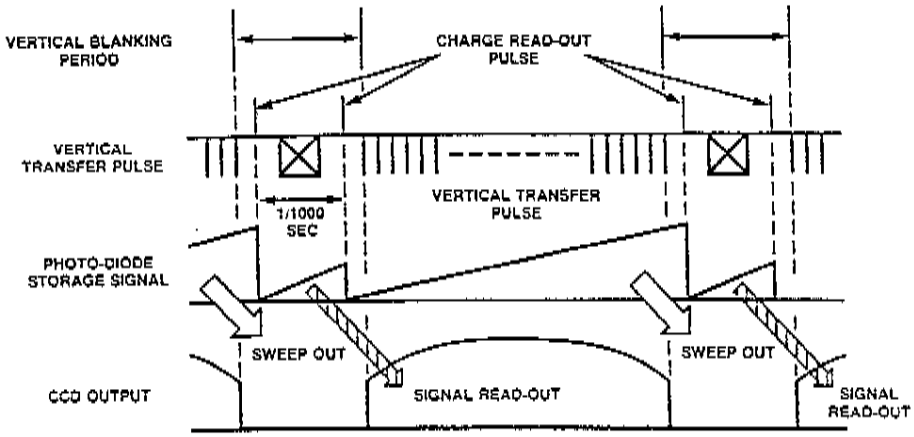
   All charges which have read-out will be sent out in turn by the vertical and horizontal transfer pulses in one field period. As mentioned above, photo-diode stores the charges for 1/60 (1/50) sec, so for stop-motion picture by the flame memory or VTR, fast moving object will not be clear.



2. SHUTTER MODE

Fig. 2 shows the function of shutter mode. In shutter mode, there are two charge read-out pulses in vertical blanking period. First pulse is for reading out the unnecessary charge and the charge will be swept out by the sweep-out pulse. After this first pulse, the necessary charge is stored for 1/1000 sec will be read-out by second pulse. In one field period this charge will be sent out.

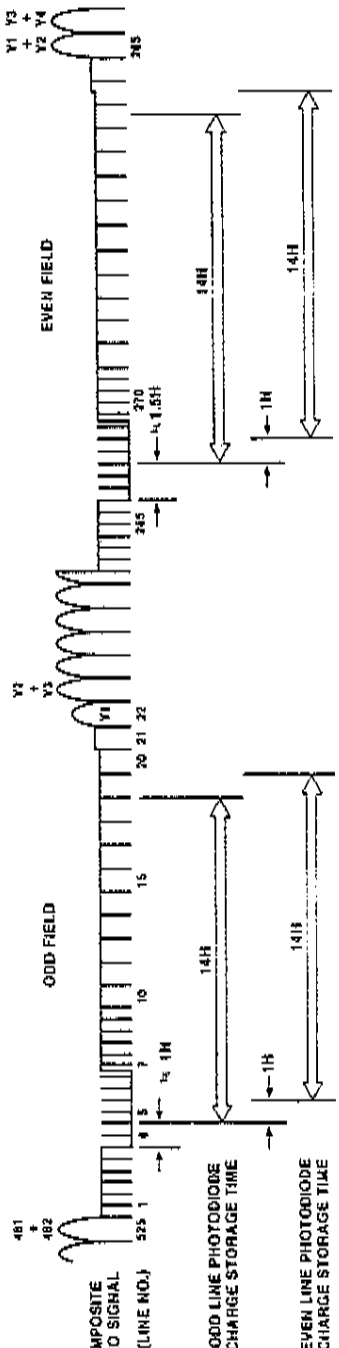
Because the charge storage time of photo-diode is 1/1000 sec, it is possible to obtain a clear stop-motion picture of the fast moving object.



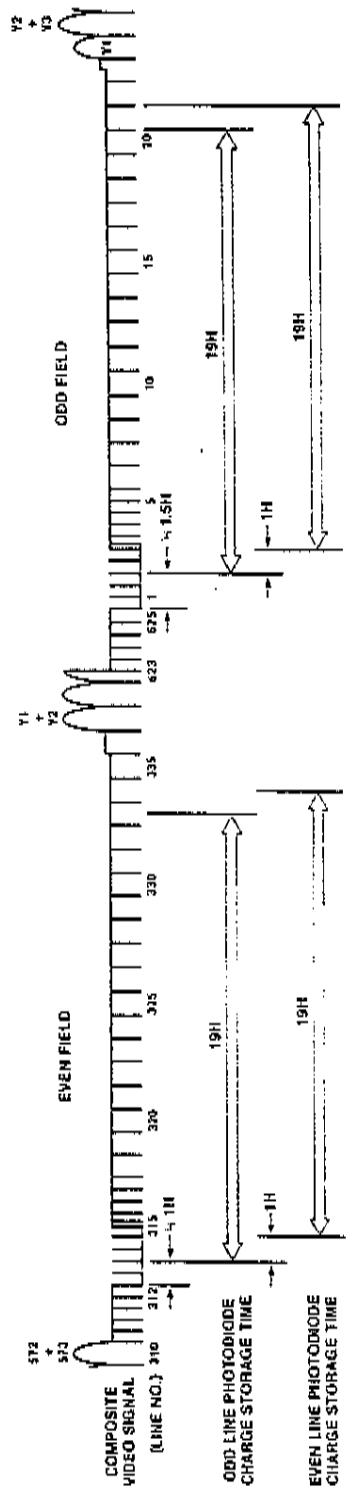
In shutter mode, charge storage time is 1/16.7 (1/20) to that of in normal mode. So output signal level is down about 4 exposure scale of lens than normal mode.

• CHARGE STORAGE TIME IN SHUTTER MODE

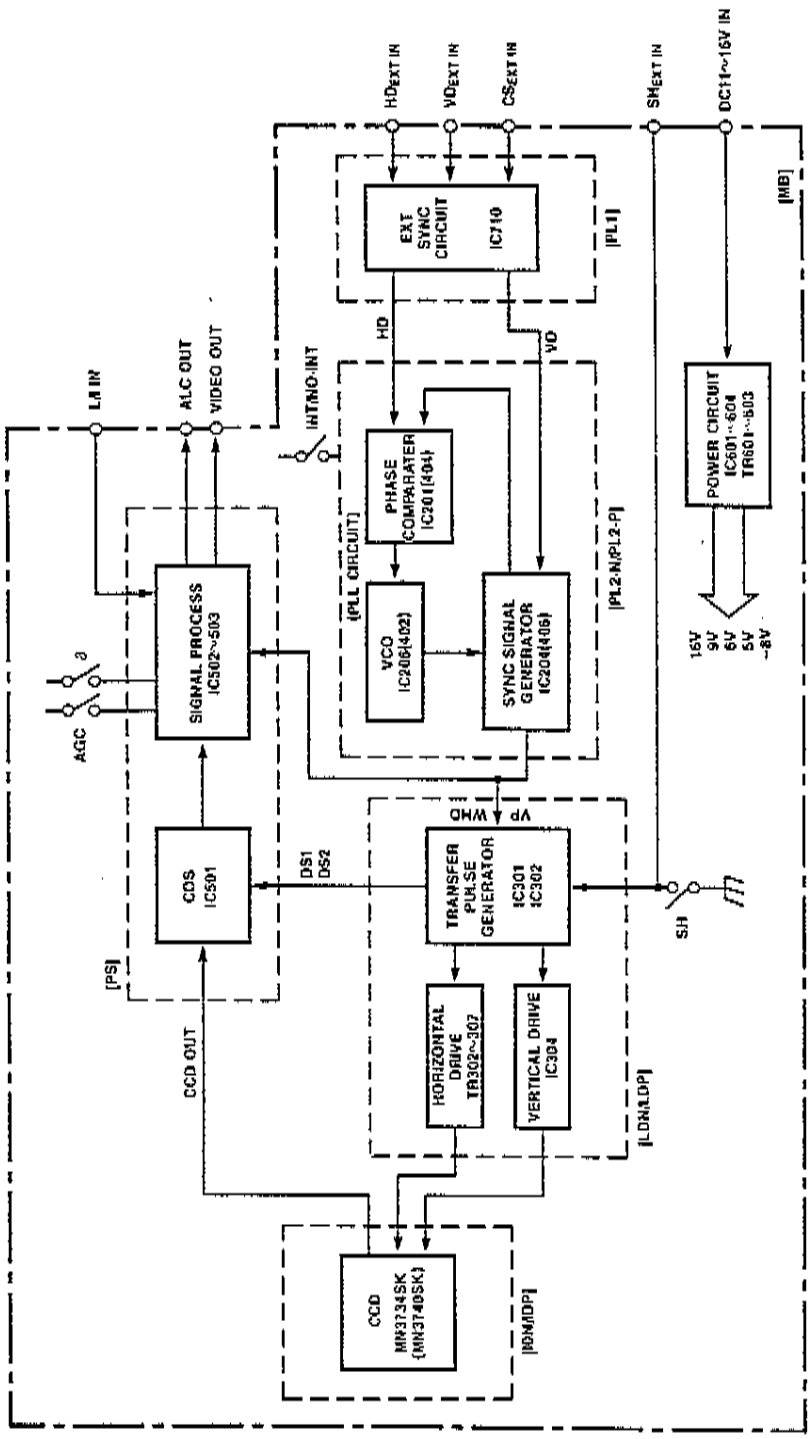
TM-440



TM-460

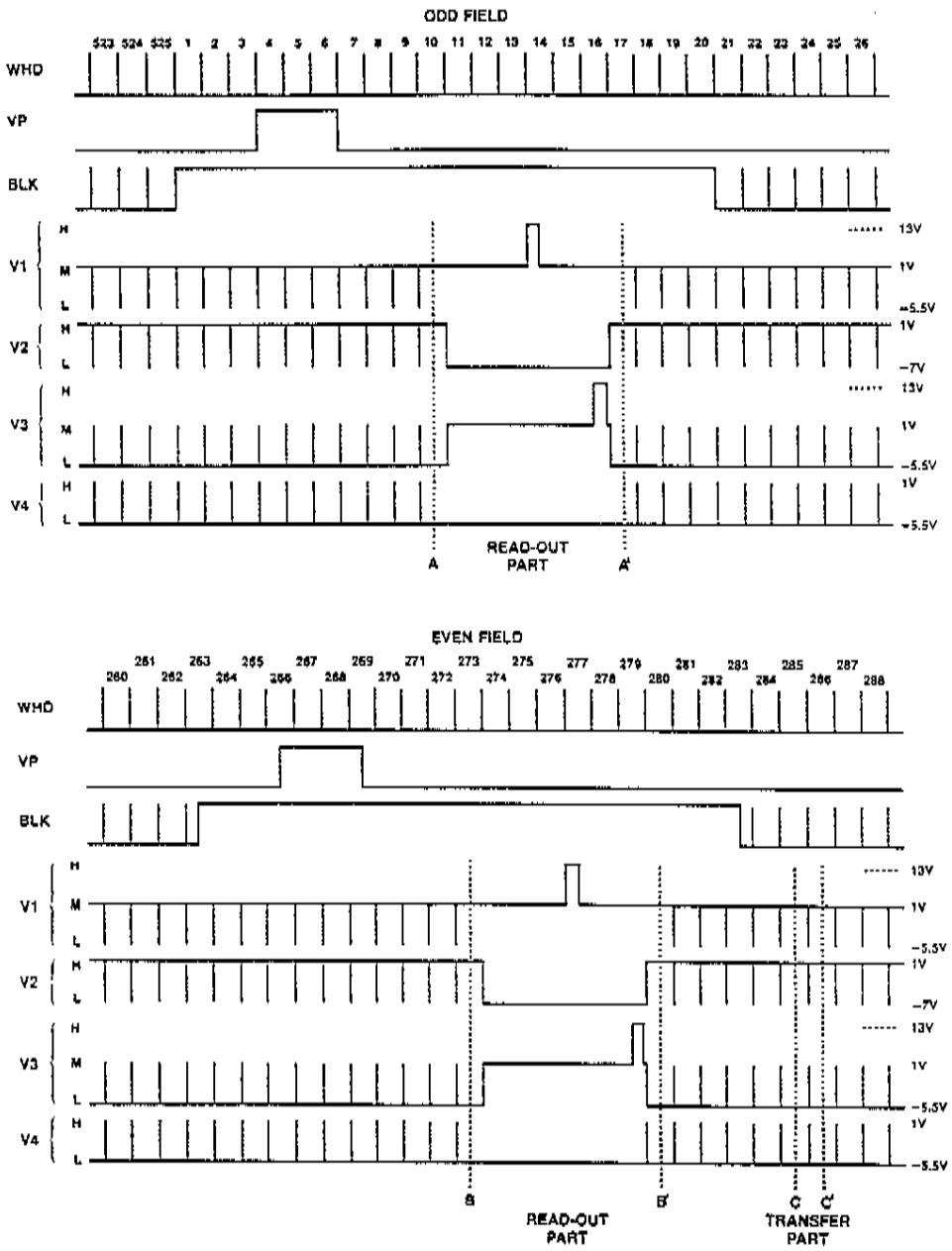


9. Block Diagram

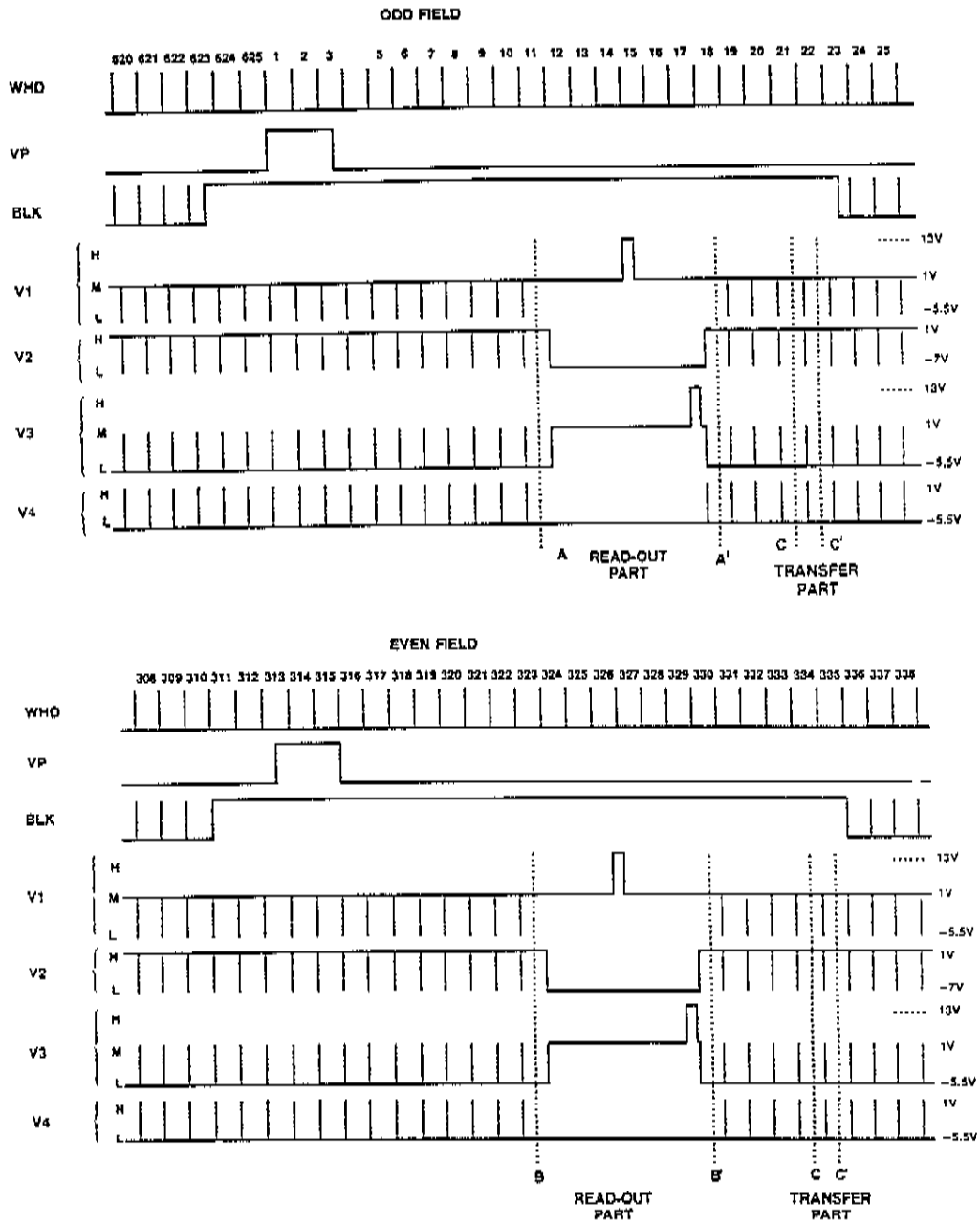


10. Vertical Transfer Pulse

1. TM-440



2. TM-460


ODD FIELD
WHD
VP
BLK
V1
V2
V3
V4
H
M
L
15V
1V
-5.5V
-7V
A
READ-OUT PART
A'
C
C'
TRANSFER PART
EVEN FIELD
B
B'
C
C'
READ-OUT PART
TRANSFER PART

11. Adjustment

Instrument of Adjustment

- Video monitor : B/W monitor TV
- Viewer : 3100K color viewer
- Test Chart : EIAJ-Cz Chart (Gray Scale)
- Oscilloscope : B.W. 100 MHz
- Spot Brightness Meter : nt-1P (MINOLTA)
- Power Supply : DC11~16V 250mA
- Voltage Controller : AC voltage controller
- Lens : F1.4, $f = 12.5$ mm
- Ext Sync Generator : HD, VD, Composite Sync output (Negative) Frequency variable Stability 10~100 ppm

When you adjust the camera module, please set the internal switches as follows.

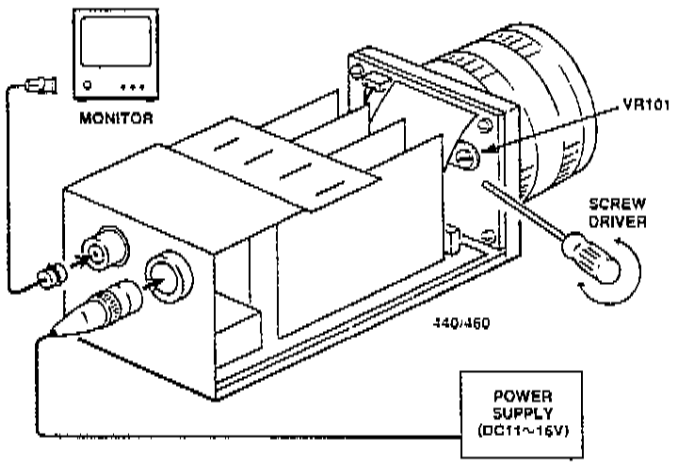
Switch	State
Interlace	2:1 interlaced scanning
∂(GAMMA)	$\partial \cong 0.6$ (OPEN)
AGC	ON (+10dB)
SHUTTER	Normal mode (OPEN)

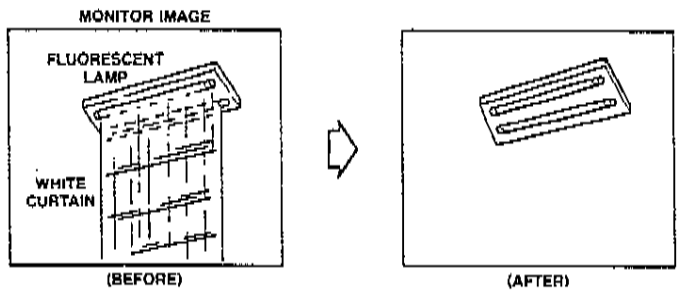
1. Vsub Adjustment

Measure Point: Composite Video Signal
Adjust Point: VR101 on IDN/IDP board
Adjust: Adjust VR101 so that the blooming will be minimum.

1. Connect the Video signal output (BNC or CN604 connector) to video monitor, and apply a DC11~16V voltage to the Power/Ext sync input connector. And take the image of fluorescent lamp.

2. Then, with the monitor at F1.4, adjust VR101 on IDN/IDP board so that the blooming of image will be minimum.



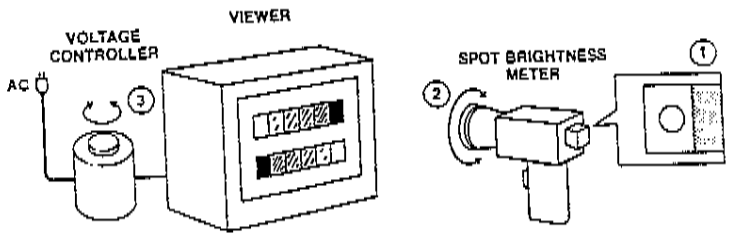


2. Gain Adjustment

Measure Point : C515 on PS board
Adjust Point : VR501 on PS board
Adjust : Adjust VR501 so that signal level of C515 will be 200 mV at F8.

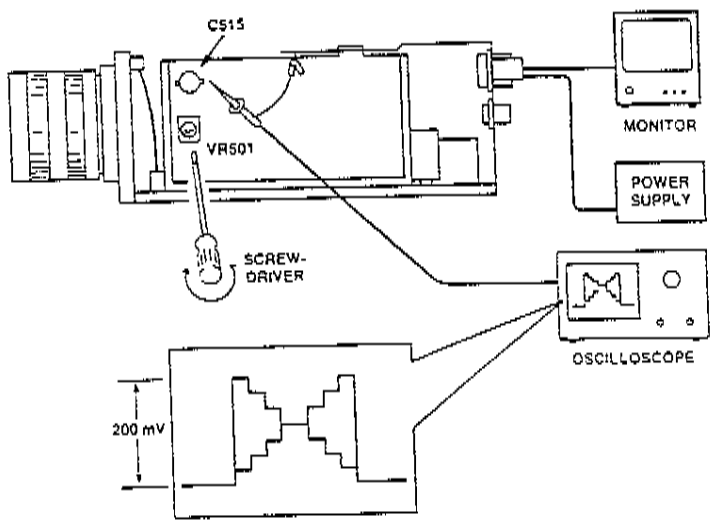
Before adjustment, please control the brightness of the viewer. Do the brightness control as follows:

1. Adjust the measuring area of SPOT BRIGHTNESS METER to the "WHITE" part of test chart.
2. Focus the SPOT BRIGHTNESS METER.
3. Adjust the viewer voltage to a level where the instrument indicates 423 nits.



Then do the gain adjustment by:

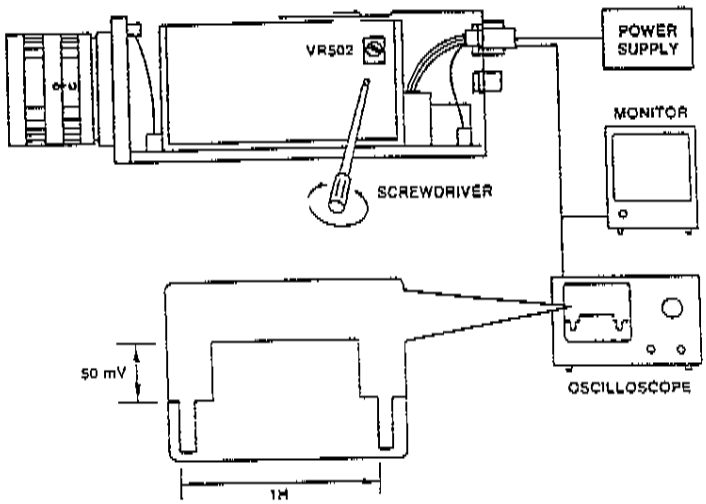
1. Set the camera module to operating mode and adjust the image area to fit the test chart.
2. With an oscilloscope, adjust the VR501 on PS board so that signal level of C515 will be 200 mV at F8.



3. Pedestal Level Adjustment

Measure Point : Composite Video Signal
Adjust Point : VR502 on PS board
Adjust : Adjust so that the pedestal level will be 50 mV.

1. Set the camera module to operating mode and close the lens.
2. With an oscilloscope, adjust the VR502 so that the pedestal level of composite video signal will be 50 mV.

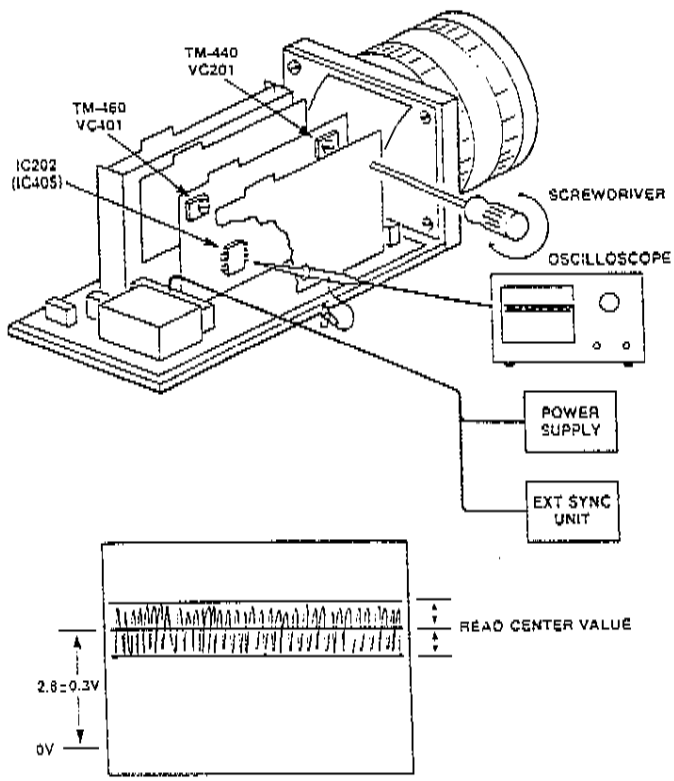


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4. External Sync VCO Adjustment

Measure Point : TM-440 IC202 1 pin on PL2-N
: TM-460 IC405 1 pin on PL2-P
Adjust Point : TM-440 VC201 on PL2-N
: TM-460 VC401 on PL2-P
Adjust : Adjust the voltage of VCO so as to be DC2.8 ± 0.3V.

1. Set the camera module to operating mode and supply the external sync signal (HD_{EXT}, VD_{EXT} or CS_{EXT}) to the module.
2. With the measure point on oscilloscope, adjust the VC201 (VC401) on PL2-N (PL2-P) board so that the voltage of VCO will be DC2.8 ± 0.3V.
   - Note that locations of VC201 and VC401 are different.
   - When you probe IC202 (IC405), take care not to touch other parts.



5. Internal Sync VCO Adjustment

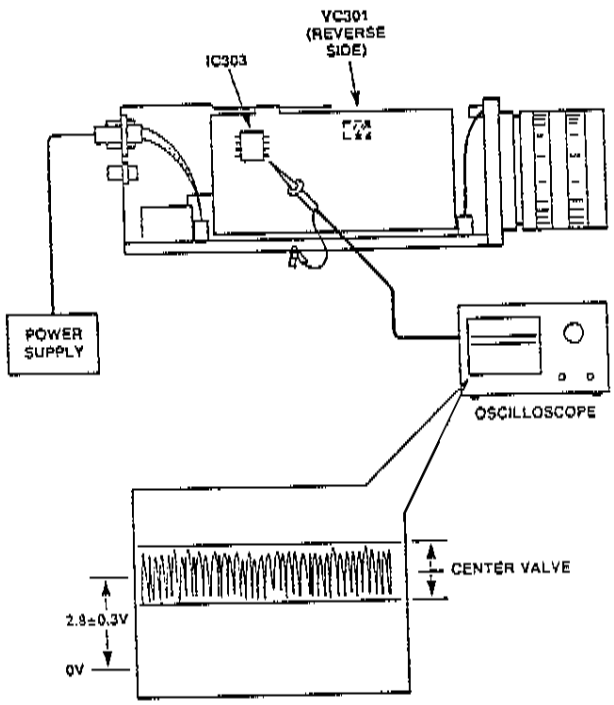
Measure Point : TM-440 IC303 1 pin on LDN
: TM-460 IC303 1 pin on LDP

Adjust Point : TM-440 VC301 on LDN
: TM-460 VC301 on LDP

Adjust : Adjust the voltage of the measuring point so as to be 2.3~3.0V.

1. Set the camera module to operating mode and connect the probe to the measuring point.

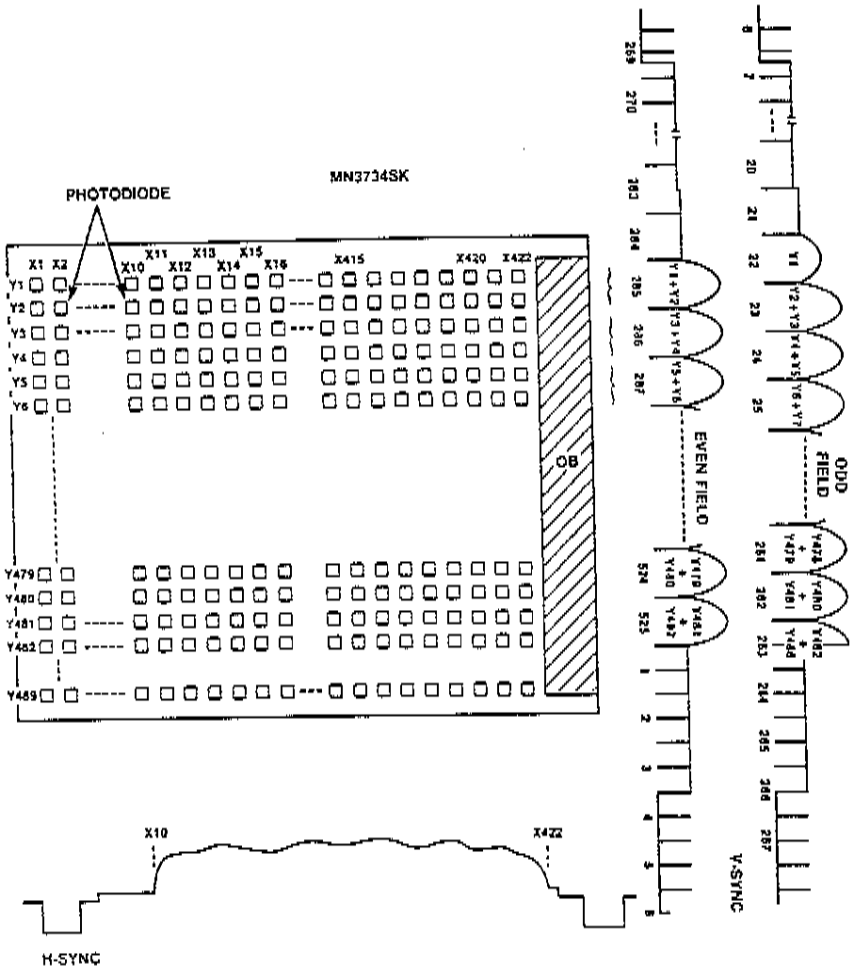
2. With an oscilloscope, adjust the VC301 so the the voltage of the measure point will be 2.3~3.0V.



12. CCD Image Address

1. TM-440 (MN3734SK)

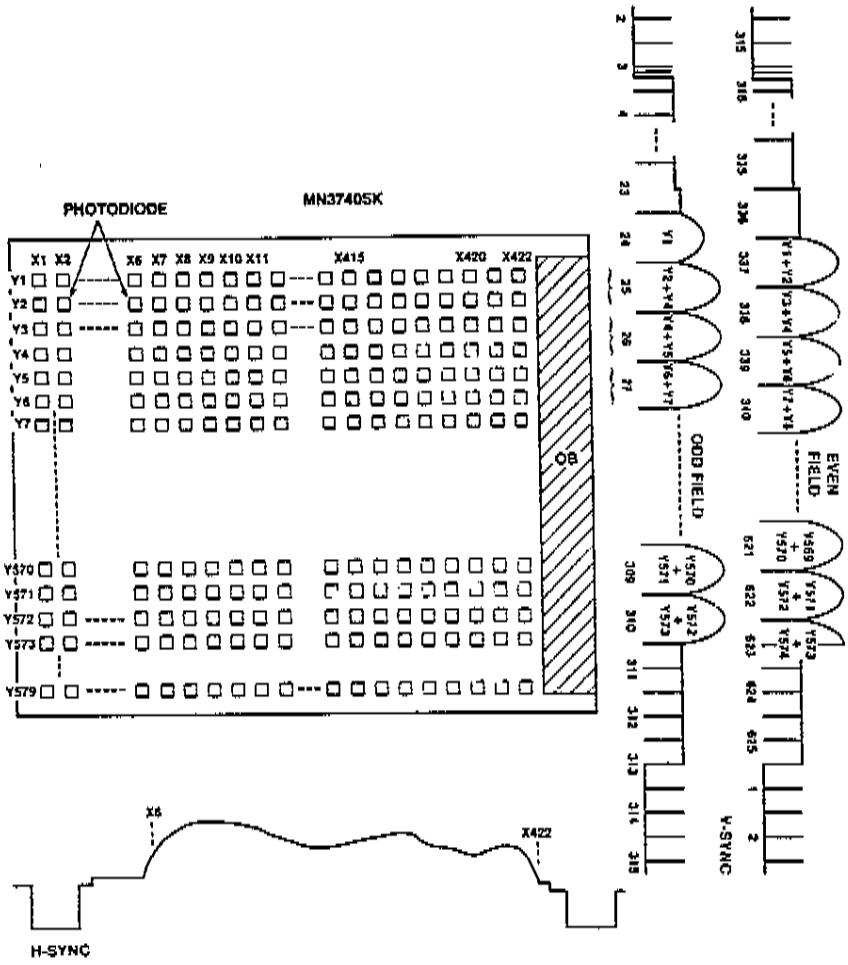
Charges of photodiodes in 2 neighboring columns are read-out at any one time. For example, in 23rd scanning line charge of the corresponding photo-diodes in Y2 and Y3 (which is above one another) are mixed and read-out.



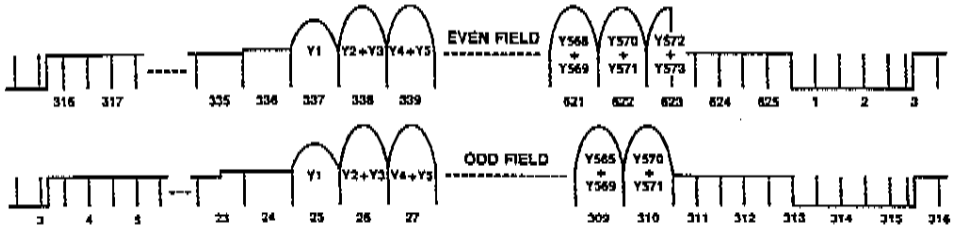
* Composite Video Signal in Non-interlaced



2. TM-460 (MN3740SK)



- Composite Video Signal in Pseudo-interlaced Scanning



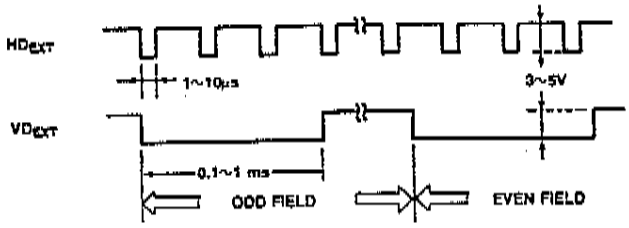
13. External Signal

1. External Sync
A. TM-440

1. HD_{EXT}, VD 2 INPUT METHOD

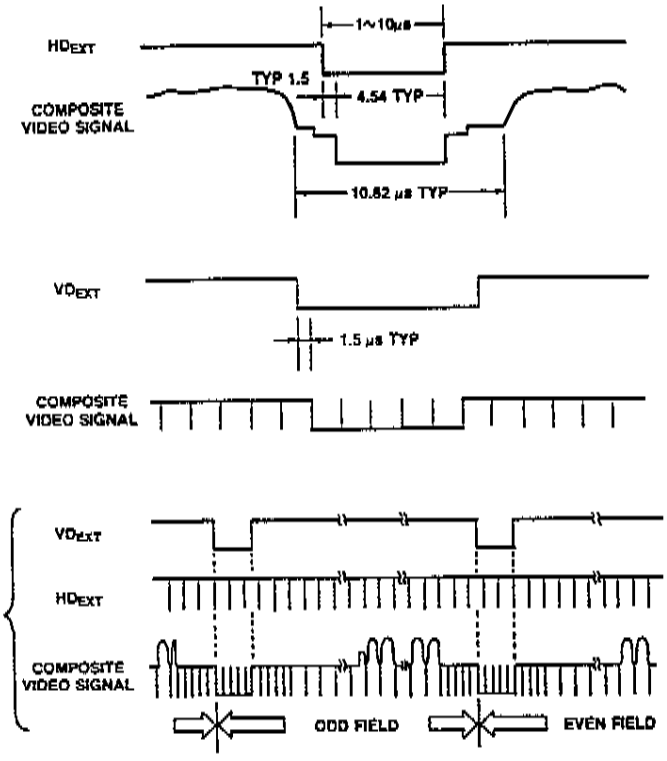
• Input Conditions

Pulse Width : HD_{EXT}: 1~10 μsec
: VD_{EXT}: 0.1~5Vp-p
Pulse Height : HD_{EXT}, VD_{EXT} ... 3~Vp-p



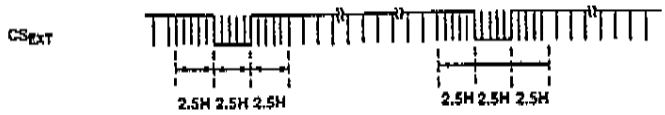
* HD_{EXT} VD_{EXT} must be synchronized.

• Composite Video Signal Timing

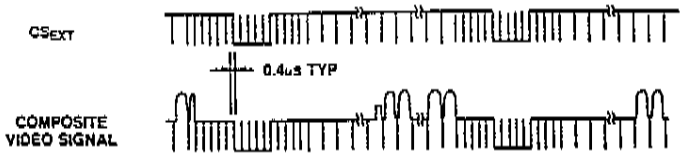


2. CS_{EXT} INPUT METHOD

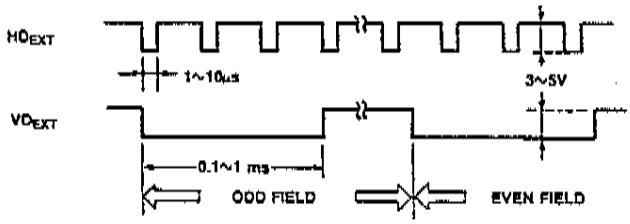
- Input Condition
  Pulse Height: 3~Vpp



- Relation of CS_{EXT} and Video Signal



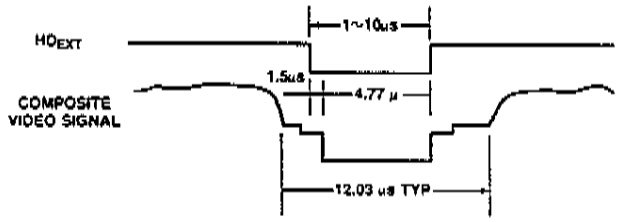
External Sync
B. TM-460

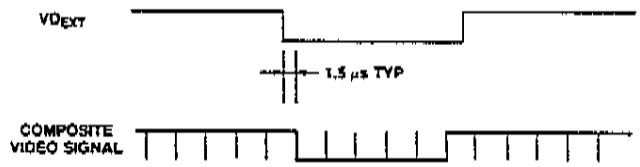


1. HD_{EXT}, VD 2 INPUT METHOD

- Input Conditions

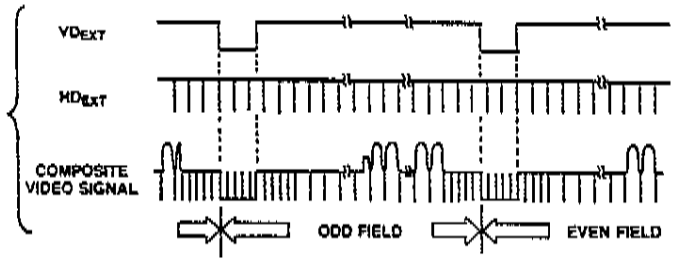
Pulse Width : HD_{EXT}: 1~10 μsec
: VD_{EXT}: 0.1~1 msec
Pulse Height : HD_{EXT}, VD_{EXT} ... 3~Vp-p



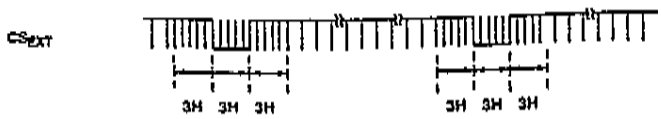


* HD_{EXT} VD_{EXT} must be synchronized.

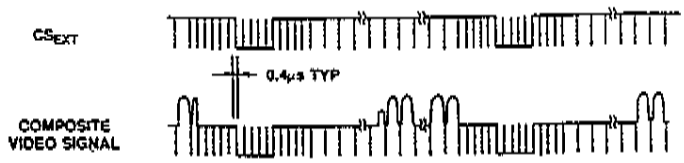
- Composite Video Signal Timing



2. CS_{EXT} INPUT METHOD
   - Input Condition
     Pulse Height: 3~Vpp



- Relation of CS_{EXT} and Video Signal

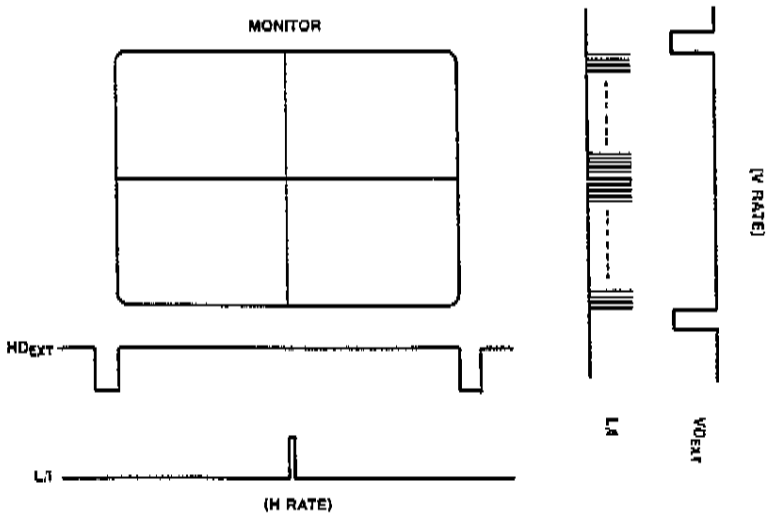


1. Letter Input (L/I) Signal (Optional)

Letter input function can be used in either internal sync or external sync mode.

In the internal sync mode, it is necessary that the L/I signal is synchronized with horizontal and vertical sync signal of composite video signal.

- Input Condition: white level 1~5V
- Timing example: cross line



2. Shutter Mode Control Signal (TM-440S/460S)

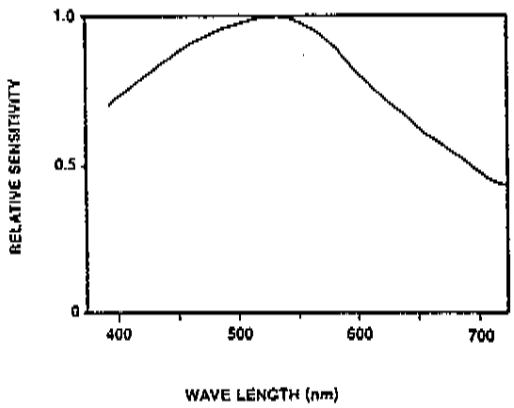
Besides switching the internal switch, the 1/1000 sec electronic shutter mode can be set by supplying the external control signal.

However when the internal switch is set in "Shutter mode", external control signal is ineffective.

Input Condition: 0V (Shutter mode)
5V or OPEN (Normal mode)

Note: When changing the mode from "Normal mode" to "Shutter mode" using both internal switch and external signals, it takes 2~3 fields time to complete the mode change.

14. Spectral Character



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