

**ADVANCE  
PRODUCT  
INFORMATION  
DATA SHEET**

**November 1986**

# $\mu$ PD3520D

**CCD, Single-Board  
Color Image Sensor**

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## CCD SINGLE-BOARD COLOR IMAGE SENSOR (NTSC COMPLEMENTARY COLOR TYPE)

The  $\mu$ PD3520D is a highly sensitive color image sensor employing CCD shift registers in its scanning unit. The image size is 1/2 inch and it is suitable for application to video cameras of the NTSC system.

The  $\mu$ PD3520D consists of photodiodes arranged in two dimensions, 427 horizontally and 492 vertically. Each diode has a PN junction of high sensitivity to visible light and visual persistence is practically nil.

The  $\mu$ PD3520D has a newly developed color filter of the complementary color type with a high transmission factor, and the generated image is quite bright and clear.

In particular, the  $\mu$ PD3520D has excellent linearity and uniformity and no skew is produced in the images, and this feature is effective in minimizing adjustment circuits and in reducing man-hours.

The pitch of a pixel is 15.3  $\mu$ m in the horizontal and 9.9  $\mu$ m in the vertical directions. The  $\mu$ PD3520D is in a 20-pin ceramic dual in-line package (DIP) of the shrunken type (1.778 mm pitch) suitable for minimizing weight and dimensions.

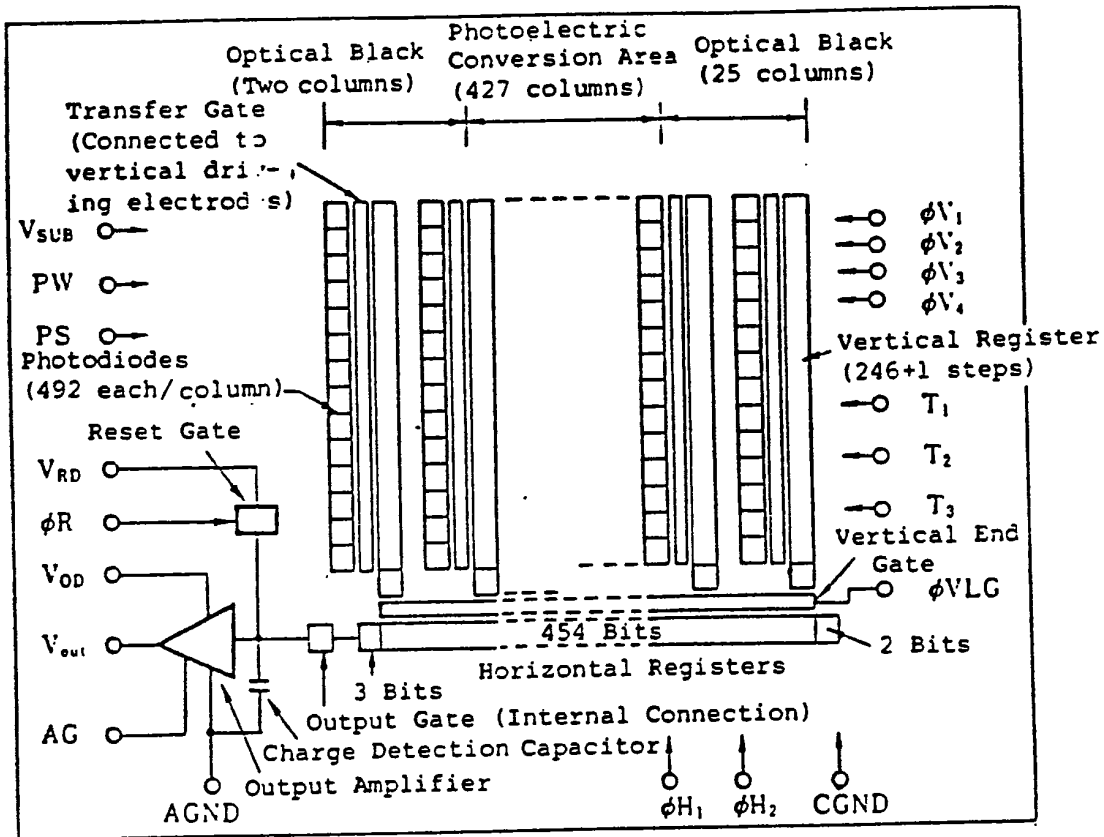
## FEATURES

- o High sensitivity. The minimum intensity of illumination required on the surface of subjects: 8 lux (F1.2, AGC:12dB).
- o Field-period reading system of high dynamic resolution.
- o Low visual persistence without comet tail, and bright images for low intensity of illumination.
- o No baking.
- o Shielding against magnetism allows placement near speakers.
- o Vibration-hardened, and no microphonic noises are generated.
- o It may be stored for a long time without degradation.
- o A digital clock system is employed for perfect color separation for low intensity of illumination.
- o Resolution           280 TV lines horizontally  
                          350 TV lines vertically
- o 1/2 inch image size (6.40 mm x 4.80 mm)

## APPLICATION

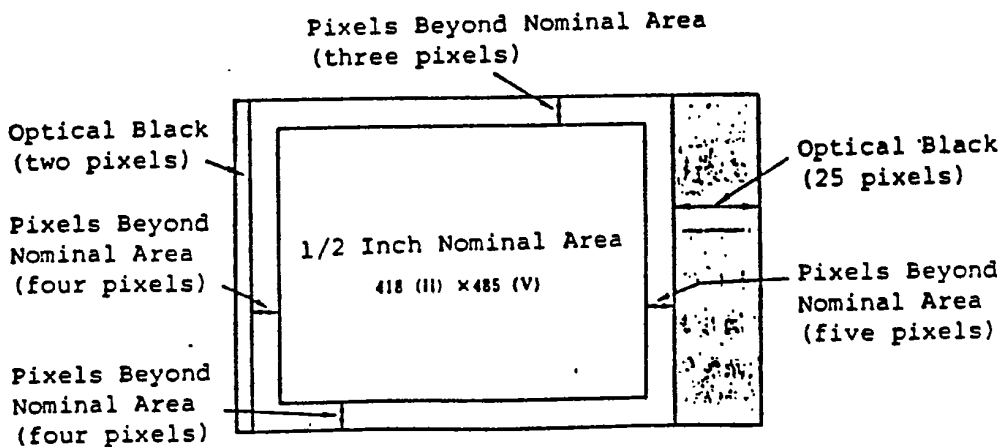
- o Color video cameras
- o Color image input equipment

## BLOCK DIAGRAM



Vertical Register:	No photodiode	1 step
	With photodiode	246 steps
Horizontal Register:	No vertical register	3 bits
	With vertical register	454 bits
	No vertical register	2 bits

## PICTURE ELEMENT CONFIGURATION



## TYPICAL CHARACTERISTICS

Number of pixels in photo-electric conversion area	427 H x 492 V
Optical black	Two pixels before and 25 pixels after nominal area in each line
Number of pixels in nominal area	418 H x 485 V
Nominal area	6.395 4 H x 4.801 5 V      mm
Photoelement pitch	15.3 H x 9.9 V $\mu\text{m}$
Source clock for synchronization and scanning systems	15.891 6 (1010 $f_H$ )      MHz
PLL comparison frequency	15.734 265 ( $f_H=4 f_{sc}/910$ )      kHz

Items	Designed Value	Standards	Unit
Horizontal scanning period	63.555 6	63.555 6	$\mu\text{s}$
Horizontal nominal area scanning time	52.606 4	52.656 $\pm$ 0.2	$\mu\text{s}$
Horizontal returning time	10.949 2	10.9 $\pm$ 0.2	$\mu\text{s}$

NTSC STANDARDS (REFERENCE)

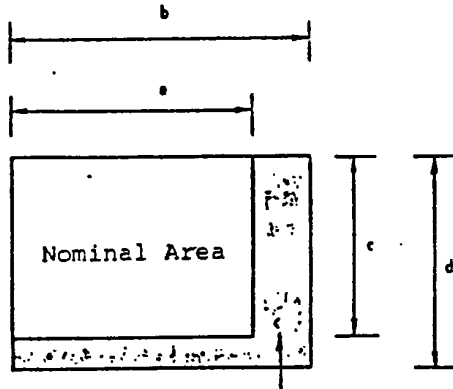
$$f_{SC} = 3.579\ 545\ \text{MHz}$$

$$f_H = 2f_{SC}/455$$

$$f_V = 2f_H/525$$

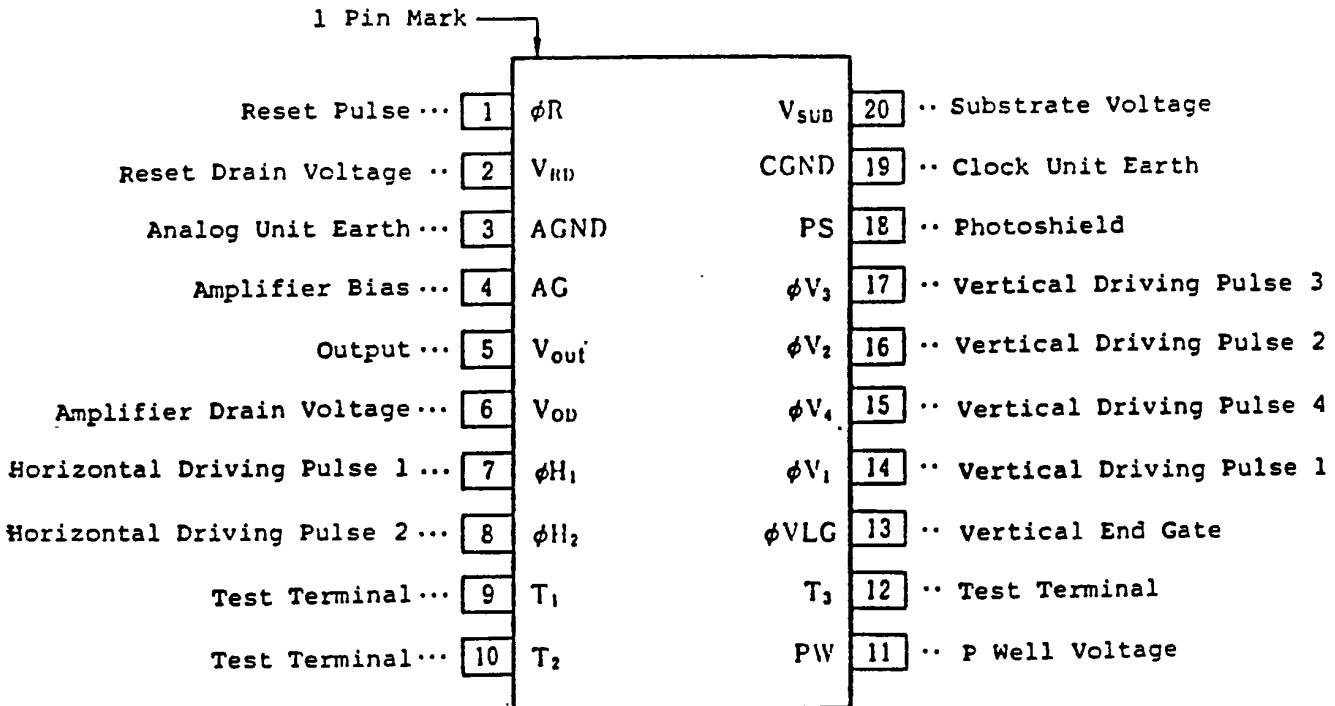
The figure below  $b = 63.555 \pm 0.63\ \mu\text{s}$ ,  $d = 16.683\ 335\ 455\ 5\ \text{ms}$

$$a = 52.656 \pm 0.2\ \mu\text{s}, \quad c = d \times 485/525 = 15.412\ 224\ 19\ \text{ms}$$



Aspect Ratio  $a:c=4:3$  Blanking Time

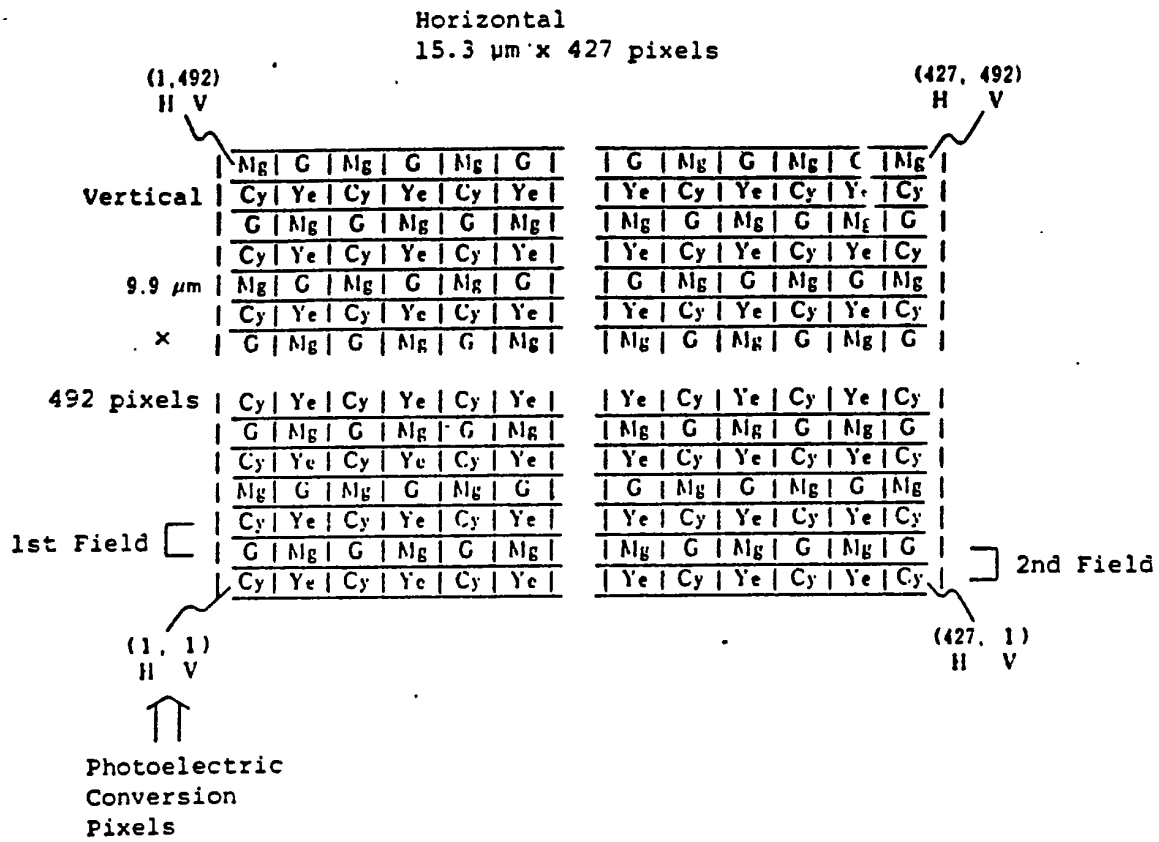
TERMINAL CONNECTIONS (TOP VIEW)



TERMINAL FUNCTIONS

No.	Symbols	Terminal Functions
1	$\phi R$	Gate driving pulse for neutralizing signal charges of charge detection capacitor
2	$V_{RD}$	Power supply for reset gate
3	AGND	Earth terminal for output amplifier unit
4	AG	Bias voltage of output amplifier
5	$V_{out}$	Output
6	$V_{OD}$	Power supply for output amplifier
7	$\phi H_1$	Driving pulse for horizontal register
8	$\phi H_2$	Driving pulse for horizontal register
9	$T_1$	Test terminal
10	$T_2$	Test terminal
11	PW	P well bias voltage for element separation
12	$T_3$	Test terminal
13	$\phi VLG$	Gate transferring signals from vertical registers to horizontal registers
14	$\phi V_1$	Driving pulse for horizontal register, transfer gate pulse ( $\phi PG$ ) is overridden
15	$\phi V_4$	Driving pulse for horizontal register
16	$\phi V_2$	Driving pulse for horizontal register
17	$\phi V_3$	Driving pulse for horizontal register, transfer gate pulse ( $\phi PG$ ) is overridden
18	PS	Electrode for light protection
19	CGND	Earth for driving unit
20	$V_{SUB}$	Substrate Bias voltage

COLOR FILTER ARRANGEMENT



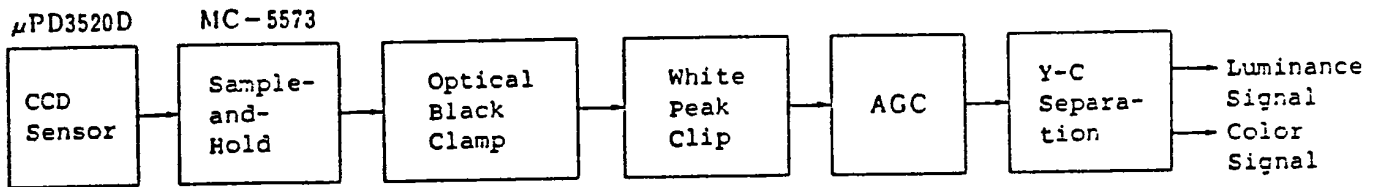
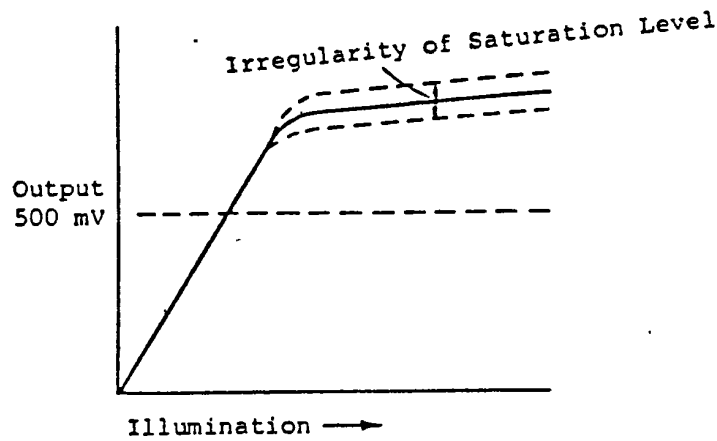
Compatible Color Temperature 4300 K  
Recommended Infrared Cut Filter HOYA C-500 with thickness of 1 mm.



REMARKS ON OUTPUT SIGNAL PROCESSING

At the saturation point of the output of the CCD sensors, an irregularity in saturation level may appear in the images. CCD sensors shall be used with their peak clipped after Sample-and-Hold processing by the MC-5573.

The clip point shall be fixed at 500 mV or shall be adjusted individually.



ABSOLUTE MAXIMUM RATINGS ( $T_a=25^{\circ}\text{C}$ )

Items	Symbols	Ratings	Unit
Amplifier drain voltage	$V_{OD}$	0 to +18	V
Reset unit drain voltage	$V_{RD}$	0 to $V_{OD}$	V
Photoshield voltage	$V_{PS}$	0 to $V_{OD}$	V
Vertical end gate voltage	$V_{\phi VLG}$	$V_{PW}$ to $V_{OD}$	V
Amplifier gate voltage	$V_{AG}$	0 to 5.0	V
Substrate voltage	$V_{SUB}$	0 to +20	V
P well voltage	$V_{PW}$	-8.3 to +0.5	V
Test terminal T1 voltage	$V_{T1}$	0 to $V_{OD}$	V
Test terminal T2 voltage	$V_{T2}$	0 to $V_{OD}$	V
Test terminal T3 voltage	$V_{T3}$	0 to $V_{OD}$	V
Horizontal transfer pulse voltage	$V_{\phi H}$	-0.3 to $V_{OD}$	V
Vertical transfer pulse voltage	$V_{\phi V}$	$V_{PW}$ to $V_{OD}$	V
Reset pulse voltage	$V_{\phi R}$	-0.3 to $V_{OD}$	V
Operational temperature	$T_{opt}$	-10 to +55	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-20 to +80	$^{\circ}\text{C}$

RECOMMENDED OPERATION TEMPERATURE ( $T_a = -10$  to  $+45^\circ\text{C}$ )

Items	Symbols	MIN.	TYP.	MAX.	Unit
Infrared cut filter	IRF	C-500 with thickness of 1 mm			
Operation temperature	$T_{opt}$	0	+25	+45	$^\circ\text{C}$
Amplifier drain voltage	$V_{OD}$	14.5	15.0	15.5	V
Reset unit drain voltage	$V_{RD}$	$V_{OD} - 0.2$	$V_{OD}$	$V_{OD}$	V
Photoshield voltage	$V_{PS}$	1.00	1.25	1.50	V
Amplifier gate voltage	$V_{AG}$	2.7	3.0	3.3	V
Upper limit of adjustable range of substrate voltage	$V_{UL(SUB)}$	18		20	V
Lower limit of adjustable range of substrate voltage	$V_{LL(SUB)}$	4.0	4.5	5.0	V
P well voltage	$V_{PW}$	-8.2	$V_{L\phi V} - 1.0$	$V_{L\phi V} - 0.7$	V
Test terminal T1 voltage	$V_{T1}$		0		V
Test terminal T2 voltage	$V_{T2}$	$V_{OD} - 3.0$	$V_{OD}$	$V_{OD}$	V
Test terminal T3 voltage	$V_{T3}$		0		V
High level voltage of vertical transfer pulse	$V_{H\phi V}$		0		V
Low level voltage of vertical transfer pulse	$V_{L\phi V}$	-7.5	-7.0	-6.8	V
Transfer gate ON voltage *1	$V_{\phi TG}$	11.5	12.0	12.5	V
High level voltage of horizontal transfer pulse	$V_{H\phi H}$	7.7	8.0	10.0	V
Low level voltage of horizontal transfer pulse	$V_{L\phi H}$	0		0.7	V
High level voltage of reset pulse	$V_{H\phi R}$	8.7	9.0	13.0	V
Low level voltage of reset pulse	$V_{L\phi H}$	0		0.7	V
High level voltage of vertical end gate	$V_{H\phi VLG}$		0		V
Low level voltage of vertical end gate	$V_{L\phi VLG}$		$V_{L\phi V}$		V

\*1: Clock peak voltage to be added on the vertical transfer clock.

PHOTOELECTRIC CHARACTERISTICS

(Ta=25°C, infrared cutting with HOYA C-500 of 1 mm thickness)

No.	Items	Symbols	Condition	MIN.	TYP.	MAX.	Unit
1	Saturated output voltage	V <sub>sat</sub>	20 times light	500	800		mV
2	Average standard output	VO	Subject luminance: 82 nt	200	250		mV
3	Sensitivity	S	*3	283	354		V/Lumen
4	Averaged output in darkness	ADS	Ta=25°C		1.5	5.0	mV
5	Blooming suppression substrate voltage	V <sub>BLM</sub>	100 times light *4	5		18	V
6	Smear	SMR	1/10 pattern of vertical direction			0.10	%

Note: \*1, \*4: In both cases, the light shall have an intensity 20 or 100 times that of the intensity when the output from the sensor is 250 mV.

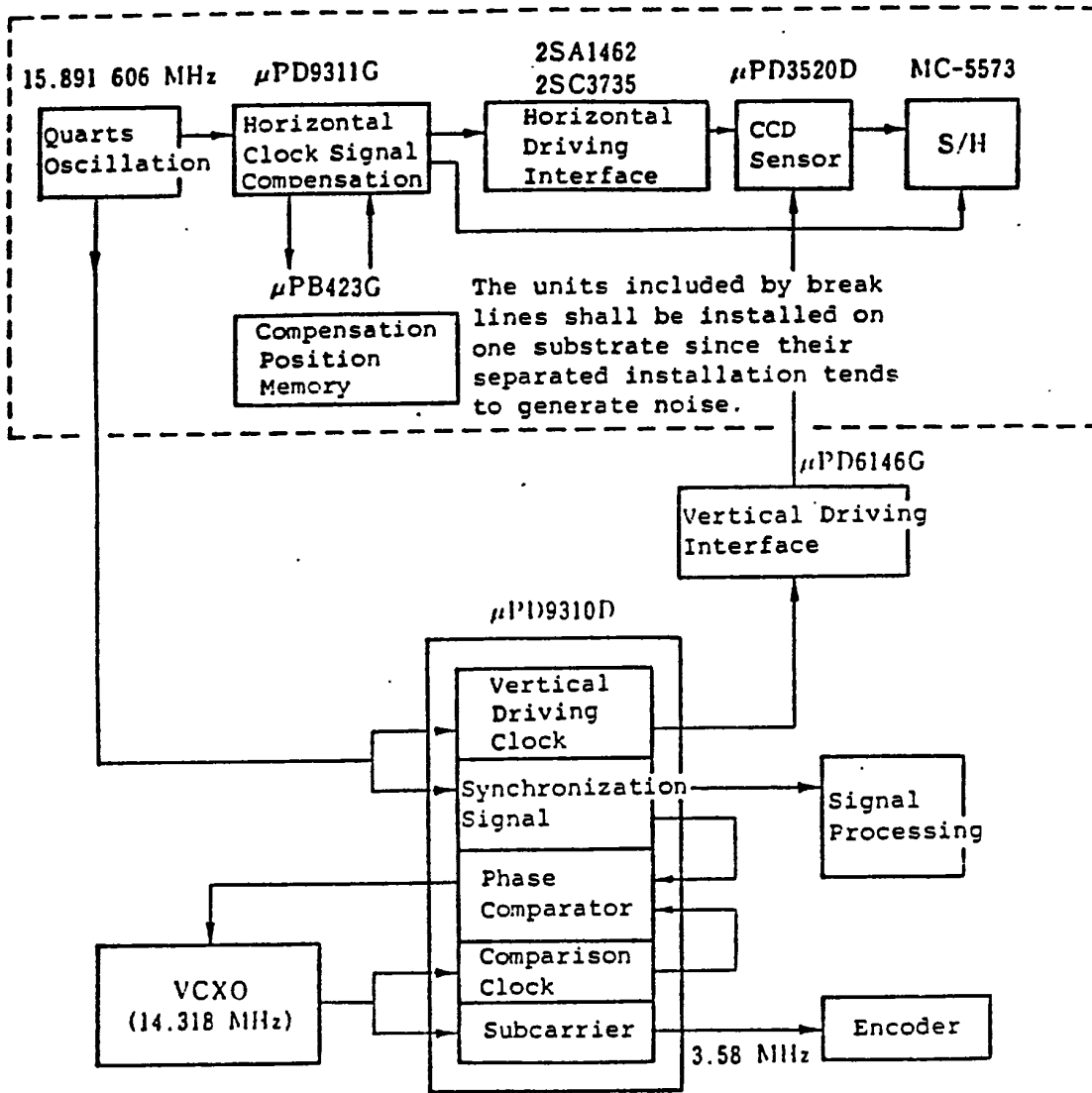
\*2: Fujinon CF25L (f=25 mm, F0.85) is used as the lens with its exposure scale set at F1.4. It corresponds to 23 lx on the surface of the sensor. For obtaining the intensity of illumination on the surface of subjects, the following formula is used.

$$\text{Luminance (nt)} = \text{Intensity of illumination (lx)} \times \text{Reflection Ratio (\%)}$$

\*3: Sensitivity value is defined to the light volume input to the nominal area so that it can be compared with sensors of different image sizes direct.

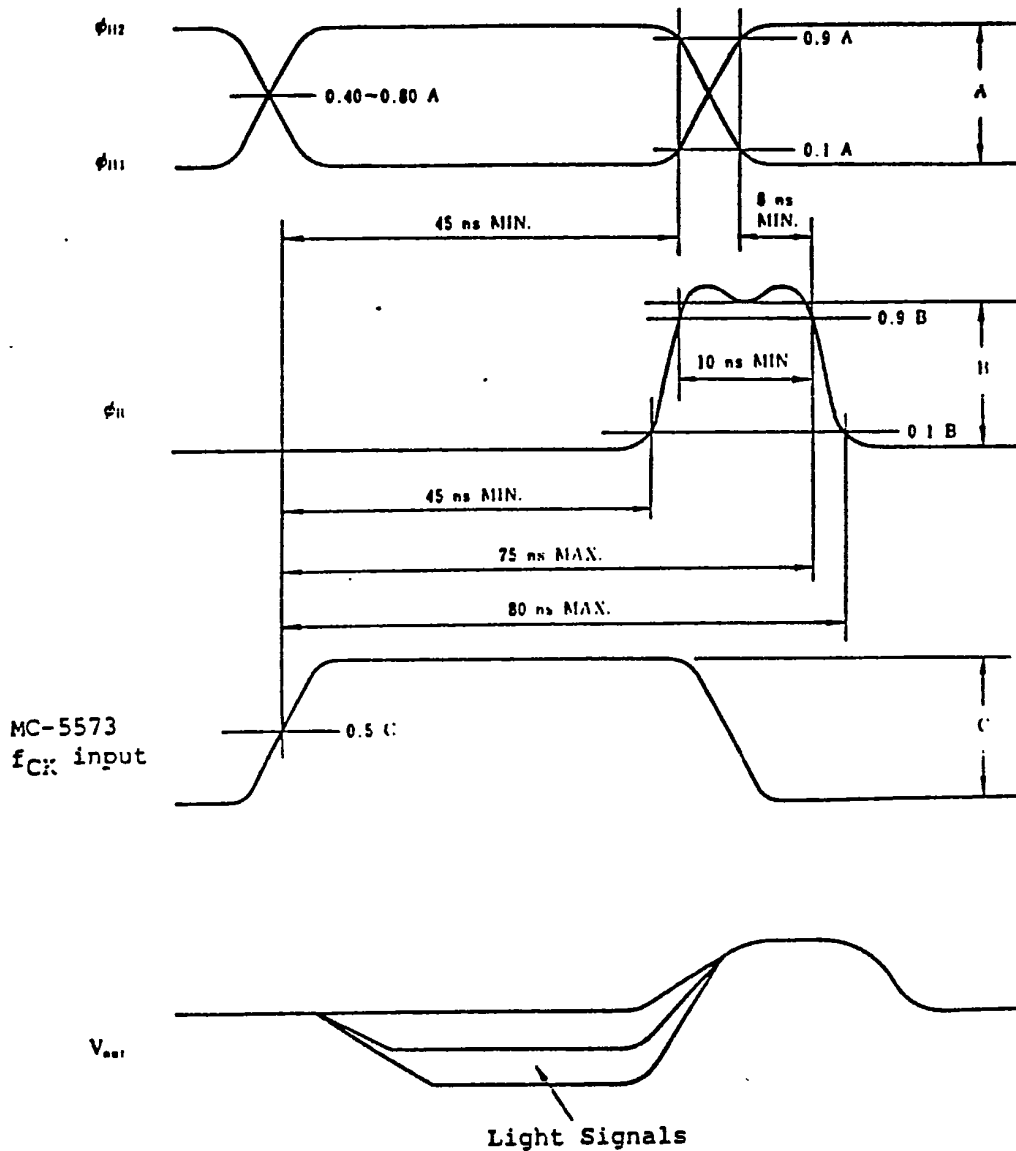
$$\text{Sensitivity (V/lumen)} = \frac{\text{Output (V)}}{\text{Intensity on chip surface (lx) x Area of nominal area (m}^2\text{)}}$$

SURROUNDING KIT BLOCK DIAGRAM (NTSC)



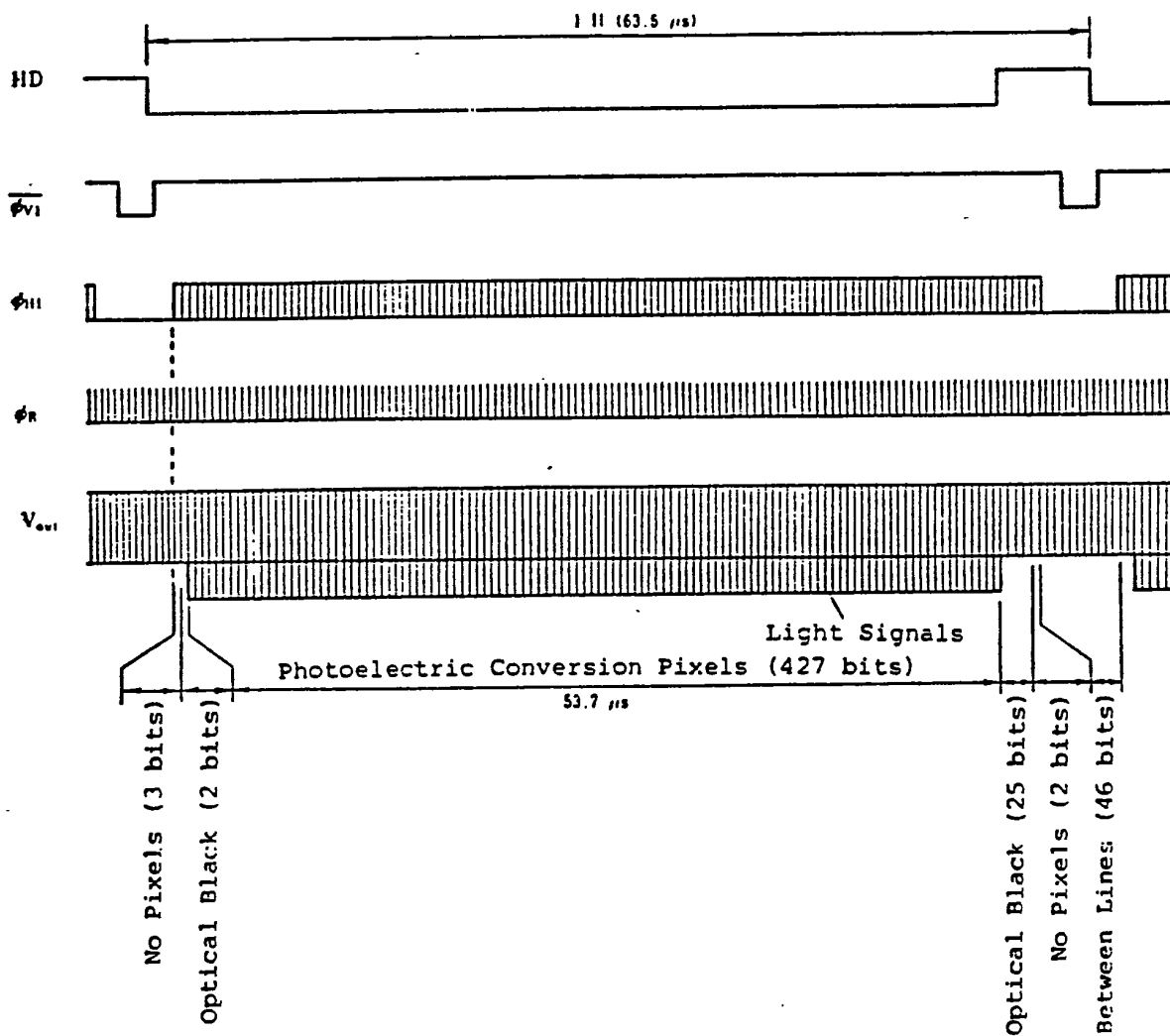
TIMING CHART

Horizontal Transfer/Reset Timing

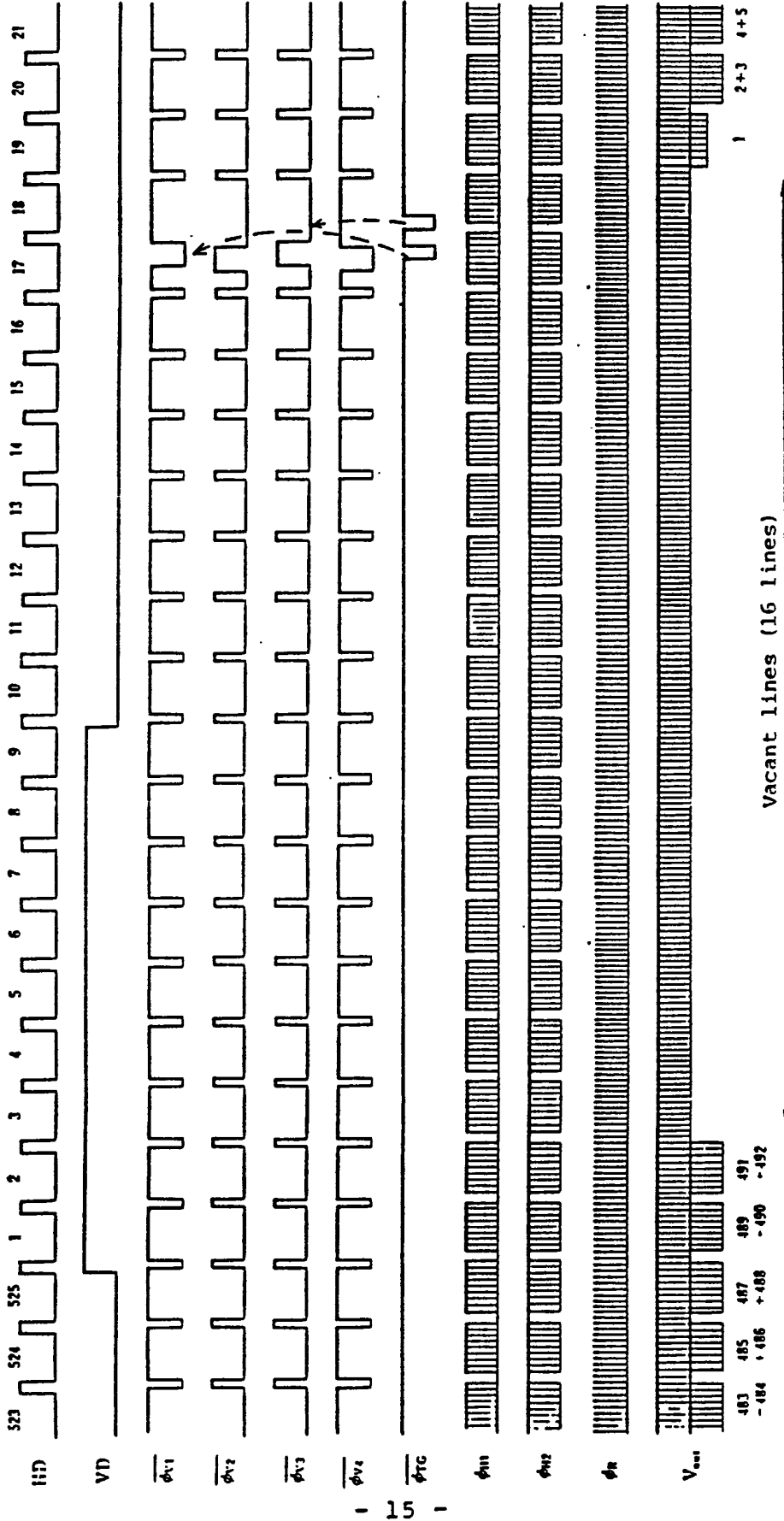


Ringings shall be minimized at the  $\phi_H$ , and also shooting to negative voltage shall be avoided.

OUTPUT TIMING (ONE LINE)



TIMING BETWEEN 1ST AND 2ND FIELDS

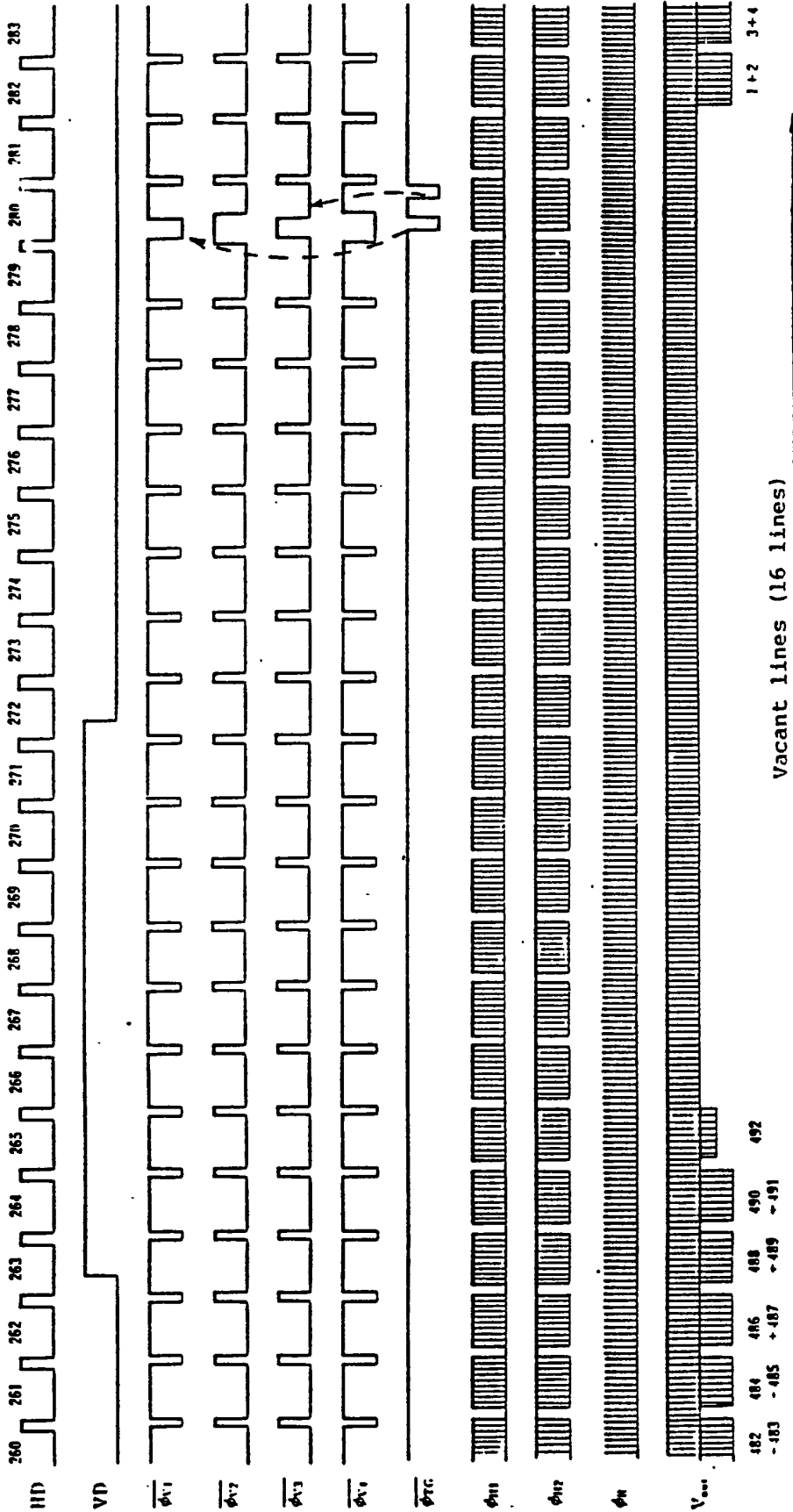


15

483 485 487 489 491  
 -484 +486 +488 -490 -492

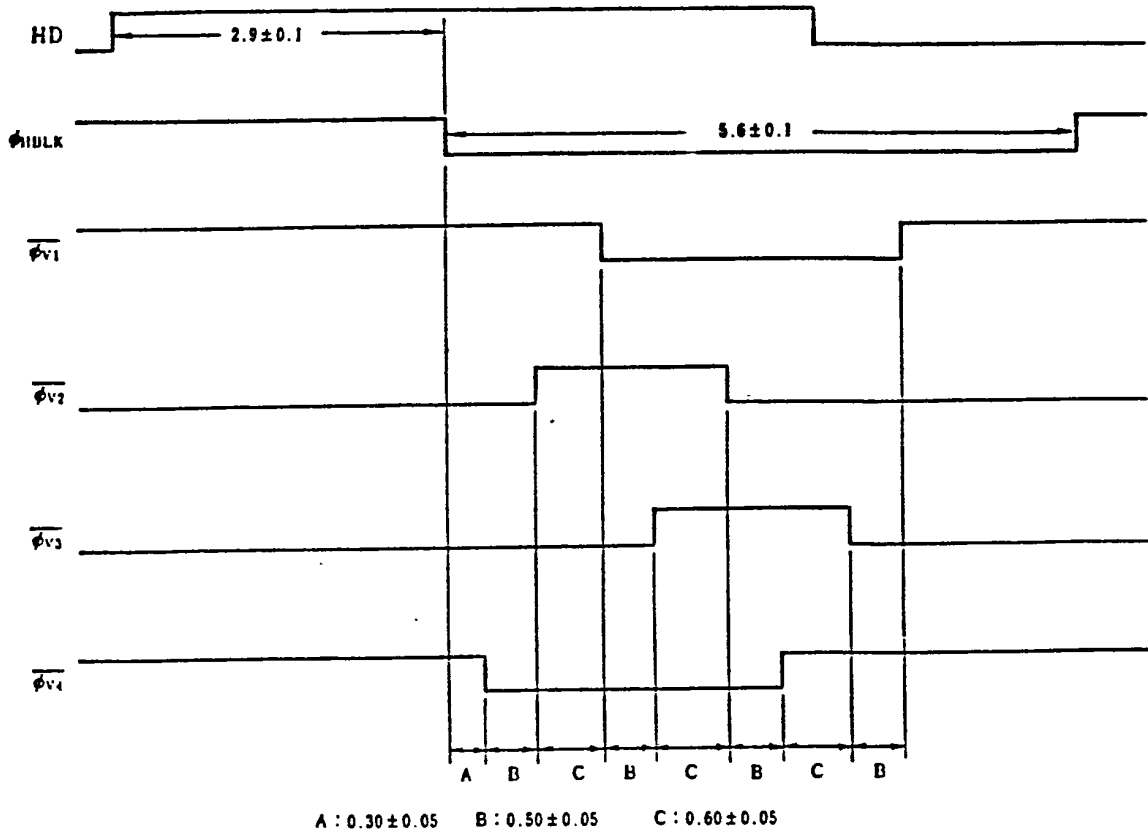


TIMING BETWEEN 1ST AND 2ND FIELDS



VERTICAL TRANSFER TIMING

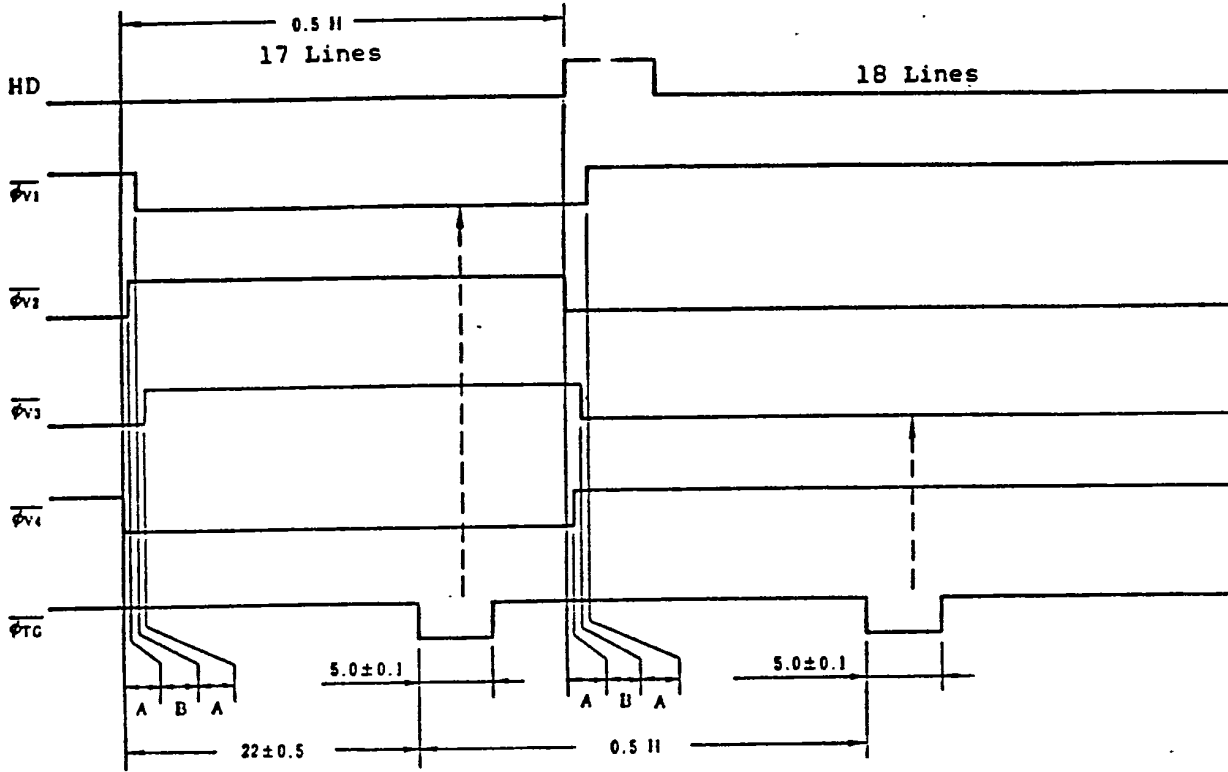
Unit:  $\mu$ s



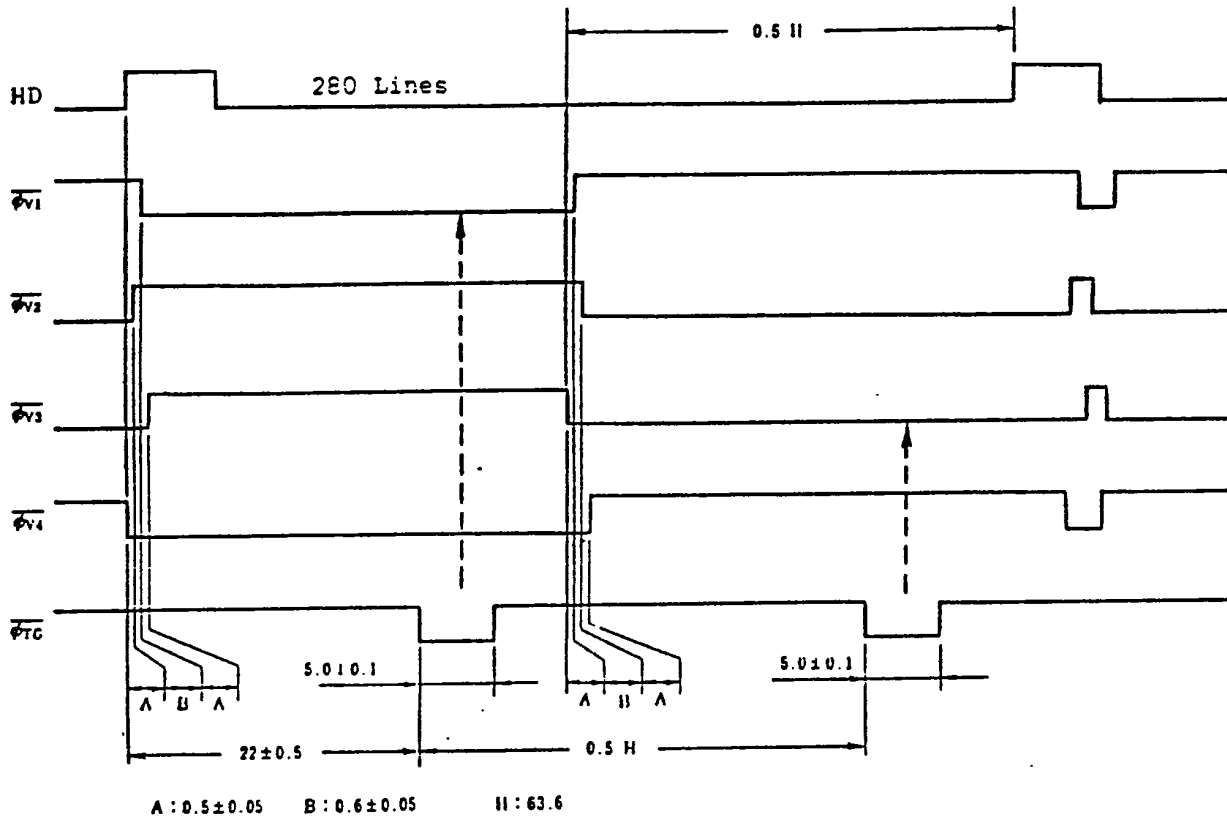
PHOTODIODE READING TIMING

1st Field

Unit:  $\mu$ s

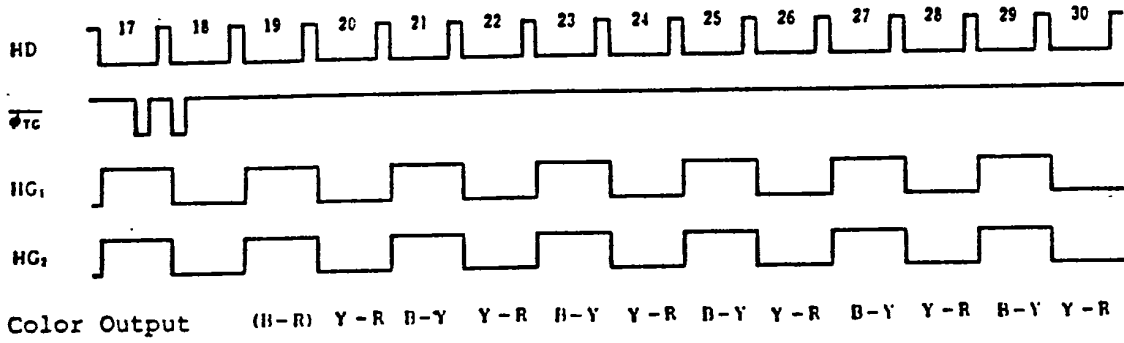


2nd Field

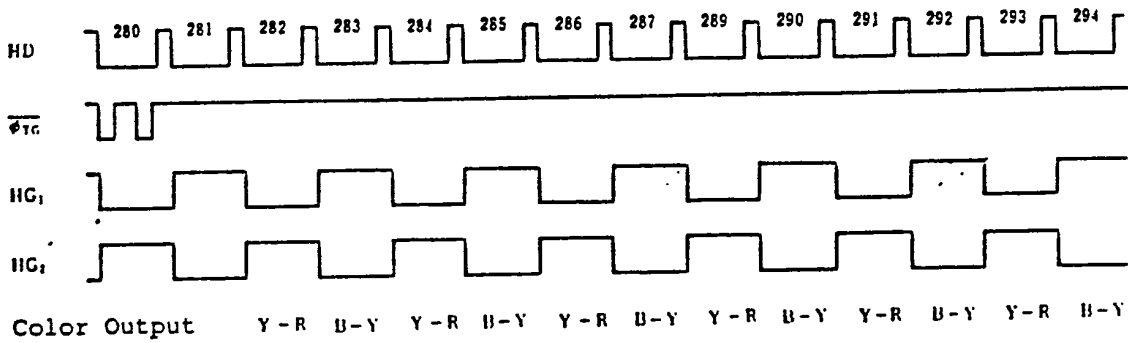


COLOR SIGNAL OUTPUT TIMING

(1) 1st Field



(2) 2nd Field

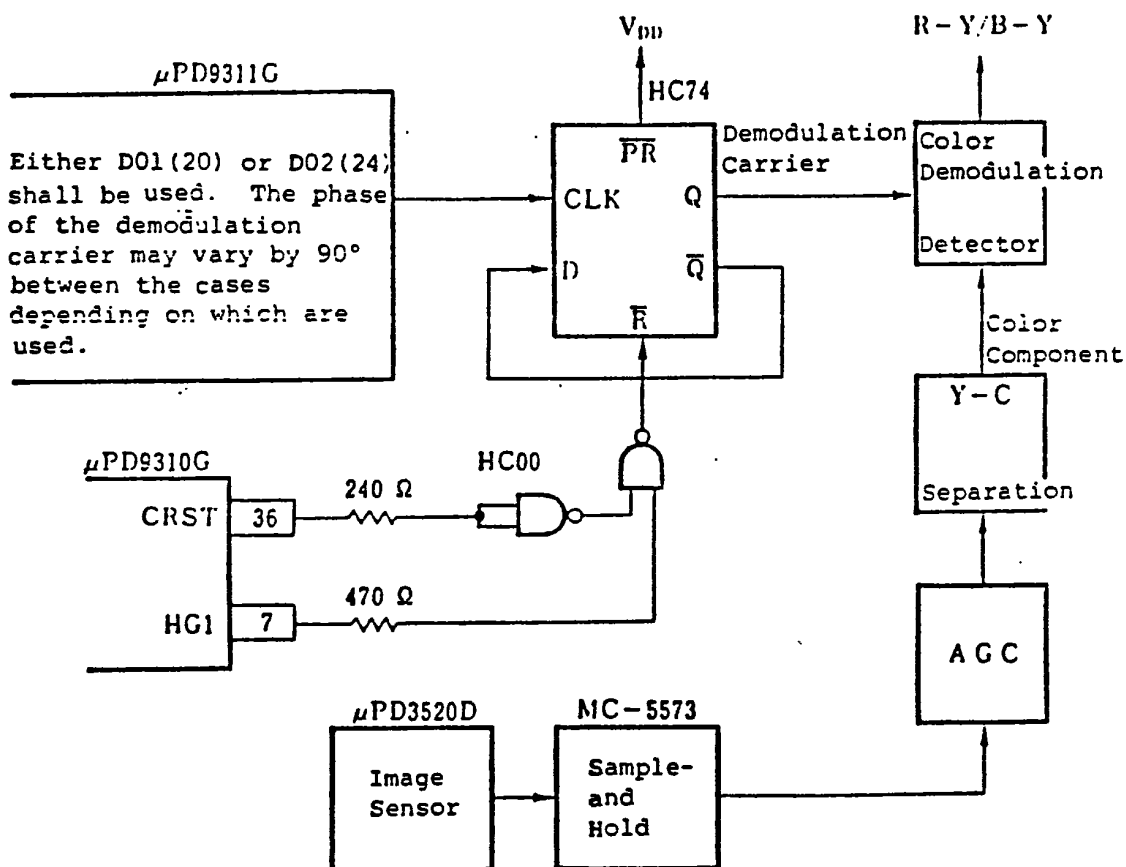


## REMARKS ON COLOR SIGNALS

In the above timing diagram, color output is expressed by Y-R and B-Y instead of R-Y and B-Y. The reason is that, if the carrier clock phase for color demodulation is matched with the scanning start of each line, the polarities of demodulated output of the R-Y component and the B-Y component are different.

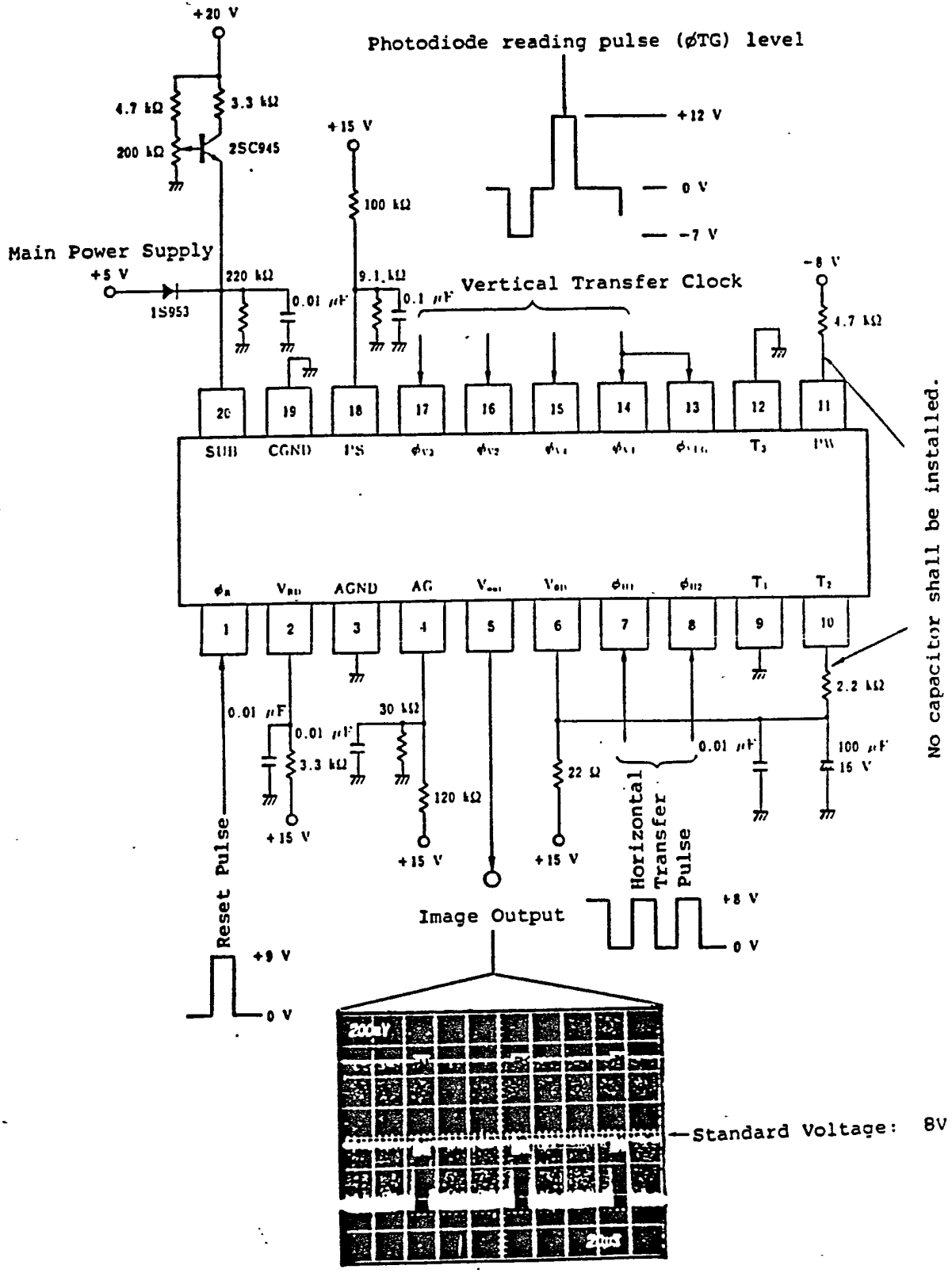
For avoiding such a discrepancy, the carrier clock phases for color demodulation shall be reversed at every other line.

If you use the  $\mu$ PD9310G or the  $\mu$ PD9311G, CRST shall be placed at every other line, as shown in the figure below.



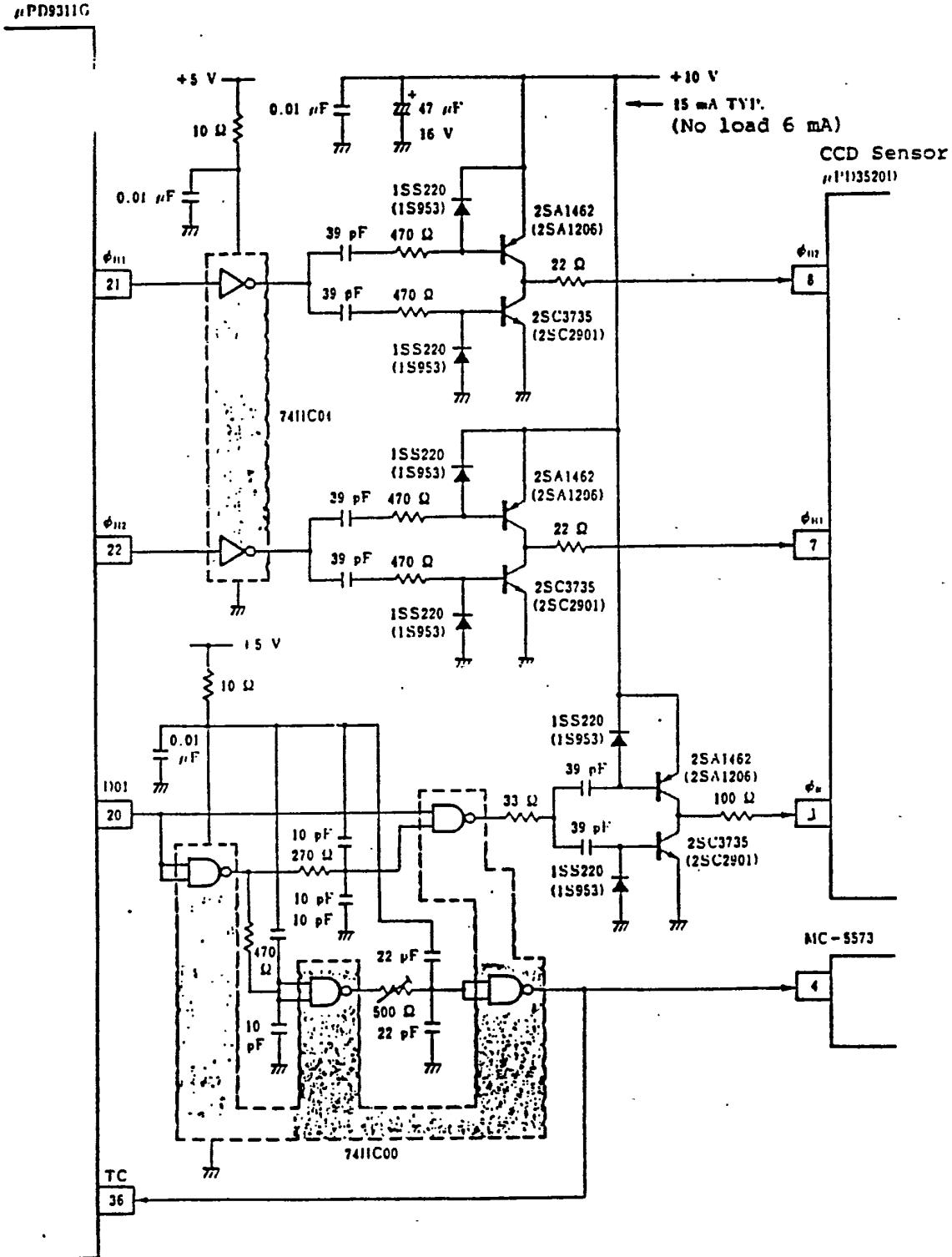
**BIAS CIRCUIT**

The sequence for turning on the power supply is SUB voltage (+5V is acceptable) → +15V → -8V.



### $\phi_H, \phi_D$ DRIVING INTERFACE AND MC-5573 CLOCK

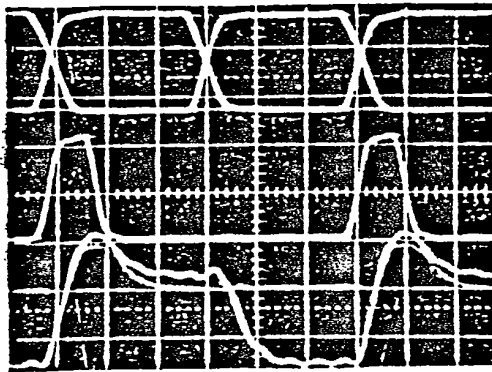
Please pay enough attention to the connection diagram, since enough consideration is not given to clock noises etc. there.





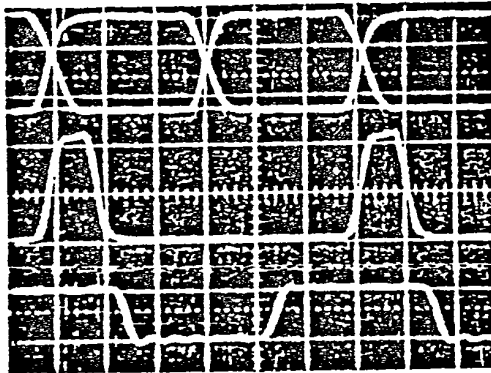
MPD3520D  $\phi_H$ ,  $\phi_D$  TIMING

Horizontal: 20 ns/div



$\phi_{12}$   
 (5 V/div)  
 $\phi_{11}$   
 $\phi_n$   
 (5 V/div)  
 $V_{001}$   
 (500 mV/div)

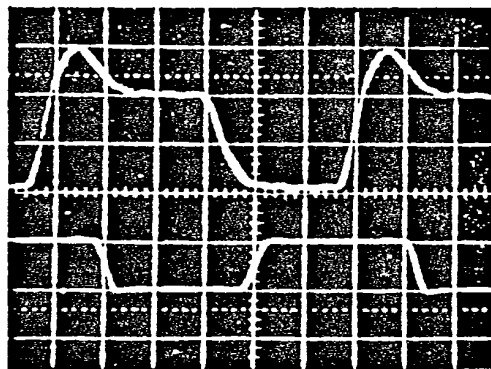
Vertical: 5V/div  
Horizontal: 20 ns/div



$\phi_{12}$   
 $\phi_{11}$   
 $\phi_n$   
 S-II

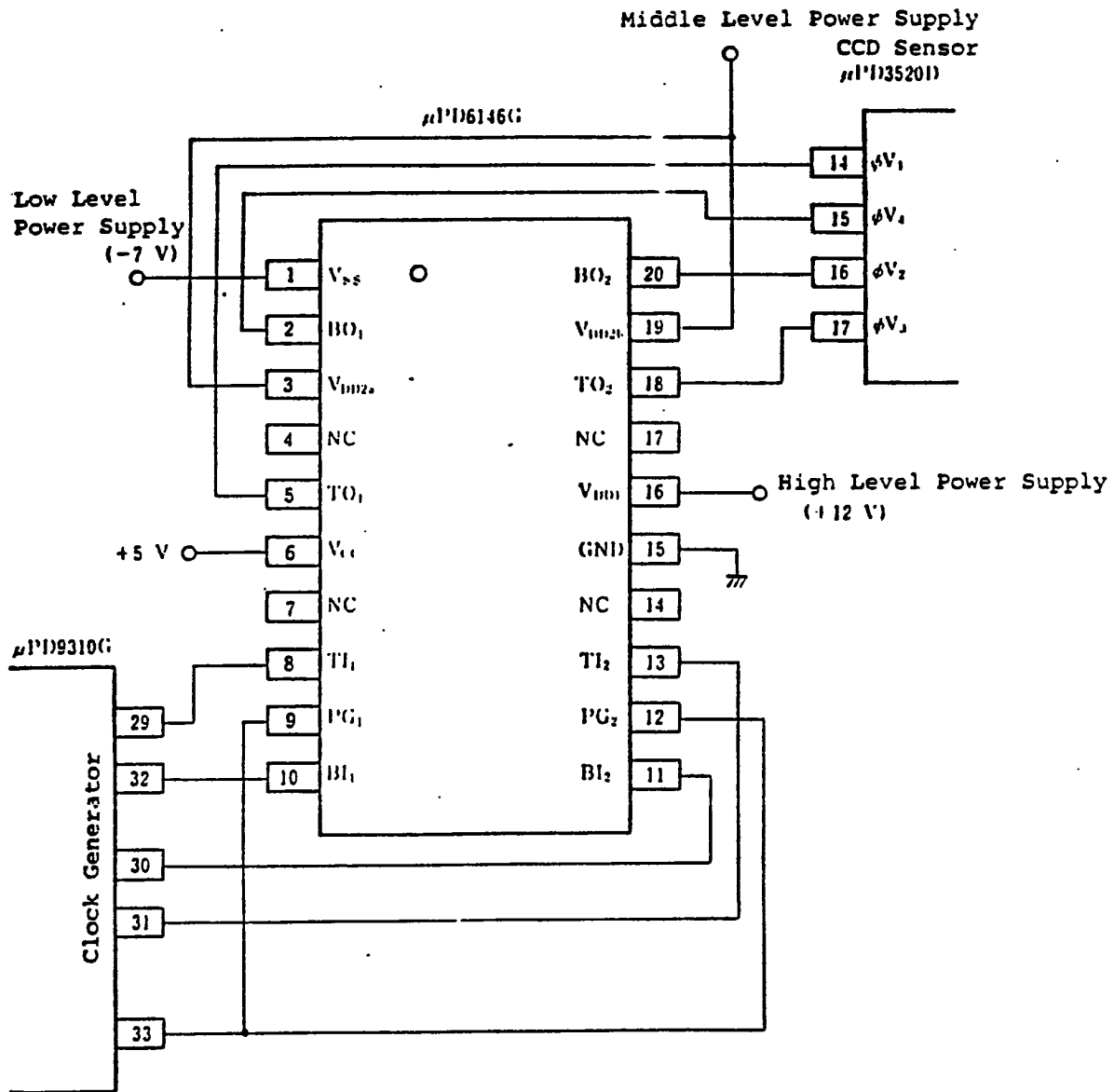
MC-5573 CLOCK TIMING

Horizontal: 20 ns/div

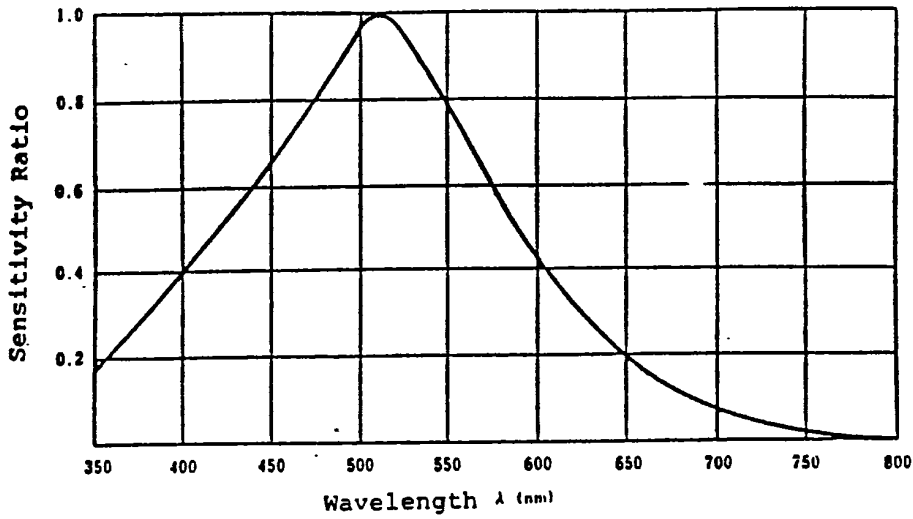


$V_{001}$   
 (500 mV/div)  
 MC-5573  
 Clock  
 (5 V/div)

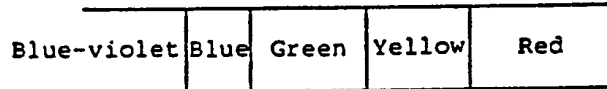
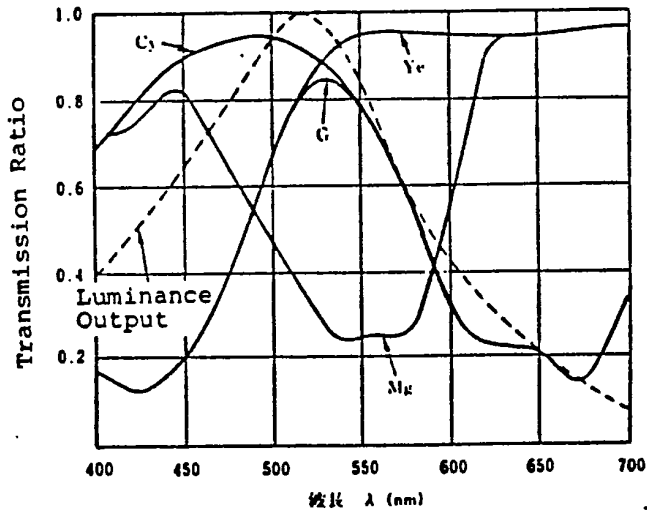
$\phi_V$  DRIVING INTERFACE



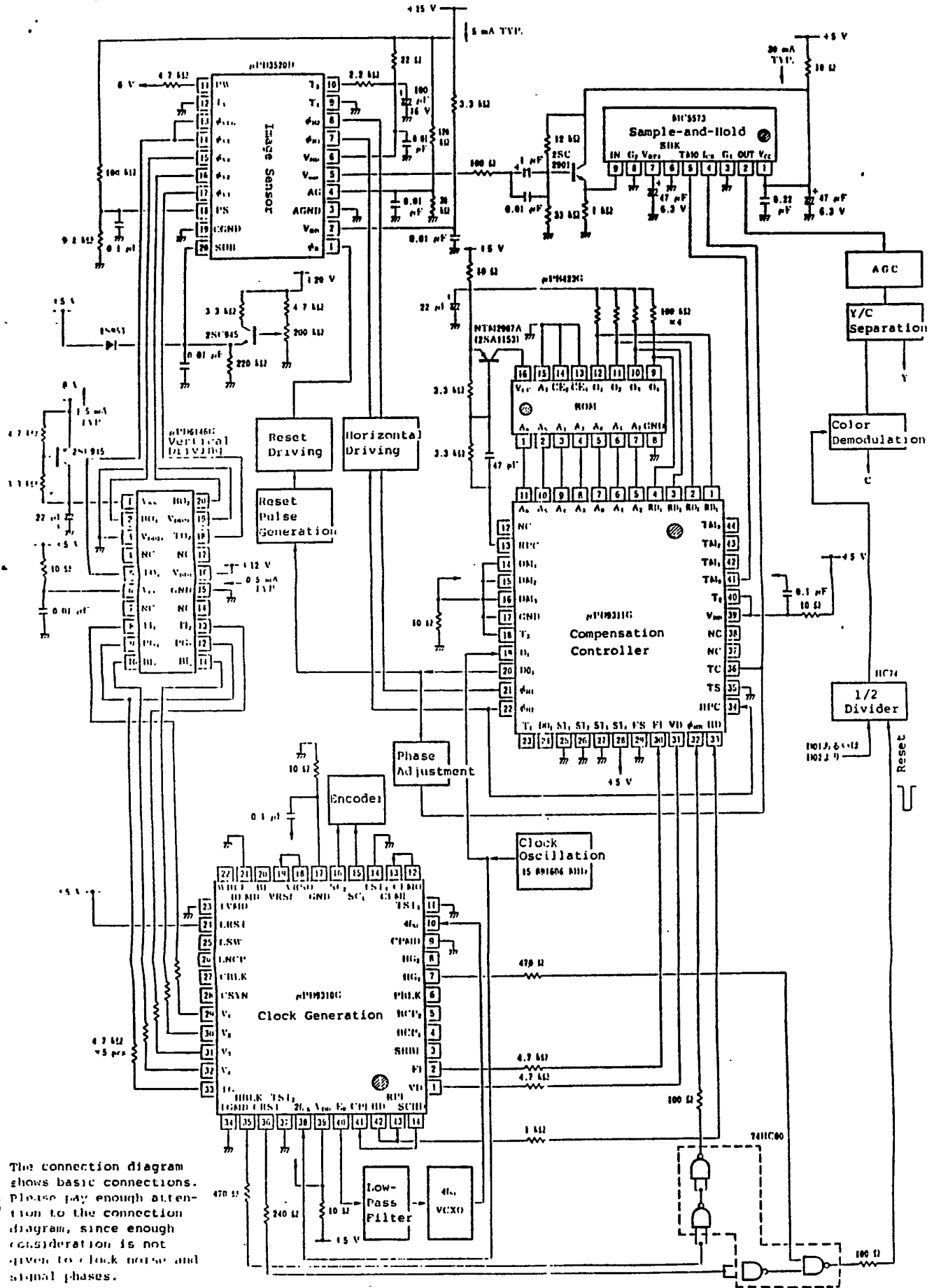
Luminance Spectrum Sensitivity  
(IR Cut, C-500 of 1 mm in thickness is used)



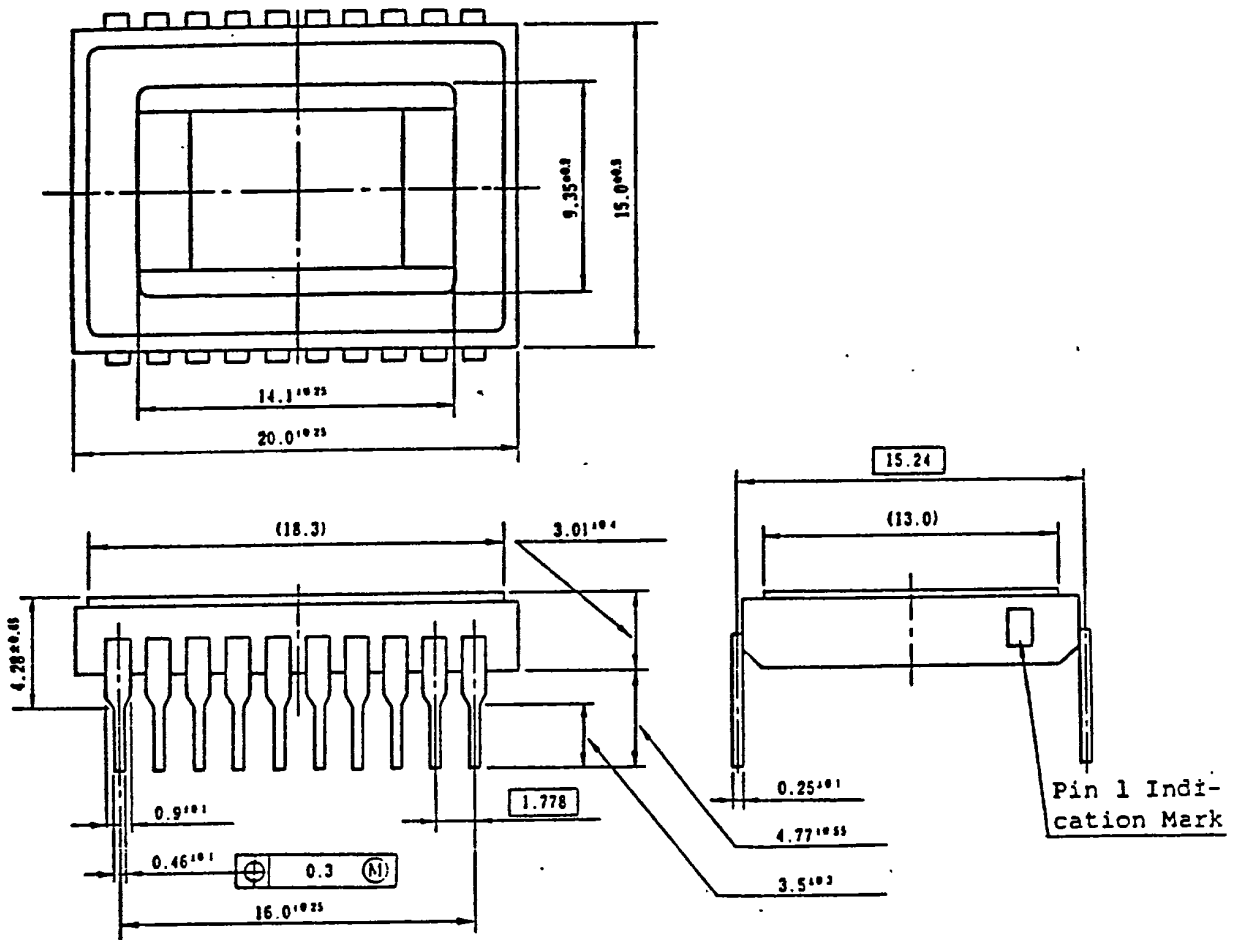
Color Filter Spectrum Characteristics



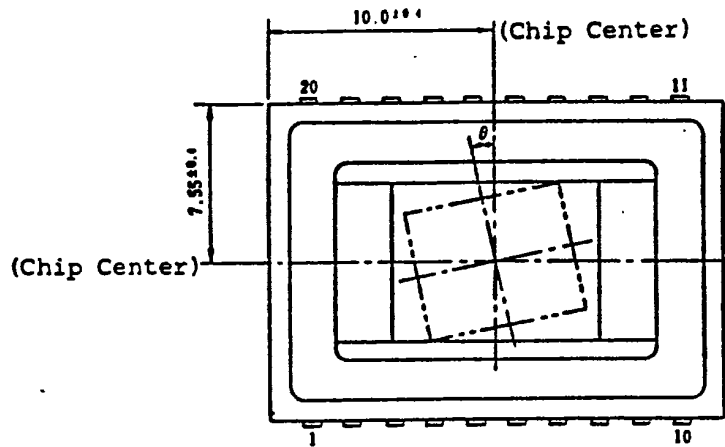
SCHEMATIC OF PERIPHERAL CIRCUITS



EXTERNAL DIMENSION DIAGRAM UNIT: mm

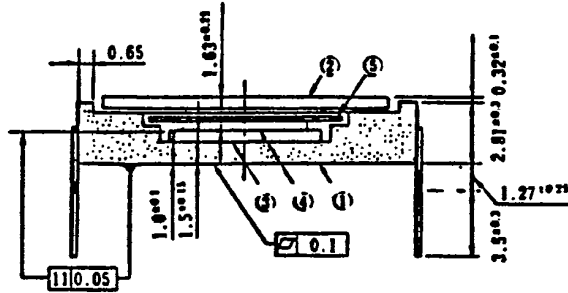


CHIP POSITION DIAGRAM UNIT: mm



Chip inclination $\theta$	$\pm 2^\circ$
Chip size	8.00 x 6.47
Image size	1/2 inch (6.4 x 4.8)

SECTIONAL VIEW UNIT: mm



①	Package
②	Shield glass
③	Chip
④	Color separation filter
⑤	Douser

Part Name	Required Size	Remarks
Glass	$0.7 \pm 0.05$	Refractire index 1.5
Filter	$0.5 \pm 0.1$	Refractire index 1.5