DATA SHEET

NEC

MOS INTEGRATED CIRCUIT

μPD3700

480 PIXELS × 1 COLOR CCD LINEAR IMAGE SENSOR

The μPD3700 is a color CCD (Charge Coupled Device) linear image sensor with a dot sequential on-chip RGB color filter, which changes optical images to electrical signal and has the function of color separation.

The μPD3700 has 1 row of 480 pixels (Red, Green, Blue : each 160 pixels (dot sequential)), 1 row of single-sided charge transfer register, reset feed-through level clamp circuit, clamp pulse generation circuit, sample and hold circuit, sample and hold pulse generation circuit, reset pulse generation circuit and voltage amplifier. The power supply is +12 V only.

It is suitable for a carriage mounted color scanner of a printer or for toy applications, as it is adopted a miniature package.

FEATURES

- Valid photocell : Red, Green, Blue each 160 pixels, total 480 pixels
- Photocell's pitch : each color 11 μm (RGB : 33 μm)
- Color filter : Primary colors (red, green and blue)
  Pigment filter (with light resistance 10^7 lx·hour)
  Dot sequential
- High sensitivity : Red 14.4 V/lx·s Green 13.1 V/lx·s Blue 7.9 V/lx·s (TYP.)
- Power supply : +12 V
- Drive clock level : CMOS output under 5 V operation
- Data rate : 3 MHz MAX.
- On-chip circuit : Reset feed-through level clamp circuit, Clamp pulse generation circuit
  Sample and hold circuit, Sample and hold pulse generation circuit
  Reset pulse generation circuit
  Voltage amplifier
  Compensation output

ORDERING INFORMATION

Part Number	Package
μPD3700CS	CCD linear image sensor 20-pin plastic shrink DIP (300 mil)

The information in this document is subject to change without notice.

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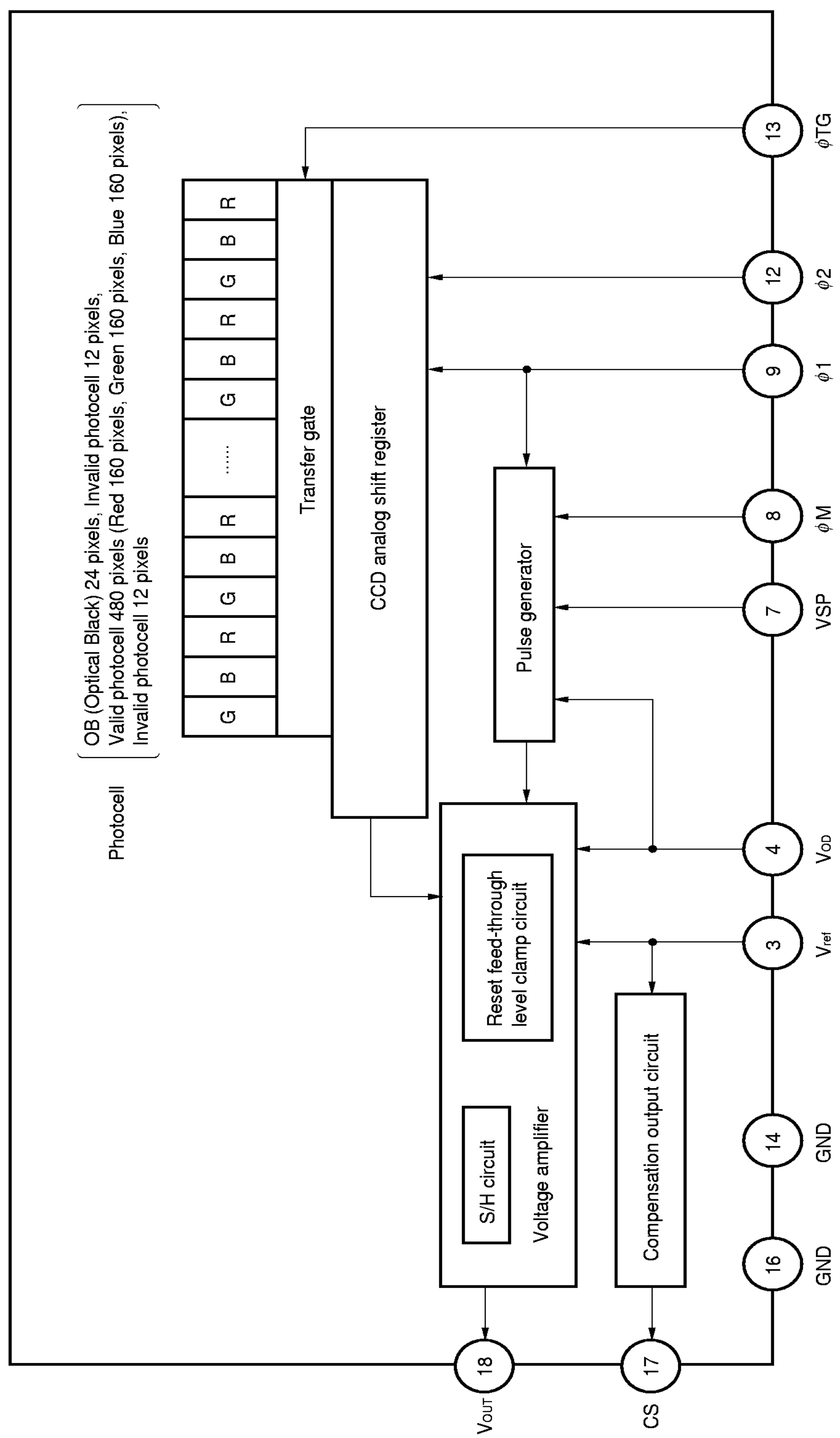
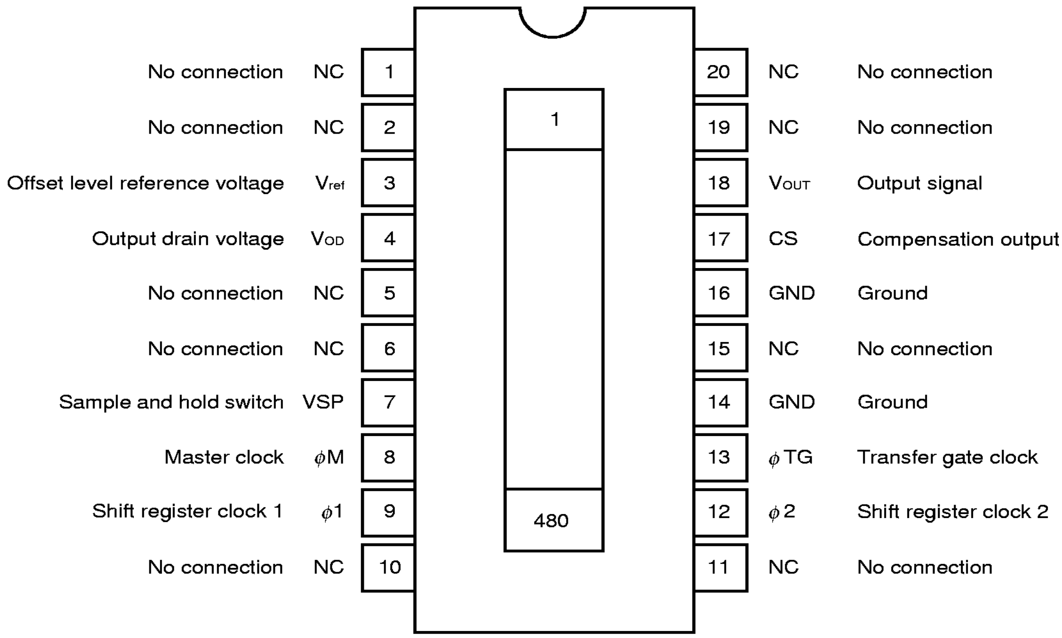
The mark ★ shows major revised points.

BLOCK DIAGRAM

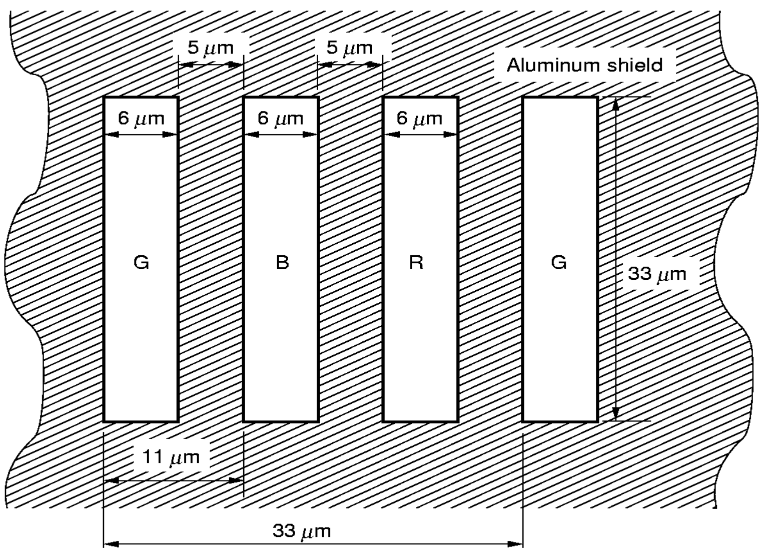


PIN CONFIGURATION (Top View)

CCD linear image sensor 20-pin plastic shrink DIP (300 mil)



PHOTOCELL STRUCTURE DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_A = +25 °C)

Parameter	Symbol	Ratings	Unit
Output drain voltage	V_{OD}	–0.3 to +15	V
Offset level reference voltage	V_{ref}	–0.3 to +15	V
Shift register clock voltage	$V_{\phi1}$, $V_{\phi2}$	–0.3 to +8	V
Master clock voltage	$V_{\phi M}$	–0.3 to +8	V
Sample and hold switch voltage	V_{VSP}	–0.3 to +8	V
Transfer gate clock voltage	$V_{\phi TG}$	–0.3 to +8	V
Operating ambient temperature	T_A	–25 to +70	°C
Storage temperature	T_{stg}	–40 to +70	°C

Caution Exposure to ABSOLUTE MAXIMUM RATINGS for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The parameters apply independently.

RECOMMENDED OPERATING CONDITIONS (T_A = +25 °C)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Output drain voltage	V_{OD}	11.4	12.0	13.0	V
Offset level reference voltage	V_{ref}	11.4	12.0	13.0	V
Shift register clock high level	$V_{\phi1H}$, $V_{\phi2H}$	4.5	5.0	5.5	V
Shift register clock low level	$V_{\phi1L}$, $V_{\phi2L}$	–0.3	0	+0.5	V
Master clock high level	$V_{\phi MH}$	4.5	5.0	5.5	V
Master clock low level	$V_{\phi ML}$	–0.3	0	+0.5	V
Sample and hold switch high level	V_{VSPH}	4.5	5.0	5.5	V
Sample and hold switch low level	V_{VSPL}	–0.3	0	+0.5	V
Transfer gate clock high level	$V_{\phi TGH}$	4.5	$V_{\phi1H}$	$V_{\phi1H}$	V
Transfer gate clock low level	$V_{\phi TGL}$	–0.3	0	+0.5	V
Master clock frequency	$f_{\phi M}$	–	4.0	6.0	MHz
Data rate	$f_{\phi1}$, $f_{\phi2}$	–	2.0	3.0	MHz

Remark On-chip sample and hold circuit:

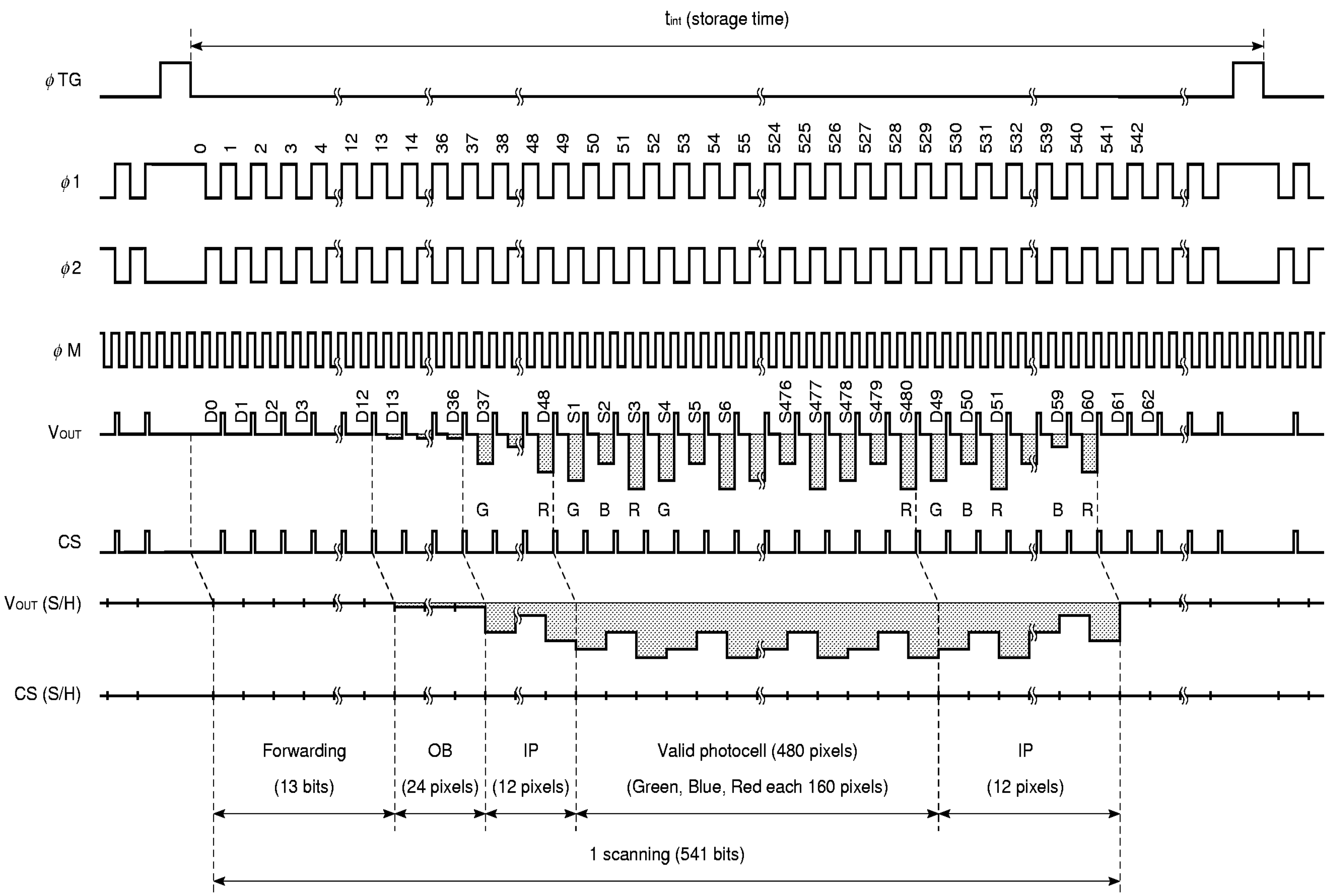
In use	VSP pin (7 pin) = High level
Not in use	VSP pin (7 pin) = Low level, φM pin (8 pin) = Low level

ELECTRICAL CHARACTERISTICS

(T_A = +25 °C , V_{OD} = 12 V, V_{ref} = 12 V, $f_{\phi M}$ = 4 MHz, data rate = 2 MHz, storage time = 10 ms,
light source: 3200 K halogen lamp + C-500S (infrared cut filter, t = 1 mm), ϕ1, ϕ2, ϕM and ϕTG = 5 V_{p-p})

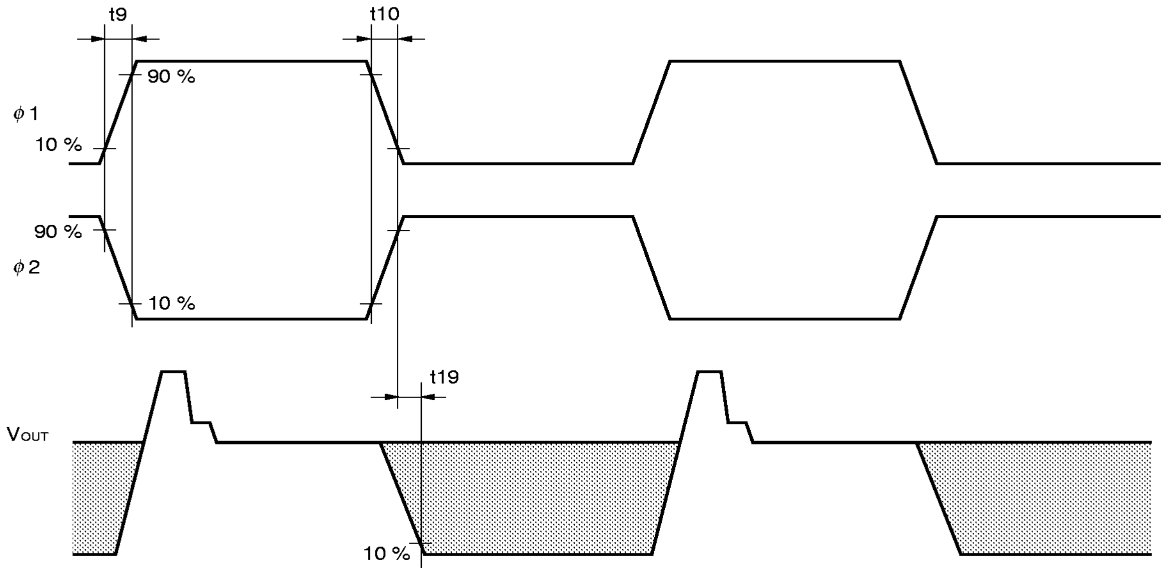
	Parameter		Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
★	Saturation voltage		V_{sat}		1.5			V
★	Saturation exposure	Red	SER		0.080			lx·s
		Green	SEG		0.088			lx·s
		Blue	SEB		0.146			lx·s
	Photo response non-uniformity		PRNU	V_{OUT} (R,G) = 500 mV		4	20	%
	Average dark signal		ADS	Light shielding		4	8	mV
	Dark signal non-uniformity		DSNU	Light shielding		4	8	mV
	Power consumption		P_W			115	220	mW
	Output impedance		Z_O			0.5	1	kΩ
	Response	Red	R_R		10.08	14.4	18.72	V/lx·s
		Green	R_G		9.17	13.1	17.03	V/lx·s
		Blue	R_B		5.53	7.9	10.27	V/lx·s
	Output signal offset level		V_{OS}		5	6	7	V
	Compensation output offset level		V_{CS}		5	6	7	V
★	Offset level difference		$V_{OS} - V_{CS}$		–150	0	+100	mV
	Total transfer efficiency		TTE	V_{OUT} (R, G) = 500 mV, data rate = 3 MHz	92			%
	Response peak	Red				630		nm
		Green				540		nm
		Blue				460		nm
	Reset feed-through noise		RFTN	Light shielding		1300		mV
	Input capacitance of shift register clock pins		$C_{\phi 1}$, $C_{\phi 2}$			120		pF
	Input capacitance of master clock pin		$C_{\phi M}$			15		pF
	Input capacitance of transfer gate clock pin		$C_{\phi TG}$			50		pF

TIMING CHART 1

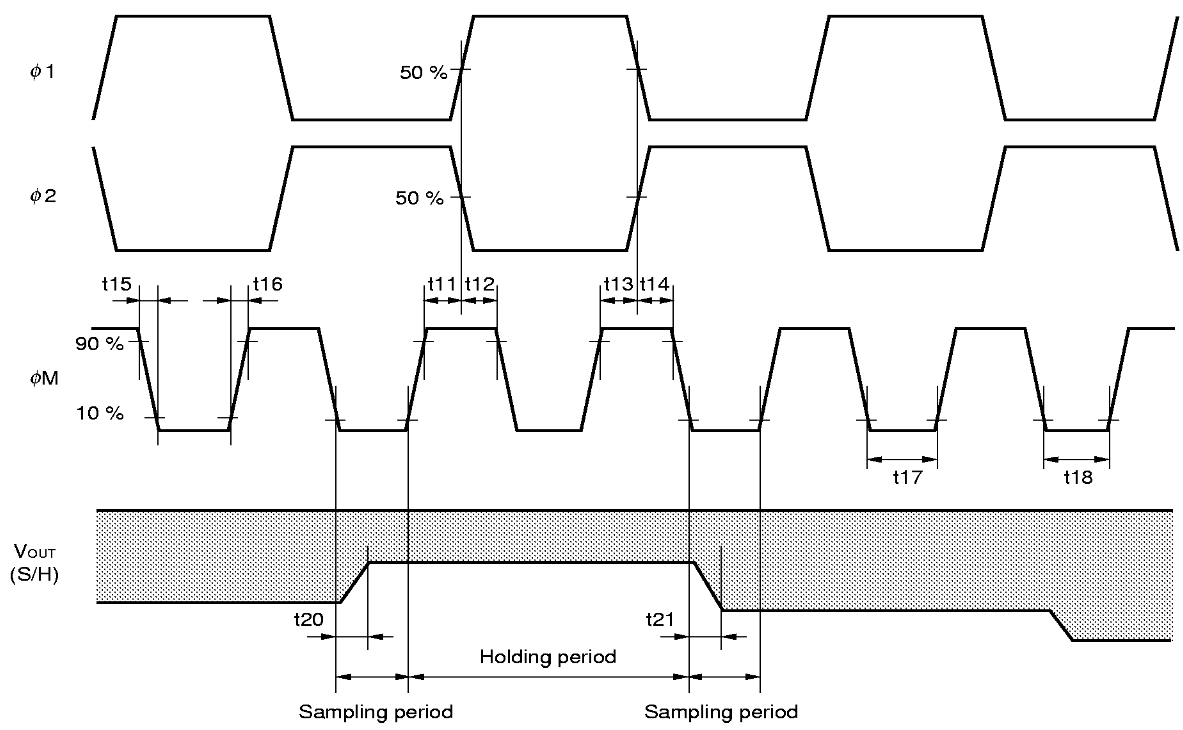


Remark OB : Optical Black (light shielded photocell)
IP : Invalid Photocell

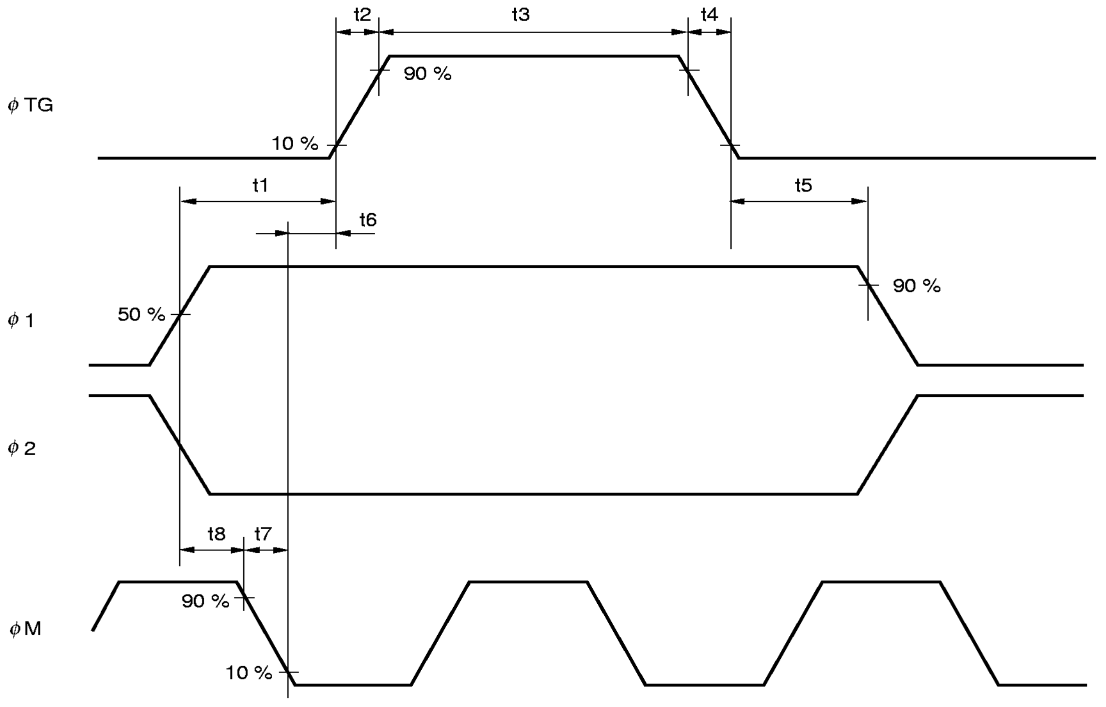
TIMING CHART 2 (Not in used on-chip sample and hold circuit)



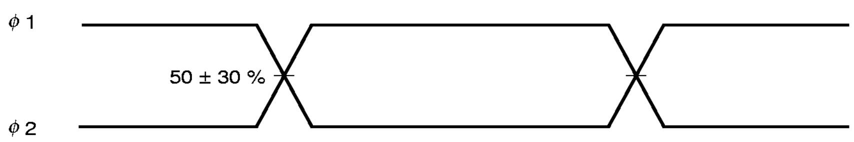
TIMING CHART 3 (In used on-chip sample and hold circuit)



TIMING CHART for φTG, φ1, φ2, φM



CROSS POINTS for φ1, φ2



Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
φTG, φ1, φ2 pulse timing	t1		60	300	–	ns
	t5		0	300	–	ns
φTG pulse rise time, fall time	t2, t4		0	50	–	ns
φTG pulse width	t3		300	1000	–	ns
φTG, φM pulse timing	t6		20	50	–	ns
φ1, φ2 pulse rise time, fall time	t9, t10		0	20	–	ns
φ1, φ2, φM pulse timing	t11, t13		20	100	–	ns
	t8, t12, t14		40	100	–	ns
φM pulse rise time, fall time	t7, t15, t16		0	20	–	ns
φM pulse width	t17, t18		80	250	–	ns
Output signal delay time	t19	Load resistance: 100 kΩ	–	60	–	ns
Sample and hold aperture delay	t20, t21		–	70	–	ns

Remark TYP. is an example of at 1 MHz data rate ($f_{\phi 1}$, $f_{\phi 2}$) operation.

DEFINITIONS OF CHARACTERISTIC ITEMS

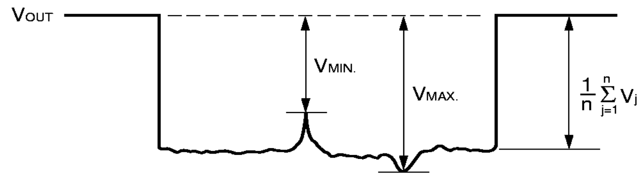
1. Saturation voltage: V_{sat}
   Output signal voltage at which the response linearity is lost.
2. Saturation exposure: SE
   Product of intensity of illumination (lx) and storage time (s) when saturation of output voltage occurs.
   This is calculated by the following formula.

$$SE\ (R, G, B)\ (lx \cdot s) = \frac{V_{sat}\ MIN.}{R_{(R,\ G,\ B)}\ MAX.}$$

3. Photo response non-uniformity: PRNU
   The output signal non-uniformity of all the valid pixels when the photosensitive surface is applied with the light of uniform illumination. This is calculated by the following formula.

$$PRNU\ (\%) = \frac{V_{MAX.} - V_{MIN.}}{\frac{1}{n}\sum_{j=1}^{n} V_j} \times 100$$

n : Number of valid pixels
V_j : Output voltage of each pixel
$V_{MAX.}$: Voltage of the highest output pixel
$V_{MIN.}$: Voltage of the lowest output pixel



4. Average dark signal: ADS
   Average output signal voltage of all the valid pixels at light shielding.
   This is calculated by the following formula.

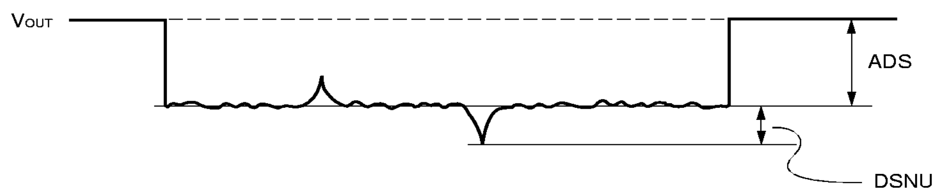
$$ADS\ (mV) = \frac{1}{n}\sum_{j=1}^{n} V_j$$

n : Number of valid pixels
V_j : Output voltage of each pixel

5. Dark signal non-uniformity: DSNU
   Absolute maximum of the difference between ADS and voltage of the highest or lowest output pixel of all the valid pixels at light shielding. This is calculated by the following formula.

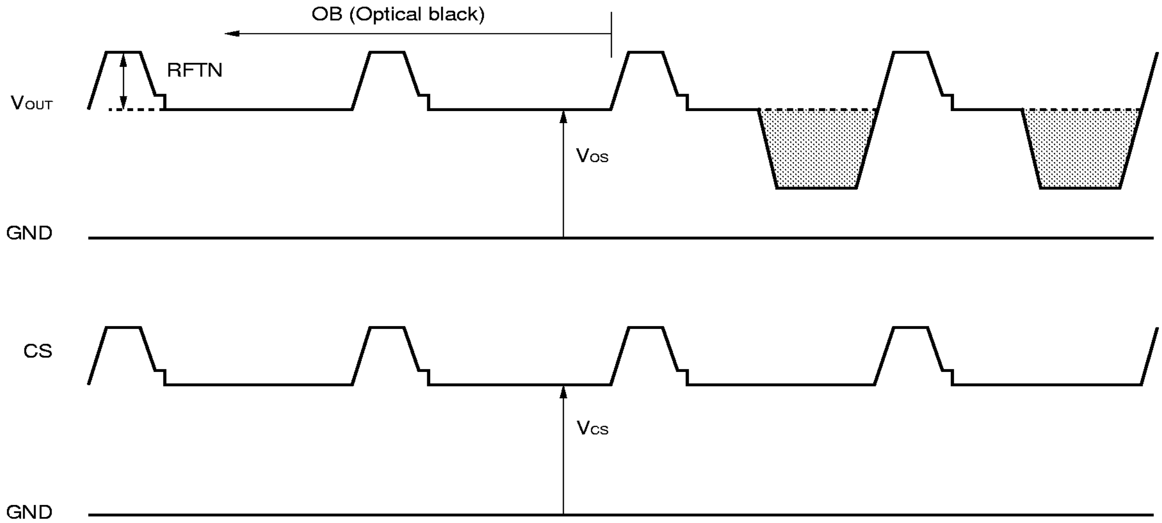
DSNU (mV): maximum of $| V_j - ADS |_{j = 1\ to\ n}$

n : Number of valid pixels
V_j : Output voltage of each pixel



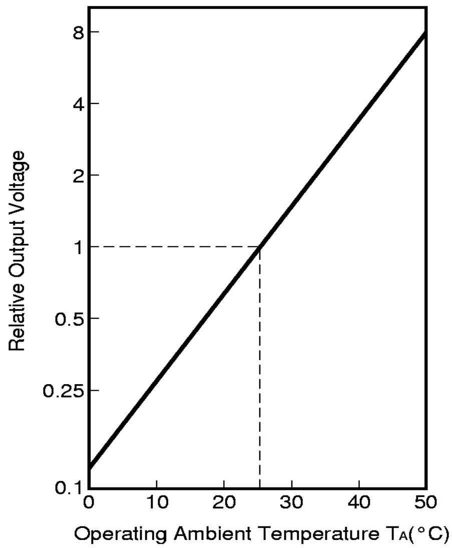
6. Output impedance: Z_O
   Impedance of the output pins viewed from outside.

7. Response: R
   Output voltage divided by exposure (lx·s).
   Note that the response varies with a light source (spectral characteristic).
8. Output signal offset level: V_{OS}
   DC voltage of the output signal at data period in the OB (optical black) pixels.
9. Compensation output offset level: V_{CS}
   DC voltage of the compensation output at data period that corresponds to the output signal's.
10. Reset feed-through noise: RFTN
   Noise of the output signal synchronized with the internal reset pulse.

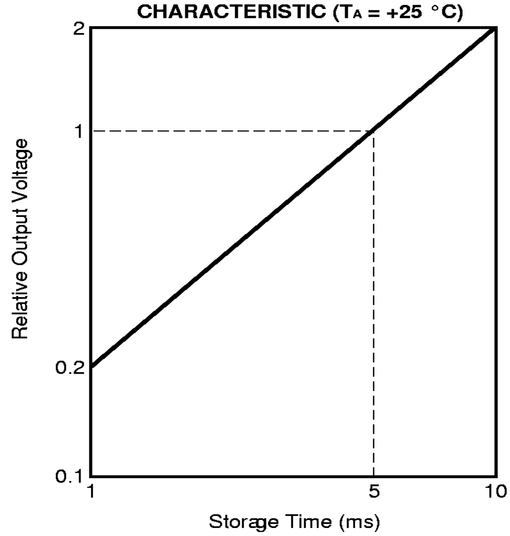


STANDARD CHARACTERISTIC CURVES

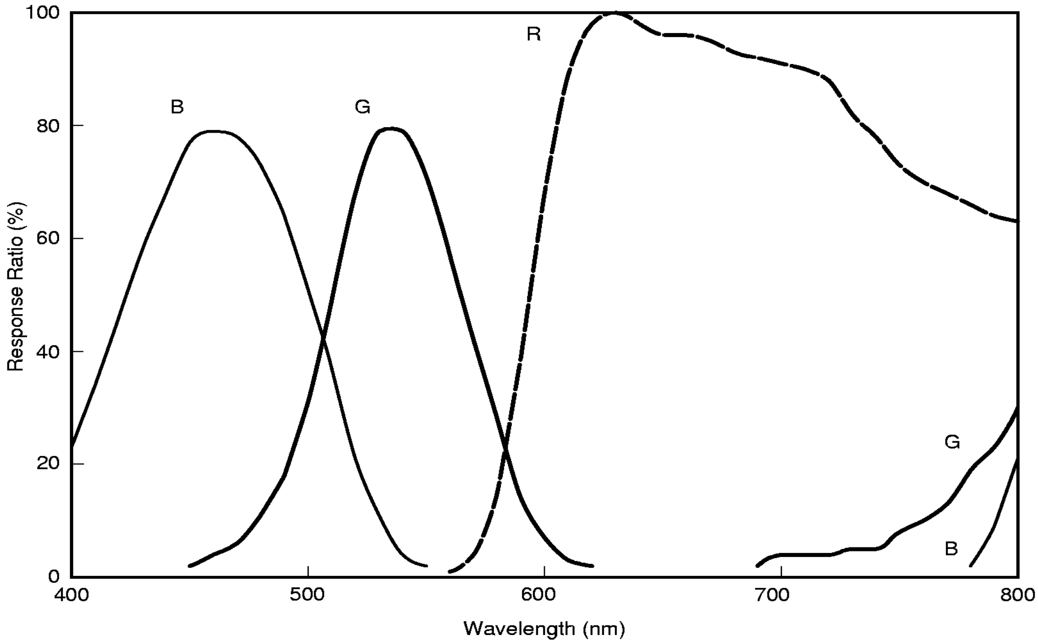
DARK OUTPUT TEMPERATURE CHARACTERISTIC



STORAGE TIME OUTPUT VOLTAGE CHARACTERISTIC (T_A = +25 °C)



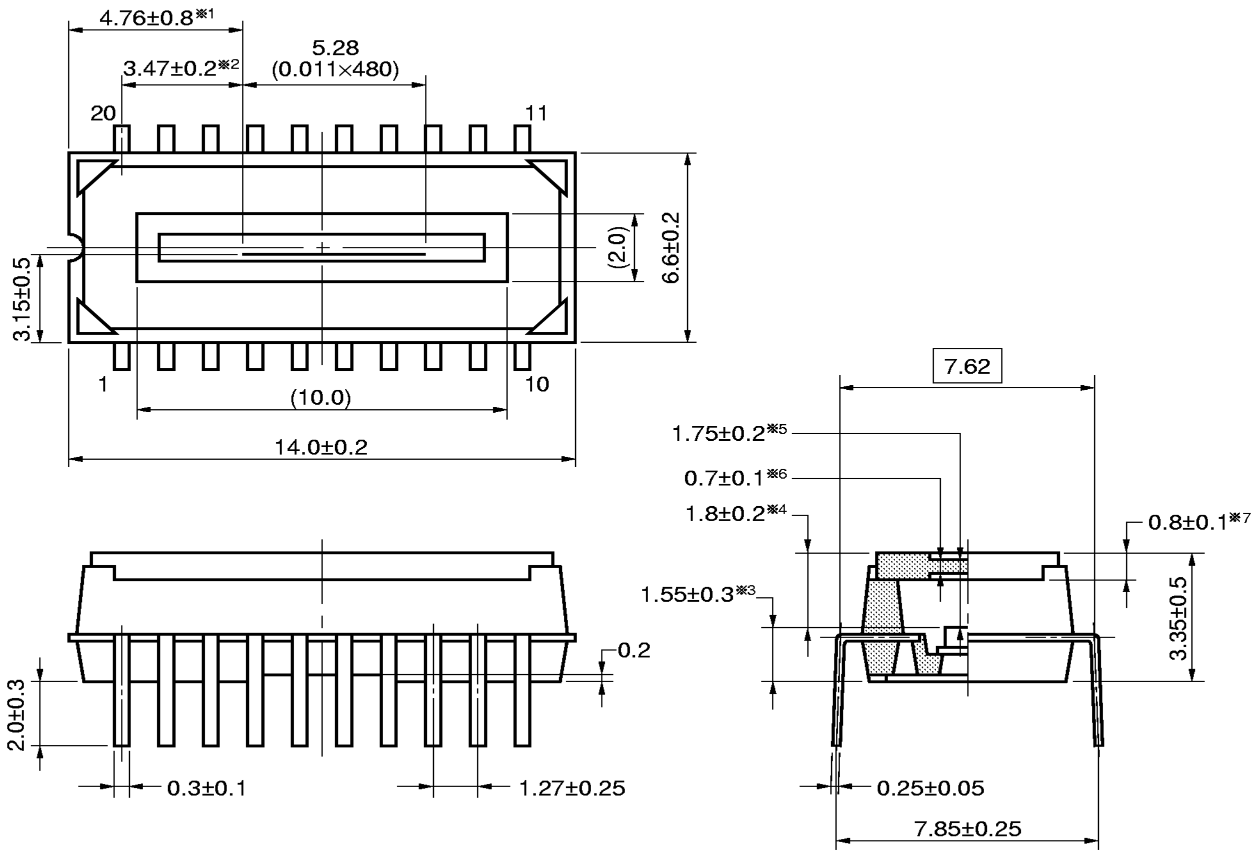
★ **TOTAL SPECTRAL RESPONSE CHARACTERISTICS (without infrared cut filter) (T_A = +25 °C)**



PACKAGE DRAWING

CCD LINEAR IMAGE SENSOR 20PIN PLASTIC SHRINK DIP (300 mil)

(Unit : mm)



※1 The 1st valid photocell (S1) ↔ The edge of the package
※2 The 1st valid photocell (S1) ↔ The center of the pin 1
※3 The top of the CCD chip ↔ The bottom of the package
※4 The top of the CCD chip ↔ The top of the cap
※5 The top of the CCD chip ↔ The top of the transparent window of the cap
※6 The thickness of the transparent window of the cap (Refractive index = 1.5)
※7 The thickness of the cap

20C-1CCD-PKG

★ RECOMMENDED SOLDERING CONDITIONS

When soldering this product, it is highly recommended to observe the conditions as shown below. If other soldering processes are used, or if the soldering is performed under different conditions, please make sure to consult with our sales offices.

For more details, refer to our document "**SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL**" **(C10535E).**

Type of Through-hole Device

μPD3700CS: CCD linear image sensor 20-pin plastic shrink DIP (300 mil)

Process	Conditions
Partial heating method	Pin temperature: 260 °C or below, Heat time: 10 seconds or less (per each lead).

Caution During assembly care should be taken to prevent solder or flux from contacting the plastic cap. The optical characteristics could be degraded by such contact.

NOTES ON CLEANING THE PLASTIC CAP

① CLEANING THE PLASTIC CAP

Care should be taken when cleaning the surface to prevent scratches.
The optical characteristics of the CCD will be degraded if the cap is scratched during cleaning.

We recommend cleaning the cap with a soft cloth moistened with one of the recommended solvents below. Excessive pressure should not be applied to the cap during cleaning. If the cap requires multiple cleanings it is recommended that a clean surface or cloth be used.

② RECOMMENDED SOLVENTS

The following are the recommended solvents for cleaning the CCD plastic cap. Use of solvents other than these could result in optical or physical degradation in the plastic cap. Please consult your sales office when considering an alternative solvent.

Solvents	Symbol
Ethyl Alcohol	EtOH
Methyl Alcohol	MeOH
Isopropyl Alcohol	IPA
N-methyl Pyrrolidone	NMP