

1760-BIT CCD LINEAR IMAGE SENSOR WITH PERIPHERAL CIRCUIT

The μ PD3732 is a 1760-bit high sensitivity CCD (Charge Coupled Device) linear image sensor which changes optical images to electrical signal.

The μ PD3732 has an output amplifier which has high gain and wide output range.

Built-in sample and hold circuit convert and output independent signal from CCD register in every bit to continuous video signal. So it is easy to interface to A/D converter or Bi-level converter.

FEATURES

- Valid photocell 1760-bit
- Photocell's pitch 14 μ m
- High response sensitivity Providing a response eight times better than the existing equivalent NEC product (μ PD35H73) to the light from a daylight fluorescent lamp
- Peak response wavelength 550 nm (green)
- Resolution 8 dot/mm across the shorter side of an A4-size (210 x 297 mm) sheet
- Power supply +12 V
- Drive clock level CMOS output under 5 V operation
- High speed scan 0.9 ms/line
- Built-in circuit Sample and hold circuit
Reset feed through level clamp circuit

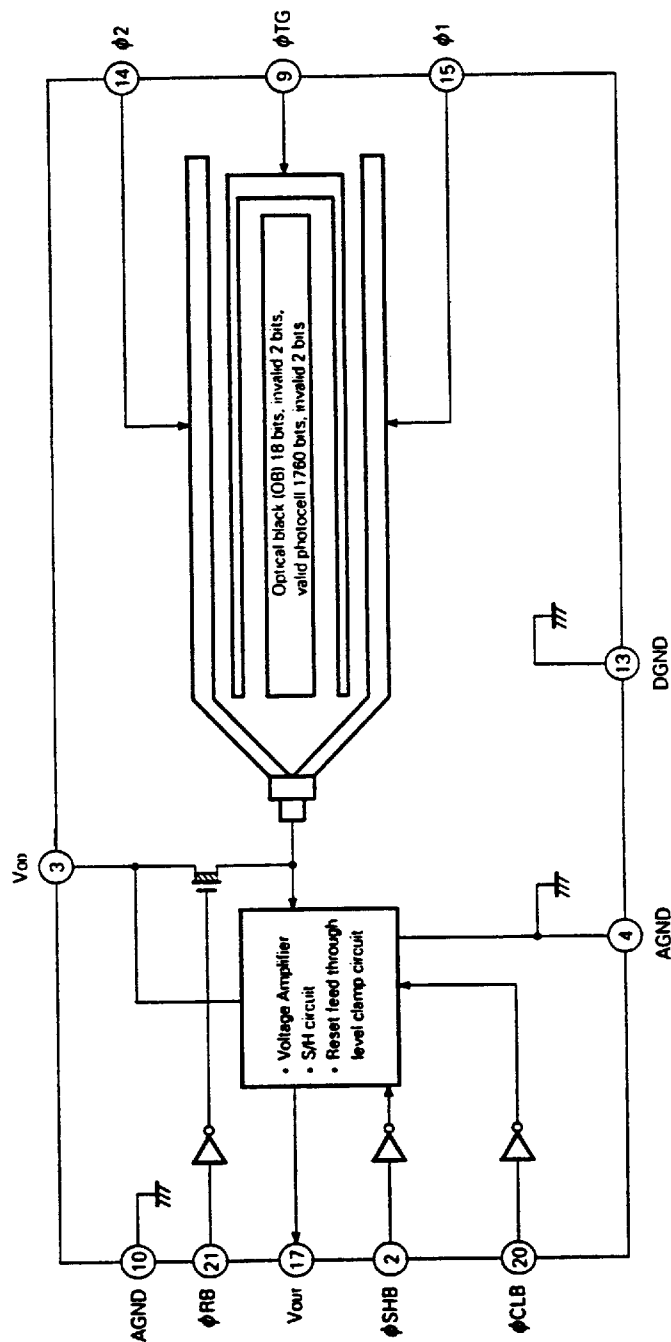
ORDERING INFORMATION

Part Number	Package	Quality Grade
μ PD3732D	22-pin ceramic DIP (CERDIP) (400 mil)	Standard

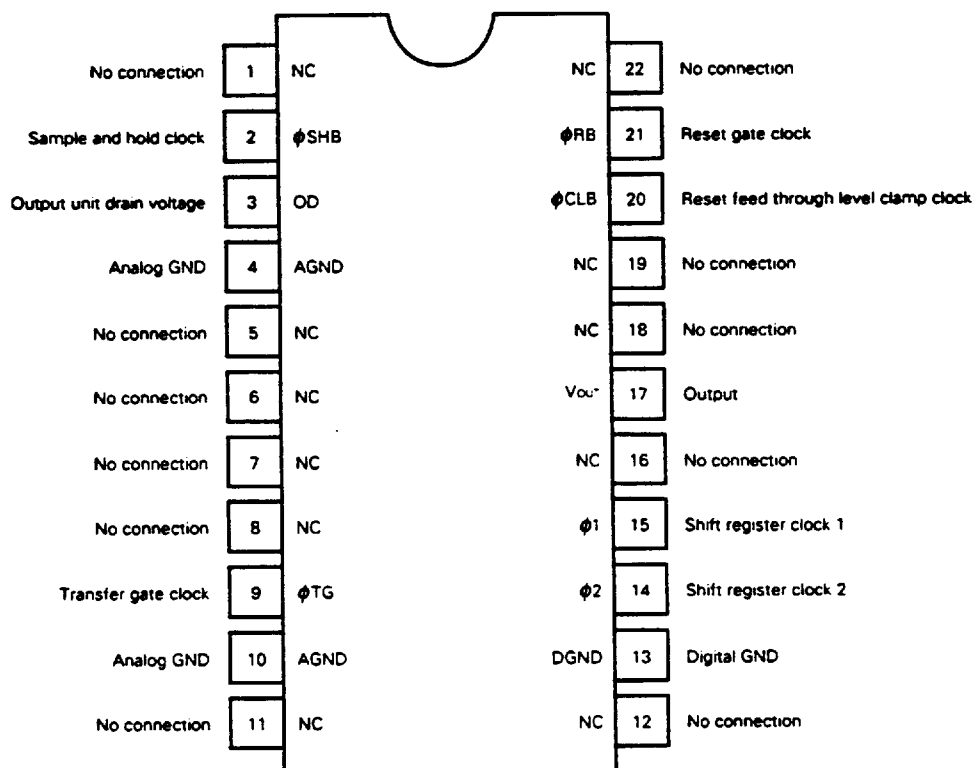
Please refer to "Quality grade on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

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

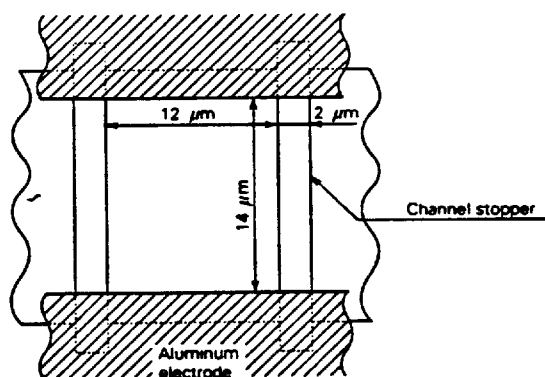
BLOCK DIAGRAM



PIN CONFIGURATION (Top View)



PHOTOCELL STRUCTURE DIAGRAM



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

Parameter	Symbol	Ratings	Unit
Output unit drain voltage	V_{DD}	-0.3 to +15	V
Shift register clock voltage	$V_{\phi 1, \phi 2}$	-0.3 to +15	V
Reset signal voltage	$V_{\phi RB}$	-0.3 to +15	V
Transfer gate signal voltage	$V_{\phi TG}$	-0.3 to +15	V
Sample and hold signal voltage	$V_{\phi SH}$	-0.3 to +15	V
Reset feed through level clamp signal voltage	$V_{\phi CL}$	-0.3 to +15	V
Operating ambient temperature	T_{OP}	-25 to +60	$^\circ\text{C}$
Storage temperature	T_{STG}	-40 to +100	$^\circ\text{C}$

RECOMMENDED OPERATING CONDITIONS ($T_a = -25$ to $+60^\circ\text{C}$)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Output unit drain voltage	V_{DD}	11.4	12.0	12.6	V
Shift register clock $\phi 1, \phi 2$ signal high level	$V_{\phi 1H, \phi 2H}$	4.5 ($V_{DD} - 3$)	5.0 (V_{DD})	5.5 ($V_{DD} + 0.6$)	V
Shift register clock $\phi 1, \phi 2$ signal low level	$V_{\phi 1L, \phi 2L}$	-0.3 (-0.3)	0 (0)	0.5 (0.8)	V
Reset signal ϕRB high level	$V_{\phi RBH}$	4.5	5.0	5.5	V
Reset signal ϕRB low level	$V_{\phi RBL}$	-0.3	0	0.5	V
Transfer gate signal high level	$V_{\phi TGH}$	4.5 ($V_{DD} - 3$)	5.0 (V_{DD})	5.5 ($V_{DD} + 0.6$)	V
Transfer gate signal low level	$V_{\phi TGL}$	-0.3 (-0.3)	0 (0)	0.5 (0.8)	V
Sample and hold signal high level	$V_{\phi SHH}$	4.5	5.0	5.5	V
Sample and hold signal low level	$V_{\phi SHL}$	-0.3	0	0.5	V
Reset feed through level clamp signal high level	$V_{\phi CLH}$	4.5	5.0	5.5	V
Reset feed through level clamp signal low level	$V_{\phi CLL}$	-0.3	0	0.5	V
Data rate	$f_{\phi H}$	0.2	1	2	MHz

Remark Values in () are for the driver under 12 V operation.

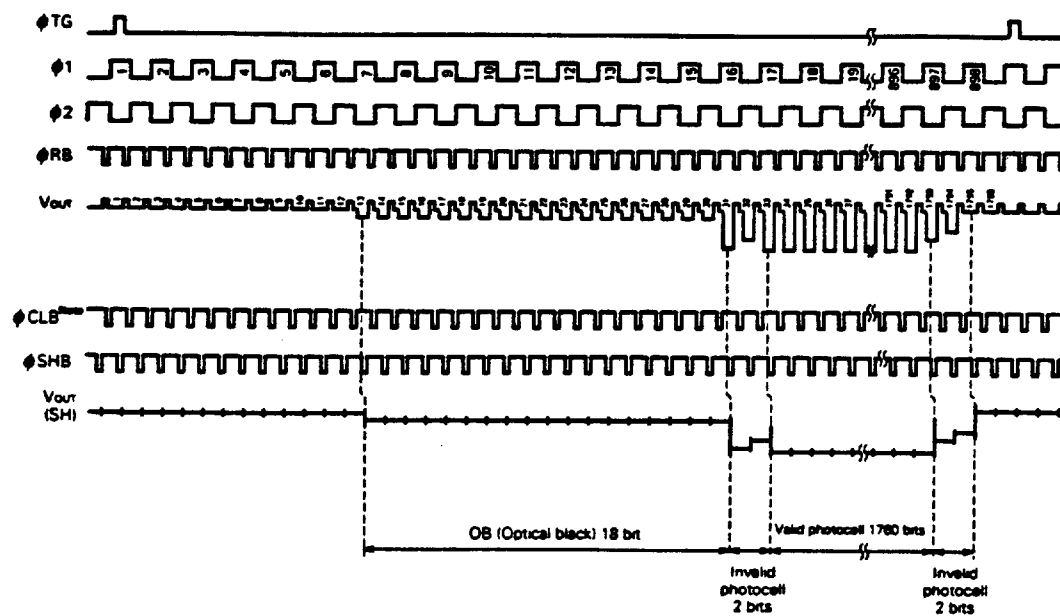
ELECTRICAL CHARACTERISTICS

($T_a = +25^\circ\text{C}$, $V_{DD} = 12\text{V}$, $f_{\phi 1} = 0.5\text{MHz}$, data rate = 1 MHz, storage time = 10 ms
light source: 3200 K halogen lamp + C500 (infrared cut filter), input clock = 5 V_{PP})

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Saturation voltage	V_{SAT}		1.5	2.0		V
Saturation exposure	SE	Daylight color fluorescent lamp		0.022		lx·s
Photo response non-uniformity	PRNU	$V_{OUT} = 500\text{mV}$		± 2	± 8	%
Average dark signal	ADS	Light shielding		1.0	8.0	mV
Dark signal non-uniformity	DSNU	Light shielding	-8	± 4	+8	mV
Power consumption	P_w			140	180	mW
Output impedance	Z_o			0.5	1	k Ω
Response	R_f	Daylight color fluorescent lamp	63	90	117	V/lx·s
	R_w	W lamp		270		
Response peak wavelength				550		nm
Image lag	IL	$V_{OUT} = 1\text{V}$		7		%
Offset level (Note 1)	V_{OS}	When ϕ_{CLB} is input	3.5	4.5	5.5	V
Input capacitance of shift register clock pin	$C_{\phi 1}$			400		pF
	$C_{\phi 2}$					
Input capacitance of reset pin	C_{RES}			5		pF
Input capacitance of sample and hold pin	C_{SHS}			5		pF
Input capacitance of reset feed through level pin	C_{CFLS}			5		pF
Input capacitance of transfer gate signal pin	C_{GTG}			100		pF
Output rise delay time	t_d			120		ns
Register imbalance	RI	$V_{OUT} = 500\text{mV}$			3	%
Transfer efficiency	TTE	$V_{OUT} = 1\text{V}$, data rate = 2 MHz	92			%
Dynamic range	DR	$V_{SAT}/DSNU$		500		times
Reset feed through noise	RFSN		0	1000	1800	mV
Sample and hold noise	SHSN		-50	0	50	mV
Bit noise 1	BN1	When ϕ_{CLB} is input		4		mV _{PP}
Bit noise 2 (Note 2)	BN2	When ϕ_{CLB} is not input (in case of inputting ϕ_{RB} clock signal to ϕ_{CLB} pin)		16		mV _{PP}
Resolution	MTF	Modulation transfer function at nyquist frequency		65		%

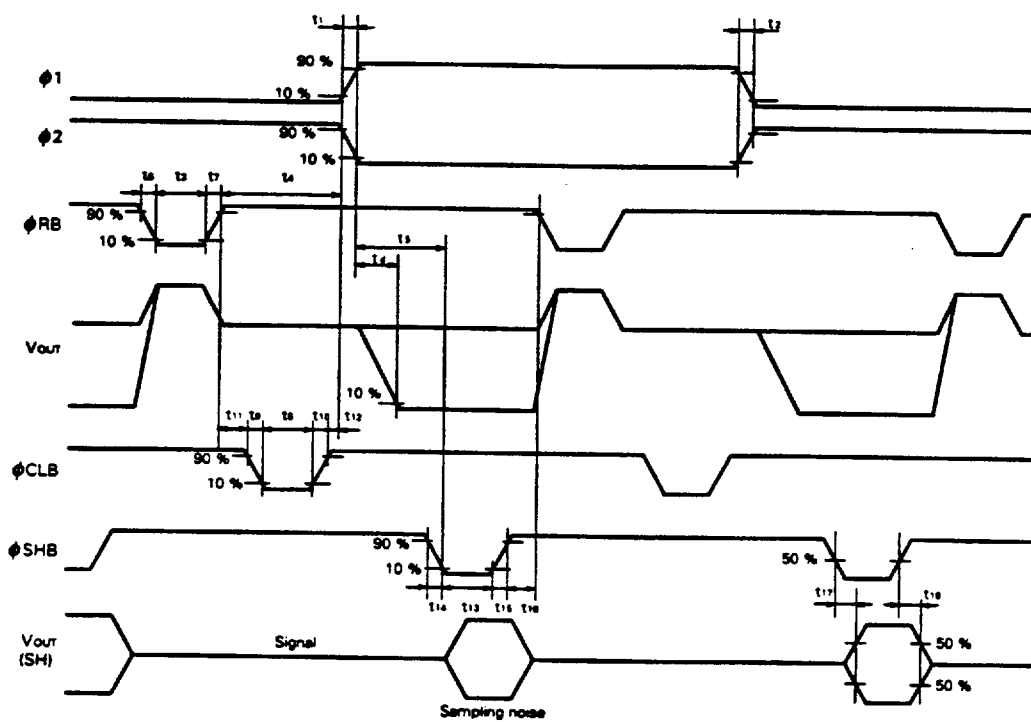
- Note 1. In case of inputting ϕ_{RB} clock signal to ϕ_{CLB} pin, offset level decreases corresponding to RFSN.
 2. When ϕ_{CLB} is not used (in case of inputting ϕ_{RB} clock signal to ϕ_{CLB} pin), because of 1/f noise of output amplifier, compared with bit noise 1 (BN1), bit noise increases.

TIMING CHART 1

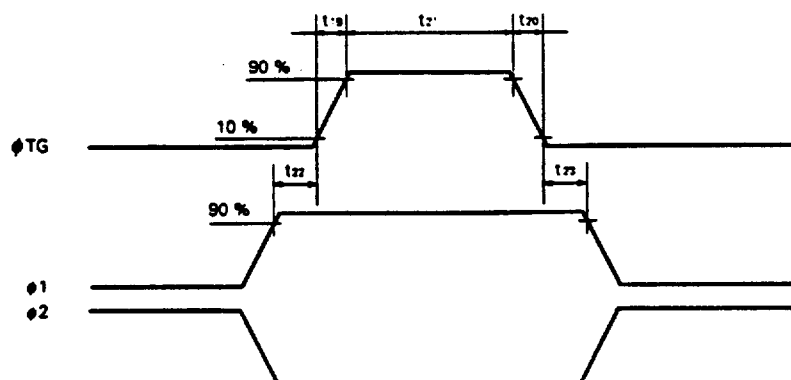
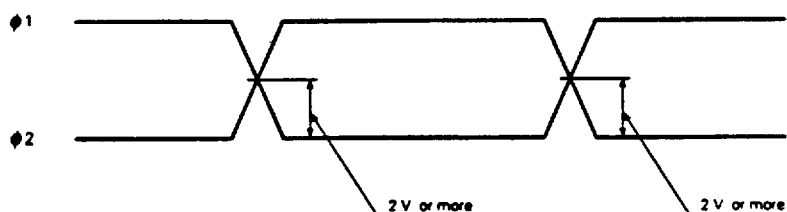


- Remark** V_{out} = Output when ϕ SHB is not used (When ϕ SHB is not used, connect ϕ SHB pin to GND)
 $V_{out} (SH)$ = Output when ϕ SHB is used.
 When ϕ CLB is used, reset feed through level of V_{out} is clamped to a certain level.
 (When ϕ CLB is not used, input ϕ RB clock to ϕ CLB pin)
- Note** When ϕ CLB is not used (in case of inputting ϕ RB clock signal to ϕ CLB pin), because of 1/f noise of output amplifier, bit noise increases. Therefore use ϕ CLB.

TIMING CHART 2



Remark $V_{out} (SH)$ = Output when ϕSHB is used.

TIMING CHART for ϕ TG, ϕ 1, ϕ 2CROSS POINTS for ϕ 1, ϕ 2

Remark Adjust cross point of ϕ 1, ϕ 2 by ϕ 1, ϕ 2 pin input resistors.

(Unit: ns)

Parameter	MIN.	TYP.	MAX.
t_1, t_2	0	50	(100)
t_3	20	100	-
t_4 (When)	220	300	-
t_5	150	300	-
t_6, t_7	0	50	-
t_8	20	100	-
t_9, t_{10}	0	50	-
t_{11}	150	250	-
t_{12}	20	50	-
t_{13}	80	100	-
t_{14}, t_{15}, t_{16}	0	50	-
t_{17}	0		
t_{18}		5	10
t_{19}, t_{20}	0	50	-
t_{21}	650	1000	(2000)
t_{22}, t_{23}	0	100	-

Note When ϕ CLB is not used (in case of inputting ϕ RB clock signal to ϕ CLB pin), $t_4 = 20$ ns MIN.

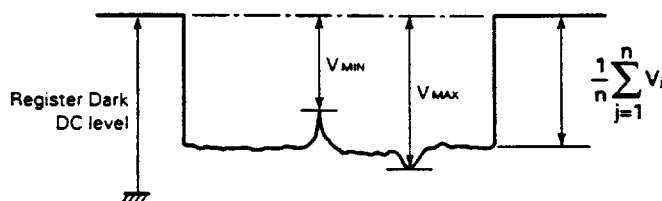
Remark The MAX. in the table above shows the operation range in which the output characteristics are kept almost enough for general purpose, does not show the limit above which the μ PD3732 is destroyed.

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.
3. **Photo response non-uniformity: PRNU**
The peak/bottom ratio to the average output voltage of all the valid bits calculated by the following formula.

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

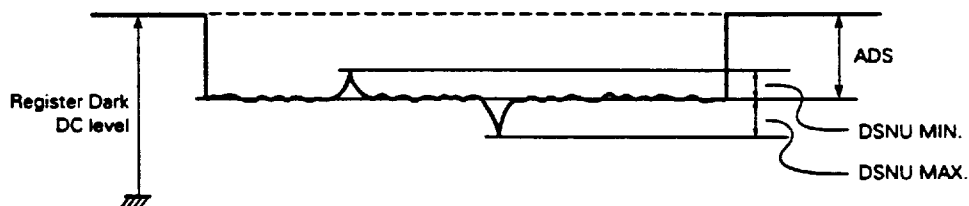
n : Number of valid bits
 V_j : Output voltage of each bit



4. **Average dark signal: ADS**
Output average voltage in light shielding

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

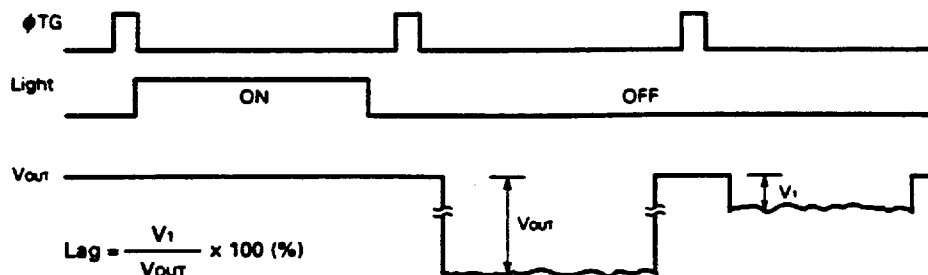
5. **Dark signal non-uniformity: DSNU**
The difference between peak or bottom output voltage in light shielding and ADS.



6. **Output impedance: Z_o**
Output pin impedance viewed from outside.
7. **Response: R**
Output voltage divided by exposure (lx·s).
Note that the response varies with the light source.

8. Image Lag: IL

The rate between the last output voltage and the next one after read out the data of a line.



9. Register Imbalance: RI

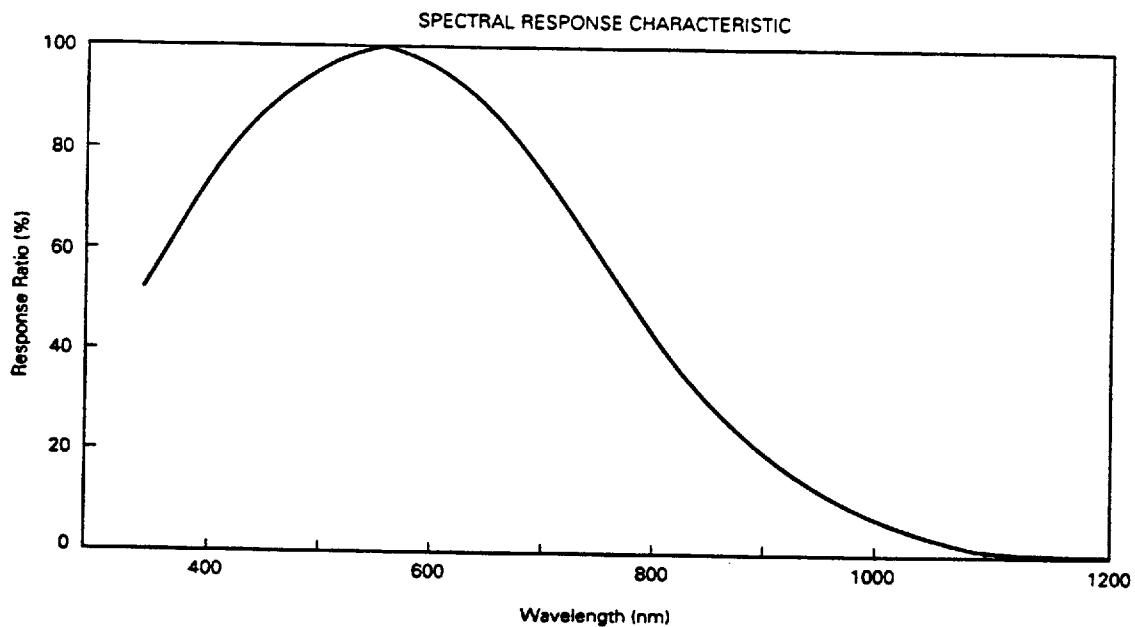
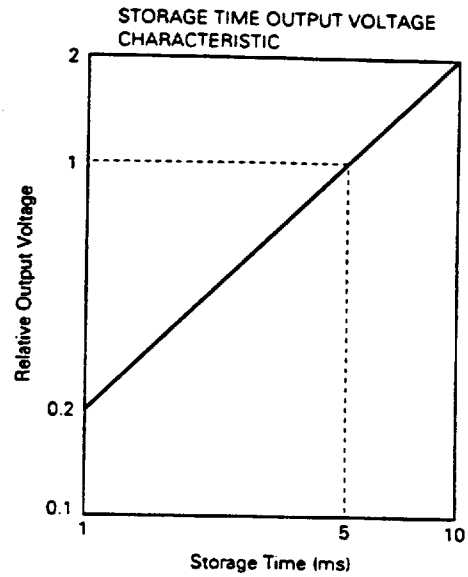
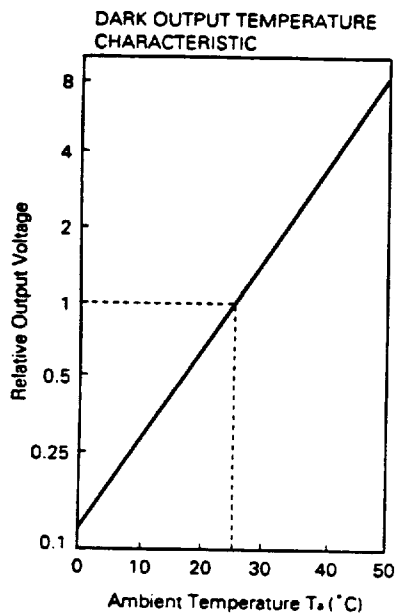
The rate of the average voltage which is the difference between the output voltage of Odd and Even bits, against the average output voltage of all the valid bits.

$$RI = \frac{\frac{1}{n} \sum_{j=1}^n |V_j - V_{j+1}|}{\frac{1}{n} \sum_{j=1}^n V_j} \times 100 (\%)$$

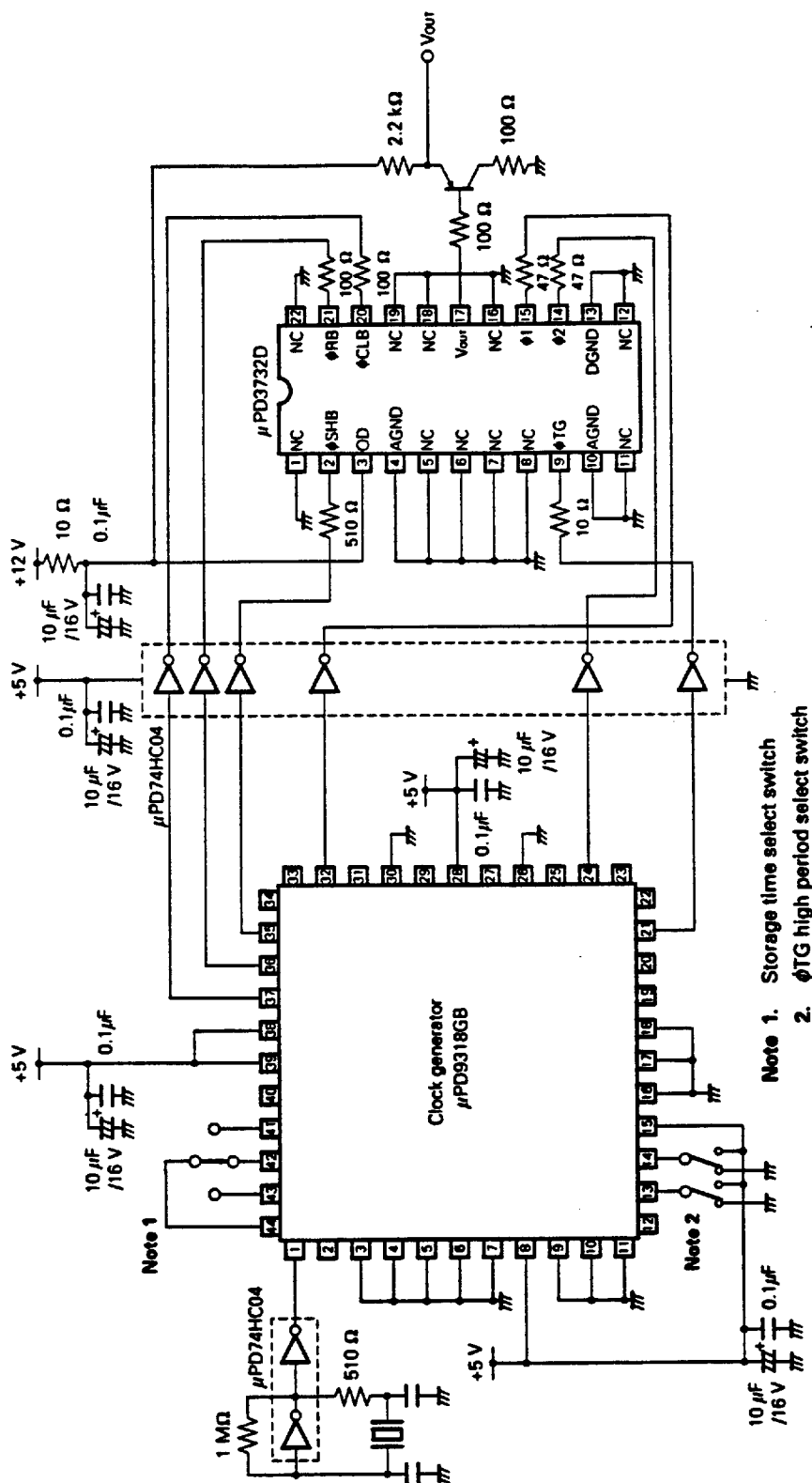
10. Bit Noise: BN

Output signal distribution of a photocell by scan.

STANDARD CHARACTERISTIC CURVES ($T_a = +25^\circ\text{C}$)



APPLICATION EXAMPLE



Remark 1. When internal sample and hold circuit of $\mu\text{PD}3732$ is not used, connect pin 2 (ϕSHB) to GND.

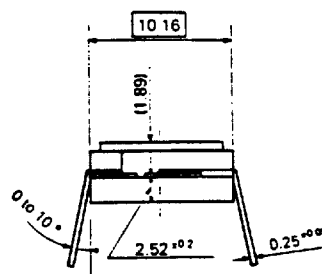
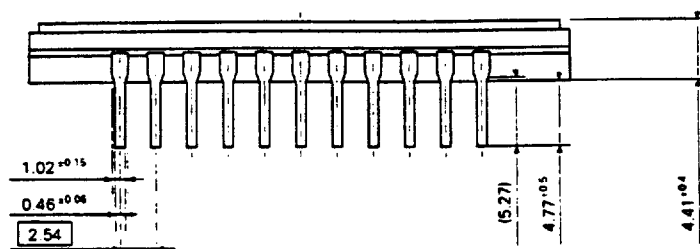
2 When internal reset feed through level clamp circuit of μ PD3732 is not used, input ϕ RB clock signal to pin 20 (ϕ CLB).

When ϕ_{CLB} is not used (in case of inputting ϕ_{RB} clock signal to ϕ_{CLB} pin), because of $1/f$ noise of output amplifier, bit noise increases.

The application circuits and their parameters are for references only and are not intended for use in actual design-in's.

Technical drawing of a rectangular component with dimensions and tolerances:

- Overall width: 43.6 ± 0.3
- Overall height: 9.65 ± 0.3
- Inner width: 39.0 ± 0.3
- Inner height: 5.6 ± 0.3
- Top edge feature: 1 bit (indicated by a dimension line and a small circle)
- Top edge feature: 1.5 ± 0.3 (indicated by a dimension line and a small circle)



Name	Dimensions	Refractive index
Glass cap	42.2 × 9.0 × 0.5	1.5