TOSHIBA CCD Linear Image Sensor　CCD (Charge Coupled Device)

TCD1304DG

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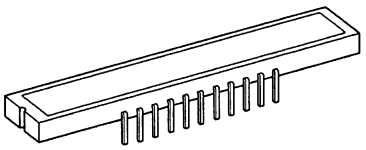
The TCD1304DG is a high sensitive and low dark current 3648 elements CCD linear image sensor.

The device consist of sensitivity CCD chip.

The TCD1304DG has electronic shutter function (ICG). Electronic shutter function can keep always output voltage constant that vary with intensity of lights.



WDIP22-G-400-2.54H

Features

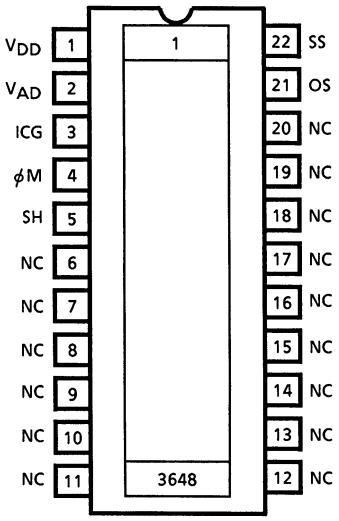
- Number of Image Sensing Elements: 3648 elements
- Image Sensing Element Size: 8 μm by 200 μm on 8 μm center
- Photo Sensing Region: High sensitive PN photodiode
- Power Supply Voltage: 3.0 V (min)
- Internal Circuit: CCD drive circuit
- Package: 22 pin CERDIP
- Function: Electronic shutter, Sample and hold circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

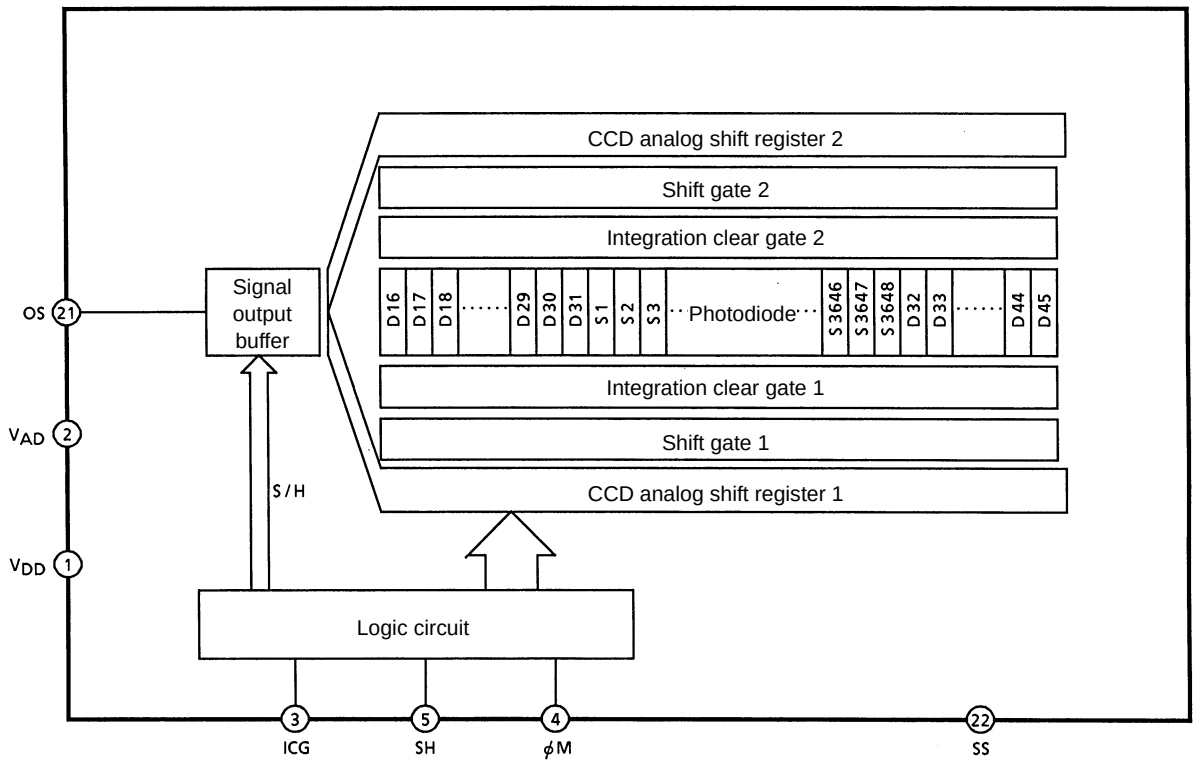
Characteristic	Symbol	Rating	Unit
Master clock pulse voltage	$V_{\phi M}$	−0.3 to +7.0	V
Shift pulse voltage	V_{SH}		
Integration clear pulse voltage	V_{ICG}		
Digital power supply voltage	V_{DD}		
Analog power supply voltage	V_{AD}		
Operating temperature	T_{opr}	−25 to +60	°C
Storage temperature	T_{stg}	−40 to +100	°C

Note 1:　All voltages are with respect to SS terminals (ground).
None of the ABSOLUTE MAXIMUM RATINGS must be exceeded, even instantaneously.
If any one of the ABSOLUTE MAXIMUM RATINGS is exceeded, the electrical characteristics, reliability and life time of the device cannot be guaranteed. If the ABSOLUTE MAXIMUM RATINGS are exceeded, the device can be permanently damaged or degraded. Create a system design in such a manner that any of the ABSOLUTE MAXIMUM RATINGS will not be exceeded under any circumstances.

Pin Connections (top view)



Circuit Diagram



Pin Names

Pin No.	Symbol	Name	Pin No.	Symbol	Name
1	VDD	Power supply (Digital)	22	SS	Ground
2	VAD	Power supply (Analog)	21	OS	Output signal
3	ICG	Integration clear gate	20	NC	Non connection
4	ϕM	Master clock	19	NC	Non connection
5	SH	Shift gate	18	NC	Non connection
6	NC	Non connection	17	NC	Non connection
7	NC	Non connection	16	NC	Non connection
8	NC	Non connection	15	NC	Non connection
9	NC	Non connection	14	NC	Non connection
10	NC	Non connection	13	NC	Non connection
11	NC	Non connection	12	NC	Non connection

Optical/Electrical Characteristics

Ta = 25°C, V_{AD} = V_{DD} = 4.0 V, V_{ϕ} = 4.0 V (pulse), f_{DATA} = 0.5 MHz, t_{INT} (integration time) = 10 ms, light source = daylight fluorescent lamp

Characteristic	Symbol	Min	Typ.	Max	Unit	Note
Sensitivity	R	110	160	—	V/lx·s	—
Photo response non uniformity	PRNU	—	—	10	%	(Note 2)
Register imbalance	RI	—	—	3	%	(Note 3)
Saturation output voltage	V_{SAT}	450	600	—	mV	(Note 4)
Dark signal voltage	V_{MDK}	—	2	5	mV	(Note 5)
Total transfer effeiciency	TTE	92	95	—	%	—
Dynamic range	DR	—	300	—	—	(Note 6)
Saturation exposure	SE	—	0.004	—	lx·s	(Note 7)
DC power dissipation	P_D	—	25	75	mW	—
DC output signal voltage	V_{OS}	1.5	2.5	3.5	V	(Note 8)
Output impedance	Z_O	—	0.5	1.0	kΩ	—
Image lag of electronic shutter	V_{LAGICG}	—	—	10	mV	t_{INT}=100μs

Note 2: PRNU is defined on a single chip by the expressions below when the photosensitive surface is applied with the light of uniform illumination and uniform color temperature, and the incident light is 50 % of SE (typ.).

$$PRNU = \frac{\Delta X}{\overline{X}} \times 100\ (\%)$$

$\overline{X}$: Average of total signal outputs
ΔX: The maximum deviation from $\overline{X}$

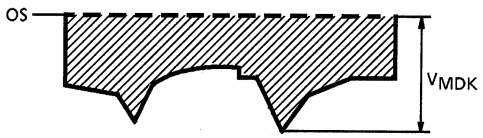
Note 3: Register imbalance is defined as follows. Measured with 50 % of SE (typ.).

$$RI = \frac{\Delta Y}{\overline{X}} \times 100\ (\%)$$

$\overline{X}$: Average of total signal outputs
ΔY: | (average of odd signal output) − (average of even signal output) |

Note 4: V_{SAT} is defined as the minimum saturation output voltage of all effective pixels. V_{AD} = V_{DD} = 3.0 V.

Note 5: V_{MDK} is defined as the maximum dark signal voltage of all effective pixels.



Note 6: Definition of DR:

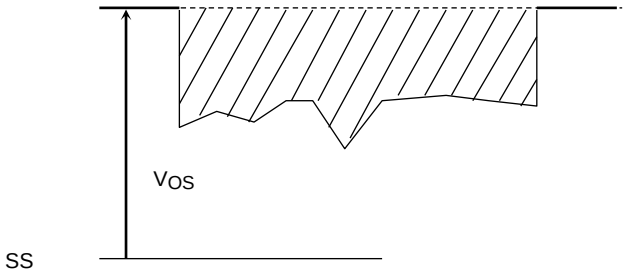
$$DR = \frac{V_{SAT}}{V_{MDK}}$$

V_{MDK} is proportional to t_{INT} (integration time). So the shorter integration time makes wider dynamic range.

Note 7: Definition of SE:

$$SE = \frac{V_{SAT}}{R}$$

Note 8: DC output signal voltage is defined as follows.



Recommended Operating Conditions (Ta = 25°C)

For best performance, the device should be used within the Recommended Operating Conditions.

Characteristic		Symbol	Min	Typ.	Max	Unit
Master clock pulse voltage	"H" level	$V_{\phi M}$	3.0	4.0	5.5	V
	"L" level		0	0	0.44	
Shift pulse voltage	"H" level	V_{SH}	3.0	4.0	5.5	V
	"L" level		0	0	0.44	
Integration clear pulse voltage	"H" level	V_{ICG}	3.0	4.0	5.5	V
	"L" level		0	0	0.44	
Digital power supply voltage		V_{DD}	3.0	4.0	5.5	V
Analog power supply voltage		V_{AD}	3.0	4.0	5.5	V

Note: $V_{AD} = V_{DD}$
max voltage of pulse voltage "H" level = $V_{DD} = V_{AD}$
min voltage of pulse voltage "H" level = $V_{DD} - 0.5\ V = V_{AD} - 0.5\ V$

Clock Characteristics (Ta = 25°C) ($V_{AD} = V_{DD} \geq 4.0$ V)

For best performance, the device should be used within the Recommended Operating Conditions.

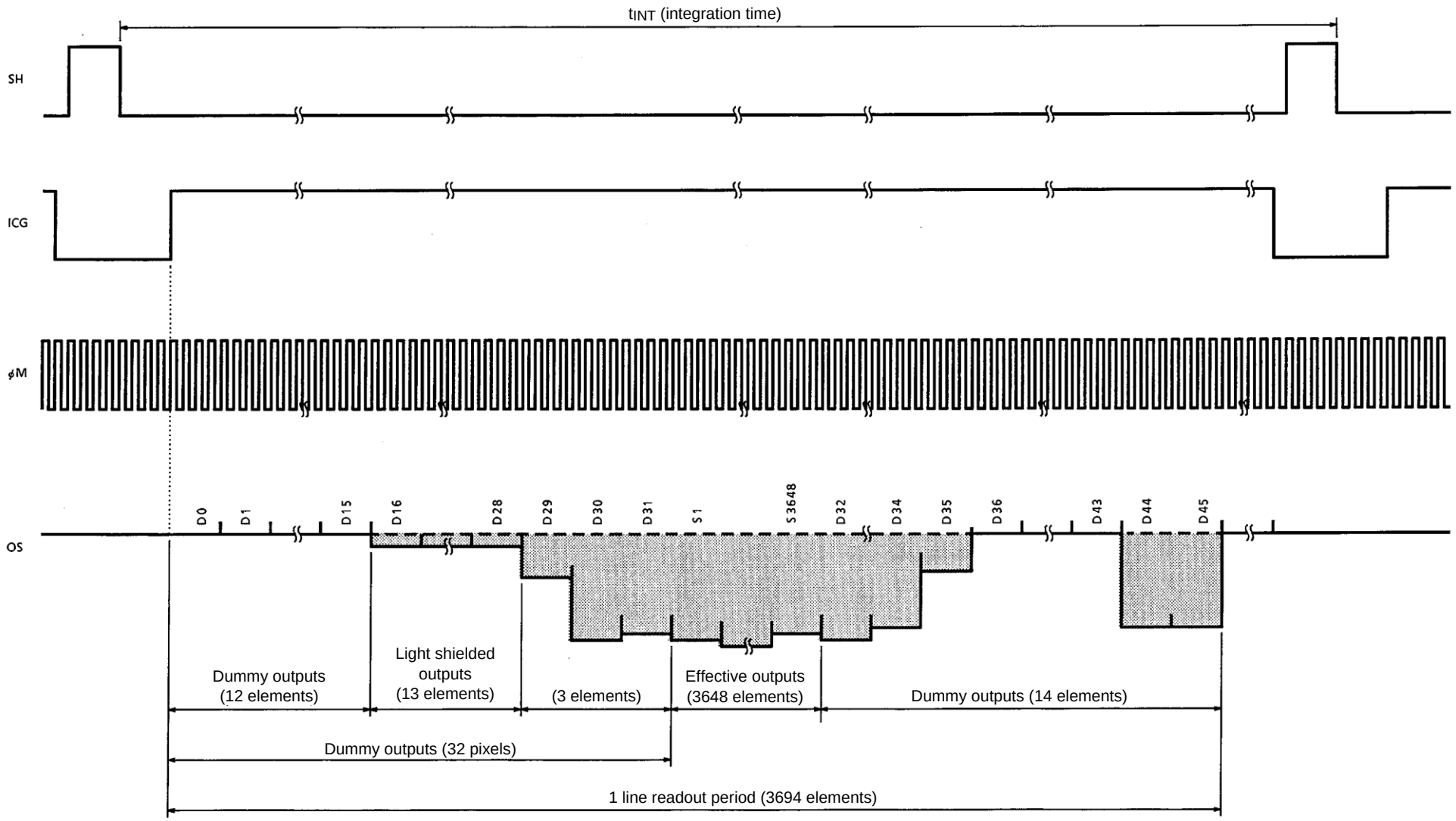
Characteristic	Symbol	Min	Typ.	Max	Unit
Master clock pulse frequency	$f_{\phi M}$	0.8	2.0	4.0	MHz
Data rate	f_{DATA}	0.2	0.5	1.0	MHz
Master clock capacitance	$C_{\phi M}$	—	10	—	pF
Shift gate capacitance	C_{SH}	—	600	—	pF
Integration clear gate capacitance	C_{ICG}	—	250	—	pF

Clock Characteristics (Ta = 25°C) (3.0 V ≤ $V_{AD} = V_{DD}$ < 4.0 V)

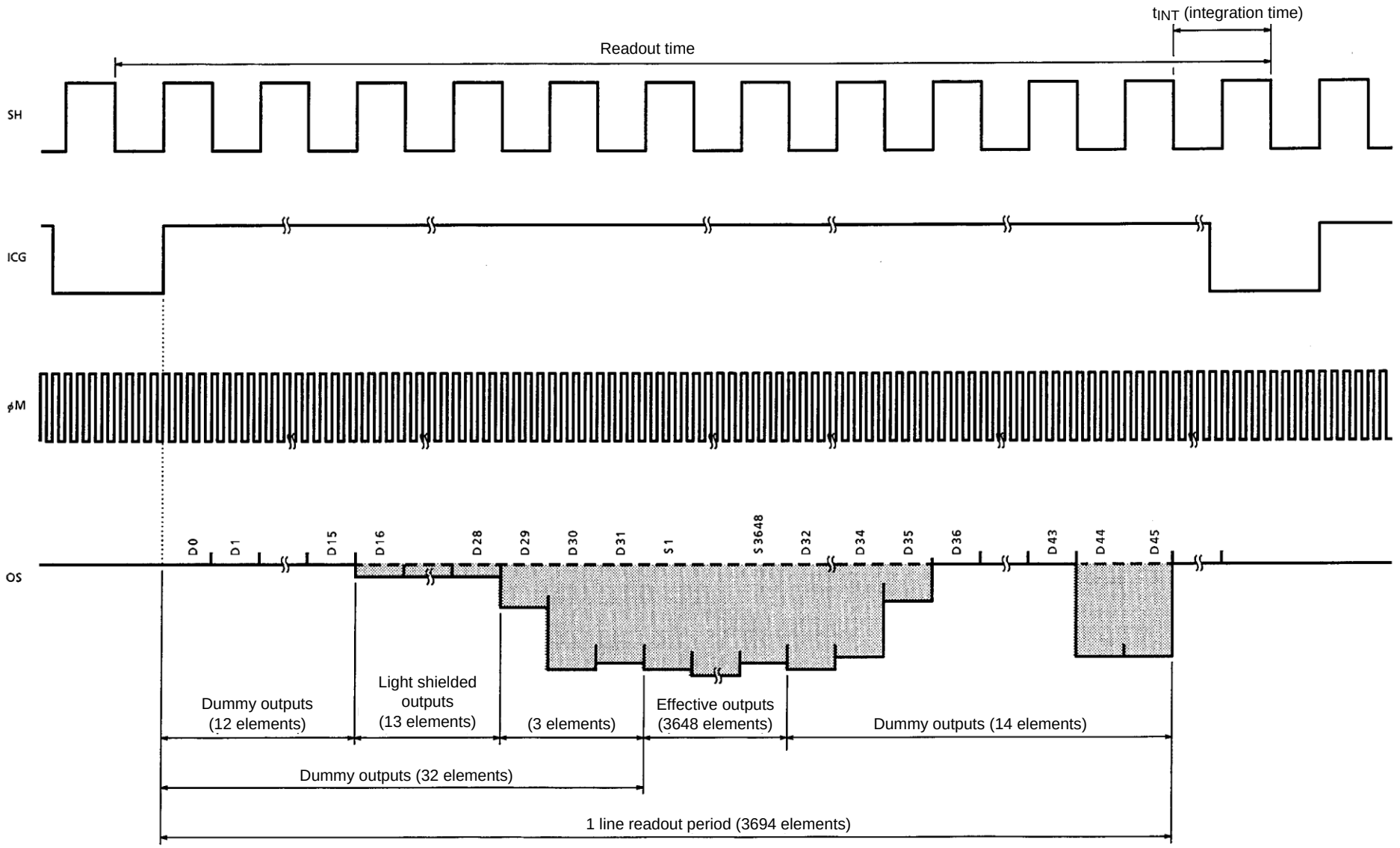
For best performance, the device should be used within the Recommended Operating Conditions.

Characteristic	Symbol	Min	Typ.	Max	Unit
Master clock pulse frequency	$f_{\phi M}$	0.8	2.0	2.4	MHz
Data rate	f_{DATA}	0.2	0.5	0.6	MHz

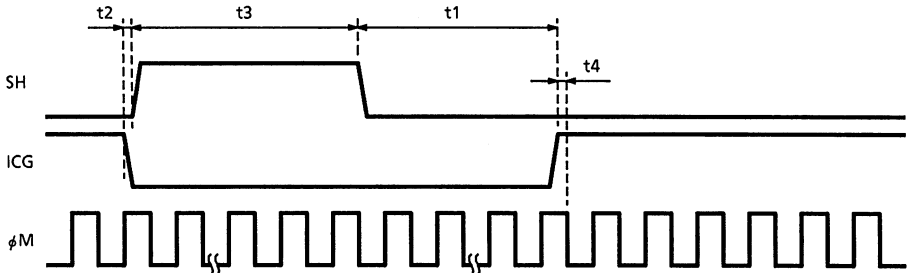
Timing Chart



Timing Chart (Use Electronic Shutter Function)



Timing Requirements



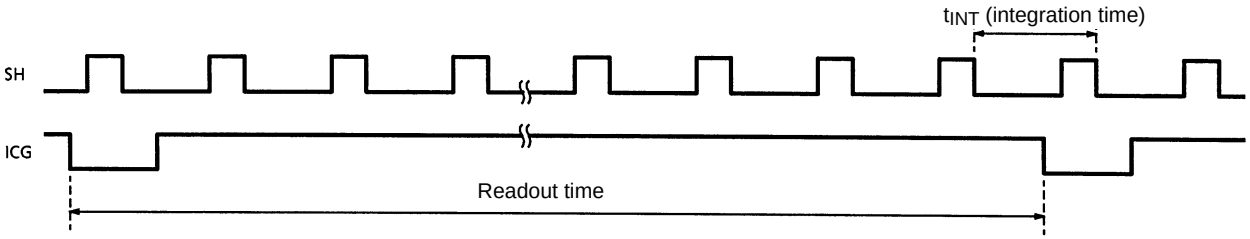
Characteristic	Symbol	Min	Typ.	Max	Unit
ICG pulse delay	t1	1000	5000	—	ns
Pulse timing of ICG and SH	t2	100	500	1000	ns
SH pulse width	t3	1000	—	—	ns
Pulse timing of ICG and ϕM	t4	0	20	*	ns

*: Keep the ϕM pin “H” level.

Use Electronic Shutter

Pulse timing of SH and ICG

- SH cycle = t_{INT}



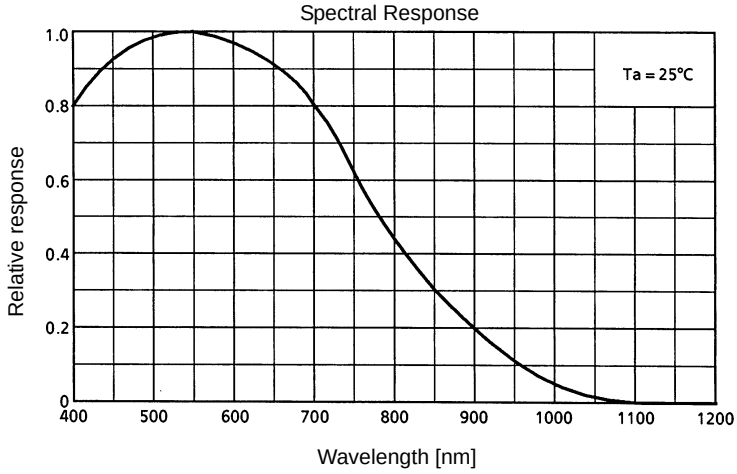
t_{INT} (min) = 10 μs

SH pulse width (t3) shold be kept constant.

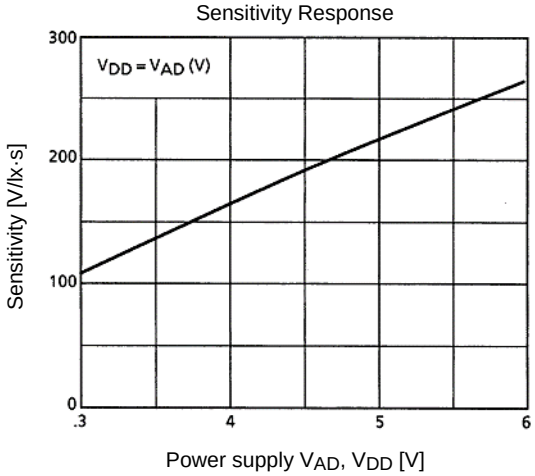
The illumination of light source must be less than 1000 times of the 450 mV output condition at t_{INT} = 10 ms.

Typical Perfomance Curves

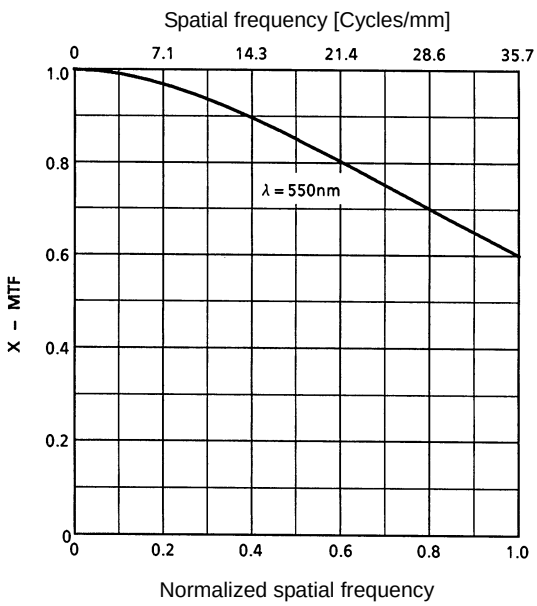
Spectral Response



Sensitivity Response

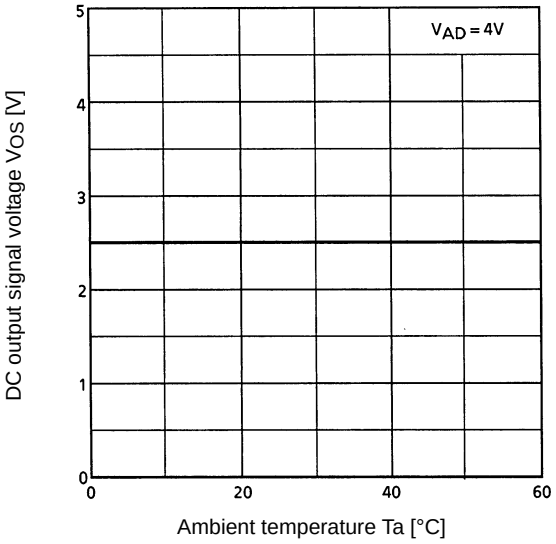


Modulation Transfer Function
of X-Direction

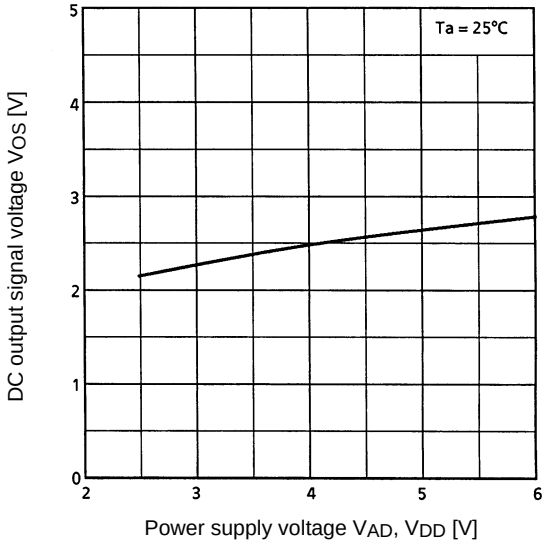


Typical Perfomance Curves

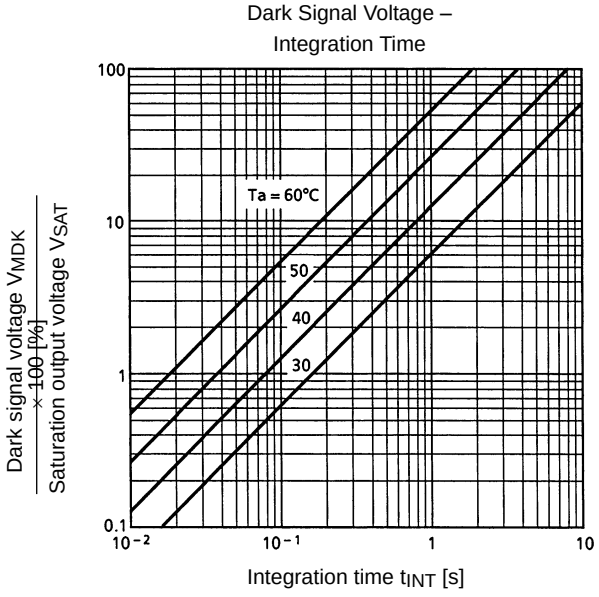
DC Output Signal Voltage –
Ambient Temperature



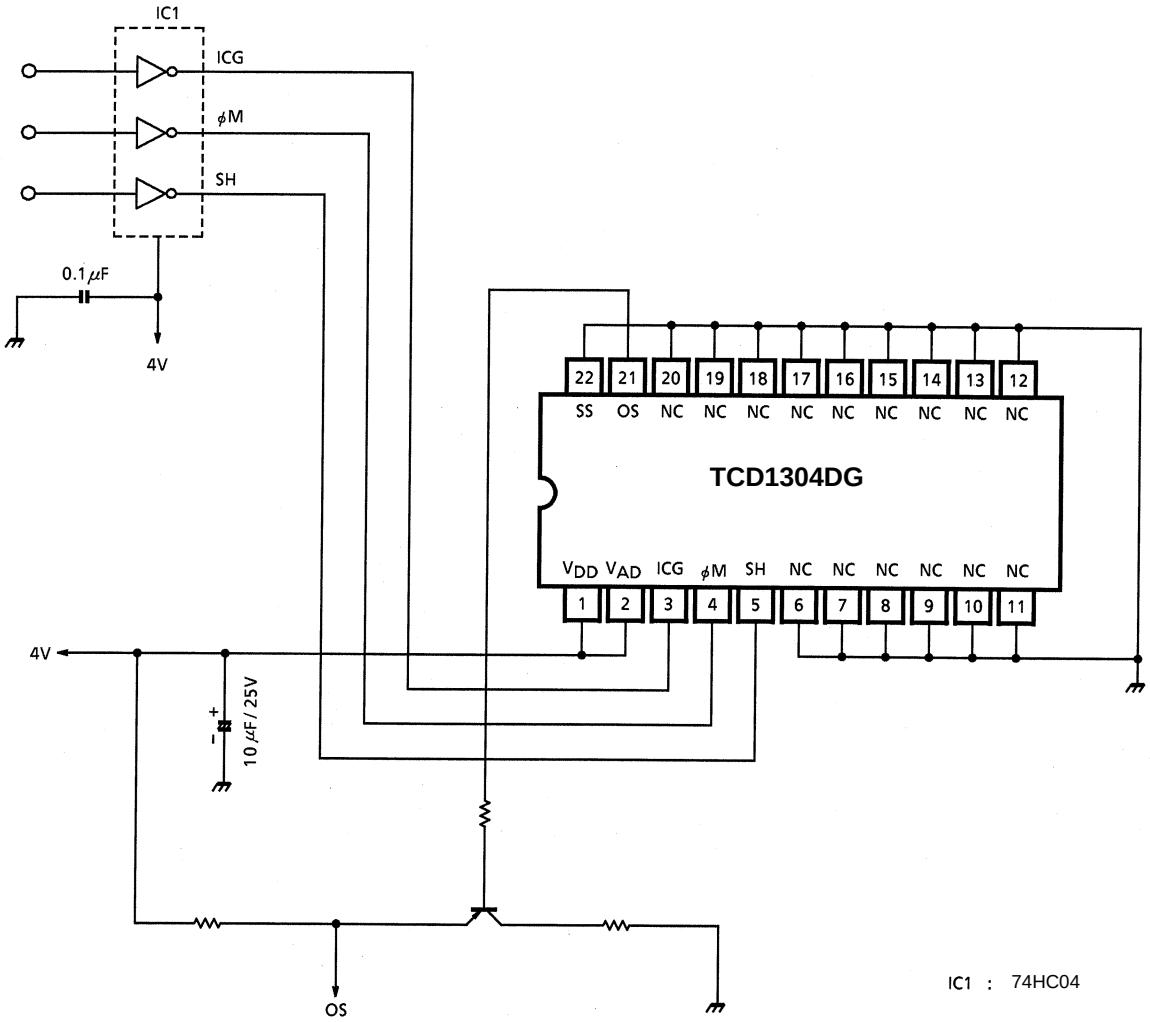
DC Output Signal Voltage –
Power Supply Voltage



Dark Signal Voltage –
Integration Time



Typical Drive Circuit



Cautions

1. Electrostatic Breakdown

Store in shorting clip or in conductive foam to avoid electrostatic breakdown.
CCD Image Sensor is protected against static electricity, but inferior puncture mode device due to static electricity is sometimes detected. In handing the device, it is necessary to execute the following static electricity preventive measures, in order to prevent the trouble rate increase of the manufacturing system due to static electricity.

a. Prevent the generation of static electricity due to friction by making the work with bare hands or by putting on cotton gloves and non-charging working clothes.
b. Discharge the static electricity by providing earth plate or earth wire on the floor, door or stand of the work room.
c. Ground the tools such as soldering iron, radio cutting pliers of or pincer.
d. Ionized air is recommended for discharge when handling CCD image sensors.

It is not necessarily required to execute all precaution items for static electricity.
It is all right to mitigate the precautions by confirming that the trouble rate within the prescribed range.

2. Window Glass

The dust and stain on the glass window of the package degrade optical performance of CCD sensor.
Keep the glass window clean by saturating a cotton swab in alcohol and lightly wiping the surface, and allow the glass to dry, by blowing with filtered dry N_2. Care should be taken to avoid mechanical or thermal shock because the glass window is easily to damage.

3. Incident Light

CCD sensor is sensitive to infrared light. Note that infrared light component degrades resolution and PRNU of CCD sensor.

4. Mounting on a PCB

This package is sensitive to mechanical stress.
TOSHIBA recommends using IC inserters for mounting, instead of using lead forming equipment.
Since this package is not strong against mechanical stress, you should not reform the lead frame.
We recommend to use an IC-inserter when you assemble to PCB.

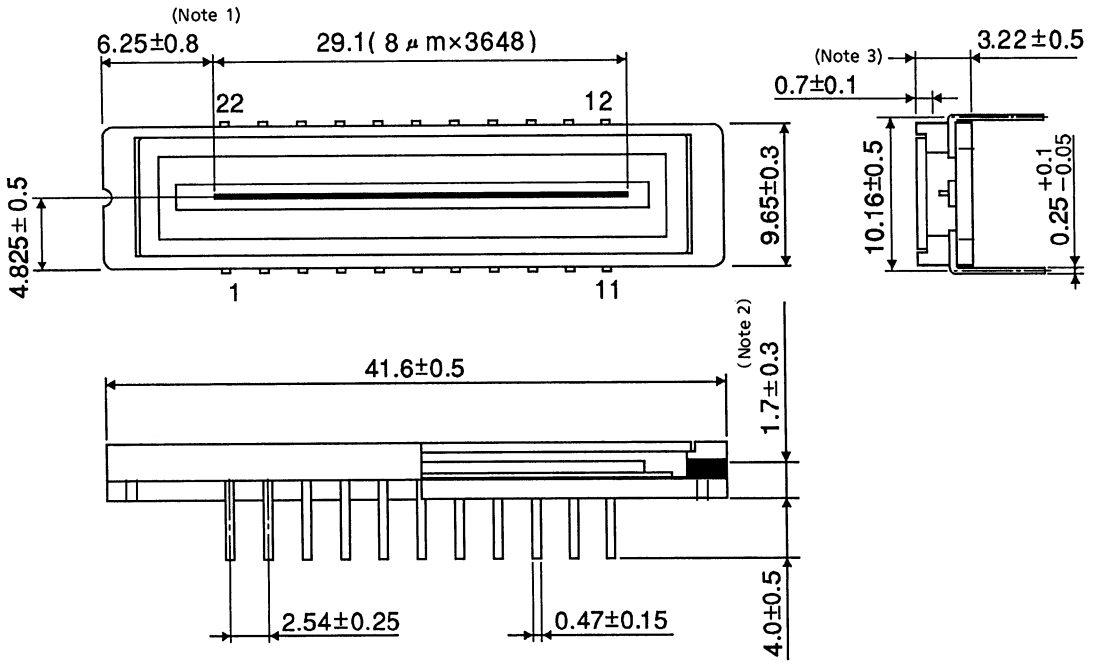
5. Soldering

Soldering by the solder flow method cannot be guaranteed because this method may have deleterious effects on prevention of window glass soiling and heat resistance.
Using a soldering iron, complete soldering within three seconds for lead temperatures of up to 350°C.

Package Dimensions

WDIP22-G-400-2.54H

Unit: mm



Note 1: Distance between the edge of the package and the first pixel (S1)
Note 2: Distance between the top of chip and bottom of the package
Note 3: Glass thickness (n = 1.5)

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