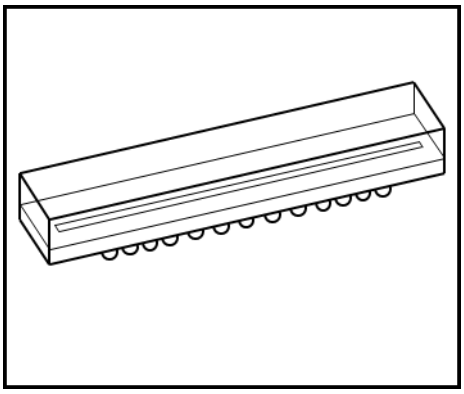
TOSHIBA CCD Linear Image Sensor　CCD (Charge Coupled Device)

TCD1256GAG

TOSHIBA CCD Linear Image Sensor　CCD (Charge Coupled Device)

TCD1256GAG



The TCD1256GAG is a high sensitive and low dark current 2500 elements CCD linear image sensor.

This device consists of sensitivity CCD chip.

The TCD1256GAG has electronic shutter function (ICG). Electronic shutter function can keep always output voltage constant that vary with intensity of lights.

Features

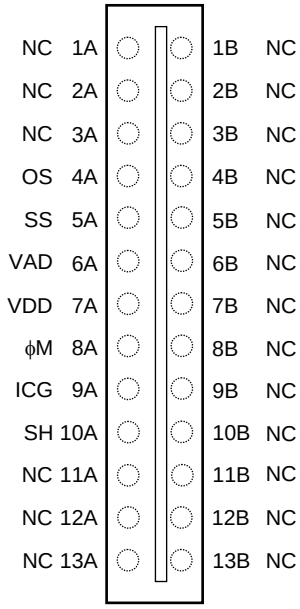
- Number of Image Sensing Elements: 2500 elements
- Image Sensing Element Size: 5.25 μm by 64 μm on 5.25 μm center
- Photo Sensing Region: High sensitive PN photodiode
- Power Supply Voltage: 3.0 V (min)
- Internal Circuit: CCD drive circuit
- Package: 26 pin WCSP
- Function: Electronic shutter, Sample and hold circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

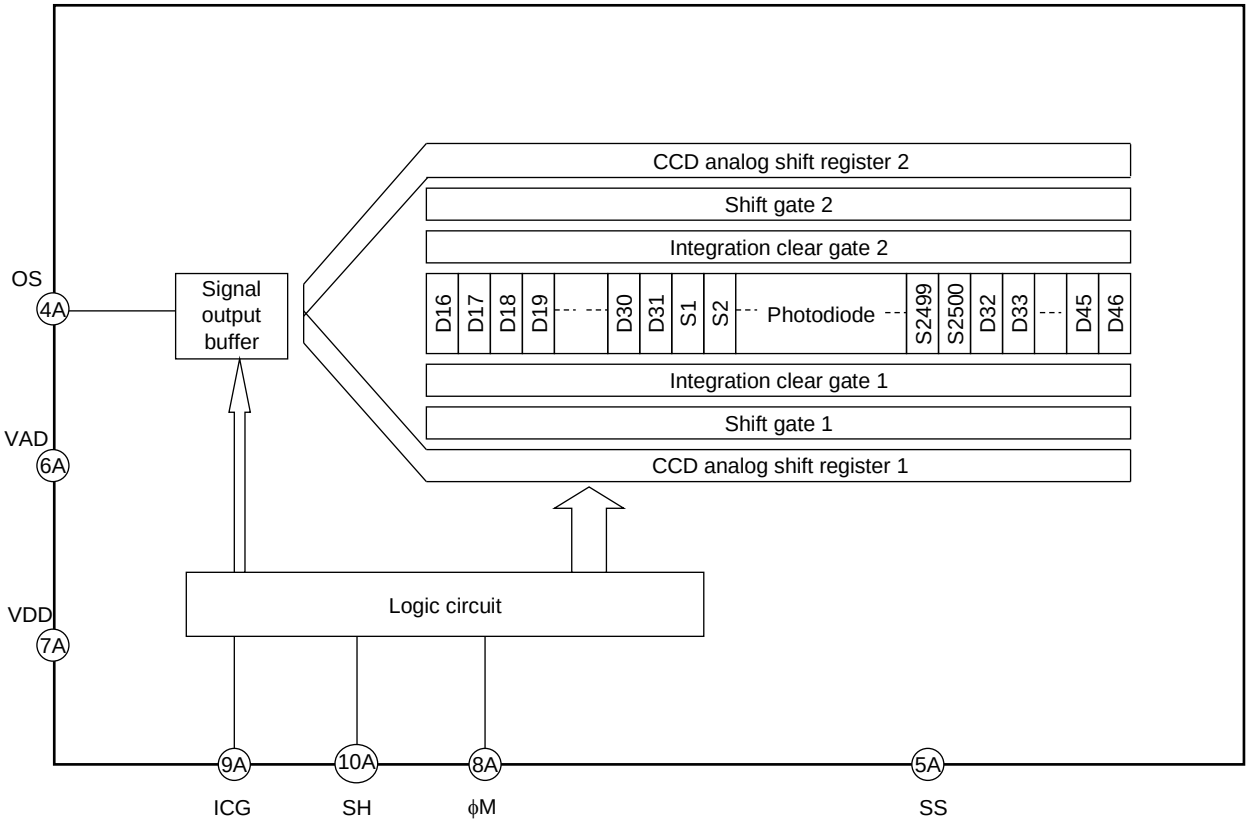
Characteristic	Symbol	Rating	Unit
Master clock pulse voltage	$V_{\phi M}$	−0.3 to +7.0	V
Shift pulse voltage	V_{SH}		
Integration clear pulse voltage	V_{ICG}		
Digital power supply voltage	V_{DD}		
Analog power supply voltage	V_{AD}		
Operating temperature	T_{opr}	−25 to +60	°C
Storage temperature	T_{stg}	−40 to +85	°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
1A	NC	Non Connection	1B	NC	Non Connection
2A	NC	Non Connection	2B	NC	Non Connection
3A	NC	Non Connection	3B	NC	Non Connection
4A	OS	Output signal	4B	NC	Non Connection
5A	SS	Ground	5B	NC	Non Connection
6A	VAD	Power supply (Analog)	6B	NC	Non Connection
7A	VDD	Power supply (Digital)	7B	NC	Non Connection
8A	ϕM	Master clock	8B	NC	Non Connection
9A	ICG	Integration clear gate	9B	NC	Non Connection
10A	SH	Shift gate	10B	NC	Non Connection
11A	NC	Non Connection	11B	NC	Non Connection
12A	NC	Non Connection	12B	NC	Non Connection
13A	NC	Non Connection	13B	NC	Non Connection

Remark: Leave NC (Pin No. 1A to 3A, 11A to 13A, 1B to 13B) unconnected.

Optical/Electrical Characteristics

Ta = 25°C, V_{AD} = V_{DD} = 4 V, V_{ϕ} = 4 V (pulse), $f_{\phi M}$ = 2.0 MHz (data rate = 1.0 MHz), tINT (integration time) = 10 ms, light source = daylight fluorescent lamp

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
Sensitivity	R	72	103	—	V/lx·s	(Note 2)
Photo response non uniformity	PRNU	—	—	10	%	(Note 3)
Register imbalance	RI	—	1.5	3.0	%	(Note 4)
Saturation output voltage	V_{SAT}	0.7	1.0	—	V	(Note 5)
Saturation exposure	SE	—	0.01	—	lx·s	(Note 6)
Dark signal voltage	V_{MDK}	—	2.5	15.0	mV	(Note 7)
DC power dissipation	P_D	—	24	60	mW	—
Total transfer efficiency	TTE	92	95	—	%	(Note 8)
Low voltage total transfer efficiency	LVTTE	92	95	—	%	(Note 9)
		83	88	—	%	(Note 10)
Output impedance	Z_O	—	0.5	1.0	kΩ	—
DC output signal voltage	V_{OS}	1.5	2.3	3.0	V	(Note 11)
Dynamic range	DR	—	400	—	—	(Note 12)

Note 2: Sensitivity is defined for signal outputs average when the photosensitive surface is applied with the light of uniform illumination and uniform color temperature.

Note 3: PRNU is defined for a single chip by the expressions below when the photosensitive surface is applied with the light of uniform illumination and uniform color temperature, where measured approximately 500 mV of signal output.

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

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

Note 4: Register imbalance is defined as follows.

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

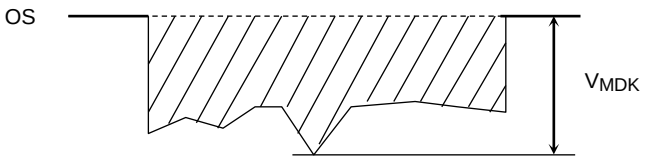
$\overline{X}$: Average of total signal outputs
ΔY: | average of odd effective signal outputs – average of even effective signal outputs |

Note 5: V_{SAT} is defined as the minimum saturation output voltage of all effective pixels.

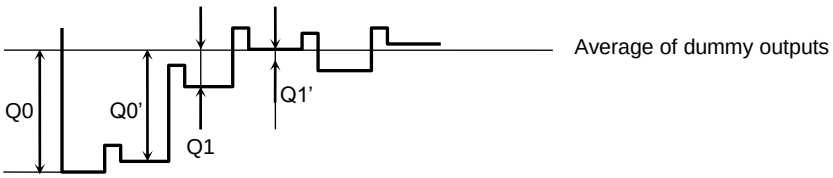
Note 6: Definition of SE:

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

Note 7: V_{MDK} is defined as the maximum dark signal voltage of all effective pixels.



Note 8: Total transfer efficiency is defined as follows.
* Q0 = 500 mV



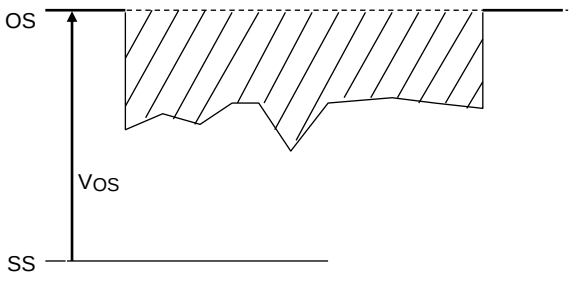
$$TTE = \frac{Q0}{Q0 + Q1} \times 100$$

Use Q0' and Q1' instead of Q0 and Q1 if Q1' > Q1.

Note 9: Definition of low voltage total transfer efficiency is the same as Note 8 except power supply and Q0 conditions.
* 4 V ≤ Power supply ≤ 5 V
* Q0 = 50 mV

Note 10: Definition is the same as Note 9 except the power supply condition.
* 3 V ≤ Power supply < 4 V

Note 11: DC output signal voltage is defined as follows.



Note 12: 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.

Recommended Operating Conditions (Ta = 25°C)

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

Characteristics		Symbol	Min	Typ.	Max	Unit	Note
Master clock pulse voltage	"H" level	$V_{\phi M}$	3.0	4.0	5.0	V	(Note 13)
	"L" level		0	0	0.44		
Shift pulse voltage	"H" level	V_{SH}	3.0	4.0	5.0	V	(Note 13)
	"L" level		0	0	0.44		
Integration clear pulse voltage	"H" level	V_{ICG}	3.0	4.0	5.0	V	(Note 13)
	"L" level		0	0	0.44		
Power supply voltage (Digital)		V_{DD}	3.0	4.0	5.0	V	(Note 14)
Power supply voltage (Analog)		V_{AD}	3.0	4.0	5.0	V	(Note 14)

Note 13: "H" level of the maximum pulse voltage = $V_{DD} \geq V_{DD} - 0.5$ V = "H" level of the minimum pulse voltage.

Note 14: $V_{AD} = V_{DD}$

Clock Characteristics (Ta = 25°C) (3.0 V ≤ V_{AD} = V_{DD} ≤ 5.0 V)

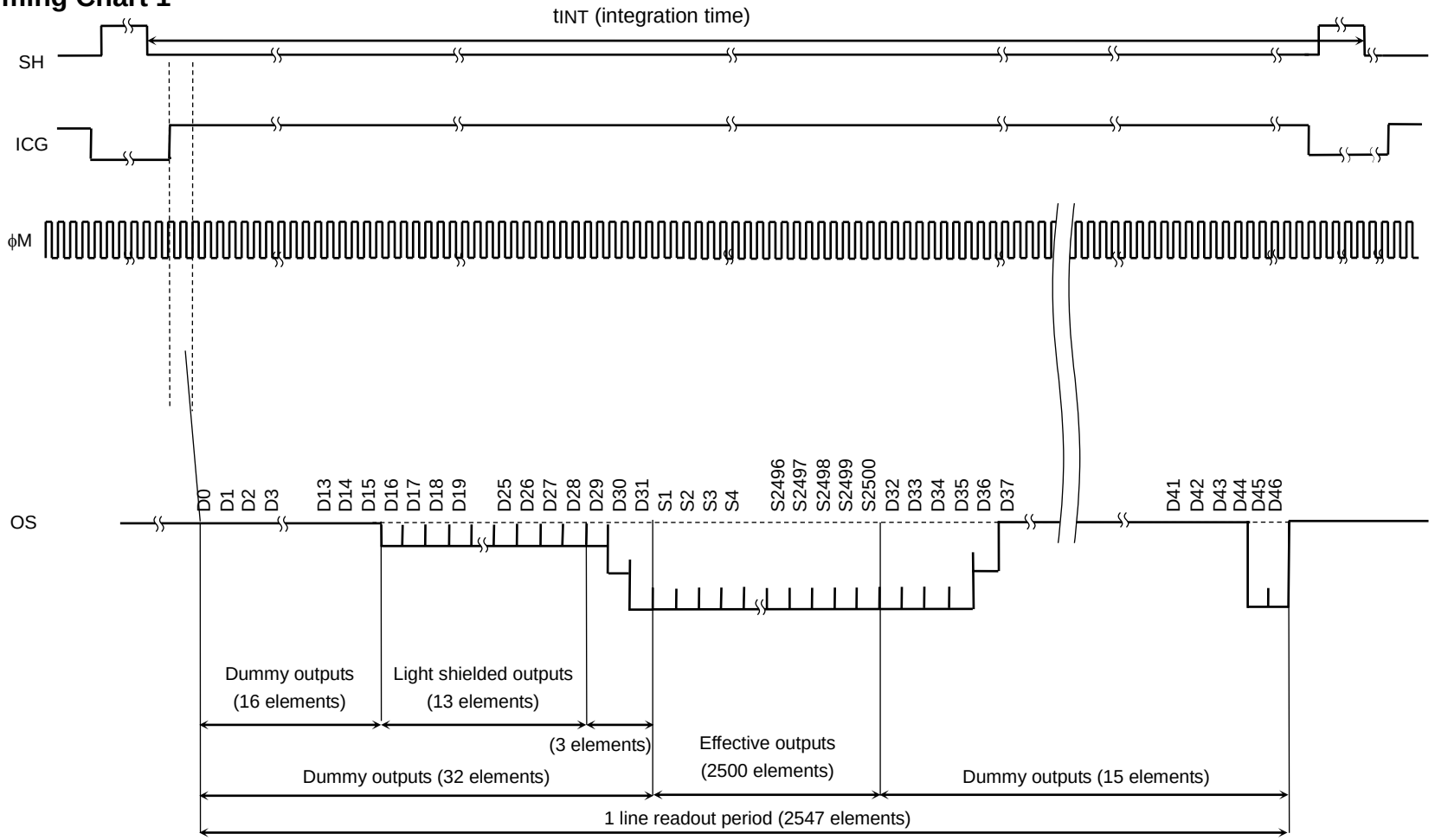
For best performance, the device should be used within the Recommended Operating Conditions.

Characteristics	Symbol	Min	Typ.	Max	Unit
Master clock pulse frequency	$f_{\phi M}$	0.4	2.0	4.0	MHz
Data rate	f_{DATA}	0.2	1.0	2.0	MHz
Master clock capacitance	$C_{\phi M}$	—	10	—	pF
Shift gate capacitance	C_{SH}	—	200	—	pF
Integration clear gate capacitance	C_{ICG}	—	50	—	pF

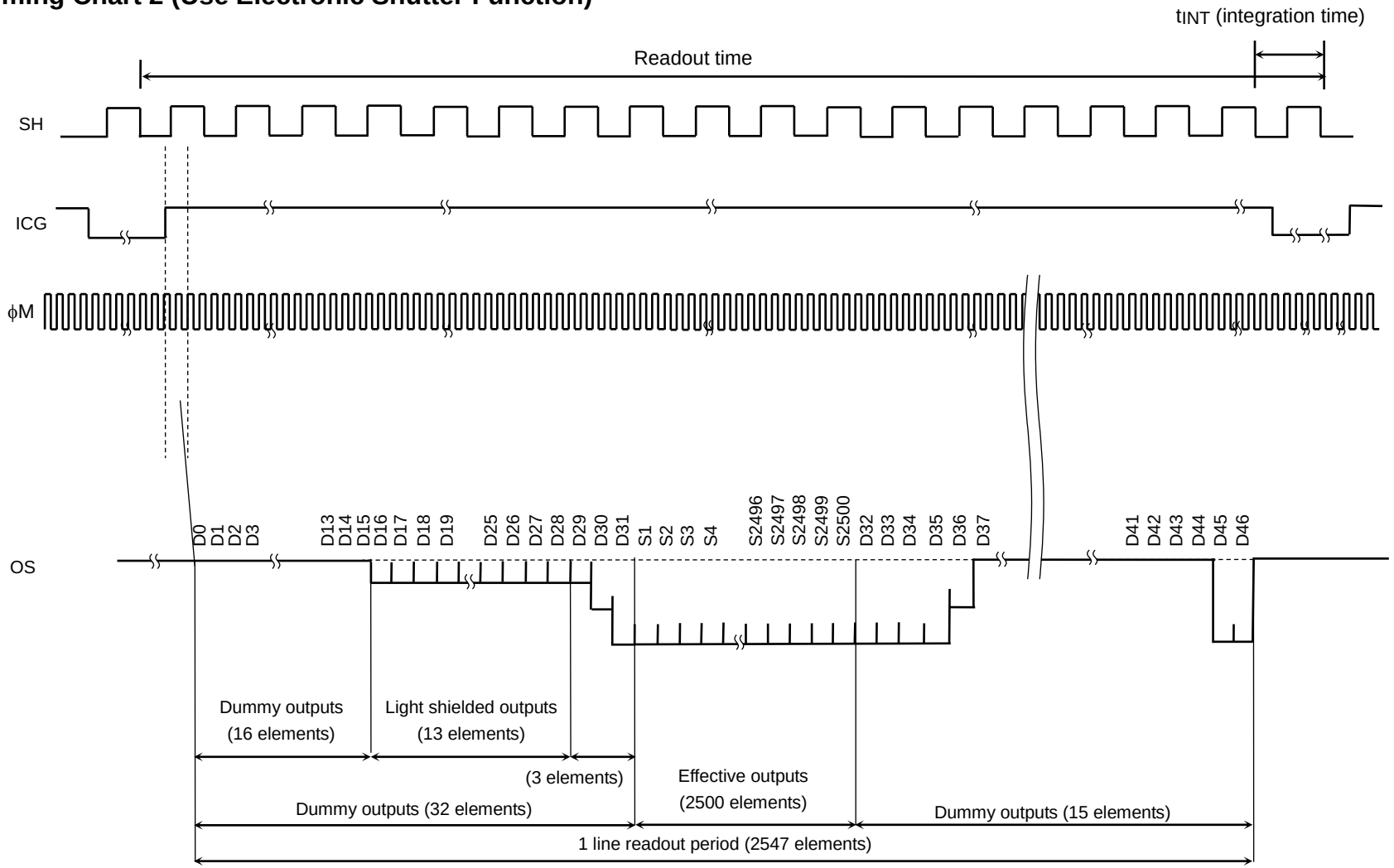
Power on sequence

CCD sensor has a characteristic that a proper output signal will come out after the power supply voltage reaches to the certain voltage level. It is required to wait for 10 cycles or more read out time after the power supply voltage reaches to the certain voltage. This characteristic should be considered for scanner system designs.

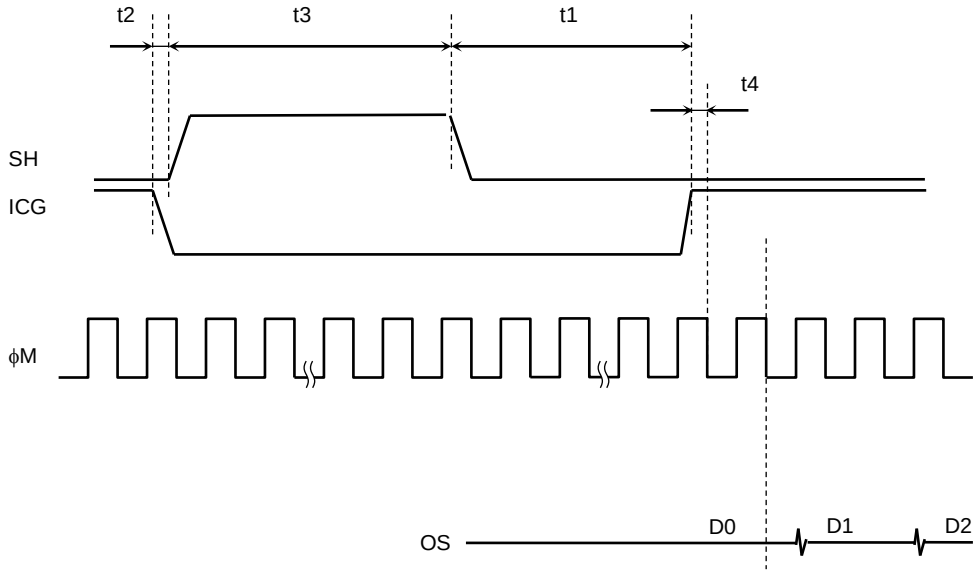
Timing Chart 1



Timing Chart 2 (Use Electronic Shutter Function)



Timing Requirements

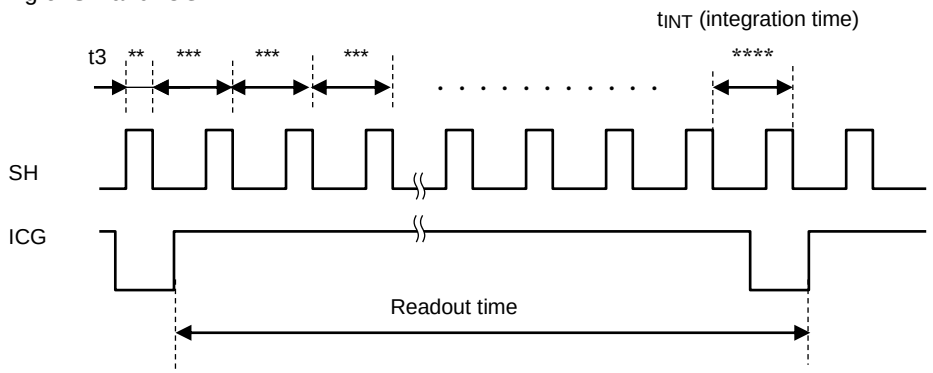


Characteristics	Symbol	Min	Typ.	Max	Unit
ICG pulse delay	t1	1000	5000	—	ns
Pulse timing of ICG and SH	t2	100	500	1000	ns
Shift pulse width	t3	1000	—	—	ns
Pulse timing of ICG and ϕM	t4	0	20	*	ns

*: To keep ϕM “H“ level when ICG switch from “L” to “H” level.

Use electronic shutter

Pulse timing of SH and ICG



** : Each SH high pulse have to keep always the same value with “t3“. (t3 ≥ 1000 ns (min))

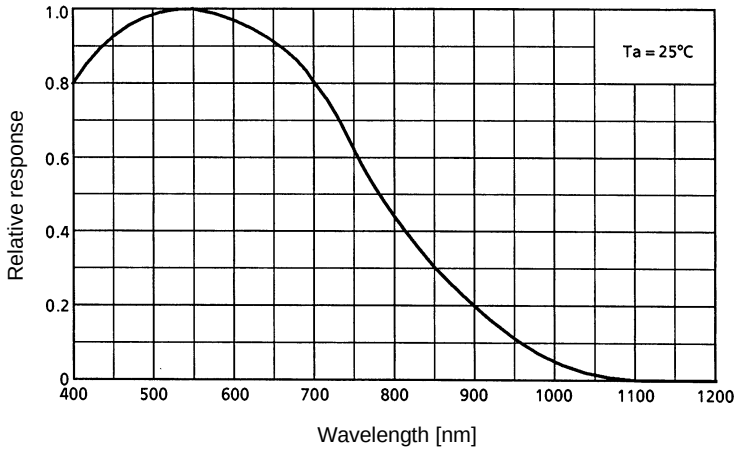
*** : SH pulse cycle have to keep the same cycle (SH cycle period ≥ 10 μs) except t_{INT} period.

**** : t_{INT} ≥ 10 μs (min)

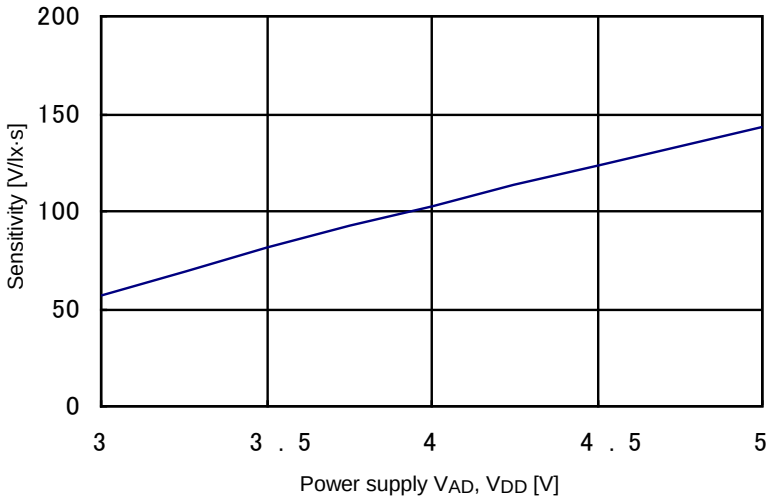
Note: The illumination of light source must be used with less than 1000 times based on 0.7 V signal output with 10 ms t_{INT}.

Typical Performance Curves

Spectral Response

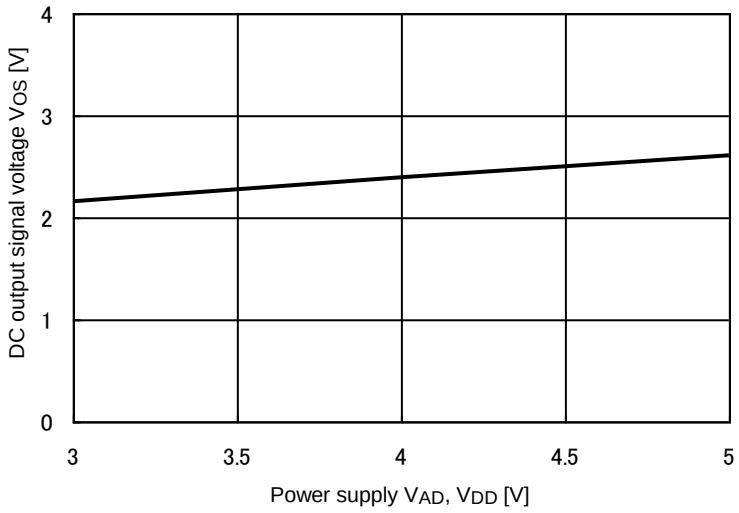


Sensitivity Response

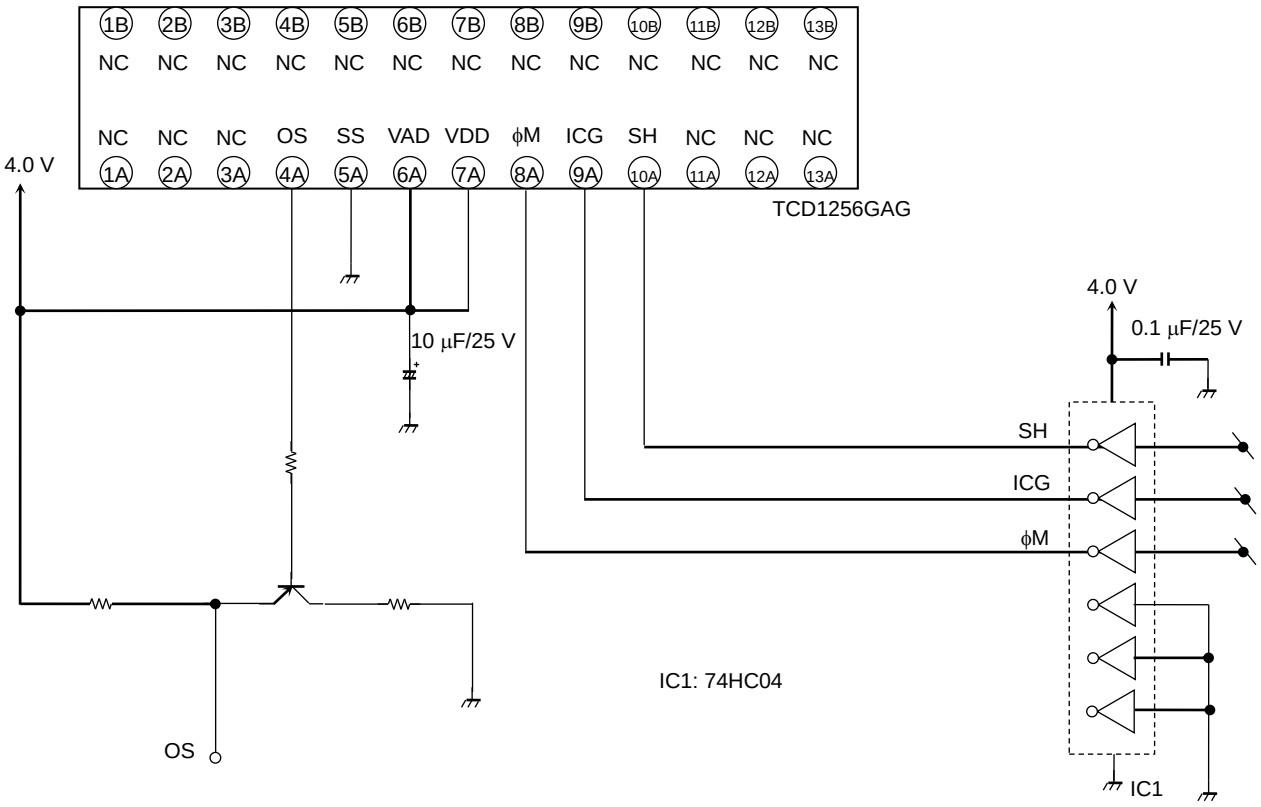


Typical performance curves

DC Output Signal Voltage –
Power Supply Voltage



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 cutting pliers, tweezers or pincer.
d. When the product is handed, please use tweezers to avoid the damage of CCD image sensor.
e. Ionizer 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. Incident Light

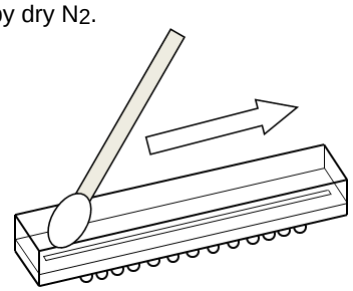
CCD sensor is sensitive to infrared light. Note that infrared light component degrades resolution and PRNU of CCD sensor.

3. Cleaning Method of the Window Glass Surface

Wiping tool
- Swab

Cleaner
- IPA

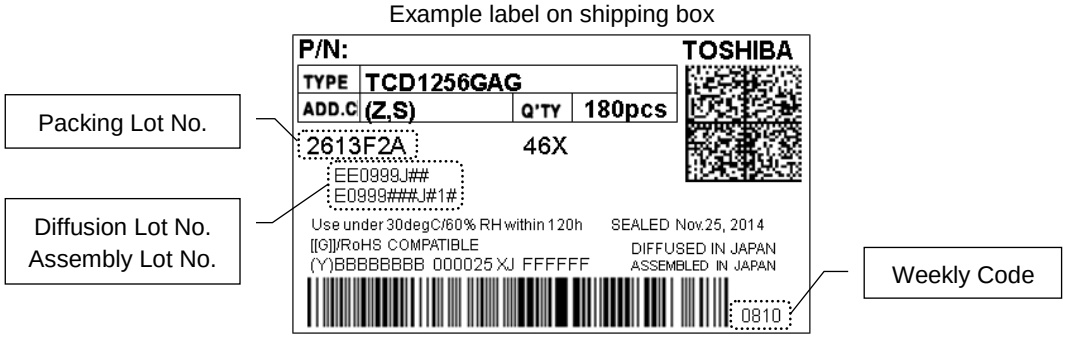
Way of cleaning
1. The surface of window glass is wiped with the wiping tool into which the cleaner was infiltrated. Please wipe down the surface of window glass at least 2 times or more.
2. Please wipe down the surface of window glass at least 3 times or more with the dry wiping tool.
3. Blow cleaning is performed by dry N_2.



4. Product Traceability

The product has TOSHIBA logo and product number on a silicon chip surface and bottom side of the package, but no unique IDs (ex. Diffusion/Assembly/Packing Lot No., Weekly Code) are marked on it. The product IDs are printed on a label on each shipping box, and it is highly recommended customers to tie up the product IDs and customer's scanner product one by one to ensure the product traceability.

Example label on shipping box

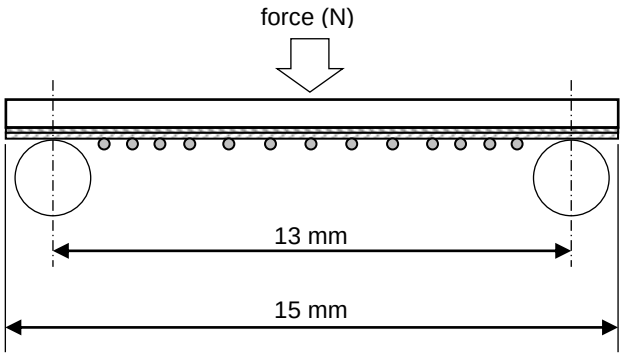


5. Caution for Package Handling

Over force on the product may cause sensor chip or glass crack. The three point bending strength of this product is the following. (Reference data)
If the stress is loaded far from a fulcrum, the stress on the package will be increase.
When you will treat CCD on every process, please be careful particularly. For example, soldering on PCB, cutting PCB, cleaning the glass surface, optical assemble and so on.

Bending Test

Bearing length 13 mm: The force from upside: 4.0 [N]



The Standard Reflow Condition for WCSP (Surface Mount Device)

1. Storage Precautions

1) CCD surface mount products may have a haze on the inside of glass, so be careful about following. Even if the haze arises inside of glass, when it is not on the pixel area, there is no problem in quality.
2) Do not drop or toss device packaging. The laminated aluminum material in it can be rendered ineffective by rough handling.
3) Ensure devices should be stored in a 30°C·85 %RH or better environment. Use devices within 12 months; do not store them longer than that.
4) In the following cases, in order to remove humidity from a device, bake for 20 hours at 125°C. When a "30 % humidity indicator" has become pink after the package opened, or when the effective period of the indicator has passed.
5) Prevent destruction of the device by static electricity in the case of the bake processing for removing humidity.
6) After opening moisture-proof packing, store a product in 30°C·60 %RH or better environment and use them within five days. If the effective usage period passed after opening the moisture-proof packing, baking should be done before use at 125°C for 20 hours.

2. Mounting Conditions Using Reflow

1)	Mounting method:	(a) Hot air reflow
		(b) Infrared ray reflow
2)	Preheating condition:	150 to 180°C, 60 to 120 s
3)	Reflow condition:	(a) Maximum 240°C
		(b) Over 230°C, within 30 to 50 s
4)	Heating times:	Only 1 time

* The temperature profile is specified in terms of the temperature of top surface of the device.
This temperature profile shows the maximum guaranteed device temperature. Please set up the optimum temperature profile conditions within the fig.1 profile.

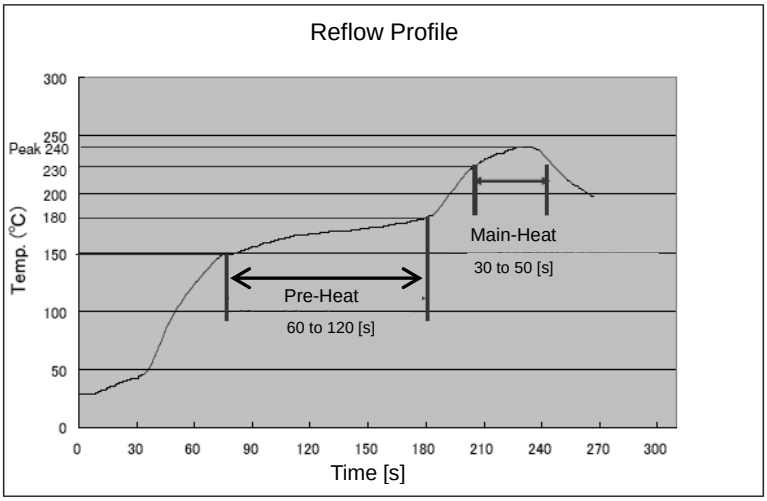


fig.1 Example of recommended temperature profile for reflows

In addition, in case of the repair work accompanied by IC removal, since the degree of parallel may be spoiled with the left solder, please do not carry out.

3. Land Pattern of PCB

We recommend fig.2's land pattern for your PCB (Printed Circuit Board).
Land pattern on the PCB substrate shall be the same as the ball layout of TCD1256GAG.

- Diameter of land pattern: ϕ0.25 mm
- Thickness of metal mask: 0.1 mm
- Recommended open aperture ratio of metal mask: 100 %

Unit: mm

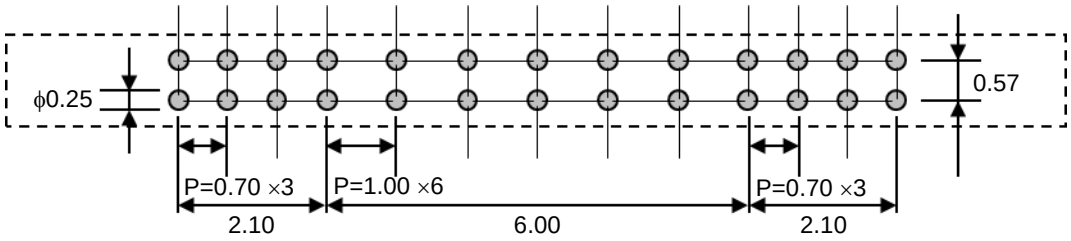
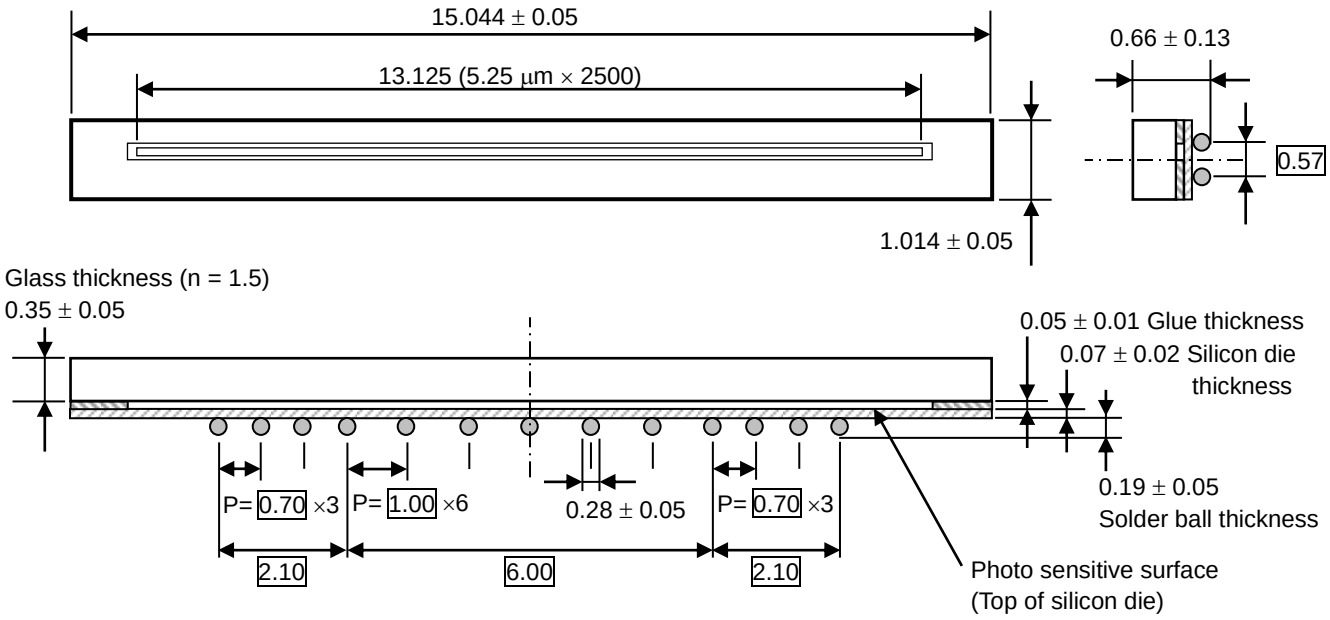


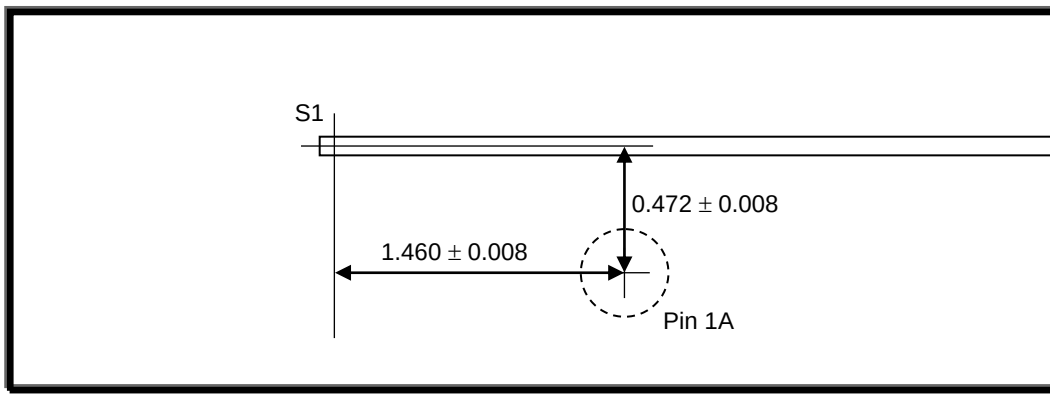
fig.2

Package Dimensions

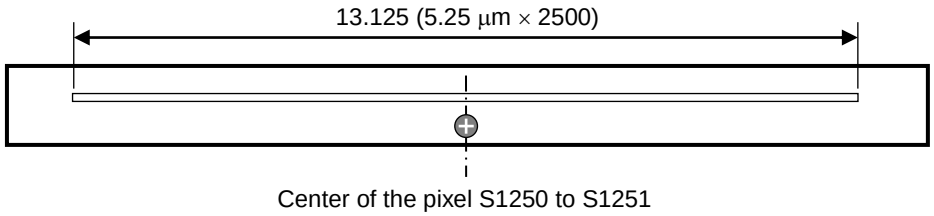
26pin WCSP Unit: mm



Center of sensor pixel (S1) to center of pin 1A (NC) (Top view)



Center mark of valid pixel array (Top view)



RESTRICTIONS ON PRODUCT USE

Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as “TOSHIBA”.
Hardware, software and systems described in this document are collectively referred to as “Product”.

- TOSHIBA reserves the right to make changes to the information in this document and related Product without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, lifesaving and/or life supporting medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, and devices related to power plant. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**