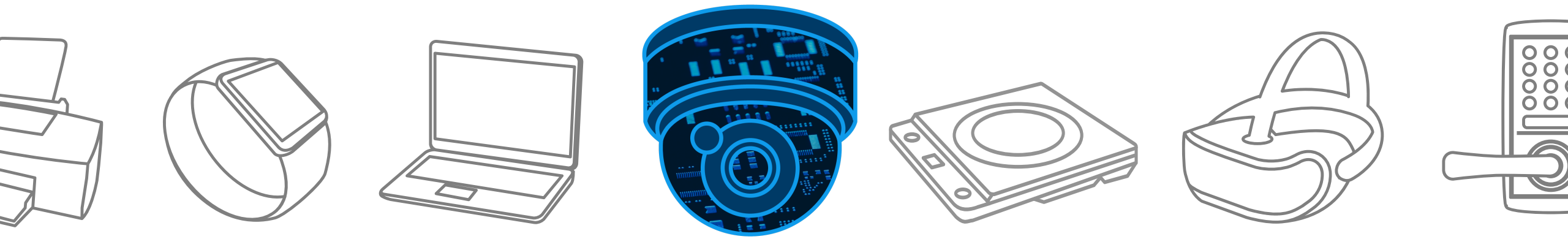
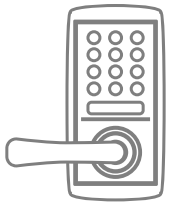
TOSHIBA

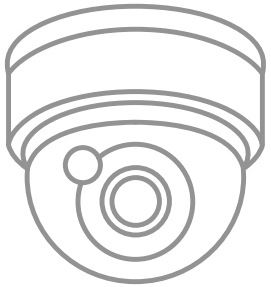
R23

Surveillance Camera

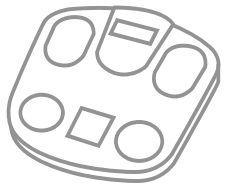
Solution Proposal by Toshiba



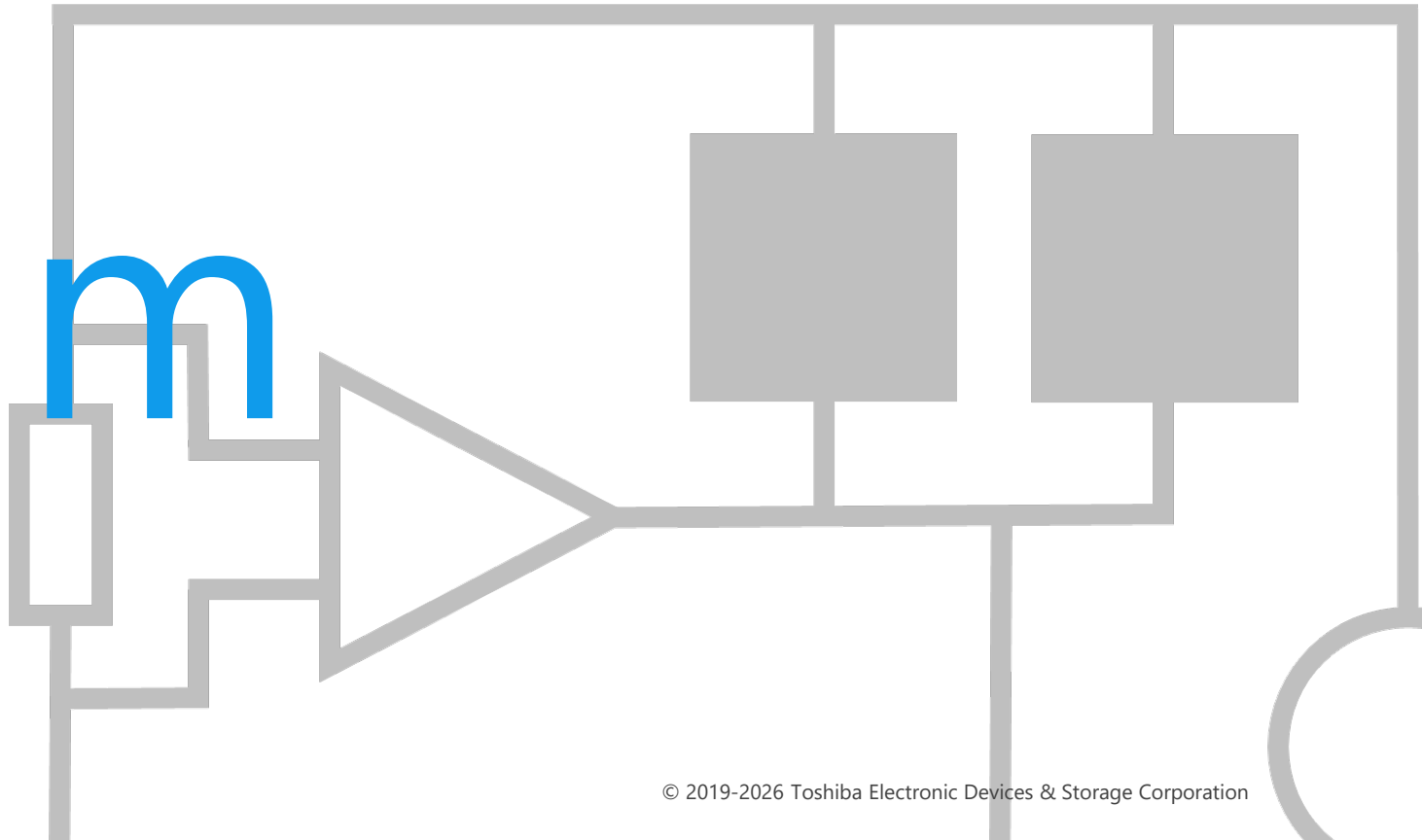




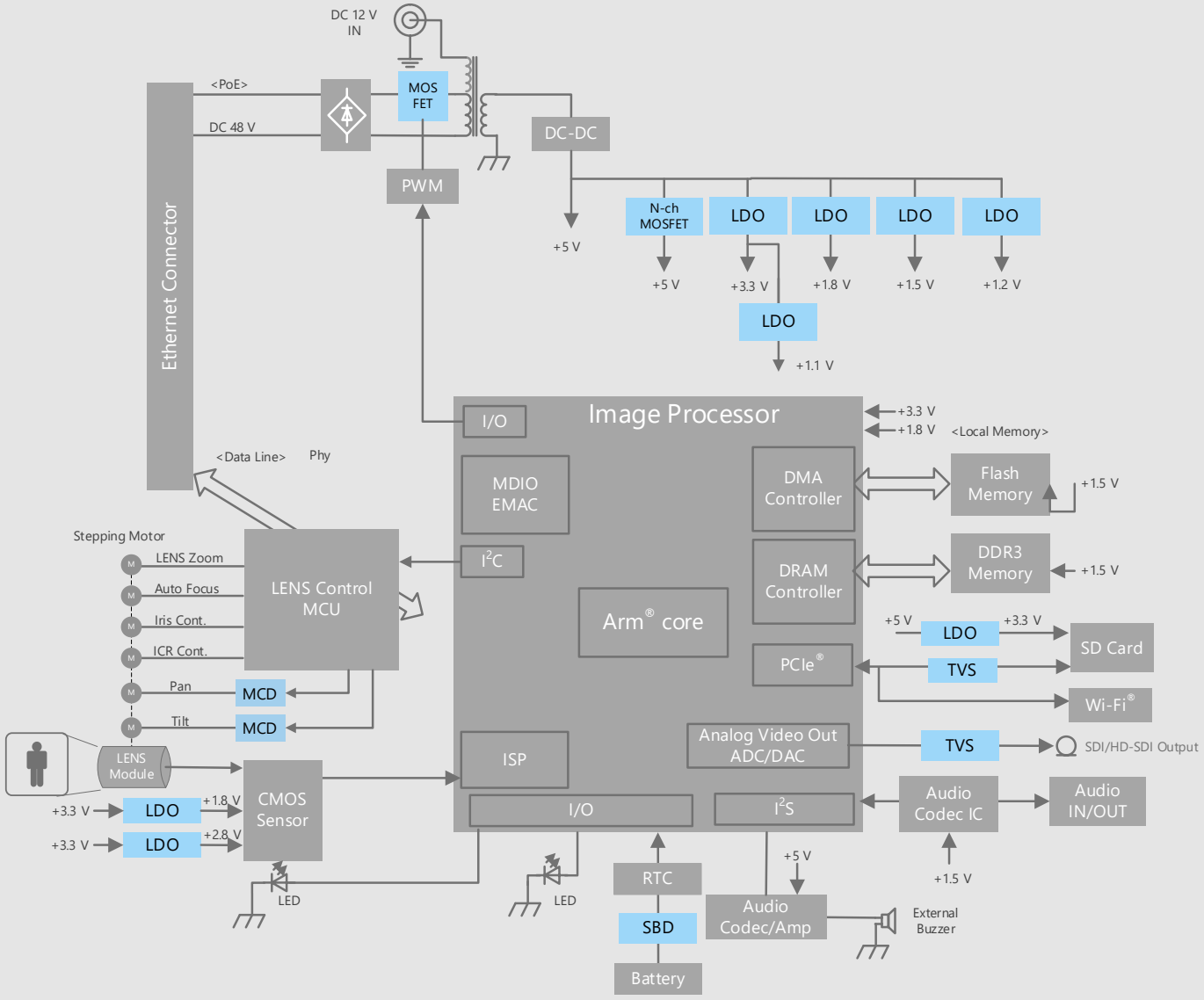
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

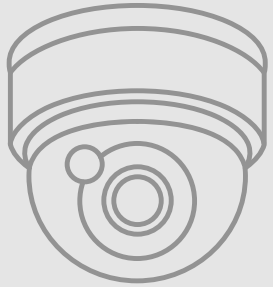


Block Diagram

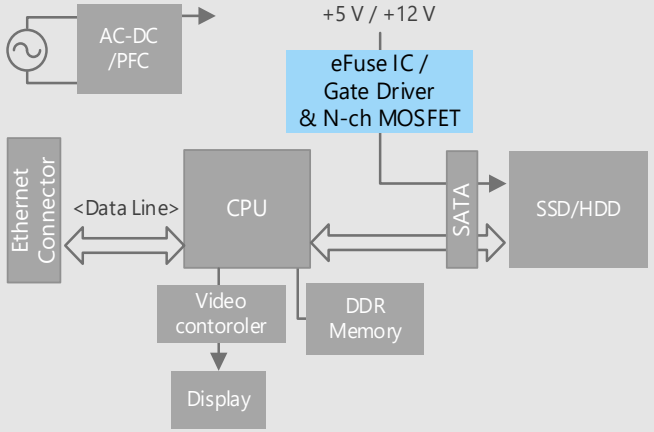


Surveillance Camera　Overall block diagram



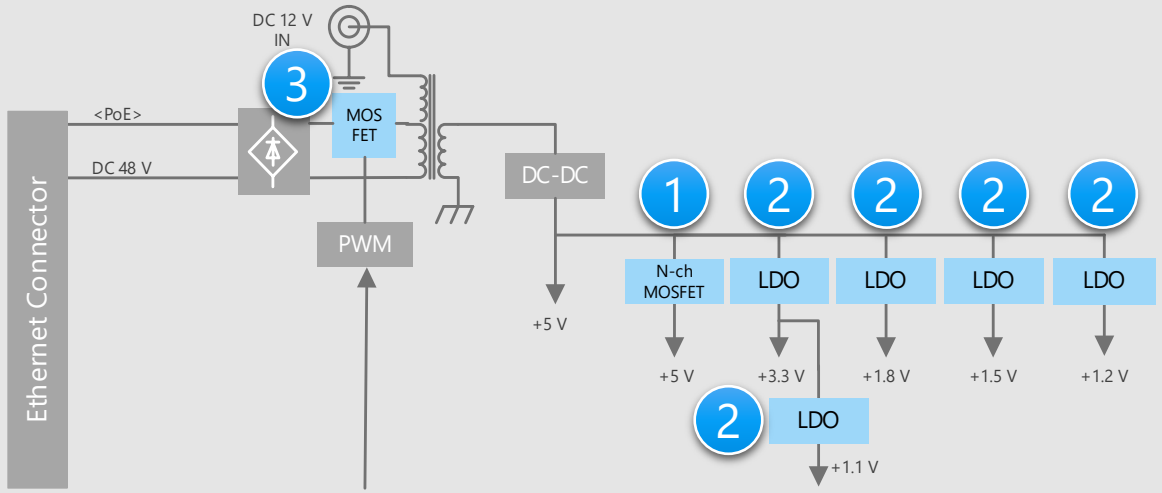


Recorder unit

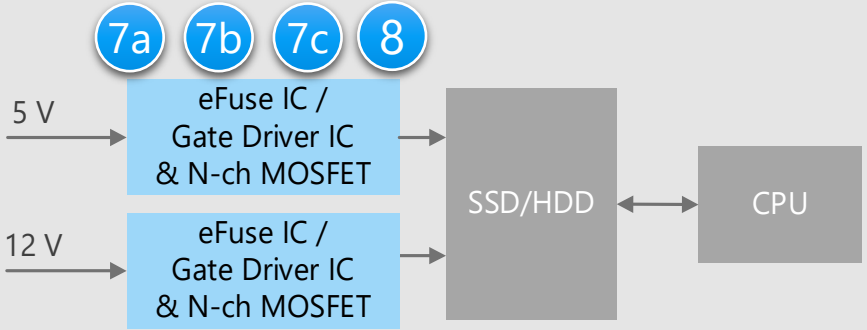


Surveillance Camera　Detail of power supply section (1)

Power supply



Power supply circuit of storage



* Click the number in the circuit diagram to jump to the detailed description page

Criteria for device selection

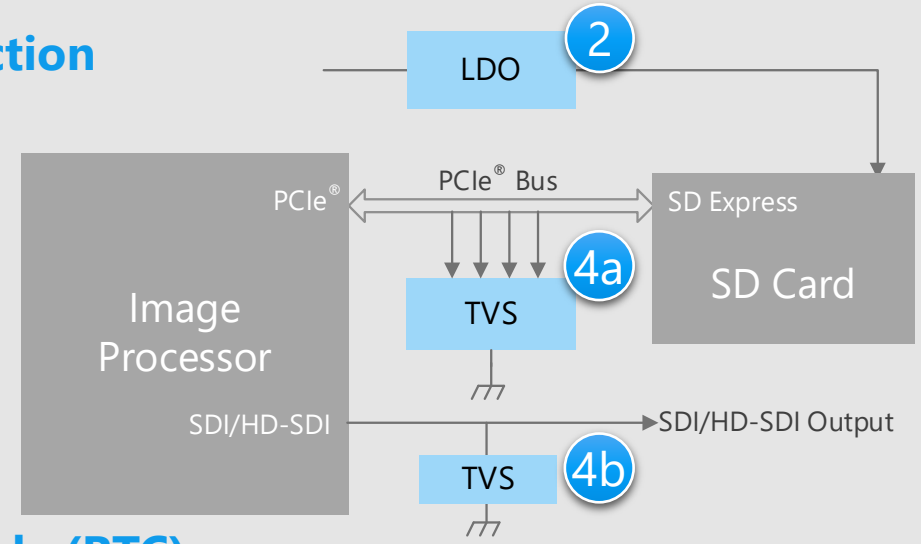
- MOSFETs with high speed and low on-resistance are suitable for the primary side of switching power supplies.
- MOSFETs with low on-resistance are suitable for load switches.

Proposals from Toshiba

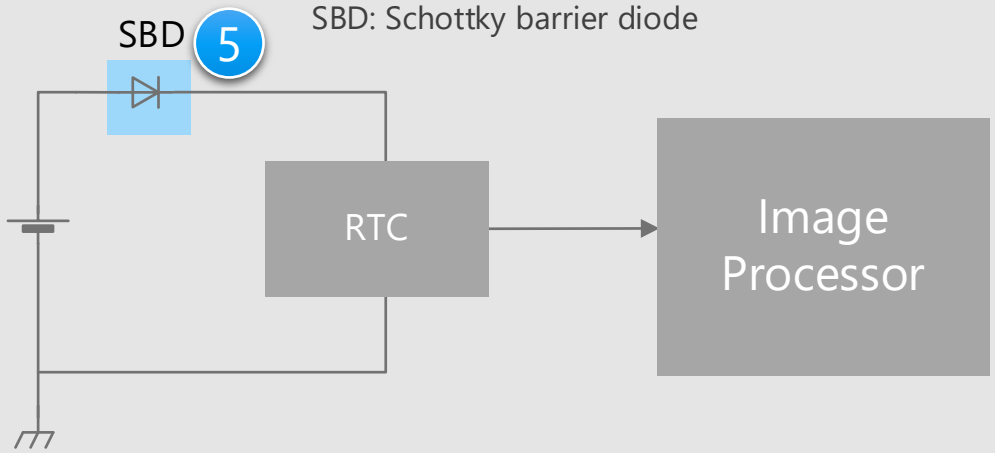
- **Realize the set with low power consumption by low on-resistance** 1
  Small signal MOSFET
- **Supply the power with low noise** 2
  Small surface mount LDO regulator
- **Suitable for high efficiency power supply switching** 3
  U-MOS Series N-ch MOSFET
- **Built-in protection function against short circuit, over current, over voltage, etc.** 7a 7b 7c
  Electronic fuse (eFuse IC)
- **Small package and built-in over voltage protection function** 8
  N-ch MOSFET gate driver IC

Surveillance Camera　Detail of power supply section (2)

SD card section



Power supply (RTC)



<u>* Click the number in the circuit diagram to jump to the detailed description page</u>

Criteria for device selection

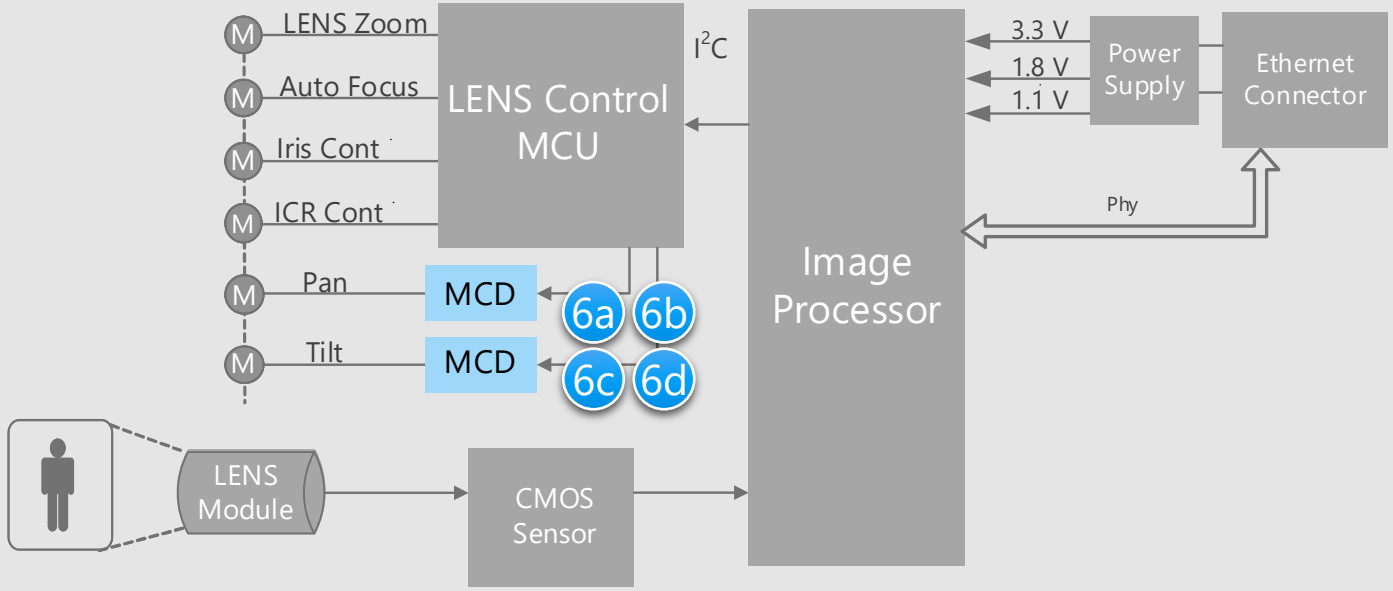
- The PSRR (Power Supply Rejection Ratio) of LDO regulator is important for SD memory card interface.
- TVS diodes are suitable for protecting high speed signal lines.
- Schottky barrier diodes with low loss are suitable for preventing current backflow.

Proposals from Toshiba

- **Supply the power with low noise** 2
  Small surface mount LDO regulator
- **Prevent circuit malfunctions by absorbing static electricity (ESD) from external terminals** 4a 4b
  TVS diode
- **High speed, low loss, small surface mounting**
  Schottky barrier diode 5

Surveillance Camera　Detail of camera motion section

Detail of camera motion section



* Click the number in the circuit diagram to jump to the detailed description page

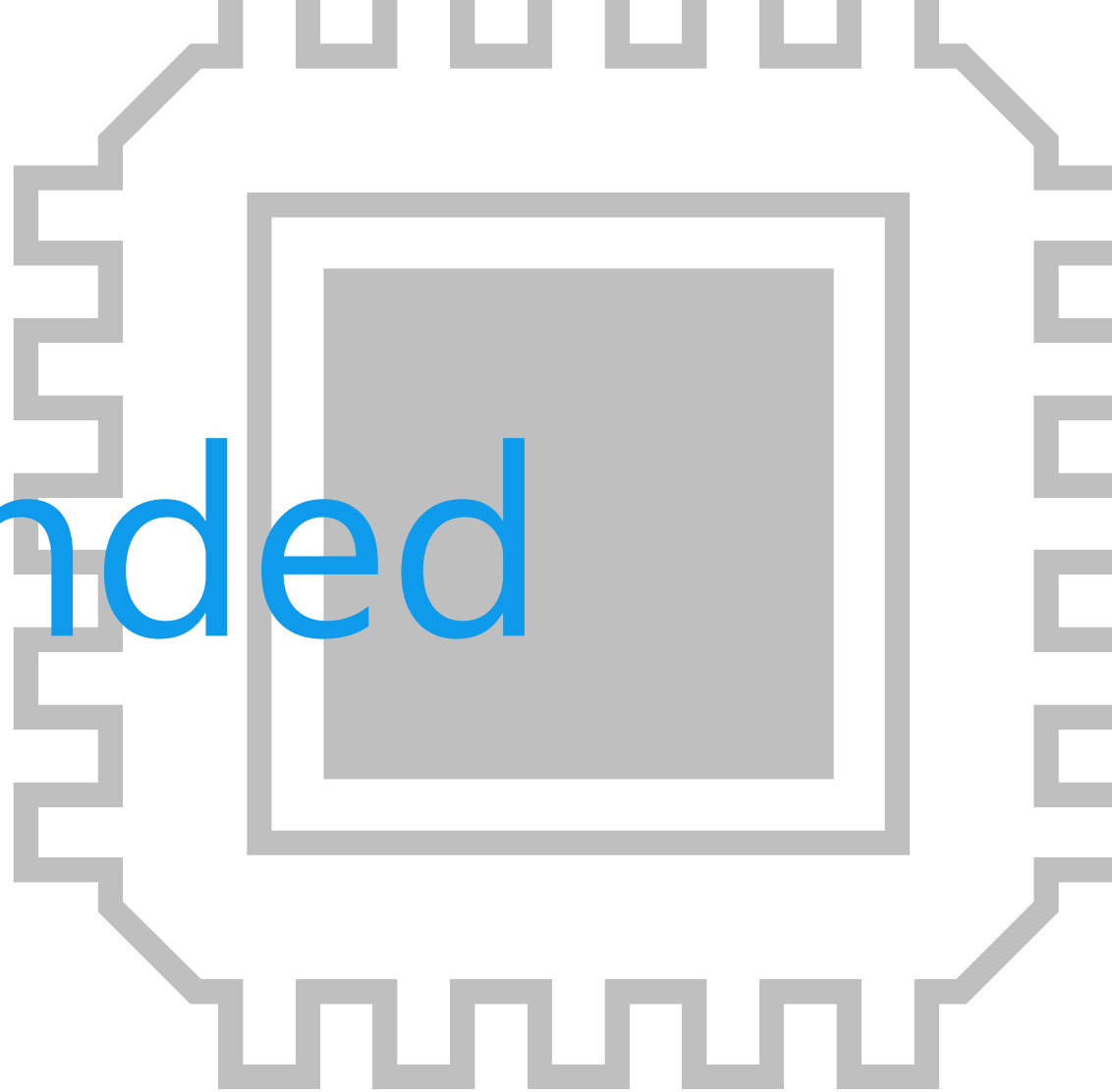
Criteria for device selection

- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

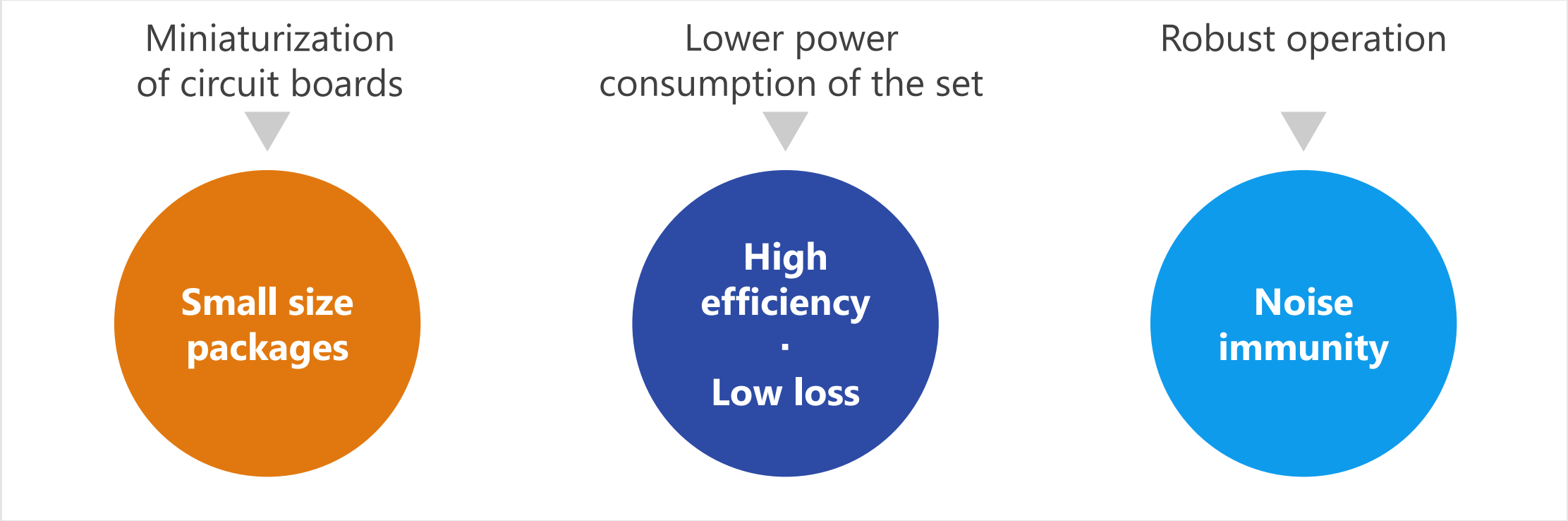
- **Low on-resistance and high efficient stepping motor control**
  Motor control driver　6a 6b 6c 6d

Recommended Devices



Device solutions to address customer needs

As described above, in the design of surveillance cameras, **“Miniaturization of circuit boards”**, **“Low power consumption of the set”** and **“Robust operation”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs

	Small size packages	High efficiency · Low loss	Noise immunity
1 Small signal MOSFET	●	●	
2 Small surface mount LDO regulator	●	●	●
3 U-MOS Series N-ch MOSFET	●	●	●
4 TVS diode	●	●	●
5 Schottky barrier diode	●	●	
6 Motor control driver	●	●	
7 Electronic fuse (eFuse IC)	●	●	
8 N-ch MOSFET gate driver IC	●	●	

1 Small signal MOSFET

SSM3K376R

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Suitable for power management switches and contributes to miniaturization.

1 Low voltage operation

Operates down to V_{GS} = 1.8 V

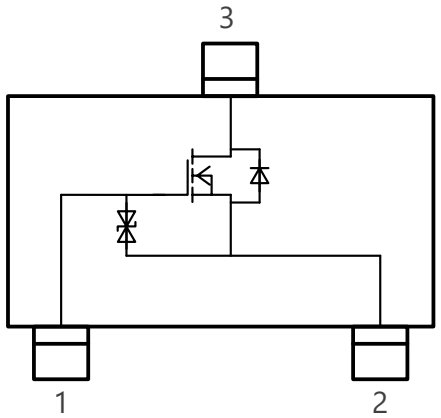
2 Low on-resistance

The on-resistance between the drain and source is low, as a result heat generation and power consumption can be kept low.

3 Small package

Sealed in SOT-23F small size package.

SSM3K376R
Internal connection diagram



Lineup

Part number	SSM3K376R
Package	SOT-23F  Top view  Bottom view
Polarity	N-ch
V_{DSS} [V]	30
I_D [A]	4
P_D [W]	1
$R_{DS(ON)}$ (Max) [mΩ] @V_{GS} = 4.5 V	56

◆Return to Block Diagram TOP

2 Small surface mount LDO regulator

TCR15AG / TCR8BM / TCR5FM / TCR5RG / TCR3RM / TCR3U / TCR3LM / TCR3D / TCR3EM / TCR1HF Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Wide lineup from general purpose type to WCSP (Wafer Level Chip Size Package) type are provided. Contribute to realize a stable power supply.

1 Low dropout voltage

The originally developed latest process significantly improved the dropout voltage characteristics.

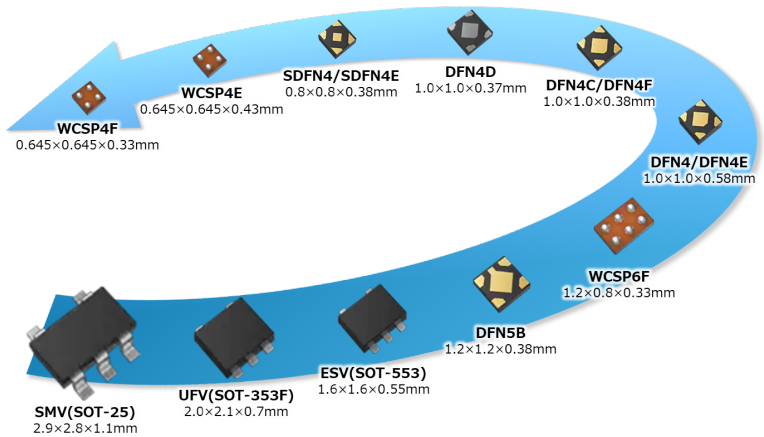
2 High PSRR Low output noise voltage

Many product series that realize both high PSRR (Power Supply Rejection Ratio) and low output noise voltage characteristics are provided. They are suitable for stable power supply for analog circuit.

3 Low current consumption

0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology.
(TCR3U Series)

Rich package lineup



Lineup

Part number	TCR15AG Series	TCR8BM Series	TCR5FM Series	TCR5RG Series	TCR3RM Series	TCR3U Series	TCR3LM Series	TCR3D Series	TCR3EM Series	TCR1HF Series
Features	Low dropout voltage High PSRR		High PSRR Low noise Low current consumption			Low current consumption		Standard type		36 V Input voltage
I_{OUT} (Max) [A]	1.5	0.8	0.5		0.3					0.15
PSRR (Typ.) [dB] @f = 1 kHz	95	98	91	100	100	70	-	72	68	70
I_B (Typ.) [μA]	25	20	10	7	7	0.34	1	86	35	170

◆Return to Block Diagram TOP

3 U-MOS Series N-ch MOSFET

TPH5900CNH

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Suitable for switching regulators and contributes to miniaturization.

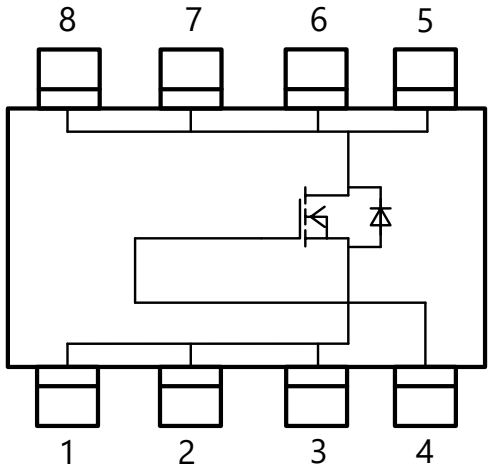
1 Fast switching speed

t_{on} (Typ.) = 14 ns
t_{off} (Typ.) = 19 ns

2 Low on-resistance

The on-resistance between the drain and source is low, as a result heat generation and power consumption can be kept low.

TPH5900CNH
Internal connection diagram



Lineup

Part number	TPH5900CNH
Package	SOP Advance  Top view  Bottom view
Polarity	N-ch
V_{DSS} [V]	150
I_D [A]	9
P_D [W]	42
$R_{DS(ON)}$ (Max) [mΩ] @V_{GS} = 10 V	59

◆Return to Block Diagram TOP

4a TVS diode
DF10G5M4N / DF10G6M4N

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

TVS diode absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

1 Improved ESD pulse absorption

ESD absorption has been improved compared to Toshiba's existing products. (50 % reduction in operating resistance) Both low operating resistance and low capacitance are realized and ensure high signal protection performance and signal quality.

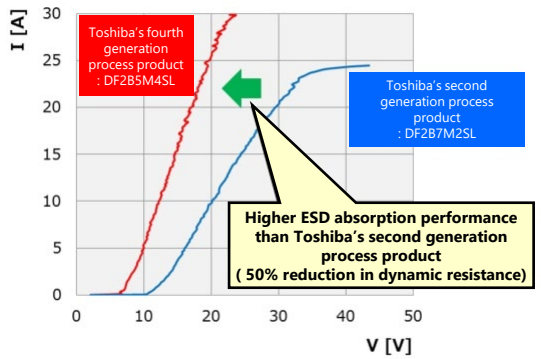
2 Suppress ESD energy by low clamp voltage

Protection of connected circuits/devices was realized by using proprietary technology.

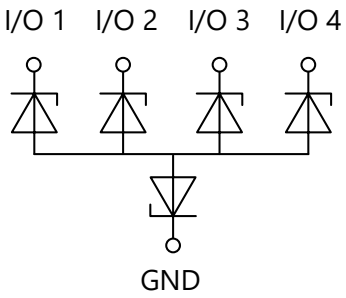
3 Suitable for high density mounting

A variety of small packages are available.

ESD Pulse Absorption Performance
(Toshiba internal comparison)



Internal connection diagram



Lineup

Part number	DF10G5M4N	DF10G6M4N
Package	DFN10  Top view  Bottom view	
V_{ESD} [kV]	±20	±20
V_{RWM} (Max) [V]	3.6	5.5
C_t (Typ.) [pF]	0.2	0.2
R_{DYN} (Typ.) [Ω]	0.5	0.5

(Note) This product is designed for ESD protection purpose and cannot be used for purposes other than ESD protection.

◆Return to Block Diagram TOP

4b TVS diode

DF2B5M4ASL / DF2B6M4ASL / DF2B6M4BSL

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

TVS diode absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

1 Improved ESD pulse absorption

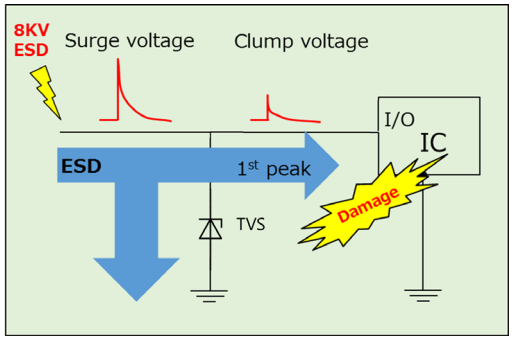
ESD absorption has been improved compared to Toshiba's existing products. Both low operating resistance and low capacitance can realize and ensure high signal protection performance and signal quality.

2 Suppress ESD energy by low clamp voltage

Protection of connected circuits/devices was realized by using proprietary technology.

3 Suitable for high density mounting

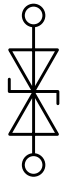
A variety of small packages are available.



Unidirectional

Suitable for paths such as logic signals. There are lineups of 1in1, 2in1, 4in1, 5in1, 7in1.

Bidirectional



Suitable for paths with both polar signals such as audio signals.

Lineup

Part number	DF2B5M4ASL	DF2B6M4ASL	DF2B6M4BSL
Package	SL2	 Top view  Bottom view	
V_{ESD} [kV]	±16	±15	±8
V_{RWM} (Max) [V]	3.6	5.5	5.5
C_t (Typ.) [pF]	0.15	0.15	0.12
R_{DYN} (Typ.) [Ω]	0.7	0.7	1.05

(Note) This product is designed for ESD protection purpose and cannot be used for purposes other than ESD protection.

◆Return to Block Diagram TOP

5 Schottky barrier diode

CUS10F30 / CTS05F40

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Can be applied to various applications which requires high speed and low loss, and contributes to miniaturization.

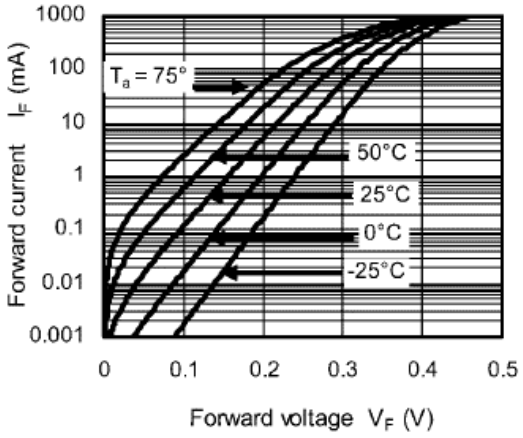
1 Fast switching

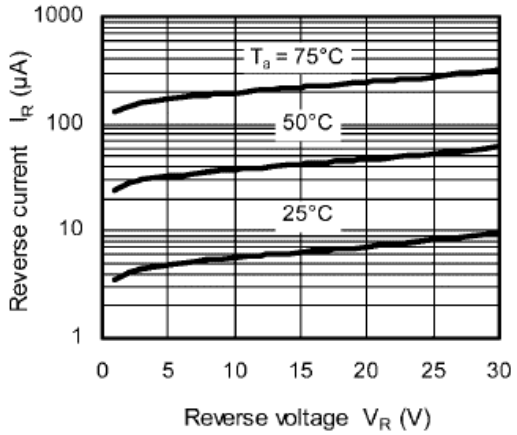
Suitable for fast switching applications.

2 Small package

Sealed in USC/CST2 small size package.

CUS10F30 Characteristics





Lineup

Part number	CUS10F30	CTS05F40
Package	USC  Top view  Bottom view	CST2  Top view  Bottom view
I_O [A]	1.0	0.5
V_R [V]	30	40
V_F (Typ.) [V] @ I_F = 0.1 A	0.28	0.40
I_R (Max) [μA] @ V_R = 10 V	50	15

◆Return to Block Diagram TOP

6a Stepping motor & Brushed DC motor driver

TC78S121FNG / TC78S121FTG / TC78S122FNG / TC78S122FTG

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

It is possible to drive two stepping motors or four brushed DC motors.

1 Four products lineup

There are two control types , clock input and phase signal input as the interface. Also, there are two package types, SSOP and QFN, respectively.

2 Error detection

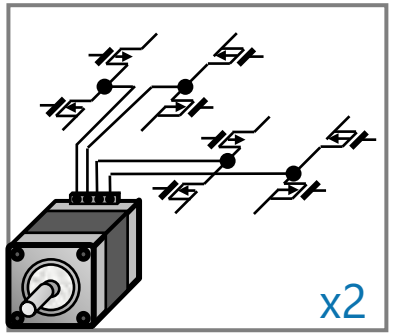
It is equipped with various error detection functions such as over current detection (ISD), thermal shutdown (TSD) and power on reset (POR).

3 Three selectable drive modes

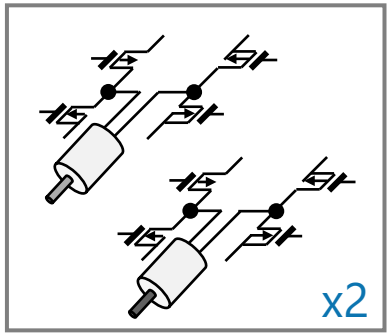
Three selectable H bridge combination according to motor type and required current as follows: 1) two stepping motors drive, 2) four brushed DC motors drive, 3) two large current brushed DC motors drive

■Three selectable drive modes

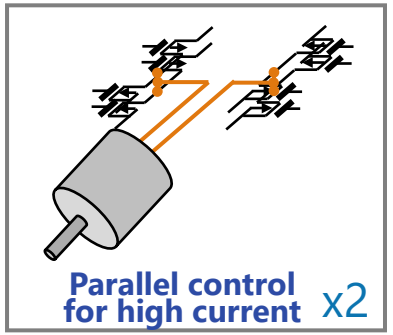
1) Two stepping motors drive



2) Four brushed DC motors drive



3) Two large current brushed DC motors drive



Lineup

Part number	TC78S121FNG/FTG	TC78S122FNG/FTG
Package	HTSSOP48-P-300-0.50 / QFN48-P-0707-0.50	
Package size	12. 5 x 8.1 x 1.2 mm / 7 x 7 x 0.9 mm	
Absolute maximum ratings	40 V / 2.0 A	
Output ON-resistance (H+L) (Typ.)	0.6 Ω	
Functions	・Over current detection, over heat detection and power on reset ・Two lineups support clock input for stepping motor control and phase input ・Single power supply without external 5 V input	

◆Return to Block Diagram TOP

6b Stepping motor & Brushed DC motor driver

TC78H670FTG / TC78H660FNG / TC78H660FTG

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Support for low voltage motor driving (2.5 V (min)) with low power consumption.

1 Low voltage operation

Motor driving voltage is 2.5 V (min) for low voltage applications such as battery operation devices.

2 Low current consumption

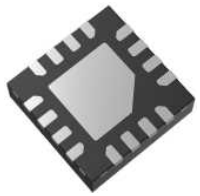
IC total standby current is below 2 µA for power saving of devices.

3 Error detection functions

Error detection functions such as over current detection (ISD), thermal shutdown (TSD) and under voltage lockout (UVLO) are available.

P-TSSOP16-0505-0.65-001 package
(5.0 × 6.4 × 1.2 mm)

Top view



Bottom view

P-VQFN16-0303-0.50-001 package
(3.0 × 3.0 × 0.9 mm)

Lineup

Part number	TC78H670FTG	TC78H660FNG	TC78H660FTG
V_M [V]	18	18	18
I_{out} [A]	2.0	2.0	2.0
$R_{on(upper\ and\ lower\ sum)}$ (Typ.) [Ω]	0.48	0.48	0.48
Control interface	MODE inputs	IN/PHASE inputs	IN/PHASE inputs
Step	2phase/1-2phase excitation	2phase/1-2phase excitation	2phase/1-2phase excitation
Motor driving voltage	2.5 V (Min) RS resistor less	2.5 V (Min) RS resistor less	2.5 V (Min) RS resistor less
Error detection function	Thermal shutdown, over current, under voltage lockout, load open	Thermal shutdown, over current, under voltage lockout	Thermal shutdown, over current, under voltage lockout
Package	P-VQFN16-0303-0.50-001	P-TSSOP16-0505-0.65-001	P-VQFN16-0303-0.50-001

◆Return to Block Diagram TOP

6c Stepping motor driver

TB67S539FTG / TB67S579FTG

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

The maximum voltage rating is 40 V. Standard stepping motor drivers with a small package.

1 High voltage and high current

Supports a maximum rated voltage of 40 V and a maximum rated current of 2 A.
The low output on-resistance realizes low power consumption, which reduces heat generation.

2 Small size and high heat dissipation

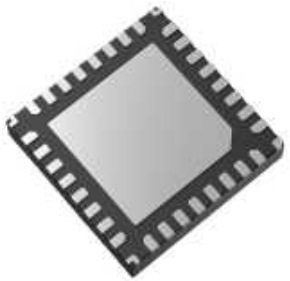
A QFN package is used. By connecting the E-pad on the bottom to the board GND, heat dissipation is improved.
This also contributes to reducing the required board area.

3 Error detection functions

Over current detection (ISD), thermal shutdown (TSD) and under voltage lockout (UVLO) are available. In addition to these features, the TB67S579FTG incorporates open-load detection (OPD) and stall detection.

Package

Top view



Bottom view

P-VQFN32-0505-0.50-004 package
(5.0 x 5.0 mm)

Lineup

Part number		TB67S539FTG	TB67S579FTG
Absolute maximum ratings	Output voltage [V]	40	
	Output current [A]	2.0	
Output ON-resistance (H+L) (Typ.) [Ω]		0.8	0.6
Driving type		PWM constant current drive	
Excitation mode		full, half, quarter, 1/8, 1/16 and 1/32 step resolutions	
Feature		Clock input type	
Error detection function		TSD, ISD, UVLO	TSD, ISD, UVLO, OPD, Stall detection
Package		P-VQFN32-0505-0.50-004	P-VQFN48-0707-0.50-006

◆Return to Block Diagram TOP

6d Stepping motor & Brushed DC motor driver

TC78H653FTG

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

It is possible to drive one stepping motor or two brushed DC motors.

1 Small package

The VQFN16 package contributes to reduce foot print areas.

2 Protection and error detection

It is equipped with a through current prevention function and various error detection functions such as over current detection (ISD), thermal shutdown (TSD) and under voltage lockout (UVLO).

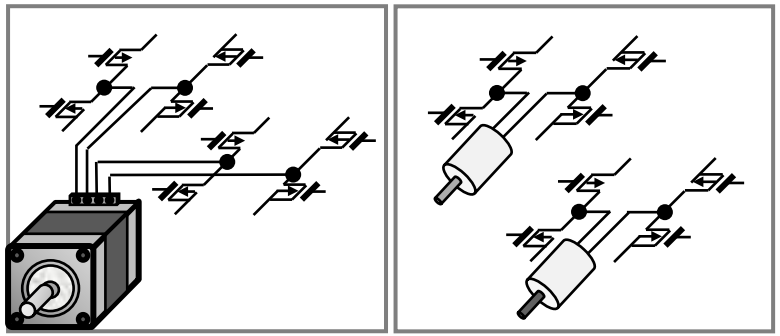
3 Two selectable drive modes

Two selectable H bridge combination according to motor type and required current as follows:

1) one stepping motor drive
2) two brushed DC motors drive

■Two selectable drive modes

1) One stepping motor drive 2) Two brushed DC motors drive



Lineup

Part number	TC78H653FTG
Package	P-VQFN16-0303-0.50-001
Package size	3.0 x 3.0 x 0.9 mm
Absolute maximum ratings	8 V / 4.0 A
Output ON-resistance (H+L) (Typ.)	0.22 Ω
Functions	・Through current preventing function ・Over current detection (ISD), thermal shutdown (TSD) and under voltage lockout (UVLO)

◆Return to Block Diagram TOP

7a Electronic fuse (eFuse IC)

TCKE8 Series / TCKE7 Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Electronic fuse (eFuse IC) can be used repeatedly to protect circuits from abnormal conditions such as overcurrent and overvoltage.

1 Can be used repeatedly

When overcurrent flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. It is not destroyed by a single overcurrent and can be used repeatedly.

2 IEC 62368-1 certified

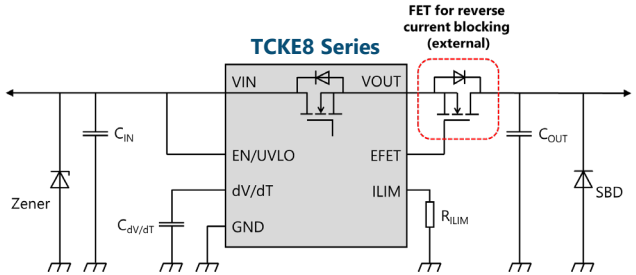
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

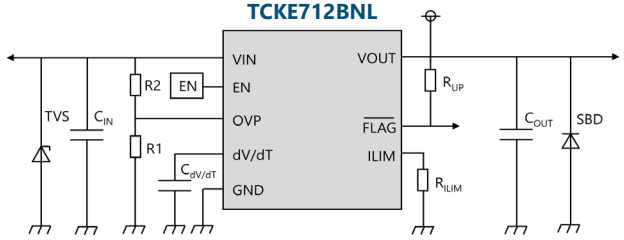
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shutdown, inrush current suppression, backflow prevention (optional), etc.

TCKE7 Series: short-circuit protection, overcurrent protection, overvoltage protection, thermal shutdown, FLAG signal output, backflow prevention (built-in), etc.

Example of peripheral circuit for TCKE8 Series



Example of peripheral circuit for TCKE7 Series



Lineup

Part number	TCKE800NA/NL	TCKE805NA/NL	TCKE812NA/NL	TCKE712BNL
Package	WSON10B 3.0 x 3.0 x 0.75 mm	Top view	Bottom view	WSON10 3.0 x 3.0 x 0.75 mm
V_{IN} [V]	4.4 to 18			4.4 to 13.2
R_{ON} (Typ.) [mΩ]	28			53
Fault response	NA: Auto-retry NL: Latched (external signal control)			Latched (external signal control)
V_{OVC} (Typ.) [V]	-	6.04	15.1	Adjustable

◆Return to Block Diagram TOP

7b Electronic fuse (eFuse IC)

TCKE9 Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Electronic fuse (eFuse IC) can be used repeatedly to protect circuits from abnormal conditions such as overcurrent and overvoltage.

1 Can be used repeatedly

When overcurrent flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. It is not destroyed by a single overcurrent and can be used repeatedly.

2 Product selection is possible according to usage

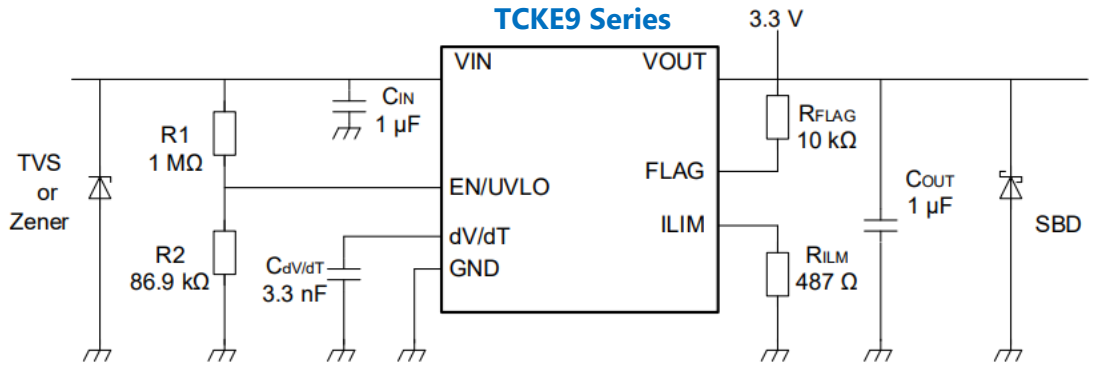
Suitable product with suitable failure response can be selected according to usage.

NA: Auto-retry type
QNA: Auto-retry with quick output discharge type
NL: Latched type

3 Rich protection functions

TCKE9 Series feature many protection functions such as adjustable over current limit, short circuit protection, over voltage clamp, adjustable slew rate control, adjustable under voltage Protection, and thermal shutdown.

Example of peripheral circuit for TCKE9 Series



Lineup

Part number	TCKE903NA/NL/QNA	TCKE905ANA/NL/QNA	TCKE912NA/NL	TCKE920NA/NL
Package	WSON8 2.0 x 2.0 x 0.75 mm	 Top view	 Bottom view	
V_{IN} [V]	2.7 to 23			
R_{ON} (Typ.) [mΩ]	34			
Fault response	NA: Auto-retry (QNA: with quick output discharge), NL: Latched			
V_{OVC} (Typ.) [V]	3.87	5.7	13.7	22.2

◆Return to Block Diagram TOP

Electronic fuse (eFuse IC)

TCKE6 Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Electronic fuse (eFuse IC) can be used repeatedly to protect circuits from abnormal conditions such as overcurrent and overvoltage.

1 Can be used repeatedly

When overcurrent flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. It is not destroyed by a single overcurrent and can be used repeatedly.

2 Product selection is possible according to usage

Suitable product can be selected according to usage.

FLAG function: TCKE601RA/RL

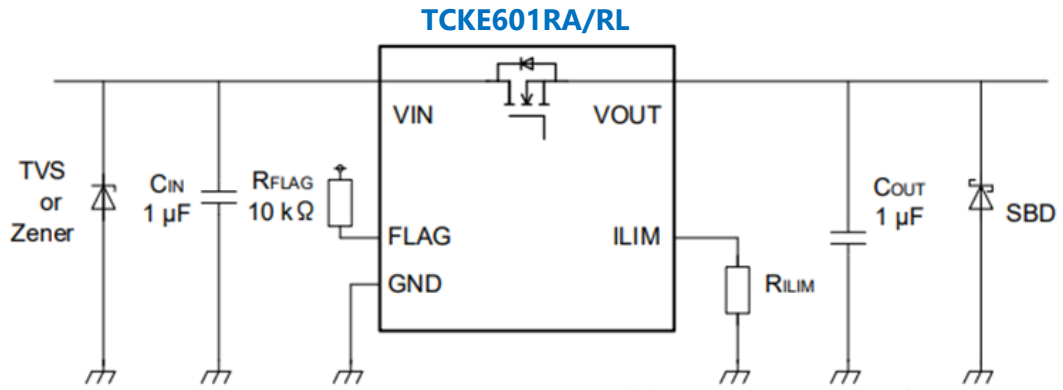
MODE function (selectable recovery mode): TCKE602

EN (enable) function: TCKE603RA/RL

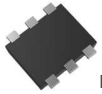
3 Rich protection functions

TCKE6 Series feature many protection functions such as adjustable over current limit, short circuit protection, under voltage protection, and thermal shutdown.

Example of peripheral circuit for TCKE601RA/RL



Lineup

Part number	TCKE601RA	TCKE601RL	TCKE602RM	TCKE603RA	TCKE603RL
Package	TSOP6F  Top view  Bottom view				
V_{IN} [V]	4.4 to 30				
R_{ON} (Typ.) [mΩ]	52				
Function	FLAG		MODE	EN	
Fault response	Auto-retry	Latched	Selectable type	Auto-retry	Latched

◆Return to Block Diagram TOP

8 N-ch MOSFET gate driver IC

TCK4xx Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

It is N-ch MOSFET gate driver IC with OVP [Note 1] function. It contributes to reduction of power consumption and miniaturization of load switch circuit.

[Note 1] OVP: Over Voltage Protection

1 Three types of N-ch MOSFET can be driven

The following types of MOSFET can be driven:
TCK40xG: Single high side connection
Common source connection
TCK42xG: Single high side connection
Common drain connection

2 Wide operating voltage range and various OVLO [Note 2] threshold voltage

Operating voltage V_{opr}: 2.7 to 28 V
Maximum input voltage: 40 V
V_{IN_OVLO} [Note 3] lineups suitable for 5 to 24 V power supply line.

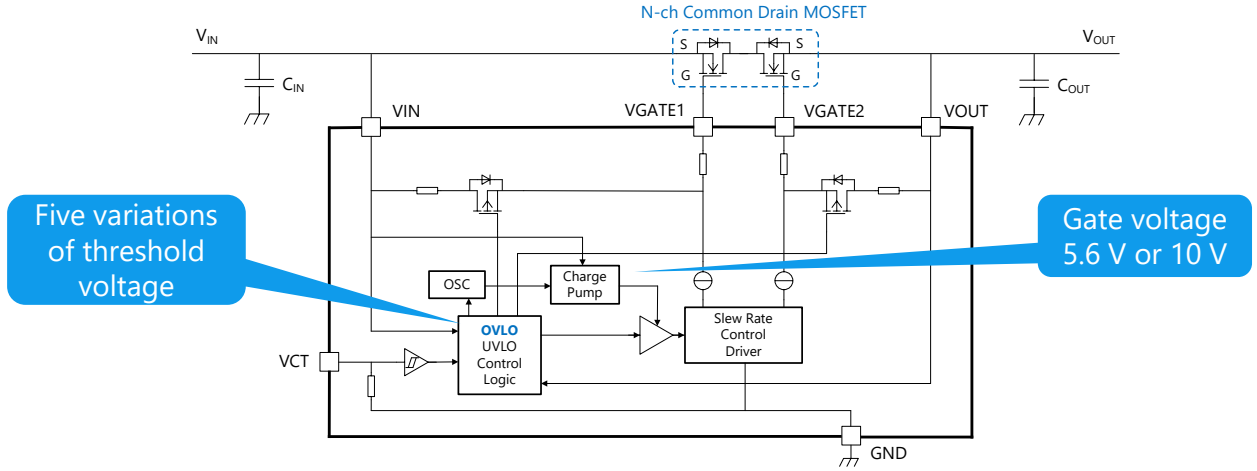
[Note 2] OVLO: Over Voltage Lock Out
[Note 3] V_{IN_OVLO}: V_{IN} OVLO threshold

3 Small packages

It contributes to reduction of the mounting area and miniaturization of the circuit board:

WCSP6E: 1.2 x 0.8 mm, t: 0.55 mm
WCSP6G: 1.2 x 0.8 mm, t: 0.35 mm

Circuit example of TCK42xG with N-ch common drain connection MOSFET



Lineup

Part number	V_{IN_OVLO} Min / Max [V]	V_{GS} Typ. / Max [V]	N-ch MOSFET type can be driven	Package
TCK401G	Over 28	Max 10 (V_{IN} ≥ 12 V)	Single high side Common Source	WCSP6E
TCK402G				
TCK420G	26.50 / 28.50	10 / 11 (V_{IN} ≥ 5 V)	Single high side Common Drain	WCSP6G
TCK421G	22.34 / 24.05			
TCK422G	13.61 / 14.91			
TCK423G	13.61 / 14.91	5.6 / 6.3		
TCK424G	10.35 / 11.47			
TCK425G	5.76 / 6.87			

◆Return to Block Diagram TOP

If you are interested in these products and have questions or comments about any of them, please do not hesitate to contact us below:

Contact address: https://toshiba.semicon-storage.com/ap-en/contact.html

Terms of use

This terms of use is made between Toshiba Electronic Devices and Storage Corporation (“We”) and Customer who downloads or uses this Reference Design. Customer shall comply with this terms of use. This Reference Design means all documents and data in order to design electronics applications on which our semiconductor device is embedded.

Section 1. Restrictions on usage
1. This Reference Design is provided solely as reference data for designing electronics applications. Customer shall not use this Reference Design for any other purpose, including without limitation, verification of reliability.
2. Customer shall not use this Reference Design for sale, lease or other transfer.
3. Customer shall not use this Reference Design for evaluation in high or low temperature, high humidity, or high electromagnetic environments.
4. This Reference Design shall not be used for or incorporated into any product or system whose manufacture, use, or sale is prohibited under any applicable laws or regulations.

Section 2. Limitations
1. We reserve the right to make changes to this Reference Design without notice.
2. This Reference Design should be treated as a reference only. WE ARE NOT RESPONSIBLE FOR ANY INCORRECT OR INCOMPLETE DATA AND INFORMATION.
3. Semiconductor devices can malfunction or fail. When designing electronics applications by referring to this Reference Design, Customer is 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 semiconductor devices could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Customer must also refer to and comply with the latest versions of all relevant our information, including without limitation, specifications, data sheets and application notes for semiconductor devices, as well as the precautions and conditions set forth in the "Semiconductor Reliability Handbook".
4. Designing electronics applications by referring to this Reference Design, Customer must evaluate the whole system sufficiently. Customer is solely responsible for applying this Reference Design to Customer's own product design or applications. WE ASSUME NO LIABILITY FOR CUSTOMER'S PRODUCT DESIGN OR APPLICATIONS.
5. WE SHALL NOT BE RESPONSIBLE FOR ANY INFRINGEMENT OF PATENTS OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS OF THIRD PARTIES THAT MAY RESULT FROM THE USE OF THIS REFERENCE DESIGN. NO LICENSE TO ANY INTELLECTUAL PROPERTY RIGHT IS GRANTED BY THIS TERMS OF USE, WHETHER EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE.
6. THIS REFERENCE DESIGN IS PROVIDED "AS IS". WE (a) ASSUME 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 (b) DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO THIS REFERENCE DESIGN, INCLUDING WITHOUT LIMITATION, WARRANTIES OR CONDITIONS OF FUNCTION AND WORKING, WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.

Section 3. Terms and Termination
It is assumed that Customer agrees to any and all this terms of use if Customer downloads or uses this Reference Design. We may, at its sole and exclusive discretion, change, alter, modify, add, and/or remove any part of this terms of use at any time without any prior notice. We may terminate this terms of use at any time and without any cause. Upon termination of this terms of use, Customer shall eliminate this Reference Design. Furthermore, upon our request, Customer shall submit to us a written confirmation to prove elimination of this Reference Design.

Section 4. Export Control
Customer shall not use or otherwise make available this Reference Design 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). This Reference Design may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Act and the U.S. Export Administration Regulations. Export and re-export of this Reference Design is strictly prohibited except in compliance with all applicable export laws and regulations.

Section 5. Governing Laws
This terms of use shall be governed and construed by laws of Japan, without reference to conflict of law principle.

Section 6. Jurisdiction
Unless otherwise specified, Tokyo District Court in Tokyo, Japan shall be exclusively the court of first jurisdiction for all disputes under this terms of use.

RESTRICTIONS ON PRODUCT USE

- Toshiba Electronic Devices & Storage Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "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.**
- Product may include products using GaAs (Gallium Arsenide). GaAs is harmful to humans if consumed or absorbed, whether in the form of dust or vapor. Handle with care and do not break, cut, crush, grind, dissolve chemically or otherwise expose GaAs in Product.
- 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.**