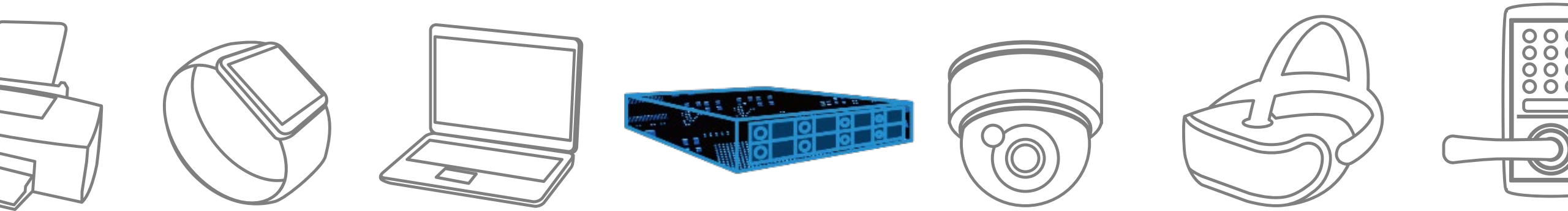
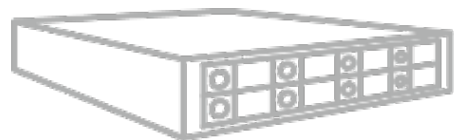


Server

Solution Proposal by Toshiba

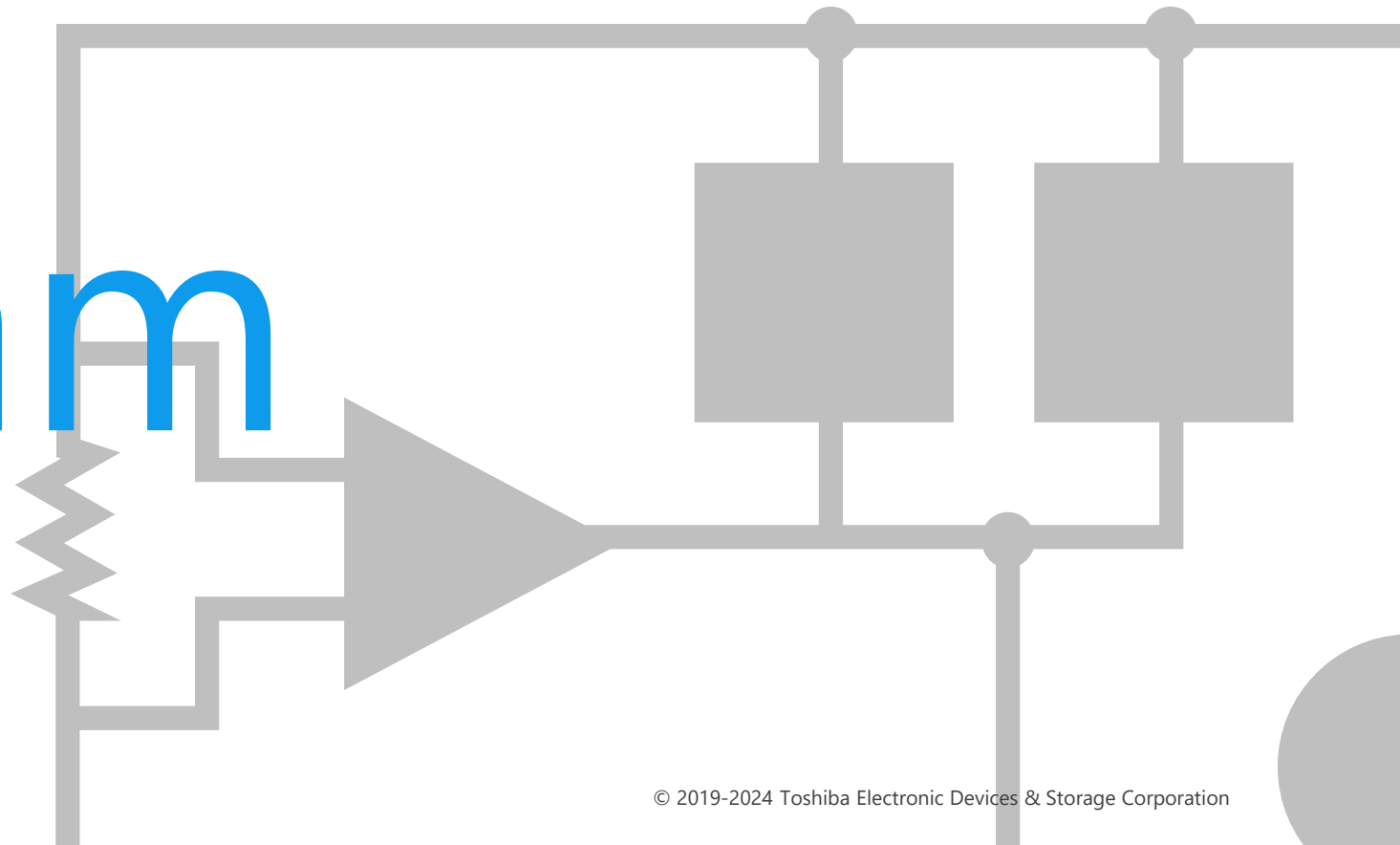




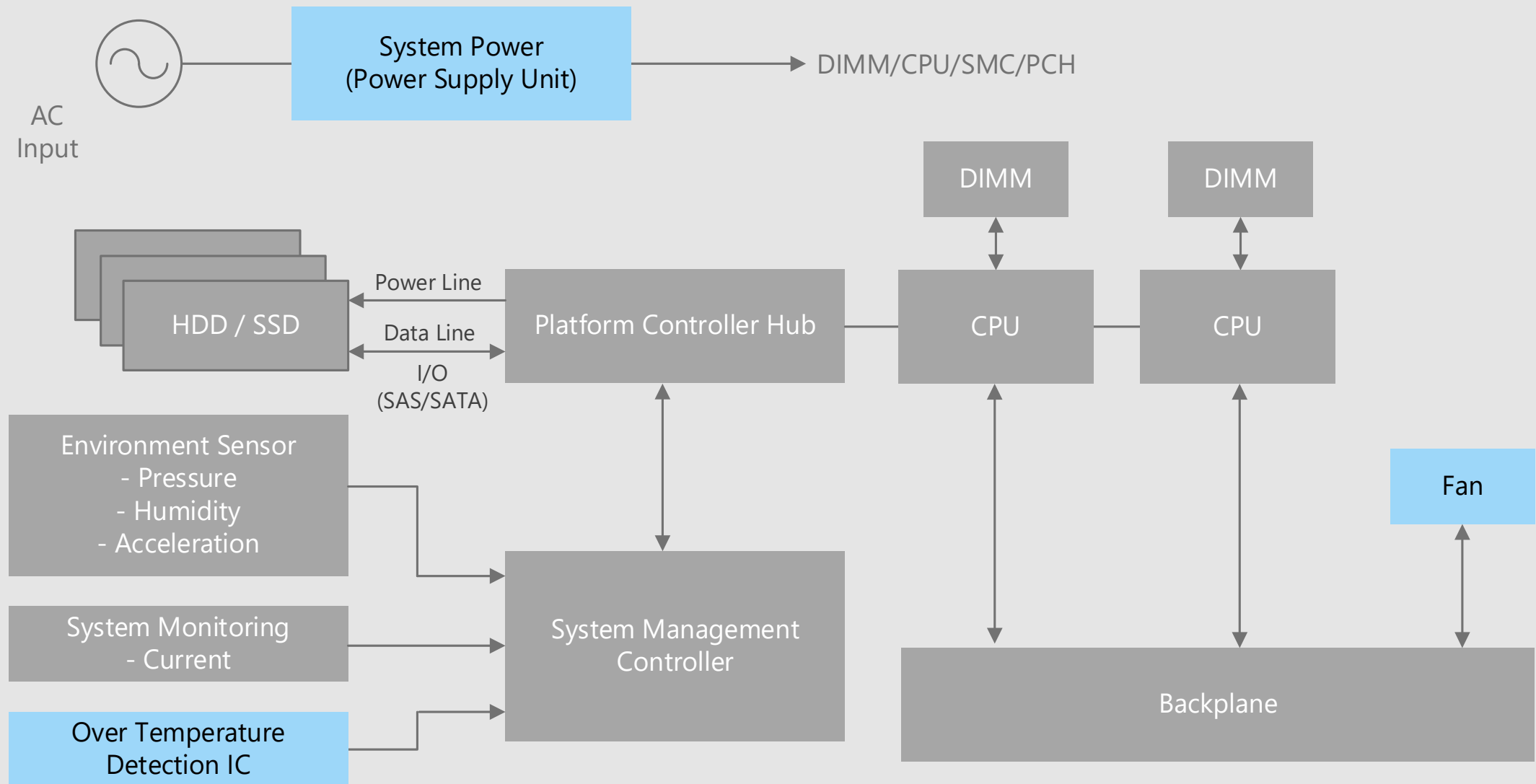
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.



Block Diagram



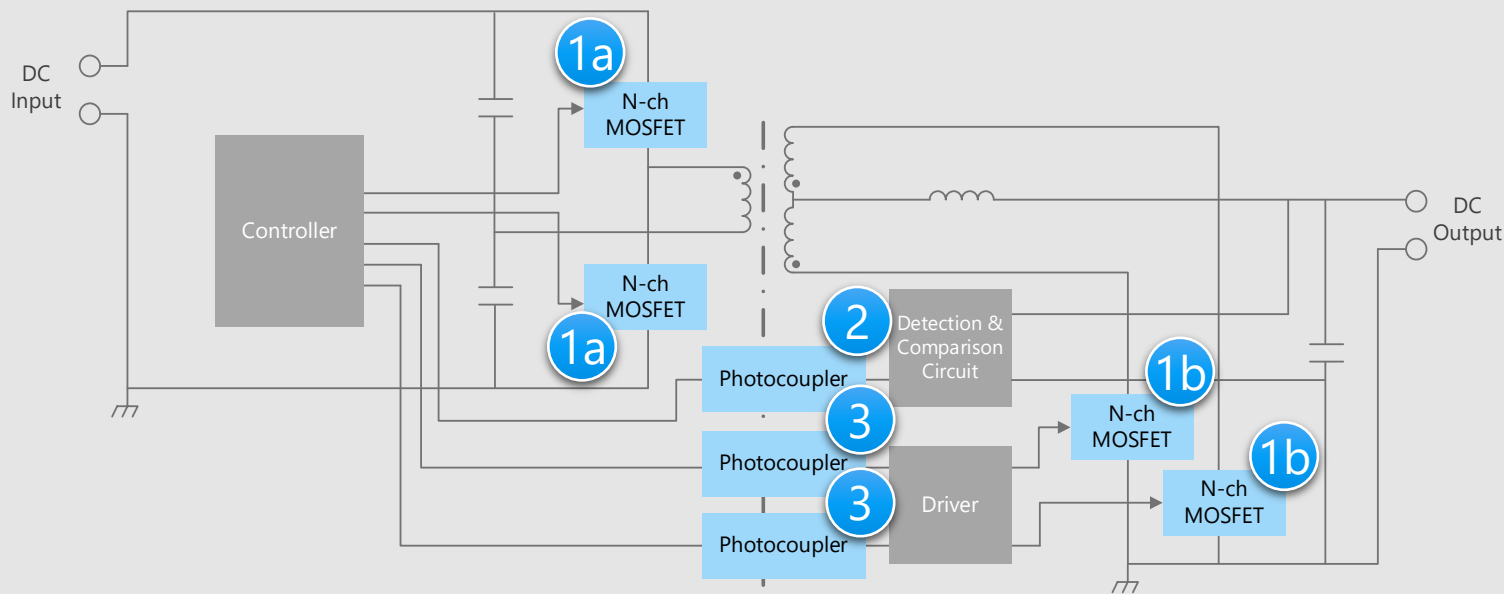
Server Overall block diagram



Server Detail of power supply circuit (1)

DC-DC converter for 48 V system

Power supply for 1.2 V and 100 A output isolated DC-DC converters
($V_{IN(DC)} = 40$ to 59.5 V, $V_{OUT} = 1.2$ V, $I_{OUT} = 100$ A)



Reference Design from here →

[Click Here](#)

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

Criteria for device selection

- A MOSFET having a high speed and a low on-resistance is suitable for the DC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the DC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

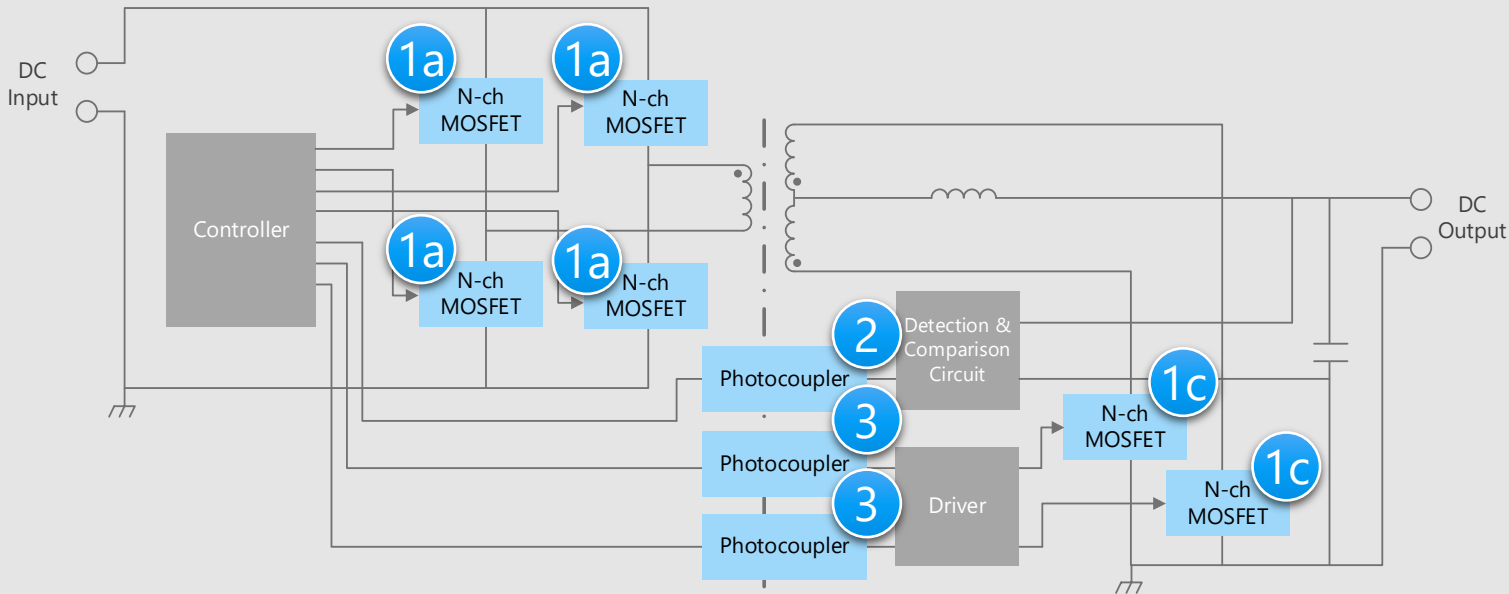
- **Suitable for efficient switching of power supply** 1a 1b
U-MOS Series MOSFET
- **Realize high speed isolated signal transmission** 2
Transistor output photocoupler 3
IC output photocoupler
for high speed communication

Server Detail of power supply circuit (2)

DC-DC converter for 48 V system

300 W isolated DC-DC converters power supply

($V_{IN(DC)} = 36$ to 75 V, $V_{OUT} = 12.0$ V, $I_{OUT} = 25$ A)



Reference Design from here →

[Click Here](#)

* [Click the number in the circuit diagram to jump to the detailed description page.](#)

Criteria for device selection

- A MOSFET having a high speed and a low on-resistance is suitable for the DC-DC power supply.
- A transistor output photocopler is typically used for feeding back voltages to the primary in the DC-DC power supply.
- The IC output photocopler for high speed communication is used for signal isolation.

Proposals from Toshiba

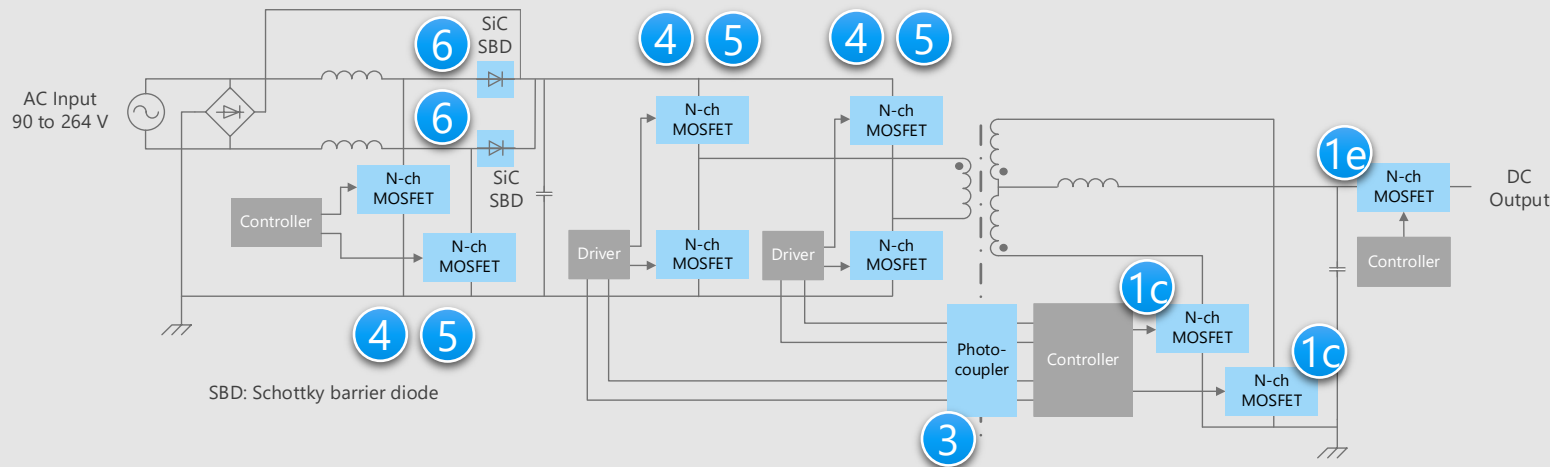
- **Suitable for efficient switching of power supply** 1a 1c
U-MOS Series MOSFET
- **Realize high speed isolated signal transmission** 2
Transistor output photocopler 3
IC output photocopler
for high speed communication

Server Detail of power supply circuit (3)

AC-DC converter for 12 V system (bridgeless PFC)

1.6 kW power supply

($V_{IN(AC)} = 90 \text{ to } 264 \text{ V}$, $V_{OUT} = 12.0 \text{ V}$, $I_{OUT} = 66.7 \text{ A} / 133 \text{ A}$)



Reference Design of the power supply circuit from here →

[Click Here](#)

Reference Design of PFC circuit from here →

[Click Here](#)

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

Criteria for device selection

- A MOSFET having a high voltage and a low on-resistance is suitable for the PFC circuit of the AC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the AC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

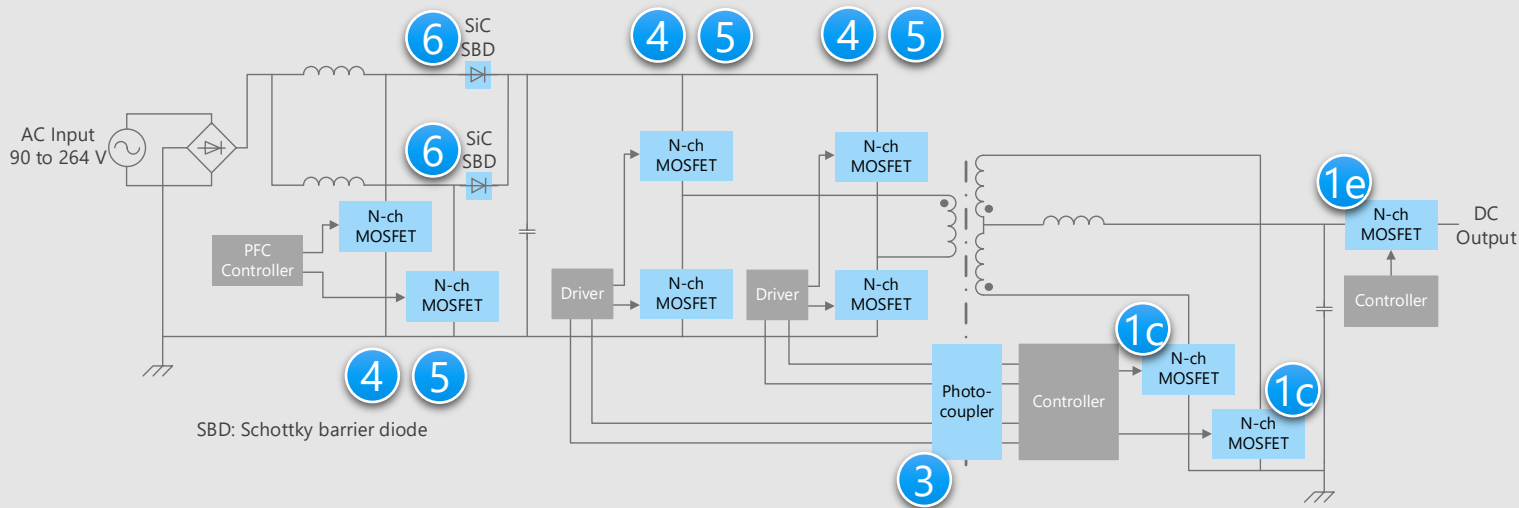
- **Suitable for efficient switching of power supply**
U-MOS Series MOSFET 1c 1e
- **Realize high speed isolated signal transmission**
IC output photocoupler 3
for high speed communication
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET 4
SiC MOSFET 5
- **Suitable for high efficiency and miniaturization of power supply**
SiC Schottky barrier diode 6

Server Detail of power supply circuit (4)

AC-DC converter for 12 V system (interleaved PFC)

1.6 kW power supply

($V_{IN(AC)} = 90 \text{ to } 264 \text{ V}$, $V_{OUT} = 12.0 \text{ V}$, $I_{OUT} = 66.7 \text{ A} / 133 \text{ A}$)



Reference Design of the power supply circuit from here →

[Click Here](#)

Reference Design of PFC circuit from here →

[Click Here](#)

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

Criteria for device selection

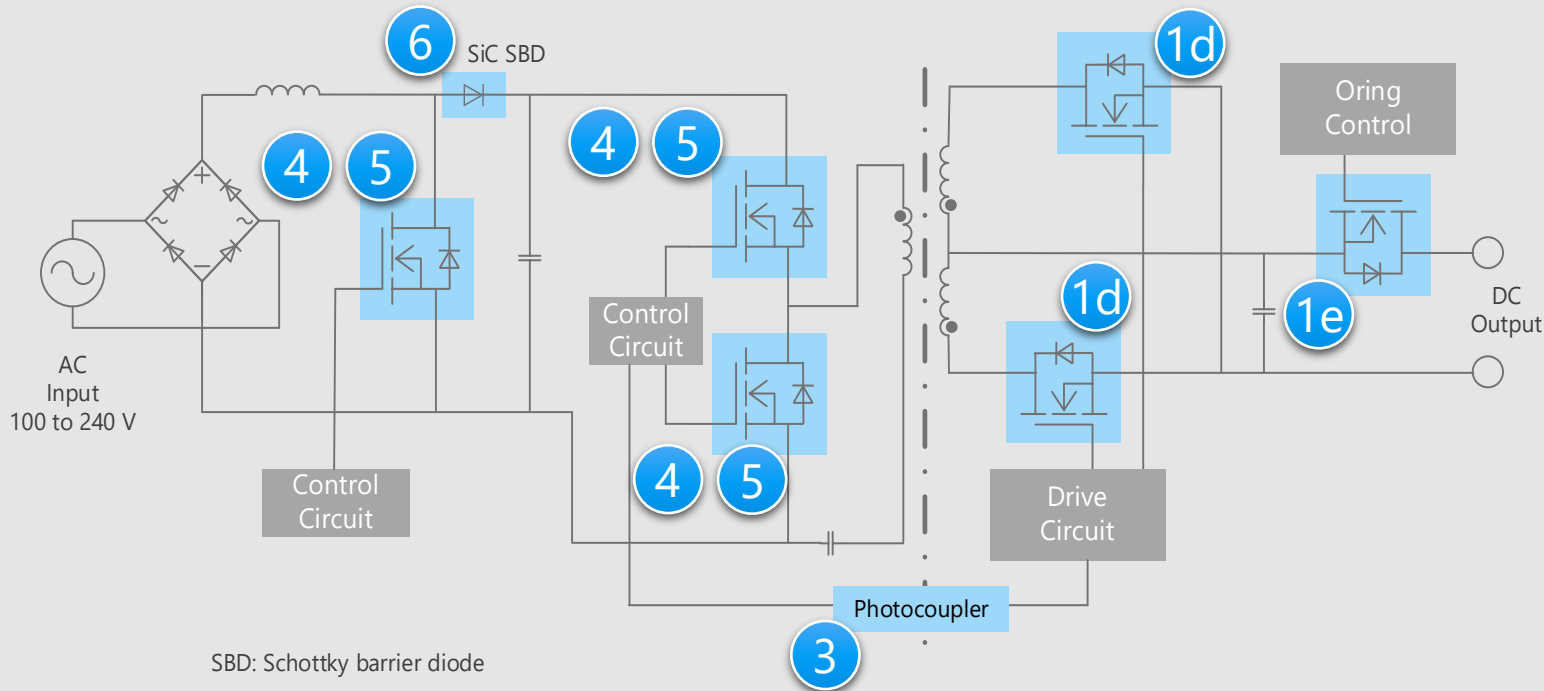
- A MOSFET having a high voltage and a low on-resistance is suitable for the PFC circuit of the AC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the AC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
U-MOS Series MOSFET 1c 1e
- **Realize high speed isolated signal transmission**
IC output photocoupler 3
for high speed communication
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET 4
SiC MOSFET 5
- **Suitable for high efficiency and miniaturization of power supply**
SiC Schottky barrier diode 6

Server Detail of power supply circuit (5)

AC-DC converter for 48 V system



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

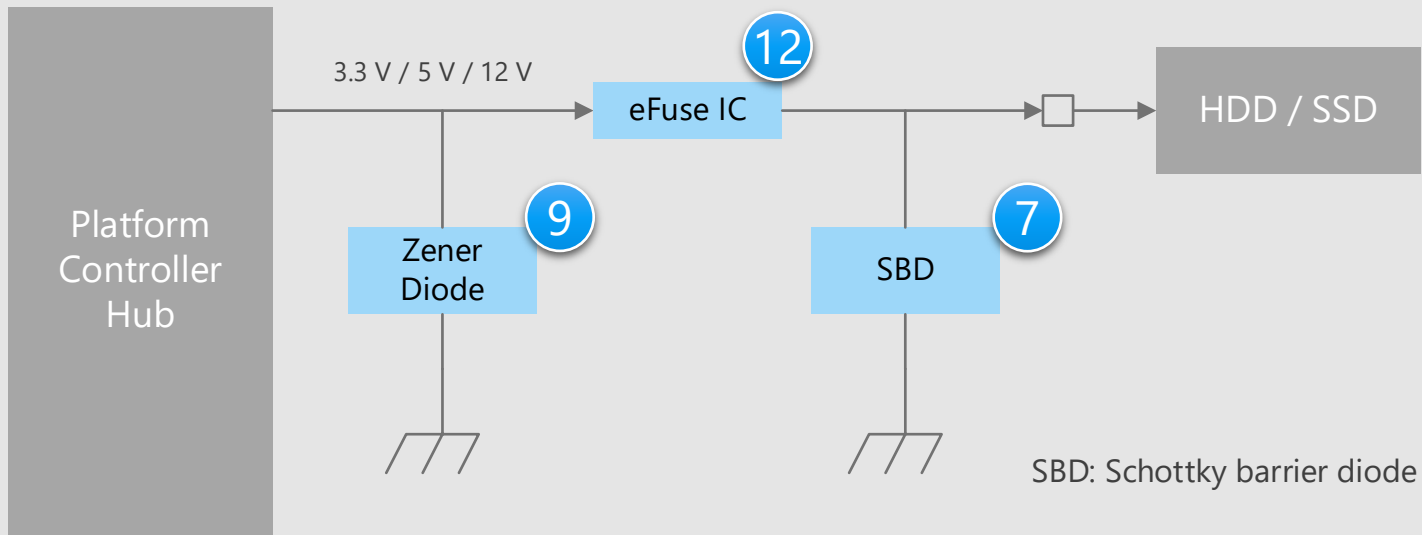
Criteria for device selection

- A MOSFET having a high voltage and a low on-resistance is suitable for the PFC circuit of the AC-DC power supply.
- A transistor output photocoupler is typically used for transmitting control signals to the secondary side in the AC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
U-MOS Series MOSFET 1d 1e
- **Realize high speed isolated signal transmission**
IC output photocoupler 3
for high speed communication
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET 4
SiC MOSFET 5
- **Suitable for high efficiency and miniaturization of power supply**
SiC Schottky barrier diode 6

Power line to storage devices



Criteria for device selection

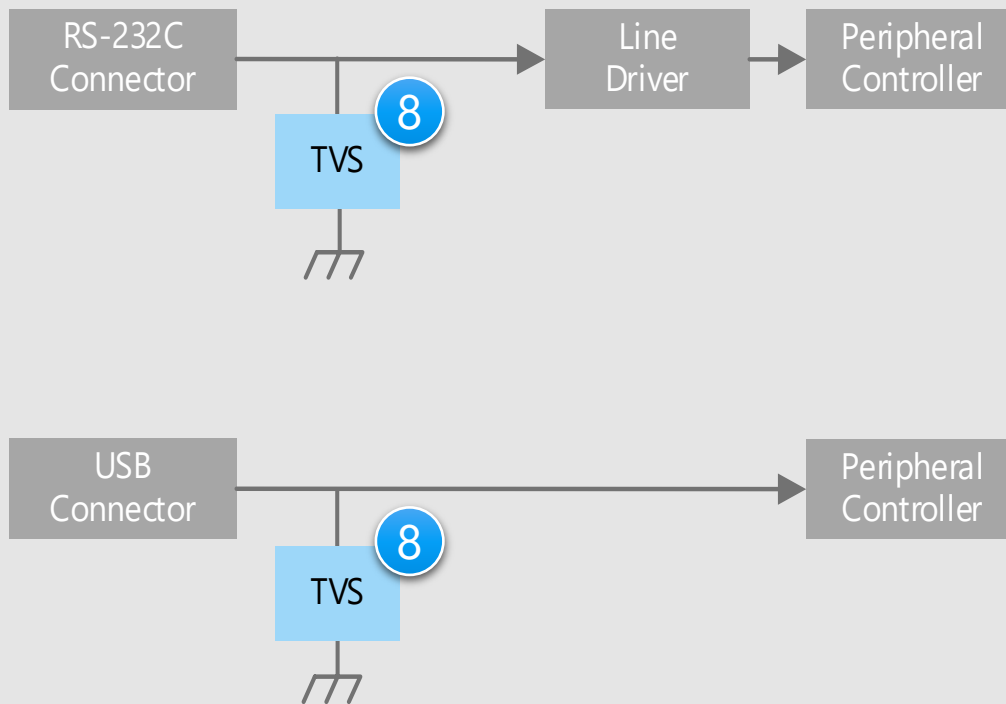
- eFuse IC protects devices from overcurrent and overvoltage caused by hot-swapping or accidental short circuits.
- Zener diode is suitable for protection against spike voltages that occur during hot-swapping.
- Schottky barrier diode(SBD) is effective against negative spike voltages that occur on the output side.

Proposals from Toshiba

- **Built-in protection function against short circuit, over current, over voltage, etc.**
Electronic fuse (eFuse IC) 12
- **Suppress input spike voltage**
Zener diode 9
- **Low V_f suppresses negative voltage surges**
Schottky barrier diode 7

* [Click the number in the circuit diagram to jump to the detailed description page.](#)

Peripheral interface circuits



* [Click the number in the circuit diagram to jump to the detailed description page.](#)

Criteria for device selection

- To improve the reliability of the set, ESD protection is required for connectors that may come into contact with the human body.
- Small TVS diodes with low terminal capacitance are suitable for ESD protection.

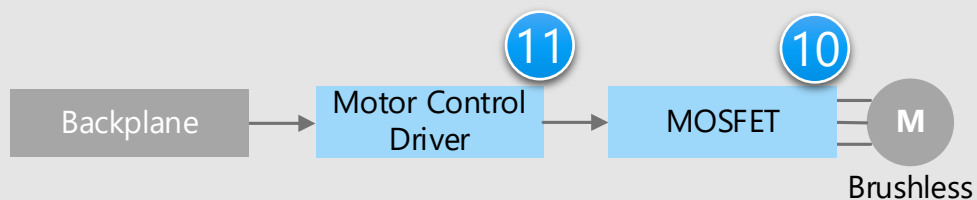
Proposals from Toshiba

- **Absorb static electricity from external terminals to prevent malfunction of the circuit and device breakdown**

TVS diode

8

Fan drive circuit



* [Click the number in the circuit diagram to jump to the detailed description page.](#)

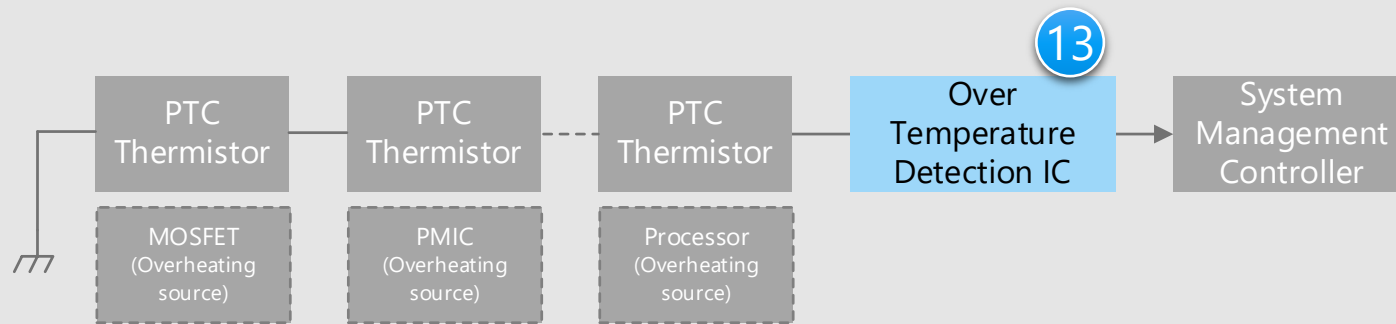
Criteria for device selection

- By using brushless DC motor drivers, three-phase brushless DC motors can be controlled easily.

Proposals from Toshiba

- **Easy control of motors**
Three-phase brushless DC motor driver IC 11
- **Suitable for high efficiency switching**
Semi-power MOSFET 10

Over temperature monitoring circuit



Criteria for device selection

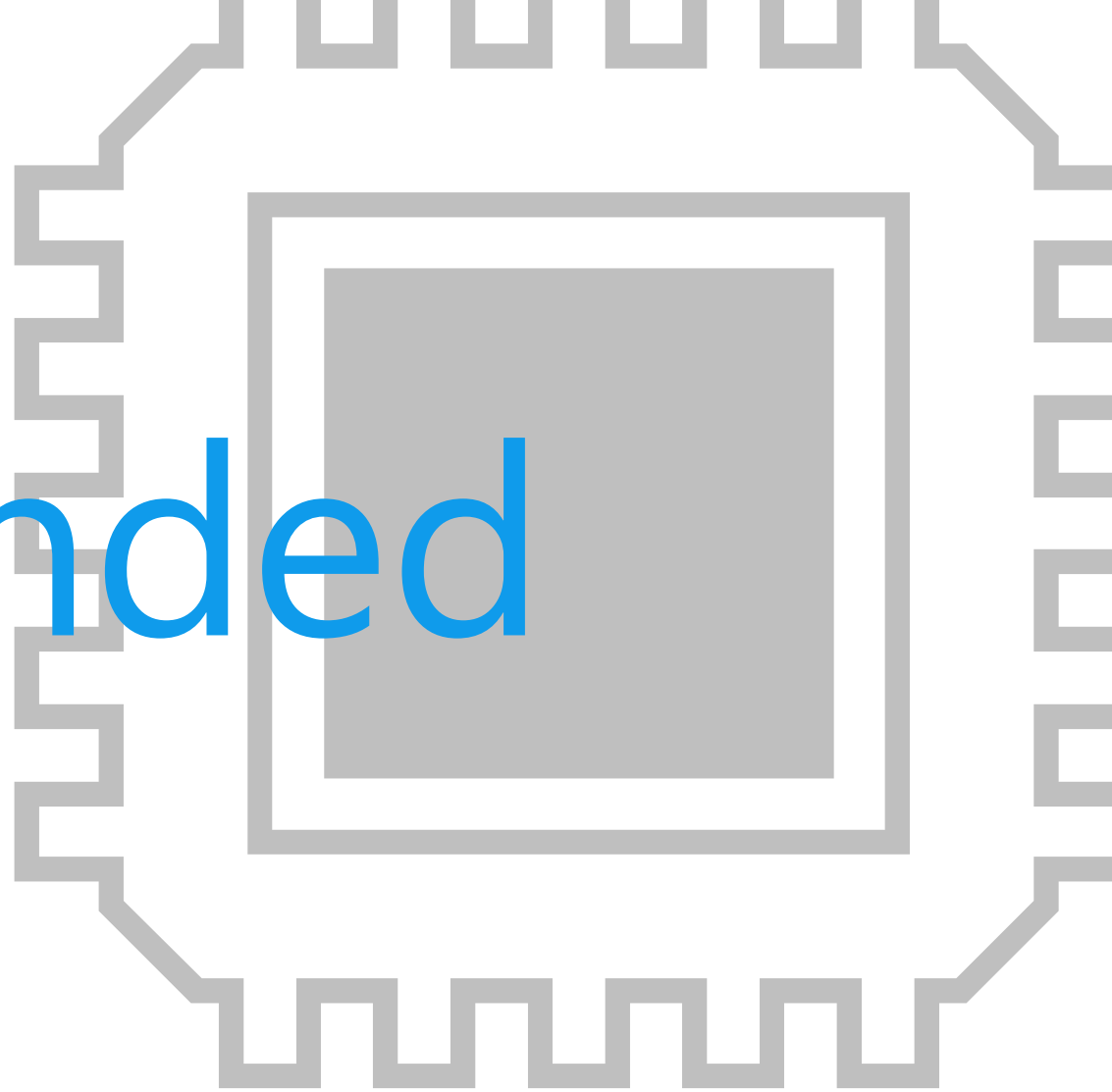
- Over temperature monitoring is required at multiple points on the circuit board such as MOSFET, PMIC and Processor.
- Low power dissipation of set can be realized by using the over temperature detection IC with low current consumption.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **Monitor temperature at multiple points with small package and low current consumption**
Over temperature detection IC
(Thermoflagger™)

* [Click the number in the circuit diagram to jump to the detailed description page.](#)

Recommended Devices



Device solutions to address customer needs

As described above, in the design of the server system, "**Low power consumption and low heat generation**", "**Improved set reliability**" and "**Miniaturization of circuit boards**" are important factors. Toshiba's proposals are based on these three solution perspectives.



Device solutions to address customer needs

Low power consumption
Low heat generation
High heat dissipation efficiency

Noise immunity

Small size packages

	Low power consumption Low heat generation High heat dissipation efficiency	Noise immunity	Small size packages
① U-MOS Series MOSFET	●		●
② Transistor output photocoupler		●	●
③ IC output photocoupler for high speed communication		●	●
④ DTMOS Series MOSFET	●		●
⑤ SiC MOSFET	●	●	
⑥ SiC Schottky barrier diode	●	●	●
⑦ Schottky barrier diode	●		●
⑧ TVS diode		●	●
⑨ Zener diode		●	●
⑩ Semi-power MOSFET	●		●

Device solutions to address customer needs

Low power consumption
Low heat generation
High heat dissipation efficiency

Noise immunity

Small size packages

11 Three-phase brushless DC motor driver IC ●

12 Electronic fuse (eFuse IC) ●

13 Over temperature detection IC (Thermoflagger™) ●

Value provided

Improved on-resistance and switching characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

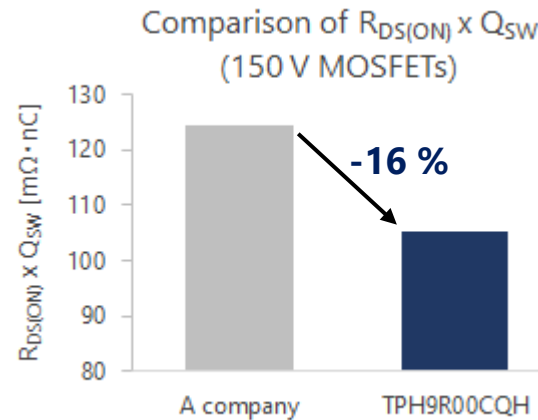
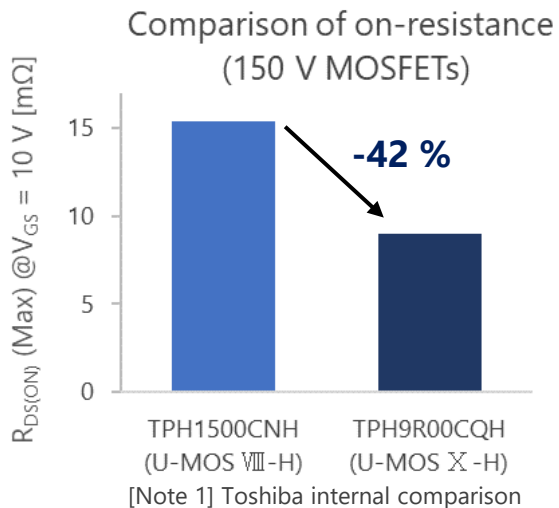
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 42 % compared to Toshiba's conventional 150 V MOSFETs. [Note 1]

2 Small gate switch charge Q_{SW}


The Q_{SW} is small and contributes to the reduction of switching loss. The $R_{DS(ON)} \times Q_{SW}$ has been reduced by 16 % compared to that of competitor's 150 V MOSFETs. [Note 2]

3 Wide variety of packages

5 x 6 mm sized SOP Advance(N) package and 3 x 3 mm sized TSON Advance package are available. Suitable packages for various applications can be selected.



[Note 2] Comparison with competitor's product with equivalent ratings. As of June, 2023. Based on Toshiba's measurement data.

Lineup				
Part number	TPH9R00CQH	TPN12008QM	TPN1200APL	
Package	SOP Advance(N) 	TSON Advance 		
Package size [mm]	5 x 6	3 x 3		
V_{DSS} [V]	150	80	100	
I_D [A]	64 (108*)	26 (60*)	40 (66*)	
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10$ V	Typ.	7.3	9.6	9.8
	Max	9.0	12.3	11.5
Generation	U-MOSX-H	U-MOSX-H	U-MOSIX-H	

*: Silicon limit

[Return to Block Diagram TOP](#)

Value provided

Improved on-resistance and output charge characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

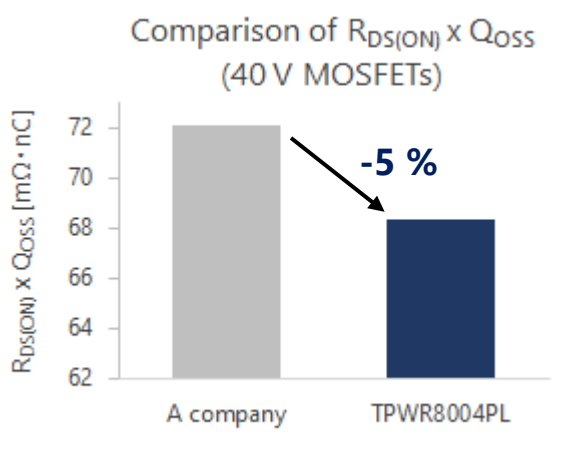
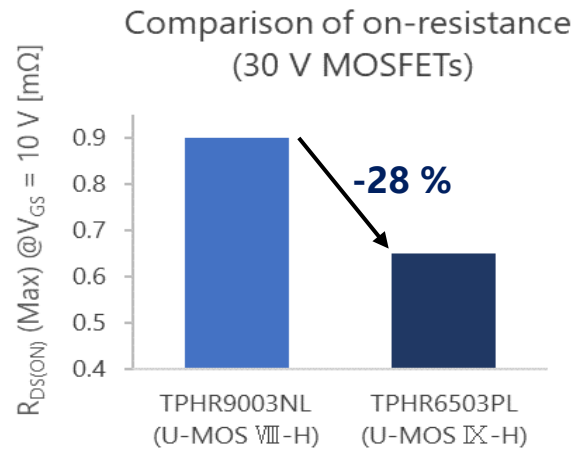
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 28 % compared to Toshiba's conventional 30 V MOSFETs. [Note 1]



2 Small output charge Q_{OSS}

The Q_{OSS} is small and contributes to the reduction of output charge loss. The $R_{DS(ON)} \times Q_{OSS}$ has been reduced by 5 % compared to that of competitor's 40 V MOSFETs. [Note 2]

3 Wide variety of packages

In addition to SOP Advance(N) package, double side cooling DSOP Advance package with same land pattern is available. Suitable packages for various applications can be selected.



Lineup				
Part number	TPHR6503PL	TPHR8504PL	TPWR6003PL	TPWR8004PL
Package	SOP Advance(N)		DSOP Advance	
Package size [mm]	5 x 6			
V_{DSS} [V]	30	40	30	40
I_D [A]	150 (393*)	150 (340*)	150 (412*)	150 (340*)
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10$ V	Typ.	0.41	0.70	0.36
	Max	0.65	0.85	0.60
Generation	U-MOSIX-H	U-MOSIX-H	U-MOSIX-H	U-MOSIX-H

*: Silicon limit

[Return to Block Diagram TOP](#)

[Note 1] Toshiba internal comparison

[Note 2] Comparison with competitor's product with equivalent ratings. As of June, 2023. Based on Toshiba's measurement data.

Value provided

Improved on-resistance and output charge characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

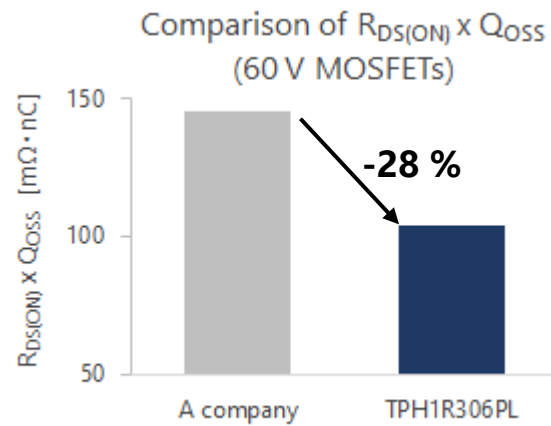
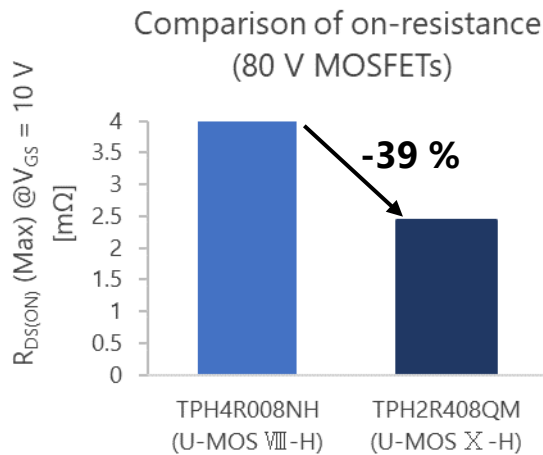
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]


2 Small output charge Q_{OSS}

The Q_{OSS} is small and contributes to the reduction of output charge loss. The $R_{DS(ON)} \times Q_{OSS}$ has been reduced by 28 % compared to that of competitor's 60 V MOSFETs. [Note 2]

3 Small reverse recovery charge Q_{rr}

The Q_{rr} is small and contributes to the reduction of reverse recovery loss. Q_{rr} has been reduced by 20 % compared to that of competitor's 80 V MOSFETs. [Note 2]



Lineup					
Part number	TPHR8504PL	TPH1R306PL	TPH2R408QM	TPH3R10AQM	
Package	SOP Advance(N)  5 x 6 mm				
V_{DSS} [V]	40	60	80	100	
I_D [A]	150 (340*)	100 (260*)	120 (200*)	120 (180*)	
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10\text{ V}$	Typ.	0.70	1.0	1.9	2.5
	Max	0.85	1.34	2.43	3.1
Generation	U-MOSIX-H	U-MOSIX-H	U-MOSX-H	U-MOSX-H	

*: Silicon limit

[Return to Block Diagram TOP](#)

[Note 1] Toshiba internal comparison

[Note 2] Comparison with competitor's product with equivalent ratings. As of June, 2023. Based on Toshiba's measurement data.

Value provided

Improved on-resistance and reverse recovery characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

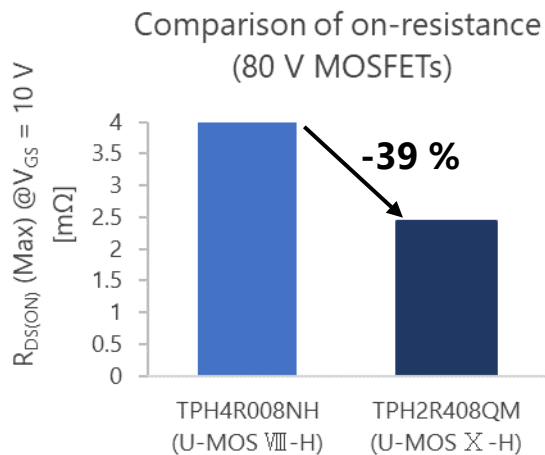
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

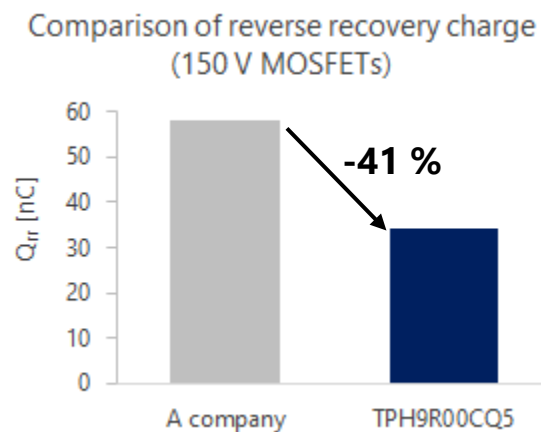
The Q_{OSS} is small and contributes to the reduction of output charge loss. The $R_{DS(ON)} \times Q_{OSS}$ has been reduced by 7 % compared to that of competitor's 150 V MOSFETs. [Note 2]

3 Small reverse recovery charge Q_{rr}

The Q_{rr} is small and contributes to the reduction of reverse recovery loss. Q_{rr} has been reduced by 41 % compared to that of competitor's 150 V MOSFETs. [Note 2]




[Note 1] Toshiba internal comparison



[Note 2] Comparison with competitor's product with equivalent ratings.
As of June, 2023. Based on Toshiba's measurement data.

Lineup

Part number	TPH2R408QM	TPH9R00CQ5
Package	SOP Advance(N)	 5 x 6 mm
V_{DSS} [V]	80	150
I_D [A]	120 (200*)	64 (108*)
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10$ V	Typ.	1.9
	Max	2.43
Generation	U-MOSX-H	U-MOSX-H

*: Silicon limit

[◆Return to Block Diagram TOP](#)

Value provided

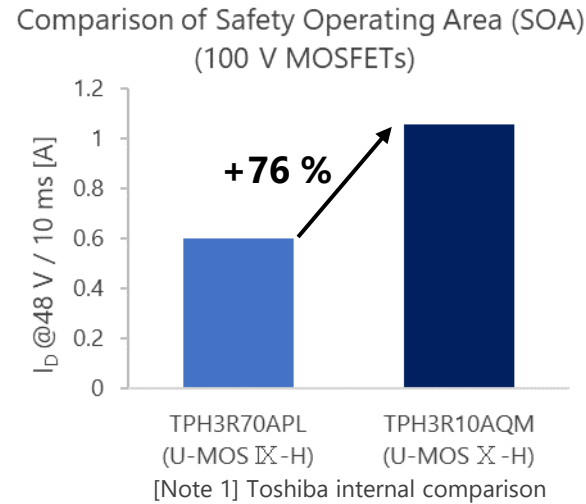
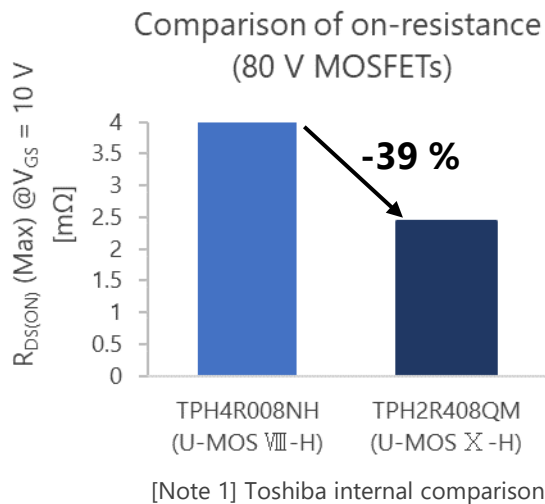
Improved on-resistance and wide Safety Operating Area (SOA) contribute to realizing the set with high efficiency and reliability.

1 Low on-resistance


Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small.
 $R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]

2 Wide Safety Operating Area (SOA)

The adoption of the latest process has increased the safety operating area by 76 % compared to Toshiba's conventional 100 V MOSFETs. [Note 1]
 Expands the operating range in the transient area.



Lineup

Part number	TPHR6503PL	TPH2R408QM	TPH3R10AQM
Package	SOP Advance(N)  5 x 6 mm		
V_{DSS} [V]	30	80	100
I_D [A]	150 (393*)	120 (200*)	120 (180*)
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10$ V	Typ.	0.41	1.9
	Max	0.65	2.43
Generation	U-MOSIX-H	U-MOSX-H	U-MOSX-H

*: Silicon limit

[Return to Block Diagram TOP](#)

2 Transistor output photocoupler

TLP383 / TLP291(SE)

Low power consumption
Low heat generation
High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

Contribute to the elimination of equipment maintenance by improving reliability and the reduction of the board footprint area.

1 High current transfer ratio

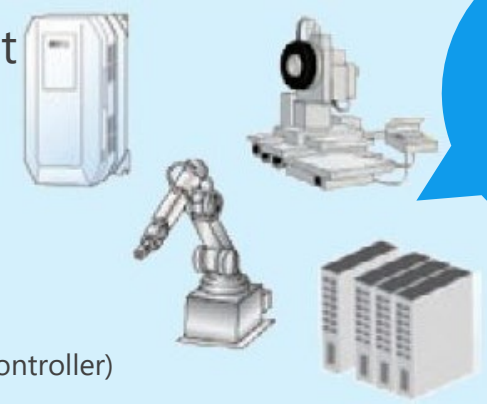
These are photo couplers of high isolation type that consists of a phototransistor optically coupled to an infrared LED. It achieves high current transfer ratio.

2 Wide operating temperature range

It is designed to operate even under severe ambient temperature conditions, such as inverters, robots, machinery, and high output power supplies.

Industrial equipment

- General purpose inverter
- Servo amplifier
- Robot
- Machine Tool
- High output power supply
- Security equipment
- Semiconductor tester
- PLC (Programmable Logic Controller)
- Server



High level of isolation and noise blocking

Lineup

Part number	TLP383	TLP291(SE)
Package	4pin SO6L 	SO4 
BV _S [Vrms]	5000	3750
T _{opr} [°C]	-55 to 125	-55 to 110

[Return to Block Diagram TOP](#)

Value provided

Photocopier that consists of an infrared light-emitting diode and an integrated photodetector with high gain and high speed.

1 High speed

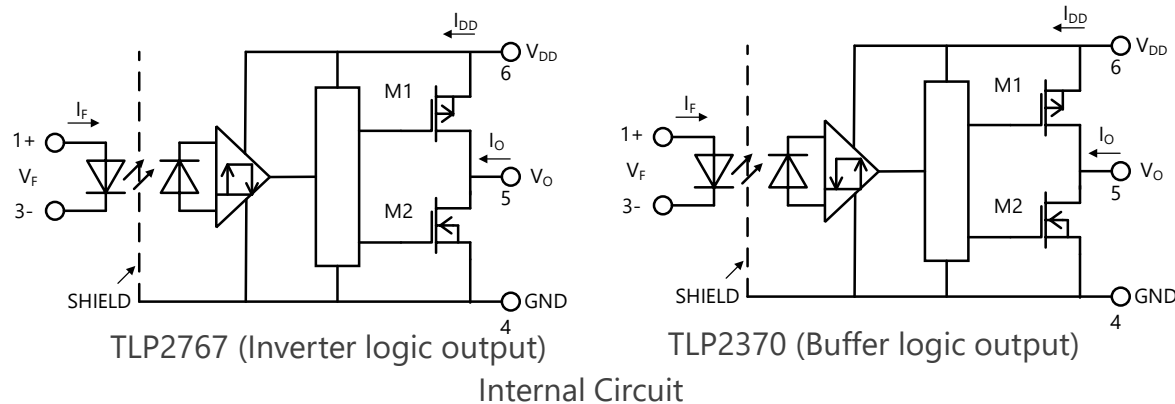
The propagation delay is 20 ns (Max) for TLP2767 and 60 ns (Max) for TLP2370. Margin design becomes easier than general phototransistor couplers.

2 Operating temperature is expanded to 125 °C



It is designed to operate even under severe ambient temperature conditions, such as inverters, robots, machinery, and high output power supplies.

3 Wide range of power supply voltages 2.7 to 5.5 V

The products can be used even in systems in which 3.3 V and 5.0 V are mixed, thereby possible to standardize components.



Lineup

Part number	TLP2767	TLP2370
Package	SO6L 	5pin SO6 
V_{DD} [V]	2.7 to 5.5	2.7 to 5.5
I_{DD} (Max) [mA]	2.5	0.4
t_{pd} (Max) [ns]	20	60
BV_S [Vrms]	5000	3750
T_{opr} [°C]	-40 to 125	-40 to 125

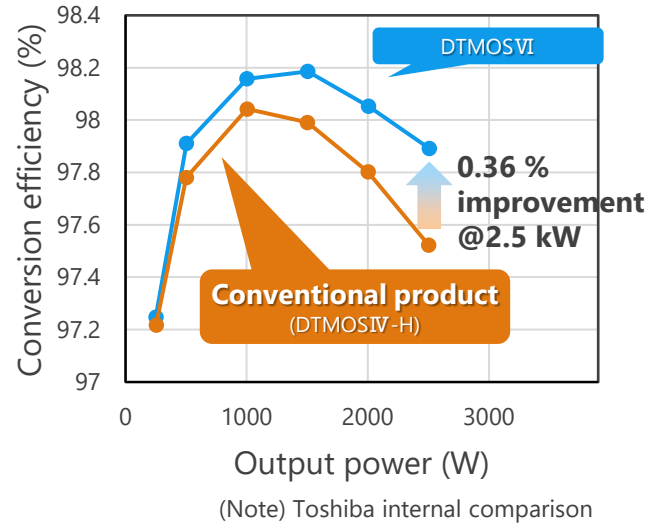
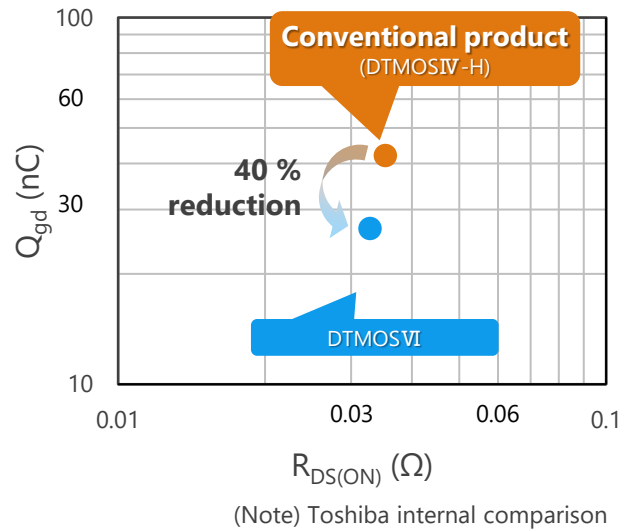
[Return to Block Diagram TOP](#)

Value provided

The $R_{DS(ON)} \times Q_{gd}$ is reduced by 40 % (compared with Toshiba's conventional products) to improve power efficiency, and contributing to miniaturization of the set.






1 $R_{DS(ON)} \times Q_{gd}$ 40 % reduction

The $R_{DS(ON)} \times Q_{gd}$ of figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison of DTMOSIV-H Products: Toshiba internal comparison)



2 Various package lineup

Various package line up from the TO-247-4L package with Kelvin terminal to thin surface mount type package (DFN8x8) with package thickness 0.85 mm.

Lineup						
Part number	TK040N65Z	TK040Z65Z	TK090A65Z	TK099V65Z	TK090U65Z	
Package	TO-247 	TO-247-4L 	TO-220SIS 	DFN8x8 	TOLL 	
V_{DSS} [V]	650	650	650	650	650	
I_D [A]	57	57	30	30	30	
$R_{DS(ON)}$ [Ω] @ $V_{GS} = 10$ V	Typ.	0.033	0.033	0.075	0.080	0.07
	Max	0.040	0.040	0.090	0.099	0.09
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	

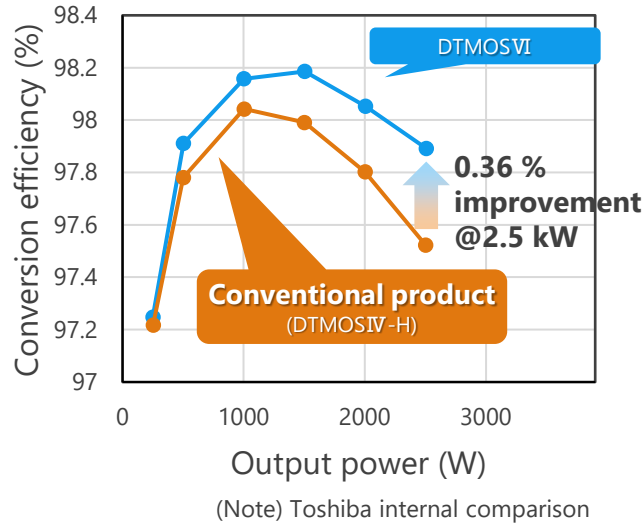
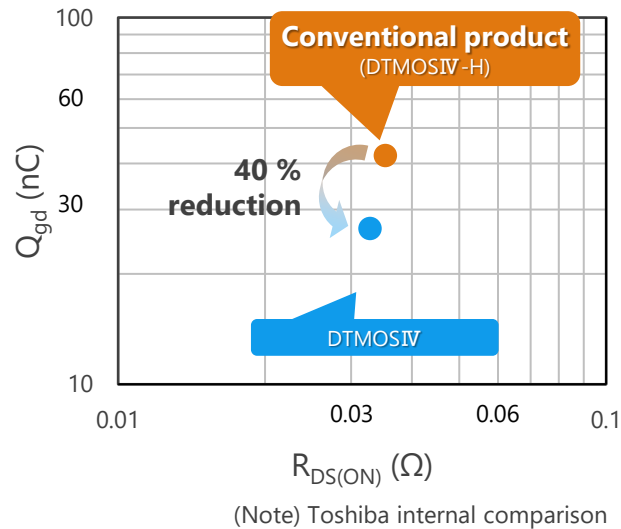
[Return to Block Diagram TOP](#)

Value provided

The $R_{DS(ON)} \times Q_{gd}$ is reduced by 40 % (compared with Toshiba's conventional products) to improve power efficiency, and contributing to miniaturization of the set.

1 $R_{DS(ON)} \times Q_{gd}$ 40 % reduction

The $R_{DS(ON)} \times Q_{gd}$ of figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison of DTMOSIV-H Products: Toshiba internal comparison)



2 Various package lineup

Various package line up from the TO-247-4L package with Kelvin terminal to thin surface mount type package (DFN8x8) with package thickness 0.85 mm.

Lineup						
Part number	TK110N65Z	TK110Z65Z	TK110A65Z	TK125V65Z	TK110U65Z	TK155U65Z
Package	TO-247	TO-247-4L	TO-220SIS	DFN8x8	TOLL	
V_{DSS} [V]	650	650	650	650	650	650
I_D [A]	24	24	24	24	24	18
$R_{DS(ON)}$ [Ω] @ $V_{GS} = 10$ V	Typ.	0.092	0.092	0.092	0.105	0.122
	Max	0.11	0.11	0.11	0.125	0.155
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI

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Value provided

The performance index $R_{DS(ON)} \times Q_{gd}$, which shows switching characteristics, is reduced by 80 % compared with Toshiba's existing products. This contributes to lower loss of power supply in application.

1 Low $R_{DS(ON)} \times Q_{gd}$

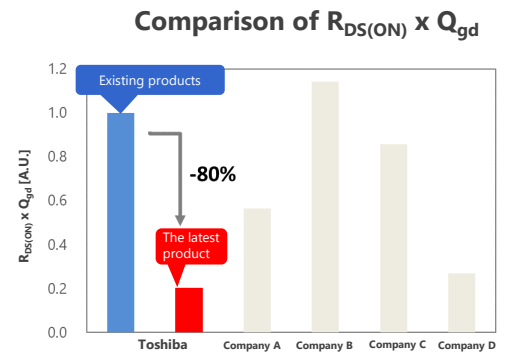
For the latest products, the performance index $R_{DS(ON)} \times Q_{gd}$, which shows the relation between conduction loss and switching loss, is reduced by 80 % compared with Toshiba's existing products by optimizing its cell structure.

2 Wide V_{GS} specification

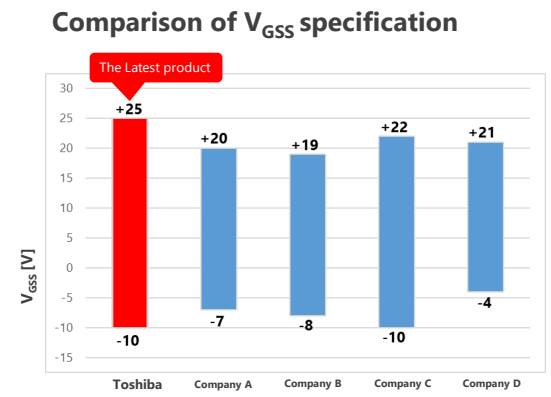
The specification of the gate-source voltage is -10 to 25 V, which is wider than that of other companies' products [Note], allows a wider margin for the drive voltage and makes gate drive design considering overshoot easier. (Recommended drive voltage: 18 V)

3 Built-in Schottky barrier diode

Built-in Schottky barrier diode reduces V_{DSF} during reverse conduction to 1.35 V (typ.). In addition, by energizing the Schottky barrier diode, fluctuation in $R_{DS(ON)}$ caused by the spread of defects is suppressed.





Measurement conditions
 $R_{DS(ON)}$: $V_{GS} = 18 \text{ V}$, $I_D = 20 \text{ A}$, $T_a = 25 \text{ }^\circ\text{C}$
 Q_{gd} : $V_{DD} = 800 \text{ V}$, $V_{GS} = 18 \text{ V}$, $I_D = 20 \text{ A}$, $T_a = 25 \text{ }^\circ\text{C}$
 (Toshiba internal comparison, as of May 2022)



[Note] Toshiba internal comparison based on the datasheet of each company's 1200 V voltage products as of July 2023.

Lineup

Part number	TW015N65C	TW027N65C	TW048N65C	TW015Z65C	TW027Z65C	TW048Z65C
Package	TO-247 			TO-247-4L(X) 		
V_{DSS} [V]	650	650	650	650	650	650
I_D [A]	100	58	40	100	58	40
$R_{DS(ON)}$ [Ω] @ $V_{GS} = 18 \text{ V}$	Typ.	0.015	0.027	0.048	0.015	0.027
	Max	0.021	0.037	0.065	0.022	0.038
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch

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Value provided

SiC SBDs [Note1] with low loss and high efficiency are realized by adopting new metal and optimizing device design.

[Note1] SBD: Schottky barrier diode

1 Low forward voltage (V_F)

For the latest products, new metal and thin wafer technology are introduced. $V_F = 1.2$ V (Typ.) is realized as compared with $V_F = 1.45$ V (Typ.) of our existing products. V_F is reduced by about 17 %.

2 Improvement of power supply efficiency

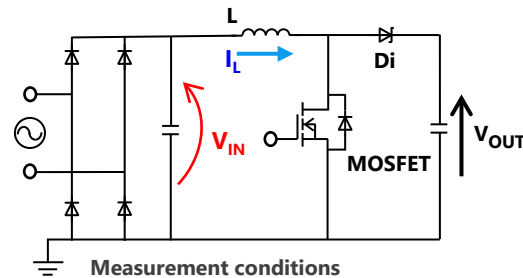
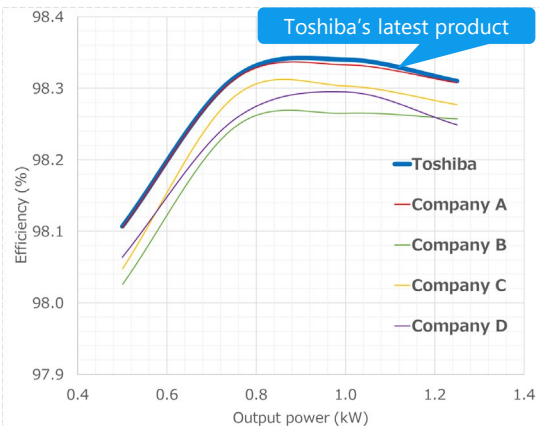
Compared with our existing products, the trade off of $V_F \times Q_C$ [Note2] of the latest products have improved. About 0.1 % of conversion efficiency improvement have also achieved under 800 W output condition in our test.

3 Expansion of package series

In addition to the existing package series, DFN8x8 surface mount package type has prepared. It contributes to miniaturization and high power density of equipment.

[Note2] The $V_F \times Q_C$ (product of forward voltage and total charge) is an index representing the loss performance of the SiC SBD. When comparing the products with the same current rating, the smaller the index, the lower the loss.

Comparison between Toshiba's latest product and competitor products







Measurement conditions

$V_{IN} = 200$ V AC
 $V_{OUT} = 400$ V DC
 $f = 65$ kHz
 MOSFET: TK040Z65Z
 MOSFET external gate resistance = 4.7Ω
 $T_a = 25$ °C

(Toshiba internal comparison, as of July 2023)

Lineup

Part number	TRS12A65F	TRS24N65FB	TRS2E65H	TRS12E65H	TRS4V65H	TRS12V65H
Package	 TO-220F-2L	 TO-247 (Center tap)	 TO-220-2L			 DFN8x8
V_{RRM} [V]	650	650	650	650	650	650
$I_{F(DC)}$ [A]	12	12 / 24 *	2	12	4	12
I_{FSM} [A]	92	92 / 184 *	19	74	28	60
V_F (Typ.) [V]	1.45 @ $I_F = 12$ A	1.45 @ $I_F = 12$ A	1.2 @ $I_F = 2$ A	1.2 @ $I_F = 12$ A	1.2 @ $I_F = 4$ A	1.2 @ $I_F = 12$ A

*: Per Leg / Both Legs

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Value provided

Wide lineup of small package with high power dissipation and reverse voltage. Low V_F Schottky barrier diode suppresses negative voltage surges.

1 Small package with high power dissipation

Wide lineup of power dissipation. US2H package has low thermal resistance.
 $(R_{th(j-a)}) = 105 \text{ }^\circ\text{C/W}$ [Note]

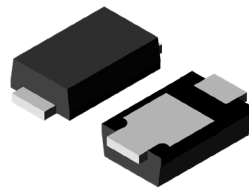
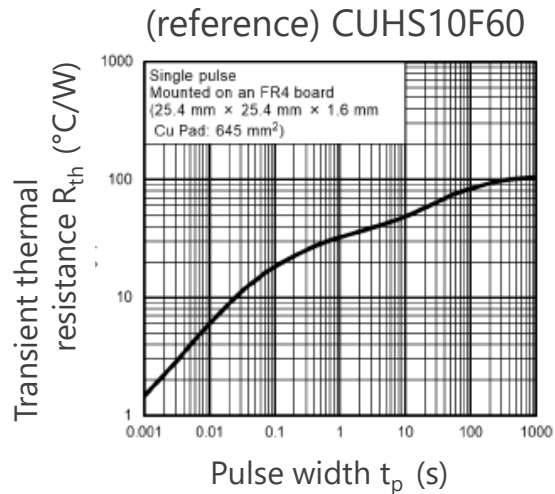
2 Wide lineup of reverse voltage

Lineup of reverse voltage V_R is 30 V, 40 V and 60 V (Max.).

3 Low V_F


Low V_F Schottky barrier diode suppresses negative voltage surges.

[Note] Assembled on FR4 circuit board (25.4 × 25.4 × 1.6 mm, Cu Pad: 25.4 x 25.4 mm)



US2H
(2.5 x 1.4 mm)

Transient thermal resistance is low and thermal design is easy.

Lineup							
Part number	CUHS20F30	CUHS20F40	CUHS10F60	CUHS15F60	CUHS20F60	CUHS15S60	CUHS20S60
Package	US2H 						
V_R [V]	30	40	60	60	60	60	60
I_O [A]	2	2	1	1.5	2	1.5	2
V_F (Typ.) [V] @ $I_F = 1 \text{ A}$	0.35	0.39	0.56	0.55	0.41	0.48	0.35
I_R (Max) [μA]	60 @ $V_R = 30 \text{ V}$	60 @ $V_R = 40 \text{ V}$	40 @ $V_R = 60 \text{ V}$	50 @ $V_R = 60 \text{ V}$	70 @ $V_R = 60 \text{ V}$	450 @ $V_R = 60 \text{ V}$	650 @ $V_R = 60 \text{ V}$

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Value provided

Absorbs static electricity from external terminals, prevents circuit malfunction, and protects devices.

1 Improved ESD pulse absorption

Improved ESD absorption compared to conventional products. (50 % reduction in operating resistance)
For some products, both low operating resistance and low capacitance are realized and ensures high signal protection performance and signal quality.

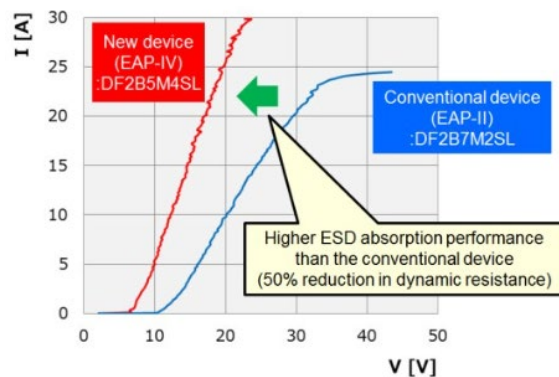
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using proprietary technology.

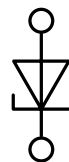
3 Suitable for high density mounting

A variety of small packages are available.

ESD Pulse Absorption Performance
Toshiba internal comparison



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	DF2B7ASL	DF2B5M4SL	DF2B6M4SL
Package		SL2 	
V_{ESD} [kV]	± 30	± 20	± 20
V_{RWM} (Max) [V]	5.5	3.6	5.5
C_t (Typ.) [pF]	8.5	0.2	0.2
R_{DYN} (Typ.) [Ω]	0.2	0.5	0.5
Purpose	Power line protection	Signal line protection	

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

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Value provided

A wide lineup of packages and Zener voltage are available to meet diverse needs.

1 Suitable for overvoltage surge protection

It can protect not only against ESD surges but also overvoltage surges close to DC.

Surge tolerance varies depending on the series.
 $P_{RSM} - t_w$ data in the data sheet is a guide. Please refer it.

2 Variety of package lineup

Various lineups of surface mount products.

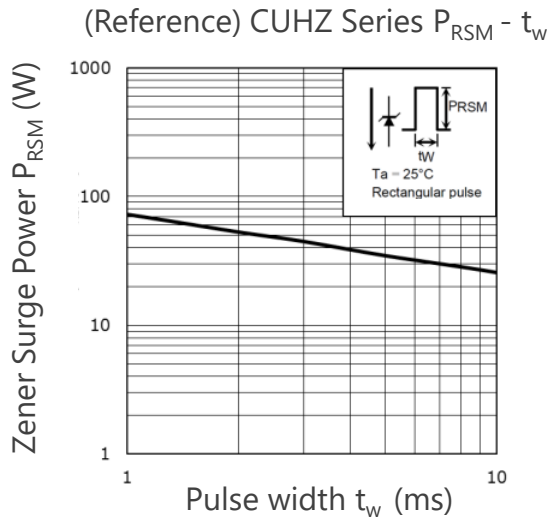
CSLZ Series: 0.62 x 0.32 mm
 CUHZ Series: 2.5 x 1.4 mm
 CRx Series: 3.5 x 1.6 mm


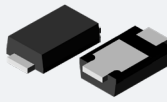

Other packages and products are here [\(Link\)](#)


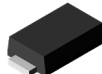

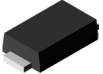


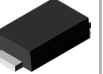

3 Wide lineup of V_Z

Lineup of V_Z (typ.) is from 5.6 V to 36 V.
 It can be used for required supply voltage.

For 3.3 V: CSLZ5V6, CUHZ5V6
 For 5 V: CSLZ6V2, CUHZ6V2, CRY62
 For 12 V: CSLZ16V, CUHZ16V, CRZ16



Series	Package information
CRx Series	 S-FLAT™ 1.6 x 3.5 x 0.98 mm
CUHZ Series	 US2H (SOD-323HE) 2.5 x 1.4 x 0.6 mm
CSLZ Series	 SL2 (SOD-962) 0.62 x 0.32 x 0.3 mm

Lineup								
Power supply voltage [V]	3.3		5			12		
Part number	CSLZ5V6	CUHZ5V6	CSLZ6V2	CUHZ6V2	CRY62	CSLZ16V	CUHZ16V	CRZ16
V_Z [V]	5.3 to 6.0	5.3 to 6.0	5.8 to 6.6	5.8 to 6.6	5.6 to 6.8	15.3 to 17.1	15.3 to 17.1	14.4 to 17.6
I_Z [mA]	5	10	5	10	10	5	10	10
Package								

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Value provided

Low on-resistance, small and high power dissipation packages contribute to miniaturization and low power consumption of the systems.

1 Low loss (reduced chip resistance)

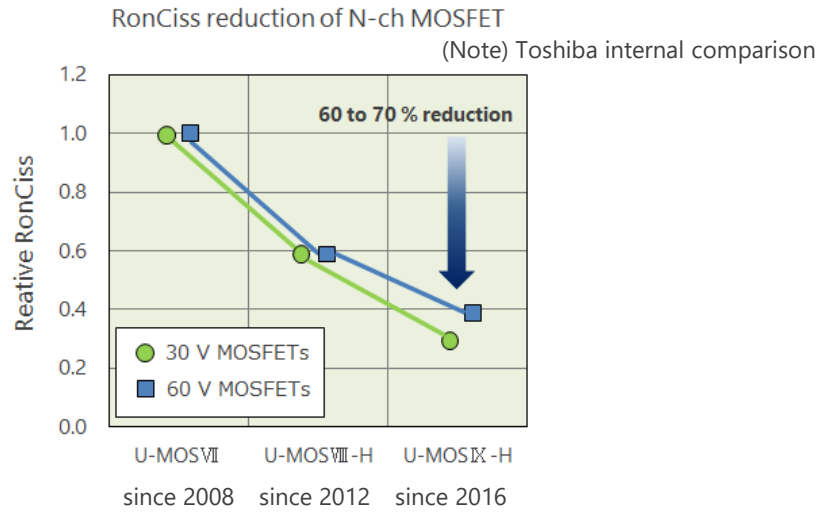
Using low chip resistance technology to contribute to reduced power consumption systems.

2 Small and high heat dissipating package



Small and high heat dissipating packages (UDFN6B, SOT-23F) contribute to space saving during mounting.

3 Low voltage drive

Power consumption of the set can be reduced by low voltage drive.



Lineup

Part number	SSM6K341NU	SSM3K341R
Package	UDFN6B 	SOT-23F 
V_{DSS} [V]	60	60
I_D [A]	6	6
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 4.5$ V	Typ.	36
	Max	51
Polarity	N-ch	N-ch

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Value provided

One hall sine wave PWM control driver for three-phase brushless DC motor. It is suitable for controlling server fans.

1 Built-in one hall phase difference detection circuit

Monitoring one hall element output voltage and controlling a motor. Possible to reduce motor unit BOM.

2 Built-in closed loop speed control

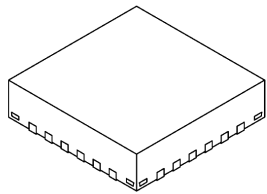
NVM [Note] is implemented. It realizes closed loop speed control function without an external MCU. It contributes to reduce system cost.

[Note] No-volatile memory

3 Small package

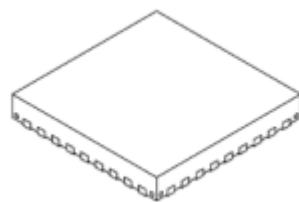
VQFN24 and WQFN36 are suitable for mounting limited space.

TC78B025FTG / TC78B027FTG



P-VQFN24-0404-002 /
P-VQFN24-0404-003
(4 x 4 x 0.9 mm)

TC78B009FTG



P-WQFN36-0505-0.50-001
(5 x 5 x 0.8 mm)

Lineup

Part number	TC78B025FTG	TC78B027FTG	TC78B009FTG
Operation voltage [V]	4.5 to 16	5 to 16	5.5 to 27
Drive type	Sine wave PWM drive		PWM drive
Others	1 hole element input position detection		Sensorless
	Closed loop speed control function, configurable speed curve		
	Standby mode		
	Soft start		
	Built-in driver (3.5 A (Max))	Built-in pre driver for N-ch MOSFET drive	
Package	P-VQFN24-0404-002	P-VQFN24-0404-003	P-WQFN36-0505-0.50-001

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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.

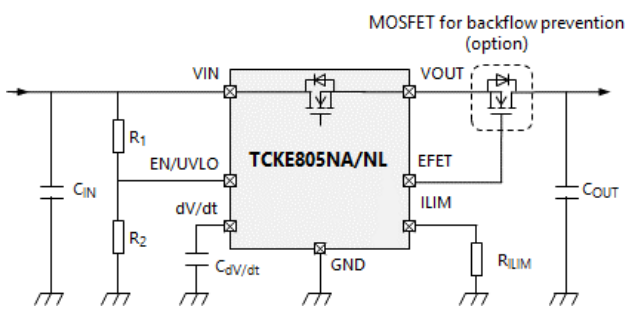
2 IEC 62368-1 certified

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.

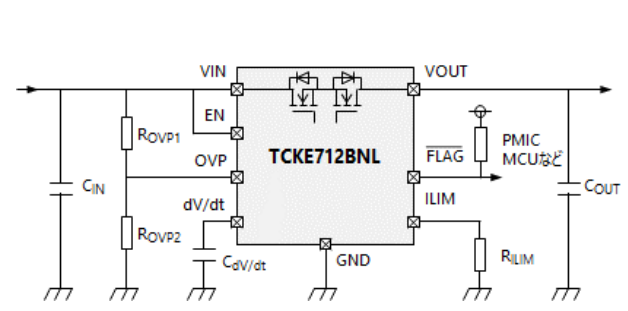
3 Various protection functions

TCKE8 Series: Short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.
TCKE7 Series: Short-circuit protection, overcurrent protection, overvoltage protection, thermal shut down, FLAG signal output, backflow prevention (built-in), etc.

Reference circuit example of TCKE8 Series



Reference circuit example of TCKE7 Series



Lineup

Part number	TCKE800NA/NL	TCKE805NA/NL	TCKE812NA/NL	TCKE712BNL
Package	WSO10B 3.0 x 3.0 x 0.75 mm			WSO10 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
Return function	NA: Automatic return NL: Latch type (external signal control)			Latch type (external signal control)
V _{OVC} (Typ.) [V]	-	6.04	15.1	Adjustable

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Value provided

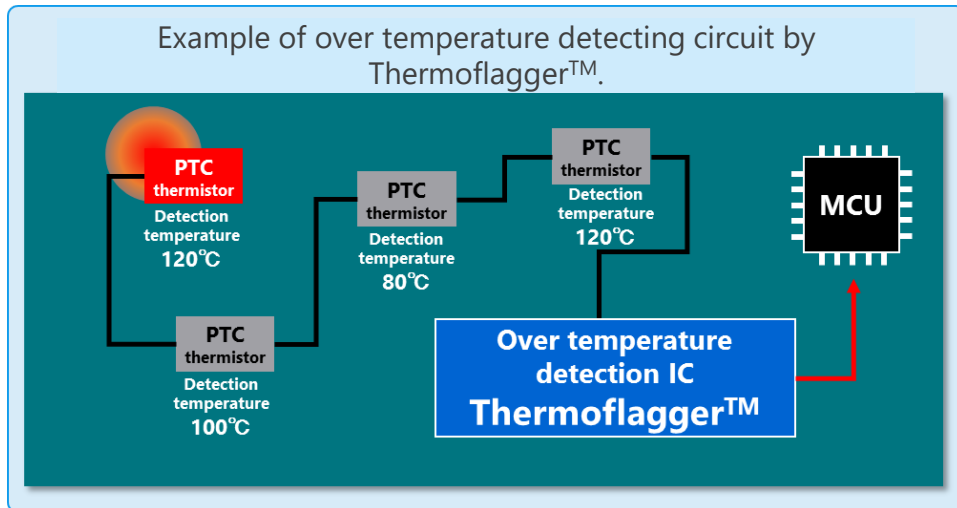
TCTH series can detect temperature rise at multiple points on the circuit board.


1 Temperature rise can be detected at multiple points

TCTH series detect an increase in resistance during over temperature by supplying a constant current (1 μA or 10 μA) to PTC (Positive Temperature Coefficient) thermistors. Multiple PTC thermistors connected in series enable to detect over temperature at multiple points on the circuit board.

2 Low current consumption and small package

TCTH01 series has $I_{DD} = 1.8 \mu\text{A}$ (Typ.) and TCTH02 series has $I_{DD} = 11.3 \mu\text{A}$ (Typ.). These packages are small size ESV type.



Lineup				
Part number	TCTH011AE TCTH011BE	TCTH012AE TCTH012BE	TCTH021AE TCTH021BE	TCTH022AE TCTH022BE
Package	ESV 1.6 x 1.6 x 0.55 mm 			
V_{DD} [V]	1.7 to 5.5			
I_{DD} (Typ.) [μA]	1.8		11.3	
PTCO Output current (Typ.) [μA]	1	1	10	10
Abnormal latch function	-	Yes	-	Yes
Output circuit type	AE: push pull, BE: open drain			

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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>



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