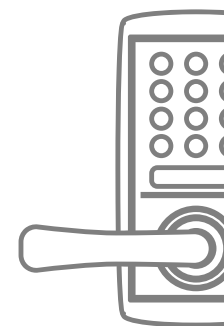
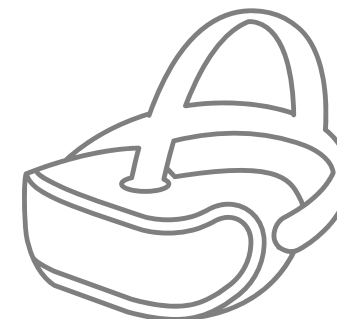
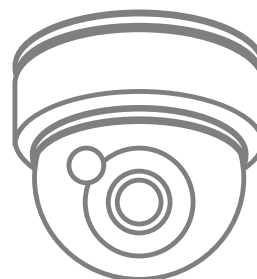
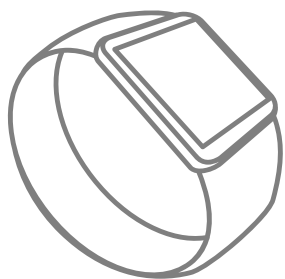
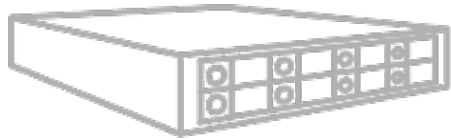
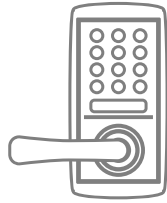
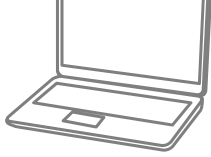


Server

Solution Proposal by Toshiba

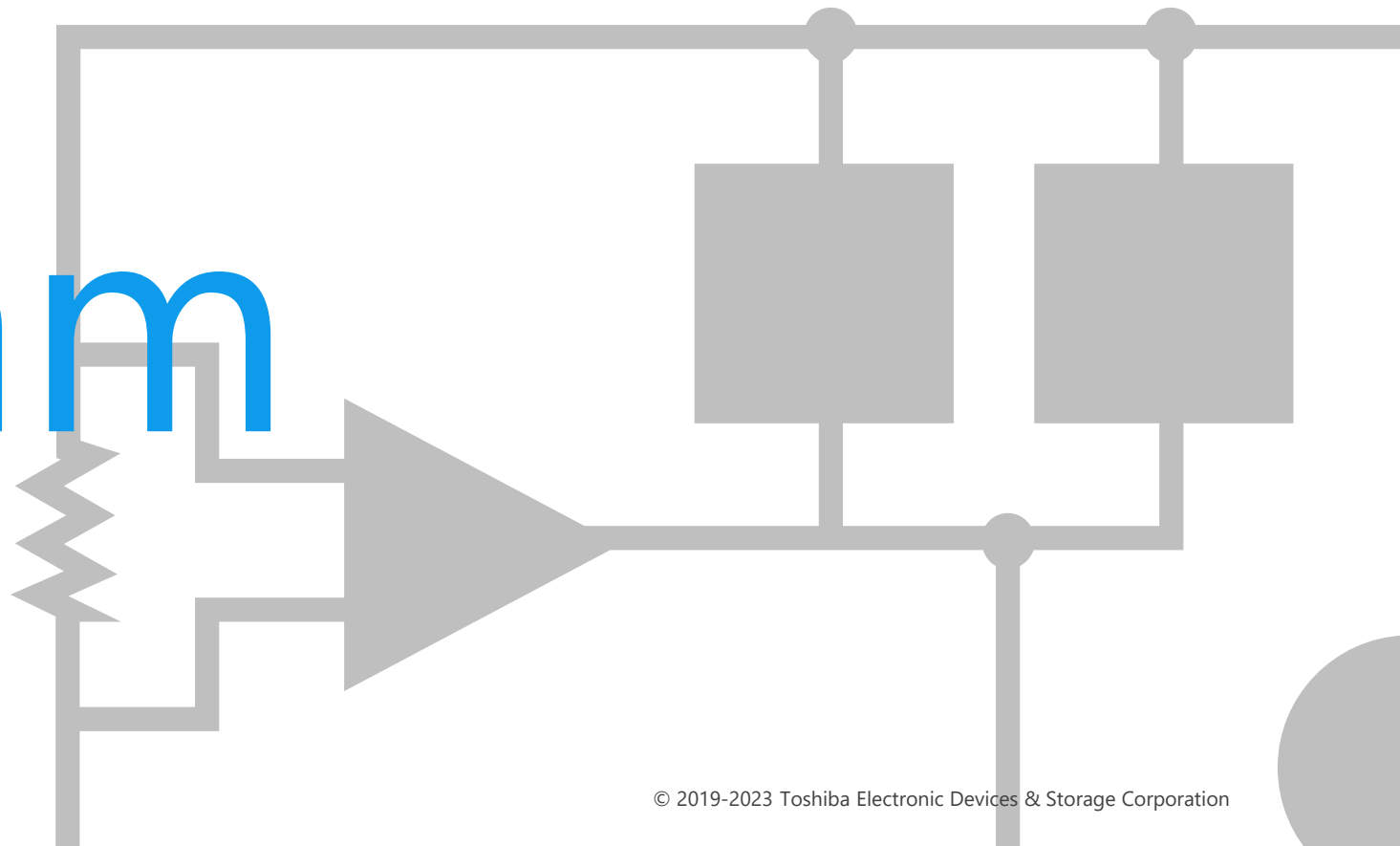




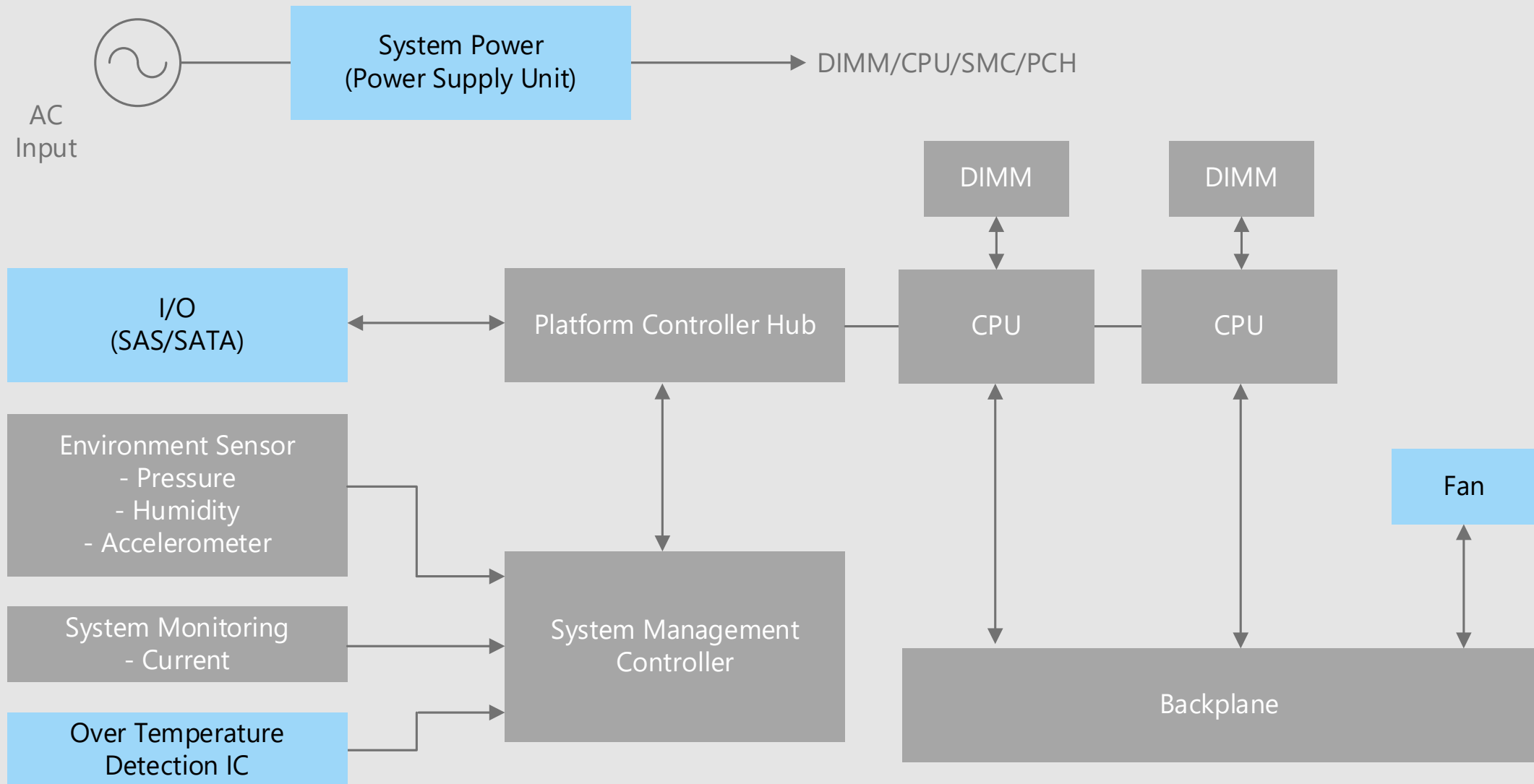
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.



Block Diagram



Server Overall block diagram

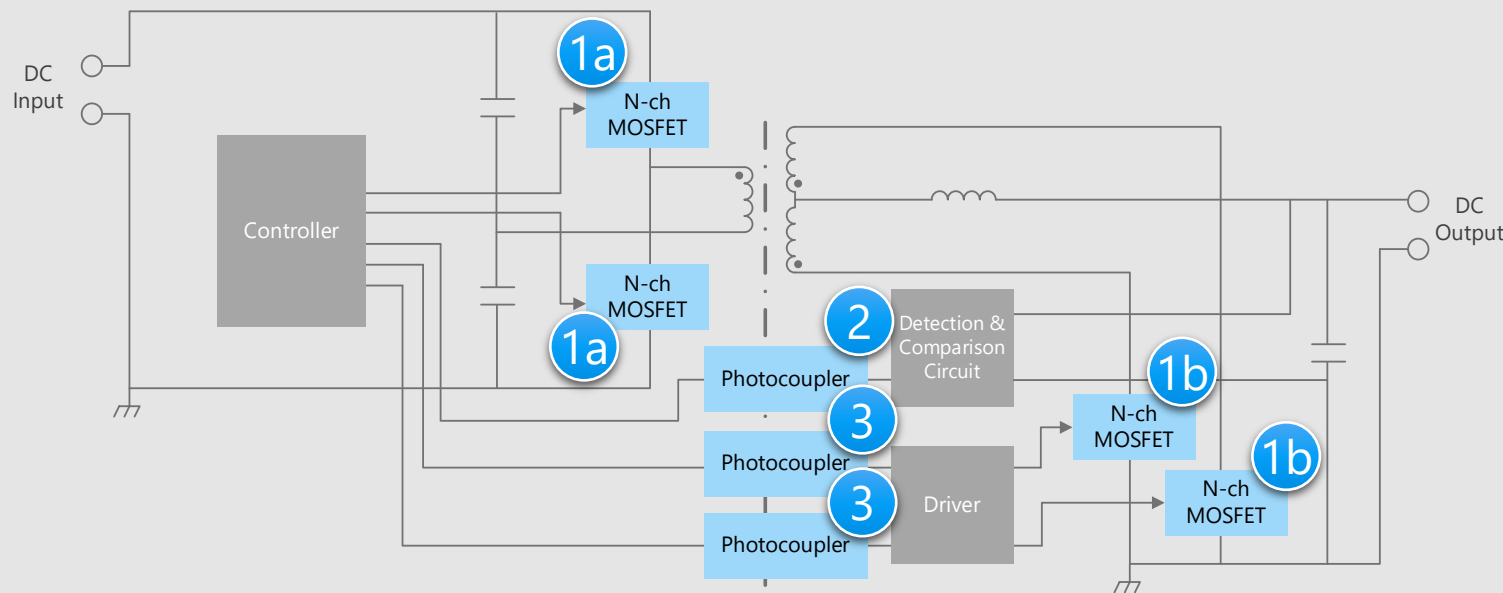


Server Detail of power supply circuit (1)

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 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**

U-MOS Series MOSFET

- **Realize high gain and high speed isolated signal transmission**

Transistor output photocopler

IC output photocopler

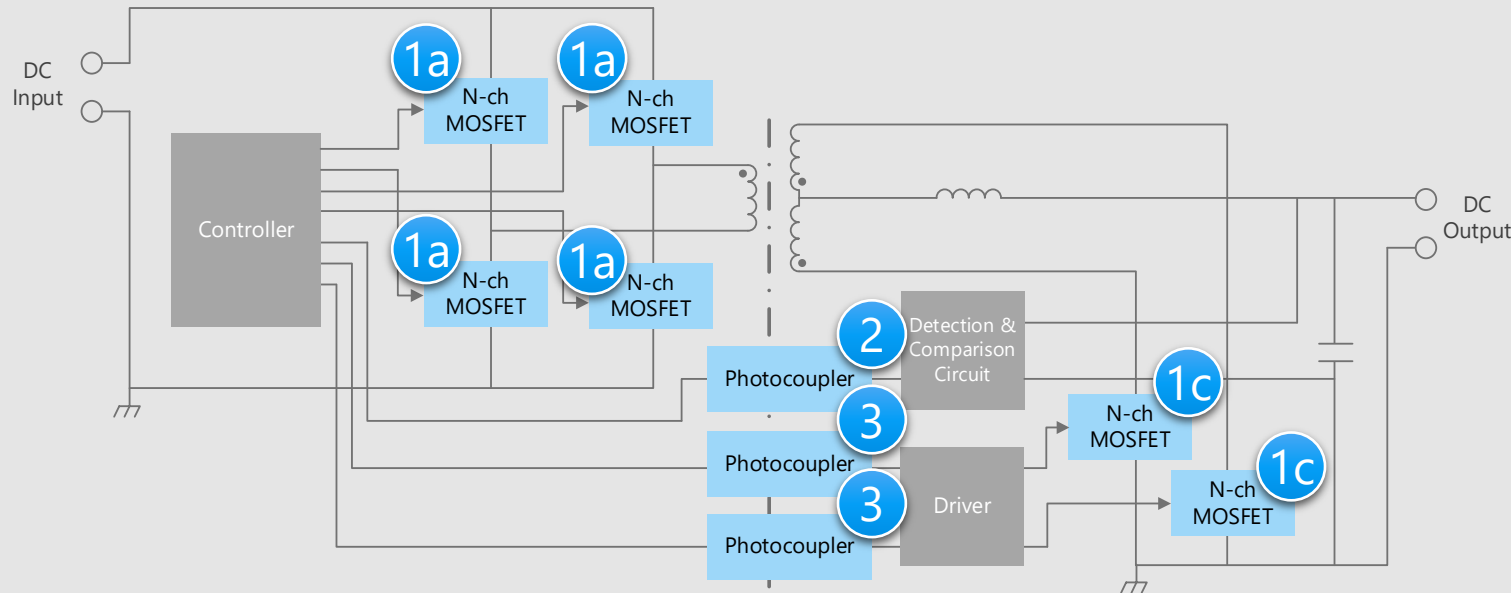
for high speed communication

Server Detail of power supply circuit (2)

DC-DC converter for 48 V system

300 W isolated DC-DC converters power supply

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



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**
U-MOS Series MOSFET
- **Realize high gain and high speed isolated signal transmission**
Transistor output photocoupler
IC output photocoupler
for high speed communication

1a 1c

2

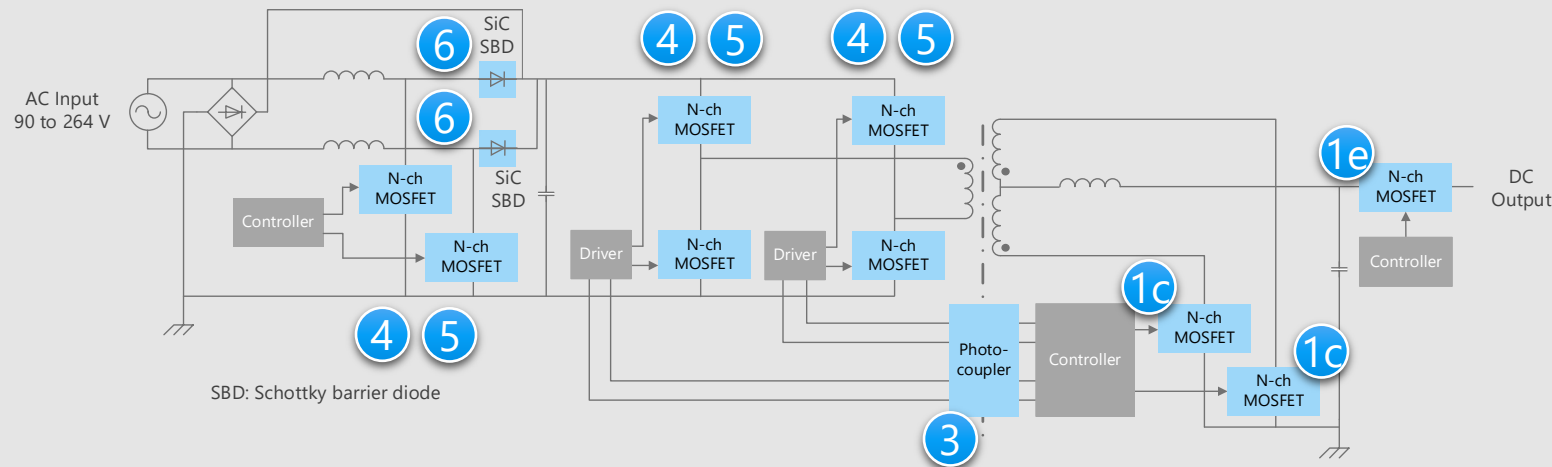
3

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

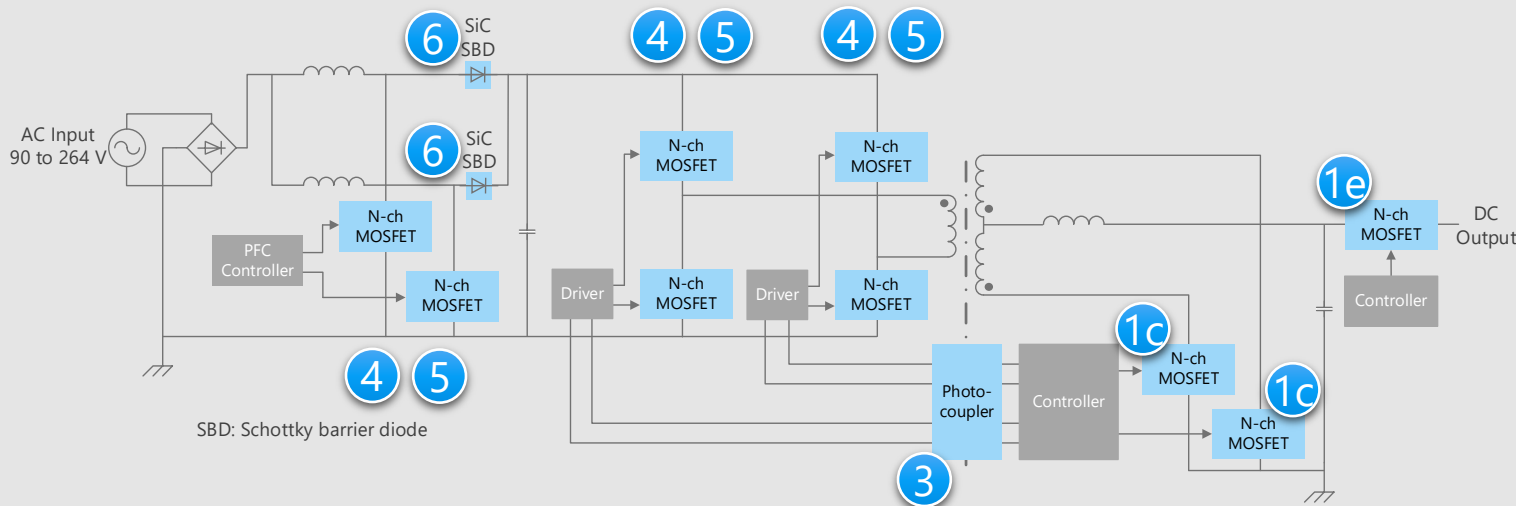
- **Suitable for efficient switching of power supply**
U-MOS Series MOSFET 1c 1e
- **Realize high gain and high speed isolated signal transmission**
IC output photocoupler for high speed communication 3
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET 4
SiC MOSFET 5
- **Preferred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

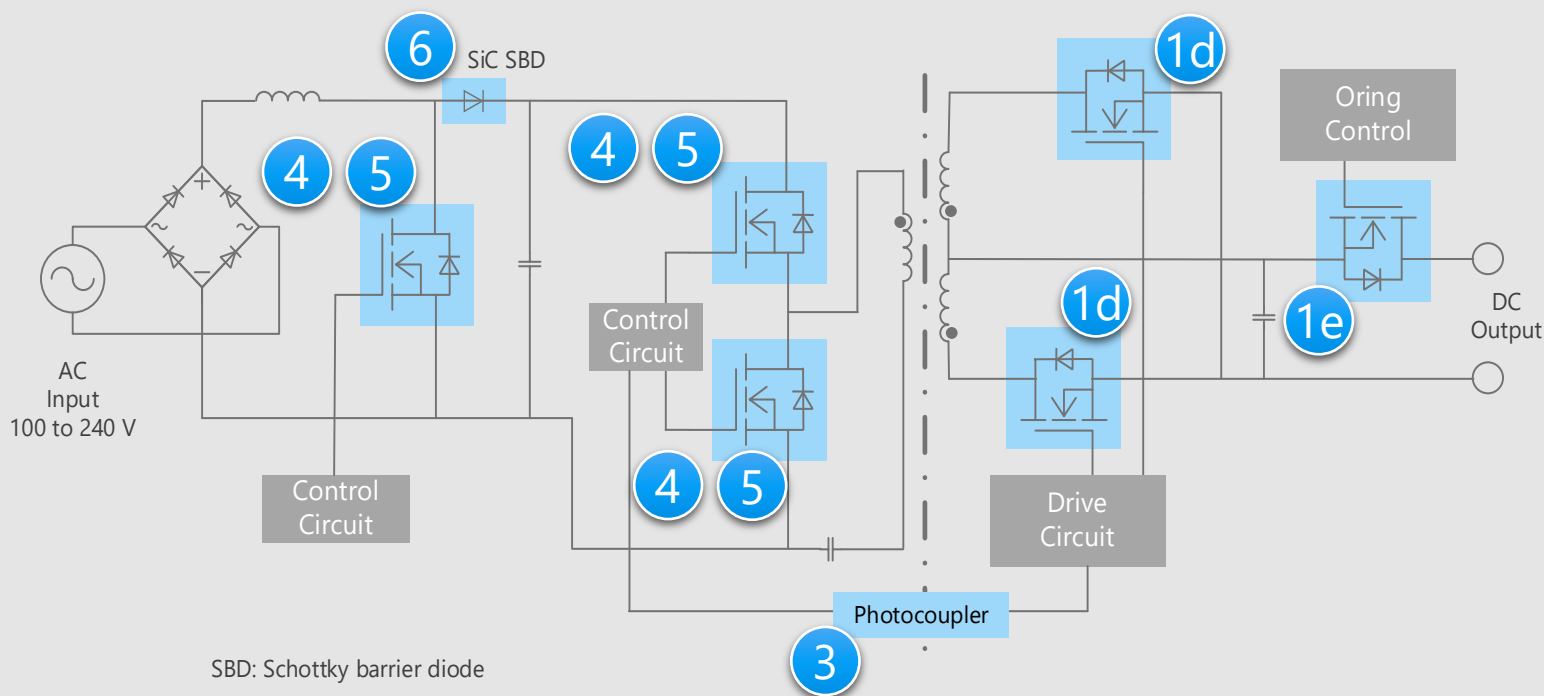
- A MOSFET having a high voltage and a low on-resistance is suitable for the PFC circuit of the AC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the AC-DC power supply.
- The IC output photocoupler for high speed communication is used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

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
U-MOS Series MOSFET
- **Realize high gain and high speed isolated signal transmission**
IC output photocoupler
for high speed communication
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET
SiC MOSFET
- **Preferred for high efficiency and miniaturization of power supply**
SiC Schottky barrier diode

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.

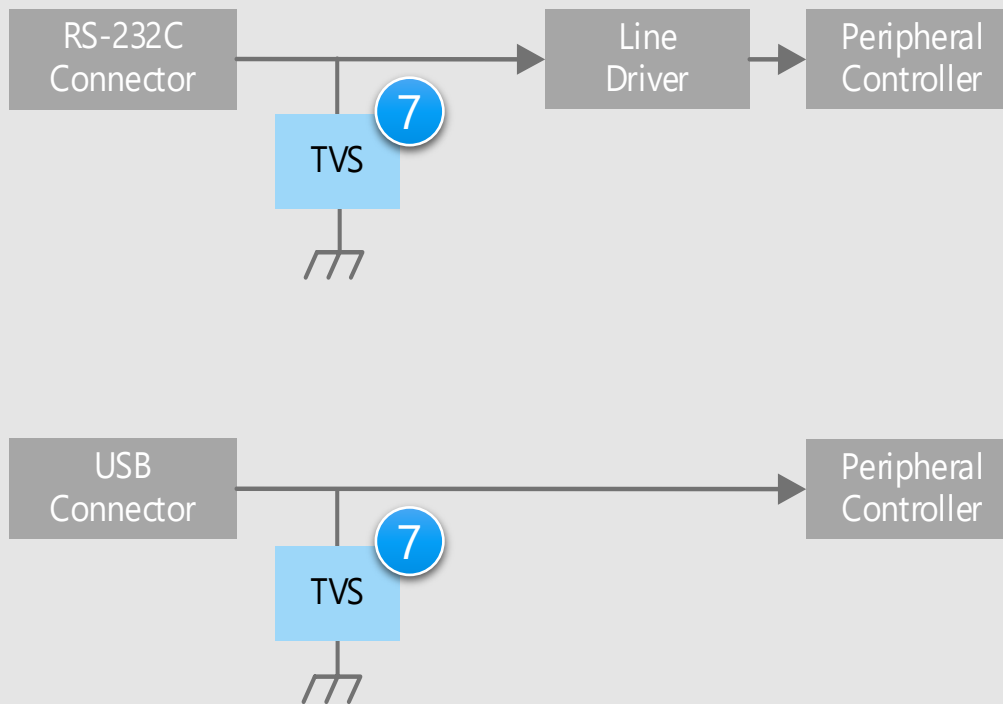
Criteria for device selection

- 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
- **Realize high gain and high speed isolated signal transmission**
IC output photocoupler
for high speed communication
- **Suitable for efficient switching of power supply**
DTMOS Series MOSFET
SiC MOSFET
- **Preferred for high efficiency and miniaturization of power supply**
SiC Schottky barrier diode

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, low- C_t TVS diodes are suitable for ESD protection.

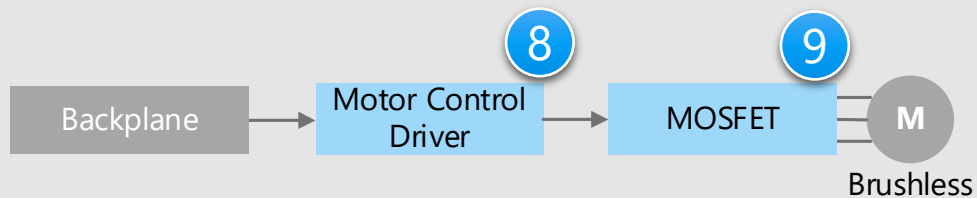
Proposals from Toshiba

- **Absorb static electricity from external terminals to prevent malfunction of the circuit.**

TVS diode

7

Fan drive circuit



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

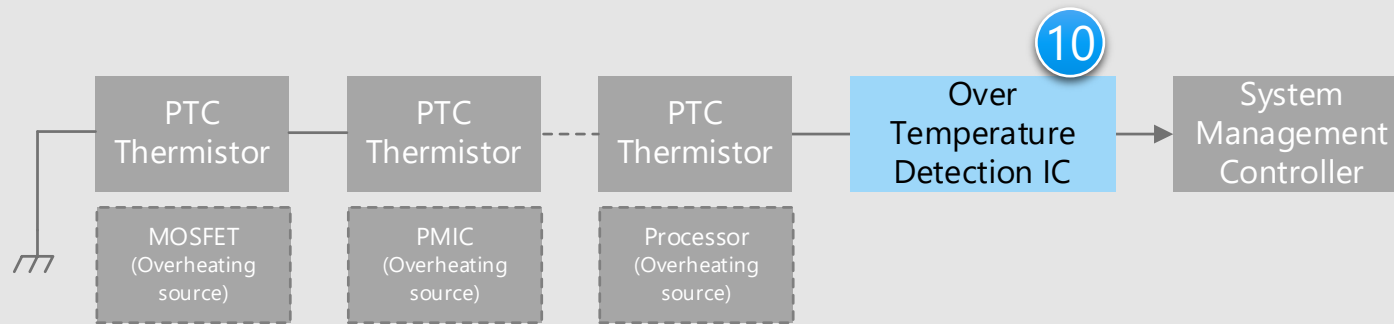
Criteria for device selection

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

Proposals from Toshiba

- **Very easy control of motors**
Three-phase brushless DC motor driver IC (8)
- **Suitable for high efficiency switching**
Semi-power MOSFET (9)

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

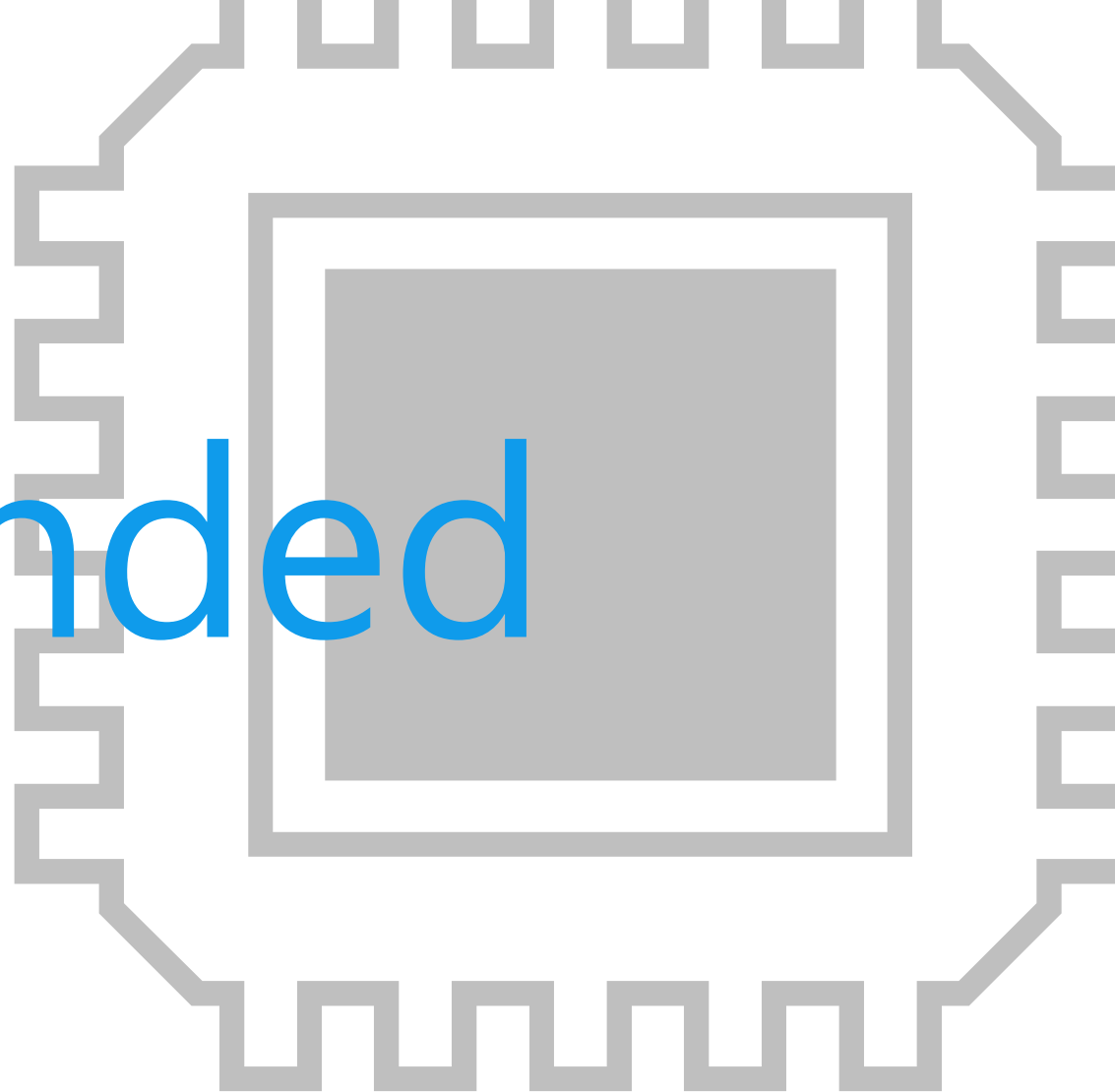
- **Monitor temperature at multiple points with small package and low current consumption**

Over temperature detection IC
(Thermoflagger™)

10

* 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

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	TVS diode		●	●
⑧	Three-phase brushless DC motor driver IC	●		●
⑨	Semi-power MOSFET	●		●
⑩	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

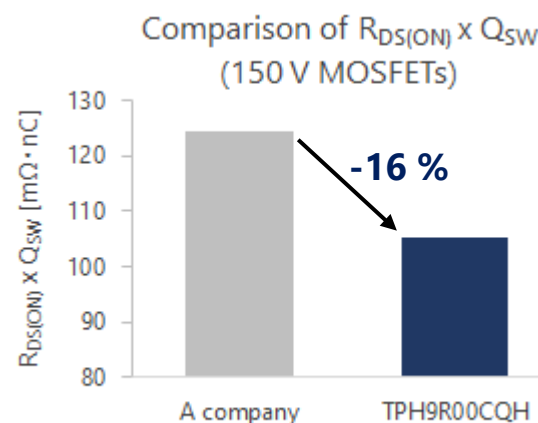
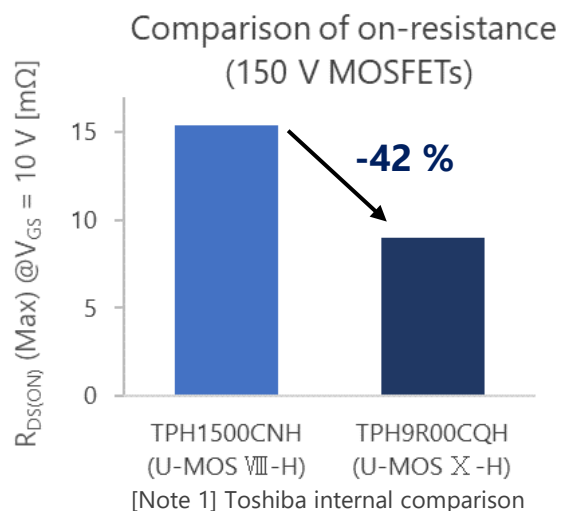
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 42 % compared to Toshiba's conventional 150 V MOSFETs. [Note 1]

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] @ $V_{GS} = 10 \text{ V}$	Typ.	7.3	9.6
	Max	9.0	12.3
Generation	U-MOSX-H	U-MOSX-H	U-MOSIX-H

*: Silicon limit

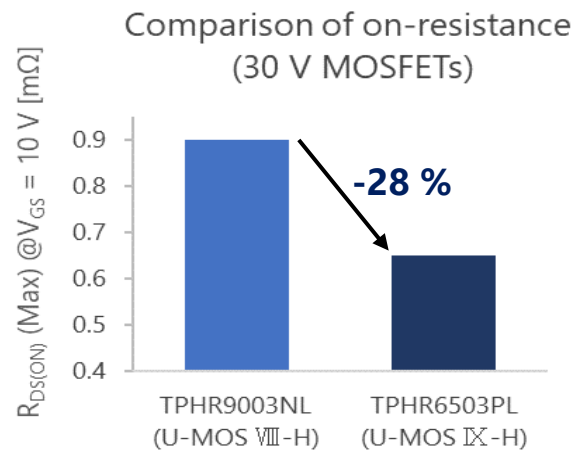
[Return to Block Diagram TOP](#)

Value provided

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

1 Low on-resistance

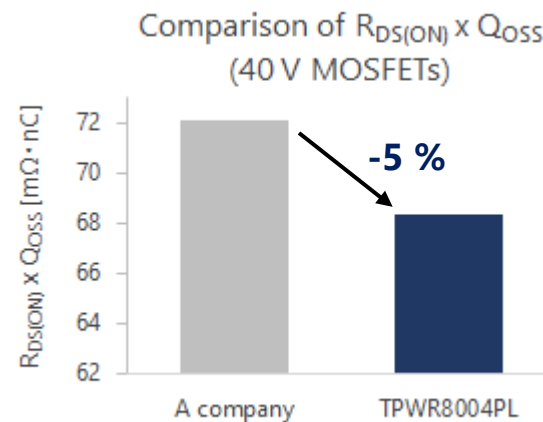
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 28 % compared to Toshiba's conventional 30 V MOSFETs. [Note 1]



[Note 1] Toshiba internal comparison

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]





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

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_{DS} [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](#)

Value provided

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

1 Low on-resistance

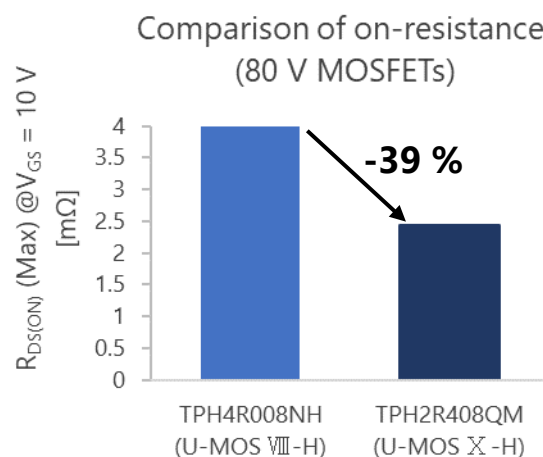
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

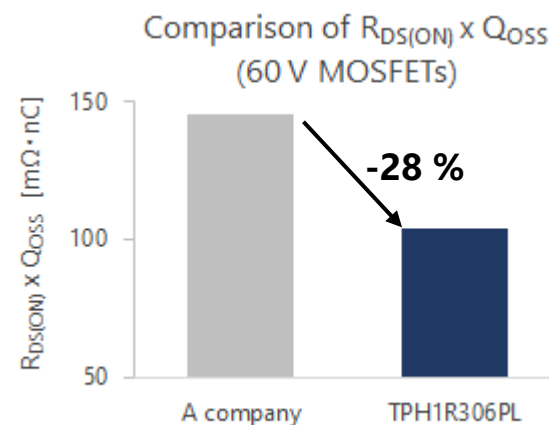
The Q_{OSS} is small and contributes to the reduction of output charge loss. The $R_{DS(ON)} \times Q_{OSS}$ has been reduced by 28 % compared to that of competitor's 60 V MOSFETs. [Note 2]

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]




[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	TPHR8504PL	TPH1R306PL	TPH2R408QM	TPH3R10AQM
Package	SOP Advance(N)  5 x 6 mm			
V_{DS} [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
	Max	0.85	1.34	2.43
Generation	U-MOSIX-H	U-MOSIX-H	U-MOSX-H	U-MOSX-H

*: Silicon limit

[◆Return to Block Diagram TOP](#)

Value provided

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

1 Low on-resistance

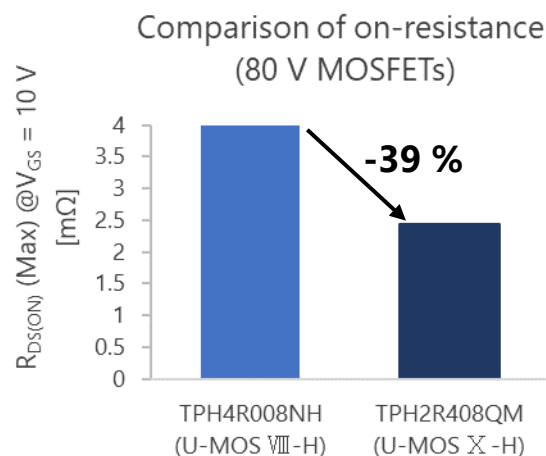
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

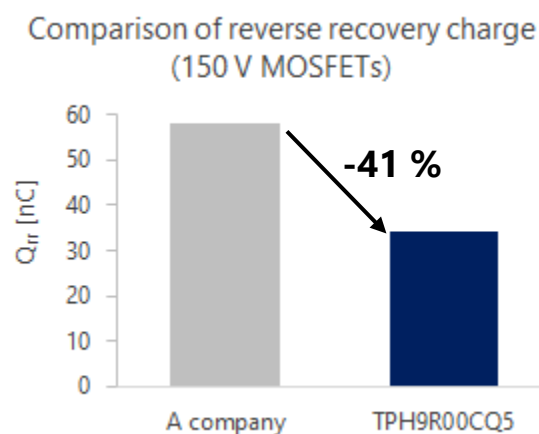
The Q_{OSS} is small and contributes to the reduction of output charge loss. The $R_{DS(ON)} \times Q_{OSS}$ has been reduced by 7 % compared to that of competitor's 150 V MOSFETs. [Note 2]

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_{DS} [V]		80	150
I_D [A]		120 (200*)	64 (108*)
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 10 V$	Typ.	1.9	7.3
	Max	2.43	9.0
Generation		U-MOSX-H	U-MOSX-H

*: Silicon limit

[◆Return to Block Diagram TOP](#)

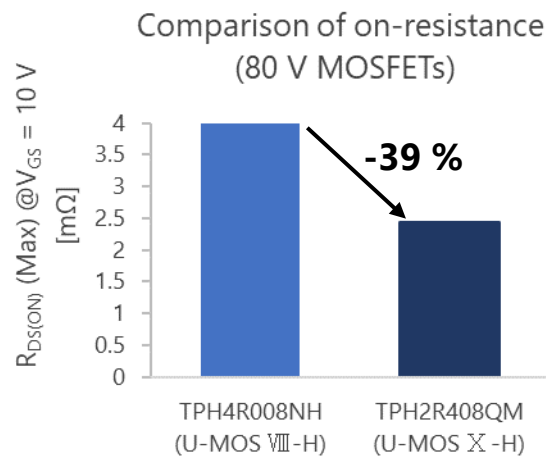
Value provided

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

1 Low on-resistance

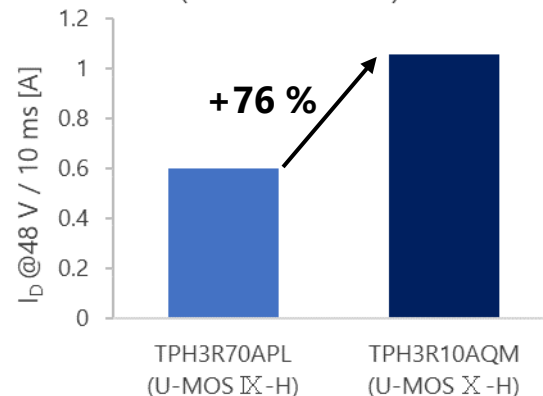
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small.

$R_{DS(ON)}$ has been reduced by 39 % compared to Toshiba's conventional 80 V MOSFETs. [Note 1]



[Note 1] Toshiba internal comparison

Comparison of Safety Operating Area (SOA)
(100 V MOSFETs)




[Note 1] Toshiba internal comparison

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_{DS} [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](#)

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

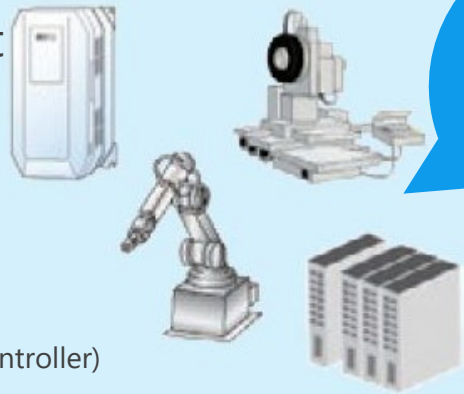
These are photo couplers of high isolation type that consists of a phototransistor optically coupled to an infrared LED. It achieves high current transfer ratio.

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

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

1 High speed

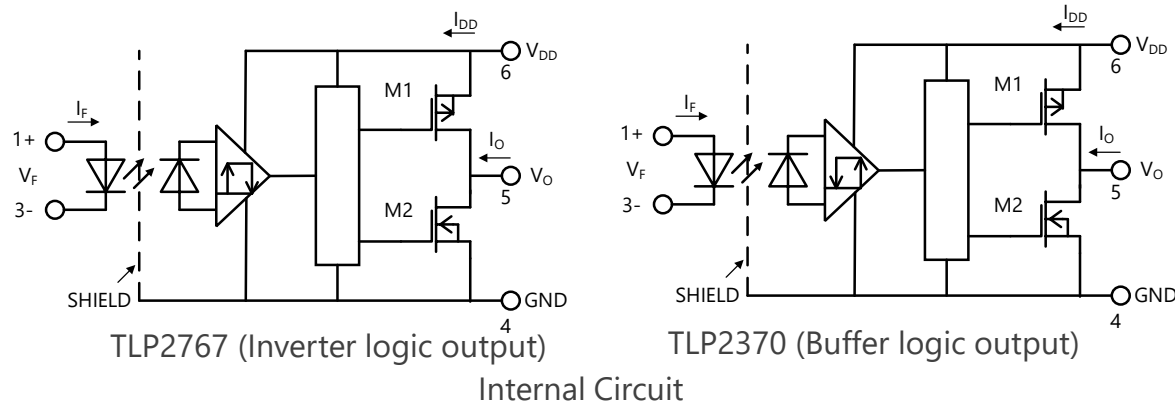
The propagation delay is 20 ns (Max) for TLP2767 and 60 ns (Max) for TLP2370. Margin design becomes easier than general phototransistor couplers.

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](#)

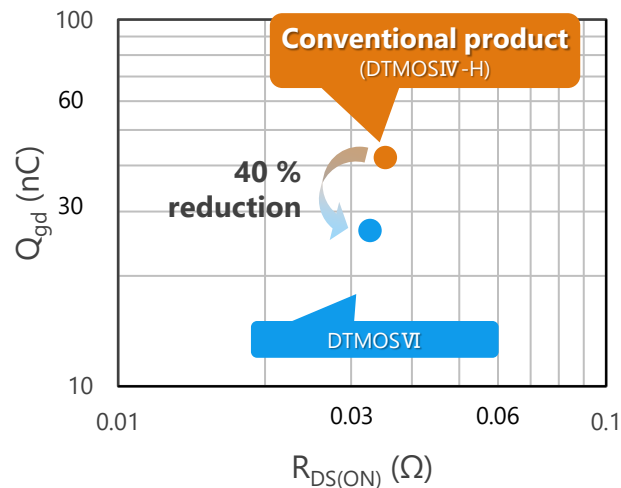
Value provided

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.

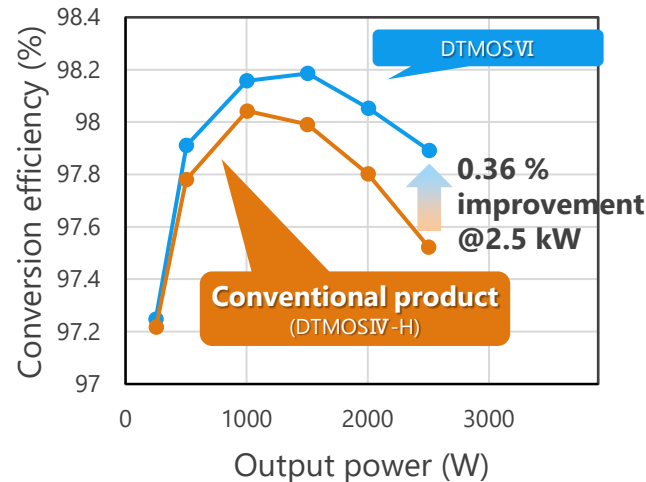
1 $R_{DS(ON)} \times Q_{gd}$ 40 % reduction

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)



(Note) Toshiba internal comparison








(Note) 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_{DS} [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
	Max	0.040	0.040	0.090	0.099
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI

[Return to Block Diagram TOP](#)

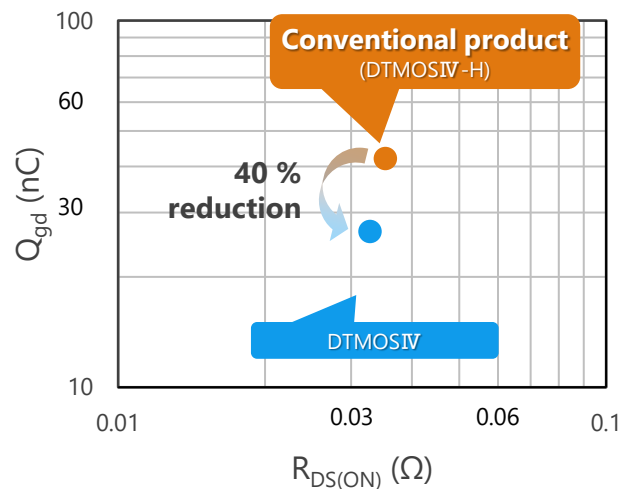
Value provided

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.

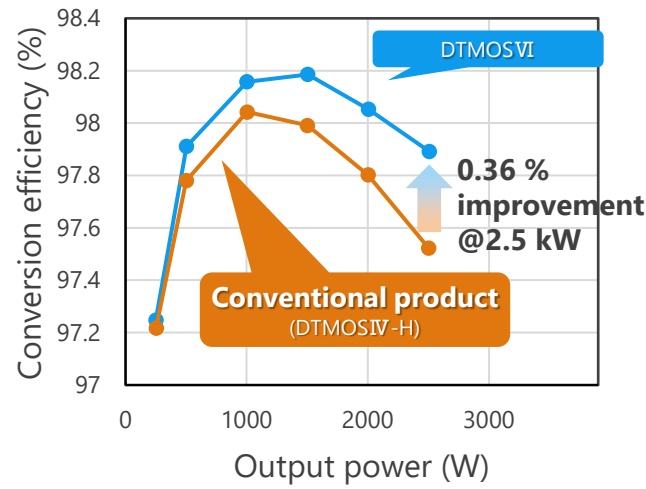
1 $R_{DS(ON)} \times Q_{gd}$ 40 % reduction

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)



(Note) Toshiba internal comparison



(Note) 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_{DS} [V]	650	650	650	650	650	650
I_D [A]	24	24	24	24	24	18
$R_{DS(ON)}$ [Ω]	Typ. 0.092 Max 0.11	0.092	0.092	0.105	0.086	0.122
@ $V_{GS} = 10$ V						
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI

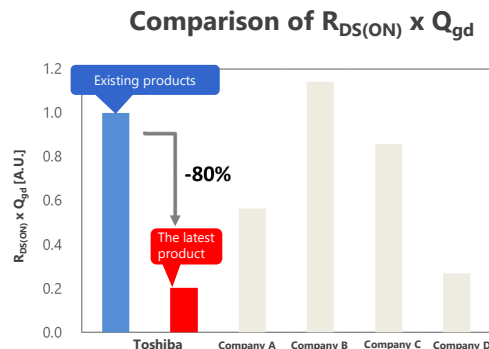
[Return to Block Diagram TOP](#)

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.



Measurement conditions

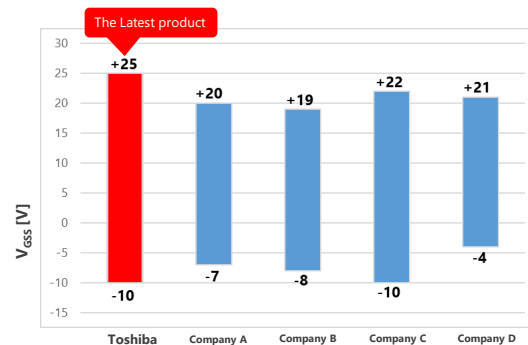
$R_{DS(ON)}$: $V_{GS} = 18 \text{ V}$, $I_D = 20 \text{ A}$, $T_a = 25 \text{ }^\circ\text{C}$

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)

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)

Comparison of V_{GS} specification





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

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.

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

[Return to Block Diagram TOP](#)

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

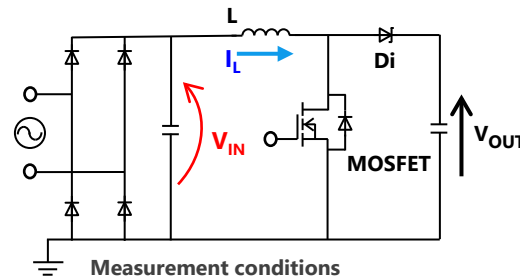
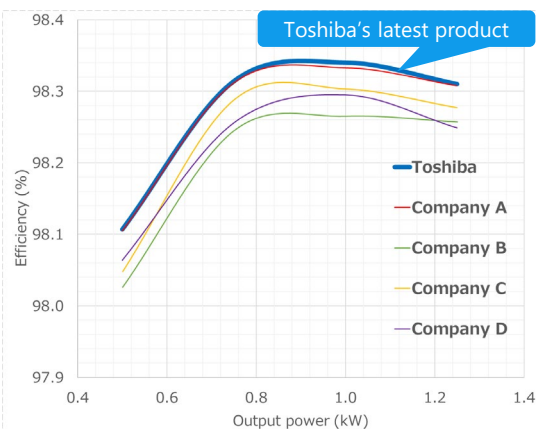
Compared with our existing products, the trade off of $V_F \times Q_C$ [Note2] of the latest products have improved. About 0.1 % of conversion efficiency improvement have also achieved under 800 W output condition in our test.

[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.

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.

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 = 4.7 Ω
 $T_a = 25$ °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
$I_{F(DO)}$ [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

[Return to Block Diagram TOP](#)

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.

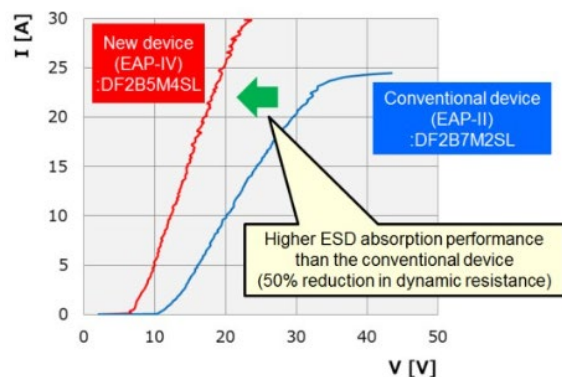
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using proprietary technology.

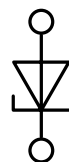
3 Suitable for high density mounting

A variety of small packages are available.

ESD Pulse Absorption Performance
Toshiba internal comparison



Unidirectional




Suitable for paths such as logic signals. There is 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.

[Return to Block Diagram TOP](#)

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

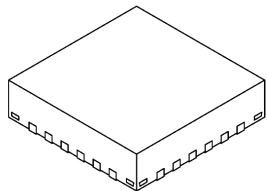
NVM ^[Note] is implemented. It realizes closed loop speed control function without an external MCU. It contributes to reduce system cost.

[Note] No-volatile memory

3 Small package

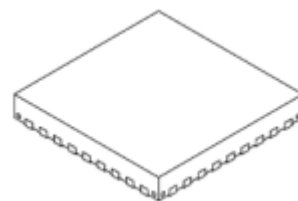
VQFN24 and WQFN36 are suitable for mounting limited space.

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

[◆Return to Block Diagram TOP](#)

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)

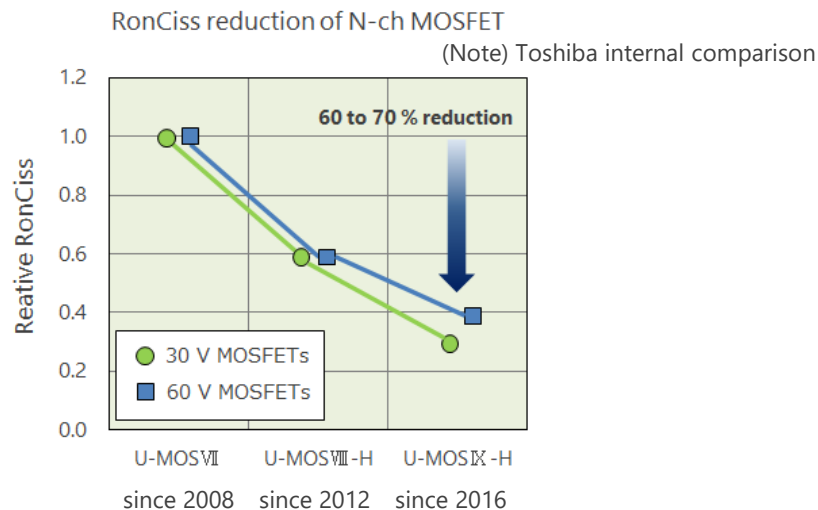
Using low chip resistance technology to contribute to reduced power consumption systems.

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_{DS} [V]		60	60
I_D [A]		6	6
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 4.5$ V	Typ.	36	36
	Max	51	51
Polarity		N-ch	N-ch

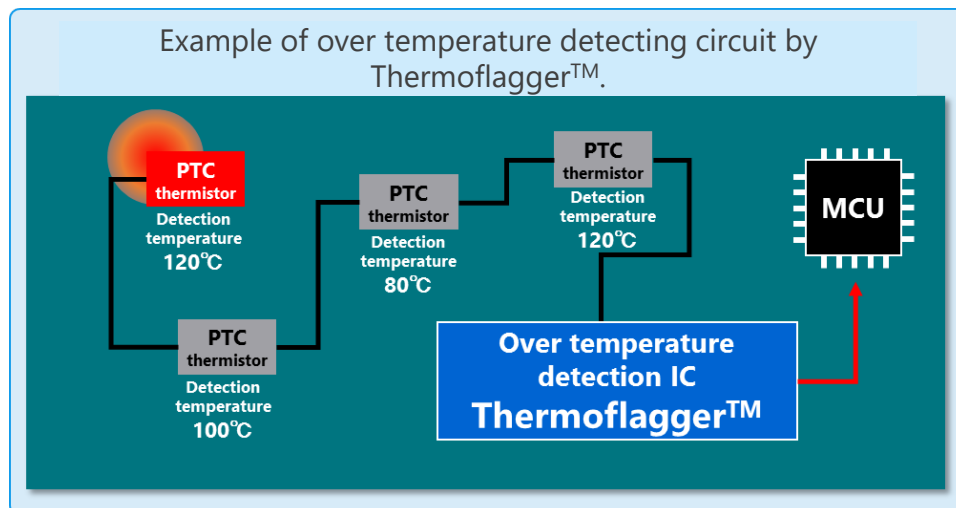
[Return to Block Diagram TOP](#)

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 μ A or 10 μ A) 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.) [μ A]	1.8		11.3	
PTCO Output current (Typ.) [μ A]	1	1	10	10
Abnormal latch function	-	Yes	-	Yes
Output circuit type	AE: push pull, BE: open drain			

[◆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.**

TOSHIBA

* Thermoflagger™ is a trademark of Toshiba Electronic Devices & Storage Corporation.

* All other company names, product names, and service names may be trademarks of their respective companies.