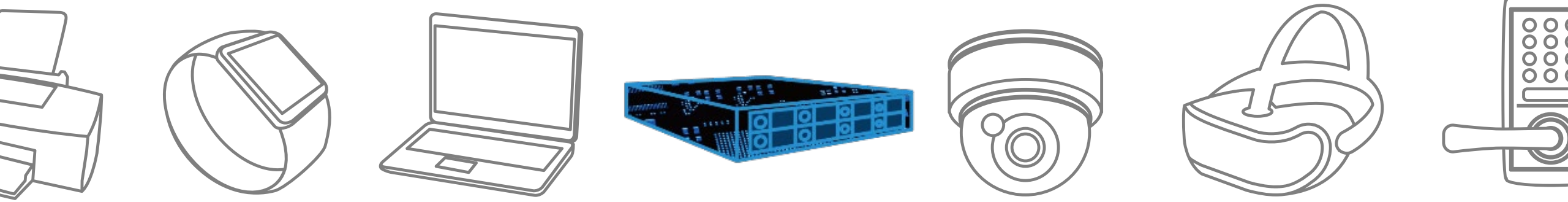
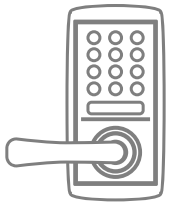
TOSHIBA

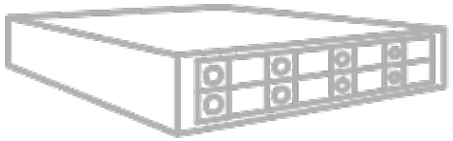
R24

Server

Solution Proposal by Toshiba

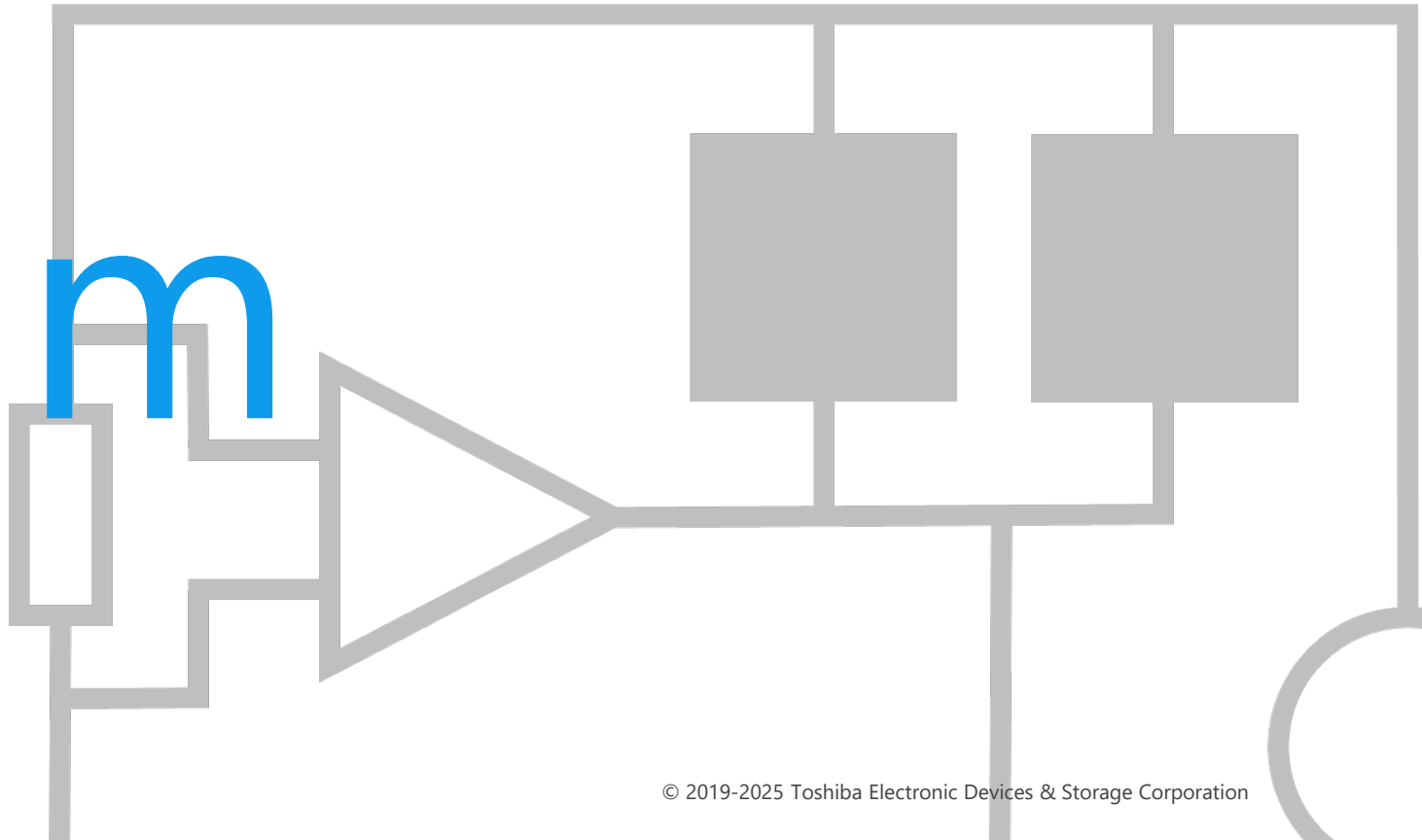




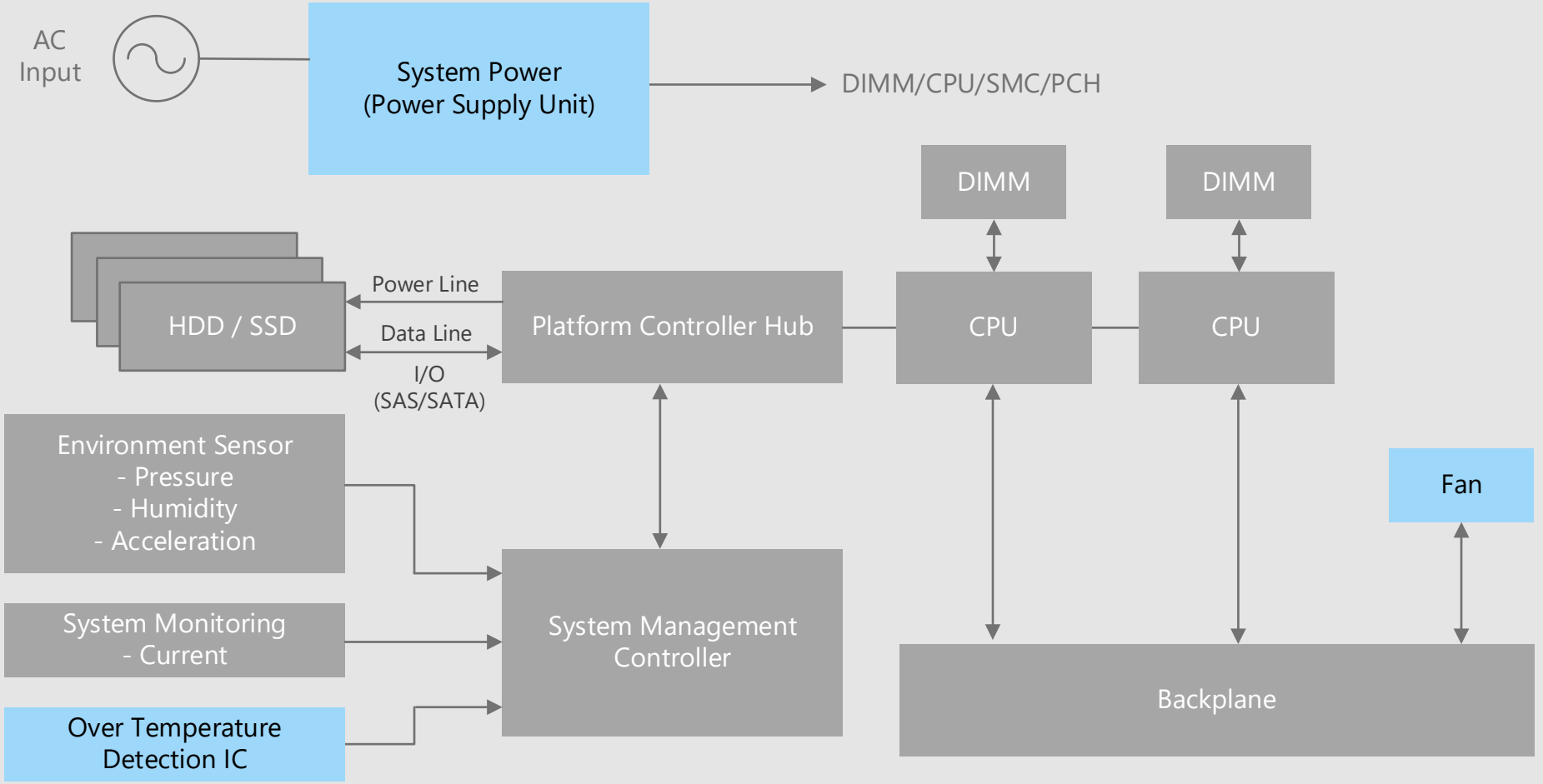


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

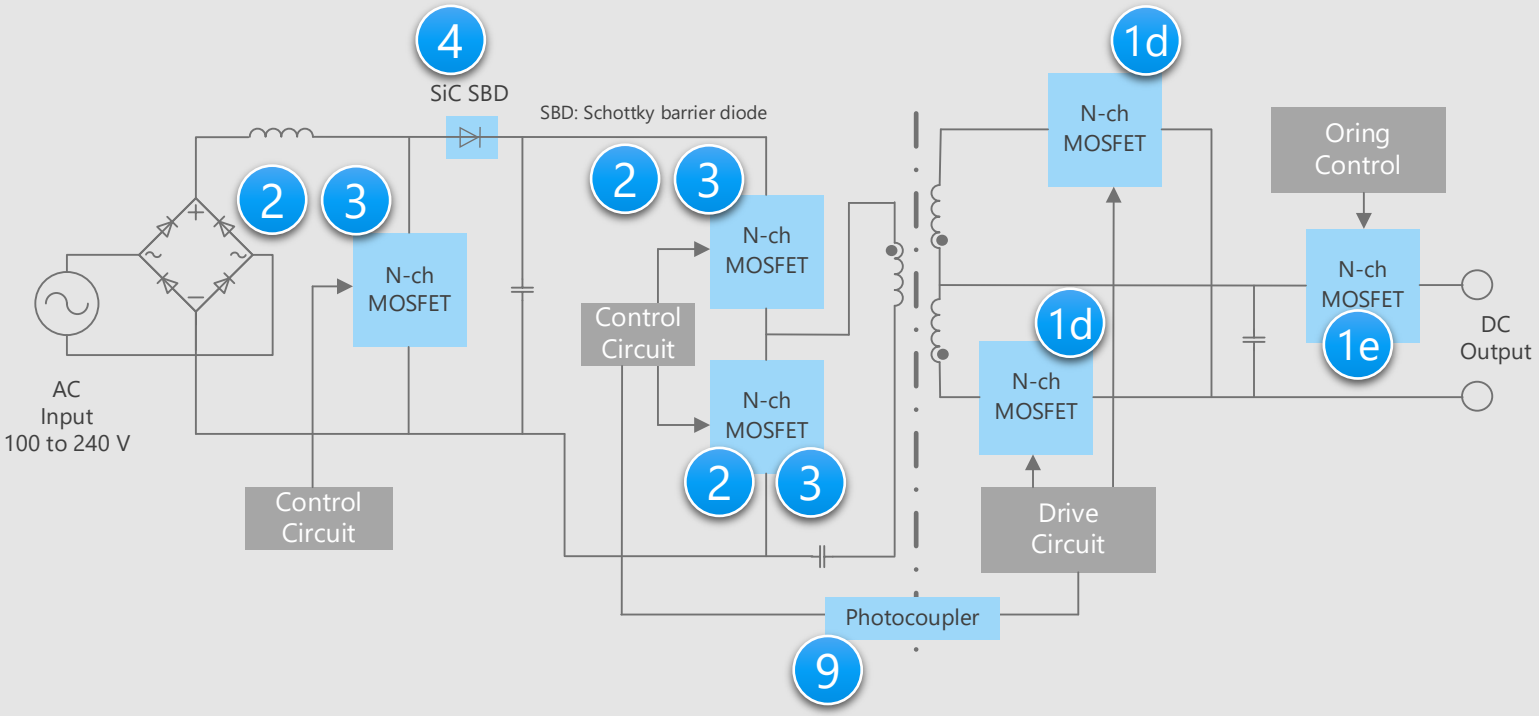


Server　Overall block diagram



Server　Detail of power supply circuit (1)

AC-DC converter for 48 V system



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

Reference Designs of power supply circuits from here → Click Here

Criteria for device selection

- A MOSFET having a high voltage and a low on-resistance is suitable for the AC-DC power supply circuit.
- An IC output photocoupler for high speed communication is used for isolation and transmission of control signals between the primary and the secondary side in the AC-DC power supply.

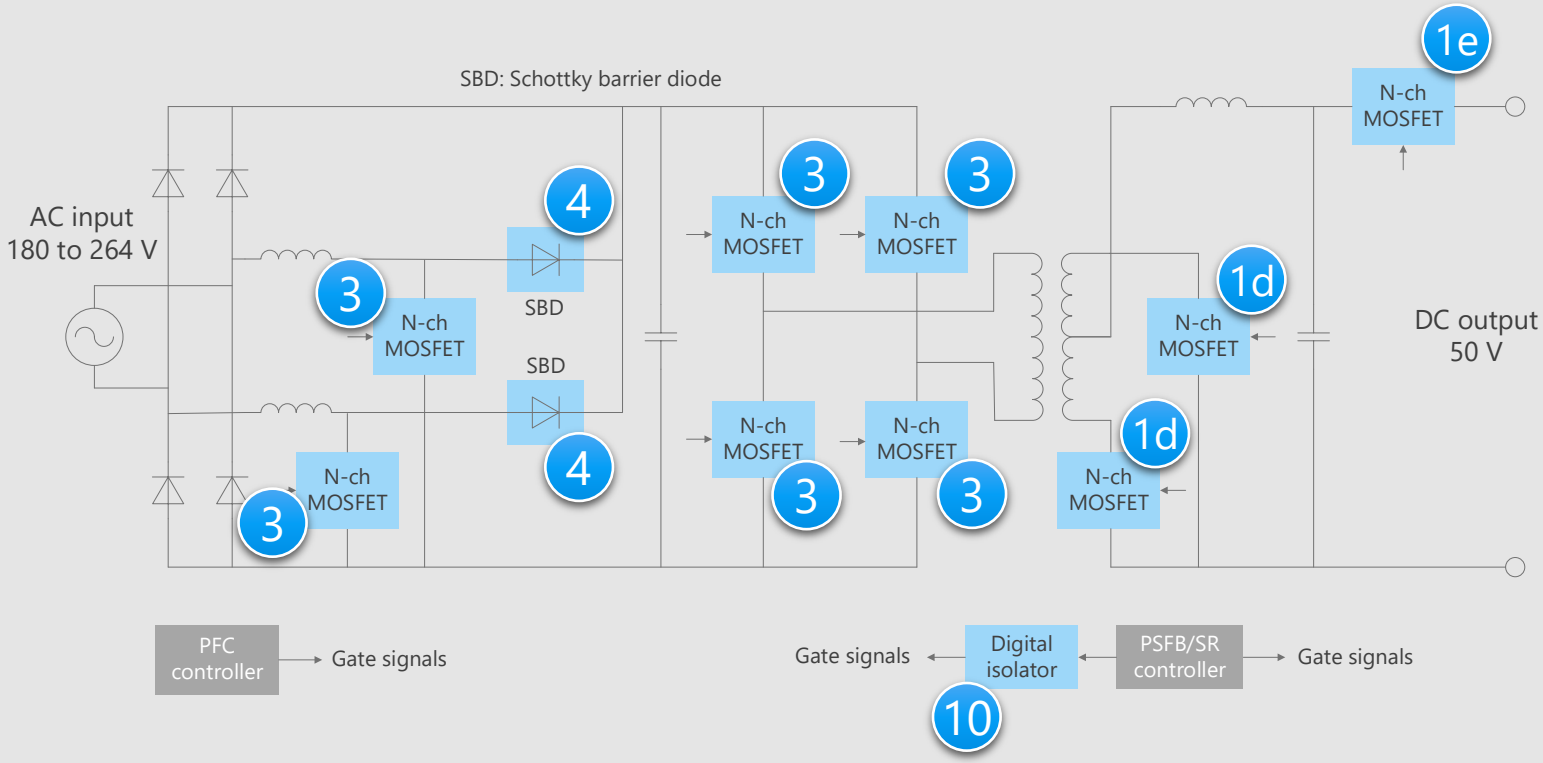
Proposals from Toshiba

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

1d 1e 2 3 4 9

Server　Detail of power supply circuit (2)

3 kW AC-DC converter for 48 V system



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

Reference Design with detailed information from here → Click Here

Criteria for device selection

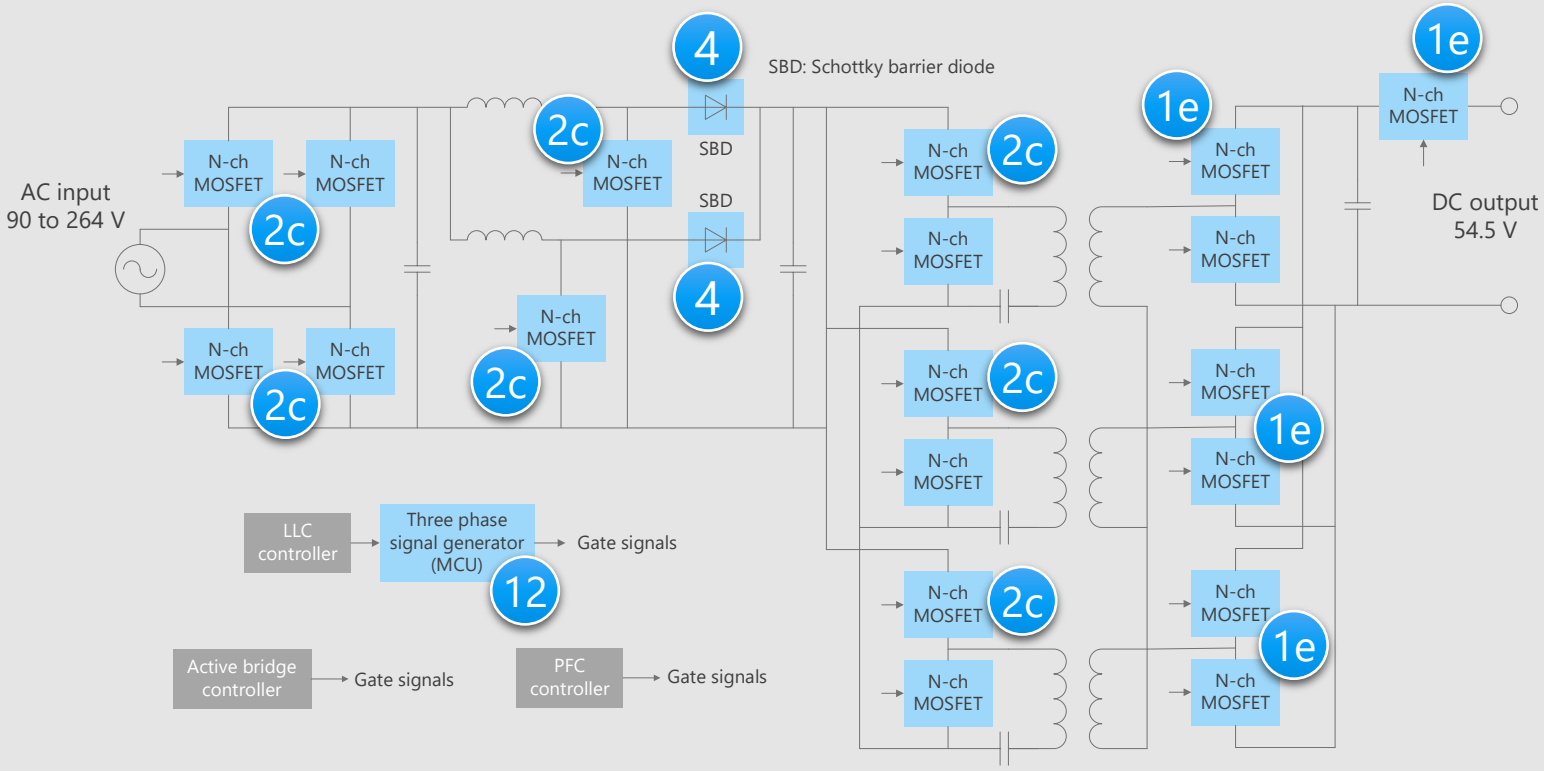
- A MOSFET having a high voltage and a low on-resistance is suitable for the AC-DC power supply circuit.
- The standard digital isolator is used for isolation and high speed transmission of control signals between the primary and the secondary side in the AC-DC power supply.

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
  U-MOS Series MOSFET
  SiC MOSFET
- **Suitable for high efficiency and miniaturization of power supply**
  SiC Schottky barrier diode
- **Realize high speed isolated signal transmission**
  Standard digital isolator

Server　Detail of power supply circuit (3)

1.6 kW LLC AC-DC converter for 48 V system



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

Reference Design with detailed information from here → Click Here

Criteria for device selection

- A MOSFET having a high voltage and a low on-resistance is suitable for the AC-DC power supply circuit.

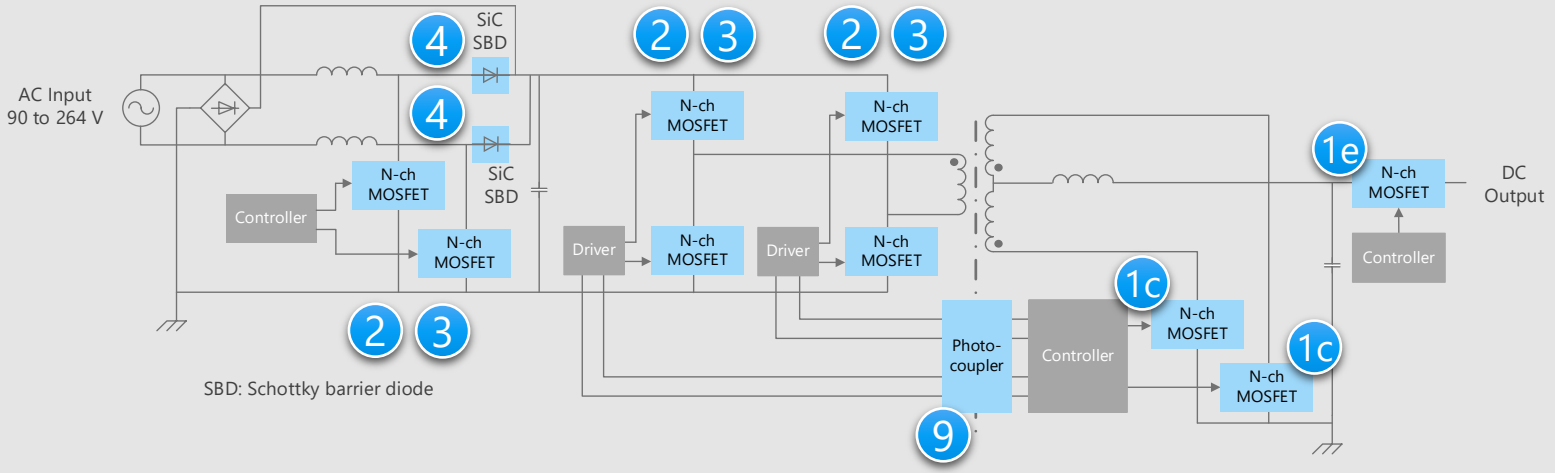
Proposals from Toshiba

- **Suitable for efficient switching of power supply**
  U-MOS Series MOSFET
  DTMOS Series MOSFET
- **Suitable for high efficiency and miniaturization of power supply**
  SiC Schottky barrier diode
- **Output three-phase PWM signal**
  MCU TMPM372FWUG

1e 2c 4 12

Server　Detail of power supply circuit (4)

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



SBD: Schottky barrier diode

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

Reference Design with detailed information from here → Click Here

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.
- An IC output photocoupler for high speed communication is used for signal isolation and transmission of feeding back voltages to the primary in the AC-DC power supply.

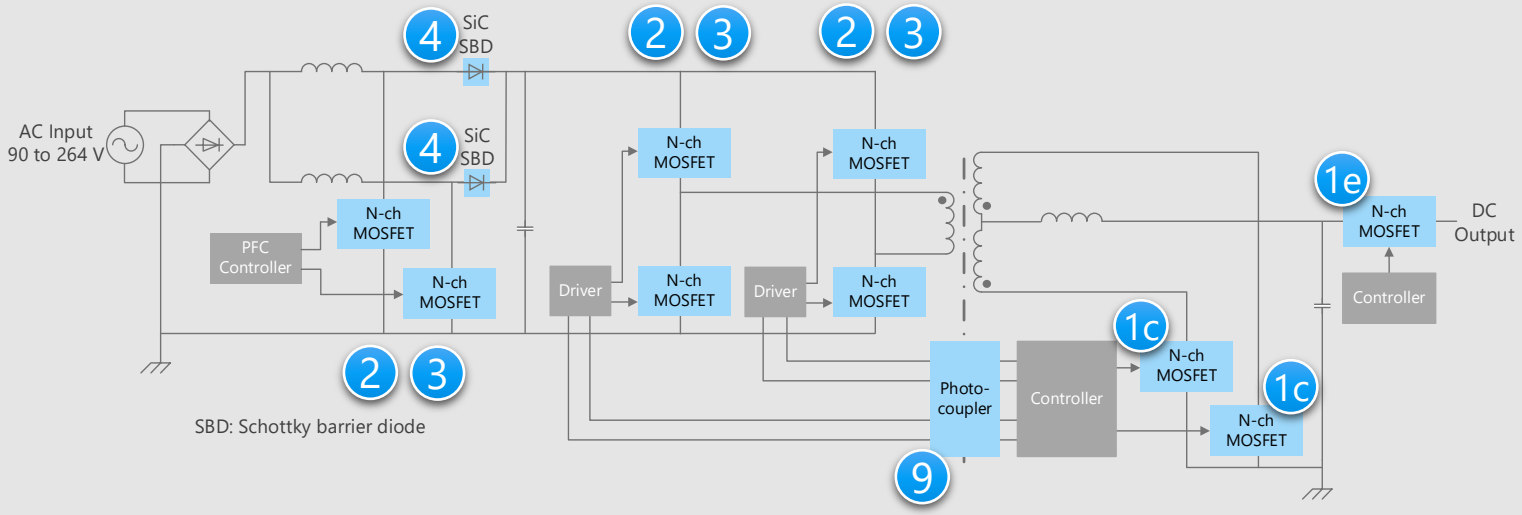
Proposals from Toshiba

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

1c 1e 2 3 4 9

Server　Detail of power supply circuit (5)

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



* 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.
- The IC output photocoupler for high speed communication is used for feeding back voltages to the primary in the AC-DC power supply.

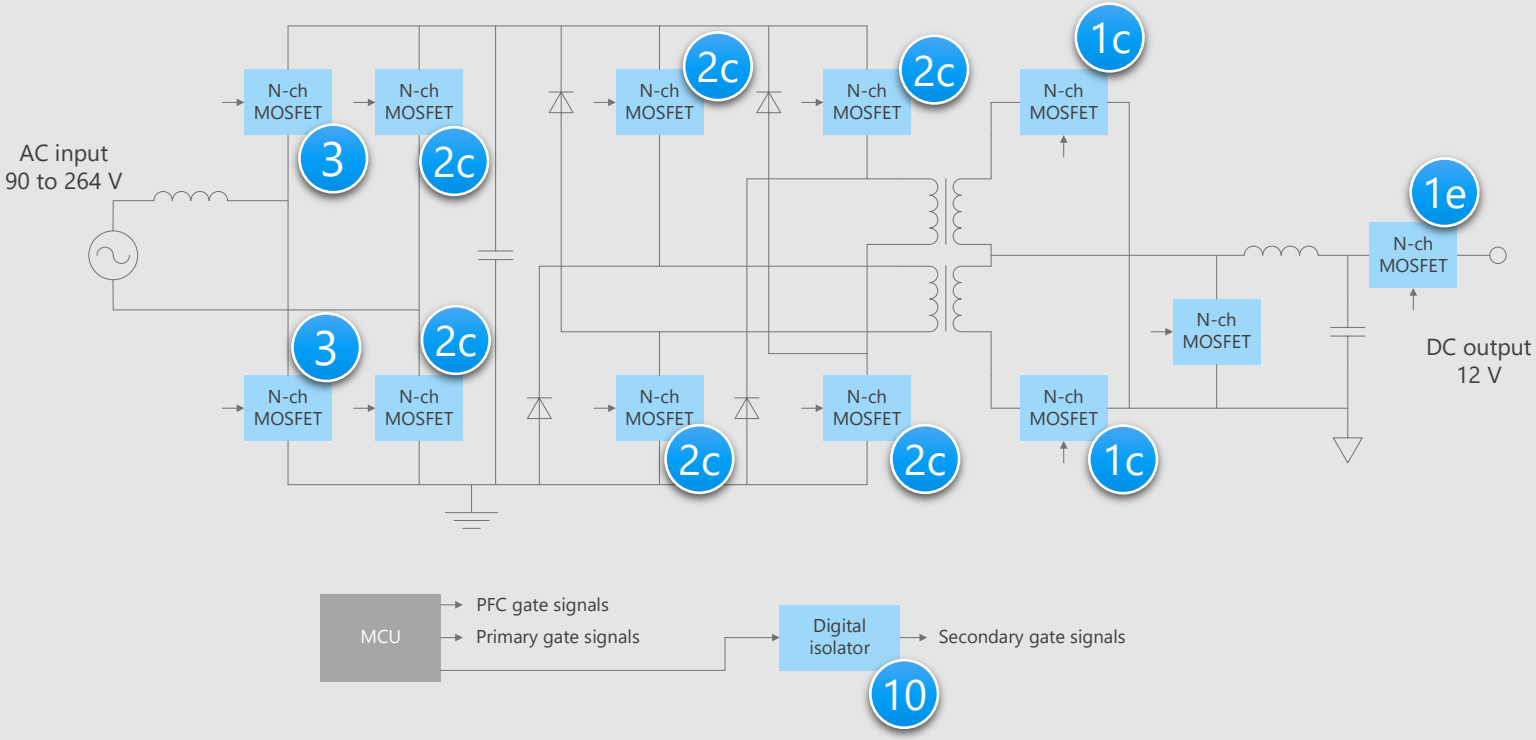
Proposals from Toshiba

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

1c 1e 2 3 4 9

Server　Detail of power supply circuit (6)

1.1 kW ITTF (Interleaved Two Transistor Forward)
AC-DC converter for 12 V system



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

Reference Design with detailed information from here → Click Here

Criteria for device selection

- A MOSFET having a high voltage and a low on-resistance is suitable for the AC-DC power supply circuit
- The standard digital isolator is used for isolation and high speed transmission of control signals between the primary and the secondary side in the AC-DC power supply.

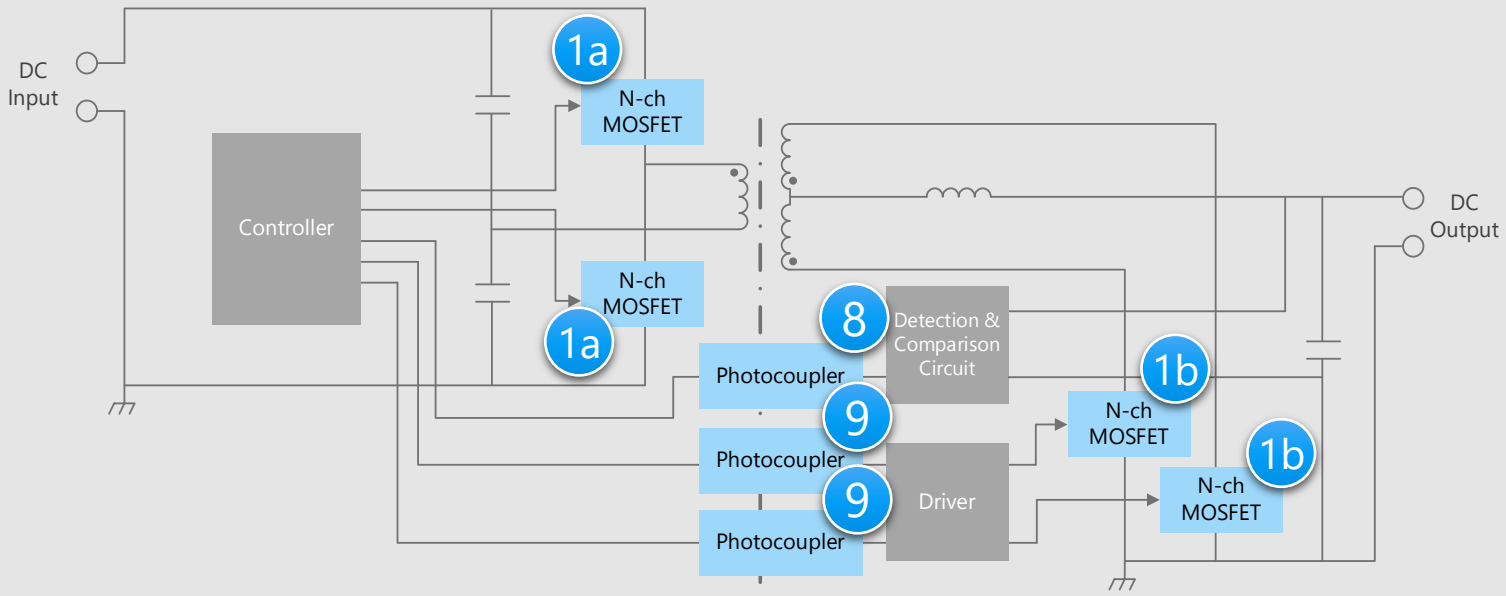
Proposals from Toshiba

- **Suitable for efficient switching of power supply**
  U-MOS Series MOSFET
  DTMOS Series MOSFET
  SiC MOSFET
- **Realize high speed isolated signal transmission**
  Standard digital isolator

1c 1e 2c 3 10

Server　Detail of power supply circuit (7)

1.2 V / 100 A output DC-DC converter for 48 V bus system



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

Reference Design with detailed information from here → Click Here

Criteria for device selection

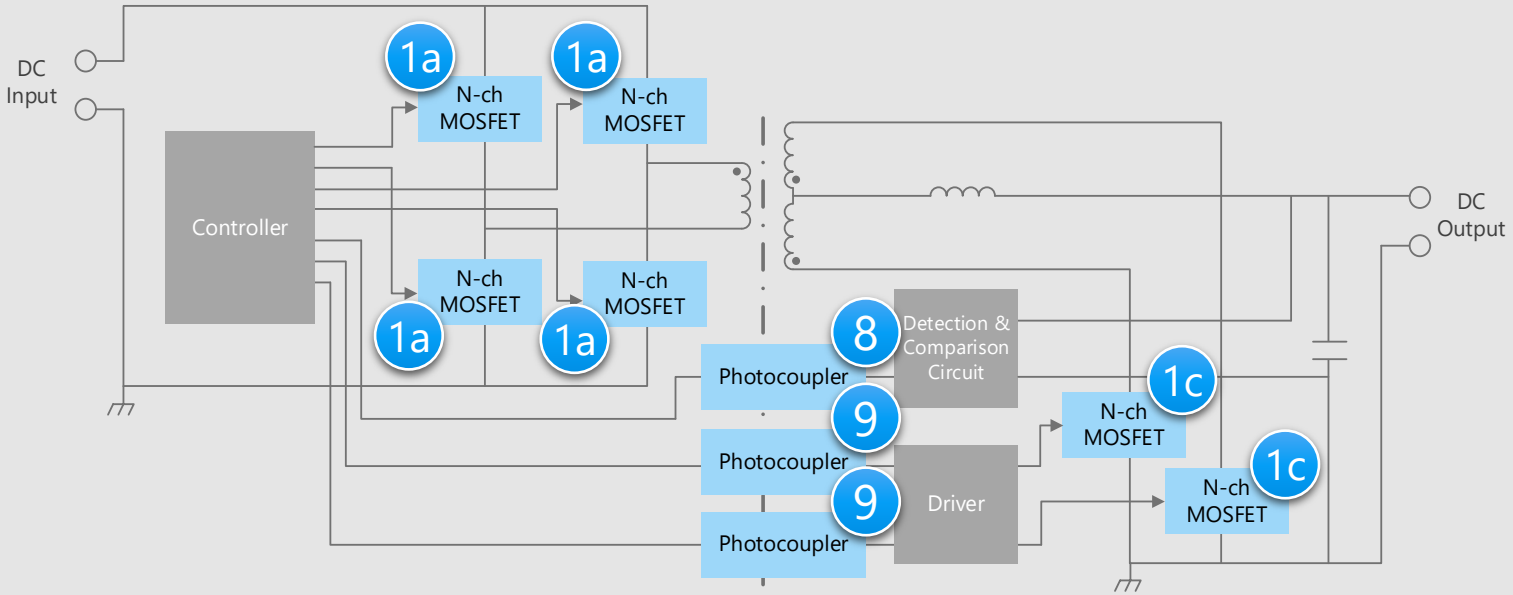
- A MOSFET having a high speed and a low on-resistance is suitable for the DC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the DC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
  U-MOS Series MOSFET　1a　1b
- **Realize high speed isolated signal transmission**
  Transistor output photocoupler　8
  IC output photocoupler　9
  for high speed communication

Server　Detail of power supply circuit (8)

300 W isolated DC-DC converter for 48 V system



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

Reference Design with detailed information from here → Click Here

Criteria for device selection

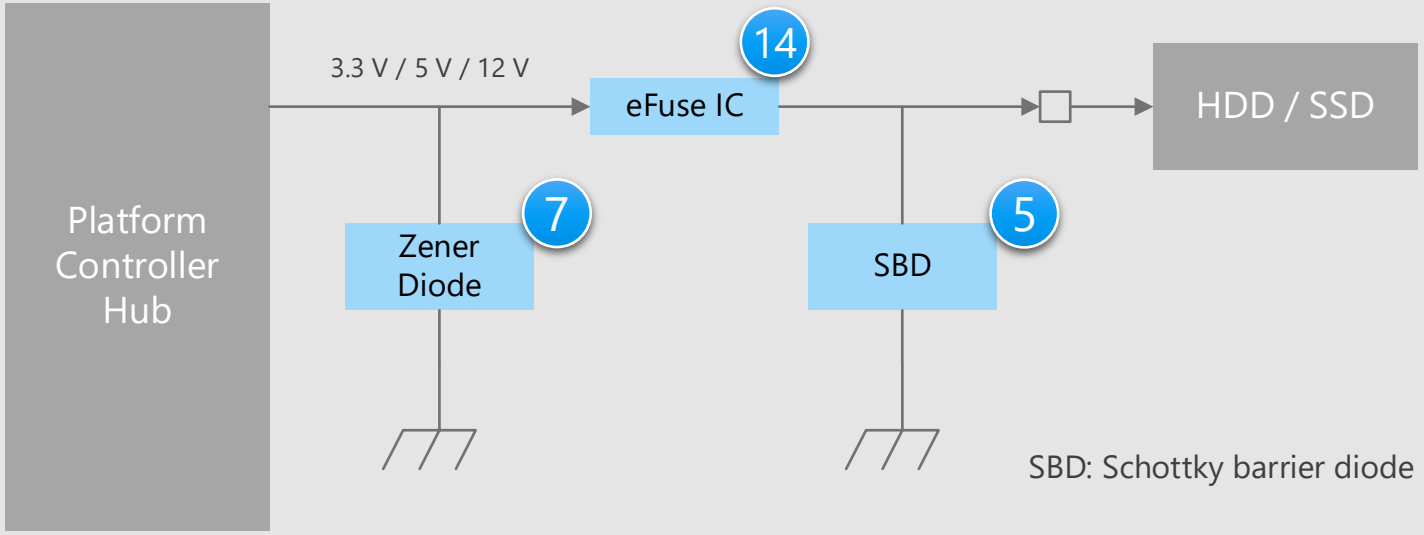
- A MOSFET having a high speed and a low on-resistance is suitable for the DC-DC power supply.
- A transistor output photocoupler is typically used for feeding back voltages to the primary in the DC-DC power supply.
- The IC output photocoupler for high speed communication is used for signal isolation.

Proposals from Toshiba

- **Suitable for efficient switching of power supply**
  U-MOS Series MOSFET　1a 1c
- **Realize high speed isolated signal transmission**
  Transistor output photocoupler　8
  IC output photocoupler　9
  for high speed communication

Server　Detail of power line to storage devices

Power line to storage devices



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

Criteria for device selection

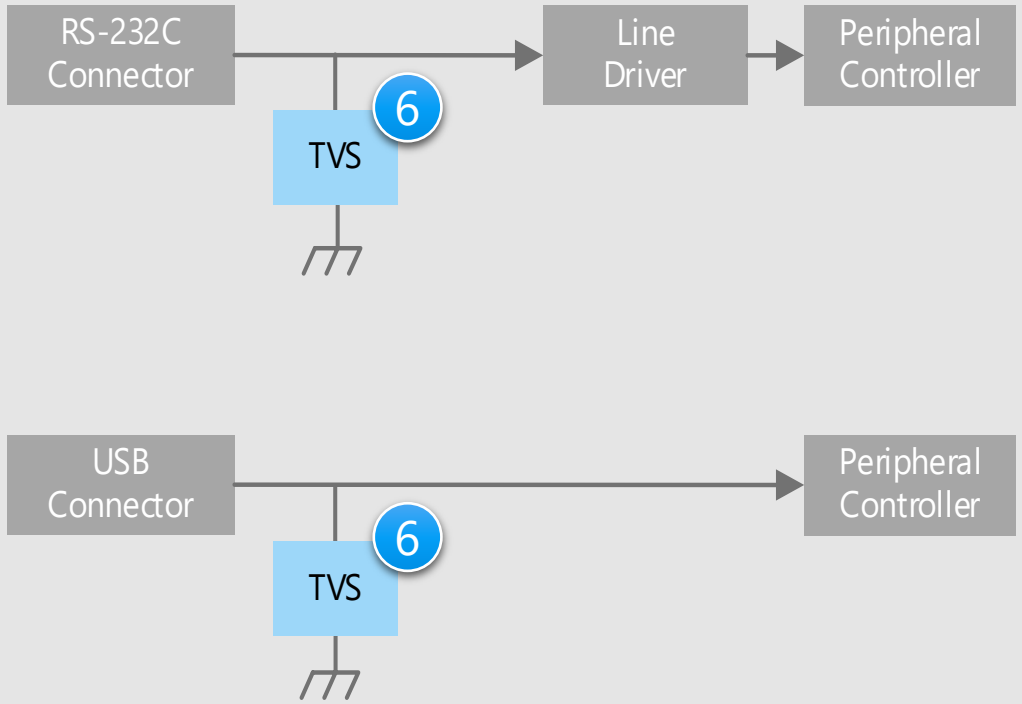
- eFuse IC protects devices from overcurrent and overvoltage caused by hot-swapping or accidental short circuits.
- Zener diode is suitable for protection against spike voltages that occur during hot-swapping.
- Schottky barrier diode (SBD) is effective against negative spike voltages that occur on the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

Proposals from Toshiba

- **Built-in protection function against short circuit, over current, over voltage, etc.**
  Electronic fuse (eFuse IC) 14
- **Suppress input spike voltage**
  Zener diode 7
- **Low V_F suppresses negative voltage surges**
  Schottky barrier diode 5

Server　Detail of peripheral interface

Peripheral interface circuits



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

Criteria for device selection

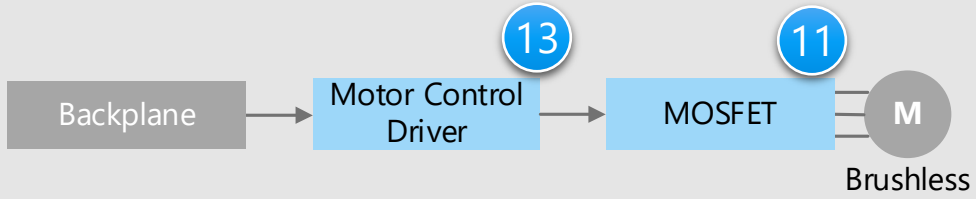
- To improve the reliability of the set, ESD protection is required for connectors that may come into contact with the human body.
- Small TVS diodes with low terminal capacitance are suitable for ESD protection.

Proposal from Toshiba

- **Absorb static electricity from external terminals to prevent malfunction of the circuit and device breakdown**
  TVS diode 6

Server　Detail of the fan unit

Fan drive circuit



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

Criteria for device selection

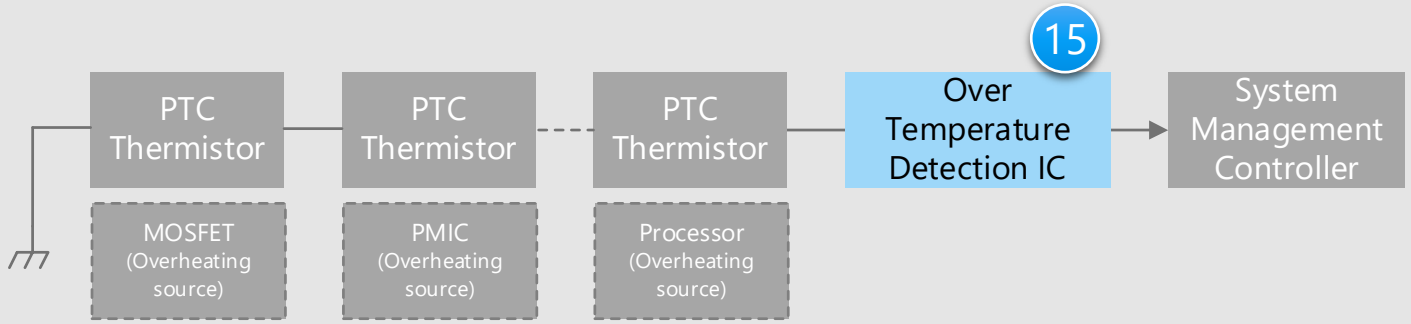
- By using brushless DC motor drivers, three-phase brushless DC motors can be controlled easily.

Proposals from Toshiba

- **Easy control of motors**
  Three-phase brushless DC motor driver IC 13
- **Suitable for high efficiency switching**
  Semi-power MOSFET 11

Server　Detail of over temperature monitoring unit

Over temperature monitoring circuit



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

Criteria for device selection

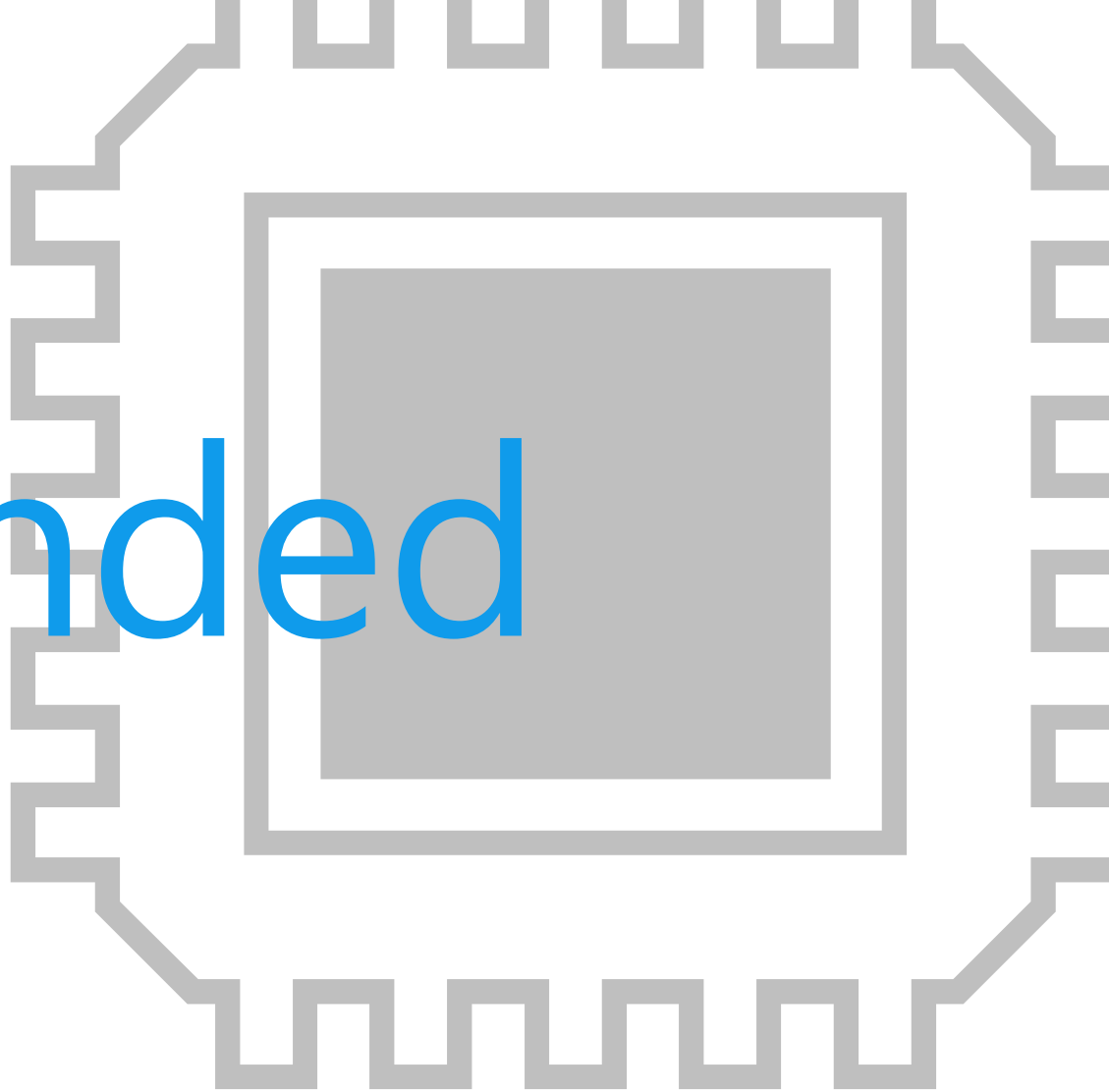
- Over temperature monitoring is required at multiple points on the circuit board such as MOSFET, PMIC and Processor.
- Low power dissipation of set can be realized by using the over temperature detection IC with low current consumption.
- Small package products contribute to the reduction of circuit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

Proposal from Toshiba

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

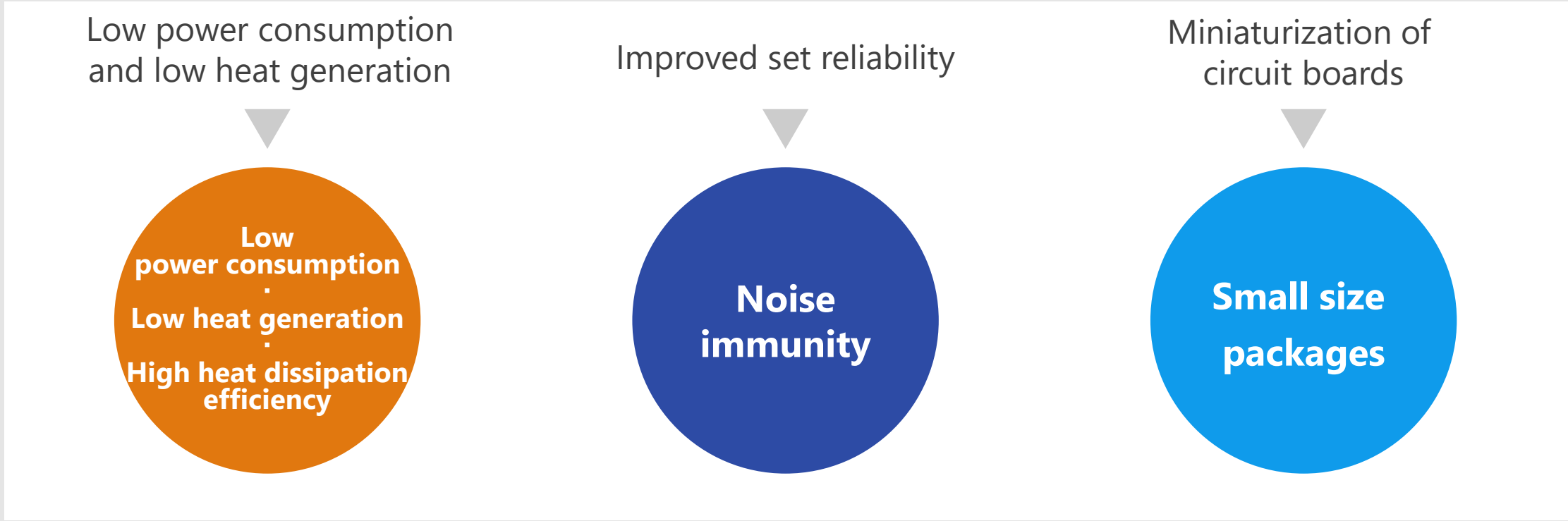
15

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	DTMOS Series MOSFET	●		●
3	SiC MOSFET	●	●	
4	SiC Schottky barrier diode	●	●	●
5	Schottky barrier diode	●		●
6	TVS diode		●	●
7	Zener diode		●	●
8	Transistor output photocoupler		●	●
9	IC output photocoupler for high speed communication		●	●
10	Standard digital isolator		●	●

Device solutions to address customer needs

	Low power consumption · Low heat generation · High heat dissipation efficiency	Noise immunity	Small size packages
11 Semi-power MOSFET	●		●
12 MCU			●
13 Three-phase brushless DC motor driver IC	●		●
14 Electronic fuse (eFuse IC)	●		●
15 Over temperature detection IC (Thermoflagger™)	●		●

1a U-MOS Series MOSFET

TPH9R00CQH / TPN12008QM / TPN1200APL

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

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 existing 150 V MOSFETs. [Note 1]

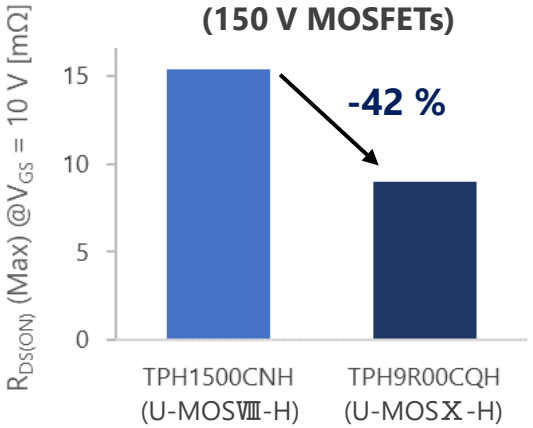
2 Small gate switch charge Q_{SW}

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

3 Wide variety of packages

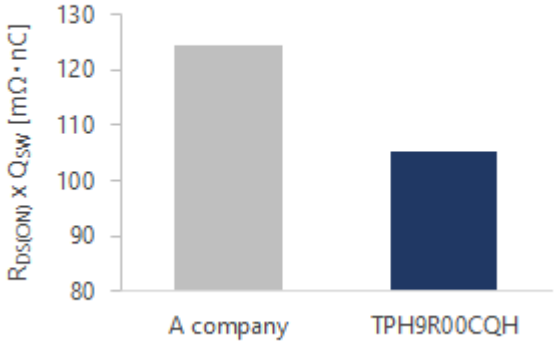
5 x 6 mm sized SOP Advance(N) package and 3 x 3 mm sized TSON Advance package are available.
Suitable packages for various applications can be selected.

Comparison of on-resistance (150 V MOSFETs)



[Note 1] Toshiba internal comparison

Comparison of $R_{DS(ON)}$ x Q_{SW} (150 V MOSFETs)



[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 / SOP Advance(N)	TSON Advance	
Package size [mm]		5 x 6 / 4.9 x 6.1	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

U-MOS Series MOSFET

TPHR6503PL / TPHR6704RL / TPWR6003PL / TPWR8004PL

Low power consumption • Low heat generation • High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

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

1 Low on-resistance

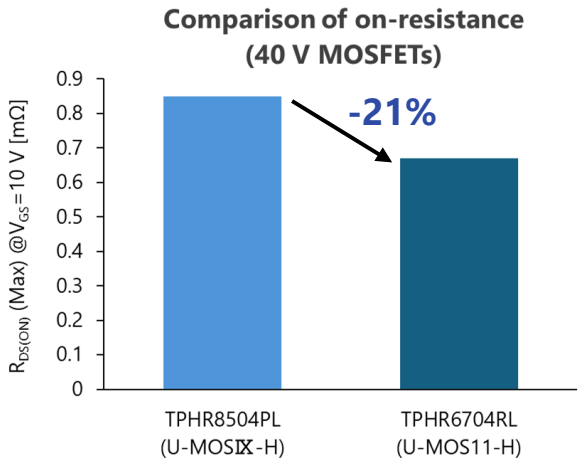
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small. $R_{DS(ON)}$ has been reduced by 21% compared to Toshiba's existing 40 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

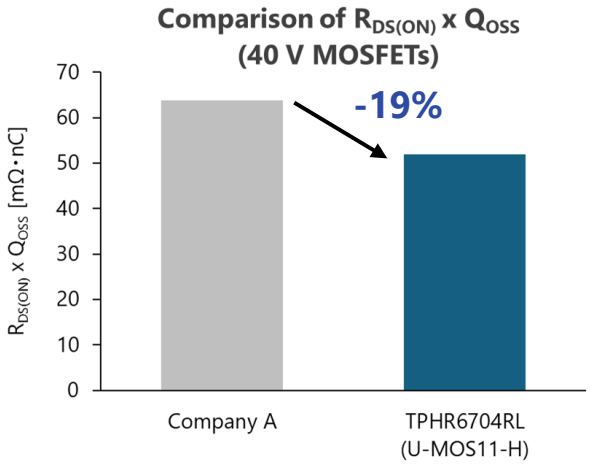
The Q_{OSS} is small and contributes to the reduction of output charge loss.
The $R_{DS(ON)}$ x Q_{OSS} has been reduced by 19% compared to that of competitor's 40 V MOSFETs. [Note 2]

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.



[Note 1] Toshiba internal comparison



[Note 2] Comparison with competitor's product with equivalent ratings.
As of October, 2025. Based on Toshiba's measurement data.

Lineup

Part number		TPHR6503PL	TPHR6704RL	TPWR6003PL	TPWR8004PL
Package		SOP Advance / SOP Advance(N)	SOP Advance(N)	DSOP Advance	
Package size [mm]		5 x 6 / 4.9 x 6.1	4.9 x 6.1	5 x 6	
V_{DSS} [V]		30	40	30	40
I_D [A]		150 (393*)	420	150 (412*)	150 (340*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	0.41	0.52	0.36	0.65
	Max	0.65	0.67	0.60	0.80
Generation		U-MOSIX-H	U-MOS11-H	U-MOSIX-H	U-MOSIX-H

*: Silicon limit

◆Return to Block Diagram TOP

U-MOS Series MOSFET

TPHR6704RL/ TPM1R006PL

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

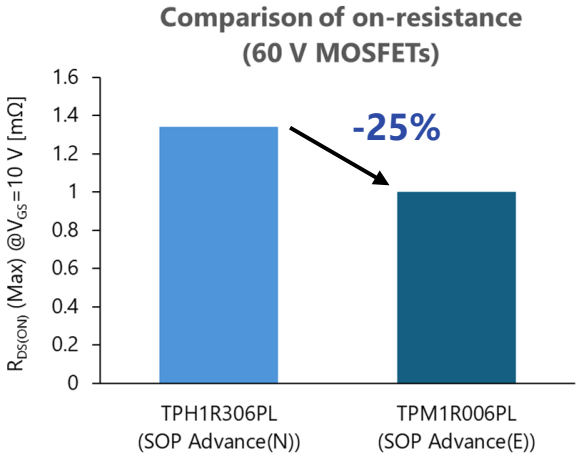
Improved on-resistance and output charge characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

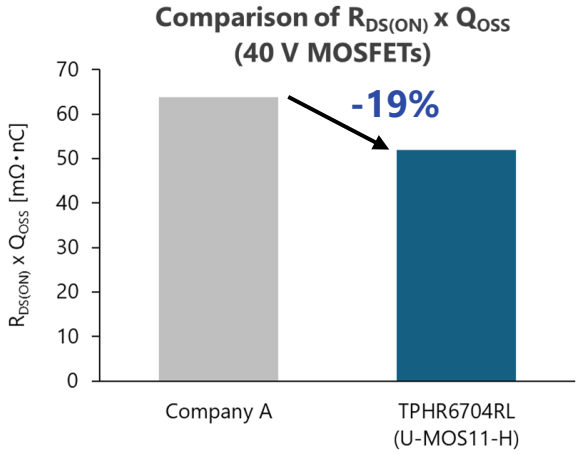
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small.
$R_{DS(ON)}$ has been reduced by 25% compared to Toshiba's existing 60 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

The Q_{OSS} is small and contributes to the reduction of output charge loss.
The $R_{DS(ON)}$ x Q_{OSS} has been reduced by 19% compared to that of competitor's 40 V MOSFETs. [Note 2]



[Note 1] Toshiba internal comparison



[Note 2] Comparison with competitor's product with equivalent ratings.
As of October, 2025. Based on Toshiba's measurement data.

Lineup

Part number		TPHR6704RL	TPM1R006PL
Package		SOP Advance(N) 4.9 x 6.1 mm	SOP Advance(E) 4.9 x 6.1 mm
V_{DSS} [V]		40	60
I_D [A]		420	341
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	0.52	0.74
	Max	0.67	1.00
Generation		U-MOS11-H	U-MOSⅨ-H

*: Silicon limit

◆Return to Block Diagram TOP

U-MOS Series MOSFET

TPM1R908QM / TPM7R10CQ5

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

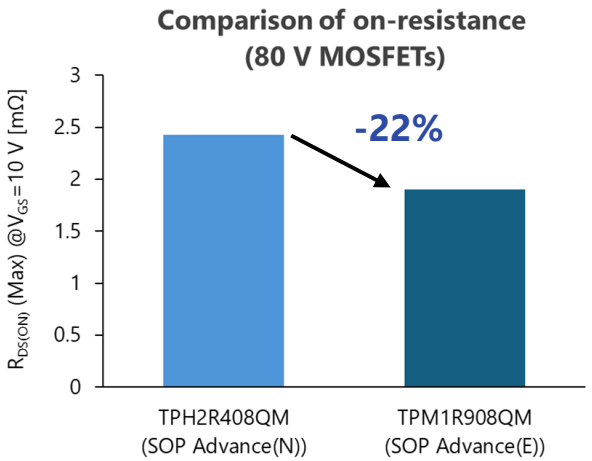
Improved on-resistance and reverse recovery characteristic contribute to realizing the set with high efficiency.

1 Low on-resistance

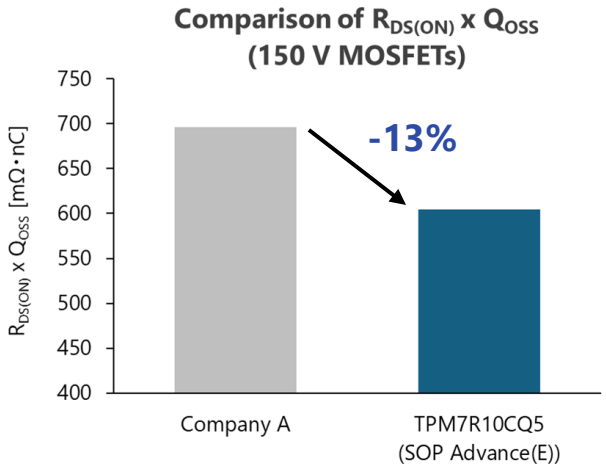
Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small.
$R_{DS(ON)}$ has been reduced by 22% compared to Toshiba's existing 80 V MOSFETs. [Note 1]

2 Small output charge Q_{OSS}

The Q_{OSS} is small and contributes to the reduction of output charge loss.
The $R_{DS(ON)}$ x Q_{OSS} has been reduced by 13% compared to that of competitor's 150 V MOSFETs. [Note 2]

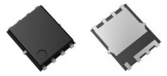


[Note 1] Toshiba internal comparison



[Note 2] Comparison with competitor's product with equivalent ratings.
As of October, 2025. Based on Toshiba's measurement data.

Lineup

Part number		TPM1R908QM	TPM7R10CQ5
Package		SOP Advance(E) 4.9 x 6.1 mm	
V_{DSS} [V]		80	150
I_D [A]		238	120
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	1.5	5.7
	Max	1.9	7.1
Generation		U-MOSⅨ-H	U-MOSⅨ-H

*: Silicon limit

◆Return to Block Diagram TOP

U-MOS Series MOSFET

TPHR6503PL / TPM1R908QM / TPH3R10AQM

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

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

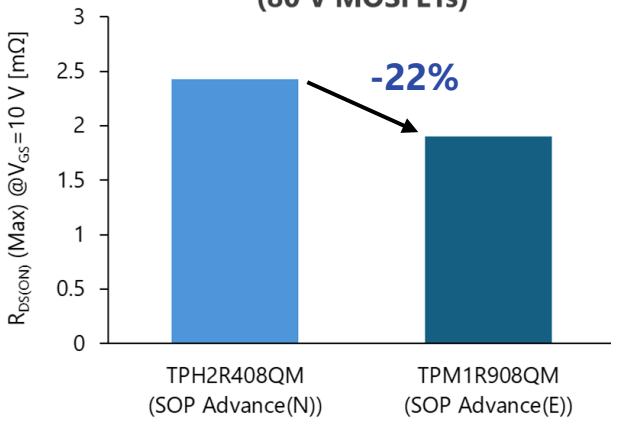
1 Low on-resistance

Reduction of $R_{DS(ON)}$ makes heat generation and power consumption small.
$R_{DS(ON)}$ has been reduced by 22% compared to Toshiba's existing 80 V MOSFETs. [Note 1]

2 Wide Safety Operating Area (SOA)

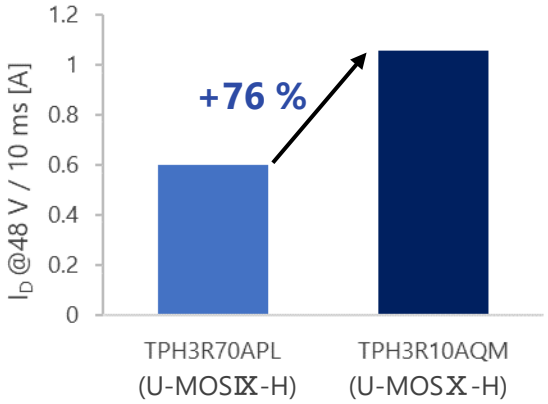
The safety operating area of U-MOSⅨ-H has increased by 76% compared to Toshiba's existing 100 V MOSFETs. [Note 2]
Expands the operating range in the transient area.

Comparison of on-resistance (80 V MOSFETs)



[Note 1] Toshiba internal comparison

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



[Note 2] Toshiba internal comparison

Lineup

Part number		TPHR6503PL	TPM1R908QM	TPH3R10AQM
Package		SOP Advance(N) 4.9 x 6.1 mm	SOP Advance(E) 4.9 x 6.1 mm	SOP Advance(N) 4.9 x 6.1 mm
V_{DSS} [V]		30	80	100
I_D [A]		150 (393*)	238	120 (180*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	0.41	1.5	2.5
	Max	0.65	1.9	3.1
Generation		U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅨ-H

*: Silicon limit

◆Return to Block Diagram TOP

DTMOS Series MOSFET

TK040N65Z / TK040Z65Z / TK090A65Z / TK099V65Z / TK090U65Z

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

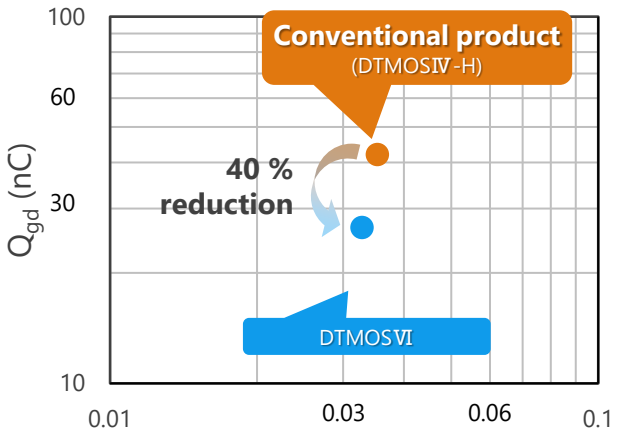
The $R_{DS(ON)}$ x Q_{gd} is reduced by 40 % (compared with Toshiba's conventional products) to improve power efficiency, and contributing to miniaturization of the set.

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

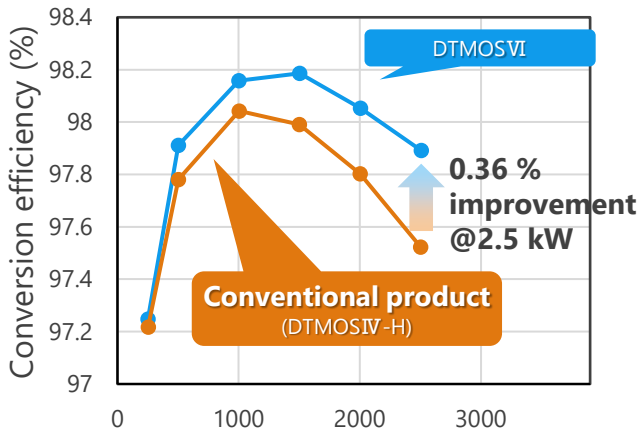
The $R_{DS(ON)}$ x Q_{gd} of figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison of DTMOSⅣ-H Products: Toshiba internal comparison)

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.



(Note) Toshiba internal comparison



(Note) Toshiba internal comparison

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

DTMOS Series MOSFET

TK110N65Z / TK110Z65Z / TK110A65Z / TK125V65Z / TK110U65Z / TK155U65Z

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

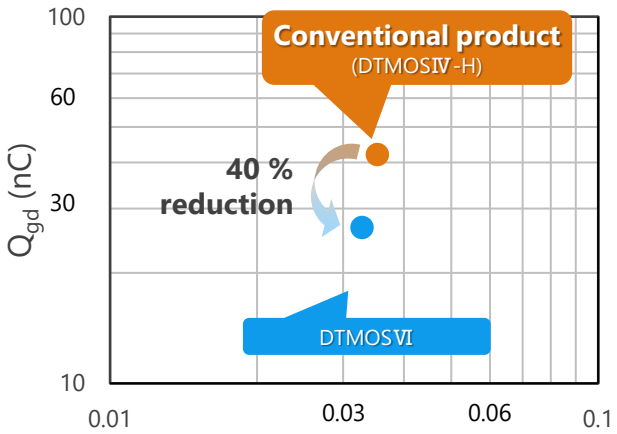
The $R_{DS(ON)}$ x Q_{gd} is reduced by 40 % (compared with Toshiba's conventional products) to improve power efficiency, and contributing to miniaturization of the set.

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

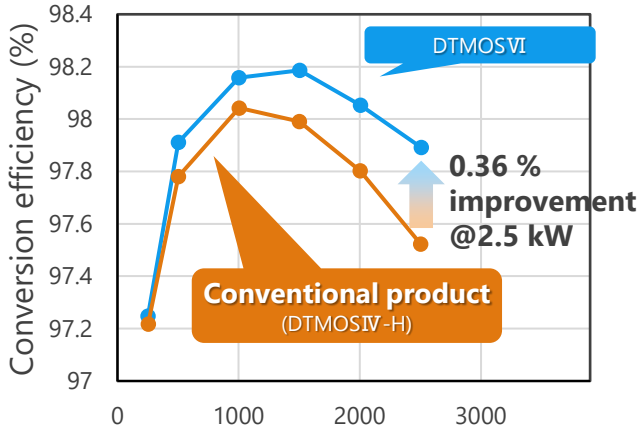
The $R_{DS(ON)}$ x Q_{gd} of figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison of DTMOSⅣ-H Products: Toshiba internal comparison)

2 Various package lineup

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



(Note) Toshiba internal comparison



(Note) Toshiba internal comparison

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	0086	0.122
	Max	0.11	0.11	0.11	0.125	0.11	0.155
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

DTMOS Series MOSFET

TK024N60Z1 / TK080N60Z1 / TK125A60Z1 / TK165V60Z1

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

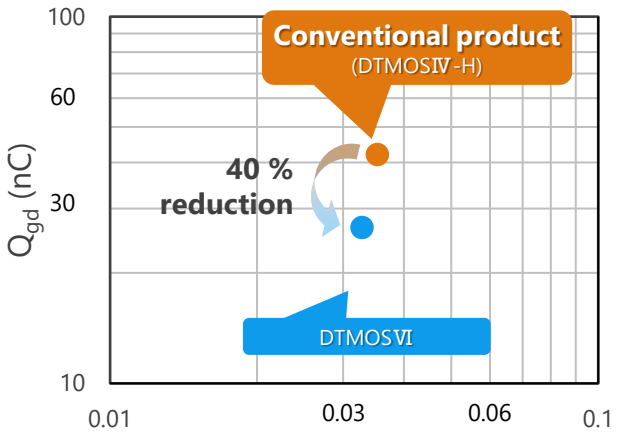
The $R_{DS(ON)}$ x Q_{gd} is reduced by 40 % (compared with Toshiba's conventional products) to improve power efficiency, and contributing to miniaturization of the set.

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

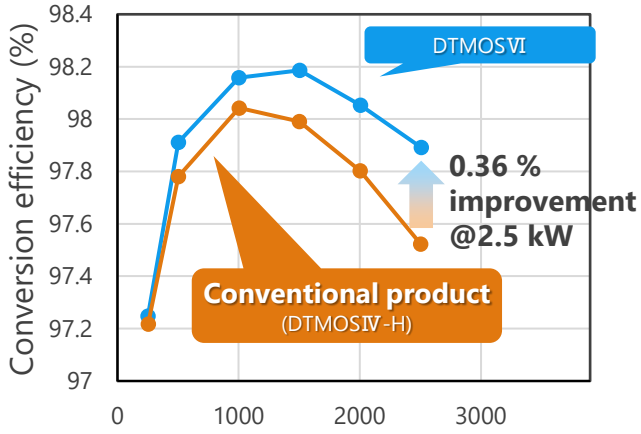
The $R_{DS(ON)}$ x Q_{gd} of figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison of DTMOSⅣ-H Products: Toshiba internal comparison)

2 Various package lineup

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



(Note) Toshiba internal comparison



(Note) Toshiba internal comparison

Lineup

Part number		TK024N60Z1	TK080N60Z1	TK125A60Z1	TK165V60Z1
Package		TO-247		TO-220S	DFN8x8
V_{DSS} [V]		600	600	600	600
I_D [A]		80	30	20	16
$R_{DS(ON)}$ [Ω] @V_{GS} =10 V	Typ.	0.02	0.067	0.105	0.138
	Max	0.024	0.08	0.125	0.165
Polarity		N-ch	N-ch	N-ch	N-ch
Generation		DTMOSⅥ	DTMOSⅥ	DTMOSⅥ	DTMOSⅥ

◆Return to Block Diagram TOP

3 SiC MOSFET

TW027U65C / TW048U65C / TW083U65C / TW015Z65C / TW027Z65C / TW048Z65C

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

The performance index $R_{DS(ON)}$ x Q_{gd}, which shows switching characteristics, is reduced. This contributes to lower loss of power supply in application.

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

For Toshiba's third generation products, the performance index $R_{DS(ON)}$ x Q_{gd}, which shows the relation between conduction loss and switching loss, is reduced by optimizing its cell structure.

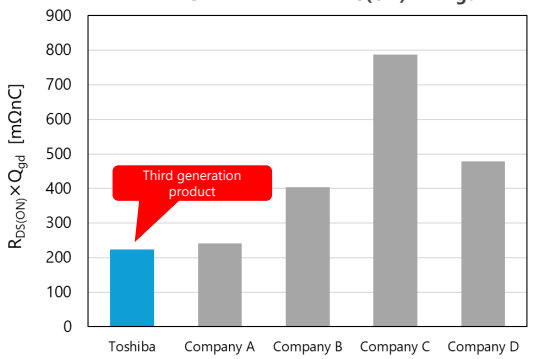
2 Wide V_{GSS} specification

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.

Comparison of $R_{DS(ON)}$ x Q_{gd}

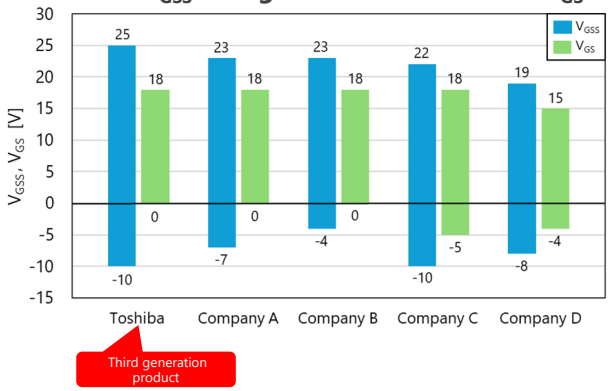


Measurement conditions

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

Q_{gd}: V_{DD} = 400 V, V_{GS} = 18 V, I_D = 20 A, T_a = 25 °C

V_{GSS} ratings and Recommended V_{GS}



[Note] Based on Toshiba's measurement data, as of October 2025.

Lineup

Part number		TW027U65C	TW048U65C	TW083U65C	TW015Z65C	TW027Z65C	TW048Z65C
Package		TOLL	 Top view	 Bottom view	TO-247-4L(X)	 Top view	 Bottom view
V_{DSS} [V]		650	650	650	650	650	650
I_D [A]		57	39	28	100	58	40
$R_{DS(ON)}$ [Ω] @V_{GS} =18 V	Typ.	0.027	0.048	0.083	0.015	0027	0.048
	Max	0.040	0.071	0.124	0.022	0.038	0.069
Polarity		N-ch	N-ch	N-ch	N-ch	N-ch	N-ch

◆Return to Block Diagram TOP

4 SiC Schottky barrier diode

TRS24N65FB / TRS2E65H / TRS8E65H / TRS12E65H / TRS4V65H / TRS12V65H

Low power consumption • Low heat generation • High heat dissipation efficiency | Noise immunity | Small size packages

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 Toshiba's third generation 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 Toshiba's existing products. V_F is reduced by about 17 %.

2 Improvement of power supply efficiency

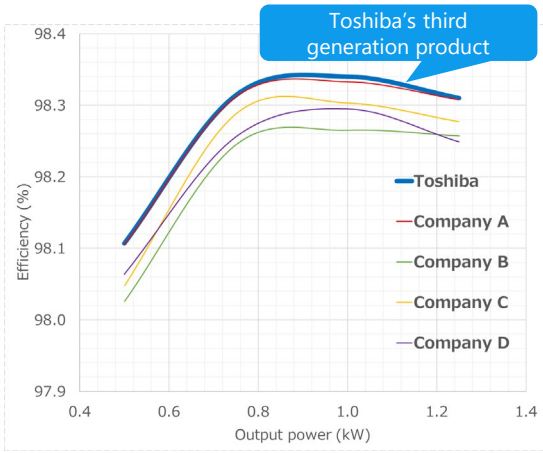
Compared with Toshiba's existing products, the trade off of V_F x Q_C [Note2] of third generation products have improved.
About 0.1 % of conversion efficiency improvement have also achieved under 800 W output condition in our test.

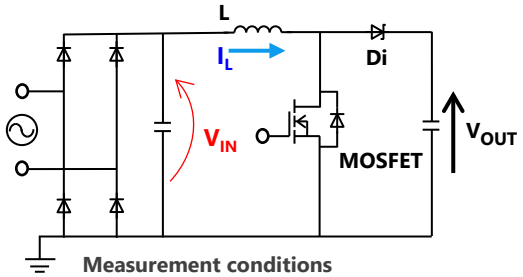
3 Expansion of package series

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 x 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.

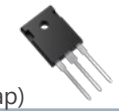
Comparison between Toshiba's third generation product and competitor products





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 (Based on Toshiba's measurement data, as of July 2023)

Lineup

Part number	TRS24N65FB	TRS2E65H	TRS8E65H	TRS12E65H	TRS4V65H	TRS12V65H
Package	TO-247 (Center tap) 	TO-220-2L 			DFN8x8 	
V_{RRM} [V]	650	650	650	650	650	650
$I_{F(DC)}$ [A]	12 / 24 *	2	8	12	4	12
I_{FSM} [A]	92 / 184 *	19	56	74	28	60
V_F (Typ.) [V]	1.45 @I_F = 12 A	1.2 @I_F = 2 A	1.2 @I_F = 8 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

5 Schottky barrier diode

CUHS20F30 / CUHS20F40 / CUHS10F60 / CUHS15F60 / CUHS20F60 / CUHS15S60 / CUHS20S60

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

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.
($R_{th(j\text{-}a)}$ = 105 °C/W [Note])

2 Wide lineup of reverse voltage

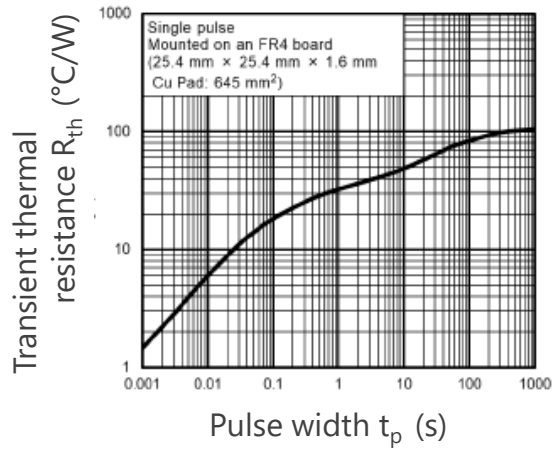
Lineup of reverse voltage V_R is 30 V, 40 V and 60 V (Max.).

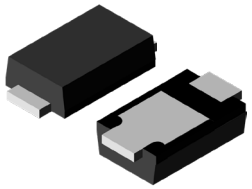
3 Low V_F

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)

(reference) CUHS10F60





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 A	0.35	0.39	0.56	0.55	0.41	0.48	0.35
I_R (Max) [μA]	60 @V_R = 30 V	60 @V_R = 40 V	40 @V_R = 60 V	50 @V_R = 60 V	70 @V_R = 60 V	450 @V_R = 60 V	650 @V_R = 60 V

◆Return to Block Diagram TOP

6 TVS diode

DF2B7ASL / DF2B5M4SL / DF2B6M4SL

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

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

1 Improved ESD pulse absorption

Improved ESD absorption compared to Toshiba's existing 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.

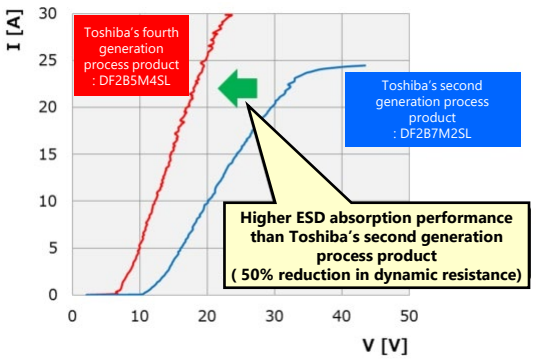
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using Toshiba own technology.

3 Suitable for high density mounting

A variety of small packages are available.

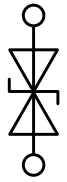
ESD Pulse Absorption Performance
(Toshiba internal comparison)



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.

◆Return to Block Diagram TOP

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

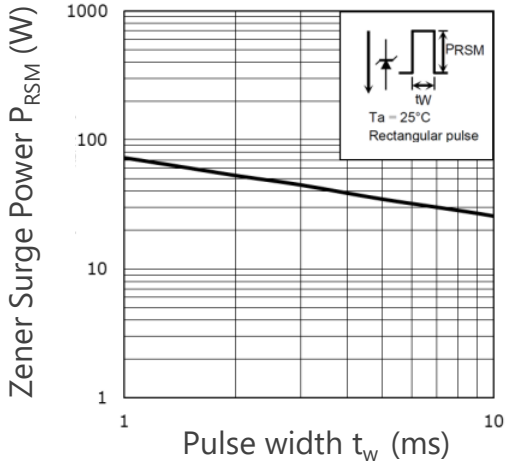
Other packages and products are here (Link)

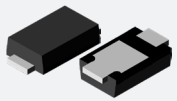
3 Wide lineup of V_Z

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

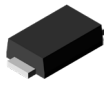
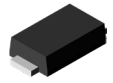
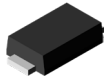
For 3.3 V: CSLZ5V6, CUHZ5V6
For 5 V: CSLZ6V2, CUHZ6V2, CRY62
For 12 V: CSLZ16V, CUHZ16V, CRZ16

(Reference) CUHZ Series P_{RSM} - t_w



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	SL2 (SOD-962) 	US2H (SOD-323HE) 	SL2 (SOD-962) 	US2H (SOD-323HE) 	S-FLAT™ 	SL2 (SOD-962) 	US2H (SOD-323HE) 	S-FLAT™ 

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8 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

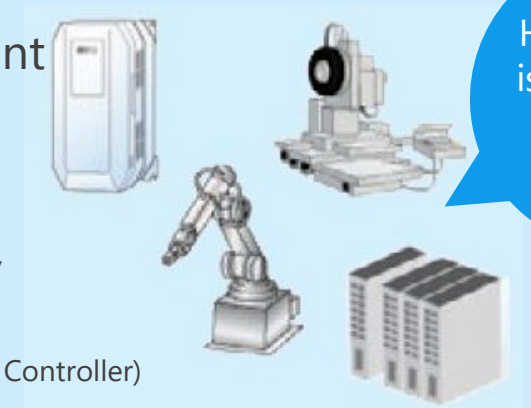
These are photo couplers of high isolation type that consists of a phototransistor optically coupled to an infrared LED. It achieves high current transfer ratio.

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

9 IC output photocoupler for high speed communication

TLP2767 / TLP2370

Low power consumption • Low heat generation • High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

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

1 High speed

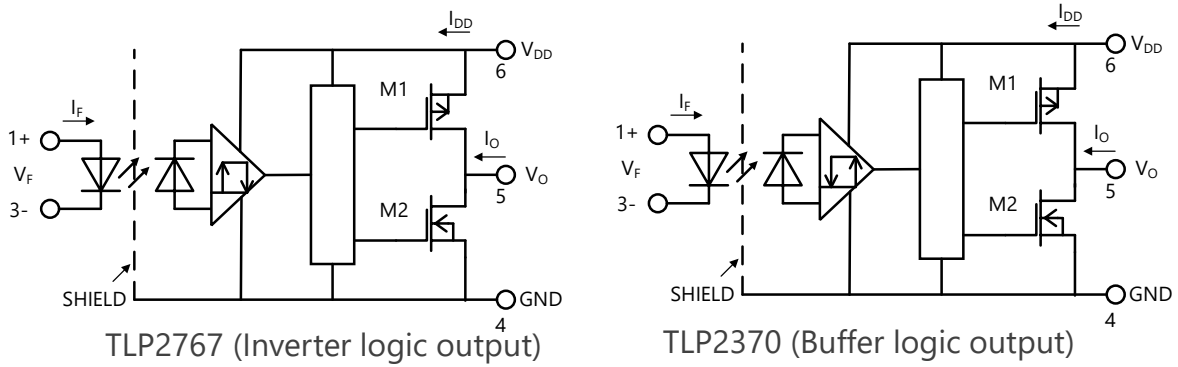
The propagation delay is 20 ns (Max) for TLP2767 and 60 ns (Max) for TLP2370. Margin design becomes easier than general phototransistor couplers.

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.



TLP2767 (Inverter logic output)

TLP2370 (Buffer logic output)

Internal Circuit

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

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10 Standard digital isolator

DCL54xx01 Series

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

Digital isolator for high-speed logic circuits, suitable for isolating communication lines.

1 High speed response

It is a four-channel high speed logic digital isolator and realizes the data rate of 150 Mbps (Max).

2 High noise immunity

Magnetic coupling type can block the common-mode noise and realize stable operation in case of large dv/dt noise is applied between the input and output during switching.

Common Mode Transient Immunity (CMTI)
= ±200 [kV/μs] (Typ.)

3 High reliability

Double isolation structure provides high dielectric strength and reliability.

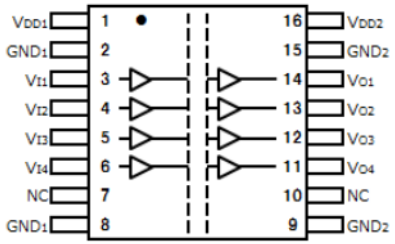
Reinforced isolation 5000 [Vrms]

Estimated isolation life >70 years [Note]

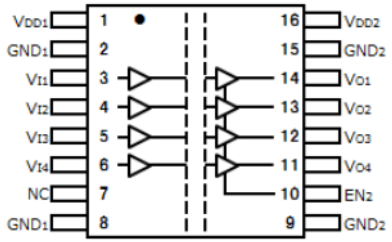
[Note] Estimated by TDDB (Time Dependent Dielectric Breakdown) test

Circuit configuration

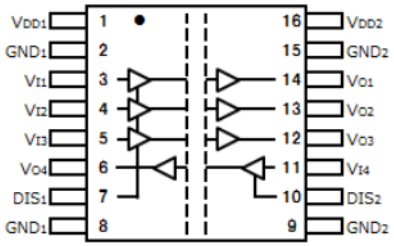
DCL540C01
DCL540D01



DCL540L01
DCL540H01



DCL541A01
DCL541B01



Lineup

Part number	DCL540C01	DCL540D01	DCL540L01	DCL540H01	DCL541A01	DCL541B01
Package	SOIC16-W 					
Channel	4 (Forward: 4, Reverse: 0)				4 (Forward: 3, Reverse: 1)	
BV_S [Vrms]	5000					
T_{opr} [°C]	-40 to 110					
Default output State	Low	High	Low	High	Low	High
Control signal	-		Output Enable		Input Disable	

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Semi-power MOSFET

SSM6K341NU / SSM3K341R

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

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.

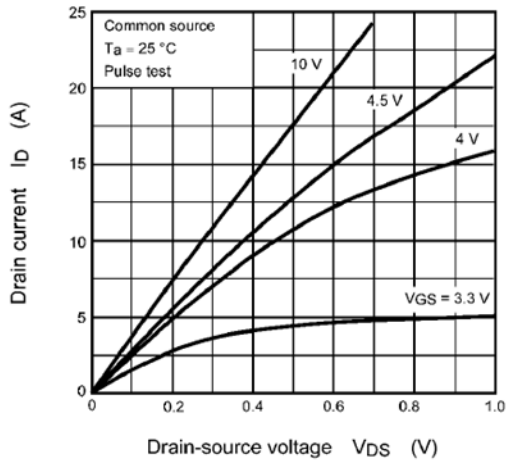
2 Small and high heat dissipating package

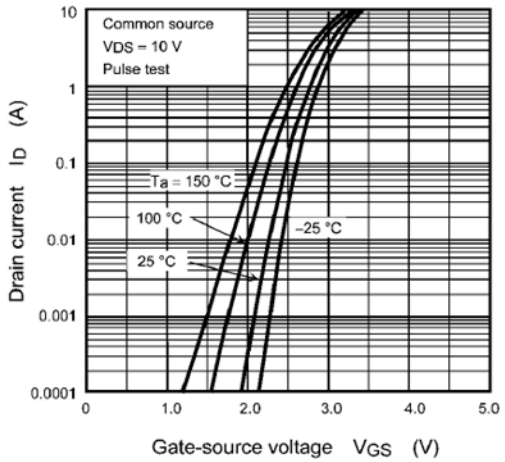
Small and high heat dissipating packages (UDFN6B, SOT-23F) contribute to space saving during mounting.

3 Low voltage drive

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

SSM3K341R





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	36
	Max	51	51
Polarity		N-ch	N-ch

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Low power consumption・Low heat generation・High heat dissipation efficiency | Noise immunity | Small size packages

Value provided

Contribute to system cost down, high efficiency system and development efficiency improvement.

1 Built-in Arm® Cortex®-M3 CPU core

Built-in Arm Cortex-M3 core with Thumb® instruction set improves energy efficiency. Various development tool and their partners allow users many options.

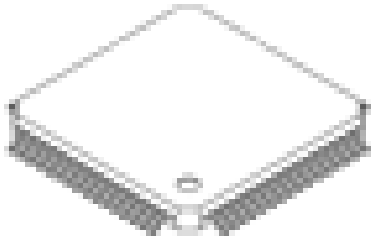
2 Suitable for sensing analog signal

Built-in multichannel AD converters and CPU system execute sensing data processing efficiently at low cost.

3 Small package and low power consumption

Cortex-M3 and original NANOFLASH™ technology bring to the small package and low power consumption. They contribute to reduction of board area and power consumption.

TMPM372FWUG



Package: LQFP64-P-1010-0.50E

Lineup

Part number	TMPM372FWUG
Maximum operation frequency	80 MHz
ROM	128 KB
RAM	6 KB
Timer/Counter	8ch
UART/SIO	4ch
AD converters	11ch (12bit)
Three-phase PWM output	1ch

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13 Three-phase brushless DC motor driver IC

TC78B025FTG / TC78B027FTG / TC78B009FTG

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

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

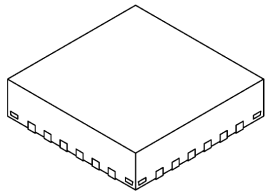
NVM [Note] is implemented. It realizes closed loop speed control function without an external MCU. It contributes to reduce system cost.

[Note] No-volatile memory

3 Small package

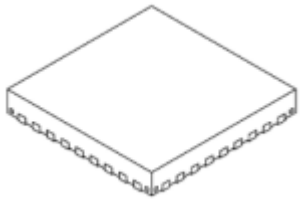
VQFN24 and WQFN36 are suitable for mounting limited space.

TC78B025FTG / TC78B027FTG



P-VQFN24-0404-0.50-002 /
P-VQFN24-0404-0.50-003
(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-VQFN24-0404-0.50-002	P-VQFN24-0404-0.50-003	P-WQFN36-0505-0.50-001

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Electronic fuse (eFuse IC)

TCKE8 Series / TCKE7 Series

Low power consumption · Low heat generation · High heat dissipation efficiency | Noise immunity | Small size packages

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

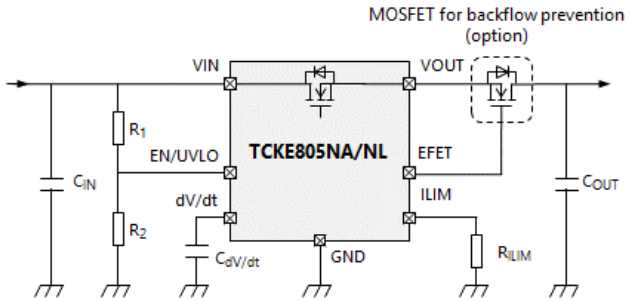
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Various protection functions

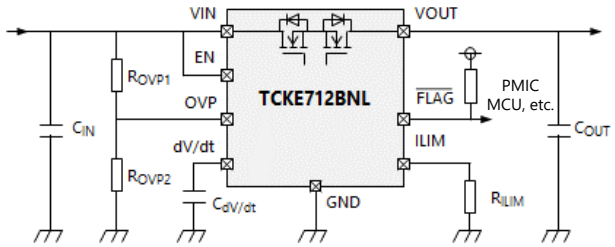
TCKE8 Series: Short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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

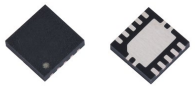
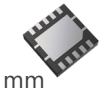
Reference circuit example of TCKE8 Series



Reference circuit example of TCKE7 Series



Lineup

Part number	TCKE800NA/NL	TCKE805NA/NL	TCKE812NA/NL	TCKE712BNL
Package	WSON10B 3.0 x 3.0 x 0.75 mm 			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
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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15 Over temperature detection IC (Thermoflagger™)

TCTH Series

Low power consumption · Low heat generation · High heat dissipation efficiency

Noise immunity

Small size packages

Value provided

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

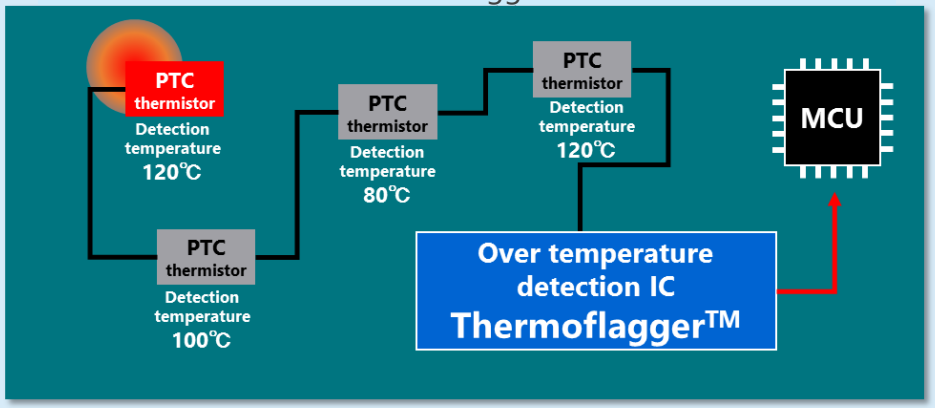
1 Temperature rise can be detected at multiple points

TCTH series detect voltage drop of PTC (Positive Temperature Coefficient) thermistors due to temperature rise by supplying a constant current (1 µA or 10 µA) to PTC thermistors. Multiple PTC thermistors connected in series enable to detect temperature rise at multiple points on the circuit board.

2 Low current consumption and small package

TCTH01 series has I_{DD} = 1.8 µA (Typ.)
and TCTH02 series has I_{DD} = 11.3 µA (Typ.).
These packages are small size ESV type.

Example of temperature rise detecting circuit by Thermoflagger™.



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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