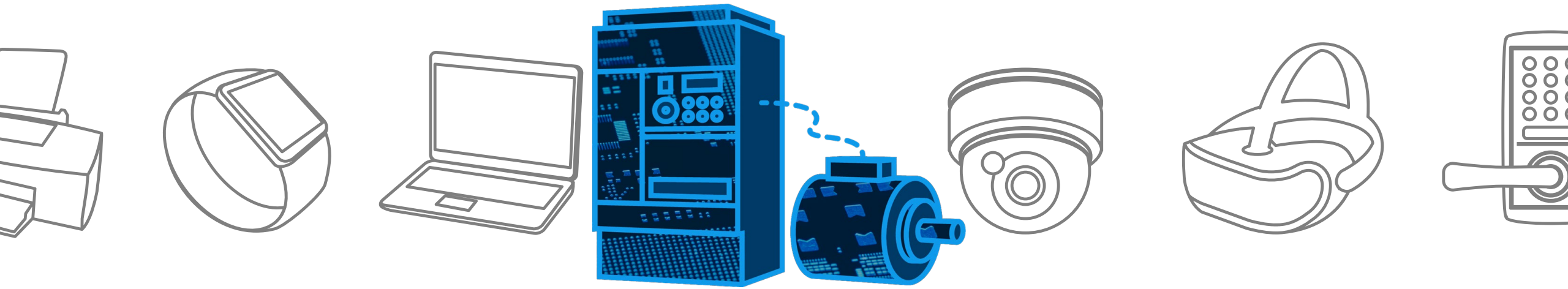
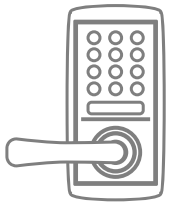
TOSHIBA

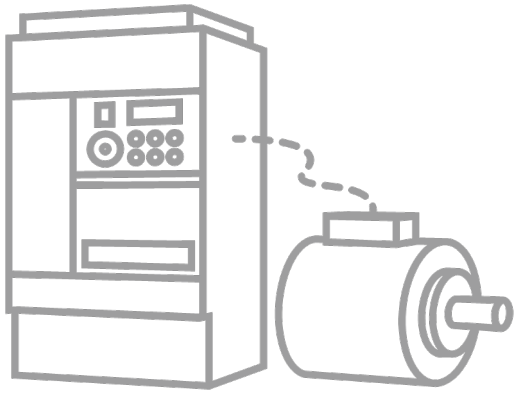
R20

Inverter/Servo

Solution Proposal by Toshiba

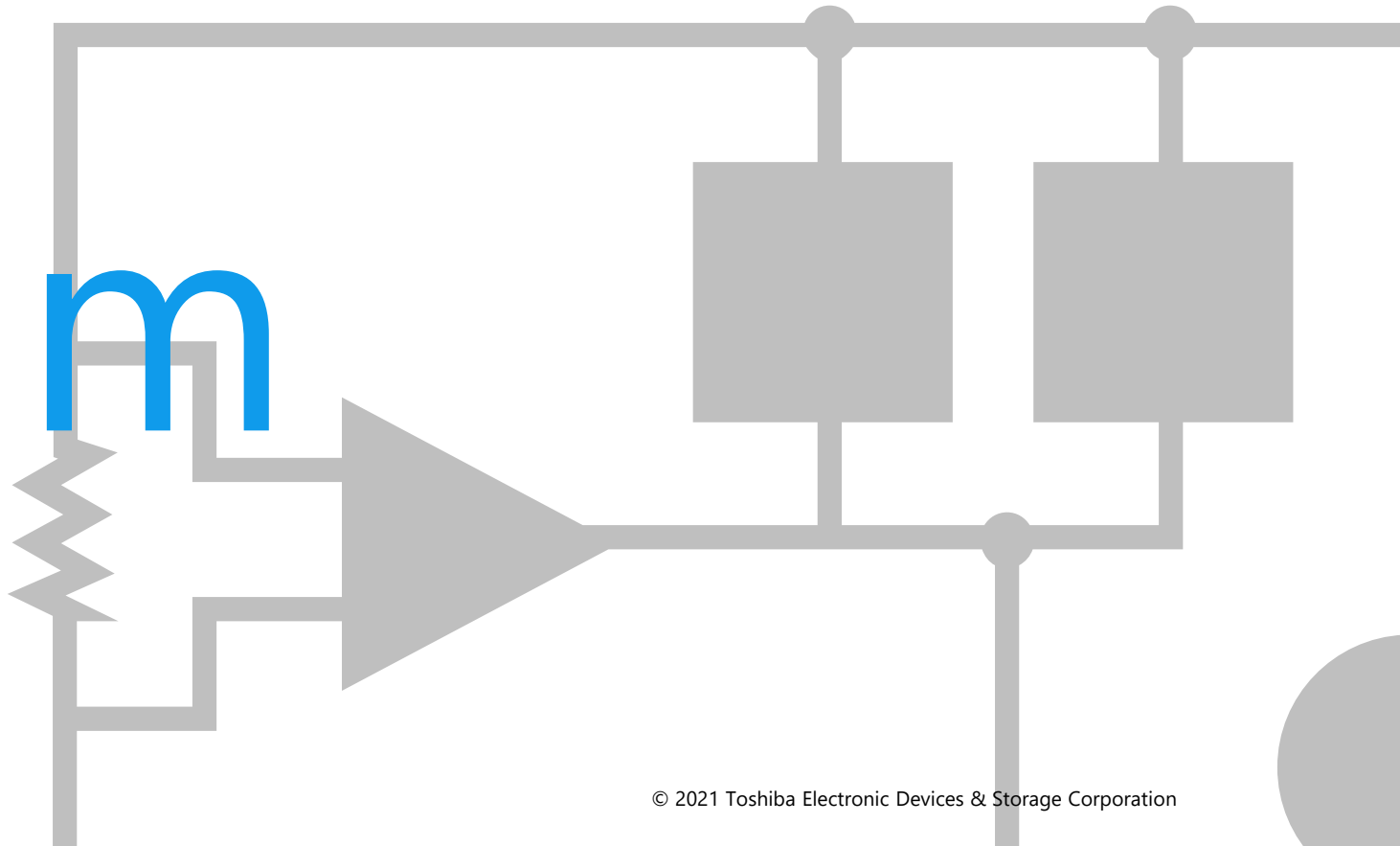




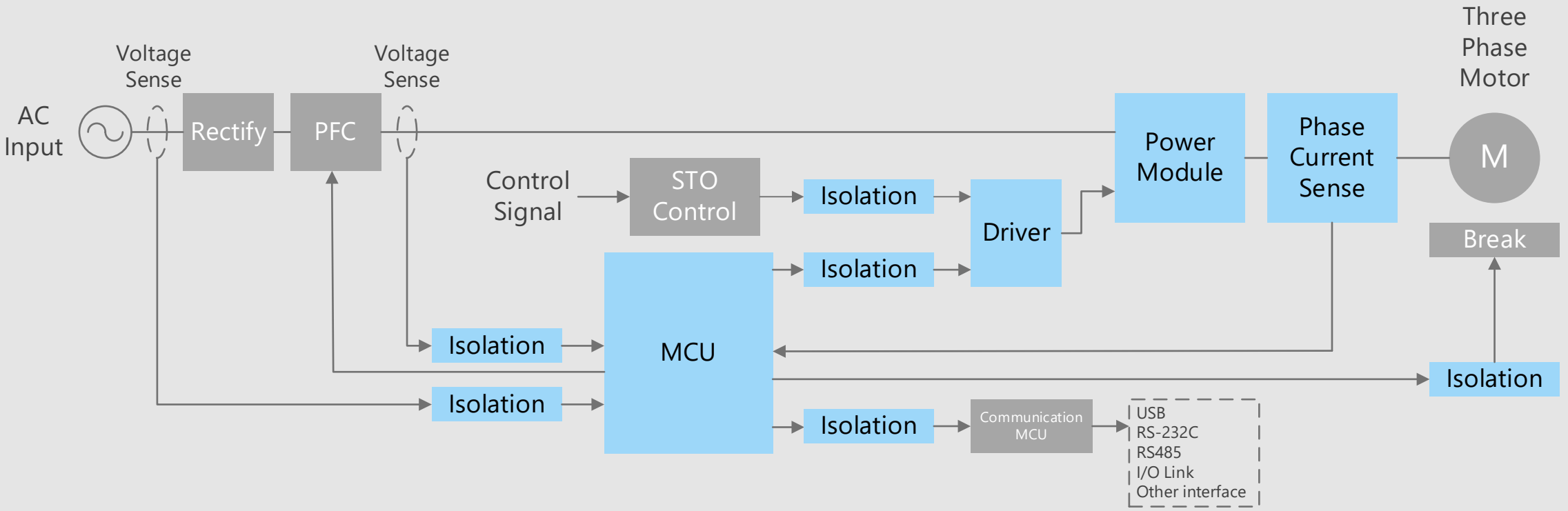


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

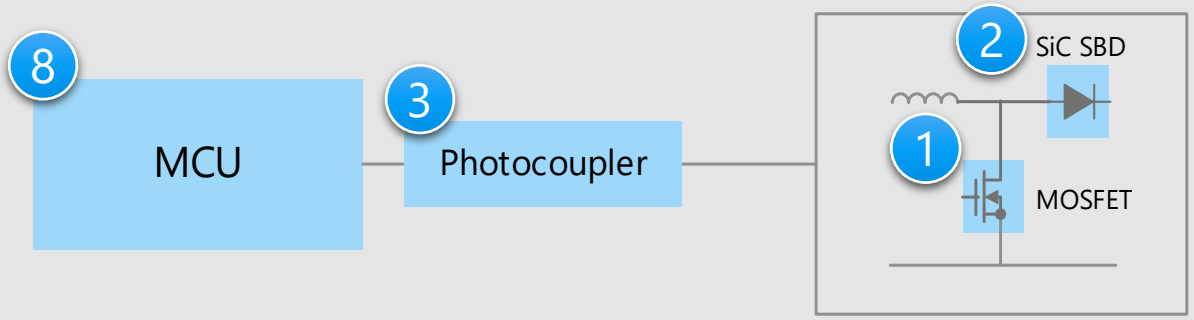


Inverter/Servo　Overall block diagram

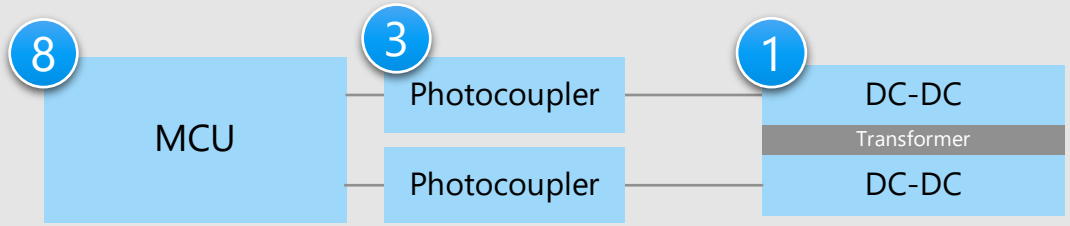


Inverter/Servo　Detail of power supply circuit

Improvement of power factor



DC-DC converter for power supply



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

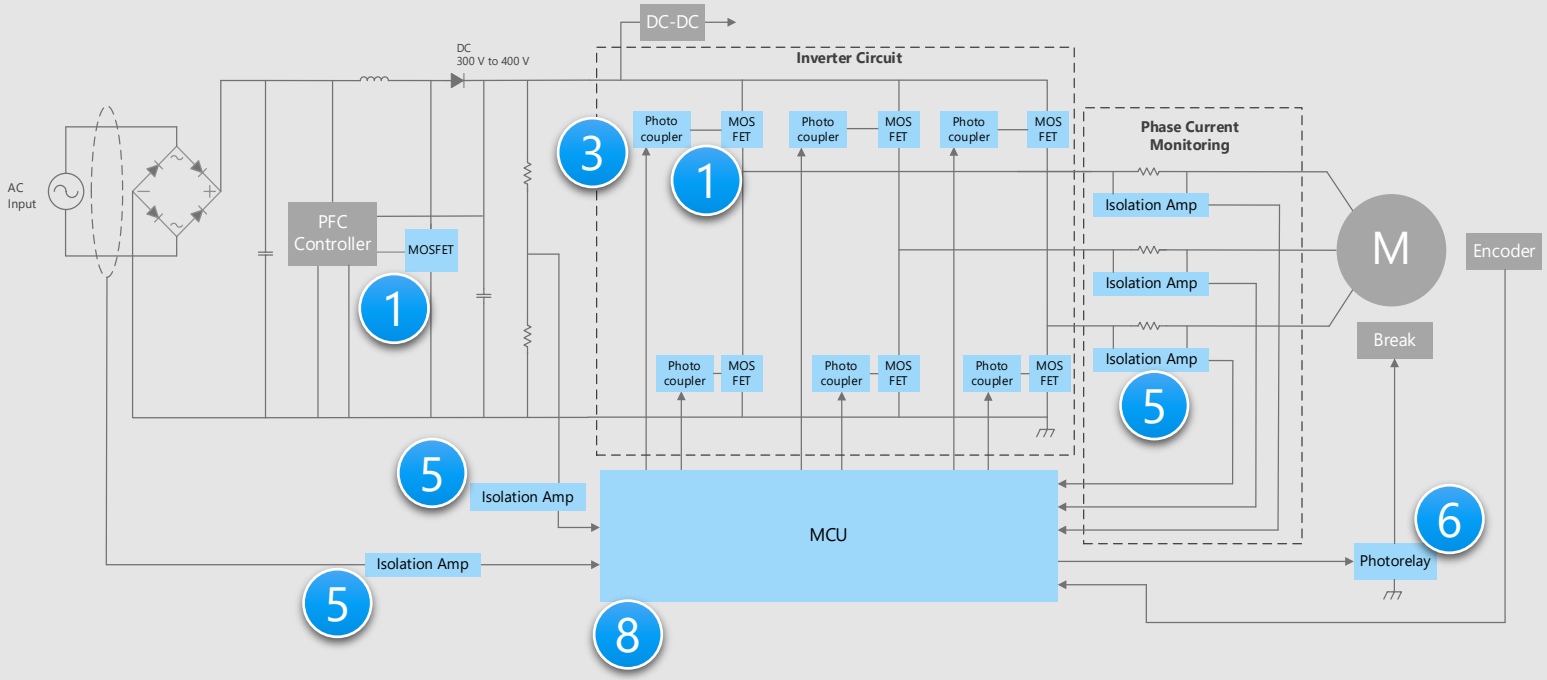
- A high voltage MOSFET with high speed recovery diodes is used for PFCs and DC-DC converters.
- SiC type Schottky barrier diodes are suitable for PFC circuits.
- Both high voltage MOSFET and low voltage MOSFET are used for DC-DC converters for power supplies.

Proposal from Toshiba

- **Suitable for high efficiency power supply switching** 1
  DTMOS Series MOSFET
  U-MOS Series MOSFET
- **Strong with efficiency figure of merit and surge current** 2
  SiC Schottky barrier diode
- **Photocoupler with excellent environmental resistance** 3
  IC output photocoupler
- **Easy software development using general purpose CPU cores** 8
  MCU

Inverter/Servo　Detail of motor driving circuit (1)

Motor driving circuit (with MOSFET)



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

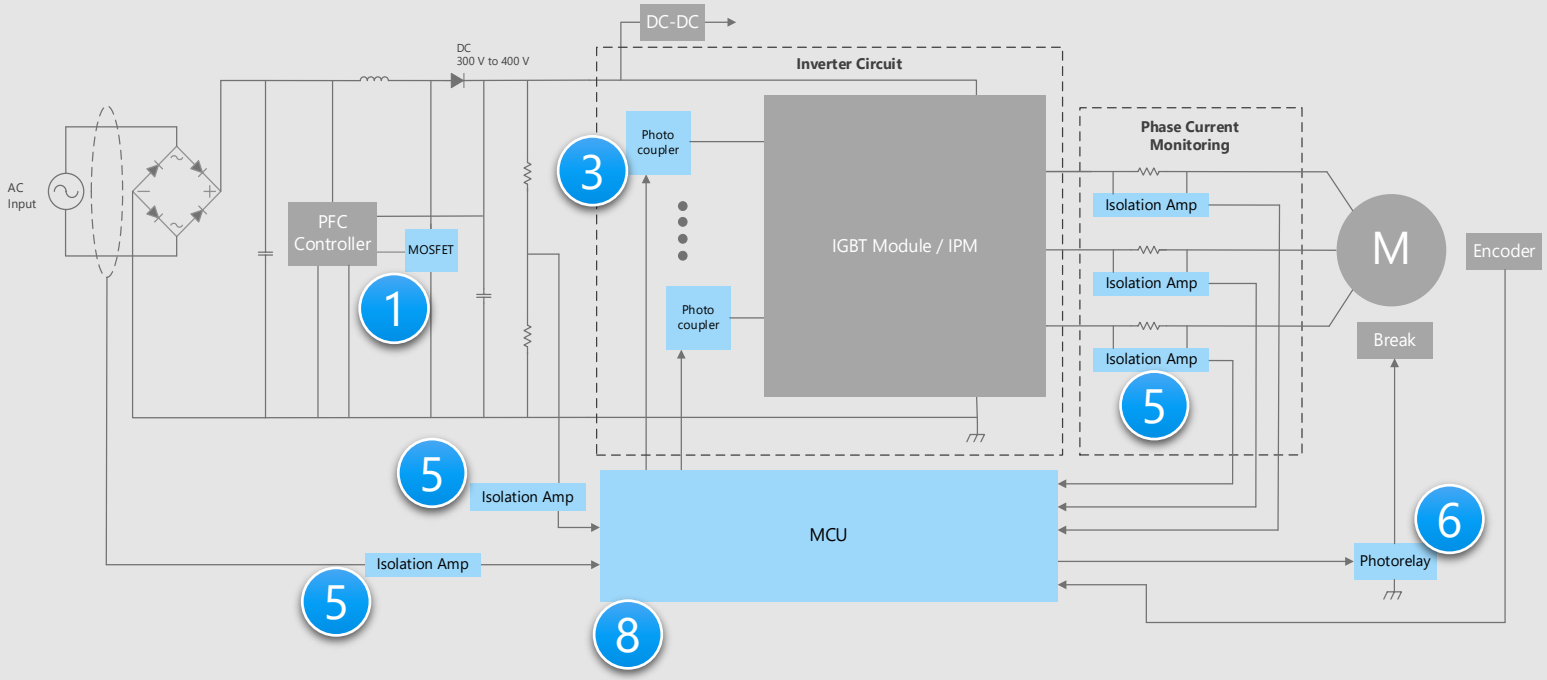
- The use of photocouplers realizes the signal transmission between the systems with different voltage levels, and suppress the noise influences.
- The use of photorelays instead of mechanical relays eliminates the life limitation caused by contact wear and welding at the contact points, enabling long life and quieter operation.

Proposal from Toshiba

- **Suitable for high efficiency power supply switching** 1
  DTMOS Series MOSFET
- **Photocoupler with excellent environmental resistance** 3
  IC output photocoupler
- **Photocoupler suitable for analog signal transmission** 5
  Isolation amplifier
- **Photocoupler suitable for analog signal transmission** 6
  Photorelay
- **Easy software development using general purpose CPU cores** 8
  MCU

Inverter/Servo　Detail of motor driving circuit (2)

Motor driving circuit (with IGBT/IPM)



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

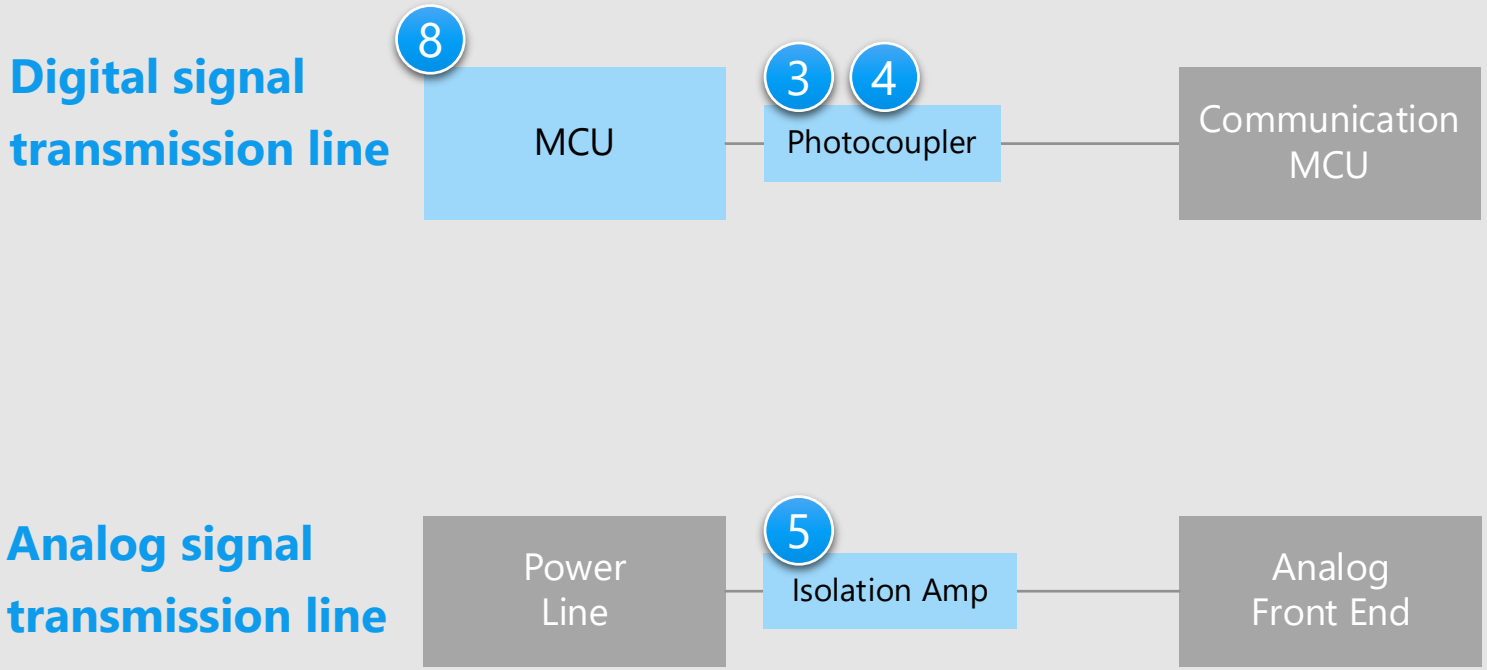
Criteria for device selection

- The use of photocouplers realizes the signal transmission between the systems with different voltage levels, and suppress the noise influences.
- The use of photorelays instead of mechanical relays eliminates the life limitation caused by contact wear and welding at the contact points, enabling long life and quieter operation.

Proposal from Toshiba

- **Suitable for high efficiency power supply switching** 1
  DTMOS Series MOSFET
- **Photocoupler with excellent environmental resistance** 3
  IC output photocoupler
- **Photocoupler suitable for analog signal transmission** 5
  Isolation amplifier
- **Photocoupler suitable for analog signal transmission** 6
  Photorelay
- **Easy software development using general purpose CPU cores** 8
  MCU

Inverter/Servo　Detail of isolated signal transmission



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

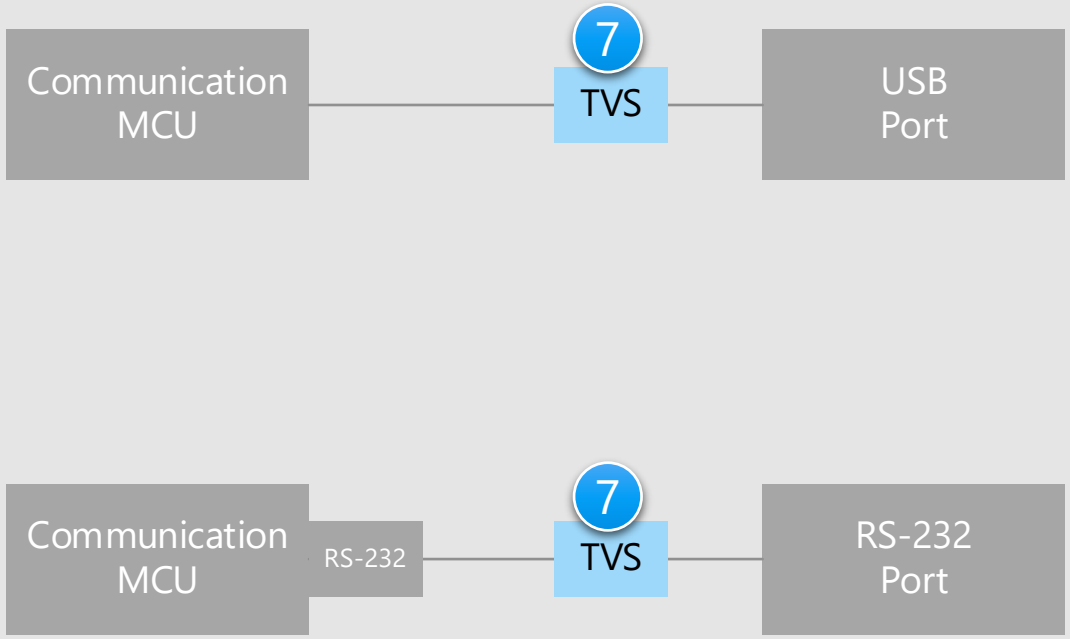
- It is necessary to isolate the MCU for control and the MCU for communication from each other.
- Protection against high voltage is required to protect the IC used internally.

Proposal from Toshiba

- **Photocoupler with excellent environmental resistance.**
  IC or Transistor output photocoupler 3 4
- **Photocoupler suitable for analog signal transmission.**
  Isolation amplifier 5
- **Easy software development using general purpose CPU cores**
  MCU 8

Inverter/Servo　Detail of interface circuit

Interface circuits



Criteria for device selection

- To protect the USB signal line, it is necessary to use a TVS diode with a low capacitance between terminals.
- Low dynamic resistance (R_{DYN}) is a key characteristic that determines the protective tolerance.
- It is important to protect not only the exterior but also the interior of the set.

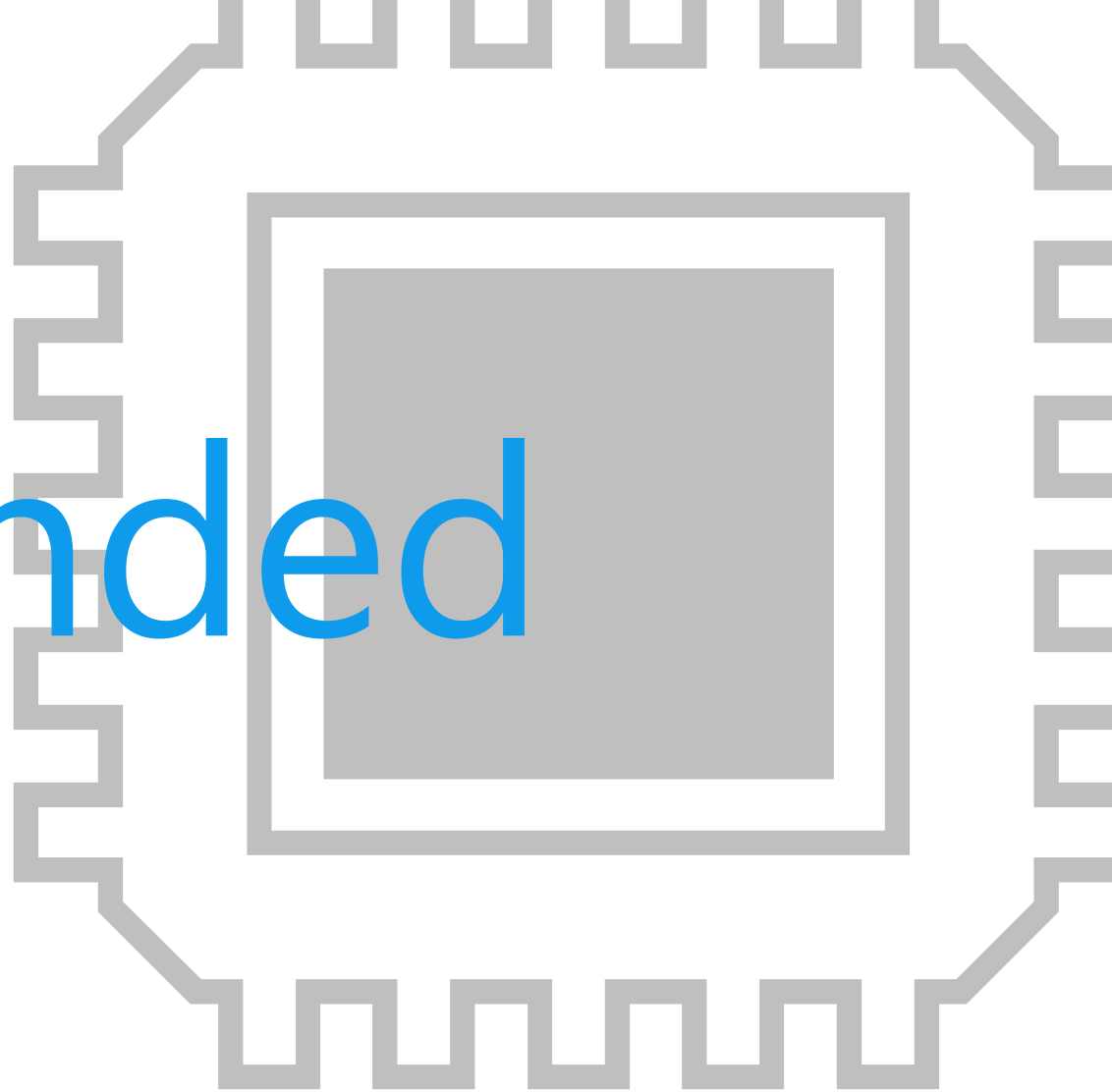
Proposal from Toshiba

- **Absorbs static electricity (ESD) and prevents circuit malfunction and device breakdown.**
  TVS diode

7

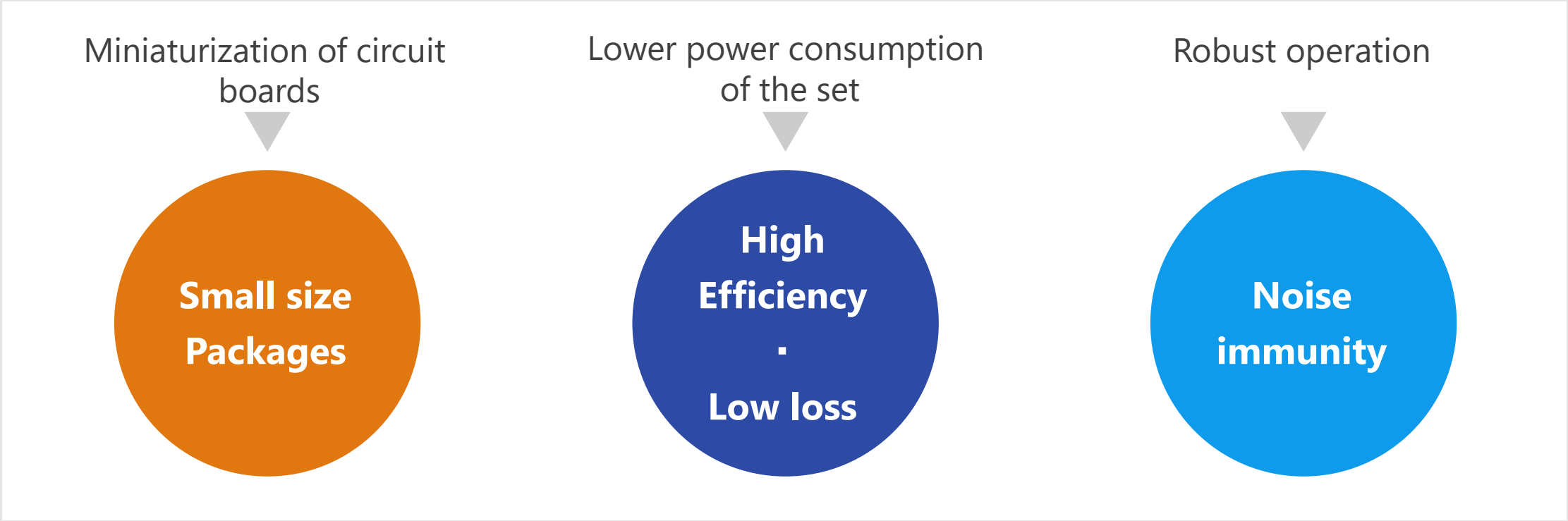
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of inverter/servo system, **"Miniaturization of circuit boards"**, **"Low power consumption of sets"** and **"Robust operation"** are important factors. Toshiba's proposals are based on these three solution perspectives.



Device solutions to address customer needs

	Small size packages	High Efficiency・Low loss	Noise immunity
1 MOSFET	●	●	●
2 SiC Shottky barrier diode	●	●	●
3 IC output photocoupler	●	●	●
4 Transistor output photocoupler	●	●	●
5 Isolation amplifier	●	●	●
6 Photorelay	●	●	●
7 TVS diode	●		●
8 MCU	●	●	

1a DTMOS Series MOSFET

TK25A60X / TK16A60W5 / TK110A65Z / TK190A65Z / TK110U65Z / TK190U65Z

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

Value provided

DTMOS series contribute to provide highly efficient power supply by improving $R_{DS(on)}$ x Q_{gd} .

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

In the DTMOSⅥ series, the $R_{DS(ON)}$ x Q_{gd} is reduced by approximately 40 % compared with Toshiba's conventional DTMOSⅣ-H series product by optimizing the gate design and processes.

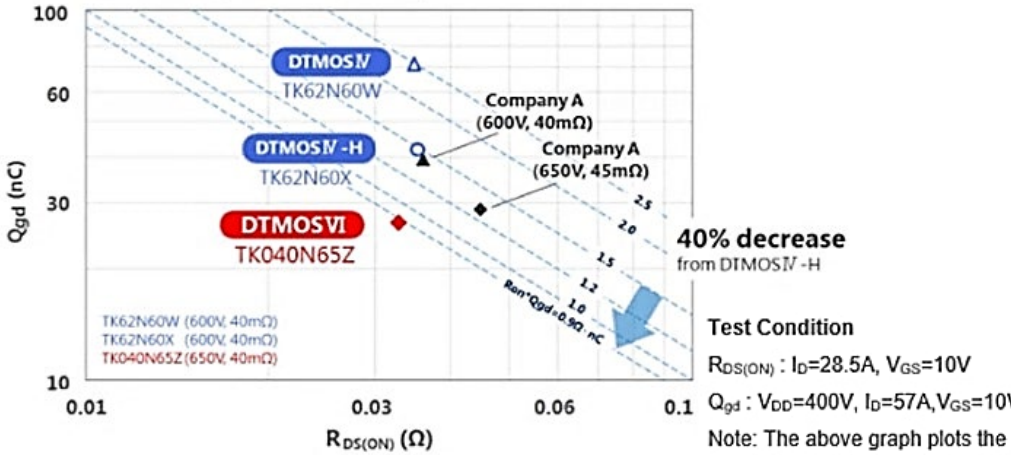
2 Body diode reverse recovery characteristics

Fast recovery body diode type based on DTMOSⅥ series, which make more efficient.
(DTMOSⅣ, High speed recovery diode type)

3 Enhancement type

This is an enhancement type that is easy to handle.

Comparisons of figures of merit Based on Toshiba's measurement data



Test Condition

$R_{DS(ON)}$: I_D=28.5A, V_{GS}=10V

Q_{gd} : V_{DD}=400V, I_D=57A, V_{GS}=10V

Note: The above graph plots the mean of the measured values.

Line up

Part number		TK25A60X	TK16A60W5	TK110A65Z	TK190A65Z	TK110U65Z	TK190U65Z
Package		TO-220SIS 				TOLL 	
V_{DSS} [V]		600	600	650	650	650	650
I_D [A]		25	16	24	15	24	15
$R_{DS(ON)}$ [Ω] @V_{GS} = 10 V	Typ.	0.105	0.18	0.092	0.158	0.086	0.149
	Max	0.125	0.23	0.11	0.19	0.11	0.19
Polarity		N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation		DTMOSⅣ-H	DTMOSⅣ	DTMOSⅥ	DTMOSⅥ	DTMOSⅥ	DTMOSⅥ

◆Return to Block Diagram TOP

1b U-MOS Series MOSFET

TPN19008QM / TPH4R008QM / TPH2R408QM / TK2R4A08QM / TK2R4E08QM / TK100E10N1

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

Value provided

With a wide lineup and ease of use, contribute to energy saving and efficiency increasing.

1 High efficiency

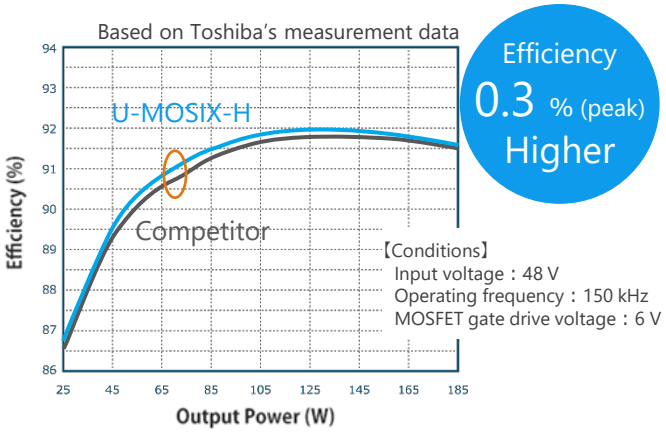
- Low on-resistance ($R_{DS(ON)}$) achieved by fine integration.
- Improved trade off between $R_{DS(ON)}$ and Q_g, Q_{sw}, Q_{oss} .

2 Wide variety of line up

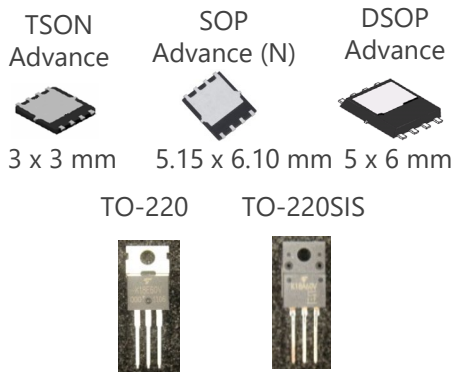
- Voltage line up from 20 V to 250 V.
- Wide variety of packages.

3 Easy to design

- Low V_{DS} spike and ringing by parasitic snubber.
- High avalanche capability.



Efficiency comparison in the case of full-bridge DC-DC converter



Wide variety of packages

Line up

Part number		TPN19008QM	TPH4R008QM	TPH2R408QM	TK2R4A08QM	TK2R4E08QM	TK100E10N1
Package		TSON Advance	SOP Advance(N)		TO-220SIS	TO-220	
V_{DSS} [V]		80	80	80	80	80	100
I_D [A]		34 (38*)	86 (140*)	120 (200*)	100 (116*)	120(290*)	100 (207*)
$R_{DS(ON)}$ [Ω] @V_{GS} = 10 V	Typ.	0.0147	0.0031	0.0019	0.00188	0.00197	0.0028
	Max	0.019	0.004	0.00243	0.00244	0.00244	0.0034
Polarity		N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation		U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅧ-H

* : Silicon limit

◆Return to Block Diagram TOP

2 SiC Schottky barrier diode

TRS4A65F / TRS4E65F / TRS12E65F / TRS12N65FB / TRS16N65FB / TRS20N65FB / TRS24N65FB

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

Value provided

Can be applied to power factor correction circuits and a wide range of power supply control applications, and greatly contributes to miniaturization.

1 High surge tolerance

The surge peak forward current I_{FSM} = 97 A (Max) (TRS12E65F).
Surge current is increased around 2 times by using improved JBS (Junction Barrier Schottky) structure.
(Comparison with Toshiba's first generation products)

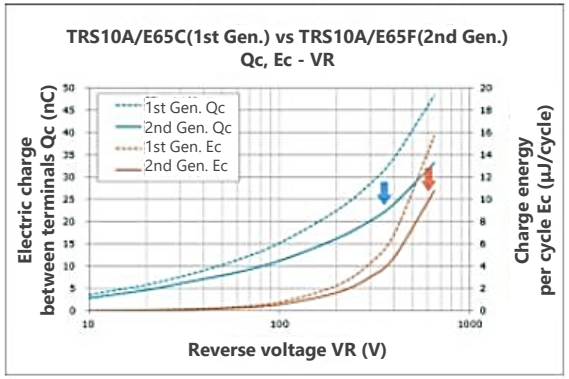
2 Second generation chip design

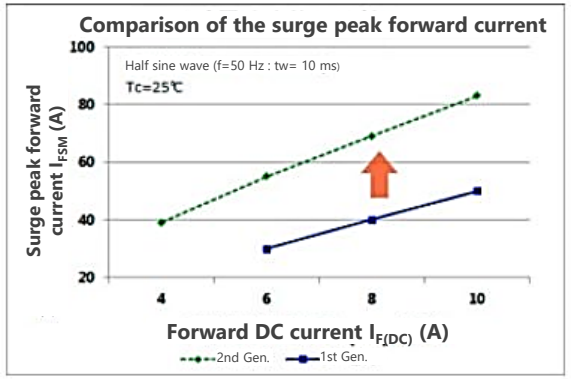
The figure of merit (V_F x Q_C) (Note1) is improved by 30 % and the surge peak forward current (I_{FSM}) is improved, thereby contributing to higher efficiency of the power supply.
(Comparison with Toshiba's first generation products)

3 Small package

Provided in TO-220 through-hole type package.

Comparison between Toshiba's the first and second generations products





Note1: The V_F * 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.

Line up

Part number	TRS4A65F	TRS4E65F	TRS12E65F	TRS12N65FB	TRS16N65FB	TRS20N65FB	TRS24N65FB
Package	TO-220F-2L	TO-220-2L		TO-247 (Center tap)			
V_{RRM} [V]	650	650	650	650	650	650	650
$I_{F(DC)}$ [A]	4	4	12	6 / 12 *	8 / 16 *	10 / 20 *	12 / 24 *
I_{FSM} [A]	37	39	97	52 / 104 *	65 / 130 *	79 / 158	92 / 184 *
V_F (Typ.) [V]	1.45 @I_F = 4 A	1.45 @I_F = 4 A	1.45 @I_F = 12 A	1.45 @I_F = 6 A	1.45 @I_F = 8 A	1.45 @I_F = 10 A	1.45 @I_F = 12 A

* : Per Leg / Both Legs

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3a IC output photocoupler (for driving power device)

TLP5774H / TLP5214A / TLP5754H / TLP2745 / TLP2719

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

Value provided

Combines an infrared light emitting diode with high optical output and an integrated circuit light receiving IC chip with high gain and high speed.

1 High noise immunity

The products have internal faraday shield that provides a guaranteed common mode transient immunity.

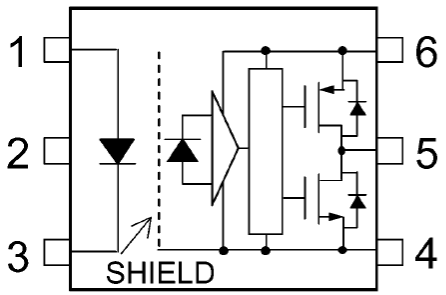
2 High isolation voltage

The isolation voltage BV_S is 5000 [Vrms] (Min).

3 High temperature operation

The products are designed to operate even under severe ambient temperature conditions, such as inverters, robots, machinery, and high-output power supplies.

Internal circuit configuration (TLP5754)



1: Anode
2: N.C.
3: Cathode
4: GND
5: V_O (Output)
6: V_{CC}

UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN60065, EN60950-1, EN 62368-1 (Note 1)

Note 1: When a VDE approved type is needed, please designate the Option (D4).

Line up

Part number	TLP5774H	TLP5214A	TLP5754H	TLP2745	TLP2719
Type	MOSFET Drive	IGBT Drive		IPM Drive	
Package	SO6L 	SO16 	SO6L 	SO6L 	
BV_S (Min) [Vrms]	5000	5000	5000	5000	5000
T_{opr} [° C]	-40 to 110	-40 to 110	-40 to 125	-40 to 110	-40 to 110
Output type	Totem-pole	Totem-pole	Totem-pole	Totem-pole	Open-collector

◆Return to Block Diagram TOP

3b IC output photocoupler (for signal communication)

TLP2710 / TLP2761 / TLP2770 / TLP2210 / TLP2261 / TLP2270

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

Value provided

Combines an infrared light emitting diode with high optical output and an integrated circuit light receiving IC chip with high gain and high speed.

1 High noise immunity

The products have internal faraday shield that provides a guaranteed common mode transient immunity.

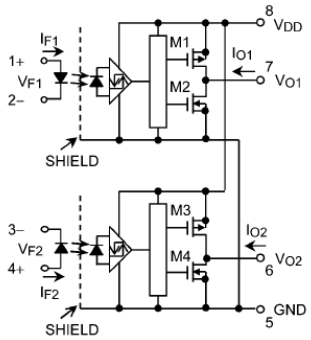
2 High isolation voltage

The isolation voltage BV_S is 5000 [Vrms] (Min).

3 High temperature operation

The products are designed to operate even under severe ambient temperature conditions, such as inverters, robots, machinery, and power supplies.

Internal circuit configuration (TLP2210)



1: Anode 1
2: Cathode 1
3: Cathode 2
4: Anode 2
5: GND
6: V_O 2 (output 2)
7: V_O 1 (output 1)
8: V_{DD}

UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN60065, EN60950-1, EN 62368-1 (Note 1)

Note 1: When a VDE approved type is needed, please designate the Option (D4).

Line up

Part number	TLP2710	TLP2761	TLP2770	TLP2210	TLP2261	TLP2270
Package	SO6L 			SO8L 		
Channel	1			2		
Data rate [Mbps]	5	15	20	5	15	20
T_{opr} [°C]	-40 to 125	-40 to 125	-40 to 125	-40 to 125	-40 to 125	-40 to 125

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4 Transistor output photocoupler

TLP383 / TLP293 / TLP785 / TLP385

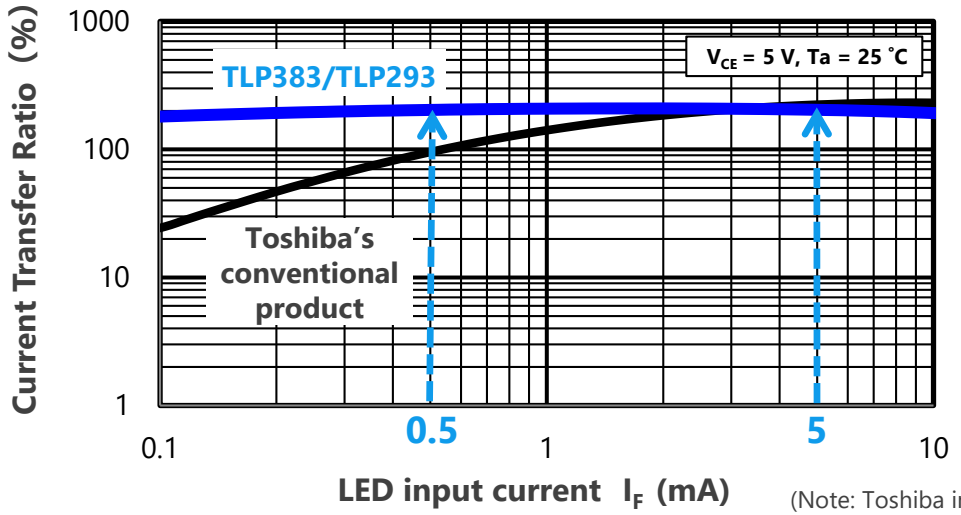
Small size packages | High efficiency · Low-loss | Noise immunity

Value provided

Reduction in required circuit board area and improving reliability enabling maintenance-free operation.

1 High current transfer ratio

The TLP383/TLP293 is a high-isolation photocoupler that optically couples a phototransistor and high output infrared LED. Compared to Toshiba's conventional products (TLP785/TLP385), higher CTR (Current Transfer Ratio) in low input current range (@ I_F = 0.5 mA) is realized.



(Note: Toshiba internal comparison)

2 Operating temperature is expanded to 125 °C

The TLP383/TLP293 are designed to operate under extreme conditions of ambient temperature such as inverter devices, robots, machine tools and high output power supplies.

Line up

Part number	TLP383	TLP293	TLP785	TLP385
Package	SO6L (4pin) 	SO4 	DIP4 	SO6L (4pin) 
BV_S (Min) [Vrms]	5000	3750	5000	5000
T_{opr} [°C]	-55 to 125	-55 to 125	-55 to 110	-55 to 110

◆Return to Block Diagram TOP

5 Isolation amplifier

TLP7820

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

Value provided

This is the most suitable isolation amplifier for current/voltage detection of motors and inverters.

1 High isolation performance

This optical coupling type isolation amplifier has a high-precision ΔΣ AD conversion circuit on the input side and a high precision DA conversion circuit on the output side.

2 Support for common mode

Common-mode transient immunity is provided with CMTI = 15 kV/μs (Min).

3 5 V system power supply voltages

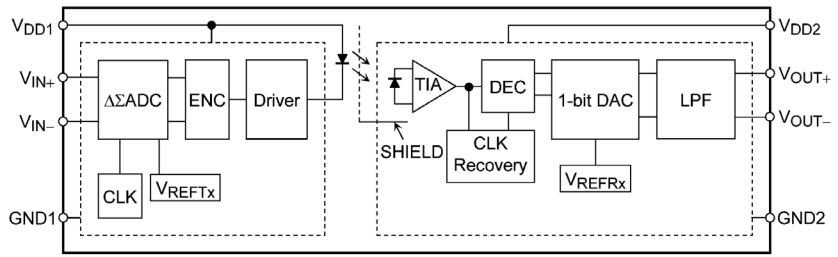
Input power supply voltage

V_{DD1} = 4.5 to 5.5 V

Output power supply voltage

V_{DD2} = 3.0 to 5.5 V

Internal circuit configuration

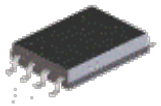


Note: A 0.1-μF bypass capacitor must be connected between 1 and 4 pins and between 5 and 8 pins.

UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN60065, EN60950-1, EN 62368-1 (Note 1)

Note 1: When a VDE approved type is needed, please designate the Option (D4).

Line up

Part number	TLP7820
Package	SO8L 
BV_S (Min) [Vrms]	5000
T_{opr} [°C]	-40 to 105
CMTI (Min) [kV/μs]	15

◆Return to Block Diagram TOP

6 Photorelay

TLP3122A / TLP170AM / TLP3545A / TLP3547 / TLP240A / TLP241B

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

Value provided

Photorelay consists of an infrared light emitting diode optically coupled to a photo-MOSFET and is suitable for replacing mechanical relays.

1 Low on-resistance R_{ON}

On-resistance R_{ON} = 0.05 Ω (Typ.)
(TLP3547: A connection) [Note 1]

2 Wide current range I_{ON}

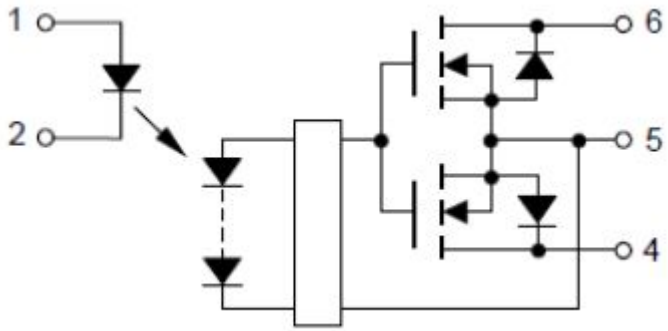
The range of on-state current I_{ON} is wide and suitable for power line control.
I_{ON} = 5.0 A (Max)
(TLP3547: A connection) [Note 1]

3 Package and isolation voltage

The line up of isolation voltage and package for freedom of design are provided.

[Note 1] Please refer to the technical data sheet for connection.

Internal equivalent circuit



Safety Standards
UL approved: UL1577, File No.E67349
cUL approved: CSA Component Acceptance Service No. 5A, File No.E67349

Line up

Part number	TLP3122A	TLP170AM	TLP3545A	TLP3547	TLP240A	TLP241B
Package	4pin SO6		DIP6	DIP8	DIP4	
I_{ON} (Max) [A]	1.4	0.7	4.0	5.0	0.5	2.0
V_{OFF} (Max) [V]	60	60	60	60	60	100
R_{ON} (Max) [Ω]	0.25	0.3	0.06	0.05	2.0	200
BV_S (Max) [Vrms]	3750	3750	2500	2500	5000	5000

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7 TVS diode

DF2B6M4SL / DF2B20M4SL / DF2B5PCT / DF2B7PCT / DFS2S14P2CTC

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

Value provided

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

1 Improved ESD pulse absorption

Improved ESD absorption compared to our 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.

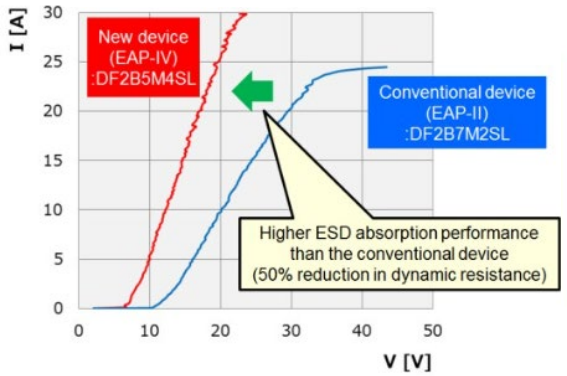
2 Suppress ESD energy by low clamp voltage

Steadily protect the connected circuits/devices using proprietary technology.

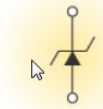
3 Suitable for high-density mounting

A variety of compact 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

Line up

Part number	DF2B6M4SL	DF2B20M4SL	DF2B5PCT	DF2B7PCT	DF2S14P2CTC
Package	SL2 		CST2 		
V_{ESD} [kV]	±20	±15	±30	±30	±30
V_{RWM} (Max) [V]	5.5	18.5	3.6	5.5	12.6
C_t (Typ.) [pF]	0.2	0.2	41	45	270
R_{DYN} (Typ.) [Ω]	0.5	0.2	0.1	0.1	0.08
Purpose	Signal line protection		Power line protection		

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

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Value provided

Based on the global standard Arm® Cortex®-M3 core, it provides high performance and a full set of basic functions

1 Motor controller logic circuit

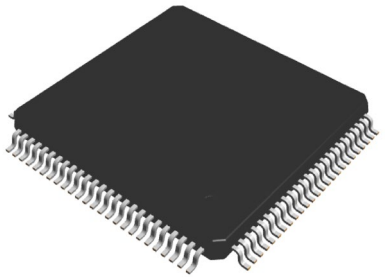
3-phase brushless motor controller, execute PWM output for rectangular wave drive and sine wave drive.

2 Motor controller co-processor

Vector engine that supports vector control, control the motor more smoothly and efficiency with a low CPU load.

3 Analog circuit for motor control

AD converter with high speed and high accuracy, allow conversion timing and PWM output to be linked.



LQFP100 Package
14 x 14 mm

Line up

Part number	Flash ROM	RAM	Package
TMPM370FYFG	256 KB	10 KB	LQFP100 14 x 14 mm
TMPM372FWUG	128 KB	6 KB	LQFP64 10 x 10 mm
TMPM373FWDUG	128 KB	6 KB	LQFP48 7 x 7 mm
TMPM374FWUG	128 KB	6 KB	LQFP44 10 x 10 mm
TMPM375FSDMG	64 KB	4 KB	SSOP30 7.5 x 10 mm
TMPM376FDFG	512 KB	32 KB	LQFP100 14 x 14 mm
TMPM37AFSQG	64 KB	4 KB	VQFN32 5 x 5 mm

* Please ask if brushless motor control by microcontroller is needed.

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

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

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