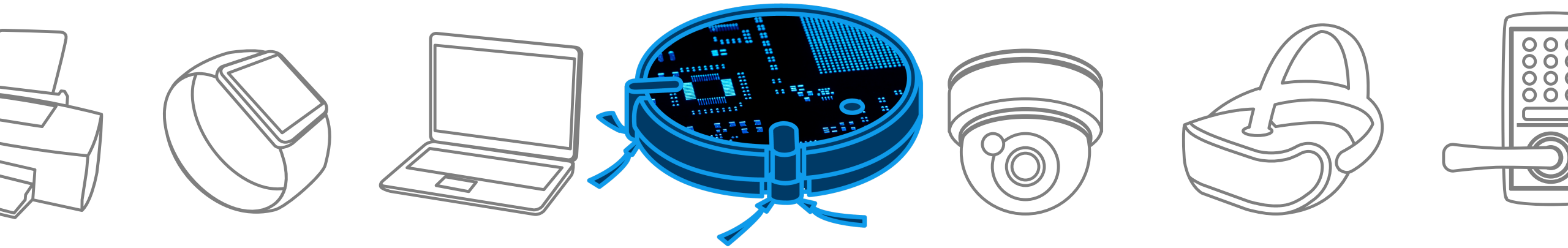
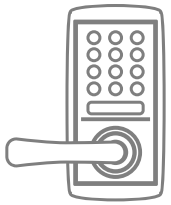
TOSHIBA

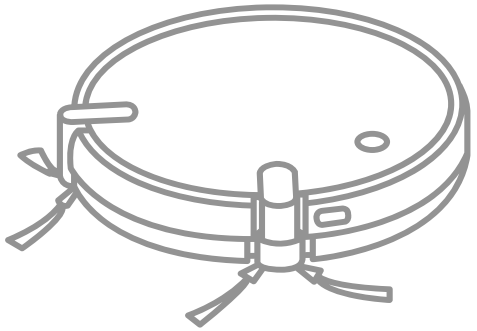
R22

Robot Cleaner

Solution Proposal by Toshiba

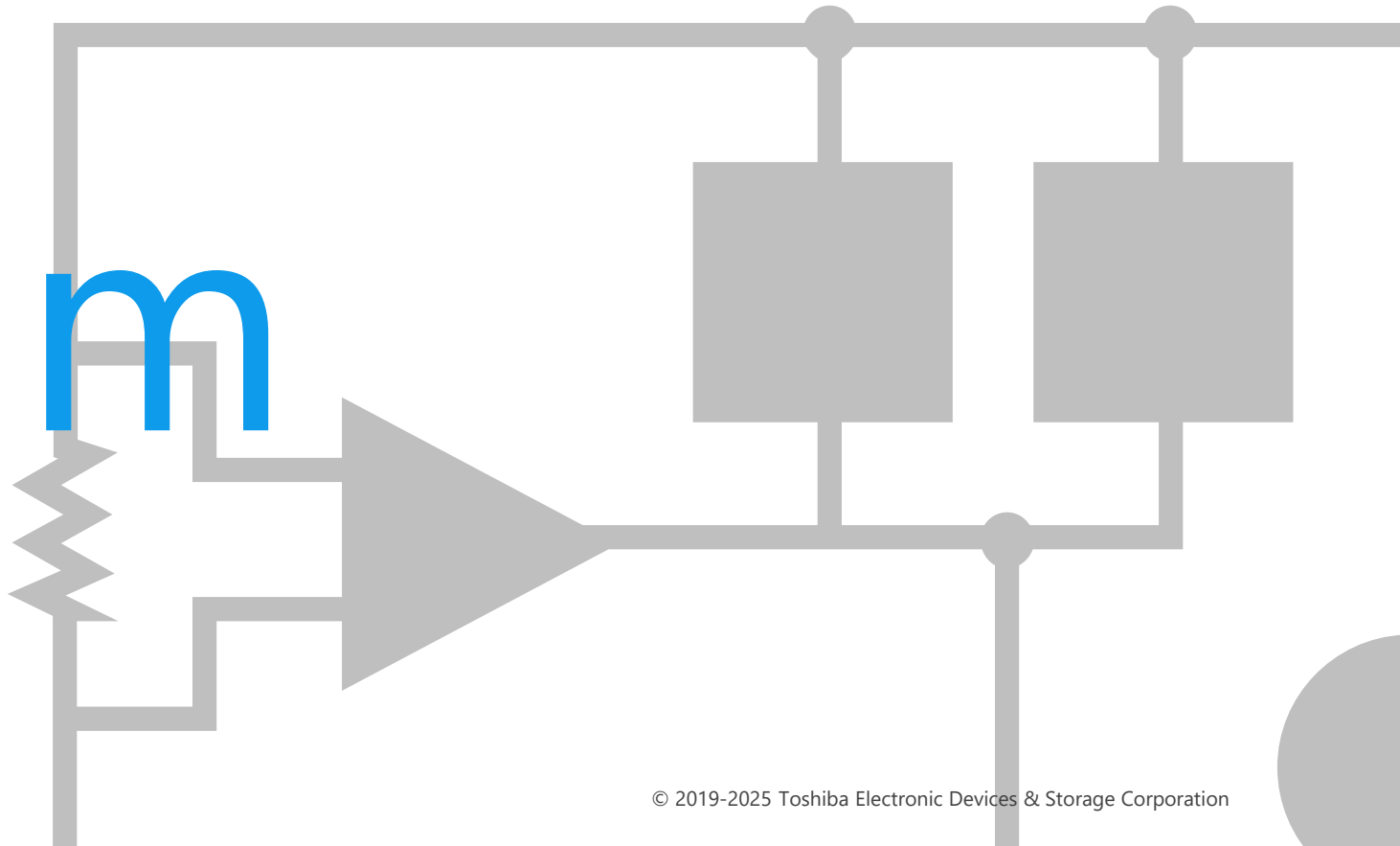




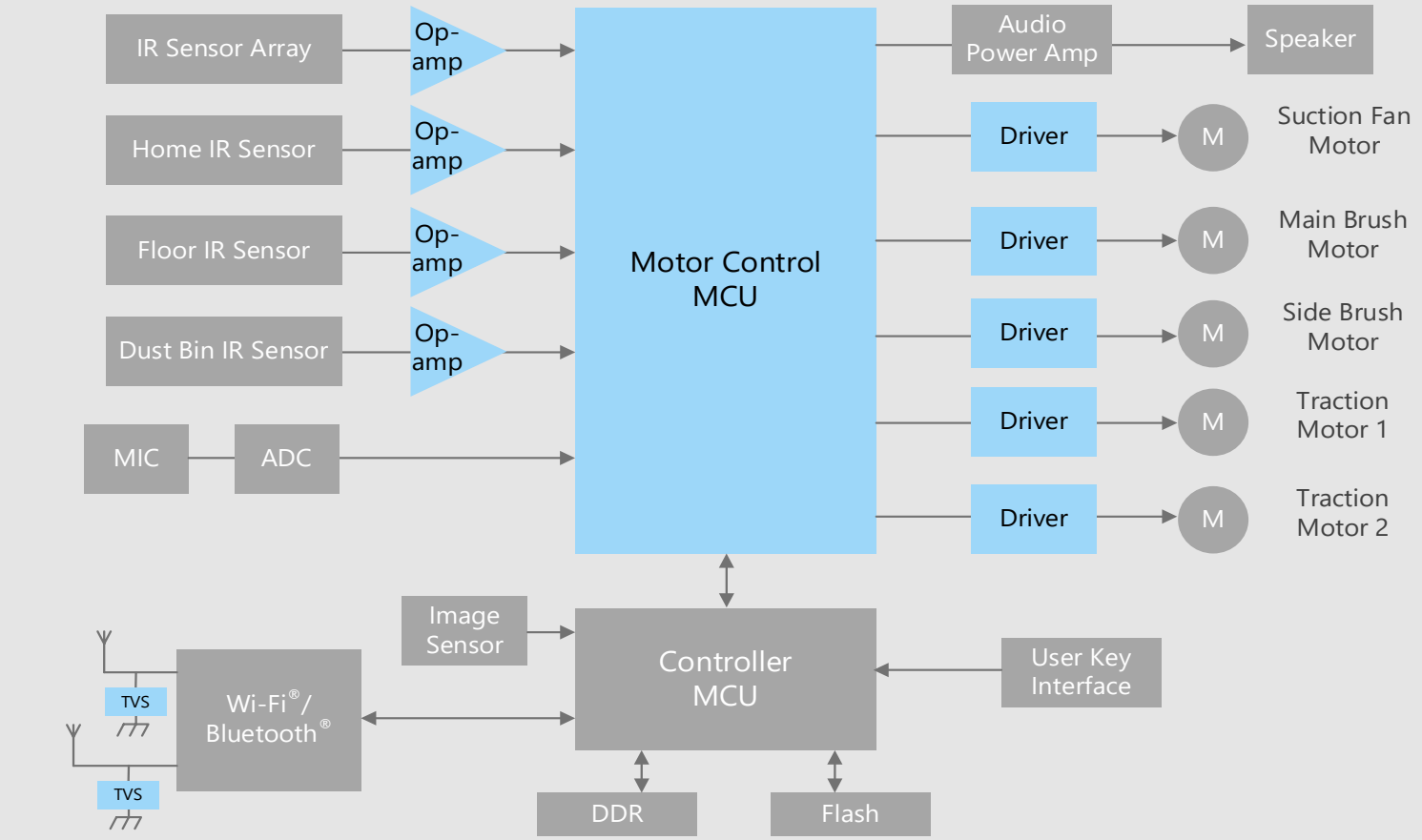


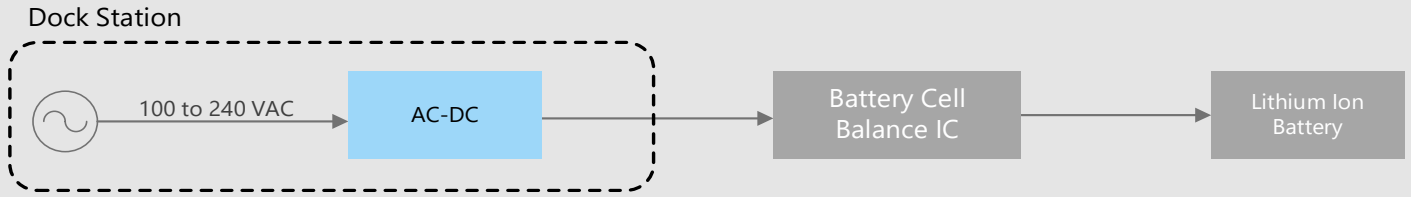
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram



Robot Cleaner　Overall block diagram

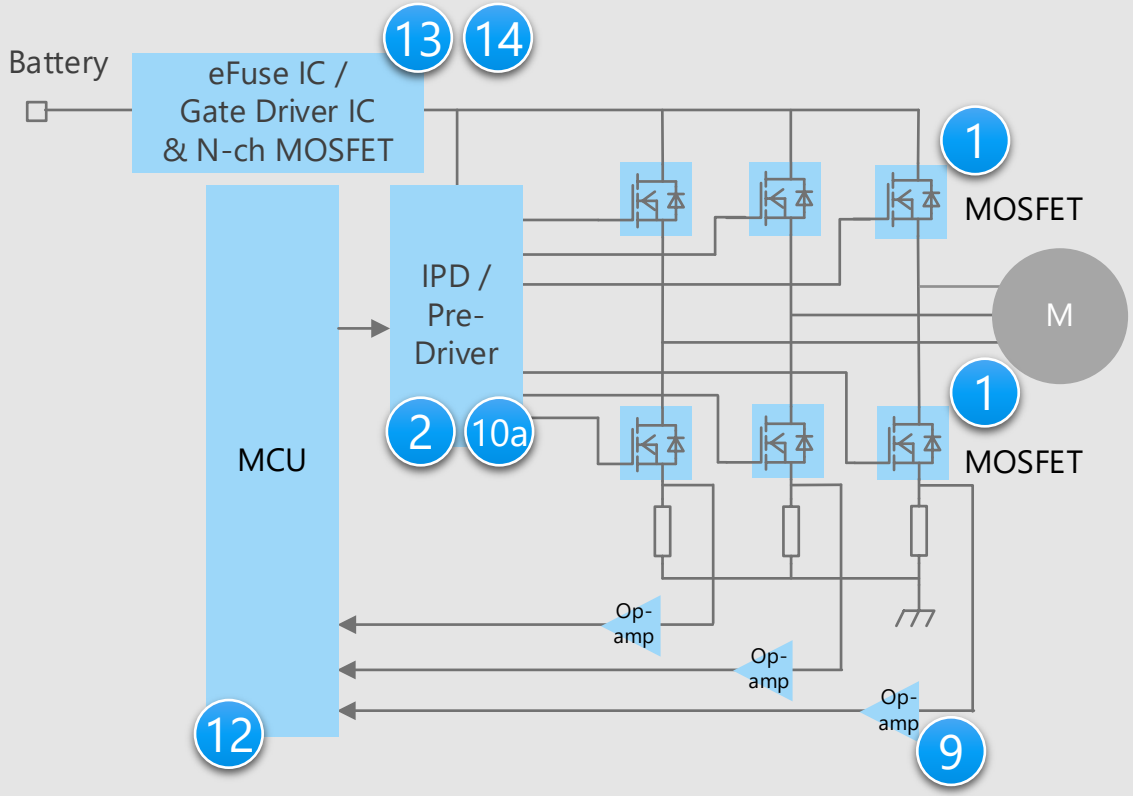




Robot Cleaner　Detail of motor drive unit (1)

Brushless DC motor drive circuit

IPD + MOSFET / Pre-driver + MOSFET type



Criteria for device selection

- To select the product with a current rating that is suitable for the motor rating.
- To select suitable pre-driver for the rating of the switching device to be driven.
- Operational amplifiers with low noise are suitable for the sensor block.
- With the increasing current density of small surface mount components, it is necessary to design a heat dissipation that takes the reliability into account.

Proposals from Toshiba

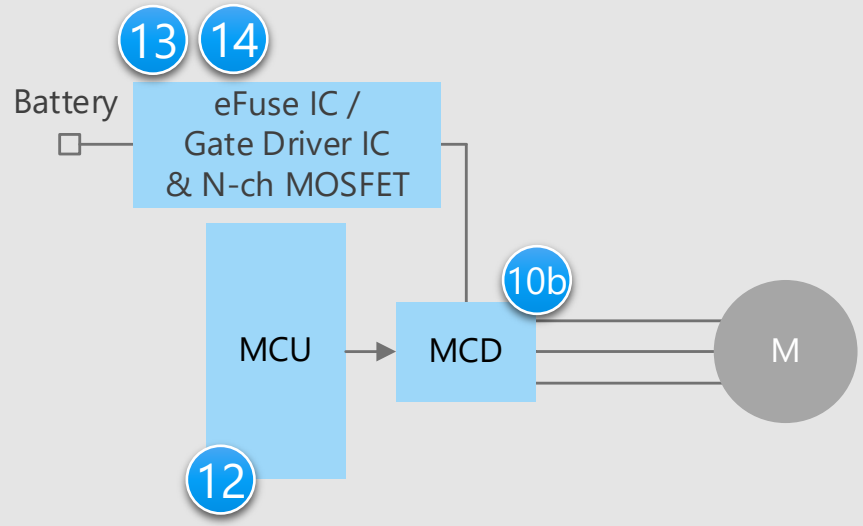
- **Realize a set with low power consumption by low on-resistance** 1
  U-MOS Series N-ch MOSFET
- **Realize full-bridge drive circuit** 2
  Intelligent power device (IPD)
- **Amplify the detected weak signal with low noise** 9
  Low noise operational amplifier
- **Easy motor drive** 10a
  Brushless DC motor pre-driver IC
- **Easy software development using general purpose CPU cores** 12
  MCU
- **Built-in protection function against short circuit, over current, over voltage, etc.** 13
  Electronic fuse (eFuse IC)
- **Small package and built-in over voltage protection function** 14
  N-ch MOSFET gate driver IC

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

Robot Cleaner　Detail of motor drive unit (2)

Brushless DC motor drive circuit

Motor Driver type



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

Criteria for device selection

- To select the product with a current rating that is suitable for the motor rating.
- With the increasing current density of small surface mount components, it is necessary to design a heat dissipation that takes the reliability into account.

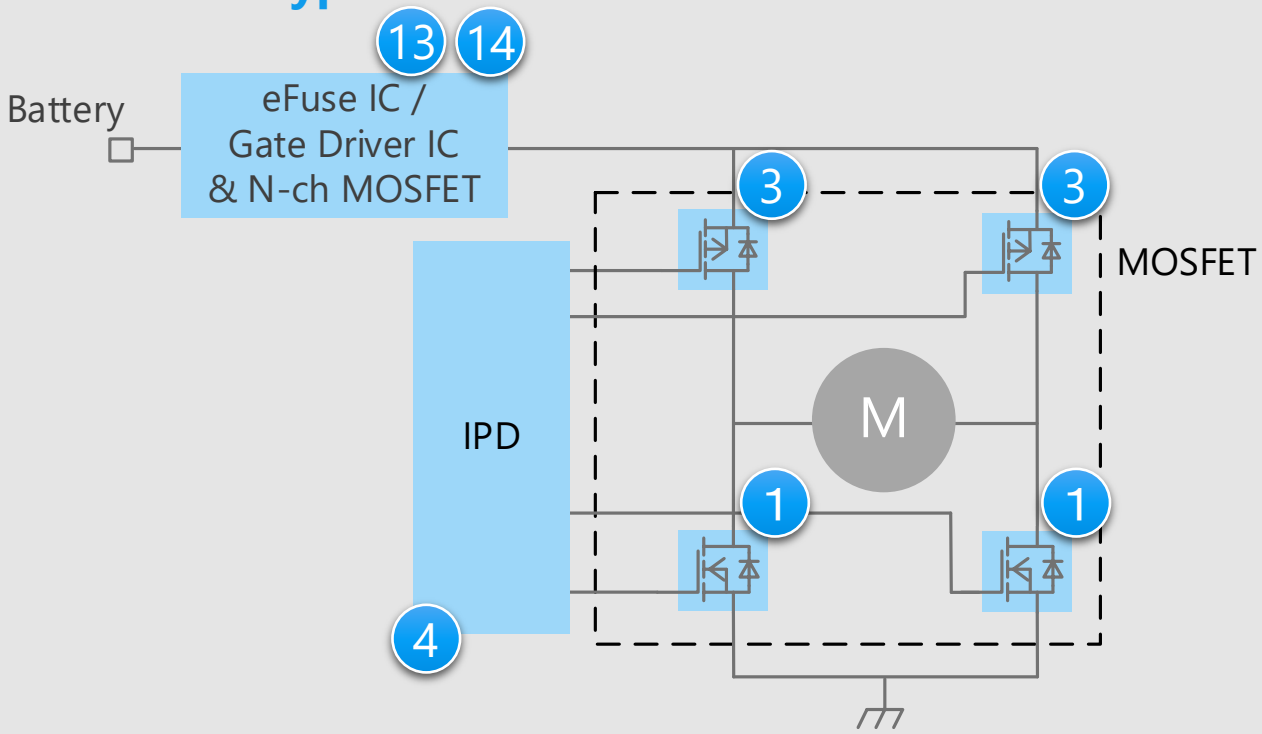
Proposals from Toshiba

- **Easy motor drive** 10b
  Brushless DC motor driver IC
- **Easy software development using general purpose CPU cores** 12
  MCU
- **Built-in protection function against short circuit, over current, over voltage, etc.** 13
  Electronic fuse (eFuse IC)
- **Small package and built-in over voltage protection function** 14
  N-ch MOSFET gate driver IC

Robot Cleaner　Detail of motor drive unit (3)

Brushed DC motor drive circuit

IPD + MOSFET type



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

Criteria for device selection

- To select the product with a current rating that is suitable for the motor rating.
- With the increasing current density of small surface mount components, it is necessary to design a heat dissipation that takes the reliability into account.

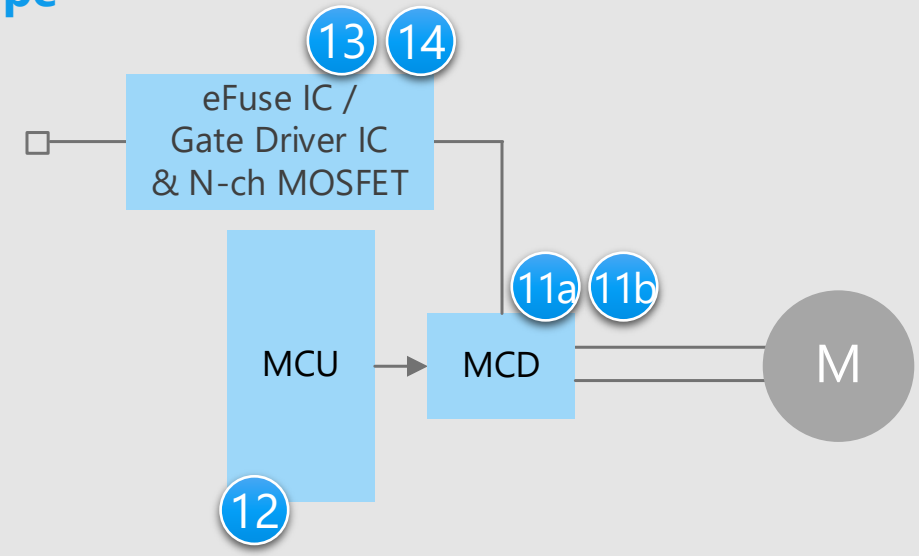
Proposals from Toshiba

- **Realize a set with low power consumption by low on-resistance**
- U-MOS Series N-ch MOSFET　1
- **Realize a set with low power consumption by low on-resistance**
- U-MOS Series P-ch MOSFET　3
- **Realize half-bridge drive circuit**
  Intelligent power device (IPD)　4
- **Built-in protection function against short circuit, over current, over voltage, etc.**
  Electronic fuse (eFuse IC)　13
- **Small package and built-in over voltage protection function**
  N-ch MOSFET gate driver IC　14

Robot Cleaner　Detail of motor drive unit (4)

Brushed DC motor drive circuit

Motor Driver type



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

Criteria for device selection

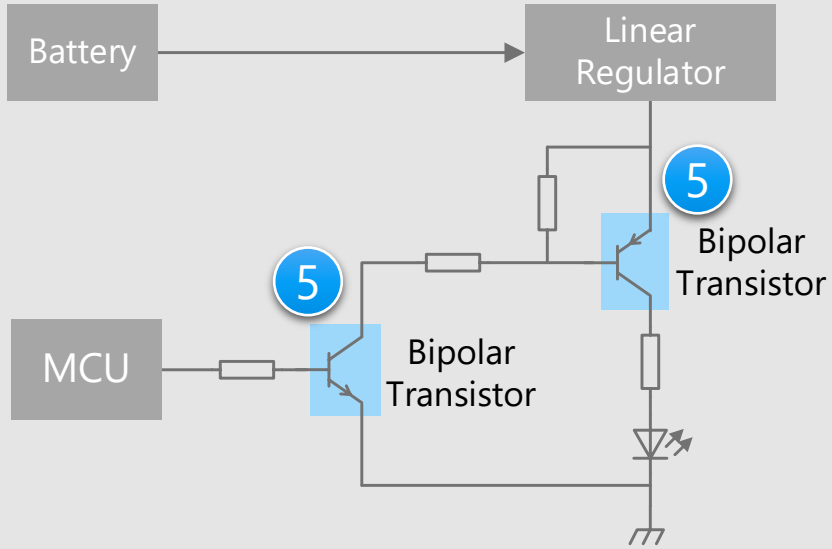
- To select the product with a current rating that is suitable for the motor rating.
- With the increasing current density of small surface mount components, it is necessary to design a heat dissipation that takes the reliability into account.

Proposals from Toshiba

- **Easy motor drive** 11a 11b
  Brushed DC motor driver IC
- **Easy software development using general purpose CPU cores**
  MCU 12
- **Built-in protection function against short circuit, over current, over voltage, etc.**
  Electronic fuse (eFuse IC) 13
- **Small package and built-in over voltage protection function**
  N-ch MOSFET gate driver IC 14

Robot Cleaner　Detail of LED drive unit

LED drive circuit for status display



Criteria for device selection

- Suppression of variations in LED brightness is possible by using constant current drive circuit.
- Use of a product with a low collector-emitter saturation voltage $V_{CE(sat)}$ has an advantage in power utilization efficiency.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

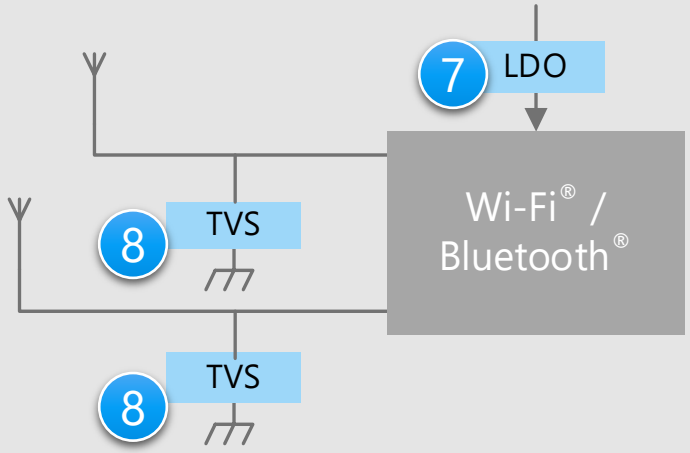
- **high h_{FE}**
  Bipolar transistor

5

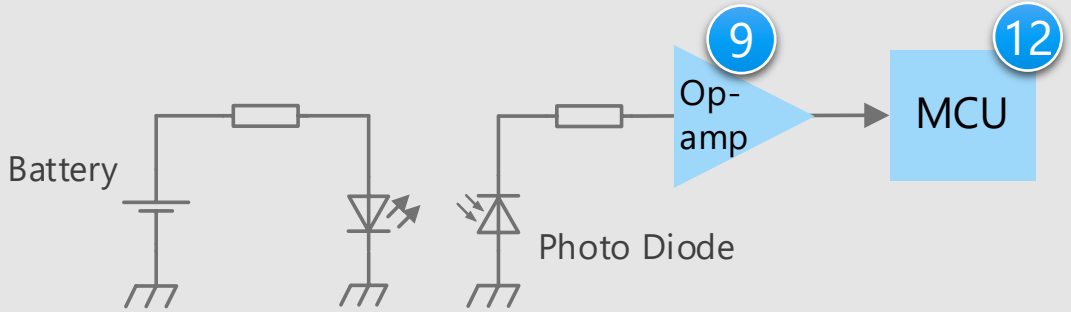
* Click on the number in the circuit diagram to jump to the detailed description page

Robot Cleaner　Detail of RF and sensor unit

Wi-Fi®/Bluetooth® circuit



Infrared sensor circuit



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

Criteria for device selection

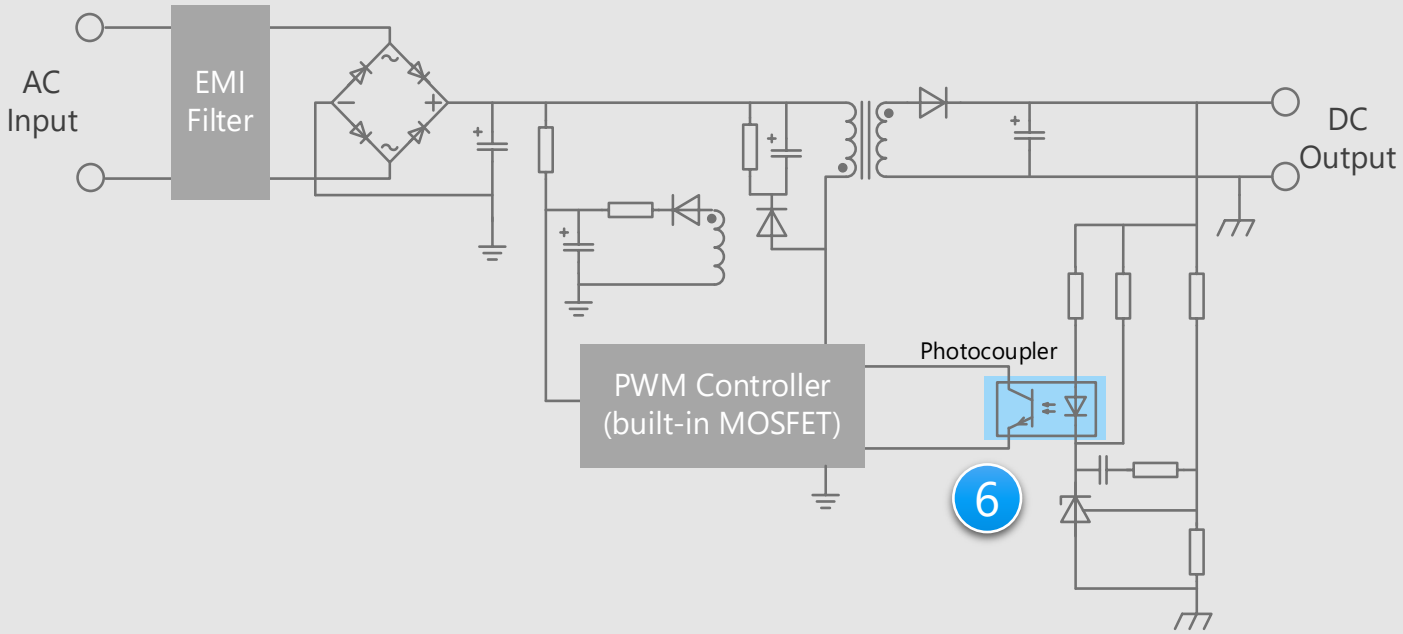
- Power Supply Rejection Ratio (PSRR) is a key characteristic for wireless systems.
- Wi-Fi® system requires high current power supply.
- A small Transient Voltage Suppressor (TVS) with low C_t is suitable for ESD protection without attenuating the antenna signal.
- Operational amplifiers with low noise are suitable for the sensor block.

Proposals from Toshiba

- **Realize noise-resistant power supply** 7
  Small surface mount LDO regulator
- **Absorb Electro Static Discharge from antennas and prevent malfunction of the circuit** 8
  TVS diode
- **Amplify the detected weak signal with low noise** 9
  Low noise operational amplifier
- **Easy software development using general purpose CPU cores** 12
  MCU

Robot Cleaner　Detail of power supply unit of dock station

Flyback AC-DC circuit



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

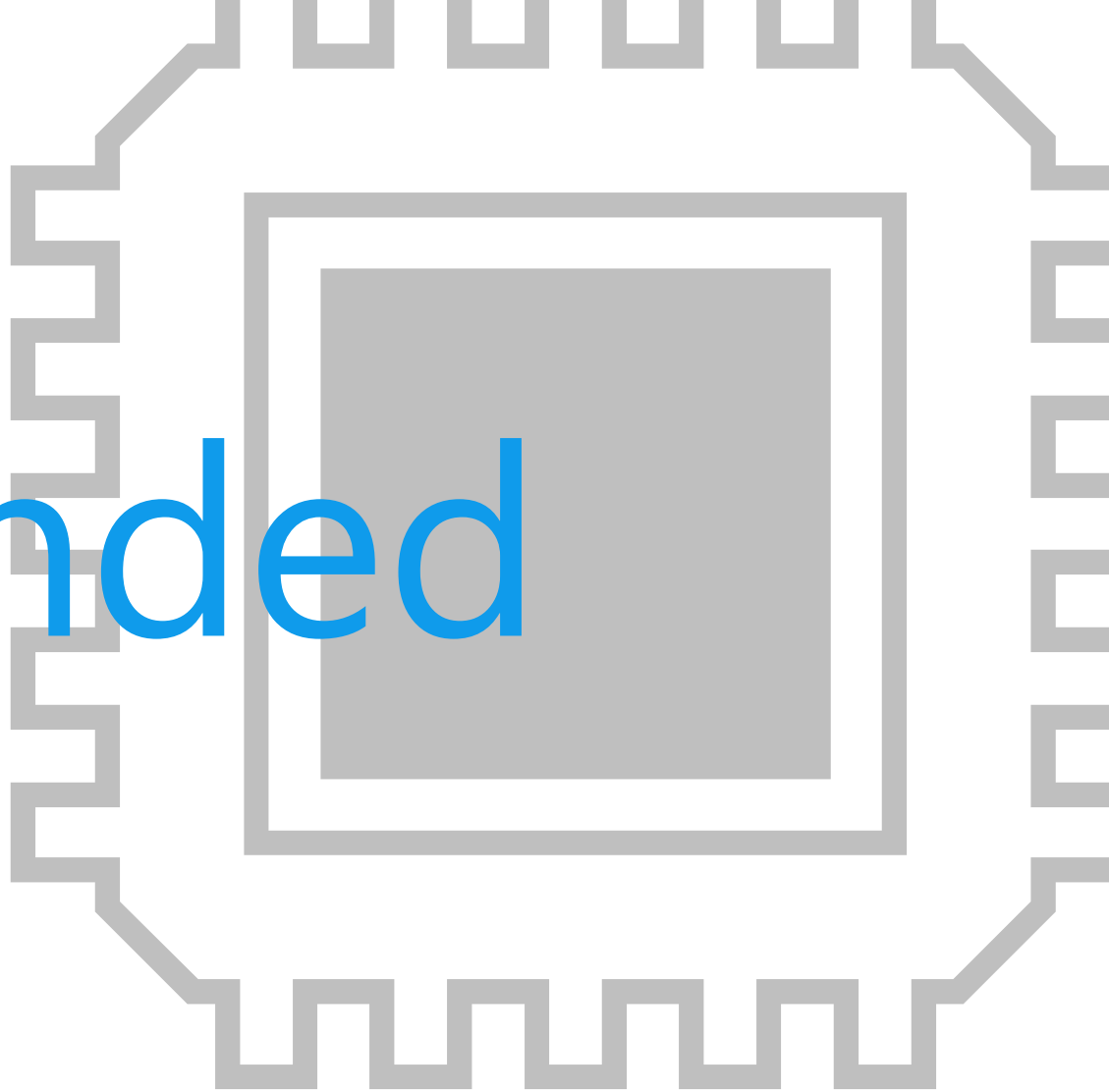
Criteria for device selection

- A transistor output photocoupler with high current transfer ratio is suitable for the power supply feedback circuit.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

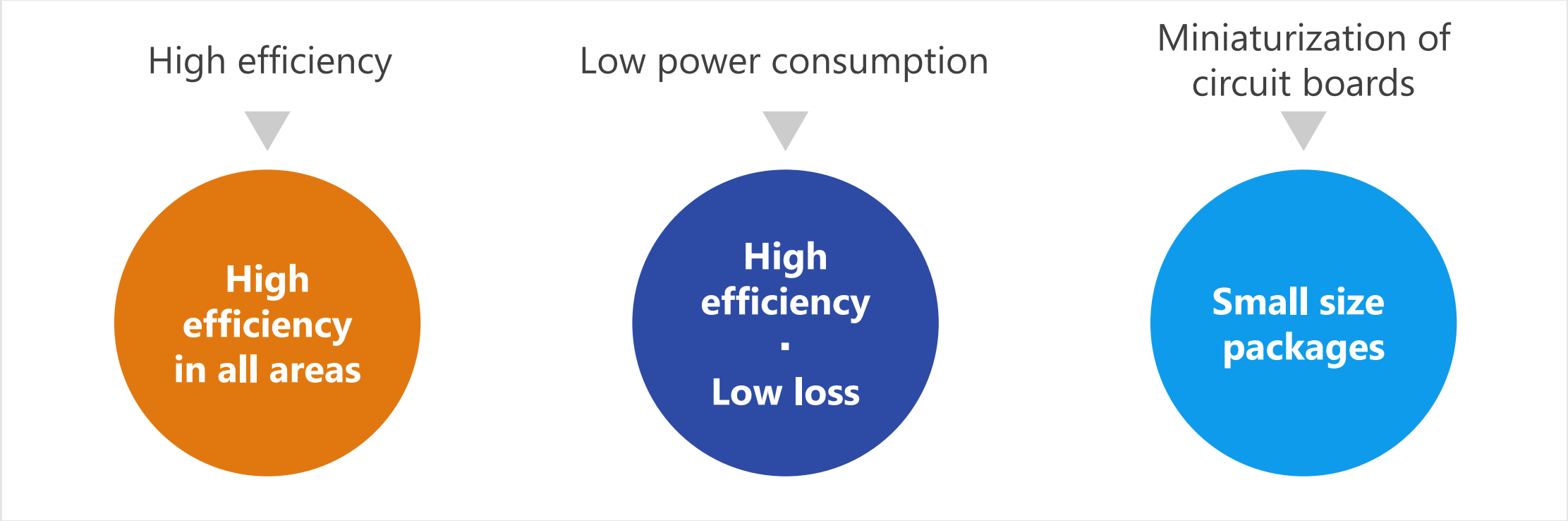
- **High current transfer ratio and high temperature operation makes easy to design.**
  Transistor output photocoupler 6

Recommended Devices



Device solutions to address customer needs

As described above, in the design of robot cleaner, **“High efficiency “**, **“Low power consumption”** and **“Miniaturization of circuit boards”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs

	High efficiency in all areas	High efficiency · Low loss	Small size packages
1 U-MOS Series N-ch MOSFET	●	●	●
2 Intelligent power device (IPD)	●	●	●
3 U-MOS Series P-ch MOSFET	●	●	●
4 Intelligent power device (IPD)	●	●	●
5 Bipolar transistor			●
6 Transistor output photocoupler	●		●
7 Small surface mount LDO regulator	●	●	●

Device solutions to address customer needs

	High efficiency in all areas	High efficiency · Low loss	Small size packages
⑧ TVS diode		●	●
⑨ Low noise operational amplifier			●
⑩ Brushless DC motor pre-driver IC / driver IC	●	●	●
⑪ Brushed DC motor driver IC	●	●	●
⑫ MCU		●	●
⑬ Electronic fuse (eFuse IC)	●	●	●
⑭ N-ch MOSFET gate driver IC		●	●

1a U-MOS Series N-ch MOSFET

TPN5R203PL / TPN7R006PL / TPHR7404PU

High efficiency in all areas

High efficiency · Low loss

Small size packages

Value provided

Contribute to energy saving and miniaturization by realizing lineup of low on-resistance type and trade-off characteristics of on-resistance between capacitance.

1 Low on-resistance

By reducing on-resistance, heat generation and power consumption can be kept low, and it contributes to miniaturization.

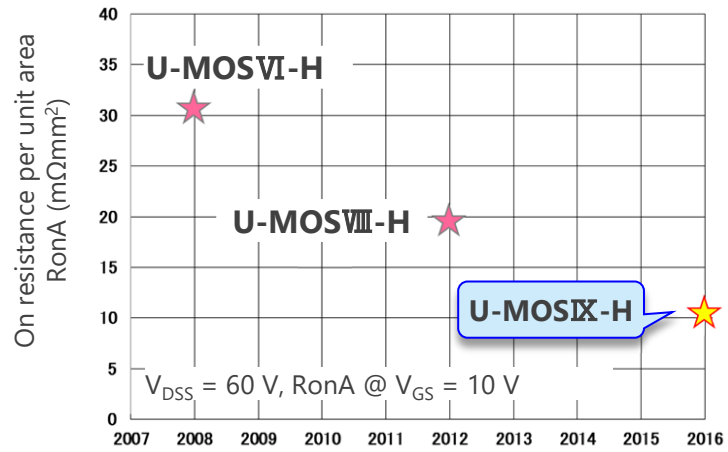
2 Small total gate charge

Small total gate charge reduces the performance required for driving the MOSFET, thereby improving the switching characteristics.

3 High speed switching

Reducing switching loss by high speed operation contributes to improving efficiency.

RonA reduction trend of N-ch MOSFET



(Note: Toshiba internal comparison)

Lineup

Part number		TPN5R203PL	TPN7R006PL	TPHR7404PU
Package		TSON Advance 		SOP Advance 
V_{DSS} [V]		30	60	40
I_D [A]		36 (76*)	54 (76*)	150 (400*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	3.9	5.4	0.51
	Max	5.2	7.0	0.74
Polarity		N-ch	N-ch	N-ch
Generation		U-MOSⅨ-H	U-MOSⅨ-H	U-MOSⅨ-H

*: Silicon limit

◆Return to Block Diagram TOP

1b U-MOS Series N-ch MOSFET (80 V)

TPH2R408QM / TPH4R008QM / TPN8R408QM / TPN12008QM / TPN19008QM / TK5R1P08QM / TK6R9P08QM

High efficiency in all areas | High efficiency - Low loss | Small size packages

Value provided

Contributes to lower power consumption of system by low on-resistance and small Q_{OSS} characteristics.

1 Low on-resistance

By keeping the drain-source on-resistance low, heat generation and power consumption can be reduced. Products are provided from low on-resistance of 1.9 mΩ.

2 Small Q_{OSS}

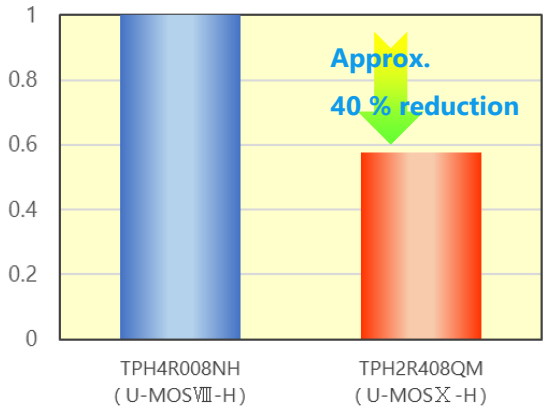
Contributes low output loss due to small Q_{OSS}. Performance index $R_{DS(ON)}$ x Q_{OSS} is reduced by approx. 30 % compared with Toshiba's previous generation product.

3 Variety of packages

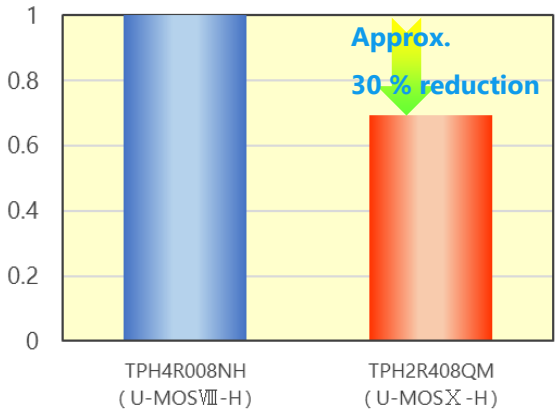
Adding SOP Advance of industries' standard package, smaller TSON Advance package had been provided.

Low on-resistance

$R_{DS(ON)}$(Typ.) @V_{GS}=10 V



$R_{DS(ON)}$ x Q_{OSS}



(Note: Toshiba internal comparison)

Lineup

Part number		TPH2R408QM	TPH4R008QM	TPN8R408QM	TPN12008QM	TPN19008QM	TK5R1P08QM	TK6R9P08QM
Package		SOP Advance(N) 		TSON Advance 			DPAK 	
V_{DSS} [V]		80	80	80	80	80	80	80
I_D [A]		120 (200*)	86 (140*)	32 (77*)	26 (60*)	34 (38*)	84 (105*)	62 (83*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	1.9	3.1	6.5	9.6	14.7	4.2	5.5
	Max	2.43	4	8.4	12.3	19	5.1	6.9
Polarity		N-ch	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation		U-MOSX-H	U-MOSX-H	U-MOSX-H	U-MOSX-H	U-MOSX-H	U-MOSX-H	U-MOSX-H

*: Silicon limit

◆Return to Block Diagram TOP

2 Intelligent power device (IPD)

TPD7212F / TPD7212FN

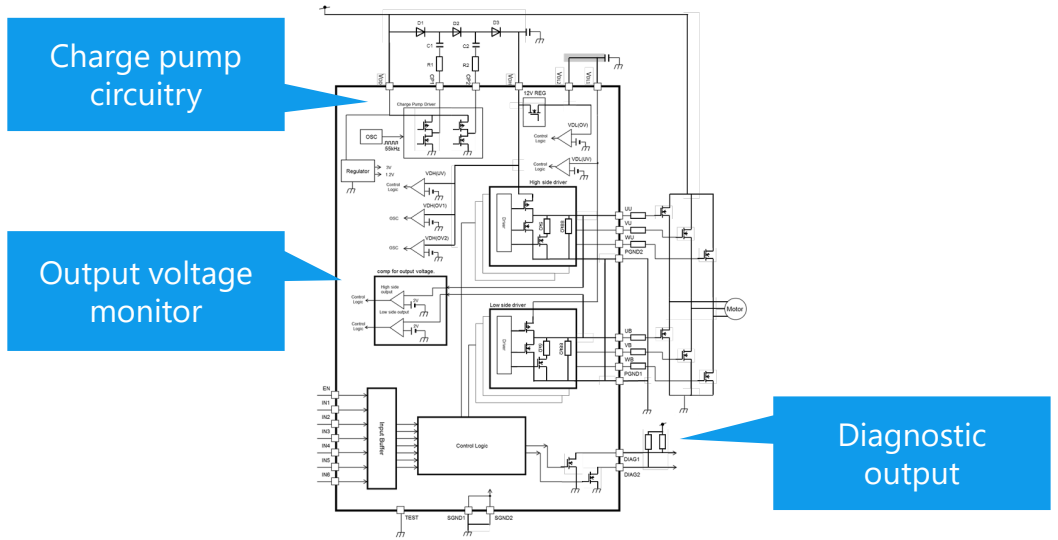
High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

The built-in charge pump circuit for the high side drive makes it easy to configure a three-phase full bridge circuit.

1 Built-in power supply voltage diagnostic function

A short circuit protection and an output protection against a short circuit and ground fault circuit are built-in.



2 Built-in charge pump circuit

The built-in charge pump circuit makes easy to configure a three-phase full-bridge circuit.

[Note] Comparison with Toshiba products

Lineup

Part number	TPD7212FN
Package	SSOP30 
$V_{DD(opr)}$ [V]	4.5 to 18
T_{opr} [°C]	-40 to 125

◆Return to Block Diagram TOP

3 U-MOS Series P-ch MOSFET

TPCC8131 / TPCA8120

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

Contribute to energy saving and miniaturization by realizing lineup of low on-resistance type and trade-off characteristics of on-resistance between capacitance.

1 Low on-resistance

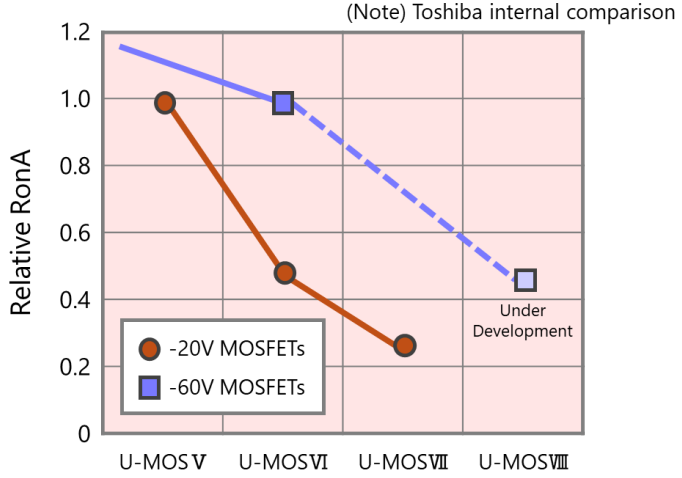
By reducing on-resistance between drain and source, heat generation and power consumption can be kept low, and it can contribute to miniaturization.

2 Small total gate charge

Small total gate charge reduces the performance required for driving the MOSFET, thereby improving the switching characteristics.

RonA reduction of P-ch MOSFET

(Note) Toshiba internal comparison



Lineup

Part number		TPCC8131	TPCA8120
Package		TSON Advance 	SOP Advance 
V_{DSS} [V]		-30	-30
I_D [A]		-30	-45
$R_{DS(ON)}$ [mΩ] @V_{GS} = -10 V	Typ.	13.5	2.4
	Max	17.6	3.0
Polarity		P-ch	P-ch
Generation		U-MOSⅥ	U-MOSⅥ

◆Return to Block Diagram TOP

4 Intelligent power device (IPD)

TPD7211F

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

A gate driver with half bridge output, which can be driven with a large current (±500 mA maximum).

1 Half bridge type

It is a half bridge type gate driver and is suited for high side P-ch type and low side N-ch type MOSFET driving.

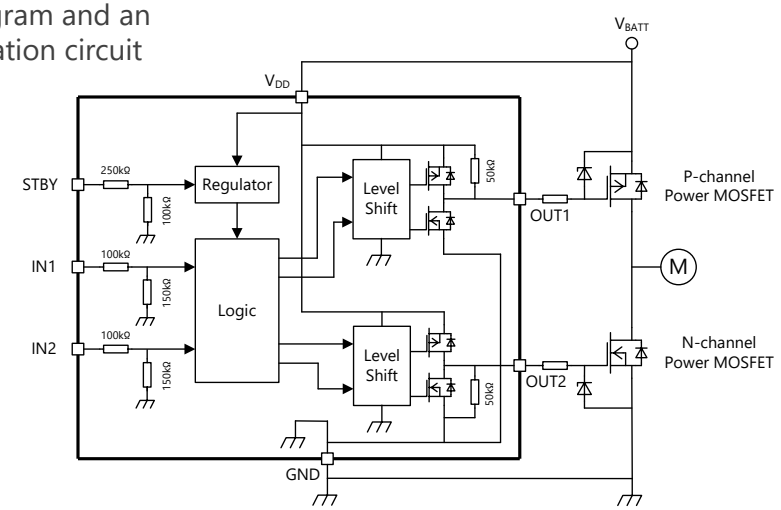
2 Can be driven with a large current

The output current rating of ±500 mA is secured, and high current driving is possible.

3 Small package

It is packaged in the small PS-8 package.
Dimensions of PS-8: 2.8 x 2.9 x 0.8 mm

Internal block diagram and an example of application circuit of TPD7211F



Lineup

Part number	TPD7211F
Package	PS-8 
$V_{DD(opr)}$ [V]	5 to 18
I_{OUT} [mA]	±500
T_{opr} [°C]	-40 to 125

◆Return to Block Diagram TOP

5 Bipolar transistor

2SC2712 / 2SA1162 / TBC847 / TBC857 / HN1B01FU

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

Through our extensive product lineup, we provide products that meet the needs of customers.

1 Various package lineups

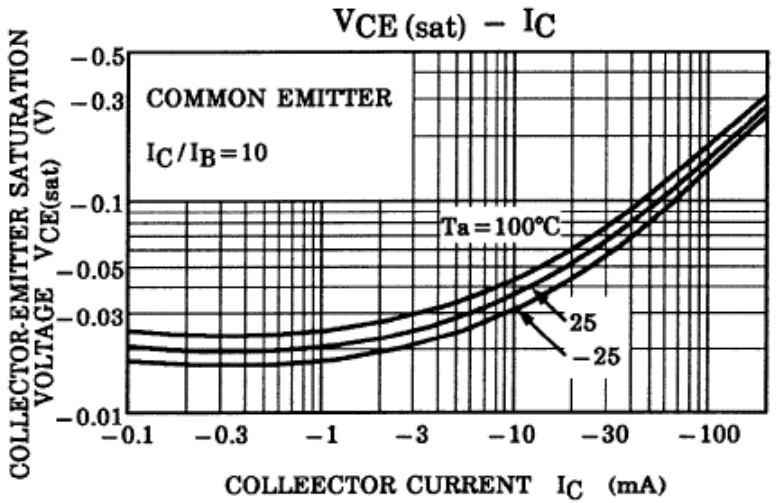
Many types of package, such as flat lead type and leadless type, are available. It is possible to choose the products.

2 Low collector-emitter saturation voltage

Low power consumption is realized by low collector-emitter saturation voltage.

3 High ESD resistance

In applications where static electricity is easily generated, bipolar transistors with higher ESD resistance are helpful.



2SA1162

Lineup

Part number	NPN	2SC2712	TBC847	HN1B01FU (NPN+PNP)
	PNP	2SA1162	TBC857	
Package		S-Mini 	SOT23 	US6 
V_{CEO} [V]		50	50	50
I_C [mA]		150	150	150

◆Return to Block Diagram TOP

6 Transistor output photocoupler
TLP383

High efficiency in all areas | Low loss | Small size packages

Value provided

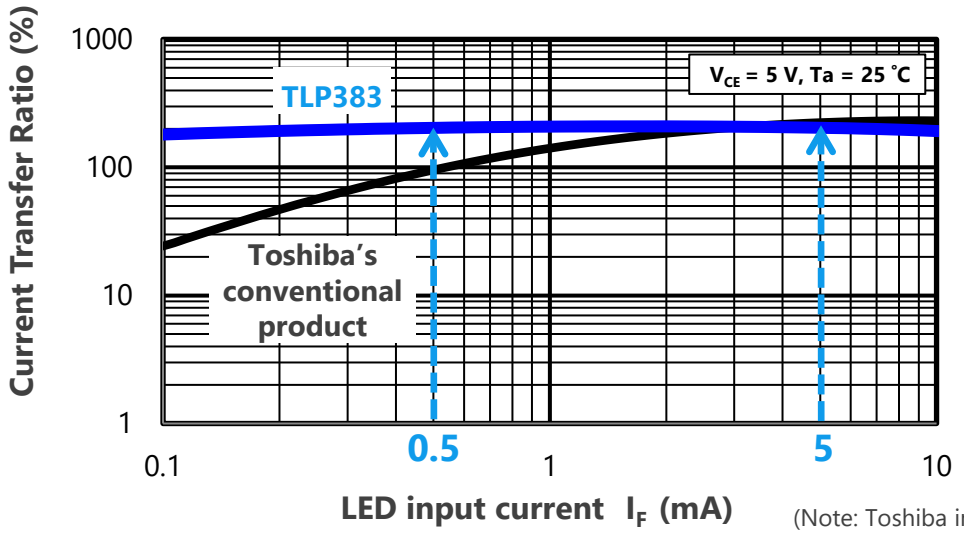
High current transfer ratio (CTR) is realized even in the low input current range (I_F=0.5 mA).

1 High current transfer ratio

Phototransistor and InGaAs infrared light emitting diode are optically coupled. Highly isolated photocouplers realize higher CTR than Toshiba's conventional products in low input current range (@ I_F = 0.5 mA).

2 The operating temperature range is extended to 125 °C

It is designed to operate under severe conditions of ambient temperature environment.



(Note: Toshiba internal comparison)

Lineup

Part number	TLP383
Package	4pin SO6L 
I_C/I_F [%] @I_F = 0.5 mA, 5 mA	50 to 600
t_{off} (Typ.) [μs] @I_F = 1.6 mA	28
BV_S [Vrms]	5000
T_{opr} [°C]	-55 to 125

◆Return to Block Diagram TOP

7 Small surface mount LDO regulator

TCR15AG / TCR13AG / TCR8BM / TCR5BM / TCR5RG / TCR3RM / TCR3U / TCR2L / TAR5 Series

High efficiency in all areas

High efficiency · Low loss

Small size packages

Value provided

Wide lineup from general purpose type to small package type are provided. Contribute to realize a stable power supply not affected by fluctuation of battery.

1 Low dropout voltage

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

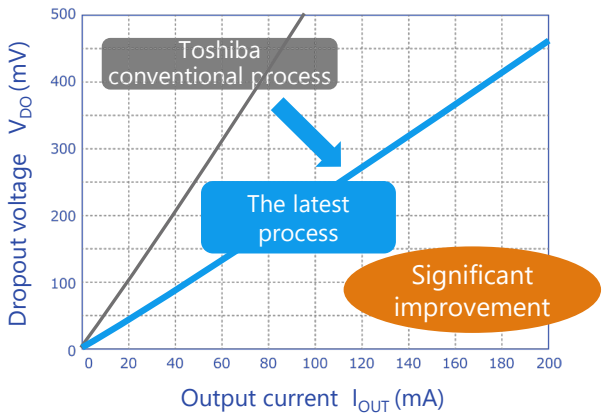
2 High PSRR Low output noise voltage

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

3 Low current consumption

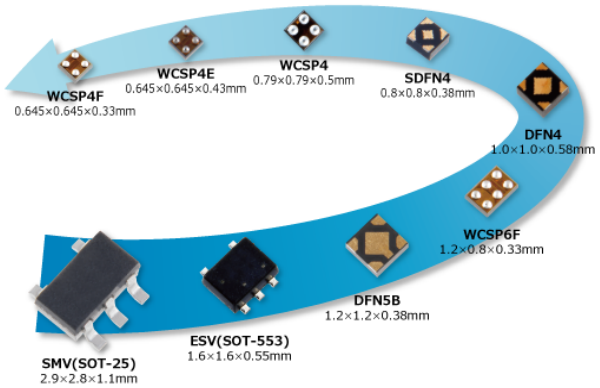
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology. (TCR3U Series)

Low dropout voltage



(Note: Toshiba internal comparison with TCR3U series.)

Rich package lineup



Lineup

Part number	TCR15AG Series	TCR13AG Series	TCR8BM Series	TCR5BM Series	TCR5RG Series	TCR3RM Series	TCR3U Series	TCR2L Series	TAR5 Series
Features	Low dropout voltage High PSRR				High PSRR Low noise Low current consumption		Low current consumption		15 V Input voltage Bipolar type
I_{OUT} (Max) [A]	1.5	1.3	0.8	0.5		0.3		0.2	
PSRR (Typ.) [dB] @f = 1 kHz	95	90	98	98	100	100	70	-	70
I_B (Typ.) [μA]	25	56	20	19	7	7	0.34	1	170

◆Return to Block Diagram TOP

8 TVS diode

DF2B6M4SL / DF2B6M4SL / DF2B6M4BSL

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

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

1 High ESD pulse absorption performance

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.

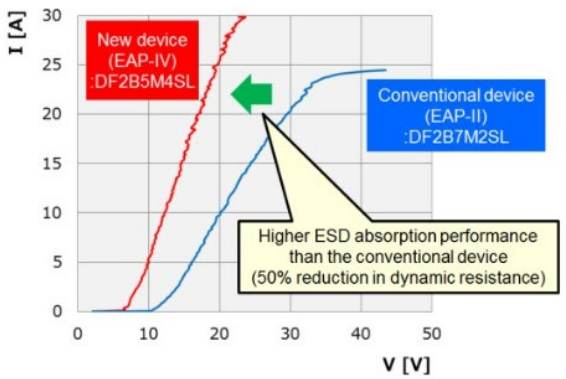
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using Toshiba own technology.

3 Suitable for high density mounting

A variety of small packages are available.

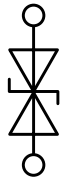
ESD Pulse Absorption Performance (Toshiba internal comparison)



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	DF2B5M4SL	DF2B6M4SL	DF2B6M4BSL
Package	SL2 		
V_{ESD} [kV]	±20	±20	±8
V_{RWM} (Max) [V]	3.6	5.5	5.5
C_t (Typ.) [pF]	0.2	0.2	0.12
R_{DYN} (Typ.) [Ω]	0.5	0.5	1.05

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

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9 Low noise operational amplifier

TC75S67TU

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

Small signals detected by various sensors can be amplified with very low noise.

1 Low noise
V_{NI} = 6.0 [nV/√Hz] (Typ.) @f = 1 kHz

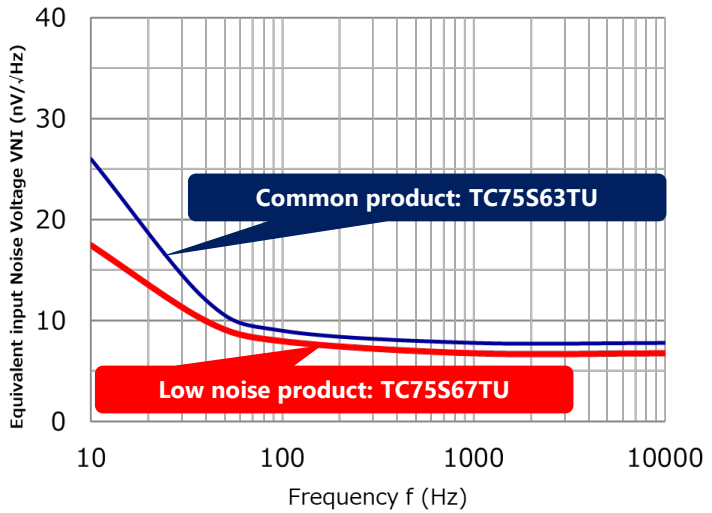
Small signals detected by various sensors [Note] can be amplify with low noise using CMOS operational amplifier by optimizing the processing. We achieved low input equivalent noise voltage.

[Note] Sensor types: vibration detection sensor, shock sensor, accelerometer, pressure sensor, infrared sensor, temperature sensor, etc.

2 Low current consumption
I_{DD} = 430 [µA] (Typ.)

Low current consumption characteristics are realized by using the CMOS process.

Noise characteristics
(Toshiba internal comparison)



Lineup

Part number	TC75S67TU
Package	UFV 
$V_{DD,SS}$ (Max) [V]	±2.75
$V_{DD,SS}$ (Min) [V]	±1.1
I_{DD} (Typ.) [µA]	430
V_{NI} [nV/√Hz] (Typ.) @f = 1 kHz	6

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10a Brushless DC motor pre-driver IC

TC78B009FTG / TC78B011FTG

High efficiency in all areas

High efficiency · Low loss

Small size packages

Value provided

Sensorless type three-phase brushless DC motor driver. It controls motor rotation speed by changing the PWM [Note] duty cycle.

[Note] Pulse Width Modulation

1 Sensorless

Driving brushless DC motor without hall sensors by the commutation signal control based on the back-EMF voltage in each phase of the coil. It contributes to reduce system BOM cost.

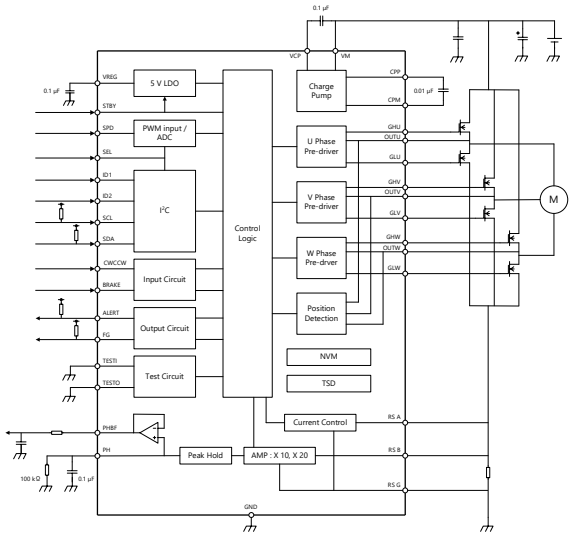
2 Low noise & low vibration

Soft switching and sine wave drive are built in. These contribute to low noise and vibration reduction of motor drive by smooth current waveform. (TC78B011FTG)

3 Abnormality detection functions

Abnormality detection functions such as Over current detection (ISD) , Overheat detection (TSD) and Low voltage detection (UVLO) are built in for stable motor driving.

TB78B009/011FTG



Lineup

Part number	TC78B009FTG	TC78B011FTG
Supply voltage *	30 V	
Control	Sensorless square wave	Sensorless sine wave
Features & Others	N-ch MOSFETs drive pre-driver Built-in closed loop speed control with adjustable speed curve Serial interface (I^2C) for various settings Standby mode CW/CCW control	
Package	WQFN36	

*: Absolute maximum ratings

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10b Brushless DC motor driver IC

TB67B001FTG

High efficiency in all areas

High efficiency · Low loss

Small size packages

Value provided

Sensorless type three-phase brushless DC motor driver. It controls motor rotation speed by changing the PWM [Note] duty cycle.

[Note] Pulse Width Modulation

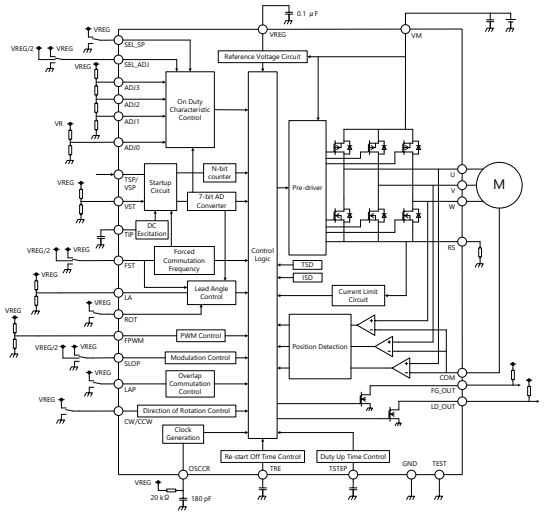
1 Sensorless

Driving brushless DC motor without hall sensors by the commutation signal control based on the back-EMF voltage in each phase of the coil. It contributes to reduce system BOM cost.

2 Abnormality detection functions

Abnormality detection functions such as
Over current detection (ISD), Overheat detection (TSD) and Low voltage detection (UVLO) are built in for stable motor driving.

TB67B001FTG



Lineup

Part number	TB67B001FTG
Supply voltage *	25 V
Control	Sensorless square wave
Features & Others	Output current * : 3A Output PWM duty adjustment Lead angle control Rotation pulse signal output Forced commutation frequency control Selectable PWM frequency
Package	VQFN36

*: Absolute maximum ratings

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11a 1ch brushed DC motor driver IC

TB67H450AFNG / TB67H451AFNG

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

High voltage & low power consumption by BiCD process. Simple single channel version.

1 High voltage (50 V)

Maximum rating of the output voltage is improved from 40 to 50 V to allow margin for air discharge test etc.

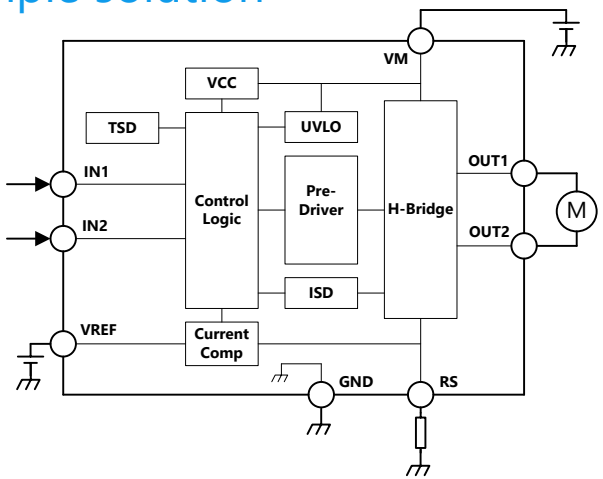
2 Wide operation voltage range

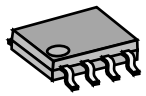
Wide power supply voltage range from 4.5 to 44 V supports battery drive applications.

3 Highly compatible package

Adopting HSOP8 package compatible with competitor's products or conventional products.

■Simple solution





P-HSOP8-0405-1.27-002
(4.9 x 6.0 mm)

Lineup

Part number	TB67H450AFNG	TB67H451AFNG
Motor type	Brushed DC motor	
Output voltage	50 V	
Output current	3.5 A	
Output on-resistance	0.6 Ω	
Output circuit	1 circuit	
Control interface	1 mode	
Phase mode	2-phase, 1-2 phase excitation	
Abnormality detection function	Overheat, over current, low voltage	
Package	P-HSOP8-0405-1.27-002	

◆Return to Block Diagram TOP

11b 2ch brushed DC motor driver IC

TB67H401FTG / TB67H420FTG

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

High voltage, high current & low power consumption by BiCD process. 2ch version adopted Toshiba original current detection.

1 High voltage (50 V)/ High current

Maximum rating of the output voltage is improved from 40 to 50 V to allow margin for air discharge test etc.
TB67H420 can handle an absolute output maximum current of 9 A.

2 Toshiba original current detection

TB67H401FTG can feedback current detection signal to controller such as MCU by the current limiter output.
TB67H420FTG realizes the constant current PWM [Note 1] without detection resistors by ACDS [Note 2] function.

3 Three selectable drive modes

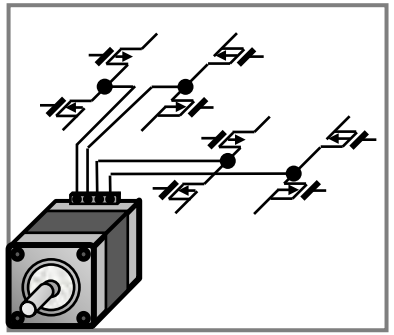
The H-bridge combination can be tailored according to the type of motor and the required current capacity as: (1) single stepper drive, (2) dual brush drive, and (3) high current, single brush drive.

[Note 1] Pulse Width Modulation

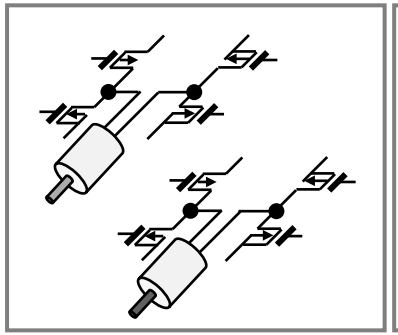
[Note 2] Advanced Current Detection System

■Three selectable drive modes

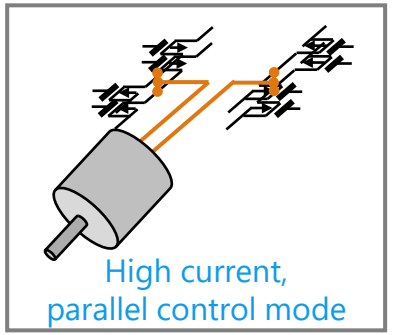
(1) Single stepper



(2) Dual brush



(3) High current, single brush



High current, parallel control mode

Lineup

Part number	TB67H401FTG	TB67H420FTG
Motor type	Brushed DC motor	
Output withstand voltage	50 V	
Output current	6.0 A (Large mode)	9.0 A (Large mode)
Output on-resistance	0.25 Ω	0.17 Ω
Output circuit	1 circuit (Large mode)	
Control impedance	4 modes	
Step resolution/excitation mode	1/1, 1/2 step (2-phase, 1-2 phase excitation)	
Error detection	Overheating, overcurrent, low voltage monitoring	
Package	QFN48	QFN48

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Value provided

System cost reduction, higher efficiency and less development work.

1 Equipped with motor control co-processor

Toshiba's original co-processor vector engine (VE) for motor control reduces CPU load and allows control of multiple motors and peripherals. [Note 1]

2 Equipped with motor control circuit

A variety of three-phase PWM [Note 2] waveforms and AD converters enable highly efficient, low noise control. The Advanced Encoder (A-ENC) reduces the load of CPU process in detecting the position performed for each PWM.

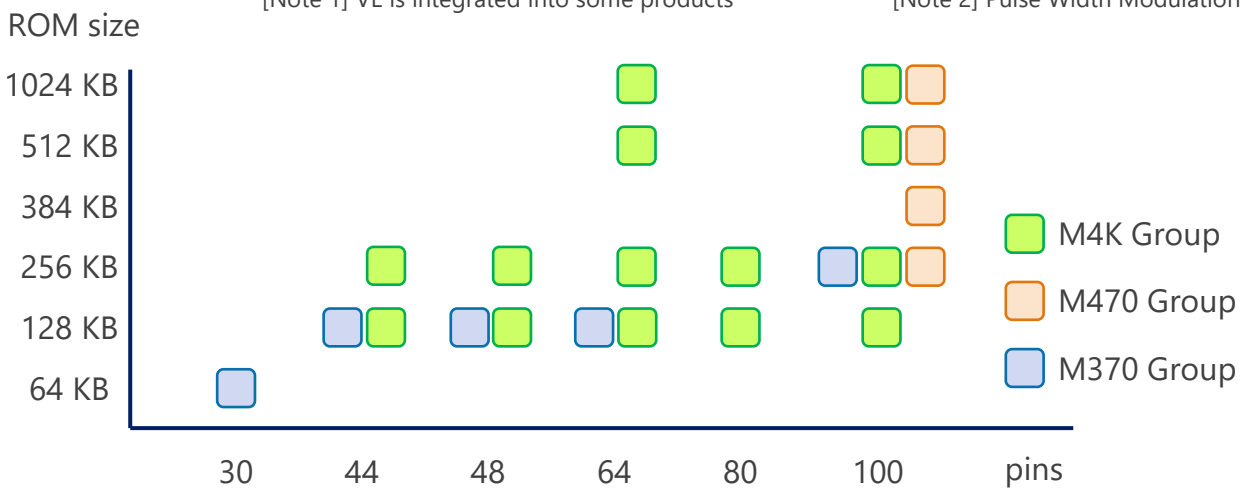
3 Provide development support tools

Third party evaluation boards and sample programs that can be used to shorten the development time are provided. Toshiba has begun offering a new, simple, versatile motor control software development kit (MCU Motor Studio). [Note 3]

[Note 1] VE is integrated into some products

[Note 2] Pulse Width Modulation

[Note 3] MCU Motor Studio supports some products and will expand in TXZ+™ family.



Lineup

Series	Group	Function
TXZ+™ 4A Series	M4K Group	Arm® Cortex®-M4, Max. 160 MHz operation 4.5 to 5.5 V, 3motor control (Max), Data Flash
TX04 Series	M470 Group	Arm® Cortex®-M4, Max. 160 MHz operation 4.5 to 5.5 V, 2motor control (Max)
TX03 Series	M370 Group	Arm® Cortex®-M3, 80 MHz operation 4.5 to 5.5 V, 2motor control (Max)

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13 Electronic fuse (eFuse IC)

TCKE8 Series / TCKE7 Series

High efficiency in all areas | High efficiency · Low loss | 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

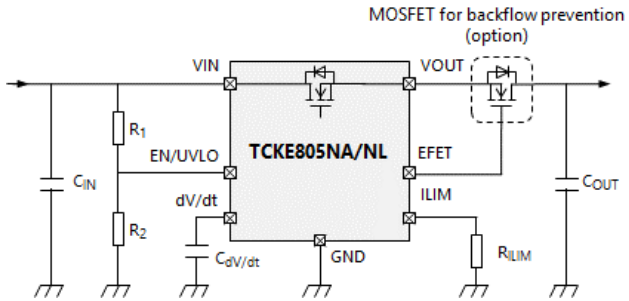
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

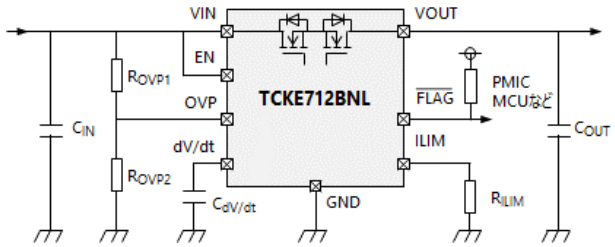
TCKE8 Series: Short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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

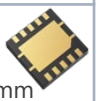
Reference circuit example of TCKE8 Series



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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14 N-ch MOSFET gate driver IC

TCK4xx series

High efficiency in all areas | High efficiency · Low loss | Small size packages

Value provided

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

[Note 1] OVP: Over Voltage Protection

1 Three types of N-ch MOSFET can be driven

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

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

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

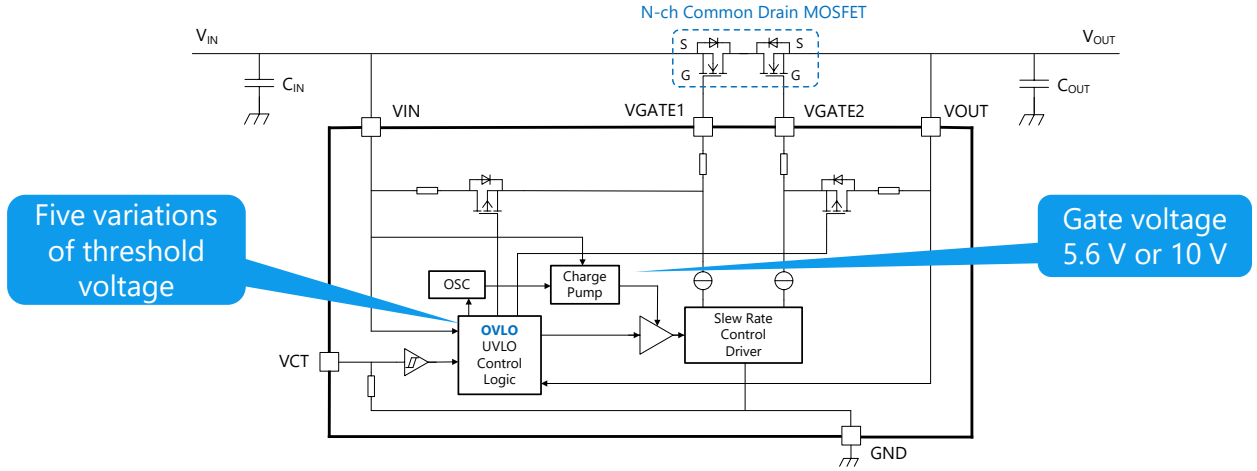
[Note 2] OVLO: Over Voltage Lock Out
[Note 3] V_{IN_OVLO}: V_{IN} OVLO threshold

3 Small packages

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

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

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



Lineup

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

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