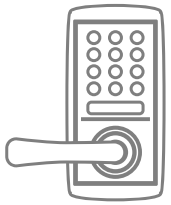
TOSHIBA

R22

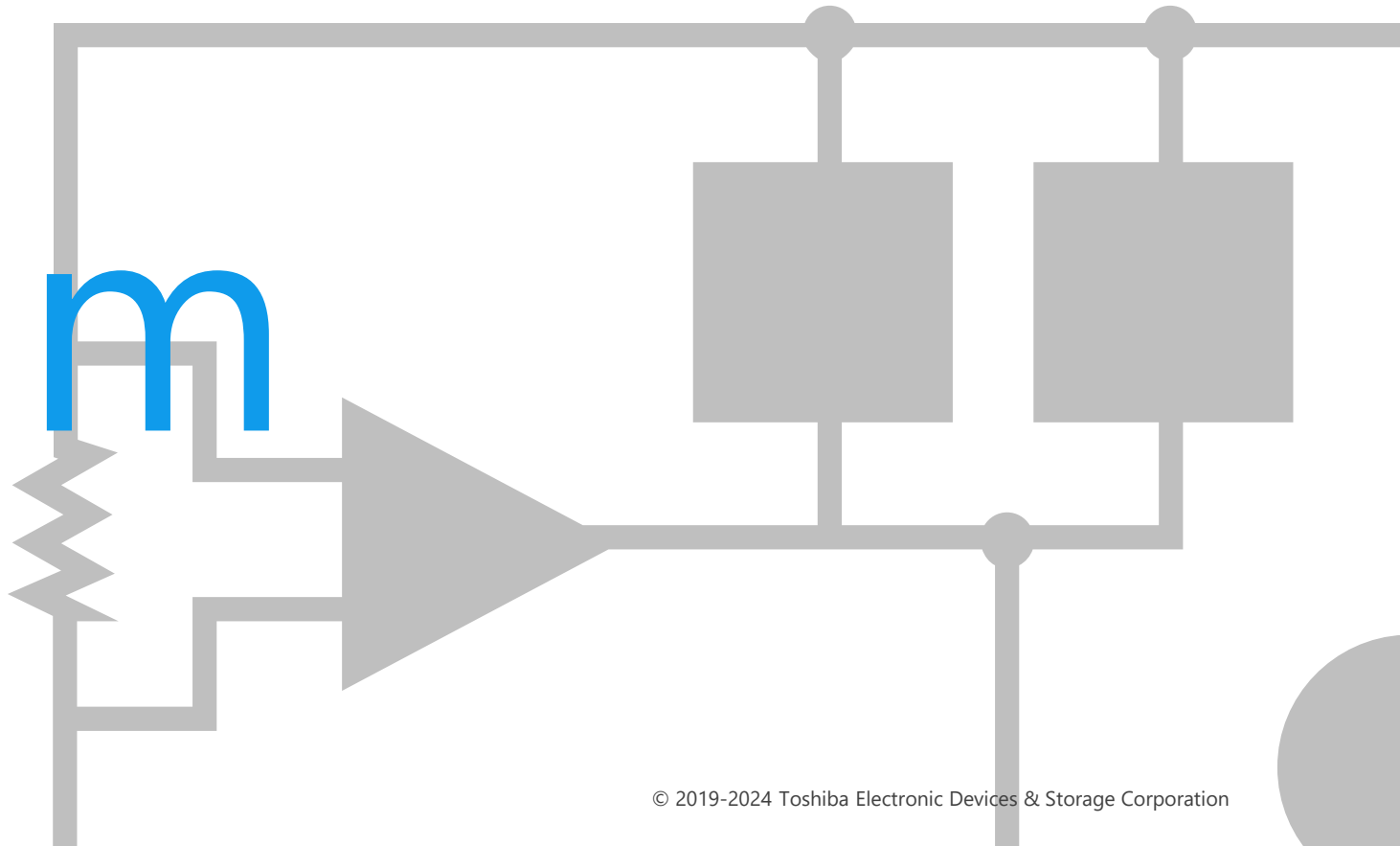
Warm Water Bidet

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

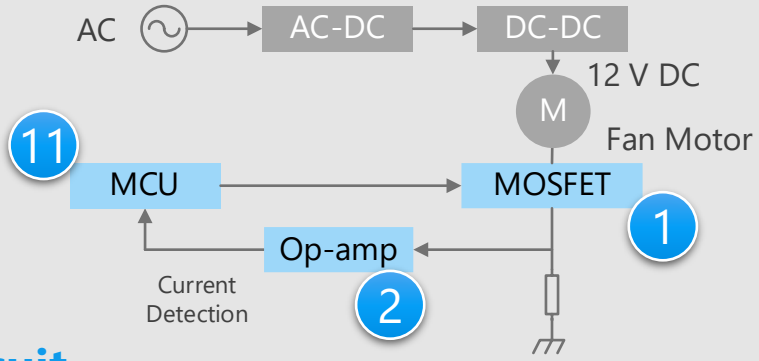


Warm Water Bidet　Overall block diagram

AC-DC Converter
DC-DC Converter
12 V: Motor, Pump, Fan
Up to 5 V: MCU, Sensor, LED, etc.
Seating Sensor
Water Tap Valve
Heater Toilet Seat
Heater Warm Water
AC
Isolation
Isolation
Isolation
12 V
Shower Pump
Nozzle Movement
Transistor Array
Open/Close Sensor
Remote Control Receiver
Beep/ Indicator
MCU
MOSFET /MCD
Lid and Seat Open/Close Motor
MOSFET /MCD
Deodorizing Fan
MOSFET /MCD
Drying Air Fan
Flash

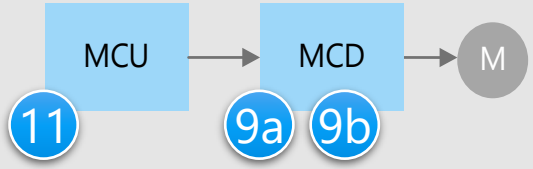
Warm Water Bidet　Details of fan motor drive / LED drive

Fan motor drive circuit

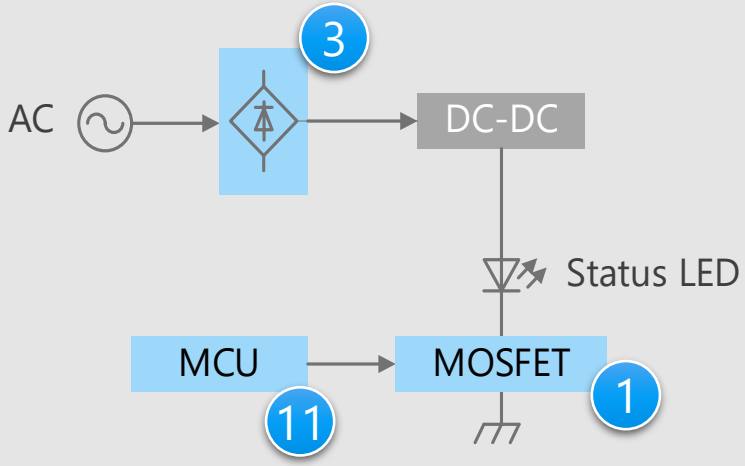


Fan motor drive circuit

(with MCD)



LED drive circuit



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

Criteria for device selection

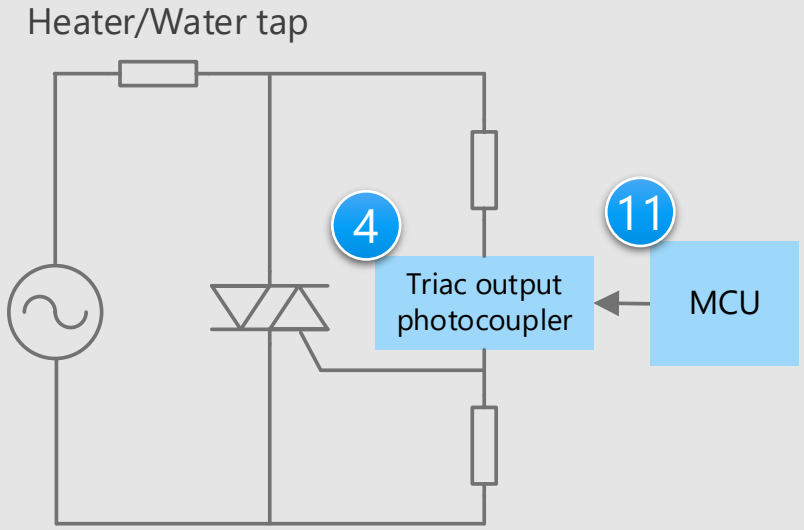
- MOSFETs with low on-resistance contribute to low loss of the set.
- Small package products contribute to the reduction of circuit board area.
- Operational amplifiers are suitable for amplifying signals such as current sensing.

Proposals from Toshiba

- **Realize a set with low power consumption by Low on-resistance**
  Small signal MOSFET　1
- **Operational amplifier with built-in phase compensation circuit**
  General purpose operational amplifier　2
- **Small surface mount package suitable for high density mounting**
  Rectifier diode　3
- **Motor controller with MOSFET that can easily drive brushless DC motor**
  Brushless DC motor driver IC　9a　9b
- **Built-in analog input interface for sensing, low power consumption, efficient software development**
  MCU M3H Group　11

Warm Water Bidet　Details of heater/water tap control unit

Heater/Water tap control circuit



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

Criteria for device selection

- A triac output photocoupler is suitable for controlling of AC load.

Proposals from Toshiba

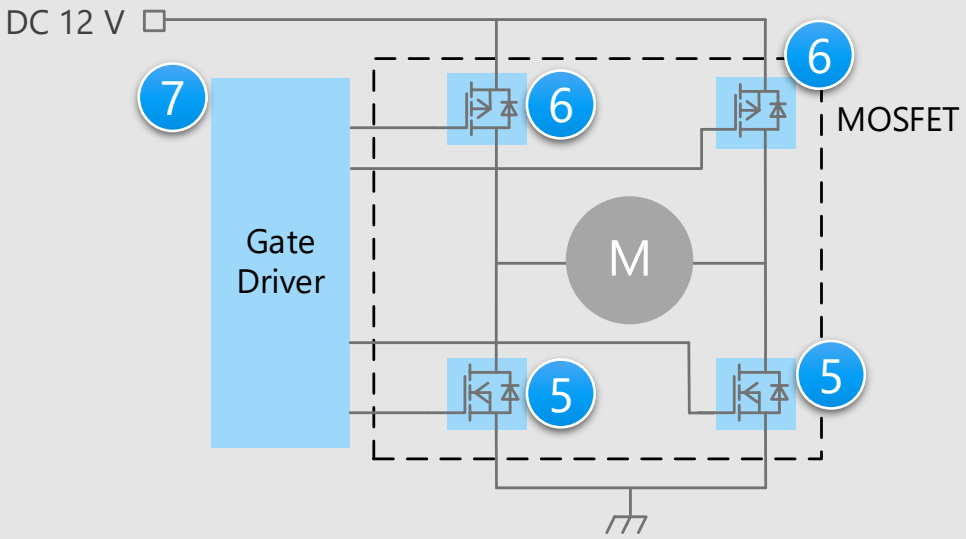
- **Efficient control of AC load**

  Triac output photocoupler 4
- **Built-in analog input interface for sensing, low power consumption, efficient software development**

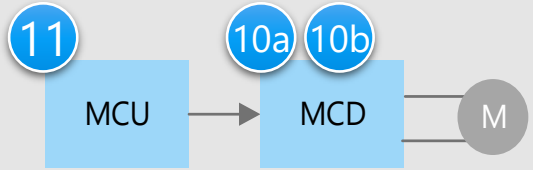
  MCU M3H Group 11

Warm Water Bidet　Details of lid and seat open/close motor drive unit

Lid and seat open/close brushed DC motor drive circuit



Lid and seat open/close brushed DC motor drive circuit (with MCD)



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

Criteria for device selection

- It is necessary to select a MOSFET with the suitable rated voltage and rated current for the motor rating.
- It is necessary to select gate drivers with the suitable for the MOSFET characteristics.
- Using MOSFETs with a high heat dissipation package makes it easier to design heat dissipation.

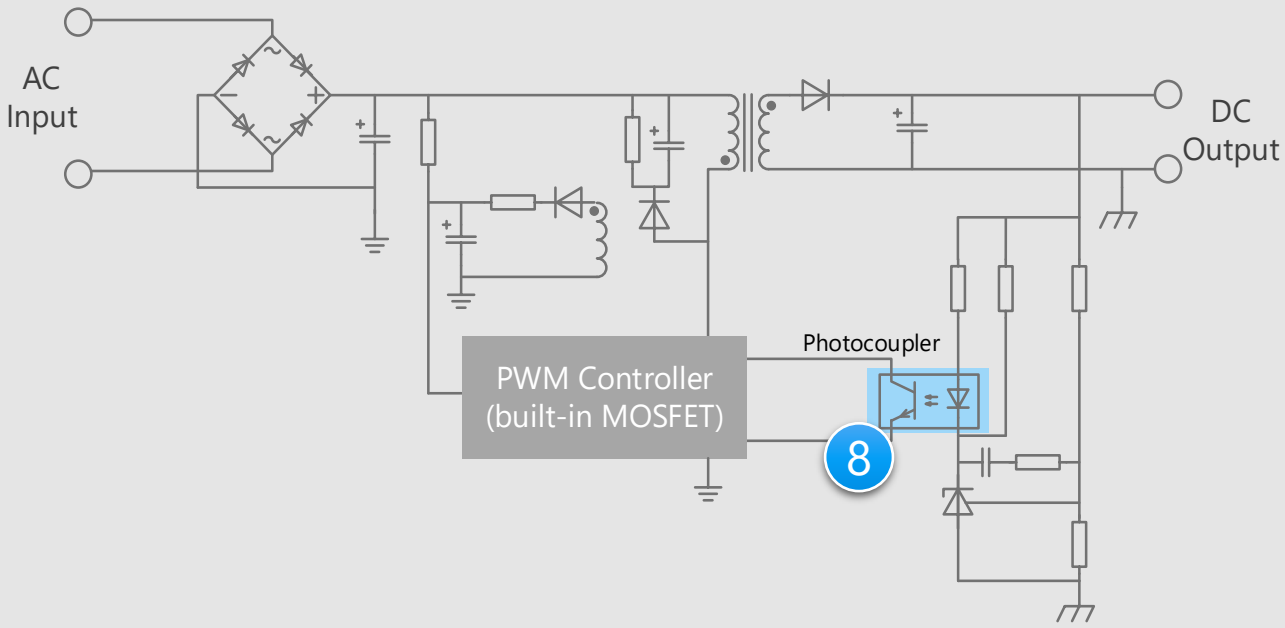
Proposals from Toshiba

- **Realize a set low power consumption of by low on-resistance**
  U-MOS Series N-ch MOSFET
  U-MOS Series P-ch MOSFET
- **Realize full-bridge drive circuit**
  Intelligent power device (IPD)
- **Low power drive using BiCD process**
  Brushed DC motor driver IC
- **Built-in analog input interface for sensing, low power consumption, efficient software development**
  MCU M3H Group

5 6 7 10a 10b 11

Warm Water Bidet　Detail of power supply unit

Flyback type AC-DC converter circuit



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

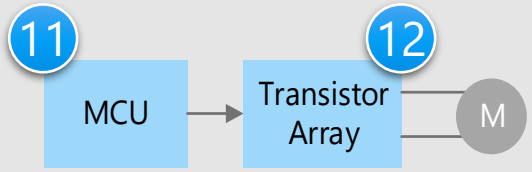
- **High current transfer ratio and high temperature operation are realized**
  Transistor output photocoupler 8

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

Warm Water Bidet　Detail of Nozzle control unit

Nozzle motor drive circuit

(with transistor array)



Criteria for device selection

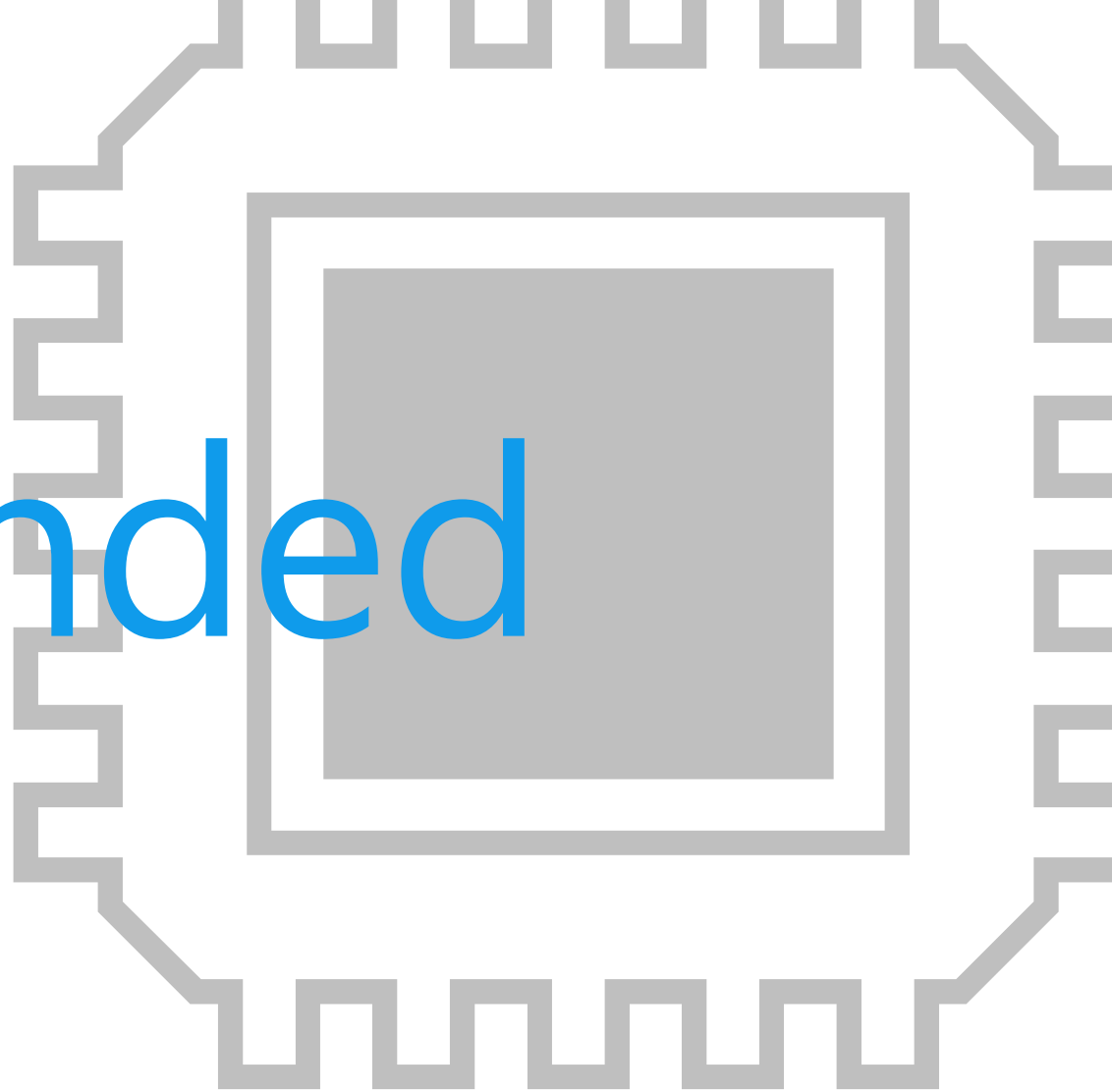
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba

- **Built-in analog input interface for sensing, low power consumption, efficient software development**
  MCU M3H Group
- **Efficiency is improved by adopting DMOS FET for output stage**
  Transistor array

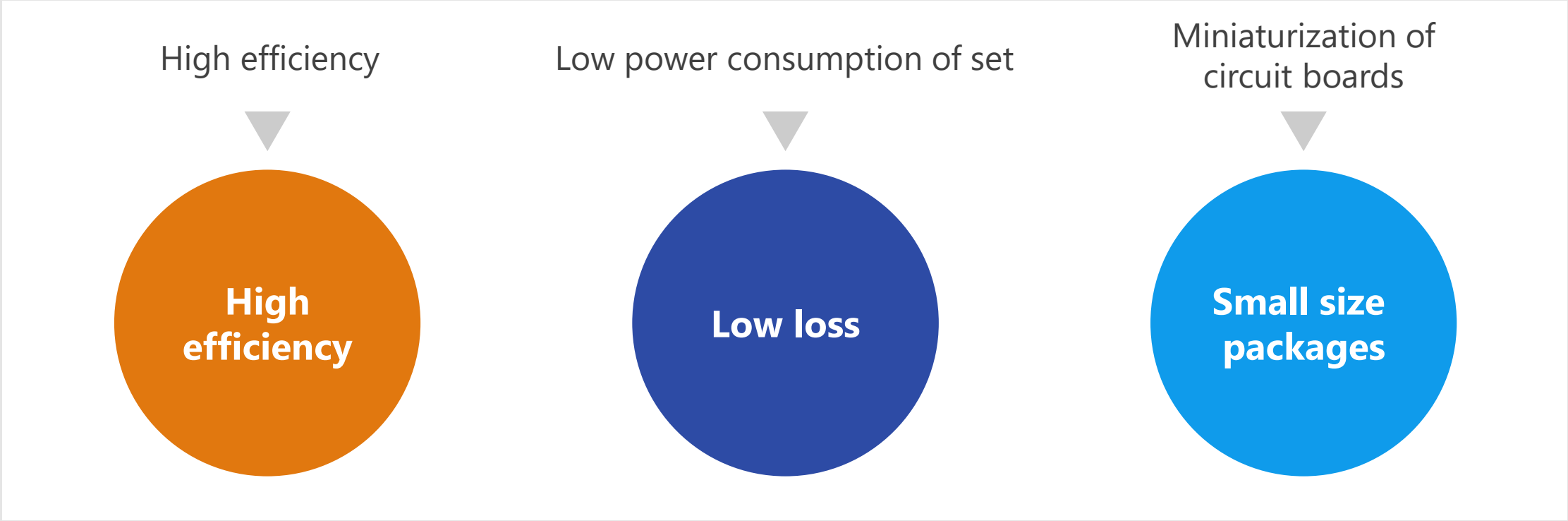
* Click on the number in the circuit diagram to jump to the detailed description page

Recommended Devices

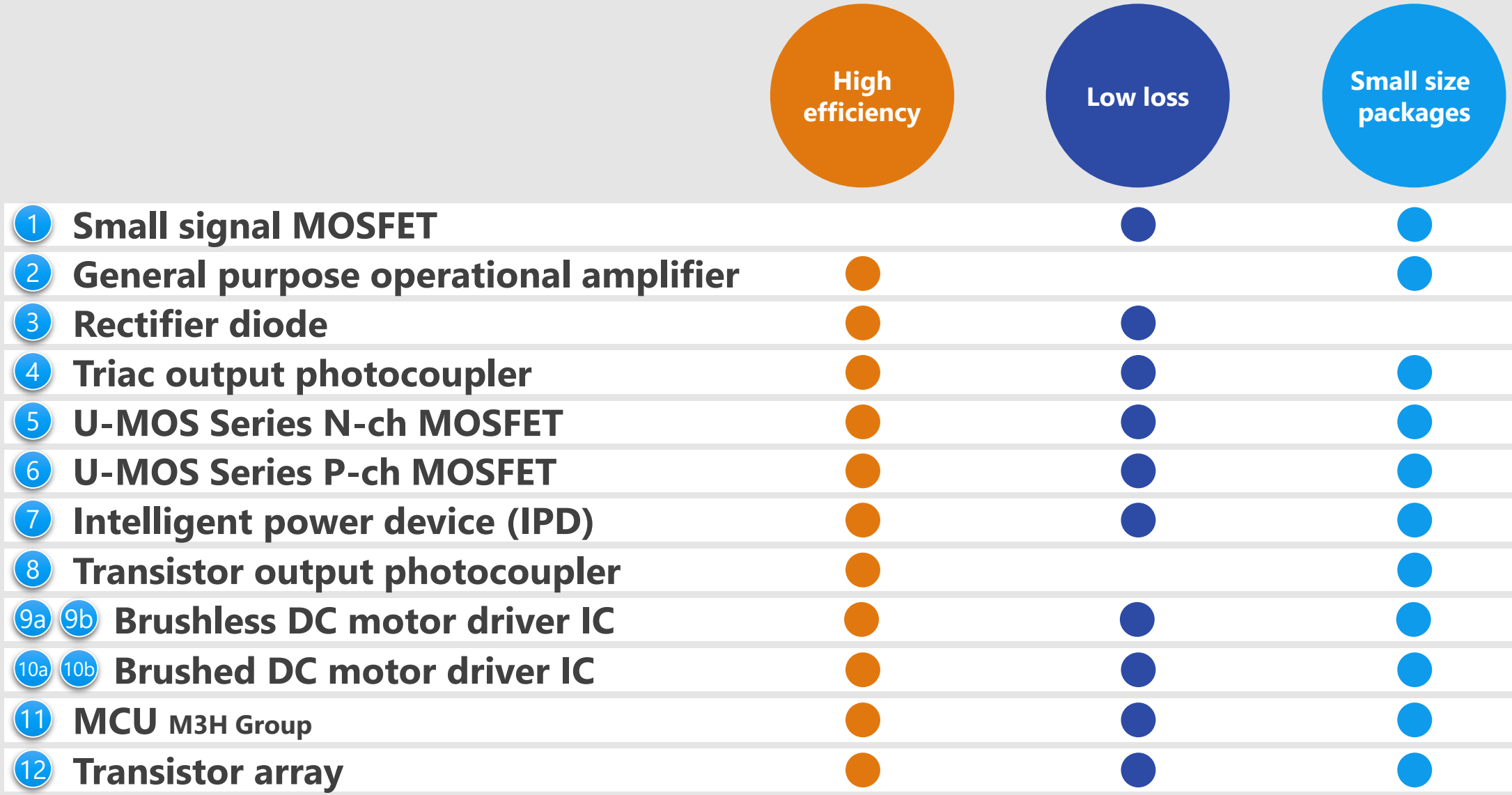


Device solutions to address customer needs

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



Device solutions to address customer needs



1 Small signal MOSFET

SSM3K56MFV / SSM6N56FE

High efficiency | Low loss | Small size packages

Value provided

U-MOS series MOSFET contributes to energy saving and miniaturization by improving the trade-off characteristics between on-resistance and 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.

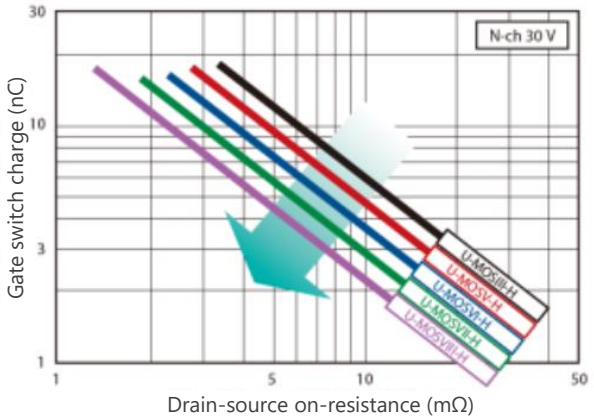
2 Small gate input charge

Switching characteristics are improved by reducing the amount of gate input charge.

3 High speed switching

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

Trade-off characteristics of on-resistance and gate input charge



(Note: Toshiba internal comparison)

Lineup

Part number		SSM3K56MFV	SSM6N56FE
Package		VESM 	ES6 
V_{DSS} [V]		20	20
I_D [A]		0.8	0.8
$R_{DS(ON)}$ [Ω] @V_{GS} = 4.5 V	Typ.	0.186	0.186
	Max	0.235	0.235
Polarity		N-ch	N-ch x 2
Generation		U-MOSⅦ-H	U-MOSⅦ-H

◆Return to Block Diagram TOP

2 General purpose operational amplifier

TC75S51FU / TC75S103F

High efficiency | Low loss | Small size packages

Value provided

CMOS single operation amplifier with a built-in phase compensator, low voltage drive, and low current consumption.

1 Low voltage operation is possible.

Compared with bipolar general purpose operational amplifiers, low voltage operation is possible [Note].

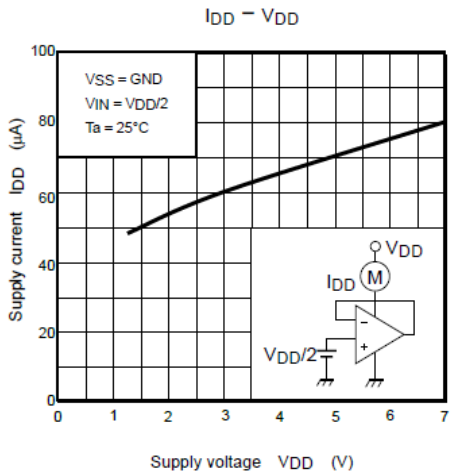
V_{DD} = ±0.75 to ±3. 5 V or 1.5 to 7 V (for TC75S51FU)

[Note] Comparison with Toshiba's products

2 Built-in phase compensator circuit

Because the phase compensation circuit is built-in, there is no need for any external device.

TC75S51FU
Characteristics chart



Lineup

Part number	TC75S51FU	TC75S103F
Package	USV 	SMV 
V_{DD} - V_{SS} [V]	1.5 to 7.0	1.8 to 5.5
I_{DD} (Typ. / Max) [μA]	60 / 200 (@V_{DD} = 3.0 V)	100 / 165 (@V_{DD} = 3.3 V)
f_T (Typ.) [MHz]	0.6	0.36
Input, Output Full Range	-	✓

◆Return to Block Diagram TOP

3 Rectifier diode
CMG06A

High efficiency | Low loss | Small size packages

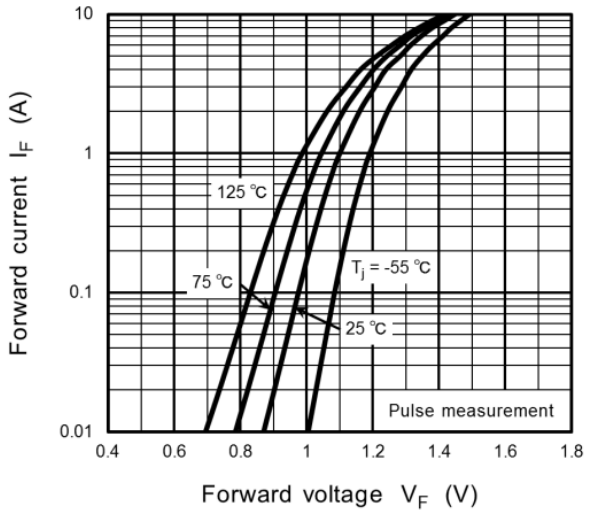
Value provided

Wide range of products are provided, mainly small package that is suitable for high density assembly.

1 Surface mount / small package

Adopting M-FLAT™ package which is lower in height compared to Toshiba conventional lead type contributes to the space saving of the equipment [Note].

[Note] Comparison with Toshiba's products



CMG06A
forward characteristic

2 Wide product lineup

Repetitive peak Reverse voltage: 200 to 1000 V Average forward current: 0.5 to 3 A Suitable product can be selected according to requirements.

Lineup

Part number	CMG06A
Package	M-FLAT™ 
$I_{F(AV)}$ [A]	1
V_{RRM} [V]	600

◆Return to Block Diagram TOP

4 Triac output photocoupler

TLP267J / TLP3052A

High efficiency | Low loss | Small size packages

Value provided

This photocoupler consists of a non-zero crossing photo triac, optically coupled to an infrared light emitting diode.

1 Non-zero cross type

This photocoupler is suitable for the case where the operation time is short and phase control is necessary.

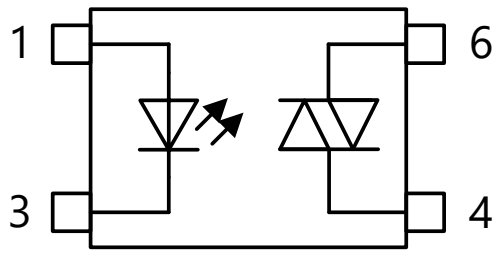
2 Switching characteristic

It has excellent features such as high speed, low noise and silence.

3 Reduction of assembly area

4pin SO6 packages have a size of 3.7 x 7.0 x 2.1 mm. (TLP267J)

TLP267J
Internal connection



UL-approved: UL1577, File No. E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN62368-1 (Note)
(Note) When a VDE approved type is needed, please designate the Option (V4).

Lineup

Part Number	TLP267J	TLP3052A
Package	4pin SO6 	5pin DIP6 
V_{DRM} [V]	600	600
BV_S [Vrms]	3750	5000
T_{opr} [°C]	-40 to 100	-40 to 100
Type	Non-zero-voltage turn-on	

◆Return to Block Diagram TOP

5 U-MOS Series N-ch MOSFET

TPH2R903PL / TPH3R003PL / TPH4R803PL / TPN2R903PL / TPN5R203PL

High efficiency | Low loss | Small size packages

Value provided

RonA characteristic has been improved and contributes to energy saving and miniaturization.

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.

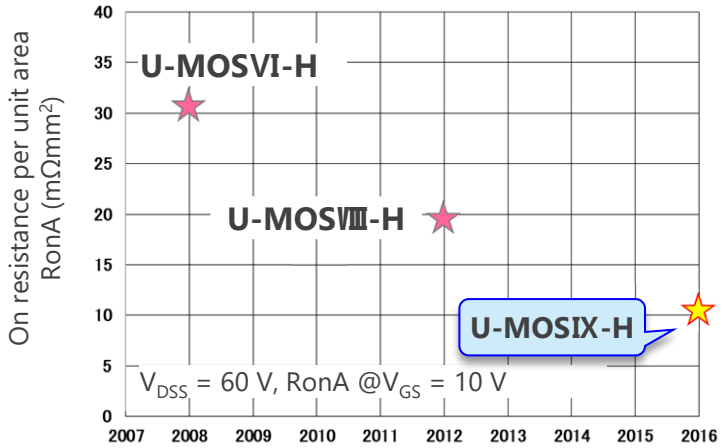
2 Small total gate charge

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

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		TPH2R903PL	TPH3R003PL	TPH4R803PL	TPN2R903PL	TPN5R203PL
Package		SOP Advance 			TSON Advance 	
V_{DSS} [V]		30	30	30	30	30
I_D [A]		70 (124*)	88 (134*)	48 (90*)	70 (122*)	38 (76*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	2.1	2.2	3.6	2.1	3.9
	Max	2.9	3.0	4.8	2.9	5.2
Polarity		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

* Silicon limit

◆Return to Block Diagram TOP

6 U-MOS Series P-ch MOSFET

TPCA8120

High efficiency | Low loss | Small size packages

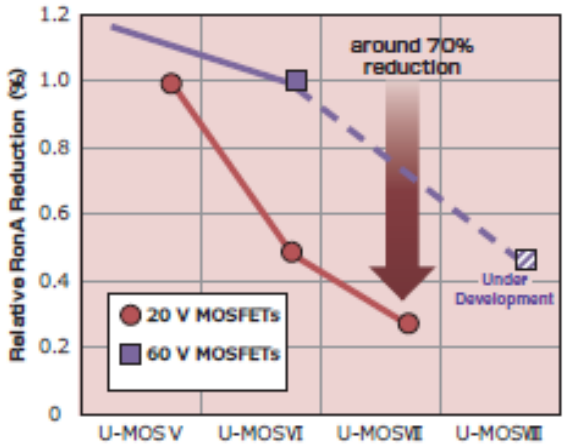
Value provided

RonA characteristic has been improved and contributes to energy saving and miniaturization.

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.

RonA reduction trend of P-ch MOSFET



(Note: Toshiba internal comparison)

2 Small total gate charge

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

Lineup

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

◆Return to Block Diagram TOP

7 Intelligent power device (IPD)

TPD7211F

High efficiency | Low loss | Small size packages

Value provided

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

1 Half bridge type

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

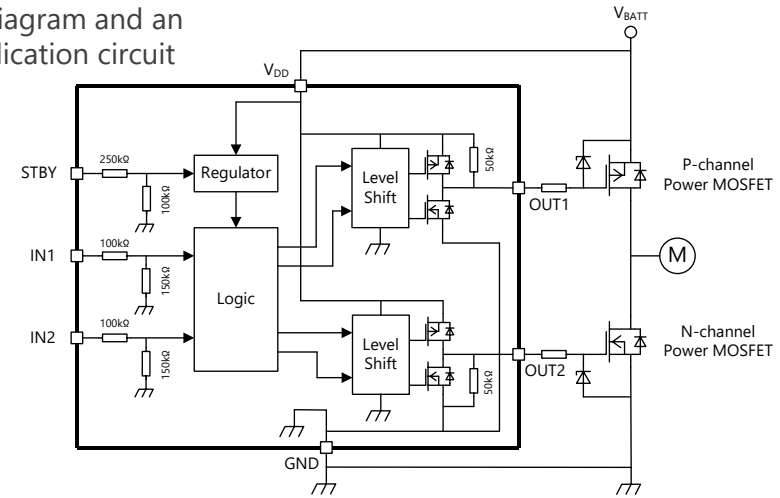
2 Can be driven with a high current

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

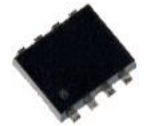
3 Small package

It is packaged in the small PS-8 package.
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

8 Transistor output photocoupler

TLP383

High efficiency | Low loss | Small size packages

Value provided

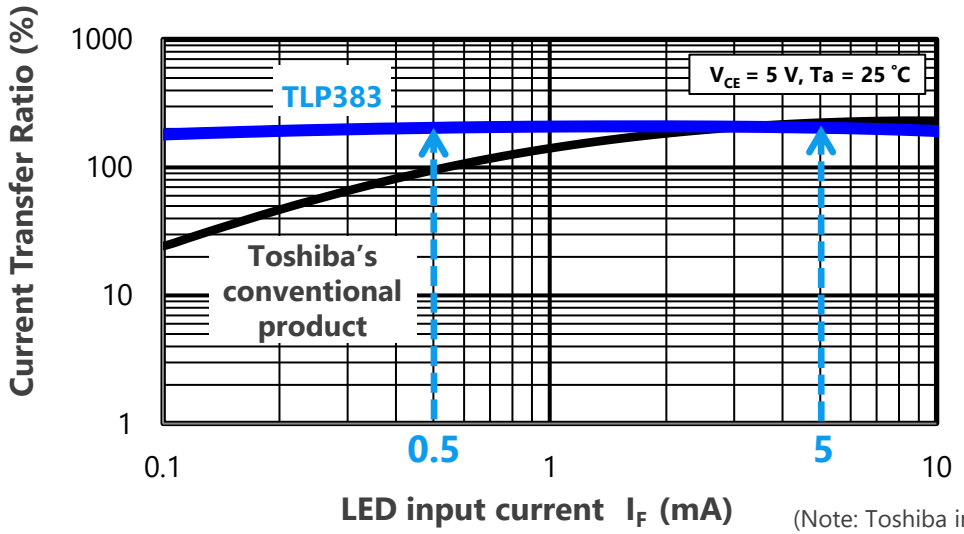
High current transfer ratio (CTR) is realized even in the low input current range (I_F = 0.5 mA).

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

9a Single phase brushless DC motor driver

TC78B002FNG / TC78B002FTG

High efficiency | Low loss | Small size packages

Value provided

Simple fan motor drive with low noise & low vibration.

1 Suitable for small fan motor

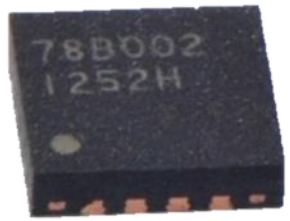
It is a single phase full wave driver and suitable for small brushless DC fan motor.

2 Low noise and low vibration motor driving

Smooth waveform by soft switching drive realizes low noise and low vibration driving of motor.

3 Small package

Small WQFN16 package with high heat dissipation. (TC78B002FTG)



WQFN16 Package (3 x 3 x 0.75 mm)

Lineup

Part number	TC78B002FNG	TC78B002FTG
Power supply voltage	5.5 to 16 V (operating range)	
Output current	1.5 A (operating range)	
Drive type	Single phase full wave drive	
Features & Others	PWM control, Soft switching drive Quick start, Hall bias circuit Error detection: Current limit, Thermal shutdown	
Package	SSOP16	WQFN16

◆Return to Block Diagram TOP

9b Three-phase brushless DC motor driver

TC78B016FTG

High efficiency | Low loss | Small size packages

Value provided

Toshiba's proprietary technology eliminates the need for phase adjustment and achieves high efficiency for a wide range of rotation speeds.

1 High efficiency is achieved for a wide range of rotation speeds

Toshiba's proprietary automatic advance angle control technology ensures high efficiency motor control at all times, regardless of motor speed, load torque and power supply voltage.

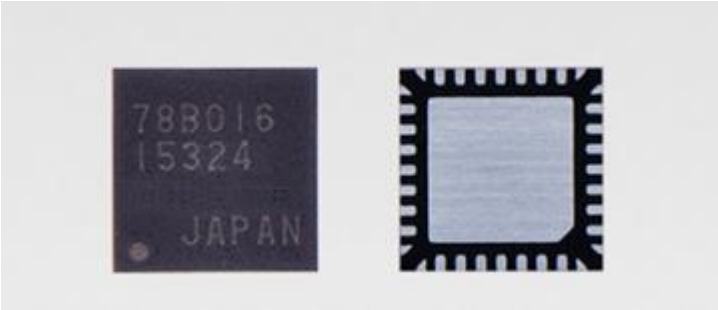
2 Motor control with low noise, and low vibration

Sine wave drive system with smooth current waveforms contributes to lower motor noise and vibration compared to conventional square wave drive system [Note].

3 Low loss, Low heat

Since the output on-resistance is a small 0.24 Ω (Typ.), the power loss of the IC itself during operation can be kept low.

[Note] Comparison with Toshiba products



WQFN36 package (5 x 5 x 0.8 mm)

Lineup

Part number	TC78B016FTG
Power supply voltage	6 to 30 V (operating range)
Output current	3 A (operating range)
Drive system	Sine wave drive system
Features	Phase control: Optimum phase control of voltage and current Hall device / Hall IC compatible Speed control input: PWM signal / analog voltage input Error detection: Thermal shutdown, overcurrent detection, motor lockout detection Output on-resistance (sum of top and bottom): 0.24 Ω (Typ.)

◆Return to Block Diagram TOP

10a 1ch brushed DC motor driver

TB67H450AFNG / TB67H451AFNG

High efficiency | Low loss | Small size packages

Value provided

High voltage and low power consumption characteristics are realized by BiCD process.
These are simple single channel version.

1 High voltage (50 V)

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

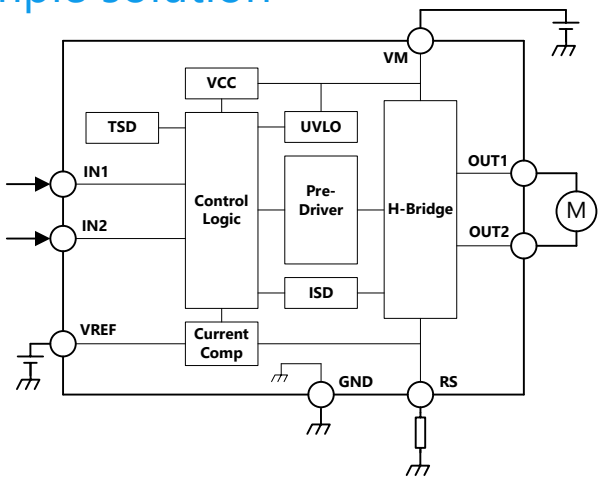
2 Wide operation voltage range

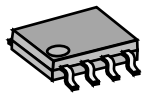
Wide power supply voltage range from 4.5 to 44 V supports battery drive applications.

3 Highly compatible package

HSOP8 package compatible with competitor's products or Toshiba's conventional products is adopted.

■ 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 [V]	50	
Output current [A]	3.5	
Output on-resistance (High side + Low side) (Typ.) [Ω]	0.6	
Output circuit	1 circuit	
Control interface	1 mode	
Phase mode	2-phase, 1-2 phase excitation	
Abnormality detection function	Thermal shutdown, over current, under voltage lockout	
Package	P-HSOP8-0405-1.27-002	

◆Return to Block Diagram TOP

10b 2ch brushed DC motor driver

TB67H400AFNG / TB67H400AFTG / TB67H400AHG / TB67H400ANG / TB67H410FTG / TB67H410NG

High efficiency | Low loss | Small size packages

Value provided

High voltage, high current and low power consumption characteristics are realized by BiCD process. These 2-channel versions can also drive stepping motors.

1 High voltage (50 V)/ High current

Maximum rating of the output voltage is improved to 50 V to allow margin for air discharge test, etc.
In addition, the parallel control function (Large mode) of the output part supports one channel high current driving.

2 Three selectable drive modes

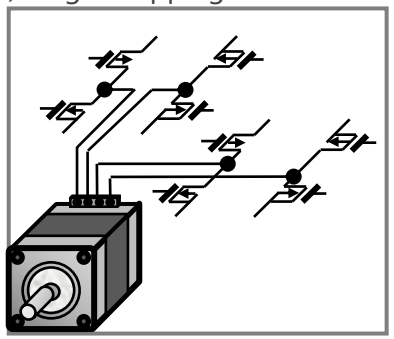
The H-bridge combination can be tailored according to the type of motor and the required current capacity as (1) single stepping motor drive, (2) dual brushed DC motor drive and (3) High current, single brushed DC motor drive.

3 Various package types

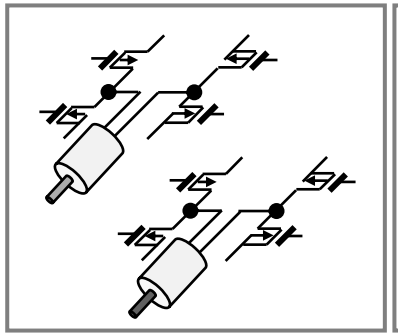
TB67H400A offers four types (HTSSOP48, WQFN48, HZIP25 and SDIP24) and TB67H410 offers two types (WQFN48 and SDIP24) of packages.

■ Three selectable drive modes

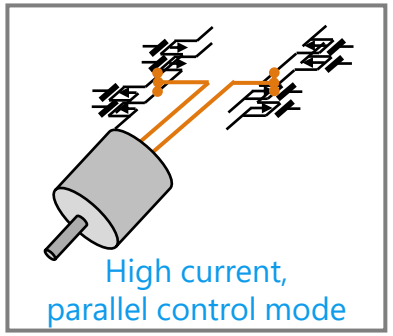
(1) Single stepping motor drive



(2) Dual brushed DC motor drive



(3) High current, single brushed DC motor drive



Lineup

Part number	TB67H400AFNG / FTG / HG / NG	TB67H410FTG / NG
Motor type	Brushed DC motor	
Output voltage [V]	50	
Output current [A]	4.0 (Small mode)	2.5 (Small mode)
Output on-resistance (High side + Low side) (Typ.) [Ω]	0.49 (Small mode)	0.8 (Small mode)
Output circuit	2 circuits (Small mode)	
Control interface	4 modes	
Step resolution / excitation mode	1/1, 1/2 step (2-phase, 1-2 phase excitation)	
Abnormality detection function	Thermal shutdown, overcurrent, power on reset	
Package	HTSSOP48 / WQFN48 / HZIP25 / SDIP24	WQFN48 / SDIP24

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High efficiency | Low loss | Small size packages

Value provided

These MCUs include AD converters, timers, and three-phase PWM output(Error accuracy: ±1%). These can control the system with low power consumption.

1 Built-in Arm® Cortex®-M3 CPU core

These implement Arm Cortex-M3 core with 120 MHz maximum operation frequency.
Various development tool and their partners allow users many options.

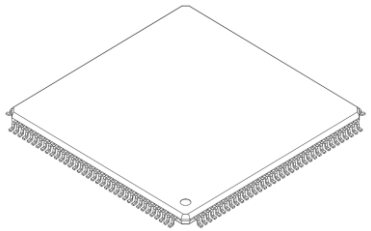
2 System cost down and development efficiency improvement

These execute sensing data monitoring and motor control efficiently by multiple built-in AD converters and timers. It also has a built-in FLASH memory that can be rewritten 0.1 million times. The product with 1 MB ROM can rewrite the codes while the microcomputer continues operation.

3 Small package and low power consumption

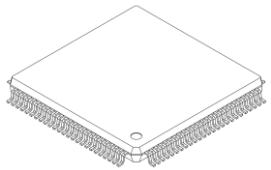
These support low power consumption library and stand by function and contribute to reduce power consumption. The packages lineup includes small LQFP64 to LQFP144.

TMPM3HQF10BFG
TMPM3HQFDAFG



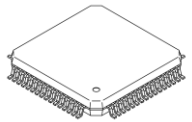
Package
P-LQFP144-2020-0.50-002

TMPM3HNF10BFG
TMPM3HNFDAFG



Package
P-LQFP100-1414-0.50-002

TMPM3HLF10BUG
TMPM3HLFDAUG



Package
P-LQFP64-1010-0.50-003

Lineup

Part number	M3H (2)	TMPM3HQF10BFG	TMPM3HNF10BFG	TMPM3HLF10BUG
	M3H (1)	TMPM3HQFD/Z/YAFG	TMPM3HNFD/Z/YAFG	TMPM3HLFD/Z/YAUG
Max. operation frequency		120 MHz		
ROM (Flash)	M3H (2)	1024 KB		
	M3H (1)	512 / 384 / 256 KB		
RAM	M3H (2)	130 KB (with parity)		
	M3H (1)	66 KB (with parity)		
Timer		32bit x 8ch (16bit x 16ch)		
AD converter		21ch (12bit)	17ch (12bit)	12ch (12bit)
Serial communication		UART: 8ch, I^2C: 4ch, TSPI: 5ch	UART: 8ch, I^2C: 3ch, TSPI: 4ch	UART: 7ch, I^2C: 2ch, TSPI: 1ch
Package		P-LQFP144-2020-0.50-002	P-LQFP100-1414-0.50-002	P-LQFP64-1010-0.50-003

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12 Transistor array

TBD62003AFWG / TBD62083AFG / TBD62064AFAG

High efficiency | Low loss | Small size packages

Value provided

DMOS FET is used for the output of drive circuit and realizes low loss. And CMOS input can control directly from controller's I/O, etc.

1 Rich product lineup

In addition to the listed products, we have lineup of various packaged products (such as DIP, SOL, SOP, SSOP, etc.) and source output type products.

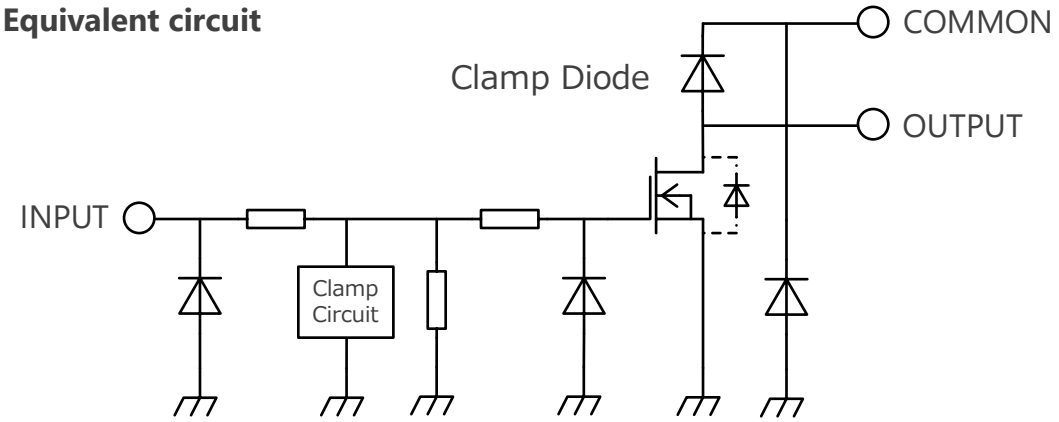
2 Built-in output clamp diode

Built-in output clamp diode regenerates the back electromotive force generated by switching of an inductive load.

3 High current drive is possible

The load can also be driven with higher current by connecting multiple outputs in parallel.

Equivalent circuit



Note: Equivalent circuit may be simplified for explanatory purpose.

Lineup

Part number	TBD62003AFWG	TBD62083AFG	TBD62064AFAG
Package	P-SOP16-0410-1.27-002	SOP18-P-375-1.27	P-SSOP24-0613-1.00-001
Output type	Sink	Sink	Sink
Number of channels	7ch	8ch	4ch
Input level	H	H	H
I_{OUT} [mA/ch]	500	500	1,500
V_{OUT} [V]	50	50	50

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