TOSHIBA

R23

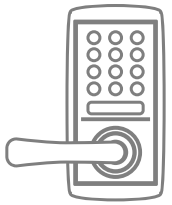
Warm Water Bidet

Solution Proposal by Toshiba



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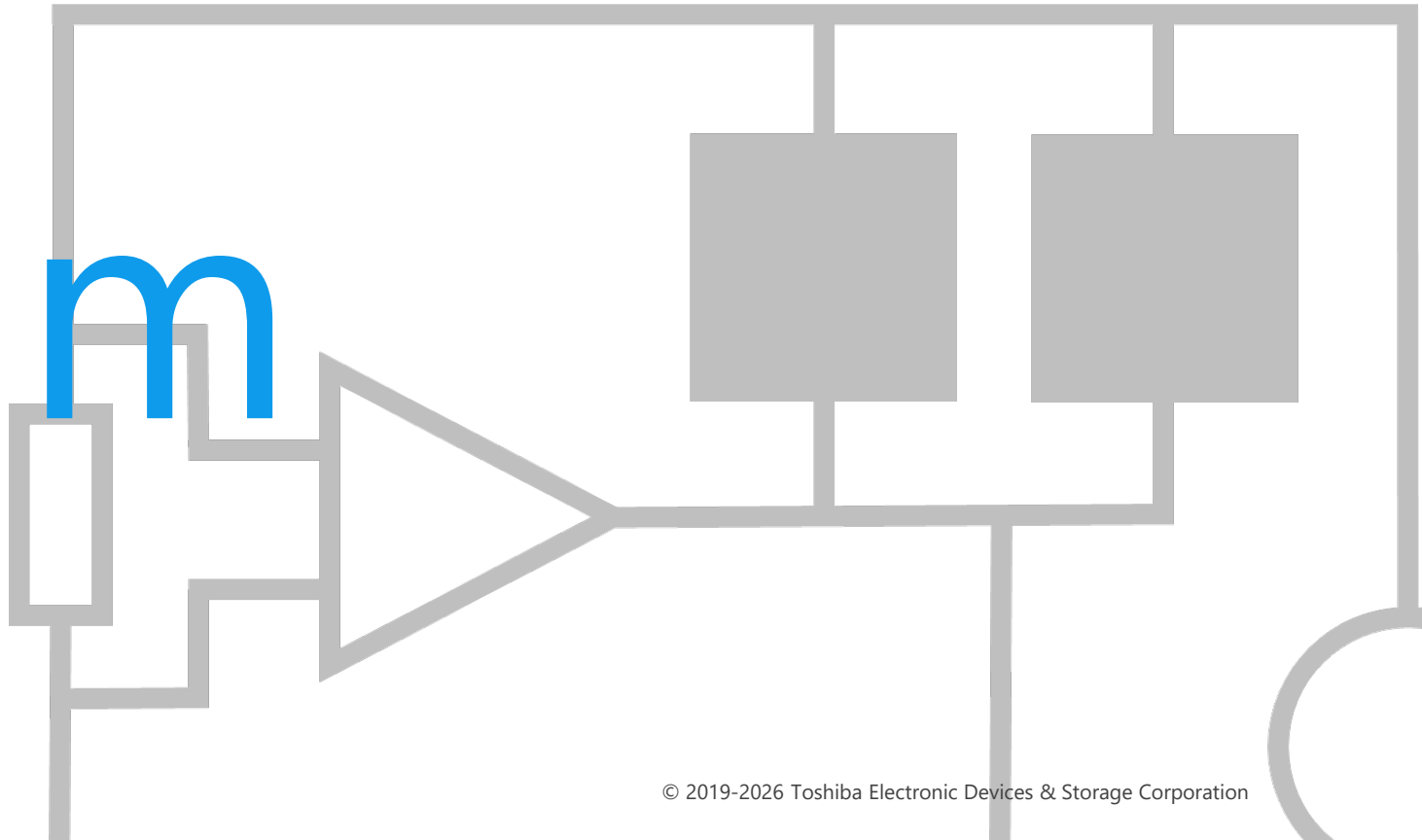




Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

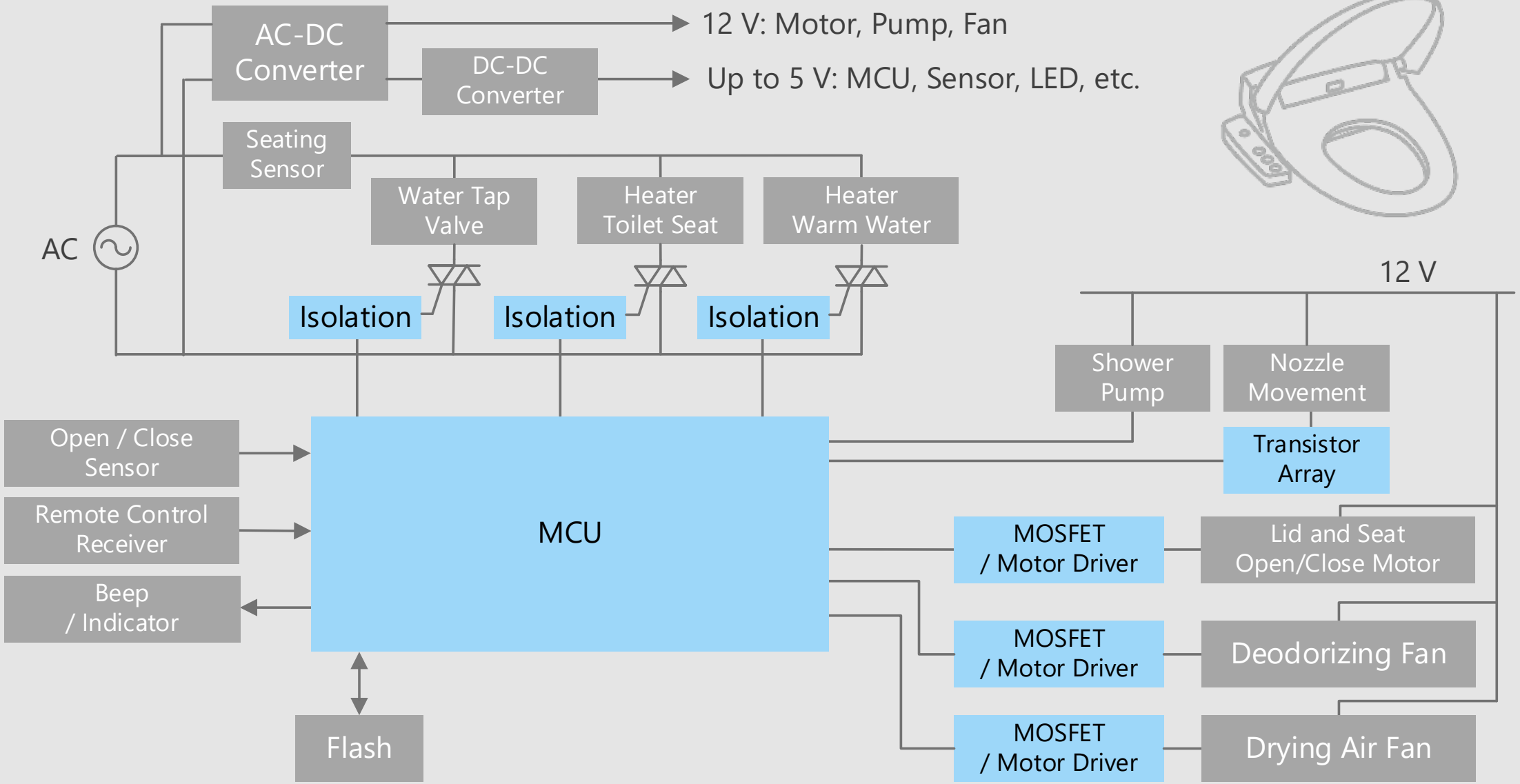
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Block Diagram



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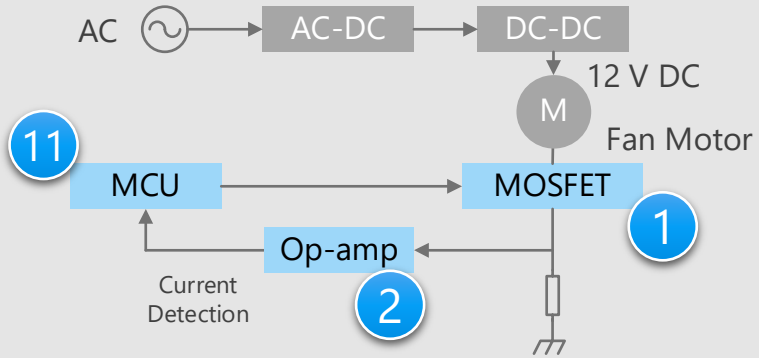
Warm Water Bidet　Overall block diagram



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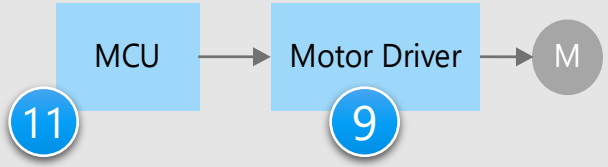
Warm Water Bidet　Details of fan motor drive / LED drive

Fan motor drive circuit

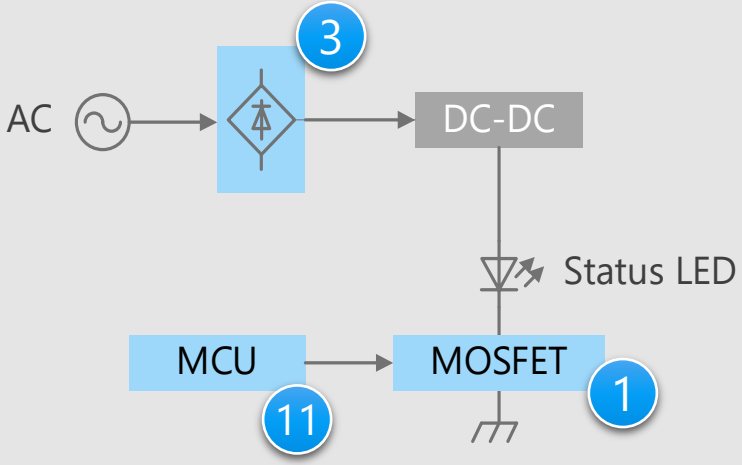


Fan motor drive circuit

(with motor driver)



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 size package products contribute to the reduction of circuit board area.
- Operational amplifiers are suitable for amplifying signals such as current sensing.

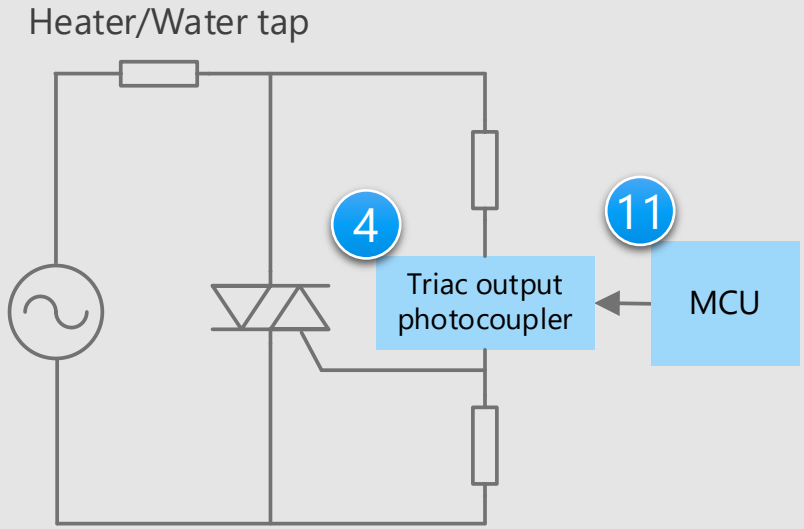
Proposals from Toshiba

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

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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**

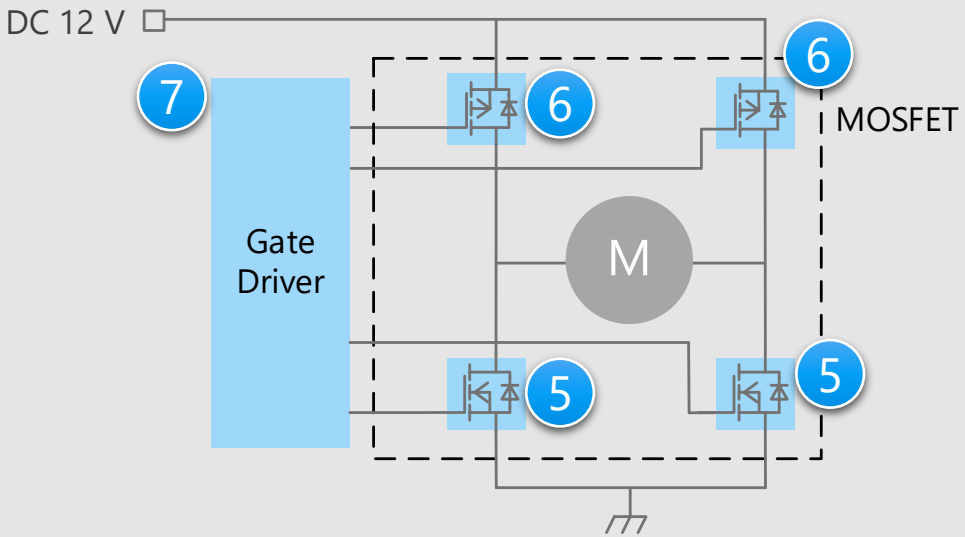
  MCU M3H Group 11

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

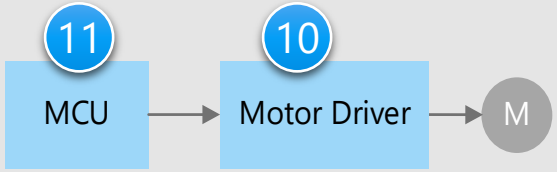
Lid and seat open/close brushed DC motor drive circuit

(with MOSFET)



Lid and seat open/close brushed DC motor drive circuit

(with motor driver)



* 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.

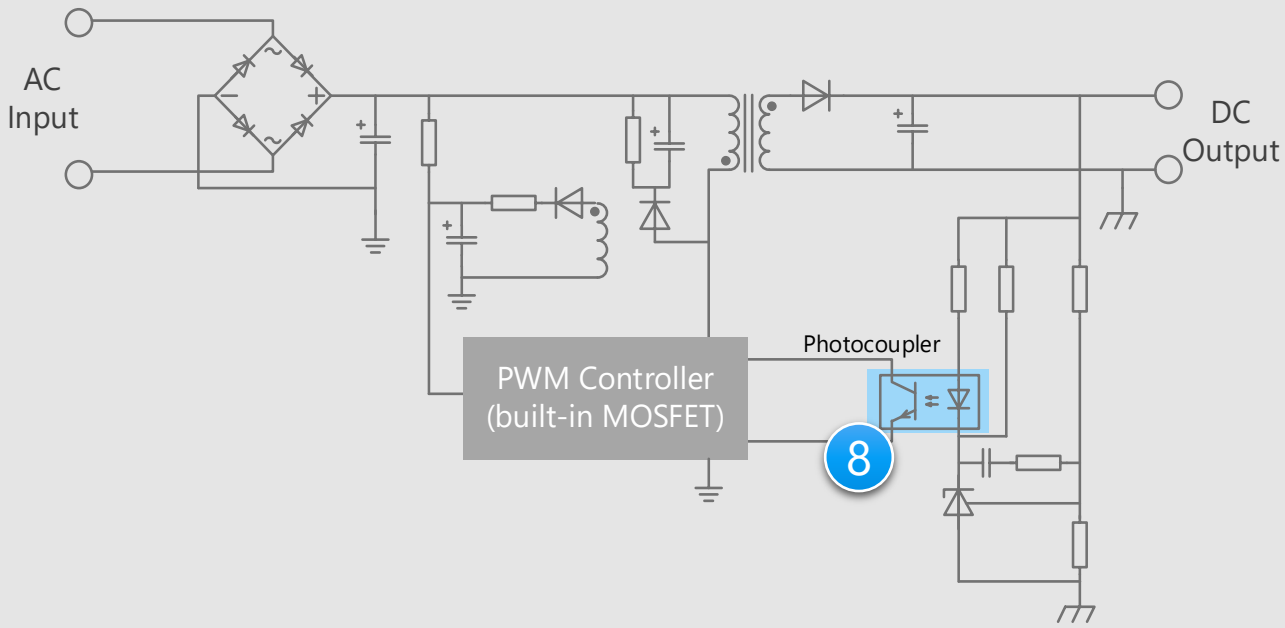
Proposals from Toshiba

- **Realize a set low power consumption of by low on-resistance** 5
  U-MOS Series N-ch MOSFET
  U-MOS Series P-ch MOSFET 6
- **Realize full-bridge drive circuit** 7
  Intelligent power device (IPD)
- **Low power drive using BiCD process** 10
  Brushed DC motor driver IC
- **Built-in analog input interface for sensing, low power consumption, efficient software development** 11
  MCU M3H Group

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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 size 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

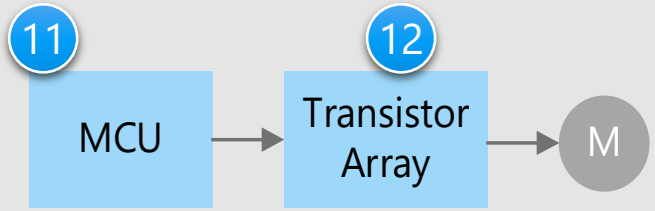
* Click on the number in the circuit diagram to jump to the detailed description page

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Warm Water Bidet　Detail of nozzle control unit

Nozzle motor drive circuit

(with transistor array)



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

Criteria for device selection

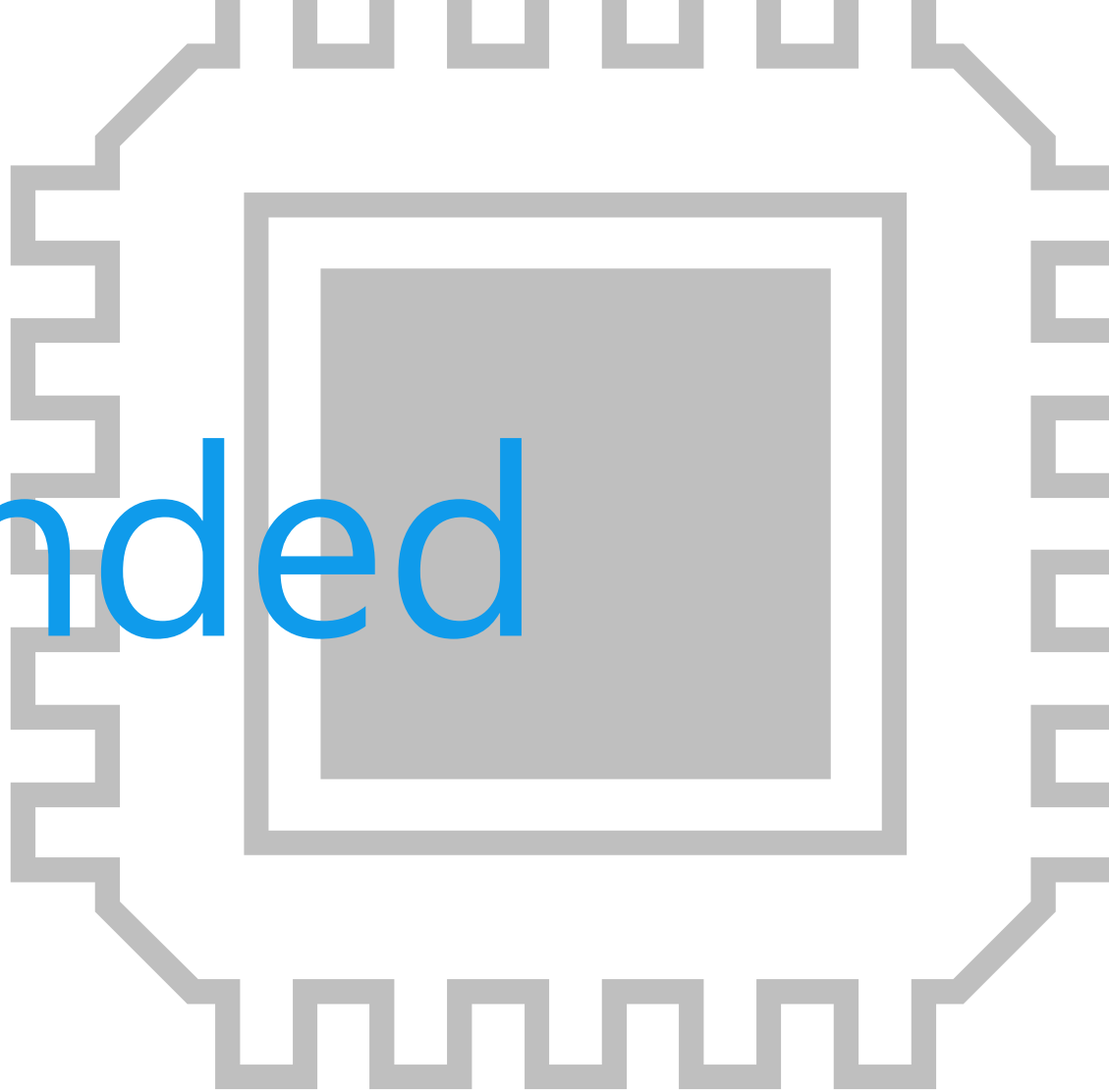
- Small size package products contribute to the reduction of circuit board area.

Proposals from Toshiba

- **Built-in analog input interface for sensing, low power consumption, efficient software development**
  MCU M3H Group　11
- **Efficiency is improved by adopting DMOS FET for output stage**
  Transistor array　12

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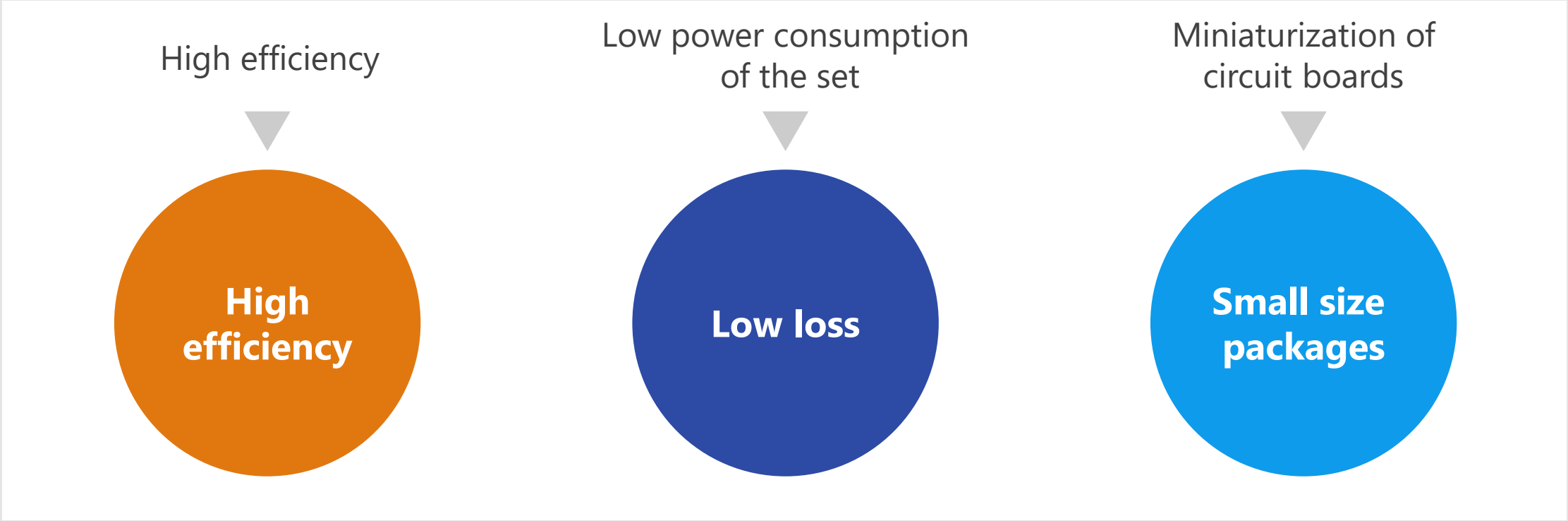
Recommended Devices



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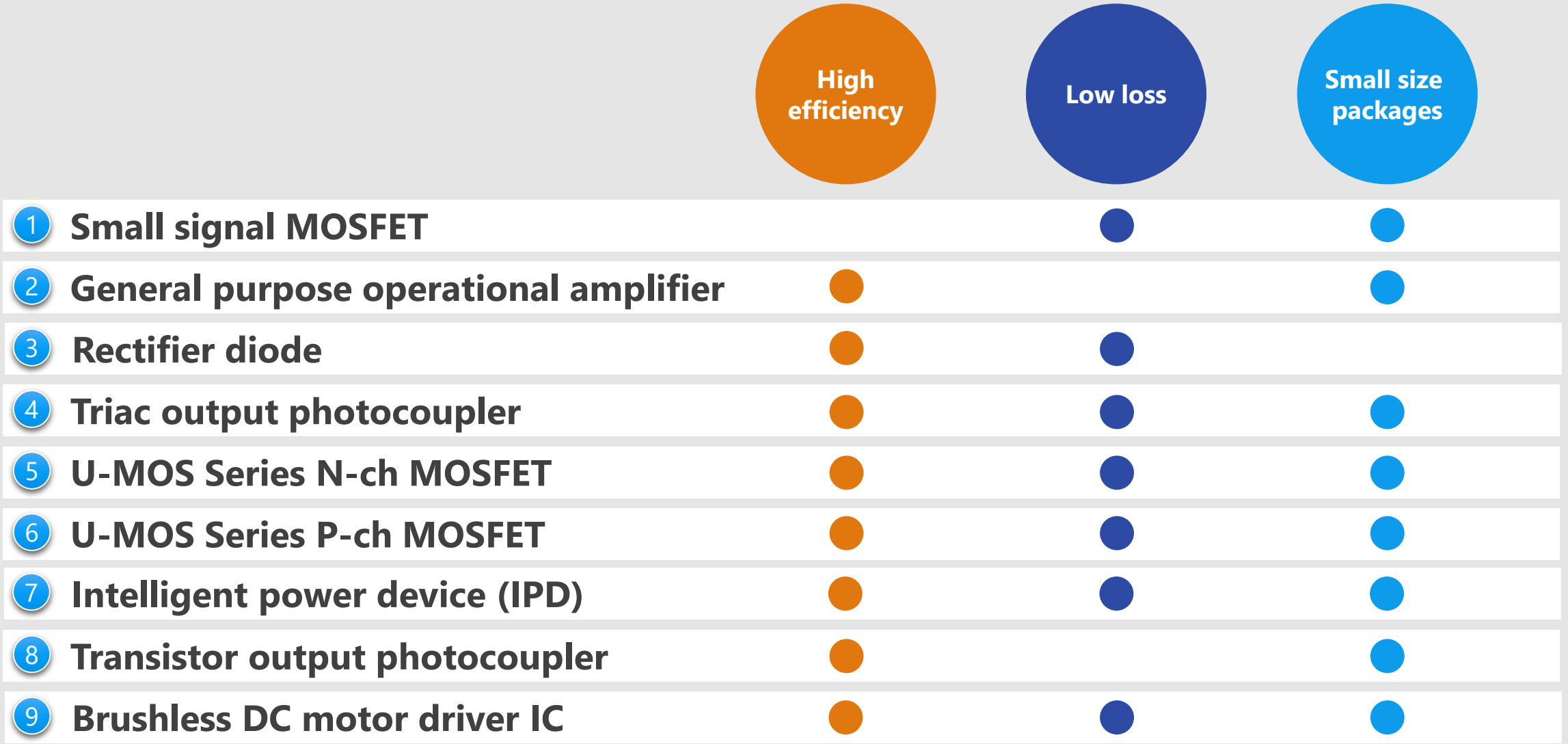
Device solutions to address customer needs

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



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Device solutions to address customer needs



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Device solutions to address customer needs

	High efficiency	Low loss	Small size packages
10 **Brushed DC motor driver IC**	●	●	●
11 **MCU** M3H Group	●	●	●
12 **Transistor array**	●	●	●

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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

The on-resistance between drain and source is low. Heat generation and power consumption can be kept low.

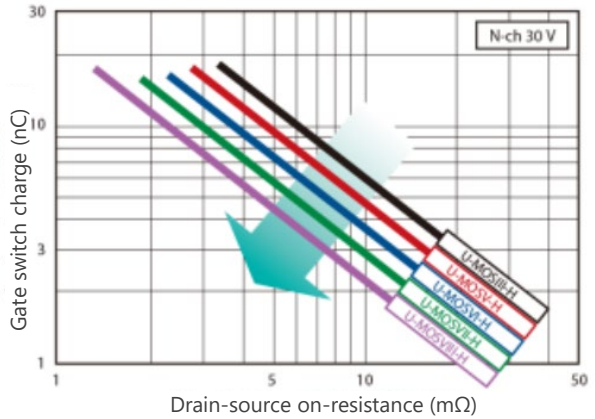
2 Small gate input charge

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

3 Fast switching speed

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		SOT-723 (VESM) 	SOT-563 (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

◆Return to Block Diagram TOP

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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

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

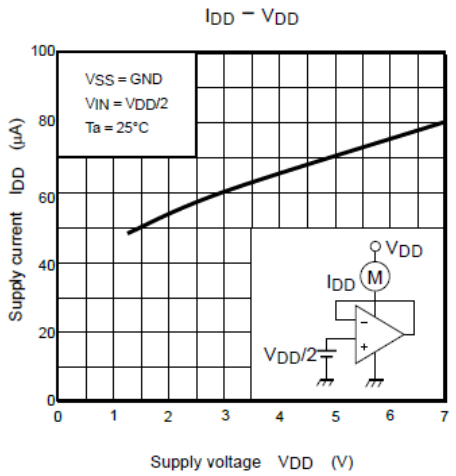
V_{DD} = ±0.75 to ±3. 5 V or 1.5 to 7 V (for TC75S51FU)

[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	SOT-353 (USV) 	SOT-25 (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]	0.60	0.36
Input, Output Full Range	-	✓

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3 Rectifier diode
CMG06A

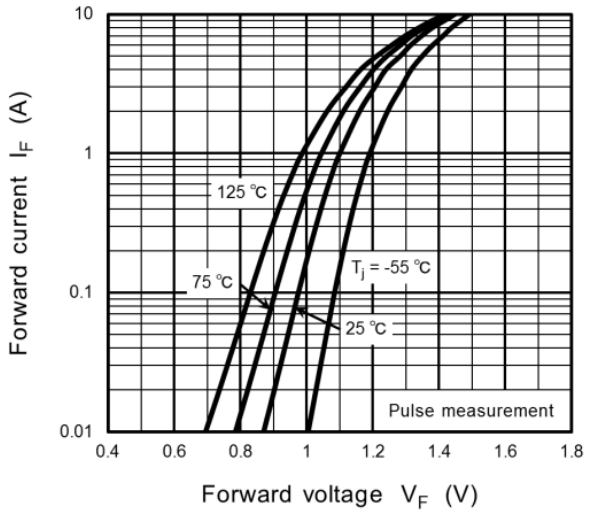
High efficiency | Low loss | Small size packages

Value provided

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

1 Small size surface mount package

Adopting M-FLAT™ package which is lower in height compared to the existing lead type contributes to the space saving of the equipment.



CMG06A
forward characteristic

2 Wide product lineup

Repetitive peak reverse voltage: 200 to 600 V
Average forward current: 0.5 to 3 A
Suitable product can be selected according to requirements.

Lineup

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

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4 Triac output photocoupler

TLP267J / TLP265J

High efficiency | Low loss | Small size packages

Value provided

The photocoupler consists of a non zero cross type phototriac, 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.

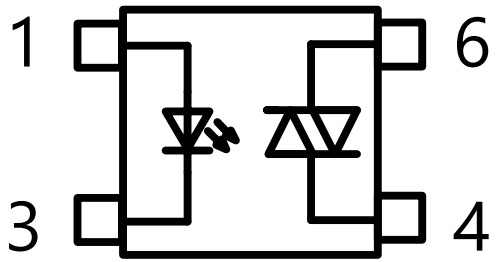
2 Switching characteristic

This photocoupler is suitable for high speed, low noise, and quiet operation.

3 Reduction of mounting area

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

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	TLP265J
Package	4pin SO6  Top view  Bottom view	
V_{DRM} [V]	600	
I_{FT} (Max) [mA]	3	10
BV_S [Vrms]	3750	
T_{opr} [°C]	-40 to 100	

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5 U-MOS Series N-ch MOSFET

TPH2R903PL / TPH3R003PL / TPH4R803PL / TPN2R903PL / TPN5R203PL

High efficiency | Low loss | Small size packages

Value provided

Low on-resistance products are available in the lineup. Improvement of trade-off characteristics between on-resistance and capacitance contributes to energy saving.

1 Low on-resistance

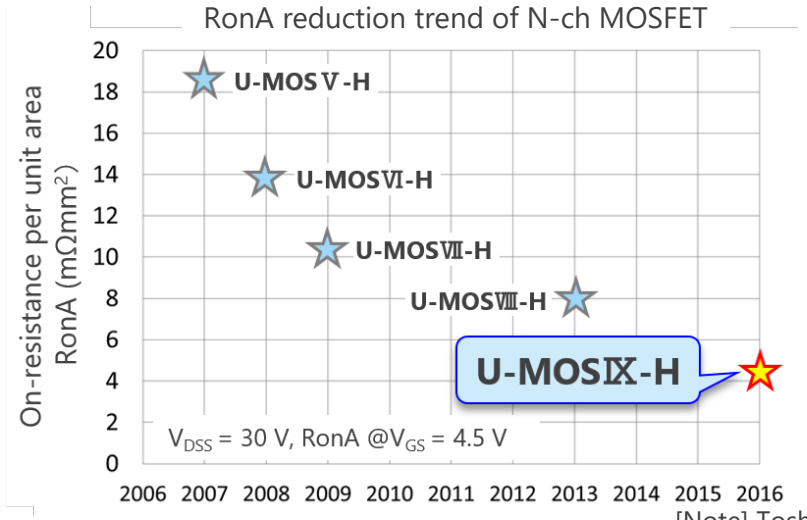
Low on-resistance between drain and source contributes to reducing heat generation and power consumption.

2 Small total gate charge

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

3 Fast switching speed

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



[Note] Toshiba internal comparison

Lineup

Part number		TPH2R903PL	TPH3R003PL	TPH4R803PL	TPN2R903PL	TPN5R203PL
Package		SOP Advance	Top view / Bottom view		TSON Advance	Top view / Bottom view
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} = 4.5 V	Typ.	3.0	2.9	4.7	3.0	4.9
	Max	4.1	4.2	6.2	4.1	6.4
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

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6 U-MOS Series P-ch MOSFET

TPCA8120

High efficiency | Low loss | Small size packages

Value provided

Low on-resistance products are available in the lineup. Improvement of trade-off characteristics between on-resistance and capacitance contributes to energy saving.

1 Low on-resistance

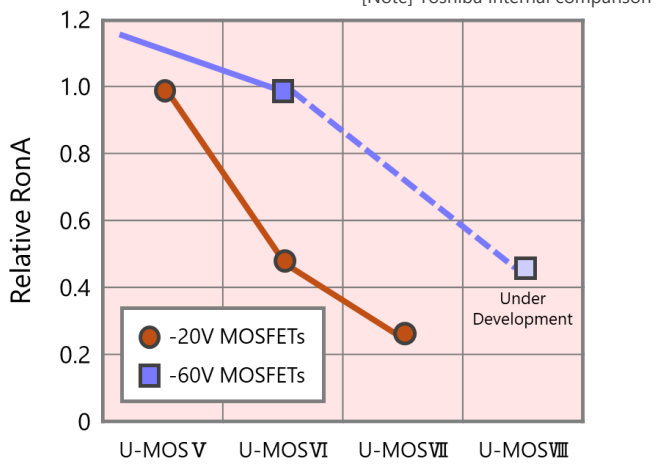
Low on-resistance between drain and source contributes to reducing heat generation and power consumption.

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

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7 Intelligent power device (IPD)

TPD7211F

High efficiency | Low loss | Small size packages

Value provided

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

1 Half bridge type

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

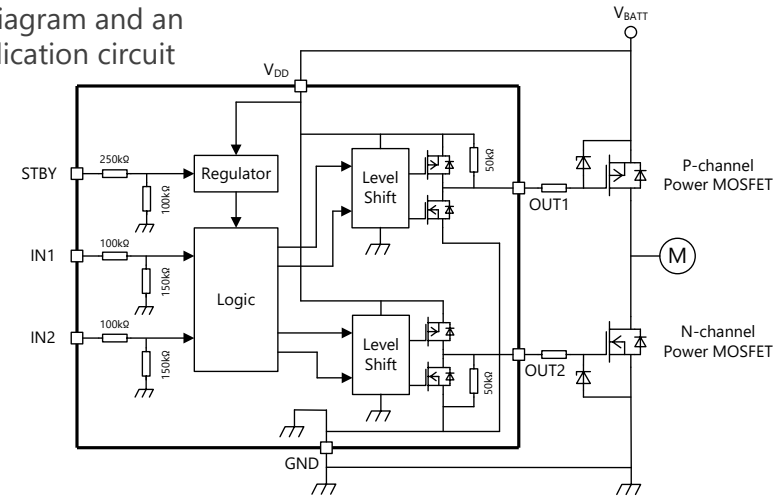
2 Can be driven with a high current

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

3 Small size package

It is 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  Top view Bottom view
$V_{DD(opr)}$ [V]	5 to 18
I_{OUT} [mA]	±500
T_{opr} [°C]	-40 to 125

◆Return to Block Diagram TOP

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8 Transistor output photocoupler

TLP383

High efficiency | Low loss | Small size packages

Value provided

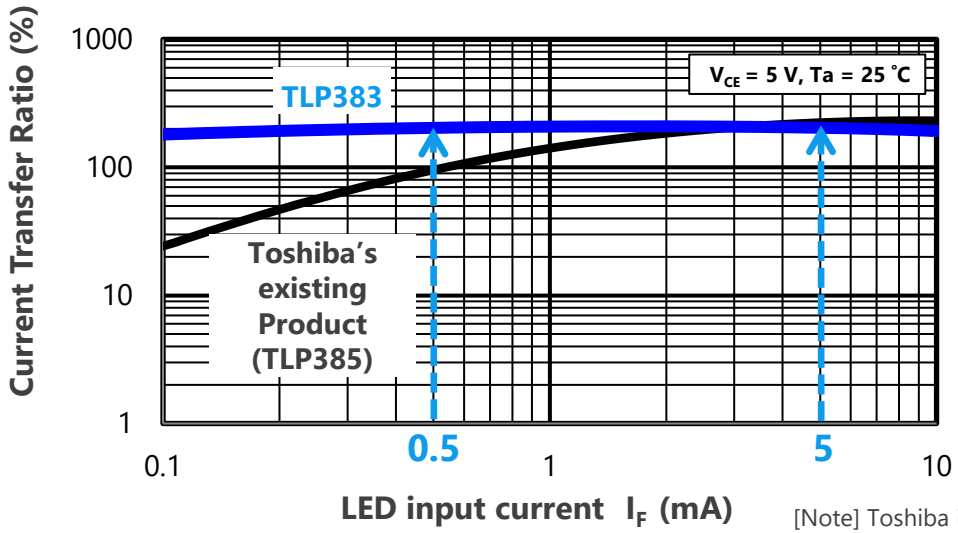
High current transfer ratio (CTR) is realized even in the low input current range (I_F = 0.5 mA).

1 High current transfer ratio

Phototransistor and InGaAs infrared light emitting diode are optically coupled. Highly isolated photocouplers realize higher CTR than Toshiba's existing product (TLP385) 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  Top view Bottom view
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

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9a Single phase brushless DC motor driver IC

TC78B002FNG / TC78B002FTG

High efficiency | Low loss | Small size packages

Value provided

This driver realizes simple, low noise and low vibration fan motor drive.

1 Suitable for small fan motor

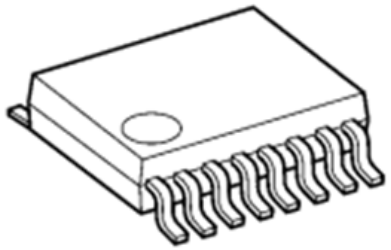
Suitable for driving simple and compact brushless DC fan motors by single-phase full wave drive.

2 Low noise and low vibration for motor

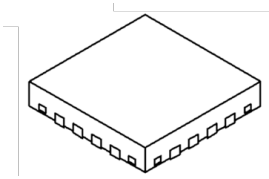
Equipped with a soft switching drive function, it contributes to low noise and low vibration during motor operation through smooth current waveforms.

3 Small size package

Small size P-WQFN16 package with high heat dissipation. (TC78B002FTG)



Package
SSOP16-P-225-0.65B
(5.0 x 6.4 x 1.2 mm)



Package
P-WQFN16-0303-0.50-002
(3.0 x 3.0 x 0.75 mm)

Lineup

Part number	TC78B002FNG	TC78B002FTG
V_M [V]	18	
I_{OUT} [A]	1.5	
Drive type	Single phase full wave drive	
Features	PWM control, Soft switching drive Quick start, Hall bias circuit Error detection: Over current protection, Thermal shutdown	
Package	SSOP16-P-225-0.65B	P-WQFN16-0303-0.50-002

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9b Three-phase brushless DC motor driver IC

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 contributes to high efficiency motor control, 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].

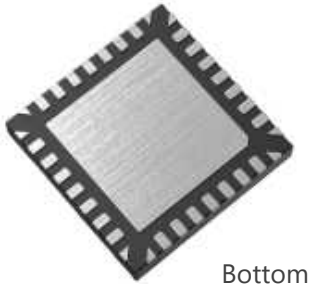
[Note] Comparison with Toshiba products

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.



Top view



Bottom view

Package
P-WQFN36-0505-0.50-001
(5.0 × 5.0 × 0.8 mm)

Lineup

Part number	TC78B016FTG
Power supply voltage [V]	6 to 30 (operating range)
Output current [A]	3 (operating range)
Drive system	Sine wave drive system
Features	Phase control: Optimum phase control of voltage and current Sensor input: 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.)

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10a 1ch brushed DC motor driver IC

TB67H450AFTG / TB67H450AFNG / TB67H451AFNG

High efficiency | Low loss | Small size packages

Value provided

High voltage, high current and low power consumption with BiCD process. Simple single channel version.

1 High absolute maximum rating of output

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

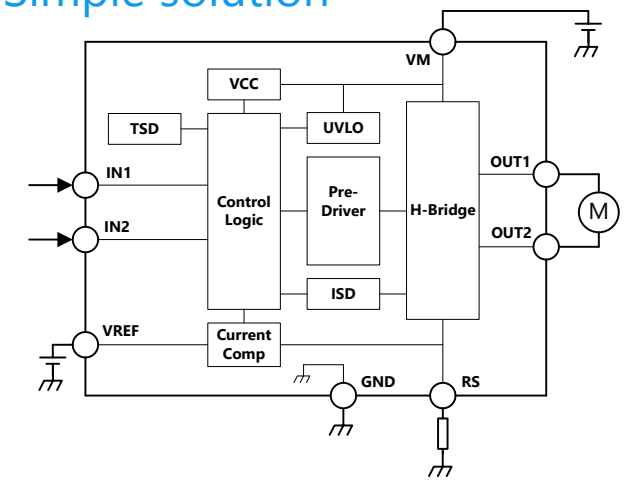
2 Wide operation voltage range

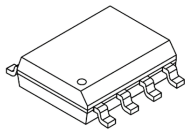
Wide power supply voltage range from 4.5 to 44 V supports battery driven applications.

3 Mature package

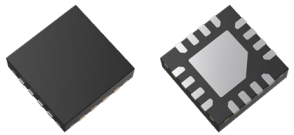
For TB67H450AFNG and TB67H451AFNG, adopting HSOP8 general purpose package.

■Simple solution





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



Package
P-VQFN16-0303-0.50-001
(3.0 x 3.0 mm)

Lineup

Part number		TB67H450AFTG	TB67H450AFNG	TB67H451AFNG
Motor type		Brushed DC motor		
Absolute maximum ratings	Output voltage [V]	50		
	Output current [A]	3.5		
Output on-resistance (H+L) (Typ.) [Ω]		0.6		
Error detection function		Thermal shut down (TSD), over current (ISD), low voltage (UVLO)		
Package		P-VQFN16-0303-0.50-001	P-HSOP8-0405-1.27-002	

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10b 2ch brushed DC motor driver IC

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

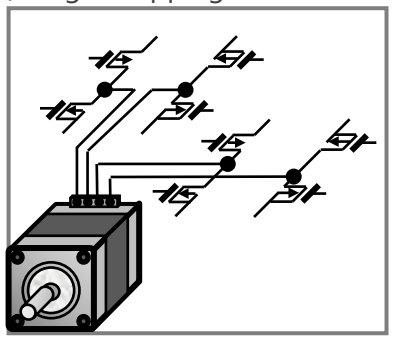
The H-bridge combination can be tailored according to the type of motor and the required current capacity as (1) single stepping motor drive, (2) dual brushed DC motor drive and (3) High current, single brushed DC motor drive.

3 Various package types

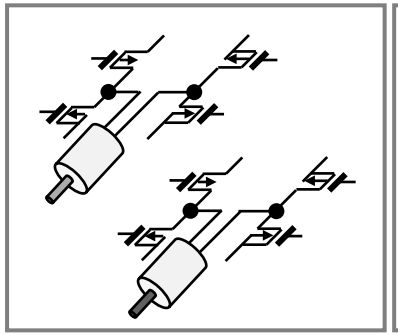
TB67H400A offers four types (HTSSOP48, WQFN48, HZIP25 and SDIP24) and TB67H410 offers two types (WQFN48 and SDIP24) of packages.

■Three selectable drive modes

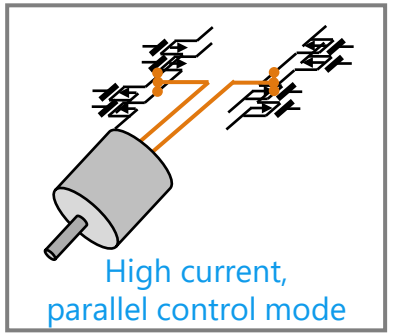
(1) Single stepping motor drive



(2) Dual brushed DC motor drive



(3) High current, single brushed DC motor drive



High current, parallel control mode

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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Value provided

These MCUs include AD converters, timers and high speed oscillator (oscillation 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 tools and their partners allow users many options.

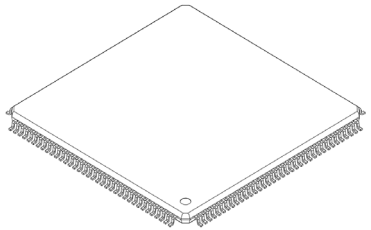
2 Higher functionality of the system

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 Low power consumption / Small size package

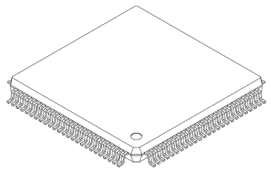
These support low power consumption library and stand by function and contribute to reduce power consumption.
The packages lineup includes small LQFP64 to LQFP144.

TMPM3HQF10BFG
TMPM3HQFDAFG



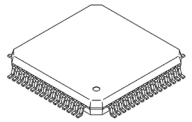
P-LQFP144-2020-0.50-002
(22.0 x 22.0 x 1.7 mm)

TMPM3HNF10BFG
TMPM3HNFDAFG



P-LQFP100-1414-0.50-002
(16.0 x 16.0 x 1.7 mm)

TMPM3HLF10BUG
TMPM3HLFDAUG



P-LQFP64-1010-0.50-003
(12.0 x 12.0 x 1.7 mm)

Lineup

Part number	M3H (2)	TMPM3HQF10BFG	TMPM3HNF10BFG	TMPM3HLF10BUG
	M3H (1)	TMPM3HQFD/Z/Y/AFG	TMPM3HNFD/Z/Y/AFG	TMPM3HLFD/Z/Y/AUG
Operating frequency (Max)		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 Wide product lineup

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

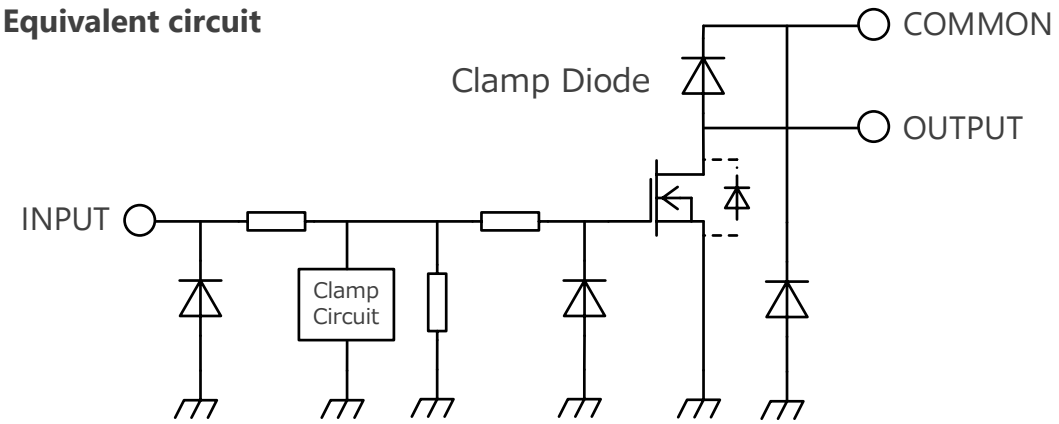
2 Built-in output clamp diode

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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