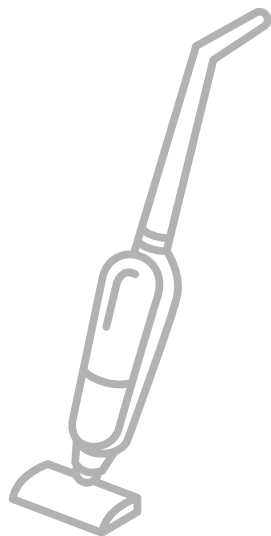


Cordless Cleaner

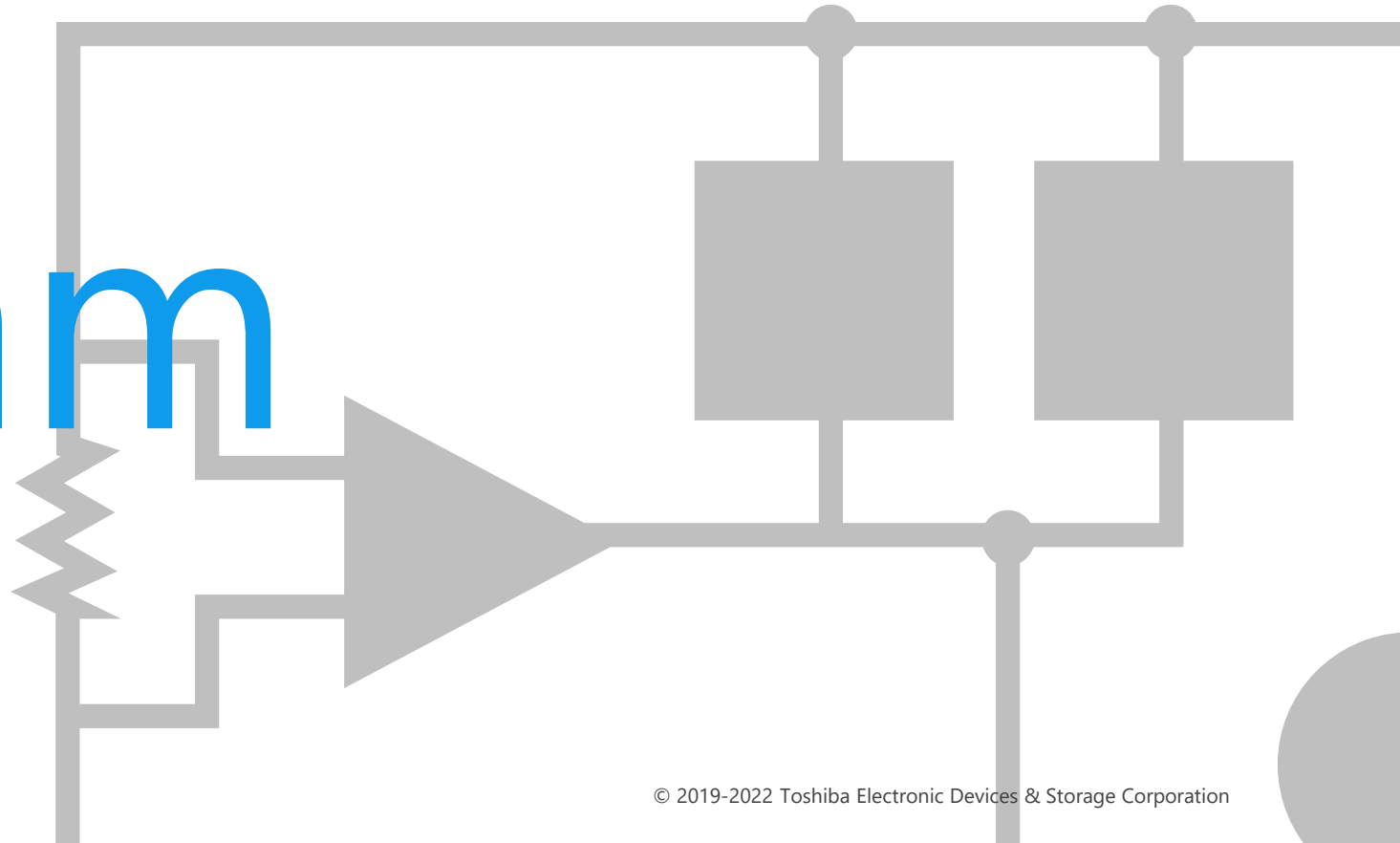
Solution Proposal by Toshiba



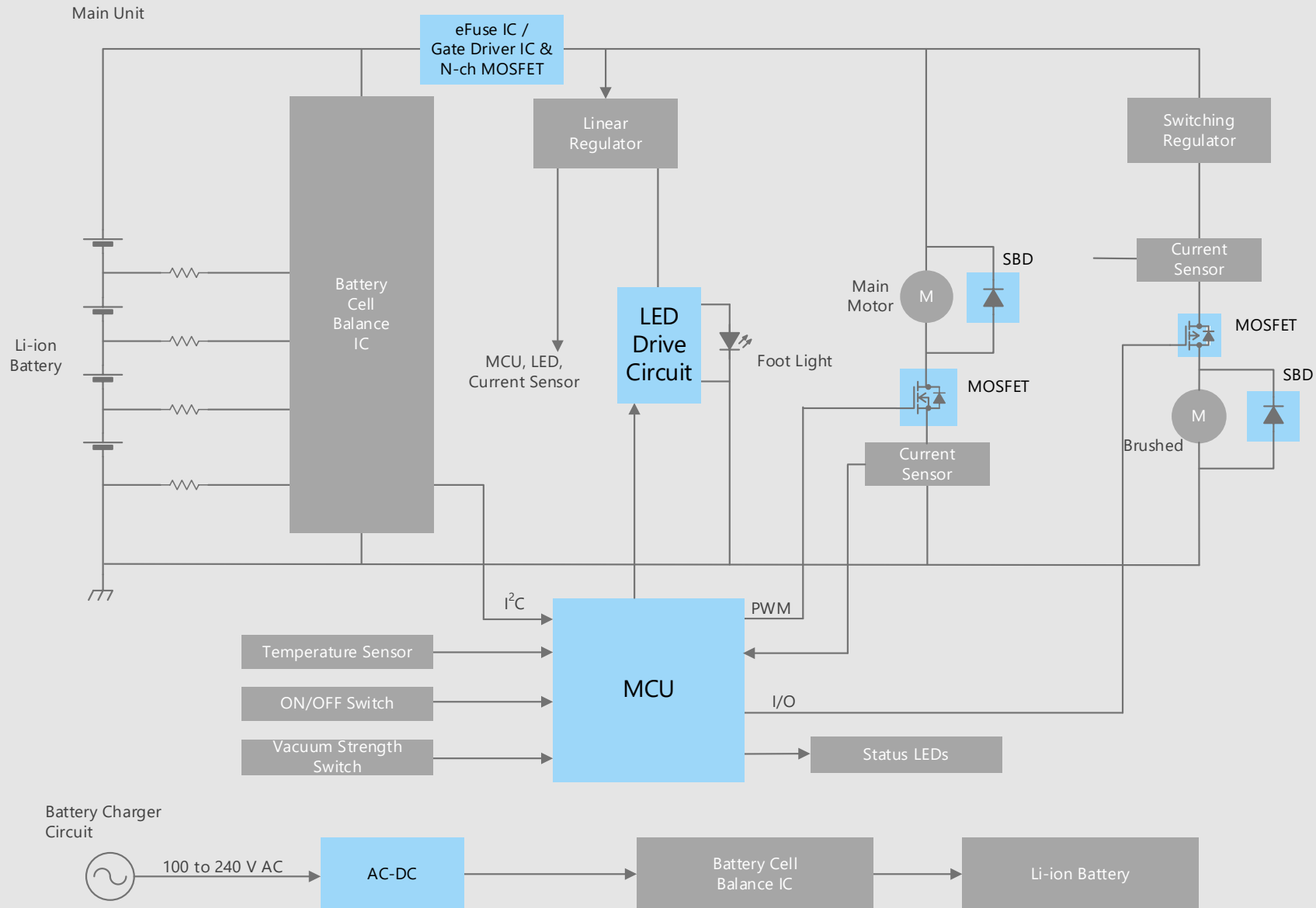


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram



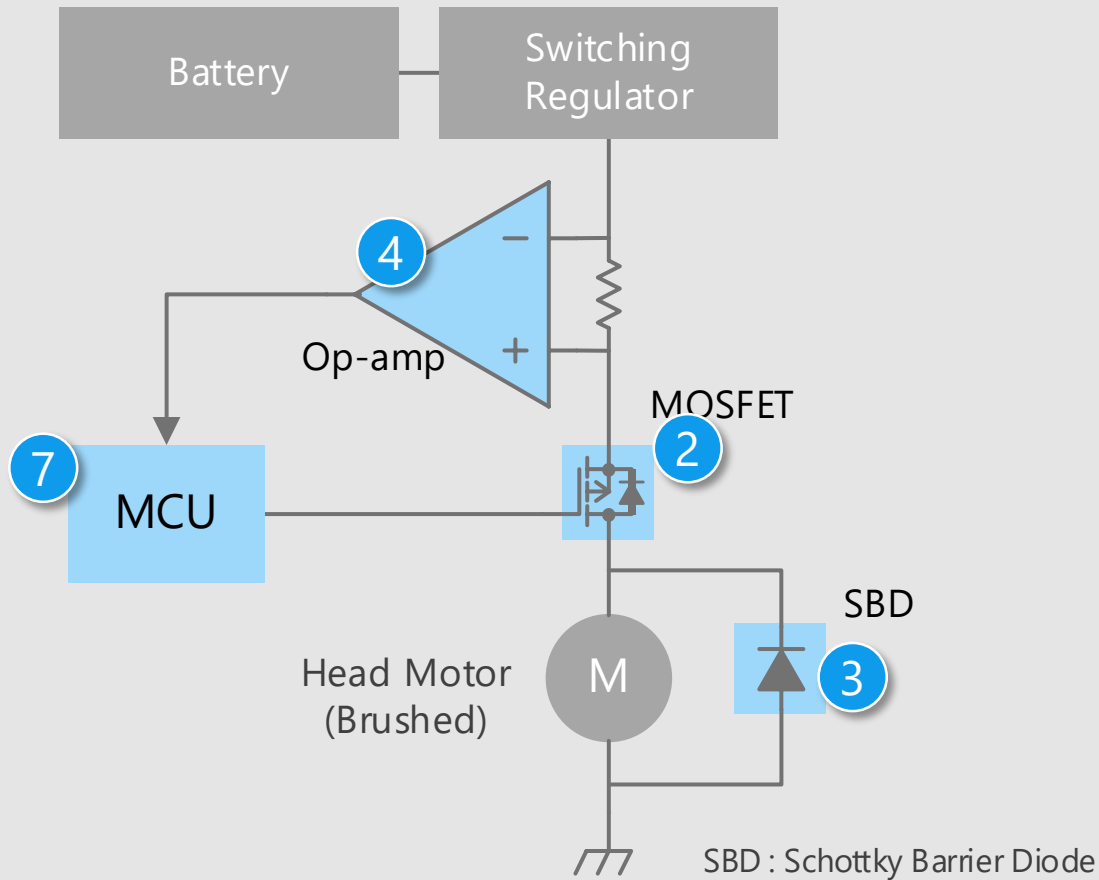
Cordless Cleaner Overall block diagram



Cordless Cleaner Detail of motor drive circuit (2)

Head motor drive circuit

Brushed DC motor



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

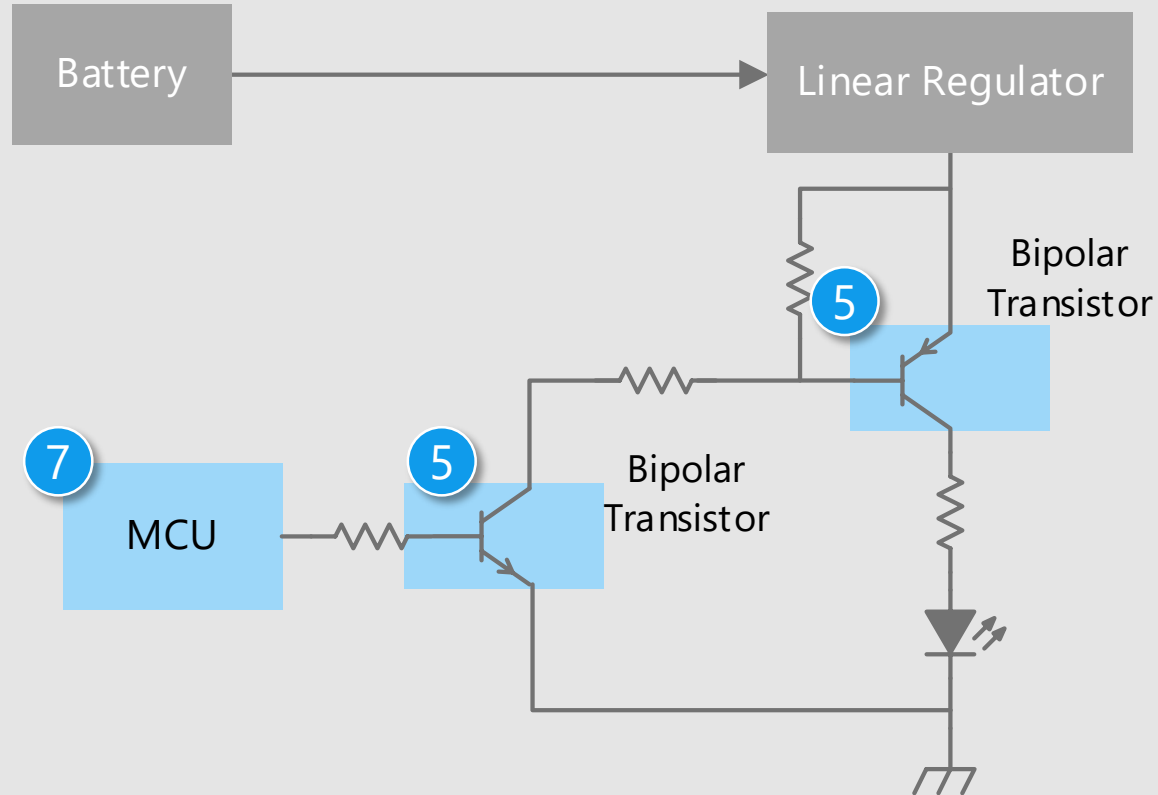
Criteria for device selection

- Motor loss can be reduced by using small package products with good heat dissipation and high speed switching.
- Small package products contribute to the reduction of circuit board area.
- High precision current detection is possible by an operational amplifier with small input offset voltage.

Proposal from Toshiba

- **Realize the set with low power consumption by low on-resistance** (2)
U-MOS Series P-ch MOSFET
- **Strong against surge current** (3)
Schottky barrier diode
- **Realize low voltage drive and low current consumption by built-in phase compensation circuit** (4)
CMOS operational amplifier
- **Built-in ADCs, timers and 3-phase PWM output. Execute system control with low power consumption** (7)
MCU

LED drive circuit for lighting



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

Criteria for device selection

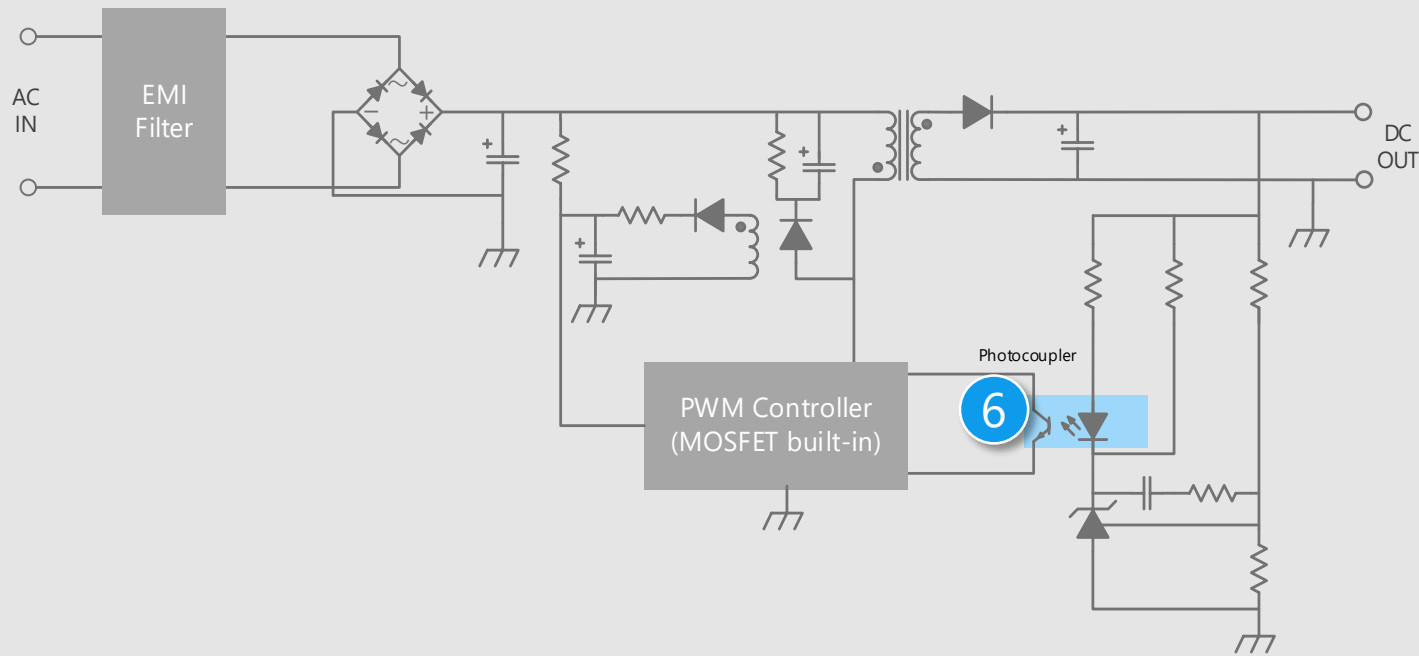
- Transistors with small package and low collector-emitter saturation voltage are required.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **High voltage and high h_{FE}**
Small surface mount bipolar transistor (5)
- **Built-in ADCs, timers and-3-phase PWM output. Execute system control with low power consumption**
MCU (7)

Cordless Cleaner Detail of power supply line

Flyback AC-DC circuits



Criteria for device selection

- Contribute to high power supply efficiency by using photocouplers with high current transfer ratio even in the low input current range.
- Small package products contribute to the reduction of circuit board area.

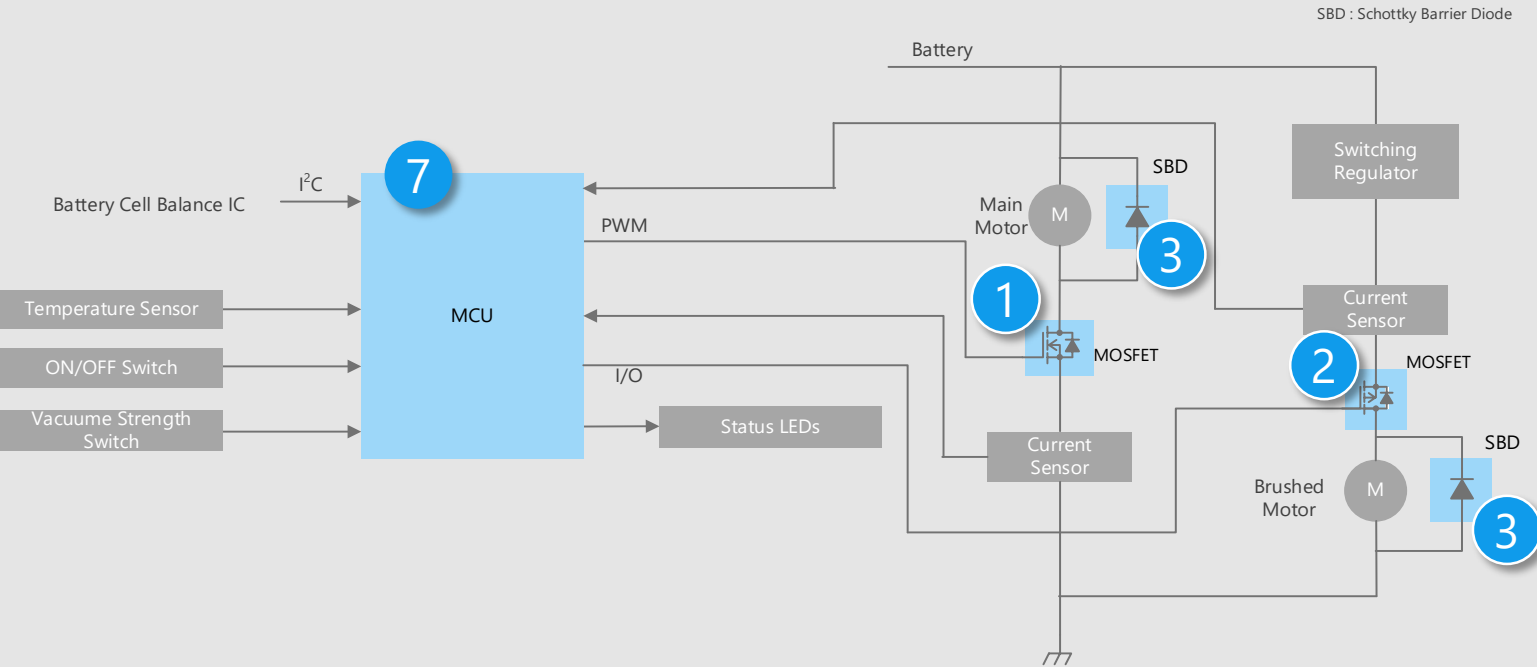
Proposal from Toshiba

- **Photocoupler with excellent environmental resistance**
Transistor output photocoupler

6

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

Main control circuit



Criteria for device selection

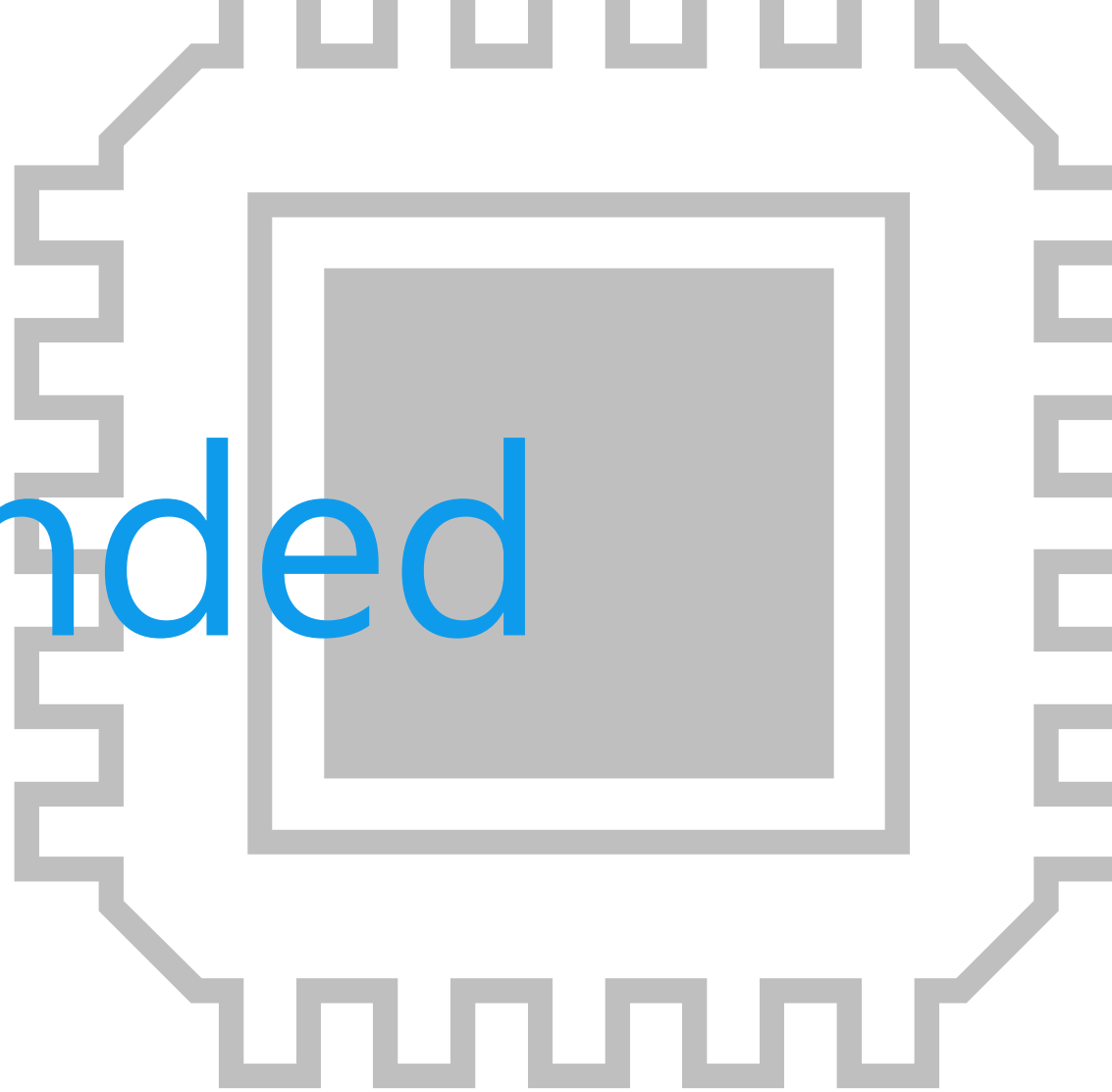
- Motor loss can be reduced by using small package products with good heat dissipation and high speed switching.
- Small package products contribute to the reduction of circuit board area.
- An MCU is required to control motors in main and brush parts at the same time.
- For system control, an MCU with monitoring various sensors such as current, temperature and light is required.

Proposal from Toshiba

- **Realize low power consumption by low on-resistance**
U-MOS Series N-ch MOSFET
U-MOS Series P-ch MOSFET
- **Strong against surge current**
Schottky barrier diode
- **Built-in ADCs, timers and 3-phase PWM output. Execute system control with low power consumption**
MCU

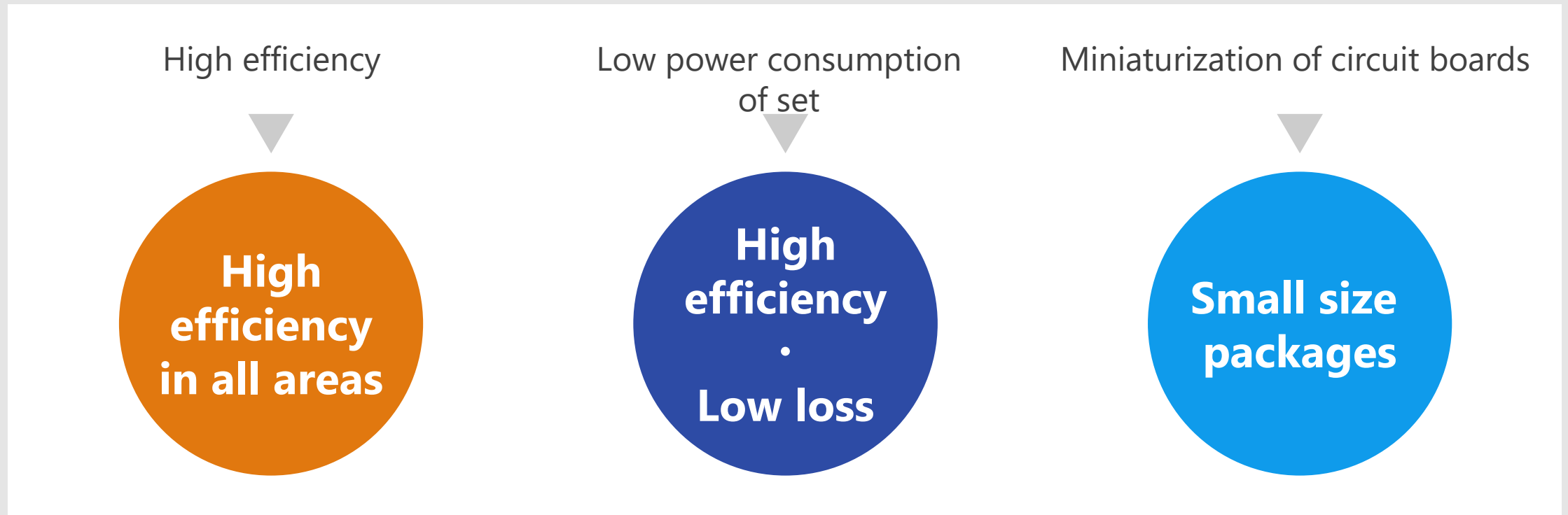
※ Click on the number in the circuit diagram to jump to the detailed description page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of cordless cleaner, “**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

High efficiency
in all areas

High efficiency
·
Low loss

Small size
packages

① U-MOS Series N-ch MOSFET



② U-MOS Series P-ch MOSFET



③ Schottky barrier diode



④ CMOS operational amplifier



⑤ Small surface mount bipolar transistor



⑥ Transistor output photocoupler



⑦ MCU



⑧ Electronic fuse (eFuse IC)



⑨ N-ch MOSFET gate driver IC



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

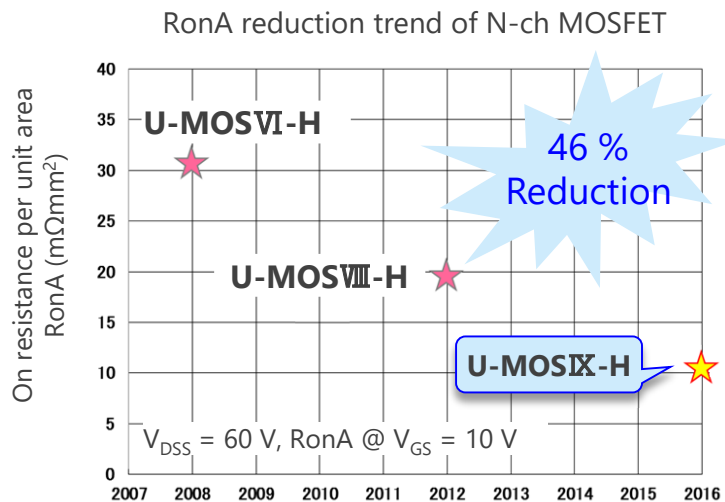
By reducing on-resistance between drain and source, heat generation and power consumption can be kept low, and it can contribute to miniaturization.

2 Small total gate charge

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	TPH7R006PL	TPH4R008QM	TPH2R408QM	TPN7R006PL	TPN8R408QM	TK5R1P08QM	TK6R9P08QM
Package	SOP Advance	SOP Advance(N)		TSOP Advance		PAK	
V _{DSS} [V]	60	80	80	60	80	80	80
I _D [A]	60 (79*)	86 (140*)	120 (200*)	54 (76*)	32 (77*)	84 (105*)	62 (83*)
R _{DS(ON)} [mΩ] @ V _{GS} = 10 V	Typ. 5.4 Max 7.0	Typ. 3.1 Max 4	Typ. 1.9 Max 2.43	Typ. 5.4 Max 7.0	Typ. 6.5 Max 8.4	Typ. 4.2 Max 5.1	Typ. 5.5 Max 6.9
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	U-MOSIX-H	U-MOSX-H	U-MOSX-H	U-MOSIX-H	U-MOSX-H	U-MOSX-H	U-MOSX-H

* : Silicon limit

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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.

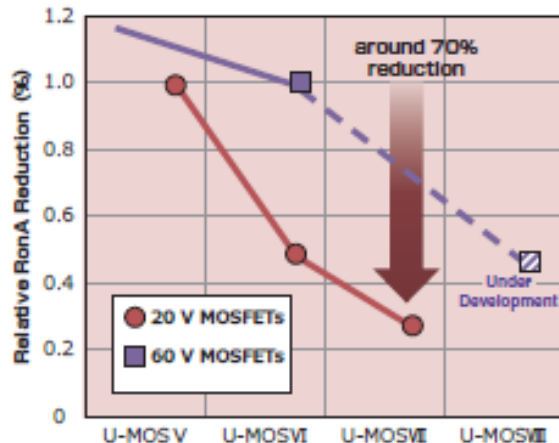
1 Low on-resistance

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


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

RonA reduction trend of P-ch MOSFET



(Note: Toshiba internal comparison)

Lineup

Part number	TPCA8120	
Package	SOP Advance 	
V_{DS} [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	

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Value provided

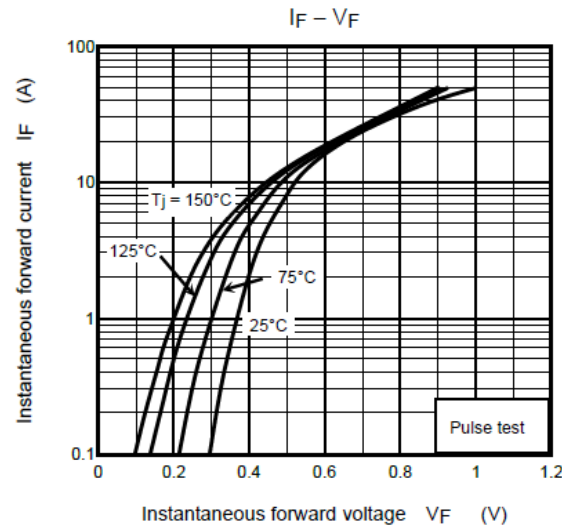
We are expanding lineup of small packages that are suitable for high density mounting.

1 Small surface mount package

Adopting M-FLAT™ package, contribute lower height and space saving of equipment compared with Toshiba conventional lead type.



2 Extensive product lineup

Extensive product lineup
Reverse voltage : up to 60 V /
Average forward current : up to 5 A
It is possible to choose suitable product according to specification of set.



CMS05
Forward characteristic

Lineup

Part number	CMS05	CMS15
Package	M-FLAT™ 	M-FLAT™ 
$I_{F(AV)}$ [A]	5	3
V_{RRM} [V]	30	60
V_{FM} (Typ.) [V]	0.43	0.55

[Return to Block Diagram TOP](#)

Value provided

Low voltage driving and low current consumption compared with bipolar type, contributing to the degree of freedom and low loss in device design.

1 Low voltage operation

CMOS processes enable low voltage operation compared to Toshiba bipolar operational amplifier.

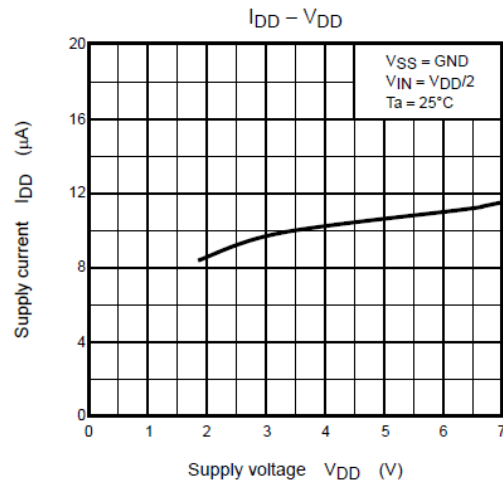
2 Low current consumption

Low current consumption characteristics of CMOS processes contribute to extending the battery life of small IoT equipment.

Note: Comparison with Toshiba's bipolar process operational amplifier



3 Built-in phase compensation circuit

Eliminating the need for external components, CMOS operational amplifier contributes to reduction in the number of parts and size of equipment.



TC75S55F
 $I_{DD} = 10 \mu\text{A}$ (Typ.)
 @ $V_{DD} = 3 \text{V}$

Low current consumption design compared with bipolar operational amplifier
 (Supply current of Toshiba's bipolar process products : $I_{CC} = 400 \mu\text{A}$ (Typ.))

Lineup		
Part number	TC75S55F	TC75S55FU
Package	SMV 	USV 
V_{DD} [V]	1.8 to 7 ± 0.9 to ± 3.5	1.8 to 7 ± 0.9 to ± 3.5
I_{DD} (Typ.) [μ A]	10	10
f_T (Typ.) [MHz]	0.16	0.16

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5 Small surface mount 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 product that suit customer's circuit board.

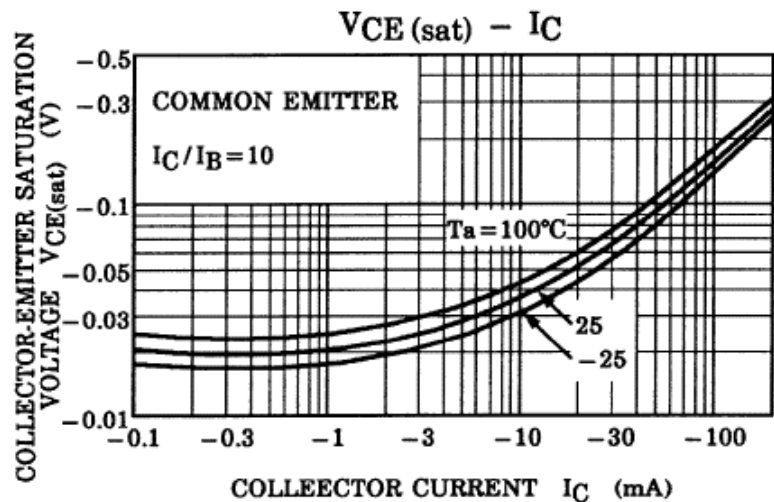
2 Low collector-emitter saturation voltage

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

3 High ESD resistance

In applications where static electricity is easily generated, such as in vacuum cleaners, bipolar transistors with higher ESD resistance than MOSFET^[Note] are helpful.

[Note] Comparison with Toshiba products



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

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Value provided

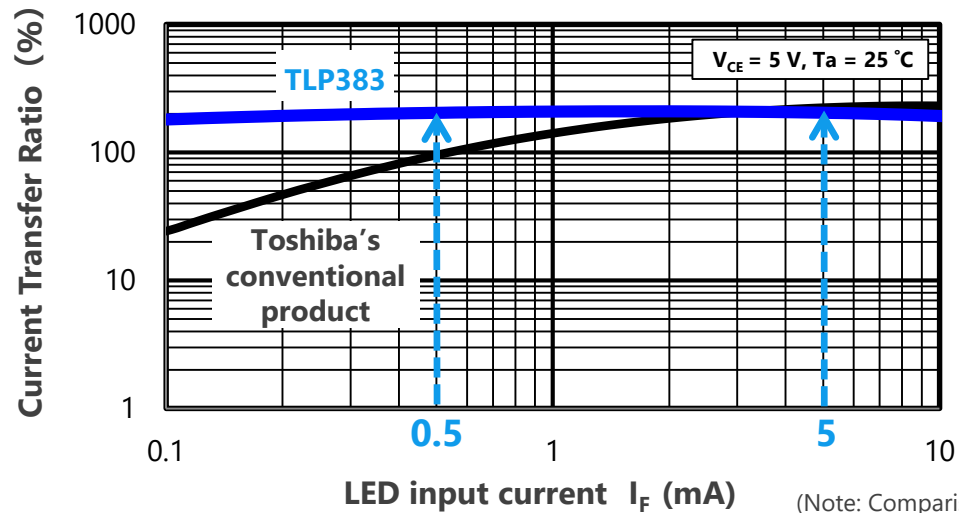
High current transfer ratio is realized even in the low input current range ($I_F=0.5$ mA).


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.



Part number		TLP383
Package		4pin SO6L 
I_C/I_F [%]	@ $I_F = 0.5$ mA, $V_{CE} = 5$ V	50 to 600
	@ $I_F = 5$ mA, $V_{CE} = 5$ V	
t_{off} (Typ.) [μ s] @ $I_F = 1.6$ mA		28
BV_S [Vrms]		5000
T_{opr} [$^\circ$ C]		-55 to 125

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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.

2 Equipped with motor control logic circuit

Versatile three-phase PWM^[Note] output and sensing timing make both high efficiency and low noise possible. The advanced encoder reduces CPU load of each PWM processing.

3 Equipped with analog circuit for motor control

Multiple high speed and high accuracy AD converters (ADCs) are integrated, allowing conversion timing and PWM output to be linked. External functions such as high performance operational amplifier are integrated on-chip.

[Note] Pulse Width Modulation

	TX ファミリー	TXZ+™ ファミリー アドバンスクラス	
Arm® Cortex®-M4 FPU機能搭載 ~200 MHz	TX04 シリーズ M470 M460 M440	TXZ+™4A シリーズ M4K M4M M4G M4N	モーター制御
Arm® Cortex®-M3 ~120 MHz	TX03 シリーズ M380 M370 M330 M360 M340	TXZ+™3A シリーズ M3H	コミュニケーション & データプロセッシング
Arm® Cortex®-M0 ~24 MHz	TX00 シリーズ M060 M030		スタンダード
Toshiba Core 8bit ~16 MHz	TLCS-870/C1 TLCS-870/C1E シリーズ 8bit		その他

Lineup		
Series	Group	Function
TX03 Series	M370 Group	Arm® Cortex® -M3, includes 1 st gen VE
TX04 Series	M470 Group	Arm® Cortex® -M4, includes 3 rd gen VE
TXZ+™4A Series	M4K Group	Arm® Cortex® -M4, includes 4 th gen VE

[◆Return to Block Diagram TOP](#)

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

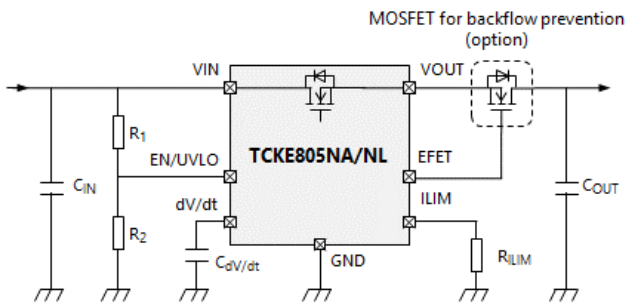
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

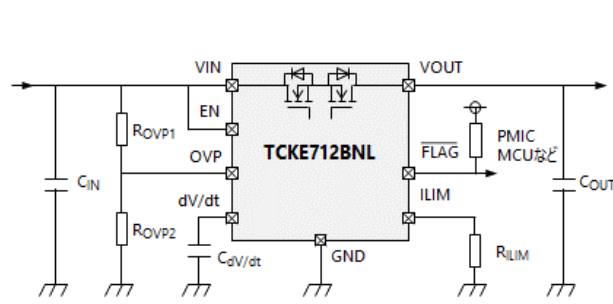
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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 /TCKE800NL	TCKE805NA /TCKE805NL	TCKE812NA /TCKE812NL	TCKE712BNL
Package	WSO10B 3.0 x 3.0 x 0.75 mm			WSO10 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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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 3 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 24 V power supply line.

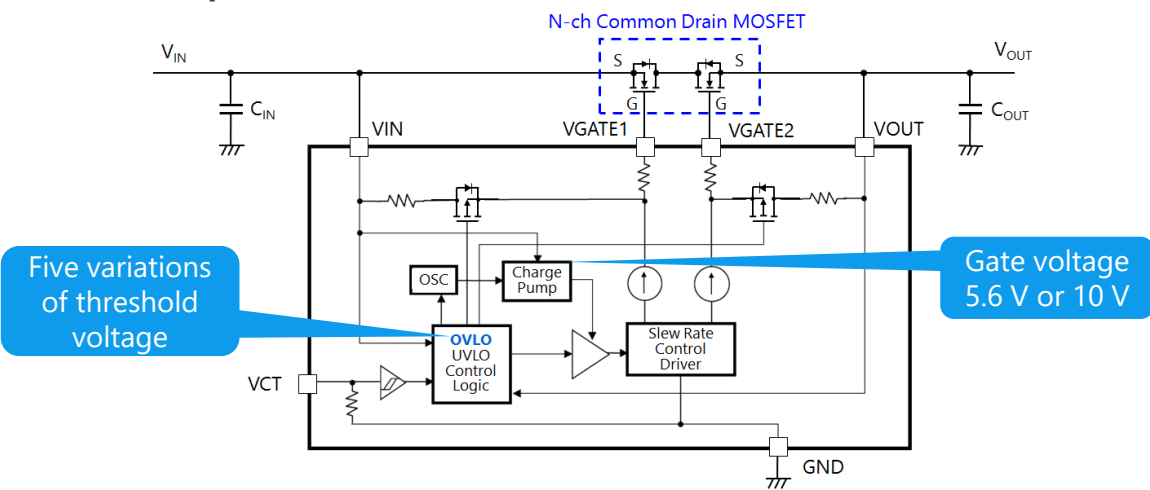
[Note 2] OVLO : Over Voltage Lock Out
[Note 3] V_{IN_OVLO} : V_{IN} OVLO threshold



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 ($V_{IN} \geq 12$ V)	Single high side	WCSP6E 
TCK402G			Common Source	
TCK420G	26.50 / 28.50	10 / 11 ($V_{IN} \geq 5$ 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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