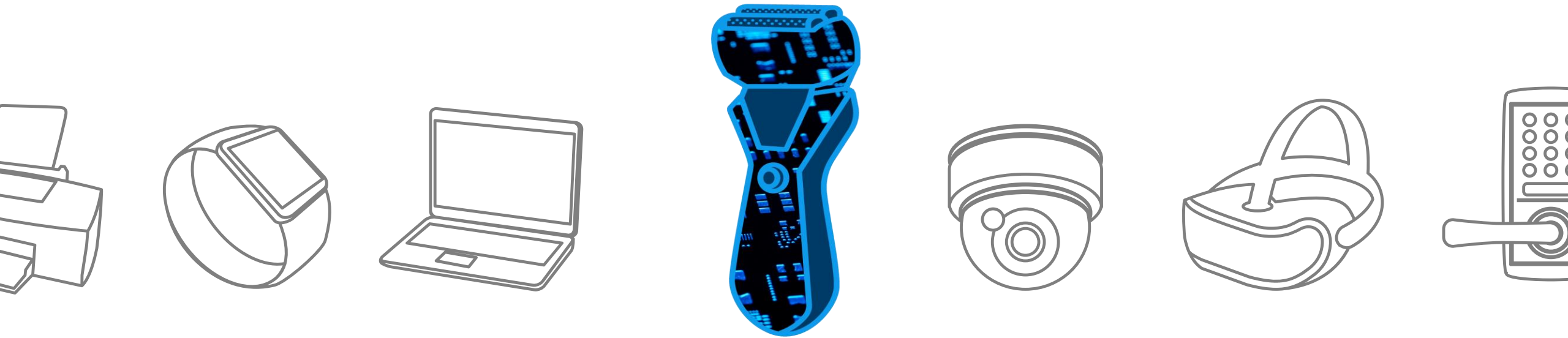
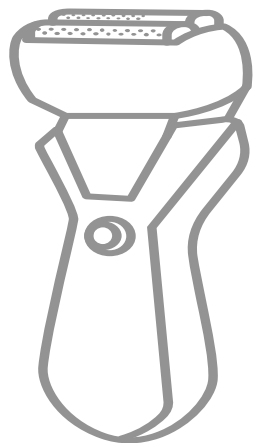
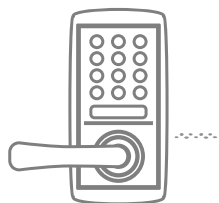


Electric Shaver

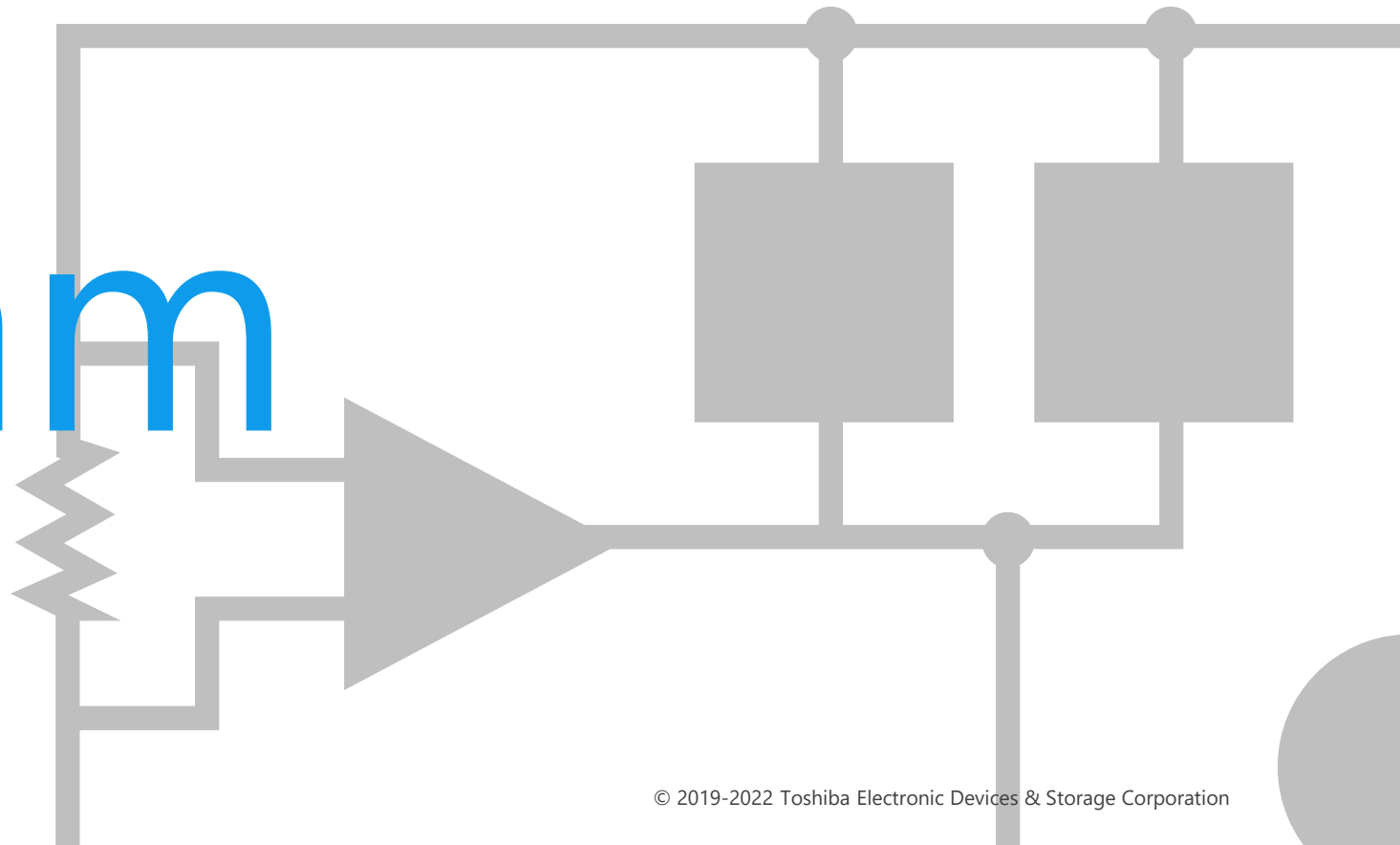
Solution Proposal by Toshiba



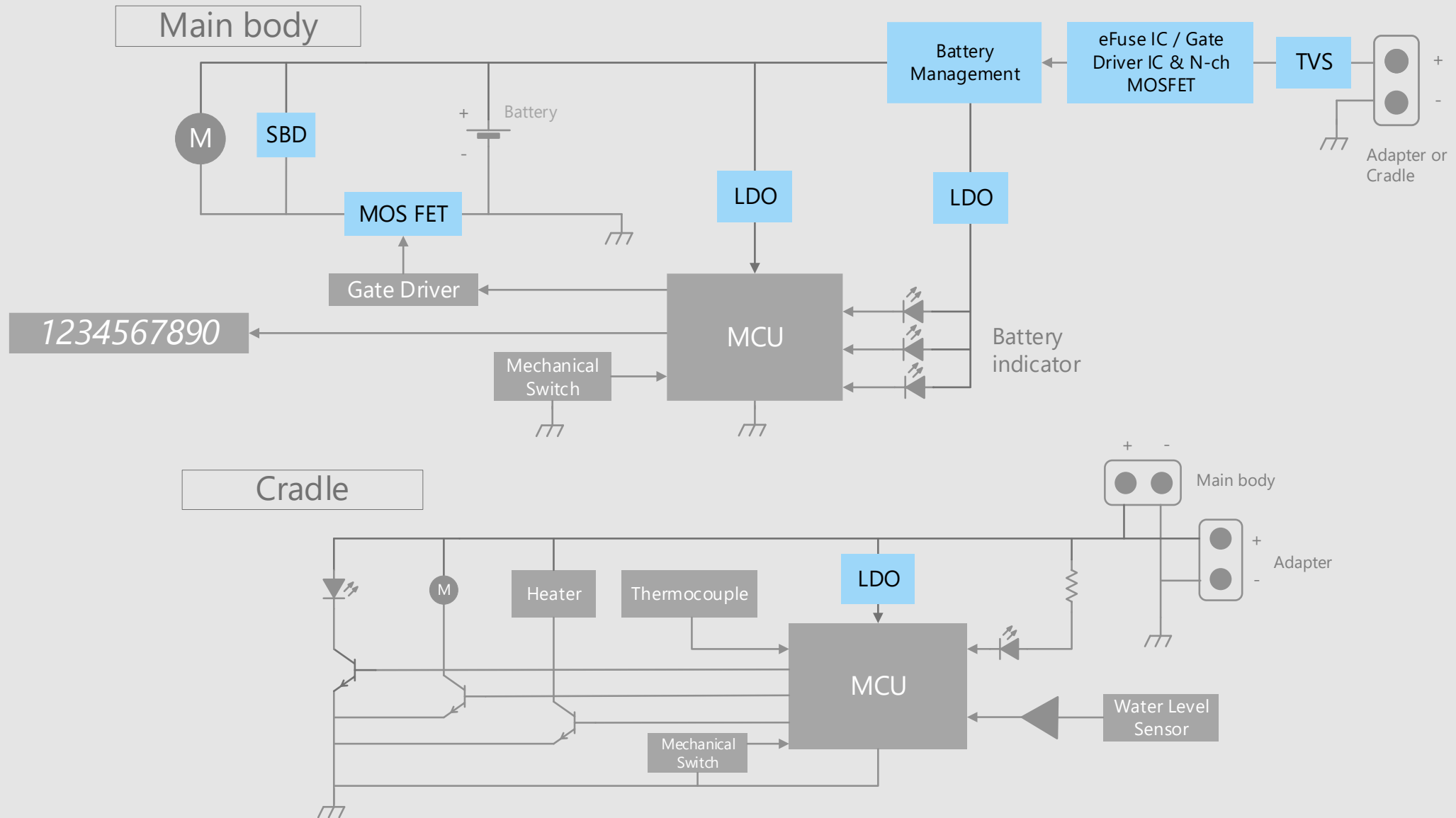


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

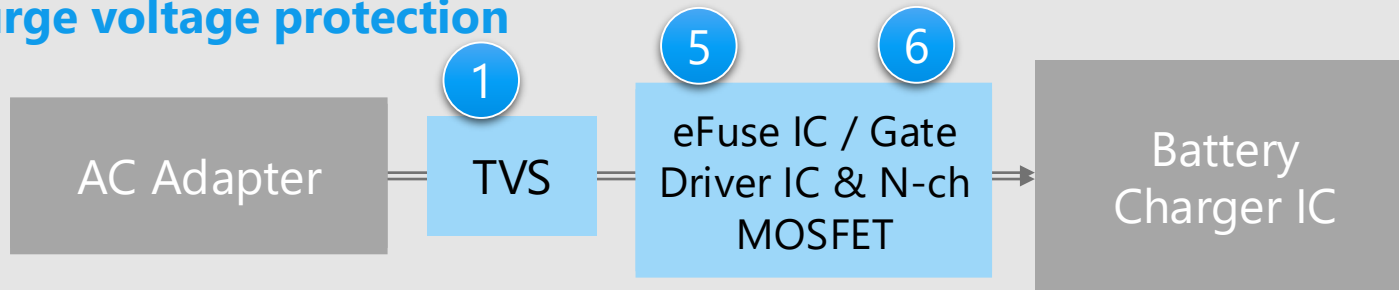


Electric Shaver Overall block diagram

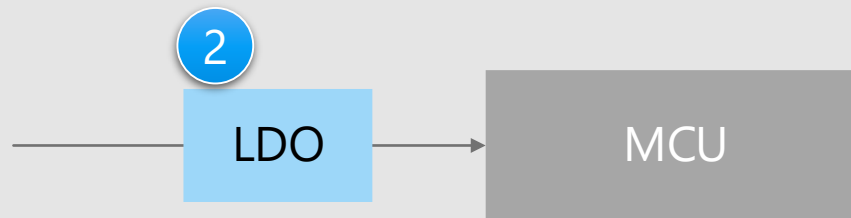


Electric Shaver Detail of power supply line

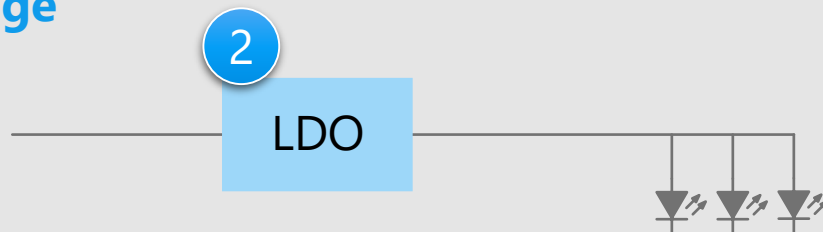
Surge voltage protection



Control MCU power supply



Constant voltage supply circuit



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

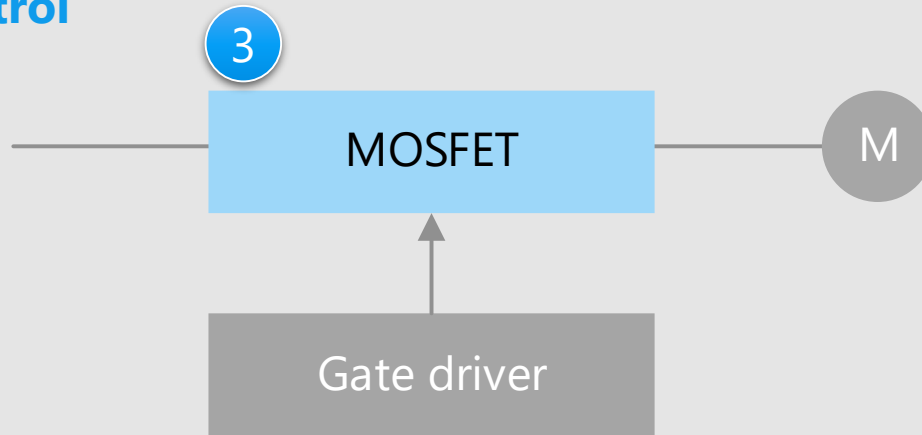
Criteria for device selection

- ESD protection is required for the power line when the AC adapter is not connected.
- LDO regulators are suitable for supplying stable voltage.
- eFuse ICs with various protection functions are suitable for stable operation of the set.

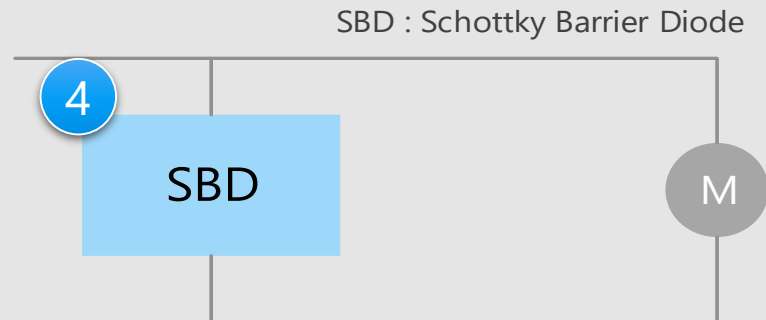
Proposals from Toshiba

- **Static electricity (ESD) from external terminals is absorbed to prevent circuit malfunction and device breakdown.** 1
TVS diode
- **Stable voltage supply** 2
Small surface mount LDO regulator
- **Built-in protection function against short circuit, over current, over voltage, etc.** 5
Electronic fuse (eFuse IC)
- **Small package and built-in over voltage protection function** 6
N-ch MOSFET gate driver IC

Motor control



Motor protection



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

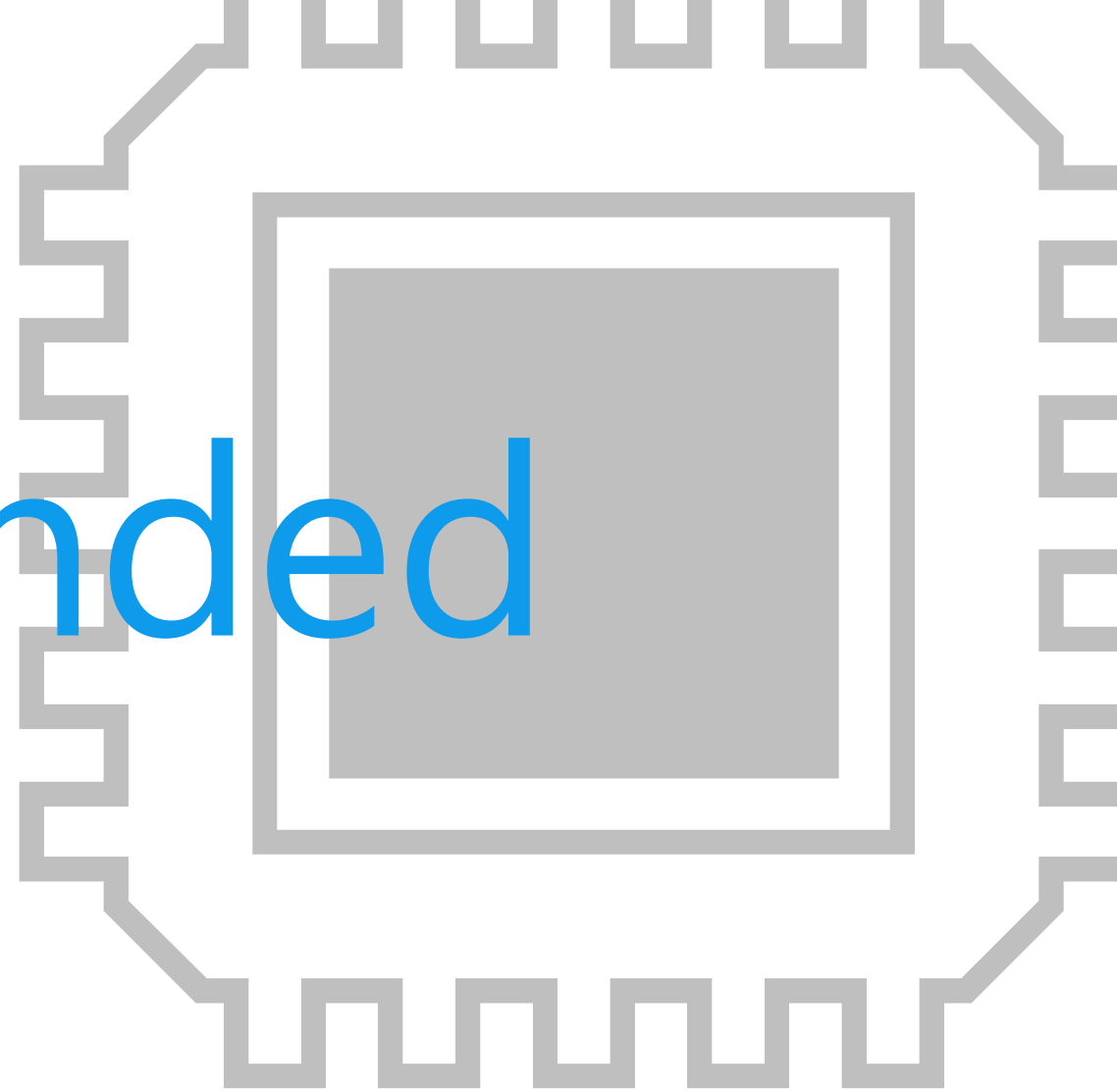
Criteria for device selection

- MOSFET with small package and low $R_{DS(ON)}$ is used to control the motors.
- Protection against regenerative current by the motor is necessary.

Proposals from Toshiba

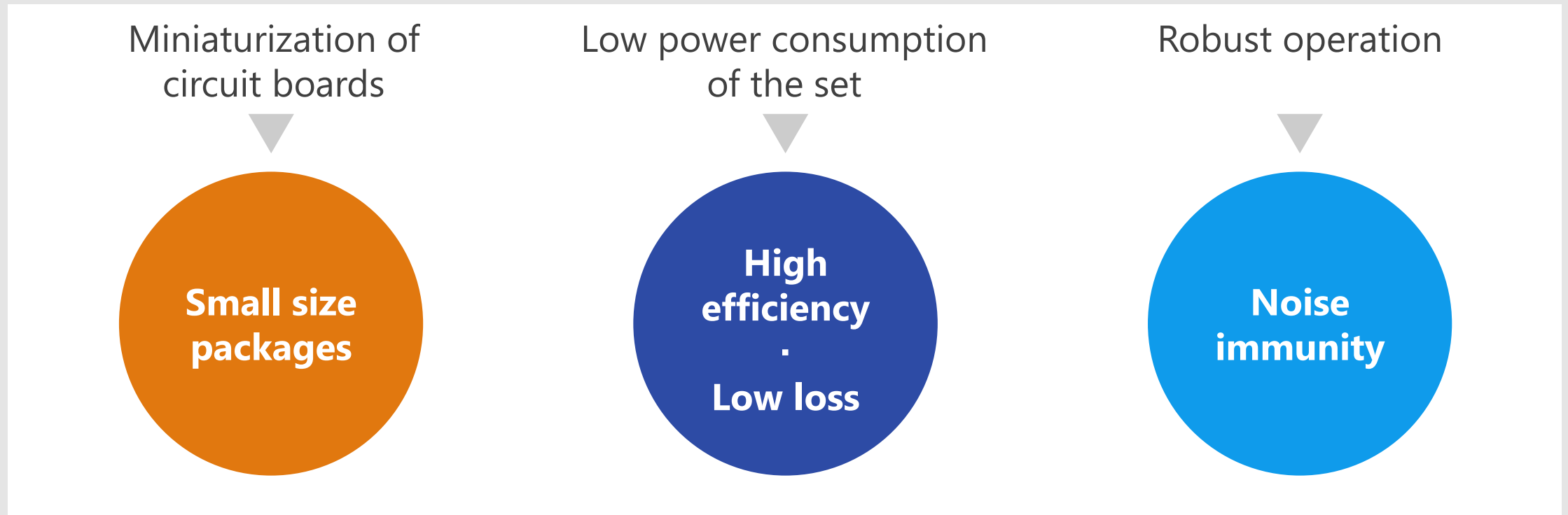
- **Realize a set with low power consumption by low on-resistance**
Small signal MOSFET 3
- **Low forward voltage / Strong against surge current**
Schottky barrier diode 4

Recommended Devices



Device solutions to address customer needs

As described above, in the design of electric shaver, “**Miniaturization of circuit boards**”, “**Low power consumption of the set**” and “**Robust operation**” are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs

Small size packages

High efficiency
·
Low loss

Noise immunity

①	TVS diode	●	●	●
②	Small surface mount LDO regulator	●	●	●
③	Small signal MOSFET	●	●	
④	Schottky barrier diode	●	●	●
⑤	Electronic fuse (eFuse IC)	●	●	
⑥	N-ch MOSFET gate driver IC	●	●	

1 TVS diode

DF2B7BSL / DF2B20M4SL / DF2B5PCT / DF2B7PCT / DF2S14P2CTC / DF2B7AFU

Small size packages

High efficiency
Low loss

Noise immunity

Value provided

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

1 Improved ESD pulse absorption

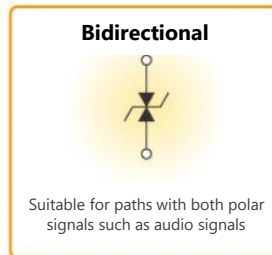
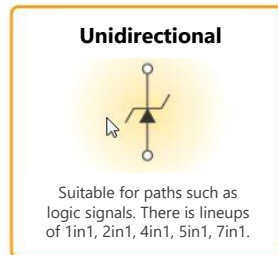
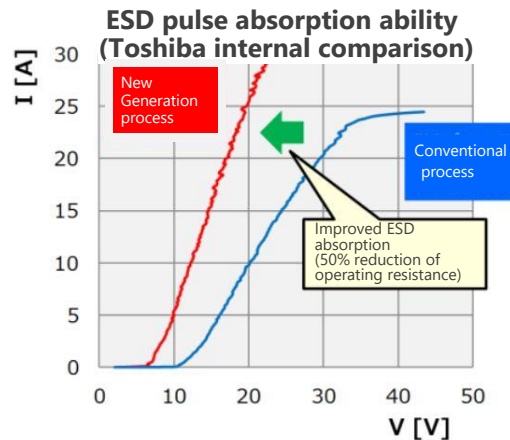
Improved ESD absorption compared to conventional products. (50 % reduction in operating resistance)
For some products, both low operating resistance and low capacitance are realized and ensures high signal protection performance and signal quality.

2 Suppress ESD energy by low clamp voltage





Protect the connected circuits/devices using proprietary technology.

3 Suitable for high-density mounting

A variety of compact packages are available.



Lineup

Part number	DF2B7BSL	DF2B20M4SL	DF2B5PCT	DF2B7PCT	DF2S14P2CTC	DF2B7AFU
Package	SL2 		CST2 		CST2C 	USC 
V_{ESD} [kV]	±30	±15	±30	±30	±30	±30
V_{RWM} (Max) [V]	5.5	18.5	3.6	5.5	12.6	5.5
C_t (Typ.) [pF]	12	0.2	41	45	270	8.5
R_{DYN} (Typ.) [Ω]	0.2	0.2	0.1	0.1	0.08	0.2

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

[Return to Block Diagram TOP](#)

2 Small surface mount LDO regulator

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

Small size packages

High efficiency
Low loss

Noise immunity

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.

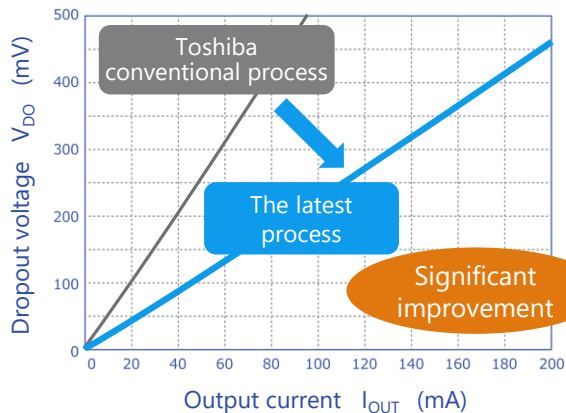
2 High PSRR Low output noise voltage

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

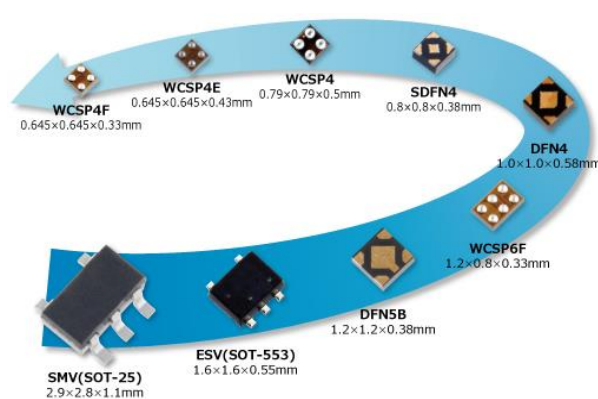
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology. (TCR3U Series)

Low dropout voltage



Note: Toshiba internal comparison

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		15V 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

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Value provided

Suitable for power management switches and greatly contributes to miniaturization.

1 Low voltage drive

It drives at $V_{GS} = 1.5\text{ V}$.

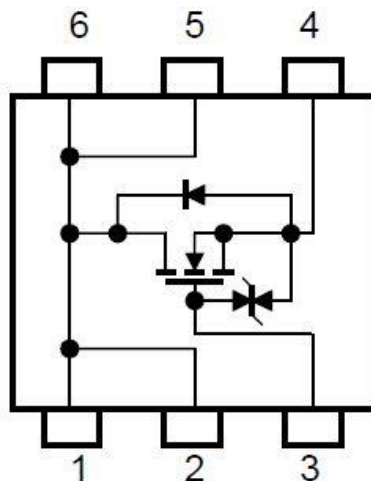
2 Low on-resistance

By reducing on-resistance between the source and drain, heat generation and power consumption can be kept low.


3 Small package

SOT-363F / VESM type packages.

SSM6K403TU
Internal connection



Lineup

Part number	SSM6K403TU	SSM3K35AMFV
Package	SOT-363F 	VESM 
Polarity	N-ch	N-ch
V_{DSS} [V]	20	20
I_D [A]	4.2	0.25
$R_{DS(ON)}$ (Max) [Ω] @ $V_{GS} = 1.5\text{ V}$	0.066	3.1

[◆Return to Block Diagram TOP](#)

Value provided

It can be applied to various applications at low loss, and greatly contributes to miniaturization.

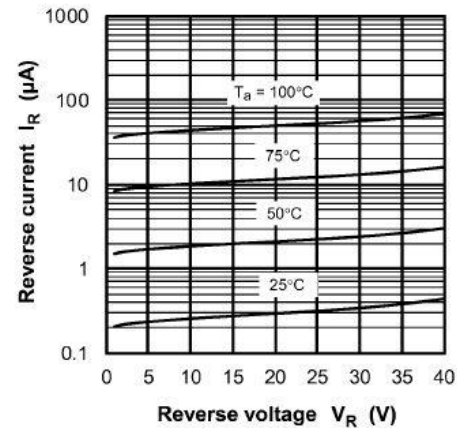
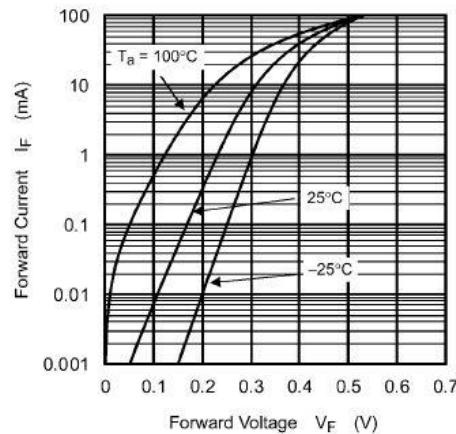
1 Low forward voltage

Since the forward voltage is low, it is suitable for use as a flywheel diode.

2 Small package

It is sealed in a USC package.

CUS357 Characteristics Curves



Lineup

Part number	CUS357
Package	USC 
I_O [A]	0.1
V_R [V]	40
V_F (Typ.) [V] @ $I_F = 100$ mA	0.54

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5 Electronic fuse (eFuse IC)

TCKE8 Series / TCKE7 Series

Small size packages

High efficiency
Low loss

Noise immunity

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 IEC62368-1 certified

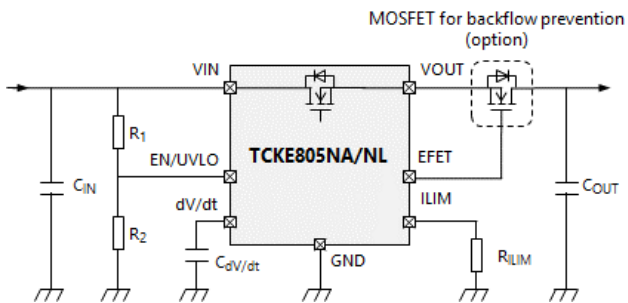
Toshiba's eFuse ICs are certified to the international safety standard IEC62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

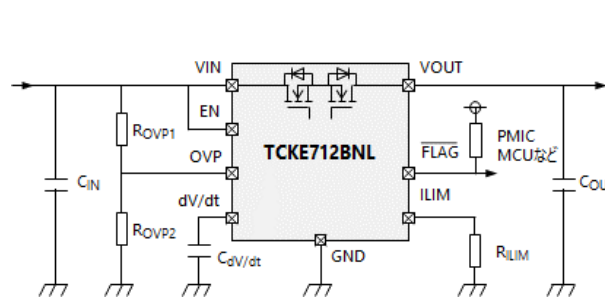
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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	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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6 N-ch MOSFET gate driver IC

TCK4xx Series

Small size packages

High efficiency
Low loss

Noise immunity

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 connection of N-ch MOSFET can be driven

3 types of connection of N-ch 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.

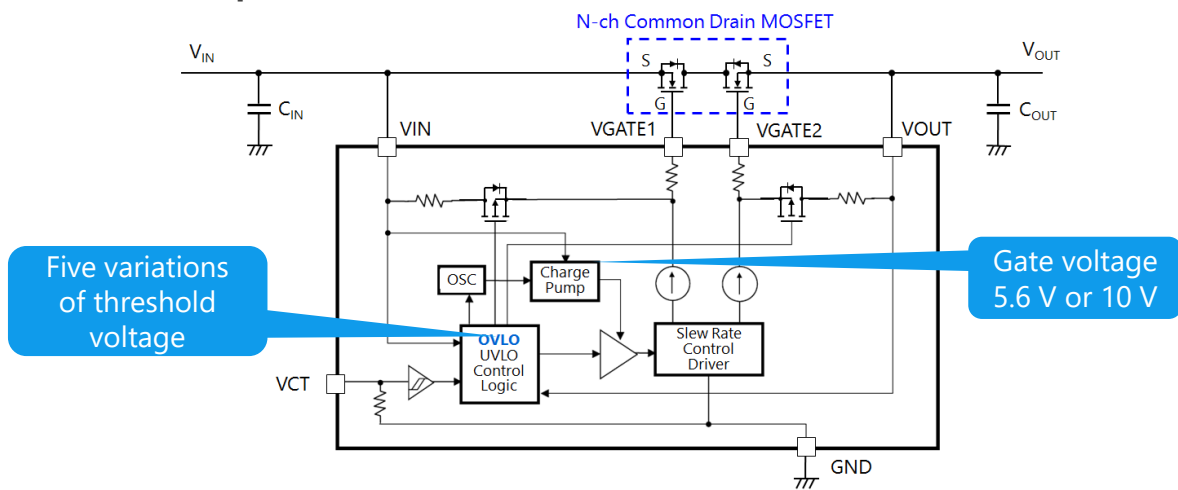
[Note 2] OVLO : Over Voltage Lock Out
 [Note 3] V_{IN_OVLO} : V_{IN} OVLO threshold



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 ($V_{IN} \geq 12$ 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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