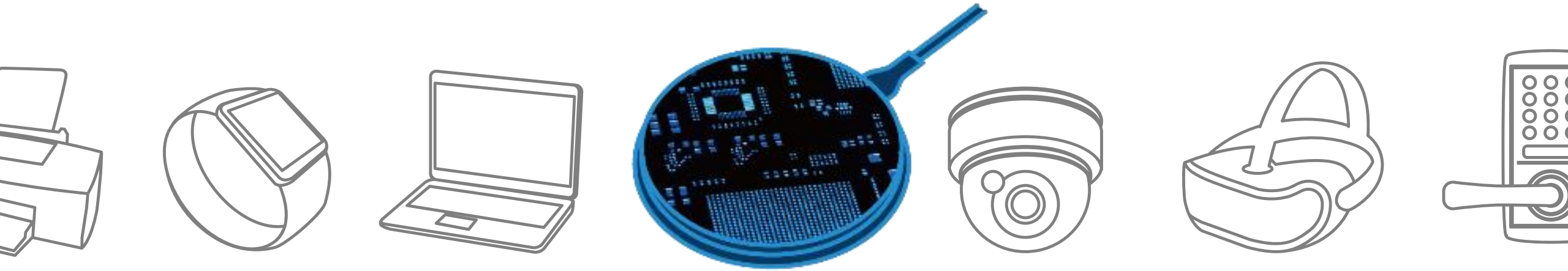
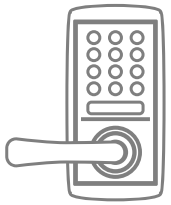
TOSHIBA

R21

Wireless Charger

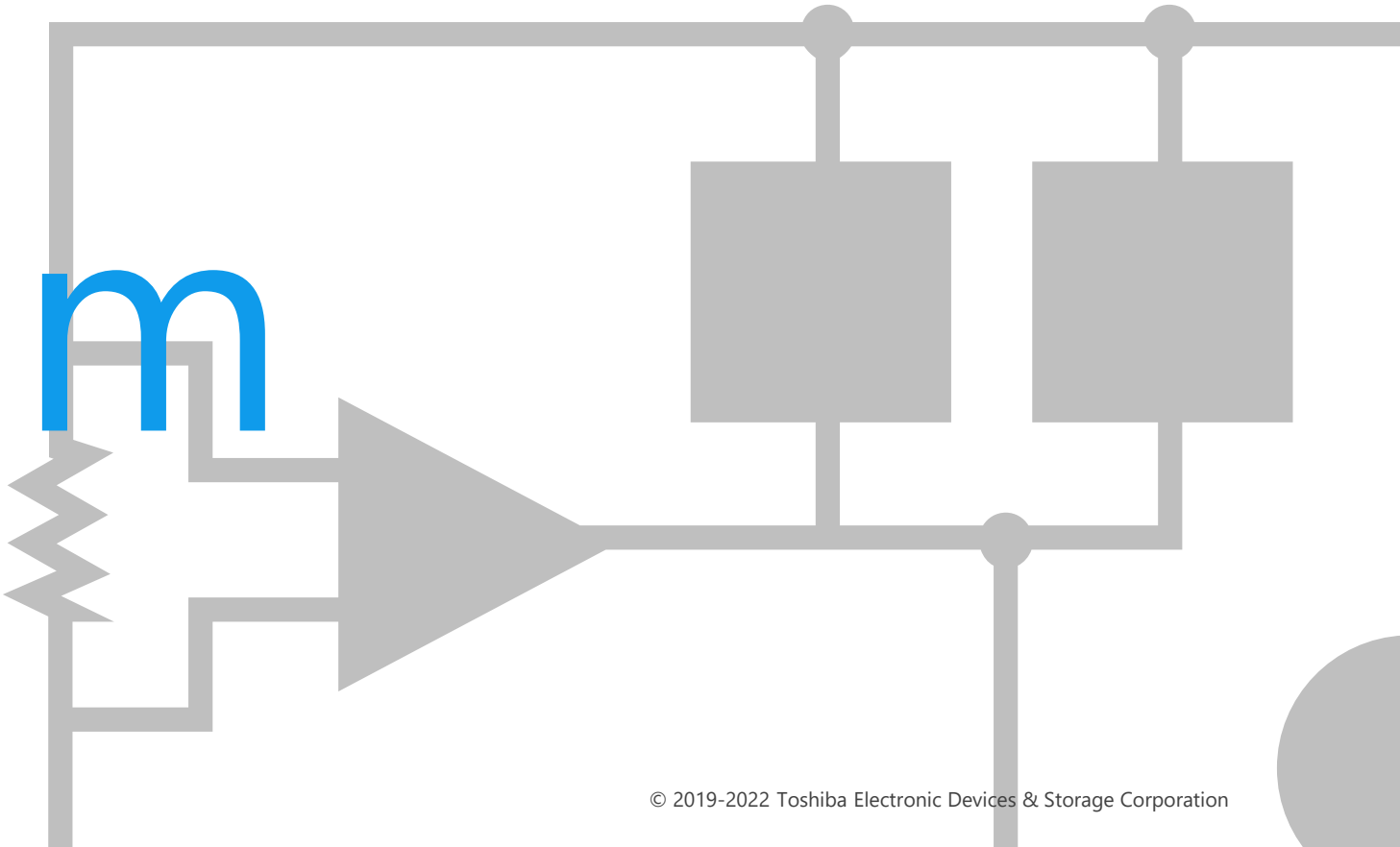
Solution Proposal by Toshiba



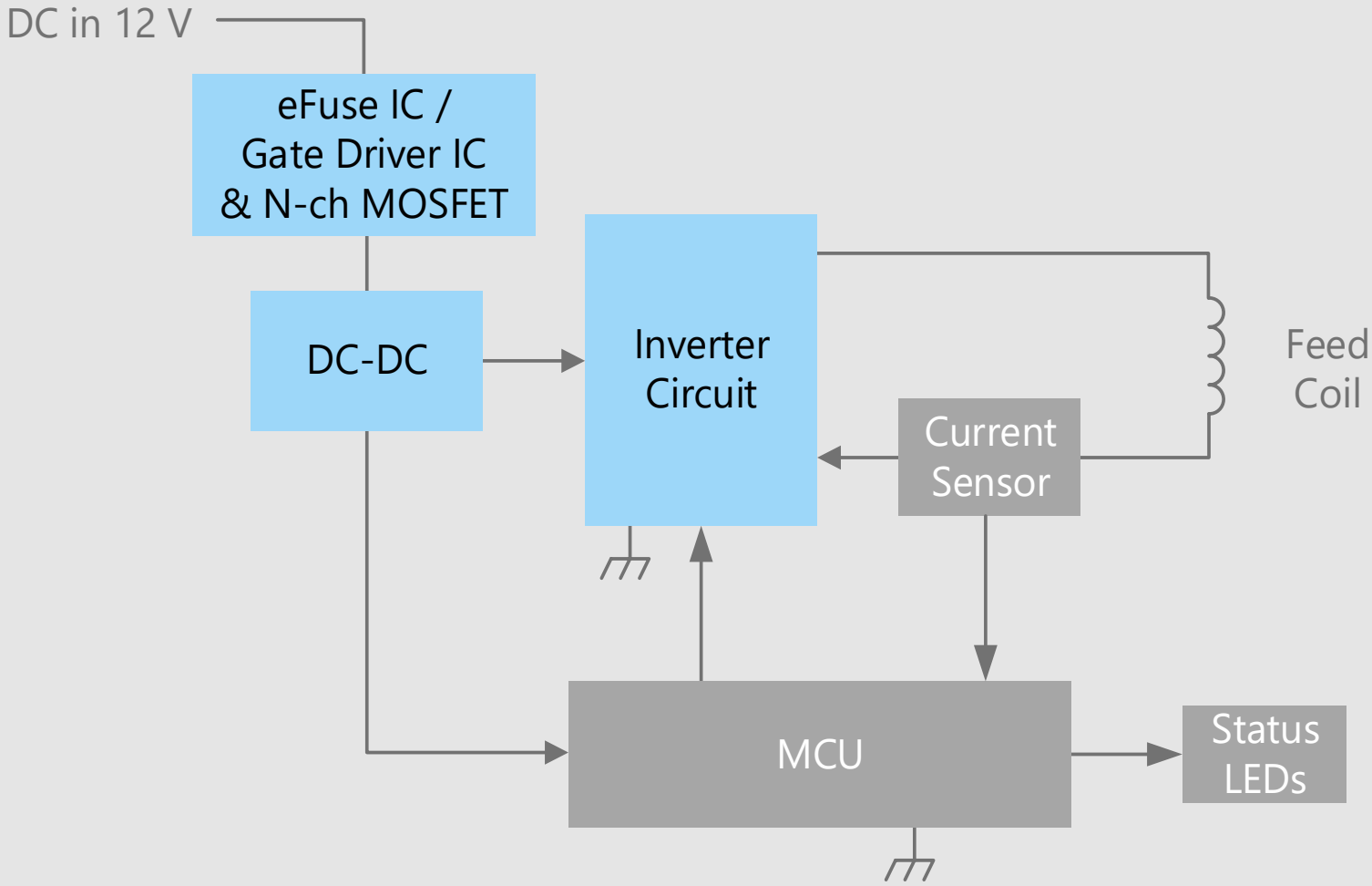


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

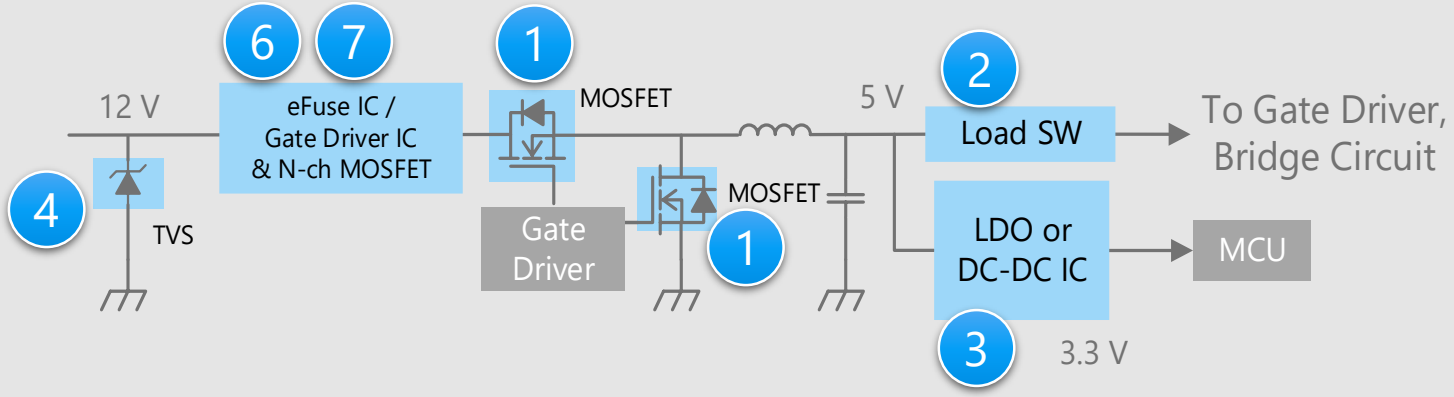


Wireless Charger　Overall block diagram

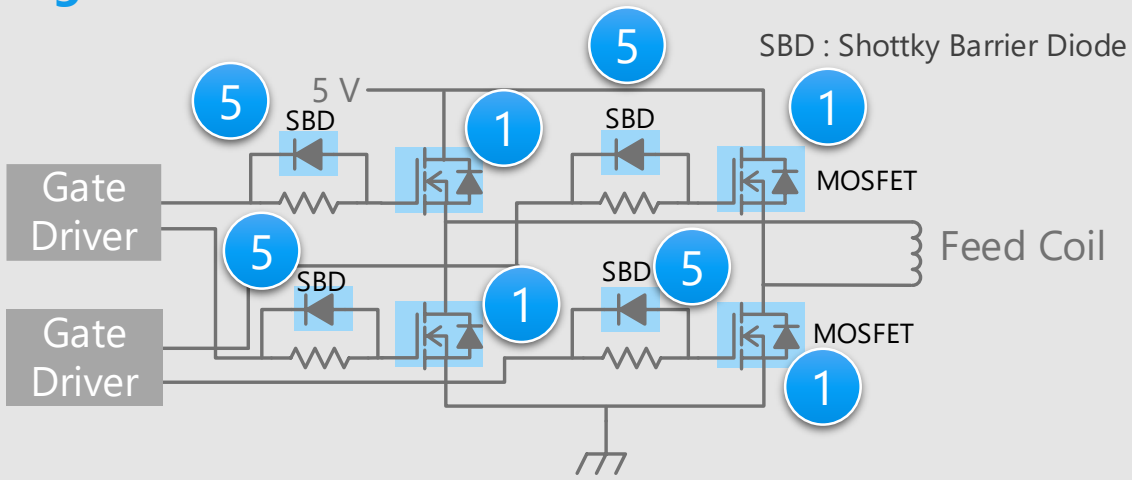


Wireless Charger　Detail of power supply circuit unit

IC-driven DC-DC power supply circuit



Full-bridge inverter circuit



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

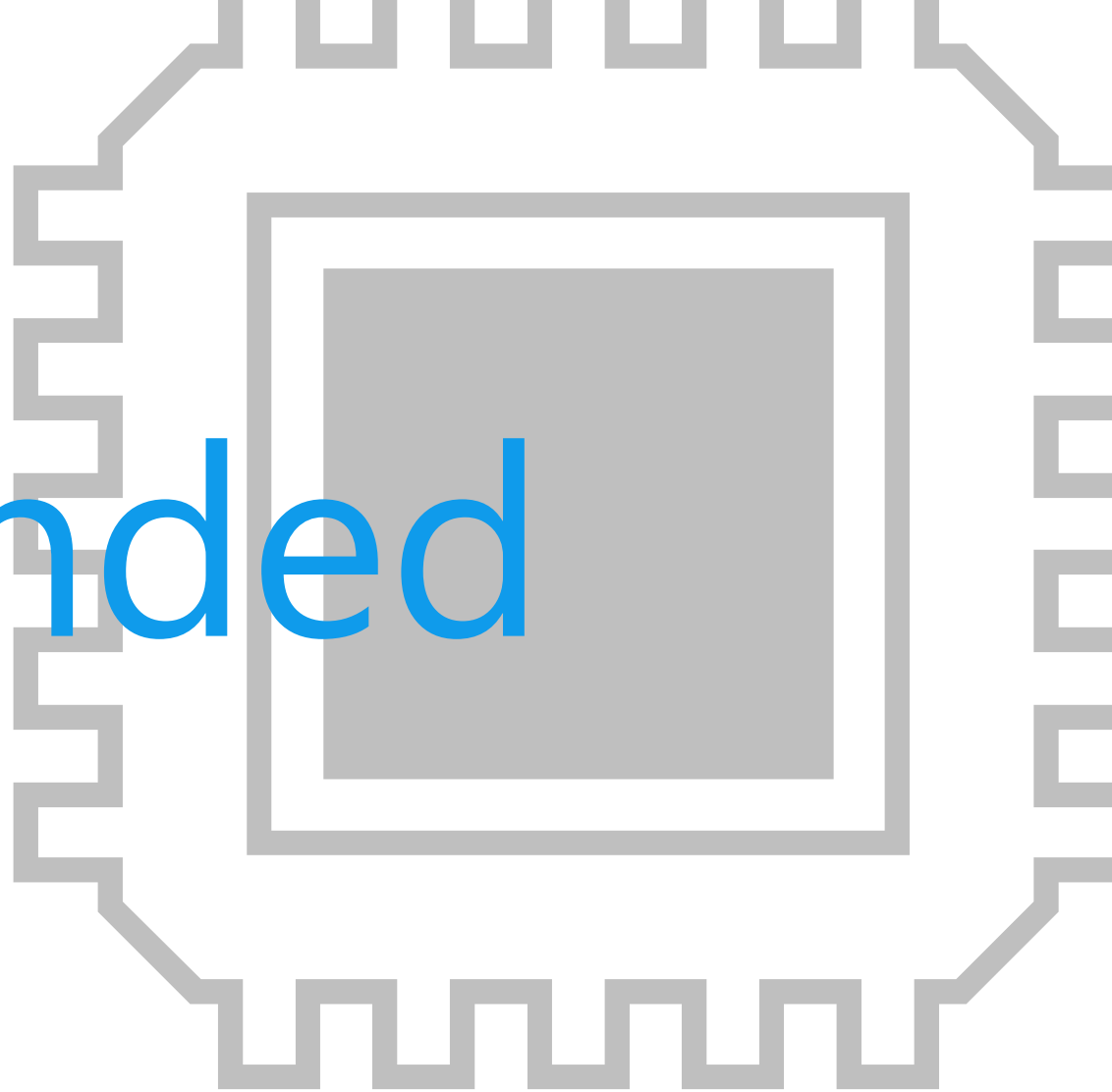
Criteria for device selection

- A high voltage MOSFET is required considering such as counter electromotive force of the feed coil.
- The use of low consumption products can improve the overall efficiency of the system.
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba

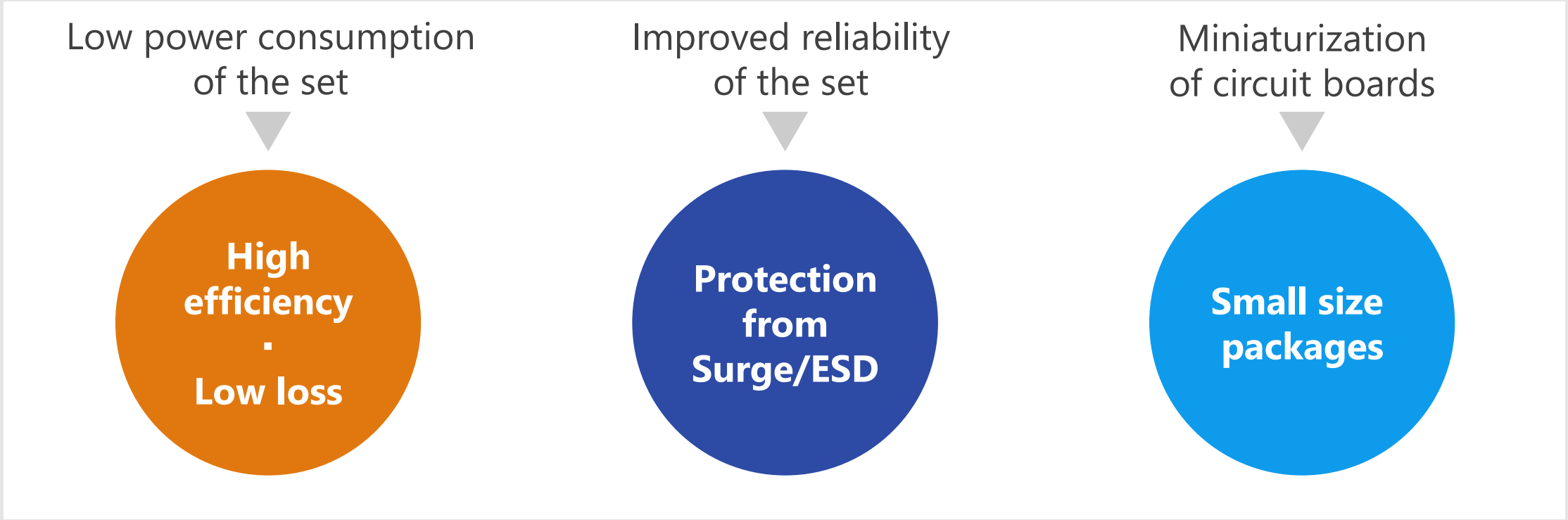
- **The set of low power consumption is realized by the low on-resistance** 1
  U-MOS Series MOSFET
- **It contributes to low power consumption of the system.** 2
  Load switch IC
- **Low dropout LDO contributes to high efficiency** 3
  Small surface mount LDO regulator
- **Small size package is suitable for high density assembly** 4
  TVS diode
- **Suppress the through current by shortening the OFF time.** 5
  Schottky barrier diode
- **Built-in protection function against short circuit, over current, over voltage, etc.** 6
  Electronic fuse (eFuse IC)
- **Small package and built-in over voltage protection function** 7
  N-ch MOSFET gate driver IC

Recommended Devices



Device solutions to address customer needs

As described above, in the design of wireless charger, **“Low power consumption of the set”**, **“Improved reliability of the 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 · Low loss	Protection from Surge/ESD	Small size packages
1 U-MOS Series MOSFET	●		●
2 Load switch IC	●	●	●
3 Small surface mount LDO regulator	●		●
4 TVS diode		●	●
5 Schottky barrier diode	●		●
6 Electronic fuse (eFuse IC)	●	●	●
7 N-ch MOSFET gate driver IC	●		●

1 U-MOS Series MOSFET

TPN7R504PL / TPN8R408QM / TPN12008QM / TPH7R204PL / TK90S06N1L / TK5R1P08QM / TK6R9P08QM

High efficiency - Low loss | Protection from Surge/ESD | Small size packages

Value provided

Lineup of low on-resistance products is provided and trade-off between on-resistance and capacitance contribute to higher power supply efficiency.

1 Fast switching speed

Reducing switching loss through high speed operation contributes to higher power supply efficiency.

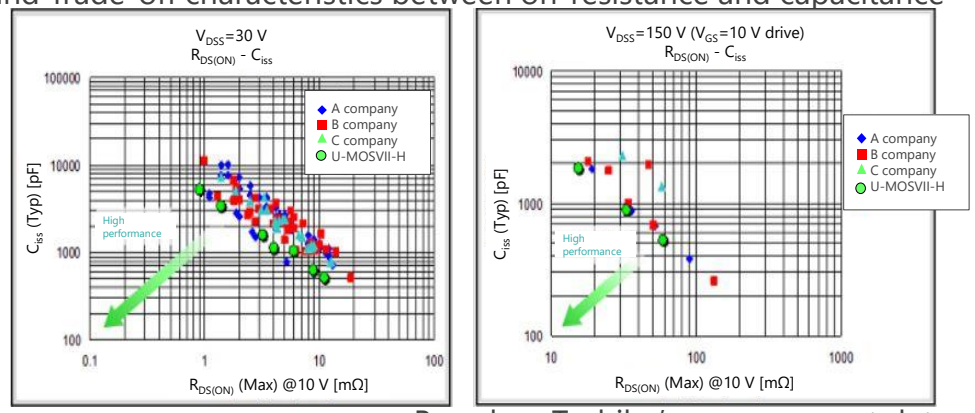
2 Small gate input charge

Small gate input charge reduces the performance required for driving the MOSFET. It contributes to improving switching characteristics.

3 Low on-resistance

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

Lineup of low on-resistance products
and Trade-off characteristics between on-resistance and capacitance



Based on Toshiba's measurement data

Lineup

Part number		TPN7R504PL	TPN8R408QM	TPN12008QM	TPH7R204PL	TK90S06N1L	TK5R1P08QM	TK6R9P08QM
Package		TSON Advance			SOP Advance	DPAK+	DPAK	
V_{DSS} [V]		40	80	80	40	60	80	80
I_D [A]		38 (68*)	32 (77*)	26 (60*)	48 (72*)	90	84 (105*)	62 (83*)
$R_{DS(ON)}$ [mΩ] @V_{GS} = 10 V	Typ.	5.6	6.5	9.6	5.4	2.7	4.2	5.5
	Max	7.5	8.4	12.3	7.2	3.3	5.1	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-MOSⅧ-H	U-MOSⅩ-H	U-MOSⅩ-H

* : Silicon limit

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Value provided

Low on-resistance is realized and it contributes to high power supply efficiency.

1 Low on-resistance

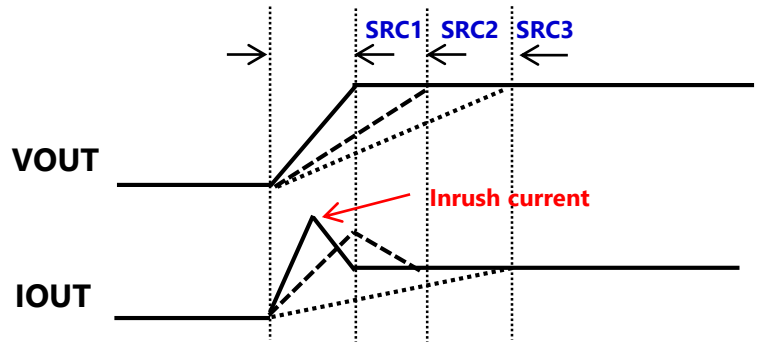
By keeping the on-resistance low, heat generation and power consumption can be kept low.

2 Adjusting the output rise time

It is possible to select products that are suitable for reducing power consumption, miniaturization of the system, sequence control and lash current suppression.

3 Suitable for high density mounting

The compact 0.4 mm pitch package WCSP6E (0.8 mm x 1.2 mm) and 0.35 mm pitch package WCSP4G (0.645 mm x 0.645 mm) enable high density mounting.



The inrush current can be reduced by selecting a slew rate (fixed value) suitable for the load.

Lineup

Part number	TCK2292xG	TCK2297xG	TCK127BG
Package	WCSP6E 		WCSP4G 
V_{IN} [V]	1.1 to 5.5		1.0 to 5.5
I_{OUT} [A]	2		1
R_{ON} (Typ.) [mΩ] @ V_{IN} = 5 V	25		46
Slew Rate	4.5 µs, 666 µs, 1.364 ms, 3.38 ms @ V_{IN} = 5 V		363 µs @ V_{IN} = 3.3 V
Auto-discharge	✓	N/A	✓

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3 Small surface mount LDO regulator

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

High efficiency · Low loss | Protection from Surge/ESD | 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.

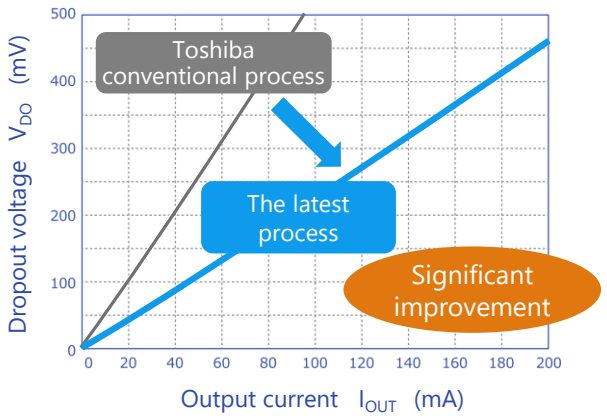
2 High PSRR Low output noise voltage

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

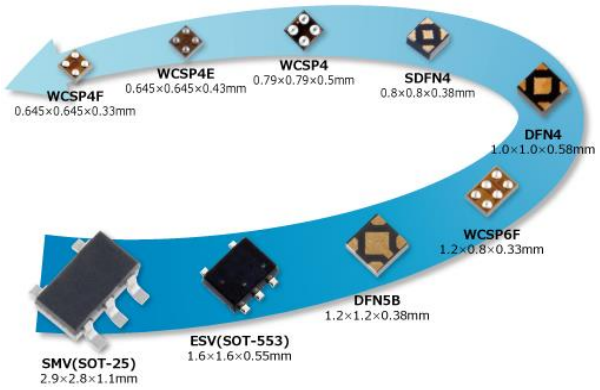
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology. (TCR3U Series)

Low dropout voltage



Note: Toshiba internal comparison

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

Various products are provided, mainly compact package that is suitable for high density assembly.

1 Lineup according to voltage

Products can be selected according to the power supply voltage.

2 Absorb high surge current

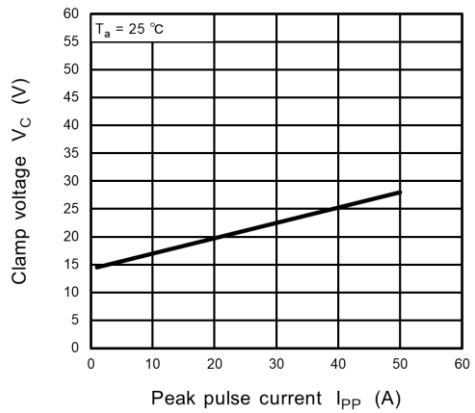
It can withstand high peak pulse current (I_{PP} [Note 2]).

3 Small package

Two types of small packages are available.
USC : 2.5 x 1.2 mm
CST2C : 1.6 x 0.8 mm

High peak pulse current (I_{PP}) can be absorbed.

(Reference) DF2S14P2FU



Lineup

Part number	DF2S6P2FU DF2S6P2CTC	DF2S12P2FU DF2S12P2CTC	DF2S14P2FU DF2S14P2CTC	DF2S23P2FU DF2S23P2CTC
Package	USC 		CST2C 	
V_{RWM} (Max) [V]	5.5	10	12.6	21
V_{ESD} [kV] [Note 1]	±30			
I_{PP} [A] [Note 2]	80	60	50	14

[Note 1] IEC61000-4-2 (contact) [Note 2] IEC61000-4-5

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5 Schottky barrier diode

CUHS20F30 / CUHS20F40 / CUHS10F60 / CUHS15F60 / CUHS20F60 / CUHS15S60 / CUHS20S60

High efficiency · Low loss | Protection from Surge/ESD | Small size packages

Value provided

Wide voltage lineup using small package with high power dissipation. It contributes to shorten the turn off time of gate voltage.

1 Small package with high power dissipation

Products lineup is suitable for various power dissipation level.
The US2H package is low thermal resistance. ($R_{th(ja)}$=105 °C/W)[Note]

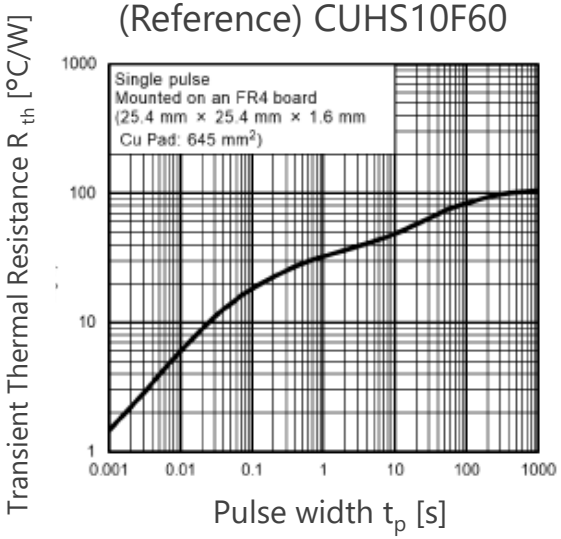
2 Lineup of various products

Products lineup offers products with reverse voltage V_R up to 30 V, 40 V and 60 V.

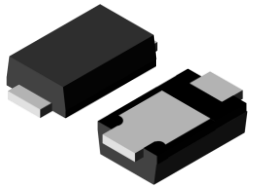
3 Switching characteristics

Low forward voltage can turn off the gate voltage quickly and contributes to improvement of the switching characteristic.

(Reference) CUHS10F60



Note: FR4 board mounting (25.4 mm × 25.4 mm × 1.6 mm, Cu Pad: 25.4 mm x 25. 4 mm)



US2H
(2.5 x 1.4 mm)

Easy to thermal design by low transient thermal resistance

Lineup

Part number	CUHS20F30	CUHS20F40	CUHS10F60	CUHS15F60	CUHS20F60	CUHS15S60	CUHS20S60
Package	US2H						
V_R [V]	30	40	60	60	60	60	60
I_O [A]	2	2	1	1.5	2	1.5	2
V_F (Typ.) [V] @I_F = 1 A	0.35	0.39	0.56	0.55	0.41	0.48	0.35
I_R (Max) [μA]	60 @V_R = 30 V	60 @V_R = 40 V	40 @V_R = 60 V	50 @V_R = 60 V	70 @V_R = 60 V	450 @V_R = 60 V	650 @V_R = 60 V

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6 Electronic fuse (eFuse IC)

TCKE8 Series / TCKE7 Series

High efficiency . Low loss | Protection from Surge/ESD | 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

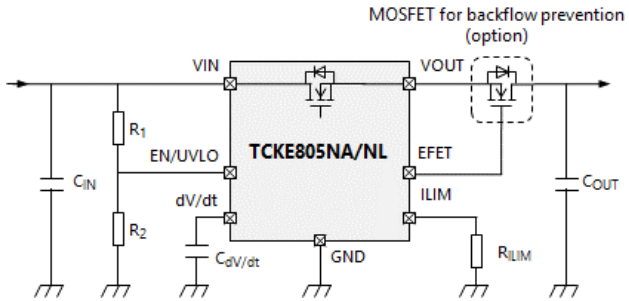
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

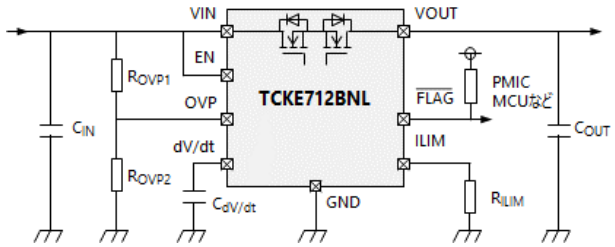
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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

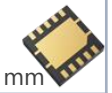
Reference circuit example of TCKE8 Series



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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7 N-ch MOSFET gate driver IC

TCK4xx Series

High efficiency . Low loss | Protection from Surge ESD | 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 3 types of connection of N-ch MOSFET can be driven

The following 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.

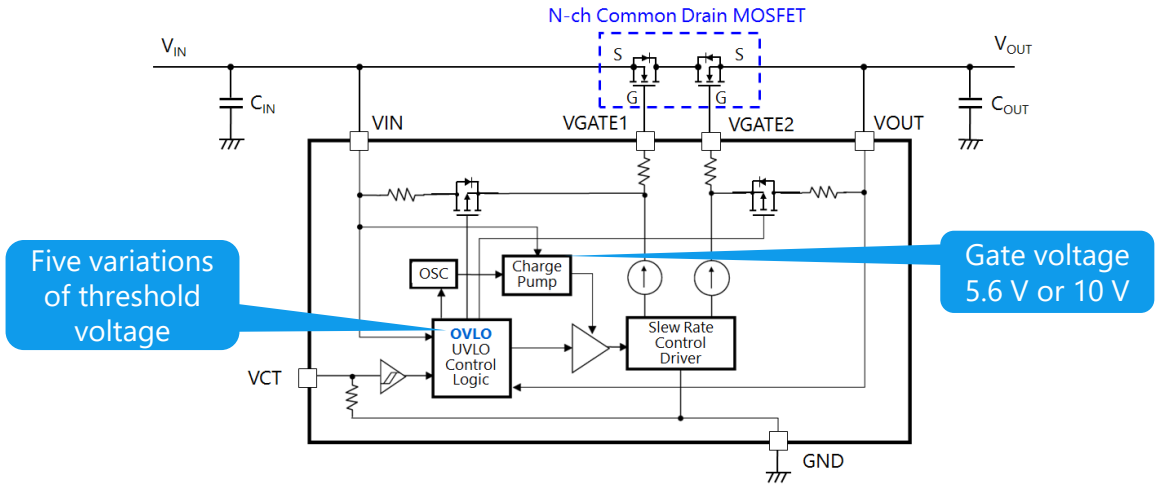
[Note 2] OVLO : Over Voltage Lock Out
[Note 3] V_{IN_OVLO} : V_{IN} OVLO threshold

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} ≥ 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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