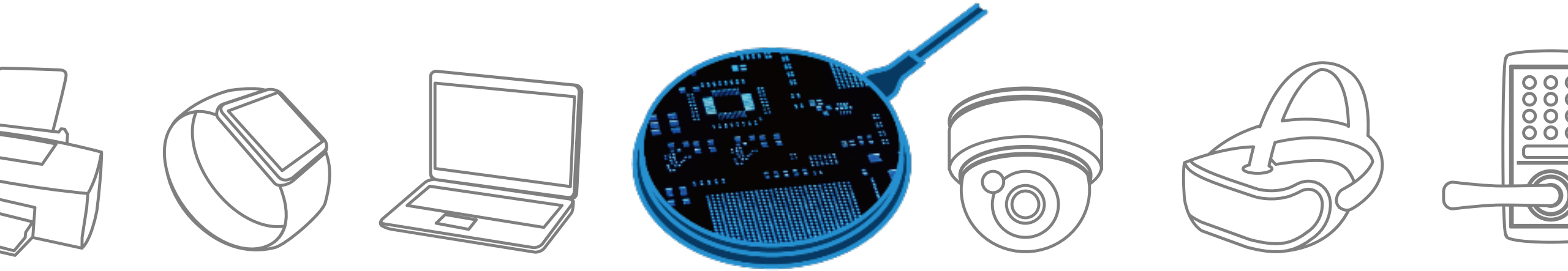
TOSHIBA

R23

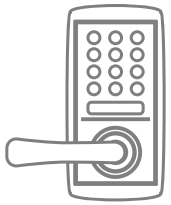
Wireless Charger

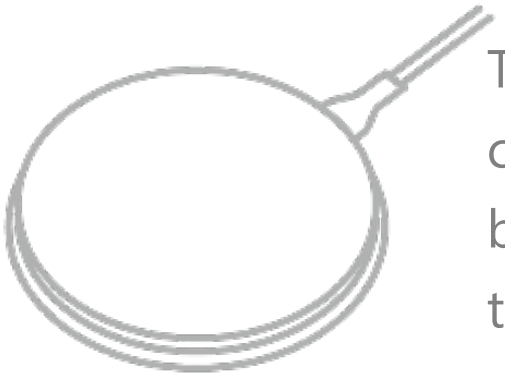
Solution Proposal by Toshiba



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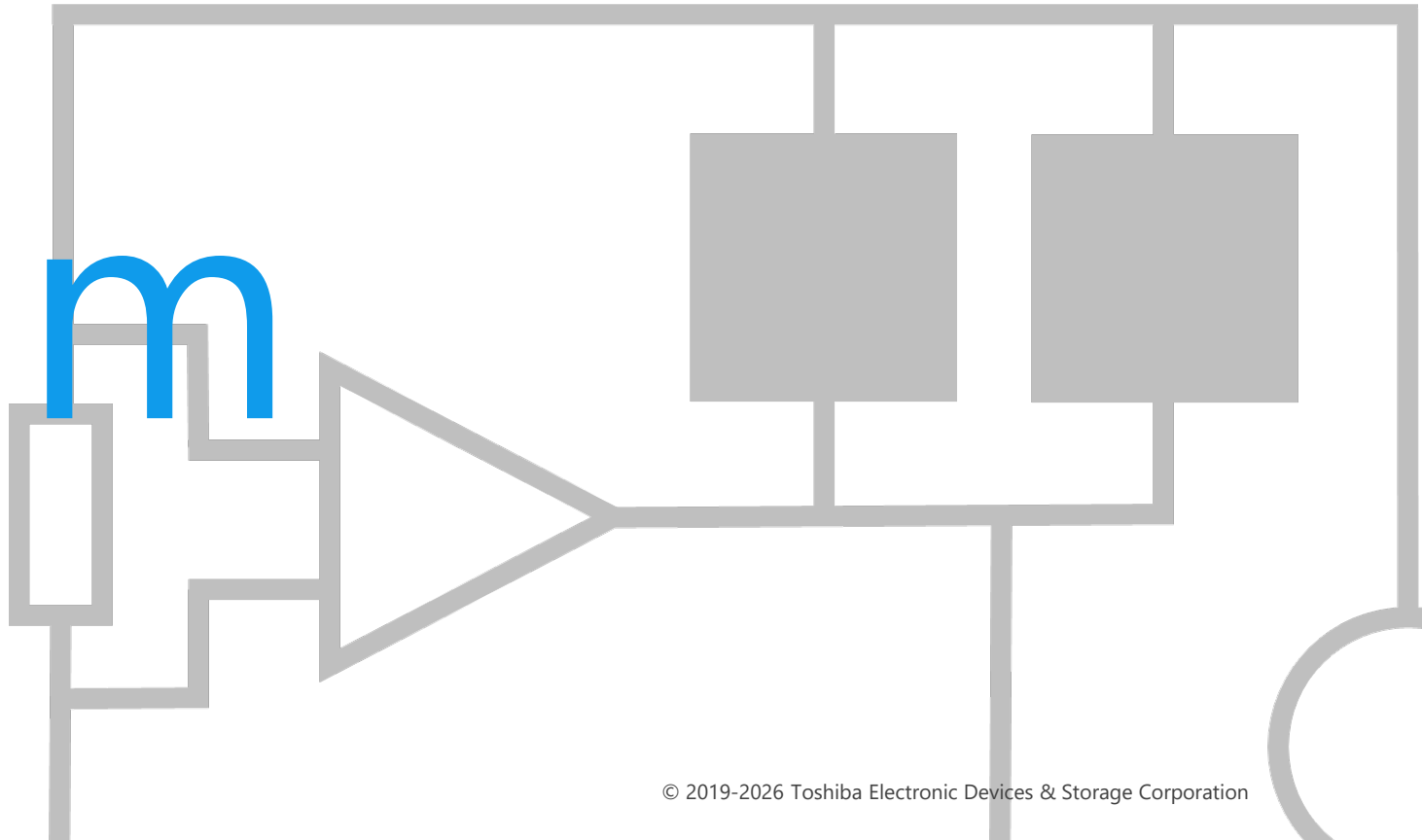
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.





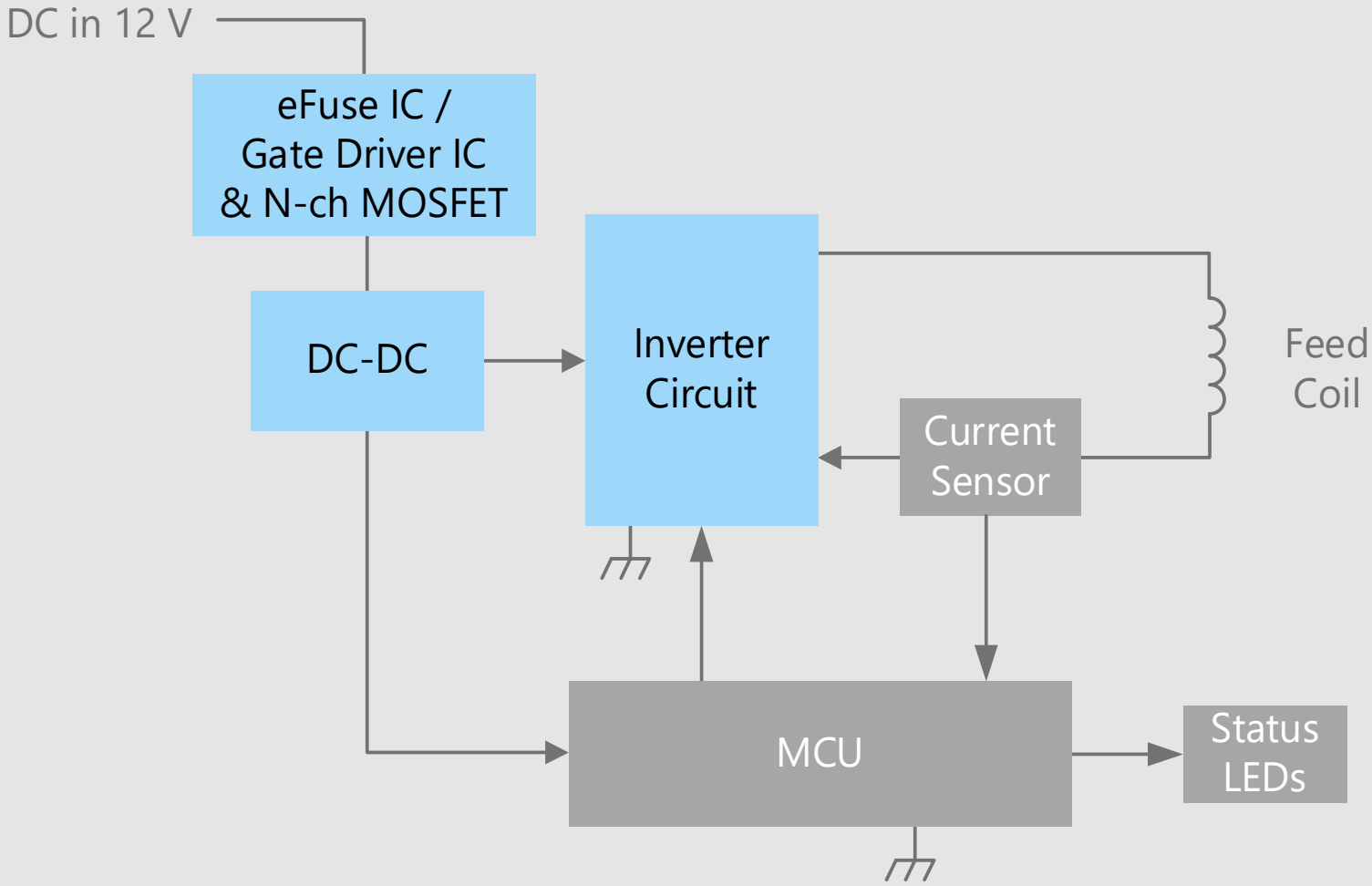
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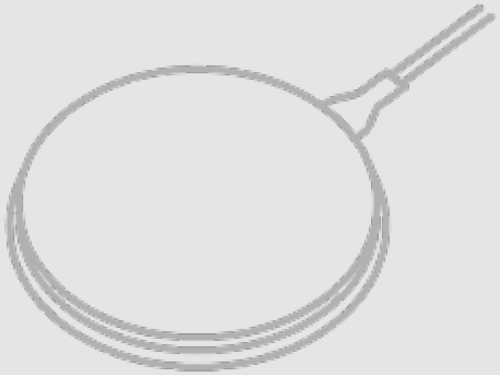
Block Diagram



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Wireless Charger　Overall block diagram

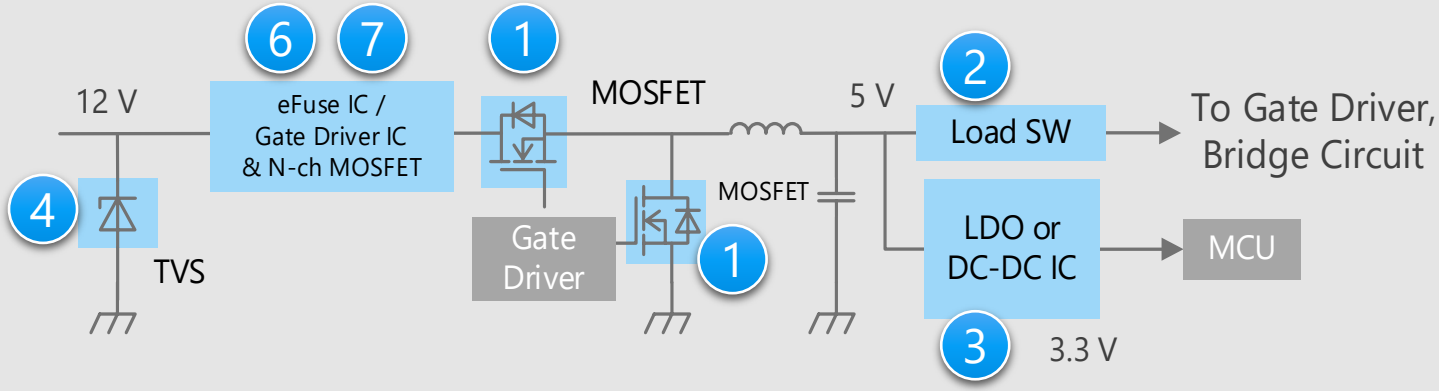




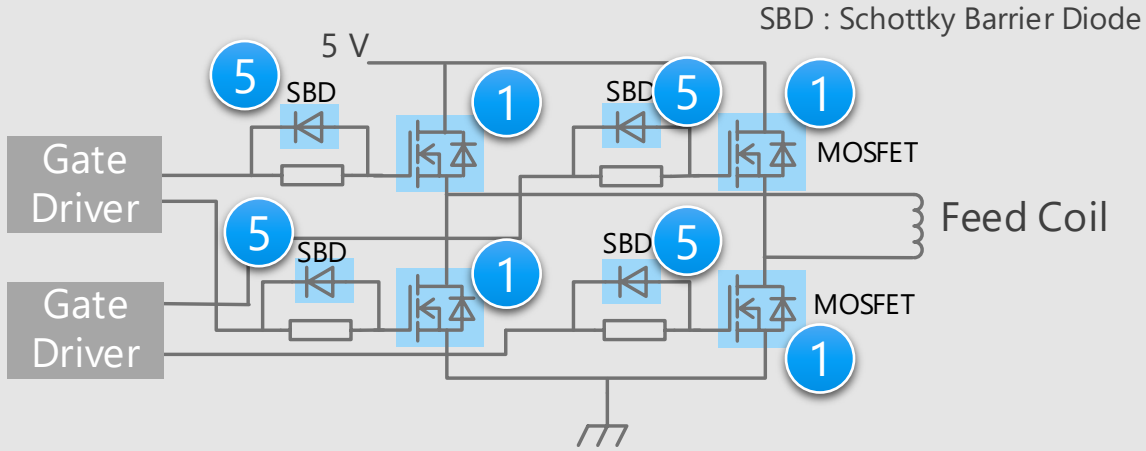
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Wireless Charger　Detail of power supply circuit unit

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

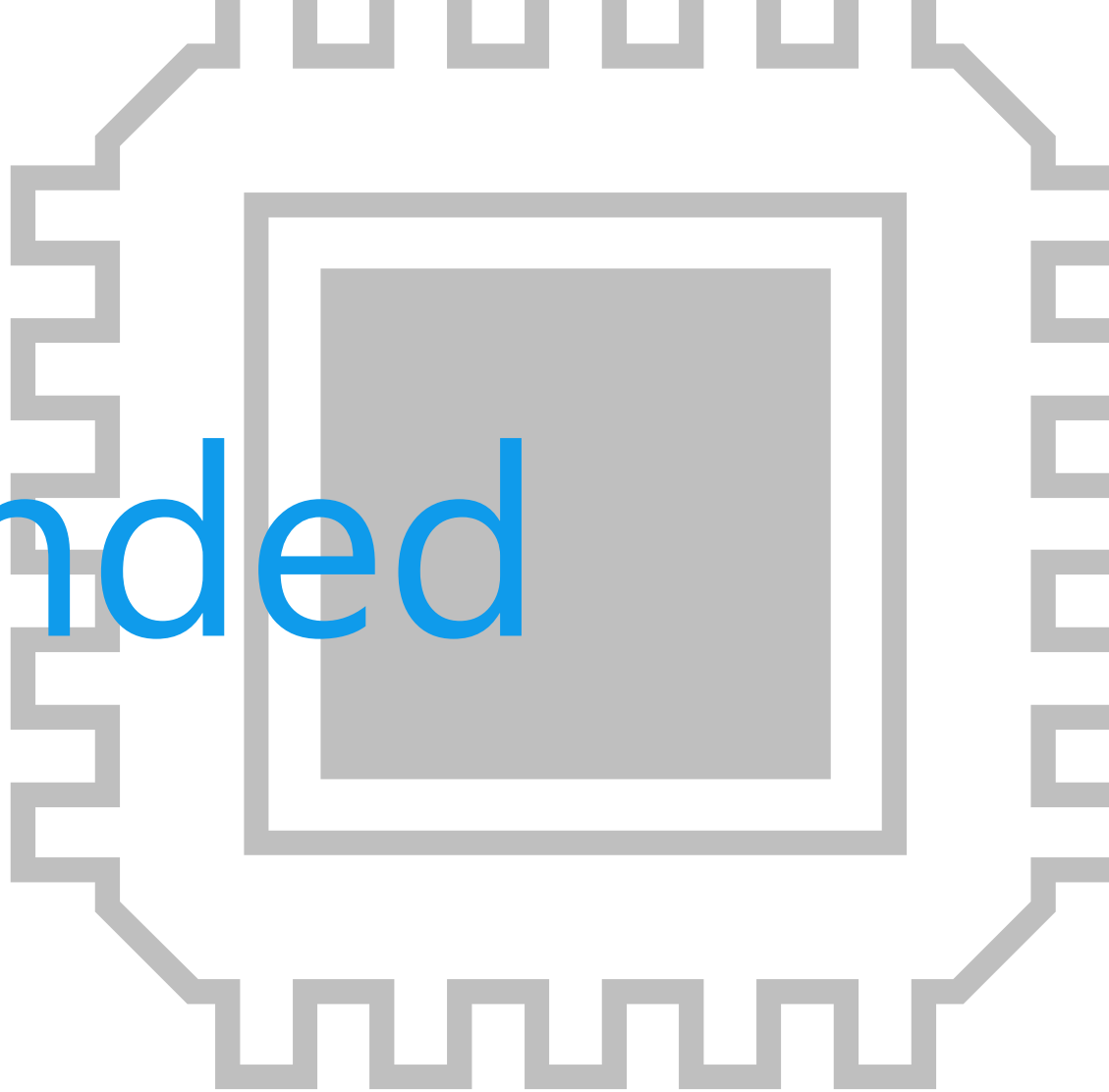
- A high voltage MOSFET is required considering such as counter electromotive force of the feed coil.
- The use of low consumption products can improve the overall efficiency of the system.
- Small size package products contribute to the reduction of circuit board area.

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
- **Absorb Electro Static Discharge (ESD) from external terminals and prevent malfunction of the circuit** 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 size package and built-in over voltage protection function** 7
  N-ch MOSFET gate driver IC

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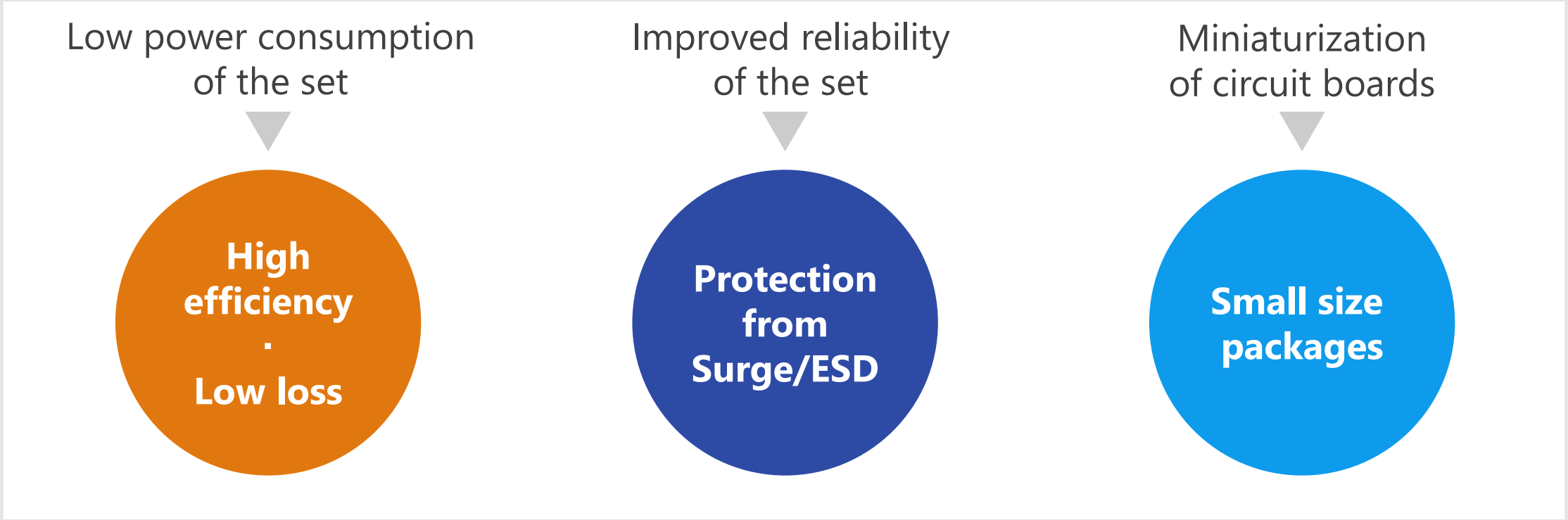
Recommended Devices



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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.



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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	●		●

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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

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

1 Fast switching speed

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

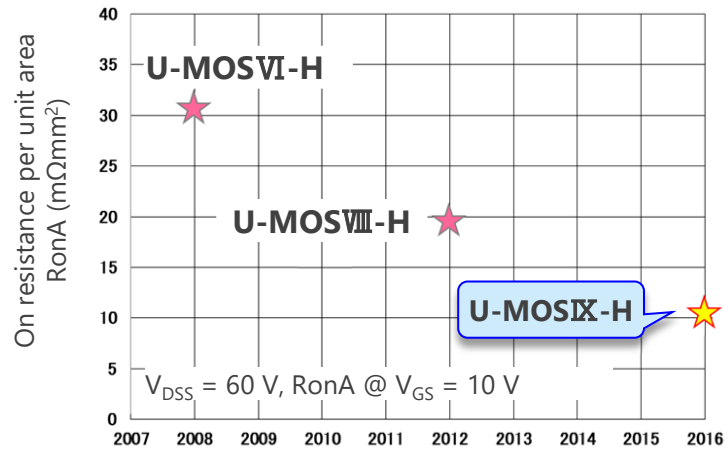
2 Small gate input charge

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

3 Low on-resistance

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

RonA reduction trend of N-ch MOSFET



[Note] Toshiba internal comparison

Lineup

Part number		TPN7R504PL	TPN8R408QM	TPN12008QM	TPH7R204PL	TK90S06N1L	TK5R1P08QM	TK6R9P08QM
Package		TSON Advance			SOP Advance	DPAK+	DPAK	
V_{DSS} [V]		40	80		40	60	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						
Generation		U-MOSⅨ-H	U-MOSⅩ-H		U-MOSⅨ-H	U-MOSⅧ-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

The on-resistance is low. Heat generation and power consumption can be reduced.

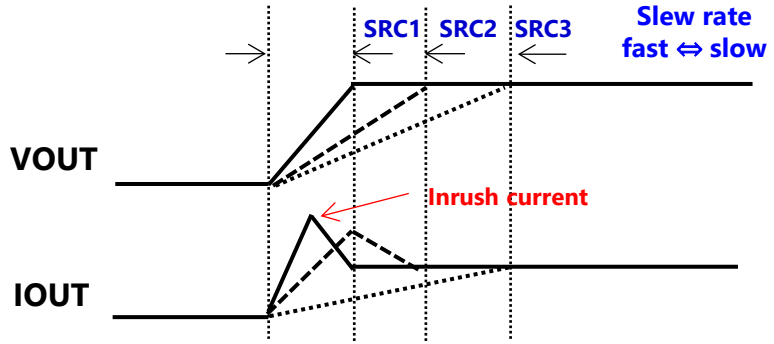
2 Adjusting the output rise time

By selecting a slew rate according to the output capacity, inrush current can be suppressed.

3 Suitable for high density mounting

The 0.4 mm pitch small size package WCSP6E (0.8 x 1.2 mm) and 0.35 mm pitch small size package WCSP4G (0.645 x 0.645 mm) are suitable for high density mounting.

Inrush current reduction function



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 function	✓	N/A	✓

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3 Small surface mount LDO regulator

TCR15AG / TCR8BM / TCR5FM / TCR5RG / TCR3RM / TCR3U / TCR3LM / TCR3D / TCR3EM / TCR1HF Series

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

Value provided

Wide lineup from general purpose type to WCSP (Wafer Level Chip Size Package) type are provided. Contribute to realize a stable power supply.

1 Low dropout voltage

Low dropout voltage characteristic has been realized by the originally developed process.

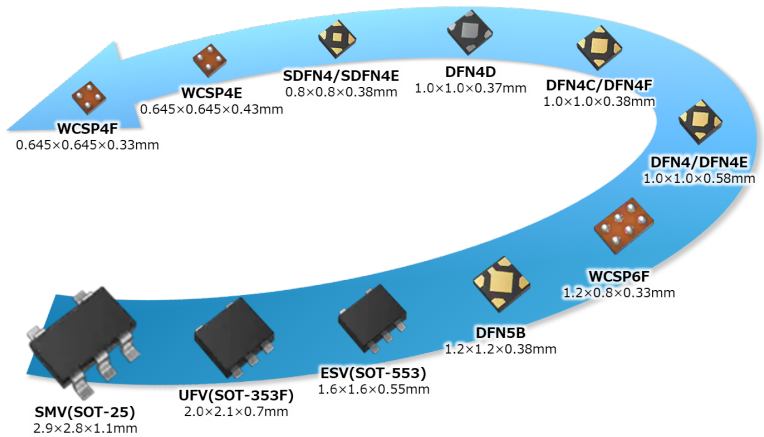
2 High PSRR Low output noise voltage

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

$I_{B(ON)}$ of 0.34 μA (typ.) @I_{OUT} = 0 mA, V_{OUT} ≦ 1.5 V is realized by utilizing CMOS process and unique circuit technology. (TCR3U Series)

Rich package lineup



Lineup

Part number	TCR15AG Series	TCR8BM Series	TCR5FM Series	TCR5RG Series	TCR3RM Series	TCR3U Series	TCR3LM Series	TCR3D Series	TCR3EM Series	TCR1HF Series
Features	Low dropout voltage High PSRR		High PSRR Low noise Low current consumption			Low current consumption		Standard type		36 V Input voltage
I_{OUT} (Max) [A]	1.5	0.8	0.5		0.3					0.15
PSRR (Typ.) [dB] @f = 1 kHz	95	98	91	100	100	70	-	72	68	70
I_B (Typ.) [μA]	25	20	10	7	7	0.34	1	86	35	170

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Value provided

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

1 Lineup according to voltage

Products can be selected according to the power supply voltage.

2 Absorb high surge current

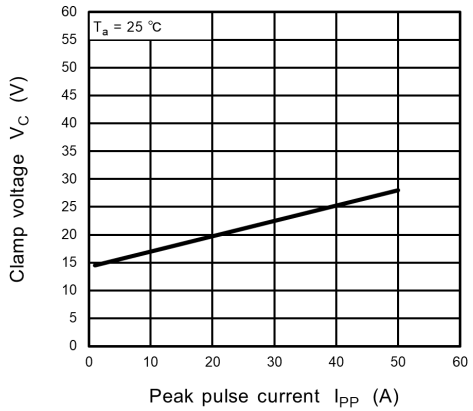
It can absorb high peak pulse current (I_{PP}[Note2]).

3 Small size package

Small size package is available.
SOD-323 (USC): 2.5 × 1.25 × 0.9 mm

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

(Reference) DF2S14P2FU



Lineup

Part number	DF2S6P2FU	DF2S12P2FU	DF2S14P2FU	DF2S23P2FU
Package	SOD-323 (USC)  Top view  Bottom view			
V_{RWM} (Max) [V]	5.5	10.0	12.6	21.0
V_{ESD} [kV] [Note1]	±30			
I_{PP} [A] [Note2]	80	60	50	14

[Note1] IEC61000-4-2 (contact) [Note2] 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 size package with high power dissipation. It contributes to shorten the turn off time of gate voltage.

1 Small size package with high power dissipation

Products lineup is suitable for various power dissipation level.
The SOD-323HE (US2H) package is low thermal resistance. ($R_{th(j\text{-}a)}$ =105 °C/W)[Note]

[Note] FR4 board mounting (25.4 x 25.4 x 1.6 mm, Cu Pad: 25.4 x 25.4 mm)

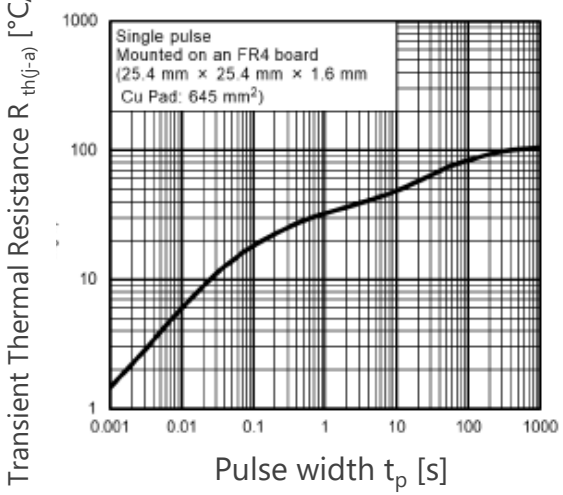
2 Lineup of various products

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

3 Contribute to improved switching characteristics

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

(Reference) CUHS10F60





Top view

Bottom view

SOD-323HE (US2H) package
(2.5 × 1.4 × 0.60 mm)

Easy to thermal design by low thermal resistance and small size package

Lineup

Part number	CUHS20F30	CUHS20F40	CUHS10F60	CUHS15F60	CUHS20F60	CUHS15S60	CUHS20S60
Package	SOD-323HE (US2H)						
V_R [V]	30	40	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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6a 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 over current and over voltage.

1 Can be used repeatedly

When over current flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. Unlike conventional fuses, eFuse IC can be used repeatedly.

2 IEC 62368-1 certified

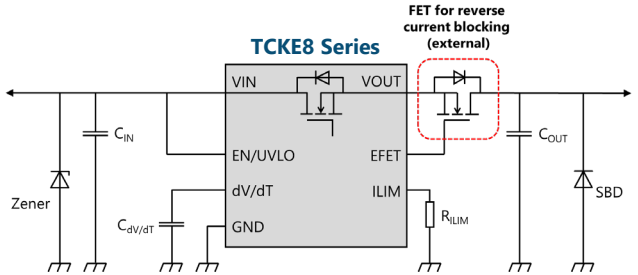
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

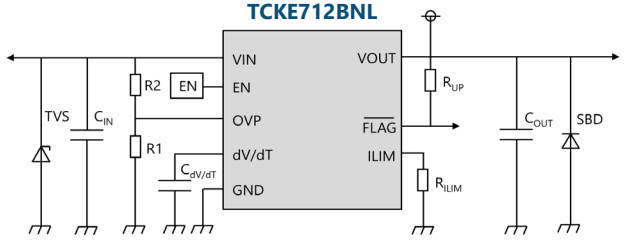
TCKE8 Series: short circuit protection, over current protection, over current clamp function, over voltage clamp function, thermal shutdown, inrush current suppression, backflow prevention (optional), etc.

TCKE7 Series: short circuit protection, over current protection, over voltage protection, thermal shutdown, FLAG signal output, backflow prevention (built-in), etc.

Example of peripheral circuit for TCKE8 Series



Example of peripheral circuit for TCKE7 Series



Lineup

Part number	TCKE800NA/NL	TCKE805NA/NL	TCKE812NA/NL	TCKE712BNL
Package	WSON10B 3.0 x 3.0 x 0.75 mm  Top view  Bottom view			WSON10 3.0 x 3.0 x 0.75 mm 
V_{IN} [V]	4.4 to 18.0			4.4 to 13.2
R_{ON} (Typ.) [mΩ]	28			53
Fault response	NA: Auto-retry NL: Latched (external signal control)			Latched (external signal control)
V_{OVC} (Typ.) [V]	-	6.04	15.1	Adjustable

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Electronic fuse (eFuse IC)

TCKE9 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 over current and over voltage.

1 Can be used repeatedly

When over current flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. Unlike conventional fuses, eFuse IC can be used repeatedly.

2 Product selection is possible according to usage

Suitable product with suitable failure response can be selected according to usage.

NA: Auto-retry type

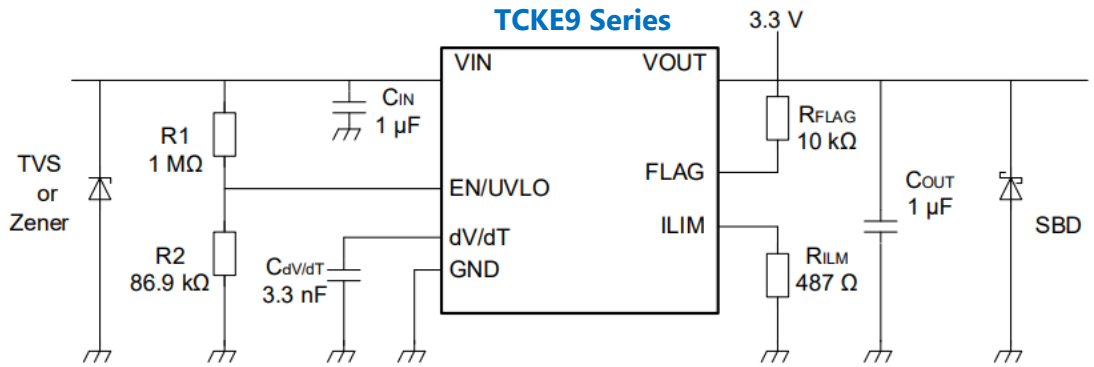
QNA: Auto-retry with quick output discharge type

NL: Latched type

3 Rich protection functions

TCKE9 Series feature many protection functions such as adjustable over current limit, short circuit protection, over voltage clamp, adjustable under voltage protection and thermal shutdown.

Example of peripheral circuit for TCKE9 Series



Lineup

Part number	TCKE903NA/NL/QNA	TCKE905ANA/NL/QNA	TCKE912NA/NL	TCKE920NA/NL
Package	WSON8 2.0 x 2.0 x 0.75 mm	 Top view	 Bottom view	
V_{IN} [V]	2.7 to 23			
R_{ON} (Typ.) [mΩ]	34			
Fault response	NA: Auto-retry (QNA: with quick output discharge), NL: Latched			
V_{OVC} (Typ.) [V]	3.87	5.7	13.7	22.2

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Electronic fuse (eFuse IC)

TCKE6 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 over current and over voltage.

1 Can be used repeatedly

When over current flows through the electronic fuse (eFuse IC), the internal detection circuit operates and switches off the internal MOSFET. Unlike conventional fuses, eFuse IC can be used repeatedly.

2 Product selection is possible according to usage

Suitable product can be selected according to usage.

FLAG function: TCKE601RA/RL

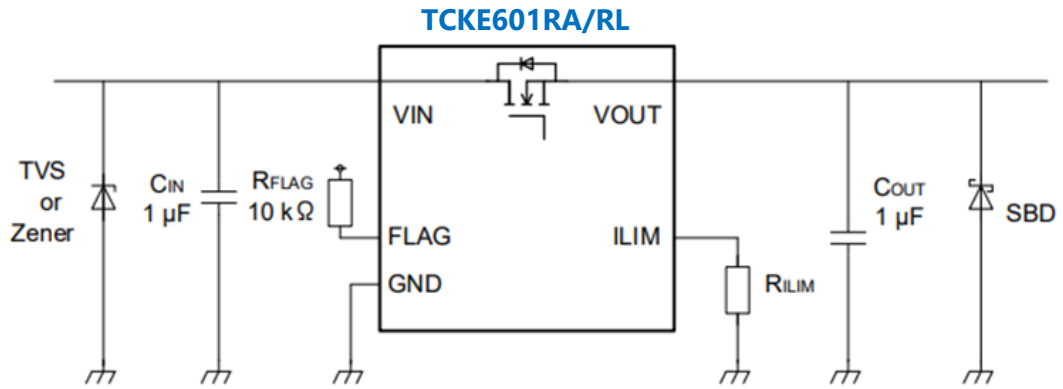
MODE function (selectable recovery mode): TCKE602RM

EN (enable) function: TCKE603RA/RL

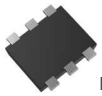
3 Rich protection functions

TCKE6 Series feature many protection functions such as adjustable over current limit, short circuit protection, under voltage protection, and thermal shutdown.

Example of peripheral circuit for TCKE601RA/RL



Lineup

Part number	TCKE601RA	TCKE601RL	TCKE602RM	TCKE603RA	TCKE603RL
Package	TSOP6F  Top view  Bottom view				
V_{IN} [V]	4.4 to 30				
R_{ON} (Typ.) [mΩ]	52				
Function	FLAG		MODE	EN	
Fault response	Auto-retry	Latched	Selectable type	Auto-retry	Latched

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7 N-ch MOSFET gate driver IC

TCK4xxG Series

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

Value provided

It is N-ch MOSFET gate driver IC with OVP[Note1] function. It contributes to reduction of power consumption and miniaturization of load switch circuit.

[Note1] OVP: Over Voltage Protection

1 Three 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[Note2] threshold voltage

Operating voltage V_{opr}: 2.7 to 28 V
Maximum input voltage: 40 V
V_{IN_OVLO}[Note3] lineups suitable for 5 to 24V power supply line.

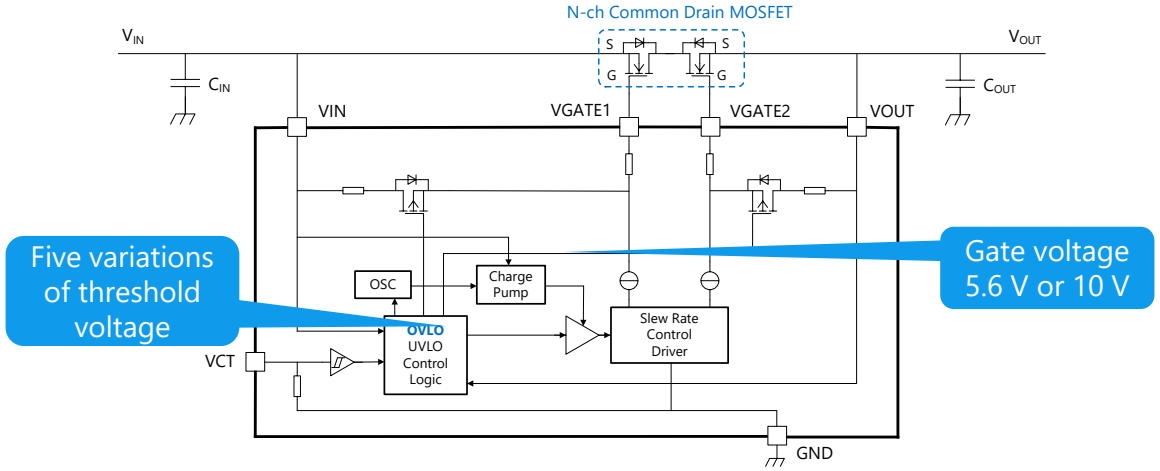
[Note2] OVLO: Over Voltage Lock Out
[Note3] V_{IN_OVLO} : V_{IN} OVLO threshold

3 Small size 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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