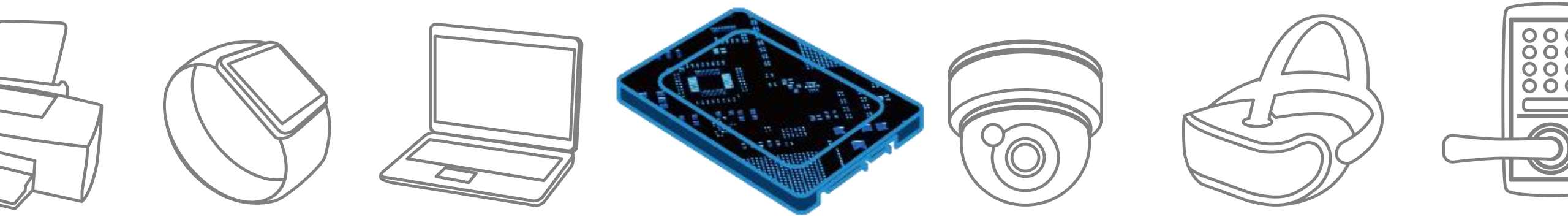
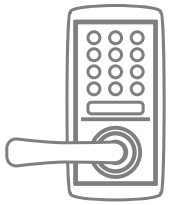
TOSHIBA

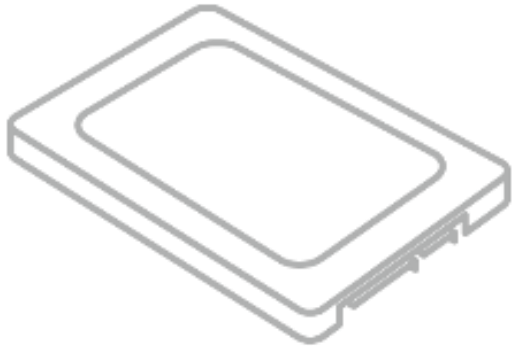
R23

Solid State Drive

Solution Proposal by Toshiba

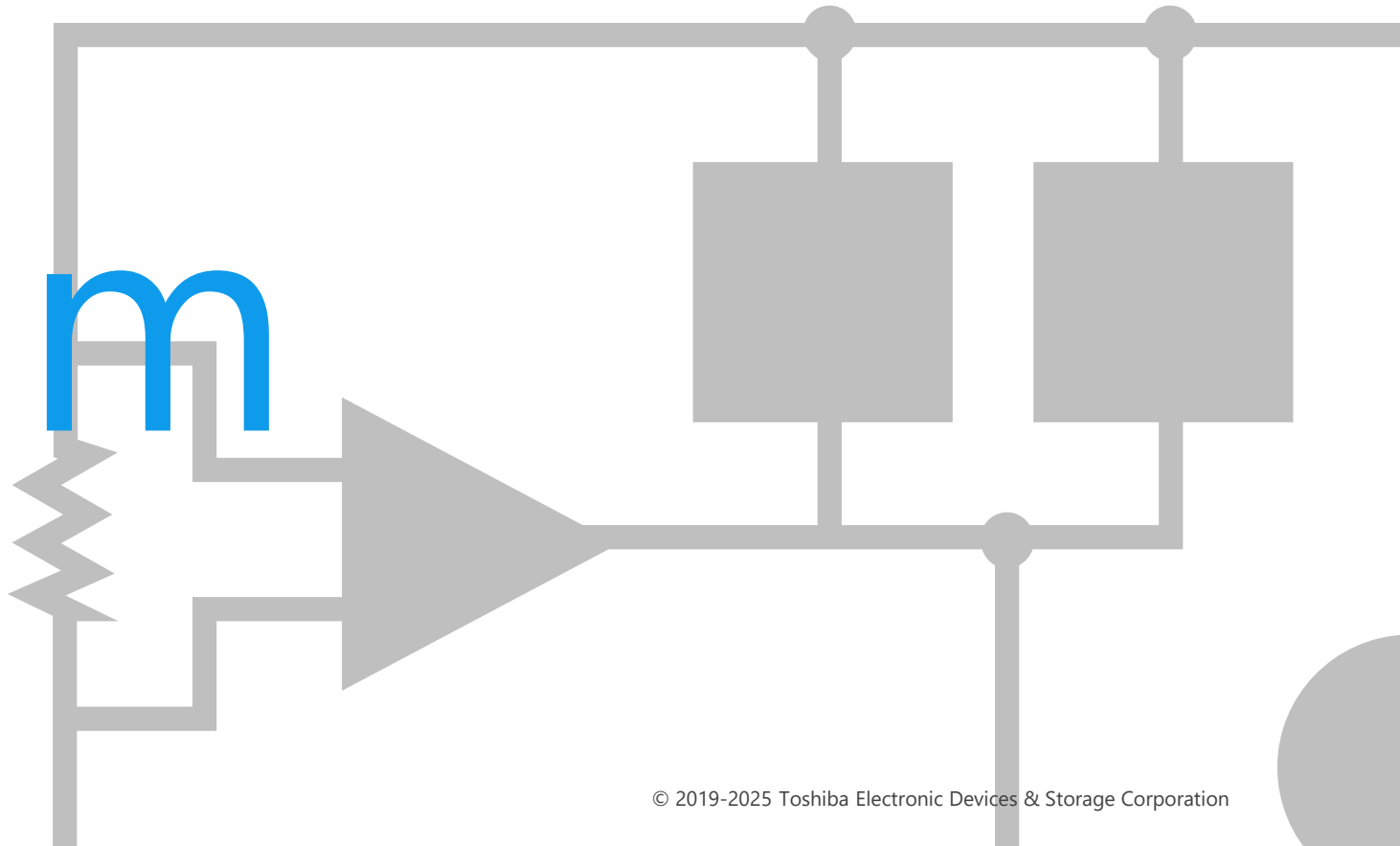




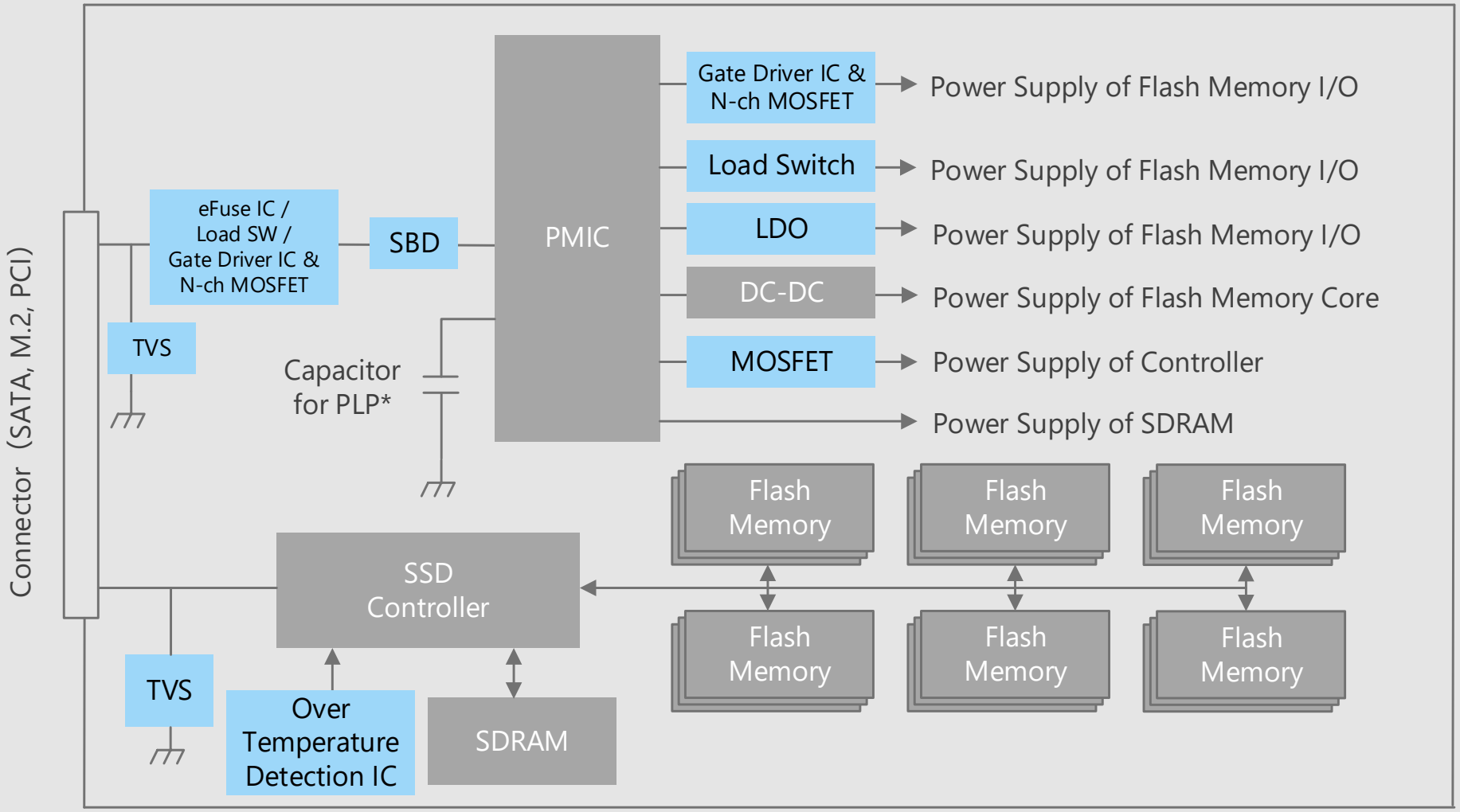


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

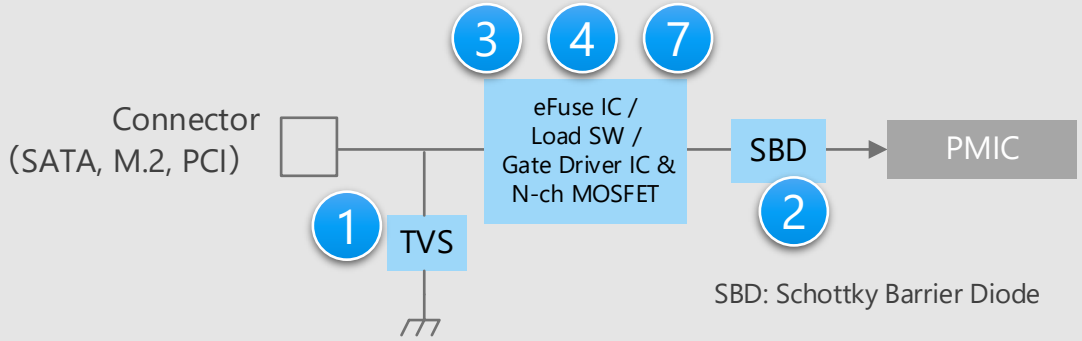


Solid State Drive　Overall block diagram



Solid State Drive　Detail of power supply

Input voltage supply section



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

Criteria for device selection

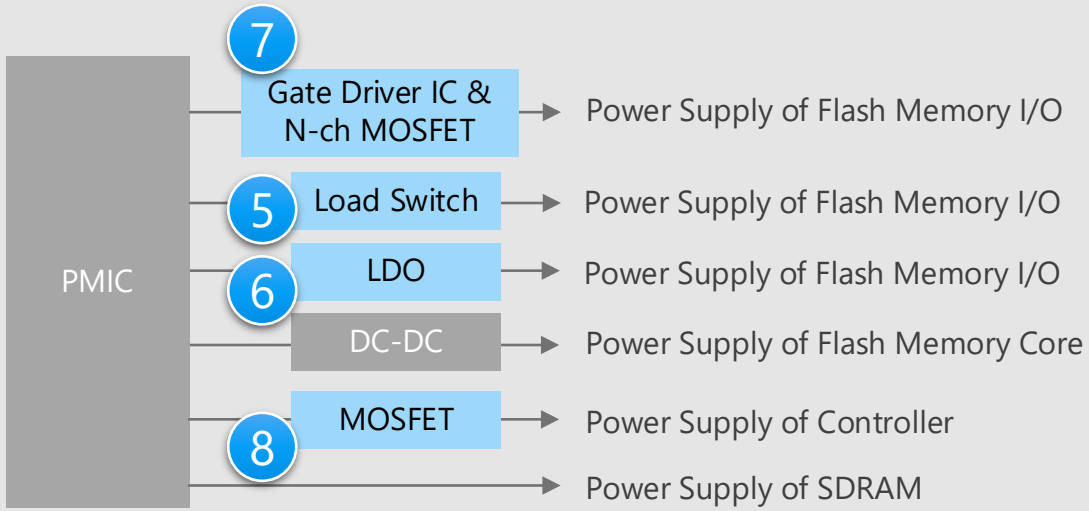
- Load switch IC and eFuse IC are suitable for power control.
- TVS diodes are suitable for protection from ESD pulses coming in through the connector.

Proposals from Toshiba

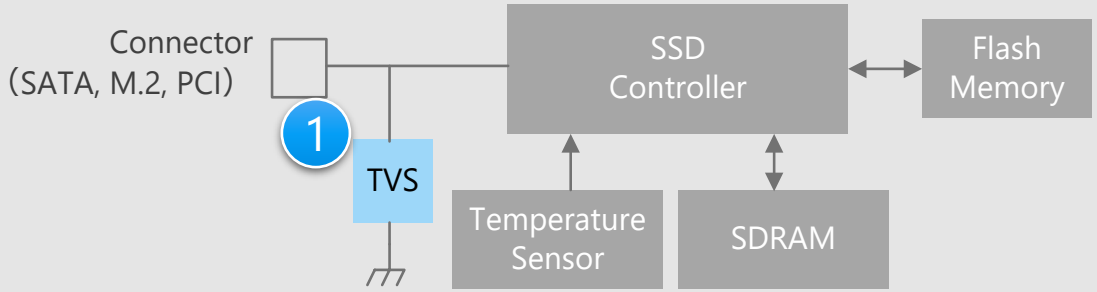
- **Absorb static electricity to prevent malfunction of the circuit**
  TVS diode (1)
- **Small and high power dissipation**
  Schottky barrier diode (2)
- **Built-in protection function against short circuit, over current, over voltage, etc.**
  Electronic fuse (eFuse IC) (3)
- **Multifunction switching IC with low on-resistance**
  High voltage load switch IC (4)
- **Small package and built-in over voltage protection function**
  N-ch MOSFET gate driver IC (7)

Solid State Drive　Details of signal line unit (1)

Power supply



Signal system



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

Criteria for device selection

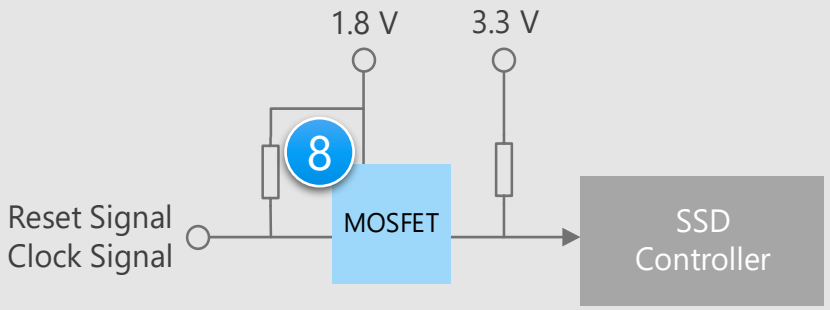
- Bi-directional TVS diode with low C_t is effective in protecting high speed differential signal lines.
- Load switch ICs with low on-resistance are suitable for highly efficient power control.
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba

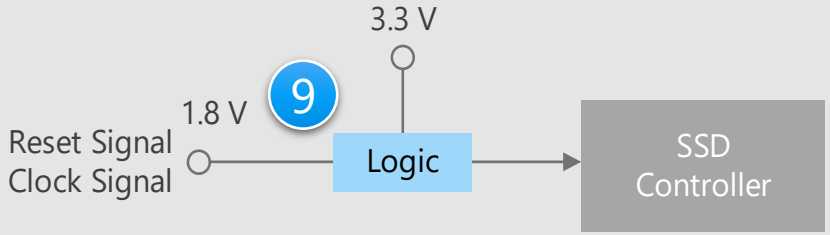
- **Absorb static electricity to prevent malfunction of the circuit**
  TVS diode　1
- **Multifunction switching IC with low on-resistance**
  Load switch IC　5
- **Supply the power with low noise**
  Small surface mount LDO regulator　6
- **Small package and built-in over voltage protection function**
  N-ch MOSFET gate driver IC　7
- **MOSFET with small package and low on-resistance**
  Small signal MOSFET　8

Solid State Drive　Details of signal line unit (2)

Level shift (1)



Level shift (2)



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

Criteria for device selection

- MOSFET with low on-resistance is used for level-shifting circuits between ICs with potential difference.
- Use of a L-MOS with level shift function to transmit signals between ICs with potential differences reduces the number of external components.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **MOSFET with small package and low on-resistance**
  Small signal MOSFET
- **It is easy to convert the voltage level**
  L-MOS with level shift function

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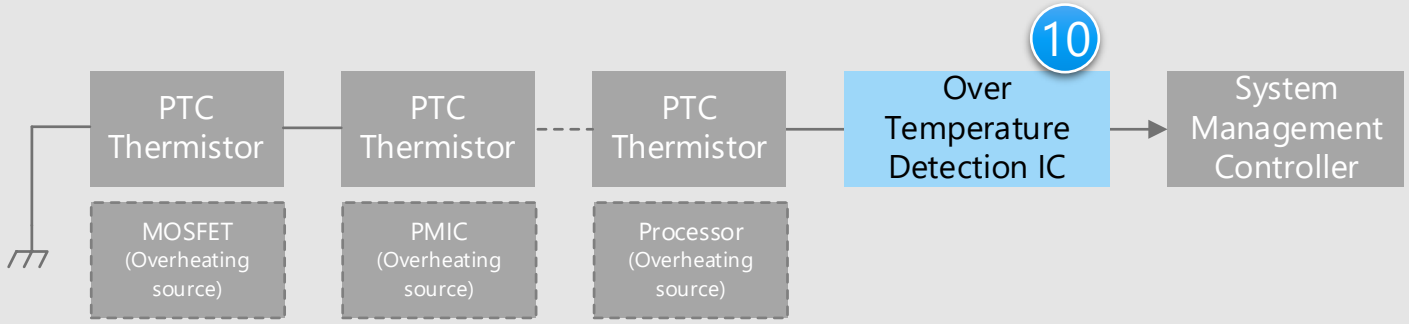
9

Solid State Drive　Detail of over temperature monitoring unit

Over temperature monitoring circuit



Criteria for device selection

- Over temperature monitoring is required at multiple points on the circuit board such as MOSFET, PMIC and Processor.
- Low power dissipation of set can be realized by using the over temperature detection IC with low current consumption.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **Monitor temperature at multiple points with small package and low current consumption**
  Over temperature detection IC
  (Thermoflagger™)

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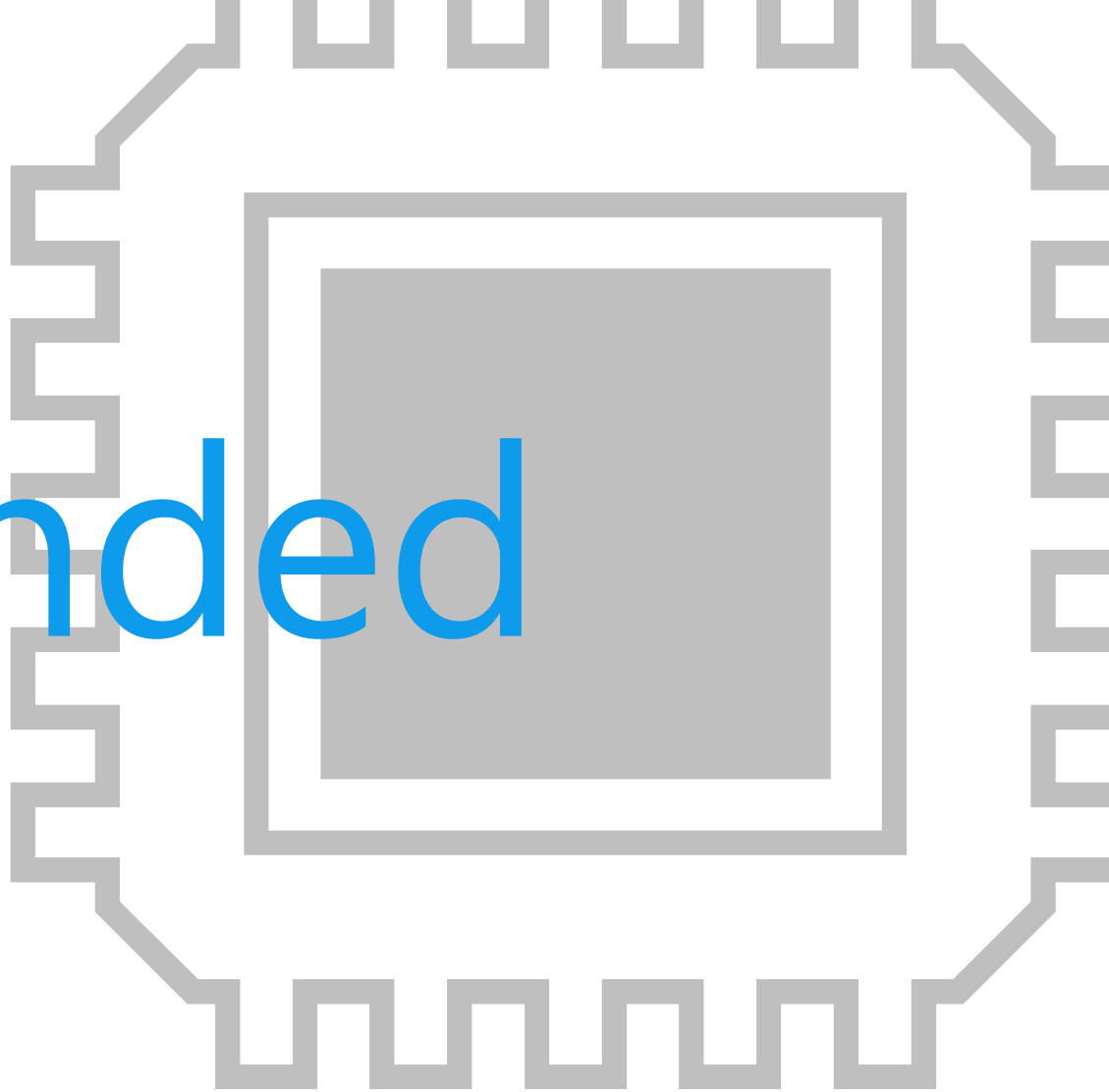
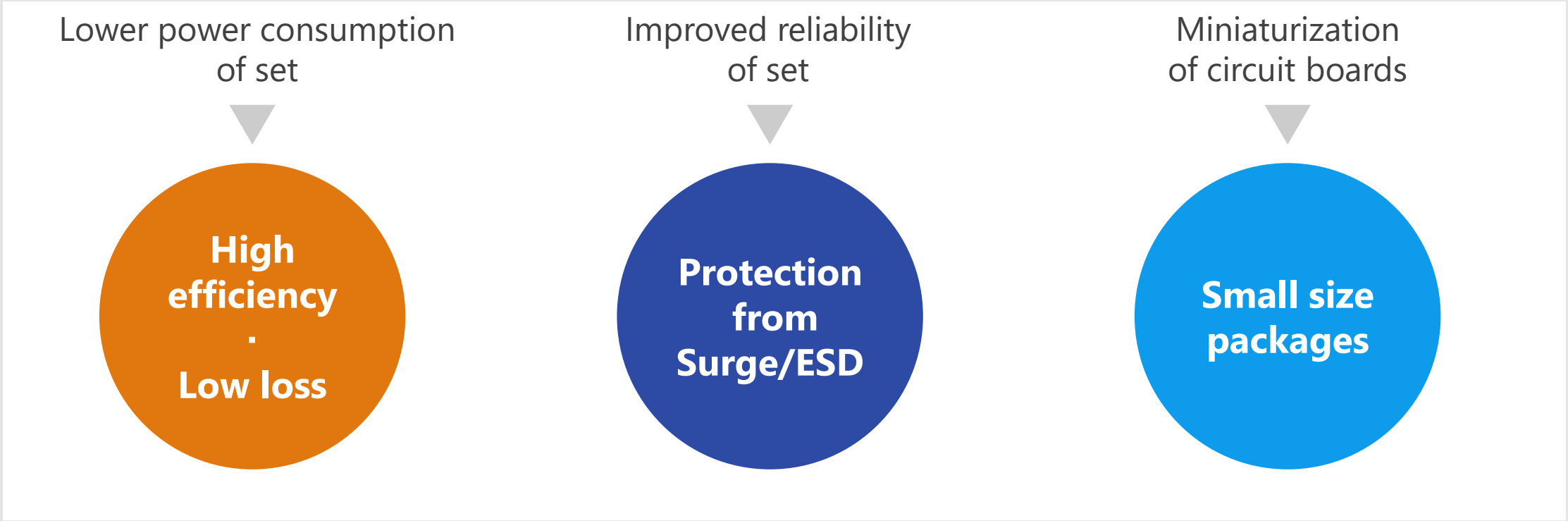
* Click the number in the circuit diagram to jump to the detailed description page

Recommended Devices



Device solutions to address customer needs

As described above, in designing a Solid State Drive, **“Lower power consumption of set”**, **“Improved reliability 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 · Low loss	Protection from Surge/ESD	Small size packages
1 TVS diode		●	●
2 Schottky barrier diode	●	●	●
3 Electronic fuse (eFuse IC)	●	●	●
4 High voltage load switch IC	●	●	●
5 Load switch IC	●		●
6 Small surface mount LDO regulator	●		●
7 N-ch MOSFET gate driver IC	●		●
8 Small signal MOSFET	●		●
9 L-MOS with level shift function			●
10 Over temperature detection IC (Thermoflagger™)	●		●

1 TVS diode

DF2B5M4ASL / DF2B6M4ASL / DF2B6M4BSL / DF2S6P1CT

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

Value provided

TVS diode absorbs static electricity from external terminals, prevents circuit malfunction and protects devices.

1 Improved ESD pulse absorption

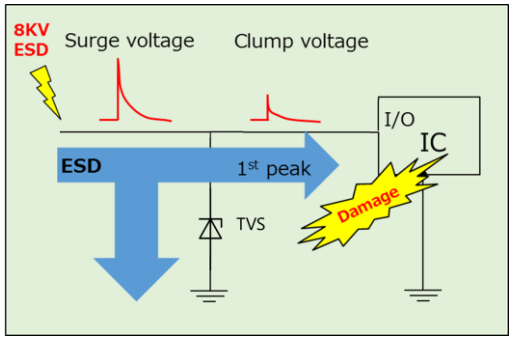
Improved ESD absorption compared to our conventional products. Both low operating resistance and low capacitance can realize and ensure high signal protection performance and signal quality.

2 Suppress ESD energy by low clamp voltage

TVS diodes protect connected circuits/devices by adopting proprietary technology.

3 Suitable for high density mounting

A variety of small packages are available.



Unidirectional

Suitable for paths such as logic signals. There is lineups of 1in1, 2in1, 4in1, 5in1, 7in1.

Bidirectional

Suitable for paths with both polar signals such as audio signals

Lineup

Part number	DF2B5M4ASL	DF2B6M4ASL	DF2B6M4BSL	DF2S6P1CT
Purpose	Signal line protection			Power line protection
Package	SL2 			CST2 
V_{ESD} [kV]	±16	±15	±8	±30
V_{RWM} (Max) [V]	3.6	5.5	5.5	5.5
C_t (Typ.) [pF]	0.15	0.15	0.12	90
R_{DYN} (Typ.) [Ω]	0.7	0.7	1.05	0.23

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

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2 Schottky barrier diode
CUHS20F30 / CUHS20F40

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

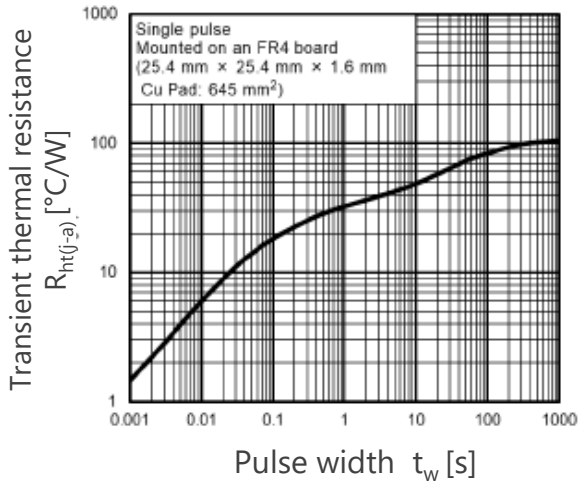
Value provided

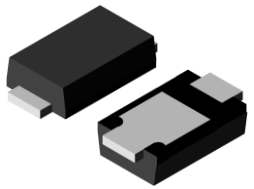
High voltage, low leakage, and reverse connection protection of the power line.

1 Small Package with high power dissipation

A lineup of US2H package with improved heat dissipation while being comparable in size to Toshiba's existing USC package.
It makes thermal design easier.
Low thermal resistance ($R_{th(j-a)}$ = 105 °C/W)

(Reference) CUHS20F30





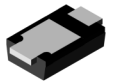
US2H
(2.5 x 1.4 mm)

With low transient thermal resistance characteristics
Thermal design is easy.

2 Lineup of products with various reverse voltage

Products with reverse voltage V_R of 30 V and 40 V are provided.
In addition to the low forward voltage characteristic, the reverse current is also suppressed to reduce the loss.

Lineup

Part number	CUHS20F30	CUHS20F40
Package	US2H 	
V_R [V]	30	40
I_O [A]	2	2
V_F (Typ.) [V] @I_F = 1 A	0.35	0.39
I_R (Max) [μA]	60 @V_R = 30 V	60 @V_R = 40 V

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3 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

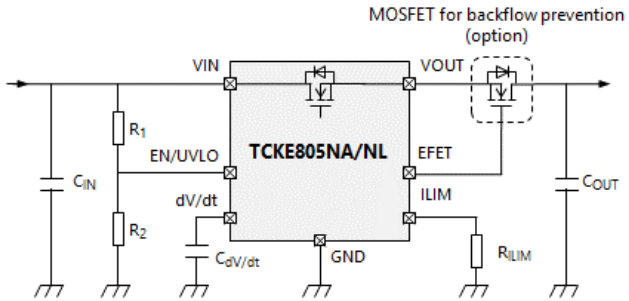
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Rich protection functions

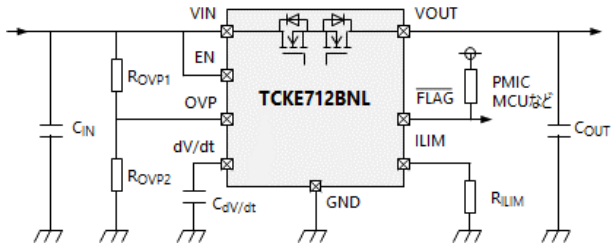
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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

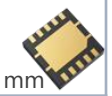
Reference circuit example of TCKE8 Series



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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4 High voltage load switch IC

TCK301G / TCK303G

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

Value provided

Various protection functions such as suppression of inrush current protect the subsequent system.

1 Low on-resistance

Low on-resistance: R_{ON} = 73 mΩ (Typ.) while ensuring 28 V of input voltage.
3 A (Max) of output current was realized.

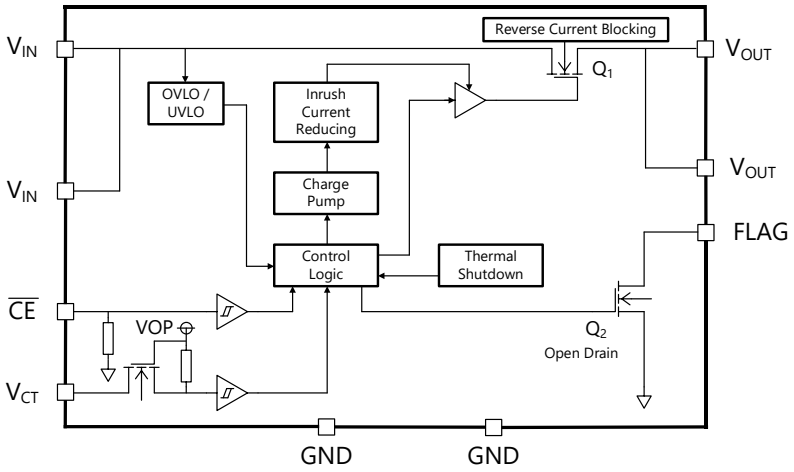
2 Built-in protection functions

Protection functions such as inrush current reducing circuit, overvoltage protection circuit, under voltage lockout ,overheat protection circuit, and reverse current blocking circuit when the switch is turned off are built in.

3 Suitable for high density mounting

WCSP9 (1.5 x 1.5 mm) is a small package with 0.5 mm pitch, enabling high density mounting and excellent heat dissipation. (Power dissipation P_D = 1.65 W)

Block diagram



Lineup

Part number	TCK301G	TCK303G
Package	WCSP9 	
V_{IN} [V]	2.3 to 28	
I_{OUT} [A]	3.0	
R_{ON} (Typ.) [mΩ]	73	
OVLO (Typ.) [V]	6.6	15.5

◆Return to Block Diagram TOP

5 Load switch IC

TCK111G / TCK127BG / TCK206G / TCK207AN

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

Value provided

Variety of product with low on-resistance and various built-in functions.

1 Low on-resistance

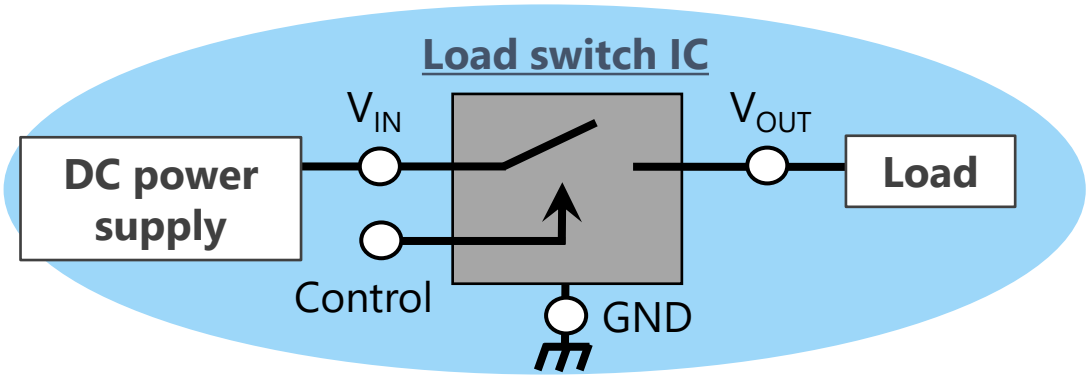
Low on-resistance and low input voltage characteristics have been realized.

2 Various built-in functions

Reverse current blocking, inrush current reducing, thermal shutdown and auto discharge function are built in.

3 Suitable for high density mounting

Variety of packages are available.



Lineup

Part number	TCK111G	TCK127BG	TCK206G	TCK207AN
Package	WCSP6C	WCSP4G	WCSP4C	DFN4A
V_{IN} [V]	1.1 to 5.5	1.0 to 5.5	0.75 to 3.6	0.75 to 3.6
I_{OUT} [A]	3.0	1.0	2.0	2.0
R_{ON} (Typ.) [mΩ]	8.3	46	18.1	21.5
Built-in function	Reverse current blocking / Inrush current reducing / Thermal shutdown	Slew rate control / Auto discharge	Slew rate control / Reverse current blocking	Slew rate control / Auto discharge / Reverse current blocking

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6 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 line up 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.

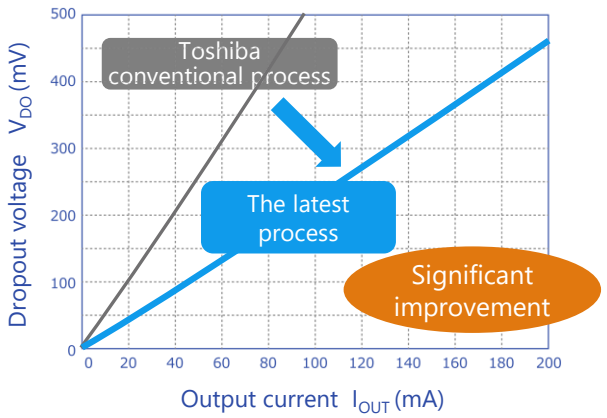
2 High PSRR Low output noise voltage

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

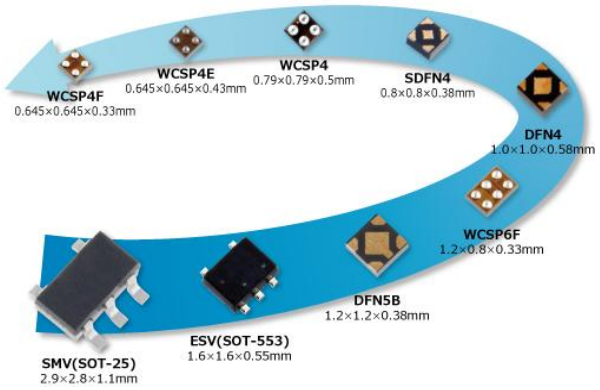
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology.
(TCR3U Series)

Low dropout voltage



(Note) Toshiba internal comparison with TCR3U series.

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		15 V 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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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 [Note 1] function. It contributes to miniaturization and reduction of power loss of load switch circuit.

[Note 1] OVP: Over Voltage Protection

1 Three 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.

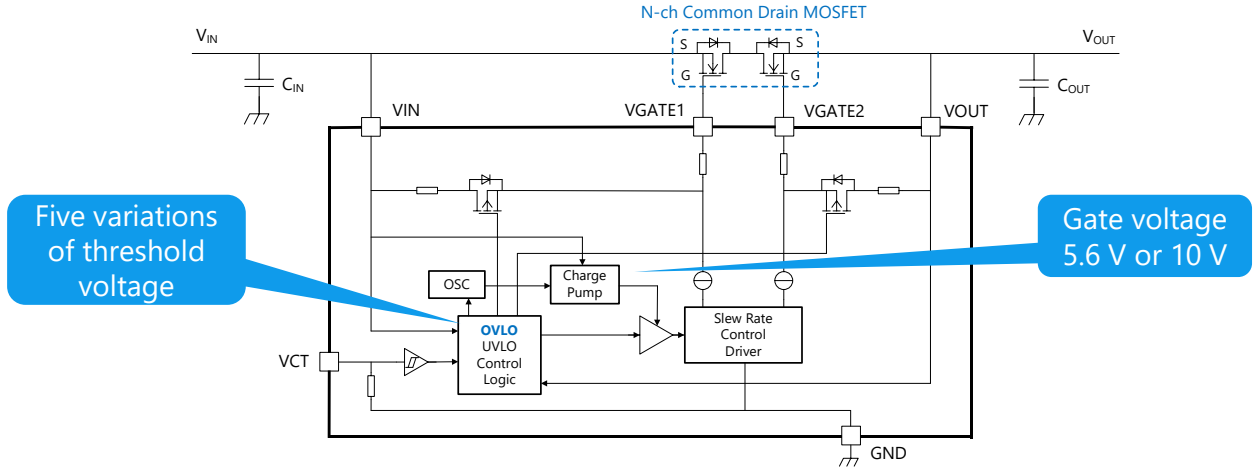
[Note 2] OVLO: Over Voltage Lock Out
[Note 3] V_{IN_OVLO}: V_{IN} OVLO threshold

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} ≥ 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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8 Small signal MOSFET

SSM3J338R / SSM3K324R / SSM3K35AMFV

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

Value provided

It is suitable for load switch applications, level shift applications, etc. and contributes to reduced power consumption and miniaturization of sets.

1 Low on-resistance

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

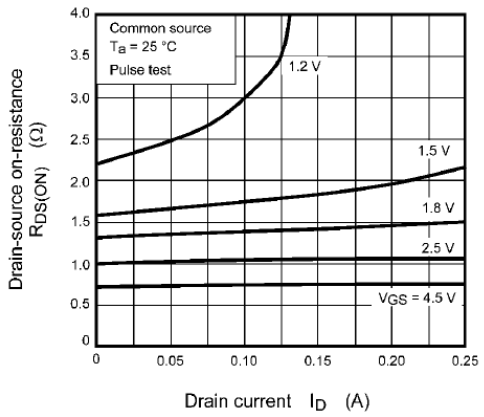
2 Low voltage operation

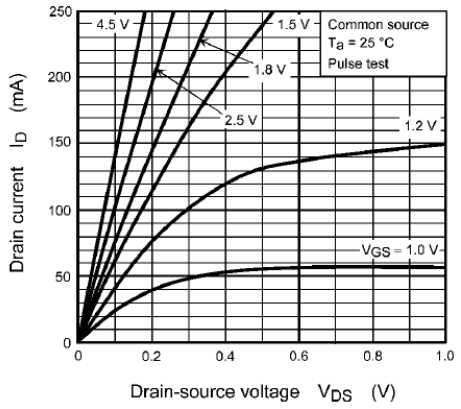
Low voltage operation with V_{GS} = 1.8 V (V_{GS} = 1.2 V for SSM3K35AMFV) is possible and can be adopted to the trend of system power supply voltage drop.

3 Small package

Variety of packages are available.

SSM3K35AMFV characteristic examples





Lineup

Part number		SSM3J338R	SSM3K324R	SSM3K35AMFV
Package		SOT-23F 		VESM 
V_{DSS} [V]		-12	30	20
I_D [A]		-6	4	0.25
$R_{DS(ON)}$ [mΩ] @| V_{GS} | = 4.5 V	Typ.	15.9	45	750
	Max	20.2	56	1100
Polarity		P-ch	N-ch	N-ch

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9 L-MOS with level shift function

7UL1T02FU / 7UL1T08FU / 7UL1T32FU

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

Value provided

Unifunctional one-gate logic IC with level shift function by single power supply.

1 Raise the logic level with single power supply

The operation to raise the logic level from 1.8 V to 3.3 V is possible by inputting 1.8 V signal directly when using the power supply voltage of 3.3 V.

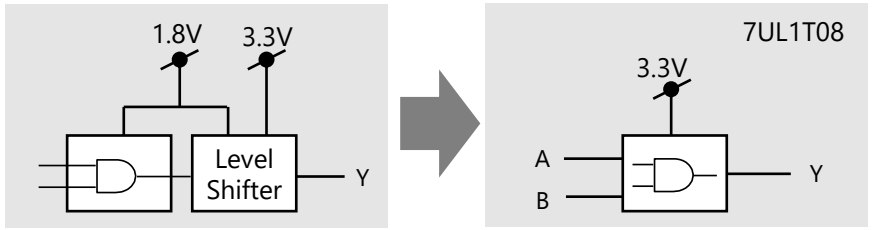
2 Lower the logic level with single power supply

The operation to lower the logic level from 3.3 V to 2.5 V is possible since power supply voltage ranges from 2.3 to 3.6 V and the input terminal has a built-in tolerant function.

3 Small Package

The product lineup is a small and versatile lead-type USV package.
(2.0 x 2.1 mm)

Examples of use of L-MOS with level shift function



Lineup

Part number		7UL1T02FU	7UL1T08FU	7UL1T32FU
Package		USV 		
V_{CC} [V]		2.3 to 3.6		
V_{IH} (Min) [V]	@V_{CC} = 2.3 to 2.7 V	1.1		
	@V_{CC} = 3.0 to 3.6 V	1.2		
Function		NOR Gate	AND Gate	OR Gate

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10 Over temperature detection IC (Thermoflagger™)

TCTH Series

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

Value provided

TCTH series can detect temperature rise at multiple points on the circuit board.

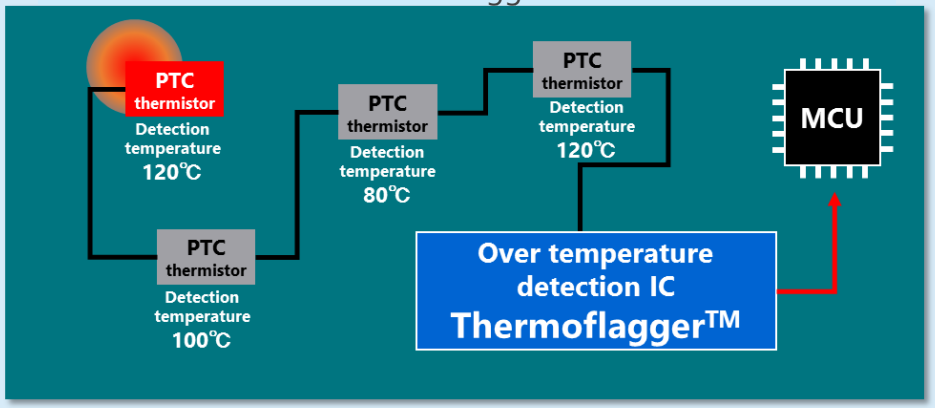
1 Temperature rise can be detected at multiple points

TCTH series detect an increase in resistance during over temperature by supplying a constant current (1 µA or 10 µA) to PTC (Positive Temperature Coefficient) thermistors. Multiple PTC thermistors connected in series enable to detect over temperature at multiple points on the circuit board.

2 Low current consumption and small package

TCTH01 series has I_{DD} = 1.8 µA (Typ.)
and TCTH02 series has I_{DD} = 11.3 µA (Typ.).
These packages are small size ESV type.

Example of over temperature detecting circuit by Thermoflagger™.



Lineup

Part number	TCTH011AE/BE	TCTH012AE/BE	TCTH021AE/BE	TCTH022AE/BE
Package	ESV 1.6 x 1.6 x 0.55 mm 			
V_{DD} [V]	1.7 to 5.5			
I_{DD} (Typ.) [µA]	1.8		11.3	
PTCO Output current (Typ.) [µA]	1	1	10	10
Abnormal latch function	-	Yes	-	Yes
Output circuit type	AE: push pull, BE: open drain			

◆Return to Block Diagram TOP

If you are interested in these products and have questions or comments about any of them, please do not hesitate to contact us below:

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