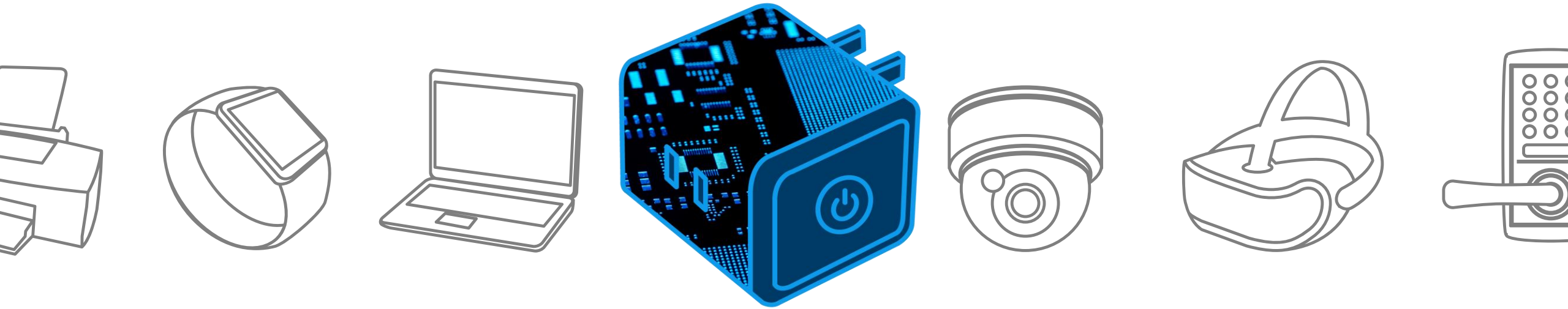
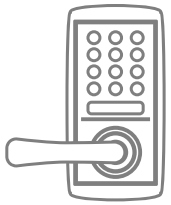
TOSHIBA

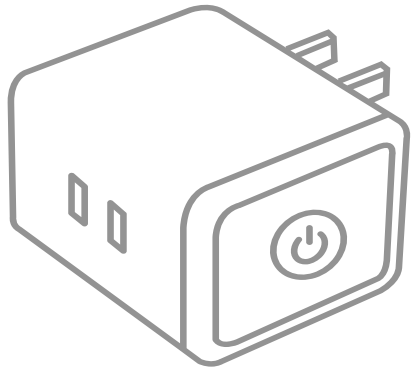
R22

Smart Plug

Solution Proposal by Toshiba

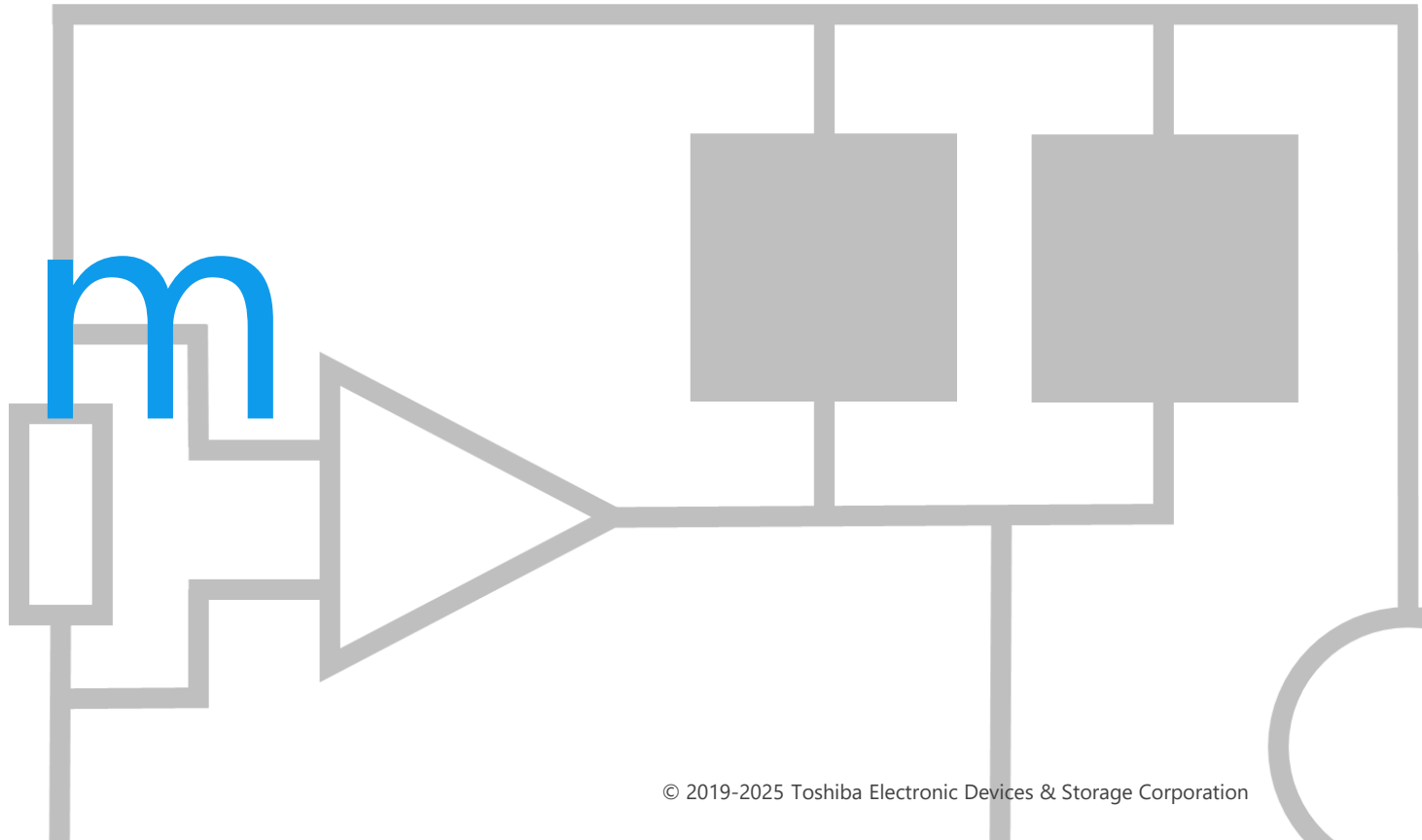




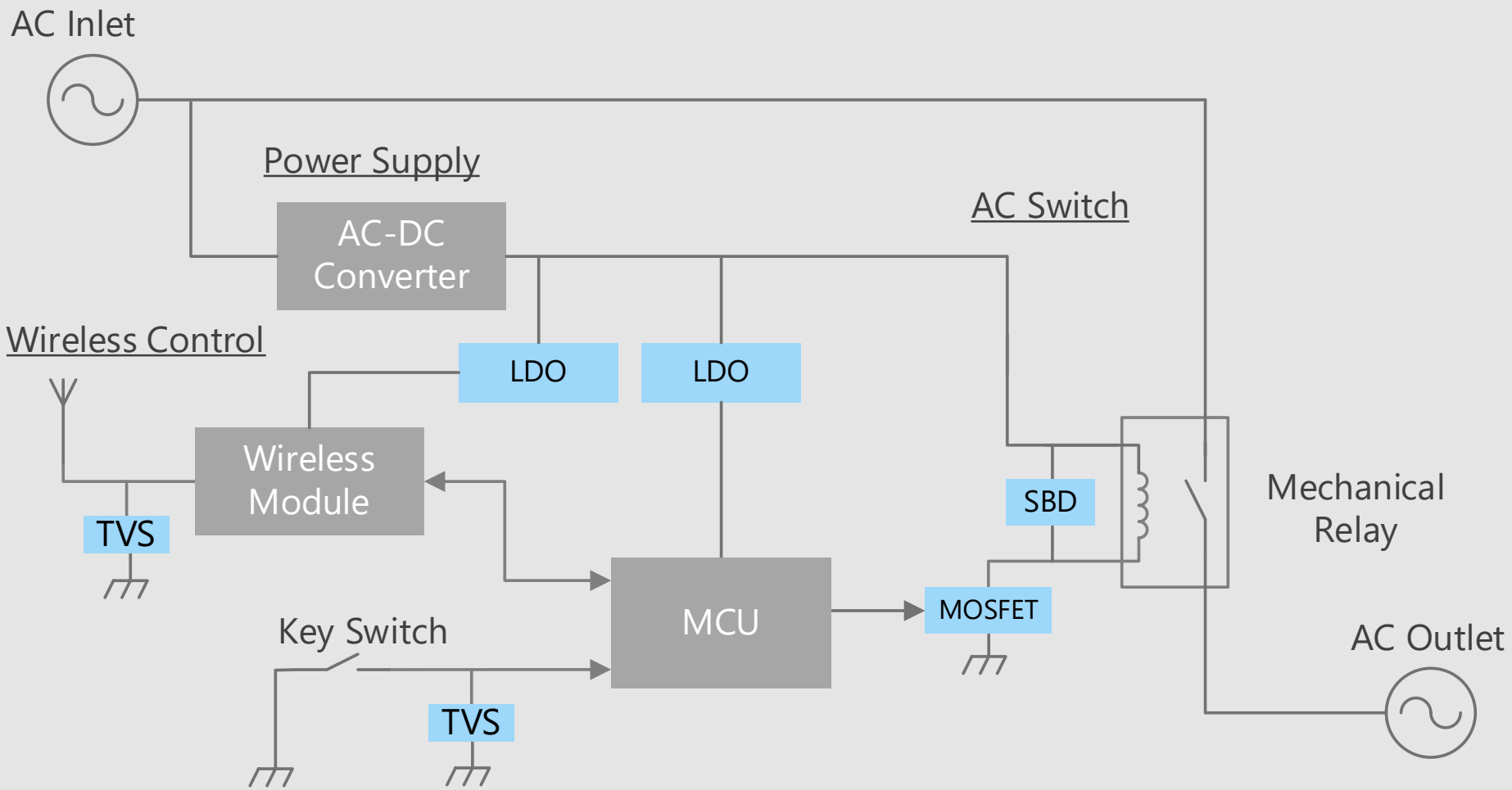


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

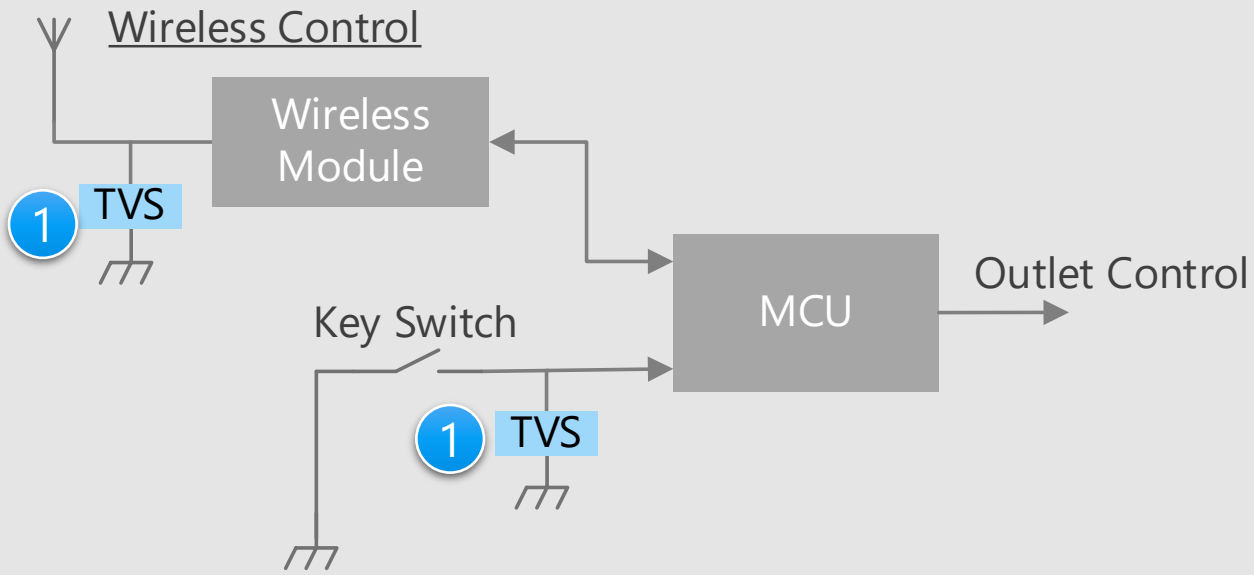


Smart Plug　Overall block diagram



Smart Plug　Detail of wireless and key switch section

Wireless and key switch input circuit



* Click on the blue circled numbers above to view detailed descriptions.

Criteria for device selection

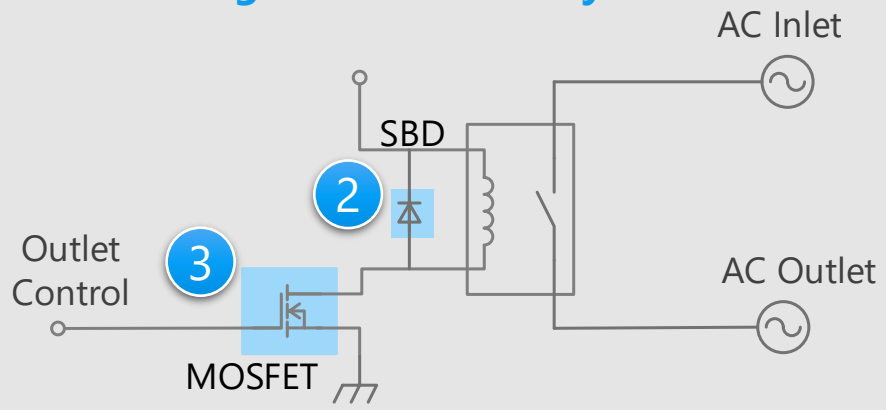
- Since components such as key switches and antennas which may be exposed to the outside environment, ESD protection circuitry may be required.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing electrostatic discharge (ESD) from external terminals**
  TVS diode 1

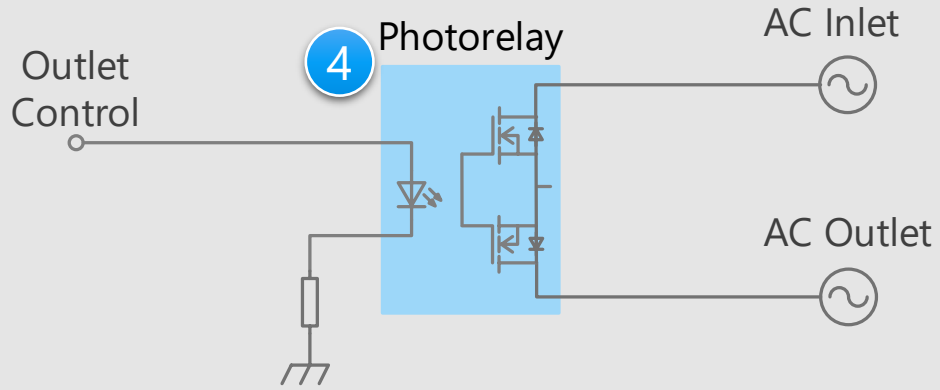
Smart Plug　Details of AC switch section (1)

AC switch circuit using mechanical relay



SBD: Schottky barrier diode

AC switch circuit using photorelay (less than 0.3 A)



* Click on the blue circled numbers above to view detailed descriptions.

Criteria for device selection

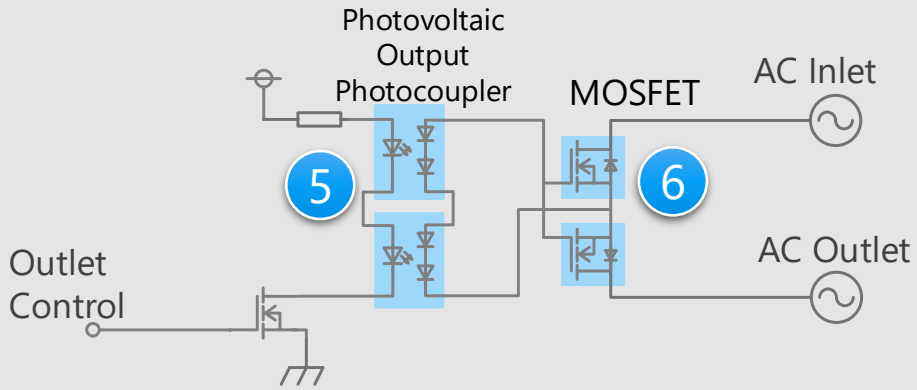
- Schottky barrier diodes are suitable for freewheeling diodes used in inductive loads such as relays.
- Low power AC switches can be realized using photorelays.

Proposals from Toshiba

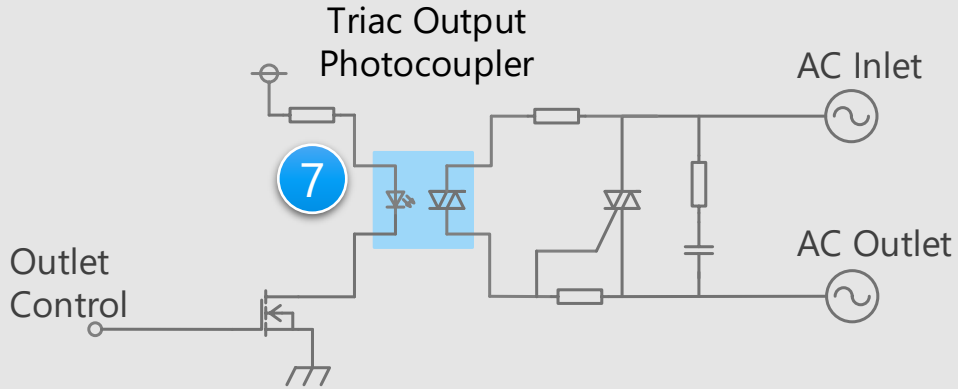
- **Diodes suitable for freewheeling diodes**
  Schottky barrier diode 2
- **Small package and low on-resistance MOSFET**
  Small signal MOSFET 3
- **Designed for high AC isolation voltage**
  Photorelay 4

Smart Plug　Details of AC switch section (2)

AC switch circuit using photovoltaic output photocouplers and MOSFETs (around 0.3 A to 1 A)



AC switch circuit using triac and triac output photocouplers (1 A or more)



* Click on the blue circled numbers above to view detailed descriptions.

Criteria for device selection

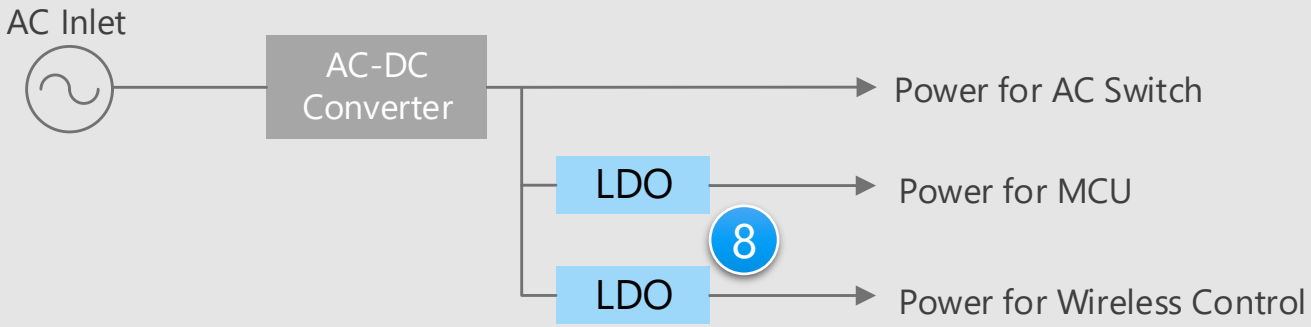
- Isolated AC switch can be realized using a MOSFET driven by a photovoltaic output photocoupler.
- AC switch can be realized using a triac driven by a triac output photocoupler.

Proposals from Toshiba

- **Photocoupler for direct MOSFET driving**
  Photovoltaic output photocoupler 5
- **Suitable for high efficiency power switching**
  DTMOSⅣ Series MOSFET 6
- **Photocoupler suitable for AC control**
  Triac output photocoupler 7

Smart Plug　Detail of power supply

Power supply circuit



* Click on the blue circled numbers above to view detailed descriptions.

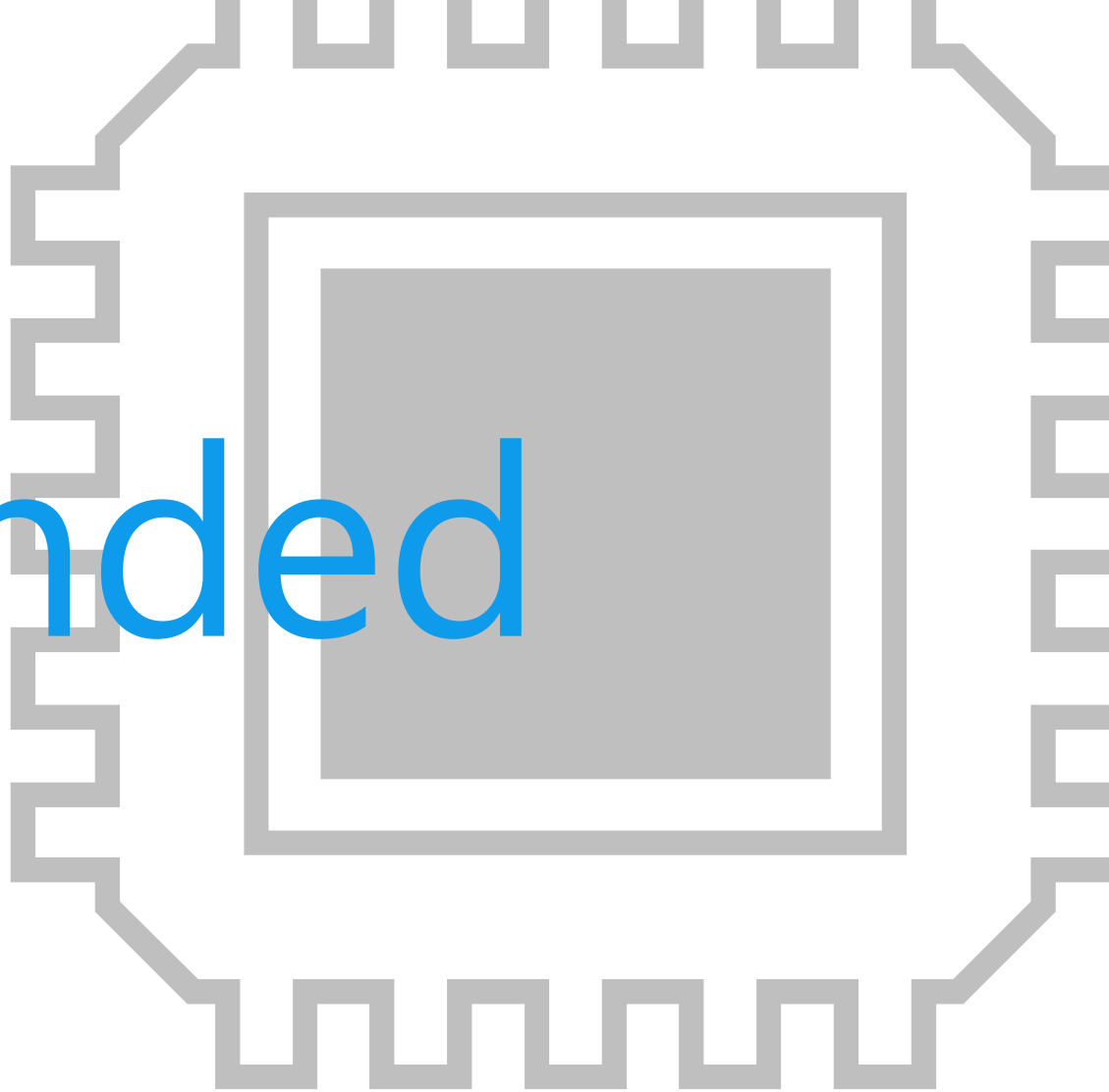
Criteria for device selection

- For the power supply of an IC including an analog circuit such as wireless control, a low noise power supply is required for stable operation of the set.

Proposal from Toshiba

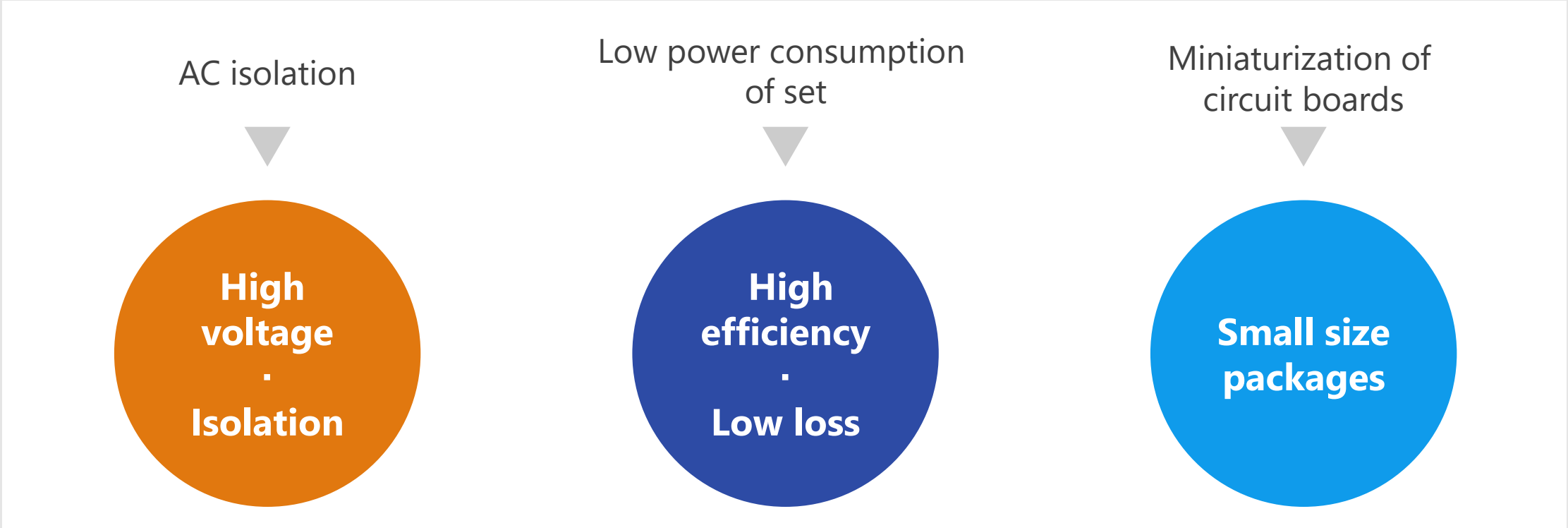
- **Supply the power with low noise**
  Small surface mount LDO regulator 8

Recommended Devices



Device solutions to address customer needs

As described above, in the design of Smart Plug, **"AC isolation"**, **"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 voltage · Isolation	High efficiency · Low loss	Small size packages
1 TVS diode		●	●
2 Schottky barrier diode		●	●
3 Small signal MOSFET		●	●
4 Photorelay	●	●	●
5 Photovoltaic output photocoupler	●	●	●
6 DTMOSⅣ Series MOSFET	●	●	●
7 Triac output photocoupler	●	●	●
8 Small surface mount LDO regulator		●	●

1 TVS diode

DF2B7ASL / DF2B5M4SL / DF2B6M4SL / DF2B6M4BSL

High voltage · Isolation | High efficiency · Low loss | Small size packages

Value provided

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

1 Improved ESD absorption

Improved ESD absorption compared to Toshiba's existing 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.

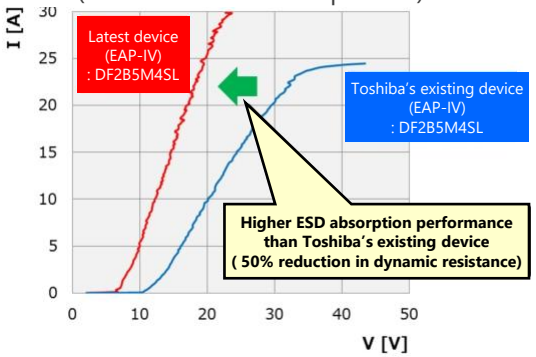
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using Toshiba own technology.

3 Suitable for high density mounting

A variety of compact packages are available.

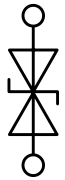
ESD Pulse Absorption Performance
(Toshiba internal comparison)



Unidirectional

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

Bidirectional



Suitable for paths with both polar signals such as audio signals.

Lineup

Part number	DF2B7ASL	DF2B5M4SL	DF2B6M4SL	DF2B6M4BSL
Package	SL2 			
V_{ESD} [kV]	±30	±20	±20	±8
V_{RWM} (Max) [V]	5.5	3.6	5.5	5.5
C_t (Typ.) [pF]	8.5	0.2	0.2	0.12
R_{DYN} (Typ.) [Ω]	0.2	0.5	0.5	1.05

◆Return to Block Diagram TOP

(Note) This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

2 Schottky barrier diode

CRS03 / CRS13

High voltage · Isolation

High efficiency · Low loss

Small size packages

Value provided

The Schottky barrier diode suitable for small equipment applications.

1 High-speed switching

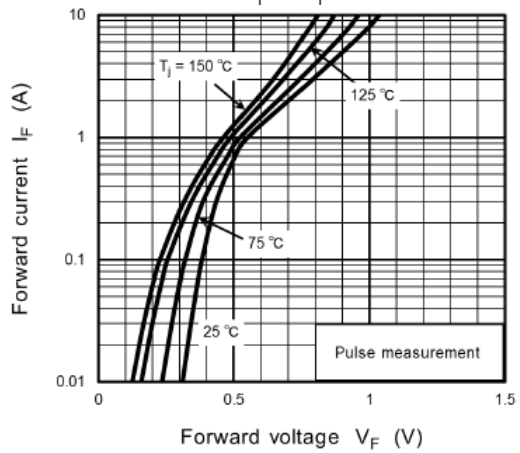
It is suitable for high-speed switching applications.

2 Small package

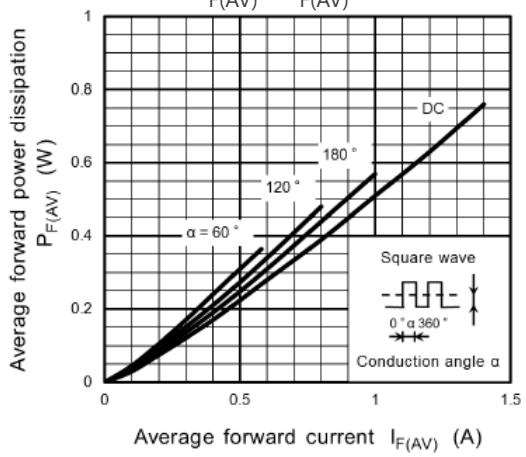
This small package is suitable for high density mounting.

CRS13 Characteristics Curves

$I_F - V_F$



$P_{F(AV)} - I_{F(AV)}$



Lineup

Part number	CRS03	CRS13
Package	S-FLAT™ 	
V_{RRM} [V]	30	60
$I_{F(AV)}$ [A]	1.0	1.0
V_{FM} (Max) [V]	0.45	0.55
I_{RRM} (Max) [μA]	100	50

◆Return to Block Diagram TOP

Value provided

Suitable for power switching and contribute to miniaturization.

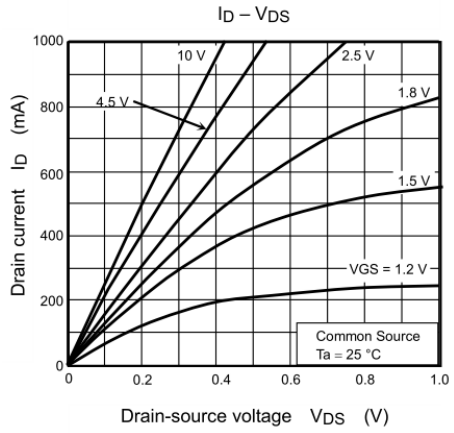
1 Low voltage operation

Operates down to V_{GS} = 1.5 V

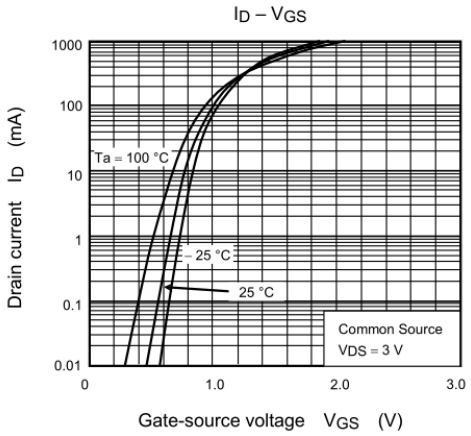
2 Low on-resistance

On-resistance between the drain and source is low and heat generation and power consumption can be kept low.

SSM3K36FS



SSM3K36FS



Lineup

Part number	SSM3K36FS	SSM3K56FS
Package	SSM 	SSM 
V_{DSS} [V]	20	20
I_D [A]	0.5	0.8
P_D [W]	0.15	0.15
$R_{DS(ON)}$ (Max) [Ω] @V_{GS} = 4.5 V	0.66	0.235
Polarity	N-ch	N-ch

◆Return to Block Diagram TOP

Value provided

Photorelay consists of an infrared light emitting diode optically coupled to a photo-MOSFET and is suitable for replacing mechanical relays.

1 Low on-resistance

Maximum on-resistance R_{ON} at turn-on is 2 Ω (at I_{ON} = 0.6 A).

2 Wide range of ON current

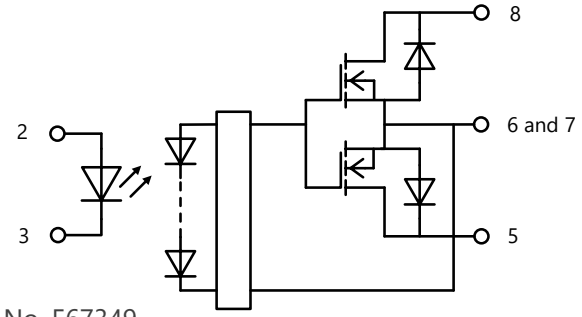
Wide range of allowed ON current I_{ON}, suitable for power line control (maximum 0.6 A : A connected) [Note1]

3 Various lead forming option

Lead forming options (through-hole type and lead forming options. Five total selections) allow design freedom and miniaturization of the set.

[Note1] Please refer to the technical data sheet for connection.

Internal equivalent circuit



UL certified UL1577, File No. E67349
cUL certified CSA Component Acceptance Service No.5A File No. E67349
UL-recognized: UL 508, File No.E499232 [Note2]
VDE-approved: EN 60747-5-5 [Note3]
[Note2] Please refer Absolute Maximum Ratings (UL-recognized UL 508) for UL 508 products.
[Note3] When a VDE approved type is needed, please designate the Option (D4).

Lineup

Part number	TLP3549
Package	DIP8 
V_{OFF} [V]	600
V_{DD} (Max) [V]	480
I_F (Max) [mA]	25
I_{ON} (Max) [A]	0.6
BV_S [Vrms]	2500

◆Return to Block Diagram TOP

5 Photovoltaic output photocoupler

TLP3906 / TLP3910

High voltage · Isolation | High efficiency · Low loss | Small size packages

Value provided

Photocoupler consists of an infrared light emitting diode optically coupled to a photo-diode array and is suitable for driving gate of MOSFET.

1 For MOSFET gate driver

Photodiode is connected in series, suitable for driving the gate of MOSFET.

2 No need to use external discharging resistor

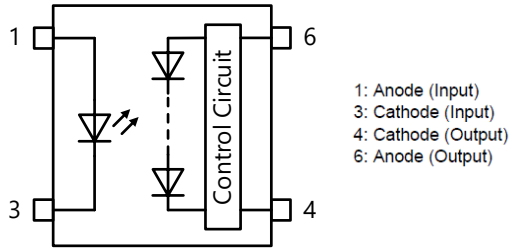
Since the control circuit is on the detector side, there is no need to connect an external discharging resistor.

3 Improved switching speed

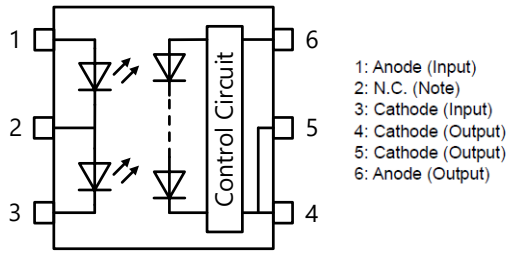
Maximum value of t_{on} and t_{off} are 1 ms and 0.5 ms, respectively. (TLP3910)

Internal equivalent circuit

TLP3906



TLP3910



UL certified UL1577, File No.E67349
cUL certified CSA Component Acceptance Service No.5A File No.E67349
VDE certified EN60747-5-5 (TLP3906/TLP3910), EN62368-1 (TLP3906) [Note]
[Note] To specify a VDE certified model, request a (V4) model

Lineup

Part number	TLP3906	TLP3910
Package	4pin SO6 	SO6L 
I_F [mA]	30	30
V_{OC} (Min) [V]	7	14
I_{SC} (Min) [μA]	12	12
BV_S [Vrms]	3750	5000
Creepage distance (Min) [mm]	5.0	8.0

◆Return to Block Diagram TOP

6 DTMOSⅣ Series MOSFET

TK8P60W / TK16G60W

High voltage · Isolation

High efficiency · Low loss

Small size packages

Value provided

30 % reduction in the figure of merit RonA (compared with Toshiba DTMOSⅢ products), improving power supply efficiency and contributing to miniaturization.

1 RonA 30 % reduction

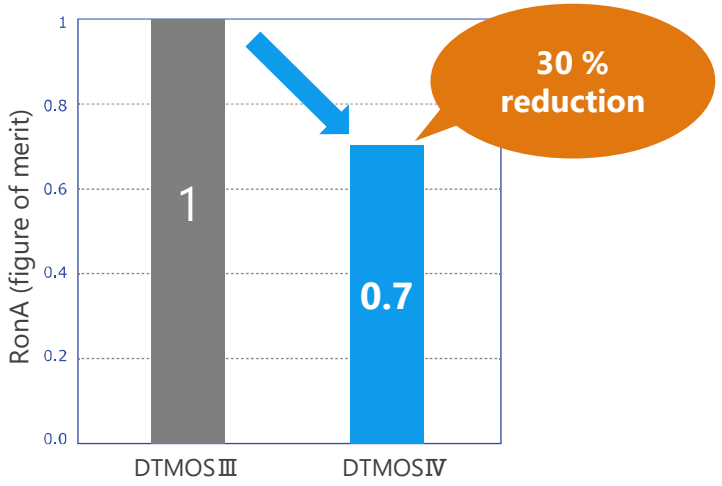
Adoption of the single-epitaxial process to reduce the figure of merit RonA by 30 %. (Compared with DTMOSⅢ products from Toshiba)

2 Reduction of on-resistance increase at high temperature

The single epitaxial process reduces the on-resistance increase at high temperature.

3 Optimization of switching speed

Optimization of switching speed has been achieved by reduction of C_{OSS} (by 12 %, compared with Toshiba conventional products) and others.



[Note] Toshiba internal comparison

Lineup

Part number	TK8P60W	TK16G60W
Package	DPAK 	D2PAK 
V_{DSS} [V]	600	600
I_D [A]	8.0	15.8
P_D [W]	80	130
C_{iss} (Typ.) [pF]	570	1350
$R_{DS(ON)}$ (Max) [Ω]	0.5	0.19
Polarity	N-ch	N-ch

◆Return to Block Diagram TOP

7 Triac output photocoupler

TLP265J / TLP266J / TLP267J / TLP268J

High voltage · Isolation

High efficiency · Low loss

Small size packages

Value provided

Photocoupler suitable for AC switching.

1 Small package (4pin SO6)

Thin 4pin SO6 (3.7 x 7.0 x 2.1 mm) package allows high density mounting.

2 High isolation voltage (3750 Vrms)

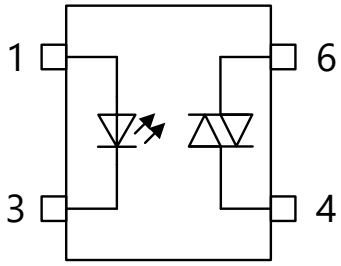
Isolation voltage is 3750 Vrms. Insulator thickness is 0.4 mm, creepage and clearance distances are 5.0 mm. Compliant with reinforced insulation safety standards.

3 Compatible with zero-cross output

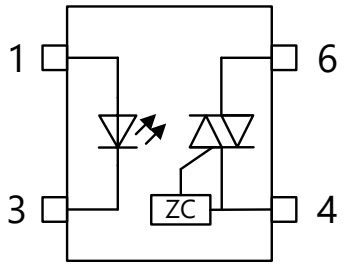
Maximum output current is 70 mA. Higher output is possible using main triac connection. Zero-cross (ZC) compatible output is also available.

Pin layout

TLP265J / TLP267J



TLP266J / TLP268J



1. Anode
3. Cathode
4. Triac pin
6. Triac pin

Lineup

Part number	TLP265J	TLP266J	TLP267J	TLP268J
Package	4pin SO6 			
Output Type	Non-ZC	ZC	Non-ZC	ZC
V_{DRM} [V]	600			
I_{FT} (Max) [mA]	10		3	
$I_{T(RMS)}$ [mA]	70			
BV_S [Vrms]	3750			

◆Return to Block Diagram TOP

8 Small surface mount LDO regulator

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

High voltage · Isolation | High efficiency · Low loss | 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 the latest generation process significantly improved the dropout voltage characteristics.

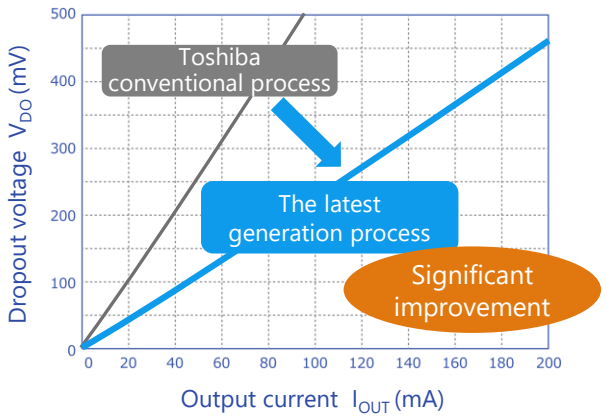
2 High PSRR Low output noise voltage

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

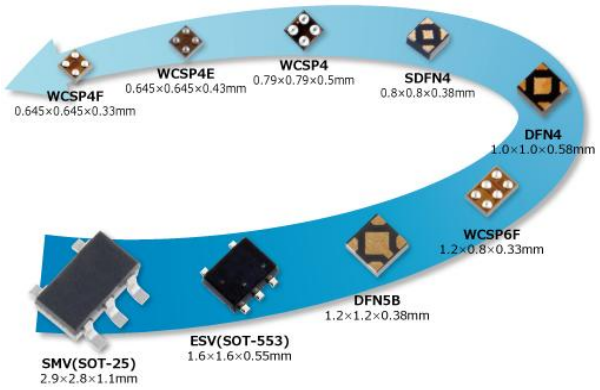
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology.
(TCR3U Series)

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		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

◆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:

Contact address: https://toshiba.semicon-storage.com/ap-en/contact.html

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