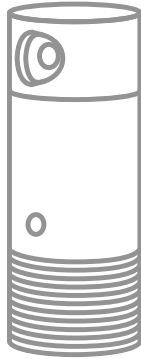
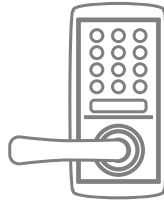
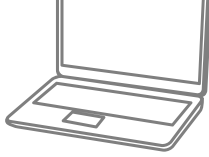


Smart Speaker

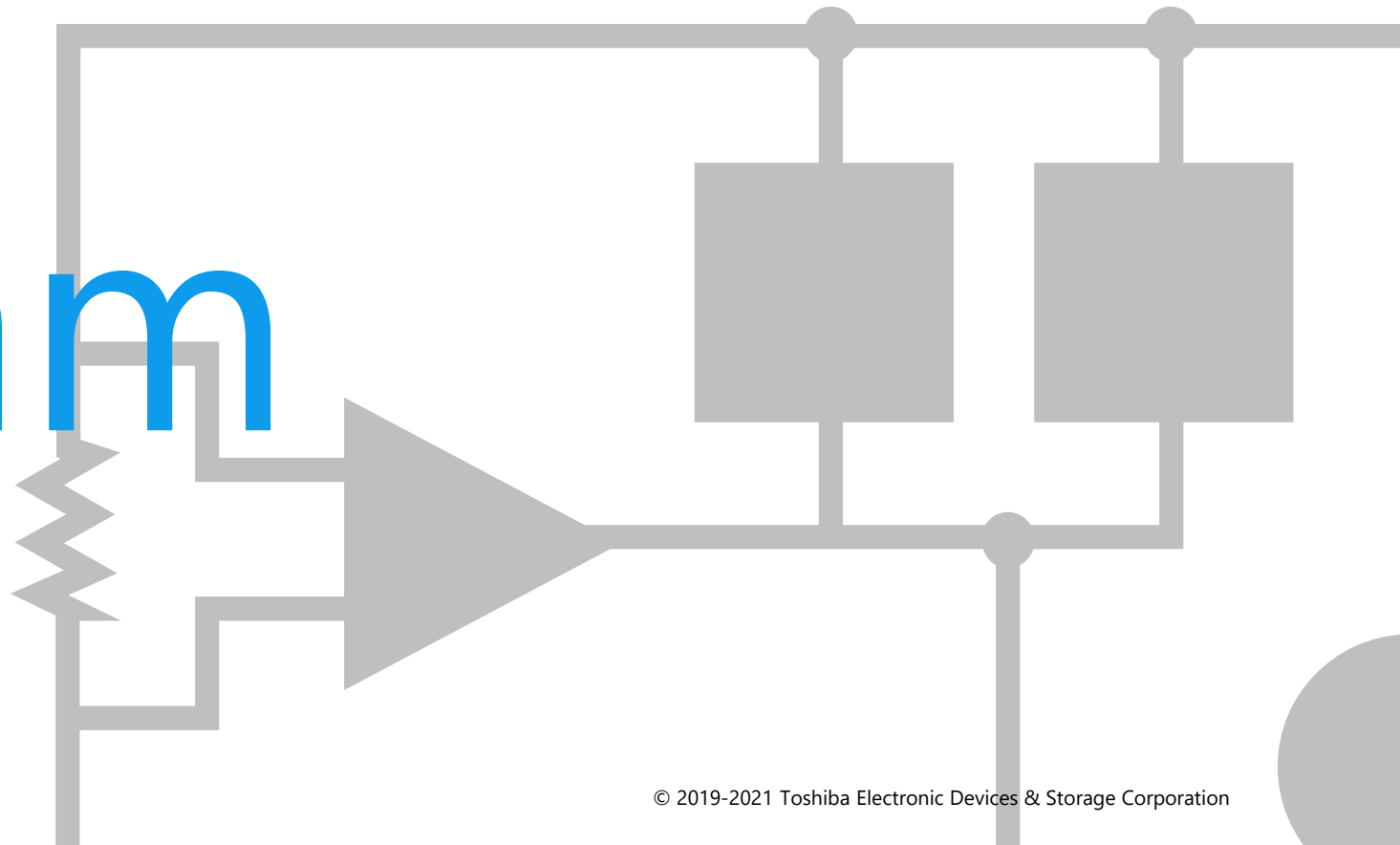
Solution Proposal by Toshiba



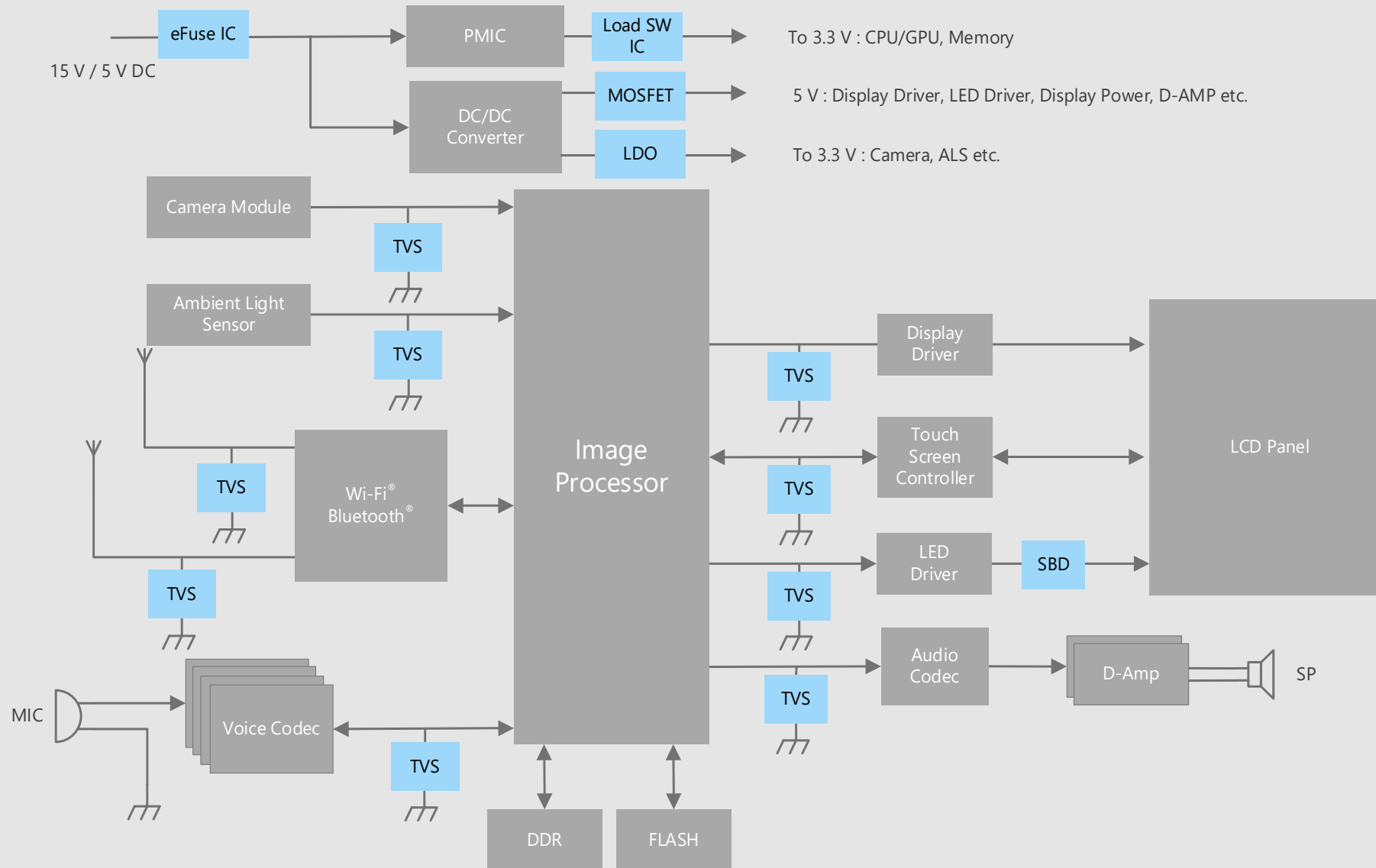


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

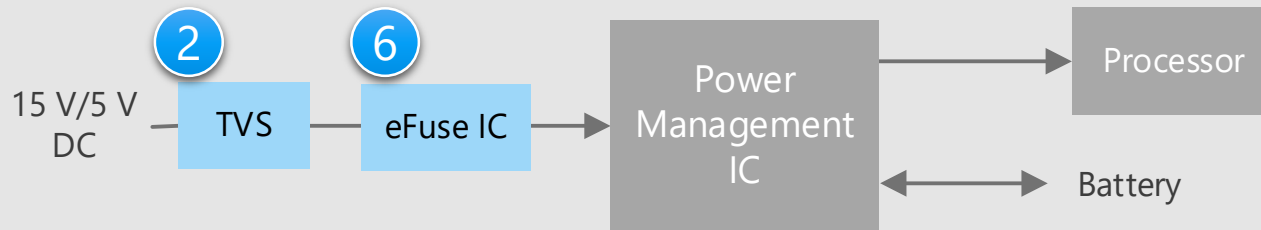


Smart Speaker Overall block diagram

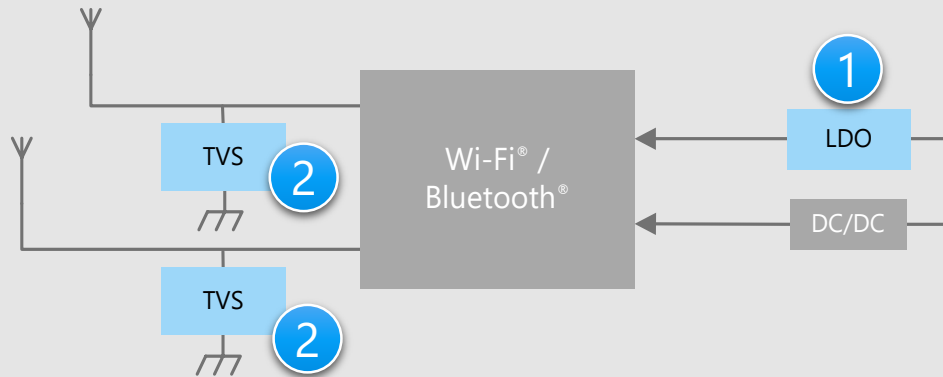


Smart Speaker Detail of Wi-Fi / Bluetooth circuit

Power supply circuit



Wi-Fi / Bluetooth solution



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

Criteria for device selection

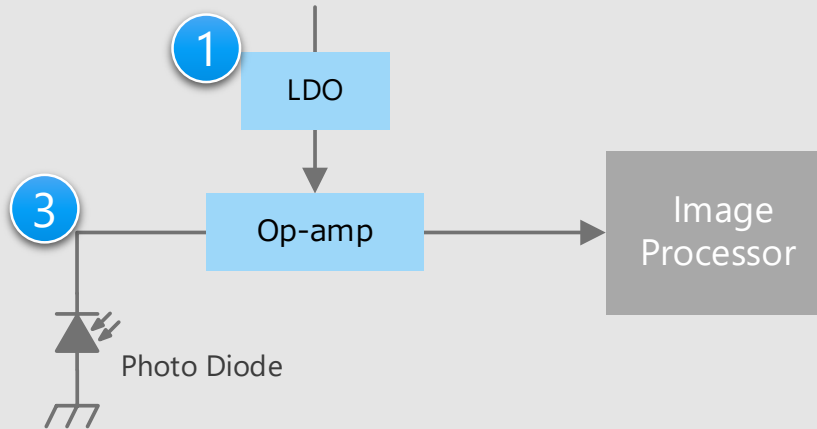
- Power Supply Rejection Ratio (PSRR) is a key characteristic for wireless systems.
- Wi-Fi system requires high-current power supply.
- A small Transient Voltage Suppressor (TVS) with low C_t is suitable for ESD protection without attenuating the antenna signal.

Proposals from Toshiba

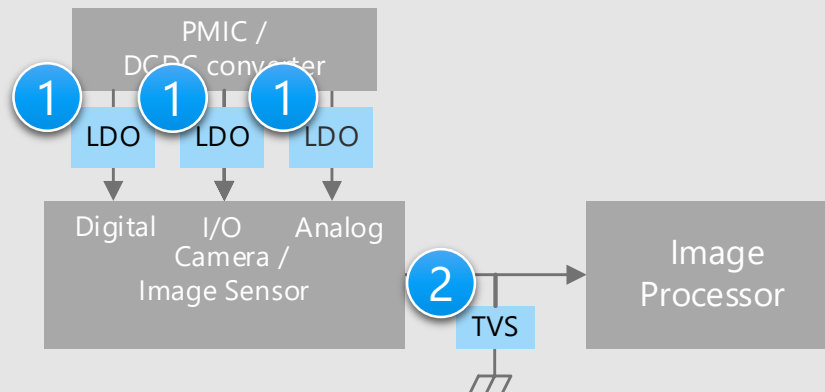
- **Realize noise-resistant power supply**
Small surface mount LDO regulator 1
- **Absorb Electro Static Discharge (ESD) from antennas and prevent malfunction of the circuit**
TVS diode 2
- **Robust protection function**
Electronic fuse (eFuse IC) 6

Smart Speaker Detail of sensor / camera circuit

Ambient light sensor



Camera modules



Criteria for device selection

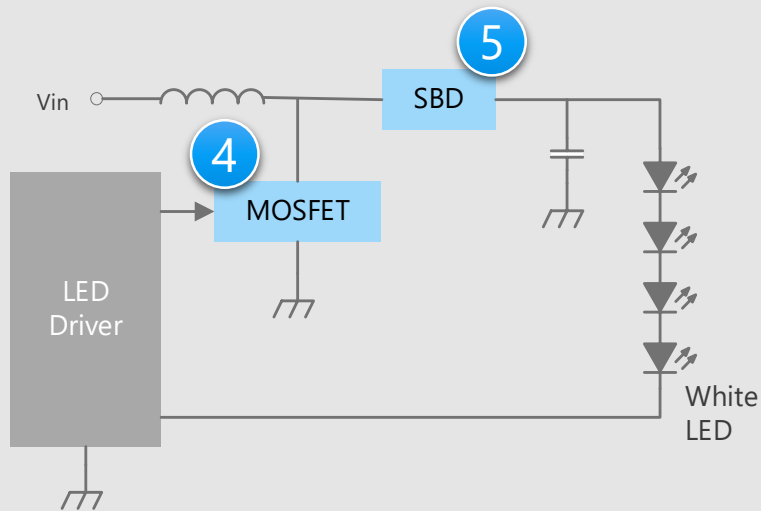
- A low noise operational amplifier is desirable for the sensor block.
- Power Supply Rejection Ratio (PSRR) is a key characteristic for camera module.
- The low C_t , small package transient voltage suppressor (TVS) is ideal for ESD protection.

Proposals from Toshiba

- **Realize noise-resistant power supply**
Small surface mount LDO regulator 1
- **Absorb Electro Static Discharge (ESD) from external terminals and prevent malfunction of the circuit**
TVS diode 2
- **Amplify the detected weak signal with low noise**
Low noise operational amplifier 3

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

LCD backlight



Criteria for device selection

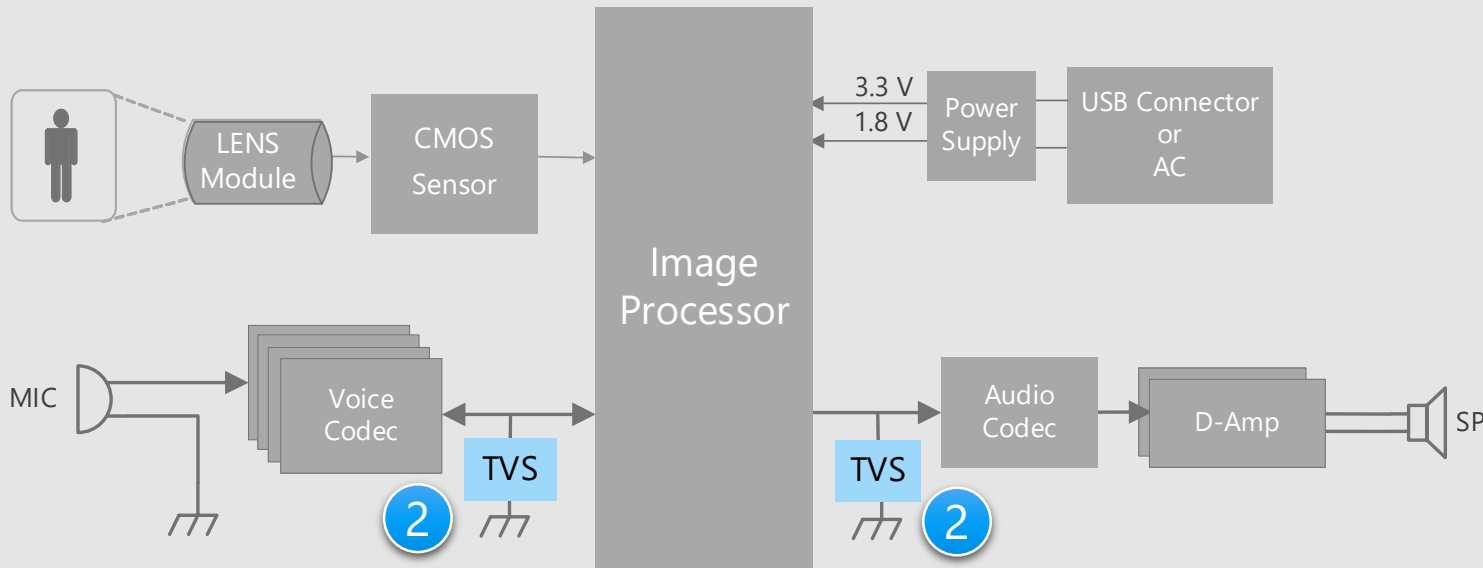
- Schottky Barrier Diode (SBD) requires low V_F and low I_R .
- High-voltage MOSFET is optimum for the boost converter.

Proposals from Toshiba

- **Realize a set with low power consumption by low on-resistance**
Small-signal MOSFET 4
- **High speed and low loss diode with a small surface mount package**
Schottky barrier diode 5

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

Smart Speaker Detail of camera motion section



Criteria for device selection

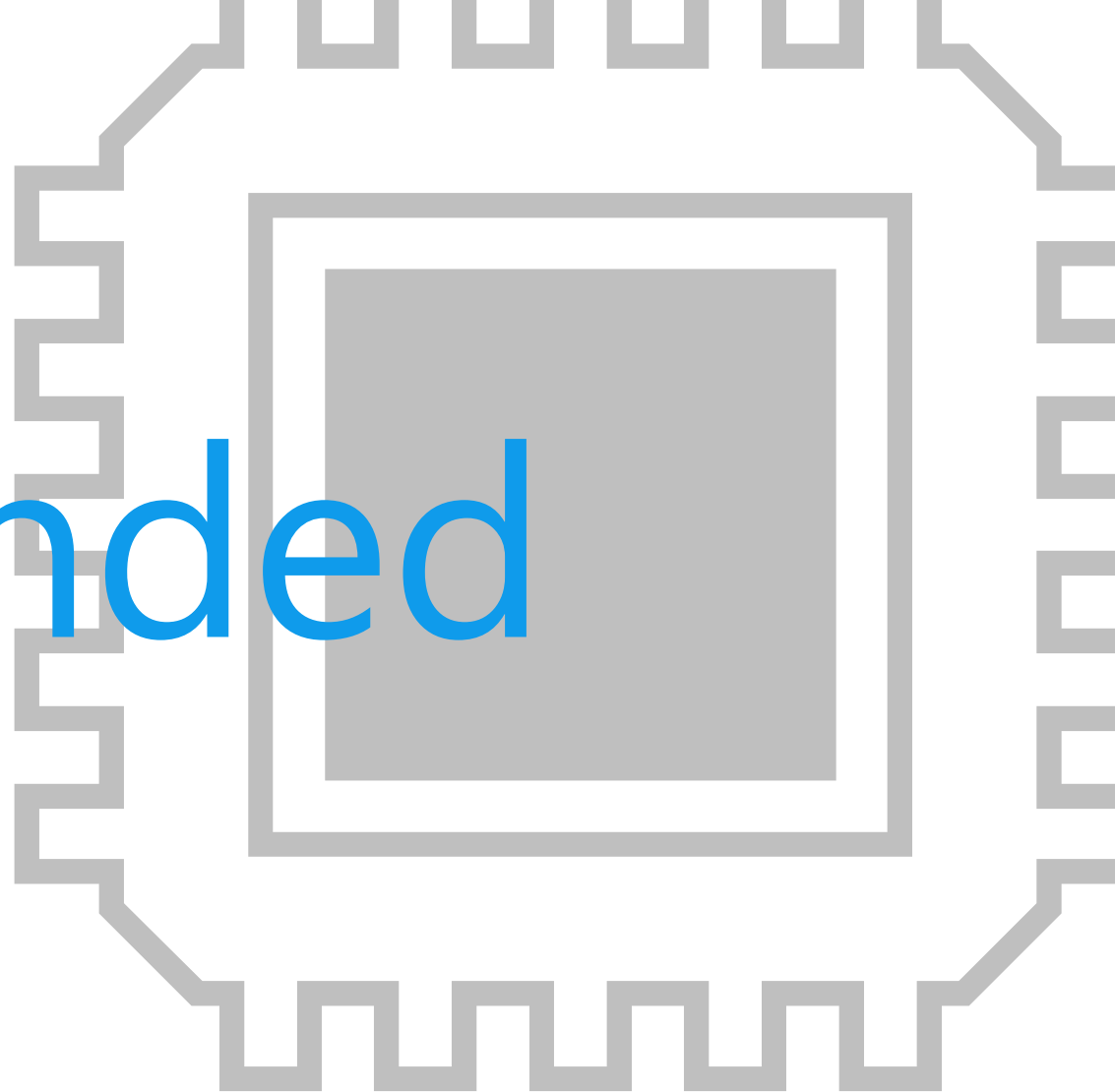
- The low C_t small package transient voltage suppressor (TVS) is ideal for ESD protection.

Proposals from Toshiba

- **Absorb Electro Static Discharge (ESD) from external terminals and prevent malfunction of the circuit**
TVS diode

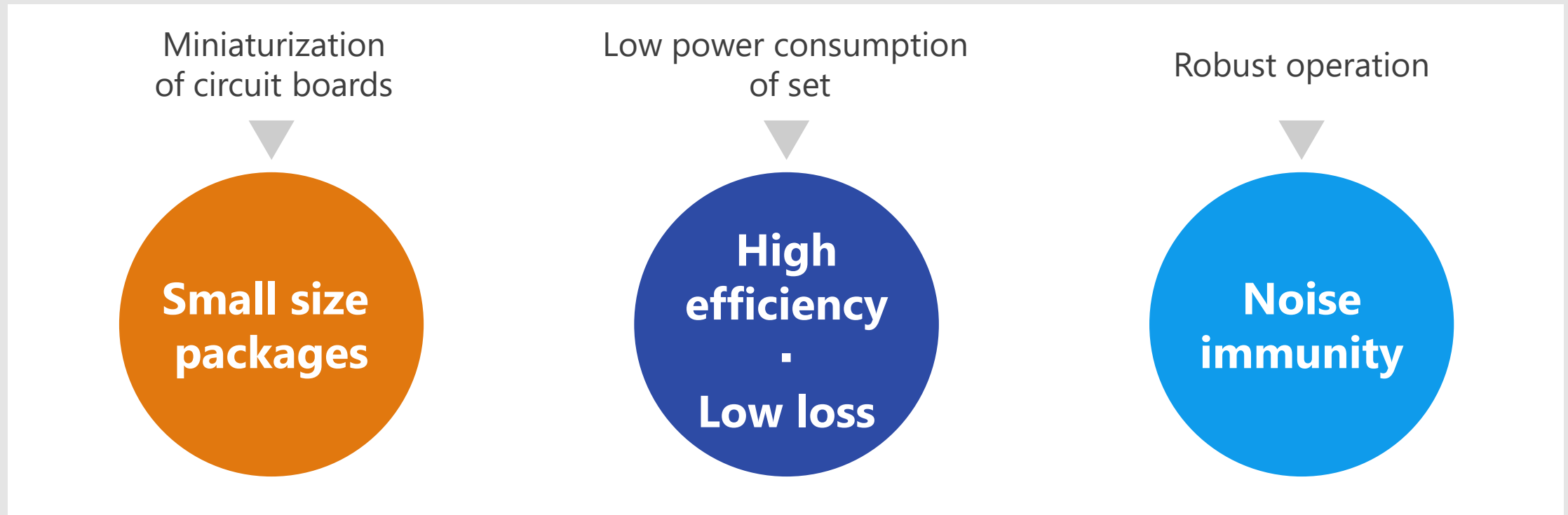
※ Click the number in the circuit diagram to jump to the detailed description page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of smart speakers, “**Miniaturization of circuit boards**”, “**Low power consumption of 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 Small surface mount LDO regulator	●	●	●
② TVS diode	●	●	●
③ Low noise operational amplifier	●	●	
④ Small-signal MOSFET	●	●	
⑤ Schottky barrier diode	●	●	
⑥ Electronic fuse (eFuse IC)	●	●	●

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 newly developed new-generation process significantly improved the drop-out voltage characteristics.

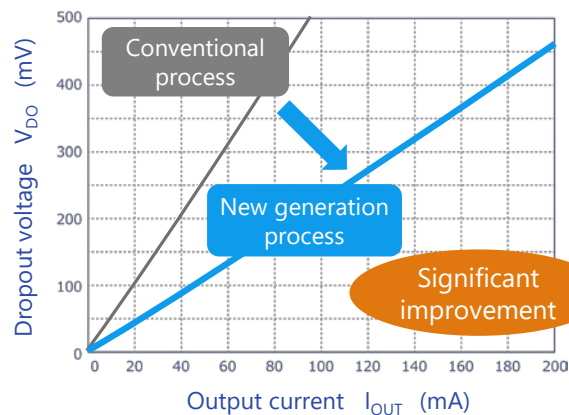
2 High PSRR Low output noise voltage

Many product series that realize both high ripple rejection and low output noise voltage characteristics are provided. They are suitable for stable power supply for analog circuit.

3 Low current consumption

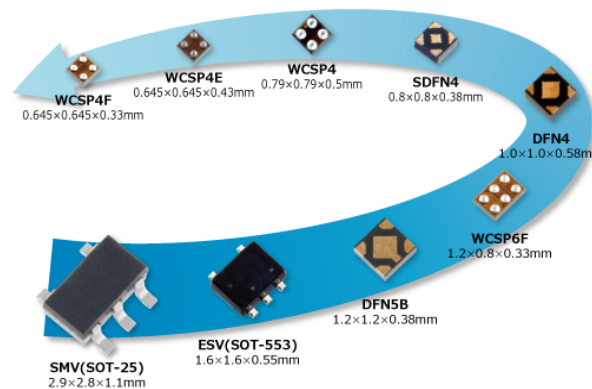
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology.

Low dropout voltage



Note: Toshiba internal comparison

Rich package line up



Line up

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	52	20	19	7	7	0.34	1	170

[Return to Block Diagram TOP](#)

Value provided

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

1 High ESD pulse absorption performance

For some products, both low operating resistance and low capacitance are realized and ensures high signal protection performance and signal quality.

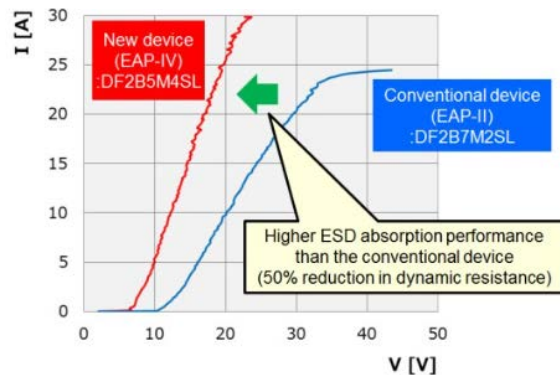
2 Suppress ESD energy by low clamp voltage

Steadily protect the connected circuits/devices using Toshiba own technology.

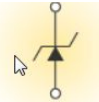
3 Optimal for high-density mounting

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

Line up

Part number	DF2B6M4SL	DF2B20M4SL	DF2B5BSL	DF2B5PCT	DF2B7PCT
Package	SL2 			CST2 	
V_{ESD} [kV]	±20	±15	±23	±30	±30
V_{RWM} (Max) [V]	5.5	18.5	3.3	3.6	5.5
C_t (Typ.) [pF]	0.2	0.2	11	41	45
R_{DYN} (Typ.) [Ω]	0.5	0.2	0.2	0.1	0.1
Purpose	For Signal line	For Signal line For Power line	For Power line	For Power line	For Power line For Audio line

(NOTE) : This product is an ESD protection diode and cannot be used for purposes other than ESD protection (including but not limited to voltage regulation diode applications).

[◆Return to Block Diagram TOP](#)

3 Low noise operational amplifier

TC75S67TU

Small size
packages

High
efficiency
·
Low loss

Noise
immunity

Value provided

Very small signals detected by various sensors can be amplified with very low noise.

1 Low noise

$V_{NI} = 6.0$ [nV/ $\sqrt{\text{Hz}}$] (Typ.)
@f = 1 kHz

Very small signals detected by various sensors [Note 1] can be amplified with low noise using CMOS operational amplifier by optimizing the processing. We achieved one of the industry's lowest [Note 2] input equivalent noise voltage.

2 Low current consumption

$I_{DD} = 430$ [μA] (Typ.)

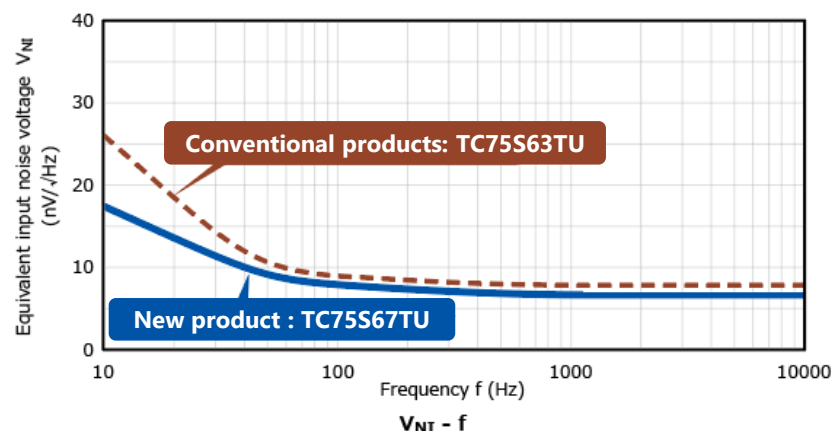
The low current consumption characteristics of CMOS processing contributes to the extension of battery life of the compact IoT devices [Note 3].

3 Enhancement type

It is easy to handle because it is an enhancement type in which no drain current flows when no gate voltage is applied.

Low-noise characteristic

(Toshiba internal comparison)



Line up

Part number	TC75S67TU
Package	UFV 
$V_{DD,SS}$ (Max) [V]	± 2.75
$V_{DD,SS}$ (Min) [V]	± 1.1
I_{DD} (Max) [μA]	700
V_{NI} (Typ.) [nV/ $\sqrt{\text{Hz}}$] @f = 1 kHz	6

[Note 1] Sensor types: vibration detection sensor, shock sensor, accelerometer, pressure sensor, infrared sensor, and temperature sensor, etc.

[Note 2] Based on Toshiba data (as of May 2017) [Note 3] Compared with Toshiba's operational amplifier using bipolar processing

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Value provided

Suitable for power management switches and greatly contributes to miniaturization.

1 Low voltage drive

It drives at $V_{GS} = 4.0\text{ V}$.

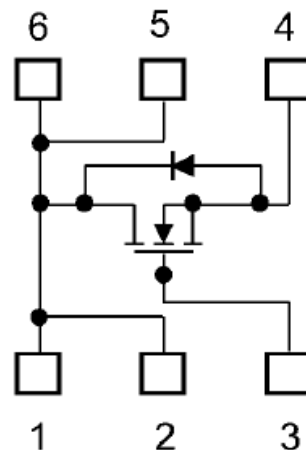
2 Low on-resistance

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

3 Small package

Small package is suitable for high-density mounting.

SSM6K514NU
Equivalent circuit



Line up

Part number	SSM3K341R	SSM6K514NU	SSM3K15ACT
Package	SOT-23F 	UDFN6B 	CST3 
Polarity	N-ch	N-ch	N-ch
V_{DSS} [V]	60	40	30
I_D [A]	6	12	0.1
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 4.5\text{ V}$	Typ.	36	11.2
	Max	51	17.3
			2.3 @ $V_{GS} = 4\text{ V}$
			3.6 @ $V_{GS} = 4\text{ V}$

[◆Return to Block Diagram TOP](#)

5 Schottky barrier diode

CUS10F30 / CTS05F40

Small size
packages

High
efficiency
·
Low loss

Noise
immunity

Value provided

Schottky barrier diode with low V_F and low I_R is suitable for high efficiency diode rectification application.

1 High speed switching

Suitable for high speed switching applications.

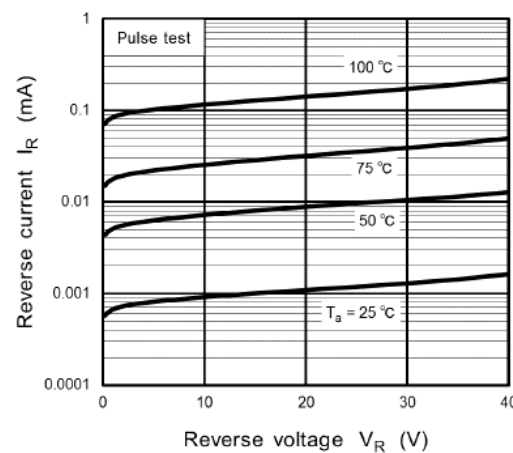
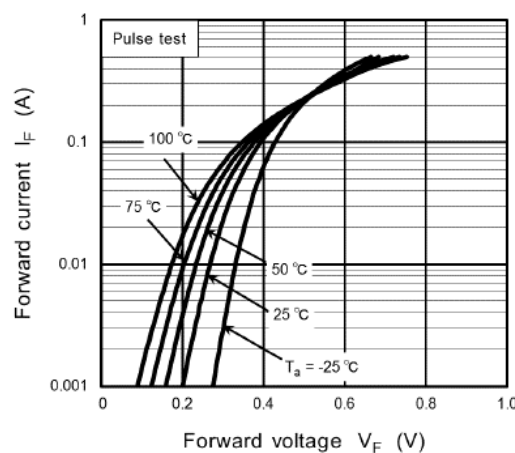
2 Resistant to reverse voltage

Reverse voltage (V_R) is high.
(CTS05F40: maximum rating of V_R is 40 V)

3 Small package

Small package is suitable for high density mounting.

CTS05F40 Characteristics chart



Line up

Part number	CUS10F30	CTS05F40
Package	USC 	CST2 
V_R (Max) [V]	30	40
I_O (Max) [A]	1.0	0.5
V_F (Max) [V]	0.50	0.81
I_R (Max) [μ A]	50	15

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6 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.

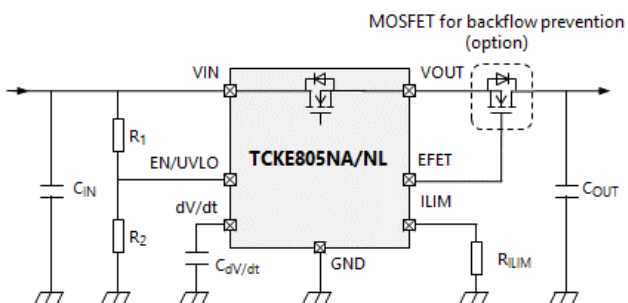
Note: TCKE712BNL is scheduled to be certified in Sep. 2021.

3 Rich protection functions

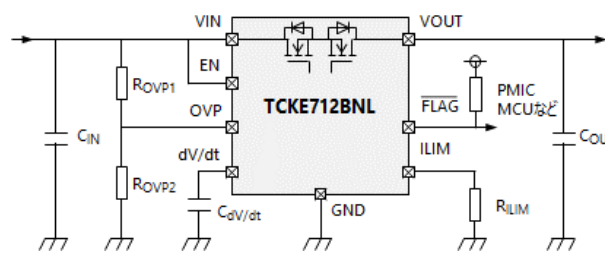
TCKE8 Series: short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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



Line up

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	15.0	Adjustable

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