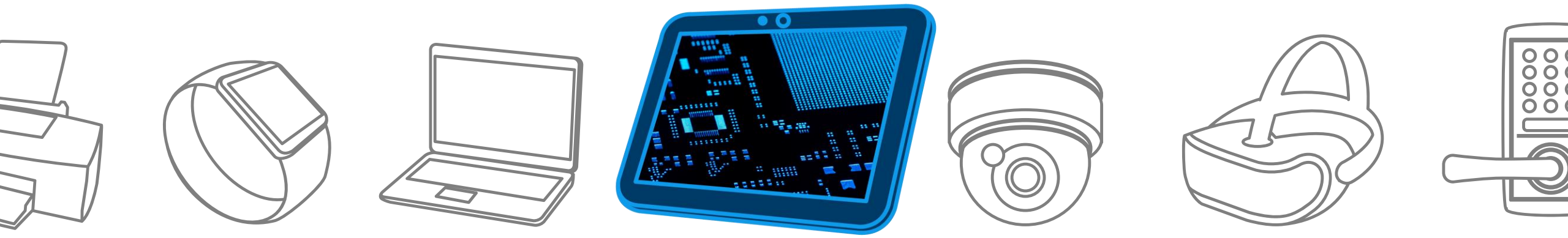
TOSHIBA

R23

Tablet Device

Solution Proposal by Toshiba



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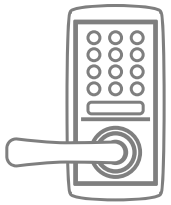

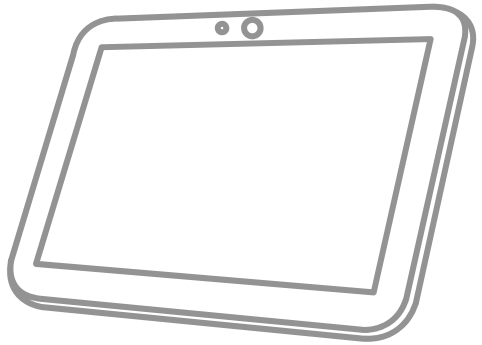

Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

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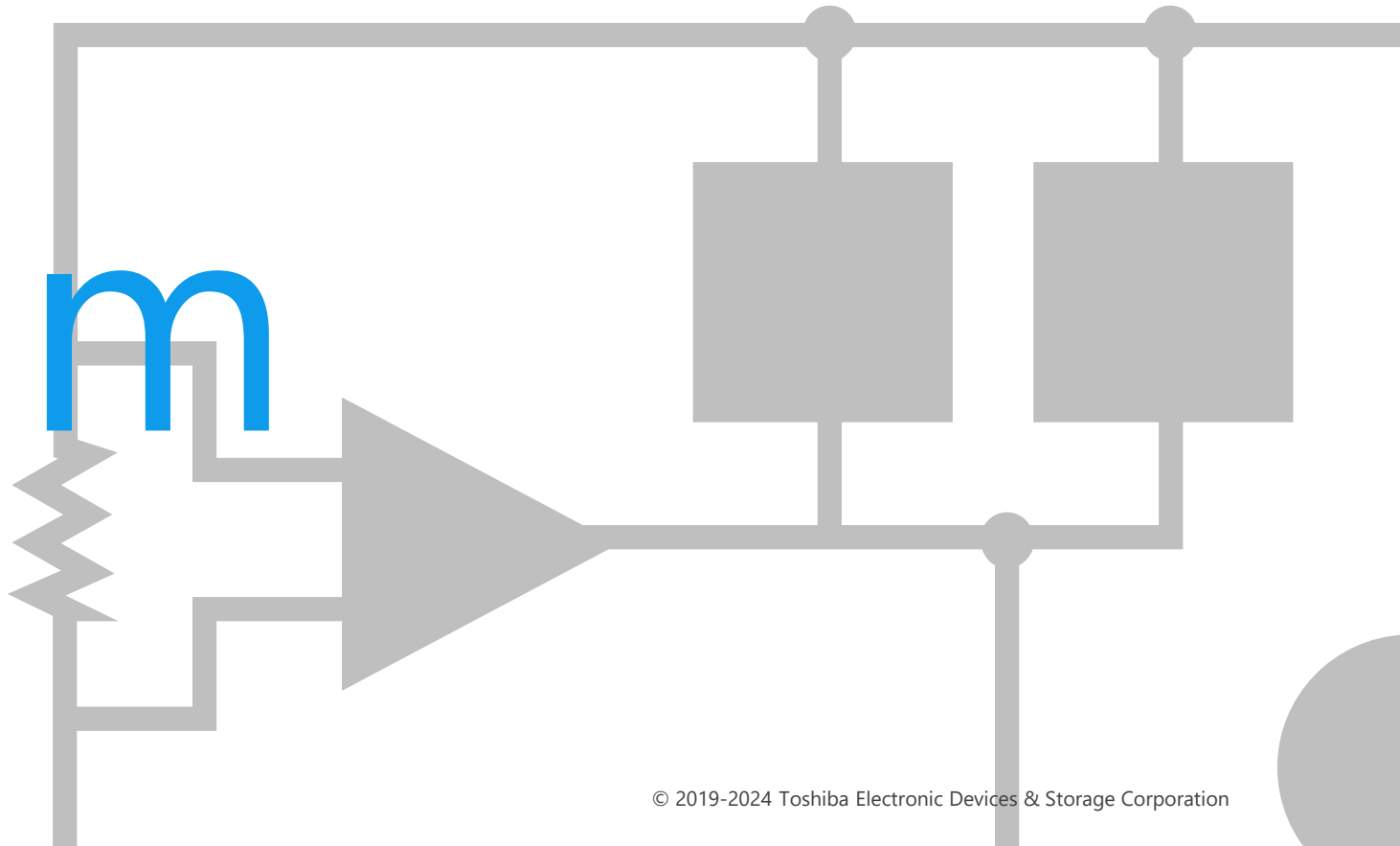
Block Diagram



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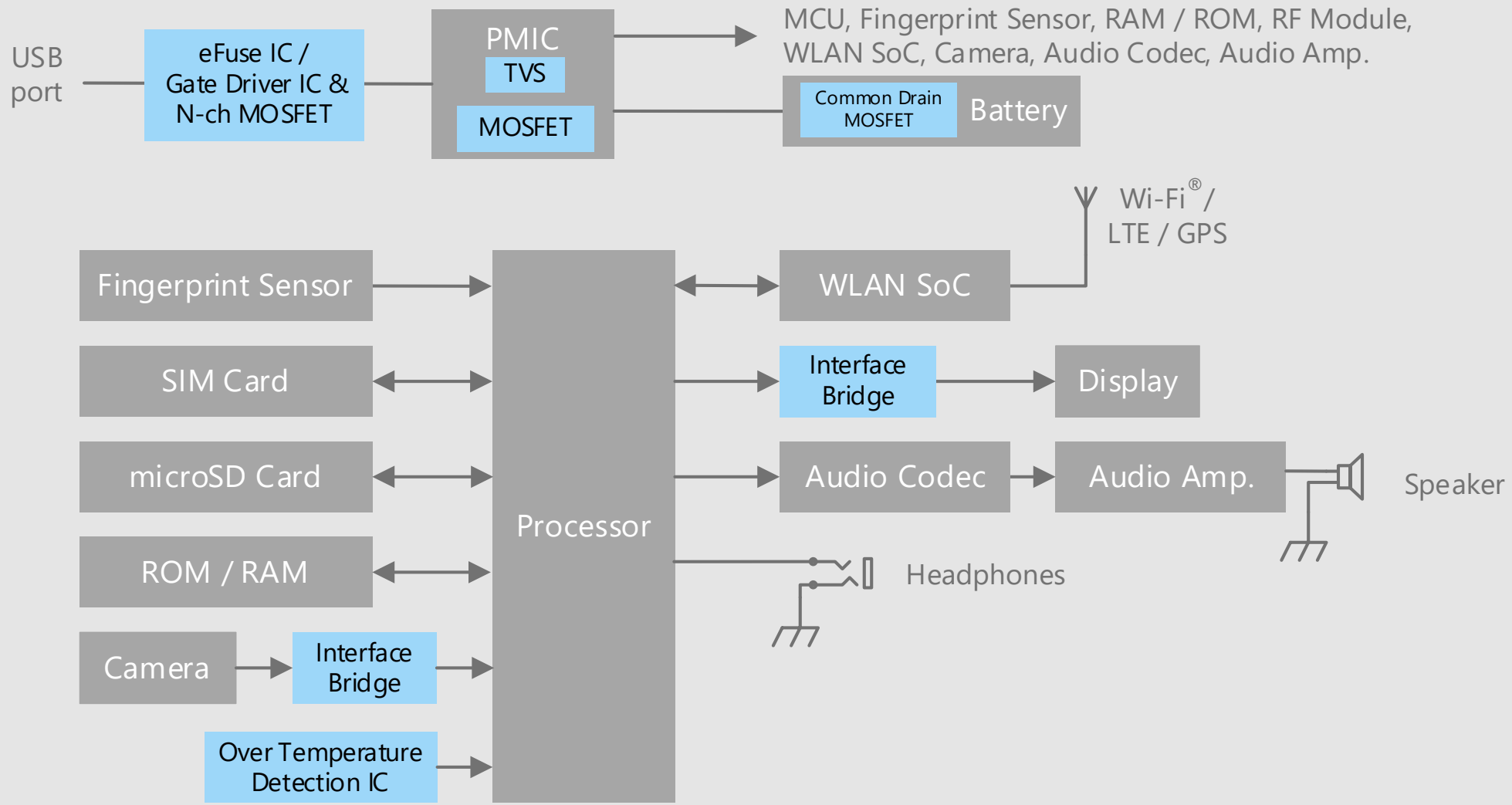
Tablet Device　Overall block diagram



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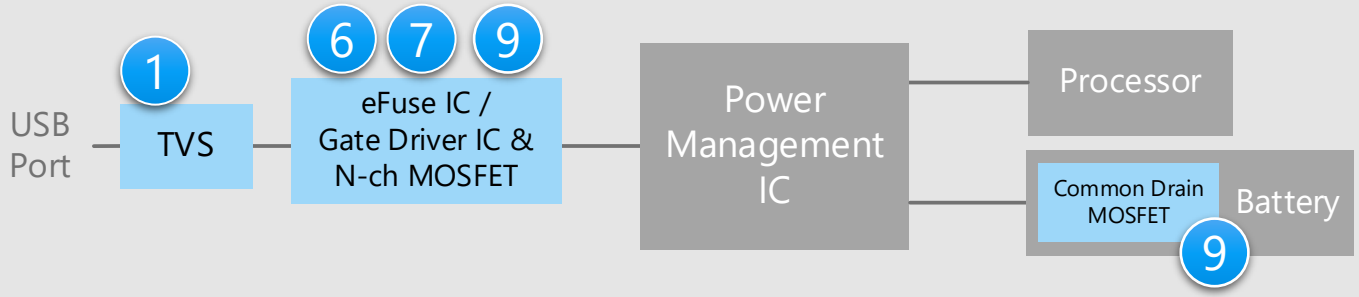
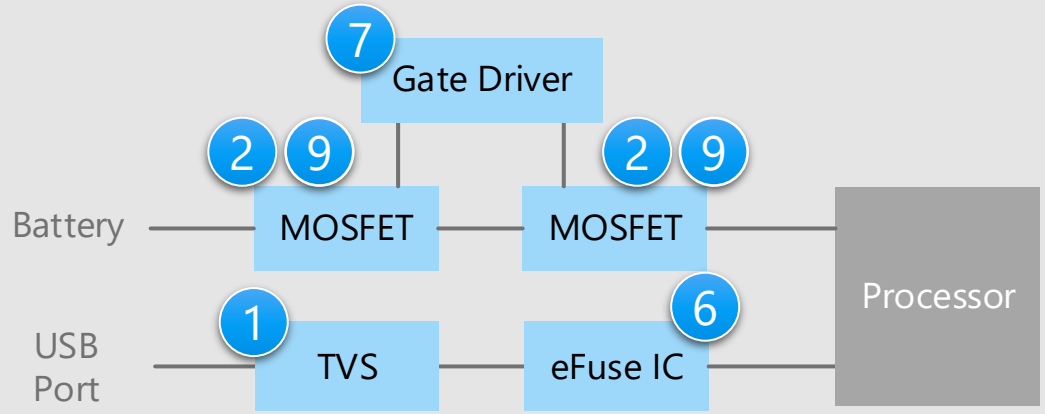
Tablet Device　Details of power supply unit

System power circuit

Method using power controller



Method without power controller



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

Criteria for device selection

- TVS diodes are suitable for ESD protection of power line.
- MOSFETs with low on-resistance are suitable for the control of USB and battery powered supply circuits.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals** 1
  TVS diode
- **Realize the set with low power consumption by low on-resistance** 2
  Small signal MOSFET
- **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
- **Low on-resistance and small package** 9
  N-ch common drain MOSFET

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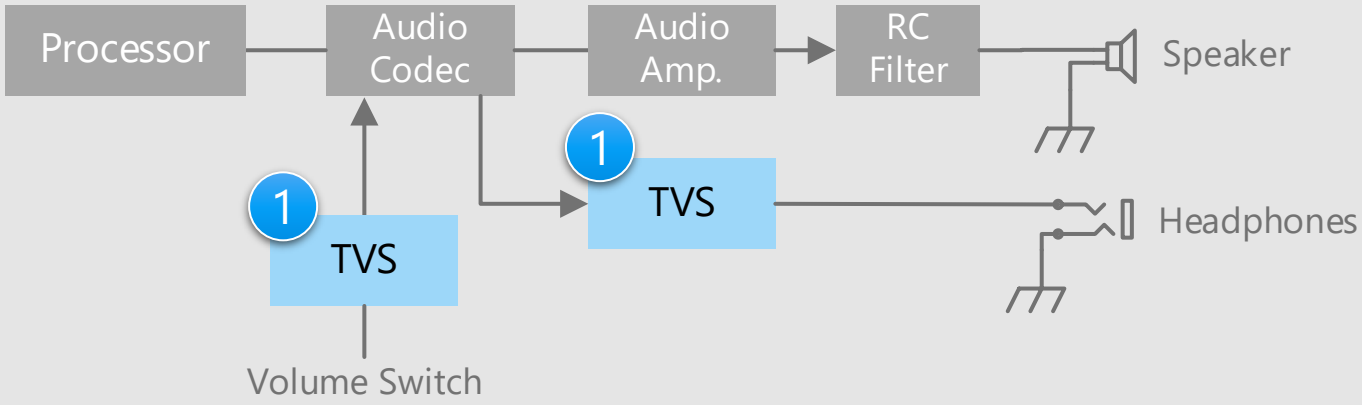
Tablet Device　Detail of audio unit

Audio unit circuit



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

Criteria for device selection

- TVS diodes are suitable for ESD protection of signal line.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals**
  TVS diode 1

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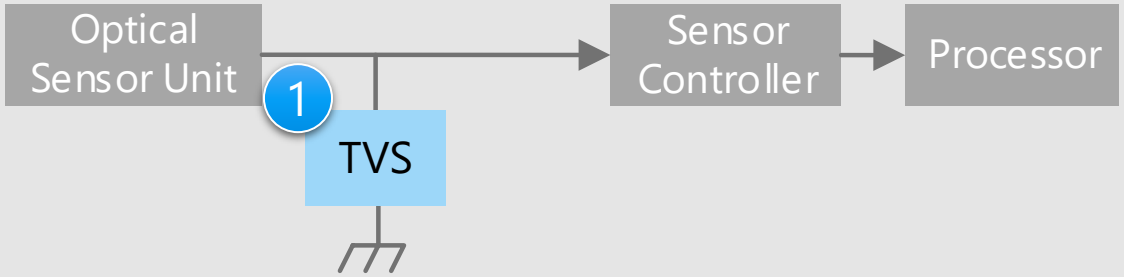
Tablet Device　Details of touch sensor unit

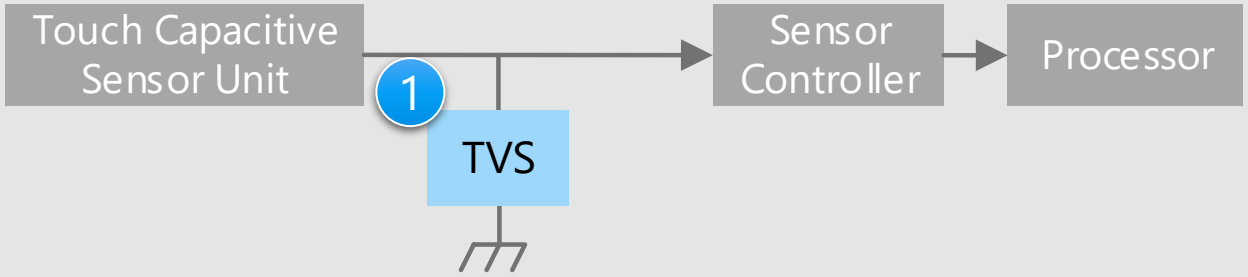
Touch sensor circuit

Optical type



Touch sensor circuit

Capacitive type



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

Criteria for device selection

- TVS diodes are suitable for ESD protection of signal line.
- Small package products contribute to the reduction of circuit board area.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals**
  TVS diode 1

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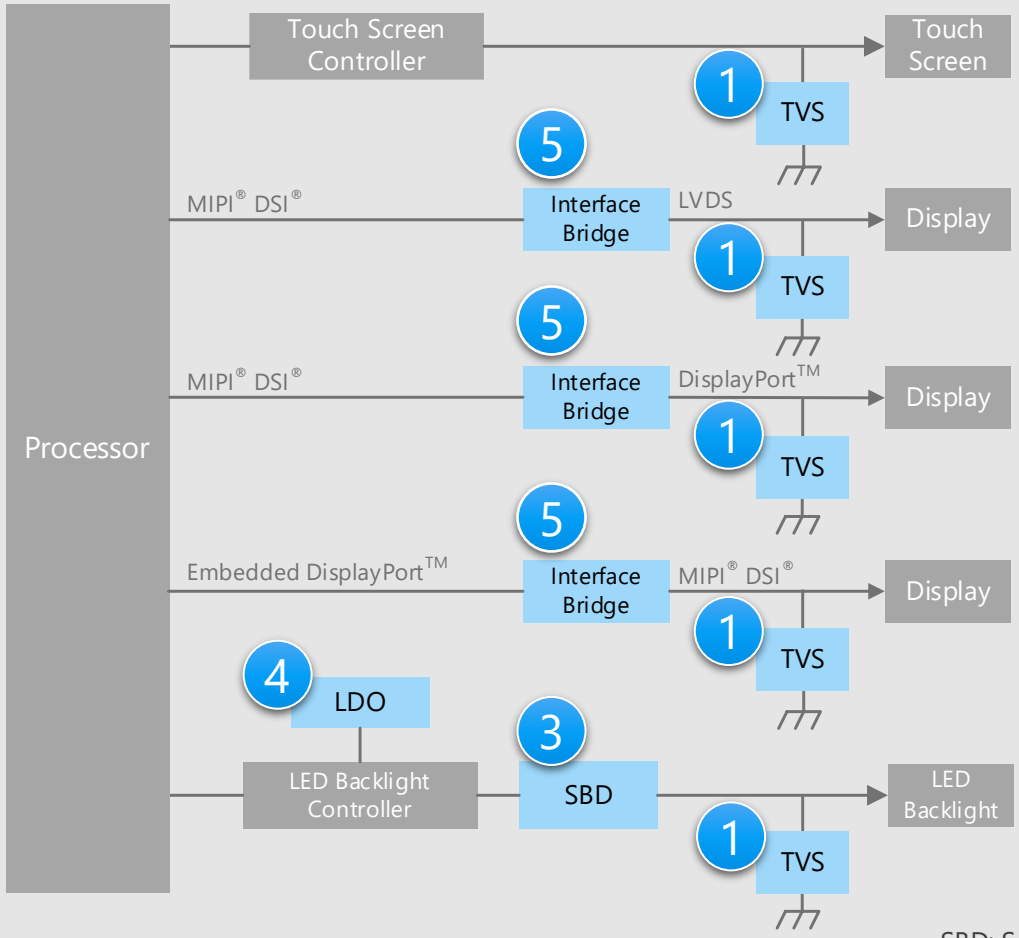
Tablet Device　Detail of display unit

Display unit circuit



SBD: Schottky barrier diode

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

Criteria for device selection

- TVS diodes are suitable for ESD protection of signal line.
- By using a Schottky barrier diode with low V_F and low I_R, the power consumption of the set can be reduced.
- Small package products contribute to the reduction of circuit board area.
- By using interface bridge, display and camera components can be selected without any concern for interface standards.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals**
  TVS diode (1)
- **High speed, low loss**
  Schottky barrier diode (3)
- **Supply the power with low noise**
  Small surface mount LDO regulator (4)
- **Eliminate differences between interfaces**
  Interface bridge (5)

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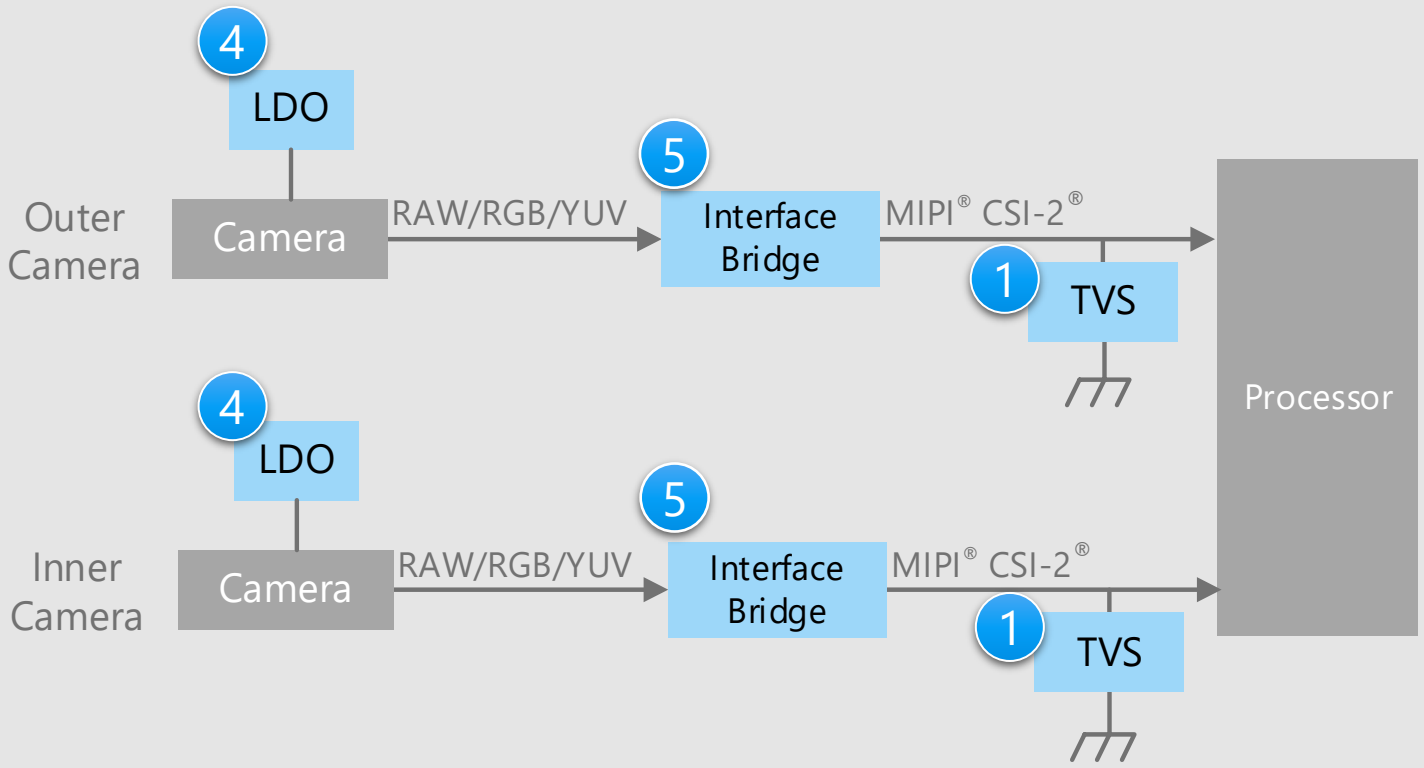
Tablet Device　Detail of camera unit

Camera unit circuit



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

Criteria for device selection

- PSRR (Power Supply Rejection Ratio) of LDO regulator is an important parameter for camera modules.
- TVS diodes are suitable for ESD protection of signal line.
- Small package products contribute to the reduction of circuit board area.
- By using interface bridge, display and camera components can be selected without any concern for interface standards.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals**
  TVS diode 1
- **Supply the power with low noise**
  Small surface mount LDO regulator 4
- **Eliminate differences between interfaces**
  Interface bridge 5

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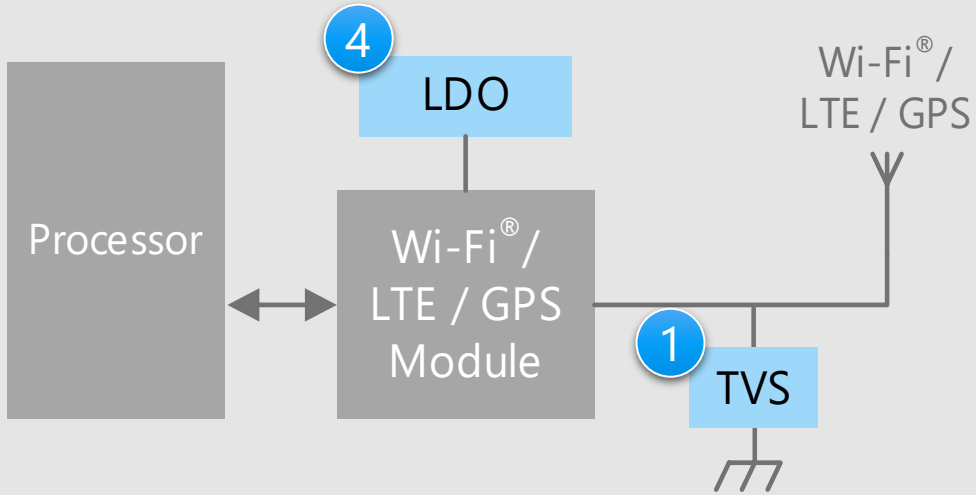
Tablet Device　Detail of wireless unit

Wireless communication circuit



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

Criteria for device selection

- Small package products contribute to the reduction of circuit board area.
- A small TVS diode with low C_t is suitable for ESD protection without attenuating the antenna signal.
- LDO regulator that can supply large current is suitable for the wireless module.

Proposal from Toshiba

- **Prevent circuit malfunctions by absorbing static electricity from external terminals**
  TVS diode 1
- **Supply the power with low noise**
  Small surface mount LDO regulator 4

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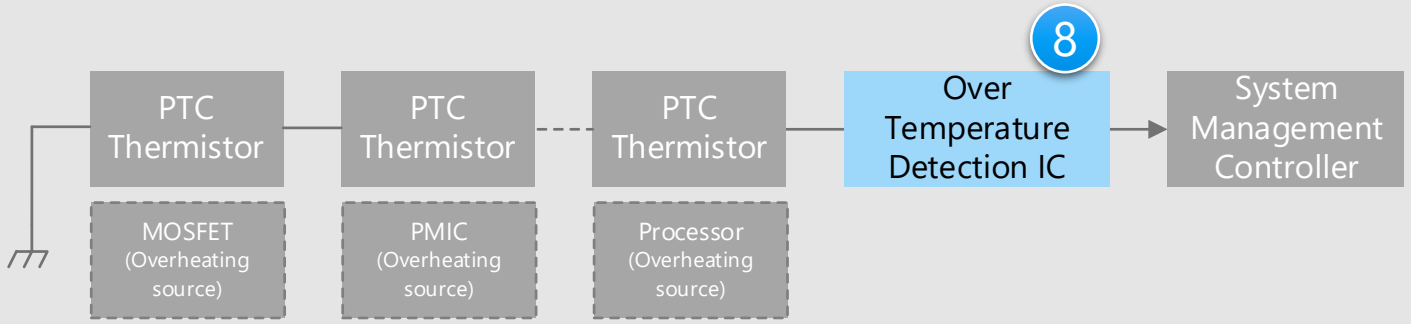
Tablet Device　Detail of over temperature monitoring unit

Over temperature monitoring circuit



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

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™) 8

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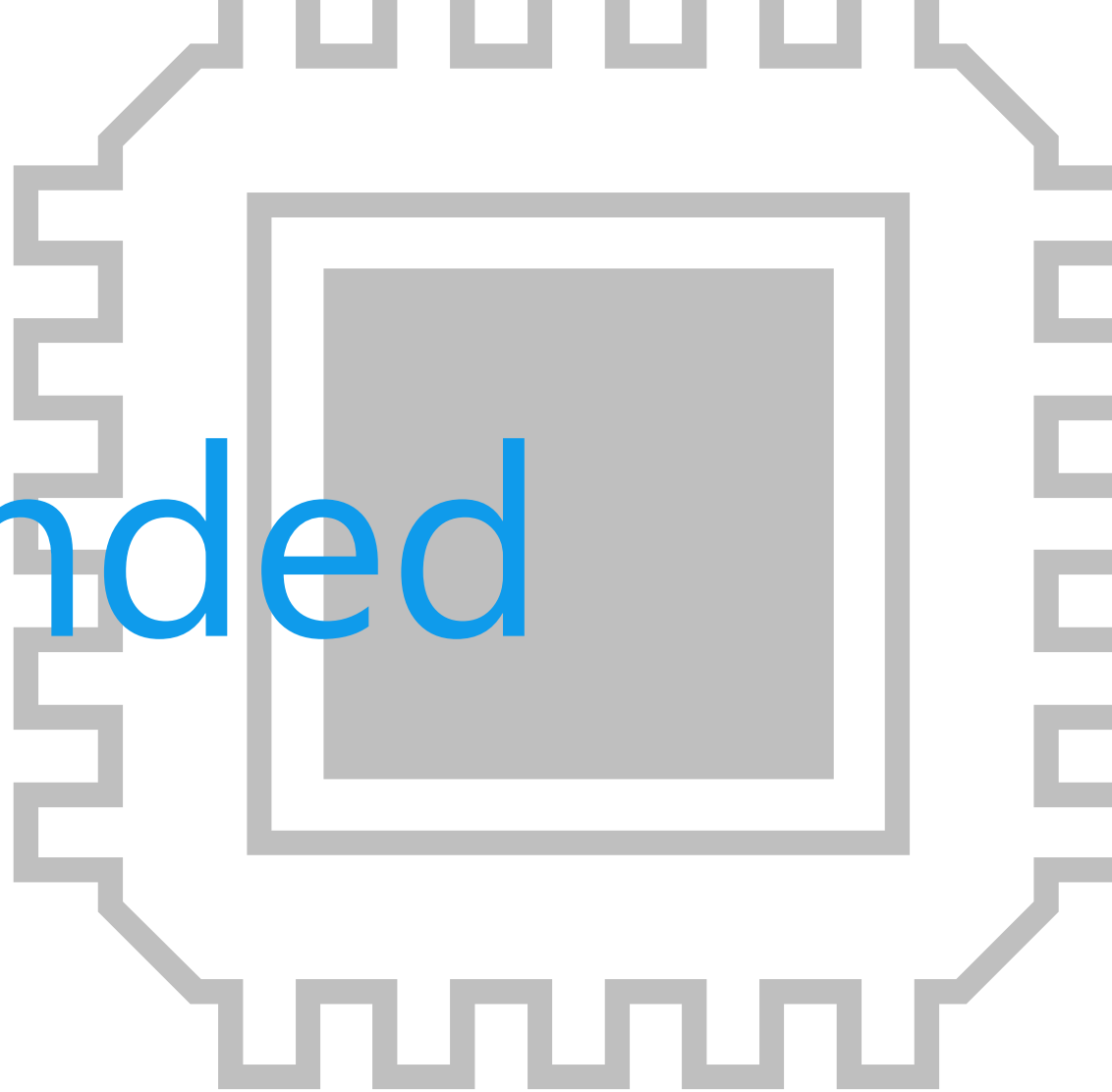
Recommended Devices



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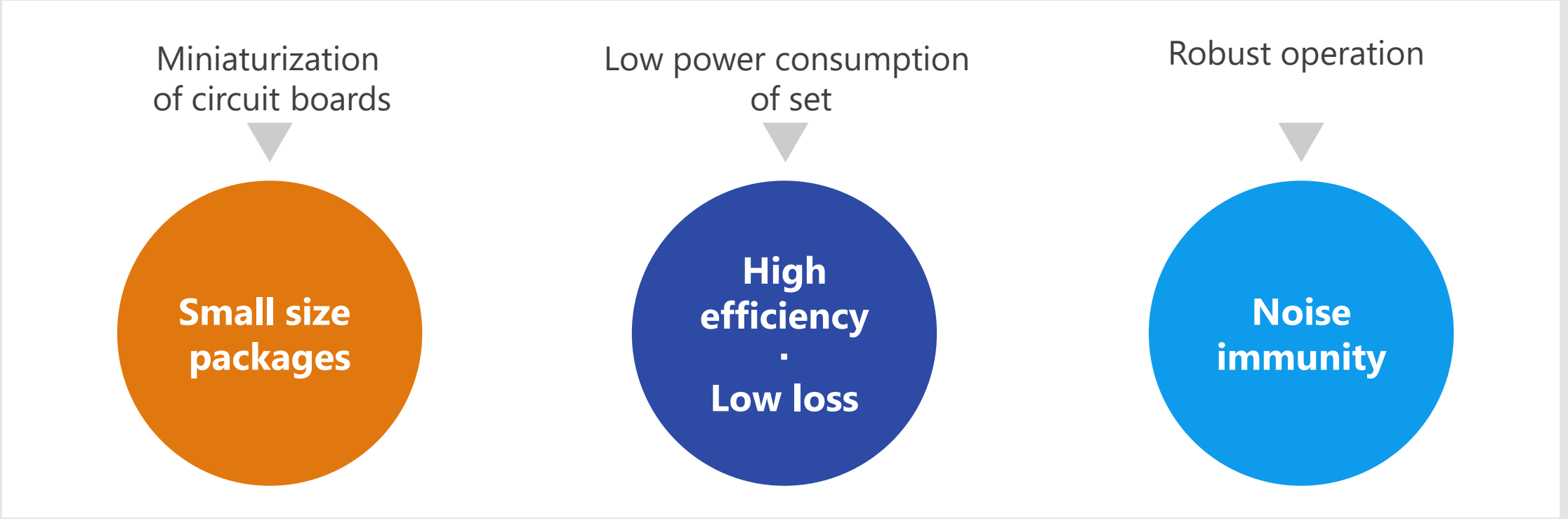
Device solutions to address customer needs

As described above, in the design of tablet device, **“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.



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Device solutions to address customer needs

	Small size packages	High efficiency · Low loss	Noise immunity
1 TVS diode	●	●	●
2 Small signal MOSFET	●	●	
3 Schottky barrier diode	●	●	●
4 Small surface mount LDO regulator	●	●	●
5 Interface bridge	●		●
6 Electronic fuse (eFuse IC)	●	●	
7 N-ch MOSFET gate driver IC	●	●	
8 Over temperature detection IC (Thermoflagger™)	●	●	
9 N-ch common drain MOSFET	●	●	

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1 TVS diode

DF2B7ASL / DF2B5M4ASL / DF2B6M4ASL / DF2B6M4BSL

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

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. (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.

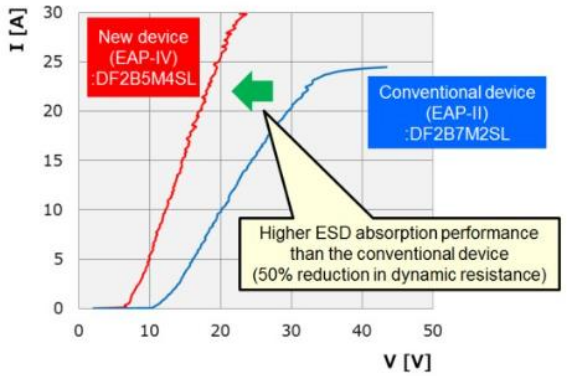
2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using proprietary technology.

3 Suitable for high density mounting

A variety of small packages are available.

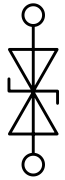
ESD Pulse Absorption Performance
Toshiba internal comparison



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	DF2B5M4ASL	DF2B6M4ASL	DF2B6M4BSL
Package	SL2	SL2	SL2	SL2
V_{ESD} [kV]	±30	±16	±15	±8
V_{RWM} (Max) [V]	5.5	3.6	5.5	5.5
C_t (Typ.) [pF]	8.5	0.15	0.15	0.12
R_{DYN} (Typ.) [Ω]	0.2	0.7	0.7	1.05

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

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2 Small signal MOSFET

SSM6K513NU / SSM6N55NU / SSM6J507NU

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Suitable for power management and contributes to miniaturization.

1 Low voltage operation

Operates down to $|V_{GS}|$ = 4.5 V

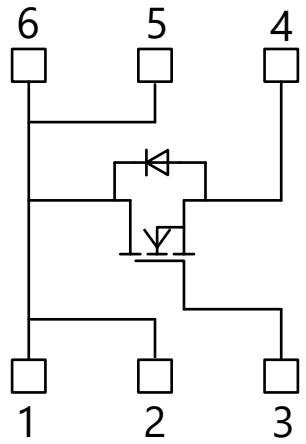
2 Low on-resistance

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

3 Small package

Sealed in SOT-1220 (2.0 x 2.0 mm) package.

Internal circuit
SSM6K513NU



Lineup

Part number		SSM6K513NU	SSM6N55NU	SSM6J507NU
Package		UDFN6B (SOT-1220)	UDFN6 (SOT-1118)	UDFN6B (SOT-1220)
Polarity		N-ch	N-ch x 2	P-ch
V_{DSS} [V]		30	30	-30
I_D [A]		15	4	-10
$R_{DS(ON)}$ [mΩ] @$\|V_{GS}\|$ = 4.5 V	Typ.	8.0	48	19
	Max	12	64	28

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3 Schottky barrier diode

CUHS20F40 / CTS05F40

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Can be applied to various applications which require high speed and low loss. And contribute to miniaturization.

1 Fast switching

For fast switching applications.

2 Small package

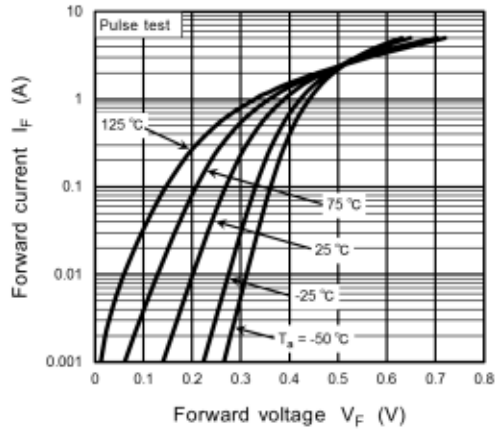
Small surface mount packages for high density assembly:

US2H: 2.5 x 1.4 x 0.6 mm

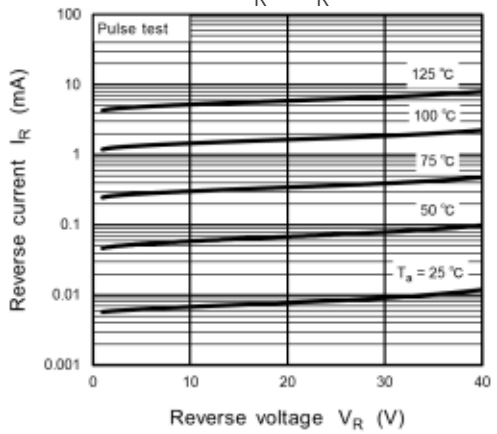
CST2: 1.0 x 0.6 x 0.38 mm

CUHS20F40 Characteristics Curves

I_F - V_F



I_R - V_R



Lineup

Part number	CUHS20F40	CTS05F40
Package	US2H	CST2
I_O [A]	2.0	0.5
V_R [V]	40	40
V_F (Typ.) [V]	0.39 @I_F = 1.0 A	0.74 @I_F = 0.5 A
I_R (Max) [μA] @V_R = 40 V	60	15

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4 Small surface mount LDO regulator

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

Small size packages | High efficiency · Low loss | Noise immunity

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.

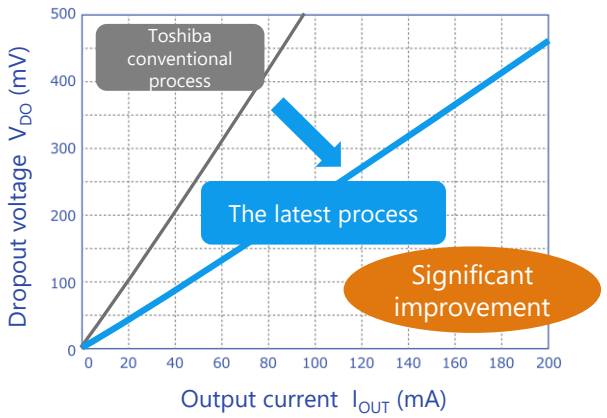
2 High PSRR Low output noise voltage

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

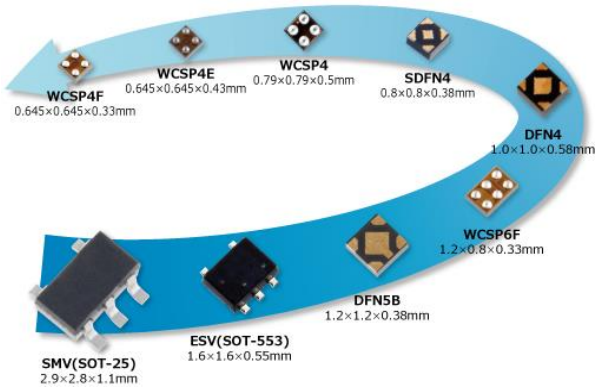
0.34 μA of $I_{B(ON)}$ is realized by utilizing CMOS process and unique circuit technology.
(TCR3U Series)

Low dropout voltage



(Note) Toshiba internal comparison 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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5 Interface bridge

TC358775XBG / TC358767AXBG / TC358860XBG / TC358746AXBG

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

Eliminating the interface gap between host and display/camera allows more options of component selection.

1 Wider component selection

Conversion of the interface allows shared procurement with other products as well as adoption of less inexpensive parts.

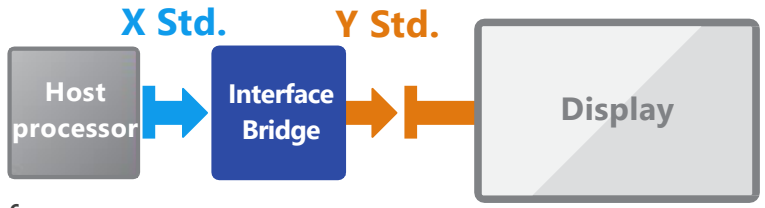
2 Noise immunity

Converting parallel communication to serial improves noise immunity and suppresses noise generation to the surroundings.

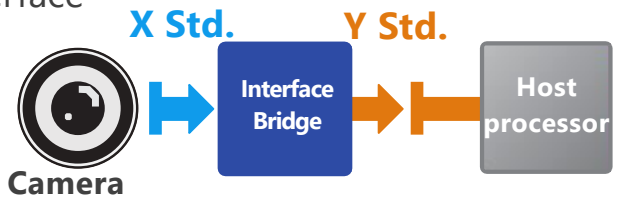
3 Less cabling

Converting from parallel communication to serial reduces total number of wires and the risks of wire breakage.

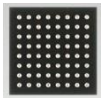
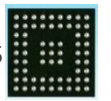
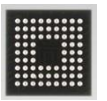
■ Display interface



■ Camera interface



Lineup

Part number	TC358775XBG	TC358767AXBG	TC358860XBG	TC358746AXBG
Package	BGA64 	BGA81	BGA65 	BGA72 
Input	MIPI® DSI® 1.01	(1) MIPI® DSI®1.01 (2) MIPI® DPI^{SM} 2.0	VESA Embedded DisplayPort™ (eDP)	(1) MIPI® CSI-2® (2) Parallel 24bit
Output	LVDS Dual Link (5 pairs / link)	VESA DisplayPort™ 1.1a	MIPI® DSI® 1.02	(1) Parallel 24bit (2) MIPI® CSI-2®

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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 IEC 62368-1 certified

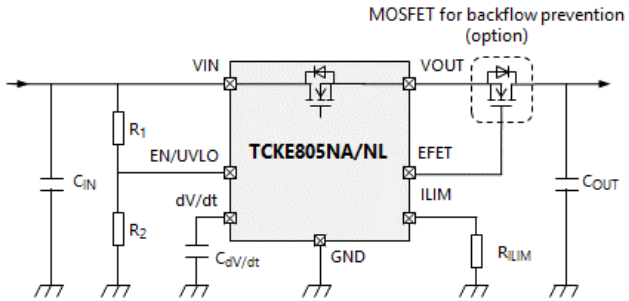
Toshiba's eFuse ICs are certified to the international safety standard IEC 62368-1 (G9: Integrated circuit (IC) current limiters) and contribute to robust protection and simplification of circuit design.

3 Various protection functions

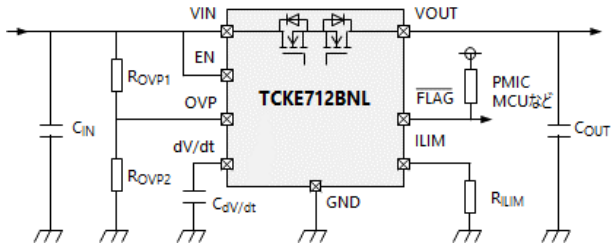
TCKE8 Series: Short-circuit protection, overcurrent protection, overcurrent clamp function, overvoltage clamp function, thermal shut down, inrush current suppression, backflow prevention (optional), etc.

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

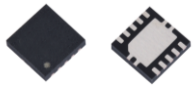
Reference circuit example of TCKE8 Series



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

TCK4xxG Series

Small size packages | High efficiency · Low loss | Noise immunity

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 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 24V power supply line.

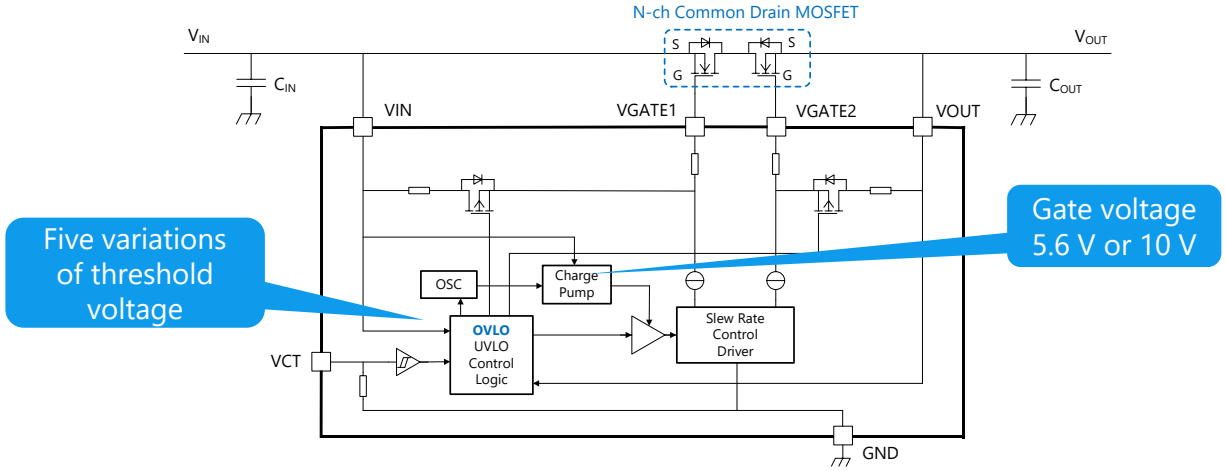
[Note 2] OVLO: Over Voltage Lock Out
[Note 3] V_{IN_OVLO}: V_{IN} OVLO threshold

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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8 Over temperature detection IC (Thermoflagger™)

TCTH Series

Small size Packages | High efficiency · Low loss | Noise immunity

Value provided

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

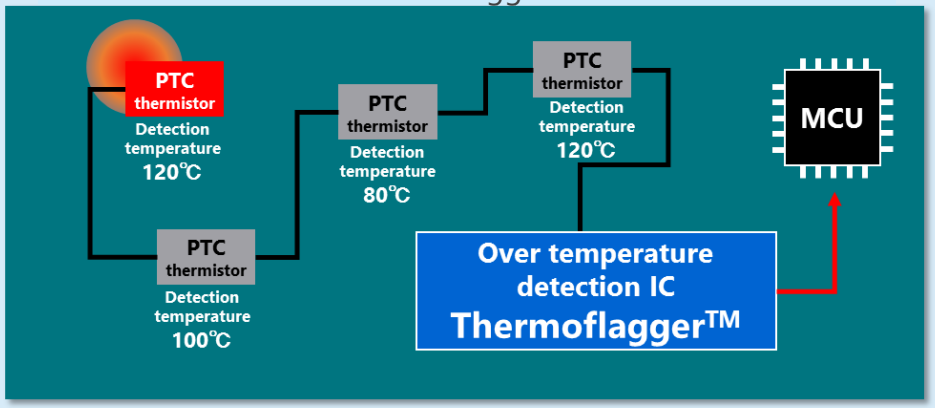
1 Temperature rise can be detected at multiple points

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			

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9 N-ch common drain MOSFET

SSMxN9 Series

Small size packages | High efficiency · Low loss | Noise immunity

Value provided

This is low on-resistance MOSFET with small and thin package. It contributes to suppressing heat generation during charging and discharging, as well as to reducing the size of set.

1 Low on-resistance

Low on-resistance is achieved by applying a low resistance diffusion process.
This contributes to suppression of heat generation.

2 Small and thin package

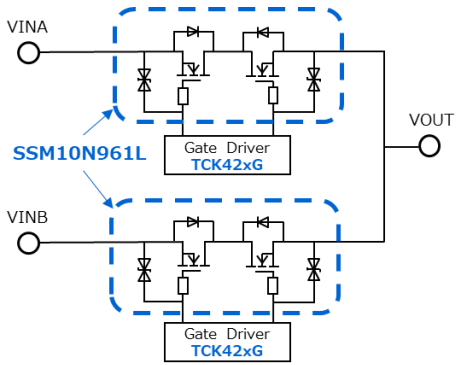
While in a dual configuration, it is a small and thin chipLGA package products.
This contributes to miniaturization of set.

3 Low gate-source leakage current

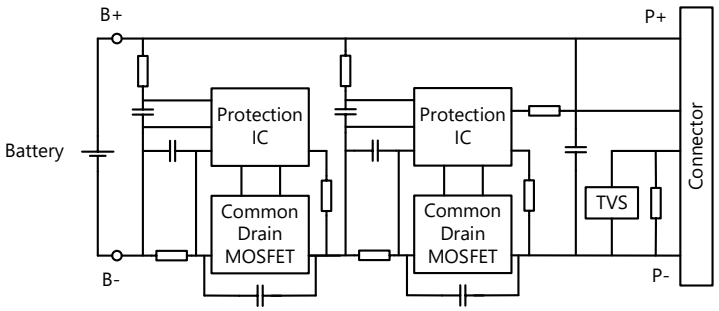
Low gate-source leakage current characteristics enable low standby power and contribute to long term operation of battery used sets.

Examples of common drain MOSFET application

Power multiplexer



Li-ion battery protection circuit



Lineup

Part number	SSM14N956L	SSM10N954L	SSM6N951L	SSM10N961L
Package	TCSPED-302701	TCSPAC-153001	TCSP6A-172101	TCSPAG-341501
Source-source voltage V_{SSS} [V]	12			30
Gate-source voltage V_{GSS} [V]	±8			±20
Source current (DC) I_S [A]	20.0	13.5	8.0	14.0
$R_{SS(ON)}$ (Typ.) [mΩ] @V_{GS} = 3.8 V	1.1	2.2	4.6	-
$R_{SS(ON)}$ (Typ.) [mΩ] @V_{GS} = 10 V	-	-	-	9.9

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