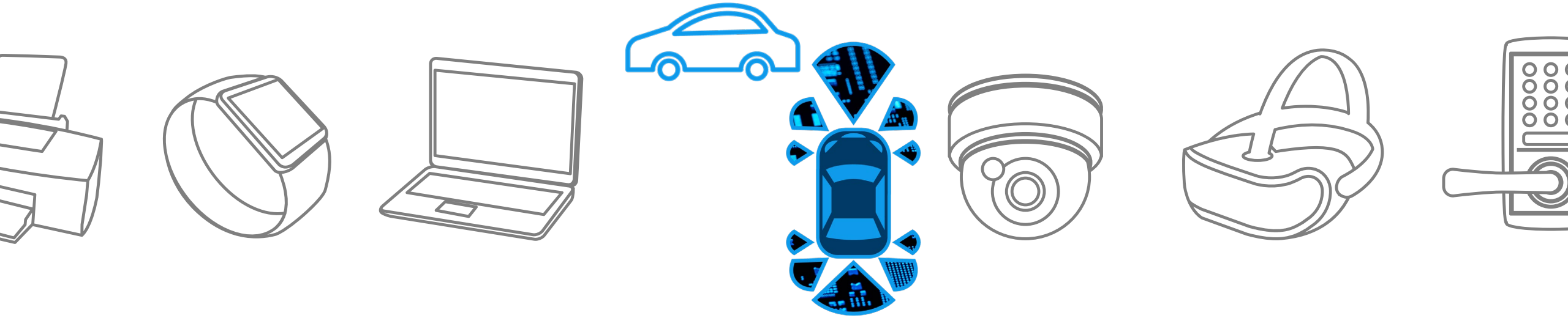
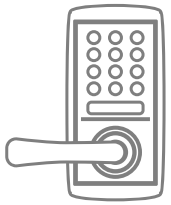
TOSHIBA

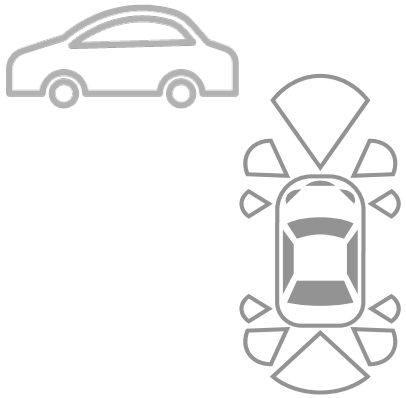
R21

Automotive ADAS

Solution Proposal by Toshiba

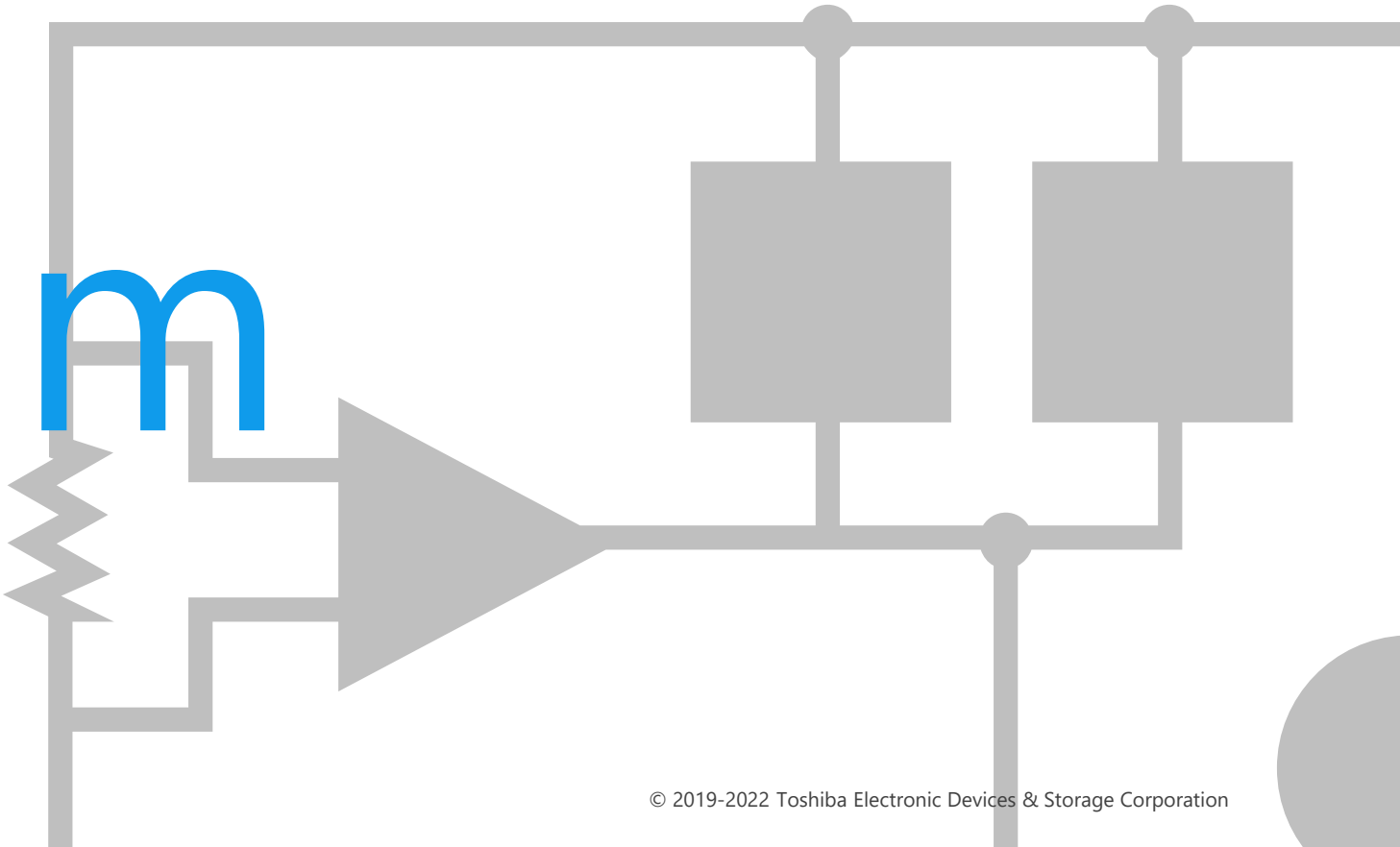




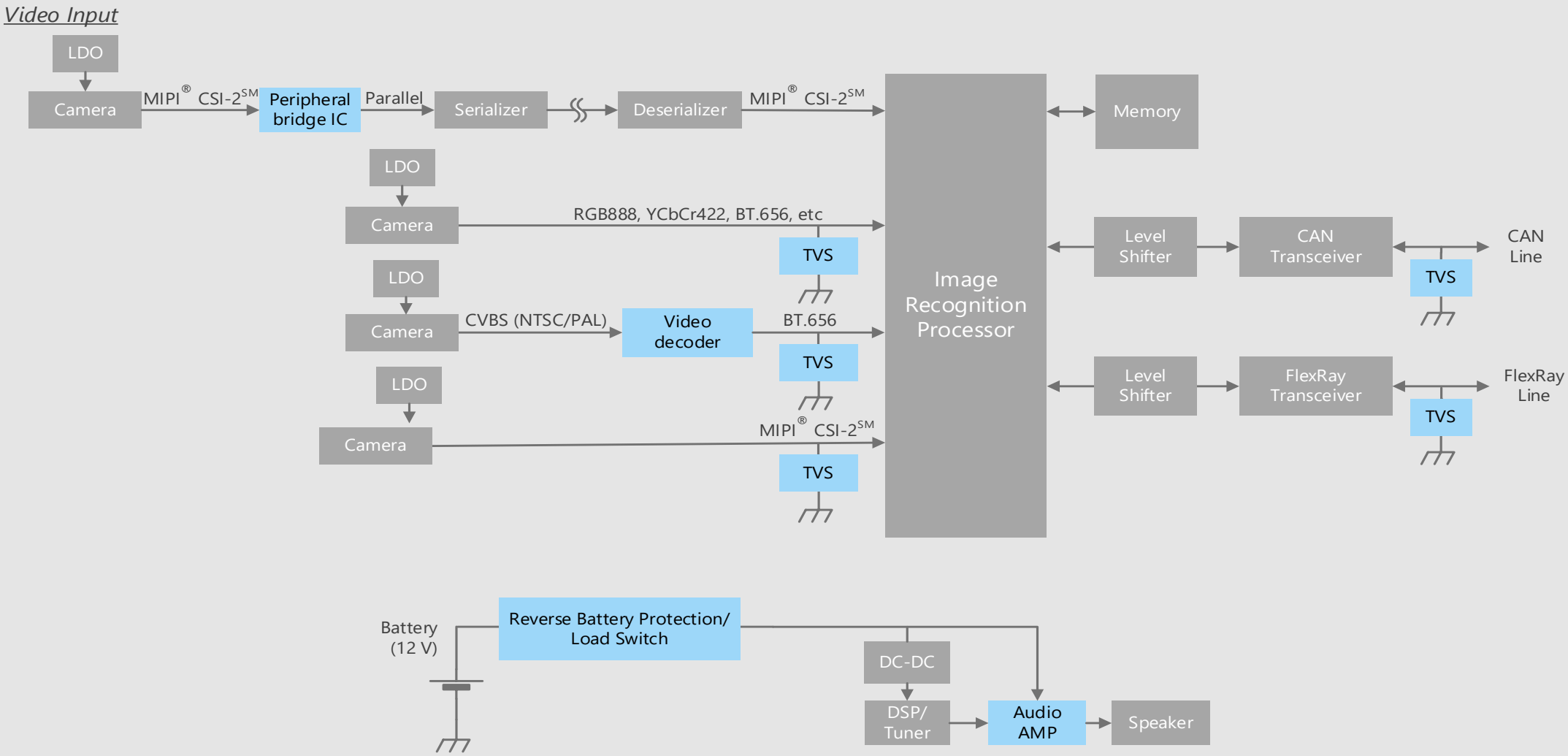


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

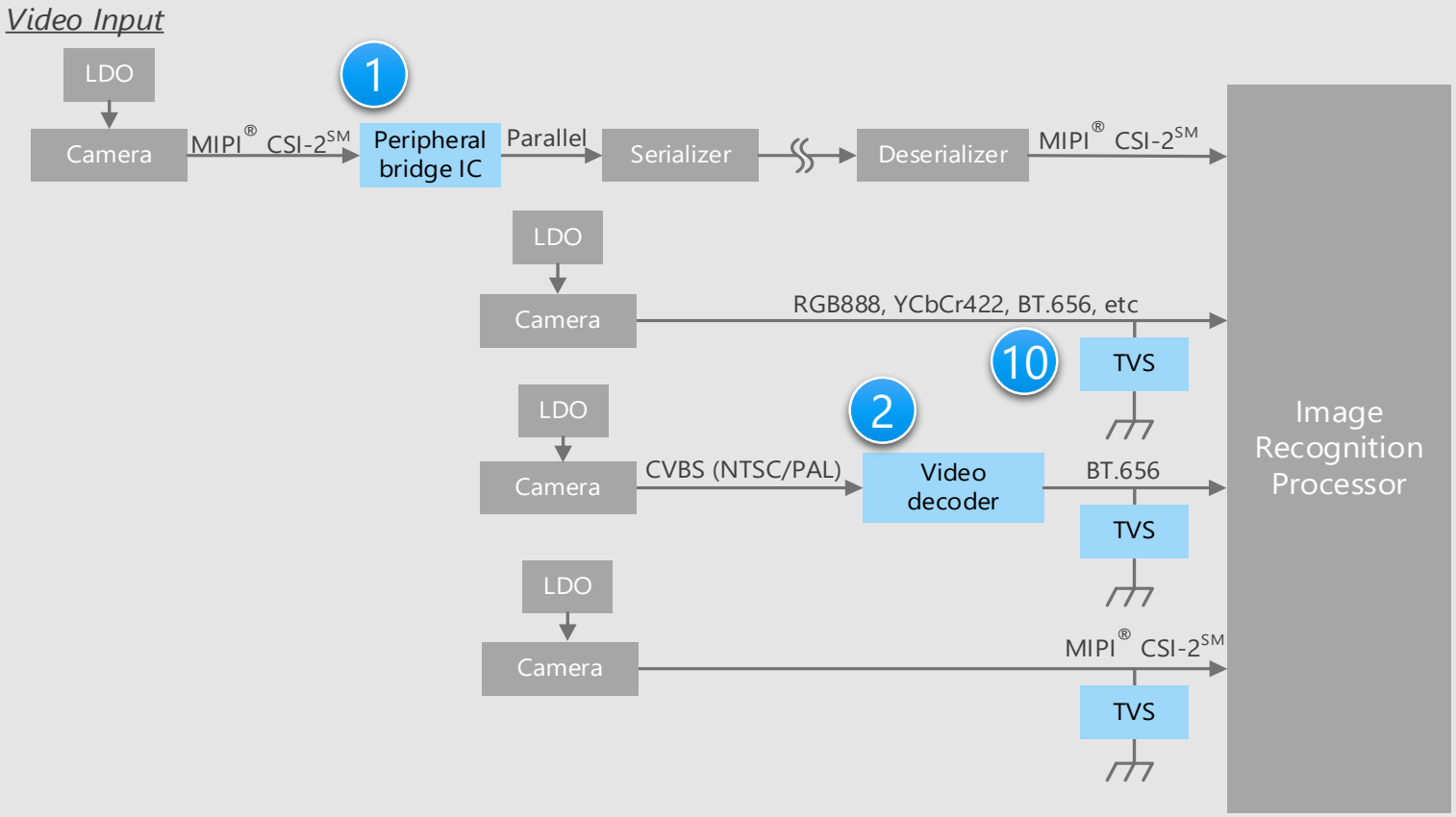


ADAS　Overall block diagram



ADAS Detail of sensing input

Image input unit



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

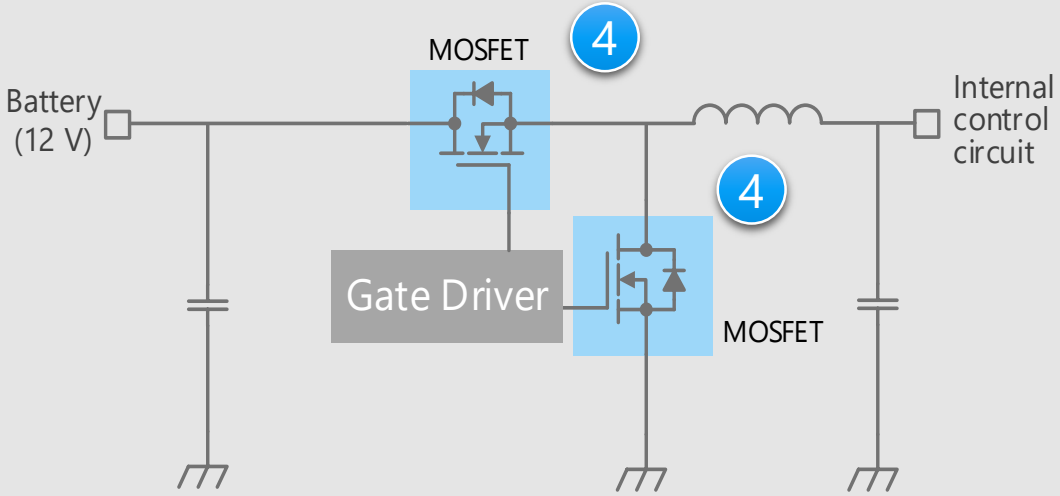
- Employing noise resistant interfaces help to reduce position constraints of camera.
- To use under various environments, video decoders need to have enhanced visual recognition capabilities.

Proposals from Toshiba

- **Resolve differences between interfaces**
  Peripheral bridge IC 1
- **Built-in visual enhancement function**
  Video decoder 2
- **Suitable for ESD protection**
  TVS diode (for high speed communication) 10

ADAS Detail of power supply circuit

DC-DC converter circuit (non-insulated buck type)



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

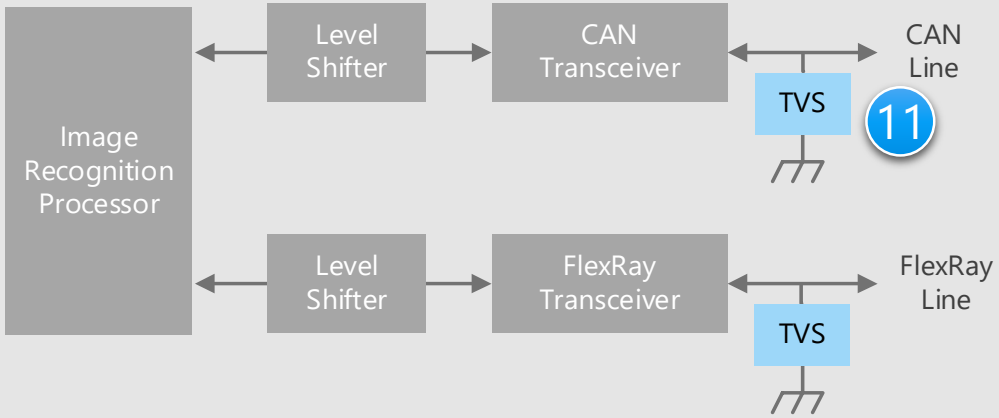
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- A small surface mount package is suitable for realizing miniaturization of the ECU.
- It is necessary to select high speed MOSFETs to prevent short through current.

Proposals from Toshiba

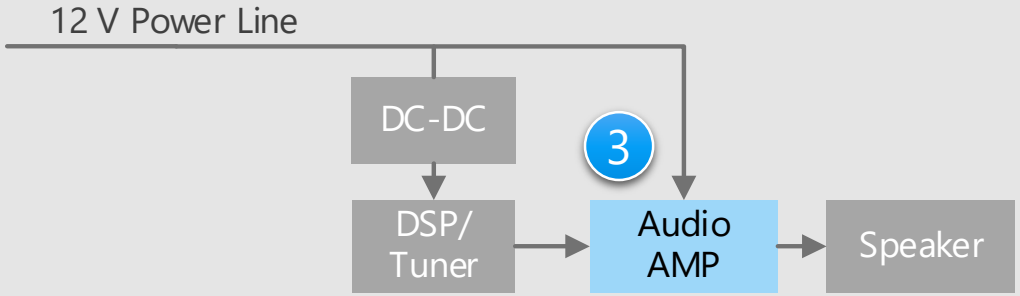
- **Low on-resistance contributes low power consumption of the system**
  U-MOS Series 40 V N-ch MOSFET 4

ADAS　Detail of data transmission / audio output unit

CAN / FlexRay transmission section



Audio output section



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

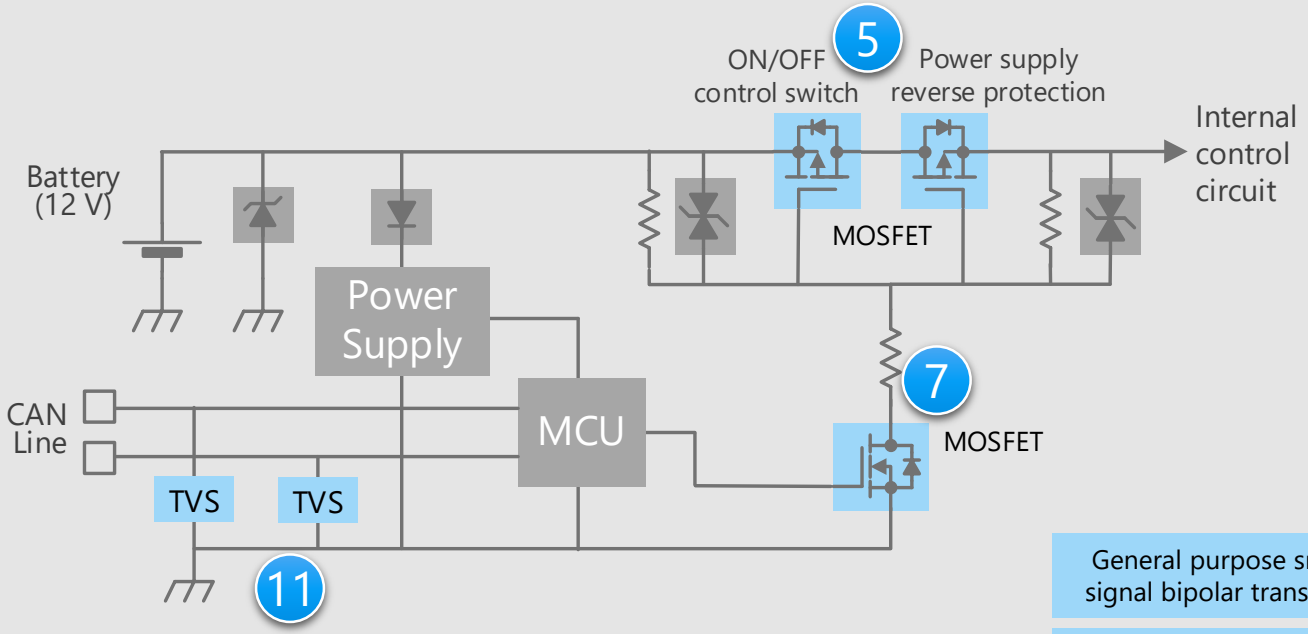
Criteria for device selection

- The TVS diode needs to be selected according to the ESD protection characteristics and capacitance value suitable for transmission speed.

Proposals from Toshiba

- **High output power with low heat generation is realized**
  Audio power amplifier IC　3
- **Suitable for ESD protection**
  TVS diode (for CAN communication)　11

Power supply ON/OFF control and reverse connection protection circuit (P-ch type)



General purpose small signal bipolar transistor 8

Small signal bias resistor built-in transistor(BRT) 9

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

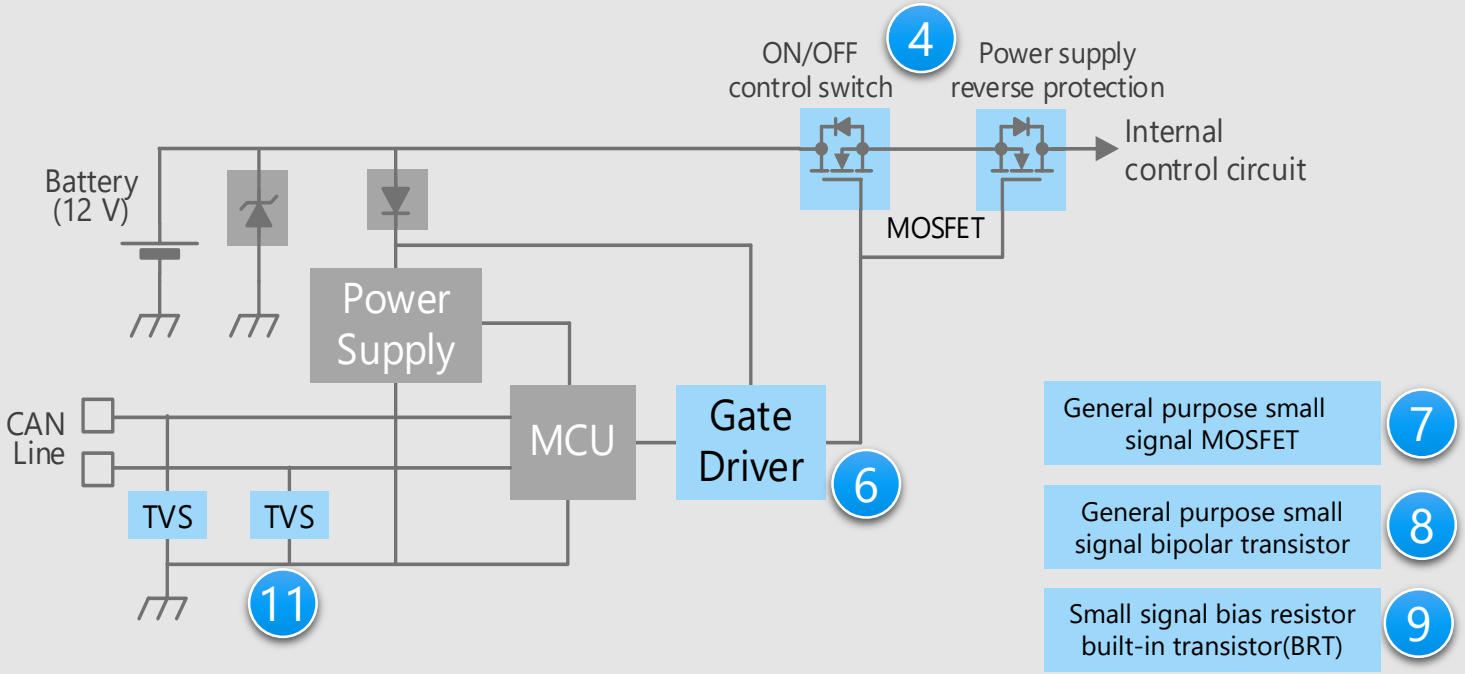
Criteria for device selection

- It is necessary to select the product with the suitable voltage and current ratings for each application.
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the ECU.

Proposals from Toshiba

- **Low on-resistance contributes low power consumption of the system**
  U-MOS Series -40 V / -60 V P-ch MOSFET 5
- **Extensive product lineup**
  General purpose small signal MOSFET 7
  General purpose small signal bipolar transistor 8
  Small signal bias resistor built-in transistor (BRT) 9
- **Suitable for ESD protection**
  TVS diode (for CAN communication) 11

Power supply ON/OFF control and reverse connection protection circuit (N-ch type)



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Criteria for device selection

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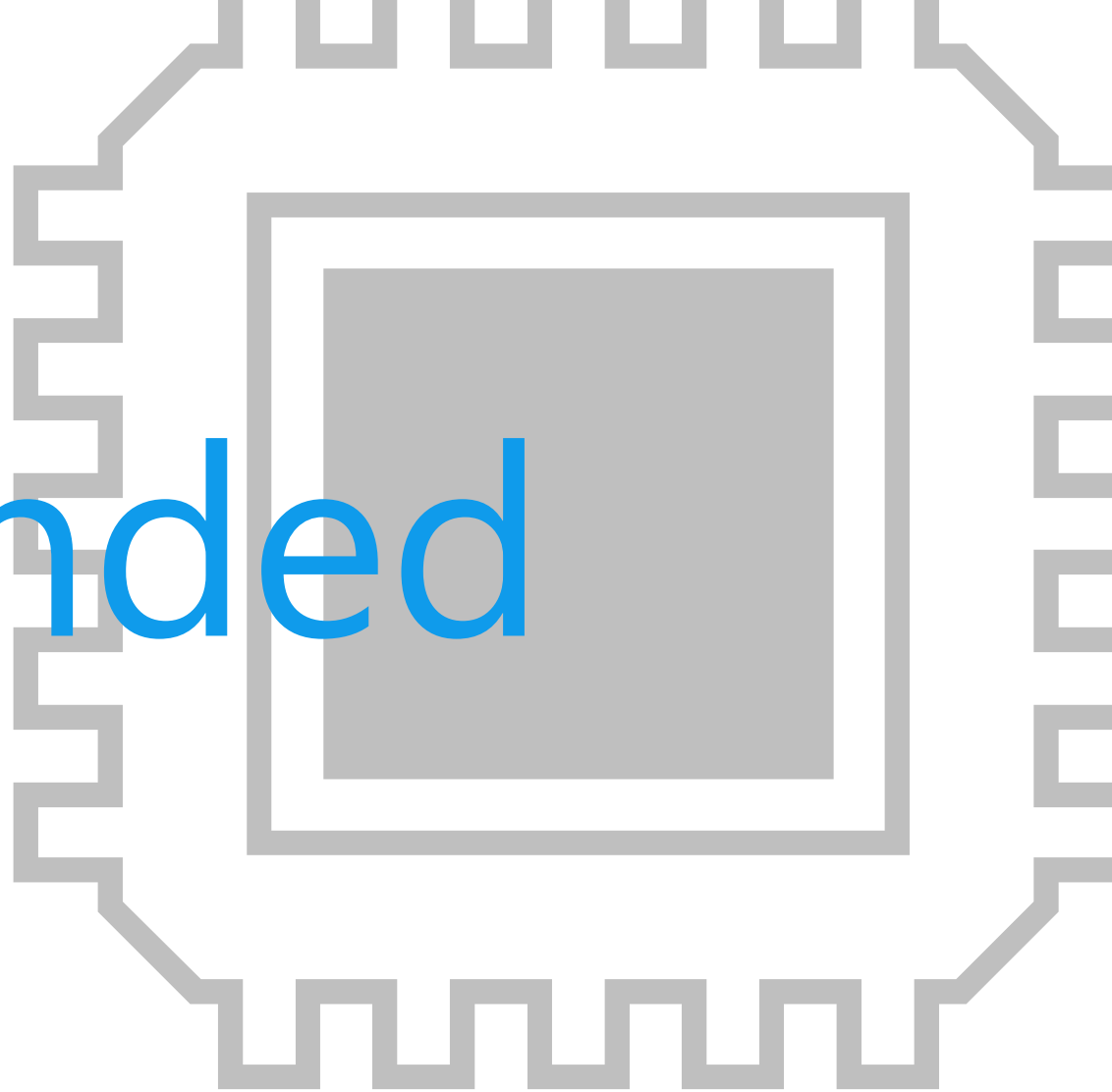
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the ECU.

Proposals from Toshiba

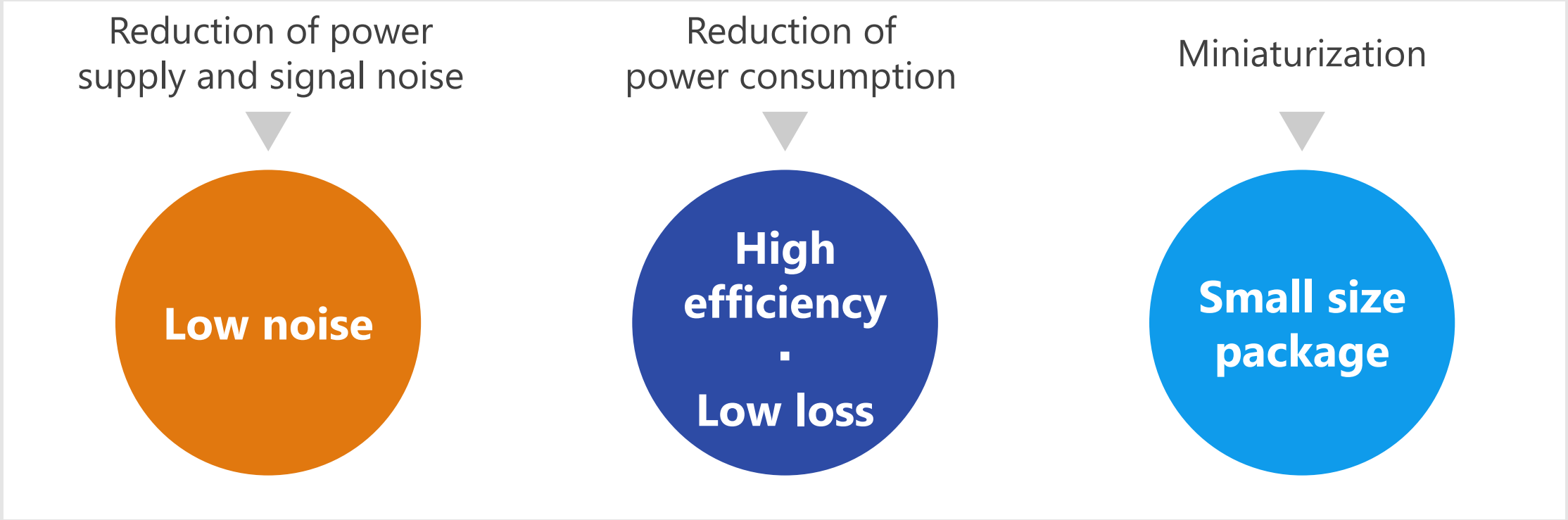
- **Low on-resistance contributes low power consumption of the system**
  U-MOS Series 40 V N-ch MOSFET 4
- **Gate driver with protection and diagnosis functions**
  Gate driver (for switch) 6
- **Extensive product lineup**
  General purpose small signal MOSFET 7
  General purpose small signal bipolar transistor 8
  Small signal bias resistor built-in transistor (BRT) 9
- **Suitable for ESD protection**
  TVS diode (for CAN communication) 11

Recommended Devices

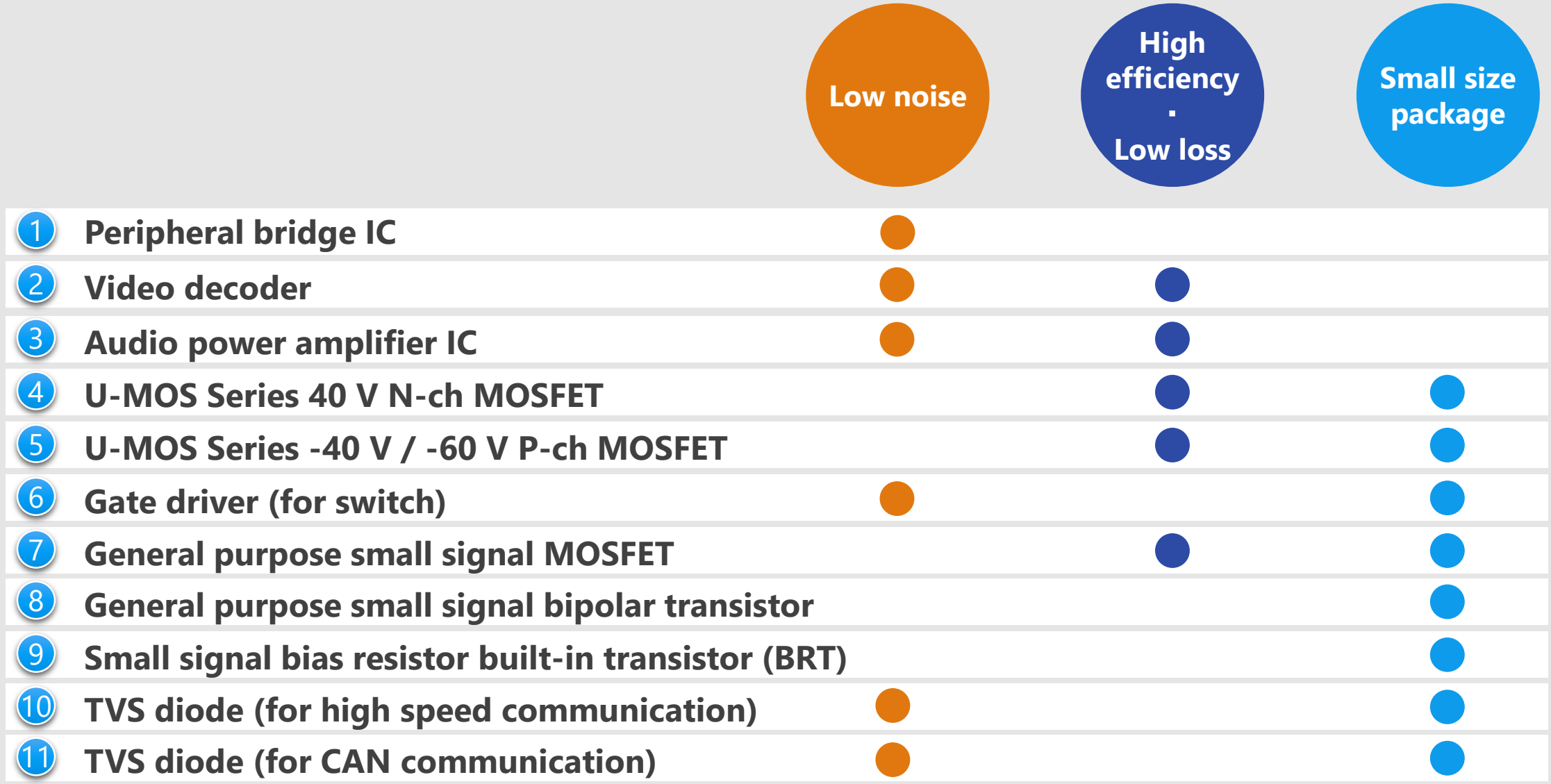


Device solutions to address customer needs

As described above, in the design of ADAS, **“Reduction of power supply and signal noise”**, **“Reduction of power consumption”** and **“Miniaturization”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs



1 Peripheral bridge IC

TC9590 / TC9591 / TC9592 / TC9593 / TC9594 / TC9595

Low noise | High efficiency · Low loss | Small size package

Value provided

Resolve gaps of interface standard between host and peripheral devices.

1 Increase the choice of parts

By using a peripheral bridge IC, it is possible to connect to various types of peripheral devices.

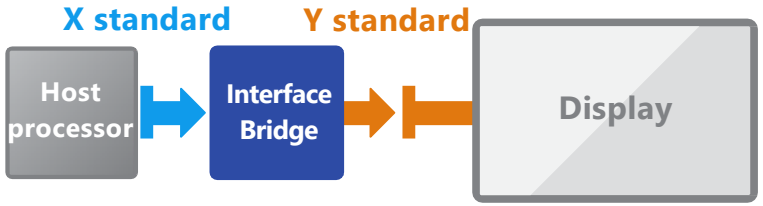
2 Reduce noise

Converting parallel bus line to serial improves noise immunity. That also suppresses the generation of own noise.

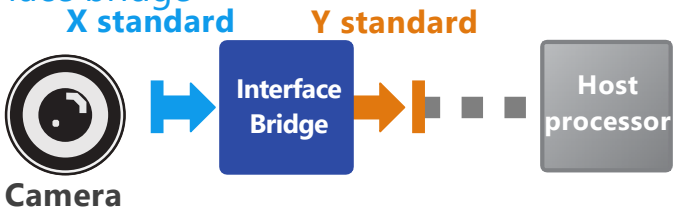
3 Reduce disconnection risk

Converting parallel bus line to serial reduces the number of wires on a board, and so reduce the risk of disconnection.

■ Display interface



■ Camera interface bridge



Line up

	Camera I/F Bridge		Display I/F Bridge			
Part Number	TC9590	TC9591	TC9592	TC9593	TC9594	TC9595
Package	VFBGA80	VFBGA80	VFBGA49	VFBGA64	VFBGA80	VFBGA80
Input	HDMI™1.4a	(1) MIPI® CSI-2SM (2) Parallel 24bit@166 MHz	MIPI DSISM 4 Lanes x 1ch		Parallel input 24bit@166 MHz	MIPI DSI 4 Lanes x 1ch. / MIPI DPI (24bit)
Output	MIPI CSI-2 4 Lanes x 1ch	(1) Parallel 24bit@100 MHz (2) MIPI CSI-2	LVDS Single Link		MIPI DSI 4 Lanes x 1ch	DisplayPort™ 1.1a x 2 Ports / MIPI DPI (24bit)

◆Return to Block Diagram TOP

2 Video decoder

TC90105FG / TC90107FG

Low noise | High efficiency · Low loss | Small size package

Value provided

Built-in image enhancement functions designed for automotive cameras.

1 HDV enhancer

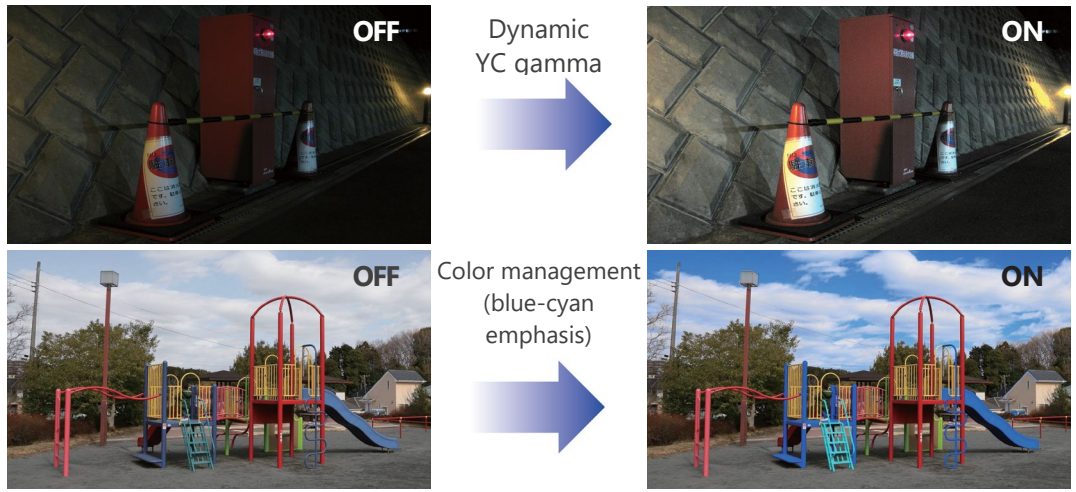
In addition to conventional horizontal and vertical edge emphasis, diagonal emphasis has been added, to enable stronger edge emphasis without increasing discomfort to the eyes.

2 Color management

This function emphasizes a specific selected color (saturation). Emphasizing certain color can improve visibility.

3 Dynamic YC gamma

Applying optimized Y gamma curves to the images reduces blackout and whiteout, and improves visibility.



Line up

Model	TC90105FG	TC90107FG
Package	LQFP 80 pin	LQFP 64 pin
ADC	2	1
New image correction	✓	
ITU-R BT.601 output	✓	-
ITU-R BT.656 output	✓	

◆Return to Block Diagram TOP

3 Audio power amplifier IC

TCB701FNG / TCB702FNG

Low noise | High efficiency · Low loss | Small size package

Value provided

These linear amplifier ICs realize same level of power loss and heat generation the class D amplifier.

1 Proprietary high efficiency amplifier (patent registered)

Realizes equivalent efficiency to the class D amplifiers [Note1] at output of 4 W or less. Power consumption of these ICs are about 1/5 of our class AB amplifiers and about 1/2 of our high efficiency linear class KB amplifiers. [Note2]

Note:1 Based on Toshiba research (April 2020) .
Note:2 Class KB = Toshiba original linear amplifier

2 Reduction of external components

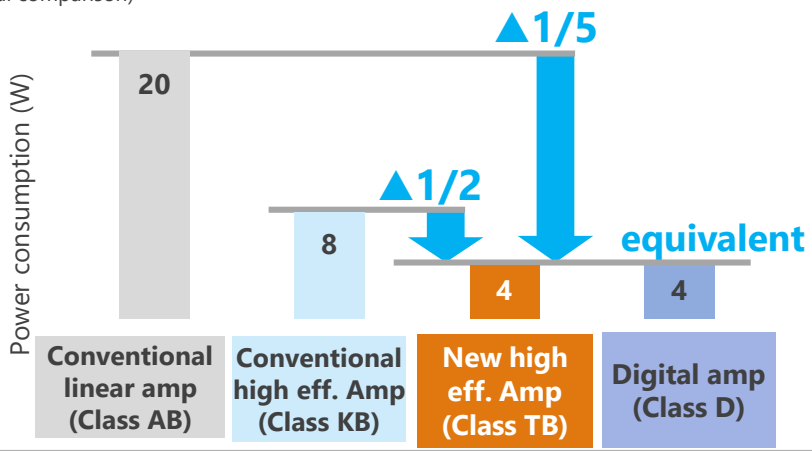
Since these ICs operate without switching such as the class D amplifier, the external parts such as low pass filter or components for EMI suppression can be reduced.

3 Built-in fulltime output offset detection (patent registered)

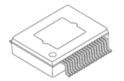
Includes a proprietary speaker burnout prevention system that continuously checks for any abnormal output DC offset regardless of input signal presence and informs the microcomputer.

■ Power consumption (for 0.8 W x 4 channels)

(Toshiba internal comparison)



Line up

Model	TCB701FNG	TCB702FNG
Package	P-HSSOP36-1116-0.65-001 (36 pin) 	
Maximum output power	49 W x 4ch (V_{CC} = 15.2 V, R_L = 4 Ω)	45 W x 4ch (V_{CC} = 15.2 V, R_L = 4 Ω)
Total harmonic distortion (THD)	0.01 % (at P_{OUT}=4 W)	
Supply voltage	6 to 18 V	
Output noise voltage	60 µVrms (Filter = DIN AUDIO)	

◆Return to Block Diagram TOP

4 U-MOS Series 40 V N-ch MOSFET

XPN3R804NC / TK1R4S04PB / TPHR7904PB / TPWR7904PB / TKR74F04PB / TK1R5R04PB

Low noise | High efficiency · Low loss | Small size package

Value provided

The advanced U-MOSⅨ-H processes enables low on-resistance and low noise, thereby reducing power consumption.

1 Low loss (reduced on-resistance)

Using low on-resistance technology to contribute to reduced power consumption systems.
On-resistance of 61 % reduction per unit area.
(compared to U-MOSⅣ)

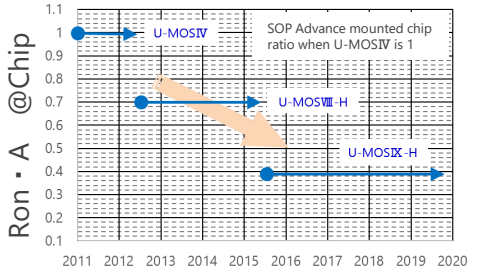
2 Compact and low loss package

By adopting a Cu connector structure and a double-sided heat dissipation structure, low loss and high heat dissipation are realized.
Wettable Frank (WF) package contributes good mountability.

3 Low noise (low EMI)

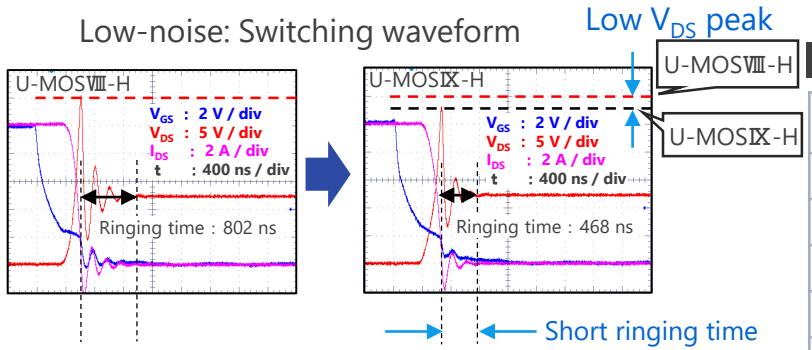
Improved chip process reduces surge voltage and ringing time.

Low Loss: RonA Trend



(Note: Toshiba internal comparison)

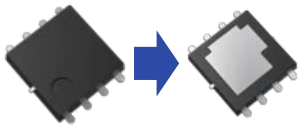
Low-noise: Switching waveform



TO-220SM(W) Cu connector design

Package resistance is reduced by 64 %, compared to D2PAK+.

DSOP Advance(WF)L double-sided cooling package



Thermal resistance is reduced by 76 % @t = 3 s, mounted on board compared to SOP Advance(WF).

Line up

Part number	Drain current	On-resistance (Max) @V_{GS} = 10 V	Package
XPN3R804NC	40 A	3.8 mΩ	TSON Advance(WF)
TK1R4S04PB	120 A	1.35 mΩ	DPAK+
TPHR7904PB	150 A	0.79 mΩ	SOP Advance(WF)
TPWR7904PB	150 A	0.79 mΩ	DSOP Advance(WF)L
TKR74F04PB	250 A	0.74 mΩ	TO-220SM(W)
TK1R5R04PB	160 A	1.5 mΩ	D2PAK+

◆Return to Block Diagram TOP

5 U-MOS Series -40 V / -60 V P-ch MOSFET

TJ90S04M3L / TJ60S06M3L / XPH3R114MC / TJ200F04M3L

Low noise | High efficiency · Low loss | Small size package

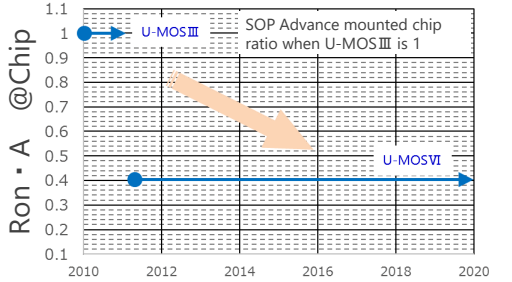
Value provided

Low on-resistance contributes to reduce system power consumption.

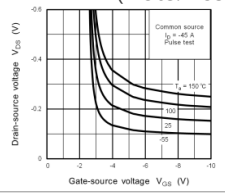
1 Low loss (reduced on-resistance) and logic level drive

Using low on-resistance technology contributes to reduce system power consumption.
Lineups of logic level drive type are supported.

Low Loss: RonA Reduction Trend



(Note: Toshiba internal comparison)



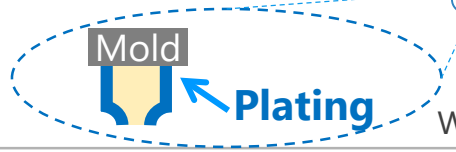
Logic level drive
TJ90S04M3L
$V_{DS(ON)}$ - V_{GS}

Large current, small size, high heat dissipation package

TO-220SM(W)
(10 x 13 mm)
Up to 200 A

DPAK+
(6.5 x 9.5 mm)
Up to 90 A

SOP Advance(WF)
(5 x 6 mm)
Up to 100 A



Wettable Flank (WF) structure

2 Small surface mount package developed

By adopting a Cu connector structure and a double-sided heat dissipation structure, low loss and high heat dissipation are realized.
Wettable Frank (WF) package contributes good mountability.

Line up

Part number	Drain-source Voltage	Drain current	On-resistance (Max) @V_{GS} = -10 V	Package
TJ90S04M3L	-40 V	-90 A	4.3 mΩ	DPAK+ 
TJ60S06M3L	-60 V	-60 A	11.2 mΩ	
XPH3R114MC	-40 V	-100 A	3.1 mΩ	SOP Advance(WF) 
TJ200F04M3L	-40 V	-200 A	1.8 mΩ	TO-220SM(W) 

◆Return to Block Diagram TOP

6 Gate driver (for switch)

TPD7104AF / TPD7106F / TPD7107F

Low noise | High efficiency · Low loss | Small size package

Value provided

A charge pump circuit for the N-ch MOSFET gate drive is built in, allowing for easy semiconductor relay configuration.

1 Built-in charge pump circuit

Built-in charge pump circuit enables N-ch MOSFET as high side switch.
Easy to configure a semiconductor relay.

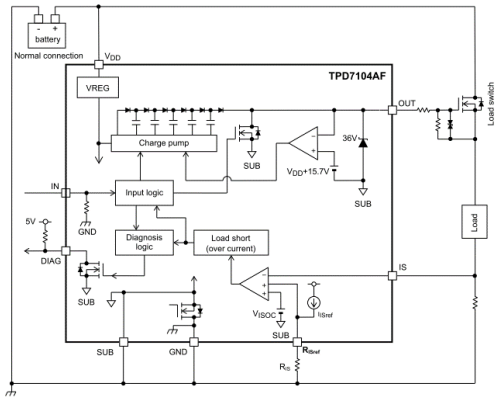
2 Can be controlled by logic level voltage

It is possible that Direct control by output signal of MCUs or CMOS logic ICs.

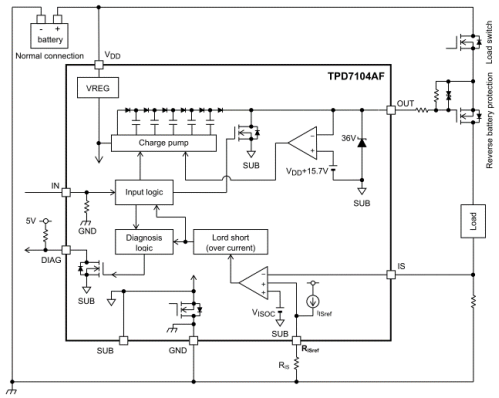
3 Small package

The small surface mount packages such as PS-8, SSOP16 and WSON10A contribute to the miniaturization of equipment.

Semiconductor relay (switch) application (TPD7104AF)



Power supply reverse connection protection MOSFET control (TPD7104AF)



Back to back configuration

Line up

Part number	TPD7104AF	TPD7106F	TPD7107F
Package	PS-8 (2.8 x 2.9 mm)	SSOP16 (5.5 x 6.4 mm)	WSON10A (3 x 3 mm)
Features	・Operating power supply voltage range: 5 to 18 V ・Built-in power supply reverse connection protection function (Supported for power supply reverse connection protection MOSFET applications)	・Operating power supply voltage range: 4.5 to 27 V ・Built-in power supply reverse connection protection function (Supported for power supply reverse connection protection MOSFET applications)	・Operating power supply voltage range: 5.75 to 26 V ・Current sense output ・Protective functions; overcurrent, overtemperature, GND disconnect etc. reverse battery connection ・Diagnosis output; overcurrent, load open, overtemperature etc.

◆Return to Block Diagram TOP

7 General purpose small signal MOSFET

SSM3K7002KF / SSM3J168F / SSM3J66MFV

Low noise | High efficiency · Low loss | Small size package

Value provided

Wide lineup of small packages contribute to reduce the size and power consumption of system.

1 Small package

A lineup of various small packages such as SOT-723 (VESM 1.2 x 1.2 mm package) is available, contributing to reduce mounting area.

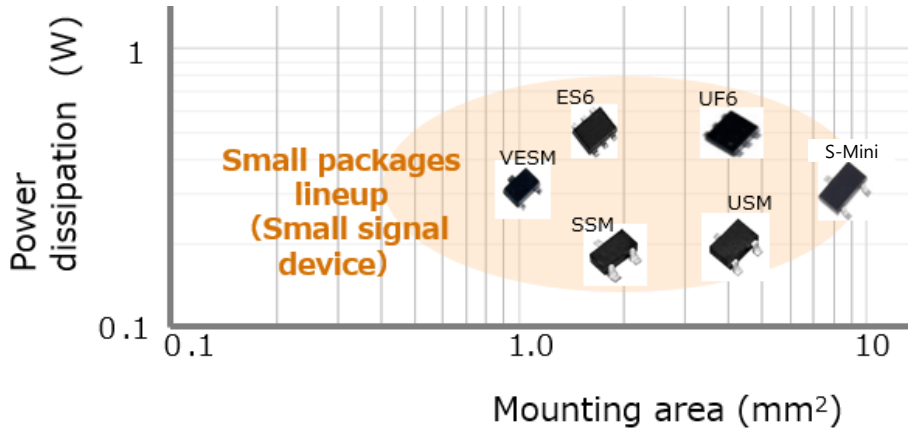
2 Low voltage drive

SSM3J66MFV can be driven at low gate-source voltage of 1.2 V.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.

Small signal package lineup



Line up

Part number		SSM3K7002KF	SSM3J168F	SSM3J66MFV
Package		S-Mini (SOT-346)	S-Mini (SOT-346)	VESM (SOT-723)
V_{DSS} [V]		60	-60	-20
I_D [A]		0.4	-0.4	-0.8
$R_{DS(ON)}$ @$\|V_{GS}\|$=4.5 V [Ω]	Typ.	1.2	1.4	0.31
	Max	1.75	1.9	0.39
Drive voltage [V]		4.5	-4.0	-1.2
Polarity		N-ch	P-ch	P-ch

◆Return to Block Diagram TOP

8 General purpose small signal bipolar transistor

2SC2712 / 2SA1162 / 2SC4116 / 2SA1586 / TTA501 / TTC501 and others

Low noise | High efficiency · Low loss | Small size package

Value provided

Extensive product lineup to meet customers' needs.

1 Extensive lineup of packages

Various packages such as 1-in-1, 2-in-1 are provided and suitable products for circuit board design are selectable.

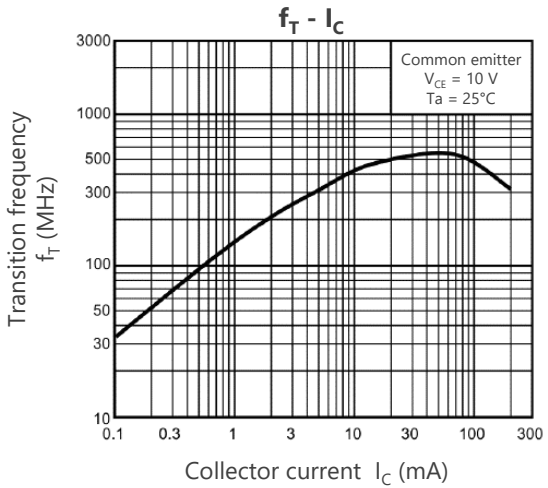
2 Extensive product lineup

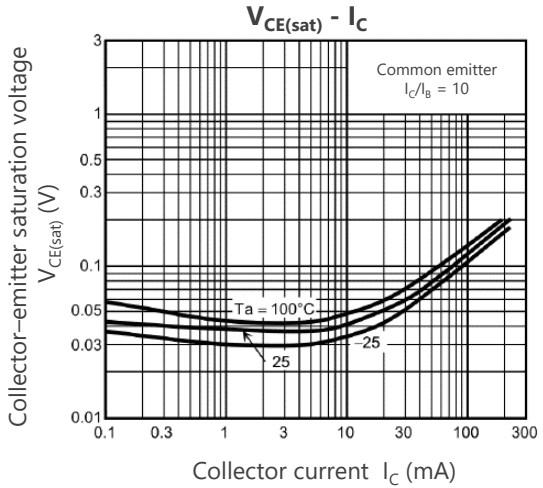
Various product lineups, such as general purpose, low noise, low $V_{CE(sat)}$ and high current types are provided. Products can be selected in accordance to the application.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.

Characteristic examples of 2SC2712





Line up

Package			SOT-23F		USM (SOT-323) UFM (SOT-323F)*		S-Mini (SOT-346)	
Classification	$\|V_{CEO}\|$ [V]	$\|I_C\|$ [mA]	NPN	PNP	NPN	PNP	NPN	PNP
General purpose	50	150			2SC4116	2SA1586	2SC2712	2SA1162
	50	500					2SC3325	2SA1313
Low noise	120	100			2SC4117	2SA1587	2SC2713	2SA1163
High current	50	1700				2SA2195*		
	50	2000		TTA501				
	100	2500	TTC501					

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9 Small signal bias resistor built-in transistor (BRT)

RN1907FE / RN2907FE / RN1901 / RN2901 Series

Low noise | High efficiency · Low loss | Small size package

Value provided

Extensive product lineup to meet customers' needs.

1 Built-in bias resistor type
(BRT : Bias Resistor built-in Transistor)

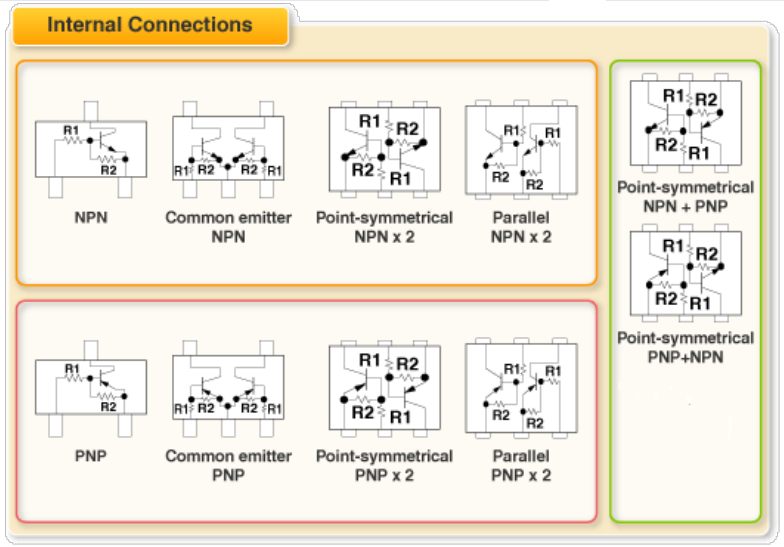
The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

2 Extensive lineup of package and pin assignment

Various package lineups, such as 1-in-1, 2-in-1 and various pin assignment type are provided and suitable products for circuit board design are selectable.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.



Line up

Part number		NPN (BRT)	PNP (BRT)
Package	ES6 (SOT-563) 	RN1907FE	RN2907FE
	US6 (SOT-363) 	RN1901	RN2901
V_{CEO} (Max) [V]		50	-50
I_C [mA]		100	-100

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10 TVS diode (for high speed communication)

DF2S5M4FS / DF2S6M4FS

Low noise | High efficiency · Low loss | Small size package

Value provided

TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1 Improve ESD pulse absorbability

Toshiba proprietary snapback technology (4th-Gen. process) improves ESD pulse absorption compared to Toshiba previous products.
(50 % reduction in R_{DYN})

2 Supports Ethernet and LVDS(*)

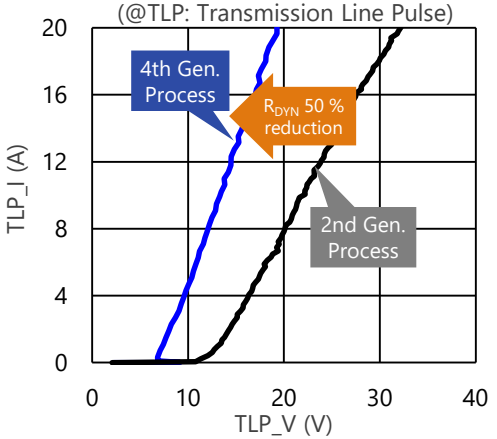
These are products applicable to high speed communications (Gbps orders) such as Ethernet and LVDS.

(*): Low voltage differential signaling

3 High ESD immunity

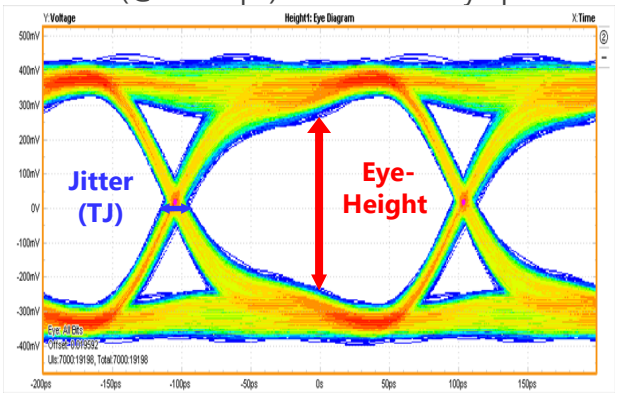
V_{ESD} > ±30 kV @ ISO 10605
V_{ESD} > ±20 kV (L4) @ IEC61000-4-2

ESD Pulse Absorption Performance
(@TLP: Transmission Line Pulse)



(Note: Toshiba internal comparison)

LVDS (@4.8 Gbps) DF2S6M4FS Eye pattern



Line up

Part number	DF2S5M4FS	DF2S6M4FS
Package	SOD-923 	
V_{ESD} [kV] @ISO10605	±30	±30
V_{RWM} (Max) [V]	3.6	5.5
C_t (Typ. / Max) [pF]	0.45 / 0.55	
R_{DYN} (Typ.) [Ω]	0.35	

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

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11 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Low noise | High efficiency · Low loss | Small size package

Value provided

TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1 Improve ESD pulse absorbability

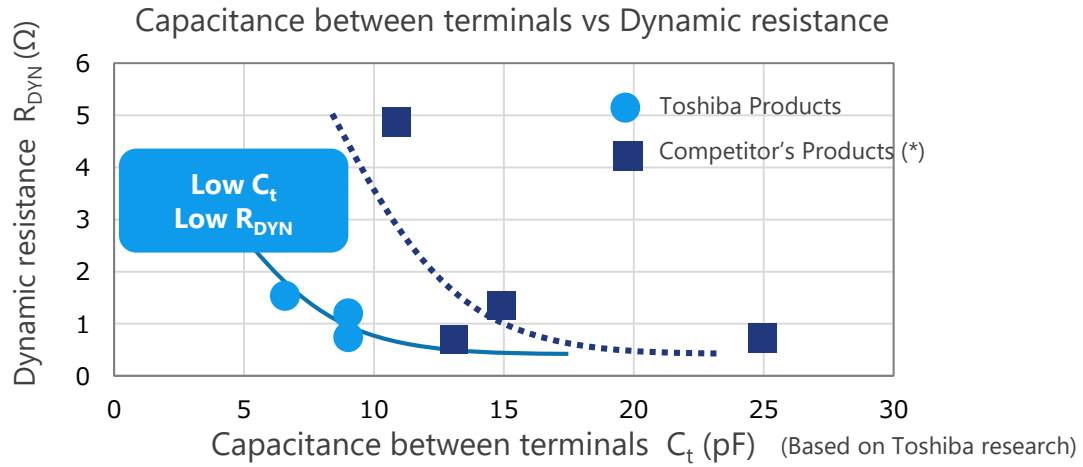
Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes.
(Both low dynamic resistance R_{DYN} and low capacitance between terminals C_t)

2 Supports CAN, CAN FD and FlexRay

These are products applicable to in-vehicle LAN communication such as CAN, CAN FD and FlexRay.

3 High ESD immunity

V_{ESD} > ±30 kV @ ISO 10605
V_{ESD} > ±20 kV (L4) @ IEC61000-4-2



(Based on Toshiba research)

(*): Measurements of the commercial product

Line up

Part number	DF3D18FU	DF3D29FU	DF3D36FU
Package	USM (SOT-323) 		
V_{ESD} [kV] @ISO10605	±30	±30	±20
V_{RWM} (Max) [V]	12	24	28
C_t (Typ. / Max) [pF]	9 / 10		6.5 / 8
R_{DYN} (Typ.) [Ω]	0.8	1.1	1.5

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

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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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