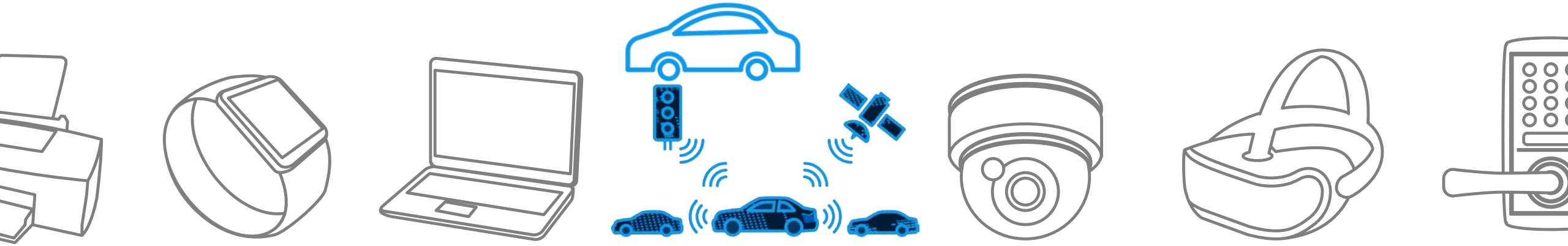
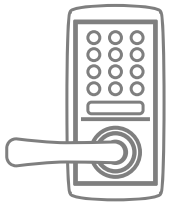
TOSHIBA

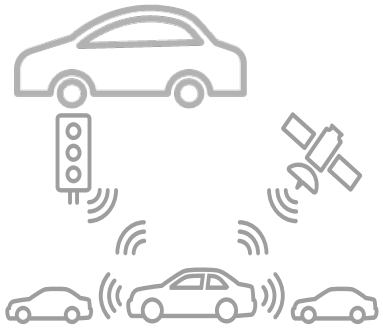
R20

Automotive V2X

Solution Proposal by Toshiba

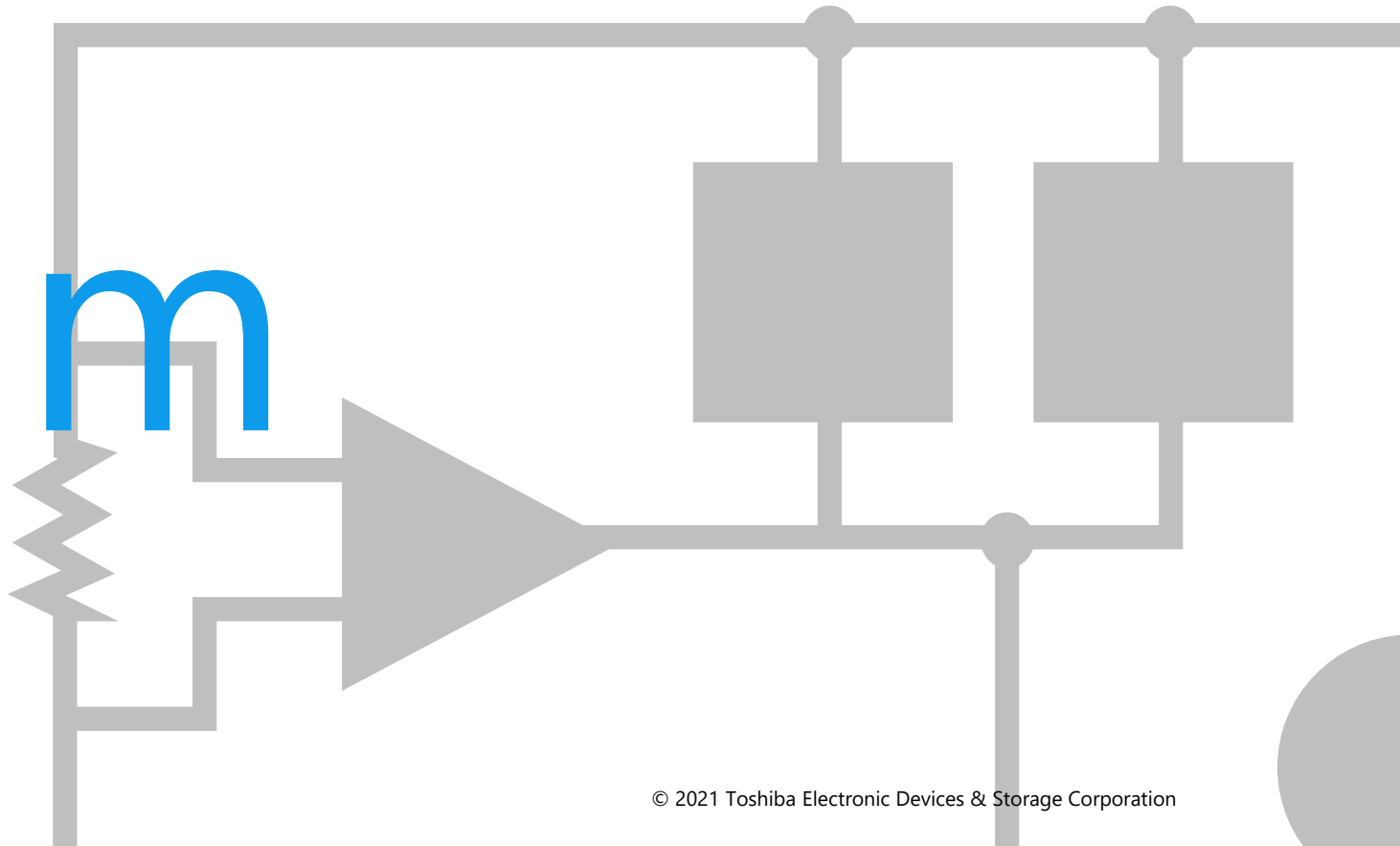




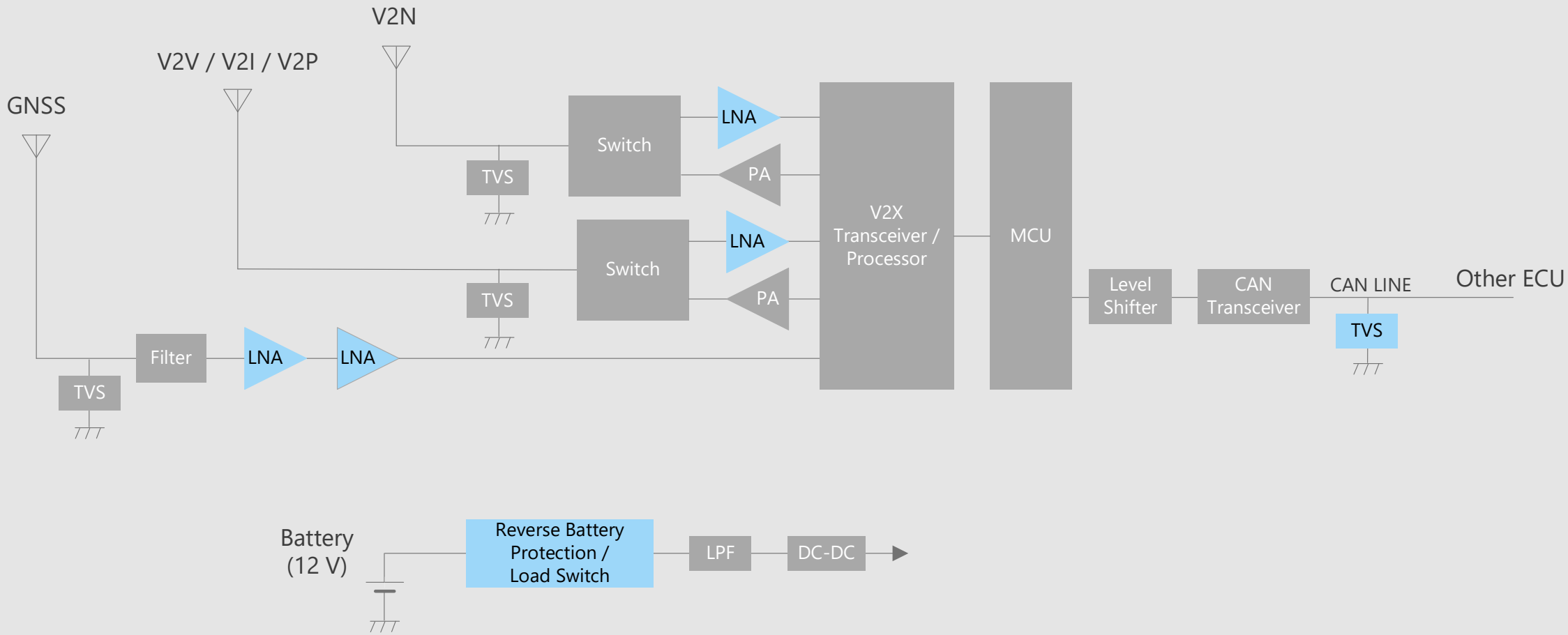


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram



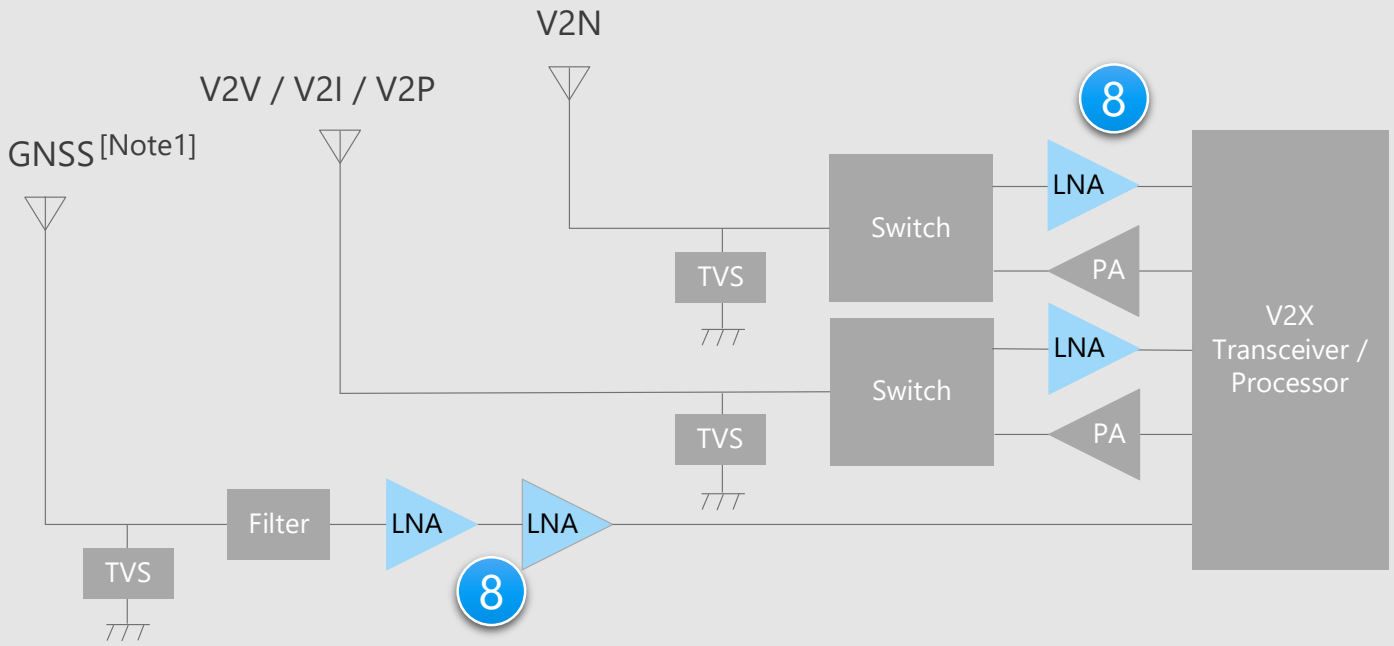
V2X　Overall block diagram



GNSS:Global Navigation Satellite System
[Global positioning satellite system: generic term for satellite positioning systems such as GPSs, GLONASS, Galileo, quasi-top satellites (QZSS)]

V2X　Detail of RF block

Antenna peripheral circuit



[Note1] GNSS:Global Navigation Satellite System

[Global positioning satellite system: generic term for satellite positioning systems such as GPSs, GLONASS, Galileo, quasi-top satellites (QZSS)]

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

Criteria for device selection

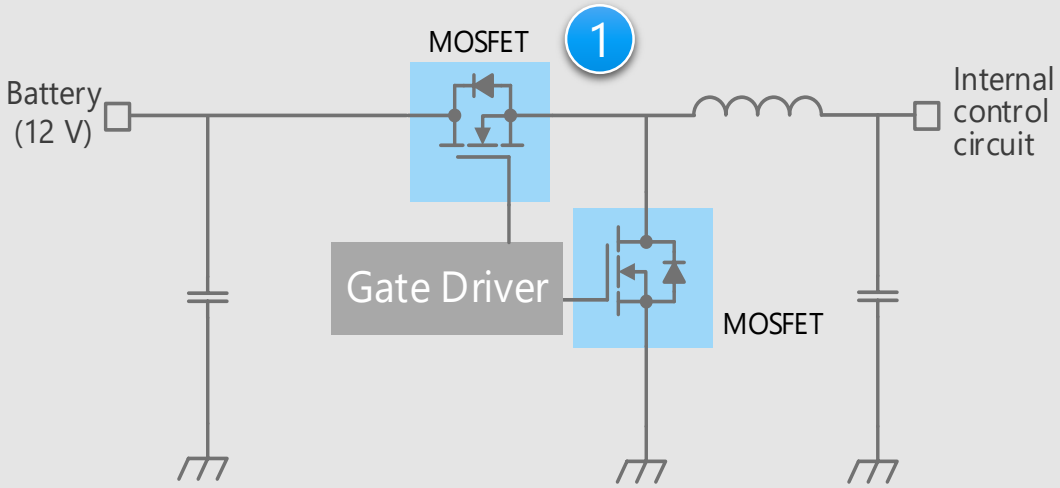
- It is necessary to select low noise and high gain device suitable for improve receiver sensitivity.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba

- **Low noise and high gain are realized**
  High frequency bipolar SiGe transistor 8

V2X Detail of power supply circuit

12 V DC-DC converter (non-isolated buck type)



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

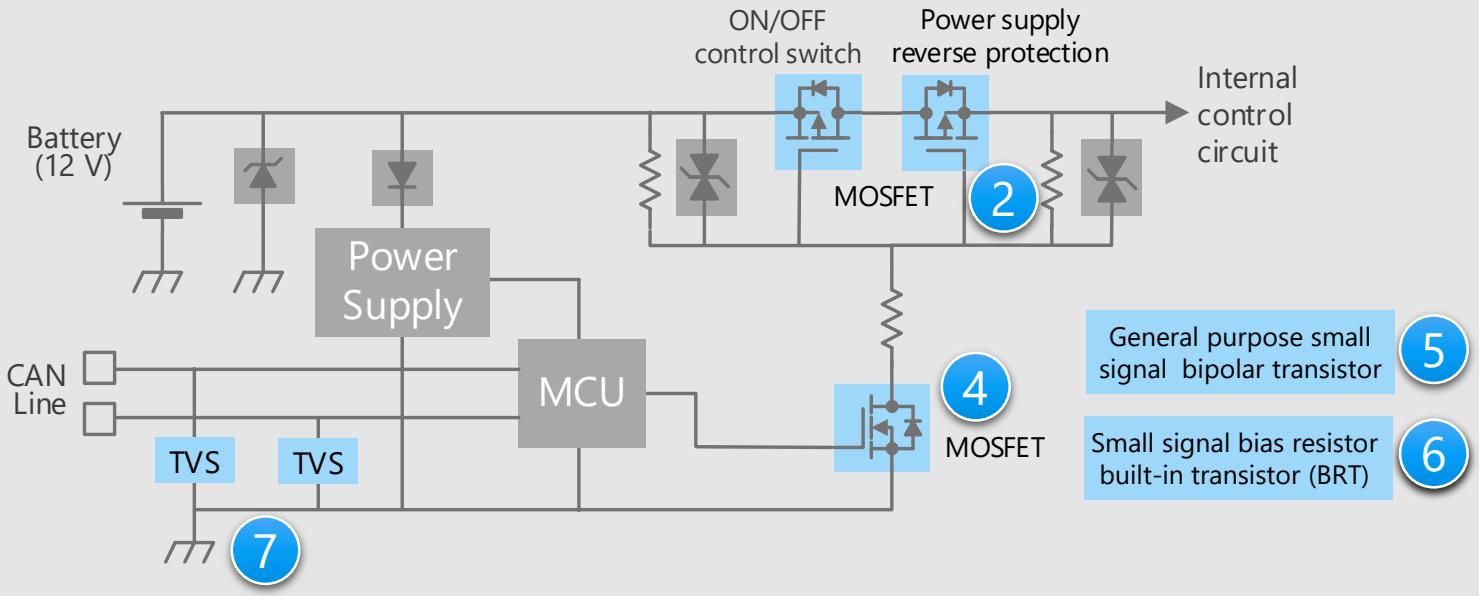
Criteria for device selection

- 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 1

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



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

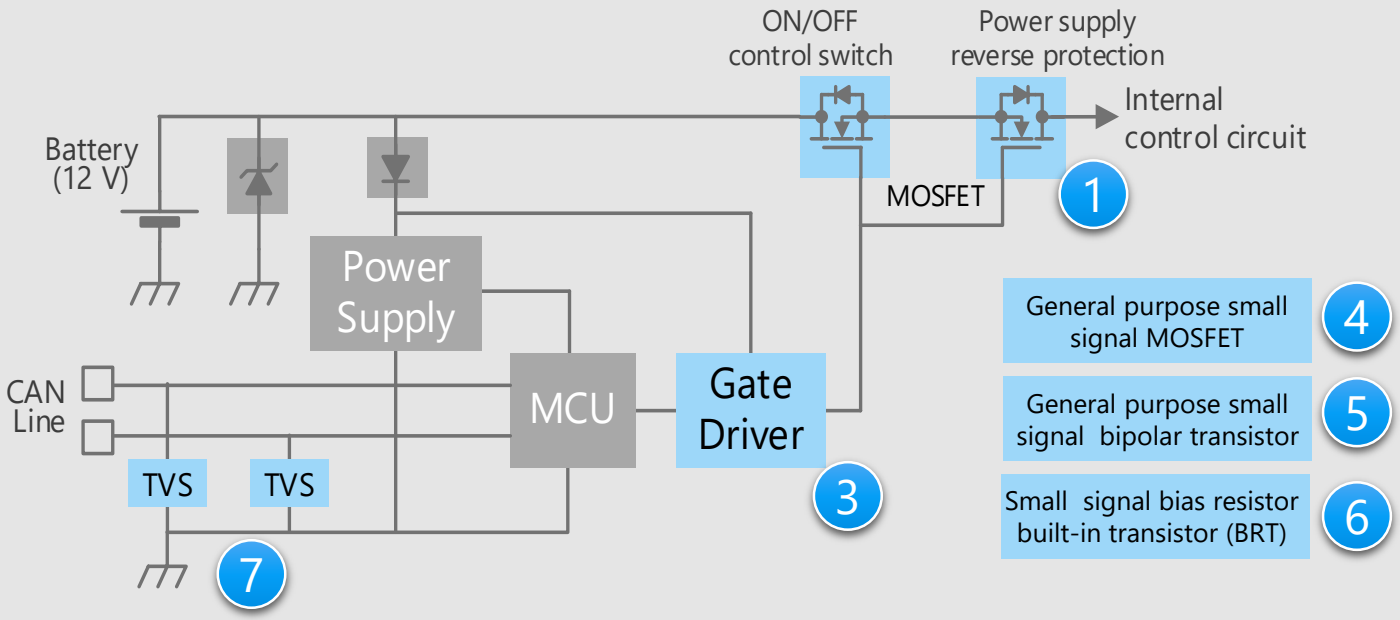
Criteria for device selection

- It is necessary to select the product with the suitable voltage and current ratings for each application.
- 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 (2)
- **Extensive product lineup**
  General purpose small signal MOSFET (4)
  General purpose small signal bipolar transistor (5)
  Small signal bias resistor built-in transistor (BRT) (6)
- **Suitable for ESD protection**
  TVS diode (for CAN communication) (7)

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



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

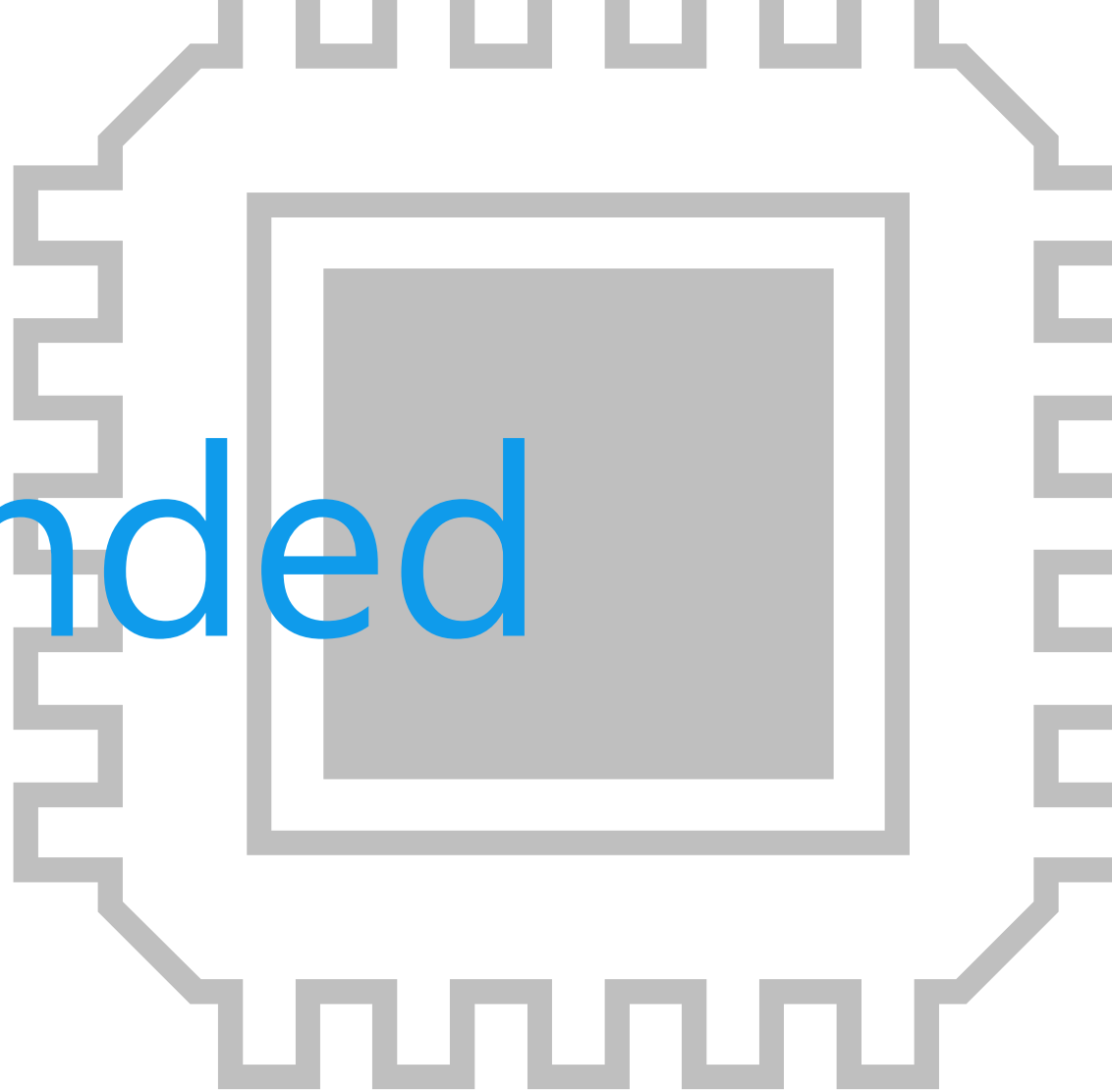
Criteria for device selection

- It is necessary to select the product with the suitable voltage and current ratings for each application.
- 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

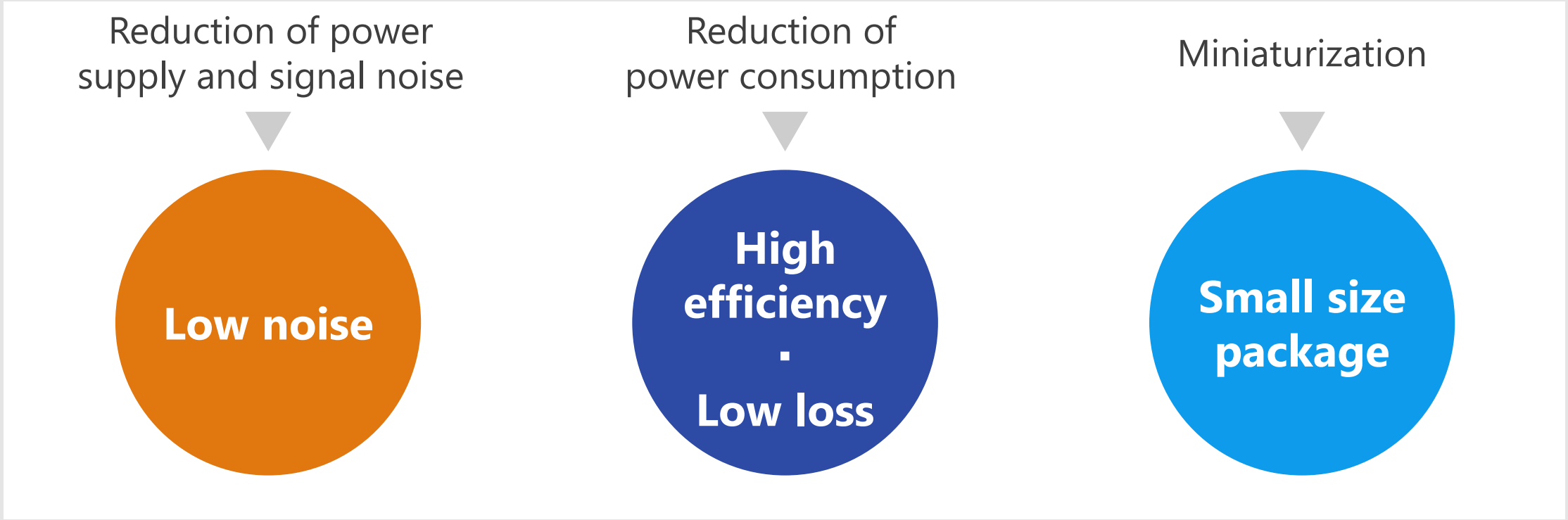
- **Low on-resistance contributes low power consumption of the system** 1
  U-MOS Series 40 V N-ch MOSFET
- **Gate driver with protection and diagnosis functions** 3
  Gate driver (for switch)
- **Extensive product lineup** 4 5
  General purpose small signal MOSFET
  General purpose small signal bipolar transistor
  Small signal bias resistor built-in transistor (BRT)
- **Suitable for ESD protection** 6 7
  TVS diode (for CAN communication)

Recommended Devices



Device solutions to address customer needs

As described above, in the design of V2X, "**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

		Low noise	High efficiency · Low loss	Small size package
1	U-MOS Series 40 V N-ch MOSFET	●	●	●
2	U-MOS Series -40 V / -60 V P-ch MOSFET		●	●
3	Gate driver (for switch)	●		●
4	General purpose small signal MOSFET		●	●
5	General purpose small signal bipolar transistor			●
6	Small signal bias resistor built-in transistor (BRT)			●
7	TVS diode (for CAN communication)	●		●
8	High frequency bipolar SiGe transistor	●		●

1 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)

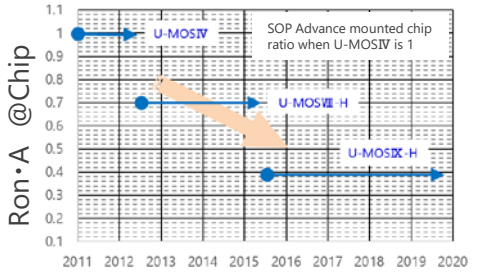
2 Compact and low loss package

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)

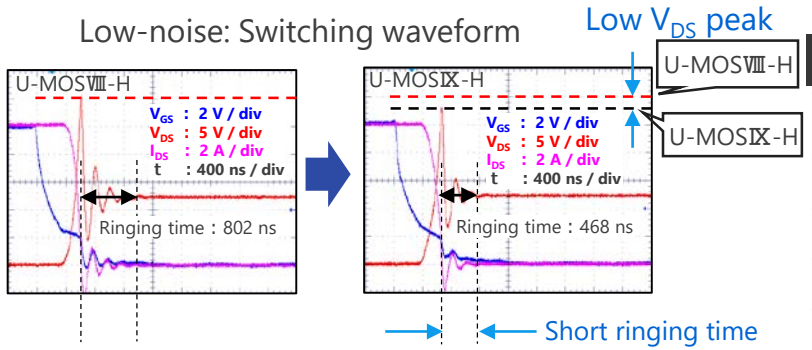
Improved chip process reduces surge voltage and ringing time.

Low Loss: RonA Trend



(Note: Toshiba internal comparison)

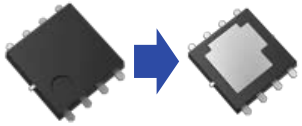
Low-noise: Switching waveform



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+

◆Block Diagram TOPへ戻る

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

TJ90S04M3L / TJ60S06M3L / XPH3R114MC / TJ200F04M3L

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

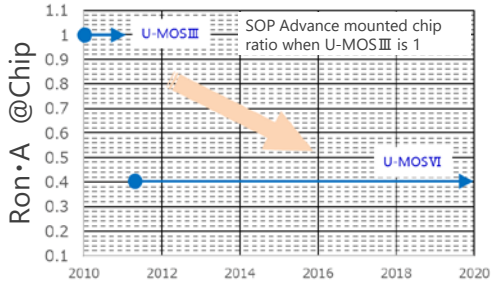
Value provided

Low on-resistance contributes to reduce system power consumption.

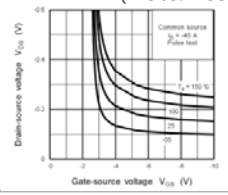
1 Low loss (reduced on-resistance) and logic level drive

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}

2 Small surface mount package developed

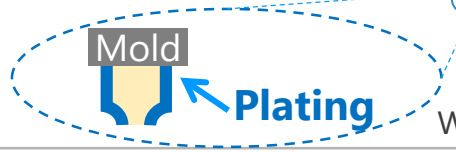
By adopting a Cu connector structure and a double-sided heat dissipation structure, low loss and high heat dissipation are realized.
Wettable Frank (WF) package contributes good mountability.

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

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

3 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-channel 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-channel MOSFET as high side switch.
Easy to configure a semiconductor relay.

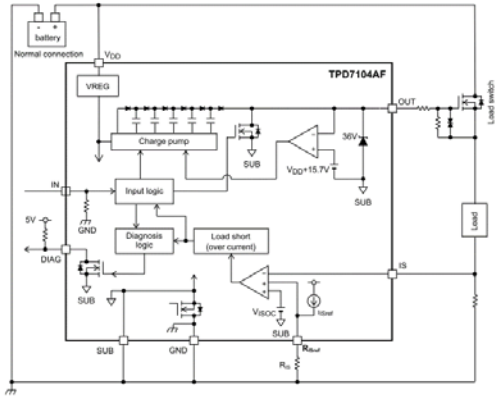
2 Can be controlled by logic level voltage

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

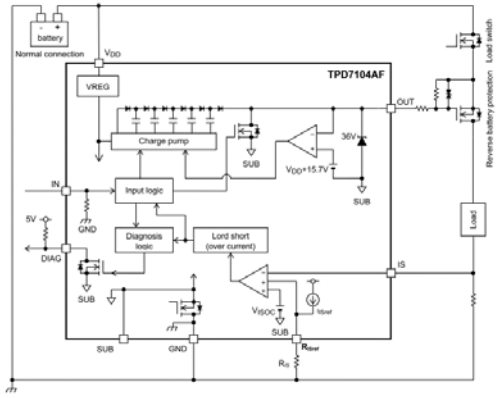
3 Small package

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

4 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.

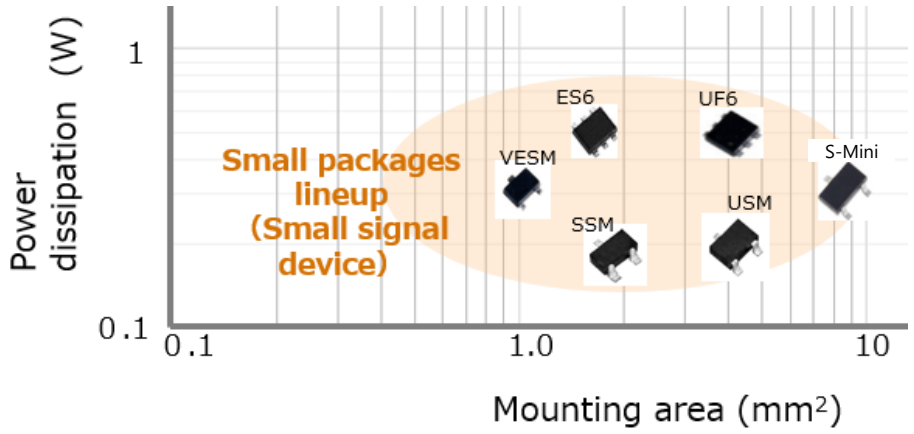
2 Low voltage drive

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

5 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.

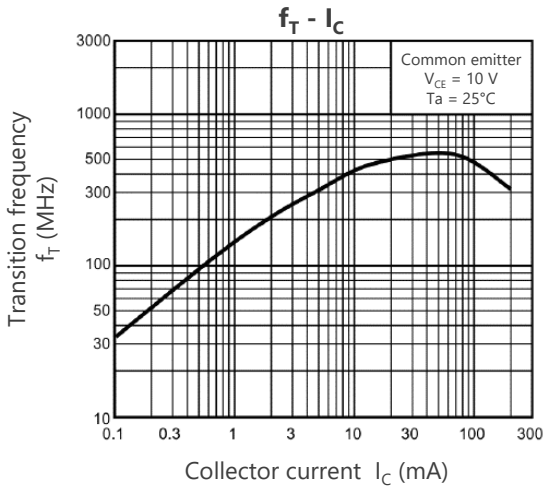
2 Extensive product lineup

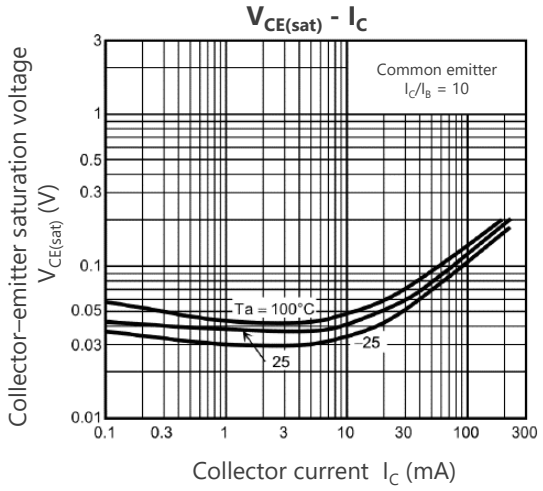
Various product lineups, such as general purpose, low noise, low $V_{CE(sat)}$ and high current types are provided. Products can be selected in accordance to the application.

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					

◆Return to Block Diagram TOP

6 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)

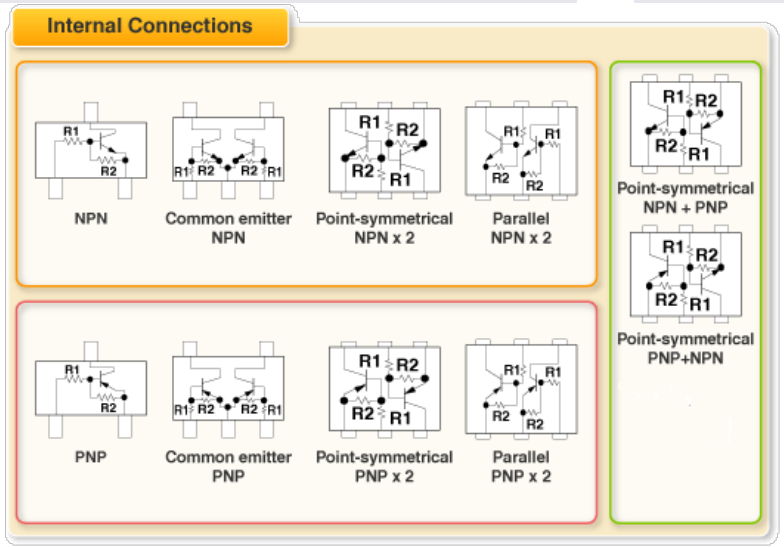
The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

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

◆Return to Block Diagram TOP

7 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

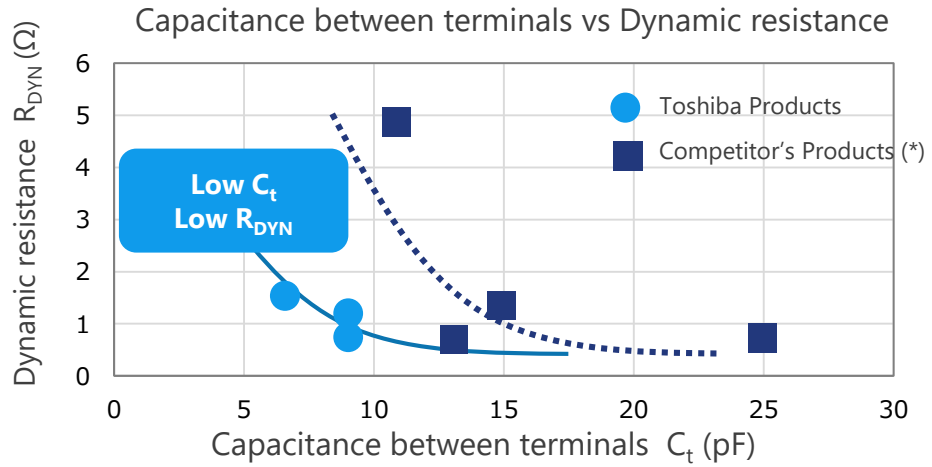
Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes.
(Both low dynamic resistance R_{DYN} and low capacitance between terminals C_t)

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's measurement data)
(*): Measurements of the commercial product

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

Line up

Part number	DF3D18FU	DF3D29FU	DF3D36FU
Package	USM (SOT-323) 		
V_{ESD} [kV] @ISO 10605	±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

◆Return to Block Diagram TOP

8 Radio frequency SiGe bipolar transistor

MT4S300U / MT4S301U

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

Value provided

Low noise and high gain are realized. That contributes to improve receiver sensitivity.

1 Low noise and high gain

Low noise and high gain are realized by using SiGe.

Noise figure (@f = 2 GHz) : 0.57 dB (Typ.)

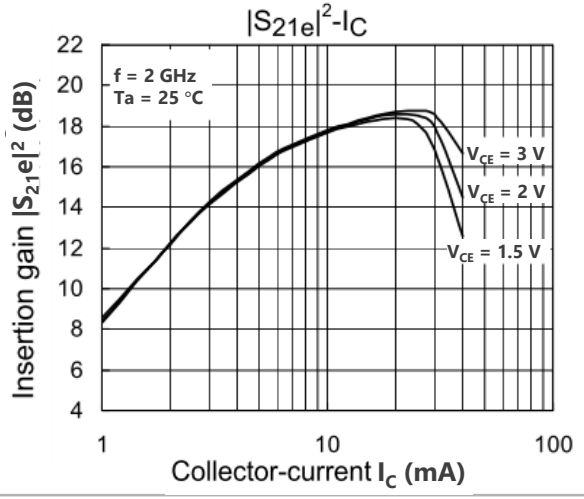
Insertion gain (@f = 2 GHz) : 18.1 dB (Typ.)

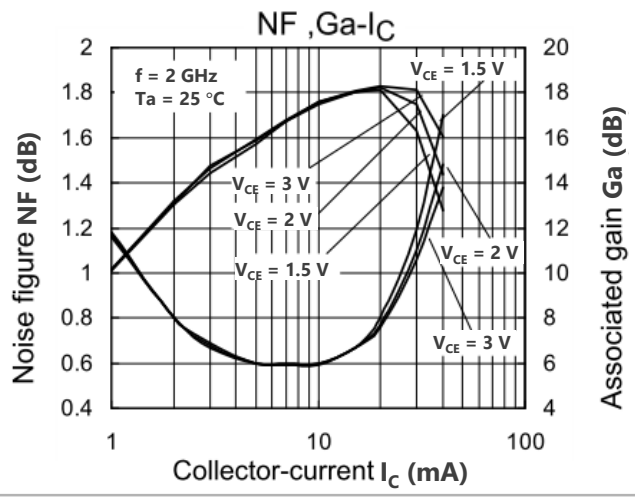
Electrostatic beakdown resistance : 2 kV or more (HBM method)
(in the case of MT4S301U)

2 Small surface mount package

The small package contributes to reduce the mounting area.

Characteristic of MT4S301U





Line up

Part number	MT4S300U	MT4S301U
Package	USQ (SOT-343) (2.0 x 2.1 mm)	
V_{CEO} (Max) [V]	4	4
I_C (Max) [mA]	50	35
Transition frequency f_T (Typ.) [GHz]	26.5	27.5
Noise figure NF (Typ.) [dB]	0.55 @f = 2 GHz	0.57 @f = 2 GHz
Insertion gain $\|S21e\|^2$ (Typ.) [dB]	16.9 @f = 2 GHz	18.1 @f = 2 GHz

◆Return to Block Diagram TOP

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