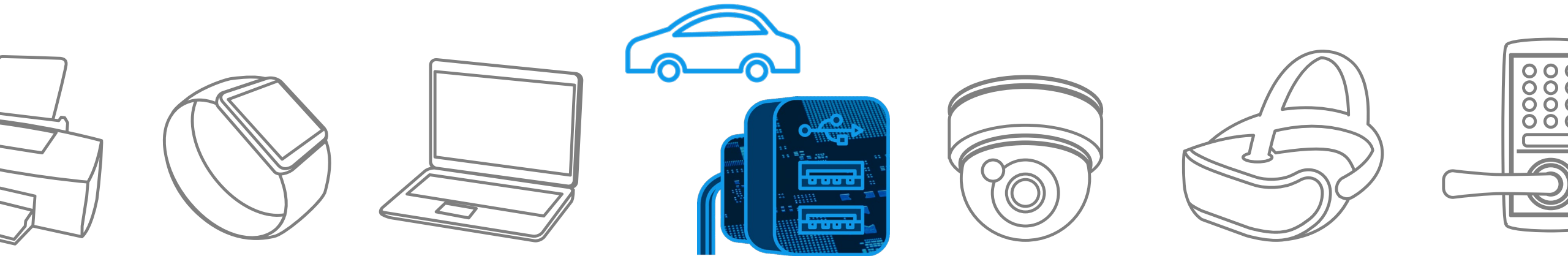
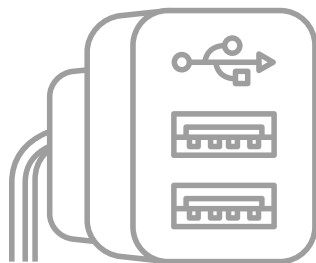
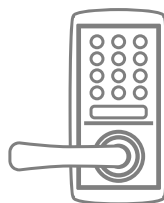


Automotive USB Power Charger

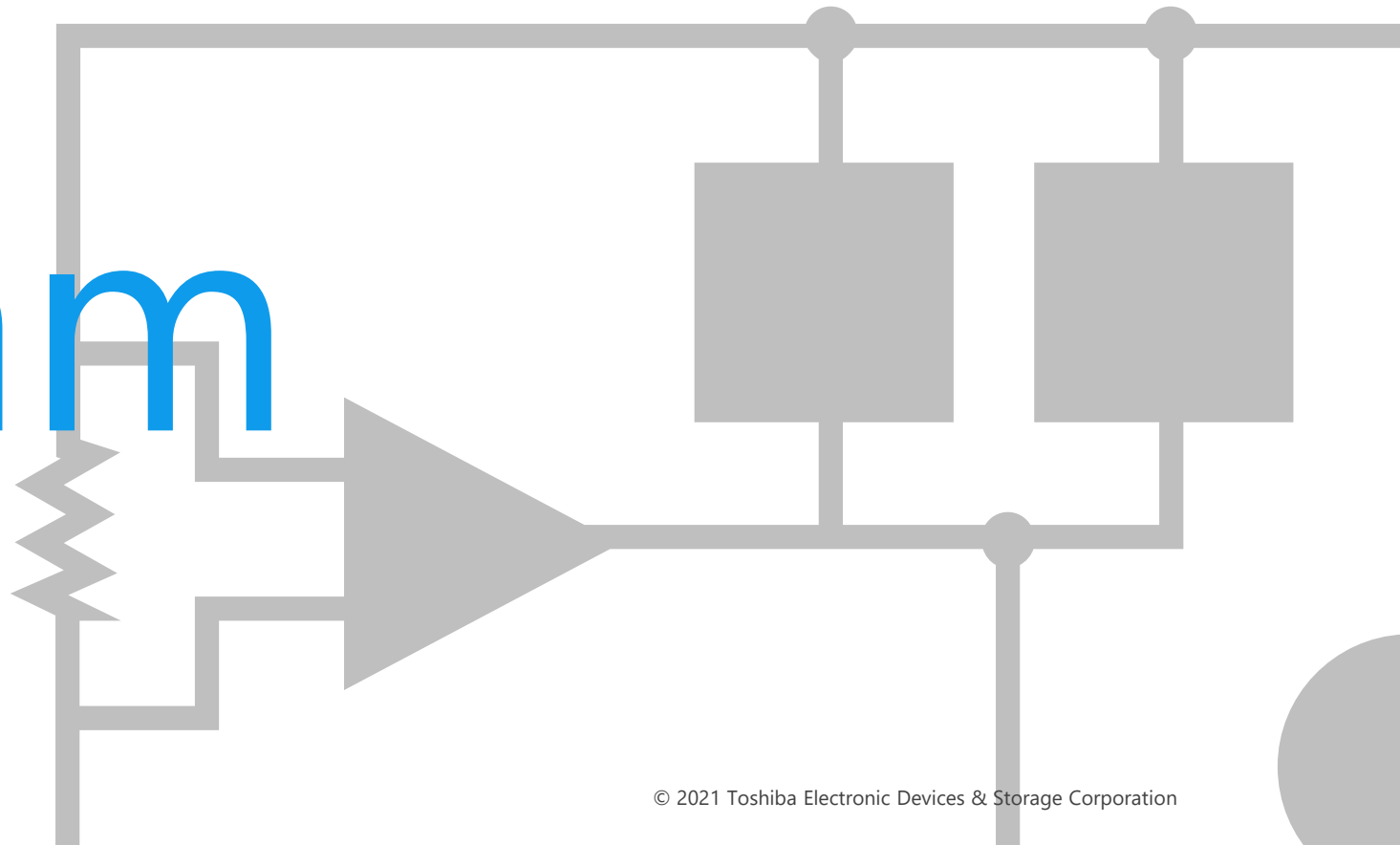
Solution Proposal by Toshiba



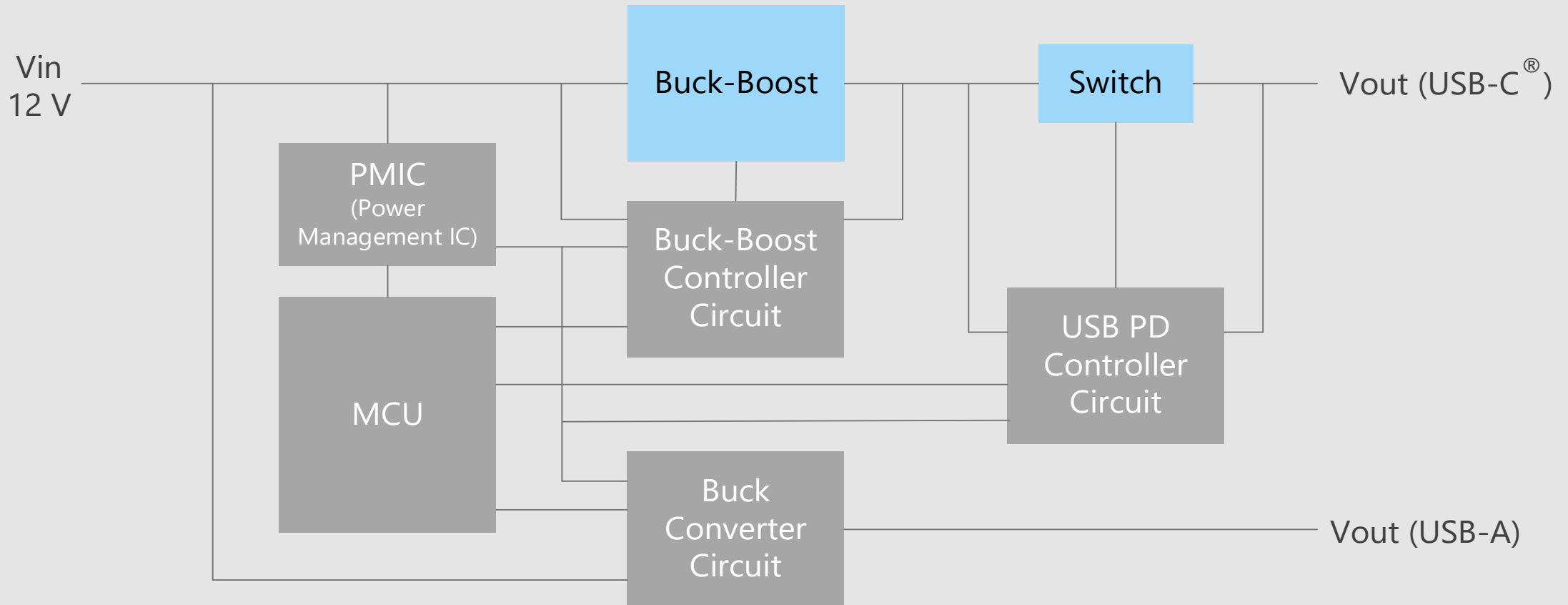


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

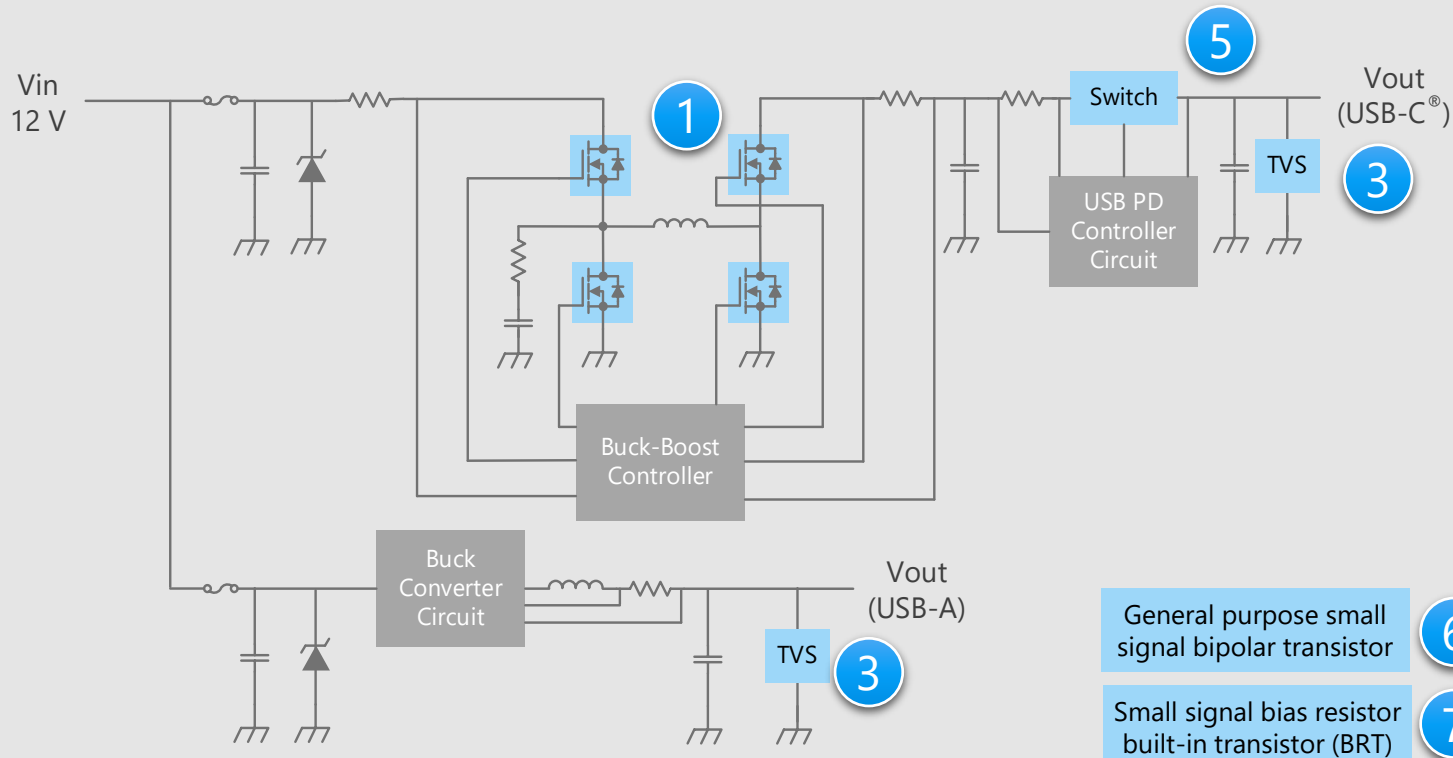
Block Diagram



USB Power Charger Overall block diagram



Circuit for cigar socket type



General purpose small signal bipolar transistor

6

Small signal bias resistor built-in transistor (BRT)

7

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.

Proposal from Toshiba

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

1

3

5

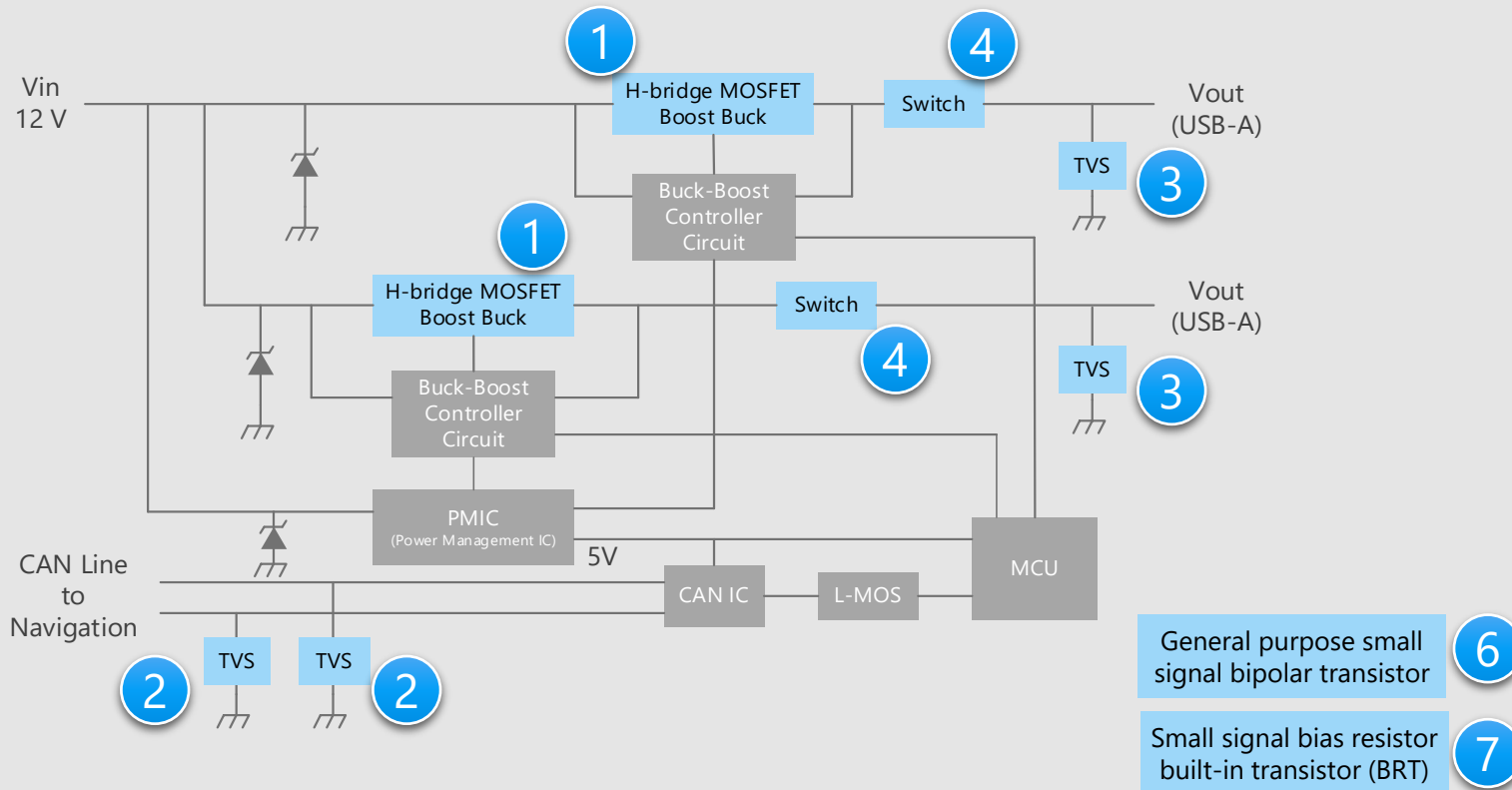
6

7

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

USB Power Charger Detail of accessory type

Circuit for accessory 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.
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Proposal from Toshiba

- **Low on-resistance contributes low power consumption of the system**

U-MOS Series 40 V N-ch MOSFET

- **Suitable for ESD protection**

TVS diode (for CAN communication)

TVS diode (for high speed communication)

- **Low on-resistance, compact and high heat dissipation package**

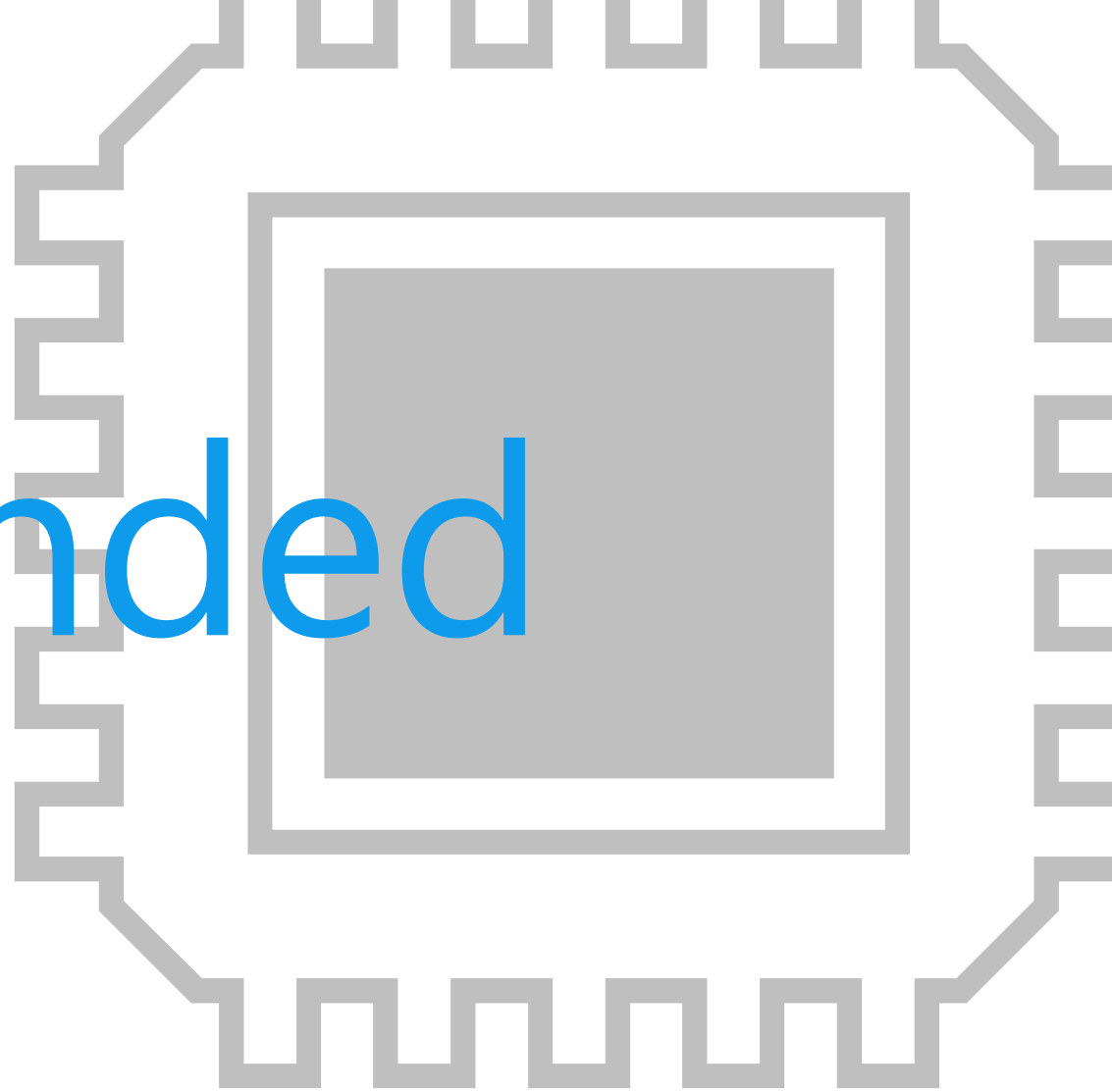
Semi-power MOSFET

- **Extensive product lineup**

General purpose small signal bipolar transistor

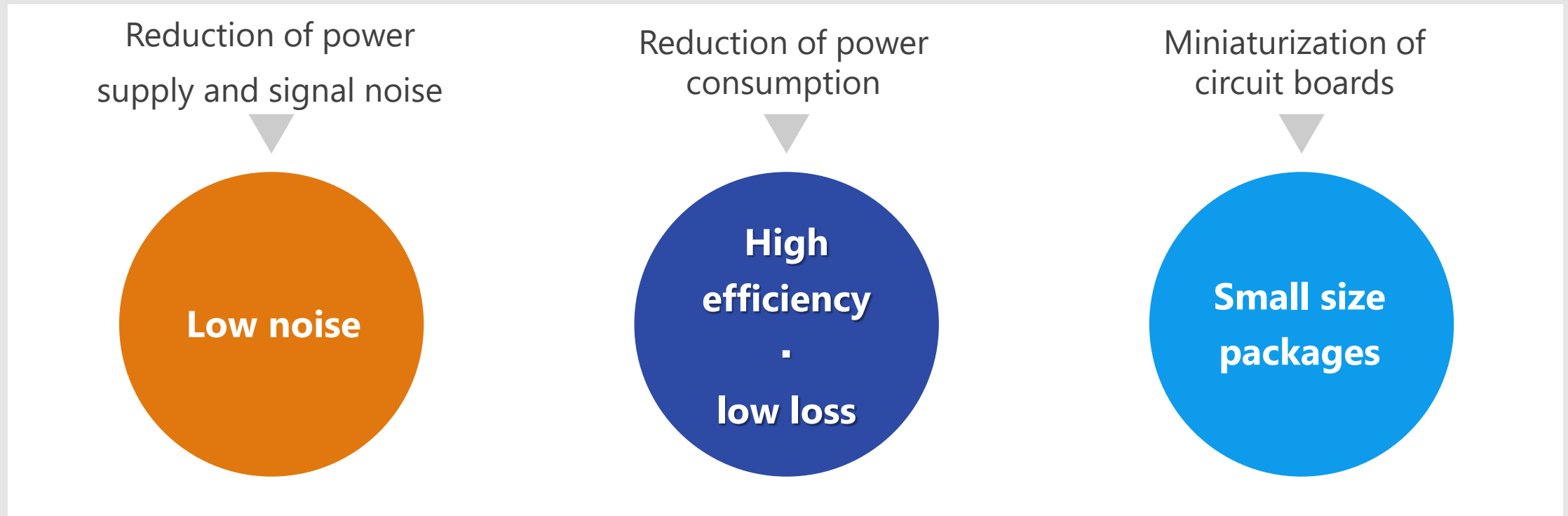
Small signal bias resistor built-in transistor (BRT)

Recommended Devices



Device solutions to address customer needs

As described above, in the design of USB Power Charger, “**Reduction of power supply and signal noise**”, “**Reduction of power consumption**” and “**Miniaturization of circuit boards**” 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 packages

1	U-MOS Series 40 V N-ch MOSFET		●	●
2	TVS diode (for CAN communication)	●		●
3	TVS diode (for high speed communication)	●		●
4	Semi-power MOSFET		●	●
5	U-MOS Series -40 V / -60 V P-ch MOSFET		●	●
6	General purpose small signal bipolar transistor			●
7	Small signal bias resistor built-in transistor (BRT)			●

Value provided

The advanced U-MOS^{IX}-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-MOS^{IV})

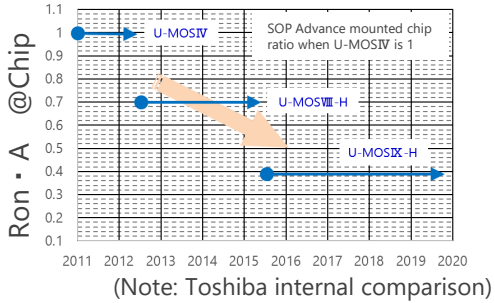
2 Compact and low loss package

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.

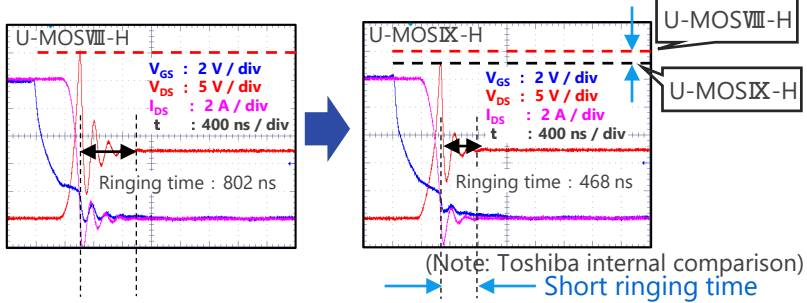
3 Low noise (low EMI)

Improved chip process reduces surge voltage and ringing time.

Low Loss: RonA Trend



Low-noise: Switching waveform



Line up

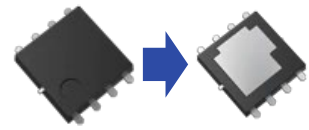
Part number	Drain current	On-resistance (Max) @V _{GS} = 10 V	Package
XPN3R804NC	40 A	3.8 mΩ	TSON Advance(WF)
TK1R4S04PB	120 A	1.35 mΩ	DPAK+
TPHR7904PB	150 A	0.79 mΩ	SOP Advance(WF)
TPWR7904PB	150 A	0.79 mΩ	DSOP Advance(WF)L
TKR74F04PB	250 A	0.74 mΩ	TO-220SM(W)
TK1R5R04PB	160 A	1.5 mΩ	D2PAK+

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).

[Return to Block Diagram TOP](#)

2 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Low noise

High efficiency
·
low loss

Small size packages

Value provided

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

1 Improve ESD pulse absorbability

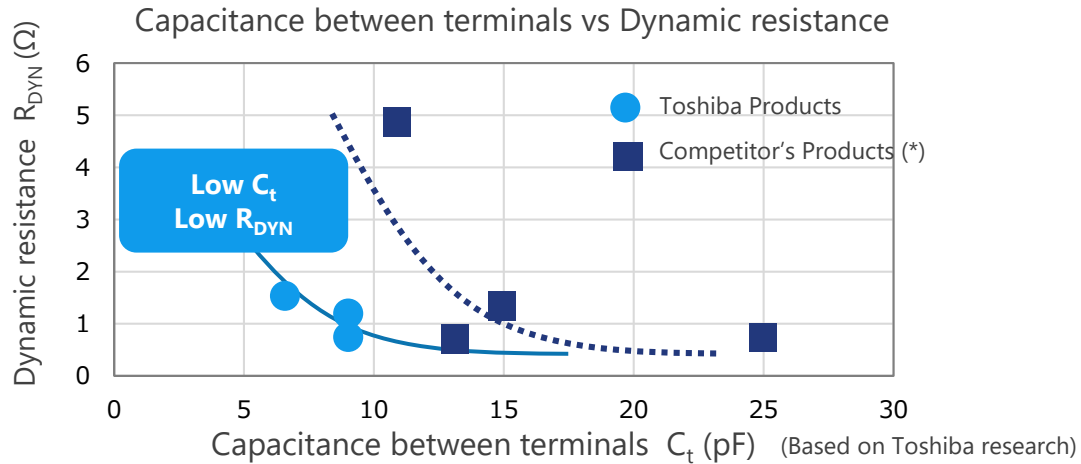
Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes.
(Both low dynamic resistance R_{DYN} and low capacitance between terminals C_t)


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

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



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

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

(*): Measurements of the commercial product

[Return to Block Diagram TOP](#)

3 TVS diode (for high speed communication)

DF2S5M4FS / DF2S6M4FS

Low noise

High efficiency
·
low loss

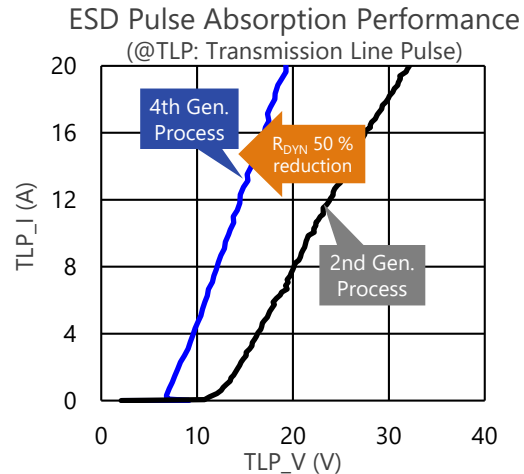
Small size packages

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})



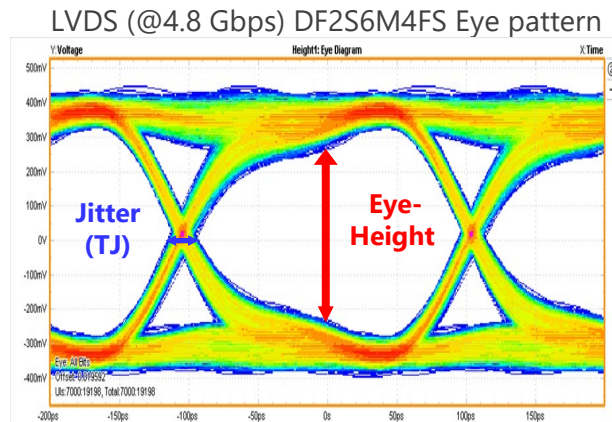
(Note: Toshiba internal comparison)

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

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

$V_{ESD} > \pm 30$ kV @ ISO 10605

$V_{ESD} > \pm 20$ kV (L4) @ IEC61000-4-2

Line up

Part number	DF2S5M4FS	DF2S6M4FS
Package	SOD-923 	
V_{ESD} [kV] @ISO 10605	± 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	

[Return to Block Diagram TOP](#)

Value provided

Low on-resistance, small and high power dissipation packages contribute to miniaturization and low power consumption of the systems.

1 Low loss (reduced chip resistance)

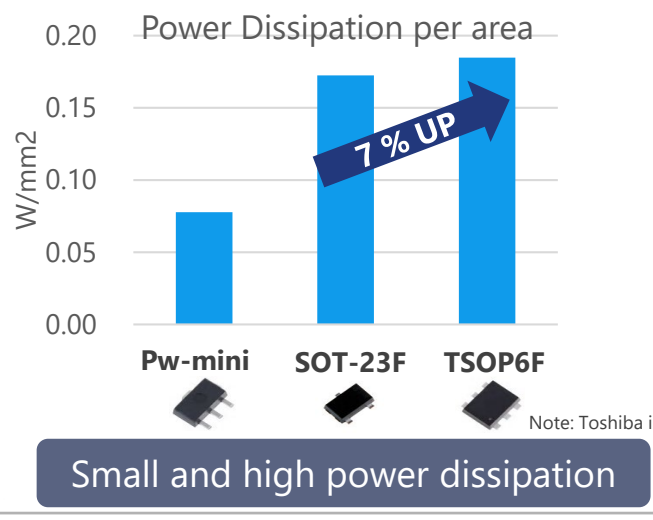
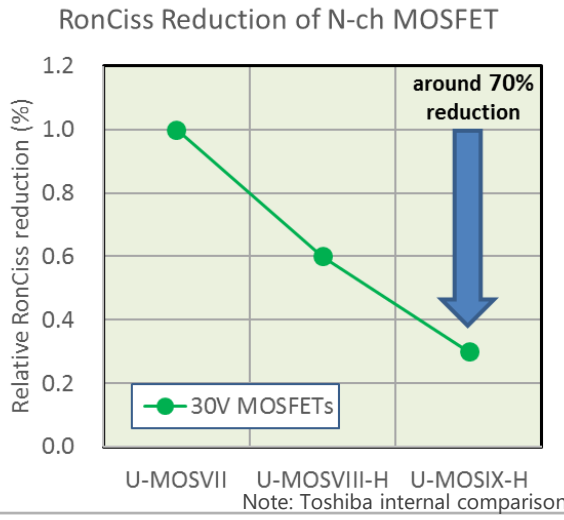
Using low chip resistance technology to contribute to reduced power consumption systems.

2 Small and high heat-dissipating package

Small and high heat-dissipating packages contribute to space saving during mounting. TSOP6F (2.9 x 2.8 mm), SOT-23F (2.9 x 2.4 mm)

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for a wide range of automotive applications.



Line up

Part number	SSM6K810R	SSM6K809R	SSM3K376R	SSM6J808R
Package	TSOP6F	TSOP6F	SOT-23F	TSOP6F
$V_{DS(DC)}$ [V]	100	60	30	-40
I_D [A]	3.5	6	4	-7
$R_{DS(ON)}$ [mΩ] @ $V_{GS} = 4.5$ V	Typ.	65	36	45
	Max	92	51	56
MOS Type	N-channel	N-channel	N-channel	P-channel

[Return to Block Diagram TOP](#)

Value provided

Low on-resistance contributes to reduce system power consumption.

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

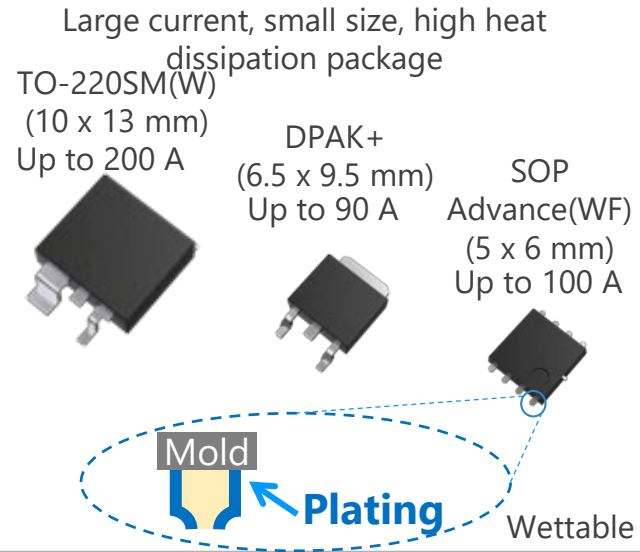
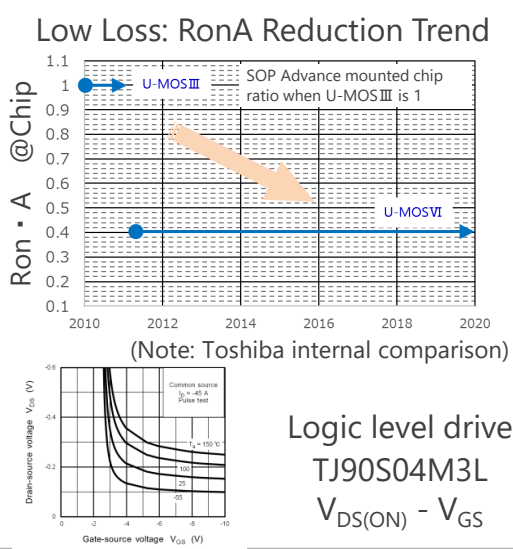
Using low on-resistance technology contributes to reduce system power consumption.

Lineups of logic level drive type are supported.




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) @ $V_{GS} = -10\text{ V}$	Package
TJ90S04M3L	-40 V	-90 A	4.3 m Ω	DPAK+ 
TJ60S06M3L	-60 V	-60 A	11.2 m Ω	
XPH3R114MC	-40 V	-100 A	3.1 m Ω	SOP Advance(WF) 
TJ200F04M3L	-40 V	-200 A	1.8 m Ω	TO-220SM(W) 

[Return to Block Diagram TOP](#)

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.

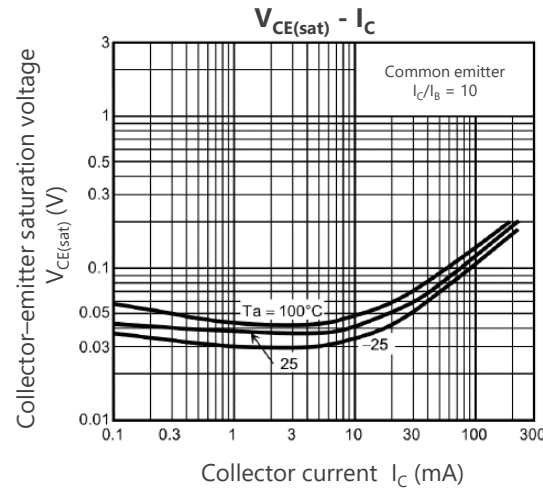
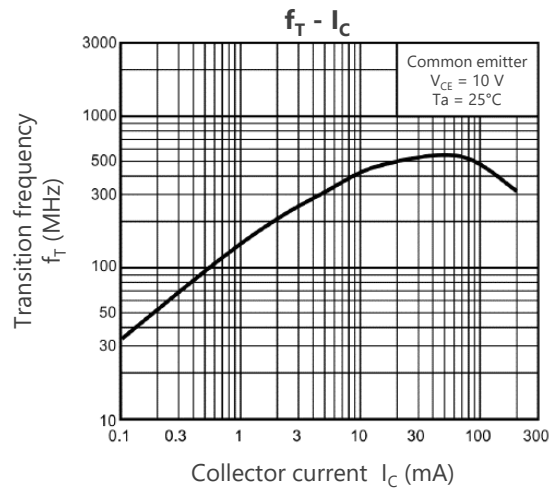
2 Extensive product lineup

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_{CE0} $ [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](#)

Value provided

Extensive product lineup to meet customers' needs.

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

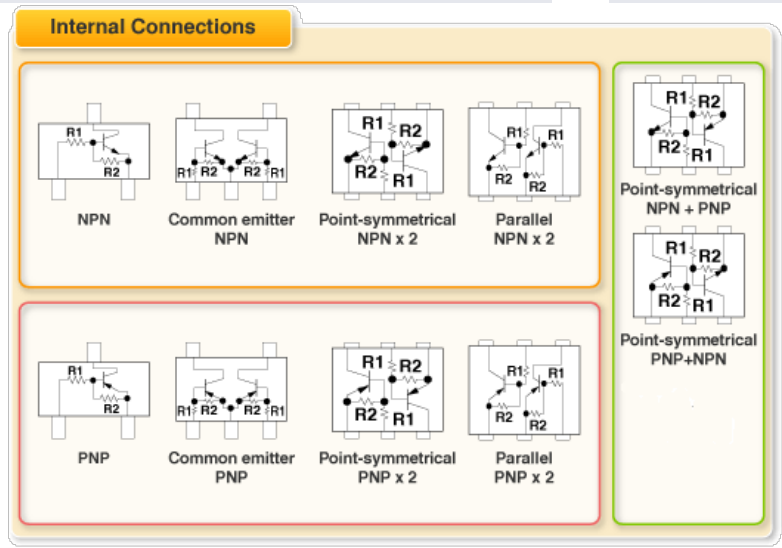
The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

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_{CE0} (Max) [V]		50	-50
I_C [mA]		100	-100

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