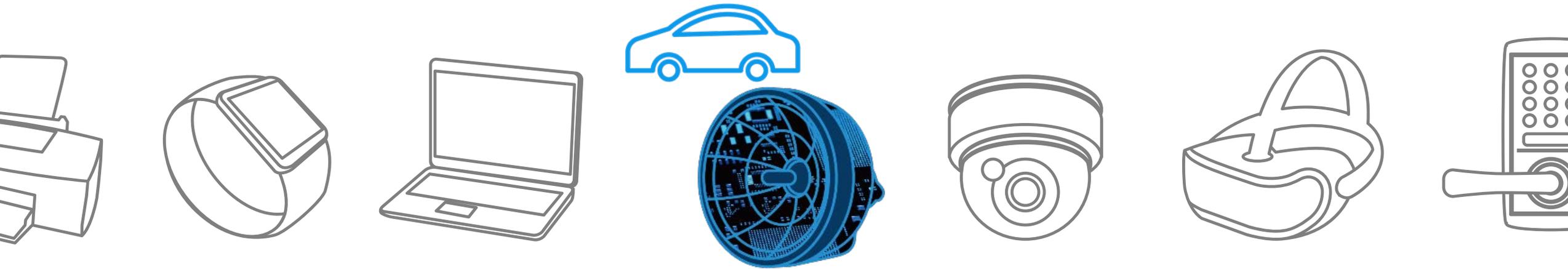
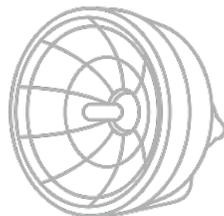
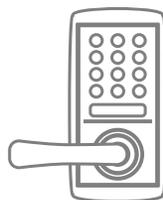


Automotive LED Headlamp

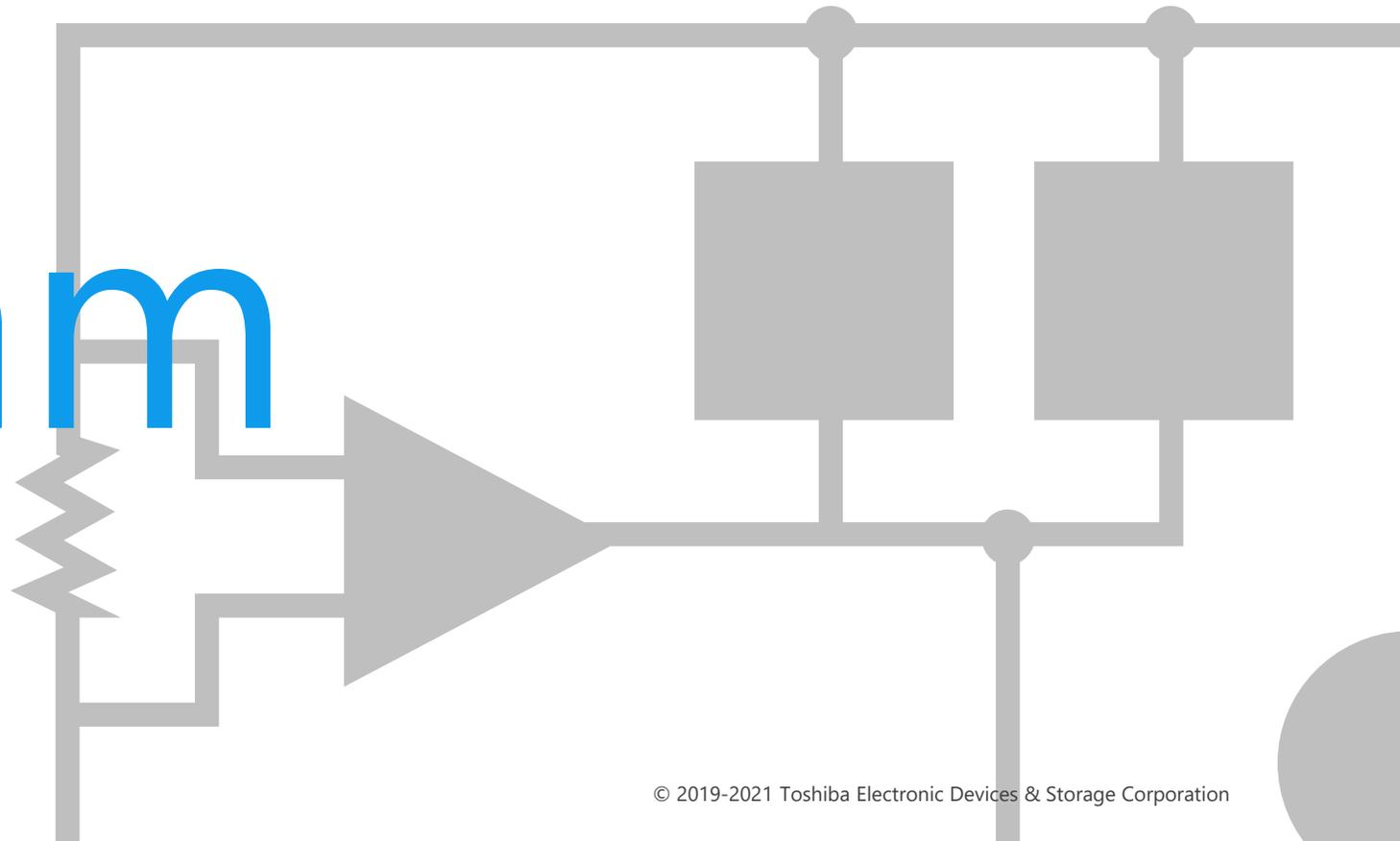
Solution Proposal by Toshiba



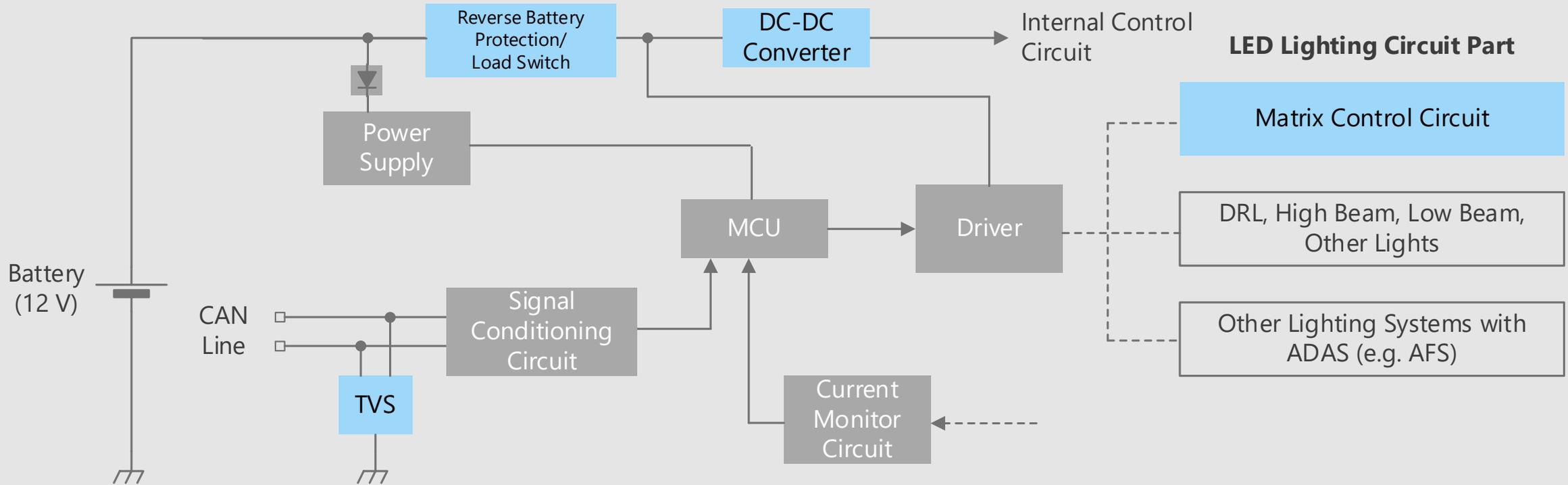


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram



LED Headlamp Overall block diagram



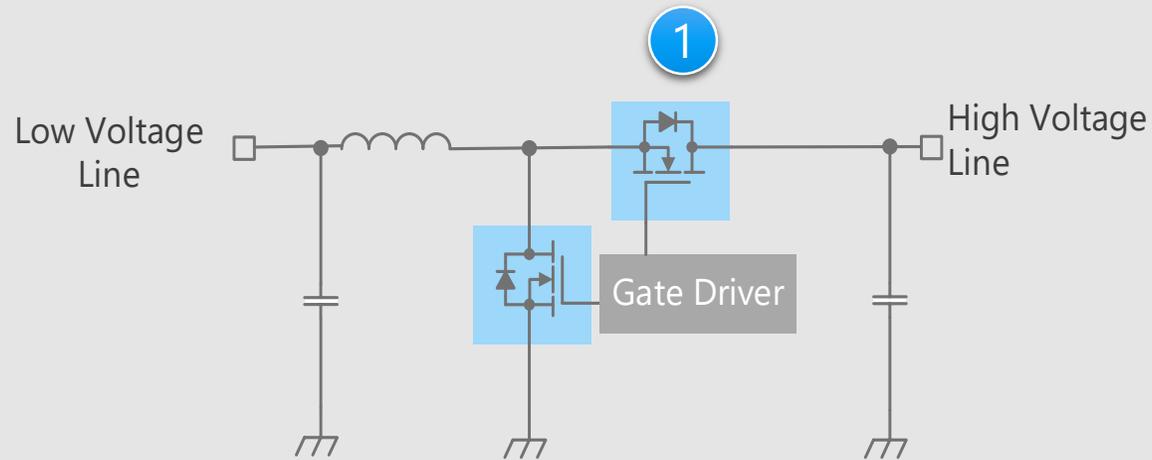
DC-DC converter circuits (non-isolated boost type)

Device selection points

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.
- The dead time must be considered to prevent the occurrence of shoot through current.

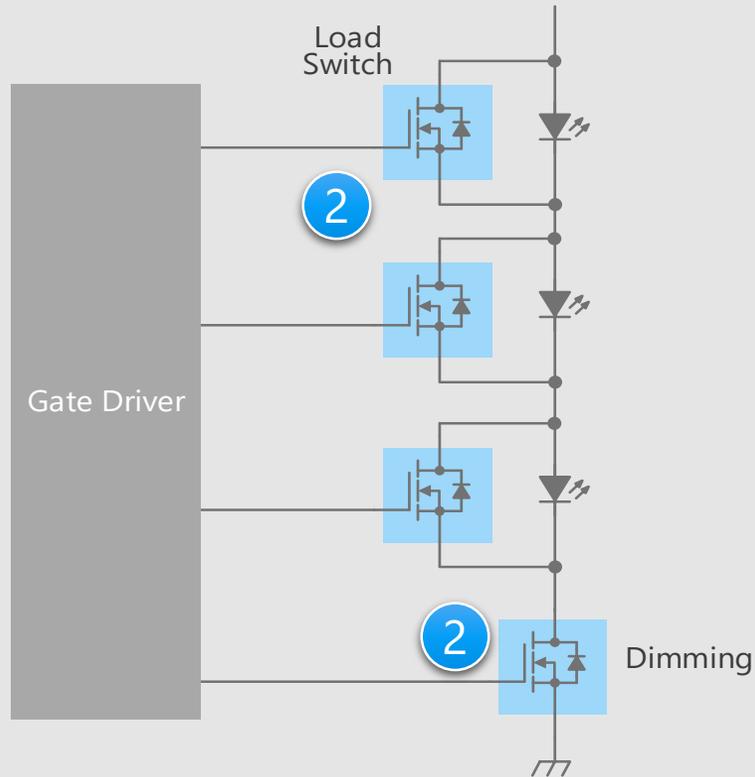
Proposals from Toshiba

- **Low power consumption of the system is realized by low on-resistance**
U-MOS Series 100 V N-ch power MOSFET



* [Click on the numbers in the circuit diagram to jump to the detailed descriptions page](#)

LED matrix control circuit (1)



Device selection points

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

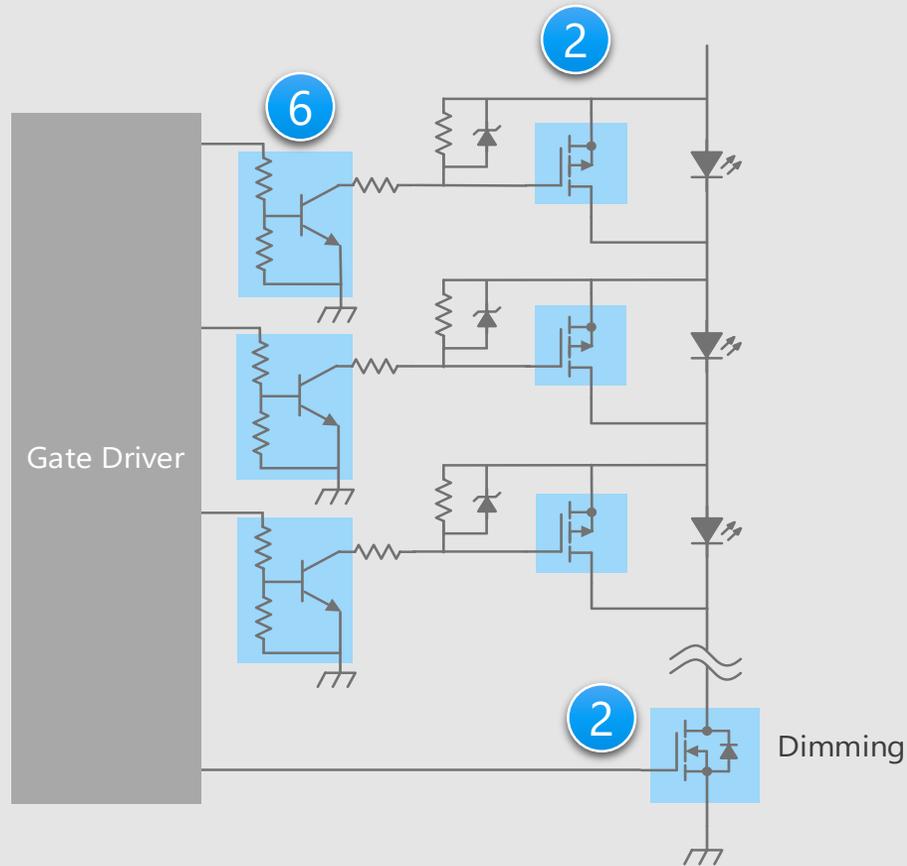
Proposals from Toshiba

- **Low power consumption of the system is realized by low on-resistance**
Semi-power MOSFET

2

* [Click on the numbers in the circuit diagram to jump to the detailed descriptions page](#)

LED matrix control circuit (2)



Device selection points

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

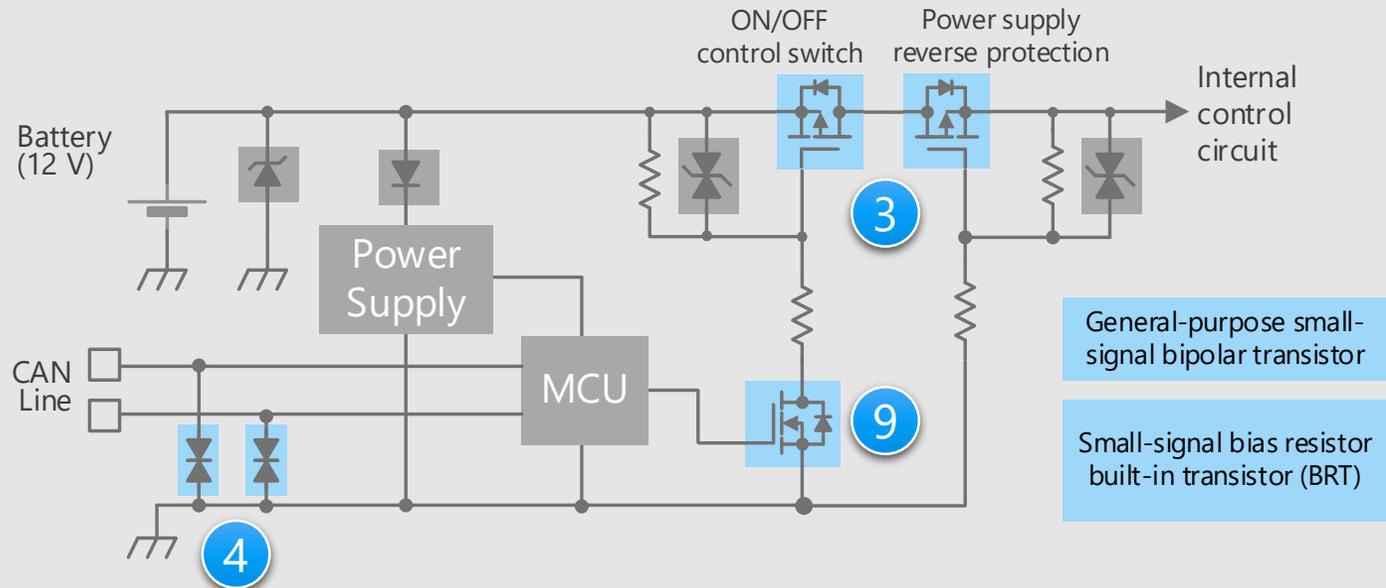
Proposals from Toshiba

- **Low power consumption of the system is realized by low on-resistance** 2
Semi-power MOSFET
- **Various product lineups and small packages** 6
Small-signal bias resistor built-in transistor (BRT)

* [Click on the numbers in the circuit diagram to jump to the detailed descriptions page](#)

Switch for power supply ON/OFF control and reverse connection protection (1)

Power supply ON/OFF control and reverse connection protecting circuit (P-ch method)



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

Device selection points

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba

- **Low power consumption of the system is realized by low on-resistance**

U-MOS Series -40 V / -60 V P-ch power MOSFET 3

- **Various product lineups and small packages**

General-purpose small-signal MOSFET 9

General-purpose small-signal bipolar transistor 5

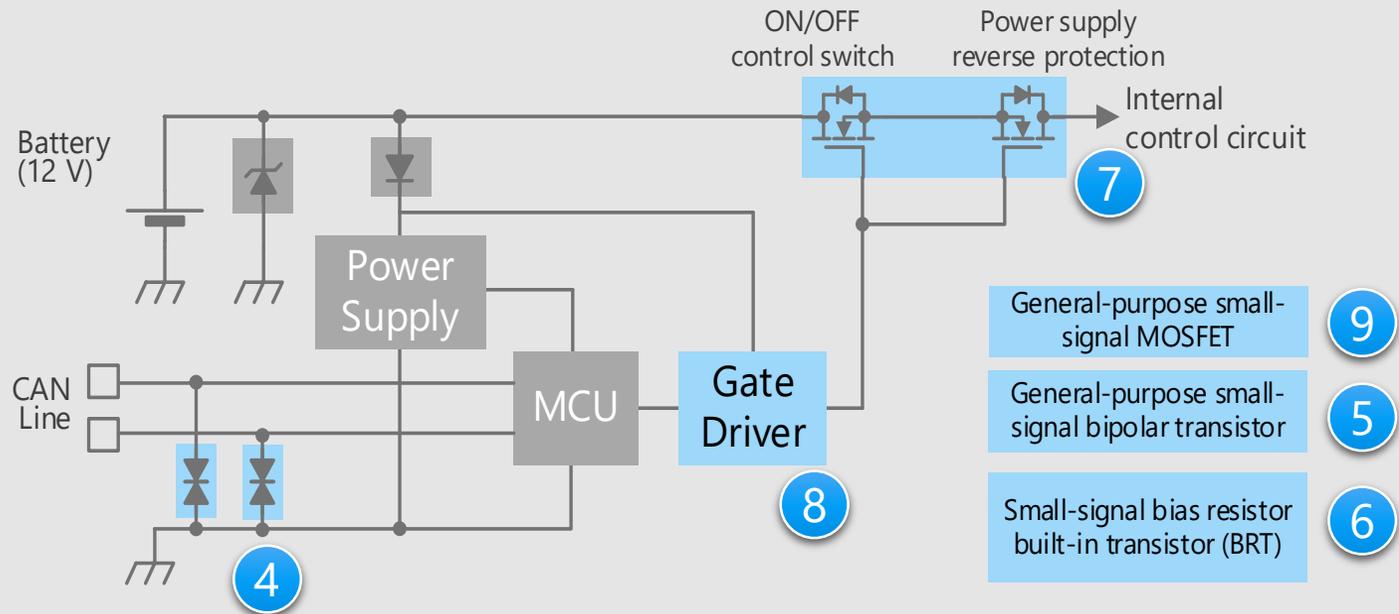
Small-signal bias resistor built-in transistor (BRT) 6

- **Both device protection and signal quality are realized**

TVS diode (for CAN communication) 4

Switch for power supply ON/OFF control and reverse connection protection (2)

Power supply ON/OFF control and reverse connection protecting circuit (N-ch method)



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

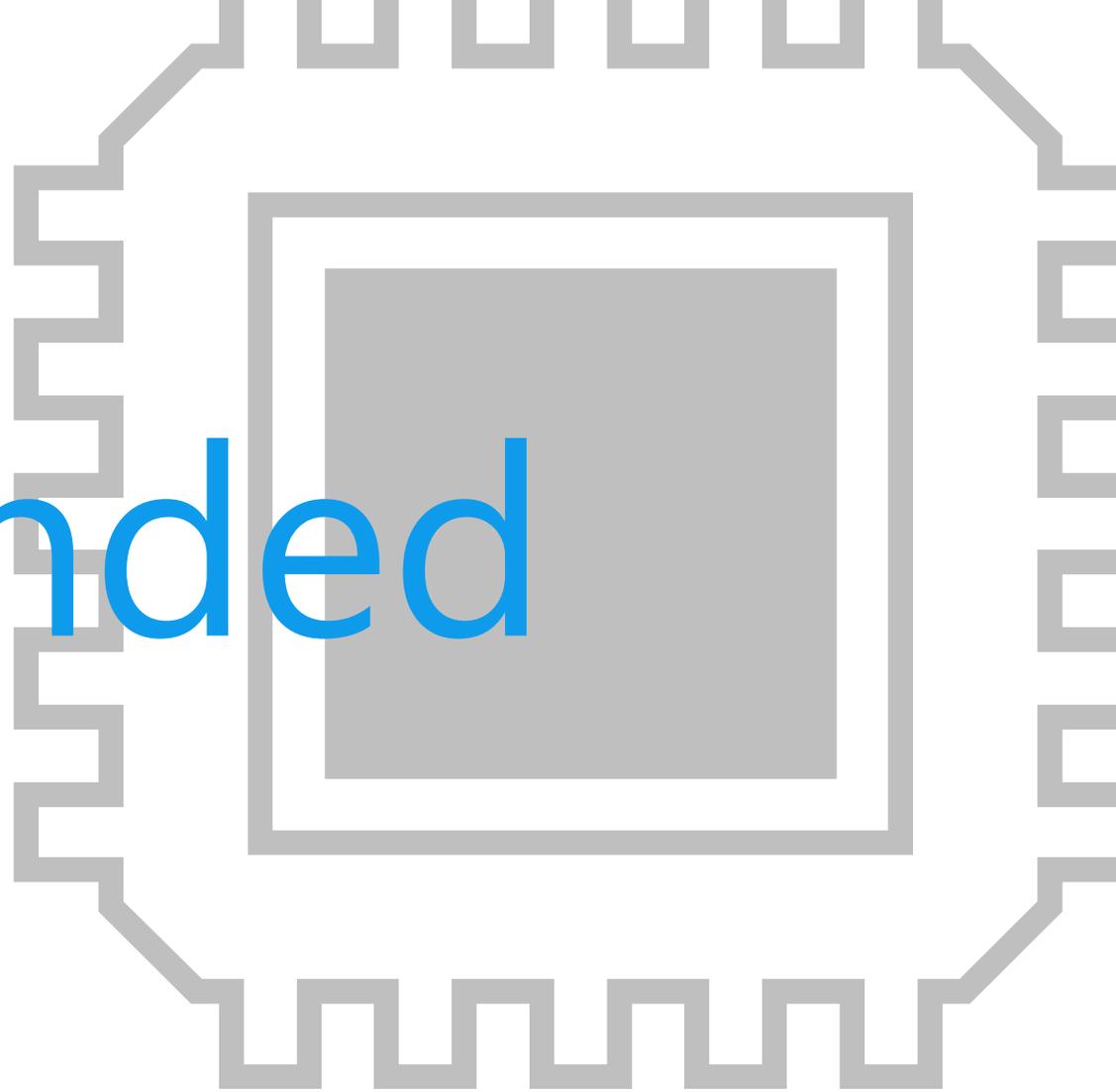
Device selection points

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba

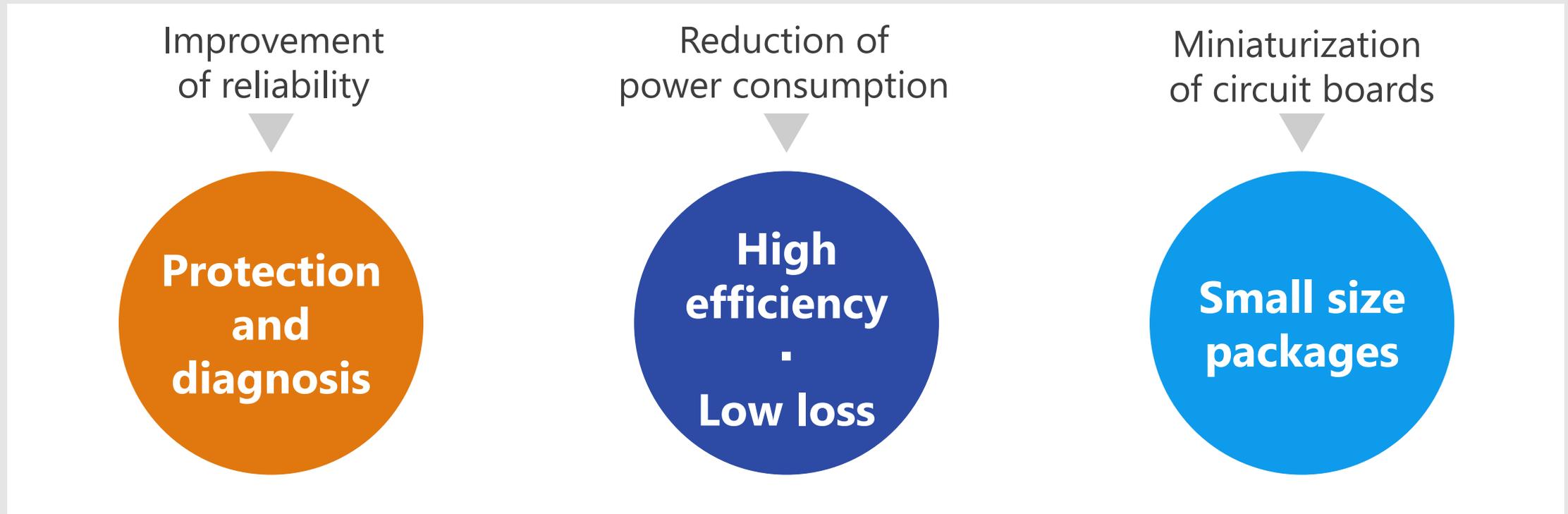
- **Low power consumption of the system is realized by low on-resistance**
U-MOS Series 40 V N-ch power MOSFET
- **Gate driver with protection diagnostic function**
Gate driver (for switch)
- **Various product lineups and small packages**
General-purpose small-signal MOSFET
General-purpose small-signal bipolar transistor
Small-signal bias resistor built-in transistor (BRT)
- **Both device protection and signal quality are realized**
TVS diode (for CAN communication)

Recommended Devices



Device solutions to address customer needs

As described above, in the design of LED headlamp, “**Improvement of reliability**”, “**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



	Protection and diagnosis	High efficiency - Low loss	Small size packages
① U-MOS Series 100 V N-ch power MOSFET		●	●
② Semi-power MOSFET		●	●
③ U-MOS Series -40 V / -60 V P-ch power MOSFET		●	●
④ TVS diode (for CAN communication)	●		●
⑤ General-purpose small-signal bipolar transistor			●
⑥ Small-signal bias resistor built-in transistor (BRT)			●
⑦ U-MOS Series 40 V N-ch power MOSFET		●	●
⑧ Gate driver (for switch)	●		●
⑨ General-purpose small-signal MOSFET		●	●

Value provided

Low on-resistance contributes to reduced system power consumption.

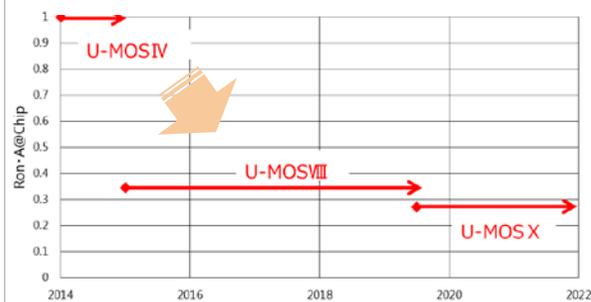
1 Low loss (reduced chip resistance)

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

2 Small, high-heat-dissipation package

By adopting a Cu connector structure and a double-sided heat dissipation structure. Development of low-loss, high-heat-dissipation packages. Mounting reliability is improved by adopting the Wettable Flank structure.

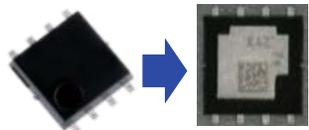
Low loss: RonA Reduction Trend [Note]



Small, high-heat-dissipation package



DSOP Advance (WF) double-sided cooling packages



Decrease of thermal resistance
76 % reduction [Note] @t=3 s,
mounted on board
Compared to SOP-8

Note: Toshiba internal comparison



Line up

Part number	Drain current	On-resistance (Max) @V _{GS} = 10 V	Package
XPN2400ANC *	20 A	23.5 mΩ	TSON Advance(WF) 
TK60S10N1L	60 A	6.11 mΩ	DPAK+ 
XPH4R10ANB	70 A	4.1 mΩ	SOP Advance(WF) 
XPW4R10ANB	70 A	4.1 mΩ	DSOP Advance(WF) 
TK160F10N1L	160 A	2.4 mΩ	TO-220SM(W) 
XK1R9F10QB	160 A	1.92 mΩ	
XK4R0F10QB *	(60 A)	(4.0 mΩ)	

* : Under Development (The specification is subject to change without notice.)

[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.

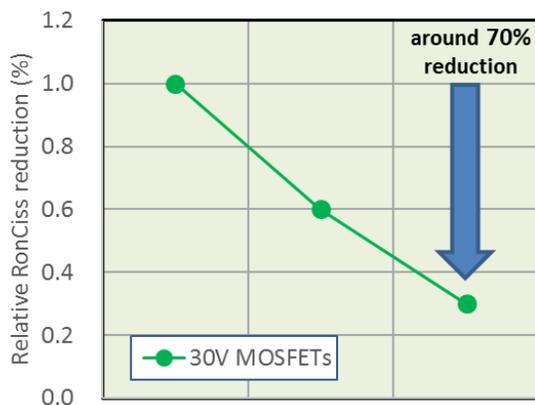
2 Small and high heat-dissipating package

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

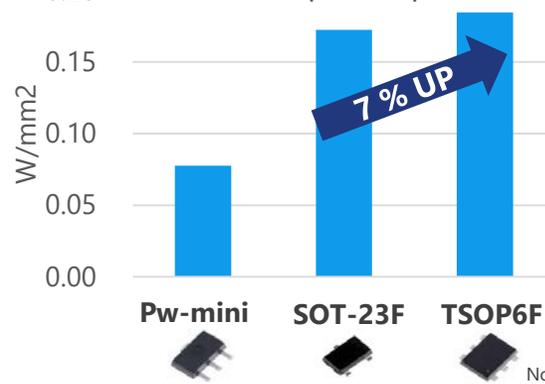
AEC-Q101 qualified and can be used for a wide range of automotive applications.

RonCiss Reduction of N-ch MOSFET



U-MOSVII U-MOSVIII-H U-MOSIX-H
Note: Toshiba internal comparison

Power Dissipation per area



Note: Toshiba internal comparison

Small and high power dissipation

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 reduced system power consumption.

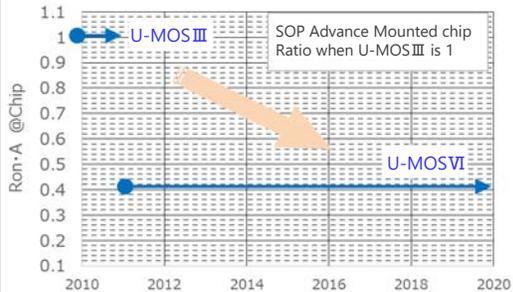
1 Low-loss (reduced chip resistance), logic-level response

Using low chip resistance technology to contribute to reduced power consumption systems.
Lineup of Logic-level-drive types.

2 Small surface mount package developed

By adopting a Cu connector structure and a double-sided heat dissipation structure. Development of low-loss, high-heat-dissipation packages. Mounting reliability is improved by adopting the Wettable Flank structure.

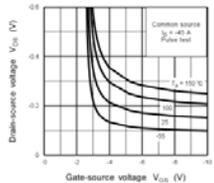
Low loss: RonA Reduction Trend



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)
to 200 A



DPAK+
(6.5 x 10 mm)
to 90 A



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



Line up

Part number	Drain-source Voltage	Drain current	On-resistance (Max) @ $V_{GS} = -10 V$	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](#)

4 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Protection and diagnosis

High efficiency
Low loss

Small size packages

Value provided

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

1 Improve ESD absorbability

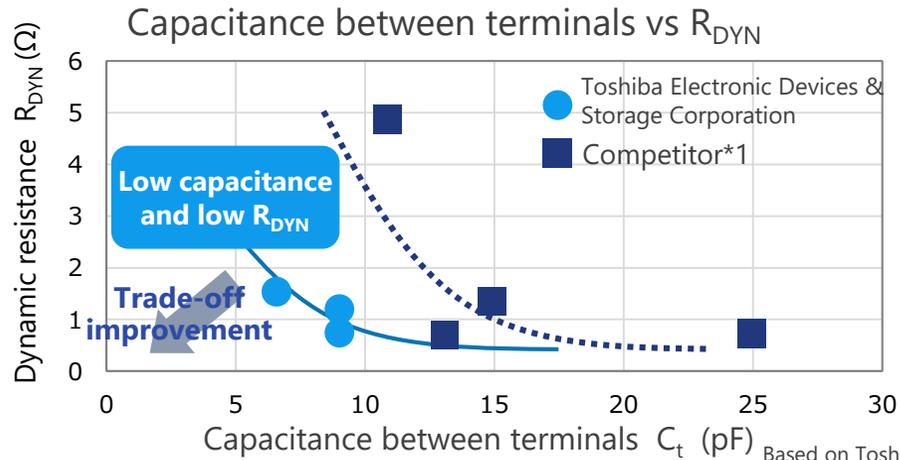
Improved absorption of ESD through our proprietary Zener process.
(Both low operating resistance R_{DYN} and low capacitance C_t)

2 Ensuring high signal integrity

Supports in-vehicle LAN communication such as CAN, CAN-FD, FlexRay. Lower capacitance ensures higher signal integrity.

3 High ESD immunity

Compliant products with
ISO10605 Standard > ± 20 kV
IEC61000-4-2 Standard > ± 20 kV (L4)



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 (including but not limited to constant voltage diode applications).

*1: Measurements of the commercial product

[Return to Block Diagram TOP](#)

Value provided

Extensive product lineup to meet all your needs.

1 Extensive lineup of packages

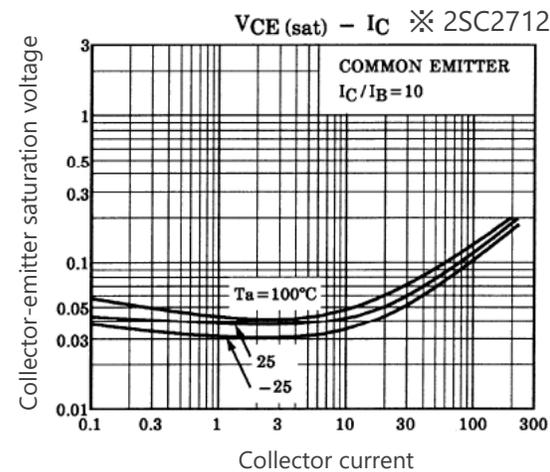
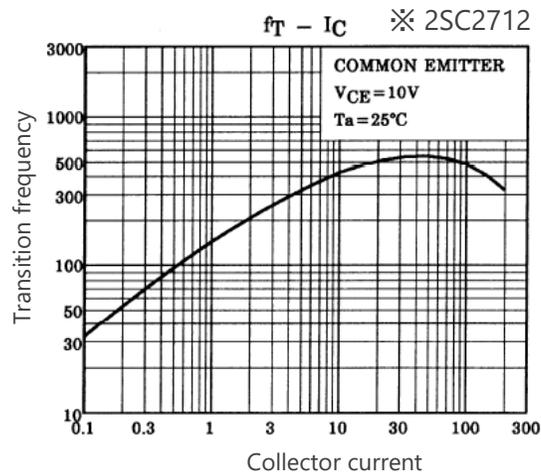
Various package lineups, such as 1in1, 2in1 are provided and suitable product for circuit board design can be selected.

2 Various product line up

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

3 AEC-Q101 qualified

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



Line up

Package	SOT-23F		USM (SOT-323) UFM (SOT-323F)		S-Mini (SOT-346)		
	NPN	PNP	NPN	PNP	NPN	PNP	
General purpose	50	150		2SC4116	2SA1586	2SC2712	2SA1162
Low noise	50	500				2SC3325	2SA1313
High current	120	100		2SC4117	2SA1587	2SC2713	2SA1163
Semi power	50	1700			2SA2195*		
	100	2500	TTC501	TTA501			

* : UFM (SOT-323F) package

[Return to Block Diagram TOP](#)

Value provided

Extensive product lineup to meet all your needs.

1 Built-in bias resistor type (BRT)

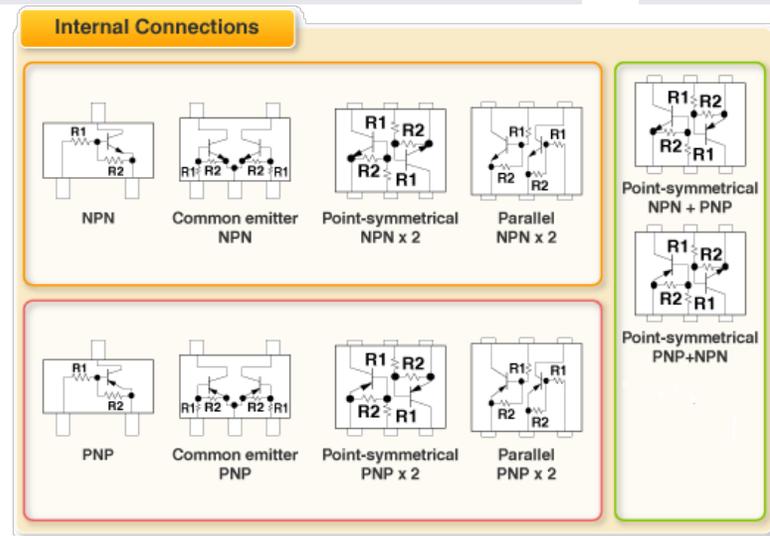
The BRT reduces the number of parts contributing to miniaturization and shorter production times.

2 Extensive lineup of package and pin assignment

Various package lineups, such as 1in1, 2in1 are provided and suitable product for circuit board design can be selected.

3 AEC-Q101 qualified

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



Line up

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

[◆Return to Block Diagram TOP](#)

Value provided

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

1 Low loss (reduced chip resistance)

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

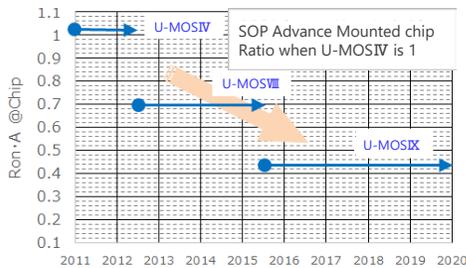
2 Compact, low-loss package

By adopting a Cu connector structure and a double-sided heat dissipation structure. Development of low-loss, high-heat-dissipation packages. Mounting reliability is improved by adopting the Wettable Flank structure.

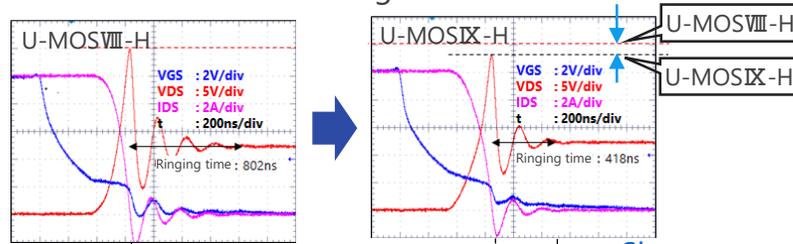
3 Low noise (low EMI)

Optimized chip process, reduce surge voltage and ringing time.

Low loss: RonA Trend [Note]



Low-noise: Switching Waveform



Line up

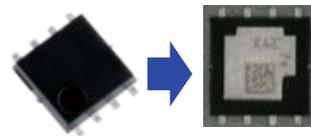
Part number	Drain current	On-resistance (Max) @V _{GS} = 10 V	Package
XPN3R804NC	40 A	3.8 mΩ	TSOP Advance(WF) 
TK1R4S04PB	120 A	1.35 mΩ	DPAK+ 
TPHR7904PB	150 A	0.79 mΩ	SOP Advance(WF) 
TPWR7904PB	150 A	0.79 mΩ	DSOP Advance(WF) 
TKR74F04PB	250 A	0.74 mΩ	TO-220SM(W) 
TK1R5R04PB	160 A	1.5 mΩ	D2PAK+ 

TO-220SM(W) Cu connector design



Package resistance reduction 64 % [Note], Compared to D2PAK

DSOP Advance(WF) double-sided cooling packages



Decrease of thermal resistance 76 % reduction [Note] @t = 3 s, mounted on board Compared to SOP-8

[Return to Block Diagram TOP](#)

Note: Toshiba internal comparison

8 Gate driver (for switch)

TPD7104AF / TPD7106F / TPD7107F

Protection and diagnosis

High efficiency
Low loss

Small size packages

Value provided

A charge pump for the FET gate drive is built-in, allowing for easy semiconductor relay configuration.

1 Built-in charge pump

No external add-ons required for driving the N-channel on the high side, making it easy to configure a semiconductor relay.

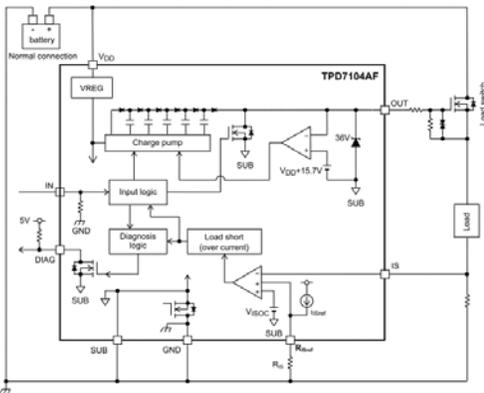
2 Logic level drive

Direct control is possible from microcomputer and CMOS logic.

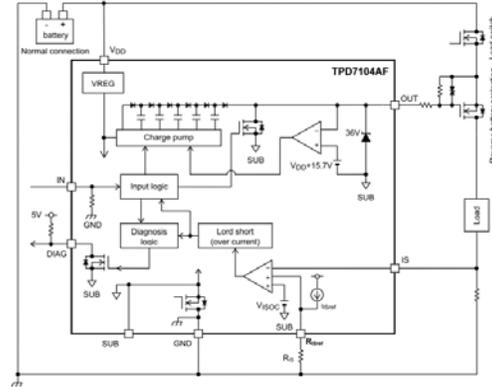
3 Small package

The small surface mount PS8 / SSOP16 / WSON10A contributes to the miniaturization of equipment.

Semiconductor relay (switch) application (TPD7104AF)



Power supply reverse connection protection FET control (TPD7104AF)



Back to back configuration

Line up

Part number	TPD7104AF	TPD7106F	TPD7107F
Package	PS8 (2.8 x 2.9 mm) 	SSOP16 (5.5 x 6.4 mm) 	WSON10A (3 x 3 mm) 
Function	High-side gate driver	High-side gate driver	High-side gate driver
Number of output	1 output	1 output	1 output
Features	<ul style="list-style-type: none"> Operating power supply voltage range: 5 to 18 V Built-in charge pump Built-in power supply reverse connection protection function (Supported for power supply reverse connection protection FET applications) 	<ul style="list-style-type: none"> Operating power supply voltage range: 4.5 to 27 V Built-in charge pump Built-in power supply reverse connection protection function (Supported for power supply reverse connection protection FET applications) 	<ul style="list-style-type: none"> Operating power supply voltage range: 5.75 to 26 V Built-in charge pump Current sense output, Protection and diagnosis output; over current, over temperature, GND disconnect, load open, reverse battery (FET turn on)

[Return to Block Diagram TOP](#)

Value provided

Choose from a wide array of small packages which contribute to the miniaturization and reduction of power consumption of equipment.

1 Small package

Starting with the SOT-723 (VESM) 1.2 x 1.2 mm package, a lineup of various small packages is available, contributing to space savings during mounting.

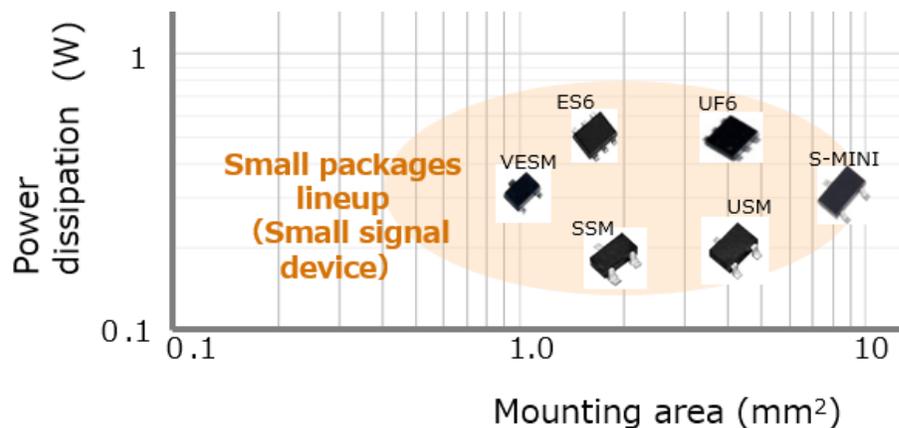
2 Low voltage drive

The gate-source voltage can be driven at a low voltage of 1.2 V (SSM3J66MFV).

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for a wide range of 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) 
$V_{DS(DC)}$ [V]	60	-60	-20
I_D [A]	0.4	-0.4	-0.8
$R_{DS(ON)}$ [Ω] @ $V_{GS} = 4.5$ V	Typ.	1.2	1.4
	Max	1.75	1.9
Drive voltage [V]	4.5	-4.0	-1.2
MOS Type	N-channel	P-channel	P-channel

[◆Return to Block Diagram TOP](#)

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Contact address: <https://toshiba.semicon-storage.com/ap-en/contact.html>



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