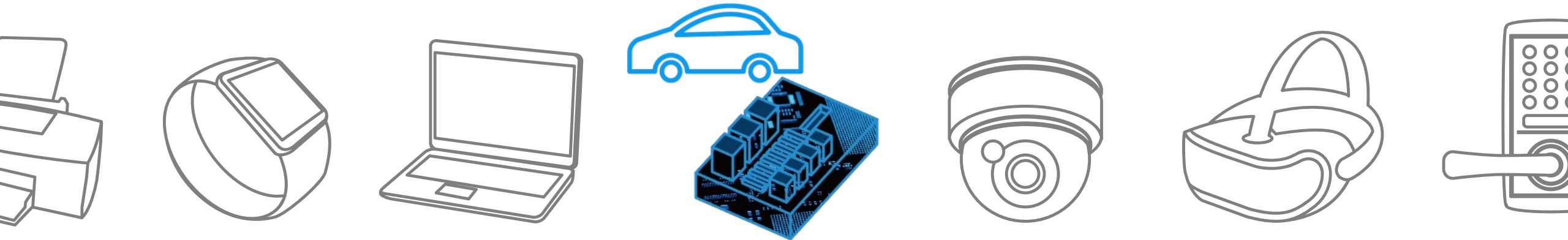


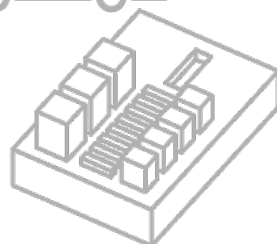
TOSHIBA

Automotive Junction Box

R17

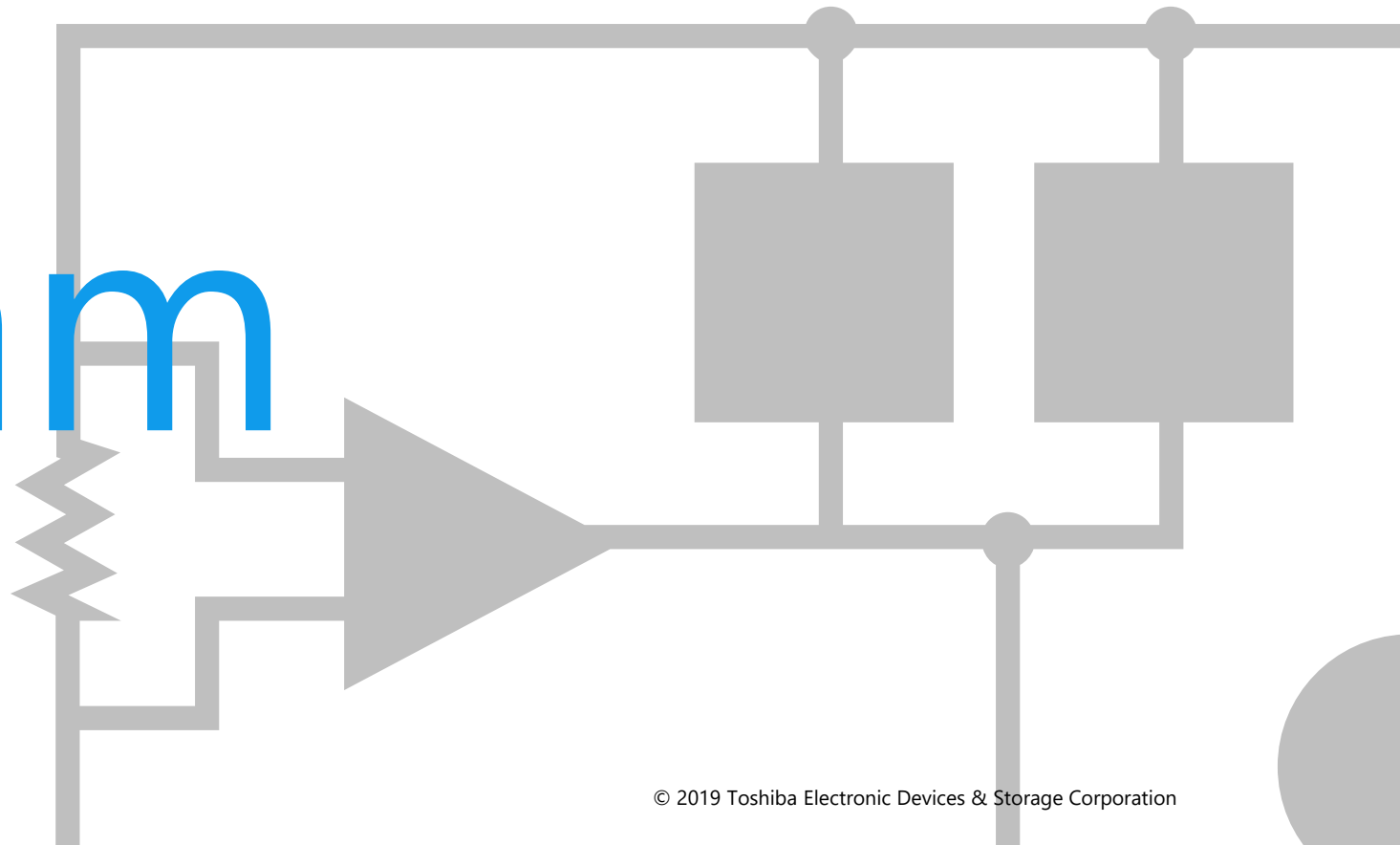
Solution Proposal by Toshiba



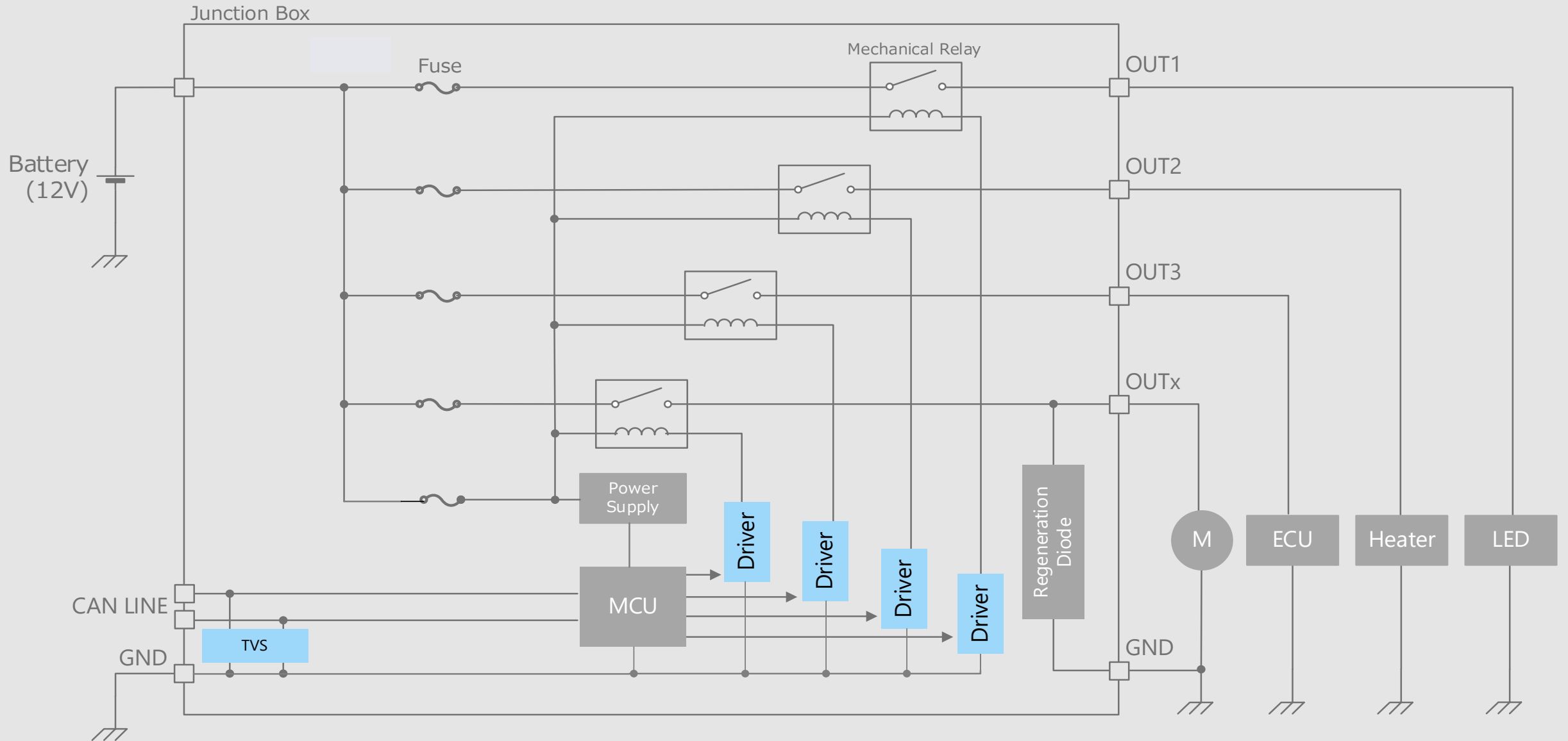


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

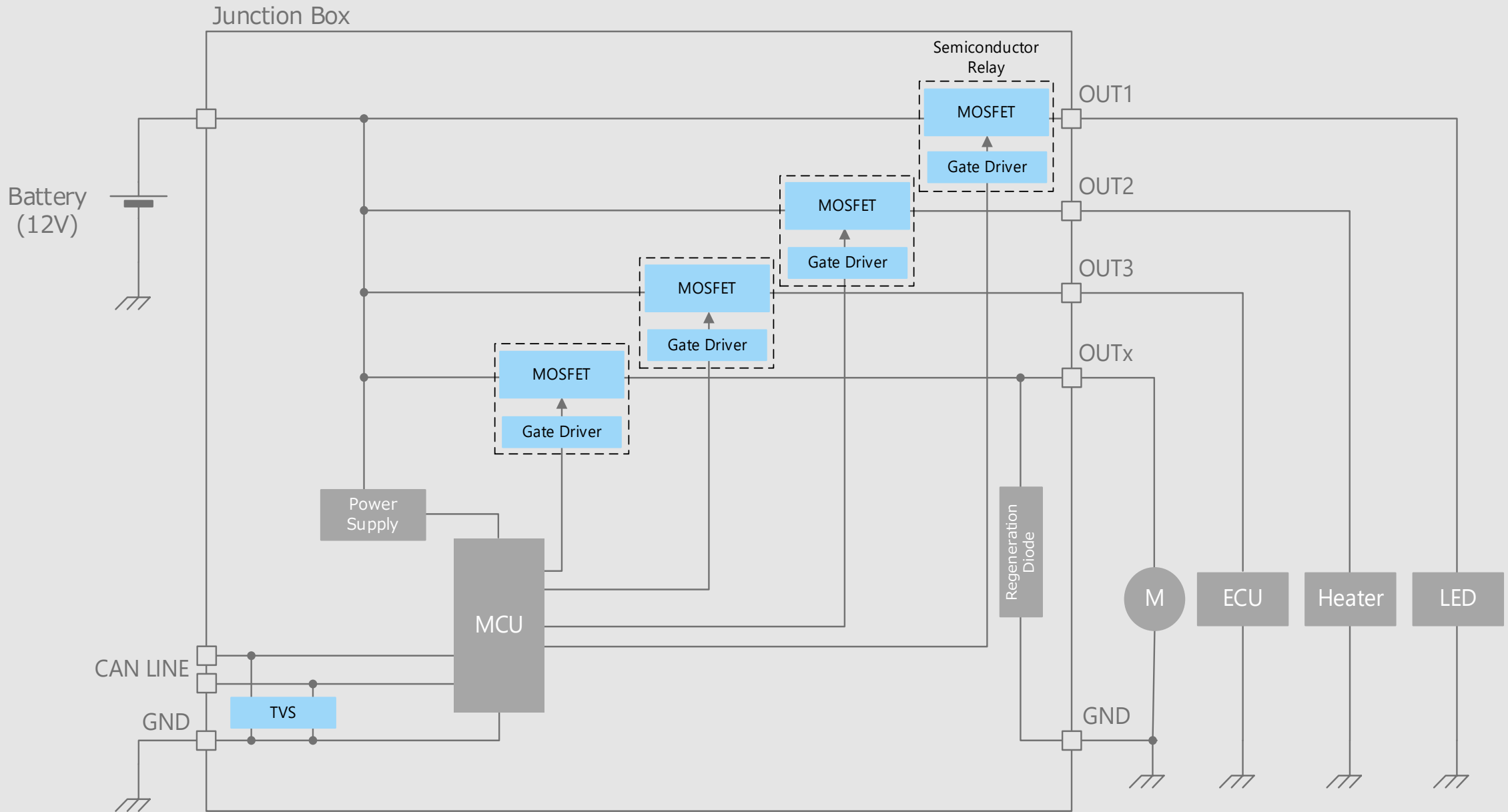
Block Diagram



Automotive Junction Box (Mechanical Relay System)

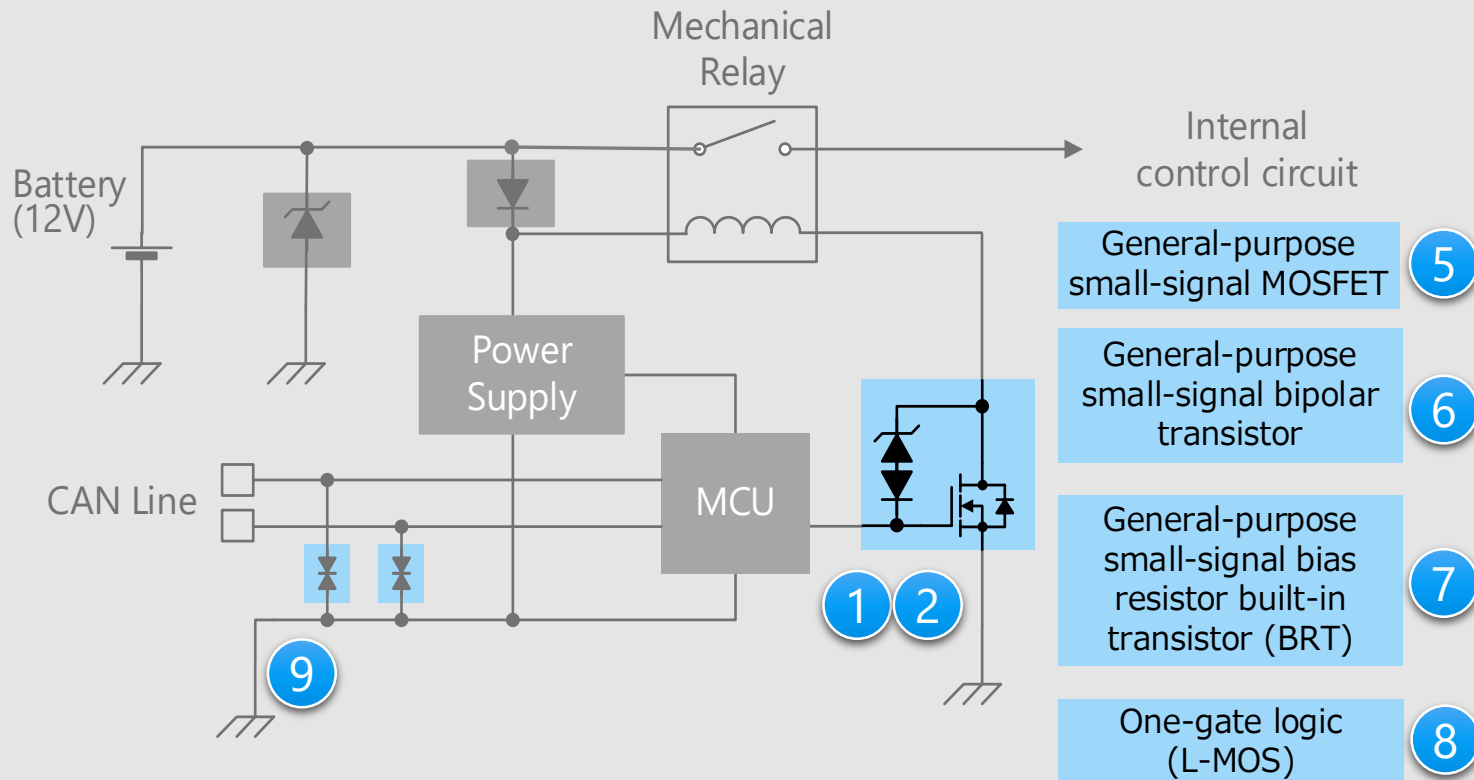


Automotive Junction Box (Semiconductor Relay System)



Mechanical relay drive circuit

Mechanical relay system



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

Device selection points

- It is necessary to select a device with a protection function against surge voltage generated from inductance of inductive load.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba

- Built-in active clamp circuit and pull-down resistor for relay drive

U-MOSIV series active clamp MOSFET

- Driver with protection function

Low-side switch/High-side switch (~1A)

- Various product lineups and small packages

General-purpose small-signal MOSFET

General-purpose small-signal bipolar transistor

General-purpose small-signal bias resistor built-in transistor (BRT)

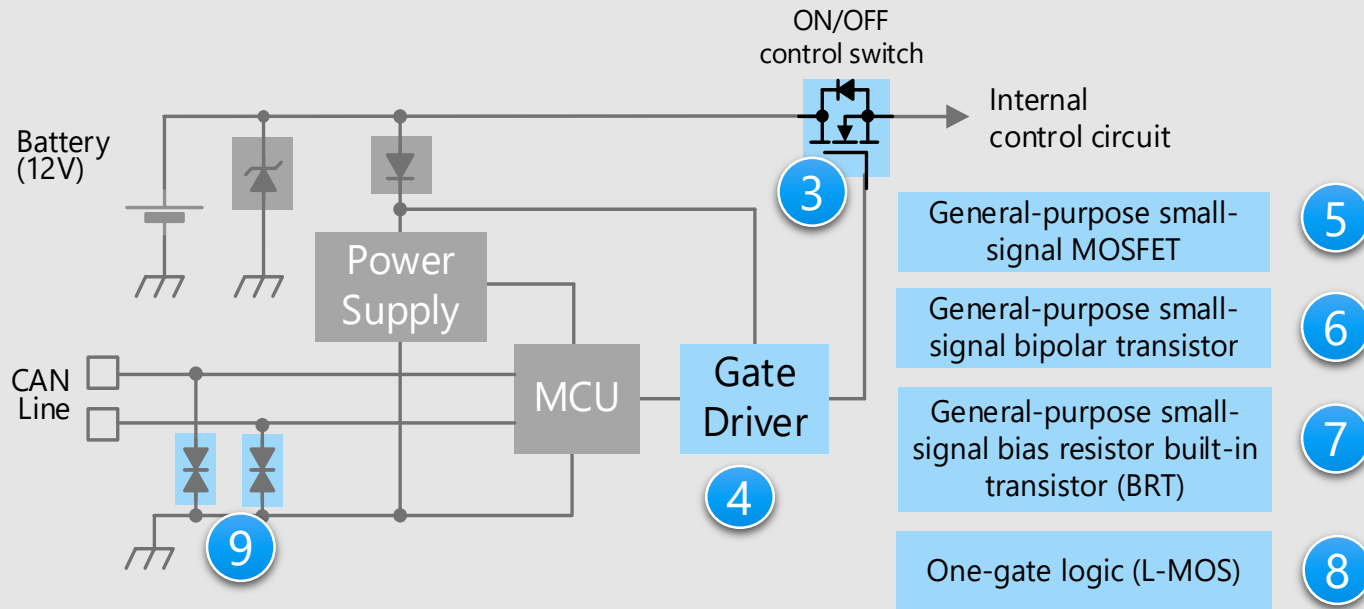
One-gate logic (L-MOS)

- Both device protection and signal quality is realized

TVS diode (for CAN communication)

Semiconductor relay

Semiconductor relay system



Device selection points

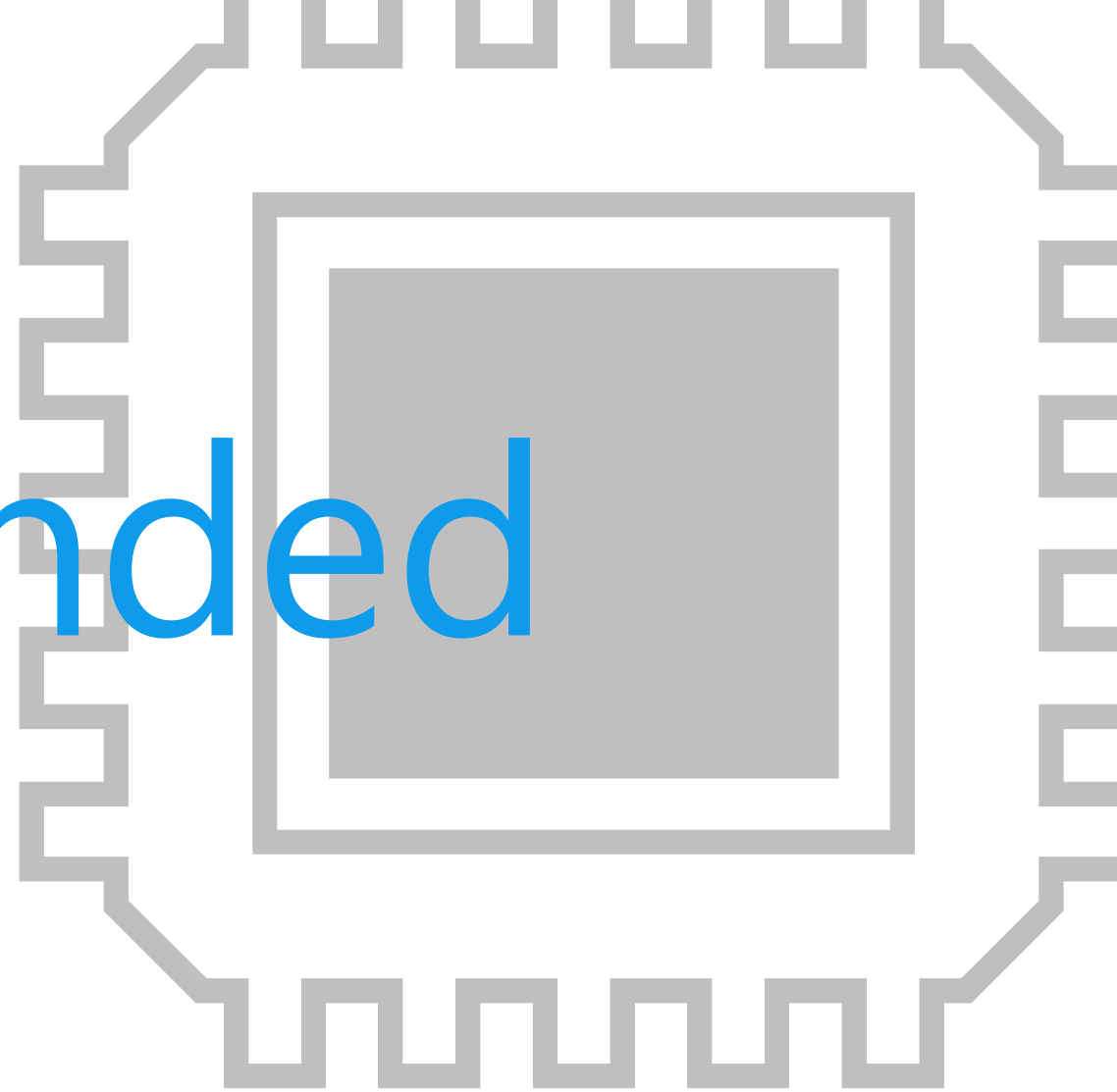
- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba

- **Low power consumption of the system is realized by low on-resistance**
U-MOS series 40V 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
General-purpose small-signal bias resistor built-in transistor (BRT)
One-gate logic (L-MOS)
- **Both device protection and signal quality is realized**
TVS diode (for CAN communication)

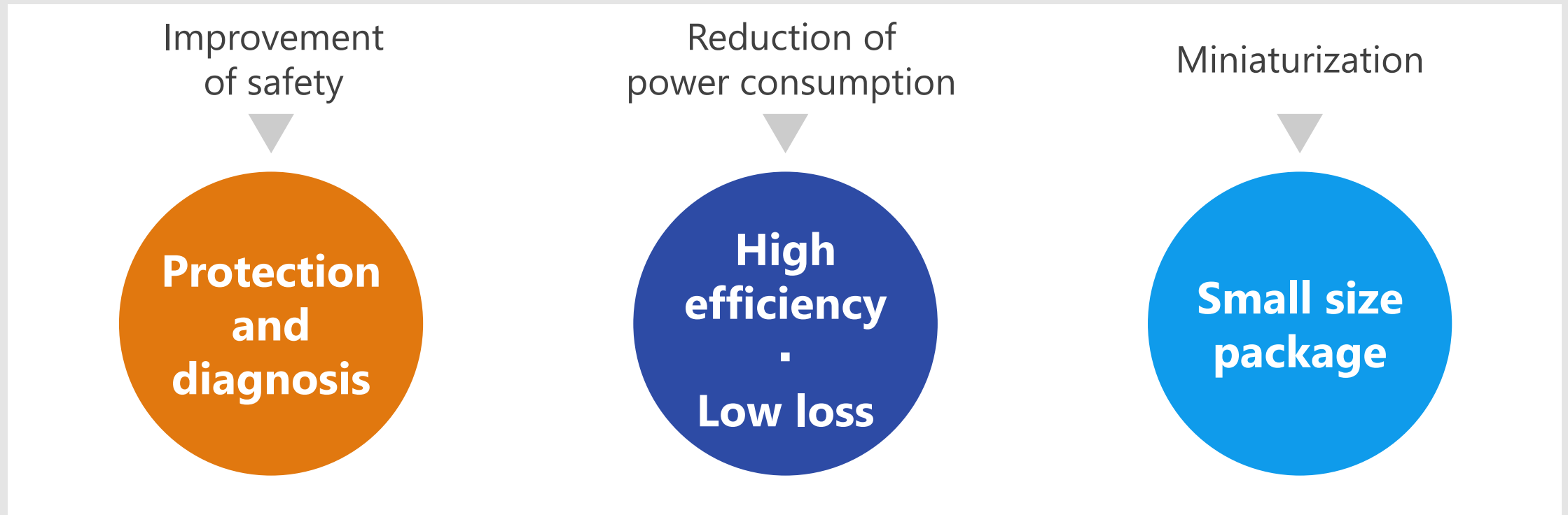
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of Junction Box, “Improvement of safety”, “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

Protection
and
diagnosis

High
efficiency
·
Low loss

Small size
package

①	U-MOSIV series active clamp MOSFET	●	●	●
②	Low-side / High-side switch (~1A)	●		●
③	U-MOS series 40V N-ch power MOSFET		●	●
④	Gate driver (for switch)	●		●
⑤	General-purpose small-signal MOSFET		●	●
⑥	General-purpose small-signal bipolar transistor			●
⑦	Small-signal bias resistor built-in transistor (BRT)			●
⑧	One-gate logic (L-MOS)			●
⑨	TVS diode (for CAN communication)	●		●

1 U-MOSIV series active clamp MOSFET

SSM3K347R / SSM3K337R

Protection
and
diagnosis

High
efficiency
·
Low loss

Small size
package

Value provided

These devices has a built-in active clamp circuit to reduce the number of components and to save mounting space.

1 Built-in active clamp circuit

An active clamp circuit MOSFET with a zener between the drain-gate terminals prevents damage due to voltage surges during inductive loads driving.

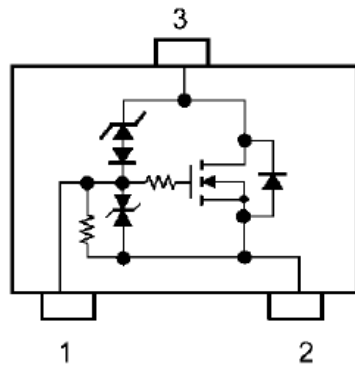
2 Built-in pull-down resistor

A 47kΩ pull-down resistor is built in between the gate-source terminals, which reduces required components and mounting space. (SSM3K347R)

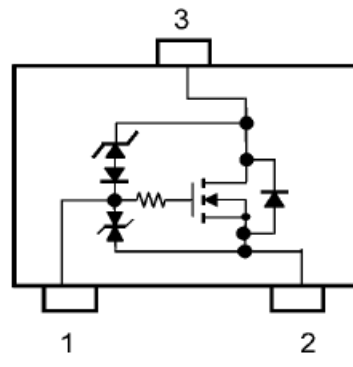
3 Low voltage drive

The gate-source voltage can be driven at a low voltage of 4.0 V

Internal circuit



SSM3K347R



SSM3K337R

Pin Assignment

1. Gate
2. Source
3. Drained

Line up

Part number	SSM3K347R	SSM3K337R
Package	SOT-23F 	SOT-23F 
$V_{DS(DC)}$ [V]	38	38
I_D [A]	2	2
$R_{DS(ON)}$ @ $V_{GS}=4.0V$ [mΩ]	Typ.	350
	Max	480
MOS Type	N-channel	N-channel

[◆Return to Block Diagram TOP](#)

Value provided

Protection and diagnostic output functions are built-in and can be directly controlled at the logic level, contributing to improved reliability and miniaturization of the equipment.

1 Built-in protection and diagnostic output function

Overcurrent and overheat protection in the event of a load error (short circuit, etc.) and feedback (diagnostic output) to the microcomputer are built-in. This contributes to the reliability of the equipment.

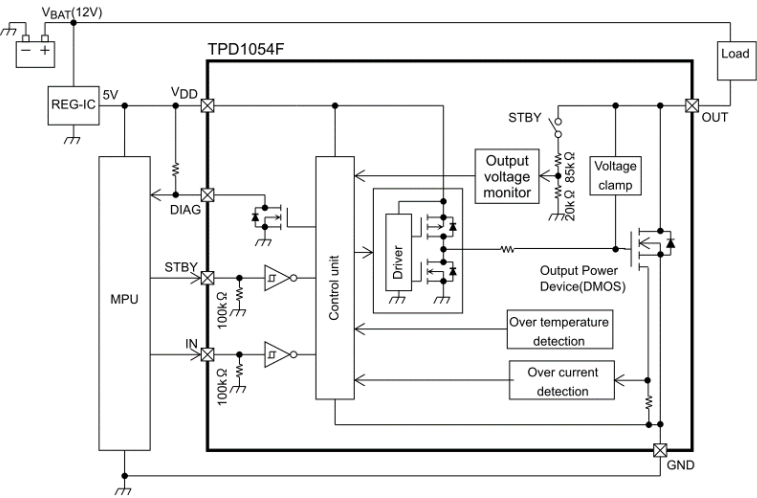
2 Logic level drive

Direct control is possible using a microcomputer and CMOS logic chip.

3 Small package

Product line-up includes small surface mount package PS8 and dual-output type. This contributes to equipment miniaturization.

Example of Low-side switch application (Block diagram of TPD1054F)



Suitable for applications with small current load below 1A, such as mechanical relay

Line up				
Function	Low-side switch			High-side switch
Number of output	1 output		2 outputs	1 output
Part number	TPD1044F	TPD1054F	TPD1030F	TPD1052F
Package	PS8 (2.8 x 2.9 mm)	PS8 (2.8 x 2.9 mm)	SOP8 (5 x 6 mm)	PS8 (2.8 x 2.9 mm)
Features	<ul style="list-style-type: none"> Overcurrent/overheat protection Active clamp on-resistance: 0.6 Ω 	<ul style="list-style-type: none"> Overcurrent/overheat protection Active clamp Diagnostic output function on-resistance: 0.8 Ω 	<ul style="list-style-type: none"> Overcurrent/overheat protection Active clamp on-resistance: 0.6 Ω 	<ul style="list-style-type: none"> Overcurrent/overheat protection Diagnostic output function on-resistance: 0.8 Ω

[Return to Block Diagram TOP](#)

Value provided

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

1 Low loss (reduced chip resistance)

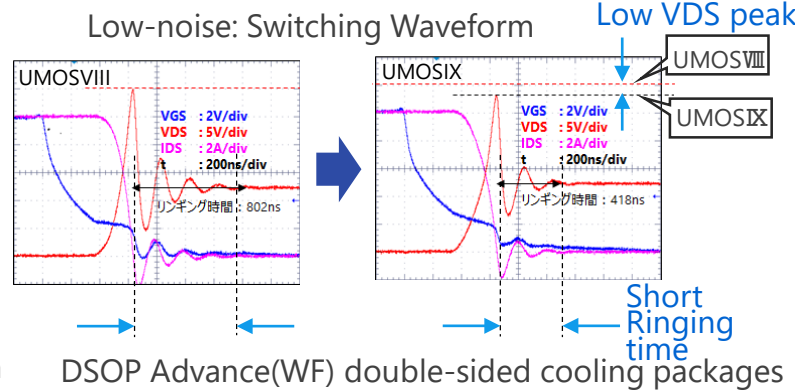
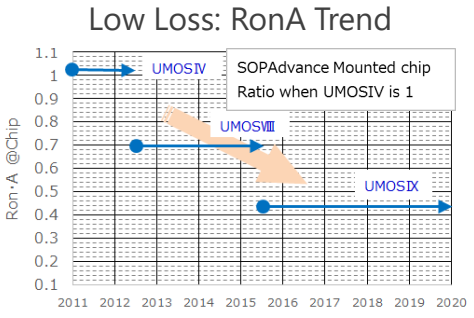
Using low chip resistance technology to contribute to reduced power consumption systems.
Chip resistance of 61% reduction per unit area (compared to U MOSIV)

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

3 Low noise (low EMI)

Optimized chip process, reduce surge voltage and ringing time.



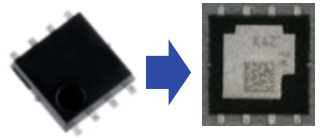
Line up			
Part number	Drain current	On-resistance (Max) @V _{GS} =10V	Package
XPN3R804NC	40A	3.8mΩ	TSON Advance(WF)
TK1R4S04PB	120A	1.35mΩ	DPAK+
TPHR7904PB	150A	0.79mΩ	SOP Advance(WF)
TPWR7904PB	150A	0.79mΩ	DSOP Advance(WF)
TKR74F04PB	250A	0.74mΩ	TO-220SM(W)
TK1R5R04PB	160A	1.5mΩ	D2PAK+

TO-220SM(W) Cu connector design



Package resistance reduction 64%, Compared to D2PAK

DSOP Advance(WF) double-sided cooling packages



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

[Return to Block Diagram TOP](#)

4 Gate driver (for switch)

TPD7104AF

Protection and diagnosis

High efficiency
Low loss

Small size package

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.

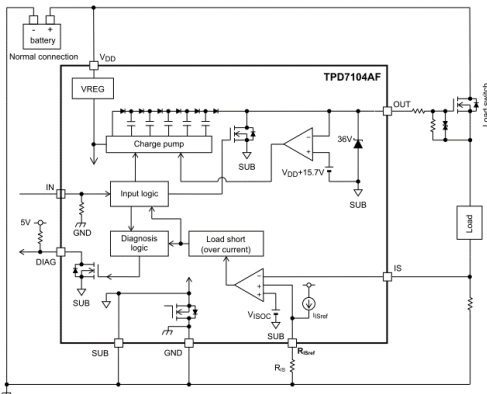
2 Logic level drive

Direct control is possible from microcomputer and CMOS logic.

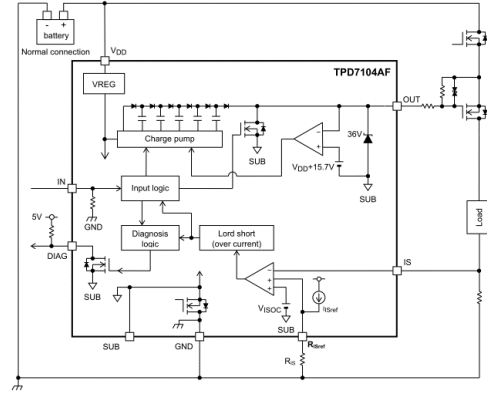
3 Small package

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

Semiconductor relay (switch) application



Power supply reverse connection protection FET control



Back to back configuration

Line up

Part number	TPD7104AF
Function	High-side gate driver
Number of 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)

Package



PS8 (2.8 x 2.9 mm)

[Return to Block Diagram TOP](#)

5 General-purpose small-signal MOSFET

SSM3K7002KF / SSM3J168F / SSM3J66MFV

Protection and diagnosis

High efficiency
Low loss

Small size package

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 1.2mm² package), a lineup of various small packages is available, contributing to space savings during mounting.

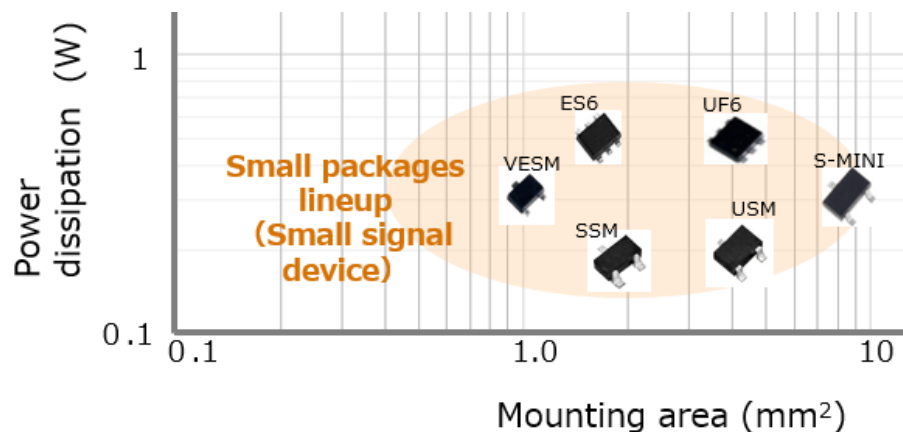
2 Low voltage drive

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
$R_{DS(ON)}$ @ $V_{GS}=4.5$ V [Ω]	Typ.	1.2	0.31
	Max	1.75	0.39
Drive voltage [V]	4.5	-4.0	-1.2
MOS Type	N-channel	P-channel	P-channel

[Return to Block Diagram TOP](#)

Value provided

Extensive product lineup to meet all your needs.

1 Extensive lineup of packages

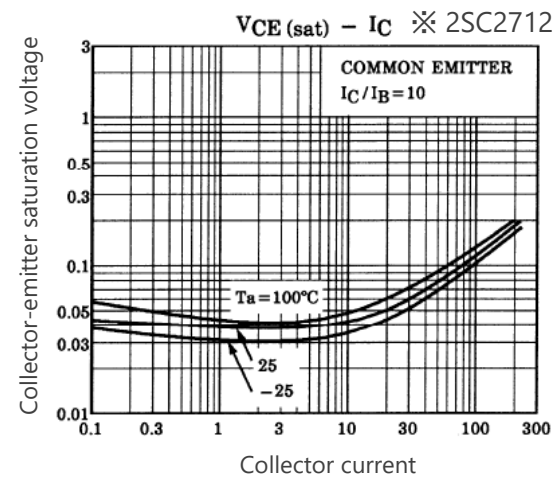
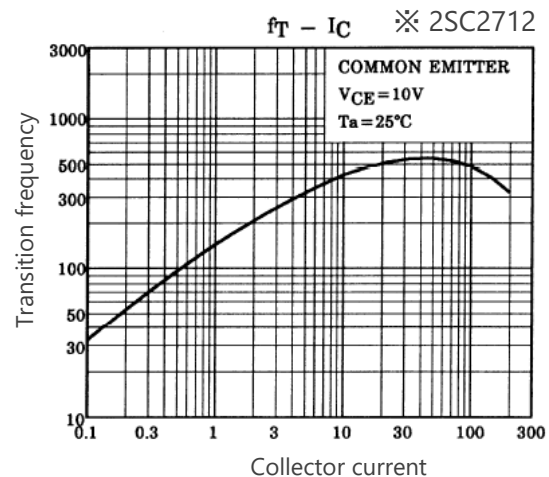
Various package lineups, such as 1in1, 2in1 are provided and suitable product for circuit board design can be selected.

2 Various product lineup

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			SSM (SOT-416)		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	2SC4738	2SA1832	2SC4116	2SA1586	2SC2712	2SA1162
	50	500					2SC3325	2SA1313
Low noise	120	100			2SC4117	2SA1587	2SC2713	2SA1163
High-current	50	1700				2SA2195*		

[◆Return to Block Diagram TOP](#)

Value provided

Extensive product lineup to meet all your needs.

1 Built-in bias resistor type (BRT)

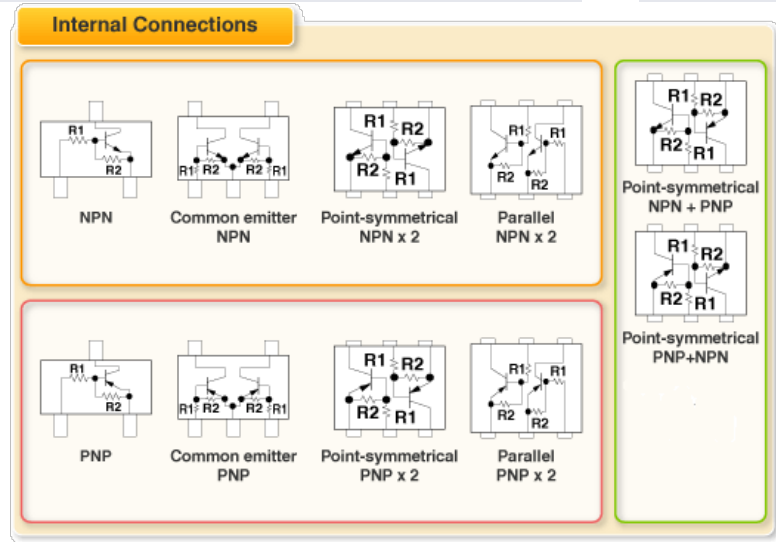
The BRT reduces the number of parts contributing to miniaturization and shorter production times.



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	SSM (SOT-416) 	RN1114	RN2114
	S-Mini (SOT-346) 	RN1414	RN2414
V_{CE0} (Max) [V]		50	-50
I_C [mA]		100	-100

[Return to Block Diagram TOP](#)

Value provided

Extensive product lineup to meet all your needs.

1 Small package

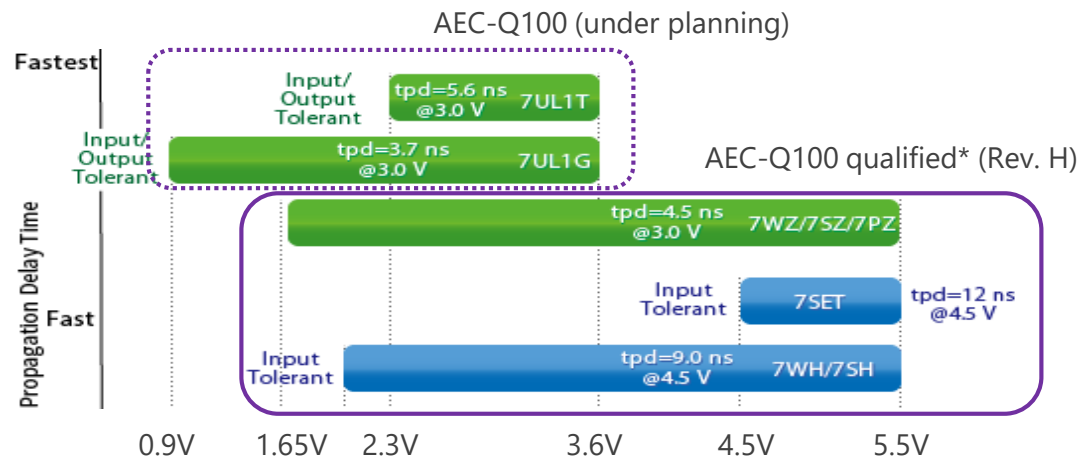
A standard multi gate CMOS is separated into individual or dual gates and embedded in a small package. This can be suited for simpler designs and contributes to miniaturization.

2 Extensive lineup

The VHS/SHS series, which is widely used in Automotive, offers a wide range of functions, including a total of 230 products.

3 AEC-Q100 qualified (reliability levels)

AEC-Q100 qualified and can be used for a wide range of automotive applications.



* Compliant products with AEC-Q100's reliability test only

Line up

		VHS series	SHS series
Package	USV (SOT-353)	TC7SH series	TC7SZ series
	US8 (SOT-765)	TC7WH Series	TC7WZ series
V _{CC} [V]		2.0 ~ 5.5	1.65/1.8 ~ 5.5
I _o [mA]		8	24

[Return to Block Diagram TOP](#)

9 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Protection and diagnosis

High efficiency
Low loss

Small size package

Value provided

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

1 Improve ESD absorbability

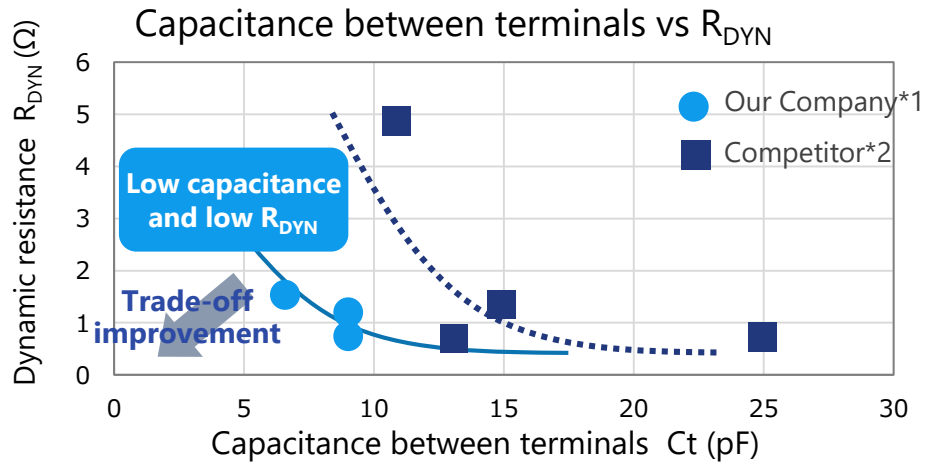
Improved absorption of ESD through our proprietary Zener process.
(Both low operating resistance R_{DYN} and low capacitance C_t)

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

[Return to Block Diagram TOP](#)

(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:TOSHIBA Electronic Device & Storage Corporation
*2:Measurements of the commercial product

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