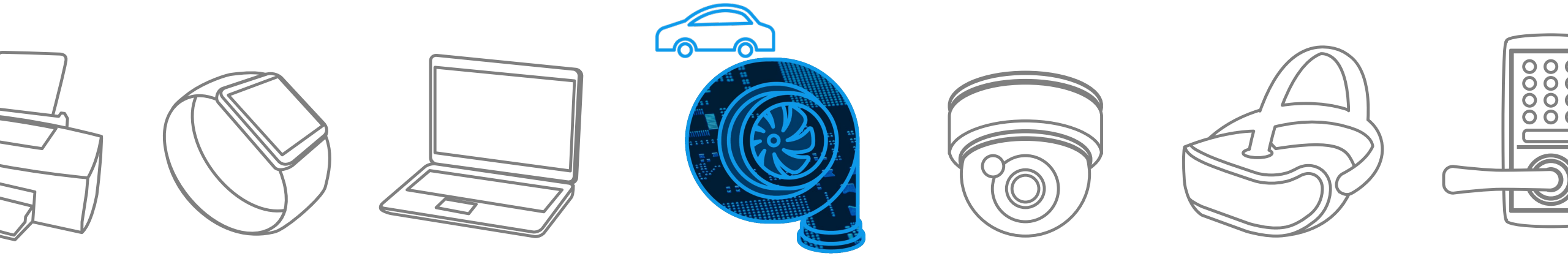
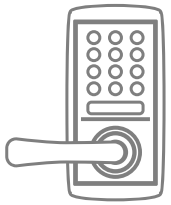
TOSHIBA

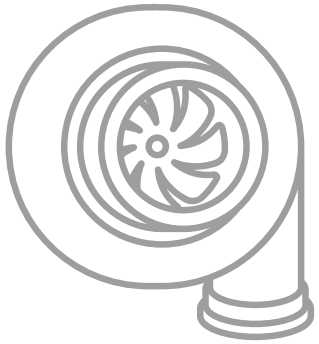
R1

Automotive Electric Turbocharger

Solution Proposal by Toshiba

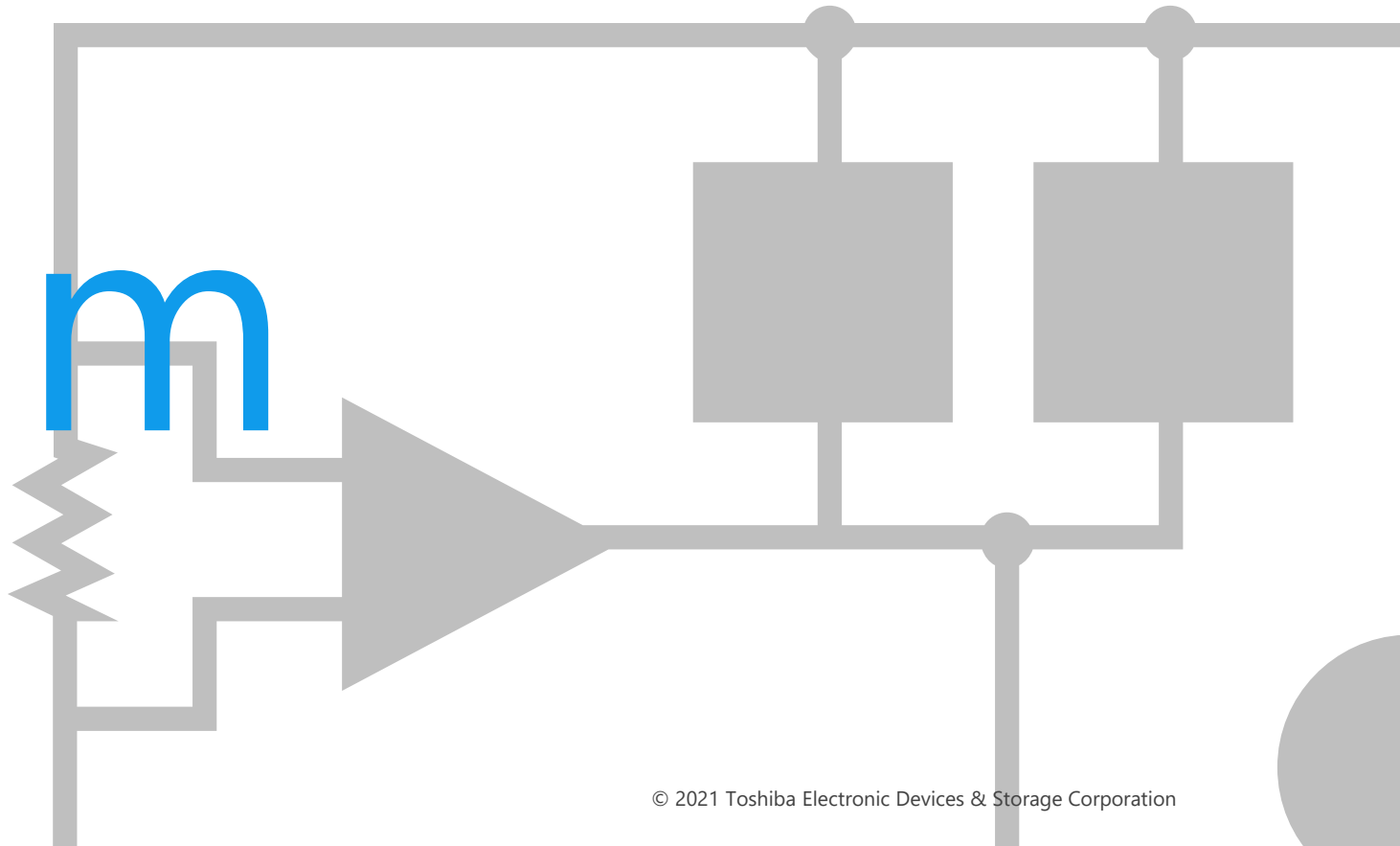




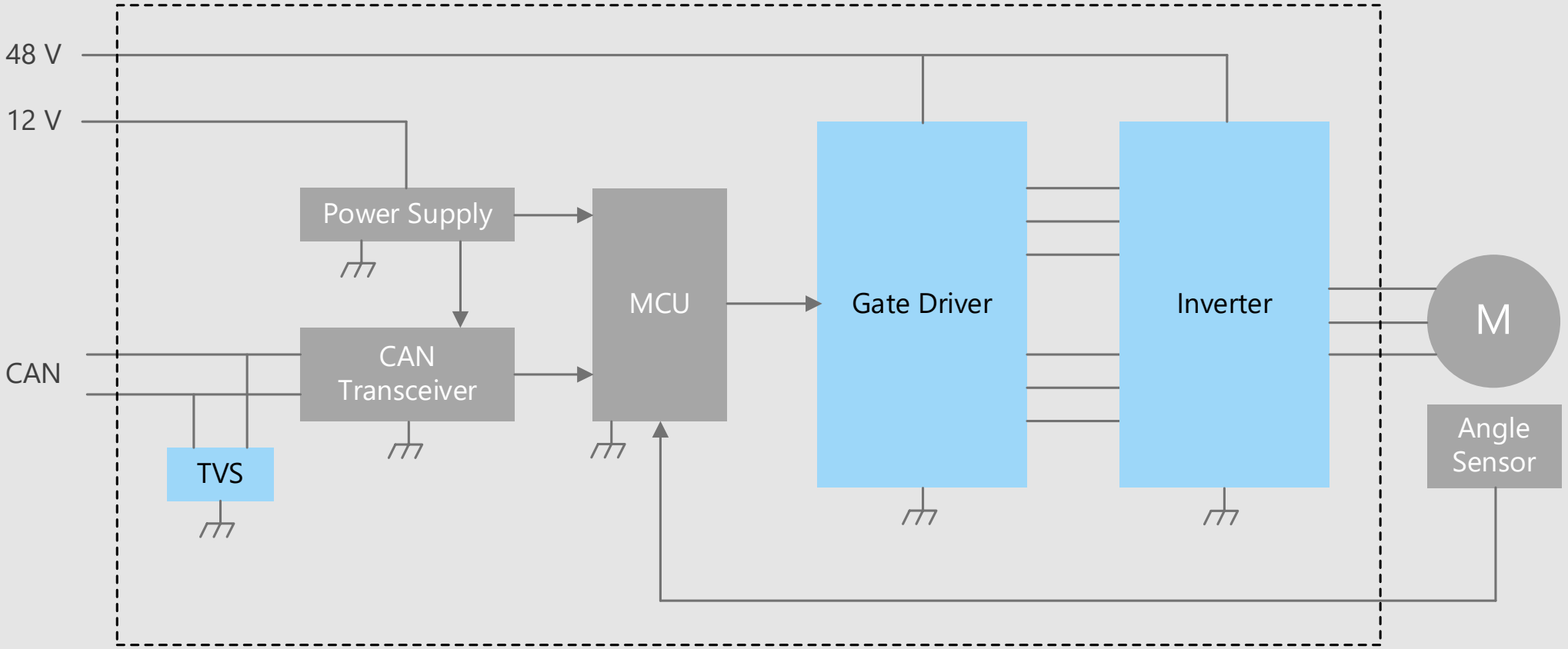


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

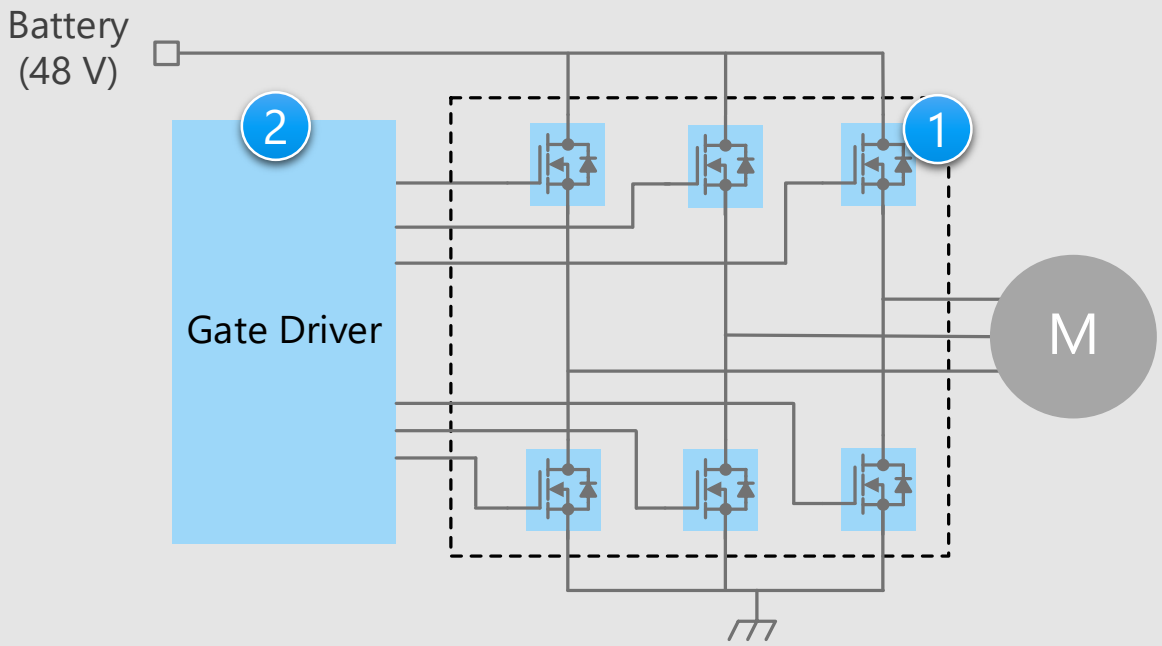


Electric Turbocharger　Overall block diagram



Electric Turbocharger　Detail of driving circuit for blushless DC motor

Driving circuit for blushless DC motor



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

Criteria for device selection

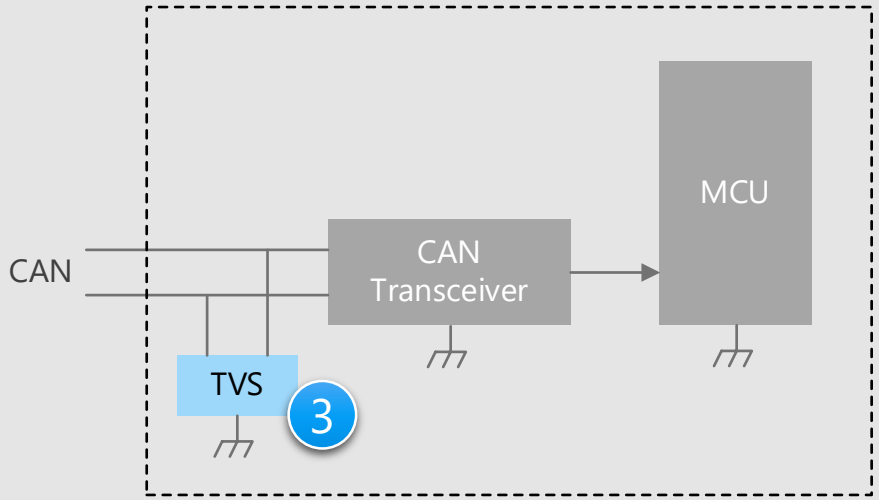
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the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

Proposal from Toshiba

- **Low on-resistance contributes low power consumption of the system**
  U-MOS Series 80 V / 100 V N-ch MOSFET 1
- **Gate driver with built-in protection and diagnosis functions**
  Gate driver (for motor) 2

Electric Turbocharger　Detail of CAN transceiver

CAN transceiver circuit



General purpose small signal MOSFET 4

General purpose small signal bipolar transistor 5

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

Criteria for device selection

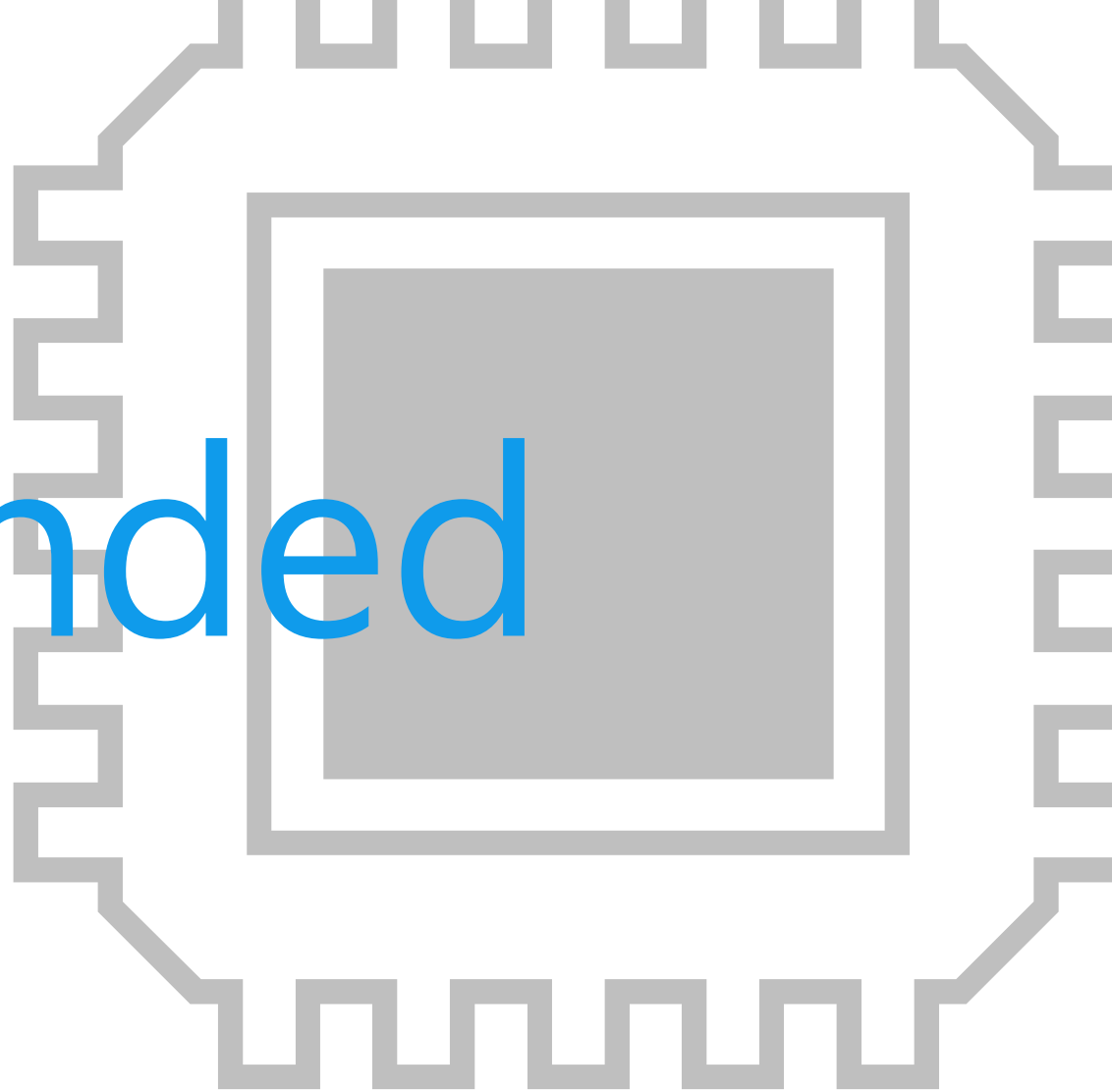
- A small surface mount package is suitable for realizing miniaturization of the ECU.

Proposal from Toshiba

- **Suitable for ESD protection**
  TVS diode (for CAN communication) 3
- **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

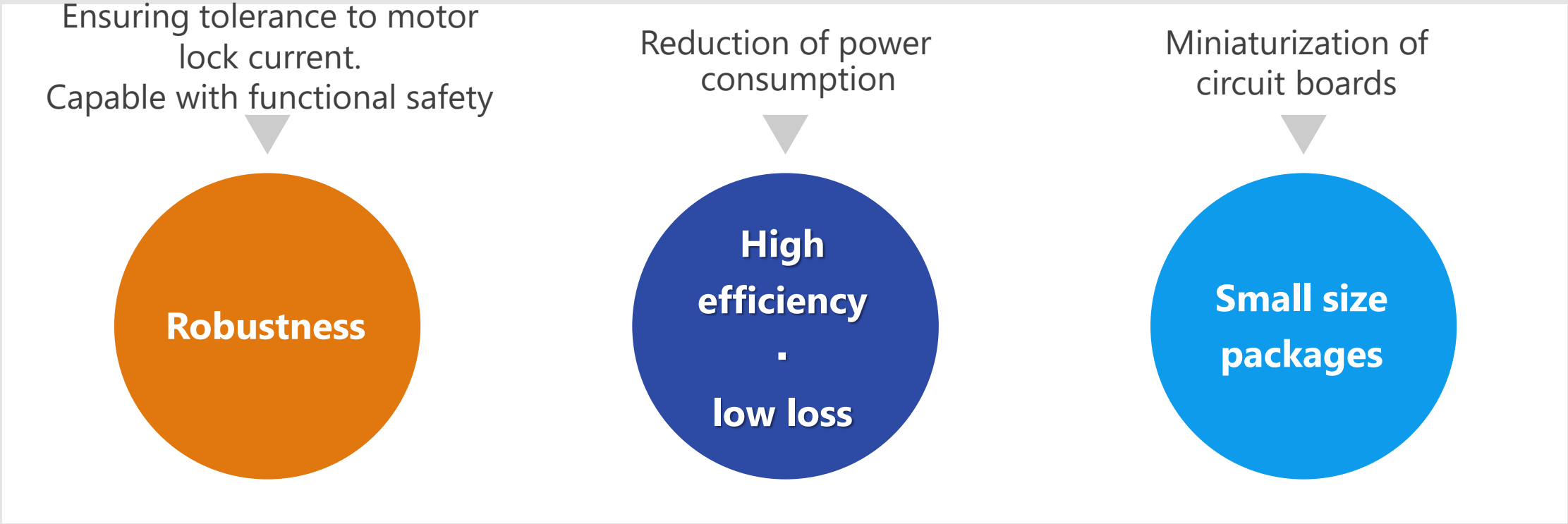
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of Electric Turbocharger, **“Ensuring tolerance to motor lock current. Capable with functional safety”**, **“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

	Robustness	High efficiency · low loss	Small size packages
1	U-MOS Series 80 V / 100 V N-ch MOSFET	●	●	●
2	Gate driver (for motor)	●	●	●
3	TVS diode (for CAN communication)	●		●
4	General purpose small signal MOSFET		●	●
5	General purpose small signal bipolar transistor			●
6	Small signal bias resistor built-in transistor (BRT)			●

1 U-MOS Series 80 V / 100 V N-ch MOSFET

XPQR8308QB / XPQ1R00AQB

Robustness | High efficiency · Low loss | Small size package

Value provided

The combination of low on-resistance and low noise by the latest U-MOS series process and a small package contributes to system performance improvement.

1 Low loss (reduced on-resistance)

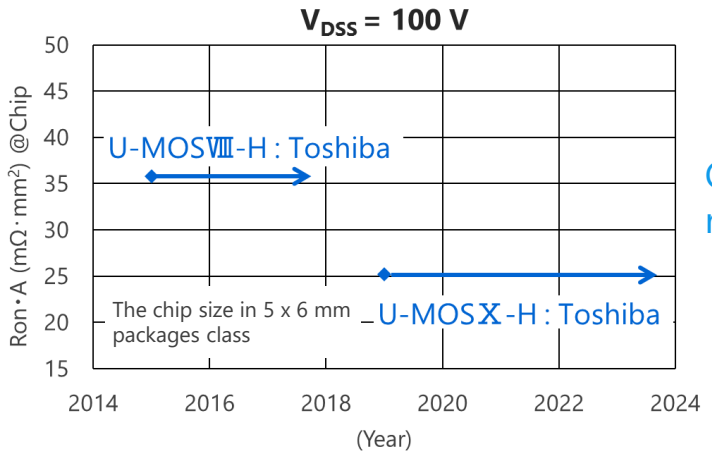
Using low on-resistance technology to contribute to reduced power consumption systems.

2 Low noise (low EMI)

Improved chip process reduces surge voltage and ringing time.

3 Compact gull wing package

Package size reduced by 23 % compared to D2PAK (10 x 5 mm). Gull wing shaped leads to reduce mounting solder stress in high environments with ambient temperature and mechanical stress.



Line up

Part number	Drain-source voltage	Drain current	On-resistance (Max) @V_{GS}=10 V	Package
XPQR8308QB*	80 V	400 A	0.8 mΩ	L-TOGL™ 
XPQ1R00AQB*	100 V	400 A	1.1 mΩ	

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

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2 Gate driver (for motor)

TPD7212F / TPD7212FN / TPD7213FN

Robustness | High efficiency · Low loss | Small size package

Value provided

The high gate drive current capability reduces MOSFET losses and improves the efficiency of system.

1 High gate drive current

High drive current capability and high speed switching contribute to reduce the loss.

- TPD7213FN : ±2 A
- TPD7212F, TPD7212FN : -1 A / +1.5 A

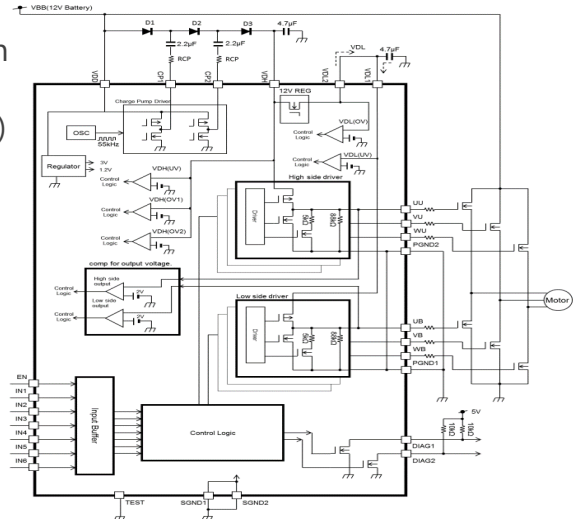
2 Built-in protection / diagnostic output function

- MOSFET is turn off when a signal is input that causes arm short circuit.
- Functions to monitor abnormalities of the power supply voltage and output voltage are built-in.

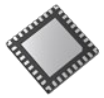
3 Small surface mount package

WQFN32, SSOP16, SSOP30

Example of application and block diagram of TPD7212F, TPD7212FN
(Three-phase brushless DC motor control)



Line up

Part number	TPD7213FN*	TPD7212F / TPD7212FN	
Function	Half bridge gate driver	Gate driver for Three-phase brushless motor	
Number of output	2 outputs	6 outputs	
Package	 SSOP16 (5.5 x 6.4 mm)	 WQFN32 (5 x 5 mm)	 SSOP30 (10.2 x 7.6 mm)
Features	・Suitable for 48V battery system ・Can be used to drive a high side N-ch MOSFET	・For driving high-side N-ch MOSFET (with built-in charge pumps) ・Built-in voltage monitoring function (power supply, output)	

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

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3 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Robustness | 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

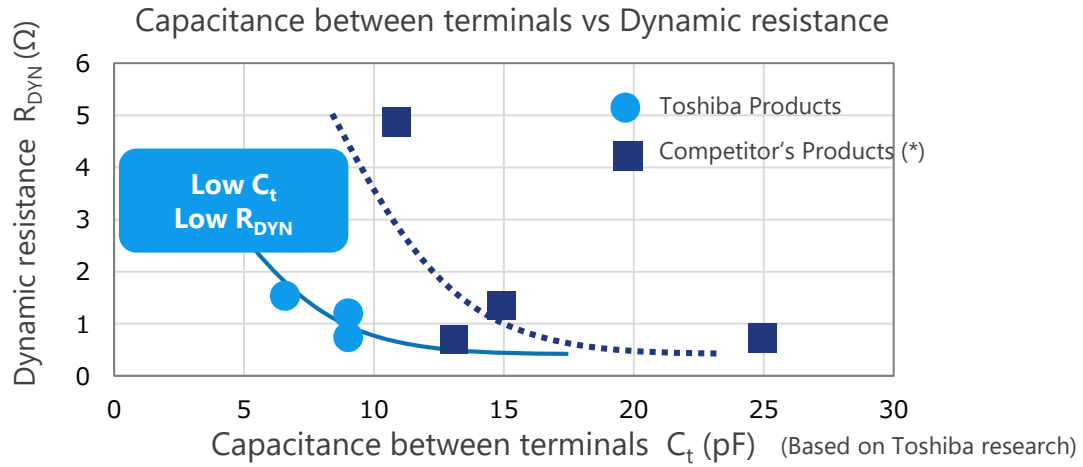
Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes.
(Both low dynamic resistance R_{DYN} and low capacitance between terminals C_t)

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)

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

(*): Measurements of the commercial product

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

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4 General purpose small signal MOSFET

SSM3K7002KF / SSM3J168F / SSM3J66MFV

Robustness | 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.

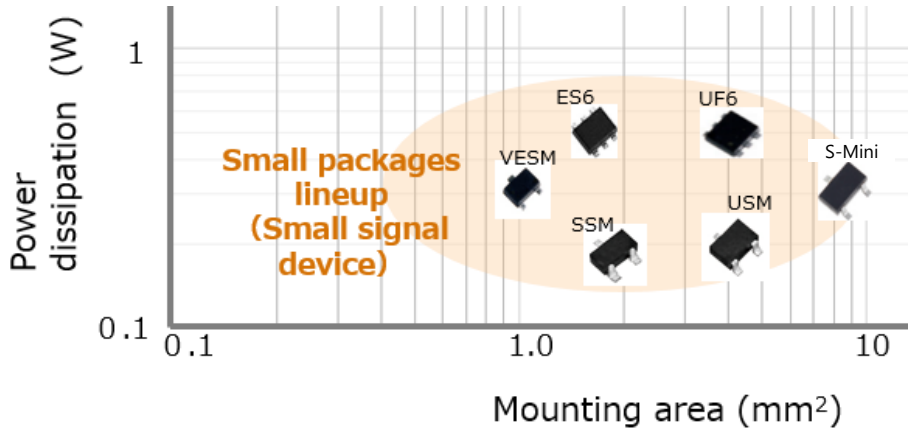
2 Low voltage drive

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

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5 General purpose small signal bipolar transistor

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

Robustness | 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.

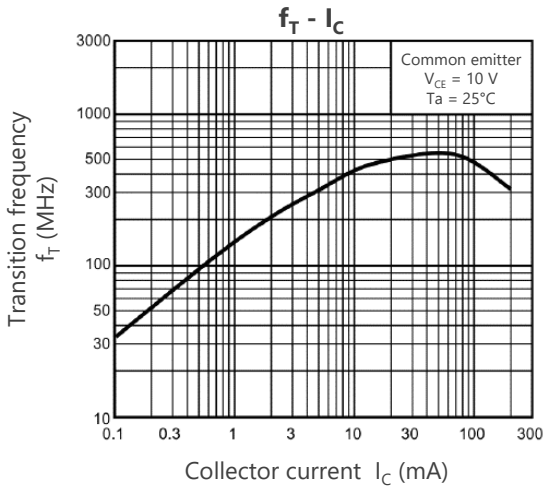
2 Extensive product lineup

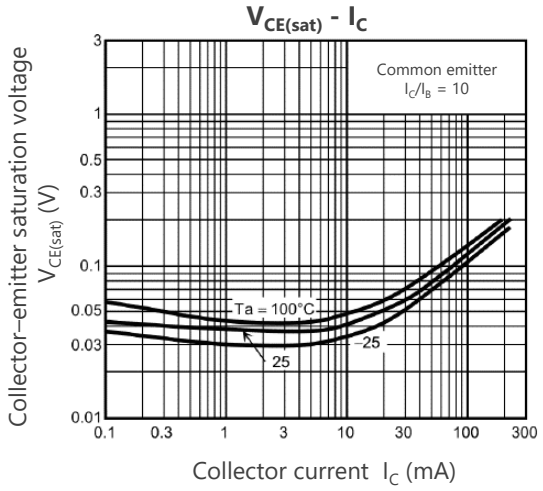
Various product lineups, such as general purpose, low noise, low $V_{CE(sat)}$ and high current types are provided. Products can be selected in accordance to the application.

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

RN1907FE / RN2907FE / RN1901 / RN2901 Series

Robustness | 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)

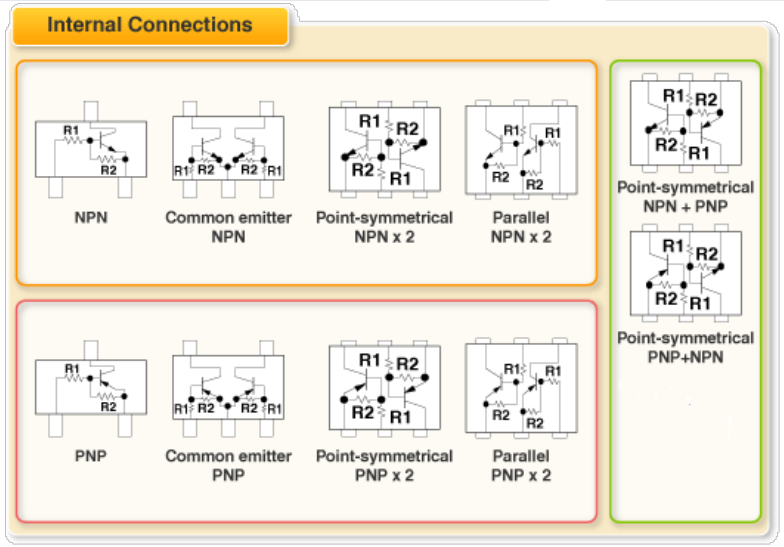
The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

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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