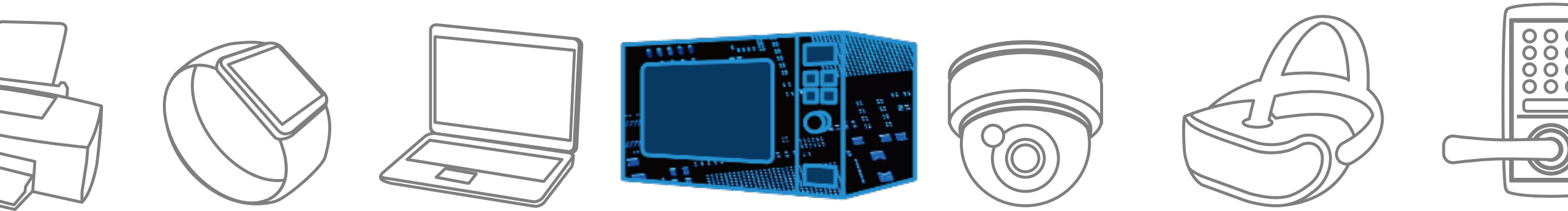
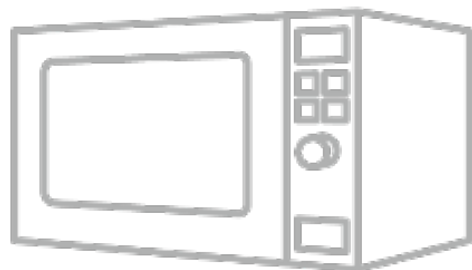


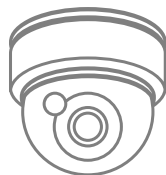
# Microwave Oven

Solution Proposal by Toshiba

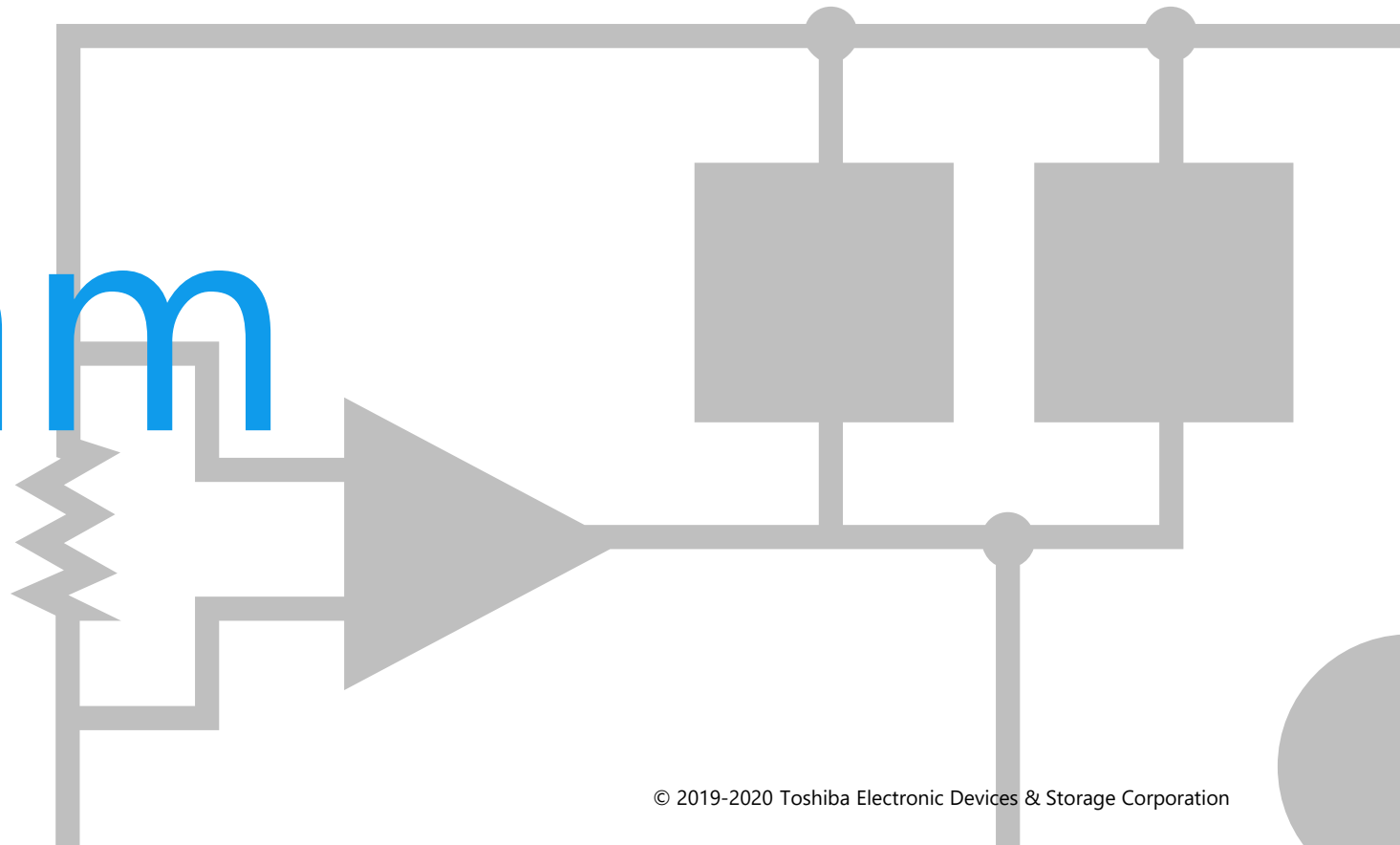




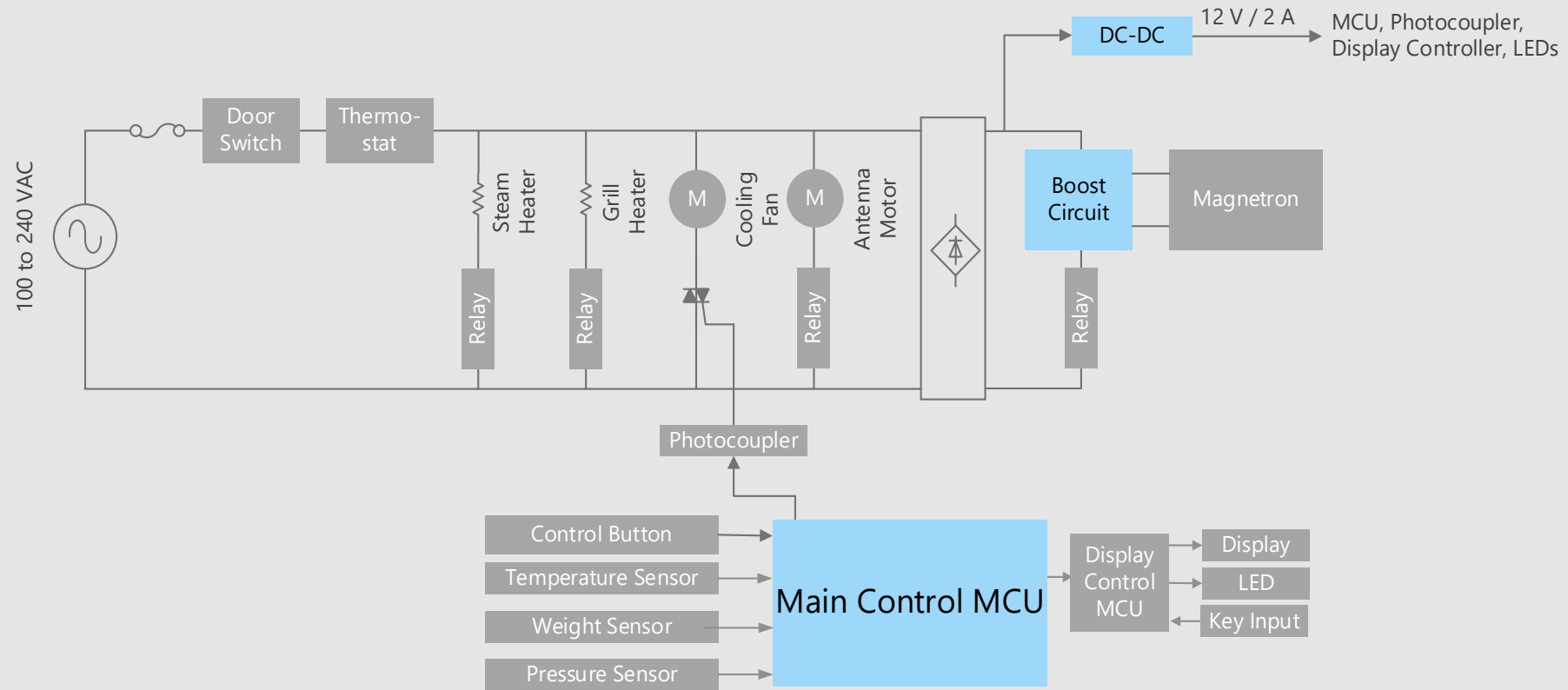
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.



# Block Diagram

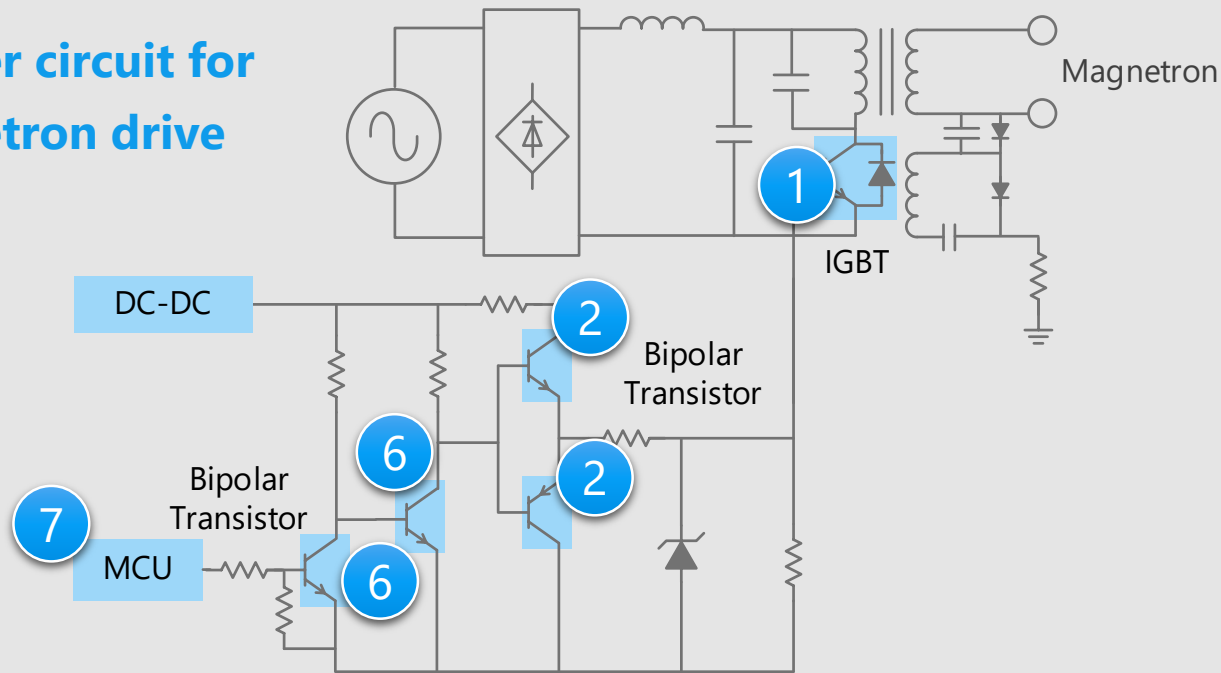


# Microwave Oven Overall block diagram

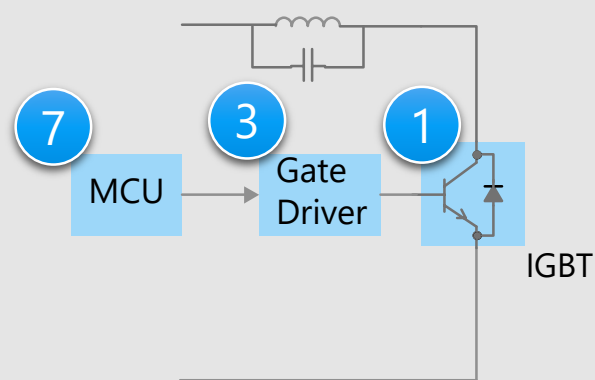


# Microwave Oven Details of power supply circuit (1)

## Booster circuit for magnetron drive



## IGBT driver



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

## Criteria for device selection

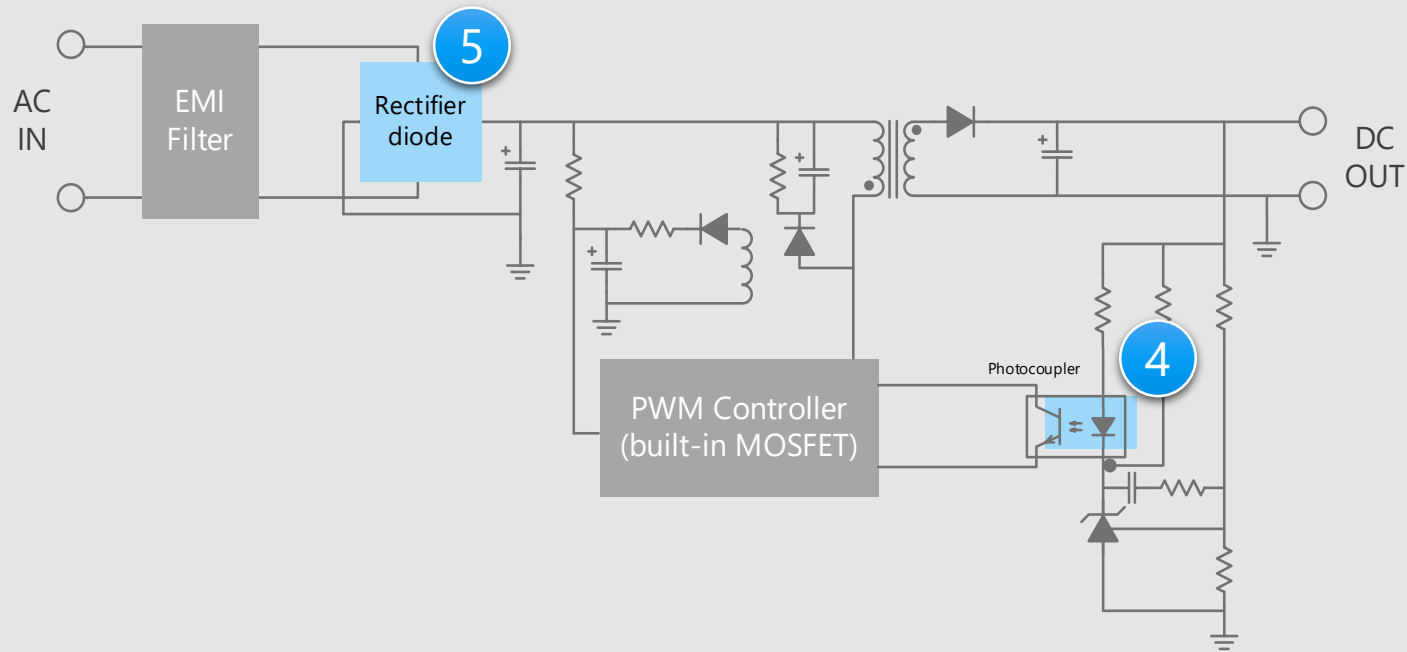
- High speed switching and low saturation voltage characteristics are required for IGBT.
- The size of the circuit board can be reduced by using small packages.
- Rail-to-rails, low voltage and low current drive characteristics are required for gate driver to reduce power consumption.
- Monitoring sensor, high speed data processing and various heaters control are needed for system control.

## Proposals from Toshiba

- **High efficiency with high speed and low saturation voltage**  
Silicon N-ch discrete IGBT 1
- **Contribute to loss reduction by high speed and high  $h_{FE}$**   
Bipolar transistor for IGBT gate drive 2
- **High efficiency due to rail-to-rail characteristics**  
IGBT gate driver coupler 3
- **High voltage and high  $h_{FE}$**   
Bipolar transistor 6
- **High efficient processing of multiple input and output data**  
MCU 7

# Microwave Oven Details of power supply circuit (2)

## Flyback AC-DC circuit



## Criteria for device selection

- Contribute to higher power supply efficiency by realizing high conversion efficiency even in the low input current range
- Use of small packages to reduce the board area

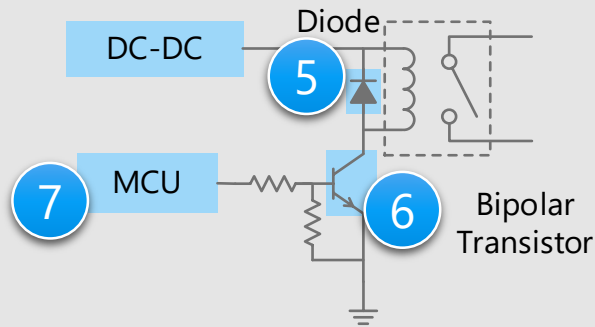
## Proposals from Toshiba

- **Photocoupler with excellent environmental resistance**  
Transistor output photocoupler 4
- **Small surface mount package suitable for high density mounting**  
Rectifier diode 5

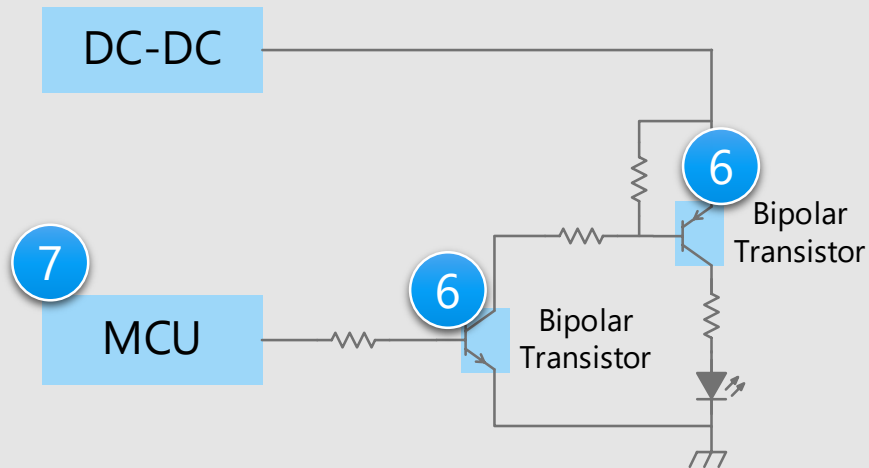
\* [Click on the numbers in the circuit diagram to jump to the detailed descriptions page](#)

# Microwave Oven Details of Relay/LED Drive

## Relay drive circuit



## LED drive circuit



## Criteria for device selection

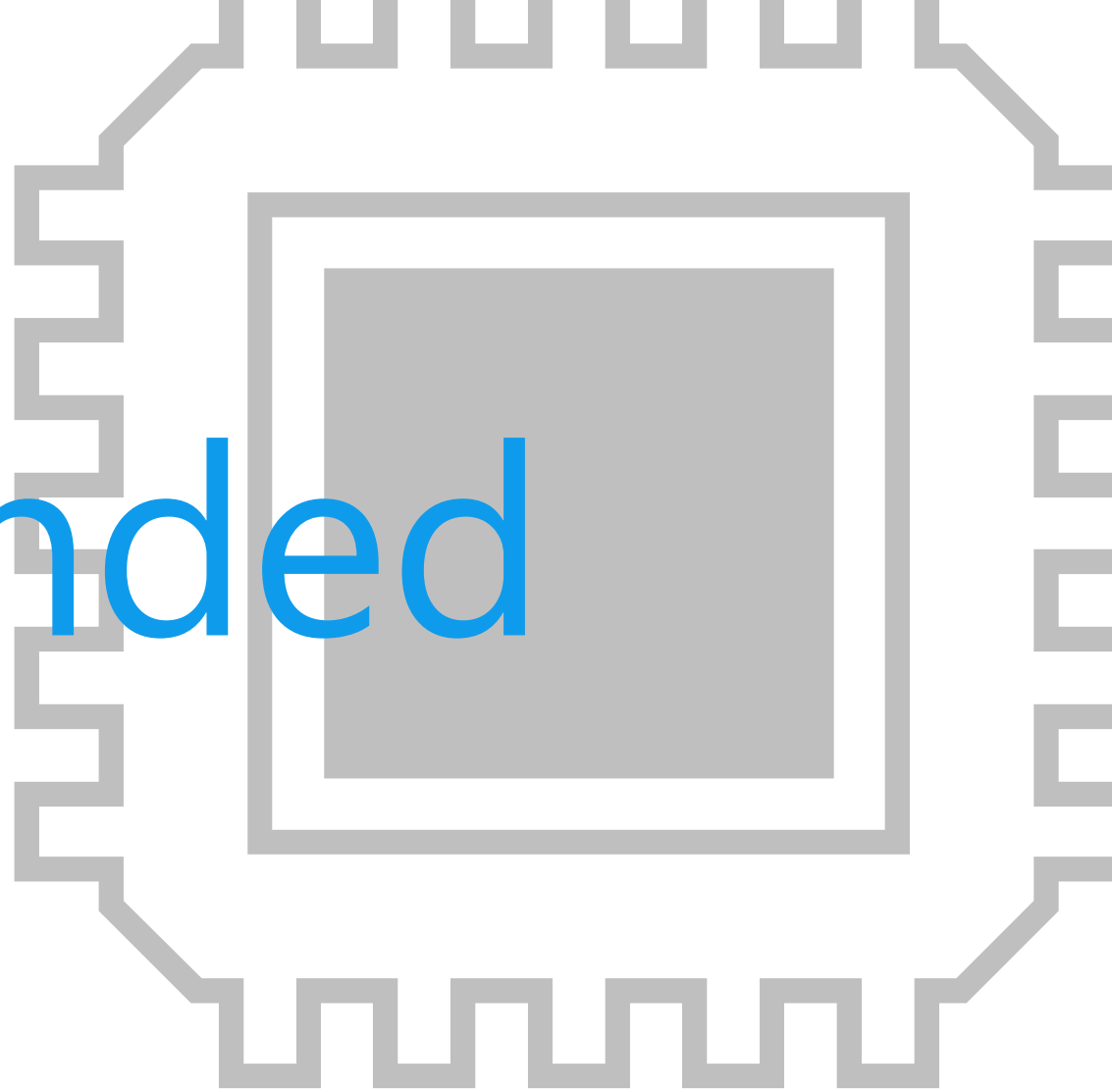
- The use of a constant current drive circuit can suppress variations in LED brightness.
- The use of a product with a low collector-emitter saturation voltage  $V_{CE(sat)}$  has an advantage in power utilization efficiency.
- Use of small packages to reduce the PCB area.
- Monitoring sensor, high speed data processing and various heaters control are needed for system control.

## Proposals from Toshiba

- **Small surface mount package suitable for high density mounting** 5
  - **High voltage and high  $h_{FE}$**  6
  - **High efficient processing of multiple input and output data** 7
- MCU

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

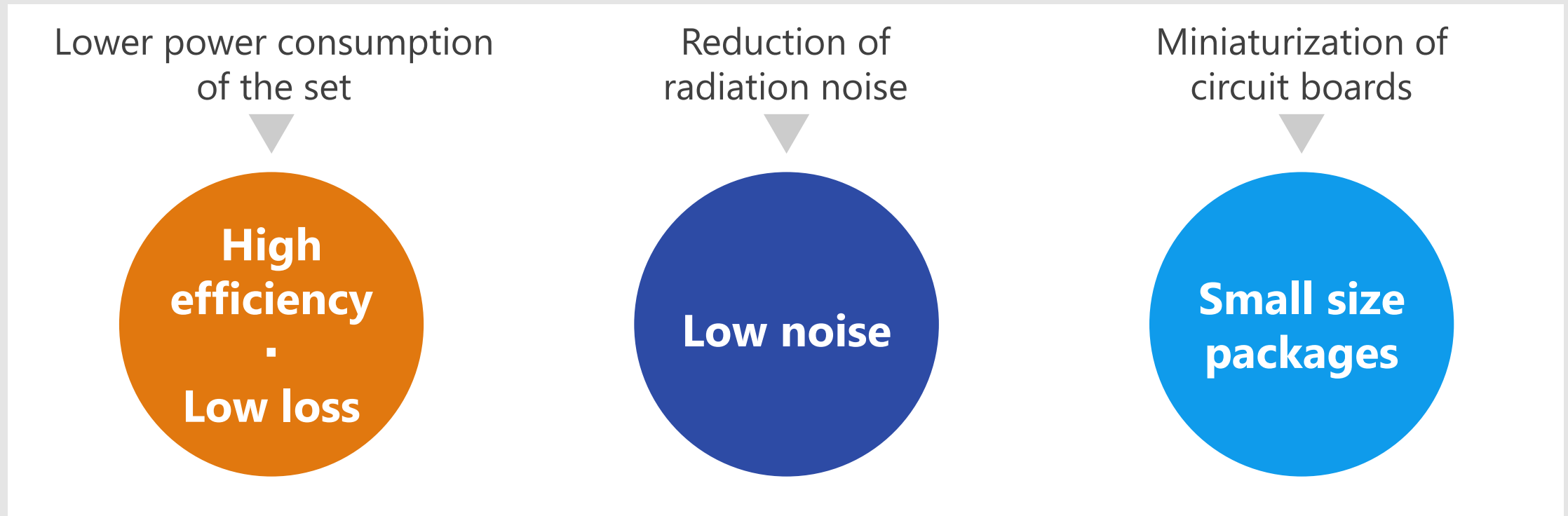
# Recommended Devices





# Device Solutions to Solve Customer Problems

As described above, in the design of microwave oven, "**Lower power consumption of the set**", "**Reduction of radiation noise**" and "**Miniaturization of the boards**" are important factors. Toshiba's proposals are based on these three solutions perspectives.



# Device Solutions to Solve Customer Problems

	High efficiency - Low loss	Low noise	Small size packages
① Silicon N-ch discrete IGBT	●	●	
② Bipolar transistor for IGBT gate drive	●		●
③ IGBT gate driver coupler	●		●
④ Transistor output photocoupler	●		●
⑤ Rectifier diode			●
⑥ Bipolar transistor			●
⑦ MCU	●		●

Value provided

High speed switching and low saturation voltage characteristics contribute to high efficiency.

## 1 High speed switching

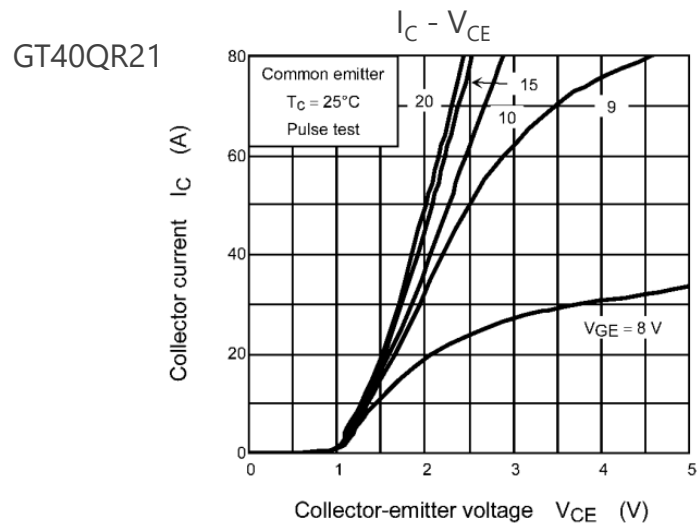
Reducing switching loss through high speed operation contributes to higher power supply efficiency.

## 2 Low saturation voltage



Saturation voltage is kept low while realizing high speed switching.

## 3 Enhancement type

Enhancement type is easy to design because no collector current flows when no gate voltage is applied.



### Line up

Part number	GT40QR21	GT30J110SRA
Package	TO-3P(N) 	TO-3P(N) 
V <sub>CES</sub> [V]	1200	1100
t <sub>f</sub> (Typ.) [μs]	0.20 @ I <sub>C</sub> = 40 A	0.17 @ I <sub>C</sub> = 60 A
V <sub>CE(sat)</sub> (Typ.) [V]	1.9 @ I <sub>C</sub> = 40 A	2.15 @ I <sub>C</sub> = 60 A

[Return to Block Diagram TOP](#)

# 2 Bipolar transistor for IGBT gate drive

HN4B101J / HN4B102J / TPCP8901 / TPCP8902

High efficiency  
Low loss

Low noise

Small size packages

Value provided

High speed switching characteristics and high  $h_{FE}$  performance enable the system to have higher frequencies and lower losses.

## 1 High speed switching operation

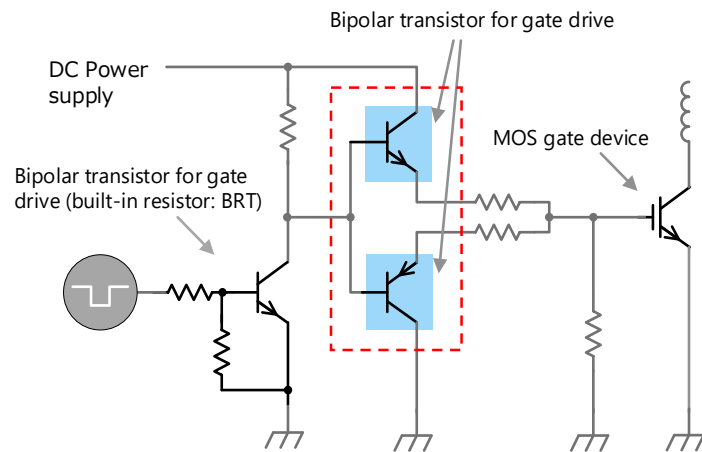
These transistors have high speed switching characteristic suitable for high frequency equipment.

## 2 High DC current gain ( $h_{FE}$ )

Maximum rating of collector current and DC current gain is improved for larger IGBT gate capacity.

## 3 Compact and thin package

Both PNP and NPN type are mounted on one small surface mount package to reduce mounting area. Emitter terminals of PS-8 package is independent, so it is easy to divide the gate resistance ON/OFF.



### Line up

Part number	HN4B101J	HN4B102J	TPCP8901	TPCP8902
Package	SMV		PS-8	
Internal structure (Top View)				
$V_{CEO}$ [V] (PNP / NPN)	-30 / 30	-30 / 30	-50 / 50	-30 / 30
$I_{CP}$ [A] (PNP / NPN)	-5 / 5	-8 / 8	-5 / 5	-8 / 8

[Return to Block Diagram TOP](#)

Value provided

**Rail-to-rail output enables the system to operate stably and reduce conduction losses.**

## 1 Rail-to-rail output

This product generates a full swing voltage output signal and contributes to low power consumption.

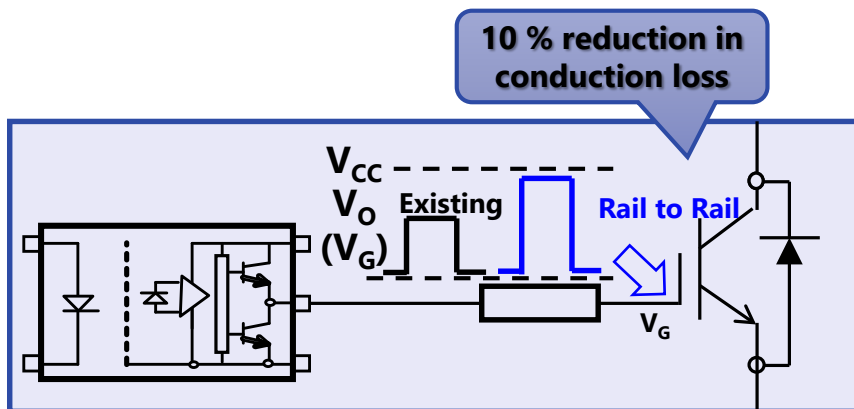
## 2 Small package

This products are 50 % smaller than the 8-pin DIP package and meets the reinforced insulation class requirements of international safety standards [Note].

## 3 Operational ambient temperature range 125 °C

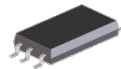
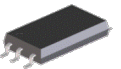
These photocouplers are designed to operate under severe ambient temperature conditions.

[Note] Comparison with our products



(Note: Toshiba internal comparison)

### Line up

Part number	TLP5771H	TLP5772H	TLP5774H	TLP5751H	TLP5752H	TLP5754H
Package	SO6L 			SO6L 		
$I_{OP}$ (Max) [A]	±1	±2.5	±4	±1	±2.5	±4
$t_{pHL}/t_{pLH}$ (Max) [ns]	150			150		
$BV_S$ [Vrms]	5000			5000		
$T_{opr}$ [°C]	-40 to 125			-40 to 125		
$V_{CC}$ [V]	10 to 30			15 to 30		
$I_{FLH}$ (Max) [mA]	2			4		

[◆Return to Block Diagram TOP](#)



Value provided

The built-in various protective functions make it easy to design the gate drive circuit.

### 1 Protective Functions

TLP5231 delivers various built-in functions<sup>[note]</sup>, including an overcurrent detection by monitoring collector voltage.  
 [note] Gate signal soft turn off, fault feedback function.

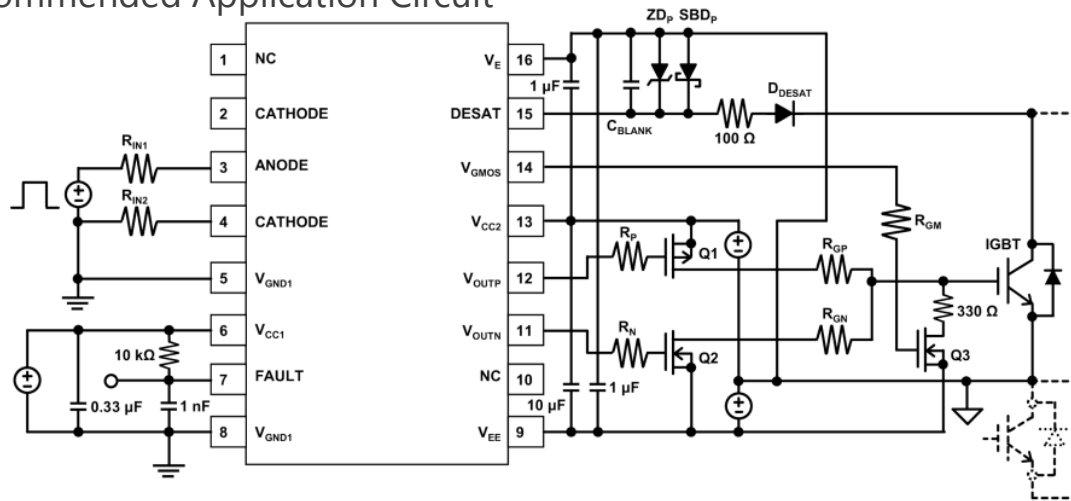
### 2 Rail-to-rail output

TLP5231 generates a full swing voltage output signal and contributes to low power consumption.


### 3 Operational ambient temperature range 110 °C

These photocouplers are designed to operate under severe ambient temperature conditions.

#### Recommended Application Circuit



#### Line up

Part number	TLP5231
Package	SO16L 
I <sub>OP</sub> (Max) [A]	±2.5
t <sub>pHL</sub> /t <sub>pLH</sub> (Max) [ns]	300
BV <sub>S</sub> (Min) [Vrms]	5000
T <sub>opr</sub> [°C]	-40 to 110
V <sub>CC2</sub> - V <sub>EE</sub> [V]	21.5 to 30
I <sub>FHL</sub> (Max) [mA]	3.5

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# 4 Transistor output photocoupler

TLP383 / TLP293 / TLP785 / TLP385

3-phase motor with high withstand voltage

High efficiency  
·  
low loss

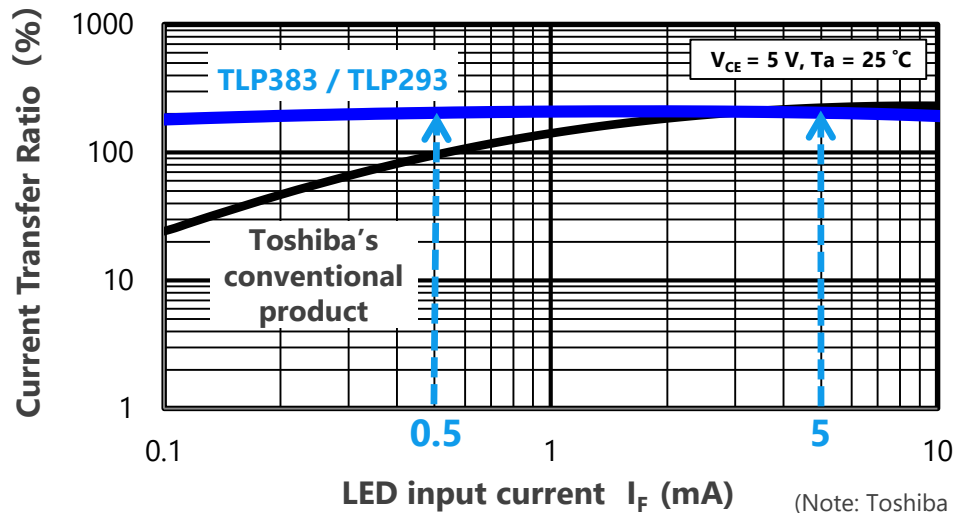
Small size packages

Value provided

## Reduction in required circuit board area and improving reliability enabling maintenance-free operation.

### 1 High current transfer ratio

The TLP383 / TLP293 is a high-isolation photocoupler that optically couples a phototransistor and high output infrared LED. Compared to Toshiba's conventional products (TLP785 / TLP385), higher CTR (Current Transfer Ratio) in low input current range (@  $I_F = 0.5 \text{ mA}$ ) is realized.



(Note: Toshiba internal comparison)

### 2 Operating temperature is expanded to 125 °C

The TLP383 / TLP293 are designed to operate under extreme conditions of ambient temperature such as inverter devices, robots, machine tools and high output power supplies.

#### Line up

Part number	TLP383	TLP293	TLP785	TLP385
Package	SO6L (4pin) 	SO4 	DIP4 	SO6L (4pin) 
BV <sub>S</sub> (Min) [Vrms]	5000	3750	5000	5000
T <sub>opr</sub> [°C]	-55 to 125	-55 to 125	-55 to 110	-55 to 110

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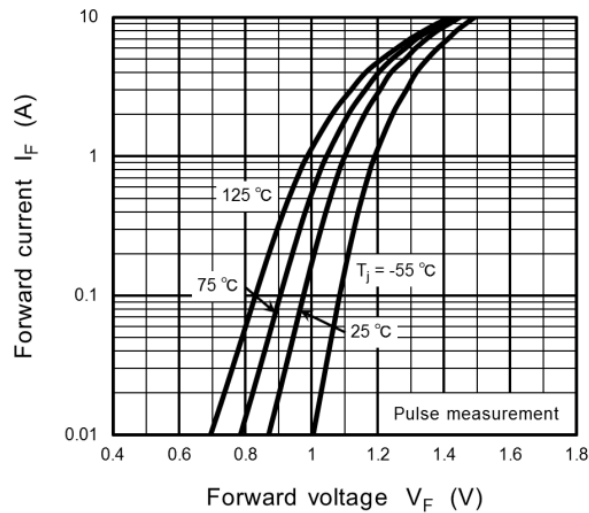
Value provided

Wide range of products are provided, mainly compact package that is suitable for high density assembly.

## 1 Surface mount / Compact package

Adopting M-FLAT™ package which is lower in height compared to the conventional lead type contributes to the space saving of the equipment [Note].

[Note] Comparison with our products



•CMG06A forward characteristic



## 2 Wide product line-up (1)

Reverse voltage : 200 V to 1000 V  
Average forward current : 0.5 A to 3 A  
Suitable product can be selected according to requirements.

## 3 Wide product line-up (2)

We also offer a lineup of low voltage, small package diodes to protect the inductive loads of mechanical relays.

### Line up

Part number	CMG06A	1SS352
Package	M-FLAT™ 	USC 
$I_{F(AV)}$ (Max) [A]	1	0.1
$V_{RRM}$ (Max) [V]	600	80 (for $V_R$ )

[Return to Block Diagram TOP](#)



Value provided

Wide range of bipolar transistors suitable for various applications, including radio frequency (RF) and power supply devices.

## 1 High voltage (collector power dissipation)

High voltage allows for large loads and instantaneous voltage changes. It also contributes to measures for product life.

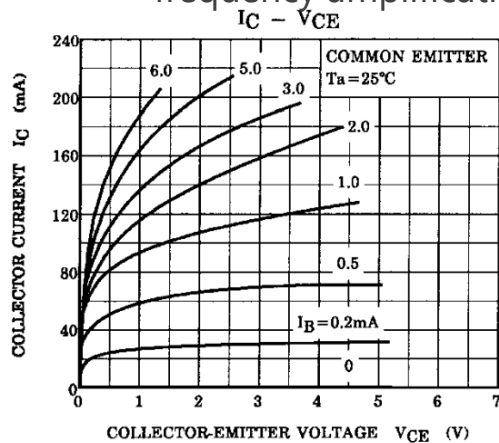
## 2 Large current (rated collector current)

It covers a wide range of applications, from high frequency applications to power supply applications, and is particularly suitable for applications requiring current capacity.

## 3 Enhancement type

It is easy to design because it is an enhancement type in which the collector current does not flow when the base voltage is not applied.

High voltage and high current, optimal for low frequency amplification



(TMBT3904: Max.)  
High breakdown voltage:  $V_{CEO} = 50\text{ V}$   
Large current :  $I_C = 200\text{ mA}$

### Line up

Part number	TMBT3906	TMBT3904	2SC4116
Package	SOT23 	SOT23 	USM 
$V_{CEO}$ (Min) [V]	-50	50	50
$I_C$ (Max) [mA]	-200	200	150
$V_{CE(SAT)}$ (Max) [V]	-0.25	0.2	0.25
$h_{FE}$ (Max)	300	300	700
Polarity	PNP	NPN	NPN

[Return to Block Diagram TOP](#)

Value provided

### System control at low power consumption by various timers and ADCs.

**1 Built-in Arm® Cortex®-M3 CPU core**

TPM383FSUG implements Cortex-M3 core with 80 MHz maximum operation frequency. Various development tool and their partners allow users many options.

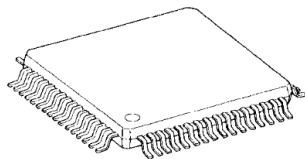
**2 System cost down and development efficiency improvement**

TPM383FSUG executes sensing data monitoring and processing efficiently by combining built-in analog function such as ADC and comparator, and CPU system. The original NANOFLASH™ is possible to rewrite at high speed. It reduces user software development time period.

**3 Small size package and low power consumption**

TPM383FSUG supports low power consumption library and stand by function. These contribute to reduce low power consumption. The package is small LQFP64.

TPM383FSUG



LQFP64

Line up

Part number	TPM383FSUG
Maximum operation frequency	40 MHz
Instruction ROM	64 KB
RAM	8 KB
Thumb-2 Instruction set	Available
Timer	16bit x 8ch
I <sup>2</sup> C	1ch
ADC	10ch (12bit)

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