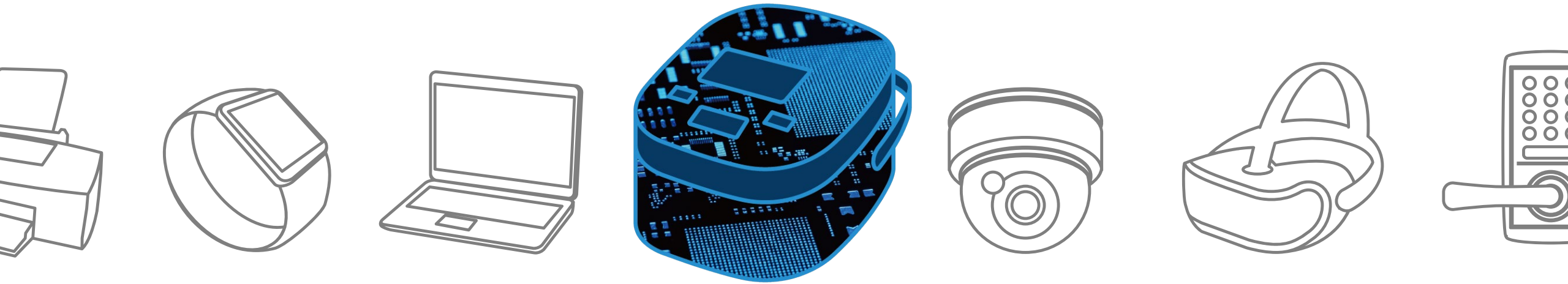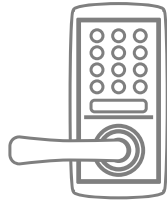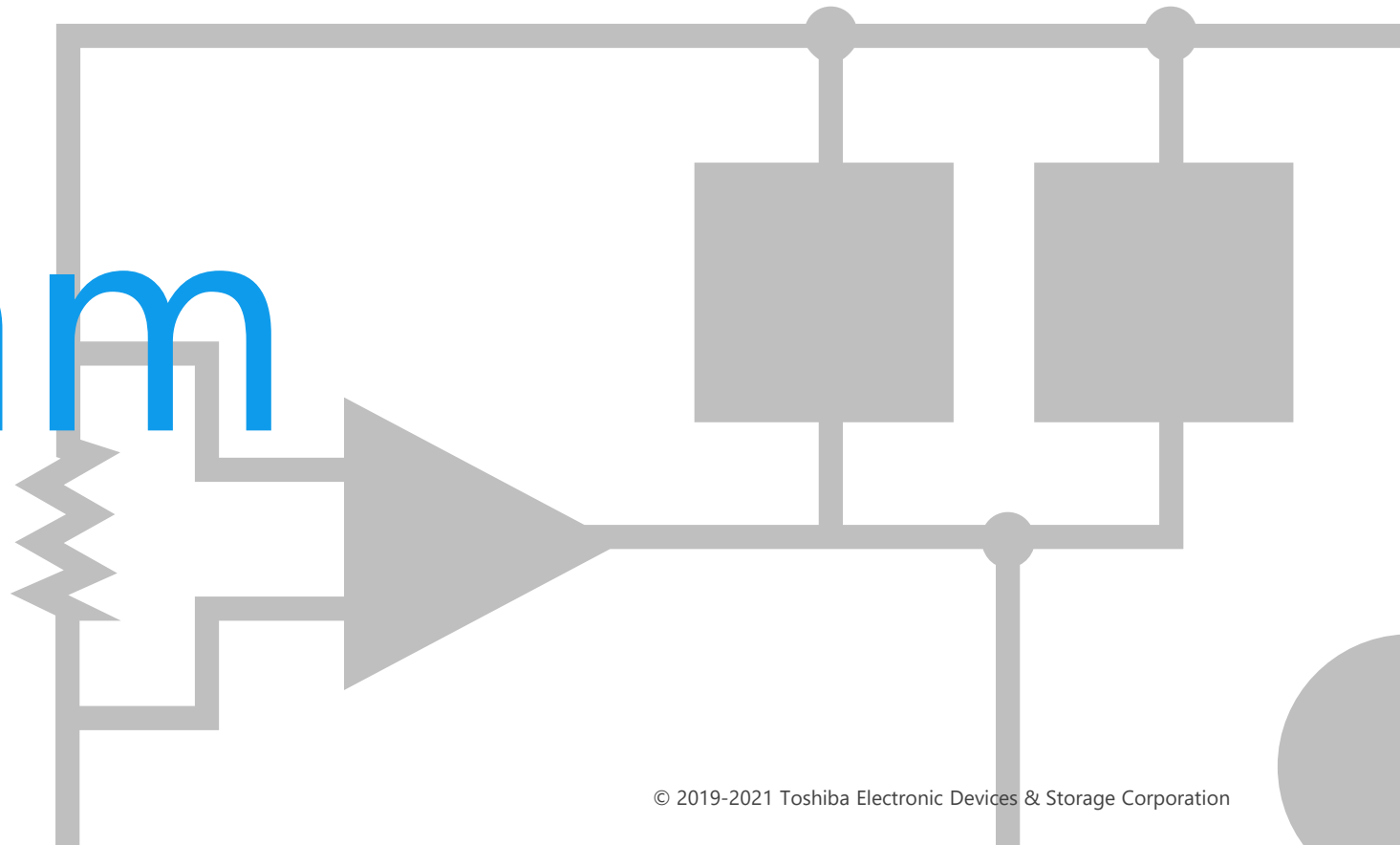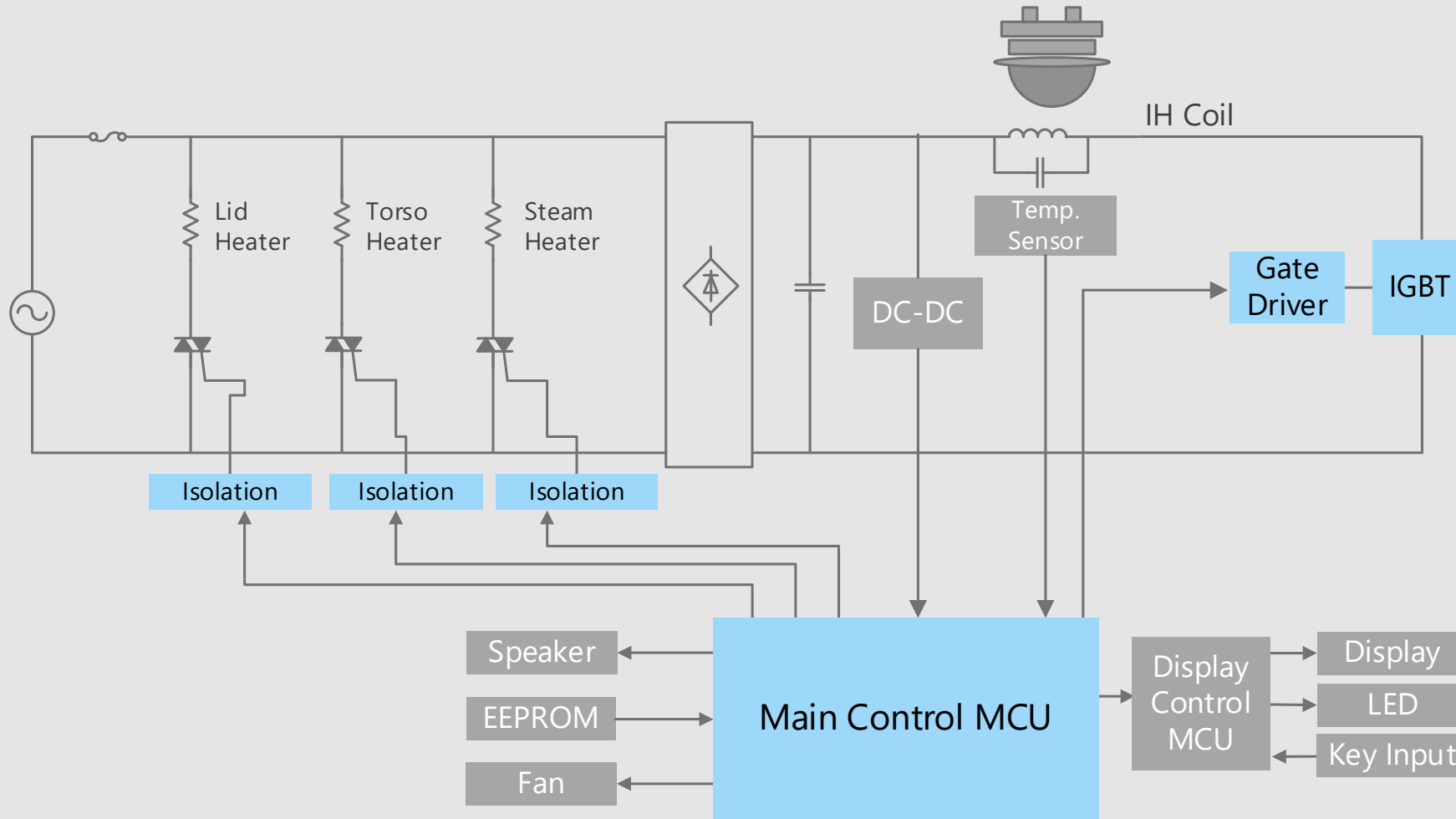# IH Rice Cooker

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.
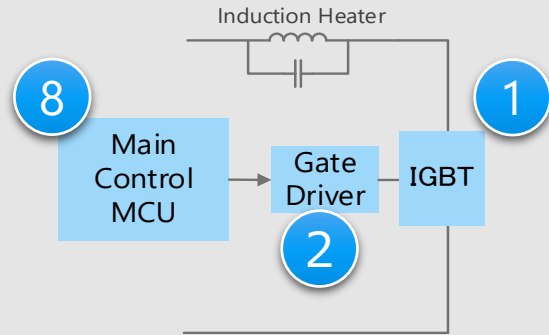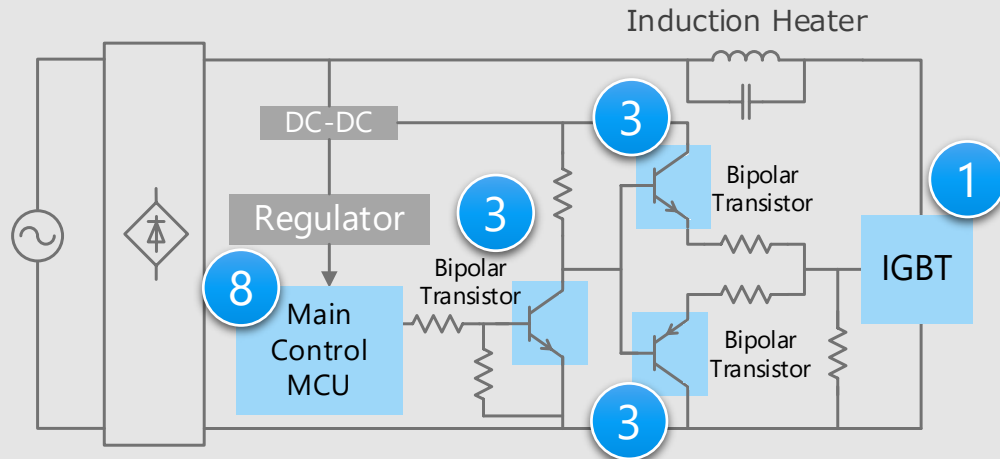
Block Diagram

Lid Heater

Torso Heater

Steam Heater

IH Coil

Temp. Sensor

Gate Driver

IGBT

DC-DC

Isolation

Isolation

Isolation

Speaker

EEPROM

Fan

Main Control MCU

Display Control MCU

Display

LED

Key Input

IH coil drive circuit (using gate driver coupler)

Induction Heater

⑧ Main Control MCU → Gate Driver — IGBT ①

②

IH coil drive circuit (using discrete components)

Induction Heater

DC-DC

Regulator

Bipolar Transistor

③

③

⑧ Main Control MCU

Bipolar Transistor

Bipolar Transistor

IGBT ①

③

※ Click the number in the circuit diagram to jump to the detailed description page
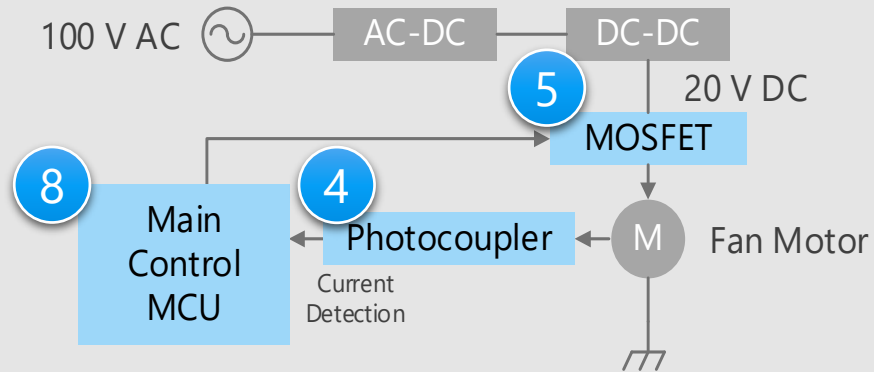
Criteria for device selection

- Fast switching and low saturation voltage characteristics are required for IGBT.
- Use of small package enables to reduce the circuit board area.
- Rail-to-Rail output, low voltage driving and low current consumption are required for gate driver to realize low power consumption of the set.
- Monitoring sensor, high speed data processing and various heaters control are needed for system control.
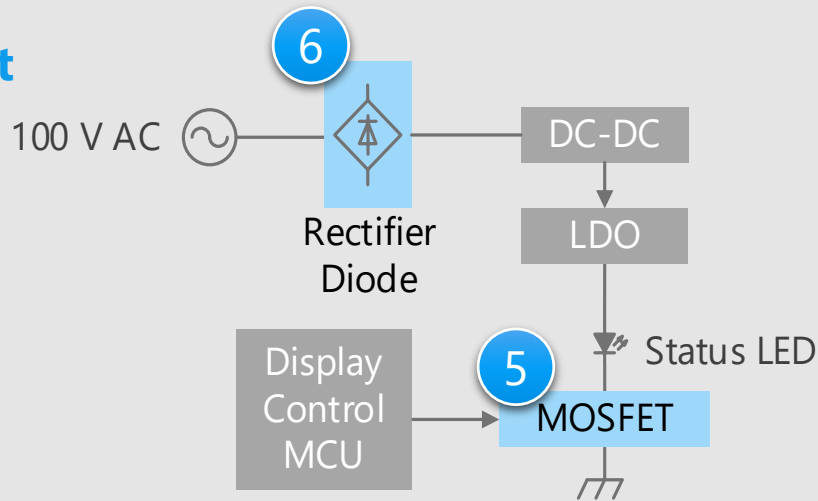
Proposals from Toshiba

- **Fast and high efficiency switching are realized**
  Silicon N-ch discrete IGBT ①
- **Higher efficiency is realized**
  IGBT gate driver coupler
  (Rail-to-Rail output type) ②
- **Contribute to reduction of switching loss**
  Bipolar transistor for IGBT gate drive ③
- **High efficient processing of a few input and output data**
  Main control MCU ⑧

Fan motor drive circuit

100 V AC — AC-DC — DC-DC

(5) 20 V DC

MOSFET

(8) Main Control MCU

(4) Photocoupler

Current Detection

M Fan Motor

LED driving circuit

100 V AC

(6) Rectifier Diode

DC-DC

LDO

Status LED

Display Control MCU

(5) MOSFET

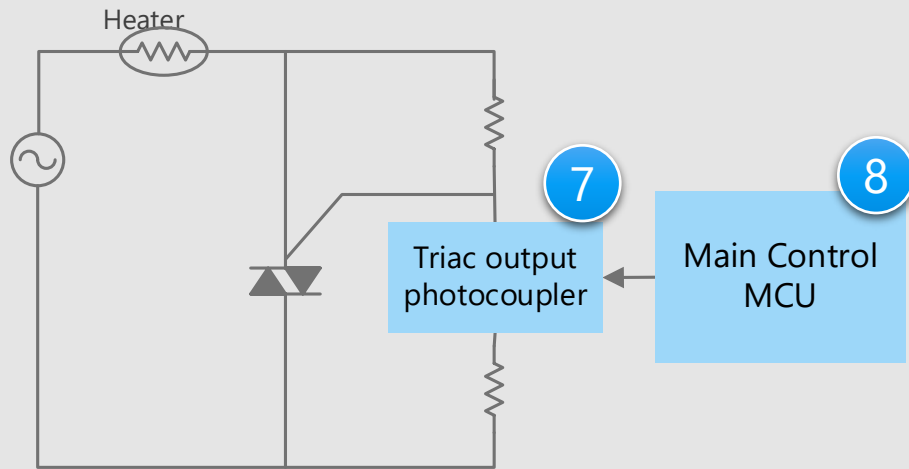※ Click the number in the circuit diagram to jump to the detailed description page

Criteria for device selection

- Low on-resistance characteristic contributes to low loss of the set.
- Use of small package enables to reduce the circuit board area.
- Monitoring sensor, high speed data processing and various heaters control are needed for system control.

Proposals from Toshiba

- **High current transfer ratio and high temperature operation makes easy to design.** (4)
  Transistor output photocoupler
- **Low on-resistance realizes a set with low power consumption** (5)
  U-MOS Series MOSFET
- **Small surface mount package suitable for high density mounting** (6)
  Rectifier diode
- **High efficient processing of a few input and output data** (8)
  Main control MCU

Heater control circuit

Heater

7

8

Triac output
photocoupler

Main Control
MCU

Criteria for device selection

- A triac output photocoupler is suitable to control AC load.
- Monitoring sensor, high speed data processing and various heaters control are needed for system control.

Proposals from Toshiba

- **Efficient control of AC load is realized.**
  Triac output photocoupler 7

- **High efficient processing of a few input and output data**
  Main control MCU 8

※ Click the number in the circuit diagram to jump to the detailed description page

Recommended Devices
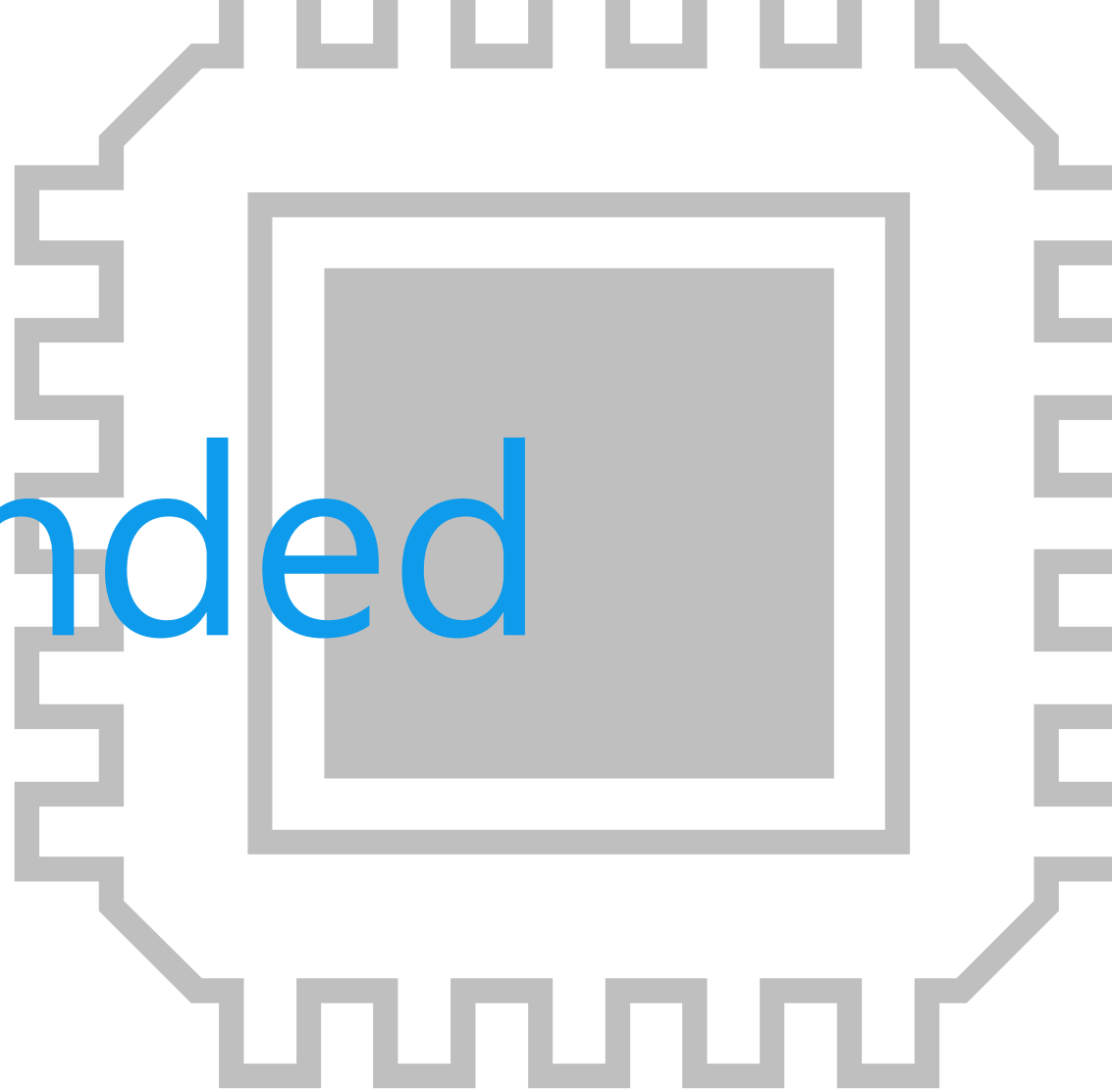
Device solutions to address customer needs

As described above, in order to design IH Rice Cooker**, "Compatibility with AC voltage in each country"**, **"Low power consumption of set"** and **"Miniaturization of circuit boards"** are important factors. Toshiba's proposals are based on these three solution perspectives.
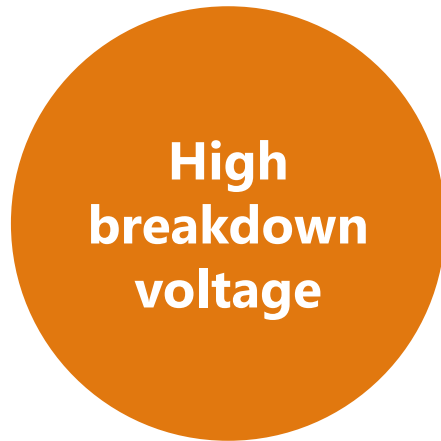
Compatibility with AC voltage in each country	Low power consumption of the set	Miniaturization of circuit boards
▽	▽	▽
High breakdown voltage	**High efficiency · Low loss**	**Small size packages**

Device solutions to address customer needs

		High breakdown voltage	High efficiency · Low loss	Small size packages
①	**Silicon N-ch discrete IGBT**	🟠	🔵	
②	**IGBT gate driver coupler**	🟠	🔵	🔵
③	**Bipolar transistor for IGBT gate drive**		🔵	🔵
④	**Transistor output photocoupler**		🔵	🔵
⑤	**U-MOS Series MOSFET**		🔵	🔵
⑥	**Rectifier diode**	🟠	🔵	🔵
⑦	**Triac output photocoupler**	🟠	🔵	🔵
⑧	**Main control MCU**		🔵	🔵

Value provided

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

1 **High speed switching**	2 **Low saturation voltage**	3 **Enhancement type**
Reducing switching loss through high speed operation contributes to higher power supply efficiency.	Saturation voltage is kept low while realizing high speed switching.	Enhancement type is easy to handle because no collector current flows when no gate voltage is applied.

GT30J110SRA
Characteristics Curves
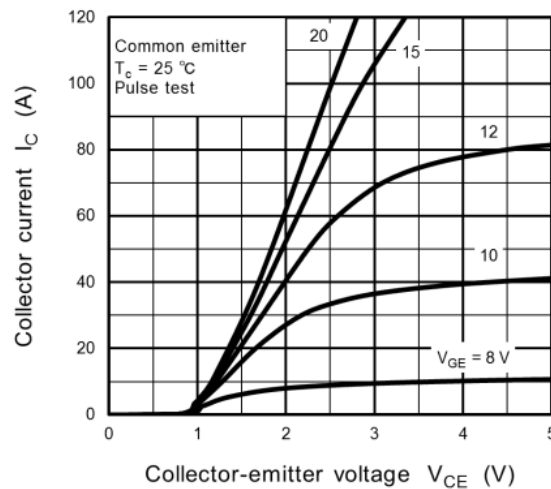
Line up

Part number	GT50N324	GT30J110SRA	GT20N135SRA
Package	TO-3P(N)		TO-247
V_{CES} (Max) [V]	1000	1100	1350
t_f (Typ.) [µs]	0.11 @I_C = 60 A	0.17 @I_C = 60 A	0.25 @I_C = 40 A
$V_{CE(sat)}$ (Typ.) [V]	1.9 @I_C = 60 A	2.15 @I_C = 60 A	2.0 @I_C = 40 A

High breakdown voltage | High efficiency · Low loss | Small size packages

Value provided

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

1 Rail-to-rail output

TLP577X and TLP575X generate a full-swing voltage output signal and contributes to low power consumption.

2 Small package

The mounting area of SO6L package is 50 % smaller than that of DIP8. And these gate driver coupler comply with reinforced insulation class of overseas safety standards.
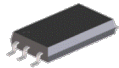
3 Operating temperature is expanded to 125 °C

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

10 % reduction in conduction loss

V_{CC}
V_O Existing — Rail to Rail
(Vg)
Vg
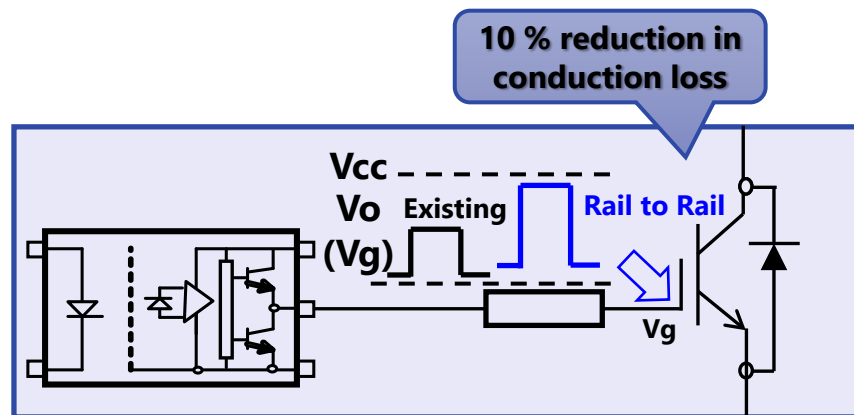
Note: Comparison with the case of using Toshiba's TLP5701/5702.

Line up

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

◆Return to Block Diagram TOP

IGBT gate driver coupler
TLP5231 (Smart Gate Driver Coupler)

Value provided

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

| 1 Protective Functions	2 Rail-to-rail output	3 Operating temperature is expanded to 110 °C
TLP5231 delivers various built-in functions [note], including an overcurrent detection by monitoring collector voltage. [note] Gate signal soft turn off, fault feedback function	TLP5231 generates a full-swing voltage output signal and contributes to low power consumption.	These photocouplers are designed to operate under severe ambient temperature conditions.

Recommended Application Circuit
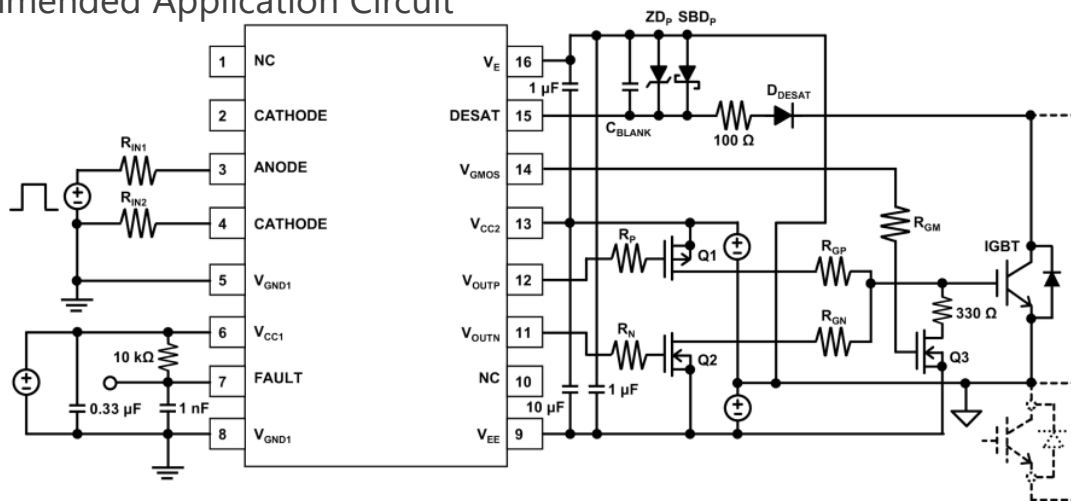
Line up

Part number	TLP5231
Package	SO16L
I_{OP} (Max) [A]	±2.5
t_{pHL} , t_{pLH} (Max) [ns]	300
BV_S [Vrms]	5000
T_{opr} [°C]	–40 to 110
$V_{CC2} - V_{EE}$ [V]	21.5 to 30
I_{FHL} (Max) [mA]	3.5

Value provided

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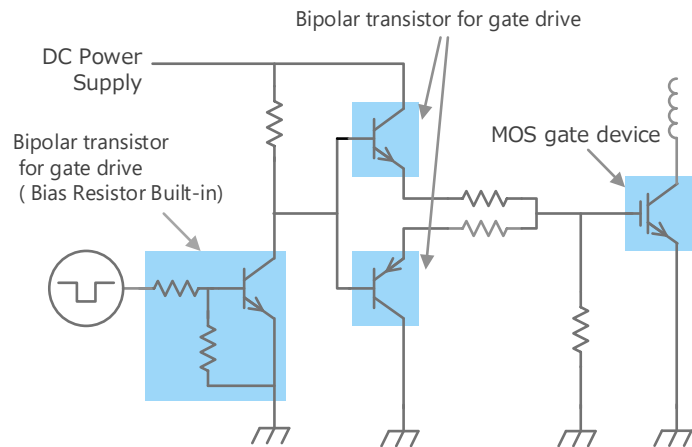
1 High speed switching operation

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 are 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.

Bipolar transistor for gate drive
DC Power Supply
Bipolar transistor for gate drive (Bias Resistor Built-in)
MOS gate device

Line up

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

◆Return to Block Diagram TOP

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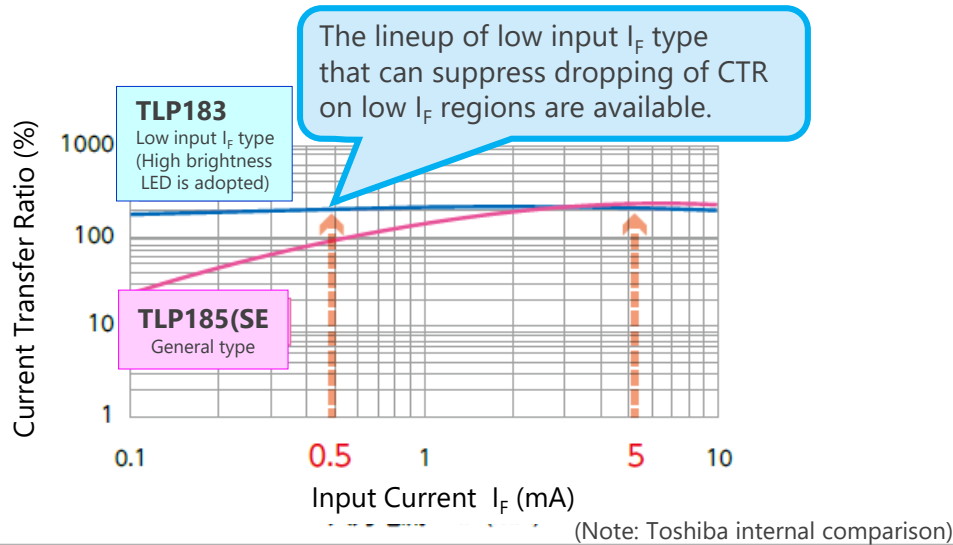
Value provided

High CTR (Current Transfer Ratio) is realized even in low input current range (I_F = 0.5 mA).

1 High current transfer ratio

Phototransistor and infrared light emitting diode are optically coupled. TLP183 is highly isolated photocoupler that is realized higher CTR than Toshiba's conventional product (TLP185(SE) in low input current range (@ I_F = 0.5 mA).

2 Wide operating temperature range

It is designed to operate even under severe ambient temperature conditions, such as inverter equipment, robots, machine tools and high-output power supplies.

> The lineup of low input I_F type that can suppress dropping of CTR on low I_F regions are available.

TLP183
Low input I_F type
(High brightness LED is adopted)

TLP185(SE
General type

Current Transfer Ratio (%)

Input Current I_F (mA)

(Note: Toshiba internal comparison)

Line up

Part number	TLP183	TLP185(SE
Package	4pin SO6	4pin SO6
BV_S (Min) [Vrms]	3750	3750
T_{opr} [°C]	-55 to 125	-55 to 110

◆Return to Block Diagram TOP

Value provided

U-MOS series MOSFET contributes to energy saving and miniaturization by improving the trade-off characteristics between on-resistance and capacitance.

1 Low on-resistance

By keeping the drain-source on-resistance low, heat generation and power consumption can be reduced and contributes to miniaturization.
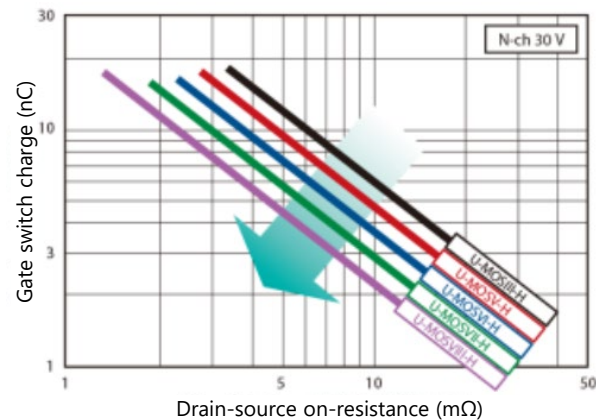
2 Small gate input charge

Reducing gate input charge needed for driving MOSFET improves switching characteristic.

3 Fast switching speed

Reducing switching loss by high speed operation contributes to higher efficiency.

Trade-off characteristics of on-resistance and gate input charge

(Note: Toshiba internal comparison)

Line up

Part number	SSM3K56MFV	SSM6N56FE
Package	VESM	ES6
V_{DSS} (Max) [V]	20	20
I_D (Max) [A]	0.8	0.8
$R_{DS(ON)}$ [Ω] @V_{GS} = 10 V Typ.	0.186	0.360
$R_{DS(ON)}$ [Ω] @V_{GS} = 10 V Max	0.235	0.840
Polarity	N-ch	N-ch × 2

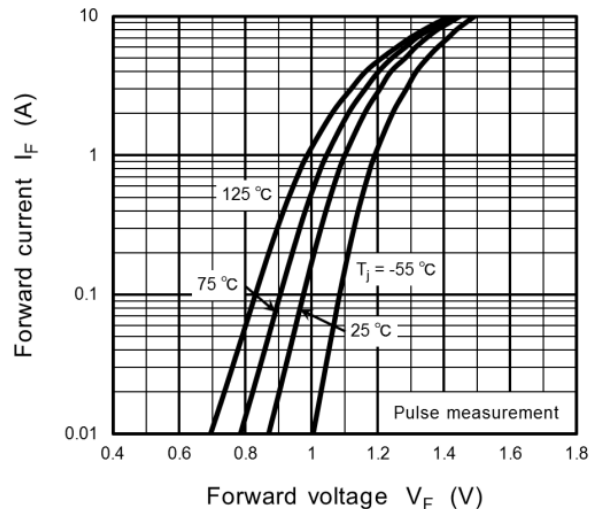Value provided

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

1	**Surface mount / compact package**

Surface mounting: Adopting M-FLAT™ package which is lower in height compared to the conventional lead type contributes to the space saving of the equipment.

2	**Wide product line-up**

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

·CMG06A
  forward characteristic

Line up

Part number	CMG06A
Package	M-FLAT
$I_{F(AV)}$ (Max) [A]	1
V_{RRM} (Max) [V]	600

◆Return to Block Diagram TOP

High breakdown voltage **High efficiency · Low loss** **Small size packages**

Value provided

This photocoupler consists of a non zero crossing photo triac, optically coupled to a infrared light emitting diode.

1 Non zero cross type

This photocoupler is suitable for the case where the operation time is short and phase control is necessary.
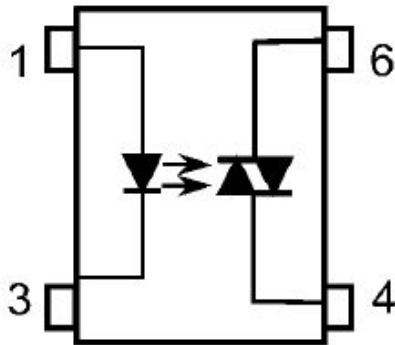
2 Switching characteristic

It has excellent features such as high speed, low noise and silence.

3 Miniaturization of mounting area

4pin SO6 packages have a size of about 3.7 × 7.0 × 2.1 mm.

TLP267J
Internal connection

UL-approved : UL1577, File No. E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN60065 or EN60950-1 (Note)
　(Note) When a VDE approved type is needed, please designate the Option (V4).

Line up

Part number	TLP267J	TLP3052A
Package	SO6	5pin DIP6
V_{DRM} (Max) [V]	600	600
BV_S (Min) [Vrms]	3750	5000
T_{opr} [°C]	-40 to 100	-40 to 100
Feature	Non-zero-voltage turn-on	

Value provided

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

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

TMPM383FSUG 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**

TMPM383FSUG 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**

TMPM383FSUG supports low power consumption library and stand by function. These contribute to reduce low power consumption. The package is small LQFP64.

TMPM383FSUG
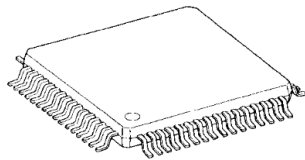
LQFP64

Line up

Part number	TMPM383FSUG
Maximum operation frequency	40 MHz
Instruction ROM	64 KB
RAM	8 KB
Thumb-2 Instruction set	Available
Timer	16bit x 8ch
I^{2}C	1ch
ADC	10ch (12bit)

◆Return to Block Diagram TOP

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