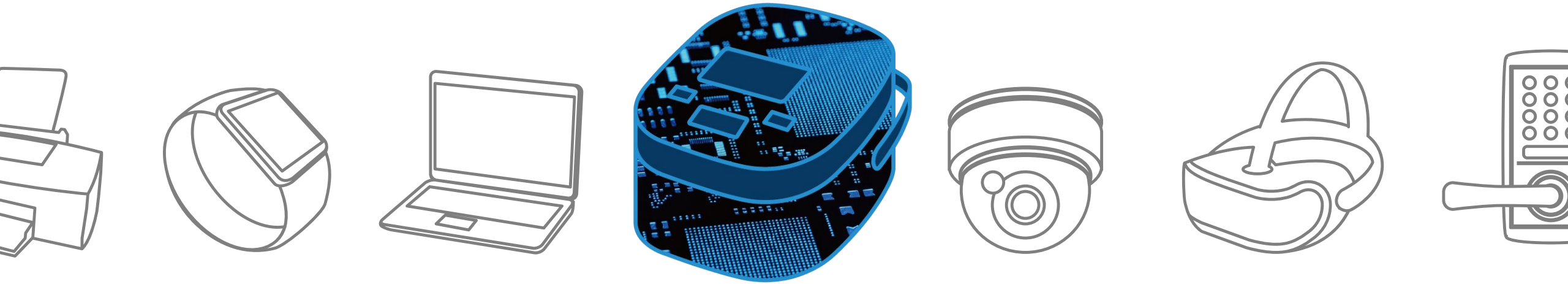
TOSHIBA

R24

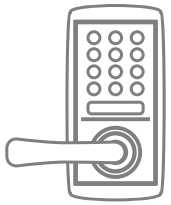
IH Rice Cooker

Solution Proposal by Toshiba



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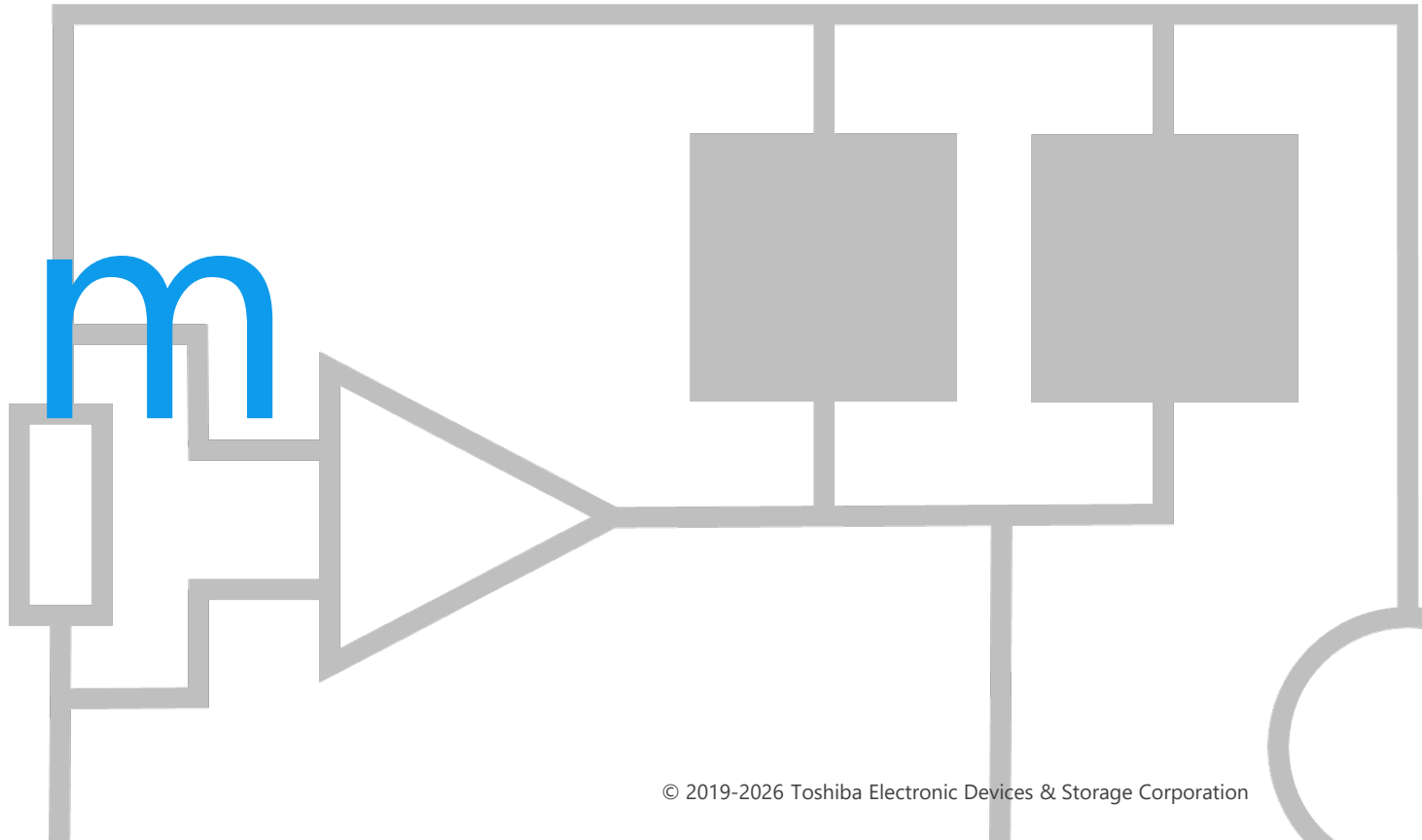
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.





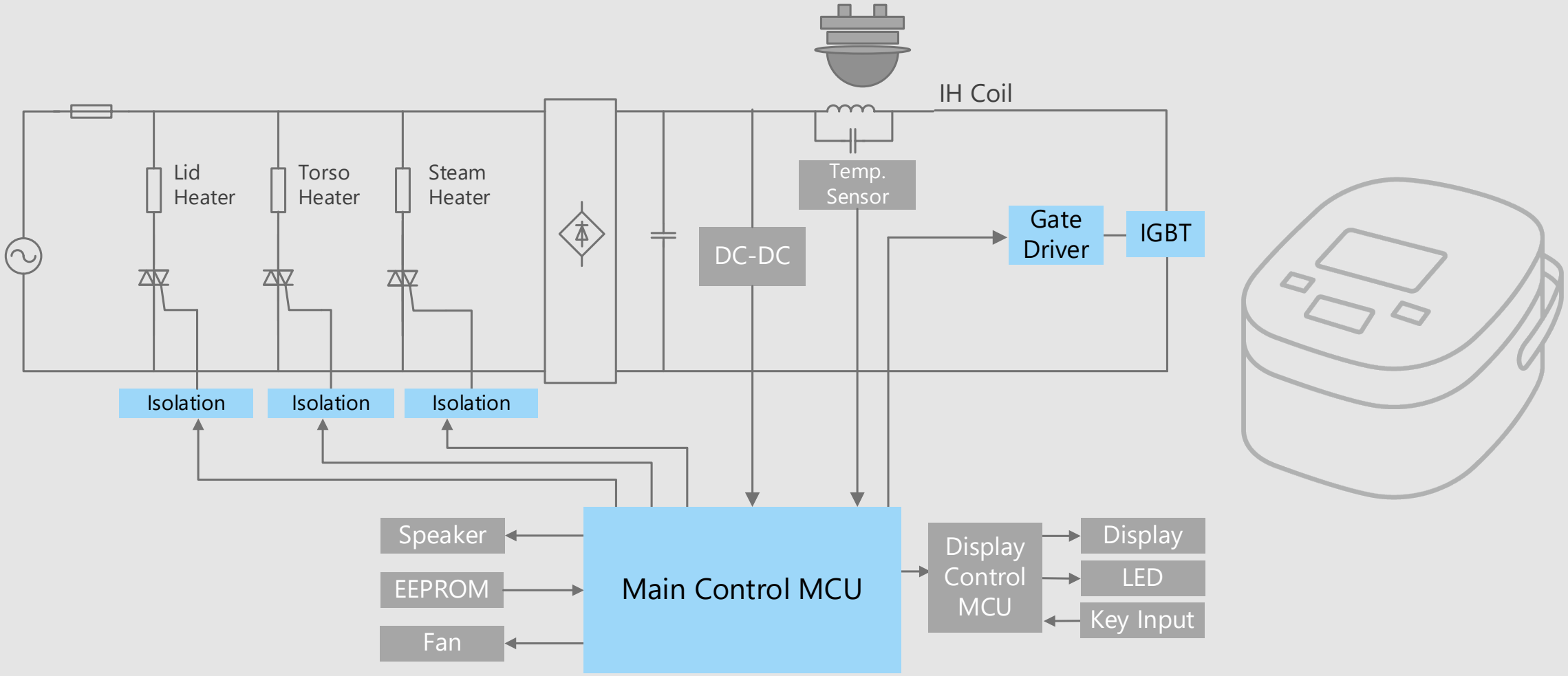
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Block Diagram



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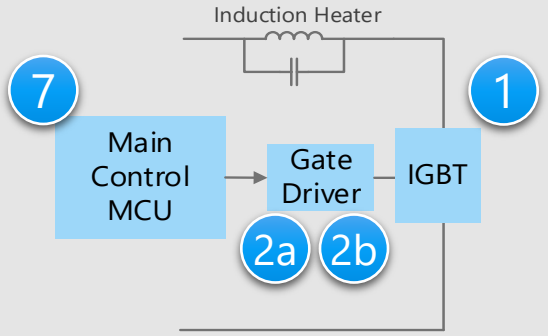
IH Rice Cooker　Overall block diagram



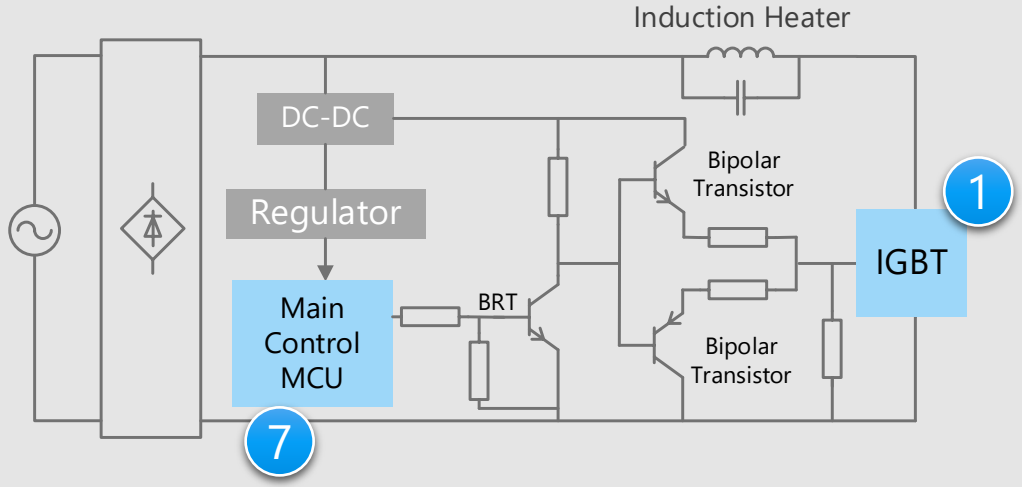
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IH Rice Cooker　Detail of IH coil drive unit

IH coil drive circuit (using gate driver coupler)



IH coil drive circuit (using discrete components)



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

Criteria for device selection

- High speed switching and low saturation voltage characteristics are required for IGBT.
- Rail-to-Rail output, low voltage driving and low current consumption are required for gate driver to realize low power consumption of the set.
- System control requires an MCU for sensor monitoring, high speed data processing and various heaters.

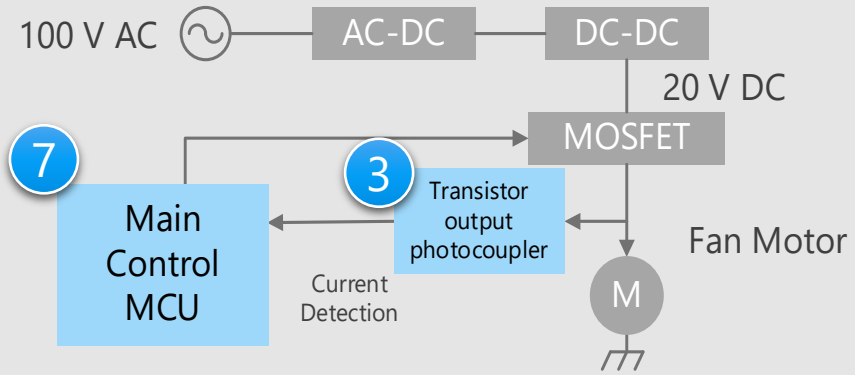
Proposals from Toshiba

- **High speed and high efficiency switching are realized**
  Discrete IGBT 1
- **High efficiency due to rail-to-rail characteristics is realized**
  IGBT gate driver coupler 2a 2b
- **High efficient processing of multiple input and output data**
  Main control MCU TLCS™-870/C1 Series 7

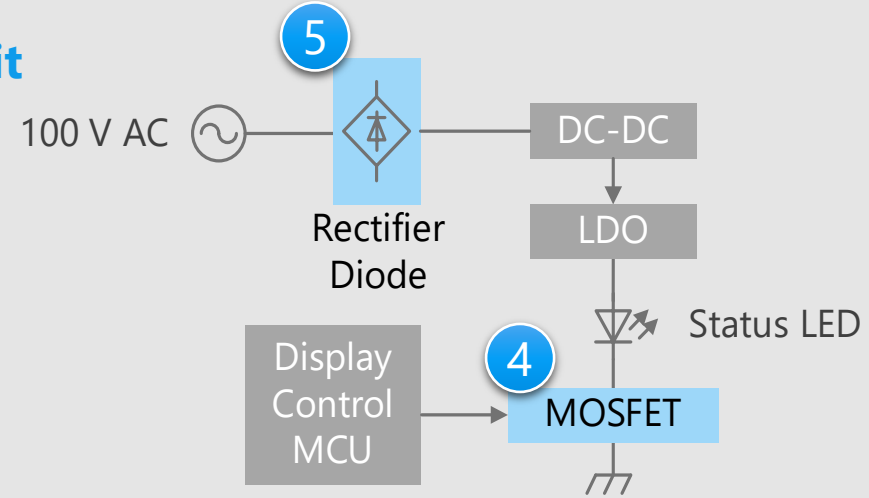
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IH Rice Cooker　Detail of fan motor drive / LED drive unit

Fan motor driving circuit



LED driving circuit



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

Criteria for device selection

- MOSFET with low on-resistance characteristic contributes to low loss of the set.
- Small package products contribute to the reduction of circuit board area.
- System control requires an MCU for sensor monitoring, high speed data processing and various heaters.

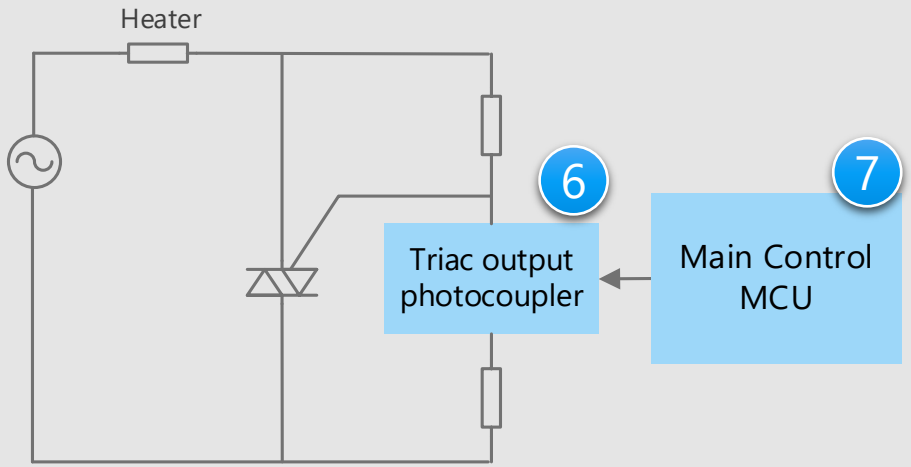
Proposals from Toshiba

- **High current transfer ratio and high temperature operation are realized**
  Transistor output photocoupler　3
- **Low on-resistance realizes a set with low power consumption**
  U-MOS Series MOSFET　4
- **Small surface mount package suitable for high density mounting**
  Rectifier diode　5
- **High efficient processing of multiple input and output data**
  Main control MCU TLCS™-870/C1 Series　7

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IH Rice Cooker　Detail of heater control unit

Heater control circuit



Criteria for device selection

- A triac output photocoupler is suitable for control AC load.
- System control requires an MCU for sensor monitoring, high speed data processing and various heaters.

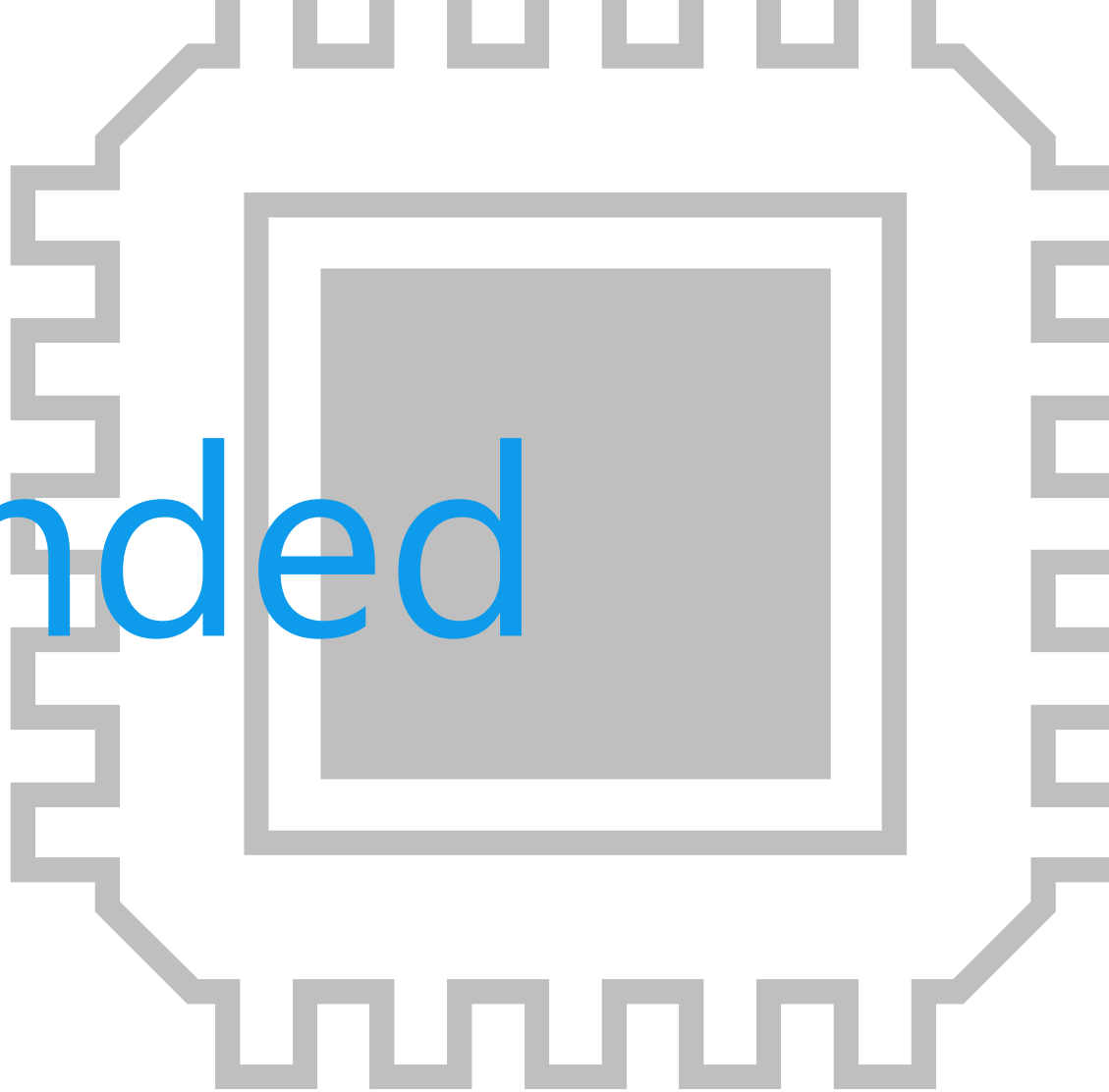
Proposals from Toshiba

- **Efficient control of AC load is realized**
  Triac output photocoupler 6
- **High efficient processing of multiple input and output data**
  Main control MCU TLCS™-870/C1 Series 7

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

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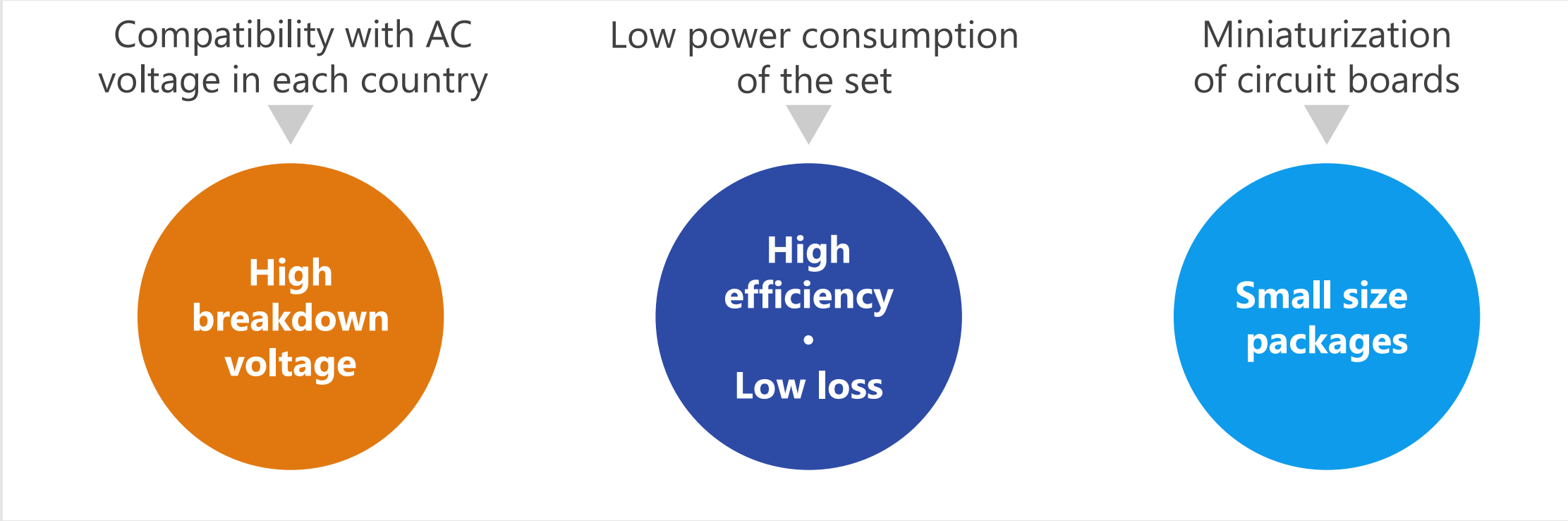
Recommended Devices



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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 the set”** and **“Miniaturization of circuit boards”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



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Device solutions to address customer needs

	High breakdown voltage	High efficiency • Low loss	Small size packages
1 Discrete IGBT	●	●	
2 IGBT gate driver coupler	●	●	●
3 Transistor output photocoupler		●	●
4 U-MOS Series MOSFET		●	●
5 Rectifier diode	●	●	●
6 Triac output photocoupler	●	●	●
7 Main control MCU TLCS™-870/C1 Series		●	●

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1 Discrete IGBT

GT30J110SRA / GT20N135SRA / GT30N135SRA

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

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 efficiency.

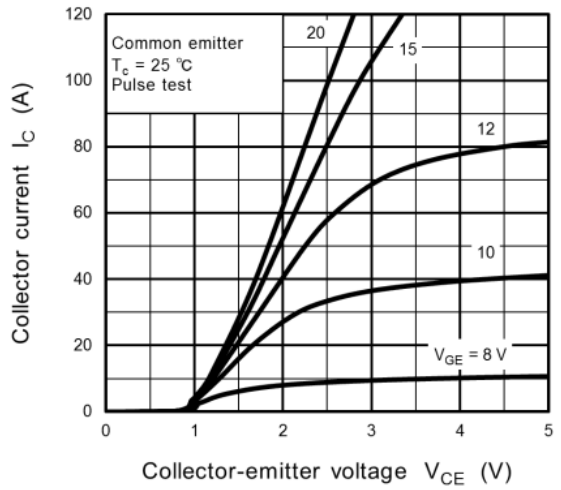
2 Low saturation voltage

Saturation voltage is kept low while realizing high speed switching.

3 Enhancement type

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

GT30J110SRA
Characteristics Curves



Lineup

Part number	GT30J110SRA	GT20N135SRA	GT30N135SRA
Package	TO-3P(N) 	TO-247  Top view  Bottom view	
V_{CES} [V]	1100	1350	1350
t_f (Typ.) [µs]	0.17 @I_C = 60 A	0.25 @I_C = 40 A	0.25 @I_C = 60 A
$V_{CE(sat)}$ (Typ.) [V]	2.15 @I_C = 60 A	2.0 @I_C = 40 A	2.15 @I_C = 60 A

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2a IGBT gate driver coupler

TLP5771H / TLP5772H / TLP5774H / TLP5751H / TLP5752H / TLP5754H

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

Value provided

Rail to Rail output contributes to stable operation of the system and reducing conduction losses.

1 Rail to Rail output

These driver couplers generate a full swing voltage output signal and contribute to low power consumption.

2 Small size package

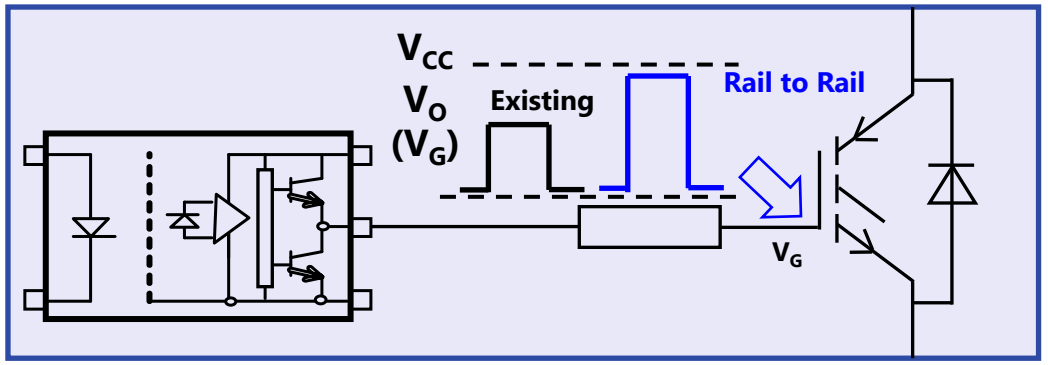
These driver couplers are 50 % smaller than the DIP8 package [Note1] and meet the reinforced insulation class requirements of international safety standards.

[Note1] Comparison with Toshiba products

3 Operational ambient temperature range 125 °C

These driver couplers are designed to operate under severe ambient temperature conditions.

Rail to Rail output



Lineup

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					
BV_S [Vrms]	5000					
T_{opr} [°C]	-40 to 125					
V_{CC} [V]	10 to 30			15 to 30		
I_{FLH} (Max) [mA]	2			4		

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2b IGBT gate driver coupler

TLP5231 (Smart Gate Driver Coupler)

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

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 [Note], including an overcurrent detection by monitoring collector voltage.

[Note] Gate signal soft turn off, fault feedback function

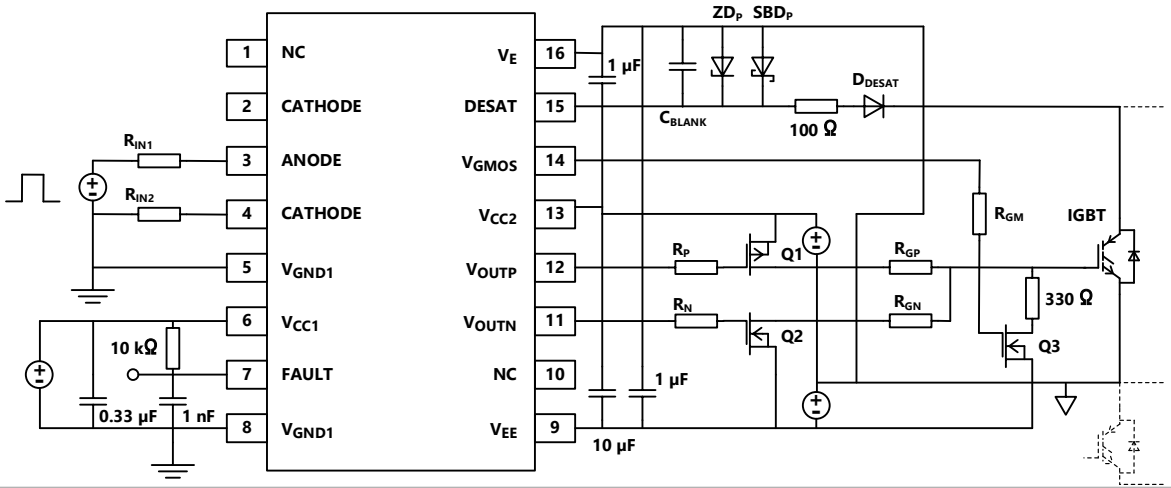
2 Rail to Rail output

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

3 Operational ambient temperature range 110 °C

TLP5231 is designed to operate under severe ambient temperature conditions.

Example Application Circuit



Lineup

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

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3 Transistor output photocoupler

TLP183 / TLP185(SE

High breakdown voltage

High efficiency · Low loss

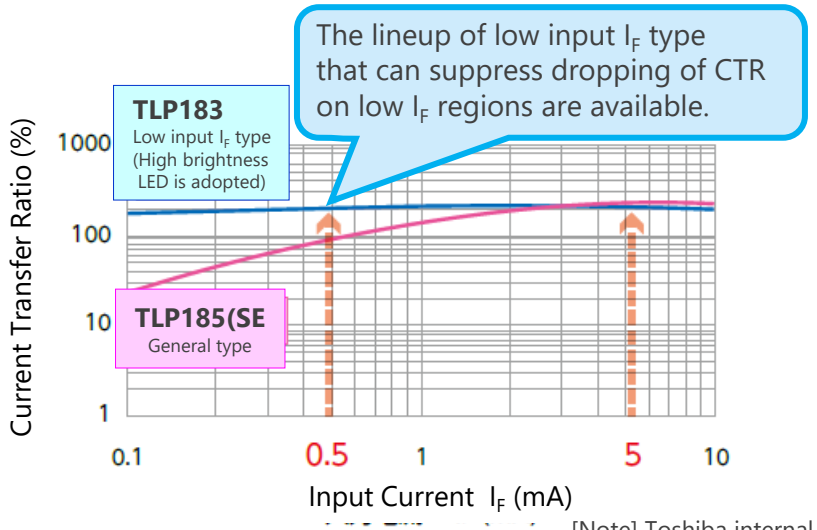
Small size packages

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

TLP183 is a high-isolation photocoupler that optically couples a phototransistor and high output infrared LED. Compared to TLP185(SE (Toshiba's existing product), high CTR (Current Transfer Ratio) in low input current range (@I_F = 0.5 mA) is realized.



[Note] Toshiba internal comparison

2 Wide operating temperature range

It is designed to operate even under severe ambient temperature conditions.

Lineup

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

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4 U-MOS Series MOSFET

SSM3K56MFV / SSM6N56FE

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

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

The drain-source on-resistance is low. Heat generation and power consumption can be reduced.

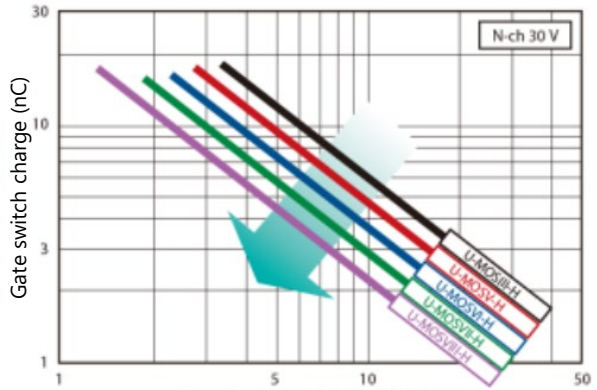
2 Small gate input charge

Switching characteristics are improved by reducing the amount of gate input charge.

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

Lineup

Part number		SSM3K56MFV	SSM6N56FE
Package		VESM 	ES6 
V_{DSS} [V]		20	
I_D [A]		0.8	
$R_{DS(ON)}$ [Ω] @V_{GS} = 4.5 V	Typ.	0.186	
	Max	0.235	
Polarity		N-ch	N-ch x 2

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5 Rectifier diode
CMG06A

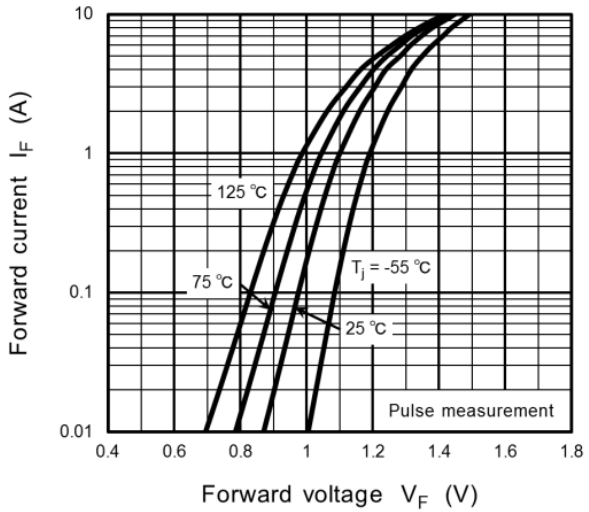
High breakdown voltage | High efficiency • Low loss | Small size packages

Value provided

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

1 Small surface mount package

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



CMG06A
forward characteristic

2 Wide product lineup

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

Lineup

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

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6 Triac output photocoupler

TLP267J / TLP3052A

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 an 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.

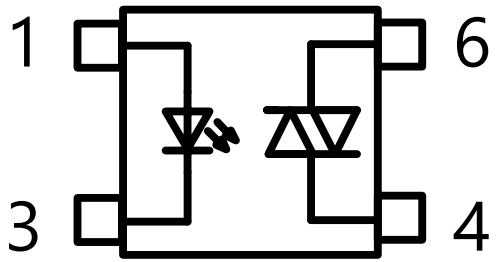
2 Switching characteristic

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

3 Miniaturization of mounting area

4pin SO6 packages have a size of 3.7 x 7.0 x 2.1 mm. (TLP267J)

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, EN62368-1 [Note]

[Note] When a VDE approved type is needed, please designate the Option (V4).

Lineup

Part number	TLP267J	TLP3052A
Package	4pin SO6 	5pin DIP6 
V_{DRM} [V]	600	
BV_S [Vrms]	3750	5000
T_{opr} [°C]	-40 to 100	
Type	Non zero crossing	

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7 Main control MCU

TLCS™-870/C1 Series TMP89FW24ADFG / TMP89FW24AFG / TMP89FW20AUG

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

Value provided

8-bit microcontroller with wide range voltage operation [Note 1] is equipped with a large capacity 124 KB flash memory and LCD driver.

1 TLCS™-870/C1 CPU

Toshiba original 8-bit CPU core and 16-bit general purpose registers can be used to execute 16-bit arithmetic and transfer instructions. Due to the configuration of another address space to code and data, the maximum address space of 124 KB is realized.

2 Low voltage / Low power consumption operation / Small size package

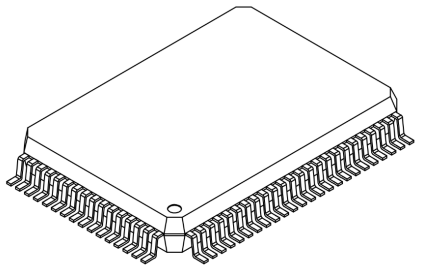
Operating with backup battery is available because minimum operating voltage is 1.8 V. Power consumption can be reduced by executing the program on shadow RAM. The packages variations are QFP80, small LQFP80 and LQFP64.

3 PPG [Note 2] output for IGBT control / System cost reduction

The built-in 10-bit timer suitable for IGBT control, can be controlled quasi-class-E and half-bridge inverter (with emergency-stop function). The built-in LCD driver and control circuit enable direct drive of the liquid crystal display.

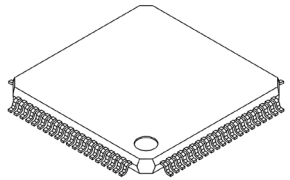
[Note 2] PPG (Programmable Phase Generator)

TMP89FW24ADFG



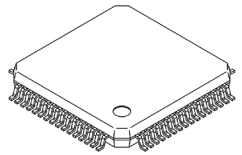
QFP80-P-1420-0.80M

TMP89FW24AFG



LQFP80-P-1212-0.50F

TMP89FW20AUG



LQFP64-P-1010-0.50E

Lineup

Part number	TMP89FW24ADFG / AFG	TMP89FW20AUG
Max operating frequency [Note 1]	16 MHz @V_{DD} = 2.7 to 5.5 V / 8 MHz @V_{DD} = 1.8 to 2.7 V	
ROM (Flash memory)	Code area: 64 KB / Data area: 60 KB	
RAM	3 KB + Shadow RAM 3 KB	
IO port	68	52
Timer/Counter	16bit x 2ch, 10bit x 1ch, 8bit x 4ch	
Serial port	UART: 3ch, SIO: 1ch, I^2C/SIO: 1ch	
AD converter	8ch (10bit)	
LCD driver	40 seg. x 4 com.	32 seg. x 4 com.
Package	QFP80-P-1420-0.80M / LQFP80-P-1212-0.50F	LQFP64-P-1010-0.50E

[Note 1] Flash memory is read only when V_{DD} = 1.8 to 2.7 V.

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