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
IH Cooking Heater  Overall block diagram

200 V AC → AC-DC → DC-DC → +24 V / 0.5 A (Fan, Gate Driver)

Regulator → +5 V / 1.0 A (MCU, Amp, Display, LED, etc)

200 V AC → IH Coil

Gate Driver → IGBT

Current Sensor → Temp. Sensor

Control Buttons → MCU

MCU → Fan

LED Driver → 7seg LED

MOSFET → Status LEDs

Buzzer
IH Cooking Heater  Detail of IH coil drive / fan motor drive

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 heater control are needed for efficient system control.

Proposals from Toshiba
- Higher efficiency is realized
  IGBT gate driver coupler (Rail-to-Rail output type)
- Fast and high efficiency switching are realized
  Silicon N-channel discrete IGBT
- High current transfer ratio and high temperature operation makes easy to design
  Transistor output photocoupler
- Low on-resistance realizes a set with low power consumption
  U-MOS series MOSFET (Trench type)
- High efficient processing of a few input and output data
  MCU

IH coil drive circuit
Current resonance circuit

Brush motor drive circuit
Brush motor

※ Click the number in the circuit diagram to jump to the detailed description page
IH Cooking Heater  
Detail of LED drive / current detector

**LED drive circuit**

200 V AC → Rectifier Diode → DC-DC → LDO → Status LED → MOSFET → MCU

**Current detector**

MCU → Gate Driver → Gate Driver → Discrete IGBT → IH Coil → Op-amp

**Criteria for device selection**

- Low on-resistance characteristic contributes to low loss of the set.
- Error detection of equipment is enabled by monitoring the current of the system power supply. The use of an operational amplifier which have low voltage operation, low current consumption and low offset voltage leads to high precision monitoring and low power consumption.
- Use of small package enables to reduce the circuit board area.
- Monitoring sensor, high speed data processing and heater control are needed for efficient system control.

**Proposals from Toshiba**

- **Low on-resistance characteristic contributes to low loss of the set.**
  U-MOS series MOSFET (Trench type)
- **Small surface mount package suitable for high density mounting**
  Rectifier diode
- **Isolated transmission of the current detection signal**
  Isolation amplifier
- **High efficient processing of a few input and output data**
  MCU

※ Click the number in the circuit diagram to jump to the detailed description page
IH Cooking Heater  Detail of display and operation section

Display and operation section

- Control Buttons
- MCU
- LED Driver
- 7seg LED
- MOSFET
- Status LEDs
- Buzzer

Criteria for device selection
- Low on-resistance characteristic contributes to low loss of the set.
- Typically the display uses 3-4 digits 7 segment LEDs.
- Monitoring sensor, high speed data processing and heater control are needed for efficient system control.

Proposals from Toshiba
- Low on-resistance characteristic contributes to low loss of the set. U-MOS series MOSFET (Trench type)
- Only one external register sets LED drive current. It can reduce BOM cost. 7 segment LED driver
- High efficient processing of a few input and output data

※ 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 Cooking Heater, “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.
## Device Solutions to address customer needs

<table>
<thead>
<tr>
<th></th>
<th>High breakdown voltage</th>
<th>High efficiency - Low loss</th>
<th>Compatible with compact packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IGBT gate driver coupler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Silicon N-channel discrete IGBT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Transistor output photocoupler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>U-MOS series MOSFET (Trench type)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rectifier diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Isolation amplifier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7 segment LED driver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>MCU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**IGBT gate driver coupler**

**TLP577X / TLP575X**

**Value provided**

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

**1 Rail-to-rail output**

TLP577X and TLP575X generates 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 High temperature of 110 °C (ambient) operation**

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

---

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP577X series</th>
<th>TLP575X series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SO6L</td>
<td></td>
</tr>
<tr>
<td>$I_{op}$ (Max) [A]</td>
<td>±1 / ±2.5 / ±4</td>
<td></td>
</tr>
<tr>
<td>$t_{PHL}$, $t_{PLH}$ (Max) [ns]</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>$B_{V_{rms}}$</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>$T_{opr}$ [°C]</td>
<td>-40 to 110</td>
<td></td>
</tr>
<tr>
<td>$V_{cc}$ [V]</td>
<td>10 to 30</td>
<td>15 to 30</td>
</tr>
<tr>
<td>$I_{FLH}$ (Max) [mA]</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

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Silicon N-channel discrete IGBT
GT50JR21 / GT50JR22

Value provided

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

1. High speed switching
Reduction 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. Line up
For more suitable design, Low saturation voltage type (GT50JR21) and fast switching type (GT50JR22) are selectable.

### Line up

<table>
<thead>
<tr>
<th>Part Number</th>
<th>GT50JR21</th>
<th>GT50JR22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>TO-3P(N)</td>
<td></td>
</tr>
<tr>
<td>$t_f$ (Typ.) [μs] @I_C = 50 A, T_a = 25 °C</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>$V_{CE(sat)}$ (Typ.) [V] @I_C = 50 A, T_a = 25 °C</td>
<td>1.45</td>
<td>1.55</td>
</tr>
</tbody>
</table>

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

1. High current transfer ratio ($I_F = 0.5$ mA in low input current range)

Phototransistor and GaAs/InGaAs infrared light emitting diode are optically coupled. Highly insulated photocouplers realize higher conversion efficiency than conventional electromagnetic relays or insulated transformers.

2. High temperature of 125 °C operation

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

### Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP183</th>
<th>TLP185(SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>4pin SO6</td>
<td>4pin SO6</td>
</tr>
<tr>
<td>$BV_S$ (Min) [Vrms]</td>
<td>3750</td>
<td>3750</td>
</tr>
<tr>
<td>$T_{opr}$ (°C)</td>
<td>-55 to 125</td>
<td>-55 to 110</td>
</tr>
</tbody>
</table>

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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

- **Gate switch charge** $Q_{SW}$ [nC]
- **Drain-Source on-resistance** $R_{DS(ON)}$ [mΩ]

---

### Line up

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

---

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

Surface mount / compact package

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

• CRG05 forward characteristic

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.

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>CRG05</th>
<th>CMG08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>S-FLAT</td>
<td>M-FLAT</td>
</tr>
<tr>
<td>(I_{FW} (\text{Max}) [\text{A}])</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(V_{RMS} (\text{Max}) [\text{V}])</td>
<td>800</td>
<td>600</td>
</tr>
</tbody>
</table>

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Isolation amplifier with low current consumption and compact package enables highly accurate current detection.

1. Low current consumption
Introduction of new digital modulation technology has reduced current consumption due to input voltage dependence.

2. Small package
Compact SO8L package contributes reducing mounting area.

3. High accuracy
This optical coupling type isolation amplifier uses ΔΣ A/D convertor with a high precision on the input side and D/A convertor with a high precision on the output side.

Current consumption characteristics

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP7820</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SO8L(LF4)</td>
</tr>
<tr>
<td>Gain accuracy [%]</td>
<td>±0.5 / ±1.0 / ±3.0 (rank selection)</td>
</tr>
<tr>
<td></td>
<td>0.00012</td>
</tr>
<tr>
<td>NL300 (Typ.) [%]</td>
<td>0.02</td>
</tr>
<tr>
<td>V0 (Typ.) [mV]</td>
<td>0.9</td>
</tr>
<tr>
<td>I0 (Typ.) [mA]</td>
<td>8.6</td>
</tr>
<tr>
<td>I0 (Typ.) [mA]</td>
<td>6.2</td>
</tr>
</tbody>
</table>

<Return to Block Diagram TOP>
LED driver which can light a 4-digit, 7-segment LED using one device

1. Suitable for 7-segment LED displays
   This driver can serially control a 4-digit 7-segment LED. Matrix drive is performed by scanning the digits at 480 Hz. The 3-wire control can also be cascaded, reducing the number of harnesses.

2. Current control possible with one external resistor
   The LED current can be set with an external resistor. No other components are needed.

3. Lead insertion type package
   We have a line-up of free-standing lead insertion packages (SDIP24) and small packages (QFN24) that can be used for the main board.

Line up

<table>
<thead>
<tr>
<th>Model</th>
<th>TB62785NG</th>
<th>TB62785FTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SDIP24</td>
<td>VQFN24</td>
</tr>
<tr>
<td>Outputs</td>
<td>4 columns x 7 outputs</td>
<td></td>
</tr>
<tr>
<td>Operating voltage</td>
<td>4 to 5.5 V</td>
<td></td>
</tr>
<tr>
<td>Internal power supply</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Max. LED power supply</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Max. output current</td>
<td>50 mA</td>
<td></td>
</tr>
<tr>
<td>Cascade connection</td>
<td>○ 16-step light control possible (total)</td>
<td></td>
</tr>
<tr>
<td>PWM control</td>
<td>○</td>
<td></td>
</tr>
</tbody>
</table>

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System control at low power consumption by using built-in 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 CPU system. The original NANO FLASH™ 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.

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TMPM383FSUG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operation frequency</td>
<td>40 MHz</td>
</tr>
<tr>
<td>Instruction ROM</td>
<td>64 KB</td>
</tr>
<tr>
<td>RAM</td>
<td>8 KB</td>
</tr>
<tr>
<td>Thumb-2 Instruction set</td>
<td>Available</td>
</tr>
<tr>
<td>Timer</td>
<td>16 bit x 8 ch</td>
</tr>
<tr>
<td>I2C</td>
<td>1 ch</td>
</tr>
<tr>
<td>ADC</td>
<td>10 ch (10 bit)</td>
</tr>
</tbody>
</table>

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