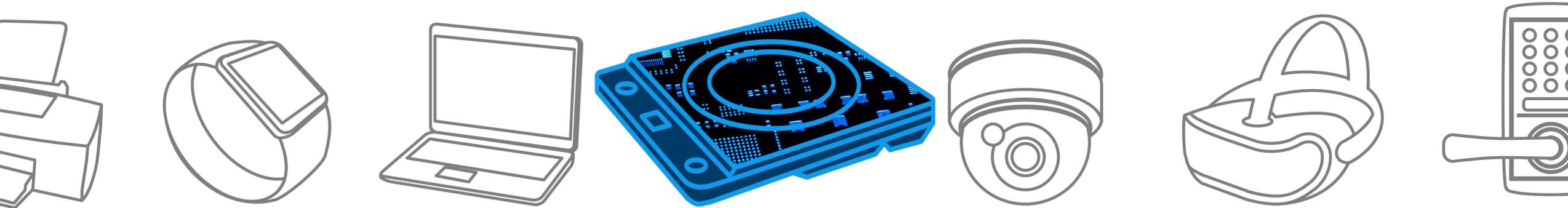
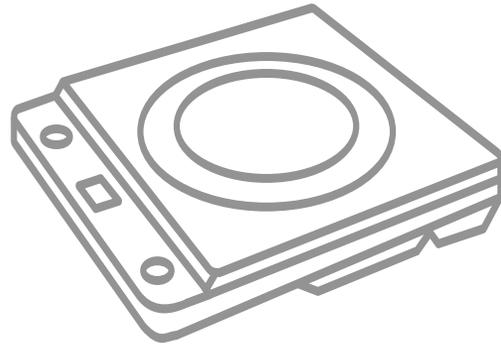


IH Cooking Heater

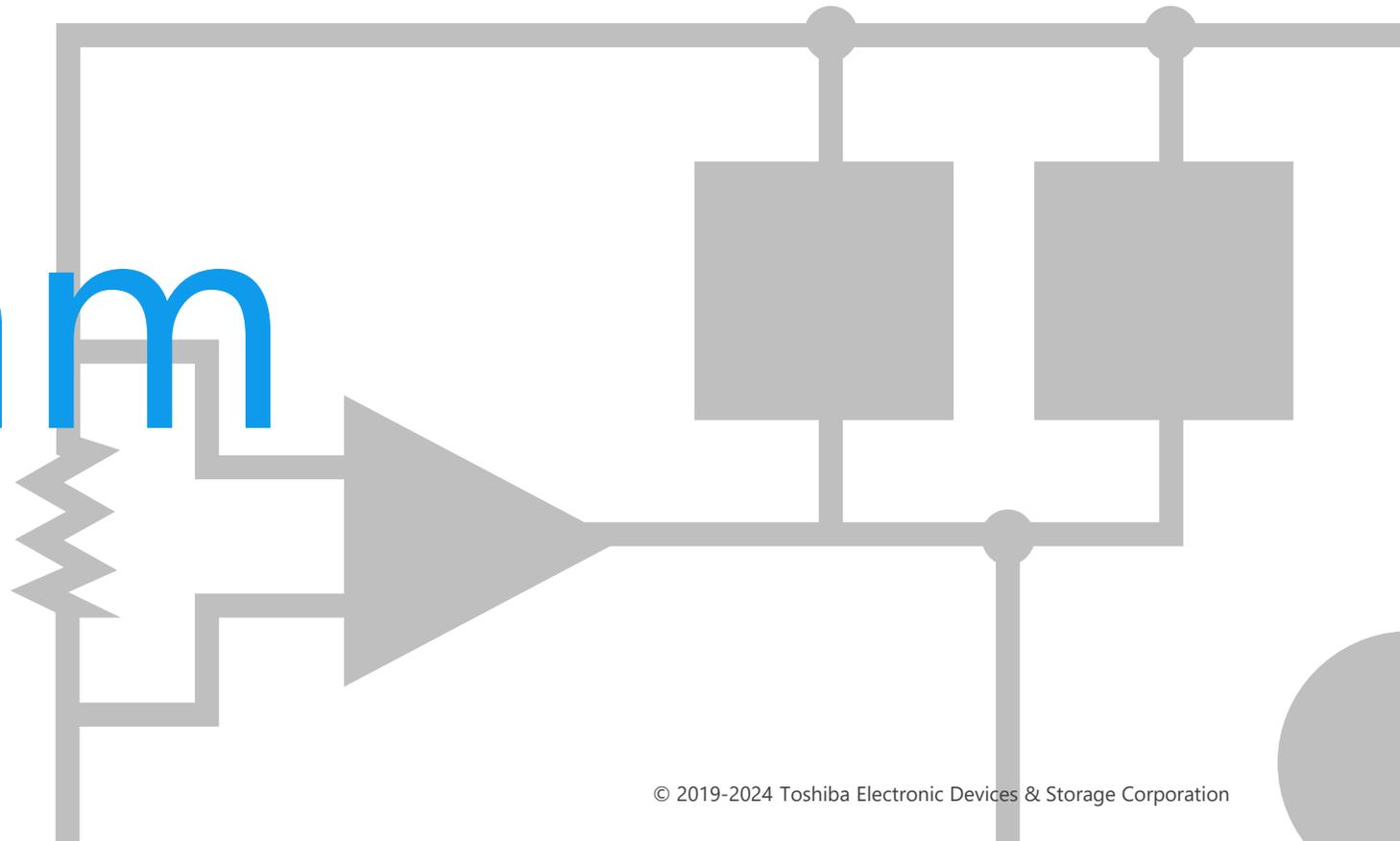
Solution Proposal by Toshiba



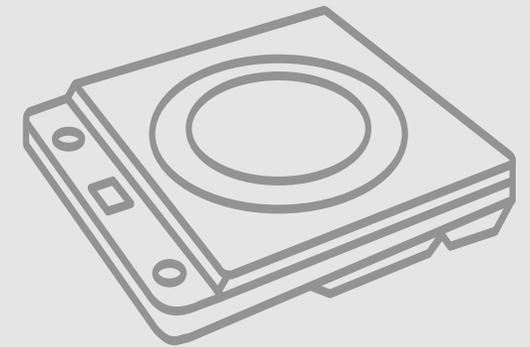
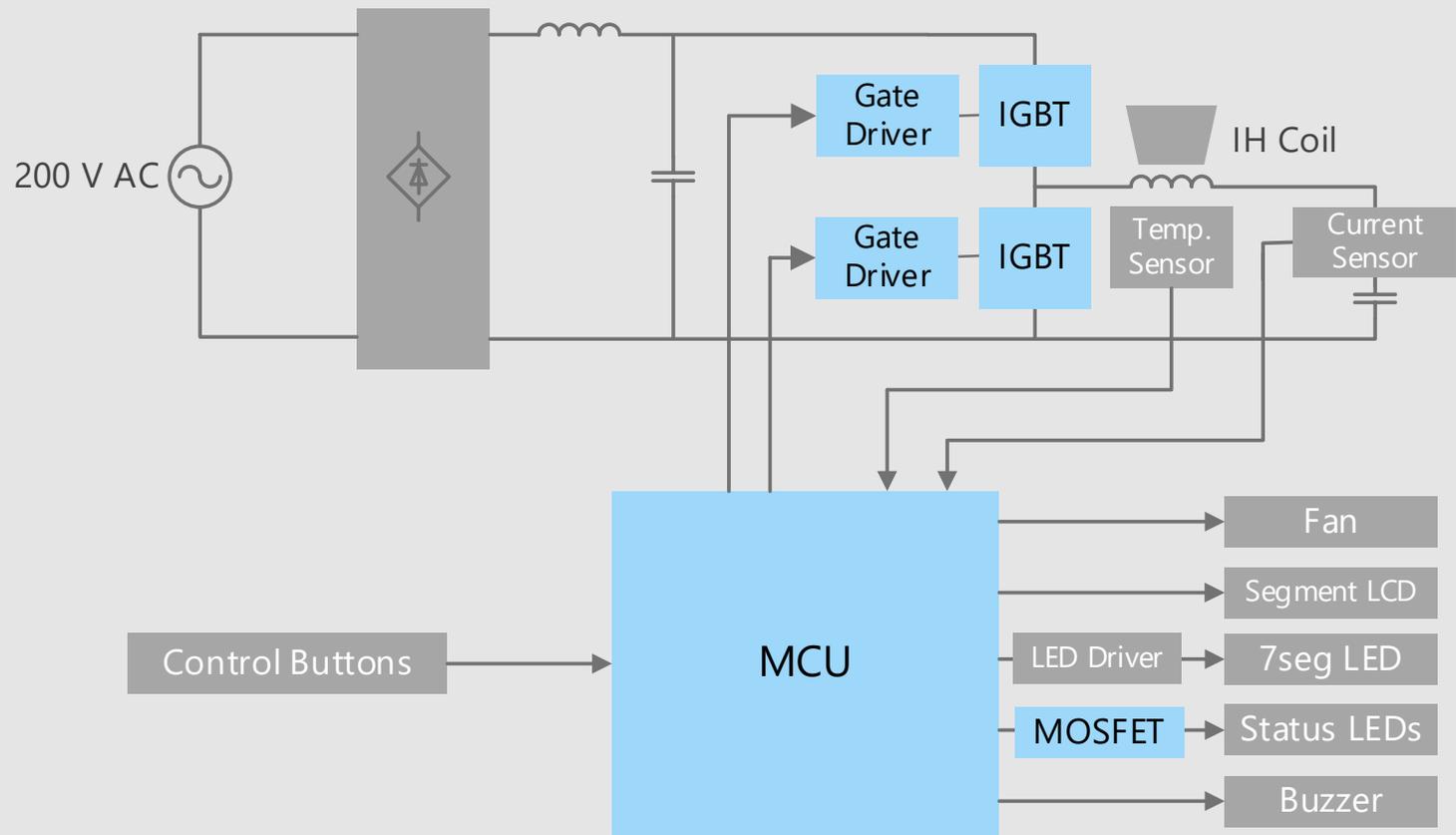


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram



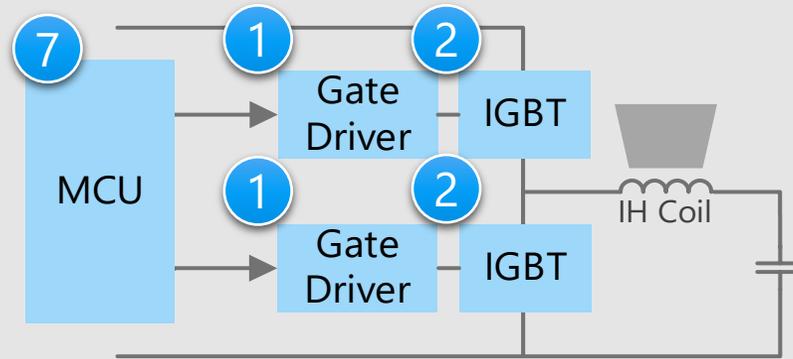
IH Cooking Heater Overall block diagram



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

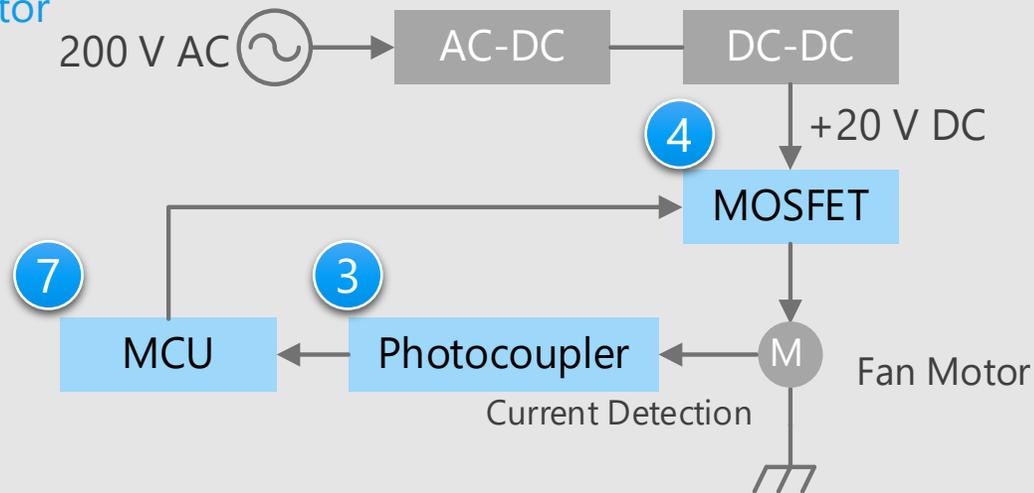
IH coil drive circuit

Current resonance circuit



Brushed DC motor drive circuit

Brushed DC motor



* 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.
- Small package products contribute to the reduction of 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.

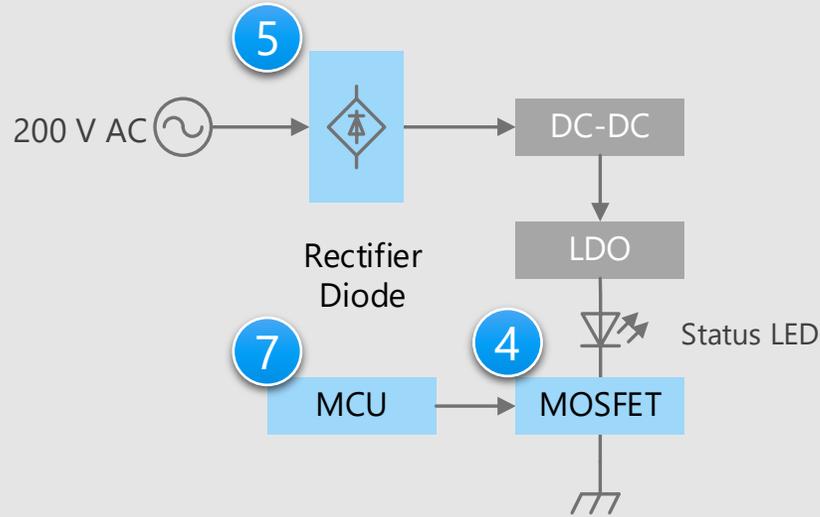
Proposals from Toshiba

- **High efficiency due to rail-to-rail characteristics is realized**
IGBT gate driver coupler
- **High speed and high efficiency switching are realized**
Silicon N-channel discrete IGBT
- **High current transfer ratio and high temperature operation are realized**
Transistor output photocoupler
- **Realize a set with low power consumption by low on-resistance**
U-MOS Series MOSFET
- **PWM control with multifunctional timer and A-PMD**

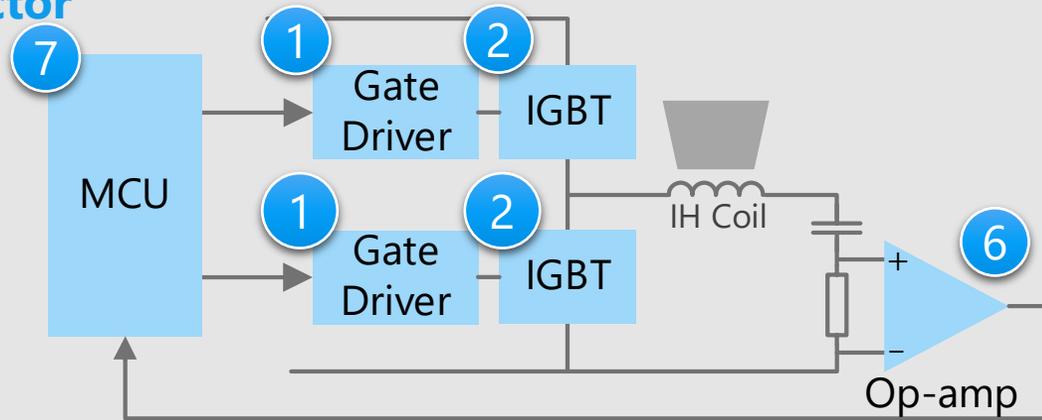
MCU M3H Group

IH Cooking Heater Detail of LED drive / current detector

LED drive circuit



Current detector



* 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.
- 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.
- Small package products contribute to the reduction of circuit board area.
- Monitoring sensor, high speed data processing and heater control are needed for efficient system control.

Proposals from Toshiba

- **High efficiency due to rail-to-rail characteristics is realized** 1
- IGBT gate driver coupler 1
- **High speed and high efficiency switching are realized** 2
- Silicon N-channel discrete IGBT 2
- **Realize a set with low power consumption by low on-resistance** 4
- U-MOS Series MOSFET 4
- **Small surface mount package suitable for high density mounting** 5
- Rectifier diode 5
- **Isolated transmission of the current detection signal** 6
- Isolation amplifier 6
- **AD converter that can generate interrupt requests with the monitoring function** 7

MCU M3H Group

Display and operation section



Criteria for device selection

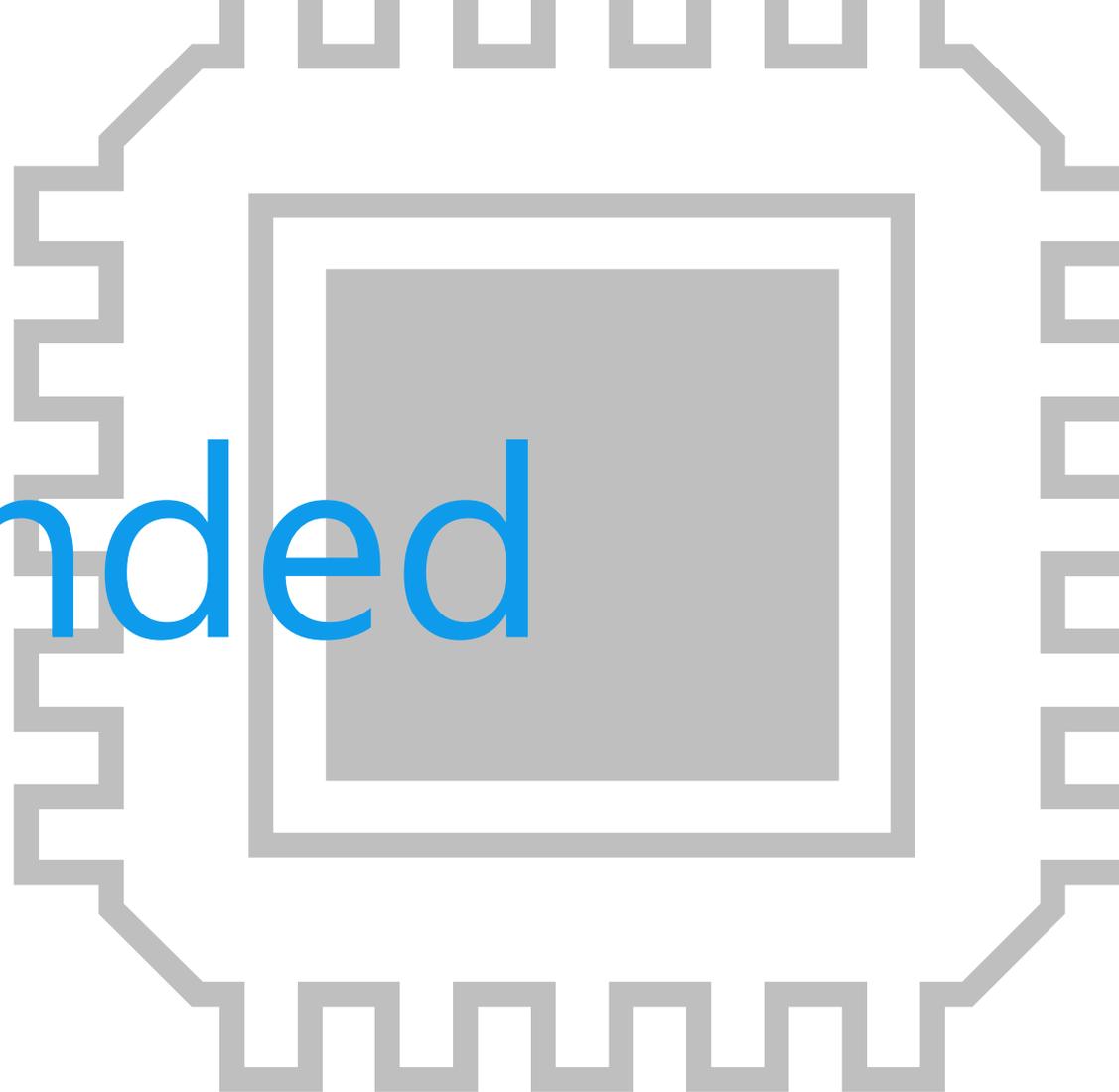
- Low on-resistance characteristic contributes to low loss of the set.
- The use of MCU with built-in external component functions reduces board BOM costs.

Proposals from Toshiba

- **Realize a set with low power consumption by low on-resistance**
U-MOS Series MOSFET 4
- **Built-in LCD display control circuit (DLCD) for non-bias driving system**
MCU M3H Group 7

* [Click the number in the circuit diagram to jump to the detailed description page](#)

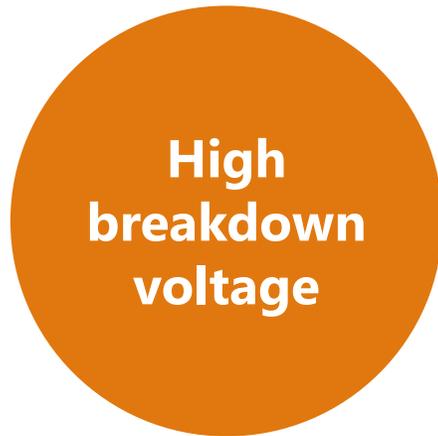
Recommended Devices



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.

Compatibility with AC voltage
in each country



Low power consumption
of set



Miniaturization
of circuit boards



Device Solutions to address customer needs

High
breakdown
voltage

High
efficiency
·
Low loss

Small size
packages

| | | | |
|-----------------------------------|---|---|---|
| ① IGBT gate driver coupler | ● | ● | ● |
| ② Silicon N-channel discrete IGBT | ● | ● | |
| ③ Transistor output photocoupler | | ● | ● |
| ④ U-MOS Series MOSFET | | ● | ● |
| ⑤ Rectifier diode | ● | ● | ● |
| ⑥ Isolation amplifier | | ● | ● |
| ⑦ MCU M3H Group | | ● | ● |

Value provided

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

1 Rail to Rail output

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

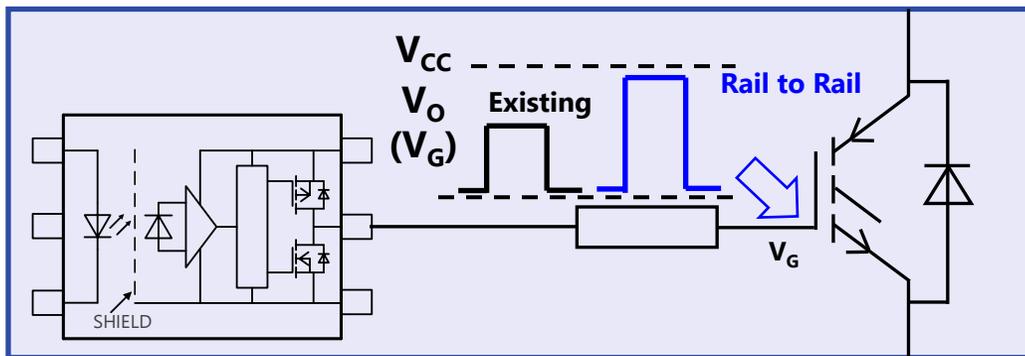
2 Small package

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

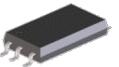
3 Operational ambient temperature range 125 °C

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

[Note] Comparison with Toshiba products



Lineup

| 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](#)



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

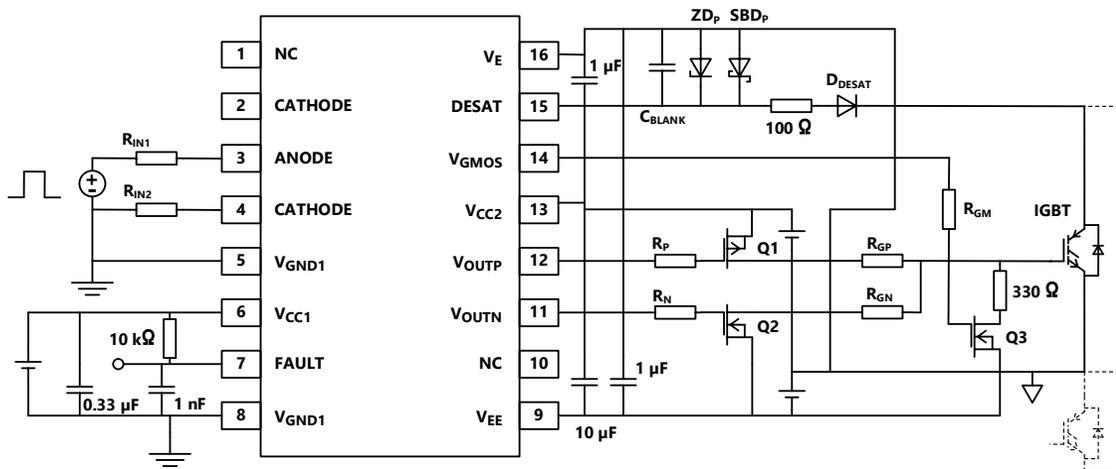
2 Rail to Rail output

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 |

[Return to Block Diagram TOP](#)

Value provided

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

1 High speed switching

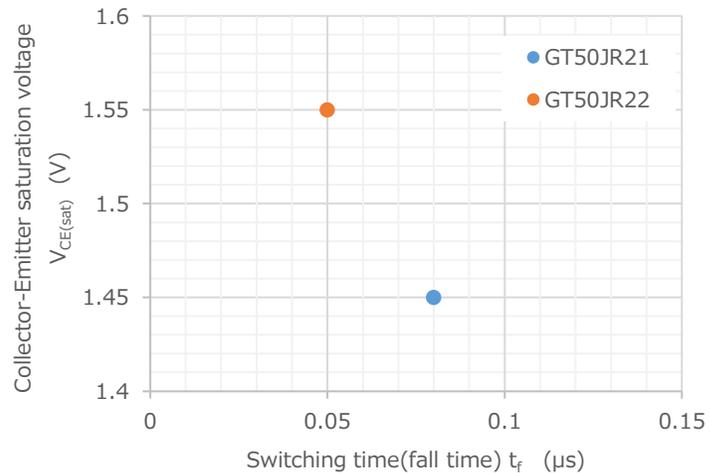
Reducing switching loss through high speed operation contributes to higher power supply efficiency.

2 Low saturation voltage

Saturation voltage is kept low while realizing high speed switching.

3 Lineup

For more suitable design, Low saturation voltage type (GT50JR21) and fast switching type (GT50JR22) are selectable.



(Note: Toshiba internal comparison)

Lineup

| Part Number | GT50JR21 | GT50JR22 |
|--|----------|--|
| Package | TO-3P(N) |  |
| t_f (Typ.) [μs] @ $I_C = 50 \text{ A}$, $T_a = 25 \text{ }^\circ\text{C}$ | 0.08 | 0.05 |
| $V_{CE(sat)}$ (Typ.) [V] @ $I_C = 50 \text{ A}$, $T_a = 25 \text{ }^\circ\text{C}$ | 1.45 | 1.55 |

[Return to Block Diagram TOP](#)

3 Transistor output photocoupler

TLP183 / TLP185(SE)

High breakdown voltage

High efficiency
Low loss

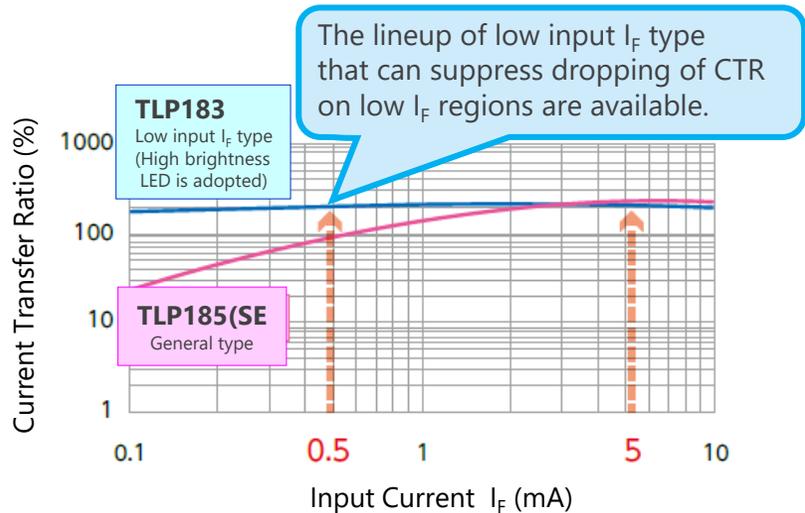
Small size packages

Value provided

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

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 conventional product), high CTR (Current Transfer Ratio) in low input current range (@ $I_F = 0.5 \text{ mA}$) 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  | 4pin SO6  |
| BV_S [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.

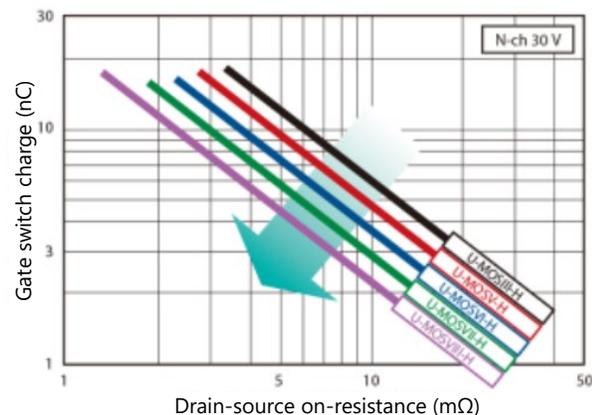
2 Small gate input charge

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

3 High speed switching

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 | 20 |
| I_D [A] | 0.8 | 0.8 |
| $R_{DS(ON)}$ [Ω] @ $V_{GS} = 4.5$ V | Typ. | 0.186 |
| | Max | 0.235 |
| Polarity | N-ch | N-ch x 2 |

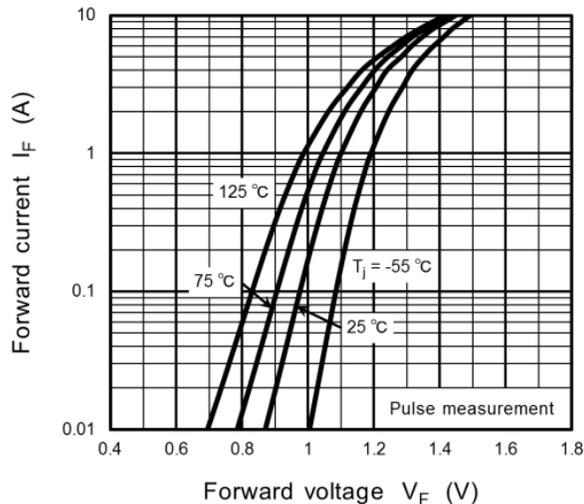
[Return to Block Diagram TOP](#)

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 conventional 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™  |
| $I_{F(AV)}$ [A] | 1 |
| V_{RRM} [V] | 600 |

[Return to Block Diagram TOP](#)

Value provided

Isolation amplifier with low current consumption and small 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.

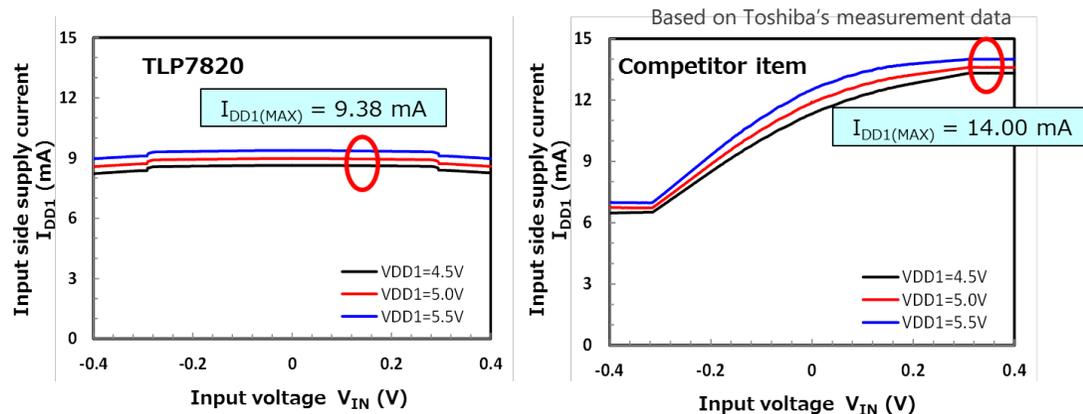
2 Small package

Small SO8L package contributes to reducing mounting area.

3 High accuracy

This optical coupling type isolation amplifier uses $\Delta\Sigma$ AD convertor with a high precision on the input side and DA convertor with a high precision on the output side.

Current consumption characteristics



Lineup

| | |
|--------------------------------------|---|
| Part number | TLP7820 |
| Package | SO8L(LF4)  |
| Gain accuracy [%] | ±0.5 / ±1.0 / ±3.0 (rank selection) |
| dG/dT _a (Typ.) [V/V/°C] | 0.00012 |
| NL ₂₀₀ (Typ.) [%] | 0.02 |
| V _{OS} (Typ.) [mV] | 0.9 |
| I _{DD1} (Typ.) [mA] | 8.6 |
| I _{DD2} (Typ.) [mA] | 6.2 |

[Return to Block Diagram TOP](#)

Value provided

AD converters, timers, and PWM ^[Note 1] output circuit are built in. The system-control runs at low power.

[Note 1] Pulse Width Modulation

1 Built-in Arm® Cortex®-M3 CPU core

The product lineup is equipped with Arm Cortex-M3 core (maximum operation frequency of 120 MHz). Various development tool and their partners allow users many options.

2 Enhancement of system functionality

Built-in multifunctional timers and A-PMD ^[Note 2] control circuit generate PWM. AD converters with monitoring capabilities are also built in. They provide efficient monitoring and IH control of the various parts of the system. It also has an LCD indicator control circuit. This enables direct drive of the liquid crystal panel ^[Note 3].

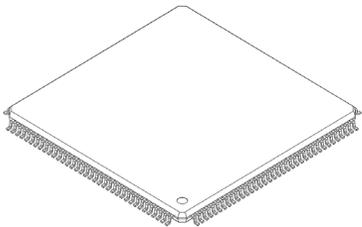
3 Small package, low power consumption

Several low power modes are available to support low power consumption. Package lineup of LQFP144 from small LQFP64 is provided.

[Note 2] Advanced Programmable Motor Control Circuit

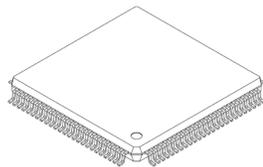
[Note 3] Excluding M3HL series.

TMPM3HQF10BFG
TMPM3HQFDAFG



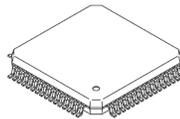
P-LQFP144-2020-0.50-002

TMPM3HNF10BFG
TMPM3HNFDAFG



P-LQFP100-1414-0.50-002

TMPM3HLF10BUG
TMPM3HLFDAUG



P-LQFP64-1010-0.50-003

Lineup

| Part number | M3H(2) | TMPM3HQF10BFG | TMPM3HNF10BFG | TMPM3HLF10BUG |
|--------------------------|---|--|---|---|
| | M3H(1) | TMPM3HQFD/Z/YAFG | TMPM3HNFD/Z/YAFG | TMPM3HLFD/Z/YAUG |
| Max. operation frequency | 120 MHz | | | |
| ROM (flash) | M3H(2) | 1024 KB (512 KB x 2 area, compatible with FOTA*) | | |
| | M3H(1) | 512 / 384 / 256 KB | | |
| RAM | M3H(2) | 130 KB (with parity) | | |
| | M3H(1) | 66 KB (with parity) | | |
| Timer | 32bit x 8ch (16bit x 16ch) | | | |
| AD converter | 21ch (12bit) | | 17ch (12bit) | 12ch (12bit) |
| Serial communication | UART: 8ch, I ² C: 4ch, TSPI: 5ch | | UART: 8ch, I ² C: 3ch, TSPI: 4ch | UART: 7ch, I ² C: 2ch, TSPI: 1ch |
| Package | P-LQFP144-2020-0.50-002 | | P-LQFP100-1414-0.50-002 | P-LQFP64-1010-0.50-003 |

* Firmware update Over The Air

[Return to Block Diagram TOP](#)

If you are interested in these products and have questions or comments about any of them, please do not hesitate to contact us below:

Contact address: <https://toshiba.semicon-storage.com/ap-en/contact.html>



Terms of use

This terms of use is made between Toshiba Electronic Devices and Storage Corporation (“We”) and Customer who downloads or uses this Reference Design. Customer shall comply with this terms of use. This Reference Design means all documents and data in order to design electronics applications on which our semiconductor device is embedded.

Section 1. Restrictions on usage

1. This Reference Design is provided solely as reference data for designing electronics applications. Customer shall not use this Reference Design for any other purpose, including without limitation, verification of reliability.
2. Customer shall not use this Reference Design for sale, lease or other transfer.
3. Customer shall not use this Reference Design for evaluation in high or low temperature, high humidity, or high electromagnetic environments.
4. This Reference Design shall not be used for or incorporated into any product or system whose manufacture, use, or sale is prohibited under any applicable laws or regulations.

Section 2. Limitations

1. We reserve the right to make changes to this Reference Design without notice.
2. This Reference Design should be treated as a reference only. WE ARE NOT RESPONSIBLE FOR ANY INCORRECT OR INCOMPLETE DATA AND INFORMATION.
3. Semiconductor devices can malfunction or fail. When designing electronics applications by referring to this Reference Design, Customer is responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of semiconductor devices could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Customer must also refer to and comply with the latest versions of all relevant our information, including without limitation, specifications, data sheets and application notes for semiconductor devices, as well as the precautions and conditions set forth in the "Semiconductor Reliability Handbook".
4. Designing electronics applications by referring to this Reference Design, Customer must evaluate the whole system sufficiently. Customer is solely responsible for applying this Reference Design to Customer's own product design or applications. WE ASSUME NO LIABILITY FOR CUSTOMER'S PRODUCT DESIGN OR APPLICATIONS.
5. WE SHALL NOT BE RESPONSIBLE FOR ANY INFRINGEMENT OF PATENTS OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS OF THIRD PARTIES THAT MAY RESULT FROM THE USE OF THIS REFERENCE DESIGN. NO LICENSE TO ANY INTELLECTUAL PROPERTY RIGHT IS GRANTED BY THIS TERMS OF USE, WHETHER EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE.
6. THIS REFERENCE DESIGN IS PROVIDED "AS IS". WE (a) ASSUME NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (b) DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO THIS REFERENCE DESIGN, INCLUDING WITHOUT LIMITATION, WARRANTIES OR CONDITIONS OF FUNCTION AND WORKING, WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.

Section 3. Terms and Termination

It is assumed that Customer agrees to any and all this terms of use if Customer downloads or uses this Reference Design. We may, at its sole and exclusive discretion, change, alter, modify, add, and/or remove any part of this terms of use at any time without any prior notice. We may terminate this terms of use at any time and without any cause. Upon termination of this terms of use, Customer shall eliminate this Reference Design. Furthermore, upon our request, Customer shall submit to us a written confirmation to prove elimination of this Reference Design.

Section 4. Export Control

Customer shall not use or otherwise make available this Reference Design for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). This Reference Design may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Act and the U.S. Export Administration Regulations. Export and re-export of this Reference Design is strictly prohibited except in compliance with all applicable export laws and regulations.

Section 5. Governing Laws

This terms of use shall be governed and construed by laws of Japan, without reference to conflict of law principle.

Section 6. Jurisdiction

Unless otherwise specified, Tokyo District Court in Tokyo, Japan shall be exclusively the court of first jurisdiction for all disputes under this terms of use.

RESTRICTIONS ON PRODUCT USE

- Toshiba Electronic Devices & Storage Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "Product") without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, lifesaving and/or life supporting medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, and devices related to power plant. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Product may include products using GaAs (Gallium Arsenide). GaAs is harmful to humans if consumed or absorbed, whether in the form of dust or vapor. Handle with care and do not break, cut, crush, grind, dissolve chemically or otherwise expose GaAs in Product.
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**

TOSHIBA

* Arm and Cortex are registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

* M-FLAT™ and TXZ+™ are trademarks of Toshiba Electronic Devices & Storage Corporation.

* All other company names, product names, and service names may be trademarks of their respective companies.