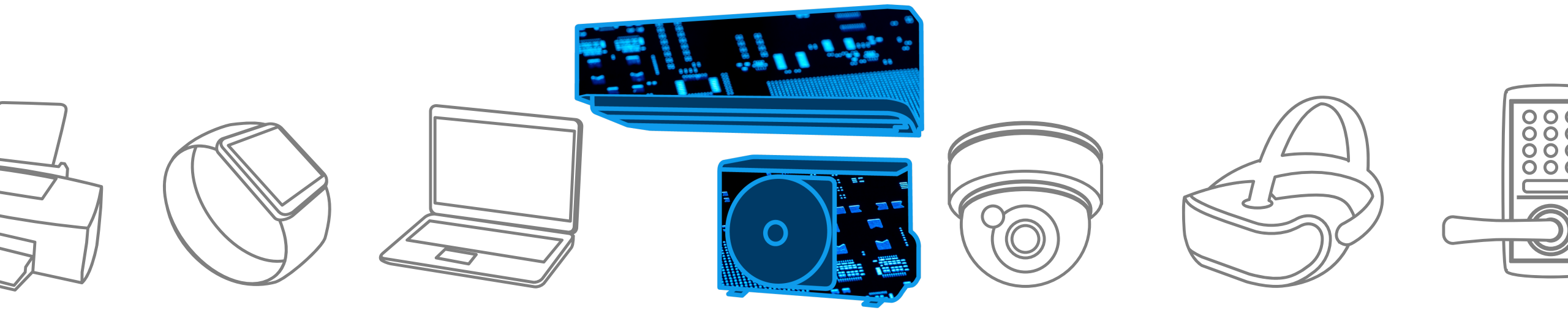
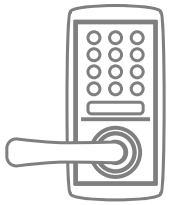
TOSHIBA

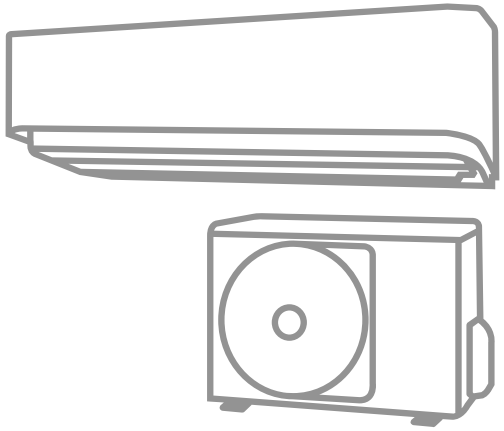
R24

# Air Conditioner

## Solution Proposal by Toshiba

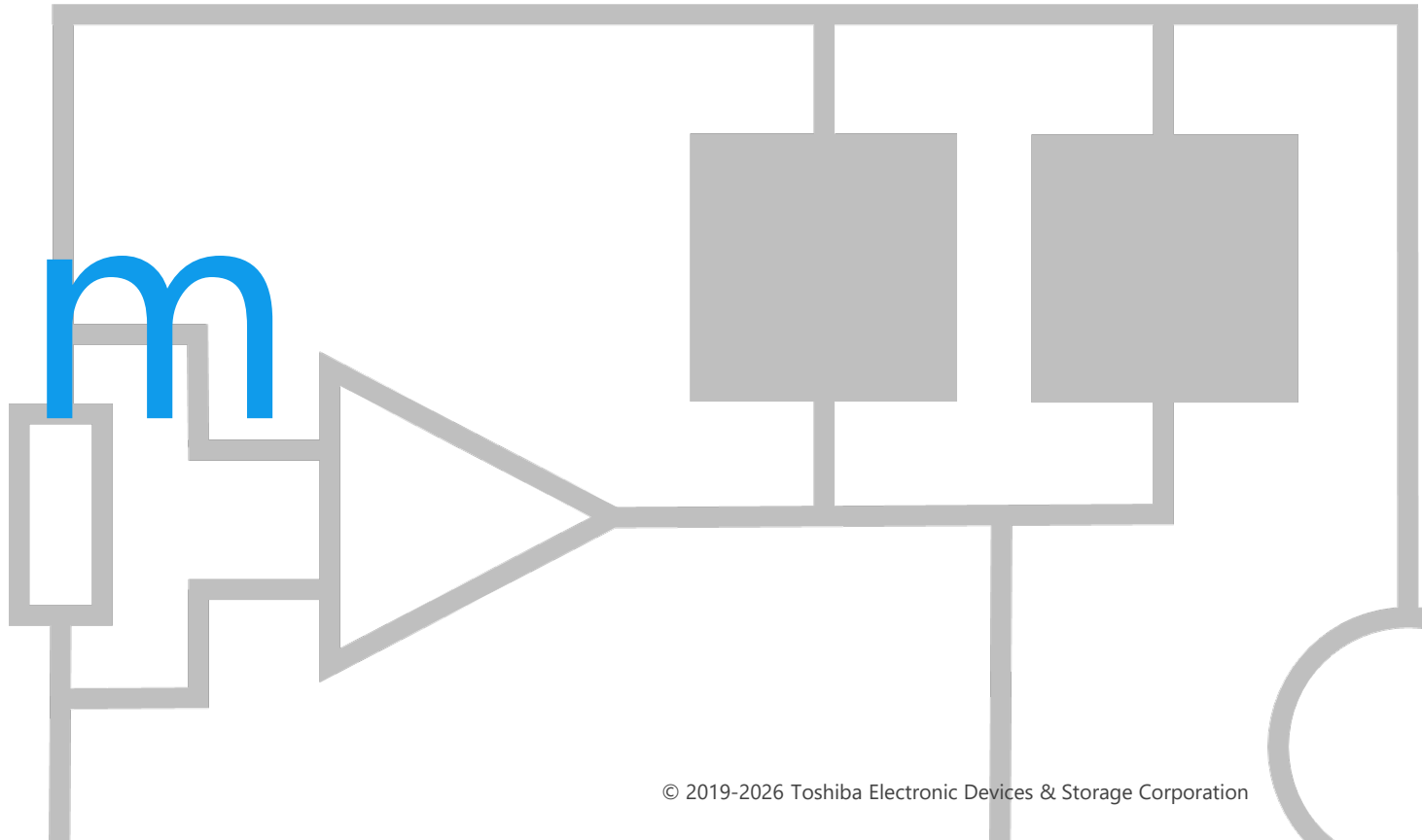




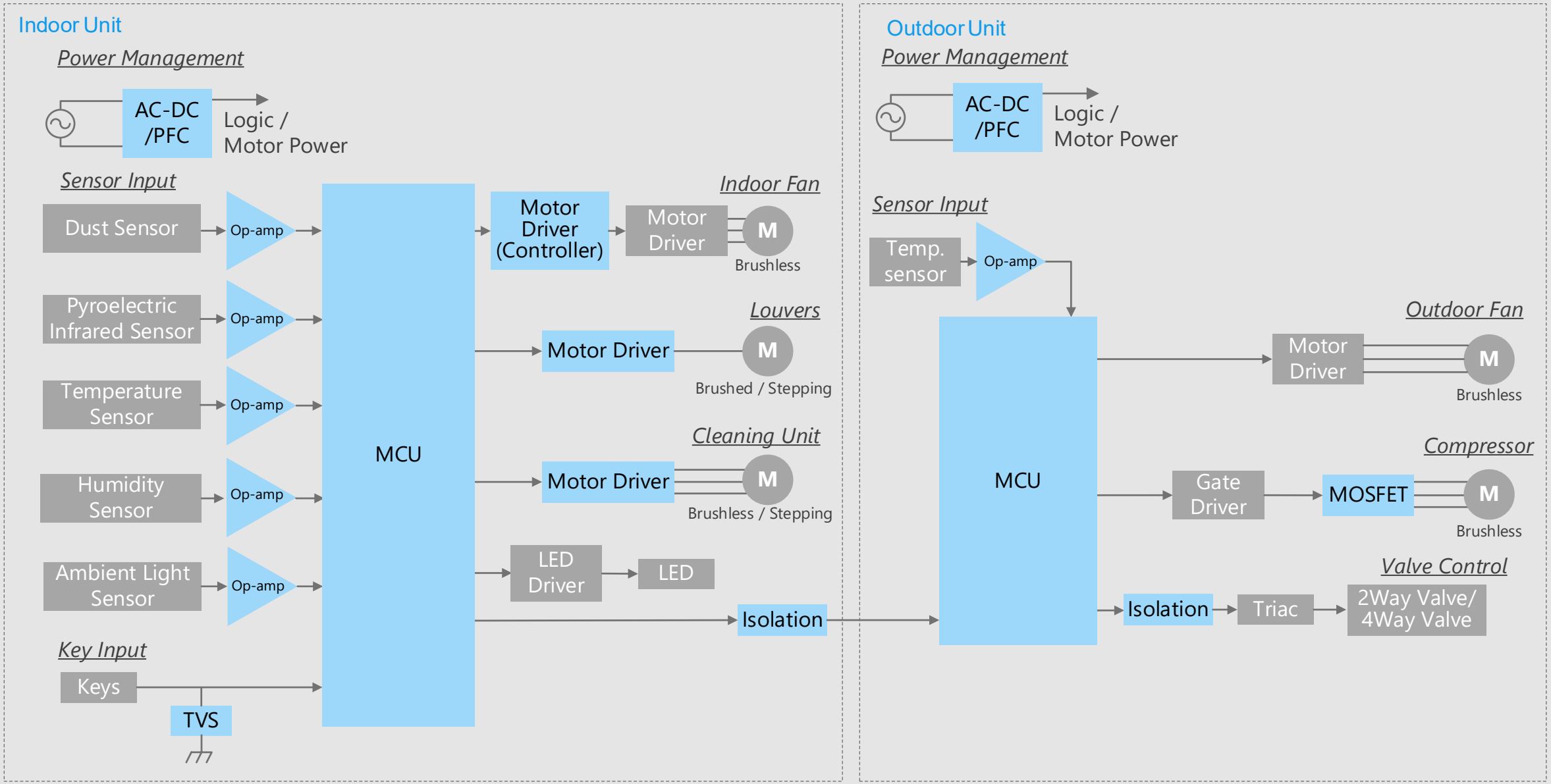


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

# Block Diagram



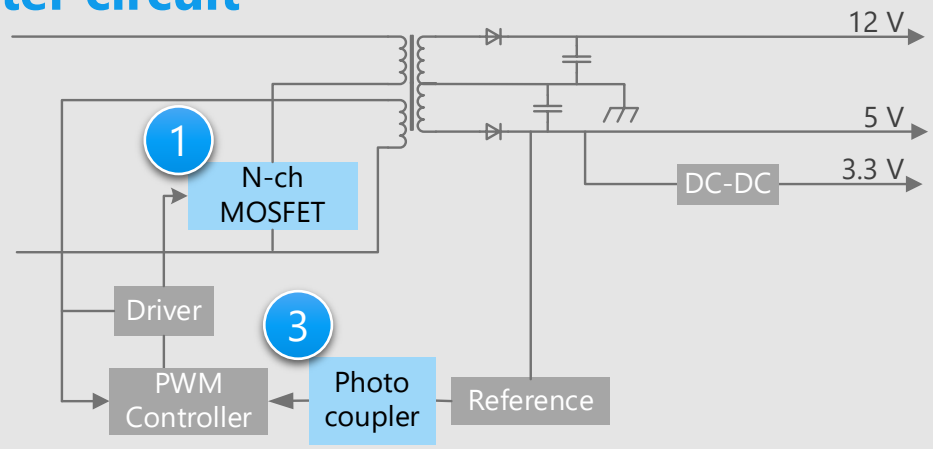
# Air Conditioner　Overall Block Diagram



# Air Conditioner　Details of AC-DC converter unit

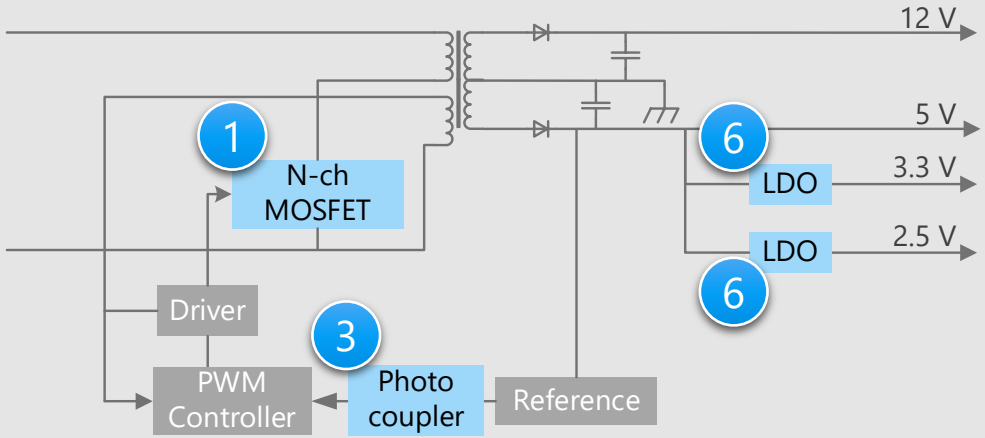
## AC-DC converter circuit

Outdoor unit




## AC-DC converter circuit

Indoor unit




## Criteria for device selection

- High voltage MOSFETs are suitable for primary switching of AC-DC converters.
- The transistor output photocoupler is for signal isolation.

## Proposals from Toshiba

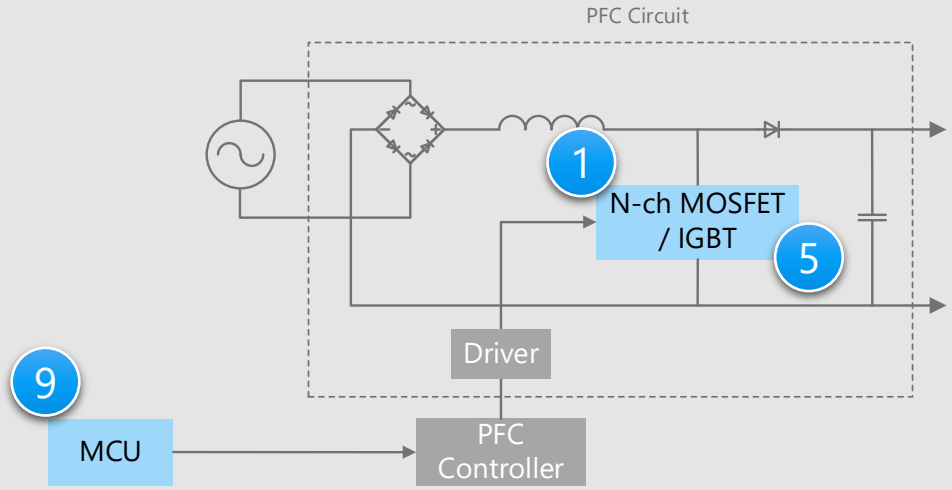
- **Suitable for high efficiency power supply switching** 1
  DTMOSⅥ Series MOSFET
- **High current transfer ratio and high temperature operation have been achieved** 3
  Transistor output photocoupler
- **Supply the power with low noise** 6
  Small surface mount LDO regulator

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

# Air Conditioner　Details of PFC unit

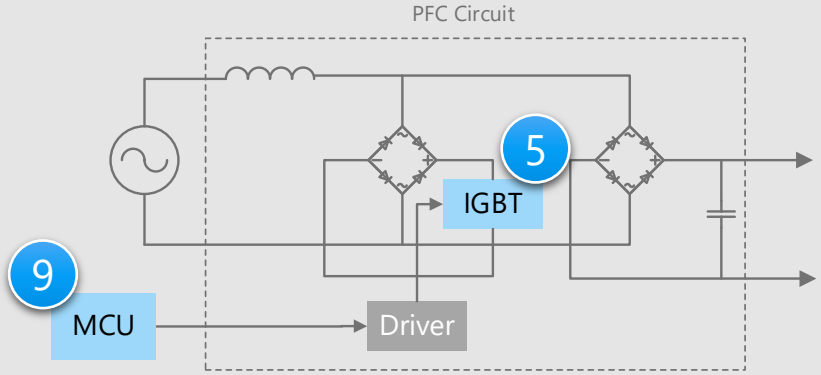
## PFC circuit

Active type




## PFC circuit

Partial switching type




## Criteria for device selection

- MOSFETs with high speed switching and low on-resistance are suitable for active type PFC circuit.
- IGBTs with low collector-emitter saturation voltage are suitable for partial switching type PFC circuit.

## Proposals from Toshiba

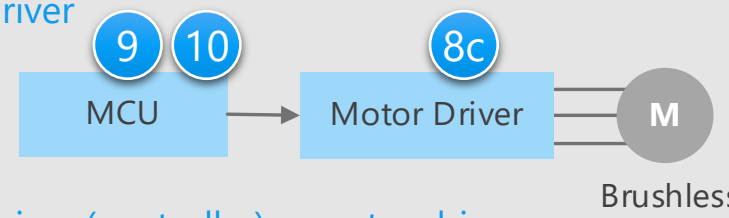
- **Suitable for high efficiency power supply switching**
  DTMOSⅥ Series MOSFET 1
- **IGBT which is suitable for high voltage and high current system**
  Discrete IGBT 5
- **Suitable for PFC and motor control**
  MCU M4K Group / M470 Group / M370 Group 9

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

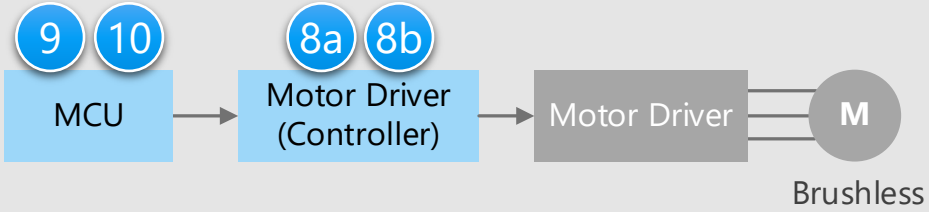
# Air Conditioner　Details of fan (indoor/outdoor) and compressor unit

## Fan section (indoor/outdoor units)

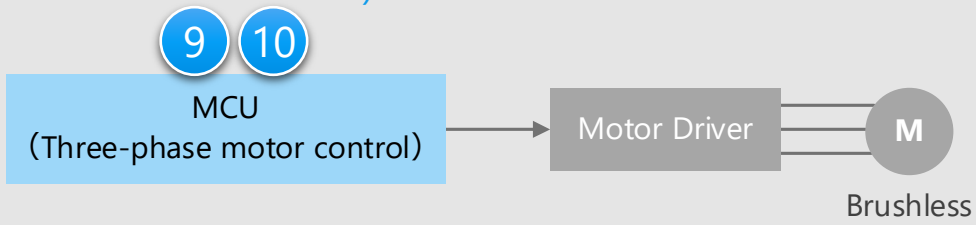
MCU + motor driver



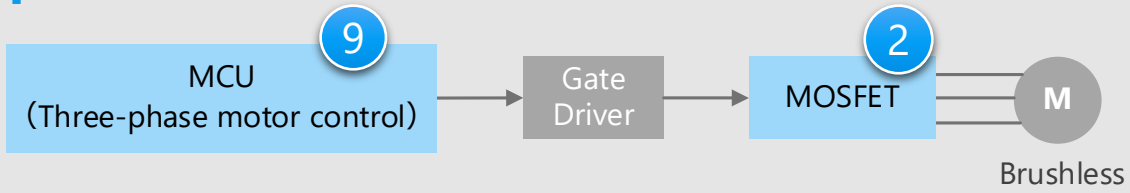

MCU + motor driver (controller) + motor driver




MCU (Three-phase motor controller) + motor driver




## Compressor section




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

## Criteria for device selection

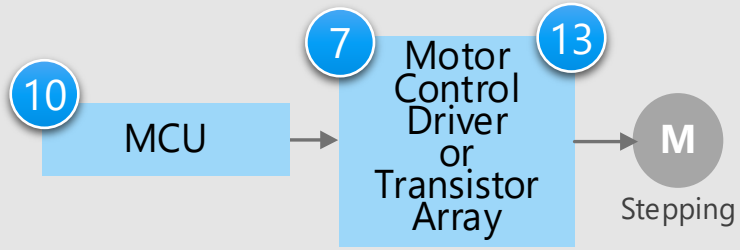
- MOSFET with short reverse recovery time is suitable for motor drive in compressors.
- By using brushless motor drivers, three-phase brushless DC motors can be controlled easily.

## Proposals from Toshiba

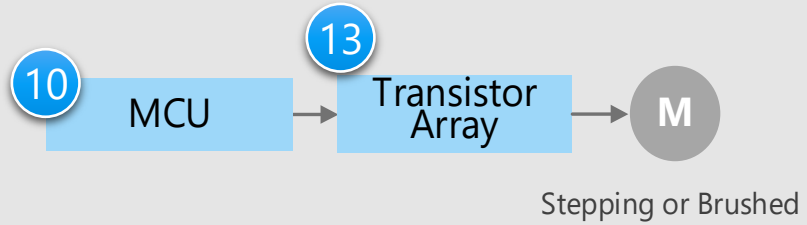
- **Suitable for inverter** 2
  DTMOSⅣ(HSD) Series MOSFET
- **Easy motor drive** 8a 8b 8c
  Three-phase brushless DC motor driver
- **Suitable for PFC and motor control**
  MCU M4K Group / M470 Group / M370 Group 9
- **Easy software development using general purpose CPU cores**
  MCU M3H Group 10

# Air Conditioner　Details of cleaning, louver and valve control unit

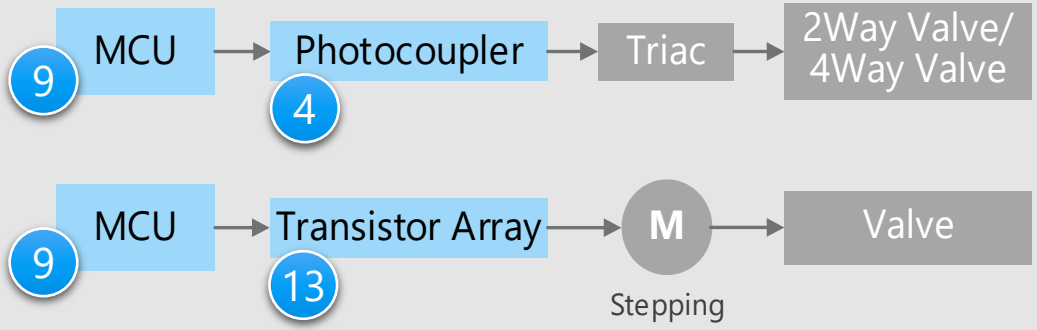
## Cleaning section




## Louver section




## Valve control section




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

## Criteria for device selection

- Stepping motor driver enables efficient motor control by optimizing real-time current to the motor.
- Brushed DC motor driver allows motor driving with low power consumption.

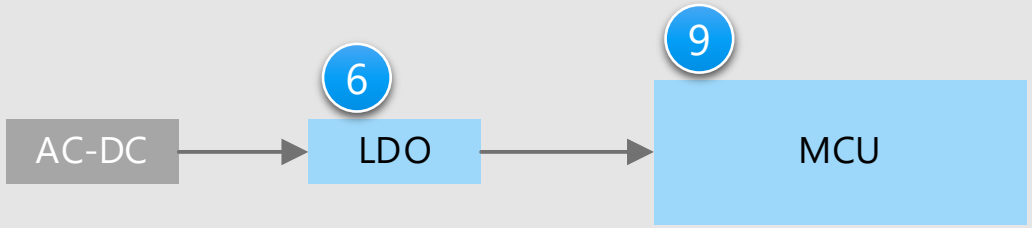
## Proposals from Toshiba

- **Easy motor drive** 7
  Stepping motor & Brushed DC motor driver
- **Triac driver for high dv/dt** 4
  Triac output photocoupler
- **Suitable for PFC and motor control** 9
  MCU M4K Group / M470 Group / M370 Group
- **Easy software development using general purpose CPU cores** 10
  MCU M3H Group
- **High efficiency and high current driver with built-in low loss DMOS FET** 13
  Transistor array

# Air Conditioner　Details of microcontroller and isolation unit

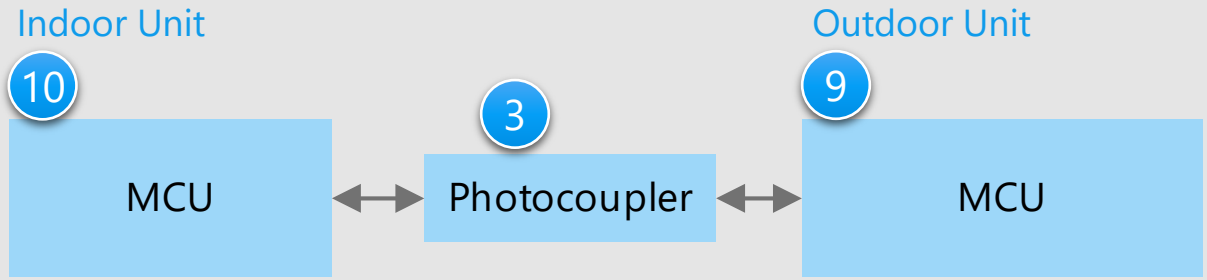
## Microcontroller section

Power control block for outdoor unit




## Isolation circuit

Between outdoor and indoor units




## Criteria for device selection

- Isolation devices such as transistor output photocouplers are effective when voltage difference exists between outdoor and indoor GNDs.
- MCUs are suitable for system monitoring and control.

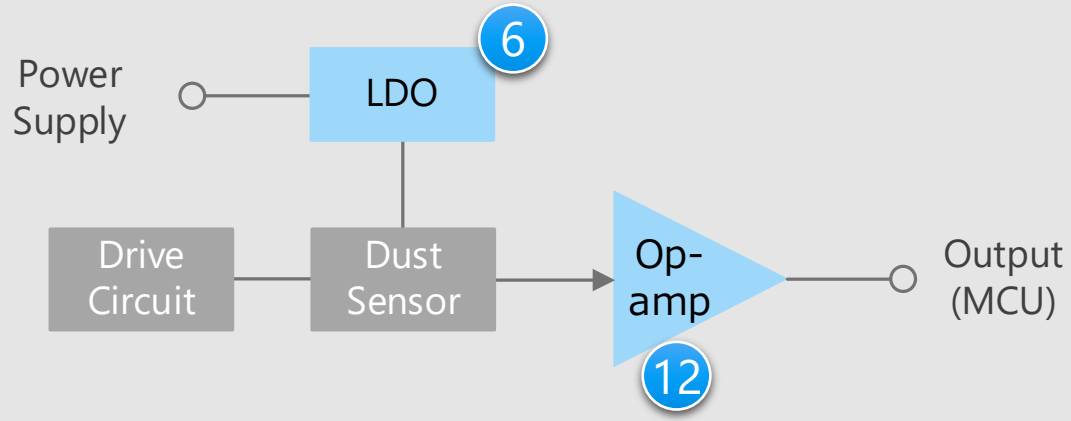
## Proposals from Toshiba

- **High current transfer ratio and high temperature operation have been achieved**
  Transistor output photocoupler 3
- **Supply the power with low noise**
  Small surface mount LDO regulator 6
- **Suitable for PFC and motor control**
  MCU M4K Group / M470 Group / M370 Group 9
- **Easy software development using general purpose CPU cores**
  MCU M3H Group 10

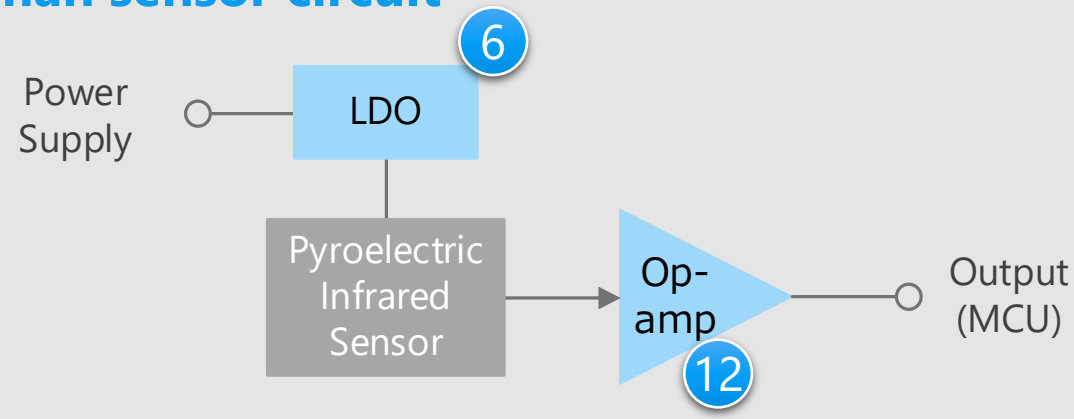
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

# Air Conditioner　Details of sensor input unit (1)

## Dust sensor circuit




## Human sensor circuit




## Criteria for device selection

- PSRR (Power Supply Rejection Ratio) of LDO regulator is an important parameter for sensor modules.
- The operational amplifier should be low current consumption or low noise device.
- Small package products contribute to the reduction of circuit board area.

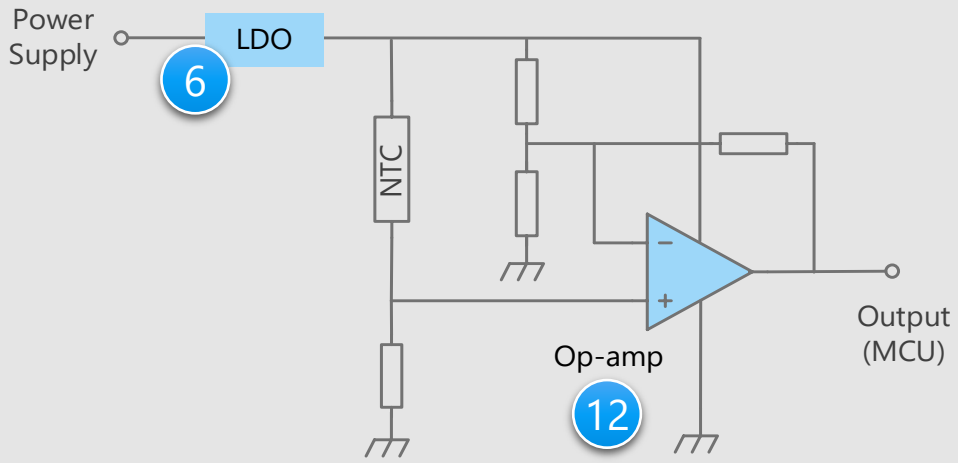
## Proposals from Toshiba

- **Supply the power with low noise**
  Small surface mount LDO regulator　6
- **Amplification of detected very small signal with low noise**
  Low current consumption op-amp / Low noise op-amp　12

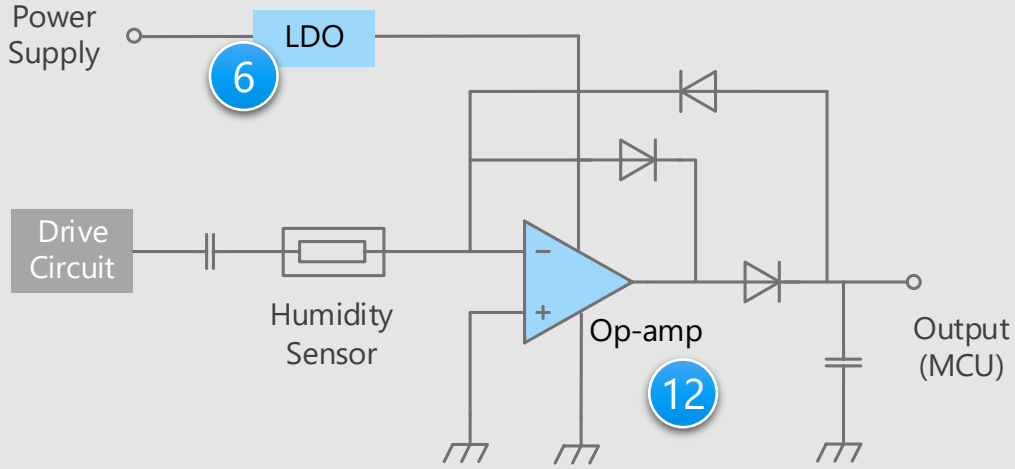
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

# Air Conditioner　Details of sensor input unit (2)

## Temperature sensor circuit




## Humidity sensor circuit




## Criteria for device selection

- PSRR (Power Supply Rejection Ratio) of LDO regulator is an important parameter for sensor modules.
- The operational amplifier should be low current consumption or low noise device.
- Small package products contribute to the reduction of circuit board area.

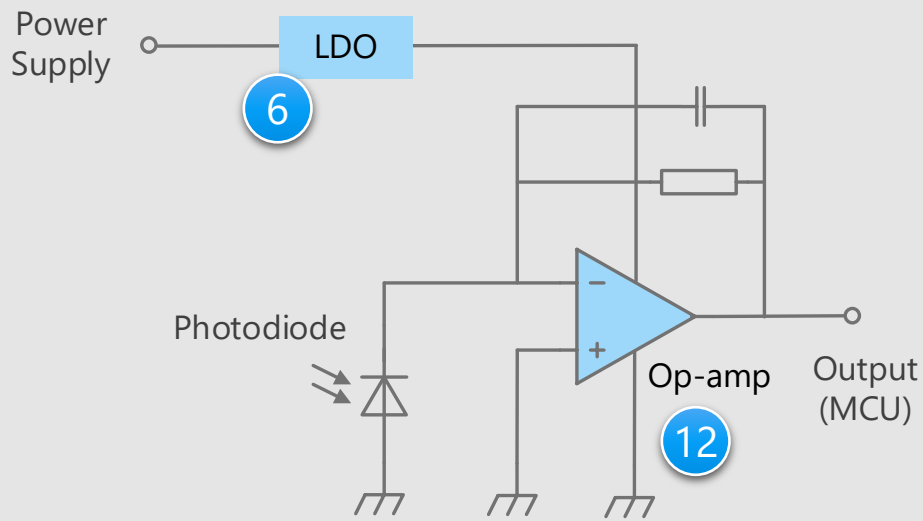
## Proposals from Toshiba

- **Supply the power with low noise**
  Small surface mount LDO regulator　6
- **Amplification of detected very small signal with low noise**
  Low current consumption op-amp / Low noise op-amp　12

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

# Air Conditioner　Details of sensor input unit (3)

## Ambient light sensor circuit




## Criteria for device selection

- PSRR (Power Supply Rejection Ratio) of LDO regulator is an important parameter for sensor modules.
- The operational amplifier should be low current consumption or low noise device.
- Small package products contribute to the reduction of circuit board area.

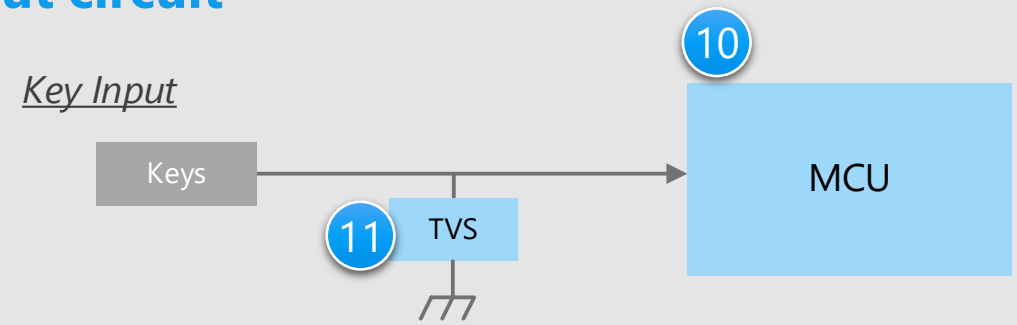
## Proposals from Toshiba

- **Supply the power with low noise**
  Small surface mount LDO regulator　6
- **Amplification of detected very small signal with low noise**
  Low current consumption op-amp / Low noise op-amp　12

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

# Air Conditioner　Detail of key input unit

## Key input circuit




## Criteria for device selection

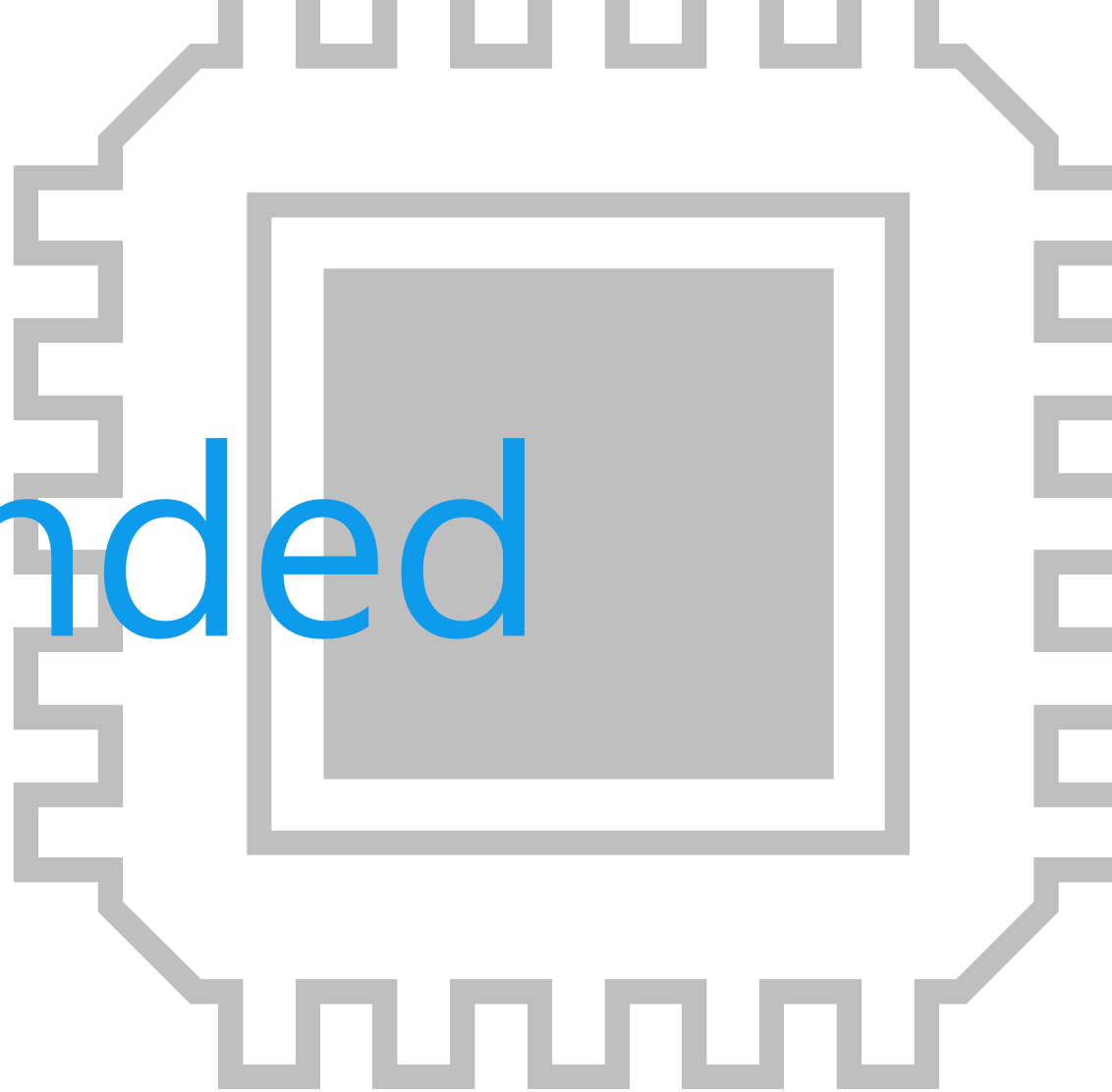
- TVS diodes are suitable for protection from ESD pulses coming in key input unit.
- Small package products contribute to the reduction of circuit board area.

## Proposals from Toshiba

- **Easy software development using general purpose CPU cores** 10
  MCU M3H Group
- **Absorb static electricity (ESD) to prevent malfunction of the circuit** 11
  TVS diode

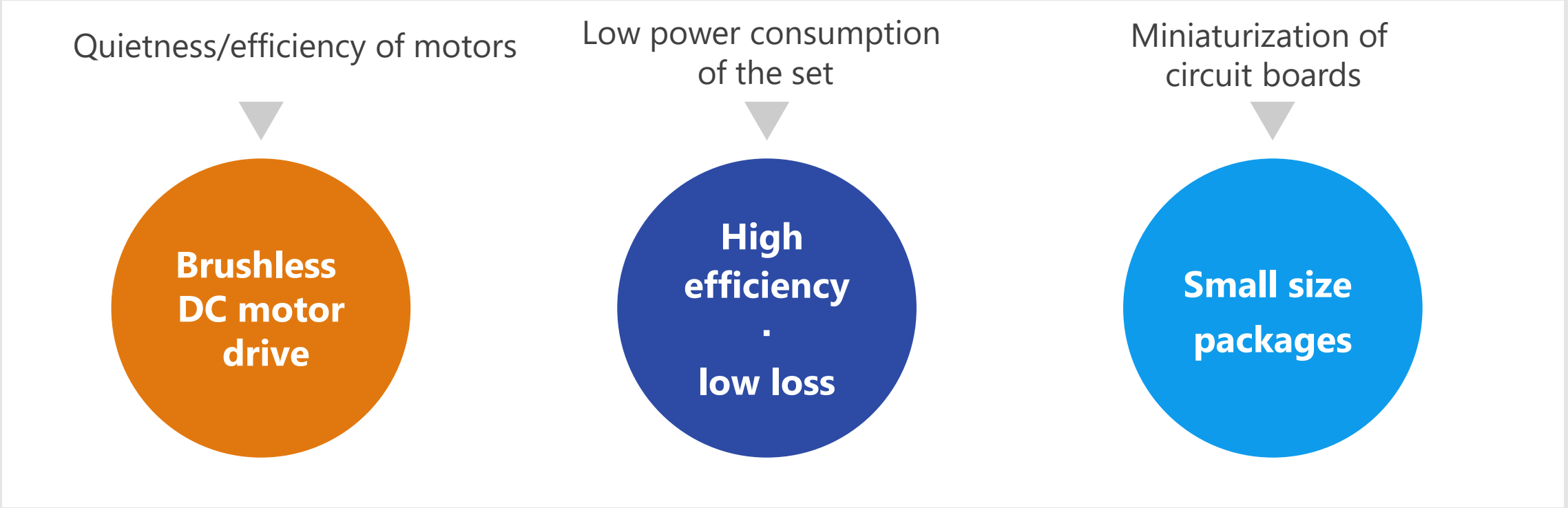
* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

# Recommended Devices



# Device solutions to address customer needs

As described above, in the design of air conditioner, **“Quietness/efficiency of motors”**, **“Low power consumption of the 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

| | | Brushless DC motor drive | High efficiency · low loss | Small size packages |
|---|---|---|---|---|
| 1 | DTMOSⅥ Series MOSFET | ● | ● | ● |
| 2 | DTMOSⅣ(HSD) Series MOSFET | ● | ● | ● |
| 3 | Transistor output photocoupler | | ● | ● |
| 4 | Triac output photocoupler | | ● | ● |
| 5 | Discrete IGBT | ● | ● | ● |
| 6 | Small surface mount LDO regulator | | ● | ● |
| 7 | Stepping motor & Brushed DC motor driver | ● | ● | ● |
| 8 | Three-phase brushless DC motor driver | ● | ● | ● |
| 9 | MCU M4K Group / M470 Group / M370 Group | ● | ● | ● |
| 10 | MCU M3H Group | ● | ● | ● |

# Device solutions to address customer needs

| | | Brushless DC motor drive | High efficiency · low loss | Small size packages |
|---|---|---|---|---|
| 11 | TVS diode | | | ● |
| 12 | Low current consumption op-amp / Low noise op-amp | | ● | ● |
| 13 | Transistor array | | ● | ● |

# 1 DTMOSⅥ Series MOSFET

**TK200U65Z5 / TK065U65Z / TK200A65Z5 / TK040N65Z**

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

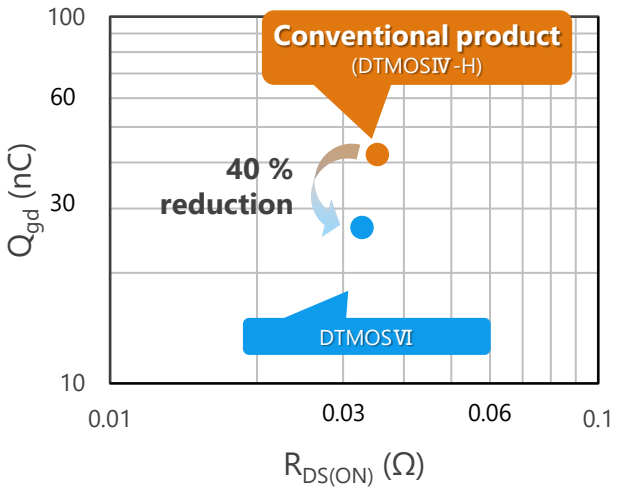
## Improved performance index $R_{DS(on)}$ x $Q_{gd}$, which shows switching characteristic, contributes to improvement of power supply efficiency.

### 1 $R_{DS(ON)}$ x $Q_{gd}$ improvement

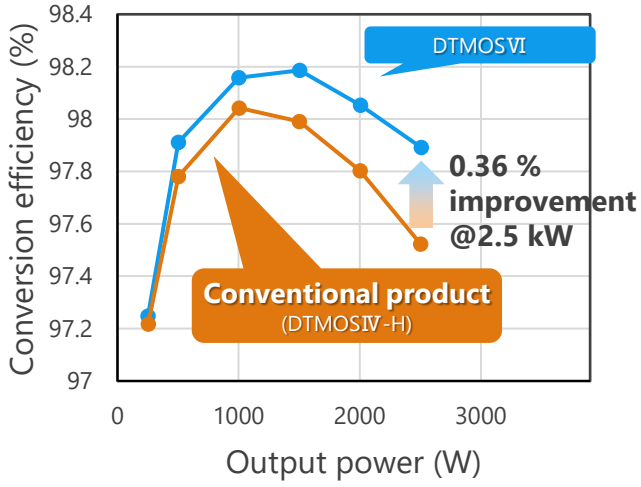
The $R_{DS(ON)}$ x $Q_{gd}$ figure of merit has been reduced by 40 % with gate design and process optimization.
(Comparison with DTMOSⅣ-H products: Toshiba internal comparison)
This characteristic improvement reduces switching loss and contributes to improving power supply efficiency of equipment.

### 2 RonA improvement

The RonA figure of merit has been reduced by 18 %. (Comparison with DTMOSIV 650 V products: Toshiba internal comparison).
Achieves low on-resistance while ensuring high voltage compared to Toshiba's existing products, contributing to improved power supply efficiency of equipment.

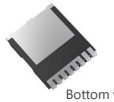



[Note] Toshiba internal comparison




[Note] Toshiba internal comparison

**Lineup**

| Part number | | TK200U65Z5 | TK065U65Z | TK200A65Z5 | TK040N65Z |
|---|---|---|---|---|---|
| Package | | TOLL  Top view  Bottom view | | TO-220SIS  Top view | TO-247  Top view |
| $V_{DSS}$ [V] | | 650 | | | |
| $I_D$ [A] | | 15 | 38 | 15 | 57 |
| $R_{DS(ON)}$ [Ω] @$V_{GS}$ = 10 V | Typ. | 0.154 | 0.051 | 0.154 | 0.033 |
| | Max | 0.200 | 0.065 | 0.200 | 0.040 |
| Polarity | | N-ch | | | |

◆Return to Block Diagram TOP

# 2 DTMOSⅣ(HSD) Series MOSFET

**TK20A60W5**

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

## The figure of merit RonA has been reduced by 30 % (compared with Toshiba's existing products), then contribute to improve efficiency of power supply.

### 1 RonA 30 % reduction

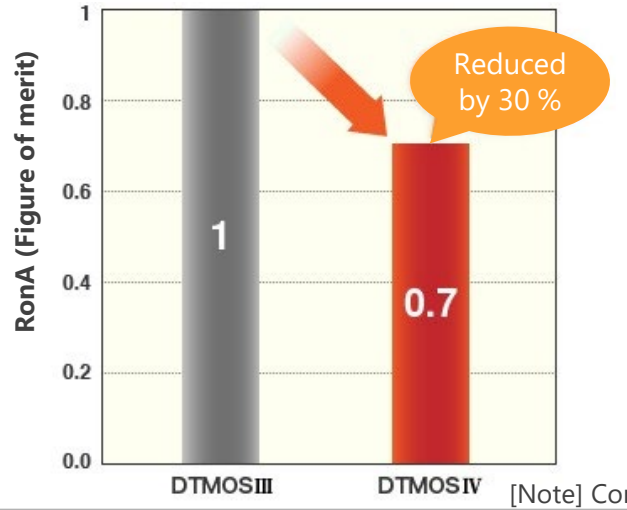
Adoption of single epitaxial process to reduce the figure of merit RonA by 30 %. (Compared with Toshiba DTMOSⅢ products)

### 2 Reduction of on-resistance increase at high temperature

The single epitaxial process reduces the on-resistance increase at high temperature.

### 3 Optimization of switching speed

Optimization of switching speed has been achieved by reduction of $C_{OSS}$ and other factors.




[Note] Compared with Toshiba DTMOSⅢ products

Lineup

| Part number | | TK20A60W5 |
|---|---|---|
| Package | | TO-220SIS  Top view Bottom view |
| $V_{DSS}$ [V] | | 600 |
| $I_D$ [A] | | 20 |
| $R_{DS(ON)}$ [Ω] @$V_{GS}$ = 10 V | Typ. | 0.15 |
| | Max | 0.175 |
| Polarity | | N-ch |

◆Return to Block Diagram TOP

# 3 Transistor output photocoupler

## TLP383 / TLP293 / TLP385

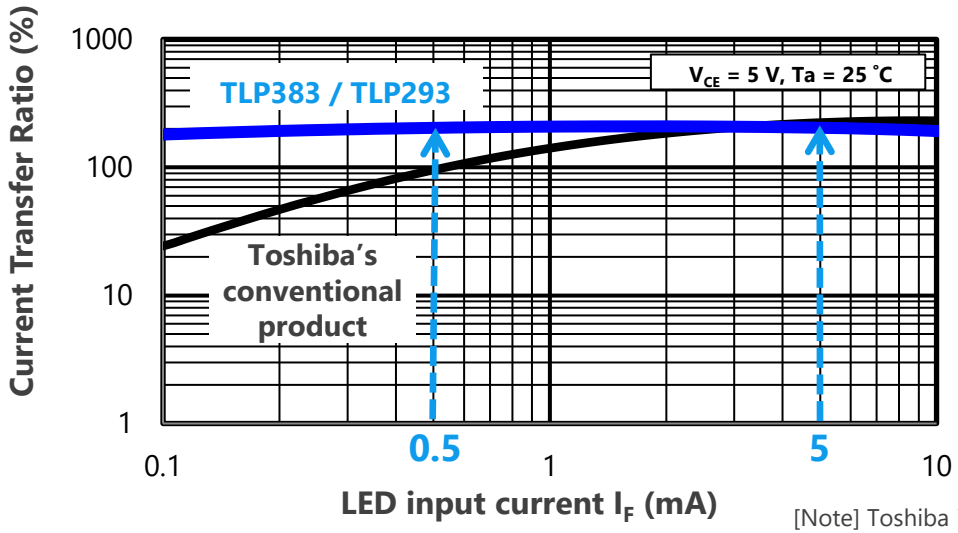
Brushless DC motor drive | High efficiency · low loss | Small size packages

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

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




[Note] Toshiba internal comparison

### 2 High temperature operation

The TLP383 and TLP293 are designed to operate even under severe ambient temperature conditions.

Lineup

| Part number | TLP383 | TLP293 | TLP385 |
|---|---|---|---|
| Package | 4pin SO6L  | SO4  | 4pin SO6L  |
| $BV_S$ [Vrms] | 5000 | 3750 | 5000 |
| $T_{opr}$ [°C] | -55 to 125 | -55 to 125 | -55 to 110 |

◆Return to Block Diagram TOP

# 4 Triac output photocoupler

## TLP3083 / TLP3073

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**Using a triac with high dv/dt pre-driver for solenoid valve control suppresses false turn-on.**

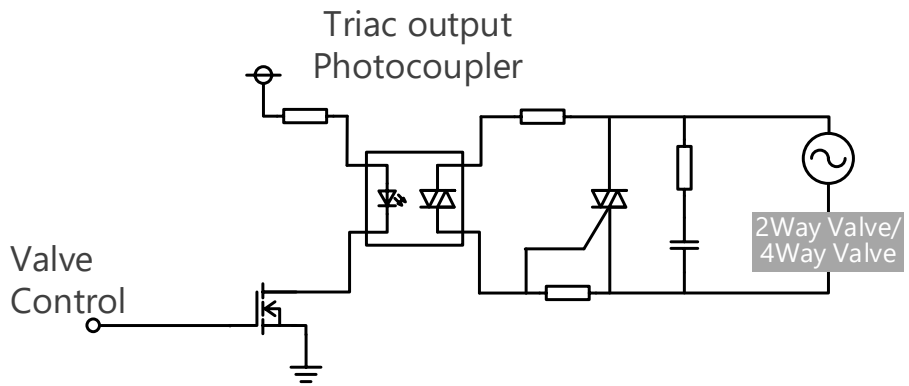
## 1 Low input and zero crossing input control

This device optically couples a photo triac and a high power infrared LED, providing high isolation equivalent to an electromagnetic relay. Capable of low input operation, the photo coupler can be directly controlled by a microcontroller.

## 2 High dv/dt

The TLP3083 is a triac having a high dv/dt of 2000 V/μs (typ.). With a high OFF-state voltage of 800 V, it can work with various AC power supplies.

■ **Example of AC switch using triac output photocoupler**




Lineup

| Part number | TLP3083 | TLP3073 |
|---|---|---|
| Package | 5pin DIP6  | |
| Output type | Zero crossing functionary (ZC) | Non zero crossing functionary (NZC) |
| $BV_S$ [Vrms] | 5000 | |
| $T_{opr}$ [°C] | -40 to 100 | |

◆Return to Block Diagram TOP

# 5 Discrete IGBT

## GT50JR22 / GT50J123 / GT30J65MRB

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**Switching devices for high voltage (600 V or more) and high current (30 A or more) application. Lineup of low $V_{CE(sat)}$ products are effective in reducing conduction loss.**

### 1 High speed, low saturation voltage

By adopting a thin wafer punch-through structure, high speed turn-off characteristics and low $V_{CE(sat)}$ characteristics are realized.

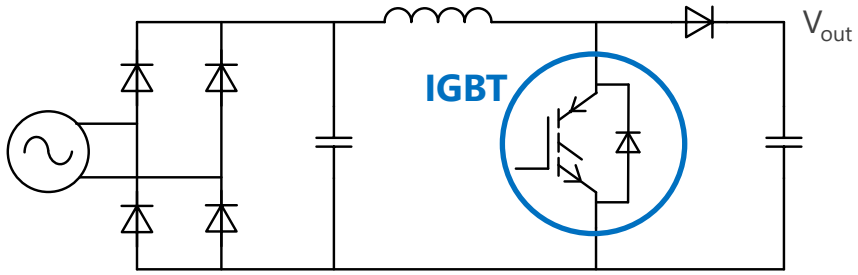
### 2 High breakdown tolerance

Toshiba has a lineup of products with high breakdown tolerance (short circuit withstand time $t_{sc}$ and reverse bias safe operating area RBSOA).

### 3 Enhancement type

Since collector current does not flow when gate voltage is not applied for enhancement devices, handling is easy.

■ **Active type PFC circuit example using discrete IGBT (GT50JR22)**




$f_{sw}$ = 20 to 35 kHz

Lineup

| Part number | | GT50JR22 | GT50J123 | GT30J65MRB |
|---|---|---|---|---|
| Package | | TO-3P(N)  | | |
| Built-in FWD | | ✓ (RC structure) | - | ✓ (RC structure) |
| $V_{CES}$ [V] | | 600 | 600 | 650 |
| $I_C$ [A] | | 50 | 59 | 60 |
| $V_{CE(sat)}$ [V] @$I_C$ = 50 A, $V_{GE}$ = 15 V, $T_a$ = 25 °C | Typ. | 1.55 | 1.90 | 1.40 @$I_C$ = 30 A |
| | Max | 2.20 | 2.50 | 1.80 @$I_C$ = 30 A |
| Breakdown tolerance | $t_{sc}$ [μs] | - | 5 | - |
| | RBSOA | - | 120 A, 600 V (full square) | - |

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# 6 Small surface mount LDO regulator

## TCR15AG / TCR8BM / TCR5FM / TCR5RG / TCR3RM / TCR3U / TCR3LM / TCR3D / TCR3EM / TCR1HF Series

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**Wide lineup from general purpose type to WCSP (Wafer Level Chip Size Package) type are provided. Contribute to realize a stable power supply.**

### 1 Low dropout voltage

Low dropout voltage characteristic has been realized by the originally developed process.

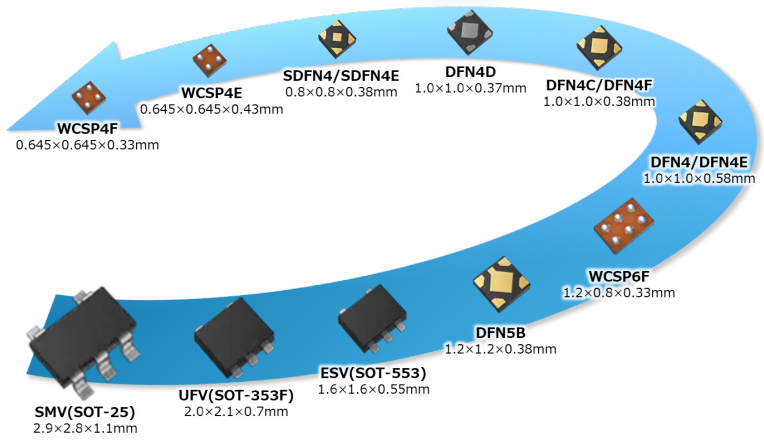
### 2 High PSRR Low output noise voltage

Many product series that realize both high PSRR (Power Supply Rejection Ratio) and low output noise voltage characteristics are provided. They are suitable for stable power supply for analog circuit.

### 3 Low current consumption

$I_{B(ON)}$ of 0.34 μA (typ.) @$I_{OUT}$ = 0 mA, $V_{OUT}$ ≦ 1.5 V is realized by utilizing CMOS process and unique circuit technology. (TCR3U Series)

**Rich package lineup**




Lineup

| Part number | TCR15AG Series | TCR8BM Series | TCR5FM Series | TCR5RG Series | TCR3RM Series | TCR3U Series | TCR3LM Series | TCR3D Series | TCR3EM Series | TCR1HF Series |
|---|---|---|---|---|---|---|---|---|---|---|
| Features | Low dropout voltage High PSRR | | High PSRR Low noise Low current consumption | | | Low current consumption | | Standard type | | 36 V Input voltage |
| $I_{OUT}$ (Max) [A] | 1.5 | 0.8 | 0.5 | | 0.3 | | | | | 0.15 |
| PSRR (Typ.) [dB] @f = 1 kHz | 95 | 98 | 91 | 100 | 100 | 70 | - | 72 | 68 | 70 |
| $I_B$ (Typ.) [μA] | 25 | 20 | 10 | 7 | 7 | 0.34 | 1 | 86 | 35 | 170 |

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# 7 Stepping motor & Brushed DC motor driver

## TC78H621FNG / TC78H660FNG / TC78H660FTG

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

## Support low voltage motor drive (2.5 V (Min)) and contributes to the power saving of set.

### 1 Low voltage operation

Motor power supply voltage is 2.5 V (Min) for low voltage applications.

### 2 Low current consumption

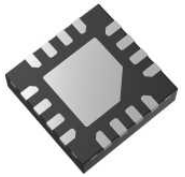
Standby current (IC total) is 2 μA or less (IC total) for power saving of devices.

### 3 Error detection functions

Over current detection (ISD), thermal shutdown (TSD) and under voltage lockout (UVLO) are available.

P-TSSOP16-0505-0.65-001
(5.0 x 6.4 x 1.2 mm)

Top view



Bottom view

P-VQFN16-0303-0.50-001
(3.0 x 3.0 x 0.9 mm)

Lineup

| Part number | TC78H621FNG | TC78H660FNG | TC78H660FTG |
|---|---|---|---|
| $V_M$ [V] | 18 | 18 | 18 |
| $I_{OUT}$ [A] | 1.1 | 2.0 | 2.0 |
| $R_{on(U+L)}$ (Typ.) [Ω] | 0.8 | 0.48 | 0.48 |
| Control interface | PHASE input | IN/PHASE inputs | IN/PHASE inputs |
| Step | 2phase/1-2phase excitation | 2phase/1-2phase excitation | 2phase/1-2phase excitation |
| Motor power supply voltage | 2.5 V (Min) | 2.5 V (Min) RS resister less | 2.5 V (Min) RS resister less |
| Error detection function | ISD, TSD, UVLO | ISD, TSD, UVLO | ISD, TSD, UVLO |
| Package | P-TSSOP16-0505-0.65-001 | | P-VQFN16-0303-0.50-001 |

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# 8a Three-phase brushless DC motor driver

## TC78B041FNG / TC78B042FTG

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**Toshiba's proprietary technology eliminates the need for phase adjustment and achieves high efficiency for a wide range of rotation speeds.**

### 1 High efficiency in a wide range of rotation speeds

Toshiba's automatic lead angle control technology realizes a high efficiency drive regardless of motor speed, load torque or power supply voltage.

### 2 Motor control with low noise and low vibration

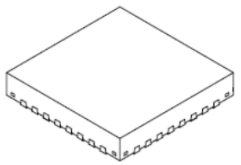
Sine wave drive system with smooth current waveforms contributes to lower motor noise and vibration compared to conventional square wave drive system [Note].

[Note] Comparison with Toshiba products

### 3 Small size package

VQFN32 package is adopted for TC78B042FTG, which requires small space. SSOP30 package is adopted for TC78B041FNG as conventional type.

SSOP30-P-300-0.65
(10.2 x 7.6 x 1.6 mm)



P-VQFN32-0505-0.50-005
(5.0 x 5.0 x 1.0 mm)

Lineup

| Part number | TC78B041FNG | TC78B042FTG |
|---|---|---|
| Power supply voltage | 6 to 16.5 V (operating range) | |
| Drive type | Sine wave drive | |
| Features | Auto lead angle control for optimizing voltage and current phases | |
| | Hall element or hall IC input | |
| | Forward/reverse rotation switch | |
| | Motor lock detection | |
| | Selectable pulse number of rotation pulse signal output | |
| | Built-in 5 V regulator (VREF pin) | Built-in 5 V regulators (VREF/VREF2 pin) |
| | Error detection positive input | Error detection positive/negative input |
| Package | SSOP30-P-300-0.65 | P-VQFN32-0505-0.50-005 |

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# 8b Three-phase brushless DC motor driver

## TB6584FNG / TB6584AFNG / TB6634FNG

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

## High voltage and high current brushless DC motor driving can be implemented by using with external power devices.

### 1 High efficient motor control by automatic phase control

Automatic phase controller by current feedback is integrated adding conventional fixed phase voltage input (32 steps).

### 2 Motor control with low noise and low vibration

Sine wave drive system with smooth current waveforms contributes to lower motor noise and vibration compared to conventional square wave drive system [Note].

[Note] Comparison with Toshiba products

### 3 Sufficient development support

Various supports such as third party evaluation board and PSpice® data for development and design are prepared.

SSOP30-P-300-0.65 package
(10.2 x 7.6 x 1.6 mm)

Lineup

| Part number | TB6584FNG | TB6584AFNG | TB6634FNG |
|---|---|---|---|
| Supply voltage | 6 to 16.5 V (operating range) | | |
| Output current | 0.002 A (for MOSFET driver) | | |
| Drive mode | Sine wave drive | | |
| Features | Lead angle control: Auto phase control (current feedback)<br>Sensor input: Hall device/Hall IC compatible<br>Internal regulator: 5 V, 30 mA (Max)<br>Error detection: overcurrent protection, abnormal position signal protection, undervoltage lockout, motor restrained detection (TB6634FNG) | | |

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# 8c Three-phase brushless DC motor driver

## TB67B000AHG / TB67B000AFG

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

## A motor control IC and IGBTs are integrated into one package, contributing to the miniaturization of circuit boards.

### 1 A motor control IC and IGBTs

A motor control IC with sine wave PWM drive function and IGBTs with 600 V and 2 A characteristics are integrated into one package.

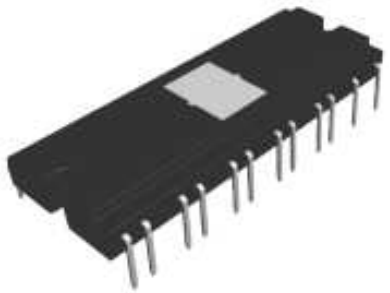
### 2 Motor control with low noise and low vibration

Sine wave drive system with smooth current waveforms contributes to lower motor noise and vibration compared to conventional square wave drive system [Note].

[Note] Comparison with Toshiba products

### 3 High heat dissipation

HDIP30 package is adopted for TB67B000AHG, which has high heat dissipation. HSSOP34 package is adopted for TB67B000AFG, which is smaller than HDIP30.



P-HDIP30-1233-1.78-001
(32.8 x 13.5 x 3.525 mm)

P-HSSOP34-0918-0.80-001
(17.5 x 11.93 x 2.2 mm)

Lineup

| Part number | TB67B000AHG | TB67B000AFG |
|---|---|---|
| Operating voltage range | Power supply for control: 13.5 to 16.5 V | |
| | Power supply for motor drive: 50 to 450 V | |
| Output current | 2 A | |
| Drive type | Sine wave PWM drive / Wide angle commutation | |
| Lead angle control | 0 to 58 degrees 32 steps / 0 to 28 degrees 16 steps | |
| Speed command input voltage | Motor operation: 2.1 to 5.4 V | |
| Features | IGBT three-phase bridge, oscillator circuit, built-in bootstrap diode, overcurrent protection, thermal shutdown, undervoltage lockout, motor lock detection | |
| Package | P-HDIP30-1233-1.78-001 | P-HSSOP34-0918-0.80-001 |

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Value provided

## System cost reduction, higher efficiency and less development work.

### 1 Equipped with motor control co-processor

Toshiba's original co-processor vector engine (VE) for motor control reduces CPU load and allows control of multiple motors and peripherals. [Note 1]

### 2 Equipped with motor control circuit

A variety of three-phase PWM [Note 2] waveforms and AD converters enable highly efficient, low noise control. The Advanced Encoder (A-ENC) reduces the load of CPU process in detecting the position performed for each PWM.

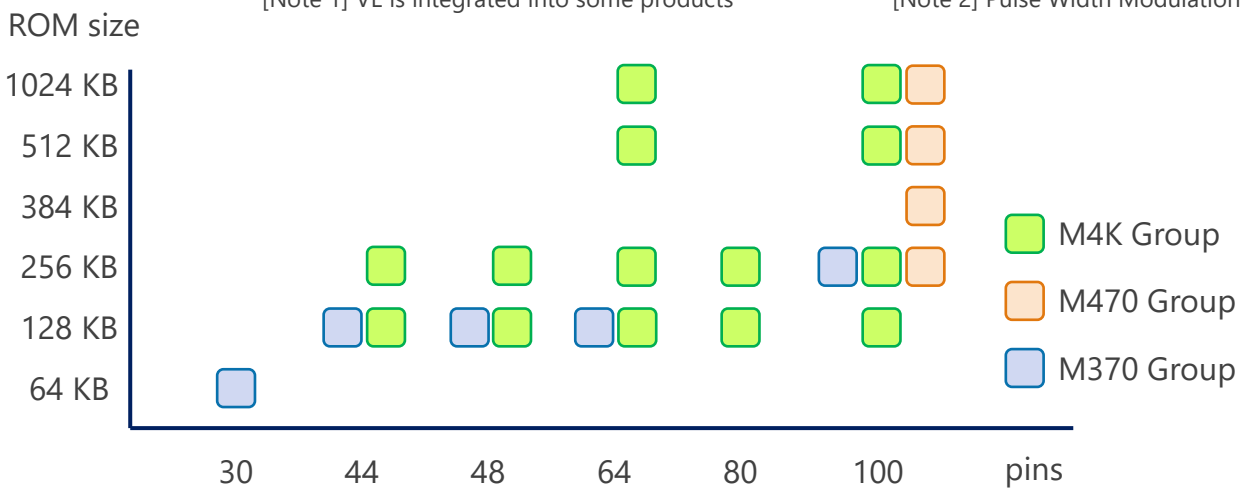
### 3 Provide development support tools

Third party evaluation boards and sample programs that can be used to shorten the development time are provided. Toshiba has also offered new, simple, versatile motor control software development kits (MCU Motor Studio). [Note 3]

[Note 1] VE is integrated into some products

[Note 2] Pulse Width Modulation

[Note 3] MCU Motor Studio supports some products and will expand in TXZ+™ family.




Lineup

| Series | Group | Function |
|---|---|---|
| TXZ+™ 4A Series | M4K Group | Arm® Cortex®-M4, Max. 160 MHz operation 4.5 to 5.5 V, 3motor control (Max), Data Flash |
| TX04 Series | M470 Group | Arm® Cortex®-M4, Max. 160 MHz operation 4.5 to 5.5 V, 2motor control (Max) |
| TX03 Series | M370 Group | Arm® Cortex®-M3, 80 MHz operation 4.5 to 5.5 V, 2motor control (Max) |

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Value provided

# MCU is equipped with many peripheral functions. MCU contributes to higher functionality as a system control MCU.

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

MCU is equipped with Arm® Cortex®-M3 core. Maximum operation frequency is 120 MHz.

## 2 Various lineup of built-in memories and packages

M3H group integrates both 512 KB (Max) code and 32 KB data flash memories which support 100,000 write cycle endurance (Max), and has a wide lineup of package from 64 to 144 pins.

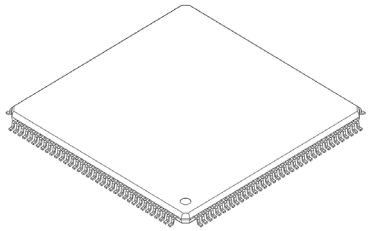
## 3 Equipped with many peripheral functions

M3H Group have many peripheral functions such as UART, SPI, I²C, 12bit AD converter, 8bit DA converter, three-phase PWM [Note1] output, ENC and digital LCD driver [Note2], etc.

[Note 1] Pulse Width Modulation

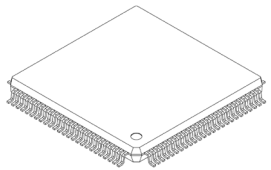
[Note2] 64 pin products aren't equipped with digital LCD driver.

TMPM3HQF10BFG
TMPM3HQFDAFG



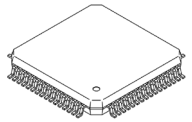
P-LQFP144-2020-0.50-002
(22.0 x 22.0 x 1.7 mm)

TMPM3HNF10BFG
TMPM3HNFDAFG



P-LQFP100-1414-0.50-002
(16.0 x 16.0 x 1.7 mm)

TMPM3HLF10BUG
TMPM3HLFDAUG



P-LQFP64-1010-0.50-003
(12.0 x 12.0 x 1.7 mm)

Lineup

| | | | | |
|---|---|---|---|---|
| Part number | M3H (2) | TMPM3HQF10BFG | TMPM3HNF10BFG | TMPM3HLF10BUG |
| | M3H (1) | TMPM3HQFD/Z/Y/AFG | TMPM3HNFD/Z/Y/AFG | TMPM3HLFD/Z/Y/AUG |
| Max. operation frequency | | 120 MHz | | |
| ROM (Flash) | M3H (2) | 1024 KB | | |
| | 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, I²C: 4ch, TSPI: 5ch | UART: 8ch, I²C: 3ch, TSPI: 4ch | UART: 7ch, I²C: 2ch, TSPI: 1ch |
| Package | | P-LQFP144-2020-0.50-002 | P-LQFP100-1414-0.50-002 | P-LQFP64-1010-0.50-003 |

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# 11 TVS diode

## DF2B7BSL / DF2B5M4SL / DF2B6M4SL

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

## Absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

### 1 High ESD pulse absorption performance

Improved ESD absorption compared to Toshiba's conventional products. (50 % reduction in operating resistance) For some products, both low operating resistance and low capacitance are realized and ensures high signal protection performance and signal quality.

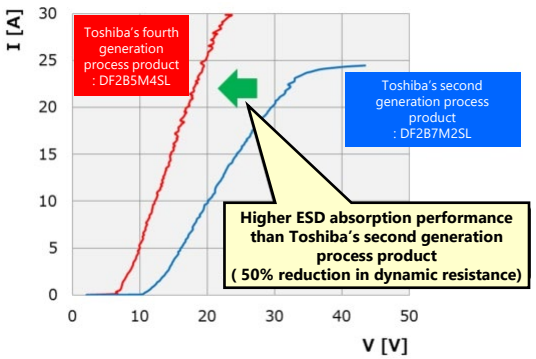
### 2 Suppress ESD energy by low clamp voltage

Protect the connected circuits and devices using Toshiba own technology.

### 3 Suitable for high density mounting

A variety of small size packages are available.

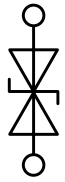
ESD Pulse Absorption Performance
(Toshiba internal comparison)




**Unidirectional**

Suitable for paths such as logic signals. There are lineups of 1in1, 2in1, 4in1, 5in1, 7in1.

**Bidirectional**



Suitable for paths with both polar signals such as audio signals.

Lineup

| Part number | DF2B7BSL | DF2B5M4SL | DF2B6M4SL |
|---|---|---|---|
| Package | SL2 |  Top view |  Bottom view |
| $V_{ESD}$ [kV] | ±30 | ±20 | ±20 |
| $V_{RWM}$ (Max) [V] | 5.5 | 3.6 | 5.5 |
| $C_t$ (Typ.) [pF] | 12 | 0.2 | 0.2 |
| $R_{DYN}$ (Typ.) [Ω] | 0.2 | 0.5 | 0.5 |

(NOTE) This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

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# Low current consumption op-amp / Low noise op-amp

## TC75S102F / TC75S67TU

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**The lineup includes a low current consumption type that contributes to reducing power consumption and a low noise type that brings out performance of the sensor.**

### 1 Low voltage operation

We have a lineup of low power supply voltage-driven operational amplifiers using CMOS process for low power supply voltage-driven wearable equipment.

### 2 Low current consumption

**(TC75S102F) $I_{DD}$ = 0.27 [µA] (Typ.)**

CMOS processes have been used to achieve lower current consumption. This contributes to lower power consumption and longer life of wearable equipment.

### 3 Low noise (TC75S67TU)

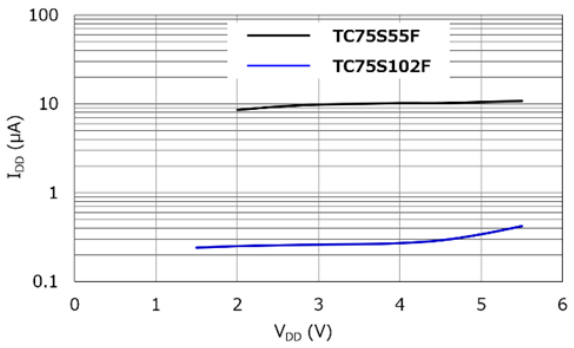
**$V_{NI}$ = 6.0 [nV/√Hz] (Typ.) @f = 1 kHz**

This CMOS operational amplifier can amplify minute signals detected by various sensors [Note] with low noises. By optimizing the process, the equivalent input noise voltage has been reduced.

[Note] Sensor types: vibration, shock, acceleration, pressure, infrared, temperature, etc.

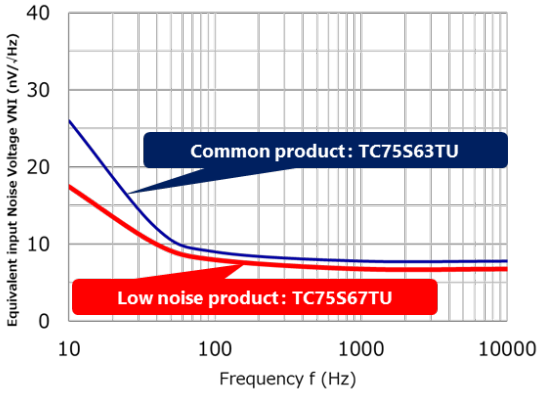
**TC75S102F**

Current Consumption Characteristic
(Toshiba internal comparison)




**TC75S67TU**

Noise Characteristic
(Toshiba internal comparison)




Lineup

| Part number | TC75S102F | TC75S67TU |
|---|---|---|
| Package | SMV  | UFV  |
| $V_{DD}$ - $V_{SS}$ [V] | 1.5 to 5.5 | 2.2 to 5.5 |
| $V_{IO}$ (Max) [mV] | 1.3 | 3 |
| $CMV_{IN}$ (Max) [V] | $V_{DD}$ | 1.4 (@$V_{DD}$ = 2.5 V) |
| $I_{DD}$ (Typ. / Max) [µA] | 0.27 / 0.46 (@$V_{DD}$ = 1.5 V) | 430 / 700 (@$V_{DD}$ = 2.5 V) |
| $V_{NI}$ (Typ.) [nV/√Hz] @f = 1 kHz | - | 6.0 |

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# 13 Transistor array

## TBD62003AFWG / TBD62083AFG / TBD62064AFAG

Brushless DC motor drive | High efficiency · low loss | Small size packages

Value provided

**DMOS FET is used for the output of drive circuit and realizes low loss. And CMOS input can control directly from controller's I/O, etc.**

### 1 Rich product lineup

In addition to the listed products, we have lineup of various packaged products (such as DIP, SOL, SOP, SSOP, etc.) and source output type products.

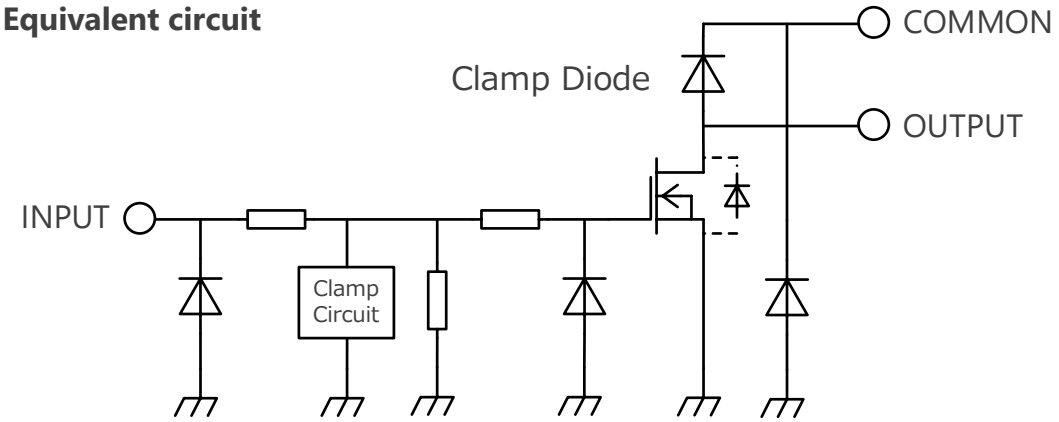
### 2 Built-in output clamp diode

Built-in output clamp diode regenerates the back electromotive force generated by switching of an inductive.

### 3 Higher current drive is possible

The load can be driven with higher current by connecting multiple outputs in parallel.

**Equivalent circuit**




[Note] Equivalent circuit may be simplified for explanatory purpose.

Lineup

| Part number | TBD62003AFWG | TBD62083AFG | TBD62064AFAG |
|---|---|---|---|
| Package | P-SOP16-0410-1.27-002 | SOP18-P-375-1.27 | P-SSOP24-0613-1.00-001 |
| Output type | Sink | Sink | Sink |
| Number of channels | 7ch | 8ch | 4ch |
| Input level | H | H | H |
| $I_{OUT}$ [mA/ch] | 500 | 500 | 1500 |
| $V_{OUT}$ [V] | 50 | 50 | 50 |

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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

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