Air Cleaner

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 Cleaner  Overall block diagram

AC Input

AC-DC  DC 10 V

Regulator

DC 5 V

Regulator  DC 3 V

Dust Sensor Module

EEPROM

MCU

Mode Switch

LEDs

Display

Single Phase AC Motor

Transistor

Regulator

EEPROM

Display

Regulator

LEDs

Single Phase AC Motor
Air Cleaner  Detail of power supply unit

**Flyback type AC-DC converter circuit**

Criteria for device selection
- A photocoupler with high current transfer ratio in the low input current range contributes to high power supply efficiency.
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba
- **High current transfer ratio and high temperature operation are realized**
  Transistor output photocoupler

*Click the number in the circuit diagram to jump to the detailed description page*
Air Cleaner  Detail of main motor unit (1)

Main motor drive unit
(When AC motor is used)

Criteria for device selection
- Small package products contribute to the reduction of circuit board area.
- Stable motor driving can be realized by using bipolar transistors, which have higher ESD tolerance than MOSFET.

Proposals from Toshiba
- Suitable for rectification
  Rectifier diode
- Suitable for use in small current switches
  Bipolar transistor
- System control at low power consumption with analog interfaces
  MCU TMPM036FWFG / TMPM037FWUG

*Click the number in the circuit diagram to jump to the detailed description page
Main motor drive unit
(When brushless DC motor is used)

Criteria for device selection
- The use of IPD enables direct variable speed driving of brushless DC motors.
- Brushless DC motor controller allows easy control of three-phase brushless DC motor using inverter control.
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba
- **High voltage motor can be driven**
  High voltage IPD
- **Easy motor control**
  Brushless DC motor controller IC
- **System control at low power consumption with analog interfaces**
  MCU TMPM036FWFG / TMPM037FWUG

*Click the number in the circuit diagram to jump to the detailed description page*
Air Cleaner  Detail of dust sensor unit

Dust sensor section

Criteria for device selection
- Small package products contribute to the reduction of circuit board area.
- Low noise operational amplifiers are suitable for high precision sensing.

Proposals from Toshiba
- **Amplify the detected very small signal with low noise**
  Low current consumption op-amp / Low noise op-amp

*Click the number in the circuit diagram to jump to the detailed description page*
Air Cleaner  Detail of operation unit

Operation unit  (Example of Key/LED)

- Key/7-seg LED
- Relay
- Buzzer
- LED Driver
- MCU

Operation unit  (Example of touch panel)

- Panel Key/LED
- LED Driver
- Haptics
- Touch & Front Panel Controller
- MCU

Criteria for device selection

- An MCU which has analog interfaces with low power consumption is suitable for monitoring of various sensors and system control.

Proposals from Toshiba

- System control at low power consumption with analog interfaces
  - MCU TMPM036FWFG / TMPM037FWUG

*Click the number in the circuit diagram to jump to the detailed description page.*
Recommended Devices
As described above, in the design of Air Cleaner, “High efficiency”, “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>Description</th>
<th>Brushless DC motorization</th>
<th>High efficiency - Low loss</th>
<th>Small size packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rectifier diode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bipolar transistor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>High voltage IPD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Low current consumption op-amp / Low noise op-amp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Transistor output photocoupler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Brushless DC motor controller IC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>MCU TMPM036FWFG / TMPM037FWUG</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Value provided

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

1 Surface mount / small package

The use of M-FLAT™ packages contributes to the reduction of height and space saving of equipment compared to previous lead type devices [Note].

[Note] Comparison with Toshiba's products

2 Wide product lineup

A lineup of repetitive peak reverse voltages of 200 to 1000 V and average forward current of 0.5 to 3 A is available, enabling the selection of devices according to requirements.

Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>CMG06A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>M-FLAT™</td>
</tr>
<tr>
<td>$I_L$ (A)</td>
<td>1</td>
</tr>
<tr>
<td>$V_{RMM}$ (V)</td>
<td>600</td>
</tr>
</tbody>
</table>

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With wide product lineup, Toshiba provides products that meet the needs of customers.

1. **Wide package lineup**
   A large number of packages, such as flat lead and leadless, are available, allowing to choose products that suit circuit boards of the set.

2. **Low collector-emitter saturation voltage**
   The low saturation voltage between the collector and emitter realize lower power consumption.

3. **High ESD resistance**
   In applications where static electricity is likely to occur, such as air cleaners, bipolar transistors with higher ESD resistance than MOSFET are needed.

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**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>2SC6026CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>NPN</td>
</tr>
<tr>
<td>Package</td>
<td>CST3</td>
</tr>
<tr>
<td>$V_{CEO}$ [V]</td>
<td>50</td>
</tr>
<tr>
<td>$I_C$ [mA]</td>
<td>100</td>
</tr>
</tbody>
</table>

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High voltage IPD
TPD4162F

Value provided

This product optimizes for brushless DC motor driving and has the functions required for motor driving into one package.

1 Contributing to low power consumption

The power consumption can be reduced by replacing from the AC motor to a brushless DC motor.

2 Contributing to reducing the number of parts

Built-in functions and protection functions required for inverter operation can reduce the number of parts.

3 Contributing to reduction of circuit board area

The use of small surface mount packages contributes to the reduction of circuit board area.

Part number: TPD4162F

<table>
<thead>
<tr>
<th>Package</th>
<th>V_{BB} [V]</th>
<th>I_{out} [A]</th>
<th>V_{CC} (Max) [V]</th>
<th>Protective function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-HSSOP31-0918-0.80-002</td>
<td>600</td>
<td>0.7</td>
<td>17.5</td>
<td>Current limitation, overcurrent protection, thermal shutdown, under voltage protection</td>
</tr>
</tbody>
</table>

Support Hall devices
Built-in bootstrap diode
Built-in square wave energizing circuit
Built-in protection functions
Built-in three-phase inverter circuit

Return to Block Diagram TOP
A brushless DC motor driver with a built-in MOSFET can be driven at a variable speed by control signals from the MCU.

1 **Built-in circuit required to drive the motor**

It contains a level shifting high side driver, low side driver and MOSFETs or IGBTs.

TPD4204F: MOSFET output
TPD4163F/TPD4163K/TPD4164F/TPD4164K: IGBT output

2 **Motor drive terminals and control terminals are separated**

High voltage and large current terminals and the control terminals are separated on both sides of the package, thereby eliminating the complexity of wiring.

3 **Various protection functions**

Over current and under voltage protection, shutdown and thermal shutdown functions are available.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPD4204F</th>
<th>TPD4163F</th>
<th>TPD4164F</th>
<th>TPD4163K</th>
<th>TPD4164K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>P-SSOP30-1120-1.00-001</td>
<td>P-HSSOP31-0918-0.80-002</td>
<td>P-HDIP30-1233-1.78-001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BB}$ [V]</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{out}$ [A]</td>
<td>2.5</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>$V_{CC}$ [V]</td>
<td></td>
<td>13.5 to 16.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Lineup includes low current consumption type that contributes to low power consumption and a low noise type that maximizes the performance of high performance sensors.

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)**

TC75S102F

Current Consumption Characteristic

(Toshiba internal comparison)

<table>
<thead>
<tr>
<th>Part number</th>
<th>TC75S102F</th>
<th>TC75S67TU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SMV</td>
<td>UFV</td>
</tr>
<tr>
<td>$V_{DD}$ - $V_{SS}$ [V]</td>
<td>1.5 to 5.5</td>
<td>2.2 to 5.5</td>
</tr>
<tr>
<td>$V_{CC}$ (Max) [mV]</td>
<td>1.3</td>
<td>3</td>
</tr>
<tr>
<td>CMV$_{IN}$ (Max) [V]</td>
<td>$V_{DD}$</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td>$I_{DD}$ (Typ. / Max) [μA]</td>
<td>0.27 / 0.46 (@$V_{DD}$ = 1.5 V)</td>
<td>430 / 700 (@$V_{DD}$ = 2.5 V)</td>
</tr>
<tr>
<td>$V_{NI}$ (Typ.) [nV/√Hz]</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Reduce 1/f noise (10 Hz) by 86% from our normal products

$V_{NI}$ = $f$ @Ta = 25°C, $V_{DD}$ = 3.3 V

3. **Low noise (TC75S67TU)**

TC75S67TU

Noise Characteristic

(Toshiba internal comparison)

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

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

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.

<table>
<thead>
<tr>
<th>Part number</th>
<th>TC75S102F</th>
<th>TC75S67TU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SMV</td>
<td>UFV</td>
</tr>
<tr>
<td>$V_{DD}$ - $V_{SS}$ [V]</td>
<td>1.5 to 5.5</td>
<td>2.2 to 5.5</td>
</tr>
<tr>
<td>$V_{CC}$ (Max) [mV]</td>
<td>1.3</td>
<td>3</td>
</tr>
<tr>
<td>CMV$_{IN}$ (Max) [V]</td>
<td>$V_{DD}$</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td>$I_{DD}$ (Typ. / Max) [μA]</td>
<td>0.27 / 0.46 (@$V_{DD}$ = 1.5 V)</td>
<td>430 / 700 (@$V_{DD}$ = 2.5 V)</td>
</tr>
<tr>
<td>$V_{NI}$ (Typ.) [nV/√Hz]</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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Transistor output photocoupler
TLP383 / TLP293 / TLP385

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 conventional products (TLP385), higher CTR (Current Transfer Ratio) in low input current range (@$I_F = 0.5 \ mA$) is realized.

![Graph showing current transfer ratio vs. LED input current for TLP383 and TLP293 compared to Toshiba's conventional product.](image)

2 High temperature operation

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

Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP383</th>
<th>TLP293</th>
<th>TLP385</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>4pin SO6L</td>
<td>SO4</td>
<td>4pin SO6L</td>
</tr>
<tr>
<td>$BV_S$ [Vrms]</td>
<td>5000</td>
<td>3750</td>
<td>5000</td>
</tr>
<tr>
<td>$T_{opr}$ [°C]</td>
<td>-55 to 125</td>
<td>-55 to 125</td>
<td>-55 to 110</td>
</tr>
</tbody>
</table>

(Note) Toshiba internal comparison

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By using IPD externally to the controller, high voltage and high current brushless DC motor drive is realized.

1 **Efficient motor control using auto lead angle control**

In addition to fixed angle control using voltage input (32 steps), auto lead angle control using current feedback is possible.

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].

(TB6584FNG, TB6584AFNG)

3 **Full development support**

Third party evaluation boards and PSpice® data can be provided to support customer development and design.

[Note] Comparison with Toshiba products

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**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB6584FNG</th>
<th>TB6584AFNG</th>
<th>TB6586AFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC [V]</td>
<td>6 to 16.5</td>
<td>6.5 to 16.5</td>
<td></td>
</tr>
<tr>
<td>IOUT [A]</td>
<td>0.002</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Drive mode</td>
<td>Sine wave drive</td>
<td>Square wave drive</td>
<td></td>
</tr>
<tr>
<td>Features</td>
<td>Lead angle control: Auto phase control (current feedback) Sensor input: Hall device/Hall IC compatible Internal regulator: 5 V, 30 mA (Max) Error detection: Overcurrent protection, position signal error, low voltage</td>
<td>Lead angle control: External input Sensor input: Hall device/Hall IC compatible Internal regulator: 5 V, 35 mA (Max) Error detection: Overcurrent protection, position signal error, low voltage</td>
<td></td>
</tr>
</tbody>
</table>

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Package: SSOP30-P-300-0.65 (10.2 x 7.6 x 1.6 mm)
Value provided

It contributes to system cost down, high efficiency system and development efficiency improvement.

1. **Built-in Arm® Cortex®-M0 CPU core**
   
   Built-in Arm Cortex-M0 core with Arm® Thumb® instruction set improves energy efficiency. Various development tool and their partners allow users many options.

2. **Suitable for sensing analog signal**
   
   Built-in multichannel AD converter executes sensing data processing efficiently at low cost.

3. **Small package and low power consumption**
   
   Cortex-M0 and Toshiba original NANO FLASH™ technology bring to the small package and low power consumption. They contribute to reduce circuit board area and power consumption.

### TMPM036FWFG

- Part number: TMPM036FWFG
- Package: LQFP100-P-1414-0.50H

### TMPM037FWUG

- Part number: TMPM037FWUG
- Package: LQFP64-P-1010-0.50E

#### Lineup

<table>
<thead>
<tr>
<th>Feature</th>
<th>TMPM036FWFG</th>
<th>TMPM037FWUG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operation frequency</td>
<td>20 MHz</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Instruction ROM</td>
<td>128 KB</td>
<td>128 KB</td>
</tr>
<tr>
<td>RAM</td>
<td>16 KB</td>
<td>16 KB</td>
</tr>
<tr>
<td>Timer</td>
<td>14ch</td>
<td>10ch</td>
</tr>
<tr>
<td>UART / SIO</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>I2C</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>AD converter</td>
<td>8ch (10bit)</td>
<td>8ch (10bit)</td>
</tr>
</tbody>
</table>

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