Warm Water Bidet

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
Warm Water Bidet  Overall block diagram

- **12 V**: Motor, Pump, Fan
- **Up to 5 V**: MCU, Sensor, LED, etc.

**Components**:
- AC-DC Converter
- DC-DC Converter
- Seating Sensor
- Water Tap Valve
- Heater Toilet Seat
- Heater Warm Water
- Isolation
- Isolation
- Isolation
- Open/Close Sensor
- Remote Control Receiver
- Beep/Indicator
- Flash
- MCU

**Additional Components**:
- Shower Pump
- Nozzle Movement
- Transistor Array
- MOSFET /MCD
- MOSFET /MCD
- MOSFET /MCD
- Lid and Seat Open/Close Motor
- Deodorizing Fan
- Drying Air Fan

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
Warm Water Bidet  Details of fan motor drive / LED drive

Fan motor drive circuit

AC → AC-DC → DC-DC

Current Detection

MCU → Op-amp → MOSFET → Fan Motor

12 V DC

1

2

3

Fan motor drive circuit
(with MCD)

MCU → MCD → M

11

9a

9b

LED drive circuit

AC → AC-DC → DC-DC

MCU → MOSFET → Status LED

11

1

9a

9b

Criteria for device selection

- MOSFETs with low on-resistance contribute to low loss of the set.
- Small package products contribute to the reduction of circuit board area.
- Operational amplifiers are suitable for amplifying signals such as current sensing.

Proposals from Toshiba

- Low on-resistance realizes a set with low power consumption
  Small signal MOSFET
- Operational amplifier with integrated phase compensation circuit
  General purpose operational amplifier
- Small surface mount package suitable for high density mounting
  Rectifier diode
- Motor controller with MOSFET that can easily drive brushless DC motor
  Brushless DC motor driver IC (Built-in MOSFET)
- Built-in analog input interface, low power consumption, efficient software development
  MCU M380 Group

※ Click on the number in the circuit diagram to jump to the detailed description page
Warm Water Bidet  Details of heater/water tap control unit

Criteria for device selection
- A triac output photocoupler is suitable to control AC load.

Proposals from Toshiba
- Efficient control of AC load
  Triac output photocoupler
- Built-in analog input interface,
  low power consumption,
  efficient software development
  MCU M380 Group

※ Click on the number in the circuit diagram to jump to the detailed description page
Warm Water Bidet  Details of lid and seat open/close motor drive unit

Lid and seat open/close brushed DC motor drive circuit

Criteria for device selection
- It is necessary to select a MOSFET with the suitable rated voltage and rated current for the motor rating.
- It is necessary to select gate drivers with the suitable for the MOSFET characteristics.
- Using MOSFETs with a high heat dissipation package makes it easier to design heat dissipation.

Proposals from Toshiba
- **Realize low power consumption of the set with low on-resistance**
  U-MOS Series N-ch MOSFET
  U-MOS Series P-ch MOSFET
- **Realize full-bridge drive circuit**
  Intelligent power device (IPD)
- **Low power drive using BiCD process**
  Brushed DC motor driver IC (Built-in MOSFET)
- **Built-in analog input interface, low power consumption, efficient software development**
  MCU M380 Group

Lid and seat open/close brushed DC motor drive circuit
(with MCD)

※ Click on the number in the circuit diagram to jump to the detailed description page
Warm Water Bidet  Detail of power supply unit

Flyback type AC-DC converter circuit

- **Criteria for device selection**
  - A transistor output photocoupler with high current transfer ratio is suitable for the power supply feedback circuit.
  - Small package products contribute to the reduction of circuit board area.

- **Proposal from Toshiba**
  - High current transfer ratio and high temperature operation makes easy to design.
  
  Transistor output photocoupler

※ Click on the number in the circuit diagram to jump to the detailed description page
Warm Water Bidet  Detail of Nozzle control unit

Nozzle motor drive circuit  (with transistor array)

Criteria for device selection
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba
- Built-in analog input interface, low power consumption, efficient software development
  MCU M380 Group
- Efficiency is improved by adopting BiCD process
  Transistor array

※ Click on the number in the circuit diagram to jump to the detailed description page
Recommended Devices
As described above, in the design of warm water bidet, “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>High efficiency</th>
<th>Low loss</th>
<th>Small size packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small signal MOSFET</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>2</td>
<td>General purpose operational amplifier</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>3</td>
<td>Rectifier diode</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>4</td>
<td>Triac output photocoupler</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>5</td>
<td>U-MOS Series N-ch MOSFET</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>6</td>
<td>U-MOS Series P-ch MOSFET</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>7</td>
<td>Intelligent power device (IPD)</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>8</td>
<td>Transistor output photocoupler</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>9a</td>
<td>Brushless DC motor driver IC (Built-in MOSFET)</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>9b</td>
<td>Brushed DC motor driver IC (Built-in MOSFET)</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>10a</td>
<td>MCU M380 Group</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
<tr>
<td>10b</td>
<td>Transistor array</td>
<td>![High efficiency icon]</td>
<td>![Small size packages icon]</td>
</tr>
</tbody>
</table>
Small signal MOSFET
SSM3K56MFV / SSM6N56FE

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 Fast switching speed

Reducing switching loss by high speed operation contributes to higher efficiency.

Trade-off characteristics of on-resistance and gate input charge

(Note: Toshiba internal comparison)

<table>
<thead>
<tr>
<th>Lineup</th>
<th>Part number</th>
<th>SSM3K56MFV</th>
<th>SSM6N56FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>VESM</td>
<td>ESG</td>
<td></td>
</tr>
<tr>
<td>V_{DSS} [V]</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>I_{D} [A]</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>R_{DSON} (Ω) @V_{GS} = 4.5 V</td>
<td>Typ. 0.186</td>
<td>0.186</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max 0.235</td>
<td>0.235</td>
<td></td>
</tr>
<tr>
<td>Polarity</td>
<td>N-ch</td>
<td>N-ch x 2</td>
<td></td>
</tr>
<tr>
<td>Generation</td>
<td>U-MOSⅦ-H</td>
<td>U-MOSⅦ-H</td>
<td></td>
</tr>
</tbody>
</table>

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
CMOS single operation amplifier with a built-in phase compensator, low voltage drive, and low current power supply.

1. Low voltage operation is possible.

Compared with bipolar general purpose operational amplifiers, low voltage operation is possible [Note].

\[ V_{DD} = \pm 0.75 \text{ to } \pm 3.5 \text{ V or } 1.5 \text{ to } 7 \text{ V (for TC75S51FU)} \]

[Note] Comparison with Toshiba’s products

2. Built-in phase compensator circuit

Because the phase compensation circuit is built-in, there is no need for any external device.

TC75S51FU
Characteristics chart

<table>
<thead>
<tr>
<th>Part number</th>
<th>TC75S51FU</th>
<th>TC75S103F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>USV</td>
<td>SMV</td>
</tr>
<tr>
<td>( V_{DD} - V_{SS} ) [V]</td>
<td>1.5 to 7.0</td>
<td>1.8 to 5.5</td>
</tr>
<tr>
<td>( I_{DD} ) (Typ. / Max) [( \mu A )]</td>
<td>60 / 200 (@( V_{DD} = 3.0 ) V)</td>
<td>100 / 165 (@( V_{DD} = 3.3 ) V)</td>
</tr>
<tr>
<td>( f_t ) (Typ.) [MHz]</td>
<td>0.6</td>
<td>0.36</td>
</tr>
<tr>
<td>Input, Output Full Range</td>
<td>-</td>
<td>✔</td>
</tr>
</tbody>
</table>
Wide range of products are provided, mainly small package that is suitable for high density assembly.

1. **Surface mount / small package**

Adopting M-FLAT™ package which is lower in height compared to Toshiba conventional lead type contributes to the space saving of the equipment [Note].

[Note] Comparison with Toshiba's products

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

<table>
<thead>
<tr>
<th>Part number</th>
<th>CMG06A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>M-FLAT™</td>
</tr>
<tr>
<td>$I_{F(AV)}$ [A]</td>
<td>1</td>
</tr>
<tr>
<td>$V_{RRM}$ [V]</td>
<td>600</td>
</tr>
</tbody>
</table>
This photocoupler consists of a non zero crossing photo triac, optically coupled to an infrared light emitting diode.

1. **Non zero cross type**
   
   This photocoupler is suitable for the case where the operation time is short and phase control is necessary.

2. **Switching characteristic**
   
   It has excellent features such as high speed, low noise and silence.

3. **Miniaturization of mounting area**
   
   4pin SO6 packages have a size of 3.7 x 7.0 x 2.1 mm. (TLP267J)

---

**Lineup**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>TLP267J</th>
<th>TLP3052A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>4pin SO6</td>
<td>5pin DIP6</td>
</tr>
<tr>
<td>$V_{DRM}$ [V]</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>$BV_L$ [Vrms]</td>
<td>3750</td>
<td>5000</td>
</tr>
<tr>
<td>$T_{opr}$ ($^\circ$C)</td>
<td>-40 to 100</td>
<td>-40 to 100</td>
</tr>
<tr>
<td>Type</td>
<td>Non-zero-voltage turn-on</td>
<td></td>
</tr>
</tbody>
</table>

---

**Internal connection**

UL-approved : UL1577, File No. E67349  
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349  
VDE-approved: EN60747-5-5, EN62368-1 (Note)  
(Note) When a VDE approved type is needed, please designate the Option (V4).
RonA characteristic has been improved and contributes to energy saving and miniaturization.

1. **Low on-resistance**

By reducing on-resistance between drain and source, heat generation and power consumption can be kept low, and it can contribute to miniaturization.

2. **Small total gate charge**

Reducing total gate charge reduces the performance required for driving the MOSFET, thereby improving the switching characteristics.

3. **Fast switching speed**

Reducing switching loss by high speed operation contributes to improving efficiency.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPH2R903PL</th>
<th>TPH3R003PL</th>
<th>TPH4R803PL</th>
<th>TPN2R903PL</th>
<th>TPN5R203PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SOP Advance</td>
<td>TSON Advance</td>
<td>SOP Advance</td>
<td>TSON Advance</td>
<td>TSON Advance</td>
</tr>
<tr>
<td>$V_{DSS}$ [V]</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>$I_D$ [A]</td>
<td>70 (124*)</td>
<td>88 (134*)</td>
<td>48 (90*)</td>
<td>70 (122*)</td>
<td>38 (76*)</td>
</tr>
<tr>
<td>$R_{DS(ON)}$ [mΩ]</td>
<td>2.1</td>
<td>2.2</td>
<td>3.6</td>
<td>2.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Polarity</td>
<td>N-ch</td>
<td>N-ch</td>
<td>N-ch</td>
<td>N-ch</td>
<td>N-ch</td>
</tr>
</tbody>
</table>

* Silicon limit

(Note: Toshiba internal comparison)
RonA characteristic has been improved and contributes to energy saving and miniaturization.

1. **Low on-resistance**

By reducing on-resistance between drain and source, heat generation and power consumption can be kept low, and it can contribute to miniaturization.

2. **Small total gate charge**

Reducing total gate charge reduces the performance required for driving the MOSFET, thereby improving the switching characteristics.

**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPCA8120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SOP Advance</td>
</tr>
<tr>
<td>$V_{DSS}$ [V]</td>
<td>-30</td>
</tr>
<tr>
<td>$I_{D}$ [A]</td>
<td>-45</td>
</tr>
<tr>
<td>$R_{DSON}$ [mΩ] @ $V_{GS} = -10$ V</td>
<td>Typ. 2.4 Max 3.0</td>
</tr>
<tr>
<td>Polarity</td>
<td>P-ch</td>
</tr>
<tr>
<td>Generation</td>
<td>U-MOSVI</td>
</tr>
</tbody>
</table>

(Note: Toshiba internal comparison)
Intelligent power device (IPD)
TPD7211F

A gate driver with half bridge output, which can be driven with a high current (±500 mA maximum).

1. **Half bridge type**
   It is a half-bridge type gate driver and is suitable for high side P-ch type and low side N-ch type power MOSFET driving.

2. **Can be driven with a high current**
   The output current rating of ±500 mA is secured, and high current driving is possible.

3. **Small package**
   It is packaged in the small PS-8 package. PS-8 : 2.8 x 2.9 x 0.8 mm

Internal block diagram and an example of application circuit of TPD7211F

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPD7211F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Package</strong></td>
<td>PS-8</td>
</tr>
<tr>
<td><strong>V_{DDopr} [V]</strong></td>
<td>5 to 18</td>
</tr>
<tr>
<td><strong>I_{OUT} [mA]</strong></td>
<td>±500</td>
</tr>
<tr>
<td><strong>T_{opr} [°C]</strong></td>
<td>-40 to 125</td>
</tr>
</tbody>
</table>

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
## High current transfer ratio is realized even in the low input current range ($I_F = 0.5$ mA).

1. **High current transfer ratio**

   Phototransistor and InGaAs infrared light emitting diode are optically coupled. Highly isolated photocouplers realize higher CTR than Toshiba’s conventional products in low input current range ($@ I_F = 0.5$ mA).

2. **The operating temperature range is extended to 125 °C**

   It is designed to operate under severe conditions of ambient temperature environment.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP383</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>4pin SO6L</td>
</tr>
<tr>
<td>$I_C/I_F$ (%) $@ I_F = 0.5$ mA, $5$ mA</td>
<td>$50$ to $600$</td>
</tr>
<tr>
<td>$t_{on}$ (Typ.) $[\mu s] @ I_F = 1.6$ mA</td>
<td>$28$</td>
</tr>
<tr>
<td>$BV_C [V_{rms}]$</td>
<td>$5000$</td>
</tr>
<tr>
<td>$T_{opr} [^\circ C]$</td>
<td>$-55$ to $125$</td>
</tr>
</tbody>
</table>

(Note: Toshiba internal comparison)

---

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
**Single phase brushless DC motor driver** (Built-in MOSFET)
TC78B002FNG / TC78B002FTG

**Simple fan motor drive with low noise & low vibration.**

1. **Suitable for small fan motor**
   It is a single phase full wave driver and suitable for small brushless DC fan motor.

2. **Low noise and low vibration motor driving**
   Smooth waveform by soft switching drive realizes low noise and low vibration driving of motor.

3. **Small package**
   Small WQFN16 package with high heat dissipation. (TC78B002FTG)

---

**WQFN16 Package (3 x 3 x 0.75 mm)**

---

**Lineup**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC78B002FNG</th>
<th>TC78B002FTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>TC78B002FNG</td>
<td>TC78B002FTG</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5.5 to 16 V</td>
<td>(operating range)</td>
</tr>
<tr>
<td>Output current</td>
<td>1.5 A</td>
<td>(operating range)</td>
</tr>
<tr>
<td>Drive type</td>
<td>Single phase full wave drive</td>
<td></td>
</tr>
</tbody>
</table>
| Features & Others        | PWM control, Soft switching drive  
Quick start, Hall bias circuit  
Error detection: Current limit, Thermal shutdown |
| Package                  | SSOP16      | WQFN16      |

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
Toshiba's proprietary technology eliminates the need for phase adjustment and achieves high efficiency for a wide range of rotation speeds.

1. **High efficiency is achieved for a wide range of rotation speeds**
   Toshiba's proprietary automatic advance angle control technology ensures high efficiency motor control at all times, regardless of motor speed, load torque and 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].

3. **Low loss, Low heat**
   Since the output on-resistance is a small 0.24 Ω (Typ.), the power loss of the IC itself during operation can be kept low.

### Lineup

<table>
<thead>
<tr>
<th>Features</th>
<th>Part number</th>
<th>Power supply voltage</th>
<th>Output current</th>
<th>Drive system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase control : Optimum phase control of voltage and current Hall device / Hall IC compatible Speed control input: PWM signal/ analog voltage input Error detection: Thermal shutdown, overcurrent detection, motor lockout detection Output ON-resistance (sum of top and bottom): 0.24 Ω (Typ.)</td>
<td>TC78B016FTG</td>
<td>6 to 30 V (operating range)</td>
<td>3 A (operating range)</td>
<td>Sine wave drive system</td>
</tr>
</tbody>
</table>

**WQFN36 package (5 x 5 x 0.8 mm)**

[Note] Comparison with Toshiba products
1ch brushed DC motor driver (Built-in MOSFET) TB67H450AFNG / TB67H451AFNG

High voltage, high current and low power consumption characteristics are realized by BiCD process. These are simple single channel version.

1 High voltage (50 V) / High current

Maximum rating of the output voltage is improved to 50 V to allow margin for air discharge test, etc.

2 Wide operation voltage range

Wide power supply voltage range from 4.5 to 44 V supports battery drive applications.

3 Popular package

HSOP8 package compatible with competitor’s products or Toshiba’s conventional products is adopted.

---

**Simple solution**

- **Part number**: TB67H450AFNG, TB67H451AFNG
- **Motor type**: Brushed DC motor
- **Output voltage [V]**: 50
- **Output current [A]**: 3.5
- **Output on-resistance (High side + Low side) (Typ.) [Ω]**: 0.6
- **Output circuit**: 1 circuit
- **Control interface**: 1 mode
- **Phase mode**: 2-phase, 1-2 phase excitation
- **Abnormality detection function**: Thermal shutdown, over current, under voltage lockout
- **Package**: HSOP8

---

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
2ch brushed DC motor driver (Built-in MOSFET) 
TB67H400AFNG / TB67H400AFTG / TB67H400AHG / TB67H400ANG / TB67H410FTG / TB67H410NG

High voltage, high current and low power consumption characteristics are realized by BiCD process. These 2-channel versions can also drive stepping motors.

1. High voltage (50 V)/ High current
   Maximum rating of the output voltage is improved to 50 V to allow margin for air discharge test, etc. In addition, the parallel control function (Large mode) of the output part supports one channel high current driving.

2. 3 selectable drive modes
   The H-bridge combination can be tailored according to the type of motor and the required current capacity as (1) single stepping motor drive, (2) dual brushed DC motor drive and (3) High current, single brushed DC motor drive.

3. Various package types
   TB67H400A offers four types (HTSSOP48, WQFN48, HZIP25 and SDIP24) and TB67H410 offers two types (WQFN48 and SDIP24) of packages.

- 3 selectable drive modes
  (1) Single stepping motor drive
  (2) Dual brushed DC motor drive
  (3) High current, single brushed DC motor drive

Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB67H400AFNG / FTG / HG / NG</th>
<th>TB67H410FTG / NG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor type</td>
<td>Brushed DC motor</td>
<td></td>
</tr>
<tr>
<td>Output voltage [V]</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Output current [A]</td>
<td>4.0 (Small mode) / 2.5 (Small mode)</td>
<td></td>
</tr>
<tr>
<td>Output on-resistance (High side + Low side) [Ω] (Typ.)</td>
<td>0.49 (Small mode) / 0.8 (Small mode)</td>
<td></td>
</tr>
<tr>
<td>Output circuit</td>
<td>2 circuits (Small mode)</td>
<td></td>
</tr>
<tr>
<td>Control interface</td>
<td>4 modes</td>
<td></td>
</tr>
<tr>
<td>Step resolution / excitation mode</td>
<td>1/1, 1/2 step (2-phase, 1-2 phase excitation)</td>
<td></td>
</tr>
<tr>
<td>Abnormality detection function</td>
<td>Thermal shutdown, overcurrent, power on reset</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>HTSSOP48 / WQFN48 / HZIP25 / SDIP24</td>
<td>WQFN48 / SDIP24</td>
</tr>
</tbody>
</table>

© 2019-2022 Toshiba Electronic Devices & Storage Corporation
Built-in 50 % duty control function in UART, compatible with Home Bus System (HBS).

1. **Built-in Arm® Cortex®-M3 CPU core**

   TMPM381/TMPM383 implement Cortex-M3 core with 40 MHz maximum operation frequency. Various development tool and their partners allow users many options.

2. **Compatible with HBS**

   UART function is equipped with 50 % duty control function and is compatible with HBS. A control system composed of HBS can be easily constructed using centralized management systems or thermostats.

3. **Reducing system cost and development load**

   TMPM381/383 executes system monitoring efficiently by using built-in AD converter. The original NANOFLASH™ is possible to rewrite at high speed. It reduces user software development time period.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TMPM381FWFG</th>
<th>TMPM383FSUG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operation frequency</td>
<td>40 MHz</td>
<td>40 MHz</td>
</tr>
<tr>
<td>Instruction ROM</td>
<td>128 KB</td>
<td>64 KB</td>
</tr>
<tr>
<td>RAM</td>
<td>10 KB</td>
<td>8 KB</td>
</tr>
<tr>
<td>Timer</td>
<td>16bit x 8ch</td>
<td>16bit x 8ch</td>
</tr>
<tr>
<td>UART / SIO</td>
<td>3ch</td>
<td>2ch</td>
</tr>
<tr>
<td>UART (50 % duty)</td>
<td>1ch</td>
<td>1ch</td>
</tr>
<tr>
<td>AD converter</td>
<td>18ch (12bit)</td>
<td>10ch (12bit)</td>
</tr>
</tbody>
</table>
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 load.

3. High current drive is possible.
   The load can also be driven with higher current by connecting multiple outputs in parallel.

---

**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TBD62003AFWG</th>
<th>TBD62083AFG</th>
<th>TBD62064AFAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>P-SOP16-0410-1.27-002</td>
<td>SOP18-P-375-1.27</td>
<td>P-SSOP24-0613-1.00-001</td>
</tr>
<tr>
<td>Output type</td>
<td>Sink</td>
<td>Sink</td>
<td>Sink</td>
</tr>
<tr>
<td>Number of channels</td>
<td>7ch</td>
<td>8ch</td>
<td>4ch</td>
</tr>
<tr>
<td>Input level</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>$I_{OUT}$ [mA/ch]</td>
<td>500</td>
<td>500</td>
<td>1,500</td>
</tr>
<tr>
<td>$V_{OUT}$ [V]</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Note: Equivalent circuit may be simplified for explanatory purpose.
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
This terms of use is made between Toshiba Electronic Devices and Storage Corporation ("We") and customers who use documents and data that are consulted to design electronics applications on which our semiconductor devices are mounted ("this Reference Design"). Customers shall comply with this terms of use. Please note that it is assumed that customers agree to any and all this terms of use if customers download 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 for any reason. Upon termination of this terms of use, customers shall destroy this Reference Design. In the event of any breach thereof by customers, customers shall destroy this Reference Design, and furnish us a written confirmation to prove such destruction.

1. Restrictions on usage
   1. This Reference Design is provided solely as reference data for designing electronics applications. Customers shall not use this Reference Design for any other purpose, including without limitation, verification of reliability.
   2. This Reference Design is for customer's own use and not for sale, lease or other transfer.
   3. Customers 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 products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.

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, 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 semiconductor devices could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Customers 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. When designing electronics applications by referring to this Reference Design, customers must evaluate the whole system adequately. Customers are solely responsible for all aspects of their own product design or applications. WE ASSUME NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.
   5. No responsibility is assumed by us 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 WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.

3. Export Control
   Customers 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 Law and the U.S. Export Administration Regulations. Export and re-export of this Reference Design are strictly prohibited except in compliance with all applicable export laws and regulations.

4. Governing Laws
   This terms of use shall be governed and construed by laws of Japan.
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.

ABSSENT 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.