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
Device selection points
- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU

Proposals from Toshiba
- Low power consumption of the system is realized by low on-resistance
  U-MOS series 40V N-ch power MOSFET
- Gate driver with protection diagnostic function
  Gate driver (for motor)
- Noise reduction using sinusoidal current wave
  Motor controller (for brushless motor)
- 5V regulator with low current consumption
  Power supply IC (for MCU) (TB9021 is Diode Built-in)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Brushless motor drive circuit(2)

Device selection points
- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba
- Low power consumption of the system is realized by low on-resistance
  U-MOS series 100V N-ch power MOSFET

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page.
Brush motor drive circuit

Device selection points
- The number of parts can be reduced by using the motor control IC with the built-in output driver.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba
- **Optimal for driving a small brush DC motor**
  Motor controller (for brush motor)
- **5V regulator with low current consumption**
  Power supply IC (for MCU)
  (TB9021 is Diode Built-in)

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

Device selection points
- The number of parts can be reduced by using the motor control IC with the built-in output driver.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba
- **Suitable for a motor valve drive**
  Motor controller (for stepping motor) for low current consumption
- **5V regulator with low current consumption**
  Power supply IC (for MCU) (TB9021 is Diode Built-in)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Power supply ON/OFF control and reverse connection protecting circuit (P-ch method)

- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Device selection points

Proposals from Toshiba
- Low power consumption of the system is realized by low on-resistance
  - U-MOS series -40V / -60V P-ch power MOSFET
- Various product lineups and small packages
  - General-purpose small-signal MOSFET
  - General-purpose small-signal bipolar transistor
  - General-purpose small-signal bias resistor built-in transistor (BRT)
  - One-gate logic (L-MOS)
- Both device protection and signal quality is realized
  - TVS diode (for CAN communication)
- 5V regulator with low current consumption
  - Power supply IC (for MCU) (TB9021 is Diode Built-in)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Power supply ON/OFF control and reverse connection protecting circuit (N-ch method)

1. Internal control circuit
2. ON/OFF control switch
3. Power supply reverse protection
4. Power supply ON/OFF control and reverse connection protecting circuit (N-ch method)
5. General-purpose small-signal MOSFET
6. General-purpose small-signal bipolar transistor
7. General-purpose small-signal bias resistor built-in transistor (BRT)
8. One-gate logic (L-MOS)
9. Power supply IC (for MCU) (TB9021 is Diode Built-in)
10. 5V regulator with low current consumption
11. Gate driver (for switch)
12. Various product lineups and small packages

Device selection points
- It is necessary to select the product with the optimum current rating for each application.
- It is necessary to select a gate driver according to the performance of the switching device to be driven.
- It is necessary to select a small surface mount package suitable for miniaturization of the ECU.

Proposals from Toshiba
- Low power consumption of the system is realized by low on-resistance
  - U-MOS series 40V N-ch power MOSFET
- Gate driver with protection diagnostic function
- Various product lineups and small packages
- Both device protection and signal quality is realized
- TVS diode (for CAN communication)
- 5V regulator with low current consumption
  - Power supply IC (for MCU) (TB9021 is Diode Built-in)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page.
Recommended Devices
As described above, in the design of Power Sliding Door, “Ensuring tolerance to motor lock current and immunity. Capable with functional safety”, “Reduction of power consumption” and “Miniaturization” are important factors. Toshiba’s proposals are based on these three solution perspectives.

- **Ensuring tolerance to motor lock current and immunity. Capable with functional safety**
- **Reduced power consumption**
- **Miniaturization**

### Diagram
- **Robustness**
  - High efficiency
  - Low loss

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## Device solutions to address customer needs

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Robustness</th>
<th>High efficiency / Low loss</th>
<th>Small size package</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U-MOS series 40V N-ch power MOSFET</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
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<tr>
<td>2</td>
<td>U-MOS series 100V N-ch power MOSFET</td>
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<tr>
<td>3</td>
<td>Gate driver (for motor)*</td>
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<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
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<tr>
<td>4</td>
<td>Motor controller *</td>
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<tr>
<td>5</td>
<td>U-MOS series -40V / -60V P-ch power MOSFET</td>
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<td><img src="#" alt="Circle" /></td>
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<tr>
<td>6</td>
<td>General-purpose small-signal MOSFET</td>
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<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
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<tr>
<td>7</td>
<td>General-purpose small-signal bipolar transistor</td>
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<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
<tr>
<td>8</td>
<td>Gate driver (for switch)</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
<tr>
<td>9</td>
<td>Small-signal bias resistor built-in transistor (BRT)</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
<tr>
<td>10</td>
<td>One-gate logic (L-MOS)</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
<tr>
<td>11</td>
<td>TVS diode (for CAN communication)</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
<tr>
<td>12</td>
<td>Power supply IC (for MCU)</td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
<td><img src="#" alt="Circle" /></td>
</tr>
</tbody>
</table>

* Damper (LIN communication): TB9056FNG/TB9058FNG/(Direct control type:TB9101FNG/TB9102FNG)
* Blower: TB9080FG / Expansion valves in refrigerant cooling system: TB9120FTG

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The advanced U-MOS IX-H processes enables low on-resistance and low noise, thereby reducing power consumption.

1. **Low loss (reduced chip resistance)**
   - Using low chip resistance technology to contribute to reduced power consumption systems.
   - Chip resistance of 61% reduction per unit area (compared to UMOS IV)

2. **Compact, low-loss package**
   - By adopting a Cu connector structure and a double-sided heat dissipation structure.
   - Development of low-loss, high-heat-dissipation packages

3. **Low noise (low EMI)**
   - Optimized chip process, reduce surge voltage and ringing time.

---

**Value provided**

**U-MOS series 40V N-ch power MOSFET**

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Drain current</th>
<th>On-resistance (Max) @VGS=10V</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPN3R804NC</td>
<td>40A</td>
<td>3.8mΩ</td>
<td>TSON Advance(WF)</td>
</tr>
<tr>
<td>TK1R4S04PB</td>
<td>120A</td>
<td>1.35mΩ</td>
<td>DPAK+</td>
</tr>
<tr>
<td>TPHR7904PB</td>
<td>150A</td>
<td>0.79mΩ</td>
<td>SOP Advance(WF)</td>
</tr>
<tr>
<td>TPWR7904PB</td>
<td>150A</td>
<td>0.79mΩ</td>
<td>DSOP Advance(WF)</td>
</tr>
<tr>
<td>TKR74F04PB</td>
<td>250A</td>
<td>0.74mΩ</td>
<td>TO-220SM(W)</td>
</tr>
<tr>
<td>TK1R5R04PB</td>
<td>160A</td>
<td>1.5mΩ</td>
<td>D2PAK+</td>
</tr>
</tbody>
</table>

---

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Low on-resistance contributes to reduced system power consumption.

1. Low loss (reduced chip resistance)

Using low chip resistance technology to contribute to reduced power consumption systems

2. Small, high-heat-dissipation package

Development of low-loss, high-heat-dissipation packages by adopting a Cu connector structure
Ensuring mountability by using the Wettable Flank (WF) structure

<table>
<thead>
<tr>
<th>Part number</th>
<th>Drain current</th>
<th>On-resistance (Max) @Vgs=10V</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK60S10N1L</td>
<td>60A</td>
<td>6.11mΩ</td>
<td>DPAK+</td>
</tr>
<tr>
<td>XPH4R10ANB</td>
<td>70A</td>
<td>4.1mΩ</td>
<td>SOP Advance(WF)</td>
</tr>
<tr>
<td>XPW4R10ANB</td>
<td>70A</td>
<td>4.1mΩ</td>
<td>DSOP Advance(WF)</td>
</tr>
<tr>
<td>TK160F10N1L</td>
<td>160A</td>
<td>2.4mΩ</td>
<td>TO-220SM(W)</td>
</tr>
<tr>
<td>TK60R10N1L</td>
<td>60A</td>
<td>6.31mΩ</td>
<td>DPAK+</td>
</tr>
</tbody>
</table>

DSOP Advance(WF) double-sided cooling packages

Decrease of thermal resistance 76% reduction @t=3s, mounted on board
Compared to SOP-8

Return to Block Diagram TOP
The large gate drive-current capability reduces power MOSFET losses and improves the efficiency of equipment.

1. **Large gate drive current**
   Improves efficiency of high-speed FET switching.
   - TPD7211F: ±0.5 A
   - TPD7212F: -1 / +1.5 A

2. **Built-in protection / diagnostic output function**
   - Hi-Lo side short is prevented and FET is switched off.
   - Functions to monitor abnormalities of the power supply voltage and output voltage are built-in.

3. **Small package**
   Small surface mount package PS8 and WQFN32

Example of application and block diagram of TPD7212F (Three-phase brushless motor control)

<table>
<thead>
<tr>
<th>Line up</th>
<th>TPD7211F</th>
<th>TPD7212F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>TPD7211F</td>
<td>TPD7212F</td>
</tr>
<tr>
<td>Function</td>
<td>Half bridge output gate driver</td>
<td>Gate driver for three-phase brushless motor</td>
</tr>
<tr>
<td>Number of output</td>
<td>2 outputs</td>
<td>6 outputs</td>
</tr>
<tr>
<td>Package</td>
<td>PS8 (2.8 x 2.9 mm)</td>
<td>Back surface WQFN32 (5 x 5 mm)</td>
</tr>
<tr>
<td>Features</td>
<td>• For high-side P-channel MOSFET drive</td>
<td>• For driving high-side N-channel MOSFET (with built-in charge pumps) • Built-in voltage monitoring function (power supply, output)</td>
</tr>
</tbody>
</table>
Motor controller (for brushless motor)
TB9080FG

**Value provided**

Sinusoidal wave control that cuts noise from the blower fan motor

1. **Two rotation instructions**
   The motor speed setting is compatible with both PWM signal input and DC voltage input.

2. **Sinusoidal**
   Realizes sinusoidal wave control, contributing to quieter motor operation.

3. **Built-in protection functions**
   This controller has built-in overcurrent detection, overheat detection, overvoltage detection and power supply voltage drop detection circuits.

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB9080FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>LQFP64</td>
</tr>
<tr>
<td>Operating Voltage Range[V]</td>
<td>7–18V</td>
</tr>
<tr>
<td>Standby current[A]</td>
<td>50μA</td>
</tr>
<tr>
<td>Number of channels</td>
<td>0.6 (Pch), 0.6 (Nch)</td>
</tr>
<tr>
<td>Drive control</td>
<td>sinusoidal wave control</td>
</tr>
</tbody>
</table>

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A motor control IC with a built-in output driver can directly drive a small brush DC motor.

1. **Built-in output driver**
   The built-in output driver enables the DC brush motor to be driven directly.

2. **Low on-resistance**
   By keeping the on-resistance between the source and drain low, heat generation and power consumption can be kept low.

3. **Built-in protection functions**
   This controller has built-in overcurrent detection, overheat detection, overvoltage detection and power supply voltage drop detection circuits.

**Line up**

<table>
<thead>
<tr>
<th></th>
<th>TB9101FNG</th>
<th>TB9102FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part number</strong></td>
<td>TB9101FNG</td>
<td>TB9102FNG</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>SSOP24</td>
<td>SSOP24</td>
</tr>
<tr>
<td><strong>Power supply voltage [V]</strong></td>
<td>7~18</td>
<td>7~18</td>
</tr>
<tr>
<td><strong>Output current [A]</strong></td>
<td>±1.0</td>
<td>±1.0</td>
</tr>
<tr>
<td><strong>Allowable power dissipation [W]</strong></td>
<td>1.32</td>
<td>1.32</td>
</tr>
<tr>
<td><strong>On-resistance (Typ.) [Ω]</strong></td>
<td>0.6 (P-ch), 0.6 (N-ch)</td>
<td>0.5 (P-ch), 0.5 (N-ch)</td>
</tr>
<tr>
<td><strong>External interface</strong></td>
<td>Direct input</td>
<td>SPI interface</td>
</tr>
</tbody>
</table>
Motor controller (for brush motor)
TB9056FNG / TB9058FNG

Value provided

Automotive DC motor driver IC with full hardware LIN slave function

1. Simple control by full hardware logic
   No need to develop software. Motor control by LIN communication.

2. Low on-resistance and power consumption
   - On-resistance (High+Low): 2.2Ω (typ.)
   - Power consumption: under 10μA (sleep mode)

3. Built-in protection functions
   built-in over current detection, over temperature detection and over voltage detection circuits.

TB9056FNG / TB9058FNG block diagram

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB9056FNG</th>
<th>TB9058FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SSOP24</td>
<td></td>
</tr>
<tr>
<td>Power supply voltage [V]</td>
<td>7–18V</td>
<td>7–18V</td>
</tr>
<tr>
<td>Output current [A]</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>DC Motor Driver</td>
<td>H Bridge 1ch</td>
<td>H Bridge 1ch</td>
</tr>
<tr>
<td>On-resistance (Typ.) [Ω]</td>
<td>1.0 (Hi side), 1.2 (Low side)</td>
<td>1.0 (Hi side), 1.2 (Low side)</td>
</tr>
<tr>
<td>Communication Method</td>
<td>LIN1.3</td>
<td>LIN1.3+Enhanced checksum</td>
</tr>
</tbody>
</table>

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Return to Block Diagram TOP
Motor controller (for stepping motor)
TB9120FTG

Value provided

Microstepping drive controlled by single clock input signal only

1. **Microstepping drive**
   - Not only full step but 1/32 step which contributes to reducing noise and vibration is also supported.
   - Neither highly functional microcontrollers nor software are required.

2. **Stall detection**
   - A stall detection signal will be output from SD pin, if the IC judges a motor runs abnormally.
   - The detection signal can be received by a microcontroller and fed back to the system.

3. **General multipurpose specifications**
   - General multipurpose specifications for various applications
     - e.g. Dampers in HVAC
     - Expansion valves in refrigerant cooling system
     - Angle adjustment for reflector in HUD

Current waveform in micro step

<table>
<thead>
<tr>
<th>Step</th>
<th>Waveform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 step</td>
<td><img src="image1" alt="Waveform" /></td>
</tr>
<tr>
<td>1/8 step</td>
<td><img src="image2" alt="Waveform" /></td>
</tr>
<tr>
<td>1/32 step</td>
<td><img src="image3" alt="Waveform" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td><strong>Package</strong></td>
</tr>
<tr>
<td><strong>Output</strong></td>
</tr>
<tr>
<td><strong>Ron</strong></td>
</tr>
<tr>
<td><strong>Detection circuit</strong></td>
</tr>
<tr>
<td><strong>Standby function</strong></td>
</tr>
</tbody>
</table>

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Value provided

Low on-resistance contributes to reduced system power consumption.

1 Low-loss (reduced chip resistance), logic-level response

Using low chip resistance technology to contribute to reduced power consumption systems
Lineup of Logic-level-drive types

Low Loss: RonA Reduction Trend

Large current, small size, high heat dissipation package

2 Small surface mount package developed

Development of low-loss, high-heat-dissipation packages by adopting a Cu connector structure
Ensuring mountability by using the Wettable Flank (WF) structure

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>Drain-source Voltage</th>
<th>Drain current</th>
<th>On-resistance (Max) @VGS=10V</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>TJ90S04M3L</td>
<td>-40V</td>
<td>-90A</td>
<td>4.3mΩ</td>
<td>DPAK+</td>
</tr>
<tr>
<td>TJ60S06M3L</td>
<td>-60V</td>
<td>-60A</td>
<td>11.2mΩ</td>
<td>DPAK+</td>
</tr>
<tr>
<td>XPH3R114MC</td>
<td>-40V</td>
<td>-100A</td>
<td>3.1mΩ</td>
<td>SOP Advance(WF)</td>
</tr>
<tr>
<td>TJ200F04M3L</td>
<td>-40V</td>
<td>-200A</td>
<td>1.8mΩ</td>
<td>TO-220SM(W)</td>
</tr>
<tr>
<td>TJ150F06M3L</td>
<td>-60V</td>
<td>-150A</td>
<td>5.6mΩ</td>
<td>TO-220SM(W)</td>
</tr>
</tbody>
</table>

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Choose from a wide array of small packages which contribute to the miniaturization and reduction of power consumption of equipment.

1. **Small package**

Starting with the SOT-723 (VESM 1.2mm² package), a lineup of various small packages is available, contributing to space savings during mounting.

2. **Low voltage drive**

The gate-source voltage can be driven at a low voltage of 1.2 V(SSM3J66MFV).

3. **AEC-Q101 qualified**

AEC-Q101 qualified and can be used for a wide range of automotive applications.

---

### Small signal package lineup

- **Power dissipation (W)**
- **Mounting area (mm²)**

#### Small packages lineup

- **Small signal device**

### Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>SSM3K7002KF</th>
<th>SSM3J168F</th>
<th>SSM3J66MFV</th>
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<tbody>
<tr>
<td>Package</td>
<td>S-Mini (SOT-346)</td>
<td>S-Mini (SOT-346)</td>
<td>VESM (SOT-723)</td>
</tr>
<tr>
<td>V_{DSS} [V]</td>
<td>60</td>
<td>-60</td>
<td>-20</td>
</tr>
<tr>
<td>I_{D} [A]</td>
<td>0.4</td>
<td>-0.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>R_{DS(on)} @V_{GS}=4.5 [Ω]</td>
<td>Typ. 1.2</td>
<td>1.4</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Max 1.75</td>
<td>1.9</td>
<td>0.39</td>
</tr>
<tr>
<td>Drive voltage [V]</td>
<td>4.5</td>
<td>-4.0</td>
<td>-1.2</td>
</tr>
<tr>
<td>MOS Type</td>
<td>N-channel</td>
<td>P-channel</td>
<td>P-channel</td>
</tr>
</tbody>
</table>

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Extensive product lineup to meet all your needs.

1. **Extensive lineup of packages**
   
   Various package lineups, such as 1in1, 2in1 are provided and suitable product for circuit board design can be selected.

2. **Various product lineup**
   
   Various product lineups, such as general-purpose, low-noise, low $V_{CE(sat)}$ and high-current types, are provided. Products can be selected depending on the application.

3. **AEC-Q101 qualified**
   
   AEC-Q101 qualified and can be used for a wide range of automotive applications.

### Line up

<table>
<thead>
<tr>
<th>Classification</th>
<th>$V_{CEO}$ [V]</th>
<th>$I_{C}$ [mA]</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>General purpose</td>
<td>50</td>
<td>150</td>
<td>SSM (SOT-416)</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>500</td>
<td>USM (SOT-323)</td>
</tr>
<tr>
<td>Low noise</td>
<td>120</td>
<td>100</td>
<td>UFM (SOT-323F)*</td>
</tr>
<tr>
<td>High-current</td>
<td>50</td>
<td>1700</td>
<td>S-Mini (SOT-346)</td>
</tr>
</tbody>
</table>

※2SC2712

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A charge pump for the FET gate drive is built-in, allowing for easy semiconductor relay configuration.

1. **Built-in charge pump**
   - No external add-ons required for driving the N-channel on the high side, making it easy to configure a semiconductor relay.

2. **Logic level drive**
   - Direct control is possible from microcomputer and CMOS logic.

3. **Small package**
   - The small surface mount PS8 contributes to the miniaturization of equipment.

### Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPD7104AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>High-side gate driver</td>
</tr>
<tr>
<td>Number of output</td>
<td>1 output</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operating power supply voltage range: 5 to 18 V</td>
</tr>
<tr>
<td>• Built-in charge pump</td>
</tr>
<tr>
<td>• Built-in power supply reverse connection protection function (Supported for power supply reverse connection protection FET applications)</td>
</tr>
</tbody>
</table>

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Small-signal bias resistor built-in transistor (BRT)
RN114 / RN2114 / RN1414 / RN2414 series

Value provided
Extensive product lineup to meet all your needs.

1. **Built-in bias resistor type (BRT)**
The BRT reduces the number of parts contributing to miniaturization and shorter production times.

2. **Extensive lineup of package and pin assignment**
Various package lineups, such as 1in1, 2in1 are provided and suitable product for circuit board design can be selected.

3. **AEC-Q101 qualified**
AEC-Q101 qualified and can be used for a wide range of automotive applications.

Internal Connections

<table>
<thead>
<tr>
<th>Line up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
</tr>
<tr>
<td>Package</td>
</tr>
<tr>
<td>SSM (SOT-416)</td>
</tr>
<tr>
<td>S-Mini (SOT-346)</td>
</tr>
<tr>
<td>(V_{CEO} ) (Max) [V]</td>
</tr>
<tr>
<td>(I_C) [mA]</td>
</tr>
</tbody>
</table>

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One-gate logic (L-MOS)

TC7SH / TC7WH / TC7SZ / TC7WZ series

Value provided

Extensive product lineup to meet all your needs.

1 Small package

A standard multi gate CMOS is separated into individual or dual gates and embedded in a small package. This can be suited for simpler designs and contributes to miniaturization.

2 Extensive lineup

The VHS/SHS series, which is widely used in Automotive, offers a wide range of functions, including a total of 230 products.

3 AEC-Q100 qualified (reliability levels)

AEC-Q100 qualified and can be used for a wide range of automotive applications.

<table>
<thead>
<tr>
<th>Package</th>
<th>VHS series</th>
<th>SHS series</th>
</tr>
</thead>
<tbody>
<tr>
<td>USV (SOT-353)</td>
<td>TC7SH series</td>
<td>TC7SZ series</td>
</tr>
<tr>
<td>US8 (SOT-765)</td>
<td>TC7WH Series</td>
<td>TC7WZ series</td>
</tr>
<tr>
<td>V_{CC} [V]</td>
<td>2.0 ~ 5.5</td>
<td>1.65/1.8 ~ 5.5</td>
</tr>
<tr>
<td>I_o [mA]</td>
<td>8</td>
<td>24</td>
</tr>
</tbody>
</table>

* Compliant products with AEC-Q100’s reliability test only
TVS diode (for CAN communication)
DF3D18FU / DF3D29FU / DF3D36FU

Value provided

TVS diode absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

1 Improve ESD absorbability

Improved absorption of ESD through our proprietary Zener process. (Both low operating resistance $R_{DYN}$ and low capacitance $C_t$)

2 Ensuring high signal integrity

Supports in-vehicle LAN communication such as CAN, CAN-FD, FlexRay. Lower capacitance ensures higher signal integrity.

3 High ESD immunity

Compliant products with ISO10605 Standard > ±20 kV
IEC61000-4-2 Standard > ±20 kV (L4)

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>DF3D18FU</th>
<th>DF3D29FU</th>
<th>DF3D36FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>USM (SOT-323)</td>
<td>USM (SOT-323)</td>
<td>USM (SOT-323)</td>
</tr>
<tr>
<td>$V_{ESS}$ [kV] @ISO10605</td>
<td>±30</td>
<td>±30</td>
<td>±20</td>
</tr>
<tr>
<td>$V_{RMIN}$ [Max] [V]</td>
<td>12</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>$C_t$ (Typ./Max) [pF]</td>
<td>9 / 10</td>
<td>6.5 / 8</td>
<td>1.5</td>
</tr>
<tr>
<td>$R_{DYN}$ (Typ.) [Ω]</td>
<td>0.8</td>
<td>1.1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

(NOTE): This product is an ESD protection diode and cannot be used for purposes other than ESD protection (including but not limited to constant voltage diode applications).

*1:TOSHIBA Electronic Device & Storage Corporation
*2:Measurements of the commercial product

◆Return to Block Diagram TOP
5V Regulator with low current consumption for automotive MCU. Built-in WDT and various abnormality detection circuits.

1. **5V Regulator with low current consumption**
   - 5V Regulator with low current consumption used external Tr. for automotive MCU. Output voltage accuracy is +/- 2%.

2. **Current limitation value is adjustable**
   - Load current is monitored by the external resistor, so current limitation value is adjustable by changing the resistor value.

3. **Built-in WDT and various error detections.**
   - MCU condition is monitored by using WDT. Implemented various abnormality detection circuits (UV detection, Current limitation etc.) contribute a system safety.

**Line up**

<table>
<thead>
<tr>
<th>Function</th>
<th>Part number</th>
<th>TB9005FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of outputs</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Output Current $I_{OUT}$(MAX)</td>
<td>Depends on External Tr.</td>
<td></td>
</tr>
<tr>
<td>WDT, Overheat detection, Overcurrent limitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td></td>
<td>SSOP20</td>
</tr>
<tr>
<td>Package body size</td>
<td></td>
<td>6.4 x 7.0mm</td>
</tr>
</tbody>
</table>
5V Regulator with low current consumption for automotive MCU. Built-in WDT and various abnormality detection circuits

1. **5V Regulator with low current consumption**
   5V Regulator with low current consumption used Built-in Tr. for automotive MCU. Output voltage accuracy is +/- 2%.

2. **Built-in WDT and various error detections.**
   MCU condition is monitored by using WDT. Implemented various abnormality detection circuits (UV detection, Current limitation etc.) contribute a system safety.

3. **AEC-Q100 qualified**
   It is compatible with the AEC-Q100 and can be used for a wide range of automotive applications.

---

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB9021FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>TSSOP16</td>
</tr>
<tr>
<td>Package body size</td>
<td>5.0 x 6.4mm</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>1</td>
</tr>
<tr>
<td>Output Current $I_{OUT}(\text{MAX})$</td>
<td>200mA</td>
</tr>
<tr>
<td>WDT, Overheat detection, Overcurrent limitation</td>
<td></td>
</tr>
</tbody>
</table>

---

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