Uninterruptible Power Supply
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
UPS  Overall block diagram of standard system (power supply)

- **AC Power Supply**
  - Normal Power Supply
  - Power Supply at Peak Cut etc.

- **DC-AC**
  - PFC

- **Bi-directional DC-DC**
  - DC bus line 300 V to 400 V
  - Discharge Charging

- **Battery (48 V)**

- **Solar Power**
  - Wind Power
  - Generator

- **Power Conditioner**

- **Application**
  - (AC input)
  - Application (DC input)
UPS  Overall block diagram of interactive DC-DC

- Gate Drivers
- MOS FETs
- ISO Amps
- MAIN MCU
- Communication MCU
- Display
- USB
- CAN
- RS-232C
- RS-422/485
- 300 V to 400 V
- 30 V to 60 V
- 30 V to 60 V
- 30 V to 60 V
- 30 V to 60 V
- 30 V to 60 V
UPS  Overall block diagram of PFC converter

AC Input  →  PFC Controller  →  MOSFET  →  MAIN MCU  →  DC 300 V to 400 V
**Criteria for device selection**
- To protect the USB signal line, it is necessary to use a TVS diode with a low capacitance between terminals.
- Low-dynamic resistivity (Rdyn) is a key feature that determines the protective tolerance.
- It is important to protect not only the exterior but also the interior of the set.

**Proposals from Toshiba**
- The absorbs static electricity (ESD) and prevents circuit malfunction and device breakdown.

TVS diode

※ Click the number in the circuit diagram to jump to the detailed description page.
Criteria for device selection
- It is necessary to isolate the DC-DC converter and the control MCU.
- It is also necessary to isolate the MCU for control and the MCU for communication from each other.
- Protection against high voltage is required to protect the IC used internally.

Proposals from Toshiba
- **Photocoupler with excellent environmental resistance**
  IC output photocoupler
- **Photocoupler suitable for analog signal transmission**
  Isolation amplifier
- **Major interface standards support**
  Main MCU

※ Click the number in the circuit diagram to jump to the detailed description page.
Criteria for device selection
- A high-voltage (normal 600V) MOSFET with high-speed recovery diodes is used for PFCs and DC-DC converters.
- SiC type Schottky barrier diodes are suitable for PFC circuits.
- Both high-voltage MOSFET and low-voltage MOSFET are used for power DC-DC converters.

Proposals from Toshiba
- Optimal for high-efficiency power supply switching
  DTMOSIV series MOSFET
  U-MOSVIII-H series MOSFET
- Strong with efficiency figure of merit and surge current
  SiC Schottky barrier diode
- Photocoupler with excellent environmental resistance
  IC output photocoupler
- Built-in 3-pashe PWM output for inverter control
  Main MCU

※ Click the number in the circuit diagram to jump to the detailed description page.
The motion analysis

Criteria for device selection
- PSRR features are key features of radio systems.
- MIMO systems require a power supply that can supply large currents.
- New WiGig systems also require a power supply that can supply large currents.

Proposals from Toshiba
- Compact surface mounting that is resistant to power supply noise
  LDO regulator
- Built-in 3-pashe PWM output for inverter control
  Main MCU

※ Click the number in the circuit diagram to jump to the detailed description page.
Recommended Devices
As described above, in order to design UPS, "Miniaturization of circuit boards", "Low power consumption of sets" and "Robust operation" are important factors. Toshiba’s proposals are based on these three solution perspectives.
## Device Solutions to Solve Customer Problems

<table>
<thead>
<tr>
<th></th>
<th>Small size Package Supported</th>
<th>High efficiency・Low-loss</th>
<th>Noise immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TVS diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MOSFET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SiC Schottky barrier diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IC output photocoupler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Isolation amplifier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Small surface mount LDO regulator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Main MCU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This absorbs static electricity (ESD) from external terminals, prevents circuit malfunction, and protects devices.

1. Improved ESD pulse absorption
   It achieves both low operating resistance and low capacitance, and ensures high signal protection performance and signal quality.

2. Reduce ESD energy by low clamp voltage
   Steadily protect the connected circuits/devices using proprietary technology.

3. Optimal for high-density packaging
   This compact package is useful for high-density printed circuit boards such as mobile devices.

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>DF2B6M4SL</th>
<th>DF2B7ASL</th>
<th>DF2B20M4SL</th>
<th>DFS2S14P2CTC</th>
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<tbody>
<tr>
<td>Package</td>
<td>SL2</td>
<td>SL2</td>
<td>SL2</td>
<td>CST2</td>
</tr>
<tr>
<td>$V_{ESD}$ [kV]</td>
<td>±20</td>
<td>±30</td>
<td>±15</td>
<td>±30</td>
</tr>
<tr>
<td>$V_{BRM}$ (Max) [V]</td>
<td>5.5</td>
<td>5.5</td>
<td>18.5</td>
<td>13</td>
</tr>
<tr>
<td>$C_t$ (Typ.) [pF]</td>
<td>0.2</td>
<td>8.5</td>
<td>0.2</td>
<td>270</td>
</tr>
<tr>
<td>$R_{DYN}$ (Typ.) [Ω]</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
<td>0.23</td>
</tr>
</tbody>
</table>

(Note): This product is designed for ESD protection purpose and cannot be used for purposes other than ESD protection (including but not limited to voltage regulation applications).

Return to Block Diagram TOP
Wide range of lineups ranging from low-voltage to high-voltage, which greatly contributes to improved power efficiency and miniaturization.

1 RonA 30 % reduction

In DTMOSIV, the performance index RonA has been reduced by 30 % through the use of a newly developed single epitaxial process. (Comparison of DTMOSIII)

2 Optimization of gate switching speed

In DTMOSIV, we have optimized the gate switching speed by reducing Coss (12 % compared with conventional products) and by reducing on-resistance.

3 Enhancement type

This is an enhancement type that is easy to handle.

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TK25A60X</th>
<th>TK16A60W5</th>
<th>TK100E10N1</th>
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<tbody>
<tr>
<td>Package</td>
<td>TO-220SIS</td>
<td>TO-220SIS</td>
<td>TO-220</td>
</tr>
<tr>
<td>V_DSS [V]</td>
<td>600</td>
<td>600</td>
<td>100</td>
</tr>
<tr>
<td>I_D [A]</td>
<td>25</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>R_D(S) [Ω]</td>
<td>Typ. 0.105</td>
<td>0.18</td>
<td>0.0028</td>
</tr>
<tr>
<td></td>
<td>Max 0.125</td>
<td>0.23</td>
<td>0.0034</td>
</tr>
<tr>
<td>Polarity</td>
<td>N-ch</td>
<td>N-ch</td>
<td>N-ch</td>
</tr>
</tbody>
</table>

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SiC Schottky barrier diode
TRS4A65F / TRS4E65F

Value provided

Can be applied to power factor correction circuits and a wide range of power supply control applications, and greatly contributes to miniaturization.

1. High surge tolerance
   The surge peak forward current $I_{FSM} = 39$ A (Max)

2. Second-generation chip design
   The figure of merit $(V_F \times Q_c)$ (Note1) is improved by 30% and the surge peak forward current $(I_{FSM})$ is improved, thereby contributing to higher efficiency of the power supply.

3. Small package
   Provided in TO-220 through-hole type package.

Comparison between the first and second generations

Note1: The $V_F \times Q_c$ (product of forward voltage and total charge) is an index representing the loss performance of the SiC SBD. When comparing the products with the same current rating, the smaller the index, the lower the loss.
Combines an infrared light-emitting diode with high optical output and an integrated circuit light-receiving IC chip with high gain and high speed.

1. **High noise immunity**
   - The products have internal Faraday shield that provides a guaranteed common-mode transient immunity.

2. **High isolation voltage**
   - The isolation voltage \(BV_S\) is 5000 [Vrms] (Min).

3. **Ambient temperature of 125 °C is guaranteed**
   - The products are designed to operate even under severe ambient temperature conditions, such as inverters, robots, machinery, and high-output power supplies. (For TLP2761/2768A)

### Value Provided

- **High efficiency**
- **Low-loss**
- **Noise immunity**

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**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP5214</th>
<th>TLP5754</th>
<th>TLP2761</th>
<th>TLP2768A</th>
</tr>
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<tbody>
<tr>
<td>Package</td>
<td>SO16</td>
<td>SO6L</td>
<td>SO6L</td>
<td>SO6L</td>
</tr>
<tr>
<td>(BV_S) (Min) [Vrms]</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
</tr>
<tr>
<td>(T_{op}) [°C]</td>
<td>-40 to 110</td>
<td>-40 to 110</td>
<td>-40 to 125</td>
<td>-40 to 125</td>
</tr>
<tr>
<td>Output type</td>
<td>IC output</td>
<td>Totem-pole Output</td>
<td>Totem-pole Output</td>
<td>Open collector Output</td>
</tr>
</tbody>
</table>

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Note 1: When a VDE approved type is needed, please designate the Option (D4).
This is the most suitable isolation amplifier for current / voltage detection of motors and inverters.

1. **High insulation capacity**
   This optical coupling type isolation amplifier has a high-precision ΔΣ AD conversion circuit on the input side and a high-precision DA conversion circuit on the output side.

2. **Support for common mode**
   Common-mode transient elimination is provided with $\text{CMTI} = 15 \, \text{kV/μs (Min)}$.

3. **5 V system power supply voltages**
   - Input power supply voltage $V_{DD1} = 4.5$ to $5.5 \, \text{V}$
   - Output Power Supply Voltage $V_{DD2} = 3.0$ to $5.5 \, \text{V}$

### Internal circuit configuration

**Note**: A 0.1-μF bypass capacitor must be connected between 1 and 4 pins and between 5 and 8 pins.

### Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TLP7820</th>
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</thead>
<tbody>
<tr>
<td>Package</td>
<td>SO8L</td>
</tr>
<tr>
<td>$BV_S$ (Min) [Vrms]</td>
<td>5000</td>
</tr>
<tr>
<td>$T_{opr}$ [°C]</td>
<td>-40 to 105</td>
</tr>
<tr>
<td>CMTI (Min) [kV/μs]</td>
<td>15</td>
</tr>
</tbody>
</table>

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Small surface mount LDO regulator
TCR5AM / TCR13AG / TCR4DG / TCR3DG series

Value provided

Variety of products that meet high performance requirements, from general-purpose package to ultra-small package type.

1. **Low dropout voltage**
   The newly developed new-generation process significantly improved the dropout characteristics.

2. **High ripple compression**
   Our LDO regulator has a high ripple rejection characteristic, and eliminates switching noise efficiently.

3. **Ceramic capacitors can be used.**
   Improved drop-out characteristics have enabled the use of ceramic capacitors as external capacitors.

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**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TCR5AM</th>
<th>TCR13AG</th>
<th>TCR4DG</th>
<th>TCR3DG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>DFN5B</td>
<td>WCSP6F</td>
<td>WCSP4E</td>
<td>WCSP4E</td>
</tr>
<tr>
<td>$V_{IN}$ (Max) [V]</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>$I_{OUT}$ (Max) [mA]</td>
<td>0.5</td>
<td>1.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Output range [V]</td>
<td>0.55 to 3.6</td>
<td>0.65 to 3.6</td>
<td>1.0 to 4.5</td>
<td>1.0 to 4.5</td>
</tr>
</tbody>
</table>

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System control MCU
TX03 series M360 group TMPM369FDFG / TMPM369FDXBG

Built-in 3-phase PWM and Ethernet function execute inverter control and internal system communication at low power consumption

1 Built-in ARM® Cortex®-M3 CPU core

TMPM369 implements Cortex®-M3 core with 80MHz maximum operation frequency. It is suitable for controlling Mega solar system. Various development tool and their partners allow users many options.

2 3-phase PWM output

TMPM369 has 2ch of 3-phase PWM output in it. It is suitable for controlling inverter system. The original NANO FLASH™ is possible to rewrite at high-speed. It reduces user software development time period.

3 Various communication interfaces

TMPM369 supports various communication standards. They can construct internal system communication easily.

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TMPM369FDFG/FDXBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operation frequency</td>
<td>80MHz</td>
</tr>
<tr>
<td>Instruction ROM</td>
<td>512KB</td>
</tr>
<tr>
<td>RAM</td>
<td>128KB</td>
</tr>
<tr>
<td>3-phase PWM output</td>
<td>2ch</td>
</tr>
<tr>
<td>Ethernet MAC</td>
<td>1ch</td>
</tr>
<tr>
<td>USB2.0</td>
<td>Host 1ch, Device 1ch</td>
</tr>
<tr>
<td>CAN, UART</td>
<td>1ch, 4ch</td>
</tr>
</tbody>
</table>

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