Automotive ADAS
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
Criteria for device selection
- Employing noise resistant interfaces help to reduce position constraints of camera.
- To use under various environments, video decoders need to have enhanced visual recognition capabilities.

Proposals from Toshiba
- **Resolve differences between interfaces**
  Peripheral bridge IC
- **Built-in visual enhancement function**
  Video decoder
- **Suitable for ESD protection**
  TVS diode (for high speed communication)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Criteria for device selection
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- A small surface mount package is suitable for realizing miniaturization of the ECU.
- It is necessary to select high speed MOSFETs to prevent short through current.

Proposals from Toshiba
- Low on-resistance contributes to low power consumption of the system
U-MOS Series 40 V N-ch MOSFET

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page.
ADAS  Detail of data transmission / audio output unit

**CAN / FlexRay transmission section**

Image Recognition Processor → Level Shifter → CAN Transceiver → CAN Line  
CAN Line → FlexRay Transceiver → Level Shifter → FlexRay Line  
FlexRay Line → TVS → CAN Line  
CAN Line → TVS → Level Shifter → CAN Transceiver  
CAN Transceiver → Level Shifter → Image Recognition Processor

**Audio output section**

12 V Power Line → DC-DC  
DC-DC → DSP/Tuner  
DSP/Tuner → Audio AMP  
Audio AMP → Speaker

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

**Criteria for device selection**
- The TVS diode needs to be selected according to the ESD protection characteristics and capacitance value suitable for transmission speed.

**Proposals from Toshiba**
- **High output power with low heat generation is realized**  
  Audio power amplifier IC
- **Suitable for ESD protection**  
  TVS diode (for CAN communication)
ADAS  Detail of Switch for power supply ON/OFF control and reverse connection protection (1)

Power supply ON/OFF control and reverse connection protection circuit (P-ch type)

Criteria for device selection
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the ECU.

Proposals from Toshiba
- Low on-resistance contributes to low power consumption of the system
  U-MOS Series -40 V / -60 V P-ch MOSFET
- Extensive product lineup
  General purpose small signal MOSFET
  General purpose small signal bipolar transistor
  Small signal bias resistor built-in transistor (BRT)
- Suitable for ESD protection
  TVS diode (for CAN communication)

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

- **Battery (12 V)**
- **Power Supply**
- **CAN Line**
- **MCU**
- **Gate Driver**
- **ON/OFF control switch**
- **Power supply reverse protection**
- **Internal control circuit**
- **MOSFET**
- **TVS**
- **Small signal bias resistor built-in transistor (BRT)**
- **General purpose small signal MOSFET**
- **General purpose small signal bipolar transistor**

**Criteria for device selection**
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the ECU.

**Proposals from Toshiba**
- Low on-resistance contributes to low power consumption of the system
  U-MOS Series 40 V N-ch MOSFET
- Gate driver with protection and diagnosis functions
  Gate driver (for switch)
- Extensive product lineup
  General purpose small signal MOSFET
  General purpose small signal bipolar transistor
  Small signal bias resistor built-in transistor (BRT)
- Suitable for ESD protection
  TVS diode (for CAN communication)

* 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 ADAS, “Reduction of power supply and signal noise”, “Reduction of power consumption” and “Miniaturization” are important factors. Toshiba’s proposals are based on these three solution perspectives.
## Device solutions to address customer needs

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Low noise</th>
<th>High efficiency - Low loss</th>
<th>Small size package</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Peripheral bridge IC</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Video decoder</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Audio power amplifier IC</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. U-MOS Series 40 V N-ch MOSFET</td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>5. U-MOS Series -40 V / -60 V P-ch MOSFET</td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>6. Gate driver (for switch)</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. General purpose small signal MOSFET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. General purpose small signal bipolar transistor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Small signal bias resistor built-in transistor (BRT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. TVS diode (for high speed communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. TVS diode (for CAN communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Value provided

Resolve gaps of interface standard between host and peripheral devices.

1. **Increase the choice of parts**
   By using a peripheral bridge IC, it is possible to connect to various types of peripheral devices.

2. **Reduce noise**
   Converting parallel bus line to serial improves noise immunity. That also suppresses the generation of own noise.

3. **Reduce disconnection risk**
   Converting parallel bus line to serial reduces the number of wires on a board, and so reduce the risk of disconnection.

**Display interface**

- **X standard**
- **Y standard**

**Camera interface bridge**

- **X standard**
- **Y standard**

**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Camera I/F Bridge</th>
<th>Display I/F Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC9590XBG</td>
<td>P-LFBGA64-0707-0.80-002</td>
<td>P-VFBGA64-0707-0.65-002</td>
</tr>
<tr>
<td>TC9591XBG</td>
<td>P-VFBGA64-0707-0.65-001</td>
<td>P-VFBGA64-0707-0.65-001</td>
</tr>
<tr>
<td>TC9592XBG</td>
<td>P-VFBGA64-0505-0.65-001</td>
<td>P-VFBGA64-0505-0.65-001</td>
</tr>
<tr>
<td>TC9593XBG</td>
<td>P-VFBGA64-0606-0.65-001</td>
<td>P-VFBGA64-0606-0.65-001</td>
</tr>
<tr>
<td>TC9594XBG</td>
<td>P-VFBGA64-0707-0.65-001</td>
<td>P-VFBGA64-0707-0.65-001</td>
</tr>
<tr>
<td>TC9595XBG</td>
<td>P-VFBGA64-0707-0.65-001</td>
<td>P-VFBGA64-0707-0.65-001</td>
</tr>
</tbody>
</table>

**Input**

- HDMI™ 1.4a (1) MIPI™ CSI-2 (2) Parallel 24 bit @ 166 MHz
- MIPI DSI™ 4lanes x 1ch
- Parallel input 24 bit @ 166 MHz
- MIPI DSI™ 4lanes x 1ch / MIPI DPI™ (24bit)

**Output**

- MIPI CSI-2 4lanes x 1ch (1) Parallel 24 bit @ 100 MHz (2) MIPI CSI-2
- LVDS Single Link
- MIPI DSI 4lanes x 1ch
- DisplayPort™ 1.1a x 2ports / MIPI DPI (24bit)

*Return to Block Diagram TOP*
Built-in image enhancement functions designed for automotive cameras.

1 HDV enhancer

In addition to conventional horizontal and vertical edge emphasis, diagonal emphasis has been added, to enable stronger edge emphasis without increasing discomfort to the eyes.

2 Color management

This function emphasizes a specific selected color (saturation). Emphasizing certain color can improve visibility.

3 Dynamic YC gamma

Applying optimized YC gamma to the images reduces blackout and whiteout, and improves visibility.

<table>
<thead>
<tr>
<th>Lineup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
</tr>
<tr>
<td>Package</td>
</tr>
<tr>
<td>AD converter</td>
</tr>
<tr>
<td>New image correction</td>
</tr>
<tr>
<td>ITU-R BT.656 output</td>
</tr>
</tbody>
</table>

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These linear amplifier ICs realize same level of power loss and heat generation the class D amplifier.

1. Proprietary high efficiency amplifier (patent registered)

Realizes equivalent efficiency to the class D amplifiers [Note1] at output of 4 W or less. Power consumption of these ICs are about 1/5 of our class AB amplifiers and about 1/2 of our high efficiency linear class KB amplifiers. [Note2]

Note:1 Based on Toshiba research (April 2020)
Note:2 Class KB = Toshiba original linear amplifier

2. Reduction of external components

Since these ICs operate without switching such as the class D amplifier, the external parts such as low pass filter or components for EMI suppression can be reduced.

3. Built-in fulltime output offset detection (patent registered)

Includes a proprietary speaker burnout prevention system that continuously checks for any abnormal output DC offset regardless of input signal presence and informs the microcomputer.

Power consumption (for 0.8 W x 4 channels)
(Toshiba internal comparison)

<table>
<thead>
<tr>
<th>Power consumption (W)</th>
<th>Conventional linear amp (Class AB)</th>
<th>Conventional high eff. Amp (Class KB)</th>
<th>New high eff. Amp (Class TB)</th>
<th>Digital amp (Class D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional linear amp (Class AB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional high eff. Amp (Class KB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New high eff. Amp (Class TB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital amp (Class D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption (W)</td>
<td>20</td>
<td>▲1/2</td>
<td>▲1/5</td>
<td>4</td>
</tr>
</tbody>
</table>

Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TCB701FNG</th>
<th>TCB702FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>P-HSSOP36-1116-0.65-001</td>
<td>(36 pin)</td>
</tr>
<tr>
<td>Maximum output power</td>
<td>49 W x 4ch (VCC = 15.2 V, RL = 4 Ω)</td>
<td>45 W x 4ch (VCC = 15.2 V, RL = 4 Ω)</td>
</tr>
<tr>
<td>Total harmonic distortion (THD)</td>
<td>0.01 % (at POUT = 0.4 W)</td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>6 to 18 V</td>
<td></td>
</tr>
<tr>
<td>Output noise voltage</td>
<td>60 μVrms (Filter = DIN AUDIO)</td>
<td></td>
</tr>
</tbody>
</table>

Note:1 Based on Toshiba research (April 2020)
Note:2 Class KB = Toshiba original linear amplifier (Toshiba internal comparison)
The latest processes enables low on-resistance and low noise, thereby reducing power consumption.

### 1. Low loss (reduced on-resistance)

Using low-on-resistance technology to contribute to reduced power consumption systems.

On-resistance of 61% reduction per unit area.

(compared to Toshiba’s U-MOSⅣ products)

**Low loss: RonA trend**

**DSOP Advance(WF) double-sided cooling package**

Thermal resistance is reduced by 76% @ t = 3 s, mounted on board compared to SOP Advance(WF).

**VGS: 2 V / div**

**VDS: 5 V / div**

**ID: 2 A / div**

**t: 400 ns / div**

**Ringing time: 802 ns**

(Note: Comparison with Toshiba products)

**Low noise: Switching waveform**

**U-MOSX-H**

**U-MOSX-H I**

**U-MOSX-H II**

**S-TOGL™ & L-TOGL™ Cu clip structure**

**High Current & Low resistance**

**Low VDS peak**

**Short ringing time**

(Note: Comparison with Toshiba products)

**Lineup**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Rated drain current [A]</th>
<th>On-resistance (Max) [mΩ] @VGS = 10 V</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPN3R804NC</td>
<td>40</td>
<td>3.8</td>
<td>TSON Advance(WF)</td>
</tr>
<tr>
<td>TK1R4S04PB</td>
<td>120</td>
<td>1.35</td>
<td>DPAK+</td>
</tr>
<tr>
<td>XPHR7904PS</td>
<td>150</td>
<td>0.79</td>
<td>SOP Advance(WF)</td>
</tr>
<tr>
<td>TPWR7904PB</td>
<td>150</td>
<td>0.79</td>
<td>DSOP Advance(WF)L</td>
</tr>
<tr>
<td>XPJRF6604PB*</td>
<td>(200)</td>
<td>(0.66)</td>
<td>S-TOGL™</td>
</tr>
<tr>
<td>XPQR3004PB</td>
<td>400</td>
<td>0.30</td>
<td>L-TOGL™</td>
</tr>
</tbody>
</table>

*: Under development (Values enclosed in parentheses are tentative specifications. Specifications are subject to change without notice.)

**Post (solder connection)**

**Cu connector**

**Postless**

**Cu clip**

**S-TOGL™ & L-TOGL™ Cu clip structure**

**High Current & Low resistance**

**U-MOSX-H**

**U-MOSX-H I**

**U-MOSX-H II**

**Return to Block Diagram TOP**

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### Low on-resistance contributes to reduce system power consumption.

#### 1. Low loss (reduced on-resistance) and logic level drive

Using a low on-resistance technology contributes to reduce system power consumption. A lineup of logic level drive type is supported. The on-resistance per area is reduced by 60% *(compared to Toshiba’s U-MOSⅢ products)*.

#### 2. Small and low loss packages

By adopting a Cu connector structure, a low loss and high power dissipation package is realized. Wettable Flank (WF) package contributes to good mountability.

### Lineup

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Rated drain-source voltage [V]</th>
<th>Rated drain current [A]</th>
<th>On-resistance (Max) [mΩ] @VGS = -10 V</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPN9R614MC</td>
<td>-40</td>
<td>-40</td>
<td>9.6</td>
<td>TSON Advance(WF)</td>
</tr>
<tr>
<td>XPH3R114MC</td>
<td>-40</td>
<td>-100</td>
<td>3.1</td>
<td>SOP Advance(WF)</td>
</tr>
<tr>
<td>XPH8R316MC*</td>
<td>-60</td>
<td>(-90)</td>
<td>(8.3)</td>
<td>DPAK+</td>
</tr>
<tr>
<td>TJ90S04M3L</td>
<td>-40</td>
<td>-90</td>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>

*Under development (Values enclosed in parentheses are tentative specifications. Specifications are subject to change without notice.)*

(Note: Comparison with Toshiba products)

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A charge pump circuit for the N-ch MOSFET gate drive is built in, allowing for easy semiconductor relay configuration.

1. **Built-in charge pump circuit**
   - Built-in charge pump circuit enables N-ch MOSFET as high side switch.
   - Easy to configure a semiconductor relay.

2. **Can be controlled by logic level voltage**
   - It is possible to be controlled directly by output signal of MCUs or CMOS logic ICs.

3. **Small package**
   - The small surface mount packages such as PS-8, SSOP16 and WSON10A contribute to the miniaturization of equipment.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPD7104AF</th>
<th>TPD7106F</th>
<th>TPD7107F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>PS-8 (2.8 x 2.9 mm)</td>
<td>SSOP16 (5.5 x 6.4 mm)</td>
<td>WSON10A (3 x 3 mm)</td>
</tr>
<tr>
<td>Function</td>
<td>High side gate driver</td>
<td>High side gate driver</td>
<td>High side gate driver</td>
</tr>
<tr>
<td>Output</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Features</td>
<td>Operating power supply voltage range: 5 to 18 V</td>
<td>Operating power supply voltage range: 4.5 to 27 V</td>
<td>Operating power supply voltage range: 5.75 to 26 V</td>
</tr>
<tr>
<td></td>
<td>Built-in power supply reverse connection protection function (Protective MOSFET control with back-to-back circuitry)</td>
<td>Built-in power supply reverse connection protection function (Protective MOSFET control with back-to-back circuitry)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protective functions; overcurrent, overtemperature, GND disconnect, etc.</td>
<td>Protective functions; overcurrent, overtemperature, GND disconnect, etc.</td>
<td>Reverse battery connection</td>
</tr>
<tr>
<td></td>
<td>Diagnosis output; overcurrent, load open, overtemperature, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Wide lineup of small packages contribute to reduce the size and power consumption of system.

1. **Small package**
   - A lineup of various small packages such as SOT-723 (VESM 1.2 x 1.2 mm package) is available, contributing to reduce mounting area.

2. **Low voltage drive**
   - SSM3J66MFV can be driven at low gate-source voltage of 1.2 V. (SSM3J66MFV)

3. **AEC-Q101 qualified**
   - AEC-Q101 qualified and can be used for various automotive applications.

### Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>SSM3K7002KF</th>
<th>SSM3J168F</th>
<th>SSM3J66MFV</th>
</tr>
</thead>
<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>$I_0$ [A]</td>
<td>0.4</td>
<td>-0.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>$R_{DSS}$ @$V_{G}$ [Ω]</td>
<td>1.2</td>
<td>1.4</td>
<td>0.31</td>
</tr>
<tr>
<td>Drive voltage [V]</td>
<td>4.5</td>
<td>-4.0</td>
<td>-1.2</td>
</tr>
<tr>
<td>Polarity</td>
<td>N-ch</td>
<td>P-ch</td>
<td>P-ch</td>
</tr>
</tbody>
</table>

- **Return to Block Diagram TOP**
General purpose small signal bipolar transistor
2SC2712 / 2SA1162 / 2SC4116 / 2SA1586 / TTA501 / TTC501 and others

Value provided

Extensive product lineup to meet customers’ needs.

1 Extensive lineup of packages

Various packages such as 1-in-1, 2-in-1 are provided and suitable products for circuit board design are selectable.

2 Extensive 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 in accordance with the application.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.

Characteristic examples of 2SC2712

<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>50 150</td>
<td>2SC4116</td>
<td>SOT-23F</td>
</tr>
<tr>
<td></td>
<td>50 500</td>
<td>2SA1586</td>
<td>SOT-23F</td>
</tr>
<tr>
<td>Low noise</td>
<td>120 100</td>
<td>2SC4117</td>
<td>UFM (SOT-323)</td>
</tr>
<tr>
<td></td>
<td>50 1700</td>
<td>2SA1587</td>
<td>UFM (SOT-323)</td>
</tr>
<tr>
<td>High current</td>
<td>50 2000</td>
<td>2SC195</td>
<td>S-Mini (SOT-346)</td>
</tr>
<tr>
<td></td>
<td>50 2500</td>
<td>TTC501</td>
<td>S-Mini (SOT-346)</td>
</tr>
</tbody>
</table>

* indicates UFM package

Return to Block Diagram TOP
Extensive product lineup to meet customers’ needs.

1. **Built-in bias resistor type**
   (BRT: Bias Resistor built-in Transistor)
   The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

2. **Extensive lineup of package and pin assignment**
   Various package lineups, such as 1-in-1, 2-in-1 and various pin assignment type are provided and suitable products for circuit board design are selectable.

3. **AEC-Q101 qualified**
   AEC-Q101 qualified and can be used for various automotive applications.

### Internal Connections

- **Part number**
  - NPN (BRT)
  - PNP (BRT)

- **Package**
  - ESO6 (SOT-563): RN1907FE, RN2907FE
  - US6 (SOT-363): RN1901, RN2901

- **$V_{CEO}$ [V]**
  - 50 (NPN), -50 (PNP)

- **$I_C$ [mA]**
  - 100 (NPN), -100 (PNP)
TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1 Improve ESD pulse absorbability
Toshiba proprietary snapback technology (4th-Gen. process) improves ESD pulse absorption compared to Toshiba previous products. (50 % reduction in $R_{\text{DYN}}$)

2 Supports Ethernet and LVDS [Note]
These are products applicable to high speed communications (Gbps orders) such as Ethernet and LVDS.

3 High ESD immunity
$V_{\text{ESD}} > \pm 30 \text{ kV} @ \text{ISO 10605}$
$V_{\text{ESD}} > \pm 20 \text{ kV} @ \text{IEC 61000-4-2} \text{ (Level 4)}$

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

Lineup

<table>
<thead>
<tr>
<th>Part number</th>
<th>DF2S5M4FS</th>
<th>DF2S6M4FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SOD-923</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{ESD}} [\text{kV}] @ \text{ISO 10605}$</td>
<td>±30</td>
<td>±30</td>
</tr>
<tr>
<td>$V_{\text{RMS}} \text{ (Max)} [\text{V}]$</td>
<td>3.6</td>
<td>5.5</td>
</tr>
<tr>
<td>$C_{\text{L}} \text{ (Typ. / Max) [pF]}$</td>
<td>0.45 / 0.55</td>
<td>0.35</td>
</tr>
</tbody>
</table>

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TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1. Improve ESD pulse absorbability
   Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes. (Achieving both low dynamic resistance $R_{DYN}$ and low capacitance between terminals $C_t$)

2. Supports CAN, CAN FD and FlexRay
   These are products applicable to in-vehicle LAN communication such as CAN, CAN FD and FlexRay.

3. High ESD immunity
   $V_{ESD} > \pm 30$ kV @ISO 10605
   $V_{ESD} > \pm 20$ kV @IEC 61000-4-2 (Level 4)

Lineup

<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</td>
<td>USM</td>
<td>USM</td>
</tr>
<tr>
<td>$V_{ESD}$ [kV] @ISO 10605</td>
<td>±30</td>
<td>±30</td>
<td>±20</td>
</tr>
<tr>
<td>$V_{RMM}$ (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></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) The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted. This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

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