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
ADAS

**Video Input**

- LDO
- Camera
- Interface Bridge
- Parallel
- Serializer
- Deserializer
- MPI® CSI-2SM
- Memory
- LDO
- Camera
- RGB888, YCbCr422, BT.656 etc
- Video Decoder
- CVBS (NTSC/PAL)
- BT.656
- TVS
- Level Shifter
- CAN Transceiver
- LDO
- Camera
- MPI® CSI-2SM
- TVS
- FlexRay Transceiver
- LDO
- Camera
- Reverse Battery Protection/Load Switch
- Battery (12V)
- DC-DC
- DSP/Tuner
- Audio AMP
- Speaker
- CAN Line
- FlexRay Line
Device selection points
- With the advent of autonomous driving, advanced image recognition is important.
- Employing a noise tolerant interface helps reduce camera placement constraints.
- To adapt to different environments, video decoders must have enhanced visual recognition capabilities.

Proposals from Toshiba
- **Realization of high-speed image recognition using a dedicated core**
  Image recognition processor
- **Absorb differences in interfaces**
  Automotive Peripheral Bridge ICs
- **On-chip visual enhancement function**
  Video decoder
- **Both device protection and signal quality is realized**
  TVS diode (for high-speed communication)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Gate Driver
Device selection points
- The MOSFET must be selected according to the load.
- With the use of small packages, it is necessary to design heat dissipation in consideration of reliability.
- The dead time must be considered to prevent the occurrence of shoot through current.

Proposals from Toshiba
- Low power consumption of the system is realized by low on-resistance U-MOS series 40V N-ch power MOSFET
ADAS (data transmission/audio output unit)

**Device selection points**
- With the advent of autonomous driving, advanced image recognition is important.
- The TVS diode must be selected according to the ESD protection performance and capacitance related to transmission speed.

**Proposals from Toshiba**
- **Realization of high-speed image recognition using a dedicated core**
  Image recognition processor
- **Realize low heat dissipation audio output**
  Audio power amplifier IC
- **Both device protection and signal quality is realized**
  TVS diode (for CAN communication)

---

**CAN / FlexRay transmission section**

1. Image Recognition Processor
   - Level Shifter
   - CAN Transceiver
   - TVS
   - CAN Line

2. Level Shifter
   - FlexRay Transceiver
   - TVS
   - FlexRay Line

**Audio output section**

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

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
SW for power supply ON/OFF control and reverse connection protection (1)

Power supply ON/OFF control and reverse connection protecting circuit (P-ch method)

- 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)

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.

* 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)

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 switch)
- 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)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
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></th>
<th>Description</th>
<th>Low noise</th>
<th>High efficiency - Low loss</th>
<th>Small size package</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Image recognition processor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Automotive peripheral bridge IC</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Video decoder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Audio power amplifier IC</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>U-MOS series 40V N-ch power MOSFET</td>
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<td></td>
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<tr>
<td>6</td>
<td>U-MOS series -40V / -60V P-ch power MOSFET</td>
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<tr>
<td>7</td>
<td>Gate driver (for switch)</td>
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<tr>
<td>8</td>
<td>General-purpose small-signal MOSFET</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>General-purpose small-signal bipolar transistor</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Small-signal bias resistor built-in transistor (BRT)</td>
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<td></td>
</tr>
<tr>
<td>11</td>
<td>One-gate logic (L-MOS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TVS diode (for high-speed communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>TVS diode (for CAN communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Achieves high speed recognition performance with low power using an optimized architecture.

1 **High speed recognition performance**

Achieves high speed of recognition using a recognition accelerator IP, high parallel architecture and high memory bandwidth.

2 **Low power consumption**

Executes recognition processing with low power consumption using heterogeneous multi-cores and low power process.

3 **Multi-use**

Applicable for diverse usages including front monitoring, rear monitoring, 360-degree monitoring, automatic parking, electronic mirror, and driver monitoring.

**Visconti4 characteristics**

- Sign recognition
- Red light recognition
- Cyclist detection
- Collsion avoidance (night time)
- Auto high beam control
- Pedestrian collision warning
- Obstacle detection
- Lane deviation warning

**Concurrent operation**

Image recognition is executed using 8 parallel image (media) processing engines and 14 image processing accelerators.

**Fast action**

Simultaneous recognition of pedestrians and vehicles can be processed in about 50 ms (about half of Visconti2).

**New image feature value enhancement - CoHOG**

Night pedestrian recognition has been improved to the same level as conventional daytime recognition.

**Line up**

<table>
<thead>
<tr>
<th>Model</th>
<th>TMPV7608XBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series</td>
<td>Visconti4</td>
</tr>
<tr>
<td>Package</td>
<td>PFBGA796</td>
</tr>
<tr>
<td>CPU</td>
<td>Toshiba original 32 bit RISC MeP x 2</td>
</tr>
<tr>
<td>MPE</td>
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</tr>
</tbody>
</table>

◆Return to Block Diagram TOP
More options for component selection by eliminating the host ↔ display/camera interface gap

1. **Wider component selection**

By adjusting to an SoC that supports only a specific video standard interface, component options can be expanded.

2. **Less noise**

Converting parallel communication to serial improves noise immunity and suppresses the generation of own noise.

3. **Reduced wiring**

Converting parallel communication to serial reduces the number of wires and the risk of bad/broken connections.

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**Camera interface bridge**

- **X standard**
  - Camera
  - Interface Bridge
- **Y standard**
  - Host processor

---

**Line up**

<table>
<thead>
<tr>
<th>Model</th>
<th>TC9591</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>VFBGA80 7mm x 7mm 0.65mm pitch</td>
</tr>
<tr>
<td>Input</td>
<td>(1) MIPI® CSI-2SM 4 Data lanes × 1ch, (2) Parallel input 24 bit@154MHz</td>
</tr>
<tr>
<td>Output</td>
<td>(1) Parallel output 24 bit@100MHz, (2) MIPI® CSI-2SM 4 Data lanes × 1ch</td>
</tr>
</tbody>
</table>
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, enabling stronger emphasis without increasing discomfort to the eyes.

2. Color management
This function emphasizes a specific selected color (saturation). The objective is to enhance visibility by emphasizing certain colors such as red.

3. Dynamic YC gamma
Applying optimized Y gamma curves to the images reduces blackout and whiteout, improving visibility.

---

### Line up

<table>
<thead>
<tr>
<th></th>
<th>TC90105FG</th>
<th>TC90107FG</th>
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<tbody>
<tr>
<td><strong>Model</strong></td>
<td></td>
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<tr>
<td><strong>Package</strong></td>
<td>LQFP 80 pin</td>
<td>LQFP 64 pin</td>
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<tr>
<td><strong>ADC</strong></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Component (D2)</strong></td>
<td></td>
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<tr>
<td><strong>Signal input</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New image correction</strong></td>
<td>○</td>
<td>-</td>
</tr>
<tr>
<td><strong>ITU-R BT.601 output</strong></td>
<td>○</td>
<td>-</td>
</tr>
<tr>
<td><strong>ITU-R BT.656 output</strong></td>
<td>○</td>
<td>-</td>
</tr>
</tbody>
</table>

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**Audio power amplifier IC**

TCB701FNG/TCB702FNG

**Value provided**

Achieves audio output with low heat dissipation at a reasonable price

1. **Proprietary high efficiency amplifier** (patent registered)
   - Realizes efficiency equivalent to a class D digital amplifier with an output of 4W or less. Power consumption inside the IC is about one-fifth of a standard class AB amplifier and about one-half of a conventional high efficiency linear KB class.

2. **Low BOM**
   - Without switching action like in a digital class D amplifier, the BOM cost can be reduced by half as there is no need for external LPF or components for EMI suppression.

3. **Continuous error detection** (patent registered)
   - Includes a proprietary speaker burnout prevention system that continuously checks for any abnormal DC offset regardless of signal presence and informs the microcomputer.

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**Line up**

<table>
<thead>
<tr>
<th>Model</th>
<th>TCB701FNG</th>
<th>TCB702FNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>P-HSSOP36-1116-0.65-001 (36 pin)</td>
<td></td>
</tr>
<tr>
<td>Max. output power</td>
<td>49W×4ch (VCC=15.2V, RL=4Ω Max Power)</td>
<td>45W×4ch (VCC=15.2V, RL=4Ω Max Power)</td>
</tr>
<tr>
<td>Total harmonic distortion (THD)</td>
<td>0.01% (at POUT=4W)</td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>6 ~ 18V</td>
<td></td>
</tr>
<tr>
<td>Output noise voltage</td>
<td>60μVrms (BW=DIN AUDIO)</td>
<td></td>
</tr>
</tbody>
</table>

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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 UMOSIV)

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.

---

### 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), 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

(10x13mm) ~200A

DPAK+ (6.5x10mm) ~90A

SOP Advance(WF) (5x6mm) ~100A

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></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></td>
</tr>
</tbody>
</table>
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.

**Value provided**

**Gate driver (for switch)**

**TPD7104AF**

**Semiconductor relay (switch) application**

**Power supply reverse connection protection FET control**

**Back to back configuration**

**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>

**Features**

- Operating power supply voltage range: 5 to 18 V
- Built-in charge pump
- Built-in power supply reverse connection protection function

(Supported for power supply reverse connection protection FET applications)

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General-purpose small-signal MOSFET
SSM3K7002KF / SSM3J168F / SSM3J66MFV

Value provided

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

Line up

<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>$V_{DSS}$</td>
<td>60</td>
<td>-60</td>
<td>-20</td>
</tr>
<tr>
<td>$I_D$</td>
<td>0.4</td>
<td>-0.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>$R_{DS(ON)}$ @$V_{GS}=4.5$ V</td>
<td>1.2</td>
<td>1.4</td>
<td>0.31</td>
</tr>
<tr>
<td>Drive voltage</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 \( V_{CE\text{(sat)}} \) 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}[\text{V}] )</th>
<th>( I_C[\text{mA}] )</th>
<th>NPN</th>
<th>PNP</th>
<th>NPN</th>
<th>PNP</th>
<th>NPN</th>
<th>PNP</th>
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<tbody>
<tr>
<td>General purpose</td>
<td>50</td>
<td>150</td>
<td>2SC4738</td>
<td>2SA1832</td>
<td>2SC4116</td>
<td>2SA1586</td>
<td>2SC2712</td>
<td>2SA1162</td>
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<tr>
<td></td>
<td>50</td>
<td>500</td>
<td>2SC3325</td>
<td>2SA1313</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low noise</td>
<td>120</td>
<td>100</td>
<td>2SC4117</td>
<td>2SA1587</td>
<td>2SC2713</td>
<td>2SA1163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-current</td>
<td>50</td>
<td>1700</td>
<td></td>
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</tr>
</tbody>
</table>

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Small-signal bias resistor built-in transistor (BRT)
RN1114 / 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.

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>NPN (BRT)</th>
<th>PNP (BRT)</th>
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<tbody>
<tr>
<td>Package</td>
<td></td>
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</tr>
<tr>
<td>SSM (SOT-416)</td>
<td>RN1114</td>
<td>RN2114</td>
</tr>
<tr>
<td>S-Mini (SOT-346)</td>
<td>RN1414</td>
<td>RN2414</td>
</tr>
<tr>
<td>V_{CEO} (Max) [V]</td>
<td>50</td>
<td>-50</td>
</tr>
<tr>
<td>I_{c} [mA]</td>
<td>100</td>
<td>-100</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.

Line up
<table>
<thead>
<tr>
<th>Package</th>
<th>VHS series</th>
<th>SHS series</th>
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<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>VCC [V]</td>
<td>2.0 ~ 5.5</td>
<td>1.65/1.8 ~ 5.5</td>
</tr>
<tr>
<td>Io[mA]</td>
<td>8</td>
<td>24</td>
</tr>
</tbody>
</table>

* Compliant products with AEC-Q100’s reliability test only
TVS diode (for high-speed communication)
DF2S5M4FS / DF2S6M4FS

**Value provided**

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

1. **Improve ESD absorbability**
   - Our proprietary snapback technology (4-Gen. EAP Process) improves ESD absorption compared to conventional products. (50% reduction in $R_{DYN}$)

2. **Ensuring High Signal integrity**
   - Supports high-speed communications of Gbps orders such as Ethernet and LVDS. Lowered capacitance ensures higher signal integrity.

3. **High ESD immunity**
   - Compliant products with ISO10605 Standard > ±30 kV
   - IEC61000-4-2 Standard > ±20 kV(L4)

**Line up**

<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>$V_{ESD}$ [kV] @ISO10605</td>
<td>±30</td>
<td>±30</td>
</tr>
<tr>
<td>$V_{BVM}$ (Max) [V]</td>
<td>3.6</td>
<td>5.5</td>
</tr>
<tr>
<td>$C_t$ (Typ./Max.) [pF]</td>
<td>0.45/0.55</td>
<td></td>
</tr>
<tr>
<td>$R_{DYN}$ (Typ) [Ω]</td>
<td>0.35</td>
<td></td>
</tr>
</tbody>
</table>

**Surge absorption performance**

LVDS(@4.8 Gbps) DF2S6M4FS Eye pattern

(Note) : This product is an ESD protection diode and cannot be used for purposes other than ESD protection (including but not limited to voltage regulation diode applications).
**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 \( R_{\text{DYN}} \) 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</td>
<td>USM</td>
<td>USM</td>
</tr>
<tr>
<td>V_{\text{ESS}} (kV) @ISO10605</td>
<td>±30</td>
<td>±30</td>
<td>±20</td>
</tr>
<tr>
<td>( V_{\text{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_{\text{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 Devices & Storage Corporation

*2:Measurements of the commercial product

**Return to Block Diagram TOP**
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