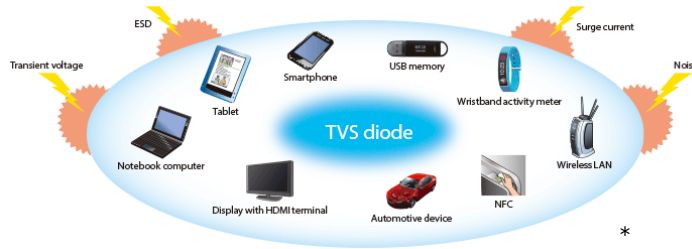


Introduction to Toshiba TVS Diodes (ESD Protection Diodes) Line-up

Toshiba offers the strong solution for the TVS* Diodes of the wide lineup and excellent protective performance to the consumer, industry and automotive application.

Product destruction caused by ESD occurs anywhere around us.

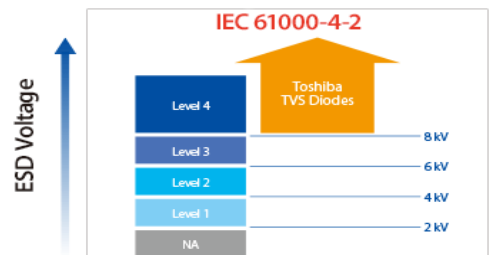
ESD* exist anywhere around us. For example, if the ESD enters into the set via the connector, it may cause problems such as internal destruction of devices and malfunction of the system. In order to prevent such problems, ESD countermeasures are important in set design, and ESD protection diodes are used in many cases.



* TVS : Transient Voltage Suppressor
ESD : Electro-Static Discharge

Toshiba TVS Diodes(ESD Protection Diodes) protect equipment with high ESD protection performance

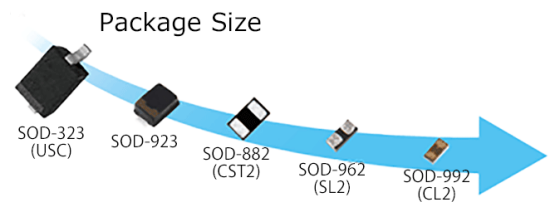
Many system-level immunity tests, such as those stipulated by IEC61000-4-2/4-5, have been adopted as an indicator of ESD tolerance. In recent years, however, similar tests have been required for TVS diodes themselves. Our products adopt system-level ESD tests and achieve ESD immunity higher than the Level 4 requirements of IEC61000-4-2 (Contact) standard, contributing robust protection of on-board devices.



*Based on our survey.

Wide support from high-speed signals to power supply lines

We have our own chip-processing technologies, and we have a wide range of lineups, from standard capacity type that can be used for protecting power lines and audio signals to low-capacity type that can be used for signal lines of high-speed communication standards such as USB 3.2, HDMI® 2.1 and Thunderbolt™ 3.










High-quality production of small packages

We have a wide range of small packages that can be used in smaller sets and smaller PCBs. We respond to the needs of our customers by offering a variety of TVS Diodes through high-quality and stable production at our plants in Japan and Thailand.


















Toshiba provides ESD protection diodes for various applications, including smartphones, PCs, tablets, wearable devices, IoT devices, consumer equipment, industrial equipment and automotive application. The next page is an example Toshiba TVS Diodes line-up.

Toshiba TVS Diodes (ESD Protection Diodes) Selection Guide(Single type)







| Signal line Application | C _t (typ.) | V _{RWM} (MAX) (V) | SL2 (SOD-962) 1.0x0.6mm  | CST2 (SOD-882) 1.0x0.6mm  | SOD-923 1.0x0.6mm  | ESC (SOD-523) 1.6x0.8mm  | USC (SOD-323) 2.5x1.25mm  |
|--|-----------------------|-----------------------------------|--|---|---|--|--|
| <p>USB 3.2(10Gbps) Thunderbolt 3(20Gbps) HDMI 2.1(16Gbps) Wi-Fi®, Bluetooth® (2.4GHz)</p> <p>USB 3.1(10Gbps) HDMI 2.0(6Gbps)</p> <p>NFC, Sensor</p> <p>USB 3.0(5Gbps)</p> <p>USB 2.0(480Mbps)</p> <p>Automotive CAN FlexRay/ LIN</p> | 0.1~ 0.15pF | 3.6V | DF2B5M4ASL | - | - | - | - |
| | | 5.5V | DF2B6M4BSL DF2B6M4ASL DF2B7M3SL | | | | |
| | 0.2~ 0.35pF | 3.6V, 3.3V | DF2B5M5SL DF2B5M4SL DF2S5M5SL DF2S5M4SL | DF2B5M4CT DF2B5M5CT DF2S5M4CT | - | - | - |
| | | 5.5V, 5V | DF2B6M5SL DF2B6M4SL DF2S6M5SL DF2S6M4SL | DF2B6M4CT DF2B6M5CT DF2S6M4CT DF2B6.8M1ACT | - | - | - |
| | | 11V, 18.5V, 24V | DF2B12M4SL DF2B20M4SL DF2B26M4SL | - | - | - | - |
| | 0.5~ 0.6pF | 3.3V | DF2S5M5SL | DF2S5M5CT | DF2S5M4FS | - | - |
| | | 5V | DF2S6M5SL | DF2S6M5CT | DF2S6M4FS | | |
| | 0.9~ 1.5pF | 5.5V, 5V | DF2B6USL | - | - DF2S6.8MFS | - | - |
| | ~45pF | 5.5V | DF2B7BSL DF2B7ASL | DF2B7ACT DF2B7PCT | DF2B7AFS | DF2B7AE DF2B6.8E | DF2B7AFU |
| | | | 3.6V, 3.3V | DF2B5BSL DF2B5SL | | | |
| Others | | DF2S5.1 ~30ASL | DF2S5.6 ~30CT | DF2S5.1 ~30FS | - | DF2S12FU DF2B18FU DF2B29FU DF2B36FU | |

| Signal line Application | C _t (typ.) | VRWM (MAX) (V) | USC (SOD-323) 2.5x1.25mm  | UDFN6B 2.0x2..0mm  |
|-------------------------|-----------------------|---------------------------------|---|---|
| Power line (VCC,VBAS) | 45pF~ | 5.5V 10V 12.6V 21V,22V | DF2S6P2FU DF2S12P2FU DF2S14P2FU DF2S23P2FU | DF6S25P3NU |

Toshiba TVS Diodes (ESD Protection Diodes) Selection Guide(Multibit type)

| Signal line Application | C _t (typ.) | V _{RWM} (MAX) (V) | 4 in 1 | 2 in 1 | DFN5 1.3x0.8mm  | DFN6 1.25x1.0mm  | DFN10 2.5x1.0mm  |
|--|-----------------------|----------------------------|---|--|--|---|---|
| USB 3.1(10Gbps) HDMI 2.0(6Gbps) | 0.2pF | 3.6V | DF10G5M4N (DFN10) DF5G5M4N (DFN5) | DF6D5M4N (DFN6) |  |  |  |
| | | 5.5V | DF10G6M4N (DFN10) DF5G6M4N (DFN5) DF5G7M2N (DFN5) | DF6D6M4N (DFN6) |  |  | |
| USB 3.0(5Gbps) USB 2.0(480Mbps) | 0.5pF | 5V | DF10G7M1N (DFN10) | DF3D6.8MS (SSM) DF6D7M1N (DFN6) |  |  | |
| GPIO, Audio,I2C etc (100MHz~kHz) Automotive CAN FlexRay/ LIN | 6pF | 5V | DF5A5.6~6.8LJE (ESV) DF5A5.6~6.8LFU (USV) DF5A6.8LF (SMV) | DF3A6.8LCT (CST3) DF3A5.6~6.8LFU (USM) DF3A5.6~6.8LFV (VESM) |  |  | |
| | 7~9pF | 12V 24V 28V | | DF3D18FU (USM) DF3D29FU (USM) DF3D36FU (USM) |  |  |  |
| | 25pF | 3.5~5V | DF5A5.6~6.8CJE (ESV) DF5A5.6~6.8CFU (USV) | | | | |
| | 45pF | 3.5~5V | DF5A5.6~6.8JE (ESV) DF5A5.6~6.8FU (USV) DF5A5.6~6.8F (SMV) DF6A6.8FU (US6) | DF3A6.8CT (CST3) DF3A6.2~6.8FV (VESM) DF3A5.6~6.8FU (USM) DF3A5.6~6.8F (S-Mini) |  |  | |

The example of reference products for USB Type-C®

| Line | Product Number | V _{RWM} (MAX) (V) | Polarity | C _t (typ.) | V _{ESD} | Bit | Package | Where to buy |
|-------|----------------------------|----------------------------|----------------|-----------------------|------------------|--------|--|---|
| VBUS | DF6S25P3NU | 22V | Unidirectional | 650pF | ±30kV | Single | UDFN6B(SOT-1220) 2.0x2.0mm  |  |
| D+/D- | DF2B6USL | 5.5V | Bidirectional | 1.5pF | ±10kV | Single | SL2(SOD-962) 1.0x0.6mm  |  |
| Tx/Rx | DF2B5M4ASL | 3.6V | Bidirectional | 0.15pF | ±16kV | Single | SL2(SOD-962) 1.0x0.6mm  |  |

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