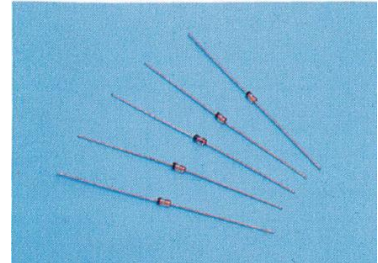


Introduction of Toshiba diode lineup for Industries

Over the years, Toshiba has expanded its lineup by incorporating various diodes into various packages. This document introduces the diode product lineup to support a wide range of industrial equipment.

Toshiba is Diode's leading company

Since Toshiba began mass production of diodes in 1956, Toshiba has been one of the diode vendors that have continued to bring their products to the market as a pioneer of the industry since the early days of the semiconductor industry. Our typical switching diode M8555, developed in 1966, has contributed to the times as a compact, high-performance, low-cost diode. Based on our experience in delivering products to many customers, we will continue to offer a wide variety of highly reliable diode products.



■ Representative old products developed in 1966
Switching diode M8555

Stable, high-quality production system at plants in Japan and Thailand

Our current diode products produce a wide range of packages, from small surface mount types, mainly in our own factories, to through-hole types.

Overview of Toshiba Diode

A diode is a two-terminal semiconductor-device with one PN junction or an alternative junction. Toshiba supplies a wide range of products using its proprietary device technology.

This is Top page for Toshiba Diodes.

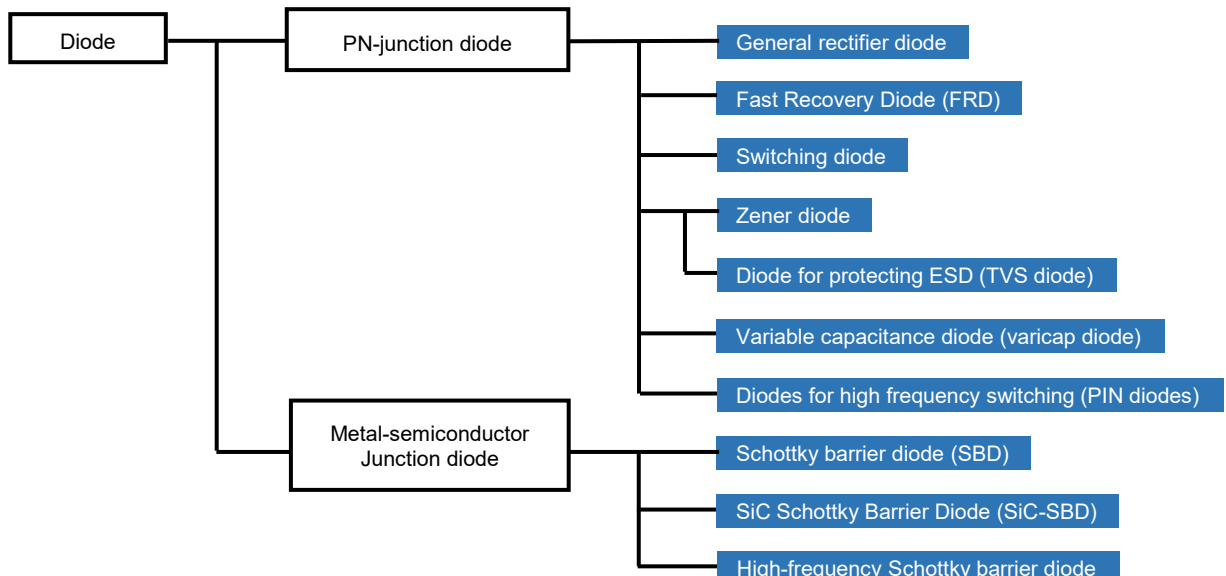
PN-junction diode

We have a wide range of products, including rectifier diodes and switching diodes, depending on their structure and application.

Metal-semiconductor junction diode

Diodes that utilize Schottky barriers generated by the junction between metal and semiconductor. As compared to PN junction diodes

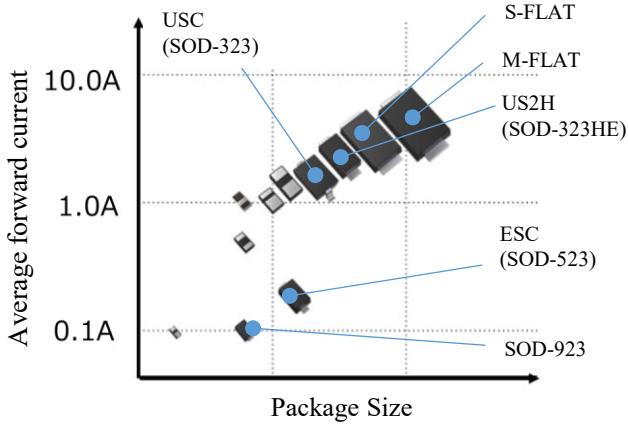
It has the advantage that the forward voltage (V_F) is low and the switching performance is fast. The power supply circuit can be made more efficient or smaller.



Toshiba Diode Package Development

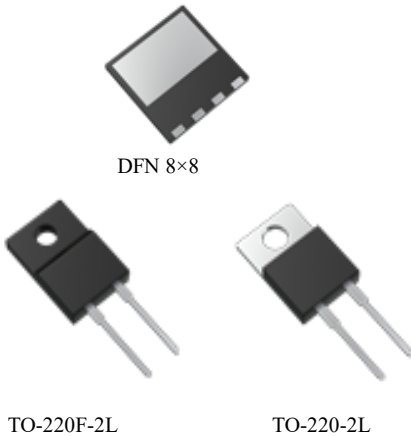
Compact and general-purpose USC(2.5 x 1.25 mm), medium-sized and relatively powerable M-FLAT(4.7 x 2.4 mm), and even smaller packages are available for a wide range of applications. In recent years, we have developed US2H packages with heatsinks to achieve compactness and power application. In addition to the power package DFN 8x8(8.0 x 8.0 of SiC devices, we also offer lead-type packages.

■ Representative 2Pin surface-mount packaging



Package Name	Size (mm)	Height (mm)
SOD-923	1.0 × 0.6	0.4
ESC	1.6 × 0.8	0.6
USC	2.5 × 1.25	0.9
US2H	2.5 × 1.4	0.6
S-FLAT	3.5 × 1.6	0.98
M-FLAT	4.7 × 2.4	0.98

■ Example Power Package Equipped with SiC SBD



Package Name	Size (mm)	Height (mm)
DFN 8 × 8	8.0 × 8.0	0.85
TO-220F-2L	10.0 × 15.0	4.5
TO-220-2L	10.05 × 15.3	4.45

For other packages, see here.

Related LINK

- [This is the diode product page.](#)
- [This is the parametric search for the product.](#)
- [Related Application Notes](#)
- [Frequently Asked Questions for Diodes \(FAQ\)](#)
- [Cross reference search is shown here.](#)

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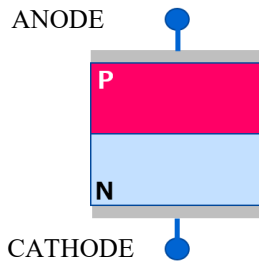
General rectifier diode

<Product Overview>

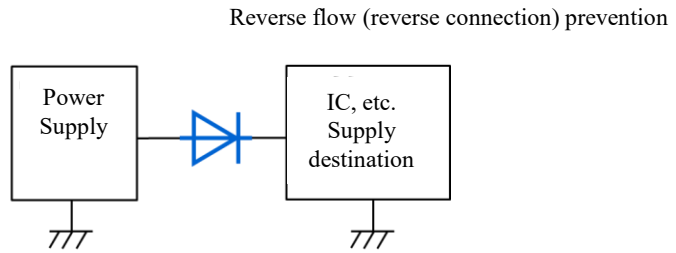
Rectifier diodes have been widely used to convert alternating current to direct current. Recently, they are mainly used to prevent backflow and reverse connection.

Our lineup of products has 400V, 600V and high-withstand voltage, so they are used for power supply lines that apply various voltages. Averaged forward currents are available from 0.4A to 2.0A and are available in surface-mount packaging suitable for high-density mounting.



<Structural drawing>



<Circuit example>



Our general rectifier diode selection table

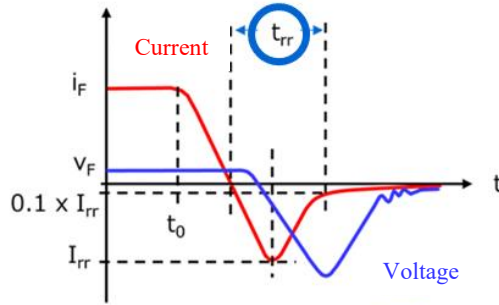
V_{RRM} (V)	I_F (A)	I_{FSM} (A)	T_j (°C)	Product name	Product type	V_{FM} Typ (V)	$@I_{FM}$	I_{RRM} Max (μ A)	Package (Common Name)	Dimensions (mm)	Purchase
							(A)				
400	0.4	8	150	CRG11B	General rectifier diode	1.1	0.4	5	S-FLAT	 1.6 × 3.5 × 0.98	
	1.0	15	150	CRG09A	General rectifier diode	1.1	0.7	5	S-FLAT		
	1.0	10	150	CRG09B	General rectifier diode	1.1	0.7	5	S-FLAT		
600	0.7	15	150	CRG10A	General rectifier diode	1.1	0.7	5	S-FLAT		
	1.0	20	150	CRG04A	General rectifier diode	1.1	1.0	5	S-FLAT		
	1.0	20	150	CMG06A	General rectifier diode	1.1	1.0	5	M-FLAT	 2.4 × 4.7 × 0.98	
	2.0	80	150	CMG03A	General rectifier diode	1.1	2.0	5	M-FLAT		

Ultrahigh-speed Rectifier (FRD)

<Product Overview>

Fast recovery diodes are a type of rectifier diodes. They have a quicker reverse-recovery-time t_{rr} than conventional rectifier diodes and are suitable for high-speed rectification. Therefore, it is used as a protective device for the snubber circuit used in the power supply circuit, as shown in the circuit below, or as a rectifying device required for DCDC converter or ACDC converter circuit. On the other hand, the forward voltage and leakage current tend to increase in comparison with the conventional rectifier diode. Therefore, a heat dissipation design considering forward loss and reverse loss should be adopted.

<Reverse-recovery-time t_{rr} >



t_{rr} guideline:

General rectifier diodes:

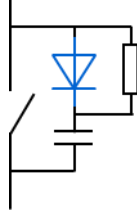
A few μ s to several tens of μ s

FRD:

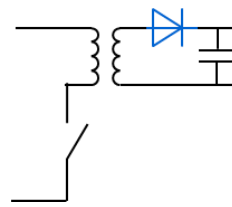
Several ns to hundreds of ns

<Circuit example>

Switching power supplies
Snubber circuit



Secondary of DCDC converter



Our FRD selection table for ultra high-speed rectification

※ 1: $I_F=1A, di/dt=-30A/\mu s$

V_{RRM} (V)	I_F (A)	I_{FSM} (A)	T_j (°C)	Product name	V_{FM} Max (V)	I_{RRM} Max (μ A)	T_{rr} Typ. (ns)*1	Package (Common Name)	Dimensions (mm)	Purchase
					@ I_{FM} (A)					
200	0.5	10	150	CRH02	0.95	0.5	10	35	1.6 × 3.5 × 0.98	Buy Online
	0.5	10	150	CRH02B	0.95	0.5	5	35		Buy Online
	1.0	15	150	CRH01	0.98	1.0	10	35		Buy Online
	1.0	10	150	CRH01B	0.98	1.0	5	35	2.4 × 4.7 × 0.98	Buy Online
	1.0	20	150	CMH04	0.98	1.0	10	35		Buy Online
	2.0	40	150	CMH07	0.98	2.0	10	35		Buy Online
	3.0	40	150	CMH01	0.98	3.0	10	35		Buy Online
600	0.7	10	150	CRF03A	2.0	0.7	50	100	1.6 × 3.5 × 0.98	Buy Online
	1.0	10	150	CMF02A	2.0	1.0	50	100	2.4 × 4.7 × 0.98	Buy Online
	2.0	30	150	CMF01A	2.0	2.0	50	100		Buy Online

Switching diode

<Product Overview>

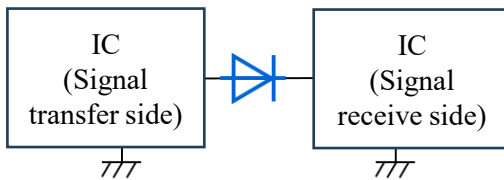
Diodes that use PN junctions for switching applications. 80mA~500mA rated current is a product lineup that includes one to four circuits in a small package. This product is ideal for high-density electronic equipment.

In addition to signal rectification (switching) applications as in circuit examples, some cases are used for protection applications such as clamp circuits.

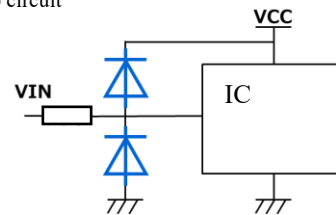
A typical 1SS352 is that the reverse-recovery-time t_{rr} is devised in the same way as the ultra-high-speed rectifier.

<Circuit example>

For signal switching (rectification)



For clamp circuit



Our switching diode selection table

Product Number	VR (Max) (V)	IO (Max) (A)	Internal connection	Pin Number	Packaging (Toshiba)	AEC-Q101	Package dimensions (mm)	Purchase
1SS387CT	80	0.1	Single	2	CST2		1.0 x 0.6 x 0.38	Buy Online
1SS387	80	0.1	Single	2	ESC	Compatible products	1.6 x 0.8 x 0.6	Buy Online
1SS403E	200	0.1	Single	2	ESC		1.6 x 0.8 x 0.6	Buy Online
BAS516	100	0.25	Single	2	ESC		1.6 x 0.8 x 0.6	Buy Online
1N4148WT	100	0.25	Single	2	ESC		1.6 x 0.8 x 0.6	Buy Online
1SS187	80	0.1	Single	3	S-Mini	Compatible products	2.9 x 2.5 x 1.1	Buy Online
1SS190	80	0.1	Single	3	S-Mini		2.9 x 2.5 x 1.1	Buy Online
1SS193	80	0.1	Single	3	S-Mini	Compatible products	2.9 x 2.5 x 1.1	Buy Online
1SS196	80	0.1	Single	3	S-Mini	Compatible products	2.9 x 2.5 x 1.1	Buy Online
1SS250	200	0.1	Single	3	S-Mini		2.9 x 2.5 x 1.1	Buy Online
1SS427	80	0.1	Single	2	SOD-923		1.0 x 0.6 x 0.4	Buy Online
TBAS16	80	0.215	Single	3	SOT23		2.9 x 2.4 x 0.9	Buy Online
1SS352	80	0.1	Single	2	USC	Compatible products	2.5 x 1.25 x 0.9	Buy Online
1SS403	200	0.1	Single	2	USC	Compatible products	2.5 x 1.25 x 0.9	Buy Online
BAS316	100	0.25	Single	2	USC		2.5 x 1.25 x 0.9	Buy Online
1N4148WS	100	0.25	Single	2	USC		2.5 x 1.25 x 0.9	Buy Online
1SS370	200	0.1	Single	3	USM		2.0 x 2.1 x 0.9	Buy Online

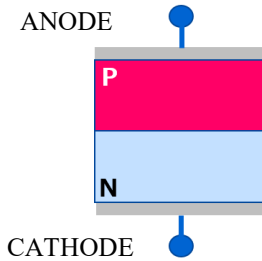
The other lineup is here.

Zener diode

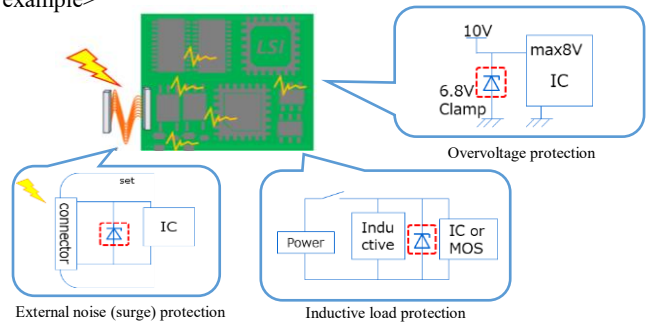
<Product Overview>

The reverse-voltage of PN junction is used to clamp the desired voltage and to protect semiconductors, such as IC, from overvoltages applied to the circuitry. In a power line, etc., a surge may be generated with a long pulse width reaching several milliseconds when the circuit is opened or closed. Zener diodes protect semi-conductor devices from overvoltages close to DC that are difficult to protect with ESD protective diodes. Of course, it can protect semi-conductor devices from ESD of less than 100 nanoseconds and from dielectric lightning surges of the order of microseconds, thus contributing to reliability improvement of equipment.


<Structural drawing>




<Usage example>



Our Zener-Diode Selection Table

Allowable Loss (W)	Product name	Zener characteristics				Dimensions (mm) (Common Name)	Purchase
		Vz(V)			@Iz (mA)		
		Min	Typ	Max			
0.7	CRY62	5.6	6.2	6.8	10	 S-FLAT 1.6 × 3.5 × 0.98	Buy Online
	CRY68	6.2	6.8	7.4	10		Buy Online
	CRY82	7.4	8.2	9.0	10		Buy Online
	CRZ10	9.0	10.0	11.0	10		Buy Online
	CRZ12	10.8	12.0	13.2	10		Buy Online
	CRZ13	11.7	13.0	14.3	10		Buy Online
	CRZ15	13.5	15.0	16.5	10		Buy Online
	CRZ16	14.4	16.0	17.6	10		Buy Online
	CRZ18	16.2	18.0	19.8	10		Buy Online
	CRZ20	18.0	20.0	22.0	10		Buy Online
	CRZ24	21.6	24.0	26.4	10		Buy Online
	CRZ27	24.3	27.0	29.7	10		Buy Online
	CRZ30	27.0	30.0	33.0	10		Buy Online
	CRZ33	29.7	33.0	36.3	10		Buy Online
	CRZ36	32.4	36.0	39.6	9		Buy Online
CRZ39	35.1	39.0	42.9	8	Buy Online		

Allowable Loss (W)	Product name	Zener characteristics				Dimensions (mm) (Common Name)	Purchase
		Vz(V)			@Iz (mA)		
		Min	Typ	Max			
0.3	CEZ5V6	5.3	5.6	6.0	5	 ESC 1.6 × 0.8 × 0.6	Buy Online
	CEZ6V2	5.8	6.2	6.6	5		Buy Online
	CEZ6V8	6.4	6.8	7.2	5		Buy Online
	CEZ7V5	7.0	7.5	7.9	5		Buy Online
	CEZ8V2	7.7	8.2	8.7	5		Buy Online
	CEZ9V1	8.5	9.1	9.6	5		Buy Online
	CEZ10V	9.4	10	10.6	5		Buy Online
	CEZ11V	10.4	11	11.6	5		Buy Online
	CEZ12V	11.4	12	12.6	5		Buy Online
	CEZ13V	12.4	13	14.1	5		Buy Online
	CEZ15V	13.8	15	15.6	5		Buy Online
	CEZ16V	15.3	16	17.1	5		Buy Online
	CEZ18V	16.8	18	19.1	5		Buy Online
	CEZ20V	18.8	20	21.2	5		Buy Online
	CEZ22V	10.8	22	23.3	5		Buy Online
	CEZ24V	22.8	24	25.6	5		Buy Online
	CEZ27V	25.1	27	28.9	2		Buy Online
	CEZ30V	28.0	30	32.0	2		Buy Online
	CEZ33V	31.0	33	35.0	2		Buy Online
	CEZ36V	34.0	36	38.0	2		Buy Online

The other lineup is here.

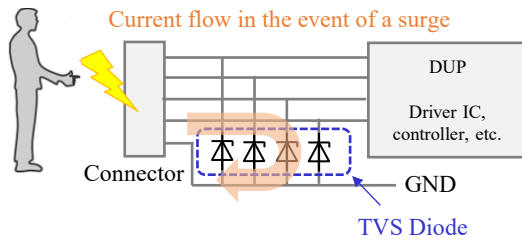
Diode for protecting ESD (TVS diode)

<Product Overview>

ESD protection diodes (TVS diodes) are diodes that protect devices from surge voltages such as static electricity entering from external terminals and prevent IC malfunctions. We contribute to protection of electronic equipment in a wide range of applications, including consumer, industrial, and automotive applications, by developing our own product lineup that focuses on low capacity and protection performance. A typical DF2S5M4FS is a low-capacitance type that uses SOD-923 packaging with excellent mounting visibility.

<Usage example>

In the event of a voltage surge



<Representative Products>

DF2S5M4FS



SOD-923
1.0x0.6x0.4mm

Features

- Compact + Mounting Visibility Package
- Low capacitance: 0.45pF(typ.)
- Low dynamic resistor: 0.35 Ω(typ.)
- AEC-Q101 conformance

Our diode for protecting ESD (TVS diode) Selection table

Signal line Application	C _t (typ.)	V _{RWM} (MAX)(V)	SL2 (SOD-962) 0.62x0.32mm	CST2 (SOD-882) 1.0x0.6mm	SOD-923 1.0x0.6mm	ESC (SOD-523) 1.6x0.8mm	USC (SOD-323) 2.5x1.25mm
USB 3.2(10Gbps) Thunderbolt™ 3(20Gbps) HDMI® 2.1(16Gbps) Wi-Fi® Bluetooth® (2.4GHz)	0.1~0.15pF	3.6V	DF2B5M4ASL	-	-	-	-
		5.5V	DF2B6M4BSL DF2B6M4ASL DF2B7M3SL	-	-	-	
USB 3.1(10Gbps) HDMI® 2.0(6Gbps)	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	-	-	-	-
NFC, Sensor	0.5~0.6pF	3.3V	DF2S5M5SL	DF2S5M5CT	DF2S5M4FS	-	-
		5V	DF2S6M5SL	DF2S6M5CT	DF2S6M4FS	-	-
USB 3.0(5Gbps)	0.9~1.5pF	5.5V, 5V	-	-	DF2S6.8MFS	-	-
USB 2.0(480Mbps)	~45pF	5.5V	DF2B7BSL DF2B7ASL	DF2B7ACT DF2B7PCT	DF2B7AFS	DF2B7AE DF2B6.8E	DF2B7AFU
GPIO, Audio, I2C etc (100MHz~kHz)	~45pF	3.6V, 3.3V	DF2B5BSL DF2B5SL	DF2B5PCT	-	-	-
		Others	DF2S5.1 ~30ASL	DF2S5.6 ~30CT	DF2S5.1 ~30FS	-	DF2S12FU DF2B18FU DF2B29FU DF2B36FU
Automotive CAN FlexRay/ LIN							

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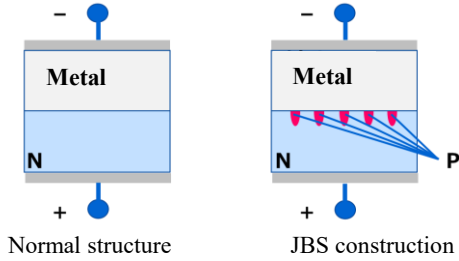
The other lineup is here.

Schottky barrier diode (SBD)

<Product Overview>

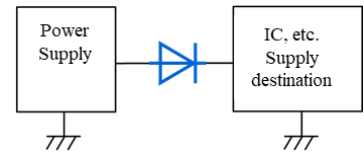
Schottky barrier diodes are devices that achieve low VF properties by joining metals and semiconductors. We range from small-signal products with a wide range of reverse voltages to products for power supply lines. In addition, by incorporating a JBS structure as compared to the conventional metal-semiconductor junction type structure, we can contribute to high-efficiency and power saving of various devices by offering a variety of low VF/ and low IR types with different performance.

<Structural drawing>

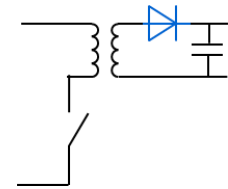


<Circuit example>

Reverse flow (reverse connection) prevention



Secondary side of the switching power supply



Our Schottky barrier diode selection table

VR (V)	IF (A)	Product name	Features	VF Typ (V)	IR Max (mA)	Internal element	Package Name (Toshiba)	Dimensions (mm)	Purchase
40	0.5	CUS05F40	Low IR	0.74	15	Single	USC	2.5 × 1.25 × 0.9	Buy Online
		CUS05S40	Low VF	0.56	50		USC	2.5 × 1.25 × 0.9	Buy Online
	1.0	CRS10I40E	High current/low IR	0.55	0.05		S-FLAT	1.6 × 3.5 × 0.98	Buy Online
		CRS10I40B	High current/low VF	0.45	0.1		S-FLAT	1.6 × 3.5 × 0.98	Buy Online
		CUS10F40	High current/low IR	0.60	20		USC	2.5 × 1.25 × 0.9	Buy Online
		CUS10S40	High current/low VF	0.45	150		USC	2.5 × 1.25 × 0.9	Buy Online
	1.5	CMS15I40A	High current/low VF	0.49	0.1		M-FLAT	2.4 × 4.7 × 0.98	Buy Online
		CUHS15F40	High current/low IR	0.57	50		US2H	2.5 × 1.4 × 0.6	Buy Online
		CUHS15S40	High current/low VF	0.45	200		US2H	2.5 × 1.4 × 0.6	Buy Online
	2.0	CRS20I40B	High current/low IR	0.52	0.1		S-FLAT	1.6 × 3.5 × 0.98	Buy Online
		CUHS20F40	High current/low IR	0.47	60		US2H	2.5 × 1.4 × 0.6	Buy Online
		CUHS20S40	High current/low VF	0.40	300		US2H	2.5 × 1.4 × 0.6	Buy Online
3.0	CMS30I40A	High current/low VF	0.55	0.1	M-FLAT	2.4 × 4.7 × 0.98	Buy Online		
60	1.0	CRS10I60E	High withstand voltage/low IR	0.62	0.05	S-FLAT	1.6 × 3.5 × 0.98	Buy Online	
	1.0	CUHS10F60	High withstand voltage/low IR	0.56	40	US2H	2.5 × 1.4 × 0.6	Buy Online	
	1.5	CUHS15F60	High withstand voltage/high current	0.66	50	US2H	2.5 × 1.4 × 0.6	Buy Online	
		CUHS15S60	High withstand voltage/low VF	0.60	450	US2H	2.5 × 1.4 × 0.6	Buy Online	
	2.0	CUHS20F60	High withstand voltage/high current	0.52	70	US2H	2.5 × 1.4 × 0.6	Buy Online	
		CUHS20S60	High withstand voltage/low VF	0.46	650	US2H	2.5 × 1.4 × 0.6	Buy Online	

The other lineup is here.

SiC Schottky Barrier Diode (SiC-SBD)

<Product Overview>

The third-generation SiC Schottky Barrier Diode (SBD) offers a lineup of 650 V withstand voltage products (seven TO-220-2L packaged products and five DFN8 eight packaged products) and uses a new Schottky metal ^[Note 1] to optimize the junction barrier Schottky (JBS) ^[Note 2] construction for the second-generation products.

This achieves the industry-leading low ^[Note 3] of forward voltage 1.2 V (Typ.), which is approximately 17% lower than the forward voltage 1.45 V (Typ of the second-generation device).

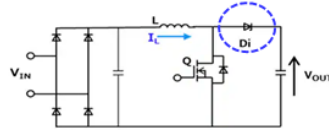
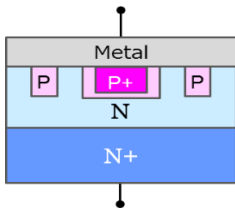
The third-generation discrete SiC SBD contributes to lower power consumption and higher power output in a variety of devices, mainly switching power supplies.

[Note 1] A metal that is bonded to a semiconductor by a Schottky barrier diode.

[Note 2] JBS: A p-type layer is embedded in the n-type layer. Between the n and p layers when a reverse bias is applied the inverse current (I_R) can be suppressed by expanding the depletion layer.

[Note 3] Our investigation. (As of June 2023.)

<Cross-sectional Structural Drawing> <Circuit, evaluation conditions>

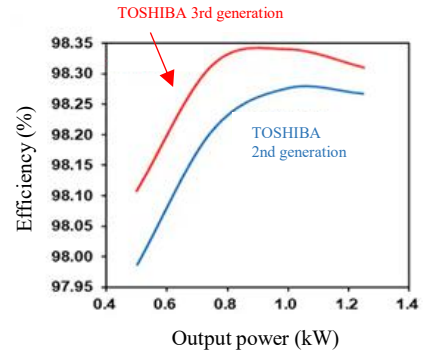


Measurement Condition

V_{IN} = 200 V AC
 V_{OUT} = 400V DC
 f = 65 kHz
MOSFET: TK040Z65Z
MOSFET external gate resistance = 4.7 ohm
 T_a = 25 deg. C

SiC-SBD

<Efficiency curve>



Our SiC Schottky Barrier Diode (SiC-SBD) Selection Table

VRRM (V)	I _o (A)	IFP (A)	IFSM (A)	T _j (°C)	Product name	VF Typ (V)	IR Max (μA)	C Typ. (pF)	Qc Typ. (nC)	Package Name (Toshiba)	Package appearance	Purchase			
650	2	120	19	175	TRS2E65H	1.2	40	10	6.5	TO-220-2L		Buy Online			
	3	170	28		TRS3E65H		45	14	9			Buy Online			
	4	230	36		TRS4E65H		55	17	12			Buy Online			
	6	310	41		TRS6E65H		70	24	17			Buy Online			
	8	410	56		TRS8E65H		90	31	22			Buy Online			
	10	510	62		TRS10E65H		100	38	27			Buy Online			
	12	640	74		TRS12E65H	120	46	33	Buy Online						
	4	230	28		TRS4V65H	1.2	DFN8x8	55	17	12		Buy Online			
	6	310	41		TRS6V65H							70	24	17	Buy Online
	8	410	45		TRS8V65H							90	31	22	Buy Online
	10	510	54		TRS10V65H							100	38	27	Buy Online
	12	640	60		TRS12V65H							120	46	33	Buy Online

The other lineup is here.

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