

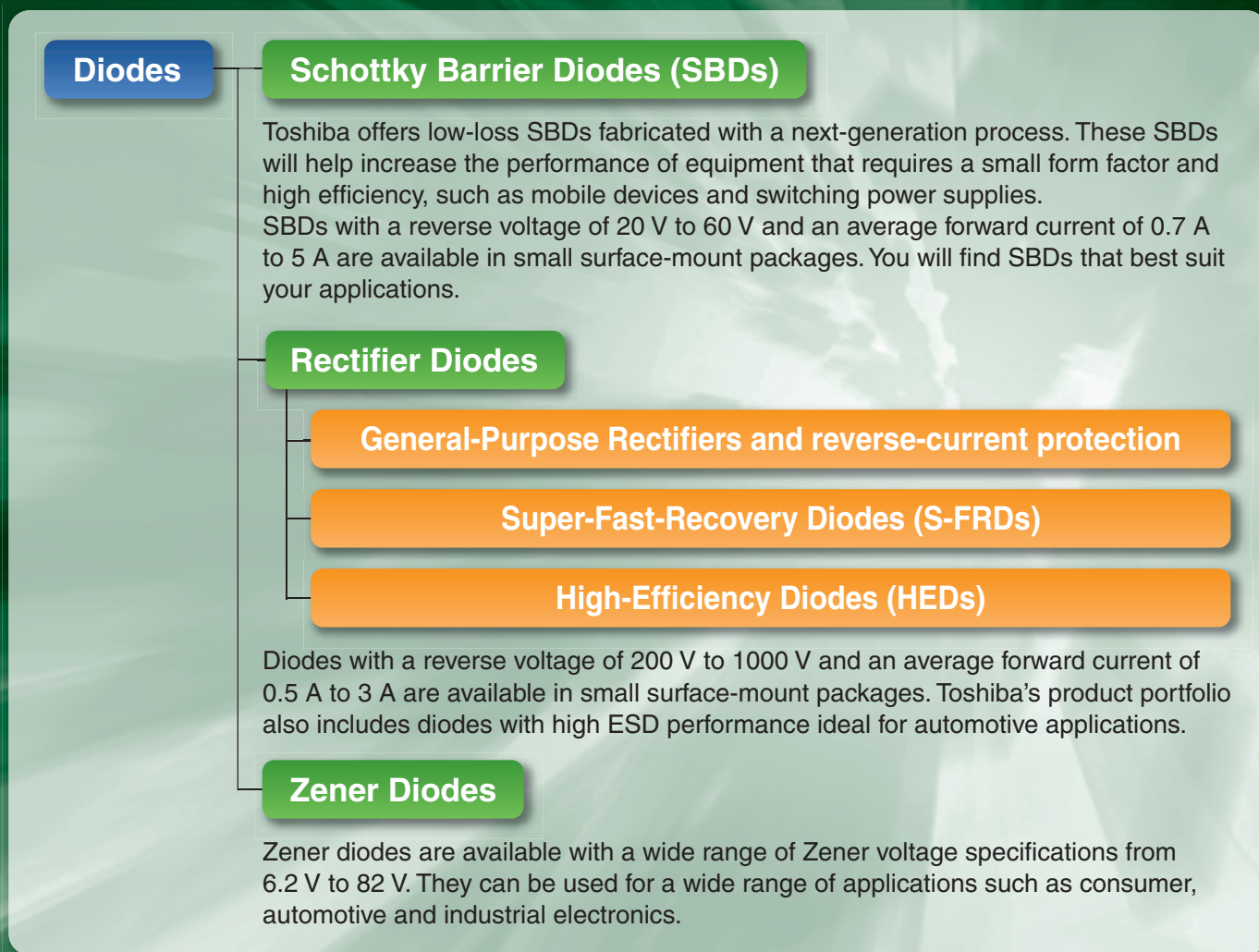
Small and Medium Diodes



Small and Medium Diodes

Recently, many products ranging from computers and home appliances to automobiles and industrial equipment have been driving the need for effective solutions to reduce size and weight. Semiconductor requirements differ from application to application. Take power supplies for example, which are being required to accommodate higher capacity in smaller dimensions. This increases the temperature at which systems are operated.

To meet these requirements, Toshiba offers an extensive portfolio of small, high-efficiency diodes, including Schottky barrier diodes (SBDs) featuring high-speed operation and low forward loss.



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This brochure contains information on small and medium diodes only. For switching diodes, small-signal Schottky barrier diodes and ESD protection diodes, see the following brochure or our homepage:

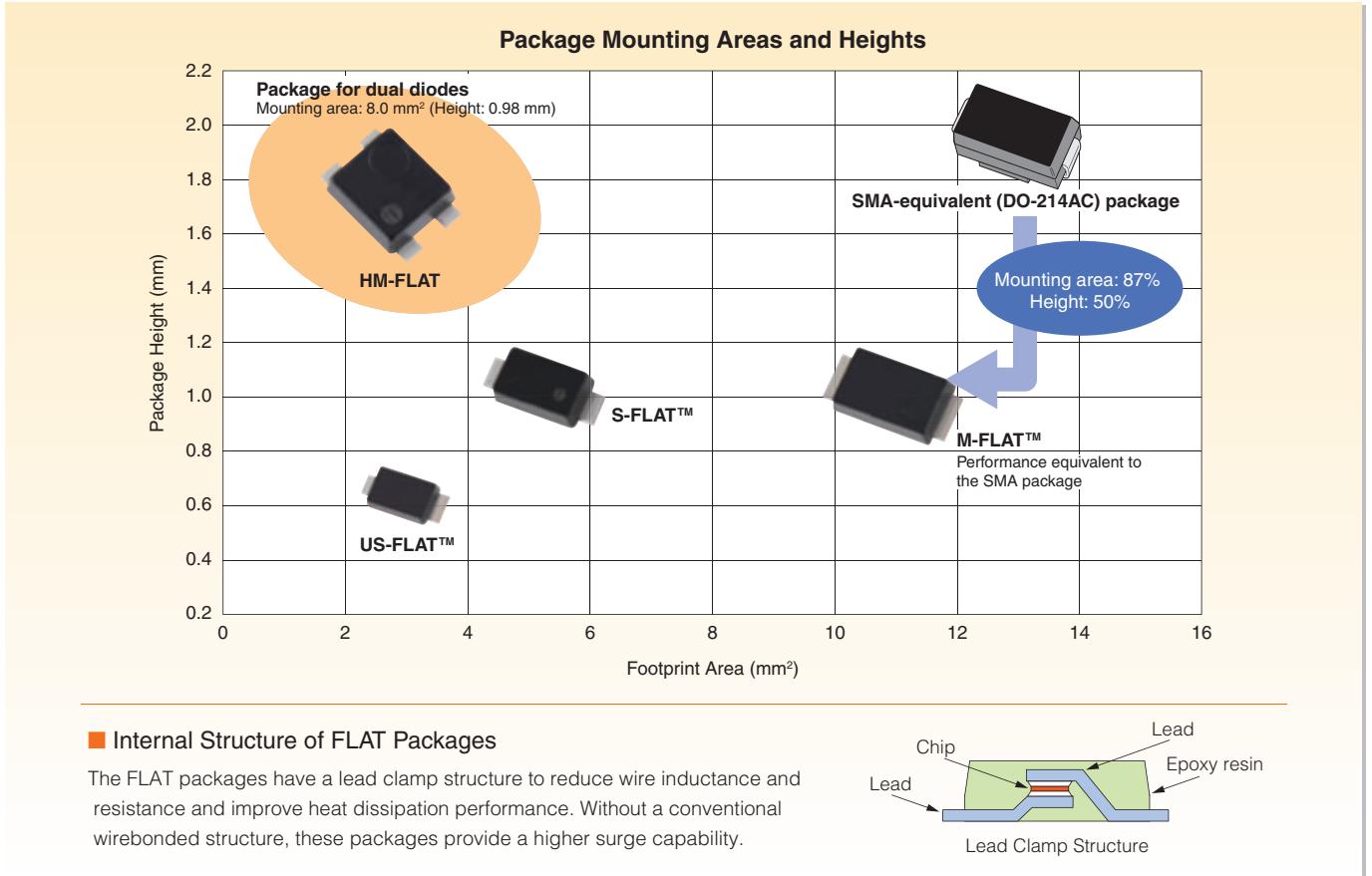
- ◆ Homepage <http://toshiba.semicon-storage.com/>
- ◆ Brochure Discrete Semiconductors, Linear ICs, Logic ICs

Product Lineup

SMALL & MEDIUM DIODES

Surface-Mount Package Trend for Diodes

In order to help improve the performance of information and communications equipment, Toshiba offers high-efficiency diodes in small surface-mount packages.

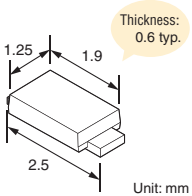


FLAT Package Series

US-FLAT™

Ultra Small Flat Package

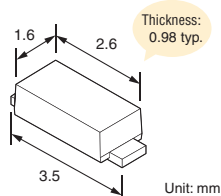
Typical product: CUS01, CUS10I30A



S-FLAT™

Small Flat Package

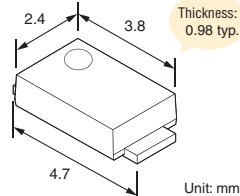
Typical product: CRS01, CRS10I30A



M-FLAT™

Middle Flat Package

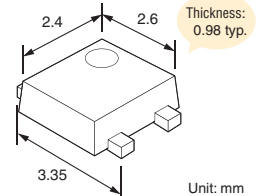
Typical product: CMS01, CMS10I30A



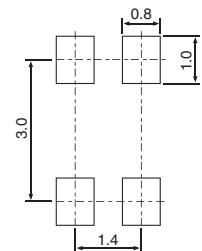
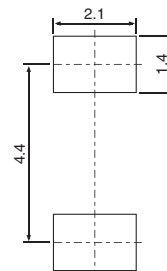
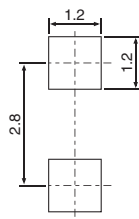
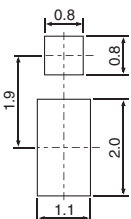
HM-FLAT

Hybrid Middle Flat Package

Typical product: HMG02



Recommended PCB land pattern dimensions (Unit: mm)



Note: The PCB land pattern dimensions shown above are for reference only and should be determined empirically.

Schottky Barrier Diodes (SBDs)

▶ SMALL & MEDIUM DIODES

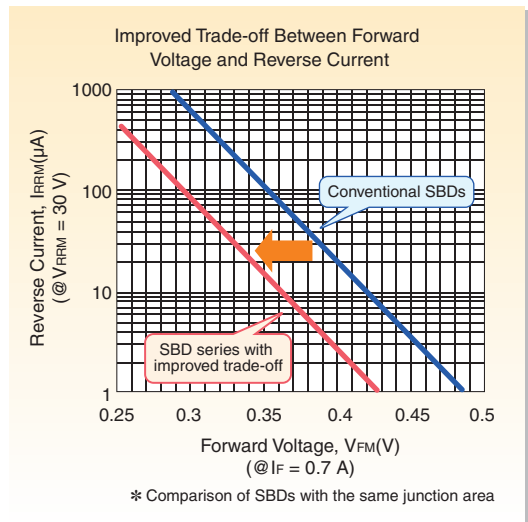
Schottky barrier diodes (SBDs) have a junction formed between a semiconductor and a metal such as molybdenum, instead of a PN junction. Unlike PN junction diodes, SBDs are majority carrier devices. Therefore, SBDs feature low forward voltage and short reverse recovery time, making them ideal for high-speed switching applications.

Toshiba offers SBDs fabricated using a new process that provides an improved V_F - I_{RRM} trade-off. These new SBDs, together with conventional SBDs, will meet diverse design requirements.

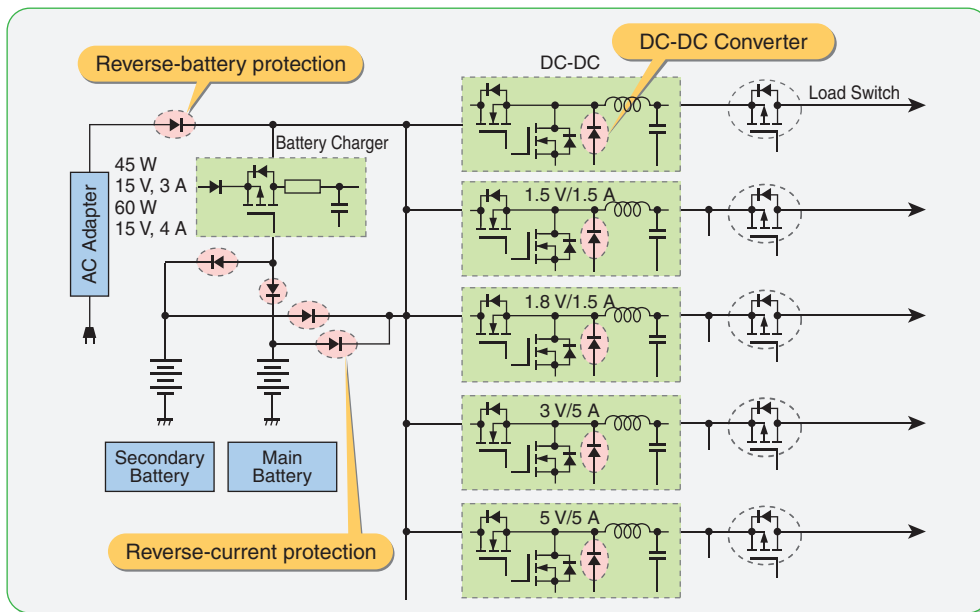
Schottky-Barrier Diodes (SBDs) with Improved Trade-Off

Toshiba now offers small to medium SBDs fabricated with a new process. Owing to low peak forward voltage (V_{FM}) and low repetitive peak reverse current (I_{RRM}) characteristics, these SBDs provide low power loss and thus help reduce the size and improve the power efficiency of mobile handsets, switching power supplies, etc.

- ▶ Voltage rating: $V_{RRM} = 30\text{ V}, 40\text{ V}$
- ▶ Current rating: $I_{F(AV)} = 1\text{ A to } 3\text{ A}$
- ▶ Peak forward voltage (Typical characteristics: CRS10I30A)
 - $V_{FM} = 0.35\text{ V typ.}$
 - $0.39\text{ V max (@ } I_{FM} = 0.7\text{ A)}$
- ▶ Small surface-mount packages (US-FLAT™/S-FLAT™/M-FLAT™)



Application Example: Notebook PC



Applications	Package	Recommended Diodes
Reverse-battery and reverse-current protection	US-FLAT™	CUS01, CUS02, CUS10I30A, CUS15I30A
	S-FLAT™	CRS01, CRS03, CRS05, CRS06, CRS08, CRS09, CRS11, CRS14
	M-FLAT™	CMS01, CMS03, CMS06, CMS07, CMS08, CMS09, CMS16
DC-DC converters	S-FLAT™	CRS03, CRS04, CRS05, CRS09, CRS13, CRS10I30A, CRS15I30A, CRS20I30A
	M-FLAT™	CMS03, CMS05, CMS14, CMS15, CMS20I30A, CMS30I30A, CMS20I40A, CMS30I40A

Product Selection Guide

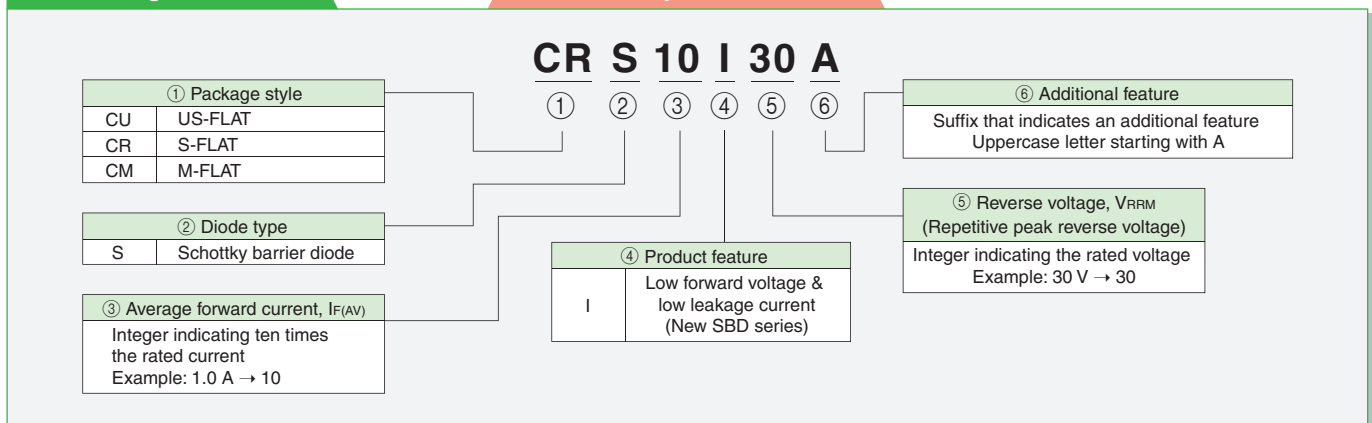
See page 10 for electrical specifications.

Average Forward Current, $I_{F(AV)}$	Package	Repetitive Peak Reverse Voltage, V_{RRM}			
		20 V	30 V	40 V	60 V
0.7 A	US-FLAT™			CUS03	CUS04
1 A	US-FLAT™	CUS05 CUS06	CUS01 CUS02 CUS10I30A	CUS10I40A	
	S-FLAT™	CRS06	CRS01 CRS03 CRS05 CRS11 CRS10I30A CRS10I30B CRS10I30C	CRS04 CRS10I40A CRS10I40B	CRS12 CRS13
	M-FLAT™		CMS08 CMS09 CMS10I30A	CMS10 CMS10I40A	
1.5 A	US-FLAT™		CUS15I30A		
	S-FLAT™		CRS08 CRS09 CRS15I30A CRS15I30B	CRS15I40A	
	M-FLAT™			CMS15I40A	
2 A	S-FLAT™		CRS14 CRS20I30A CRS20I30B	CRS20I40A CRS20I40B	
	M-FLAT™		CMS06 CMS07 CMS17 CMS20I30A	CMS11 CMS20I40A	CMS14
3 A	S-FLAT™		CRS15◇ CRS30I30A		
	M-FLAT™		CMS01 CMS03 CMS30I30A	CMS16 CMS30I40A	CMS15
5 A	M-FLAT™		CMS04 CMS05		

◇: $I_{F(DC)} = 3 A$

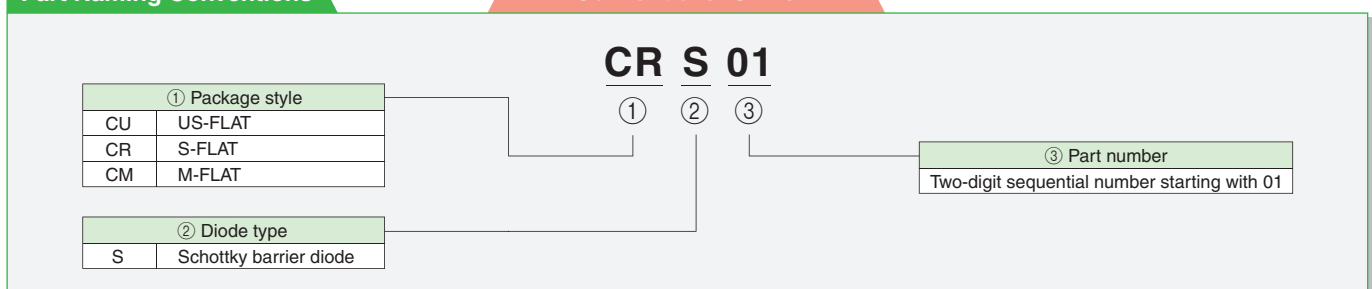
Part Naming Conventions

SBDs with improved trade-offs



Part Naming Conventions

Conventional SBDs



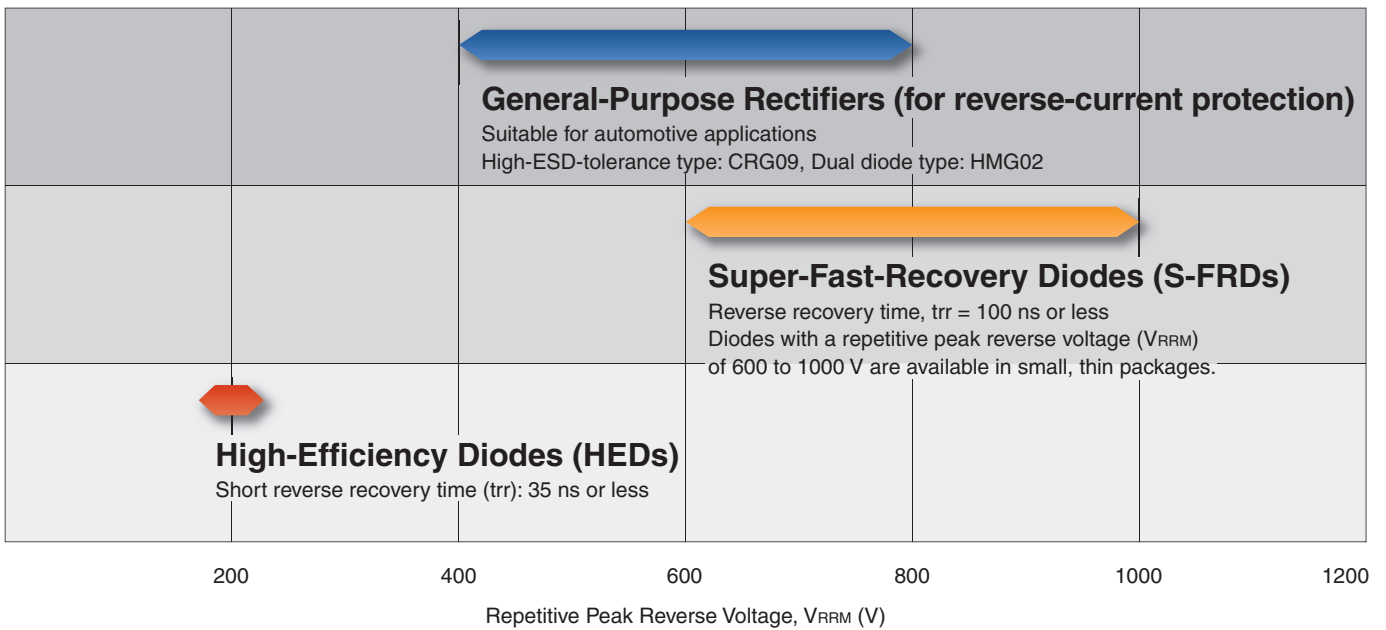
Rectification Diodes

SMALL & MEDIUM DIODES

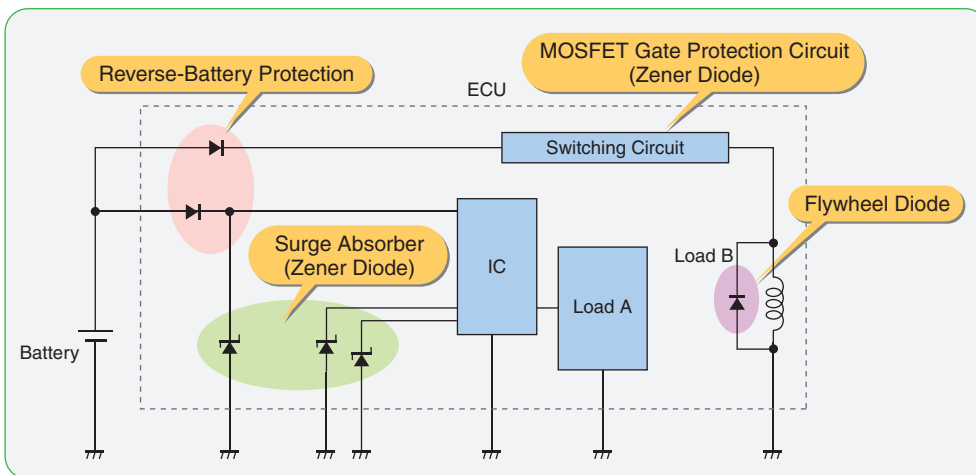
Toshiba offers rectification diodes in surface-mount packages with a reverse voltage ranging from 200 V to 1000 V and an average forward current ranging from 0.5 A to 3 A.

Toshiba's product portfolio of General-Purpose Rectifiers (for reverse-current protection) includes diodes with high ESD tolerance and dual diode devices suitable for automotive applications. Super-Fast Recovery Diodes (S-FRDs) are available in small, thin packages with a V_{RRM} of up to 1000 V. High-Efficiency Diodes (HEDs) provide a short reverse recovery time of 35 ns or less.

Product Lines



Application Example: Automobiles



Applications	Package	Recommended Diodes
Reverse-battery and reverse-current protection	S-FLAT™	CRG04, CRG05, CRG07, CRG09, CRG03, HMG02
	M-FLAT™	CMG02, CMG03, CMG05, CMG06, CMG07, CMG08
Flywheeling	S-FLAT™	CRH01, CRH02
	M-FLAT™	CMH01, CMH04, CMH07

* See "Zener Diodes" on pages 8-9 for a description of diodes for MOSFET gate protection and surge absorber applications.

Product Selection Guide

► General-Purpose Rectifiers (for reverse-current protection)

See page 11 for electrical specifications.

Average Forward Current, $I_{F(AV)}$	Package	Repetitive Peak Reverse Voltage, V_{RRM}		
		400 V	600 V	800 V
0.7 A	HM-FLAT	HMG02 ⁽¹⁾		
	S-FLAT™	CRG07		
1 A	S-FLAT™	CRG03	CRG04	CRG05
		CRG09 ⁽²⁾		
	M-FLAT™	CMC02 ⁽³⁾	CMG06 CMG08	
2 A	M-FLAT™	CMG05 CMG07	CMG03	
		CMG02		

(1) Dual diodes (two separate diodes)

(2) High ESD protection

(3) Designed for strobe discharge applications.

► Super-Fast-Recovery Diodes (S-FRDs)

Average Forward Current, $I_{F(AV)}$	Package	Reverse Recovery Time, t_{rr} (Max)	Repetitive Peak Reverse Voltage, V_{RRM}			
			600 V	800 V	900 V	1000 V
0.5 A	S-FLAT™	100 ns		CRF02		
	M-FLAT™			CMF04	CMF03	CMF05
0.7 A	S-FLAT™		CRF03			
1 A	M-FLAT™		CMF02			
2 A	M-FLAT™		CMF01			

► High-Efficiency Diodes (HEDs)

Average Forward Current, $I_{F(AV)}$	Package	Reverse Recovery Time, t_{rr} (Max)	Repetitive Peak Reverse Voltage, V_{RRM}			
			200 V			
0.5 A	S-FLAT™	35 ns		CRH02		
1 A	S-FLAT™		CRH01			
	M-FLAT™		CMH04			
2 A	M-FLAT™		CMH07			
3 A	M-FLAT™		CMH01			

Part Naming Conventions

CR G 03

① Package style	
CR	S-FLAT
CM	M-FLAT
HM	HM-FLAT

② Diode type	
G	General-Purpose Rectifiers
F	Super-fast-recovery diodes (S-FRDs)
H	High-efficiency diodes (HEDs)
C	For strobe flash dischargers

③ Part number
Two-digit sequential number starting with 01

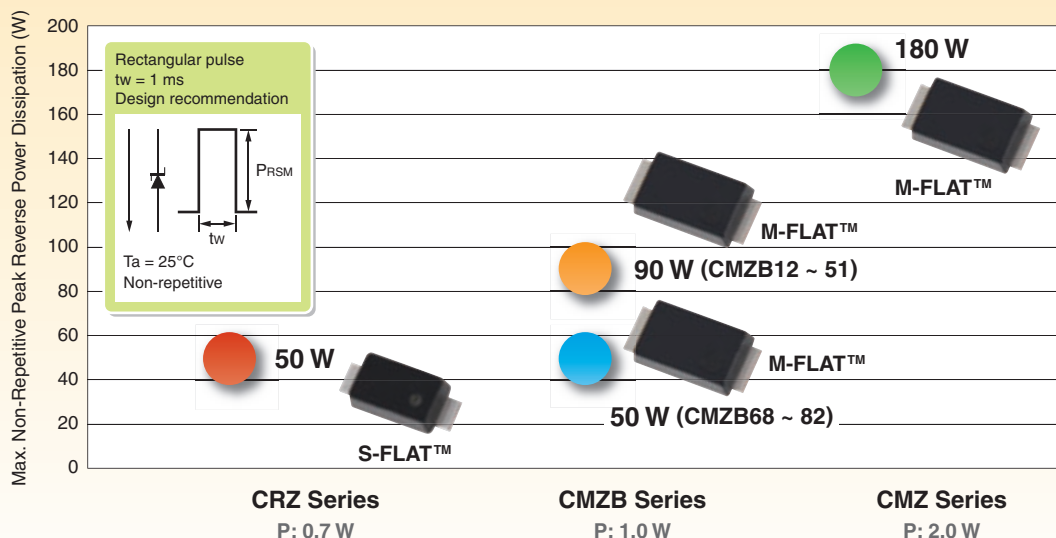
Zener Diodes

SMALL & MEDIUM DIODES

Recent electronic circuits generally incorporate microcontrollers and memory chips to provide complicated control functions. High-precision voltage regulation is required to drive these advanced devices. To address this need, Toshiba offers Zener diodes for constant-voltage regulation for a wide range of input voltage from 6.2 V to 82 V. Zener diodes can also be used for circuit protection purposes such as surge absorption and noise limiting. They are suitable for a broad spectrum of applications, including commercial, automotive and industrial equipment.

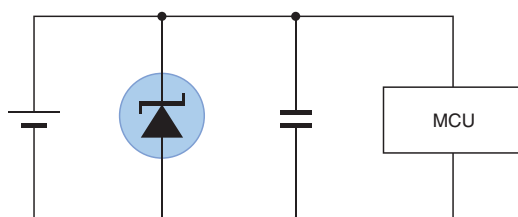
Features

Toshiba offers Zener diodes in small, thin packages with a power dissipation of 0.7 W to 2 W featuring a high current surge capability.

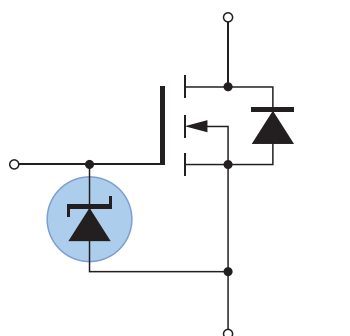


Design Recommendation for Maximum Non-Repetitive Peak Reverse Power Dissipation (Pulse Width, $t_w = 1$ ms)

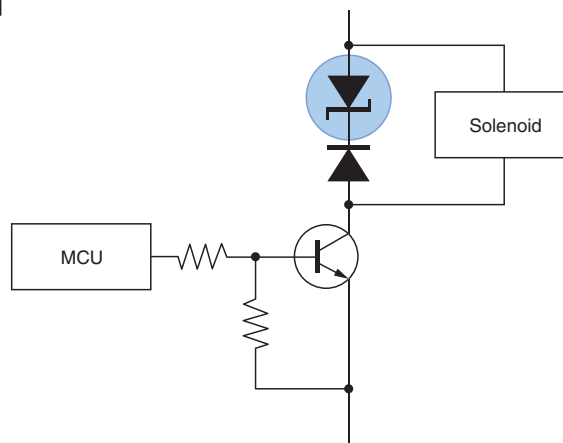
Basic Circuit Example



Microcontroller Unit (MCU) Protection



MOSFET Gate Protection

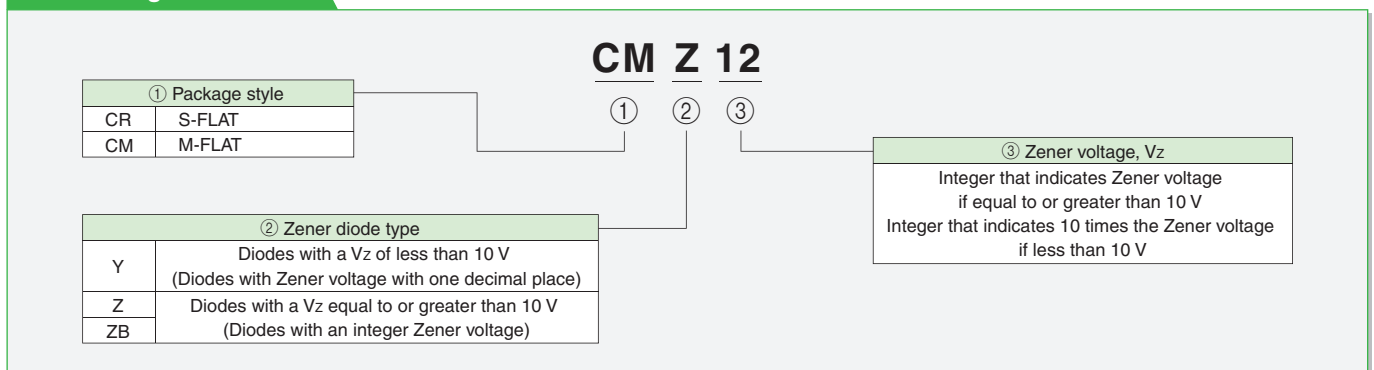


Solenoid Protection (Surge Absorber)

Power Dissipation	0.7 W	1.0 W	2.0 W
Zener Voltage Vz(V) typ.	S-FLAT™	M-FLAT™	
6.2	CRY62		
6.8	CRY68		
8.2	CRY82		
10	CRZ10		
12	CRZ12	CMZB12	CMZ12
13	CRZ13	CMZB13	CMZ13
15	CRZ15	CMZB15	CMZ15
16	CRZ16		
18	CRZ18	CMZB18	CMZ18
20	CRZ20	CMZB20	CMZ20
24	CRZ24	CMZB24	CMZ24
27	CRZ27	CMZB27	CMZ27
30	CRZ30	CMZB30	CMZ30
33	CRZ33	CMZB33	CMZ33
36	CRZ36	CMZB36	CMZ36
39	CRZ39	CMZB39	CMZ39
43		CMZB43	CMZ43
47		CMZB47	CMZ47
51		CMZB51	CMZ51
68		CMZB68	
75		CMZB75	
82		CMZB82	

The Zener voltage values listed above are the values measured at the specified Zener current (Iz). For Zener voltage measurement, a pulse measurement method is used to minimize the increase in diode temperature. Therefore, Zener voltage could be different, depending on the actual usage conditions and Zener current. Temperature changes and variations should also be considered. When Zener voltage starts to rise (i.e., while Zener current is still low), a Zener diode has a large dynamic resistance (rd), causing significant variations in Zener voltage. For voltage regulation purposes, it is desirable to use a Zener diode in a low dynamic resistance region where sufficient Zener current flows.




Part Naming Conventions



Rectification Diodes

► General-Purpose Rectifiers (for reverse-current protection)

(Ta = 25°C)

	Package	Part Number	Absolute Maximum Ratings					Electrical Characteristics (Max)		
			V _{RRM} (V)	I _{F(AV)} (A)	I _{FSM} (A)	T _j (°C)	T _{stg} (°C)	I _{RRM} (μA)	V _{FM} (V)	@ I _{FM} (A)
Single	 S-FLAT™	CRG07	400	0.7	15	175	-40 to 175	10	1.1	0.7
		CRG03	400	1.0	15	150	-40 to 150	10	1.1	0.7
		CRG09 ⁽¹⁾	400	1.0	15	150	-40 to 150	10	1.1	0.7
		CRG04	600	1.0	15	150	-40 to 150	10	1.1	1.0
		CRG05	800	1.0	15	150	-40 to 150	10	1.2	1.0
	 M-FLAT™	CMC02 ⁽²⁾	400	1.0	30	150	-40 to 150	10	1.0	1.0
		CMG05	400	1.0	15	150	-40 to 150	10	1.1	1.0
		CMG07	400	1.0	30	150	-40 to 150	10	1.1	1.0
		CMG02	400	2.0	80	150	-40 to 150	10	1.1	2.0
		CMG06	600	1.0	15	150	-40 to 150	10	1.1	1.0
Dual	 HM-FLAT	CMG08	600	1.0	30	150	-40 to 150	10	1.1	1.0
		CMG03	600	2.0	80	150	-40 to 150	10	1.1	2.0
		HMG02 ⁽³⁾	400	0.7	10	175	-40 to 175	10	1.0	0.5

(1) High ESD protection

(2) Designed for strobe discharge applications

(3) I_{F(AV)}, I_{FSM}, I_{RRM} and V_{FM} are specified per diode.

► Super-Fast-Recovery Diodes (S-FRDs)

(Ta = 25°C)

Package	Part Number	Absolute Maximum Ratings					Electrical Characteristics (Max)				
		V _{RRM} (V)	I _{F(AV)} (A)	I _{FSM} (A)	T _j (°C)	T _{stg} (°C)	I _{RRM} (μA)	V _{FM} (V)	@ I _{FM} (A)	t _{rr} (ns)	Conditions
 S-FLAT™	CRF02	800	0.5	10	150	-40 to 150	50	3.0	0.5	100	I _F = 1 A, di/dt = -30 A/μs
	CRF03	600	0.7	10	150	-40 to 150	50	2.0	0.7	100	
 M-FLAT™	CMF01	600	2.0	30	150	-40 to 150	50	2.0	2.0	100	I _F = 1 A, di/dt = -30 A/μs
	CMF02	600	1.0	10	150	-40 to 150	50	2.0	1.0	100	
	CMF04	800	0.5	10	150	-40 to 150	50	2.5	0.5	100	
	CMF03	900	0.5	10	125	-40 to 150	50	2.5	0.5	100	
	CMF05	1000	0.5	10	125	-40 to 150	50	2.7	0.5	100	

► High-Efficiency Diodes (HEDs)

(Ta = 25°C)

Package	Part Number	Absolute Maximum Ratings					Electrical Characteristics (Max)				
		V _{RRM} (V)	I _{F(AV)} (A)	I _{FSM} (A)	T _j (°C)	T _{stg} (°C)	I _{RRM} (μA)	V _{FM} (V)	@ I _{FM} (A)	t _{rr} (ns)	Conditions
 S-FLAT™	CRH02	200	0.5	10	150	-40 to 150	10	0.95	0.5	35	I _F = 1 A, di/dt = -30 A/μs
	CRH01	200	1.0	15	150	-40 to 150	10	0.98	1.0	35	
 M-FLAT™	CMH04	200	1.0	20	150	-40 to 150	10	0.98	1.0	35	I _F = 1 A, di/dt = -30 A/μs
	CMH07	200	2.0	40	150	-40 to 150	10	0.98	2.0	35	
	CMH01	200	3.0	40	150	-40 to 150	10	0.98	3.0	35	

Product Characteristics

SMALL & MEDIUM DIODES

Zener Diodes

CRY/CRZ Series (S-FLAT™)

Power Dissipation: 0.7 W

(Ta = 25°C)

Part Number	Power Dissipation (W)	Zener Characteristics					Temperature Coefficient of Zener Voltage α_T (mV/°C)		Forward Voltage V_F (V)	Measurement Current I_F (A)	Reverse Current I_R (μ A)	Measurement Voltage V_R (V)
		Zener Voltage V_Z (V)			Dynamic Resistance r_d (Ω)	Measurement Current I_Z (mA)	Typ.	Max				
		Min	Typ.	Max								
CRY62	0.7	5.6	6.2	6.8	60	10	2	3	1.0	0.2	10	3.0
CRY68	0.7	6.2	6.8	7.4	60	10	3	4	1.0	0.2	10	3.0
CRY82	0.7	7.4	8.2	9.0	30	10	4	6	1.0	0.2	10	4.9
CRZ10	0.7	9.0	10.0	11.0	30	10	6	9	1.0	0.2	10	6.0
CRZ12	0.7	10.8	12.0	13.2	30	10	8	13	1.0	0.2	10	8.0
CRZ13	0.7	11.7	13.0	14.3	30	10	9	14	1.0	0.2	10	9.0
CRZ15	0.7	13.5	15.0	16.5	30	10	11	17	1.0	0.2	10	10.0
CRZ16	0.7	14.4	16.0	17.6	30	10	12	19	1.0	0.2	10	11.0
CRZ18	0.7	16.2	18.0	19.8	30	10	14	23	1.0	0.2	10	13.0
CRZ20	0.7	18.0	20.0	22.0	30	10	16	26	1.0	0.2	10	14.0
CRZ24	0.7	21.6	24.0	26.4	30	10	20	32	1.0	0.2	10	17.0
CRZ27	0.7	24.3	27.0	29.7	30	10	23	36	1.0	0.2	10	19.0
CRZ30	0.7	27.0	30.0	33.0	30	10	25	40	1.0	0.2	10	21.0
CRZ33	0.7	29.7	33.0	36.3	30	10	26	41	1.0	0.2	10	26.4
CRZ36	0.7	32.4	36.0	39.6	30	9	28	45	1.0	0.2	10	28.8
CRZ39	0.7	35.1	39.0	42.9	35	8	30	48	1.0	0.2	10	31.2

CMZB Series (M-FLAT™)

Power Dissipation: 1 W

(Ta = 25°C)

Part Number	Power Dissipation (W)	Zener Characteristics					Temperature Coefficient of Zener Voltage α_T (mV/°C)		Forward Voltage V_F (V)	Measurement Current I_F (A)	Reverse Current I_R (μ A)	Measurement Voltage V_R (V)
		Zener Voltage V_Z (V)			Dynamic Resistance r_d (Ω)	Measurement Current I_Z (mA)	Typ.	Max				
		Min	Typ.	Max								
CMZB12	1.0	10.8	12	13.2	30	10	8	13	1.2	0.2	10	8
CMZB13	1.0	11.7	13	14.3	30	10	9	14	1.2	0.2	10	9
CMZB15	1.0	13.5	15	16.5	30	10	11	17	1.2	0.2	10	10
CMZB18	1.0	16.2	18	19.8	30	10	14	23	1.2	0.2	10	13
CMZB20	1.0	18.0	20	22.0	30	10	16	26	1.2	0.2	10	14
CMZB24	1.0	21.6	24	26.4	30	10	20	32	1.2	0.2	10	17
CMZB27	1.0	24.3	27	29.7	30	10	23	36	1.2	0.2	10	19
CMZB30	1.0	27.0	30	33.0	30	10	25	40	1.2	0.2	10	21
CMZB33	1.0	29.7	33	36.3	30	10	26	41	1.2	0.2	10	26.4
CMZB36	1.0	32.4	36	39.6	30	9	28	45	1.2	0.2	10	28.8
CMZB39	1.0	35.1	39	42.9	35	8	30	48	1.2	0.2	10	31.2
CMZB43	1.0	38.7	43	47.3	40	7	33	53	1.2	0.2	10	34.4
CMZB47	1.0	42.3	47	51.7	65	6	38	60	1.2	0.2	10	37.6
CMZB51	1.0	45.9	51	56.1	65	6	43	68	1.2	0.2	10	40.8
CMZB68	1.0	61.2	68	74.8	120	4	57	90	1.2	0.2	10	54.4
CMZB75	1.0	67.5	75	82.5	150	4	66	104	1.2	0.2	10	60
CMZB82	1.0	73.8	82	90.2	170	3	71	113	1.2	0.2	10	65.6

► **CMZ Series (M-FLAT™)**

Power Dissipation: 2 W

(Ta = 25°C)

Part Number	Power Dissipation (W)	Zener Characteristics					Temperature Coefficient of Zener Voltage α_T (mV/°C)		Forward Voltage V_F (V)	Measurement Current I_F (A)	Reverse Current I_R (μ A)	Measurement Voltage V_R (V)
		Zener Voltage V_Z (V)			Dynamic Resistance r_d (Ω)	Measurement Current I_Z (mA)	Typ.	Max				
		Min	Typ.	Max								
CMZ12	2.0	10.8	12	13.2	30	10	8	13	1.2	0.2	10	8
CMZ13	2.0	11.7	13	14.3	30	10	9	14	1.2	0.2	10	9
CMZ15	2.0	13.5	15	16.5	30	10	11	17	1.2	0.2	10	10
CMZ18	2.0	16.2	18	19.8	30	10	14	23	1.2	0.2	10	13
CMZ20	2.0	18.0	20	22.0	30	10	16	26	1.2	0.2	10	14
CMZ24	2.0	21.6	24	26.4	30	10	20	32	1.2	0.2	10	17
CMZ27	2.0	24.3	27	29.7	30	10	23	36	1.2	0.2	10	19
CMZ30	2.0	27.0	30	33.0	30	10	25	40	1.2	0.2	10	21
CMZ33	2.0	29.7	33	36.3	30	10	26	41	1.2	0.2	10	26.4
CMZ36	2.0	32.4	36	39.6	30	9	28	45	1.2	0.2	10	28.8
CMZ39	2.0	35.1	39	42.9	35	8	30	48	1.2	0.2	10	31.2
CMZ43	2.0	38.7	43	47.3	40	7	33	53	1.2	0.2	10	34.4
CMZ47	2.0	42.3	47	51.7	65	6	38	60	1.2	0.2	10	37.6
CMZ51	2.0	45.9	51	56.1	65	6	43	68	1.2	0.2	10	40.8

Marking

Package	Device Marking (Examples)	
US-FLAT™		<p>Part number (abbreviated) Examples</p> <p>Abbreviation Part number 1: CUS01 7: CUS10I30A</p>
S-FLAT™		<p>Part number (abbreviated) Examples</p> <p>Abbreviation Part number S3: CRS03 G9: CRG09 H1: CRH01</p>
M-FLAT™		<p>Part number (abbreviated) Examples</p> <p>Abbreviation Part number G2: CMG02 F3: CMF03 H7: CMH07</p>
HM-FLAT		<p>Part number (abbreviated) Examples</p> <p>Abbreviation Part number GG2: HMG02</p>

Note

Handwriting practice lines consisting of horizontal dashed lines.



Note

A series of horizontal dashed lines for writing notes.

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- Irvine, Headquarters
Tel: (949)462-7700 Fax: (949)462-2200
- Buffalo Grove (Chicago)
Tel: (847)484-2400 Fax: (847)541-7287
- Duluth/Atlanta
Tel: (770)931-3363 Fax: (770)931-7602
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Toshiba Electronics do Brasil Ltda.

- Tel: (011)2936-6681 Fax: (011)2936-6675

Toshiba India Private Ltd.

- New Delhi Office
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Tel: (080)251-90800 Fax: (080)490-91945

Toshiba Electronics Europe GmbH

- Düsseldorf Head Office
Tel: (0211)5296-0 Fax: (0211)5296-400
- France Branch
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- Shanghai Head Office
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