IXYS

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Symbols and Definitions

Symbol	Definition
C_{ies}	Input capacitance of IGBT
C_{iss}	Input capacitance of MOSFET
$-di/dt$	Rate of decrease of forward current
I_C	DC collector current
I_D	Drain current
I_F	Forward current of diode
$I_{F(AV)M}$	Maximum average forward current at specified T_h
I_{FSM}	Peak one cycle surge forward current
I_{GT}	Gate trigger current
I_R	Reverse current
I_{RM}	Maximum peak recovery current
I_T	Forward current of thyristor
$I_{T(AV)M}$	Maximum average on-state current of a thyristor at specified T_h
I_{TSM}	Maximum surge current of a thyristor
$R_{DS(on)}$	Static drain-source on-state resistance
R_{thjc}	Thermal resistance junction to case
r_T	Slope resistance of a thyristor or diode (for power loss calculations)
T_{case}	Case temperature
T_h	Heatsink temperature
t_{fi}	Current fall time with inductive load
T_j, $T_{(vj)}$	Junction temperature
T_{jm}, $T_{(vj)m}$	Maximum junction temperature
t_{rr}	Reverse recovery time of a diode
$V_{CE(sat)}$	Collector-emitter saturation voltage
V_{CES}	Maximum collector-emitter voltage
V_{DRM}	Maximum repetitive forward blocking voltage of thyristor
V_{DSS}	Drain-source break-down voltage
V_F	Forward voltage of diode
V_R	Reverse voltage
V_{RRM}	Maximum peak reverse voltage of thyristor or diode
V_T	On-state voltage of thyristor
V_{T0}	Threshold voltage of thyristors or diodes (for power loss calculation only)

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Nomenclature

IGBT and MOSFET Discrete

IXSD 40N60A	**(Example)**
IX	IXYS
	Die technology
E	NPT[3] IGBT
F	HiPerFETTM Power MOSFET
G	Fast IGBT
S	IGBT with SCSOA capability
T	Standard Power MOSFET
D	Unassembled chip (die)
40	Current rating, 40 = 40 A
N	N-channel type
P	P-channel type
60	Voltage class, 60 = 600 V
xx	
	MOSFET
A	Prime RDS(on) for standard MOSFET
Q	Low gate charge die
Q2	Low gate charge die, 2nd generation
P	PolarHTTM Power MOSFET
L	Linear Mode MOSFET
	IGBT
--	No letter, low VCE(sat)
A	Or A2, std speed type
B	Or B2, high speed type
C	Or C2, very high speed type

Diode and Thyristor Chips

C-DWEP 69-12	**(Diode Example)**
C	Package type
D	Chip function D = Silicon rectifier diode
W	Unassembled chip
EP	Process designator EP = Epitaxial rectifier diode N = Rectifier diode, cathode on top P = Rectifier diode, anode on top FN = Fast Rectifier diode, cathode on top FP = Fast Rectifier diode, anode on top
69	Current rating value of one chip in A
-12	Voltage class, 12 = 1200 V

W-CWP 55-12/18	**(Thyristor Example)**
W	Package type
C	Chip function C = Silicon phase control thyristor
W	Unassembled chip
P	Process designator P = Planar passivated chip cathode on top
55	Current rating value of one chip in A
12/18	Voltage class, 12/18 = 1200 up to 1800 V

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General Informations for Chips

When mounting Power Semiconductor chips to a header, ceramic substrate or hybrid thick film circuit, the solder system and the chip attach process are very important to the reliability and performance of the final product. This brochure provides several guidelines that describe recommended chip attachment pro-cedures. These methods have been used successfully for many years at IXYS.

Available forms of chip packings

IXYS offers various options.
Please order from one of the following possibilities:

Packaging Options	Delivery form		
C-...*	Chips in tray (Waffle Pack);	Electrically tested	
T-...*	Chips in wafer, unsawed;	Bipolar = 5" (125 mm∅) wafer;	Electrically tested, rejects are inked
W-...*	Chips in wafer on foil, sawed;	Bipolar = 5" (125 mm∅) wafer;	Electrically tested, rejects are inked

...* must be amended by the exact chip type designation.

Packing, Storage and Handling

Chips should be transported in their original containers. All chip transfer to other containers or for assembly should be done only with rubber-tipped vacuum pencils. Contact with human skin (or with a tool that has been touched by hand) leaves an oily residue that may adversely impact subsequent chip attach or reliability.

At temperatures below 104°F (40°C), there is no limitation on storage time for chips in sealed original packages. Chips removed from original packages should be assembled immediately. The wetting ability of the contact metallization with solder can be preserved by storage in a clean and dry nitrogen atmosphere.

The IGBT and MOSFET Chips are electrostatic discharge (ESD) sensitive. Normal ESD precautions for handling must be observed. Prior to chip attach, all testing and handling of the chips must be done at ESD safe work stations according to DIN IEC 47(CO) 701. Ionized air blowers are recommended for added ESD protection.

Contamination of the chips degrades the assembly results.Finger prints, dust or oily deposits on the surface of the chips have to be absolutely avoided.
Rough mechanical treatment can cause damage to the chip.

Electrical Tests

The electrical properties listed in the data sheet presume correctly assembled chips. Testing of **non-**assembled chips requires the following precautions:

- High currents have to be supplied homogeneously to the whole metallized contact area.
- Kelvin probes must be used to test voltages at high currents
- Applying the full specified blocking or reverse voltage may cause arcing across the glass passivated junction termination, because the electrical field on top of the passivation glass causes ionization of the surrounding air. This phenomenon can be avoided by using inert fluids or by increasing the pressure of the gas surrounding the chip to values above 30 psig (2 bars).

General Rules for Assembly

The linear thermal expansion coefficient of silicon is very small compared to usual contact metals. If a large area metallized silicon chip is directly soldered to a metal like copper, enormous shear stress is caused by temperature changes (e.g. when cooling down from the solder temperature or by heating during working conditions) which can disrupt the solder mountdown.

If it is found that larger chips are cracking during mountdown or in the application, then the use of a low thermal expansion coefficient buffer layer, e.g. tungsten, molybdenum or Trimetal®, for strain relief should be considered. An alternative solution is to soft-solder these larger chips to DCB ceramic substrates because of their matching thermal expansion coefficients.

Assembly Instructions

MOS/IGBT Chips

Recommended Solder System

IXYS recommends a soft solder chip attach using a solder composition of 92.5 % Pb, 5 % Sn and 2.5 % Ag. The maximum chip attach temperature is 460°C for MOSFET and 360°C for HiPerFET™ and IGBT.

Wire Bonding

It is recommended to use wire of diameter not greater than 0.38 mm (0.015") for bonding to the source emitter and gate pads. Multiple wires should be used in place of thicker wire to handle high drain or emitter currents. See tables for number of recommended wire bonds. At smaller gate pads 0.15 mm is recommended.

Thermal Response Testing

To assure good chip attach processing, thermal response testing per MIL STD 750, Method 3161 or equivalent should be performed.

Bipolar Chips

Assembling

IXYS bipolar semiconductor chips have a soft-solderable, multi-layer metallization (Ti/Ni/Ag) on the bottom side and, on top, either the same metallization scheme or an alumunium layer sufficiently thick for ultrasonic bonding. Note that the last layer of metal for soldering is pure silver.

Regardless of their type all chips possess the same glass passivated junction termination system on top of the chip. For that reason they can be easily chip bonded or they can all be simply soldered to a flat contacting electrode in accordance to the General Rules on Page 3. All kinds of the usual soft solders with melting points below 660°F (350°C) can be used thanks to their pure silver top metal. Solders with high melting points are preferable due to their better power cycling capability, i.e. they are more resistant to thermal fatigue.

Soldering temperature should not exceed 750°F (400°C). The maximum temperature should not be applied for more than five minutes.

As already mentioned above the electrical properties quoted in the data sheets can only be obtained with properly assembled chips. This is only possible when all contact materials to be soldered together are well wetted and the solder is practically free of voids.

A simple means to achieve good solder connections is to use a belt furnace running with a process gas containing at least 10 % Hydrogen in Nitrogen.
Other approved methods are also allowed, provided that the above mentioned temperature-time-limits are not exceeded and temperature shocks above 930°F/min (500 K/min) are avoided.

We do not recommend the use of fluxes for soldering!

Ultrasonic Wire Bonding

Chips provided with a thick aluminium layer are designed for ultrasonic wire bonding. Wire diameters up to 500 µm can be used dependent on chip types. Setting wires in parallel and application of stitch bonding lead to surge current ratings comparable to soldered chips.

Coating

Although the chips are glass passivated, they must be protected against arcing and environmental influences. The coating material that is in contact with the chip surface must have the following properties:

- elasticity (to prevent mechanical stress)
- high purity, no contamination with alkali metals
- good adhesion to metals and glass passivation.

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FRED, Rectifier Diode and Thyristor Chips in Planar Design

Fast Recovery Epitaxial Diodes (FRED)

Power switches (IGBT, MOSFET, BJT, GTO) for applications in electronics are only as good as their associated free-wheeling diodes. At increasing switching frequencies, the proper functioning and efficiency of the power switch, aside from conduction losses, is determined by the turn-off behavior of the diode (characterized by Q_{rr}, I_{RM} and t_{rr} - Fig. 1.

The reverse current character-istic following the peak reverse current I_{RM} is another very im-portant property. The slope of the decaying reverse current di_{rr}/dt results from design para- meters (technology and dif-fusion of the FRED chip Fig. 2. In a circuit this current slope, in conjunction with parasitic induc-tances (e.g. connecting leads, causes over-voltage spikes and high frequency interference vol-tages.The higher the di_{rr}/dt ("hard recovery" or "snap-off" behavior) the higher is the resulting additional stress for both the diode and the paralleled switch. A slow decay of the reverse current ("soft recovery" behavior), is the most desirable characteristic, and this is designed into all FRED. The wide range of available blocking voltages makes it possible to apply these FRED as output rectifiers in switch-mode power supplies (SMPS) as well as protective and free-wheeling diodes for power switches in inverters and welding power supplies.

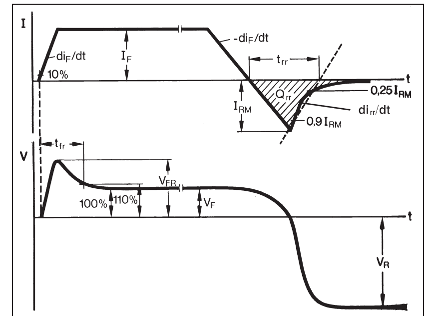


Fig. 1: Current and voltage during turn-on and turn-off switching of fast diodes

Rectifier Diode and Thyristor Chips

The figures 3 a-c show cross sectional views of the diode and thyristor chips in the passivation area. All thyristor and diode chips (DWN, DWFN, CWP) are fabricated using separation diffusion processes so that all junctions terminate on the topside of the chip. Now the entire bottom surfaces of all chips are available for soldering onto a DCB or other ceramic substrate without a molybdenum strain buffer. The elimination of the strain buffer and its solder joint reduces thermal resistance and increases blocking voltage stability. The junction termination areas are passivated with glass, whose thermal expansion coefficient matches that of silicon. All silicon chips increasingly use planar technology with guard rings and channel stoppers to reduce electric fields on the chip surface.
The contact areas of the chips have vapor deposited metal layers which contribute substantially to their high power cycle capability. All chips are processed on silicon wafers of 5" diameter and diced after a wafer sample test which auto-matically marks chips not meeting the electrical specification. The chip geometry is square or rectangular.

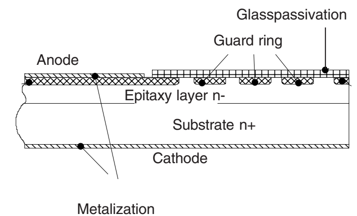


Fig. 2: Cross section of glassivated planar epitaxial diode chip with seperation diffusion (type DWEP)

Fig. 3a-c
Cross sections of Chips in the passivation area
a) Diode chip, type DWN, DWFN
b) Diode chip, type DWP, DWFP
c) Thyristor chip, type CWP

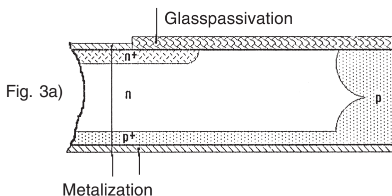


Fig. 3a)

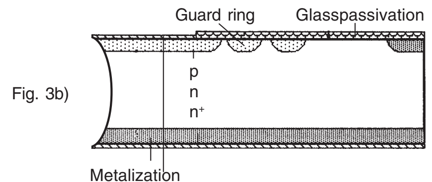


Fig. 3b)

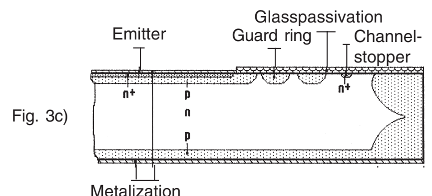
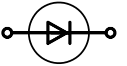


Fig. 3c)

Rectifier Diodes



Type	V_{RRM}	I_R	T_{VJM}	$I_{F(AV)M}$	R_{thJC} ①	V_F			I_{FSM}	Reverse Recovery		
		V_{RRM}		rect. d = 0.5		T_{VJ} =		@ I_F		I_{RM}	@ I_F	@ -di/dt
		T_{VJM}		T_C = 100°C	typ.	25°C	125°C			25°C; V_R = 100 V		
	V	typ. mA	°C	A	K/W	V	V	A	A	A	A	A/µs
DWN 5	800 -	0.7	150	12	2.80	1.14	1.14	7	140	tbd	tbd	tbd
DWP 5	1200	0.7		12	2.80	1.14	1.14	7	140	tbd	tbd	tbd
DWN 2	1200 -	0.7		12	2.80	1.14	1.14	7	150	tbd	tbd	tbd
DWN 9	1800	1.0		20	1.80	1.28	1.28	30	300	tbd	tbd	tbd
DWN 17		1.5		31	1.10	1.34	1.34	50	320	tbd	tbd	tbd
DWP 17		1.5		31	1.10	1.37	1.37	50	320	tbd	tbd	tbd
DWN 21		3.0		42	0.90	1.33	1.33	80	500	tbd	tbd	tbd
DWP 21		3.0		41	0.90	1.35	1.35	80	500	tbd	tbd	tbd
DWN 35		1.5		59	0.65	1.24	1.24	80	630	11	50	0.64
DWP 35		1.5		58	0.65	1.25	1.25	80	630	11	50	0.64
DWN 50		2.0		78	0.50	1.31	1.31	150	900	12	50	1
DWP 50		2.0		76	0.50	1.33	1.33	150	900	12	50	1
DWN 75		2.0		115	0.33	1.26	1.26	200	1500	24	50	3
DWP 75		2.0		118	0.35	1.27	1.27	200	1500	24	50	3
DWN 110		3.5		253	0.16	1.18	1.18	300	3200	45	50	6
DWP 110		3.5		253	0.16	1.18	1.18	300	3200	45	50	6
DWN 340		15.0		416	0.10	1.09	1.09	300	5900	235	30	50
DWN 108	1600 -	3.5		253	0.16	1.18	1.18	300	3200	45	50	6
DWN 347	2200	3.5		788	0.05	1.10	1.10	600	10500	45	40	50

① **Mounted on DCB**

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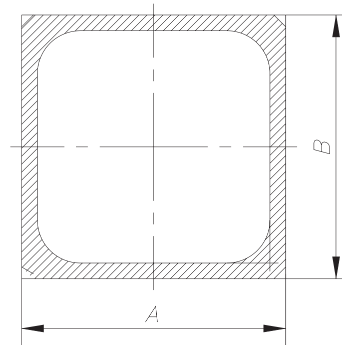
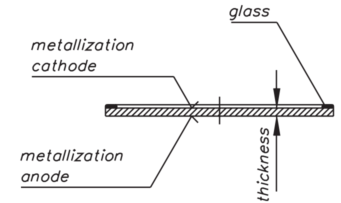
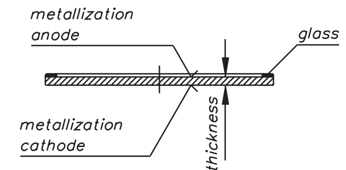
Rectifier Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A mm	Dimensions B mm	Si-thickn. mm
DWN 5		•	1123	4.40	2.10	0.265
DWP 5		•	716	4.40	2.10	0.265
DWN 2	•		1204	2.95	2.95	0.265
DWN 9	•	•	684	3.90	3.90	0.265
DWN 17	•		518	4.45	4.45	0.265
DWP 17	•	•	518	4.45	4.45	0.265
DWN 21	•	•	346	5.40	5.40	0.265
DWP 21	•	•	346	5.40	5.40	0.265
DWN 35	•		259	6.20	6.20	0.265
DWP 35	•		259	6.20	6.20	0.265
DWN 50	•	•	198	7.10	7.10	0.265
DWP 50		•	198	7.10	7.10	0.265
DWN 75	•		125	8.70	8.70	0.265
DWP 75	•		125	8.70	8.70	0.265
DWN 110	•		58	12.30	12.30	0.265
DWP 110	•	•	58	12.30	12.30	0.265
DWN 340	•		32	16.20	16.20	0.265
DWN 108	•	•	58	12.30	12.30	0.315
DWN 347	•		16	25.30	18.50	0.315
Tolerance				-0.1	-0.1	±5%





DWN



DWP

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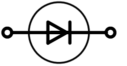
***F**RED - **F**ast **R**ecovery **E**pitaxial **D**iodes*



Type	V_{RRM}	I_R	T_{VJM}	$I_{F(AV)M}$	R_{thJC} ①	V_F				I_{FSM}	Reverse Recovery					
		V_{RRM} 125°C		rect. d = 0.5 T_C = 100°C	typ.	T_{VJ} = 25°C		@	@I_F		I_{RM} 25°C; V_R = 100 V	@I_F	@-di/dt	t_{rr} V_R = 30 V	@I_F	@-di/dt
	V	mA	°C	A	K/W	V	V	°C	A	A	A			typ. ns	A	A/µs
DWEP 27-02	200	5.0	150	54	0.9	1.09	0.84	150	30	300	4	50	100	35	1	100
DWEP 37-02		11.0		91	tbd	1.03	0.87	150	100	475	4	100	100	35	1	200
DWEP 77-02		20.0		244	0.4	1.12	0.87	150	125	1200	2	12.5	25	tbd	1	350
DWEP 8-06	600	1.5		tbd	2.5	1.65	1.48	150	8	50	5	12	100	tbd	tbd	tbd
DWEP 12-06		1.5		8	2.5	1.45	1.31	150	8	100	5	25	100	35	1	50
DWEP 15-06		3.0		12	1.6	1.65	1.48	150	16	100	5	25	100	35	1	50
DWEP 23-06		7.0		30	0.9	1.53	1.33	150	30	250	5	50	100	35	1	100
DWEP 25-06		7.0		30	0.9	1.53	1.38	150	43	300	5	50	100	35	1	100
DWEP 35-06		14.0		60	0.8	1.73	1.48	150	70	550	5	100	100	35	1	200
DWEP 55-06		17.0		80	0.7	1.58	1.38	125	75	600	5	100	100	35	1	200
DWEP 75-06		20.0		162	0.4	1.31	1.10	125	75	1000	20	80	200	35	1	350
DWEP 3-10	1000	2.0		tbd	2.5	2.65	2.09	150	6	40	7	12	100	tbd	tbd	tbd
DWEP 10-10		4.0		12	1.6	2.65	2.09	150	12	75	5	25	100	35	1	50
DWEP 18-10		7.0		30	0.9	2.43	2.04	150	30	200	7	50	100	35	1	100
DWEP 20-10		7.0		30	0.9	2.35	1.99	150	36	200	7	50	100	35	1	100
DWEP 30-10		14.0		60	0.8	2.24	1.79	150	60	500	7	100	100	35	1	200
DWEP 50-10		17.0		82	0.7	2.12	1.68	125	50	500	6	50	120	35	1	200
DWEP 70-10		20.0		129	0.4	1.89	1.57	125	75	800	14	80	200	35	1	350
DWEP 6-12	1200	2.0		tbd	2.5	2.55	2.19	150	5	80	7	10	100	tbd	tbd	tbd
DWEP 9-12		4.0		12	1.6	2.55	2.19	150	12	75	5	25	100	50	1	50
DWEP 17-12		7.0		30	0.9	2.60	2.19	150	30	200	7	50	100	40	1	100
DWEP 19-12		7.0		30	0.9	2.50	2.19	150	30	200	7	50	100	40	1	100
DWEP 29-12		14.0		60	0.7	2.35	1.94	150	60	500	7	100	100	40	1	200
DWEP 49-12		17.0		77	0.7	2.19	1.89	125	50	500	9	50	100	40	1	200
DWEP 69-12		20.0		123	0.4	1.77	1.54	125	75	800	20	75	200	40	1	350

① **Mounted on DCB**

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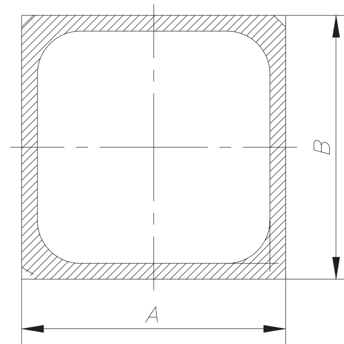
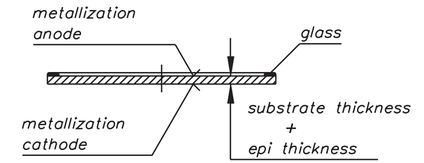
FRED - Fast Recovery Epitaxial Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A	Dimensions B	Si-thickn.
				mm	mm	mm
DWEP 27-02		•	518	4.45	4.45	0.35
DWEP 37-02		•	257	6.20	6.20	0.35
DWEP 77-02	•	•	151	8.91	7.22	0.35
DWEP 8-06		•	1612	3.60	1.80	0.35
DWEP 12-06	•	•	1851	2.40	2.40	0.35
DWEP 15-06	•	•	990	3.25	3.25	0.35
DWEP 23-06	•	•	531	5.50	3.50	0.35
DWEP 25-06	•	•	518	4.45	4.45	0.35
DWEP 35-06	•	•	257	6.20	6.20	0.35
DWEP 55-06		•	230	8.65	4.95	0.35
DWEP 75-06	•	•	151	8.91	7.22	0.35
DWEP 3-10		•	1612	1.80	3.60	0.35
DWEP 10-10		•	990	3.25	3.25	0.35
DWEP 18-10		•	531	5.50	3.50	0.35
DWEP 20-10		•	518	4.45	4.45	0.35
DWEP 30-10	•	•	257	6.20	6.20	0.35
DWEP 50-10		•	230	8.65	4.95	0.35
DWEP 70-10		•	151	8.91	7.22	0.35
DWEP 6-12		•	1851	2.40	2.40	0.35
DWEP 9-12	•	•	990	3.25	3.25	0.35
DWEP 17-12	•	•	531	5.50	3.50	0.35
DWEP 19-12	•	•	518	4.45	4.45	0.35
DWEP 29-12	•	•	257	6.20	6.20	0.35
DWEP 49-12	•	•	230	8.65	4.95	0.35
DWEP 69-12	•	•	151	8.91	7.22	0.35
Tolerance				-0.1	-0.1	±5%





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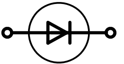
Low Leakage Fast Recovery Epitaxial Diodes



Type	V_{RRM}	I_R V_{RRM} T_{VJM}	T_{VJM}	$I_{F(AV)M}$ rect. d = 0.5 T_C= 100°C	R_{thJC} ① typ.	V_F T_{VJ} = 25°C	V_F T_{VJ} = 175°C	@I_F	I_{FSM}	Reverse Recovery I_{RM} 25°C; V_R = 100 V	@I_F	@-di/dt	t_{rr} V_R = 30 V typ. ns	@I_F	@-di/dt
	V	mA	°C	A	K/W	V	V	A	A	A			typ. ns	A	A/µs
DWLP 4-02	200	0.20	175	14	2.50	1.21	0.75	5	80	2.4	10	100	25	1	50
DWLP 15-02		0.50		29	1.60	0.99	0.74	12	140	2.4	25	100	25	1	100
DWLP 15-02B		0.50		25	1.60	1.13	0.78	12	140	1.1	25	100	25	1	100
DWLP 25-02		0.20		46	0.90	1.10	0.80	30	325	2.0	50	100	25	1	200
DWLP 4-03	300	0.20		13	2.80	1.63	0.96	5	40	1.3	10	100	30	1	50
DWLP 8-03		0.25		15	2.50	1.45	0.95	6	60	1.4	12	100	30	1	50
DWLP 15-03		0.50		25	1.60	1.44	0.94	12	110	1.4	25	100	30	1	100
DWLP 15-03A		0.50		29	1.60	1.26	0.60	12	110	1.4	25	100	30	1	100
DWLP 23-03		1.00		51	0.90	1.19	0.77	30	300	3.0	50	100	30	1	200
DWLP 23-03A		1.00		41	0.90	1.49	0.99	30	300	1.9	50	100	25	1	200
DWLP 55-03		2.50		72	0.65	1.42	0.91	60	600	2.8	130	100	30	1	300
DWLP 75-03		4.00		117	0.40	1.43	0.92	100	1000	3.2	200	100	30	1	400
DWLP 8-04	400	0.25		14	2.50	1.40	0.91	6	60	1.4	12	100	30	1	50
DWLP 15-04		0.50		24	1.60	1.40	0.90	12	110	2.5	25	100	30	1	100
DWLP 23-04		1.00		46	0.90	1.43	0.93	30	300	2.5	50	100	30	1	200
DWLP 55-04		2.50		67	0.65	1.12	0.81	60	600	3.5	130	100	30	1	300
DWLP 75-04		4.00		117	0.40	1.39	0.89	100	1000	4.0	200	100	30	1	400
DWLP 150-04		8.50		148	0.35	6.14	9.72	300	1200	9.5	200	100	30	1	800
DWLP 4-06	600	0.20		11	2.80	1.97	1.14	5	40	2.6	10	100	30	1	50
DWLP 8-06A		0.25		12	2.50	1.95	1.13	6	50	2.6	12	100	35	1	50
DWLP 8-06B		0.25		11	2.50	2.39	1.25	6	50	1.4	12	100	30	1	50
DWLP 15-06A		0.50		21	1.60	1.95	1.12	12	110	2.9	25	100	35	1	100
DWLP 15-06B		0.50		16	1.60	2.38	1.23	12	110	1.5	25	100	35	1	100
DWLP 23-06A		1.00		40	0.90	1.54	1.10	30	250	3.5	50	100	35	1	200
DWLP 23-06B		2.00		30	0.90	2.45	1.35	30	250	2.0	50	100	30	1	200
DWLP 55-06		2.50		62	0.65	1.92	1.10	60	600	4.0	130	100	35	1	300
DWLP 75-06		4.00		99	0.40	1.93	1.11	100	1000	4.5	200	100	35	1	400
DWLP 8-12	1200	0.25		9	2.50	2.61	1.46	6	40	5.0	12	100	40	1	50
DWLP 15-12		0.50		14	1.60	2.45	1.52	12	90	5.7	25	100	40	1	100
DWLP 23-12		1.00		29	0.90	2.68	1.52	30	200	6.7	50	100	40	1	200
DWLP 55-12		2.50		48	0.65	2.54	1.40	60	500	7.0	130	100	40	1	300
DWLP 75-12		4.00		78	0.40	2.56	1.42	100	800	7.4	200	100	40	1	400

① **Mounted on DCB**

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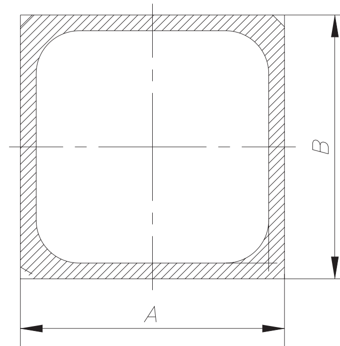
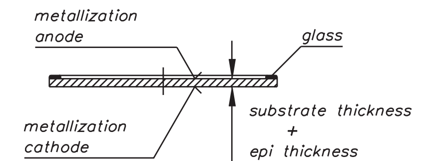
Low Leakage Fast Recovery Epitaxial Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A mm	Dimensions B mm	Si-thickn. mm
DWLP 4-02		•	1960	3.00	1.80	0.37
DWLP 15-02		•	990	3.25	3.25	0.37
DWLP 15-02B		•	990	3.25	3.25	0.37
DWLP 25-02		•	518	4.45	4.45	0.37
DWLP 4-03		•	1960	3.00	1.80	0.37
DWLP 8-03		•	1612	3.60	1.80	0.37
DWLP 15-03		•	990	3.25	3.25	0.37
DWLP 15-03A		•	990	3.25	3.25	0.37
DWLP 23-03		•	531	5.50	3.50	0.37
DWLP 23-03A		•	531	5.50	3.50	0.37
DWLP 55-03	•	•	230	8.65	4.95	0.37
DWLP 75-03		•	151	8.91	7.22	0.37
DWLP 8-04		•	1612	3.60	1.80	0.38
DWLP 15-04		•	990	3.25	3.25	0.38
DWLP 23-04		•	531	5.50	3.50	0.38
DWLP 55-04	•	•	230	8.65	4.95	0.38
DWLP 75-04	•	•	151	8.91	7.22	0.38
DWLP 150-04	•	•	74	13.00	9.77	0.38
DWLP 4-06		•	1960	3.00	1.80	0.40
DWLP 8-06A		•	1612	3.60	1.80	0.40
DWLP 8-06B		•	1612	3.60	1.80	0.40
DWLP 15-06A		•	990	3.25	3.25	0.40
DWLP 15-06B		•	990	3.25	3.25	0.40
DWLP 23-06A		•	531	5.50	3.50	0.40
DWLP 23-06B		•	531	5.50	3.50	0.40
DWLP 55-06	•	•	230	8.65	4.95	0.40
DWLP 75-06	•	•	151	8.91	7.22	0.40
DWLP 8-12		•	1612	3.60	1.80	0.46
DWLP 15-12		•	990	3.25	3.25	0.46
DWLP 23-12		•	531	5.50	3.50	0.46
DWLP 55-12	•	•	230	8.65	4.95	0.46
DWLP 75-12		•	151	8.91	7.22	0.46
Tolerance				-0.1	-0.1	±5%





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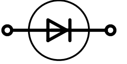
SONIC-FRD™ Diodes



Type	V_{RRM}	I_R	T_{VJM}	$I_{F(AV)M}$	R_{thJC} ①	V_F			I_{FSM}	Reverse Recovery			
		V_{RRM} 125°C		rect. d = 0.5 T_C = 100°C	typ.	T_{VJ} = 25°C	150°C	@ I_F		I_{RM} 25°C	t_{rr} typ.	@ I_F	@ -di/dt
	V	typ. mA	°C	A	K/W	V	V	A	A	typ. A	ns	A	A/µs
DWHP 8-06 F	in design	tbd	150	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
DWHP 15-06 F	600	tbd		tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
DWHP 23-06 F		tbd		tbd	0.90	1.94	1.68	20	200	tbd	tbd	20	200
DWHP 56-06 F		tbd		tbd	0.65	2.04	1.78	60	450	tbd	tbd	60	450
DWHP 69-06 F		tbd		tbd	0.40	2.05	1.80	100	750	tbd	tbd	100	750
DWHP 150-06 F	in design	tbd		tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
DWHFP 15-12 F	1200	0.1		12	0.90	3.08	2.61	10	100	tbd	tbd	10	100
DWHFP 23-12 F		0.2		17	0.90	2.97	2.49	20	200	7	65	20	200
DWHFP 56-12 F		0.6		29	0.65	3.15	2.70	60	450	18	50	60	450
DWHFP 56-12 S		0.6		37	0.65	2.12	1.98	60	450	28	175	60	tbd
DWHFP 69-12 F		1		47	0.40	3.17	2.72	100	750	36	125	100	750
DWHFP 69-12 S		1		60	0.40	2.13	1.99	100	750	53	330	100	750
DWHFP 150-12 S		1.5		150	tbd	2.00	1.87	150	1150	54	170	150	1150
DLFP 55-17 S	1700	0.6		31	0.65	2.35	2.46	60	350	30	tbd	60	400
DLFP 68-17 S		1		51	0.40	2.34	2.44	100	650	50	150	100	600
DLFP 150-17 S		1.8		tbd	0.22	1.95	2.03	tbd	1150	78	350	150	1150
DLFP 200-17 S		tbd		tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
DLFP 15-16/18 F	1600-	0.1		12	0.90	3.01	3.08	10	50	tbd	tbd	10	50
DLFP 25-16/18 F	1800	0.2		16	0.90	2.86	2.90	20	150	21	180	20	450
DLFP 55-16/18 F		0.6		27	0.65	2.90	2.94	60	350	30	330	60	450
DLFP 68-16/18 F		1		44	0.40	2.89	2.93	100	650	50	240	100	800

① **Mounted on DCB**

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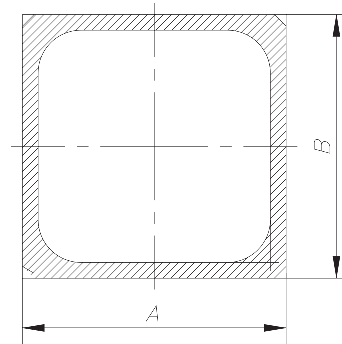
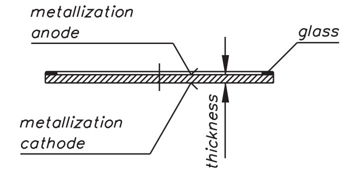
SONIC-FRD™ Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A mm	Dimensions B mm	Si-thickn. mm
DWHP 8-06 F		•	tbd	3.60	1.80	0.180
DWHP 15-06 F		•	968	3.25	3.25	
DWHP 23-06 F		•	532	5.50	3.50	
DWHP 56-06 F		•	231	8.65	4.95	
DWHP 69-06 F		•	152	8.91	7.22	
DWHP 150-06 F		•	88	11.40	9.40	
DWHFP 15-12 F		•	968	3.25	3.25	
DWHFP 23-12 F		•	532	5.50	3.50	
DWHFP 56-12 F		•	231	8.65	4.95	
DWHFP 56-12 S		•	231	8.65	4.95	
DWHFP 69-12 F		•	152	8.91	7.22	
DWHFP 69-12 S		•	152	8.91	7.22	
DWHFP 150-12 S		•	88	11.40	9.40	
DLFP 55-17 S		•	231	8.65	4.95	0.265
DLFP 68-17 S		•	152	8.91	7.22	
DLFP 150-17 S		•	88	11.40	9.40	
DLFP 200-17 S		•	59	12.40	12.40	
DLFP 15-16/18 F		•	968	3.25	3.25	
DLFP 25-16/18 F		•	532	4.45	4.45	
DLFP 55-16/18 F		•	231	8.65	4.95	
DLFP 68-16/18 F		•	152	8.91	7.22	
Tolerance				-0.1	-0.1	±5%





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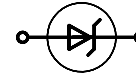
GaAs Schottky Diodes



Type	V_{RRM}	T_{VJM}	$I_{F(AV)M}$ rect. d = 0.5	R_{thJC} T_C = 90°C typ.	$V_{F\,typ}$ T_{VJ} = 25°C	$V_{F\,typ}$ T_{VJ} = 125°C	@I_F	I_R typ @V_{RRM} 125°C	C_j 0,5*V_{RRM} 125°C	I_{FSM}
	V	°C	A	K/W	V	V	A	µA	pF	A
DWGS04-01A	100	175	8.5	10.12	0.62	0.54	2.0	700	19.0	12.5
DWGS10-01C			25.0	5.20	0.99	0.94	10.0	< 10	19.0	80.0
DWGS04-018A	180		5.0	10.12	0.85	0.85	2.0	700	8.8	12.5
DWGS04-018C			8,4	10.12	1.25	1.02	4.0	< 10	8.8	32.0
DWGS10-018A			11.0	5.20	0.80	0.80	5.0	1300	22.0	30.0
DWGS10-018C			15.0	5.20	1.21	1.04	10.0	< 10	22.0	80.0
DWGS20-018A			17.0	3.70	0.80	0.80	7.5	2000	33.0	50.0
DWGS20-018C			23.0	3.70	1.24	1.07	20.0	< 10	33.0	120.0
DWGS04-025A	250		3.9	10.12	1.30	1.30	2.0	700	6.4	12.5
DWGS04-025C			7.8	10.12	1.26	1.05	4.0	< 10	6.4	32.0
DWGS10-025A			9.0	5.20	1.25	1.25	5.0	1300	18.0	30.0
DWGS10-025C			14.0	5.20	1.26	1.07	10.0	< 10	18.0	80.0
DWGS20-025A			13.0	3.70	1.25	1.25	7.5	2000	26.0	50.0
DWGS20-025C			20.0	3.70	1.24	1.10	20.0	< 10	26.0	120.0
DWGS04-03A	300		3.5	10.12	1.60	1.60	2.0	700	3.7	12.5
DWGS04-03C			6.0	10.12	1,56	1,10	4.0	< 10	3.7	32.0
DWGS10-03A			8.0	5.20	1.60	1.60	5.0	1300	9.0	30.0
DWGS10-03C			17.5	5.20	1.56	1.11	10.0	10	9.0	80.0
DWGS20-03C			25.0	3.70	1,56	1,14	20.0	15	14.0	120.0

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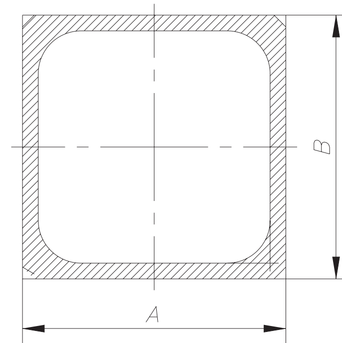
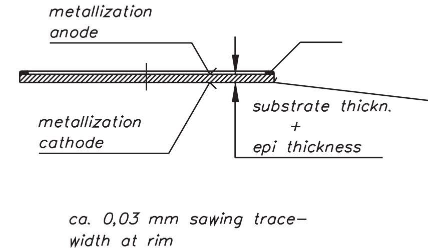
GaAs Schottky Diodes

	solderable	bondable	Chips per Wafer	Dimensions A mm	Dimensions B mm
DWGS04-01A		•	4060	1.30	1.30
DWGS10-01C		•	2126	2.10	1.60
DWGS04-018A		•	4060	1.30	1.30
DWGS04-018C		•	4060	1.30	1.30
DWGS10-018A		•	2126	2.10	1.60
DWGS10-018C		•	2126	2.10	1.60
DWGS20-018A		•	1480	3.00	1.60
DWGS20-018C		•	1480	3.00	1.60
DWGS04-025A		•	4060	1.30	1.30
DWGS04-025C		•	4060	1.30	1.30
DWGS10-025A		•	2126	2.10	1.60
DWGS10-025C		•	2126	2.10	1.60
DWGS20-025A		•	1480	3.00	1.60
DWGS20-025C		•	1480	3.00	1.60
DWGS04-03A		•	4060	1.30	1.30
DWGS04-03C		•	4060	1.30	1.30
DWGS10-03A		•	2126	2.10	1.60
DWGS10-03C		•	2126	2.10	1.60
DWGS20-03C		•	1480	3.00	1.60
Tolerance				-0.1	-0.1





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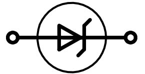
Schottky Diodes



Type	V_{RRM}	I_R	T_{VJM}	$I_{F(AV)M}$	R_{thJC} ①	V_F		@I_F	I_{FSM}	Reverse Recovery			
		V_{RRM} 125°C [1] = 100°C		rect. d = 0.5 T_C = 125°C [1] = 100°C	typ.	25°C	T_{VJ} = A version: 150°C B version: 125°C			I_{RM} 25°C	t_{rr} typ.	@I_F	@-di/dt
	V	mA	°C	A	K/W	V	V	A	A	A	ns	A	A/µs
DWS 39-08D	8	145 [1]	150	145 [1]	0.8	0.31	0.18	60	1000	tbd	tbd	50	200
DWS 9-15B	15	tbd	150	tbd	1.7	0.40	0.28	10	160	tbd	tbd	tbd	tbd
DWS 19-15B		65 [1]	150	65 [1]	1.4	0.39	0.24	20	350	tbd	tbd	20	200
DWS 29-15B		98 [1]	150	98 [1]	1.1	0.39	0.25	40	660	tbd	tbd	40	200
DWS 7-30B	30	tbd	tbd	tbd	tbd	0.63	0.43	10	tbd	tbd	tbd	tbd	tbd
DWS 17-30B		tbd	150	tbd	1.4	tbd	tbd	20	330	2.40	tbd	20	200
DWS 27-30B		82 [1]	150	82 [1]	1.1	0.42	0.29	40	520	tbd	tbd	40	200
DWS 37-30B		102 [1]	150	102 [1]	0.8	0.40	0.27	40	800	tbd	tbd	50	200
DWS 217-30B		65 [1]	150	65 [1]	1.2	0.41	0.30	28	420	5.50	tbd	30	200
DWS 3-45B	45	28 [1]	150	28 [1]	1.7	0.48	0.41	10	160	1.00	tbd	10	200
DWS 4-45A		32	175	32	1.7	0.66	0.50	10	140	1.00	tbd	10	200
DWS 13-45B		42 [1]	150	42 [1]	1.4	0.48	0.41	20	320	1.40	tbd	20	200
DWS 14-45A		47	175	47	1.4	0.66	0.50	20	280	1.50	tbd	20	200
DWS 23-45B		63 [1]	150	63 [1]	1.1	0.48	0.42	40	640	2.00	tbd	40	200
DWS 24-45A		68	175	68	1.1	0.66	0.50	40	550	2.00	tbd	40	200
DWS 33-45B		89 [1]	150	89 [1]	0.8	0.48	0.41	60	900	2.60	tbd	50	200
DWS 34-45A		95	175	95	0.8	0.66	0.51	60	800	2.50	tbd	50	200

① **Mounted on DCB**

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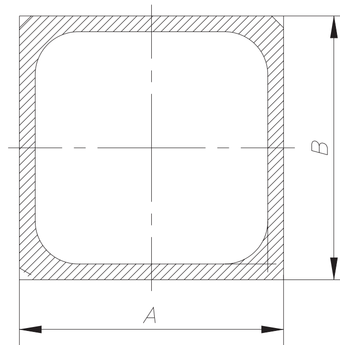
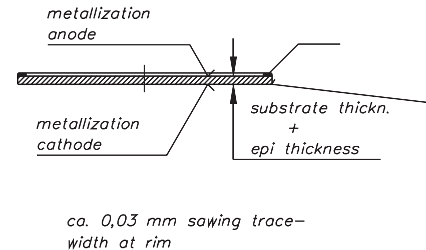
Schottky Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A mm	Dimensions B mm	Si-thickn. mm
DWS 39-08D	•		343	5.40	5.40	0.25/0.43
DWS 9-15B		•	1886	2.40	2.40	0.25/0.43
DWS 19-15B		•	990	3.25	3.25	
DWS 29-15B		•	515	4.45	4.45	
DWS 7-30B		•	2857	2.40	2.40	0.25
DWS 17-30B		•	990	3.25	3.25	
DWS 27-30B		•	515	4.45	4.45	
DWS 37-30B		•	515	5.40	5.40	
DWS 217-30B		•	729	3.25	4.45	
DWS 3-45B		•	2857	2.40	2.40	
DWS 4-45A		•	1886	2.40	2.40	
DWS 13-45B		•	1515	3.25	3.25	
DWS 14-45A		•	990	3.25	3.25	
DWS 23-45B	•	•	757	4.45	4.45	
DWS 24-45A		•	757	4.45	4.45	
DWS 33-45B	•	•	515	5.40	5.40	
DWS 34-45A	•	•	515	5.40	5.40	
Tolerance				-0.1	-0.1	±5%





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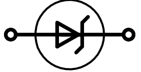
Schottky Diodes



Type	V_{RRM}	I_R at V_{RRM} 125°C 1) = 100°C	T_{VJM}	$I_{F(AV)M}$ rect. d = 0.5 T_C = 125°C 1) = 100°C	R_{thJC} ① typ.	V_F T_{VJ} = 25°C	V_F T_{VJ} = 150°C	@ I_F	I_{FSM}	Reverse Recovery I_{RM} 25°C	Reverse Recovery t_{rr} typ.	Reverse Recovery @ I_F	Reverse Recovery @ -di/dt
	V	mA	°C	A	K/W	V	V	A	A	A	ns	A	A/µs
DWS 5-60A	60	tbd	175	tbd	1.7	tbd	tbd	10	170	tbd	tbd	tbd	tbd
DWS 15-60B		43	150	43	1.4	0.60	0.60	20	320	tbd	tbd	20	200
DWS 25-60B		63 1)	150	63	1.1	0.59	0.50	40	660	tbd	tbd	40	200
DWS 35-60B		82 1)	150	82	0.8	0.53	0.48	60	900	2.50	tbd	50	200
DWS 25-80B	80	66 1)	150	66	1.1	0.70	0.55	40	660	1.50	tbd	40	200
DWS 36-80A		91	175	91	0.8	0.74	0.58	60	700	2.00	tbd	50	200
DWS 2-100A	100	32	175	32	1.7	0.77	0.57	10	120	2.00	tbd	10	200
DWS 12-100A		45	175	45	1.4	0.78	0.57	20	230	2.30	tbd	20	200
DWS 22-100A		65	175	65	1.1	0.78	0.58	40	450	2.60	tbd	40	200
DWS 32-100A		92	175	92	0.8	0.77	0.57	60	700	3.40	tbd	50	200
DWS 1-150A	150	30	175	30	1.7	0.81	0.62	10	120	3.00	tbd	10	200
DWS 11-150A		43	175	43	1.4	0.81	0.62	20	200	4.00	tbd	20	200
DWS 21-150A		60	175	60	1.1	0.81	0.63	40	450	tbd	tbd	40	200
DWS 31-150A		85	175	85	0.8	0.81	0.62	60	700	4.50	tbd	50	200
DWS 1-180A	180	30	175	30	1.7	0.81	0.62	10	120	3.50	tbd	10	200
DWS 30-200A	200	tbd	175	tbd	0.8	0.00	0.00	60	700	5.00	tbd	50	200

① **Mounted on DCB**

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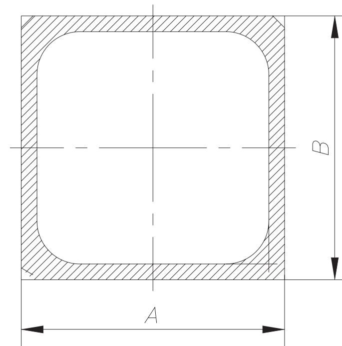
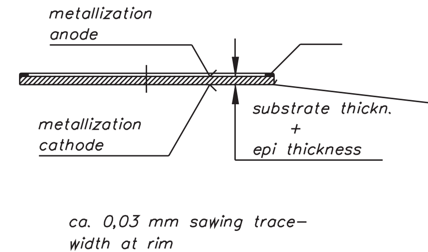
Schottky Diodes

Type	solderable	bondable	Chips per Wafer	Dimensions A	Dimensions B	Si-thickn.
				mm	mm	mm
DWS 5-60A		•	2857	2.40	2.40	0.25
DWS 15-60B		•	990	3.25	3.25	
DWS 25-60B		•	757	4.45	4.45	
DWS 35-60B		•	515	5.40	5.40	
DWS 25-80B		•	515	4.45	4.45	
DWS 36-80A		•	343	5.40	5.40	
DWS 2-100A		•	1886	2.40	2.40	
DWS 12-100A		•	990	3.25	3.25	
DWS 22-100A		•	757	4.45	4.45	
DWS 32-100A	•	•	515	5.40	5.40	
DWS 1-150A		•	2857	2.40	2.40	
DWS 11-150A		•	1515	3.25	3.25	
DWS 21-150A		•	757	4.45	4.45	
DWS 31-150A		•	515	5.40	5.40	
DWS 1-180A		•	1886	2.40	2.40	
DWS 30-200A		•	515	5.40	5.40	
Tolerance				-0.1	-0.1	±5%





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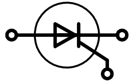
Phase Control Thyristors



Type	V_{DRM} V_{RRM} (V)	I_R V_{RRM} T_{VJM} (mA)	T_{VJM} (°C)	$I_{T(AV)M}$ rect. d = 0.5 T_C = 100°C [1] = 75°C (A)	R_{thJC} ① max. (K/W)	V_T T_{VJ} = 25°C (V)	V_T T_{VJ} = 150°C (V)	@I_T (A)	I_{TSM} non-rep. t_p = 10ms (A)	t_q V_R = 100V, V_D = $^2/_3$ V_{DRM} t_p = 200µs, di/dt = -10A/µs T_{VJ} = T_{VJM} (µs)	dv/dt (V/µs)	@I_T (A)	I_H R_{GK} = ∝ V_D = 6 V T_{VJ} = 25°C (ns)	I_L T_{VJ} = 25°C (mA)	@t_p (µs)
CWP 7-CG	800 -	5	125	15 [1]	1.7	1.55	1.41	20	200	tbd	tbd	tbd	50	75	10
CWP 8	1200	4	150	tbd	1.7	1.53	1.53	44	300	60	20	16	40	100	10
CWP 8-CG		4	150	tbd	1.7	1.53	1.53	44	300	60	20	16	80	100	10
CWP 35		20	150	tbd	0.7	1.46	1.49	150	1200	100	10	50	80	100	10
CWP 16-CG	1200 -	8	150	25	1.2	1.40	1.41	45	400	150	10	11	100	150	10
CWP 21-CG	1600 -	12		61	1.1	1.56	1.57	80	520	150	20	15	100	150	10
CWP 22-CG		12		36	0.9	1.55	1.57	80	520	150	15	20	100	450	10
CWP 24		20		tbd	0.9	1.33	tbd	60	600	60	20	25	100	200	10
CWP 25-CG		20		tbd	0.9	1.33	1.31	60	600	60	20	25	100	200	10
CWP 41	1200 -	20		125	0.5	1.53	1.58	200	1150	150	20	120	200	450	10
CWP 50	1800	20		tbd	0.6	1.38	1.38	200	1500	150	20	150	200	450	10
CWP 55		20		tbd	0.5	1.29	1.26	200	1900	150	20	150	200	450	10
CWP 71		20		tbd	0.4	1.35	1.35	300	2400	185	20	150	200	450	10
CWP 130		30		204	0.2	1.21	1.16	350	4750	150	20	160	200	300	30
CWP 180		40		372	0.2	1.22	1.17	450	5200	150	20	300	200	300	30
CWP 341		40		tbd	0.2	1.21	1.17	600	7000	200	50	300	150	200	30
CWP 347		60		540	0.1	1.17	1.11	600	9500	200	50	300	150	200	30
CWP 69	1600 -	20		tbd	0.2	1.55	tbd	300	1700	185	20	150	150	200	30
CWP 339	2200	40		tbd	0.2	1.26	tbd	300	6000	150	20	160	150	200	30
CWP 345		60		520	0.1	1.34	1.34	600	8000	200	50	300	150	200	30

① **Mounted on DCB**

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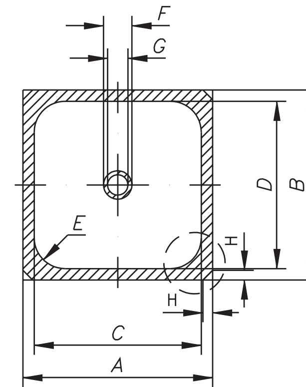
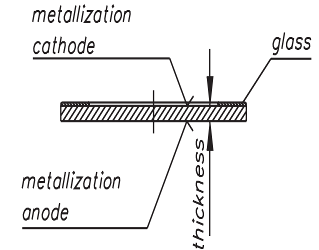
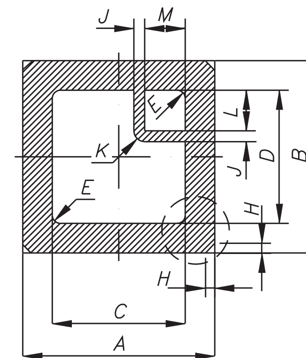
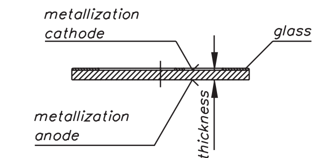
Phase Control Thyristors

Type	solderable	bondable	Chips per Wafer	Dimensions A mm	B mm	F mm	G mm	Corner Gate J mm	L mm	M mm	Si-thickn. mm
CWP 7-CG	•	•	518	4.45	4.45	-	-	0.2	1.1	1.6	0.38
CWP 8	•	•	375	5.20	5.20	1.80	0.90	-	-	-	0.38
CWP 8-CG		•	375	5.20	5.20	1.80	0.90	0.2	1.1	1.6	0.32
CWP 35	•	•	125	8.70	8.70	1.80	1.00	-	-	-	0.38
CWP 16-CG	•	•	239	6.50	6.50	-	-	0.2	1.1	1.6	0.38
CWP 21-CG	•	•	196	7.10	7.10	-	-	0.2	1.1	1.6	0.38
CWP 22-CG	•	•	196	7.10	7.10	-	-	0.2	1.1	1.6	0.38
CWP 24	•	•	196	7.10	7.10	1.80	1.00	-	-	-	0.32
CWP 25-CG	•	•	196	7.10	7.10	-	-	0.2	1.1	1.6	0.32
CWP 41	•	•	94	10.00	10.00	2.30	1.50	-	-	-	0.38
CWP 50	•	•	74	13.00	9.77	2.30	1.50	-	-	-	0.38
CWP 55	•	•	58	12.30	12.30	2.30	1.50	-	-	-	0.38
CWP 71	•	•	50	13.40	13.40	2.30	1.50	-	-	-	0.38
CWP 130	•	•	29	19.05	15.40	3.46	2.50	-	-	-	0.38
CWP 180	•	•	20	20.55	17.65	3.50	2.50	-	-	-	0.38
CWP 341	•		16	25.30	18.50	3.50	2.50	-	-	-	0.38
CWP 347	•		13	23.40	23.40	3.50	2.50	-	-	-	0.38
CWP 69	•		50	13.40	13.40	2.30	1.50	-	-	-	0.46
CWP 339	•		16	18.50	25.30	3.50	2.50	-	-	-	0.46
CWP 345	•		13	23.40	23.40	3.50	2.50	-	-	-	0.46
Tolerance				-0.1	-0.1	-0.1	+0.1	-0.1	+0.1	+0.1	±5%









...-CG types

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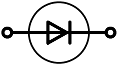
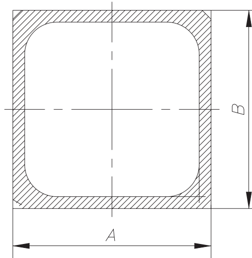
Fast Rectifier Diodes

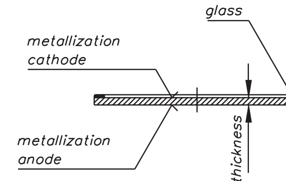


Type	V_{RRM}	I_R	T_{VJM}	$I_{F(AV)M}$	R_{thJC} ①	V_F			I_{FSM}	Reverse Recovery					
		V_{RRM}		rect. d = 0.5		T_{VJ} =		@ I_F		I_{RM}	@ I_F	@ -di/dt	t_{rr}	@ I_F	@ -di/dt
		T_{VJM}		T_C = 75°C	typ.	25°C	125°C			25°C			typ.		
	V	typ. mA	°C	A	K/W	V	V	A	A	A			µs	A	A/µs
DWFN 2-16/18	1600 - 1800	2	125	10	2.9	1.79	tbd	10	75	tbd	tbd	tbd	1.5	4	5
DWFN 9-16/18		4		16	1.6	1.98	tbd	30	160	tbd	tbd	tbd	1.5	8	5
DWFN 17-16/18		5		17	1.3	1.89	tbd	55	300	tbd	tbd	tbd	1.5	10	10
DWFP 17-16/18		5		17	1.3	2.10	tbd	55	300	tbd	tbd	tbd	1.5	10	10
DWFN 21-16/18		8		23	0.9	1.98	tbd	70	400	tbd	tbd	tbd	1.5	15	15
DWFN 35-16/18		10		26	0.7	1.88	tbd	80	500	tbd	tbd	tbd	1.5	25	25

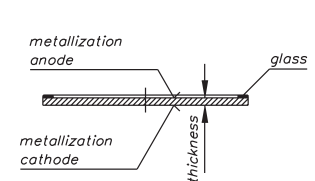
① **Mounted on DCB**

Type	solderable	bondable	Chips per Wafer	Dimensions A	Dimensions B	Si-thickn.
				mm	mm	mm
DWFN 2-16/18		•	1204	2.95	2.95	0.265
DWFN 9-16/18		•	684	3.90	3.90	0.265
DWFN 17-16/18	•	•	518	4.45	4.45	0.265
DWFP 17-16/18	•	•	239	4.45	4.45	0.265
DWFN 21-16/18		•	346	5.40	5.40	0.265
DWFN 35-16/18		•	259	6.20	6.20	0.265
Tolerance				-0.1	-0.1	±5%





DWFN



DWFP

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