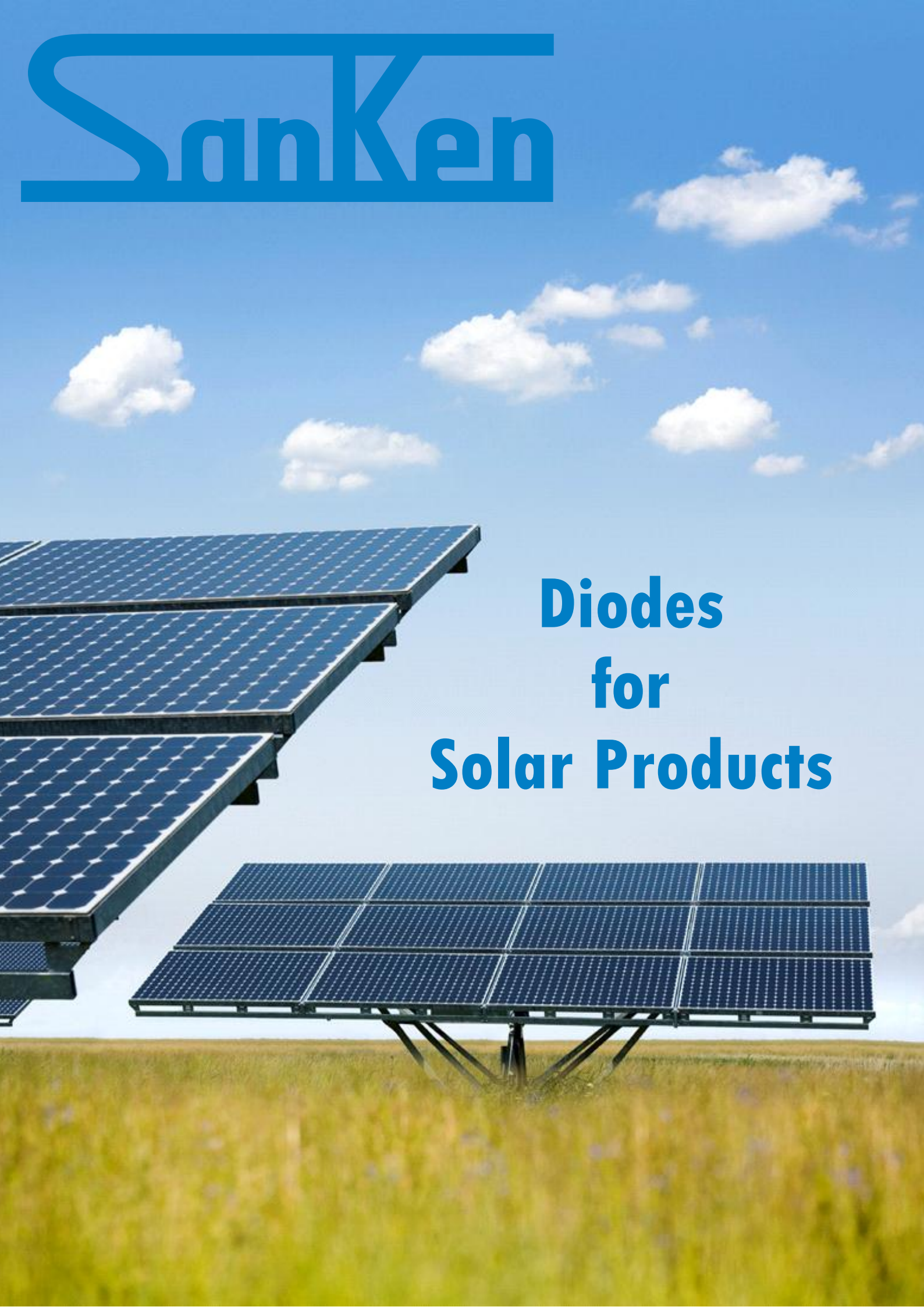
SanKen



Diodes for Solar Products

Sanken Electric Co Ltd was founded in Tokyo, Japan in 1946 and has established a firm position as a power electronics manufacturer, providing high quality solutions to meet diverse customer needs.

With headquarters located in the Saitama prefecture, Sanken Electric has nearly 30 group companies worldwide and employs over 10,000 people.

Sanken continues to use its knowledge and expertise to provide customers with original and creative products as a power electronics innovator within the semiconductor and power management sectors.

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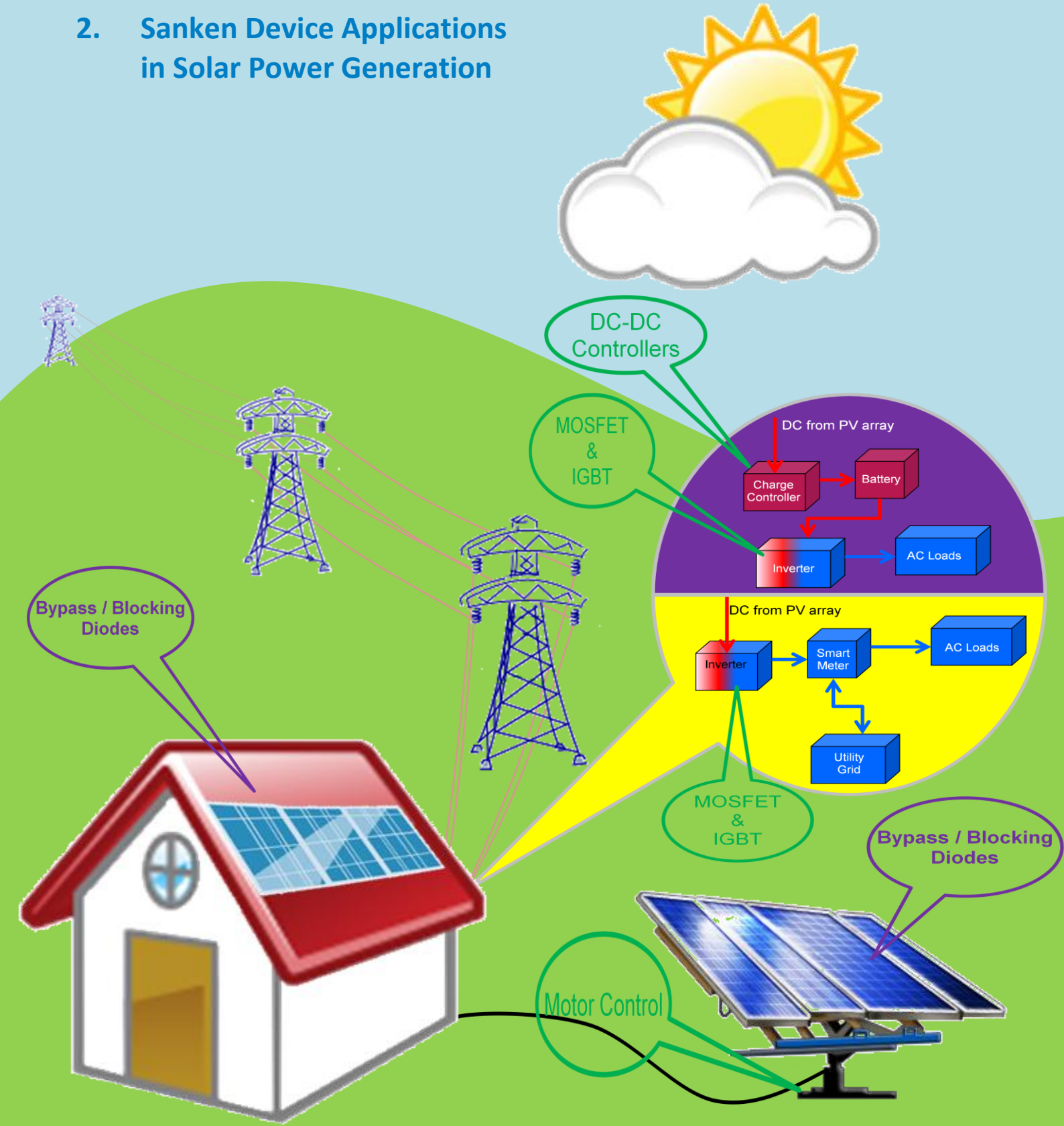
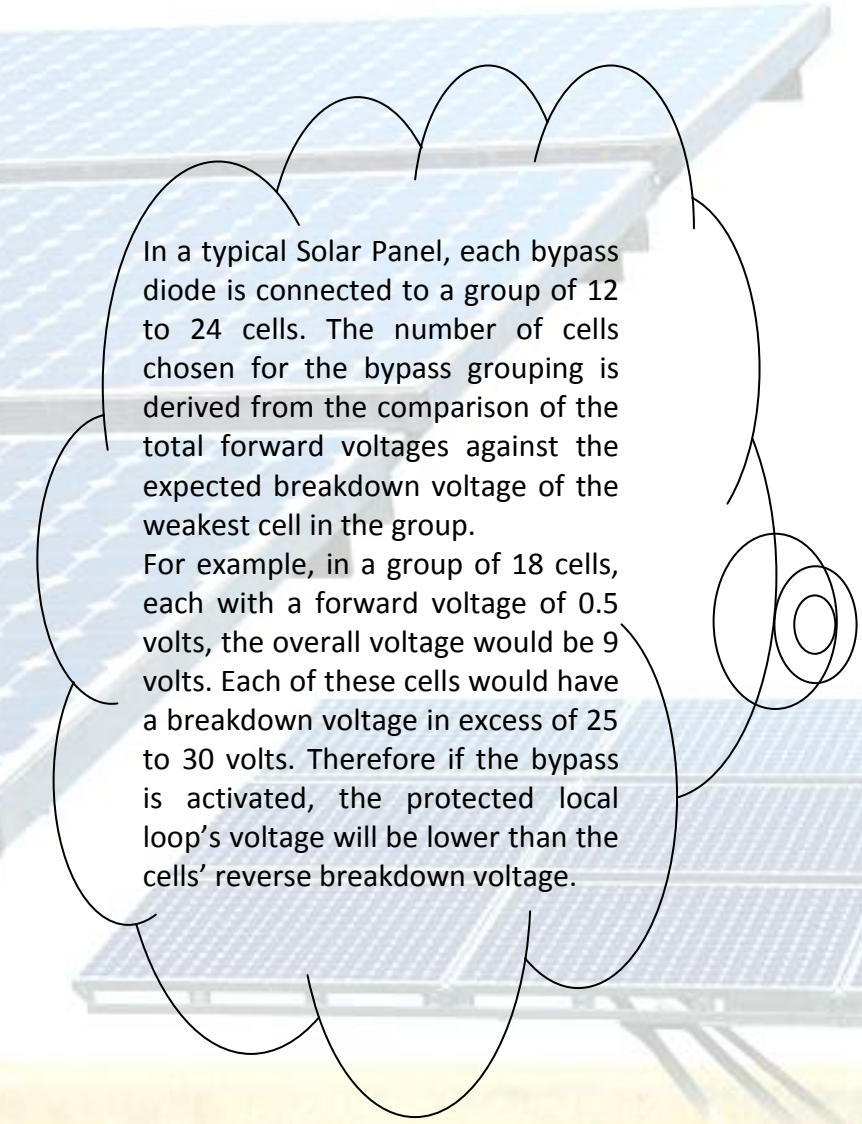
2. Sanken Device Applications in Solar Power Generation



3. Bypass Diodes



In a typical Solar Panel, each bypass diode is connected to a group of 12 to 24 cells. The number of cells chosen for the bypass grouping is derived from the comparison of the total forward voltages against the expected breakdown voltage of the weakest cell in the group.

For example, in a group of 18 cells, each with a forward voltage of 0.5 volts, the overall voltage would be 9 volts. Each of these cells would have a breakdown voltage in excess of 25 to 30 volts. Therefore if the bypass is activated, the protected local loop's voltage will be lower than the cells' reverse breakdown voltage.

4. Diodes – Rectifier Type

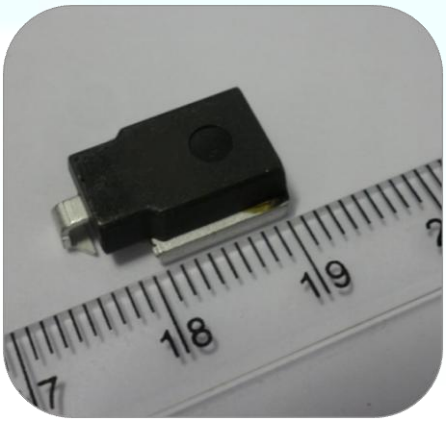
Sanken rectifier diodes for solar applications (part number PV…..) are suitable for Reverse blocking and bypass applications due to their high reliability, low forward voltage loss and high voltage capacity.

Part No.	V_R (V)	I_F (A)	V_F (V)	T_J (max)*1	Package Outline	Samples Available	Status
PVMPM-1053	300	5.0	1.00 (I_F=5.0A)	~190°C	TO-263	YES	**In Development**
PVRM05C	1000	5.0	0.97 (I_F=5.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**In Development**
PVRM10C	1000	10.0	0.97 (I_F=10.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**Mass Production due October 2011**
PVRM15C	1000	15.0	0.97 (I_F=15.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**Mass Production due October 2011**
PVSZ-10M20C	1000	20.0	0.97 (I_F=20.0A)	~190°C	SZ-10	YES	**In Production**
PVFMM-G2CS	1000	20.0	1.10 (I_F=20.0A)	~190°C	TO-220F (2 Pin)	YES	**In Production**
PVFMM-G2C	1000	30.0	0.97 (I_F=20.0A) 1.10 (I_F=30.0A)	~190°C	TO-220F (2 Pin)	YES	**In Production**
PVRM15F	1500	15.0	1.00 (I_F=15.0A)	~175°C	Axial (Ø6.5/Ø1.4)	YES	**In Development**
PVFMM-115F	1500	15.0	1.00 (I_F=15.0A)	~175°C	TO-220F (2 Pin)	YES	**In Development**

*1 … Continuous forward bias operation within one hour. (Non-repetitive condition)

5. SZ-10M20C Diode

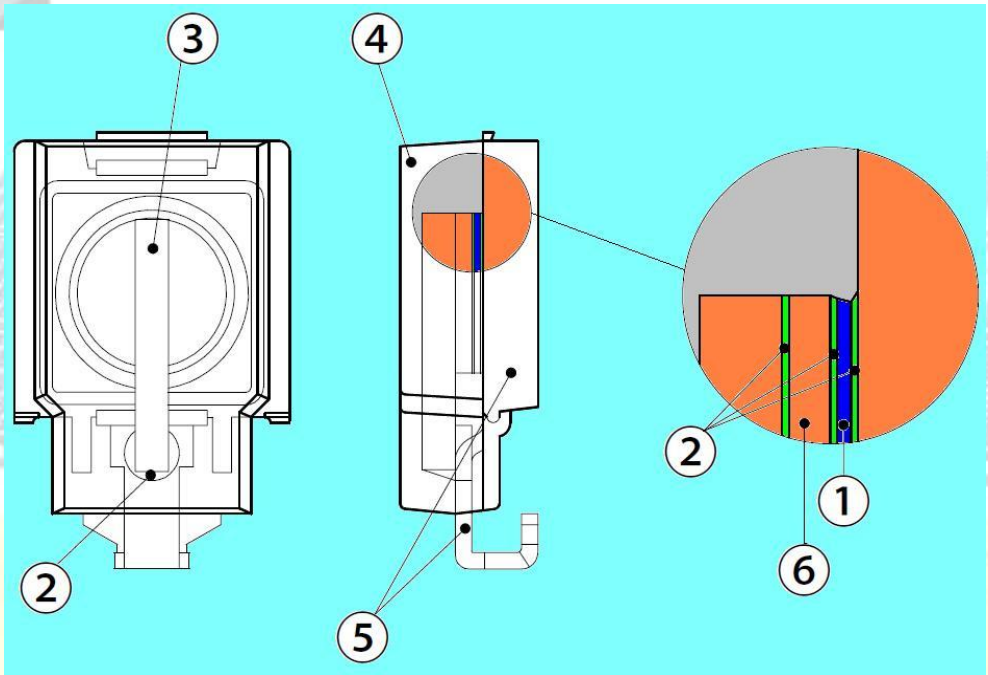
In 2009, Sanken launched a new bypass diode for solar cells, the SZ-10M20C, which reduces V_F by about 10% (up to 0.97 Volts) compared to previous TO220F-package bypass diodes. Thus enabling a significant reduction in the amount of heat generation.



Also, by adopting an original package with low thermal resistance (the SZ-10 package), Sanken has succeeded in cutting the diode's thermal resistance to 0.5°C/W. This is a mere 1/8th of the thermal resistance of conventional bypass diodes. The new package is also structured to facilitate the transfer of heat from the chip to the frame. Moreover, because the frame is attached directly to a heat sink, heat is easily transferred to the heat sink, realizing improved heat dissipation compared to TO220F package, which uses a resin frame.

No.	Part	Material
①	Die	Silicon
②	Solder	Pb Based Solder
③	Inside Lead	Nickel plated Copper
④	Plastic Body	Epoxy Resin
⑤	Lead Frame	Outer Sn plated on Nickel plated copper
⑥	Disc	Nickel Plated Copper

Parameter	Symbol	Rating	Unit
Reverse voltage	V_R	1000	V
Forward current	I_F(AV)	20	A
Forward voltage	V_F	0.97 max	V
Junction temperature	T_j	-40 to +190	°C
Thermal resistance	Rth(j-c)	0.5 max	°C/W



6. Diodes – Schottky Barrier Type

Part No.	V_R (V)	I_F (A)	V_F (V)*1	T_J (max)*2	Package Outline	Samples Available	Status
PVRW54	40	5.0	0.55 (I_F=5.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	In Production
PVRW104	40	10.0	0.55 (I_F=10.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	Ready for Mass Production
RVRW154	40	15.0	0.55 (I_F=15.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	Ready for Mass Production
PVRW204	40	20.0	0.55 (I_F=20.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	Ready for Mass Production
PVRW304	40	30.0	0.55 (I_F=30.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	Ready for Mass Production
PVFMW-1204	40	20.0	0.55 (I_F=20.0A)	~190°C	TO-220F (2 Pin)	YES	Ready for Mass Production
PVFMW-1304	40	30.0	0.55 (I_F=30.0A)	~190°C	TO-220F (2 Pin)	YES	Ready for Mass Production
PVMPW-2154	40	20.0	0.60 (I_F=20.0A)	~190°C	TO-263	YES	Ready for Mass Production
PVMPW-2304	40	30.0	0.55 (I_F=15.0A)	~190°C	TO-263	YES	In Production
PVMPW-2306	60	30.0	0.70 (I_F=15.0A)	~190°C	TO-263	YES	Ready for Mass Production

*1... Junction temperature at 25°C unless otherwise stated.
*2 ... Continuous forward bias operation within one hour. (Non-repetitive condition)

7. Reverse Blocking Diodes

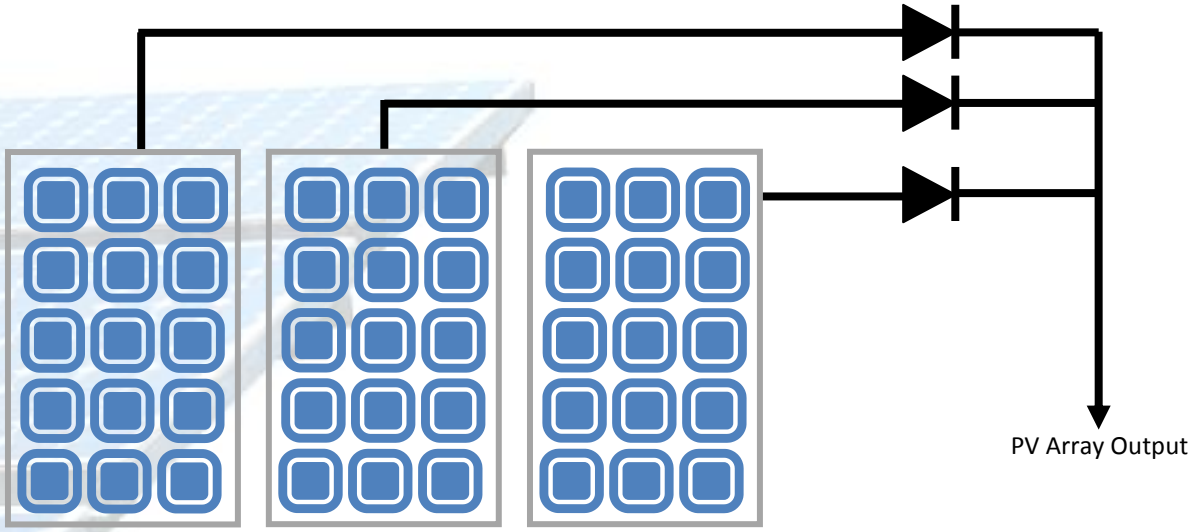
Diodes placed in series with cells or modules can perform the function of blocking a reverse leakage current through the PV module. There are two situations where this could occur.

- Blocking reverse flow of current from the battery through the module during the night.

At night the module potential will drop to zero. If the modules where connected to a battery system, the battery could discharge through the panels and the battery would loss it's stored energy. Diodes placed between the modules and the battery would prevent this from happening.

- Blocking reverse flow down damaged modules from parallel strings of modules during the day.

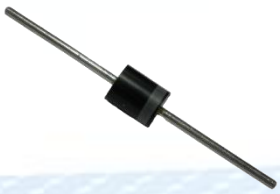
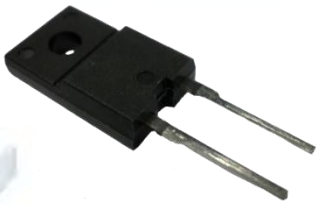
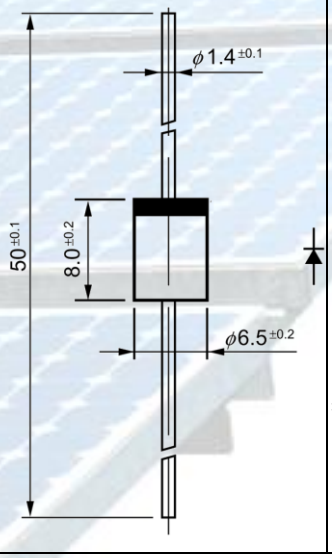
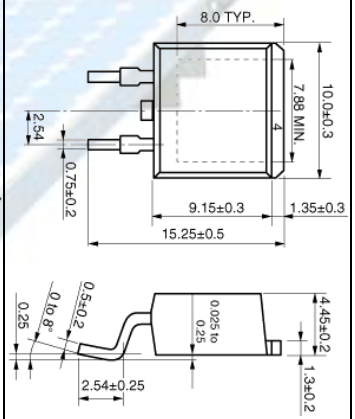
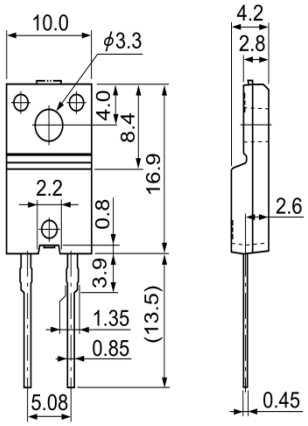
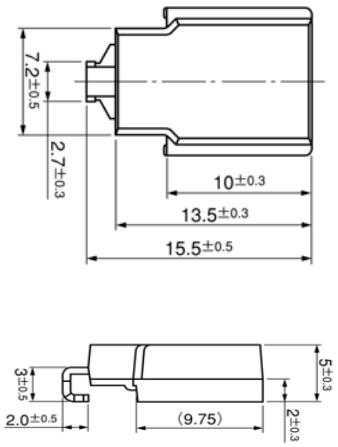
Blocking diodes placed in an array of separate parallel wired strings, in high voltage systems, can have another function during daylight. If one string be comes shaded, or a short circuit develops in module, the blocking diode prevents the rest of the array from loosing current through the shaded or damaged string.



Part No.	V_R (V)	I_F (A)	V_F (V)	T_J (max)*1	Package Outline	Samples Available	Status
PVRM05C	1000	5.0	0.97 (I_F=5.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**In Development**
PVRM10C	1000	10.0	0.97 (I_F=10.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**Mass Production due October 2011**
PVRM15C	1000	15.0	0.97 (I_F=15.0A)	~190°C	Axial (Ø6.5/Ø1.4)	YES	**Mass Production due October 2011**
PVRM15F	1500	15.0	1.00 (I_F=15.0A)	~175°C	Axial (Ø6.5/Ø1.4)	YES	**In Development**
PVFMM-115F	1500	15.0	1.00 (I_F=15.0A)	~175°C	TO-220F (2 Pin)	YES	**In Development**

*1 … Continuous forward bias operation within one hour. (Non-repetitive condition)

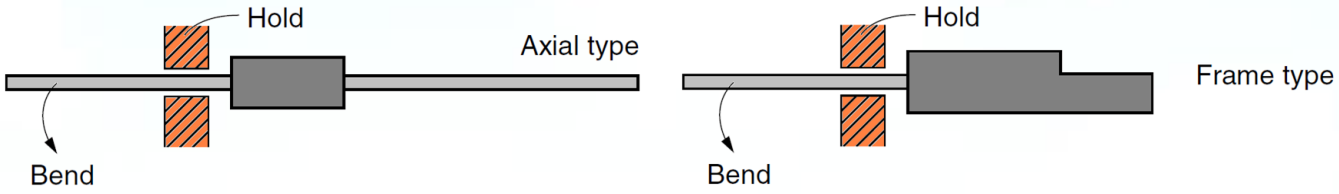
8. Package Outlines

Axial (Ø6.5/Ø1.4)	TO-263	TO-220F (2 pin)	SZ-10
Thermal Resistance **Maximum = 4.0 to 8.0 °C/W**	**Thermal Resistance** **Maximum = 2.0 °C/W**	**Thermal Resistance** **Maximum = 2.5 to 4.0 °C/W**	**Thermal Resistance** **Typical = 0.2 °C/W** **Max. = 0.5 °C/W**
			
			

9. Diode Handling

➢ Lead Forming

When forming leads, hold the lead wire on the main body's side to prevent stress from being applied to the main body.



➢ Mounting

To mount a frame-type diode on a heat sink, use the screw hole. Do not fix to the resin body, as the silicon dies may get damaged.

➢ Temperature Measurement

For an axial type diode, measure the temperature of the lead wire on the main body side. The thermocouple to be used must be as thin as possible (approximately ϕ0.125mm).

➢ Temperature Rise Consideration

A diode's temperature increases due to losses from forward current, reverse current and reverse recovery time. In normal use, losses are mainly attributable to forward current and voltage. However, in high frequency circuits such as switching power supplies, losses due to reverse recovery time also occurs. Moreover, in diodes having large reverse currents like Schottky barrier diodes, the losses due to reverse current cannot be disregarded. Forward loss tends to decrease at high temperatures. However, reverse loss tends to increase at high temperatures. Therefore, it is necessary to consider the ambient temperature when verifying operation.

➢ Inrush Current

In a capacitor-input type rectifier circuit, inrush current flows when the power supply is switched on. The peak value of this inrush current shall be set less than peak forward surge current IFSM (I^2t can also be obtained but set the minimum pulse width to 1 msec). The value of IFSM is guaranteed for a single shot only. If the inrush current is repeated within a short period of time, a derating has to be taken into account.

➢ Peak Current

Considering normal use, the limit of the peak current must be set to 10 times of the average current IF (AV). If the peak value increases, the diode's forward loss also increases. In this case, check the temperature rise.

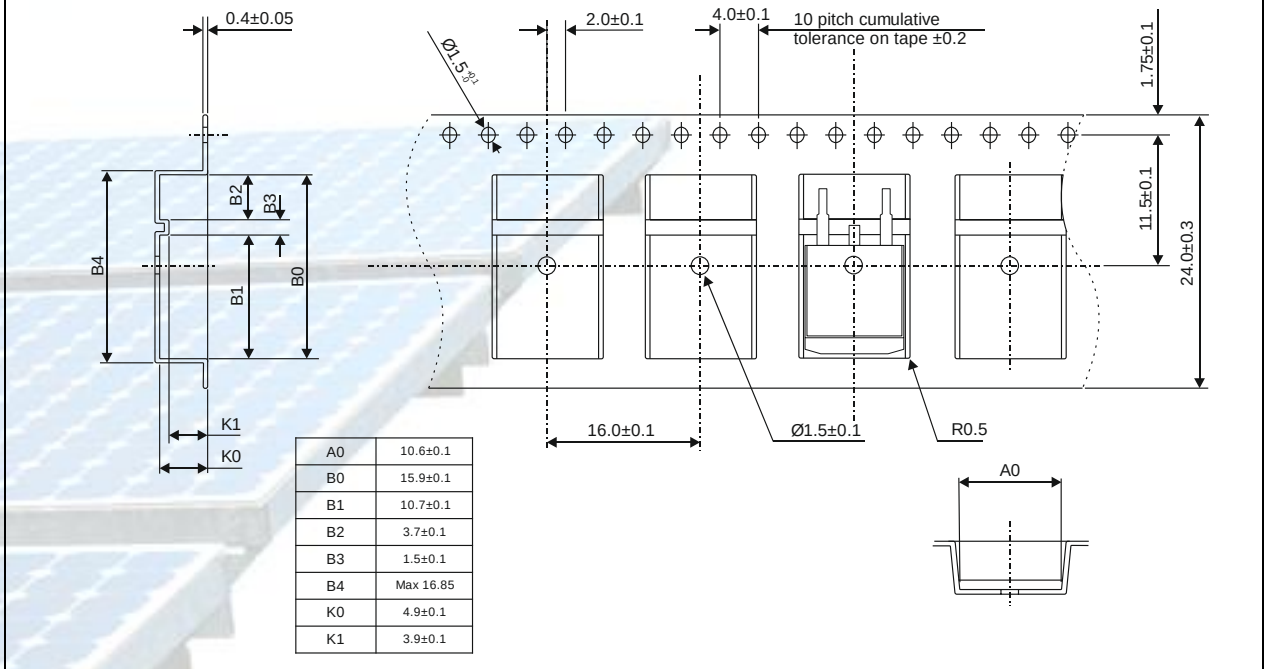
10. Packing Specifications

- **Axial (Ø6.5mm Body/Ø1.4mm Lead) Package**
  Packaged in bulk quantity of 500 pieces.

- **TO-220F Package**
  Packaged in bulk quantity of 500 pieces.

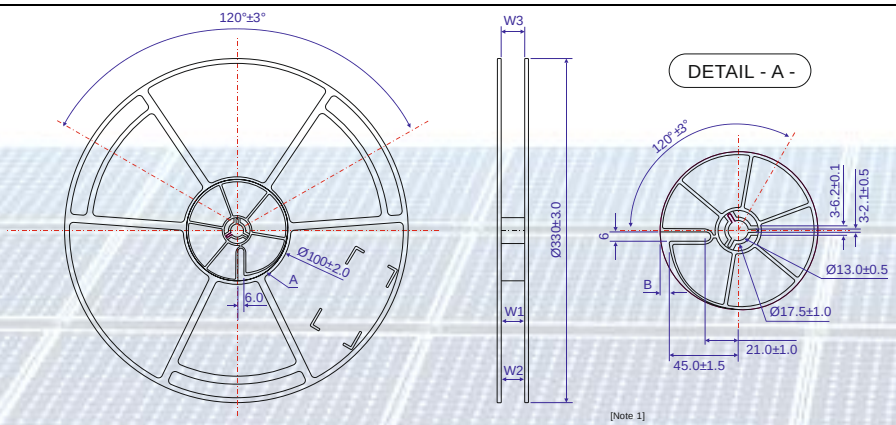
- **TO-263 Package**

Taping Type, Dimensions (mm)



A0	10.6±0.1
B0	15.9±0.1
B1	10.7±0.1
B2	3.7±0.1
B3	1.5±0.1
B4	Max 16.85
K0	4.9±0.1
K1	3.9±0.1

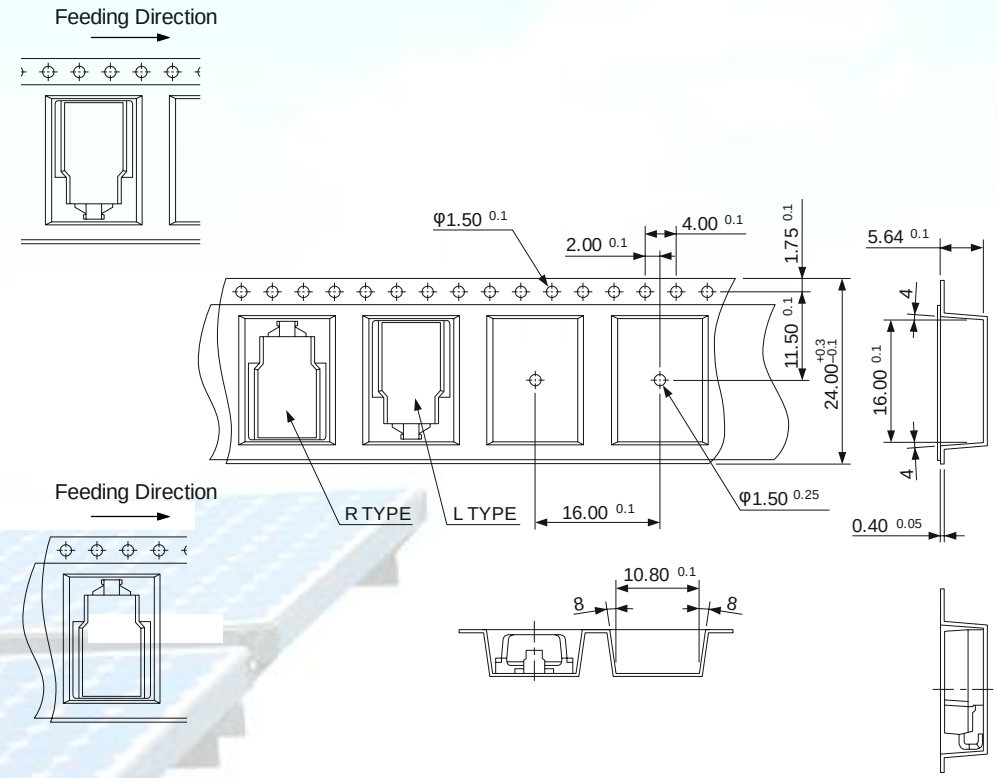
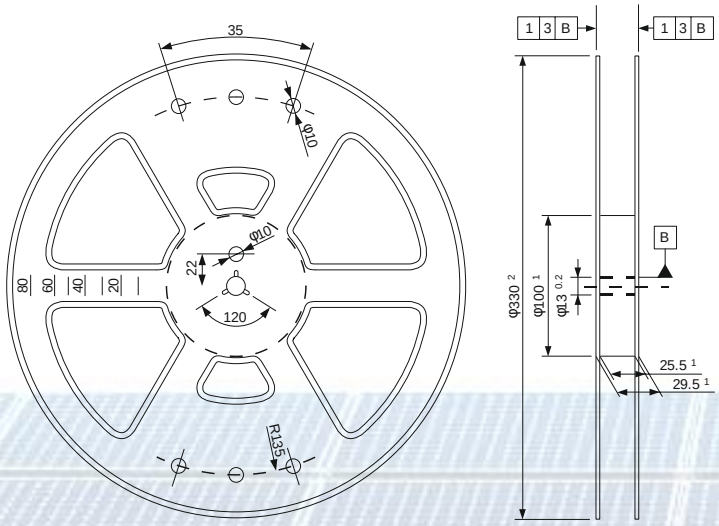
Quantity 800 pcs/reel



PKG	NORMAL WIDTH	W1 (+2/-0)	W2 MAX	W3 (+3/-0.5)	B	REEL COLOUR
TO-252	16mm	16.4	22.4	16.4	3.5±2	BLACK
						BLUE
TO-263	24mm	24.4	30.4	24.4	5.5±2	BLACK
						BLUE

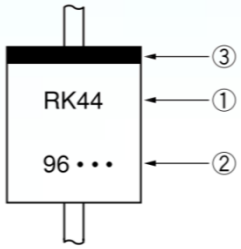
[Note 1]
1. MATERIAL : PLASTIC HIPS (High Impact Polystyrene)
2. ANTISTATIC : 1 YEAR Max ±100 [Volts]
3. SURFACE RESISTANCE : Max 10^11 Ω /cm²]

➢ SZ-10 Package

Taping Name	Taping Type, Dimensions (mm)
VL To specify the taping type, add a suffix [VL]	
VR To specify the taping type, add a suffix [VR]	
Quantity 750 pcs/reel	

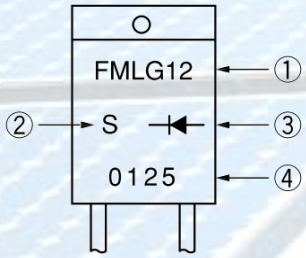
11. Marking Guide

- **Axial Package**



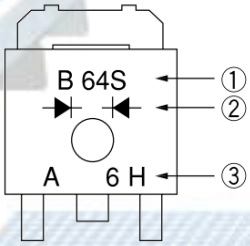
① Part Number: 2 set marking
② Manufacturing Date and period: 2 set marking
First Letter: Year (Last digit of year)
Second Letter: Month (1 to 9, O, N, D)
• First 10 days of month
•• Middle 10 days of month
••• Last 10 days of month
③ Cathode Band
Colour of The band:
White: For Power Supply and SBD
Yellow: For medium speed
Red: For fast and ultrafast

- **TO-220F (2 pin) Package**



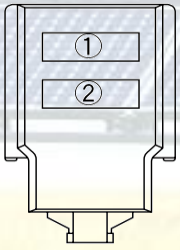
① Part Number: Excluding last letter
e.g. FML-G12S is indicated as “FML-G12”
② Last letter of part number
③ Polarity: Rectifier symbol
④ Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
Third and fourth letters: Day
Laser marking or White ink marking

- **TO-263 Package**



① Part Number
② Polarity: Rectifier Symbol
③ Lot No.
First letter: Lot code
Second letter: Year (Last digit of year)
Third letter: Month (A to M except I)

- **SZ-10 Package**



① Part Number
② Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
Third and fourth letters: Day

12. Further Information

For further information on Sanken products contact:

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