

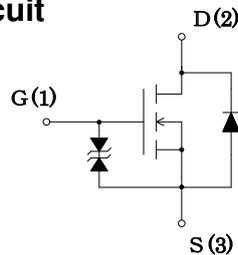
## Features

- $V_{DS}$ -----100V
- $I_D$ -----20A
- $R_{DS(ON)}$  -----33m $\Omega$  typ ( $V_{GS}=10V, I_D=10A$ )
- Built-in gate protection diode

## Applications

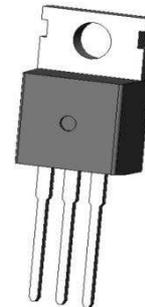
- Low Voltage DC Motor driver
- Solenoid driver

## Equivalent Circuit



## Package

TO220



(1) (2) (3)  
G D S

## Key Specifications

- $V_{(BR)DSS} = 100V$  ( $I_D=1mA$ )
- $R_{DS(ON)} = 52m\Omega$  max ( $V_{GS}=10V, I_D=10A$ )

## Absolute maximum ratings (Ta = 25°C, unless otherwise specified)

Characteristic	Symbol	Rating	Unit	Notes
Drain to Source Voltage	$V_{DSS}$	100	V	
Gate to Source Voltage	$V_{GSS}$	$\pm 20$	V	
Continuous Drain Current	$I_{D(DC)}$	20	A	
Pulsed Drain Current	$I_{D(pulse)}$	60	A	$PW \leq 100\mu sec$ ,Duty cycle $\leq 1\%$
Continuous Diode Forward Current	$I_{SD(DC)}$	20	A	
Diode Pulse Current	$I_{SD(pulse)}$	60	A	$PW \leq 100\mu sec$ ,Duty cycle $\leq 1\%$
Single Pulse Avalanche Energy	$E_{AS}$	50	mJ	$V_{DD}=20V, L=200\mu H, I_{LP}=20A,$ unclamped, $R_g=50\Omega$ , See Fig.1
Maximum avalanche current	$I_{AS}$	20	A	
Maximum Power Dissipation	$P_D$	55	W	$T_c=25^\circ C$
Thermal Resistance	$\theta_{j-c}$	2.27	$^\circ C/W$	
	$\theta_{j-a}$	62.5	$^\circ C/W$	
Operating Junction Temperature	$T_j$	150	$^\circ C$	
Storage Temperature	$T_{stg}$	-55 ~ 150	$^\circ C$	

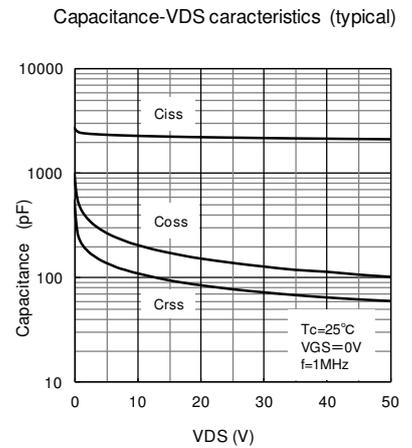
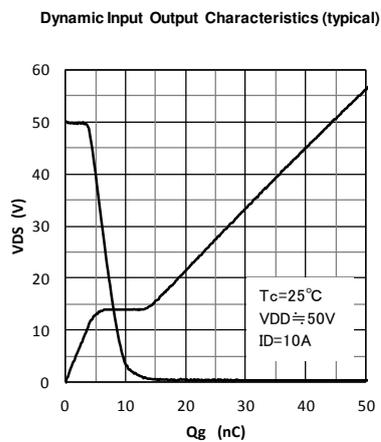
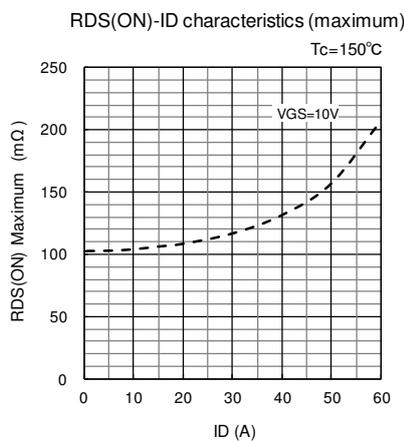
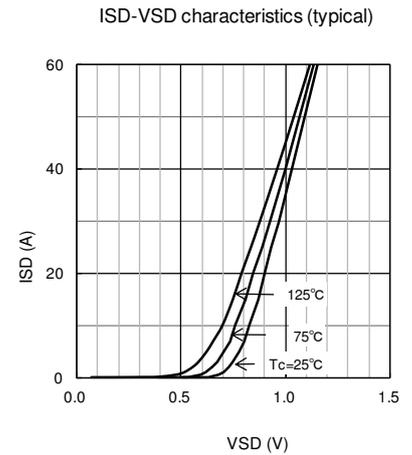
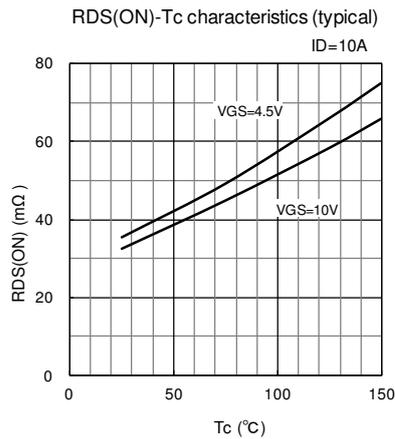
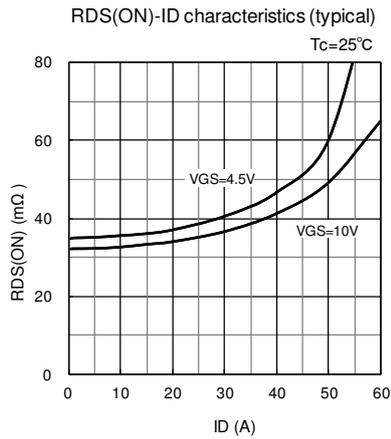
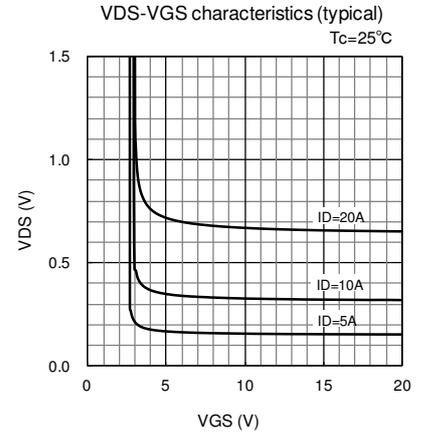
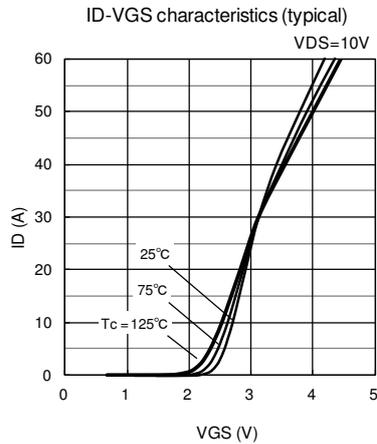
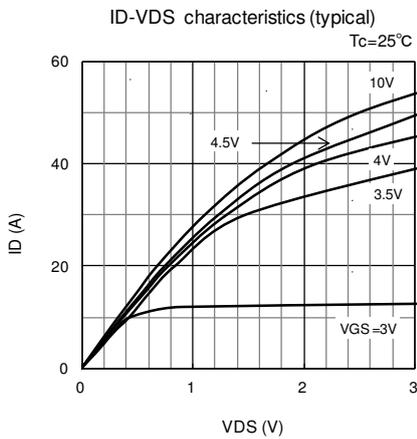
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**Electrical characteristics** (Ta = 25 °C, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Limits			Unit
			MIN.	TYP.	MAX.	
Drain to Source Breakdown Voltage	$V_{(BR)DSS}$	$I_D=1mA, V_{GS}=0V$	100	—	—	V
Drain to Source Breakdown Voltage Temp.	$\Delta V_{(BR)DSS}$	$I_D=1mA, V_{GS}=0V$	—	80	—	mV/°C
Drain to Source Leakage Current	$I_{DSS}$	$V_{DS}=100V, V_{GS}=0V$	—	—	100	$\mu A$
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V$	—	—	$\pm 10$	$\mu A$
Gate Threshold Voltage	$V_{TH}$	$V_{DS}=10V, I_D=1mA$	1.5	2.0	2.5	V
Gate Threshold Voltage Temp. Coefficient	$\Delta V_{TH}$	$V_{DS}=10V, I_D=1mA$	—	-6	—	mV/°C
Static Drain to Source On-Resistance	$R_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	—	33	52	m $\Omega$
		$I_D=10A, V_{GS}=4.5V$	—	36	59	
Forward Transconductance	$Re(y_{fs})$	$V_{DS}=10V, I_D=10A$	9.0	—	—	S
Input Capacitance	$C_{iss}$	$V_{DS}=10V$	—	2200	—	pF
Output Capacitance	$C_{oss}$	$V_{GS}=0V$	—	210	—	
Reverse Transfer Capacitance	$C_{rss}$	$f=1MHz$	—	110	—	
Total Gate Charge	$Q_g$	$V_{DD}=50V$	—	45	—	nC
Gate to Source Charge	$Q_{gs}$	$I_D=10A, V_{GS}=10V$	—	4	—	
Gate to Drain Charge	$Q_{gd}$	$R_L=5\Omega, R_g=10\Omega$	—	9	—	
Turn-On Delay Time	$td(on)$	$V_{DD}=50V$	—	15	—	ns
Rise Time	$tr$	$I_D=10A$	—	20	—	
Turn-Off Delay Time	$td(off)$	$R_L=5\Omega, R_g=10\Omega$	—	180	—	
Fall Time	$tf$	$V_{GS}=10V$ , See Fig.3	—	90	—	
Source-Drain Diode Forward Voltage	$V_{SD}$	$I_{SD}=20A, V_{GS}=0V$	—	0.9	1.2	V
Source-Drain Diode Reverse Recovery	$t_{rr}$	$I_{SD}=20A, di/dt=100A/\mu s$	—	50	—	ns
Source-Drain Diode Recovery Charge	$Q_{rr}$	See Fig.2	—	90	—	nC
Source-Drain Diode Recovery Time	$t_{rr}$	$I_{SD}=20A, di/dt=100A/\mu s$	—	60	—	ns
Source-Drain Diode Recovery Charge	$Q_{rr}$	$T_c=150^\circ C$ , See Fig.2	—	120	—	nC

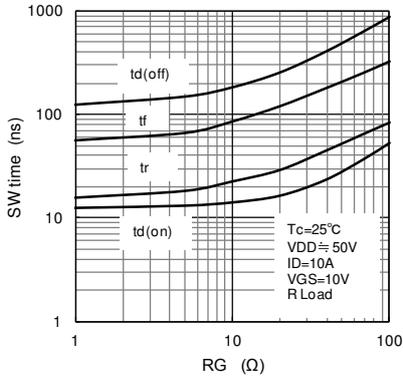
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## Performance Curves

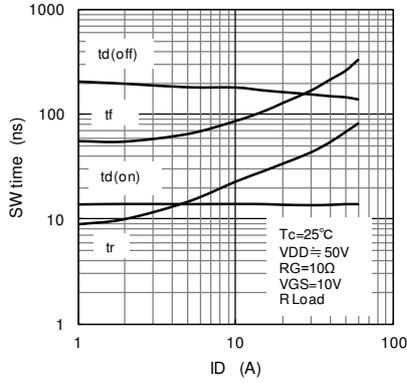


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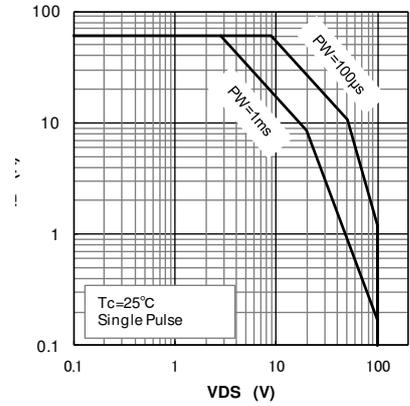
SW time - RG Characteristics (typical)



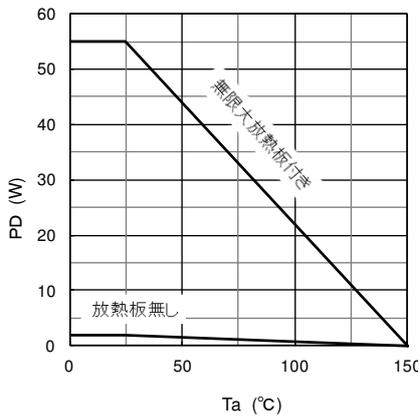
SW time - ID Characteristics (typical)



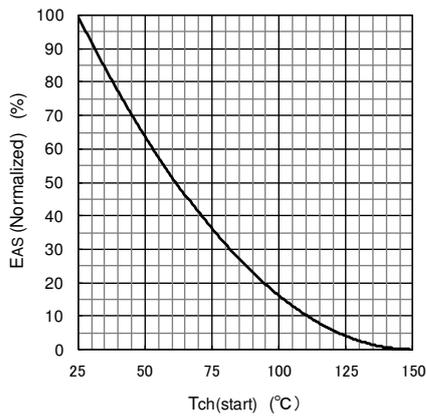
Safe Operating Area



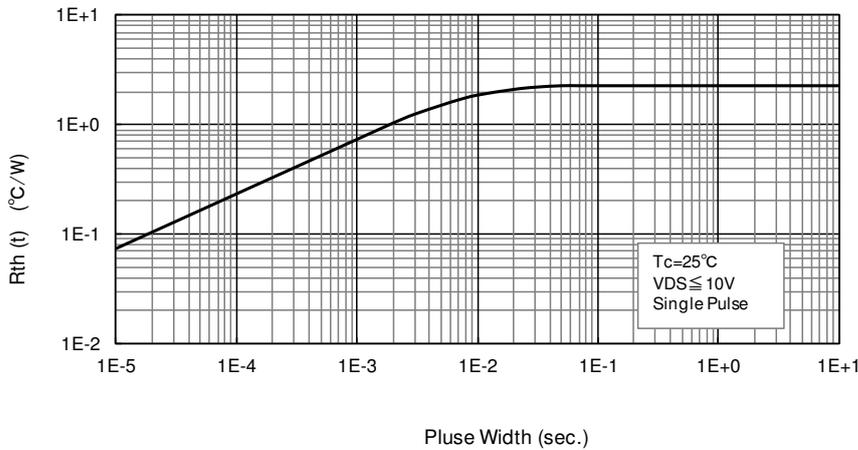
PD-Ta Characteristics



EAS - Tc(start) Characteristics



Transient Thermal Resistance - Pulse Width

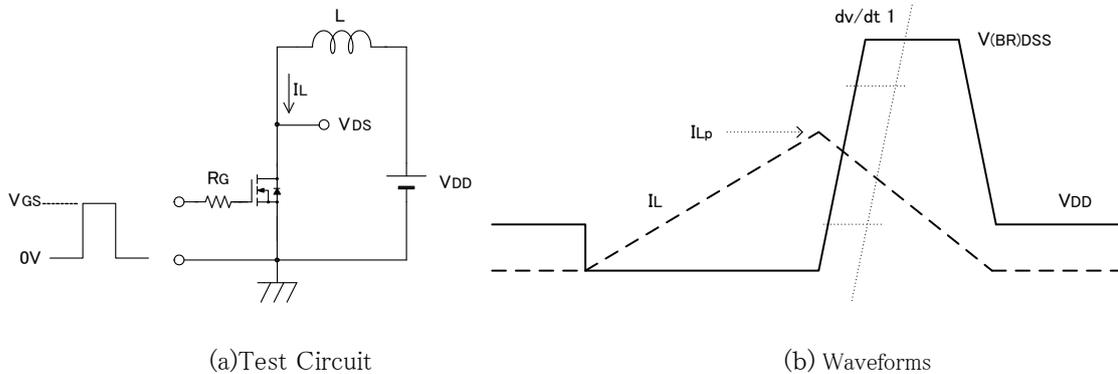


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## Unclamped Inductive Test Method

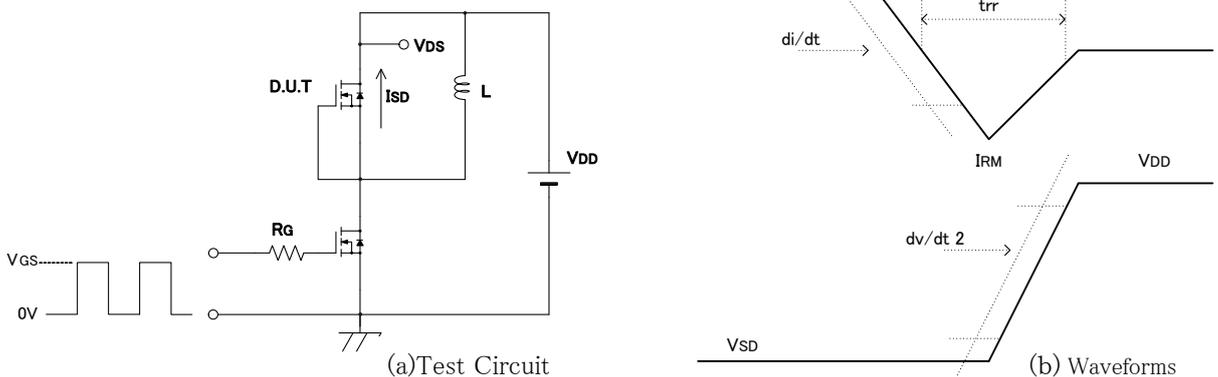
Fig.1 Unclamped Inductive Test Method

$$EAS = \frac{1}{2} \cdot L \cdot I_{LP}^2 \cdot \frac{V_{(BR)DSS}}{V_{(BR)DSS} - V_{DD}}$$



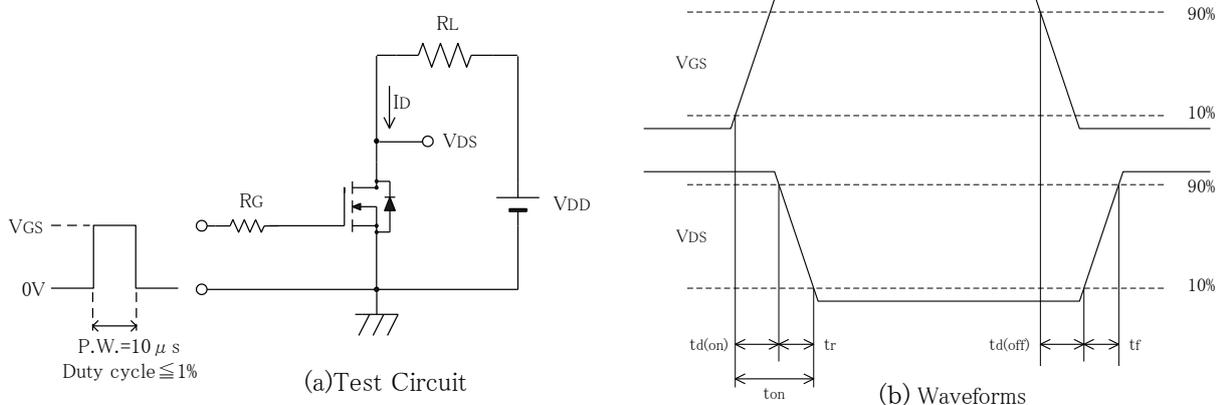
## Diode Reverse Recovery Time Test Method

Fig.2 Diode Reverse Recovery Time Test Method



## Switching Time Test Method

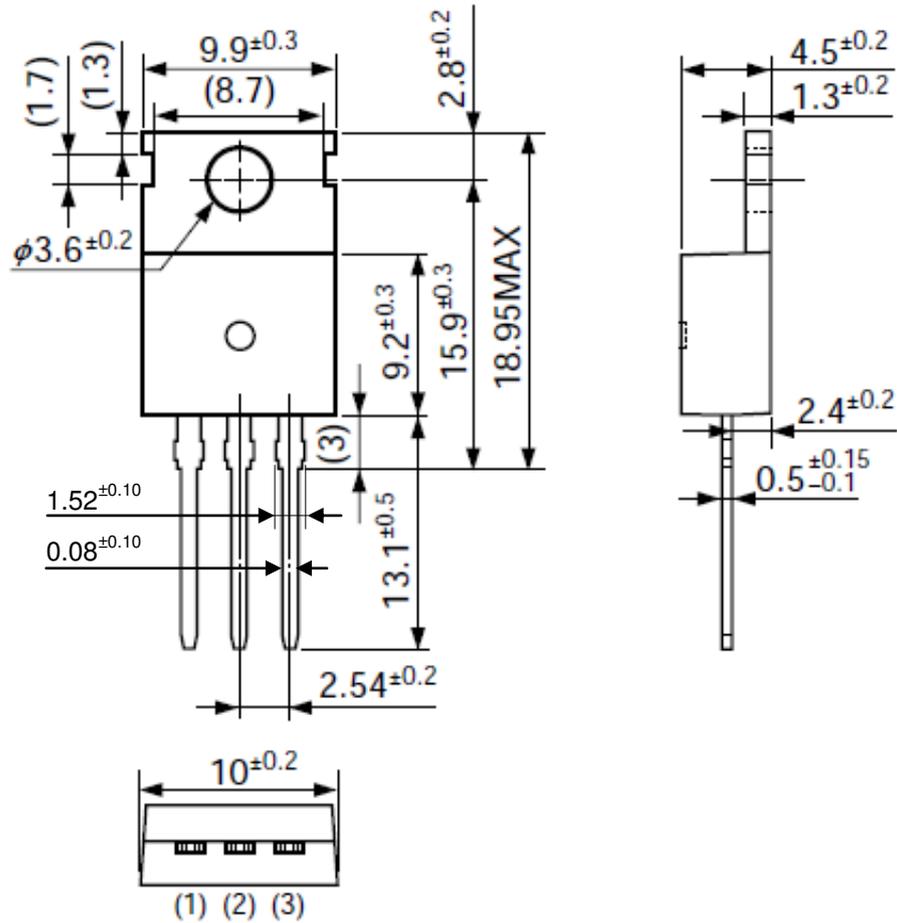
Fig.3 Switching Time Test Method



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## Package Outline

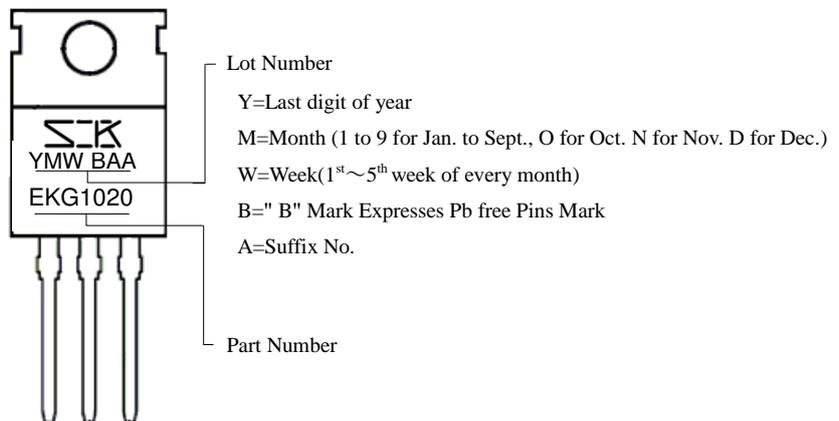
TO220



**NOTES:**

- 1) All liner dimensions are in millimeters
- 2) Pin treatment Pb-free. Device composition compliant with the RoHS directive

## Marking Diagram



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## OPERATING PRECAUTIONS

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

### Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5 to 35°C) and the standard relative humidity (around 40 to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of the products that have been stored for a long time.

### Cautions for Testing and Handling

When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing device, shorts between the product pins, and wrong connections. Ensure all test parameters are within the ratings specified by SanKen for the products.

### Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting the products on a heatsink, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce excess stress.
- Volatile-type silicone greases may crack after long periods of time, resulting in reduced heat radiation effect. Silicone greases with low consistency (hard grease) may cause cracks in the mold resin when screwing the products to a heatsink.

Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	Momentive Performance Materials Inc.
SC102	Dow Corning Toray Co., Ltd.

### Cautions for Mounting to a Heatsink

- When the flatness around the screw hole is insufficient, such as when mounting the products to a heatsink that has an extruded (burred) screw hole, the products can be damaged, even with a lower than recommended screw torque. For mounting the products, the mounting surface flatness should be 0.05mm or less.
- Please select suitable screws for the product shape. Do not use a flat-head machine screw because of the stress to the products. Self-tapping screws are not recommended. When using self-tapping screws, the screw may enter the hole diagonally, not vertically, depending on the conditions of hole before threading or the work situation. That may stress the products and may cause failures.
- Recommended screw torque

Package	Recommended Screw Torque
TO-220 , TO-220F	0.490 to 0.686 N·m (5 to 7 kgf·cm)
TO-3P , TO-3PF	0.686 to 0.882 N·m (7 to 9 kgf·cm)
SLA	0.588 to 0.784 N·m (6 to 8 kgf·cm)

- For tightening screws, if a tightening tool (such as a driver) hits the products, the package may crack, and internal stress fractures may occur, which shorten the lifetime of the electrical elements and can cause catastrophic failure. Tightening with an air driver makes a substantial impact. In addition, a screw torque higher than the set torque can be applied and the package may be damaged. Therefore, an electric driver is recommended.

When the package is tightened at two or more places, first pre-tighten with a lower torque at all places, then tighten with the specified torque. When using a power driver, torque control is mandatory.

- Please pay special attention about the slack of the press mold. In case that the hole diameter of the heatsink is less than 4 mm, it may cause the resin crack at tightening.

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## Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:
  - 260 ± 5 °C 10 ± 1 s (Flow, 2 times)
  - 380 ± 10 °C 3.5 ± 0.5 s (Soldering iron, 1 time)
- Soldering should be at a distance of at least 1.5 mm from the body of the products.

## Electrostatic Discharge

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the products.
- The products should always be stored and transported in SanKen shipping containers or conductive containers, or be wrapped in aluminum foil.

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