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Current Mode Control PWM Regulator ICs For Switching Power Supplies

Features and Benefits

- Current mode PWM control
- Built-in Random Switching function: reduces EMI noise, simplifies EMI filters, and cuts cost by external part reduction
- Built-in Slope Compensation function: avoids subharmonic oscillation
- Built-in Leading Edge Blanking (LEB) function
- Auto Standby function:
 - Input power, $P_{IN} < 25 \text{ mW}$ at no load
 - Normal load operation: PWM switching
 - Light load operation: Standby mode (Burst oscillation)
- Soft Start function: reduces stress on internal power MOSFET and output rectifier diode

Continued on the next page...

Package: TO-220F-6L



Not to scale

Description

The STR2W152D and STR2W153D are power ICs for switching power supplies, incorporating a power MOSFET and a current mode PWM controller IC in one package.

Including a startup circuit and a standby function in the controller, the products achieve low power consumption, low standby power, and high cost-effectiveness in power supply systems, while reducing external components.

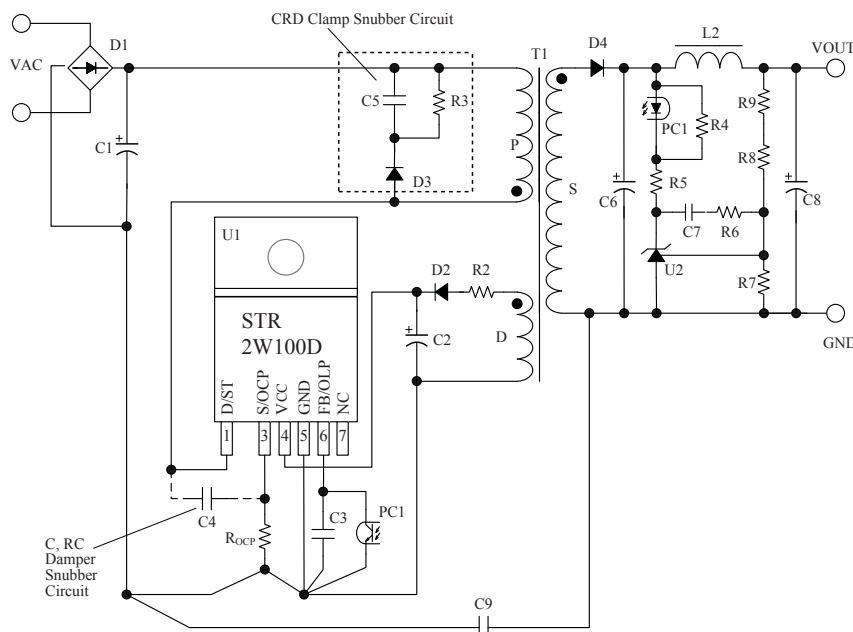
The products are provided in fully molded TO-220 package types. Pin 2 is deleted for greater isolation.

Applications

Switching power supplies for electronic devices such as:

- Home appliances
- Digital appliances
- Office automation (OA) equipment
- Industrial apparatus
- Communication facilities

Typical Application



Features and Benefits (continued)

- Protection Functions:
 - Overcurrent Protection function (OCP); Pulse-by-pulse, built-in compensation circuit to minimize OCP point variation on AC input voltage
 - Overload Protection function (OLP); Auto restart, built-in timer, reduces heat during overload condition, and no external components required
 - Overvoltage Protection function (OVP); Auto restart
 - Thermal Shutdown function (TSD); Auto restart

Selection Guide

Part Number	f _{osc} (kHz)	MOSFET		P _{out} * (W)	
		V _{DSS(min)} (V)	R _{DS(on)} (max) (Ω)	230 VAC	85 to 265 VAC
STR2W152D	67	650	3.0	60	40
STR2W153D			1.9	90	60

*The listed output power is based on the package thermal ratings, and the peak output power can be 120% to 140% of the value stated here. At low output voltage and short duty cycle, the output power may be less than the value stated here.

The polarity value for current specifies a sink as "+," and a source as "–," referencing the IC.

Absolute Maximum Ratings Unless specifically noted, T_A is 25°C

Characteristic	Symbol	Notes	Pins	Rating	Unit
Drain Peak Current ¹	I _{DPeak}	STR2W152D	1 – 3	6.0	A
		STR2W153D		9.5	A
Maximum Switching Current ²	I _{DMAX}	STR2W152D	1 – 3	6.0	A
		STR2W153D		9.5	A
Avalanche Energy ³	E _{AS}	STR2W152D	1 – 3	62	mJ
		STR2W153D		86	mJ
	I _{LPKAK}	STR2W152D		2.3	A
		STR2W153D		2.7	A
S/OCP Pin Voltage	V _{OCP}		3 – 5	–2 to 6	V
Control Part Input Voltage	V _{CC}		4 – 5	32	V
FB/OLP Pin Voltage	V _{FB}		6 – 5	–0.3 to 14	V
FB/OLP Sink Current	I _{FB}		6 – 5	1.0	mA
MOSFET Power Dissipation ⁴	P _{D1}	STR2W152D	1 – 3	23.8	W
		STR2W153D		26.5	W
		Without heatsink		1.3	W
Control Part Power Dissipation	P _{D2}	Specified by V _{CC} × I _{CC}	4 – 5	0.13	W
Internal Frame Temperature in Operation ⁵	T _F		–	–20 to 115	°C
Operating Ambient Temperature	T _{OP}		–	–20 to 115	°C
Storage Temperature	T _{stg}		–	–40 to 125	°C
Channel Temperature	T _{ch}		–	150	°C

¹Refer to MOSFET Safe Operating Area Curve.

²I_{DMAX} is the drain current determined by the drive voltage of the IC and the threshold voltage, V_{th}, of the MOSFET.

³Refer to MOSFET Avalanche Energy Derating Coefficient Curve.

⁴Refer to MOSFET Temperature versus Power Dissipation Curve.

⁵Maximum recommended internal frame temperature, T_{F(max)} = 105°C.

Electrical Characteristics of Control Part Unless specifically noted, T_A is 25°C, $V_{CC} = 18\text{ V}$

Characteristic	Symbol	Test Conditions	Pins	Min.	Typ.	Max.	Unit
Operation Start Voltage	$V_{CC(ON)}$		4 – 5	13.8	15.3	16.8	V
Operation Stop Voltage*	$V_{CC(OFF)}$		4 – 5	7.3	8.1	8.9	V
Circuit Current in Operation	$I_{CC(ON)}$	$V_{CC} = 12\text{ V}$	4 – 5	–	–	2.5	mA
Minimum Start Voltage	$V_{ST(ON)}$		4 – 5	–	40	–	V
Startup Current	$I_{STARTUP}$	$V_{CC} = 13.5\text{ V}$	4 – 5	–3.9	–2.5	–1.1	mA
Startup Current Threshold Biasing Voltage*	$V_{CC(BIAS)}$	$I_{CC} = -100\text{ }\mu\text{A}$	4 – 5	8.5	9.5	10.5	V
Average Operation Frequency	$f_{OSC(AVG)}$		1 – 5	60	67	74	kHz
Frequency Modulation Deviation	Δf		1 – 5	–	5	–	kHz
Maximum Duty Cycle	D_{MAX}		1 – 5	65	74	83	%
Leading Edge Blanking Time	t_{BW}		–	–	390	–	ns
OCP Compensation Coefficient	DPC		–	–	17	–	mV/ μs
OCP Compensation Duty Cycle Limit	D_{DPC}		–	–	36	–	%
OCP Threshold Voltage at Zero Duty Cycle	$V_{OCP(L)}$		3 – 5	0.69	0.78	0.87	V
OCP Threshold Voltage at 36% Duty Cycle	$V_{OCP(H)}$		3 – 5	0.79	0.88	0.97	V
Maximum Feedback Current	$I_{FB(MAX)}$	$V_{CC} = 12\text{ V}$	6 – 5	–280	–170	–90	μA
Minimum Feedback Current	$I_{FB(MIN)}$		6 – 5	–30	–15	–7	μA
FB/OLP Oscillation Stop Threshold Voltage	$V_{FB(OFF)}$	$V_{CC} = 32\text{ V}$	6 – 5	1.3	1.4	1.5	V
OLP Threshold Voltage	$V_{FB(OLP)}$	$V_{CC} = 32\text{ V}$	6 – 5	7.3	8.1	8.9	V
OLP Operation Current	$I_{CC(OLP)}$	$V_{CC} = 12\text{ V}$	4 – 5	–	230	–	μA
OLP Delay Time	t_{OLP}		1 – 5	54	68	82	ms
FB/OLP Clamp Voltage	$V_{FB(CLAMP)}$		6 – 5	11	12.8	14	V
OVP Threshold Voltage	$V_{CC(OVP)}$		4 – 5	26	29	32	V
Thermal Shutdown Activating Temperature	$T_{J(TSD)}$		–	130	–	–	°C

* $V_{CC(BIAS)} > V_{CC(OFF)}$ always.

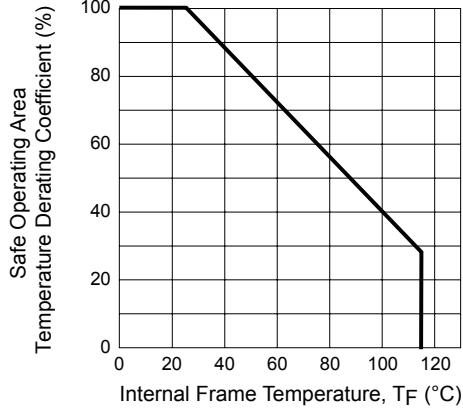
Electrical Characteristics of MOSFET Unless specifically noted, T_A is 25°C

Characteristic	Symbol	Test Conditions	Pins	Min.	Typ.	Max.	Unit
Drain-to-Source Breakdown Voltage	V_{DSS}		1 – 5	650	–	–	V
Drain Leakage Current	I_{DSS}		1 – 5	–	–	300	μA
On-Resistance	$R_{DS(ON)}$	STR2W152D	1 – 5	–	–	3.0	Ω
		STR2W153D		–	–	1.9	Ω
Switching Time	t_f		1 – 5	–	–	250	ns
Thermal Resistance*	$R_{\theta ch-F}$	STR2W152D	–	–	–	2.48	°C/W
		STR2W153D		–	–	1.95	°C/W

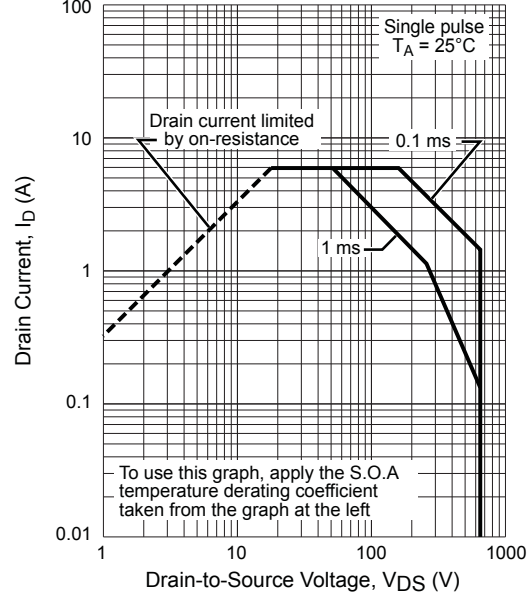
*The thermal resistance between the channels of the MOSFET and the internal frame.

Characteristic Performance
STR2W152D

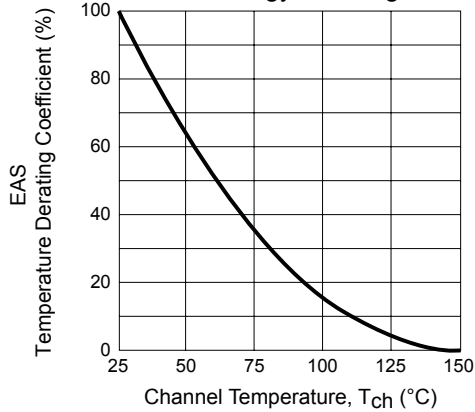
S. O. A. Temperature Derating Coefficient Curve



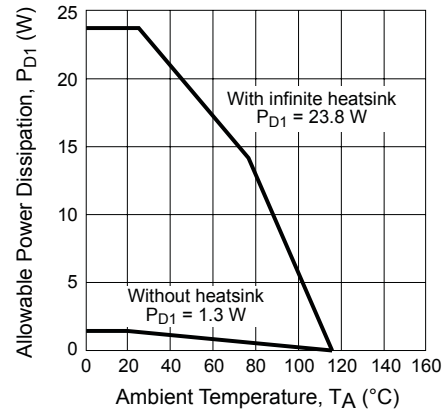
MOSFET Safe Operating Area Curve



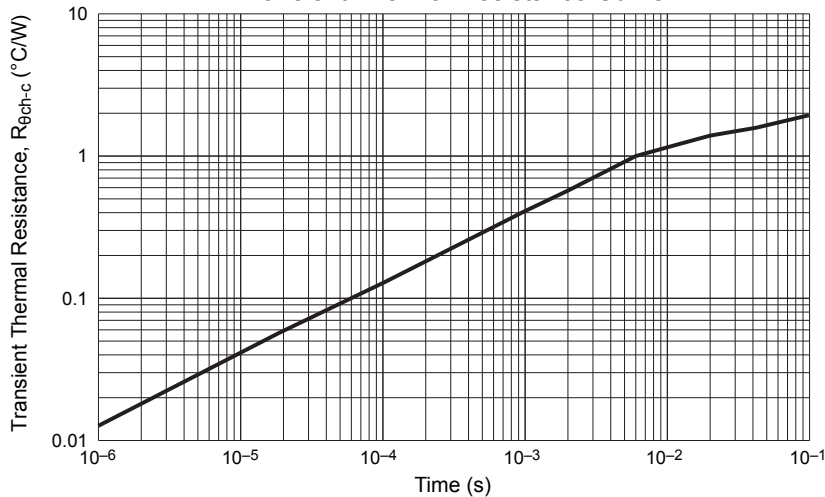
MOSFET Avalanche Energy Derating Coefficient Curve



MOSFET Temperature versus Power Dissipation Curve

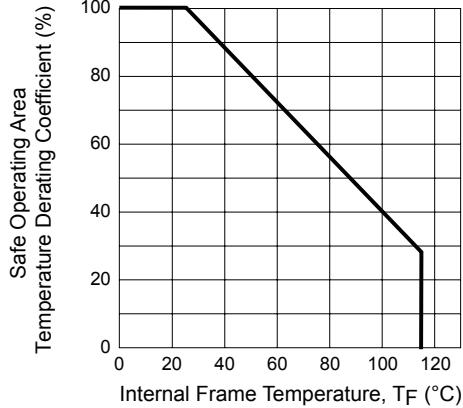


Transient Thermal Resistance Curve

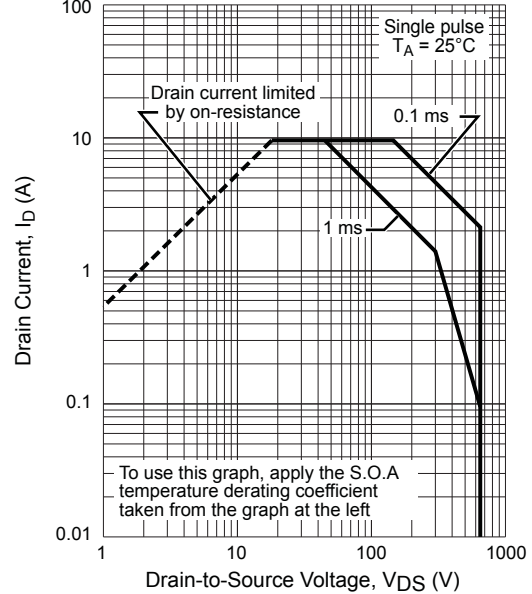


Characteristic Performance
STR2W153D

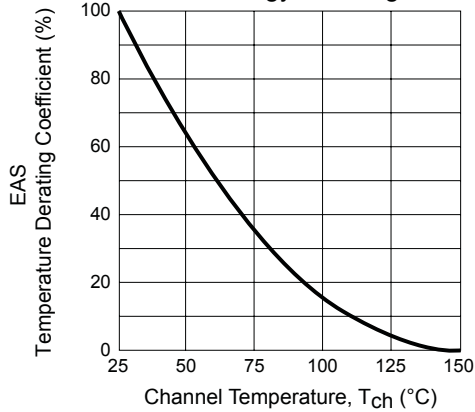
S. O. A. Temperature Derating Coefficient Curve



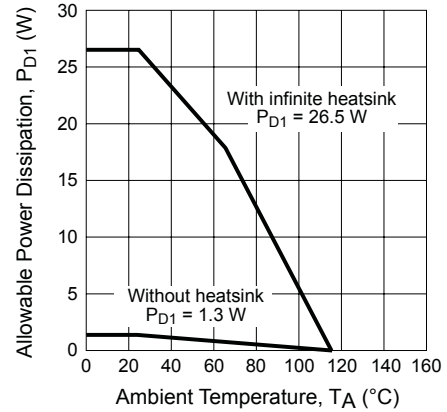
MOSFET Safe Operating Area Curve



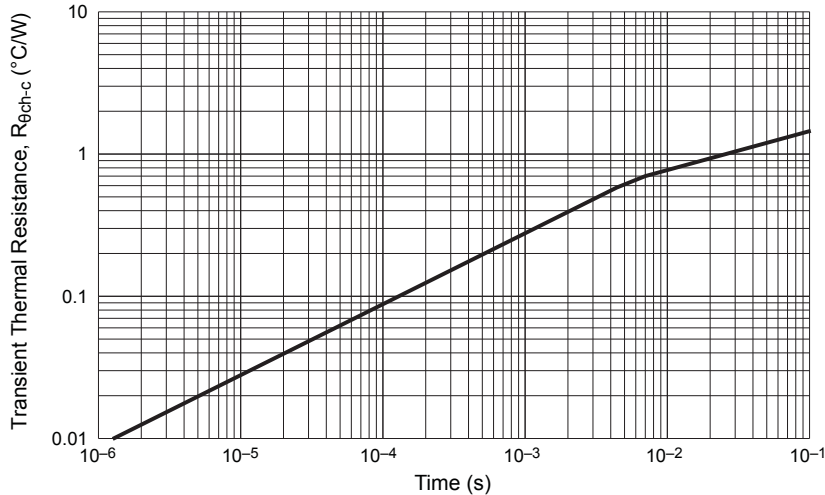
MOSFET Avalanche Energy Derating Coefficient Curve



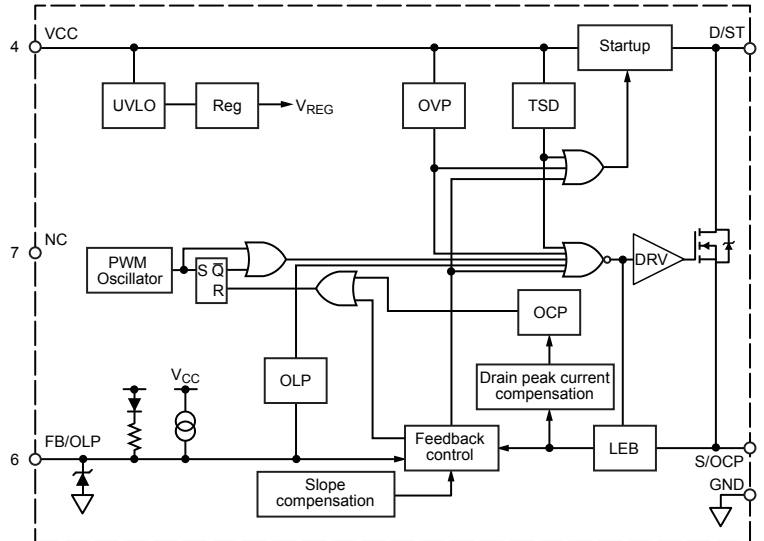
MOSFET Temperature versus Power Dissipation Curve



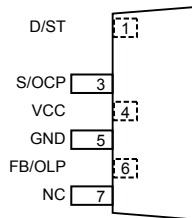
Transient Thermal Resistance Curve



Functional Block Diagram



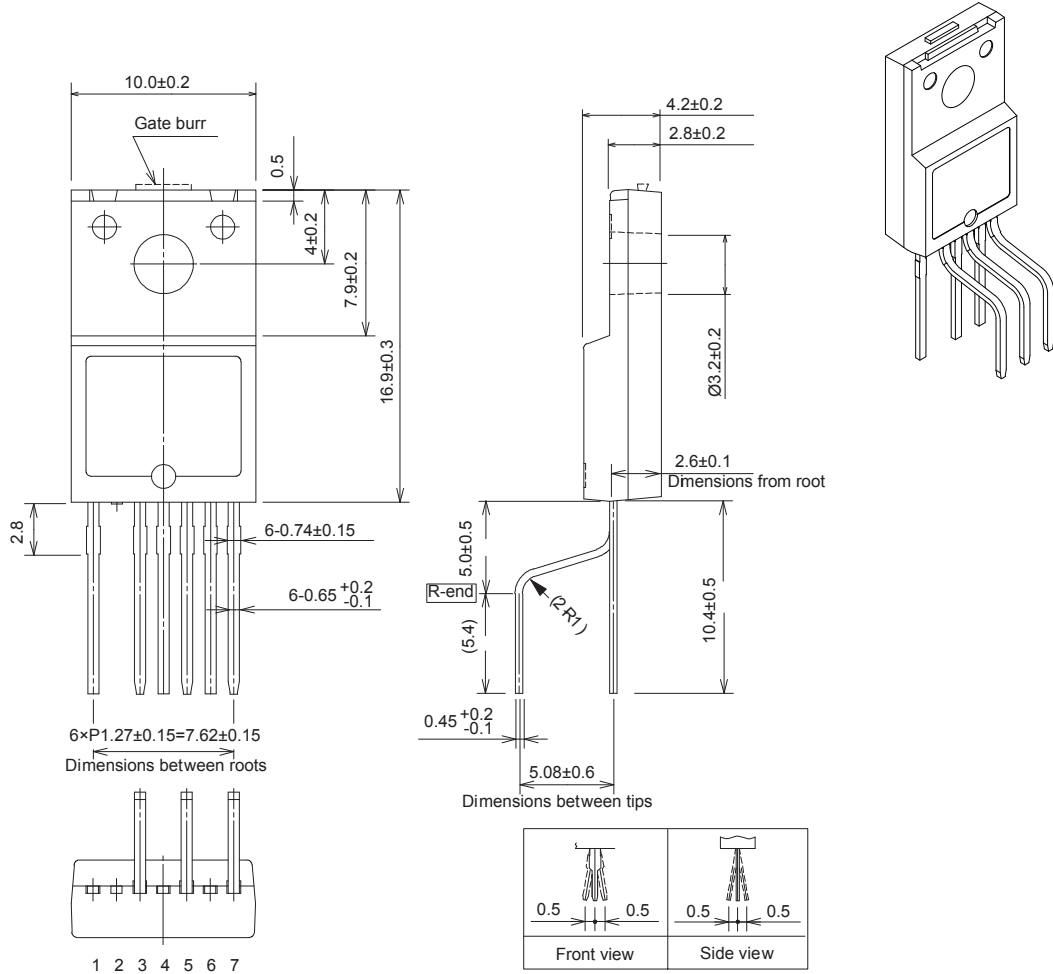
Pin-out Diagram



STR2W100D Pin List Table

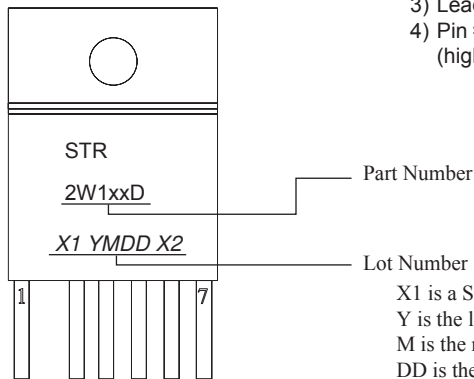
Number	Name	Function
1	D/ST	MOSFET drain pin and input of the startup current
3	S/OCP	MOSFET source and input of Overcurrent Protection (OCP) signal
4	VCC	Power supply voltage input for Control Part and input of Overvoltage Protection (OVP) signal
5	GND	Ground
6	FB/OLP	Feedback signal input for constant voltage control signal and input of Overload Protection (OLP) signal
7	NC	No connection

Package Diagram
TO-220F-6L



Pin treatment Pb-free. Device composition compliant with the RoHS directive.

Marking Diagram



NOTES:

- 1) Unit: mm
- 2) Gate Burr: indicates protrusion of 0.3 mm (max)
- 3) Leadform: No. LF2003
- 4) Pin #2 removed in order to secure distance between pin #1 (high-voltage pin) and pin #3 (low-voltage pin)

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°C 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 0.05 mm 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: 0.588 to 0.785 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.

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 2.0 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 1 MΩ 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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In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature affects the reliability significantly.

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