

Features and Benefits (continued)

- Audible Noise Suppression function during Standby mode
- Protection features
 - Overcurrent protection (OCP): pulse-by-pulse, with input compensation function
 - Overvoltage protection (OVP): auto-restart
 - Overload protection (OLP): auto-restart, with timer
 - Thermal shutdown protection (TSD): auto-restart

Selection Guide

Part Number	Power MOSFET		Output Power*, P _{OUT} (W)	
	V _{DSS} (min) (V)	R _{DS(ON)} (max) (Ω)	230 VAC	85 to 265 VAC
STR-W6051S	650	3.95	45	30
STR-W6052S	650	2.8	60	40
STR-W6053S	650	1.9	90	60

*The listed output power is based on the 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 otherwise specified, $T_A = 25^\circ\text{C}$

Characteristic	Symbol	Conditions		Pins	Rating	Unit
Drain Peak Current ¹	I _{DPEAK}	STR-W6051S	Single pulse	1 – 3	5.0	A
		STR-W6052S			7.0	A
		STR-W6053S			9.5	A
Maximum Switching Current ²	I _{DMAX}	STR-W6051S	Single pulse, T _A = –20°C to 125°C	1 – 3	5.0	A
		STR-W6052S			7.0	A
		STR-W6053S			9.5	A
Avalanche Energy ³	E _{AS}	STR-W6051S	Single pulse, V _{DD} = 99 V, L = 20 mH, I _{LPEAK} = 2 A	1 – 3	47	mJ
		STR-W6052S	Single pulse, V _{DD} = 99 V, L = 20 mH, I _{LPEAK} = 2.3 A		62	mJ
		STR-W6053S	Single pulse, V _{DD} = 99 V, L = 20 mH, I _{LPEAK} = 2.7 A		86	mJ
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 Pin Sink Current	I _{FB}			6 – 5	1.0	mA
BR Pin Voltage	V _{BR}			7 – 5	–0.3 to 7	V
BR Pin Sink Current	I _{BR}			7 – 5	1.0	mA
Power Dissipation of MOSFET ⁴	P _{D1}	STR-W6051S	With infinite heatsink	1 – 3	22.3	W
		STR-W6052S			23.6	W
		STR-W6053S			26.5	W
		Without heatsink			1.3	W
Power Dissipation of Control Part	P _{D2}	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.

²The maximum switching current is the drain current determined by the drive voltage of the IC and threshold voltage (V_{th}) of the MOSFET.

³Refer to MOSFET Avalanche Energy Derating Coefficient Curve.

⁴Refer to MOSFET Temperature versus Power Dissipation Curve.

⁵The recommended internal frame temperature, T_F , is 105°C (max).

Electrical Characteristics of Control Part Unless otherwise specified, $T_A = 25^\circ\text{C}$, $V_{CC} = 18\text{ V}$

Characteristic	Symbol	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	63	71	79	%
Leading Edge Blanking Time	t_{BW}		–	–	390	–	ns
OCP Compensation Coefficient	DPC		–	–	18	–	mV/ μs
OCP Compensation Duty Cycle Limit	D_{DPC}		–	–	36	–	%
OCP Threshold Voltage at Zero Duty Cycle	$V_{OCP(L)}$		3 – 5	0.70	0.78	0.86	V
OCP Threshold Voltage at 36% Duty Cycle	$V_{OCP(H)}$	$V_{CC} = 32\text{ V}$	3 – 5	0.79	0.88	0.97	V
Maximum Feedback Current	$I_{FB(MAX)}$	$V_{CC} = 12\text{ V}$	6 – 5	–340	–230	–150	μA
Minimum Feedback Current	$I_{FB(MIN)}$		6 – 5	–30	–15	–7	μA
FB/OLP Pin Oscillation Stop Threshold Voltage	$V_{FB(STB)}$		6 – 5	0.85	0.95	1.05	V
OLP Threshold Voltage	$V_{FB(OLP)}$		6 – 5	7.3	8.1	8.9	V
OLP Delay Time	t_{OLP}		6 – 5	54	68	82	ms
OLP Operation Current	$I_{CC(OLP)}$	$V_{CC} = 12\text{ V}$	4 – 5	–	300	–	μA
FB/OLP Pin Clamp Voltage	$V_{FB(CLAMP)}$		6 – 5	11	12.8	14	V
Brown-In Threshold Voltage	$V_{BR(IN)}$	$V_{CC} = 32\text{ V}$	7 – 5	5.2	5.6	6	V
Brown-Out Threshold Voltage	$V_{BR(OUT)}$	$V_{CC} = 32\text{ V}$	7 – 5	4.45	4.8	5.15	V
BR Pin Clamp Voltage	$V_{BR(CLAMP)}$	$V_{CC} = 32\text{ V}$	7 – 5	6	6.4	7	V
BR Function Disabling Threshold Voltage	$V_{BR(DIS)}$	$V_{CC} = 32\text{ V}$	7 – 5	0.3	0.48	0.7	V
VCC Pin OVP Threshold Voltage	$V_{CC(OVP)}$		4 – 5	26	29	32	V
Thermal Shutdown Temperature	$T_{J(TSD)}$		–	130	–	–	$^\circ\text{C}$

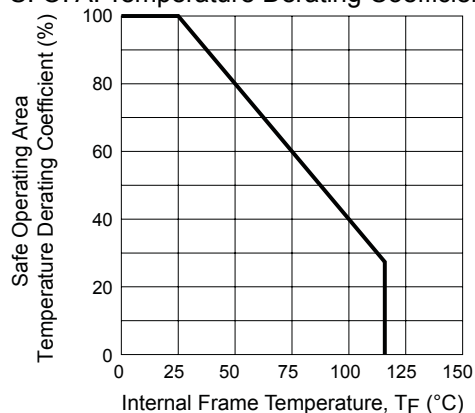
* $V_{CC(BIAS)} > V_{CC(OFF)}$ always.

Electrical Characteristics of MOSFET Unless otherwise specified, T_A is 25°C

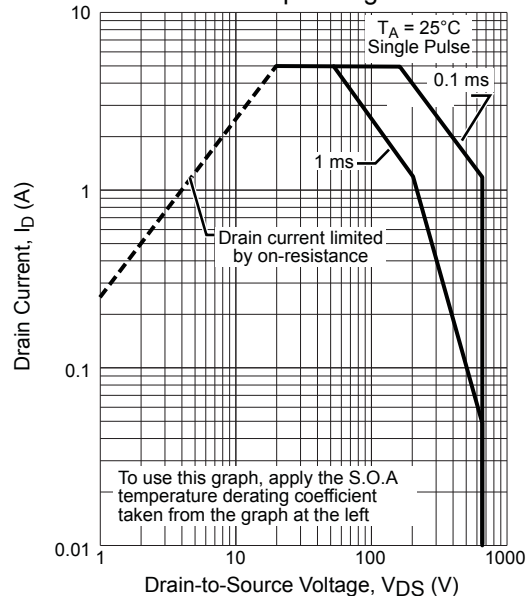
Characteristic	Symbol	Conditions		Pins	Min.	Typ.	Max.	Unit
Drain-to-Source Breakdown Voltage	V _{DSS}			1 – 3	650	–	–	V
Drain Leakage Current	I _{DSS}			1 – 3	–	–	300	μA
On-Resistance	R _{DS(ON)}	STR-W6051S		1 – 3	–	–	3.95	Ω
		STR-W6052S			–	–	2.8	Ω
		STR-W6053S			–	–	1.9	Ω
Switching Time	t _f			1 – 3	–	–	250	ns
Thermal Resistance	R _{θch-F}	STR-W6051S	The thermal resistance between the channels of the MOSFET and the internal frame.	–	–	–	2.63	°C/W
		STR-W6052S			–	–	2.26	°C/W
		STR-W6053S			–	–	1.95	°C/W

**Characteristic Performance
STR-W6051S**

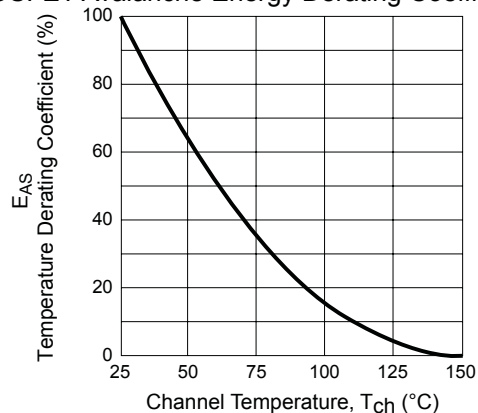
S. O. A. Temperature Derating Coefficient Curve



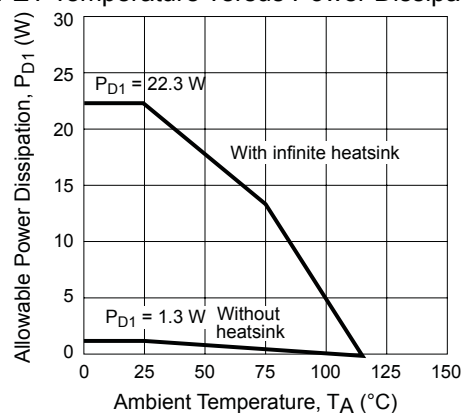
MOSFET Safe Operating Area Curve



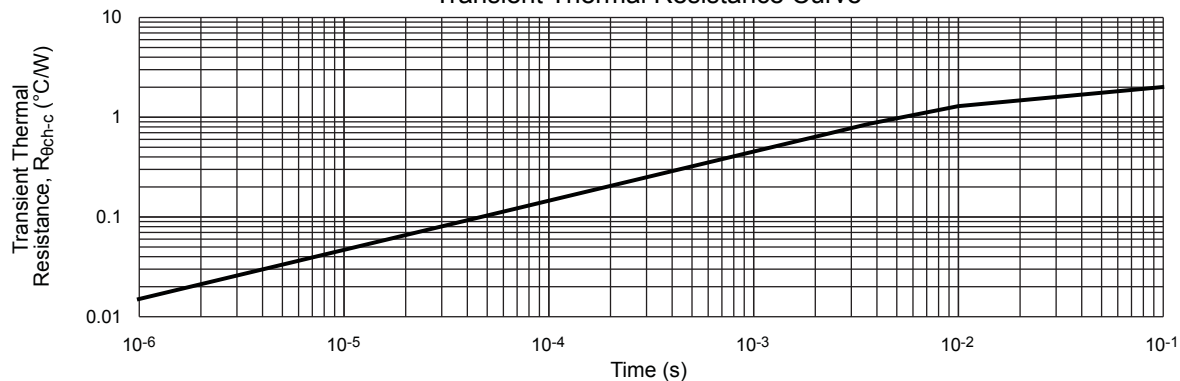
MOSFET Avalanche Energy Derating Coefficient Curve



MOSFET Temperature versus Power Dissipation Curve

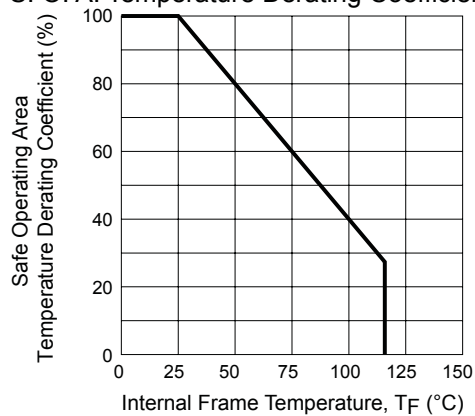


Transient Thermal Resistance Curve

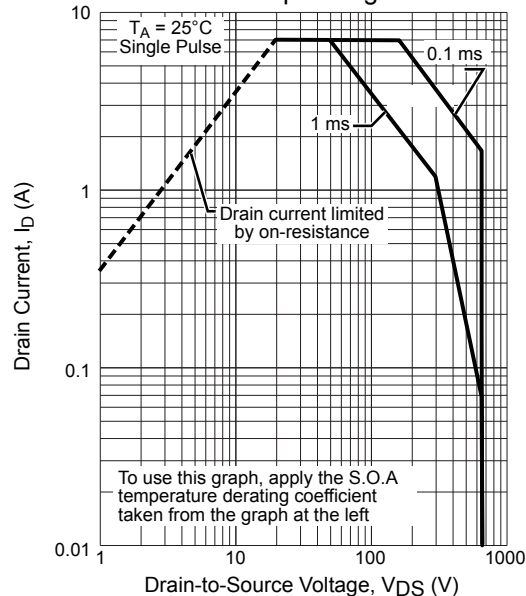


**Characteristic Performance
STR-W6052S**

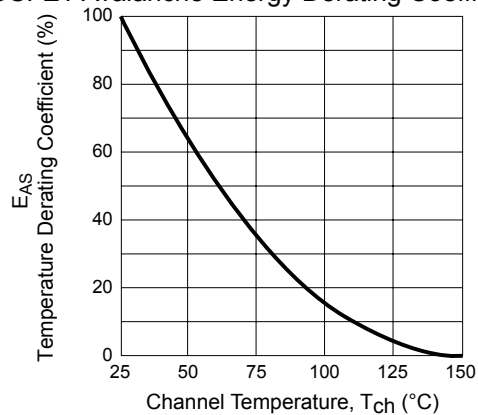
S. O. A. Temperature Derating Coefficient Curve



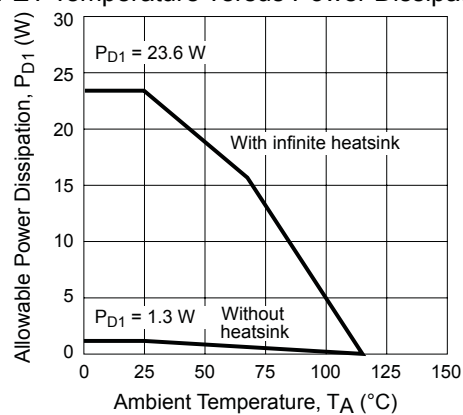
MOSFET Safe Operating Area Curve



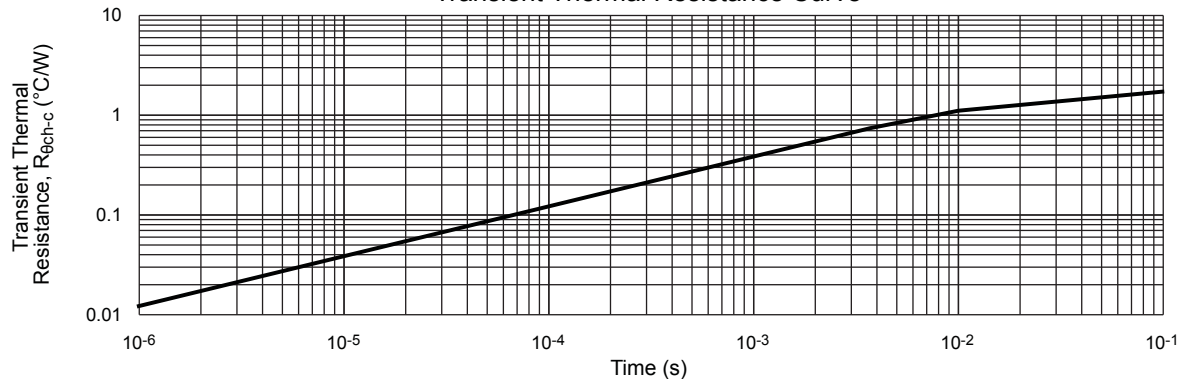
MOSFET Avalanche Energy Derating Coefficient Curve



MOSFET Temperature versus Power Dissipation Curve

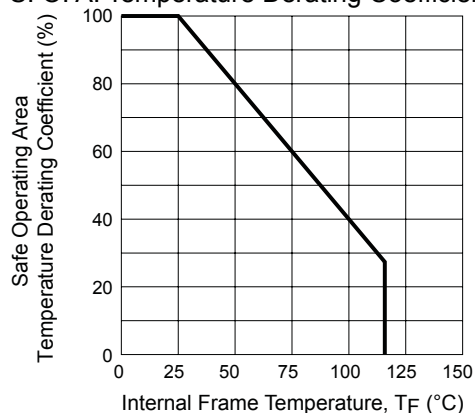


Transient Thermal Resistance Curve

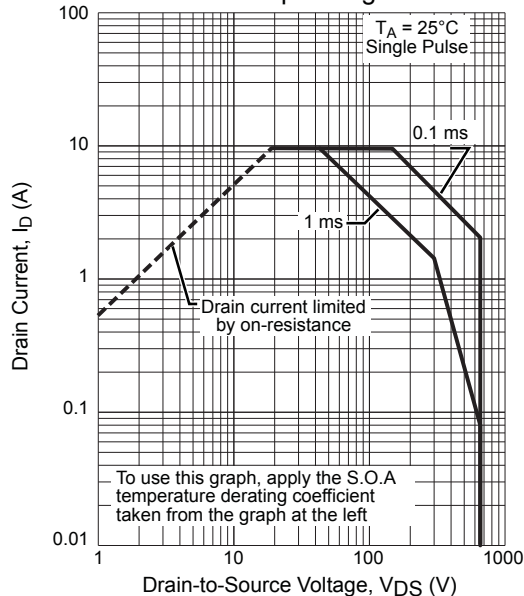


Characteristic Performance
STR-W6053S

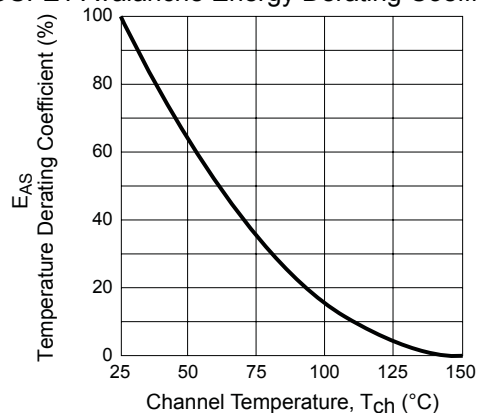
S. O. A. Temperature Derating Coefficient Curve



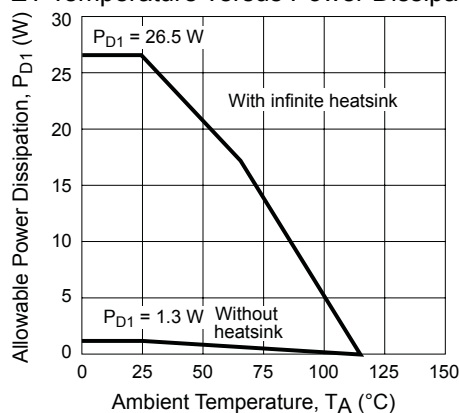
MOSFET Safe Operating Area Curve



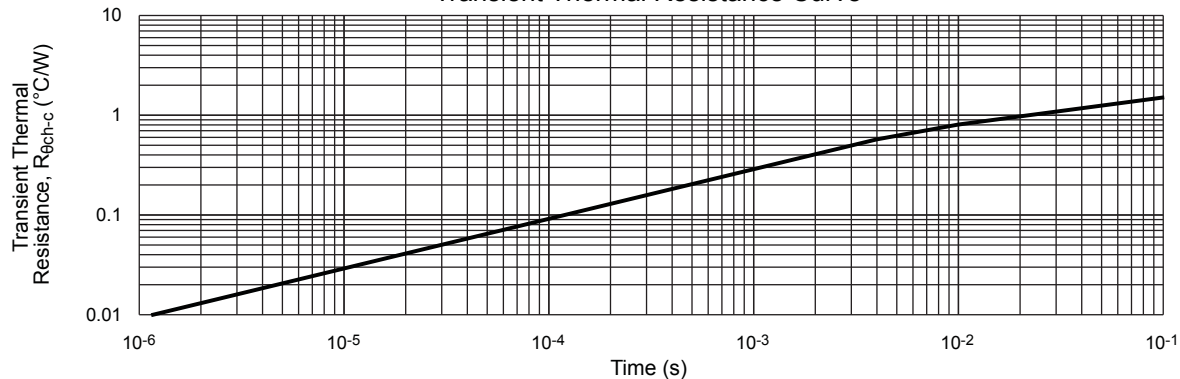
MOSFET Avalanche Energy Derating Coefficient Curve



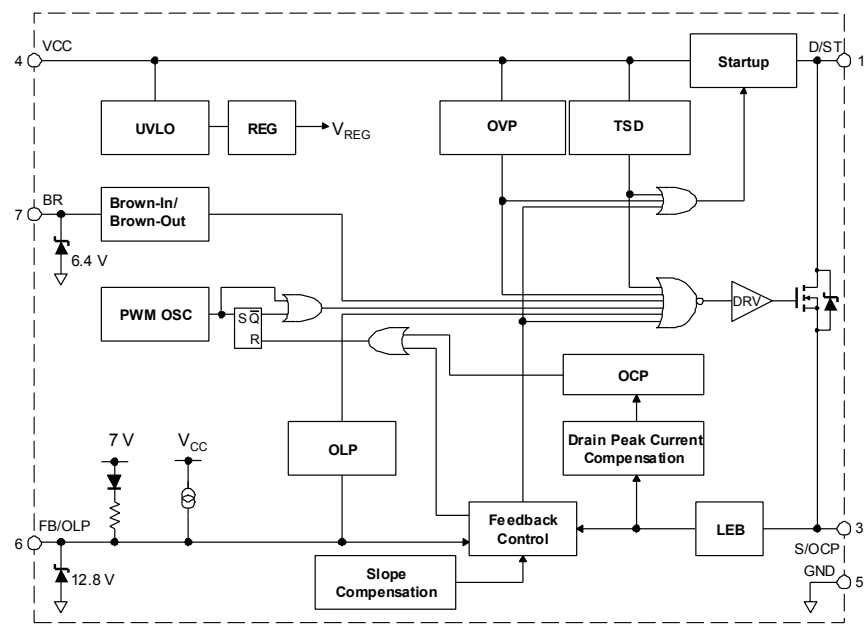
MOSFET Temperature versus Power Dissipation Curve



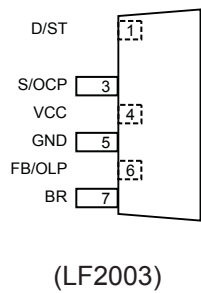
Transient Thermal Resistance Curve



Functional Block Diagram

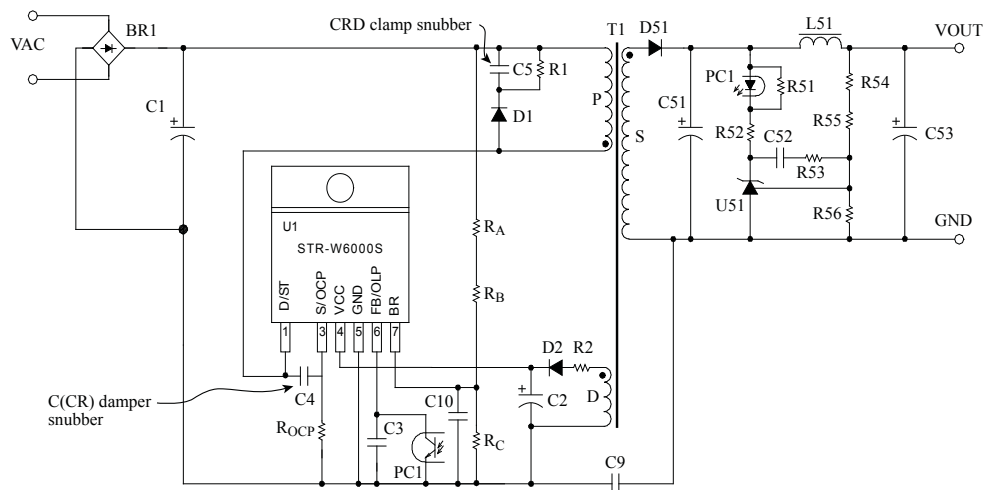


Pin List Table

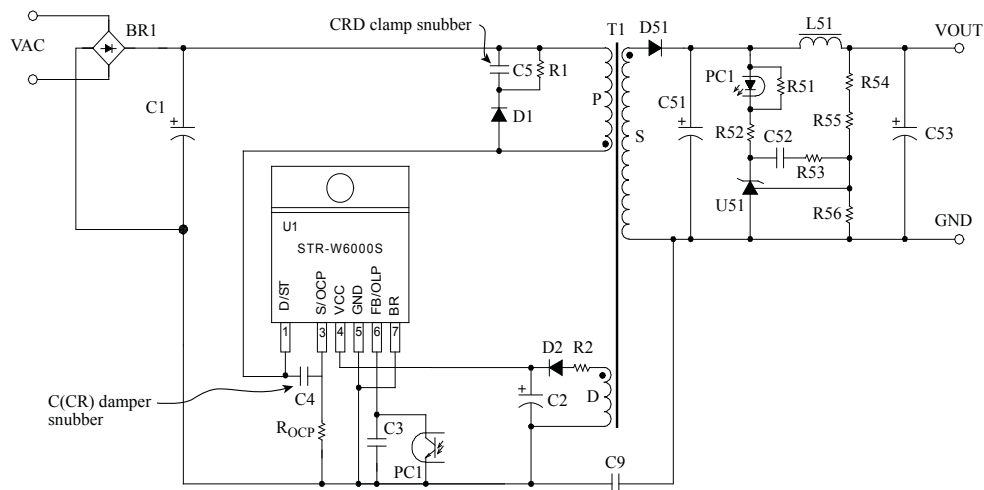


Number	Name	Function
1	D/ST	MOSFET drain, and input of the startup current
2	—	(Pin removed)
3	S/OCP	MOSFET source, and input of Overcurrent Protection (OCP) signal
4	VCC	Power supply voltage input for Control Part, and input of Overvoltage Protection (OVP) signal
5	GND	Ground
6	FB/OLP	Feedback signal input for constant voltage control signal, and input of Overload Protection (OLP) signal
7	BR	Input of Brown-In and Brown-Out detection voltage

Typical Application Circuits



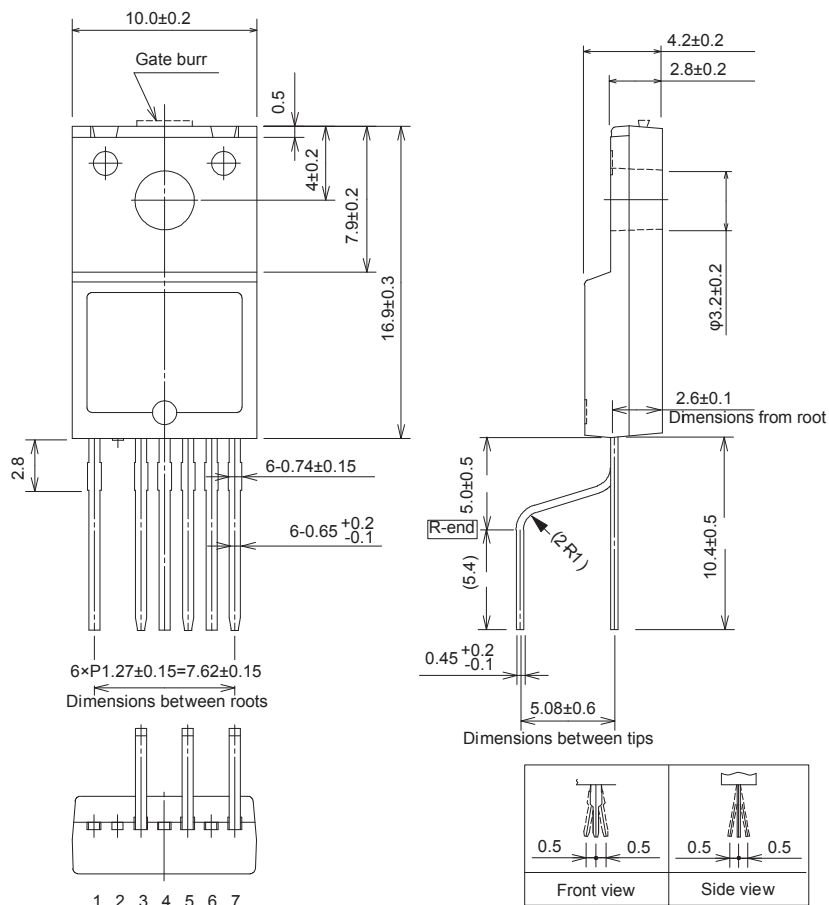
Typical application circuit example, enabled Brown-In/Brown-Out function (DC line detection)



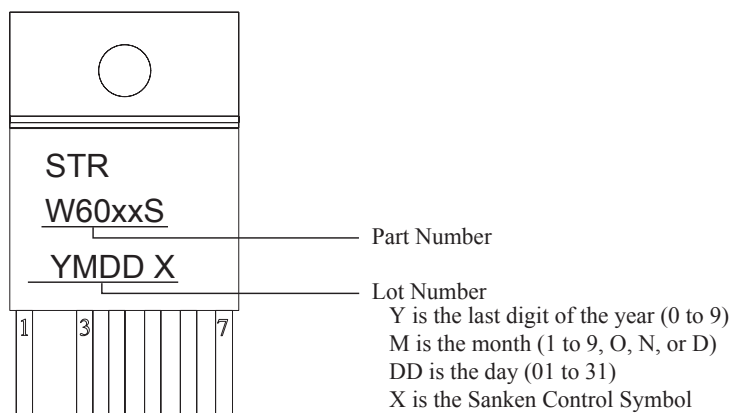
Typical application circuit example, disabled Brown-In/Brown-Out function

Package Diagram

- TO-220F-6L package
- The pin 2 is removed to provide greater creepage and clearance isolation between the high voltage pin (pin 1: D/ST) and the low voltage pin (pin 3: S/OCP).



Marking Diagram



Operating Precautions

In the case that you use Sanken products or design your products by using Sanken products, the reliability largely depends on the degree of derating to be made to the rated values. Derating may be interpreted as a case that an operation range is set by derating the load from each rated value or surge voltage or noise is considered for derating in order to assure or improve the reliability. In general, derating factors include electric stresses such as electric voltage, electric current, electric power etc., environmental stresses such as ambient temperature, humidity etc. and thermal stress caused due to self-heating of semiconductor products. For these stresses, instantaneous values, maximum values and minimum values must be taken into consideration. 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.

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 0.05 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 1MΩ of resis-

tance 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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