

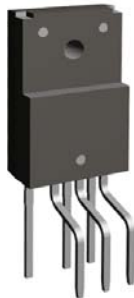
## 30 W-Universal Input/45 W-230 Vac Input PWM Switching Regulators

### Features and Benefits

- Overcurrent protection (OCP) with ac input voltage compensation function; no additional peripheral circuits required—minimizes dependency of OCP on ac input
- Overload protection (OLP) with integrated timer reduces power stress (temperature rise) at overload condition, requires no peripheral components
- Avalanche-guaranteed MOSFET improves device capability of withstanding excess surge voltage, providing a simple surge absorber circuit without breakdown voltage derating
- Start-up circuit eliminates the need for a start-up resistor, and helps to reduce input power consumption

*Continued on the next page...*

### Package: TO-220



*Not to scale*

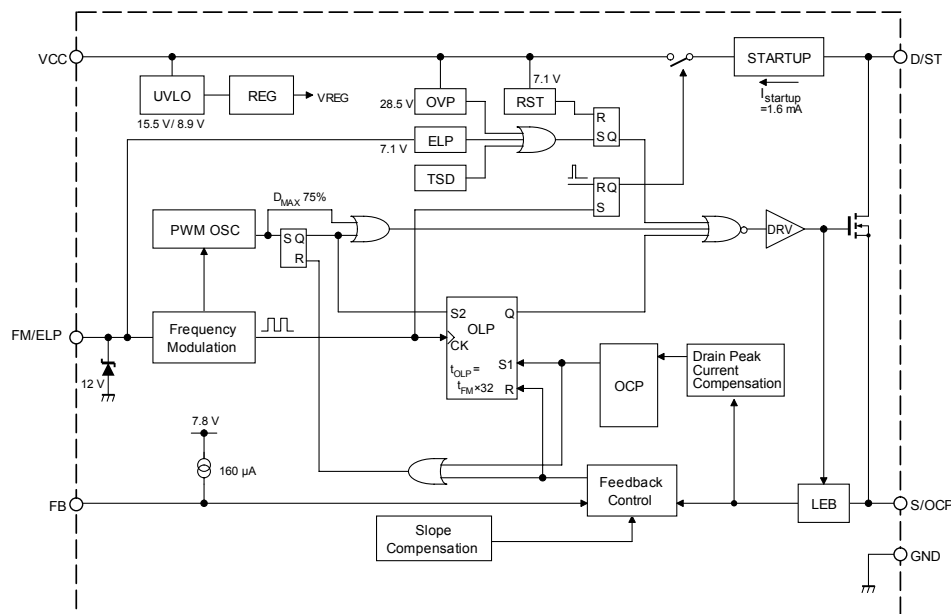
### Description

The STR-W6200D series are current-mode PWM ICs that incorporate controller chips. These devices are manufactured using a proprietary high-voltage BCD process, and avalanche-guaranteed MOSFETs. These elements allow power supply systems designs that are highly reliable and simple, with fewer peripheral components. These ICs also provide Auto-Burst mode operation, which lowers input power requirements at light loads, and improves efficiency over the entire load range and universal-input range.

Applications include:

- TV set top box
- LCD PC monitor, LCD TV
- Printer, scanner
- General consumer, PC, and industrial applications requiring SMPS power supply with standby mode

### Functional Block Diagram



# STR-W6251D

## 30 W-Universal Input/45 W-230 Vac Input PWM Switching Regulators

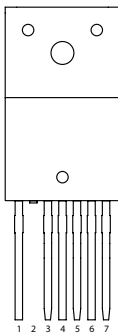
### Features and Benefits (continued)

- Bias Assist function improves start-up performance by self-biasing the VCC pin, and allows a use of a small value VCC capacitor, resulting in improved response to overvoltage conditions
- Very low current consumption in nonoperating (UVLO) state:  $I_{CC(off)} = 5 \mu A$  (typical) at  $V_{CC} = 13.8 V$
- Slope compensation circuit stabilizes operation, preventing interference from subharmonics
- Leading Edge Blanking
- Various protections:
  - Overcurrent Protection (OCP), pulse-by-pulse sensing
  - Overload Protection (OLP), auto restart after certain duration
  - External Latch Protection (ELP), latched
  - Overvoltage Protection (OVP), latched
  - Thermal Shut Down (TSD), latched
- Externally-activated shut down protection (ELP) for emergency system shut down
- Auto-Burst Standby function (pin  $< 0.1 W$  at zero output load condition)
- Audible noise reducing function in Standby mode
- TO-220 full-molded package with 6 pins

### Selection Guide

Part Number	Packing
STRW6251D	50 pieces per tube

### Pin-out Diagram



### Terminal List Table

Number	Name	Description	Functions
1	D/ST	Drain/startup terminal	MOSFET drain and input of start-up signal
2	NC	Clipped	No connection
3	S/OCP	Source/Overcurrent Protection terminal	MOSFET source and input of overcurrent detection signal
4	VCC	Power supply terminal	Input of power supply for control circuit
5	GND	Ground terminal	Ground
6	FB	Feedback terminal	Input of constant voltage control signal
7	FM/ELP	Frequency jittering and External Latch Protection terminal	Control input for frequency jittering control and External Latch Protection

All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and an ambient temperature,  $T_A$ , of 25°C, unless otherwise stated.

# STR-W6251D

## 30 W-Universal Input/45 W-230 Vac Input PWM Switching Regulators

ABSOLUTE MAXIMUM RATINGS at  $T_A = 25^\circ\text{C}$

Characteristic	Symbol	Terminal	Note	Rating	Unit
Drain Current <sup>1</sup>	$I_{Dpeak}$	1-3	Single Pulse	2.6	A
Maximum Switching Current <sup>2</sup>	$I_{Dmax}$	1-3	$T_A = -20$ to $125^\circ\text{C}$	2.6	A
Single Pulse Avalanche Energy <sup>3</sup>	$E_{AS}$	1-3	Single Pulse	47	mJ
	$I_{Dpeak}$	1-3	$V_{DD} = 99\text{ V}$ , $L = 20\text{ mH}$	2	A
S/OCP Terminal Voltage	$V_{OCP}$	3-5		-6 to 6	V
FM/ELP Terminal Voltage	$V_{FM}$	7-5		-0.3 to 14	V
FM/ELP Terminal Inflow Current	$I_{FM}$	7-5		3	mA
FB Terminal Voltage	$V_{FB}$	6-5		-0.3 to 9	V
Controller (MIC) Input Voltage	$V_{CC}$	4-5		0 to 32	V
MOSFET Power Dissipation <sup>4</sup>	$P_{D1}$	8-1	With infinite heatsink	25	W
			Without heatsink	1.3	W
Controller (MIC) Power Dissipation	$P_{D2}$	5-3	For $V_{CC} \times I_{CC}$	0.8	W
Operating Internal Frame Temperature	$T_F$	-	Refer to $T_{OP}$	-20 to 115	$^\circ\text{C}$
Operating Ambient Temperature	$T_{op}$	-		-20 to 115	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-		-40 to 125	$^\circ\text{C}$
Channel Junction Temperature	$T_J$	-		150	$^\circ\text{C}$

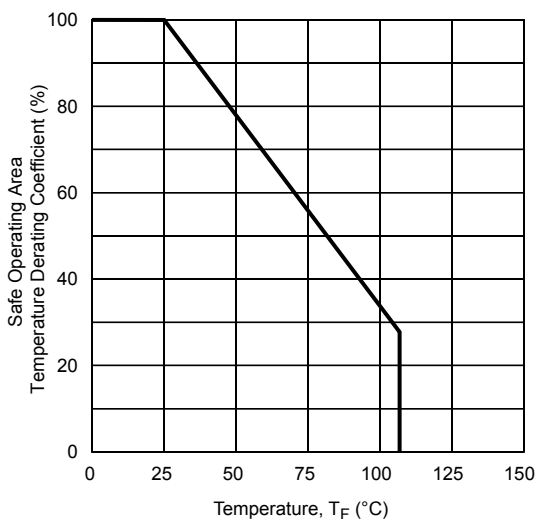
<sup>1</sup>Refer to figure 1

<sup>2</sup> $I_{Dmax}$  is the drain current on the D/ST pin determined by the drive voltage of the IC and the threshold voltage,  $V_{th}$ , of the MOSFET

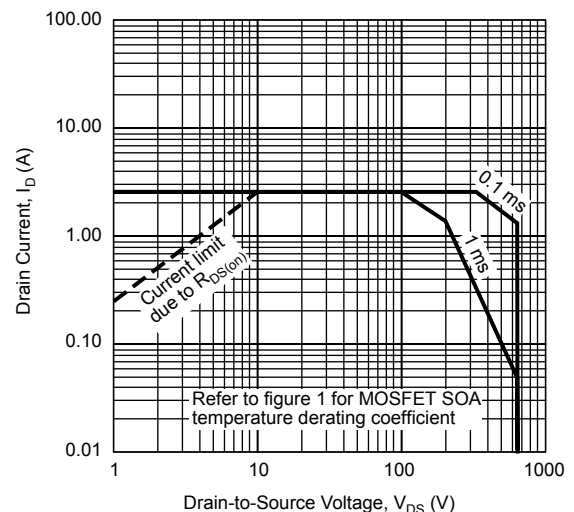
<sup>3</sup>Refer to figure 3

<sup>4</sup>Refer to figure 4

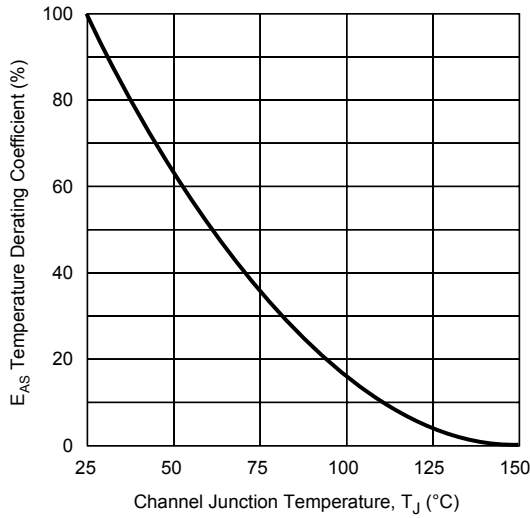
**Figure 1 – MOSFET Safe Operating Area  
Derating Curve**



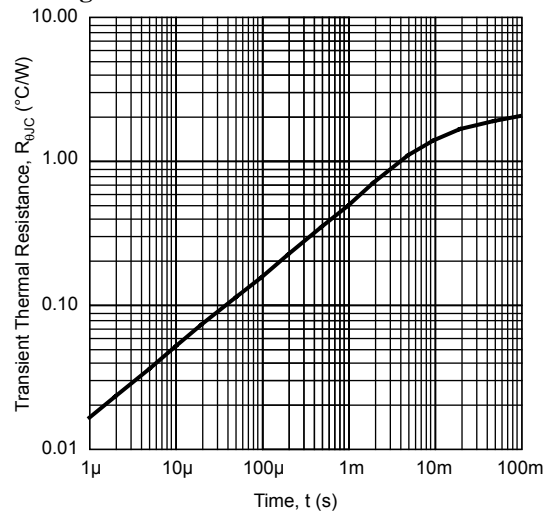
**Figure 2 – MOSFET Safe Operating Area  
Drain Current versus Voltage  
at  $T_A = 25^\circ\text{C}$ , Single Pulse**



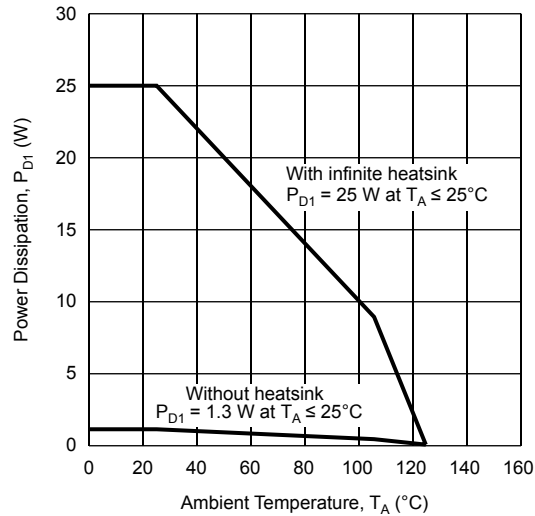
**Figure 3 – MOSFET Avalanche Energy Derating Curve**



**Figure 4 – Transient Thermal Resistance**



**Figure 5 – MOSFET Power Dissipation versus Temperature**



## ELECTRICAL CHARACTERISTICS valid at $V_{CC} = 18\text{ V}$ , $T_A = 25^\circ\text{C}$ , unless otherwise specified

Characteristic	Symbol	Terminal	Test Conditions	Min.	Typ.	Max	Units
<b>Power Supply Start-up Operation</b>							
Operation Start Voltage	$V_{CC(ON)}$	4-5	(VCC voltage at which operation starts) Measurement circuit 1, $V_{CC} = 0$ through 13.9 through 17.1 V	13.9	15.5	17.1	V
Operation Stop Voltage	$V_{CC(OFF)}$	4-5	(VCC voltage at which operation stops) Measurement circuit 1, $V_{CC} = 17.1$ through 9.8 to 8.0 V	8.0	8.9	9.8	V
Circuit Current in Operation	$I_{CC(ON)}$	4-5	(Inflow current into VCC terminal in oscillation) Measurement circuit 1	–	1.4	2.8	mA
Circuit Current in Non-Oscillation	$I_{CC(STOP)}$	4-5	(Inflow current into VCC terminal at $V_{FB} = 0\text{ V}$ ) Measurement circuit 1	–	0.8	1.3	mA
Circuit Current in Non-Operation	$I_{CC(OFF)}$	4-5	(Inflow current into VCC terminal prior to oscillation) Measurement circuit 1, $V_{CC} = 13.8$	–	5	20	$\mu\text{A}$
Start-up Current	$I_{startup}$	4-5	(Inflow current into D/ST terminal) Measurement circuit 7, $V_{CC} = 0$ , D/ST = 450 V	–0.9	–1.6	–2.3	mA
Bias Assist Voltage	$V_{BIAS}$	4-5	(VCC voltage at which $I_{startup}$ starts, and $I_{startupBias}$ begins) Measurement circuit 7, $V_{CC} = 17.1$ through 13.6 to 16.8 V	13.6	15.2	16.8	V
<b>Normal Operating Characteristics</b>							
FM/ELP High Threshold Voltage	$V_{FM(H)}$	7-5	(FM/ELP terminal voltage at which $I_{FM}$ changes from $-13\ \mu\text{A}$ to $13\ \mu\text{A}$ ) Measurement circuit 2	4.0	4.5	5.0	V
FM/ELP Low Threshold Voltage	$V_{FM(L)}$	7-5	(FM/ELP terminal voltage at which $I_{FM}$ changes from $13\ \mu\text{A}$ to $-13\ \mu\text{A}$ ) Measurement circuit 2	2.4	2.8	3.2	V
FM/ELP Voltage Hysteresis	$V_{FMhys}$	7-5	$(V_{FM(H)} - V_{FM(L)})$ Measurement circuit 2	1.3	1.7	1.9	V
FM/ELP Outflow Current <sup>1</sup>	$I_{FMsrc}$	7-5	(FM/ELP terminal outflow current at $V_{FM} = V_{FM(L)}$ ) Measurement circuit 2	–17.4	–13	–8.6	$\mu\text{A}$
FM/ELP Inflow Current <sup>1</sup>	$I_{FMsink}$	7-5	(FM/ELP terminal inflow current at $V_{FM} = V_{FM(H)}$ ) Measurement circuit 2	8.6	13	17.4	$\mu\text{A}$
Average Switching Frequency	$f_{OSC(av)}$	1-5	(D/ST terminal average oscillation frequency) Measurement circuit 2	60	67	74	kHz
Frequency Jitter Deviation	$\Delta f$	1-5	$f_{OSC}$ (peak-to-peak) Measurement circuit 2	4.8	6.9	9	kHz
Maximum Duty Cycle	$D_{MAX}$	1-5	(Maximum width of the low portion of the D/ST terminal waveform) Measurement circuit 2	71	75	79	%
FB Maximum Feedback Current <sup>1</sup>	$I_{FB(MAX)}$	6-5	(FB terminal outflow current at $V_{FB} = 0\text{ V}$ ) Measurement circuit 3	–220	–160	–100	$\mu\text{A}$
Burst Threshold Voltage	$V_{burst(th)}$	6-5	Set $V_{FM} = 0\text{ V}$ and decrease $V_{FB}$ ( $V_{burst(th)}$ is the FB terminal voltage level at which D/ST changes from low to high) Measurement circuit 3	0.99	1.10	1.21	V
Slope Compensation Start-up Duty Cycle	$D_{SLP}$	6-5	$D_{SLP} = (\beta / t_4) \times 100$ (see figure for measurement circuit 4 for values of t) Measurement circuit 4	–	27	–	%
Slope Compensation Rate	SLP	6-5	$SLP = 0.02 / (t_2 - t_1)$ (see figure for measurement circuit 4 for values of t) Measurement circuit 4	–22	–17	–12	mV/ $\mu\text{s}$

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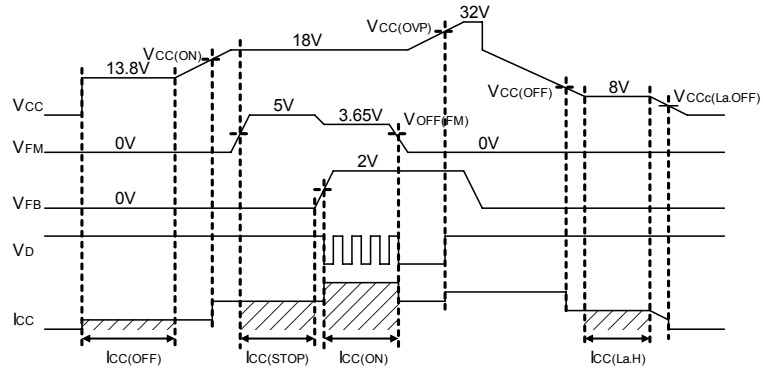
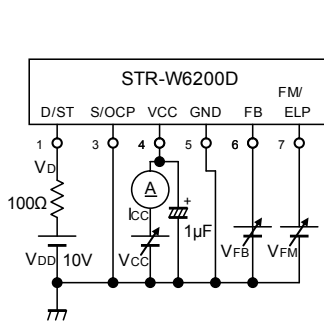
**ELECTRICAL CHARACTERISTICS, continued, valid at  $V_{CC} = 18\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise specified**

Characteristic	Symbol	Terminal	Test Conditions	Min.	Typ.	Max	Units
<b>Protection Operation</b>							
OCP Threshold Voltage at Zero Duty Cycle (0% On-Duty)	$V_{OCP1}$	3-5	Set $V_{FM} = 0\text{ V}$ and increase $V_{OCP}$ . ( $V_{OCP1}$ is the S/OCP terminal voltage level at which D/ST changes from low to high) Measurement circuit 5	0.71	0.78	0.86	V
Drain Peak Current Compensation Coefficient	$D_{PC}$	–	$D_{PC} = -0.75 \times SLP / f_{OSC(av)}$	1.5	1.9	2.3	mV/DC%
OCP Threshold Voltage After Compensation	$V_{OCP2}$	3-5	$V_{OCP2} = D_{PC} \times D_{MAX} + V_{OCP1}$	0.82	0.93	1.04	V
Leading Edge Blanking Time	$t_{blank}$	1-5	(The low portion of the D/ST terminal waveform at $V_{OCP} = 2\text{ V}$ ) Measurement circuit 5	280	400	520	ns
OLP Delay Time	$t_{OLP}$	1-5	(Time between setting FB terminal open and when oscillation stops) Measurement circuit 6	–	200	–	ms
Circuit Current in OLP-Operation	$I_{CC(OLP)}$	4-5	(Inflow current into VCC terminal after OLP operation) Measurement circuit 6	–	410	700	$\mu\text{A}$
OVP Protection Voltage	$V_{CC(OVP)}$	4-5	(VCC terminal voltage at which the voltage of D/ST terminal is switched from low to high by decreasing $V_{FB}$ after setting $V_{FM} = 0\text{ V}$ ) Measurement circuit 1, $V_{CC} = 18.0\text{ V}$ through 27 to 30 V	27	28.5	30	V
Latch Circuit Sustaining Current <sup>2</sup>	$I_{CC(La,H)}$	4-5	(Inflow current into VCC terminal after OVP operation) Measurement circuit 1, $V_{CC} = 8\text{ V}$	–	140	220	$\mu\text{A}$
Latch Circuit Release Voltage <sup>2</sup>	$V_{CC(La,OFF)}$	4-5	(VCC voltage at which $I_{CC}$ is dropped below 20 $\mu\text{A}$ by decreasing $V_{CC}$ after OVP operation) $V_{CC} = 31.0\text{ V}$ through 7.8 to 6.4 V	6.4	7.1	7.8	V
ELP Threshold Voltage	$V_{ELP}$	7-5	(FM/ELP terminal voltage at which the oscillation of the D/ST terminal waveform is stopped by increasing $V_{FM}$ ) Measurement circuit 2	6.4	7.1	7.8	V
Inflow Current at External Latch Protection	$I_{ELP}$	7-5	(Inflow current at $V_{FM} = V_{ELP}$ ) Measurement circuit 2	–	55	100	$\mu\text{A}$
Thermal Shut Down Operating Temperature	$T_{JTSD}$	–		135	–	–	$^\circ\text{C}$
<b>Power MOSFET Characteristics</b>							
Drain-to-Source Breakdown Voltage	$V_{DSS}$	1-3	$I_D = 300\ \mu\text{A}$ , Measurement circuit 8	650	–	–	V
Drain Leakage Current	$I_{DSS}$	1-3	$V_D = 650\text{ V}$ , Measurement circuit 7	–	–	300	$\mu\text{A}$
ON-Resistance	$R_{DS(ON)}$	1-3	$I_D = 0.6\text{ A}$ , $V_{FM} = 0\text{ V}$ Measurement circuit 10	–	–	3.95	$\Omega$
Switching Time	$t_r$	1-3	Measurement circuit 9	–	–	400	ns
Thermal Resistance	$R_{\theta J-F}$	–	Measured between junction and internal frame	–	–	2.23	$^\circ\text{C/W}$
Single Pulse Avalanche Energy	$E_{AS}$	–	Measurement circuit 11	–	–	–	–

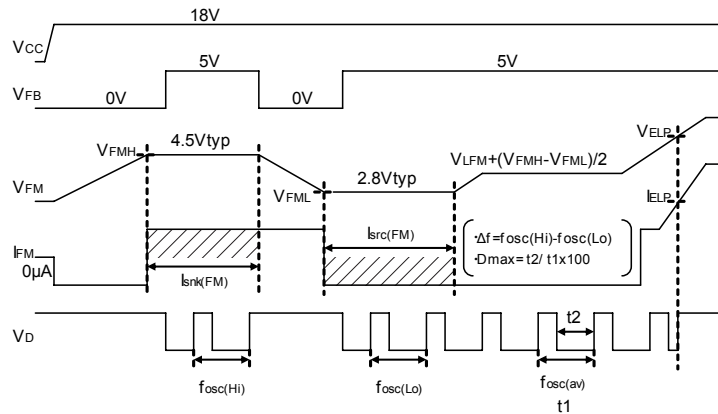
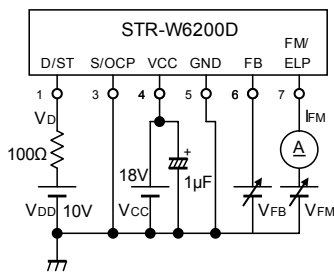
<sup>1</sup>Input and output current polarity at the device pin; plus(+) represents sink and minus(–) represents source.

<sup>2</sup>The latch circuit means a circuit operated ELP, OVP, and TSD.

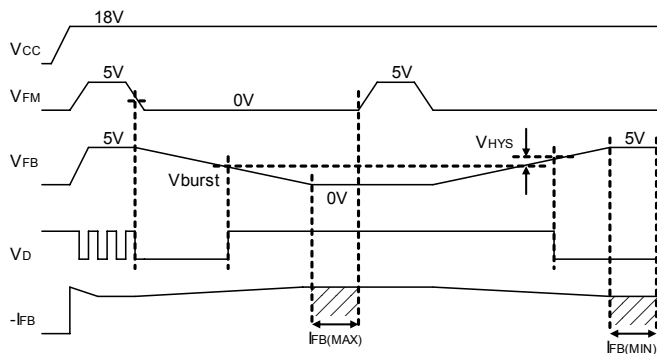
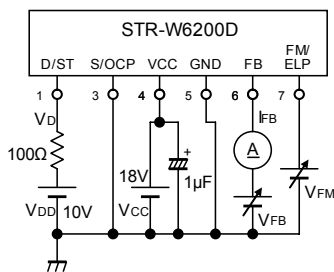
### Measurement Circuit 1



### Measurement Circuit 2



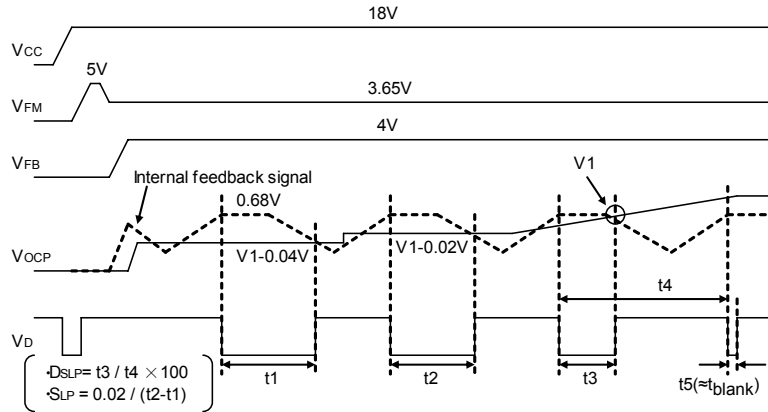
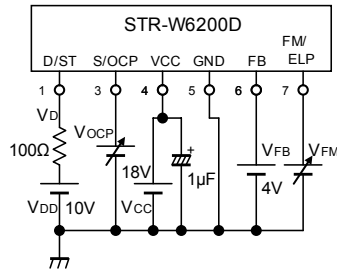
### Measurement Circuit 3



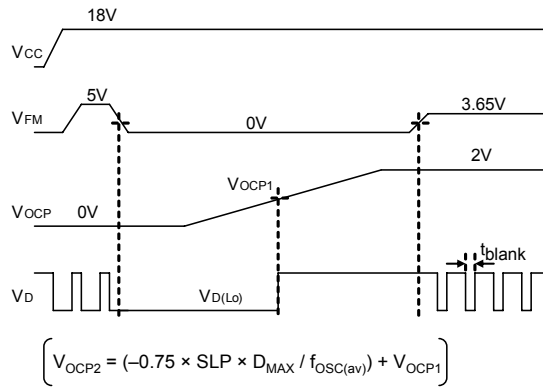
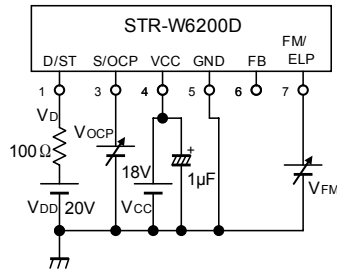
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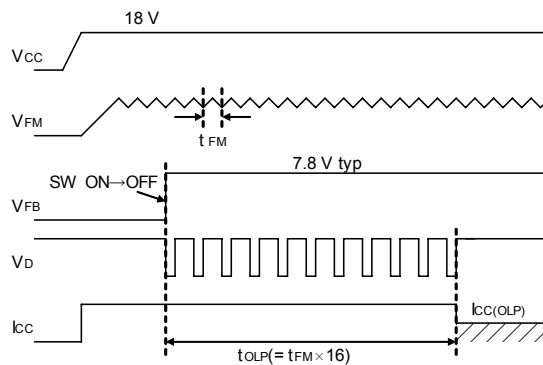
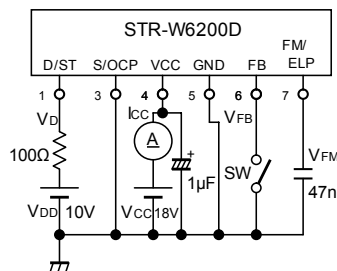
### Measurement Circuit 4



### Measurement Circuit 5



### Measurement Circuit 6

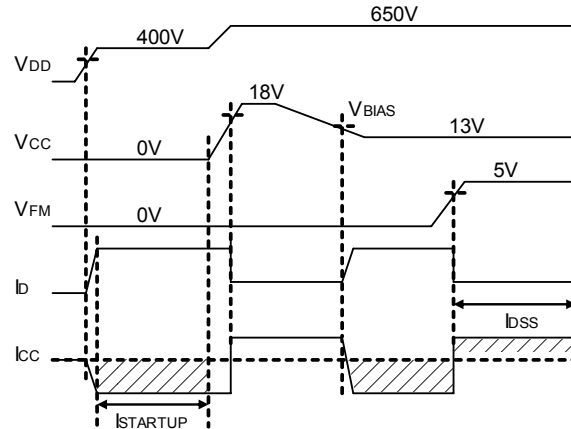
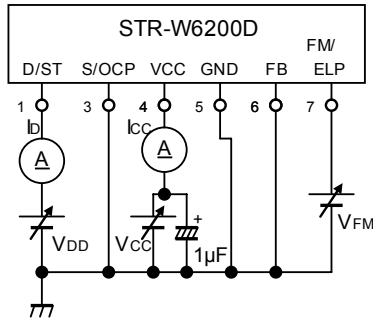




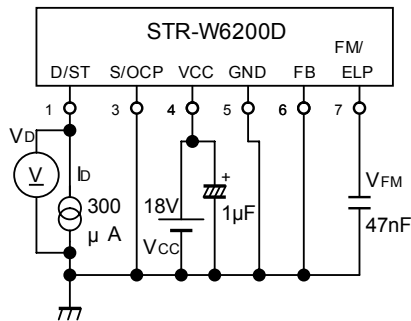
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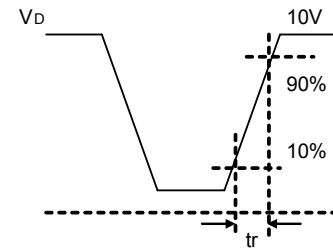
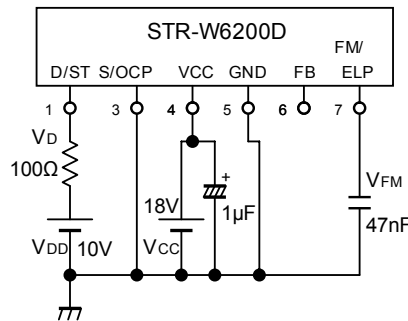
Measurement Circuit 7



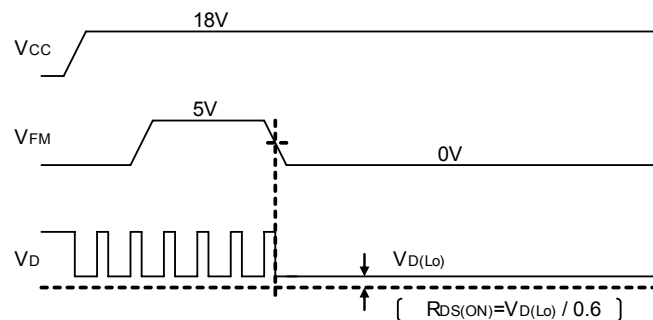
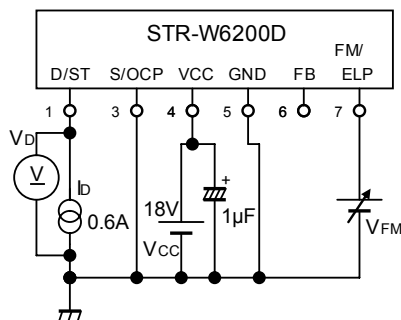
Measurement Circuit 8



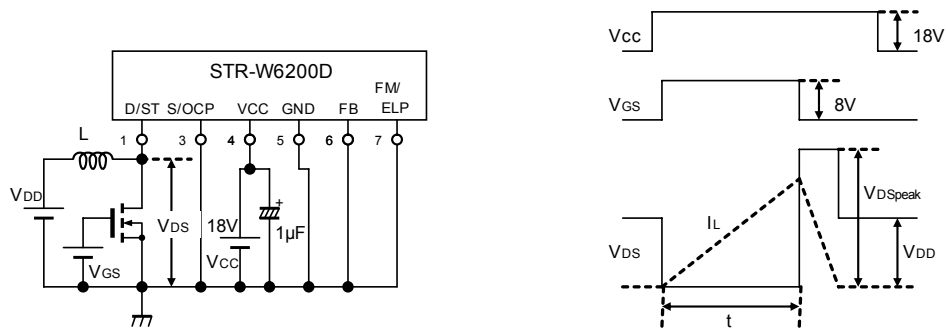
Measurement Circuit 9



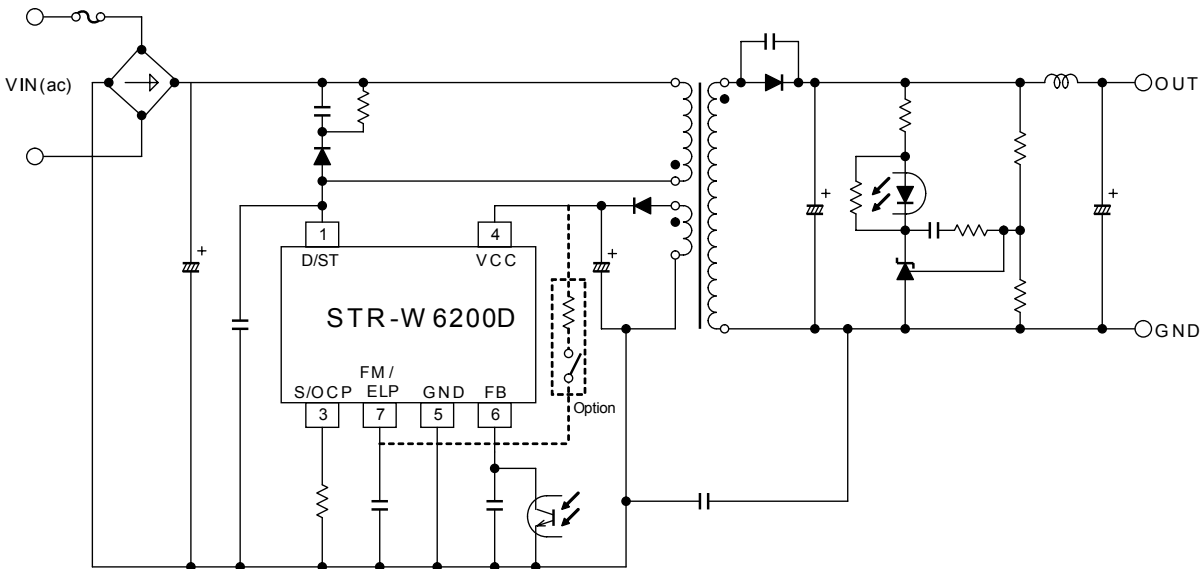
Measurement Circuit 10



Measurement Circuit 11



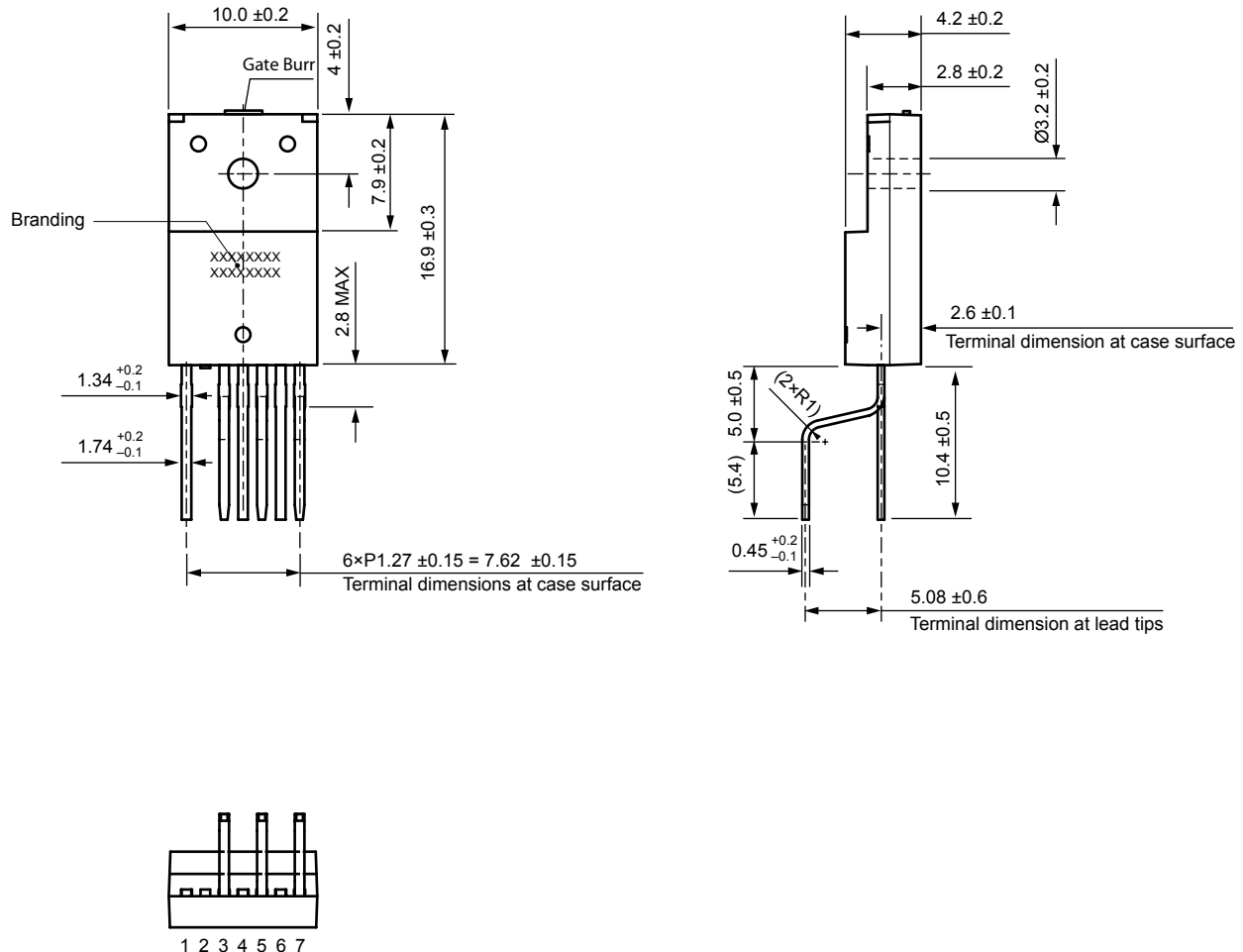
TYPICAL APPLICATION CIRCUIT



# STR-W6251D

## 30 W-Universal Input/45 W-230 Vac Input PWM Switching Regulators

### PACKAGE DIMENSIONS, TO-220



Gate burr: 0.3 mm (max.)  
Terminal core material: Cu  
Terminal treatment: Ni plating and solder dip  
Heat sink material: Cu  
Heat sink treatment: Ni plating  
Leadform: 2003  
Weight (approximate): 2.3 g

Dimensions in millimeters

Drawing for reference only  
Branding codes (exact appearance at manufacturer discretion):  
1st line, type: W6251  
2nd line, lot: YMDD R  
Where: Y is the last digit of the year of manufacture  
M is the month (1 to 9, O, N, D)  
DD is the 2-digit date  
R is the manufacturer registration symbol

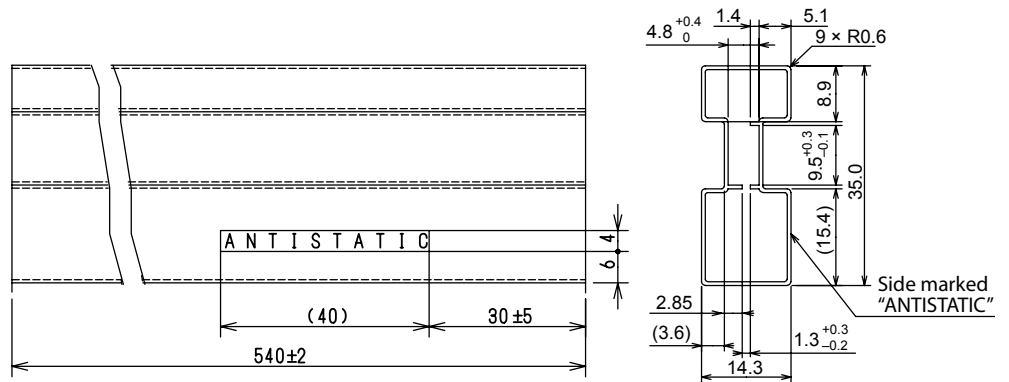
Leadframe plating Pb-free. Device composition complies with the RoHS directive.

# STR-W6251D

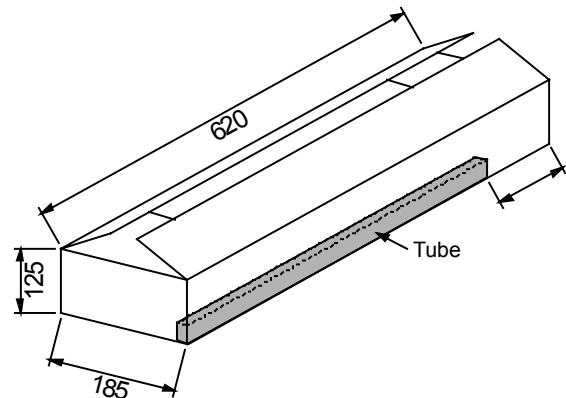
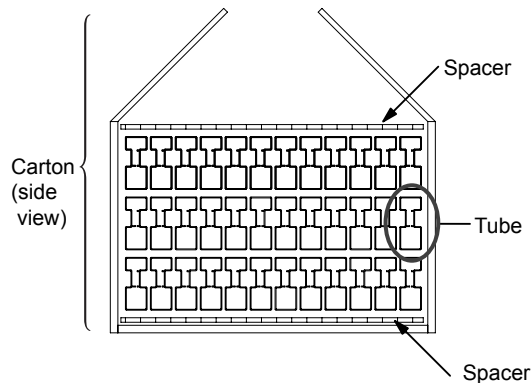
## 30 W-Universal Input/45 W-230 Vac Input PWM Switching Regulators

### PACKING SPECIFICATIONS Minimum packing option: Tube FM-205 E

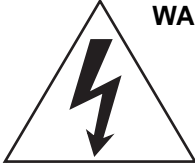
**Shipping Tube Dimensions:**  
Wall thickness:  $0.6 \pm 0.3$  mm  
Wall warp:  $< 2$  mm  
Material: Hardened polyvinyl  
Coating: antistatic  
Tolerance  $\pm 0.4$  mm,  
unless otherwise specified



**Shipping Carton Dimensions:**  
Capacity: 1800 pieces maximum per carton  
36 tubes per carton  
3 rows, 12 tubes per row



All dimensions: mm



**WARNING** — These devices are designed to be operated at lethal voltages and energy levels. Circuit designs that embody these components must conform with applicable safety requirements. Precautions must be taken to prevent accidental contact with power-line potentials. Do not connect grounded test equipment.

The use of an isolation transformer is recommended during circuit development and breadboarding.

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 in leads and solderability of 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 adjacent products, and shorts to the heatsink.

#### Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting this product on a heatsink, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce stress.
- Volatile-type silicone greases may produce cracks after long periods of time, resulting in reduced heat radiation effect. Silicone grease with low consistency (hard grease) may cause cracks in the mold resin when screwing the product 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	GE Toshiba Silicone Co., Ltd.
SC102	Dow Corning Toray Silicone Co., Ltd.

#### Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:  
260±5°C 10 s  
350±5°C 3 s
- Soldering iron should be at a distance of at least 1.5 mm from the body of the products

#### Electrostatic Discharge

- When handling the products, operator must be grounded. Grounded wrist straps worn should have at least 1 MΩ of resistance to ground to prevent shock hazard.
- 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 our shipping containers or conductive containers, or be wrapped in aluminum foil.

#### Assembly

- During soldering or other operations, the interior frame temperature of the device should never exceed 105°C.
- Recommended screw torque through the mounting tab is 0.588 to 0.785 N • m (6 to 8 kgf • cm)

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