

# STR-X6737M

Sep. 2013

## ◆ General description

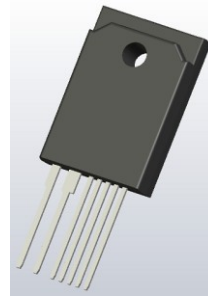
The STR-W6737M is power IC for quasi-resonant type switching power supply, incorporating a power MOSFET and a controller IC. The product achieves high efficiency and low noise power supply systems by the quasi-resonant operation and the bottom-skip quasi-resonant operation.

## ◆ Features

- Multi operation mode  
The operation mode switching according to load conditions achieves the optimal high efficiency and low noise power supply systems across the full load range.
- Current mode control
- Built-in PWM oscillator  
The PWM operates with the minimum frequency of around 22kHz, until the quasi-resonant signal becomes valid, reduces the stress on components at startup and load-shorted.
- Built-in soft start function
- Step-drive function, reducing switching noise
- Input compensation at overcurrent  
The function reduces the distortion of overcurrent operation point to AC input voltage change by adding three components.
- Avalanche energy guaranteed by two chips structure (Simplification of surge absorbing circuit)
- Protection functions  
Overcurrent protection (OCP); Pulse-by-pulse  
Overload protection (OLP); latched shutdown  
Overvoltage protection (OVP); latched shutdown

## ◆ Package

Package name: TO-3PF-7L



## ◆ Specification

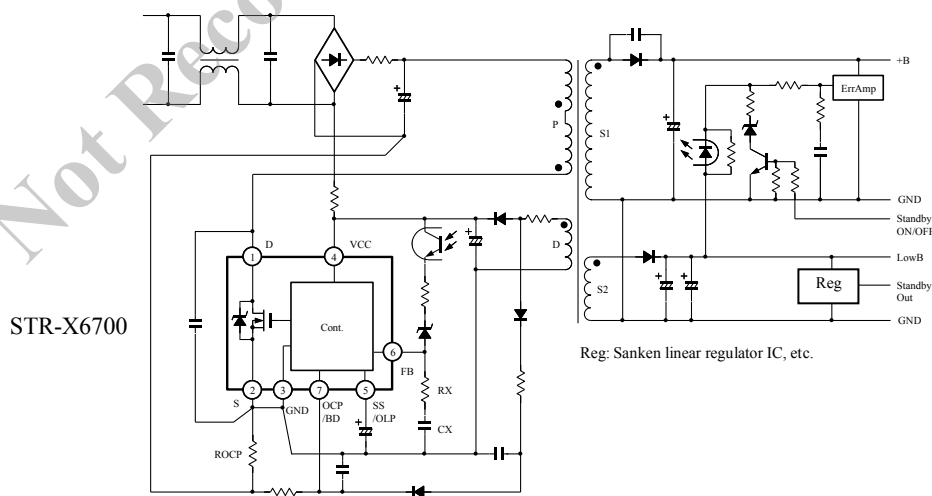
MOSFET 500V(MIN), 0.36Ω(MAX)

## ◆ Application

Switching power supplies for

- LCD-TVs, PDP-TVs, CRT-TVs and Digital consumer equipment
- Home appliances
- OA equipments
- Industry machines
- Communication devices

## ◆ Typical application circuit



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## Absolute maximum ratings

- The polarity value for current specifies a sink as "+," and a source as "-", referencing the IC.
- Unless otherwise specified,  $T_A = 25\text{ }^\circ\text{C}$

| Item                              | Pin | Symbol            | Ratings     | Unit             | Remark   |
|-----------------------------------|-----|-------------------|-------------|------------------|--|
| Drain Current                     | 1-2 | $I_{Dpeak}^{(1)}$ | 22          | A                | Single pulse   |
| Maximum Switching Current         | 1-2 | $I_{DMAX}^{(2)}$  | 22          | A                | $T_a = -20$ to $+125\text{ }^\circ\text{C}$                            |
| Avalanche Energy                  | 1-2 | $E_{AS}^{(3)}$    | 239         | mJ               | Single pulse   |
|                                   |     |                   |             |                  | $V_{DD} = 30\text{V}$ , $L = 50\text{mH}$<br>$I_{Lpeak} = 3.0\text{A}$ |
| Control Power Supply Voltage      | 4-3 | $V_{CC}$          | 35          | V                |  |
| SS/OLP pin Voltage                | 5-3 | $V_{SSOLP}$       | -0.5 to 6.0 | V                |  |
| FB pin Inflowing Current          | 6-3 | $I_{FB}$          | 10          | mA               |  |
| FB pin Voltage                    | 6-3 | $V_{FB}$          | -0.5 to 9.0 | V                | Within $I_{FB}$ control  |
| OCP/BD pin Voltage                | 7-3 | $V_{OCPBD}$       | -1.5 to 5.0 | V                |  |
| MOS FET Power Dissipation         | 1-2 | $P_{D1}^{(4)}$    | 44          | W                | By infinite radiator   |
|                                   |     |                   | 2.8         | W                | No radiator  |
| Control Power Dissipation (MIC)   | 4-3 | $P_{D2}^{(5)}$    | 0.8         | W                | Defined by $V_{CC} \times I_{CC}$                                      |
| Operating Inner Flame Temperature | -   | $T_F$             | -20 to +125 | $^\circ\text{C}$ | Refer to recommended operating temperature                             |
| Operating Ambient Temperature     | -   | $T_{OP}$          | -20 to +125 | $^\circ\text{C}$ |  |
| Storage Temperature               | -   | $T_{stg}$         | -40 to +125 | $^\circ\text{C}$ |  |
| Channel Temperature               | -   | $T_{ch}$          | +150        | $^\circ\text{C}$ |  |

<sup>(1)</sup> Refer to MOS FET A.S.O. curve

<sup>(2)</sup> Regarding the maximum switching current

The maximum switching current is drain current IC determined by inner drive voltage and MOS FET  $V_{th}$ .

<sup>(3)</sup> Refer to MOS FET  $T_{ch} - E_{AS}$  curve

<sup>(4)</sup> Refer to MOS FET  $T_a - P_{D1}$  curve

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## Electrical characteristics

### Electrical characteristics for control part

- The polarity value for current specifies a sink as "+," and a source as "-," referencing the IC.
- Unless otherwise specified,  $T_A = 25\text{ }^\circ\text{C}$ ,  $V_{CC} = 20\text{V}$

| Item   | Pin | Symbol           | Ratings |        |        | Unit          | Remark |
|--|-----|------------------|---------|--------|--------|---------------|--------|
|  |     |                  | MIN     | TYP    | MAX    |               |        |
| <b>Power supply Start-up Operation</b>         |     |                  |         |        |        |               |        |
| Operation start power supply voltage           | 4-3 | $V_{CC(ON)}$     | 16.3    | 18.2   | 19.9   | V             |        |
| Operation stop power supply voltage            | 4-3 | $V_{CC(OFF)}$    | 8.8     | 9.7    | 10.6   | V             |        |
| Circuit current in operation                   | 4-3 | $I_{CC(ON)}$     | -       | -      | 6      | mA            |        |
| Circuit current in non-operation               | 4-3 | $I_{CC(OFF)}$    | -       | -      | 100    | $\mu\text{A}$ |        |
| Oscillation frequency                          | 1-2 | $f_{OSC}$        | 19      | 22     | 25     | kHz           |        |
| Soft start operating stop voltage              | 5-3 | $V_{SSOLP(SS)}$  | 1.1     | 1.2    | 1.4    | V             |        |
| Soft start operating charging current          | 5-3 | $I_{SSOLP(SS)}$  | -710    | -550   | -390   | $\mu\text{A}$ |        |
| <b>Normal Operation</b>                        |     |                  |         |        |        |               |        |
| Bottom-skip operation threshold voltage 1      | 7-3 | $V_{OCPBD(BS1)}$ | -0.720  | -0.665 | -0.605 | V             |        |
| Bottom-skip operation threshold voltage 2      | 7-3 | $V_{OCPBD(BS2)}$ | -0.150  | -0.100 | -0.050 | V             |        |
| Overcurrent detection threshold voltage        | 7-3 | $V_{OCPBD(LIM)}$ | -0.995  | -0.940 | -0.895 | V             |        |
| OCP/BD pin source current                      | 7-3 | $I_{OCPBD}$      | -250    | -100   | -40    | $\mu\text{A}$ |        |
| Quasi-resonant operation threshold voltage 1   | 7-3 | $V_{OCPBD(TH1)}$ | 0.28    | 0.40   | 0.52   | V             |        |
| Quasi-resonant operation threshold voltage 2   | 7-3 | $V_{OCPBD(TH2)}$ | 0.67    | 0.80   | 0.93   | V             |        |
| FB pin threshold voltage                       | 6-3 | $V_{FB(OFF)}$    | 1.32    | 1.45   | 1.58   | V             |        |
| FB pin sink current (Normal operation)         | 6-3 | $I_{FB(ON)}$     | 600     | 1000   | 1400   | $\mu\text{A}$ |        |
| <b>Stand-by Operation</b>                      |     |                  |         |        |        |               |        |
| Stand-by operation start voltage               | 4-3 | $V_{CC(S)}$      | 10.3    | 11.2   | 12.1   | V             |        |
| Stand-by operation start voltage interval      | 4-3 | $V_{CC(SK)}$     | 1.10    | 1.35   | 1.65   | V             |        |
| Stand-by non-operation circuit current         | 4-3 | $I_{CC(S)}$      | -       | 20     | 56     | $\mu\text{A}$ |        |
| FB pin sink current (stand-by operation)       | 6-3 | $I_{FB(S)}$      | -       | 4      | 14     | $\mu\text{A}$ |        |
| FB pin threshold voltage (stand-by operation)  | 6-3 | $V_{FB(S)}$      | 0.55    | 1.10   | 1.50   | V             |        |
| Minimum ON time                                | 1-2 | $t_{ON(MIN)}$    | 0.75    | 1.10   | 1.50   | $\mu\text{s}$ |        |
| <b>Protection Operation</b>                    |     |                  |         |        |        |               |        |
| Maximum ON time                                | 1-2 | $t_{ON(MAX)}$    | 27.5    | 32.5   | 39.0   | $\mu\text{s}$ |        |
| OLP operation threshold voltage                | 5-3 | $V_{SSOLP(OLP)}$ | 4.0     | 4.9    | 5.8    | V             |        |
| Charge current in OLP operation                | 5-3 | $I_{SSOLP(OLP)}$ | -16     | -11    | -6     | $\mu\text{A}$ |        |
| OVP operation power supply voltage             | 4-3 | $V_{CC(OVP)}$    | 25.5    | 27.7   | 29.9   | V             |        |
| Latch circuit holding current *                | 4-3 | $I_{CC(H)}$      | -       | 45     | 140    | $\mu\text{A}$ |        |
| Latch circuit releasing power supply voltage * | 4-3 | $V_{CC(La.OFF)}$ | 6.0     | 7.2    | 8.5    | V             |        |

\*Latch circuit refers to operation during OVP and OLP.

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## Electrical characteristics for MOSFET part

- Unless otherwise specified,  $T_A = 25\text{ }^\circ\text{C}$ ,

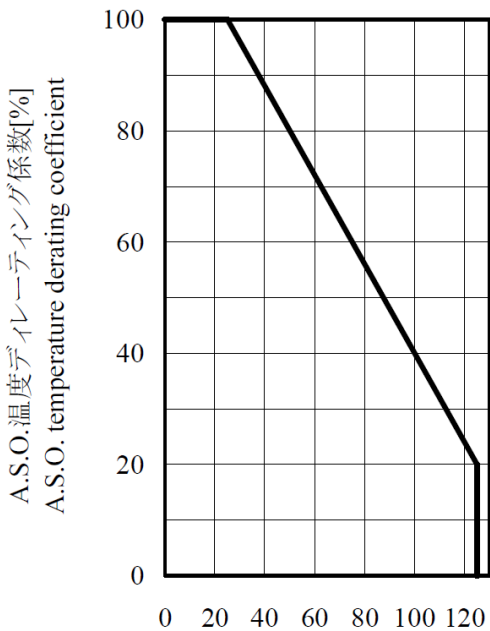
| Item                    | Pin | Symbol          | Ratings |     |      | Unit               | Remark                    |
|-------------------------|-----|-----------------|---------|-----|------|--------------------|---------------------------|
|                         |     |                 | MIN     | TYP | MAX  |                    |                           |
| Drain-to-Source voltage | 1-2 | $V_{DSS}$       | 500     | –   | –    | V                  |                           |
| Drain leak current      | 1-2 | $I_{DSS}$       | –       | –   | 300  | $\mu\text{A}$      |                           |
| ON resistance           | 1-2 | $R_{DS(ON)}$    | –       | –   | 0.36 | $\Omega$           |                           |
| Switching time          | 1-2 | $t_f$           | –       | –   | 500  | ns                 |                           |
| Thermal resistance      | –   | $\theta_{ch-F}$ | –       | –   | 1.09 | $^\circ\text{C/W}$ | Channel to Internal frame |

Not Recommended for New Designs

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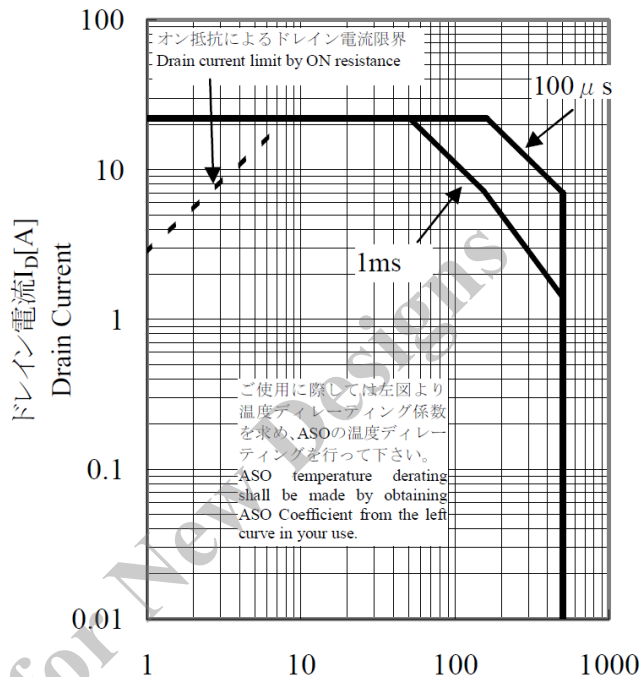
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STR-X6737M  
A.S.O.温度ディレーティング係数曲線  
A.S.O. temperature derating coefficient  
curve



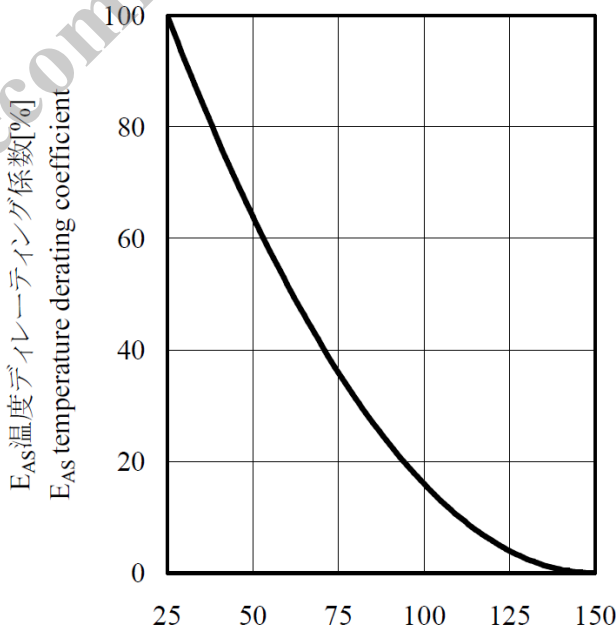
内部フレーム温度  $T_F$  [°C]  
Internal frame temperature

STR-X6737M  
MOSFET A.S.O.曲線  
Curve  
 $T_a=25^\circ\text{C}$   
シングルパルス  
Single pluse



ドレイン・ソース間電圧  $V_{DS}$  [V]  
Drain-to-Source Voltage

STR-X6737M  
アバランシェ・エネルギー耐量  
ディレーティング曲線  
Avalanche energy derating curve

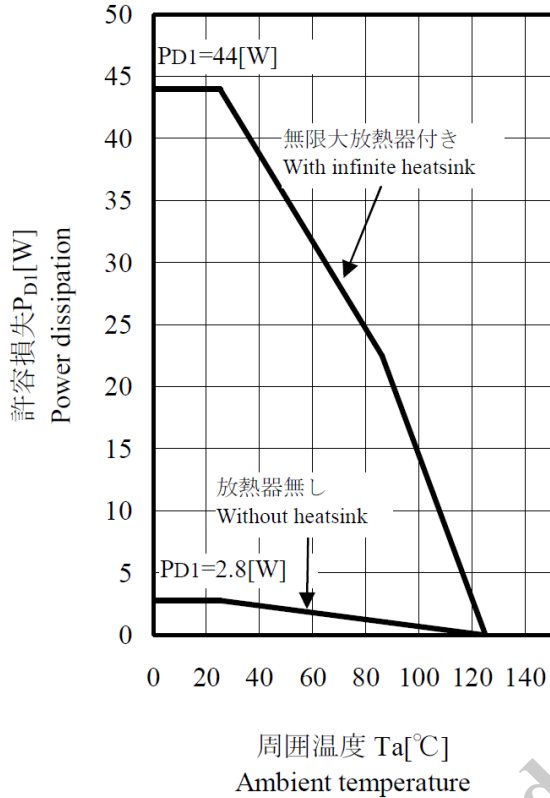


チャンネル温度  $T_{ch}$  [°C]  
Channel temperature

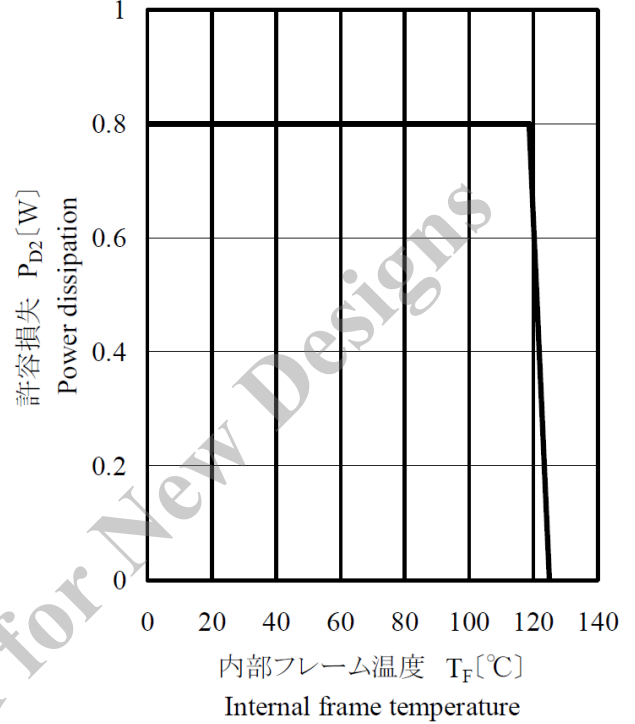
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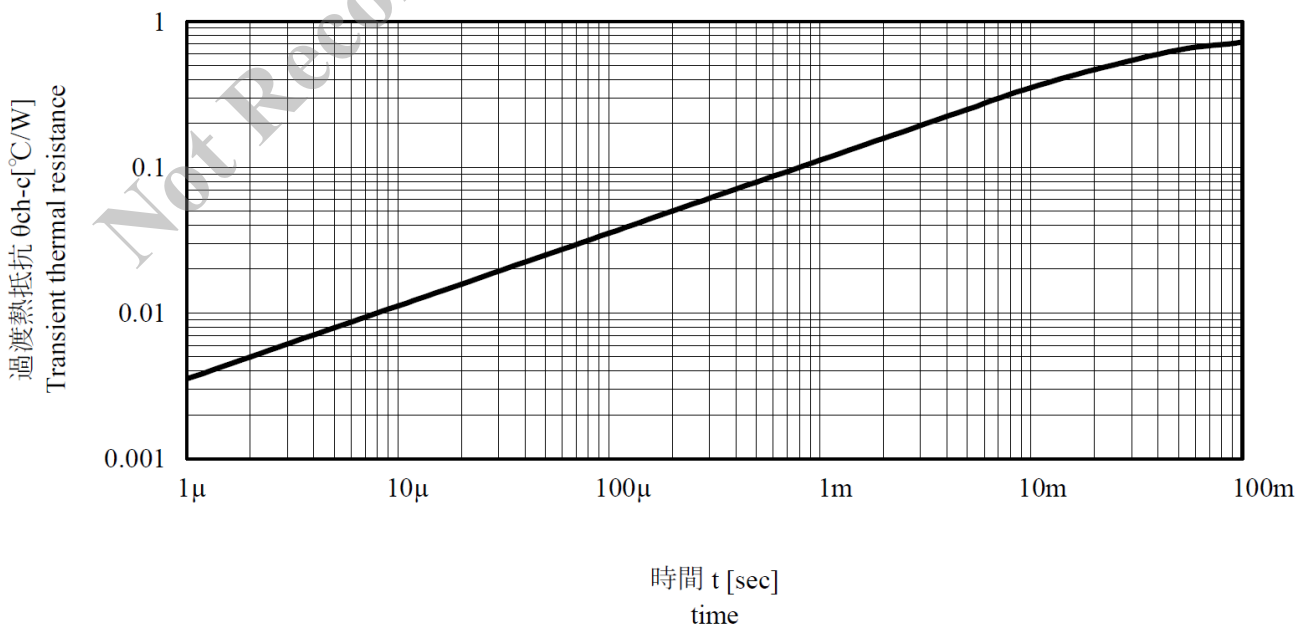
STR-X6737M  
MOSFET Ta-P<sub>D1</sub> 曲線  
Curve



STR-X6737M  
MIC T<sub>F</sub>-P<sub>D2</sub> 曲線  
curve



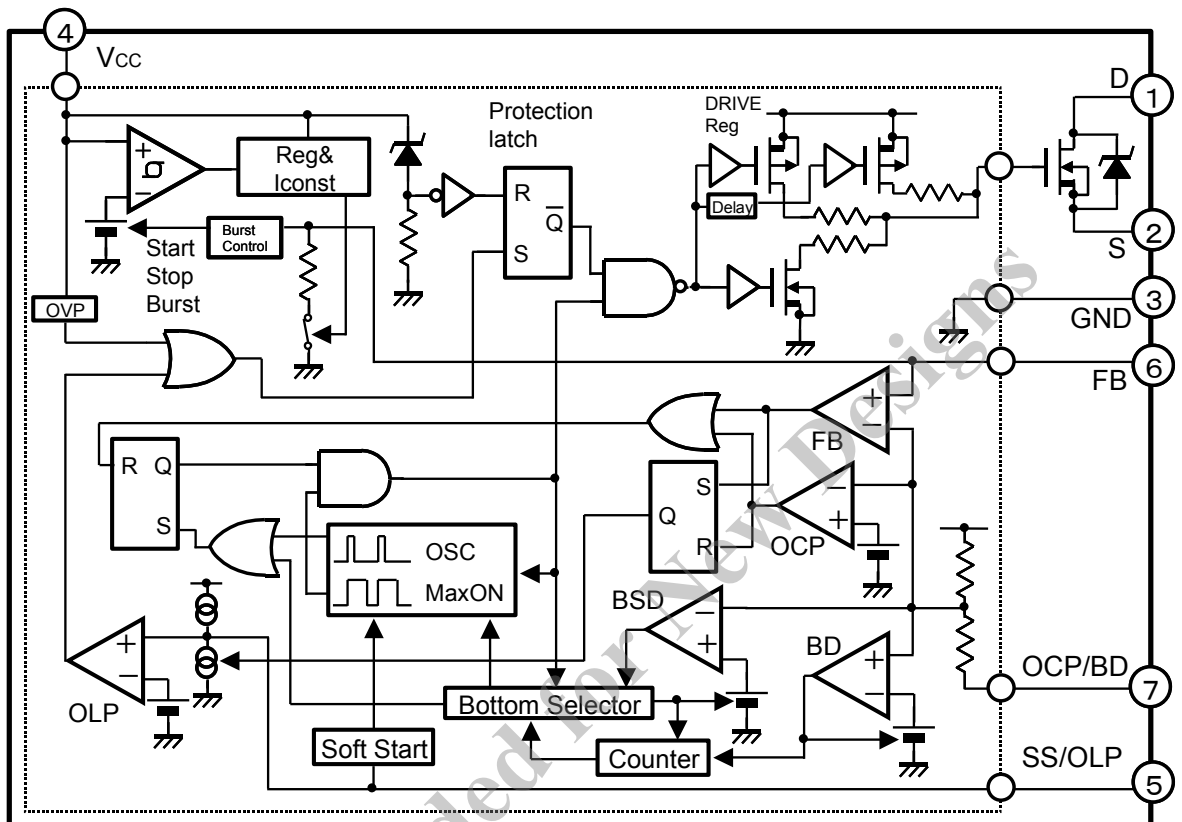
STR-X6737M  
過渡熱抵抗曲線  
Transient thermal resistance curve



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## Block diagram



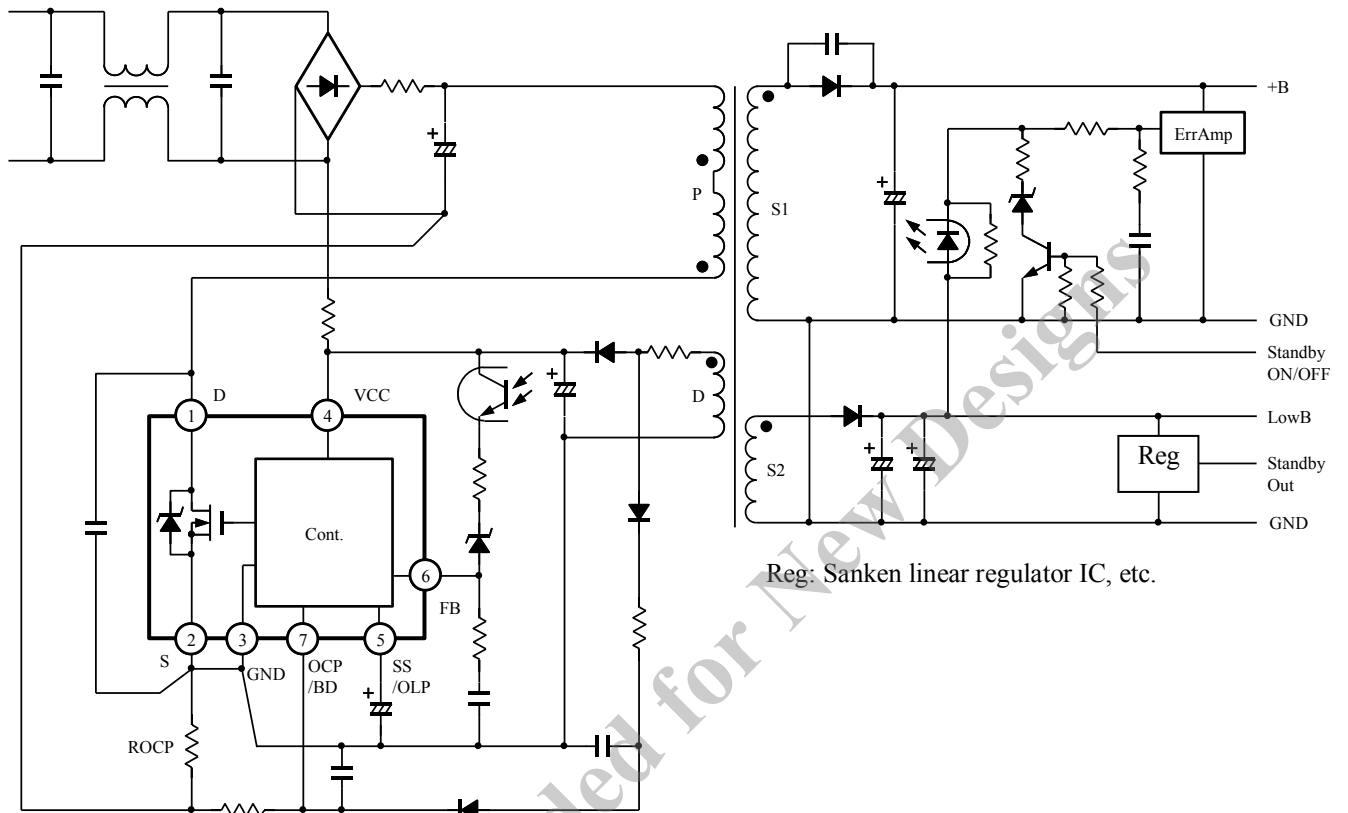
## Pin function description

| Pin number | Symbol          | Description                        | Function   |
|------------|-----------------|------------------------------------|--|
| 1          | D               | Drain pin                          | MOSFET drain   |
| 2          | S               | Source                             | MOSFET source  |
| 3          | GND             | Ground pin                         | Ground   |
| 4          | V <sub>CC</sub> | Power supply pin                   | Input for power supply for control circuit   |
| 5          | SS/OLP          | Softstart/ overload protection pin | Input for set delay for overload detection and softstart operation                   |
| 6          | FB              | Feedback pin                       | Input for constant voltage control and intermittent mode oscillation control signals |
| 7          | OCP/BD          | OCP input/ Bottom detection pin    | Input for overcurrent detection and bottom detection signals                         |

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## Typical application circuit

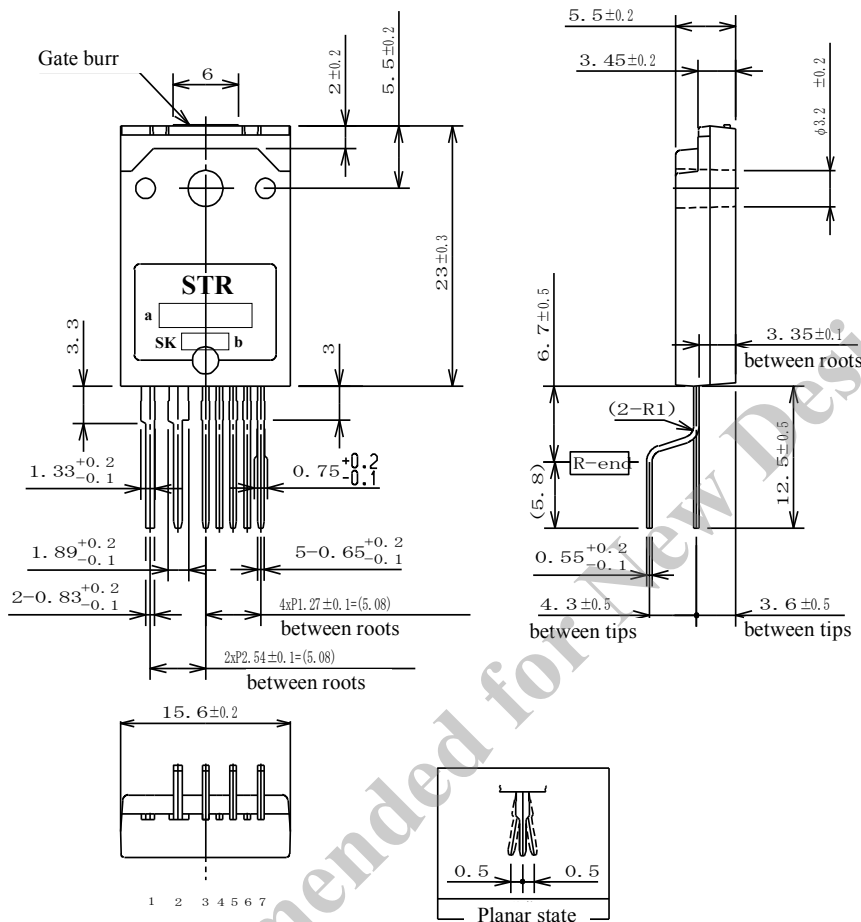




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## Package



Note 1)  
- . . . . part shows the point gate burr (height 0.3 max) occurred

Pin material: Cu  
Pin treatment: Ni plating and solder dip  
Product weight (approximate): 6.0g

Dimensions in millimeters

a. Part number X6737M  
b. Lot number

1<sup>st</sup> letter : The Last digit of year  
2<sup>nd</sup> letter : Month  
Jan. to Sep. Arabic number  
Oct. O  
Nov. N  
Dec. D

3<sup>rd</sup> & 4<sup>th</sup> letter : day  
01-31 Arabic numbers

## 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 0.05mm 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: 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 1.5 mm from the body of the products.

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## 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.

## IMPORTANT NOTES

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