

RS2201

Switching Power Supply Controller

Description

RS2201, produced by advanced integrated circuit process, is a switch power supply controller, which could offer over-load and saturation protection, and achieve green economize on energy and environmental protection standard. RS2201 could achieve AC/DC conversion and can be widely applied to economical switching power supply equipment. For instance, Charger、DVD, Induction cooker, STB, Printer, LCD and so on.

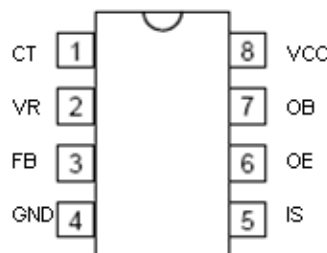
Features

- Over-load and saturation protection could protect over-load, switch transformer saturation and output short circuit or the relative failures.
- It is economical that triode is used for switch device, which could start up the circuit with its amplification function and reduce ten times of power consumption of the start-up resistance.
- Built-in Synchronized Slope Compensation circuit, thermal protection circuit, slope current drive circuit.
- Zero-load output power consumption could be less than 0.3W, is less than 0.2W while 220V AC input.
- Pin to Pin THX201
- Pb-Free DIP-8 and SOP-8 Package.

Applications

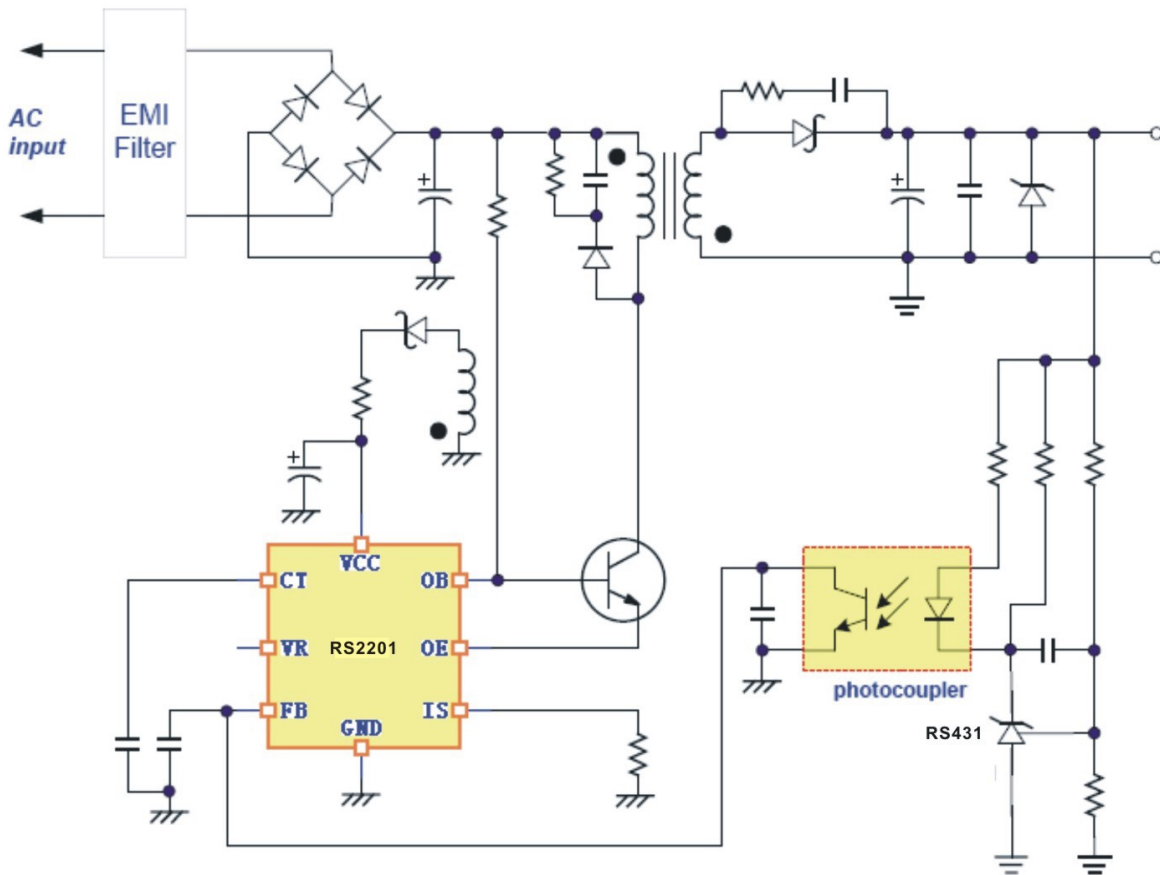
- Switching AC/DC Adaptor
- Battery Charger
- Open Frame Switching Power Supply
- Standby Power Supplies
- Set-Top Box Power Supplies
- 384X Replacement

Pin Configurations



| Name | Description |
|------|---|
| CT | By connecting a cap to ground to set the switching frequency |
| VR | 2.5V reference voltage output |
| FB | Feedback pin |
| GND | GND |
| IS | Current sense. |
| OE | Power Transistor Emitter drive output and start-up current input. |
| OB | Power Transistor Base drive output and start-up current control. |
| VCC | Power Supply. |

Typical Application Circuit



Operation description

- Initially, after power up, no output of VR. FB pull-up current source is turn off. OE inputs start-up current from power transistor to VCC. OB controls the base current of power transistor and limits the collector current (start-up accept current of RS2201) of power transistor so to safeguard the power transistor. When the VCC voltage rises to 7.8V, the start-up phase completes and goes to the normal operation.
- In normal operation, VCC voltage must keep 4.75~9.8V, VR outputs 2.5V reference voltage. FB pull-up current source turns on. Oscillator outputs OSC1 to decide the maximum duty cycle and OSC2 to trigger power supply entering the open cycle and cover spike value of power transistor start-up current. If FB is less than 1.8V(about 1.2-1.8V), the less the FB is, the wider the oscillation cycle is. (This characteristics reduces the standby consumption of the switching power supply) . If external feedback intends to get VCC greater than 9.8V, the internal feedback circuit regular VCC on 9.8V. (Making use of this characteristics to stable output voltage no using external feedback circuit, but the regulating is not precise) . In open cycle, OB provides the base current for power transistor, OE pulls down the emitter of power transistor to IS and OB adopts slop current drive (OB open current is IS function, when IS=0V,OB open current is about 40mA, and OB open current is increasing with IS linear increasing. When IS increases 0.6V, OB open current is about 120mA. This characteristics makes use of output current of OB effectively and reduces power consumption of RS2201). If IS detects the FB designated current, it enters closed cycle. In closed cycle, OB pulls down, the power transistor is not be turn off immediately but OE clamps 1.5V (after power transistor is turn off, the base is reverse bias, the breakdown voltage of power transistor is improved). In the open or closed cycle, if power transistor is detected to exceed upper limit current, the upper limit current trigger will set firstly and forces FB to pull down, duty cycle reduced, so to protect power transistor and transformer. In the next closed cycle start-up time, or when FB is less than 1.8V, upper current trigger resets. In addition, RS2201 is built in thermal protection, when the internal temperature is above 140°C, it will widen the cycle of oscillator, so that the temperature of RS2201 will not exceed 150°C. Slop compensation is built in to stabilization open/closed cycle during the maximum duty cycle or the continual current mode of RS2201.
- If VCC reduces to 4.4V, oscillator is turn off, OSC1 OSC2 low level, power supply keeps closed cycle. when VCC continually reduces to about 4.0 V , RS2201 enters start-up phase again.

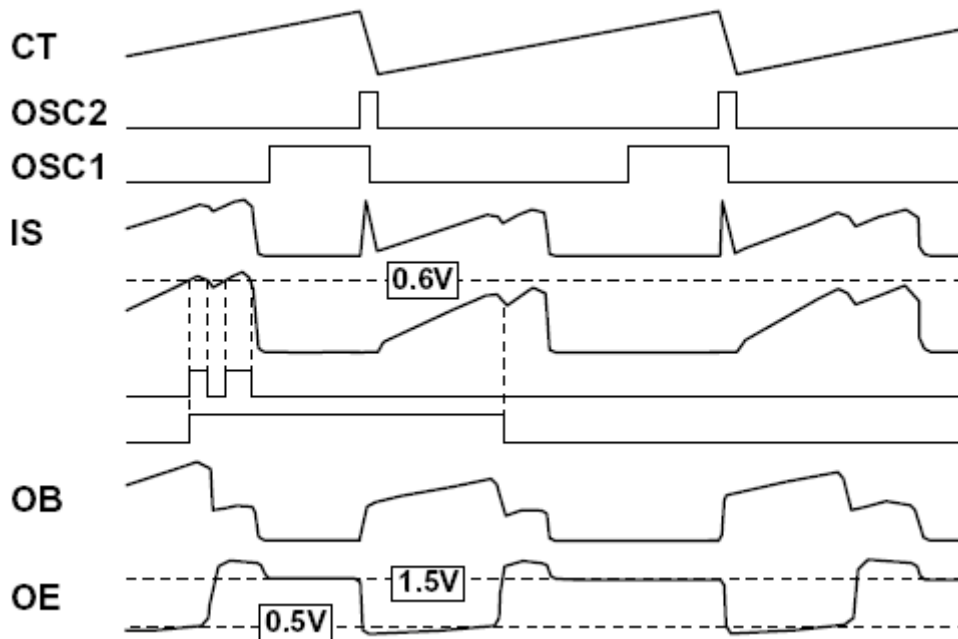


Fig.1 OPEN/CLOSED CYCLE WAVES IN NORMAL OPERATION

Electrical parameter definition

- Start-up accept current: OE node current when OB has a 0.1mA pull-down current in start-up phase.
- Start-up static current: VCC connects to filter capacitor and adjustable current source, CT connects to 680PF , other pins are floating. It is the minimum current that could oscillate the VCC.
- Start-up voltage: The max. value of VCC oscillation above.
- Restart voltage: The min. value of VCC oscillation above.
- Voltage of Oscillator is turn off: VCC value, which stops the oscillator in falling time of VCC oscillation above.
- Static current: In normal operation, FB connects to the grand through 1.8K resistor. VCC power supply current.
- The pull-up/ pull-down current of oscillator: In normal operation, FB=2.5V,CT=1.25V, pull-up /pull-down current on CT.

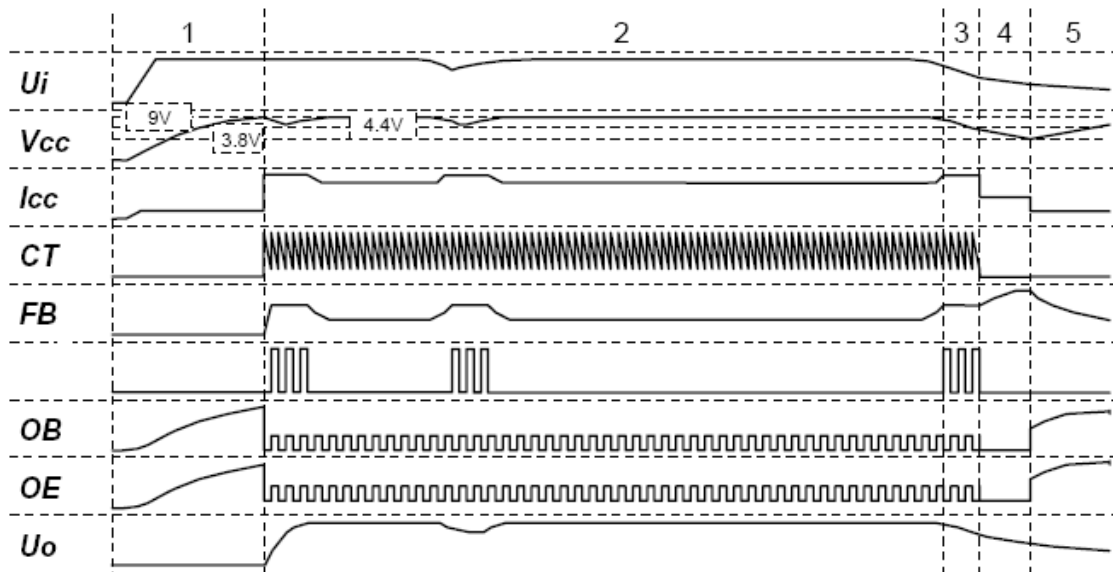


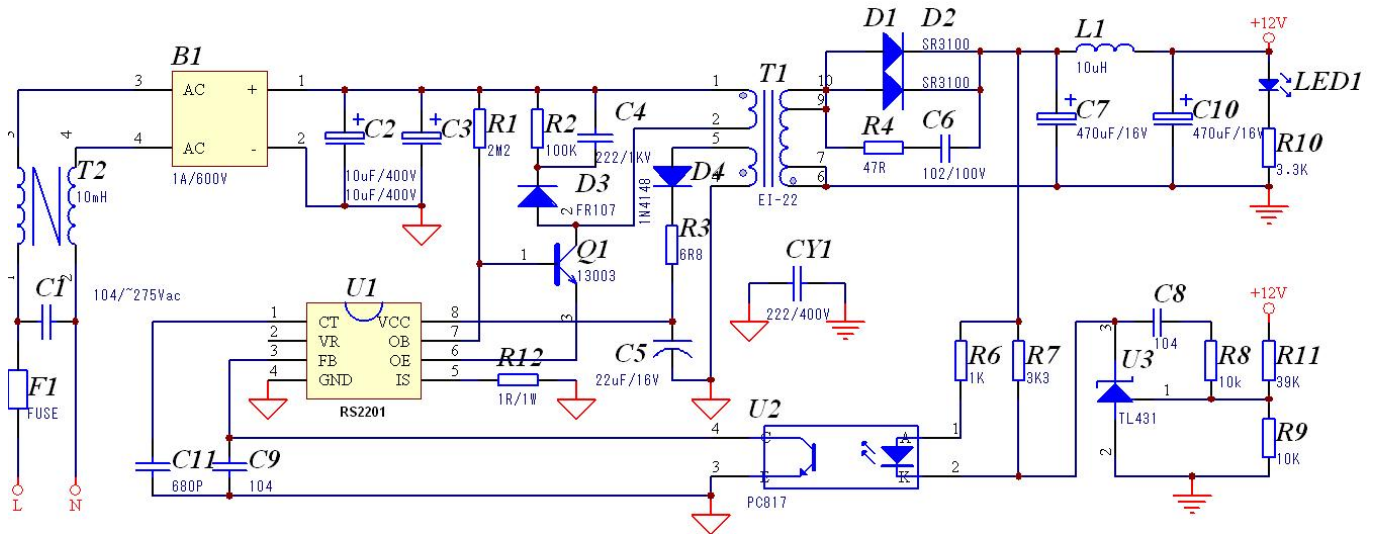
Fig.2 RS2201 ALL SIGNAL WAVES

- FB pull-up current: In normal operation, when FB=2.5V,IS=0V, pull up current on FB.
- FB protecting upper limit current: In normal operation, FB=2.5V,IS=0.8V , pull down current on FB.
- Internal feedback power supply voltage: In normal operation, VCC value of RS2201 power supply without external standby feedback circuit.
- IS upper limit current: FB=2.5V , external adjustable power supply to IS, there is minimal IS voltage of pull-down current on FB.
- Slope current drive: OB open current is IS function, when IS=0V,OB open current is about 40mA, and OB open current is increasing with IS linear increasing. When IS increases 0.6V, OB open current is about 120mA.
- OSC Frequency: C function of CT pin external capacitor, is about C*24000 seconds.

Electrical Characteristics

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--------|--------------------------------|-----------------|------|------|------|------|
| Ics | Start-up accept current | | 1.6 | 2.0 | 2.4 | mA |
| | Start-up static current | | | 55 | 80 | uA |
| | Start-up voltage | | 7.6 | 7.8 | 8.0 | V |
| | Oscillator cut off voltage | | 4.25 | 4.50 | 4.75 | V |
| | Restart voltage | | | 4.0 | | V |
| | Inner oscillator voltage | | 9.6 | 10.0 | 10.4 | V |
| Icc | Operating Current | VCC=8V | | 3.5 | | mA |
| VR | VR reference voltage | | 2.4 | 2.5 | 2.6 | V |
| Fosc | Oscillator Frequency | CT*24000 | | 64 | | KHz |
| | Oscillator pull-up current | CT=1.25V | | 100 | | uA |
| | Oscillator pull-down current | CT=1.25V | | 1.9 | | mA |
| | Maximum Duty Cycle | CT=680PF | 53 | 55 | 61 | % |
| | FB Feedback Voltage | IS=0.5V,CT=0.6V | | 4.8 | | V |
| | FB pull-up current | FB=2.5V,IS=0V | | 590 | | uA |
| | FB prevent upper limit current | FB=2.5V,IS=0.8V | | 310 | | uA |
| | IS upper limit current | R IS-GND =0.75Ω | 0.54 | 0.60 | 0.62 | V |
| | OE Clamp Voltage | OE=0.001~1.2A | | 1.6 | | V |
| | OB open current | IS=0.5V | 102 | 120 | 140 | mA |
| | OB open current | IS=0.0V | 32 | 44 | 60 | mA |
| | OB closed current | OB-IS=1V | -145 | -210 | -230 | mA |
| | OB closed current | OB-IS=0.25V | | -4.5 | -6 | mA |
| | OE output current | OE-IS=0.6V | | -1.2 | -1 | A |

RS2201 - 12W (12V/1A) Demo Board Circuit Diagram



BOM List

| Part Location | Description | Value | QTY | UNIT |
|---------------|--|------------|-----|------|
| R1 | RES;SMD;1206;+/-5% | 2.2M | 1 | PCS |
| R2 | RES;SMD;1206;+/-5% | 100K | 1 | PCS |
| R3 | RES;SMD;0805;+/-5% | 4.7Ω | 1 | PCS |
| R4, R5 | RES;SMD;1206;+/-5% | 47Ω | 1 | PCS |
| R6 | RES;SMD;0805;+/-5% | 1K | 1 | PCS |
| R7, R10 | RES;SMD;0805;+/-5% | 3.3K | 2 | PCS |
| R8 | RES;SMD;0805;+/-5% | 10K | 1 | PCS |
| R9 | RES;SMD;0805;+/-3% | 10K | 1 | PCS |
| R11 | RES;SMD;0805;+/-3% | 39K | 1 | PCS |
| R12 | RES;MOF;+/-5%,1W | 1Ω | 1 | PCS |
| C1, C2 | C/E;Φ10*15;105°C;+/-20%;KMG | 10uF/400V | 2 | PCS |
| C3 | C/C;DIP;+/-10%;Pintch=200mil | 222/1KV | 1 | PCS |
| C4 | C/E;Φ5*11;105°C;+/-20% | 47uF/25V | 1 | PCS |
| C5 | C/C;DIP;+/-10%;Pintch=200mil | 102/100V | 1 | PCS |
| C6 | C/C;SMD;+/-10%;0805 | 681/25V | 1 | PCS |
| C7 | C/C;SMD;+/-10%;0805 | 104/25V | 1 | PCS |
| C8 | C/C;SMD;+/-10%;0805 | 103/25V | 1 | PCS |
| C9,C10 | C/E;Φ8*12;105°C;+/-20%;Pintch=150mil | 470uF/16V | 2 | PCS |
| CX1 | C/X1;+/-20%;275V;Pintch=400mil;DAIN | 104/275Vac | 1 | PCS |
| CY1 | C/Y1;+/-20%;Pintch=400mil; | 222M/400V | 1 | PCS |
| B1 | BRIGE; SMD;1A | 1A/600V | 1 | PCS |
| D1;D2 | DIODE; 3A;100V; DO-201AD | SR3100 | 2 | PCS |
| D3 | DIODE; 1A;1000V;Fast Recovery;SMA-214 | FR107 | 1 | PCS |
| D4 | DIODE;1A;100V;DO-35 | 1N4148 | 1 | PCS |
| F1 | FUSE,T2AL/250V;4.5*14.5L;Glass | FUSE | 1 | PCS |
| L1 | Φ7*10; 1 A | 10uH | 1 | PCS |
| LF1 | FILTER;UU9.8 | 20mH | 1 | PCS |
| Q1 | 1.5A;TRANSISTOR;Vcev≥700V HFE=20;+/-10%;TO225A | MJE13003 | 1 | PCS |
| T1 | TRANSFORMER; | EI-22 | 1 | PCS |
| LED1 | GREEN;Φ3 | GREEN | 1 | PCS |
| U1 | DIP8 | RS2201 | 1 | PCS |
| U2 | DIP | PC817 | 1 | PCS |
| U3 | SOT23-3 | TL431 | 1 | PCS |

Transformer Design

Transformer Specification

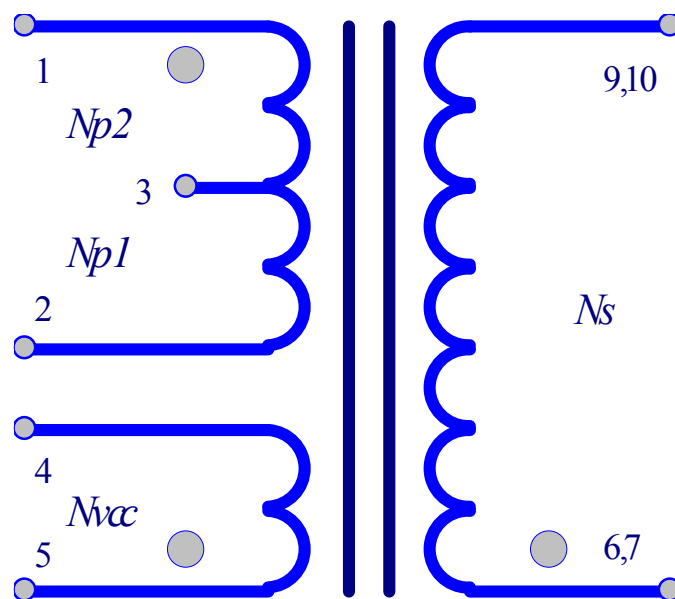
1) Bobbin & Pin : EI22(10PIN)

2) Core : PC40(TDK)

3) $L(1-3) = 1.3\text{mH} \pm 5\%$ (1KHZ , 0.3V , 25°C)

Winding Table

| Part No. | Winding | Start | Closed | (T) | Wire Gauge(mm) | Note |
|----------|---------|-------|--------|-----|----------------------|------|
| 1 | NP1 | 2 | 3 | 48 | $\Phi 0.27 \times 1$ | |
| 2 | TAPE | | | 2 | W=8mm | |
| 3 | NS | 9,10 | 7,6 | 15 | $\Phi 0.51 \times 1$ | |
| 4 | TAPE | | | 2 | W=8mm | |
| 5 | NP2 | 3 | 1 | 46 | $\Phi 0.27 \times 1$ | |
| 6 | TAPE | | | 2 | W=8mm | |
| 7 | NVCC | 4 | 5 | 9 | $\Phi 0.18 \times 1$ | |
| 8 | TAPE | | | 2 | W=8mm | |



Features of Power supply design

- Switching power supply design of fly back current control, discontinuous(a little continuous on the low voltage) current operating mode.
- Start-up current of power supply is designed of 0.5-3mA , the amplification multiple of power transistor should be calculate as 10 times. To choose start-up resistor, the base current of power transistor must be 0.05-0.3mA when power supply starts up. So the power consumption of start-up resistor should be reduced 10 times to reduce standby power consumption.
- C5=680pF , the maximum operating frequency is about 60KHz.
- Switching transformer providing operation current for RS2201 with operating power supply consults winding commutating output 4.8-9V(6V is recommend).
- If the maximum value of primary peak current of switching transformer is 0.8A. When demagnetization voltage is 140V in 220Vac, the maximum output power is 22W considering of power supply efficiency or other factors. If the wide voltage and 90V demagnetization voltage in 110Vac, a little continuous current mode is adapted when the voltage is below 95Vac, the maximum output power is 18W.
- The choice of power transistor: If the maximum peak value current is 0.8A, the β value of power transistor should reach 10@5Vce@0.8A considering of OB open current and the corresponding detecting resistor is 0.75 Ω . The power transistor should work at the saturation zone in any case and detecting resistor is 0.6V/the maximum value peak current.
- Even the RS2201 has thermal protection, but if high output power is needed, it would reduce output power and output voltage if widening thermolysis area of PCB is not considered. And when the output power is high, power transistor thermolysis issue must be considered.

RS2201 12W (12V/1A) DEMO CHARACTERISTIC TEST REPORT

Table 1 Input characteristic at full load

| Input voltage | I _{rms} (A) | P _{in} (W) | V _o (V) | I _o (A) | η | Specification | Test result |
|---------------|----------------------|---------------------|--------------------|--------------------|--------|---------------|-------------|
| 90V/63Hz | 0.163 | 14.9 | 12.202 | 1 | 81.9 | >75% | Pass |
| 115V/60Hz | 0.122 | 14.5 | 12.202 | 1 | 84.2 | | |
| 230V/50Hz | 0.056 | 14.5 | 12.201 | 1 | 84.2 | | |
| 264V/47Hz | 0.053 | 14.7 | 12.201 | 1 | 83.0 | | |

Table 2 Standby power at no load(4mA LED current)

| Input voltage | V _o (V) | P _{in} (W) | Specification | Test result |
|---------------|--------------------|---------------------|---------------|-------------|
| 90V/63Hz | 12.205 | 0.19 | <0.3W | Pass |
| 115V/60Hz | 12.205 | 0.20 | | |
| 230V/50Hz | 12.204 | 0.25 | | |
| 264V/47Hz | 12.204 | 0.27 | | |

Table 3 Line Regulation & Load Regulation

| Input voltage | No load | Half load | Full load | Specification | Test result |
|-----------------|---------|-----------|-----------|---------------|-------------|
| 90Vac/60HZ | 12.205 | 12.203 | 12.202 | | |
| 115Vac/60HZ | 12.205 | 12.203 | 12.202 | | |
| 132Vac/60HZ | 12.204 | 12.203 | 12.202 | | |
| 180Vac/50HZ | 12.205 | 12.203 | 12.201 | | |
| 230Vac/50HZ | 12.204 | 12.203 | 12.201 | | |
| 264Vac/50HZ | 12.204 | 12.202 | 12.201 | | |
| Line Regulation | 0.008% | | | <1% | Pass |
| Load Regulation | 0.033% | | | <5% | Pass |

Table 4 Line Regulation & Load Regulation

| Input voltage | No load | Full load | Specification | Test result | Note |
|---------------|---------|-----------|---------------|-------------|------|
| 90Vac/60HZ | 10.3mV | 23.4mV | <60mV | Pass | |
| 115Vac/60HZ | 12.5mV | 24.2mV | | Pass | |
| 230Vac/50HZ | 17.6mV | 26.8mV | | Pass | |
| 264Vac/50HZ | 19.4mV | 29.0mV | | Pass | |

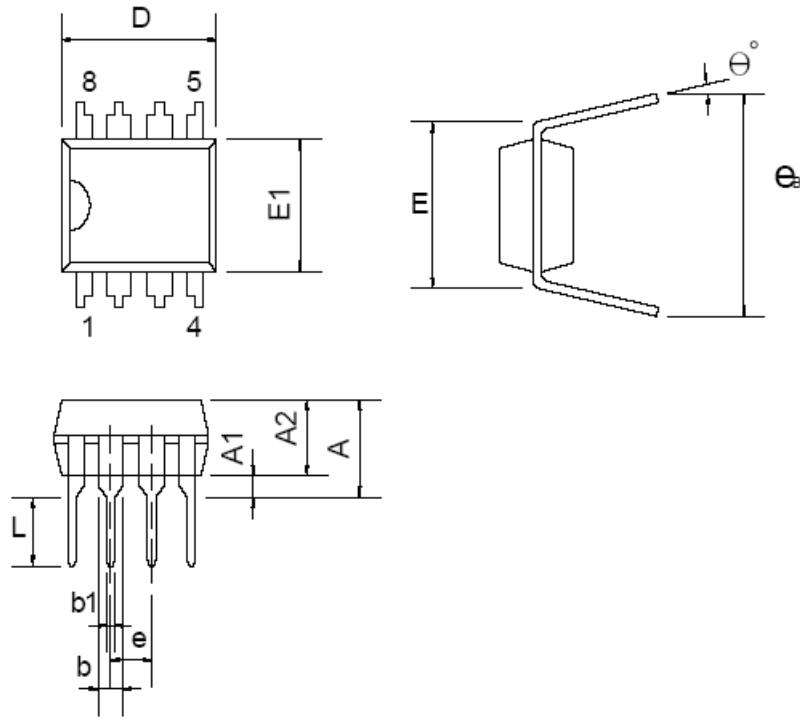
Note: Ripple & noise was measured at DC cord end(1.2M/18AWG)with a 0.1uF/100V ceramic cap connected in parallel with a 10uf/50V electrolytic cap. Bandwidth was limited to 200MHz.

Table 5

| Test Item | | Specification | Test result |
|-------------------------------|---------------------------------|---------------|-------------|
| Input characteristic | | | |
| Input current | | 0.3A Max. | 0.163A |
| Standby power | (264Vac,with LED (4mA current)) | <0.3W | 0.27W |
| Efficiency | | >75% | 81.9%(min) |
| Output characteristic | | | |
| Line regulation | | 1% | 0.008% |
| Load regulation | | 5% | 0.033% |
| Ripple & Noise | | 60mV | 29mV(max) |
| Over shoot & Under shoot | | 600mV | 350mV |
| Dynamic test | | 600mV | 300mV |
| Time sequence | | | |
| Turn on delay time | | <1S | 300mS(max) |
| Hold up time | | >10mS | 12.4mS |
| Rise time | | | 14.6 mS |
| Fall time | | | 11.7 mS |
| Protection | | | |
| Over voltage protection | | | Pass |
| Over current protection | | | 1.2~1.7A |
| Short circuit protection | | | Pass |
| 5. Brownout/Brownout recovery | | | Pass |

PACKAGE DEMENSIONS

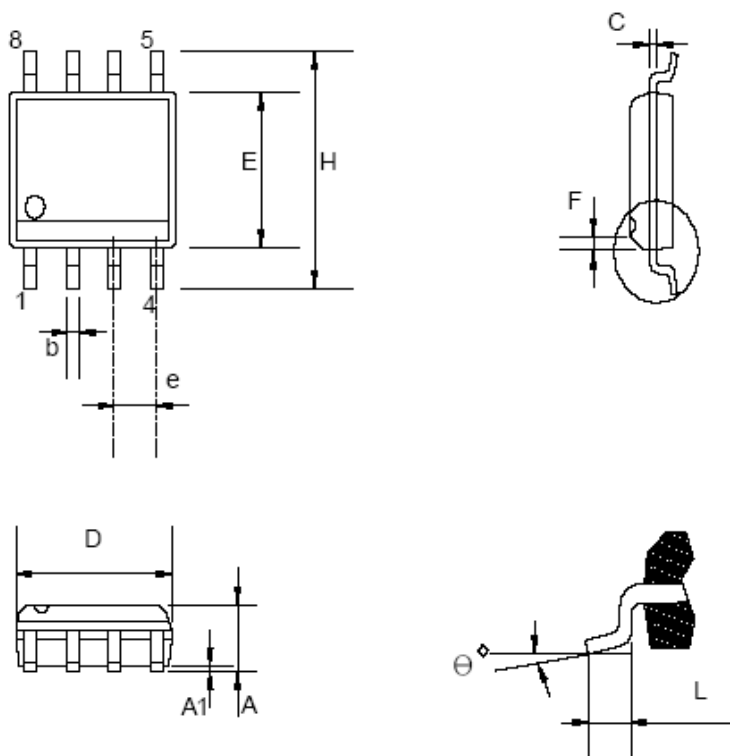
DIP-8L



Dimensions

| Symbol | Millimeters | | | Inches | | |
|----------------|-------------|-------|--------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 5.334 | | | 0.210 |
| A1 | 0.381 | | | 0.015 | | |
| A2 | 3.175 | 3.302 | 3.429 | 0.125 | 0.130 | 0.135 |
| b | | 1.524 | | | 0.060 | |
| b1 | | 0.457 | | | 0.018 | |
| D | 9.017 | 9.271 | 10.160 | 0.355 | 0.365 | 0.400 |
| E | | 7.620 | | | 0.300 | |
| E1 | 6.223 | 6.350 | 6.477 | 0.245 | 0.250 | 0.255 |
| e | | 2.540 | | | 0.100 | |
| L | 2.921 | 3.302 | 3.810 | 0.115 | 0.130 | 0.150 |
| eB | 8.509 | 9.017 | 9.525 | 0.335 | 0.355 | 0.375 |
| θ° | 0° | 7° | 15° | 0° | 7° | 15° |

SOP-8L



Dimensions

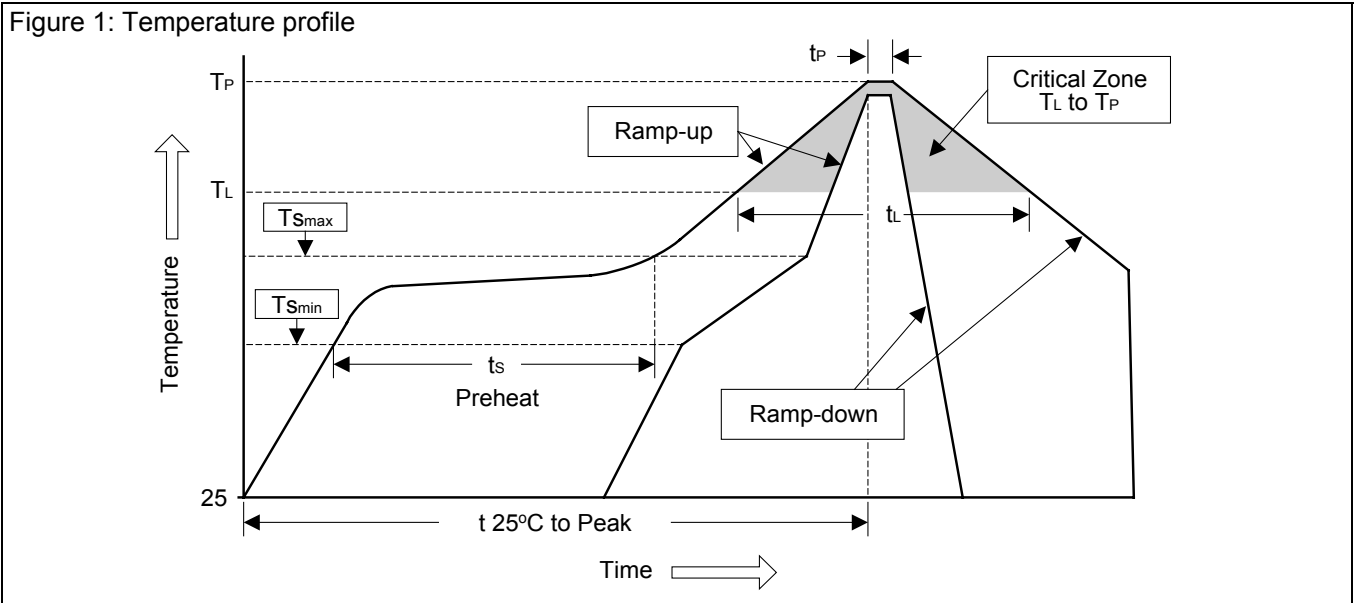
| Symbol | Millimeters | | | Inches | | |
|----------------|-------------|----------|-------|--------|----------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 1.346 | | 1.752 | 0.053 | | 0.069 |
| A1 | 0.101 | | 0.254 | 0.004 | | 0.010 |
| b | | 0.406 | | | 0.016 | |
| c | | 0.203 | | | 0.008 | |
| D | 4.648 | | 4.978 | 0.183 | | 0.196 |
| E | 3.810 | | 3.987 | 0.150 | | 0.157 |
| e | 1.016 | 1.270 | 1.524 | 0.040 | 0.050 | 0.060 |
| F | | 0.381X45 | | | 0.015X45 | |
| H | 5.791 | | 6.197 | 0.228 | | 0.244 |
| L | 0.406 | | 1.270 | 0.016 | | 0.050 |
| θ° | 0° | | 8° | 0° | | 8° |

Ordering Information

| PART NUMBER | PIN-PACKAGE |
|-------------|-------------|
| RS2201S | SOP-8L |
| RS2201P | DIP-8L |

Soldering Methods for Orister's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices



| Profile Feature | Sn-Pb Eutectic Assembly | Pb-Free Assembly |
|--|-------------------------|------------------|
| Average ramp-up rate (T _L to T _P) | <3°C/sec | <3°C/sec |
| Preheat | | |
| - Temperature Min (T _{Smin}) | 100°C | 150°C |
| - Temperature Max (T _{Smax}) | 150°C | 200°C |
| - Time (min to max) (ts) | 60~120 sec | 60~180 sec |
| T _{Smax} to T _L | | |
| - Ramp-up Rate | <3°C/sec | <3°C/sec |
| Time maintained above: | | |
| - Temperature (T _L) | 183°C | 217°C |
| - Time (t _L) | 60~150 sec | 60~150 sec |
| Peak Temperature (T _P) | 240°C +0/-5°C | 260°C +0/-5°C |
| Time within 5°C of actual Peak Temperature (t _P) | 10~30 sec | 20~40 sec |
| Ramp-down Rate | <6°C/sec | <6°C/sec |
| Time 25°C to Peak Temperature | <6 minutes | <8 minutes |

3. Flow (wave) soldering (solder dipping)

| Products | Peak temperature | Dipping time |
|------------------|------------------|--------------|
| Pb devices. | 245°C ±5°C | 5sec ±1sec |
| Pb-Free devices. | 260°C +0/-5°C | 5sec ±1sec |

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