

## 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.

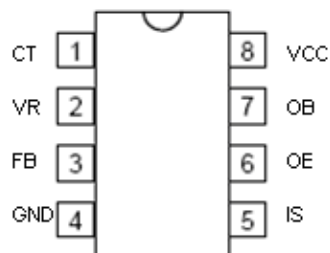
#### Features

- 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

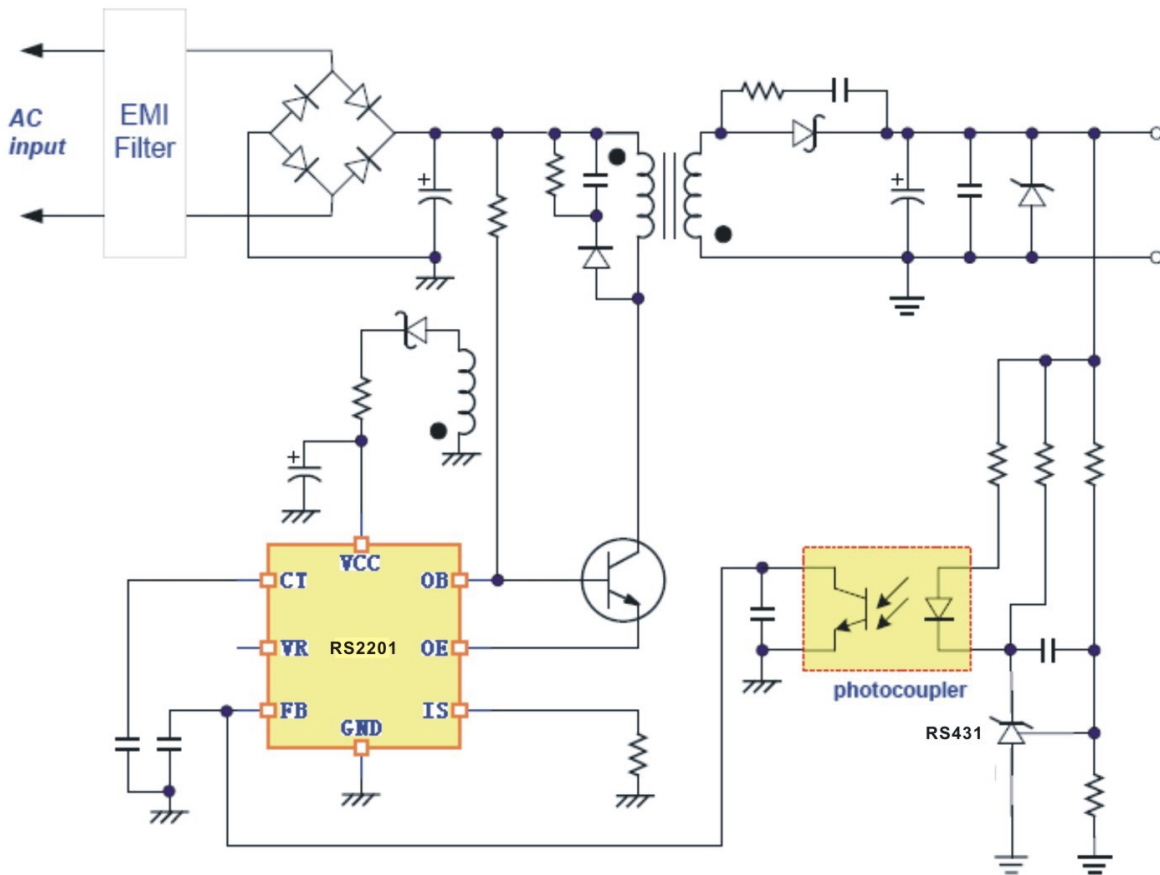
- Switching AC/DC Adaptor
- Battery Charger
- Open Frame Switching Power Supply
- Standby Power Supplies
- Set-Top Box Power Supplies
- 384X Replacement

#### 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.

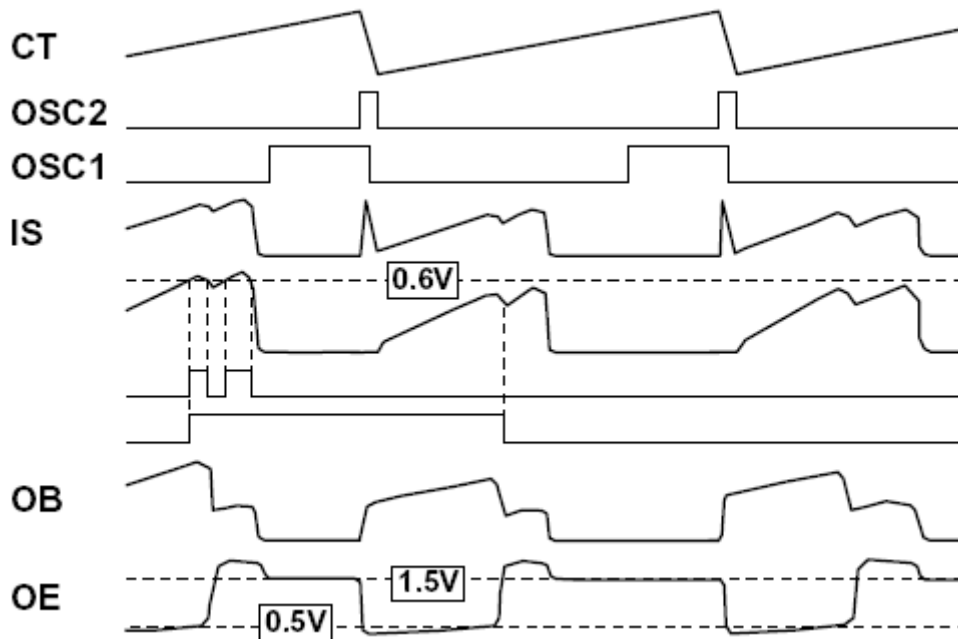


Fig.1 OPEN/CLOSED CYCLE WAVES IN NORMAL OPERATION

## 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.

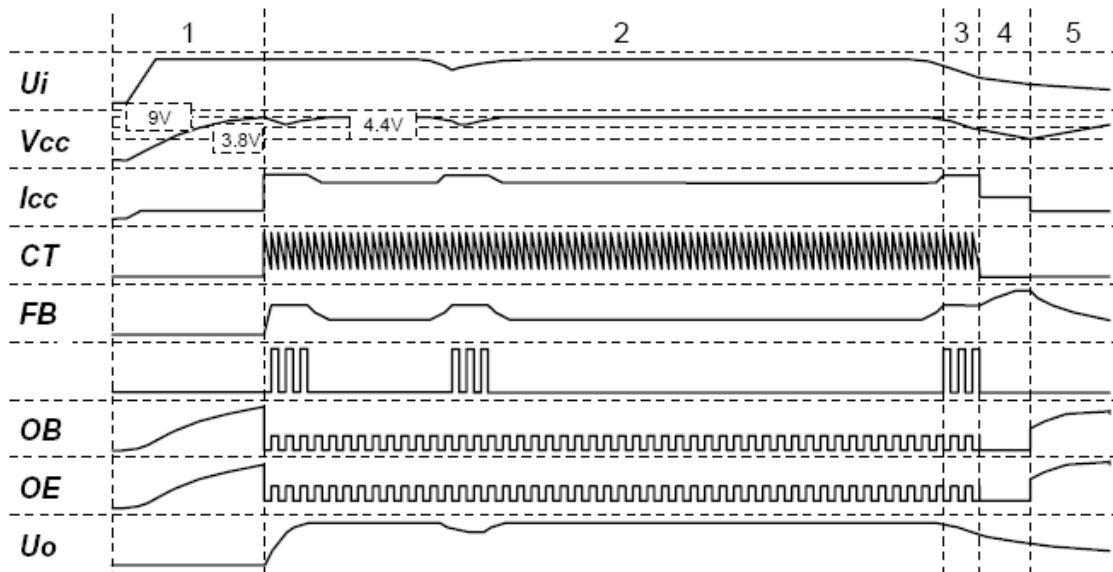


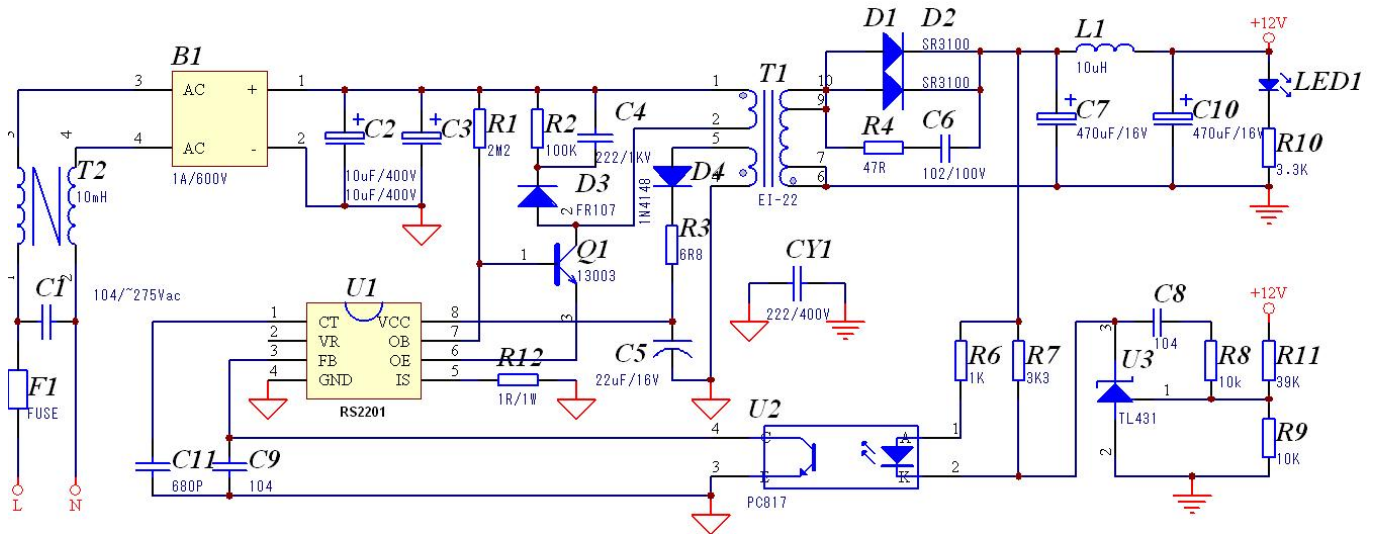
Fig.2 RS2201 ALL SIGNAL WAVES

- 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

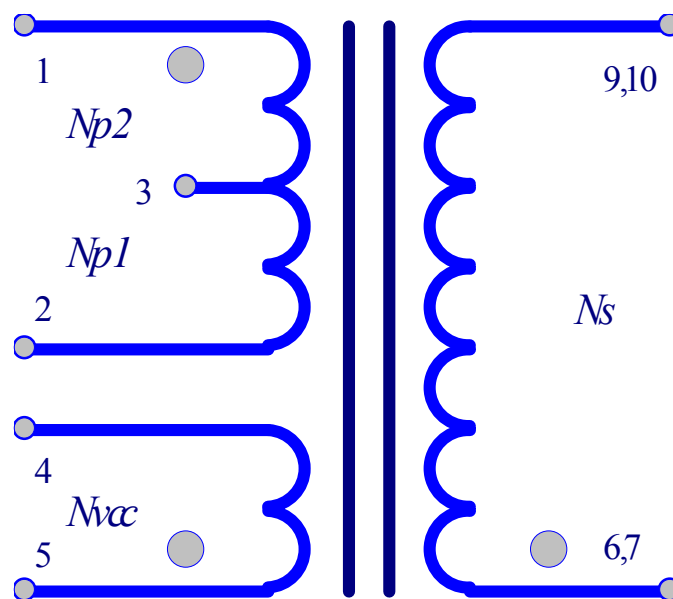
1) Bobbin & Pin : EI22(10PIN)

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  $\beta$  value of power transistor should reach 10@5Vce@0.8A considering of OB open current and the corresponding detecting resistor is 0.75 $\Omega$ . 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 <sub>rms</sub> (A)	P <sub>in</sub> (W)	V <sub>o</sub> (V)	I <sub>o</sub> (A)	$\eta$	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 <sub>o</sub> (V)	P <sub>in</sub> (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.**

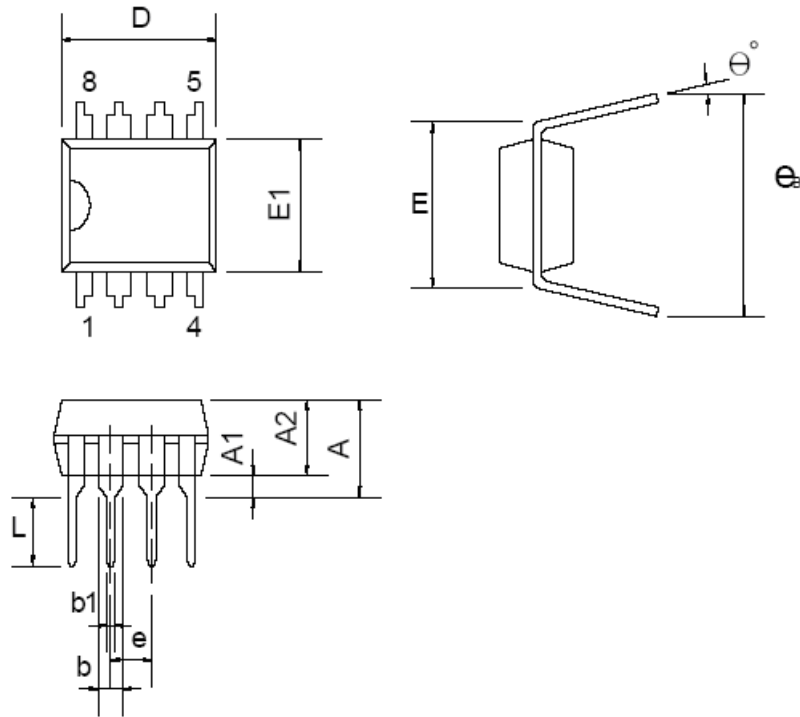
**Table 5**

Test Item	Specification	Test result
<b>Input characteristic</b>		
Input current	0.3A Max.	0.163A
Standby power	(264Vac,with LED (4mA current))	<0.3W
Efficiency	>75%	81.9%(min)
<b>Output characteristic</b>		
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
<b>Time sequence</b>		
Turn on delay time	<1S	300mS(max)
Hold up time	>10mS	12.4mS
Rise time		14.6 mS
Fall time		11.7 mS
<b>Protection</b>		
Over voltage protection		Pass
Over current protection		1.2~1.7A
Short circuit protection		Pass
5. Brownout/Brownout recovery		Pass



## PACKAGE DIMENSIONS

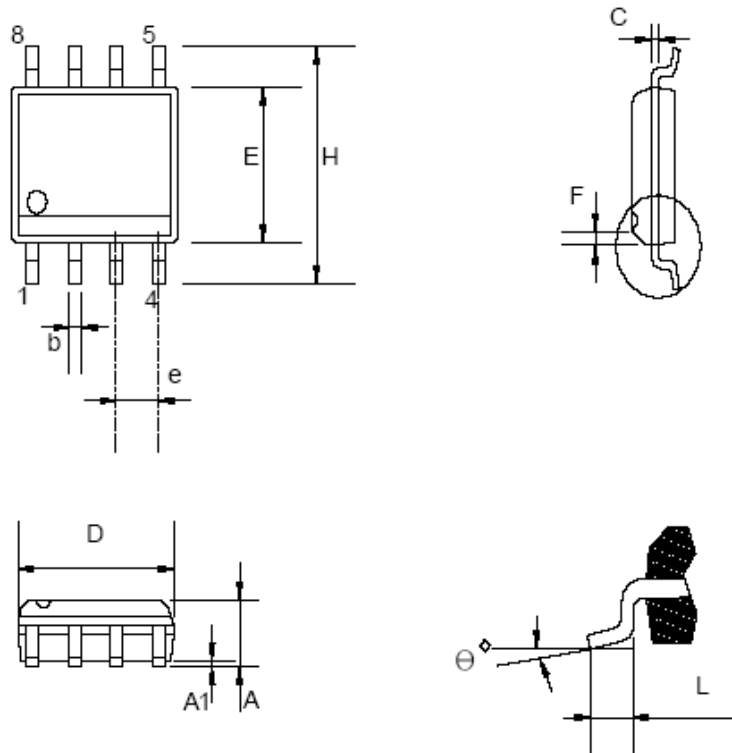
### DIP-8L



### 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
$\theta^\circ$	0°	7°	15°	0°	7°	15°

## SOP-8L



## Dimensions

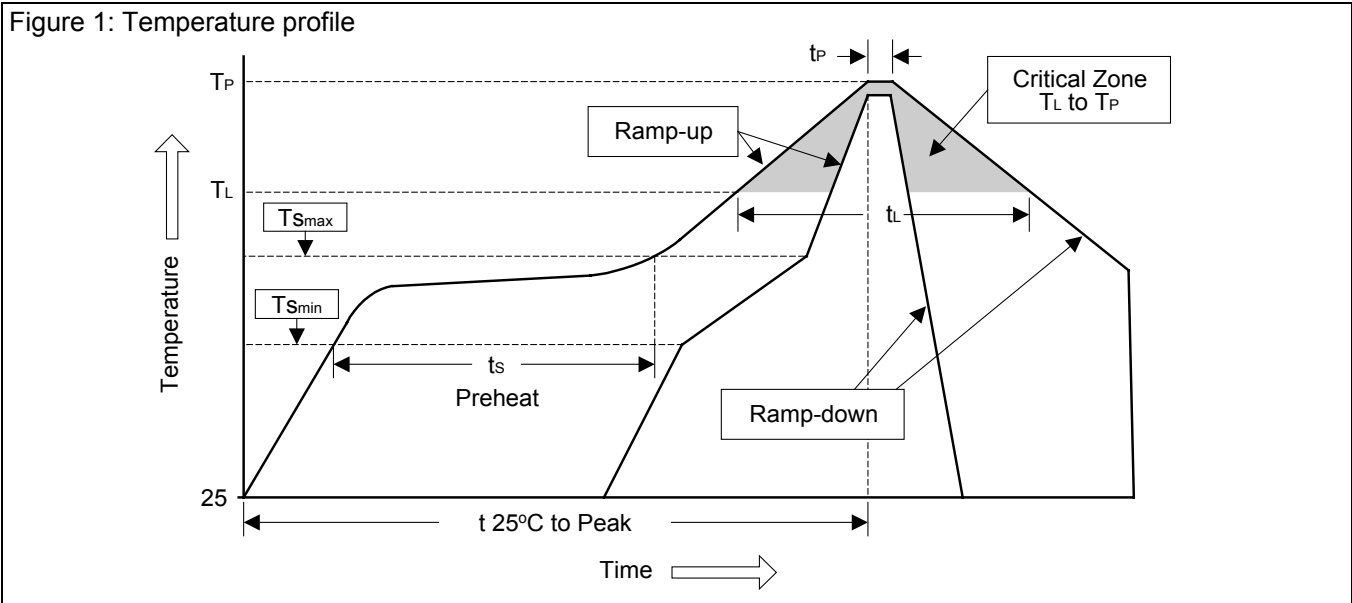
Symbol	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.346		1.752	0.053		0.069
A1	0.101		0.254	0.004		0.010
b		0.406			0.016	
c		0.203			0.008	
D	4.648		4.978	0.183		0.196
E	3.810		3.987	0.150		0.157
e	1.016	1.270	1.524	0.040	0.050	0.060
F		0.381X45			0.015X45	
H	5.791		6.197	0.228		0.244
L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