RS2022

Low Power OFF-Line SMPS Primary Switcher

The RS2022 combines a dedicated current mode PWM controller with a high voltage Power MOSFET on the same silicon chip.

Typical applications cover off line power supplies for battery charger adapters, standby power supplies for TV or monitors, auxiliary supplies for motor control, etc. The internal control circuit offers the following benefits:

- ◎ Large input voltage range on the VCC pin accommodates changes in auxiliary supply voltage. This feature is well adapted to battery charger adapter configurations.
- ◎ Automatic burst mode in low load condition.
- ◎ Over voltage protection in HICCUP mode.

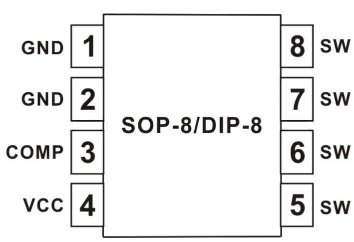
Features

- ◎ 85V to 265V wide range AC voltage input
- ◎ A 700V MOSFET on the same silicon chip
- ◎ Auto start up with high voltage current source
- ◎ PWM with current mode control
- ◎ 9V to 38V wide range VCC voltage
- ◎ Fixed 60KHz switching frequency
- ◎ Automatic skip cycle mode in low load condition
- ◎ Over temperature, over current and over voltage protection
- ◎ Auxiliary under voltage lockout with hysteresis

Applications

- ◎ Power AC/DC Adapters for Chargers
- ◎ DVD/VCD power supplies
- ◎ Electromagnetic Oven power supplies
- ◎ Air Conditioner power supplies
- ◎ STB power supplies
- ◎ AC/DC LED Driver Applications

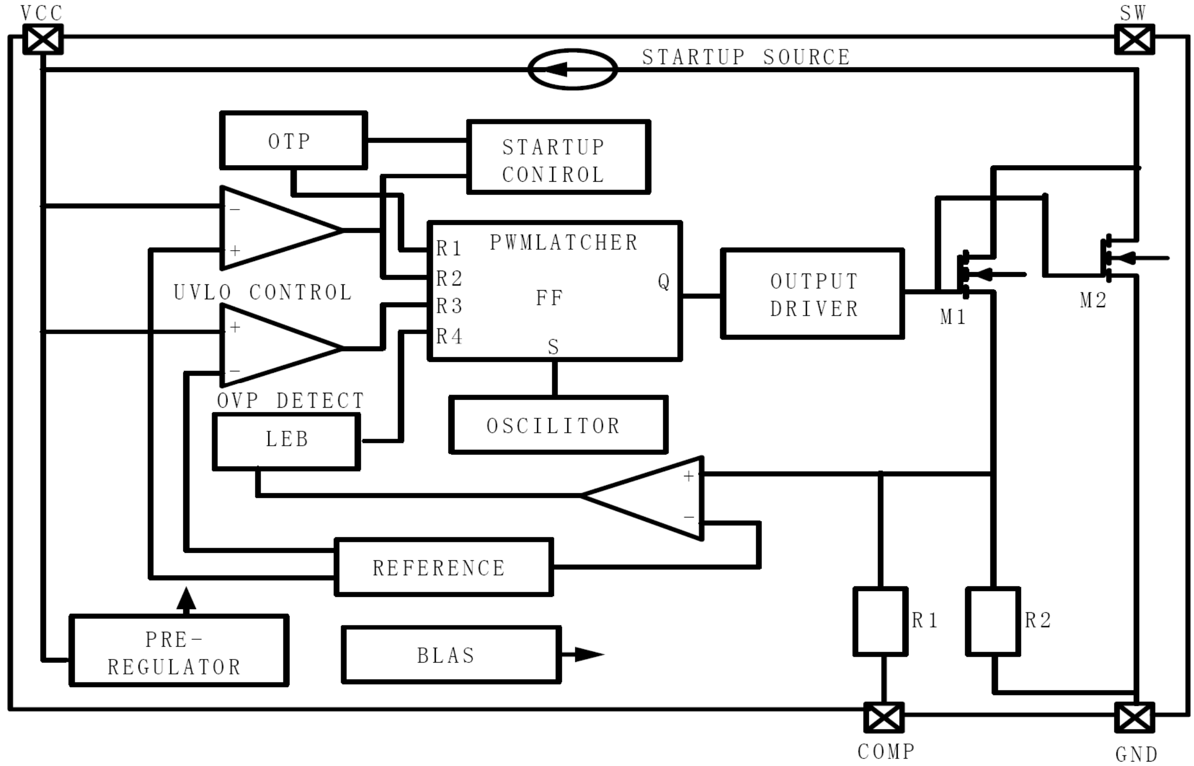
Pin Configurations



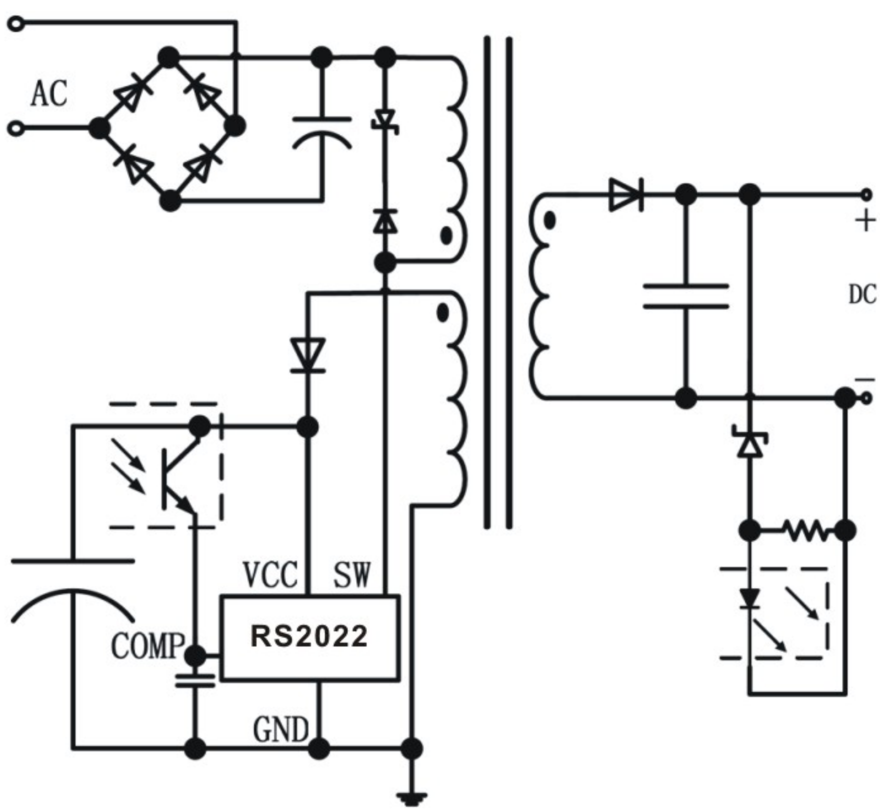
TYPE	SOP-8L	DIP-8L
European (195-265 Vac)	12W	20W
US (85-265 Vac)	7W	12W

Pin Number	Pin Name	Function Description
1, 2	GND	Sense FET source terminal on primary side and internal control ground.
3	COMP	Feedback input defines the peak drain MOSFET current.
4	VCC	Positive supply voltage input. Although connected to an auxiliary transformer winding, current is supplied from SW via an internal switch during startup (see Internal Block Diagram section). It is not until VCC reaches them UVLO upper threshold (14.5V) that the internal start-up switch opens and device power is supplied via the auxiliary transformer winding.
5, 6, 7, 8	SW	The SW pin is designed to connect directly to the primary lead of the transformer and is capable of switching a maximum of 700V.

Block Diagram



Typical Application Circuit



Absolute Maximum Ratings (Ta=25°C, unless otherwise specified)

Symbol	Parameter	Range	Units
V_{SW}	SW to GND Voltage (T_J =25-125°C)	-0.3 to 730	V
I_D	Continuous VDMOS Drain Current	Internally limited	A
VCC	Supply Voltage	0 to 50	V
I_{COMP}	Feedback Current	3	mA
V_{ESDMM}	Electrostatic Discharge: Machine Model (R=0Ω ; C=200pF)	200	V
V_{ESDHBM}	Electrostatic Discharge: HBM	2000	V
T_J	Junction Operating Temperature	Internally limited-	°C
T_C	Case Operating Temperature	-40 to +150	°C
T_{STG}	Storage Temperature	-55 to +150	°C

Electrical Characteristics (Power)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	VDMOS Breakdown Voltage	I_D=1mA; V_{COMP}=2V	730			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=500V; V_{COMP}=2V;			100	uA
R_{DSON}	Static Drain-Source on Resistance	V_{GS}=10V I_D=0.4A;		15	17	Ω
T_R	Rise Time	I_D=0.1A; V_{IN}=300V		50		ns
T_F	Fall Time	I_D=0.2A; V_{IN}=300V		100		ns
C_{OSS}	VDMOS Drain Capacitance	V_{DS}=25V		40		pF

Electrical Characteristics (Control) (Ta=25°C, VCC=18V, unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
UVLO SECTION						
V_{START}	VCC Start Threshold Voltage	V_{COMP} =0V	13	14.5	16	V
V_{STOP}	VCC Stop Threshold Voltage	V_{COMP} =0V	7	8	9	V
V_{HYS}	VCC Threshold Hysteresis		5.8	6.5	7.2	V
OSCILLATOR SECTION						
F_{OSC}	Initial Accuracy	$V_{STOP} \le VCC \le 35V$; $0 \le T_J \le 100°C$	54	60	66	KHz
ΔF/ΔT	Frequency Change With Temperature	$-25°C \le T_J \le +85°C$		±5	±10	%
FEEDBACK SECTION						
I_{COMP}	Feedback Shutdown Current	T_J =25°C, V_{COMP} = 0V		0.9		mA
R_{COMP}	COMP Pin Input Impedance	I_D =0mA		1.2		kΩ
CURRENT LIMIT (SELF-PROTECTION) SECTION						
G_{ID}	ICOMP to ID Current Gain			560		
I_{LIM}	Peak Current Limit	T_J = 25°C	0.56	0.70	0.84	A
T_D	Current Sense Delay to Turn-Off	I_D =0.2A			200	ns
T_B	Blanking Time				500	ns
T_{ONMIN}	Minimum Turn On Time				700	ns
PROTECTION SECTION						
T_{SD}	Thermal Shutdown Temperature		140	170		°C
T_{HYST}	Thermal Shutdown Hysteresis			40		°C
V_{OVP}	Over Voltage Protection		38	42	46	V
SUPPLY CURRENT SECTION						
I_{CH}	Startup Charging Current			-1		mA
I_{CHOFF}	Start Up Charging Current in Thermal Shutdown	VCC=5V; V_{DS} =100V $T_J > T_{SD}$			0.2	mA
I_{OP0}	Operating Supply Current (Control Part Only) Switching	V_{COMP} = 0V		4.5		mA
I_{OP1}	Operating Supply Current (Control Part Only) Not Switching	V_{COMP} = 2V		3	5	mA

Functional Description

1. Startup

This device includes a high voltage start up current source connected on the SW of the device. As soon as a voltage is applied on the input of the converter, this start up current source is activated and to charge the VCC capacitor as long as VCC is lower than VSTART. When reaching VSTART, the start up current source is cut off by UVLO&TSD and the device begins to operate by turning on and off its main power MOSFET. As the COMP pin does not receive any current from the opto-coupler, the device operates at full current capacity and the output voltage rises until reaching the regulation point where the secondary loop begins to send a current in the opto-coupler. At this point, the converter enters a regulated operation where the COMP pin receives the amount of current needed to deliver the right power on secondary side.

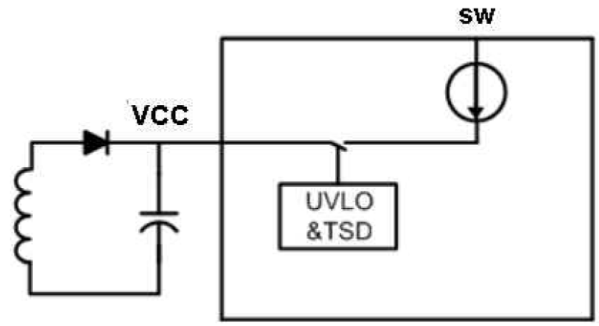
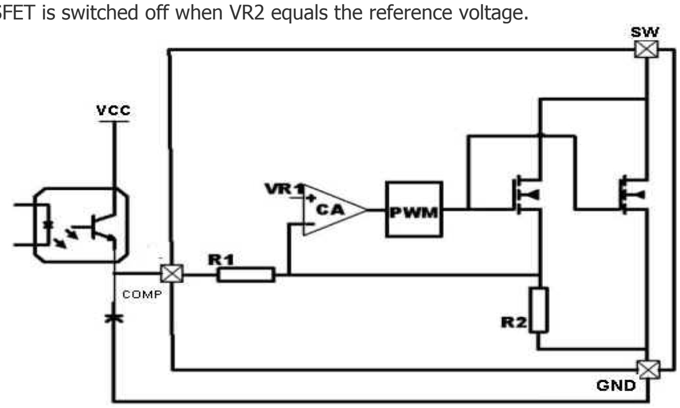


Fig 1 Startup circuit

2. Feedback

A feedback pin controls the operation of the device. Unlike conventional PWM control circuits which use a voltage input, the COMP pin is sensitive to current. **Figure 2** presents the internal current mode structure. The Power MOSFET delivers a sense current which is proportional to the main current. R2 receives this current and the current coming from the COMP pin. The voltage across R2 VR2 is then compared to a fixed reference voltage. The MOSFET is switched off when VR2 equals the reference voltage.



3. Leading Edge Blanking (LEB)

At the instant the internal Sense FET is turned on, there usually exists a high current spike through the Sense FET, caused by the primary side capacitance and secondary side rectifier diode reverse recovery. Excessive voltage across the sense resistor would lead to false feedback operation in the current mode PWM control. To counter this effect, the device employs a leading edge blanking (LEB) circuit. This circuit inhibits the PWM comparator for a short time (typically 500ns) after the Sense FET is turned on.

4. Under Voltage Lock Out

Once fault condition occurs, switching is terminated and the Sense FET remains off. This causes VCC to fall. When VCC reaches the UVLO stop voltage, 8V, the protection is reset and the internal high voltage current source charges the VCC capacitor. When VCC reaches the UVLO start voltage, 14.5V, the device resumes its normal operation. In this manner, the auto-restart can alternately enable and disable the switching of the power Sense FET until the fault condition is eliminated.

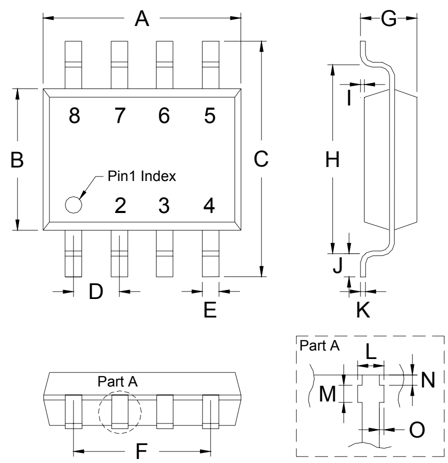
5. Thermal Shutdown (TSD)

The Sense FET and the control IC are integrated in the same chip, making it easier for the control IC to detect the temperature of the Sense FET. When the temperature exceeds approximately 170°C, thermal shutdown is activated, the device turn off the Sense FET and the high voltage current source to charge VCC. The device will go back to work when the lower threshold temperature about 140°C is reached.

6. Over Voltage Protection (OVP)

In case of malfunction in the secondary side feedback circuit, or feedback loop open caused by a defect of solder, the current through the opto-coupler transistor becomes almost zero. Because excess energy is provided to the output, the output voltage may exceed the rated voltage, resulting in the breakdown of the devices in the secondary side. In order to prevent this situation, an over voltage protection (OVP) circuit is employed. If VCC exceeds 42V, OVP circuit is activated resulting in termination of the switching operation. In order to avoid undesired activation of OVP during normal operation, VCC should be properly designed to be below 42V.

SOP-8L Dimension

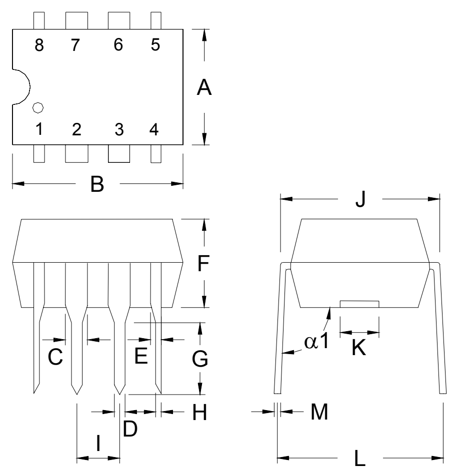


8-Lead SOP-8L Plastic Surface Mounted Package
Package Code: S

DIM	Min.	Max.
A	4.85	5.10
B	3.85	3.95
C	5.80	6.20
D	1.22	1.32
E	0.37	0.47
F	3.74	3.88
G	1.45	1.65
H	4.80	5.10
I	0.05	0.20
J	0.30	0.70
K	0.19	0.25
L	0.37	0.52
M	0.23	0.28
N	0.08	0.13
O	0.00	0.15

*: Typical, Unit: mm

DIP-8 Dimension



8-Lead DIP-8
Plastic Package
Package Code: P

DIM	Min.	Max.
A	6.29	6.40
B	9.22	9.32
C	-	*1.52
D	-	*1.27
E	-	*0.99
F	3.25	3.35
G	3.17	3.55
H	0.38	0.53
I	2.28	2.79
J	7.49	7.74
K	-	*3.00
L	8.56	8.81
M	0.229	0.381
α1	94°	97°

*: Typical, Unit: mm

Ordering Information

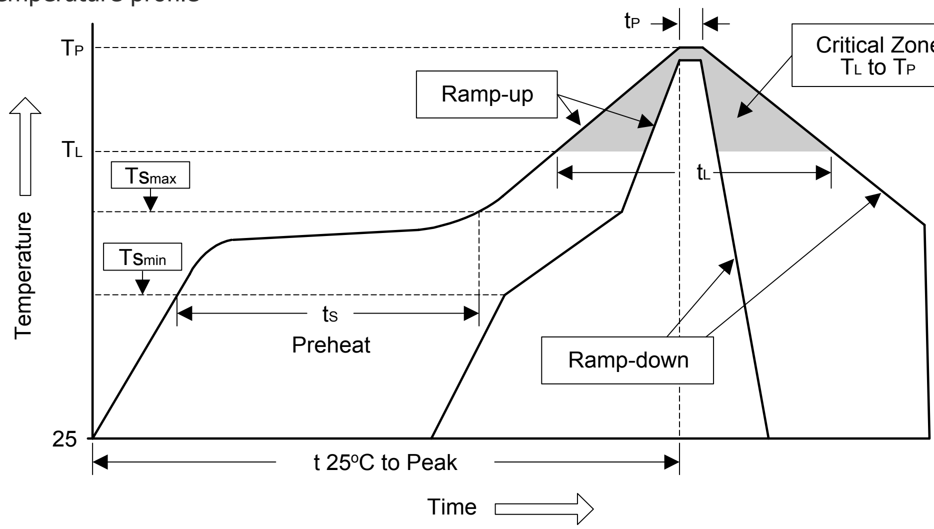
PART NUMBER	PACKAGE
RS2022S	SOP-8L
RS2022P	DIP-8L

Soldering Methods for Orister's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%

2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



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 (Ts_{min}) - Temperature Max (Ts_{max}) - Time (min to max) (ts)	 100°C 150°C 60~120 sec	 150°C 200°C 60~180 sec
Tsmax to T_L - Ramp-up Rate	 <3°C/sec	 <3°C/sec
Time maintained above: - Temperature (T_L) - Time (t_L)	 183°C 60~150 sec	 217°C 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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