

RS2111/RS2112

Primary-Side Regulation PWM Power Switch

Description

RS2111/RS2112 is an offline PWM Power switch for low power AC/DC charger and adaptor applications. It operates in primary-side sensing and regulation. Consequently, opto-coupler and TL431 could be eliminated from design. Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the figure below.

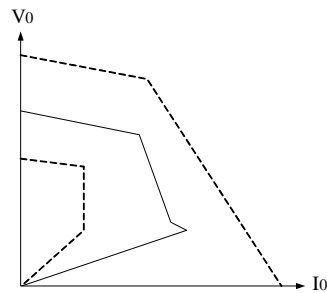


Fig1. Typical CC/CV Curve

In CC control, the current and output power setting can be adjusted externally by the sense resistor R_s at CS pin. In CV control, multi-mode operations are utilized to achieve high performance and high efficiency. Device operates in fixed frequency mode at large load conditions, frequency reduction mode at light/medium load and 'Extended burst mode' at No/light load conditions.

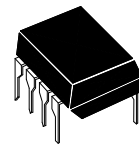
RS2111/RS2112 offers power on soft start control and complete protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over-voltage clamp and UVLO, fail-safe protection for open loop fault condition. Excellent EMI performance is achieved with Orister proprietary frequency Jiggling technique together with soft switching control at the totem pole gate drive output with No-Y Cap design.

Features

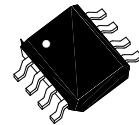
- Primary-side Sensing and Regulation With No 431 and Opto-coupler
- Multi-mode operation for High Efficiency
- Programmable CV and CC Regulation
- Adjustable Constant Current and Output Power setting
- Frequency Jiggling and Adjustable Gate Drive Greatly Improved EMI
- Power on Soft-start Time (4ms)
- Burst mode Control for Improved Efficiency and Minimum standby Design
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- VDD Over Voltage Shutdown and Clamp
- Auto-restart in Over Voltage condition
- Fail-safe protection for open loop fault condition
- Compatible with OB2211/OB2212
- Pb-Free SOP-8L & DIP-8L

Applications

- Low Power AC/DC offline SMPS
- Cell Phone Charge
- Digital Cameras Charger
- Small Power Adaptor
- Auxiliary Power for PC, TV etc.
- Linear Regulator/RCC Replacement



8-Lead Plastic DIP-8
Package Code: P

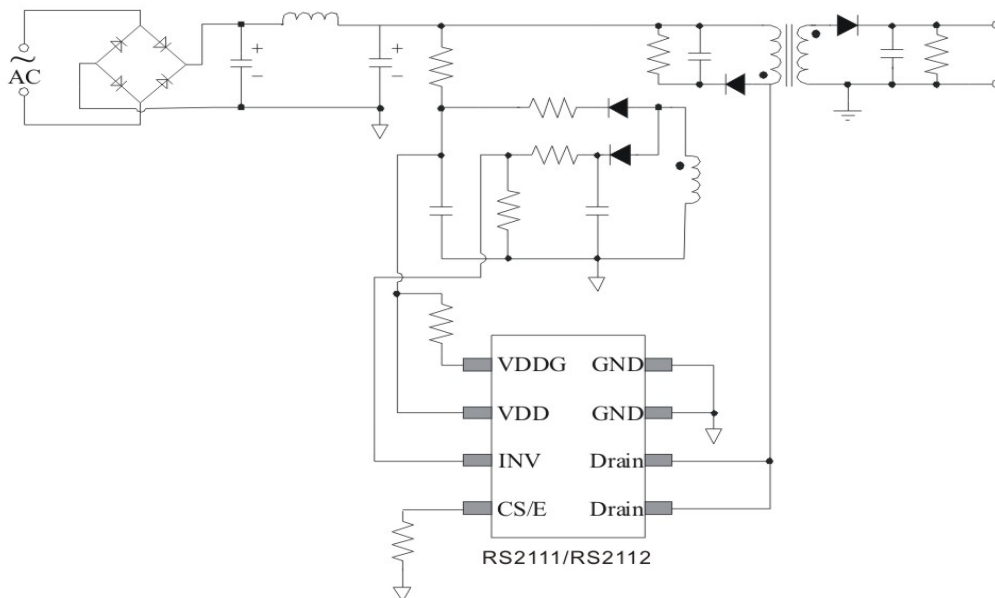


8-Lead Plastic SOP-8
Package Code: S

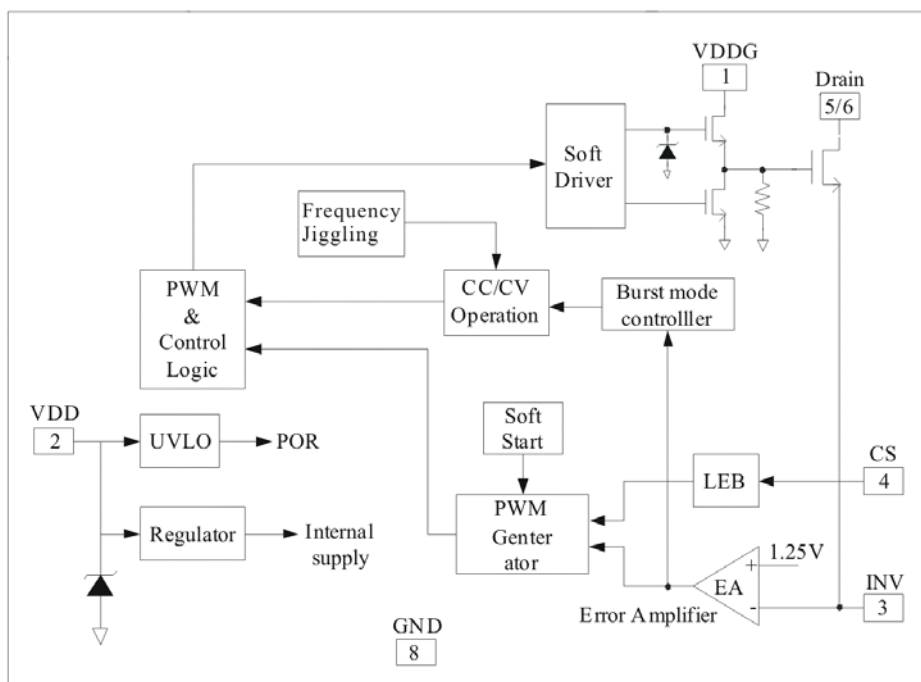
Pin Connections

Pin Name	I/O	Description
PIN 1: VDD-G	P	Internal Gate Driver Power Supply
PIN 2: VDD	P	IC DC power supply Input
PIN 3: INV	I	Inverting input of error amplifier (EA). Connected to resistor divider from primary sensing winding reflecting output voltage. PWM duty cycle is determined by EA output and current sense signal at pin4.
PIN 4: CS	I	Current sense input
PIN 5 & 6: DRAIN	O	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer.
PIN 7 & 8: GND	P	Ground

Typical Application Circuit



Block Diagram



Absolute Maximum Rating ^(Note)

Parameter	Value	Unit
Drain Voltage (off state)	-0.3 to 650	V
VDD Voltage	-0.3 to 35	V
VDD-G Input Voltage	-0.3 to 35	V
VDD Clamp Continuous Current	10	mA
FB Input Voltage	-0.3 to 7	V
Sense Input Voltage	-0.3 to 7	V
Min/Max Operating junction Temperature T _J	-20 to 150	°C
Min/Max Storage Temperature T _{stg}	-55 to 160	°C
Lead Temperature (Soldering, 10secs)	260	°C

Note: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Output Power Table

Package	230VAC±15%	85-265VAC
	Open Frame ¹	Open Frame ¹
SOP-8	10W	8W
DIP-8	20W	12W

Notes: Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50 °C ambient.

Electrical Characteristics (Ta=25 °C unless otherwise noted, V_{DD} = 16V)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I _{DD_ST}	Standby current	V _{DD} =13V		5	10	uA
I _{DD_OP}	Operation Current	Operation supply current INV=1.25V, CS=0V, V _{DD} =V _{DDG} =20V		1.0	2.0	mA
UVLO _(ON)	V _{DD} Under Voltage Lockout Enter		7.5	8.5	9.5	V
UVLO _(OFF)	V _{DD} Under Voltage Lockout Exit		14.0	15	16.0	V
OVP _(ON)	Over voltage protection voltage	CS=0V, INV=1V Ramp up V _{DD} until gate clock is off	28.5	30.0	31.5	V
V _{DD_clamp}	I _{DD} =10mA			33		V
Current Sense Input Section						
T _{LEB}	LEB time			540		ns
V _{th_oc}	V _{TH_OC_test}		780	820	860	mV
T _{d_oc}	Propagation delay			330		ns
Z _{SENSE_IN}	Input Impedance			50		KΩ
T _{ss}	Soft start time			4		ms
CV Section						
Freq	Normal mode frequency		45	50	55	KHz
Freq_burst	Burst Mode Base Frequency			22		KHz
Δf/Freq	Frequency Jiggling range			±4		%
CC Section						
Freq	Oscillation Frequency	Minimum frequency		12		KHz
		Maximum frequency		50		KHz
Error Amplifier section						
V _{ref_EA}	Reference voltage for EA		1.21	1.25	1.29	V
G _{dc}	DC gain of the EA			50		dB
GBW	Unity gain bandwidth			37.5		KHz
Power MOSFET Section						
BV _{dss}	Mos Drain-Source Breakdown Voltage	V _{GS} =0V, I _{DS} =250uA	600	650		V
R _{DS(on)}	Static Drain to Source On Resistance	V _{GS} =10V, I _{DS} =1A		4.5	5.5	Ω

OPERATION DESCRIPTION

RS2111/RS2112 are cost effective PWM power switch optimized for off-line low power AC/DC applications including battery chargers and adaptors. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary CC control and built-in error amplifier can achieve a good CC/CV performance.

Startup Current and Start up Control

Startup current of RS2111/RS2112 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

Operating Current

The operating current of RS2111/RS2112 is as low as 1mA. Good efficiency is achieved with the low operating current together with 'Extended burst mode' control features.

Soft Start

MCD 6221 features an internal 4ms soft start to minimize the component electrical over-stress during power on startup. As soon as VDD reaches UVLO(OFF), the control algorithm will ramp peak current voltage threshold gradually from nearly zero to normal setting of 0.82V. Every restart is a soft start.

CC/CV operation

RS2111/RS2112 is designed to produce good CC/CV control characteristic as shown in the Fig.1. In charger applications, a discharged battery charging starts in the CC portion of the curve until it is nearly full charged and smoothly switches to operate in CV portion of the curve.

In an AC/DC adapter, the normal operation occurs only on the CV portion of the curve. The CC portion provides added cycle-by-cycle current limiting protection. In CV operation, the output voltage is sensed signal controls the duty cycle through a built-in error amplifier (EA).

To support RS2111/RS2112 proprietary CC/CV control, system needs to be designed in DCM mode for flyback system. When INV is equivalent or larger than 1.25V, the system works in CV control. Otherwise, the system works in CC control.

Error Amplifier (EA)

Connected to a resistor divider from the primary side sensing winding, the inverting input of the Error Amplifier (EA) is compared to an internal reference voltage of 1.25V to regulate the output voltage. The EA output is internally connected to the PWM generator and control the duty cycle.

Adjustable CC point and Output Power

In RS2111/RS2112, the CC point and output power can be externally adjusted by external current sense resistor R_s at CS pin. The output power is adjusted through CC point change. The larger R_s , the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Fig.2.

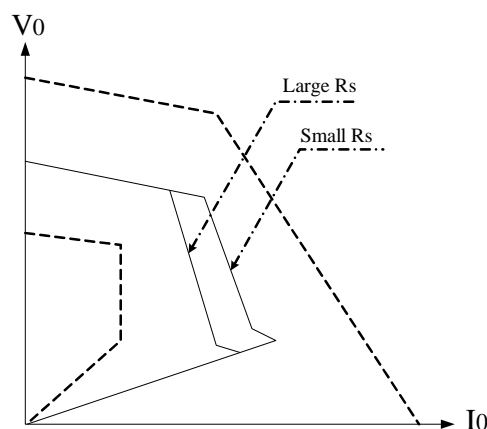


Fig.2 Adjustable output power by changing R_s

Burst Mode Operation

At light load or zero load condition, most of the power dissipation in a switching mode power supply is from switch loss, the core loss of the transformer and the loss on the snubber circuit. The magnitude of power loss is in proportion to the switching frequency. Lower switching frequency leads to the reduction on the power loss and thus conserves the energy.

RS2111/RS2112 self adjusts the switching frequency according to the loading condition. The switch frequency is reduced at light/no load condition to improve the conversion efficiency. At light load/no load condition, the output of the Error amplifier (EA) drops below the burst mode threshold level and device enters Burst Mode control. The frequency control also eliminates the audio noise at any loading conditions.

Operation switching frequency

The switching frequency of RS2111/RS2112 is internally set and adjusted according to CC/CV operation. No external frequency setting components are required.

Frequency Jiggling for EMI improvement

The frequency Jiggling/jittering (switching frequency modulation) is implemented in MCD6211. The oscillation frequency is modulated with a pseudo random source so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore eases the system design.

Current sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in RS2111/RS2112 current mode PWM control. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal power MOSFET on state due to snubber diode reverse recovery and surge current of power MOSFET due to Drain/source Cap so that the external RC filtering on sense input is no longer needed. The PWM duty cycle is determined by the current sense input voltage and the EA output voltage.

Adjustable Driver Capability

The internal power MOSFET in RS2111/RS2112 is driven by a dedicated gate driver for power switch control. Too weak the gate drive strength results in higher conduction and switch loss of MOSFET while too strong gate drive compromises EMI.

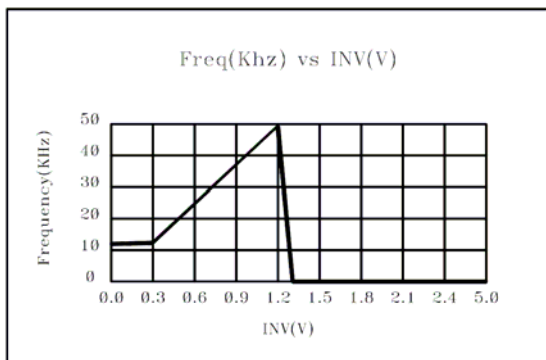
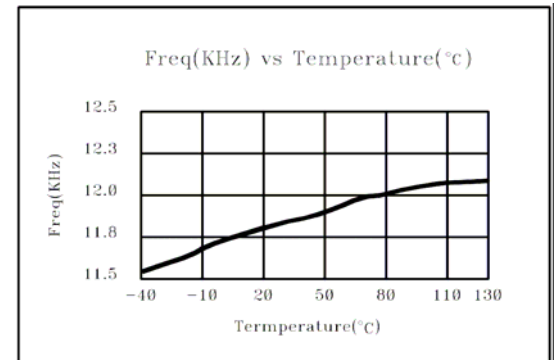
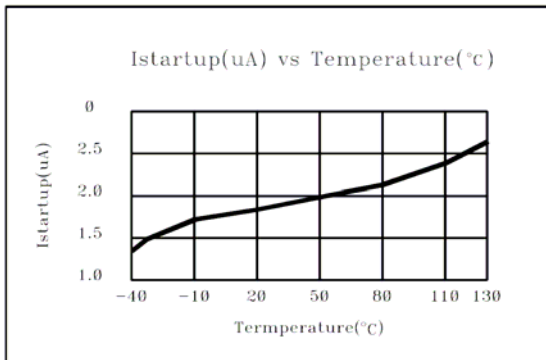
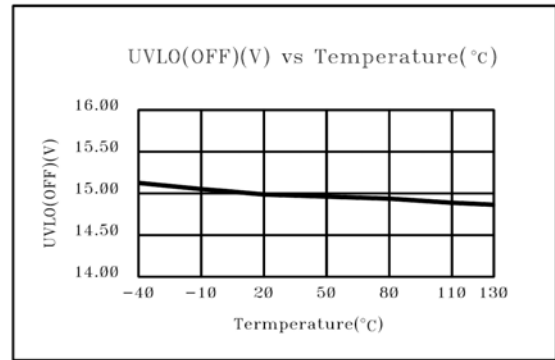
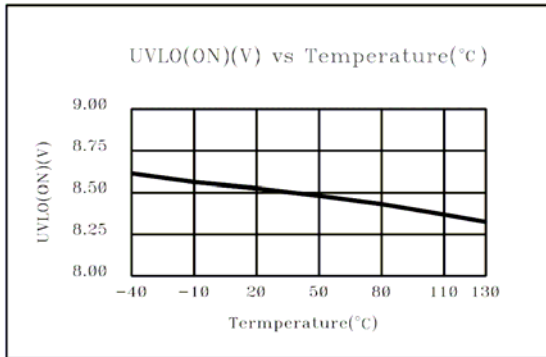
A good tradeoff is achieved through the built-in totem pole gate design with right output strength control. The gate drive strength can be adjusted externally by a resistor connected between VDD and VDDG. The low idle loss and good EMI system design is possible with this dedicated control scheme.

Protection Control

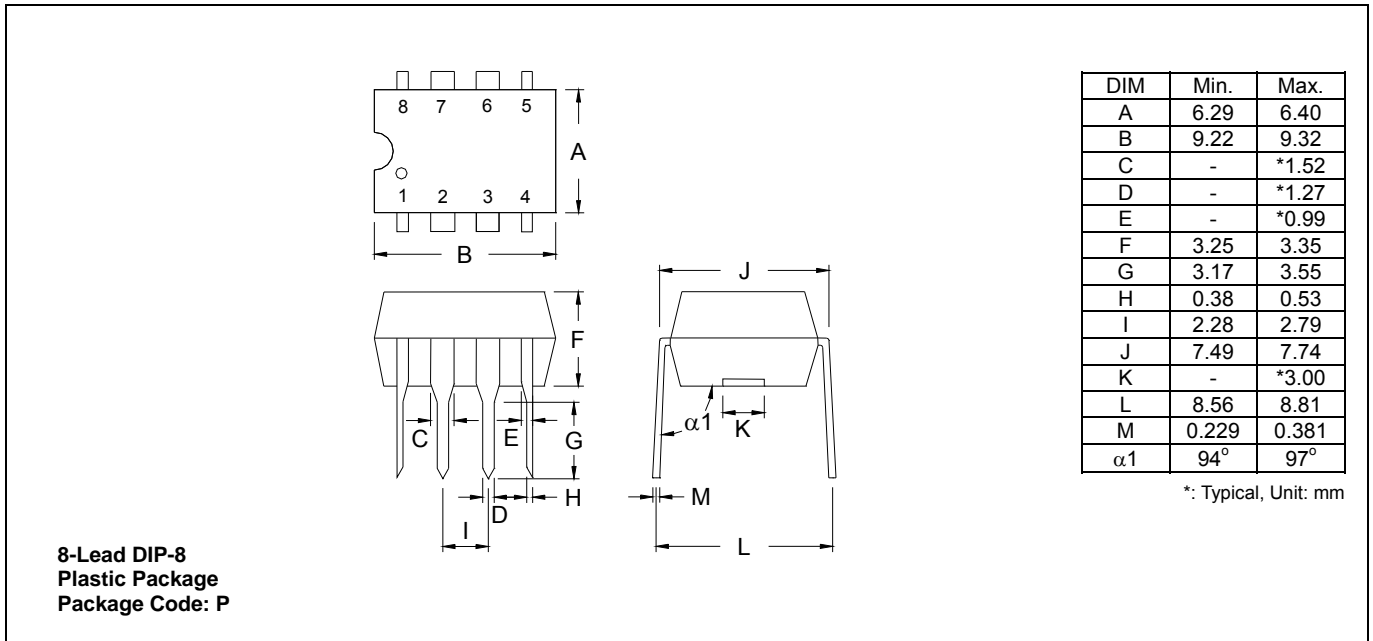
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD over voltage protection and clamp, Power on Soft Start, and Under Voltage Lockout on VDD (UVLO).

VDD is supplied by transformer auxiliary winding output. PWM output of RS2111/RS2112 is shut down when VDD is higher than 30V due to over voltage protection triggering. The output of RS2111/RS2112 is shut down when VDD drops below UVLO(ON) limit and Switcher enters power on start-up sequence thereafter.

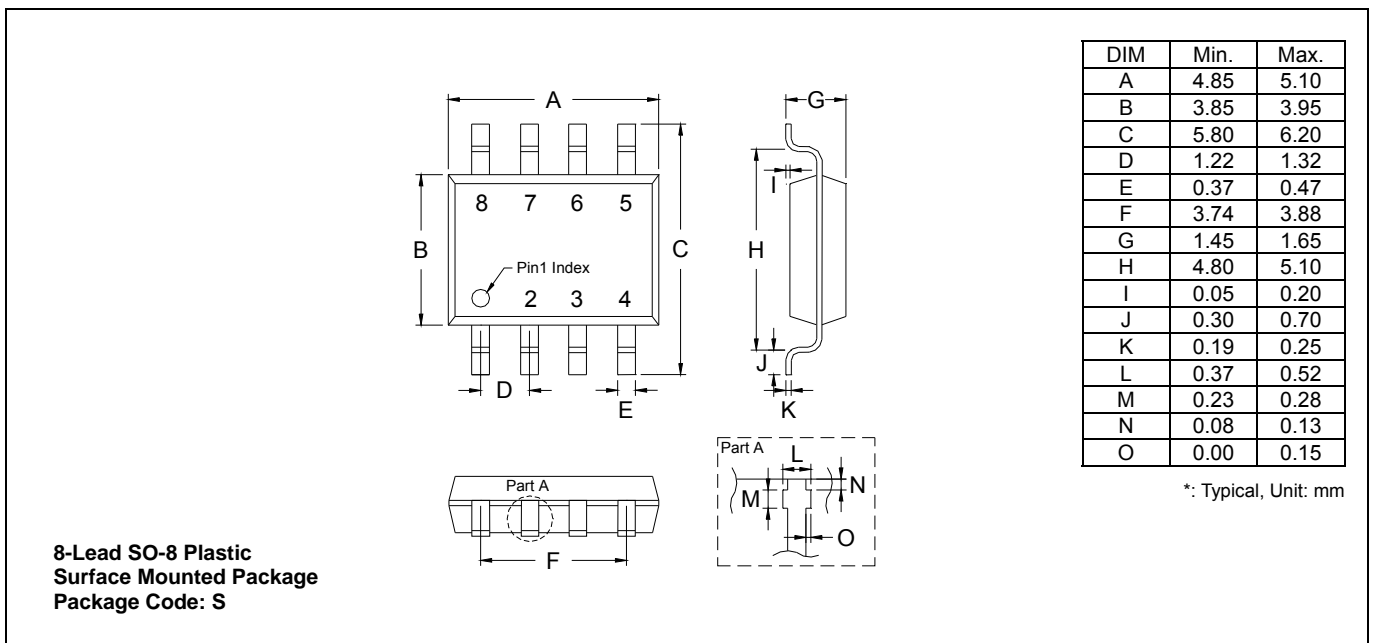
Characteristics Curve



DIP-8 Dimension



SOP-8 Dimension



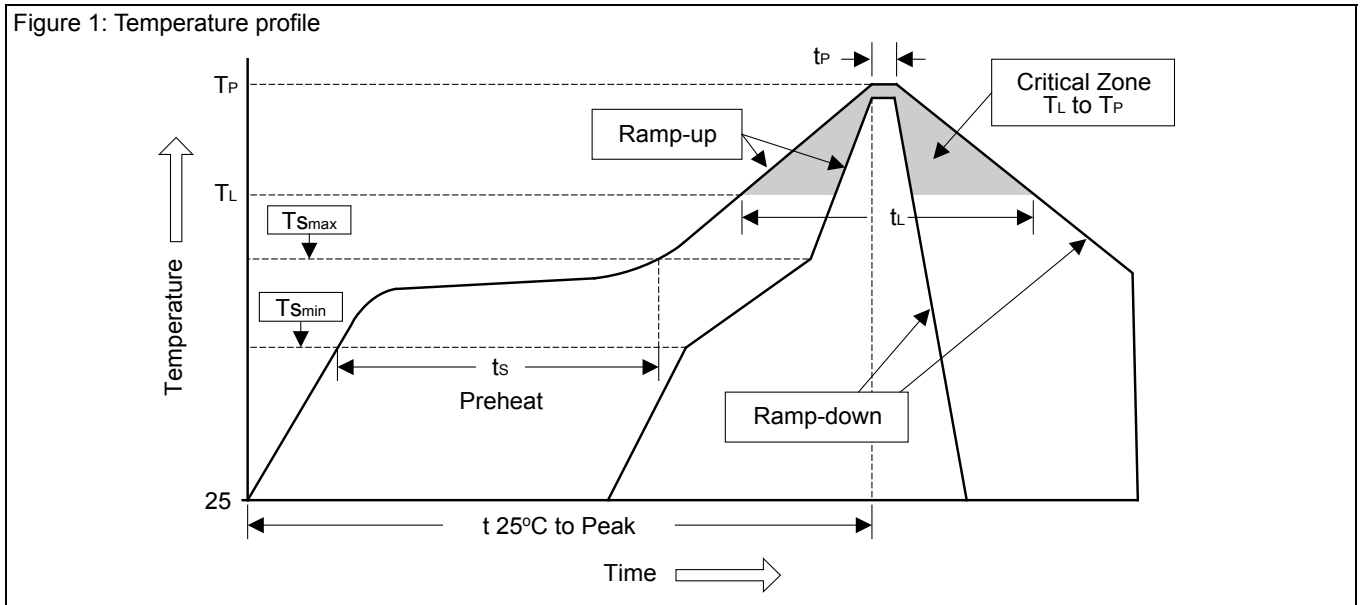
Ordering Information

Part Number	Package
RS2111S / RS2112S	SOP-8
RS2111P / RS2112P	DIP-8

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 (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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