

Low BOM Cost Power Switch

Features

- Internal 650V Power MOSFET
- Current Mode Control
- Green Mode Control
- 45KHz Switching Frequency
- Frequency Jittering
- Standby Power <math>< 0.15\text{W}</math>
- Over Load Protection
- VCC Over Voltage Protection
- Internal Over Temperature Protection
- Adjustable Output voltage
- SOP-7/DIP-7 and SOP-8/DIP-8 Package

Description

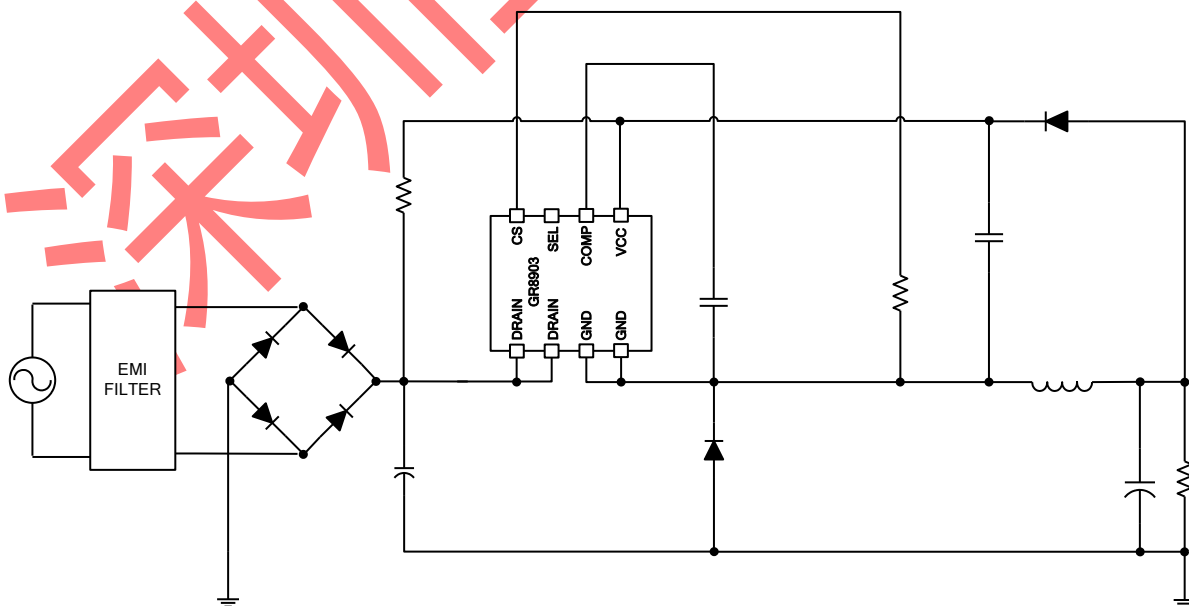
The GR8903 is a highly integrated, current mode power switch with green mode control for low BOM cost buck and flyback application. It provides functions of low standby power consumption ($< 0.15\text{W}$), green-mode power-saving operation for green design. The specific adjustable output voltage function provides the feasibility for wider output application. The integrated functions of VCC OVP, OLP, and internal OTP prevent the circuit being damaged from the abnormal conditions.

It minimizes the components counts and is available in SOP-7/DIP-7 and SOP-8/DIP-8 package. Those make it an ideal design for low cost application.

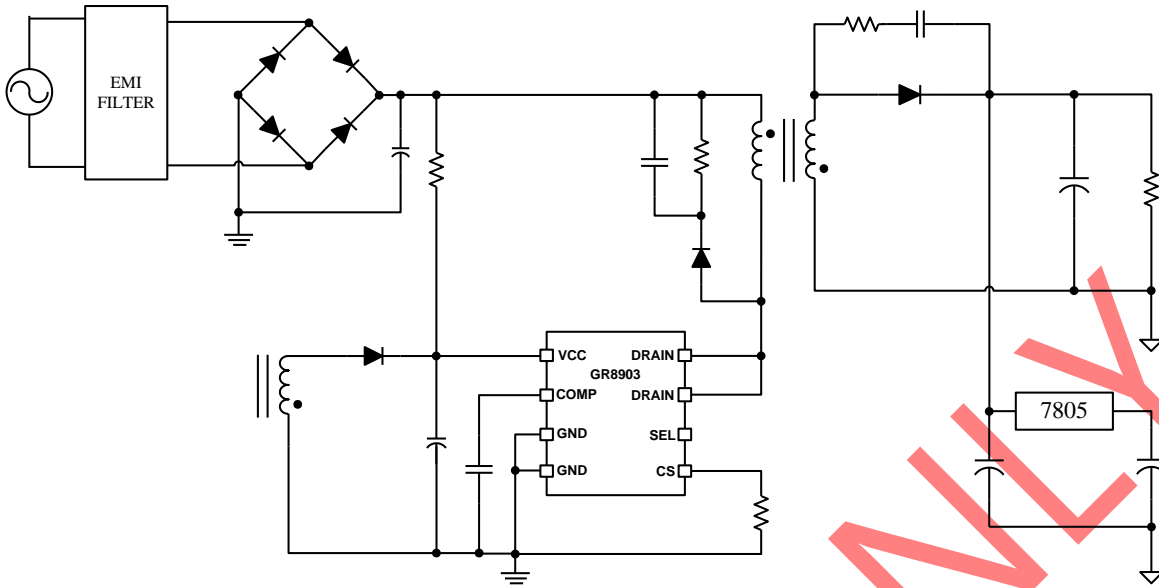
Application

- Home Appliance

Application Information



Inversed Buck Application


Flyback Application

Ordering and Marking Information

GR8903

Package Code
 JA: DIP-7
 KA: SOP-7
 J: DIP-8
 K: SOP-8

RoHS Code
 G: Green (Halogen Free) Device

GR8903
XX XXX

Code 1 ← ↓ → Serial No.
 Code 2

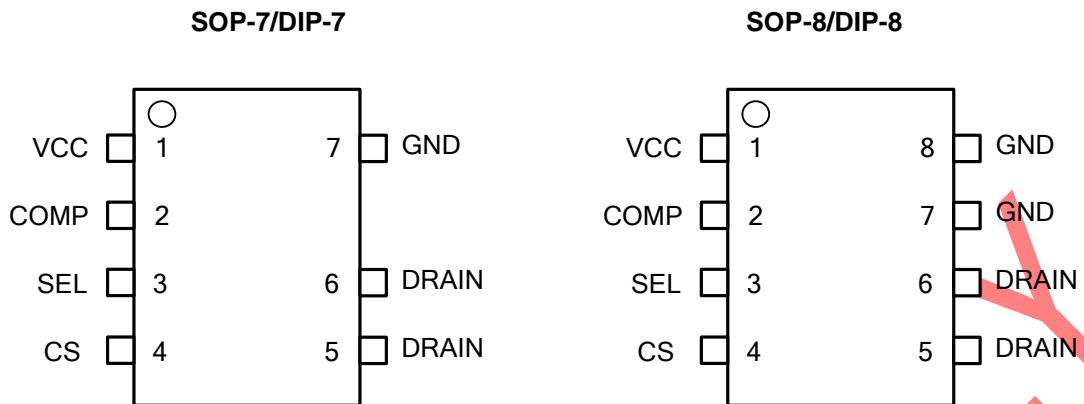
| | | | | | | | | | |
|--------|------|------|------|------|-----|--|--|--|--|
| Code 1 | 8 | 9 | A | B | | | | | |
| Year | 2008 | 2009 | 2010 | 2011 | | | | | |
| Code 2 | 1 | 2 | 3 | 4 | ... | | | | |
| Month | Jan. | Feb. | Mar. | Apr. | | | | | |

| | | | |
|------|------|------|------|
| G | H | I | J |
| 2016 | 2017 | 2018 | 2019 |
| 9 | A | B | C |
| Sep. | Oct. | Nov. | Dec. |

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Pin Configuration

TOP VIEW



Pin Description

| Pin No. | | Name | Function |
|--------------------|--------------------|-------|---|
| SOP-7/DIP-7 | SOP-8/DIP-8 | | |
| 1 | 1 | VCC | Power supply pin |
| 2 | 2 | COMP | Voltage Feedback pin |
| 3 | 3 | SEL | Output Voltage Select pin. The output voltage will be 18V as the SEL pin is floating. The output voltage will be 12V as the SEL pin is connected to GND directly. And the output voltage will be 24V as the SEL is connected to GND with a 20kΩ resistor. |
| 4 | 4 | CS | Current sense pin, connect to sense the power MOS current |
| 5,6 | 5,6 | DRAIN | Drain of internal HV MOSFET |
| 7 | 7,8 | GND | Ground |

Absolute Maximum Ratings

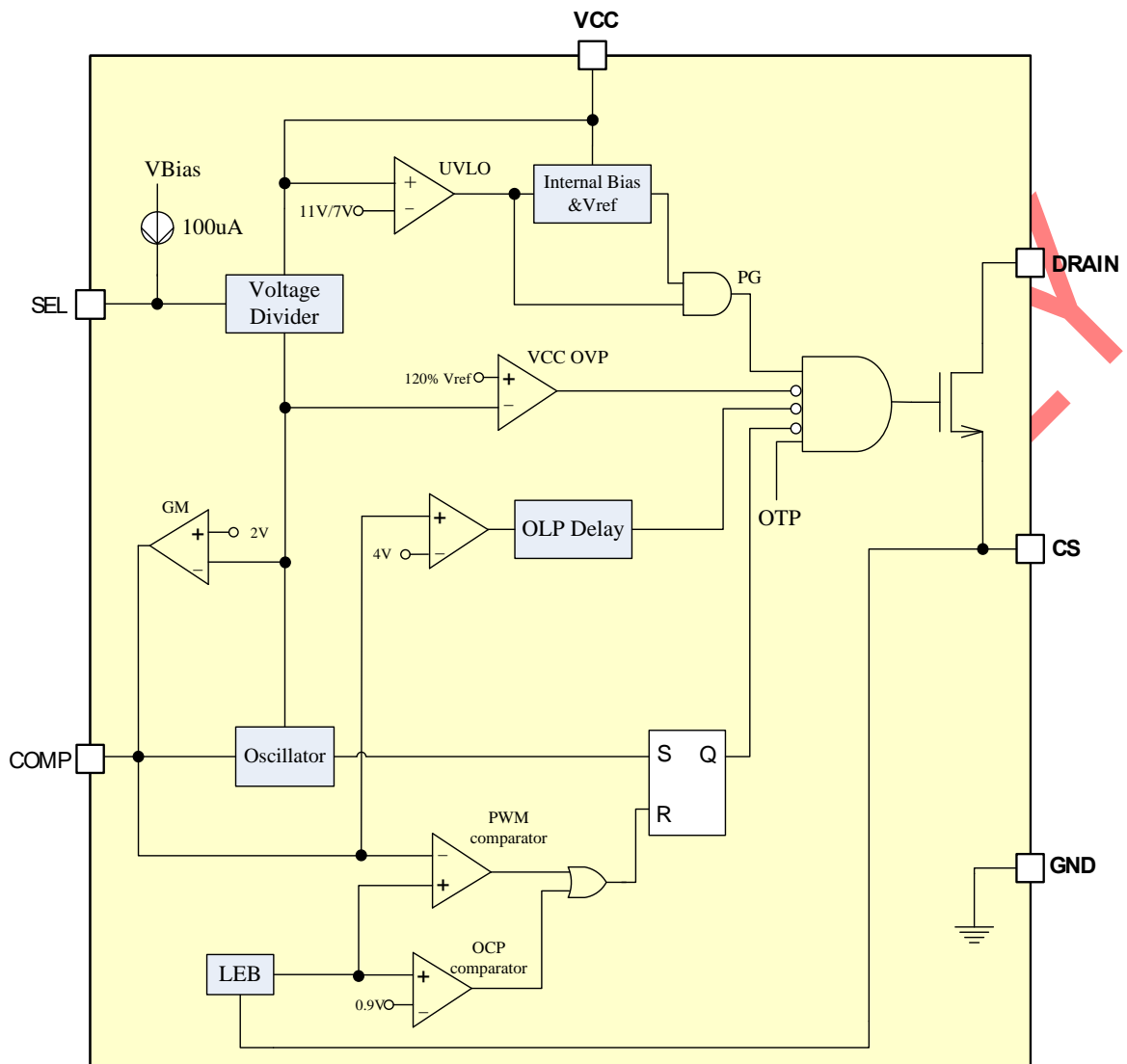
| | | |
|--|-------|----------------|
| Supply Voltage VCC | ----- | 30V |
| COMP, SEL, CS | ----- | -0.3 ~ 7V |
| DRAIN Voltage | ----- | -0.3~650V |
| Junction Temperature | ----- | 150°C |
| Operating Ambient Temperature | ----- | -20°C to 85°C |
| Storage Temperature Range | ----- | -65°C to 150°C |
| Lead Temperature (Soldering,10sec) | ----- | 260°C |
| ESD Voltage Protection, Human Body Model (Exclude Drain pin) | ----- | 2.0 kV |
| ESD Voltage Protection, Machine Model | ----- | 200 V |

Recommended Operating Conditions

| Item | Min | Max | Unit |
|--------------------|-------|-----|------|
| Supply voltage VCC | 7 | 25 | V |
| VCC capacitor | 4.7 | 10 | uF |
| COMP pin capacitor | 0.022 | 0.1 | uF |

| R _{SEL} | Output Voltage |
|------------------|----------------|
| 0Ω | 12V |
| Floating | 18V |
| 20kΩ | 24V |

Block Diagram



Electrical Characteristics (VCC = 15V & TA = 25°C, unless otherwise specified.)

| Parameter | Test Conditions | Min | Typ | Max | Unit |
|-----------|-----------------|-----|-----|-----|------|
|-----------|-----------------|-----|-----|-----|------|

VCC SECTION

| | | | | | |
|-----------------------|------------------------------------|------|------|------|----|
| Start-Up Current | VCC<UVLO on | | 8 | 15 | μA |
| Operating Current | Vcomp=0V | | 0.7 | | mA |
| | Vcomp=2.5V | | 1 | | mA |
| | Protection tripped (OVP, OLP, OCP) | | 0.7 | | mA |
| On Threshold Voltage | | 10.5 | 11.0 | 11.5 | V |
| Off Threshold Voltage | | 6.5 | 7.0 | 7.5 | V |
| VCC OVP | 120% VCC Level | 115 | 120 | 125 | % |
| | De-bounce Time(*) | | 100 | | μs |

OSCILLATOR SECTION

| | | | | | |
|------------------------------------|---------|----|-----|----|-----|
| Switching Frequency | VCC=18V | 40 | 45 | 50 | KHz |
| Frequency Jittering | | | ±6 | | % |
| Minimum Frequency | VCC=20V | | 500 | | Hz |
| Voltage stability (VCC=12~25V) (*) | | | | 3 | % |

SEL

| | | | | | |
|-------------------|--|--|-----|--|----|
| I _{SEL} | | | 100 | | μA |
| De-bounce time(*) | | | 100 | | μs |

CURRENT-SENSE SECTION

| | | | | | |
|-------------------------|--|------|-----|------|----|
| Input Impedance | | 1 | | | MΩ |
| Peak Current Limitation | | 0.85 | 0.9 | 0.95 | V |
| Leading Edge Blanking | | | 350 | | ns |
| Delay to Output | | | 100 | | ns |
| Max On time | | | 23 | | μs |

ERROR AMPLIFIER (COMP pin)

| | | | | | |
|-----------------------|--|--|-------|--|------|
| Reference Voltage | | | 2 | | V |
| Trans-conductance(*) | | | 150 | | μmho |
| Output Sink Current | | | 15.0 | | μA |
| Output Source Current | | | -15.0 | | μA |
| Output Clamp Voltage | | | 5.4 | | V |
| OLP triple level | | | 4 | | V |
| OLP delay time | | | 60 | | ms |

MOSFET SECTION (GR8903)

| | | | | | |
|---------------------|--|-----|----|--|---|
| BV _{dss} | | 650 | | | V |
| R _{ds(on)} | | | 12 | | Ω |



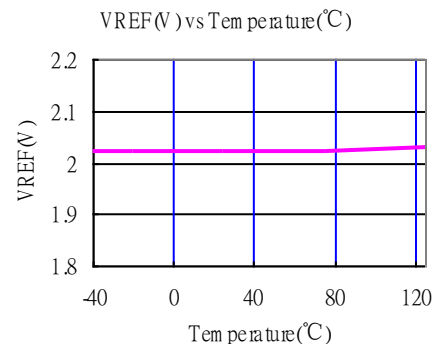
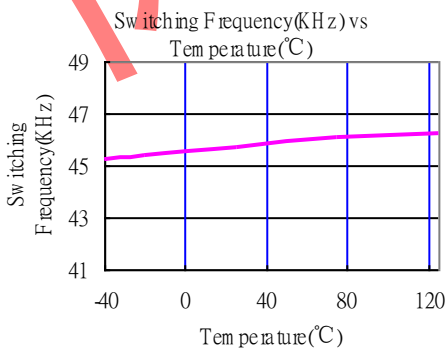
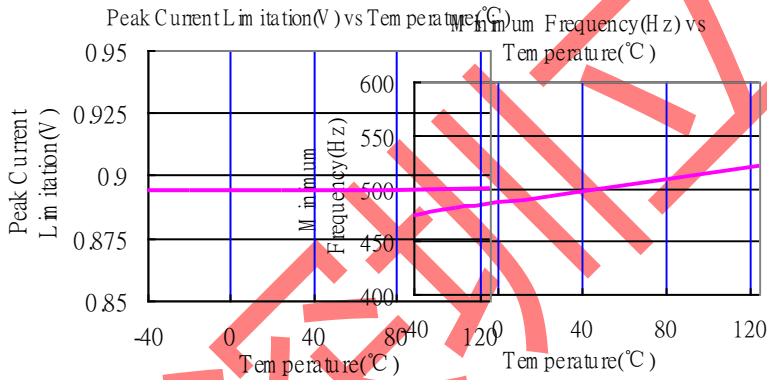
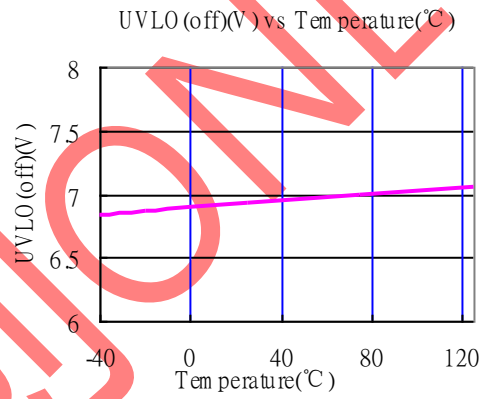
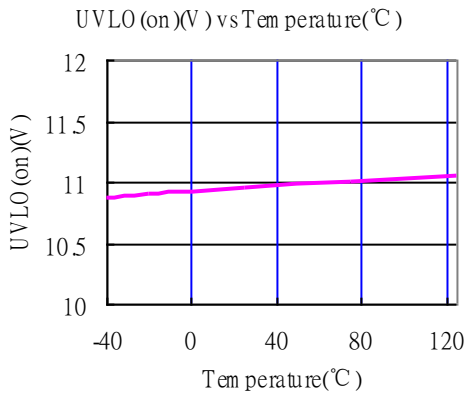
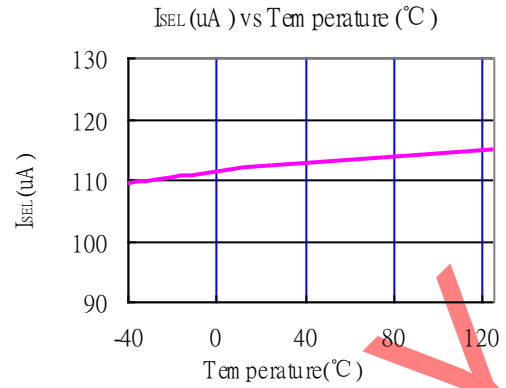
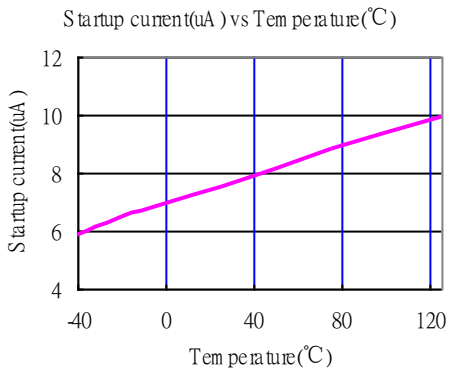
ON-CHIP OVER TEMPERATURE PROTECTION

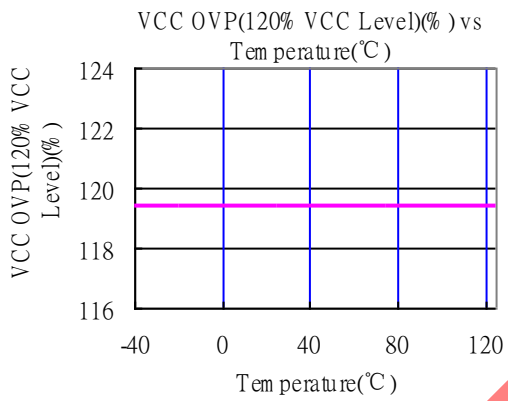
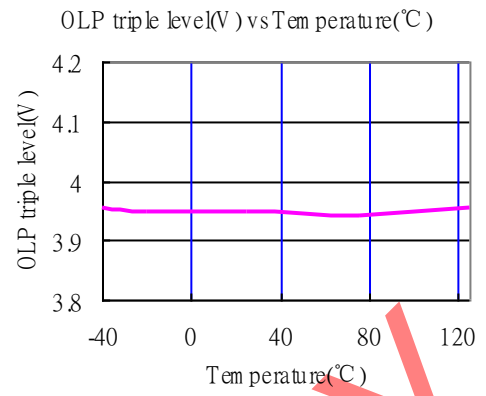
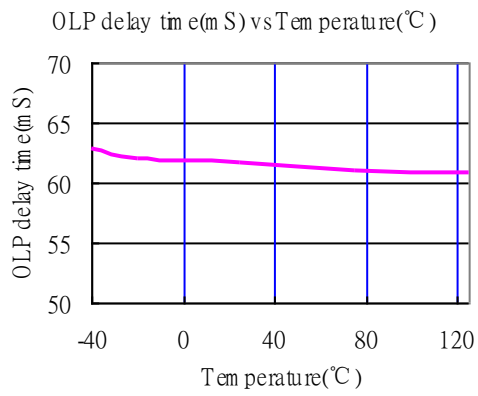
| | | | | | |
|---------------------|------------|--|-----|--|----|
| OTP Triple level(*) | | | 150 | | °C |
| | Hysteresis | | 30 | | °C |

* : Design guarantee

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Typical Performance Characteristic





家私立包ONLY

Application Information

■ Overview

The GR8903 provides a cost effective PWM control solution for buck and flyback application, especially in home appliance market. With highly integrated functions, a low cost and component count design can be achieved easily.

■ Start-up Current

The typical start-up current is about 8uA. It provides the energy for internal circuits and charging the capacitor on VCC pin before UVLO on.

Generally, we desire to use a lower start-up resistor to get a faster start-up. But there is always trade-off between the value of start-up resistor and the power dissipation. With this low start-up current, a larger start-up resistor is available not only for reducing the power dissipation on it but matching the start-up requirement.

■ UVLO (Under Voltage Lockout)

A UVLO comparator with hysteresis is implemented in GR8903. The turn-on and turn-off threshold level are set as 11.0V and 7.0V respectively.

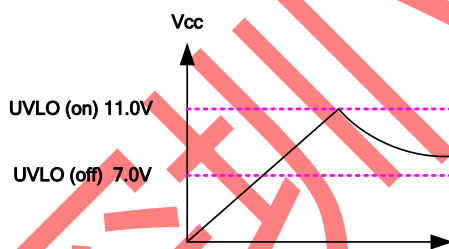


Fig.1

■ Oscillator and Switching Frequency

The maximum switching frequency of GR8903 is 45kHz. The switching frequency is controlled by VCC and COMP level as shown in Fig.2 and Fig. 3. The switching frequency will be the fixed 45kHz if the VCC level is lower than Vth1. And the switching frequency starts to decrease for a better response as VCC level is higher than Vth1. And the switching frequency will be the minimum value of 500Hz if VCC level is higher than Vth2 as shown in

Fig.2. In order to have a better power saving and regulation, the oscillator is also controlled by COMP level as shown in Fig.3.

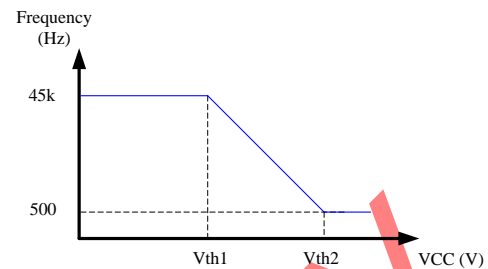


Fig.2

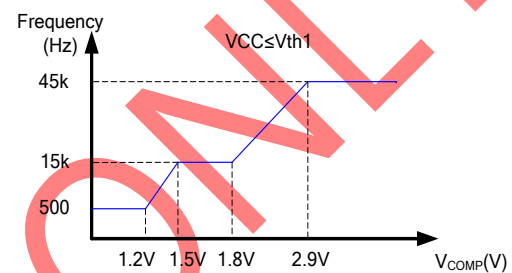


Fig.3

■ Output Regulation (Built-in error amplifier)

In GR8903, the output regulation is implemented by an error amplifier inside. The output voltage is feedback thru a resistor divider to the inverted input of the error amplifier. After comparing with the 2V voltage reference on non-inverted input, the output of the error amplifier will modulate the COMP pin level for output regulation.

■ Current Sense & Leading-Edge Blanking(LEB)

The operation mode of GR8903 is current mode control with cycle by cycle current detection. The current is detected thru a sense resistor on CS pin. A 350ns leading-edge blanking (LEB) time is built-in to avoid the false triggering of turn-on current spike caused by the switching-on of the power MOSFET. During this blanking period, the gate driver will be turned-on continually but can't be turned-off. It could be a substitute for traditional RC filter on CS pin.

However, to prevent CS pin from being damaged by negative spike (<-0.3V) caused by some parasitical

parameters and PCB layout. The RC-filter on CS pin is still recommended.

■ Frequency Jittering for EMI Improvement

The built-in frequency jittering function is implemented for EMI improvement in GR8903. The switching frequency is modulated by the oscillator control mechanism inside and the spectrum energy is spread out to a wide range. It will reduce the conduction emission and suppression solution on system for a cost effective design.

■ SEL (Output Voltage Selection)

GR8903 provides variable output voltage. Through SEL pin, the output voltage is adjustable based on the resistance on SEL pin. The output voltage will be 18V as the SEL pin is floating. The output voltage will be 12V as the SEL pin is connected to GND directly. And the output voltage will be 24V as the SEL is connected to GND with a 20kΩ resistor.

| R_{SEL} | Output Voltage |
|-----------|----------------|
| 0Ω | 12V |
| Floating | 18V |
| 20kΩ | 24V |

Table.1

■ OVP (Over Voltage Protection)

To prevent system from damaged, the OVP function is implemented in GR8903. As the VCC rises up to a higher level than the OVP threshold, the output of gate driver will be turned off immediately to shutdown the switching of the power MOSFET. The operation mode of OVP is auto recovery mode. That is, the protection will be reset at UVLO(off) and the output of gate driver will be turned on again at next UVLO(on) as shown in Fig. 4.

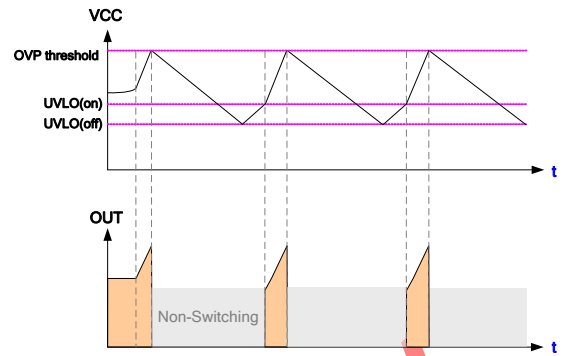


Fig.4

■ OLP (Over Load Protection)

The Over Load Protection function in GR8903 can prevent the system from being damaged during the over load condition. At the over load occurs, the feedback mechanism will pull the level of COMP pin up to reach the balance. As the level of COMP pin being raised over 4.0V, the internal circuits start to count the duration. After a 60ms OLP delay time with exceeding COMP level is accomplished, the output driver will be turned-off immediately. The VCC starts to decrease until UVLO off and then restarts again. Fig.5 shows the waveform of the OLP operation.

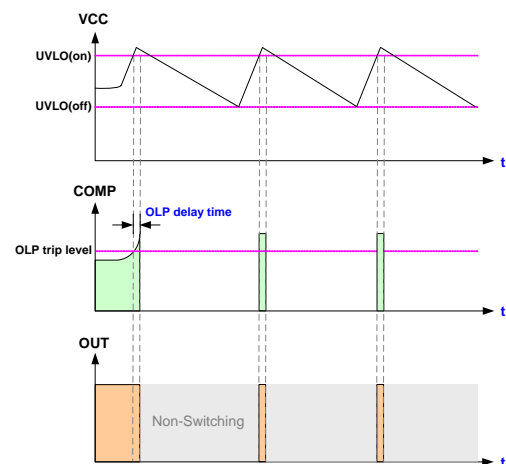


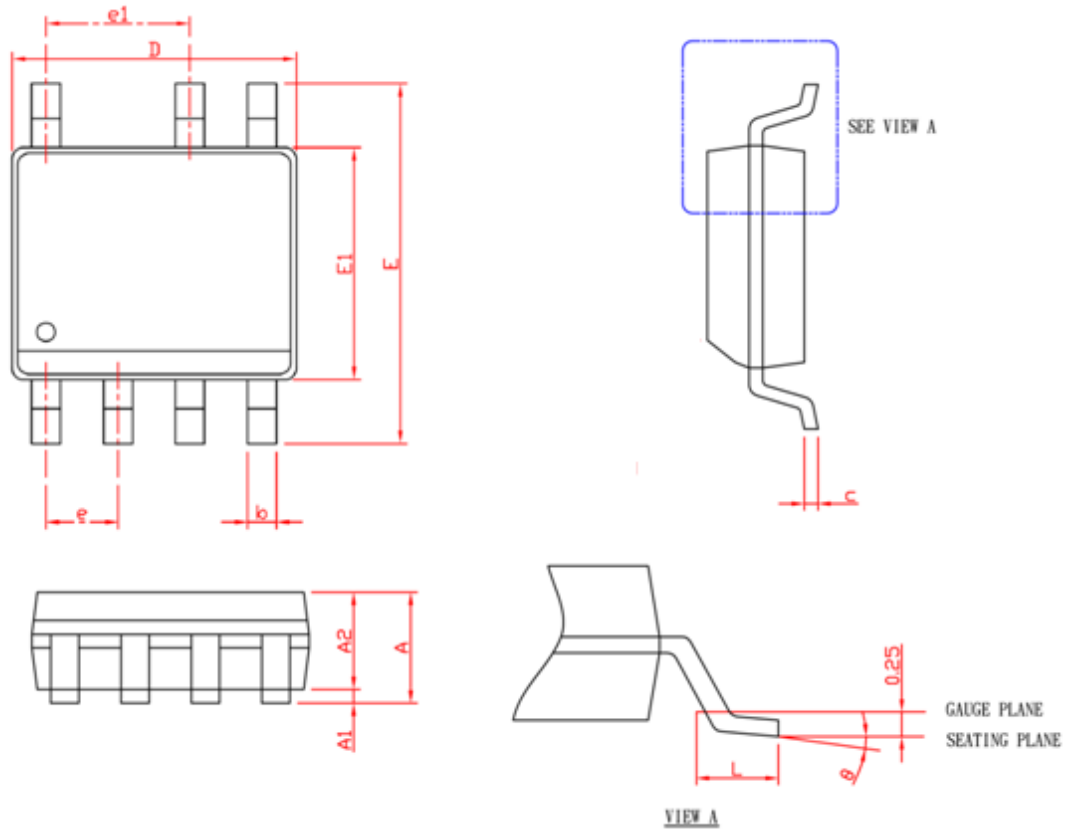
Fig.5

■ Maximum On Time

In order to prevent the system from being damaged in abnormal conditions, there is a fixed 20μs maximum on time limitation in GR8903.

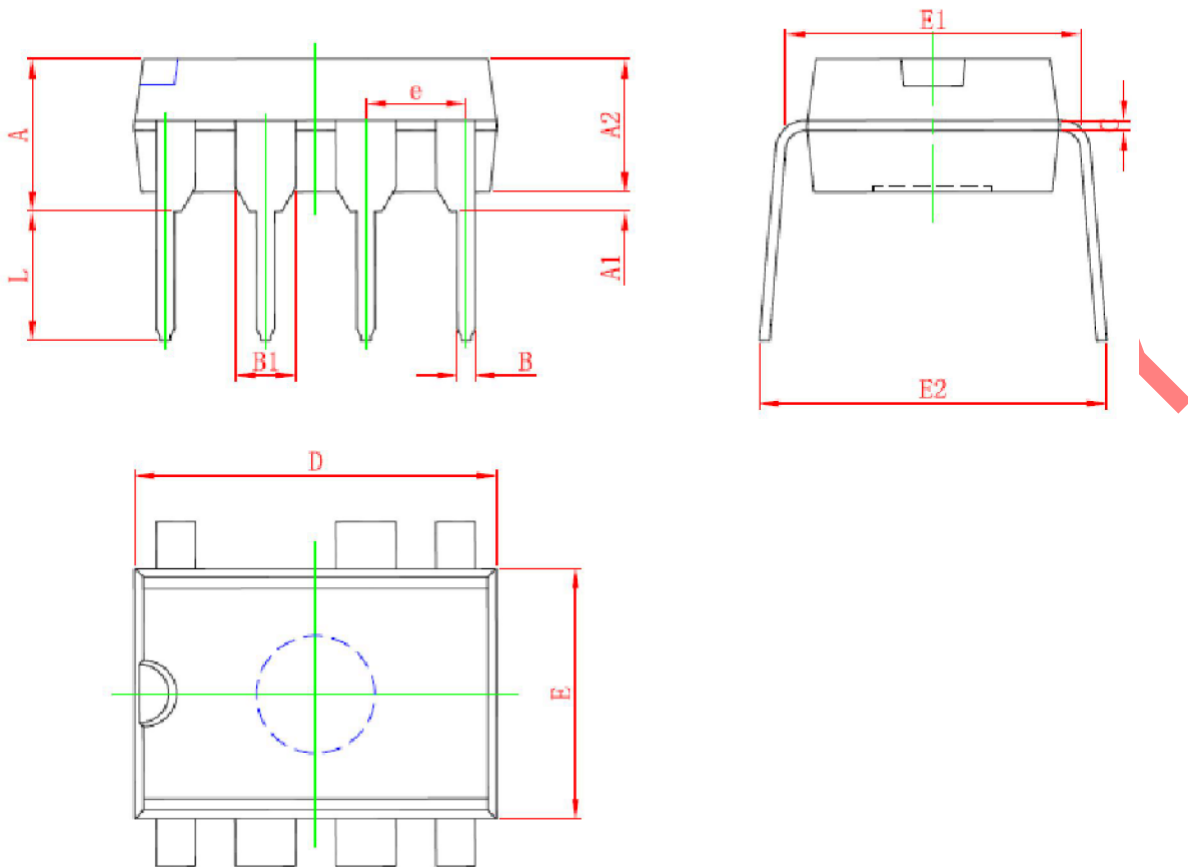
Package Information

SOP-7



| SYMBOL | SOP-7 | |
|--------|-------------|------|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | | 1.75 |
| A1 | 0.10 | 0.25 |
| A2 | 1.25 | |
| b | 0.31 | 0.51 |
| c | 0.10 | 0.25 |
| D | 4.70 | 5.10 |
| E | 5.80 | 6.20 |
| E1 | 3.70 | 4.10 |
| e | 1.27 BSC | |
| e1 | 2.54 BSC | |
| L | 0.40 | 1.27 |
| θ | 0° | 8° |

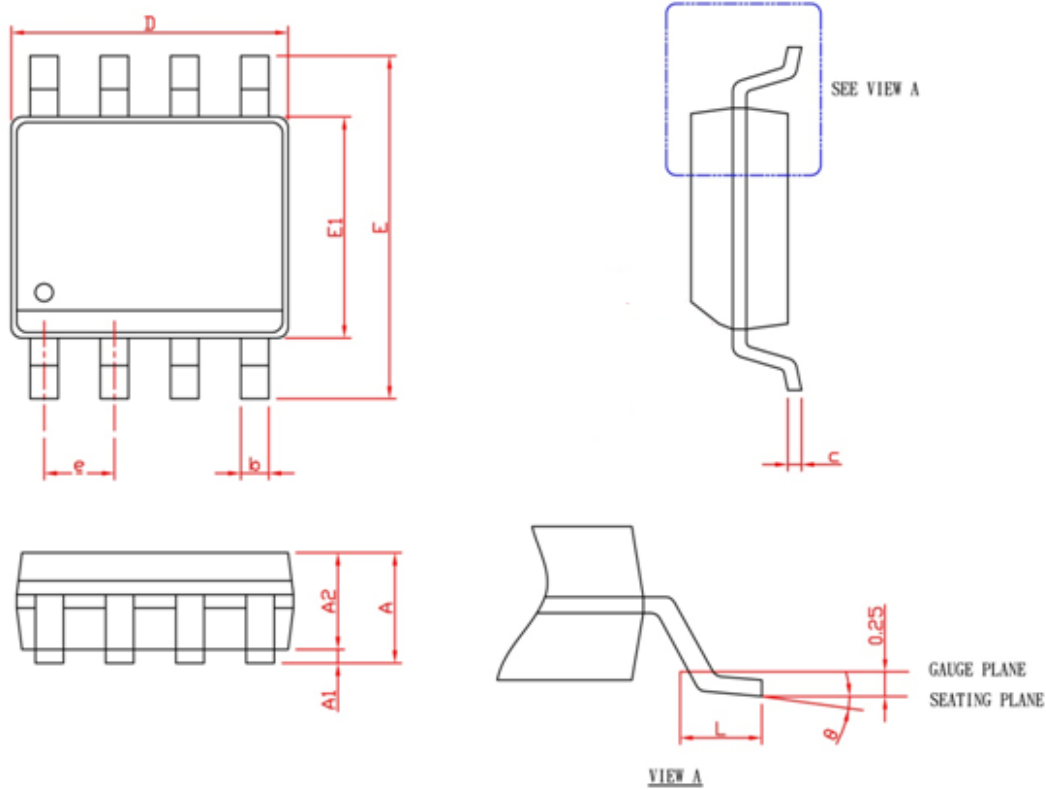
- Note: 1. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
2. Dimension "E" does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

DIP-7


| SYMBOL | DIP-7 | | | |
|--------|-------------|-------|-----------|-------|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | | 5.33 | | 0.210 |
| A1 | 0.38 | | 0.015 | |
| A2 | 2.92 | 4.95 | 0.115 | 0.195 |
| B | 0.36 | 0.56 | 0.014 | 0.022 |
| B1 | 1.14 | 1.78 | 0.045 | 0.070 |
| C | 0.204 | 0.36 | 0.008 | 0.014 |
| D | 9.01 | 10.16 | 0.355 | 0.400 |
| E | 6.10 | 7.11 | 0.240 | 0.280 |
| E1 | 7.62 | 8.26 | 0.300 | 0.325 |
| E2 | | 10.92 | | 0.430 |
| e | 2.54 BSC | | 0.100 BSC | |
| L | 2.92 | 3.81 | 0.115 | 0.150 |

Note: 1. Followed from JEDEC MS-001.

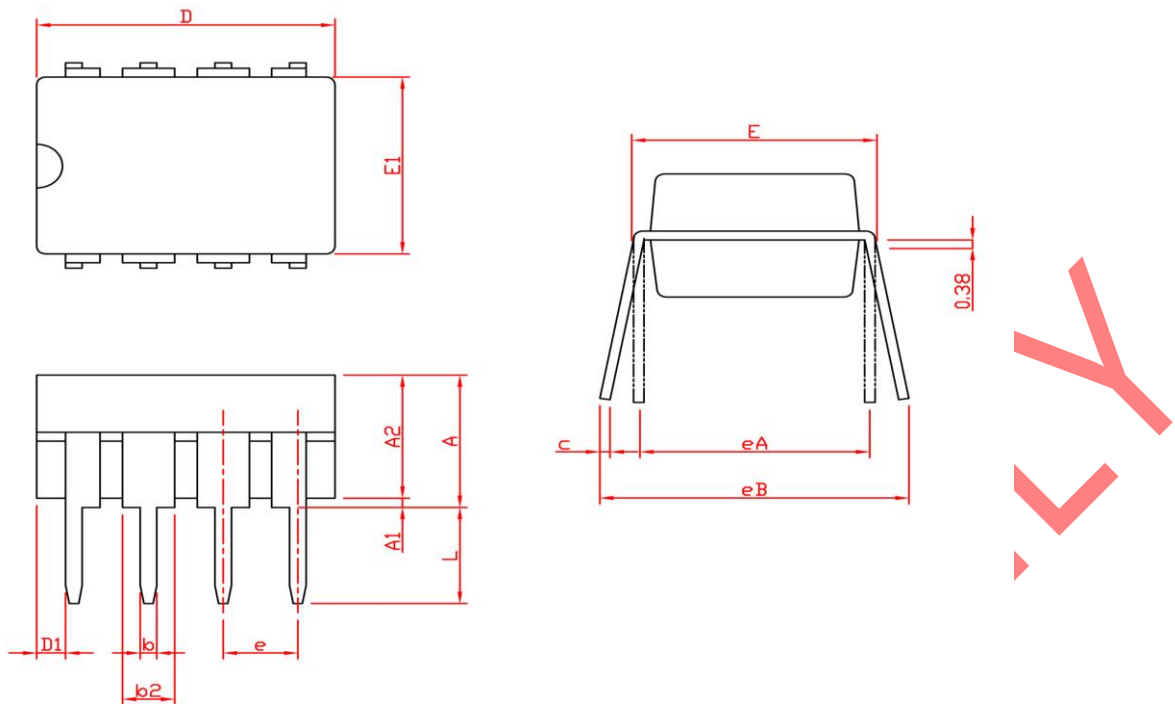
2. Dimension D and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 10 mil.

SOP-8


| SYMBOL | SOP-8 | |
|----------|-------------|------|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | | 1.75 |
| A1 | 0.10 | 0.25 |
| A2 | 1.25 | |
| b | 0.31 | 0.51 |
| c | 0.10 | 0.25 |
| D | 4.70 | 5.10 |
| E | 5.80 | 6.20 |
| E1 | 3.70 | 4.10 |
| e | 1.27 BSC | |
| L | 0.40 | 1.27 |
| θ | 0° | 8° |

Note:

1. Followed from JEDEC MS-012 AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension "E" does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

DIP-8


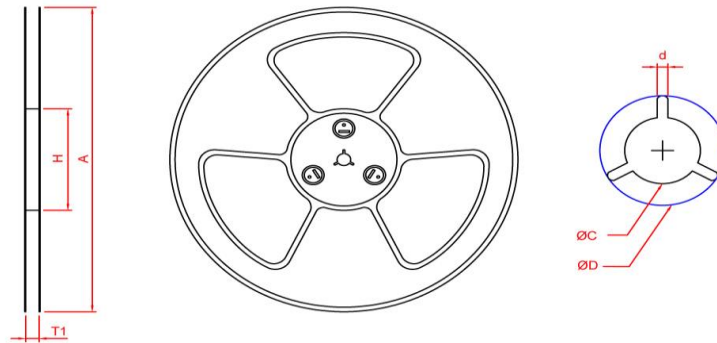
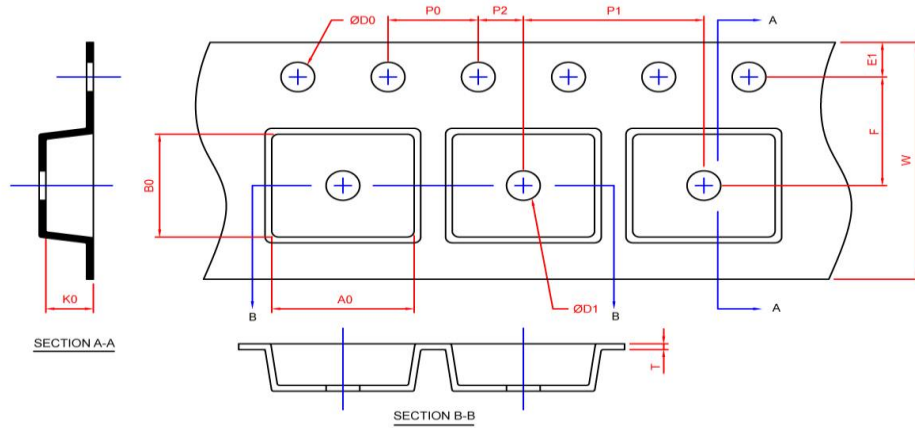
| SYMBOL | DIP-8 | | | |
|--------|-------------|-------|-----------|-------|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | | 5.33 | | 0.210 |
| A1 | 0.38 | | 0.015 | |
| A2 | 2.92 | 4.95 | 0.115 | 0.195 |
| b | 0.36 | 0.56 | 0.014 | 0.022 |
| b2 | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.20 | 0.35 | 0.008 | 0.014 |
| D | 9.01 | 10.16 | 0.355 | 0.400 |
| D1 | 0.13 | | 0.005 | |
| E | 7.62 | 8.26 | 0.300 | 0.325 |
| E1 | 6.10 | 7.11 | 0.240 | 0.280 |
| e | 2.54 BSC | | 0.100 BSC | |
| eA | 7.62 BSC | | 0.300 BSC | |
| eB | | 10.92 | | 0.430 |
| L | 2.92 | 3.81 | 0.115 | 0.150 |

Note: 1. Followed from JEDEC MS-001 BA.

2. Dimension D, D1 and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 10 mil.

Carrier Tape & Reel Dimensions

SOP- 7 & SOP-8



| Application | A | H | T1 | C | d | D | W | E1 | F |
|----------------------|-----------|----------|--------------------|--------------------|----------|-------------------|-----------|-----------|-----------|
| SOP- 7 & SOP-8 | 330.0±2.0 | 50 MIN. | 12.4+2.00 -0.00 | 13.0+0.50 -0.20 | 1.5 MIN. | 20.2 MIN. | 12.0±0.30 | 1.75±0.10 | 5.5±0.05 |
| | P0 | P1 | P2 | D0 | D1 | T | A0 | B0 | K0 |
| | 4.0±0.10 | 8.0±0.10 | 2.0±0.05 | 1.5+0.10 -0.00 | 1.5 MIN. | 0.6+0.00 -0.40 | 6.40±0.20 | 5.20±0.20 | 2.10±0.20 |

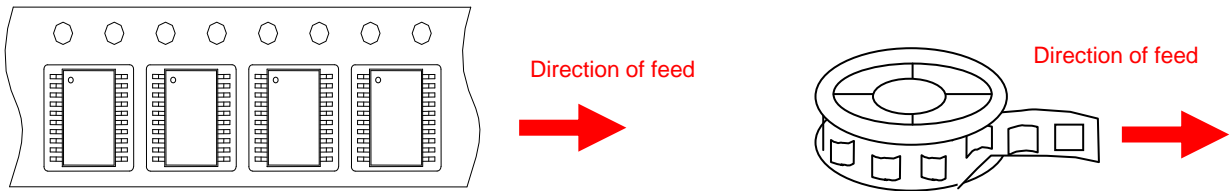
(mm)

Devices Per Unit

| Application | Carrier Width | Cover Tape Width | Devices Per Reel |
|----------------|---------------|------------------|------------------|
| SOP- 7 & SOP-8 | 12 | - | 2500 |

Tape and Specification Reel

SOP-7 & SOP-8



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