

# SEN012-013 SENZero® Family

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## Zero<sup>1</sup> Loss High Voltage Sense Signal Disconnect IC

### Product Highlights

#### Features and Performance

- Eliminates significant standby losses
  - Disconnects unnecessary circuit blocks during standby, remote-off, or light-load conditions
- Ultra low leakage (maximum 1  $\mu$ A) 650 V MOSFETs
  - <0.5 mW per channel during standby
- Single component provides remote disconnect functionality
  - No external components or additional bias supply needed for remote-off
  - Integrates multiple disconnect MOSFETs, gate drive, and protection
  - Minimal component count provides higher reliability
- Protection features to help production/manufacturing yields
  - Pin-to-pin fault and ESD protection
- Triggerable via remote-off signal or load conditions
  - Integrated gate pull down circuit protects against loss of trigger signal fault
- Green package technology
  - RoHS compliant and halogen free
- Withstands high differential surge conditions
  - S1, S2 and S3 interface with controller pins up to 6.5 V above system ground

#### EcoSmart® – Energy Efficient

- <3 mW loss at 230 VAC in Off/standby mode

#### Applications

- ACDC converters with high-voltage resistive signal paths
- Ideal for all very low standby systems such as those meeting EuP Lot 6 and similar energy efficiency standards

#### Description

SENZero is a compact low cost solution to eliminate losses in resistive signal paths connected between high-voltage rails and switching power supply controller(s). Examples include feed-forward or feedback signal paths connected to boost controllers in power factor corrected systems and feedforward signal paths in two switch forward / LLC / half and full bridge converters.

The device is available in 2 (SEN012) and 3 (SEN013) channel versions according to the application's requirements. The internal gate drive and protection circuitry provides gate drive signals to the internal 650 V MOSFETs in response to the voltage applied to the VCC pin. This simple configuration provides easy integration into existing systems by using the system V<sub>CC</sub> rail as an input to the SENZero.

The SENZero family uses a low cost compact SO-8 package to reduce PCB area while the pin configuration is designed to meet pin-pin fault conditions.

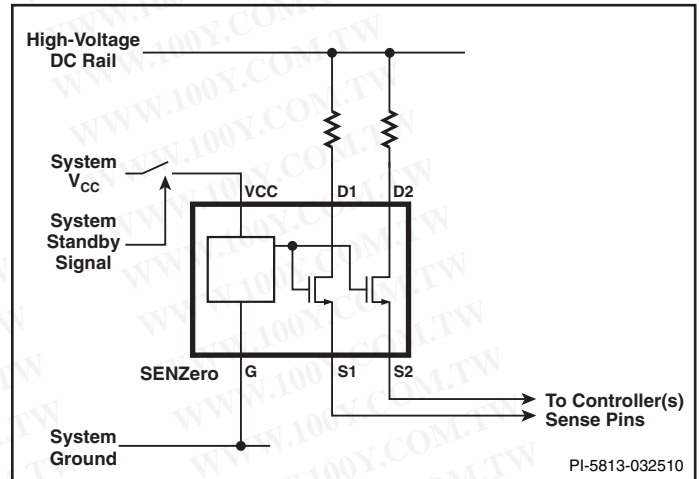


Figure 1. Typical Application SEN012.

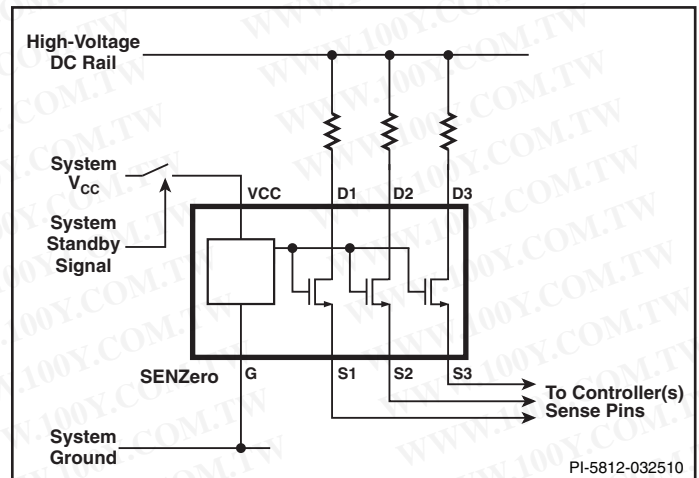


Figure 2. Typical Application SEN013.

#### Component Selection Table

Product <sup>2</sup>	Integrated Disconnect MOSFETs	230 VAC Power Consumption in Standby
SEN012DG	2	<1 mW
SEN013DG	3	<1.5 mW

Table 1. Component Selection Table.

Notes:

- IEC 16301 clause 4.5 rounds standby power use below 5 mW to zero.
- Package: D: SO-8.

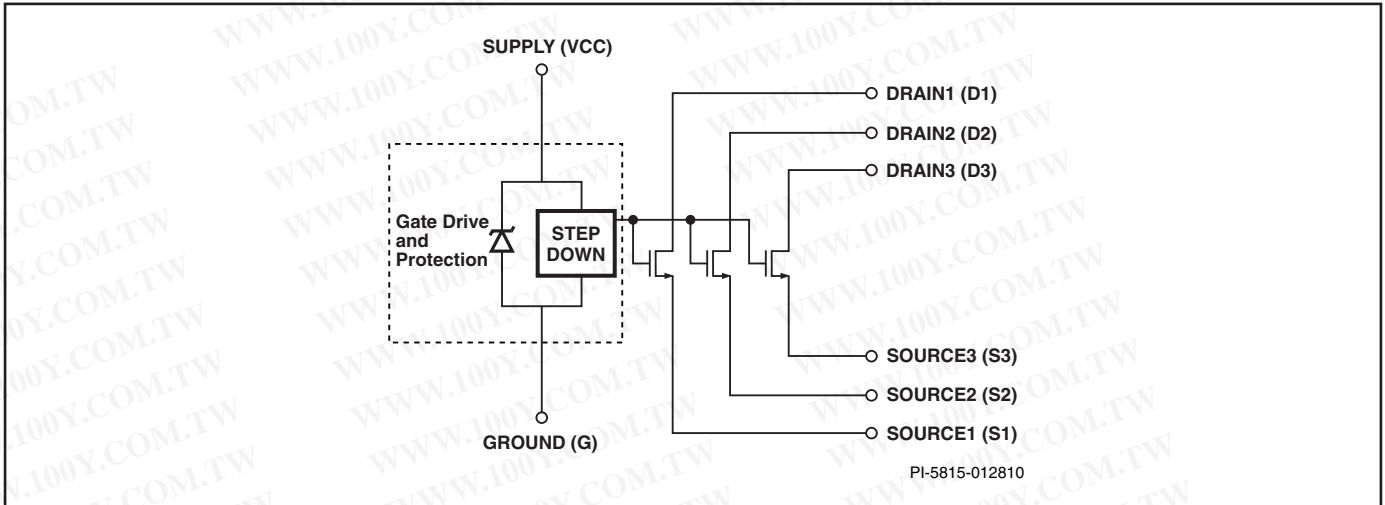


Figure 3. SENZero Functional Block Diagram

**Pin Functional Description**

**SOURCE (S1, S2, S3) Pins :**

Internally connect to the SOURCES of MOSFETs 1, 2 and 3 respectively.

**DRAIN (D1, D2, D3) Pins :**

Internally connect to the DRAINS of MOSFETs 1, 2 and 3 respectively.

**VOLTAGE SUPPLY (VCC) pin**

The internal MOSFETs are fully turned on when the VCC pin voltage is  $V_{CC(ON)}$  (see parameter table) or more greater than their SOURCE voltage relative to GROUND. VCC pin should be connected to GROUND to turn the MOSFETs off.

**GROUND (G) Pin:**

This is the ground reference for all the SENZero pin voltages.

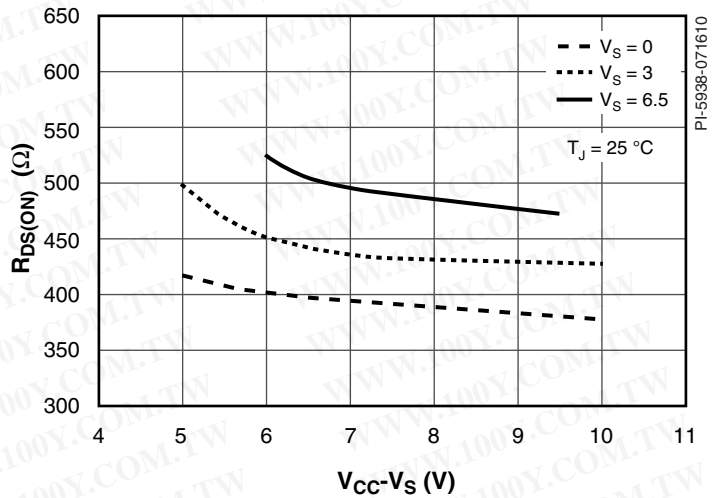


Figure 5. Typical  $R_{DS(ON)}$  as a Function of  $V_{CC}-V_S$  Voltage.

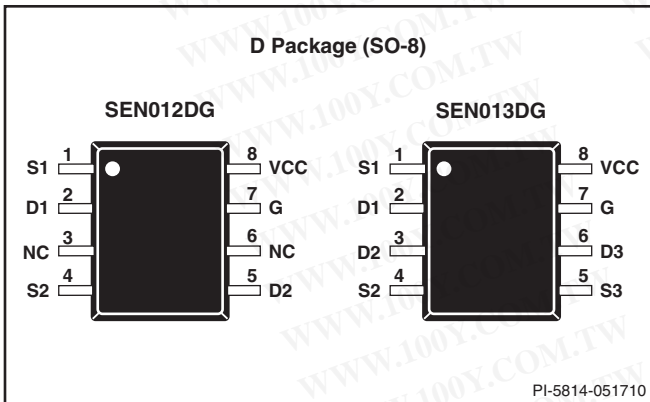


Figure 4. Pin Configuration.

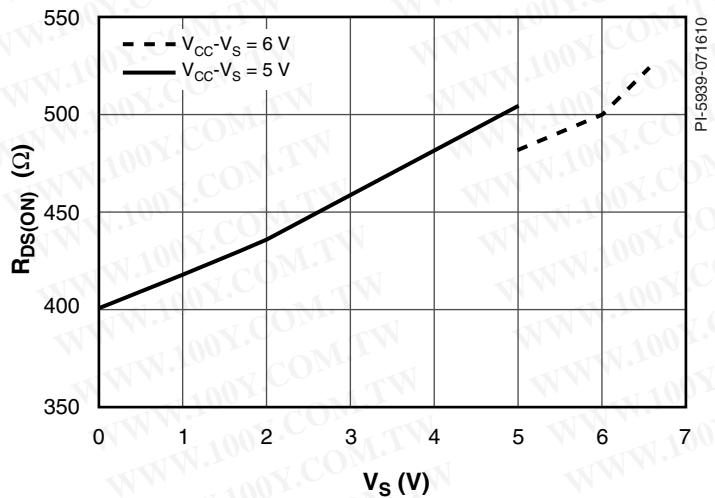


Figure 6. Typical  $R_{DS(ON)}$  as a Function of  $V_S$  Voltage.

**Applications Considerations**

The maximum voltage that the device can sustain across the VCC and G pin is 16 V. The maximum voltage that any of the source channels can be at with respect to the ground terminal is 6.5 V. SENZero has a typical on state resistance of approximately 500 Ω at room temperature. The device is therefore typically used in series with high ohmic value resistors where this on resistance is a small percentage of the total series impedance.

It is not necessary to provide a local bypass capacitor on the VCC pin.

**Operating Configurations for the SENZero**

One configuration to power up the SENZero is shown in Figure 7. In this circuit, SENZero is powered up from an unregulated bias winding through a simple series pass regulator formed by Q1, R<sub>B</sub> and V<sub>Z</sub>. This configuration ensures the VCC voltage is limited even if the maximum bias voltage exceeds 16 V. During power down, as soon as the bias voltage falls below V<sub>Z</sub>, SENZero will turn off.

The series pass transistor Q1 is necessary only if the bias winding voltage regulation is not tight enough (unregulated). If the voltage on the bias winding is regulated or is such that the voltage on the VCC pin can be maintained in the range 6 V < VCC < 16 V, then the series pass transistor (Q1, R<sub>B</sub> and V<sub>Z</sub>) can be eliminated.



Figure 7. SENZero Powered from an Unregulated Bias Winding Through a Series Pass Regulator. Device is Enabled When Bias Voltage is Present.

A configuration that can be used to trigger remote-off functionality is shown in Figure 8. In this configuration, a regulated auxiliary output is used to power the IC. Transistor Q1 serves as the ON/OFF switch which is commanded by the Enable/Disable signal at its base.

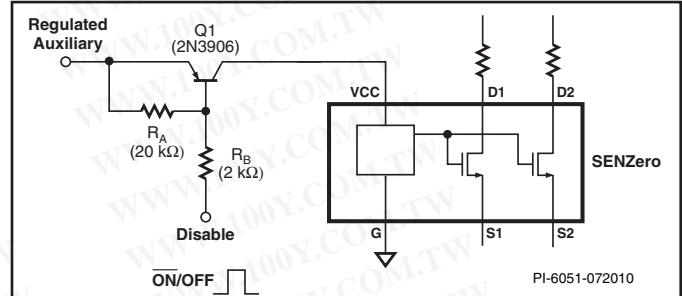


Figure 8. SENZero Powered From a Regulated Auxiliary Winding.

An alternative remote-off configuration is shown in Figure 9 where an unregulated bias voltage supplies the SENZero through a series pass regulator similar to the one shown in Figure 7. However the circuit of Figure 9 includes an ON/OFF transistor Q2. In other versions of this circuit Q2 can be replaced by an optocoupler allowing the ON/OFF disable signal to be communicated from a secondary of the power supply such as in PC power supplies.

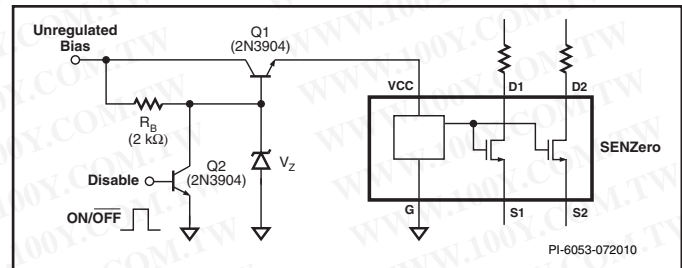


Figure 9. A Modified Version of an Unregulated Bias Winding Supplying Power Through a Series Pass Regulator. Transistor Q2 Provides Remote-Off Functionality.

**Absolute Maximum Ratings<sup>(1)</sup>**

DRAIN Pin Voltage (D1, D2, D3) .....	-0.3 V to 650 V	Notes: 1. All voltages referenced to Ground, $T_A = 25\text{ }^\circ\text{C}$ . 2. 1/16 in. from case for 5 seconds.
VCC Pin Voltage.....	-0.3 V to 16 V	
Voltage on S1, S2, S3 Pins.....	-0.3 V to 6.5 V	
Storage Temperature .....	-65 °C to 150 °C	
Operating Junction Temperature.....	-40 °C to 125 °C	
Lead Temperature <sup>(2)</sup> .....	260 °C	

Parameter	Symbol	Conditions		Min	Typ	Max	Units
		$T_A = -40\text{ }^\circ\text{C}$ to $105\text{ }^\circ\text{C}$ (Unless Otherwise Specified)					
<b>Input</b>							
VCC Pin Input Current	$I_{VCC}$	Measured at $V_{CC(MAX)}$				0.5	mA
MOSFET ON Drive Voltage ( $V_{CC} - [\text{Max of } V_{S1}, V_{S2} \text{ and } V_{S3}]$ )	$V_{CC(ON)}$	See Note A	$V_S < 5\text{ V}$	5			V
			$V_S \geq 5\text{ V}$	6			
<b>Output</b>							
ON-State Resistance	$R_{DS(ON)}$	$V_S = 0\text{ V}$ $V_{CC(ON)} = 5\text{ V}$ $I_D = 1\text{ mA}$ See Note D	$T_J = 25\text{ }^\circ\text{C}$		400		$\Omega$
			$T_J = 100\text{ }^\circ\text{C}$		550		
			$T_J = 25\text{ }^\circ\text{C}$		525	650	
			$T_J = 100\text{ }^\circ\text{C}$		750	1000	
OFF-State Drain Leakage	$I_{DSS}$	$V_{DS} = 325\text{ V}$ , $T_J = 25\text{ }^\circ\text{C}$ , $V_{CC} = V_S = 0\text{ V}$ See Note B				1	$\mu\text{A}$
Breakdown Voltage	$BV_{DSS}$	$T_J = 25\text{ }^\circ\text{C}$ See Note C		650			V
Q1, Q2 and Q3 Saturation Current	$I_{DS(ON)}$	$T_J = 100\text{ }^\circ\text{C}$ , $V_{CC(ON)} = 5\text{ V}$		1			mA

Notes

- A. This is the minimum voltage difference required between  $V_{CC}$  and the highest of voltages  $V_{S1}$ ,  $V_{S2}$  and  $V_{S3}$  to achieve the  $R_{DS(ON)}$  specification in the parameter table. As an example, if S1 externally connects to a controller pin having a voltage of 4 V relative to G pin,  $V_{CC(ON)}$  of 5 V will be achieved by having at least  $(5\text{ V} + 4\text{ V}) = 9\text{ V}$  applied to the SENZero VOLTAGE SUPPLY (VCC) pin relative to the G pin.
- B. Per channel.
- C. Between Ground and Drain of individual MOSFET under test.
- D. Guaranteed by design.

