SOLID STATE OPTRONICS



SP946

Zero Cross
800V / 1.2A
AC Solid State Relay

Description

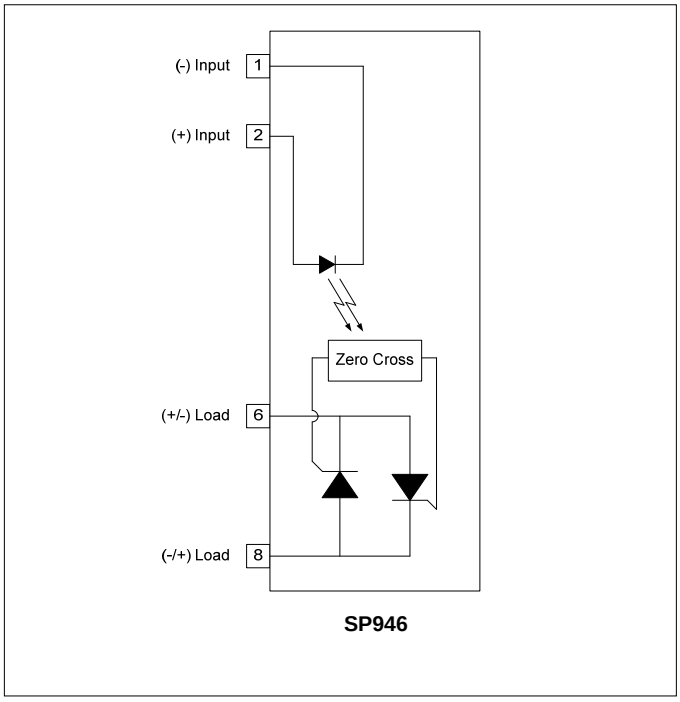
The SP946 is a bi-directional, single-pole, single-throw, normally open multipurpose solid-state relay. The circuit is composed of one input IR LED which activates an optically coupled IC on the output that controls the firing angle of two back-to-back SCRs. This circuit assures no false triggering under most adverse conditions, and a tight zero-volt switching window not exceeding 5V. The SP946 provides high peak load voltage (800V+) and high input-to-output isolation voltage (up to 5kV$_{RMS}$).

The SP946 comes in a compact 4 pin SIP package, making it ideal for high-density board applications.

Applications

- Valve Control
- Solenoid Control
- Home Appliances
- Metering Equipment
- Heating Elements
- Gas Pump Control Circuitry

Schematic Diagram



SP946

Features

- Zero-Volt Cross Switching
- High Blocking Voltage (800V MIN)
- High Transient Immunity
- 1.2A Maximum Continuous Current
- Low Input Control Current
- Long Life / High Reliability
- RoHS / Pb-Free / REACH Compliant

Agency Approvals

UL/C-UL:	File # E90096
VDE:	File # 40035191 (EN 60747-5-2)

Absolute Maximum Ratings

The values indicated are absolute stress ratings. Functional operation of the device is not implied at these or any conditions in excess of those defined in electrical characteristics section of this document. Exposure to absolute Maximum Ratings may cause permanent damage to the device and may adversely affect reliability.

Storage Temperature	-55 to +125°C
Operating Temperature	-40 to +85°C
Continuous Input Current	50mA
Transient Input Current	500mA
Reverse Input Control Voltage	5V
Input Power Dissipation	40mW
Total Power Dissipation	1.2W
Solder Temperature – Wave (10sec)	260°C
Solder Temperature – IR Reflow (10sec)	260°C

Ordering Information

Part Number	Description
SP946	4 pin SIP, (25/Tube)
SP946-H	5kV$_{RMS}$ V$_{ISO}$, 4 pin SIP, (25/Tube)

NOTE: Suffixes listed above are not included in marking on device for part number identification

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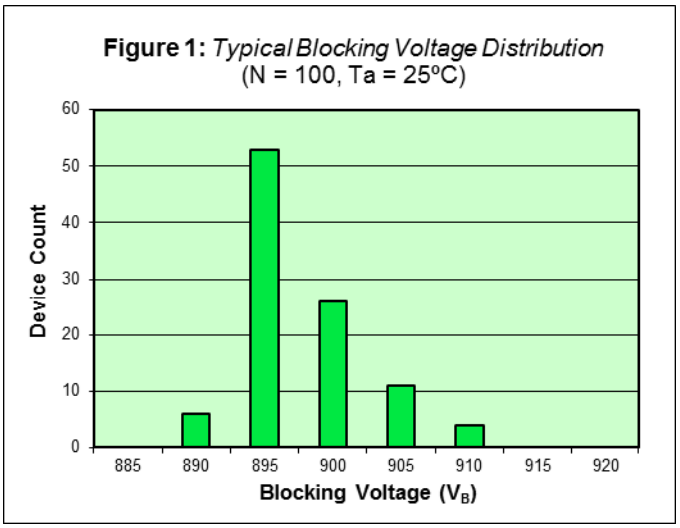
Electrical Characteristics, T_A = 25°C (unless otherwise specified)

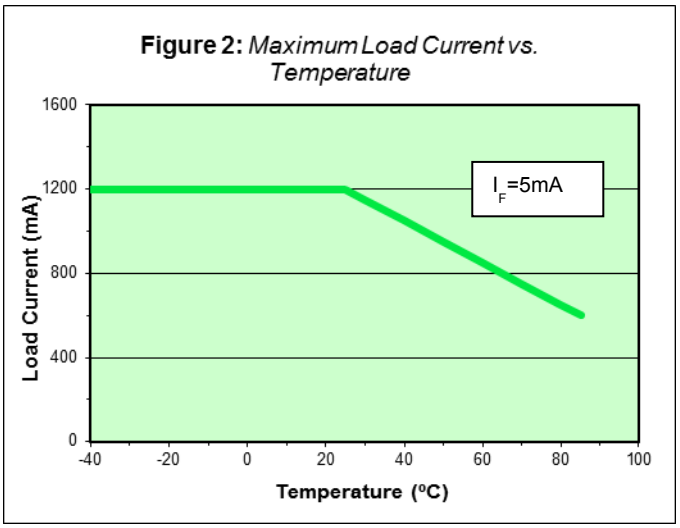
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input Specifications						
LED Forward Voltage	V_F	-	1.2	1.5	V	I_F = 10mA
LED Reverse Voltage	BV_R	5	-	-	V	I_R = 10µA
Trigger (Must Operate) Current[1]	I_F	-	3	5	mA	$I_O = I_{O(MAX)}$ [Resistive Load]
Junction Capacitance	C_J	-	5	-	pF	I_F=0mA
Output Specifications						
Blocking Voltage	V_B	800	-	-	V	I_F = 0mA, I_O = 1µA
Continuous Load Current	$I_{O(MAX)}$	-	-	1.2	A	I_F = 5mA
Surge Current	$I_{(SURGE)}$	-	-	10	A	T ≤ 16mS
Holding Current	I_{HOLD}	-	-	10	mA	I_F = 5mA
On Voltage	V_{ON}	-	-	1.2	V	I_F = 5mAV, I_O = 1.2A
Voltage Across Load at Turn On	-	-	-	5	V	I_F = 5mA
Leakage Current	I_{Oleak}	-	100	250	µA	I_F = 0mA, V_O = 250V
Thermal Resistance	-	-	80	-	°C/W	
Power Factor[2]	-	-	0.3	-	-	
Critical Rate of Rise (dV/dt)[3]	dV/dt	400	-	-	V/µS	
Coupled Specifications						
Turn-On Time	T_{ON}	-	-	0.5	Cycles	I_F = 5mA
Turn-Off Time	T_{OFF}	-	-	0.5	Cycles	I_F = 5mA
Coupled Capacitance	$C_{COUPLED}$	-	2	-	pF	
Contact Transient Ratio	-	2,000	7,000	0	V/µS	dV = 50V
Isolation Specifications						
Isolation Voltage	V_{ISO}	3750	-	-	V_{RMS}	RH ≤ 50%, t=1min
(-H Option)		5000	-	-		
Input-Output Resistance	R_{I-O}	-	10^{12}	-	Ω	V_{I-O} = 500V_{DC}

NOTES:

1) Resistive load. For inductive loads, higher drive current is recommended
2) Snubber circuits may be required for lower power factors
3) This is for static dV/dt.

SP946 Performance & Characteristics Plots, T_A = 25°C (unless otherwise specified)





ZERO-VOLT SWITCHING

This solid state relay has been designed with a driver circuit that controls the operation of two back-to-back silicon controlled rectifiers (SCRs), each responsible for one half of the AC cycle. If an AC signal is examined, the turn on, turn off and zero-volt switching can be seen. Figure 3 shows a typical 60 HZ, 120VAC signal with a corresponding relay input signal:

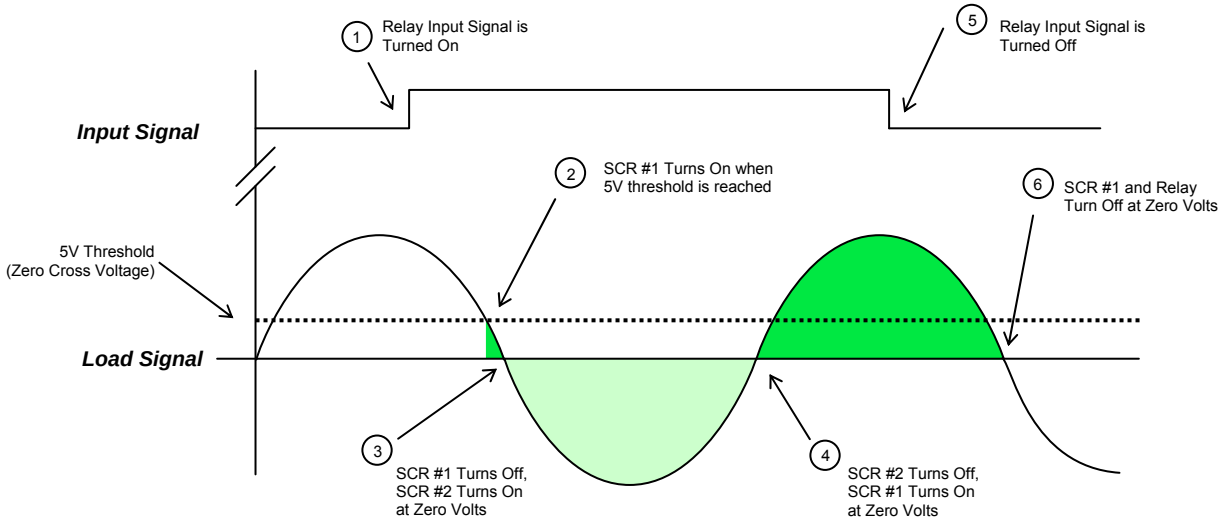


Figure 3: *Zero-Volt Switching Cycle*

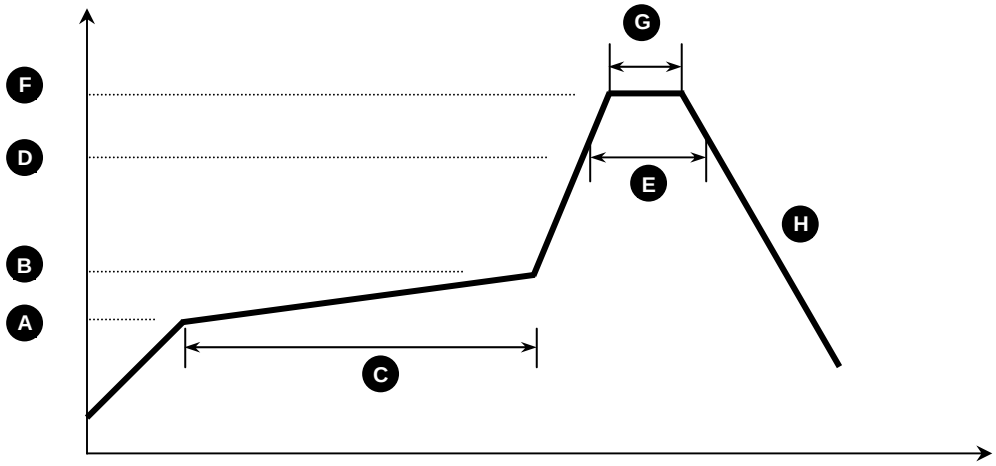
Figure 3 shows the sequence of zero-volt switching operation. At Stage 1, an input signal is applied to the relay. The relay will not turn on until the threshold voltage of 5V is reached. Once this point is reached (Stage 2), SCR #1 (designated as the SCR which controls positive AC voltage) turns on. However, SCR #1 only conducts for an instant, as the cycle quickly crosses zero. At this point (Stage 3), SCR #1 will turn off and SCR #2 (negative AC voltage) turns on. Likewise, at the next zero cross (Stage 4), SCR #2 will turn off and SCR #1 conducts again. Even though the input signal is terminated at Stage 5, the relay will continue to conduct (typical SCR behavior) until Stage 6, when SCR #1 crosses zero and ceases to conduct. Please note that turn on can likewise begin on the negative phase of the AC cycle with a -5V threshold, though only the positive phase is shown here.

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SP946 Solder Reflow Temperature Profile Recommendations

(1) *Infrared Reflow:*

Refer to the following figure as an example of an optimal temperature profile for single occurrence infrared reflow. Soldering process should not exceed temperature or time limits expressed herein. Surface temperature of device package should not exceed 250ºC:



Process Step	Description	Parameter
A	Preheat Start Temperature (ºC)	150ºC
B	Preheat Finish Temperature (ºC)	180ºC
C	Preheat Time (s)	90 - 120s
D	Melting Temperature (ºC)	230ºC
E	Time above Melting Temperature (s)	30s
F	Peak Temperature, at Terminal (ºC)	260ºC
G	Dwell Time at Peak Temperature (s)	10s
H	Cool-down (ºC/s)	<6ºC/s

(2) *Wave Solder:*

Maximum Temperature:	260ºC (at terminal)
Maximum Time:	10s
Pre-heating:	100 - 150ºC (30 - 90s)
Single Occurrence	

(3) *Hand Solder:*

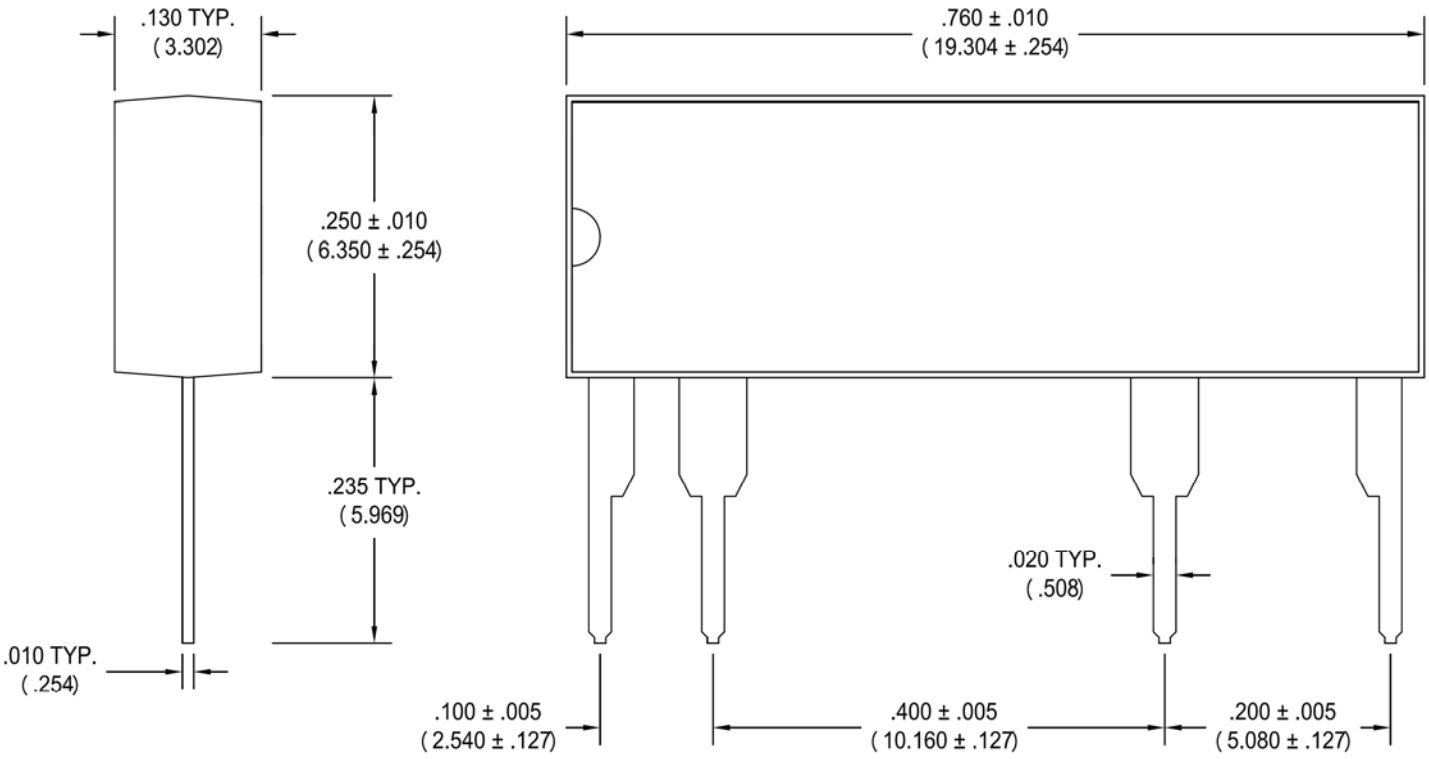
Maximum Temperature:	350ºC (at tip of soldering iron)
Maximum Time:	3s
Single Occurrence	

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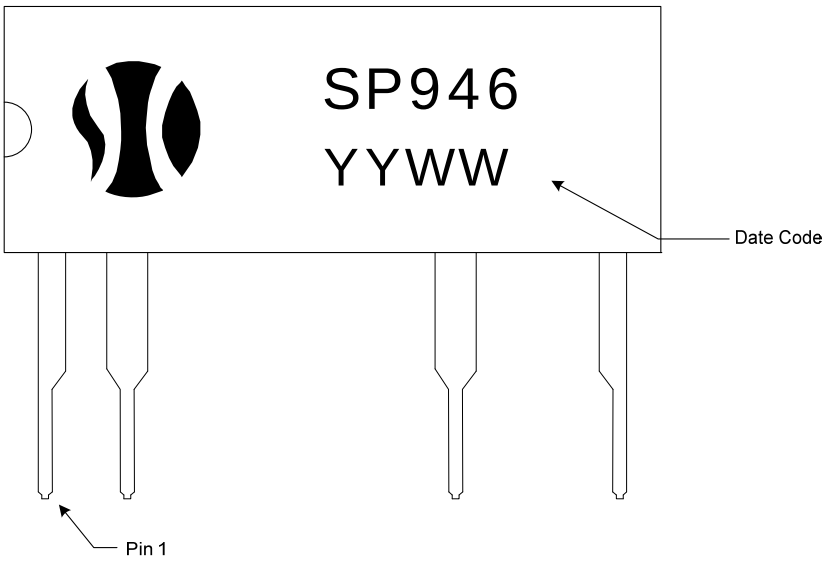
SP946 Package Dimensions

4 PIN SIP Package

Note: *All dimensions in inches ["] with millimeters in parenthesis ()*



SP946 Package Marking



SP946 Package Weights

Device	Single Unit	Full Tube (25pcs)	Full Pouch (10 tubes)
SP946-(H)	0.88	35	370

Note: *All weights above are in GRAMS, and include packaging materials where applicable*

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