HIP1090

Protected High Side Power Switch with Transient Suppression

March 1995

Features

- ±90V Transient Suppression
- 4V to 16V Operating Voltage
- 1A Current Load Capability
- Low Input-Output Voltage Drop With Controlled Saturation Detector for
  - Fast Low Current Turn-OFF
  - Reduced No-Load Idle Current
- Over-Voltage Shutdown Protection
- Short Circuit Current Limiting
- Over-Temperature Limiting Protected
- Thermal Limiting at T_J = +150°C
- -40°C to +125°C Operating Temperature Range

Applications

- Electronic Circuit Breaker
- Transient Suppressor
- Over-Voltage Monitor
- High Side Driver Switch for
  - Relays
  - Solenoids
  - Heaters
  - Motors
  - Lamps

Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HIP1090AS	-40°C to +125°C	TO-220AB SIP

Description

The HIP1090 is a Protected Power Interface Switch designed to suppress potentially damaging over-voltage transients with peak voltage source inputs ranging up to ±90V in amplitude. It is designed to be operated in a 'hard-wired' pass-thru mode or as a high side power switch which controls the current flow through a PNP pass transistor of the IC. In either mode The HIP1090 has a low saturated forward voltage drop. The protected load circuit is connected to the output of the IC. As such, the HIP1090 operates as a transient suppressor where the PNP drive transistor is switched off when V_{IN} is greater than the Over-Voltage Shutdown range of 16V to 19V. Shutdown also occurs when V_{IN} is less than the forward turn-on threshold of approximately 2.5V, including the negative voltage range.
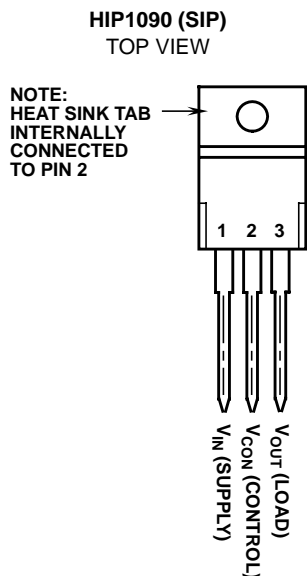
The merits of transient suppression depend on the required integrity of the applications load elements. Instrument panel signal warning lights for critical functions such as over-temperature or low fluid levels can be protected by the HIP1090 against high level transient voltages and double battery conditions that may potentially cause bulb burnouts. The HIP1090 may be used to protect the power supplies of small signal or logic circuits with voltages ranging from 4V to 16V, effectively blocking higher peak voltages.

The HIP1090 has internal current limiting protection in the range of 1A to 2A for short circuit to ground conditions and thermal shutdown protection when the junction temperature is greater than 150°C. It is capable of driving resistive, inductive or lamp loads (such as lamps No. 168 or 194) with minimum risk of damage under harsh environmental stress conditions. The HIP1090 is supplied in a 3 lead TO-220AB package.
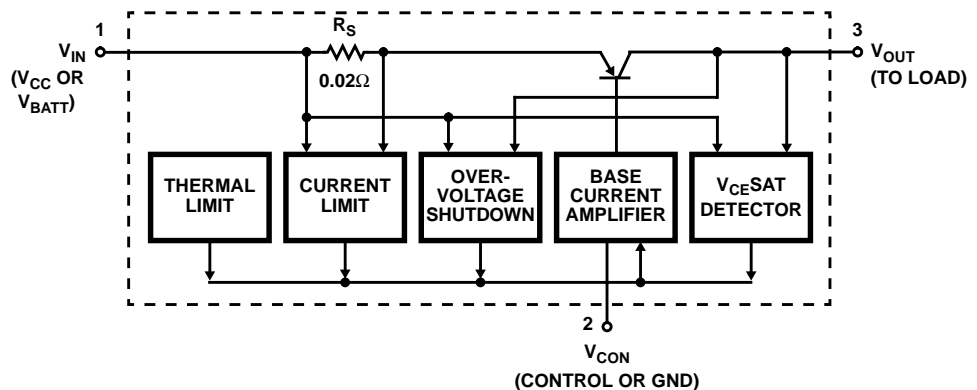
Pinout

HIP1090 (SIP)
TOP VIEW

NOTE:
HEAT SINK TAB INTERNALLY CONNECTED TO PIN 2

1 V_{IN} (SUPPLY)
2 V_{CON} (CONTROL)
3 V_{OUT} (LOAD)

Functional Block Diagram

1 V_{IN} (V_{CC} OR V_{BATT})

R_S 0.02Ω

3 V_{OUT} (TO LOAD)

THERMAL LIMIT | CURRENT LIMIT | OVER-VOLTAGE SHUTDOWN | BASE CURRENT AMPLIFIER | V_{CE}SAT DETECTOR

2 V_{CON} (CONTROL OR GND)

File Number **3398.3**

Specifications HIP1090

Absolute Maximum Ratings

Input (Supply) Voltage, V_{IN} (Control Pin Reference) . . . . ±24V
Transient Max Voltage, V_{IN} (15ms) . . . . ±90V
Load Current, I_{OUT} . . . . Short Circuit Protected

Thermal Information

Thermal Resistance	θ_{JA}	θ_{JC}
Plastic SIP Package	50°C/W	4°C/W

Maximum Power Dissipation, (Note 4)
At T_A = +105°C, Infinite Heat Sink. 11.25W
Junction Temperature . . . . +150°C
Ambient Temperature Range . . . . -40°C to +125°C
Storage Temperature Range. . . . . -40°C to +150°C
Lead Temperature (Soldering During). . . . . +265°C
1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s maximum

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications T_A = -40°C to +125°C; V_{IN} = 4V to 16V; V_{CON} = GND or 0V, Unless Otherwise Specified

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input (Supply) Voltage Operating Range	V_{IN}	(Note 1); Also, See Figure 4 for Expanding V_{IN} Range	4	-	16	V
Input Voltage Threshold for Forward Turn-On to Load	V_{THD}	Load = 1kΩ	-	2.5	-	V
Input Voltage for Output Shutdown	V_{SHSD}	(Note 2)	16	-	19	V
Output Shutdown Leakage	I_{LEAK1}	V_{IN} = 19V and 24V; Load = 1kΩ	-	-	100	µA
Output Cutoff Leakage	I_{LEAK2}	V_{IN} = 16V; Control Open; Load = 1kΩ	-	1	-	µA
Thermal Shutdown Temperature	T_{SD}		-	150	-	°C
Maximum Output Transient Pulse Current	I_{OUT}(Tran)	V_{IN} = ±90V for 15ms, V_{OUT} = 14V	-20	-	+20	mA
Maximum Control Transient Pulse Current	I_{CON}(Tran)	V_{IN} = ±90V for 15ms, V_{OUT} = 14V	-50	-	+50	mA
Short Circuit Current	I_{SC}		1	-	2	A
Input-to-Output Voltage Drop		V_{IN} = 4V, I_{OUT} = 175mA	-	-	0.25	V
		V_{IN} = 9V, I_{OUT} = 500mA	-	-	0.65	V
		V_{IN} = 16V, I_{OUT} = 800mA	-	-	1.05	V
		V_{IN} = 16V, I_{OUT} = 1A	-	0.8	-	V
Control Current	I_{CON}	V_{IN} = 16V, I_{OUT} = 100mA	-	-	25	mA
		V_{IN} = 16V, I_{OUT} = 800mA	-	-	50	mA
		V_{IN} = 16V, I_{OUT} = 1A	-	50	-	mA
Turn ON (Rise Time); "Pass-Thru" Mode	t_{ON}	Switch V_{IN} 0V(GND) to 5.5V; Measure V_{OUT} (to 90%); Load = 1kΩ (Note 3)	-	-	20	µs
Turn OFF (Fall Time); "Pass-Thru" Mode	t_{OFF}	Switch V_{IN} 5.5V to 0V(GND); Measure V_{OUT} (to 90%); Load = 1kΩ (Note 3)	-	-	20	µs
Turn ON (Rise Time); High Pass Switch Mode	t_{ON}	See Figure 3 and Figure 4 (Note 3)	-	15	-	µs
Turn OFF (Fall Time); High Pass Switch Mode	t_{OFF}	See Figure 3 and Figure 4 (Note 3)	-	15	-	µs

NOTES:

1. The Input Operating Voltage is not limited by the threshold of Shutdown. The V_{IN} voltage may range to ±24V while the normal functional switching range is typically +2.5V to +17.5V (reference to V_{CON}).

2. The Output Drive is switched-off when the Input voltage(Supply pin), referenced to the Control pin exceeds the threshold shutdown VSHSD or the input voltage is less than the forward turn-on threshold (Including negative voltages within the transient peak ratings).

3. T_{ON} and T_{OFF} times include Prop Delay and Rise/Fall time.

4. The worst case thermal resistance, θ_{JC} for the SIP TO-220 is 4°C/W. The calculation for dissipation and junction temperature rise due to dissipation is:

$$P_D = (V_{IN} - V_{OUT}) + (V_{IN})(I_{CON})$$

$$T_J = T_{AMBIENT} + (P_D)(\theta_{JC}) \text{ for an infinite Heat Sink.}$$

Derating from 150°C is based on the reciprocal of thermal resistance, $\theta_{JC} + \theta_{HS}$. For example: Where θ_{JC} = 4°C/W and given θ_{HS} = 6°/W as the thermal resistance of an external Heat Sink, the junction-to-air thermal resistance, θ_{JA} = 10°C/W. Therefore, for the maximum allowed dissipation, derate 0.1W/°C for each degree from T_{AMB} to the maximum rated junction temperature of 150°C. If T_{AMB} = 100°C, the maximum P_D is (150 - 100) x 0.1W/°C = 5W.

Figure 3 shows the pulsed output switching characteristics of the HIP1090 as a high side driver. A small delay step is noted on the rising edge due to the hold-off of a $V_{CE}SAT$ detector circuit. The $V_{CE}SAT$ circuit senses the saturation level of the PNP pass transistor and controls the drive as a ratio of load current. As the load current is reduced, the drive current to the output transistor is reduced. Under low current operation, the saturation level is controlled and the turn-OFF switching time is much faster. The control switching element is shown as a 2N5320 NPN transistor but may be any open collector or MOS gate. A pull-up resistor of 2kΩ is used for a slight improvement in the turnoff fall time but is not an essential requirement. The V_{CON} terminal may be controlled with a mechanical switch or may be controlled from any driver output that can sink the worst case condition of pin 2 current, I_{CON} when the output load current is increased to 1A (typically 50mA).
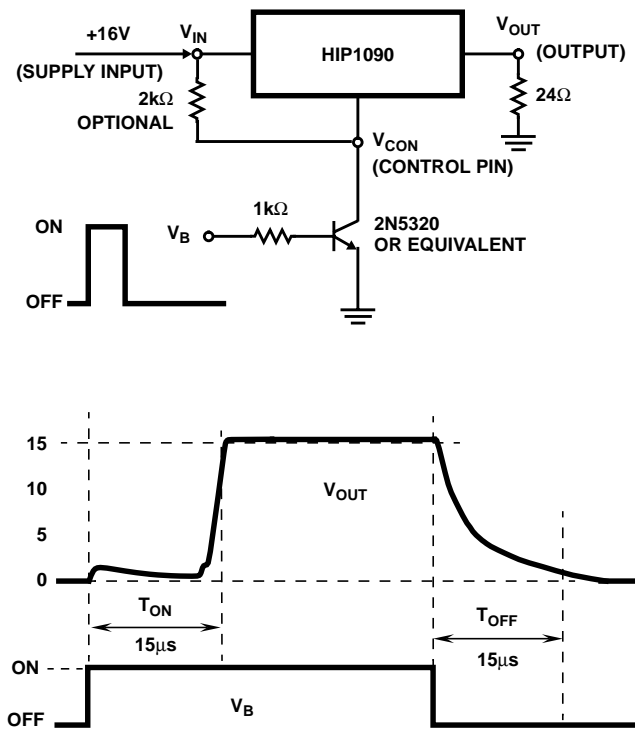
The circuit of Figure 4 shows how the HIP1090 transient suppression voltage shutdown threshold may be increased by using a zener diode from the V_{CON} terminal to the collector terminal of the transistor switch. The preferred method is to use a zener diode for a fixed level shift. While a resistor in place of the zener diode having the same voltage drop will work well, the parametric variation of the I_{CON} current will cause variations of the Over-Voltage Shutdown Threshold. In this circuit, a 10V zener provides a typical over-voltage threshold shift to ~27V. The threshold for over-voltage shutdown is referenced to the (V_{IN} - V_{CON}) voltage difference.
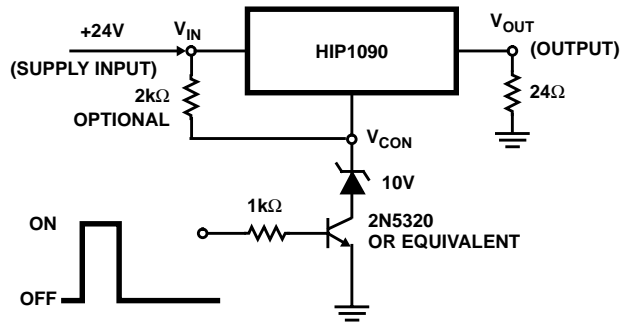

FIGURE 4. A TYPICAL APPLICATION CIRCUIT THAT USES A ZENER TO THE V_{CON} TRANSISTOR SWITCH TO RAISE THE OVER-VOLTAGE SHUTDOWN THRESHOLD

Also, it is important to note that high peak current values may be reached when driving nonlinear and inductive loads. The peak output current of the HIP1090 is self limiting in the 1A to 2A range to protect against short circuit conditions. Sustained high peak current may increase the junction temperature to 150°C and cause thermal shutdown. When this happens, the output current will fall off briefly before recovering, unless the over-temperature condition is sustained. Internally, both input and output over-voltage conditions are sensed to protect the circuit, making the high levels of transient voltage ratings possible. Sustained voltage ratings of ±24VDC with transient ratings to ±90V allow a wide variety of applications in high stress environments.

Except for the $V_{CE}SAT$ detector circuit, the HIP1090 is a higher current version of the CA3273 high side driver, which turns-on without the delayed step on the leading edge of the output pulse; switching with a typical T_{ON} time of ~0.5μs. The CA3273 has a higher transient suppression threshold.

FIGURE 3. TYPICAL ON-OFF SWITCHING CHARACTERISTIC OF THE HIP1090 USING AN NPN TRANSISTOR TO SWITCH THE V_{CON} INPUT TERMINAL
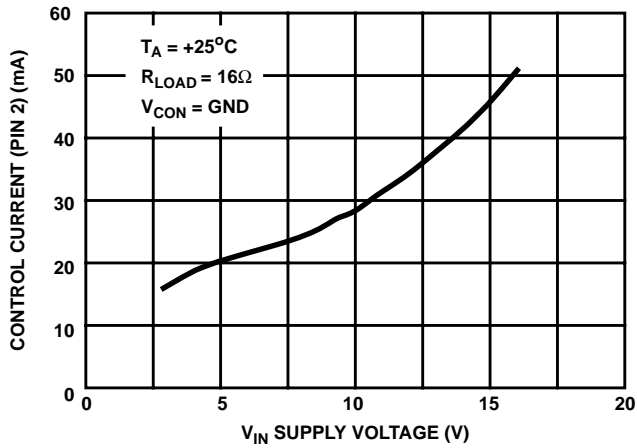
Typical Performance Curves

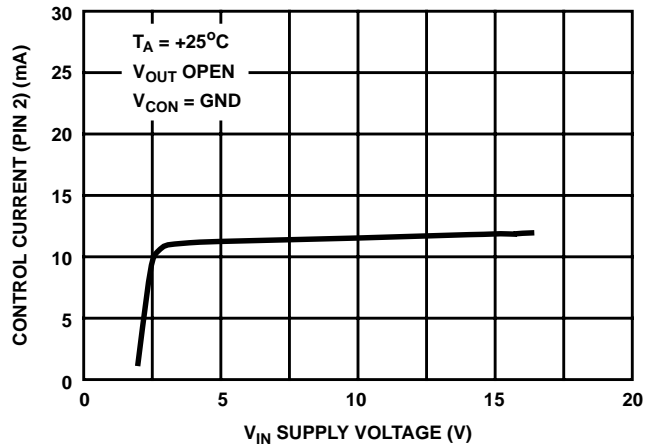FIGURE 5. CONTROL (QUIESCENT) CURRENT CHARACTER-ISTIC WITH LOAD

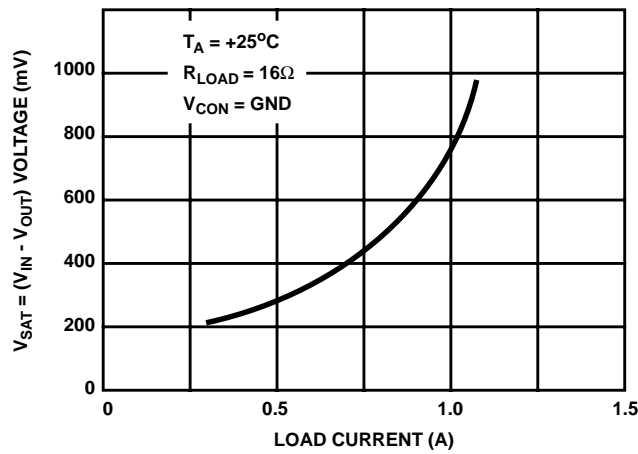FIGURE 6. CONTROL (QUIESCENT) CURRENT CHARACTER-ISTIC WITH NO LOAD

FIGURE 7. SATURATION (V_{IN} - V_{OUT}) CHARACTERISTIC

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