



## DS1687/DS3687 Negative Voltage Relay Driver

### General Description

The DS1687/DS3687 is a high voltage/current negative voltage relay driver having many features not available in present relay drivers.

PNP inputs provide both TTL/LS compatibility and high input impedance for low input loading.

Output leakage is specified over temperature at an output voltage of  $-54V$ . Minimum output breakdown (ac/latch breakdown) is specified over temperature at  $-5$  mA. This clearly defines the actual breakdown of the device since the circuit has incorporated in it an internal reference which does not allow output breakdown latching found in existing relay drivers. Additionally, this internal reference circuit feature will eliminate the need in most cases of an external clamping (inductive transient voltage protection) diode. When the output is turned "OFF" by input logic conditions the resulting inductive voltage transient seen at the output is detected by an internal zener reference. The reference then momentarily activates the output transistor long enough so that the relay energy is discharged. This feature eliminates the need of external circuit protection components and insures output transistor protection.

The outputs are Darlington connected transistors, which allow high current operation at low internal  $V_{CC}$  current levels—base drive for the output transistor is obtained from the load in proportion to the required loading conditions. Typical  $V_{CC}$  power with both outputs "ON" is 90 mW.

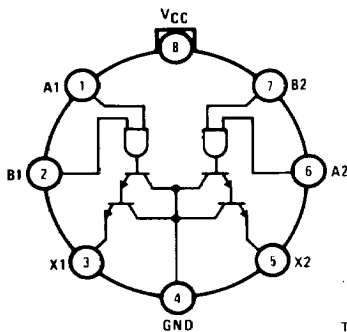
The circuit also features output transistor protection if the  $V_{CC}$  supply is lost by forcing the output into the high impedance "OFF" state with the same breakdown levels as when  $V_{CC}$  was applied.

### Features

- TTL/LS/CMOS compatible inputs
- High impedance inputs (PNP's)
- High output voltage breakdown ( $-65V$  typ)
- High output current capability (300 mA max)
- Internal protection circuit eliminates need for output protection diode
- Output breakdown protection if  $V_{CC}$  supply is lost
- Low  $V_{CC}$  power dissipation (90 mW (typ) both outputs "ON")
- Voltage and current levels compatible for use in telephone relay applications

### Connection Diagrams

Metal Can Package

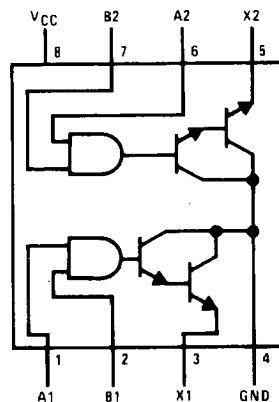


Top View

Pin 4 is in electrical contact with the case  
**Order Number DS1687H or DS3687H**  
**See NS Package Number H08C**

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Dual-In-Line Package



Top View

**Order Number DS1687J-8,**  
**DS3687J-8 or DS3687N**  
**See NS Package Number J08A or N08E**

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### Truth Table

Positive logic:  $\overline{AB} = X$

A	B	Output X
0	0	1
1	0	1
0	1	1
1	1	0

Logic "0" output "ON"

Logic "1" output "OFF"

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	7V
Input Voltage	15V
Output Voltage	56V
Storage Temperature Range	-65°C to +150°C
Maximum Power Dissipation* at 25°C	
Cavity Package	1133 mW
Molded Package	1022 mW
TO-5 Package	787 mW
Lead Temperature (Soldering, 4 seconds)	260°C

\*Derate cavity package 7.6 mW/°C above 25°C; derate molded package 8.2 mW/°C above 25°C; derate TO-5 package 5.2 mW/°C above 25°C.

**Operating Conditions**

	Min	Max	Units
Supply Voltage, $V_{CC}$			
DS1687	4.5	5.5	V
DS3687	4.75	5.25	V
Temperature, $T_A$			
DS1687	-55	+125	°C
DS3687	0	+70	°C

**Electrical Characteristics** (Note 2 and 3)

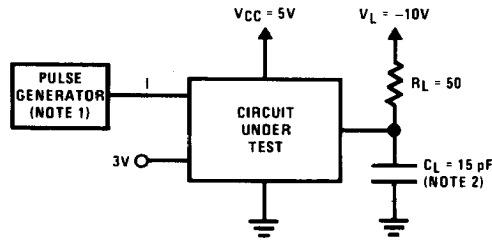
Symbol	Parameter	Conditions	Min	Typ	Max	Units		
$V_{IH}$	Logical "1" Input Voltage		2.0			V		
$I_{IH}$	Logical "1" Input Current	$V_{CC} = \text{Max}, V_{IN} = 5.5V$		1.0		$\mu A$		
$V_{IL}$	Logical "0" Input Voltage				0.8	V		
$I_{IL}$	Logical "0" Input Current	$V_{CC} = \text{Max}, V_{IN} = 0.4V$		-150	-250	$\mu A$		
$V_{CD}$	Input Clamp Voltage	$V_{CC} = 5V, I_{CLAMP} = -12 \text{ mA}, T_A = 25^\circ C$		-1.0	-1.5	V		
$V_{OH}$	Output Breakdown	$V_{CC} = \text{Max}, V_{IN} = 0V, I_{OUT} = -5 \text{ mA}$	-56	-65		V		
$I_{OH}$	Output Leakage	$V_{CC} = \text{Max}, V_{IN} = 0V, V_{OUT} = -54V$		-0.5	-250	$\mu A$		
$V_{OL}$	Output ON Voltage	$V_{CC} = \text{Min}, V_{IN} = 2V$		DS1687	$I_{OL} = -100 \text{ mA}$	-0.9	-1.1	V
					$I_{OL} = -300 \text{ mA}$	-1.0	-1.3	V
				DS3687	$I_{OL} = -100 \text{ mA}$	-0.9	-1.0	V
					$I_{OL} = -300 \text{ mA}$	-1.0	-1.2	V
$I_{CC(1)}$	Supply Current (Both Drivers)	$V_{CC} = \text{Max}, V_{IN} = 0V, \text{Outputs Open}$		2	4	mA		
$I_{CC(0)}$	Supply Current (Both Drivers)	$V_{CC} = \text{Max}, V_{IN} = 3V, \text{Outputs Open}$		18	28	mA		
$t_{PD(ON)}$	Propagation Delay to a Logical "0" (Output Turn ON)	$C_L = 15 \text{ pF}, V_L = -10V, R_L = 50\Omega, T_A = 25^\circ C, V_{CC} = 5V$		50		ns		
$t_{PD(OFF)}$	Propagation Delay to a Logical "1" (Output Turn OFF)	$C_L = 15 \text{ pF}, V_L = -10V, R_L = 50\Omega, T_A = 25^\circ C, V_{CC} = 5V$		1.0		$\mu s$		

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:** Unless otherwise specified min/max limits apply across the -55°C to +125°C temperature range for the DS1687 and across the 0°C to +70°C range for the DS3687. All typicals are given for  $V_{CC} = 5V$  and  $T_A = 25^\circ C$ .

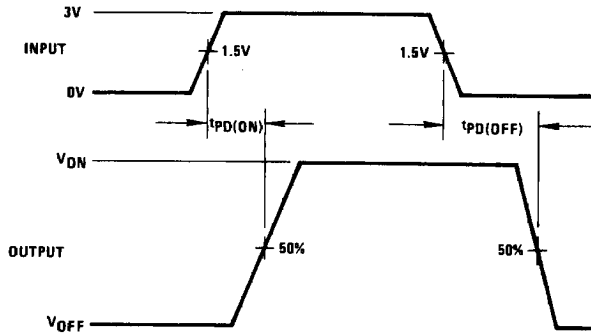
**Note 3:** All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min or absolute value basis.

# AC Test Circuit and Switching Time Waveforms



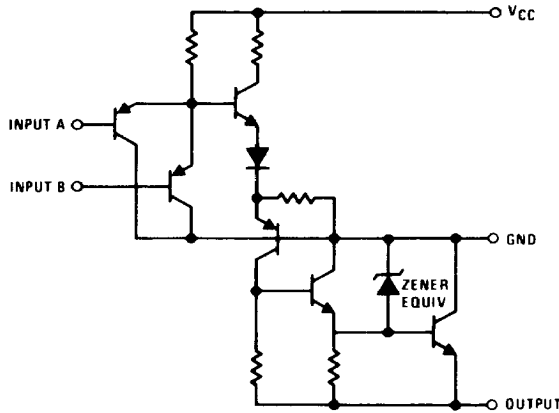
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**Note 1:** The pulse generator has the following characteristics:  
 PRR = MHz, 50% duty cycle,  $Z_{OUT} \approx 50\Omega$ ,  $t_r = t_f \leq 10$  ns.  
**Note 2:**  $C_L$  includes probe and jig capacitance.



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## Schematic Diagram



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