

## SINGLE POLE HIGH-VOLTAGE SOLID-STATE RELAY

AN AT & T PRODUCT

- HIGH VOLTAGE IC FABRICATED IN A DIE-ELECTRIC ISOLATION PROCESS
- OPTICAL COUPLING BETWEEN INPUT AND OUTPUT
- CAN SWITCH LOADS UP TO 350V AT CURRENTS UP TO 100mA
- LOW ON-RESISTANCE
- CLEAN, BOUNCE-FREE SWITCHING
- HIGH CURRENT SURGE CAPABILITY
- LOW-POWER CONSUMPTION
- NO ELECTROMAGNETIC INTERFERENCE

### DESCRIPTION

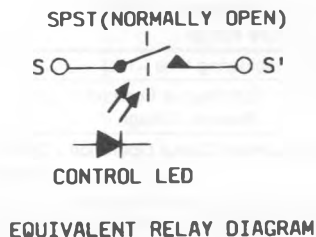
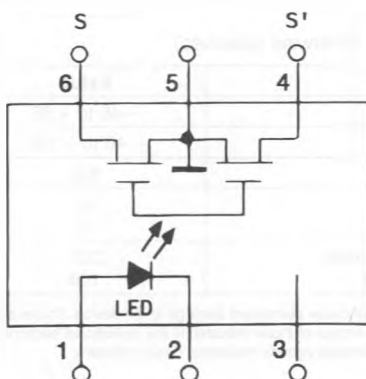
The LH1056 (Multipurpose Solid-State Relay) is a low-cost, bi-directional, SPST designed to switch both AC and DC loads. Output is rated at 350 volts and can handle loads up to 100mA. It is packaged in a special 6-pin plastic DIP.

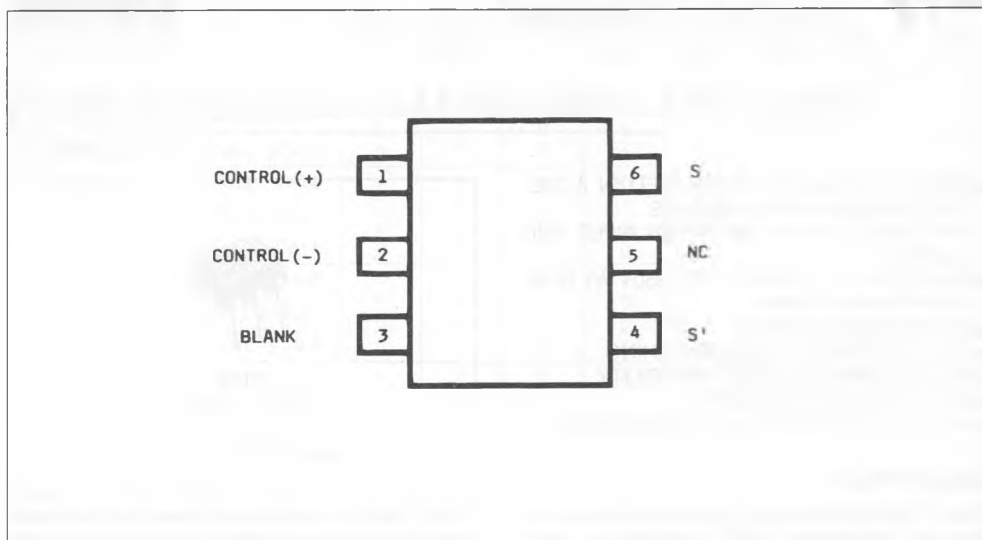
Each device consists of one GaAlAs LED to optically couple the control signal to a high-voltage integrated circuit. The typical ON-Resistance is 30 ohms at



25mA, and is exceptionally linear up to 50mA. Beyond 50mA, the incremental resistance becomes even less, thereby minimizing internal power dissipation. The LH1056 also has internal current limiting which clamps the load current at 150mA to insure that the device will survive during current surges.

**Figure 1 : Functional and Equivalent Relay Diagrams.**



**PIN CONNECTION** (top view)**PIN DESCRIPTION**

Name	Description
Control + Control -	These pins are the positive and negative inputs respectively to the input control LED. An appropriate amount of current through the LED will close the circuit path between S and S'.
S-S'	These pins are the outputs. The pin pair S-S' represents one normally open relay pole.
Blank	This pin may be used as a tie-point for external components. Voltage on this pin should not exceed 300V.
NC	This pin is connected to internal circuitry. It should not be used as a tie-point for external circuitry.

**ABSOLUTE MAXIMUM RATINGS** (at 25°C unless otherwise specified)

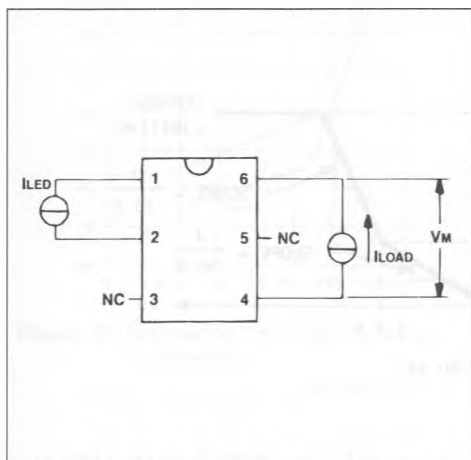
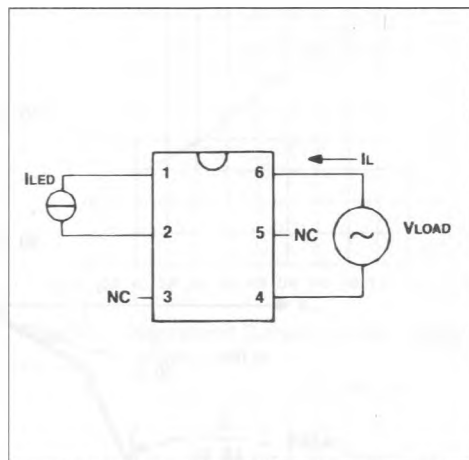
Parameter	Value	Unit
Ambient Operating Temperature Range	- 40 to + 85	°C
Storage Temperature Range	- 40 to + 100	°C
Pin Temperature (soldering time =15s)	300	°C
LED Input Ratings : Continuous Forward Current	20	mA
Reverse Voltage	10	V
Recommended Maximum Output Operation : Operating Voltage	350	V
Load Current	100	mA

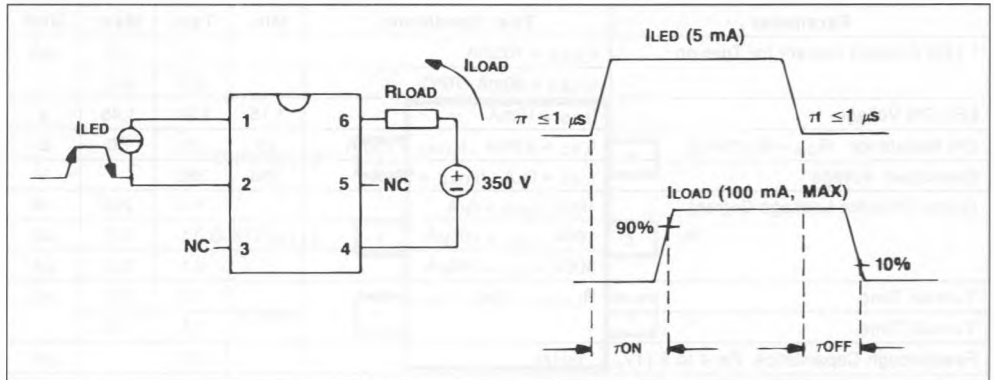
Stresses in excess of those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions in excess of those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**ELECTRICAL CHARACTERISTICS** (at 25°C unless otherwise noted)

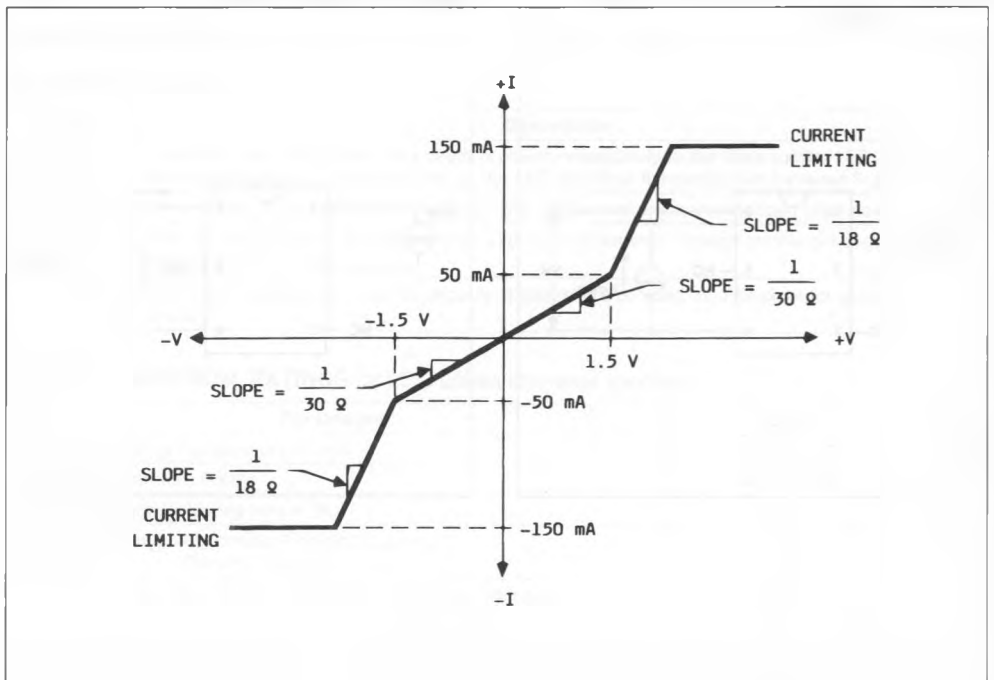
Parameter	Test Conditions	Min.	Typ.	Max.	Unit
* LED Forward Current for Turn-on	I <sub>LOAD</sub> = 100mA		1.5	2.5	mA
	I <sub>LOAD</sub> = 80mA, 70°C		2.5	5.0	
LED ON Voltage	I <sub>LED</sub> = 10mA	1.15	1.30	1.45	V
ON Resistance : R <sub>ON</sub> = V <sub>M</sub> /25mA	I <sub>LED</sub> = 2.5mA ; I <sub>LOAD</sub> = 25mA	20	30	50	Ω
Breakdown Voltage	I <sub>LED</sub> = 0μA ; I <sub>LOAD</sub> = 50μA	350	380		V
Output Off-state Leakage Current	100V, I <sub>LED</sub> = 0μA		1.0	200	nA
	100V, I <sub>LED</sub> = 200μA		0.1	2.0	μA
	300V, I <sub>LED</sub> = 200μA		0.1	5.0	μA
Turn-on Time	R <sub>LOAD</sub> = 10kΩ ; I <sub>LED</sub> = 5mA		1.0	2.0	ms
Turn-off Time			0.5	2.0	
Feedthrough Capacitance, Pin 4 to 6 (4V <sub>p-p</sub> , 1kHz)			24		pF

\* Supply a minimum of 6mA LED current to insure proper operation over the full operating temperature range.

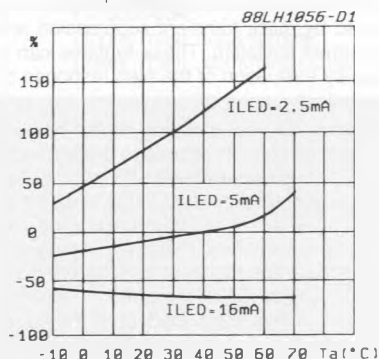
**TEST CIRCUITS****Figure 2 :  $R_{ON}$ , ON Voltage and Breakdown Voltage.****Figure 3 : Leakage Current.**

**Figure 4 :**  $\tau_{ON}/\tau_{OFF}$  Test Circuit and Waveform.

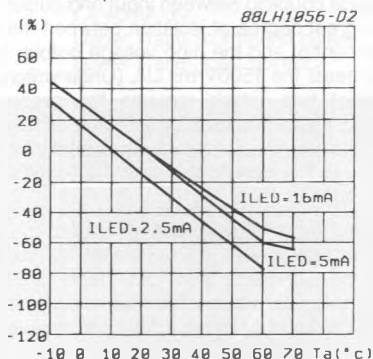
## CHARACTERISTIC CURVES

**Figure 5 :** Solid-state Relay Typical ON Characteristics.

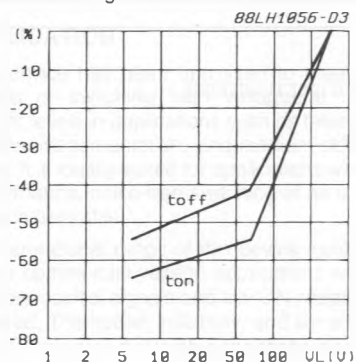
**Figure 6 :** Normalized Turn-on Time vs. Temperature.



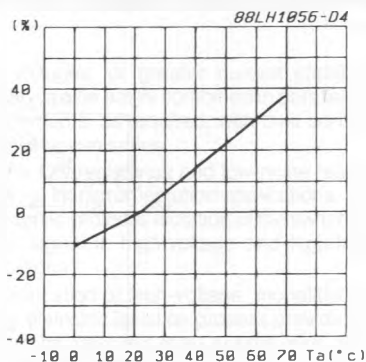
**Figure 7 :** Normalized Turn-off Time vs. Temperature.



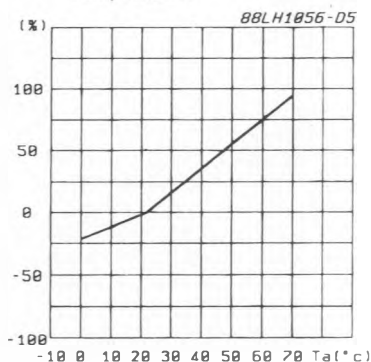
**Figure 8 :** Normalized Switching Time vs. Load Voltage.



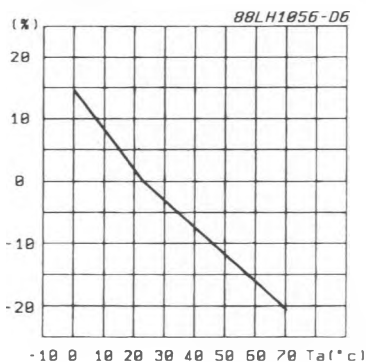
**Figure 9 :** Normalized On-resistance vs. Temperature.



**Figure 10 :** Normalized Threshold Current vs. Temperature.



**Figure 11 :** Normalized Current Limit vs. Temperature.



## INPUT/OUTPUT ISOLATION

The optical coupling between input and output provides a great degree of isolation between the low-voltage control and the high voltage output. Each device meets the 1500Vrms U/L (Underwriters Laboratories) test, which requires the product to withstand 1500Vrms for a time of one minute. For throughput purposes, U/L allows reduction of the test time to 1 second if the stress is increased to 1800Vrms.

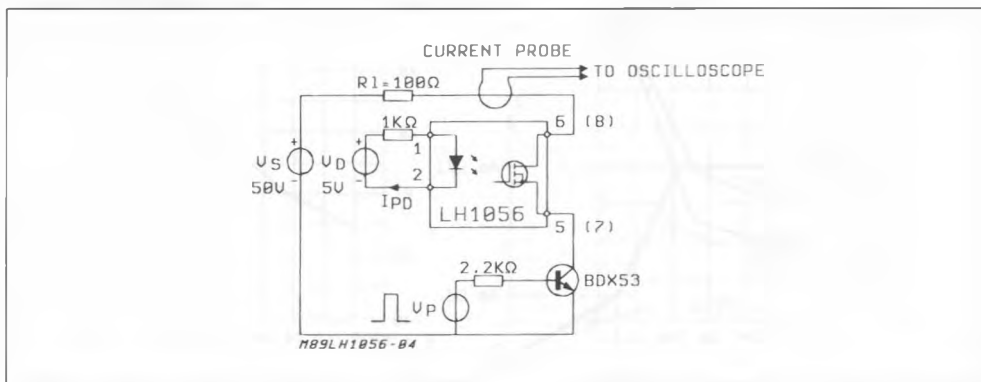
In order to further assure long term reliability, each device is tested with an additional 600Vrms of guardband, bringing the total test stress to 2400Vrms for one second. During the test, less than 100nA of leakage is required. After passing this test, the part is subjected to the parameters specified by the data sheet.

## LOAD PROTECTION

The LH1056 has been designed to protect the switching load by quick transient suppression and by output current limitation. These features can be illustrated by evaluation of the step response of the closed contact.

The circuit used for evaluation is shown in figure 12. First, a control signal is applied in order to activate the switch. Then transistor TR1 is turned on, which activates a 50V step through  $100\Omega$  across the closed switch. The switch reacts to the leading edge of the step by quickly deactivating, stopping current flow in the load. The resultant load current is shown in figure 13. After  $250\mu\text{s}$ , the switch recloses, allowing current to flow in the load, up to the current limit of the device, if necessary. This clamping can be seen in figure 14 which also shows the fast shutoff at the leading edge of the step.

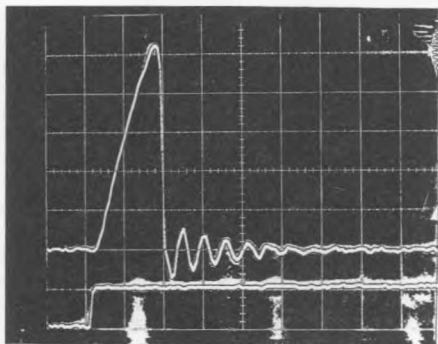
**Figure 12 :** Circuit used for Measurements of figures 13, 14.



**Figure 13 :** Current Spike ( $R_L = 100\Omega$ ,  $V_S = 22V$ ).X =  $0.5\mu s/div$ .Y =  $30mA/div$ .

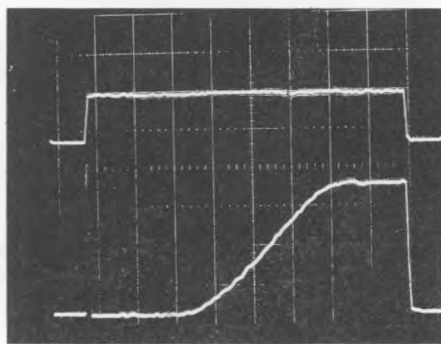
Upper Trace : load current.

Lower Trace : command pulse.

**Figure 14 :** Current limiting ( $V_S = 22V$ ,  $R_L = 100\Omega$ ).X =  $0.2ms/div$ .Y =  $40mA/div$ .

Upper Trace : command pulse.

Lower Trace : load current.



## APPLICATION

This device has been optimized to meet the demands of switching high voltages at moderate current levels in applications such as telecommunications, instrumentation, and medium-power switching. It is ideally suited for applications where high performance, noise-free switching of ac and dc signals is desirable.

The operational range of this device includes low-power commercial voltage applications where millampere control signals and low ON-resistance are required. The speed, reliability, and linearity of this switch makes it well suited for those applications which are beyond the range of mechanical relays, thyristors, and triacs. For lower ON resistance, hi-

gher voltages, or greater current capability, the LH1056 can be easily combined in parallel or series arrangements, as required, with their control LEDs simply driven in series.

The low ON-resistance and low-noise features are beneficial in instrumentation applications. The optical coupling provides isolation of the switch from the control signal in high-voltage and high-frequency applications.

The fabrication of high-voltage, monolithic ICs in a unique dielectric isolation process provides high reliability and the solid-state construction eliminates problems associated with mechanical relays such as sensitivity to shock and vibration.

Figure 15 : Triac Predriver.

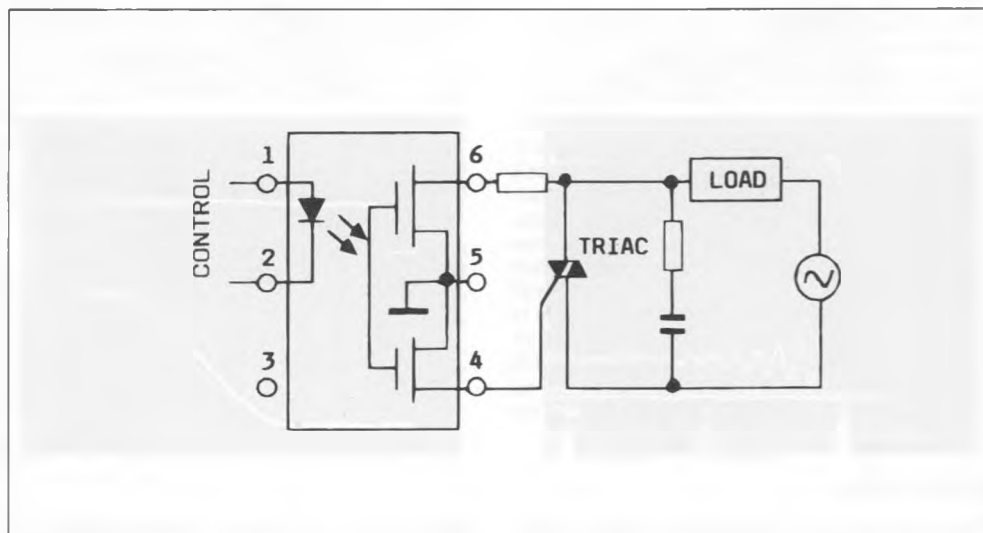


Figure 16 : Telephone Switchhook.

