

# CA3059

## Zero Voltage Switch

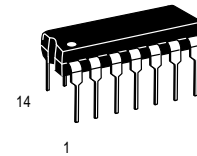
This series is designed for thyristor control in a variety of AC power switching applications for AC input voltages of 24 V, 120 V, 208/230 V, and 277 V @ 50/60 Hz.

### Applications:

- Relay Control
- Valve Control
- On-Off Motor Switching
- Differential Comparator with Self-Contained Power Supply for Industrial Applications
- Synchronous Switching of Flashing Lights
- Heater Control
- Lamp Control

## ZERO VOLTAGE SWITCH

### SEMICONDUCTOR TECHNICAL DATA

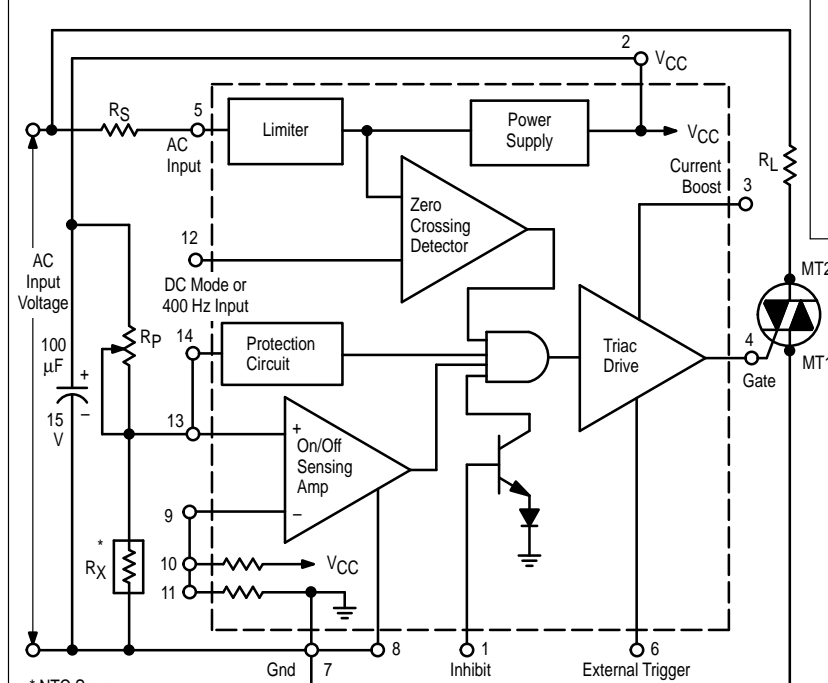


PLASTIC PACKAGE  
CASE 646

### ORDERING INFORMATION

Device	Operating Temperature Range	Package
CA3059	$T_A = -40^\circ$ to $+85^\circ\text{C}$	Plastic DIP

Figure 1. Representative Block Diagram



### FUNCTIONAL BLOCK DESCRIPTION

1. **Limiter-Power Supply** — Allows operation of the CA3059 directly from an AC line. Suggested dropping resistor ( $R_S$ ) values are given in the table below.
2. **Differential On/Off Sensing Amplifier** — Tests for condition of external sensors or input command signals. Proportional control capability or hysteresis may be implemented using this block.
3. **Zero-Crossing Detector** — Synchronizes the output pulses to the zero voltage point of the AC cycle. This synchronization eliminates RFI when used with resistive loads.
4. **Triac Drive** — Supplies high-current pulses to the external power controlling thyristor.
5. **Protection Circuit** — A built-in circuit may be actuated, if the sensor opens or shorts, to remove the drive current from the external triac.
6. **Inhibit Capability** — Thyristor firing may be inhibited by the action of an internal diode gate at Pin 1.
7. **High Power DC Comparator Operation** — Operation in this mode is accomplished by connecting Pin 7 to Pin 12 (thus overriding the action of the zero-crossing detector). When Pin 13 is positive with respect to Pin 9, current to the thyristor is continuous.

AC Input Voltage (50/60 Hz) Vac	Input Series Resistor ( $R_S$ ) $k\Omega$	Dissipation Rating for $R_S$ W
24	2.0	0.5
120	10	2.0
208/230	20	4.0
277	25	5.0

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## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage (Between Pins 2 and 7)	$V_{CC}$	12	Vdc
DC Supply Voltage (Between Pins 2 and 8)	$V_{CC}$	12	Vdc
Peak Supply Current (Pins 5 and 7)	$I_{5,7}$	$\pm 50$	mA
Fail-Safe Input Current (Pin 14)	$I_{14}$	2.0	mA
Output Pulse Current (Pin 4) (Note 1)	$I_{out}$	150	mA
Junction Temperature	$T_J$	150	$^{\circ}C$
Operating Temperature Range	$T_A$	- 40 to + 85	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	- 65 to + 150	$^{\circ}C$

## ELECTRICAL CHARACTERISTICS (Operation @ 120 Vrms, 50–60 Hz, $T_A = 25^{\circ}C$ [Note 2])

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
DC Supply Voltage Inhibit Mode $R_S = 10\text{ k}$ , $I_L = 0$ $R_S = 5.0\text{ k}$ , $I_L = 2.0\text{ mA}$ Pulse Mode $R_S = 10\text{ k}$ , $I_L = 0$ $R_S = 5.0\text{ k}$ , $R_L = 2.0\text{ mA}$	2	$V_S$	6.1 — 6.0 —	6.5 6.1 6.4 6.2	7.0 — 7.0 —	Vdc
Gate Trigger Current ( $V_{GT} = 1.0\text{ V}$ , Pins 3 and 2 connected)	3	$I_{GT}$	—	160	—	mA
Peak Output Current, Pulsed With Internal Power Supply, $V_{GT} = 0$ Pin 3 Open Pins 3 and 2 Connected With External Power Supply, $V_{CC} = 12\text{ V}$ , $V_{GT} = 0$ Pin 3 Open Pins 3 and 2 Connected	3 4	$I_{OM}$	50 90 — —	125 190 230 300	— — — —	mA
Inhibit Input Ratio (Ratio of Voltage @ Pin 9 to Pin 2)	5	$V_9/V_2$	0.465	0.485	0.520	—
Total Gate Pulse Duration ( $C_{Ext} = 0$ ) Positive dv/dt Negative dv/dt	6	$t_p$ $t_n$	70 70	100 100	140 140	$\mu s$
Pulse Duration After Zero Crossing ( $C_{Ext} = 0$ , $R_{Ext} = \infty$ ) Positive dv/dt Negative dv/dt	6	$t_{p1}$ $t_{n1}$	— —	50 60	— —	$\mu s$
Output Leakage Current Inhibit Mode (Note 3)	3	$I_4$	—	0.001	10	$\mu A$
Input Bias Current	7	$I_{IB}$	—	0.15	1.0	$\mu A$
Common Mode Input Voltage Range (Pins 9 and 13 Connected)	—	$V_{CMR}$	—	1.4 to 5.0	—	Vdc
Inhibit Input Voltage	8	$V_1$	—	1.4	1.6	Vdc
External Trigger Voltage	—	$V_6-V_4$	—	1.4	—	Vdc

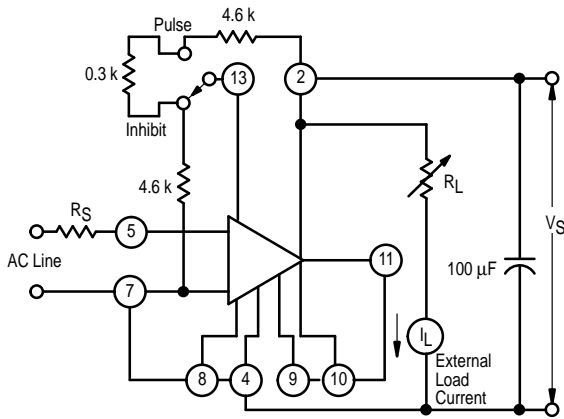
- NOTES:** 1. Care must be taken, especially when using an external power supply, that total package dissipation is not exceeded.  
 2. The values given in the Electrical Characteristics Table at 120 V also apply for operation at input voltages of 24 V, 208/230 V, and 277 V, except for Pulse Duration test. However, the series resistor ( $R_S$ ) must have the indicated value, shown in Table A for the specified input voltage.  
 3.  $I_4$  out of Pin 4, 2.0 V on Pin 1,  $S_1$  position 2.

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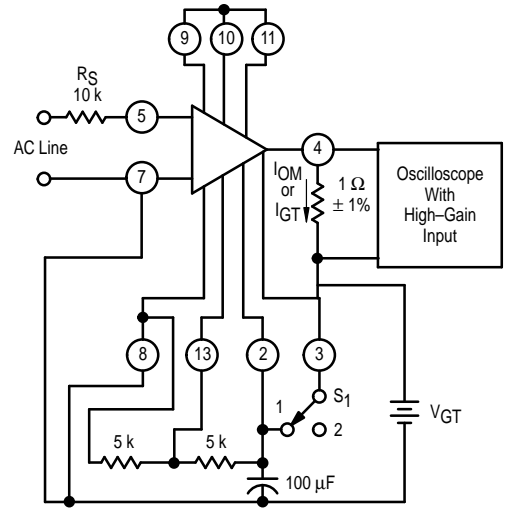
## TEST CIRCUITS

(All resistor values are in ohms)

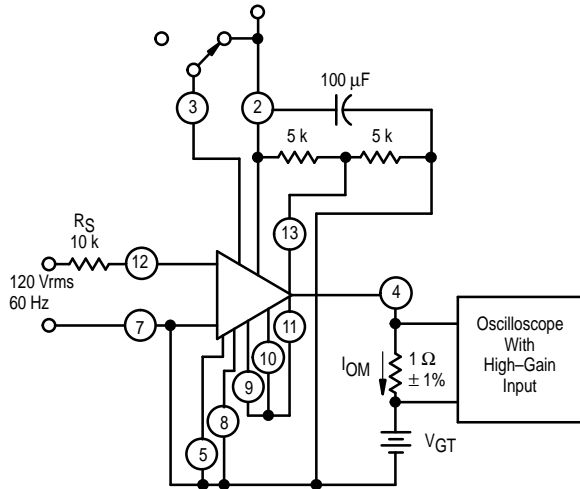
**Figure 2. DC Supply Voltage**



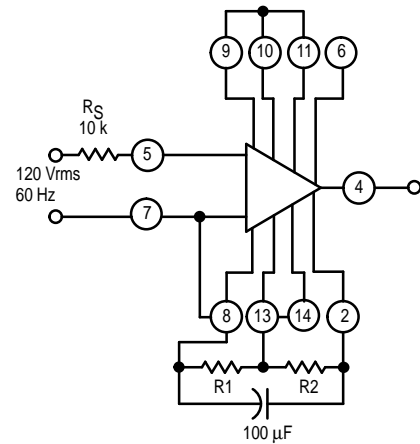
**Figure 3. Peak Output (Pulsed) and Gate Trigger Current with Internal Power Supply**



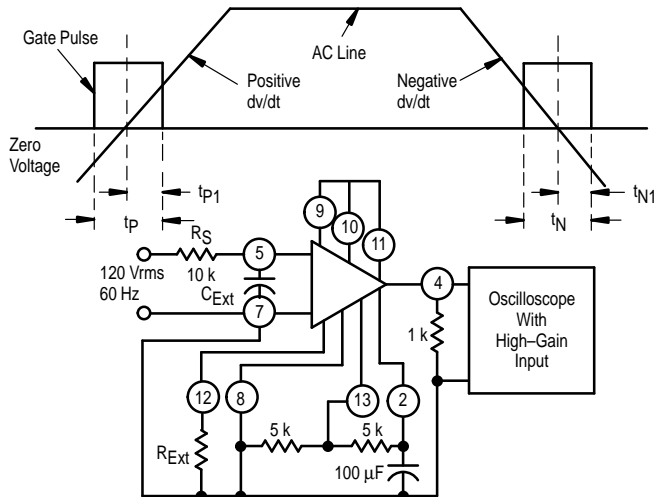
**Figure 4. Peak Output Current (Pulsed) with External Power Supply**



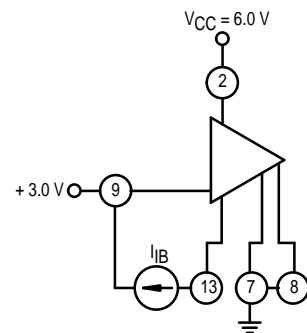
**Figure 5. Input Inhibit Ratio**



**Figure 6. Gate Pulse Duration Test Circuit with Associated Waveform**



**Figure 7. Input Bias Current Test Circuit**



TYPICAL CHARACTERISTICS

Figure 8. Inhibit Input Voltage Test

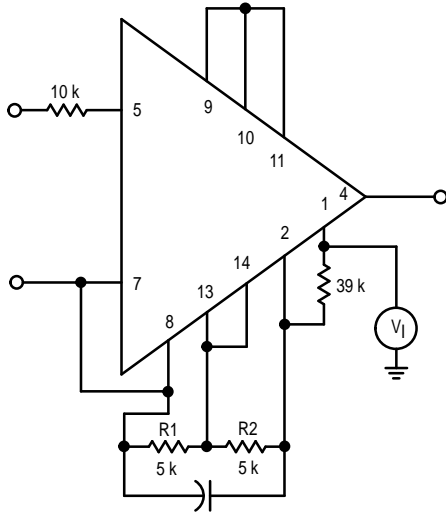


Figure 9. Peak Output Current (Pulsed) versus External Power Supply Voltage

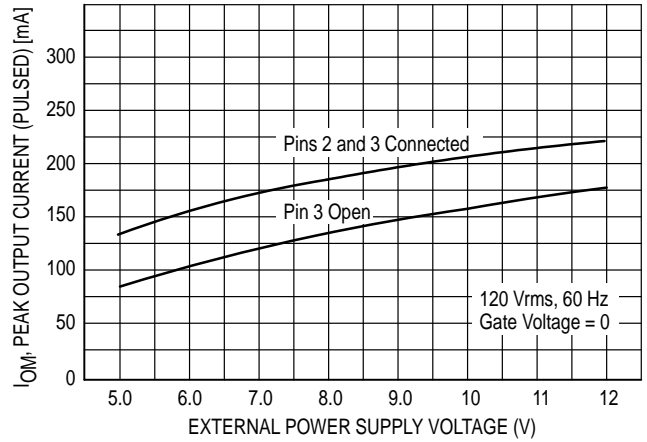


Figure 10. Peak Output Current (Pulsed) versus Ambient Temperature

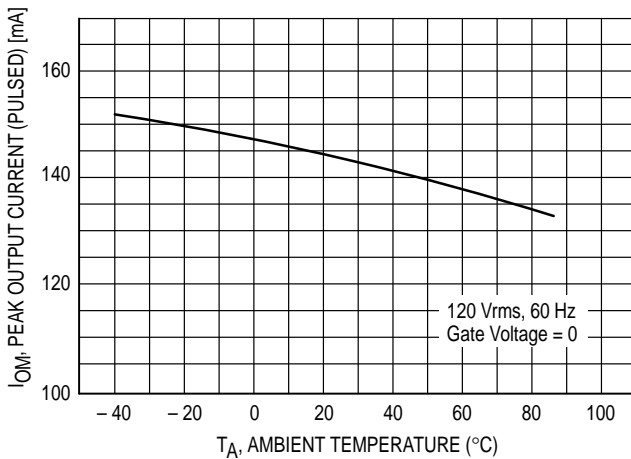


Figure 11. Total Pulse Width versus Ambient Temperature

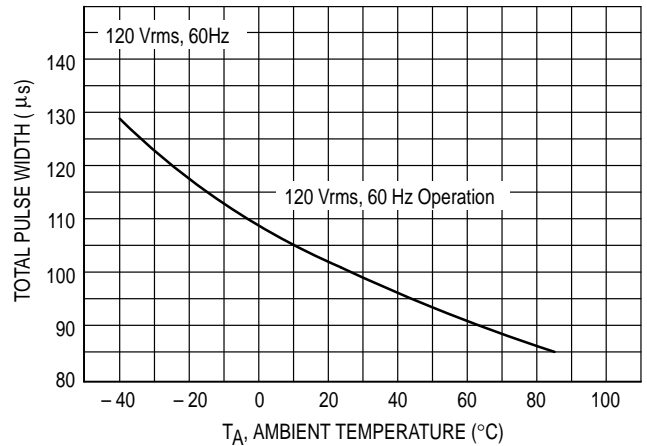


Figure 12. Internal Supply versus Ambient Temperature

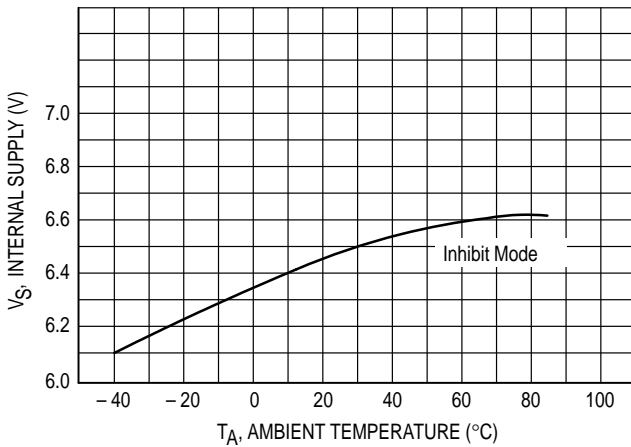
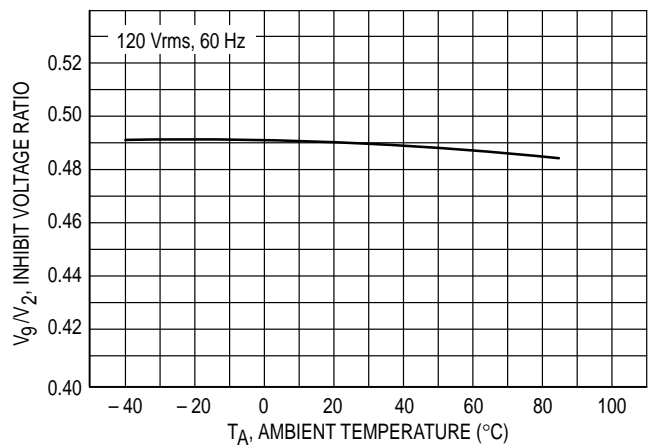
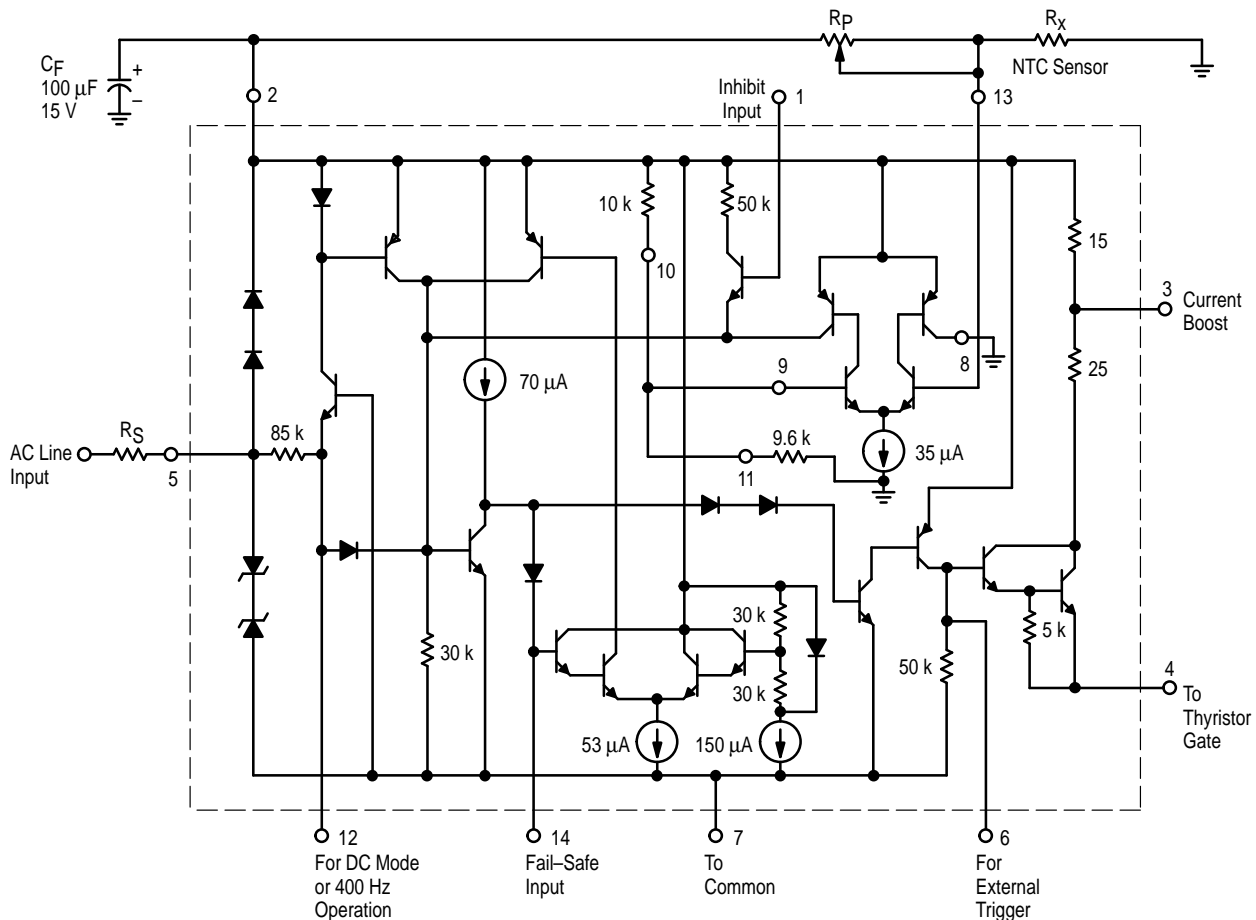


Figure 13. Inhibit Voltage Ratio versus Ambient Temperature



# CA3059

Figure 14. Circuit Schematic



NOTE: Current sources are established by an internal reference.

## APPLICATION INFORMATION

### Power Supply

The CA3059 is a self-powered circuit, powered from the AC line through an appropriate dropping resistor (see Table A). The internal supply is designed to power the auxiliary power circuits.

In applications where more output current from the internal supply is required, an external power supply of higher voltage should be used. To use an external power supply, connect Pin 5 and Pin 7 together and apply the synchronizing voltage to Pin 12 and the DC supply voltage to Pin 2 as shown in Figure 4.

### Operation of Protection Circuit

The protection circuit, when connected, will remove current drive from the triac if an open or shorted sensor is detected. This circuit is activated by connecting Pin 13 to Pin 14 (see Figure 1).

The following conditions should be observed when the protection circuit is utilized:

- The internal supply should be used and the external load current must be limited to 2 mA with a 5 k $\Omega$  dropping resistor.

- Sensor Resistance ( $R_X$ ) and  $R_P$  values should be between 2 k $\Omega$  and 100 k $\Omega$ .
- The relationship  $0.33 < R_X/R_P < 3$  must be met over the anticipated temperature range to prevent undesired activation of the circuit. A shunt or series resistor may have to be added.

### External Inhibit Function

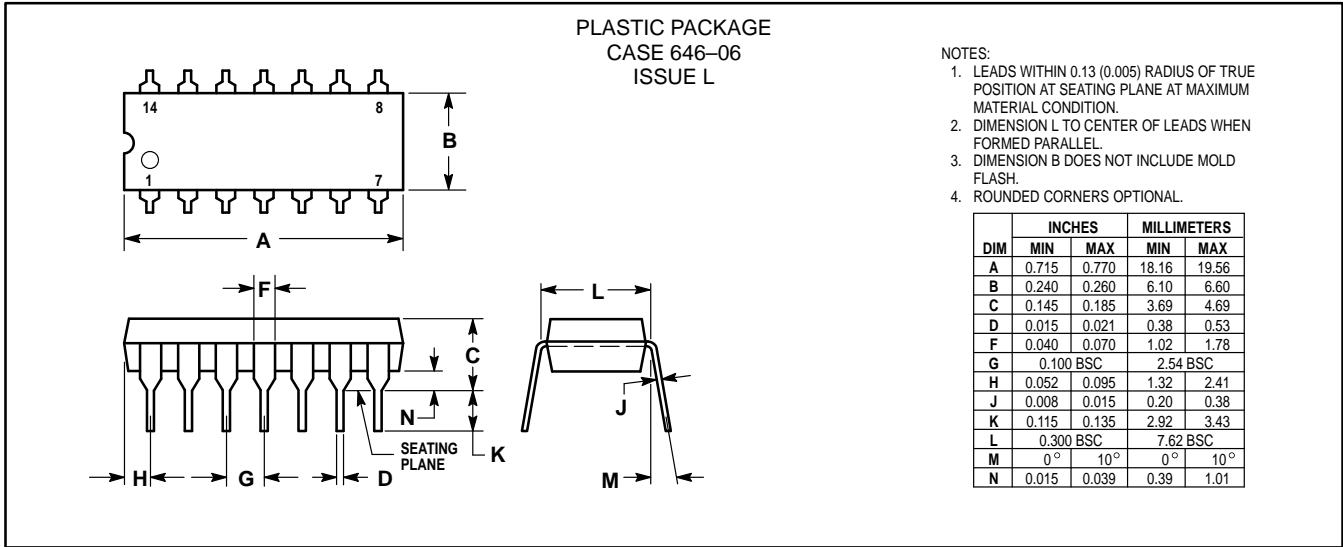
A priority inhibit command applied to Pin 1 will remove current drive from the thyristor. A command of at least +1.2 V @ 10  $\mu$ A is required. A DTL or TTL logic 1 applied to Pin 1 will activate the inhibit function.

### DC Gate Current Mode

When comparator operation is desired or inductive loads are being switched, Pins 7 and 12 should be connected. This connection disables the zero-crossing detector to permit the flow of gate current from the differential sensing amplifier on demand. Care should be exercised to avoid possible overloading of the internal power supply when operating the device in this mode. A resistor should be inserted between Pin 4 and the thyristor gate in order to limit the current.

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## OUTLINE DIMENSIONS



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