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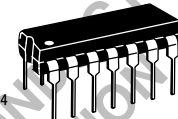- Synchronous Switching of Flashing Lights

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ZERO VOLTAGE SWITCH

SEMICONDUCTOR TECHNICAL DATA

PLASTIC PACKAGE
CASE 646

ORDERING INFORMATION

Device	Operating Temperature Range	Package
CA3059	$T_A = -40°$ to $+85°C$	Plastic DIP

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.
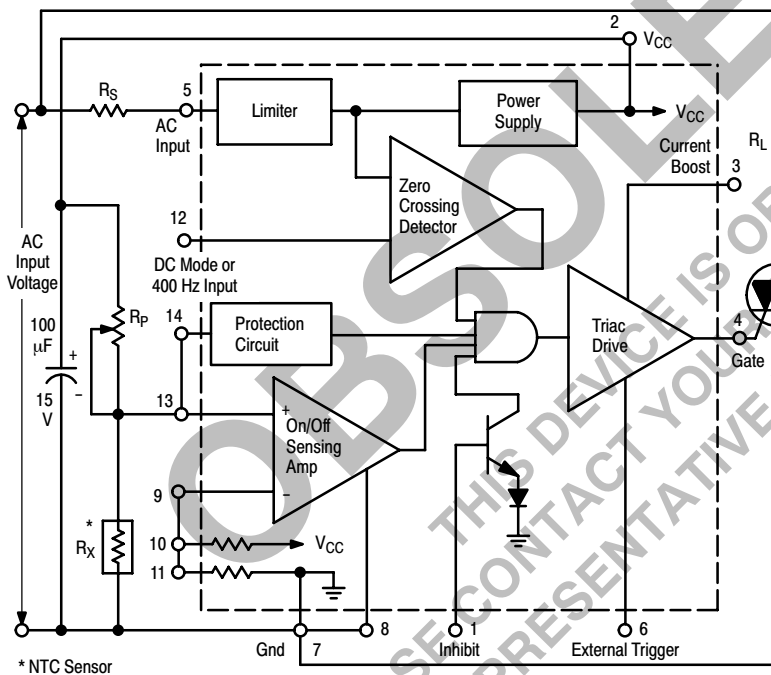

Figure 1. Representative Block Diagram

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

1

CA3059

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)	$I_{5,7}$	±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	°C
Operating Temperature Range	T_A	− 40 to + 85	°C
Storage Temperature Range	T_{stg}	− 65 to + 150	°C

ELECTRICAL CHARACTERISTICS (Operation @ 120 Vrms, 50−60 Hz, T_A = 25°C [Note 2])

Characteristic	Figure	Symbol	Min	Typ	Max	Unit

DC Supply Voltage
Inhibit Mode
  R_S = 10 k, I_L = 0
  R_S = 5.0 k, I_L = 2.0 mA
Pulse Mode
  R_S = 10 k, I_L = 0
  R_S = 5.0 k, R_L = 2.0 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 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 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	µs
Pulse Duration After Zero Crossing (C_{Ext} = 0, R_{Ext} = ∞) Positive dv/dt Negative dv/dt	6	 t_{p1} t_{n1}	 — —	 50 60	 — —	µs
Output Leakage Current Inhibit Mode (Note 3)	3	I_4	—	0.001	10	µA
Input Bias Current	7	I_{IB}	—	0.15	1.0	µA
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.

CA3059

TEST CIRCUITS
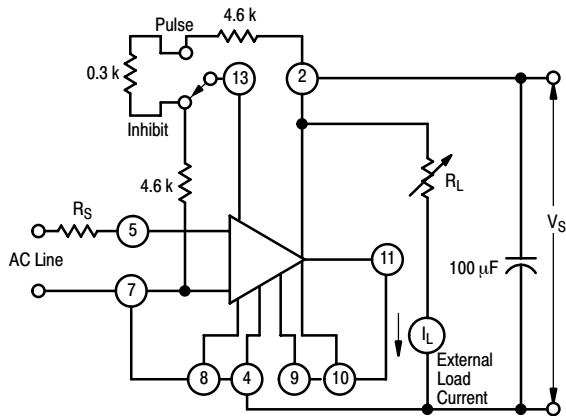(All resistor values are in ohms)
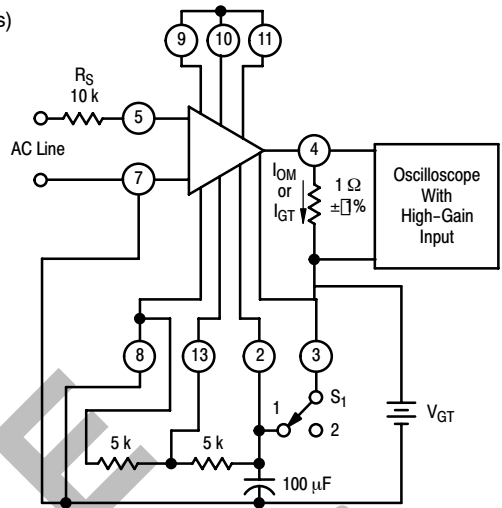
Figure 2. DC Supply Voltage

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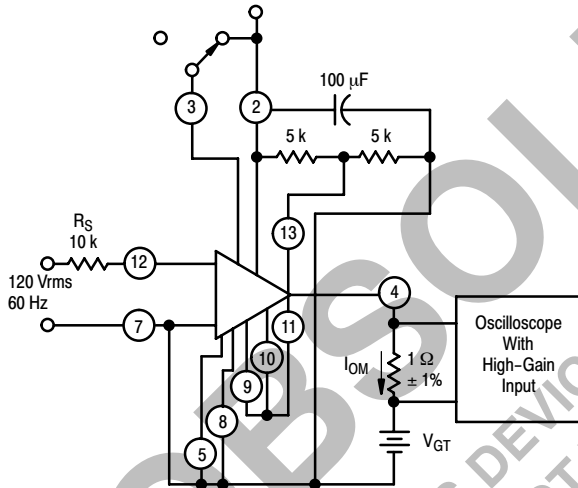Trigger Current with Internal Power Supply

Figure 4. Peak Output Current (Pulsed)
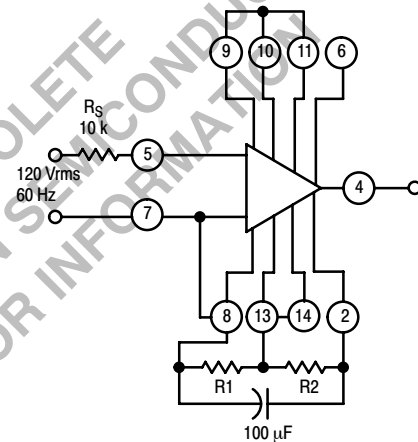with External Power Supply
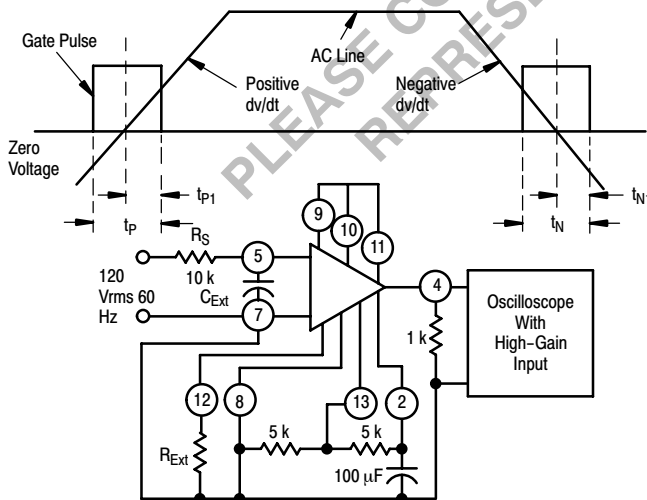
Figure 5. Input Inhibit Ratio

Figure 6. Gate Pulse Duration Test Circuit
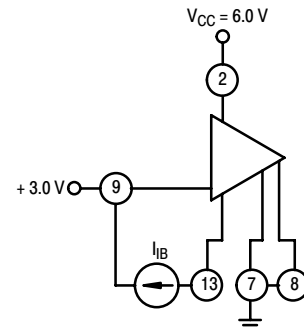with Associated Waveform
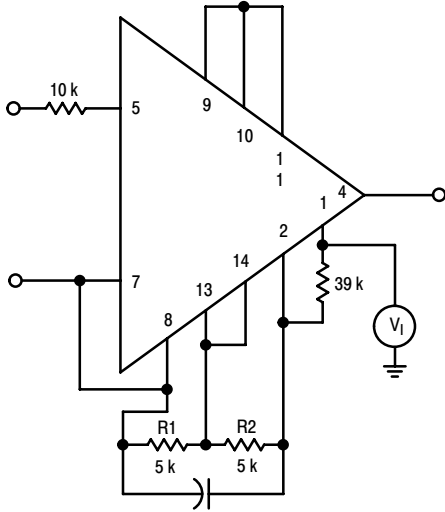
Figure 7. Input Bias Current Test Circuit

CA3059
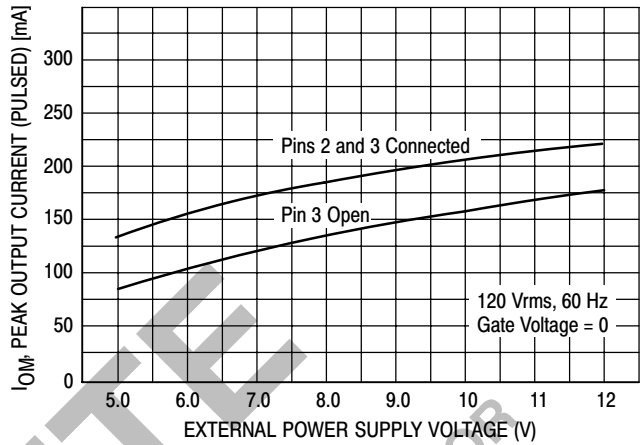
TYPICAL CHARACTERISTICS

Figure 8. Inhibit Input Voltage Test

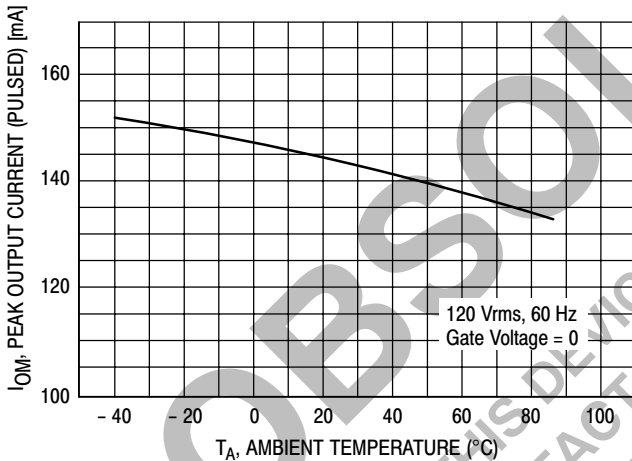**Figure 9. Peak Output Current (Pulsed) versus External Power Supply Voltage**

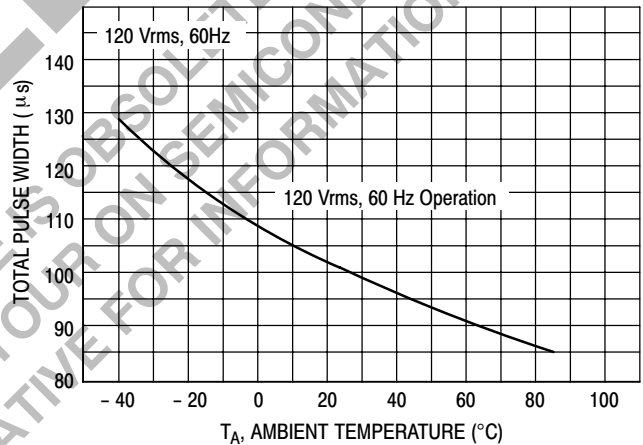**Figure 10. Peak Output Current (Pulsed) versus Ambient Temperature**
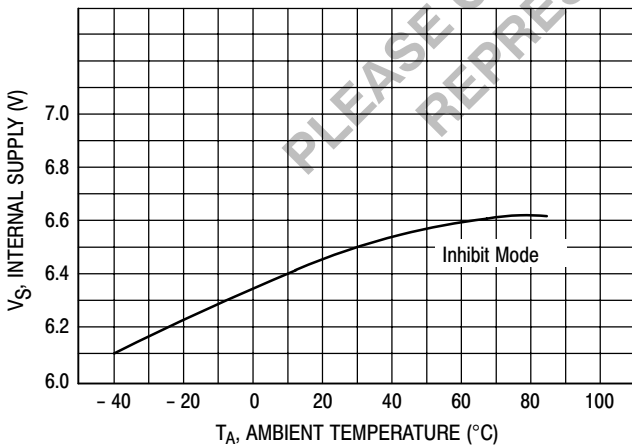

Figure 11. Total Pulse Width versus Ambient Temperature

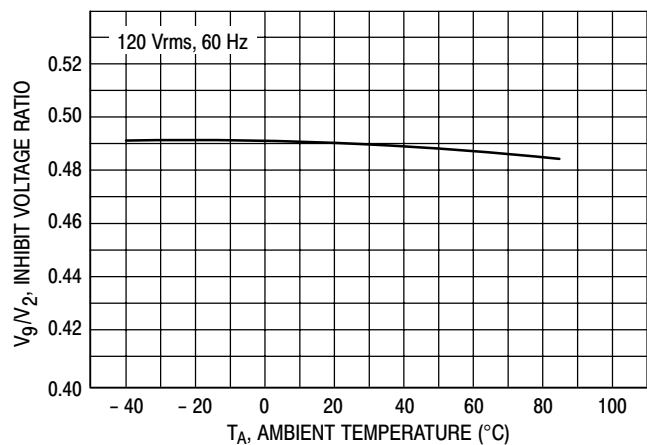**Figure 12. Internal Supply versus Ambient Temperature**

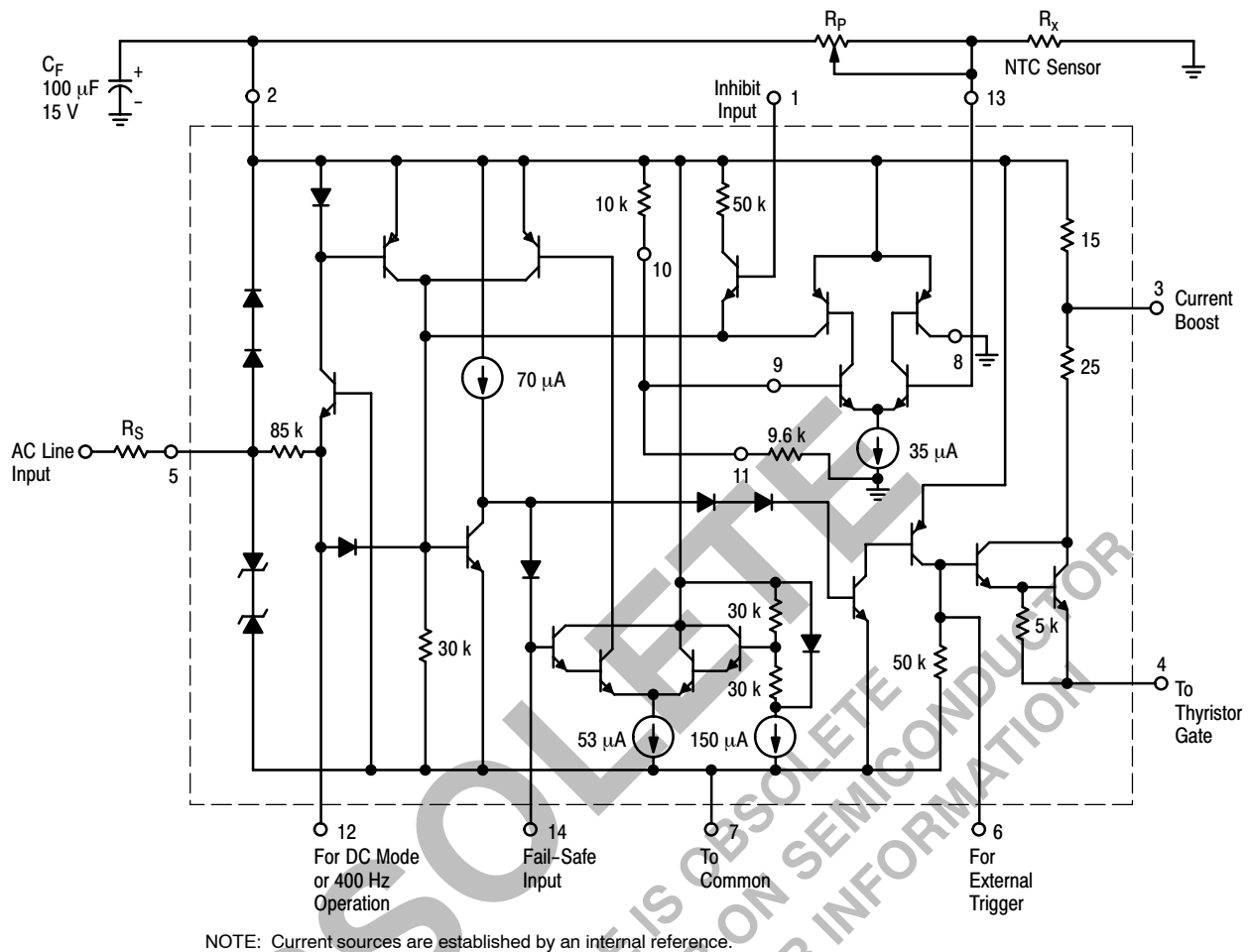**Figure 13. Inhibit Voltage Ratio versus Ambient Temperature**

NOTE: Current sources are established by an internal reference.

Figure 14. Circuit Schematic

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:

  a. The internal supply should be used and the external load current must be limited to 2 mA with a 5 kΩ dropping resistor.

  b. Sensor Resistance (R_X) and R_P values should be between 2 kΩ and 100 kΩ.

  c. 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 μA 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.

CA3059

PACKAGE DIMENSIONS

PLASTIC PACKAGE
CASE 646–06
ISSUE M
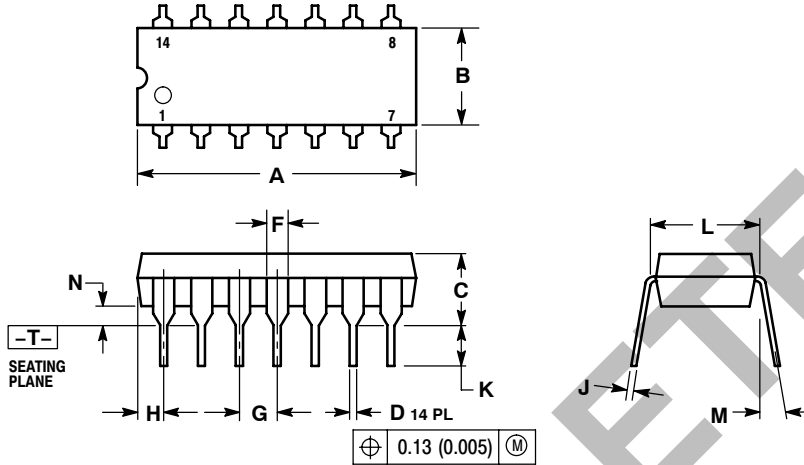
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

⊕ | 0.13 (0.005) | Ⓜ

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	18.80
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.290	0.310	7.37	7.87
M	---	10°	---	10°
N	0.015	0.039	0.38	1.01