



## TL494 Pulse Width Modulation Control Circuits

The TL494 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to specific application .

The TL494 contains 2 error amplifiers, an on-chip adjustable oscillator, a dead-time control comparator, pulse-steering control flip-flop, a 5V, 5%-precision regulator, and output-control circuits.

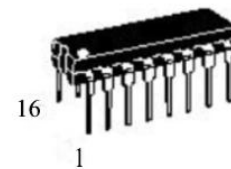
The error amplifier exhibits a common-mode voltage range from -0.3V to  $V_{CC}-2V$ . The dead-time control comparator has a fixed offset that provides approximately 5% dead time when externally altered. The on-chip oscillator may be bypassed by terminating  $R_T$  (pin 6) to the reference output and providing a sawtooth input to  $C_T$  (pin 5), or it may be used to drive the common circuits in synchronous multiple-rail power supplies.

The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Each device provides for push-pull or single-ended output operation, which may be selected through the output control function. The architecture of this device prohibits the possibility of either output being pulsed twice during push-pull operation.

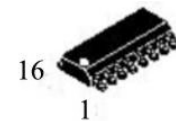
### ● FEATURE

1. Complete PWM Power Control Circuitry
2. Uncommitted Outputs for 200mA Sink or Source Current
3. Output Control Selects Single-Ended or Push-Pull Operation
4. Internal Circuitry Prohibits Double Pulse at Either Output
5. Variable Dead Time Provides Control Over Total Range
6. Internal Regulator Provides a Stable 5V Reference Supply With 5% Tolerance
7. Circuit Architecture Allows Easy Synchronization

### ● PIN ARRANGEMENT



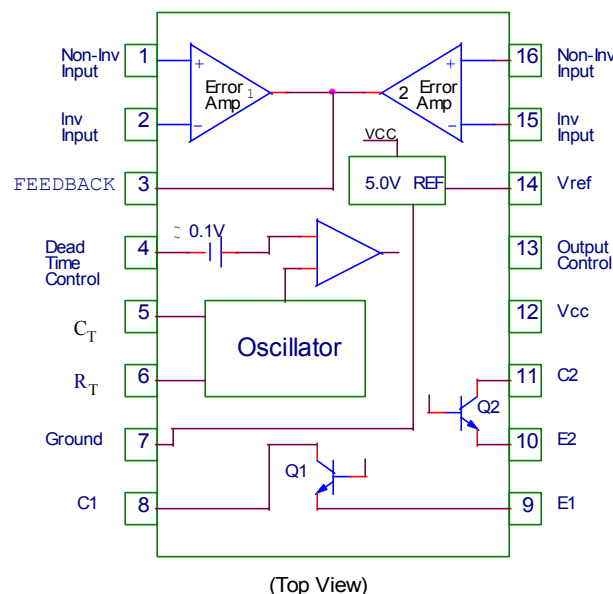
**DIP-16**



**SOP-16**

### ● ORDERING INFORMATION

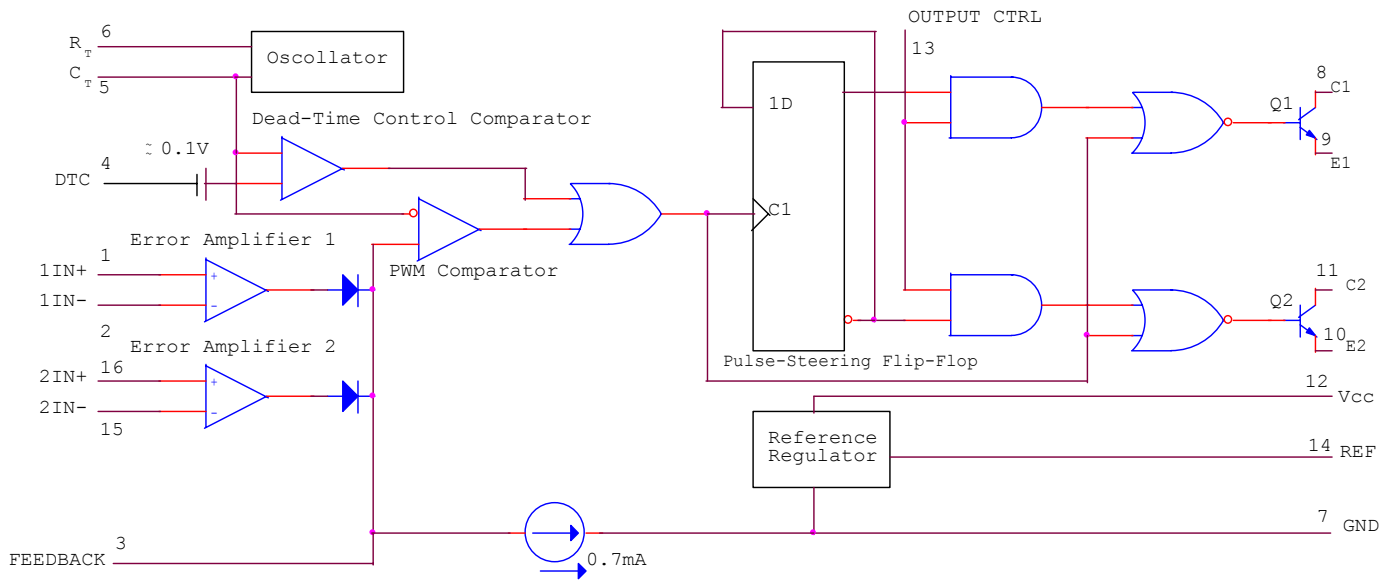
Device	Temperature Range	Package
TL494	0°C to +70°C	DIP-16
TL494S	0°C to +70°C	SOP-16





## TL494 Pulse Width Modulation Control Circuits

### ● FUNCTIONAL BLOCK DIAGRAM



### ● ABSOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR TEMPERATURE RANGE (unless otherwise noted)

Item	Symbol	TL494	Unit
Power Supply Voltage(See Note 1)	V <sub>cc</sub>	41	V
Collector Output Voltage	V <sub>O</sub>	41	V
Collector Output Current	I <sub>O</sub>	250	mA
Amplifier Input Voltage	V <sub>I</sub>	V <sub>cc</sub> +0.3	V
Operating free-air Temperature Range	T <sub>A</sub>	0 to 70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to 150	°C
Lead Temperature 1.6mm(1/16 inch)form case for 10 sec	-	260	°C

Note 1: All voltage values, except differential voltages, are with respect to the network ground terminal.

### ● RECOMMENDED OPERATING CONDITIONS

Item	Symbol	TL494		Unit
		Min	Max	
Power Supply Voltage	V <sub>cc</sub>	7	40	V
Collector Output Voltage	V <sub>O</sub>	-	40	V
Collector Output Current(each transistor)	I <sub>O</sub>	-	200	mA
Amplifier Input Voltage	V <sub>I</sub>	-0.3	V <sub>cc</sub> -2	V
Current Into Feedback Terminal	I <sub>fb</sub>	-	0.3	mA
Timing Resistor	R <sub>T</sub>	1.8	500	KΩ
Timing Capacitor	C <sub>T</sub>	0.47	10000	nF
Oscillator Frequency	f <sub>osc</sub>	1.0	300	KHz
Operating free-air temperature	T <sub>A</sub>	0	70	°C



## TL494 Pulse Width Modulation Control Circuits

- ELECTRICAL CHARACTERISTICS OVER RECOMMENDED OPERATING FREE-AIR TEMPERATURE RANGE,  $V_{CC}=15V, f=10kHz$  (unless otherwise noted)**  
 For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions  
 All typical values except for parameter changes with temperature are at  $T_A=25^\circ C$

### REFERENCE SECTION

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Output Voltage $I_o=1.0mA$	$V_{ref}$	4.75	5.0	5.25	V
Input Regulation $V_{CC}=7.0V$ to 40V	-	-	2	25	mV
Output Regulation $I_o=1.0mA$ to 10mA	-	-	1	15	mV
Short- Circuit Output Current (See Note 2) $V_{ref}=0V$	$I_{sc}$		35		mA
Output Voltage Change with Temperature $\Delta T_A=MIN$ to MAX	-		0.2 %	1 %	

### OSCILLATOR SECTION(See Fig 1)

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Frequency $C_T=0.01\mu F, R_T=12K \Omega$ ,	$f_{osc}$	-	10	-	KHz
Standard Deviation of Frequency(See Note 3) All values of $V_{CC}, C_T, R_T$ and $T_A$ constant	$\delta f_{osc}$	-	10	-	%
Frequency Change with Voltage $V_{CC}=7.0V$ to 40V, $T_A=25^\circ C$	$\Delta f_{osc}(\Delta V)$	-	0.1	-	%
Frequency Change with Temperature $\Delta T_A=MIN$ to MAX (See Note 4) $C_T=0.01\mu F, R_T=12K \Omega$	$\Delta f_{osc}(\Delta T)$	-	-	1	%

### ERROR AMPLIFIER SECTION(See Fig 2)

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Input Offset Voltage $V_o(\text{Pin } 3) = 2.5V$	$V_{IO}$	-	2	10	mV
Input Offset Current $V_o(\text{Pin } 3) = 2.5V$	$I_{IO}$	-	25	250	nA
Input Bias Current $V_o(\text{Pin } 3) = 2.5V$	$I_{IB}$	-	0.2	1	$\mu A$
Common-Mode Input Voltage Range $V_{CC}=7V$ to 40V, $T_A=25^\circ C$	$V_{ICR}$	-0.3V to $V_{CC}-2.0$	-	-	V
Open-Loop Voltage Amplification $\Delta V_o=3V, V_o=0.5$ to 3.5V, $R_L=2K \Omega$	$A_{VOL}$	70	95	-	dB
Unity-Gain Crossover Frequency $V_o=0.5$ to 3.5V, $R_L=2K \Omega$	$f_c$	-	800	-	KHz
Common-Mode Rejection Ratio $\Delta V_o=40V, T_A=25^\circ C$	CMRR	65	80		dB
Output Sink Current $V_o(\text{Pin } 3)=0.7V, V_{ID}=-15mV$ to -5V	$I_{O-}$	0.3	0.7	-	mA
Output Source Current $V_o(\text{Pin } 3)=3.5V, V_{ID}=15mV$ to 5V	$I_{O+}$	-2	-	-	mA



## TL494 Pulse Width Modulation Control Circuits

### OUTPUT SECTION

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Collector Off-State Current $V_{CC}=40V, V_{CE}=40V$	$I_{C(off)}$	-	2	100	$\mu A$
Emitter Off-State Current $V_{CC}=40V, V_C=40V, V_E=0V$	$I_{E(off)}$	-	-	-100	$\mu A$
Collector-Emitter Saturation Voltage Common-Emitter: $V_E=0V, I_C=200mA$ Emitter-Follower: $V_C=15V, I_E=-200mA$	$V_{SAT(C)}$ $V_{SAT(E)}$	-	1.1 1.5	1.3 2.5	V
Output Control Input Current $V_I=V_{ref}$	$I_{OCI}$	-	-	3.5	mA

### DEAD-TIME CONTROL SECTION(See Fig 1)

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Input Bias Current (Pin 4) $V_I=0$ to 5.25V	$I_{IB(DT)}$	-	-2	-10	$\mu A$
Maximum Duty Cycle, Each Output, $V_I(\text{Pin } 4)=0V, C_T=0.1 \mu F, R_T=12K \Omega$	$DC_{max}$		45		%
Input Threshold Voltage (Pin 4) Zero Duty Cycle Maximum Duty Cycle	$V_{TH}$	- 0	3 -	3.3 -	V

### PWM COMPARATOR SECTION (See Fig 1)

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Input Threshold Voltage(Pin 3) Zero duty cycle	$V_{TH}$	-	4	4.5	V
Input Sink Current $V_o(\text{Pin } 3)=0.7V$	$I_{I-}$	0.3	0.7	-	mA

### TOTAL DEVICE

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Standby Supply Current Pin 6 at $V_{ref}$ , All Other Inputs and Outputs Open $V_{CC}=15V$ $V_{CC}=40V$	$I_{CC}$	- -	6 9	10 15	mA
Average Supply Current $V_I(\text{Pin } 4)=2V, \text{See Figure 1}$	-	-	7.5	-	mA



## TL494 Pulse Width Modulation Control Circuits

### SWITCHING CHARACTERISTICS(T<sub>A</sub>=25°C)

Characteristics	Symbol	TL494			UNIT
		Min	Typ	Max	
Output Voltage Rise Time(See Fig 3) Common-Emitter Configuration		-	100	200	ns
Output Voltage Fall Time(See Fig 3) Common-Emitter Configuration		-	25	100	
Output Voltage Rise Time(See Fig 4) Emitter-Follower Configuration		-	100	200	
Output Voltage Fall Time(See Fig 4) Emitter-Follower Configuration		-	40	100	

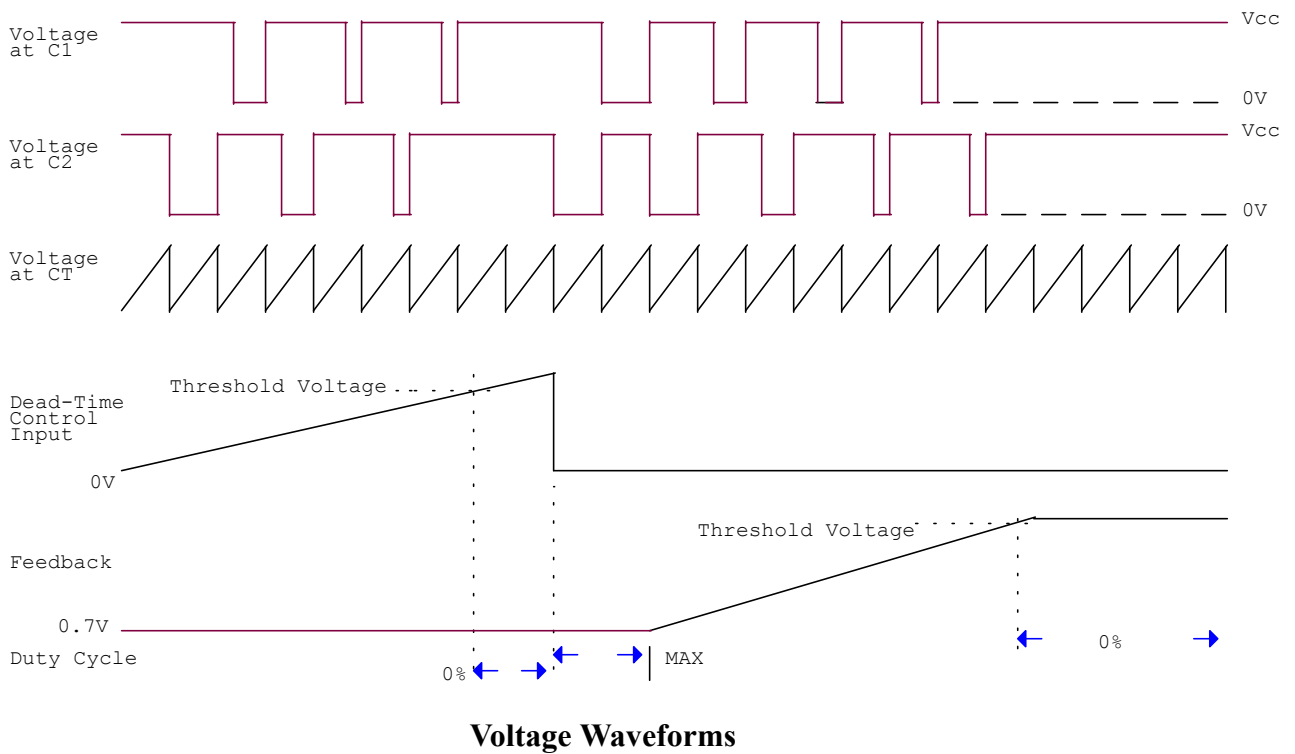
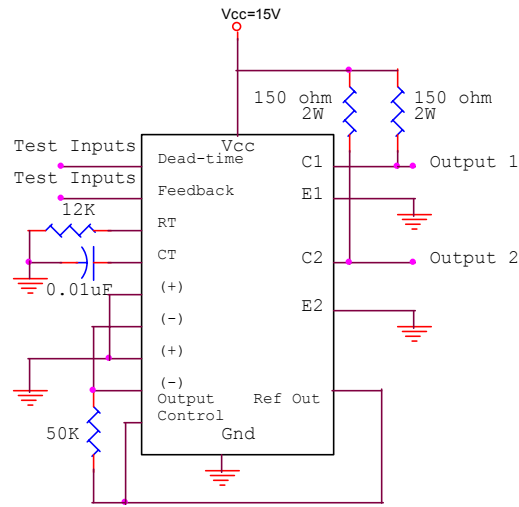
Note 2:Duration of the short-circuit should not exceed one second.

Note 3:Standard deviation is a measure of the statistical distribution about the mean as derived form the

$$\text{formula : } \sigma = \sqrt{\frac{\sum_{n=1}^N (X_n - \bar{X})^2}{N - 1}}$$

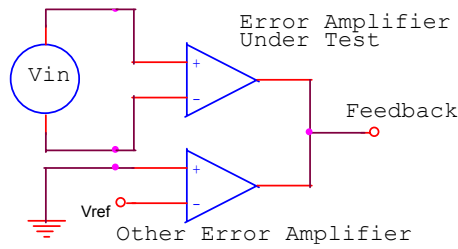
Note 4:Temperature coefficient of timing capacitor and timing resistor not taken into account.

## ● TEST CIRCUIT DIAGRAMS

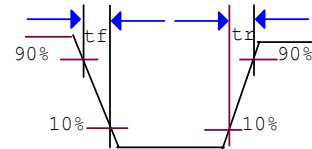
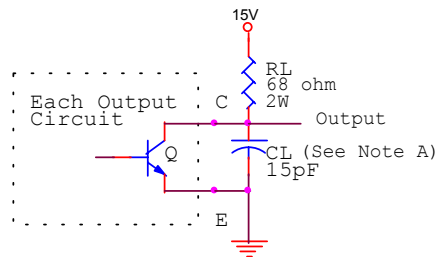


**Fig 1.Operational Test Circuit and Waveforms**

## ● APPLICATION EXAMPLES



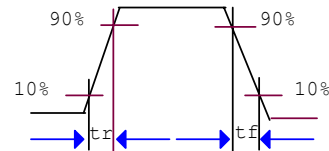
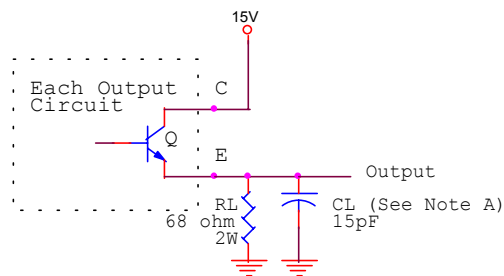
**Fig 2. Amplifier Characteristics**



**Output Voltage Waveform**

Note A:CL includes probe and jig capacitance.

**Fig 3. Common-Emitter Configuration**

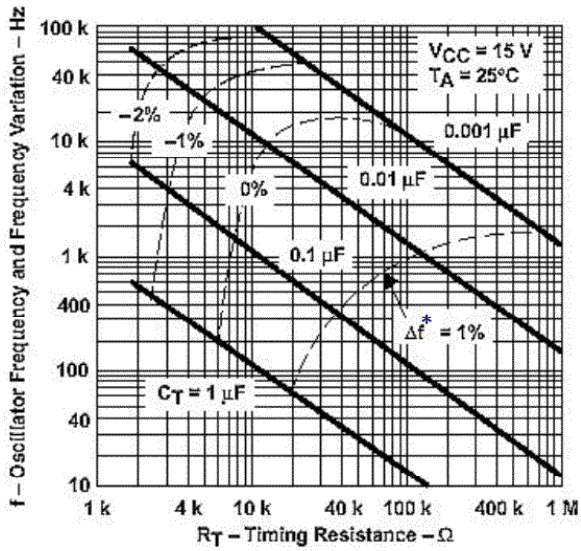


**Output Voltage Waveform**

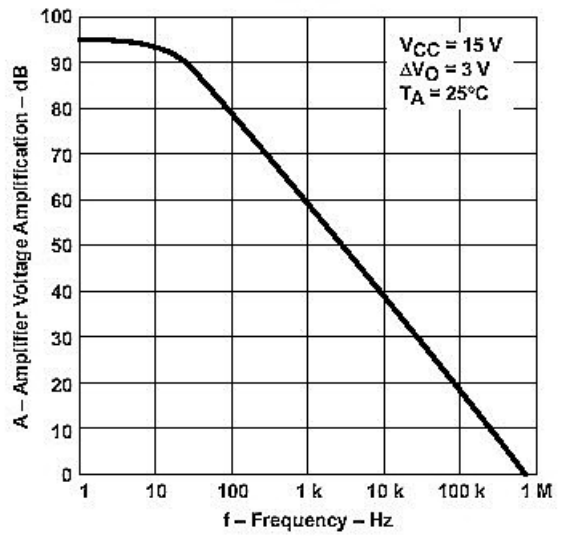
Note A:CL includes probe and jig capacitance.

**Fig 4. Emitter-Follower Configuration**

## ● ELECTRICAL CHARACTERISTICS CURVES



**Fig 5. Oscillator Frequency and Frequency Variation vs Timing Resistance**

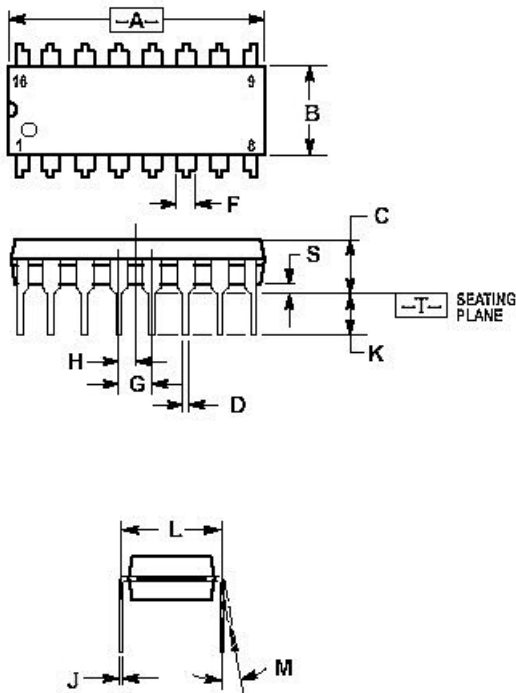


**Fig 6. Amplifier Voltage Amplification vs Frequency**

\*Frequency variation ( $\Delta f$ ) is the change in oscillator frequency that occurs over the full temperature range

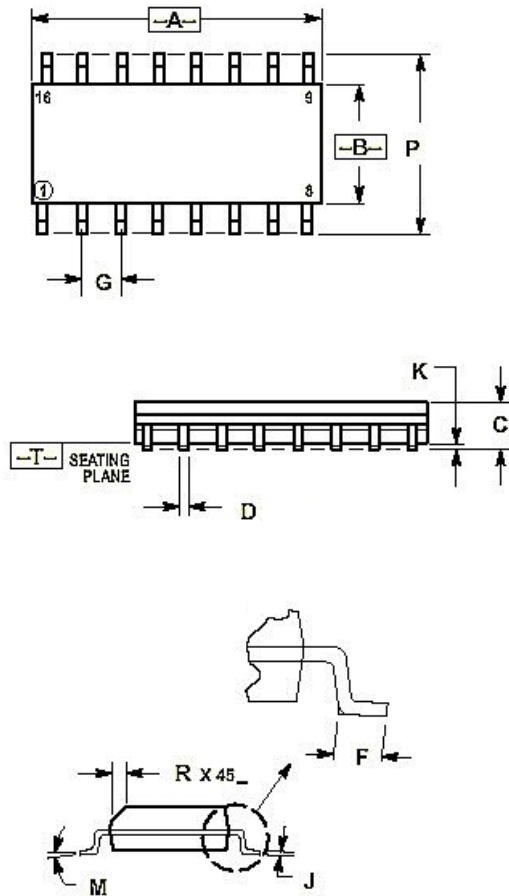


## ● EXTERNAL DIMENSIONS



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.740	0.770	18.80	19.55
B	0.244	0.270	6.20	6.85
C	0.122	0.157	3.10	4.00
D	0.015	0.021	0.39	0.53
F	0.040	0.070	1.02	1.78
G	0.100BSC		2.54BSC	
H	0.050BSC		1.27BSC	
J	0.008	0.015	0.21	0.38
K	0.126	0.154	3.20	3.90
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
S	0.020	0.040	0.51	1.01

### DIP-16 Outline Dimensions



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.386	0.393	9.80	10.00
B	0.150	0.157	3.80	4.00
C	0.054	0.068	1.35	1.75
D	0.014	0.019	0.35	0.49
F	0.016	0.049	0.40	1.25
G	0.050BSC		1.27BSC	
J	0.008	0.009	0.19	0.25
K	0.004	0.009	0.10	0.25
M	0°	7°	0°	7°
P	0.229	0.244	5.80	6.20
R	0.010	0.019	0.25	0.50

**SOP-16 Outline Dimensions**