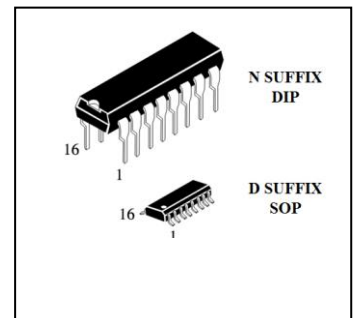


PWM Control Circuit

IL494A

The IL494 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, the IL494 contains an on-chip 5-volt regulator, two error amplifiers, adjustable oscillator, dead-time control comparator, pulse-steering flip-flop, and output-control circuitry. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Push-pull or single-ended output operation may be selected through the output-control function. The architecture of the IL494 prohibits the possibility of either output being pulsed twice during push-pull operation.



FEATURE

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 mA Sink or Source
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Internal Regulator Provides a Stable 5 V Reference Supply
- Variable Dead-Time Provides Control Over Total Range

ORDERING INFORMATION

| Device | Operating Temperature Range | Package | Shipping |
|----------|--|-------------------|-------------|
| IL494AN | T _A = -20° to 85° C for all packages | Plastic DIP-16 | Tube |
| IL494AD | | SOP-16 | Tube |
| IL494ADT | | SOP-16 | Tape & Reel |

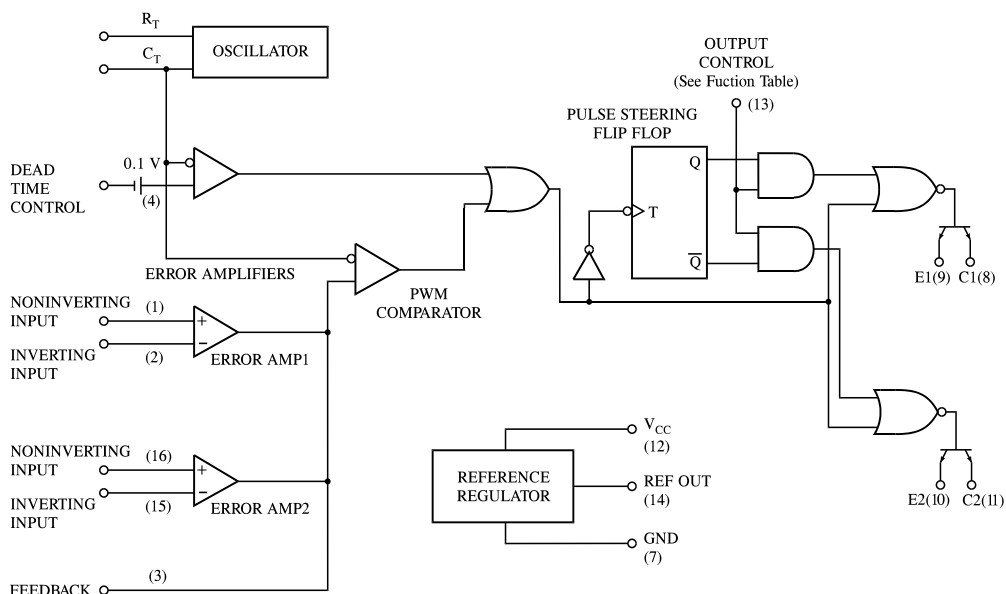
PIN ASSIGNMENT

| | | | |
|-------------------|-----|----|-----------------|
| NONINV. INPUT | 1 ● | 16 | NONINV. INPUT |
| INV. INPUT | 2 | 15 | INV. INPUT |
| FEEDBACK | 3 | 14 | REF OUT |
| DEAD TIME CONTROL | 4 | 13 | OUTPUT CONTROL |
| C _T | 5 | 12 | V _{CC} |
| R _T | 6 | 11 | C2 |
| GND | 7 | 10 | E2 |
| C1 | 8 | 9 | E1 |

FUNCTION TABLE

| Output Control | Output Function |
|---------------------|---------------------------------|
| Grounded | Single-ended or Parallel Output |
| At V _{ref} | Normal Push-Pull Operation |

LOGIC DIAGRAM



MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------------|--------------------------|----------------------|------|
| V _{CC} | Supply Voltage | 41 | V |
| V _I | Amplifier Input Voltage | V _{CC} +0.3 | V |
| V _O | Collector Output Voltage | 41 | V |
| | Collector Output Current | 250 | mA |
| T _{stg} | Storage Temperature | -65 to +150 | °C |

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|-----------------|--|------|---------------------|------|
| V _{CC} | Supply Voltage | 7 | 40 | V |
| V _I | Amplifier Input Voltage | -0.3 | V _{CC} - 2 | V |
| V _O | Collector Output Voltage | | 40 | V |
| | Collector Output Current (Each Transistor) | | 200 | mA |
| | Current Into Feed back Terminal | | 0.3 | mA |
| C _T | Timing Capacitor | 0.47 | 10.000 | nF |
| R _T | Timing Resistor | 1.8 | 500 | KΩ |
| | Oscillator Frequency | 1 | 300 | KHz |
| T _A | Operating Free-Air Temperature | -20 | +85 | °C |

ELECTRICAL CHARACTERISTICS (Temperature -20 ~ 85°C, $V_{CC} = 15\text{ V}$, $f=10\text{ kHz}$)

| Symbol | Parameter | Test Conditions | Min | Max | Unit |
|----------------------------------|--|---|------|--------------|---------------|
| Reference Section | | | | | |
| V_{ref} | Output Voltage | $I_O=1\text{ mA}$ | 4.95 | 5.05 | V |
| V_{regin} | Output regulation | $V_{CC}=7\text{ V to }40\text{ V}$, $T_A=25^\circ\text{C}$ | | 25 | mV |
| V_{regout} | Input regulation | $I_O=1\text{ to }10\text{ mA}$, $T_A=25^\circ\text{C}$ | | 15 | mV |
| ΔV_{ref} | Output Voltage change with temperature | $T_A= -20^\circ\text{C to }85^\circ\text{C}$ | | 1 | % |
| I_{SC} | Short-circuit output current (Note 1) | $V_{ref}=0$ | | 50 | mA |
| Oscillator Section | | | | | |
| f_{OSC} | Frequency | $C_T=0.01\ \mu\text{F}$, $R_T=12\text{ k}\Omega$ | 6 | 14 | KHz |
| δf_{OSC} | Standard deviation of frequency (Note 2) | All values of V_{CC} , C_T , R_T , T_A Constant | | 15 | % |
| $\delta f_{OSC(\Delta V)}$ | Frequency change with voltage | $V_{CC}= 7\text{ V to }40\text{ V}$, $T_A=25^\circ\text{C}$ | | 10 | % |
| $\delta f_{OSC(\Delta T)}$ | Frequency change with temperature | $C_T=0.01\ \mu\text{F}$, $R_T=12\text{ k}\Omega$ $T_A= -20^\circ\text{C to }85^\circ\text{C}$ | | 2 | % |
| Dead Time Control Section | | | | | |
| $I_{IB(2T)}$ | Input bias current (pin 4) | $V_I= 0\text{ to }5.25\text{ V}$ | | -10 | μA |
| DC_{max} | Maximum duty cycle, each output | $V_{I(\text{pin }4)}=0\text{ V}$ | 45 | | % |
| V_{THD} | Input threshold voltage (pin 4) | Zero duty cycle | | 3.3 | V |
| | | Maximum duty cycle | 0 | | |
| Error Amp Section | | | | | |
| V_{IO} | Input offset voltage | $V_{O(\text{pin }3)}=2.5\text{ V}$ | | 10 | mV |
| I_{IO} | Input offset current | $V_{O(\text{pin }3)}=2.5\text{ V}$ | | 250 | nA |
| I_{IB} | Input bias current | $V_{O(\text{pin }3)}=2.5\text{ V}$ | | 1 | μA |
| | Common-mode input voltage range | $V_{CC}= 7\text{ V to }40\text{ V}$ | LOW | -0.3 | V |
| | | | HIGH | $V_{CC} - 2$ | |
| A_{vol} | Open-loop voltage amplification | $\Delta V_O=3\text{ V}$, $V_O=0.5\text{ to }3.5\text{ V}$ | 70 | | dB |
| f_b | Unity-gain bandwidth | | 100 | | kHz |
| CMRR | Common-mode rejection ratio | $V_{CC}=40\text{ V}$, $T_A=25^\circ\text{C}$ | 65 | | dB |
| I_O | Output sink current (pin 3) | $V_{ID}=-15\text{ mV to }-5\text{ V}$, $V_{O(\text{pin }3)}=0.7\text{ V}$ | 0.3 | | mA |
| I_{O+} | Output source current (pin 3) | $V_{ID}=15\text{ mV to }5\text{ V}$, $V_{O(\text{pin }3)}=3.5\text{ V}$ | -2 | | mA |

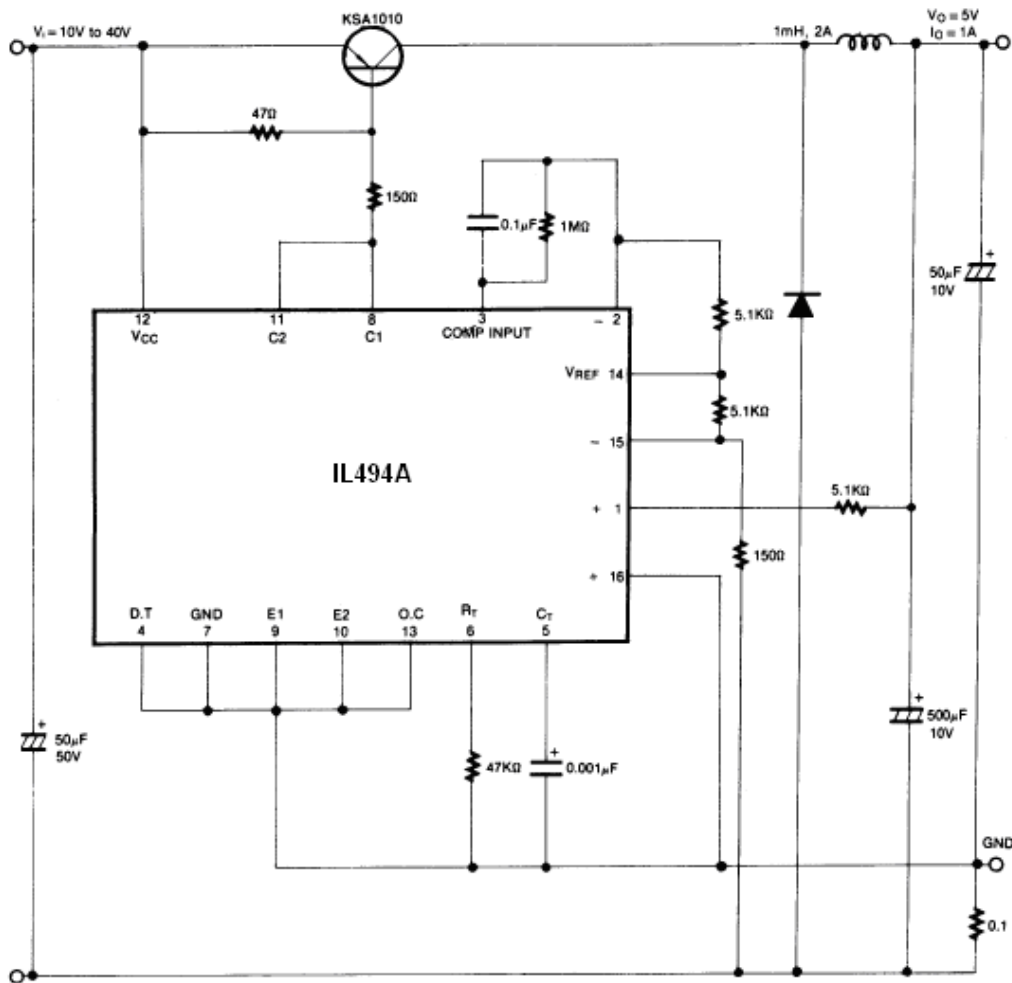
ELECTRICAL CHARACTERISTICS (Temperature -20 ~ 85°C, V_{CC} = 15 V, f=10 kHz)

| Symbol | Parameter | Test Conditions | Min | Max | Unit |
|----------------------------------|---------------------------------|---|-----------------------|------|------|
| PWM Comparator Section | | | | | |
| V _{THP} | Input threshold voltage (pin 3) | Zero duty cycle | | 4.5 | V |
| I _I | Input sink current (pin 3) | V _{O(pin 3)} =0.7 V | 0.3 | | mA |
| Switching Characteristics | | | | | |
| t _{rc} | Output voltage rise time | Common-emitter configuration | | 200 | ns |
| t _{fc} | Output voltage fall time | Common-emitter configuration | | 100 | ns |
| t _{rf} | Output voltage rise time | Emitter-follower configuration | | 200 | ns |
| t _{ff} | Output voltage fall time | Emitter-follower configuration | | 100 | ns |
| Output Section | | | | | |
| I _{C(off)} | Collector off-state current | V _{CE} =40 V, V _{CC} =40 V | | 100 | μA |
| I _{E(off)} | Emitter off-state current | V _{CC} =V _C =40 V, V _E =0 | | -100 | μA |
| V _{SAT} | Collector-saturation voltage | Common-emitter V _E =0, I _C =200 mA | | 1.3 | V |
| | Emitter-saturation voltage | Emitter-follower V _C =15 V, I _E =-200 mA | | 2.5 | |
| I _{OCH} | Output control input current | V _I =V _{ref} | | 3.5 | mA |
| Total Device | | | | | |
| I _{CC} | Standby supply current | All other inputs & outputs open | V _{CC} =15 V | 10 | mA |
| | | | V _{CC} =40 V | 15 | |
| I _{CCA} | Average supply current | V _(pin 4) =2 V | | 17 | mA |

- Notes:** 1. Duration of the short circuit should not exceed one second.
 2. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula

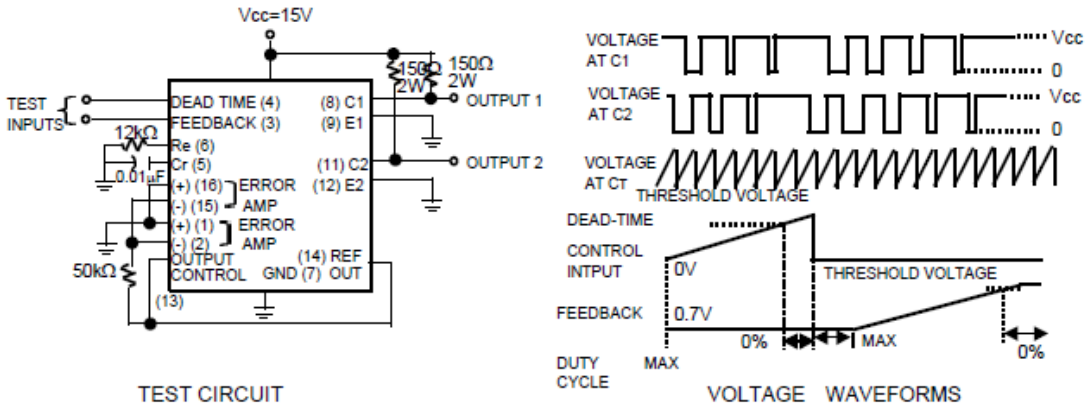
$$\sigma = \sqrt{\frac{\sum_{n=1}^N (x_n - \bar{x})^2}{N - 1}}$$

Typical Application
Pulse Width Modulated Step-down Converter

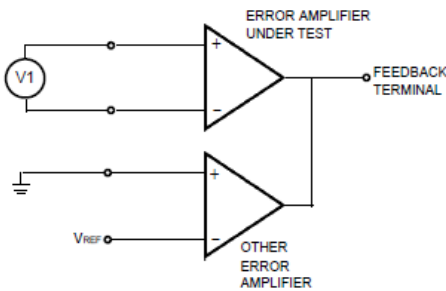


Parameter Measurement Information

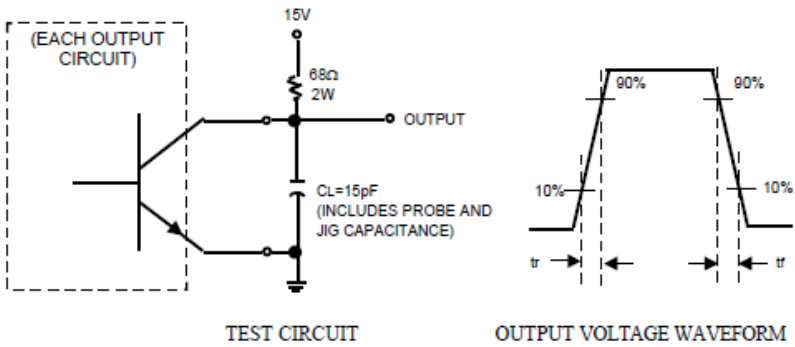
1. Dead time and Feedback Control



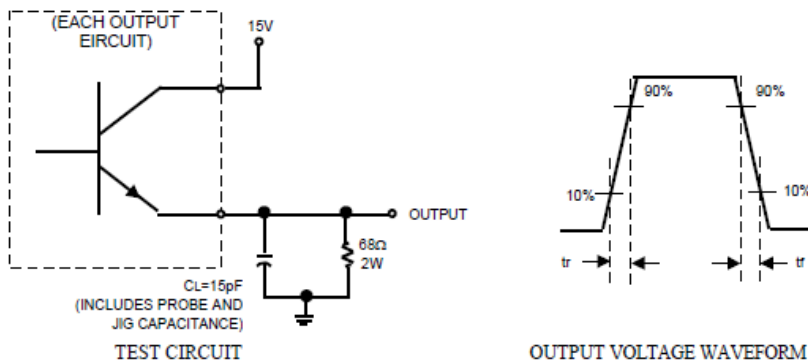
2. Error Amplifier Characteristics



3. Common-Emitter Configuration



4. Emitter-Follower Configuration



Typical Performance Curves

FIGURE 1 – OSCILLATOR FREQUENCY vs. TIMING RESISTANCE

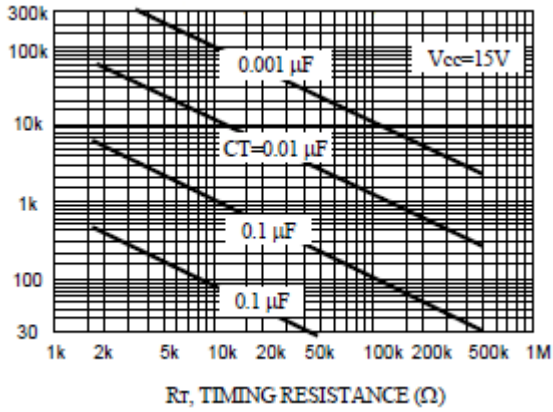


FIGURE 2 – OPEN LOOP VOLTAGE GAIN AND PHASE vs. FREQUENCY

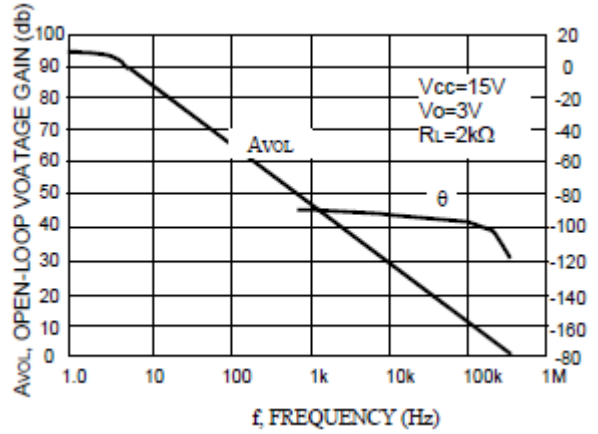


FIGURE 3 – PERCENT DEAD TIME vs. OSCILLATOR FREQUENCY

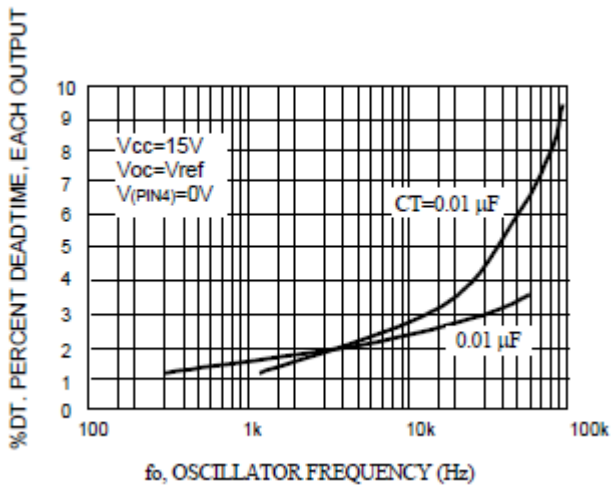


FIGURE 4 – PERCENT DUTY CYCLE vs. DEAD-TIME CONTROL VOLTAGE

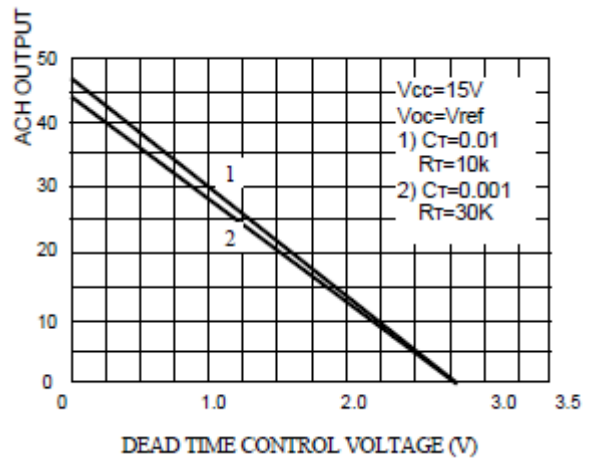


FIGURE 5 – EMITTER-FOLLOWER CONFIGURATION OUTPUT-SATURATION VOLTAGE vs. EMITTER CURRENT

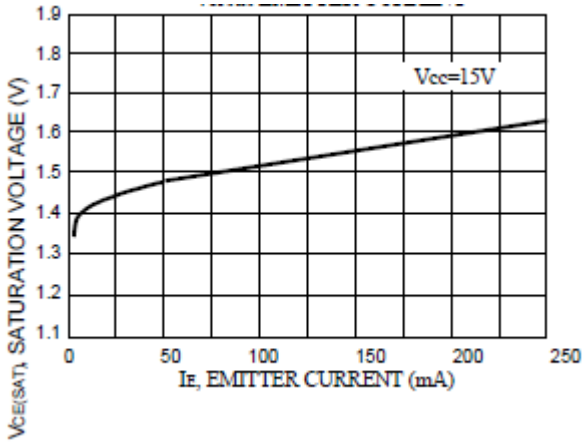


FIGURE 6 – COMMON-EMITTER CONFIGURATION OUTPUT-SATURATION VOLTAGE vs. COLLECTOR CURRENT

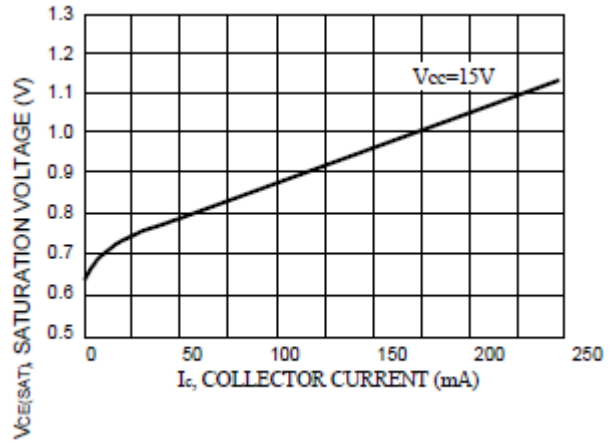
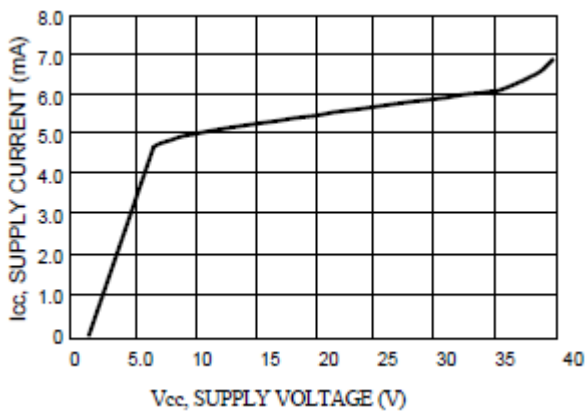
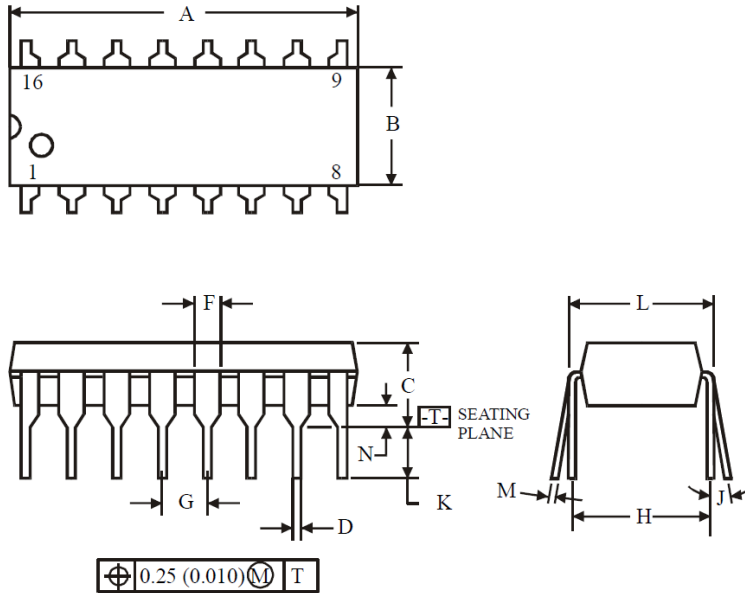
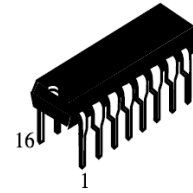


FIGURE 7 – STANDBY-SUPPLY CURRENT vs. SUPPLY VOLTAGE



N SUFFIX DIP
(MS - 001BB)



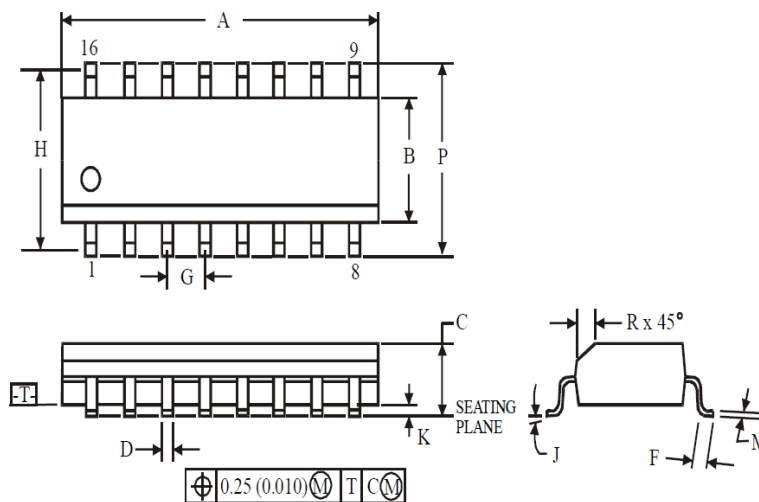
$\oplus 0.25 (0.010) \text{ (M) T}$

NOTES:

- Dimensions "A", "B" do not include mold flash or protrusions.
Maximum mold flash or protrusions 0.25 mm (0.010) per side.

| | Dimension, mm | |
|--------|---------------|-------|
| Symbol | MIN | MAX |
| A | 18.67 | 19.69 |
| B | 6.10 | 7.11 |
| C | | 5.33 |
| D | 0.36 | 0.56 |
| F | 1.14 | 1.78 |
| G | 2.54 | |
| H | 7.62 | |
| J | 0° | 10° |
| K | 2.92 | 3.81 |
| L | 7.62 | 8.26 |
| M | 0.20 | 0.36 |
| N | 0.38 | |

D SUFFIX SOP
(MS - 012AC)



$\oplus 0.25 (0.010) \text{ (M) T (CM)}$

NOTES:

- Dimensions A and B do not include mold flash or protrusion.
- Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B - 0.25 mm (0.010) per side.

| | Dimension, mm | |
|--------|---------------|-------|
| Symbol | MIN | MAX |
| A | 9.80 | 10.00 |
| B | 3.80 | 4.00 |
| C | 1.35 | 1.75 |
| D | 0.33 | 0.51 |
| F | 0.40 | 1.27 |
| G | 1.27 | |
| H | 5.72 | |
| J | 0° | 8° |
| K | 0.10 | 0.25 |
| M | 0.19 | 0.25 |
| P | 5.80 | 6.20 |
| R | 0.25 | 0.50 |