Order this data sheet by MC33039/D

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

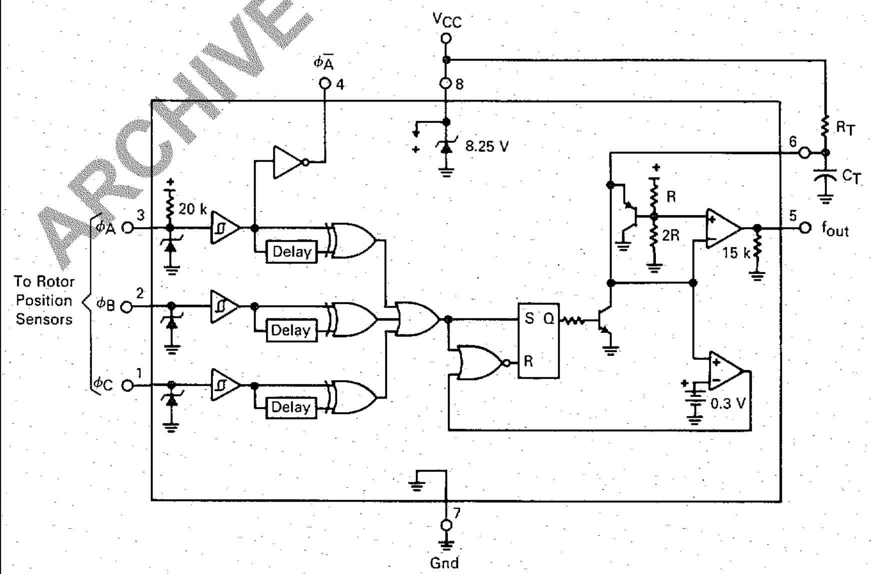
MC33039

CLOSED-LOOP BRUSHLESS MOTOR ADAPTER

The MC33039 is a high performance closed-loop speed control adapter specifically designed for use in brushless dc motor control systems. Implementation will allow precise speed regulation without the need for a magnetic or optical tachometer. This device contains three input buffers each with hysteresis for noise immunity, three digital edge detectors, a programmable monostable, and an internal shunt regulator. Also included is an inverter output for use in systems that require conversion of sensor phasing. Although this device is primarily intended for use with the MC33034 brushless motor controller, it can be used cost effectively in many other closed-loop speed control applications.

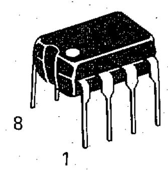
- Digital Detection of Each Input Transition for Improved Low Speed Motor Operation
- TTL Compatible Inputs With Hysteresis
- Operation Down to 5.5 V for Direct Powering from MC33034 Reference
- Internal Shunt Regulator Allows Operation from a Non-Regulated Voltage Source
- Inverter Output for Easy Conversion Between 60°/300° and 120°/240° Sensor Phasing Conventions

REPRESENTATIVE BLOCK DIAGRAM

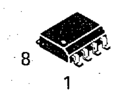


CLOSED-LOOP BRUSHLESS MOTOR ADAPTER

SILICON MONOLITHIC INTEGRATED CIRCUIT

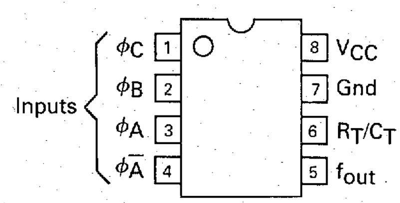


P SUFFIX
PLASTIC PACKAGE
CASE 626



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-8)

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Temperature Range	Package
MC33039D	−40°C to +85°C	SO-8
MC33039P		Plastic DIP

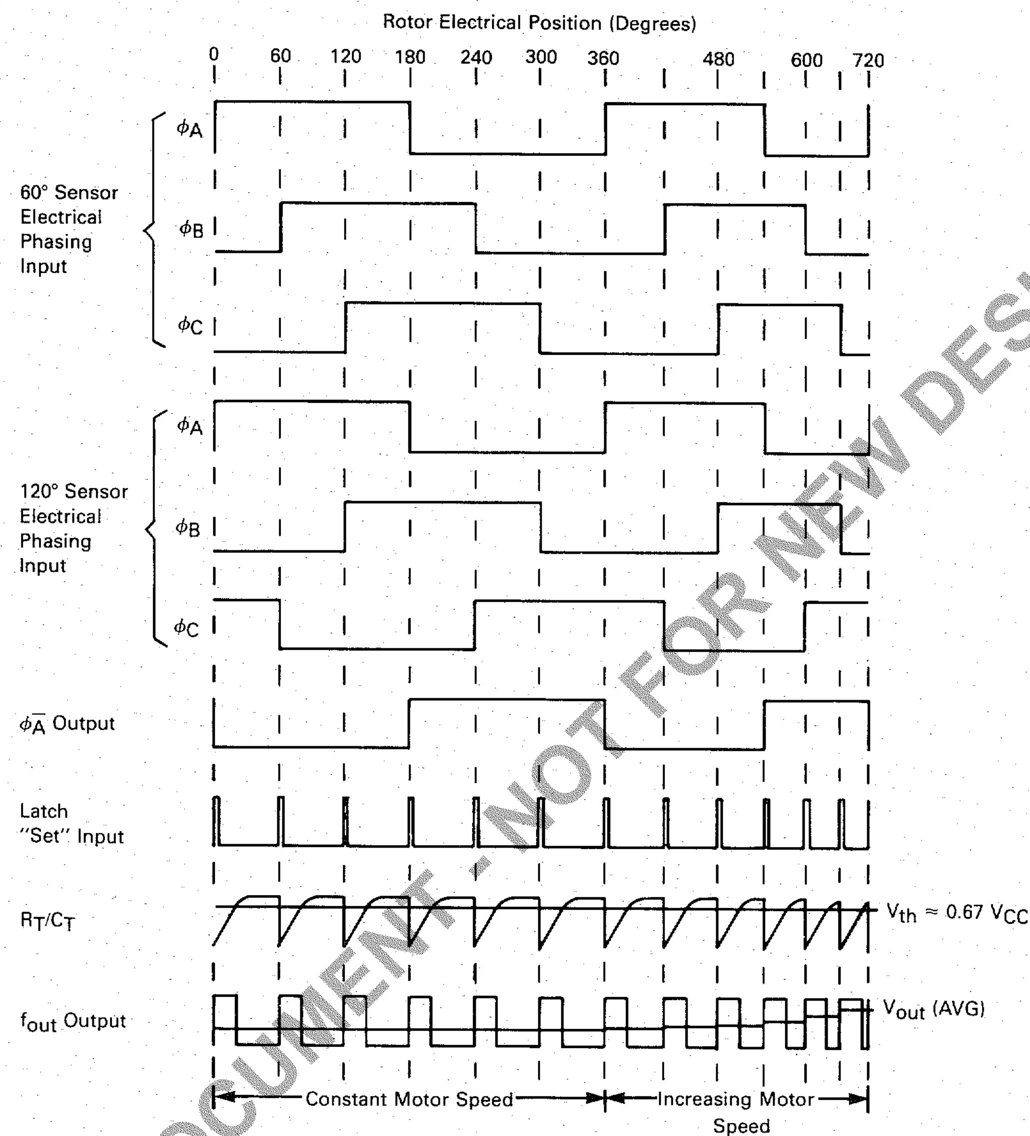
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
V_{CC} Zener Current	$I_{Z(V_{CC})}$	30	mA
Logic Input Current (Pins 1, 2, 3)	I_{IH}	5.0	mA
Output Current (Pin 4, 5), Sink or Source	I_{DRV}	20	mA
Power Dissipation and Thermal Characteristics Maximum Power Dissipation @ $T_A = +85°C$ Thermal Resistance Junction to Air	 P_D $R_{\theta JA}$	 650 100	 mW °C/W
Operating Junction Temperature	T_J	+150	°C
Operating Ambient Temperature Range	T_A	−40 to +85	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 6.25 V, R_T = 10 k, C_T = 22 nF, T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
LOGIC INPUTS					
Input Threshold Voltage High State Low State Hysteresis	 V_{IH} V_{IL} V_H	 2.4 — 0.4	 2.1 1.4 0.7	 — 1.0 0.9	V
Input Current High State (V_{IH} = 5.0 V) ϕA ϕB, ϕC Low State (V_{IL} = 0 V) ϕA ϕB, ϕC	 I_{IH} I_{IL}	 −40 — −190 —	 −60 −0.3 −300 −0.3	 −80 −5.0 −380 −5.0	μA
MONOSTABLE AND OUTPUT SECTIONS					
Output Voltage High State f_{out} (I_{source} = 5.0 mA) $\phi \overline{A}$ (I_{source} = 2.0 mA) Low State f_{out} (I_{sink} = 10 mA) $\phi \overline{A}$ (I_{sink} = 10 mA)	 V_{OH} V_{OL}	 3.60 4.20 — —	 3.95 4.75 0.25 0.25	 4.20 — 0.50 0.50	V
Capacitor C_T Discharge Current	I_{dischg}	20	35	60	mA
Output Pulse Width (Pin 5)	t_{PW}	205	225	245	μs
POWER SUPPLY SECTION					
Power Supply Operating Voltage Range (T_A = −40°C to +85°C)	V_{CC}	5.5	—	V_Z	V
Power Supply Current	I_{CC}	1.8	3.9	5.0	mA
Zener Voltage (I_Z = 10 mA)	V_Z	7.5	8.25	9.0	V
Zener Dynamic Impedance (ΔI_Z = 10 mA to 20 mA, f ≤ 1.0 kHz)	$\lvert Z_{ka} \rvert$	—	2.0	5.0	Ω

FIGURE 1 — TYPICAL THREE PHASE, SIX STEP MOTOR APPLICATION



OPERATING DESCRIPTION

The MC33039 provides an economical method of implementing closed-loop speed control of brushless dc motors by eliminating the need for a magnetic or optical tachometer. Shown in the timing diagram of Figure 1, the three inputs (Pins 1, 2, 3) monitor the brushless motor rotor position sensors. Each sensor signal transition is digitally detected, OR'ed at the Latch 'Set' Input, and causes C_T to discharge. A corresponding output pulse is generated at f_{out} (Pin 5) of a defined amplitude, and programmable width determined by the values selected for R_T and C_T (Pin 6). The average voltage of the output pulse train increases with motor speed. When fed through a low pass filter or integrator, a dc voltage proportional to speed is generated. Figure 2 shows the proper connections for a typical closed loop application using the MC33034 brushless motor controller. Constant speed operation down to 100 RPM is possible with economical three phase four pole motors.

The $\phi_{\bar{A}}$ inverter output (Pin 4) is used in systems where the controller and motor sensor phasing conventions are not compatible. A method of converting from either convention to the other is shown in Figure 3. For a more detailed explanation of this subject, refer to the text above Figure 39 on the MC33034 data sheet.

The output pulse amplitude V_{OH} is constant with temperature and controlled by the supply voltage on V_{CC} (Pin 8). Operation down to 5.5 V is guaranteed over temperature. For systems without a regulated power supply, an internal 8.25 V shunt regulator is provided.

FIGURE 2 — TYPICAL CLOSED-LOOP SPEED CONTROL APPLICATION

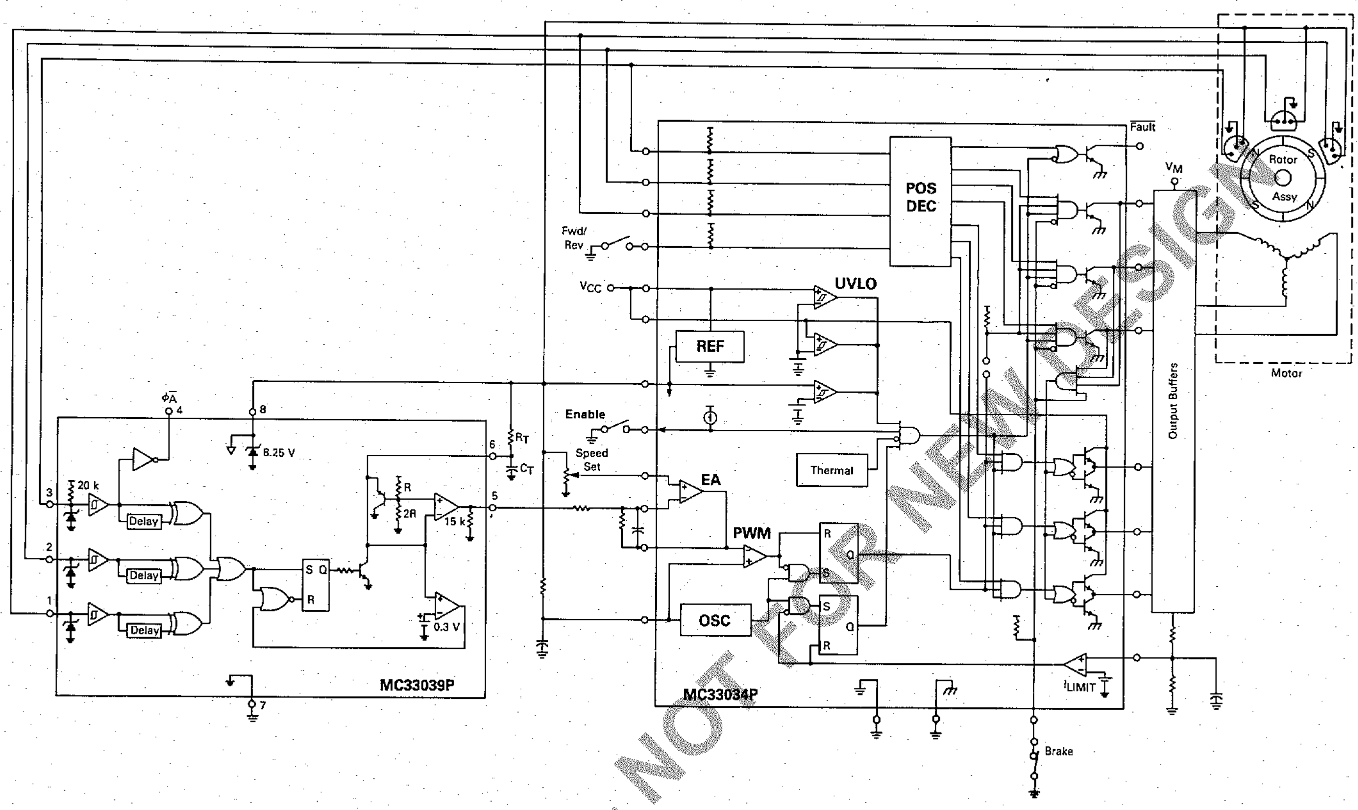


FIGURE 3 — CONVERSION BETWEEN SENSOR PHASING CONVENTIONS

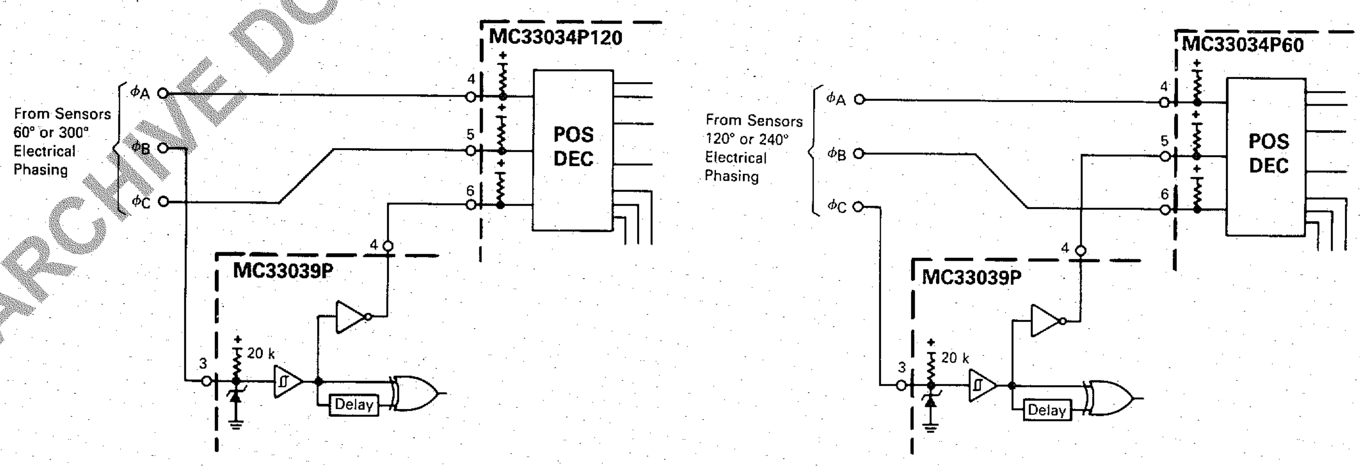


FIGURE 4 — f_{out} PULSE WIDTH versus TIMING RESISTOR

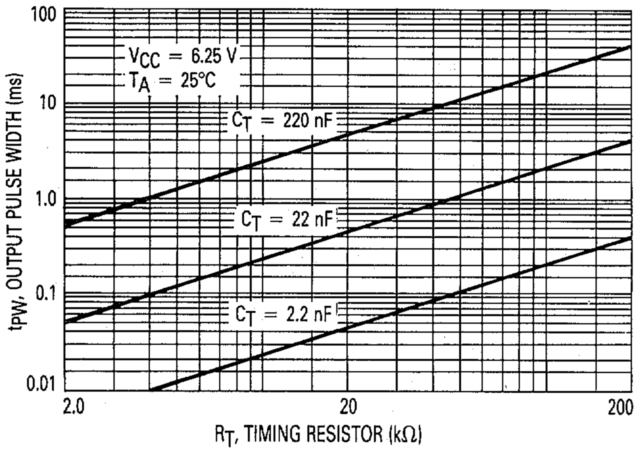


FIGURE 5 — f_{out}, PULSE WIDTH CHANGE versus TEMPERATURE

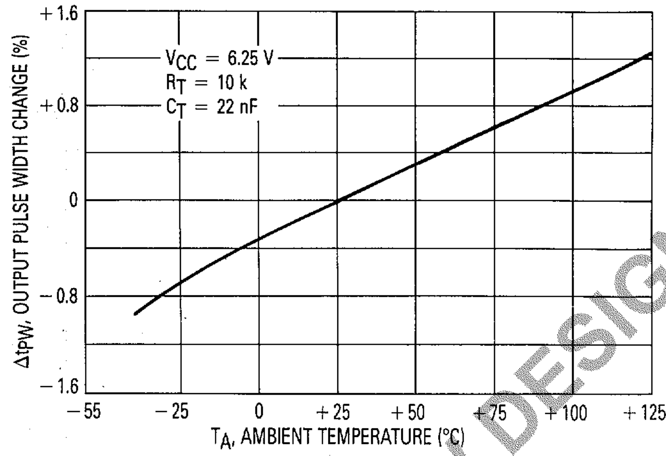


FIGURE 6 — f_{out} PULSE WIDTH CHANGE versus SUPPLY VOLTAGE

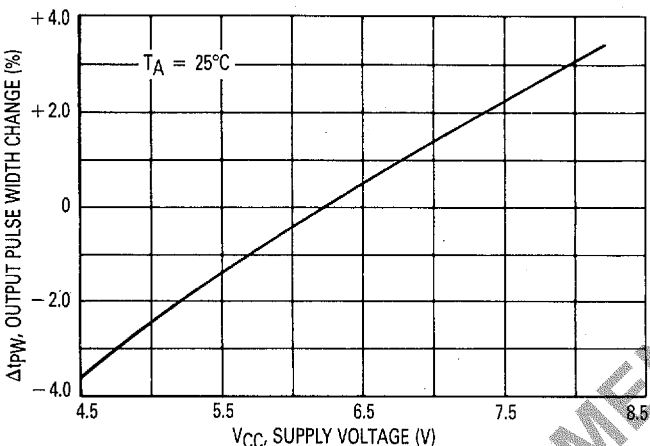


FIGURE 7 — SUPPLY CURRENT versus SUPPLY VOLTAGE

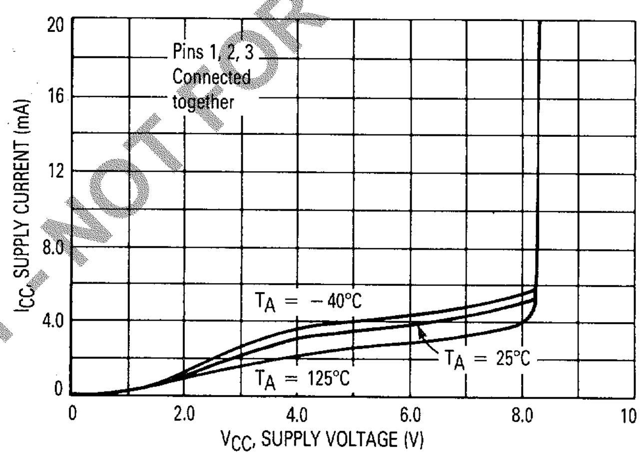


FIGURE 8 — f_{out}, SATURATION versus LOAD CURRENT

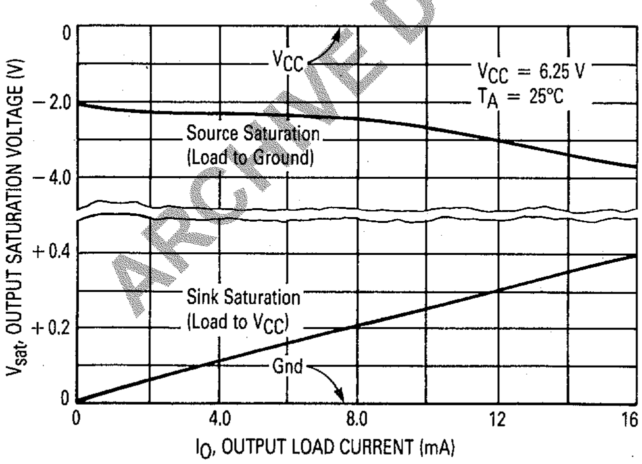
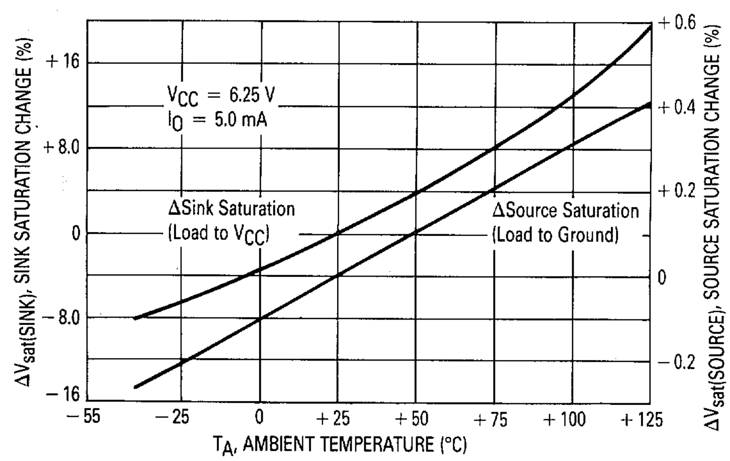


FIGURE 9 — f_{out}, SATURATION CHANGE versus TEMPERATURE



THERMAL INFORMATION

The maximum power consumption an integrated circuit can tolerate at a given operating ambient temperature, can be found from the equation:

$$P_{D(T_A)} = \frac{T_{J(max)} - T_A}{R_{\theta JA}(Typ)}$$

Where: $P_{D(T_A)}$ = Power Dissipation allowable at a given operating ambient temperature.

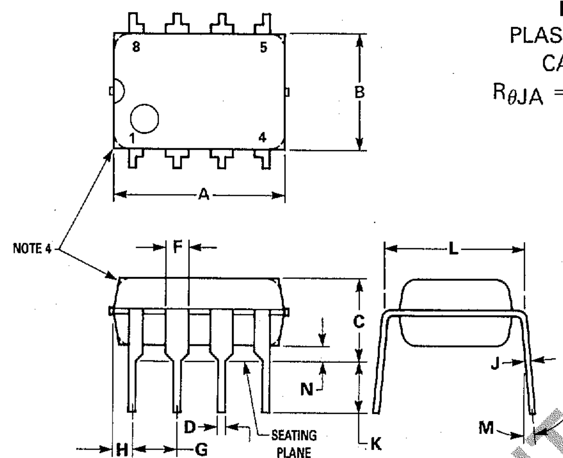
$T_{J(max)}$ = Maximum Operating Junction Temperature as listed in the Maximum Ratings Section

T_A = Maximum Desired Operating Ambient Temperature

$R_{\theta JA}(Typ)$ = Typical Thermal Resistance Junction to Ambient

OUTLINE DIMENSIONS

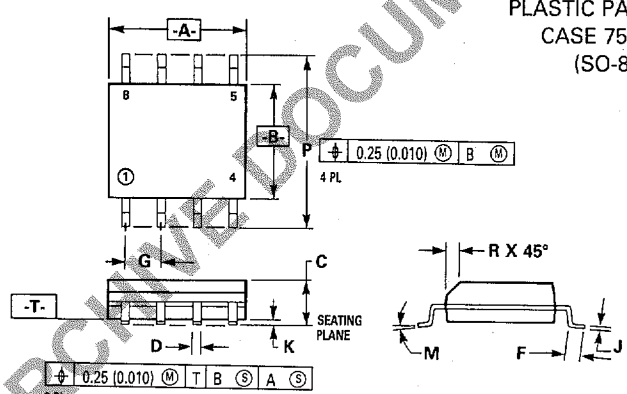
P SUFFIX
PLASTIC PACKAGE
CASE 626-05
$R_{\theta JA}$ = 100°C/W (Typ)



NOTES:
1. LEAD POSITIONAL TOLERANCE: ⌖ ϕ 0.13 (0.005) Ⓜ T A Ⓜ B Ⓜ
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
4. DIMENSIONS A AND B ARE DATUMS.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	—	10°	—	10°
N	0.76	1.01	0.030	0.040

D SUFFIX
PLASTIC PACKAGE
CASE 751-03
(SO-8)



NOTES:
1. DIMENSIONS "A" AND "B" ARE DATUMS AND "T" IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIM: MILLIMETER.
4. DIMENSION "A" AND "B" DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.18	0.25	0.007	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

Literature Distribution Centers:

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