

# MC74VHCT374A

## Octal D-Type Flip-Flop with 3-State Output

The MC74VHCT374A is an advanced high speed CMOS octal flip-flop with 3-state output fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

This 8-bit D-type flip-flop is controlled by a clock input and an output enable input. When the output enable input is high, the eight outputs are in a high impedance state.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output.

The VHCT inputs are compatible with TTL levels. This device can be used as a level converter for interfacing 3.3 V to 5.0 V, because it has full 5.0 V CMOS level output swings.

The VHCT374A input and output (when disabled) structures provide protection when voltages between 0 V and 5.5 V are applied, regardless of the supply voltage. These input and output structures help prevent device destruction caused by supply voltage-input/output voltage mismatch, battery backup, hot insertion, etc.

### Features

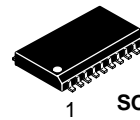
- High Speed:  $f_{max} = 140$  MHz (Typ) at  $V_{CC} = 5.0$  V
- Low Power Dissipation:  $I_{CC} = 4$   $\mu$ A (Max) at  $T_A = 25^\circ$ C
- TTL-Compatible Inputs:  $V_{IL} = 0.8$  V;  $V_{IH} = 2.0$  V
- Power Down Protection Provided on Inputs and Outputs
- Balanced Propagation Delays
- Designed for 4.5 V to 5.5 V Operating Range
- Low Noise:  $V_{OLP} = 1.6$  V (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance:
  - Human Body Model > 2000 V;
  - Machine Model > 200 V
- Chip Complexity: 276 FETs or 69 Equivalent Gates
- Pb-Free Packages are Available\*



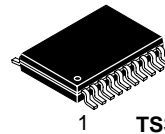
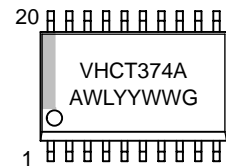
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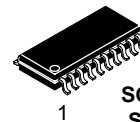
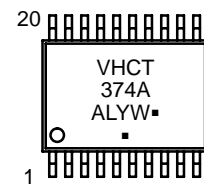
### MARKING DIAGRAMS



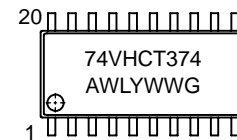
**SOIC-20WB  
SUFFIX DW  
CASE 751D**



**TSSOP-20  
SUFFIX DT  
CASE 948E**



**SOEIAJ-20  
SUFFIX M  
CASE 967**



A = Assembly Location  
 WL, L = Wafer Lot  
 YY, Y = Year  
 WW, W = Work Week  
 G or ■ = Pb-Free Package  
 (Note: Microdot may be in either location)

### FUNCTION TABLE

INPUTS			OUTPUT
$\overline{OE}$	CP	D	Q
L		H	H
L		L	L
L	L, H,	X	No Change
H	X	X	Z

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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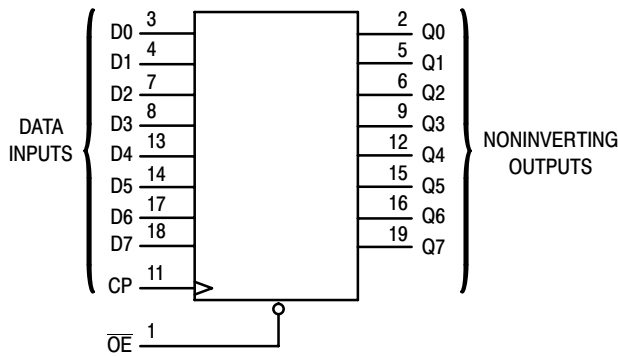


Figure 1. Logic Diagram

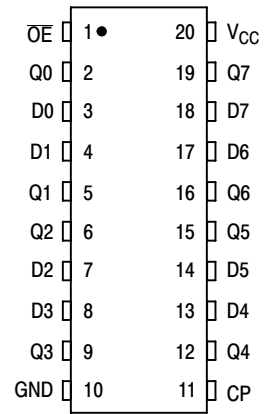


Figure 2. Pin Assignment

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	DC Supply Voltage	- 0.5 to + 7.0	V
$V_{in}$	DC Input Voltage	- 0.5 to + 7.0	V
$V_{out}$	DC Output Voltage Outputs in 3-State High or Low State	- 0.5 to + 7.0 - 0.5 to $V_{CC} + 0.5$	V
$I_{IK}$	Input Diode Current	- 20	mA
$I_{OK}$	Output Diode Current ( $V_{OUT} < GND$ ; $V_{OUT} > V_{CC}$ )	$\pm 20$	mA
$I_{out}$	DC Output Current, per Pin	$\pm 25$	mA
$I_{CC}$	DC Supply Current, $V_{CC}$ and GND Pins	$\pm 75$	mA
$P_D$	Power Dissipation in Still Air, SOIC Package† TSSOP Package†	500 450	mW
$T_{stg}$	Storage Temperature	- 65 to + 150	°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open.

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

†Derating - SOIC Packages: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	DC Supply Voltage	4.5	5.5	V
$V_{in}$	DC Input Voltage	0	5.5	V
$V_{out}$	DC Output Voltage Outputs in 3-State High or Low State	0 0	5.5 $V_{CC}$	V
$T_A$	Operating Temperature	- 40	+ 85	°C
$t_r, t_f$	Input Rise and Fall Time $V_{CC} = 5.0V \pm 0.5V$	0	20	ns/V

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## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40 to 85°C		Unit
				Min	Typ	Max	Min	Max	
V <sub>IH</sub>	Minimum High-Level Input Voltage		4.5 to 5.5	2.0			2.0		V
V <sub>IL</sub>	Maximum Low-Level Input Voltage		4.5 to 5.5			0.8		0.8	V
V <sub>OH</sub>	Minimum High-Level Output Voltage V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -50μA	4.5	4.4	4.5		4.4		V
		I <sub>OH</sub> = -8mA	4.5	3.94			3.80		
V <sub>OL</sub>	Maximum Low-Level Output Voltage V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 50μA	4.5		0.0	0.1		0.1	V
		I <sub>OL</sub> = 8mA	4.5			0.36		0.44	
I <sub>in</sub>	Maximum Input Leakage Current	V <sub>in</sub> = 5.5 V or GND	0 to 5.5			± 0.1		± 1.0	μA
I <sub>OZ</sub>	Maximum 3-State Leakage Current	V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>out</sub> = V <sub>CC</sub> or GND	5.5			± 0.25		± 2.5	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current	V <sub>in</sub> = V <sub>CC</sub> or GND	5.5			4.0		40.0	μA
I <sub>CCT</sub>	Quiescent Supply Current	Per Input: V <sub>IN</sub> = 3.4V Other Input: V <sub>CC</sub> or GND	5.5			1.35		1.50	mA
I <sub>OPD</sub>	Output Leakage Current	V <sub>OUT</sub> = 5.5V	0			0.5		5.0	μA

## AC ELECTRICAL CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0ns)

Symbol	Parameter	Test Conditions	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40 to 85°C		Unit
			Min	Typ	Max	Min	Max	
f <sub>max</sub>	Maximum Clock Frequency (50% Duty Cycle)	V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 15pF C <sub>L</sub> = 50pF	90 85	140 130		80 95		MHz
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, CP to Q	V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 15pF C <sub>L</sub> = 50pF		4.1 5.6	9.4 10.4	1.0 1.0	10.5 11.5	ns
t <sub>PZL</sub> , t <sub>PZH</sub>	Output Enable Time, OE to Q	V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 15pF R <sub>L</sub> = 1kΩ C <sub>L</sub> = 50pF		6.5 7.3	10.2 11.2	1.0 1.0	11.5 12.5	ns
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Output Disable Time OE to Q	V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 50pF R <sub>L</sub> = 1kΩ		7.0	11.2	1.0	12.0	ns
t <sub>OSLH</sub> , t <sub>OSHL</sub>	Output to Output Skew	V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 50pF (Note 1)			1.0		1.0	ns
C <sub>in</sub>	Maximum Input Capacitance			4	10		10	pF
C <sub>out</sub>	Maximum 3-State Output Capacitance (Output in High-Impedance State)			9				pF

C <sub>PD</sub>	Power Dissipation Capacitance (Note 2)	Typical @ 25°C, V <sub>CC</sub> = 5.0V		pF
		25		

- Parameter guaranteed by design. t<sub>OSLH</sub> = |t<sub>PLHm</sub> - t<sub>PLHn</sub>|, t<sub>OSHL</sub> = |t<sub>PHLm</sub> - t<sub>PHLn</sub>|.
- C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I<sub>CC(OPR)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>in</sub> + I<sub>CC</sub>/8 (per flip-flop). C<sub>PD</sub> is used to determine the no-load dynamic power consumption; P<sub>D</sub> = C<sub>PD</sub> • V<sub>CC</sub><sup>2</sup> • f<sub>in</sub> + I<sub>CC</sub> • V<sub>CC</sub>.

## NOISE CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0ns, C<sub>L</sub> = 50pF, V<sub>CC</sub> = 5.0V)

Symbol	Parameter	T <sub>A</sub> = 25°C		Unit
		Typ	Max	
V <sub>OLP</sub>	Quiet Output Maximum Dynamic V <sub>OL</sub>	1.2	1.6	V
V <sub>OLV</sub>	Quiet Output Minimum Dynamic V <sub>OL</sub>	-1.2	-1.6	V
V <sub>IHD</sub>	Minimum High Level Dynamic Input Voltage		2.0	V
V <sub>ILD</sub>	Maximum Low Level Dynamic Input Voltage		0.8	V

## TIMING REQUIREMENTS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0ns)

Symbol	Parameter	Test Conditions	T <sub>A</sub> = 25°C		T <sub>A</sub> = -40 to 85°C	Unit
			Typ	Limit	Limit	
t <sub>w</sub>	Minimum Pulse Width, CP	V <sub>CC</sub> = 5.0 ± 0.5 V		6.5	8.5	ns
t <sub>su</sub>	Minimum Setup Time, D to CP	V <sub>CC</sub> = 5.0 ± 0.5 V		2.5	2.5	ns
t <sub>h</sub>	Minimum Hold Time, D to CP	V <sub>CC</sub> = 5.0 ± 0.5 V		2.5	2.5	ns

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## ORDERING INFORMATION

Device	Package	Shipping†
MC74VHCT374ADWR2	SOIC-20WB	1000 / Tape & Reel
MC74VHCT374ADWRG	SOIC-20WB (Pb-Free)	1000 / Tape & Reel
MC74VHCT374ADTR2	TSSOP-20*	2500 / Tape & Reel
MC74VHCT374ADTRG	TSSOP-20*	2500 / Tape & Reel
MC74VHCT374AMEL	SOEIAJ-20	2000 / Tape & Reel
MC74VHCT374AMELG	SOEIAJ-20 (Pb-Free)	2000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.

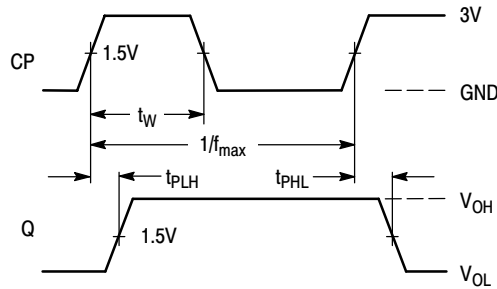


Figure 3. Switching Waveform

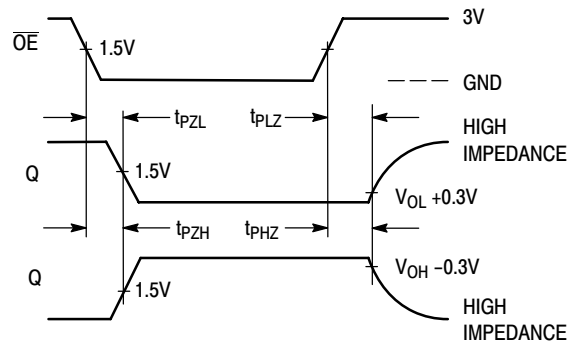


Figure 4. Switching Waveform

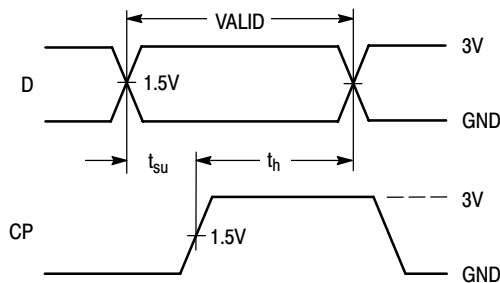
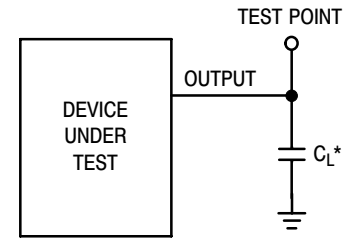


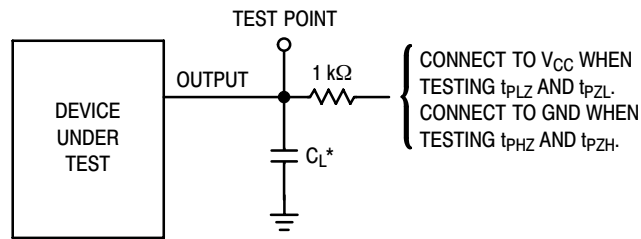
Figure 5. Switching Waveform

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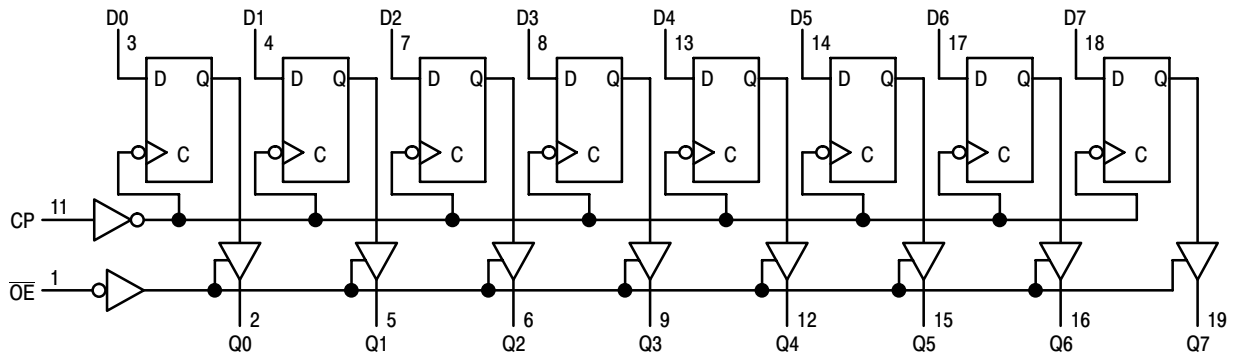
\*Includes all probe and jig capacitance

**Figure 6. Test Circuit**



\*Includes all probe and jig capacitance

**Figure 7. Test Circuit**

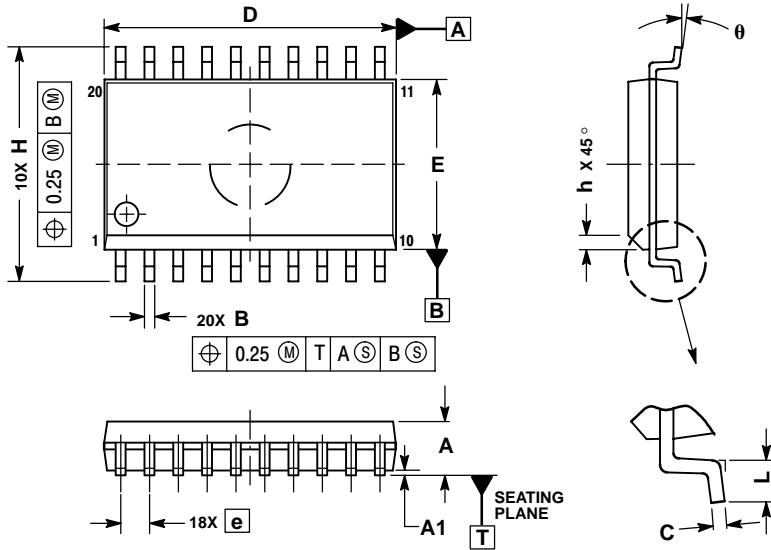


**Figure 8. Expanded Logic Diagram**

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## PACKAGE DIMENSIONS

SOIC-20 WB  
DW SUFFIX  
CASE 751D-05  
ISSUE G

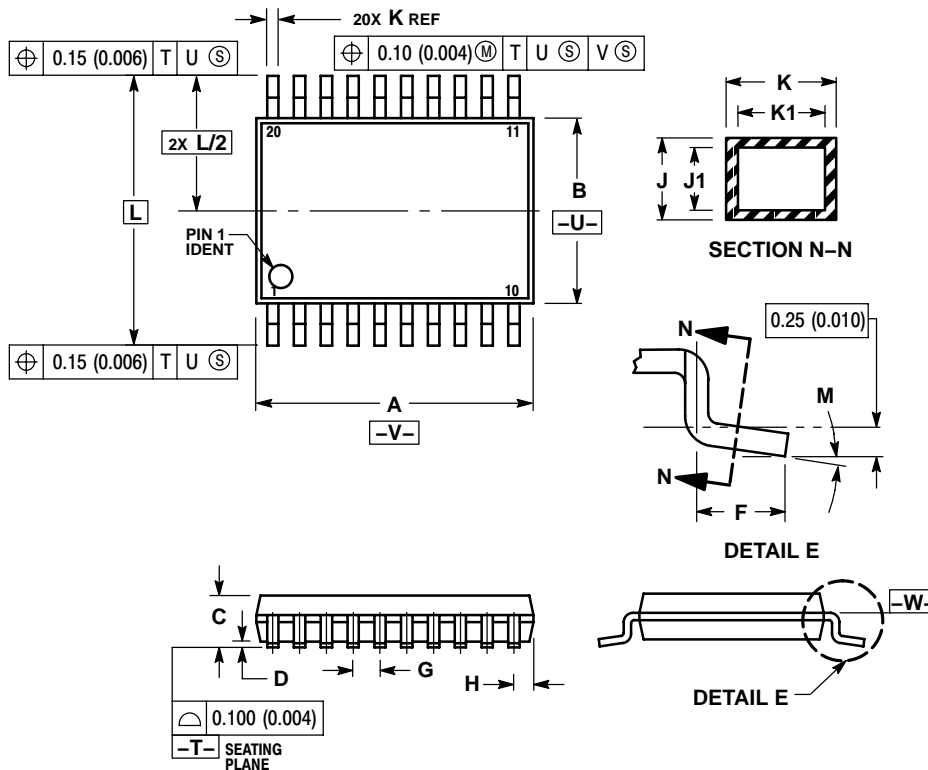


NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS	
	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
θ	0°	7°

TSSOP-20  
D5 SUFFIX  
CASE 948E-02  
ISSUE B



NOTES:

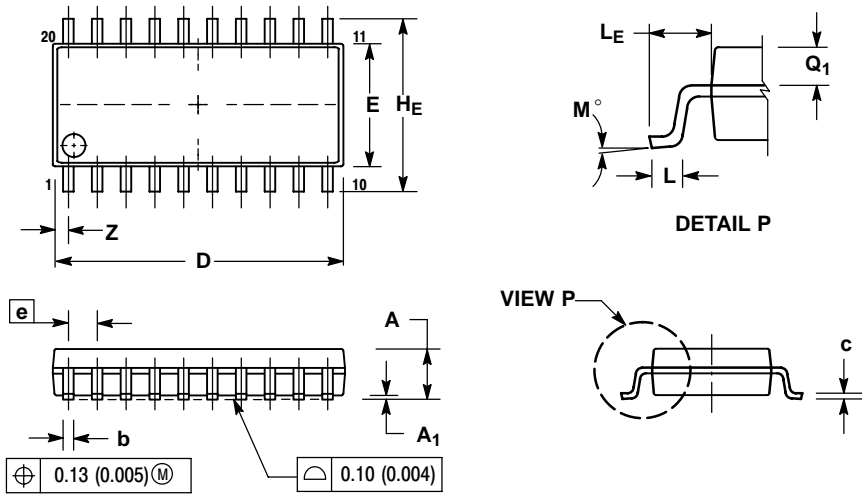
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

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## PACKAGE DIMENSIONS

SOEIAJ-20  
M SUFFIX  
CASE 967-01  
ISSUE A



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A <sub>1</sub>	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.15	0.25	0.006	0.010
D	12.35	12.80	0.486	0.504
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
HE	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
LE	1.10	1.50	0.043	0.059
M	0°	10°	0°	10°
Q <sub>1</sub>	0.70	0.90	0.028	0.035
Z	---	0.81	---	0.032

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