MC14504B

Hex Level Shifter for TTL to CMOS or CMOS to CMOS

The MC14504B is a hex non−inverting level shifter using CMOS technology. The level shifter will shift a TTL signal to CMOS logic levels for any CMOS supply voltage between 5 and 15 volts. A control input also allows interface from CMOS to CMOS at one logic level to another logic level: Either up or down level translating is accomplished by selection of power supply levels V_{DD} and V_{CC}. The V_{CC} level sets the input signal levels while V_{DD} selects the output voltage levels.

Features

- UP Translates from a Low to a High Voltage or DOWN Translates from a High to a Low Voltage
- Input Threshold Can Be Shifted for TTL Compatibility
- No Sequencing Required on Power Supplies or Inputs for Power Up or Power Down
- 3 to 18 Vdc Operation for V_{DD} and V_{CC}
- Diode Protected Inputs to V_{SS}
- Capable of Driving Two Low−Power TTL Loads or One Low−Power Schottky TTL Load Over the Rated Temperature Range
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free and are RoHS Compliant

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage Range	−0.5 to +18.0	V
V_{DD}	DC Supply Voltage Range	−0.5 to +18.0	V
V_{in}	Input Voltage Range (DC or Transient)	−0.5 to +18.0	V
V_{out}	Output Voltage Range (DC or Transient)	−0.5 to V_{DD} + 0.5	V
I_{in}, I_{out}	Input or Output Current (DC or Transient) per Pin	±10	mA
P_D	Power Dissipation, per Package (Note 1)	500	mW
T_A	Ambient Temperature Range	−55 to +125	°C
T_{stg}	Storage Temperature Range	−65 to +150	°C
T_L	Lead Temperature (8−Second Soldering)	260	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Temperature Derating: “D/DW” Packages: –7.0 mW/°C From 65°C To 125°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 $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

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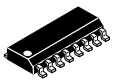
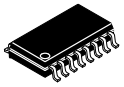
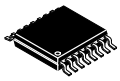


SOIC−16
D SUFFIX
CASE 751B

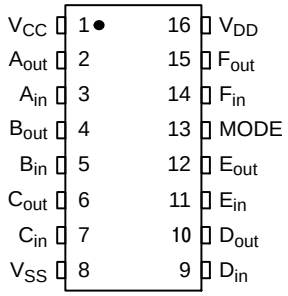


SOEIAJ−16
F SUFFIX
CASE 966

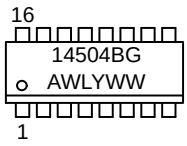


TSSOP−16
DT SUFFIX
CASE 948F

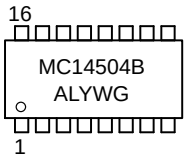
PIN ASSIGNMENT



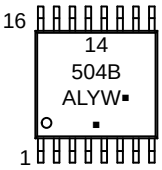
MARKING DIAGRAMS



SOIC−16



SOEIAJ−16



TSSOP−16

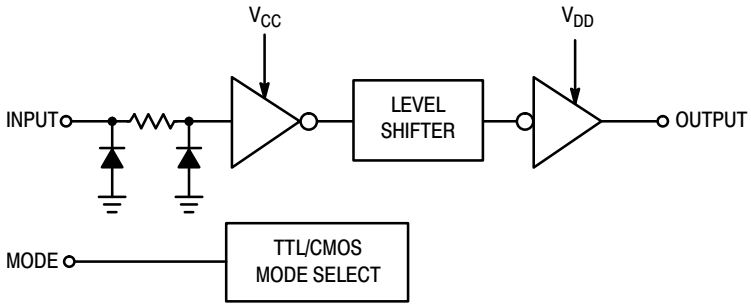
A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G or ▪ = Pb−Free Indicator

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

LOGIC DIAGRAM



Mode Select	Input Logic Levels	Output Logic Levels
1 (V_{CC})	TTL	CMOS
0 (V_{SS})	CMOS	CMOS

1/6 of package shown.

ORDERING INFORMATION

Device	Package	Shipping†
MC14504BDG	SOIC−16 (Pb−Free)	48 Units / Rail
NLV14504BDG*		
MC14504BDR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
NLV14504BDR2G*		
MC14504BDTG	TSSOP−16 (Pb−Free)	96 Units / Rail
NLV14504BDTG*		
MC14504BDTR2G	TSSOP−16 (Pb−Free)	2500 Units / Tape & Reel
NLV14504BDTR2G*		
MC14504BFELG	SOEIAJ−16 (Pb−Free)	2000 Units / 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.

*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V_{CC} Vdc	V_{DD} Vdc	− 55°C Min	− 55°C Max	25°C Min	25°C Typ (Note 2)	25°C Max	125°C Min	125°C Max	Unit
Output Voltage “0” Level	V_{OL}	−	5.0	−	0.05	−	0	0.05	−	0.05	Vdc
V_{in} = 0 V		−	10	−	0.05	−	0	0.05	−	0.05	
		−	1 5	−	0.05	−	0	0.05	−	0.05	
“1” Level	V_{OH}	−	5.0	4.95	−	4.95	5.0	−	4.95	−	Vdc
V_{in} = V_{CC}		−	10	9.95	−	9.95	10	−	9.95	−	
		−	15	14.95	−	14.95	15	−	14.95	−	
Input Voltage “0” Level	V_{IL}										Vdc
(V_{OL} = 1.0 Vdc) TTL−CMOS		5.0	10	−	0.8	−	1.3	0.8	−	0.8	
(V_{OL} = 1.5 Vdc) TTL−CMOS		5.0	15	−	0.8	−	1.3	0.8	−	0.8	
(V_{OL} = 1.0 Vdc) CMOS−CMOS		5.0	10	−	1.5	−	2.25	1.5	−	1.4	
(V_{OL} = 1.5 Vdc) CMOS−CMOS		5.0	15	−	1.5	−	2.25	1.5	−	1.5	
(V_{OL} = 1.5 Vdc) CMOS−CMOS		10	15	−	3.0	−	4.5	3.0	−	2.9	
Input Voltage “1” Level	V_{IH}										Vdc
(V_{OH} = 9.0 Vdc) TTL−CMOS		5.0	10	2.0	−	2.0	1.5	−	2.0	−	
(V_{OH} = 13.5 Vdc) TTL−CMOS		5.0	15	2.0	−	2.0	1.5	−	2.0	−	
(V_{OH} = 9.0 Vdc) CMOS−CMOS		5.0	10	3.6	−	3.5	2.75	−	3.5	−	
(V_{OH} = 13.5 Vdc) CMOS−CMOS		5.0	15	3.6	−	3.5	2.75	−	3.5	−	
(V_{OH} = 13.5 Vdc) CMOS−CMOS		10	15	7.1	−	7.0	5.5	−	7.0	−	
Output Drive Current	I_{OH}										mAdc
(V_{OH} = 2.5 Vdc) Source		−	5.0	– 3.0	−	– 2.4	– 4.2	−	– 1.7	−	
(V_{OH} = 4.6 Vdc)		−	5.0	–0.64	−	–0.51	– 0.88	−	–0.36	−	
(V_{OH} = 9.5 Vdc)		−	10	– 1.6	−	– 1.3	– 2.25	−	– 0.9	−	
(V_{OH} = 13.5 Vdc)		−	15	– 4.2	−	– 3.4	– 8.8	−	– 2.4	−	
(V_{OL} = 0.4 Vdc) Sink	I_{OL}	−	5.0	0.64	−	0.51	0.88	−	0.36	−	mAdc
(V_{OL} = 0.5 Vdc)		−	10	1.6	−	1.3	2.25	−	0.9	−	
(V_{OL} = 1.5 Vdc)		−	15	4.2	−	3.4	8.8	−	2.4	−	
Input Current	I_{in}	−	15	−	±0.1	−	±0.00001	±0.1	−	±1.0	μAdc
Input Capacitance (V_{in} = 0)	C_{in}	−	−	−	−	−	5.0	7.5	−	−	pF
Quiescent Current	I_{DD} or	−	5.0	−	0.05	−	0.0005	0.05	−	1.5	μAdc
(Per Package)	I_{CC}	−	10	−	0.10	−	0.0010	0.10	−	3.0	
CMOS−CMOS Mode		−	15	−	0.20	−	0.0015	0.20	−	6.0	
Quiescent Current	I_{DD}	5.0	5.0	−	0.5	−	0.0005	0.5	−	3.8	μAdc
(Per Package)		5.0	10	−	1.0	−	0.0010	1.0	−	7.5	
TTL−CMOS Mode		5.0	15	−	2.0	−	0.0015	2.0	−	15	
Quiescent Current	I_{CC}	5.0	5.0	−	5.0	−	2.5	5.0	−	6.0	mAdc
(Per Package)		5.0	10	−	5.0	−	2.5	5.0	−	6.0	
TTL−CMOS Mode		5.0	15	−	5.0	−	2.5	5.0	−	6.0	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

SWITCHING CHARACTERISTICS (C_L = 50 pF, T_A = 25°C)

Characteristic	Symbol	Shifting Mode	V_{CC} Vdc	V_{DD} Vdc	Limits			Unit
					Min	Typ (Note 3)	Max	
Propagation Delay, High to Low	t_{PHL}	TTL – CMOS	5.0	10	–	140	280	ns
		$V_{DD} > V_{CC}$	5.0	15	–	140	280	
		CMOS – CMOS	5.0	10	–	120	240	
		$V_{DD} > V_{CC}$	5.0	15	–	120	240	
			10	15	–	70	140	
		CMOS – CMOS	10	5.0	–	185	370	
		$V_{CC} > V_{DD}$	15	5.0	–	185	370	
			15	10	–	175	350	
Propagation Delay, Low to High	t_{PLH}	TTL – CMOS	5.0	10	–	170	340	ns
		$V_{DD} > V_{CC}$	5.0	15	–	160	320	
		CMOS – CMOS	5.0	10	–	170	340	
		$V_{DD} > V_{CC}$	5.0	15	–	170	340	
			10	15	–	100	200	
		CMOS – CMOS	10	5.0	–	275	550	
		$V_{CC} > V_{DD}$	15	5.0	–	275	550	
			15	10	–	145	290	
Output Rise and Fall Time	t_{TLH}, t_{THL}	ALL	–	5.0	–	100	200	ns
			–	10	–	50	100	
			–	15	–	40	80	

3. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

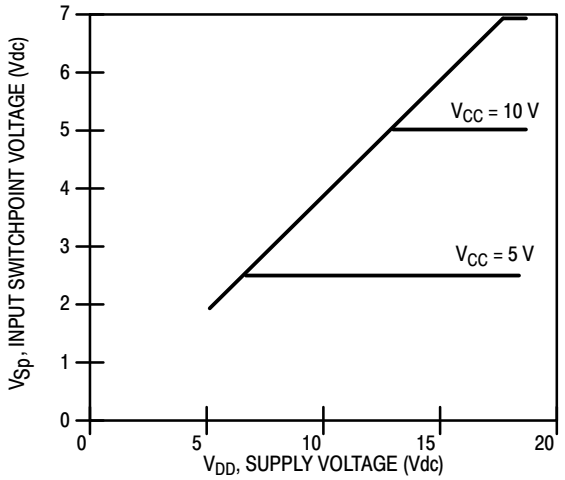


Figure 1. Input Switchpoint CMOS to CMOS Mode

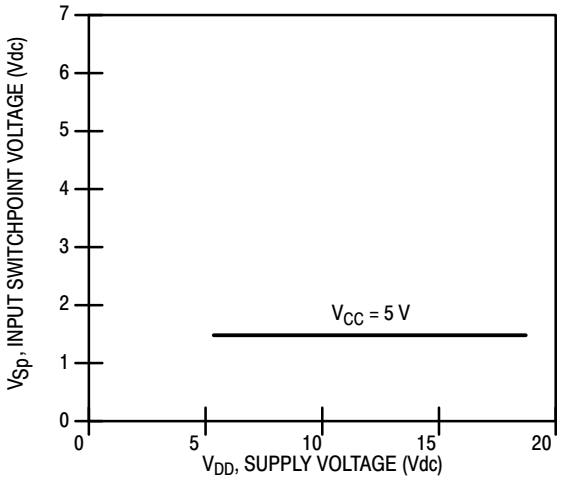


Figure 2. Input Switchpoint TTL to CMOS Mode

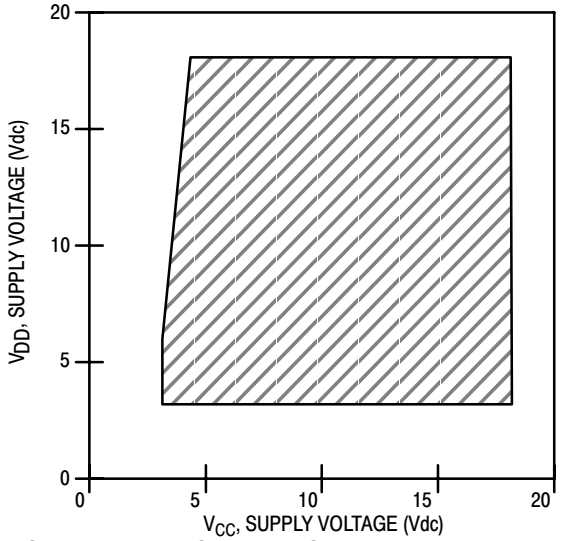


Figure 3. Operating Boundary CMOS to CMOS Mode

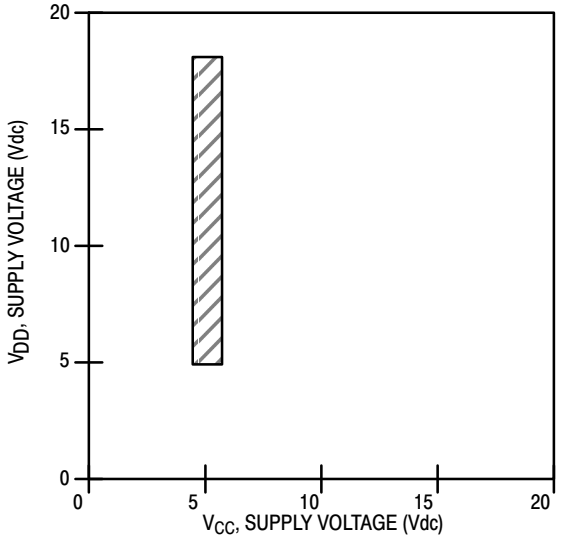
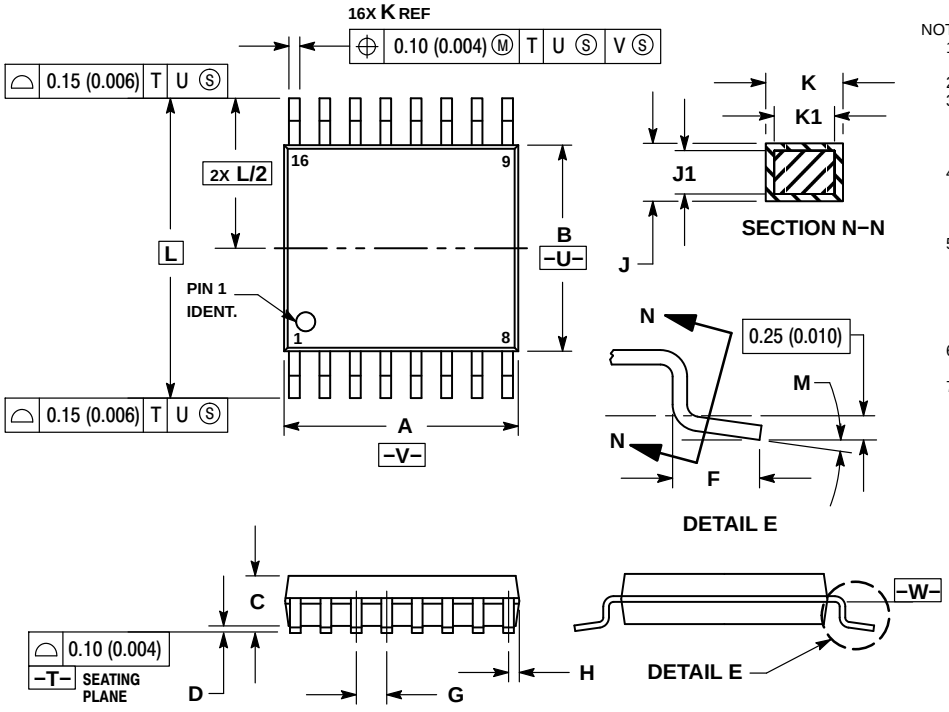


Figure 4. Operating Boundary TTL to CMOS Mode

PACKAGE DIMENSIONS

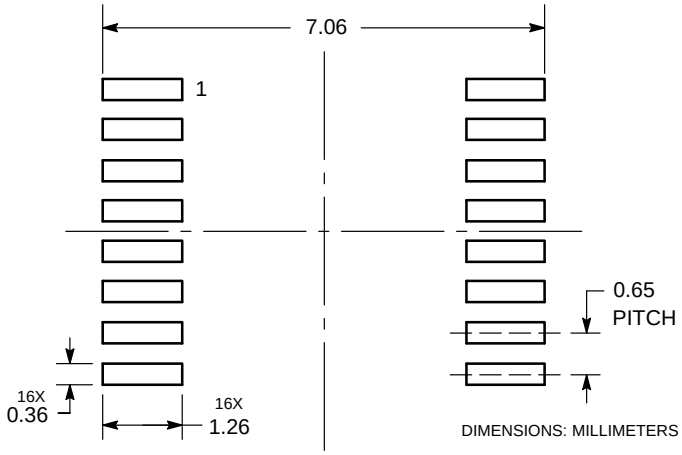
TSSOP−16
DT SUFFIX
PLASTIC TSSOP PACKAGE
CASE 948F
ISSUE B



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−.

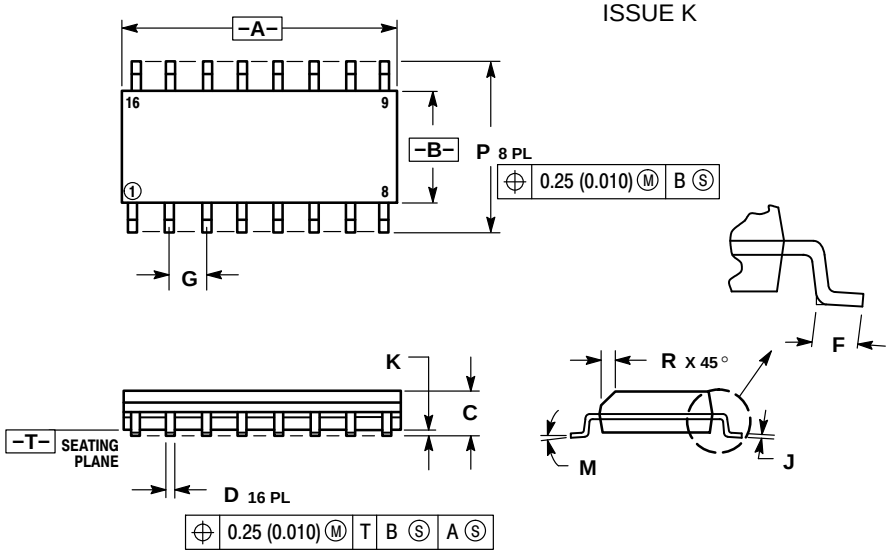
	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	−−−	1.20	−−−	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.18	0.28	0.007	0.011
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0 °	8 °	0 °	8 °

SOLDERING FOOTPRINT



PACKAGE DIMENSIONS

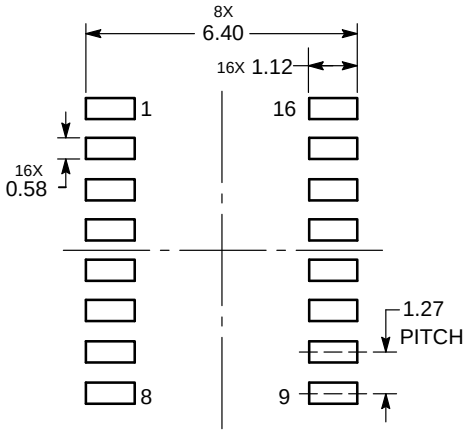
SOIC−16
D SUFFIX
PLASTIC SOIC PACKAGE
CASE 751B−05
ISSUE K



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
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	0.19	0.25	0.008	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

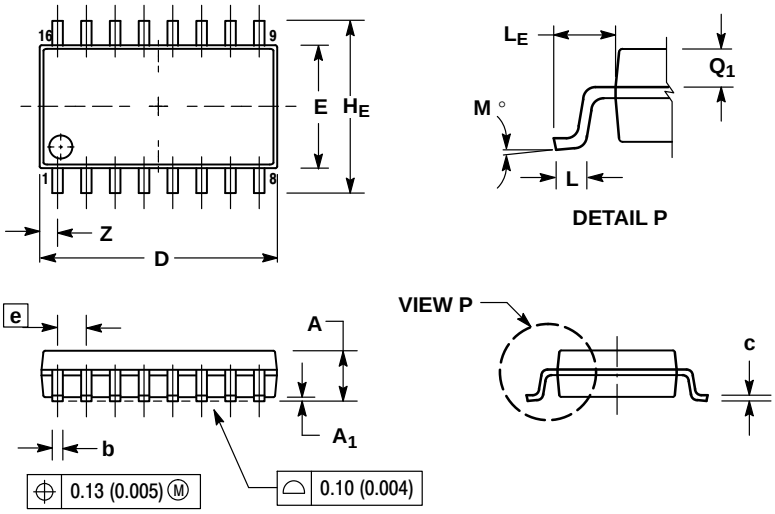
SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

PACKAGE DIMENSIONS

SOEIAJ−16
F SUFFIX
PLASTIC EIAJ SOIC PACKAGE
CASE 966
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).

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A_1	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.10	0.20	0.007	0.011
D	9.90	10.50	0.390	0.413
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H_E	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
L_E	1.10	1.50	0.043	0.059
M	0 °	10 °	0 °	10 °
Q_1	0.70	0.90	0.028	0.035
Z	---	0.78	---	0.031

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