

# Hex Level Shifter for TTL to CMOS or CMOS to CMOS

## MC14504B

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 $V_{SS}$ )

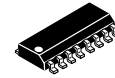
Symbol	Parameter	Value	Unit
$V_{CC}$	DC Supply Voltage Range	-0.5 to +18.0	V
$V_{DD}$	DC Supply Voltage Range	-0.5 to +18.0	V
$V_{in}$	Input Voltage Range (DC or Transient)	-0.5 to +18.0	V
$V_{out}$	Output Voltage Range (DC or Transient)	-0.5 to $V_{DD} + 0.5$	V
$I_{in}, I_{out}$	Input or Output Current (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.

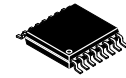
1. Temperature Derating: "D/DW" Packages: -7.0 mW/°C From 65°C To 125°C.

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  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

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.

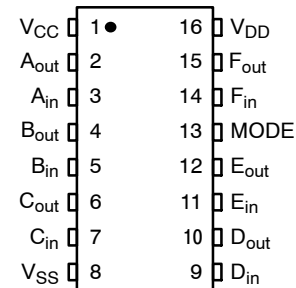


SOIC-16  
D SUFFIX  
CASE 751B

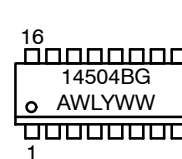


TSSOP-16  
DT SUFFIX  
CASE 948F

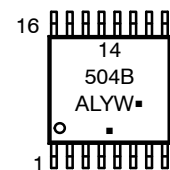
### PIN ASSIGNMENT



### MARKING DIAGRAMS



SOIC-16



TSSOP-16

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

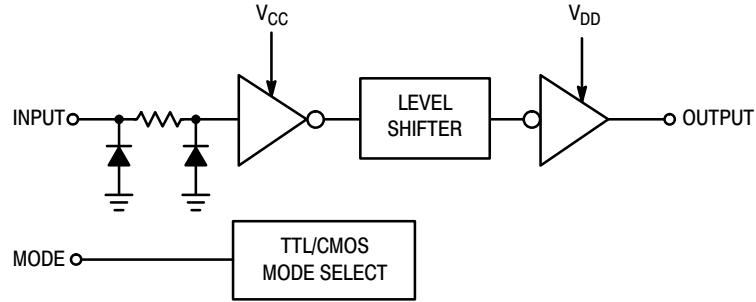
(Note: Microdot may be in either location)

### ORDERING INFORMATION

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

# MC14504B

## 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 <sup>†</sup>
MC14504BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14504BDR2G	SOIC-16 (Pb-Free)	2500 Units / Tape & Reel
NLV14504BDR2G*		
MC14504BDTG	TSSOP-16 (Pb-Free)	96 Units / Rail
MC14504BDTR2G	TSSOP-16 (Pb-Free)	2500 Units / Tape & Reel
NLV14504BDTR2G*		

<sup>†</sup>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.

# MC14504B

## ELECTRICAL CHARACTERISTICS (Voltages Referenced to V<sub>SS</sub>)

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

# MC14504B

## SWITCHING CHARACTERISTICS (C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C)

Characteristic	Symbol	Shifting Mode	V <sub>CC</sub> Vdc	V <sub>DD</sub> Vdc	Limits			Unit
					Min	Typ (Note 3)	Max	
Propagation Delay, High to Low	t <sub>PHL</sub>	TTL – CMOS V <sub>DD</sub> > V <sub>CC</sub>	5.0	10	–	140	280	ns
			5.0	15	–	140	280	
		CMOS – CMOS V <sub>DD</sub> > V <sub>CC</sub>	5.0	10	–	120	240	
			5.0	15	–	120	240	
		CMOS – CMOS V <sub>CC</sub> > V <sub>DD</sub>	10	5.0	–	185	370	
			15	5.0	–	185	370	
CMOS – CMOS V <sub>CC</sub> > V <sub>DD</sub>	15	10	–	175	350			
	15	10	–	175	350			
Propagation Delay, Low to High	t <sub>PLH</sub>	TTL – CMOS V <sub>DD</sub> > V <sub>CC</sub>	5.0	10	–	170	340	ns
			5.0	15	–	160	320	
		CMOS – CMOS V <sub>DD</sub> > V <sub>CC</sub>	5.0	10	–	170	340	
			5.0	15	–	170	340	
		CMOS – CMOS V <sub>CC</sub> > V <sub>DD</sub>	10	5.0	–	100	200	
			15	5.0	–	100	200	
CMOS – CMOS V <sub>CC</sub> > V <sub>DD</sub>	15	5.0	–	275	550			
	15	5.0	–	275	550			
CMOS – CMOS V <sub>CC</sub> > V <sub>DD</sub>	15	10	–	145	290			
	15	10	–	145	290			
Output Rise and Fall Time	t <sub>TLH</sub> , t <sub>THL</sub>	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.

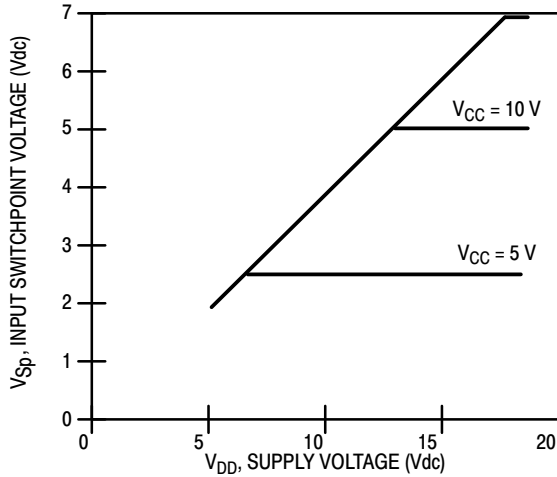


Figure 1. Input Switchpoint CMOS to CMOS Mode

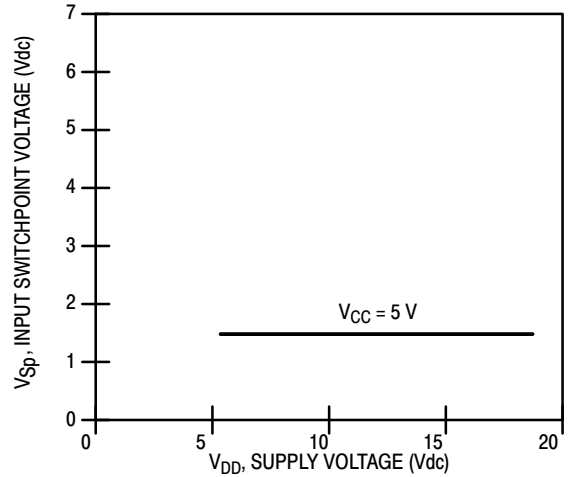


Figure 2. Input Switchpoint TTL to CMOS Mode

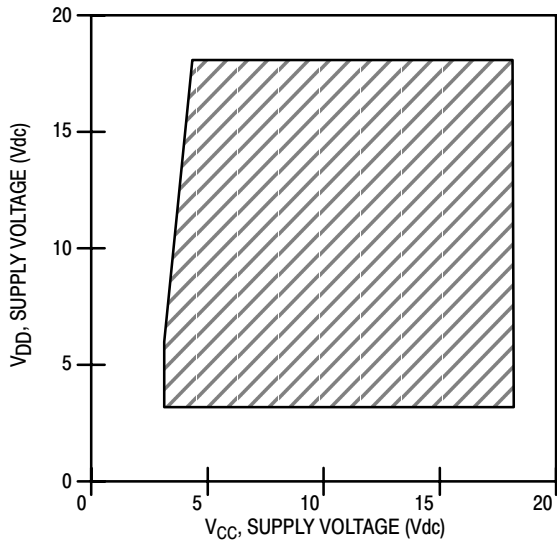


Figure 3. Operating Boundary CMOS to CMOS Mode

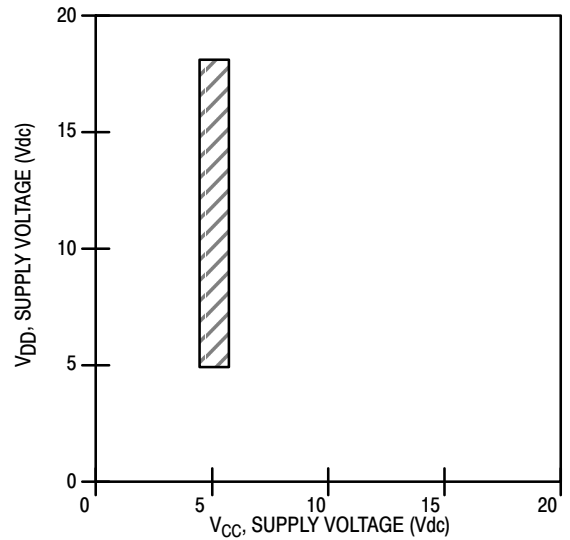
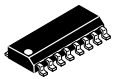


Figure 4. Operating Boundary TTL to CMOS Mode

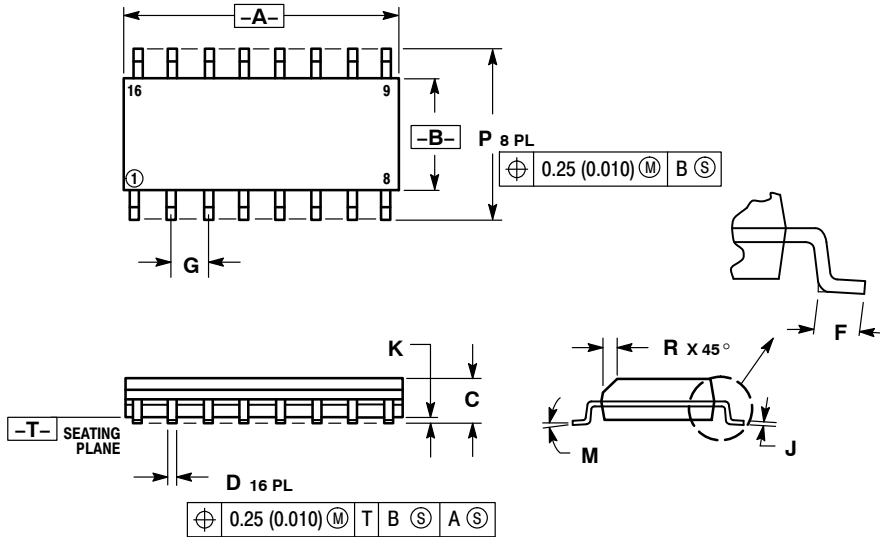
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-16  
CASE 751B-05  
ISSUE K

DATE 29 DEC 2006



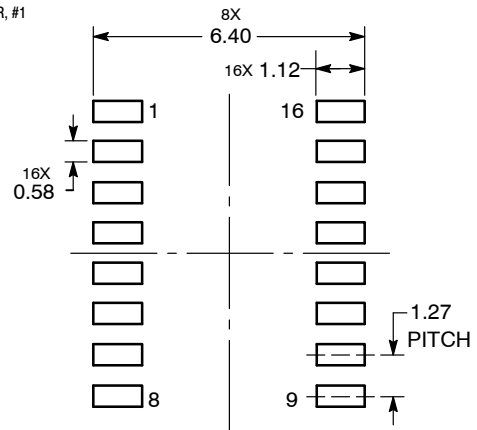
NOTES:

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.

DIM	MILLIMETERS		INCHES	
	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

- |  |  |  |  |
|--|--|--|--|
| <p>STYLE 1:</p> <p>PIN 1. COLLECTOR</p> <p>2. BASE</p> <p>3. EMITTER</p> <p>4. NO CONNECTION</p> <p>5. EMITTER</p> <p>6. BASE</p> <p>7. COLLECTOR</p> <p>8. COLLECTOR</p> <p>9. BASE</p> <p>10. EMITTER</p> <p>11. NO CONNECTION</p> <p>12. EMITTER</p> <p>13. BASE</p> <p>14. COLLECTOR</p> <p>15. EMITTER</p> <p>16. COLLECTOR</p>                           | <p>STYLE 2:</p> <p>PIN 1. CATHODE</p> <p>2. ANODE</p> <p>3. NO CONNECTION</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. NO CONNECTION</p> <p>7. ANODE</p> <p>8. CATHODE</p> <p>9. CATHODE</p> <p>10. ANODE</p> <p>11. NO CONNECTION</p> <p>12. CATHODE</p> <p>13. CATHODE</p> <p>14. NO CONNECTION</p> <p>15. ANODE</p> <p>16. CATHODE</p> | <p>STYLE 3:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. BASE, #1</p> <p>3. EMITTER, #1</p> <p>4. COLLECTOR, #1</p> <p>5. COLLECTOR, #2</p> <p>6. BASE, #2</p> <p>7. EMITTER, #2</p> <p>8. COLLECTOR, #2</p> <p>9. COLLECTOR, #3</p> <p>10. BASE, #3</p> <p>11. EMITTER, #3</p> <p>12. COLLECTOR, #3</p> <p>13. COLLECTOR, #4</p> <p>14. BASE, #4</p> <p>15. EMITTER, #4</p> <p>16. COLLECTOR, #4</p>   | <p>STYLE 4:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. COLLECTOR, #1</p> <p>3. COLLECTOR, #2</p> <p>4. COLLECTOR, #2</p> <p>5. COLLECTOR, #3</p> <p>6. COLLECTOR, #3</p> <p>7. COLLECTOR, #4</p> <p>8. COLLECTOR, #4</p> <p>9. BASE, #4</p> <p>10. EMITTER, #4</p> <p>11. BASE, #3</p> <p>12. EMITTER, #3</p> <p>13. BASE, #2</p> <p>14. EMITTER, #2</p> <p>15. BASE, #1</p> <p>16. EMITTER, #1</p> |
| <p>STYLE 5:</p> <p>PIN 1. DRAIN, DYE #1</p> <p>2. DRAIN, #1</p> <p>3. DRAIN, #2</p> <p>4. DRAIN, #2</p> <p>5. DRAIN, #3</p> <p>6. DRAIN, #3</p> <p>7. DRAIN, #4</p> <p>8. DRAIN, #4</p> <p>9. GATE, #4</p> <p>10. SOURCE, #4</p> <p>11. GATE, #3</p> <p>12. SOURCE, #3</p> <p>13. GATE, #2</p> <p>14. SOURCE, #2</p> <p>15. GATE, #1</p> <p>16. SOURCE, #1</p> | <p>STYLE 6:</p> <p>PIN 1. CATHODE</p> <p>2. CATHODE</p> <p>3. CATHODE</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. CATHODE</p> <p>7. CATHODE</p> <p>8. CATHODE</p> <p>9. ANODE</p> <p>10. ANODE</p> <p>11. ANODE</p> <p>12. ANODE</p> <p>13. ANODE</p> <p>14. ANODE</p> <p>15. ANODE</p> <p>16. ANODE</p>                                 | <p>STYLE 7:</p> <p>PIN 1. SOURCE N-CH</p> <p>2. COMMON DRAIN (OUTPUT)</p> <p>3. COMMON DRAIN (OUTPUT)</p> <p>4. GATE P-CH</p> <p>5. COMMON DRAIN (OUTPUT)</p> <p>6. COMMON DRAIN (OUTPUT)</p> <p>7. COMMON DRAIN (OUTPUT)</p> <p>8. SOURCE P-CH</p> <p>9. SOURCE P-CH</p> <p>10. COMMON DRAIN (OUTPUT)</p> <p>11. COMMON DRAIN (OUTPUT)</p> <p>12. COMMON DRAIN (OUTPUT)</p> <p>13. GATE N-CH</p> <p>14. COMMON DRAIN (OUTPUT)</p> <p>15. COMMON DRAIN (OUTPUT)</p> <p>16. SOURCE N-CH</p> |  |

RECOMMENDED  
SOLDERING FOOTPRINT\*



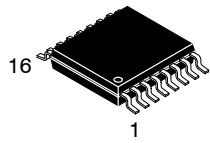
DIMENSIONS: MILLIMETERS

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

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DESCRIPTION:	SOIC-16	PAGE 1 OF 1

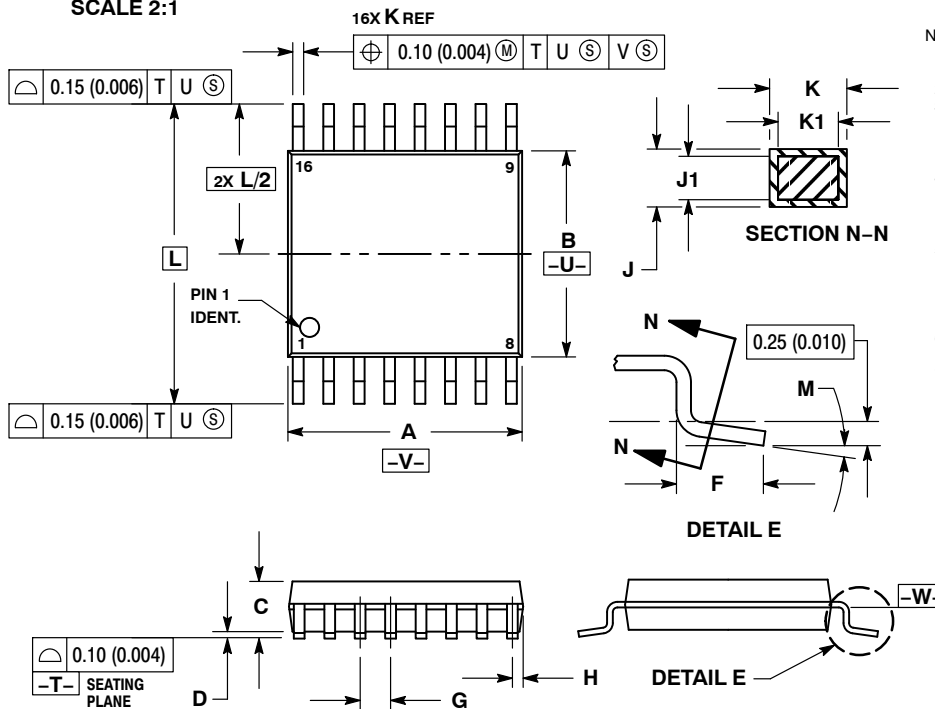
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**TSSOP-16 WB**  
CASE 948F  
ISSUE B

DATE 19 OCT 2006

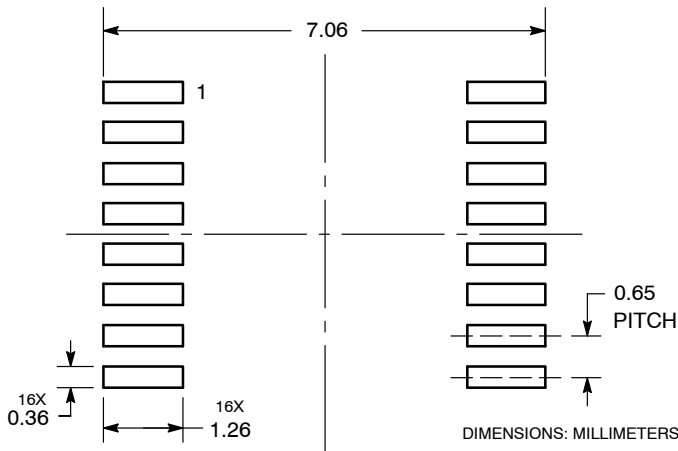


**NOTES:**

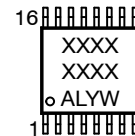
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
- DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
- 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.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
- DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	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°

**RECOMMENDED  
SOLDERING FOOTPRINT\***



**GENERIC  
MARKING DIAGRAM\***



- XXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- G or ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

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

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