

MC14543B

BCD-to-Seven Segment Latch/Decoder/Driver for Liquid Crystals

The MC14543B BCD-to-seven segment latch/decoder/driver is designed for use with liquid crystal readouts, and is constructed with complementary MOS (CMOS) enhancement mode devices. The circuit provides the functions of a 4-bit storage latch and an 8421 BCD-to-seven segment decoder and driver. The device has the capability to invert the logic levels of the output combination. The phase (Ph), blanking (BI), and latch disable (LD) inputs are used to reverse the truth table phase, blank the display, and store a BCD code, respectively. For liquid crystal (LC) readouts, a square wave is applied to the Ph input of the circuit and the electrically common backplane of the display. The outputs of the circuit are connected directly to the segments of the LC readout. For other types of readouts, such as light-emitting diode (LED), incandescent, gas discharge, and fluorescent readouts, connection diagrams are given on this data sheet.

Applications include instrument (e.g., counter, DVM etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

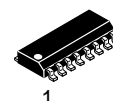
Features

- Latch Storage of Code
- Blanking Input
- Readout Blanking on All Illegal Input Combinations
- Direct LED (Common Anode or Cathode) Driving Capability
- Supply Voltage Range = 3.0 V to 18 V
- Capable of Driving 2 Low-power TTL Loads, 1 Low-power Schottky TTL Load or 2 HTL Loads Over the Rated Temperature Range
- Pin-for-Pin Replacement for CD4056A (with Pin 7 Tied to V_{SS}).
- Chip Complexity: 207 FETs or 52 Equivalent Gates
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.
- This Device is Pb-Free and is RoHS Compliant



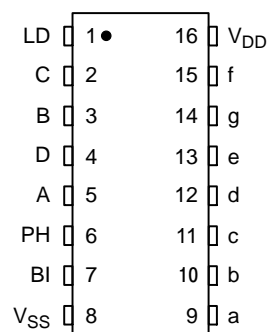
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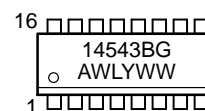


SOIC-16
D SUFFIX
CASE 751B

PIN ASSIGNMENT



MARKING DIAGRAM



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

MC14543B

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

Parameter	Symbol	Value	Unit
DC Supply Voltage Range	V_{DD}	-0.5 to +18.0	V
Input Voltage Range, All Inputs	V_{in}	-0.5 to $V_{DD} + 0.5$	V
DC Input Current per Pin	I_{in}	± 10	mA
Power Dissipation per Package (Note 1)	P_D	500	mW
Operating Temperature Range	T_A	-55 to +125	$^{\circ}C$
Storage Temperature Range	T_{stg}	-65 to +150	$^{\circ}C$
Maximum Continuous Output Drive Current (Source or Sink)	I_{OHmax} I_{OLmax}	10 (per Output)	mA
Maximum Continuous Output Power (Source or Sink) (Note 2)	P_{OHmax} P_{OLmax}	70 (per Output)	mW

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" Package: -7.0 mW/ $^{\circ}C$ From 65 $^{\circ}C$ To 125 $^{\circ}C$

2. $P_{OHmax} = I_{OH} (V_{OH} - V_{DD})$ and $P_{OLmax} = I_{OL} (V_{OL} - V_{SS})$

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.

TRUTH TABLE

Inputs							Outputs							Display
LD	BI	Ph*	D	C	B	A	a	b	c	d	e	f	g	
X	1	0	X	X	X	X	0	0	0	0	0	0	0	Blank
1	0	0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	1	1	0	0	0	0	1
1	0	0	0	0	1	0	1	1	1	1	0	0	1	2
1	0	0	0	0	1	1	1	1	1	1	0	0	1	3
1	0	0	0	1	0	0	0	1	1	0	0	1	1	4
1	0	0	0	1	0	1	1	0	1	1	0	1	1	5
1	0	0	0	1	1	0	1	0	1	1	1	1	1	6
1	0	0	0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	0	0	1	1	1	1	1	0	1	1	9
1	0	0	1	0	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	0	1	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	1	0	0	0	0	0	0	0	Blank
0	0	0	X	X	X	X	**							**
†	†	†	†				Inverse of Output Combinations Above							Display as above

X = Don't care

† = Above Combinations

* = For liquid crystal readouts, apply a square wave to Ph

For common cathode LED readouts, select Ph = 0

For common anode LED readouts, select Ph = 1

** = Depends upon the BCD code previously applied when LD = 1

MC14543B

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V _{DD} Vdc	- 55° C		25° C			125° C		Unit
			Min	Max	Min	Typ (Note 3)	Max	Min	Max	
Output Voltage "0" Level V _{in} = V _{DD} or 0	V _{OL}	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 _{in} = 0 or V _{DD}	V _{OH}	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 "0" Level (V _O = 4.5 or 0.5 Vdc) (V _O = 9.0 or 1.0 Vdc) (V _O = 13.5 or 1.5 Vdc)	V _{IL}	5.0	–	1.5	–	2.25	1.5	–	1.5	Vdc
		10	–	3.0	–	4.50	3.0	–	3.0	
15		–	4.0	–	6.75	4.0	–	4.0		
"1" Level (V _O = 0.5 or 4.5 Vdc) (V _O = 1.0 or 9.0 Vdc) (V _O = 1.5 or 13.5 Vdc)	V _{IH}	5.0	3.5	–	3.5	2.75	–	3.5	–	Vdc
		10	7.0	–	7.0	5.50	–	7.0	–	
		15	11	–	11	8.25	–	11	–	
Output Drive Current (V _{OH} = 2.5 Vdc) (V _{OH} = 4.6 Vdc) (V _{OH} = 0.5 Vdc) (V _{OH} = 9.5 Vdc) (V _{OH} = 13.5 Vdc)	Source I _{OH}	5.0	–3.0	–	–2.4	–4.2	–	–1.7	–	mAdc
		5.0	–0.64	–	–0.51	–0.88	–	–0.36	–	
10		–	–	–	–10.1	–	–	–		
(V _{OL} = 0.4 Vdc) (V _{OL} = 0.5 Vdc) (V _{OL} = 9.5 Vdc) (V _{OL} = 1.5 Vdc)	Sink I _{OL}	5.0	0.64	–	0.51	0.88	–	0.36	–	mAdc
		10	1.6	–	1.3	2.25	–	0.9	–	
		10	–	–	–	10.1	–	–	–	
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	C _{in}	–	–	–	–	5.0	7.5	–	–	pF
Quiescent Current (Per Package) V _{in} = 0 or V _{DD} , I _{out} = 0 μA	I _{DD}	5.0	–	5.0	–	0.005	5.0	–	150	μAdc
		10	–	10	–	0.010	10	–	300	
		15	–	20	–	0.015	20	–	600	
Total Supply Current (Note 4, 5) (Dynamic plus Quiescent, Per Package) (C _L = 50 pF on all outputs, all buffers switching)	I _T	5.0	I _T = (1.6 μA/kHz) f + I _{DD}							μAdc
		10	I _T = (3.1 μA/kHz) f + I _{DD}							
		15	I _T = (4.7 μA/kHz) f + I _{DD}							

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.

3. Noise immunity specified for worst-case input combination.

$$\begin{aligned} \text{Noise Margin for both "1" and "0" level} &= 1.0 \text{ V min @ } V_{DD} = 5.0 \text{ V} \\ &= 2.0 \text{ V min @ } V_{DD} = 10 \text{ V} \\ &= 2.5 \text{ V min @ } V_{DD} = 15 \text{ V} \end{aligned}$$

4. To calculate total supply current at loads other than 50 pF: $I_T(C_L) = I_T(50 \text{ pF}) + 3.5 \times 10^{-3} (C_L - 50) V_{DD} f$ where: I_T is in μA (per package), C_L in pF, V_{DD} in V, and f in kHz is input frequency.

5. The formulas given are for the typical characteristics only at 25°C.

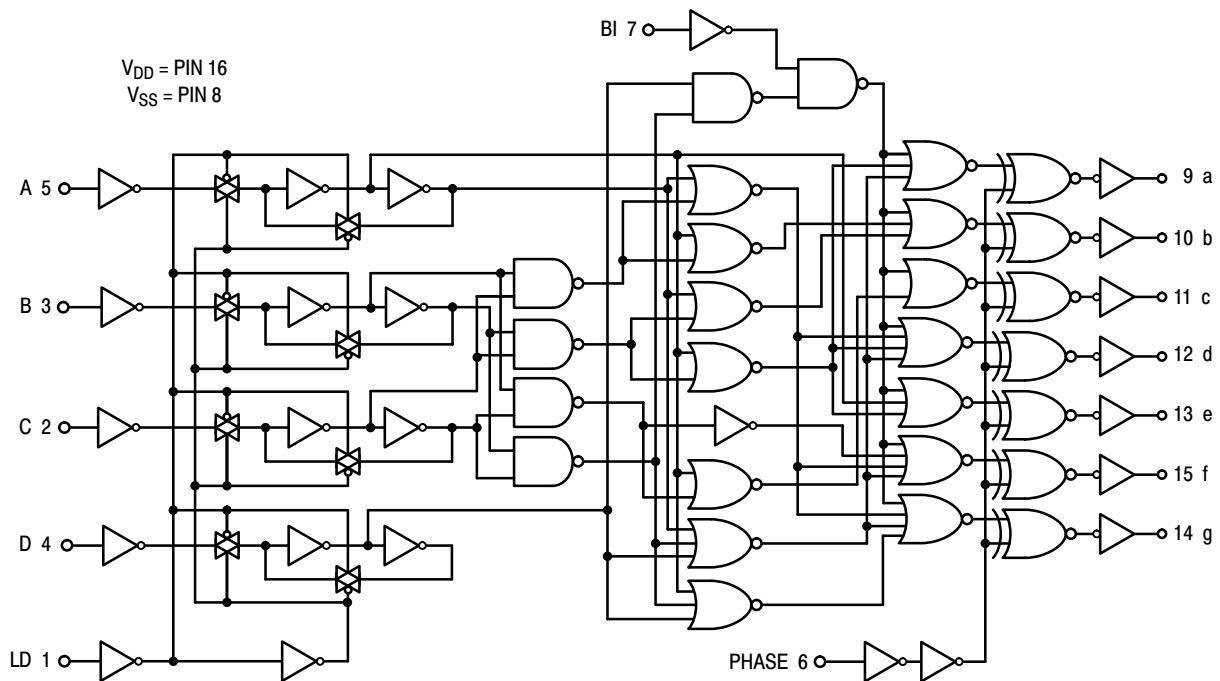
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SWITCHING CHARACTERISTICS (Note 6) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

Characteristic	Symbol	V_{DD}	Min	Typ	Max	Unit
Output Rise Time $t_{TLH} = (3.0 \text{ ns/pF}) C_L + 30 \text{ ns}$ $t_{TLH} = (1.5 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{TLH} = (1.1 \text{ ns/pF}) C_L + 10 \text{ ns}$	t_{TLH}	5.0 10 15	– – –	100 50 40	200 100 80	ns
Output Fall Time $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{THL} = (0.55 \text{ ns/pF}) C_L + 12.5 \text{ ns}$	t_{THL}	5.0 10 15	– – –	100 50 40	200 100 80	ns
Turn-Off Delay Time $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 520 \text{ ns}$ $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 217 \text{ ns}$ $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 160 \text{ ns}$	t_{PLH}	5.0 10 15	– – –	605 250 185	1210 500 370	ns
Turn-On Delay Time $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 420 \text{ ns}$ $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 172 \text{ ns}$ $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 130 \text{ ns}$	t_{PHL}	5.0 10 15	– – –	505 205 155	1650 660 495	ns
Setup Time	t_{su}	5.0 10 15	350 450 500		– – –	ns
Hold Time	t_h	5.0 10 15	40 30 20		– – –	ns
Latch Disable Pulse Width (Strobing Data)	t_{WH}	5.0 10 15	250 100 80	125 50 40	– – –	ns

6. The formulas given are for the typical characteristics only.

LOGIC DIAGRAM



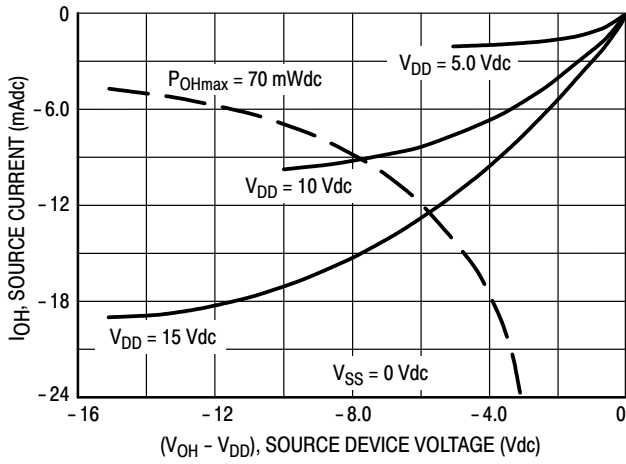


Figure 1. Typical Output Source Characteristics

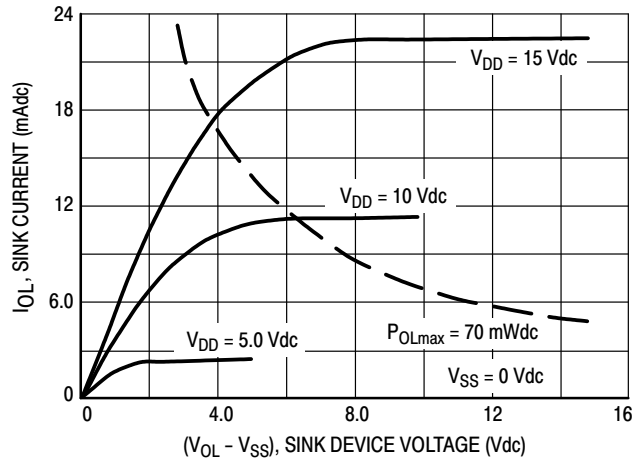


Figure 2. Typical Output Sink Characteristics

Inputs BI and Ph low, and Inputs D and LD high.
f in respect to a system clock.
All outputs connected to respective C_L loads.

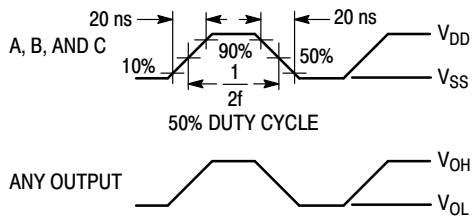
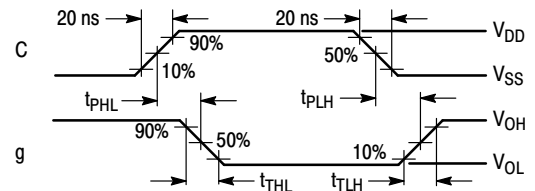
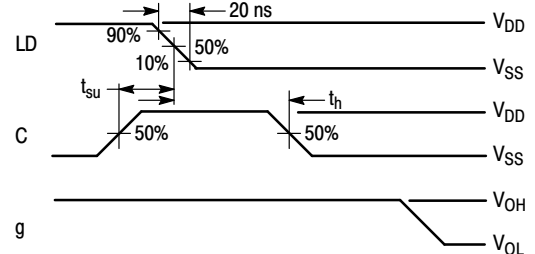


Figure 3. Dynamic Power Dissipation Signal Waveforms

(a) Inputs D, Ph, and BI low, and Inputs A, B, and LD high.



(b) Inputs D, Ph, and BI low, and Inputs A and B high.



(c) Data DCBA strobed into latches

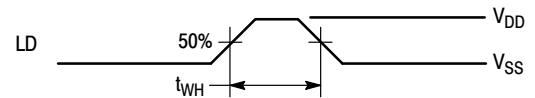
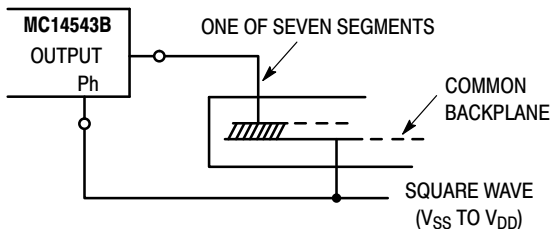


Figure 4. Dynamic Signal Waveforms

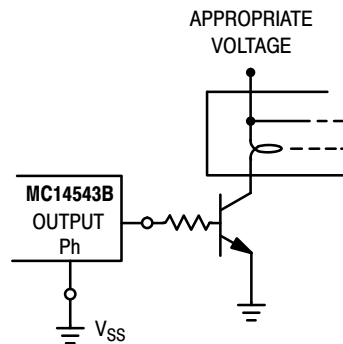
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CONNECTIONS TO VARIOUS DISPLAY READOUTS

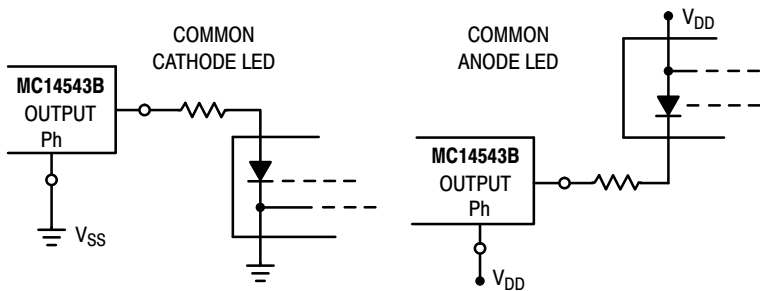
LIQUID CRYSTAL (LC) READOUT



INCANDESCENT READOUT

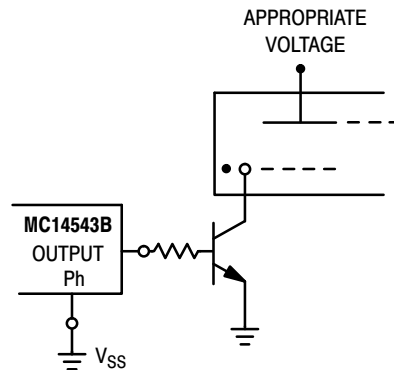


LIGHT EMITTING DIODE (LED) READOUT

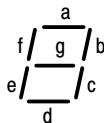


NOTE: Bipolar transistors may be added for gain (for $V_{DD} \leq 10$ V or $I_{out} \geq 10$ mA).

GAS DISCHARGE READOUT

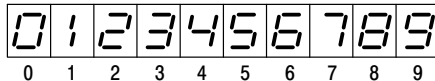


CONNECTIONS TO SEGMENTS



V_{DD} = PIN 16
 V_{SS} = PIN 8

DISPLAY



MC14543B

ORDERING INFORMATION

Device	Package	Shipping†
MC14543BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14543BDR2G	SOIC-16 (Pb-Free)	2500 / Tape & Reel
NLV14543BDR2G*	SOIC-16 (Pb-Free)	2500 / 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.

MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

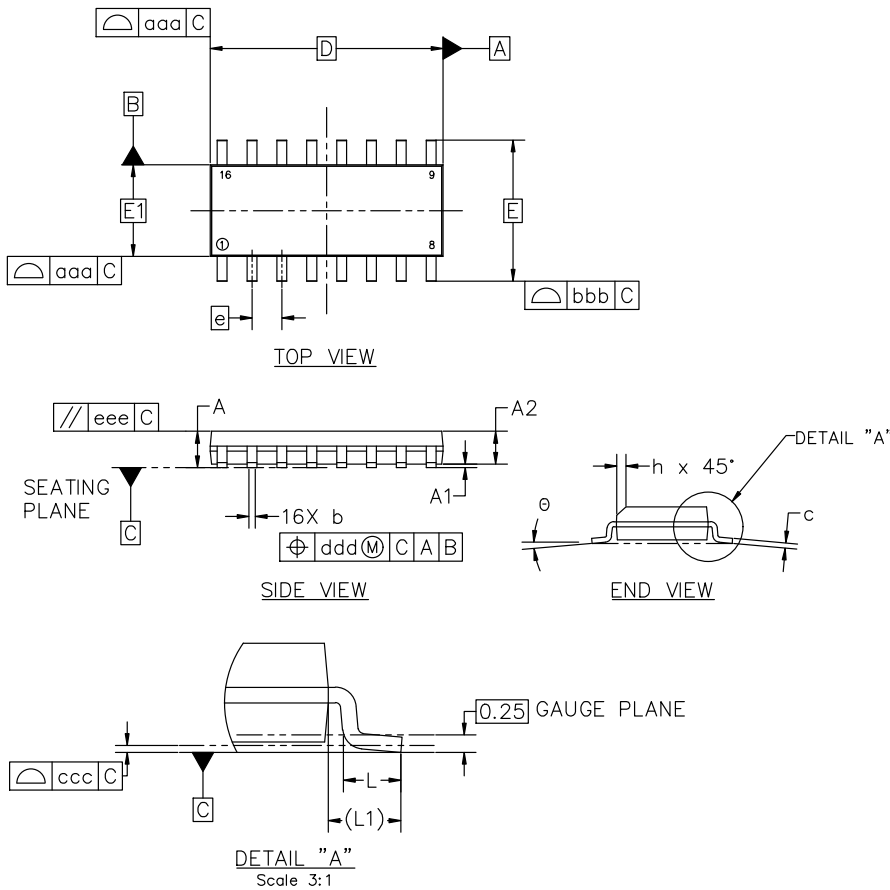


SOIC-16 9.90x3.90x1.50 1.27P
CASE 751B
ISSUE L

DATE 29 MAY 2024

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. DIMENSION IN MILLIMETERS. ANGLE IN DEGREES.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15mm PER SIDE.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127mm TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.



MILLIMETERS			
DIM	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.00	0.05	0.10
A2	1.35	1.50	1.65
b	0.35	0.42	0.49
c	0.19	0.22	0.25
D	9.90 BSC		
E	6.00 BSC		
E1	3.90 BSC		
e	1.27 BSC		
h	0.25	---	0.50
L	0.40	0.83	1.25
L1	1.05 REF		
θ	0°	---	7°
TOLERANCE OF FORM AND POSITION			
aaa	0.10		
bbb	0.20		
ccc	0.10		
ddd	0.25		
eee	0.10		



RECOMMENDED MOUNTING FOOTPRINT

*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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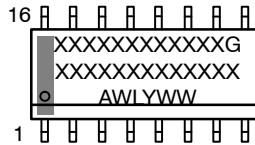
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS



SOIC-16 9.90x3.90x1.50 1.27P
CASE 751B
ISSUE L

DATE 29 MAY 2024

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = 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.

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

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DESCRIPTION:	SOIC-16 9.90X3.90X1.50 1.27P	PAGE 2 OF 2

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