

Octal Bus Buffer

MC74VHC541, MC74VHCT541A

The MC74VHC541/MC74VHCT541A is an advanced high speed CMOS octal bus buffer fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

The device is a noninverting 3-state buffer/line driver/line receiver. When either OE1 or OE2 are high, the terminal outputs are in the high impedance state.

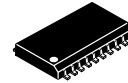
The MC74VHC541 inputs are compatible with standard CMOS levels while the MC74VHCT541A inputs are compatible with TTL levels. The MC74VHCT541A device can be used as a level converter for interfacing 3.3 V to 5.0 V, because it has full 5.0 V CMOS level output swings.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The MC74VHC541 and MC74VHCT541A inputs tolerate voltages up to 5.5 V, allowing the interface of 5 V systems to 3 V systems.

The MC74VHCT541A output structures provide protection when $V_{CC} = 0$ V. These output structures help prevent device destruction caused by supply voltage – input/output voltage mismatch, battery backup, hot insertion, etc.

Features

- High Speed: $t_{PD} = 3.7$ ns (Typ) at $V_{CC} = 5.0$ V (VHC)
 $t_{PD} = 5.4$ ns (Typ) at $V_{CC} = 5.0$ V (VHCT)
- Low Power Dissipation: $I_{CC} = 4.0$ μ A (Max) at $T_A = 25^\circ$ C
- High Noise Immunity: $V_{NIH} = V_{NIL} = 28\%$
- Power Down Protection Provided
- Balanced Propagation Delays
- Designed for: 2.0 V to 5.5 V (VHC)
4.5 V to 5.5 V (VHCT)
- Low Noise: $V_{OLP} = 0.8$ V (Max) (VHC)
 $V_{OLP} = 1.1$ V (Max) (VHCT)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 100 mA
- ESD Performance: Human Body Model > 2000 V;
- Chip Complexity: 134 FETs

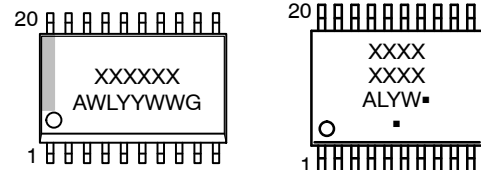


SOIC-20
DW SUFFIX
CASE 751D



TSSOP-20
DT SUFFIX
CASE 948E

MARKING DIAGRAMS



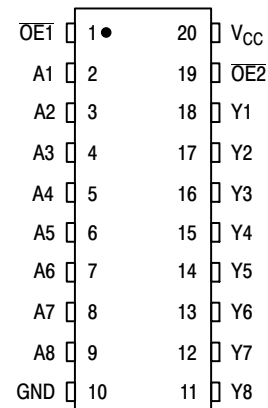
SOIC-20

TSSOP-20

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

(Note: Microdot may be in either location)

PIN ASSIGNMENT



FUNCTION TABLE

Inputs			Output Y
OE1	OE2	A	
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

MC74VHC541, MC74VHCT541A

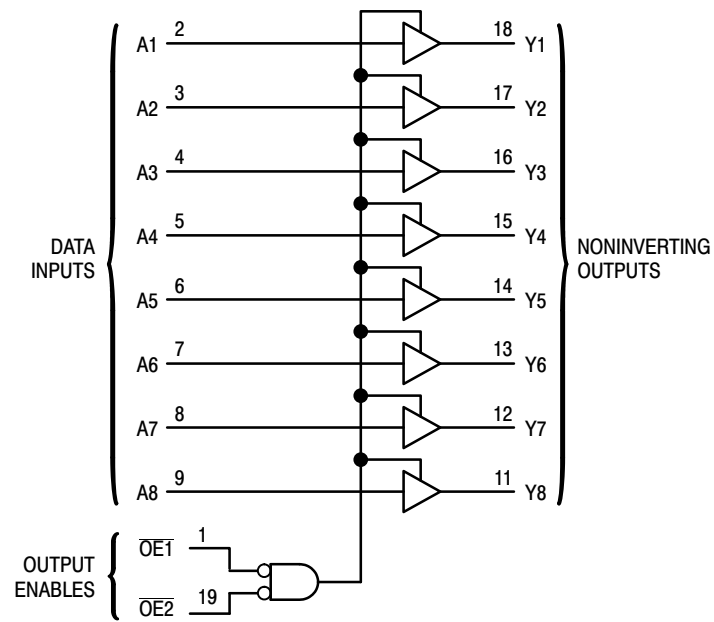


Figure 1. Logic Diagram

MC74VHC541, MC74VHCT541A

MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage	-0.5 to +6.5	V
V_{IN}	DC Input Voltage	-0.5 to +6.5	V
V_{OUT}	DC Output Voltage (MC74VHC)	-0.5 to $V_{CC}+0.5$	V
	DC Output Voltage (MC74VHCT)	-0.5 to $V_{CC}+0.5$	
	Active Mode (High or Low State)	-0.5 to +6.5	
	Tristate Mode (Note 1)	-0.5 to +6.5	
	Power-Off Mode ($V_{CC} = 0$ V)	-0.5 to +6.5	
I_{IN}	DC Input Current, per Pin	± 20	mA
I_{OUT}	DC Output Current, Per Pin	± 25	mA
I_{CC}	DC Supply Current, V_{CC} and GND Pins	± 75	mA
I_{IK}	Input Clamp Current	-20	mA
I_{OK}	Output Clamp Current	MC74VHC ± 20	mA
		MC74VHCT -20	
T_{STG}	Storage Temperature Range	-65 to +150	°C
T_L	Lead Temperature, 1 mm from Case for 10 secs	260	°C
T_J	Junction Temperature Under Bias	+150	°C
θ_{JA}	Thermal Resistance (Note 2)	SOIC-20W	°C/W
		TSSOP-20	
P_D	Power Dissipation in Still Air at 25°C	SOIC-20W	mW
		TSSOP-20	
MSL	Moisture Sensitivity	Level 1	-
F_R	Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.541 in
V_{ESD}	ESD Withstand Voltage (Note 3)	Human Body Model	V
		Charged Device Model	
$I_{LATCHUP}$	Latchup Performance (Note 4)	± 100	mA

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. Applicable to devices with outputs that may be tri-stated.

2. Measured with minimum pad spacing on an FR4 board, using 76 mm-by-114 mm, 2-ounce copper trace no air flow per JESD51-7.

3. HBM tested to EIA / JESD22-A114-A. CDM tested to JESD22-C101-A. JEDEC recommends that ESD qualification to EIA/JESD22-A115A (Machine Model) be discontinued.

4. Tested to EIA/JESD78 Class II.

MC74VHC541, MC74VHCT541A

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
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MC74VHC

V _{CC}	DC Supply Voltage	2.0	5.5	V	
V _{IN}	DC Input Voltage (Note 5)	0	5.5	V	
V _{OUT}	DC Output Voltage (Note 5)	0	V _{CC}	V	
T _A	Operating Temperature	−55	+125	°C	
t _r , t _f	Input Rise or Fall Rate	V _{CC} = 3.0 V to 3.6 V	0	100	ns/V
		V _{CC} = 4.5 V to 5.5 V	0	20	

MC74VHCT

V _{CC}	DC Supply Voltage	4.5	5.5	V
V _{IN}	DC Input Voltage (Note 5)	0	5.5	V
V _{OUT}	DC Output Voltage (Note 5)	0	V _{CC}	V
	Active Mode (High or Low State)	0	5.5	
	Tristate Mode	0	5.5	
	Power-Off Mode (V _{CC} = 0 V)	0	5.5	
T _A	Operating Temperature	−55	+125	°C
t _r , t _f	Input Rise or Fall Rate	V _{CC} = 4.5 V to 5.5 V		ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

5. 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.

MC74VHC541, MC74VHCT541A

DC ELECTRICAL CHARACTERISTICS (MC74VHC541)

Symbol	Parameter	Test Conditions	V _{CC} V	T _A = 25°C			T _A = - 55 to 125°C		Unit
				Min	Typ	Max	Min	Max	
V _{IH}	Minimum High-Level Input Voltage		2.0 3.0 to 5.5	1.50 V _{CC} × 0.7			1.50 V _{CC} × 0.7		V
V _{IL}	Maximum Low-Level Input Voltage		2.0 3.0 to 5.5			0.50 V _{CC} × 0.3		0.50 V _{CC} × 0.3	V
V _{OH}	Minimum High-Level Output Voltage	V _{in} = V _{IH} or V _{IL} I _{OH} = - 50 μA	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5		1.9 2.9 4.4		V
		V _{in} = V _{IH} or V _{IL} I _{OH} = - 4 mA I _{OH} = - 8 mA	3.0 4.5	2.58 3.94			2.48 3.80		
V _{OL}	Maximum Low-Level Output Voltage	V _{in} = V _{IH} or V _{IL} I _{OL} = 50 μA	2.0 3.0 4.5		0.0 0.0 0.0	0.1 0.1 0.1		0.1 0.1 0.1	V
		V _{in} = V _{IH} or V _{IL} I _{OL} = 4 mA I _{OL} = 8 mA	3.0 4.5			0.36 0.36		0.44 0.44	
I _{in}	Maximum Input Leakage Current	V _{in} = 5.5 V or GND	0 to 5.5			±0.1		±1.0	μA
I _{OZ}	Maximum 3-State Leakage Current	V _{in} = V _{IL} or V _{IH} V _{out} = V _{CC} or GND	5.5			±0.25		±2.5	μA
I _{CC}	Maximum Quiescent Supply Current	V _{in} = V _{CC} or GND	5.5			4.0		40.0	μA

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.

MC74VHC541, MC74VHCT541A

AC ELECTRICAL CHARACTERISTICS (MC74VHC541)

Symbol	Parameter	Test Conditions	T _A = 25°C			T _A = - 55 to 125°C		Unit
			Min	Typ	Max	Min	Max	
t _{PLH} , t _{PHL}	Maximum Propagation Delay, A to Y	V _{CC} = 3.3 ± 0.3 V C _L = 15 pF C _L = 50 pF		5.0 7.5	7.0 10.5	1.0 1.0	8.5 12.0	ns
		V _{CC} = 5.0 ± 0.5 V C _L = 15 pF C _L = 50 pF		3.5 5.0	5.0 7.0	1.0 1.0	6.0 8.0	
t _{PZL} , t _{PZH}	Output Enable Time, OE to Y	V _{CC} = 3.3 ± 0.3 V C _L = 15 pF C _L = 50 pF		6.8 9.3	10.5 14.0	1.0 1.0	12.5 16.0	ns
		V _{CC} = 5.0 ± 0.5 V C _L = 15 pF C _L = 50 pF		4.7 6.2	7.2 9.2	1.0 1.0	8.5 10.5	
t _{PLZ} , t _{PHZ}	Output Disable Time, OE to Y	V _{CC} = 3.3 ± 0.3 V C _L = 50 pF		11.2	15.4	1.0	17.5	ns
		V _{CC} = 5.0 ± 0.5 V C _L = 50 pF		6.0	8.8	1.0	10.0	
t _{OSLH} , t _{OSHL}	Output to Output Skew	V _{CC} = 3.3 ± 0.3 V C _L = 50 pF (Note 6)			1.5		1.5	ns
		V _{CC} = 5.0 ± 0.5 V C _L = 50 pF (Note 6)			1.0		1.0	ns
C _{in}	Maximum Input Capacitance			4	10		10	pF
C _{out}	Maximum Three-State Output Capacitance (Output in High Im- pedance State)			6				pF

C _{PD}	Power Dissipation Capacitance (Note 7)	Typical @ 25°C, V _{CC} = 5.0 V	pF
		18	

6. Parameter guaranteed by design. t_{OSLH} = |t_{PLHm} - t_{PLHn}|, t_{OSHL} = |t_{PHLm} - t_{PHLn}|.

7. C_{PD} 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_{CC(OPR)} = C_{PD} • V_{CC} • f_{in} + I_{CC}/8 (per bit). C_{PD} is used to determine the no-load dynamic power consumption; P_D = C_{PD} • V_{CC}² • f_{in} + I_{CC} • V_{CC}.

NOISE CHARACTERISTICS (MC74VHC541)

Symbol	Parameter	T _A = 25°C		Unit
		Typ	Max	
V _{OLP}	Quiet Output Maximum Dynamic V _{OL}	0.9	1.2	V
V _{OLV}	Quiet Output Minimum Dynamic V _{OL}	-0.9	-1.2	V
V _{IHD}	Minimum High Level Dynamic Input Voltage		3.5	V
V _{ILD}	Maximum Low Level Dynamic Input Voltage		1.5	V

MC74VHC541, MC74VHCT541A

DC ELECTRICAL CHARACTERISTICS (MC74VHCT541A)

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

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.

AC ELECTRICAL CHARACTERISTICS (MC74VHCT541A)

Symbol	Parameter	Test Conditions	T _A = 25°C			T _A = - 40 to 85°C		Unit
			Min	Typ	Max	Min	Max	
t _{PLH} , t _{PHL}	Maximum Propagation Delay, A to Y	V _{CC} = 5.0 ± 0.5 V C _L = 15 pF C _L = 50 pF		5.0 5.5	6.9 7.9	1.0 1.0	8.0 9.0	ns
t _{PZL} , t _{PZH}	Output Enable Time, OE to Y	V _{CC} = 5.0 ± 0.5V C _L = 15 pF C _L = 50 pF		8.3 8.8	11.3 12.3	1.0 1.0	13.0 14.0	ns
t _{PLZ} , t _{PHZ}	Output Disable Time, OE to Y	V _{CC} = 5.0 ± 0.5 V C _L = 50 pF		9.4	11.9	1.0	13.5	ns
t _{OSLH} , t _{OSHL}	Output to Output Skew	V _{CC} = 5.0 ± 0.5 V C _L = 50 pF (Note 8)			1.0		1.0	ns
C _{in}	Maximum Input Capacitance			4	10		10	pF
C _{out}	Maximum 3-State Output Capacitance (Output in High Impedance State)			9				pF

C _{PD}	Power Dissipation Capacitance (Note 9)	Typical @ 25°C, V _{CC} = 5.0 V	pF
		19	

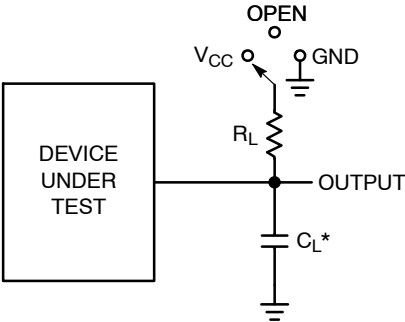
8. Parameter guaranteed by design. t_{OSLH} = |t_{PLHm} - t_{PLHn}|, t_{OSHL} = |t_{PHLm} - t_{PHLn}|.

9. C_{PD} 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_{CC(OPR)} = C_{PD} • V_{CC} • f_{in} + I_{CC}/8 (per bit). C_{PD} is used to determine the no-load dynamic power consumption; P_D = C_{PD} • V_{CC}² • f_{in} + I_{CC} • V_{CC}.

NOISE CHARACTERISTICS (MC74VHCT541A)

Symbol	Parameter	T _A = 25°C		Unit
		Typ	Max	
V _{OLP}	Quiet Output Maximum Dynamic V _{OL}	1.2	1.6	V
V _{OLV}	Quiet Output Minimum Dynamic V _{OL}	-1.2	-1.6	V
V _{IHD}	Minimum High Level Dynamic Input Voltage		2.0	V
V _{ILD}	Maximum Low Level Dynamic Input Voltage		0.8	V

MC74VHC541, MC74VHCT541A



*C_L Includes probe and jig capacitance
Input signal t_R = t_F = 3 ns

Test	Switch Position	C _L	R _L
t _{PLH} / t _{PHL}	Open	See AC Characteristics Table	1 kΩ
t _{PLZ} / t _{PZL}	V _{CC}		
t _{PHZ} / t _{PZH}	GND		

Figure 2. Test Circuits

SWITCHING WAVEFORMS

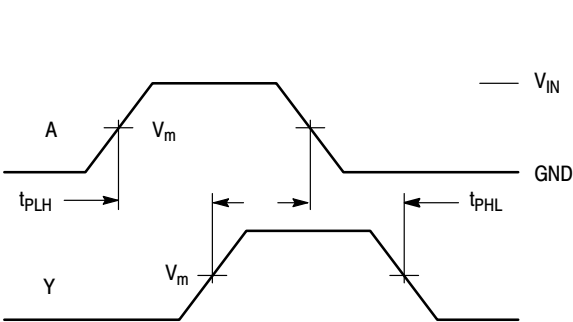


Figure 3.

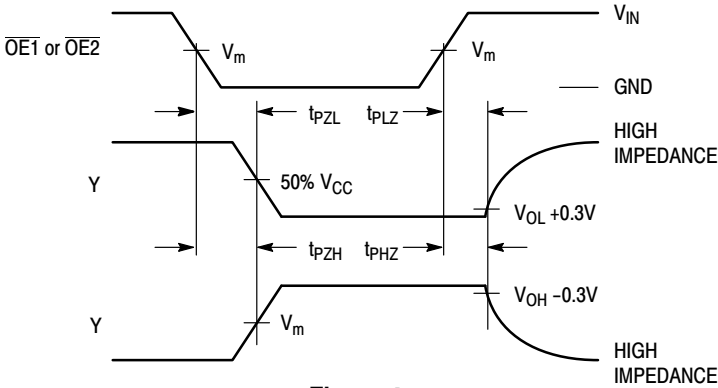


Figure 4.

Device	V _{IN} , V	V _m , V
MC74VHC541	V _{CC}	50% x V _{CC}
MC74VHCT541A	3 V	1.5 V

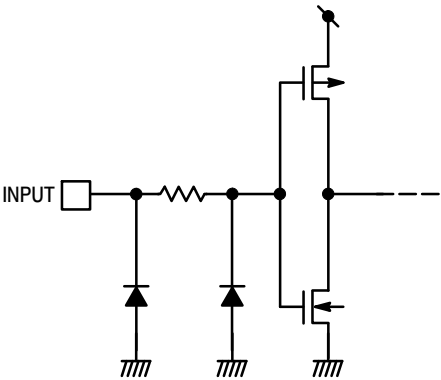


Figure 5. Input Equivalent Circuit

MC74VHC541, MC74VHCT541A

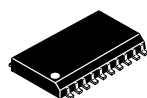
ORDERING INFORMATION

Device	Marking	Package	Shipping†
MC74VHC541DWR2G	VHC541G	SOIC-20 WB	1000 Units / Tape & Reel
MC74VHC541DTG	VHC 541	TSSOP-20	75 Units / Rail
MC74VHC541DTR2G	VHC 541	TSSOP-20	2500 Units / Tape & Reel
MC74VHCT541ADWG	VHCT541AG	SOIC-20 WB	38 Units / Rail
MC74VHCT541ADWR2G	VHCT541AG	SOIC-20 WB	1000 Units / Tape & Reel
MC74VHCT541ADTG	VHCT 541A	TSSOP-20	75 Units / Rail
MC74VHCT541ADTR2G	VHCT 541A	TSSOP-20	2500 Units / Tape & Reel
MC74VHCT541ADTR2G-Q*	VHCT 541A	TSSOP-20	2500 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.

*-Q Suffix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

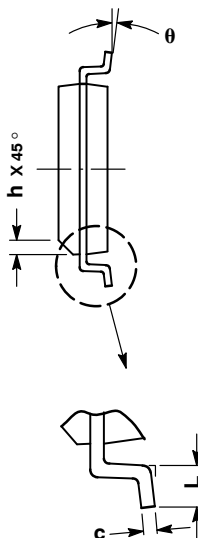
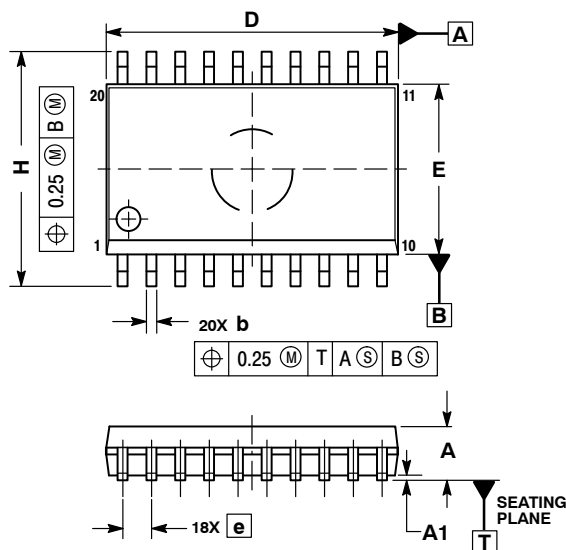
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-20 WB
CASE 751D-05
ISSUE H

DATE 22 APR 2015

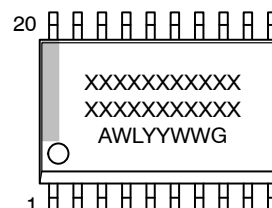


NOTES:

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.

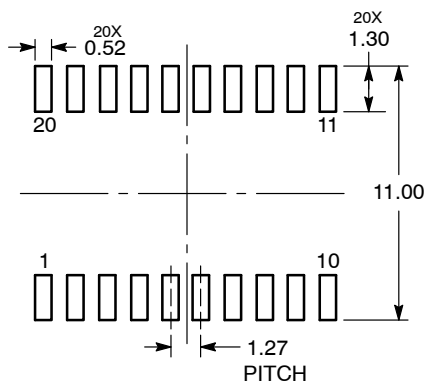
DIM	MILLIMETERS	
	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
b	0.35	0.49
c	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27	BSC
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
θ	0°	7°

GENERIC MARKING DIAGRAM*



XXXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb-Free Package

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

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

*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.

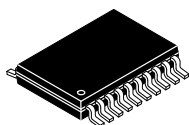
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DESCRIPTION:	SOIC-20 WB	PAGE 1 OF 1

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MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®

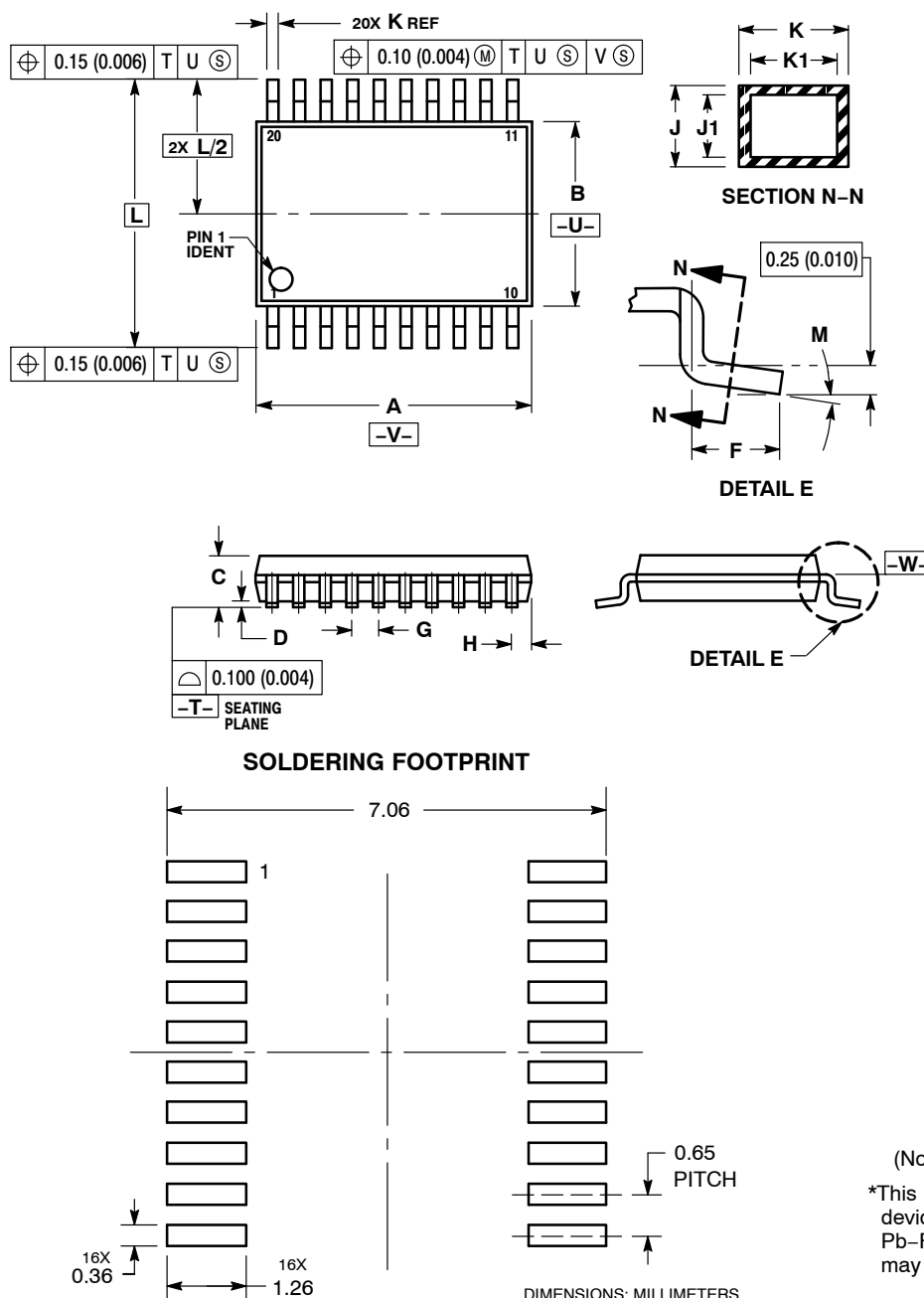
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SCALE 2:1

TSSOP-20 WB
CASE 948E
ISSUE D

DATE 17 FEB 2016

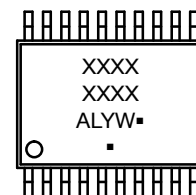


NOTES:

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°

GENERIC MARKING DIAGRAM*



- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

*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.

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