Octal Bus Buffer/Line Driver MC74VHC245, MC74VHCT245A

The MC74VHC245/MC74VHCT245A is an advanced high speed CMOS octal bus buffer fabricated with silicon gate CMOS technology.

It is intended for two−way asynchronous communication between data buses. The direction of data transmission is determined by the level of the DIR input. The output enable pin (OE) can be used to disable the device, so that the buses are effectively isolated.

All inputs are equipped with protection circuits against static discharge.

The MC74VHC245 inputs are compatible with standard CMOS levels while the MC74VHCT245A inputs are compatible with TTL levels. The MC74VHCT245A 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 MC74VHC245 and MC74VHCT245A inputs tolerate voltages up to 5.5 V, allowing the interface of 5 V systems to 3 V systems.

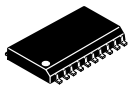
The MC74VHCT245A output structures provide protection when VCC = 0 V. These output structures help prevent device destruction caused by supply voltage − input/output voltage mismatch, battery backup, hot insertion, etc.

Features

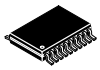
- High Speed: t_{PD} = 4.0 ns (Typ) at V_{CC} = 5.0 V (VHC)
  t_{PD} = 4.9 ns (Typ) at V_{CC} = 5.0 V (VHCT)
- Low Power Dissipation: I_{CC} = 4.0 μA (Max) at T_A = 25°C
- High Noise Immunity: VNIH = VNIL = 28%
- Power Down Protection Provided
- Balanced Propagation Delays
- Designed for: 2.0 V to 5.5 V (VHC)
  4.5 V to 5.5 V (VHCT)
- Low Noise: V_{OLP} = 1.2 V (Max) (VHC)
  V_{OLP} = 1.6 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: 308 FETs
- −Q Suffix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free and are RoHS Compliant

Application Notes

- Do not force a signal on an I/O pin when it is an active output, damage may occur.
- All floating (high impedance) input or I/O pins must be fixed by means of pull up or pull down resistors or bus terminator ICs.
- A parasitic diode is formed between the bus and V_{CC} terminals. Therefore, the VHC245 cannot be used to interface 5 V to 3 V systems directly.

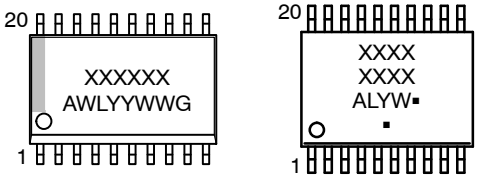


SOIC−20
DW SUFFIX
CASE 751D



TSSOP−20
DT SUFFIX
CASE 948E

MARKING DIAGRAMS

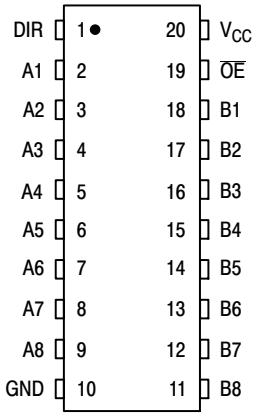


SOIC−20 **TSSOP−20**

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

(Note: Microdot may be in either location)

PIN ASSIGNMENT



ORDERING INFORMATION

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

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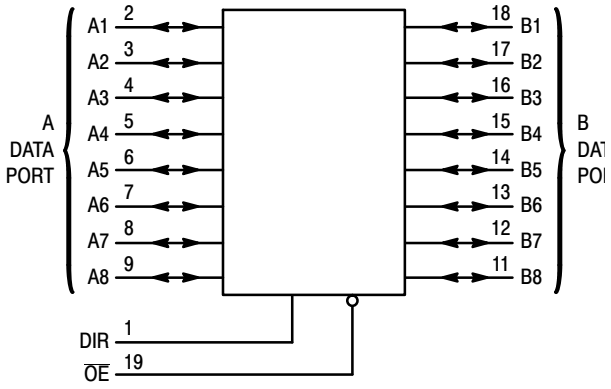

Figure 1. Logic Diagram

FUNCTION TABLE

Control Inputs		
OE	**DIR**	**Operation**
L	L	Data Transmitted from Bus B to Bus A
L	H	Data Transmitted from Bus A to Bus B
H	X	Buses Isolated (High−Impedance State)

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)	Active Mode (High or Low State) Tristate Mode (Note 1) Power−Off Mode (V_{CC} = 0 V)	−0.5 to V_{CC}+0.5 −0.5 to +6.5 −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 MC74VHCT	±20 −20	mA
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 TSSOP−20	96 150	°C/W
P_D	Power Dissipation in Still Air at 25°C	SOIC−20W TSSOP−20	1302 833	mW
MSL	Moisture Sensitivity	SOIC−20W All Other Packages	Level 3 Level 1	−
F_R	Flammability Rating	Oxygen Index: 28 to 34	UL 94 V−0 @ 0.245 in	−
V_{ESD}	ESD Withstand Voltage (Note 3)	Human Body Model Charged Device Model	2000 N/A	V
$I_{LATCHUP}$	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.

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RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Min	Max	Unit
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		−40	+85	°C
t_r, t_f	Input Rise or Fall Rate	V_{CC} = 3.0 V to 3.6 V V_{CC} = 4.5 V to 5.5 V	0 0	100 20	ns/V
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)	Active Mode (High or Low State) Tristate Mode Power−Off Mode (V_{CC} = 0 V)	0 0 0	V_{CC} 5.5 5.5	V
T_A	Operating Temperature		−40	+85	°C
t_r, t_f	Input Rise or Fall Rate	V_{CC} = 4.5 V to 5.5 V	0	20	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.

DC ELECTRICAL CHARACTERISTICS (MC74VHC245)

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		2.0 3.0 to 5.5	1.50 V_{CC} x 0.7			1.50 V_{CC} x 0.7		V
V_{IL}	Maximum Low−Level Input Voltage		2.0 3.0 to 5.5			0.50 V_{CC} x 0.3		0.50 V_{CC} x 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 (DIR, $\overline{OE}$)	0 to 5.5			±0.1		±1.0	μA
I_{OZ}	Maximum Three−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.

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AC ELECTRICAL CHARACTERISTICS (MC74VHC245)

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 B or B to A	V_{CC} = 3.3 ± 0.3 V C_L = 15 pF		5.8	8.4	1.0	10.0	ns
		V_{CC} = 3.3 ± 0.3 V C_L = 50 pF		8.3	11.9	1.0	13.5	
		V_{CC} = 5.0 ± 0.5 V C_L = 15 pF		4.0	5.5	1.0	6.5	
		V_{CC} = 5.0 ± 0.5 V C_L = 50 pF		5.5	7.5	1.0	8.5	
t_{PZL}, t_{PZH}	Output Enable Time $\overline{OE}$ to A or B	V_{CC} = 3.3 ± 0.3 V C_L = 15 pF		8.5	13.2	1.0	15.5	ns
		V_{CC} = 3.3 ± 0.3 V C_L = 50 pF		11.0	16.7	1.0	19.0	
		V_{CC} = 5.0 ± 0.5 V C_L = 15 pF		5.8	8.5	1.0	10.0	
		V_{CC} = 5.0 ± 0.5 V C_L = 50 pF		7.3	10.6	1.0	12.0	
t_{PLZ}, t_{PHZ}	Output Disable Time $\overline{OE}$ to A or B	V_{CC} = 3.3 ± 0.3 V C_L = 50 pF		11.5	15.8	1.0	18.0	ns
		V_{CC} = 5.0 ± 0.5 V C_L = 50 pF		7.0	9.7	1.0	11.0	
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 DIR, $\overline{OE}$			4	10		10	pF
$C_{I/O}$	Maximum Three−State I/O Capacitance			8				pF

		Typical @ 25°C, V_{CC} = 5.0 V	
C_{PD}	Power Dissipation Capacitance (Note 7)	21	pF

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: $I_{CC(OPR)} = C_{PD} \bullet V_{CC} \bullet f_{in} + I_{CC} / 8$ (per bit). C_{PD} is used to determine the no−load dynamic power consumption; $P_D = C_{PD} \bullet V_{CC}^2 \bullet f_{in} + I_{CC} \bullet V_{CC}$.

NOISE CHARACTERISTICS (MC74VHC245)

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

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DC ELECTRICAL CHARACTERISTICS (MC74VHCT245A)

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.

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AC ELECTRICAL CHARACTERISTICS (MC74VHCT245A)

Symbol	Parameter	Test Conditions		T_A = 25°C Min	T_A = 25°C Typ	T_A = 25°C Max	T_A = – 40 to 85°C Min	T_A = – 40 to 85°C Max	Unit
t_{PLH}, t_{PHL}	Maximum Propagation Delay A to B or B to A	V_{CC} = 5.0 ± 0.5 V	C_L = 15 pF C_L = 50 pF		4.9 5.4	7.7 8.7	1.0 1.0	8.5 9.5	ns
t_{PZL}, t_{PZH}	Output Enable Time $\overline{OE}$ to A or B	V_{CC} = 5.0 ± 0.5 V	C_L = 15 pF C_L = 50 pF		9.4 9.9	13.8 14.8	1.0 1.0	15.0 16.0	ns
t_{PLZ}, t_{PHZ}	Output Disable Time $\overline{OE}$ to A or B	V_{CC} = 5.0 ± 0.5 V	C_L = 50 pF		10.1	15.4	1.0	16.5	ns
t_{OSLH}, t_{OSHL}	Output to Output Skew	V_{CC} = 5.0 ± 0.5 V (Note 8)	C_L = 50 pF			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)				13				pF

Symbol		Typical @ 25°C, V_{CC} = 5.0 V	Unit
C_{PD}	Power Dissipation Capacitance (Note 9)	16	pF

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: $I_{CC(OPR)} = C_{PD} \bullet V_{CC} \bullet f_{in} + I_{CC}/8$ (per bit). C_{PD} is used to determine the no–load dynamic power consumption; $P_D = C_{PD} \bullet V_{CC}^2 \bullet f_{in} + I_{CC} \bullet V_{CC}$.

NOISE CHARACTERISTICS (MC74VHCT245A)

Symbol	Parameter	T_A = 25°C Typ	T_A = 25°C Max	Unit
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

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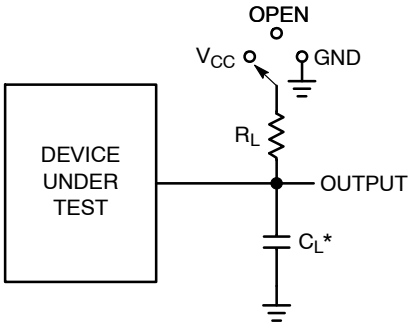

*C_L Includes probe and jig capacitance
Input signal $t_R = t_F = 3$ ns

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

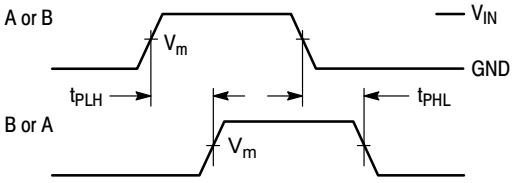

Figure 3.

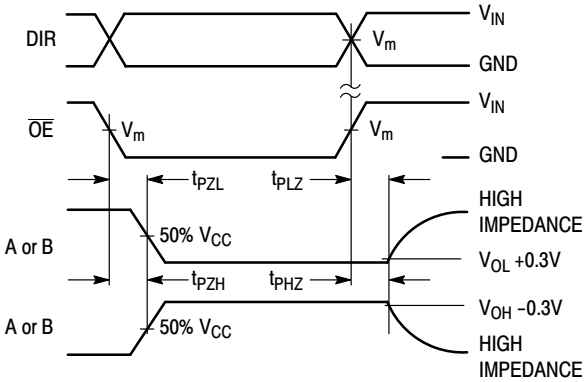

Figure 4.

Device	V_{IN}, V	V_m, V
MC74VHC245	V_{CC}	50% x V_{CC}
MC74VHCT245A	3 V	1.5 V

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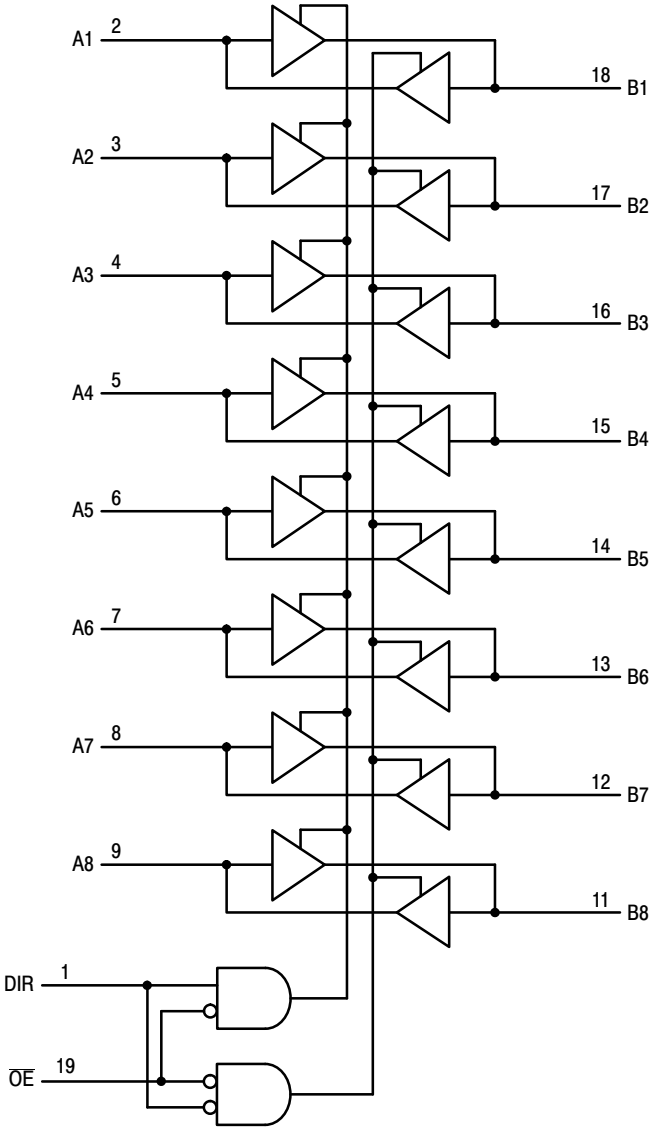

Figure 5. Expanded Logic Diagram

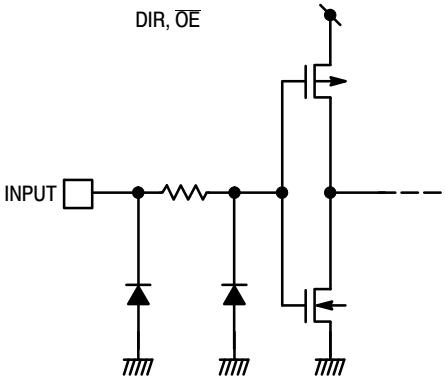

Figure 6. Input Equivalent Circuit

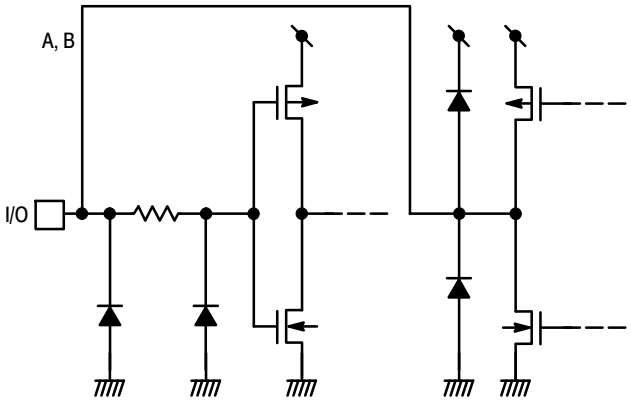

Figure 7. Bus Terminal Equivalent Circuit

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ORDERING INFORMATION

Device	Marking	Package	Shipping†
MC74VHC245DWG	VHC245G	SOIC−20 WB	38 Units / Rail
MC74VHC245DWR2G	VHC245G	SOIC−20 WB	2500 / Tape & Reel
MC74VHC245DTG	VHC 245	TSSOP−20	75 Units / Rail
MC74VHC245DTR2G	VHC 245	TSSOP−20	1000 / Tape & Reel
MC74VHCT245ADWG	VHCT245AG	SOIC−20 WB	38 Units / Rail
MC74VHCT245ADWR2G	VHCT245AG	SOIC−20 WB	2500 / Tape & Reel
MC74VHCT245ADTG	VHCT 245A	TSSOP−20	75 Units / Rail
MC74VHCT245ADTR2G	VHCT 245A	TSSOP−20	1000 / 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

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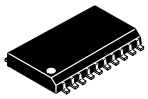
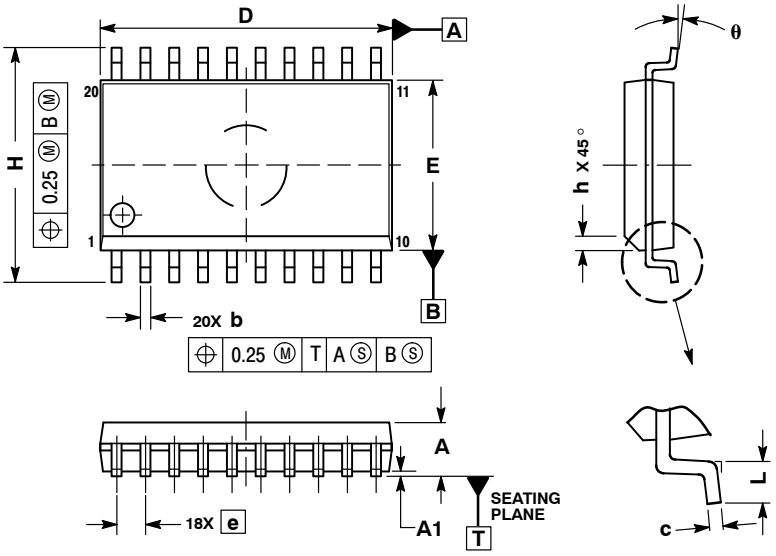
ISSUE H

DATE 22 APR 2015



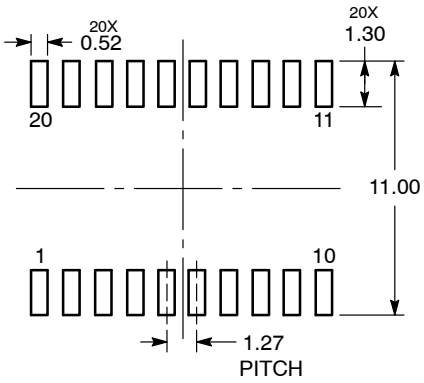
SCALE 1:1



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.

	MILLIMETERS	
DIM	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°

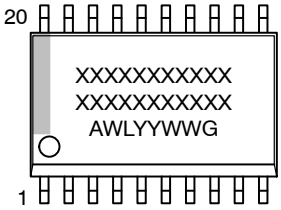
RECOMMENDED SOLDERING FOOTPRINT*



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.

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = 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.

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DESCRIPTION:	**SOIC−20 WB**		**PAGE 1 OF 1**

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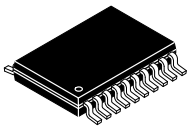
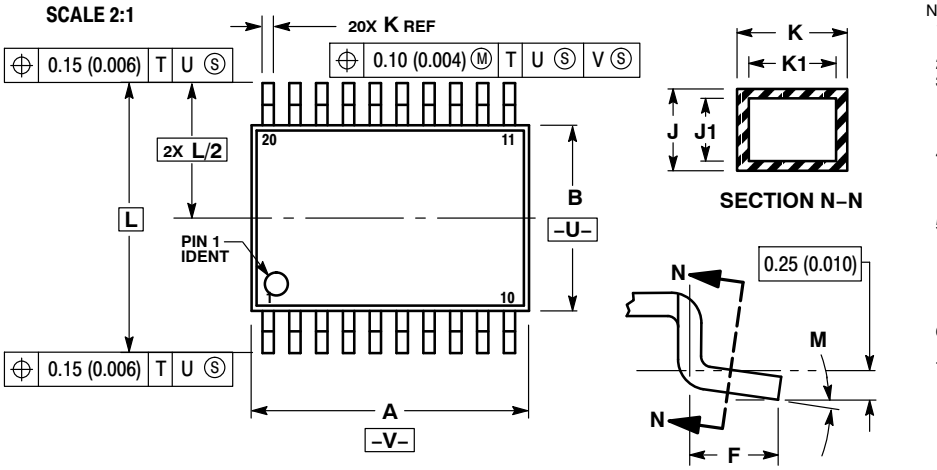
TSSOP–20 WB
CASE 948E
ISSUE D

DATE 17 FEB 2016

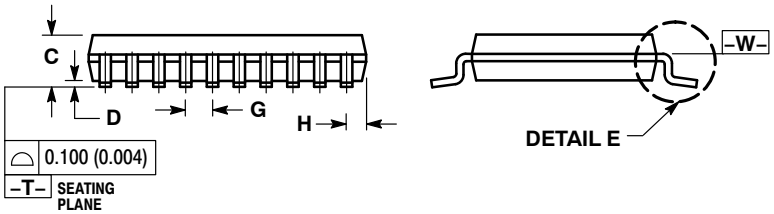


SCALE 2:1



SECTION N–N

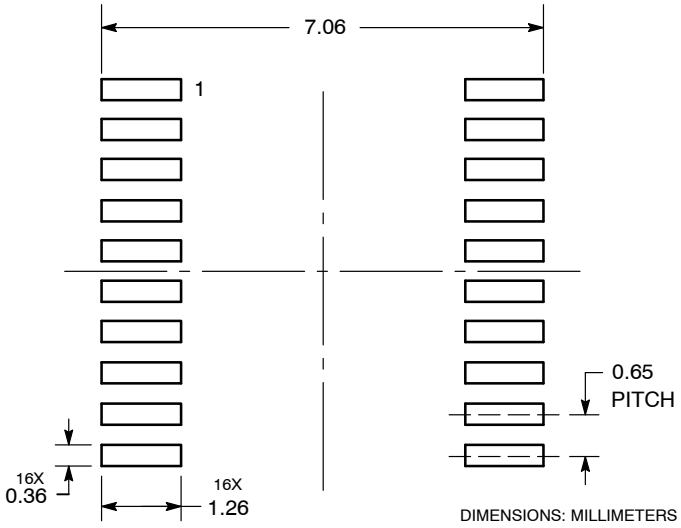
DETAIL E



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	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°

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

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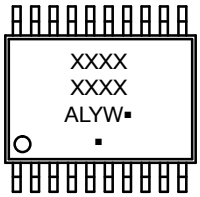
GENERIC MARKING DIAGRAM*



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. Some products may not follow the Generic Marking.

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