MC74VHCT374A

Octal D-Type Flip-Flop with 3-State Output

The MC74VHCT374A is an advanced high speed CMOS octal flip−flop with 3−state output fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

This 8−bit D−type flip−flop is controlled by a clock input and an output enable input. When the output enable input is high, the eight outputs are in a high impedance state.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output.

The VHCT inputs are compatible with TTL levels. This 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 VHCT374A input and output (when disabled) structures provide protection when voltages between 0 V and 5.5 V are applied, regardless of the supply voltage. These input and output structures help prevent device destruction caused by supply voltage−input/output voltage mismatch, battery backup, hot insertion, etc.

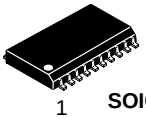
Features

- High Speed: f_{max} = 140 MHz (Typ) at V_{CC} = 5.0 V
- Low Power Dissipation: I_{CC} = 4 μA (Max) at T_A = 25°C
- TTL−Compatible Inputs: V_{IL} = 0.8 V; V_{IH} = 2.0 V
- Power Down Protection Provided on Inputs and Outputs
- Balanced Propagation Delays
- Designed for 4.5 V to 5.5 V Operating Range
- Low Noise: V_{OLP} = 1.6 V (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance:
  - Human Body Model > 2000 V;
  - Machine Model > 200 V
- Chip Complexity: 276 FETs or 69 Equivalent Gates
- These Devices are Pb−Free and are RoHS Compliant

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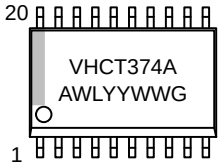
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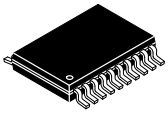
MARKING DIAGRAMS



1

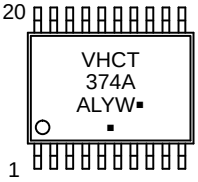
SOIC−20WB
SUFFIX DW
CASE 751D





1

TSSOP−20
SUFFIX DT
CASE 948E



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)

FUNCTION TABLE

INPUTS			OUTPUT
$\overline{OE}$	CP	D	Q
L	↑	H	H
L	↑	L	L
L	L, H, ↓	X	No Change
H	X	X	Z

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

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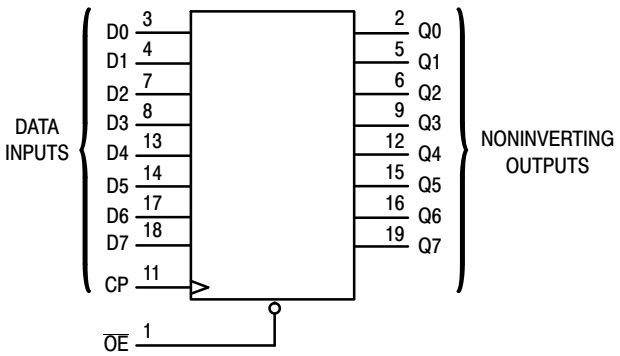


Figure 1. Logic Diagram

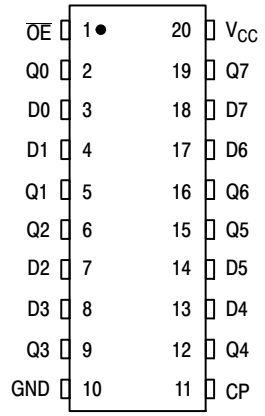


Figure 2. Pin Assignment

MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage	– 0.5 to + 7.0	V
V_{in}	DC Input Voltage	– 0.5 to + 7.0	V
V_{out}	DC Output Voltage Outputs in 3−State High or Low State	– 0.5 to + 7.0 – 0.5 to V_{CC} + 0.5	V
I_{IK}	Input Diode Current	− 20	mA
I_{OK}	Output Diode Current (V_{OUT} < GND; V_{OUT} > V_{CC})	± 20	mA
I_{out}	DC Output Current, per Pin	± 25	mA
I_{CC}	DC Supply Current, V_{CC} and GND Pins	± 75	mA
P_D	Power Dissipation in Still Air, SOIC Package† TSSOP Package†	500 450	mW
T_{stg}	Storage Temperature	– 65 to + 150	°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.

†Derating − SOIC Packages: – 7 mW/°C from 65° to 125°C
TSSOP Package: − 6.1 mW/°C from 65° 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 GND ≤ (V_{in} or V_{out}) ≤ V_{CC}.

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.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{CC}	DC Supply Voltage	4.5	5.5	V
V_{in}	DC Input Voltage	0	5.5	V
V_{out}	DC Output Voltage Outputs in 3−State High or Low State	0 0	5.5 V_{CC}	V
T_A	Operating Temperature	− 40	+ 85	°C
t_r, t_f	Input Rise and Fall Time V_{CC} =5.0V ±0.5V	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.

DC ELECTRICAL CHARACTERISTICS

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} = − 50μA	4.5	4.4	4.5		4.4		V
		I_{OH} = − 8mA	4.5	3.94			3.80		
V_{OL}	Maximum Low−Level Output Voltage V_{in} = V_{IH} or V_{IL}	I_{OL} = 50μA	4.5		0.0	0.1		0.1	V
		I_{OL} = 8mA	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} = 3.4V Other Input: V_{CC} or GND	5.5			1.35		1.50	mA
I_{OPD}	Output Leakage Current	V_{OUT} = 5.5V	0			0.5		5.0	μA

AC ELECTRICAL CHARACTERISTICS (Input t_r = t_f = 3.0ns)

Symbol	Parameter	Test Conditions	T_A = 25°C			T_A = − 40 to 85°C		Unit
			Min	Typ	Max	Min	Max	
f_{max}	Maximum Clock Frequency (50% Duty Cycle)	V_{CC} = 5.0 ± 0.5V C_L = 15pF C_L = 50pF	90 85	140 130		80 95		MHz
t_{PLH}, t_{PHL}	Maximum Propagation Delay, CP to Q	V_{CC} = 5.0 ± 0.5V C_L = 15pF C_L = 50pF		4.1 5.6	9.4 10.4	1.0 1.0	10.5 11.5	ns
t_{PZL}, t_{PZH}	Output Enable Time, $\overline{OE}$ to Q	V_{CC} = 5.0 ± 0.5V C_L = 15pF R_L = 1kΩ C_L = 50pF		6.5 7.3	10.2 11.2	1.0 1.0	11.5 12.5	ns
t_{PLZ}, t_{PHZ}	Output Disable Time $\overline{OE}$ to Q	V_{CC} = 5.0 ± 0.5V C_L = 50pF R_L = 1kΩ		7.0	11.2	1.0	12.0	ns
t_{OSLH}, t_{OSHL}	Output to Output Skew	V_{CC} = 5.0 ± 0.5V C_L = 50pF (Note 1)			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

		Typical @ 25°C, V_{CC} = 5.0V	
C_{PD}	Power Dissipation Capacitance (Note 2)	25	pF

1. Parameter guaranteed by design. t_{OSLH} = $|t_{PLHm} - t_{PLHn}|$, t_{OSHL} = $|t_{PHLm} - t_{PHLn}|$.
2. 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 flip−flop). 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 (Input t_r = t_f = 3.0ns, C_L = 50pF, V_{CC} = 5.0V)

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

TIMING REQUIREMENTS (Input t_r = t_f = 3.0ns)

Symbol	Parameter	Test Conditions	T_A = 25°C		T_A = − 40 to 85°C	Unit
			Typ	Limit	Limit	
t_w	Minimum Pulse Width, CP	V_{CC} = 5.0 ± 0.5 V		6.5	8.5	ns
t_{su}	Minimum Setup Time, D to CP	V_{CC} = 5.0 ± 0.5 V		2.5	2.5	ns
t_h	Minimum Hold Time, D to CP	V_{CC} = 5.0 ± 0.5 V		2.5	2.5	ns

ORDERING INFORMATION

Device	Package	Shipping†
MC74VHCT374ADWRG	SOIC−20WB (Pb−Free)	1000 / Tape & Reel
MC74VHCT374ADTRG	TSSOP−20 (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.

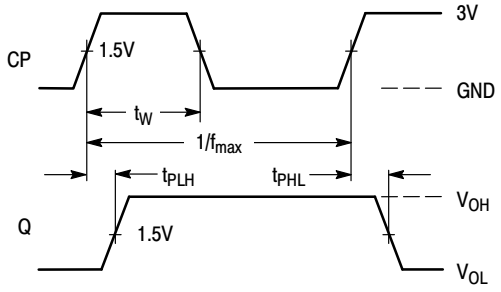


Figure 3. Switching Waveform

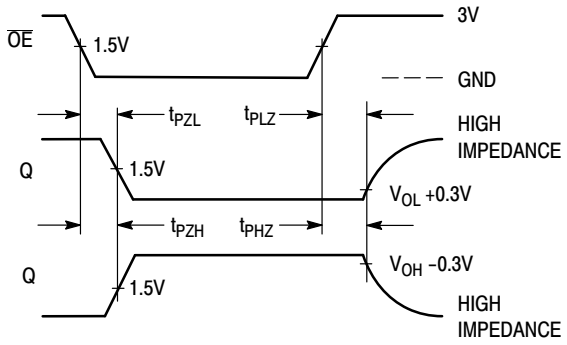


Figure 4. Switching Waveform

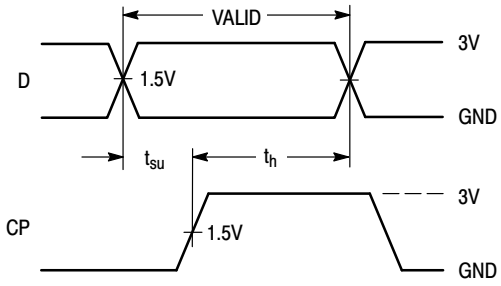
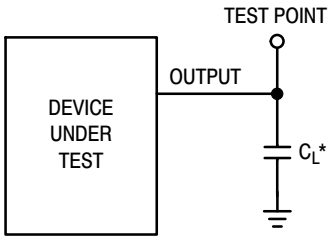
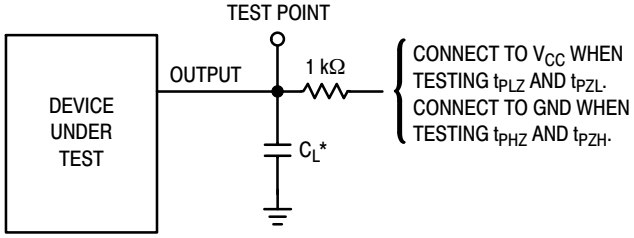


Figure 5. Switching Waveform



*Includes all probe and jig capacitance

Figure 6. Test Circuit



*Includes all probe and jig capacitance

Figure 7. Test Circuit

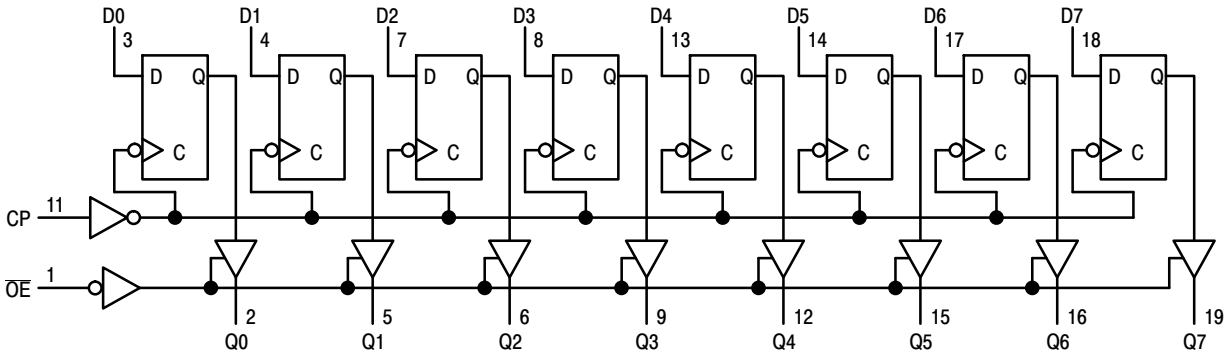
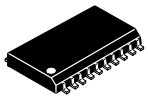


Figure 8. Expanded Logic Diagram

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

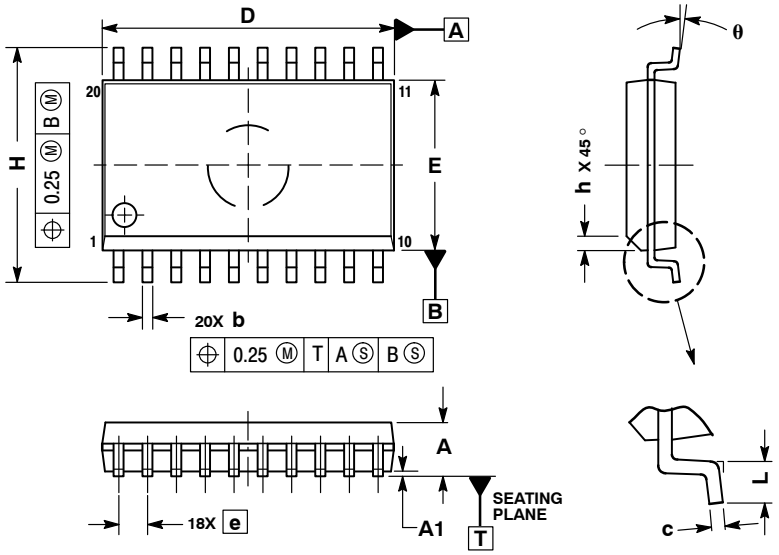
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SOIC−20 WB
CASE 751D−05
ISSUE H

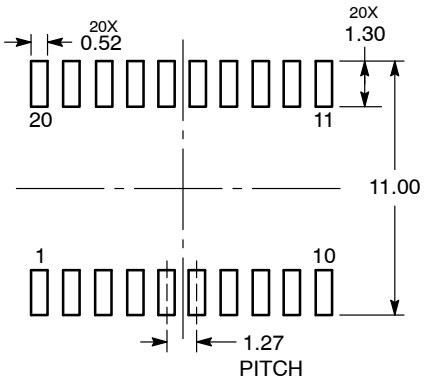
DATE 22 APR 2015



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.

	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°

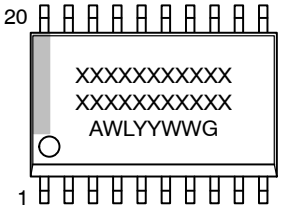
RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor 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.

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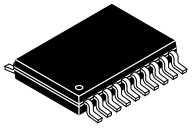
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MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

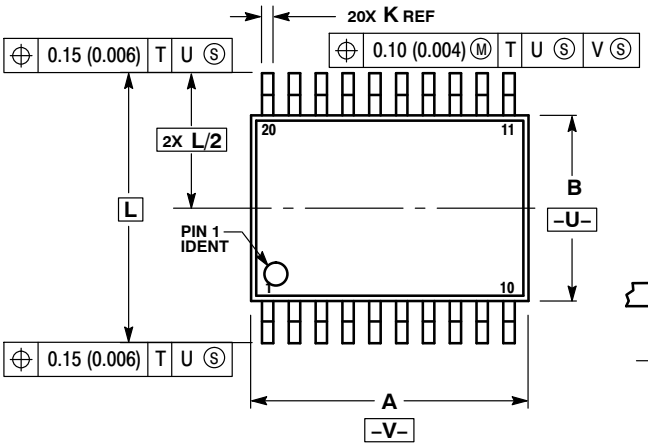
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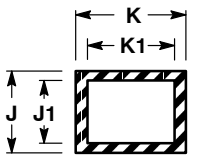
TSSOP−20 WB
CASE 948E
ISSUE D

DATE 17 FEB 2016

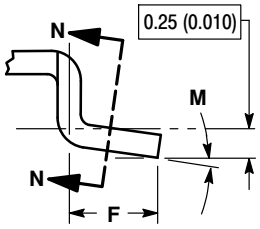


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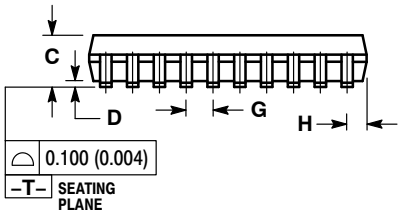


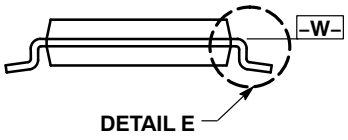


SECTION N−N



DETAIL E

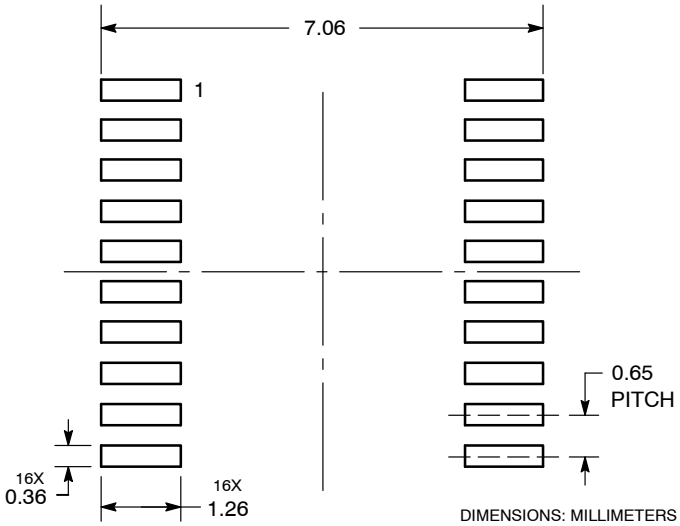




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD 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−.

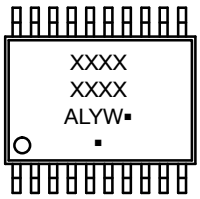
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DIM	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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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