MC100EP40

3.3V / 5V ECL Differential Phase-Frequency Detector



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Description

The MC100EP40 is a three−state phase−frequency detector intended for phase−locked loop applications which require a minimum amount of phase and frequency difference at lock. Advanced design significantly reduces the dead zone of the detector. For proper operation, the input edge rate of the R and V inputs should be less than 5 ns. The device is designed to work with a 3.3 V / 5 V power supply.

When Reference (R) and Feedback (FB) inputs are unequal in frequency and/or phase the differential UP (U) and DOWN (D) outputs will provide pulse streams which when subtracted and integrated provide an error voltage for control of a VCO.

When Reference (R) and Feedback (FB) inputs are 80 ps or less in phase difference, the Phase Lock Detect pin will indicate lock by a high state (V_{OH}). The V_{TX} (V_{TR}, $\overline{V_{TR}}$, V_{TFB}, $\overline{V_{TFB}}$) pins offer an internal termination network for 50 Ω line impedance environment shown in Figure 2. An external sinking supply of V_{CC}−2 V is required on V_{TX} pin(s). If you short the two differential pins V_{TR} and $\overline{V_{TR}}$ (or V_{TFB} and $\overline{V_{TFB}}$) together, you provide a 100 Ω termination resistance. For more information on termination of logic devices, see AND8020.

The V_{BB} pin, an internally generated voltage supply, is available to this device only. For single-ended input conditions, the unused differential input is connected to V_{BB} as a switching reference voltage. V_{BB} may also rebias AC coupled inputs. When used, decouple V_{BB} and V_{CC} via a 0.01 μF capacitor and limit current sourcing or sinking to 0.5 mA. When not used, V_{BB} should be left open.

For more information on Phase Lock Loop operation, refer to AND8040.

Special considerations are required for differential inputs under No Signal conditions to prevent instability.

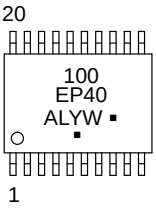
Features

- Maximum Frequency > 2 GHz Typical
- Fully Differential
- Advanced High Band Output Swing of 400 mV
- Theoretical Gain = 1.11
- T_{rise} 97 ps Typical, F_{fall} 70 ps Typical
- The 100 Series Contains Temperature Compensation
- PECL Mode Operating Range: V_{CC} = 3.0 V to 5.5 V with V_{EE} = 0 V
- NECL Mode Operating Range: V_{CC} = 0 V with V_{EE} = −3.0 V to −5.5 V
- 50 Ω Internal Termination Resistor
- These are Pb−Free Devices



TSSOP−20
DT SUFFIX
CASE 948E

MARKING DIAGRAM*



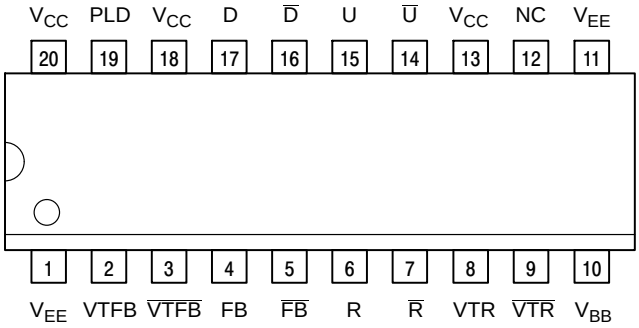
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)
*For additional marking information, refer to Application Note AND8002/D.

ORDERING INFORMATION

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

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Warning: All V_{CC} and V_{EE} pins must be externally connected to Power Supply to guarantee proper operation.

Figure 1. 20−Lead Pinout (Top View)

Table 1. PIN DESCRIPTION

PIN	FUNCTION
U, $\overline{U}$	ECL Up Differential Outputs
D, $\overline{D}$	ECL Down Differential Outputs
FB, $\overline{FB}$	ECL Feedback Differential Inputs
R, $\overline{R}$	ECL Reference Differential Inputs
PLD	ECL Phase Lock Detect Function
VTR	ECL Internal Termination for R
$\overline{VTR}$	ECL Internal Termination for $\overline{R}$
VTFB	ECL Internal Termination for FB
$\overline{VTFB}$	ECL Internal Termination for $\overline{FB}$
V_{BB}	Reference Voltage Output
V_{CC}	Positive Supply
V_{EE}	Negative Supply
NC	No Connect

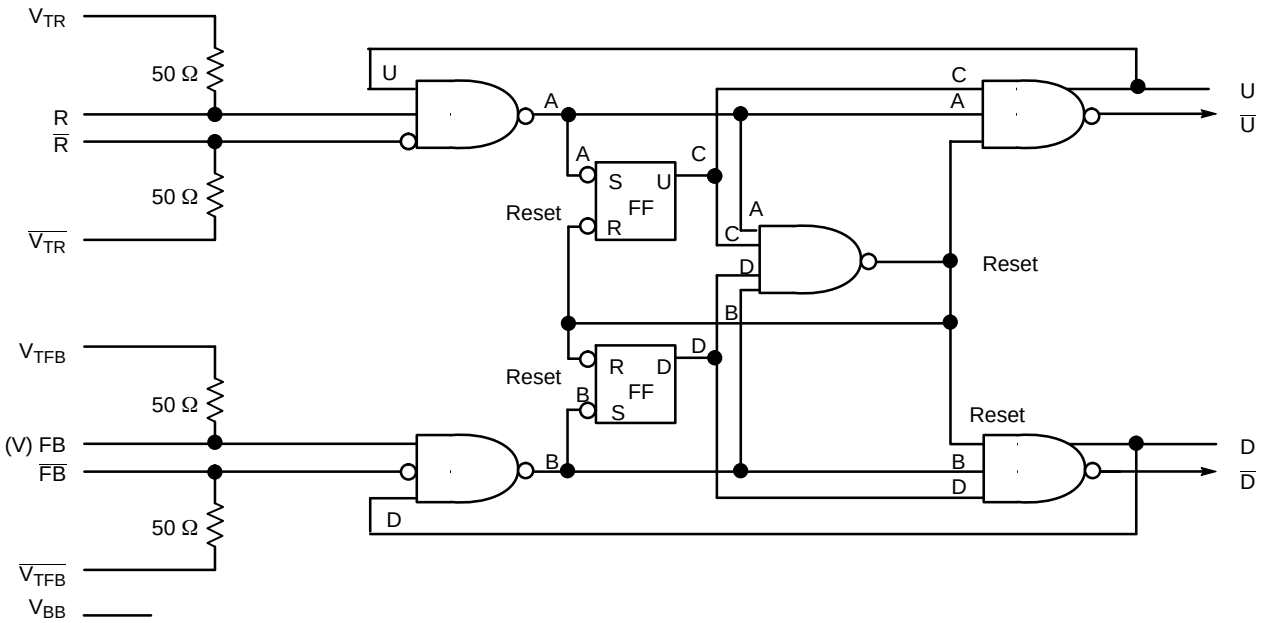


Figure 2. Logic Diagram

Table 2. ATTRIBUTES

Characteristics		Value	
Internal Input Pulldown Resistor		N/A	
Internal Input Pullup Resistor		N/A	
ESD Protection	Human Body Model Machine Model Charged Device Model	> 4 kV > 100 V > 2 kV	
Moisture Sensitivity, Indefinite Time Out of Drypack (Note 1)		Pb Pkg	Pb−Free Pkg
	TSSOP−20	Level 1	Level 3
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V−0 @ 0.125 in	
Transistor Count		699 Devices	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test			

1. For additional information, see Application Note AND8003/D.

Table 3. MAXIMUM RATINGS

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V_{CC}	PECL Mode Power Supply	V_{EE} = 0 V		6	V
V_{EE}	NECL Mode Power Supply	V_{CC} = 0 V		−6	V
V_I	PECL Mode Input Voltage NECL Mode Input Voltage	V_{EE} = 0 V V_{CC} = 0 V	$V_I \le V_{CC}$ $V_I \ge V_{EE}$	6 −6	V V
I_{out}	Output Current	Continuous Surge		50 100	mA mA
I_{BB}	V_{BB} Sink/Source			± 0.5	mA
T_A	Operating Temperature Range			−40 to +85	°C
T_{stg}	Storage Temperature Range			−65 to +150	°C
θ_{JA}	Thermal Resistance (Junction−to−Ambient)	0 lfpm 500 lfpm	TSSOP−20 TSSOP−20	140 100	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction−to−Case)	Standard Board	TSSOP−20	23 to 41	°C/W
T_{sol}	Wave Solder Pb Pb−Free			265 265	°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.

Table 4. 100EP DC CHARACTERISTICS, PECL V_{CC} = 3.3 V, V_{EE} = 0 V (Note 2)

		−40°C			25°C			85°C			
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
I_{EE}	Power Supply Current	100	128	160	100	130	160	110	140	170	mA
V_{OH}	Output HIGH Voltage (Note 3)	2225	2350	2475	2275	2400	2525	2300	2425	2550	mV
V_{OL}	Output LOW Voltage (Note 3) U, $\overline{U}$, B, $\overline{B}$ PLD	1775 1305	1900 1480	2025 1605	1800 1305	1925 1480	2050 1605	1825 1305	1950 1480	2075 1605	mV
V_{IH}	Input HIGH Voltage (Single−Ended)	2075		2420	2075		2420	2075		2420	mV
V_{IL}	Input LOW Voltage (Single−Ended)	1305		1675	1305		1675	1305		1675	mV
V_{BB}	Output Voltage Reference	1775	1875	1975	1775	1875	1975	1775	1875	1975	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 4)	2.0		3.3	2.0		3.3	2.0		3.3	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	−150			−150			−150			μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

2. Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to −2.2 V.
3. All loading with 50 Ω to V_{CC} − 2.0 V.
4. V_{IHCMR} min varies 1:1 with V_{EE}, V_{IHCMR} max varies 1:1 with V_{CC}. The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 5. 100EP DC CHARACTERISTICS, PECL V_{CC} = 5.0 V, V_{EE} = 0 V (Note 5)

		−40°C			25°C			85°C			
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
I_{EE}	Power Supply Current (Note 6)	100	128	160	100	130	160	110	140	170	mA
V_{OH}	Output HIGH Voltage (Note 7)	3925	4050	4175	3975	4100	4225	4000	4125	4250	mV
V_{OL}	Output LOW Voltage (Note 7) U, $\overline{U}$, B, $\overline{B}$ PLD	3475 3005	3600 3180	3725 3305	3500 3005	3625 3180	3750 3305	3525 3005	3650 3180	3775 3305	mV
V_{IH}	Input HIGH Voltage (Single−Ended)	3775		4120	3775		4120	3775		4120	mV
V_{IL}	Input LOW Voltage (Single−Ended)	3005		3375	3005		3375	3005		3375	mV
V_{BB}	Output Voltage Reference	3475	3575	3675	3475	3575	3675	3475	3575	3675	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 8)	2.0		5.0	2.0		5.0	2.0		5.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	−150			−150			−150			μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

5. Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to −2.2 V.
6. For (V_{CC} − V_{EE}) > 3.3 V, 5 Ω to 10 Ω in line with V_{EE} required for maximum thermal protection at elevated temperatures. Recommend V_{CC}−V_{EE} operation at $\leq$ 3.3 V.
7. All loading with 50 Ω to V_{CC} − 2.0 V.
8. V_{IHCMR} min varies 1:1 with V_{EE}, V_{IHCMR} max varies 1:1 with V_{CC}. The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 6. 100EP DC CHARACTERISTICS, NECL V_{CC} = 0 V; V_{EE} = −5.5 V to −3.0 V (Note 9)

		−40°C			25°C			85°C			
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
I_{EE}	Power Supply Current (Note 10)	100	128	160	100	130	160	110	140	170	mA
V_{OH}	Output HIGH Voltage (Note 11)	−1075	−950	−825	−1025	−900	−775	−1000	−875	−750	mV
V_{OL}	Output LOW Voltage (Note 11) U, $\overline{U}$, B, $\overline{B}$ PLD	 −1525 −1995	 −1400 −1820	 −1275 −1695	 −1500 −1995	 −1375 −1820	 −1250 −1695	 −1475 −1995	 −1350 −1820	 −1225 −1695	mV
V_{IH}	Input HIGH Voltage (Single−Ended)	−1225		−880	−1225		−880	−1225		−880	mV
V_{IL}	Input LOW Voltage (Single−Ended)	−1995		−1625	−1995		−1625	−1995		−1625	mV
V_{BB}	Output Voltage Reference	−1525	−1425	−1325	−1525	−1425	−1325	−1525	−1425	−1325	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 12)	V_{EE} + 2.0		0.0	V_{EE} + 2.0		0.0	V_{EE} + 2.0		0.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	−150			−150			−150			μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

9. Input and output parameters vary 1:1 with V_{CC}.
10. For (V_{CC} − V_{EE}) > 3.3 V, 5 Ω to 10 Ω in line with V_{EE} required for maximum thermal protection at elevated temperatures. Recommend V_{CC}–V_{EE} operation at $\leq$ 3.3 V.
11. All loading with 50 Ω to V_{CC} − 2.0 V.
12. V_{IHCMR} min varies 1:1 with V_{EE}, V_{IHCMR} max varies 1:1 with V_{CC}. The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 7. AC CHARACTERISTICS V_{CC} = 0 V; V_{EE} = −3.0 V to −5.5 V or V_{CC} = 3.0 V to 5.5 V; V_{EE} = 0 V (Note 13)

		−40°C			25°C			85°C			
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
f_{max}	Maximum Frequency (Figure 3)		> 2			> 2			> 2		GHz
t_{PLH}, t_{PHL}	Propagation Delay to Output Differential FB to D/U R to D/U	400	525	700	410	550	750	450	575	775	ps
t_{JITTER}	Random Clock Jitter (Figure 3)		0.2	< 1		0.2	< 1		0.2	< 1	ps
V_{PP}	Input Voltage Swing (Differential Configuration)	150	800	1200	150	800	1200	150	800	1200	mV
t_r t_f	Output Rise/Fall Times Q, $\overline{Q}$ (20% − 80%)	60	85	130	60	110	150	80	120	160	ps

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

13. Measured using a 750 mV source, 50% duty cycle clock source. All loading with 50 Ω to V_{CC} − 2.0 V.

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.

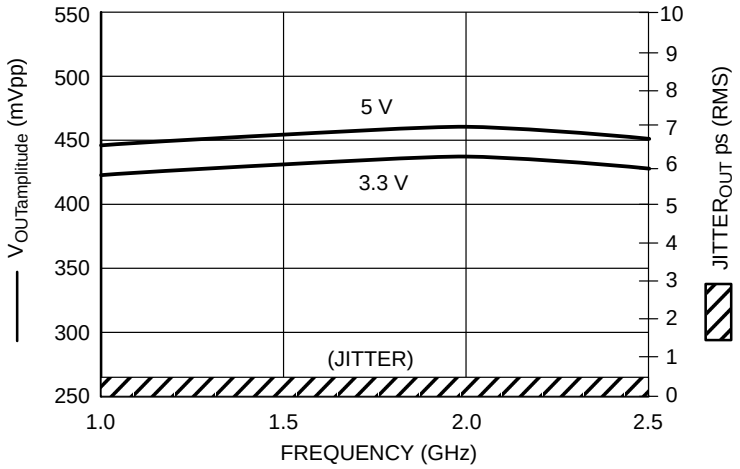


Figure 3. F_{max}/Jitter @ 25°C

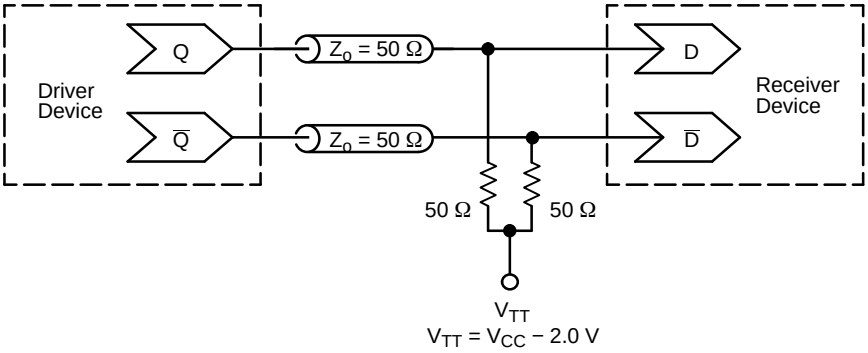


Figure 4. Typical Termination for Output Driver and Device Evaluation
(See Application Note AND8020/D − Termination of ECL Logic Devices.)

ORDERING INFORMATION

Device	Package	Shipping†
MC100EP40DTG	TSSOP−20*	75 Units / Rail
MC100EP40DTR2G	TSSOP−20*	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.
*This package is inherently Pb−Free.

Resource Reference of Application Notes

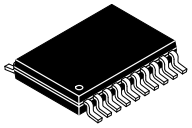
AN1405/D − ECL Clock Distribution Techniques
AN1406/D − Designing with PECL (ECL at +5.0 V)
AN1503/D − ECLinPS™ I/O SPiCE Modeling Kit
AN1504/D − Metastability and the ECLinPS Family
AN1568/D − Interfacing Between LVDS and ECL
AN1672/D − The ECL Translator Guide
AND8001/D − Odd Number Counters Design
AND8002/D − Marking and Date Codes
AND8020/D − Termination of ECL Logic Devices
AND8066/D − Interfacing with ECLinPS
AND8090/D − AC Characteristics of ECL Devices

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

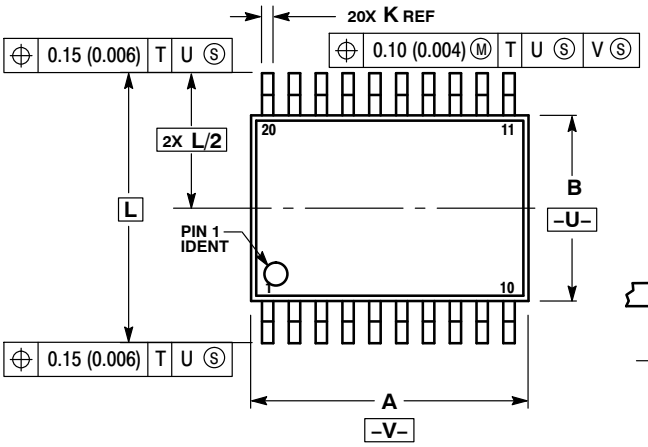
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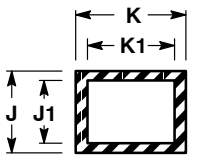
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CASE 948E
ISSUE D

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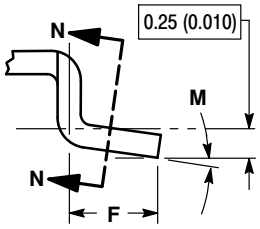


SCALE 2:1

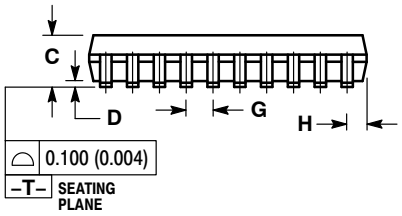


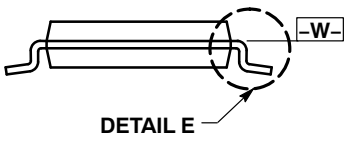


SECTION N−N



DETAIL E

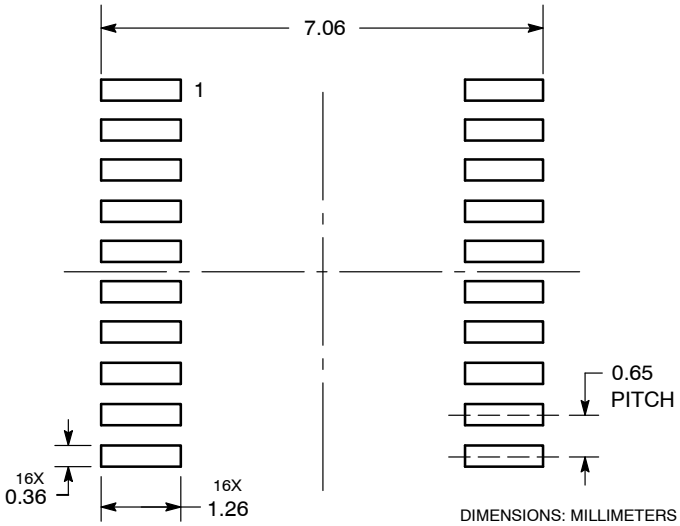




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD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

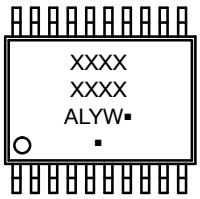
	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010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

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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