

# 3.3V / 5V ECL Differential Phase-Frequency Detector

## MC100EP40

### 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  $\Omega$  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  $\Omega$  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  $\mu$ F capacitor and limit current sourcing or sinking to 0.5 mA. When not used,  $V_{BB}$  should be left open.

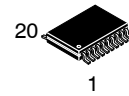
For more information on Phase Lock Loop operation, refer to AND8040.

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

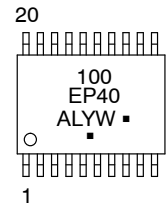
### Features

- 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  $\Omega$  Internal Termination Resistor
- These are Pb-Free Devices

### MARKING DIAGRAM\*



TSSOP-20  
DT SUFFIX  
CASE 948E



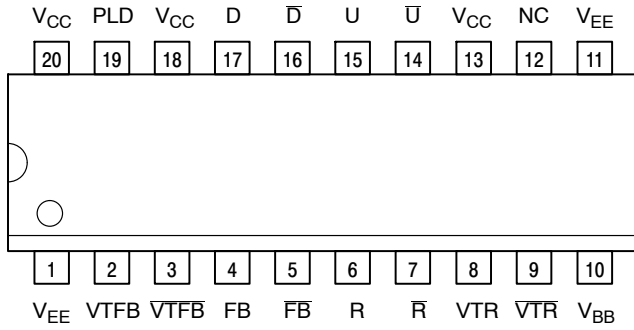
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(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 on page 6 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, $\bar{U}$	ECL Up Differential Outputs
D, $\bar{D}$	ECL Down Differential Outputs
FB, $\bar{FB}$	ECL Feedback Differential Inputs
R, $\bar{R}$	ECL Reference Differential Inputs
PLD	ECL Phase Lock Detect Function
VTR	ECL Internal Termination for R
$\bar{VTR}$	ECL Internal Termination for $\bar{R}$
VTFB	ECL Internal Termination for FB
$\bar{VTFB}$	ECL Internal Termination for $\bar{FB}$
$V_{BB}$	Reference Voltage Output
$V_{CC}$	Positive Supply
$V_{EE}$	Negative Supply
NC	No Connect

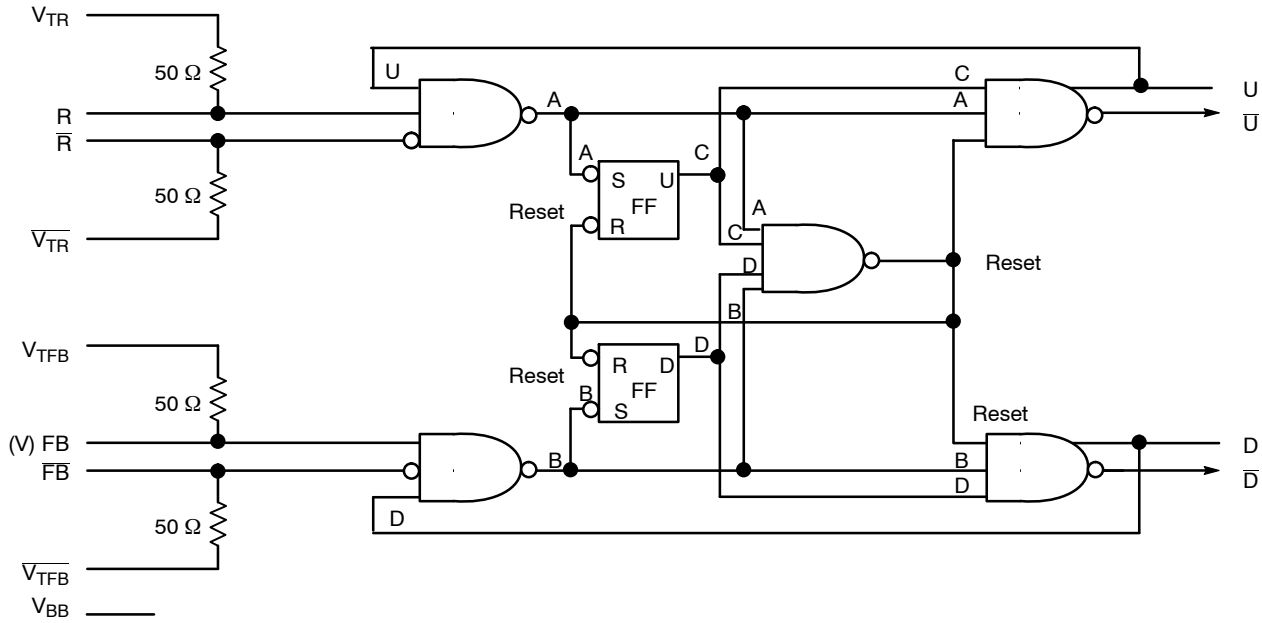


Figure 2. Logic Diagram

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**Table 2. ATTRIBUTES**

Characteristics	Value	
Internal Input Pulldown Resistor	N/A	
Internal Input Pullup Resistor	N/A	
ESD Protection	Human Body Model	> 4 kV
	Machine Model	> 100 V
	Charged Device Model	> 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 <sub>CC</sub>	PECL Mode Power Supply	V <sub>EE</sub> = 0 V		6	V
V <sub>EE</sub>	NECL Mode Power Supply	V <sub>CC</sub> = 0 V		-6	V
V <sub>I</sub>	PECL Mode Input Voltage	V <sub>EE</sub> = 0 V	V <sub>I</sub> ≤ V <sub>CC</sub>	6	V
	NECL Mode Input Voltage	V <sub>CC</sub> = 0 V	V <sub>I</sub> ≥ V <sub>EE</sub>	-6	V
I <sub>out</sub>	Output Current	Continuous Surge		50	mA
				100	mA
I <sub>BB</sub>	V <sub>BB</sub> Sink/Source			± 0.5	mA
T <sub>A</sub>	Operating Temperature Range			-40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range			-65 to +150	°C
θ <sub>JA</sub>	Thermal Resistance (Junction-to-Ambient)	0 lfpm	TSSOP-20	140	°C/W
		500 lfpm	TSSOP-20	100	°C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case)	Standard Board	TSSOP-20	23 to 41	°C/W
T <sub>sol</sub>	Wave Solder			265	°C
	Pb-Free			265	

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.

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

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	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, $\bar{U}$ , B, $\bar{B}$ 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	$\mu\text{A}$
$I_{IL}$	Input LOW Current	-150			-150			-150			$\mu\text{A}$

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 lfm.

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  $\Omega$  to  $V_{CC} - 2.0\text{ V}$ .

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**  $V_{CC} = 5.0\text{ V}$ ,  $V_{EE} = 0\text{ V}$  (Note 5)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	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, $\bar{U}$ , B, $\bar{B}$ 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	$\mu\text{A}$
$I_{IL}$	Input LOW Current	-150			-150			-150			$\mu\text{A}$

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 lfm.

5. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +0.3 V to -2.2 V.

6. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ , 5  $\Omega$  to 10  $\Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC} - V_{EE}$  operation at  $\leq 3.3\text{ V}$ .

7. All loading with 50  $\Omega$  to  $V_{CC} - 2.0\text{ V}$ .

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.

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

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	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, $\bar{U}$ , B, $\bar{B}$ 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	$\mu\text{A}$
$I_{IL}$	Input LOW Current	-150			-150			-150			$\mu\text{A}$

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 lpm.

9. Input and output parameters vary 1:1 with  $V_{CC}$ .

10. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ ,  $5\ \Omega$  to  $10\ \Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC}-V_{EE}$  operation at  $\leq 3.3\text{ V}$ .

11. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ .

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**  $V_{CC} = 0\text{ V}$ ;  $V_{EE} = -3.0\text{ V}$  to  $-5.5\text{ V}$  or  $V_{CC} = 3.0\text{ V}$  to  $5.5\text{ V}$ ;  $V_{EE} = 0\text{ V}$  (Note 13)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{max}$	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, $\bar{Q}$ (20% – 80%)	60	85	130	60	110	150	80	120	160	ps

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.

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 lpm.

13. Measured using a 750 mV source, 50% duty cycle clock source. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ .

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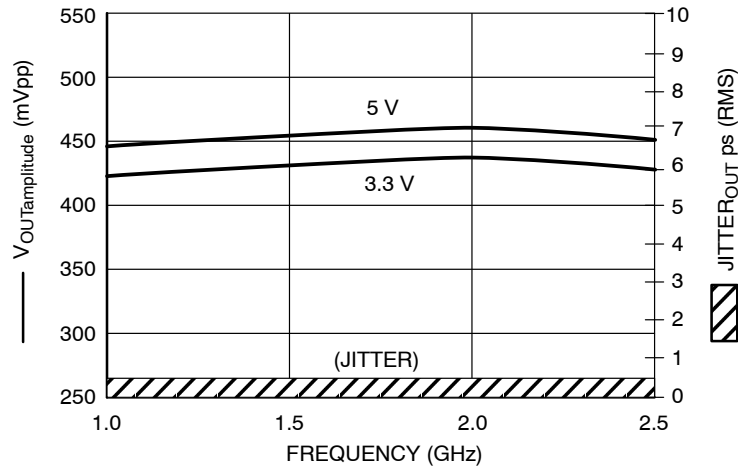


Figure 3. F<sub>max</sub>/Jitter @ 25°C

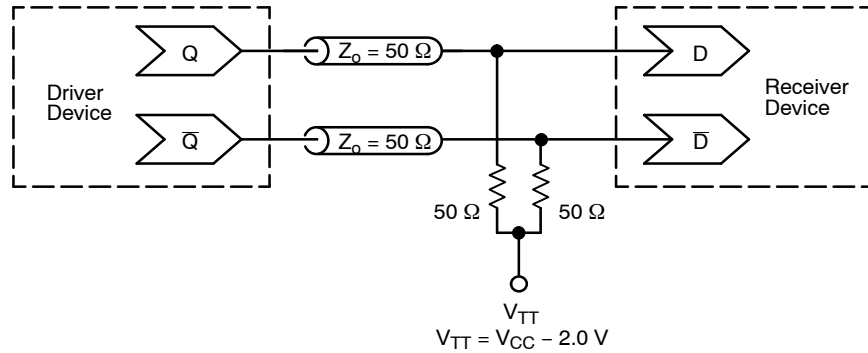


Figure 4. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
MC100EP40DTG	TSSOP-20*	75 Units / Rail
MC100EP40DTR2G	TSSOP-20*	2500 / Tape & Reel

<sup>†</sup>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.

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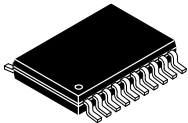
## Resource Reference of Application Notes

- 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

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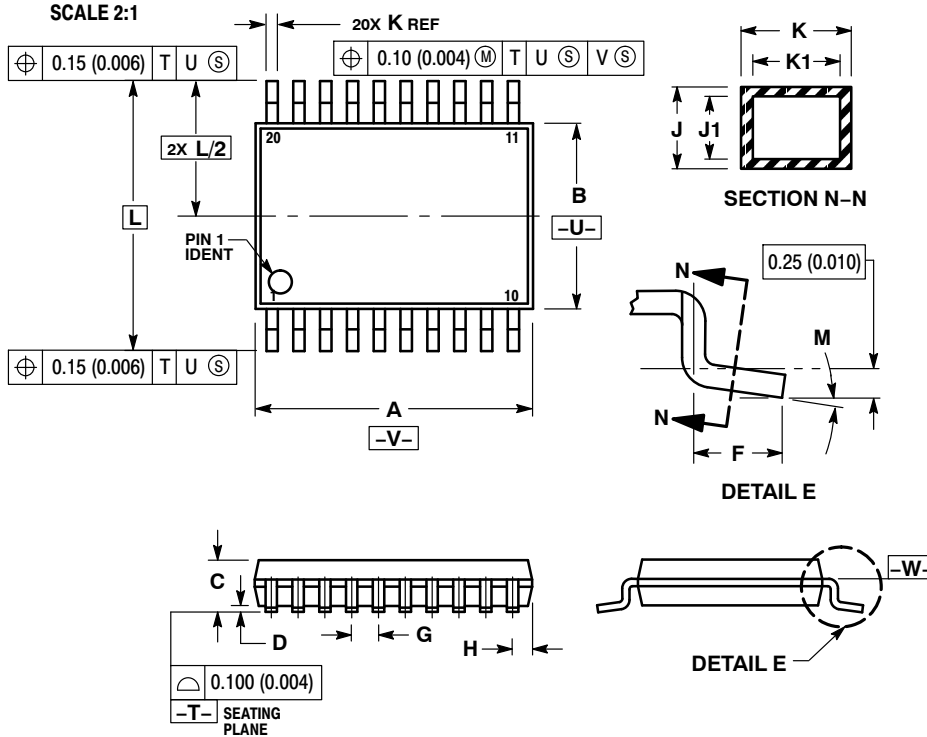
# MC100EP40

## PACKAGE DIMENSIONS



TSSOP-20 WB  
CASE 948E  
ISSUE D

DATE 17 FEB 2016

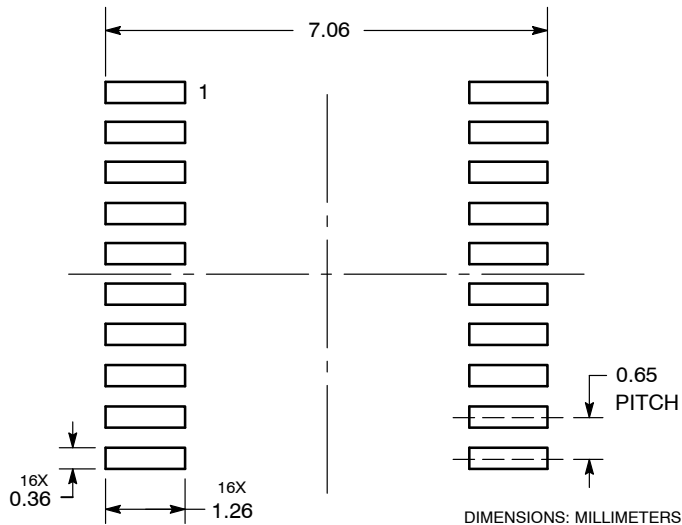


NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- 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.
- DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
- 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.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
- DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

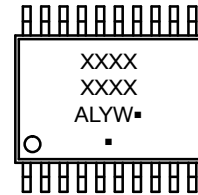
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010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

### RECOMMENDED SOLDERING FOOTPRINT\*



\*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\*



- 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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