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MC14040B

12-Bit Binary Counter

The MC14040B 12−stage binary counter is constructed with MOS P−Channel and N−Channel enhancement mode devices in a single monolithic structure. This part is designed with an input wave shaping circuit and 12 stages of ripple−carry binary counter. The device advances the count on the negative−going edge of the clock pulse. Applications include time delay circuits, counter controls, and frequency−driving circuits.

Features

- Fully Static Operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low−power TTL Loads or One Low−power Schottky TTL Load Over the Rated Temperature Range
- Common Reset Line
- Pin−for−Pin Replacement for CD4040B
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free and are RoHS Compliant

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	−0.5 to +18.0	V
V_{in}, V_{out}	Input or Output Voltage Range (DC or Transient)	−0.5 to V_{DD} + 0.5	V
I_{in}, I_{out}	Input or Output Current (DC or Transient) per Pin	±10	mA
P_D	Power Dissipation, per Package (Note 1)	500	mW
T_A	Ambient Temperature Range	−55 to +125	°C
T_{stg}	Storage Temperature Range	−65 to +150	°C
T_L	Lead Temperature (8−Second Soldering)	260	°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.
1. Temperature Derating: "D/DW" Packages: −7.0 mW/°C From 65°C 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 $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

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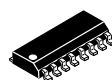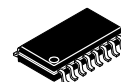
SOIC−16	SOEIAJ−16	TSSOP−16
D SUFFIX	F SUFFIX	DT SUFFIX
CASE 751B	CASE 966	CASE 948F

PIN ASSIGNMENT

Q12	1●	16	V_{DD}
Q6	2	15	Q11
Q5	3	14	Q10
Q7	4	13	Q8
Q4	5	12	Q9
Q3	6	11	R
Q2	7	10	C
V_{SS}	8	9	Q1

MARKING DIAGRAMS

```
16
14040BG
AWLYWW
1
```
SOIC−16

```
16
MC14040B
ALYWG
1
```
SOEIAJ−16
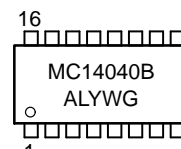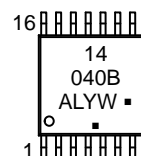
```
16
14
040B
ALYW ■
1
```
TSSOP−16

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)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

MC14040B

TRUTH TABLE

Clock	Reset	Output State
⌐	0	No Change
⌐	0	Advance to next state
X	1	All Outputs are low

X = Don't Care

LOGIC DIAGRAM

Q4 = PIN 5 Q7 = PIN 4 V_{DD} = PIN 16
Q5 = PIN 3 Q8 = PIN 13 V_{SS} = PIN 8
Q6 = PIN 2 Q9 = PIN 12

ORDERING INFORMATION

Device	Package	Shipping†
MC14040BDG	SOIC−16 (Pb−Free)	48 Units / Rail
NLV14040BDG*	SOIC−16 (Pb−Free)	48 Units / Rail
MC14040BDR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
NLV14040BDR2G*	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
MC14040BDTR2G	TSSOP−16 (Pb−Free)	2500 Units / Tape & Reel
NLV14040BDTR2G*	TSSOP−16 (Pb−Free)	2500 Units / Tape & Reel
MC14040BFELG	SOEIAJ−16 (Pb−Free)	2000 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.
*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

MC14040B

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V_{DD} Vdc	−55°C Min	−55°C Max	25°C Min	25°C Typ (Note 2)	25°C Max	125°C Min	125°C Max	Unit
Output Voltage "0" Level V_{in} = V_{DD} or 0	V_{OL}	5.0	–	0.05	–	0	0.05	–	0.05	Vdc
		10	–	0.05	–	0	0.05	–	0.05	
		15	–	0.05	–	0	0.05	–	0.05	
"1" Level V_{in} = 0 or V_{DD}	V_{OH}	5.0	4.95	–	4.95	5.0	–	4.95	–	Vdc
		10	9.95	–	9.95	10	–	9.95	–	
		15	14.95	–	14.95	15	–	14.95	–	
Input Voltage "0" Level (V_O = 4.5 or 0.5 Vdc) (V_O = 9.0 or 1.0 Vdc) (V_O = 13.5 or 1.5 Vdc)	V_{IL}	5.0	–	1.5	–	2.25	1.5	–	1.5	Vdc
		10	–	3.0	–	4.50	3.0	–	3.0	
		15	–	4.0	–	6.75	4.0	–	4.0	
"1" Level (V_O = 0.5 or 4.5 Vdc) (V_O = 1.0 or 9.0 Vdc) (V_O = 1.5 or 13.5 Vdc)	V_{IH}	5.0	3.5	–	3.5	2.75	–	3.5	–	Vdc
		10	7.0	–	7.0	5.50	–	7.0	–	
		15	11	–	11	8.25	–	11	–	
Output Drive Current (V_{OH} = 2.5 Vdc) Source (V_{OH} = 4.6 Vdc) (V_{OH} = 9.5 Vdc) (V_{OH} = 13.5 Vdc)	I_{OH}	5.0	−3.0	–	−2.4	−4.2	–	−1.7	–	mAdc
		5.0	−0.64	–	−0.51	−0.88	–	−0.36	–	
		10	−1.6	–	−1.3	−2.25	–	−0.9	–	
		15	−4.2	–	−3.4	−8.8	–	−2.4	–	
(V_{OL} = 0.4 Vdc) Sink (V_{OL} = 0.5 Vdc) (V_{OL} = 1.5 Vdc)	I_{OL}	5.0	0.64	–	0.51	0.88	–	0.36	–	mAdc
		10	1.6	–	1.3	2.25	–	0.9	–	
		15	4.2	–	3.4	8.8	–	2.4	–	
Input Current	I_{in}	15	–	±0.1	–	±0.00001	±0.1	–	±1.0	µAdc
Input Capacitance (V_{in} = 0)	C_{in}	–	–	–	–	5.0	7.5	–	–	pF
Quiescent Current (Per Package)	I_{DD}	5.0	–	5.0	–	0.005	5.0	–	150	µAdc
		10	–	10	–	0.010	10	–	300	
		15	–	20	–	0.015	20	–	600	
Total Supply Current (Notes 3 & 4) (Dynamic plus Quiescent, Per Package) (C_L = 50 pF on all outputs, all buffers switching)	I_T	5.0 10 15	I_T = (0.42 µA/kHz) f + I_{DD} I_T = (0.85 µA/kHz) f + I_{DD} I_T = (1.43 µA/kHz) f + I_{DD}							µAdc

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.

2. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

3. The formulas given are for the typical characteristics only at 25°C.

4. To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) \text{ Vfk}$$

where: I_T is in µA (per package), C_L in pF, V = ($V_{DD} - V_{SS}$) in volts, f in kHz is input frequency, and k = 0.001.

SWITCHING CHARACTERISTICS (Note 5) (C$_L$ = 50 pF, T$_A$ = 25°C)

Characteristic	Symbol	V$_{DD}$ Vdc	Min	Typ (Note 6)	Max	Unit
Output Rise and Fall Time T$_{TLH}$, T$_{THL}$ = (1.5 ns/pF) C$_L$ + 25 ns T$_{TLH}$, T$_{THL}$ = (0.75 ns/pF) C$_L$ + 12.5 ns T$_{TLH}$, T$_{THL}$ = (0.55 ns/pF) C$_L$ + 9.5 ns	t$_{TLH}$, t$_{THL}$	 5.0 10 15	 – – –	 100 50 40	 200 100 80	ns

Propagation Delay Time
Clock to Q1
    t$_{PHL}$, t$_{PLH}$ = (1.7 ns/pF) C$_L$ + 315 ns
    t$_{PHL}$, t$_{PLH}$ = (0.66 ns/pF) C$_L$ + 137 ns
    t$_{PHL}$, t$_{PLH}$ = (0.5 ns/pF) C$_L$ + 95 ns
	t$_{PLH}$,
	t$_{PHL}$
		
		5.0
		10
		15
			
			–
			–
			–
				
				260
				115
				80
					
					520
					230
					160
						ns

Clock to Q12
    t$_{PHL}$, t$_{PLH}$ = (1.7 ns/pF) C$_L$ + 2415 ns
    t$_{PHL}$, t$_{PLH}$ = (0.66 ns/pF) C$_L$ + 867 ns
    t$_{PHL}$, t$_{PLH}$ = (0.5 ns/pF) C$_L$ + 475 ns
		
		5.0
		10
		15
			
			–
			–
			–
				
				1625
				720
				500
					
					3250
					1440
					1000
						ns

Propagation Delay Time
Reset to Q$_n$
    t$_{PHL}$ = (1.7 ns/pF) C$_L$ + 485 ns
    t$_{PHL}$ = (0.86 ns/pF) C$_L$ + 182 ns
    t$_{PHL}$ = (0.5 ns/pF) C$_L$ + 145 ns
	t$_{PHL}$	
		
		5.0
		10
		15
			
			–
			–
			–
				
				370
				155
				115
					
					740
					310
					230
						ns

Clock Pulse Width	t$_{WH}$	5.0 10 15	385 150 115	140 55 38	– – –	ns
Clock Pulse Frequency	f$_{cl}$	5.0 10 15	– – –	2.1 7.0 10.0	1.5 3.5 4.5	MHz
Clock Rise and Fall Time	t$_{TLH}$, t$_{THL}$	5.0 10 15		No Limit		ns
Reset Pulse Width	t$_{WH}$	5.0 10 15	960 360 270	320 120 80	– – –	ns
Reset Removal Time	t$_{rem}$	5.0 10 15	130 50 30	65 25 15	– – –	ns

5. The formulas given are for the typical characteristics only at 25°C.
6. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.
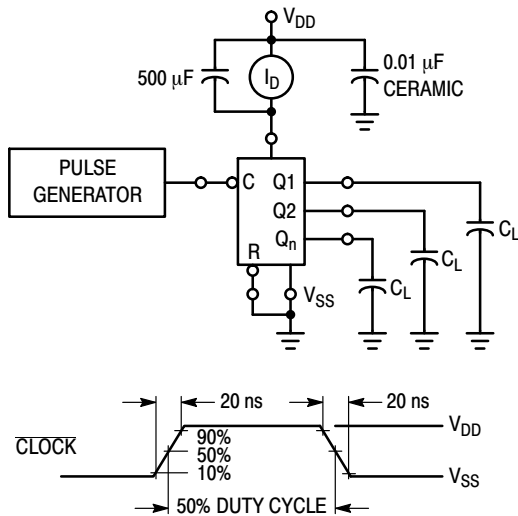

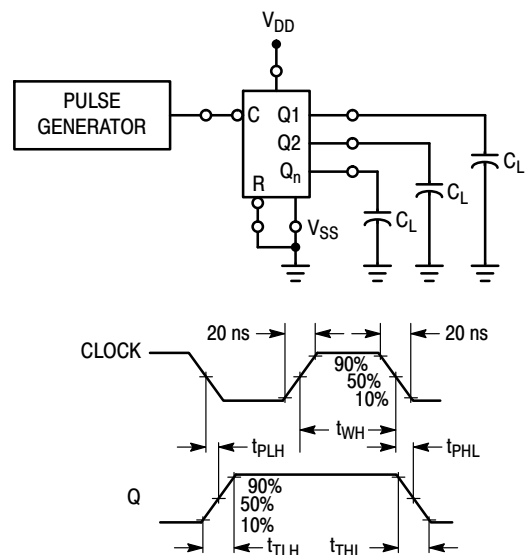**Figure 1. Power Dissipation Test Circuit and Waveform**

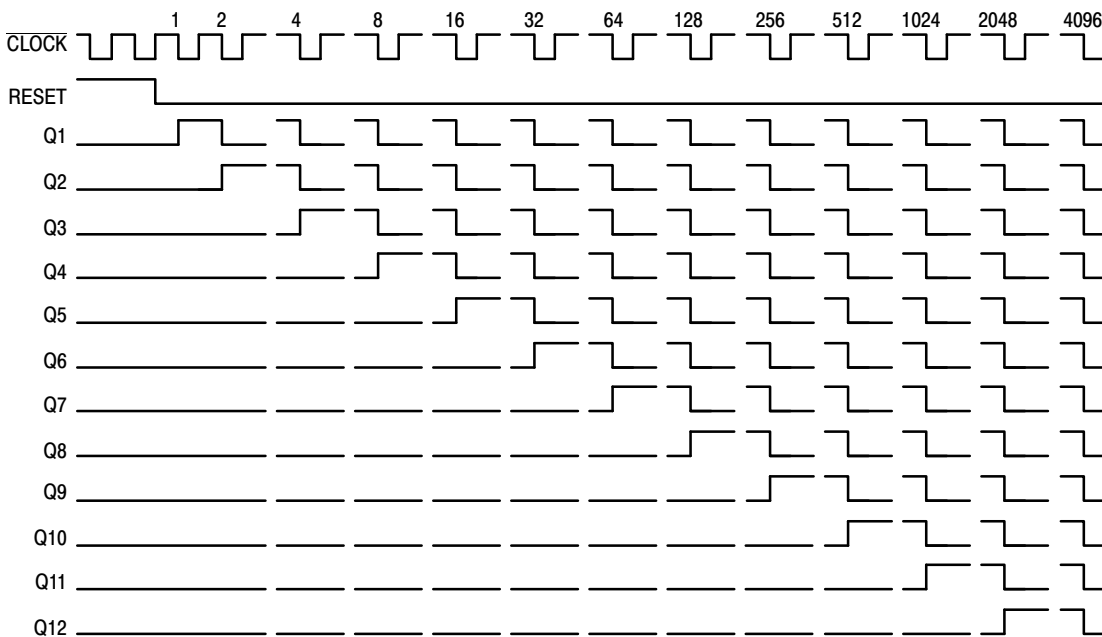**Figure 2. Switching Time Test Circuit and Waveforms**

MC14040B

Figure 3. Timing Diagram

APPLICATIONS INFORMATION

TIME−BASE GENERATOR

A 60 Hz sinewave obtained through a 1.0 Megohm resistor connected directly to a standard 120 Vac power line is applied to the clock input of the MC14040B. By selecting outputs Q5, Q10, Q11, and Q12 division by 3600 is accomplished. The MC14012B decodes the counter outputs, produces a single output pulse, and resets the binary counter. The resulting output frequency is 1.0 pulse/minute.
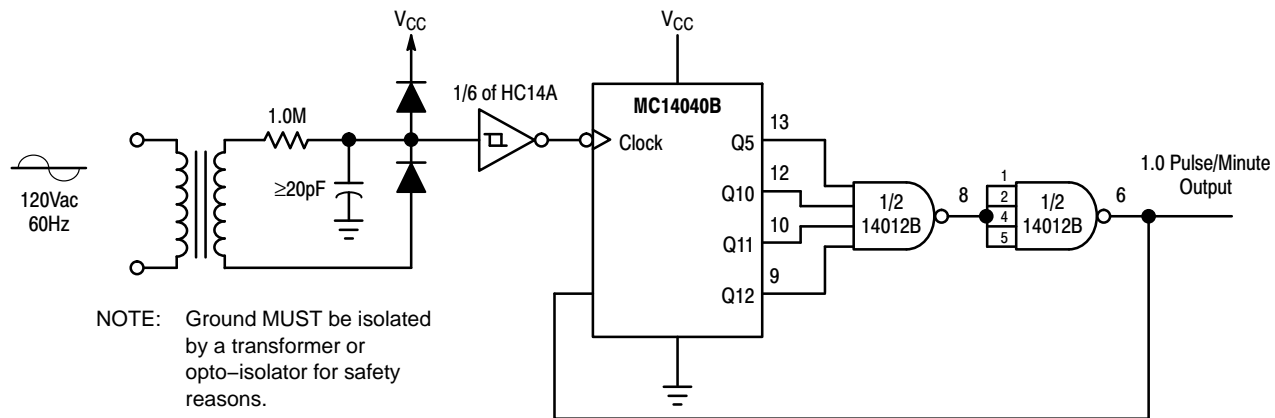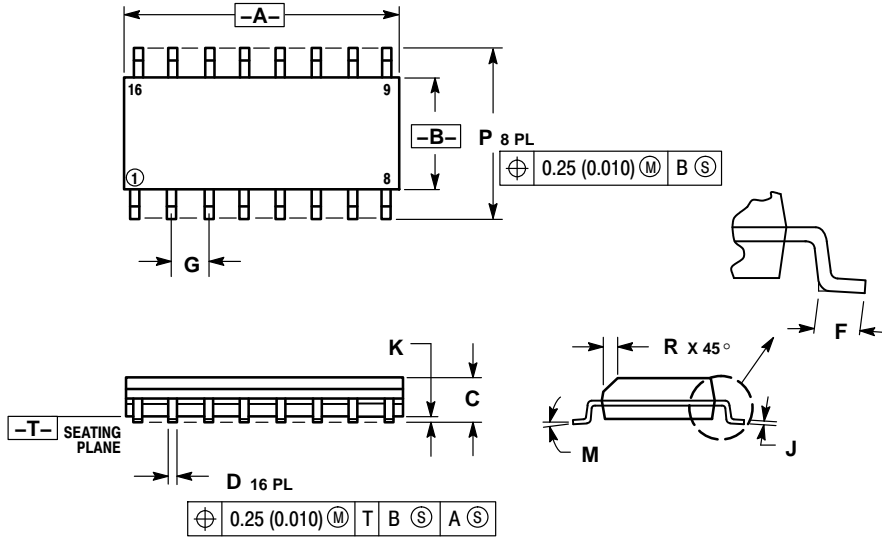

Figure 4. Time−Base Generator

MC14040B

PACKAGE DIMENSIONS

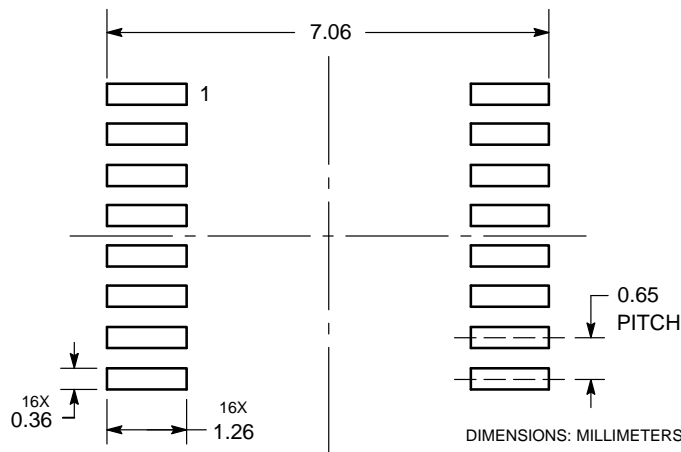**SOIC−16**
D SUFFIX
PLASTIC SOIC PACKAGE
CASE 751B−05
ISSUE K

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

|	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

SOLDERING FOOTPRINT*
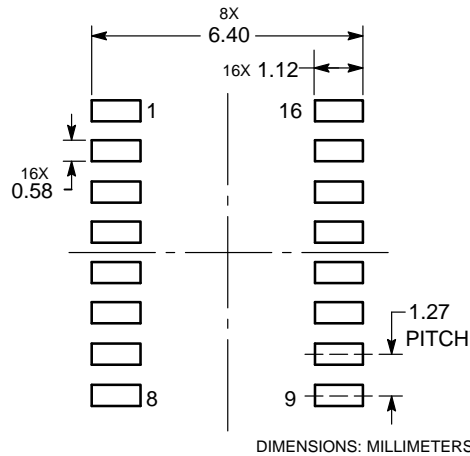
DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.
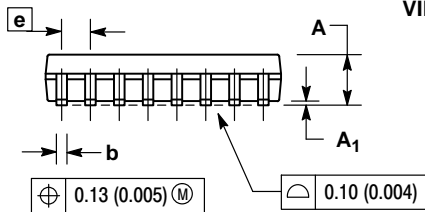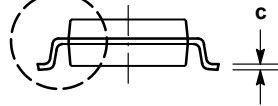
MC14040B

PACKAGE DIMENSIONS

TSSOP−16
DT SUFFIX
PLASTIC TSSOP PACKAGE
CASE 948F
ISSUE B
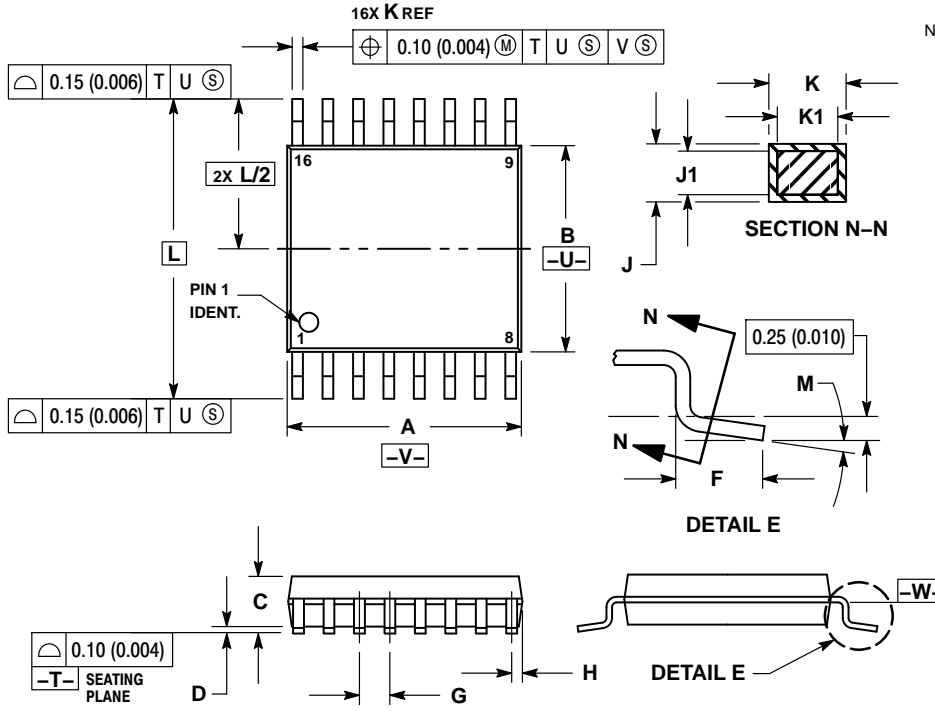
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD 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	4.90	5.10	0.193	0.200
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	0.18	0.28	0.007	0.011
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 °

SECTION N−N

DETAIL E

SOLDERING FOOTPRINT*

7.06

0.65 PITCH

16X 0.36

16X 1.26

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.

MC14040B

PACKAGE DIMENSIONS

SOEIAJ–16
F SUFFIX
PLASTIC EIAJ SOIC PACKAGE
CASE 966
ISSUE A
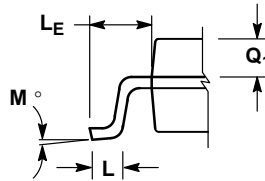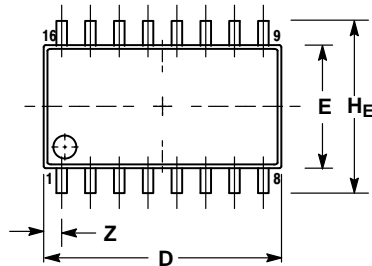
DETAIL P

VIEW P

⊕ 0.13 (0.005) Ⓜ

⬒ 0.10 (0.004)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A₁	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.10	0.20	0.007	0.011
D	9.90	10.50	0.390	0.413
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H_E	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
L_E	1.10	1.50	0.043	0.059
M	0 °	10 °	0 °	10 °
Q₁	0.70	0.90	0.028	0.035
Z	---	0.78	---	0.031

MC14040B/D

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