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MC14060B

14-Bit Binary Counter and Oscillator

The MC14060B is a 14−stage binary ripple counter with an on−chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on the chip is a reset function which places all outputs into the zero state and disables the oscillator. A negative transition on Clock will advance the counter to the next state. Schmitt trigger action on the input line permits very slow input rise and fall times. Applications include time delay circuits, counter controls, and frequency dividing circuits.

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 $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$.

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.

Features

- Fully Static Operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 V to 18 V
- Capable of Driving Two Low−power TTL Loads or One Low−power Schottky TTL Load Over the Rated Temperature Range
- Buffered Outputs Available from Stages 4 Through 10 and 12 Through 14
- Common Reset Line
- Pin−for−Pin Replacement for CD4060B
- 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.

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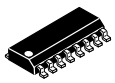
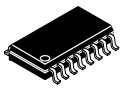


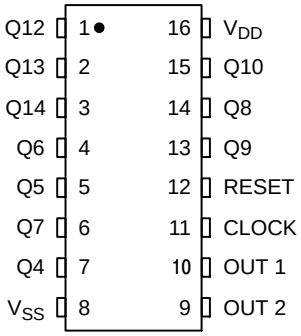
SOIC−16
D SUFFIX
CASE 751B



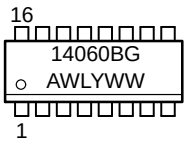
SOEIAJ−16
F SUFFIX
CASE 966

TSSOP−16
DT SUFFIX
CASE 948F

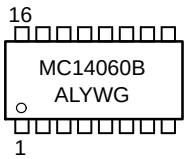
PIN ASSIGNMENT



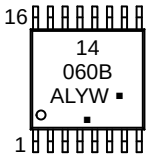
MARKING DIAGRAMS



SOIC−16



SOEIAJ−16



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.

Table 1. Truth Table

Clock	Reset	Output State
⎍	L	No Change
⎎	L	Advance to Next State
H	H	All Outputs are Low

X = Don't Care

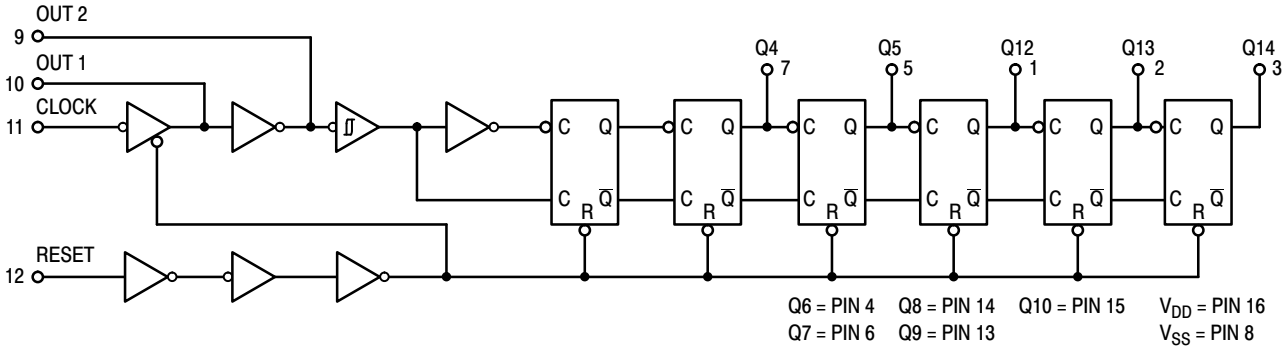


Figure 1. Logic Diagram

ORDERING INFORMATION

Device	Package	Shipping†
MC14060BDG	SOIC−16 (Pb−Free)	48 Units / Rail
NLV14060BDG*	SOIC−16 (Pb−Free)	48 Units / Rail
MC14060BDR2G	SOIC−16 (Pb−Free)	2500 / Tape & Reel
NLV14060BDR2G*	SOIC−16 (Pb−Free)	2500 / Tape & Reel
MC14060BDTR2G	TSSOP−16 (Pb−Free)	2500 / Tape & Reel
NLV14060BDTR2G*	TSSOP−16 (Pb−Free)	2500 / Tape & Reel
MC14060BFELG	SOEIAJ−16 (Pb−Free)	2000 / 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.

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Symbol	Characteristic	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
V_{OL}	Output Voltage “0” Level V_{in} = V_{DD} or 0	5.0 10 15	− − −	0.05 0.05 0.05	− − −	0 0 0	0.05 0.05 0.05	− − −	0.05 0.05 0.05	V
V_{OH}	V_{in} = 0 or V_{DD} “1” Level	5.0 10 15	4.95 9.95 14.95	− − −	4.95 9.95 14.95	5.0 10 15	− − −	4.95 9.95 14.95	− − −	V
V_{IL}	Input Voltage “0” Level (V_O = 4.5 or 0.5 V) (V_O = 9.0 or 1.0 V) (V_O = 13.5 or 1.5 V)	 5.0 10 15	 − − −	 1.5 3.0 4.0	 − − −	 2.25 4.50 6.75	 1.5 3.0 4.0	 − − −	 1.5 3.0 4.0	V
V_{IH}	(V_O = 0.5 or 4.5 V) “1” Level (V_O = 1.0 or 9.0 V) (V_O = 1.5 or 13.5 V)	5.0 10 15	3.5 7.0 11.0	− − −	3.5 7.0 11.0	2.75 5.50 8.25	− − −	3.5 7.0 11.0	− − −	V
V_{IL}	Input Voltage “0” Level (V_O = 4.5 Vdc) (For Input 11 (V_O = 9.0 Vdc) and Output 10) (V_O = 13.5 Vdc)	 5.0 10 15	 − − −	 1.0 2.0 2.5	 − − −	 2.25 4.50 6.75	 1.0 2.0 2.5	 − − −	 1.0 2.0 2.5	Vdc
V_{IH}	(V_O = 0.5 Vdc) “1” Level (V_O = 1.0 Vdc) (V_O = 1.5 Vdc)	5.0 10 15	4.0 8.0 12.5	− − −	4.0 8.0 12.5	2.75 5.50 8.25	− − −	4.0 8.0 12.5	− − −	Vdc
I_{OH}	Output Drive Current (V_{OH} = 2.5 V) (Except Source (V_{OH} = 4.6 V) Pins 9 and 10) (V_{OH} = 9.5 V) (V_{OH} = 13.5 V)	 5.0 5.0 10 15	 –3.0 –0.64 –1.6 – 4.2	 − − − −	 –2.4 –0.51 –1.3 –3.4	 –4.2 –0.88 –2.25 –8.8	 − − − −	 – 1.7 – 0.36 – 0.9 – 2.4	 − − − −	mA
I_{OL}	(V_{OL} = 0.4 V) Sink (V_{OL} = 0.5 V) (V_{OL} = 1.5 V)	5.0 10 15	0.64 1.6 4.2	− − −	0.51 1.3 3.4	0.88 2.25 8.8	− − −	0.36 0.9 2.4	− − −	mA
I_{in}	Input Current	15	−	±0.1	−	±0.00001	±0.1	−	±1.0	μA
C_{in}	Input Capacitance (V_{in} = 0)	−	−	−	−	5.0	7.5	−	−	pF
I_{DD}	Quiescent Current (Per Package)	5.0 10 15	− − −	5.0 10 20	− − −	0.005 0.010 0.015	5.0 10 20	− − −	150 300 600	μA
I_T	Total Supply Current (Notes 3, 4) (Dynamic plus Quiescent, Per Package) (C_L = 50 pF on all outputs, all buffers switching)	5.0 10 15	I_T = (0.25 μA/kHz) f + I_{DD} I_T = (0.54 μA/kHz) f + I_{DD} I_T = (0.85 μA/kHz) f + I_{DD}							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.

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: $I_T(C_L) = I_T(50\ pF) + (C_L - 50)\ Vfk$
   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 = 0.002.

SWITCHING CHARACTERISTICS (C_L = 50 pF, T_A = 25°C)

Symbol	Characteristic	V_{DD} Vdc	Min	Typ (Note 5)	Max	Unit
t_{TLH}	Output Rise Time (Counter Outputs)	5.0 10 15	– – –	40 25 20	200 100 80	ns
t_{THL}	Output Fall Time (Counter Outputs)	5.0 10 15	– – –	50 30 20	200 100 80	ns
t_{PLH} t_{PHL}	Propagation Delay Time Clock to Q4	5.0 10 15	– – –	415 175 125	740 300 200	ns
	Clock to Q14	5.0 10 15	– – –	1.5 0.7 0.4	2.7 1.3 1.0	μs
t_{wH}	Clock Pulse Width	5.0 10 15	100 40 30	65 30 20	– – –	ns
f_ϕ	Clock Pulse Frequency	5.0 10 15	– – –	5 14 17	3.5 8 12	MHz
t_{TLH} t_{THL}	Clock Rise and Fall Time	5.0 10 15	No Limit			ns
t_w	Reset Pulse Width	5.0 10 15	120 60 40	40 15 10	– – –	ns
t_{PHL}	Propagation Delay Time Reset to On	5.0 10 15	– – –	170 80 60	350 160 100	ns

5. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

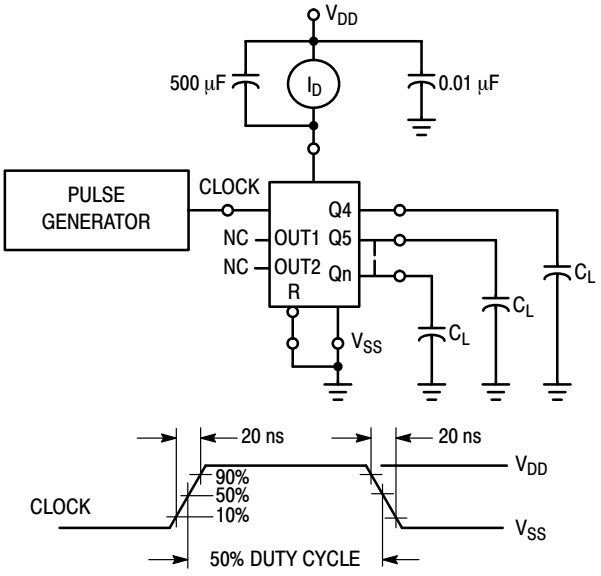


Figure 1. Power Dissipation Test Circuit and Waveform

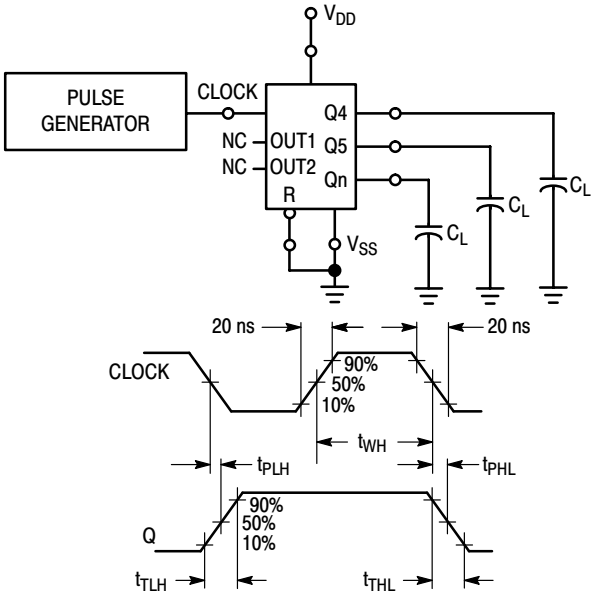
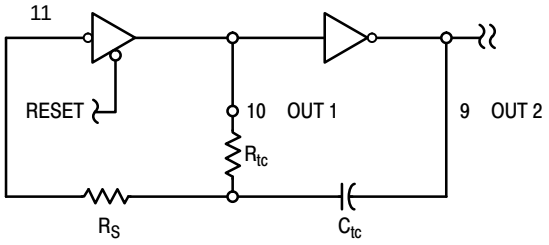


Figure 2. Switching Time Test Circuit and Waveforms



$$f \approx \frac{1}{2.3 R_{tc} C_{tc}}$$

if 1 kHz ≤ f ≤ 100 kHz
and $2R_{tc} < R_S < 10R_{tc}$
(f in Hz, R in ohms, C in farads)

The formula may vary for other frequencies. Recommended maximum value for the resistors in 1 MΩ.

Figure 3. Oscillator Circuit Using RC Configuration

TYPICAL RC OSCILLATOR CHARACTERISTICS

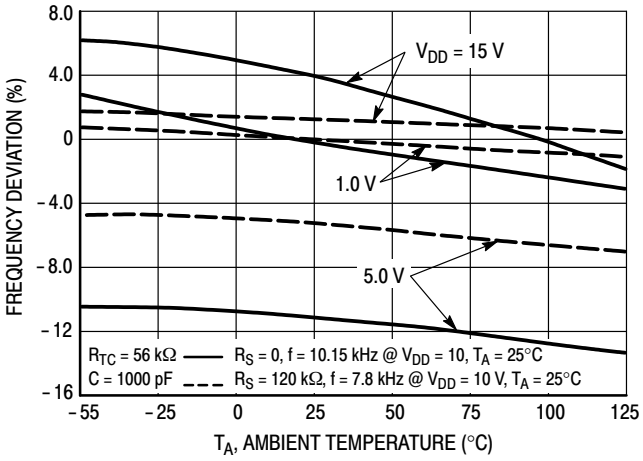


Figure 4. RC Oscillator Stability

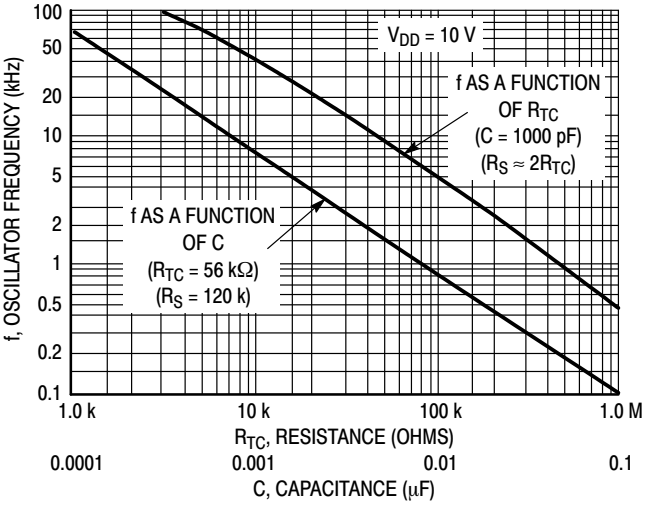


Figure 5. RC Oscillator Frequency as a Function of R_{TC} and C

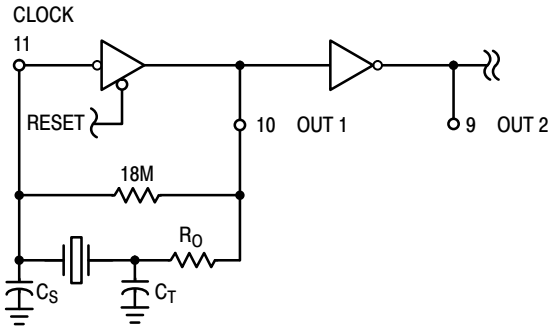


Figure 6. Typical Crystal Oscillator Circuit

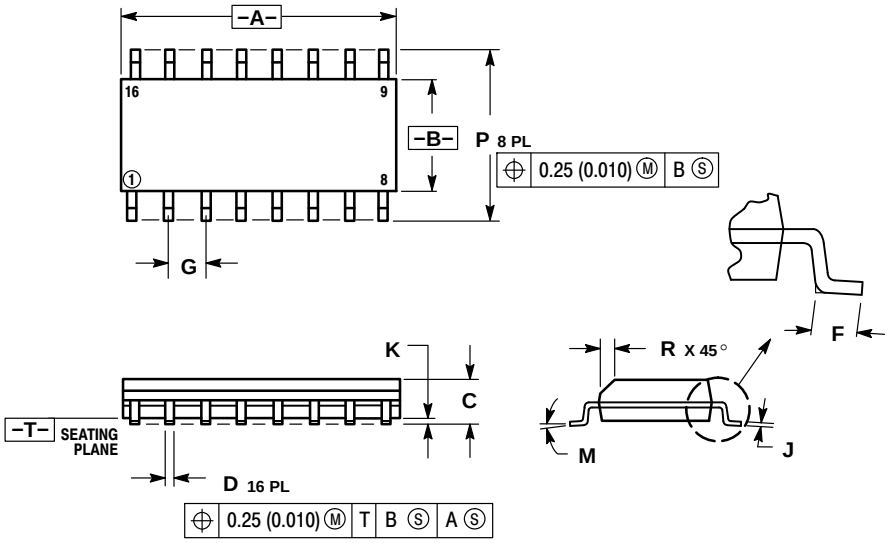
Table 2. Typical Data for Crystal Oscillator Circuit

Characteristic	500 kHz Circuit	32 kHz Circuit	Unit
Crystal Characteristics			
Resonant Frequency	500	32	kHz
Equivalent Resistance, R_S	1.0	6.2	kΩ
External Resistor/Capacitor Values			
R_O	47	750	kΩ
C_T	82	82	pF
C_S	20	20	pF
Frequency Stability			
Frequency Changes as a Function of V_{DD} (T_A = 25°C)			
V_{DD} Change from 5.0 V to 10 V	+6.0	+2.0	ppm
V_{DD} Change from 10 V to 15 V	+2.0	+2.0	ppm
Frequency Change as a Function of Temperature (V_{DD} = 10 V)			
T_A Change from − 55°C to +25°C Complete Oscillator (Note 6)	+100	+120	ppm
T_A Change from + 25°C to +125°C Complete Oscillator (Note 6)	–160	–560	ppm

6. Complete oscillator includes crystal, capacitors, and resistors.

PACKAGE DIMENSIONS

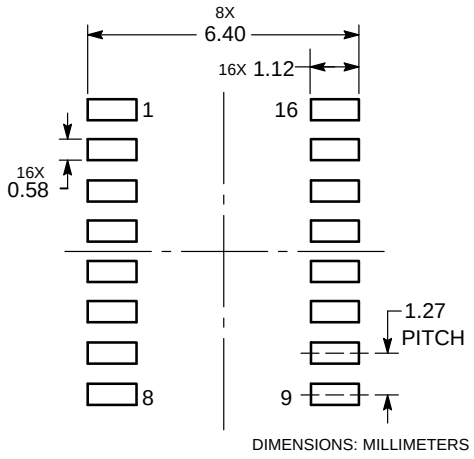
SOIC−16
D SUFFIX
CASE 751B−05
ISSUE K



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

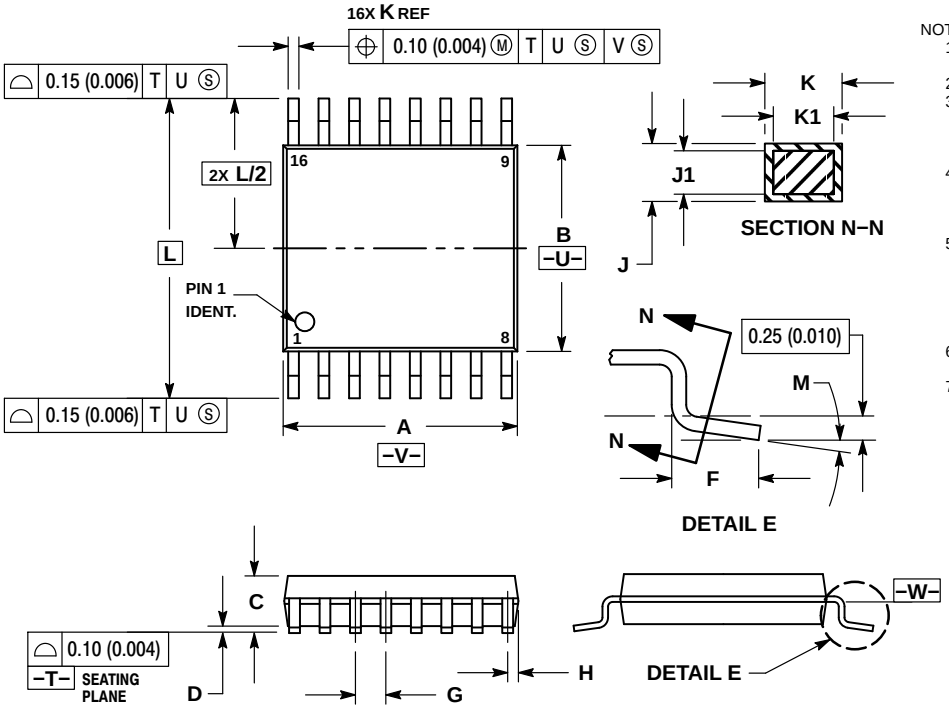
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

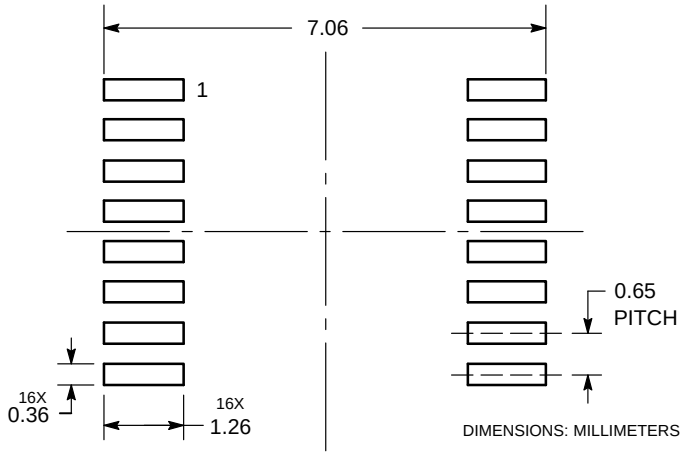
TSSOP−16
DT SUFFIX
CASE 948F
ISSUE B



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−.

	MILLIMETERS		INCHES	
DIM	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 °

SOLDERING FOOTPRINT*



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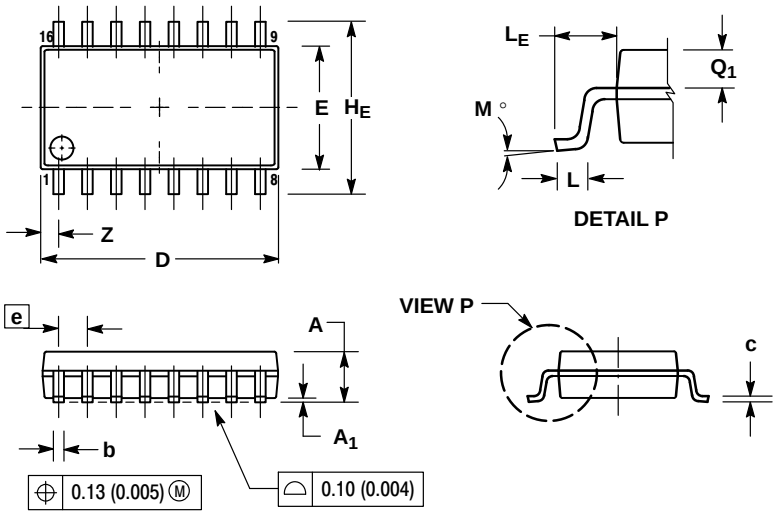
PACKAGE DIMENSIONS

SOEIAJ−16
F SUFFIX
CASE 966
ISSUE A



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).

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A_1	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 °
Q_1	0.70	0.90	0.028	0.035
Z	---	0.78	---	0.031

PUBLICATION ORDERING INFORMATION

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