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Contact us

MC14028B

BCD-To-Decimal Decoder
Binary-To-Octal Decoder

The MC14028B decoder is constructed so that an 8421 BCD code on the four inputs provides a decimal (one−of−ten) decoded output, while a 3−bit binary input provides a decoded octal (one−of−eight) code output with D forced to a logic "0". Expanded decoding such as binary−to−hexadecimal (one−of−sixteen), etc., can be achieved by using other MC14028B devices. The part is useful for code conversion, address decoding, memory selection control, demultiplexing, or readout decoding.

Features

- 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
- Positive Logic Design
- Low Outputs on All Illegal Input Combinations
- Similar to CD4028B
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- This Device is Pb−Free and is RoHS Compliant

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

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

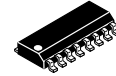1. Temperature Derating: "D/DW" Packages: −7.0 mW/°C From 65°C To 125°C

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.
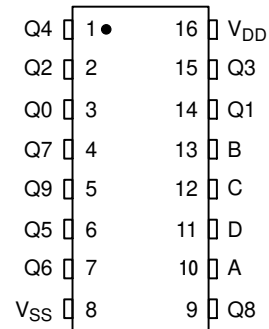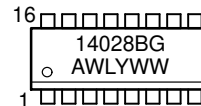
ON Semiconductor®

http://onsemi.com

**SOIC−16
D SUFFIX
CASE 751B**

PIN ASSIGNMENT

Q4	1●	16	V_{DD}
Q2	2	15	Q3
Q0	3	14	Q1
Q7	4	13	B
Q9	5	12	C
Q5	6	11	D
Q6	7	10	A
V_{SS}	8	9	Q8

MARKING DIAGRAM

16 ∏∏∏∏∏∏∏∏
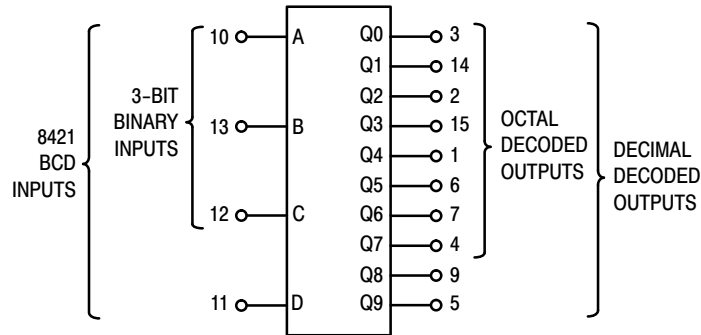14028BG
○ AWLYWW
1 ∐∐∐∐∐∐∐∐

A = Assembly Location
WL = Wafer Lot
YY, Y = Year
WW = Work Week
G = Pb−Free Package

ORDERING INFORMATION

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

MC14028B

BLOCK DIAGRAM

8421 BCD INPUTS	3-BIT BINARY INPUTS	10 ○— A Q0 —○ 3
		Q1 —○ 14
		Q2 —○ 2
		13 ○— B Q3 —○ 15

A   Q0 → 3
Q1 → 14
Q2 → 2
Q3 → 15
Q4 → 1
Q5 → 6
Q6 → 7
Q7 → 4
Q8 → 9
Q9 → 5

10 ○— A
13 ○— B
12 ○— C
11 ○— D

OCTAL DECODED OUTPUTS

DECIMAL DECODED OUTPUTS

V_{DD} = PIN 16
V_{SS} = PIN 8

TRUTH TABLE

D	C	B	A	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0
0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	0	0	0	0	1	0
0	0	1	0	0	0	0	0	0	0	0	1	0	0
0	0	1	1	0	0	0	0	0	0	1	0	0	0
0	1	0	0	0	0	0	0	0	1	0	0	0	0
0	1	0	1	0	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	0	1	0	0	0	0	0	0
0	1	1	1	0	0	1	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	0	0	0	0
1	0	0	1	1	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0	0	0

ORDERING INFORMATION

Device	Package	Shipping[†]
MC14028BDG	SOIC−16 (Pb−Free)	48 Units / Rail
MC14028BDR2G	SOIC−16 (Pb−Free)	2500 / Tape & Reel
NLV14028BDR2G*	SOIC−16 (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.
*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$_{SS}$)

Characteristic		Symbol	V$_{DD}$ Vdc	−55°C		25°C			125°C		Unit
				Min	Max	Min	Typ (Note 2)	Max	Min	Max	
Output Voltage "0" Level V$_{in}$ = V$_{DD}$ or 0		V$_{OL}$	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	Vdc
"1" Level V$_{in}$ = 0 or V$_{DD}$		V$_{OH}$	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	– – –	Vdc
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 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	Vdc
"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 10 15	3.5 7.0 11	– – –	3.5 7.0 11	2.75 5.50 8.25	– – –	3.5 7.0 11	– – –	Vdc
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 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	– – – –	mAdc
(V$_{OL}$ = 0.4 Vdc) Sink (V$_{OL}$ = 0.5 Vdc) (V$_{OL}$ = 1.5 Vdc)		I$_{OL}$	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	– – –	mAdc
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 10 15	– – –	5.0 10 20	– – –	0.005 0.010 0.015	5.0 10 20	– – –	150 300 600	µAdc
Total Supply Current (Note 3, 4) (Dynamic plus Quiescent, Per Package) (C$_L$ = 50 pF on all outputs, all buffers switching)		I$_T$	5.0 10 15	I$_T$ = (0.3 µA/kHz) f + I$_{DD}$ I$_T$ = (0.6 µA/kHz) f + I$_{DD}$ I$_T$ = (0.9 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 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 = 0.001.

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

Characteristic	Symbol	V$_{DD}$	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 t$_{PLH}$, t$_{PHL}$ = (1.7 ns/pF) C$_L$ + 215 ns t$_{PLH}$, t$_{PHL}$ = (0.66 ns/pF) C$_L$ + 97 ns t$_{PLH}$, t$_{PHL}$ = (0.5 ns/pF) C$_L$ + 65 ns	t$_{PLH}$, t$_{PHL}$	5.0 10 15	– – –	300 130 90	600 260 180	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.

MC14028B

Inputs B, C, and D switching
in respect to a BCD code.

20 ns

INPUT A

90%

20 ns

50%

10%

V_{DD}

V_{SS}

1/f
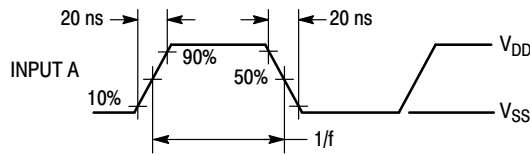
All outputs connected to respective
C_L loads. f in respect to a system clock.

20 ns

20 ns

INPUT C

90%

50%

10%

V_{DD}

V_{SS}

Inputs A, B, and D low.

t_{PLH}

t_{PHL}

90%

50%

Q4

10%

V_{OH}

V_{OL}

t_{TLH}

t_{THL}
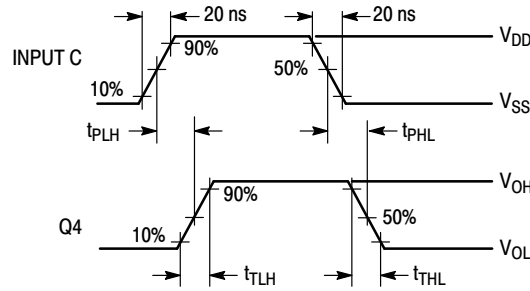
Figure 1. Dynamic Signal Waveforms

A

B

C

D

Q0
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
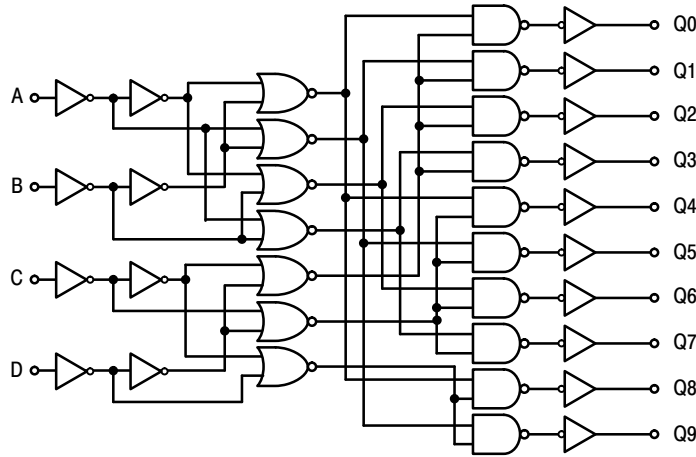
LOGIC DIAGRAM

APPLICATIONS INFORMATION

Expanded decoding can be performed by using the MC14028B and other CMOS Integrated Circuits. The circuit in Figure 2 converts any 4−bit code to a decimal or hexadecimal code. The accompanying table shows the input binary combinations, the associated "output numbers" that go "high" when selected, and the "redefined output numbers" needed for the proper code. For example: For the combination DCBA = 0111 the output number 7 is redefined for the 4−bit binary, 4−bit gray, excess−3, or excess−3 gray codes as 7, 5, 4, or 2, respectively. Figure 3 shows a 6−bit binary 1−of−64 decoder using nine MC14028B circuits and two MC14069UB inverters.

The MC14028B can be used in decimal digit displays, such as, neon readouts or incandescent projection indicators as shown in Figure 4.

INPUTS

D   C   B   A

D   C   B   A   D   C   B   A
MC14028B   MC14028B
Q9 — — — — Q0   Q9 — — — — Q0

15 — — — — −8   15 — — — — −0
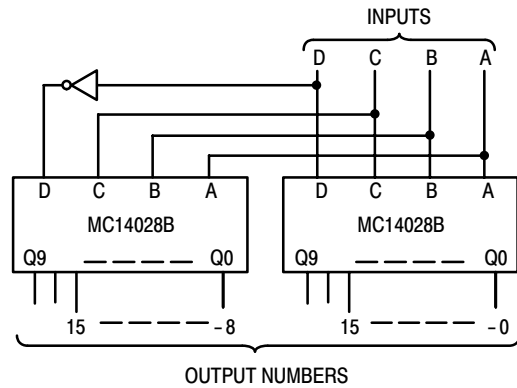
OUTPUT NUMBERS

Figure 2. Code Conversion Circuit and Truth Table

MC14028B

Inputs				Output Numbers																Hexadecimal — Code and Redefined Output Numbers			Decimal		
D	C	B	A	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	4–Bit Binary	4–Bit Gray	Excess–3	Excess–3 Gray	Aiken	4221
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0			0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1			1	1
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3		0	2	2
0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	2	0	3	3	
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	7	1	4	4	
0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5	6	2			3
0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	6	4	3	1		
0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	5	4	2		4
1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8	15	5			
1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	9	14	6			5
1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	10	12	7		9	6
1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	13	8			
1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12	8	9	5	6	
1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	13	9		6	7	7
1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	11		8	8	8
1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	10		7	9	9

INPUTS

A B C D E F INHIBIT (NO SELECTION)

A B C –D MC14028B Q0 — — Q9

A B C D MC14028B Q0 — — Q9 (×8 blocks)

0   7 8   15 16   23 24   31 32   39 40   47 48   55 56   63

*1/6 MC14069UB   64 OUTPUTS (SELECTED OUTPUT IS HIGH)
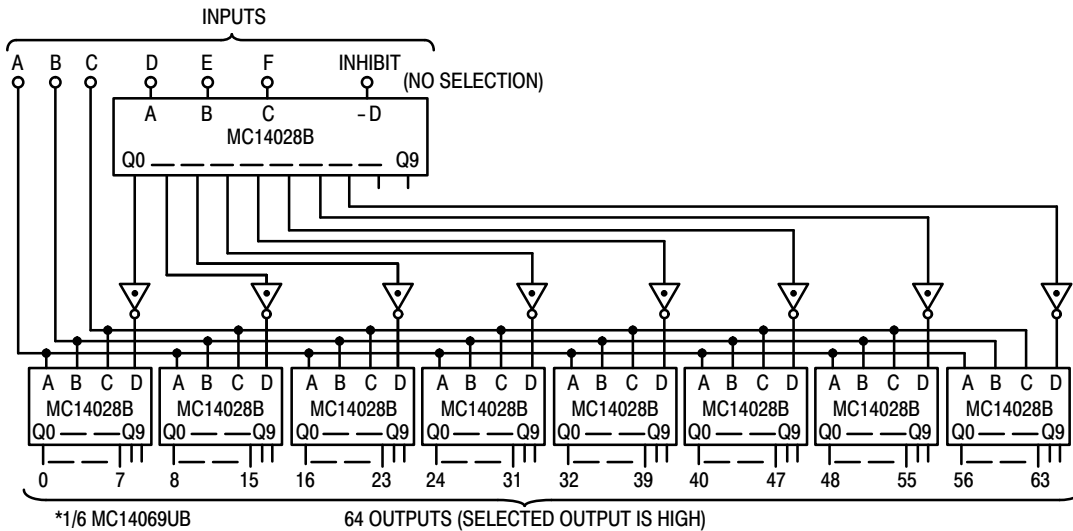
Figure 3. Six–Bit Binary 1–of–64 Decoder

MC14028B — Inputs A B C D; Outputs Q0 Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

APPROPRIATE VOLTAGE — NEON DISPLAY   9 ... 0   OR   APPROPRIATE VOLTAGE — INCANDESCENT DISPLAY   9   2   1   0
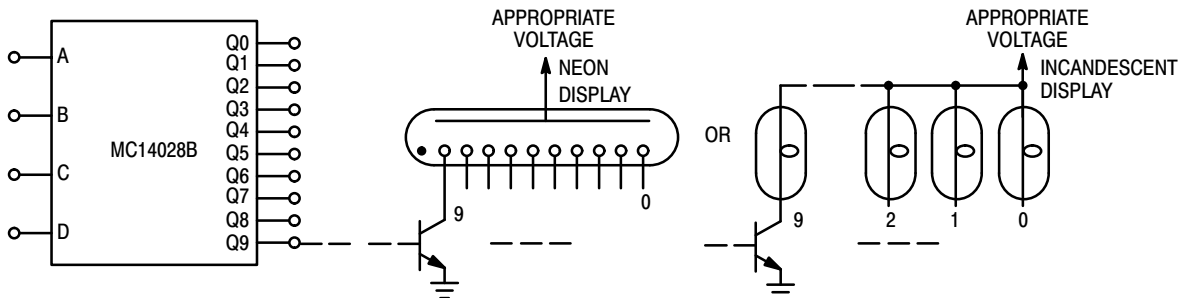
Figure 4. Decimal Digit Display Application

MC14028B

PACKAGE DIMENSIONS

SOIC–16
D SUFFIX
CASE 751B–05
ISSUE K
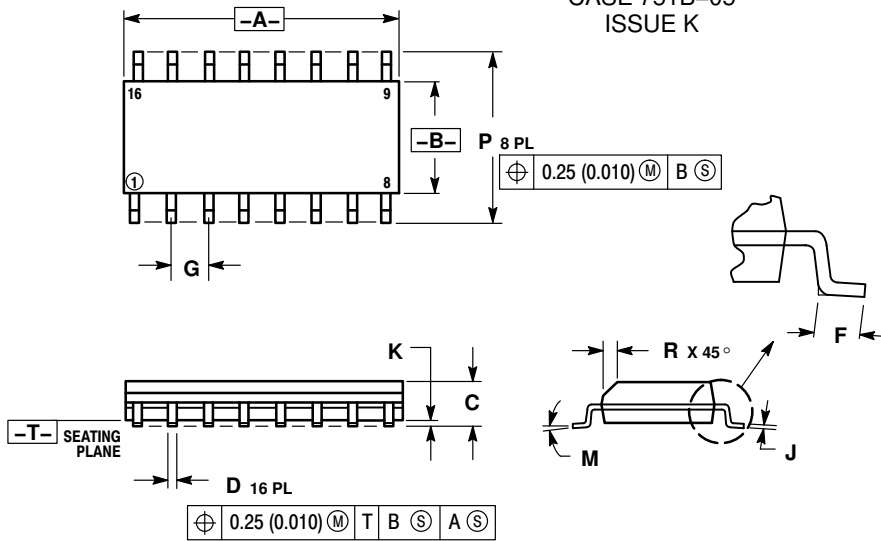
0.25 (0.010) Ⓜ B Ⓢ

0.25 (0.010) Ⓜ T B Ⓢ A Ⓢ

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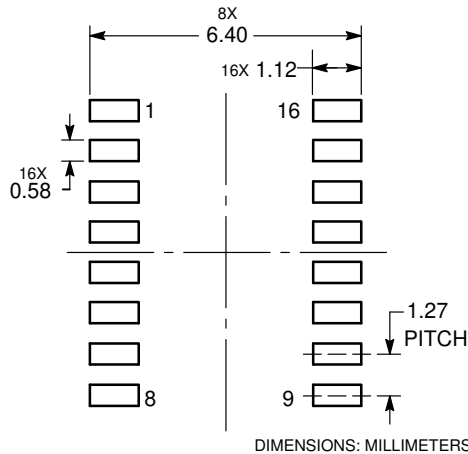
*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

MC14028B/D