

# NB4L52

## 2.5 V/3.3 V/5.0 V Differential Data/Clock D Flip-Flop with Reset

### Multi-Level Inputs to LVPECL Translator w/ Internal Termination

The NB4L52 is a differential Data and Clock D flip-flop with a differential asynchronous Reset. The differential inputs incorporate internal 50 Ω termination resistors and will accept PECL, LVPECL, LVCMOS, LVTTTL, CML, or LVDS logic levels. When Clock transitions from Low to High, Data will be transferred to the differential LVPECL outputs. The differential Clock inputs allow the NB4L52 to also be used as a negative edge triggered device. The device is housed in a small 3x3 mm 16 pin QFN package.

#### Features

- Maximum Input Clock Frequency > 4 GHz Typical
- 330 ps Typical Propagation Delay
- 145 ps Typical Rise and Fall Times
- Differential LVPECL Outputs, 750 mV Peak-to-Peak, Typical
- Operating Range:  $V_{CC} = 2.375\text{ V}$  to  $5.5\text{ V}$  with  $V_{EE} = 0\text{ V}$
- Internal Input Termination Resistors, 50 Ω
- Functionally Compatible with Existing 2.5 V/3.3 V/5.0 V LVEL, LVEP, EP, and SG Devices
- $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  Ambient Operating Temperature
- These are Pb-Free Devices



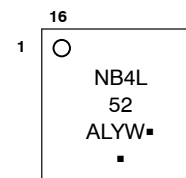
ON Semiconductor®

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#### MARKING DIAGRAM\*



QFN-16  
MN SUFFIX  
CASE 485G



- 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.

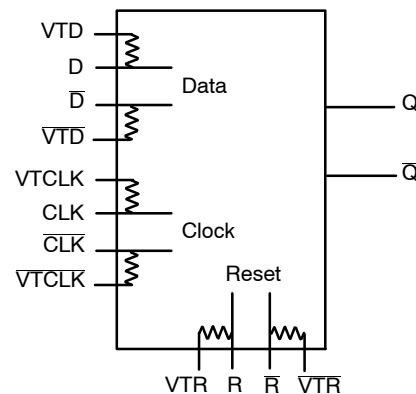


Figure 1. Logic Diagram

Table 1. TRUTH TABLE

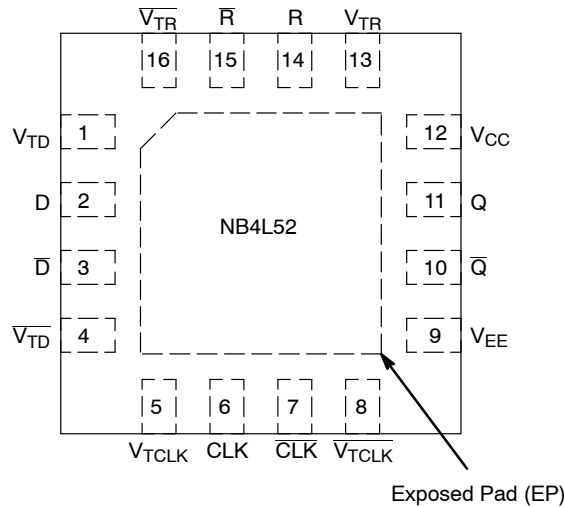
| R | D | CLK | Q |
|---|---|-----|---|
| H | x | x   | L |
| L | L | Z   | L |
| L | H | Z   | H |

Z = LOW to HIGH Transition  
x = Don't Care

#### ORDERING INFORMATION

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

## NB4L52



**Figure 2. Pinout (Top View)**

**Table 2. PIN DESCRIPTION**

| Pin | Name                  | I/O                                  | Description   |
|-----|-----------------------|--------------------------------------|---|
| 1   | $V_{TD}$              | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| 2   | D                     | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Noninverted Differential Input. (Note 1)  |
| 3   | $\bar{D}$             | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Inverted Differential Input. (Note 1)   |
| 4   | $\overline{V_{TD}}$   | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| 5   | $V_{TCLK}$            | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| 6   | CLK                   | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Noninverted Differential Input. (Note 1)  |
| 7   | $\overline{CLK}$      | ECL, CML, LVCMOS, LVDS, LVTTTL Input | Inverted Differential Input. (Note 1)   |
| 8   | $\overline{V_{TCLK}}$ | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| 9   | $V_{EE}$              | -                                    | Negative Supply Voltage   |
| 10  | $\bar{Q}$             | ECL Output                           | Inverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{CC} - 2.0$ V.   |
| 11  | Q                     | ECL Output                           | Noninverted Differential Output. Typically terminated with 50 $\Omega$ resistor to $V_{CC} - 2.0$ V.  |
| 12  | $V_{CC}$              | -                                    | Positive Supply Voltage   |
| 13  | $V_{TR}$              | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| 14  | R                     | LVECL, LVCMOS, LVTTTL Input          | Noninverted Differential Reset Input. (Note 1)  |
| 15  | $\bar{R}$             | LVECL, LVCMOS, LVTTTL Input          | Inverted Differential Reset Input. (Note 1)   |
| 16  | $\overline{V_{TR}}$   | -                                    | Internal 50 $\Omega$ Termination Pin. (See Table 4)   |
| -   | EP                    | -                                    | The Exposed Pad (EP) on the QFN-16 package bottom is thermally connected to the die for improved heat transfer out of package. The pad is not electrically connected to the die, but is recommended to be electrically and thermally connected to $V_{EE}$ on the PC board. |

1. In the differential configuration when the input termination pin ( $V_{TD}$ ,  $\overline{V_{TD}}$ ,  $V_{TR}$ ,  $\overline{V_{TR}}$ ,  $V_{TCLK}$ ,  $\overline{V_{TCLK}}$ ) are connected to a common termination voltage or left open, and if no signal is applied on D/ $\bar{D}$ , CLK/ $\overline{CLK}$ , R/ $\bar{R}$  input then the device will be susceptible to self-oscillation.

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**Table 3. ATTRIBUTES**

| Characteristic   | Value   |                             |
|--|---|-----------------------------|
| ESD Protection   | Human Body Model<br>Machine Model<br>Charged Device Model | > 2 kV<br>> 200 V<br>> 1 kV |
| Moisture Sensitivity (Note 2)                          | Pb Pkg  | Pb-Free Pkg                 |
|  | QFN-16  | Level 1      Level 1        |
| Flammability Rating Oxygen Index: 28 to 34             | UL 94 V-0 @ 0.125 in                                      |                             |
| Transistor Count                                       | 164   |                             |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test |   |                             |

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

**Table 4. MAXIMUM RATINGS**

| Symbol        | Parameter  | Condition 1                                    | Condition 2                            | Rating      | Unit   |
|---------------|--|--|--|-------------|--|
| $V_{CC}$      | Positive Power Supply                              | $V_{EE} = 0\text{ V}$                          |  | 6.0         | V  |
| $V_{EE}$      | Negative Power Supply                              | $V_{CC} = 0\text{ V}$                          |  | -6.0        | V  |
| $V_{IO}$      | Positive Input/Output<br>Negative Input/Output     | $V_{EE} = 0\text{ V}$<br>$V_{CC} = 0\text{ V}$ | $V_I \leq V_{CC}$<br>$V_I \geq V_{EE}$ | 6.0<br>-6.0 | V<br>V   |
| $I_{IN}$      | Input Current Through $R_T$ (50 $\Omega$ Resistor) | Static<br>Surge                                |  | 45<br>80    | mA<br>mA   |
| $I_{out}$     | Output Current                                     | Continuous<br>Surge                            |  | 25<br>50    | mA<br>mA   |
| $T_A$         | Operating Temperature Range                        |  |  | -40 to +85  | $^{\circ}\text{C}$   |
| $T_{stg}$     | Storage Temperature Range                          |  |  | -65 to +150 | $^{\circ}\text{C}$   |
| $\theta_{JA}$ | Thermal Resistance (Junction-to-Ambient)           | 0 LFPM<br>500 LFPM                             | 16 QFN<br>16 QFN                       | 42<br>35    | $^{\circ}\text{C}/\text{W}$<br>$^{\circ}\text{C}/\text{W}$ |
| $\theta_{JC}$ | Thermal Resistance (Junction-to-Case)              | 2S2P (Note 3)                                  | 16 QFN                                 | 4.0         | $^{\circ}\text{C}/\text{W}$                                |
| $T_{sol}$     | Wave Solder      Pb-Free                           |  |  | 265         | $^{\circ}\text{C}$   |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

3. JEDEC standard multilayer board – 2S2P (2 signal, 2 power) with 8 filled thermal vias under exposed pad.

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**Table 5. DC CHARACTERISTICS, CLOCK INPUTS, LVPECL OUTPUTS**

( $V_{CC} = 2.375\text{ V to }5.5\text{ V}$ ,  $V_{EE} = 0\text{ V or }V_{CC} = 0\text{ V}$ ,  $V_{EE} = -2.375\text{ to }-5.5\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ )

| Symbol   | Characteristic   | Min                                     | Typ                                     | Max                                    | Unit |
|----------|--|---|---|--|------|
| $I_{EE}$ | Power Supply Current (Inputs and Outputs Open)   |   | 16                                      | 25                                     | mA   |
| $V_{OH}$ | Output HIGH Voltage (Note 4, 5)<br>$V_{CC} = 5.0\text{ V}$<br>$V_{CC} = 3.3\text{ V}$<br>$V_{CC} = 2.5\text{ V}$ | $V_{CC} - 1145$<br>3855<br>2155<br>1355 | $V_{CC} - 1020$<br>3980<br>2280<br>1480 | $V_{CC} - 895$<br>4105<br>2405<br>1605 | mV   |
| $V_{OL}$ | Output LOW Voltage (Note 4, 5)<br>$V_{CC} = 5.0\text{V}$<br>$V_{CC} = 3.3\text{V}$<br>$V_{CC} = 2.5\text{V}$     | $V_{CC} - 1945$<br>3055<br>1355<br>555  | $V_{CC} - 1770$<br>3230<br>1530<br>730  | $V_{CC} - 1600$<br>3400<br>1700<br>900 | mV   |

**DIFFERENTIAL INPUT DRIVEN SINGLE-ENDED (Figures 4 & 7)**

|          |  |                |  |                |    |
|----------|--|----------------|--|----------------|----|
| $V_{th}$ | Input Threshold Reference Voltage Range (Note 6) | 1050           |  | $V_{CC} - 150$ | mV |
| $V_{IH}$ | Single-ended Input HIGH Voltage                  | $V_{th} + 150$ |  | $V_{CC}$       | mV |
| $V_{IL}$ | Single-ended Input LOW Voltage                   | $V_{EE}$       |  | $V_{th} - 150$ | mV |

**DIFFERENTIAL INPUT DRIVEN DIFFERENTIALLY (Figures 5, 6 & 8)**

|           |  |          |    |                |               |
|-----------|--|----------|----|----------------|---------------|
| $V_{IHD}$ | Differential Input HIGH Voltage  | 1200     |    | $V_{CC}$       | mV            |
| $V_{ILD}$ | Differential Input LOW Voltage   | $V_{EE}$ |    | $V_{CC} - 150$ | mV            |
| $V_{CMR}$ | Input Common Mode Range (Differential Configuration) (Note 7)                                      | 1125     |    | $V_{CC} - 75$  | mV            |
| $V_{ID}$  | Differential Input Voltage ( $V_{IHD} - V_{ILD}$ )   | 150      |    | $V_{CC}$       | mV            |
| $I_{IH}$  | Input HIGH Current $D / \bar{D}$ , $CLK / \bar{CLK}$ , $R / \bar{R}$ ( $V_{Tx}/\bar{V}_{Tx}$ Open) | -150     |    | 150            | $\mu\text{A}$ |
| $I_{IL}$  | Input LOW Current $D / \bar{D}$ , $CLK / \bar{CLK}$ , $R / \bar{R}$ ( $V_{Tx}/\bar{V}_{Tx}$ Open)  | -150     |    | 150            | $\mu\text{A}$ |
| $R_{TIN}$ | Internal Input Termination Resistor  | 40       | 50 | 60             | $\Omega$      |

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. 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.

4. LVPECL outputs loaded with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$  for proper operation.
5. Input and output parameters vary 1:1 with  $V_{CC}$ .
6.  $V_{th}$  is applied to the complementary input when operating in single-ended mode.
7.  $V_{CMRMIN}$  varies 1:1 with  $V_{EE}$ ,  $V_{CMRMAX}$  varies 1:1 with  $V_{CC}$ . The  $V_{CMR}$  range is referenced to the most positive side of the differential input signal.

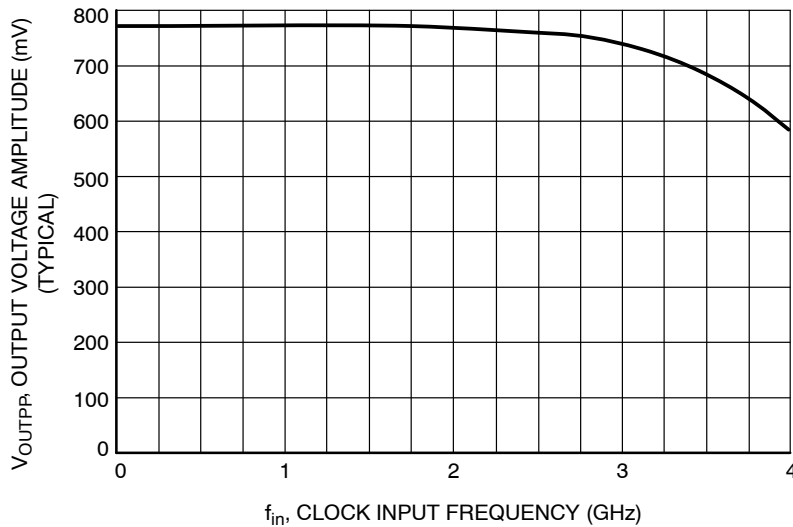
# NB4L52

**Table 6. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }5.5\text{ V}$ ;  $V_{EE} = 0\text{ V or }V_{CC} = 0\text{ V}$ ,  $V_{EE} = -2.375\text{ to }-5.5\text{ V}$  (Note 8)

| Symbol                   | Characteristic  | -40°C |     |      | 25°C |     |      | 85°C |     |      | Unit |
|--------------------------|---|-------|-----|------|------|-----|------|------|-----|------|------|
|                          |   | Min   | Typ | Max  | Min  | Typ | Max  | Min  | Typ | Max  |      |
| $V_{OUTPP}$              | Output Voltage Amplitude (@ $V_{INPPmin}$ )<br>(Note 10) (See Figure 4)<br>$f_{in} \leq 2.0\text{ GHz}$<br>$f_{in} \leq 3.0\text{ GHz}$<br>$f_{in} \leq 4.0\text{ GHz}$ | 530   | 770 |      | 530  | 780 |      | 530  | 760 |      | mV   |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation Delay to<br>Output Differential<br>CLK to Q, R to Q   | 300   | 400 | 500  | 300  | 400 | 500  | 300  | 400 | 500  | ps   |
| $t_s$                    | Setup Time  | 100   |     |      | 100  |     |      | 100  |     |      | ps   |
| $t_h$                    | Hold Time   | 50    |     |      | 50   |     |      | 50   |     |      | ps   |
| $t_{RR}$                 | Reset Recovery  | 400   |     |      | 400  |     |      | 400  |     |      | ps   |
| $t_{PW}$                 | Minimum Pulse Width<br>R/R  | 250   |     |      | 250  |     |      | 250  |     |      | ps   |
| $t_{JITTER}$             | RMS Random Clock Jitter (Note 9)<br>$f_{in} \leq 2.0\text{ GHz}$<br>$f_{in} \leq 3.0\text{ GHz}$<br>$f_{in} \leq 4.0\text{ GHz}$  |       | 1   |      |      | 1   |      |      | 1   |      | ps   |
| $V_{INPP}$               | Input Voltage Swing/Sensitivity<br>(Differential Configuration) (Note 10)   | 150   |     | 2800 | 150  |     | 2800 | 150  |     | 2800 | mV   |
| $t_r$<br>$t_f$           | Output Rise/Fall Times @ 0.5 GHz<br>(20% – 80%)   | 80    | 135 | 190  | 80   | 145 | 190  | 80   | 155 | 190  | 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.

8. Measured by forcing  $V_{INPP}$  (MIN) from a 50% duty cycle clock source. All loading with an external  $R_L = 50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ . Input edge rates 40 ps (20% – 80%).
9. Additive RMS jitter with 50% duty cycle clock signal.
10. Input and output voltage swing is a single-ended measurement operating in differential mode.



**Figure 3. Output Voltage Amplitude ( $V_{OUTPP}$ ) vs. Clock Input Frequency at Ambient Temperature (Typical).**

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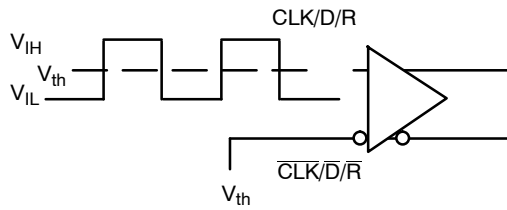


Figure 4. Differential Input Driven Single-Ended

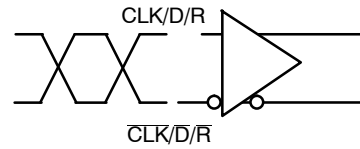


Figure 5. Differential Inputs Driven Differentially

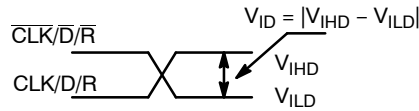


Figure 6. Differential Inputs Driven Differentially

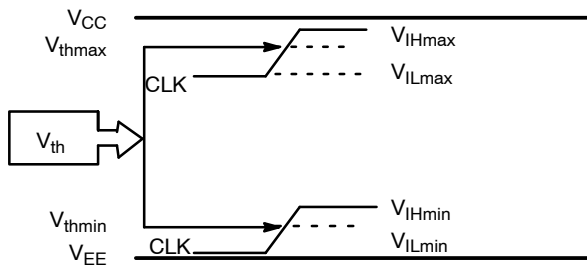


Figure 7.  $V_{th}$  Diagram

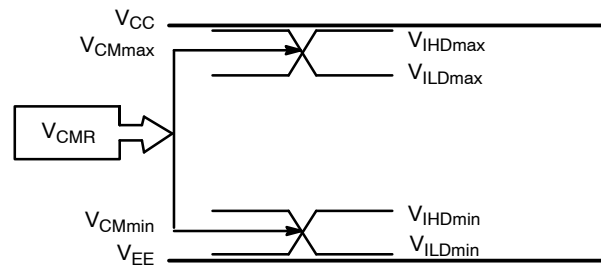


Figure 8.  $V_{CM}$  Diagram

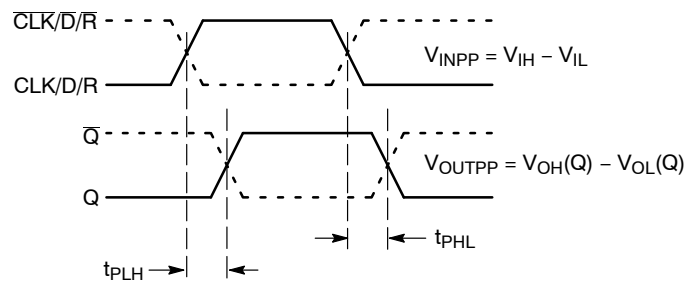
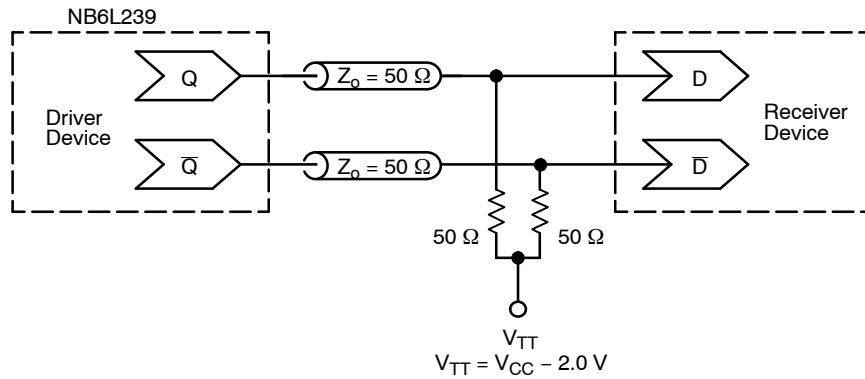


Figure 9. AC Reference Measurement

## NB4L52



**Figure 10. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)**

### ORDERING INFORMATION

| Device      | Package                       | Shipping†          |
|-------------|-------------------------------|--------------------|
| NB4L52MNG   | QFN-16, 3 x 3 mm<br>(Pb-Free) | 123 Units / Rail   |
| NB4L52MNR2G | QFN-16, 3 x 3 mm<br>(Pb-Free) | 3000 / 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.

### 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

The products described herein (NB4L52), may be covered by U.S. patents including 6,362,644. There may be other patents pending.

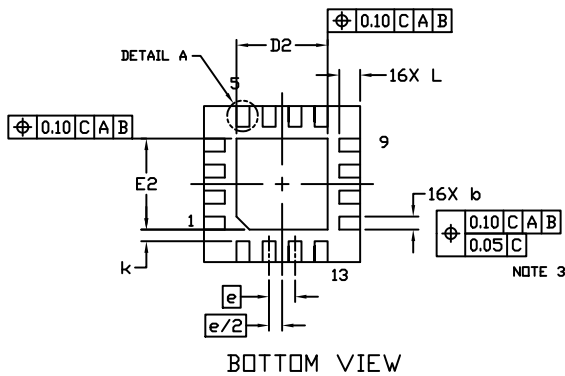
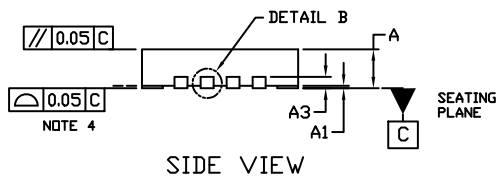
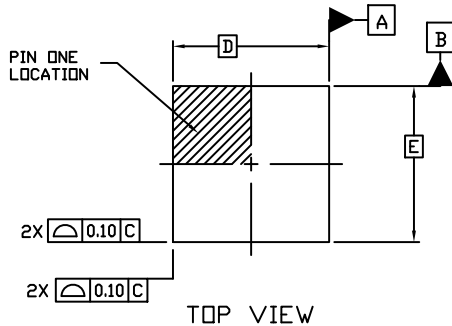
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

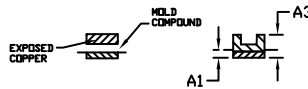
**QFN16 3x3, 0.5P**  
CASE 485G  
ISSUE G

DATE 08 OCT 2021

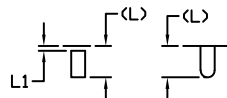


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION *b* APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.



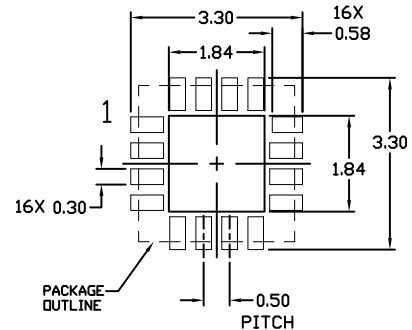
DETAIL B  
ALTERNATE  
CONSTRUCTIONS



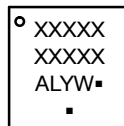
DETAIL A  
ALTERNATE TERMINAL  
CONSTRUCTIONS

| DIM      | MILLIMETERS |      |      |
|----------|-------------|------|------|
|          | MIN.        | NDM. | MAX. |
| A        | 0.80        | 0.90 | 1.00 |
| A1       | 0.00        | 0.03 | 0.05 |
| A3       | 0.20 REF    |      |      |
| <i>b</i> | 0.18        | 0.24 | 0.30 |
| D        | 3.00 BSC    |      |      |
| D2       | 1.65        | 1.75 | 1.85 |
| E        | 3.00 BSC    |      |      |
| E2       | 1.65        | 1.75 | 1.85 |
| <i>e</i> | 0.50 BSC    |      |      |
| <i>k</i> | 0.18 TYP    |      |      |
| L        | 0.30        | 0.40 | 0.50 |
| L1       | 0.00        | 0.08 | 0.15 |

**MOUNTING FOOTPRINT**



**GENERIC MARKING DIAGRAM\***



- XXXXX = Specific Device Code
- 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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| <b>DESCRIPTION:</b>     | <b>QFN16 3X3, 0.5P</b> | <b>PAGE 1 OF 1</b>   |

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