

# NCN1154

## DP3T USB 2.0 High Speed / Audio Switch with Negative Swing Capability

The NCN1154 is a DP3T switch for combined true-ground audio, USB 2.0 high speed data, and UART applications. It allows portable systems to use a single port to pass either USB data or audio signals from an external headset. The switch is capable of passing signals with negative voltages as low as 2 V below ground.

The NCN1154 features shunt resistors on the audio ports. These resistors are switched in when the audio channel is off and provide a safe path to ground for any charge that may build up on the audio lines. This reduces Pop & Click noise in the audio system. The device has an extended  $V_{CC}$  range which can operate off  $V_{CC}$  up to 4.2 V while passing true ground audio signals down to -2 V.

### Features

- 480 Mbps High Speed USB Capable
- Capable of Passing Negative Swing Signals Down to -2 V
- 1.8 V Compatible Control Pins for  $2.7\text{ V} \leq V_{CC} \leq 4.2\text{ V}$
- High USB Path Bandwidth (850 MHz)
- USB/Audio/UART
- Audio Channel Shunt Resistors for Pop & Click Noise Reduction
- Ultra Low THD in Audio Mode: 0.01% into 16  $\Omega$  Load
- 5.25 V Tolerant Common Pins
- This is a Pb-Free Device

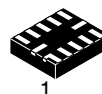
### Typical Applications

- Shared USB/UART/Audio Connector
- Mobile Phones
- Portable Devices



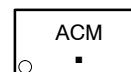
ON Semiconductor®

<http://onsemi.com>



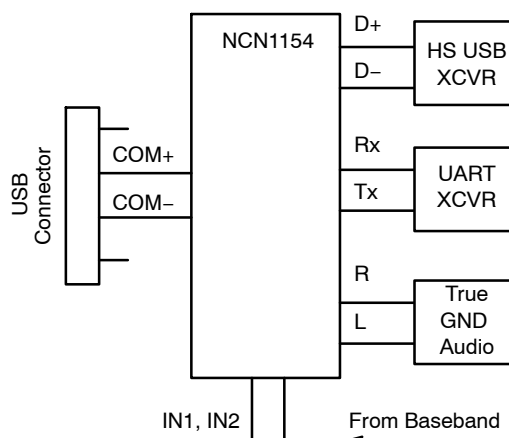
UQFN12  
MU SUFFIX  
CASE 523AE

### MARKING DIAGRAM



AC = Specific Device Code  
M = Date Code  
■ = Pb-Free Package

### APPLICATION DIAGRAM



### ORDERING INFORMATION

| Device       | Package          | Shipping†          |
|--------------|------------------|--------------------|
| NCN1154MUTAG | UQFN12 (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 Specification Brochure, BRD8011/D.

# NCN1154

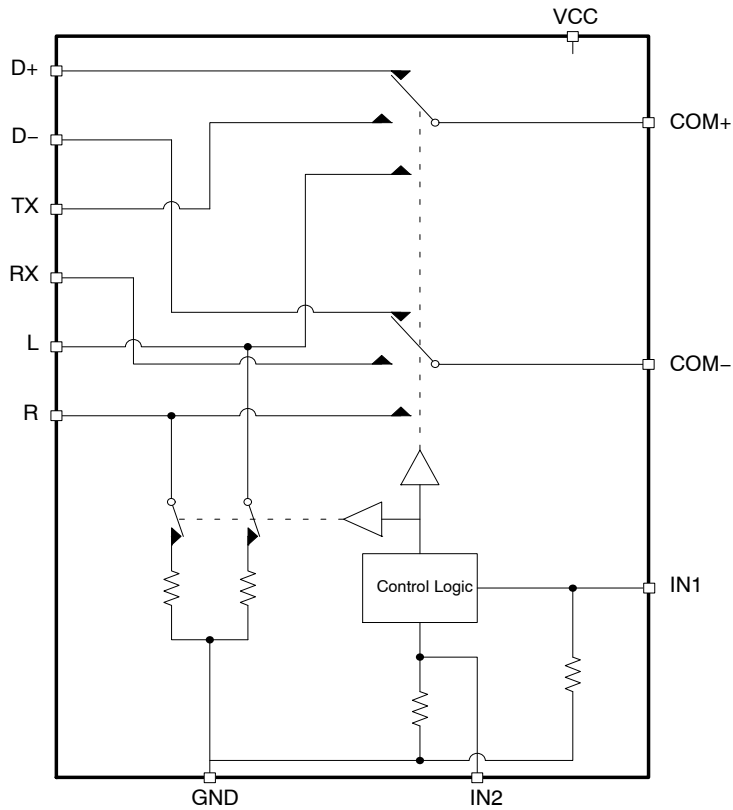


Figure 1. Functional Block Diagram

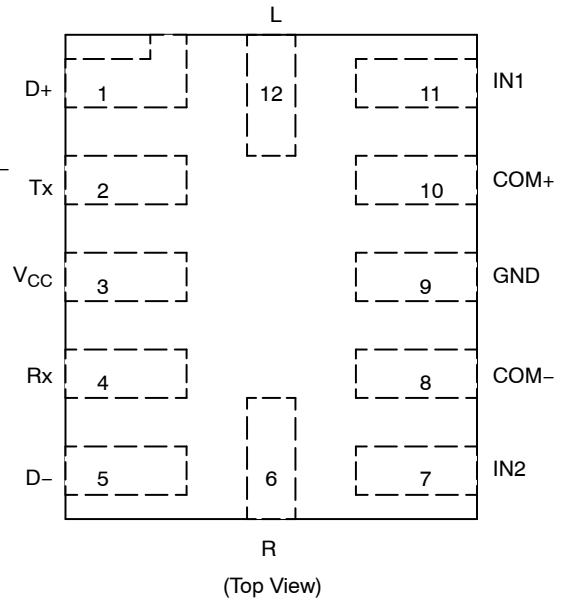


Figure 2. Pinout Diagram

## PIN DESCRIPTIONS

| Pin # | Name            | Direction | Description                             |
|-------|-----------------|-----------|-----------------------------------------|
| 1     | D+              | I/O       | Positive Data Line for USB Signals      |
| 2     | Tx              | I/O       | Transmit Data Line for UART Signals     |
| 3     | V <sub>CC</sub> | Power     | Power Supply                            |
| 4     | Rx              | I/O       | Receive Data Line for UART Signals      |
| 5     | D-              | I/O       | Negative Data Line for USB Signals      |
| 6     | R               | I/O       | Right Line for Audio Signals            |
| 7     | IN2             | Input     | Control Input Select Line               |
| 8     | COM-            | I/O       | Right Audio / Negative Data Common Line |
| 9     | GND             | Power     | Ground                                  |
| 10    | COM+            | I/O       | Left Audio / Positive Data Common Line  |
| 11    | IN1             | Input     | Control Input Select Line               |
| 12    | L               | I/O       | Right Line for Audio Signals            |

## TRUTH TABLE

| IN1 | IN2 | D+, D- | R <sub>x</sub> /T <sub>x</sub> | L, R | L, R SHUNT |
|-----|-----|--------|--------------------------------|------|------------|
| 0   | 0   | Hi Z   | Hi Z                           | Hi Z | ON         |
| 0   | 1   | ON     | Hi Z                           | Hi Z | ON         |
| 1   | 0   | Hi Z   | Hi Z                           | ON   | OFF        |
| 1   | 1   | Hi Z   | ON                             | Hi Z | ON         |

## OPERATING CONDITIONS

## MAXIMUM RATINGS

| Symbol              | Pins                             | Parameter                                       | Value                         | Unit |
|---------------------|----------------------------------|-------------------------------------------------|-------------------------------|------|
| V <sub>CC</sub>     | V <sub>CC</sub>                  | Positive DC Supply Voltage                      | –0.5 to +6.0                  | V    |
| V <sub>IS</sub>     | D+ to COM+, D– to COM–           | Analog Signal Voltage                           | –0.5 to +6.0                  | V    |
|                     | L to COM+, R to COM–             |                                                 | –2.5 to V <sub>CC</sub> + 0.5 |      |
|                     | Tx to COM+, Rx to COM–           |                                                 | –2.5 to V <sub>CC</sub> + 0.5 |      |
| V <sub>IS</sub>     | COM+, COM–                       | DC Signal Voltage Tolerance (<24 hours)         | 5.25                          | V    |
| V <sub>IN</sub>     | IN1, IN2                         | Control Input Voltage                           | –0.5 to +6.0                  | V    |
| I <sub>CC</sub>     | V <sub>CC</sub>                  | Positive DC Supply Current                      | 50                            | mA   |
| T <sub>S</sub>      |                                  | Storage Temperature                             | –65 to +150                   | °C   |
| I <sub>IS_CON</sub> | COM+, COM–, R, L, D+, D–, Rx, Tx | Analog Signal Continuous Current–Closed Switch  | ± 100                         | mA   |
| I <sub>IS_PK</sub>  | COM+, COM–, R, L, D+, D–, Rx, Tx | Analog Signal Continuous Current 10% Duty Cycle | ± 500                         | mA   |
| I <sub>IN</sub>     | IN1, IN2                         | Control Input Current                           | 1.0                           | mA   |

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.

NOTE: These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage.

## RECOMMENDED OPERATING CONDITIONS

| Symbol          | Pins                   | Parameter                  | Min  | Max             | Unit |
|-----------------|------------------------|----------------------------|------|-----------------|------|
| V <sub>CC</sub> | V <sub>CC</sub>        | Positive DC Supply Voltage | 2.7  | 5.0             | V    |
| V <sub>IS</sub> | D+ to COM+, D– to COM– | Analog Signal Voltage      | GND  | V <sub>CC</sub> | V    |
|                 | L to COM+, R to COM–   |                            | –2.0 | V <sub>CC</sub> |      |
|                 | Tx to COM+, Rx to COM– |                            | GND  | V <sub>CC</sub> |      |
| V <sub>IN</sub> | IN1, IN2               | Control Input Voltage      | GND  | V <sub>CC</sub> | V    |
| T <sub>A</sub>  |                        | Operating Temperature      | –40  | +85             | °C   |

Minimum and maximum values are guaranteed through test or design across the Recommended Operating Conditions, where applicable. Typical values are listed for guidance only and are based on the particular conditions listed for section, where applicable. These conditions are valid for all values found in the characteristics tables unless otherwise specified in the test conditions.

## DC ELECTRICAL CHARACTERISTICS

**CONTROL INPUT** Min and Max apply for T<sub>A</sub> between –40°C to +85°C and T<sub>J</sub> up to +125°C (Unless otherwise noted). Typical values are referenced to T<sub>A</sub> = +25°C, V<sub>CC</sub> = 3.3 V.

| Symbol          | Pins     | Parameter                     | Test Conditions                       | V <sub>CC</sub> (V) | –40°C to +85°C    |     |                   | Unit |
|-----------------|----------|-------------------------------|---------------------------------------|---------------------|-------------------|-----|-------------------|------|
|                 |          |                               |                                       |                     | Min               | Typ | Max               |      |
| V <sub>IH</sub> | IN1, IN2 | Control Input HIGH Voltage    |                                       | 2.7<br>3.3<br>4.2   | 1.3<br>1.4<br>1.5 | –   | –                 | V    |
| V <sub>IL</sub> | IN1, IN2 | Control Input LOW Voltage     |                                       | 2.7<br>3.3<br>4.2   | –                 | –   | 0.4<br>0.4<br>0.4 | V    |
| I <sub>IN</sub> | IN1, IN2 | Current Input Leakage Current | 0 ≤ V <sub>IS</sub> ≤ V <sub>CC</sub> |                     | –                 | –   | ±50               | nA   |

**SUPPLY CURRENT AND LEAKAGE** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ .

| Symbol           | Pins                     | Parameter         | Test Conditions                                                                                                                                                   | $V_{CC}$ (V) | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |     |           | Unit          |
|------------------|--------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------|-----|-----------|---------------|
|                  |                          |                   |                                                                                                                                                                   |              | Min                                            | Typ | Max       |               |
| $I_{NC,NO(OFF)}$ | D+, D-<br>R, L<br>Tx, Rx | OFF State Leakage | $V_{COM-}, V_{COM+} = 0\text{ V}, 4.2\text{ V}$<br>$V_{D+}, V_{D-} = 4.2\text{ V}, 0\text{ V}$ or float<br>$V_L, V_R = \text{float or } 4.2\text{ V}, 0\text{ V}$ | 4.2          |                                                |     | $\pm 80$  | nA            |
| $I_{COM(ON)}$    | COM-,<br>COM+            | ON State Leakage  | $V_{COM-}, V_{COM+} = 0\text{ V}, 4.2\text{ V}$<br>$V_{D+}, V_{D-} = 4.2\text{ V}, 0\text{ V}$ or float<br>$V_L, V_R = \text{float or } 4.2\text{ V}, 0\text{ V}$ | 4.2          |                                                |     | $\pm 100$ | nA            |
| $I_{CC}$         | $V_{CC}$                 | Quiescent Supply  | $V_{IS} = \text{GND to } V_{CC}; I_D = 0\text{ A}$                                                                                                                | 4.2          |                                                | 21  | 35        | $\mu\text{A}$ |
| $I_{OFF}$        | COM-,<br>COM+            | Power OFF Leakage | $0 \leq V_{IS} \leq 5.0\text{ V}$                                                                                                                                 | 0            |                                                |     | 50        | $\mu\text{A}$ |

**USB ON RESISTANCE** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ .

| Symbol          | Pins                     | Parameter              | Test Conditions                                             | $V_{CC}$ (V)      | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |                      |                   | Unit     |
|-----------------|--------------------------|------------------------|-------------------------------------------------------------|-------------------|------------------------------------------------|----------------------|-------------------|----------|
|                 |                          |                        |                                                             |                   | Min                                            | Typ                  | Max               |          |
| $R_{ON}$        | D+ to COM+<br>D- to COM- | On-Resistance          | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 5.5<br>5.5<br>5.5    | 7.5<br>7.5<br>7.5 | $\Omega$ |
| $R_{FLAT}$      | D+ to COM+<br>D- to COM- | On-Resistance Flatness | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 0.08<br>0.08<br>0.08 |                   | $\Omega$ |
| $\Delta R_{ON}$ | D+ to COM+<br>D- to COM- | On-Resistance Matching | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 0.03<br>0.03<br>0.03 |                   | $\Omega$ |

**AUDIO ON RESISTANCE** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ .

| Symbol          | Pins                   | Parameter                               | Test Conditions                                           | $V_{CC}$ (V)      | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |                      |                   | Unit     |
|-----------------|------------------------|-----------------------------------------|-----------------------------------------------------------|-------------------|------------------------------------------------|----------------------|-------------------|----------|
|                 |                        |                                         |                                                           |                   | Min                                            | Typ                  | Max               |          |
| $R_{ON}$        | R to COM+<br>L to COM- | On-Resistance                           | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = -1.5\text{ to } 1.5$ | 2.7<br>3.3<br>4.2 |                                                | 3.0<br>3.0<br>3.0    | 4.7<br>4.7<br>4.7 | $\Omega$ |
| $R_{FLAT}$      | R to COM+<br>L to COM- | On-Resistance Flatness                  | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = -1.5\text{ to } 1.5$ | 2.7<br>3.3<br>4.2 |                                                | 0.11<br>0.11<br>0.11 |                   | $\Omega$ |
| $\Delta R_{ON}$ | R to COM+<br>L to COM- | On-Resistance Matching                  | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = -1.5\text{ to } 1.5$ | 2.7<br>3.3<br>4.2 |                                                | 0.03<br>0.03<br>0.03 |                   | $\Omega$ |
| $R_{SH}$        | L, R                   | Shunt Resistance<br>(Resistor + Switch) | $I_{ON} = 10\text{ mA}$                                   | 2.7 – 4.2         |                                                | 118                  | 160               | $\Omega$ |

**UART ON RESISTANCE** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ .

| Symbol          | Pins                     | Parameter              | Test Conditions                                             | $V_{CC}$ (V)      | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |                      |                   | Unit     |
|-----------------|--------------------------|------------------------|-------------------------------------------------------------|-------------------|------------------------------------------------|----------------------|-------------------|----------|
|                 |                          |                        |                                                             |                   | Min                                            | Typ                  | Max               |          |
| $R_{ON}$        | Tx to COM+<br>Rx to COM- | On-Resistance          | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 5.5<br>5.5<br>5.5    | 7.5<br>7.5<br>7.5 | $\Omega$ |
| $R_{FLAT}$      | Tx to COM+<br>Rx to COM- | On-Resistance Flatness | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 0.08<br>0.08<br>0.08 |                   | $\Omega$ |
| $\Delta R_{ON}$ | Tx to COM+<br>Rx to COM- | On-Resistance Matching | $I_{ON} = 10\text{ mA}$<br>$V_{IS} = 0\text{ V to } V_{CC}$ | 2.7<br>3.3<br>4.2 |                                                | 0.03<br>0.03<br>0.03 |                   | $\Omega$ |

## AC ELECTRICAL CHARACTERISTICS

**TIMING/FREQUENCY** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ ,  $R_L = 50\ \Omega$ ,  $C_L = 35\text{ pF}$ ,  $f = 1\text{ MHz}$ .

| Symbol    | Pins                     | Parameter                      | Test Conditions                           | $V_{CC}$ (V) | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |     |     | Unit          |
|-----------|--------------------------|--------------------------------|-------------------------------------------|--------------|------------------------------------------------|-----|-----|---------------|
|           |                          |                                |                                           |              | Min                                            | Typ | Max |               |
| $t_{ON}$  |                          | Turn-ON Time (Closed to Open)  |                                           |              |                                                | 15  |     | $\mu\text{s}$ |
| $t_{OFF}$ |                          | Turn-OFF Time (Closed to Open) |                                           |              |                                                | 67  |     | ns            |
| $T_{BBM}$ |                          | Break-Before-Make Time         |                                           |              |                                                | 11  |     | $\mu\text{s}$ |
| BW        | D+ to COM+<br>D- to COM- | -3 dB Bandwidth                | $C_L = 5\text{ pF}$<br>$R_S = 50\ \Omega$ |              |                                                | 850 |     | MHz           |

**ISOLATION** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ ,  $R_L = 50\ \Omega$ ,  $C_L = 5\text{ pF}$ .

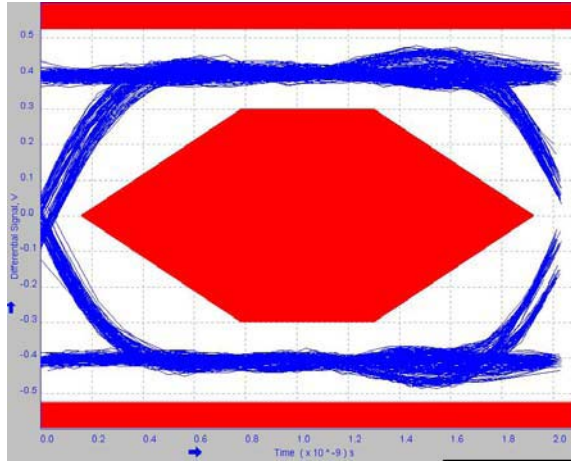
| Symbol     | Pins         | Parameter                         | Test Conditions                                                                                                   | $V_{CC}$ (V) | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |       |     | Unit |
|------------|--------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------|-------|-----|------|
|            |              |                                   |                                                                                                                   |              | Min                                            | Typ   | Max |      |
| $O_{IRR}$  | Open         | OFF-Isolation                     | $f = 100\text{ kHz}$ ,<br>$R_S = 50\ \Omega$                                                                      |              |                                                | -81   |     | dB   |
| $X_{TALK}$ | COM+ to COM- | Non-Adjacent Channel Crosstalk    | $f = 100\text{ kHz}$ ,<br>$R_S = 50\ \Omega$                                                                      |              |                                                | -93   |     | dB   |
| THD+N      |              | Total Harmonic Distortion + Noise | IN1, IN2 = 3.0 V<br>$f = 20\text{ Hz}$ to $20\text{ kHz}$<br>$V_{COM} = 0.5\text{ V}_{pp}$<br>$R_L = 600\ \Omega$ | 3.0          |                                                | 0.001 |     | %    |
| PSRR       |              | Power Supply Rejection Ratio      | $f = 10\text{ kHz}$<br>$R_{COM} = 50\ \Omega$                                                                     | 3.0          |                                                | 60    |     | dB   |

**CAPACITANCE** Min and Max apply for  $T_A$  between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $T_J$  up to  $+125^{\circ}\text{C}$  (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$ ,  $R_L = 50\ \Omega$ ,  $C_L = 5\text{ pF}$ ,  $f = 1\text{ MHz}$ .

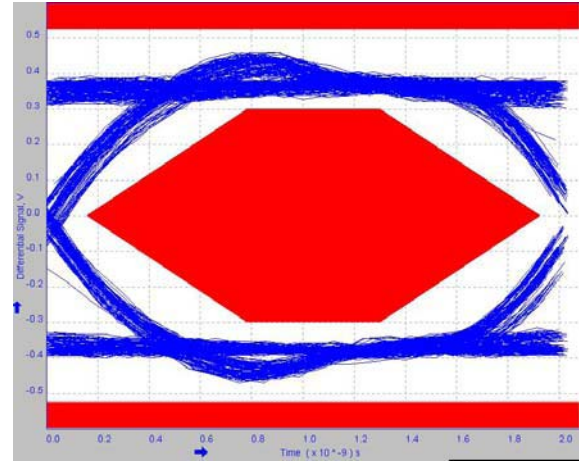
| Symbol    | Pins                             | Parameter                     | Test Conditions       | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |     |     | Unit |
|-----------|----------------------------------|-------------------------------|-----------------------|------------------------------------------------|-----|-----|------|
|           |                                  |                               |                       | Min                                            | Typ | Max |      |
| $C_{IN}$  | IN1, IN2                         | Control Pin Input Capacitance | $V_{CC} = 0\text{ V}$ |                                                | 2.0 |     | pF   |
| $C_{ON}$  | D+, Tx to COM+<br>D-, Rx to COM- | USB, UART ON Capacitance      |                       |                                                | 9.0 |     | pF   |
| $C_{ON}$  | R to COM+<br>L to COM-           | Audio ON Capacitance          |                       |                                                | 8.5 |     | pF   |
| $C_{OFF}$ | D+, D-<br>Tx, Rx                 | USB, UART OFF Capacitance     |                       |                                                | 3.5 |     | pF   |

## TABLE OF GRAPHS

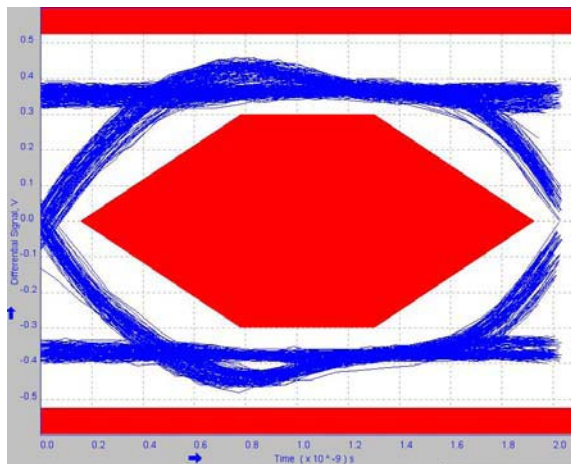
| Symbol | Parameter                      | Figure      |
|--------|--------------------------------|-------------|
| NE     | Near End Signaling Eye Diagram | 3, 4, 5, 6  |
| FE     | Far End Signaling Eye Diagram  | 7, 8, 9, 10 |



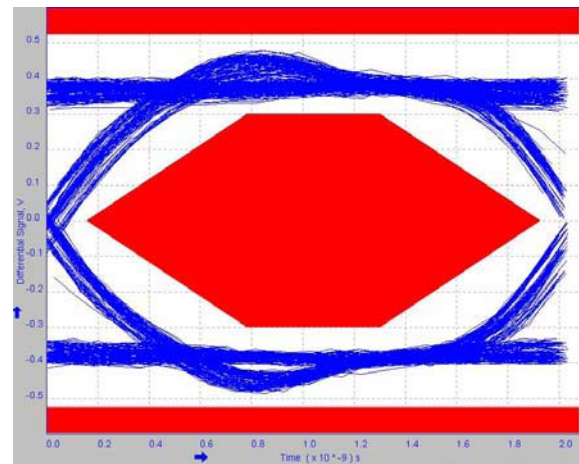
**Figure 3. Reference Near End Eye Diagram**  
(Path Trough Dedicated Line, Temp = 25°C)



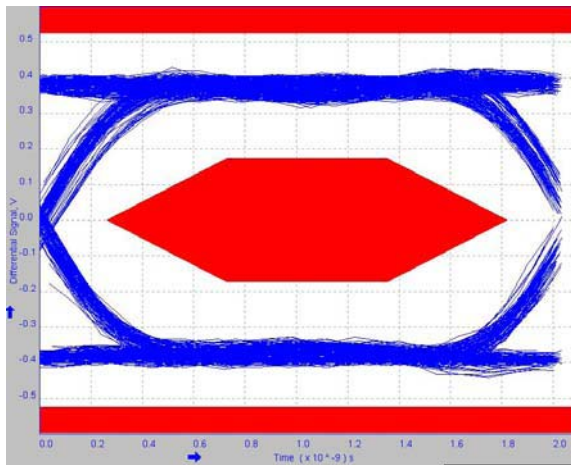
**Figure 4. USB Switch Near End Eye Diagram**  
( $V_{CC} = 3.6$  V,  $IN1 = 0$ ,  $IN2 = 1$ , Temp = 25°C)



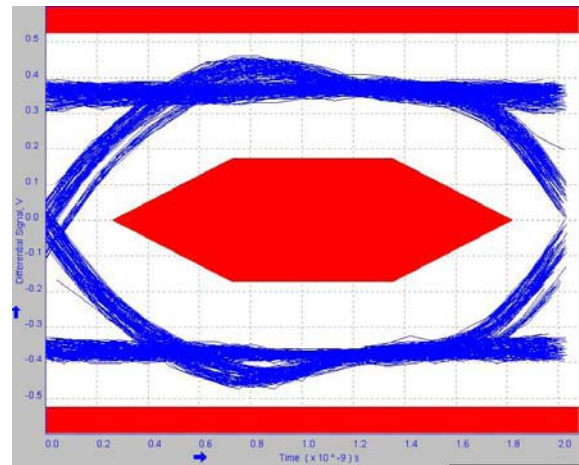
**Figure 5. UART Switch Near End Eye Diagram**  
( $V_{CC} = 3.6$  V,  $IN1 = 1$ ,  $IN2 = 1$ , Temp = 25°C)



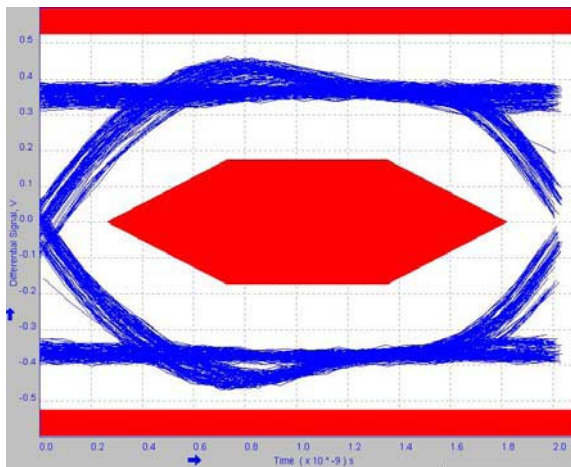
**Figure 6. Audio Switch Near End Eye Diagram**  
( $V_{CC} = 3.6$  V,  $IN1 = 1$ ,  $IN2 = 0$ , Temp = 25°C)



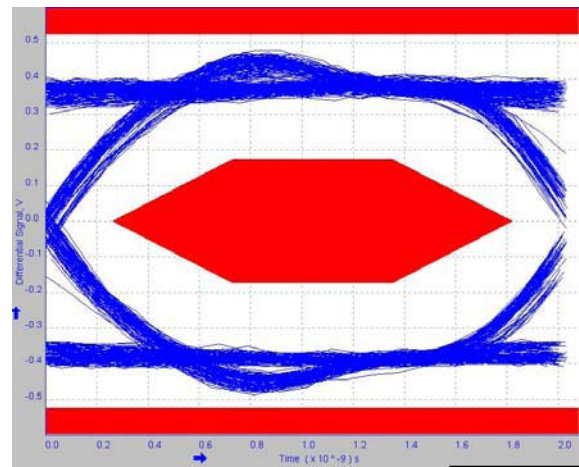
**Figure 7. Reference Far End Eye Diagram**  
(Path Trough Dedicated Line, Temp = 25°C)



**Figure 8. USB Switch Far End Eye Diagram**  
( $V_{CC} = 3.6V$ , IN1 = 0, IN2 = 1, Temp = 25°C)

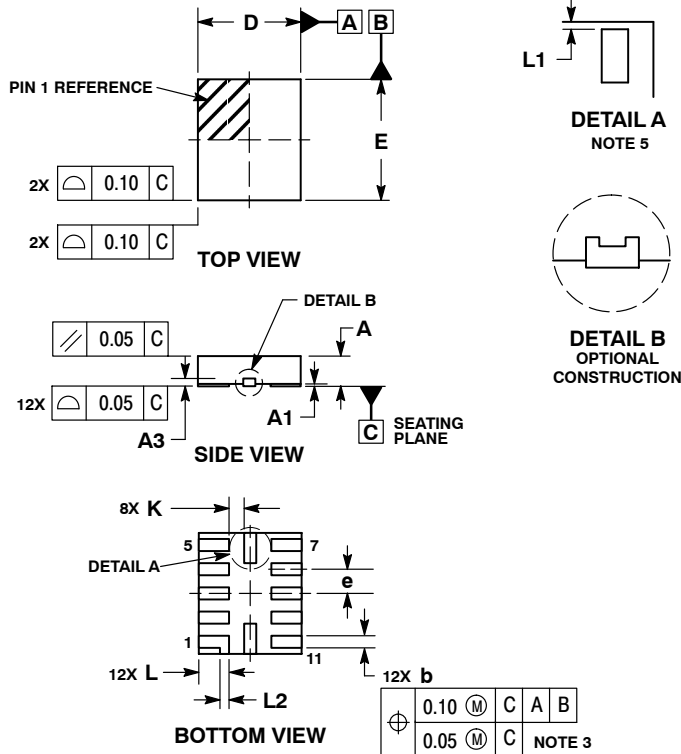


**Figure 9. UART Switch Far End Eye Diagram**  
( $V_{CC} = 3.6 V$ , IN1 = 1, IN2 = 1, Temp = 25°C)



**Figure 10. Audio Switch Far End Eye Diagram**  
( $V_{CC} = 3.6 V$ , IN1 = 1, IN2 = 0, Temp = 25°C)

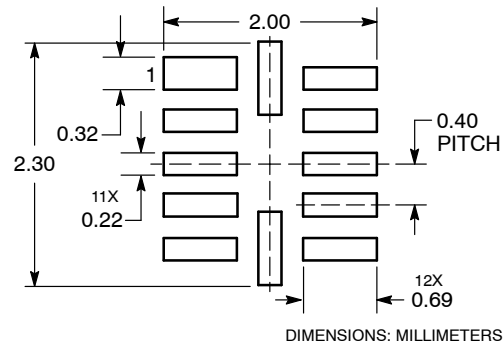
## PACKAGE DIMENSIONS

UQFN12 1.7x2.0, 0.4P  
CASE 523AE-01  
ISSUE A

## 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 TERMINAL TIP.
4. MOLD FLASH ALLOWED ON TERMINALS ALONG EDGE OF PACKAGE. FLASH 0.03 MAX ON BOTTOM SURFACE OF TERMINALS.
5. DETAIL A SHOWS OPTIONAL CONSTRUCTION FOR TERMINALS.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.45        | 0.55 |
| A1  | 0.00        | 0.05 |
| A3  | 0.127 REF   |      |
| b   | 0.15        | 0.25 |
| D   | 1.70 BSC    |      |
| E   | 2.00 BSC    |      |
| e   | 0.40 BSC    |      |
| K   | 0.20        | ---  |
| L   | 0.45        | 0.55 |
| L1  | 0.00        | 0.03 |
| L2  | 0.15 REF    |      |

MOUNTING FOOTPRINT  
SOLDERMASK DEFINED

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

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