# NL3S22S

# USB 2.0 + Audio Switch

The NL3S22S is a double−pole/double−throw (DPDT) analog switch for routing high speed differential data and audio. The high−speed data path is compliant with High Speed USB 2.0, Full Speed USB 1.1, Low Speed USB 1.0 and any generic UART protocol. The multi−purpose audio path is capable of passing signals with negative voltages as low as 2 V below ground and features shunt resistors to reduce Pop and Click noise in the audio system.

### Features

- $V_{CC}$ Range: 2.7 V to 5.5 V
- Control Pins Compatible with 1.8 V Interfaces
- $I_{CC}$: 23 μA (Typ)
- ESD Performance: 4 kV HBM
- Available in1.4 mm x 1.8 mm UQFN10
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

### High Speed Data Path

- Input Signal Range: 0 V to 3.7 V
- $R_{DS(on)}$: 5 Ω (Typ)
- $C_{ON}$: 4.5 pF (Typ)
- Data Rate: USB 2.0–Compliant – up to 480 Mbps

### Audio Path

- Input Signal Range: −2.0 V to 2.0 V
- $R_{DSON}$: 3 Ω (Typ)
- $R_{ON(FLAT)}$: 0.002 Ω (Typ)
- THD: 0.002% ($R_L$ = 16 Ω / $V_{IS}$ = 0.4 $V_{RMS}$)

### Applications

- Smartphones
- Tablets
- USB 2.0 Hosts/Peripherals
- Audio / High−Speeds Data Switching

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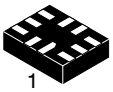
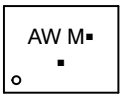
**MARKING DIAGRAM**




**UQFN10**
**CASE 488AT**




AW = Device Code
M = Date Code
▪ = Pb−Free Device

(Note: Microdot may be in either location)

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| NL3S22SMUTAG | UQFN10 (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.

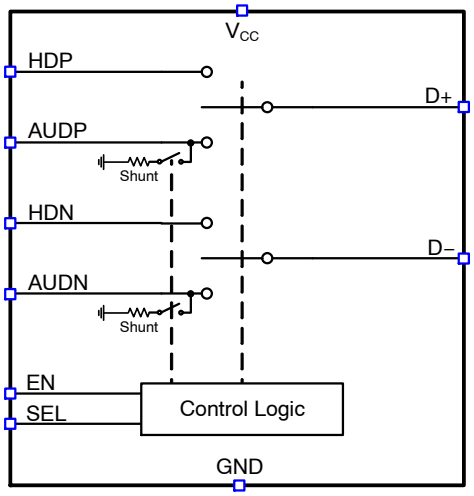



**Figure 1. Block Diagram**

**FUNCTION TABLE**

| EN | SEL | Shunt Status | D+/D− Function |
|---|---|---|---|
| 0 | X | ON | No Connect |
| 1 | 0 | OFF | AUDP/AUDN |
| 1 | 1 | ON | HDP/HDN |

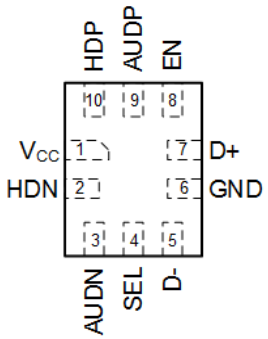



**Figure 2. UQFN10 – Top Through View**

**PIN DESCRIPTION**

| Pin Name | Pin | Description |
|---|---|---|
| $V_{CC}$ | 1 | Power Supply |
| HDN | 2 | High Speed Differential Data (−) |
| AUDN | 3 | Audio Signal (−) |
| SEL | 4 | Function Select |
| D− | 5 | Audio/Data Common I/O (−) |
| GND | 6 | Ground |
| D+ | 7 | Audio/Data Common I/O (+) |
| EN | 8 | Chip Enable |
| AUDP | 9 | Audio Signal (+) |
| HDP | 10 | High Speed Differential Data (+) |

## MAXIMUM RATINGS

| Rating | Symbol | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Positive DC Supply Voltage | | −0.3 to +6 | V |
| $V_{IS}$ | Analog Input/Output Voltage | HDP, HDN | −0.3 to +5.5 | V |
| | | AUDP, AUDN | −2.5 to $V_{CC}$ + 0.3 | |
| | | D+, D− | −2.5 to +5.5 | |
| $V_{IN}$ | Digital Control Pin Voltage on EN, SEL | | −0.3 to $V_{CC}$ + 0.3 | V |
| $T_s$ | Storage Temperature | | −55 to +150 | °C |
| $T_L$ | Lead Temperature, 1 mm from Case for 10 seconds | | 260 | °C |
| $T_J$ | Junction Temperature Under Bias | | 150 | °C |
| MSL | Moisture Sensitivity (Note 1) | | Level 1 | |
| $I_{LU}$ | Latchup Current (Note 2) | | ±100 | mA |
| ESD | ESD Protection (Note 3) | Human Body Model | 4000 | V |

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. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J−STD−020A.
2. Latch up Current Maximum Rating: ±100 mA per JEDEC standard: JESD78.
3. This device series contains ESD protection and passes the following tests:
   Human Body Model (HBM) ±4.0 kV per JEDEC standard: JESD22−A114 for all pins.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CCEN}$ | Positive DC Supply Voltage | | 2.7 | 5.5 | V |
| $V_{IS}$ | Switch Input / Output Voltage (Note 4) | HDP, HDN | 0 | 3.7 | V |
| | | AUDP, AUDN | −2.0 | 2.0 | |
| | | D+, D− | −2.0 | 3.7 | |
| $V_{IN}$ | Digital Control Input Voltage | | GND | $V_{CC}$ | V |
| $T_A$ | Operating Temperature Range | | −40 | +85 | °C |

4. f the audio channel is not in use, it is recommended that no signals are applied on the audio inputs AUDN and AUDP.

**DC ELECTRICAL CHARACTERISTICS** (Typical values are at $V_{CC}$ = +3.6 V and $T_A$ = +25 °C)

| Symbol | Parameter | Test Conditions | $V_{CC}$ (V) | −40 °C to 85 °C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| **POWER SUPPLY** | | | | | | | |
| $I_{CC}$ | Supply Current | $I_{IS}$ = 0 mA | 4.2 | – | 23 | 105 | μA |
| **Control Logic (EN, SEL)** | | | | | | | |
| $V_{IH}$ | Input High Voltage | | 4.2 | 1.5 | – | – | V |
| | | | 3.6 | 1.4 | – | – | |
| | | | 2.7 | 1.3 | – | – | |
| $V_{IL}$ | Input Low Voltage | | 4.2 | – | – | 0.4 | V |
| | | | 3.6 | – | – | 0.4 | |
| | | | 2.7 | – | – | 0.4 | |
| $V_{IHYS}$ | Input Hysteresis | | 2.7 – 5.5 | – | 250 | – | mV |
| $I_{IN}$ | Leakage Current | | 2.7 – 5.5 | – | – | ±150 | nA |
| **AUDIO SWITCH (AUDP/AUDN ↔ D+/D−)** | | | | | | | |
| $R_{ON}$ | ON−Resistance | $V_{IS}$ = −2.0 V to 2.0 V, $I_{IS}$ = 50 mA | 3.0 | – | 3 | 5 | Ω |
| $\Delta R_{ON}$ | ON−Resistance Matching Between Channels | $V_{IS}$ = −2.0 V to 2.0 V, $I_{IS}$ = 50 mA | 3.0 | – | 0.05 | – | Ω |
| $R_{FLAT(ON)}$ | ON Resistance Flatness | $V_{IS}$ = −2.0 V to 2.0 V, $I_{IS}$ = 50 mA | 3.0 | – | 0.002 | – | Ω |
| $R_{SH}$ | Shunt Resistance | | 3.6 | – | 125 | 200 | Ω |
| **DATA SWITCH (HDP/HDN ↔ D+/D−)** | | | | | | | |
| $R_{ON}$ | ON−Resistance | $V_{IS}$ = 0 V to 1.7 V, $I_{IS}$ = 15 mA | 3.0 | – | 5 | 7.5 | Ω |
| $\Delta R_{ON}$ | ON−Resistance Matching Between Channels | $V_{IS}$ = 0 V to 1.7 V, $I_{IS}$ = 15 mA | 3.0 | – | 0.02 | – | Ω |
| $R_{FLAT(ON)}$ | ON Resistance Flatness | $V_{IS}$ = 0 V to 1.7 V, $I_{IS}$ = 15 mA | 3.0 | – | 0.003 | – | Ω |
| $I_{SW(OFF)}$ | OFF−State Leakage | $V_{IS}$ = 0 V to 3.6 | 3.6 | – | – | 200 | nA |
| $I_{SW(ON)}$ | ON−State Leakage | $V_{IS}$ = 0 V to 3.6 | 3.6 | – | – | ±200 | nA |

**AC ELECTRICAL CHARACTERISTICS** (Typical values are at $V_{CC}$ = +3.6 V and $T_A$ = +25 °C)

| Symbol | Parameter | Test Conditions | $V_{CC}$ (V) | −40 °C to 85 °C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| **AUDIO SWITCH (AUDP/AUDN ↔ D+/D−)** | | | | | | | |
| THD | Audio THD | f = 20 Hz to 20 kHz, $V_{IS}$ = 0.4 $V_{RMS}$, DC Bias = 0 V, $R_L$ = 16 Ω | 2.7 − 5.5 | − | 0.002 | − | % |
| PSRR | Power Supply Ripple Rejection | From $V_{CC}$ unto AUDP/AUDN, f = 217 Hz, $R_L$ = 16 Ω | 2.7 − 5.5 | − | 118 | − | dB |
| **DATA SWITCH (HDP/HDN ↔ D+/D−)** | | | | | | | |
| $C_{ON}$ | Equivalent ON−Capacitance | Switch ON, f = 1 MHz | 3.6 | − | 4.84 | − | pF |
| $C_{OFF}$ | Equivalent OFF−Capacitance | Switch OFF, f = 1 MHz | 3.6 | − | 2.06 | − | pF |
| $D_{IL}$ | Differential Insertion Loss | f = 10 MHz | 2.7 − 5.5 | − | −0.42 | − | dB |
| | | f = 800 MHz | 2.7 − 5.5 | − | −1.89 | − | |
| | | f = 1.1 GHz | 2.7 − 5.5 | − | −3.01 | − | |
| $D_{ISO}$ | Differential Off−Isolation | f = 10 MHz | 2.7 − 5.5 | − | −60 | − | dB |
| | | f = 800 MHz | 2.7 − 5.5 | − | −15 | − | |
| | | f = 1.1 GHz | 2.7 − 5.5 | − | −15 | − | |
| $D_{CTK}$ | Differential Crosstalk | f = 10 MHz | 2.7 − 5.5 | − | −67 | − | dB |
| | | f = 800 MHz | 2.7 − 5.5 | − | −23 | − | |
| | | f = 1.1 GHz | 2.7 − 5.5 | − | −19 | − | |
| PSRR | Power Supply Ripple Rejection | From $V_{CC}$ unto D+/D−, f = 217 Hz, $R_L$ = 50 Ω | 2.7 − 5.5 | − | 108 | − | dB |
| **DYNAMIC TIMING** | | | | | | | |
| $t_{PD}$ | Propagation Delay (Notes 5 and 6) | $V_{NOn}$ or $V_{NCn}$ = 0V, $R_L$ = 50 Ω, | 2.7 − 5.5 | − | 0.25 | − | ns |
| $t_{ON}$ | Turn−On Time | $V_{IS}$ = 1 V, $R_L$ = 50 Ω, $C_L$ = 7 pF (fixture only) | 2.7 − 5.5 | | | | µs |
| | | EN or SEL to AUDP/AUDN | | − | 2.2 | − | |
| | | EN or SEL to HDP/HDN | | − | 6.2 | − | |
| $t_{OFF}$ | Turn−Off Time | $V_{IS}$ = 1 V, $R_L$ = 50 Ω, $C_L$ = 7 pF (fixture only) | 2.7 − 5.5 | | | | ns |
| | | EN or SEL to AUDP/AUDN | | − | 67 | − | |
| | | EN or SEL to HDP/HDN | | − | 1200 | − | |
| $t_{sk(b-b)}$ | Bit to bit skew | Within the same differential channel | 2.7 − 5.5 | − | 5 | − | ps |
| $t_{sk(ch-ch)}$ | Channel to channel skew | Maximum skew between all channels | 2.7 − 5.5 | − | 5 | − | ps |

5. Guaranteed by design.
6. No other delays than the RC network formed by the load resistance and the load capacitance of the switch are added on the bus. For a 10 pF load, this delay is 5 ns which is much smaller than rise and fall time of typical driving systems. Propagation delays on the bus are determined by the driving circuit on the driving side and its interactions with the load of the driven side.

## PARAMETER MEASUREMENT INFORMATION

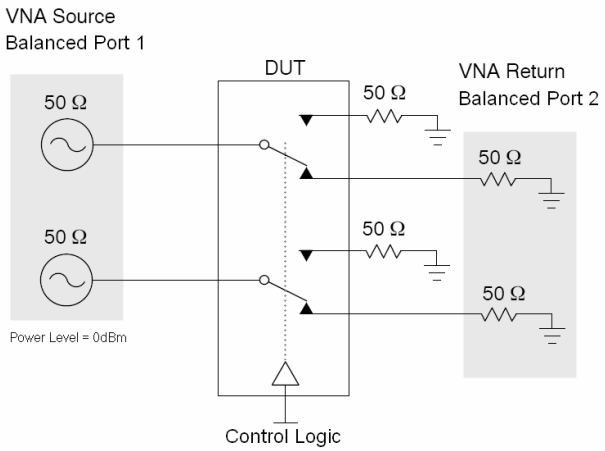



**Figure 3. Differential Insertion Loss ($S_{DD21}$)**

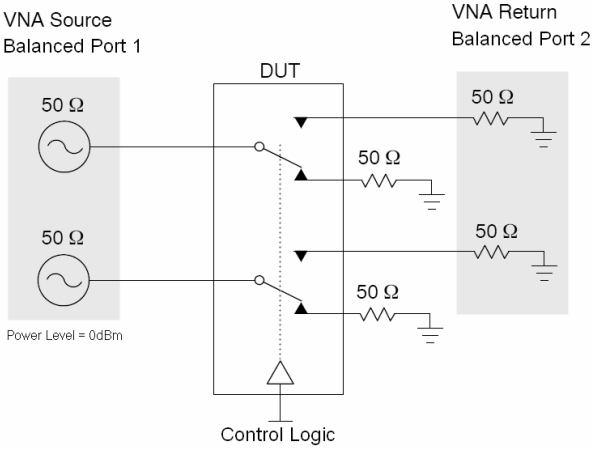



**Figure 4. Differential Off Isolation ($S_{DD21}$)**

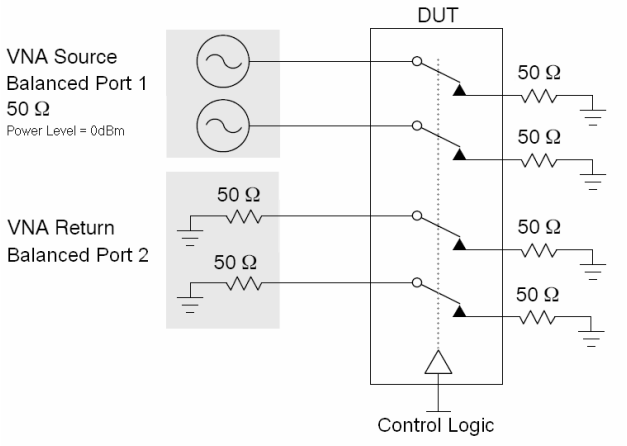
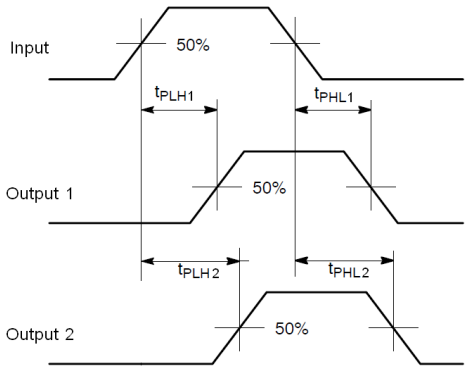
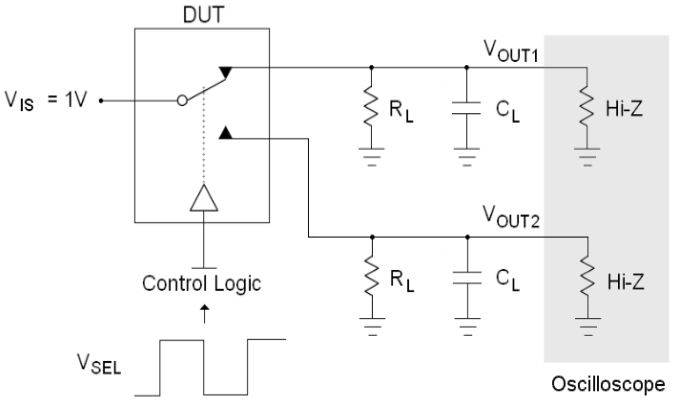



**Figure 5. Differential Crosstalk ($S_{DD21}$)**




$t_{skew} = |t_{PLH1}\text{-}t_{PLH2}|$ or $|t_{PHL1}\text{-}t_{PHL2}|$

**Figure 6. Bit−to−Bit and Channel−to−Channel Skew**



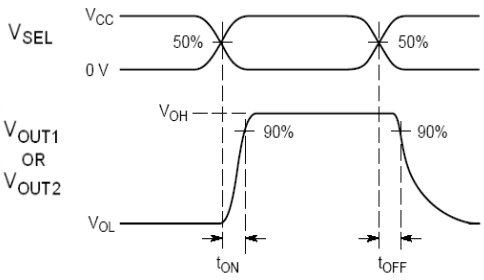




**Figure 7. $t_{ON}$ and $t_{OFF}$**

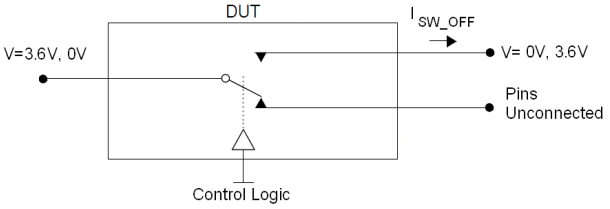



**Figure 8. Off State Leakage**

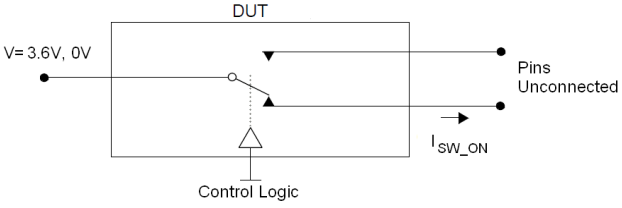



**Figure 9. On State Leakage**

## TYPICAL OPERATING CHARACTERISTICS

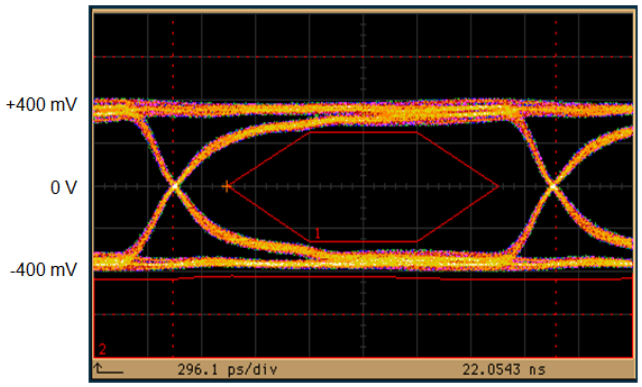



**Figure 10. USB 2.0 High Speed Eye Diagram**

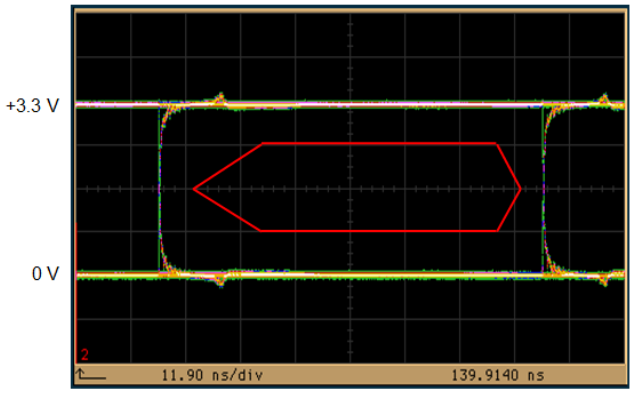



**Figure 11. USB 1.1 Full Speed Eye Diagram**

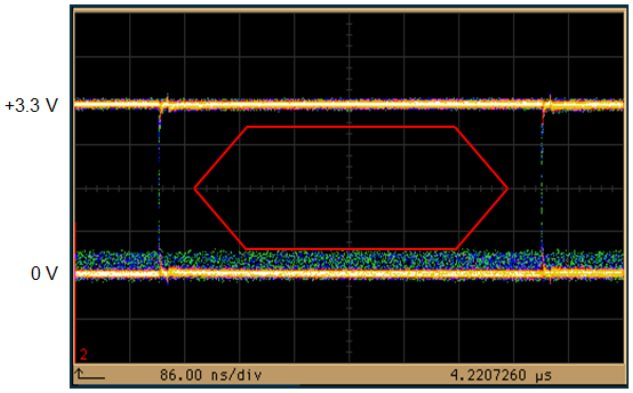



**Figure 12. USB 1.0 Low Speed Eye Diagram**

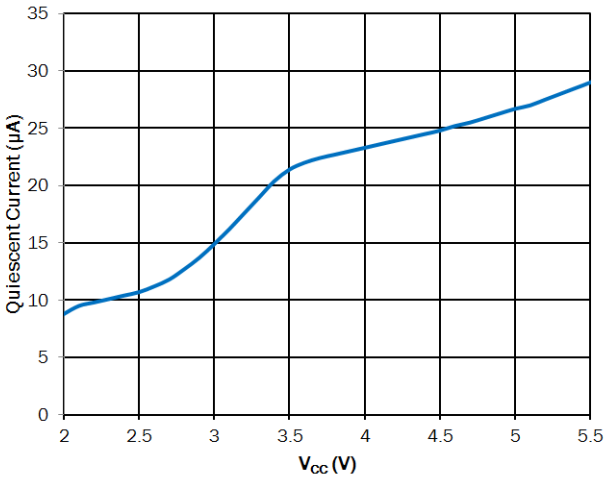



**Figure 13. Product Supply Current**

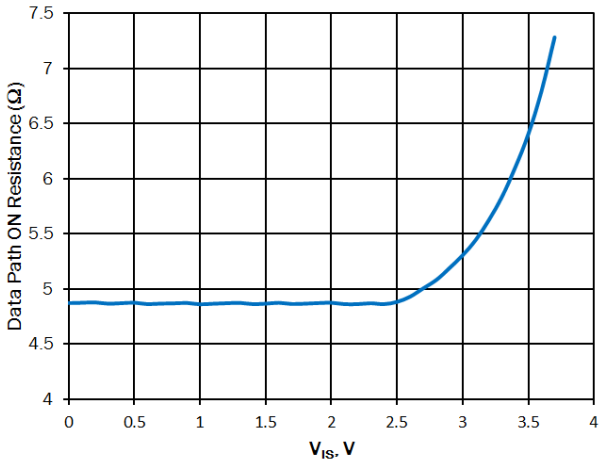



**Figure 14. Data Path On Resistance**

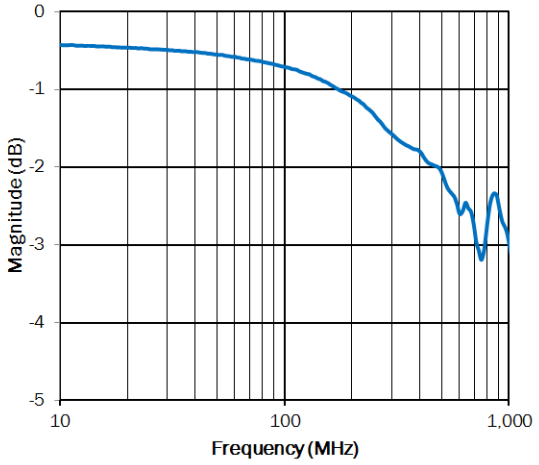



**Figure 15. Data Switch Differential Insertion Loss**

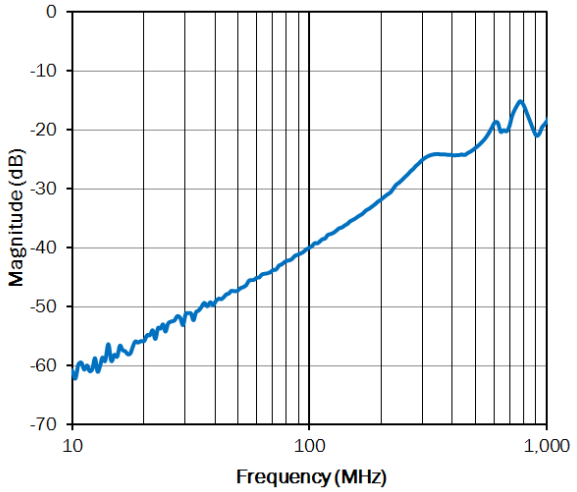



**Figure 16. Data Switch Differential Off−Isolation**

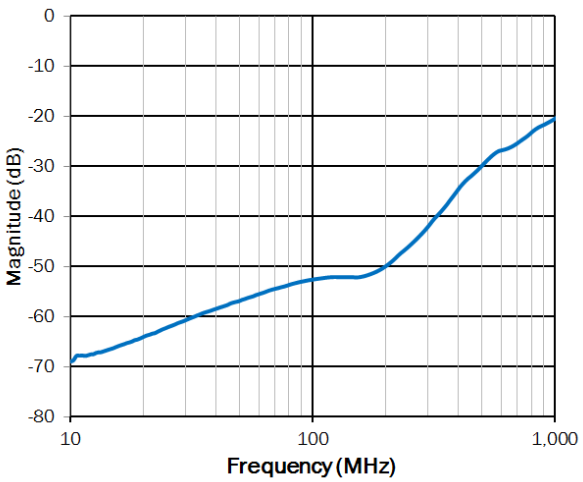



**Figure 17. Data Switch Differential Crosstalk**

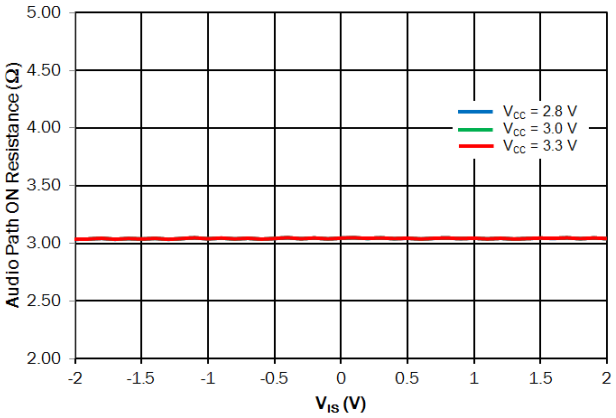



**Figure 18. Audio Path On Resistance**

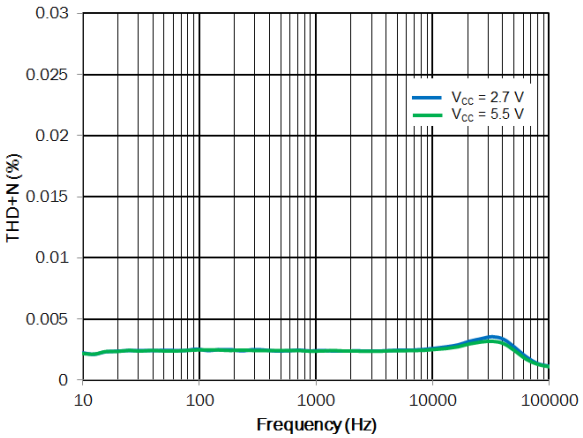
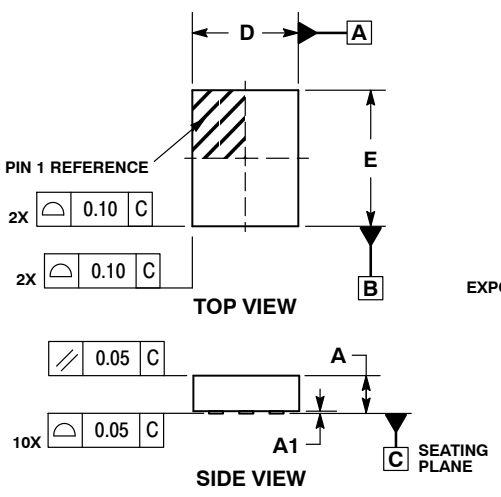
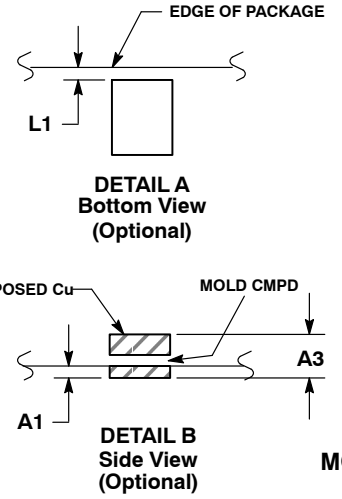



**Figure 19. Audio THD**

## PACKAGE DIMENSIONS

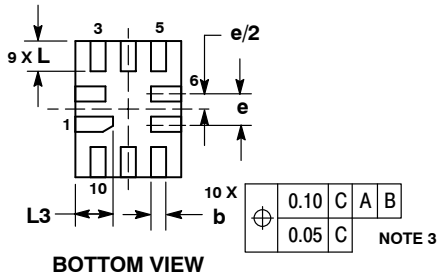
**UQFN10 1.4x1.8, 0.4P**
CASE 488AT
ISSUE A



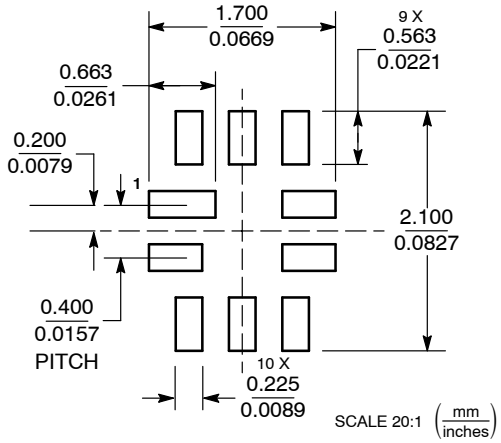




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.45 | 0.60 |
| A1 | 0.00 | 0.05 |
| A3 | 0.127 REF | |
| b | 0.15 | 0.25 |
| D | 1.40 BSC | |
| E | 1.80 BSC | |
| e | 0.40 BSC | |
| L | 0.30 | 0.50 |
| L1 | 0.00 | 0.15 |
| L3 | 0.40 | 0.60 |




**MOUNTING 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.



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