# DIO32020

# USB2.0 High-Speed and Audio/USB/UART Switch with Negative Swing Capacity

## Features

- Low Ron Audio/USB analog switch
- Low USB Con: 7pF
- Negative Signal Swing Capable
- Low Audio Distortion
- USB Switch -3dB Bandwidth: 1100MHz
- High Crosstalk and Off-isolation
- Voltage Supply Operation: 2.7 to 5.5V
- Three Green Packages: DQFN-10, QFN-10, MSOP-10

## Applications

- Cell-Phone/PDA
- MP3/MP4/PMP
- Portable Instrumentation
- Battery Powered Communications
- Computer Peripherals

## Descriptions

The DIO32020 is dual SPDT (Single Pole/Double Throw) switch which combines low distortion audio/USB/UART and USB2.0 high-speed data signal switching in the same low voltage device. This architecture is designed to allow negative signal passing as low as 3V below ground. When a voltage is detected on $V_{BUS}$, DIO32020 will immediately switch to USB mode. Due to ultra low capacitance design, the audio channels (pin 3 and pin 4 input/outputs) are able to not only switch audio signal but also high speed USB signal or low voltage UART signal as well.

DIO32020 provides packages with Green or RoHS tiny 10L packages, and operates over a temperature range of -40°C to 85°C.

## Block Diagram
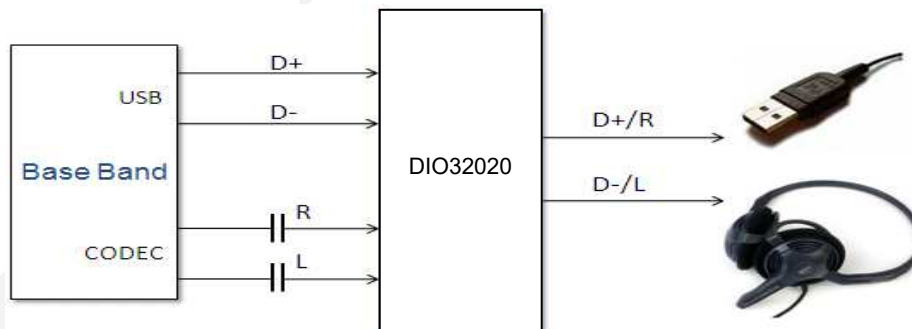


## Ordering Information

| Order Part Number | Top Marking | | $T_A$ | | Package |
|---|---|---|---|---|---|
| DIO32020LP10 | YW0A | Green | -40 to 85°C | DQFN-10 | Tape & Reel, 3000 |
| DIO32020QN10 | YW0A | Green | -40 to 85°C | QFN-10 | Tape &Reel, 3000 |
| DIO32020MP10 | D32020 | Green | -40 to 85°C | MSOP-10 | Tape &Reel, 3000 |

# DIO32020

## Pin Assignment

**DQFN-10**

**MSOP-10**

**QFN-10**
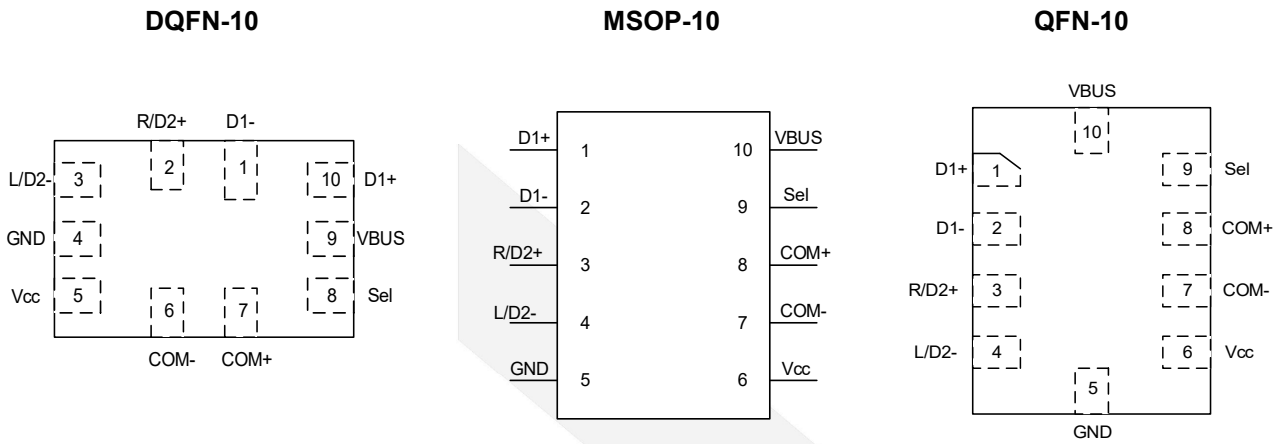
**Figure 1 Top View**

## Pin Descriptions

| Pin Name | Direction | Description |
|----------|-----------|-------------|
| D1+, D1- | I/O | Differential USB Data Input 1 |
| R/D2+, L/D2- | I/O | Audio R/L or differential USB data input 2 |
| V$_{BUS}$ | I | Switch Select |
| COM+/COM- | I/O | Data/Audio Common Port |
| Sel | I | Control Input |
| Vcc/ GND | P | Power |

## Truth Table

| Sel | V$_{BUS}$ | L/D2-, R/D2+ | D1+, D1- |
|-----|-----------|--------------|----------|
| Low | Low | ON | OFF |
| Low | High | OFF | ON |
| High | X | ON | OFF |

**DIO32020**

# Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Symbol | Parameter | | Rating | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | -0.5 to 6.5 | V |
| $V_{BUS}$ | $V_{BUS}$ Control Input Voltage | | -0.5 to 6.5 | V |
| $V_{IN}$ | $A_{SEL}$ Control Input Voltage | | -0.5 to 6.5 | V |
| $V_{SW}$ | USB Path Analog Signal Voltage | | -0.5 to 6.5 | V |
| | Audio Path Analog Signal Voltage | | -3.5 to 6.5 | |
| | Storage Temperature | | -65 to 150 | °C |
| $I_{IN}$ | $A_{SEL}$ Control Input Current | | 5 | µA |
| | $V_{BUS}$ Control Input Current | | 5 | |
| $I_{SW\_CON}$ | Analog Signal Continuous Current | | ±100 | mA |
| $I_{SW\_PK}$ | Analog Signal Peak Current | | ±500 | mA |
| ESD | HBM, JEDEC: JESD22-A114 | I/O to GND | 5 | kV |
| | | Others | 8 | |

# Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not Recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 2.7 to 5.5 | V |
| $V_{IN}$ | $V_{BUS}$ Control Input Voltage | 0 to 5.5 | V |
| | $A_{SEL}$ Control Input Voltage | 0 to $V_{CC}$ | |
| $V_{SW}$ | USB to COM Analog Signal Voltage | 0 to $V_{CC}$ | V |
| | Audio to COM Analog Signal Voltage | -3 to $V_{CC}$ | |
| $T_A$ | Operating Temperature Range | -40 to 85 | °C |

# DC Electrical Characteristics

All typical value are at $T_A$ = 25°C unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **CONTROL INPUT** ($T_A$=25°C, $V_{CC}$=3.3V) | | | | | | |
| $V_{IH}$ | $A_{SEL}$ Control Input High Voltage | $V_{CC}$=2.7-4.2V | 1.3 | | | V |
| $V_{IL}$ | $A_{SEL}$ Control Input Low Voltage | $V_{CC}$=2.7-4.2V | | | 0.5 | V |
| $I_{IN}$ | $A_{SEL}$ Control Input Leakage Current | $0 \leq V_{SW} \leq V_{CC}$ | | 1 | 2 | µA |
| $V_{IH}$ | $V_{BUS}$ Control Input High Voltage | $V_{CC}$=2.7-4.2V | 1.3 | | | V |
| $V_{IL}$ | $V_{BUS}$ Control Input Low Voltage | $V_{CC}$=2.7-4.2V | | | 0.5 | V |
| $I_{IN}$ | $V_{BUS}$ Control Input Leakage Current | $0 \leq V_{SW} \leq V_{CC}$ | | 1 | 2 | µA |
| $R_{VBUS\_PD}$ | $V_{BUS\_CTRL}$ Pull down Resistance | $I_{ON}$=10mA | | 4000 | | kΩ |
| **SUPPLY CURRENT AND LEAKAGE** ($T_A$=25°C, $V_{CC}$=3.3V) | | | | | | |
| $I_{OZ-USB}$ | Off Leakage Current of port DN/DP | DN/DP=0V to 4.2V, R, L, COM+, COM- float | -1 | | 1 | uA |
| $I_{OZ-AUDIO}$ | Off Leakage Current of port R/L | R/L=-3V to 3V, DN, DP, COM+, COM- float | -1 | | 1 | uA |
| $I_{ON-USB}$ | On Leakage Current of USB Switch | COM+/COM- =0V to 4.2V, R, L, DN, DP float | -1 | | 1 | uA |
| $I_{ON-AUDIO}$ | On Leakage Current of AUDIO Switch | COM+/COM- =-3V to 3V, R, L, DN, DP float | -1 | | 1 | uA |
| $I_{off}$ | Power off leakage | $V_{CC}$=0V | -1 | | 1 | uA |
| $I_{CC}$ | Quiescent Supply | | | 18 | 35 | µA |
| **USB SWITCHES (D+, D-)** ($T_A$=25°C, $V_{CC}$=3.3V) | | | | | | |
| $R_{ON}$ | On Resistance | $I_{ON}$=10mA, $V_{SW}$=0V to $V_{CC}$ | | 3.8 | | Ω |
| $R_{FLATE}$ | On Resistance Flatness | $I_{ON}$=10mA, $V_{SW}$=0V to $V_{CC}$ | | 15 | | mΩ |
| $\Delta R_{ON}$ | On Resistance Matching | $I_{ON}$=10mA, $V_{SW}$=0V to $V_{CC}$ | | 100 | | mΩ |
| **AUDIO SWITCHES (R, L)** ($T_A$=25°C, $V_{CC}$=3.3V) | | | | | | |
| $R_{ON}$ | On Resistance | $I_{ON}$=100mA, $V_{SW}$=-3 to 3V | | 0.8 | | Ω |
| $R_{FLATE}$ | On Resistance Flatness | $I_{ON}$=100mA, $V_{SW}$=-3 to 3V | | 2 | | mΩ |
| $\Delta R_{ON}$ | On Resistance Matching | $I_{ON}$=100mA, $V_{SW}$=-3 to 3V | | 50 | | mΩ |

# Electrical Characteristics (Continued)

All typical value are at $T_A$ =25°C unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Parameter** ($T_A$=25°C, $V_{CC}$=3.3V, $R_L$=50Ω, $C_L$=5pF, unless otherwise specified) | | | | | | |
| $t_{ON}$ | USB Turn-on Time | DP=DN=1.5V, $R_L$=50Ω, $C_L$=35pF | | 32 | | µs |
| | Audio Turn-on Time | L=R=1.5V, $R_L$=50Ω, $C_L$=35pF | | 32 | | µs |
| $t_{OFF}$ | USB Turn-off Time | DP=DN=1.5V, $R_L$=50Ω, $C_L$=35pF | | 100 | | ns |
| | Audio Turn-off Time | L=R=1.5V, $R_L$=50Ω, $C_L$=35pF | | 150 | | ns |
| $T_{BBM}$ | Break Before Make Time | Audio off to USB on | | 30 | | µs |
| | | USB off to Audio on | | 30 | | µs |
| BW | -3dB Bandwidth USB Channel | $R_L$=50Ω, $C_L$=5pF | | 1100 | | MHz |
| OIRR | USB OFF-Isolation | $V_{SW}$=1$V_{RMS}$, $R_L$=50Ω, f=240MHz | | -23 | | dB |
| | Audio OFF-Isolation | $V_{SW}$=1$V_{RMS}$, $R_L$=50Ω, f=1kHz | | -110 | | dB |
| $X_{TALK}$ | USB Crosstalk | $R_L$=50Ω, f=240MHz | | -45 | | dB |
| | Audio Crosstalk | $R_L$=50Ω, f=1kHz | | -80 | | dB |
| THD+N | Total Harmonic Distortion + Noise | $R_L$=600Ω, f=1kHz, $V_{SW}$=2$V_{RMS}$, With A-weighted | | -110 | | dB |
| | | $R_L$=32Ω, f=1kHz, $V_{SW}$=1$V_{RMS}$, With A-weighted | | -100 | | |
| | | $R_L$=16Ω, f=1kHz, $V_{SW}$=0.5$V_{RMS}$, With A-weighted | | -100 | | |
| PSRR | Power Supply Rejection Ratio | f=10kHz, $R_{COM}$=50Ω | | -75 | | dB |
| **CAPACITANCE** ($T_A$=25°C, $V_{CC}$=3.3V, $R_L$=50Ω, $C_L$=5pF, f=1MHz, $A_{SEL}$=0V, unless otherwise specified) | | | | | | |
| $C_{IN}$ | $A_{SEL}$ Control Input Capacitance | $V_{CC}$= 0V | | 2 | | pF |
| $C_{ON}$ | USB ON Capacitance | f=1MHz, $V_{BUS}$=VDD, $V_{SEL}$=LOW, $V_{D-}$ or $V_{D+}$ = $V_{COMX}$ = 0V | | 7 | | pF |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $C_{ON}$ | Audio ON Capacitance | $V_{BUS}$=LOW, $V_{SEL}$=LOW | | | 7 | | pF |
| $C_{OFF}$ | USB OFF Capacitance | $V_{BUS}$=VDD, $V_{SEL}$=LOW | | | 3 | | pF |
| $C_{OFF}$ | Audio OFFCapacitance | $V_{BUS}$=LOW, $V_{SEL}$=LOW | | | 4 | | pF |

# Typical Performance Characteristics

$T_A$=25°C, Vcc=3.3V, unless other otherwise specified.
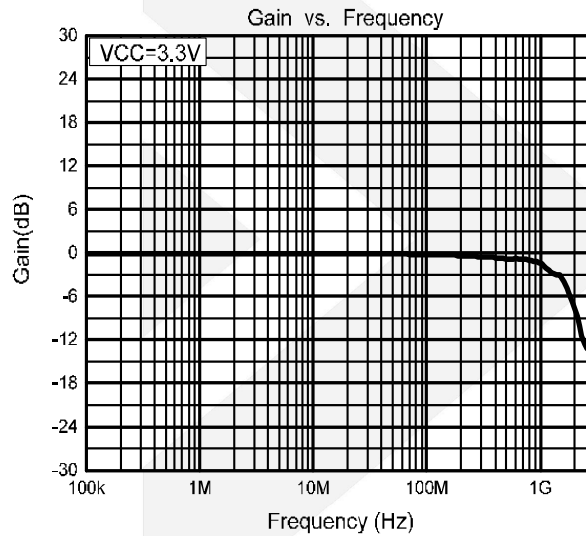


## DIO32020 USB 2.0 high speed (480Mbps) eye pattern
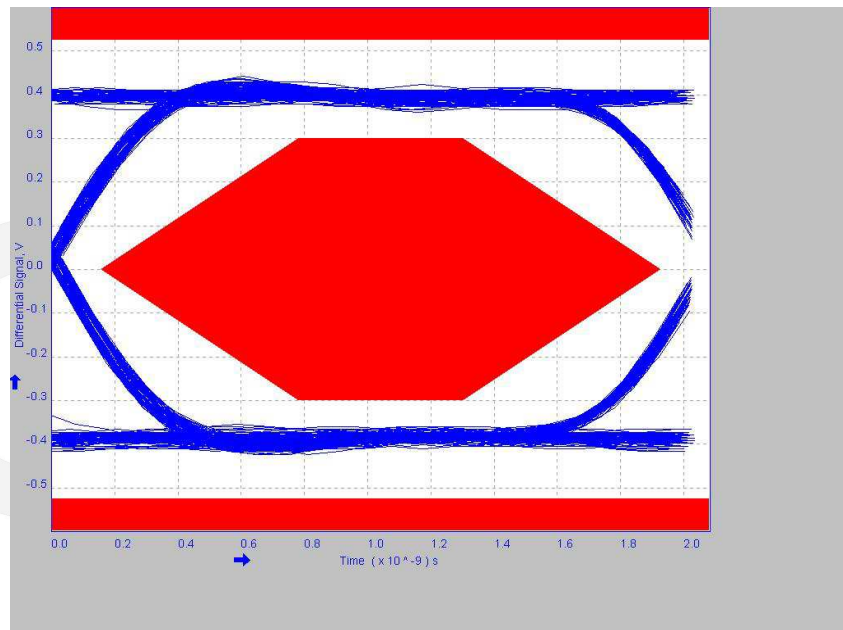


**TIME SCALE (0.2ns/DIV)**

**Figure 2 Eye Pattern: 480Mbps with USB switch In signal path**
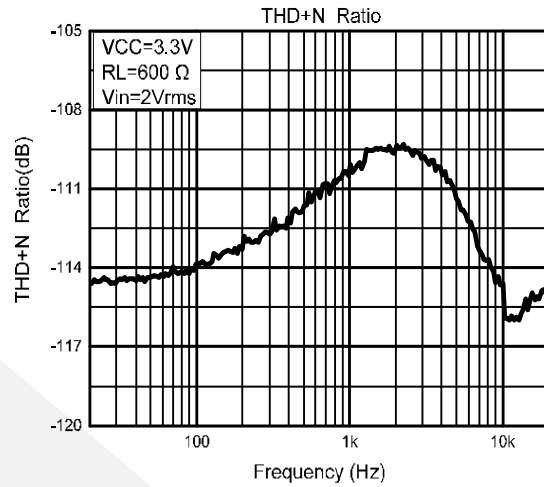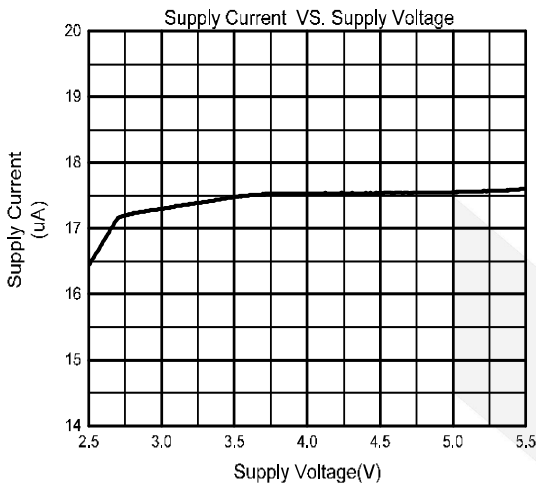
## Applications Design Guide

DIO32020 is used in applications where the slim and thin smart phone designs are expected. By sharing the USB connector between USB2.0 data lines and audio headphone outputs, the designers can eliminate the using of bulky headphone jacks. Meanwhile, using the mini-USB connectors as audio outputs allows the end users to reduce the cost to buy too many different types of cell phone accessories.

DIO32020 unique architectures allow the part to allow the part to have constant Ron, Ron (flatness) and THD performance independent of Vcc supply value. So in some applications such as mobile cell phone designs, if the designers want to achieve the lowest standby power consumption when the battery is turned OFF, it is highly recommended that DIO32020 be powered by 2.8V, no need of being powered by battery (4.3V) directly. This will help designers to be freed from the complex logic designs to ensure the part will get into sleep mode.

DIO32020's control pins are 1.8V control logic compatible, so the parts can be controlled by baseband processor GPIO directly without worrying about the level shifting issues. Regarding high speed signal integrity, DIO32020 is recommended to be placed as close as possible to the USB controller outputs to reduce the signal reflection under high speed mode (480Mbps). In the meanwhile, the Vcc pin of DIO32020 is required to have decoupling capacitors to reduce the supply ripples.

The below is the DIO32020 USB 2.0 high speed (480Mbps) eye diagram compliance test under near-end mode (most challenging mode).
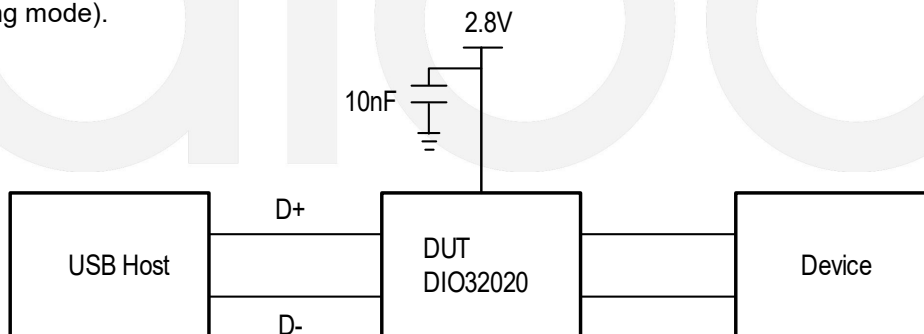


**Figure 3 USB2.0 high speed eye diagram test circuit**

# DIO32020

DIO32020 features not only 100dB total harmonic distortion (THD), but also superior off isolation capability. When DIO32020 is powered under audio mode, audio channel can pass at least -3V negative audio signal with up to 100dB THD performance. Under USB mode or device being powered OFF($V_{CC}=0$), the negative audio signal on audio ports can be isolated as well to allow flexible design needs.

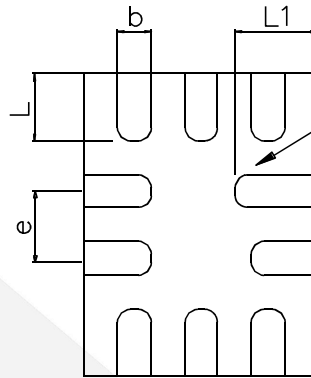**USB2.0 High-Speed and Audio Switch with Negative Swing Capacity**

# DIO32020

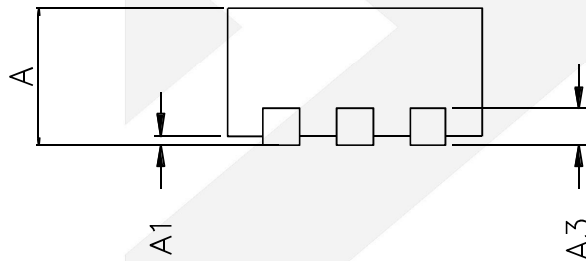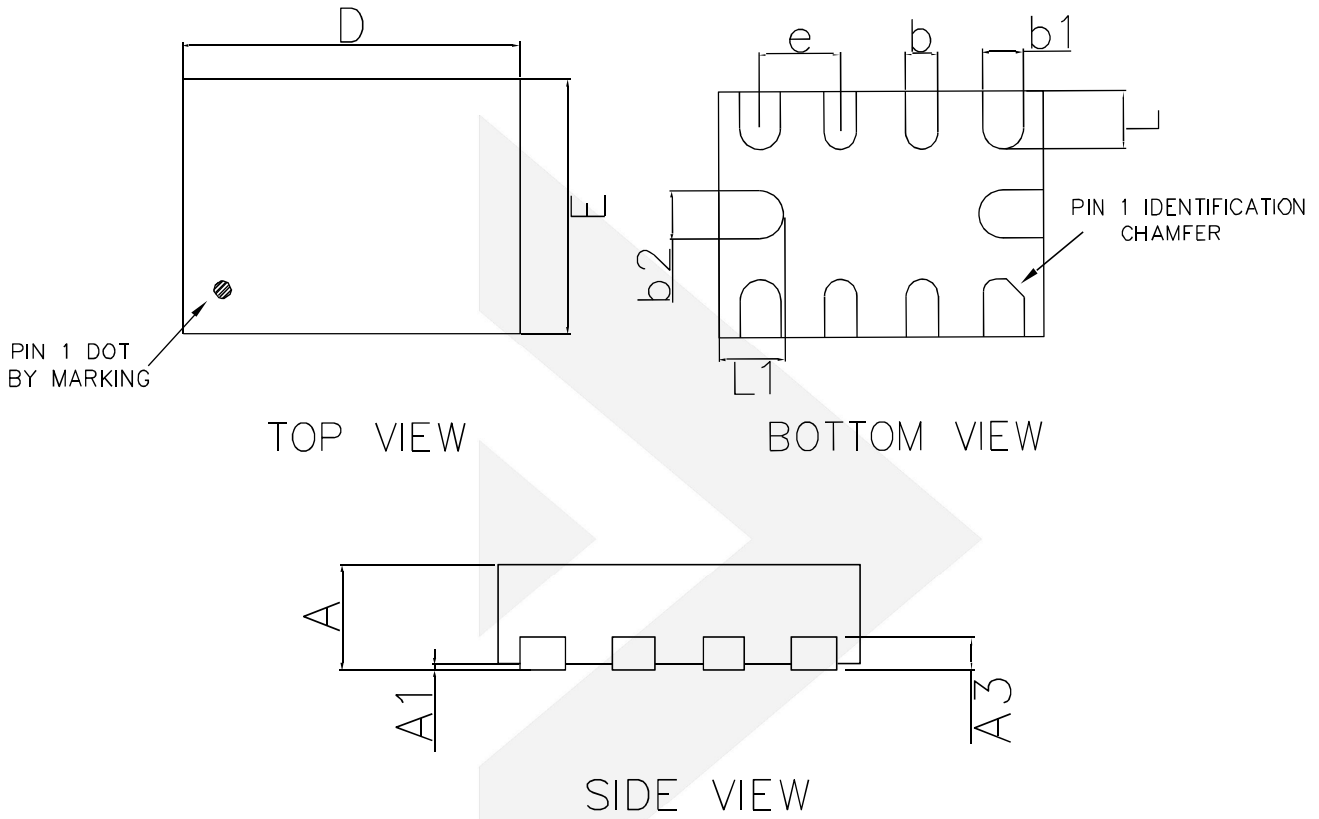## Physical Dimensions: DQFN-10

PIN 1 DOT
BY MARKING

D

E

PIN 1 IDENTIFICATION

b    L1

L

e
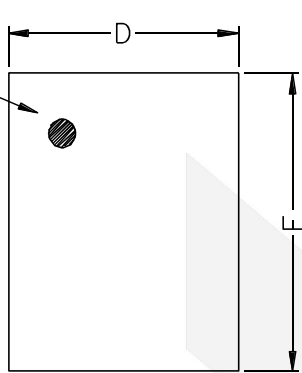
TOP VIEW          BOTTOM VIEW

A

A1

A3

| COMMON DIMENSIONS(MM) | | | |
|---|---|---|---|
| PKG. | UT:ULTRA THIN | | |
| REF. | MIN. | NOM | MAX |
| A | 0.5 | 0.55 | 0.6 |
| A1 | 0 | | 0.05 |
| A3 | 0.15REF. | | |
| D | 1.35 | 1.4 | 1.45 |
| E | 1.75 | 1.8 | 1.85 |
| b | 0.15 | 0.2 | 0.25 |
| L | 0.3 | 0.4 | 0.5 |
| L1 | 0.4 | 0.5 | 0.6 |
| e | 0.4BSC | | |

## Physical Dimensions: QFN-10

TOP VIEW

PIN 1 DOT BY MARKING

BOTTOM VIEW

PIN 1 IDENTIFICATION CHAMFER

SIDE VIEW

| COMMON DIMENSIONS(MM) | | | |
|---|---|---|---|
| **PKG.** | **UT:ULTRA THIN** | | |
| **REF.** | **MIN.** | **NOM** | **MAX** |
| A | 0.50 | 0.55 | 0.60 |
| A1 | 0.00 | | 0.05 |
| A3 | 0.15REF. | | |
| D | 1.95 | 2.00 | 2.05 |
| E | 1.45 | 1.50 | 1.55 |
| b | 0.15 | 0.20 | 0.25 |
| b1 | 0.20 | 0.25 | 0.30 |
| b2 | 0.25 | 0.30 | 0.35 |
| L | 0.30 | 0.35 | 0.40 |
| L1 | 0.35 | 0.40 | 0.45 |
| e | 0.50 BSC | | |

## Physical Dimensions: MSOP-10



**USB2.0 High-Speed and Audio Switch with Negative Swing Capacity**
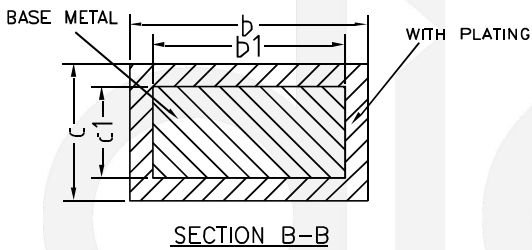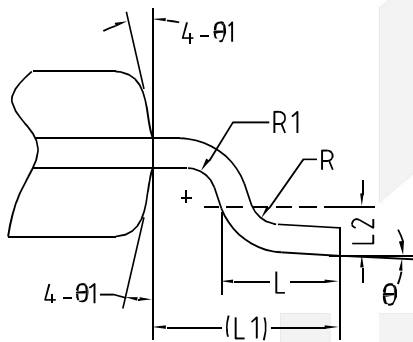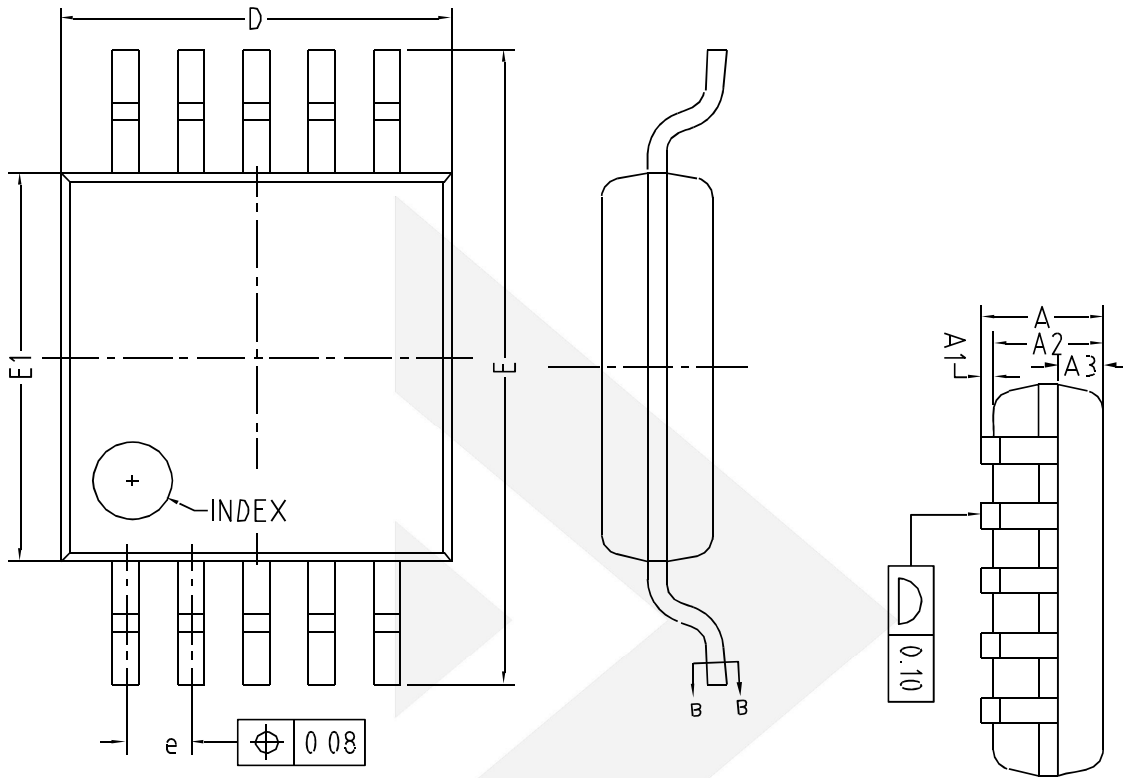
| Symbol | Min | Typ | Max |
|--------|-----|-----|-----|
| A | - | - | 1.10 |
| A1 | 0 | - | 0.15 |
| A2 | 0.75 | 0.85 | 0.95 |
| A3 | 0.25 | 0.35 | 0.39 |
| b | 0.18 | - | 0.27 |
| b1 | 0.17 | 0.20 | 0.23 |
| c | 0.15 | - | 0.20 |
| c1 | 0.14 | 0.15 | 0.16 |
| D | 2.90 | 3.00 | 3.10 |
| E | 4.70 | 4.90 | 5.10 |
| E1 | 2.90 | 3.00 | 3.10 |
| e | 0.40 | 0.50 | 0.60 |
| L | 0.40 | 0.60 | 0.80 |
| L1 | 0.95REF | | |
| L2 | 0.25BSC | | |
| R | 0.07 | - | - |
| R1 | 0.07 | - | - |
| Θ | 0° | - | 8° |
| Θ1 | 9° | 12° | 15° |

## CONTACT US

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ADGS1414DBCCZ  ADG658YRUZ-REEL7  RS2117YUTQK10  RS2118YUTQK10  RS2227XUTQK10  SP2526A-1EN-L/TR  FSA4157P6X
BA7603F-E2  MAX4702EUE+  MAX4617CUE+  MAX4599EUT+T  MAX4066ESD+  MAX4052ACSE+  MAX396CAI+  MAX391CPE+
MAX4730EXT+T  MAX314CPE+  MAX4051AEEE+  BU4066BCFV-E2  MAX313CPE+  BU4S66G2-TR  TS3A4751PWR
NCN1154MUTAG  DG444DY-E3  NLAS4157DFT2G  NLAS4599DFT2G  NLAS7242MUTBG  NLASB3157DFT2G  NLAST4599DFT2G
NLAST4599DTT1G  DG403DY-T1-E3  MAX4714EXTT  MAX392CPE  BGSX22G2A10E6327XTSA1  ADG1611BRUZ-REEL7