DIO32020

USB 2.0 High-Speed and Audio/USB/UART Switch with Negative Swing Capacity

Features

- Low R_{ON} audio/USB analog switch
- Low USB C_{ON}: 7 pF
- Negative signal swing capable
- Low audio distortion
- USB switch -3 dB bandwidth: 1100 MHz
- High crosstalk and off-isolation
- Voltage supply operation: 2.7 to 5.5 V
- Three green packages: DQFN-10, QFN-10, MSOP-10

Applications

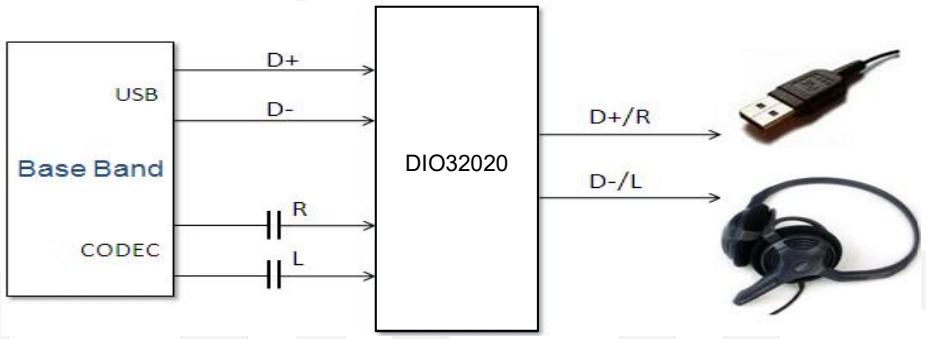
- Cell-phones/PDA
- MP3/MP4/PMP
- Portable instrumentation
- Battery powered communications
- Computer peripherals

Descriptions

The DIO32020 is dual SPDT (Single Pole / Double Throw) switch which combines low distortion audio/USB/UART and USB 2.0 high-speed data signal switching in the same low voltage device. This architecture is designed to allow negative signal passing as low as 3 V below ground. When a voltage is detected on V_{BUS}, the 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.

The 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

Part Number	Top Marking	RoHS	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

Pin Assignment

DQFN-10 **MSOP-10** **QFN-10**

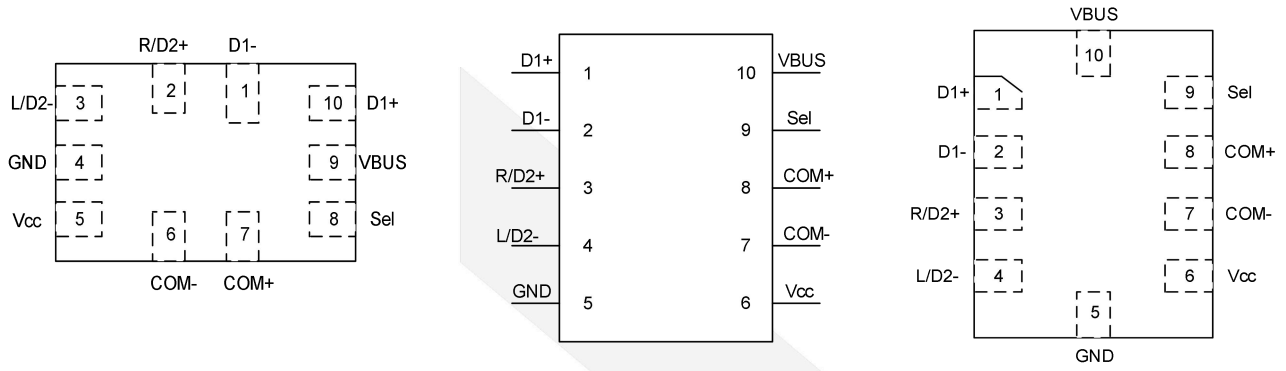


Figure 1. Top View

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 selection
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

Absolute Maximum Ratings

Stresses beyond those listed under the Absolute Maximum Rating table 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		-3.5 to V_{CC}	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	-3 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} = 3.3 V)						
V_{IH}	A_{SEL} control input high voltage	V_{CC} = 2.7 - 4.2 V	1.3			V
V_{IL}	A_{SEL} control input low voltage	V_{CC} = 2.7 - 4.2 V			0.5	V
I_{IN}	A_{SEL} control input leakage current	0 ≤ V_{SW} ≤ V_{CC}		1	2	μA
V_{IH}	V_{BUS} control input high voltage	V_{CC} = 2.7 - 4.2 V	1.3			V
V_{IL}	V_{BUS} control input low voltage	V_{CC} = 2.7 - 4.2 V			0.5	V
I_{IN}	V_{BUS} control input leakage current	0 ≤ V_{SW} ≤ V_{CC}		1	2	μA
R_{VBUS_PD}	V_{BUS_CTRL} pull down resistance	I_{ON} = 10 mA		4000		kΩ
Supply current and leakage (T_A = 25°C, V_{CC} = 3.3 V)						
I_{OZ-USB}	Off leakage current of port DN/DP	DN/DP = 0 V to 4.2 V, R, L, COM+, COM- float	-1		1	uA
$I_{OZ-AUDIO}$	Off leakage current of port R/L	R/L = -3 V to 3 V, DN, DP, COM+, COM- float	-1		1	uA
I_{ON-USB}	On leakage current of USB switch	COM+/COM- = 0 V to 4.2 V, R, L, DN, DP float	-1		1	uA
$I_{ON-AUDIO}$	On leakage current of AUDIO switch	COM+/COM- = -3 V to 3 V, R, L, DN, DP float	-1		1	uA
I_{off}	Power off leakage	V_{CC} = 0 V	-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} = 10 mA, V_{SW} = 0 V to V_{CC}		3.8		Ω
R_{FLATE}	On resistance flatness	I_{ON} = 10 mA, V_{SW} = 0 V to V_{CC}		15		mΩ
ΔR_{ON}	On resistance matching	I_{ON} = 10 mA, V_{SW} = 0 V to V_{CC}		100		mΩ
AUDIO switches (R, L) (T_A=25°C, V_{CC}=3.3V)						
R_{ON}	On resistance	I_{ON} =100 mA, V_{SW} = -3 to 3 V		0.8		Ω
R_{FLATE}	On resistance flatness	I_{ON} = 100 mA, V_{SW} =-3 to 3V		2		mΩ
ΔR_{ON}	On resistance matching	I_{ON} = 100 mA, V_{SW} = -3 to 3 V		50		mΩ

Electrical Characteristics (Continued)

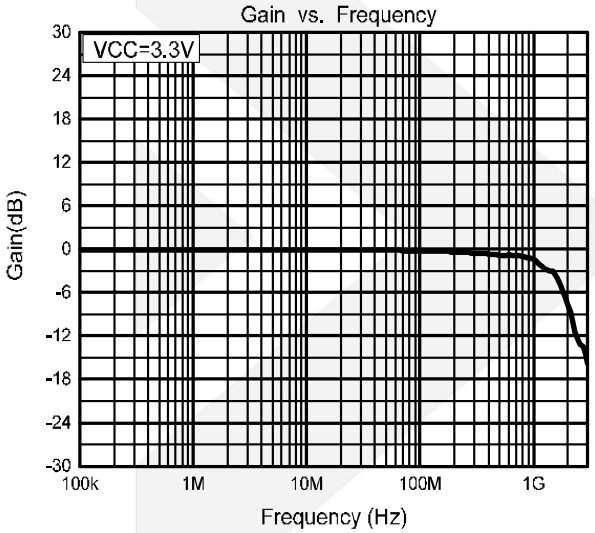
All typical value are at T_A = 25°C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
AC parameter (T_A = 25°C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, unless otherwise specified)						
t_{ON}	USB turn-on time	DP = DN = 1.5 V, R_L = 50 Ω, C_L = 35 pF		32		μs
	Audio turn-on time	L = R = 1.5 V, R_L = 50 Ω, C_L = 35 pF		32		μs
t_{OFF}	USB turn-off time	DP = DN = 1.5 V, R_L = 50 Ω, C_L = 35 pF		100		ns
	Audio turn-off time	L = R = 1.5 V, R_L = 50 Ω, C_L = 35 pF		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 = 50 Ω, C_L = 5 pF		1100		MHz
OIRR	USB OFF-isolation	V_{SW} = 1 V_{RMS}, R_L = 50 Ω, f = 240 MHz		-23		dB
	Audio OFF-isolation	V_{SW} = 1 V_{RMS}, R_L = 50 Ω, f = 1 kHz		-110		dB
X_{TALK}	USB crosstalk	R_L = 50 Ω, f = 240 MHz		-45		dB
	Audio crosstalk	R_L = 50 Ω, f = 1 kHz		-80		dB
THD+N	Total harmonic distortion + noise	R_L = 600 Ω, f = 1 kHz, V_{SW} = 2 V_{RMS}, with A-weighted		-110		dB
		R_L = 32 Ω, f = 1 kHz, V_{SW} = 1 V_{RMS}, with A-weighted		-100		
		R_L = 16 Ω, f = 1 kHz, V_{SW} = 0.5 V_{RMS}, with A-weighted		-100		
PSRR	Power supply rejection ratio	f = 10 kHz, R_{COM} = 50 Ω		-75		dB
Capacitance (T_A = 25°C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, A_{SEL} = 0 V, unless otherwise specified)						
C_{IN}	A_{SEL} control input capacitance	V_{CC} = 0 V		2		pF
C_{ON}	USB ON capacitance	f = 1 MHz, V_{BUS} = VDD, V_{SEL} = LOW, V_{D-} or V_{D+} = V_{COMX} = 0 V		7		pF

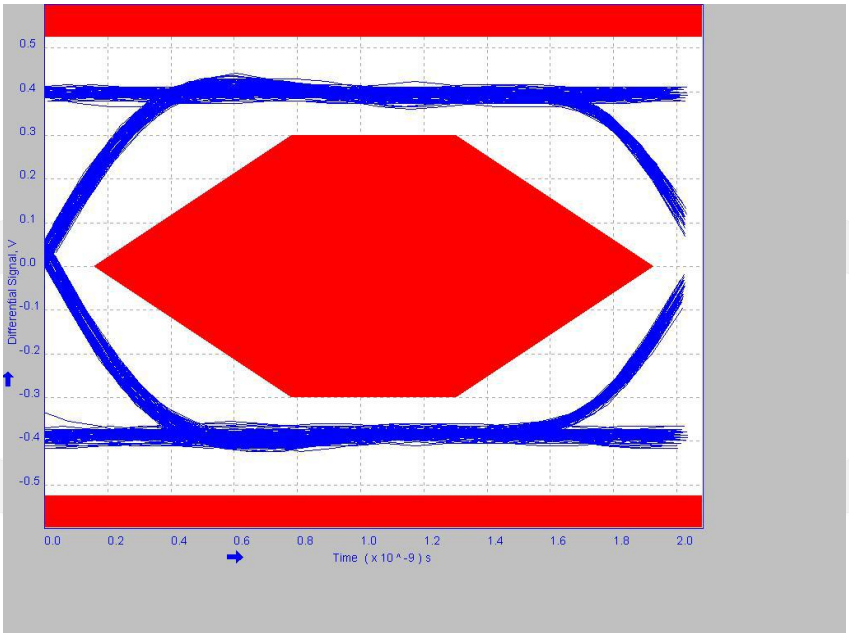
C_{ON}	Audio ON capacitance	V_{BUS} = LOW, V_{SEL} = LOW		7		pF
C_{OFF}	USB OFF capacitance	V_{BUS} = VDD, V_{SEL} = LOW		3		pF
C_{OFF}	Audio OFF capacitance	V_{BUS} = LOW, V_{SEL} = LOW		4		pF

Typical Performance Characteristics

T_A = 25°C, V_{CC} = 3.3 V, unless other otherwise specified.

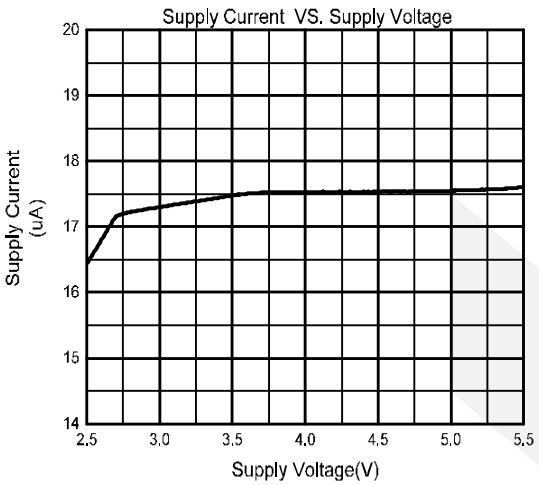


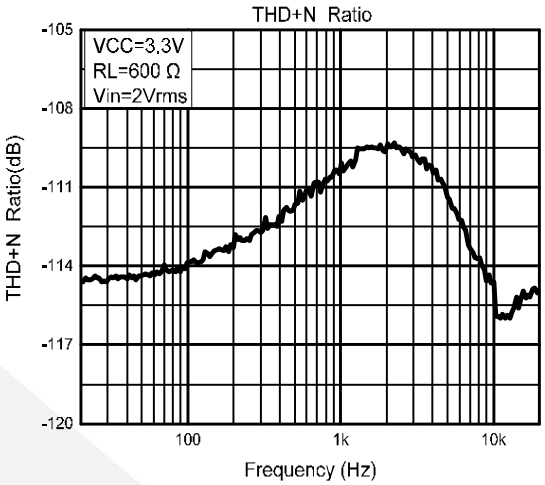
DIO32020 USB 2.0 high speed (480 Mbps) eye pattern



TIME SCALE (0.2 ns/DIV)

Figure 2 Eye Pattern: 480 Mbps with USB switch in signal path





Applications Design Guide

The DIO32020 is used in applications where slim and thin smartphone designs are expected. By sharing the USB connector between USB 2.0 data lines and audio headphone outputs, the designers can eliminate the use 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 types of cell phone accessories.

The DIO32020 unique architectures allow the part to have constant R_{ON}, R_{ON} (flatness) and THD performance independent of V_{CC} 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 2.8 V, with no need of being powered by a battery (4.3 V) directly. This will help designers to be freed from the complex logic designs to ensure that the part will get into sleep mode.

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

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

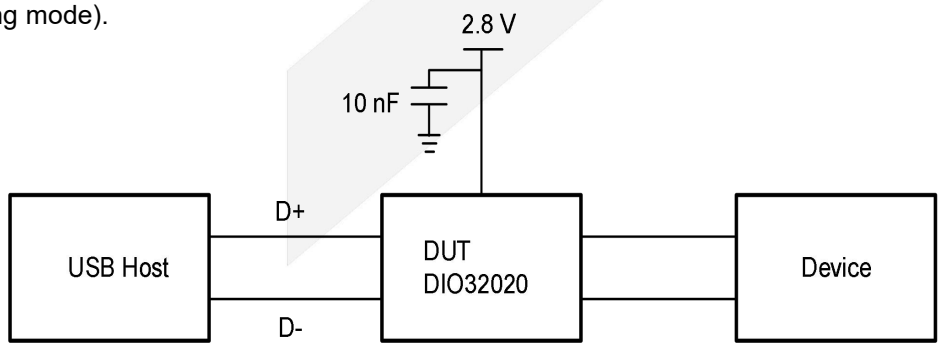
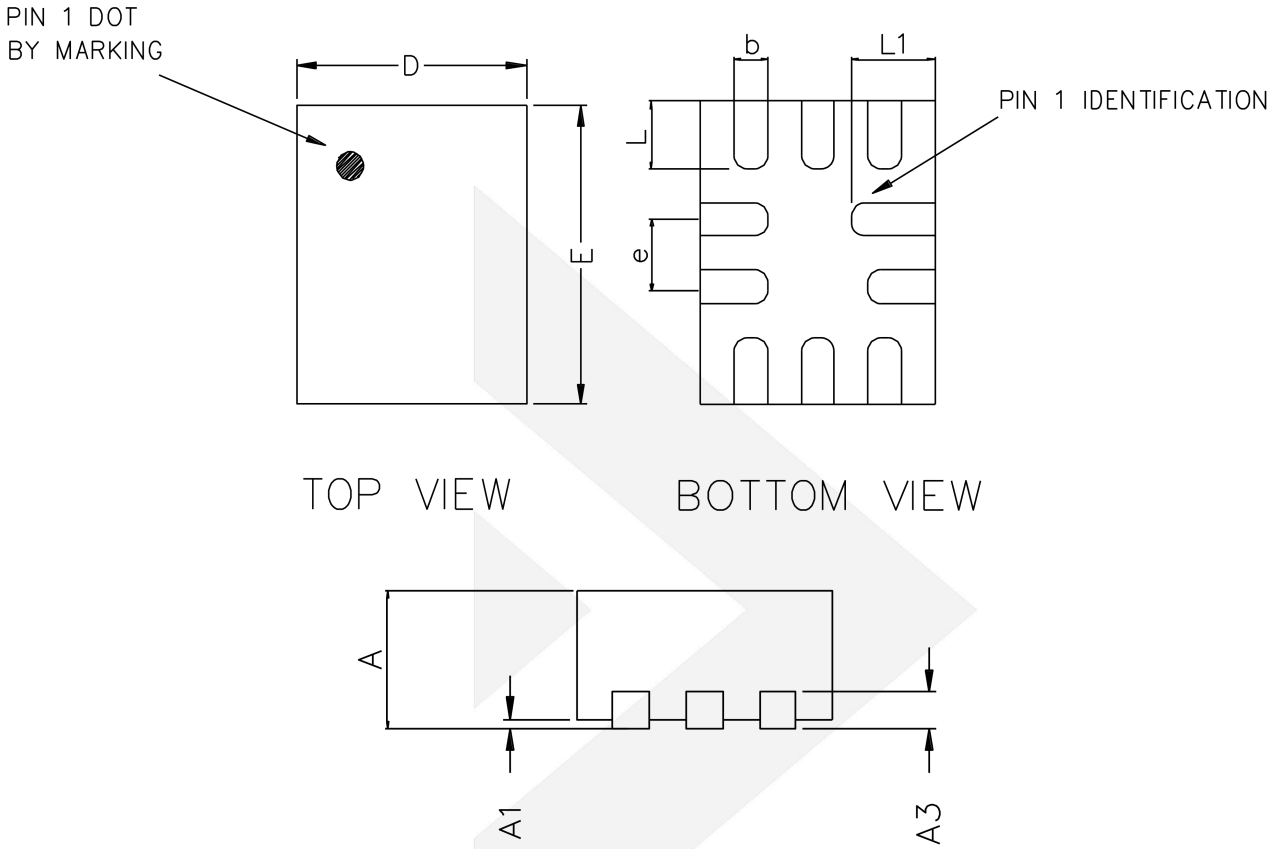
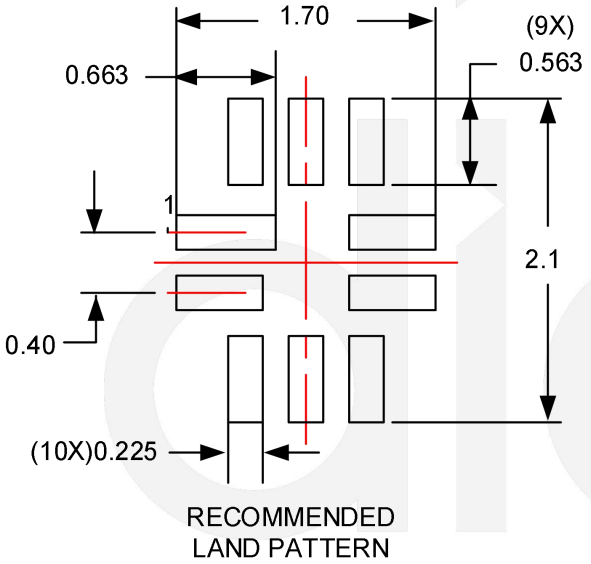


Figure 3. USB 2.0 high speed eye diagram test circuit

The DIO32020 features not only 100 dB total harmonic distortion (THD), but also superior off isolation capability. When the DIO32020 is powered under audio mode, audio channel can pass at least -3 V negative audio signal with up to 100 dB 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.

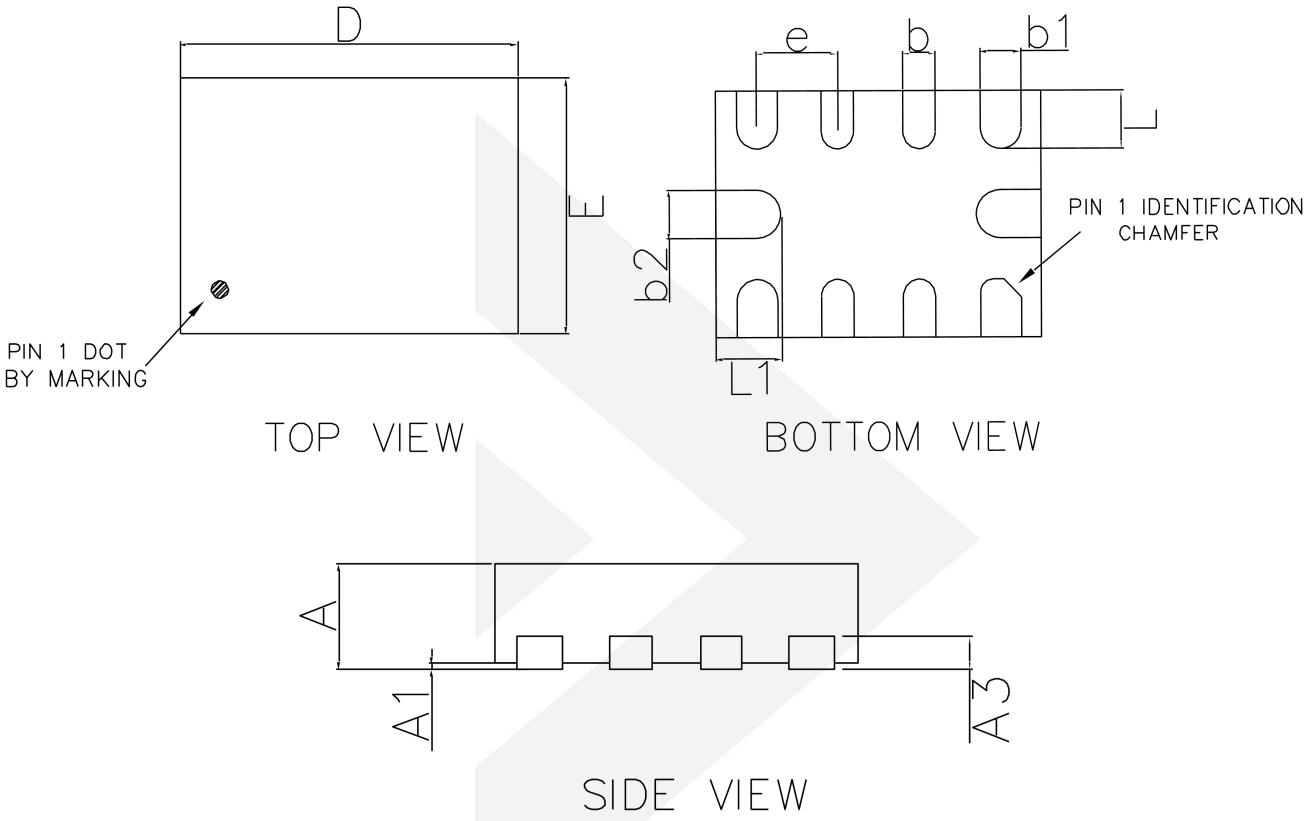
Physical Dimensions: DQFN-10





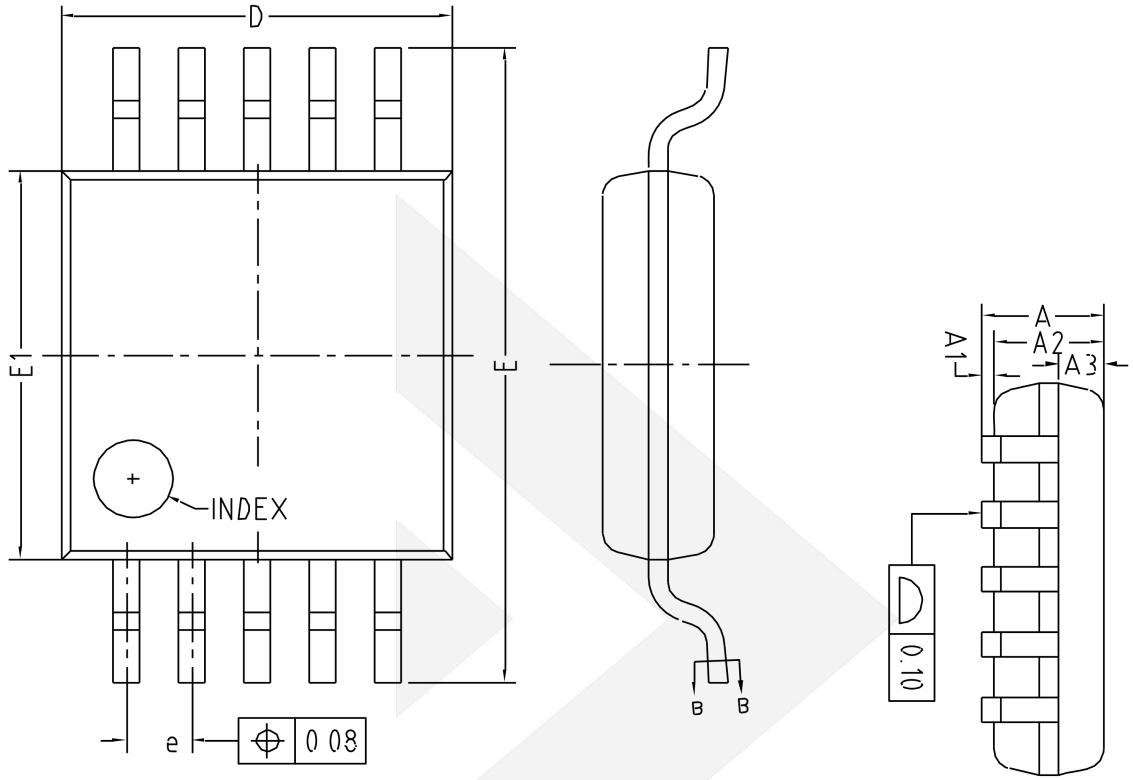
Common Dimensions (mm)			
PKG	**UT: ULTRA THIN**		
REF	**Min**	**Nom**	**Max**
A	0.5	0.55	0.6
A1	0		0.05
A3		0.15 REF	
D	1.35	1.4	1.45
E	1.75	1.8	1.85
b	0.15	0.2	0.25
L	0.3	0.4	0.5
L1	0.4	0.5	0.6
e		0.4 BSC	

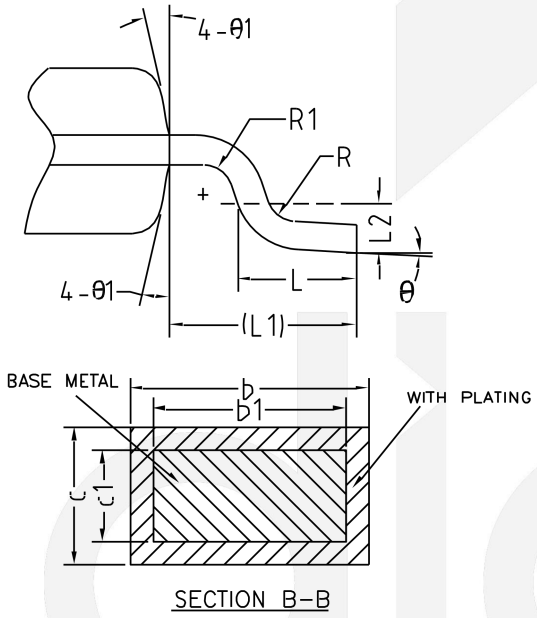
Physical Dimensions: QFN-10



Common Dimensions (mm)			
PKG	UT: ULTRA THIN		
REF	Min	Nom	Max
A	0.50	0.55	0.60
A1	0.00		0.05
A3	0.15 REF		
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





Common Dimensions (mm)			
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	0.95 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
θ	0°	-	8°
θ1	9°	12°	15°

CONTACT US

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