

## Description

The IDTHS231P16 is a high-performance hybrid switch device, combined with hybrid low distortion audio, UART and an USB 2.0 high speed data (480 Mbps) signal switches. When operated with a 1.8 V single supply, this high performance switch allows audio signal swings below-ground, allowing the use of a common USB and audio headphone connector in personal media players and other portable battery powered devices.

The IDTHS231P16 logic SELx control pins are 1.8 V compatible which allows for control via a standard  $\mu$ controller. With a VDD voltage in the range of 1.7 V to 1.95 V, the device can pass USB 3 V signal sources in the portable device, with up to 5.5 V tolerant on USB and COM signal pins. The part has an audio enable control pin to open all the switches and put the part in a low power state.

The IDTHS231P16 is available in a small 16-pin QFN package.

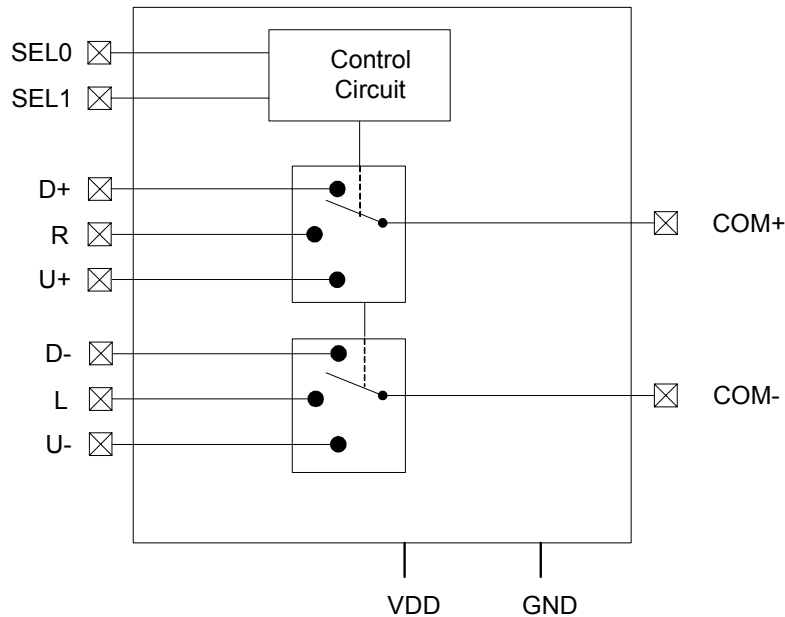
## Features

- +1.7 V to +1.95 V single-supply operation
- Low distortion negative signal handling capability with  $R_{on}$  typically  $3\Omega$  for Audio signal
- Control pin to open all switches and enter low power state
- Cross-talk audio channels (20 Hz to 20 kHz): -110dB
- -3dB bandwidth USB switches: 700 MHz
- Available in 16-pin QFN package – RoHS compliant
- Compliant with USB 2.0 short circuit requirements without additional external components

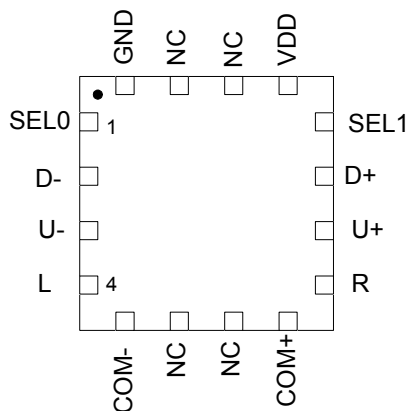
## Applications

- MP3 and other personal media players
- PDA's
- Audio/USB Switching
- Cellular and mobile phones

## Block Diagram



## Pin Assignment (16-pin QFN)



16-pin QFN

## Truth Table (COM+, COM-)

SEL1	SEL0	COM+	COM-
0	0	Power Down	
0	1	D+	D-
1	0	U+	U-
1	1	R	L

## Pin Descriptions

Pin Number	Pin Name	Pin Description
1	SEL0	Control signal pin. Internal pull-down resistor.
2	D-	3 V USB Signal. Bi-directional.
3	U-	UART Signal. Bi-directional.
4	L	Audio signal pin (left). Uni-directional. $\pm 1.5$ V signal.
5	COM-	Audio and USB signal common pin. Bi-direction in USB mode, uni-directional in Audio mode.
6	NC	No connection.
7	NC	No connection.
8	COM+	Audio and USB signal common pin. Bi-direction in USB mode, uni-directional in Audio mode.
9	R	Audio signal pin (right). Uni-directional. $\pm 1.5$ V signal.
10	U+	UART Signal. Bi-directional.
11	D+	3 V USB Signal. Bi-directional.
12	SEL1	Control signal pin. Internal pull-down resistor.
13	VDD	Power pin. +1.8 V VDD.
14	NC	No connection.
15	NC	No connection.
16	GND	Ground pin. 0V reference.

## Detailed Description

The IDTHS231P16 device is a dual single pole/triple throw (SPTT) high performance switch device that can operate from a single DC power supply in the range of 1.7 V to 1.95 V. It was designed to function as a dual 3 to 1 multiplexer to select between USB differential data signals, UART signals and audio L and R stereo signals. It comes in tiny QFN packages for use in cell phones, MP3 players, PDAs, and other personal media players.

The part consists of one hybrid dual  $3\Omega$  audio,  $5\Omega$  UART and  $5\Omega$  USB switches. The hybrid switch can accept audio signals that swing below ground and USB signals. They were designed to pass audio left and right stereo signals, and are ground referenced, with minimal distortion. The USB switches were designed to pass high-speed USB differential data signals with minimal edge and phase distortion.

The IDTHS231P16 was specifically designed for cell phones and other personal media player applications that need to combine the audio headphone jack and the USB data connector into a single shared connector, thereby saving space and component cost.

The IDTHS231P16 has SELx pins that select between the audio switches, UART and the USB switches. These pins can be driven LOW or HIGH to switch between the audio inputs and USB data inputs.

### Audio Switches

The two audio switches (L, R) are typically  $3\Omega$  switches that can pass signals that swing below ground by as much as 1.5 V. They were designed to pass ground reference stereo signals with minimal insertion loss and very low distortion. Crosstalk between the audio switches over the audio band is typically  $< -110\text{dB}$ .

These audio switches are uni-directional switches. The audio drivers should be connected at the L and R side of the switch and the speaker loads should be connected at the COM side of the switch.

**Note:** Whenever the audio switches are ON the USB and UART transceivers need to be in the high impedance state or static high or low state.

### USB/ UART Switches

The two USB switches (D+, D-) and two UART switches (U+,

U-) are typically  $5\Omega$  bidirectional switches that were designed to pass high-speed USB differential signals in the range of  $\pm 0\text{V}$  to 400 mV, and UART signals. These switches have low capacitance and high bandwidth to pass USB high-speed signals (480 Mbps) with minimum edge and phase distortion to meet USB 2.0 high-speed signal quality specifications.

The maximum signal range for the USB switches is from 0V to 3.6 V. The signal voltage at D- and D+ should not be allowed to exceed the 3.6 voltage rail or go below ground.

The USB switches are active (turned ON) whenever the SEL voltage is  $\geq 1.2\text{ V}$ .

**Note:** Whenever the USB switches are ON, the UART or the audio drivers of the CODEC need to be at AC or DC ground or floating to keep from interfering with the data transmission.

### Logic Control

The state of the IDTHS231P16 device is determined by the voltage at the SEL pins. Refer to truth table on page 2 of data sheet. These logic pins are 1.8 V logic compatible so that it can be controlled by a standard  $\mu$ processor.

The SELx pins is internally pulled low through a  $4\text{M}\Omega$  resistor to ground and can be left floating or tri-stated by the  $\mu$ processor.

### Logic control voltage levels:

SELx = Logic "0" (Low) when  $\leq 0.5\text{ V}$   
 SELx = Logic "1" (High) when  $\geq 1.2\text{ V}$

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the IDTHS231P16. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Item	Rating
VDD to GND	-0.3 V to 6.0 V
Ambient Operating Temperature Range	-40°C to +85°C
Continuous Current (audio switches)	±150 mA
Peak Current (audio switches) Pulsed 1 ms, 10% duty cycle max.	±300 mA
Continuous Current (USB or UART switches)	±40 mA
Peak Current (USB or UART switches) Pulsed 1 ms, 10% duty cycle max.	±100 mA
<b>Voltages</b>	
Switch I/O Voltage - D+, D-, COM+, COM- (see note below)	-0.3 V to +6 V
Switch I/O Voltage - L, R (see note below)	-2 V to +2 V
SELx (see note below)	-0.3 V to [(VDD) + 0.3 V]
<b>ESD Rating</b>	
HBM	>7 kV
MM	>200 V
CDM	>1 kV

**Note:** These specifications are for absolute maximum rating. Not recommended for typical operation.

## Recommended Operating Conditions <sup>1</sup>

Symbol	Parameter	Rating
V <sub>DD</sub>	Supply Voltage	1.7 V to 1.95 V
	Storage Temperature	-40°C to +85°C

Note 1: The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed. DC switch voltage may never exceed 1.95 V.

## Electrical Characteristics – 1.7 V to 1.95 V Supply

Unless stated otherwise, VDD = 1.7 V to 1.95 V, GND = 0V

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
<b>Audio Switches (L, R)</b>						
Audio Signal Range	$V_{ANALOG}$		-1.5		1.5	V
On-Resistance	$R_{ON}$	$V_{L/R} = -2\text{ V}, 0\text{ V}, 0.7\text{ V}, V_{BUS} = 0\text{ V}$ $V_{AUDIO} = 0.7\text{ V}, V_{AUDIO\ I_{ON}} = -26\text{ mA}$		3		$\Omega$
$R_{ON}$ Matching Between Channels	$\Delta R_{ON}$	$V_{L/R} = 0.7\text{ V}, I_{ON} = -26\text{ mA}$		0.3		$\Omega$
$R_{ON}$ Flatness	$R_{FLAT(ON)}$	$I_{ON} = -26\text{ mA}$		1.5		$\Omega$
<b>USB/UART Switches (D+, D-, U+, U-)</b>						
USB Signal Range	$V_{Digital}$		0		3.6	V
On-Resistance	$R_{ON}$	$V_{D+/D-} = 0\text{ V}, 0.4\text{ V}, I_{ON} = -8\text{ mA}$		5		$\Omega$
$R_{ON}$ Matching Between Channels	$\Delta R_{ON}$	$V_{D+/D-} = 0\text{ V}, I_{ON} = -8\text{ mA}$		0.3		$\Omega$
OFF-leakage Current	$I_{D+(OFF)}$ or $I_{D-(OFF)}$	D+, D-, R, L = Floating VDD = 1.8 V		$\pm 50$		nA
ON-leakage Current	$I_{Dx}$	U+, U-, D+, D-, R, L = 0.3 V VDD = 1.8 V		$\pm 50$		nA

Parameter	Symbol	Conditions	Min. (Note 2)	Typ.	Max. (Note 2)	Units
<b>Dynamic Characteristics</b>						
Turn-on Time	$t_{ON}$	$R_L = 50\Omega$ , $C_L = 50$ pF, 1 V Pk-Pk signal		1		$\mu$ s
Turn-off Time	$t_{OFF}$	$R_L = 50\Omega$ , $C_L = 50$ pF, 1 V Pk-Pk signal		1		$\mu$ s
Break-Before-Make Delay	$t_D$			100		ns
Skew	$t_{SKEW}$	$R_L = 45\Omega$ , $C_L = 10$ pF, $t_R=t_F=750$ ps at 480 Mbps, (Duty cycle=50%)		50		ps
Additive Jitter	$t_{J(RMS)}$	$R_L=45\Omega$ , $C_L=10$ pF, $t_R=t_F=750$ ps at 480 Mbps		10		ps
Propagation Delay	$t_{PD}$	$R_L=45\Omega$ , $C_L=10$ pF (Fig.7)		250		ps
Crosstalk (Channel-to-channel)	R to COM-, L to COM+	$R_L=32\Omega$ , $f = 20$ Hz to 20 kHz, $V_L$ or $V_R=0.707 V_{RMS}$ (2V <sub>P-P</sub> )		-110		dB
Total Harmonic Distortion	THD	$f = 20$ Hz to 20 kHz, $V_L$ or $V_R=0.707 V_{RMS}$ (2V <sub>P-P</sub> ), $R_S$ , $R_T$		0.01		%
USB Switch -3 dB Bandwidth		$R_L=50\Omega$ , $C_L=5$ pF		700		MHz
UART Switch -3 dB Bandwidth		$R_L=50\Omega$ , $C_L=5$ pF		200		MHz
D+/D- OFF Capacitance	$C_{D+}(OFF)$ , $C_{D-}(OFF)$	$f=1$ MHz, $V_L$ or $V_R=V_{COMx}=0V$		6		pF
L/R OFF Capacitance	$C_{LOFF}$ $C_{ROFF}$	$f=1$ MHz, $V_{D+}$ or $V_{D-}=V_{COMx}=0V$		9		pF
COM ON Capacitance	$C_{COM-(ON)}$ , $C_{COM+(ON)}$	$f=1$ MHz, $V_{DD}=3.3$ V, $V_{D-}$ or $V_{D+}=V_{COMx}=0V$		10		pF
<b>Power Supply</b>						
Power Supply Range	$V_{DD}$		1.7		1.95	V
Positive Supply Current	$I_{DD}$			5	10	$\mu$ A
Positive Supply Current (Low Power State)	$I_{DD}$	SELx = 00, No input signal		10	100	nA
Voltage Low	$V_{IL}$	SELx pins			0.5	V
Voltage High	$V_{IH}$	SELx pins	1.2			V
Internal Pull-down Resistor	$R_{CTRL}$	SELx pins		10		M $\Omega$

**Note 1:** D+, D-, U+, U-, COM+, COM-, SELx can tolerate up to 5.5 V signals.

### Test Circuits and Waveforms

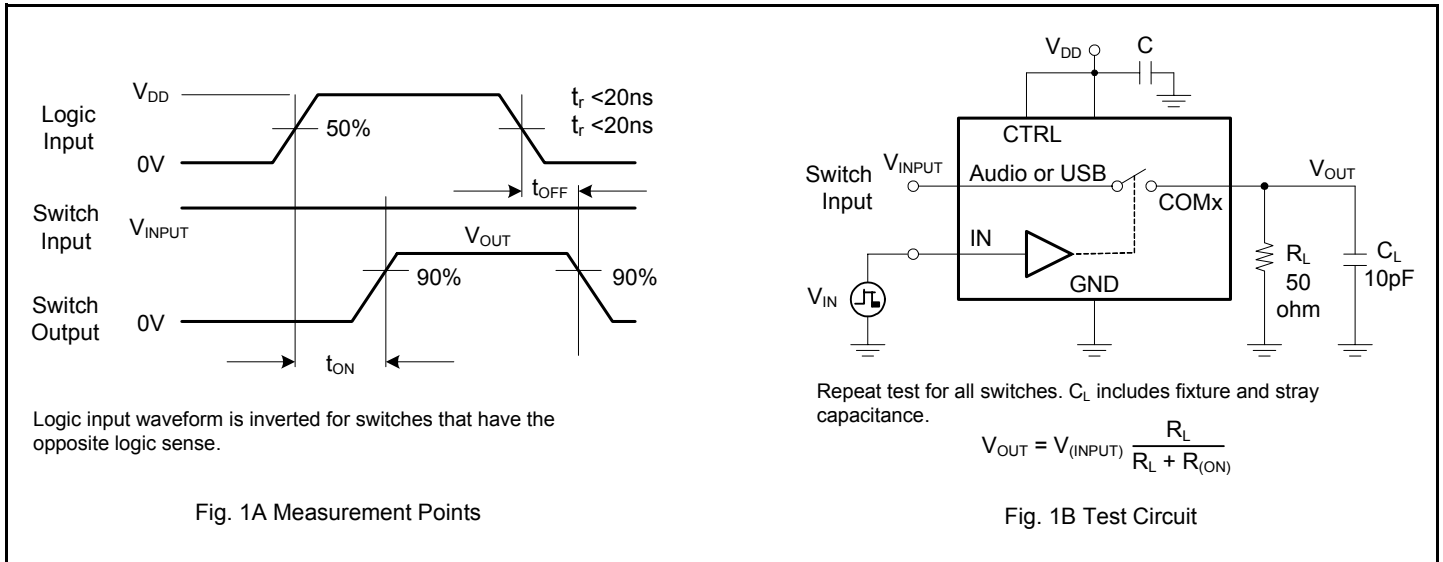


Figure 1: Switching Times

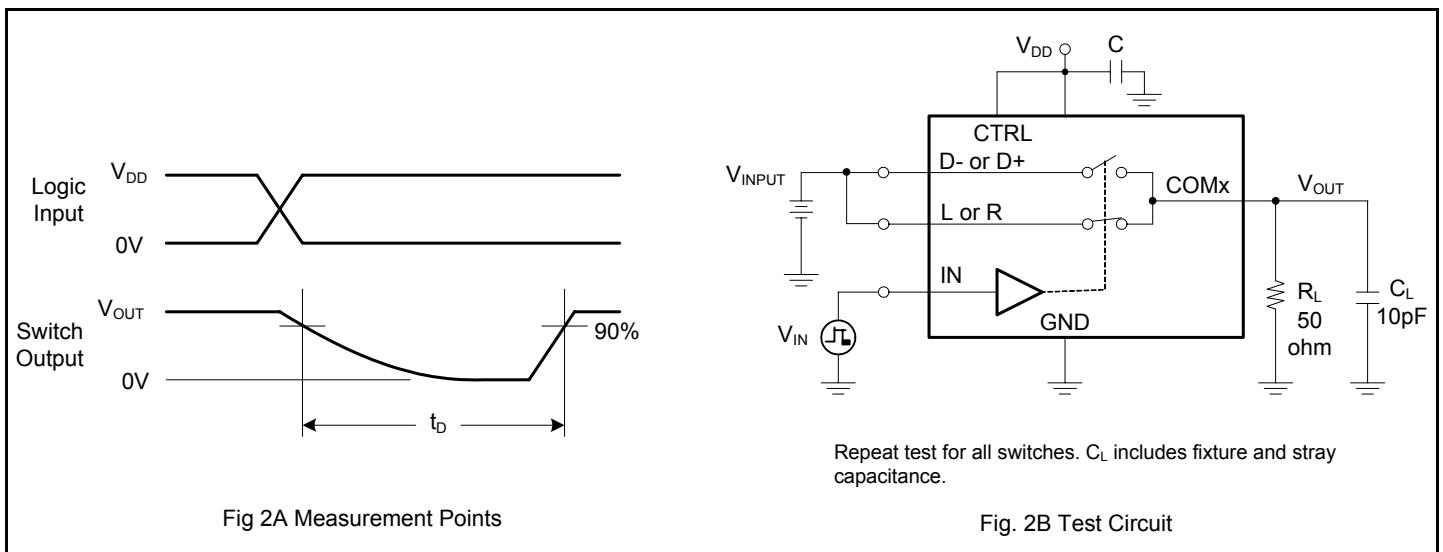
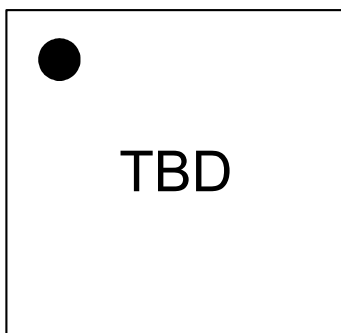


Figure 2: Break-Before-Make Time

## Marking Diagram (QFN)



### Notes:

1. "Z" is the device step (1 to 2 characters).
2. YYWW is the last two digits of the year and week that the part was assembled.
3. "\$" is the assembly mark code.
4. "G" after the two-letter package code designates RoHS compliant package.
5. "I" at the end of part number indicates industrial temperature range.
6. Bottom marking: country of origin if not USA.

## Thermal Characteristics

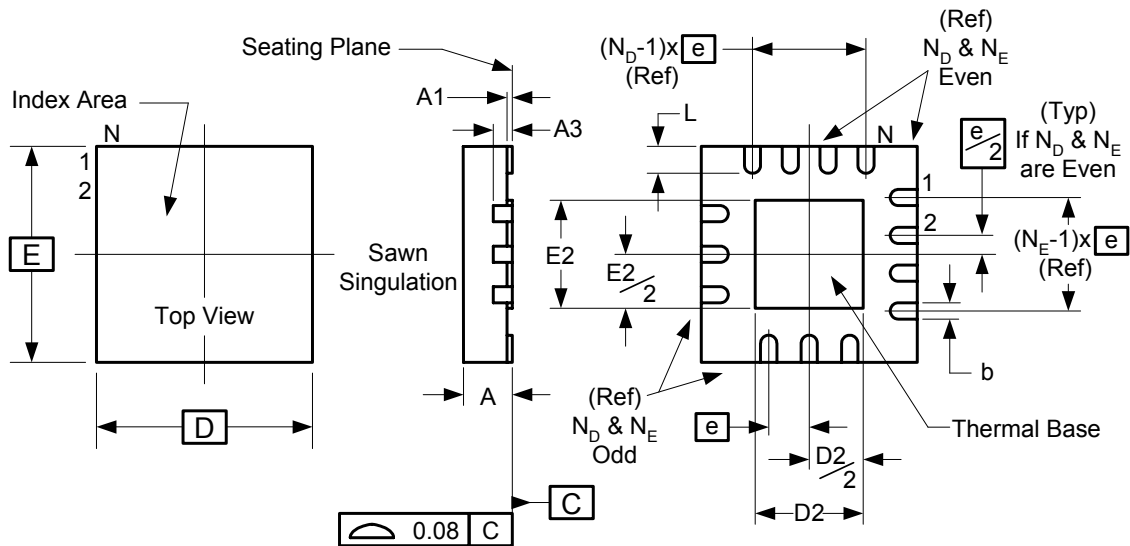
Parameter	Symbol	Rating	Units
<b>Thermal Resistance (see note below)</b>			
16-pin QFN package	$\theta_{JA}$	TBD	$^{\circ}\text{C}/\text{W}$
Maximum Junction Temperature (plastic package)		+150	$^{\circ}\text{C}$
Maximum Storage Temperature Range		-65 to +150	$^{\circ}\text{C}$

**Note:**  $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air.



## Package Outline and Package Dimensions (16-pin 2.5x2.5mm QFN)

Package dimensions are kept current with JEDEC Publication No. 95



Symbol	Millimeters	
	Min	Max
A	0.50	0.60
A1	0	0.05
A3	0.25 Reference	
b	0.15	0.25
e	0.40 BASIC	
N	16	
$N_D$	4	
$N_E$	4	
D x E BASIC	2.50 x 2.50	
D2	1.00	1.25
E2	1.00	1.25
L	0.255	0.425

## Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
HS231P16NDGI	TBD	Tubes	16-pin QFN	-40 to +85°C
HS231P16NDGI8		Tape and Reel	16-pin QFN	-40 to +85°C

Parts that are ordered with a “G” after the two-letter package code are the Pb-Free configuration and are RoHS compliant.

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