

HYBRID SWITCH WITH NEGATIVE SIGNAL HANDLING

IDTHS221P10

Description

The IDTHS221P10 is a high-performance hybrid switch device, combined with hybrid low distortion audio and USB 2.0 high speed data (480 Mbps) signal switches, and analog 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 IDTHS221P10 logic SEL control pin is 1.8 V compatible which allows for control via a standard μ 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 IDTHS221P10 is available in a small 10-pin μ MLP package.

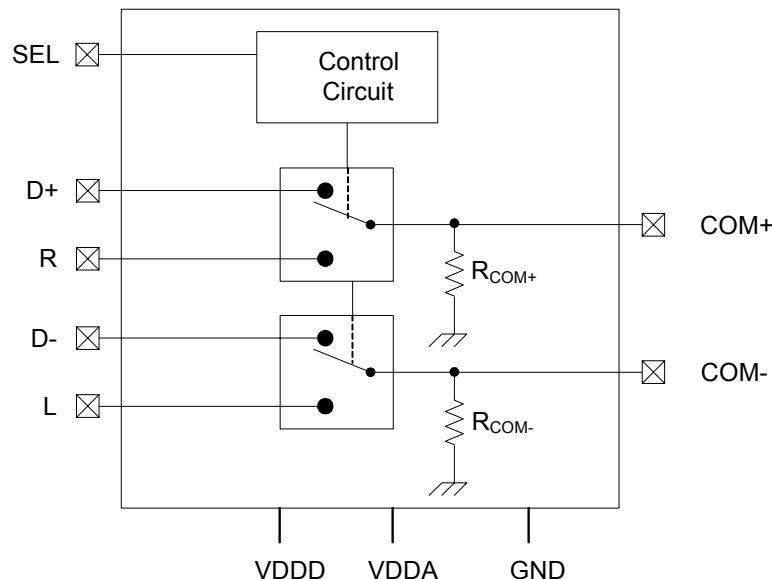
Features

- +1.7 V to +1.95 V single-supply operation (VDDx)
- Low distortion negative signal handling capability with R_{on} less than 2 ohm 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 μ MLP packages – RoHS compliant
- Compliant with USB 2.0 short circuit requirements without additional external components
- Power off protection on common D+/R, D-/L ports

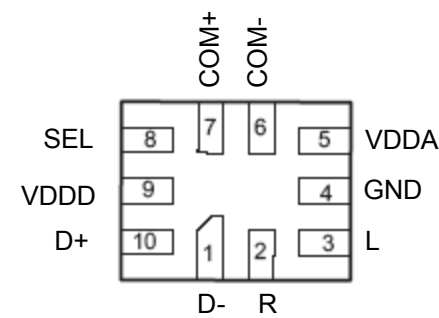
Applications

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

Block Diagram



Pin Assignment (10-pin μMLP)



Truth Table (COM+, COM-)

SEL	COM+	COM-
0	R	L
1	D+	D-

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	D-	3 V USB Signal. Bi-directional.
2	R	Audio signal pin (right). Uni-directional. ±1.5 V signal.
3	L	Audio signal pin (left). Uni-directional. ±1.5 V signal.
4	GND	Ground pin. 0V reference.
5	VDDA	Power pin for Audio R/L signal. +1.8 V VDD.
6	COM-	Audio and USB signal common pin. Bi-direction in USB mode, uni-directional in Audio mode.
7	COM+	Audio and USB signal common pin. Bi-direction in USB mode, uni-directional in Audio mode
8	SEL	Control signal pin. Internal pull-down resistor.
9	VDDD	Power pin for USB. +1.8 V VDD.
10	D+	3 V USB Signal. Bi-directional.

Detailed Description

The IDTHS221P10 device is a dual single pole/double throw (SPDT) 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 2 to 1 multiplexer to select between USB differential data signals and audio L and R stereo signals. It comes in tiny μ MLP packages for use in cell phones, MP3 players, PDAs, and other personal media players.

The part consists of one hybrid dual 2Ω audio and 5Ω 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 IDTHS221P10 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 IDTHS221P10 has a SEL pin that select between the audio switches and the USB switches. This pin 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 2Ω 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. The audio switches are active (turned ON) whenever the SEL voltage to $\leq 0.5\text{ V}$.

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

USB Switches

The two USB switches (D+, D-) are 5Ω bidirectional

switches that were designed to pass high-speed USB differential signals in the range of $\pm 0\text{V}$ to 400 mV. 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 allow 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 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 IDTHS221P10 device is determined by the voltage at the SEL pin. Refer to truth table on page 2 of data sheet. These logic pins are 1.8 V logic compatible, and can be controlled by a standard μ processor.

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

Logic control voltage levels:

SEL = Logic "0" (Low) when $\leq 0.5\text{ V}$

SEL = Logic "1" (High) when $\geq 1.2\text{ V}$

Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the IDTHS221P10. 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 switches)	±40 mA
Peak Current (USB switches) Pulsed 1 ms, 10% duty cycle max.	±100 mA
Voltages	
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]
ESD Rating	
HBM	>8 kV
MM	>400 V
CDM	>1 kV

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

Recommended Operating Conditions ¹

Symbol	Parameter	Rating
V _{CC}	Supply Voltage	1.7 V to 1.95 V
V _{IN}	DC Switch Voltage	0V to V _{DD}
	DC Input Diode Current	0V to V _{DD}
	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
Audio Switches (L, R)						
Audio Signal Range	V_{ANALOG}		-1.5		1.5	V
On-Resistance	R_{ON}			2		Ω
R_{ON} Matching Between Channels	ΔR_{ON}			0.2		Ω
R_{ON} Flatness	$R_{FLAT(ON)}$			1.5		Ω
Discharge Pull-down Resistance	R_{COM+} , R_{COM-}	POP discharge pull-down resistor		10		k Ω
USB Switches (D+, D-)						
USB Signal Range	V_{ANALOG}		0		3.6	V
On-Resistance	R_{ON}			5		Ω
R_{ON} Matching Between Channels	ΔR_{ON}			0.1		Ω
R_{ON} Flatness	$R_{FLAT(ON)}$			1.5		Ω
OFF-leakage Current	$I_{D+(OFF)}$ or $I_{D-(OFF)}$			± 50		nA
ON-leakage Current	I_{Dx}			± 50		nA

Parameter	Symbol	Conditions	Min. (note 2)	Typ.	Max. (note 2)	Units
Dynamic Characteristics						
Turn-on Time	t_{ON}			20		μs
Turn-off Time	t_{OFF}			5		μs
Break-Before-Make Delay	t_D			25		μs
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	$R_L=45\Omega$, $C_L=10$ pF, $t_R=t_F=750$ ps at 480 Mbps		100		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 $V_R=0.707 V_{RMS}$ ($2V_{P-P}$)		-110		dB
Total Harmonic Distortion	THD	$f = 20$ Hz to 20 kHz, V_L or $V_R=0.707 V_{RMS}$ ($2V_{P-P}$), $R_L=32\Omega$		0.06		%
USB Switch -3 dB Bandwidth		$R_L=50\Omega$, $C_L=5$ pF		700		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
Power Supply						
Power Supply Range	V_{DD}		1.7		1.95	V
Positive Supply Current	I_{DD}			5	10	μA
Voltage Low	V_{IL}	SEL pin			0.5	V
Voltage High	V_{IH}	SEL pin	1.2			V
Internal Pull-down Resistor	R_{SEL}	SEL pin		4		M Ω

Test Circuits and Waveforms

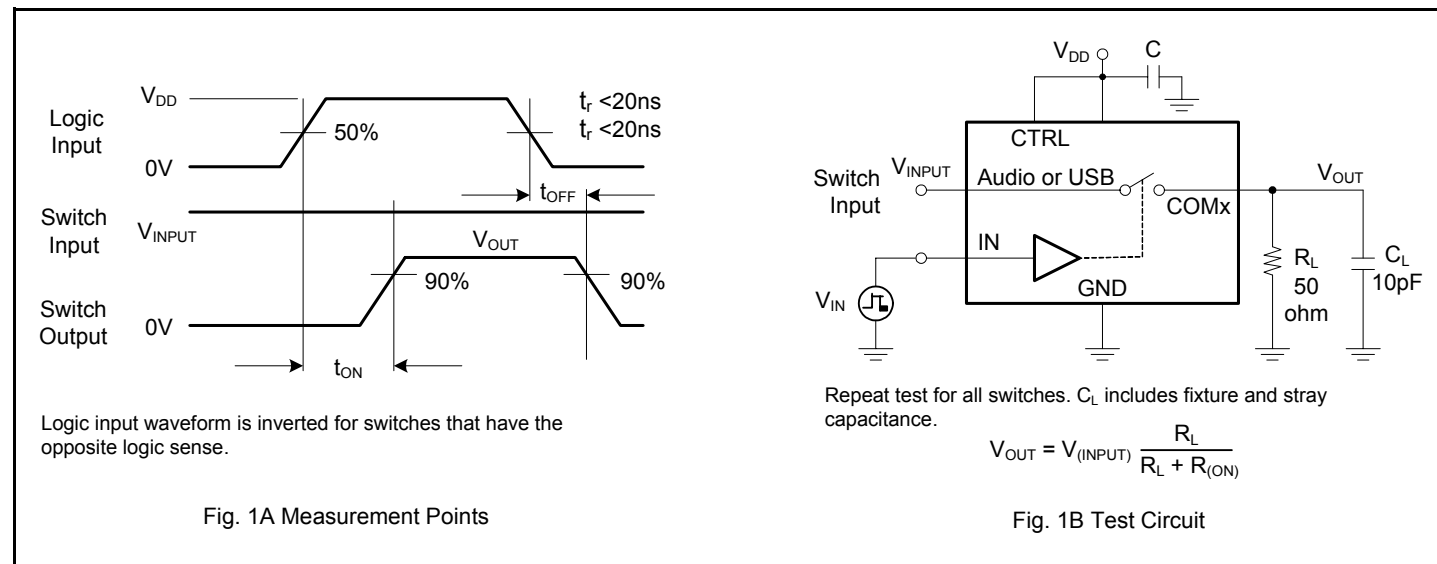


Figure 1: Switching Times

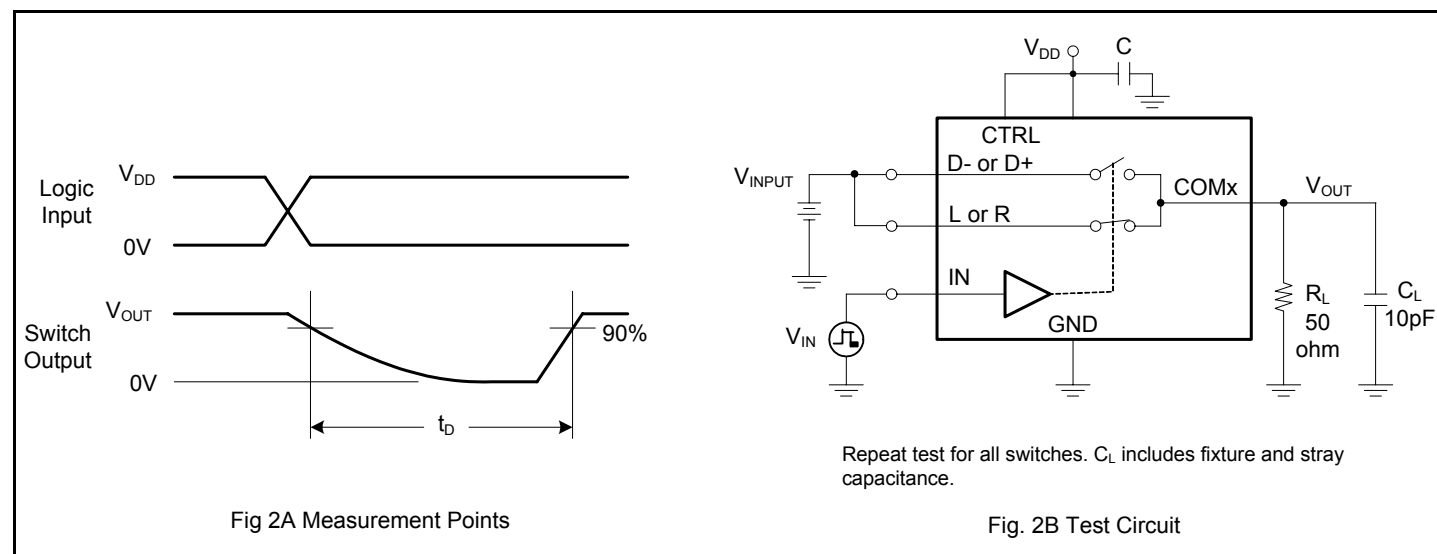
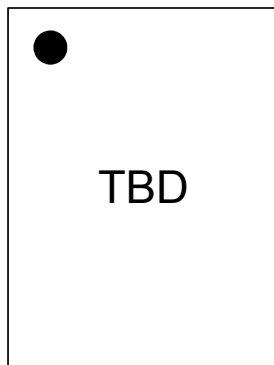


Figure 2: Break-Before-Make Time

Marking Diagram (μMLP)



Notes:

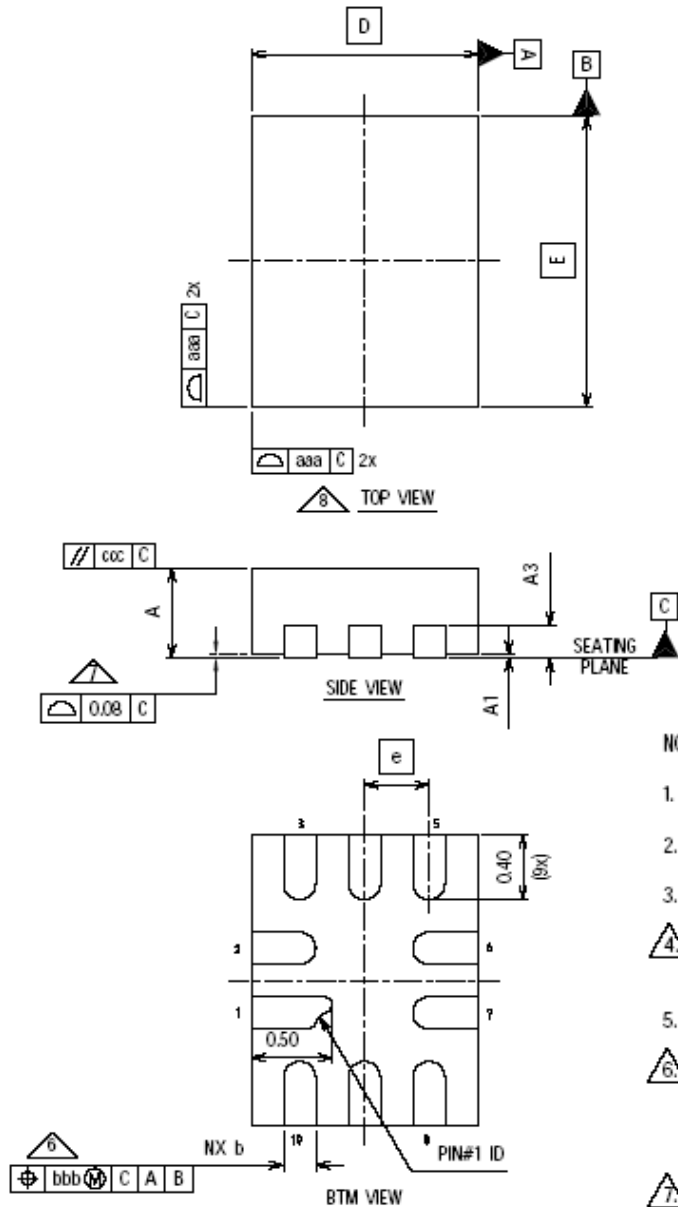
1. "Z" is the device step (1 to 2 characters).
2. YYWW is the last two digits of the year and week that the part was assembled.
3. "\$" is the assembly mark code.
4. "G" after the two-letter package code designates RoHS compliant package.
5. "I" at the end of part number indicates industrial temperature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

Thermal Characteristics

Parameter	Symbol	Rating	Units
Thermal Resistance (see note below)			
10-pin μMLP package	θ_{JA}	TBD	°C/W
Maximum Junction Temperature (plastic package)		+150	°C
Maximum Storage Temperature Range		-65 to +150	°C

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

Package Outline and Package Dimensions (10-pin μ MLP)



SYMBOL	Millimeters			Notes
	MIN	NOM	MAX	
A	0.51	0.55	0.60	1, 2
A1	0.00	0.02	0.05	1, 2
A3		0.15 ref		1, 2
b	0.15	0.20	0.25	
c	0.09		0.20	
D	1.40 BASIC			
E	1.80 BASIC			
E1	6.00		6.20	
N	10			3
ND	3			5
NE	2			5
e	0.40			
aaa	0.15			
bbb	0.10			
ccc	0.10			

NOTE:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. All dimensions are in millimeters, angles are in degrees(°).
3. N is the total number of terminals.
4. The location of the terminal #1 identifier and terminal numbering convention conforms to JEDEC publication 95 SPP-002.
5. ND and NE refer to the number of terminals on each D and E side respectively.
6. Dimension b applies to metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip. If the terminal has the optional radius on the other end of the terminal, the dimension b should not be measured in that radius area.
7. Coplanarity applies to the terminals and all other bottom surface metallization.
8. Drawing shown are for illustration only.

Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
HS221P10NDGI	TBD	Tubes	10-pin μ MLP	-40 to +85° C
HS221P10NDGI8		Tape and Reel	10-pin μ MLP	-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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Revision History

Rev.	Originator	Date	Description of Change
A	EL	10/22/07	Preliminary datasheet. Initial release.
B	EL	11/09/07	Added Low Power State
C		01/04/08	Changed supply voltage from 1.8 V \pm 0.1 V to 1.7 V – 1.95 V.
D		01/04/08	Added Rcom+ and Rcom- resistors to Block Diagram; updated Electrical Characteristics table.
E		01/29/08	Absolute I/O Voltage ratings. Industrial temperature range.
F		11/21/08	Updated ESD; clarification on POP discharge resistor.

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