

# High-Speed USB 2.0 (480Mbps) DPST Switch with Overvoltage Protection (OVP) and Dedicated Charger Port Detection

## ISL54226

The Intersil ISL54226 is a single supply, dual SPST (Single Pole/Single Throw) switch that is configured as a DPST. It can operate from a single 2.7V to 5.25V supply. The part was designed for switching or isolating a USB high-speed source or a USB high-speed and full-speed source in portable battery powered products.

The 3.5Ω SPST switches were specifically designed to pass USB full speed and USB high-speed data signals. They have high bandwidth and low capacitance to pass USB high-speed data signals with minimal distortion.

The ISL54226 has OVP detection circuitry on the COM pins to open the SPST switches when the voltage at these pins exceeds 3.8V or goes negative by -0.45V. It isolates fault voltages up to +5.25V or down to -5V from getting passed to the other side of the switch, thereby protecting the USB down-stream transceiver.

The OE/ALM logic pin is an open drain input/output that can be driven to open the switches or monitored to tell when the part is in an overvoltage state.

The part has an interrupt ( $\overline{\text{INT}}$ ) output pin to indicate a 1 to 1 (high/high) state on the COM lines to inform the  $\mu$ processor when entering a dedicated charging port mode of operation.

The ISL54226 is available in 8 Ld 1.2mmx1.4mm  $\mu$ TQFN and 8 Ld 2mmx2mm TDFN packages. It operates over a temperature range of -40 to +85°C.

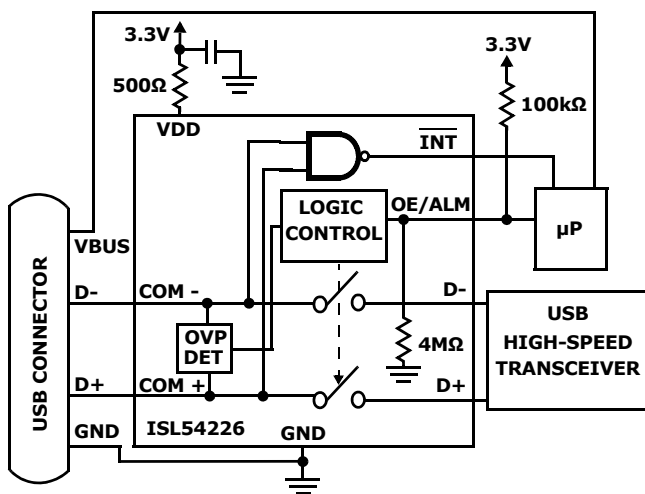
## Features

- High-Speed (480Mbps) and Full-Speed (12Mbps) Signaling Capability per USB 2.0
- 1.8V Logic Compatible (2.7V to +3.6V Supply)
- OE/ALM Pin to Open all Switches and Indicate Overvoltage Fault Condition
- Charger Interrupt Indicator Output
- Power OFF Protection
- COM Pins Overvoltage Protection for +5.25V and -5V Fault Voltages
- -3dB Frequency . . . . . 790MHz
- Low ON Capacitance @ 240MHz . . . . . 2pF
- Low ON-Resistance . . . . . 3.5Ω
- Single Supply Operation ( $V_{DD}$ ) . . . . . 2.7V to 5.25V
- Available in  $\mu$ TQFN and TDFN Packages
- Pb-Free (RoHS Compliant)
- Compliant with USB 2.0 Short Circuit and Overvoltage Requirements without Additional External Components

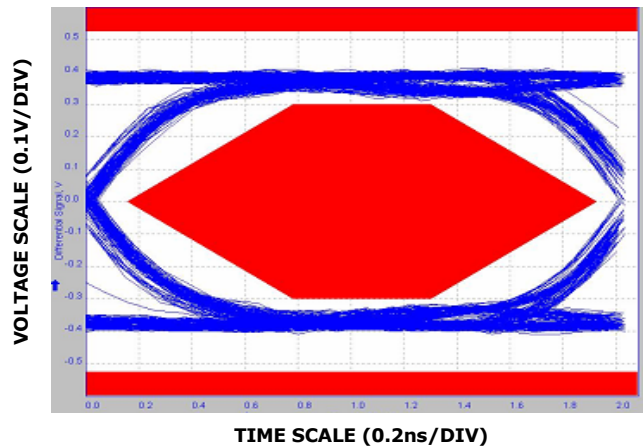
## Applications\* (see page 16)

- MP3 and Other Personal Media Players
- Cellular/Mobile Phones, PDA's
- Digital Cameras and Camcorders
- USB Switching

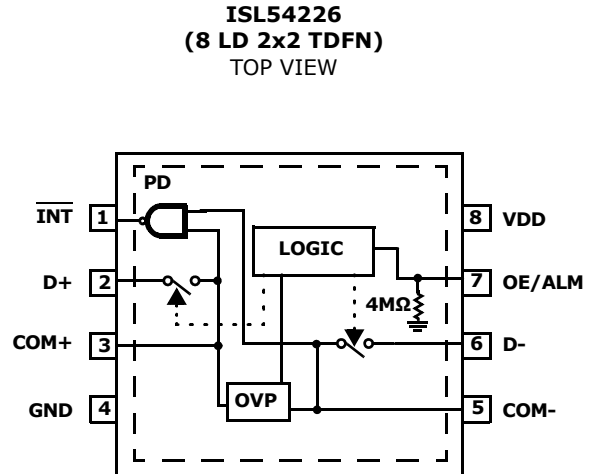
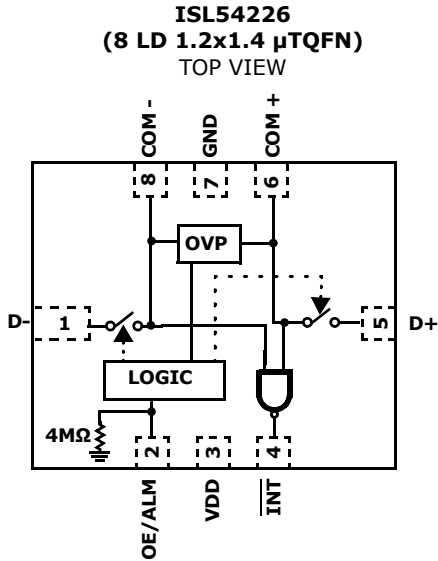
## Typical Application



## USB 2.0 HS Eye Pattern with Switches in the Signal Path



## Pin Configurations



NOTE:

1. Switches Shown for OE/ALM = Logic "0".

## Pin Descriptions

$\mu$ TQFN	TDFN	PIN NAME	DESCRIPTION
4	1	$\overline{\text{INT}}$	Charger Mode Interrupt Output
5	2	D+	USB Data Port
6	3	COM+	USB Data Port
7	4	GND	Ground Connection
8	5	COM-	USB Data Port
1	6	D-	USB Data Port
2	7	OE/ALM	Switch Enable/Alarm (Open Drain) Drive Low to Open Switches Outputs a Low when OTV is Activated
3	8	VDD	Power Supply
-	PD	PD	Thermal Pad. Tie to Ground or Float

## Truth Table

INPUT		OUTPUT			
SIGNAL AT COM PINS	OE/ALM	D-, D+	$\overline{\text{INT}}$	OE/ALM	STATE
0V to 3.6V	0	OFF	High	Low	Normal
0V to 3.6V	1	ON	High	High	Normal
Overvoltage Range	0	OFF	High	Low	OVP
Overvoltage Range	1	OFF	High	Low	OVP
COM Pins Tied Together	0	OFF	Low	Low	Charger Port (CP)
COM Pins Tied Together	1	ON	High	High	Normal

Logic "0" when  $\leq 0.5V$ , Logic "1" when  $\geq 1.4V$  with a 2.7V to 3.6V Supply.

TABLE 1. OVP TRIP POINT VOLTAGE

SYSTEM VOLTAGE CONDITIONS				TRIP POINT	
CODEC SUPPLY	SWITCH SUPPLY ( $V_{DD}$ )	COMs SHORTED TO	PROTECTED	MIN	MAX
2.7V to 3.3V	2.7V to 5.25V	VBUS	Yes	3.62V	3.95V
2.7V to 3.3V	2.7V to 5.25V	-5V	Yes	-0.6V	-0.29V

## Ordering Information

PART NUMBER (Notes 2, 5)	PART MARKING	TEMP. RANGE (°C)	PACKAGE Tape & Reel (Pb-Free)	PKG. DWG. #
ISL54226IRUZ-T (Note 4)	U5	-40 to +85	8 Ld 1.2mmx1.4mm $\mu$ TQFN	L8.1.4x1.2
ISL54226IRUZ-T7A (Note 4)	U5	-40 to +85	8 Ld 1.2mmx1.4mm $\mu$ TQFN	L8.1.4x1.2
ISL54226IRTZ-T (Note 3)	226	-40 to +85	8 Ld 2mmx2mm TDFN	L8.2x2C
ISL54226IRTZ-T7A (Note 3)	226	-40 to +85	8 Ld 2mmx2mm TDFN	L8.2x2C
ISL54226IRZEVAL1Z	Evaluation Board			

### NOTES:

- Please refer to [TB347](#) for details on reel specifications.
- These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
- These Intersil Pb-free plastic packaged products employ special Pb-free material sets; molding compounds/die attach materials and NiPdAu plate - e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
- For Moisture Sensitivity Level (MSL), please see device information page for [ISL54226](#). For more information on MSL please see techbrief [TB363](#).

## Absolute Maximum Ratings

VDD to GND	-0.3 to 6.5V
VDD to COMx	10.5V
COMx to Dx	8.6V
Input Voltages	
D+, D-	-0.3V to 6.5V
COM+, COM-	-5V to 6.5V
OE/ALM	-0.3 to 6.5V
Continuous Current (COM - / D-, COM + / D+)	±40mA
Peak Current (COM-/D-, COM+/D+)	
(Pulsed 1ms, 10% Duty Cycle, Max)	±100mA
ESD Rating:	
Human Body Model (Tested per JESD22-A114-F)	>2kV
Machine Model (Tested per JESD22-A115-A)	>150V
Charged Device Model (Tested per JESD22-C101-D)	>2kV
Latch-up (Tested per JEDEC; Class II Level A)	at +85°C

## Thermal Information

Thermal Resistance (Typical)	$\theta_{JA}$ (°C/W)	$\theta_{JC}$ (°C/W)
8 Ld $\mu$ TQFN Package (Notes 7, 9)	210	165
8 Ld TDFN Package (Notes 6, 8)	96	19
Maximum Junction Temperature (Plastic Package)	+150°C	
Maximum Storage Temperature Range	-65°C to +150°C	
Pb-Free Reflow Profile	see link below	
	<a href="http://www.intersil.com/pbfree/Pb-FreeReflow.asp">http://www.intersil.com/pbfree/Pb-FreeReflow.asp</a>	

## Normal Operating Conditions

Temperature Range	-40°C to +85°C
VDD Supply Voltage Range	2.7V to 5.25V
Logic Control Input Voltage	0V to 5.25V
Analog Signal Range	
VDD = 2.7V to 5.25V	0V to 3.6V

**CAUTION:** Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

### NOTES:

- $\theta_{JA}$  is measured in free air with the component mounted on a high effective thermal conductivity test board with "direct attach" features. See Tech Brief TB379.
- $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.
- For  $\theta_{JC}$ , the "case temp" location is the center of the exposed metal pad on the package underside.
- For  $\theta_{JC}$ , the "case temp" location is taken at the package top center.

**Electrical Specifications - 2.7V to 5.25V Supply** Test Conditions: VDD = +3.3V, GND = 0V, V<sub>OE/ALMH</sub> = 1.4V, V<sub>OE/ALML</sub> = 0.5V, (Note 10), Unless Otherwise Specified. **Boldface limits apply over the operating temperature range, -40°C to +85°C.**

PARAMETER	TEST CONDITIONS	TEMP (°C)	MIN (Notes 11, 12)	TYP	MAX (Notes 11, 12)	UNITS
<b>ANALOG SWITCH CHARACTERISTICS</b>						
ON-Resistance, r <sub>ON</sub> (High-Speed)	VDD = 2.7V, OE/ALM = 1.4V, IDx = 17mA, VCOM+ or VCOM- = 0V to 400mV (see Figure 2, Note 15)	25	-	3.5	5	Ω
		Full	-	-	<b>7</b>	Ω
r <sub>ON</sub> Matching Between Channels, Δr <sub>ON</sub> (High-Speed)	VDD = 2.7V, OE/ALM = 1.4V, IDx = 17mA, VCOM+ or VCOM- = Voltage at max r <sub>ON</sub> , (Notes 14, 15)	25	-	0.2	0.45	Ω
		Full	-	-	<b>0.55</b>	Ω
r <sub>ON</sub> Flatness, R <sub>FLAT(ON)</sub> (High-Speed)	VDD = 2.7V, OE/ALM = 1.4V, IDx = 17mA, VCOM+ or VCOM- = 0V to 400mV, (Notes 13, 15)	25	-	0.26	1	Ω
		Full	-	-	<b>1.2</b>	Ω
ON-Resistance, r <sub>ON</sub>	VDD = 3.3V, OE/ALM = 1.4V, ICOMx = 17mA, VCOM+ or VCOM- = 3.3V (see Figure 2, Note 15)	+25	-	6.8	17	Ω
		Full	-	-	<b>22</b>	Ω
OFF Leakage Current, IDx(OFF)	VDD = 5.25V, OE/ALM = 0V, VDx = 0.3V, 3.3V, VCOMx = 3.3V, 0.3V	25	-20	1	20	nA
		Full	-	30	-	nA
ON Leakage Current, IDx(ON)	VDD = 5.25V, OE/ALM = 5.25V, VDx = 0.3V, 3.3V, VCOMx = 0.3V, 3.3V	25	-9	-	9	μA
		Full	<b>-12</b>	-	<b>12</b>	μA
Power OFF Leakage Current, ICOM+, ICOM-	VDD = 0V, VCOM+ = 5.25V, VCOM- = 5.25V, OE/ALM = 0V	25	-	-	11	μA
Power OFF Logic Current, IOE/ALM	VDD = 0V, OE/ALM = 5.25V	25	-	-	22	μA
Power OFF D+/D- Current, ID+, ID-	VDD = 0V, OE/ALM = VDD, VD+ = VD- = 5.25V	25	-	-	1	μA

# ISL54226

**Electrical Specifications - 2.7V to 5.25V Supply** Test Conditions:  $V_{DD} = +3.3V$ ,  $GND = 0V$ ,  $V_{OE/ALMH} = 1.4V$ ,  $V_{OE/ALML} = 0.5V$ , (Note 10), Unless Otherwise Specified. **Boldface limits apply over the operating temperature range, -40°C to +85°C. (Continued)**

PARAMETER	TEST CONDITIONS	TEMP (°C)	MIN (Notes 11, 12)	TYP	MAX (Notes 11, 12)	UNITS
<b>Overvoltage Protection Detection</b>						
Positive Fault-Protection Trip Threshold, $V_{PFP}$	$V_{DD} = 2.7V$ to $5.25V$ , $OE/ALM = V_{DD}$ (see Table 1 on page 2)	25	3.62	3.8	3.95	V
Negative Fault-Protection Trip Threshold, $V_{NFP}$	$V_{DD} = 2.7V$ to $5.25V$ , $OE/ALM = V_{DD}$ (see Table 1 on page 2)	25	-0.6	-0.45	-0.29	V
OFF Persistence Time Fault Protection Response Time	Negative OVP Response: $V_{DD} = 2.7V$ , $OE/ALM = V_{DD}$ , $V_{DX} = 0V$ to $-5V$ , $R_L = 1.5k\Omega$	25	-	102	-	ns
	Positive OVP Response: $V_{DD} = 2.7V$ , $OE/ALM = V_{DD}$ , $V_{DX} = 0V$ to $5.25V$ , $R_L = 1.5k\Omega$	25	-	2	-	$\mu s$
ON Persistence Time Fault Protection Recovery Time	$V_{DD} = 2.7V$ , $OE/ALM = V_{DD}$ , $V_{DX} = 0V$ to $5.25V$ or $0V$ to $-5V$ , $R_L = 1.5k\Omega$	25	-	45	-	$\mu s$
<b>DYNAMIC CHARACTERISTICS</b>						
Turn-ON Time, $t_{ON}$	$V_{DD} = 3.3V$ , $V_{INPUT} = 3V$ , $R_L = 50\Omega$ , $C_L = 50pF$ (see Figure 1)	25	-	160	-	ns
Turn-OFF Time, $t_{OFF}$	$V_{DD} = 3.3V$ , $V_{INPUT} = 3V$ , $R_L = 50\Omega$ , $C_L = 50pF$ (see Figure 1)	25	-	60	-	ns
Skew, ( $t_{SKEWOUT} - t_{SKEWIN}$ )	$V_{DD} = 3.3V$ , $OE/ALM = 3.3V$ , $R_L = 45\Omega$ , $C_L = 10pF$ , $t_R = t_F = 500ps$ at 480Mbps, (Duty Cycle = 50%) (see Figure 5)	25	-	50	-	ps
Rise/Fall Degradation (Propagation Delay), $t_{PD}$	$V_{DD} = 3.3V$ , $OE/ALM = 3.3V$ , $R_L = 45\Omega$ , $C_L = 10pF$ , (see Figure 5)	25	-	250	-	ps
Crosstalk	$V_{DD} = 3.3V$ , $R_L = 50\Omega$ , $f = 240MHz$ (see Figure 4)	25	-	-39	-	dB
OFF-Isolation	$V_{DD} = 3.3V$ , $OE/ALM = 0V$ , $R_L = 50\Omega$ , $f = 240MHz$	25	-	-23	-	dB
-3dB Bandwidth	Signal = 0dBm, 0.86VDC offset, $R_L = 50\Omega$	25	-	790	-	MHz
OFF Capacitance, $C_{OFF}$	$f = 1MHz$ , $V_{DD} = 3.3V$ , $OE/ALM = 0V$ (see Figure 3)	25	-	2.5	-	pF
COM ON Capacitance, $C_{(ON)}$	$f = 1MHz$ , $V_{DD} = 3.3V$ , $OE/ALM = 3.3V$ , (see Figure 3)	25	-	4	-	pF
COM ON Capacitance, $C_{(ON)}$	$f = 240MHz$ , $V_{DD} = 3.3V$ , $OE/ALM = 3.3V$	25	-	2	-	pF
<b>POWER SUPPLY CHARACTERISTICS</b>						
Power Supply Range, $V_{DD}$		Full	<b>2.7</b>		<b>5.25</b>	V
Positive Supply Current, $I_{DD}$	$V_{DD} = 5.25V$ , $OE/ALM = 5.25V$	25	-	45	56	$\mu A$
		Full	-	-	<b>59</b>	$\mu A$
Positive Supply Current, $I_{DD}$	$V_{DD} = 3.6V$ , $OE/ALM = 3.6V$	25	-	23	30	$\mu A$
		Full	-	-	<b>34</b>	$\mu A$
Positive Supply Current, $I_{DD}$	$V_{DD} = 4.3V$ , $OE/ALM = 2.6V$	25	-	35	45	$\mu A$
		Full	-	-	<b>50</b>	$\mu A$

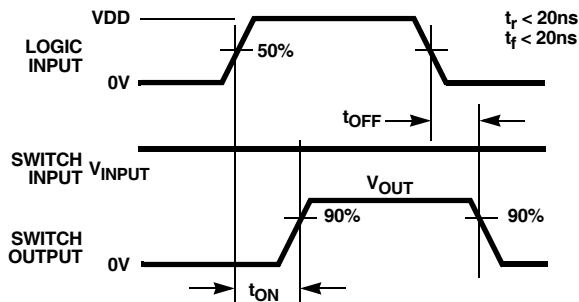
**Electrical Specifications - 2.7V to 5.25V Supply** Test Conditions:  $V_{DD} = +3.3V$ ,  $GND = 0V$ ,  $V_{OE/ALMH} = 1.4V$ ,  $V_{OE/ALML} = 0.5V$ , (Note 10), Unless Otherwise Specified. **Boldface limits apply over the operating temperature range, -40°C to +85°C. (Continued)**

PARAMETER	TEST CONDITIONS	TEMP (°C)	MIN (Notes 11, 12)	TYP	MAX (Notes 11, 12)	UNITS
Positive Supply Current, $I_{DD}$	$V_{DD} = 3.6V$ , $OE/ALM = 1.4V$	25	-	25	32	$\mu A$
		Full	-	-	<b>38</b>	$\mu A$
<b>DIGITAL INPUT CHARACTERISTICS</b>						
Input Voltage Low, $V_{OE/ALML}$	$V_{DD} = 2.7V$ to $3.6V$	Full	-	-	<b>0.5</b>	V
Input Voltage High, $V_{OE/ALMH}$	$V_{DD} = 2.7V$ to $3.6V$	Full	<b>1.4</b>	-	-	V
Input Voltage Low, $V_{OE/ALML}$	$V_{DD} = 3.7V$ to $4.2V$	Full	-	-	<b>0.7</b>	V
Input Voltage High, $V_{OE/ALMH}$	$V_{DD} = 3.7V$ to $4.2V$	Full	<b>1.7</b>	-	-	V
Input Voltage Low, $V_{OE/ALML}$	$V_{DD} = 4.3V$ to $5.25V$	Full	-	-	<b>0.8</b>	V
Input Voltage High, $V_{OE/ALMH}$	$V_{DD} = 4.3V$ to $5.25V$	Full	<b>2.0</b>	-	-	V
Input Current, $I_{OE/ALML}$	$V_{DD} = 5.25V$ , $OE/ALM = 0V$	Full	-	-8.2	-	nA
Input Current, $I_{OE/ALMH}$	$V_{DD} = 5.25V$ , $OE/ALM = 5.25V$ , $4M\Omega$ Pull-down	Full	-	1.4	-	$\mu A$

**NOTES:**

10.  $V_{LOGIC}$  = Input voltage to perform proper function.
11. The algebraic convention, whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
12. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested.
13. Flatness is defined as the difference between maximum and minimum value of ON-resistance over the specified analog signal range.
14.  $r_{ON}$  matching between channels is calculated by subtracting the channel with the highest max  $r_{ON}$  value from the channel with lowest max  $r_{ON}$  value.
15. Limits established by characterization and are not production tested.

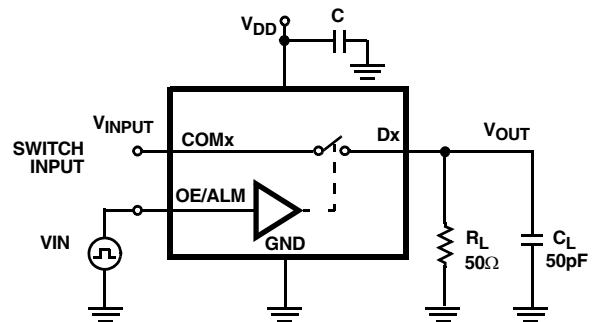
## Test Circuits and Waveforms



Logic input waveform is inverted for switches that have the opposite logic sense.

**FIGURE 1A. MEASUREMENT POINTS**

**FIGURE 1. SWITCHING TIMES**

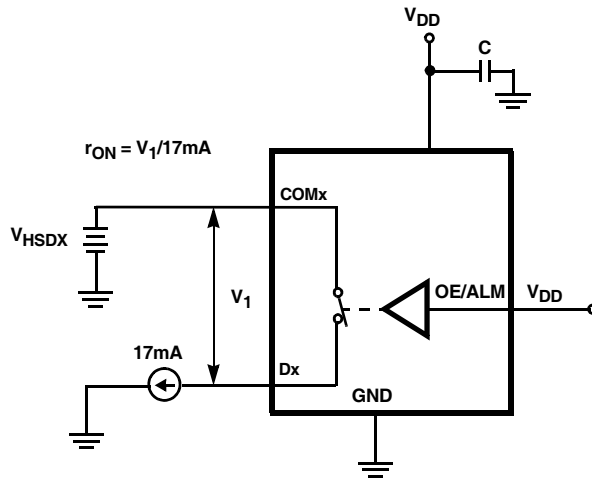


Repeat test for all switches.  $C_L$  includes fixture and stray capacitance.

$$V_{OUT} = V_{(INPUT)} \frac{R_L}{R_L + r_{ON}}$$

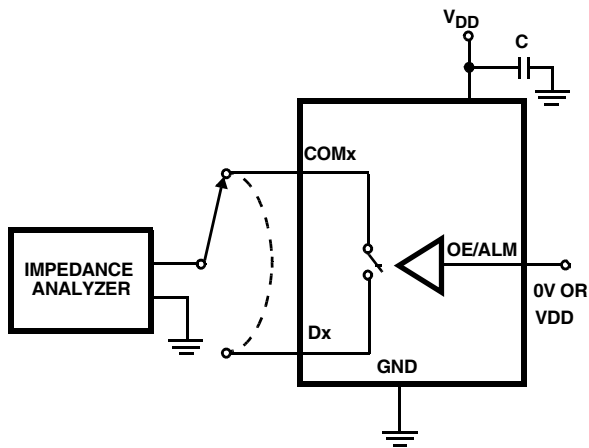
**FIGURE 1B. TEST CIRCUIT**

Test Circuits and Waveforms (Continued)



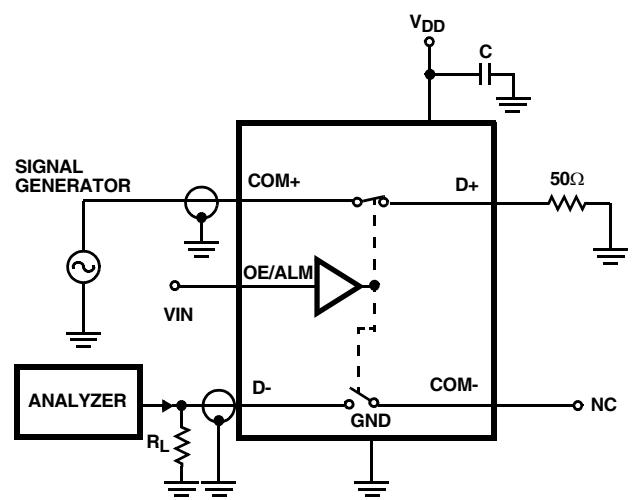
Repeat test for all switches.

FIGURE 2.  $r_{ON}$  TEST CIRCUIT



Repeat test for all switches.

FIGURE 3. CAPACITANCE TEST CIRCUIT



Signal direction through switch is reversed, worst case values are recorded. Repeat test for all switches.

FIGURE 4. CROSTALK TEST CIRCUIT

Test Circuits and Waveforms (Continued)

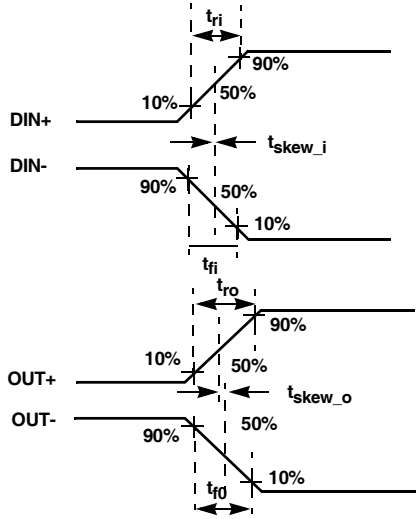
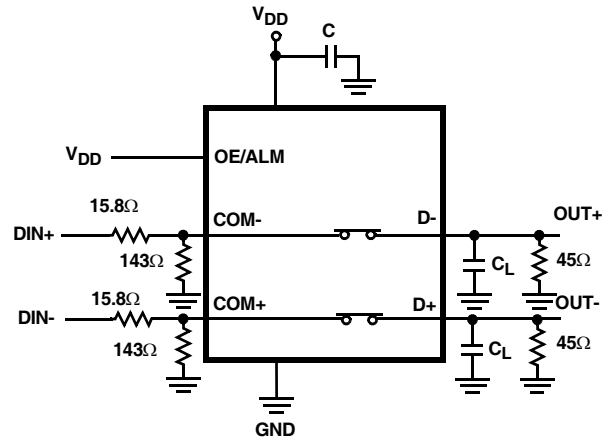


FIGURE 5A. MEASUREMENT POINTS

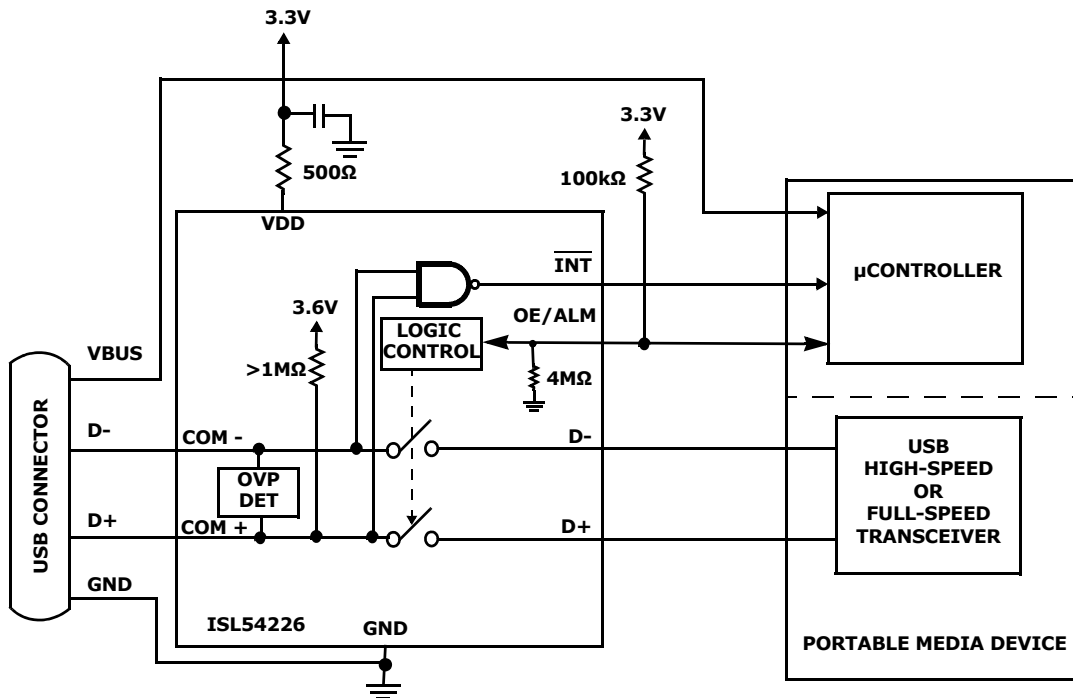


[tro - tr] Delay Due to Switch for Rising Input and Rising Output Signals.  
 [tfo - tf] Delay Due to Switch for Falling Input and Falling Output Signals.  
 [tskew\_o] Change in Skew through the Switch for Output Signals.  
 [tskew\_i] Change in Skew through the Switch for Input Signals.

FIGURE 5B. TEST CIRCUIT

FIGURE 5. SKEW TEST

Application Block Diagram





## Detailed Description

The ISL54226 device is a dual single pole/single throw (SPST) analog switch configured as a DPST that operates from a single DC power supply in the range of 2.7V to 5.25V.

It was designed for switching a USB high-speed or full-speed source in portable battery powered products. It is offered in small  $\mu$ TQFN and TDFN packages for use in MP3 players, cameras, PDAs, cellphones, and other personal media players.

The part consists of two  $3.5\Omega$  high-speed SPST switches. These switches have high bandwidth and low capacitance to pass USB high-speed (480Mbps) differential data signals with minimal edge and phase distortion. They can also swing from 0V to 3.6V to pass USB full speed (12Mbps) differential data signals with minimal distortion.

The part contains special overvoltage detection and protection (OVP) circuitry on the COM+ and COM- pins. This circuitry acts to open the USB in-line switches when the part senses a voltage on the COM pins that is  $>3.8V$  (typ) or  $<-0.45V$  (typ). It isolates voltages up to 5.25V and down to -5V from getting through to the other side of the switch to protect the USB transceiver connected at the D+ and D- pins.

The device has an open drain OE/ALM pin that can be driven "Low" to open all switches. The OE/ALM pin gets internally pulled "Low" whenever the part senses an overvoltage condition. The pin must be externally pulled "High" with a  $100k\Omega$  pull-up resistor and monitored for a "Low" to determine when an overvoltage condition has occurred.

The part has charger port interrupt detection circuitry (CP) on the COM pins that outputs a Low on the  $\overline{INT}$  pin to inform the  $\mu$ Controller or power management circuitry when entering a dedicated charging port mode of operation. The charger mode operation is initiated by driving the OE/ALM pin Low and externally connecting the COM pins together which pulls the COM lines High, triggering the  $\overline{INT}$  pin to go Low and the SPST switches to open.

The ISL54226 was designed for MP3 players, cameras, cellphones, and other personal media player applications that need to switch a high-speed or full-speed transceiver source. A "Typical Application Block Diagram" of this functionality is shown on page 8.

A detailed description of the SPST switches is provided in the following section.

### High-Speed (Dx) SPST Switches

The Dx switches are bi-directional switches that can pass USB high-speed and USB full-speed signals when VDD is in the range of 2.7V to 5.25V.

When powered with a 2.7V supply, these switches have a nominal  $r_{ON}$  of  $3.5\Omega$  over the signal range of 0V to 400mV with a  $r_{ON}$  flatness of  $0.26\Omega$ . The  $r_{ON}$  matching

between the switches over this signal range is only  $0.2\Omega$ , ensuring minimal impact by the switches to USB high-speed signal transitions. As the signal level increases, the  $r_{ON}$  switch resistance increases. At signal level of 3.3V, the switch resistance is nominally  $9.8\Omega$ . See Figures 9, 10, 11, 12, 13, 14 in the "Typical Performance Curves" beginning on page 12.

The Dx switches were specifically designed to pass USB 2.0 high-speed (480Mbps) differential signals in the range of 0V to 400mV. They have low capacitance and high bandwidth to pass the USB high-speed signals with minimum edge and phase distortion to meet USB 2.0 high-speed signal quality specifications. See Figure 15 in the "Typical Performance Curves" on page 13 for USB High-speed Eye Pattern taken with switch in the signal path.

The Dx switches can also pass USB full-speed signals (12Mbps) in the range of 0V to 3.6V with minimal distortion and meet all the USB requirements for USB 2.0 full-speed signaling. See Figure 16 in the "Typical Performance Curves" on page 14 for USB Full-speed Eye Pattern taken with switch in the signal path.

The switches are active (turned ON) whenever the OE/ALM voltage is logic "1" (High) and OFF when the OE/ALM voltage is logic "0" (Low).

### Overvoltage Protection (OVP)

The maximum normal operating signal range for the Dx switches is from 0V to 3.6V. For normal operation the signal voltage should not be allowed to exceed these voltage levels or go below ground by more than  $-0.3V$ .

However, in the event that a positive voltage  $>3.8V$  (typ) to 5.25V, such as the USB 5V  $V_{BUS}$  voltage, gets shorted to one or both of the COM+ and COM- pins or a negative voltage  $<-0.45V$  (typ) to -5V gets shorted to one or both of the COM pins, the ISL54226 has OVP circuitry to detect the over voltage condition and open the SPST switches to prevent damage to the USB down-stream transceiver connected at the signal pins (D-, D+).

The OVP and power-off circuitry allows the COM pins (COM-, COM+) to be driven up to 5.25V while the  $V_{DD}$  supply voltage is in the range of 0V to 5.25V. In this condition the part draws  $<100\mu A$  of  $I_{COMx}$  and  $I_{DD}$  current and causes no stress to the IC. In addition the SPST switches are OFF and the fault voltage is isolated from the other side of the switch.

The OE/ALM pin gets internally pulled low whenever the part senses an overvoltage condition. The pin must be externally pulled "High" with a  $100k\Omega$  pull-up resistor and monitored for a "Low" to determine when an overvoltage condition has occurred. This output can be monitored by a  $\mu$ Controller to indicate a fault condition to the system.

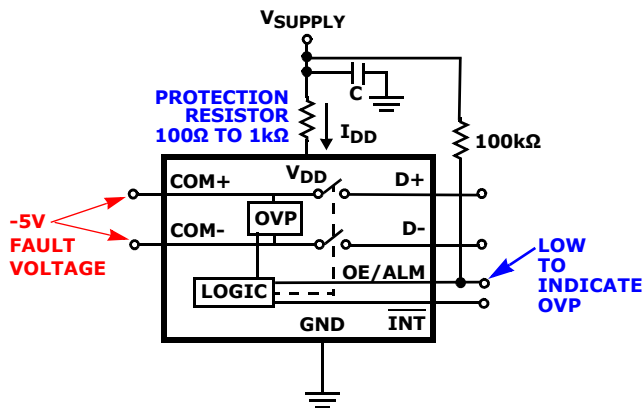
**External V<sub>DD</sub> Series Resistor to Limit I<sub>DD</sub> Current during Negative OVP Condition**

A 100Ω to 1kΩ resistor in series with the V<sub>DD</sub> pin (see Figure 6) is required to limit the I<sub>DD</sub> current draw from the system power supply rail during a negative OVP fault event.

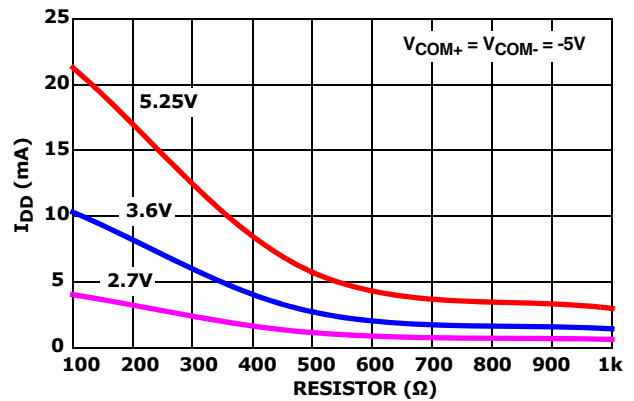
With a negative -5V fault voltage at both com pins, the graph in Figure 7 shows the I<sub>DD</sub> current draw for different external resistor values for supply voltages of 2.7V, 3.6V, and 5.25V. Note: With a 500Ω resistor the current draw is limited to around 5mA. When the negative fault voltage is removed the I<sub>DD</sub> current will return to it's normal operation current of 25μA to 45μA.

The series resistor also provides improved ESD and latch-up immunity. During an overvoltage transient event (such as occurs during system level IEC 61000 ESD testing), substrate currents can be generated in the IC that can trigger parasitic SCR structures to turn ON, creating a low impedance path from the V<sub>DD</sub> power supply to ground. This will result in a significant amount of current flow in the IC, which can potentially create a latch-up state or permanently damage the IC. The external V<sub>DD</sub> resistor limits the current during this overstress situation and has been found to prevent latch-up or destructive damage for many overvoltage transient events.

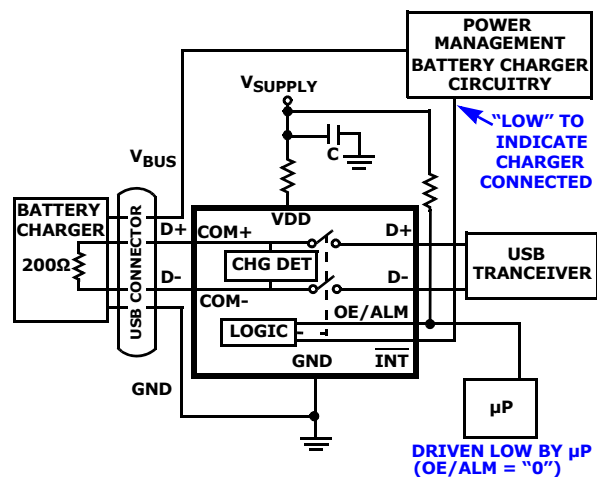
Under normal operation the low microamp I<sub>DD</sub> current of the IC produces an insignificant voltage drop across the series resistor resulting in no impact to switch operation or performance.



**FIGURE 6. V<sub>DD</sub> SERIES RESISTOR TO LIMIT I<sub>DD</sub> CURRENT DURING NEGATIVE OVP AND FOR ENHANCED ESD AND LATCH-UP IMMUNITY**



**FIGURE 7. NEGATIVE OVP I<sub>DD</sub> CURRENT vs RESISTOR VALUE vs V<sub>SUPPLY</sub>**



**FIGURE 8. CHARGER PORT DETECTION**

**CHARGER PORT DETECTION**

The ISL54226 has special charger port detection circuitry that monitors the voltage at the com pins to detect when a battery charger has been connected into the USB port (see Figure 8).

When the battery charger is connected to the USB connector it shorts the COM+ and COM- pins together. The shorting of the pins is sensed by the ISL54226 IC and it pulls the COM+ and COM- lines high and as long as the OE/ALM pin is driven low (OE/ALM = "0") by the μP, it will drive its INT logic output "Low" to tell the power management circuitry that a battery charger is connected at the port and not a USB host transceiver. The power management circuitry will then set the appropriate current level and use the USB connector VBUS line to charge the battery.

## ISL54226 Operation

The following will discuss using the ISL54226 shown in the "Application Block Diagram" on page 8.

### Power

The power supply connected at the VDD pin provides the DC bias voltage required by the ISL54226 part for proper operation. The ISL54226 can be operated with a V<sub>DD</sub> voltage in the range of 2.7V to 5.25V.

For lowest power consumption you should use the lowest VDD supply.

A 0.01μF or 0.1μF decoupling capacitor should be connected from the VDD pin to ground to filter out any power supply noise from entering the part. The capacitor should be located as close to the VDD pin as possible.

In a typical application, V<sub>DD</sub> will be in the range of 2.8V to 4.3V and will be connected to the battery or LDO of the portable media device.

### Logic Control

The state of the ISL54226 device is determined by the voltage at the OE/ALM pin and the signal voltage at the COM pins. Refer to "Truth Table" on page 2.

The OE/ALM pin is internally pulled low through 4MΩ resistors to ground and can be tri-stated by a μProcessor.

The OE/ALM pin is an open drain connection. It should be pulled high through an external 100kΩ pull-up resistor. The OE/ALM pin can then be driven "Low" by a μProcessor to open all switches or it can be monitored by the μProcessor for a "Low" when the part goes into an overvoltage condition.

The ISL54226 is designed to minimize I<sub>DD</sub> current consumption when the logic control voltage is lower than the V<sub>DD</sub> supply voltage. With V<sub>DD</sub> = 3.6V and the OE/ALM logic pin is at 1.4V the part typically draws only 25μA. With V<sub>DD</sub> = 4.3V and the OE/ALM logic pin is at 2.6V the part typically draws only 35μA. Driving the logic pin to the V<sub>DD</sub> supply rail minimizes power consumption.

The OE/ALM pin can be driven with a voltage higher than the V<sub>DD</sub> supply voltage. It can be driven up to 5.25V with a V<sub>DD</sub> supply in the range of 2.7V to 5.25V.

**TABLE 2. LOGIC CONTROL VOLTAGE LEVELS**

V <sub>DD</sub> SUPPLY RANGE	LOGIC = "0" (LOW)	LOGIC = "1" (HIGH)
	OE/ALM	OE/ALM
2.7V to 3.6V	≤0.5V or floating	≥1.4V
3.7V to 4.2V	≤0.7V or floating	≥1.7V
4.3V to 5.25V	≤0.8V or floating	≥2.0V

### Normal Operation Mode

With a signal level in the range of 0V to 3.6V the switches will be ON when the OE/ALM pin = Logic "1" and will be OFF (high impedance) when the OE/ALM pin = Logic "0".

### USB 2.0 V<sub>BUS</sub> Short Requirements

The USB specification in section 7.1.1 states a USB device must be able to withstand a V<sub>BUS</sub> short (4.4V to 5.25V) or a -1V short to the D+ or D- signal lines when the device is either powered off or powered on for at least 24 hours.

The ISL54226 part has special power-off protection and OVP detection circuitry to meet these short circuit requirements. This circuitry allows the ISL54226 to provide protection to the USB down-stream transceiver connected at its signal pins (D-, D+) to meet the USB specification short circuit requirements.

The power-off protection and OVP circuitry allows the COM pins (COM-, COM+) to be driven up to 5.25V or down to -5V while the V<sub>DD</sub> supply voltage is in the range of 0V to 5.25V. In these overvoltage conditions with a 500Ω external VDD resistor the part draws <55μA of current into the COM pins and causes no stress/damage to the IC. In addition all switches are OFF and the shorted V<sub>BUS</sub> voltage will be isolated from getting through to the other side of the switch channels, thereby protecting the USB transceiver.

Typical Performance Curves  $T_A = +25^\circ\text{C}$ , Unless Otherwise Specified

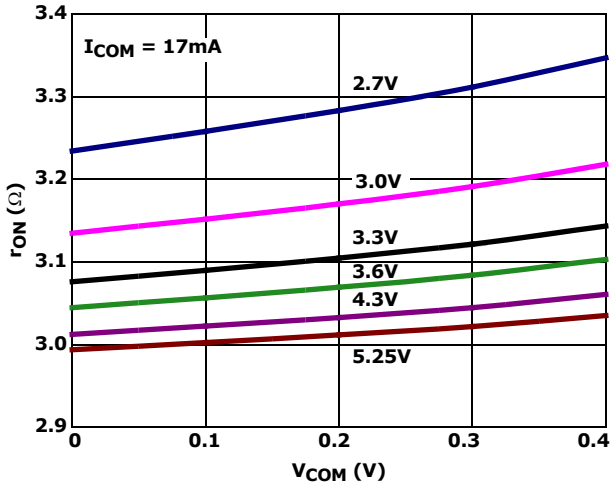


FIGURE 9. ON-RESISTANCE vs SUPPLY VOLTAGE vs SWITCH VOLTAGE

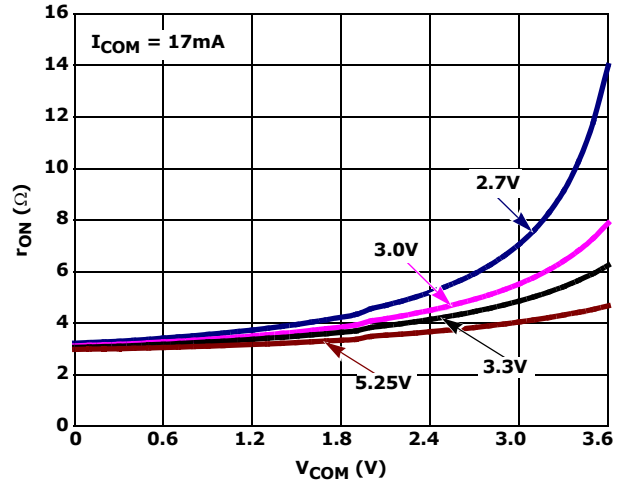


FIGURE 10. ON-RESISTANCE vs SUPPLY VOLTAGE vs SWITCH VOLTAGE

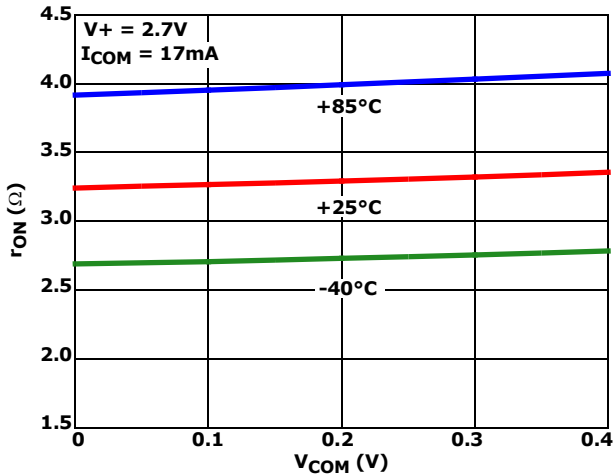


FIGURE 11. ON-RESISTANCE vs SWITCH VOLTAGE

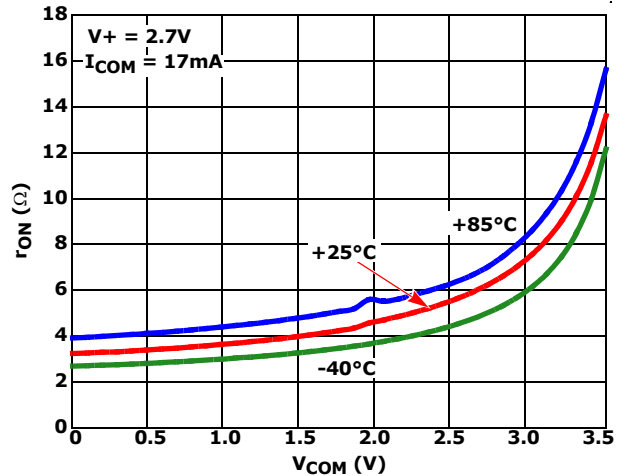


FIGURE 12. ON-RESISTANCE vs SWITCH VOLTAGE

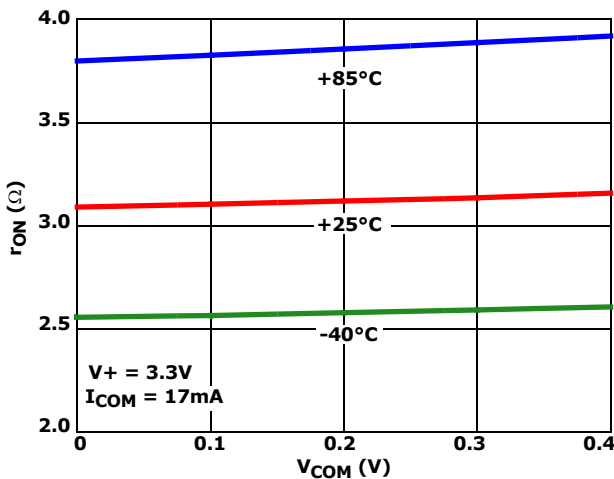


FIGURE 13. ON-RESISTANCE vs SWITCH VOLTAGE

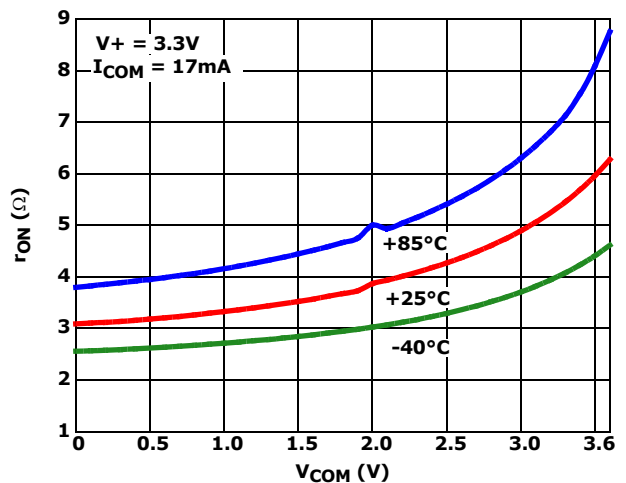
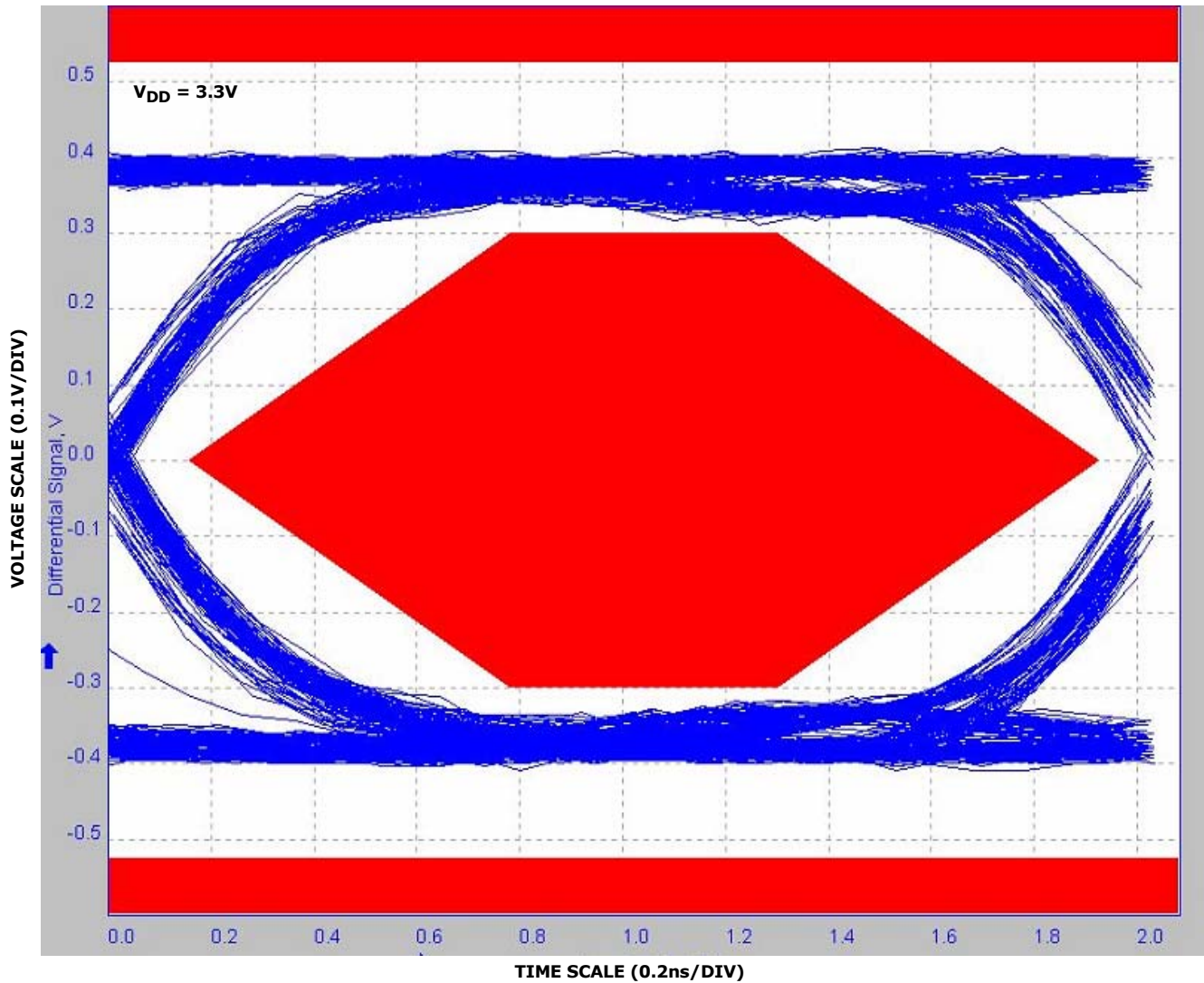


FIGURE 14. ON-RESISTANCE vs SWITCH VOLTAGE

**Typical Performance Curves**  $T_A = +25^\circ\text{C}$ , Unless Otherwise Specified (Continued)**FIGURE 15. EYE PATTERN: 480Mbps WITH USB SWITCHES IN THE SIGNAL PATH**

Typical Performance Curves  $T_A = +25^\circ\text{C}$ , Unless Otherwise Specified (Continued)

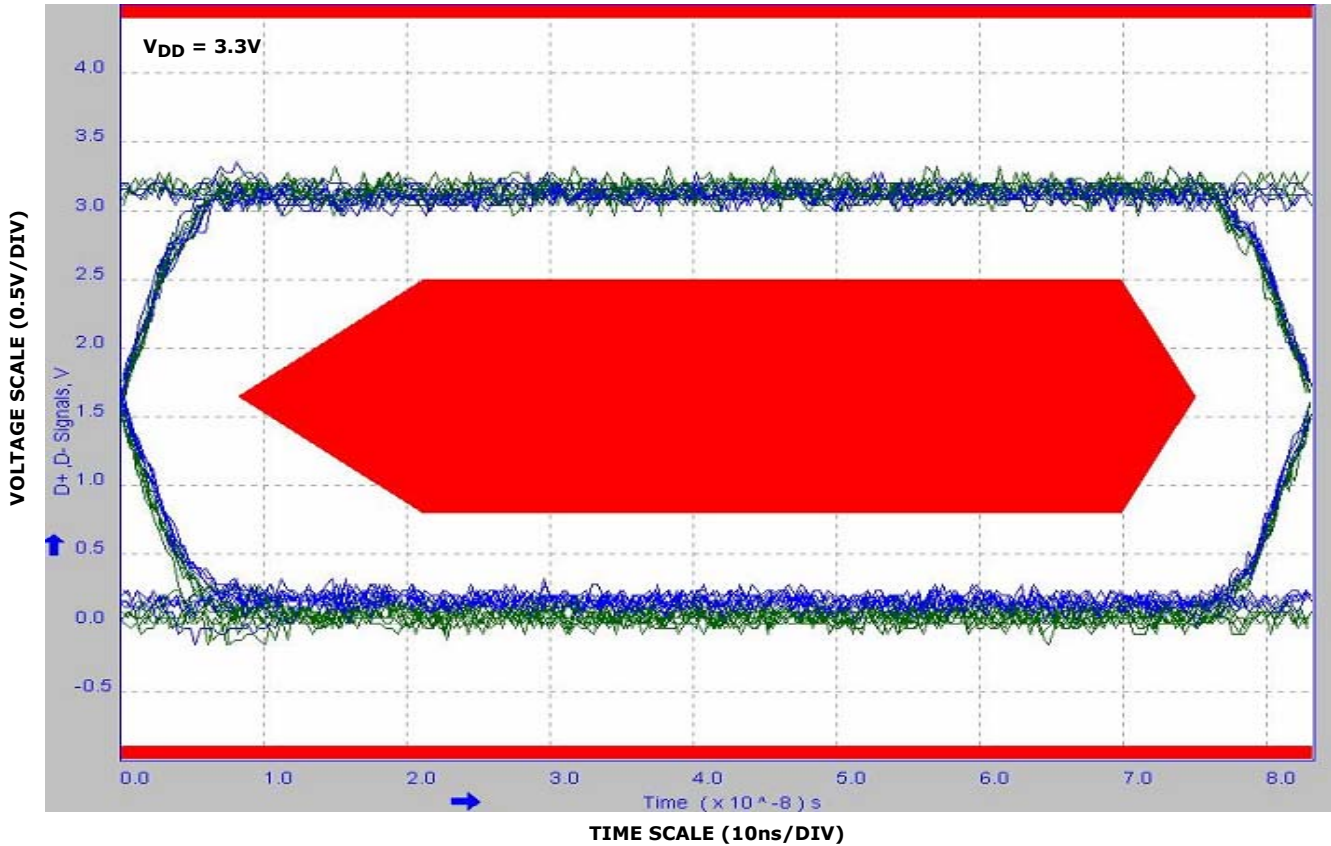


FIGURE 16. EYE PATTERN: 12Mbps WITH USB SWITCHES IN THE SIGNAL PATH

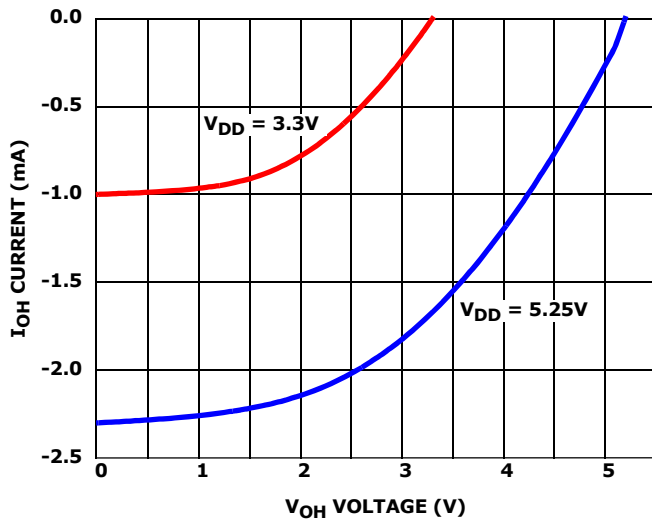


FIGURE 17.  $I_{OH}$  vs  $V_{OH}$  vs  $V_{DD}$  for  $\overline{INT}$

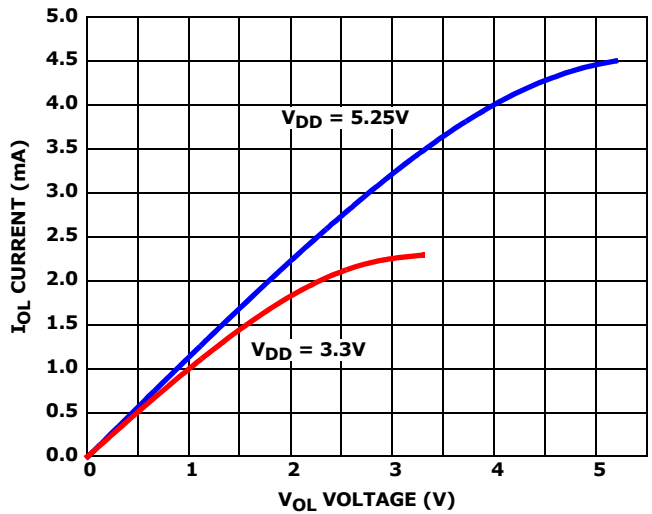


FIGURE 18.  $I_{OL}$  vs  $V_{OL}$  vs  $V_{DD}$  for  $\overline{INT}$

**Typical Performance Curves**  $T_A = +25^\circ\text{C}$ , Unless Otherwise Specified (Continued)

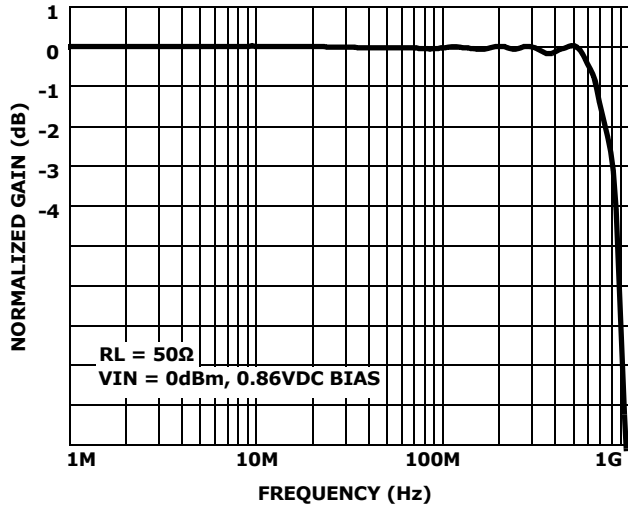


FIGURE 19. FREQUENCY RESPONSE

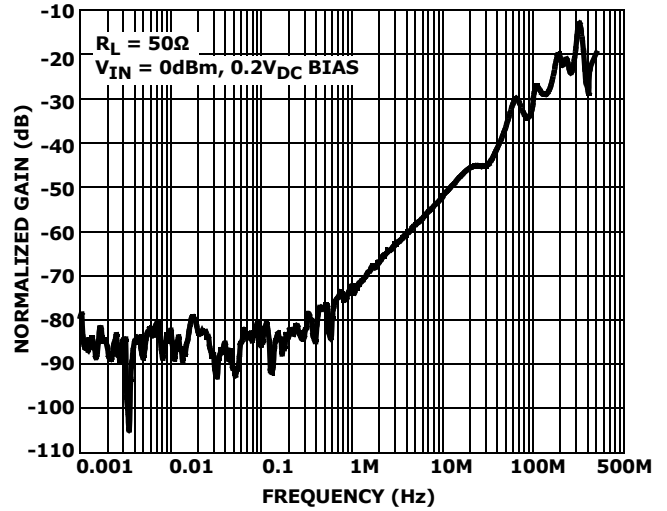


FIGURE 20. OFF-ISOLATION

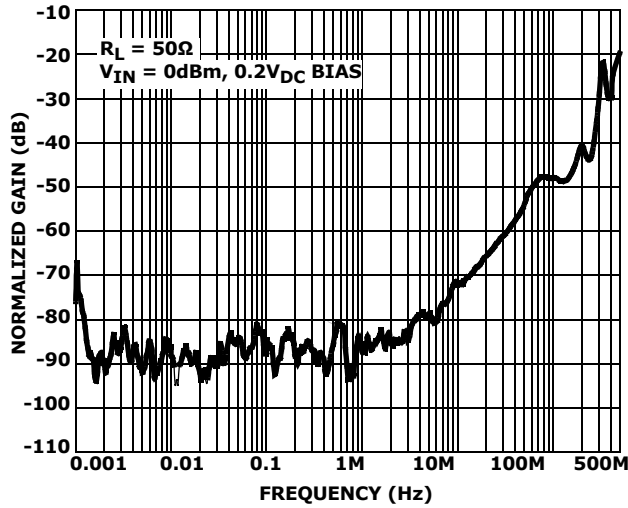


FIGURE 21. CROSSTALK

**Die Characteristics**

**SUBSTRATE AND TDFN THERMAL PAD POTENTIAL (POWERED UP):**

GND

**TRANSISTOR COUNT:**

1297

**PROCESS:**

Submicron CMOS

## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Rev.

DATE	REVISION	CHANGE
7/29/10	FN7614.0	Initial Release.

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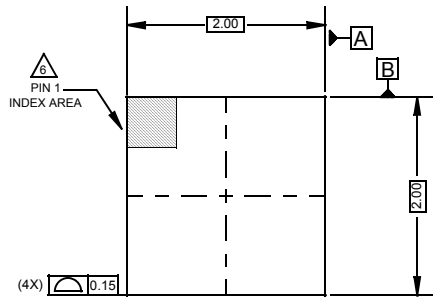


# Package Outline Drawing

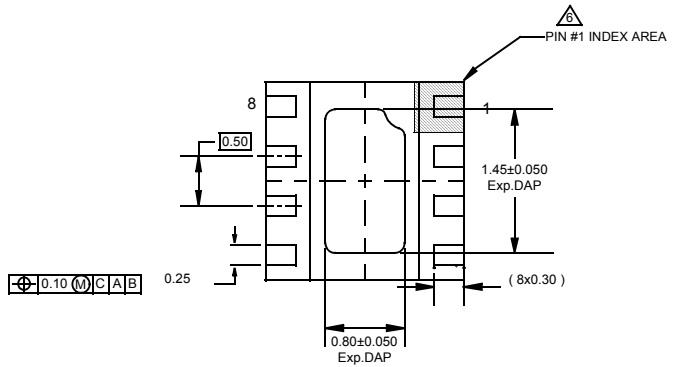
## L8.2x2C

8 LEAD THIN DUAL FLAT NO-LEAD PLASTIC PACKAGE (TDFN) WITH E-PAD

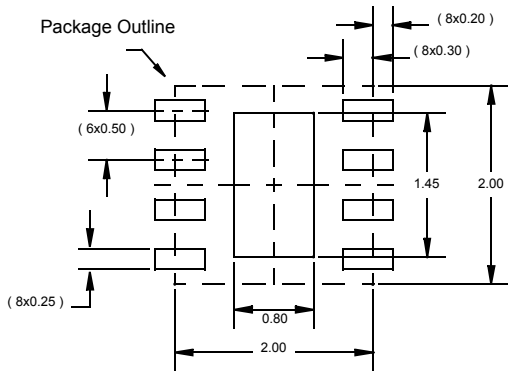
Rev 0, 07/08



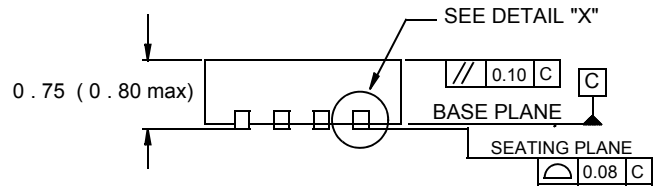
TOP VIEW



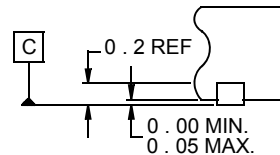
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW



DETAIL "X"

NOTES:

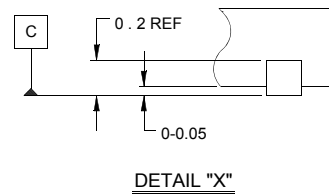
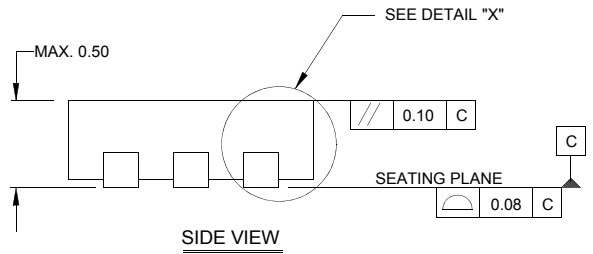
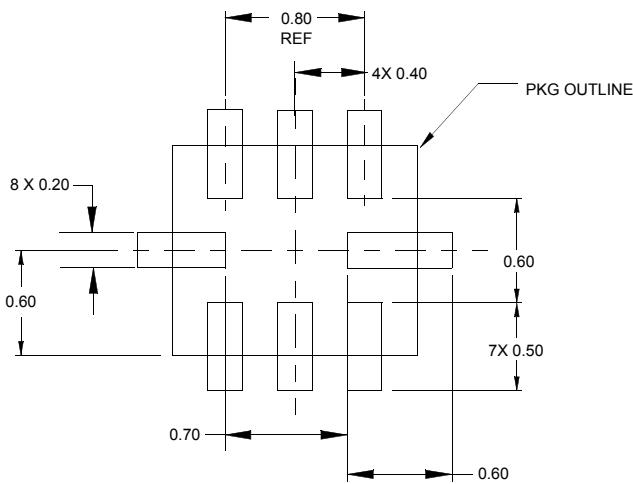
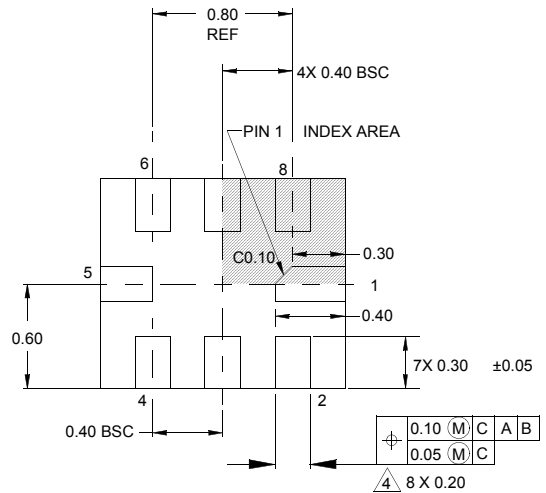
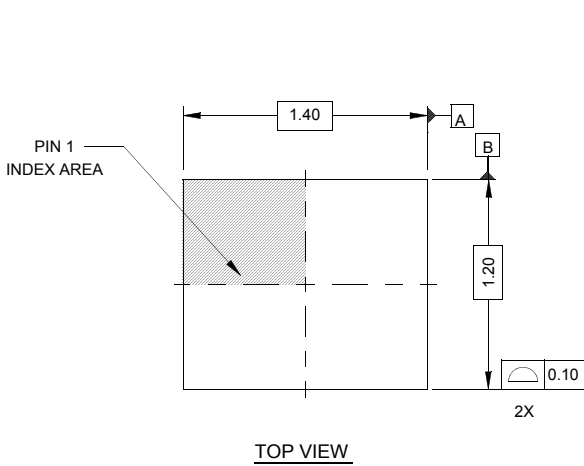
1. Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal ± 0.05
4. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.

# Package Outline Drawing

## L8.1.4x1.2

### 8 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE

Rev 0, 4/09



**NOTES:**

1. Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal  $\pm 0.05$
4. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.