# ⚡ PERICOM®

PI5L100

Wide Bandwidth Low Voltage LanSwitch Quad 2:1 Mux/Demux

Features

- Replaces mechanical relays
- High-performance, low-cost solution for switching between different LAN signals
- Ultra-low quiescent power (0.1 µA typical)
- Low crosstalk: –40 dB @ 30 Mbps
- Low insertion loss or On-Resistance: 3ohms typical
- Single extended supply operation up to 6.2V ± 5%
- Off isolation: –30 dB @ 30 Mbps
- Wide bandwidth data rates > 200 Mbps
- Packages (Pb-free & Green available):
  - 16-pin 150-mil wide plastic SOIC (W)
  - 16-pin 150-mil wide plastic QSOP (Q)
  - 20-pin 173-mil wide plastic TSSOP (L)

Description

Pericom Semiconductor's PI5L100 is a Quad 2:1 multiplexer/demultiplexer LanSwitch with three-state outputs. This device can be used for switching between various standards, such as 10 Base-T, 100 Base-T, 100VG-AnyLAN or Token Ring. Generally, this part can be used to replace mechanical relays in low voltage LAN applications that have phsical layer, unshielded twisted pair media (UTP) with either CAT 3 or CAT 5 grade cable.

To reduce insertion loss, PI5L100 is powered by a 6.2V Zener voltage.

Block Diagram

16-Pin Configuration

20-Pin Configuration

Truth Table[1]

$\overline{E}$	S	YA	YB	YC	YD	Function
H	X	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Disable
L	L	IA0	IB0	IC0	ID0	S = 0
L	H	IA1	IB1	IC1	ID1	S = 1

Note:
1. H = High Voltage Level
   L = Low Voltage Level
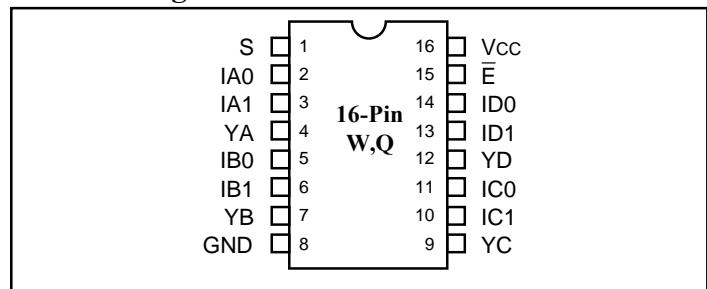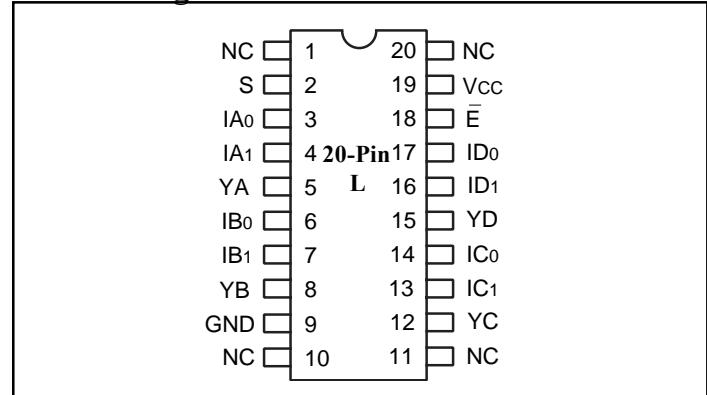
Product Pin Description

Pin Name	Description
IAn-IDn	Data Inputs
S	Select Inputs
$\overline{E}$	Enable
YA-YD	Data Outputs
GND	Ground
V_{CC}	Power

1

Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

Storage Temperature .... –65°C to +150°C

Ambient Temperature with Power Applied .... 0°C to +70°C

Supply Voltage to Ground Potential .... –0.5V to +7.0V

DC Input Voltage .... –0.5V to +7.0V

DC Output Current 120mA

Power Dissipation 0.5W

Note:
Stresses greater than those listed under MAXIMUM RAT-INGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

DC Electrical Characteristics (Over the Operating Range, $T_A = 0°C$ to $+70°C$, $V_{CC} = 6.2V$, $+5\%, -2\%$)

Parameter	Description	Test Conditions	Min.	Typ[2]	Max.	Units
V_{IH}	Input HIGH Voltage	Guaranteed Logic HIGH Level	2.0	—	—	V
V_{IL}	Input LOW Voltage	Guaranteed Logic LOW Level	–0.5	—	0.8	
I_{IH}	Input HIGH Current	$V_{CC} = $ Max., $V_{IN} = V_{CC}$	—	—	±1	µA
I_{IL}	Input LOW Current	$V_{CC} = $ Max., $V_{IN} = $ GND	—	—	±1	
I_{OZH}	High Impedance Output Current	$0 \leq A, B \leq V_{CC}$	—	—	±1	V
V_{IK}	Clamp Diode Voltage	$V_{CC} = $ Min., $I_{IN} = –18mA$	—	–0.7	–1.2	
I_{OS}	Short Circuit Current[3]	A (B) = 0V, B (A) = V_{CC}	100	—	—	mA
V_H	Input Hysteresis at Control Pins		—	150	—	mV
V_{ON}	Switch On Voltage	$V_{IN} = 4.5V$, $\overline{E} = $ LOW, See Figure 10, $R_L = 100\Omega$	3.7[4]	4.06[5]	—	V
R_{ON}[6]	M1 Switch On Resistance	Calculated from V_{ON}	19	11.2	—	
R_{ON}[7]	M2 Switch On Resistance	$V_{IN} = 4.5V$, $\overline{E} = $ LOW, See Figure 10, $R_L = 100\Omega$	2.0	3.0	—	Ω
ΔR_{ON}	On Resistance Match	$V_{IN} = 4.5V$, $\overline{E} = $ LOW	—	1.0	—	

Notes:

1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $V_{CC} = 6.2V$, $T_A = 25°C$ ambient temperature.
3. Not more than one output should be shorted at one time. Duration of the test should not exceed one second.
4. V_{ON} (min) value is at $V_{CC} = 6.1V$, $T_A = 70°C$.
5. The expected AC V_{ON} value is about 125 mV higher than the DC V_{ON} value using the similar test circuit in Figure 10 with V_{IN} swing from 0.0V to 4.5V at 10 MHz sine wave.
6. The value of R_{ON} of M1 is calculated with the equvalent mathematical formula of the test circuit in Figure 10.

$$R_{ON} (M1) = \frac{V_{IN} - V_{ON}}{I_{ON}}$$

were

$$I_{ON} = \frac{V_{ON}}{R_L + R_{ON} (M2)}$$

with $R_{ON} (M2) = 3$ ohms

7. This parameter is determined by device characterization but is not production tested.

Capacitance ($T_A = 25°C$, $f = 1\,MHz$)

Parameters[1]	Description	Test Conditions	Typ.	Units
C_{IN}	Input Capacitance	$V_{IN} = 0V$	6	
C_{OFF}	A/B Capacitance, Switch Off	$V_{IN} = 0V$	6	pF
C_{ON}	A/B Capacitance, Switch On	$V_{IN} = 0V$	8	

Note:
1. This parameter is determined by device characterization but is not production tested.

Power Supply Characteristics

Parameters[1]	Description	Test Conditions		Min.	Typ.	Max.	Units
I_{CC}	Quiescent Power Supply Current	$V_{CC} = 5.5V$	$V_{IN} = GND$ or V_{CC}		0.1	3.0	μA
ΔI_{CC}	Supply Current per Input @ TTL High	$V_{CC} = 5.5V$	$V_{IN} = 3.4V$[2]			2.5	mA
I_{CCD}	Supply Current per MHz[3]	$V_{CC} = 5.5V$ Input Pins Open $\overline{E} = GND$ Control Input Toggling 50% Duty Cycle				0.25	μA/MHz

Notes:
1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device.
2. Per TTL driven input ($V_{IN} = 3.4V$, control inputs only); A and B pins do not contribute to I_{CC}.
3. This current applies to the control inputs only and represent the current required to switch internal capacitance at the specified frequency. The A and B inputs generate no significant AC or DC currents as they transition. This parameter is not tested, but is guaranteed by design.

Switching Characteristics over Operating Range

Parameters	Description	Conditions[1]	PI5L100 Com.			Units
			Min.	Typ.	Max.	
t_{IY}	Propagation Delay[2,3], I_N to Y	$C_L = 50pF$ $R_L = 500$ ohms	—	—	0.25	ns
t_{SY}	Bus Enable Time, S to Y		0.5		5.2	
t_{PHZ}, t_{PLZ}	Bus Disable Time, $\overline{E}$ to Y		0.5		5.0	
t_{EY}	Bus Disable Time, $\overline{E}$ to Y		0.5		4.8	
$X_{TALK}(Dif)$	Differential Crosstalk[2]	$R_L = 100$ ohms, f = 10MHz, See Figure 11	–40	–60	—	
X_{TALK}	Crosstalk	$R_L = 100$ ohms, f = 30MHz, See Figure 9	—	–40	—	
O_{IRR}	Off Isolation	$R_L = 100$ ohms, f = 30MHz, See Figure 6	—	–30	—	
B_W	–3dB Bandwidth	$R_L = 100$ ohms, See Figure 9	—	216	—	
t_{ON}	Turn On Time	$R_L = 100$ ohms, $C_L = 35pF$, See Figure 8	—	11	—	
t_{OFF}	Turn Off Time		—	11	—	

Notes:
1. See test circuit and waveforms.
2. This parameter is guaranteed but not tested.
3. The bus switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 50pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the bus switch when used in a system is determined by the driving circuit on the driving side of the switch and its interaction with the load on the driven side.

RON   VIN = 4.5000V,   RON = 14.3E+00, VON = 3.9569V   VON
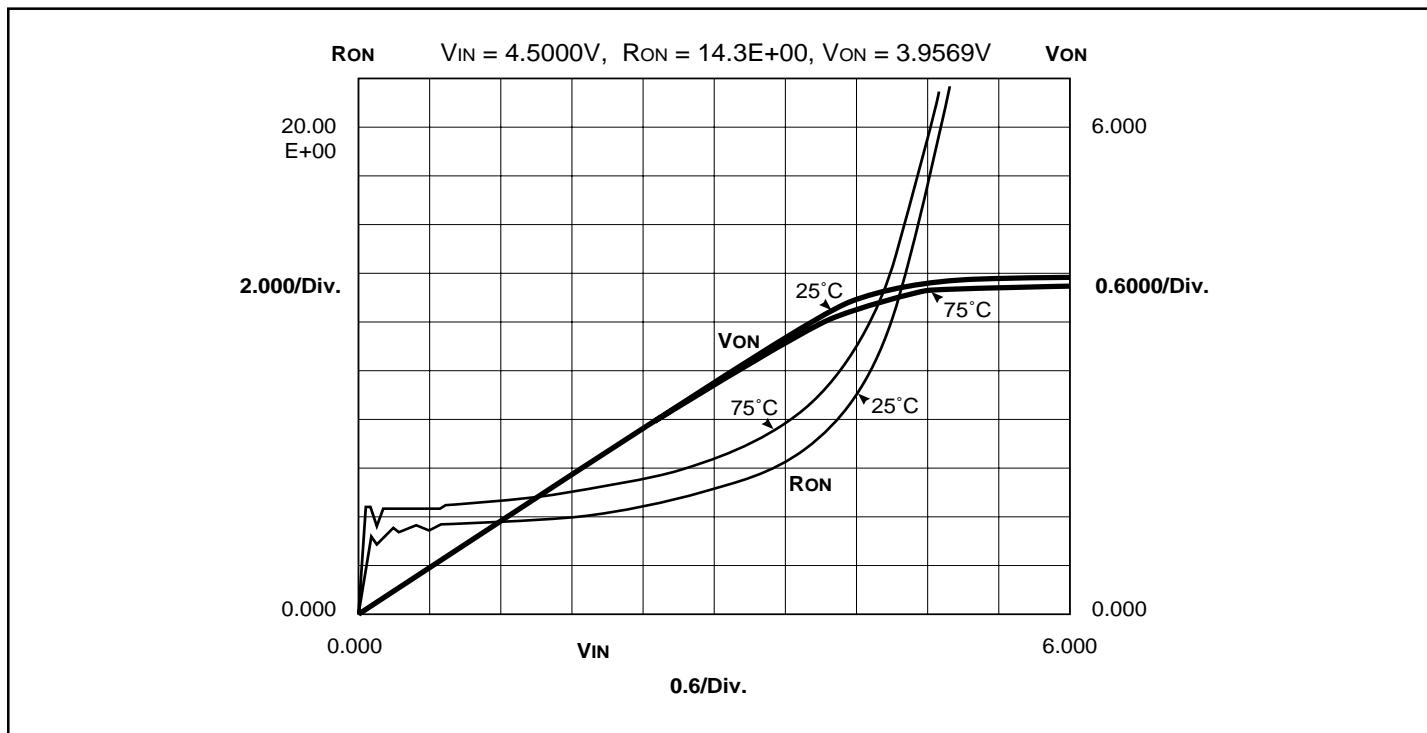
Figure 3. R$_{ON}$ vs Input Voltage over Temperature
(R$_{ON}$ at V$_{CC}$ = 6.1V @ 75°C)

RON   VIN = 4.5000V,   RON = 10.9E+00, VON = 4.0720V   VON
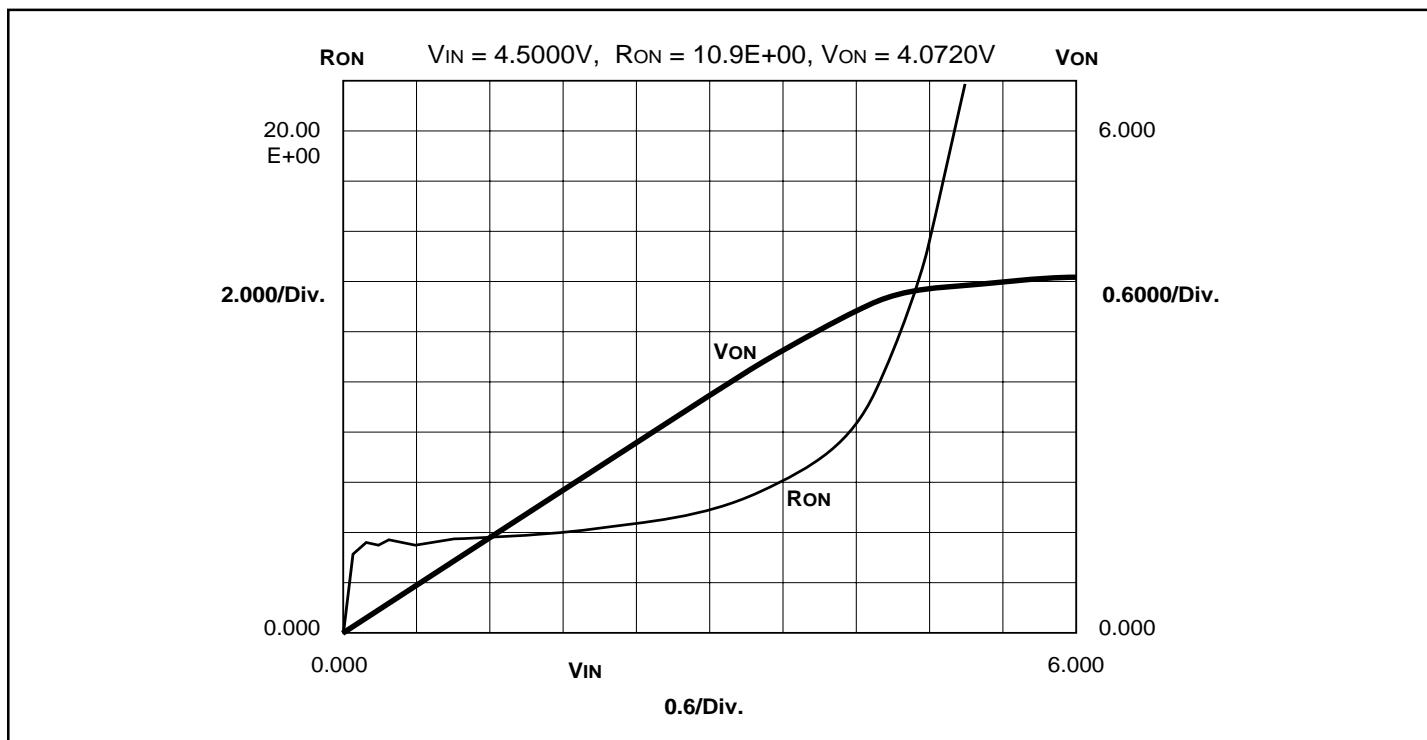

Figure 4. R$_{ON}$ vs Input Voltage
(R$_{ON}$ at V$_{CC}$ = 6.2V @ 25°C)
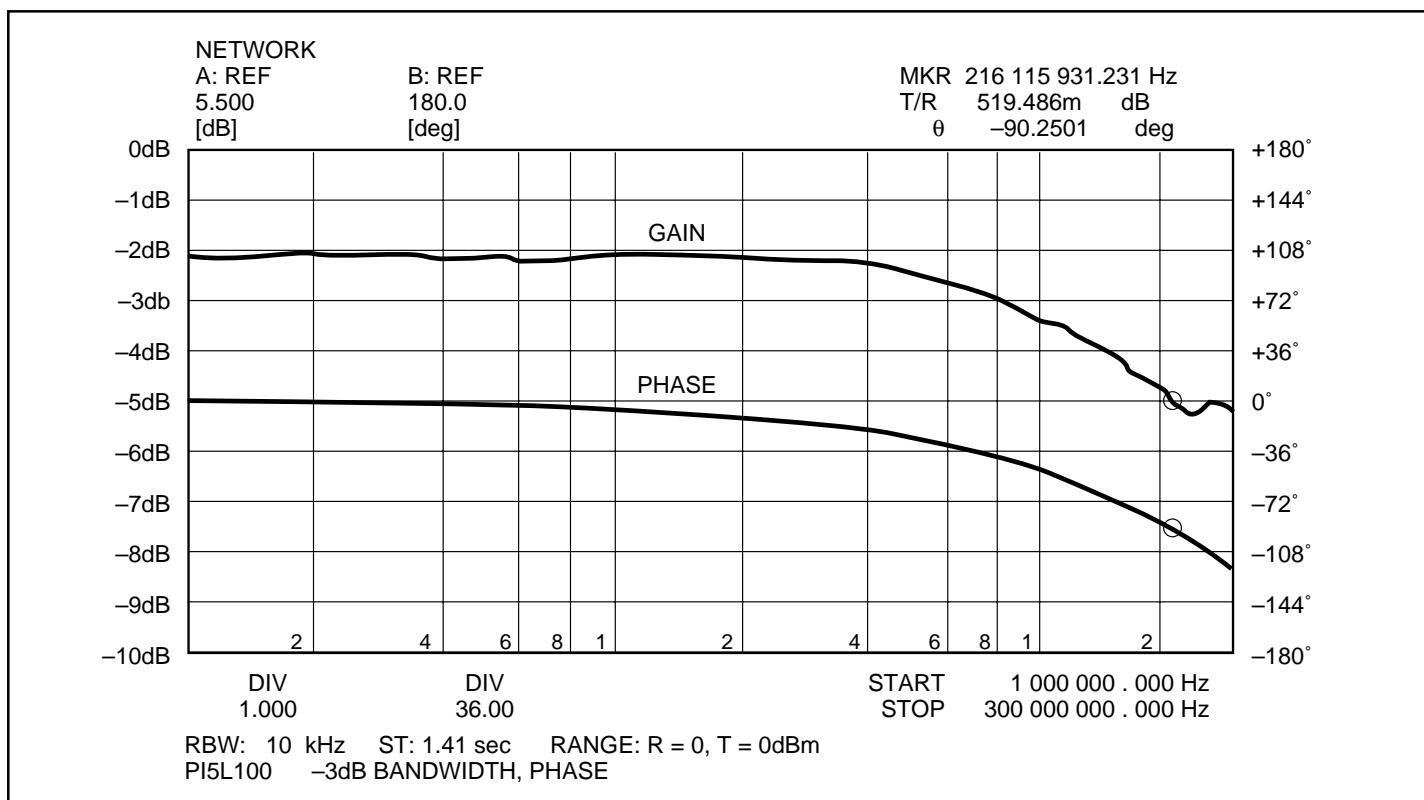
Figure 5. Gain/Phase vs Frequency
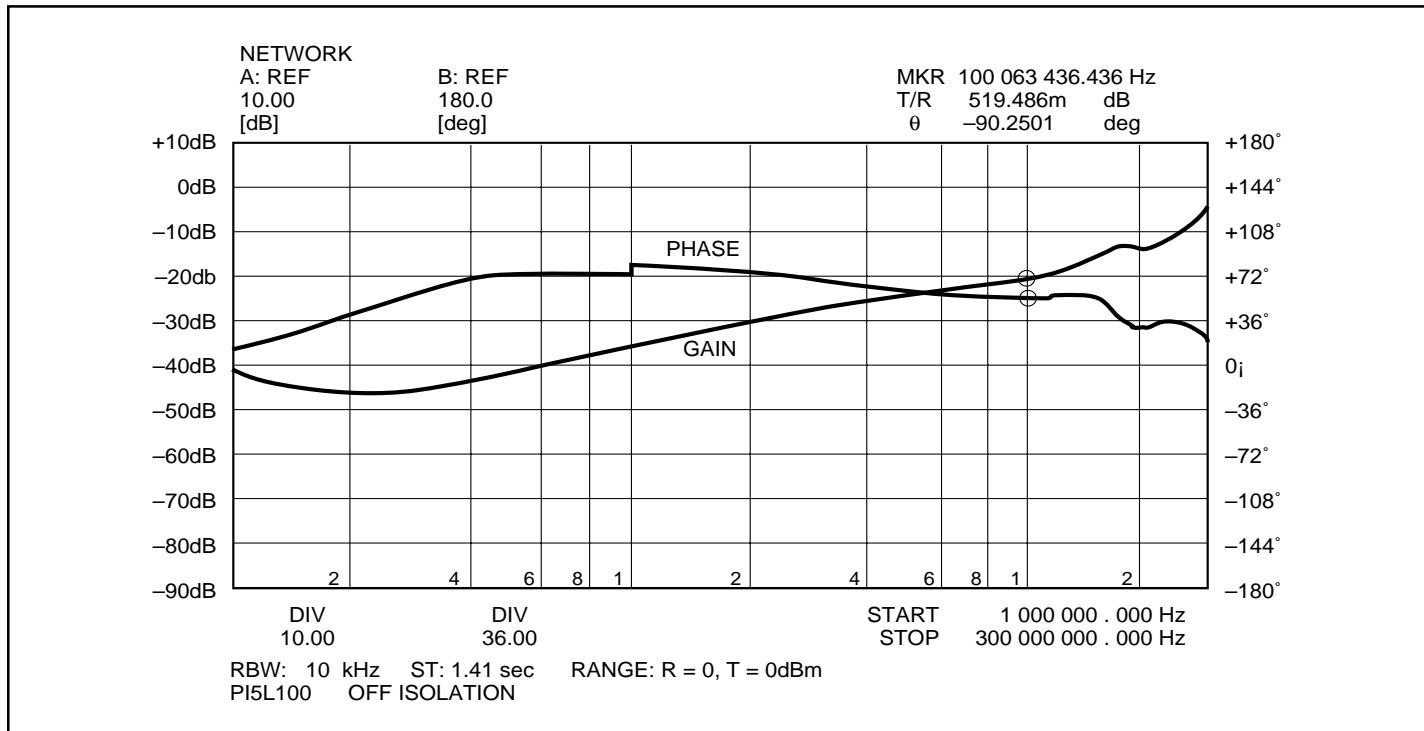
Figure 6. Off Isolation vs Frequency

NETWORK
A: REF 0.000 [dB]   B: REF 180.0 [deg]   MKR 10 074 746.057 Hz
T/R 519.486m dB
θ −90.2501 deg

PHASE

MAGNITUDE

DIV 10.00   DIV 36.00   START 1 000 000 . 000 Hz
STOP 300 000 000 . 000 Hz

RBW: 10 kHz   ST: 4.05 sec   RANGE: R = 0, T = 0dBm
PI5L100   XTALK 10 MHz, RL = 50 Ohm
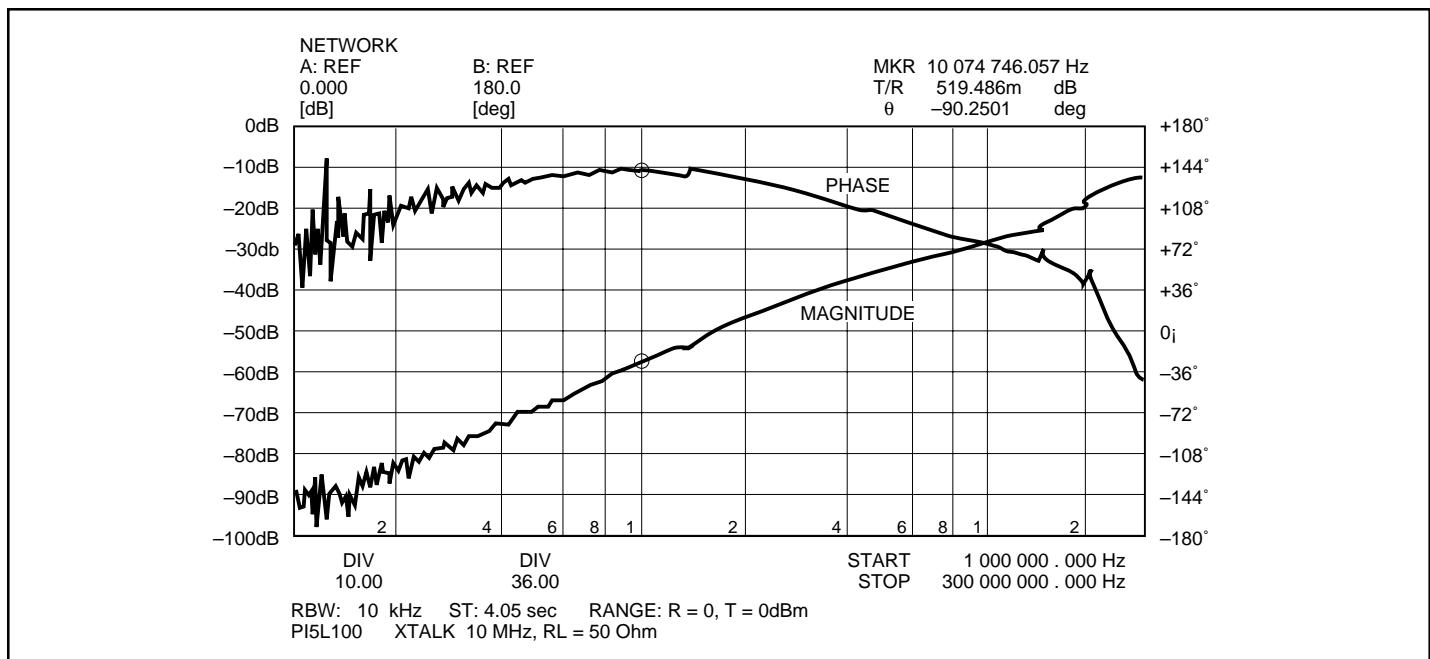
Figure 7. Crosstalk vs Frequency

Applications

LAN Switch Applications

The PI5L100 was designed to switch between various standards such as 10Base-T, 100Base-T, 100VG-AnyLAN, and Token Ring. Also general purpose applications such as loopback, line termination, and line clamps that might normally use mechanical relays are also ideal uses for this LAN Switch (see Figure 11 applications). Generally speaking, this LAN Switch can be used for data rates to 200 Mbps and data signal levels from 0V to 4.5V.

LAN Standards	Data Rate per twisted pair (UTP)
10Base-T	10 Mbps
100Base-T	100 Mbps
100VG-AnyLAN	25 Mbps

Differential Crosstalk . . . X$_{TALK}$ (DIF)

Adjacent pins cause the most crosstalk because of the interlead package capacitance which is generally in the order of 0.5pF (pin-to-pin). It can be seen in Figure 11 that this Evaluation (EV) Board schematic uses four pairs of switches. Pair 1B/2B are RX1 that connect to YA and YB. The second pair, 3B/4B, are TX1 and connect to YC and YB. Pairs 3 and 4 are grounded for this differential crosstalk test. The purpose of this EV board is to determine the amount of crosstalk between the transmit and receive pairs in a full duplex application. Figure 15 shows the scope waveforms. Traces

1 and 2 are single ended inputs to the differential inputs of the DUT. Trace 3 is the differential X$_{TALK}$ output which equates to $20LOG\ V_{OUT}/V_{IN} = 20LOG\ 30\ mV/5V = -44dB$. Since the edge rate is 2ns, the effective input frequency is equal to $0.3/t_R$ which is ~150 MHz. So the approximate Differential Crosstalk at 150 MHz is −44dB.

Because pins measured are not adjacent, the differential crosstalk is typically > 60 dB at 10 MHz. The load resistor (R_L) used was 100 (to match the UTP impedance). Increasing the data rate or R_L will also increase differential crosstalk.

V$_{CC}$ Bias Voltage vs R$_{ON}$

To keep R_{ON} to a minimum, it is recommended that the V_{CC} voltage be increased to a voltage between +6.0V and +6.5V (see Figure 13). The R_{ON} vs. V_{IN} curve shows the effect of on-resistance and input voltage which is exponential. Ideally an input voltage between 0.2V and 3.6V will keep R_{ON} in the flat part of the curve (ΔR_{ON} or flatness is ~2 ohms).

Signal Distortion

Distortion of the input signal is equated to $20LOG\ \Delta R_{ON}/ R_L$. So keeping R_{ON} flat as data signal level varies is critical to low distortion. Also, increasing the data rate increases harmonic distortion which also effects the signal amplitude.

Evaluation Board

Figure 14 shows the layout for an EV board that can be used for evaluation. This is a 2-layer board and is one-inch square.

**Test Circuits**
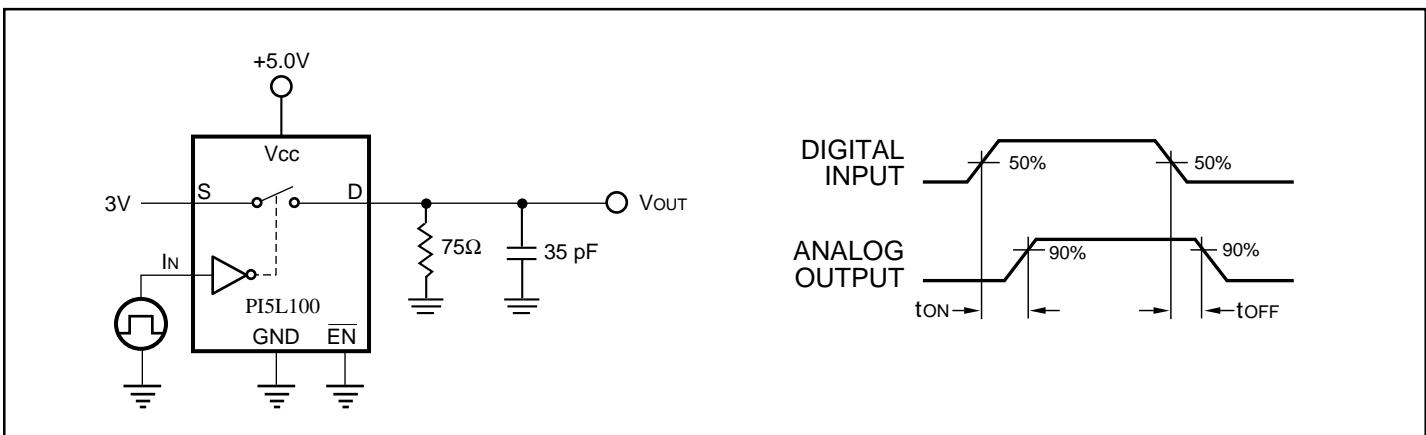
Figure 8. Switching Time
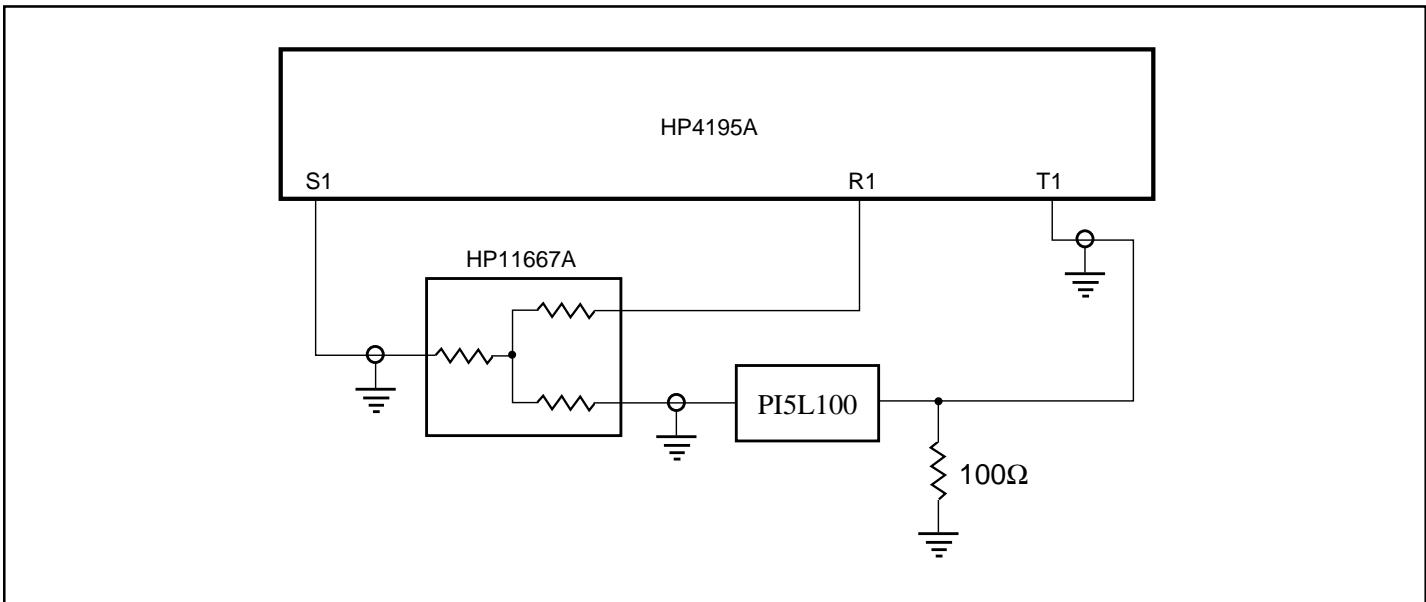

**Figure 9. Gain/Phase Crosstalk, Off Isolation**
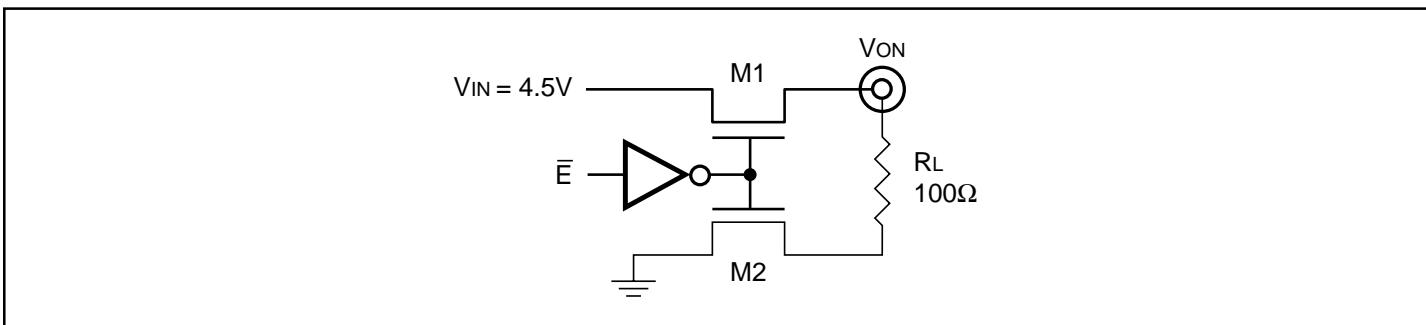
Figure 10. Switch ON Voltage Test Circuit

8
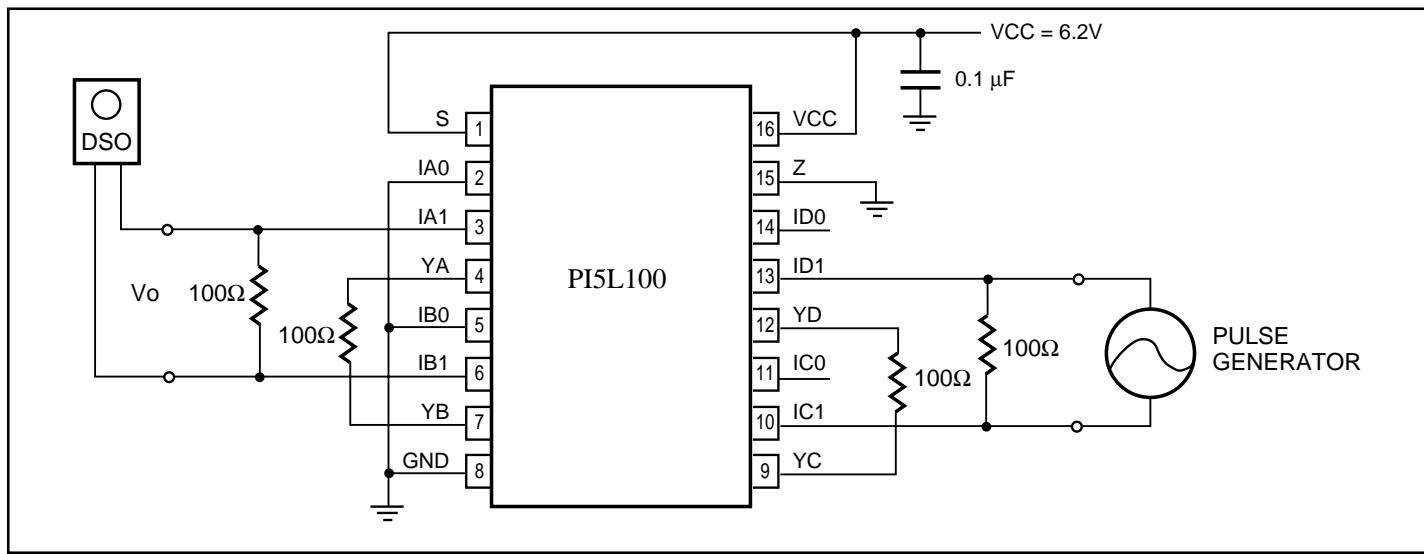
Figure 11. Differential Crosstalk Measurement
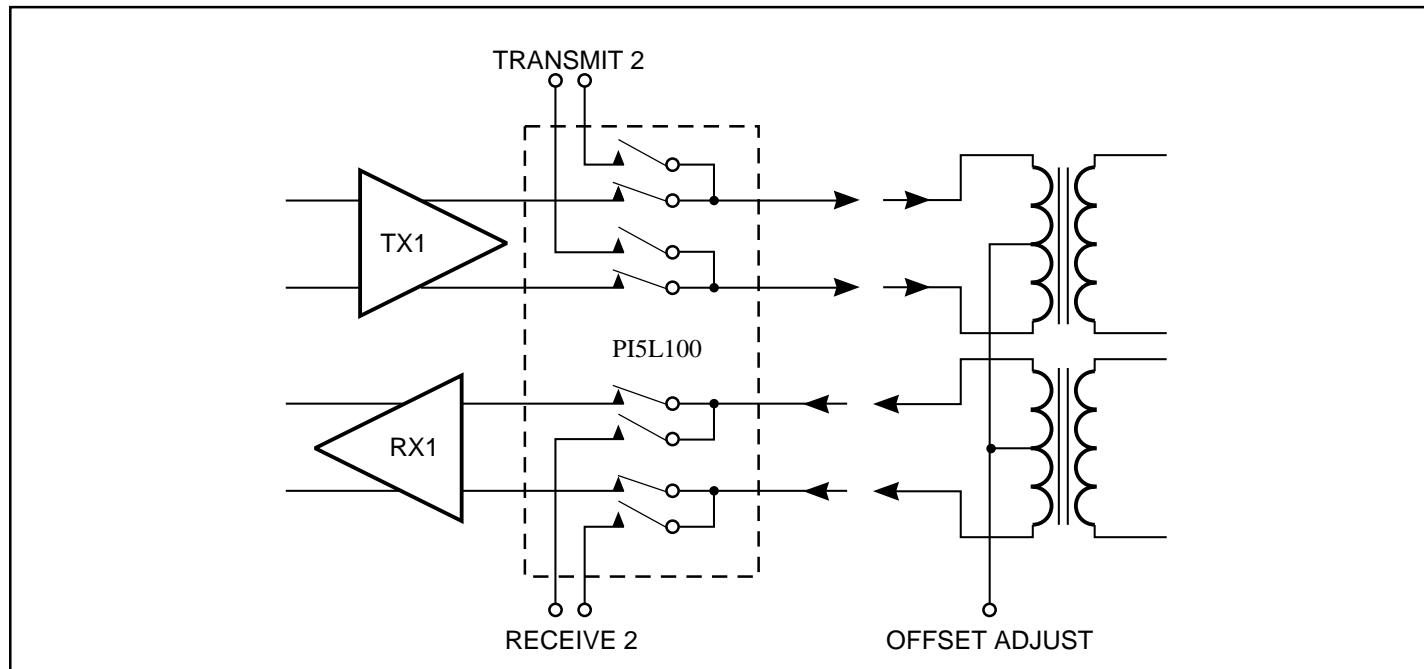
Figure 12a. Full Duplex Transceiver
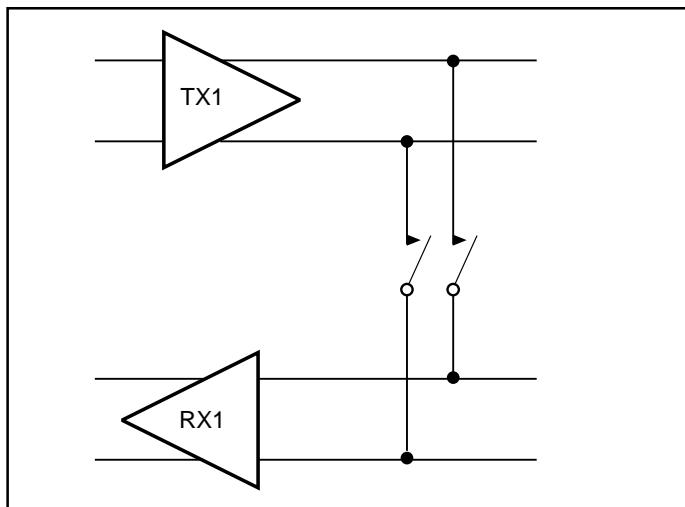
**Figure 12b. Loop Back**
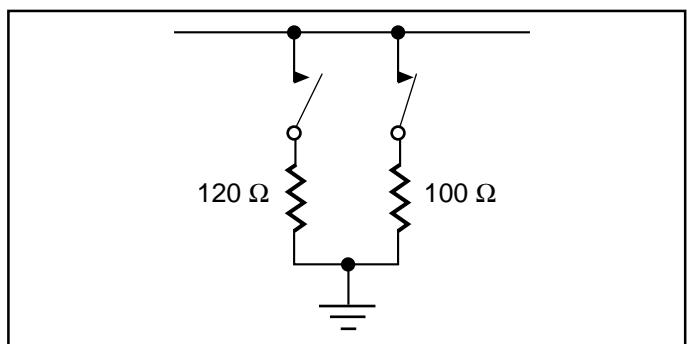
Figure 12c. Line Termination
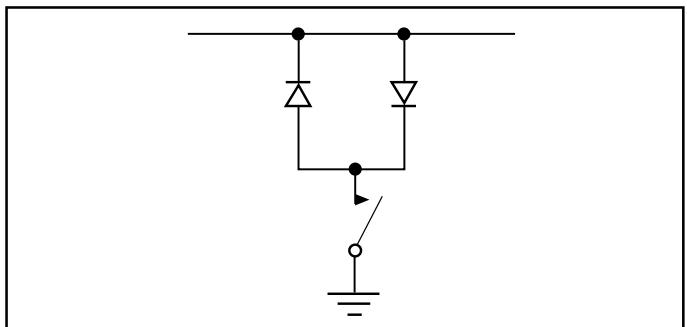
Figure 12d. Line Clamp
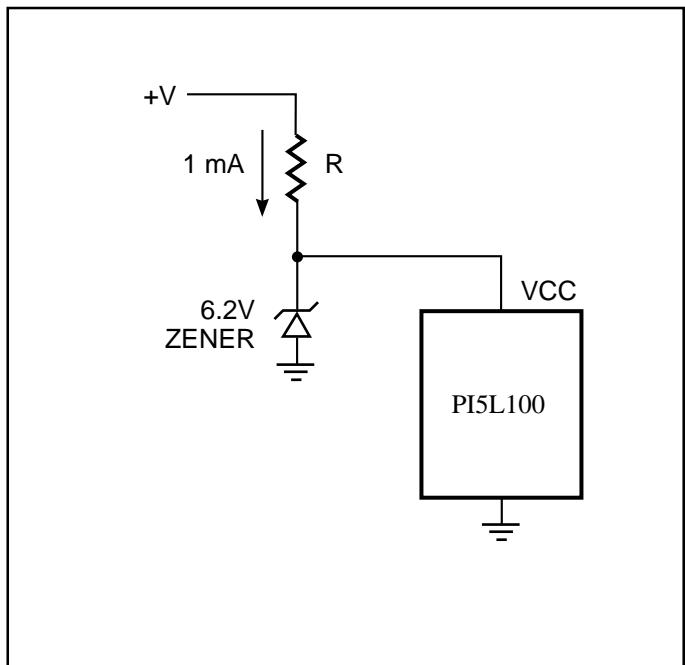
Figure 13. V_{CC} Bias Current
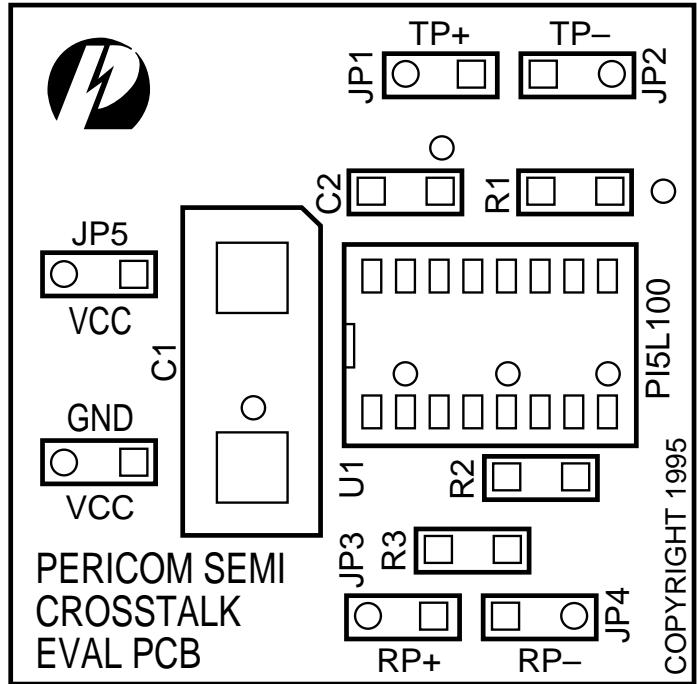

Figure 14a. Crosstalk EV Board

PS7031F   09/17/04
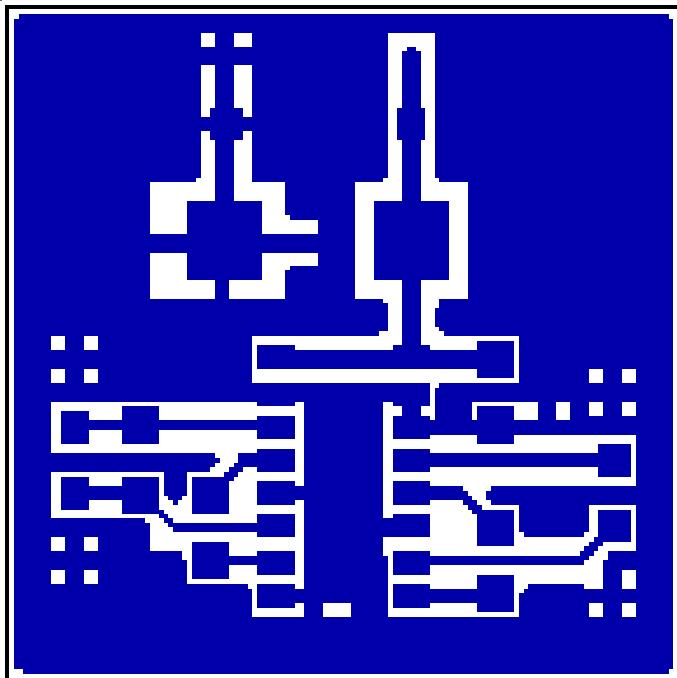
Figure 14b. Component Side
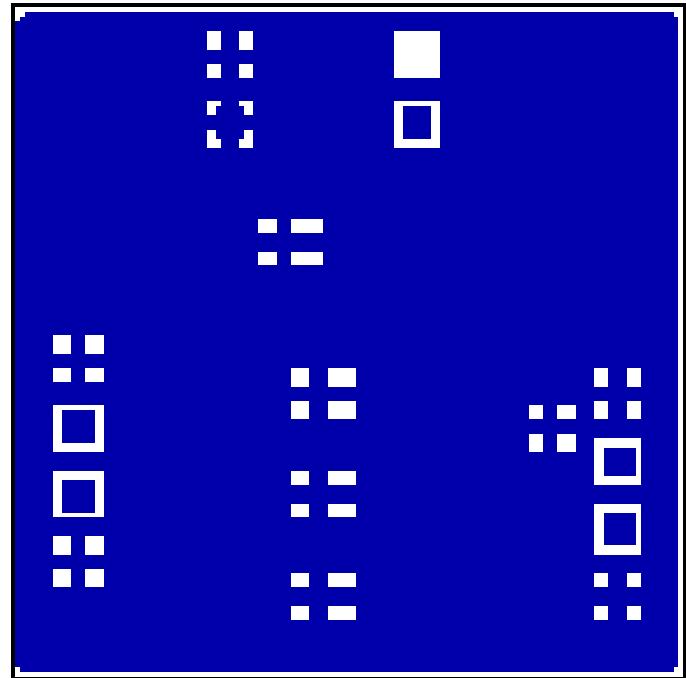
**Figure 14c. Solder Side**
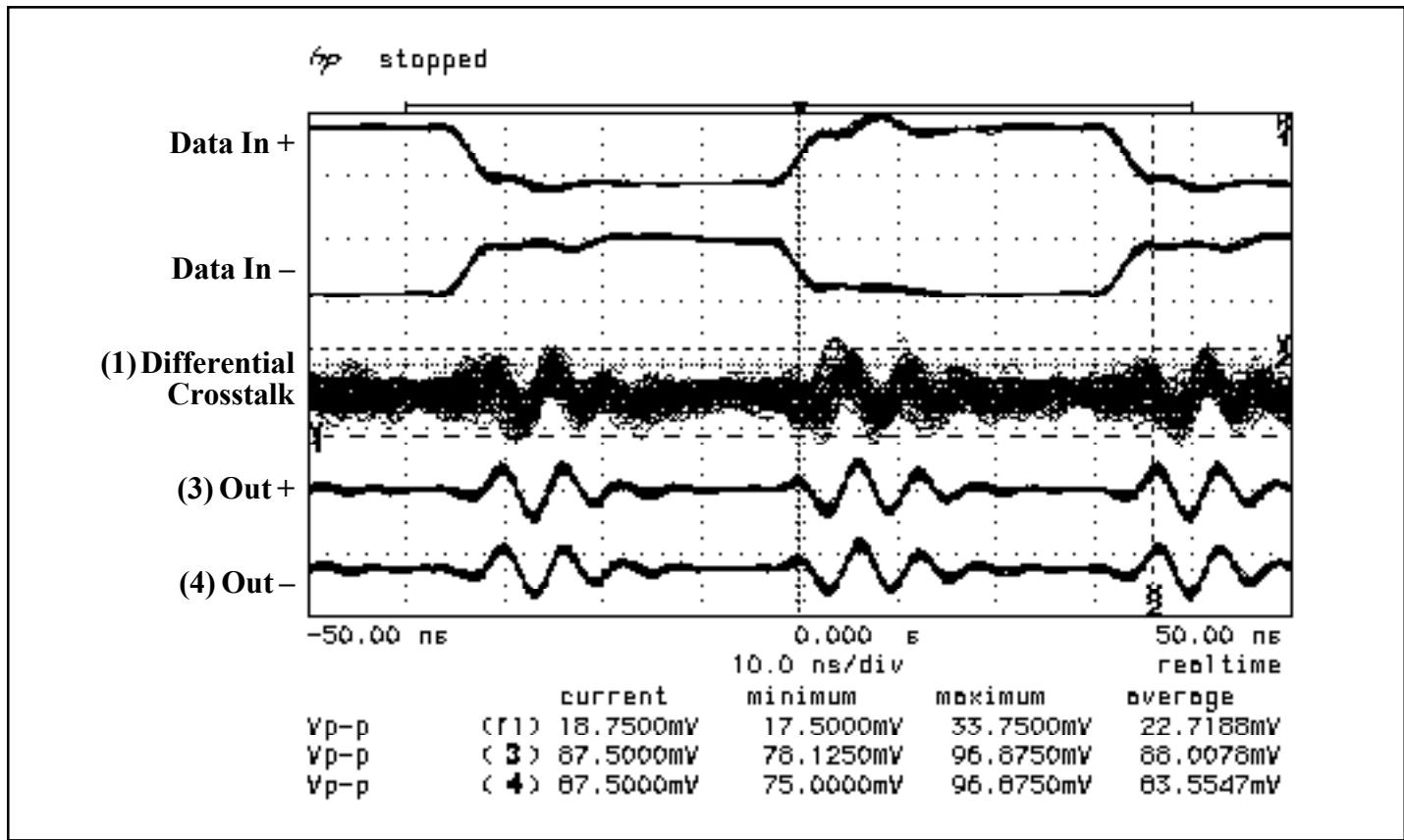

Figure 15. Crosstalk Waveform

Packaging Mechanical: 16-pin SOIC (W)
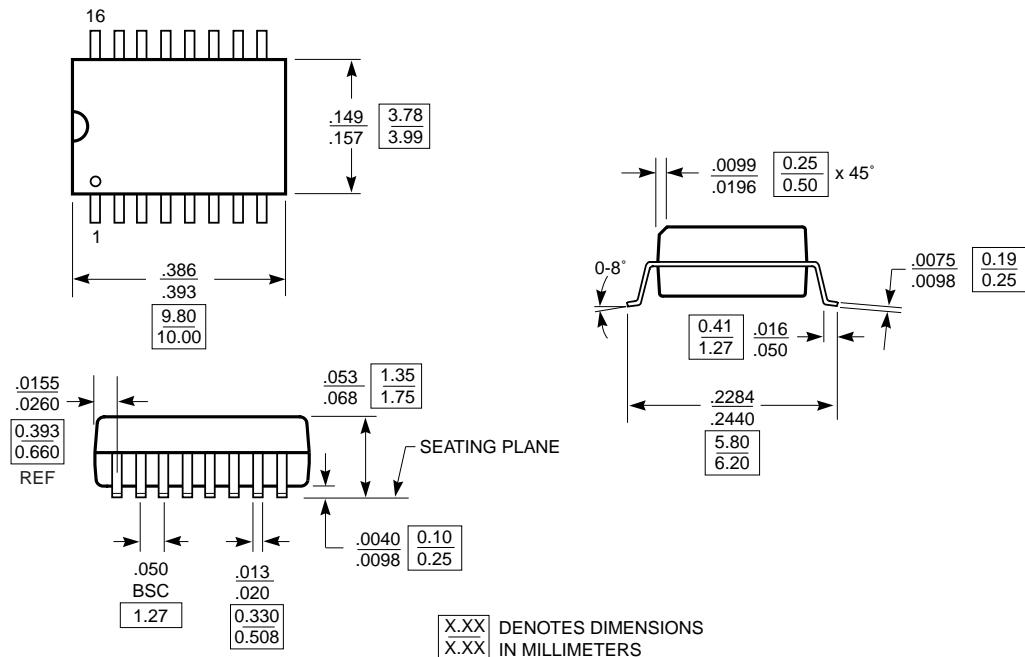
Packaging Mechanical: 16-pin QSOP (Q)
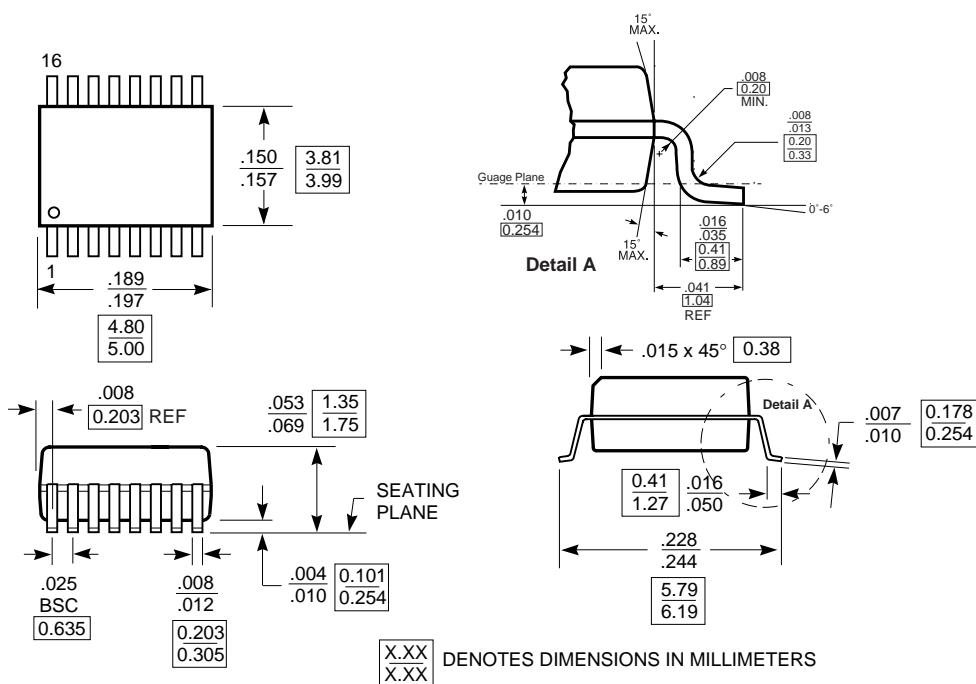
Packaging Mechanical: 20-pin TSSOP (L)
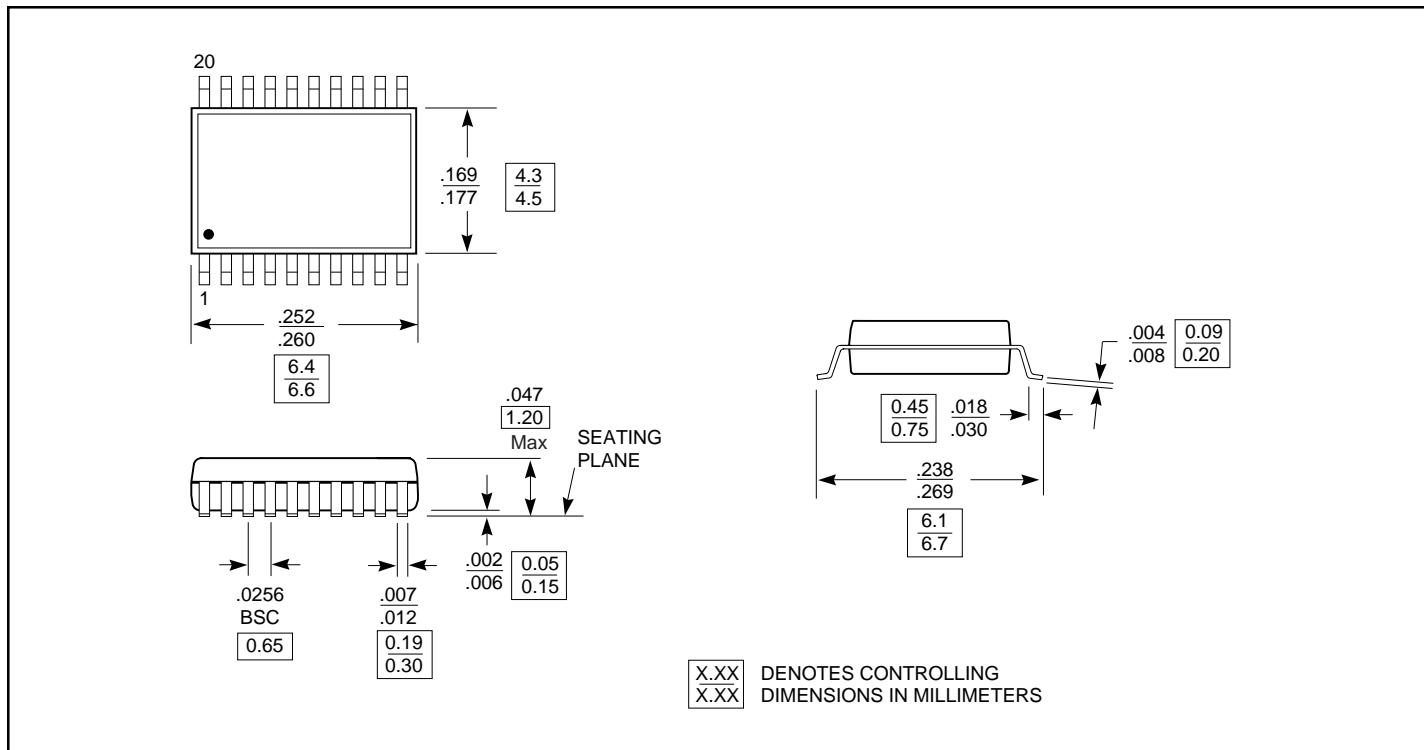
Ordering Information

Ordering Code	Package Code	Package Type
PI5L100W	W	16-pin 150-mil wide plastic SOIC
PI5L100WE	W	Pb-free & Green, 16-pin 150-mil wide plastic SOIC
PI5L100Q	Q	16-pin 150-mil wide plastic QSOP
PI5L100QE	Q	Pb-free & Green, 16-pin 150-mil wide plastic QSOP
PI5L100L	L	20-pin 173-mil wide plastic TSSOP
PI5L100LE	L	Pb-free & Green, 20-pin 173-mil wide plastic TSSOP

Notes:

1. Thermal characteristics can be found on the company web site at www.pericom.com/packaging/