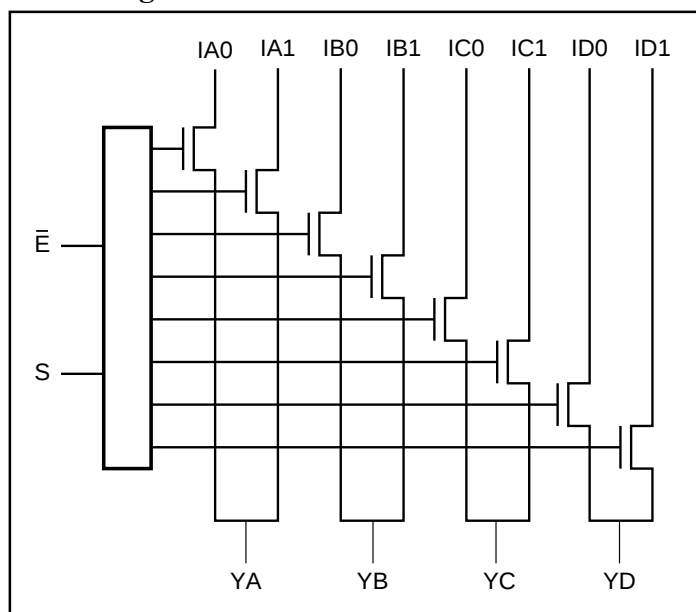


# Wide Bandwidth Low Voltage LanSwitch Quad 2:1 Mux/Demux

## Features

- Replaces mechanical relays
- High-performance, low-cost solution for switching between different LAN signals
- Ultra-low quiescent power (0.1  $\mu$ A typical)
- Low crosstalk:  $-40$  dB @ 30 Mbps
- Low insertion loss or On-Resistance: 3ohms typical
- Single extended supply operation up to  $6.2V \pm 5\%$
- 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)

## Block Diagram



**Truth Table<sup>(1)</sup>**

| 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:

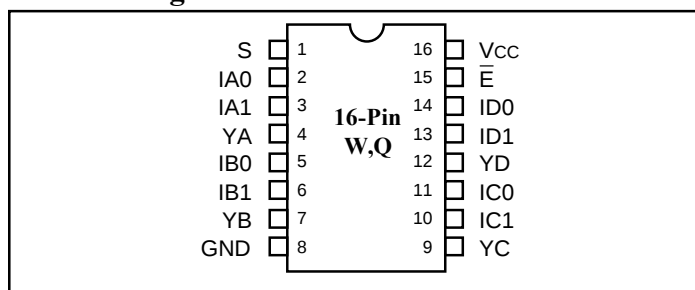
1. H = High Voltage Level  
L = Low Voltage Level

## Description

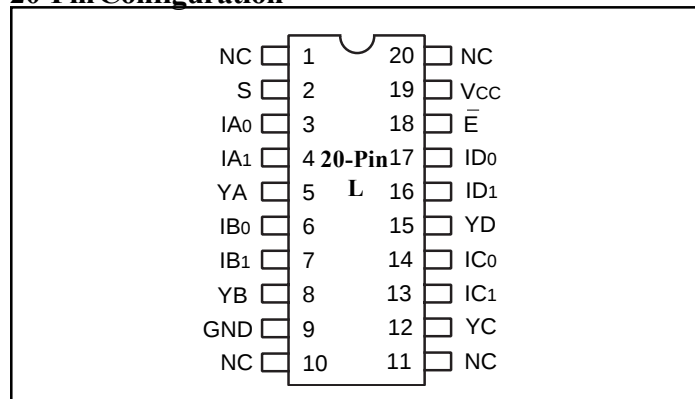
Pericom Semiconductor's PI5L100 is a Quad 2:1 multiplexer/demultiplexer LanSwitch with three-state outputs. This device can be used for switching between various standards, such as 10 Base-T, 100 Base-T, 100VG-AnyLAN or Token Ring. Generally, this part can be used to replace mechanical relays in low voltage LAN applications that have physical 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.

## 16-Pin Configuration



## 20-Pin Configuration



## Product Pin Description

| Pin Name        | Description   |
|-----------------|---------------|
| IAn-IDn         | Data Inputs   |
| S               | Select Inputs |
| $\bar{E}$       | Enable        |
| YA-YD           | Data Outputs  |
| GND             | Ground        |
| V <sub>CC</sub> | Power         |

## 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 RATINGS 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<sub>A</sub> = 0°C to +70°C, V<sub>CC</sub> = 6.2V, +5%, −2%)

| Parameter                      | Description                          | Test Conditions                                                               | Min.               | Typ <sup>(2)</sup>  | Max. | Units |
|--------------------------------|--------------------------------------|-------------------------------------------------------------------------------|--------------------|---------------------|------|-------|
| V <sub>IH</sub>                | Input HIGH Voltage                   | Guaranteed Logic HIGH Level                                                   | 2.0                | —                   | —    | V     |
| V <sub>IL</sub>                | Input LOW Voltage                    | Guaranteed Logic LOW Level                                                    | −0.5               | —                   | 0.8  | μA    |
| I <sub>IH</sub>                | Input HIGH Current                   | V <sub>CC</sub> = Max., V <sub>IN</sub> = V <sub>CC</sub>                     | —                  | —                   | ±1   |       |
| I <sub>IL</sub>                | Input LOW Current                    | V <sub>CC</sub> = Max., V <sub>IN</sub> = GND                                 | —                  | —                   | ±1   |       |
| I <sub>OZH</sub>               | High Impedance Output Current        | 0 ≤ A, B ≤ V <sub>CC</sub>                                                    | —                  | —                   | ±1   | V     |
| V <sub>IK</sub>                | Clamp Diode Voltage                  | V <sub>CC</sub> = Min., I <sub>IN</sub> = −18mA                               | —                  | −0.7                | −1.2 | mA    |
| I <sub>OS</sub>                | Short Circuit Current <sup>(3)</sup> | A (B) = 0V, B (A) = V <sub>CC</sub>                                           | 100                | —                   | —    |       |
| V <sub>H</sub>                 | Input Hysteresis at Control Pins     |                                                                               | —                  | 150                 | —    | mV    |
| V <sub>ON</sub>                | Switch On Voltage                    | V <sub>IN</sub> = 4.5V, $\bar{E}$ = LOW, See Figure 10, R <sub>L</sub> = 100Ω | 3.7 <sup>(4)</sup> | 4.06 <sup>(5)</sup> | —    | V     |
| R <sub>ON</sub> <sup>(6)</sup> | M1 Switch On Resistance              | Calculated from V <sub>ON</sub>                                               | 19                 | 11.2                | —    | Ω     |
| R <sub>ON</sub> <sup>(7)</sup> | M2 Switch On Resistance              | V <sub>IN</sub> = 4.5V, $\bar{E}$ = LOW, See Figure 10, R <sub>L</sub> = 100Ω | 2.0                | 3.0                 | —    |       |
| ΔR <sub>ON</sub>               | On Resistance Match                  | V <sub>IN</sub> = 4.5V, $\bar{E}$ = LOW                                       | —                  | 1.0                 | —    |       |

### Notes:

- For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at V<sub>CC</sub> = 6.2V, T<sub>A</sub> = 25°C ambient temperature.
- Not more than one output should be shorted at one time. Duration of the test should not exceed one second.
- V<sub>ON</sub> (min) value is at V<sub>CC</sub> = 6.1V, T<sub>A</sub> = 70°C.
- The expected AC V<sub>ON</sub> value is about 125 mV higher than the DC V<sub>ON</sub> value using the similar test circuit in Figure 10 with V<sub>IN</sub> swing from 0.0V to 4.5V at 10 MHz sine wave.
- The value of R<sub>ON</sub> of M1 is calculated with the equivalent mathematical formula of the test circuit in Figure 10.

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

where

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

with R<sub>ON</sub> (M2) = 3 ohms

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

**Capacitance** ( $T_A = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ )

| Parameters <sup>(1)</sup> | Description                 | Test Conditions      | Typ. | Units |
|---------------------------|-----------------------------|----------------------|------|-------|
| $C_{IN}$                  | Input Capacitance           | $V_{IN} = 0\text{V}$ | 6    | pF    |
| $C_{OFF}$                 | A/B Capacitance, Switch Off | $V_{IN} = 0\text{V}$ | 6    |       |
| $C_{ON}$                  | A/B Capacitance, Switch On  | $V_{IN} = 0\text{V}$ | 8    |       |

**Note:**

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

**Power Supply Characteristics**

| Parameters <sup>(1)</sup> | Description                           | Test Conditions                                                                                                      |                                  | Min. | Typ. | Max. | Units             |
|---------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------|------|------|------|-------------------|
| $I_{CC}$                  | Quiescent Power Supply Current        | $V_{CC} = 5.5\text{V}$                                                                                               | $V_{IN} = \text{GND or } V_{CC}$ |      | 0.1  | 3.0  | $\mu\text{A}$     |
| $\Delta I_{CC}$           | Supply Current per Input @ TTL High   | $V_{CC} = 5.5\text{V}$                                                                                               | $V_{IN} = 3.4\text{V}^{(2)}$     |      |      | 2.5  | mA                |
| $I_{CCD}$                 | Supply Current per MHz <sup>(3)</sup> | $V_{CC} = 5.5\text{V}$<br>Input Pins Open<br>$\overline{E} = \text{GND}$<br>Control Input Toggling<br>50% Duty Cycle |                                  |      |      | 0.25 | $\mu\text{A/MHz}$ |

**Notes:**

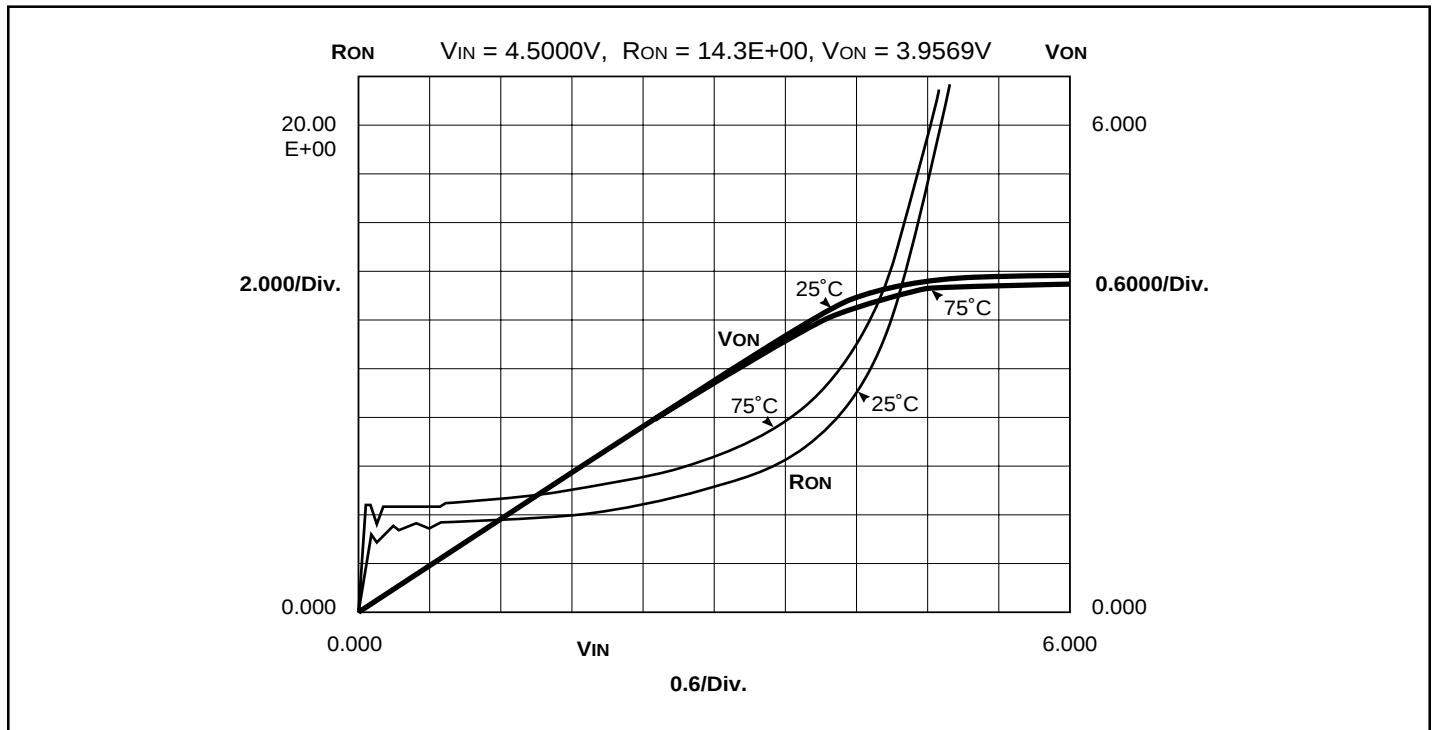
1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device.
2. Per TTL driven input ( $V_{IN} = 3.4\text{V}$ , control inputs only); A and B pins do not contribute to  $I_{CC}$ .
3. This current applies to the control inputs only and represent 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

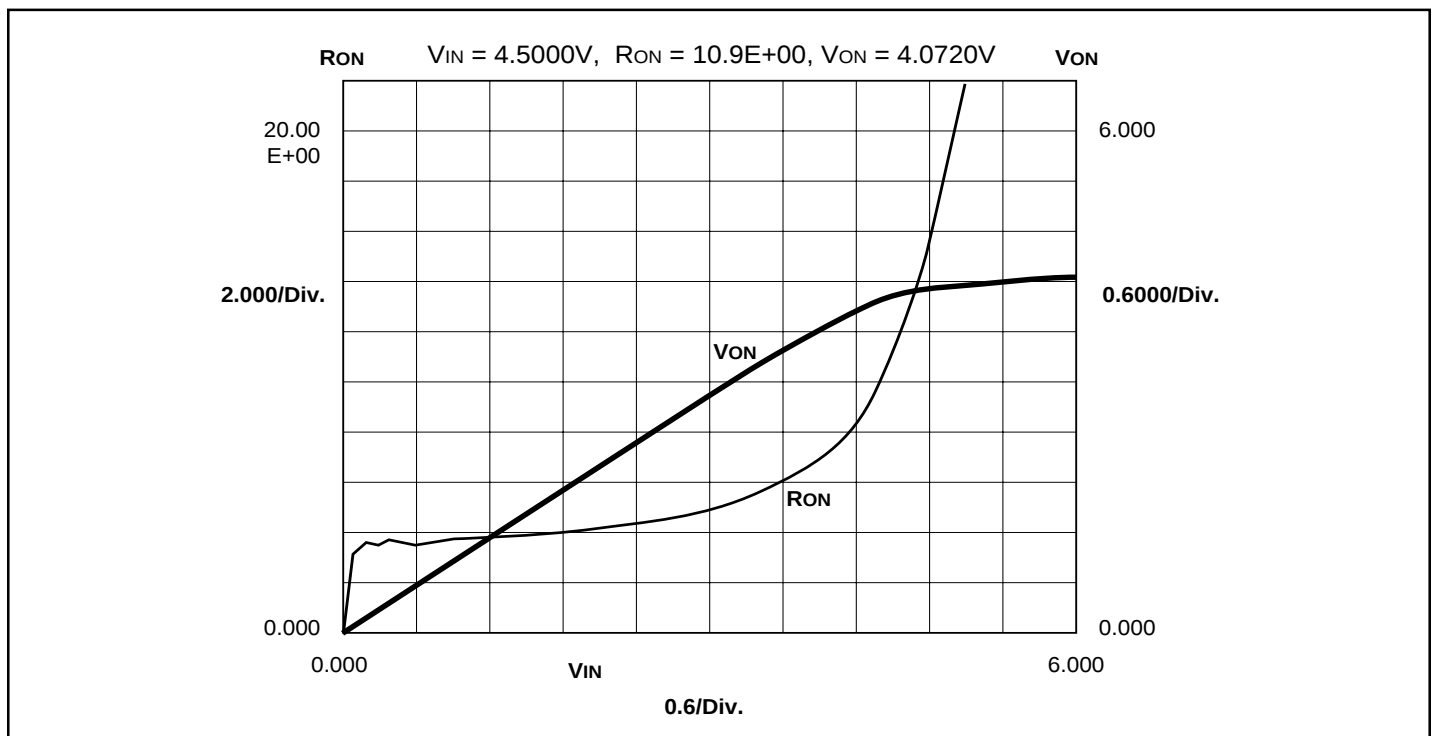
| Parameters                          | Description                                              | Conditions <sup>(1)</sup>                                      | PI5L100 |      |      | Units |
|-------------------------------------|----------------------------------------------------------|----------------------------------------------------------------|---------|------|------|-------|
|                                     |                                                          |                                                                | Com.    |      |      |       |
|                                     |                                                          |                                                                | Min.    | Typ. | Max. |       |
| t <sub>IY</sub>                     | Propagation Delay <sup>(2,3)</sup> , I <sub>N</sub> to Y | C <sub>L</sub> = 50pF<br>R <sub>L</sub> = 500 ohms             | —       | —    | 0.25 | ns    |
| t <sub>SY</sub>                     | Bus Enable Time, S to Y                                  |                                                                | 0.5     |      | 5.2  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Bus Disable Time, $\bar{E}$ to Y                         |                                                                | 0.5     |      | 5.0  |       |
| t <sub>EY</sub>                     | Bus Disable Time, $\bar{E}$ to Y                         |                                                                | 0.5     |      | 4.8  |       |
| X <sub>TALK</sub> (Dif)             | Differential Crosstalk <sup>(2)</sup>                    | R <sub>L</sub> = 100 ohms, f = 10MHz, See Figure 11            | −40     | −60  | —    |       |
| X <sub>TALK</sub>                   | Crosstalk                                                | R <sub>L</sub> = 100 ohms, f = 30MHz, See Figure 9             | —       | −40  | —    |       |
| O <sub>IRR</sub>                    | Off Isolation                                            | R <sub>L</sub> = 100 ohms, f = 30MHz, See Figure 6             | —       | −30  | —    |       |
| B <sub>W</sub>                      | −3dB Bandwidth                                           | R <sub>L</sub> = 100 ohms, See Figure 9                        | —       | 216  | —    |       |
| t <sub>ON</sub>                     | Turn On Time                                             | R <sub>L</sub> = 100 ohms, C <sub>L</sub> = 35pF, See Figure 8 | —       | 11   | —    |       |
| t <sub>OFF</sub>                    | Turn Off Time                                            |                                                                | —       | 11   | —    |       |

#### Notes:

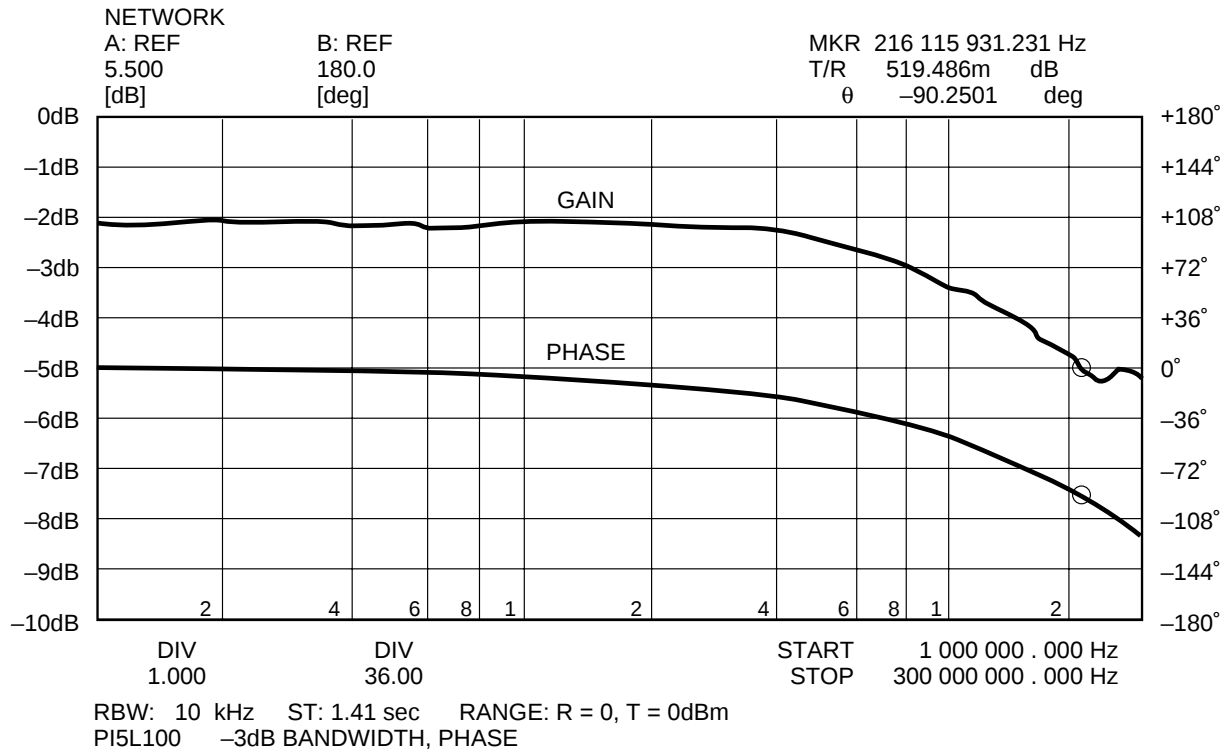
1. See test circuit and waveforms.
2. This parameter is guaranteed but not tested.
3. The bus switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 50pF load. 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.



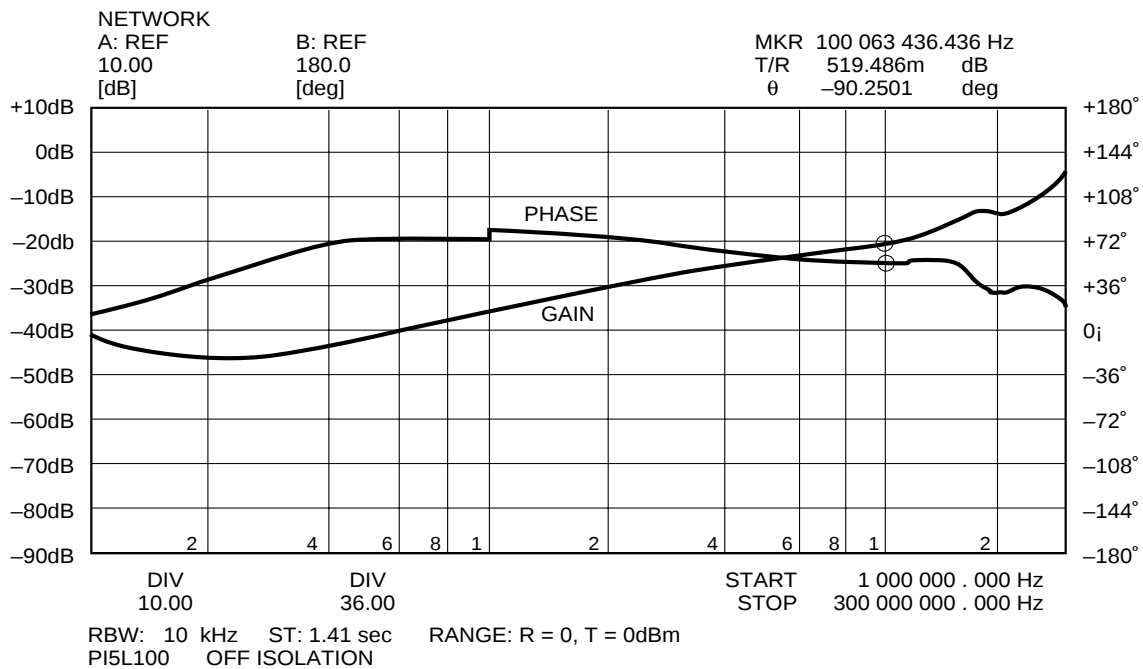
**Figure 3.  $R_{ON}$  vs Input Voltage over Temperature**  
( $R_{ON}$  at  $V_{CC} = 6.1V$  @ 75°C)



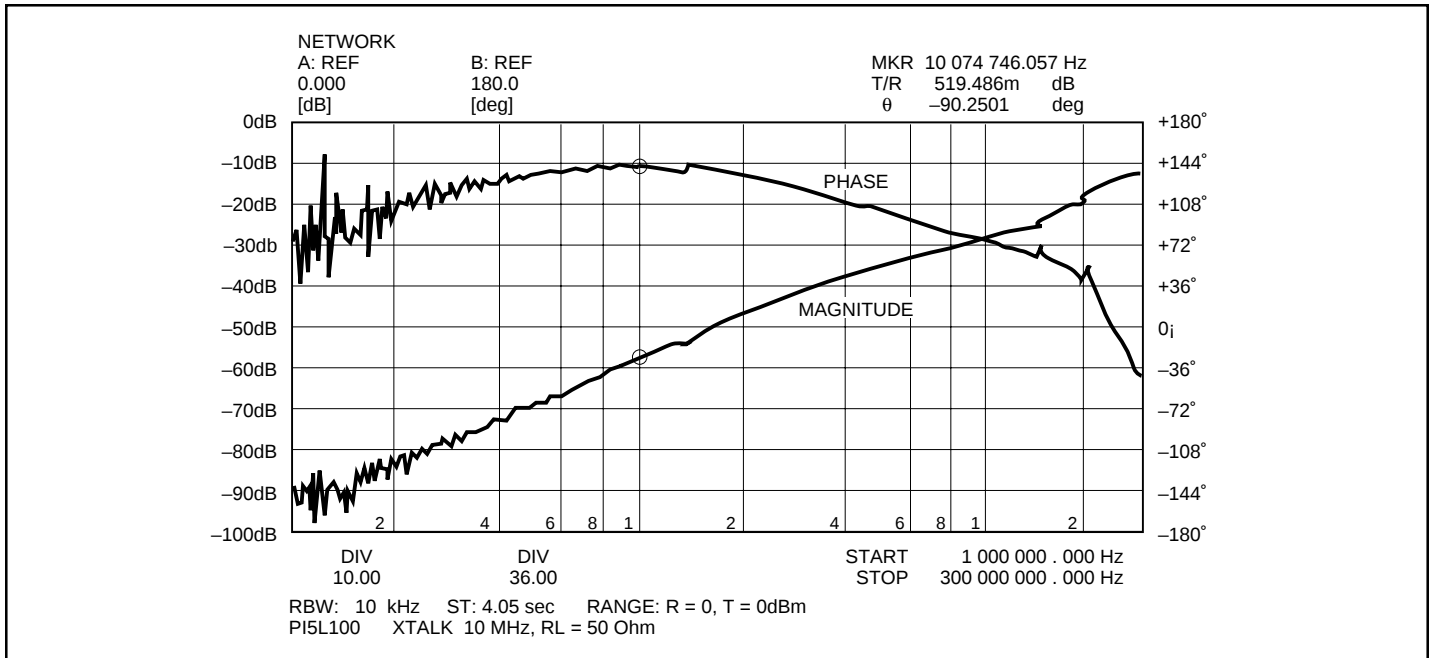
**Figure 4.  $R_{ON}$  vs Input Voltage**  
( $R_{ON}$  at  $V_{CC} = 6.2V$  @ 25°C)



**Figure 5. Gain/Phase vs Frequency**



**Figure 6. Off Isolation vs Frequency**



**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  $20\text{LOG } V_{OUT}/V_{IN} = 20\text{LOG } 30\text{ mV}/5\text{ V} = -44\text{ dB}$ . Since the edge rate is 2ns, the effective input frequency is equal to  $0.3/t_r$  which is  $\sim 150\text{ MHz}$ . So the approximate Differential Crosstalk at 150 MHz is  $-44\text{ dB}$ .

Because pins measured are not adjacent, the differential crosstalk is typically  $> 60\text{ dB}$  at 10 MHz. The load resistor ( $R_L$ ) used was 100 ( $\Omega$ ) 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 ( $\Delta R_{ON}$  or flatness is  $\sim 2\text{ ohms}$ ).

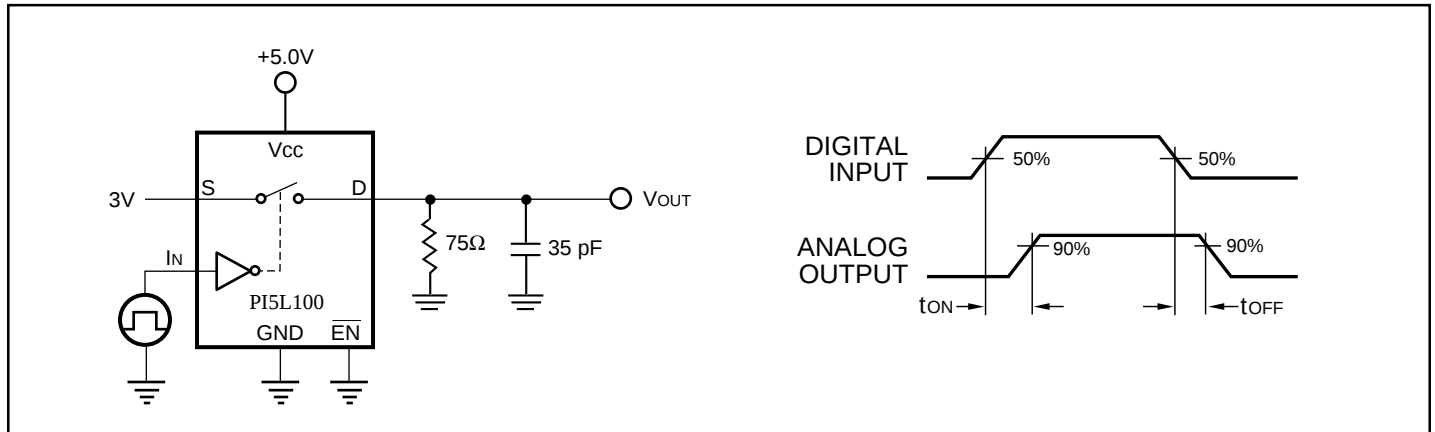
### Signal Distortion

Distortion of the input signal is equated to  $20\text{LOG } \Delta R_{ON}/R_L$ . 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.

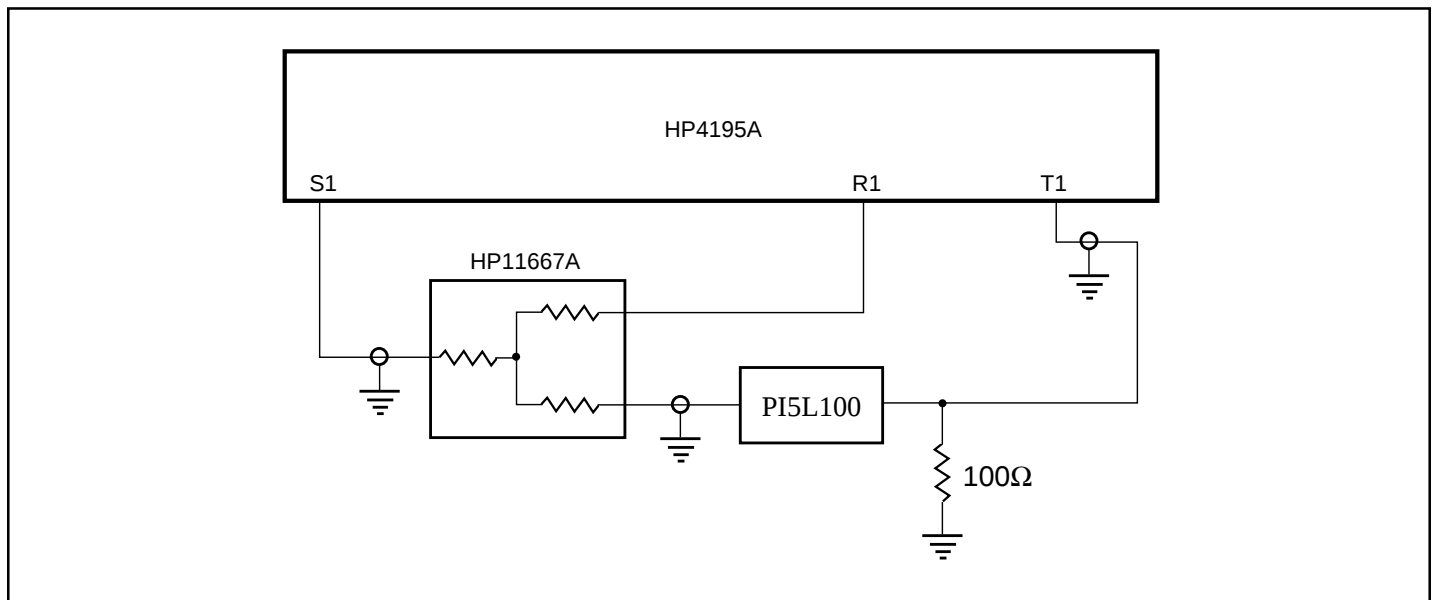
### Evaluation Board

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.

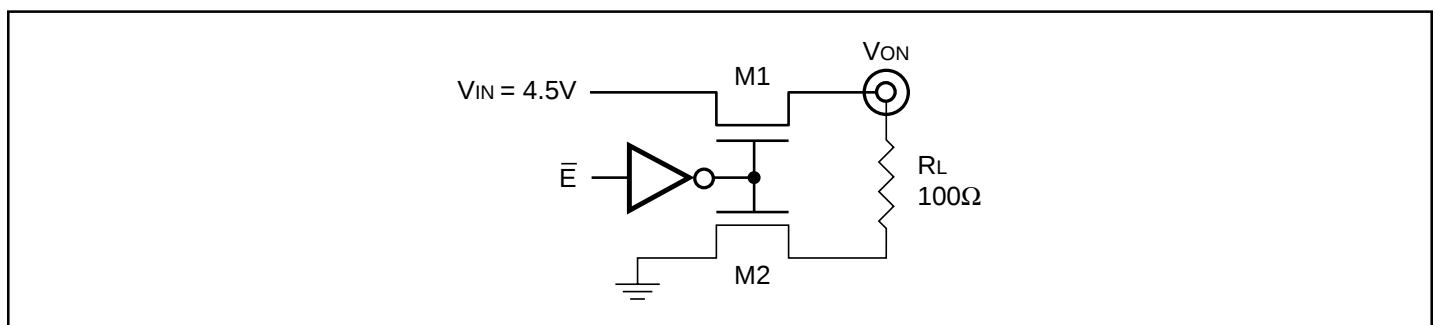
## Test Circuits



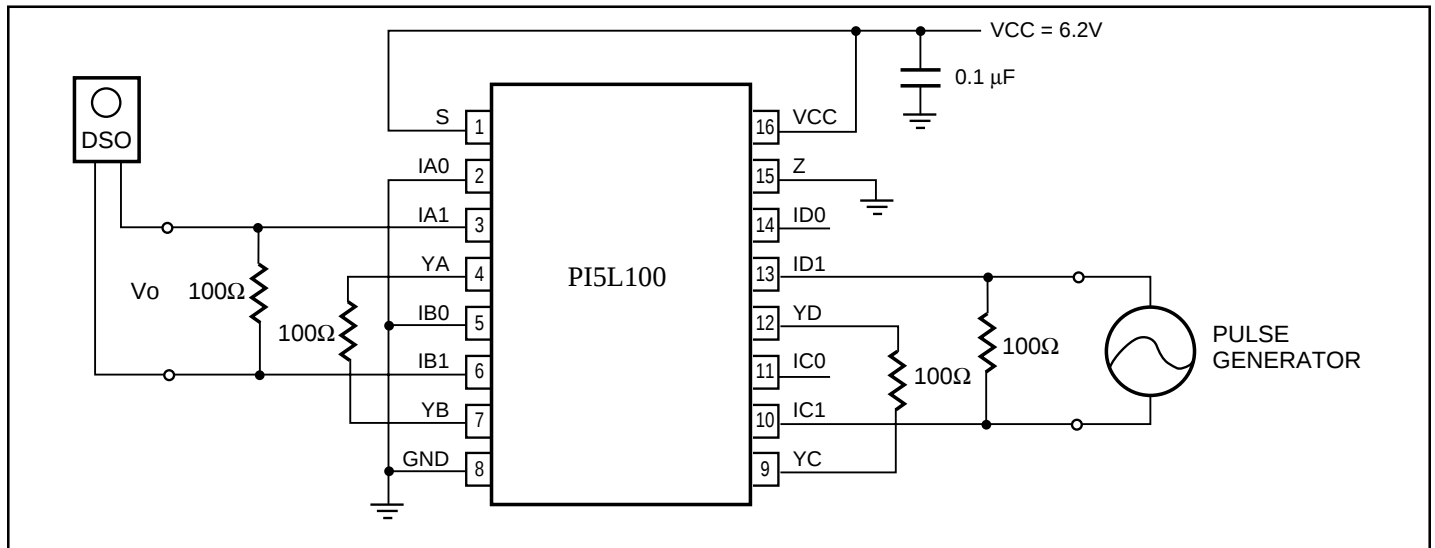
**Figure 8. Switching Time**



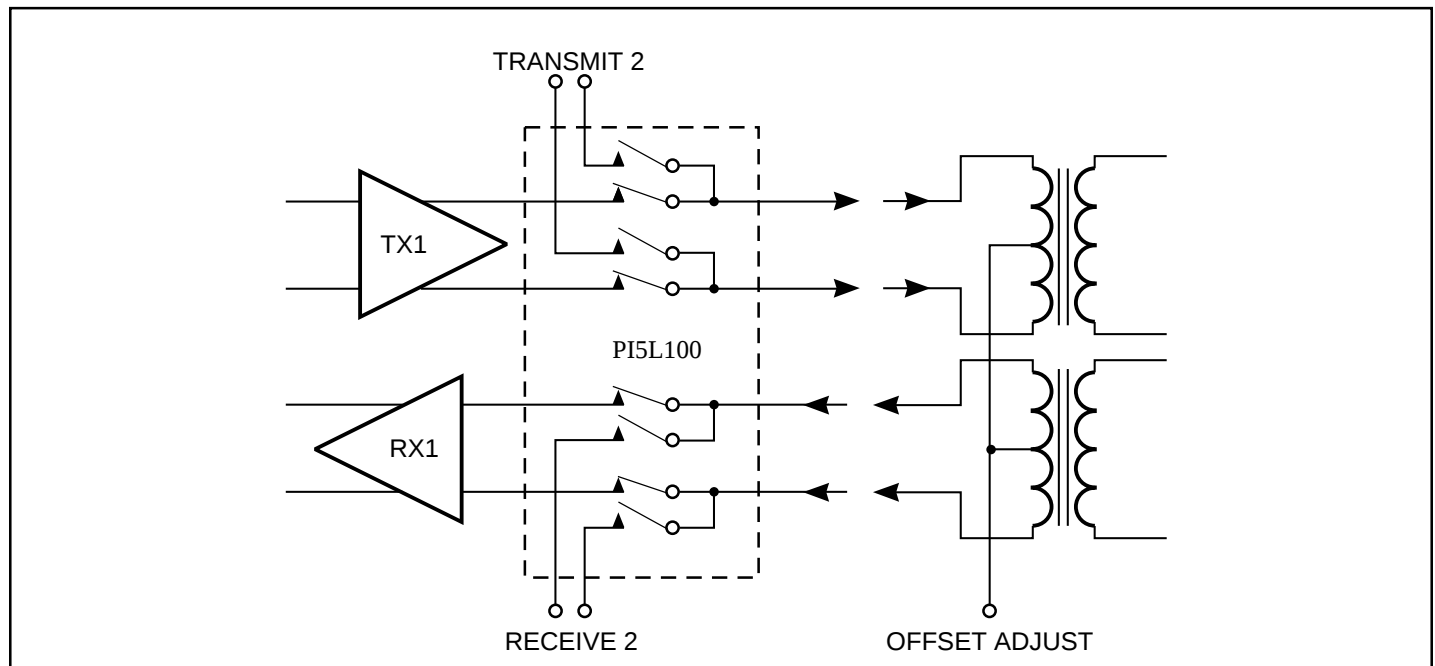
**Figure 9. Gain/Phase Crosstalk, Off Isolation**



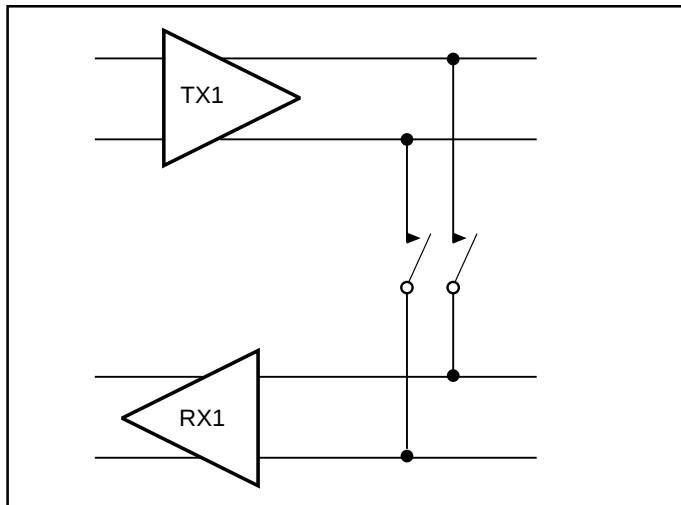
**Figure 10. Switch ON Voltage Test Circuit**



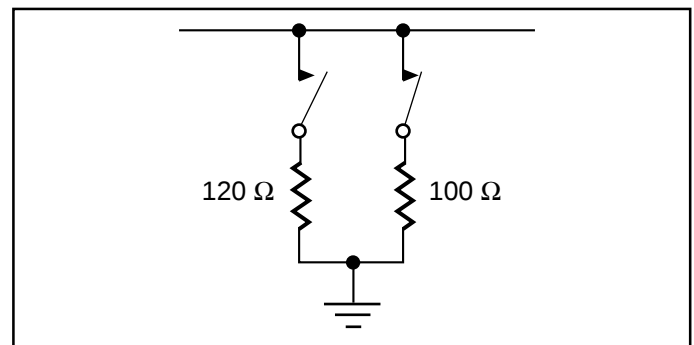
**Figure 11. Differential Crosstalk Measurement**



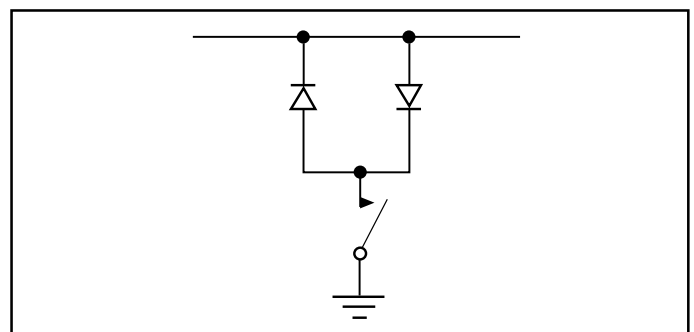
**Figure 12a. Full Duplex Transceiver**



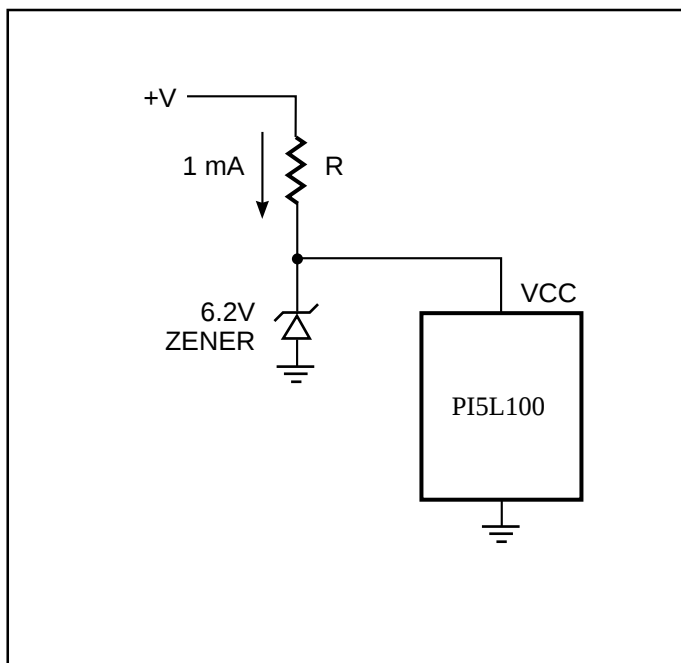
**Figure 12b. Loop Back**



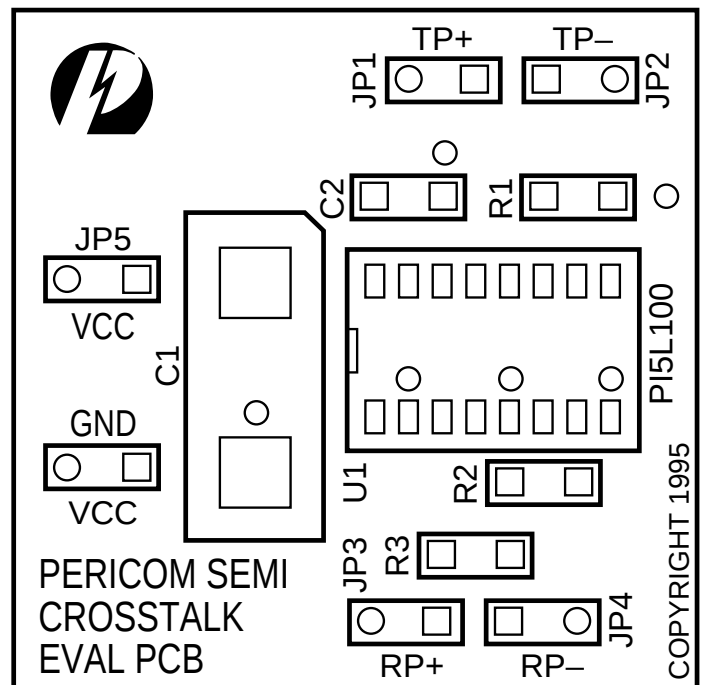
**Figure 12c. Line Termination**



**Figure 12d. Line Clamp**



**Figure 13. V<sub>CC</sub> Bias Current**



**Figure 14a. Crosstalk EV Board**

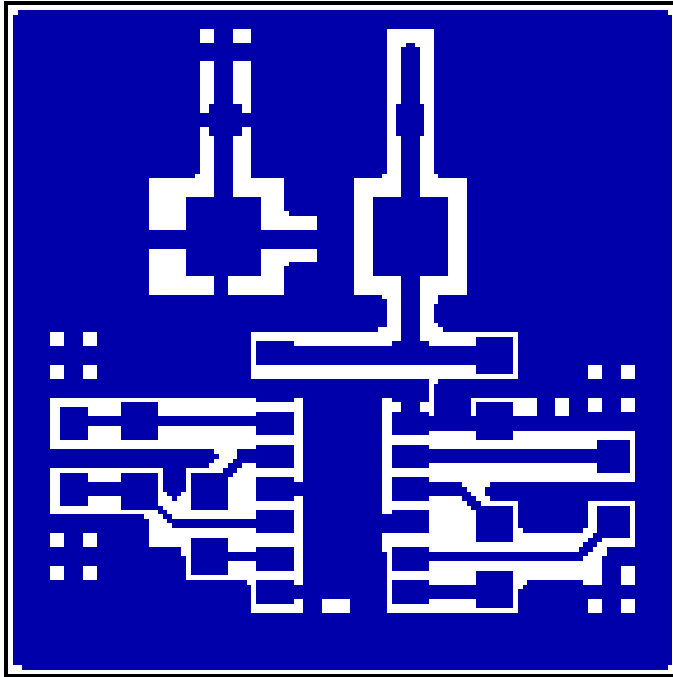


Figure 14b. Component Side

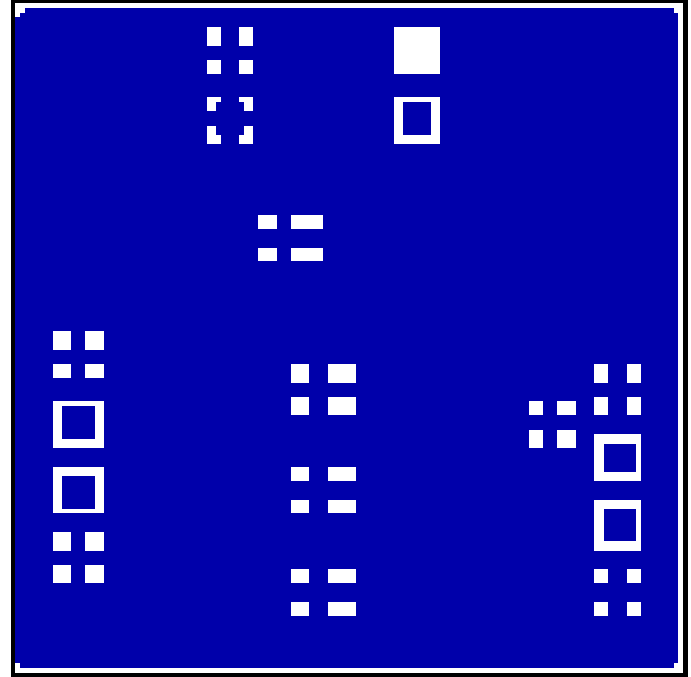


Figure 14c. Solder Side

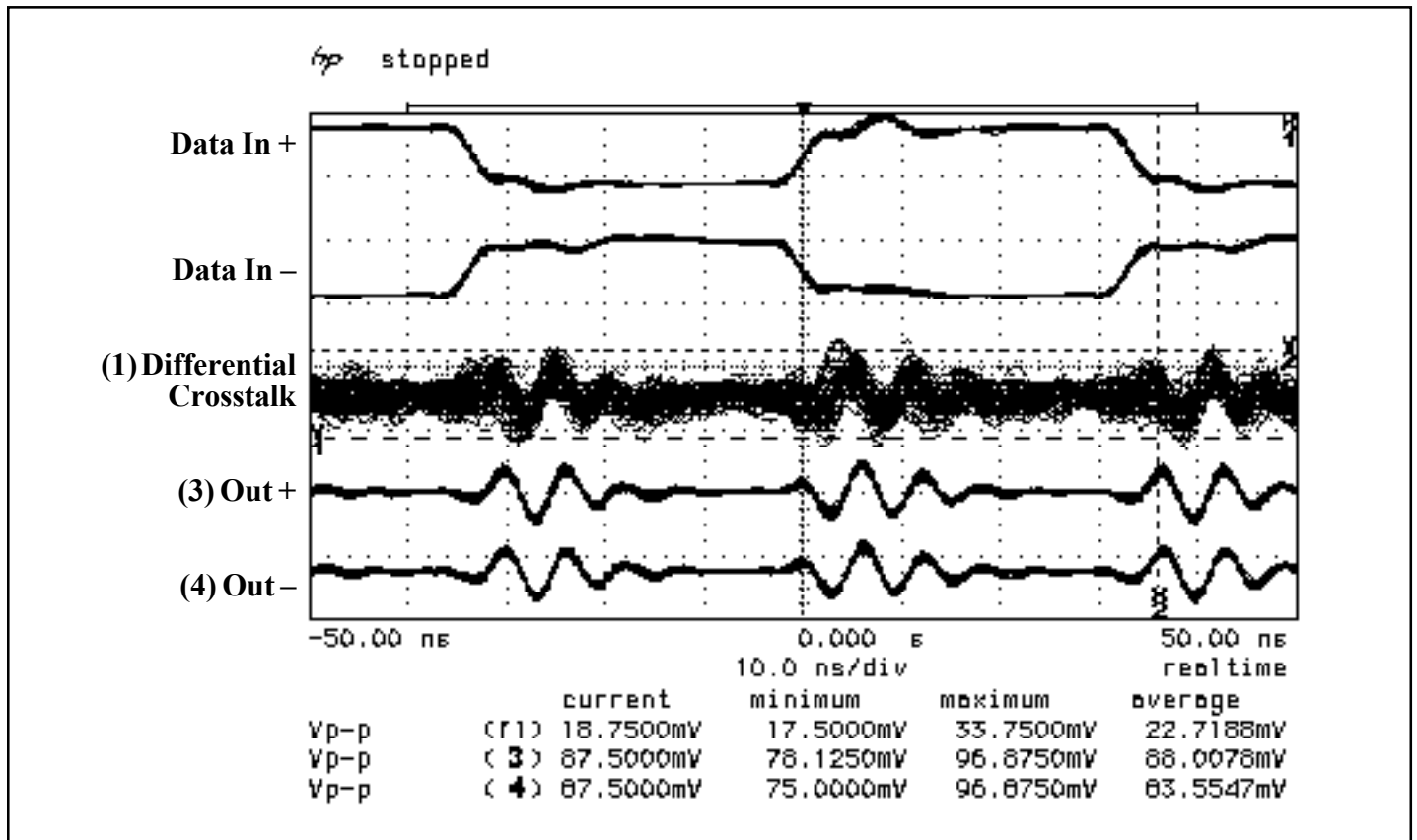
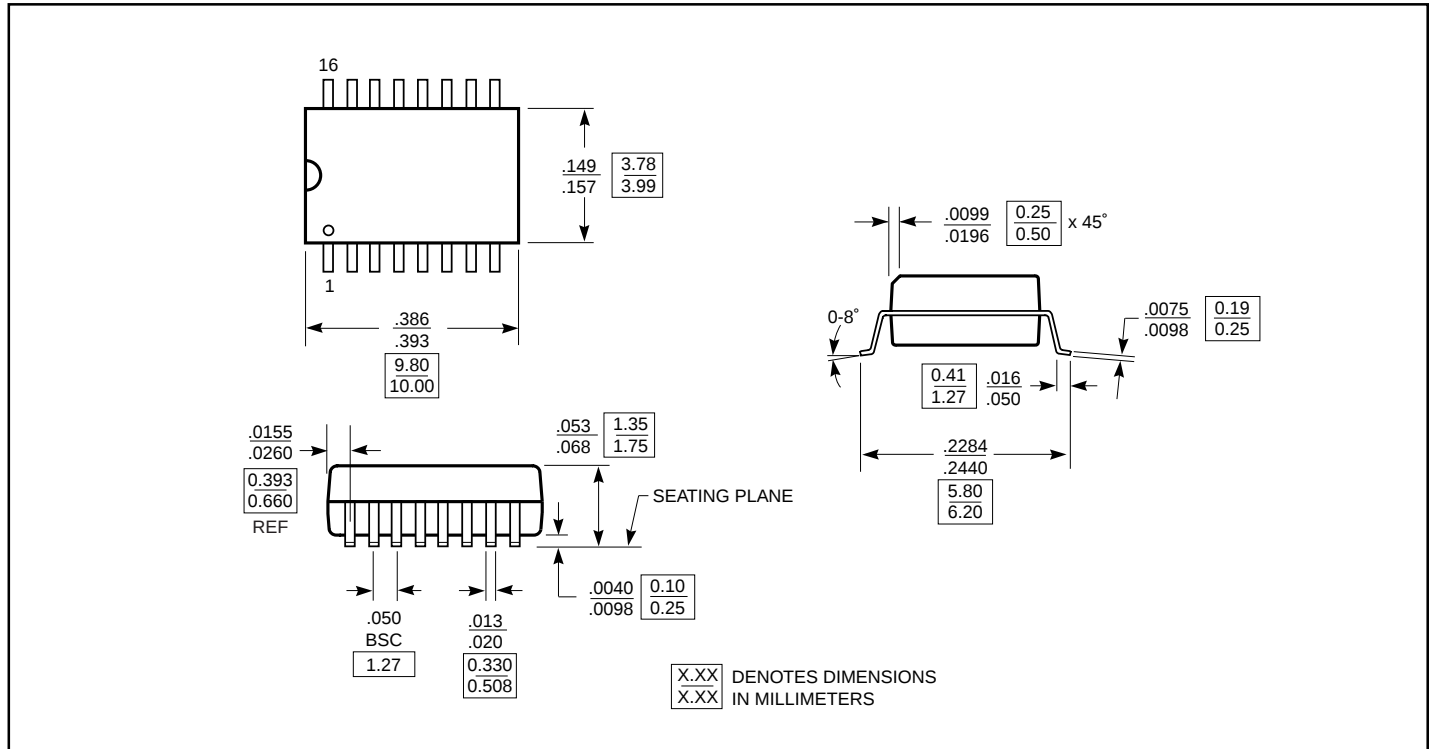
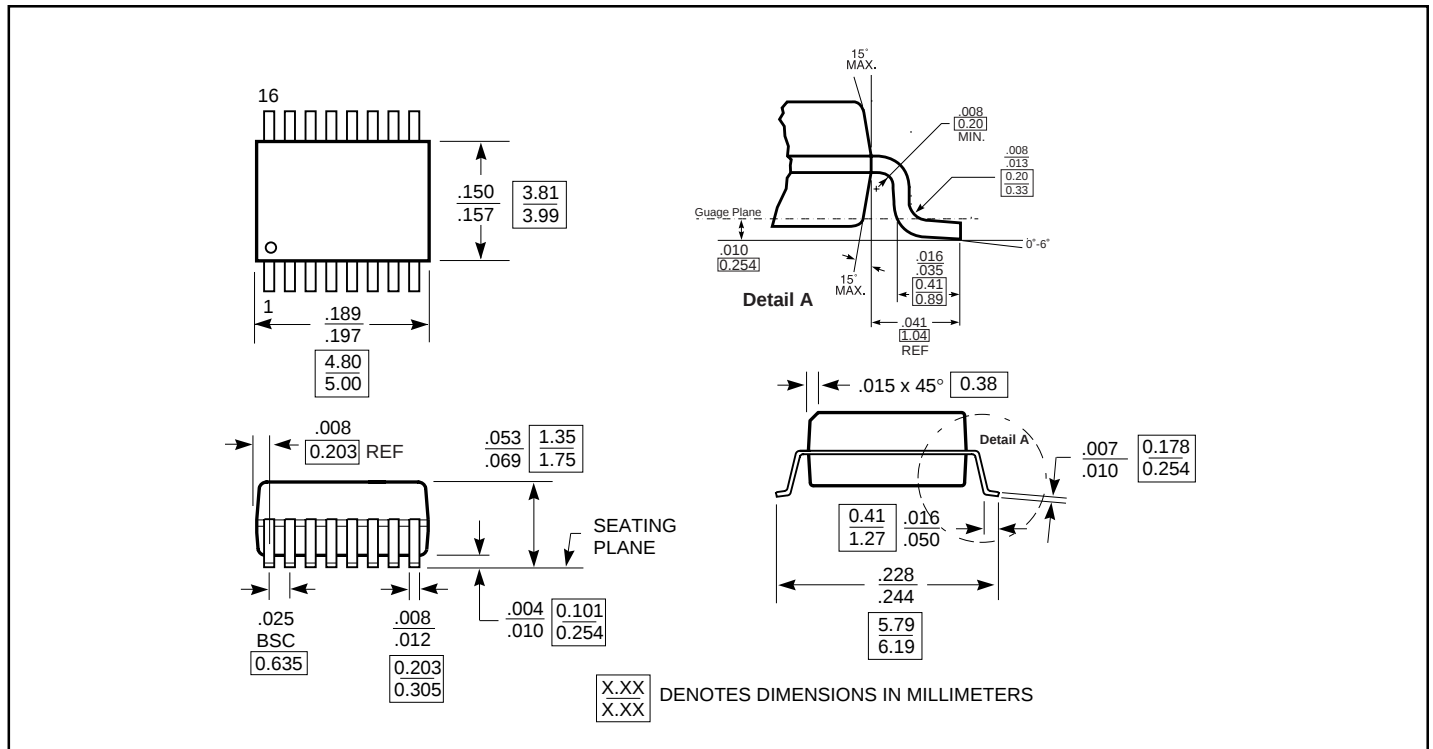
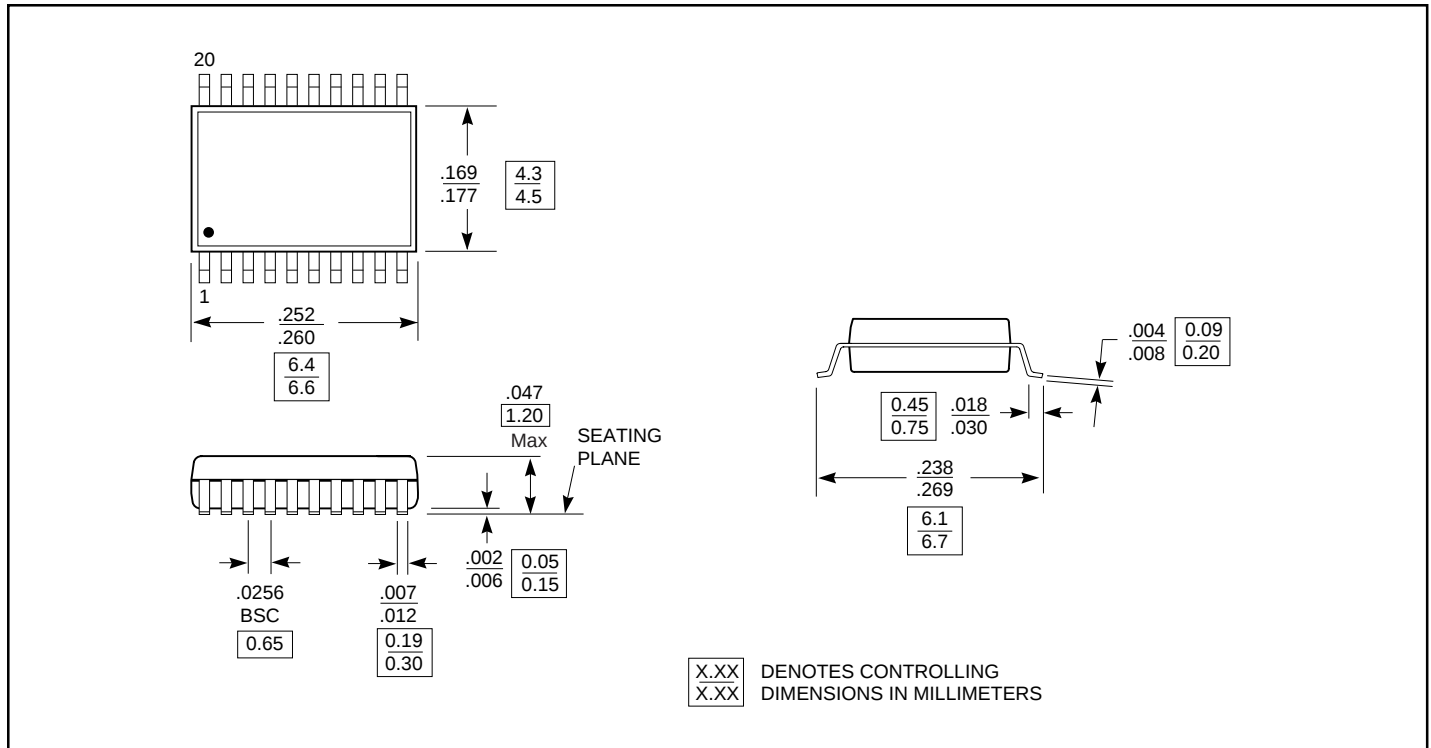


Figure 15. Crosstalk Waveform

**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:

- Thermal characteristics can be found on the company web site at [www.pericom.com/packaging/](http://www.pericom.com/packaging/)