PERICOM

PI5L100

Wide Bandwidth Low Voltage LanSwitch Quad 2:1 MUX/DEMUX

Product 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: 3Ω typical
- Single extended supply operation up to 6.2V ± 5%
- Off isolation: –30 dB @ 30 Mbps
- Wide bandwidth data rates > 200 Mbps
- Packages 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)

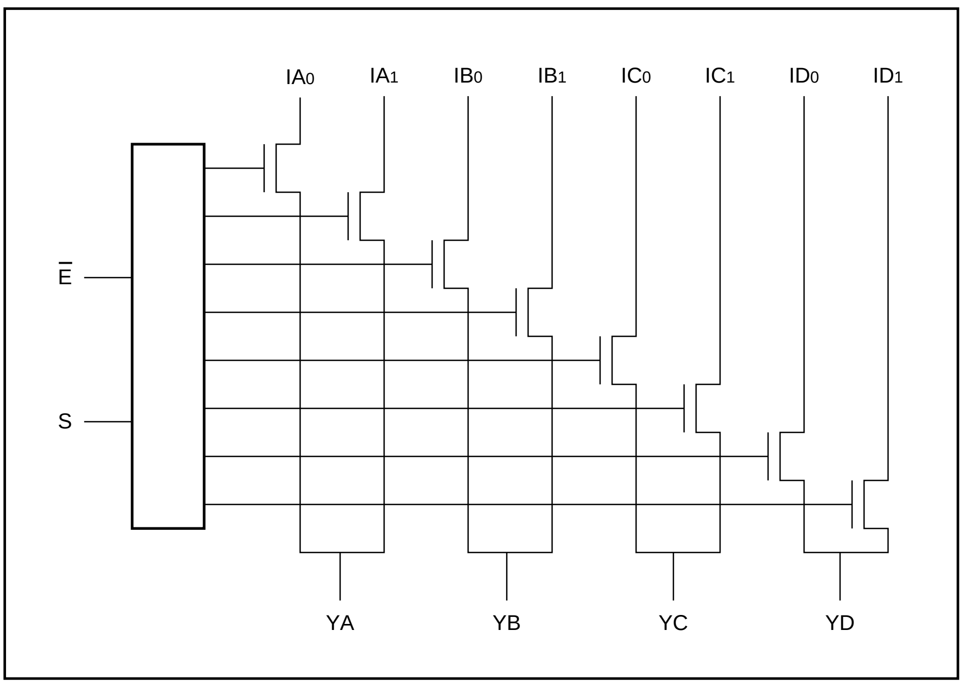
Product Description:

Pericom Semiconductor's PI5L series of logic circuits are produced in the Company's advanced submicron CMOS technology.

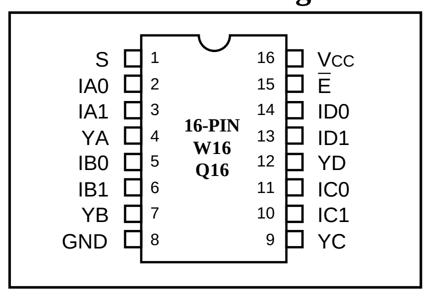
The PI5L100 is a Quad 2:1 multiplexer/demultiplexer LanSwitch with three-state outputs. This device can be used for switching between various standards, such as 10 Base-T, 100 Base-T, 100VG-AnyLAN or Token Ring. Generally, this part can be used to replace mechanical relays in low voltage LAN applications that have phsical layer, unshielded twisted pair media (UTP) with either CAT 3 or CAT 5 grade cable.

The PI5L100 is powered from a 6.2V Zener voltage to reduce the insertion loss.

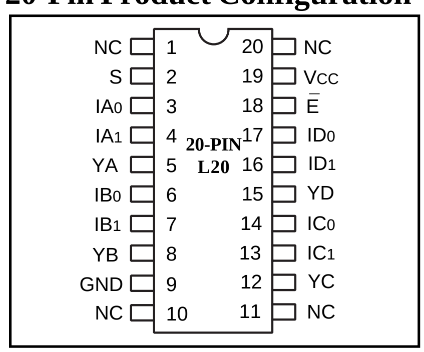
Logic Block Diagram



16-Pin Product Configuration



20-Pin Product 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
VCC	Power

Maximum Ratings

(Above which the 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 (Inputs & Vcc Only) .... –0.5V to +7.0V
Supply Voltage to Ground Potential (Outputs & D/O Only) .... –0.5V to +7.0V
DC Input Voltage .... –0.5V to +7.0V
DC Output Current .... 120 mA
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_A = 0°C to +70°C, V_{CC} = 6.2V, + 5%, – 2%)

Parameters	Description	Test Conditions(1)	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	V
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	µA
I_{OZH}	High Impedance Output Current	0 ≤ A, B ≤ V_{CC}	—	—	±1	µA
V_{IK} V	Clamp Diode Voltage	V_{CC} = Min., I_{IN} = –18 mA		—	–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, E = LOW See Figure 10, R_L = 100Ω	3.7(4)	4.06(5)	—	V
R_{ON}(6)	M1 Switch On Resistance	Calculated from V_{ON}	19	11.2	—	Ω
R_{ON}(7)	M2 Switch On Resistance	V_{IN} = 4.5V, E = LOW See Figure 10, R_L = 100Ω	2.0	3.0	—	Ω
ΔR_{ON}	On Resistance Match	V_{IN} = 4.5V, E = LOW	—	1.0	—	Ω

Notes:
1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at Vcc = 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 Vcc = 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 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_{ON} (M2) = 3 Ohm

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	Max.	Units
C_{IN}	Input Capacitance	V_{IN} = 0V		6	pF
C_{OFF}	Capacitance, Switch Off	V_{IN} = 0V		6	pF
C_{ON}	Capacitance, Switch On	V_{IN} = 0V		8	pF

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

Power Supply Characteristics

Parameters	Description	Test Conditions[1]		Min.	Typ[2]	Max.	Units
I_{CC}	Quiescent Power Supply Current	V_{CC} = Max.	V_{IN} = GND or V_{CC}	—	0.1	3.0	µA
ΔI_{CC}	Supply Current per Input @ TTL HIGH	V_{CC} = Max.	V_{IN} = 3.4V[3]	—	—	2.5	mA
I_{CCD}	Supply Current per Input per MHz[4]	V_{CC} = Max., Input Pins Open, $\overline{E}$ = GND, Control Input Toggling, 50% Duty Cycle		—	—	0.25	mA/MHz

Notes:
1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device.
2. Typical values are at Vcc = 6.2V, +25°C ambient.
3. Per TTL driven input (V_{IN} = 3.4V, control inputs only); A and B pins do not contribute to Icc.
4. 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. Min	PI5L100 Com. Typ	PI5L100 Com. Max	Unit
t_{IY}	Propagation Delay[2,3] In to Y	C_L = 50 pF R_L = 500Ω	—	—	0.25	ns
t_{SY}	Bus Enable Time S to Y		0.5	—	5.2	ns
t_{PHZ} t_{PLZ}	Bus Disable Time $\overline{E}$ to Y		0.5	—	5.0	ns
t_{EY}	Bus Disable Time $\overline{E}$ to Y		0.5	—	4.8	ns
X_{TALK} (Dif)	Differential Crosstalk[2]	R_L = 100Ω f = 10 MHz See Figure 11	–40	–60	—	dB
X_{TALK}	Crosstalk	R_L = 100Ω f = 30 MHz See Figure 9	—	–40	—	dB
O_{IRR}	Off Isolation	R_L = 100Ω f = 30 MHz See Figure 6	—	–30	—	dB
B_W	–3 dB Bandwidth	R_L = 100Ω See Figure 9	—	216	—	MHz
t_{ON}	Turn On Time	R_L = 100Ω	—	11	—	ns
t_{OFF}	Turn Off Time	C_L = 35 pF See Figure 8	—	11	—	ns

Notes:
1. See test circuit and wave forms.
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 0.25 ns for 50 pF 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.

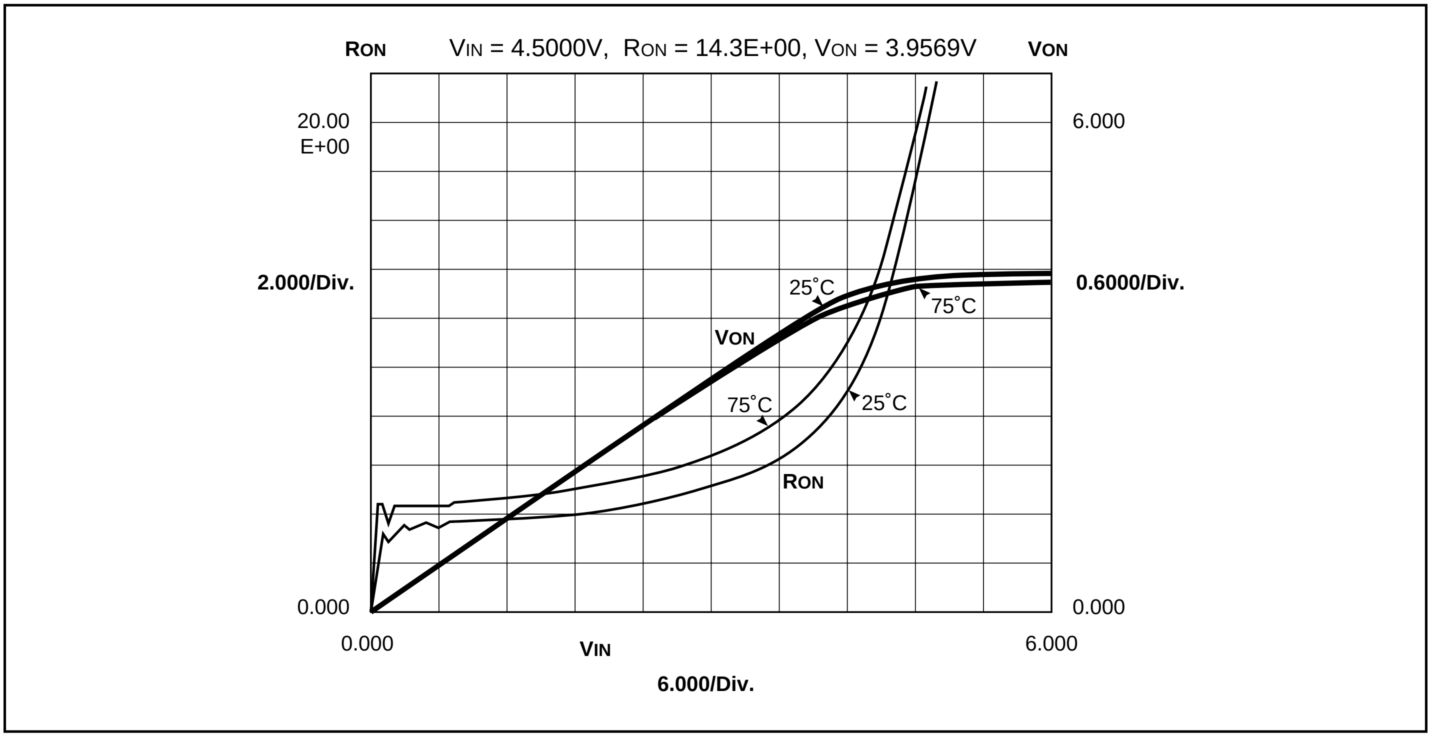


Figure 3. RON vs Input Voltage over Temperature (RON at Vcc = 6.1V @ 75°C)

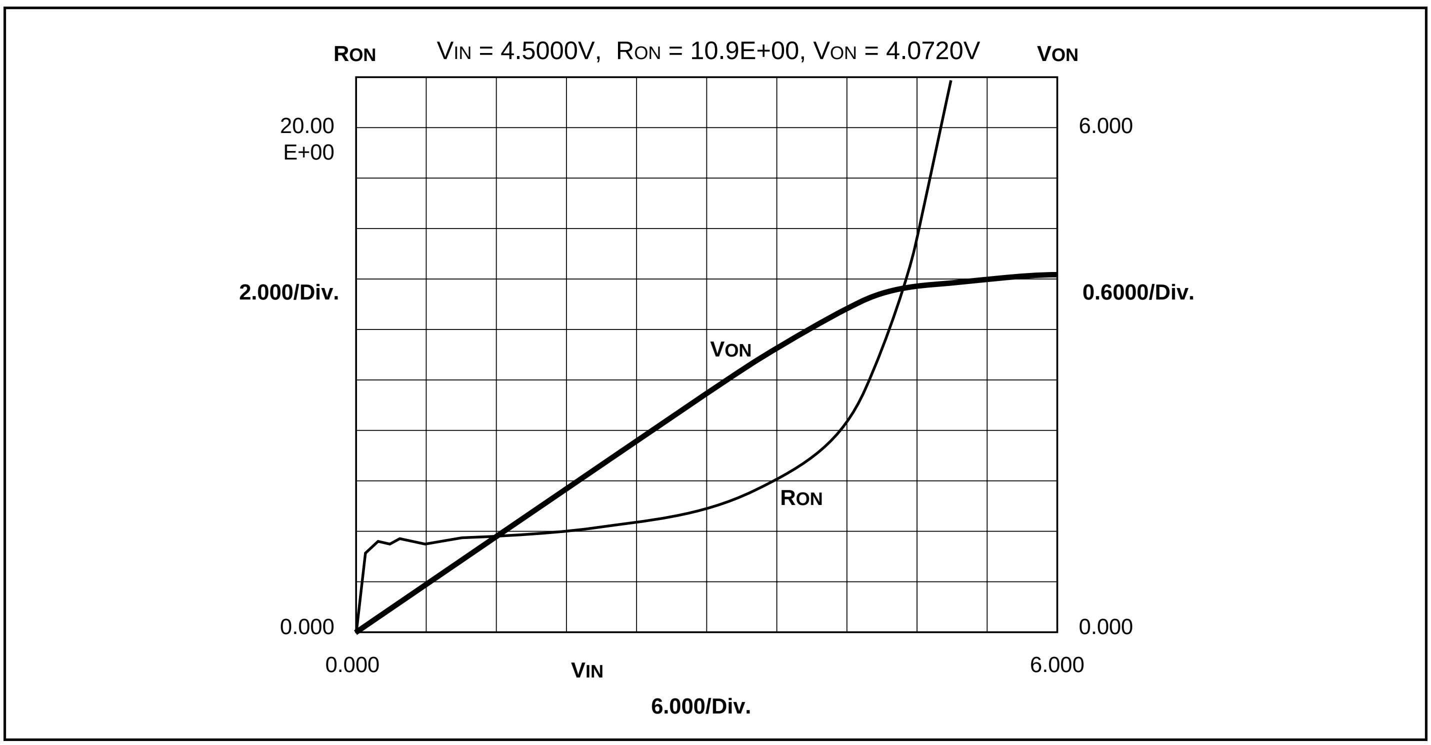


Figure 4. RON vs Input Voltage (RON at Vcc = 6.2V @ 25°C)

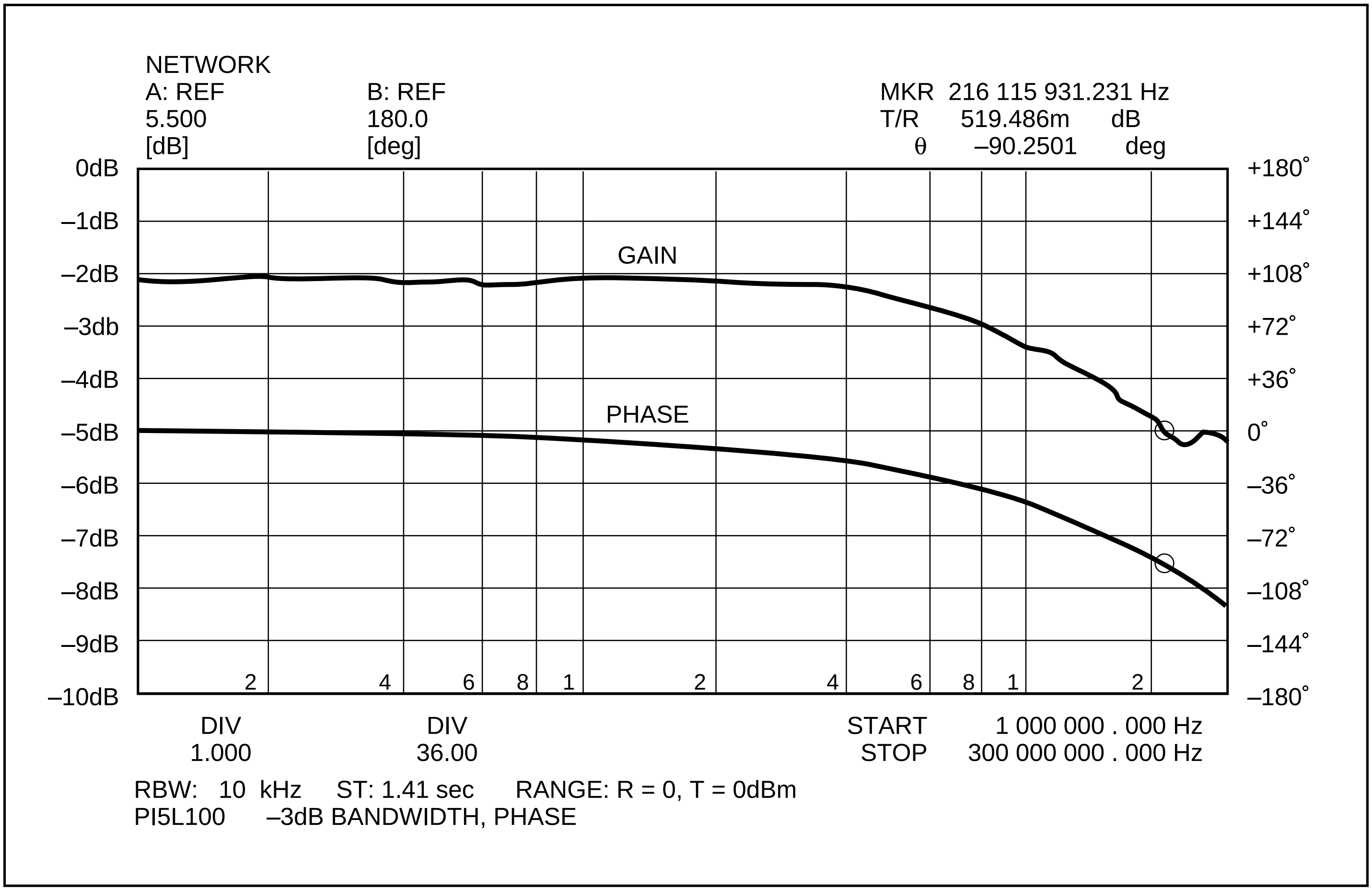


Figure 5. Gain/Phase vs Frequency

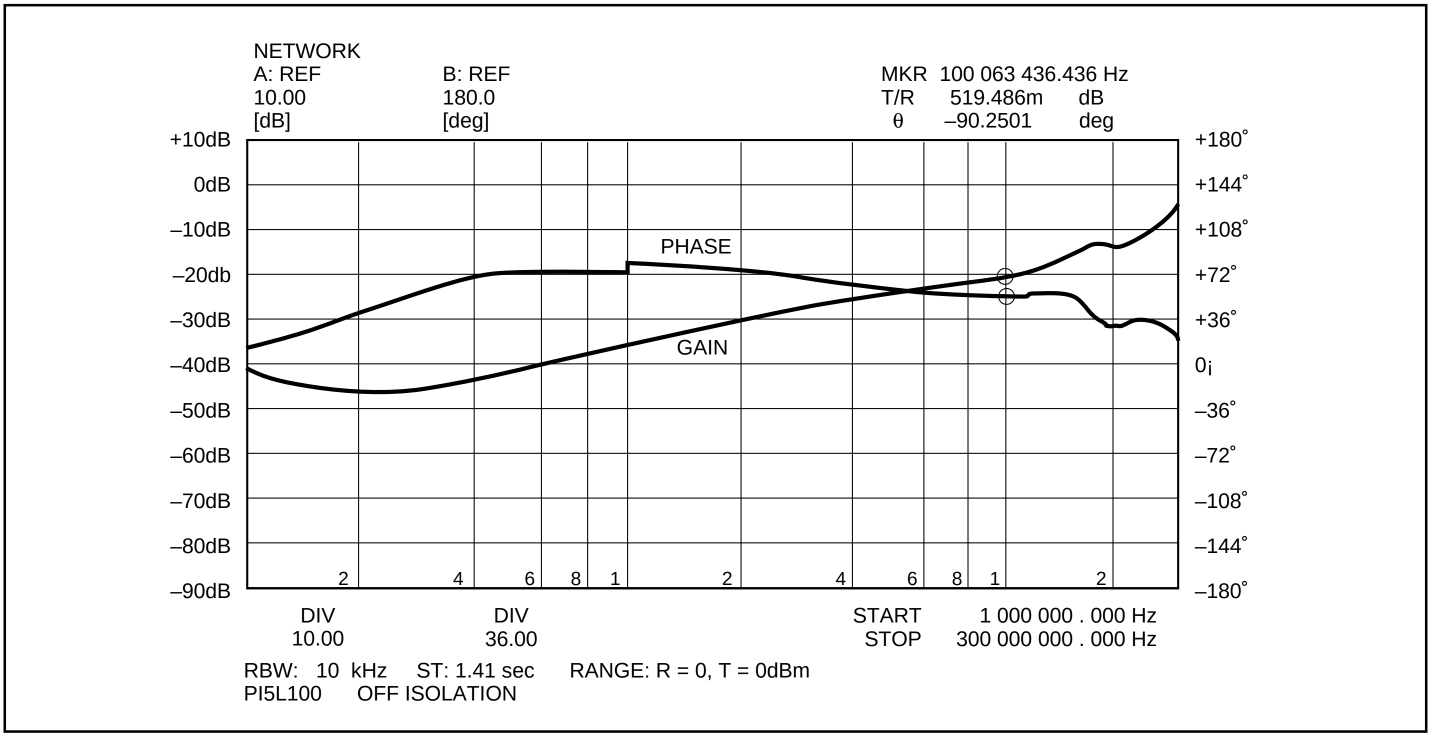


Figure 6. Off Isolation vs Frequency

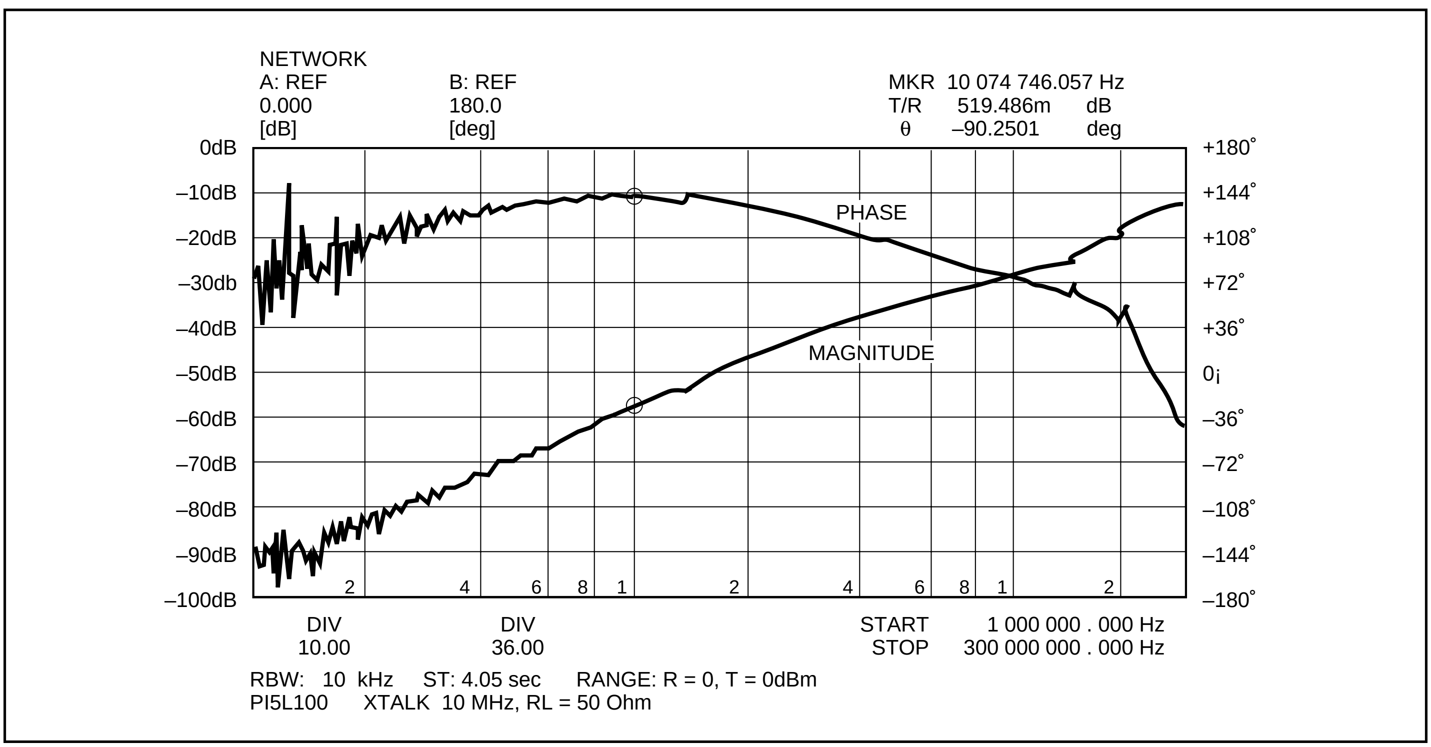


Figure 7. Crosstalk vs Frequency

APPLICATIONS SECTION

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 ...XTALK (DIF)

Adjacent pins cause the most crosstalk because of the interlead package capacitance which is generally in the order of 0.5 pF (pin-to-pin). It can be seen in Figure 11 that this Evaluation (EV) Board schematic uses four pairs of switches. The 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 amont 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 XTALK output which equates to 20LOG V_{OUT}/V_{IN} = 20LOG 30 mV/5V = –44dB. Since the edge rate is 2 ns, 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 RON in the flat part of the curve (ΔR_{ON} or flatness is ~2Ω).

Signal Distortion

Distortion of the input signal is equated to 20LOG ΔRON/R_L. So keeping RON flat as the data signal level varies is critical to low distortion. It should also be noted that 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

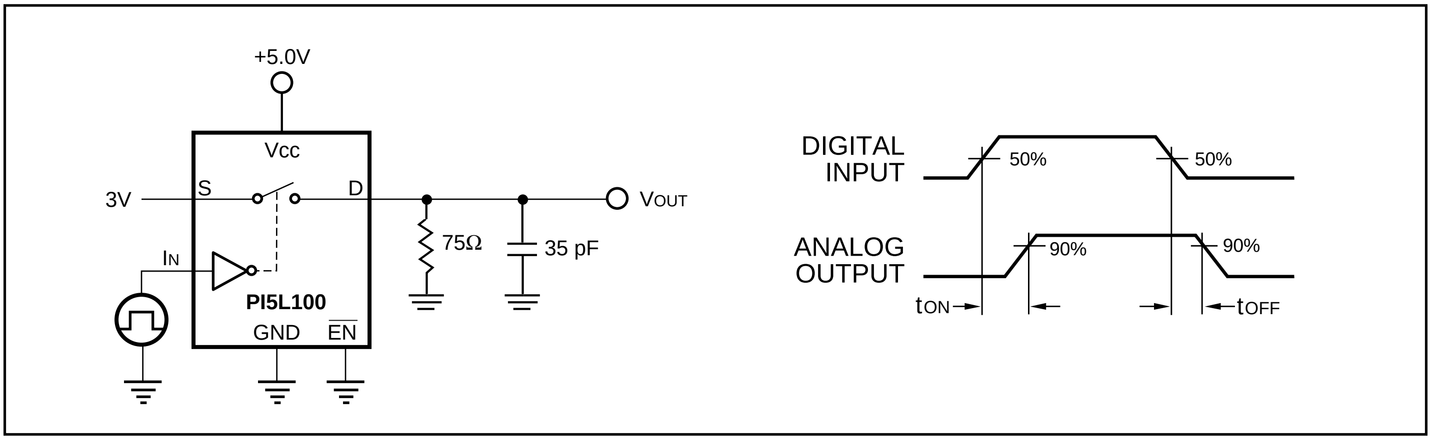


Figure 8. Switching Time

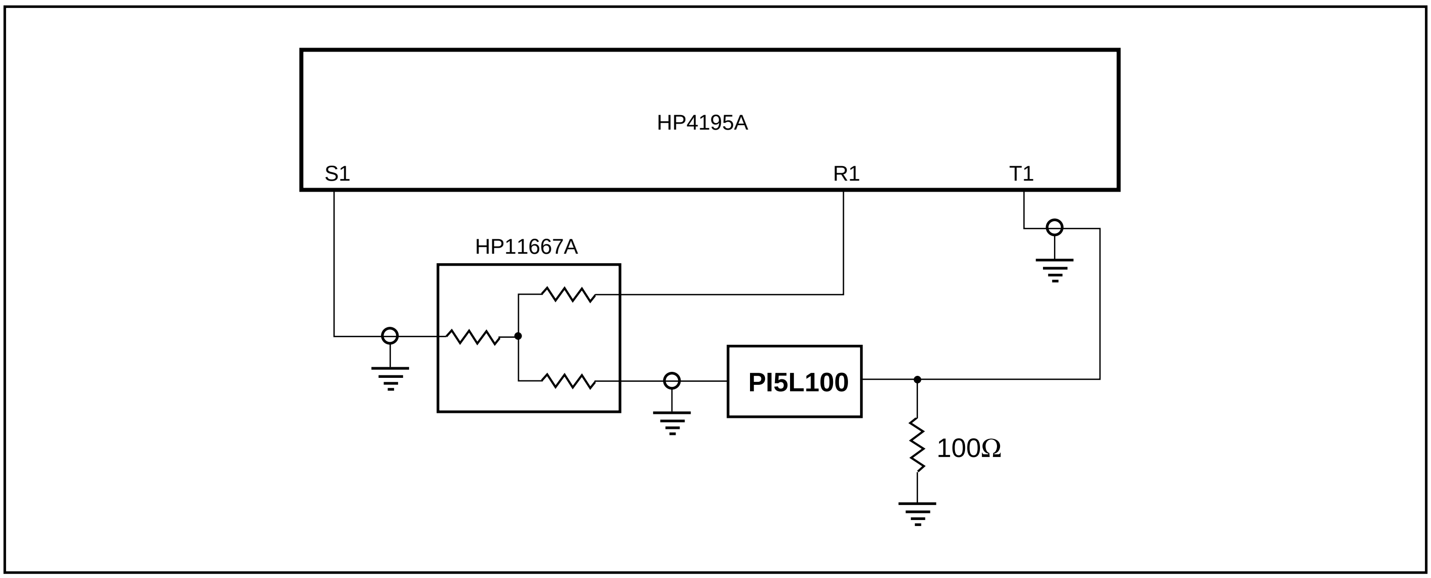


Figure 9. Gain/Phase Crosstalk, Off Isolation

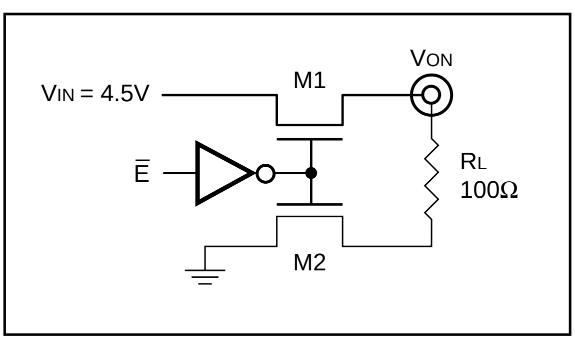


Figure 10. Switch ON Voltage Test Circuit

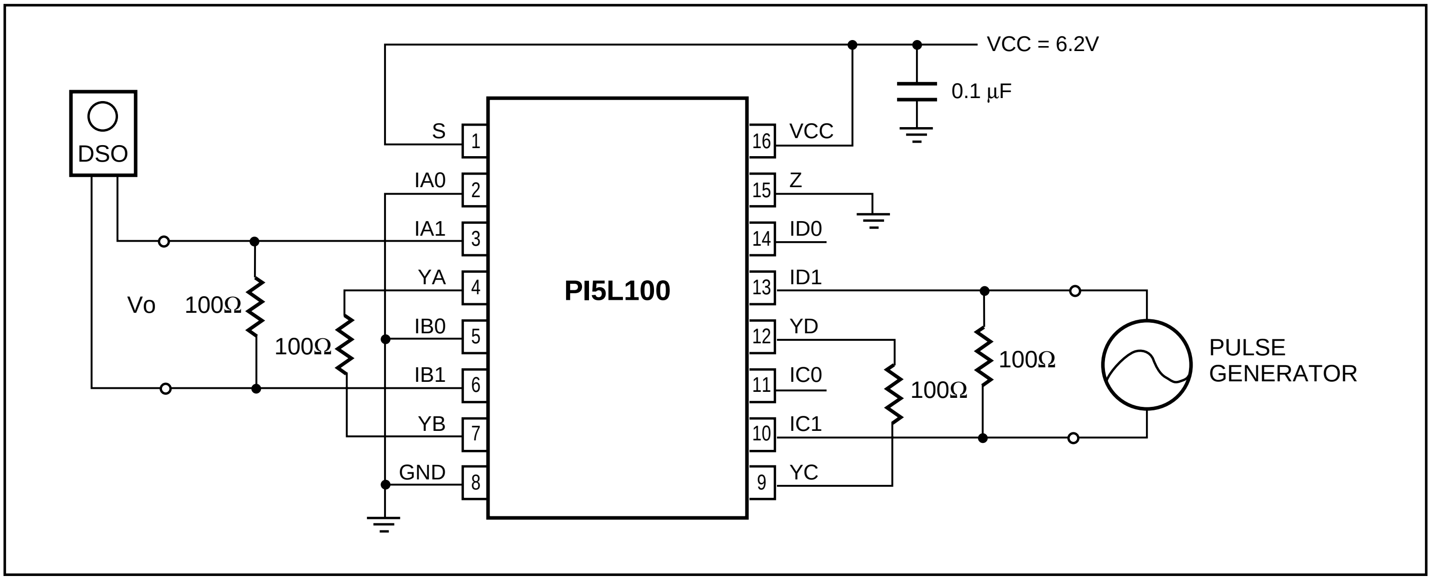


Figure 11. Differential Crosstalk Measurement

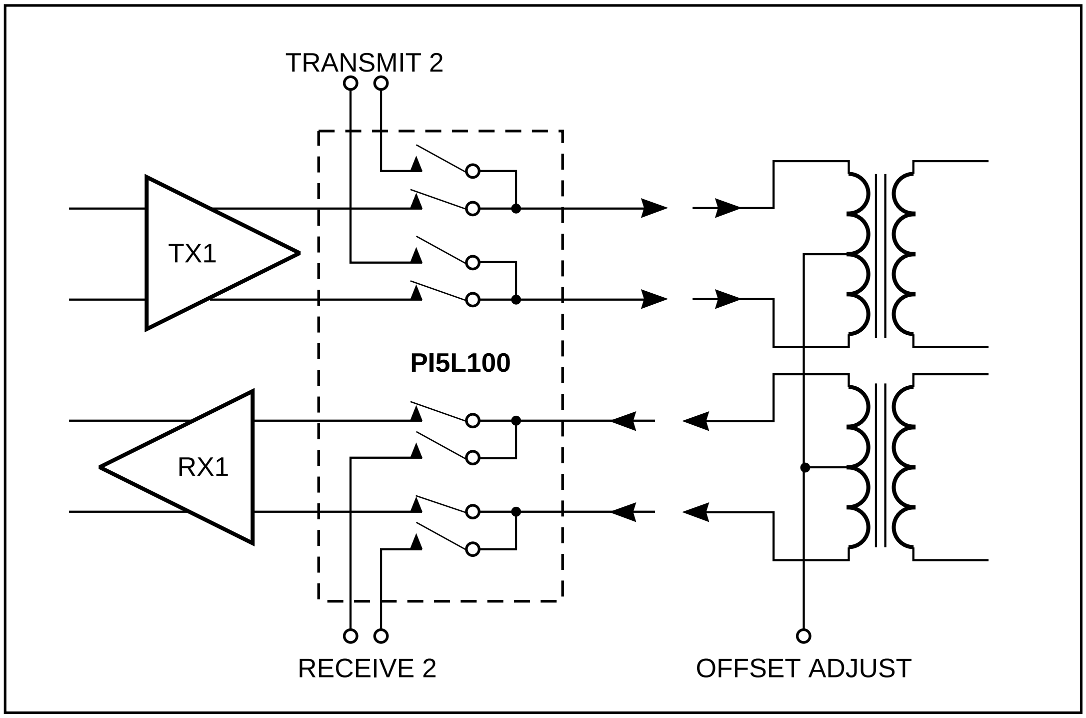


Figure 12a. Full Duplex Transceiver

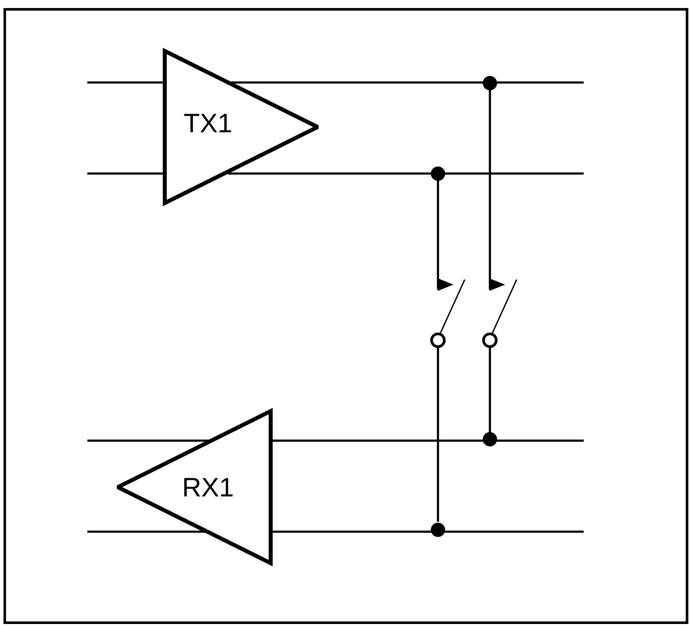


Figure 12b. Loop Back

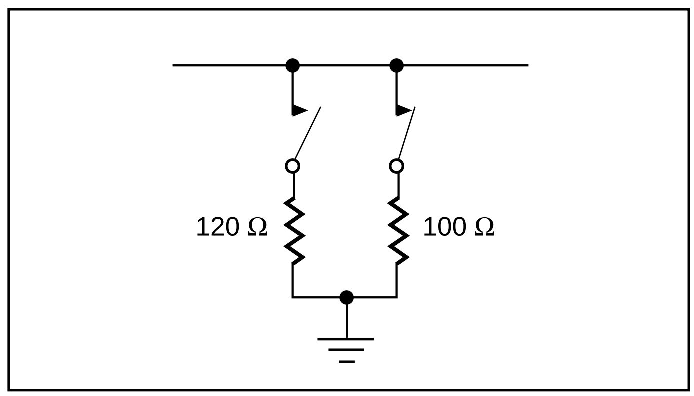


Figure 12c. Line Termination

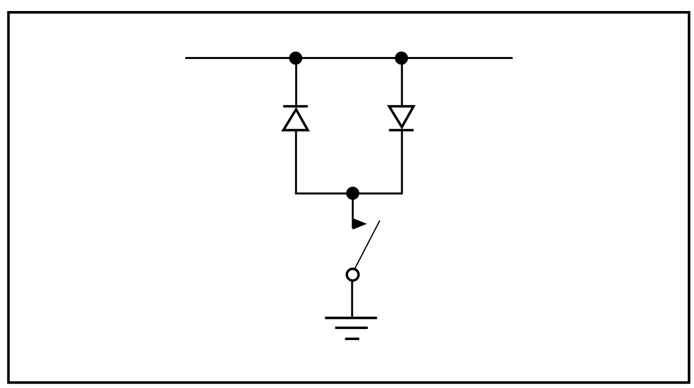


Figure 12d. Line Clamp

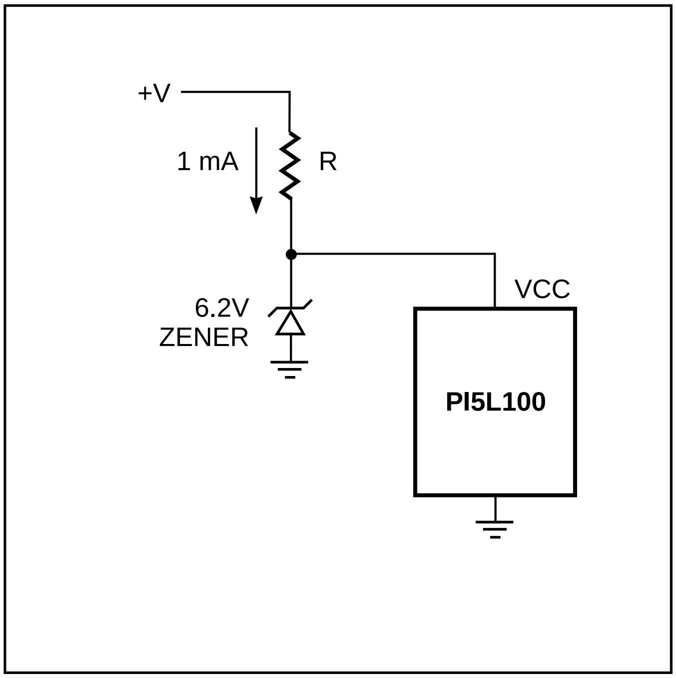


Figure 13. Vcc Bias Current

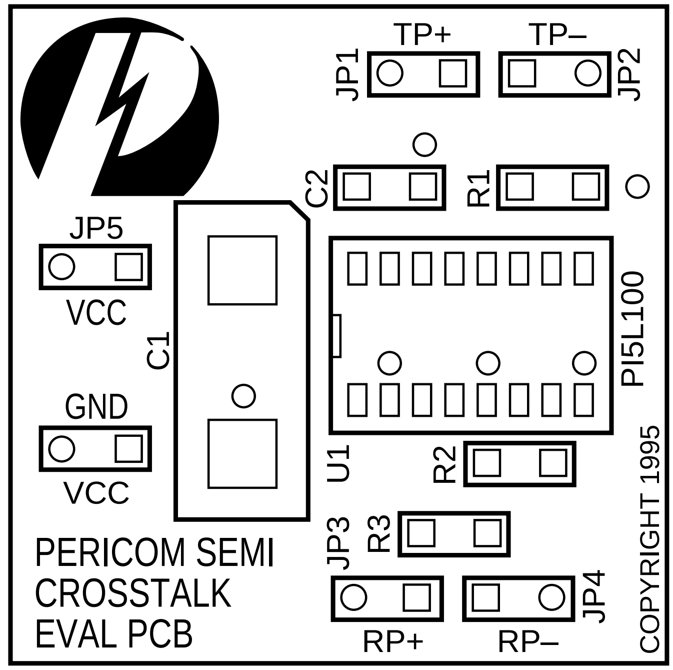


Figure 14a. Crosstalk EV Board

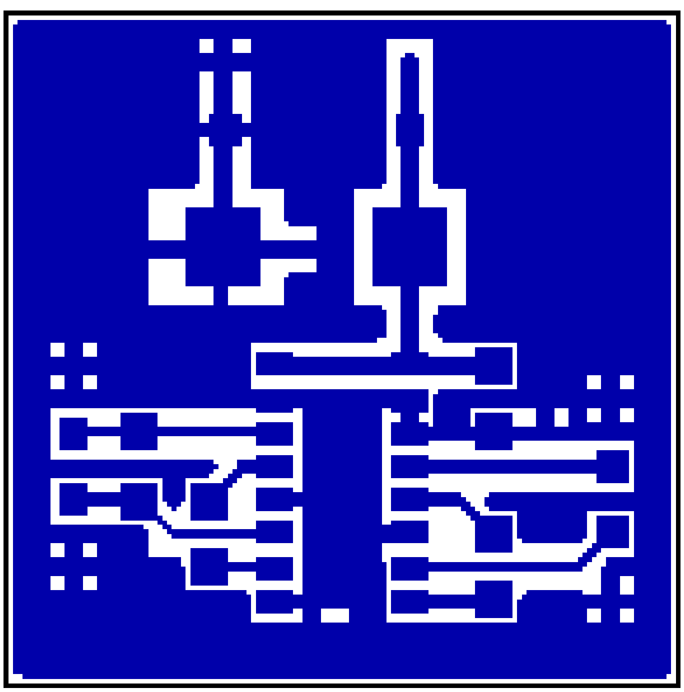


Figure 14b. Component Side

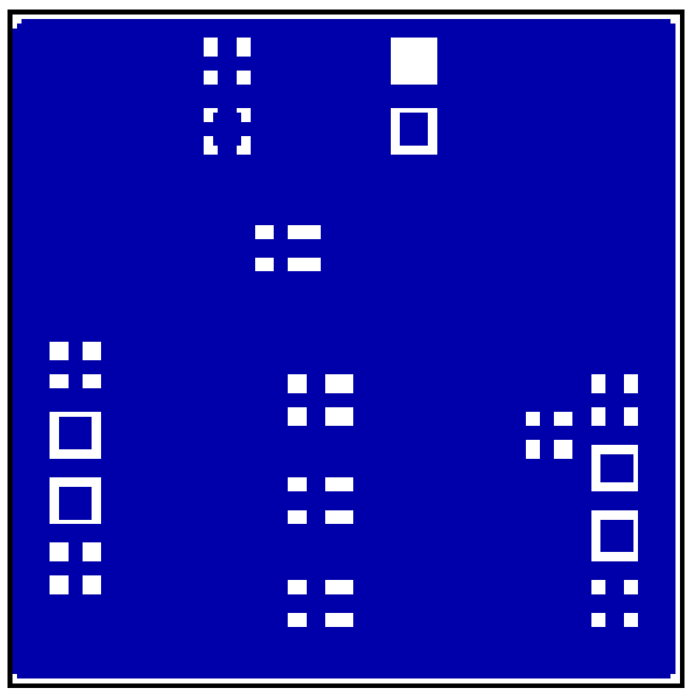


Figure 14c. Solder Side

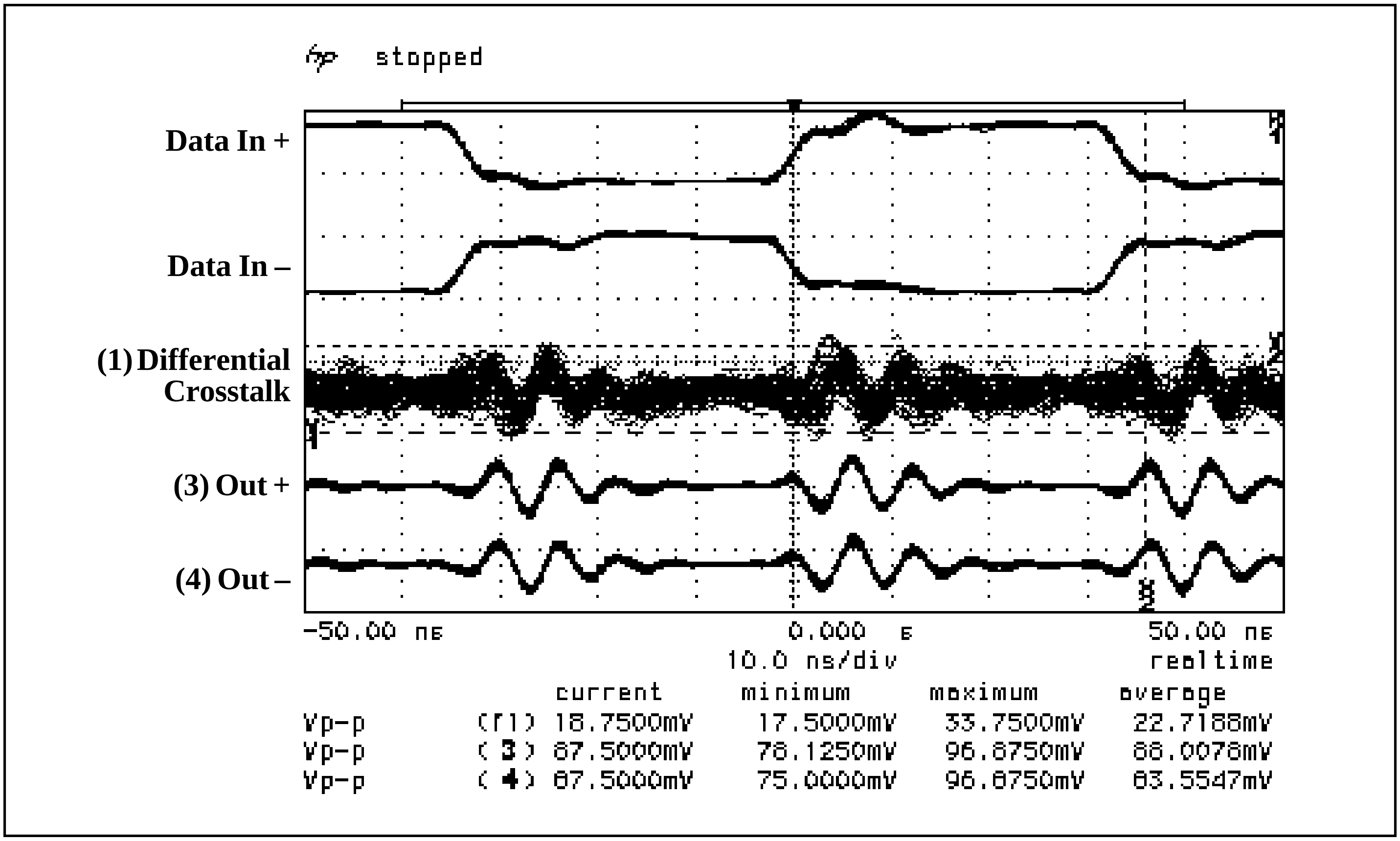


Figure 15. Crosstalk Waveform

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   (b) support or sustain life and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
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PERICOM Semiconductor, Inc. • 2380 Bering Drive • San Jose, CA 95131 • (408) 435-0800 • Fax: (408) 435-1100