10/100 ETHERNET PROTECTION

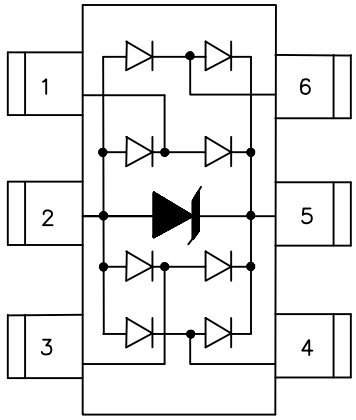
10/100 Ethernet ICs are vulnerable to damage from electrostatic discharge (ESD). The fatal discharge may originate from a charged cable or a “human body”. Furthermore, devices used in telecommunications equipment may be exposed to lightning induced transients. This application note illustrates a protection circuit suitable for use in 10/100 Ethernet applications.

The original 10Base-T Ethernet chips were fairly large geometry CMOS products that were not very sensitive to static over-voltage. Newer 10/100 Ethernet devices however have become extremely sensitive to latch-up or damage as IC manufacturers have moved to 0.35-micron and smaller line widths. These small geometries are sensitive to fatal electrostatic discharges that may originate from a charged cable, lightning or a “human body”.

One of the most common electrostatic discharges is a Cable Discharge Event (CDE). An Ethernet cable can store up energy that will discharge into the circuit when the cable is plugged into the connector causing a CDE. Another frequent phenomenon is human thumbing of the connectors of the cable. This charges each of the connections that will discharge into the circuit upon contact. Lightning can also induce high voltage onto the lines that can be transferred to the protected IC. Discharge from any source into the Ethernet interface will charge the secondary windings of its transformer. Once the surge is removed, the secondary winding will stop charging and will transfer its stored energy to the primary side where the protected IC sits. The internal protection in the PHY chip, if any, often is not enough due to the high energy of the discharges. If the discharge is catastrophic, it will destroy the protected IC. If it is less severe, it will cause latent failures that are very difficult to find.

10/100 Ethernet operates at 125MHz clock over a twisted pair interface. In a typical system, the twisted-pair interface for each port consists of two differential signal pairs: one for the transmitter and one for the receiver, with the transmitter input being the most sensitive to damage. The fatal discharge occurs differentially across the transmit or receive line pair and is capacitively coupled through the transformer to the Ethernet chip. The challenge is to find a TVS (transient voltage suppressor) that will clamp low enough as to prevent latch-up or damage to the Ethernet IC. Also, the protection device must add minimal loading capacitance as high parasitic capacitance can cause significant degradation to the 100Mbps signal.

Semtech’s SRV05-4 meets all these criteria. The circuit diagram of SRV05-4 is shown in Figure 1. It is in a SOT-23 6L package and may be used to protect two high-speed line pairs. The SRV05-4 combines performance with proprietary process technology to produce a low clamping voltage and capacitance (typically 3pF line-to-ground and 1pF line-to-line) device at an operating voltage of 5V. The 8kV contact ESD response of the SRV05-4 can be seen in Figure 2. Figure 3 shows the capacitance verse reverse voltage curve. A plot of the SRV05-4 insertion loss from 3kHz to 3GHz is shown in Figure 4. An eye pattern of the SRV05-4 operating at 125MHz is shown in Figure 5 in a line-to-ground configuration and in Figure 6 in a line-to-line configuration. Figure 2 through 6 shows that the SRV05-4 will maintain the Ethernet signal integrity without attenuation. It also offers superior protection to meet IEC 61000-4-2 level 4 (ESD – 15kV air and 8kV contact), IEC 61000-4-4, level 4 EFT and IEC 61000-4-5 16A (8 x 20µs) lightning surge.



SRV05-4

Figure 1 - SRV05-4 Schematic and Pin Configuration

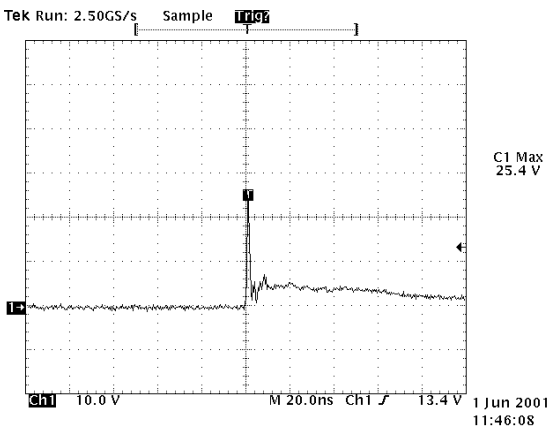


Figure 2 - SRV05-4 8kV Contact ESD Response

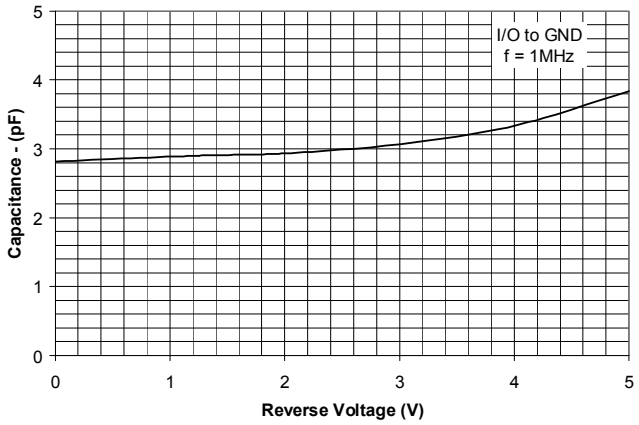


Figure 3 - SRV05-4 Typical Capacitance Verse Reverse Voltage

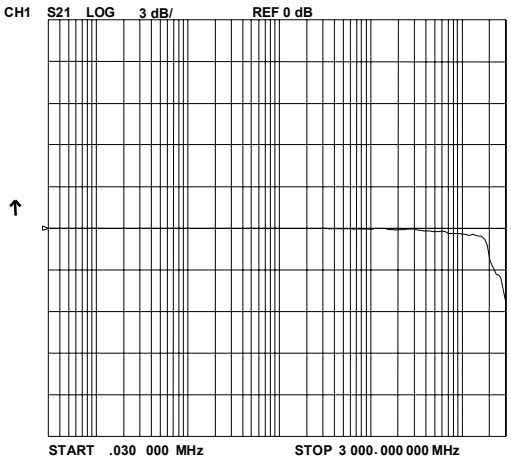


Figure 4 - SRV05-4 Insertion Loss

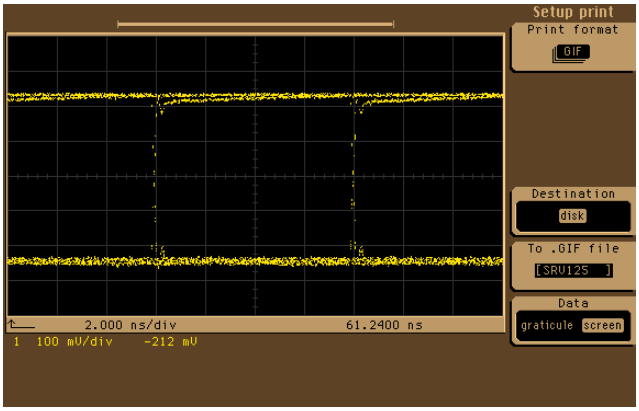


Figure 6 - 125MHz with SRV05-4 Line-to-Line

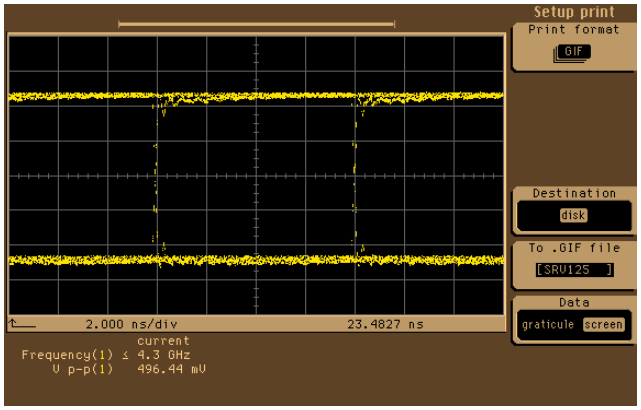


Figure 5 - 125MHz with SRV05-4 Line-to-Ground

Figure 7 shows how one SRV05-4 can be configured to protect both twisted pairs (four lines) on the 10/100 Ethernet port. In this configuration, one SRV05-4 provides bi-directional differential mode protection for positive and negative surges. Transformer isolation of at least 1.5kV is usually sufficient for common mode protection. Pin 1 is connected to one line of a twisted pair while pin 6 is connect to the other line of that same twisted pair. Pin 3 is connected to one line of another twisted pair while pin 4 is connect to the other line of that same twisted pair. During a positive or negative surge on a twisted pair, the surge goes through a steering diode from pin 1,3,4, or 6 to turn on the TVS and shunt the current away from the protected IC and back to the source.

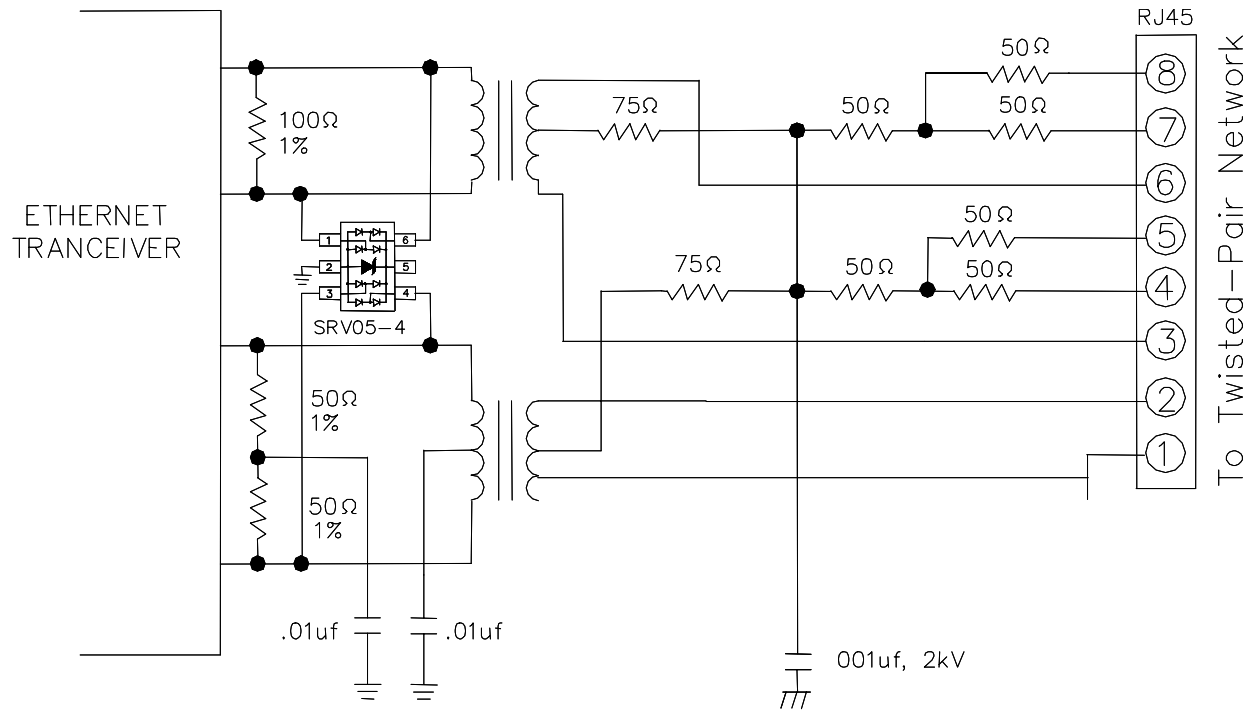


Figure 7 - SRV05-4 in 10/100 Ethernet for Differential and Common Mode Protection