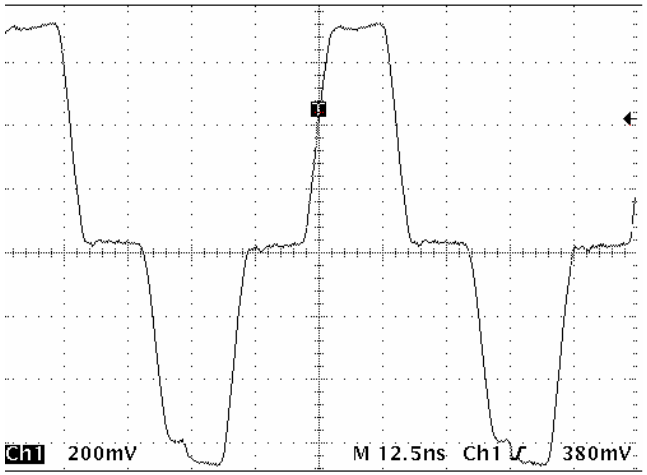
High Band Communications Port Protect Solutions

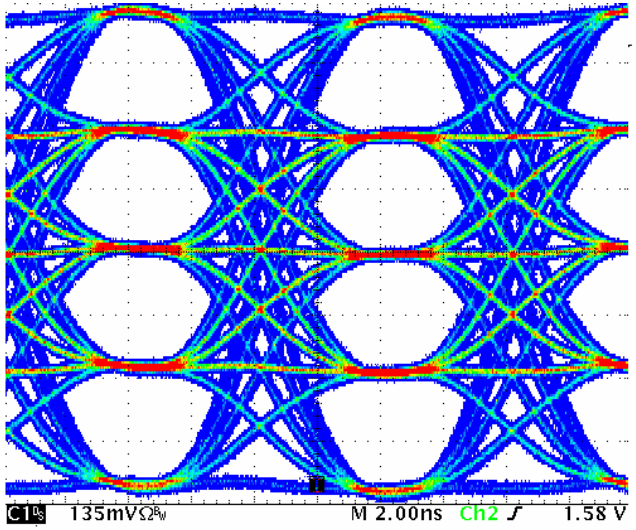
BOURNS®

Ethernet Signaling-100/1000Base T

Ethernet Signaling –100BASE-T
100 Mb/s Ethernet has the following characteristics:
Data rate: 100 Mb/s Signaling: 125 MHz, Differential, MLT-3 (Multi Level Transition) Encoding: 4b5b (4 bits of data in 5 bits transmitted) Wires used: 2 pair (each Simplex) Specification: IEEE 802.3u Bit error rate: 1 error in 10e10 bits



1000 Mb/s or Gigabit Ethernet has the following characteristics:
Data rate: 1000 Mb/s
Signaling: 125 MHz, Differential, PAM-5 (Pulse Amplitude Modulation)
Encoding: 8b10b (8 bits of data for 10 bits transferred)
Wires used: 4 pair (each Full Duplex)
Specification: IEEE 802.3ab Bit error rate: 1 error in 10e10 bits



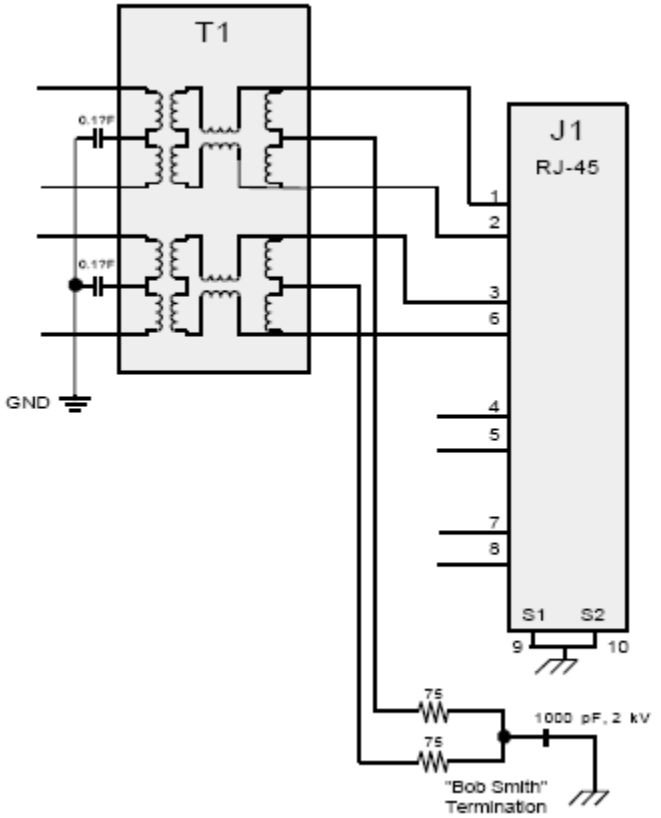
What Ethernet Port do

(i)The signal of ethernet like 100base T, 1000BaseT couple through ethernet transformer to PHY

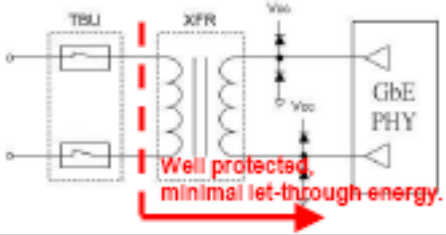
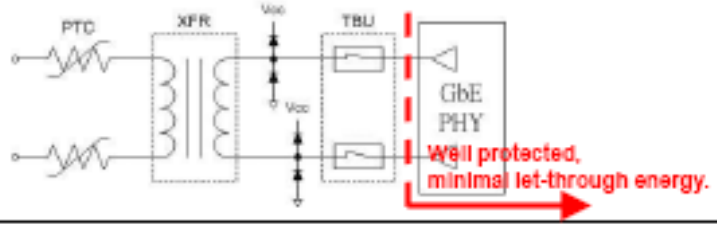
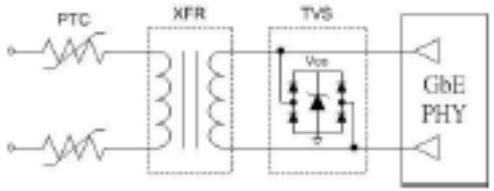
(ii) Bob-Smith" reduce noise resulting common mode current flows and susceptibility noise from unused pairs.

(iii) Bob-Smith termination does not apply for POE.

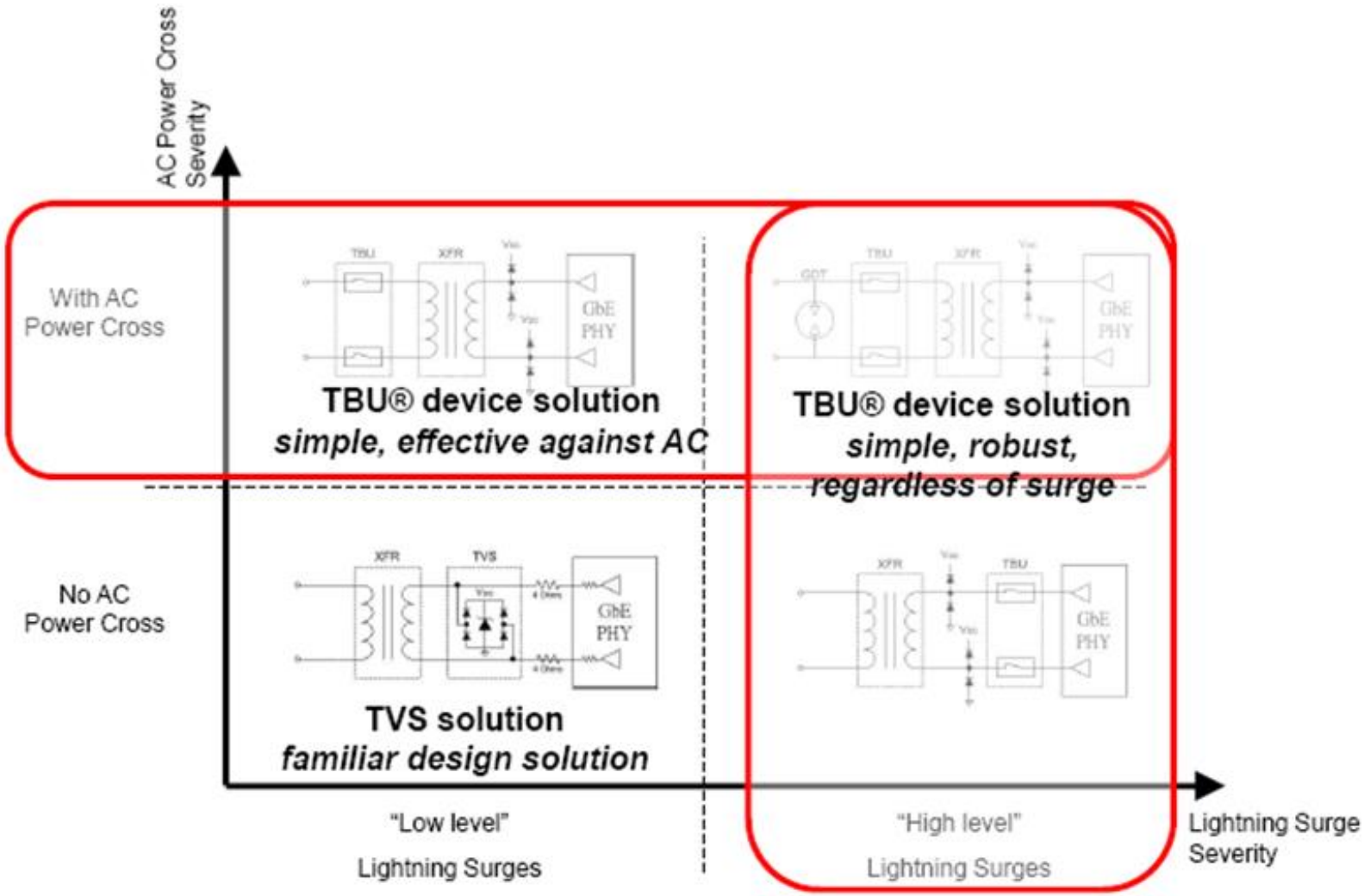
(iv) Gigabit ethernet require Quad Transformer



Protection Solutions-Comparison

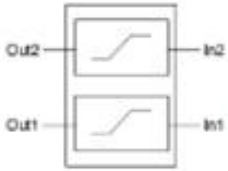
Solution	Pros	Cons
1. **TBU® + Transformer (+ ESD diodes)** 	Smallest footprint and most robust solution. Any transformer can be used	850 V transverse limitation
2. **PTC + Transformer (+ ESD Diodes) +TBU®** 	PHY is well protected.	Transformer is exposed to transverse and AC power cross surges
3. **PTC + Transformer +TVS** 	Familiar design solution	Transformer is exposed to transverse and AC power cross surges. Surge capability of low-C_j TVS is limited

Protection Solutions-Comparison



What is a Transient Current Suppressor?

- *Bourns® TCS™ line of Transient Current Suppressors are compact, ultra high-speed, bidirectional, low resistance solid-state current limiting devices*

Dual Channel Devices		Package Style	Trigger current	Resistance
	TCS-DL004-250-WH	DFN 2.5 x 4 mm	375 mA	2.3 Ω
 	TCS-DL004-500-WH	DFN 3.5 x 4 m	750 mA	1.4 Ω
	TCS-DL004-500-WH	DFN 4.5 x 4 mm	1100 mA	1.0 Ω

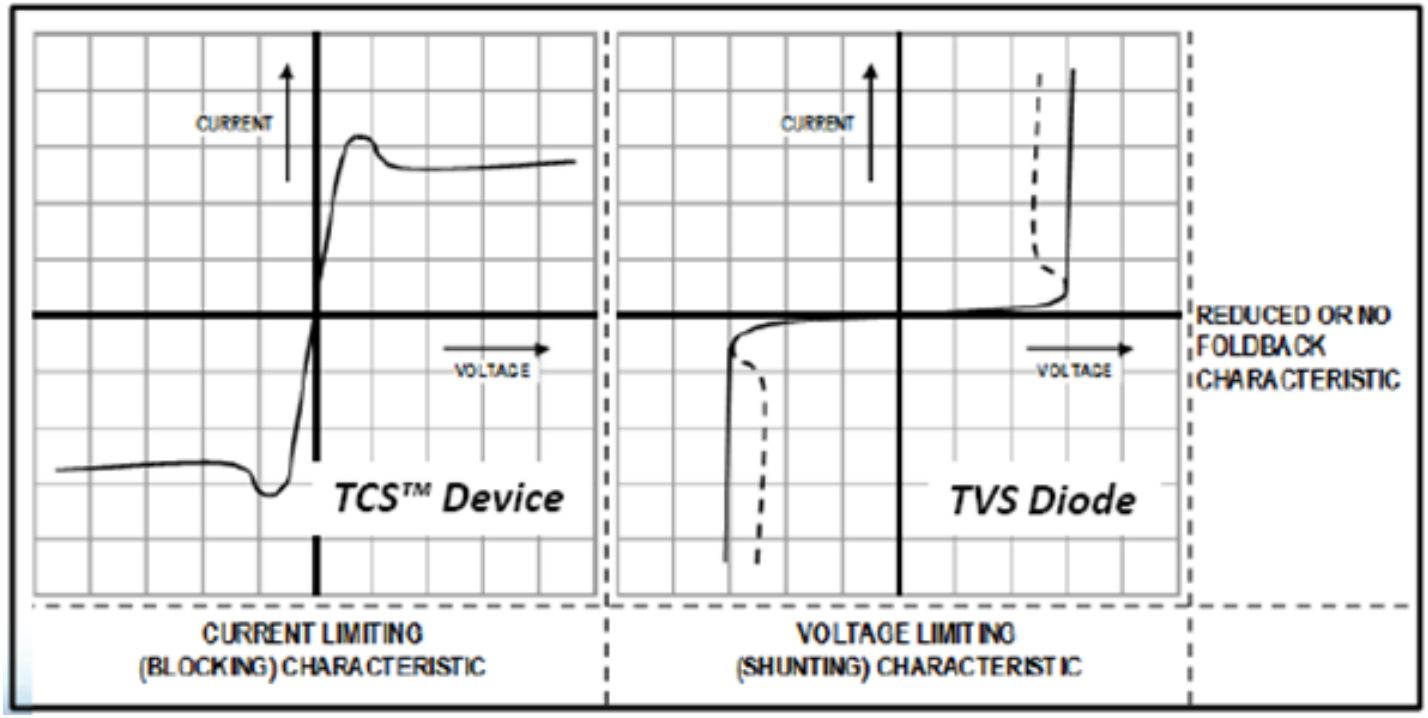
Meeting Telecom & Industrial Circuit Protection Needs

- *Cost-effective, ultra-fast protection for very high data rate signal lines -- xDSL and Gb-Ethernet*
  - *Provides current limiting and/or voltage isolation when used with a voltage limiting device such as a TVS diode*
- *Optimizes surge protection while maintaining system performance*
  - *Ultra-fast reacting -- does not alter signal performance of high speed communication ports*
  - *"Create the Ideal Diode" response when used with an overvoltage protection device*
- *Small footprint helps simplify retrofitting/upgrading at minimum redesign costs.*
  - *In most cases, designers can simply add a TCS™ device to an existing TVS protection design*

What Makes Bourns® TCS™ Products Innovative?

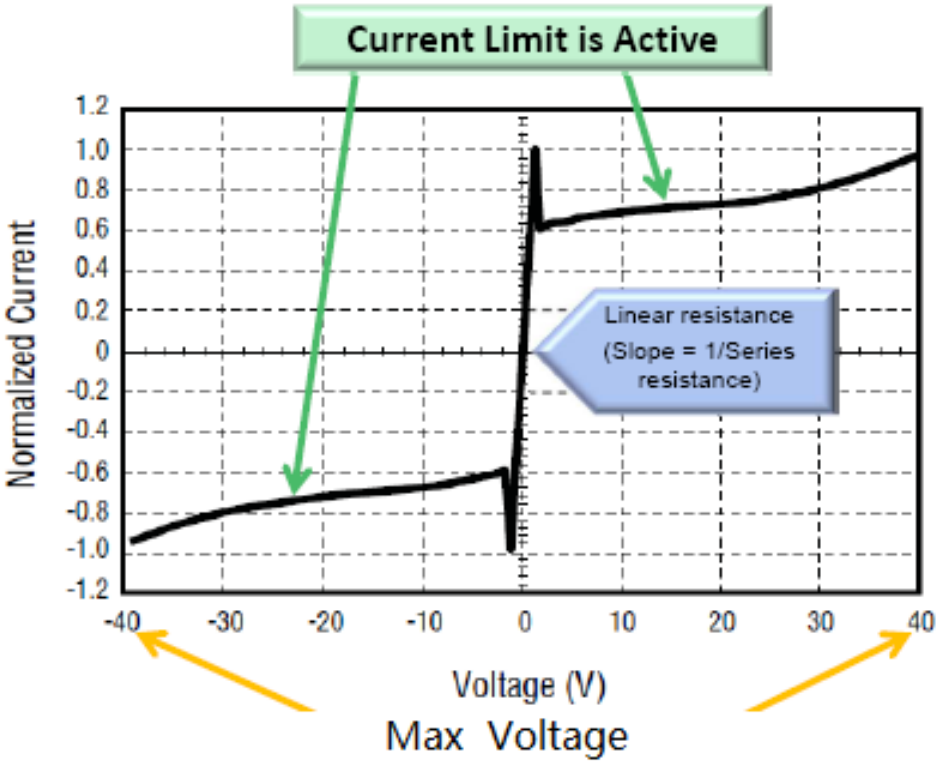
Current vs. Voltage Plot

- *A TCS™ product is a bidirectional device which has a general I-V curve as shown below. The I-V curve for a TVS diode is also shown for comparison. Note that a TCS™ device limits current while a TVS diode limits voltage.*



Bourns P/N TCS-DL004-xxx-WH

Normalized V-I Curve Under Surge Conditions

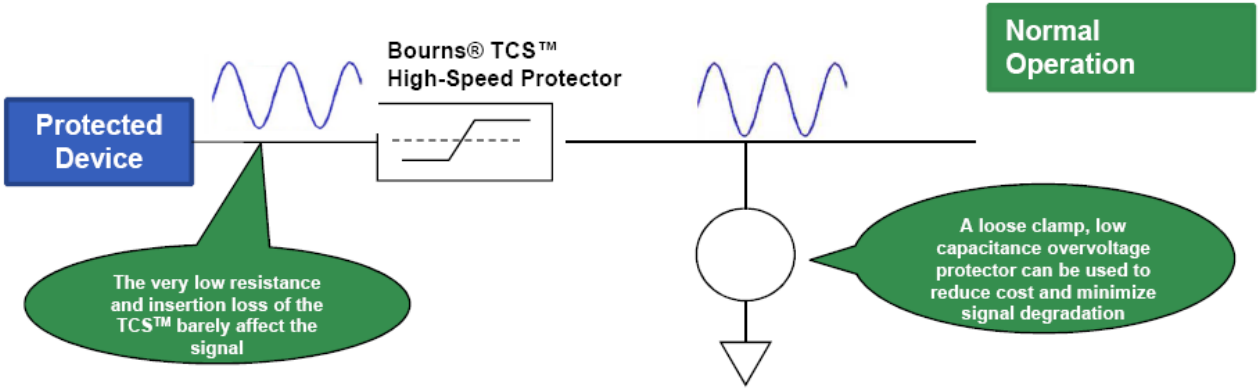


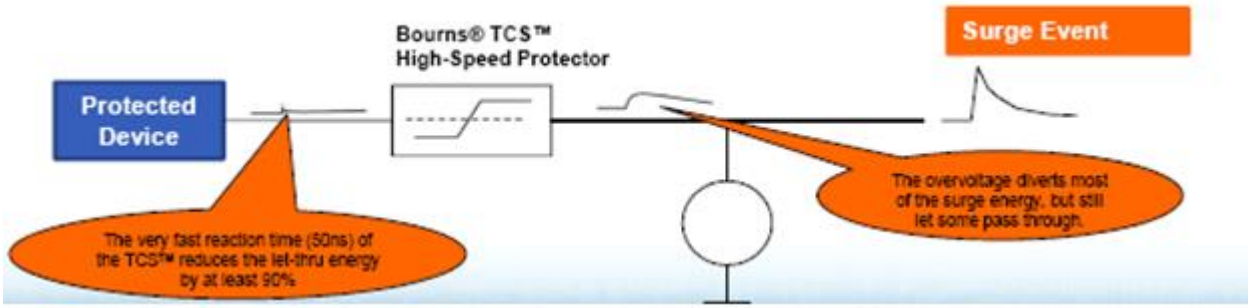
A voltage waveform with a slew rate of about 1 V/µs was applied across the device to generate this graph. The graph is normalized to the peak current through the device.

The Trigger Current is the peak current level right before current limiting operation begins.

Normal and Surge Operation

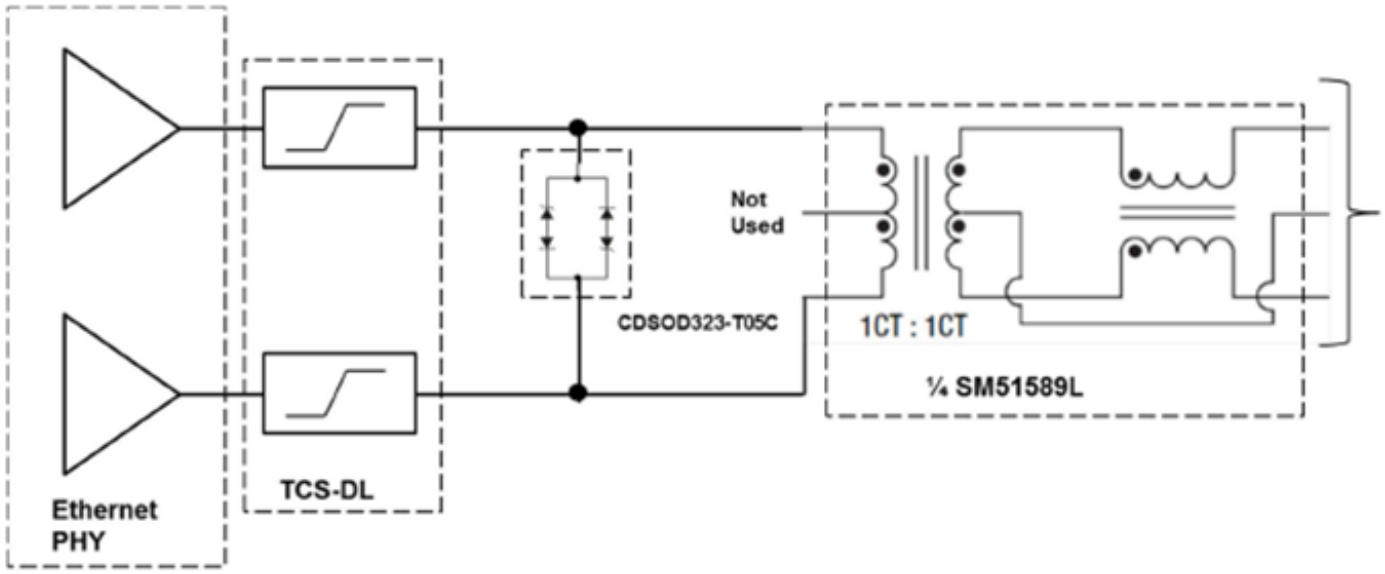
The Bourns® TCS™ is designed to be used in coordination with a suitable overvoltage limiting device such as a TVS diode or a TISP® thyristor. A steering diode clamp to the power supply rail and/or ground can also be used.





Bourns® TCS™ Product Applications

Gigabit Ethernet (GbE)



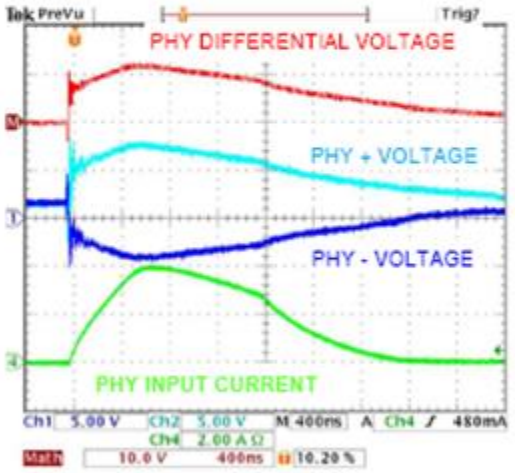
The above solution uses a TCS-DL device in conjunction with a TVS diode to reduce the stress on the PHY input/outputs.

Bourns® TCS™ Product Applications

GbE Signal Line Application: 1.2/50, 8/20 µs CW Surge Test (800 V/100 A)

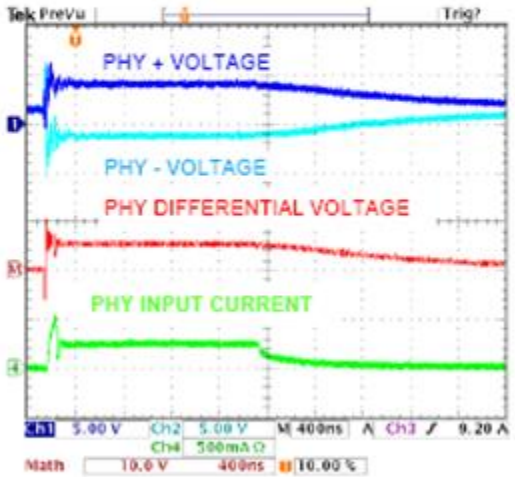
Protecting a Typical Ethernet Port with a TCS-DL004-250-WH

With TVS Diode Only



PHY sees: Peak Voltage: >12 V
Peak Current: 4 A
Energy: ~ 50 µJ

With TCS™ Device and TVS Diode



PHY sees: Peak Voltage: <6 V after initial peak
Peak Current: <300 mA after initial peak
Energy: ~ 3 µJ

TCS™ Device reduces PHY stress by more than 90 %

Bourns® TCS™ Product Applications

GbE Signal Line Application Summary

Protecting a PHY with a TCS-DL004-250-WH as compared to TVS protection alone:

The TCS-DL004-250-WH significantly reduces the current seen by the GbE PHY signal inputs.

After the initial peak, current is reduced by ~90 %.

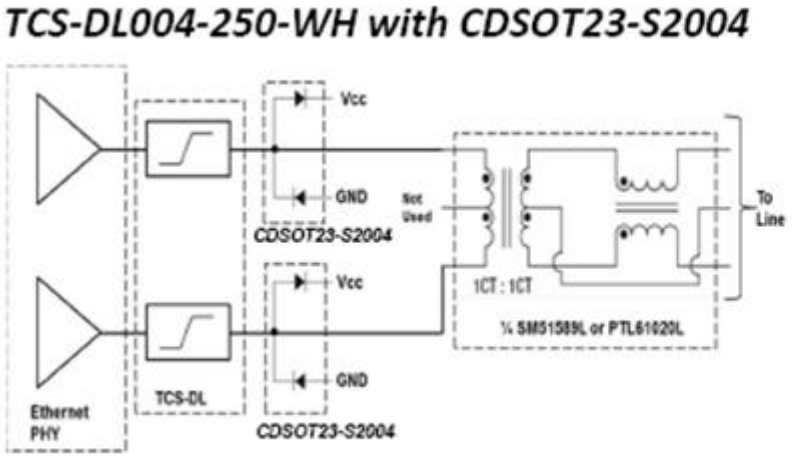
The TCS-DL004-250-WH also isolates the PHY inputs from the voltage across the TVS diode.

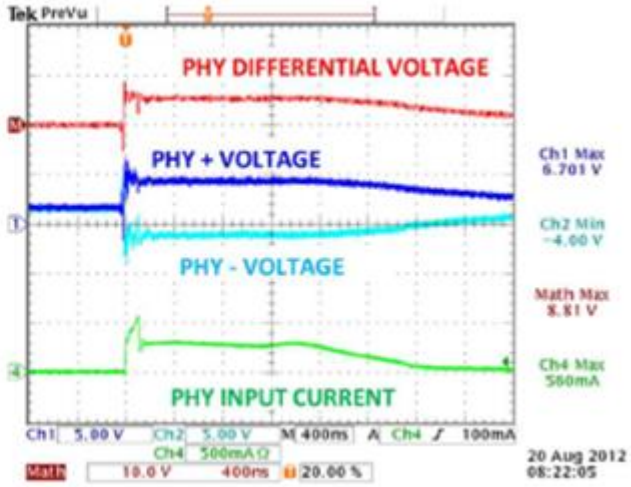
Peak PHY input voltage is determined by its ESD protection and the current through the TCS-DL device. In this case, the voltage level is reduced by over 50 %.

The energy the PHY had to absorb was reduced by more than 90 %.

Alternative GbE Solution

With TCS™ and Clamp Diodes





PHY See: Peak Voltage: <6 V
Peak Current: 560 mA (quickly reduced to 300mA)
Energy: <3uJ

Stress on the PHY is virtually identical to the TCS™/TVS Design even with a softer voltage clamp design!