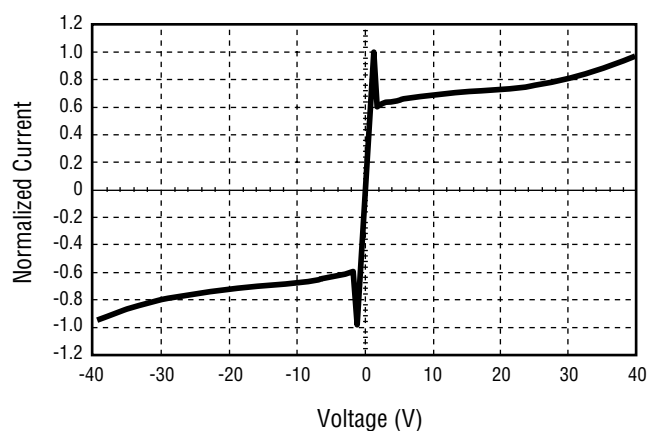


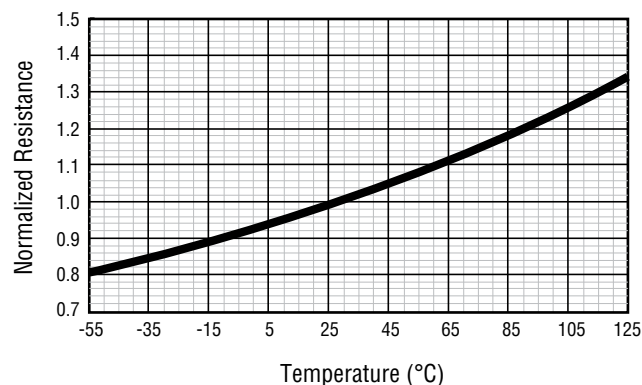
Performance Graphs

Graph 1 below shows a normalized Typical V-I curve for Bourns® TCS™ DL Series High-Speed Protector products under surge conditions. Graphs 2 and 3 show the change in resistance and trip current versus temperature, respectively.

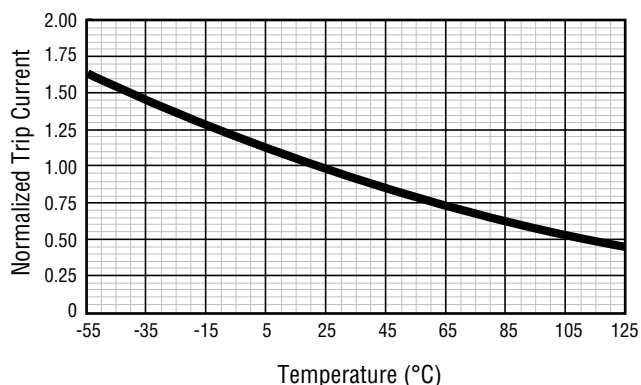
Normalized V-I Curve Under Surge Conditions



Resistance Change vs. Temperature



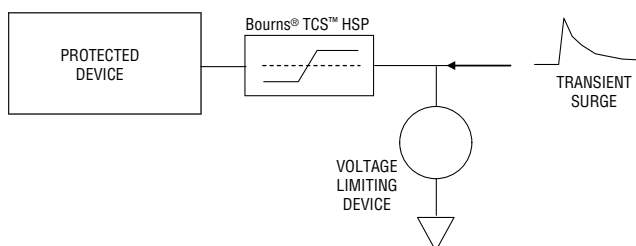
Trip Current Change vs. Temperature



Basic Device Operation

SURGE PROTECTION

The Bourns® TCS™ High-Speed Protector is designed to be used in conjunction with a suitable overvoltage limiting device, such as a TVS diode or a TISP® thyristor as shown below, to provide comprehensive current and voltage limiting protection against surges.



Coordination of Bourns® TCS™ High-Speed Protector with Overvoltage Limiting Device

This two-stage protection limits the maximum voltage at the interface to the clamping voltage of the overvoltage device, while also limiting the current into the protected device to the defined limit of the Bourns® TCS™ High-Speed Protector. Designers should choose a Bourns® TCS™ High-Speed Protector with a current limit that the protected device can handle for the duration of the surge event.

The Bourns® TCS™ High-Speed Protector acts like a low value resistor during normal operation. As the Bourns® TCS™ High-Speed Protector has no electrical connection to anything other than the signal line it protects, the capacitance to ground is purely dictated by the capacitance of the device to surrounding components and PCB traces, which with careful layout can be kept to an absolute minimum.

The Bourns® TCS™ High-Speed Protector can block voltages up to 40 V. This enables very low voltage electronics to be protected by a lower capacitance, higher voltage TVS device, thus achieving very low capacitive loading on high-speed signal lines. For example, on a 3.3 V driver, a 12 V rated TVS may be used, having much lower and more linear capacitance than a lower voltage type. Even though a high voltage TVS is used, the maximum stress seen by the protected device is much lower than would be seen by using a low voltage TVS by itself, as the current is limited to within the maximum limits of the Bourns® TCS™ High-Speed Protector.

The Bourns® TCS™ High-Speed Protector is primarily designed to offer superior and cost-effective protection of sensitive electronics against high energy surges that are transient in nature. Unlike the more complex TBU® High-Speed Protector device, the TCS™ Protector does not exhibit a strong foldback

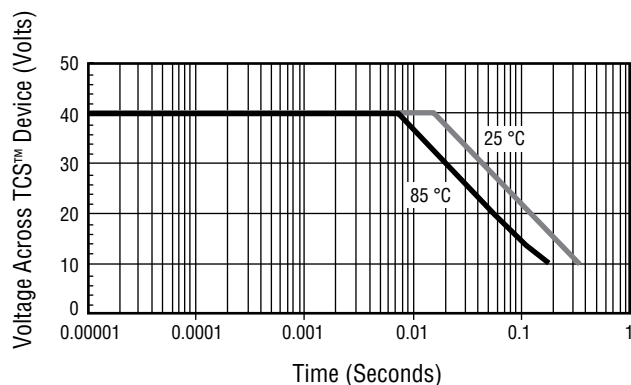
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Basic Device Operation (Continued)

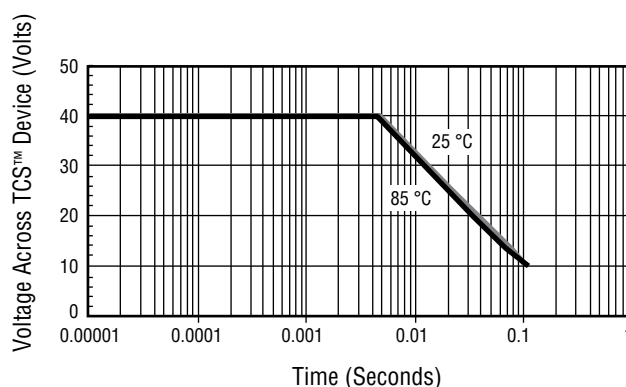
characteristic after reaching the current limit, and therefore doesn't protect against DC and low frequency stresses (typically achieved through the use of a transformer or capacitive coupling). This is analogous to comparing the shunting characteristics of a Transient Voltage Suppressor device to a thyristor type of protector, such as Bourns® TISP® devices. Both the Bourns® TCS™ High-Speed Protector and TVS

device have limited or no foldback characteristic, and therefore have relatively low short term surge energy limits. When used together in a protection circuit, the surge must not exceed the thermal capability of either device. The following three graphs show the maximum surge duration with respect to voltage of the three TCS-DL devices at both +25 °C and +85 °C.

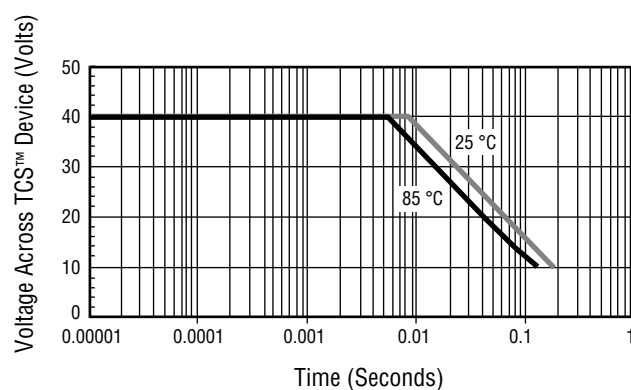
TCS-DL004-250-WH SOA Single Surge Duration



TCS-DL004-750-WH SOA Single Surge Duration



TCS-DL004-500-WH SOA Single Surge Duration



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Basic Device Operation (Continued)

COORDINATION

In all applications, the overvoltage protection device should be chosen to limit the maximum voltage across the Bourns® TCS™ High-Speed Protector to less than the maximum voltage rating of the device. If this maximum voltage limit is exceeded, the Bourns® TCS™ High-Speed Protector may begin to avalanche, and it will cease to effectively block the current into the protected device, which may result in damage.

USING MULTIPLE TCS-DL DEVICES IN SERIES OR PARALLEL

Bourns® TCS™ High-Speed Protectors may be connected in parallel to achieve even lower on-state resistance. If matching is required, use two Bourns® TCS-DL Series HSPs, and connect one Bourns® TCS™ High-Speed Protector from each DL device in parallel. In addition, because of their ultra-fast response, multiple Bourns® TCS™ High-Speed Protectors may be connected in series to achieve multiples of the breakdown voltage.

Reference Applications

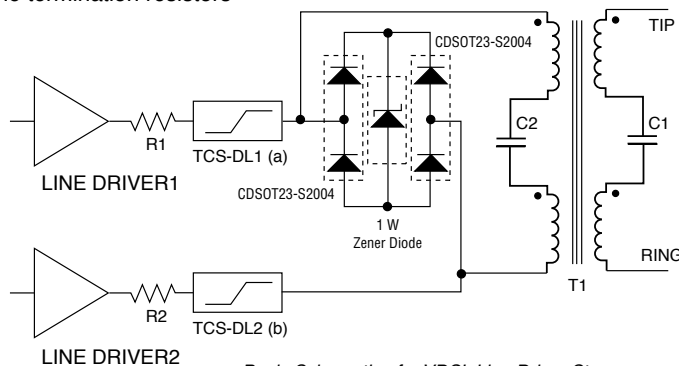
Two good examples of applications where the combination of a Bourns® TCS™ High-Speed Protector and a voltage limiting device provides exceptional performance are in VDSL

and Ethernet circuits, where the line is driven differentially by a transformer.

VDSL

In the VDSL application shown below, the transformer provides additional protection against sustained DC faults and the coupling capacitors, C1 and C2, provide protection against DC and mains frequency power faults. The termination resistors

R1 and R2 are reduced in value by the nominal resistance of the Bourns® TCS™ High-Speed Protector to maintain the overall termination resistance.

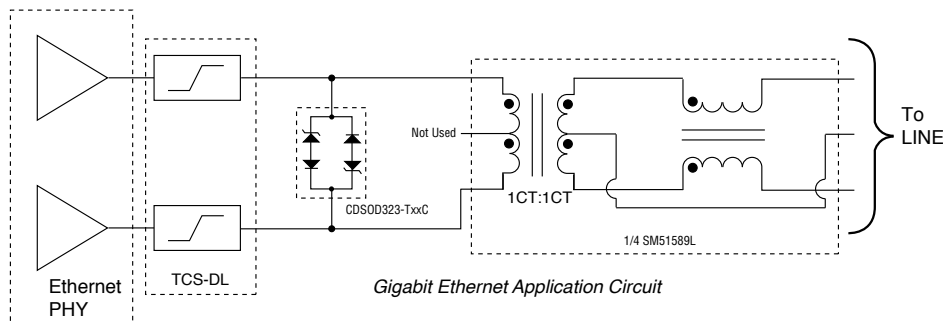


Basic Schematic of a VDSL Line Driver Stage

GbE

In the Gigabit Ethernet (GbE) application circuit shown below, the transformer provides additional protection against sustained DC faults and provides some isolation from surge conditions such as lightning strikes. The TCS™ device limits the current that the PHY will be subjected to under a surge condition. It also provides voltage isolation so that the peak voltage that the

PHY is subjected to will be lower than the TVS diode clamp voltage. The TVS diode will sink the majority of the transformer secondary current and clamp the voltage to a level that is below the 40 V maximum rating of the TCS™ device.



Gigabit Ethernet Application Circuit

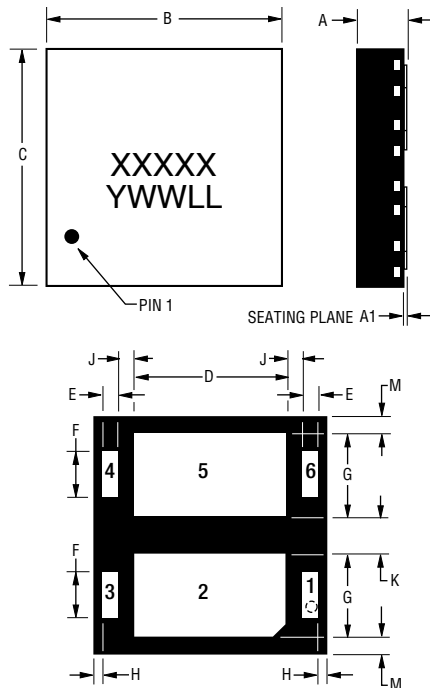
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TCS-DL Series - TCS™ Dual Transient Current Suppressors

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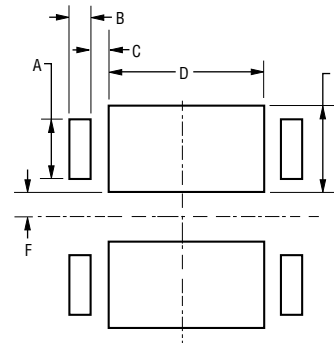
Product Dimensions



Dim.	TCS-DL004-250-WH			TCS-DL004-500-WH			TCS-DL004-750-WH		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80 (.031)	0.90 (.035)	1.00 (.039)	0.80 (.031)	0.90 (.035)	1.00 (.039)	0.80 (.031)	0.90 (.035)	1.00 (.039)
A1	0.00 (.000)	0.025 (.001)	0.05 (.002)	0.00 (.000)	0.025 (.001)	0.05 (.002)	0.00 (.000)	0.025 (.001)	0.05 (.002)
B	2.40 (.094)	2.50 (.098)	2.60 (.102)	3.4 (.134)	3.5 (.138)	3.6 (.142)	4.4 (.173)	4.5 (.177)	4.6 (.181)
C	3.90 (.154)	4.00 (.157)	4.10 (.161)	3.90 (.154)	4.00 (.157)	4.10 (.161)	3.90 (.154)	4.00 (.157)	4.10 (.161)
D	1.05 (.041)	1.10 (.043)	1.15 (.045)	2.05 (.081)	2.10 (.083)	2.15 (.085)	3.05 (.120)	3.10 (.122)	3.15 (.124)
E	0.20 (.008)	0.25 (.010)	0.30 (.012)	0.20 (.008)	0.25 (.010)	0.30 (.012)	0.20 (.008)	0.25 (.010)	0.30 (.012)
F	0.75 (.030)	0.8 (.031)	0.85 (.033)	0.75 (.030)	0.8 (.031)	0.85 (.033)	0.75 (.030)	0.8 (.031)	0.85 (.033)
G	1.40 (.055)	1.45 (.057)	1.50 (.059)	1.40 (.055)	1.45 (.057)	1.50 (.059)	1.40 (.055)	1.45 (.057)	1.50 (.059)
H	0.10 (.004)	0.15 (.006)	0.20 (.008)	0.10 (.004)	0.15 (.006)	0.20 (.008)	0.10 (.004)	0.15 (.006)	0.20 (.008)
J	0.25 (.010)	0.30 (.012)	0.35 (.014)	0.25 (.010)	0.30 (.012)	0.35 (.014)	0.25 (.010)	0.30 (.012)	0.35 (.014)
K	0.55 (.022)	0.60 (.024)	0.65 (.026)	0.55 (.022)	0.60 (.024)	0.65 (.026)	0.55 (.022)	0.60 (.024)	0.65 (.026)
M	0.20 (.008)	0.25 (.010)	0.30 (.012)	0.20 (.008)	0.25 (.010)	0.30 (.012)	0.20 (.008)	0.25 (.010)	0.30 (.012)

DIMENSIONS: $\frac{\text{MM}}{(\text{INCHES})}$

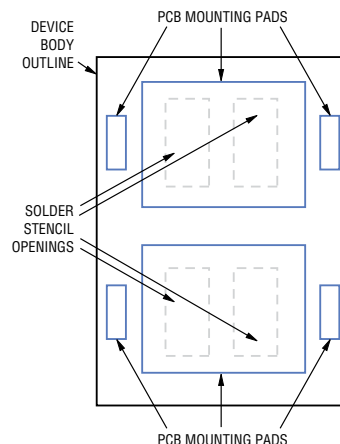
Recommended Pad Layout



Dim.	TCS-DL004-250-WH	TCS-DL004-500-WH	TCS-DL004-750-WH
A	0.80 (.031)	0.80 (.031)	0.80 (.031)
B	0.25 (.010)	0.25 (.010)	0.25 (.010)
C	0.30 (.012)	0.30 (.012)	0.30 (.012)
D	1.1 (.043)	2.1 (.083)	3.1 (.122)
E	1.45 (.057)	1.45 (.057)	1.45 (.057)
F	0.30 (.012)	0.30 (.012)	0.30 (.012)

Pad Designation

Pad #	Apply	Pad #	Apply
1	Line 1 In/Out	4	Line 2 Out/In
2	No Connection	5	No Connection
3	Line 1 Out/In	6	Line 2 In/Out



Bourns® TCS™ High-Speed Protectors have a matte-tin termination. The recommended solder stencil thickness is 0.10 to 0.12 mm (0.004 to 0.005 in.). The stencil opening for pins 1, 3, 4 and 6 should be the same size as the recommended PCB pad size. The stencil openings for pins 2 and 5 of the device should cover 60-70 % of the area of the PCB pad and should be divided into smaller areas as shown in the solder stencil figure.

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TCS-DL Series - TCS™ Dual Transient Current Suppressors

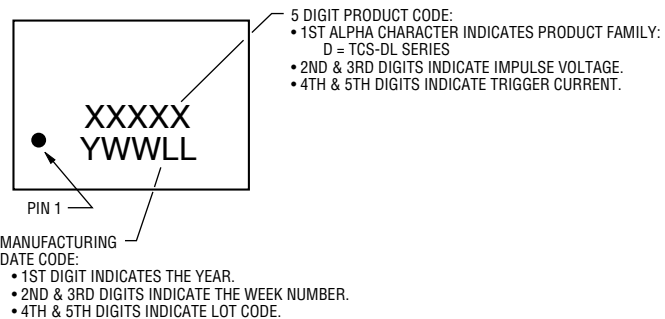
BOURNS®

How to Order

TCS - DL 004 - 500 - WH

TCS™ Product _____
Series _____
 DL = Dual Series
Impulse Voltage Rating _____
 004 = 40 V
Minimum Trigger Current _____
 250 = 250 mA
 500 = 500 mA
 750 = 750 mA
Hold to Trip Ratio Suffix _____
 W = 2:1 Maximum to Minimum Trigger Current Ratio
Package Suffix _____
 H = DFN Package

Typical Part Marking



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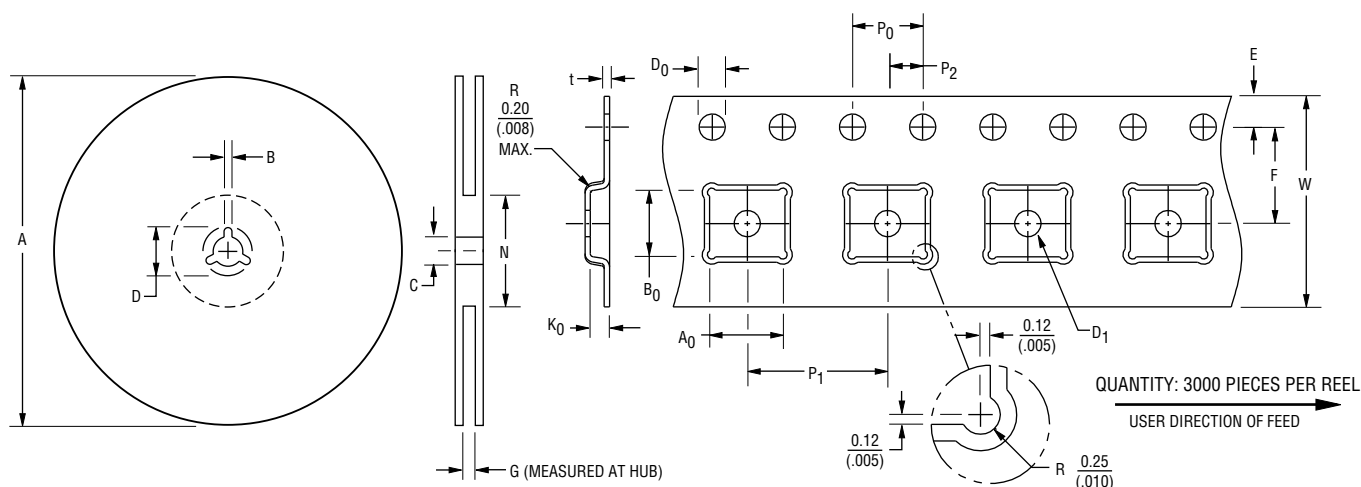
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TCS-DL Series - TCS™ Dual Transient Current Suppressors

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Packaging Specifications



QUANTITY: 3000 PIECES PER REEL
USER DIRECTION OF FEED

A		B		C		D		G	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
326 (12.835)	330 (13.002)	1.5 (.059)	2.5 (.098)	12.8 (.504)	13.5 (.531)	20.2 (.795)	—	12.4 (.488)	14.4 (.567)

N		A ₀		D ₀		D ₁		E	
Ref.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
100 (3.937)		4.20 (.165)	4.40 (.173)	1.50 (.059)	1.60 (.063)	1.50 (.059)	—	1.65 (.065)	1.85 (.073)

F		K ₀		P ₀		P ₁		P ₂	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
5.45 (.215)	5.55 (.219)	1.00 (.039)	1.20 (.047)	3.90 (.154)	4.10 (.161)	7.90 (.311)	8.10 (.319)	1.95 (.077)	2.05 (.081)

t		W	
Min.	Max.	Min.	Max.
0.25 (.010)	0.35 (.014)	11.70 (.461)	12.30 (.484)

DIMENSIONS: $\frac{\text{MM}}{\text{(INCHES)}}$

TCS-DL004-250-WH		TCS-DL004-500-WH		TCS-DL004-750-WH	
B ₀					
Min.	Max.	Min.	Max.	Min.	Max.
2.70 (.106)	2.90 (.114)	3.70 (.146)	3.90 (.154)	4.70 (.185)	4.90 (.193)

REV. 02/17

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