



## APPLICATION NOTE 398

# T3/E3/STS-1 LIU Secondary Surge Protection Design

*Abstract: Application note 398 is a design guide that has all the information necessary for a designer to build a network interface circuit for a piece of telecommunications equipment using Dallas Semiconductor T3, E3, or STS-1 line interface units (LIUs). The network interface is the part of the system that connects to other telecommunications equipment through coaxial cable. The main focus is on inter-building connections which require overvoltage/overcurrent protection. Protection is often needed in telecommunications circuits to prevent damage from lightning strikes or power line cross events. The application note begins with a general overview of the protected network interface and a listing of the various specification test procedures. This is followed by an example circuit for metallic protection along with the component selection guide. Because the outer conductor of the transmission line is grounded, it is only necessary to provide a solution for metallic type surges. This design guide will enable the designer to meet the stringent specifications required when designing the network interface for telecommunications equipment.*

## Introduction to Protection Circuits

T3, E3, and STS-1 lines are used primarily in intra-building applications to connect one piece of equipment to another. Although the potential dangers from lightning strike and power-line cross are inherently less for intra-building lines than for externally-run lines (such as T1), various telecom standards organizations have established surge protection requirements for intra-building lines. For line interface designs to meet these requirements, protection networks must be used to direct high voltages and currents away from sensitive low-voltage CMOS devices.

Surge protection networks are divided into two categories: primary and secondary. Primary protection is usually provided by gas discharge tubes or carbon blocks located at the point where the line enters the premises. Since primary protection only limits voltage surges to  $1000V_{PEAK}$  and power line cross to  $600V_{RMS}$ , secondary voltage protection is also necessary. Secondary protection provides additional voltage and current limiting to protect the LIU from damage.

Longitudinal (common mode) surge types are from tip to ground or from ring to ground, while metallic (differential) surge types are between tip and ring. Longitudinal surges are formed on the tip and ring conductors by lightning currents that enter the conductive shield of the cable. Because the outer conductor in T3/E3/STS-1 cables is grounded, it is only necessary to protect against metallic surges.

## Recommended Protection Circuit

**Figure 1** is Dallas Semiconductor's recommended metallic surge-suppression circuit for intra-building T3/E3/STS-1 applications. This circuit is designed to comply with the requirements listed in Table 1.

**Table 1. Applicable intra-building protection requirements**

TEST	VOLTAGE	CURRENT (Amp)	DURATION
<b>Telecordia GR-1089-CORE</b>			
Lightning Surge Test	800V <sub>PEAK</sub>	100	2 x 10µs
AC Power Test	120V <sub>RMS</sub> 60Hz	25	15 minutes
<b>UL 60950 (formerly UL 1950)</b>			
AC Power Test	600V <sub>RMS</sub> 60 Hz	40	5 seconds
AC Power Test	600V <sub>RMS</sub> 60 Hz	7	5 seconds
AC Power Test	600V <sub>RMS</sub> 60 Hz	2.2	30 minutes
<b>ITU-T K.20</b>			
Lightning Surge Test	1000V <sub>PEAK</sub>	25	10 x 700µs
AC Power Test	600V <sub>RMS</sub>	2	200ms
<b>ITU-T K.21</b>			
Lightning Surge Test	1000V <sub>PEAK</sub>	25	10 x 700µs
AC Power Test	600V <sub>RMS</sub>	2	200ms
AC Power Test	230V <sub>RMS</sub>	23	15 minutes
AC Power Test	230V <sub>RMS</sub>	1.15	15 minutes
AC Power Test	230V <sub>RMS</sub>	0.38	15 minutes
<b>TIA/EIA-IS-968 (formerly FCC Part 68)</b>			
Lightning Surge Test	800V <sub>PEAK</sub>	100	10 x 560µs
Lightning Surge Test	1000V <sub>PEAK</sub>	25	9 x 720µs

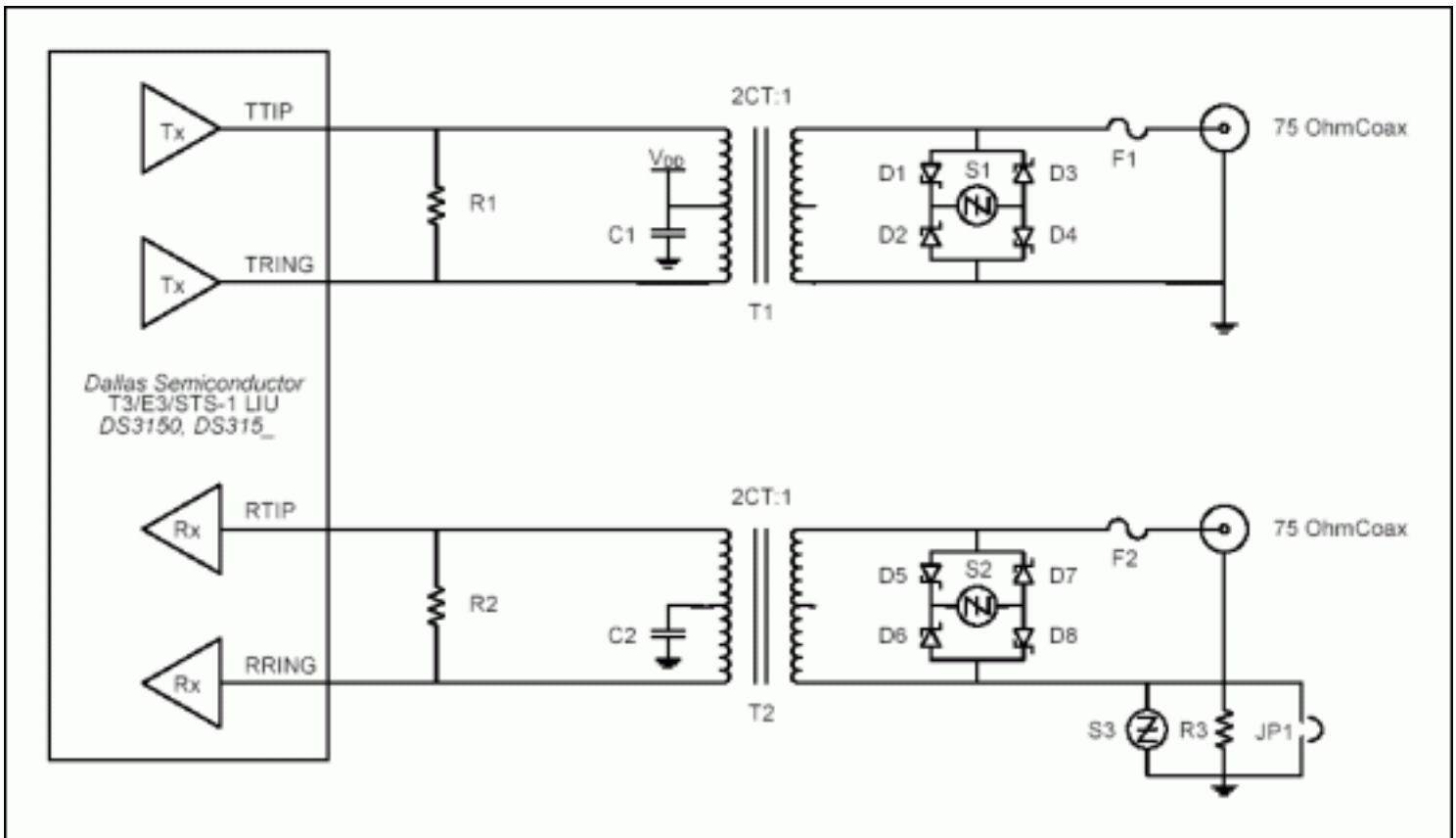


Figure 1. Recommended metallic surge-protection circuit for T3/E3/STS-1.

- Note 1:** The layout from the transformers to the network interface is critical. Traces should be at least 25mils wide and separated from other circuit lines by at least 150mils.
- Note 2:** The trace impedance from the transformer to the device and the transformer to the network connectors should be matched to the line impedance of either 75Ω or 300Ω.

The three main components used for protection are the fuse, the thyristor, and the diodes. The fuse protects the transformer against high-current conditions such as power-line cross. Typical fuses have a surge current rating above 100A for the different surge profiles. The fuses in Table 2 pass the 2 x 10μs, 10 x 160μs, 10 x 560μs, and 10 x 1000μs surges without opening. The thyristor is a solid state crowbar device that changes from an open circuit to a short circuit condition when the voltage across the device exceeds the switching voltage. The thyristor remains in the short circuit state until the current flowing through the device falls below a set holding current. In the short circuit state, excess current is routed to ground, thus stopping it from damaging the LIU device. The thyristor cannot be connected directly between tip and ring because its capacitance is large enough to distort the T3/E3/STS-1 signal. The diodes remove the thyristor capacitance from the tip/ring differential pair while still allowing the thyristor to perform its crowbar function.

**Table 2. Recommended protection components**

COMPONENT	DESCRIPTION	PART	SUPPLIER	NOTES
D1-D8	Ultrafast Power Rectifier	MURS160T3	On Semiconductor	Surface-mount
		MUR1100E	On Semiconductor	Through-hole
F1, F2	1.25A slow blow fuse	SMP 1.25	Bel Fuse	
	1.25A slow blow fuse	F1250T	Teccor Electronics	
C1, C2	0.05 $\mu$ F, 5% Tol, 10V		Kemet	
R1, R2	330 $\Omega$ , 1% Tol, 1/8W		Vishay	
R3	50 $\Omega$ , 1% Tol, 1/8W		Vishay	
S1, S2	77V max transient suppressor	P0640SC MC	Teccor Electronics	
S3	6V max transient suppressor	P0080SC MC	Teccor Electronics	
T1, T2	Transformer 1:2CT	PE-65968	Pulse Engineering	Surface-mount
		PE-65969	Pulse Engineering	Through-hole
		TG07-0206NE	Halo Electronics	Surface-mount
		TD07-0206NE	Halo Electronics	Through-hole

**Suppliers List**

SUPPLIER	PHONE	FAX	WEBSITE
Bel Fuse, Inc.	(201) 432 - 0463	(201) 432 - 9542	<a href="http://www.belfuse.com">www.belfuse.com</a>
Halo Electronics, Inc.	(650) 903 - 3800	(650) 903 - 9300	<a href="http://www.haloelectronics.com">www.haloelectronics.com</a>
Pulse Engineering, Inc.	(858) 674 - 8100	(858) 674 - 8262	<a href="http://www.pulseeng.com">www.pulseeng.com</a>
Teccor Electronics	(972) 580 - 7777	(972) 550 - 1309	<a href="http://www.teccor.com">www.teccor.com</a>

Application Note 398: <http://www.maxim-ic.com/an398>

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