Application Note 398
T3/E3/STS-1 LIU Secondary Surge Protection Design

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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

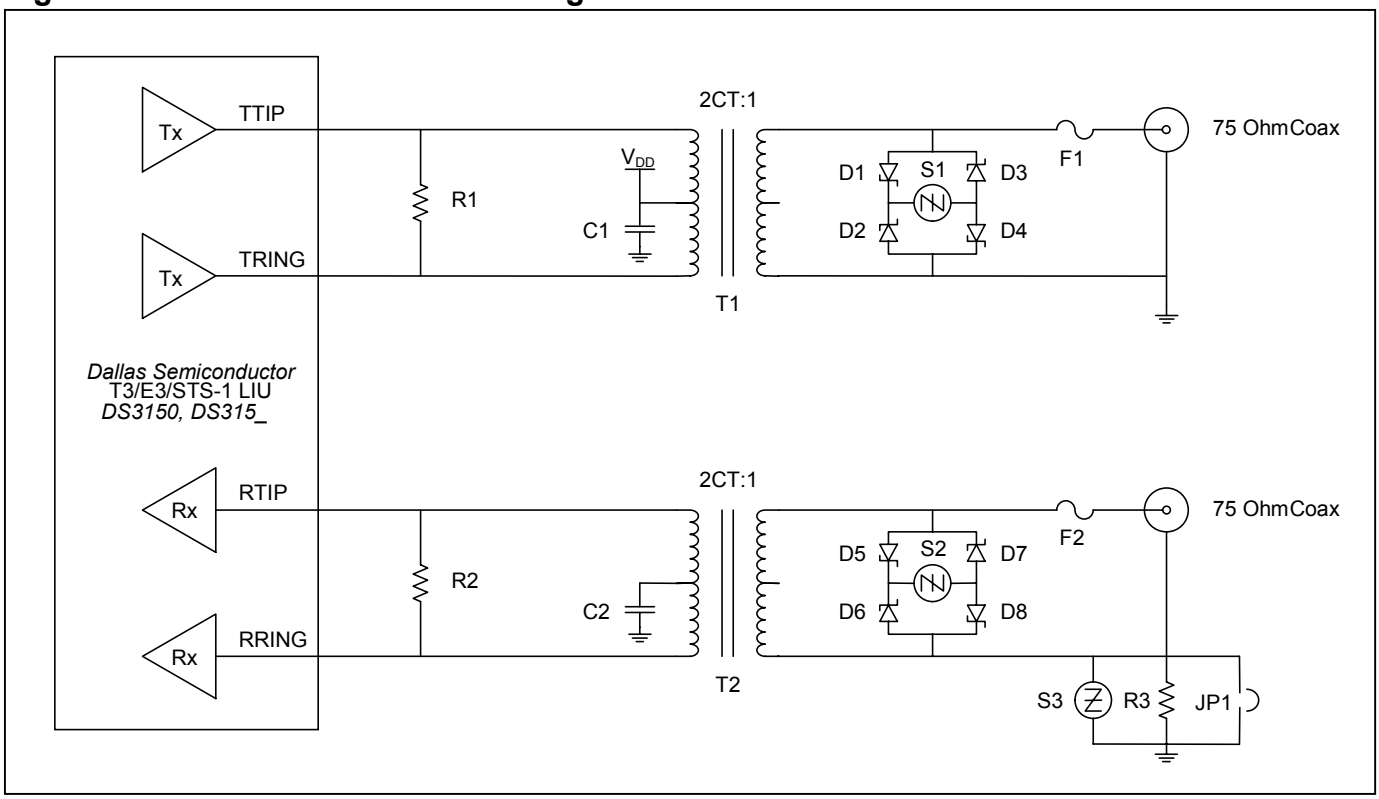
Figure 1 is Dallas Semiconductor's recommended metallic surge-suppression circuit for intra-building T3/E3/STS-1 applications. This circuit is designed to comply with the requirements listed in Table 1.

Table 1. Applicable Intra-Building Protection Requirements

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

REV: 030403

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	0.05µF, 5% Tol, 10V		Kemet	
R1, R2	330Ω, 1% Tol, 1/8W		Vishay	
R3	50Ω, 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	www.belfuse.com
Halo Electonics, Inc.	(650) 903 - 3800	(650) 903 - 9300	www.haloeletronics.com
Pulse Engineering, Inc.	(858) 674 - 8100	(858) 674 - 8262	www.pulseeng.com
Teccor Electronics	(972) 580 - 7777	(972) 550 - 1309	www.teccor.com