INTRODUCTION

Physical layer devices, such as DS-1/E1 LIU (Line Interface Units) and Framer Combo devices with integrated LIU, are responsible for the interconnection between network elements. These devices, which interface to telecommunication lines are exposed to over voltage transients posed by environmental threats. An over voltage transient is a pulse of energy concentrated over a small period of time, usually under a few milliseconds. These pulses are random and exceed the operating conditions of CMOS transceiver ICs. Electronic equipment connecting to data lines are susceptible to many forms of over voltage transients such as, lightning, AC power faults and electrostatic discharge (ESD).

LIGHTNING

Lightning is the most common cause of transients to telecommunications systems. When an electric field between a cloud and the ground reaches a certain voltage, the air molecules ionize along a narrow path and air becomes a conductor. This allows a free flow of charge between the cloud and the ground. Around the world, there are approximately 2,000 thunderstorms at any given moment and approximately 100 lightning strikes every second. There are two types of tests performed to evaluate a telecommunication system's ability to withstand first and second level lightning strikes, Metallic (lightning strike potential between Tip and Ring) and Longitudinal (lightning strike potential between Tip/Ring and Ground). Longitudinal is the most common occurrence with lightning induced overstresses. See Figure 1 for a simplified block diagram of the metallic and longitudinal modes.

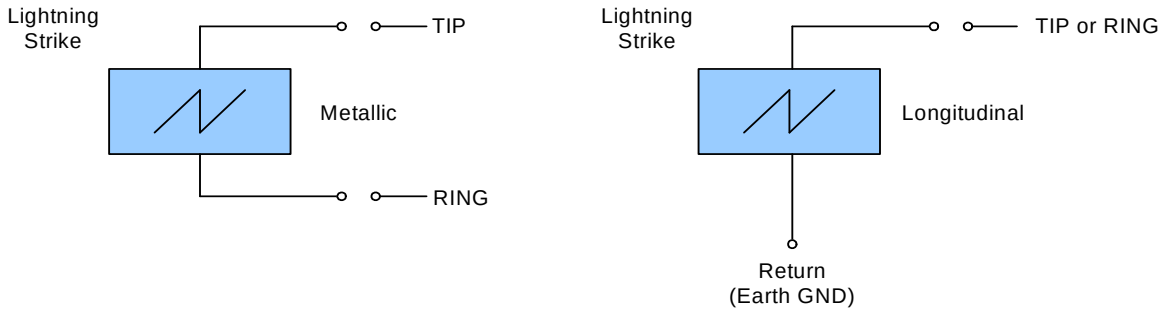

Figure 1. Metallic and Longitudinal Modes

REFERENCE SCHEMATIC

In order for CMOS ICs to pass GR 1089-CORE Lightning Surge Tests, they must be designed with proven surge components as outlined in this application note. Figures 2 and 3 are reference schematics used for EXAR DS-1/E1 physical layer devices to comply with Telecom and Surge requirements. These reference designs are equipped with suggested configurations for Intra (short-haul) and Inter (long-haul) Building protection. Component part numbers and their manufacturers are given in Tables 1 and 2.

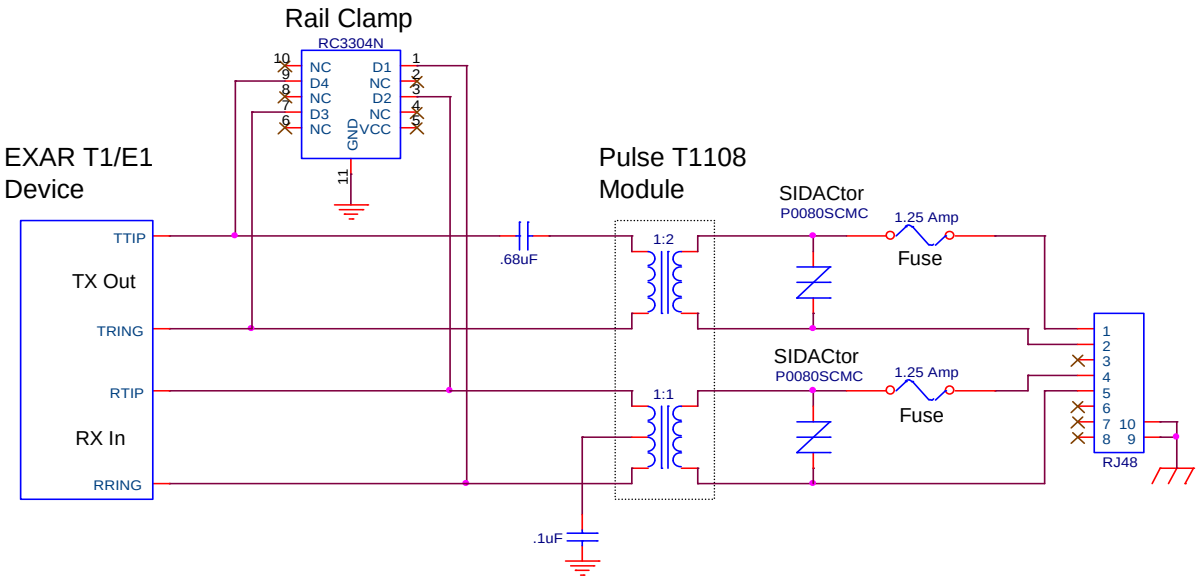

Figure 2. Reference Schematic for GR-1089 Protection – Applications Without Power Feed on Twisted Pair

Component	Part Number	Manufacturer
Fuse	04611.25 (1.25 Amp)	Littelfuse, Inc.
SIDACtor	P0080SCMC	Littelfuse, Inc.
Rail Clamp	RClamp3304N	Semtech Corp.

Table 1. Surge Protection Components – Applications Without Power Feed on Twisted Pair

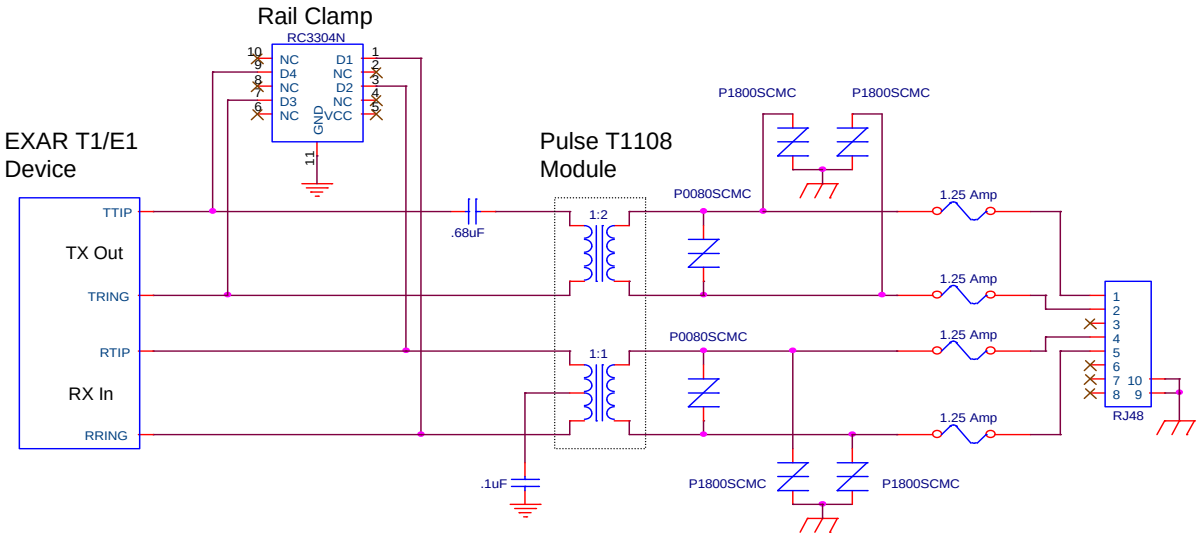

Figure 3. Reference Schematic for GR-1089 Protection – Inter-Building Applications With Power Feed on Twisted Pair

Component	Part Number	Manufacturer
Fuse	04611.25 (1.25 Amp)	Littelfuse, Inc.
SIDACtor	P0080SCMC	Littelfuse, Inc.
SIDACtor	P1800SCMC	Littelfuse, Inc.
Rail Clamp	RClamp3304N	Semtech Corp.

Table 2. Surge Protection Components - Inter-Building Applications With Power Feed on Twisted Pair

The tests listed in Table 3 verify compliance with the GR 1089-CORE Intra-Building Lightning Surge requirements.

Test	Surge Voltage (Peak)	Waveform (µS)	Surge Current (Amp)	Repetitions (Each Polarity)
TX and RX Metallic Surge (Tip to Ring)	+/- 800 V	2x10	100	1
Longitudinal Surge (All 4 TX, RX Tip and Ring Leads to Ground)	+/- 1500 V	2x10	100	1

Table 3. Intra-Building Lightning Surge Tests

The tests listed in Table 4 verify compliance with the GR 1089-CORE Inter-Building Lightning Surge requirements.

Test	Surge Voltage (Peak)	Waveform (µS)	Surge Current (Amp)	Repetitions (Each Polarity)
TX and RX Metallic Surge (Tip to Ring)	+/- 1000 V	10x1000	100	25
Longitudinal Surge (All 4 TX, RX Tip and Ring Leads to Ground)	+/- 2500 V	2x10	500	25
Longitudinal Surge (All 4 TX, RX Tip and Ring Leads to Ground)	+/- 1000 V	10x1000	100	25

Table 4. Inter-Building Lightning Surge Tests

The tests listed in Table 5 verify compliance with GR 1089-Core First Level AC Power Fault requirements.

Test	Applied Voltage 60 Hz (V_{RMS})	Short Circuit Current (Amp)	Duration	Number of Repetitions
TX and RX Metallic Surge (Tip to Ring)	600	1.2	1 Second	60
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	1.2	1 Second	60
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	1.2	1 Second	60
TX and RX Metallic Surge (Tip to Ring)	600	2.2	2 Seconds	1
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	2.2	2 Seconds	1
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	2.2	2 Seconds	1
TX and RX Metallic Surge (Tip to Ring)	600	3.0	1 Second	1
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	3.0	1 Second	1
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	3.0	1 Second	1

Table 5. First Level AC Power Fault Tests

Note: The fuse must not open and system must be operational after these tests.

The tests listed in Table 6 verify compliance with GR 1089-Core Second Level AC Power fault requirements.

Test	Applied Voltage 60 Hz (V_{RMS})	Short Circuit Current (Amp)	Duration	Number of Repetitions
TX and RX Metallic Surge (Tip to Ring)	600	7	5 Seconds	1
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	7	5 Seconds	1
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	7	5 Seconds	1
TX and RX Metallic Surge (Tip to Ring)	600	2.2	15 Minutes	1
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	2.2	15 Minutes	1
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	2.2	15 Minutes	1
TX and RX Metallic Surge (Tip to Ring)	600	60	5 Seconds	1
Longitudinal Surge (2 TX Tip and Ring Leads to Ground)	600	60	5 Seconds	1
Longitudinal Surge (2 RX Tip and Ring Leads to Ground)	600	60	5 Seconds	1

Table 6. Second Level AC Power Fault Tests

Note: The fuse may open, and the system does not have to be operational after these tests. However, the system must not create a fire, fragmentation, or an electrical safety hazard.