

**PROTECTION PRODUCTS**

**TRANSIENT IMMUNITY STANDARDS : BELLCORE  
 TR-NWT-001089 & FCC PART 68**

Over the years, telephone companies have become aware of the problem that lightning induced transients can cause to equipment which is connected to their networks. Therefore, telephone companies require equipment that they purchase undergo testing which emulates the worst case conditions that it can be expected to encounter in the field. The major transient immunity standards which apply to T1 equipment in the United States are Bellcore's TR-NWT-001089 "Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunication Equipment" and the Federal Communications Commission's FCC Part 68 "Connection of Terminal Equipment to the Telephone Network". FCC Part 68 establishes requirements to insure equipment will not harm the public network to which it is connected. Bellcore TR-NWT-001089 presents guidelines that Regional Bell Operating Companies may require for equipment they purchase or allow customers to connect to their networks. The requirements in TR-NWT-001089 are similar but not identical to those found in FCC Part 68. This article will focus primarily on the lightning surge immunity requirements of each of these standards.

**BELLCORE TR-NWT-001089**

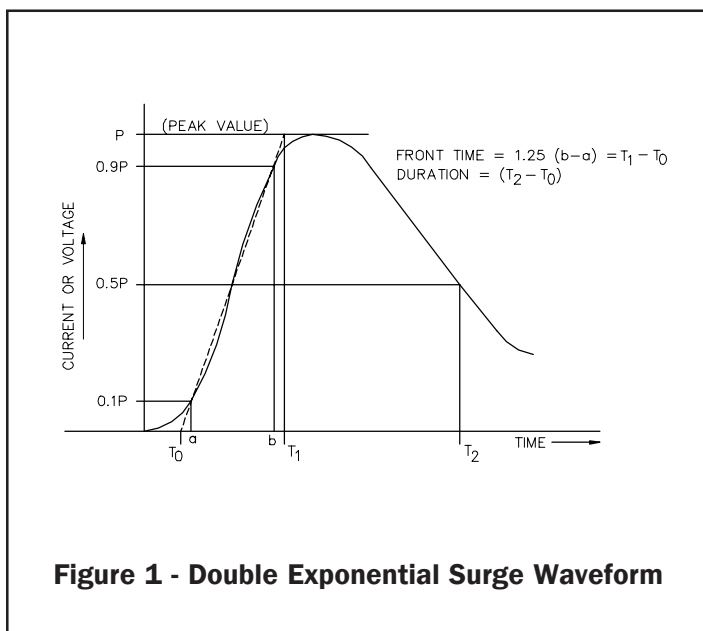
Bellcore technical reference TR-NWT-001089 contains requirements for both inside and outside plant network equipment and customer premises equipment which

will be used in a Regional Bell Operating Company Network. Bellcore TR-NWT-001089 classifies equipment into one of four type categories based upon the nature of its connection to the network and intended operating environment.

**Lightning Immunity**

TR-NWT-001089 specifies lightning immunity tests for equipment which is installed either on inside lines only or outside lines. These tests are the result of 30 years of field studies measuring actual lightning events in the United States. The studies found that lightning strikes in close proximity produced the fastest rise times, while distant strikes produced slower, longer lasting strikes. The actual shape of the waveforms also varied but Bellcore settled on a double exponential waveform as being representative of lightning surges. The double exponential surge waveform is shown in Figure 1. A double exponential waveform is defined as having an exponential rate of rise to the peak and an exponential decay from that peak. Table 1 and Table 2 summarize the surges which Bellcore defines as the envelope of lightning events which can be expected at the network interface. For long duration events, the 10 x 1000µs wave shape is chosen. For short duration events, the 2 x 10µs waveform is used.

The surges are applied in two stages. First, equipment designed to connect to outside lines are subject to the



**Figure 1 - Double Exponential Surge Waveform**

Surge	Min. Voltage* [Vpk]	Rise/Decay Time µs	Min. Current [A]	Repetitions Each Polarity
1. L,M	600	10/1000	100	25
2. L,M	1000	10/360	100	25
3. L,M	1000	10/1000	100	25
4. L	2500	2/10	500	10
5. L	1000	10/360	25	5

Notes:

1. L = Longitudinal Mode, M - Metallic Mode
2. Surge 3 is optional in place of Surges 1 and 2.
3. These tests are repeated at a voltage just below the operating threshold of any secondary protectors. Primary protectors removed.
4. Primary protectors removed.

**Table 1 - TR-NWT-001089 First Level Lightning Surges**

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Surge	Min. Voltage* [Vpk]	Rise/Decay Time $\mu$ s	Min. Current [A]	Repetitions Each Polarity
1. L	5000	2/10	500	1

Notes:

1. L = Longitudinal Mode
2. Primary protectors removed.
3. Repeated at a voltage just below the operating threshold of any secondary voltage limiting device.

**Table 2 - TR-NWT-001089 Second Level Lightning Surges**

first level metallic and longitudinal surges summarized in Table 1. After these tests the equipment must function correctly. Upon completion of the first level test, the second level longitudinal surge test in Table 2 is conducted. After this test, the equipment may be damaged but must not become a fire, fragmentation, or safety hazard. Even equipment which has no connections external to the building is tested. The Bellcore defined series of surges for equipment interfaces used for inter-building connections is shown in Table 3. For these tests the 2 x 10 $\mu$ s waveform is applied.

### FCC PART 68

FCC Part 68 registration is required for all customer premises telecommunications equipment which connects to the public network. Unlike Bellcore TR-NWT-001089, FCC Part 68 requirements do not focus on insuring that the equipment itself will not become a fire or safety hazard, but instead focuses on protecting the network from damage which may occur due to poorly designed equipment. Part 68 establishes test guidelines on hazardous voltages and currents, signal power levels, line balance, and billing protection. These requirements must be met before and after environmental stress testing.

Table 4 summarizes the FCC Part 68 lightning surge requirements applicable to telecommunication equipment which will be interfaced to outside lines. The surge waveform specified is the double exponential specified in the Bellcore specification. The first is a 800V 10 x 560 $\mu$ s pulse applied in a metallic configuration. The second is a 1500V 10 x 160 $\mu$ s pulse applied in longitudinal configuration. For AC powered equipment, additional surges are specified between the line

Surge	Min. Voltage* [Vpk]	Rise/Decay Time $\mu$ s	Min. Current [A]	Repetitions Each Polarity
1. M	800	2/10	100	1
2. L	1500	2/10	100	1

Notes:

1. L = Longitudinal Mode, M - Metallic Mode
2. Primary protectors removed.
3. Repeated at a voltage just below the operating threshold of any secondary voltage limiting device.

**Table 3 - TR-NWT-001089 Intra-Building Lightning Surges**

Surge	Min. Voltage* [Vpk]	Rise/Decay Time $\mu$ s	Min. Current [A]	Repetitions Each Polarity
1. L	800	10/560	100	2
2. M	1500	10/160	200	2

Notes:

1. L = Longitudinal Mode, M = Metallic Mode
2. Primary protectors removed.

**Table 4 - FCC Part 68 Lightning Surges**

and neutral connections of the AC line.

### CONCLUSION

During its operational lifetime, telecommunication equipment will be exposed to a variety of threats including lightning surges. Bellcore TR-NWT-001089 and FCC Part 68 are but two of the standards which attempt to define the worst case lightning threats. Good equipment design should provide secondary surge protection to insure reliable protection in all environments.

References:

1. Stearman, Greg; Stillings, Larry; Taylor, Roger; "Secondary Line Protection for T1 and E1 Line Cards", Crystal Semiconductor Corporation Application Note AN34REV1, September, 1994.
2. Curtis, Jon; "Meeting Bellcore's TR-NWT-001089 Surge Requirements", Compliance Engineering, Summer 1993.