7 Regulatory Requirements

Due to the enormous cost of interrupted service and failed network equipment, telephony service providers have adopted various specifications to help regulate the reliability and performance of the telecommunications products that they purchase. In Europe and much of the Far East, the most common standards are ITU-T K.20 and K.21. In North America, most operating companies base their requirements on GR 1089, TIA-968-A (formerly known as FCC Part 68), and UL 60950.

Note: This section is a paraphrase of existing documents and does not cover the listed regulatory requirements in their entirety. This information is intended to be used only as a reference. For exact specifications, obtain the referenced document from the appropriate source.

GR 1089–Core

In the United States, the telecommunication network is primarily operated by the Regional Bell Operating Companies (RBOC) who follow the standards set by GR 1089 or a derivative thereof. GR 1089–Core (often referred to as GR 1089), “Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunications Equipment,” covers the requirements for telecommunications equipment connected to the outside world through twisted pair. It also addresses the criteria for protection from lightning and AC power fault disturbances.

Because twisted pair are metallic conductors exposed to lightning and AC power faults, GR 1089 documents the requirements to be met by manufacturers of public switched telephone network (PSTN) equipment to ensure safe and reliable operation.

The criteria for these standards are based on transient conditions at exposed sites, such as remote facilities, central offices, and customers’ premises where operating companies provide some type of primary voltage protection to limit transient voltages to 1000 V peak for surge conditions and 600 V rms for power fault conditions.

All network equipment shall be listed by a Nationally Recognized Testing Laboratory (NRTL) if the equipment is directly powered by Commercial AC. Network equipment located on customer premises shall be listed by NRTL.

In conjunction with primary voltage protectors, operating companies also may incorporate fuse links if there is the possibility of exposing the twisted pair to outside power lines. These fuse links are equivalent to 24- or 26-gauge copper wire and are coordinated with the current-carrying capacity of the voltage protector.

The last element of protection that may be provided by the operating company are current limiters which, if provided, are found on the line side of the network equipment after the primary voltage protection device. These current limiters typically come in the form of heat coils and have a continuous rating of 350 mA.

Requirements

Equipment required to meet GR 1089 must be designed to pass:

- Both First and Second Level Lightning Surge and AC Power Fault Tests
- Current Limiter Test
- Short Circuit Test

Also, changes to Chapter 4 of the GR 1089 in October 2002 now require conformance with additional definitions and tests:

- Ethernet (including 10BaseT, 100BaseT, and 1000BaseT) are considered telecommunications lines and GR 1089 requirements apply.
- The 2x10 surge is not used for systems having primary protectors mounted on the side of the enclosure or within the enclosure. It also is not used if the length of the conductors between the primary protector and the circuit pack is less than one meter **if** a metallic enclosure is used and all terminals are bonded to the enclosure and the longest dimension of the enclosure is less than three meters.
- The 600 V and 1000 V 100 A 10x1000 surge events voltage level may be reduced for CO equipment using solid state protectors.

- The secondary protector must coordinate with the primary protector OR have a 100 A 10x1000 rating. This requirement becomes effective January 2006; until then it is only an objective.
- First level power fault adds a 440 V 2.2 A two-second test and a 600 V 3 A 1.1-second test.
- Second level testing allows the wiring simulator fuse to be either the MDL 2 A or the MDQ 1.6 A. The second level requirement is the same for either the CPE or non-CPE. Additional 15-minute test conditions of 3 A, 3.75 A, 5 A, 10 A, 12.5 A, 20 A, and 30 A conditions have been added. However, compliance with UL 60950 Annex NAC conditions 3, 4, and 5 are still accepted. The 2 A and 2.6 A tests are conducted without the simulator fuse. However, it must meet applicable time-current curve.

A minimum of three units are tested for each of the operating states in which the Equipment Under Test (EUT) may be expected to function—idle, transmit, receive, on-hook, off-hook, talking, dialing, ringing, and testing. Table 7.1 and Table 7.2 show test connections, and Figure 7.1 shows the connection appearances.

Table 7.1 Test Conditions

Test	Two-wire Interface	Four-wire Interface
A	1. Tip to Generator, Ring to Ground 2. Ring to Generator, Tip to Ground 3. Tip and Ring to Generator simultaneously	1. Each lead (T, R, T_1, R_1) to the Generator with the other three leads grounded 2. Tip and Ring to Generator, simultaneously; T_1 and R_1 to Ground 3. T_1 and R_1 to Generator, simultaneously; Tip and Ring to Ground
B	Tip and Ring to Generator simultaneously	T, R, T_1, R_1 to Generator simultaneously

Notes:
- When performing longitudinal tests, the test generator will have a dual output.
- Refer to Table 7.2 for switch positions for each test condition.

Table 7.2 Connections to Test Generator

Condition	S1	S2	S3	S4
Condition A-1 of Table 7.1	Closed	Open	Open	Closed
Condition A-2 of Table 7.1	Open	Closed	Closed	Open
Condition A-3 of Table 7.1	Closed	Open	Closed	Open

Note: Other outside plant leads associated with the unit should be grounded during the test and the test repeated with these leads terminated as in service. Leads that do not connect to outside plant should be terminated as appropriate for the operating mode(s) of the unit.

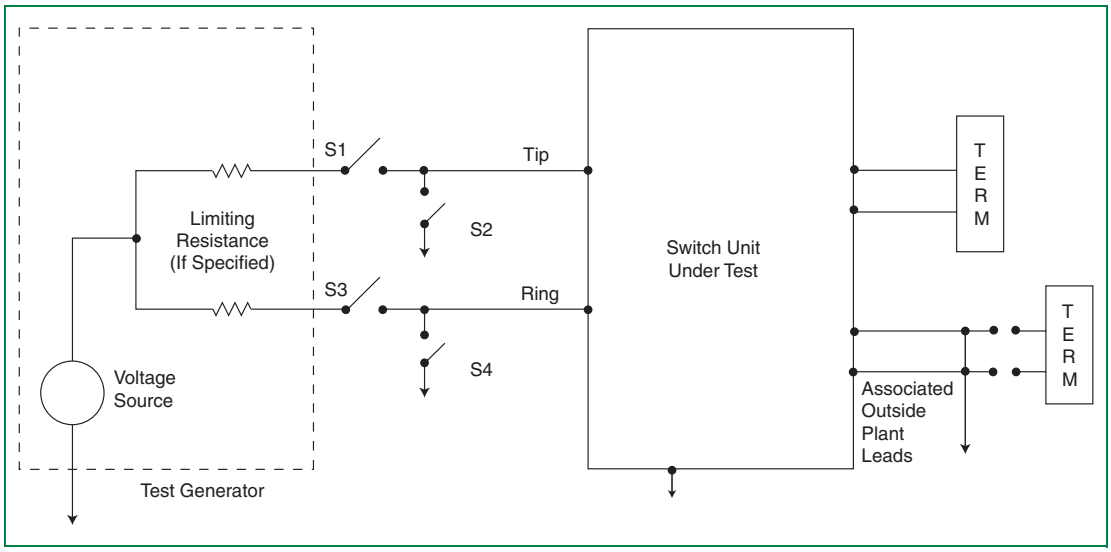


Figure 7.1 Connection Appearances

Passing Criteria

Passing criteria for the First Level Lightning Surge Test and the First Level AC Power Fault Test is that the EUT will not be damaged and that it will operate as intended after the stress is removed. Passing criteria for the Second Level Lightning Surge Test and Second Level AC Power Fault Test is that the EUT may be damaged, but it may not become a fire, fragmentation, or electrical safety hazard. Passing criteria for the Current Limiter Test is that the EUT may be damaged but it may not exceed the acceptable time/current criteria (that is, cannot cause the wiring simulator as shown in Figure 7.2 to open) nor become a fire, fragmentation, or electrical safety hazard.

The indicator used in measuring fire, fragmentation, and electrical safety hazards is a bleached, untreated cotton cheesecloth wrapped around the EUT. Compliance with testing is determined by the absence of ignition, charring, and the ejection of molten material or fragments.

It is recommended that equipment containing secondary protection do one of the following:

- Coordinate with the primary protection that is provided by the telecommunication service provider
- Have a surge withstand capability of 100 A for a 10x1000 µs surge event

Littelfuse's C-, D-, and E-rated *SIDACtor*® devices and *Greentube™* gas plasma arresters meet or exceed this surge rating. If this type of robust secondary protection is not used, then a coordination test must be applied to demonstrate compliance. (Table 7.3)

Table 7.3 Protection Coordination Lightning Surge Test

Peak Voltage V	Peak Current A	Waveform µs	Repetitions
400–2000	100 A at 1 kV	10x1000	10

Refer to the equipment supplier documentation for specifications on the primary protection with which the equipment is designed to coordinate. The maximum switching voltage threshold value for this primary protector must comply with GR 974 (1 kV for a 1 kV/µs event). This coordination test procedure requires that the peak voltage of this test start at the primary protector's specified voltage-limiting value. This value must be a minimum of 400 V and a maximum of 1000 V. The primary protector must effectively turn on during each of these conditions

First Level Lightning Surge Test

To pass the First Level Lightning Surge Test, the EUT must be undamaged and continue to operate properly after the stress is applied. This is referred to as passing "operationally." Table 7.4 presents the conditions for the First Level inter-building criteria. Applicants have the option to submit their equipment to meet surges 1, 2, 4, and 5 or surges 3, 4, and 5. Table 7.5 presents the conditions for the intra-building criteria.

Table 7.4 First Level Lightning Surge Test

Test (Notes 1 & 2)	Surge Voltage (V_{PK})	Waveform (µs)	Surge Current per Conductor (A)	Repetitions Each Polarity	Test Connections (Table 7.1, Figure 7.1)
1	±600	10x1000	100	25	A
2 (Note 3)	±1000	10x360	100	25	A
3 (Note 3)	±1000	10x1000	100	25	A
4 (Note 4)	±2500	2x10	500	10	B
5 (Note 5)	±1000	10x360	25	5	B

Notes:
1. Primary protectors are removed for all tests.
2. For EUT containing secondary voltage limiting and current limiting protectors, tests are to be performed at the indicated voltage(s) and repeated at a reduced voltage and current just below the operating threshold of the secondary protectors.
3. Test 1 and 2 can be replaced with Test 3 or vice versa.
4. Alternatively, a surge generator of 1.2x50 µs open-circuit voltage waveform (8x20 µs short-circuit current waveform) per IEEE C62.41 may be used. The current shall be limited by the inclusion of a series 3 Ω resistor placed externally to the surge generator.
5. This test is to be performed on up to 12 Tip and Ring pairs simultaneously.

Table 7.5 Intra-building Lightning Surge Test

Test	Surge Voltage (V_{PK})	Wave-form (µs)	Surge Current per Conductor (A)	Repetitions Each Polarity	Test Connections (Table 7.1, Figure 7.1)
1	±800	2x10	100	1	A1, A2
2	±1500	2x10	100	1	B

Notes:
- For EUT containing secondary voltage limiting and current limiting protectors, tests are to be performed at the indicated voltage(s) and repeated at a reduced voltage and current just below the operating threshold of the secondary protectors.
- Alternatively, a surge generator of 1.2x50 µs open-circuit voltage waveform (8x20 µs short-circuit current waveform) per IEEE C62.41 may be used. The current shall be limited by the inclusion of a series 6 Ω resistor for Test 1 and a 12 Ω resistor for Test 2, placed externally to the surge generator.

Second Level Lightning Surge Test

The Second Level Lightning Surge Test, presented in Table 7.6, does not require the EUT to pass operationally, but GR 1089 does require that the EUT not become a fire, fragmentation, or electrical safety hazard. This is referred to as passing “non-operationally.”

Table 7.6 Second Level Lightning Surge Test

Test	Surge Voltage (V_{PK})	Waveform (µs)	Surge Current (A)	Repetitions Each Polarity	Test Connections (Table 7.1, Figure 7.1)
1	±5000	2x10	500	1	B

Notes:
- Primary protectors are removed.
- For EUT containing secondary voltage limiting and current limiting protectors, tests are to be performed at the indicated voltage(s) and repeated at a reduced voltage and current just below the operating threshold of the secondary protectors.
- Alternatively, a surge generator of 1.2x50 µs open-circuit voltage waveform (8x20 µs short-circuit current waveform) per IEEE C62.41 may be used. The current shall be limited by the inclusion of a series 8 Ω resistor placed externally to the surge generator.

AC Power Fault Tests

Power companies and telephone operating companies often share telephone poles and trenches; therefore, network equipment is often subjected to the voltages seen on power lines. If direct contact between the telephone line and the primary power line occurs, the operating company’s network equipment may see as much as 600 V rms for five seconds, by which time the power company’s power system should clear itself. If direct contact occurs with the secondary power line, voltages will be limited to 277 V rms; however, these voltages may be seen indefinitely because the resultant current may be within the operating range of the power system, and the power system will not reset itself.

Another risk involved with power lines is indirect contact. Because of the large magnetic fields created by the currents in the power lines, large voltages may be induced upon phone lines via electro-magnetic coupling. In this instance voltages should be limited to 1000 V peak and 600 V rms using primary protectors, while the current will be limited by the current-carrying capacity of the 24-gauge wire.

First Level AC Power Fault Criteria

Table 7.7 presents test conditions for the First Level AC Power Fault Test. The EUT is required to pass operationally.

Table 7.7 First Level AC Power Fault Test

Test	Applied Voltage, 60 Hz (V_{RMS})	Short Circuit Current per Conductor (A)	Duration	Primary Protectors	Test Connections (Table 7.1, Figure 7.1)
1 (Note 1)	50	0.33	15 min	Removed	A
2 (Note 1)	100	0.17	15 min	Removed	A
3 (Note 1)	200, 400, 600	1A at 600 V	60 applications, 1 s each	Removed	A
4 (Note 4)	1000	1	60 applications, 1 s each	In place	B
5 (Note 2)	N/A	N/A	60 applications, 5 s each	Removed	N/A
6 (Note 3)	600	0.5	30 s	Removed	A
7 (Note 3)	440	2.2	2 s	Removed	A
8 (Note 3)	600	3	1 s	Removed	A
9 (Note 3)	1000	5	0.5 s	In place	B

Notes:
1. For EUT containing secondary voltage limiting and current limiting protectors, tests are to be performed at the indicated voltage(s) and repeated at a reduced voltage and current just below the operating threshold of the secondary protectors.
2. Test 5 simulates a high impedance induction fault. For specific information, contact Littelfuse, Inc.
3. Sufficient time may be allowed between applications to preclude thermal accumulation.
4. This test is intended to establish compatibility of the EUT with the primary protector. The maximum current is limited to 1 A rms as in Test 3, but the voltage is increased to 1,000 V to permit operation of the protector. Sufficient time may be allowed between applications to preclude thermal accumulation.

Second Level AC Power Fault Criteria

Test conditions for the Second Level AC Power Fault Test are dependent on whether the EUT is intended for customer premises equipment or non-customer premises equipment. In both instances, although the EUT is not required to pass operationally, it may not become a fire, fragmentation, or electrical safety hazard.

Second Level AC Power Fault Criteria for Non-customer Premises Equipment

Table 7.8 presents test conditions for non-customer premises equipment. (Note that test conditions 1, 3, and 4 may be omitted if the EUT has previously met UL 60950.) See Figure 7.1 for test connection appearances.

Table 7.8 Second Level AC Power Fault Test for Non-Customer Premises Equipment

Test (Notes 1, 2)	Applied Voltage, 60 Hz (V_{RMS})	Short Circuit Current per Conductor (A) (Note 5)	Duration	Test Connections (Table 7.1, Figure 7.1)
1 (Note 6)	120, 277	25	15 min	A
2	600	60	5 s	A
3	600	7	5 s	A
4 (Note 3)	100-600	2.2A at 600 V	15 min	A
5 (Note 4)	N/A	N/A	15 min	N/A

Notes:
1. Primary protectors are removed for all tests.
2. For EUT containing secondary voltage limiting and current limiting protectors, tests are to be performed at the indicated voltage(s) and repeated at a reduced voltage and current just below the operating threshold of the secondary protectors.
3. This test is to be performed between the ranges of 100 V to 600 V and is intended to produce the greatest heating effect.
4. Test 5 simulates a high impedance induction fault. Specific information regarding this test is available upon request.
5. These tests are repeated using a short-circuit value just below the operating threshold of the current limiting device, or, if the EUT uses a fuse as current limiting protection, the fuse may be bypassed and the short circuit current available adjusted to 135 percent of the fuse rating.
6. Intra-building, second level power fault test uses test condition 1 only. The applied voltage is at 120 V rms only.

Second Level AC Power Fault for Customer Premises Equipment

For customer premises equipment, the EUT is tested to the conditions presented in Table 7.9 and connected to a circuit equivalent to that shown in Figure 7.2. During this test, the wiring simulator cannot open. For equipment that uses premises type of wiring, the wiring simulator is a 1.6 A Type MDQ fuse from Bussman. For equipment that is connected by cable, the wiring simulator is a piece of 26-gauge copper wire.

Table 7.9 Second Level AC Power Fault for Customer Premises Equipment

Test	Applied Voltage, 60 Hz (V_{RMS}) (Notes 2, 3)	Source Impedance Ohms	Test Connections (Table 7.1, Figure 7.2)
1	300	20	(Note 1)
2	600	20	A

Notes:
1. Applied between exposed surfaces and Ground
2. The 60 Hz signal is applied with an initial amplitude of 30 V rms and increased by 20 percent every 15 minutes until one of the following occurs:
   — Voltage reaches the maximum specified
   — Current reaches 20 A or the wiring simulator opens
   — EUT fails open circuit
3. If the EUT fails open circuit, the test continues for an additional 15 minutes to ensure that another component of the EUT does not create a fire, fragmentation, or electrical safety hazard.

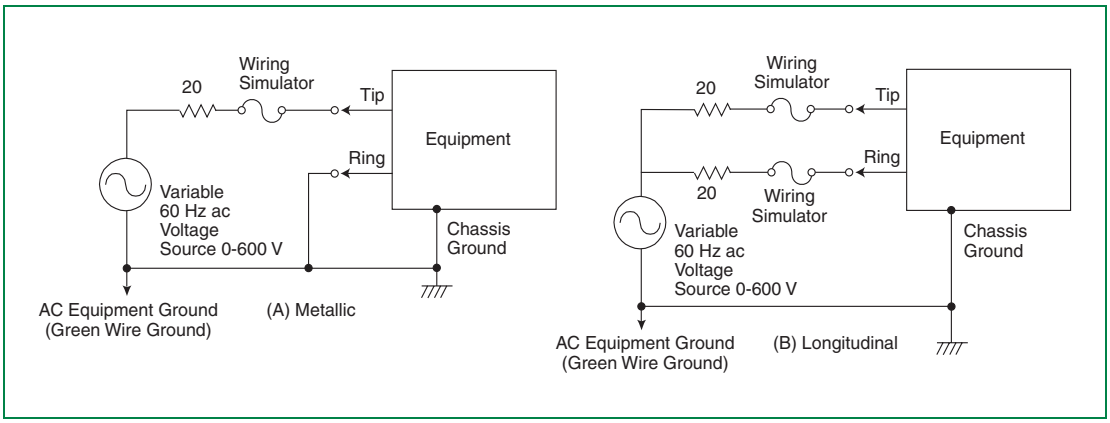


Figure 7.2 Second Level AC Power Fault and Current Limiter Connection

Current Limiting Protector Test

The purpose of the Current Limiting Protector Test presented in Table 7.10 is to determine if the EUT allows an excessive amount of current flow under power fault conditions. During this test, the EUT is connected to a circuit equivalent to that shown in Figure 7.2 with a 1.6 A Type MDQ fuse from Bussman used as the wiring simulator. If the EUT draws enough current to open the fuse, then the acceptable time/current criteria have not been met, and external current limiting protectors must be specified for use with that equipment in the manufacturer's documentation. This test is conducted at 2.2 A and 2.6 A without the wiring simulator. It is then tested at 3 A, 3.75 A, 5 A, 7 A, 10 A, 12.5 A, 20 A, 25 A, and 30 A for 15 minutes at each subsequent value until the wiring simulator opens. At 2.2 A and 2.6 A the acceptable time-current curve cannot be exceeded.

Table 7.10 Current Limiting Protector Test

Test	Applied Voltage, 60 Hz (V_{RMS})	Source Impedance Ohms	Duration	Test Connections (Table 7.1, Figure 7.2
1	600	2	15 min	A

Short-circuit Test

In addition to the AC Power Fault and Current Limiter Tests, equipment must also pass a Short-circuit Test to comply with GR 1089. During this test, a short-circuit condition is applied to the following Tip and Ring appearances for 30 minutes while the EUT is powered and under operating conditions:

- Tip-to-Ring, Tip-to-Ground with Ring open circuit
- Ring-to-Ground with Tip open circuit
- Tip- and Ring-to-Ground simultaneously for 30 minutes

At no time will the short circuit exceed 1 Ω. For equipment with more than one twisted pair, the short circuit is applied to all twisted pair simultaneously. To comply with the short circuit test, the EUT must function normally after the short-circuit condition is removed, and a fire hazard may not be present. The equipment shall not require manual intervention to restore service.

ITU-T K.20 and K.21

Although the International Telecommunication Union (ITU) does not have the authority to legislate that organizations follow their recommendations, their standards are recognized throughout Europe and the Far East.

ITU-T, the Telecommunication Standardization Sector of the ITU, developed fundamental testing methods that cover various environmental conditions to help predict the survivability of network and customer-based switching equipment. The testing methods cover the following conditions:

- Surges due to lightning strikes on or near twisted pair and plant equipment (excluding a direct strike)
- Short-term induction of AC voltage from adjacent power lines or railway systems
- Direct contact between telecommunication lines and power lines (often referred to as AC power fault)

Two ITU-T standards apply for most telecommunications equipment connected to the network:

- ITU-T K.20
- ITU-T K.21

ITU-T K.20 is primarily for switching equipment powered by the central office; however, for complex subscriber equipment, test administrators may choose either K.20 or K.21, depending on which is deemed most appropriate.

Note: Both standards are intended to address equipment reliability versus equipment safety. For specific concerns regarding equipment safety, research and follow national standards for each country in which the equipment is intended for use.

K.21 covers telecommunication equipment installed in customer premises. Equipment submitted under these requirements must meet one of two levels: basic or enhanced. Guidelines for determining under which level the equipment under test (EUT) falls can be found in ITU-T K.11, but note that the final authority rests with the test administrator. ITU-T K.44 describes the test conditions used in K.20 and K.21.

ITU-T defines the following acceptance criteria:

- **Criterion A** states that equipment shall withstand the test without damage and shall operate properly after the test. It is not required to operate correctly during the test.
- **Criterion B** states that a fire hazard shall not occur as a result of the tests. Any damage shall be confined to a small part of the equipment.

Table 7.11 shows the lightning surge test conditions for ITU K.20. Figure 7.3 shows the connection schematic for the lightning surge tests. Table 7.12 shows the power fault test conditions for ITU K.20. Figure 7.4 shows the connection schematic for the power fault tests. Table 7.13 and Table 7.14 show the same test conditions respectively for ITU K.21.

Table 7.11 K.20 Lightning Test Conditions for Telecom Equipment in Central Office/Remote Terminal

Voltage (10x700 µs)		Current (5x310 µs) Basic/Enhanced (A)	Repetitions *	Primary Protection	Acceptance Criteria
Single Port Metallic and Longitudinal Basic/Enhanced	Multiple Ports Longitudinal Only Basic/Enhanced				
1 kV/1.5 kV		25/37.5	±5	None **	A
4 kV/4 kV		100/100	±5	Installed if used	A
	1.5 kV/1.5 kV	37.5/37.5	±5	None	A
	4 kV/6 kV	100/150	±5	Installed if used	A

* One-minute rest between repetitions
** Test not conducted if primary protection is used

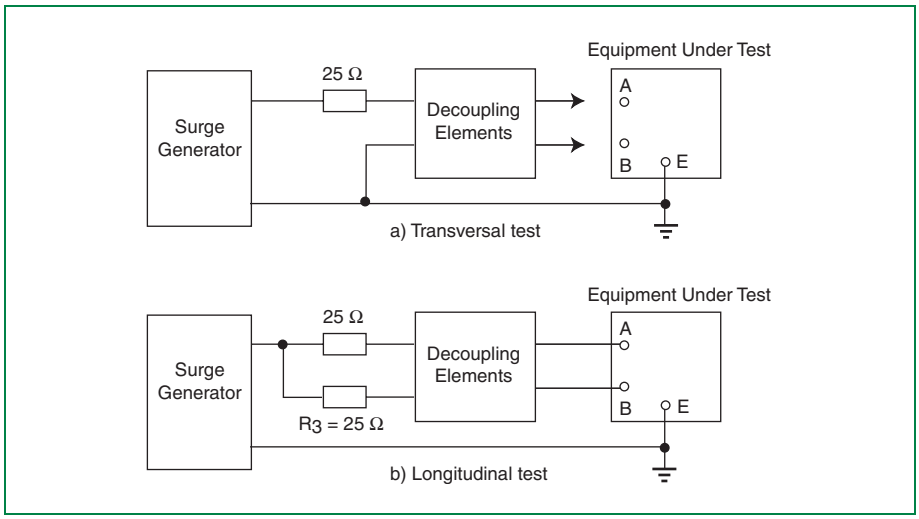


Figure 7.3 Connection Appearances

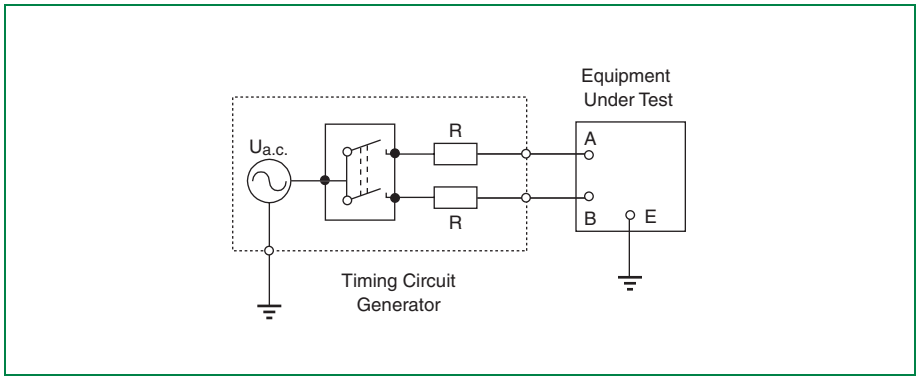


Figure 7.4 Connection Appearances (R = 10 Ω, 20 Ω, 40 Ω, 80 Ω, 160 Ω, 300 Ω, 600 Ω, and 1000 Ω for the various power fault tests)

Table 7.12 K.20 Power Fault Test Conditions for Telecom Type Ports, Metallic, and Longitudinal

Voltage Basic/Enhanced	Current Basic/Enhanced (A)	Duration Basic/Enhanced	Repetitions *	Primary Protection	Acceptance Criteria Basic/Enhanced
600 V/600 V 50 Hz or 60 Hz	1/1	0.2 s	5	None	A/A
600/1.5 kV 50 Hz or 60 Hz	1/7.5	1 s/2 s	5	None	A/A
230/230 V 50 Hz or 60 Hz	23/23	15 min	1	None	B/B
	11.5/11.5				B/B
	5.75/5.75				B/B
	2.875/2.875				B/B
	1.44/1.44				B/A
	0.77/0.77				B/A
	0.38/0.38				B/A
	0.23/0.23				B/B

* One-minute rest between repetitions

Table 7.13 K.21 Lightning Test Conditions for Telecom Equipment on Customer Premises

Voltage (10x700 µs)			Current (5x310 µs) Basic/Enhanced (A)	Repetitions *	Primary Protection	Acceptance Criteria
Single Port		Multiple Ports Longitudinal Only (kV) Basic/Enhanced				
Longitudinal (kV) Basic/Enhanced	Metallic (kV) Basic/Enhanced					
1.5/6 **			37.5/150	±5	None	A ***
4/6			100/150	±5	Installed if used	A
	1.5/1.5	1.5/1.5	37.5/37.5	±5	None	A ***
	4/6	4/6	100/150	±5	Installed if used	A

* One-minute rest between repetitions
** Reduce to 1.5 kV if SPD connects to Ground
*** Does not apply if primary protectors are used

Table 7.14 K.21 Power Fault Test Conditions for Telecom Type Ports, Metallic, and Longitudinal

Voltage Basic/Enhanced	Current Basic/Enhanced (A)	Duration Basic/Enhanced	Repetitions *	Primary Protection	Acceptance Criteria Basic/Enhanced
600 V / 600 V 50 Hz or 60 Hz	1/1	0.2 s	5	None	A/A
600 V / 1.5 kV 50 Hz or 60 Hz	1/7.5	1 s/2 s	5	Installed if used	A/A
230 V / 230 V 50 Hz or 60 Hz	23/23	15 min	1	None	B/B
	11.5/11.5				B/B
	5.75/5.75				B/B
	2.875/2.875				B/B
	1.44/1.44				B/A
	0.77/0.77				B/A
	0.38/0.38				B/A
	0.23/0.23				B/B

* One-minute rest between repetitions

Enhanced power fault test condition of 1.5 kV 200 W 2 second test must meet the time current curve shown in Figure 7.5.

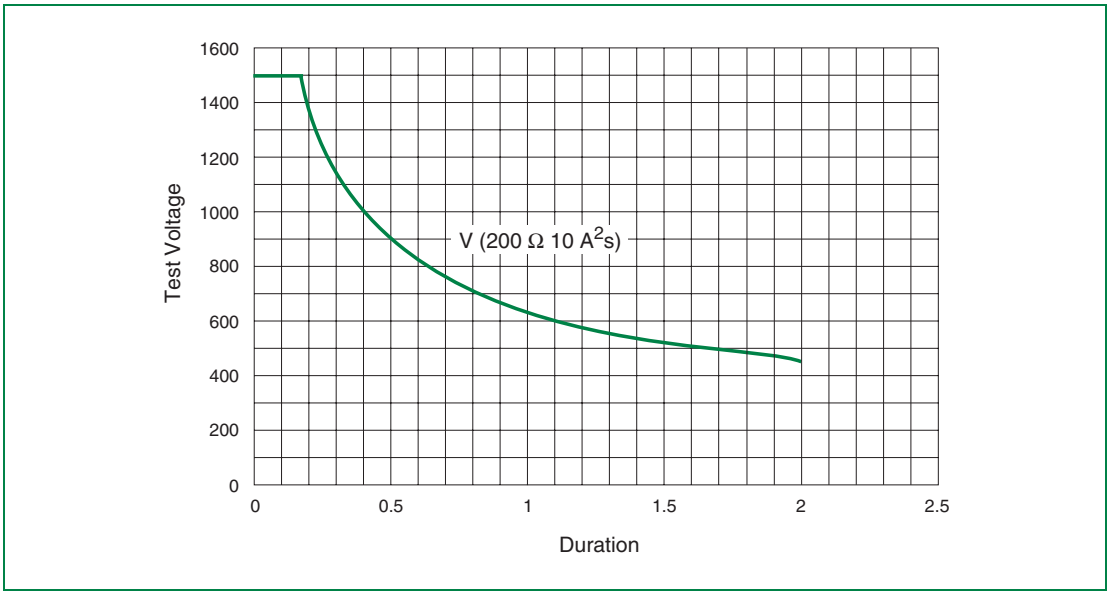


Figure 7.5 Test Voltage Versus Duration for Specific Energy / Source Resistance

TIA-968-A (formerly known as FCC Part 68)

TIA-968-A applies to all terminal equipment connected to the Public Switched Telephone Network (PSTN) and holds the “rule of law” by congressional order.

The purpose of TIA-968-A is to provide a set of uniform standards to protect the telephone network from any damage or interference caused by the connection of terminal equipment. This standard includes environmental simulations such as vibration tests, temperature and humidity cycling, drop tests and tests for hazardous voltages and currents, as well as tests for signal power levels, line balance, on-hook impedance, and billing protection. All these standards must be met before and after the environmental tests are applied.

Overvoltage Test

TIA-968-A compliant equipment must undergo an overvoltage test that includes a Type A and Type B Metallic Voltage Surge and a Type A and Type B Longitudinal Voltage Surge. These surges are part of the environmental simulation, and although a provision does allow the EUT to reach an open circuit failure mode during the Type A tests, failures must:

1. Arise from an intentional design that will cause the phone to be either disconnected from the public network or repaired rapidly
2. Be designed so that it is substantially apparent to the end user that the terminal equipment is not operable [A common example of an acceptable failure would be an open circuit due to an open connection on either Tip or Ring.]

For Type B surges, equipment protection circuitry is not allowed to fail. The EUT must be designed to withstand Type B surges and continue to function in all operational states.

Metallic Voltage Surge

The Type A and Type B Metallic Voltage Surges are applied in both the positive and negative polarity across Tip and Ring during all operational states (on-hook, off-hook, ringing, and so on). The Type A surge is an 800 V, 100 A peak surge while the Type B surge is a 1000 V, 25 A peak surge, as presented in Table 7.15.

Table 7.15 TIA-968-A Voltage Surge

Surge Type	Peak Voltage (V_{PK})	Rise & Decay Time (Voltage Waveform)	Peak Current (A)	Rise & Decay Time (Current Waveform)	Repetitions Each Polarity
Metallic A	±800	10x560 µs	100	10x560 µs	1
Longitudinal A	±1500	10x160 µs	200	10x160 µs	1
Metallic B	±1000	9x720 µs	25	5x320 µs	1
Longitudinal B	±1500	9x720 µs	37.5	5x320 µs	1

Notes:
- For Type A surges, the EUT may pass either “operationally” or “non-operationally.”
- For Type B surges, the EUT must pass “operationally.”
- The peak current for the Type A longitudinal surge is the total available current from the surge generator.
- The peak current for the Type B longitudinal surge is the current supplied to each conductor.

Longitudinal Voltage Surge

The Type A and Type B Longitudinal Voltage Surges are applied in both positive and negative polarity during all operational states. The Type A surge is a 1500 V, 200 A peak surge applied to the EUT with Tip and Ring tied together with respect to Ground. The Type B Longitudinal Voltage Surge is a simultaneous surge in which 1500 V and 37.5 A are applied concurrently to Tip with respect to Ground and Ring with respect to Ground, as presented in Table 7.15.

Note: Type B surge requirements guarantee only a minimum level of surge protection. For long term reliability of terminal equipment, consideration should be given to complying with Type A surges operationally.

On-hook Impedance Limitations

Another important aspect of TIA-968-A is on-hook impedance, which is affected by transient protection. On-hook impedance is analogous to the leakage current between Tip and Ring, and Tip, Ring, and Ground conductors during various on-hook conditions. "On-hook Impedance Measurements" (next paragraph) outlines criteria for on-hook impedance and is listed as part of the Ringer Equivalent Number (REN). The REN is the largest of the unitless quotients not greater than five; the rating is specified as the actual quotient followed by the letter of the ringer classification (for example, 2B).

On-hook Impedance Measurements

On-hook impedance measurements are made between Tip and Ring and between Tip and Ground and Ring and Ground. For all DC voltages up to and including 100 V, the DC resistance measured must be greater than 5 MΩ. For all DC voltages between 100 V and 200 V, the DC resistance must be greater than 30 kΩ. The REN values are then determined by dividing 25 MΩ by the minimum measured resistance up to 100 V and by dividing 150 kΩ by the minimum measured resistance between 100 V and 200 V.

On-hook impedance is also measured during the application of a simulated ringing signal. This consists of a 40 V rms through 150 V rms ringer signal at frequencies ranging from 15.3 Hz to 68 Hz superimposed on a 56.5 V dc for a class “B” ringer. During this test, the total DC current may not exceed 3 mA. In addition, the minimum DC resistance measured between Tip and Ring must be greater than 1600 Ω, while the DC resistance measured between the Tip and Ring conductors and Ground must be greater than 100 kΩ. The REN values for the simulated ringing test are determined by dividing the maximum DC current flowing between Tip and Ring by 0.6 mA, and by dividing 8000 Ω by the minimum impedance value measured.

UL 60950 3rd Edition

After the divestiture of the AT&T/Bell system, the National Electric Code (NEC) implemented Article 800-4, which mandates that “all equipment intended for connection to the public telephone network be listed for that purpose” in order to ensure electrical safety. A manufacturer can meet this requirement by listing their product with Underwriters Laboratories under UL 60950 (based on IEC 60950, 3rd edition).

The NEC requires all telecommunication wiring that enters a building to pass through a primary protector, which is designed to limit AC transients in excess of 600 V rms. These transients are due to the fact that telephone lines run in close proximity to AC power lines. Most telecommunication equipment uses a secondary overvoltage protector such as the *SIDACtor*® device. The secondary devices typically limit transients in excess of 350 V rms. Therefore, a potentially dangerous condition exists because of the voltage threshold difference of the primary protector and the secondary protector. To minimize this danger, compliance with UL 60950 overvoltage tests is required.

UL 60950 covers equipment with a rated voltage (primary power voltage) not exceeding 600 V and equipment designed to be installed in accordance with the NEC NFPA 70. This standard does not apply to air-conditioning equipment, fire detection equipment, power supply systems, or transformers.

The effective date of UL 60950 allows new products submitted through April 1, 2003 to be evaluated using the requirements of either UL 60950 or UL 1950, 3rd edition. After April 1, 2003, all new product submittals must be evaluated using only UL 60950.

Products certified by UL to requirements of UL 1459 prior to April 1, 2000 may continue to be certified without further reinvestigation until April 1, 2005, provided no significant changes or revisions are made to the products. Products certified by UL to requirements of UL 1950 3rd edition prior to April 1, 2003 may continue to be certified without further reinvestigation until April 1, 2005.

In order to have the UL Mark applied after April 1, 2005, all products, including those previously certified by UL, must comply with UL 60950.

UL 60950 is intended to prevent injury or harm due to electrical shock, energy hazards, fire, heat hazards, mechanical hazards, radiation hazards, and chemical hazards.

It defines three classes of equipment:

- Class 1—protection achieved by basic insulation
- Class 2—protection achieved by double or reinforced insulation
- Class 3—protection relying upon supply from SELV circuits (voltages up to 40 V peak or 60 V dc)

UL 60950 also defines five categories of insulation:

- Functional
- Basic
- Supplementary
- Reinforced
- Double

UL 60950 Terminology

The following definitions assist in understanding UL 60950:

SELV	Secondary circuit whose voltage values do not exceed a safe value (voltage less than hazardous levels of 42.4 V peak or 60 V dc)
TNV	Telecommunication Network Voltage (a secondary circuit)
TNV3	≥ SELV but with exposure to surges
TNV2	≥ SELV but without exposure to surges
TNV1	≤ SELV with exposure to surges

Creepage distance is the shortest distance between two conductors, measured along the surface of the insulation. DC voltages shall be included in determining the working voltage for creepage distances. (The peak value of any superimposed ripple or short disturbances, such as cadenced ringing signals, shall be ignored.)

Clearance distance is the shortest distance between two conductive parts or between a conductive part and the outer surface of the enclosure measured through air. DC voltages and the peak value of any superimposed ripple shall be included in determining the working voltage for clearance distances.

Creepage and clearance distances are also subject to the pollution degree of the equipment:

- Pollution degree 1—components and assemblies sealed to prevent ingress of dust and moisture
- Pollution degree 2—generally applicable to equipment covered by UL 60950
- Pollution degree 3—equipment subject to conductive pollution or to dry non-conductive pollution, which could become conductive due to expected condensation

To ensure safe operating conditions of the equipment, UL 60950 focuses on the insulation rating of the circuit(s) under consideration. Table 7.16 and Table 7.17 indicate the required creepage and clearance distances depending on material group, pollution degree, working voltage, and maximum transient voltage in the secondary circuit. For a typical telecommunication application with a working voltage of 200 V, pollution degree 2, material group IIIb, the creepage distance is 2 mm. The clearance distance is 2 mm for reinforced insulation.

Table 7.16 Minimum Clearances in Secondary Circuits (millimeters)

Working Voltage up to and including		Nominal AC Mains Supply Voltage ≤ 150 V (transient rating for Secondary Circuit 800 V)						Nominal AC Mains Supply Voltage > 150 V ≤ 300 V (transient rating for Secondary Circuit 1500 V)						Nominal AC Mains Supply Voltage > 300 V ≤ 600 V (transient rating for Secondary Circuit 2500 V)			Circuit Not Subject to Transient Overvoltages		
		Pollution Degrees 1 and 2			Pollution Degree 3			Pollution Degrees 1 and 2			Pollution Degree 3			Pollution Degrees 1, 2, and 3			Pollution Degrees 1 and 2 only		
V *	V **	F	B/S	R	F	B/S	R	F	B/S	R	F	B/S	R	F	B/S	R	F	B/S	R
71	50	0.4	0.7	1.4	1	1.3	2.6	0.7	1	2	1	1.3	2.6	1.7	2	4	0.4	0.4	0.8
140	100	0.6	0.7	1.4	1	1.3	2.6	0.7	1	2	1	1.3	2.6	1.7	2	4	0.6	0.7	1.4
210	150	0.6	0.9	1.8	1	1.3	2.6	0.7	1	2	1	1.3	2.6	1.7	2	4	0.6	0.7	1.4
280	200	F 1.1; B/S 1.4; R 2.8												1.7	2	4	1.1	1.1	2.2
420	300	F 1.6; B/S 1.94; R 3.8												1.7	2	4	1.4	1.4	2.8

* Voltage peak or DC
** Voltage rms (sinusoidal)

Note: F = Functional
B/S = Basic/Supplementary
R = Reinforced

Table 7.17 Minimum Creepage Distances (millimeters)

Working Voltage V RMS or DC	Functional, Basic, and Supplementary Insulation							
	Pollution Degree 1	Pollution Degree 2			Pollution Degree 3		
	Material Group	Material Group			Material Group		
	I, II, IIIa, or IIIb	I	II	IIIa or IIIb	I	II	IIIa or IIIb
≤ 50	Use the Clearance from the appropriate table	0.6	0.9	1.2	1.5	1.7	1.9
100		0.7	1	1.4	1.8	2	2.2
125		0.8	1.1	1.5	1.9	2.1	2.4
150		0.8	1.1	1.6	2	2.2	2.5
200		1	1.4	2	2.5	2.8	3.2
250		1.3	1.8	2.5	3.2	3.6	4
300		1.6	2.2	3.2	4	4.5	5
400		2	2.8	4	5	5.6	6.3
600		3.2	4.5	6.3	8	9.6	10
800		4	5.6	8	10	11	12.5
1000		5	7.1	10	12.5	14	16

Note: Linear interpolation is permitted between the nearest two points, the calculated spacing being rounded to the next higher 0.1 mm increment.

The following separations require the specified insulation grade:

- TNV3 from TNV3—functional insulation
- TNV3 from SEL—basic insulation
- TNV3 from TNV1—basic insulation
- TNV3 from TNV2—basic insulation

The application must meet the creepage and clearance distances and electric strength of Section 5.3.2 of UL 60950 for functional insulation. The electric strength test (Table 5B of

UL 60950) lists 1 kV to 1.5 kV as the test voltages for functional and supplementary grade of insulation and 2 kV to 3 kV for reinforced grade of insulation.

Separation requirements are tested (Section 6.2.2.1 of UL 60950) by applying an impulse test and an electric strength test:

- Impulse test allows for the *SIDACtor* device to turn on (either a 10x700 2.5 kV 62.5 A or 1 kV 37.5 A 10 times with 60-second rest period).
- Electric strength test allows the *SIDACtor* device to be removed (60 Hz at rated voltage for 60 seconds).

These are applied between Ground and all Tip and Rings connected together, and/or between Ground and all conductors intended to be connected to other equipment connected together.

Basic insulation is not required if all the following conditions are met:

- SELV, TNV1 circuit is connected to the protective earth.
- Installation procedures specify that protective earth terminal shall have a permanent connection to earth.
- Any TNV2 or TNV3 circuit with an external port connection intended to receive signals in excess of SELV (60 V dc or 50 V peak) will have the maximum normal expected operating voltage applied to it for up to 30 minutes without deterioration. (If no maximum normal specification exists, then 120 V 100 mA 60 Hz is applied.)

(In other words, if a permanent Ground connection is made, then creepage distances may not be required.)

Any surge suppressor that bridges the insulation (connects to Ground) shall have a minimum DC turn-on voltage of 1.6 times the rated voltage **UNLESS** one of the following occurs (Section 6.1.2.2 of UL 60950):

- Equipment is permanently connected or uses an industrial plug and socket-outlet.
- Equipment is installed by service personnel.
- Equipment has provision for a permanently connected protective earth.

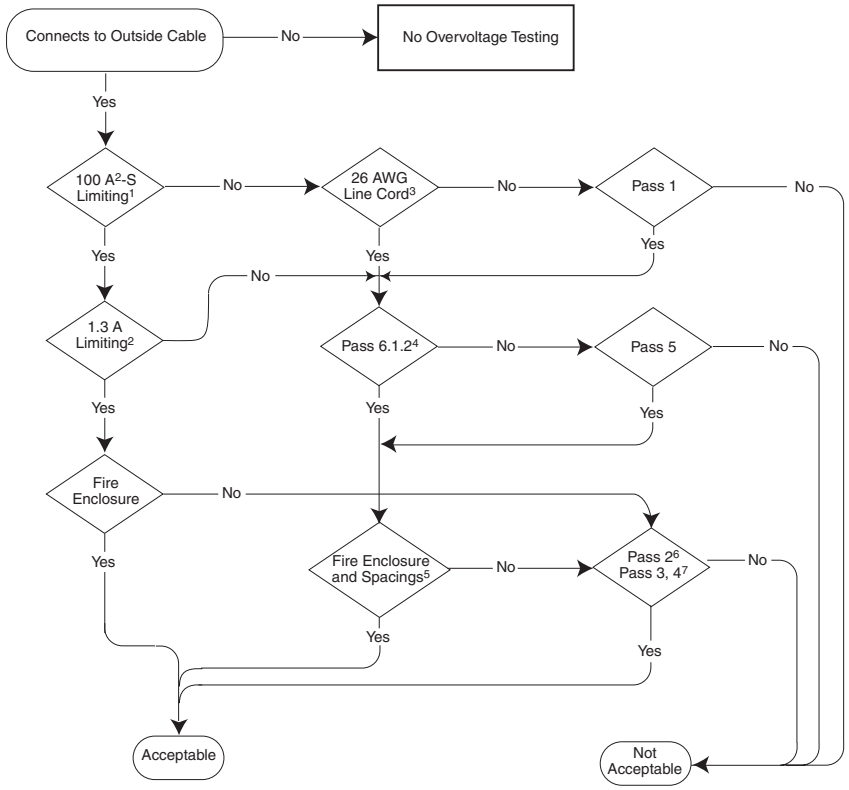
ANNEX C of UL 60950 covers transformers.

The secondary side is loaded for maximum heating effect. The maximum working voltage is applied to the primary. The DC peak value of any superimposed ripple shall be included. The permitted temperature limits for the windings depend on the classification:

- Class A limit is 150 °C.
- Class B limit is 175 °C.
- Class E limit is 165 °C.
- Class F limit is 190 °C.
- Class H limit is 210 °C.

Overvoltage Flowchart

The overvoltage flowchart in Figure 7.6 shows specific guidelines for determining overvoltage requirements applicable to specific designs.



Notes:
1. Current Limiting — Equipment that has a method for limiting current to an I^2t rating of $100A^2s$
2. Current Limiting — Equipment that has a method for limiting current to 1.3 A max steady state
3. 26 AWG Line Cord — Minimum 26 American Wire Gauge (AWG) telecommunications line cord either supplied with the equipment or described in the safety instructions
4. Clause 6.3.3 — The telephone line must be adequately isolated from earth for the operating mode being considered and at a voltage of 120 V rms. Refer to Section 6.1.2 of UL 60950.
5. Fire Enclosure and Spacing — Fire enclosures minimize fire hazards by containing any emission of flame, molten metal, flaming drops, or glowing particles that could be emitted by the equipment under fault conditions. Fire enclosure construction is covered in Section 4.4.6 of UL 60950. Spacing applies to parts in the TNV circuits that might ignite under overvoltage conditions. Spacing requirements mandate that parts be separated from internal materials of flammability class V-2 or lower, by at least 25 mm of air or a barrier material of flammability class V-1 or better. Parts also should be separated from openings in the top or sides of the enclosure by at least 25 mm of air or a material barrier.
6. Test Condition 2 is not required for equipment with 1.3 A limiting.
7. Test Conditions 3 and 4 are not required for connections limited to outside cable less than 1,000 m.

Figure 7.6 Overvoltage Flowchart

Passes 1, 2, 3, 4, and 5 shown in Figure 7.6 refer respectively to Tests L1 and M1, L2 and M2, L3 and M3, L4 and M4, and L5 shown in Table 7.18.

Equipment may be subject to the overvoltage tests shown in Table 7.18. The tests are designed to simulate the following:

- Contact with primary power
- Short-term induction as a result of a primary power fault to a multi-earth neutral
- Long duration power fault to Ground
- Direct contact between the power mains and a telecommunications cable

Table 7.18 UL 60950 Overvoltage Test

Test	Voltage (V_{RMS})	Current (A)	Time	Comments
L1	600 V	40	1.5 s	
L2	600 V	7	5 s	
L3	600 V	2.2	See Note 2	Reduce to 135% fuse rating
L4	See Note 1	2.2	See Note 2	Reduce to 135% fuse rating
L5	120 V	25	See Note 2	
M1	600 V	40	1.5 s	
M2	600 V	7	5 s	
M3	600 V	2.2	See Note 2	Reduce to 135% fuse rating
M4	See Note 1	2.2	See Note 2	Reduce to 135% fuse rating

Note 1: Voltage < conduction voltage of protection
Note 2: Test for 30 minutes or until an open circuit occurs unless it appears possible that a risk of fire or safety hazard will eventually result; then continue test until ultimate results are obtained (maximum of seven hours).

General Notes:

- ISDN S/T interface only L1, L2, L5, M1, and M2.
- Reduce to 135% rated value of fuse if Test 3 resulted in open condition.
- L4 and M4 are conducted only if *SIDACtor* $V_S \geq 285$ V_S and then run at voltage level just below V_S.
- For test conditions M1, L1, M5, and L5 a wiring simulator (MDL 2 A fuse) is used.
- Compliance means no ignition or charring of the cheesecloth, and/or the wiring simulator does not open.
- If the secondary protector simulator is used (MDQ 1.6), it is allowed to open.
- Tests 2, 3, and 4 are required only if the unit is not a fire enclosure.
- Figure 7.7 and Figure 7.8 show the M (metallic) and L (longitudinal) test connections.

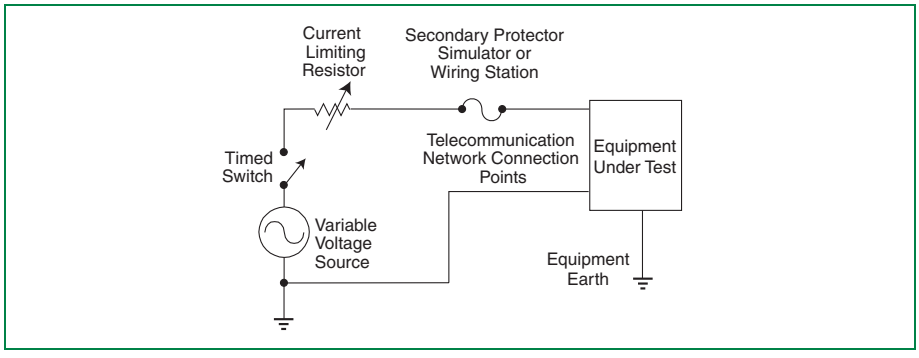


Figure 7.7 Metallic Connection Appearances

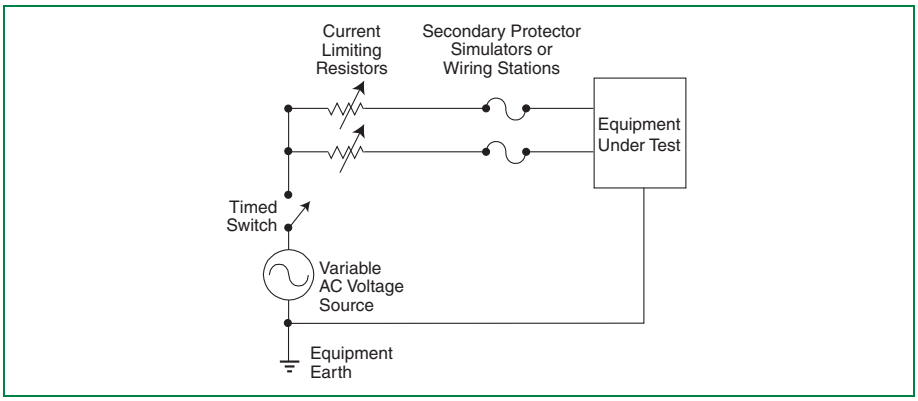


Figure 7.8 Longitudinal Connection Appearances

Overvoltage Test Procedures

Use the following criteria when applying the overvoltage tests presented in Table 7.18.

1. Test Set-up—Equipment is to be mounted as it is intended to be used. Tests may be conducted on either the equipment as an assembly, individual subassemblies, or a partial assembly containing those components which may be exposed to an overvoltage condition.
2. Indicators—Before testing, two single pieces of cheesecloth are to be wrapped tightly around the assembly, subassembly, or partial assembly. The cheesecloth acts as an indicator for conditions that may result in fire.
3. Line Cords—Equipment with a removable telecommunications line cord is to be connected to the test circuit with a line cord having 0.4 mm (26 AWG) or larger copper wire conductors and not more than 1 Ω total resistance.
4. Functional Circuitry—UL mandates that functional circuitry must be used for each overvoltage test conducted. This allows repair or replacement of damaged circuitry before subsequent testing. Alternatively, separate samples may be used for each test.
5. Wiring Simulators—A wiring simulator is used to indicate whether the maximum I^2t imposed upon telecommunications wiring has been exceeded. For Tests 1 and 5, a wiring simulator is to be used unless the equipment is specified for use with a suitable secondary protector or a secondary protector simulator. The wiring simulator can consist of one of the following:
   a. 50 mm length of 0.2 mm (32 AWG) bare or enameled solid copper wire (for test condition 1)
   b. Bussman Mfg. Co. Type MDL-2A fuse (for test condition 1)
   c. 300 mm length of 0.4 mm (26 AWG) solid copper wire which connects to a representative installation (includes wiring and connectors)
      [This option is used when the manufacturer specifies the complete installation from the network interface to the equipment.]
   d. Current probe used with a 300 mm length of 0.5 mm (24 AWG) copper wire (for test condition 1)

Note: Test conditions 2, 3, and 4 do not require the use of a wiring simulator or a secondary protector simulator. Any secondary protection simulators used in Tests 1 and 5 should be similar to the test fuse used in UL 497A, “Standard for Secondary Protectors for Communications Circuits.”

Overvoltage Test Compliance

Equipment is deemed compliant if each of the following conditions are met during test:

- Absence of ignition or charring of the cheesecloth indicator
  (Charring is deemed to have occurred when the threads are reduced to char by a glowing or flaming condition.)
- Wiring simulator does not open during test condition 1 or 5
- For test condition 1, presented in Table 7.18, the integral I^2t measured with a current probe is less than 100 A^2s.

After completion of the overvoltage tests, equipment must comply with either the Dielectric Voltage-withstand Test requirements with all components in place or the Leakage Current Test requirements.

Special Considerations Regarding the *SIDACtor*® Device and UL 60950

The epoxy used for *SIDACtor* devices is UL recognized and the encapsulated body passes UL 94V-0 requirements for flammability.

The only specific requirements of UL 60950 that pertain to the *SIDACtor* device itself are the impulse test and the mandate that components be UL recognized. All other UL 60950 requirements pertain to the equipment being evaluated.

UL 497

UL 497 Series of Safety Standards

The UL 497 series is a family of three safety standards that provides requirements for protection devices used in low-voltage circuits.

- UL 497 addresses requirements for primary protectors used in paired communications circuits.
- UL 497A covers secondary protectors for use in single or multiple pair-type communications circuits.
- UL 497B addresses protectors used in data communication and fire alarm circuits.
- UL 497C addresses protectors for coaxial circuits.

The focus of UL 497 is to ensure that paired communication circuit protectors do not become a fire or safety hazard. The requirements in UL 497 cover any protector that is designed for paired communications circuits and is employed in accordance with Article 800 of the National Electric Code. The protectors covered in UL 497 include solid state primary and station protectors. These circuit protectors are intended to protect equipment, wiring, and service personnel against the effects of excessive voltage potential and currents in the telephone lines caused by lightning, power fault, power induction, and rises in Ground potential.

UL 497 Construction and Performance Requirements

The “Construction” section covers the following requirements:

- General
- Enclosures
- Protection Against Corrosion
- Field-wiring Connections
- Components
- Spacing

The “Performance” section covers the following requirements:

- General
- Line Fuse Test
- Instrument Fuse Test
- Arrester Test
- Polymeric Material Test
- Rubber Materials Test
- Corrosion Test, Outdoor Use Protector
- Jarring Test
- Water Spray Test
- Drop Test
- Cover Replacement Test
- Strain Relief Test
- Replacement Arresters Installation Test
- Appliqué Assemblies Installation Test
- Dielectric Voltage-withstand Test
- Manufacturing and Production Tests
- Marking

Performance Tests

Key performance tests which concern overvoltage protectors are detailed in the arrester test section. Specific requirements are:

- Breakdown Voltage Measurement—*A*rresters are to be tested in the protector blocks or panels in which they are intended to be employed. Arresters are required to break down within ±25% of the manufacturer's specified breakdown rating. In no case shall the breakdown voltage exceed 750 V peak when subjected to the strike voltage test. (Figure 7.9) At no time during this test will the supply voltage be increased at a rate greater than 2000 V/µs.
- Impulse Spark-over Voltage Measurement—The arrester must break down at less than 1000 V peak when subjected to a single impulse potential. Arresters are to be tested in each polarity with a rate of voltage rise of 100 V/µs, ±10%.
- Abnormal Operation—Single pair fuseless arresters must be able to simultaneously carry 30 A rms at 480 V rms for 15 minutes without becoming a fire hazard. A fire hazard is determined by mounting the arrester on a vertical soft wood surface and covering the unit with cheesecloth. Any charring or burning of the cheesecloth results in test failure. During this test, although the arresters may short, they must not have an impulse spark-overvoltage or DC breakdown voltage greater than 1500 V peak.
- Discharge Test—Protectors must comply with the strike voltage requirements after being subjected to five successive discharges from a 2 µF capacitor charged to 1000 V dc. (Figure 7.10).
- Repeated Discharge Test—The arrester must continue to break down at or below its maximum rated breakdown voltage after being subjected to 500 discharges from a 0.001 µF capacitor charged to a potential of 10,000 V dc. The interval between pulses is five seconds. Arresters are to be tested in each polarity, and it is acceptable for the protector to short circuit following the discharge testing. (Figure 7.10)

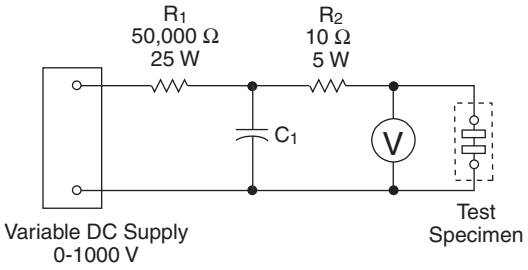


Figure 7.9 UL 497 Breakdown Voltage Measurement

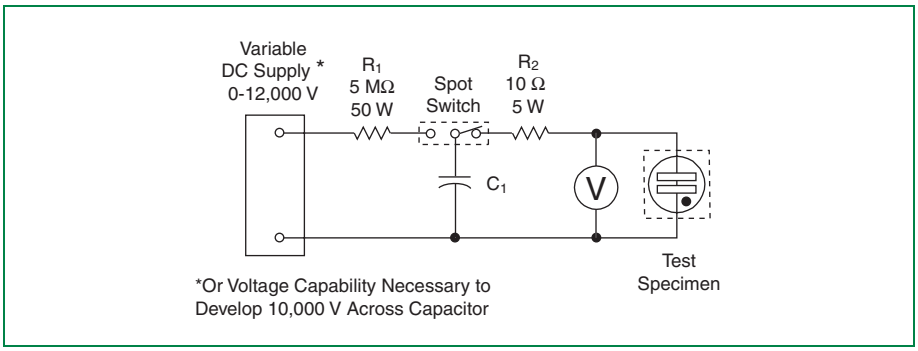


Figure 7.10 UL 497 Discharge Test

UL 497A

UL 497A addresses secondary protectors for use in single or multiple pair-type communication circuits intended to be installed in accordance with Article 800 of the National Electric Code (NEC) and to have an operating voltage of less than 150 V rms with respect to Ground. The purpose of UL 497A is to help reduce the risk of fire, electric shock, or injury resulting from the deployment and use of these protectors. UL 497A requirements do not cover telephone equipment or key systems.

UL 497A Construction, Risk of Injury, and Performance Requirements

The “Construction” section covers the following requirements:

- General
- Product Assembly
- Enclosures
- Internal Material
- Accessibility and Electric Shock
- Protection Against Corrosion
- Cords
- Current-carrying Parts
- Internal Wiring
- Interconnecting Cords and Cables
- Insulating Material
- Printed Wiring
- Spacing

The “Risk of Injury” section covers the following requirements:

- Modular Jacks
- Sharp Edges
- Stability
- Protection of Service Personnel

The “Performance” section covers the following requirements:

- General
- Impulse Voltage Measurement
- Overvoltage Test
- Endurance Conditioning
- Component Temperature Test
- Drop Test
- Crush Test
- Leakage Current Test
- Dielectric Voltage-withstand Test
- Rain Test
- Maximum Moment Measurement Test
- Weather-o-meter and Micro Tensile Strength Test
- Thermal Aging and Flame Test
- Electric Shock Current Test
- Manufacturing and Production Line Test
- Marking, Installation, and Instructions

Performance Tests

The following key performance tests relate to overvoltage protection of the secondary protectors:

1. Impulse Voltage Measurement Test—Secondary protectors must break down within ±25% of the manufacturer's breakdown rating when tested in each polarity with a rate of voltage rise of 100 V/µs, ±10%. Note that the manufacturer may assign separate breakdown voltage ratings for the Breakdown Voltage Measurement Test. This requirement only applies to secondary protectors that connect between Tip and Ring of the telephone loop.
2. Breakdown Voltage Measurement Test—Secondary protectors must break down within ±25% of the manufacturer's breakdown rating when tested in each polarity with a rate of voltage rise no greater than 2000 V/s. The secondary protector is to be mounted in accordance with the manufacturer's installation instructions and then subjected to the test circuit shown in Figure 7.11. This requirement applies only to secondary protectors connected between Tip and Ring or Tip/Ring and Ground of the telephone loop.
3. Overvoltage Test—Secondary protectors must limit current and extinguish or open the telephone loop without loss of its overvoltage protector, indication of fire risk, or electric shock. Upon completion of this test, samples must comply with the Dielectric Voltage-withstand Test.

The overvoltage test is used to determine the effects on secondary protectors and is shown in Table 7.19. Test connections are shown in Figure 7.12.

Test Compliance

Compliance with the overvoltage test is determined by meeting the following criteria:

- Cheesecloth indicator may not be either charred or ignited
- Wiring simulator (1.6 A Type MDQ fuse or 26 AWG line cord) may not be interrupted
- Protector meets the applicable dielectric voltage withstand requirements after the completion of the overvoltage tests

Table 7.19 UL 497A Overvoltage Test

Test	Voltage (V_{RMS})	Current (A)	Time	Connection
L1	600	40	1.5 s	(Note 1, Figure 4.11)
L2	600	7	5 s	(Note 1, Figure 4.11)
L3	600	2.2, 1, 0.5, 0.25	30 min at each current level	(Note 2, Figure 4.11)
L4	200 V rms or just below the breakdown voltage of the overvoltage protection device	2.2 A or just below the interrupt value of the current interrupting device	30 min	(Note 2, Figure 4.11)
L5	240	24	30 min	(Note 1, Figure 4.11)

Notes:
1. Apply Tests L1, L2, and L5 between Tip and Ground or Ring and Ground.
2. Apply Tests L3 and L4 simultaneously from both Tip and Ring to Ground.

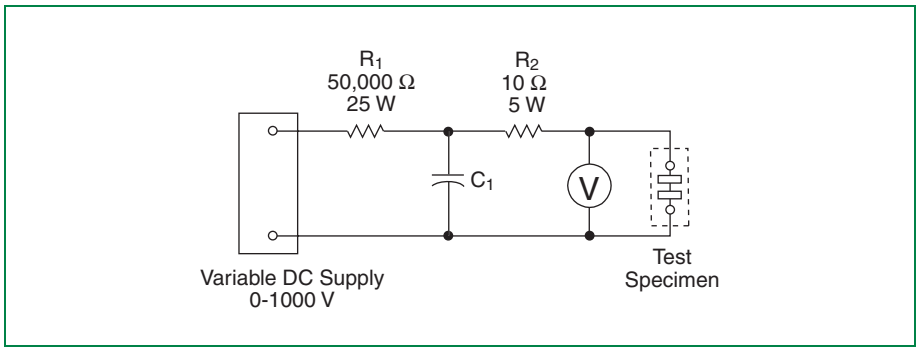


Figure 7.11 UL 497A Breakdown Voltage Measurement Test

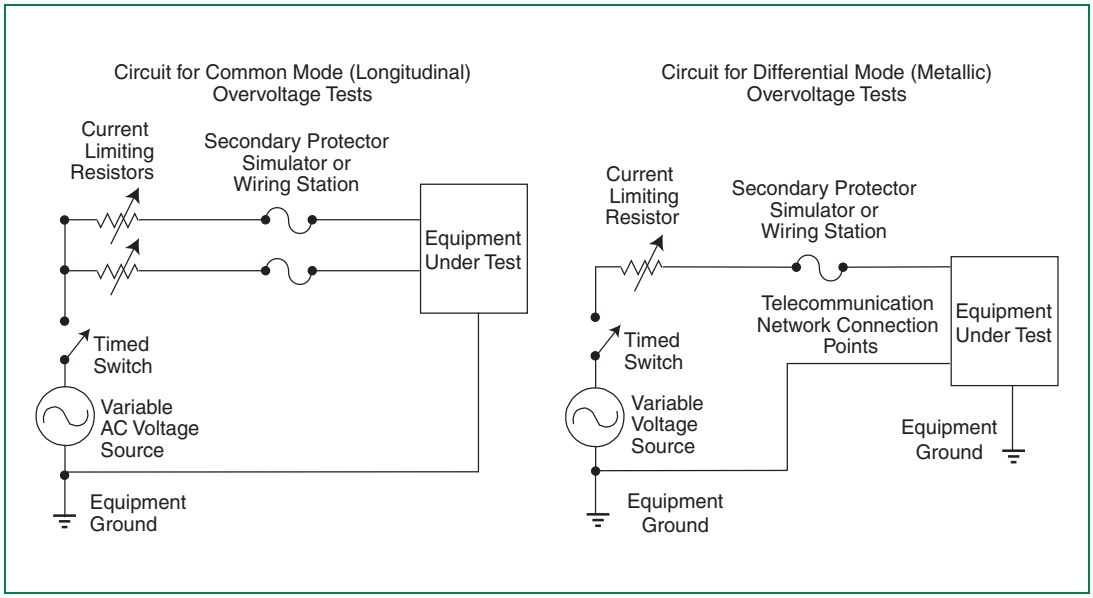


Figure 7.12 UL 497A Overvoltage Test

UL 497B

UL 497B provides requirements for protectors used in communication and fire alarm circuits. This standard does not cover devices for primary protection or protection devices used on telephone lines. *SIDACtor*® devices are components recognized in accordance with UL 497B under UL file number E133083.

Construction and Performance Requirements

The “Construction” section covers the following requirements:

- General
- Corrosion Protection
- Field-wiring Connections
- Components
- Spacing
- Fuses

The “Performance” section covers the following requirements:

- General
- Strike Voltage Breakdown
- Endurance Conditioning
- Temperature Test
- Dielectric Voltage-withstand Test
- Vibration Conditioning
- Jarring Test
- Discharge Test
- Repeated Discharge Test
- Polymeric Materials Test
- High Temperature Test
- Marking

Performance Requirements Specific to *SIDACtor*® Devices

1. Strike Voltage Breakdown Test—Protectors are required to break down within the manufacturer’s specified breakdown range or within 10% of a nominal single breakdown voltage rating. (Figure 7.13)
2. Endurance Conditioning—Protectors are subjected to 50 impulse cycles. Each cycle is a 1000 V peak, 10 A, 10x1000 µs pulse. Pulses are applied in one polarity at 10-second intervals and then repeated in the opposite polarity.
3. Variable Ambient Conditioning—Protectors must comply with the strike voltage requirements after being subjected to an ambient temperature of 0 °C for four hours and again after being subjected to an ambient temperature of 49 °C for an additional four hours.
4. Discharge Test—Protectors must comply with strike voltage requirements after being subjected to five successive discharges from a 2 µF capacitor charged to 1000 V dc. (Figure 7.14)
5. Repeated Discharge Test—Protectors must not break down at a voltage higher than the manufacturer’s maximum rated breakdown voltage nor lower than rated stand-off voltage after being subjected to 500 discharges from a 0.001 µF capacitor charged to

10,000 V dc. The discharges are applied in five-second intervals between one side of the protector and Ground. Upon completion of the discharge tests, protectors are once again required to meet the strike voltage requirement. (Figure 7.14)

Note: The epoxy used to construct a *SIDACtor* device body meets UL 94V-0 requirements for flammability.

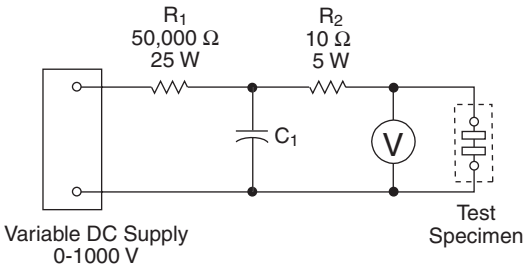


Figure 7.13 UL 497B Strike Voltage Breakdown Test

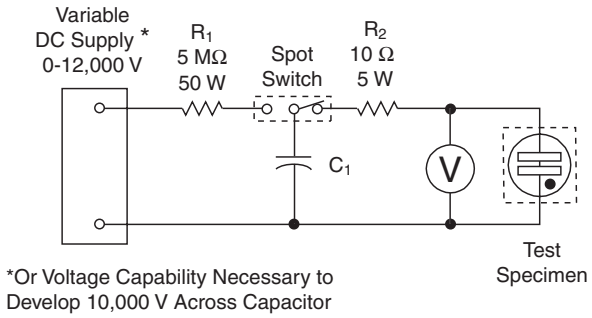


Figure 7.14 UL 497B Discharge Test

UL 497C

UL 497C requirements cover protectors for use on coaxial cable circuits. This standard covers construction and performance requirements.

UL 497C Construction and Performance Requirements

The “Construction” section covers the following requirements:

- General
- Corrosion Protection
- Field-wiring Connections
- Components
- Spacing
- Enclosures

The “Performance” section covers the following requirements:

- General
- I^2t Limiting
- Abnormal Sustained Current
- Component Temperature Test
- Breakdown Voltage Measurement
- Impulse Spark-over Voltage Measurement
- Limited Short-circuit Test
- High Current Ground Path Test
- Cable Shield Fuse Test
- Endurance Conditioning Test
- Induced Low Current Test
- Distortion Test
- Flame Test
- Impact Test (Polymeric Enclosures)
- Jarring Test
- Water Spray Test
- Leakage Current Test
- Dielectric Voltage-withstand Test
- Ultraviolet Light and Water Exposure
- Tensile Strength and Elongation Tests
- Air Oven Aging
- Ozone Exposure

Performance Requirements Specific to *SIDACtor*® Devices

1. Strike Voltage Breakdown Test—Protectors are required to break down within ±25% of the manufacturer’s specified breakdown range but no higher than 750 V at ≤ 2 kV/s rise time.
2. Endurance Conditioning—Protectors are subjected to 500 impulse cycles. Each cycle is a 1000 V peak, 10 A, 10x1000 µs pulse. Pulses are applied in one polarity at 10-second intervals and then repeated in the opposite polarity. Then, 100 cycles of 1000 V peak, 100 A, 10x1000 µs pulse are applied to three new protectors. Finally, two cycles of 1000 V peak, 5000 A, 8x20 µs pulse are applied to three new protectors, with a rest period of one minute between surges.

3. Variable Ambient Conditioning—Protectors must comply with the strike voltage requirements after being subjected to an ambient temperature of 25 °C for four hours and again after being subjected to an ambient temperature of 90 °C for an additional four hours.
4. Discharge Test—Protectors must comply with strike voltage requirements after being subjected to a discharge of 1000 V, 100 ± 10 V/µs, 10 A impulse.

Mainland China Standard—YD/T 950-1998

YD/T 950-1998 establishes the technical requirements and test methods for protection against overvoltages and overcurrents on telecommunication switching equipment for Mainland China.

This Standard is based on the ITU-T Recommendation K.20 “Resistibility of Telecommunication Equipment Installed in a Telecommunications Center for Overvoltages and Overcurrents” (1996 version).

It was approved by the Ministry of Information Industry of the People’s Republic of China on August 7, 1998 and has been in effect since September 1, 1998.

Technical Requirements

The following major transmission parameters and interface feature parameters of the equipment should comply with requirements contained in GF 002-9002 or YD 344:

- Transmission loss
- Loss frequency distortion
- Gains changing with input level
- Cross talk
- Scratching noise
- Return loss
- Unbalanced earth impedance

After the following tests are conducted, the equipment should provide normal communications functions and comply with these requirements.

Without primary protection:

1. When the lightning waveform is 10/700 µs and the peak voltage is 1 kV
2. When the induction voltage of the power line is 600 V rms and the duration is 0.2 s

With primary protection:

1. When the lightning waveform is 10/700 µs and the peak voltage is 4 kV
2. When the induction voltage of the power line is 600 V rms and the duration is 1 s

Without primary protection, the equipment should be fireproof when it is in contact with power lines with a voltage of 220 V rms for a duration of 15 minutes and should provide normal communications functions after the test.

After the equipment is tested for contact discharge at an electrostatic voltage of 6 kV or for air discharge at 8 kV, it should provide normal communications functions.

Test Methods

All tests should be conducted in the following standard atmospheric conditions:

- Temperature: 15 °C ~ 35 °C
- Relative humidity: 45% ~ 75%
- Air pressure: 86 ~ 106 kPa

Test procedure sequence is as follows:

1. Normal equipment operation
2. Characteristics and parameters
3. Simulation of lightning strike
4. Check of functions
5. Power line induction
6. Check of functions
7. Check of functions
8. ESD
9. Check of functions
10. Power line contact
11. Characteristics and parameters

Table 7.20 Simulation of Lightning Strike

Testing Terminals	V/I Waveform	Peak Voltage	Peak Current	Number of Tests	Primary Protection
Tip to Ring Grounded	10x700 / 5x310	1 kV	25 A	±5	No
Ring to Tip Grounded	10x700 / 5x310	1 kV	25 A	±5	No
Tip and Ring to Ground	10x700 / 5x310	1 kV	25 A	±5	No
Tip to Ring Grounded	10x700 / 5x310	4 kV	100 A	±5	Yes
Ring to Tip Grounded	10x700 / 5x310	4 kV	100 A	±5	Yes
Tip and Ring to Ground	10x700 / 5x310	4 kV	100 A	±5	Yes
Tip and Ring to Ground *	10x700 / 5x310	1 kV	25 A	±5	No

* Simultaneous surge for 50% of the ports

Power Line Induction

Without primary protection:

600 V, 1 A, 0.2 s applied between Tip and Ring to Ground five times

With primary protection:

600 V, 1 A, 1 s applied between Tip and Ring to Ground five times

Time between successive events shall be one minute. Characteristics and parameters shall be tested within 30 minutes after the completion of these events.

Power Line Contact

Without primary protection:

220 V rms @ 0.367 A, 1, 1 A, 22 A for 15 minutes applied between Tip and Ring to Ground one time each

With primary protection:

220 V rms 0.367 A for 15 minutes applied between Tip and Ring to Ground five times

ESD

±5 repetitions direct contact with one-second duration between successive discharges

±5 repetitions indirect contact (0.1 m distance) with one-second duration between successive discharges

Table 7.21 Waveform Parameters

Indicated Voltage	Peak of Initiation of the Discharge Currents I_p	Time of Rising During Discharge Switch On / Off t_r	Current at 20 ms I_1	Current at 60 ns I_2
6 kV	22.5 A ± 10%	0.7–1 ns	12 A ± 30%	6 A ± 30%

Mainland China Standard—YD/T 993-1998

YD/T 993-1998 establishes the technical requirements and test methods for lightning protection of telecommunication terminal equipment for Mainland China.

This Chinese Standard parallels the ITU-T K.21 “Resistibility of Subscriber’s Terminal to Overvoltages and Overcurrents” (1996) document very closely. This standard is the technical basis for simulated lightning induced event testing requirements for Telecommunication Terminal Equipment such as modems, fax machines, telephone sets, and so on.

Table 7.22 Surge Simulations for Tip and Ring Connections

Lightning Surge Test Conditions			Voltage and Current Waveform µs	Test Voltage / Current * (kV/A)
Without Primary Protection	Metallic Test	Single Tip and Ring Pair	10x700 / 5x310	1.5/37.5
			10x700 / 5x310	1.5/37.5
	Longitudinal Test	Single Tip and Ring Pair	10x700 / 5x310	1/25
			10x700 / 5x310	1/25
		All Tip and Ring Pair	10x700 / 5x310	1/25
			10x700 / 5x310	1/25
With Primary Protection	Metallic Test	Single Tip and Ring Pair	10x700 / 5x310	4/100
			10x700 / 5x310	4/100
	Longitudinal Test	Single Tip and Ring Pair	10x700 / 5x310	4/100
			10x700 / 5x310	4/100
		All Tip and Ring Pair	10x700 / 5x310	4/100
			10x700 / 5x310	4/100

* All tests are conducted ±5 times with at least one minute between events.

Table 7.23 Surge Simulations for Power Line Connections

Lightning Surge Test Conditions			Voltage and Current Waveform µs	Test Voltage / Current * (kV/A)
Without Primary Protection	Metallic Test	Power Line	1.2x50 / 8x20	1.5/750
			1.2x50 / 8x20	1.5/750
	Longitudinal Test	Power Line	1.2x50 / 8x20	1/83.3
			1.2x50 / 8x20	1/83.3
With Primary Protection	Metallic Test	Power Line	1.2x50 / 8x20	4/2000
			1.2x50 / 8x20	4/2000
	Longitudinal Test	Power Line	1.2x50 / 8x20	4/333.3
			1.2x50 / 8x20	4/333.3

* All tests are conducted ±5 times with at least one minute between events.

Normal operation of EUT is not required during the lightning surge simulation test. However, all functions of the EUT should meet the requirements of relevant standards after the completion of these tests. All lightning surge simulation tests should be conducted at:

- Temperature: 15 °C – 35 °C
- Relative humidity: ±5% – ±75%
- Air pressure: 86 – ±56 kPa

Once the lightning surge simulation testing is completed, an electric isolation test is conducted. The power is removed from the unit for this test.

Table 7.24 Electrical Insulation Test

Equipment Type	Voltage / Current	V&I Waveform µs	Repetition
Handheld	2.5 kV / 62.5 A	10x700 / 5x310	±5
Non-handheld	1.5 kV / 37.5 A	10x700 / 5x310	±5

Measure the insulation with 500 V dc voltage after the completion of the insulation test. The resistance should be no less than 2 MΩ.

Mainland China Standard—YD/T 1082-2000

YD/T 1082-2000 establishes the technical specifications on overvoltage and overcurrent protection of access network equipment for Mainland China.

This Chinese Standard parallels the ITU-T K series. This Standard specifies the technical requirements and test methods for overvoltage and overcurrent protection and the basic environmental adaptability of access network equipment. This Standard does not deal with protection against radiated electromagnetic fields.

The specifications as presented here are a succinct summary of the lightning surge, power fault, and ESD testing required by this document.

The ports of the Network equipment are classified into five categories:

I. Ports used to connect the twisted pairs introduced from outside of the building, namely analog user interface, ISDN-BRA interface, ADSL interface, and so on

II. Twisted pair ports used to interconnect the different equipment inside the building, namely V.24 interface, V.35 interface, 2048 kbits/s interface connected to twisted pairs, 10/100 Base-T Ethernet interface, and so on

III. Coaxial cable port: 2048 kbits/s interface connected to coaxial cables, ISDN-PRA interface, and so on

IV. AC Power interface

V. DC power interface

The sequence of testing shall follow this order:

ESD ⇒ EFT ⇒ simulation of lightning strike ⇒ power line induction ⇒ power line contact

ESD Testing

The environmental conditions for ESD testing shall be:

- Temperature—15 °C ~ 35 °C
- Relative humidity—30% ~ 60%
- Air pressure —86 ~ 106 kPa

The waveform of the generator should meet the requirements of YD/T 950 as shown in the following table.

Table 7.25 Waveform Parameters

Indicated Voltage	Peak of Initiation of the Discharge Currents I_p	Time of Rising During Discharge Switch On / Off t_r	Current at 20 ms I_1	Current at 60 ns I_2
6 kV	22.5 A ± 30%	0.7–1 ns	12 A ± 30%	6 A ± 30%

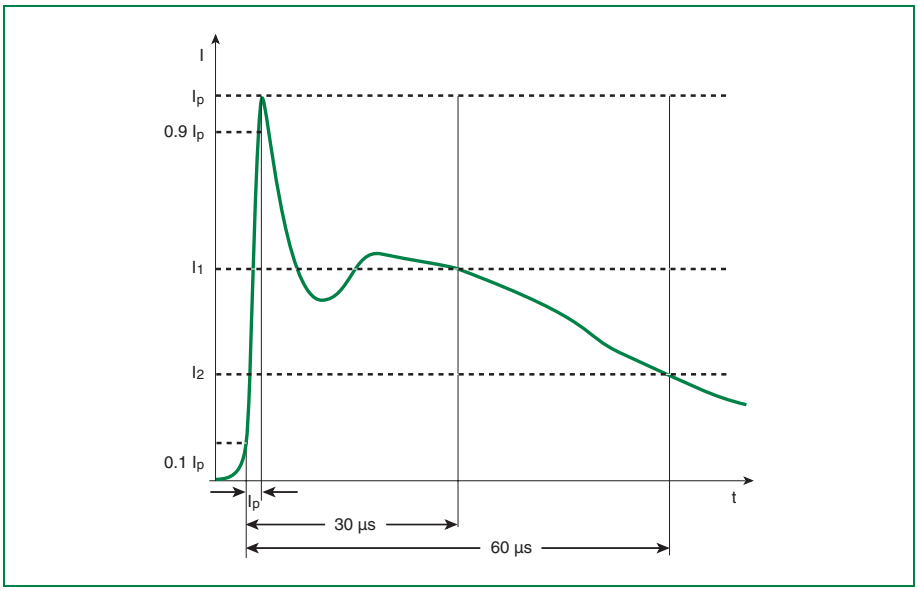


Figure 7.15 ESD Waveform

Establish a communications link via any port of the EUT before the test. The communications link should be capable of normal use without being attended to manually after the test.

EFT (Electrically Fast Transient)

Waveform of the generator should meet the requirements of ITU-T K.34.

Table 7.26 EFT

Tested Port	Number of Ports		Test Conditions
	Remote	Central Office	
I	1	—	1 kV, 5 kHz, ≥ 1 min
II	1	1	1 kV, 5 kHz, ≥ 1 min
III	1	1	1 kV, 5 kHz, ≥ 1 min
IV	1	—	2 kV, 2.5 kHz, ≥ 1 min
V	—	1	2 kV, 2.5 kHz, ≥ 1 min
VI	—	1	2 kV, 2.5 kHz, ≥ 1 min

Table 7.27 Lightning Surge Test Conditions

Class of Port	Number of Ports		Voltage and Current Waveforms µs	Amplitude *
	Central Office	Remote		
I	—	3	10/700 – 5/310	4 kV
		8	1.2/50 – 8/20	6 kA
II	1	1	1.2/50 – 8/20	500 V
III	1	1	1.2/50 – 8/20	500 V
IV	—	1	1.2/50 – 8/20	10 kV, 5 kA
V	1	1	1.2/50 – 8/20	500 V

* All tests are conducted ±5 times with at least one minute between events.

Table 7.28 Power Line Induction and Power Line Contact Testing

Tested Port	Number of Ports		Test Conditions
	Remote	Central Office	
I	3	—	600 V, 600Ω, 50 Hz, 1 s
I	1	—	220 V, 50 Hz, 1 h, 600/200/10Ω

Certification and Accreditation Administration of the People's Republic of China

Type testing and initial inspection of the factory and follow-up inspection similar to UL standards shall be required in China.

The formal application shall be submitted with the following documents:

1. Circuit diagram and/or system block
2. List of critical components and/or materials
3. Description of the difference between the different model/type of products in the same application unit.
4. Service manual and user's manual in Chinese
5. Nameplate and warnings in Chinese
6. Other necessary documents

Testing standards are as follows:

1. GB4943-1995 *Safety of Information Technology Equipment Including Electrical Business Equipment*
2. YD/T993 *Technical Requirements and Test Methods of Lightning Resistibility for Telecommunication Terminal Equipment*
3. GB9254-1998 *Information Technology Equipment—Radio Disturbance Characteristics – Limits and Methods of Measurement*
4. YD1103 *Requirements and Measurement Methods of Electromagnetic Compatibility for Cordless Telephone*
5. YD1032 *Limits and Measurement Methods of Electromagnetic Compatibility for 900/1800 MHz Digital Cellular Telecommunications System Part 1: Mobile Station and Ancillary Equipment*
6. YD1169.1 *Requirement and Measurement Method of Electromagnetic Compatibility for 800 MHz CDMA Digital Cellular Telecommunications System Part 1: Mobile Station and Ancillary Equipment*

These documents require:

1. Test items for safety
   Note: The test items for safety shall include all appropriate items specified in standards of GB4943-1995.
2. Testing items for lightning, lightning test of telecommunication interface, and lightning test of power line
3. Testing items for EMC

Standard	Testing Item
GB9254	Radiated emissions Conducted emissions

Standard	Testing Item
YD1103	Radiated emissions Conducted emissions Electrostatic discharge (ESD) immunity Radiated radio-frequency electromagnetic field immunity Electric fast transient / burst immunity Immunity to conducted disturbance, induced by radio-frequency fields
YD1032	Conducted spurious emissions Radiated spurious emissions Radiated emissions Conducted emissions Electrostatic discharge (ESD) immunity Electric fast transient / burst immunity Surge immunity
YD1169.1	Conducted spurious emissions Radiated spurious emissions Radiated emissions Conducted emissions Electrostatic discharge (ESD) immunity Radiated radio-frequency electromagnetic field immunity Electric fast transient / burst immunity Surge immunity
YD1103 only applies to cordless telephone and YD1032 applies to GSM mobile terminal while YD1169.1 only applies to CDMA mobile terminal.	

The following parameters outline testing procedures for lightning-induced surges and power fault events:

- Surge requirements:
  100 A 10x1000 waveform
  10 A, 50 Hz, 1 s
  5 A, 50 Hz, 30 s
  260 V on 100 kV/s
  400 V on 1 kV/µs
- Temperature limits: -40 to 65 °C
- Insulation leakage requirements: 0.1 µA @ 100 V dc
- Maximum load capacitance: 200 pF

The following is actual text of the circular from the Certification and Accreditation Administration of the People's Republic of China (CNCA).

Circular Relevant to the Implementation of the Compulsory Product Certification System

by the Certification and Accreditation Administration of the People's Republic of China (CNCA)
December 3, 2001

The Compulsory Product Certification System (CPCS) is jointly announced for statutory implementation by the State General Administration for Quality Supervision and Inspection and Quarantine of the People's Republic of China (AQSIQ) and the Certification and Accreditation Administration of the People's Republic of China (CNCA). This new system consists of Regulations for Compulsory Product Certification, Regulations for Compulsory Product Certification Mark, and the First Catalogue of Products Subject to Compulsory

Certification (hereinafter referred to as the Catalogue), and so on. The Old System, namely, the Safety License System for Import Commodities administered by the former State Administration for Entry-Exit Inspection and Quarantine of the People's Republic of China (CIQ), and the Compulsory Supervision System for Product Safety Certification administered by the former China State Bureau of Quality and Technical Supervision (CSBTS), will be replaced. The following circular is announced concerning the transition from the Old System to the New System.

1. *The time when the New System is implemented and the Old System is annulled*
   Regulations for Compulsory Product Certification stipulates that the New System be implemented on May 1, 2002 and the Old System be annulled on May 1, 2003 so as to ensure a smooth transition and an effective safeguard of the legitimate rights and interests of all the parties concerned.
2. *Supervision of products applicable to either the New System or the Old System*
   1) Starting from May 1, 2003, the Catalogue products either marketed by domestic manufacturers or imported must obtain the certificate for compulsory product certification (hereinafter referred to as the New Certificate) and be applied China Compulsory Certification mark (hereinafter referred to as the New Mark) before they are imported or marketed.
   2) Starting from May 1, 2003, the sales outlets or importers are not permitted to purchase, import or sell the Catalogue products that do not bear the New Certificate and the New Mark. Whereby the Catalogue products that are purchased or imported before April 30, 2003 and bear either the Import Safety License and CCIB Mark or the Safety Certificate and the Great Wall Mark (hereinafter referred to as the Old Certificate and the Old Mark) may still be sold under the supervision of the AQSIQ local branches with which such products are filed.
   3) Starting from May 1, 2003, if the Catalogue products that have obtained the New Certificate and the New Mark need continue to use the outer packing applied with the Old Mark, they can be marketed or imported only when the New Mark is applied along with the Old Mark.
   4) Prior to April 30, 2003, the Catalogue products for which the Old Certificate and the Old Mark is compulsory can be marketed or imported by either the Old Certificate and the Old Mark or the New Certificate and the New Mark.
   5) Starting from May 1, 2002, with regard to products for which the Old Certificate and the Old Mark was compulsory but being no longer covered by the Catalogue this time, the Old Certificate and the Old Mark will not be required when they are marketed or imported.
3. *The acceptance of the certification application*
   1) Starting from May 1, 2002, the certification bodies designated by CNCA (hereinafter referred to as DCBs) begin to accept applications for the New Certificate and the New Mark relevant to the Catalogue products and will no longer accept applications for the Old Certificate and the Old Mark.
   2) Prior to April 30, 2002, the Catalogue products for which the Old Certificate and the Old Mark is compulsory may continue to apply for the Old Certificate and the Old Mark.
4. *Supplements*
   1) With regard to the Catalogue products for which the application has already been filed but the Old Certificate is yet to be granted, or for which the Old Certificate has been granted, the New Certificate and the New Mark can be granted upon further application by the applicant and the confirmation of the product's qualification by the DCB.
   2) The cost incurred for the New Certificate an the New Mark referred to in 4.1 will be

borne by the applicant based on the actual items required according to the fee chart of the New System.

Regulations for Compulsory Product Certification
Chapter I General Provisions

Article 1

Based on relevant laws and regulations covering product safety licensing and product quality certification so as to improve and enhance regulatory functions in the field of compulsory product certification as well as to effectively safeguard national and public interests in a feasible manner, the following regulations are announced for statutory implementation in accordance with the functions of the State General Administration for Quality Supervision and Inspection and Quarantine of the People's Republic of China (AQSIQ) and the Certification and Accreditation Administration of the People's Republic of China (CNCA) authorized by the State Council.

Article 2

The Compulsory Product Certification System (hereinafter referred to as CPCS) is applied to products related to human life and health, animals, plants, environmental protection and national security.

Article 3

Authorized by the State Council, CNCA is in charge of nation-wide certification and accreditation activities.

Article 4

With regard to CPCS, one Catalogue of Products Subject to Compulsory Product Certification (hereinafter referred to as the Catalogue), one set of applicable technical regulations, national standards and conformity assessment procedures, one obligatory mark and one structural fee chart will be announced for statutory implementation.

Article 5

Any product covered by the Catalogue must first be certified by a certification body designated by relevant competent authorities (hereinafter referred to as DCB). The subject product must obtain the certificate and be applied the certification mark before it can be marketed, imported or used for any commercial purposes.

Regulatory Compliant Solutions

When determining the most appropriate solution to meet the lightning and AC power fault conditions for regulatory requirements, coordination is essential between the *SIDACtor*® device, fuse, and any series impedance that may be used.

Figure 7.16 and Figure 7.17 show templates in which this coordination is considered for the most cost effective and reliable solutions available. For exact design criteria and information regarding the applicable regulatory requirements, refer to the *SIDACtor* device and fuse selection criteria in this Section 7, “Regulatory Requirements”, and in Section 8, “Technical Notes”.

GR 1089 and ITU-T K.20 and K.21

Figure 7.16 and Figure 7.17 show line interface protection circuits to meet GR 1089 surge immunity requirements without the additional use of series resistance. Use the “C” series *SIDACtor* device and 04611.25 to meet GR 1089 surge immunity requirements. Use the “A” series *SIDACtor* device and 0461.500 to meet ITU-T K.20 and K.21 basic surge immunity requirements without the additional use of resistance.

The enhanced surge immunity requirements of ITU K.20 and K.21 require the use of “C” rated *SIDACtor* devices if no series resistor is used.

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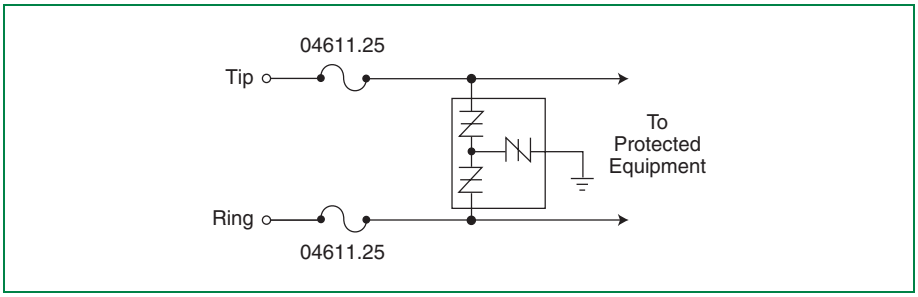

Figure 7.16 Balanced Line Protection using Littelfuse’s “AC” or “AA” series

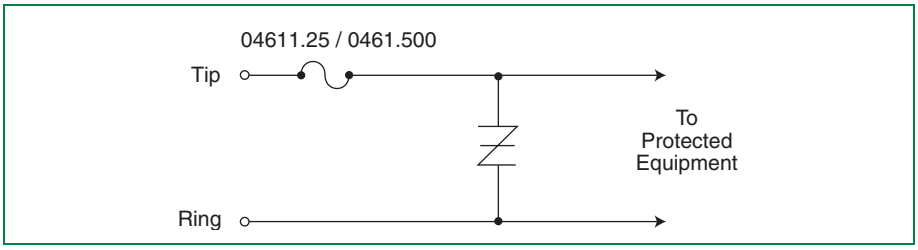

Figure 7.17 Metallic-only Solution using Littelfuse’s “SC” or “SA” series

Coordination Considerations

Coordination between the primary protection and the secondary protection may require the addition of a resistor. (Figure 7.18)

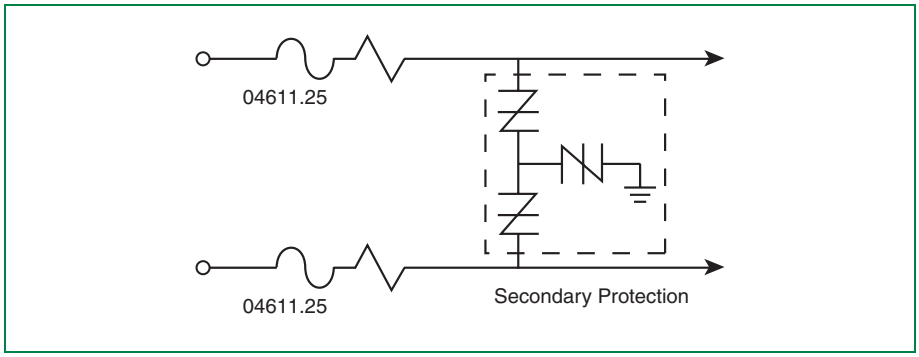

Figure 7.18 Coordination Solution with Resistor

The coordinating resistor value depends on:

- Distance between the primary and secondary protector
- Turn-on characteristics of the primary and secondary protector
- Surge rating of the secondary protector

For compliance with the GR 1089 requirement, the additional component is not required IF the peak pulse surge rating of the secondary protector is at least 100 A for a 10x1000 event. The ITU recommendations have an alternative solution as well, depending on whether Basic or Enhanced compliance is desired.

For Basic compliance, if the secondary protector has a peak pulse surge rating of at least 1000 A for an 8x20 event, then the additional component is not required. For the Enhanced level, it must be able to withstand a 5000 A for an 8x20 event; otherwise, a coordinating component is required. This component allows the primary protector to turn on during surge events even though the secondary protector may turn on first. The power rating of this resistor can be reduced by including the *TeleLink*® overcurrent protection device. However, it must not open during the surge events. Typically, a 1-3 W resistor will be sufficient.

TIA-968-A (formerly known as FCC Part 68) and UL 60950

Because equipment that is tested to TIA-968-A specifications is also generally tested to UL 60950 specifications, it is easiest to look at a solution that meets both FCC and UL requirements simultaneously.

TIA-968-A Operational Solution and UL 60950

Figure 7.19 and Figure 7.20 show line interface protection circuits that meet UL 60950 power fault requirements and pass TIA-968-A Type A and Type B lightning immunity tests operationally.

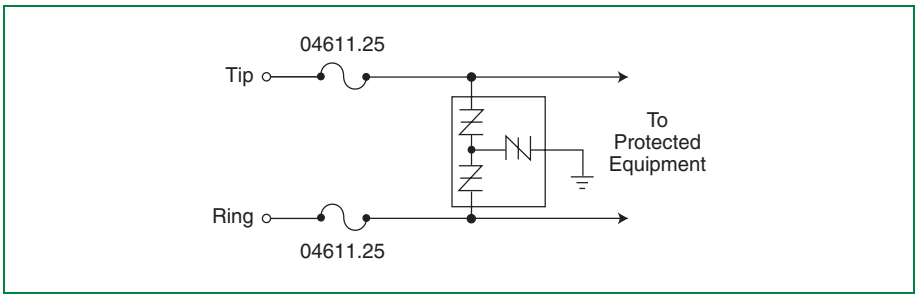

Figure 7.19 Balanced Line Protection using Littelfuse's "AC" Series

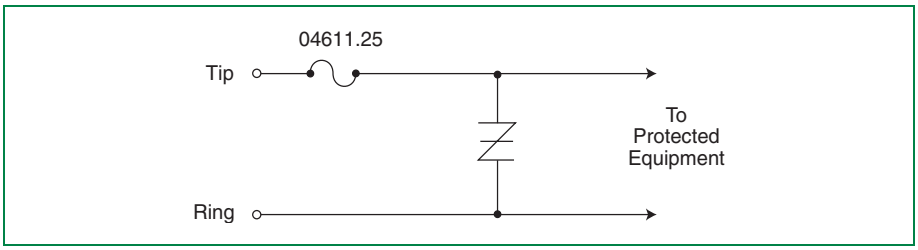

Figure 7.20 Metallic-only Solution using Littelfuse's "SB" or "EB" Series

TIA-968-A Non-Operational Solution and UL 60950

Although the circuits shown in Figure 7.19 and Figure 7.20 provide an operational solution for TIA-968-A, TIA-968-A allows telecommunications equipment to pass Type A surges non-operationally as well. For non-operational TIA-968-A solutions, coordinate the I_{PP} rating of the *SIDACtor* device and the I^2t rating of the fuse so that both will withstand the TIA-968-A Type B surge, but that during the Type A surge the fuse will open.

Figure 7.21 and Figure 7.22 are line interface protection circuits that meet UL power fault requirements and pass TIA-968-A lightning immunity surge A tests "non-operationally."

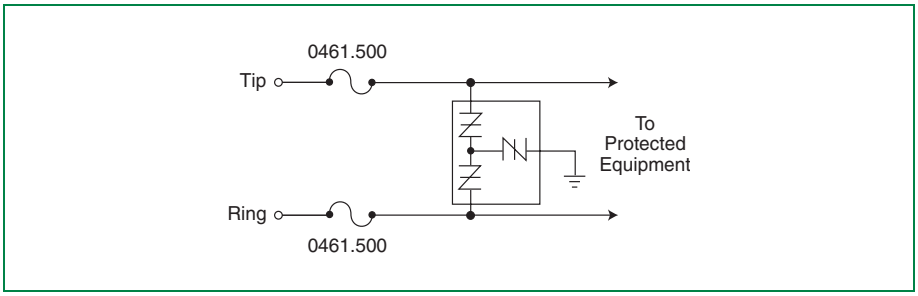

Figure 7.21 Balanced Line Protection using Littelfuse's "AA" Series

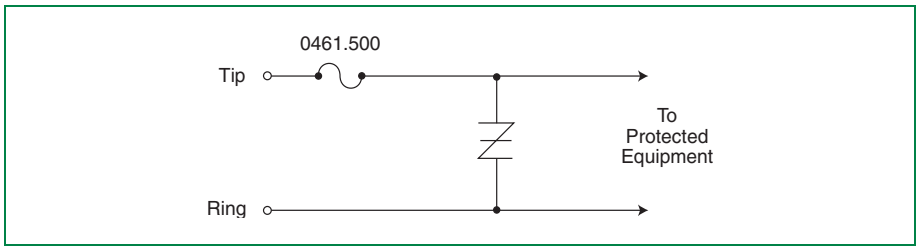

Figure 7.22 Metallic-only Solution using Littelfuse's "SA" or "EA" Series

Surge Waveforms for Various Standards

TIA-968-A now replaces FCC Part 68, except for hearing aid compatibility (HAC), volume control, and indoor cabling. This has become harmonized with Canadian requirements. Various countries around the world have adopted this regulation.

GR 1089 is a standard generally supported by the US Regional Bell Operating Companies (RBOC). It is updated by Telcordia Technology (formerly Bellcore). The RBOC typically requires compliance with GR 1089 for any of their telecom purchases.

ITU is a specialized agency of the UN devoted to international harmonization. Most European countries recognize the ITU standards.

CNET is the Centre National d'etudes de Telecommunications, a French organization.

VDE is the Verband Deutsher Elektrotechniker, a Federation of German electrical engineers. VDE is very similar to the IEEE (Institute of Electrical and Electronics Engineers) but is national in scope rather than global.

ANSI is the American National Standards Institute, which is a non-government organization. The British equivalent to this is BSI.

IEC is the International Electrotechnical Commission, a result of Europe's move toward a single market structure and its drive to formalize and harmonize member countries' requirements.

FTZ R12 is a German specification.

Table 7.29 shows the recommended *SIDACtor*® device surge rating for each standard.

Table 7.29 Surge Waveforms for Various Standards

Standard		Voltage	Voltage Waveform	Current	Current Waveform	*SIDACtor* Device
		Volts	µs	Amps	µs	w/o series R
TIA-968-A	Surge A Metallic	800	10x560	100	10x560	B or C
	Surge A Longitudinal	1500	10x160	200	10x160	C
	Surge B Metallic	1000	9x720	25	5x320	A, B, or C
	Surge B Longitudinal	1500	9x720	37.5	5x320	A, B, or C
GR 1089	Test 1	600	10x1000	100	10x1000	C
	Test 2	1000	10x360	100	10x360	B or C
	Test 3	1000	10x1000	100	10x1000	C
	Test 4	2500	2x10	500	2x10	C
	Test 5	1000	10x360	25	10x360	A, B, or C
CNET 131-24		1000	0.5x700	25	0.8x310	A, B, or C
VDE 0433		2000	10x700	50	5x310	A, B, or C
VDE 0878		2000	1.2x50	50	1x20	A, B, or C
IEC 61000-4-5		2000	1.2x50	50	8x20	A, B, or C
		4000	1.2x50	100	8x20	A, B, or C
		4000	10x700	100	5x310	B or C
FTZ R12		2000	10x700	50	5x310	A, B, or C
YD/T 993-1998	Without Primary Protection Metallic, Single Tip and Ring Pair	1500	10x700	37.5	5x310	A, B, or C
		1500	10x700	37.5	5x310	A, B, or C
	Without Primary Protection Longitudinal, Single Tip and Ring Pair	1500	10x700	37.5	5x310	A, B, or C
		1500	10x700	37.5	5x310	A, B, or C
	Without Primary Protection Longitudinal, All Tip and Ring Pair	1000	10x700	25	5x310	A, B, or C
		1000	10x700	25	5x310	A, B, or C
	With Primary Protection Metallic, Single Tip and Ring Pair	4000	10x700	100	5x310	C
		4000	10x700	100	5x310	C
	With Primary Protection Longitudinal, Single Tip and Ring Pair	4000	10x700	100	5x310	C
		4000	10x700	100	5x310	C
	With Primary Protection Longitudinal, All Tip and Ring Pair	4000	10x700	100	5x310	C
		4000	10x700	100	5x310	C
		Without Primary Protector / With Primary Protector				
ITU K.20	Basic single port	1000 / 4000	10x700	25 / 100	5x310	A, B, C / B, C
	Enhanced single	1500 / 4000	10x700	37.5 / 100	5x310	A, B, C / B, C
	Basic multiple ports	1500 / 4000	10x700	37.5 / 100	5x310	A, B, C / B, C
	Enhanced multiple	1500 / 6000	10x700	37.5 / 100	5x310	A, B, C / C
	Basic power fault	600	50 Hz, 60 Hz	1	0.2 s	04611.25
	Enhanced power fault	600 / 1500	50 Hz, 60 Hz	1 / 7.5	0.2 s / 2 s	04611.25
ITU K.21	Basic single port	1500 / 4000	10x700	37.5 / 100	5x310	A, B, C / B, C
	Enhanced single	6000 / 6000	10x700	37.5 / 150	5x310	A, B, C / C
	Basic multiple ports	1500 / 4000	10x700	37.5 / 100	5x310	A, B, C / B, C
	Enhanced multiple	1500 / 6000	10x700	37.5 / 150	5x310	A, B, C / C
	Basic power fault	600	50 Hz, 60Hz	1	0.2 s	04611.25
	Enhanced power fault	600 / 1500	50 Hz, 60Hz	1 / 7.5	0.2 s / 2 s	04611.25