ITU-T Recommendations
Application Note

Telecommunication equipment has become ever more sensitive to overvoltage and overcurrent hazards on telephone lines. Conventional transformer-based architectures have been replaced by sensitive IC-based architectures. At the same time, the dependence on telecommunication systems and the increased competition between telecom operators has increased the need for highly reliable telecommunication network equipment with low maintenance costs.

Overvoltage and overcurrent hazards usually result from lightning, from transients induced by adjacent power lines, from direct contact with power lines, or from malfunctioning subscriber equipment. These hazards may destroy valuable network equipment and even cause injury to subscribers and maintenance personnel. The rising cost of advanced telecommunication system failure, the increase of unattended equipment in remote locations, and subscribers' high service expectations all make loss of a telephone line from overcurrent faults unacceptable. Consequently, a number of telecom equipment manufacturers have turned to resettable overcurrent protection devices, such as the PolySwitch device, and foldback devices, such as the SiBar device, in order to increase the reliability and safety of equipment and reduce the cost of maintenance.

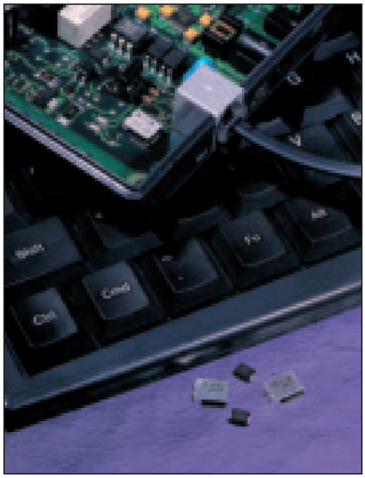
The Problem

All network equipment is exposed to two types of electrical hazards. The first hazard results from natural lightning strikes that can sometimes directly hit a network, though more often they induce high-voltage spikes in the pair of telephone wires. These spikes can damage sensitive electronic equipment at either end of the network, and therefore they need to be shunted to ground by using overvoltage devices such as SiBar devices.

The second hazard comes from induced AC power currents or from direct AC power contact. If the voltage of an overcurrent event is below the breakover voltage of the overvoltage protection, the result is continuous current into the equipment, which can damage downstream electronic components. On the other hand, when the voltage of the overcurrent fault is higher than the breakover voltage of the overvoltage protection device, then the overvoltage device itself needs to be protected from prolonged exposure to high current. A PolySwitch overcurrent protection device used in conjunction with a SiBar device can provide protection against both events.

Industry Recommendations: ITU-T

In most of the world, network switching and transmission equipment manufacturers must meet requirements, such as those recommended by the ITU-T (Telecommunication Standardization Sector of the



International Telecommunication Union). The ITU-T issues publications and recommendations on the protection of telecommunication equipment. The most relevant ITU-T recommendations are listed in Table 1.

The continual evolution of telecommunication networks leads to the evolution of standards worldwide. The ITU-T committee will shortly publish a revised set of recommendations within the K series. Described in the following pages are some of the requirements included in the K.20 and K.21 recommendations.

Recommendation K.20, relating to telephone exchanges and similar switching centers, is summarized in Table 2 and Figures 1 through 5. The ITU-T distinguishes between unexposed and exposed areas. Unexposed areas have low lightning activity and relatively low soil resistivity. Cities often are classified as unexposed areas. All other

3

environments are classified as exposed areas (mainly rural areas). The equipment is usually expected to operate satisfactorily in both environments. The test conditions with agreed primary protection simulate proper functioning in the more severe environments.

Recommendation K.21 deals with subscribers' terminals and assumes that line protectors are fitted externally to the equipment in exposed areas. It is summarized in Table 3.

Table 1. Most Relevant ITU-T Publications

Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines.
Recommendation K.11 Principles of protection against overvoltages and overcurrents.
Recommendation K.12 Characteristics of gas discharge tubes for the protection of telecommunications installations.
Recommendation K.20 Resistibility of telecommunication switching equipment to overvoltages and overcurrents.
Recommendation K.21 Resistibility of subscribers' terminals to overvoltages and overcurrents.
Recommendation K.28 Characteristics of semiconductor arrestor assemblies for the protection of telecommunications installations.
Recommendation K.30 Characteristics of self-restoring current-limiting devices.
Recommendation K.36 Selection of protective devices.
Recommendation K.44 Resistibility of telecommunication equipment to overvoltages and overcurrents.
Recommendation K.45 Resistibility of access network equipment to overvoltages and overcurrents.

Upcoming modifications in the ITU-T K series recommendations

The ITU-T committee has been reviewing the K.20 and K.21 recommendations. Soon to be published is a new set of recommendations:

- **K.44** seeks to establish fundamental testing methods and criteria for the resistibility of telecommunication equipment to overvoltages and overcurrents for use by network operators and manufacturers. This recommendation is overarching and thus will not specify either test levels or particular acceptance criteria for specific equipment. The appropriate test levels and test points will be contained in the specific product family recommendations (K.20, K.21, K45).
- **K.20** will specify resistibility requirements and test procedures for telecommunication equipment installed in a telecommunication center.
- **K.21** will specify resistibility requirements and test procedures for telecommunication equipment installed in or on a customer premise.
- **K.45** will specify resistibility requirements and test procedures for telecommunication equipment installed between a telecommunication center and customer premise.

Following either K.20, K.21, or K.45 is based on the type of grounding employed at the location of the equipment. For grounding recommendations related to K.20, K.21, and K.45 equipment, refer to recommendations K.27, K.31, and K.35 respectively.

Recommendations will include lightning, power induction, and power contact tests. These will include both "basic" and "enhanced" level tests, with optional higher power induction levels and a lightning coordination test. Resettable protection is required to meet the enhanced power contact test.

Please contact your local Raychem Circuit Protection representatives for the latest information on the status and timing of ITU-T regulatory changes.

Overcurrent Solution

PolySwitch overcurrent protection devices are positive temperature coefficient (PTC) devices that are resettable devices designed to protect sensitive telecommunications network equipment from overcurrent faults. When an overcurrent fault occurs, the resistance of a TR250, TC250, TCF250, TS250, or TSV250 PolySwitch device increases from its base resistance, by several decades, to a much higher resistance, effectively isolating the fault. In its high-resistance state the surface

(continued on page 82)

Table 2. Summary of ITU-T K.20, Resistability of telecommunications equipment installed in customer premises to overvoltage and overcurrents, Edition February 2000. This summary pertains to test conditions for ports connected to external symmetric pair cables.

	Test No.	Test Description	Test Circuit and Waveshape	Basic Test Levels	Enhanced Test Levels	Number of Tests	Primary Protection	Acceptance Criteria
Single port lightning tests	1.1.a[1]	inherent longitudinal	Figure 1 and Figure 2 10/700 µs	$U_{C(MAX)}$ = 1.0 kV R = 25Ω	$U_{C(MAX)}$ = 1.5 kV R = 25Ω	5 of each polarity	None	A
	1.1.b[1]	inherent transverse	Figure 1 and Figure 3a & 3b 10/700 µs	$U_{C(MAX)}$ = 1.0 kV R = 25Ω	$U_{C(MAX)}$ = 1.5 kV R = 25Ω	5 of each polarity	None	A
	1.2.a[2]	coordination longitudinal	Figure 1 and Figure 2 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 4 kV R = 25Ω	5 of each polarity	Special test protector (Note 3, next page)	A During the test, the special test protector must operate at $U_c = U_{C(MAX)}$
	1.2.b[2]	coordination transverse	Figure 1 and Figure 3a & 3b 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 4 kV R = 25Ω	5 of each polarity		
Multiple port lightning tests	1.3[3]	inherent longitudinal	Figure 1 and Figure 4 10/700 µs	$U_{C(MAX)}$ = 1.5 kV R = 25 Ω	$U_{C(MAX)}$ = 1.5 kV R = 25 Ω	5 of each polarity	None	A
	1.4[4 5]	longitudinal	Figure 1 and Figure 4 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 6 kV R = 25Ω	5 of each polarity	Agreed primary protector (Note 4, next page)	A
Lighting current tests	1.5[6]	Single port	8/20 µs current generator and Figure 2	I = 1 kA/wire R = 0Ω	I = 5 kA/wire R = 0Ω	5 of each polarity	None	A
	1.6[4 6]	Multiple port	8/20 µs current generator and Figure 4	I = 1 kA/wire Limited to 6 kA total R = 0Ω	I = 5 kA/wire Limited to 30 kA total R = 0Ω	5 of each polarity	None	A
Power induction tests	2.1.a[1]	inherent longitudinal and earth potential rise	Figure 5 and Figure 2	$W_{SP(MAX)}$ = 0.2 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$ = 600 V	$W_{SP(MAX)}$ = 0.2 A^2s Frequency = 16 2/3 50 or 60 Hz $U_{A.C.(MAX)}$ = 600 V	5	None	A
	2.1.b[1]	inherent transverse	Figure 5 and Figure 3a & 3b	R = 600Ω t = 0.2 s	R = 600Ω t = 0.2 s	5	None	A
	2.2.a[2]	inherent/ coordination longitudinal and earth potential rise	Figure 5 and Figure 2	$W_{SP(MAX)}$ = 1 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$=600 V R = 600Ω	$W_{SP(MAX)}$ = 10 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$=1500 V R = 200Ω	5	Special test protector (Note 3, next page)	A
	2.2.b[2]	inherent/ coordination transverse	Figure 5 and Figure 3a & 3b	t = 1.0 s (Note 1, next page)	$t_{(MAX)}$ = 2 s (4-1/K.20) (Note 2, next page)	5		A
Mains power contact tests	3.1.a[7 8]	longitudinal	Figure 5 and Figure 2	$U_{A.C.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000Ω.	$U_{A.C.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000Ω	1	None	For basic level: Criterion B. For enhanced level: Criterion A for test resistors 160, 300 and 600 W, Criterion B for the other resistor
	3.1.b[7 8]	transverse	Figure 5 and Figure 3a & 3b	See acceptance criteria column.	See acceptance criteria column.	1	None	

[1] This test does not apply when the equipment is designed to be always used with primary protection.
[2] When the equipment contains high current carrying components which eliminate the need for primary protection, refer to 10.1.1/K.44.
[3] The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports. This test does not apply when the equipment is designed to be always used with primary protection.
[4] The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports.
[5] When the equipment contains high current carrying components which eliminate the need for primary protection, do not remove these components and do not add primary protection.
[6] This test only applies when the equipment contains high current carrying components which eliminate the need for primary protection.
[7] Refer to I.1.4 of K.44/Appendix I for guidance on performing this test.
[8] When the equipment is designed to be always used with primary protection, perform this test with the special test protector.

Note 1: The test conditions for the Test 2.2 (basic test level) may be adapted to the local conditions, by variation of the test parameters within the following limits, so that I^2t equal to = 1 A^2s is fulfilled: $U_{A.C.(MAX)}$ = 300 V........600 V, selected to meet local conditions; t≤1.0 s, selected to meet local conditions; R≤600 W, is to be calculated according to equation 1:

$$R = U_{A.C.(MAX)} \sqrt{\frac{t}{1A^2s}}$$

Note 2: For Test 2.2 (enhanced test level), the equipment shall comply with the specified Criterion for all voltage/time combinations bounded (on and below) by the 10 A^2s voltage/time curve defined by equation 1 and boundary conditions in 2.1.a through 3.1.b in Table 2.

Note 3: Special test protector is a component or circuit used to replace the agreed primary protector for purposes of confirming coordination. More information can be found in ITU-T K.44 section 8.4.

Note 4: Agreed primary protection is a type of surge protective device that is used to protect the equipment based on an agreement between manufacturer and the network operator. The agreed primary protection can be nothing if it has been agreed that no external protection elements need to be used. More infomation can be found in ITU-T K.44.

Table 3. Summary of ITU-T K.21, Resistability of telecommunications equipment installed in customer premises to overvoltage and overcurrents, Edition October 2000. This summary pertains to test conditions for ports connected to external symmetric pair cables.

	ITU Test No.	Test Description	Test Circuit and Waveshape	Basic Test Levels	Enhanced Test Levels	Number of Tests	Primary Protection	Acceptance Criteria
Single port lightning tests	1.1.a[1]	inherent longitudinal	Figure 1 and Figure 2 10/700 µs	$U_{C(MAX)}$ = 1.5 kV R = 25Ω	$U_{C(MAX)}$ = 6 kV R = 25Ω	5 of each polarity	None	A
	1.1.b[1]	inherent transverse	Figure 1 and Figure 3a & 3b 10/700 µs	$U_{C(MAX)}$ = 1.5 kV R = 25Ω	$U_{C(MAX)}$ = 1.5 kV R = 25Ω	5 of each polarity	None	A
	1.2.a[2]	coordination longitudinal	Figure 1 and Figure 2 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 6 kV R = 25Ω	5 of each polarity	Special test protector (Note 3, next page)	A During the test, the special test protector must operate at $U_C = U_{C(MAX)}$
	1.2.b[2]	coordination transverse	Figure 1 and Figure 3a & 3b 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 6 kV R = 25Ω	5 of each polarity		
Multiple port lightning tests	1.3[3]	inherent longitudinal	Figure 1 and Figure 4 10/700 µs	$U_{C(MAX)}$ = 1.5 kV R = 25 Ω	$U_{C(MAX)}$ = 1.5 kV R = 25 Ω	5 of each polarity	None	A
	1.4[4 5]	longitudinal	Figure 1 and Figure 4 10/700 µs	$U_{C(MAX)}$ = 4 kV R = 25Ω	$U_{C(MAX)}$ = 6 kV R = 25Ω	5 of each polarity	Agreed primary protector (Note 4, next page)	A
Lighting current tests	1.5[6]	Single port	8/20 µs current generator and Figure 2	I = 1 kA/wire R = 0Ω	I = 5 kA/wire R = 0Ω	5 of each polarity	None	A
	1.6[4 6]	Multiple port	8/20 µs current generator and Figure 4	I = 1 kA/wire Limited to 6 kA total R = 0Ω	I = 5 kA/wire Limited to 30 kA total R = 0Ω	5 of each polarity	None	A
Power induction tests	2.1.a[1]	inherent longitudinal and earth potential rise	Figure 5 and Figure 2	$W_{SP(MAX)}$ = 0.2 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$ = 600 V R = 600Ω t = 0.2 s	$W_{SP(MAX)}$ = 0.2 A^2s Frequency = 16 2/3 50 or 60 Hz $U_{A.C.(MAX)}$ = 600 V R = 600Ω t = 0.2 s	5	None	A
	2.1.b[1]	inherent transverse	Figure 5 and Figure 3a & 3b			5	None	A
	2.2.a[2]	inherent/ coordination longitudinal and earth potential rise	Figure 5 and Figure 2	$W_{SP(MAX)}$ = 1 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$=600 V R = 600Ω t = 1.0 s (Note 1, next page)	$W_{SP(MAX)}$ = 10 A^2s Frequency = 16 2/3, 50 or 60 Hz $U_{A.C.(MAX)}$=1500 V R = 200Ω $t_{(MAX)}$ = 2 s (4-1/K.20) (Note 2, next page)	5	Special test protector (Note 3, next page)	A
	2.2.b[2]	inherent/ coordination transverse	Figure 5 and Figure 3a & 3b			5		A
Mains power contact tests	3.1.a[7 8]	longitudinal	Figure 5 and Figure 2	$U_{A.C.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000Ω.	$U_{A.C.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000Ω	1	None	For basic level: Criterion B. For enhanced level: Criterion A for test resistors 160, 300 and 600 W, Criterion B for the other resistor
	3.1.b[7 8]	transverse	Figure 5 and Figure 3a & 3b	See acceptance criteria column.	See acceptance criteria column.	1	None	

[1] This test does not apply when the equipment is designed to be always used with primary protection.

[2] When the equipment contains high current carrying components which eliminate the need for primary protection, refer to 10.1.1/K.44.

[3] The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports. This test does not apply when the equipment is designed to be always used with primary protection.

[4] The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports.

[5] When the equipment contains high current carrying components which eliminate the need for primary protection, do not remove these components and do not add primary protection.

[6] This test only applies when the equipment contains high current carrying components which eliminate the need for primary protection.

[7] Refer to I.1.4 of K.44/Appendix I for guidance on performing this test.

[8] When the equipment is designed to be always used with primary protection, perform this test with the special test protector.

[9] If the inherent protection of the port under test contains surge protective devices that are connected to ground, $U_{C(MAX)}$ of 1.5 kV shall be used instead of 6 kV

[10] If equipment has an insulted case, the 6 kV test is applied with equipment wrapped in conductive foil and the foil is connected to the generator return.

Note 1: The test conditions for the Test 2.2 (basic test level) may be adapted to the local conditions, by variation of the test parameters within the following limits, so that I^2t equal to = 1 A^2s is fulfilled: $U_{A.C.(MAX)}$ = 300 V........600 V, selected to meet local conditions; t≤1.0 s, selected to meet local conditions; R≤600 W, is to be calculated according to equation 1:

$$R = U_{A.C.(MAX)}\sqrt{\frac{t}{1A^2s}}$$

Note 2: For Test 2.2 (enhanced test level), the equipment shall comply with the specified Criterion for all voltage/time combinations bounded (on and below) by the 10 A^2s voltage/time curve defined by equation 1 and boundary conditions in 2.1.a through 3.1.b in Table 3.

Note 3: Special test protector is a component or circuit used to replace the agreed primary protector for purposes of confirming coordination. More information can be found in ITU-T K.44 section 8.4.

Note 4: Agreed primary protection is a type of surge protective device that is used to protect the equipment based on an agreement between manufacturer and the network operator. The agreed primary protection can be nothing if it has been agreed that no external protection elements need to be used. More infomation can be found in ITU-T K.44.

Figure 1. ITU-T K.44 10/700 µs Voltage Surge Generator

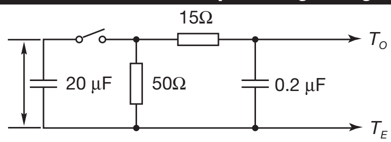


Figure 2. Example of Test Circuit for Longitudinal Overvoltage or Overcurrent Tests on a Single Port

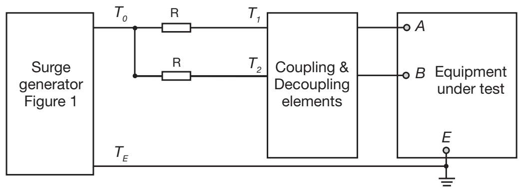


Figure 3a. Example of Test Circuit for Tranverse Overvoltage or Overcurrent Tests on Single Port—Terminal A to Ground

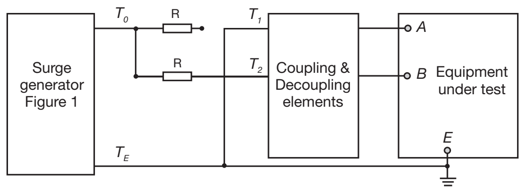


Figure 3b. Example of Test Circuit for Tranverse Overvoltage or Overcurrent Tests on Single Port—Terminal B to Ground

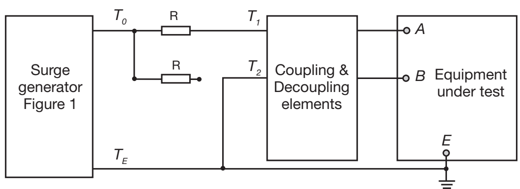


Figure 4. Example of Test Circuit for Longitiudinal Overvoltage and Overcurrent Tests on Multiple Ports

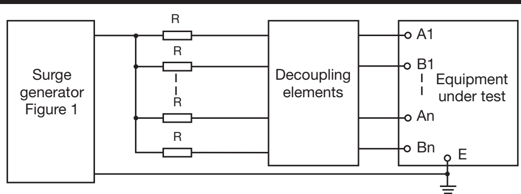
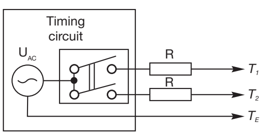


Figure 5. Power Induction, Power Contact and rise of nuetral potential generator. Appropriate values for current limiting resistors, R, are listed in the for K.20 and K.21 are listed in Tables 1 and 2 respectively.



temperature of the device will be approximately 120°C. A small trickle current will maintain the PolySwitch device in its high-resistance state, dissipating little power. Once the fault condition and power are removed, the PolySwitch device—unlike a fuse—will reset to a low impedance state so normal telephone operation can resume.

Fast Tripping

At currents between 200 and 350mA, PolySwitch 250V devices will trip before damage to the line interface can occur. PolySwitch devices, however, are not tripped by lightning-induced transients. Most alternate solutions, like fuses, that are lightning robust will not trip until an overcurrent fault of more than 500mA exists, allowing a much larger current to pass into the subscriber line interface card (SLIC). This higher level can damage telecommunication equipment.

PolySwitch devices typically trip faster than ceramic PTC devices, limiting power let-through and allowing downstream electronic components such as secondary overvoltage devices and resistors to be sized smaller.

Small Size, Multiple Form Factors

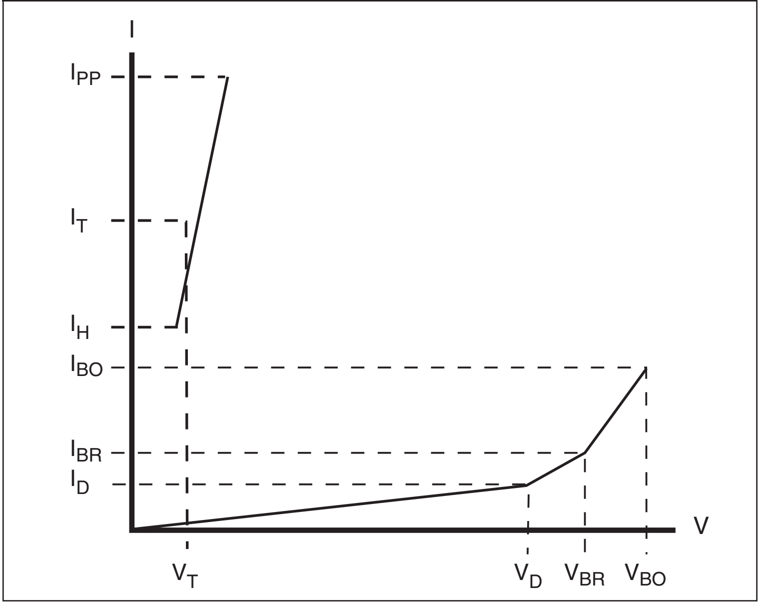
PolySwitch devices are typically smaller than ceramic PTC devices for a given resistance. Furthermore, they can be supplied as surface-mount, radial-leaded, and chip-form factors to fit the stringent space requirements of compact protection modules and tightly packed PC boards.

Overvoltage Solution

SiBar thyristors overvoltage protectors are foldback devices which have the current-voltage curve shown in Figure 6. The device is normally in a "high resistance" state for voltages below the breakover voltage. In this state very little current flows through the device when voltage is across the device. When the voltage exceeds the breakover voltage, the device "folds back", creating a low-impedance path and effectively shorting out the overvoltage condition. The device will remain in this low-impedance state until the current through the device is decreased below its hold rating. SiBar devices are designed so that the I_{HOLD} of the device is typically >200mA, above the maximum loop current in the telecom system. After an overvoltage event has passed, the device can reset to its high-impedance state and allow normal system operation to occur.

For a given fault current, the power dissipated in a thyristor is much smaller than a clamp device such as a metal oxide varistor or an avalanche diode, since the voltage across the foldback device will be smaller. This allows the device to be smaller. The smaller size results in lower capacitance, which is highly desirable for higher speed communication equipment. The silicon-based device allows the breakover voltage to be accurately set, and it will not degrade after multiple fault events. The SiBar devices are supplied in an SMB surface-mount package to meet the space requirements of densely packed electronic boards.

Figure 6. Current-Voltage Curve of a SiBar Foldback Device



Application

Figure 7 displays a typical protection system employed by network equipment manufacturers in order to comply with ITU-T K.20 requirements. The SiBar device protects the sensitive electronics from fast overvoltage events, including lightning transients. The line feed resistor serves the purpose of regulating the steady-state current to the telephone.

The 250V families of PolySwitch devices provide current limiting that may be required during power contact events that have a voltage lower than the fold-back voltage of the SiBar device. Additionally, the base resistance of the PolySwitch device limits the current during events that exceed the foldback voltage of the SiBar device, thus enabling the SiBar device to survive.

Figure 7. Typical Protection System for Network Equipment

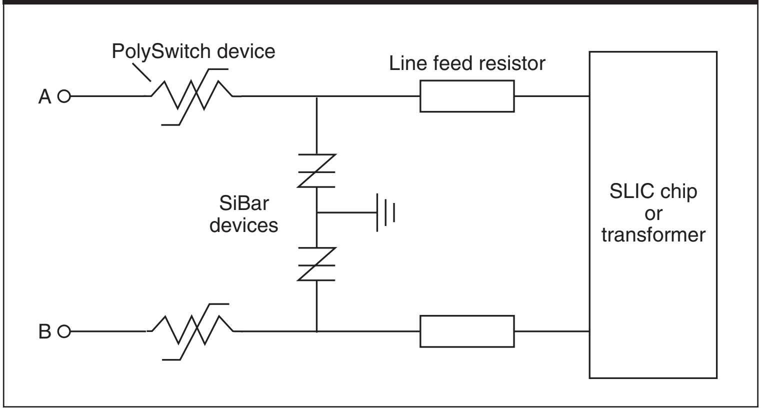


Table 4.
Summary of Field Studies Showing 50/60-Hz AC Overcurrent Faults

Study Location (Author)	Frequency of 50/60 Hz Faults	Characteristics of Faults
Canada (Bell Canada)		Average voltage: 300V
USA (AT&T)		Average voltage: 371V; average current: 2.71A
USA (BellSouth)		Average voltage: 300V
Italy (SIP)		Average voltage: 430V; average current: 2.35A
France (FranceTelcom)	7.3 events per line per year	75% of voltage below 200V
Australia (Telstra)	5 events per line per year	95% of voltage below 600V peak. 98.7% of current below 5A peak.

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Table 5. PolySwitch Devices for ITU-T Requirements

Device	I_{hold} (mA)	Resistance (Ω)	Typical Trip Time at 1A (s)
TCF250-120T	120	6.3–12.0	0.6
TR250-120	120	4.0–8.0	1.5
TR250-120T	120	6.0–10.5	0.6
TS250-130	130	6.5–12.0	1.5
TSV250-130	130	4.0–7.0	2.0
TR250-145	145	3.0–6.0	2.0
TR250-180	180	0.8–2.0	10.5

PolySwitch Device Benefits

When a PolySwitch device is installed in the circuit, it provides two important advantages. First, it protects the line feed resistors from overheating. Without a PolySwitch device, during AC sneak current events (that is, currents in the 200mA to 1A range), these resistors do not fuse open. They typically overheat and can damage the circuit board. If a PolySwitch device is installed, it limits the sneak current and prevents overheating of the line feed resistor.

Second, network equipment manufacturers and network operators have to provide a highly reliable telecommunication service, with minimal loss of system availability and minimal maintenance costs. If nonresettable overcurrent protection is used, even after the overcurrent fault is cleared, the circuit will be out of service, and a service technician will have to be dispatched to change the line card or subscriber's terminal. However, with a PolySwitch resettable device, the circuit will reset and telephone service will resume without need for repair or a service call.

The most probable range of overcurrent hazards as measured in field studies is shown in Table 4. Typical currents measured are from 350mA up to 5A.

Device Selection

As described in Figure 7, use of the PolySwitch device requires coordinated design between the line feed resistor, the secondary overvoltage protection device, and the SLIC circuit. Please refer to the TR, TS, TSV product line data for specific information on resistance, switching speed, dimensions, and current and voltage ratings. Please refer to the TVB data section of this Databook for specific information on SiBar devices.

Table 5 shows the most important characteristics of the PolySwitch 250V devices. All of these devices (TR250, TC250, TCF250, TS250, TSV250) are rated to interrupt ITU power faults. Upon inspection of Tables 2 and 3, one notes tests conducted with and without primary protection in place. SiBar TVBxxxSA devices are rated at 50A under a 10/1000-μs waveform. This device rating exceeds all surge currents obtainable under ITU K.20 and K.21 lightning test without primary protection in place. When a primary protector is in place, sufficient line impedance (resistance and/or inductance) must be in place between the primary overvoltage protector and the secondary overvoltage protector to ensure that the primary protector operates under the lightning test.

SiBar devices used in conjunction with TR250, TC250, TCF250, TS250, and TSV250 devices will assist the designer in meeting the power induction and power contact test conditions specified by ITU K.20 and K.21. The appropriate PolySwitch device and SiBar device must be evaluated and tested for each application.

Hundreds of Millions of Lines Protected

PolySwitch devices are in use all over the world, as resettable overcurrent protection elements in central office switching equipment, digital loop carriers, primary protection modules, subscriber protection equipment, PBXs, and subscriber equipment. A number of newer technologies—such as ADSL modems, T1 repeaters, ISDN lines, and others—have also included PolySwitch resettable device protection.

SiBar devices are designed to assist in meeting the overvoltage requirements of ITU K.20 and K.21 and can be used in secondary applications where PolySwitch devices are currently being used. Please refer to the SiBar-TVB product line data for information and check with your local Raychem Circuit Protection representative.