Short-haul/Intrabuilding Protection Requirements
Application Note

Problem/Solution

The need for data exchange, either locally or over the Internet, has led to a rapid proliferation of intrabuilding communication systems in enterprise, industrial, and residential environments.

Enterprise environments and global local network connectivity systems are rapidly proliferating. These systems interconnect data-based systems, digital telephones using Voice over Internet Protocol (VoIP), the Public Switched Telephone Network (PSTN), and company controlled Wide Area Network (WAN) and others shown in Figure 1 are separated from the external environment by gateways, routers, and switches. More recently wireless networks receivers can also provide access for a business without any physical connection to the PSTN. In the consumer or residential environment, cable-based systems are now available which can provide telephony service through VoIP, again without connecting directly to the PSTN. Circuit protection for this equipment might be different from that for conventional network or customer premise equipment.

In the industrial plant, RS-485 and RS-232 data communications systems provide control and feedback from centralized controllers to remote equipment, frequently through unshielded twisted pair wires. Communications systems in general need to be protected from

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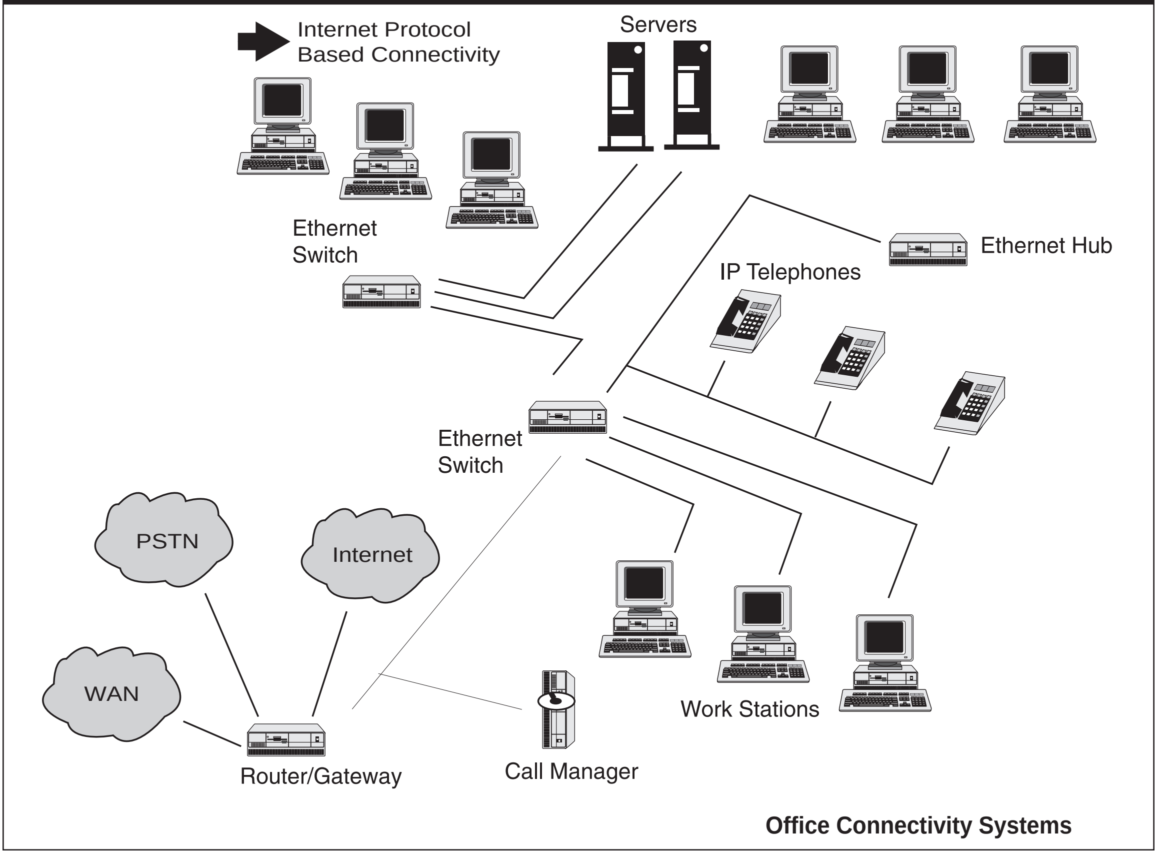
Figure 1. Emerging Enterprise Connectivity Systems Illustrating Intrabuilding Circuit Protection Applications



three basic hazards: power contact, power induction, and lightning. PolySwitch resettable devices and SiBar TSPDS (Thyristor Surge Protection Devices) are available to protect equipment against such faults.

Potential Hazards

While power contact or power induction from interaction with the medium voltage distribution system is not an issue, accidental power cross with low voltage power lines, e.g. 120V or 240V, can be a common occurrence, especially during the initial installation. It is common to hear of industrial data communications lines being miswired with AC power, or an errant staple from a staple gun inadvertently crossing the AC power line and the LAN line. Though not as severe as a power contact with distribution voltages, accidentally applying AC mains voltage to a communications line can create a serious safety hazard and damage or destroy expensive communications equipment.

The threat of lightning in intrabuilding installations is also less severe than for externally connected equipment, but still may present a hazard. Most buildings, especially those in high lightning areas, typically contain a lightning rod or other lightning protection scheme used to shunt direct or induced lightning strikes to ground and thus reduce the interaction with other conductors within the building. Though much less severe than lightning on external lines, overvoltages may still be induced in intrabuilding communications lines when lightning strikes are shunted through these lightning protection systems. Without protection, equipment connected to these lines can be damaged or destroyed and create a safety hazard as well.

Telcordia Intrabuilding Protection Requirements

Residing within the GR-1089-CORE specification published by Telcordia Technologies, (formerly Bellcore), are a set of requirements specifically meant for intrabuilding installations.

The requirements derive from the need to protect customer-resident networking equipment from the AC mains voltage power cross and induced lightning hazards as previously described. Table 1 on page 88 summarizes the key specification elements. These tests apply to a wide range of equipment. Telcordia GR-1089 specifies that: “paired-conductor interface ports shall be tested regardless of what type of traffic they carry or what function they perform. For example, 10 BaseT and 100 BaseT Ethernet and other ports are considered telecommunications ports and shall be tested”.

The lightning tests are applied either as a “metallic” waveform, i.e. using a potential difference tip-to-ring, or “longitudinal,” i.e. using a potential difference tip-to-ground and ring-to-ground. The lightning waveform should have a rise time of 2µsec and a time-to-half of 10µsec with a short-circuit current of 100A. For each longitudinal and metallic test, one surge is applied using positive voltage and one using negative voltage. The equipment must meet failure criterion A, i.e. it must continue to operate after the test. For example, if a fuse is used in the equipment it is not allowed to open during the test. If a generator capable of producing 2/10µsec surges is not available, an 8/20µsec open-circuit voltage waveform including an additional 6Ω resistor for Surge 1 or 12Ω resistor for Surge 2 may be substituted.

The power contact test comprises a single 120V/25A short-circuit surge applied for 15 minutes. The equipment must meet failure criterion B, i.e. it must not cause a fire as measured by a cheesecloth fire indicator wrapped around the equipment. A “wiring simulator”—typically a 1.6A fuse for test purposes—is also applied in series with the equipment and must not operate during the test. The use of a wiring simulator ensures that the current limiting device can operate fast enough to protect conventional communications wiring from creating a fire hazard within the building.

While 120V is an appropriate test voltage for North American residential and business installations, higher mains voltages may be present in other countries or in certain industrial applications. In these circumstances, it may be appropriate to conduct the power contact test at 250V to cover these applications.

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[1] These tests apply to a wide range of equipment and GR-1089 specifies that paired-conductor interrface ports shall be tested regardless of what type of traffic they carry or what function they perform. For example, 10 baseT and 100 baseT ethernet and other similar ports are considered telecommunications ports and should be tested.

Table 1. Summary of North America Intrabuilding Test Requirements

Spec Type and Level	Connection	Open Circuit Wave Form (µsec)	Open Circuit Voltage (V)	Short-Circuit Current (A)	Number of Surges	Test Results*	Note**
Lightning							
Surge 1	Metallic	2/10	800	100	± 1	A	1
Surge 2	Longitudinal	2/10	1,500	100	± 1	A	1
Spec type and level	**Primary Protection**	**Open Circuit Voltage (V)**	**Short-Circuit Current (A)**	**Duration Min.**	**Number of Surges**	**Test Results***	**Note****
Power Contact Level 2, Test 1	No	120	25	15 min	1	B	2

Note: * A = Must continue to operate after test.
B = Must not cause fire. Also, for equipment located on customer premise, a wiring simulator e.g. Bussman MDQ 1.6A fuse shall not open during the test.

** 1) Alternatively, a 1.2/50µsec (open-circuit voltage) and 8/20µsec short-circuit current waveshape may be used. Same voltages are used–current is limited by a 6Ω resistor for test 1 and 12Ω resistor for test 2.

2) Equipment containing a current-limiting device is to be tested as indicated, and repeated using an available short-circuit current just below the operating threshold of the current-limiting device. Alternatively, if a fuse is used it may be bypassed and the equipment tested at 135% of the rated fuse current.

Though not shown directly in the Table, Note 2 describes an important additional test which should be carried out if the equipment contains a current-limiting or overcurrent-protective device such as a fuse. In this situation, a power contact test is applied at 120V (or 250V) and a current just below the operating current of the current-limiting device. As an alternative test procedure, the specification states that the fuse can be bypassed and the equipment tested at 135% of the rated fuse current. For other current-limiting devices, it may be appropriate to use a slightly different current, as will be described later. In either case, the objective is to test the impact on the equipment of a fault current just below the operating point of the current limiting device.

ITU Recommendations

Neither ITU-T Recommendations K.20 or K.21 contains specific reference to intrabuilding protection applications. However, Appendix A to K.21 describes one of the purposes of the Recommendation as providing resistibility of equipment to “direct contacts between telecommunications lines and power lines, usually of a low voltage nature” and “surges due to direct and indirect lightning strikes on or near the line plant.”

In this regard the power contact test of ITU-T K.21 is particularly relevant to intrabuilding applications. This test comprises application of mains voltage (230V or as appropriate to the local power system) to the telecom terminals of the equipment for 15 minutes per the circuit diagram shown in Figure 2. The recommended pass-fail criteria is that the equipment should not create a fire hazard as a result of the test.

The resulting current-voltage conditions for equipment per ITU-T K.21 power contact test are essentially identical to those contained in the Bellcore Intrabuilding Specification at our recommended higher voltage. From Figure 2, assuming U_{AC} of 250V is applied to the 10Ω circuit impedance, this will produce a short-circuit fault current of 250V/10Ω = 25A, identical to that of the Bellcore specification. A summary of the recommended power contact test is shown in Table 2.

Intrabuilding Protection Solutions

PolySwitch TR250, TS250, TSL250, and TSV250 devices may be used to help meet both the Telcordia and ITU power contact requirements described in Table 2. Raychem Circuit Protection’s SiBar families of thyristor surge protectors (see section SiBar Thyristor) all meet the lightning requirements previously described in Table 1.

Recommended intrabuilding protection solutions are provided for a cable-based telephony system (See Figure 3) and for a linecard or grounded CPE interface (See Figure 4). As described above, a TR250-120, TS250-130, TSV250-130, or TSL 250-080 device and TVBxxxSA devices meet the requirements of the intrabuilding power cross and lightning requirements, respectively.

Figure 2. ITU-T K.21 Test Circuit for Power Contact

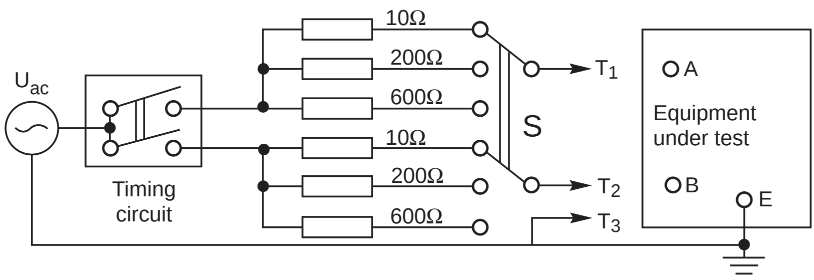

Table 2. Summary of Power Contact Test Procedures

Spec Type and Level	Open Circuit Voltage	Short-Circuit Current	Duration	Number of Surges	Test Results
Power Contact GR-1089 and ITU-T	250V	25A	15 min.	1	- No fire hazard - Wiring simulator does not open
Note 2 GR-1089	250V	Just below operating point of current-limiting device: - 135% of fuse rated current - 200% of PTC hold current	15 min.	1	- No fire hazard - Wiring simulator does not open

For multi-line applications, such as might be implemented for an apartment building or multi-family dwelling, identical protection is recommended for each twisted pair.

PolySwitch devices are available in both surface-mount (TS250 and TSV250-series) and radial-leaded (TR250-series) form factors. Additional hold currents are available for applications requiring faster time-to-trip or higher holding currents.

Device Selection

Telecommunications equipment which does not interface with the PSTN can have special protection needs. The Bellcore Intrabuilding Specification and a portion of ITU-T Recommendation K.21 provide a set of recommendations for protecting such equipment, examples of which include industrial data communications systems, equipment connected to LANs (e.g. routers and switches), WLL transceivers, and cable-based telephony systems.

TR250, TS250, TSL250, and TSV250 PolySwitch devices can be used with TVBxxxSA SiBar components or other applicable overvoltage protection to meet these needs. Correct selection and implementation of such protection can provide a coordinated, fully resettable solution which helps protect equipment against hazardous real-world fault conditions.

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Figure 3. Fully Resettable Protection Solution for Cable-based Telephony System

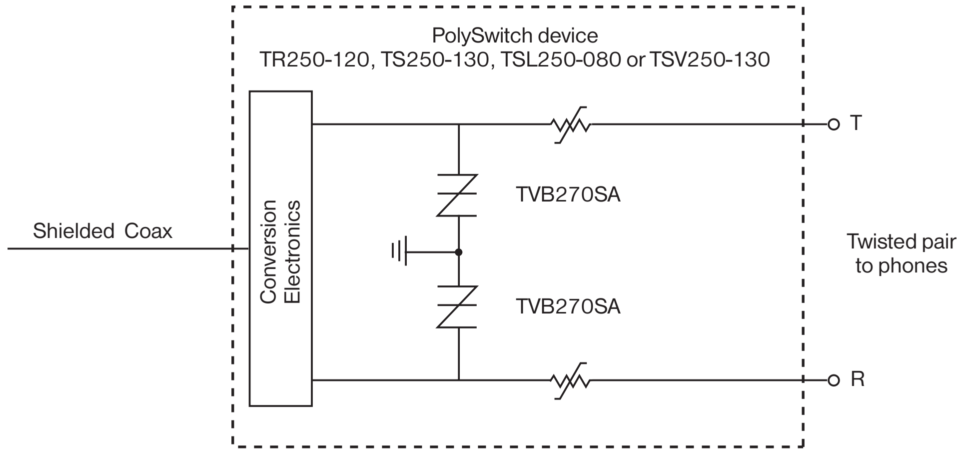

Figure 4. Linecard or Grounded CPE Protection