



Surge Protection and Grounding Issues

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 **TII**
network
technologies, inc.

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Introduction

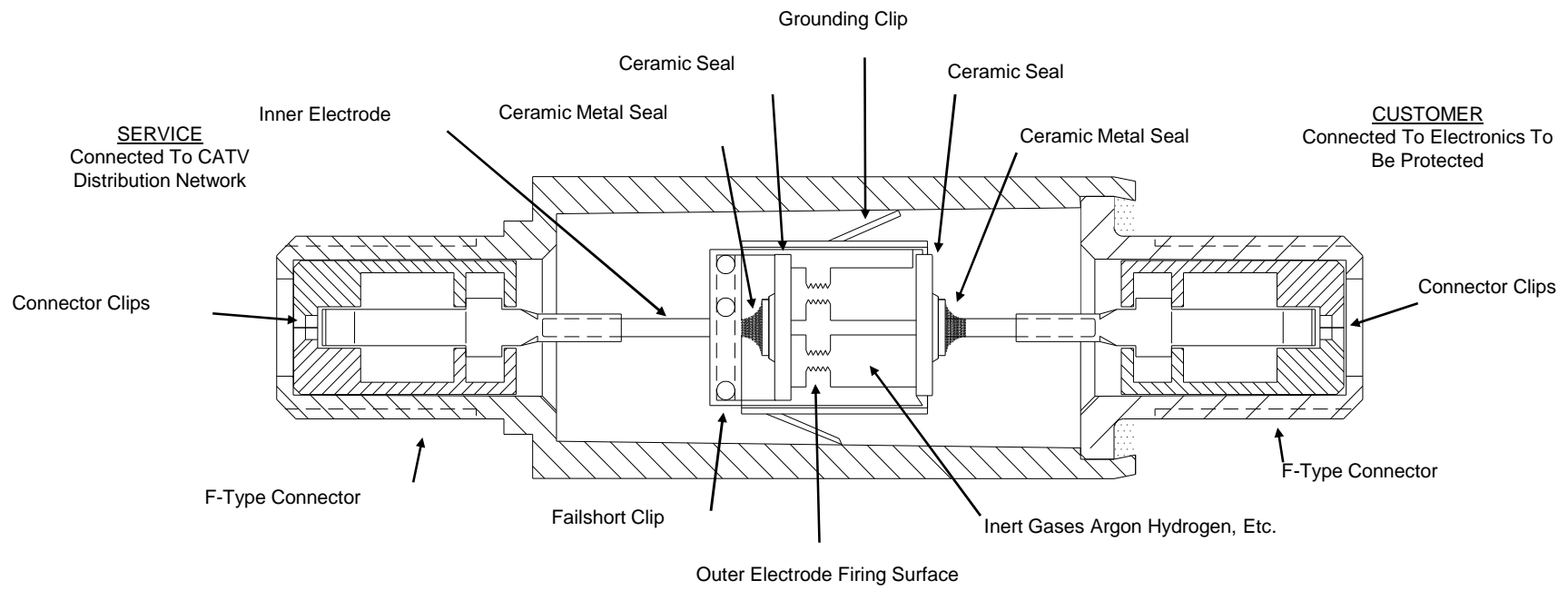
- Transients caused by disturbances on the power lines and by lightning strikes have been analyzed thoroughly for twisted pair transmission lines.
- It was assumed that the coaxial cable center conductor had not been affected by the transients on the coax cable. Considering multiple layers of outer conductor might provide adequate shielding and prevent any damage to the equipment connected to the coax cable.
- Reports from the field on damaged equipment suggest that the assumption of being protected is wrong. Many television sets, TV cable converters and other cable connected equipment have been damaged by transients. The degree of damage varies from large sections of a device being vaporized to simple degraded performance.

TII as a Surge Protection Provider

- TII has been in the forefront of providing quality surge protection devices to the telecommunications industry. TII at present has a number of high performance broadband coaxial surge protection devices just for 75 ohm coax cable surge protection at the customer premises.
- These surge protection devices have very minimal insertion loss up to the highest broadband frequencies used on CATV networks.



Coax Protector Design



Theory of Operation 1

- The body of the coax protector is a conductive nickel plated die cast zinc material. When grounded it forms the outer conductor of a coax line. The center conductor carries the RF signal.
- The 75 ohms impedance of the device is determined by the size of the center conductor, the air gap (or dielectric) and the inside diameter of the body. The coax gas tube consists of outer electrode, inner electrode and ceramic insulating discs.

Theory of Operation 2

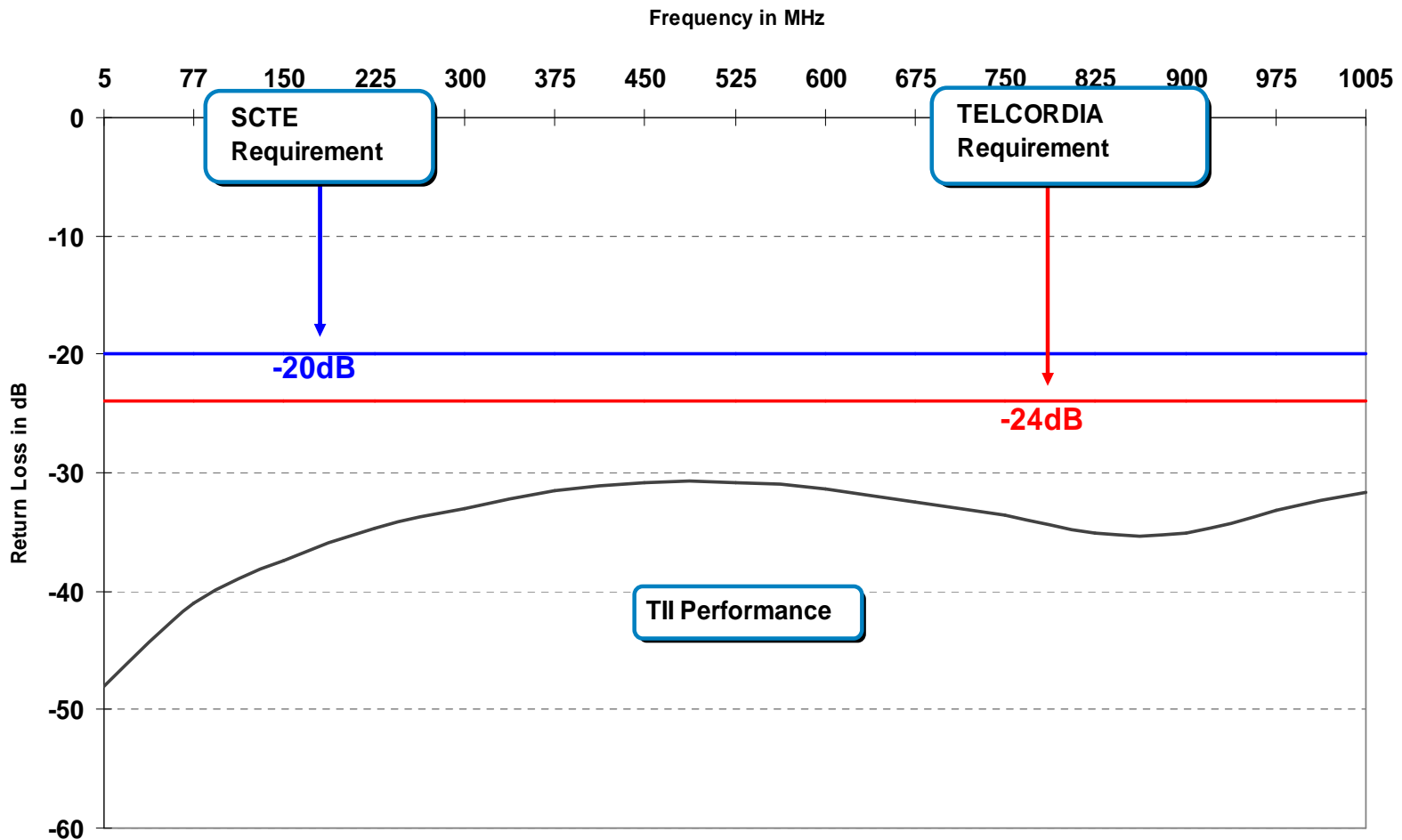
- The two ceramic discs form a hermetically sealed space that contains a suitable gas mixture. This gas mixture is composed of argon, hydrogen and some other rare gasses. The inside surfaces of the ceramic discs have a carbon film coating that enable a high speed reaction to surges on the center conductor. The arc initiated by the fast reaction on the ceramic disc energizes the gas and sustains the electron path to the body or ground.
- There is a failshort clip pressed into the service end of the coax protector. The failshort clip is made of a spring metal that is in contact with the inside diameter of the gas tube body. In a power cross condition the thin plastic insulating sleeve melts and the failshort clip shorts the center conductor to ground protecting the electronics.

TII Coax Protection

Typical Voltage Breakdown Levels

Device	@ 2000V/sec		@ 100V/sec	
	+	-	+	-
1	213	209	351	363
2	230	228	369	390
3	238	232	361	364
4	267	259	385	371
5	244	231	391	358
6	233	239	360	387

TII 75 Ohm Coax Protector Typical Return Loss

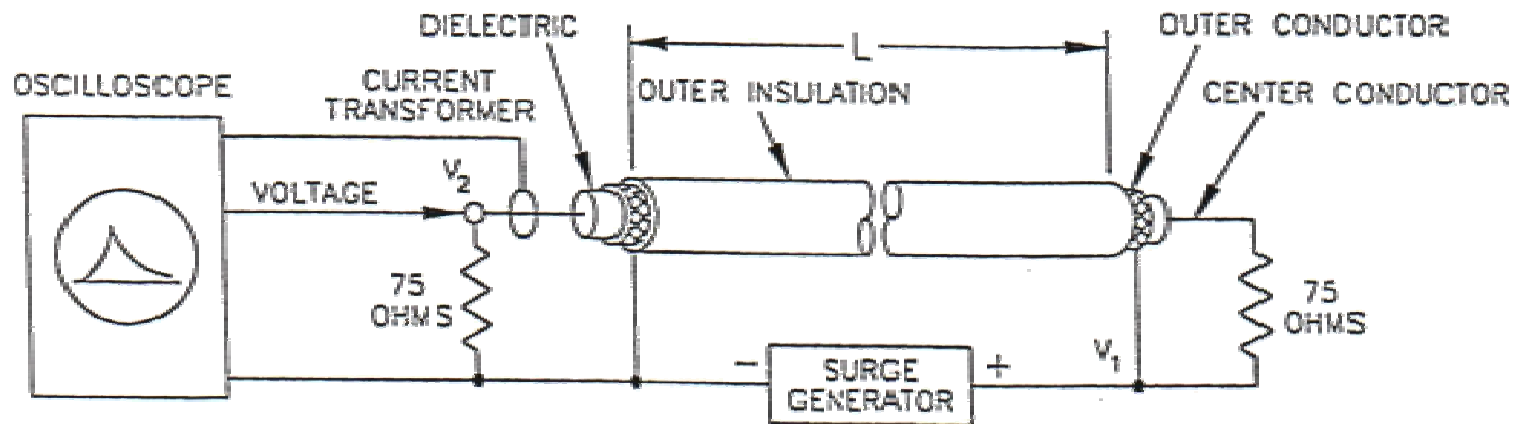


TII Surge Characterization

- TII conducted a series of tests by impressing lightning surges to the outer conductor of various sizes and lengths of coaxial cables.
- Data and figures on the following pages show that high energy lightning surges can be induced on the center conductor of a coax cable.
- The magnitude of voltage induced on the center conductor is proportional to the length and inversely proportional to the size of the coax cable.

Experiment 1

Magnitude of Induced Surges Test Circuit Setup



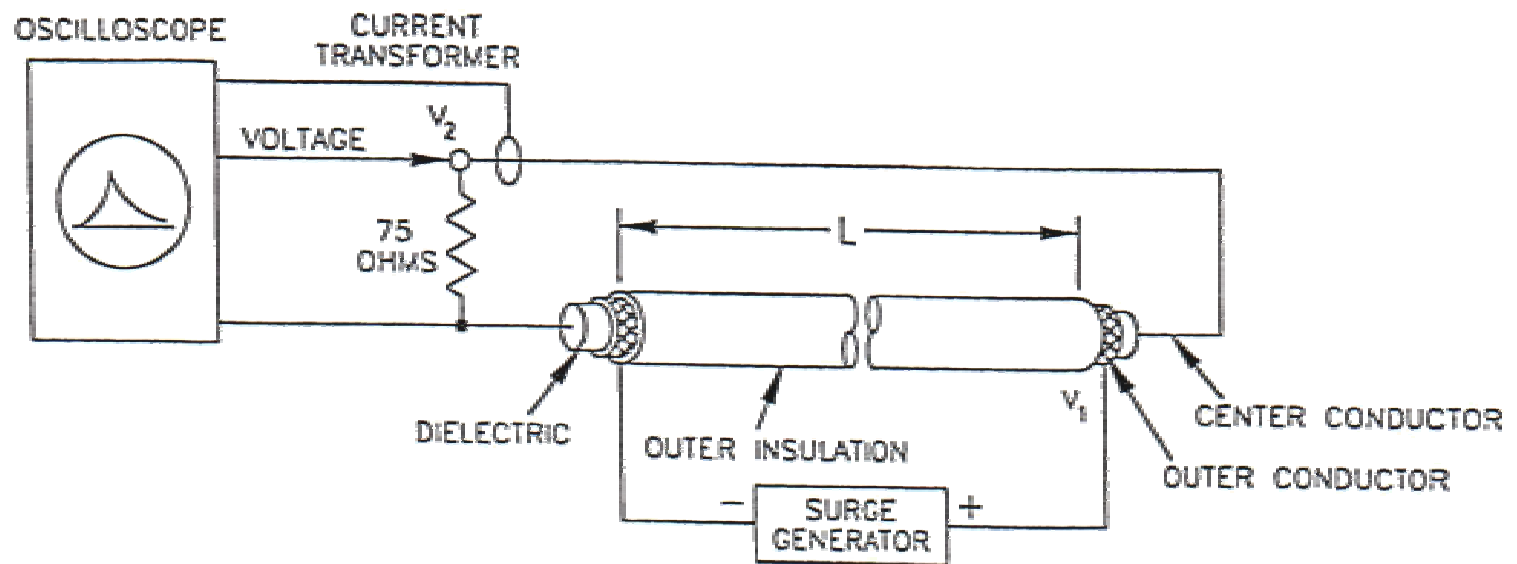
Experiment 1 Results

- 2KA, $10/250\mu\text{s}$ surge applied on outer conductor
- Monitored induced voltage and current on inner conductor for various lengths of coax cable

Cable Length (ft)	RG 59		RG 6		RG 11	
	Induced		Induced		Induced	
	Current (A)	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Voltage (V)
20	1.8	120	1.5	110	1.2	85
50	3.0	220	2.6	180	2.0	150
100	5.0	350	4.0	300	3.0	240
200	6.0	460	5.2	400	4.5	330

Experiment 2

Magnitude of Induced Surges (Inner Conductor Isolated)
Test Circuit Setup



Experiment 2 Results

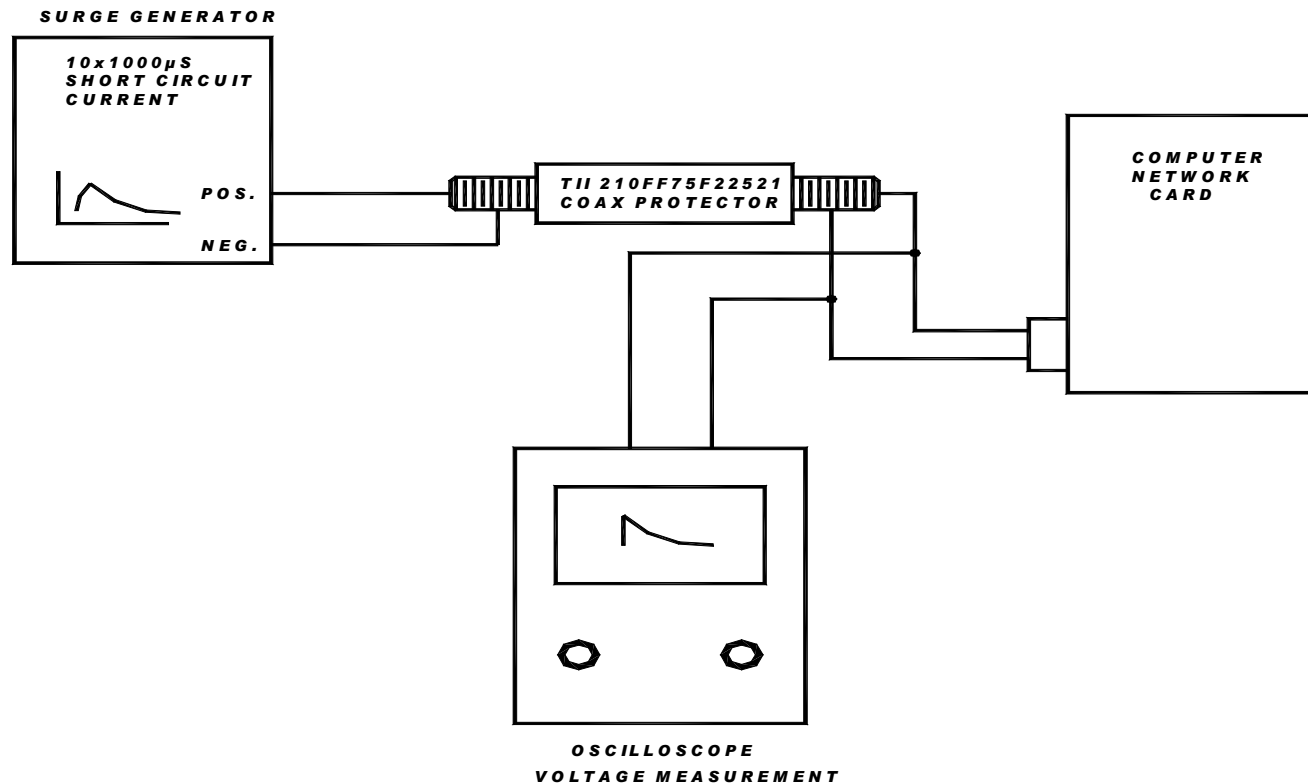
- Repeated Experiment 1 with inner conductor
- Completely isolated from outer conductor
- Monitored induced voltage and current on inner conductor for various lengths of coax cable

Cable Length (ft)	RG 59		RG 6		RG 11	
	Induced Current (A)	Induced Voltage (V)	Induced Current (A)	Induced Voltage (V)	Induced Current (A)	Induced Voltage (V)
20	1.0	750	0.9	700	0.7	650
50	1.4	1050	1.3	1050	1.6	1000
100	1.5	1150	1.6	1300	1.7	1300
200	1.75	1300	1.8	1500	2.0	1600

Experiment 3

Surge Testing of Network Interface Card

Apply increasing current levels of $10/1000$ surge to coax protector, monitor let through voltage.



Experiment 3 Results

Surge Current Level	Peak Let Thru Voltage (V)	NIC Card With TII Protection (OK)	NIC Card Without TII Protection (OK)
10	9.28	Y	Y
20	16.83	Y	Y
30	25.30	Y	Y
40	28.40	Y	Y
50	40.60	Y	Y
60	48.20	Y	Y
70	57.40	Y	N
80	70.60	Y	N
90	87.60	Y	N
100	111.00	Y	N

Experiment Summary

- Potentially damaging surge activity may be present on the center conductor of the coax cable
- Use of surge protection devices reduce damage to the connected equipment
- A surge protection device should be transparent to signal transmission for good reception



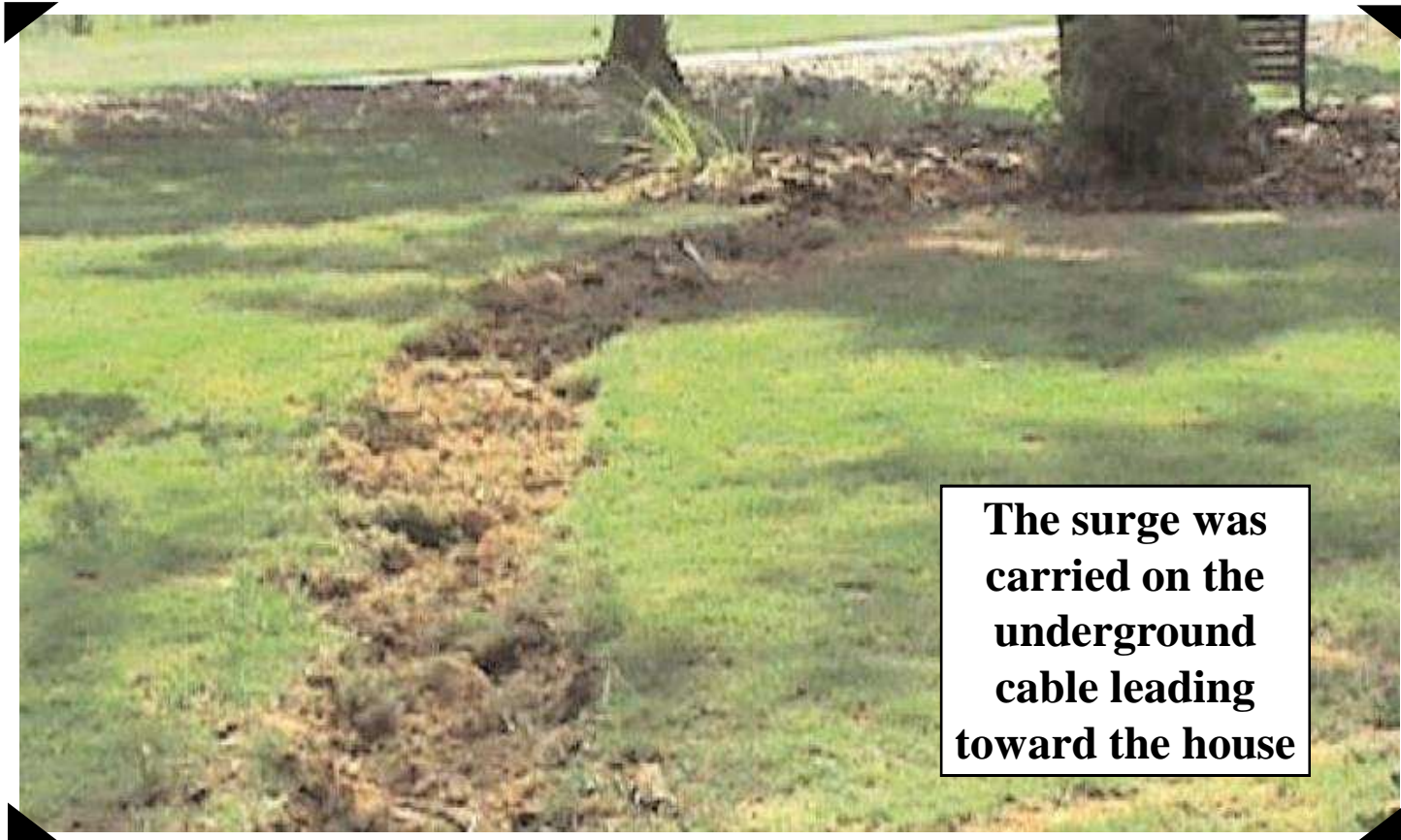
Field Lightning Damage Testimony

Lightning Damage

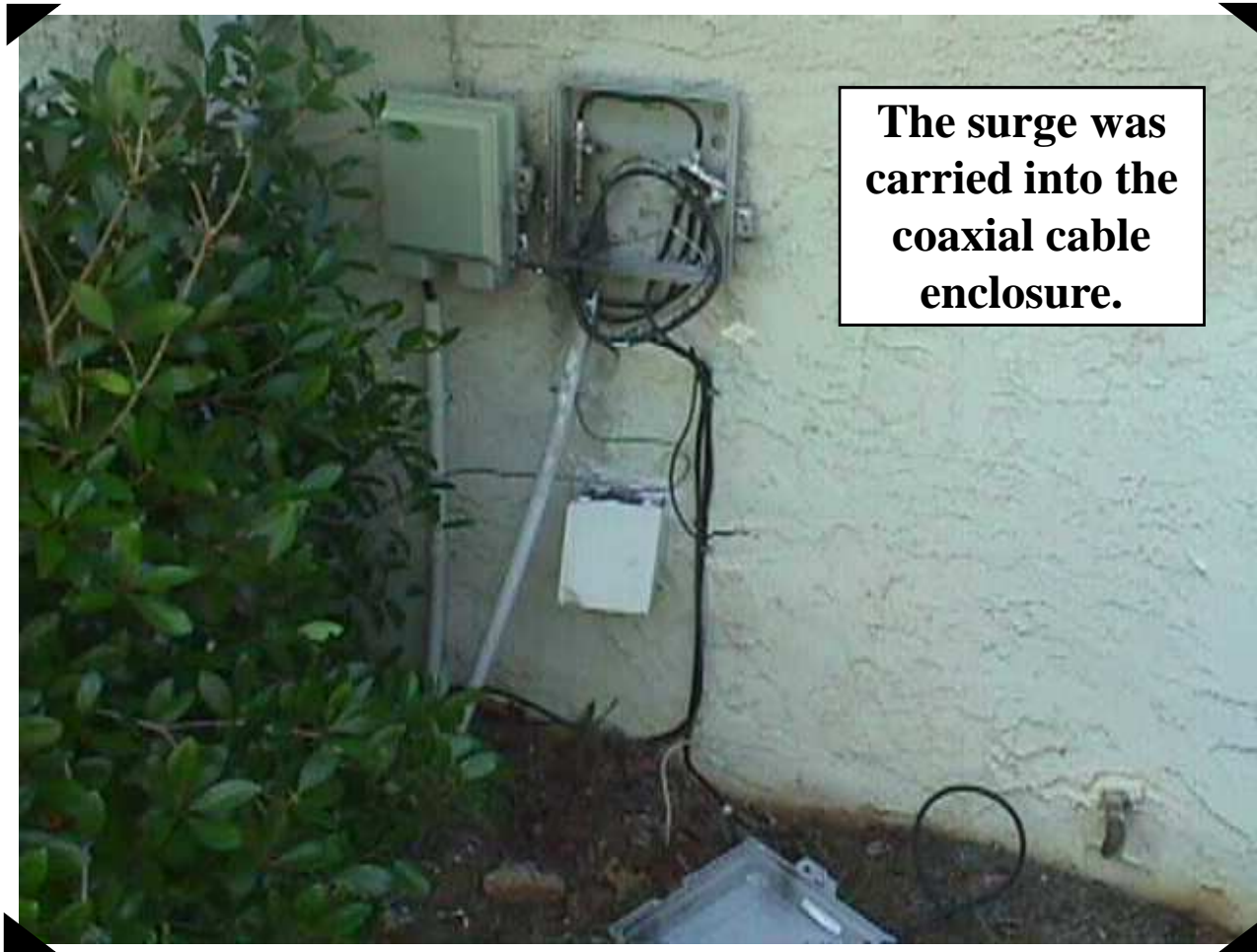


**Lightning
struck a cable
coming down
a tree.**

Lightning Damage

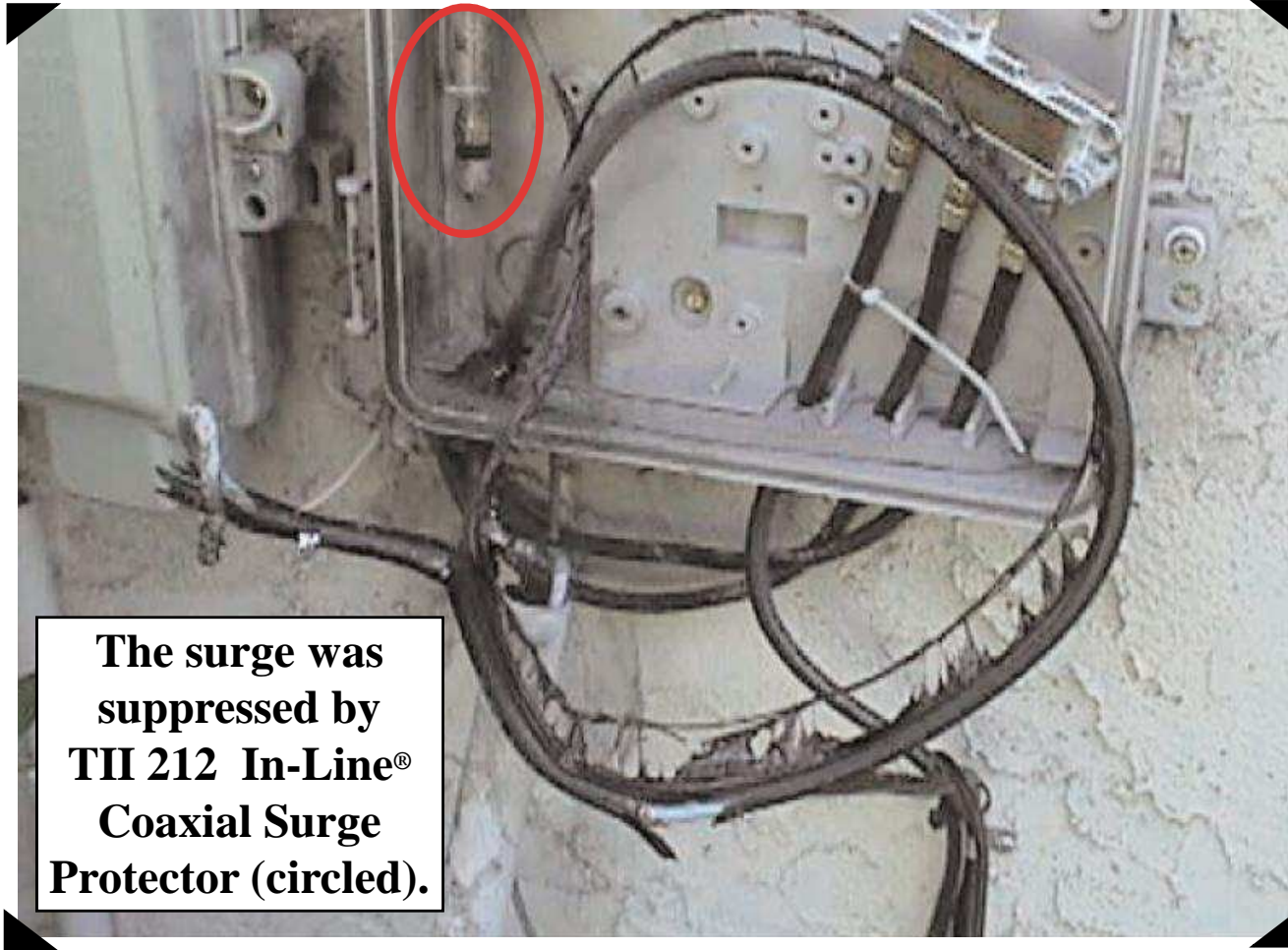


Lightning Damage



The surge was carried into the coaxial cable enclosure.

Lightning Damage





Grounding and Bonding Issues

National Electrical Code (NEC)

- Article 800 Communication Circuits
- Article 810 Radio and Television Equipment
- Article 820 Community Antenna Television (CATV) and
Radio Distribution Systems
- Article 830 Network Powered Broadband Communication
Systems

NEC Article 820

Sections of Article 820 cover various aspects of CATV systems at the customer premises including:

- Point of Entrance
- Protection
- Grounding Conductor
- Bonding of Electrodes

NEC Article 830

Geared more toward network powered communication systems covers following:

- Power Limitations
- Electrical Protection
- Grounding Methods
- Direct-Buried Cables & Raceways; Mechanical Protection
- Fault Protection Device

Grounding

820.33 – Grounding of Outer Conductive Shield of a Coaxial Cable

- The outer conductive shield of the coaxial cable shall be grounded at the building premises as close to the point of cable entrance or attachment as practicable.

Grounding

820.40 – Grounding of the Coaxial Cable Shield is specified as:

- **Insulation.** The grounding conductor shall be insulated and shall be listed as suitable for the purpose.
- **Material.** The grounding conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.
- **Size.** The grounding conductor shall not be smaller than 14 AWG
- **Length.** The grounding conductor shall be as short as practicable, not to exceed 6.0m (20ft) in length.
- **Run In Straight-Line.** The grounding conductor shall be run to the grounding electrode in as straight a line as practicable.
- **Physical Protection where subject to physical damage.** The grounding conductor shall be adequately protected where the grounding conductor is run in a metal raceway both ends of the raceway shall be bonded to the grounded conductor or the same terminal or electrode to which the grounding conductor is connected.

Point of Entrance

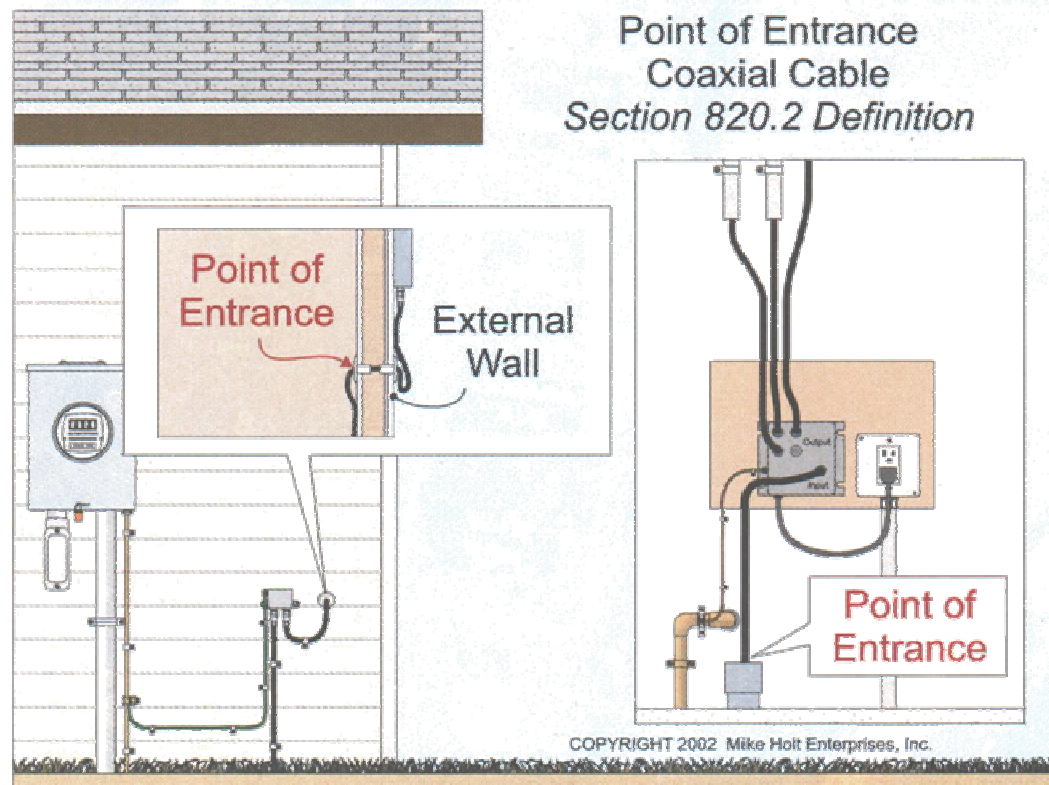


Fig. 1. "Point of entrance" may be the most important term you learn with respect to Art. 820. It's the point where cable emerges from an external wall or concrete slab or an RMC or IMC.

Support

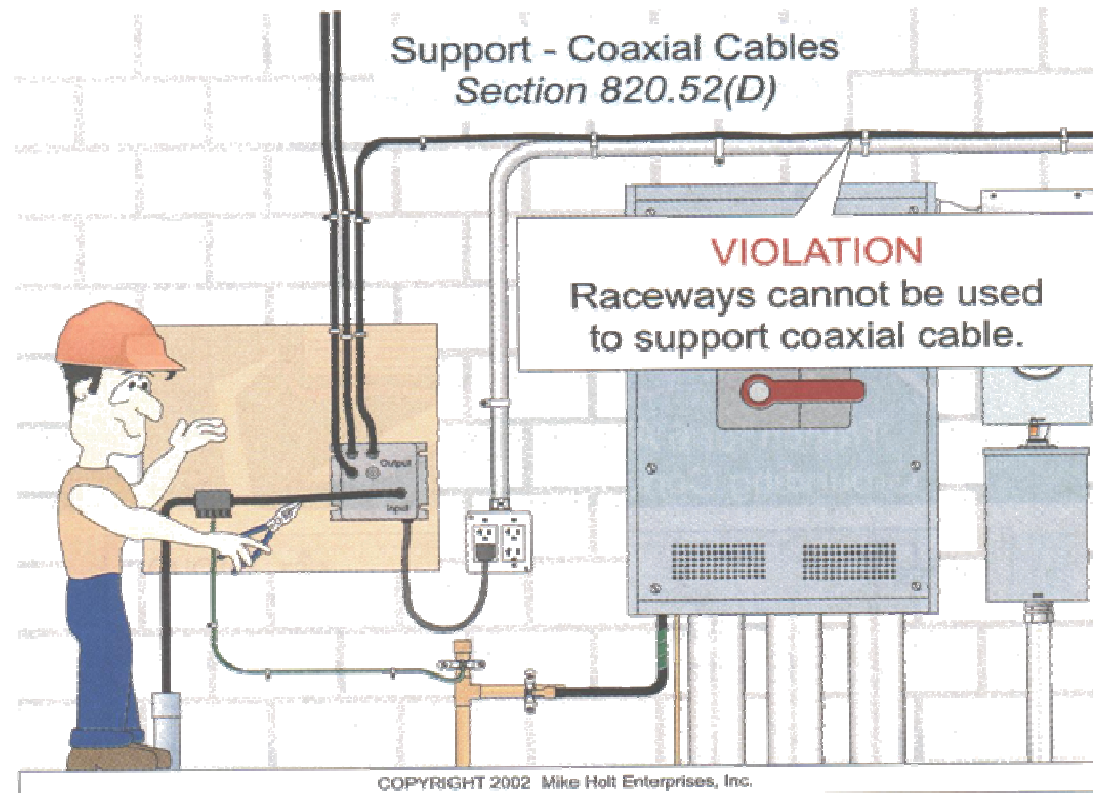


Fig. 2. The Code doesn't allow you to use conduit as a means of support for the routing of coax cable unless the raceway is intended for the support of communications cables.

Grounding

CATV Grounding Conductor Over 20 Ft
One- or Two-Family Dwellings
Section 820.40(A)(4) Exception

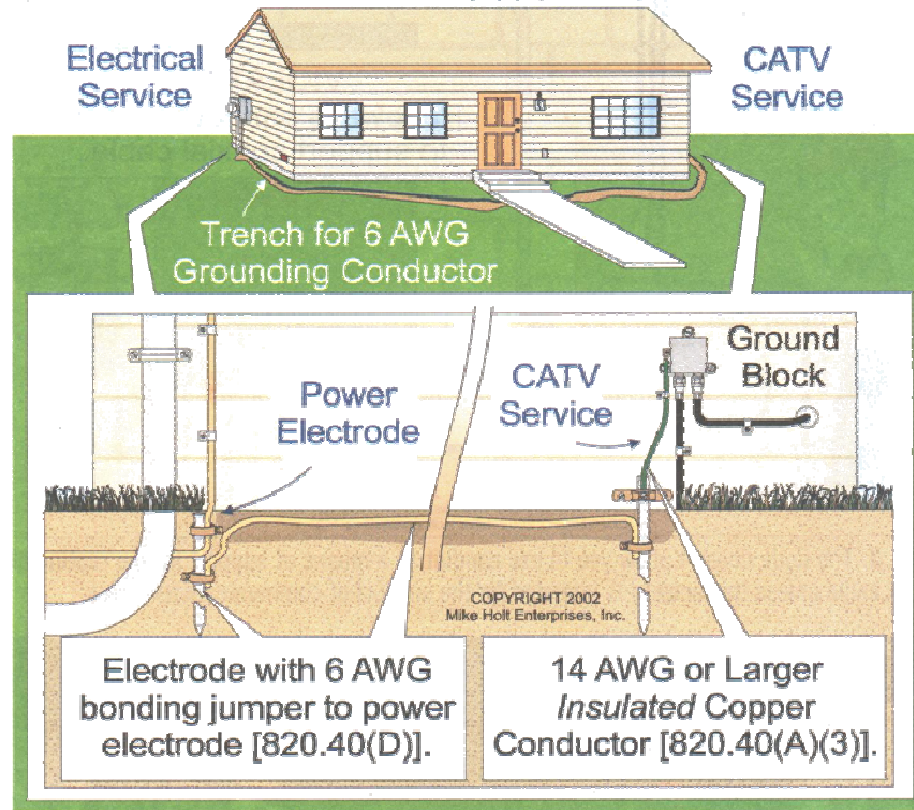


Fig. 3. When driving a second ground rod for the CATV system be sure to bond it to the power-grounding electrode.

Bonding

Bonding Metal Raceway Enclosing Grounding Conductor *Section 820.40(A)(6)*

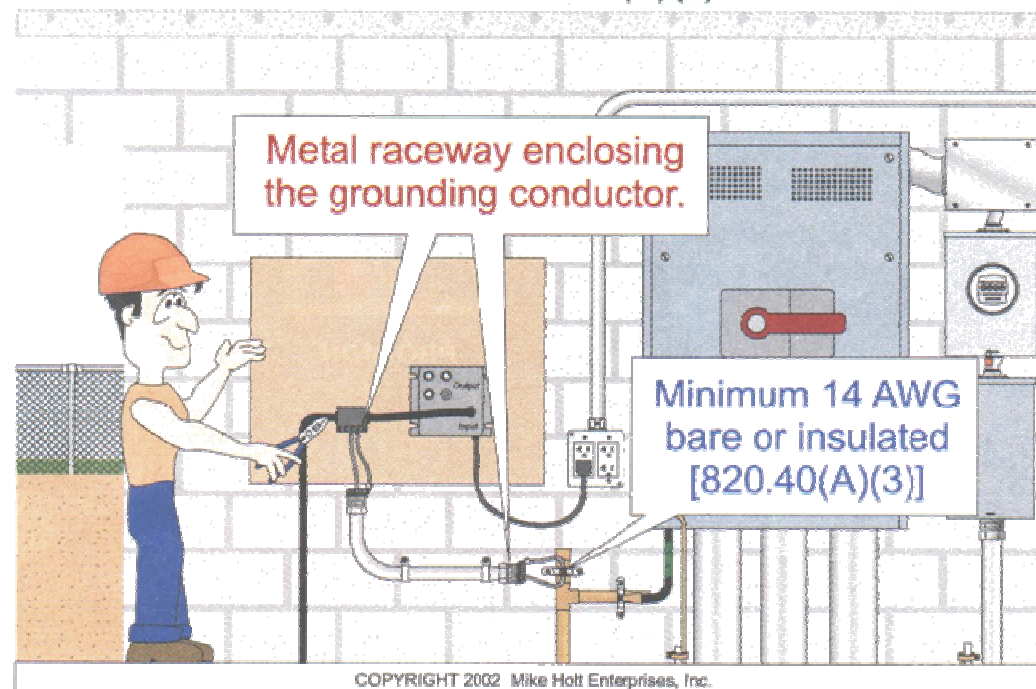


Fig. 4. Where a grounding conductor is located in a metal raceway, both ends of the raceway must be bonded to the grounding conductor or the same terminal as the terminal or electrode to which the grounding conductor is connected.

Conclusion

- Proper grounding and bonding practices need to be followed for a reliable safe CATV service.
- Surges do cause damage to the equipment at the customer premises.
- A surge protection device, when properly installed, will provide necessary protection to the equipment and property.