Protezione dalle scariche atmosferiche

ARI UDINE

Roberto Turco IV3GKE

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Esonero da responsabilità

Questa relazione riflette esperienze personali,

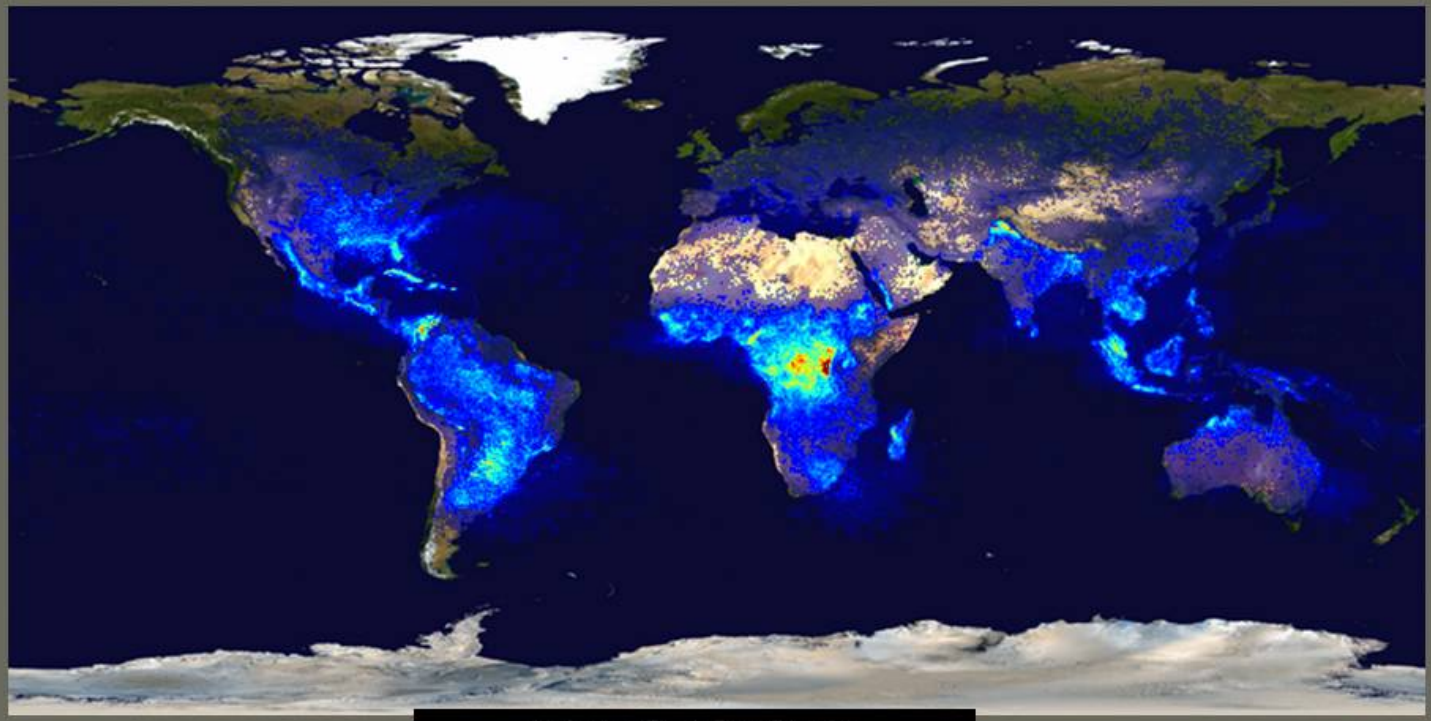
ogni stazione radioamatoriale ha caratteristiche diverse

che vanno affrontate congruamente.

Si rimanda alle norme del Comitato Elettrotecnico Italiano (CEI)

per informazioni pertinenti.

Mappa mondo densità fulmini per Km^2



La mia storia

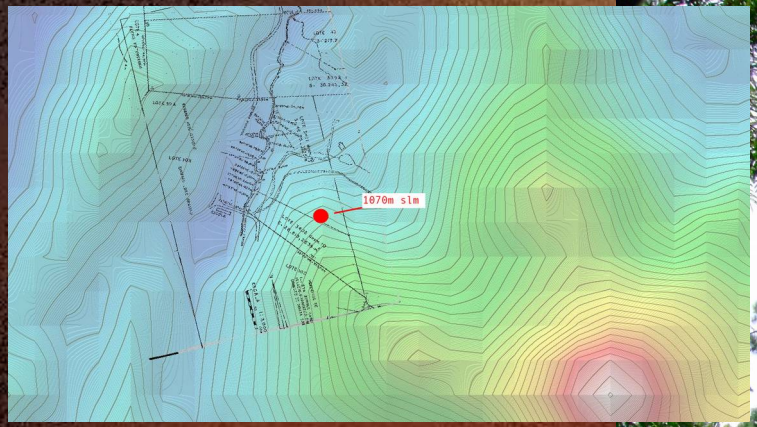
1997 - Brasile stazione radio in quota 1030m

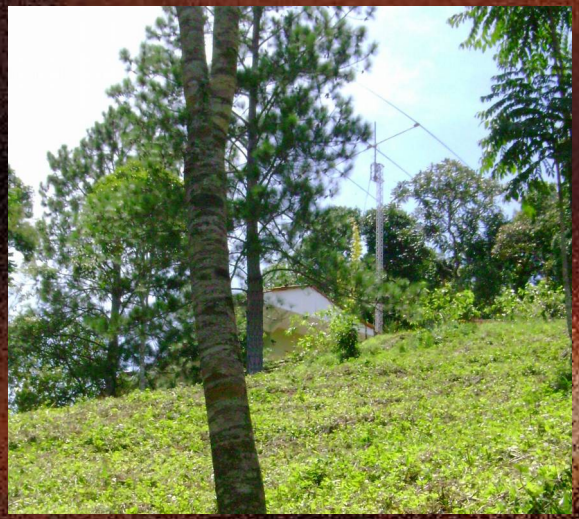
Antenne: dipolo colineare per 20
direttiva 3 elementi poi 4el.
traliccio auto costruito 18m
yagi 5 el per 10m con boom 6m
yagi 7 el per 10m con boom 12m
SteppIR 3 elementi 6m a 20m
antenna 2 el V orizzontale per 40m
delta loop 3el per 10m 2el per 15m

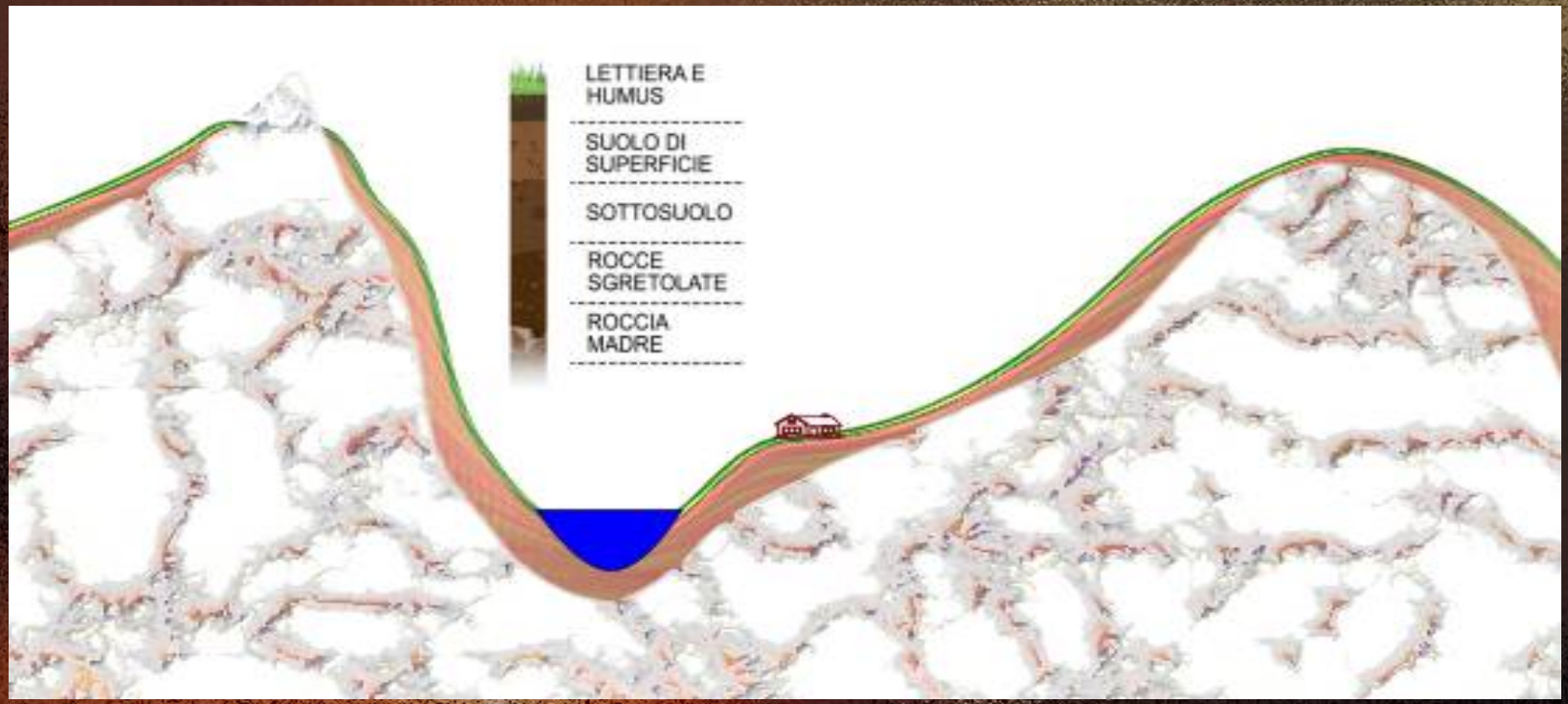
2005 – Quota 1070

Antenne: direttiva 3el poi 4el per 20m boom 12m
traliccio auto costruito 18m
yagi 5 el per 15m boom 12m
yagi 4 el per 20 boom 12m
SteppIR 3 elementi 6m a 20m
2 el V orizzontale per 40m
Verticale per 40m

Stazione sita in Montagna

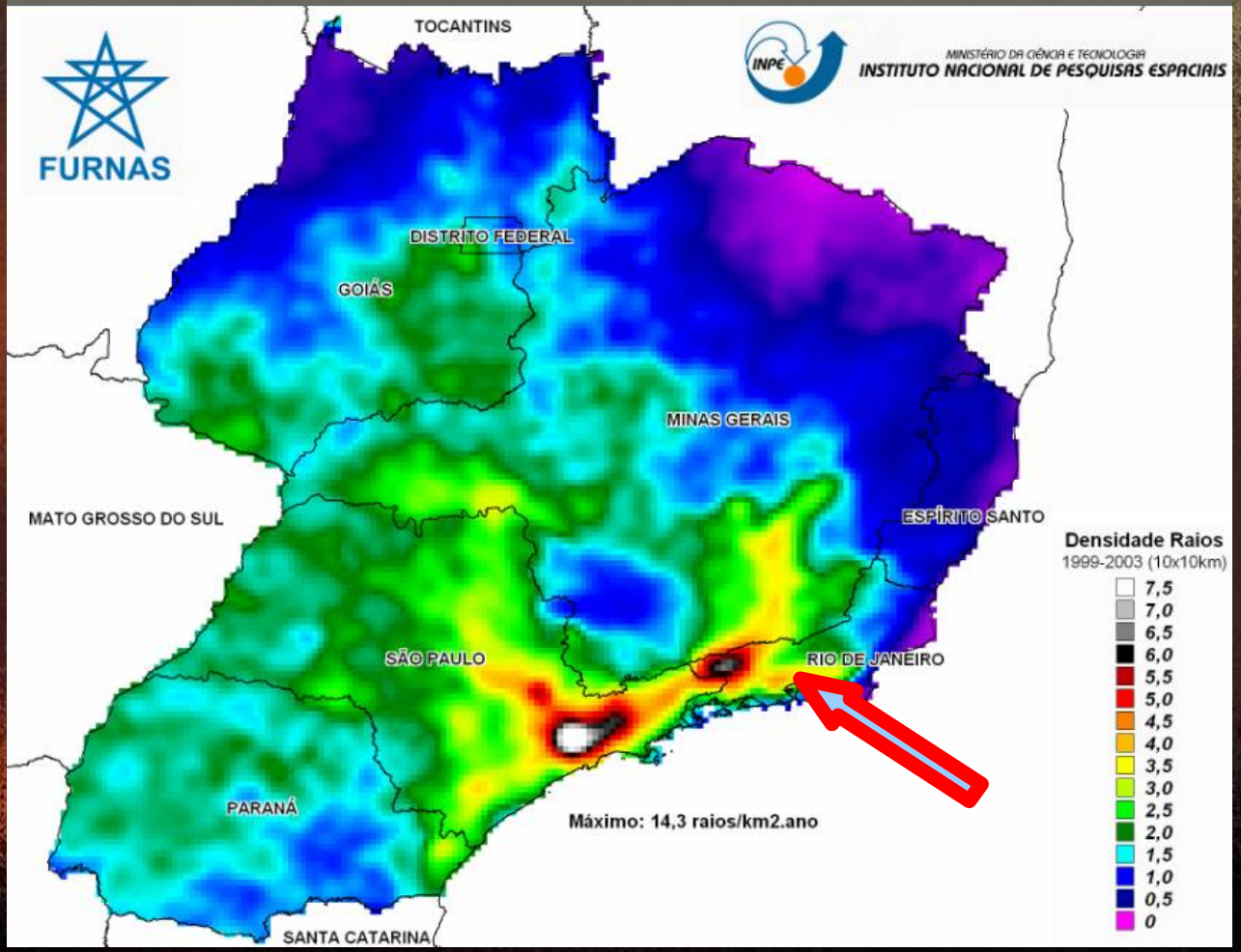




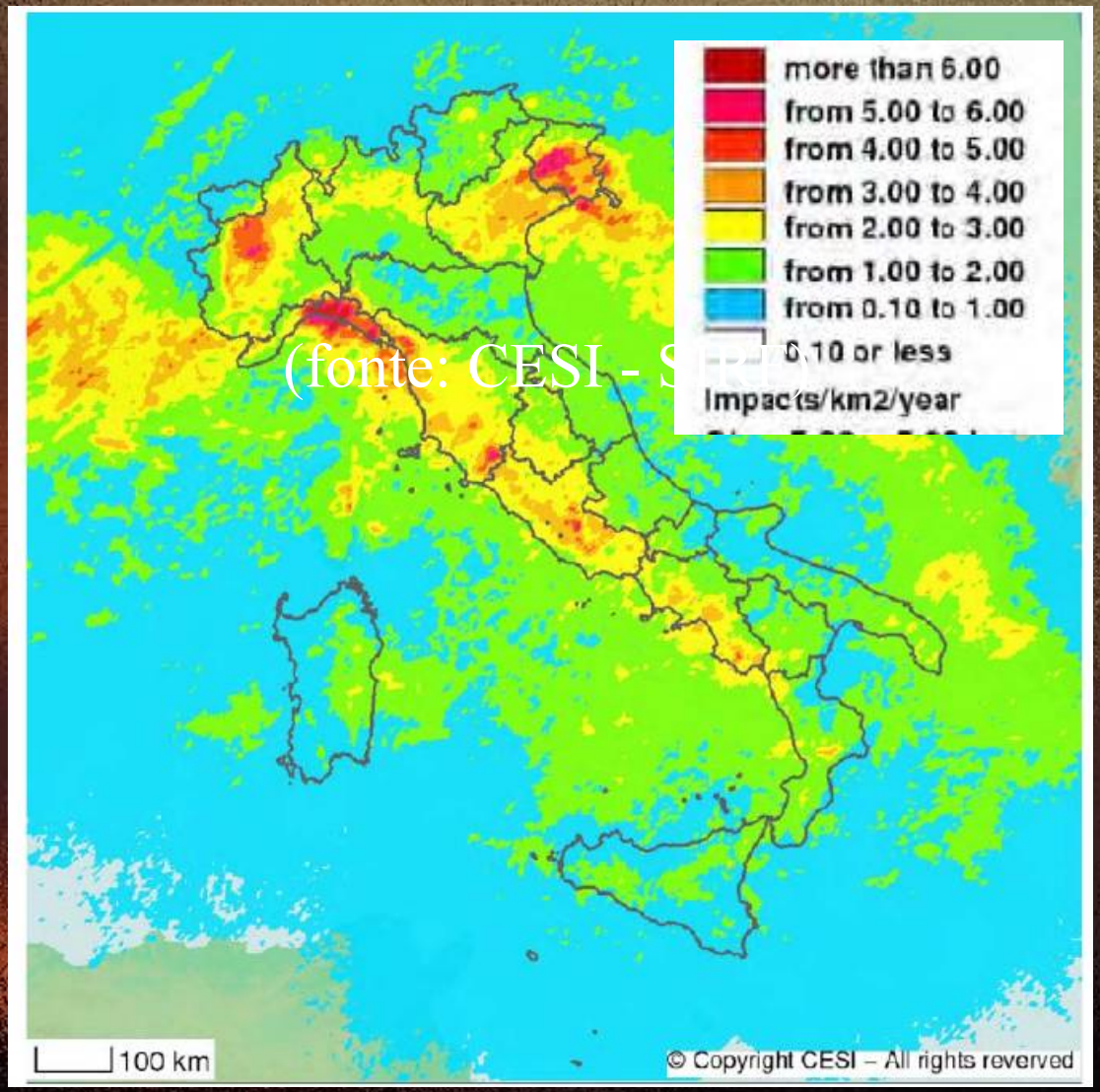

LETTIERA E
HUMUS
SUOLO DI
SUPERFICIE
SOTTOSUOLO
ROCCE
SGRETOLATE
ROCCIA
MADRE

Montagna in granito coperta da strato argilloso

Mappa Brasile densità fulmini per Km^2



Densità di fulmini al suolo in Italia (media dal 2010 al 2015)



(fonte: CESI - SIRF)

Scarica atmosferica

PLAY

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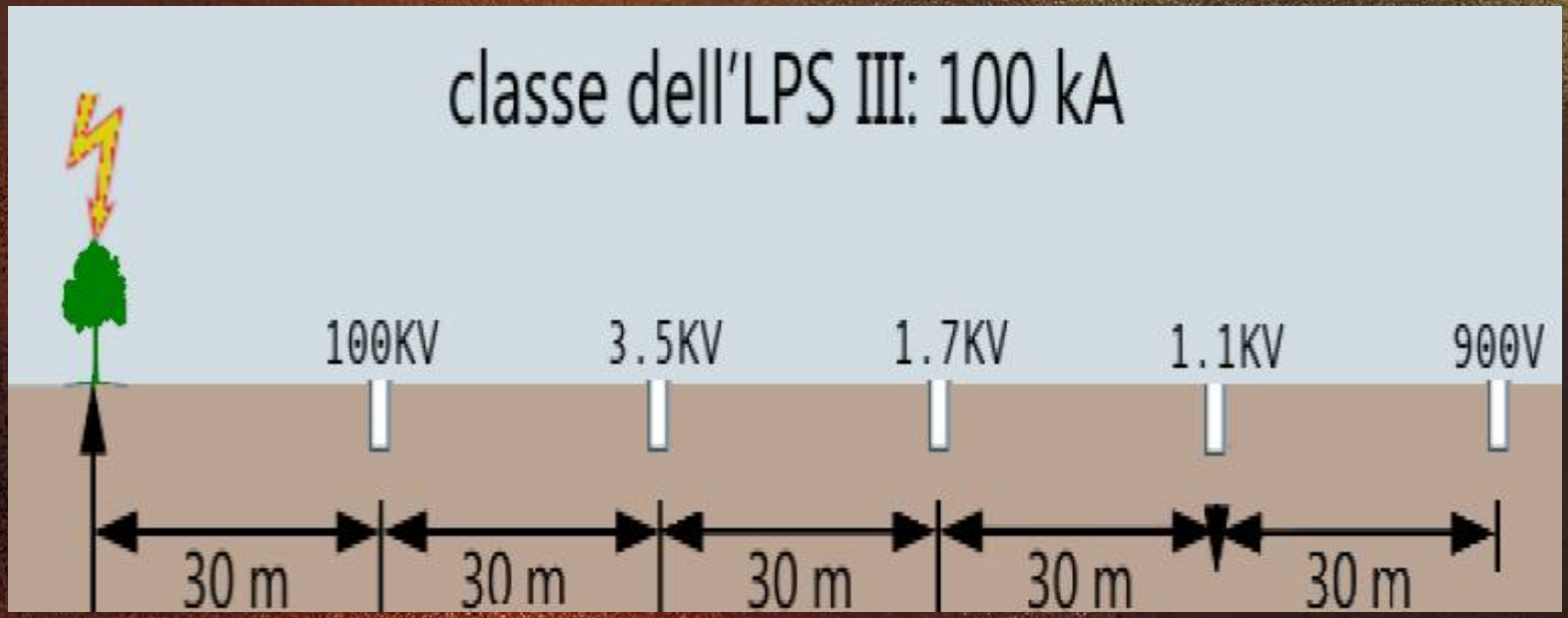
Scarica atmosferica

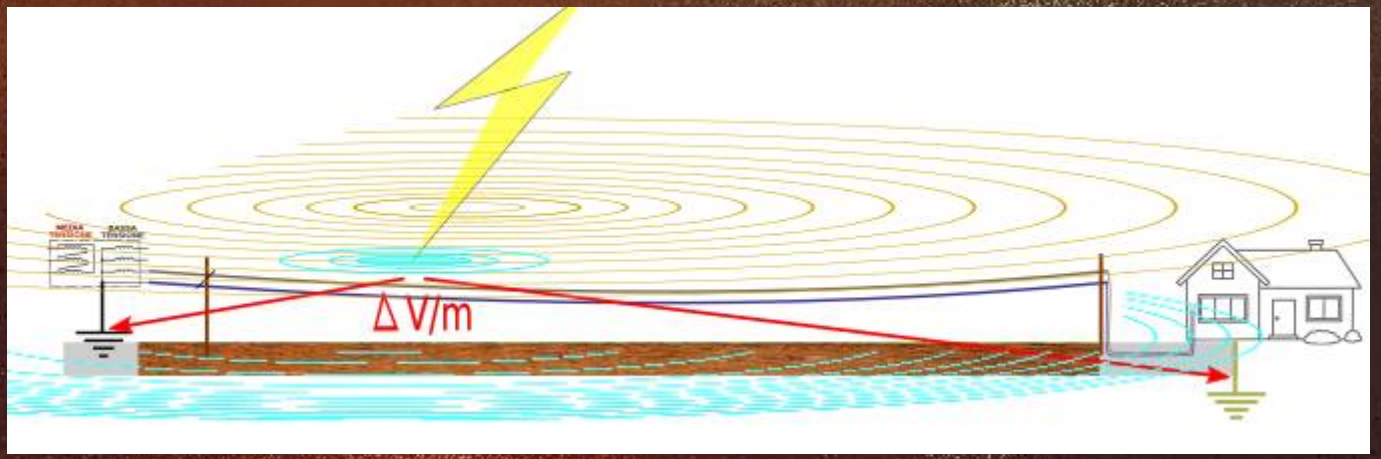
PLAY


classe dell'LPS III: 100 kA
100KV
3.5KV
1.7KV
1.1KV
900V
30 m
30 m
30 m
30 m
30 m

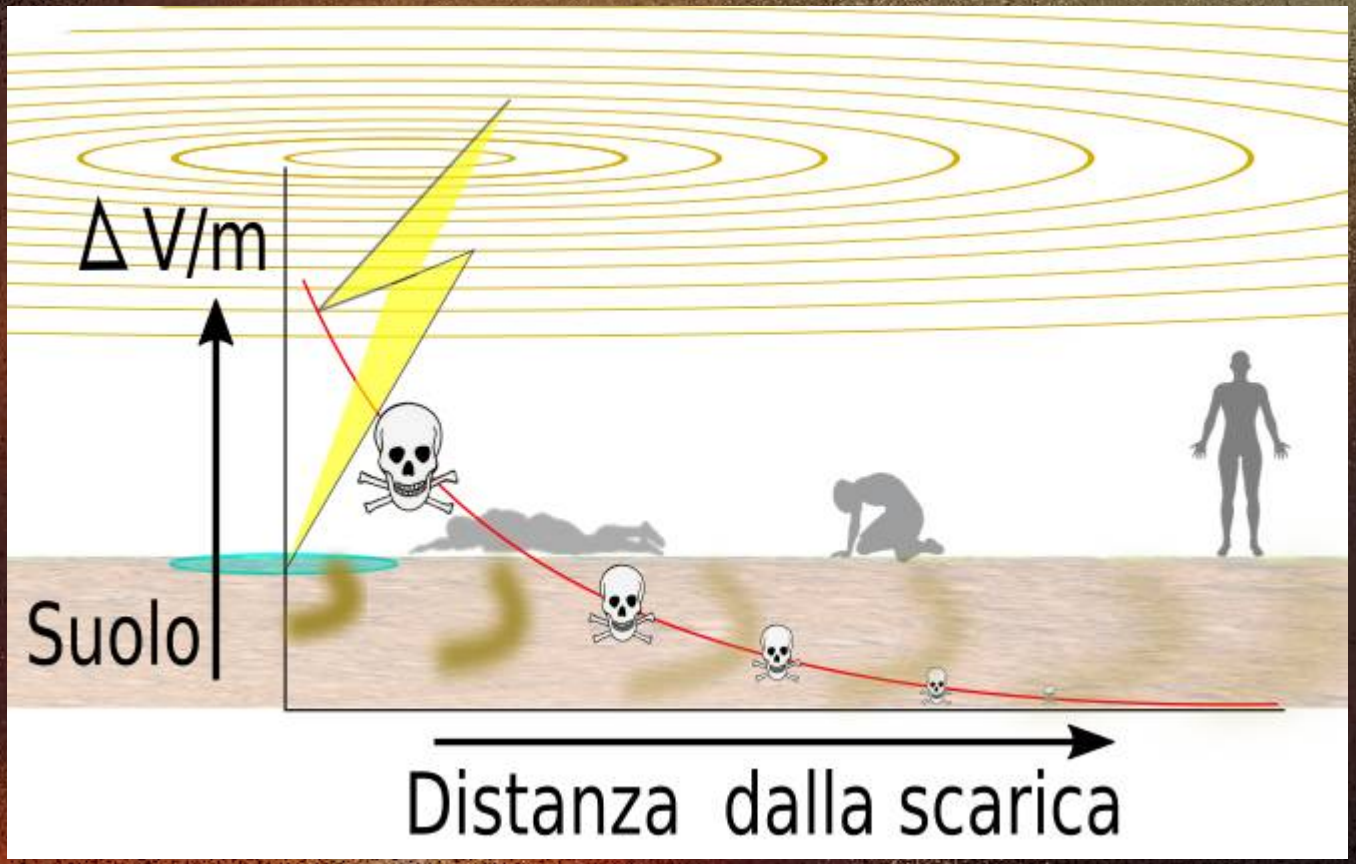
La sovratensione indiretta può arrivare per:

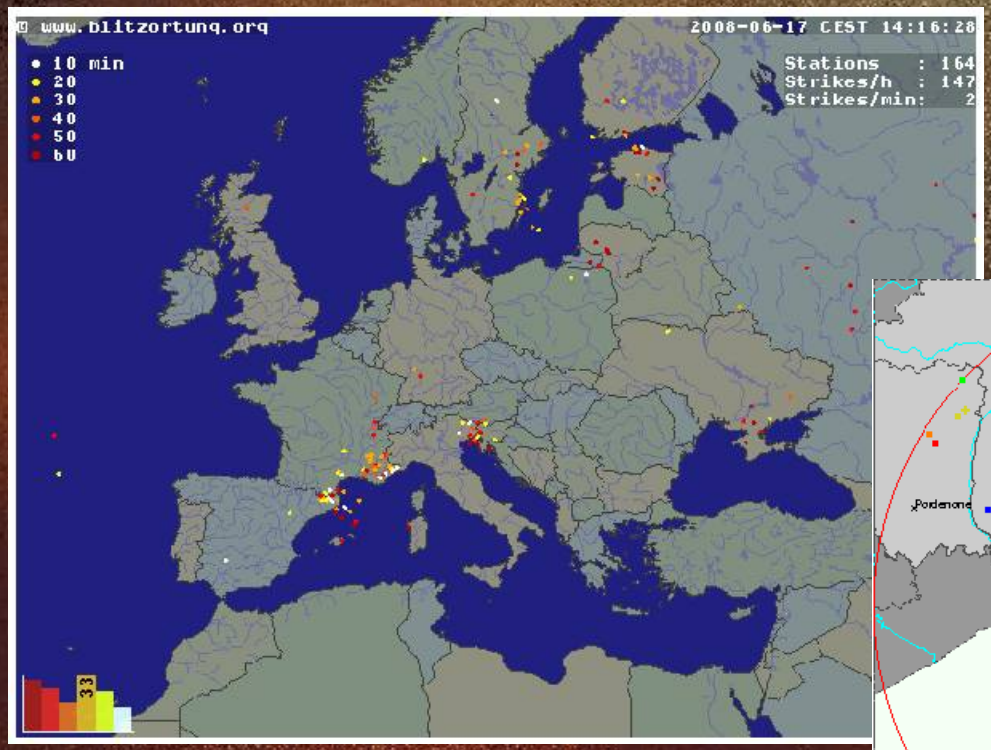
induzione elettromagnetica aerea
attraverso le linee fisiche d'ingresso
per differenza di potenziale a terra

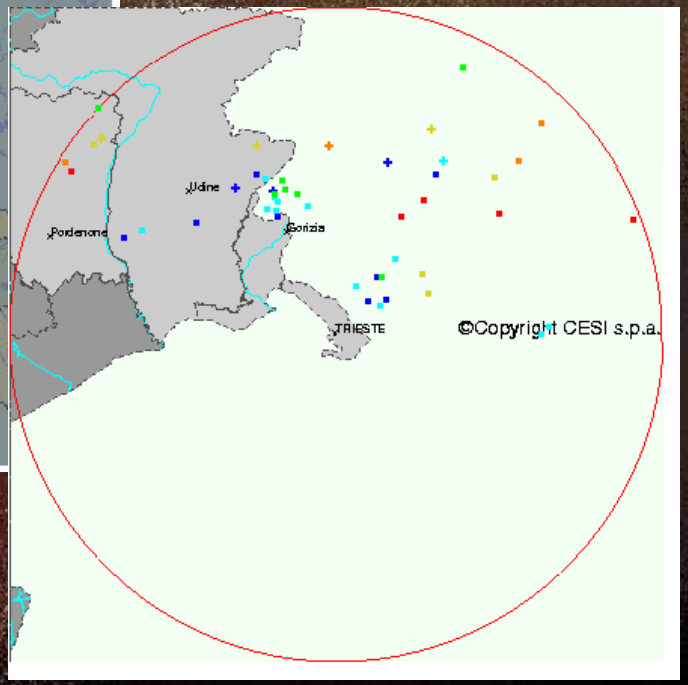
Generalmente per influenza di entrambe!



Ranking de incidencia de Descargas Atmosfericas por Municipio







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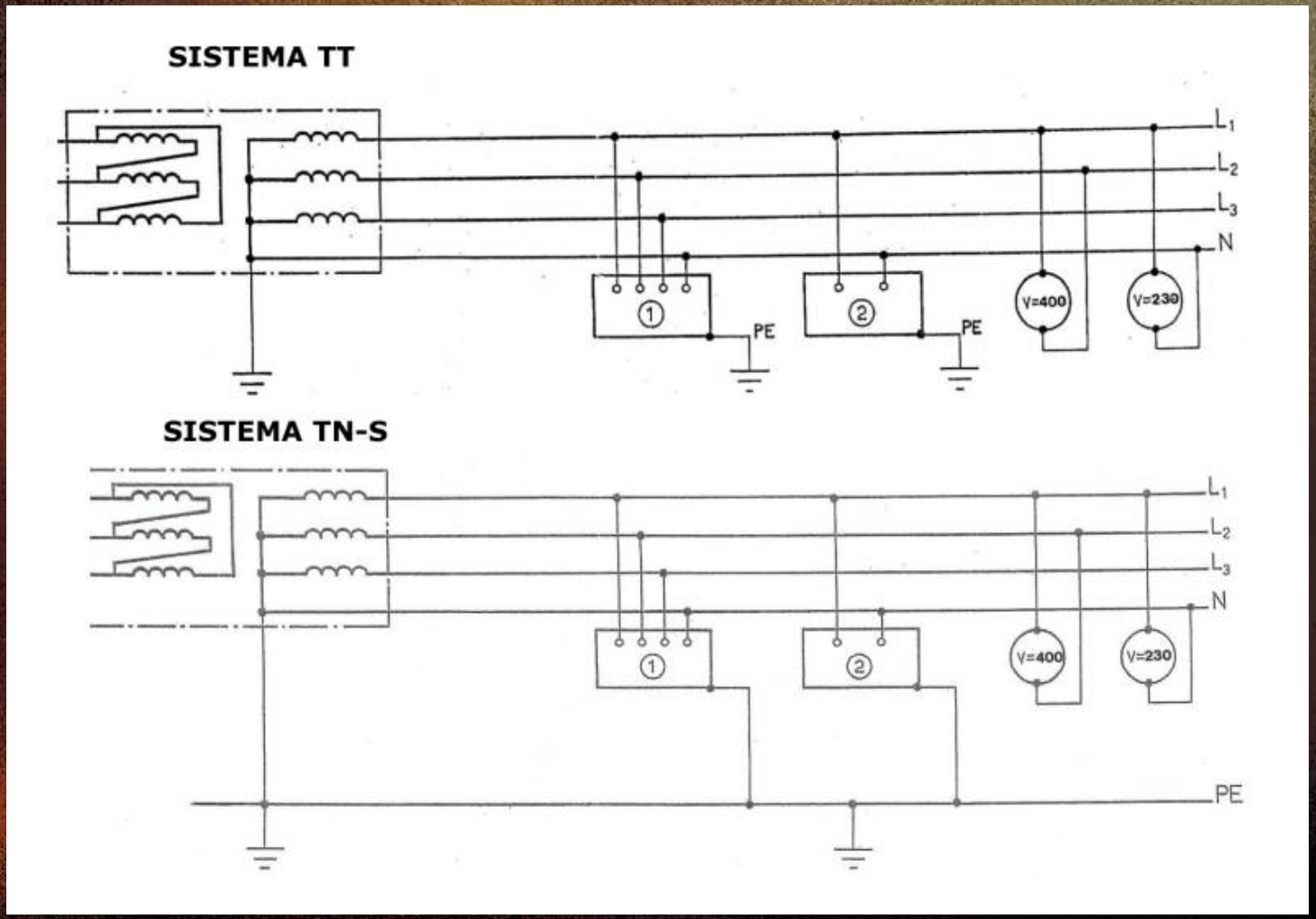
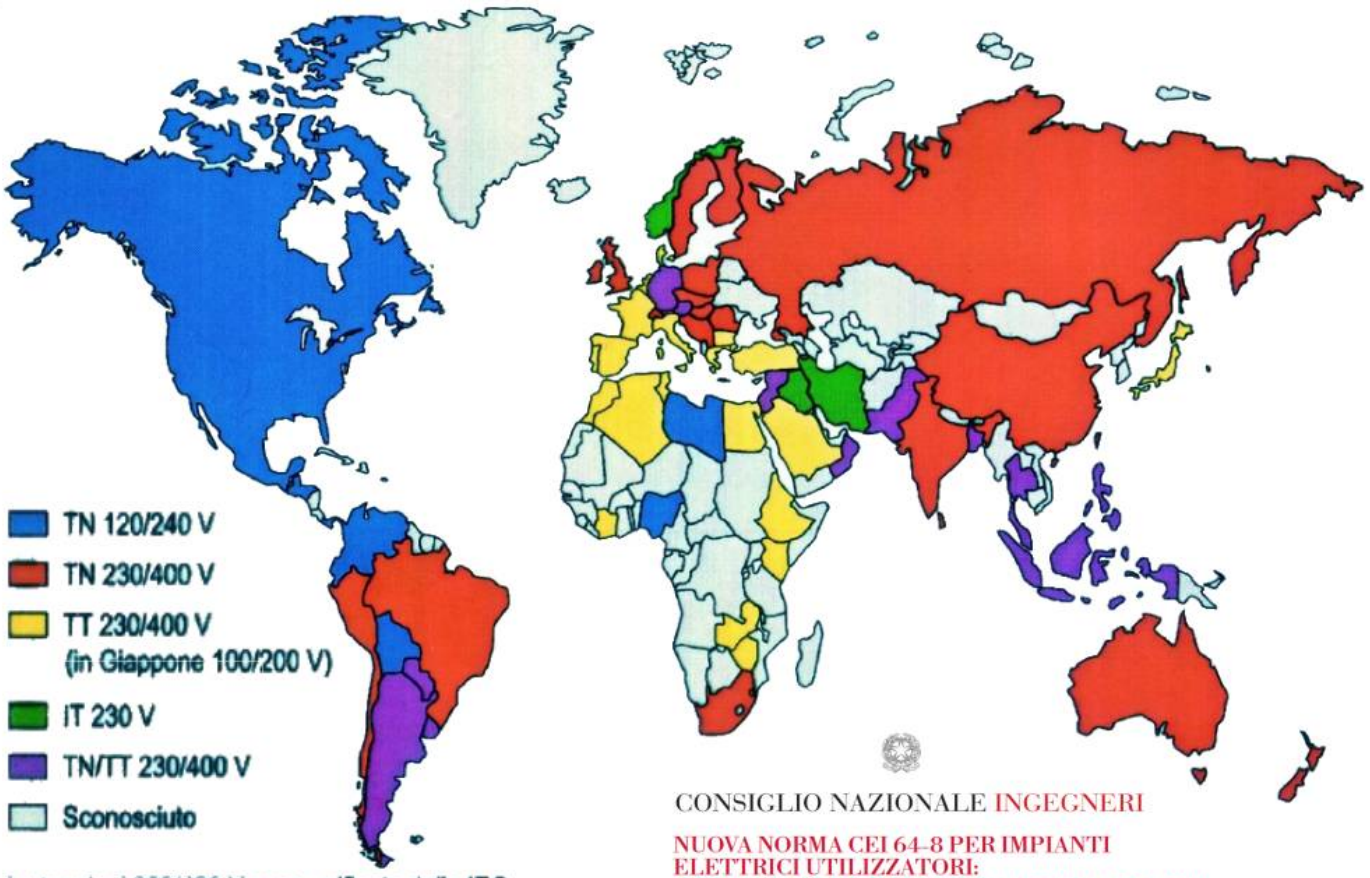
Attenzione! : In Italia si usa il sistema TT, non usare collegamenti TN spesso suggeriti in video di internet....



ELETTRO-MAPPA-MONDO

(sistemi di distribuzione pubblica in bassa tensione)



Le tensioni 230/400 V sono unificate dalla IEC.
Molti paesi, tra cui l'Italia, utilizzano ancora 220/380 V.

CONSIGLIO NAZIONALE INGEGNERI

NUOVA NORMA CEI 64-8 PER IMPIANTI ELETTRICI UTILIZZATORI: APPROFONDIMENTI E SPECIFICHE TECNICHE PER LE ATTIVITÀ DI PROGETTAZIONE

Si definisce sovratensione una tensione che supera il valore di picco della massima tensione presente nell'impianto in condizioni ordinarie di funzionamento

Le sovratensioni possono essere di origine:

- interna (manovre, distacco di grossi carichi, guasti, intervento di fusibili, ecc.)

oppure

- esterna (scariche atmosferiche)

Fulmine diretto e forma di protezione usando diffusori di cariche elettriche

PLAY

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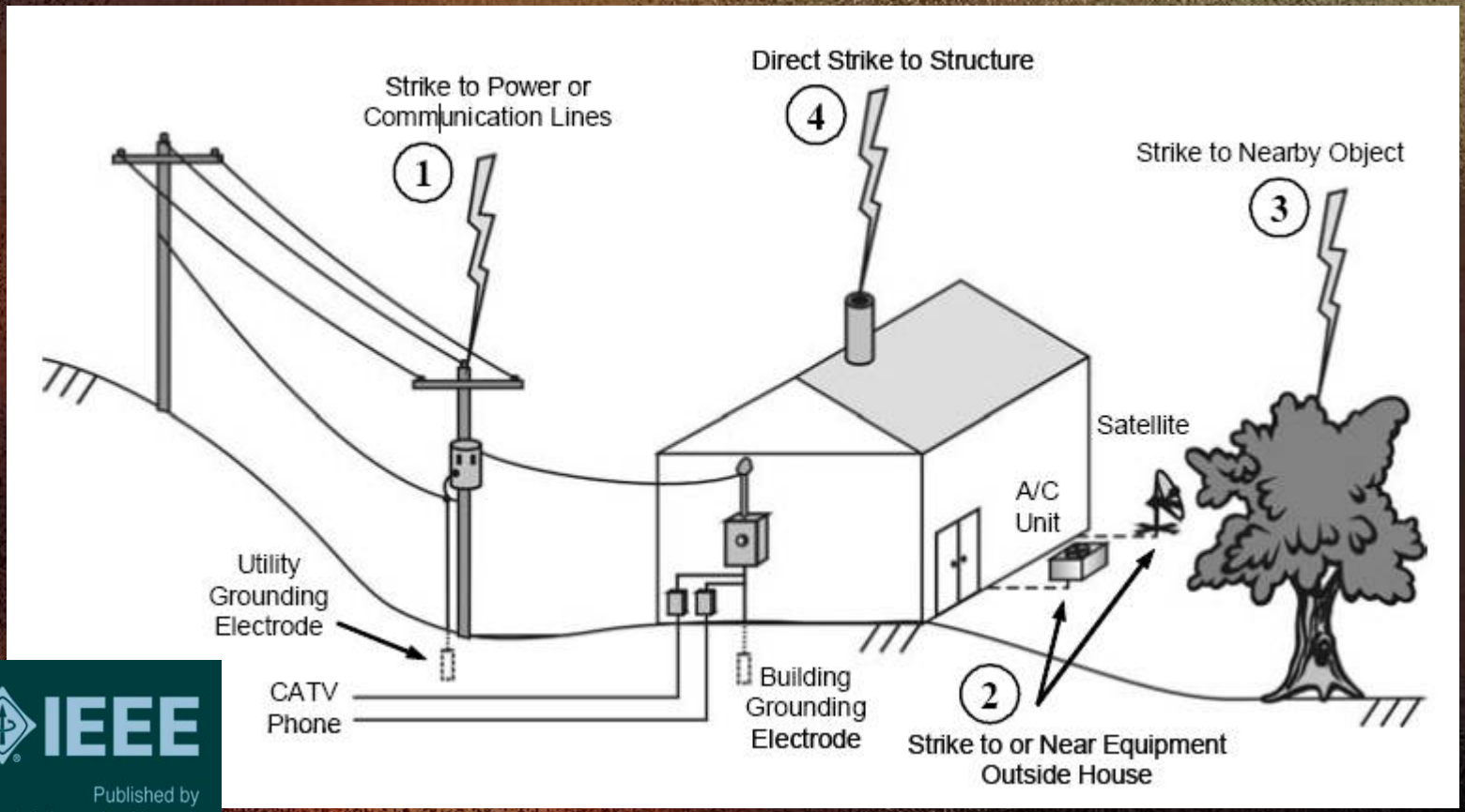

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Aumento di Potenziale al suolo

Il fulmine colpendo il terreno,
provoca un innalzamento del potenziale del suolo, inducendo alti valori di sovratensioni in fili o cavi interrati.

Aumento di potenziale al suolo

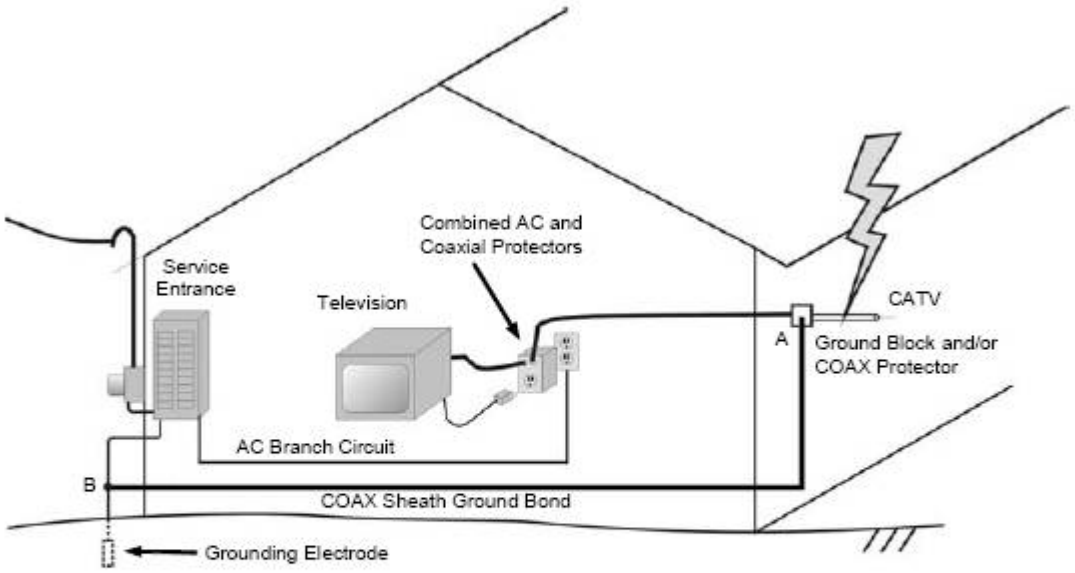

Figure 7: Even with coax cable grounding that meets code requirements, if the coaxial line enters far away from the building ground, the long grounding wire A–B can develop very large voltages which can damage the TV set. The multiport protector shown at the TV set can greatly decrease the voltage between the AC ground and the coax cable, preventing damage to the set.

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Aumento di potenziale al suolo

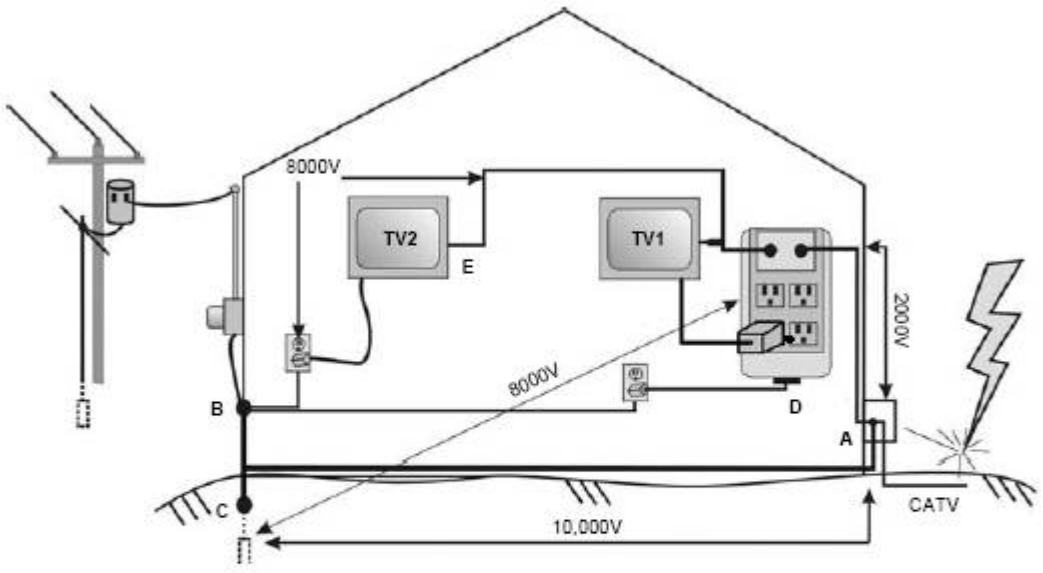

Figure 8: Ground potential differences within a building under lightning strike conditions: how down-line TV sets get damaged. With a 3,000A surge rising in 3 μs, and a 30 foot ground bond (A–C), ~10,000 V develops between A and C. Even with a multi-port protector (D) for TV1, the ground voltage at D is conveyed to TV2 by the coaxial cable, resulting in an 8,000 V potential across TV2, which will probably destroy it. A second multi-port protector as shown in Fig. 7 is required to protect TV2.

Aumento di potenziale al suolo

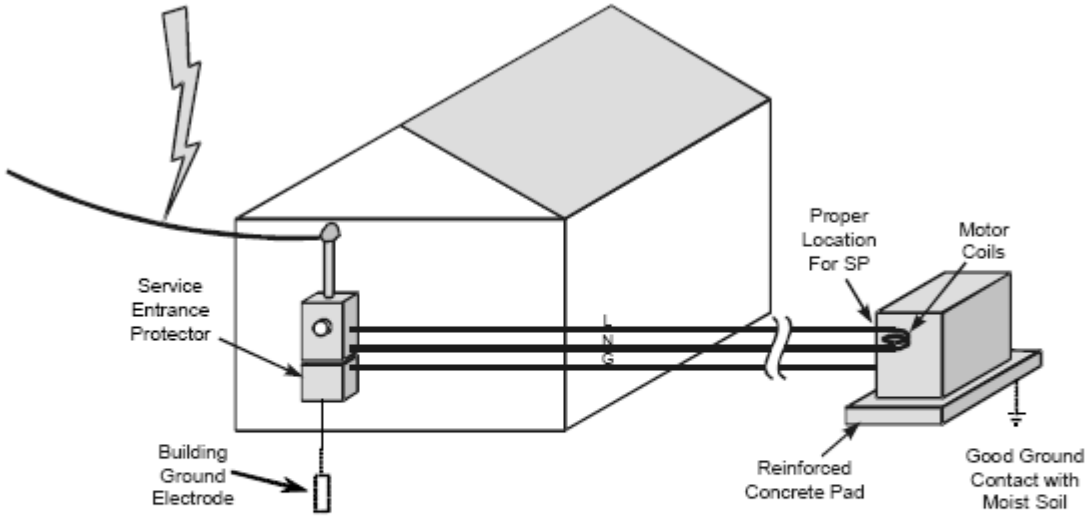

Figure 9: Equipment that has its own ground can be damaged by potential differences between two grounds. During a lightning surge into the ground electrode, the voltage rises by 750 kV for a 30 kA strike and 25 Ω ground. The insulation between the motor coil and the frame/housing sees a significant fraction of the 750 kV developed at the building ground, and may break down the insulation of the motor, controls, or wiring.

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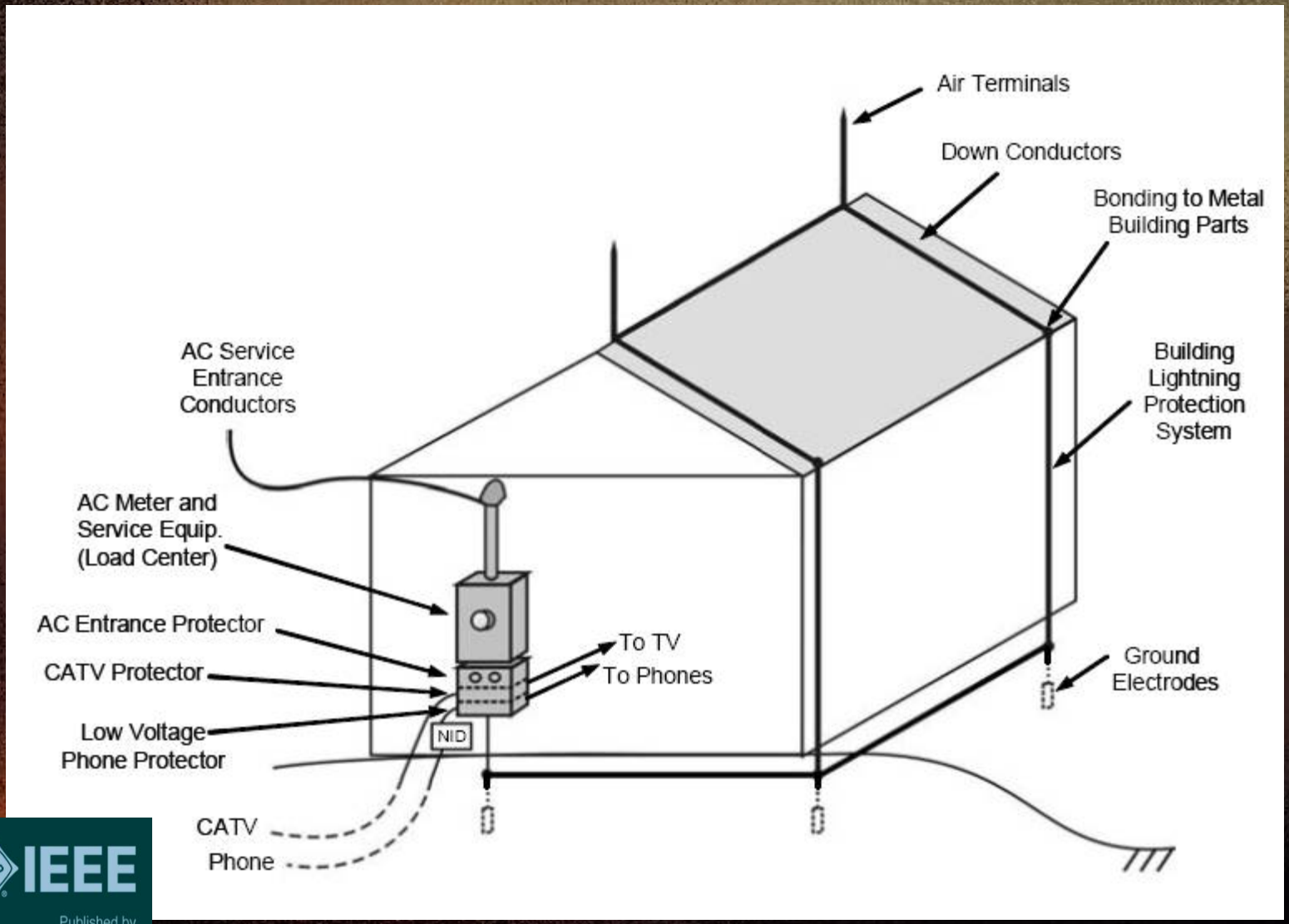
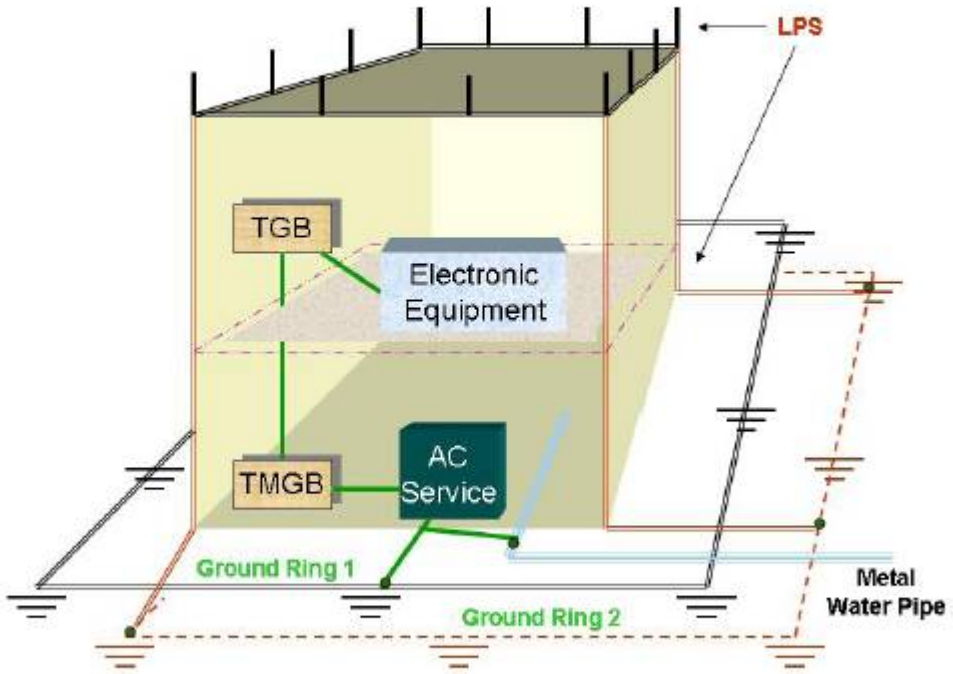


NFPA 70 vs. 780

PANDUIT LABORATORIES



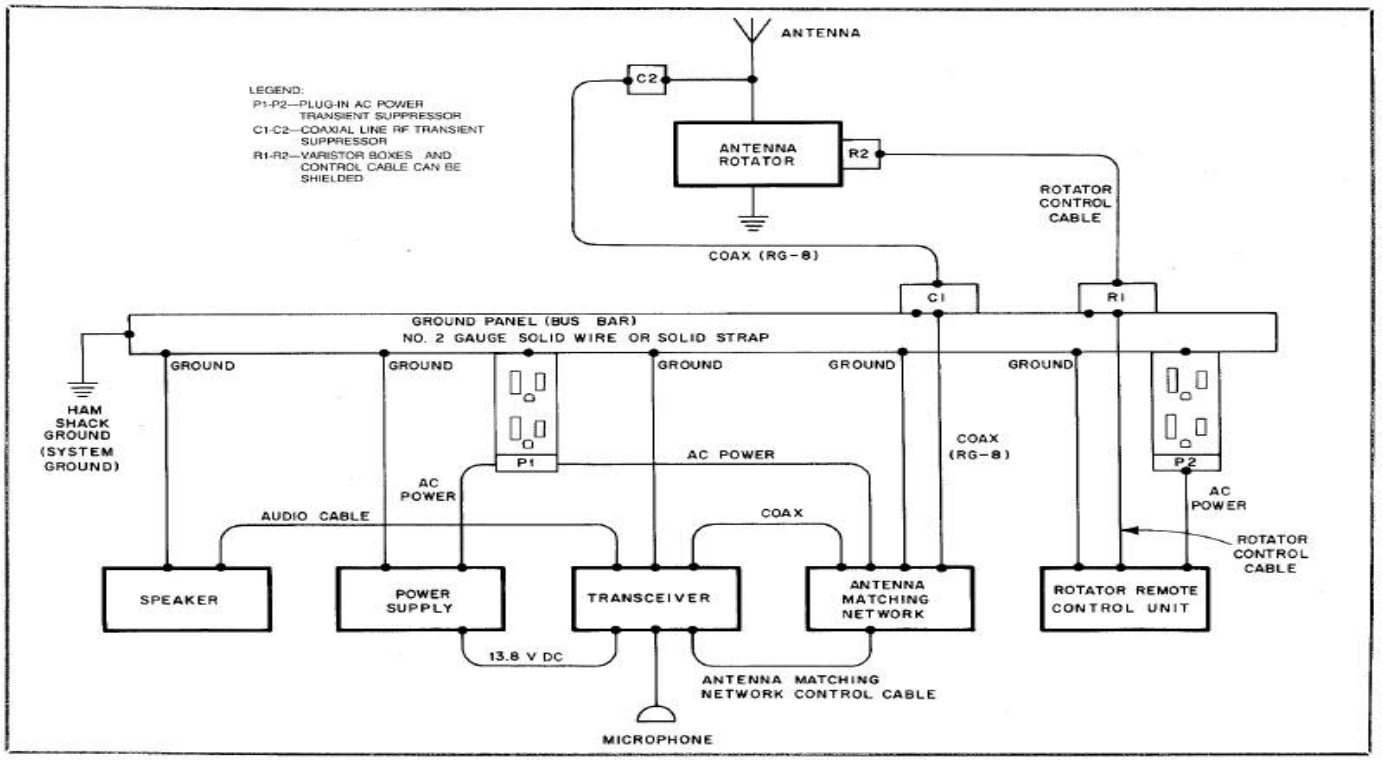
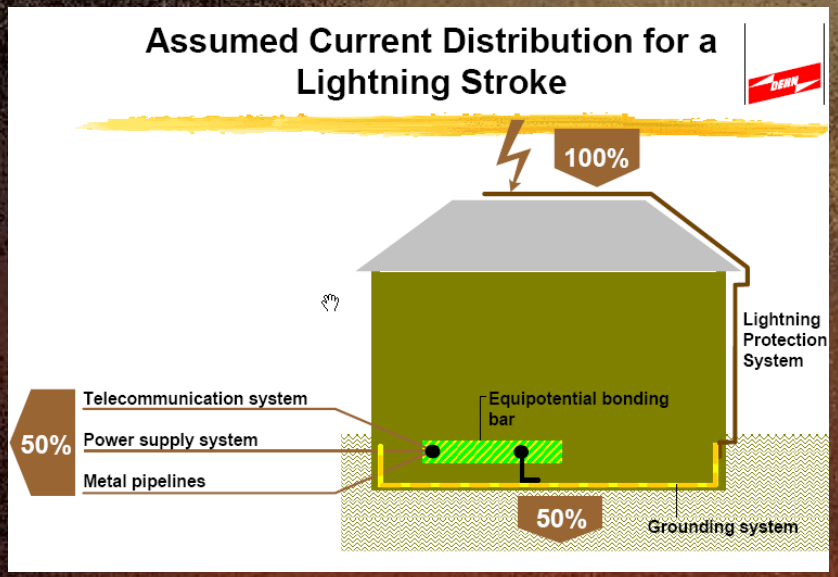
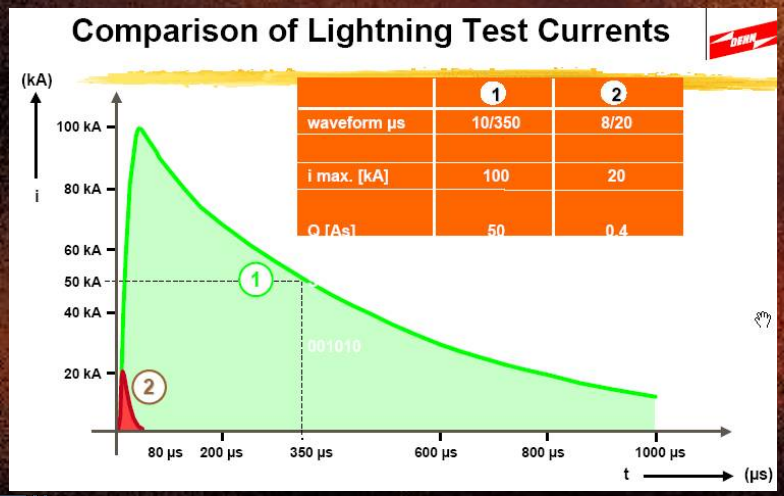
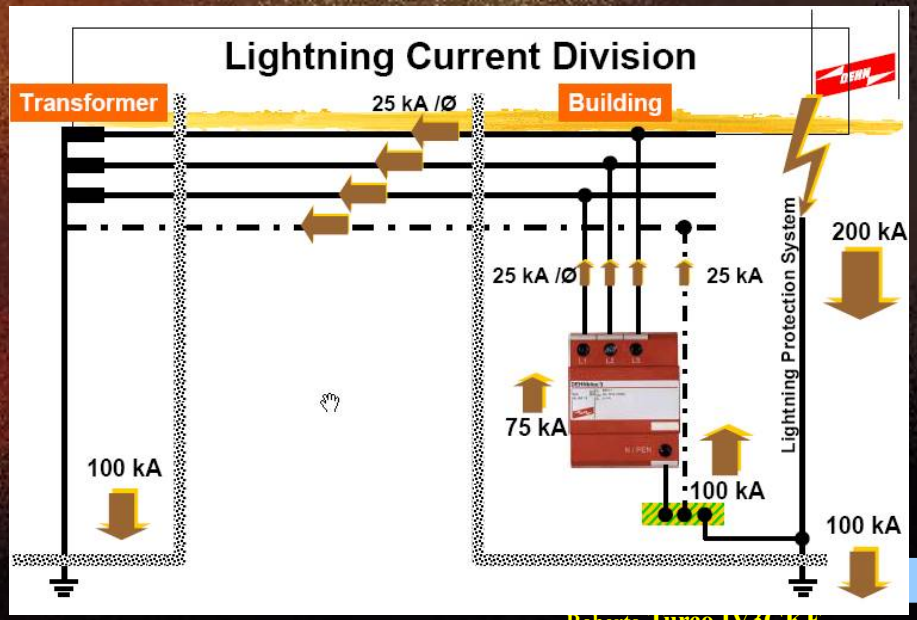


Fig 12—Transient suppression techniques applied to an Amateur Radio station.


Assumed Current Distribution for a Lightning Stroke
100%
Lightning Protection System
Telecommunication system
Power supply system
Metal pipelines
50%
Equipotential bonding bar
50%
Grounding system


Comparison of Lightning Test Currents
(kA)
i
100 kA
80 kA
60 kA
50 kA
40 kA
20 kA
1
2
80 µs
200 µs
350 µs
600 µs
800 µs
1000 µs
t
(µs)
1
2
waveform µs
10/350
8/20
i max. [kA]
100
20
Q [As]
50
0.4


Lightning Current Division
Transformer
25 kA /Ø
Building
25 kA /Ø
25 kA
200 kA
75 kA
100 kA
100 kA
100 kA
Lightning Protection System

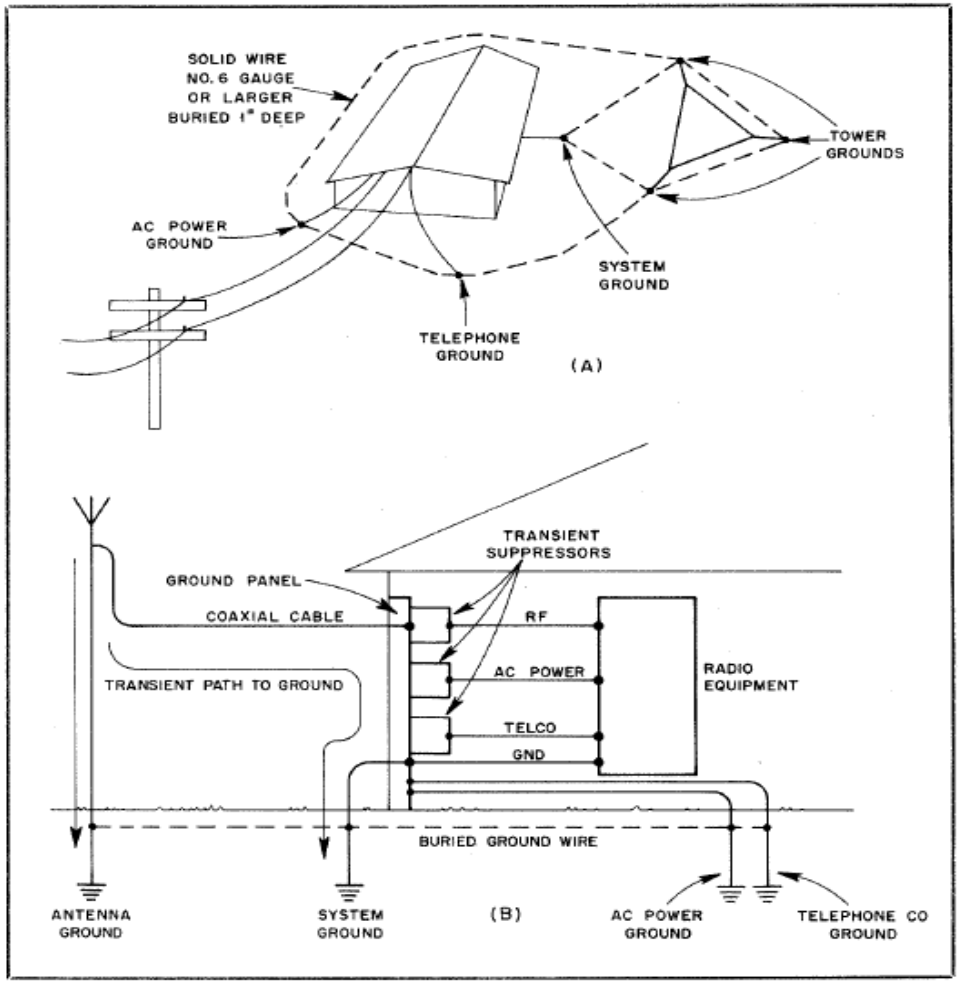


Fig 13—At A, the proper method of tying all ground points together. The transient path to ground with a single-point ground system and use of transient suppressors is shown at B.

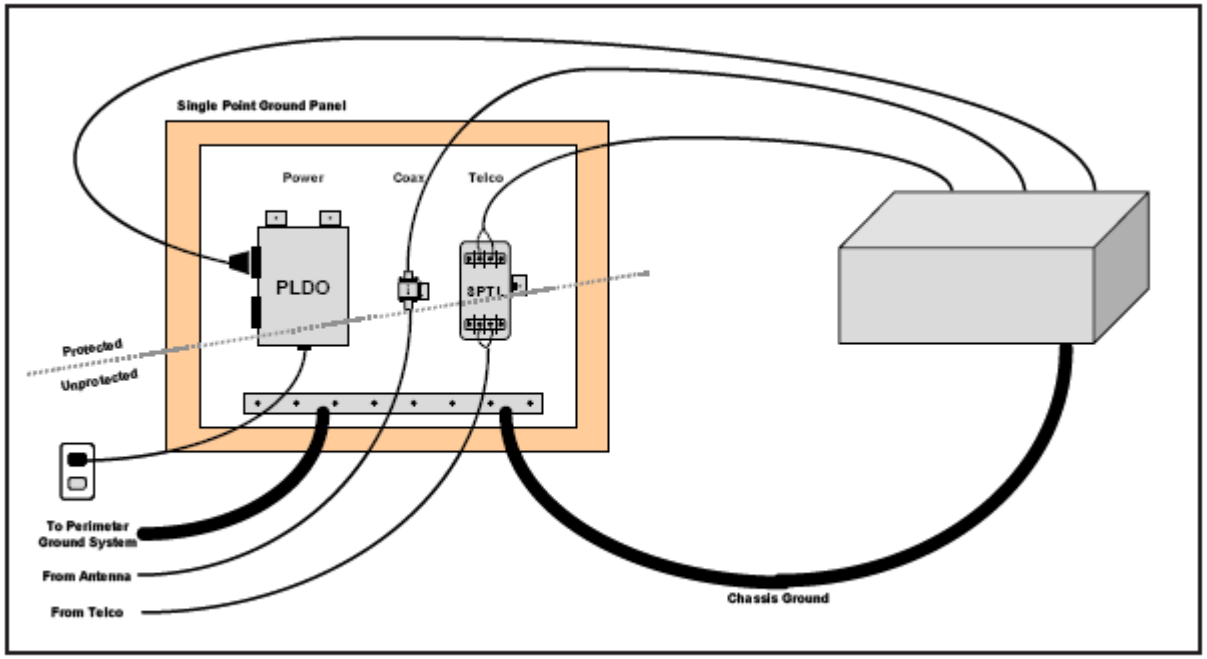


Figure 12—The SPGP showing the division of the protected and unprotected cables.

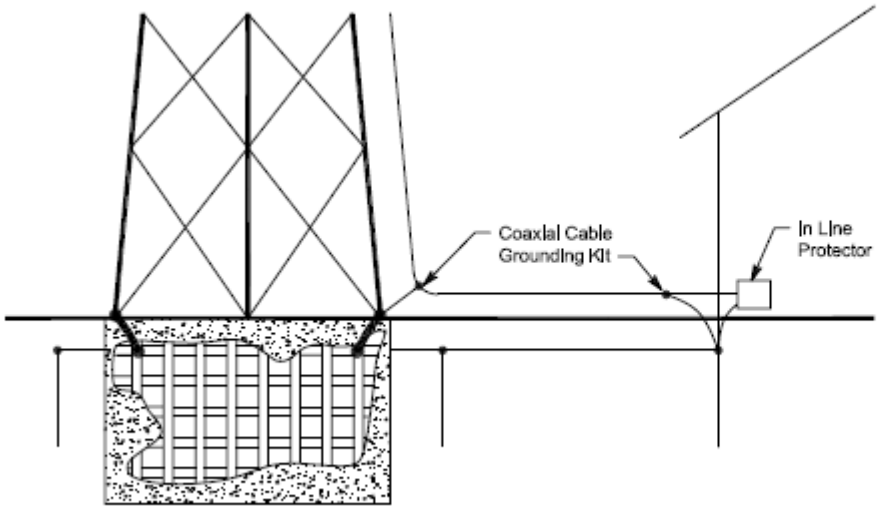
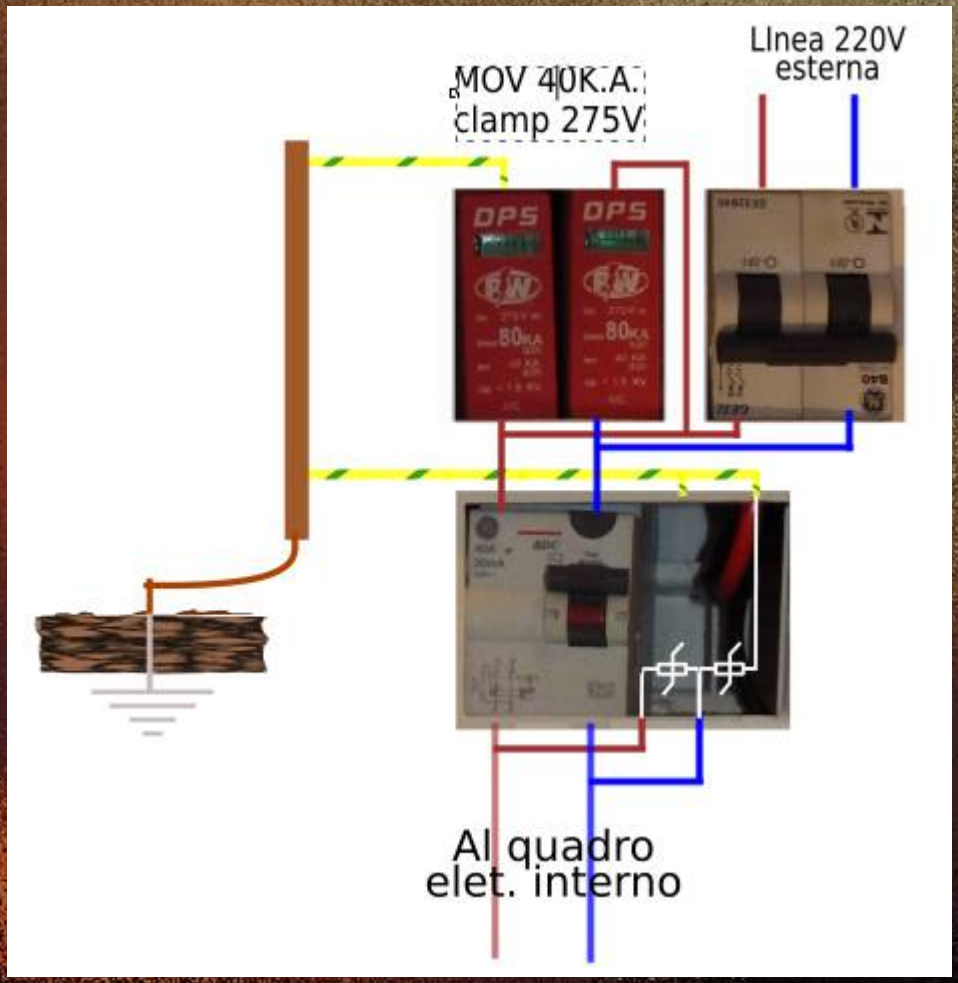


Figure 14—Grounding coaxial cables should be done at both the tower base and the entry point to the house or building. For minimum energy transfer from the tower, bring the coax all the way down the tower and apply a ground kit. Coax Take-off Point drawing, *The "Grounds" for Lightning and EMP Protection*, Roger R. Block, PolyPhaser Corporation, Minden, Nevada.

Soluzione finale in montagna!



Linea rigida colpita da scarica diretta

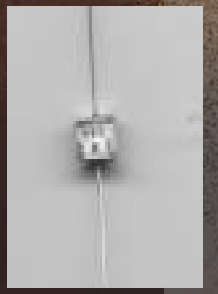
COMPONENTI VALIDI PER PROTEZIONE

Varistore

Componente elettronico non lineare con resistenza inversamente proporzionale alla tensione, con curva di funzionamento moderatamente ripida nel range desiderato. Protegge i sistemi elettronici dagli sbalzi di tensione scaricandola, dissipando parte dell'energia.
Ha un'elevata velocità di attuazione, una sopravvivenza moderata, un'elevata capacità di dissipazione dell'energia.

Spinterometro

Lo spinterometro funziona come un interruttore azionato dalla tensione. Quando la tensione supera il valore operativo, si crea un arco. percorso preferenziale per l'atterraggio.
Ha una bassa velocità di attuazione, efficace solo sopra i 50V, bassa capacitanza.



Tranzorb

Componente elettronico non lineare funziona secondo il principio "a valanga", lavorando in configurazione unidirezionale o bidirezionale.
Ha una curva di funzionamento molto nitida, alta precisione, alta velocità, Alta sopravvivenza, bassa capacità di dissipazione di potenza.

Roberto Turco IV3GKE

SPINTEROGENO
Calcolo valore minimo della tensione del scaricatore

$$V = \sqrt{P \times Z} \times SWR$$

where
P = peak power in W
Z = impedance of the coaxial cable (ohms)

P = 100 W
Z = 52 ohms
SWR = 1.5

Substituting these values in Eq 3:

$$V = \sqrt{100 \times 52} \times 1.5$$

$$V = 108.17$$

Tensione in volts per una linea TX di 52 OHM

POTENZA \ SWR	1.1	1.5	2	3	5
50	56	76	102	153	255
100	79	108	144	216	361
500	177	242	322	484	806
1000	251	342	456	684	1,140
5000	561	765	1,020	1,530	2,550

Varistor Specification
Device Ratings and Characteristics

Explanation of Part Numbers

05		D	2	2	0	K

Element Dia.	
05	ψ5.0mm
07	ψ7.0mm
10	ψ10.0mm
14	ψ14.0mm
18	ψ18.0mm
20	ψ20.0mm

Type
D

Varistor Voltage

Examples

2 2 0

$22 \times 10^0 = 22V$

2 2 1

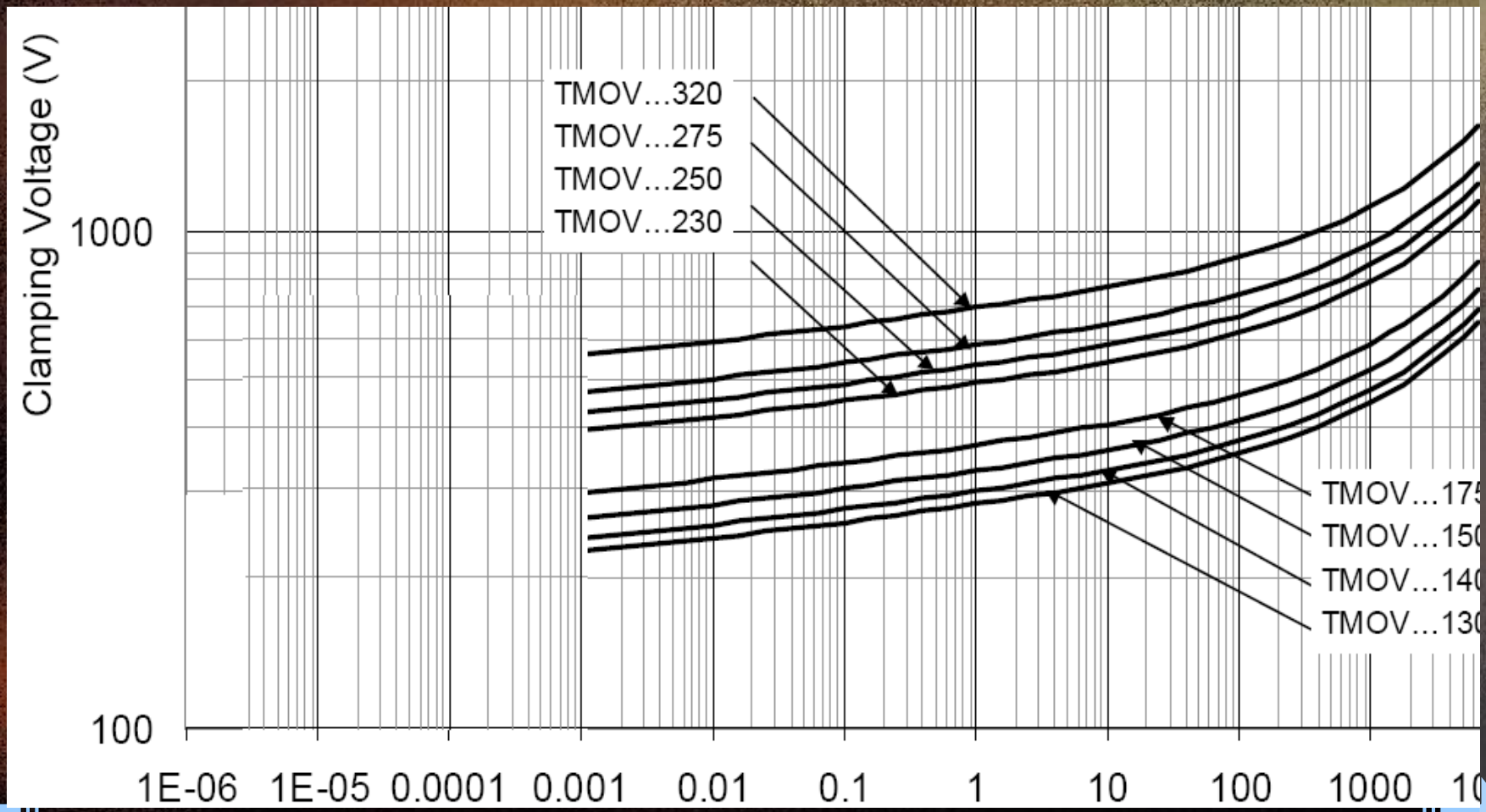
$22 \times 10^1 = 220V$

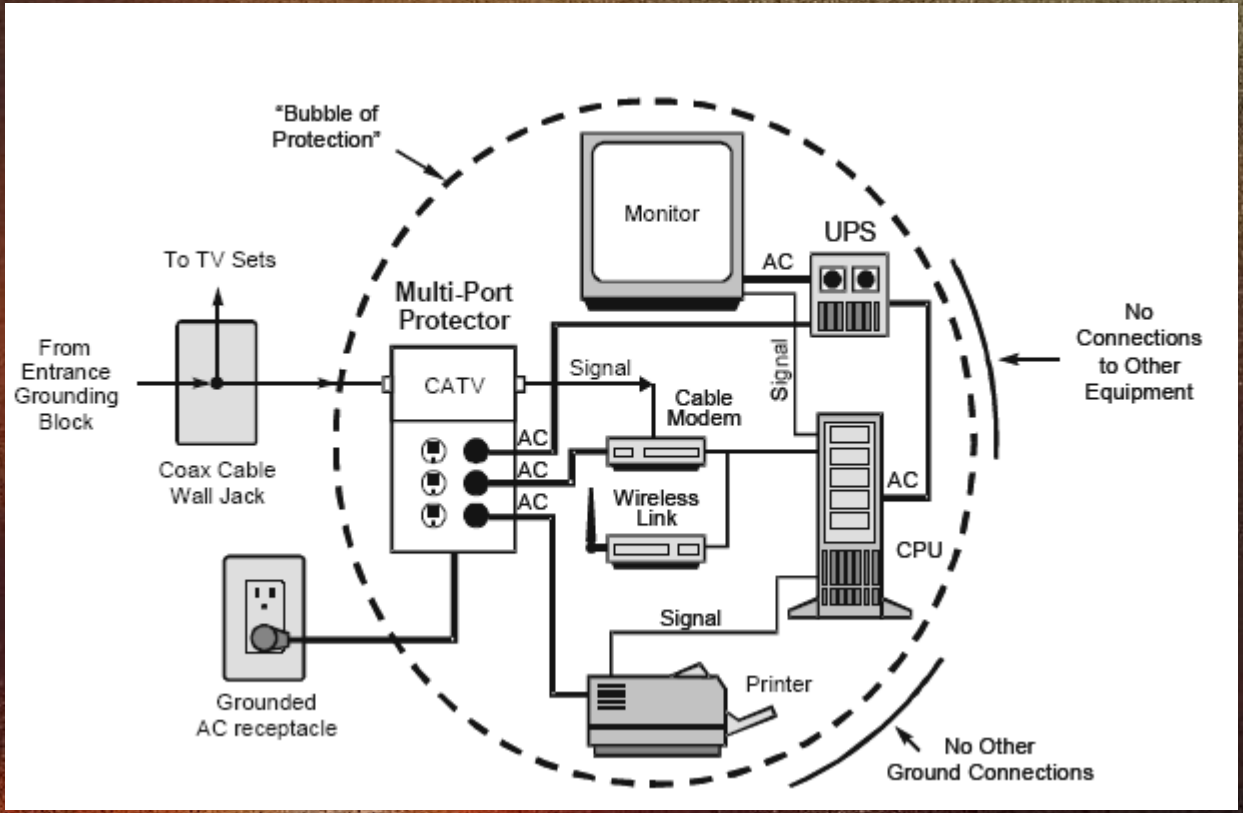
Tolerance
K:±10% or customer special requirement

20D Series

Part No. / Device Marking	Maximum Allowable Voltage		Varistor Voltage (@1mA)			Clamping Voltage @ Test Current (8/20μs)		Maximum Energy (J)	Maximum Peak Current (8/20μs)	Rated Power	Typical Capacitance (@1KHz)	Standards
	ACrms(V)	DC(V)	Min.	Vb(Vdc)	Max.	Vc(V)	Ip(A)	10/1000μs	(A)	(W)	(pF)	
20D180K	11	14	14.4	18	21.6	39	20	11.0	2000	0.2	40000	☆
20D220K	14	18	18.7	22	26.0	43	20	14.0	2000	0.2	30000	☆
20D270K	17	22	23.0	27	31.1	53	20	18.0	2000	0.2	24500	☆
20D330K	20	26	29.5	33	36.5	65	20	23.0	2000	0.2	20000	☆
20D390K	25	31	35	39	43	77	20	26.0	2000	0.2	13800	☆
20D470K	30	38	42	47	52	93	20	33.0	2000	0.2	13500	☆
20D560K	35	45	50	56	62	110	20	41.0	2000	0.2	12200	☆
20D680K	40	56	61	68	75	135	20	46.0	2000	0.2	11500	☆
20D820K	50	65	74	82	90	135	100	38.0	6500	1.0	8200	☆ ◎
20D101K	60	85	90	100	110	165	100	45.0	6500	1.0	8000	☆ ◎
20D121K	75	100	108	120	132	200	100	55.0	6500	1.0	5500	☆ ◎
20D151K	95	125	135	150	165	250	100	70.0	6500	1.0	4200	☆ ◎
20D181K	115	150	162	180	198	300	100	85.0	6500	1.0	2500	☆ ◎
20D201K	130	170	185	200	225	340	100	95.0	6500	1.0	2300	☆ △ ※ ◎
20D221K	140	180	198	220	242	360	100	100.0	6500	1.0	2200	☆ △ ※ ◎
20D241K	150	200	216	240	264	395	100	108.0	6500	1.0	2200	☆ △ ※ ◎
20D271K	175	225	247	270	303	455	100	127.0	6500	1.0	2100	☆ △ ※ ◎
20D301K	195	250	270	300	330	500	100	150.0	6500	1.0	1800	☆ △ ※ ◎
20D331K	210	275	297	330	363	550	100	163.0	6500	1.0	1750	☆ △ ※ ◎
20D361K	230	300	324	360	396	595	100	163.0	6500	1.0	1700	☆ △ ※ ◎
20D391K	250	320	351	390	429	650	100	180.0	6500	1.0	1400	☆ △ ※ ◎
20D431K	275	350	387	430	473	710	100	190.0	6500	1.0	1350	☆ △ ※ ◎

Transient V-I Characteristic Curves




"Bubble of Protection"
Monitor
UPS
AC
To TV Sets
Multi-Port Protector
From Entrance Grounding Block
CATV
Signal
Cable Modem
Signal
No Connections to Other Equipment
AC
AC
AC
Wireless Link
AC
CPU
Coax Cable Wall Jack
Signal
Printer
Grounded AC receptacle
No Other Ground Connections

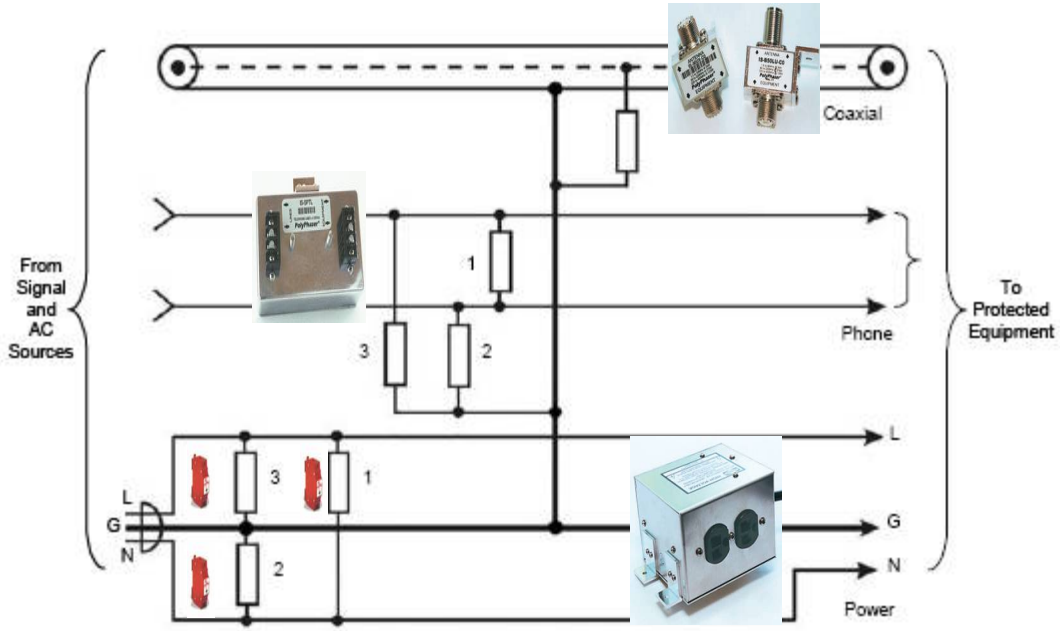


Figure 10: Basic Plug-in Multi-port Protector (Surge Reference Equalizer). There is a protector for each port (cable), and the grounds for all the protectors are connected (bonded).

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ANTENNA
IS-B50LU-C0
PolyPhaser
EQUIPMENT
ANTENNA
IS-50UX-C0
PolyPhaser
EQUIPMENT


IS-SPTL
LINES
EQUIPMENT
TELEPHONE LINES +/-200Vdc
PolyPhaser

FINE