How to Ensure Reliable, High QoE Video-Streaming Applications in LANs

By Russ Gundrum, MBA PMP SSGB

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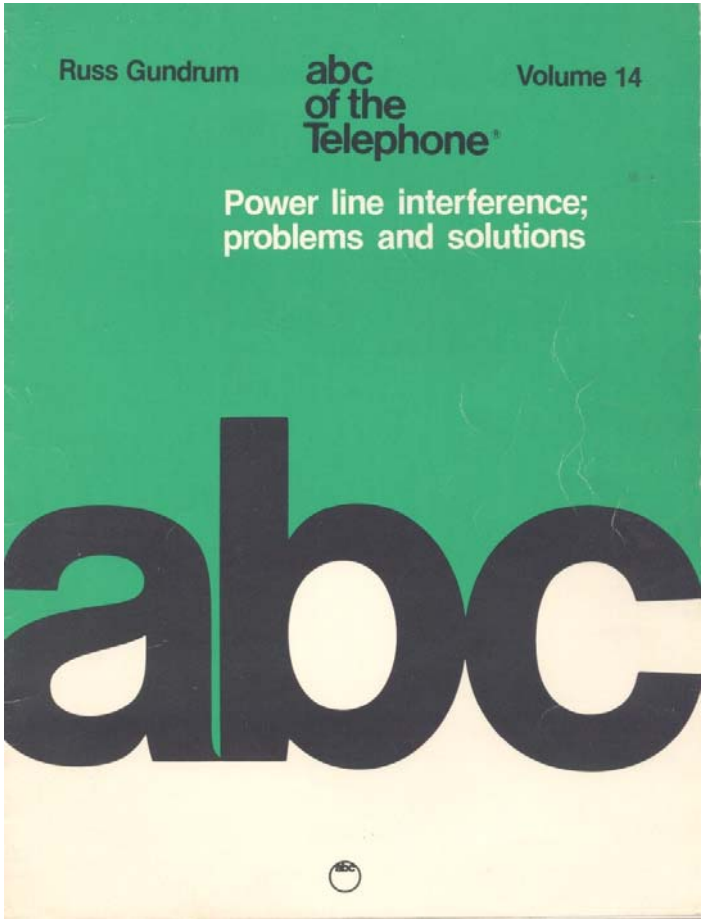
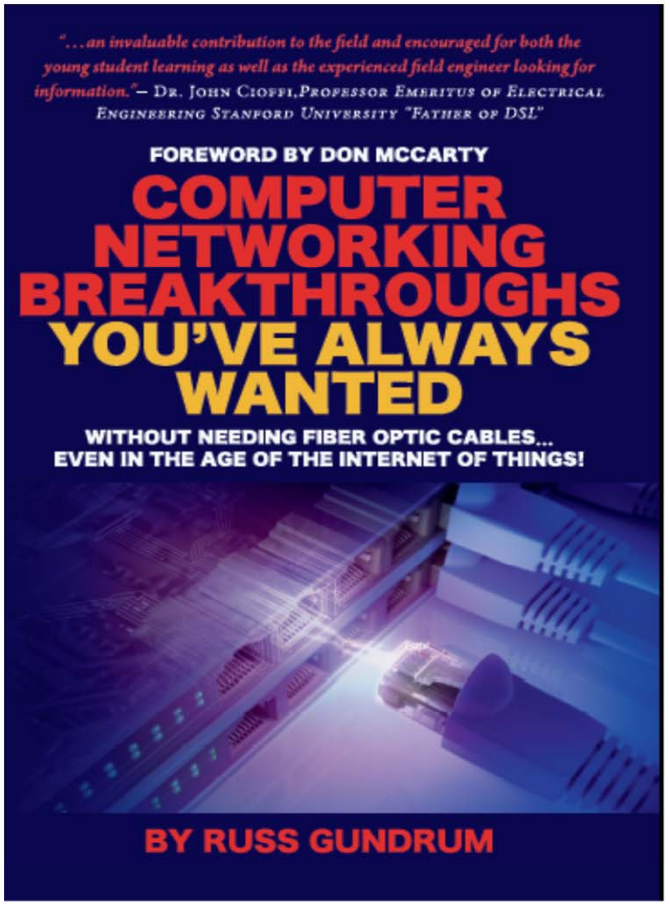
Agenda

- Issues affecting the performance and reliability of high-speed ICT wireline networks
- How certain mysterious things can cause malfunctions to critical network operations
- Quickly identifying and correcting potential IPTV service-affecting problems
- A breakthrough computer networking technology is the solution!
- Wi-Fi/AXT issues
- PoE issues
- EMP





www.computernetworkingbreakthroughs.com

"...existing copper facilities in the telecom and computer networking industry can be operated reliably and economically in providing high bandwidth applications without being replaced by fiber optic cables."

A flavor of the book can be seen by some of the 22 chapter titles:

- That Antiquated and Obsolete Copper Network…Really?
- Wasn't Twisted Pair Supposed to be the Answer?
- Wasn't Shielded Cable Supposed to be the Answer?
- My One-Year Stint with the Cable Guys…and This Neat Little "One-Wire" Coaxial System
- What does the IEEE have to say about All of This?
- Wi-Fi is THE Network!
- But What About 5G?
- Oh, and Have You Heard About the EMP Threat?

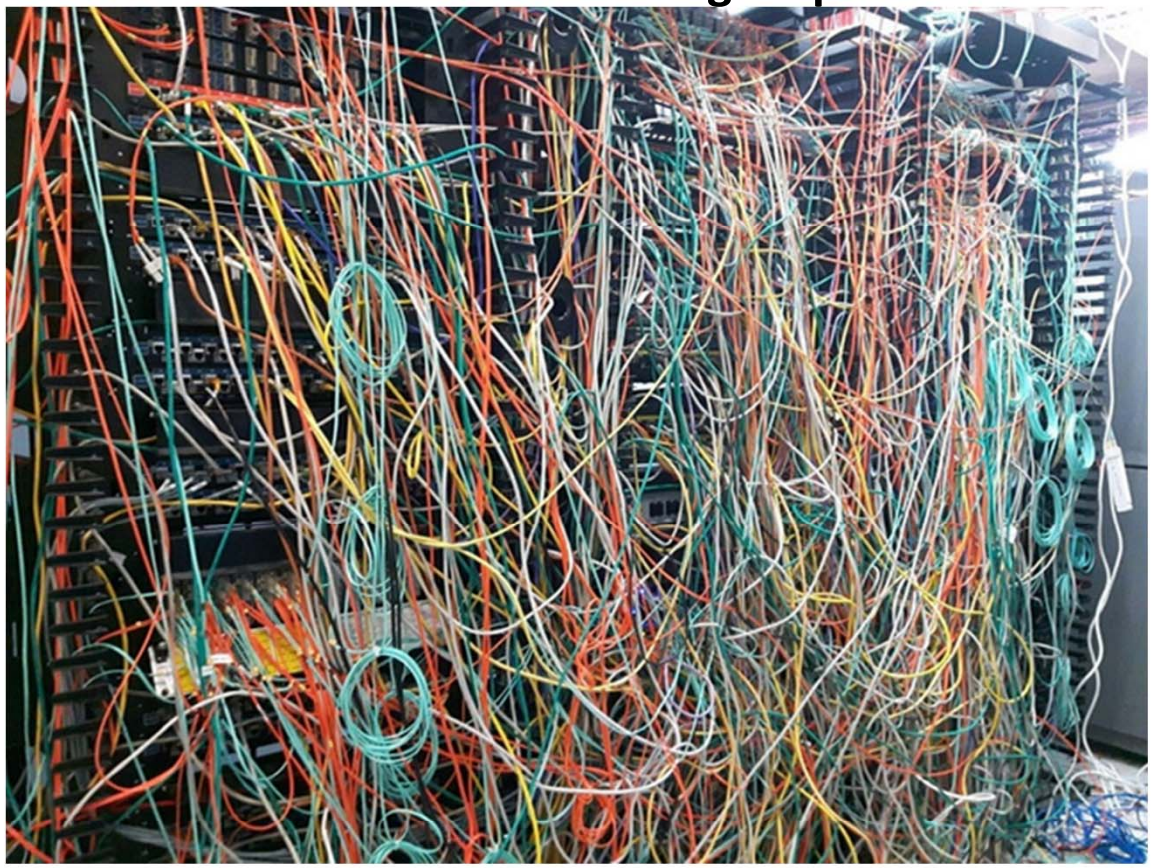
INSIDENETWORKS.CO.**UK** JUL 19

“More than half of IT staff frustrated by nasty network surprises

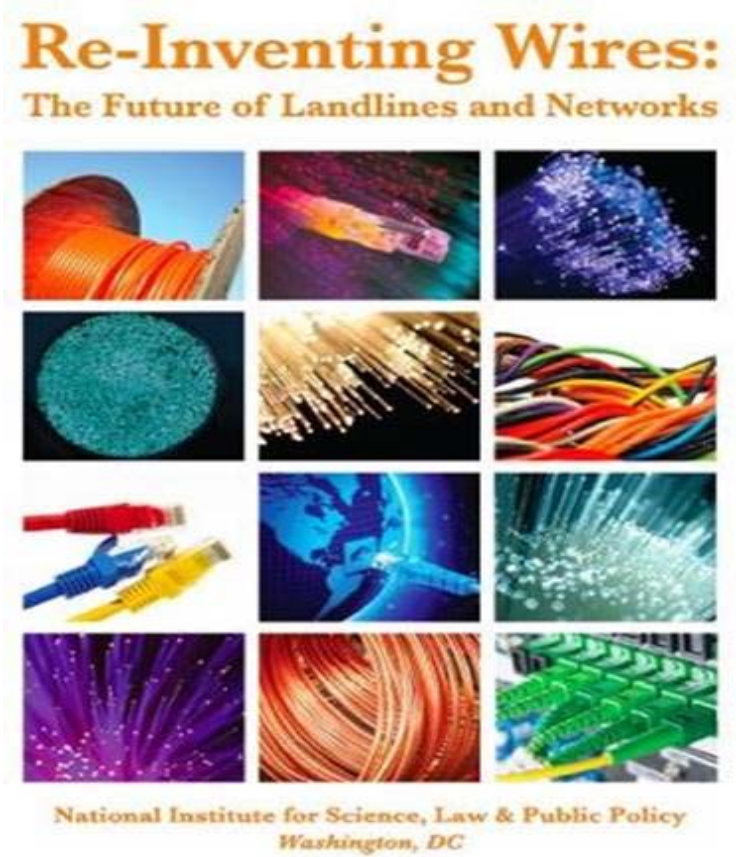
According to new research from Paessler, UK IT staff’s **biggest frustrations in the workplace are networks unexpectedly failing with no warning (63 per cent)** and end users reporting problems before IT even knew about them (54 per cent).”

https://www.insidenetworks.co.uk/magazine/jul19/?

Cries for cabling help

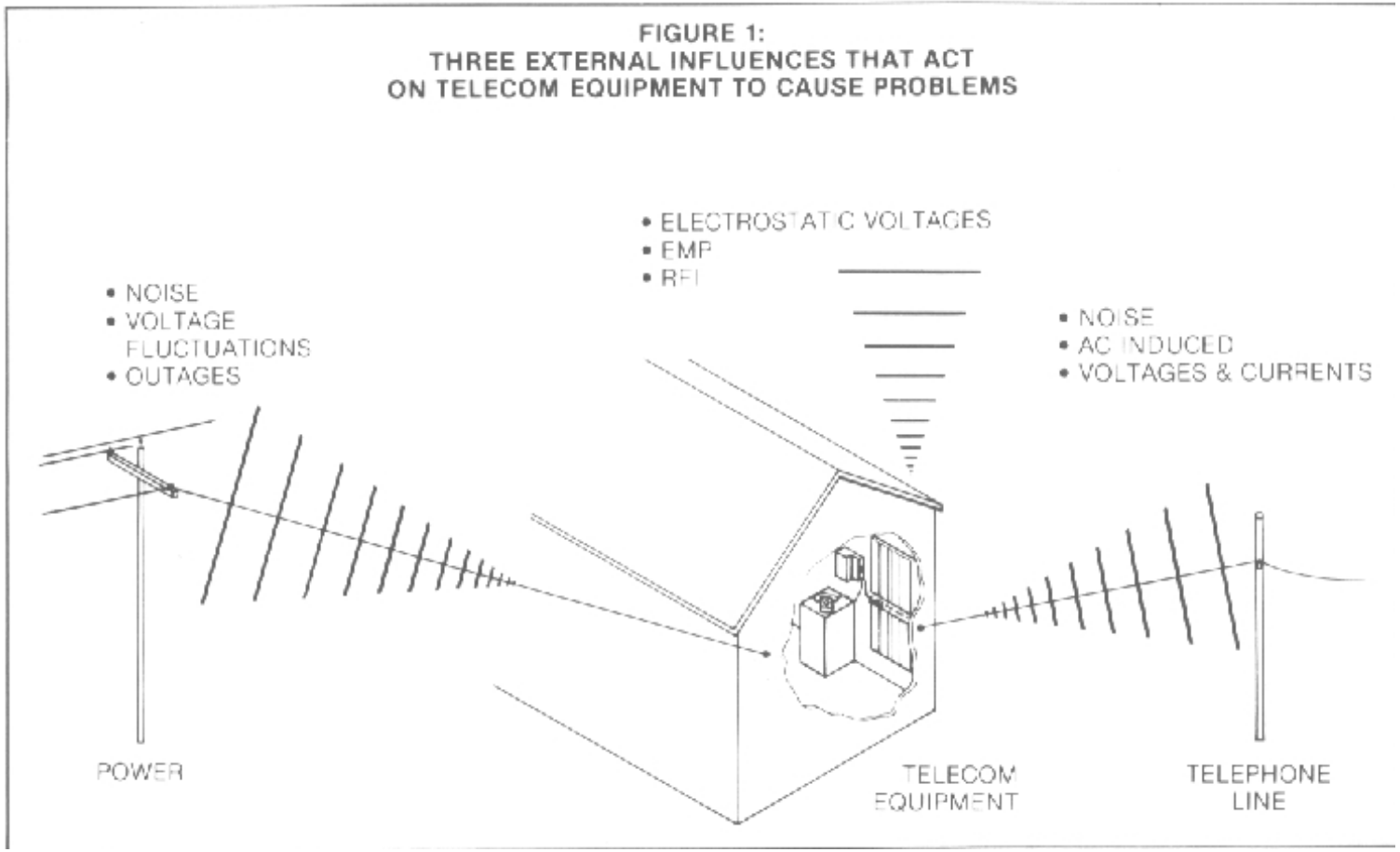


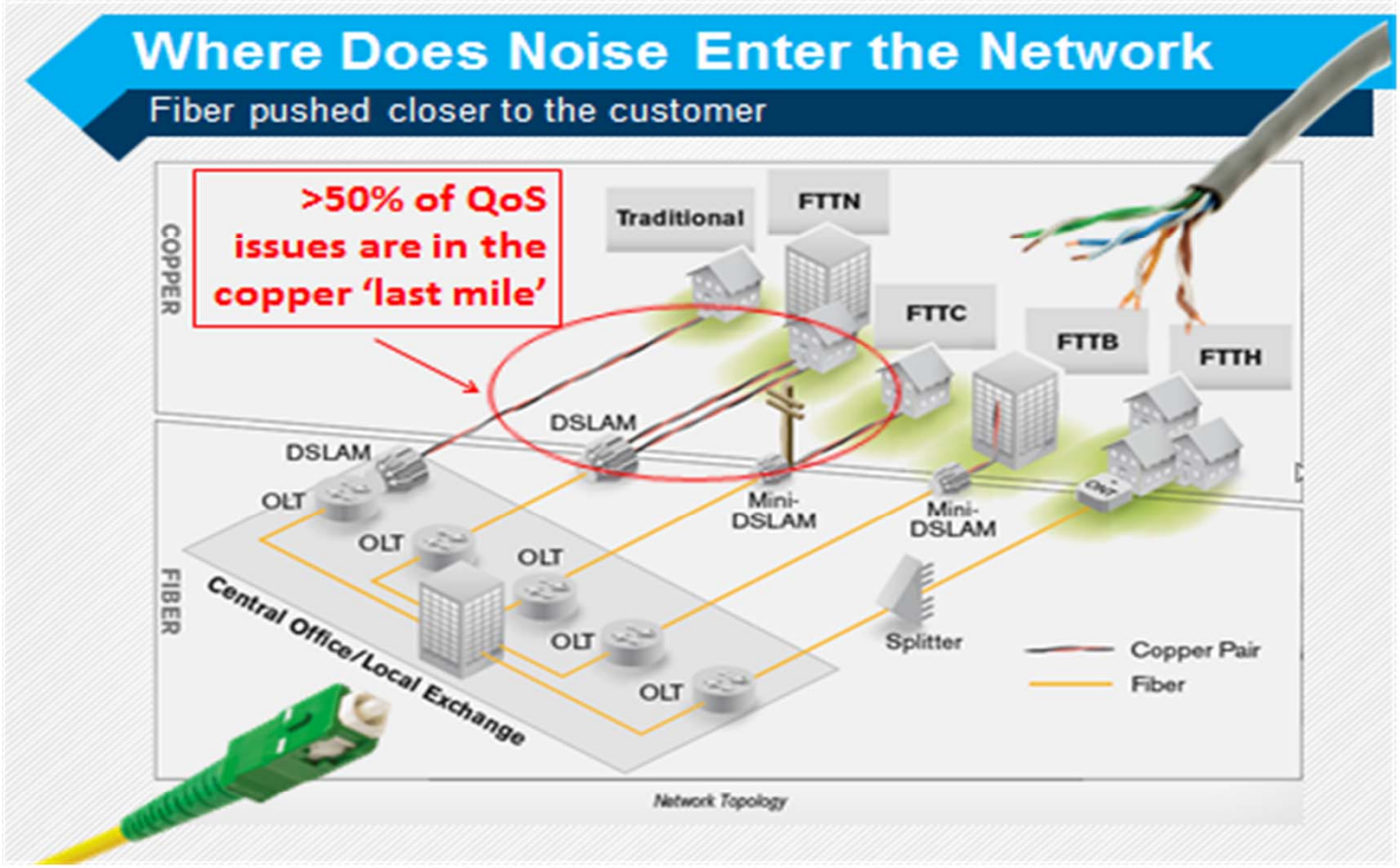
https://www.**cablinginstall.com**/design-install/article/14034598/cries-for-cabling-help-mustsee-photos?



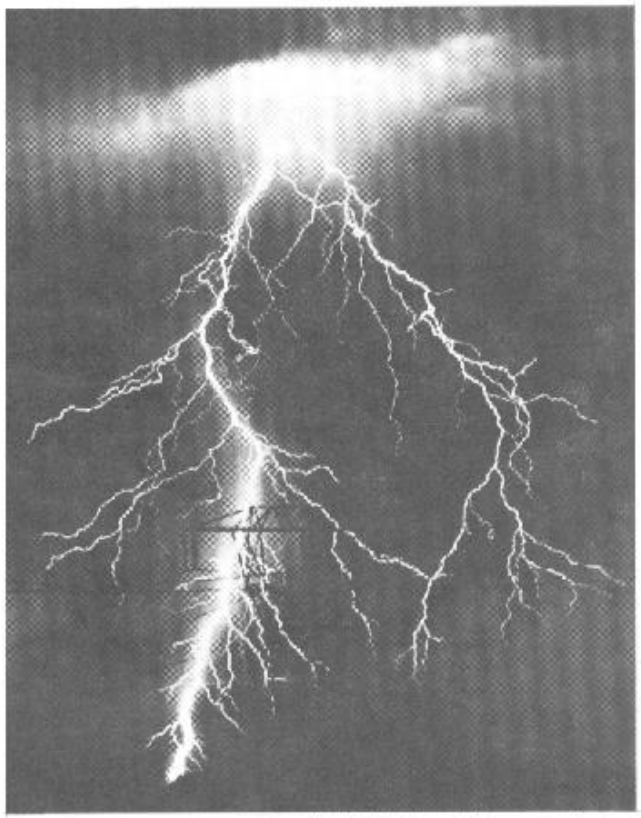
There really is a "copper phobia" in the industry!

So Where Does All of This EMI Stuff Come From Anyway?





https://www.**exfo**.com/en/resources/webinars/xdsl-**iptv-qoe**-webinar/

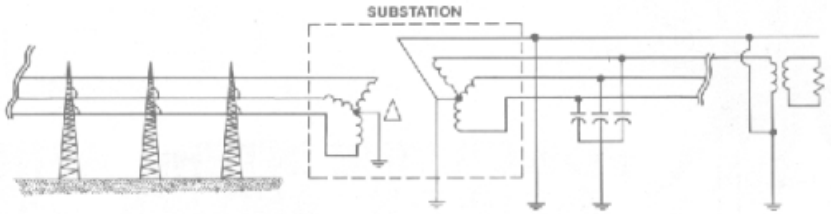


While rarely witnessed or photographed, lightning striking power lines accounts for many protection problems. It's always interesting to correlate information from the power company to see what problems they have had after a storm passes by, and how it impacted on the telephone plant during the same time frame.

MAGNETIC INTERFERENCE INTERACTION MODEL

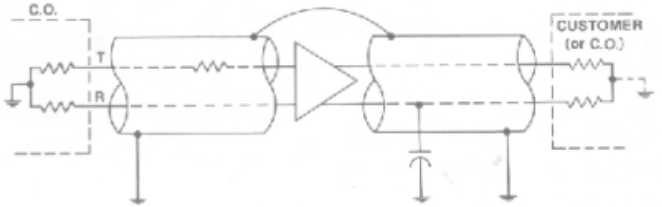
POWER INFLUENCE:

- Voltage
- Current
- 3, 2, 1 Phase
- Balance vs Unbalance
- Geometry
- Waveshape
- Grounding
- Impedance of Neutral



COUPLING:

- Frequency of interference
- Mutual Impedance
- Earth Resistivity
- Separation
- Shielding of cable sheath and other conductors
- Sheath Bonding (continuity)
- Sheath Grounding

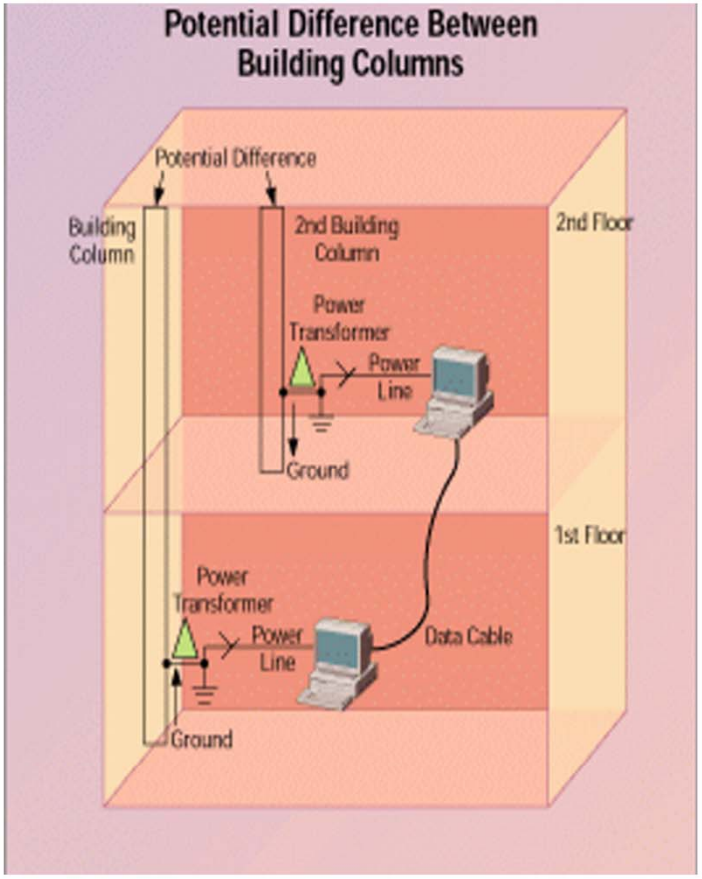


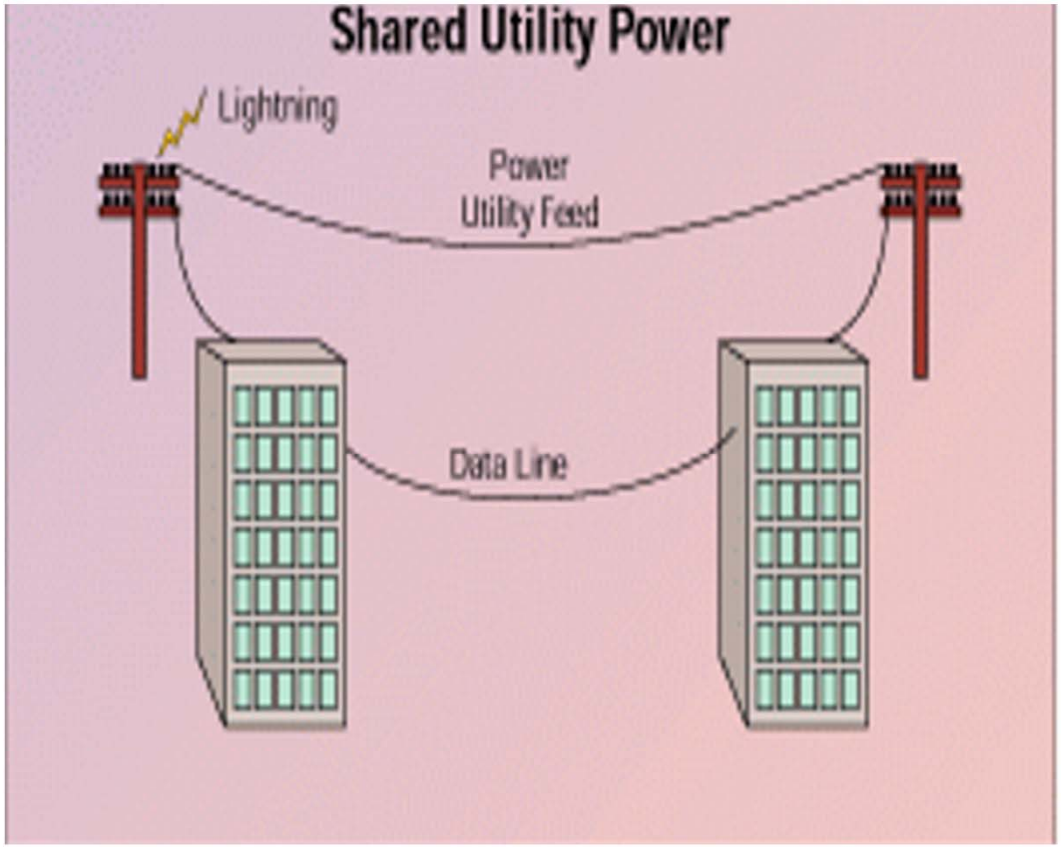
SUSCEPTIBILITY:

- Equipment termination unbalance (Noise)
- Cable pair unbalance (Noise)
- Electronic equipment sensitivity (Malfunctions/Damages)
- Electrical Safety

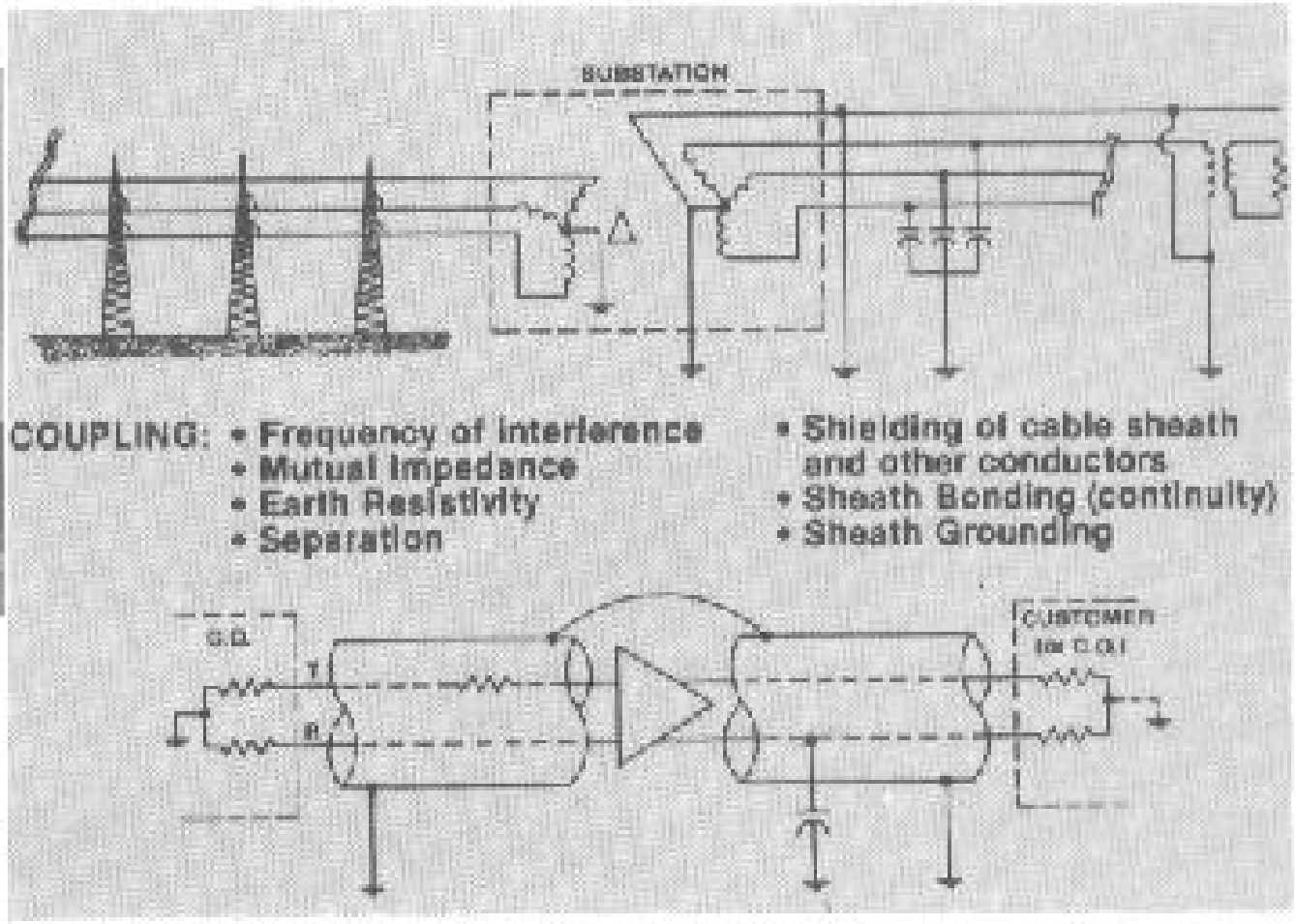
- Focal point of concern in order to assure a safe, reliable and economical telecommunications system while operating in a hostile electrical environment.
- Model 1:1 turns ratio transformer.
- Only concerned with electromagnetic interference (Electrostatic effects eliminated with grounded cable shields).
- Eliminate any one parameter (Influence, Coupling, Susceptibility) and you will *not* have a problem!

Ground Potential Rise (GPR)

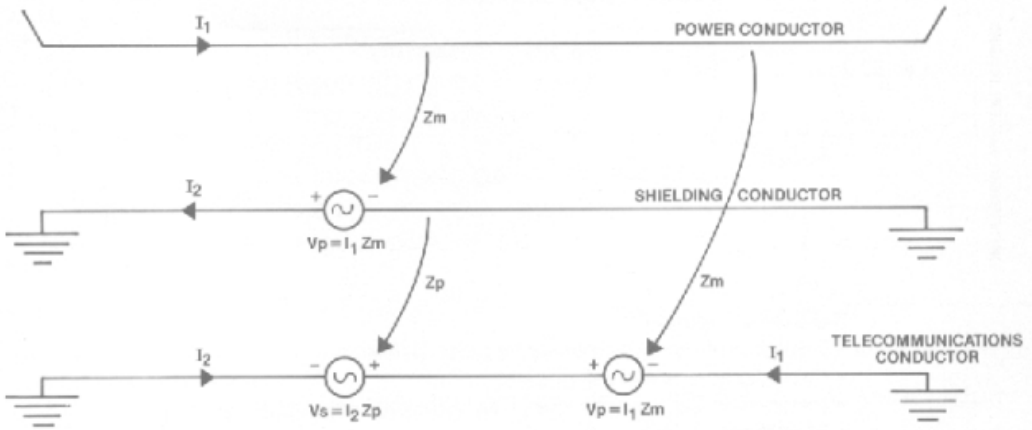




Horizontal lightning or cloud-cloud lightning is a source of longitudinal induction.



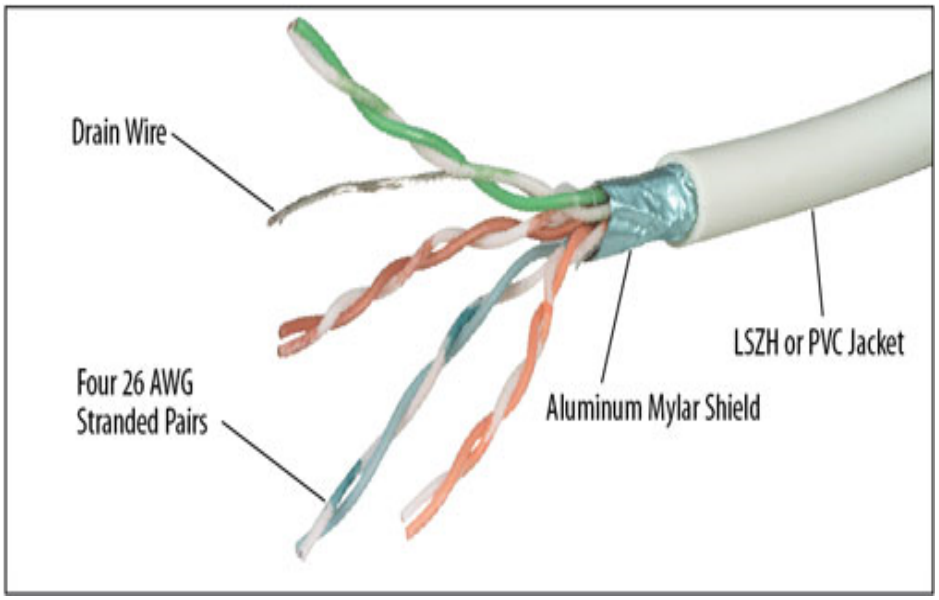
It is not practically possible to secure perfect shielding by the adjustment mentioned above, since with any pair of ground return circuits their mutual resistance and reactance are always less than the self resistance and reactance of either circuit. However, any addition to the self impedance of the shielding circuit which at the same time is added to the mutual impedance of this circuit and the disturbing or disturbed circuit diminishes the shield factor, and if the added impedance is large the shielding can be made almost perfect. One application of this principle is through the insertion at intervals of mutual inductance coils, so-called "neutralizing transformers." In cases where the shielding conductor is the



Zm = MUTUAL IMPEDANCE BETWEEN POWER CONDUCTOR AND SHIELDING AND TELECOMMUNICATIONS CONDUCTORS

Zp = MUTUAL IMPEDANCE BETWEEN SHIELDING AND TELECOMMUNICATIONS CONDUCTORS (DEPENDS ON PERMEABILITY OF SHIELDING MATERIAL)

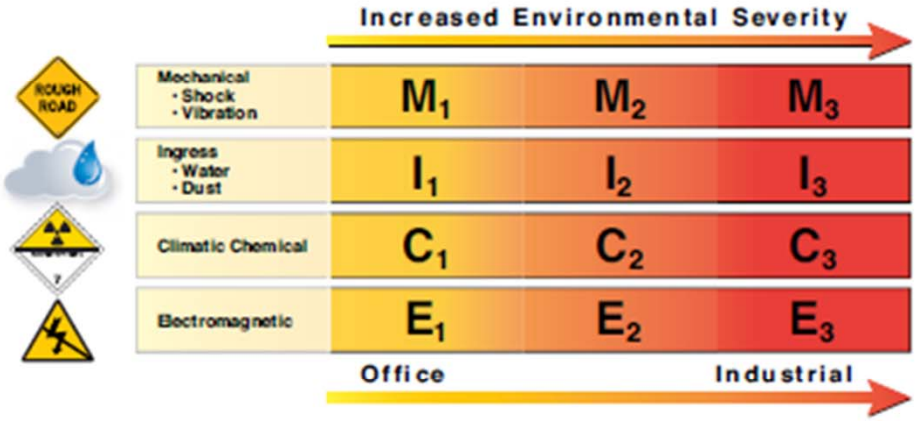
- Only need two grounds for an effective electromagnetic shield.
- Grounds should be low resistance for maximum current flow.
- Shield should be continuous with low resistance bonds across the splices.
- The telephone pairs do not have to be enclosed by the shield for it to be effective — as long as it is within 30 feet of the power or telephone conductor.
- A shield factor of 1.0 represents no shielding and factors close to 0.0 represent excellent shielding.
- Non-ferromagnetic shielding materials such as copper and aluminum have low permeabilities and Zm = Zp. Therefore, shielding at low fundamental frequencies is only about 1% effective. (Shield factor of 0.99).
- Heavy ferromagnetic shielding materials such as steel have higher permeabilities and have up to 35% shielding reductions at low frequencies under steady-state conditions. This increases under fault current conditions, but can cause saturation and revert back to that of no shield!



Shielded Cat 6 Cable (STP)

Bottom Image Shows Shielding Typically Found in Cat 6a Cable

TSB-185 Environmental Classification (M.I.C.E.)

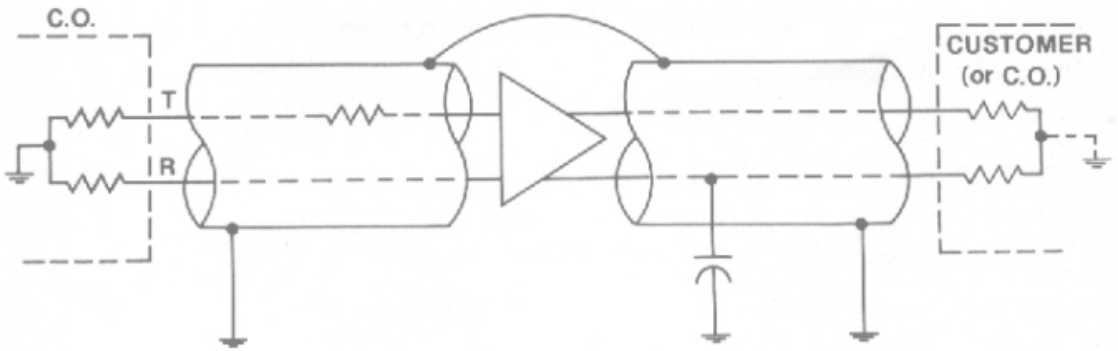


Environmental classification $M_3I_2C_1E_2$

Element

Severity (based on worse-case element parameter)

	Elements			
	M	**I**	**C**	**E**
Parameters	Shock/bump	Particulate ingress	Ambient temperature	Electrostatic discharge
	Vibration	Immersion	Humidity	Radiated RF
	Crush		Liquid polution	Conducted RF
	Impact		Gaseous polution	Magnetic field

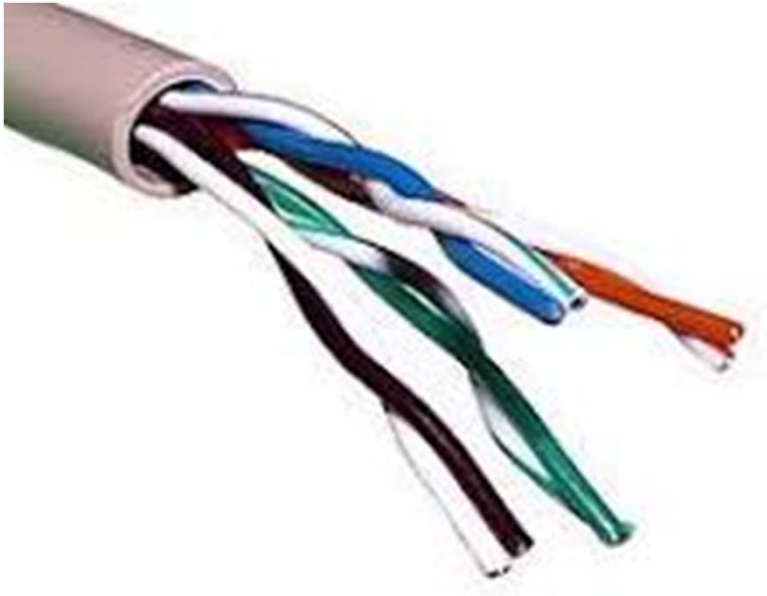


SUSCEPTIBILITY:

- **Equipment termination unbalance (Noise)**
- **Cable pair unbalance (Noise)**
- **Electronic equipment sensitivity (Malfunctions/Damages)**
- **Electrical Safety**

- Circuit Balance = Power Influence – Circuit Noise.
- In practice, perfectly balanced circuits do *not* exist!
- DC resistive unbalances – shorts, opens and grounds
  AC capacitive unbalances – water, bridge taps, split pairs, insulation leakage
- No established standards on acceptable levels of steady-state induced AC voltages or currents before equipment malfunctions or damages occur.
- However, standards have been established by some governing bodies that state that more than 30 volts-to-ground and 5 milliamperes through a 1500 ohm load can be a safety hazard!
- It is often hard to distinguish where noise mitigation ends and protection begins.

Understanding the Physical Layer



Category 5 UTP

This is something you will
not see…or hear…
ANYWHERE in the world!!!

By Russ Gundrum, MBA PMP SSGB
Principal Consultant

Telecom Problem Solvers, LLC

Russ Gundrum and his EMI demo in July 2018
for his telecom class at UH

Problems with Video

Network Impairments

- Freezing
- Buffering
- Packet Loss

Encoding Impairments

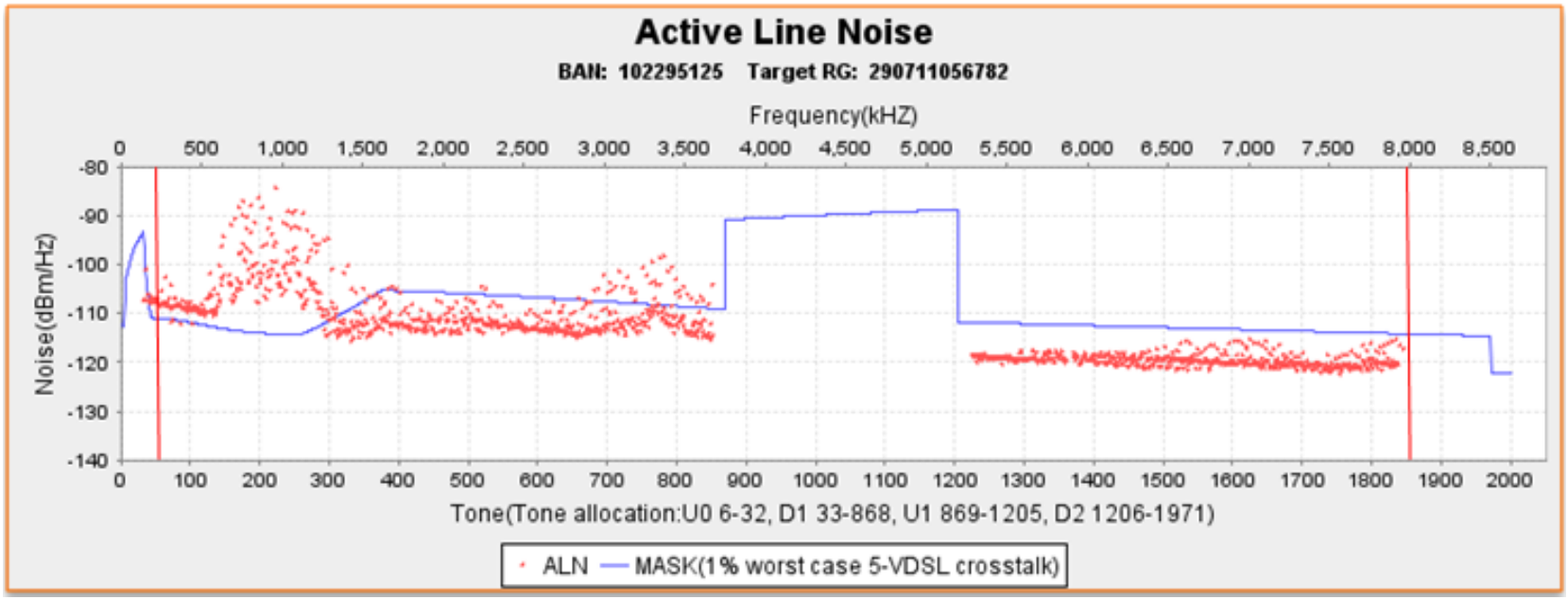
- Blockiness
- Blurriness
- Scaling

Camera Impairments

- Noise
- Focus

Spirent Webinar by Jan Arvik on June 4, 2019
"Measuring Video Quality Using AI"

Induced 60 Hz/Noise Effects on VDSL



AC Power can affect a very broad range of frequencies at once. AC can amplify other minor or severe impairments causing the modest of impairments to become severely detrimental. (**Blue** indicates a satisfactory level; **red** indicates measured noise levels)

Effects on video service:

Pixilation **Freezing** **High FEC count** **REINIT's (Dropping Sync)**

Wiring Issues Affecting IPTV QoS/QoE

- It was determined in tests made in Fluke Labs that Power Influence levels exceeding **92 dBrnc caused loss of sync between IPTV video equipment**
- It is known that **excessive impulse noise can cause pixelization and picture "freezes"** which can cause the length of the subscriber pair to be shortened in order to obtain acceptable IPTV service
- Induced longitudinal currents/voltages can be the cause of **RGs and/or STBs to "lock-up"** and require **re-booting or momentarily being unplugged** in order to release the surge of electricity that caused the problem
- Higher levels of induced currents/voltages can even **damage the video equipment ports and RGs**, causing **unnecessary customer outages**, truck rolls and the additional expense of replacing the units
- There are similar EMI issues of less magnitude in the inside wiring from the RG to the STB/DVR, especially due to the use of **unshielded Cat 5/6 cabling**. Compact Fluorescent Lights **(CFLs), tread mills, light dimmer switches**, and a host of other harmonic producing electrical loads can create high frequency electrical noise problems that can affect the signal quality and customer TV watching experience (QoE)

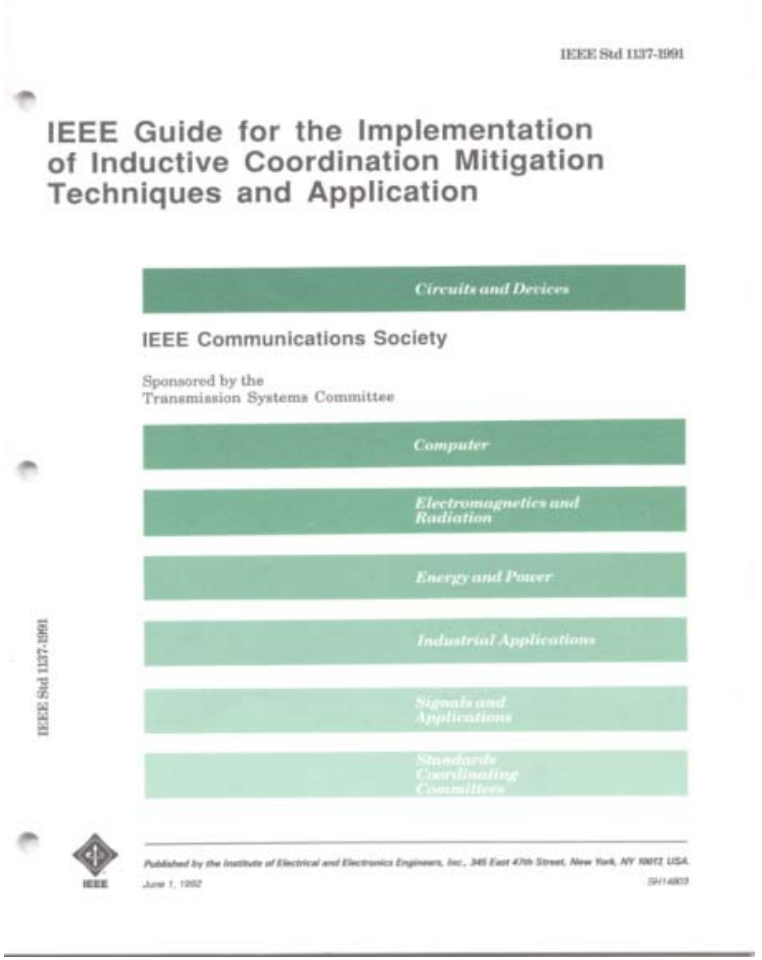
Bottom Line

Quick Things to Consider for Potential QoS/QoE Issues

- Long cable runs
- Cables running between buildings
- Poor longitudinal cable pair balance
- UTP
- STP where the shield is not continuous or grounded at both ends
- High levels of impulse noise
- Lightning/power surges
- Continuous induced voltages > 10 Vg or continuous induced currents > 10 mA

Updated in 2019

"1. Scope
This recommended practice addresses the inductive environment that exists in the vicinity of electric power and **wire-line** telecommunications systems and the interfering effect that may be produced thereby; guidance is offered for the control or modification of the environment and the susceptibility of the affected systems in order to maintain an **acceptable** level of interference. **An acceptable level is defined as an amount of steady state or surge induced longitudinal voltage or current that does not cause a personnel or public safety hazard, damage to cable or equipment, and/or circuit degradation or failure**."



1991 IEEE Standard 1137 Front Cover

1995 Letter to Editor *Cabling Installation & Maintenance* still on the web!

Grounding and bonding

November 1, 1995

Russ Gundrum
Kingwood, TX

Just wanted to add a few comments to Mark Waller`s article "Grounding and bonding ensure a safe installation" (see September 1995, page 21).

Instead of using modems, opto-isolators or data-port protectors, or replacing copper cable with fiber-optic cabling, I`d like to suggest a less-expensive and more-effective solution to the problem of induced voltages and currents on data lines. And shielded cable isn`t the answer either--as the telephone industry learned years ago.

Neutralizing transformers were developed more than 60 years ago for use on open-wire telephone lines to reduce induced voltages and currents simultaneously. You don`t need to specify an operating threshold for this device because it doesn`t clamp the circuit and shunt it to ground. There is no time delay, because it operates instantaneously, and it is a multi-pair device, so you only need it at one end of the circuit.

In the 1960s, large units were built for critical telecommunications and data circuits serving substations and power plants that might be exposed to thousands of volts. In the 1970s, smaller and less-expensive units were designed to suppress hundreds of volts. **Now I`m waiting for one to be designed for the local area network market to solve an even lower voltage problem**. **Any takers out there?**

http://www.cablinginstall.com/articles/print/volume-3/issue-11/crosstalk-feedback/to-the-editor/grounding-and-bonding.html

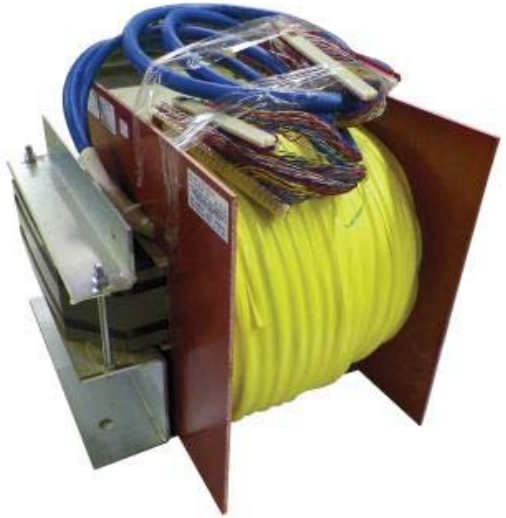
What's A Neutralizing Transformer?

- Dates back to the open-wire days of telephony
- Multi-pair device which substantially reduces induced AC voltages *AND* currents
- HVNT is used in power generating plants & substations to reduce GPR
- INT is much smaller and less expensive

25 Pair INT in Houston AT&T C.O. Cable Vault

Unique Design Characteristics of a DSL INT

- **Size, weight & cost is much less** than standard INTs
- Patented design **eliminates crosstalk** problems with standard INTs
- Patented design improves performance in **reducing impulse noise levels** due to a higher longitudinal inductance



100 pair DSL INT

https://www.sncmfg.com/product/telecommunications/quiet-tel/dsl-t1/

DSL INT Prototype in December 2009

US007266154B2

(12) **United States Patent**
Gundrum

(10) **Patent No.: US 7,266,154 B2**
(45) **Date of Patent: Sep. 4, 2007**

(54) **DIGITAL SUBSCRIBER LINE INDUCTION NEUTRALIZING TRANSFORMER NETWORK**

(75) Inventor: **Russell F. Gundrum**, Kingwood, TX (US)

(73) Assignee: **The Southwestern Bell Telephone Co.**, San Antonio, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 902 days.

(21) Appl. No.: **10/143,130**

(22) Filed: **May 10, 2002**

(65) **Prior Publication Data**

US 2003/0210747 A1 Nov. 13, 2003

(51) **Int. Cl.**
H04B 3/00 (2006.01)

(52) **U.S. Cl.** **375/258**

(58) **Field of Classification Search** 375/257, 375/258; 336/15, 221

See application file for complete search history.

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SNC INT's, The low-frequency interference solution (article) 4 pages.
Induction neutralizing transformer can reduce power line disturbances. Reprint from TELEPHONY, Sep. 8, 1980. 4 pages.

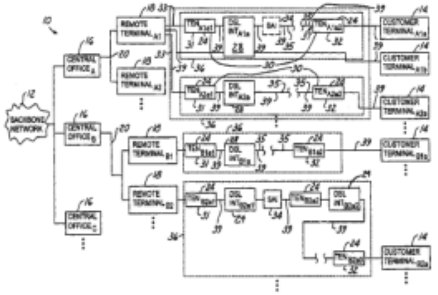
(Continued)

Primary Examiner—David B. Lugo
(74) *Attorney, Agent, or Firm*—Toler Schaffer LLP

(57) **ABSTRACT**

A digital subscriber line (DSL) induction-neutralizing transformer (INT) (**28**) for use in a DSL INT network (**10**) is provided. The DSL INT (**28**) includes a core (**72**) and a coil (**74**) that is electrically coupled to and wound around the core (**72**). The coil (**74**) includes approximately 100-200 feet of approximately 24-gauge wire. The core (**72**) and coil (**74**) add longitudinal inductance to a telecommunication line and reduce induced voltage levels at a non-digital subscriber line frequency on the telecommunication line. The DSL INT network (**10**), containing at least one DSL INT (**28**), and a method of routing DSL communication signals within the DSL INT network (**10**), are also provided.

17 Claims, 4 Drawing Sheets

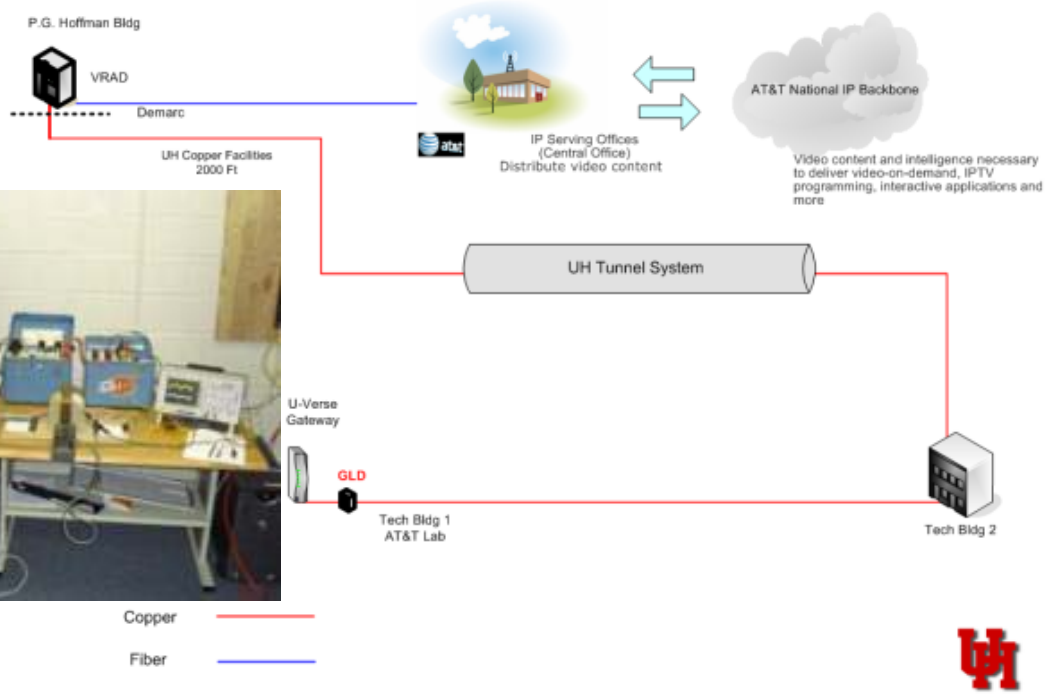


AT&T Technology Lab at UH's College of Technology http://uh.edu/tech/att/

Successful Demo of INT on AT&T Lab's U-verse Circuit October 2008

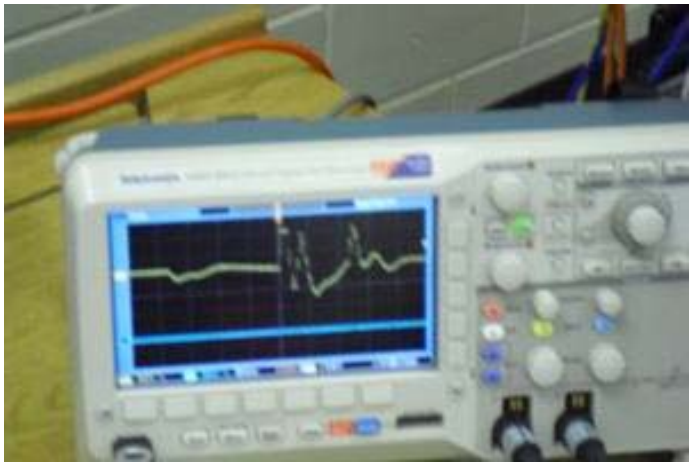
INT in HumZapper used on U-verse Circuit

AT&T U-Verse GLD Evaluation Test Circuit



DSL INT prototype on UH AT&T Lab's U-verse Circuit 5/23/10

Before & after 60 Hz transient with
6 pair INT in HumZapper



Before & after lightning transients through DSL INT prototype on AT&T Lab U-verse circuit November 8, 2011

“I agree the area of noise reduction is important and often underestimated. This is certainly a good step in the right direction, particularly for the lightning surges that won't be solved by digital processing.”

Dr. John Cioffi

Professor Emeritus of Electrical Engineering

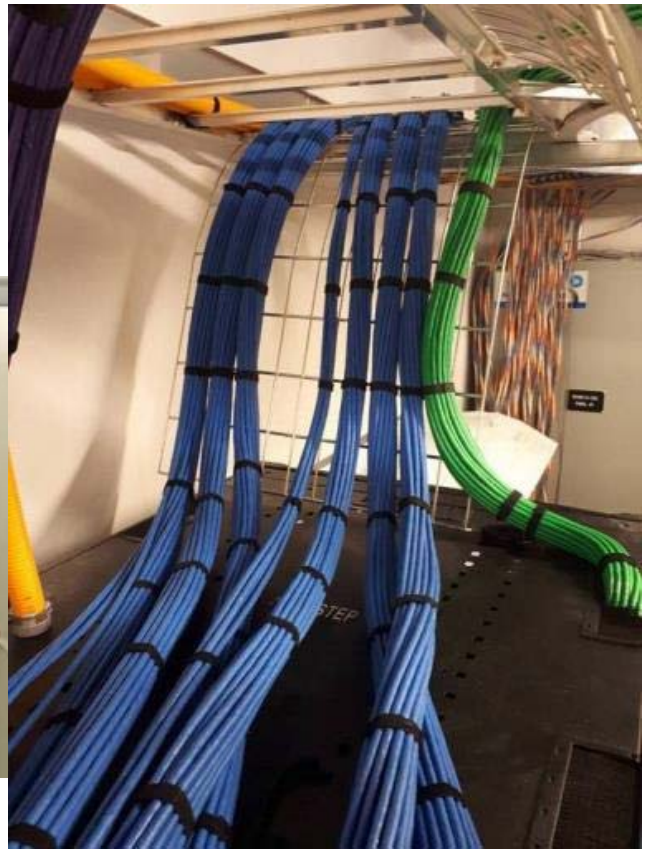
Stanford University

“Father of DSL”

February 18, 2012

Wi-Fi is where it's at! But "there are a **lot of wires** in **wireless**"…☺

But can we have a problem due to this situation?



So what could be the problem???

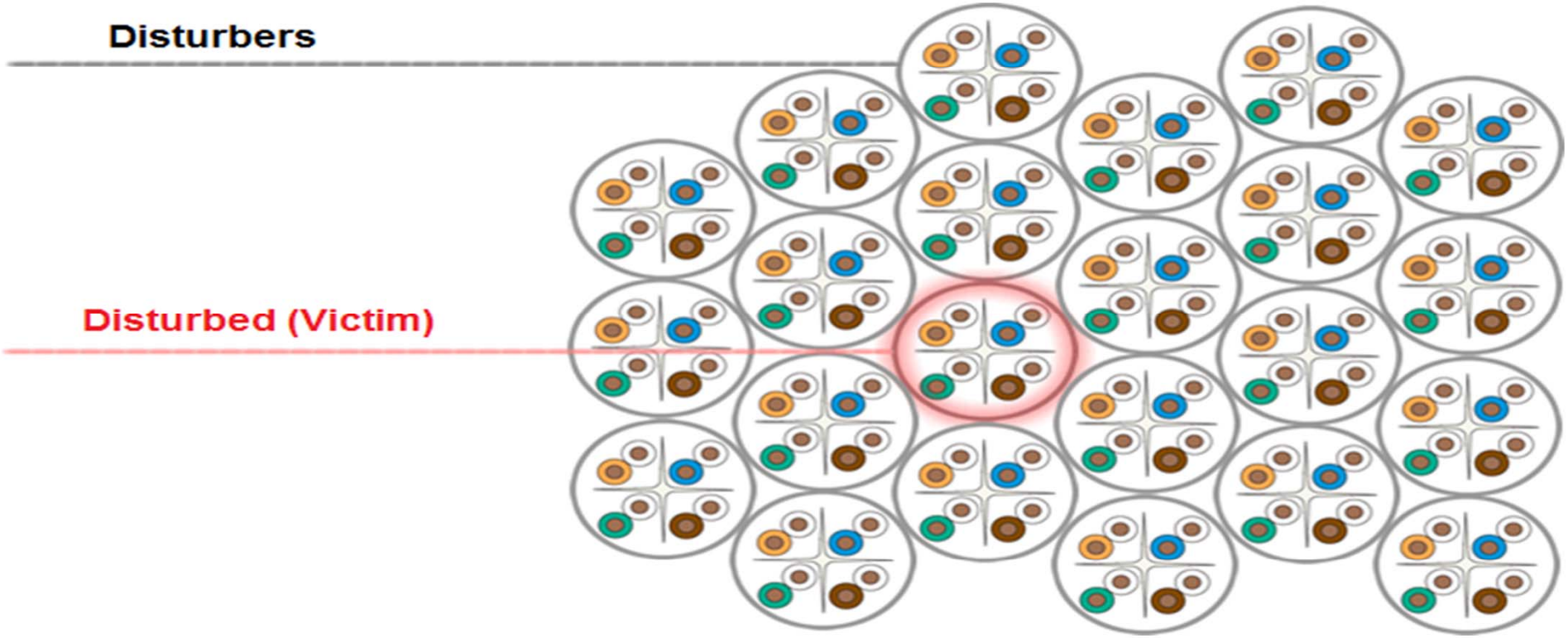
- The deployment of so-called **“Wave 2” 802.11ac wireless access points** continues to ramp up
- With multi-gig a reality for users of 802.11ac technologies, the **horizontal cabling that provides the backhaul for wireless transmission must be able to support, at a minimum, the same speed**

New **UH** research project on **Alien Crosstalk** in LANs

"**ALSNR**" is nothing more than **the same old inductive interference issues** the telecom industry has been dealing with all these years!

You mean like **Foreign EMF** or **Foreign Voltage**???

Alien Crosstalk Explained and Measured



So Will It Work?

0m <= Bundled cabling length <= 50m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

50m <= Bundled cabling length <= 75m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

75m <= Bundled cabling length <= 100m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

ALSNR Risk	High	Medium	Low

ALSNR Mitigation Techniques

- Use "**Enhanced Performance Patch cords**"
- **Increase physical separation** between cables and ports and **unbundle the horizontal cables**
- **Limit the length of paralleling cables**
- Provide **additional shielding conductors**, such as grounding unused pairs or possible use of **PoE**
- **Install Induction Neutralizing Transformers?**

Field Problems with PoE

- "PoE was **intended to stay within a building or structure**
- PoE was **not intended to have any large electrical voltage potentials or currents from AC Mains switching transients, Induced lightning transients or lightning related GPR imposed on it**
- PoE was **intended to be a longitudinally balanced, symmetric, twisted pair, high grade cable insulation system**, with at least 2400V impulse isolation to ground (see IEEE 802.3af/at isolation test)
- PoE **can be very susceptible to longitudinal impulses**, while still complying with options 'A' or 'B' of the IEEE 802.3 isolation test
- PoE **can be very susceptible to electrical impulse transients between powering pairs** as well as differentially
- PoE often has multiple ports, and **can be very susceptible to electrical impulse transients between ports (especially GPR's)**"

Problems with most PoE Protectors

- "**Most will cause more damage than they will prevent**
- Some don't protect data pairs, just power pairs
- Most PoE equipment is NRTL safety Listed as "SELV" interfaces (not TNV) and thus MUST be 'isolated' from exposure to the OSP or cabling between structures. ADTRAN is only vendor known to offer Ethernet (patented) and PoE (patent pending) protectors that provide true isolation (>6KV impulse)
- Technically a 'non-isolating' protector is not allowed for lightning protection applications
- If there are electrical transients that could be on a PoE interface the equipment needs to be Listed as TNV. If it is TNV, it would require a UL497A protector. If not TNV the protector would have to have isolation. Only SELV interfaces can have UL497B protectors (no current limiting)
- TVS/gas tube protection to ground, but no current limiting as required by UL-497A.
- Generally no place to connect the ground of the protector
- Most PoE protectors are un-Listed, or listed to the wrong UL-497 standard (typically UL-497B, instead of UL-497A, or UL 497)
- Designed with gas tubes to ground in an OSP enclosure with diagrams showing OSP deployment/exposure and hazardous warnings, yet not Listed to UL-497. How can that meet code???"

“The Data Center's Hidden Threat: EMPs”

Conclusions

- The subject of EMI can be very confusing and difficult to understand
- However, there are simple and practical solutions to mitigate its impact on wireline LANs
- These will also insure a very reliable and high QoE, especially with critical video-streaming applications
- These can all be accomplished without the additional expense of placing optical fiber cables
- For electrical protection and lower-frequency EMI issues, the installation of an INT should be considered, especially on longer circuits and any OSP cables interconnecting buildings where GPR conditions are suspected
- Any new installations should seriously consider using STP and a tighter twisted pair, such as Cat 6a
- An INT would still be required in handling GPR issues on OSP cables, and many surge protection problems that traditional protectors can't adequately resolve

Any Final Questions??????

For more information:

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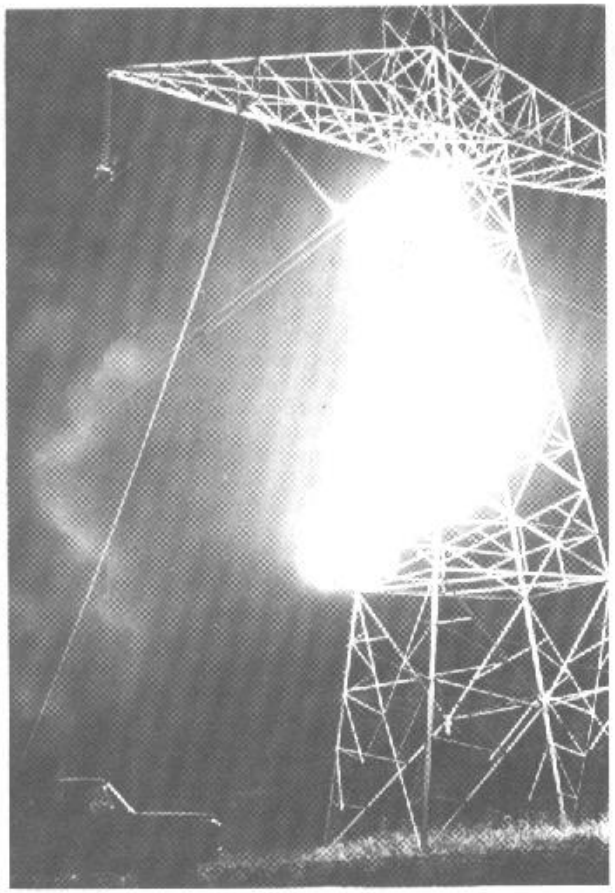
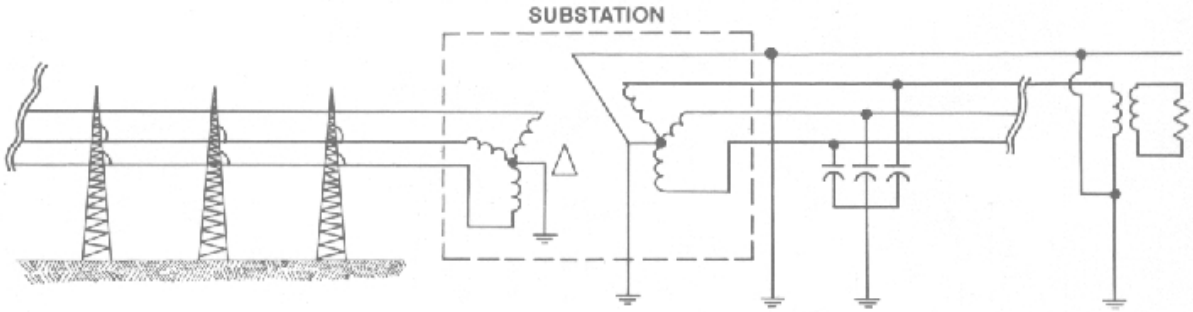
Appendix



Worst-case Induction occurs under temporary line-to-ground faults. This provides visual evidence of ground return current, but the resulting magnetic field still cannot be seen and appreciated.

POWER INFLUENCE:

- Voltage
- Current
- 3, 2, 1 Phase
- Balance vs Unbalance
- Geometry
- Waveshape
- Grounding
- Impedance of Neutral



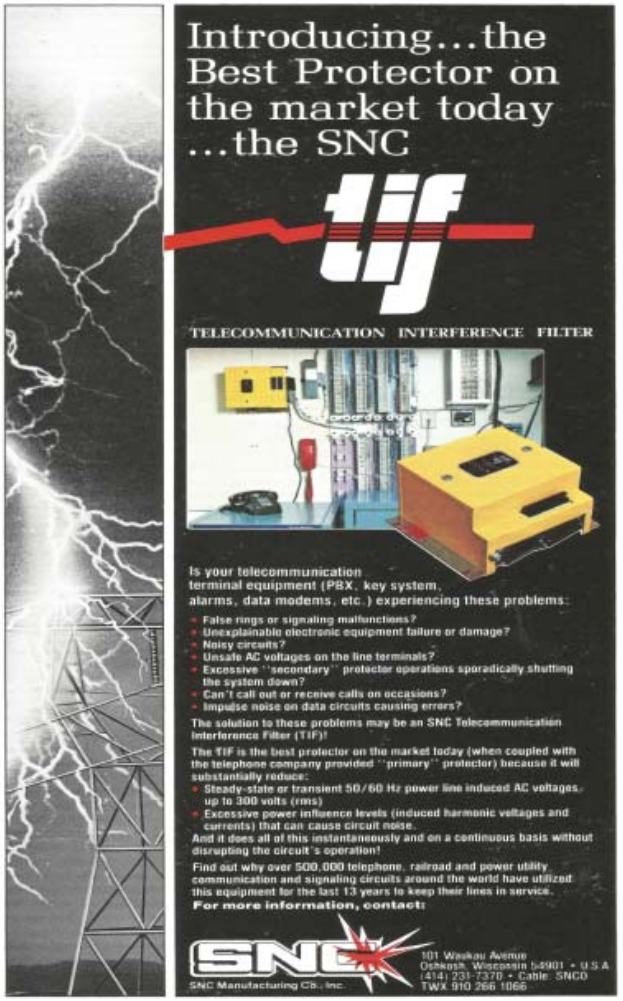
- Hardest of all three parameters to control.
- Steady-state induction problems usually are not severe when exposed to high voltage transmission lines (> 69 Kv) unless cables parallel within 1,000 feet. However, these lines generally cause the greatest fault (surge) induced voltages.
- Most induction problems occur from low voltage (< 35 Kv) multi-grounded neutral distribution systems.
- 1 and 2 phase systems are inherently unbalanced by design.
- Unbalanced currents cause induction.
- Induction problems are usually the greatest during peak electrical load demands.
- Harmonics are generated by transformers and non-linear loads.
- Grounded capacitor banks can increase harmonic induction problems.

Advantages of a DSL INT

- **Passive** (no electronics or power required)
- **Extremely reliable** & rugged (does not require protectors)
- **Simple to install** (like splicing in a piece of cable!)
- **No maintenance required**
- **Continuous operation**
- **No time-delay response**
- **No clamping the circuit-to-ground or causing it to go open, disrupting data transmissions**
- **Transparent to metallic signals** & **passes DC**
- **Least expensive** method of **solving AC induction problems**

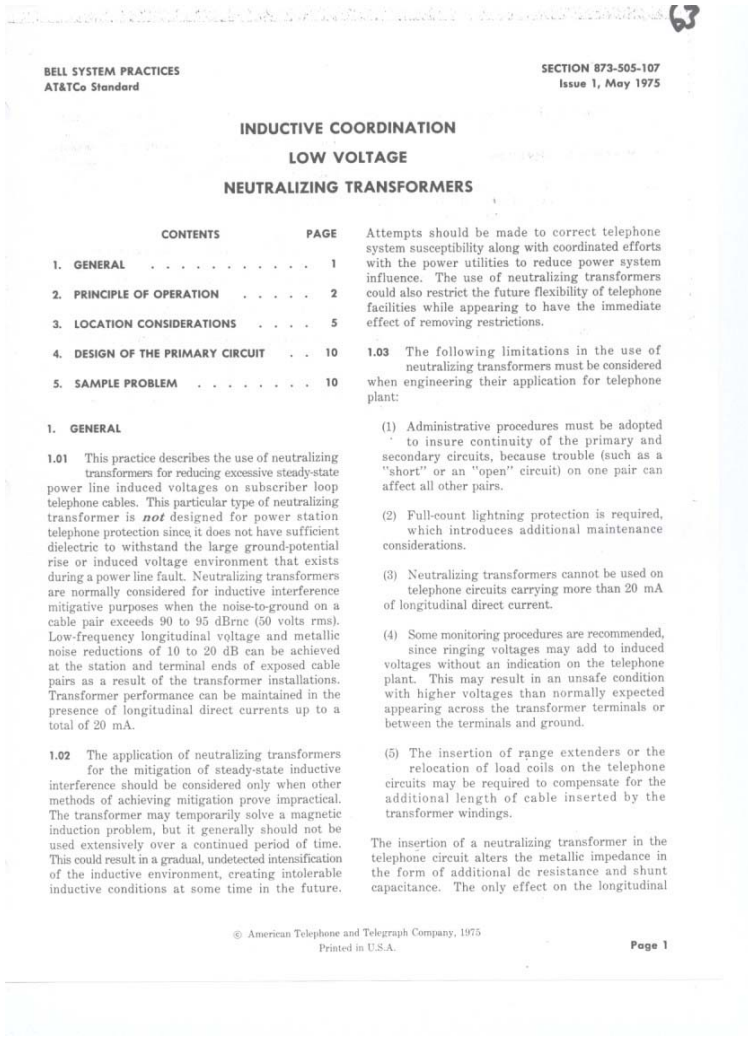
Benefits of a DSL INT Installation

- **Eliminates** potential public & technician electrical **safety hazards**
- **Instantaneously** reduces over 95% of the **steady-state or surge** induced **voltages and currents** appearing at the telecom/computer networking equipment
- Substantially **reduces** VF harmonic noise (20 - 30 dB) and **impulse noise**, which **increases SNR margins** allowing for **longer DSL/Ethernet circuits**, thus providing **additional revenues**
- **Reduces** repeated truck rolls and maintenance **expense dollars** related to trouble shooting and **certifying circuit quality**
- **Reduces customer trouble reports** and allows for **reliable**, advertised high-speed **transmissions** (improved QoS and **QoE**)
- Allows the promise of **cost/performance** benefits of DSL/Ethernet technology to be realized


Introducing...the Best Protector on the market today ...the SNC
tif
TELECOMMUNICATION INTERFERENCE FILTER
Is your telecommunication terminal equipment (PBX, key system, alarms, data modems, etc.) experiencing these problems:
• False rings or signaling malfunctions?
• Unexplainable electronic equipment failure or damage?
• Noisy circuits?
• Unsafe AC voltages on the line terminals?
• Excessive "secondary" protector operations sporadically shutting the system down?
• Can't call out or receive calls on occasions?
• Impulse noise on data circuits causing errors?
The solution to these problems may be an SNC Telecommunication Interference Filter (TIF)!
The TIF is the best protector on the market today (when coupled with the telephone company provided "primary" protector) because it will substantially reduce:
• Steady-state or transient 50/60 Hz power line induced AC voltages up to 300 volts (rms)
• Excessive power influence levels (induced harmonic voltages and currents) that can cause circuit noise.
And it does all of this instantaneously and on a continuous basis without disrupting the circuit's operation!
Find out why over 500,000 telephone, railroad and power utility communication and signaling circuits around the world have utilized this equipment for the last 13 years to keep their lines in service.
For more information, contact:
SNC
SNC Manufacturing Co., Inc.
101 Waukau Avenue
Oshkosh, Wisconsin 54901 • U.S.A.
(414) 231-7370 • Cable: SNCO
TWX 910 266 1066

TLC - Telecom Line Conditioner

Russ Gundrum's
AT&T Bell System Practice on
Inductive Coordination
Low Voltage
Neutralizing Transformers
873-505-107
May 1975



63

BELL SYSTEM PRACTICES
AT&TCo Standard

SECTION 873-505-107
Issue 1, May 1975

INDUCTIVE COORDINATION
LOW VOLTAGE
NEUTRALIZING TRANSFORMERS

CONTENTS PAGE

1. GENERAL

1.01 This practice describes the use of neutralizing transformers for reducing excessive steady-state power line induced voltages on subscriber loop telephone cables. This particular type of neutralizing transformer is ***not*** designed for power station telephone protection since it does not have sufficient dielectric to withstand the large ground-potential rise or induced voltage environment that exists during a power line fault. Neutralizing transformers are normally considered for inductive interference mitigative purposes when the noise-to-ground on a cable pair exceeds 90 to 95 dBrnc (50 volts rms). Low-frequency longitudinal voltage and metallic noise reductions of 10 to 20 dB can be achieved at the station and terminal ends of exposed cable pairs as a result of the transformer installations. Transformer performance can be maintained in the presence of longitudinal direct currents up to a total of 20 mA.

1.02 The application of neutralizing transformers for the mitigation of steady-state inductive interference should be considered only when other methods of achieving mitigation prove impractical. The transformer may temporarily solve a magnetic induction problem, but it generally should not be used extensively over a continued period of time. This could result in a gradual, undetected intensification of the inductive environment, creating intolerable inductive conditions at some time in the future. Attempts should be made to correct telephone system susceptibility along with coordinated efforts with the power utilities to reduce power system influence. The use of neutralizing transformers could also restrict the future flexibility of telephone facilities while appearing to have the immediate effect of removing restrictions.

1.03 The following limitations in the use of neutralizing transformers must be considered when engineering their application for telephone plant:

(1) Administrative procedures must be adopted to insure continuity of the primary and secondary circuits, because trouble (such as a "short" or an "open" circuit) on one pair can affect all other pairs.

(2) Full-count lightning protection is required, which introduces additional maintenance considerations.

(3) Neutralizing transformers cannot be used on telephone circuits carrying more than 20 mA of longitudinal direct current.

(4) Some monitoring procedures are recommended, since ringing voltages may add to induced voltages without an indication on the telephone plant. This may result in an unsafe condition with higher voltages than normally expected appearing across the transformer terminals or between the terminals and ground.

(5) The insertion of range extenders or the relocation of load coils on the telephone circuits may be required to compensate for the additional length of cable inserted by the transformer windings.

The insertion of a neutralizing transformer in the telephone circuit alters the metallic impedance in the form of additional dc resistance and shunt capacitance. The only effect on the longitudinal

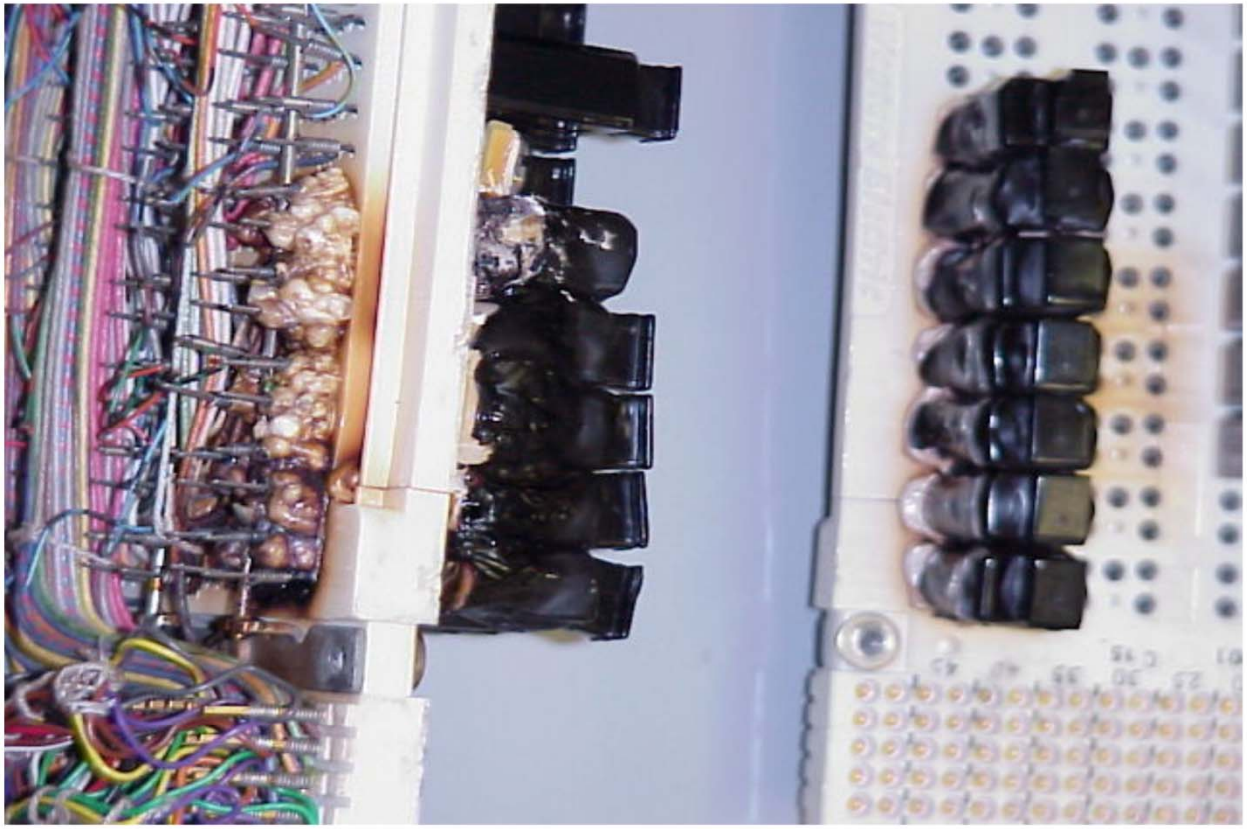
“Primary” Protection

Electrical protection devices ***legally*** required to be placed by Communication Service Providers at a building’s entrance and before any terminal equipment if their Outside Plant cable facilities are exposed to voltages in excess of **300 Vg**.

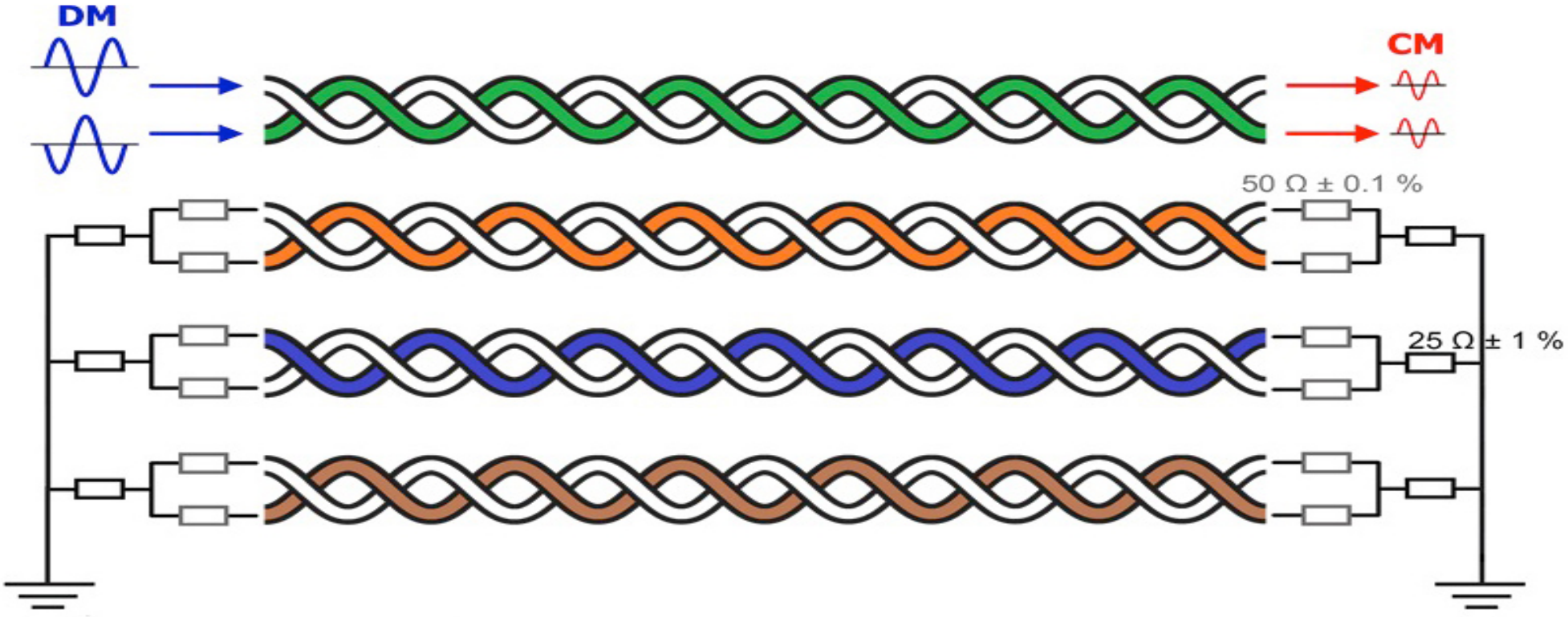
“Secondary” Protection

Electrical protection devices usually provided by the ***end user*** or that may be built into the terminal equipment by the manufacturer to suppress voltages that are **under the operational threshold of the primary protector** and/or to limit ***currents***.

With better coordination of primary & secondary protection devices, maybe we could hopefully avoid situations like this:



But what is **ELTCTL**????



06/19/2013 10:04:13 pm

TEST LIMIT

Limit Groups

- Last Used
- TIA
- ISO
- **Balance Measurements**
- Aus-NZ
- China
- EN
- JIS

06/19/2013 10:04:26 pm

TEST LIMIT

Balance Measurements

- ISO11801 PL2 Class Ea (+TCL)
- ISO11801 PL3 Class Ea (+TCL)
- ISO11801 PL Class E (+TCL)
- ISO11801 PL Class D (+TCL)
- ISO11801 Channel Class F (+TCL)
- ISO11801 Channel Class Ea (+TCL)
- ISO11801 Channel Class E (+TCL)
- ISO11801 Channel Class D (+TCL)

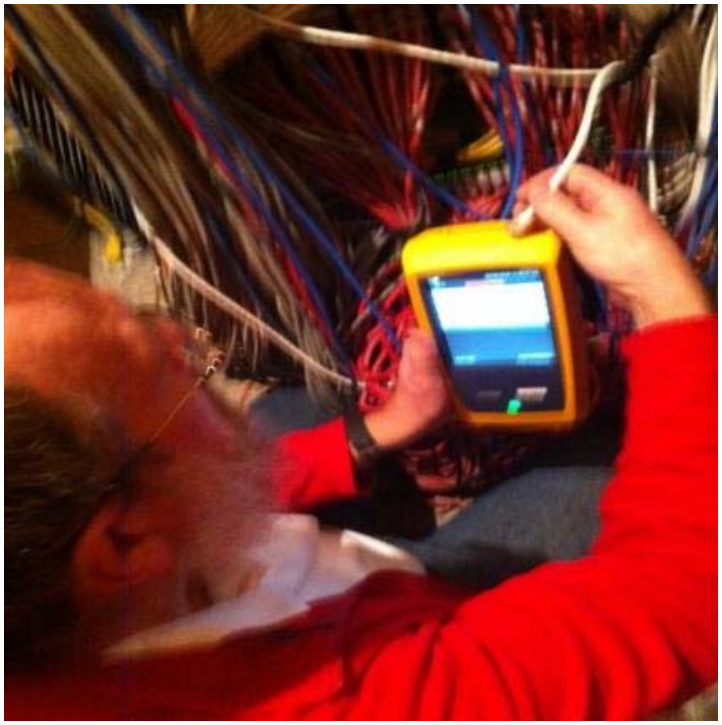
06/19/2013 10:04:39 pm

TEST LIMIT

Balance Measurements

- TIA Cat 5e Perm. Link (+TCL)
- TIA Cat 6A Channel (+TCL)
- TIA Cat 6 Channel (+TCL)
- TIA Cat 5e Channel (+TCL)
- TIA 1005 Cat 6A Channel E1 (+TCL)
- TIA 1005 Cat 6A Channel E2 (+TCL)
- TIA 1005 Cat 6A Channel E3 (+TCL)

Fluke ALSNR testing at **UH**



What is PoE?

"**Power over Ethernet** (**PoE)** describes any of several standardized or proprietary Ethernet systems which carry electrical power along with data on Cat 3 or higher type cable. This allows a **single 8 conductor cable to provide both data connection and electrical power to devices such as IP Phones, IP Cameras, IP monitoring equipment, and wireless access points**. PoE allows data communications up to 100M (≈330 feet). Power may be carried on the same conductors as the data, or it may be carried on dedicated conductors in the same cable. The system or network circuit consists of a **PSE (Power Source Equipment) and a PD (Powered Equipment**)."

Characteristics of PoE

- "Similar topology to **traditional T1 'Span Powering'**
- Uses **2 Pairs for power** (10/100 baseT, GigE)
- Proprietary system might supply power on 4 pairs
- Power can be on unused pairs (10/100 baseT) or data pairs
- Mode A and Mode B Powering schemes
- Voltage limits are **always under 60 Vdc** (SELV, ES1)
- Current and Power are tightly controlled by IEEE standards (**IEEE 802.3af & 802.3at**)
- **Type 1** – Limits PSE output power to **15.4W** (af/at)
- **Type 2** (PoE+) – Limits PSE output power of **30.0W** (at)"

Mode A and Mode B Powering for 10/100 baseT

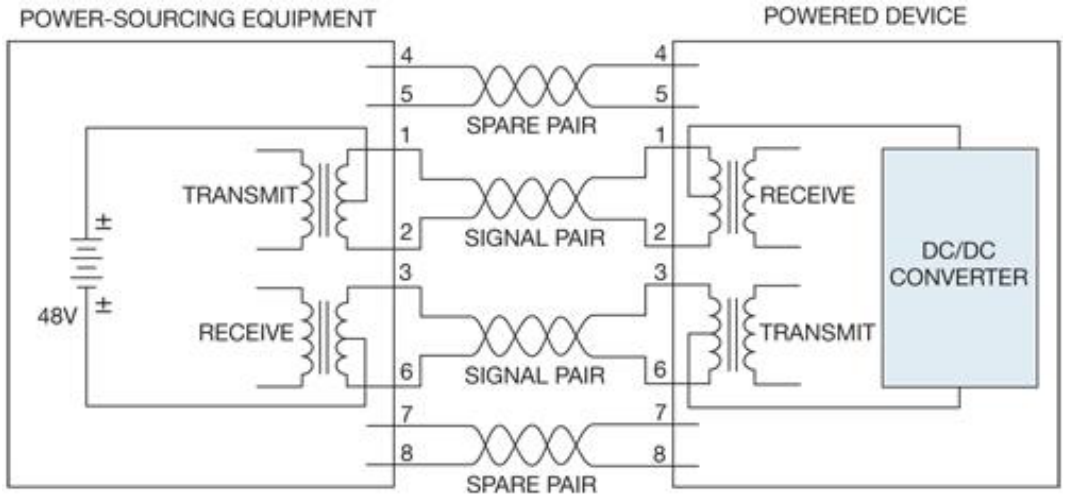


Figure 2 Mode A POE uses the data-signaling pairs 1, 2 and 3, 6, thereby combining the dc voltage with the signal over these data pairs.

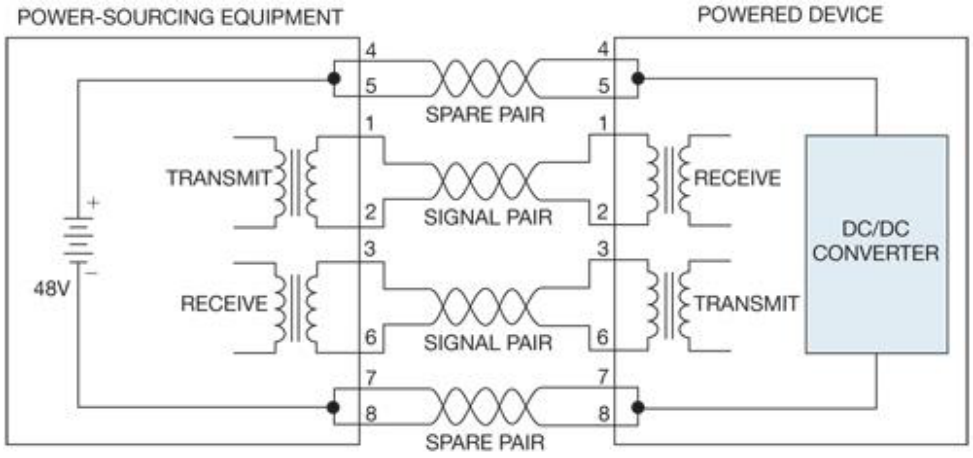
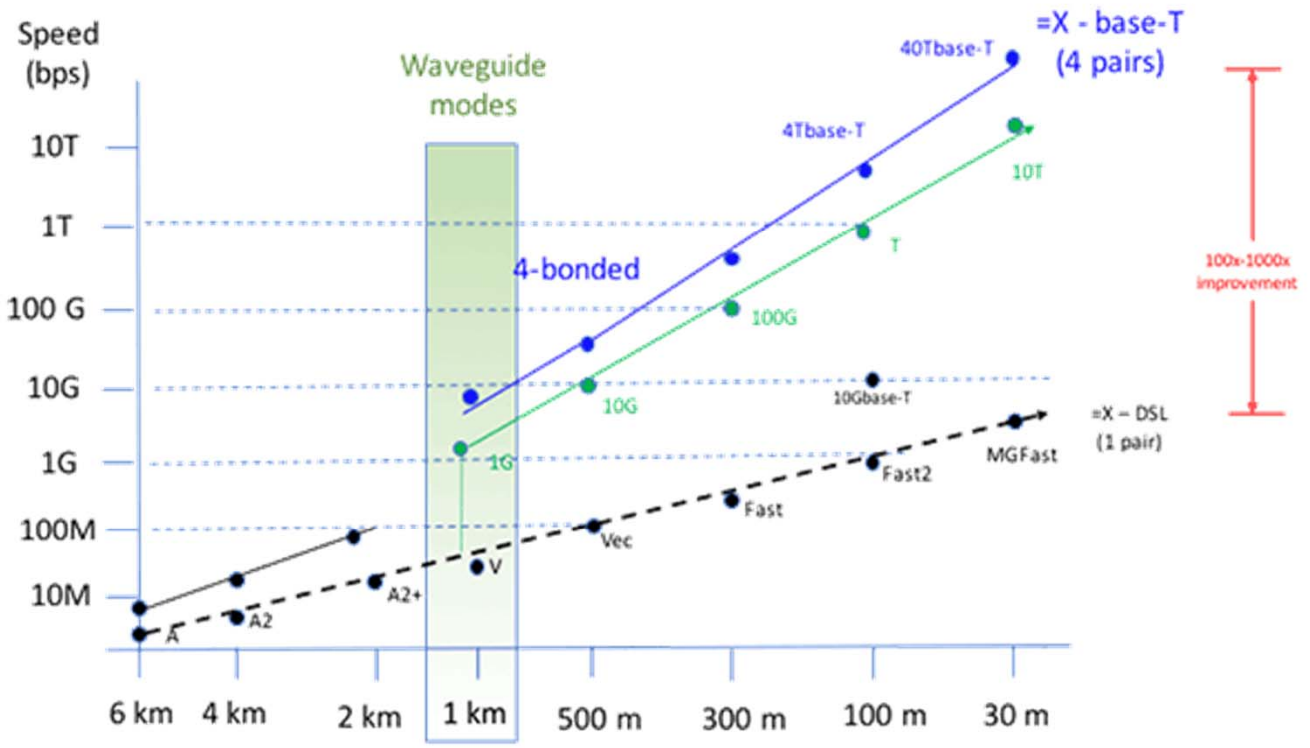


Figure 1 Apply POE Mode B power over the "spare" data pairs in 10 or 100BaseTX systems or over pairs 4 to 5 and 7 to 8 of a 1000BaseT system. POE uses the phantom powering technique so that a pair carries a 0V potential difference between its leads; power-supply voltage is the difference between two wire pairs.



2

“Will DSL Destroy 5G in the Battle Over the Last Mile?”

COPPER TESTING

What's Old Is New Again

Why Gundrum's Law Still Applies to VDSL2/G.fast and IPTV Services

By Russ Gundrum

Figure 1. Gundrum's Law Plaque.

What does Gundrum's Law have to do with today's challenges in deploying high-bandwidth services over short copper loops? In one word: everything.

When the book, *abc of the Telephone* Volume 14 on Power Line Interference; Problems and Solutions, was first published in 1982, my recommendation was this: "As a general rule of thumb from a maximum safety, equipment malfunction and noise reduction standpoint, one Induction Neutralizing Transformer should be required for every five miles of cable that is exposed to power lines."

This configuration usually yields the best overall results and represents the most economical approach in controlling inductive interference on loops up to 5 miles (8 Km) in length. I also recommended placing 3 mitigative devices on the copper loop, most notably the Induction Neutralizing Transformer (INT).

Later, as a result of my trip to the Far East in 1983, I amended that advice for loops exceeding this 5-mile (8 Km) length. They should have multiple INTs.

Though I had never previously referred to it as Gundrum's Law, my experience in the jungle outside of Bangkok, Thailand, changed that. I was asked to meet with one of the telephone company's managers on a hot, humid Saturday, where he had brought his technicians together. Though I thought I was going to give a training

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"Until there is no more copper, this law is relevant. Read why."