

MYTHBUSTING Takes on Shielded Cabling

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Objectives

- Take on myths of shielded cabling and use modern-day science to show what's real and what's fiction - through trial and error actually demonstrate it.

Background

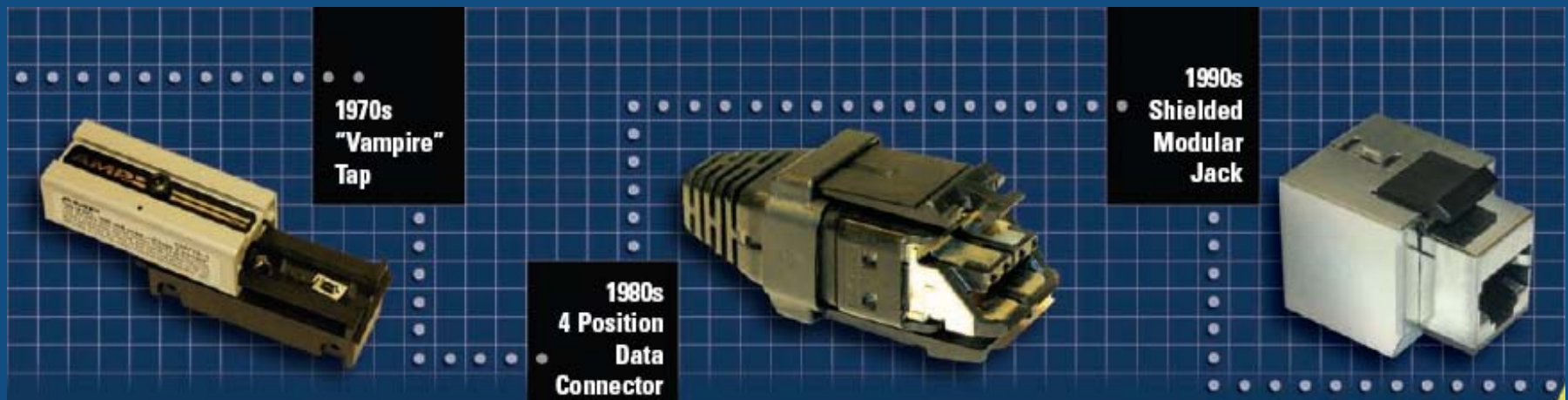
- Shielded is century-old technology (1880)
 - Dating back to early coaxial cabling
- Shielded Twisted-pair Cabling is over 25 years old
 - Dating back to IBM Type I Cabling

Background

- Wide industry experience with IBM Type 1
 - That experience was, admittedly, mostly negative
 - Partly why the industry preference moved to unshielded in North America ('cheap and easy' over 'high performance')

Background

- Shielded technology has innovated, evolved and developed
 - Evidence of that has not been widely seen in North America due to the limited use of shielded cabling



Background

- So, the previous convictions of IBM Type 1 are still applied to all shielded cabling regarding:
 - Cable Termination
 - The Antenna Effect
 - Ground Loops
 - The Baked Potato Effect

Cable Termination

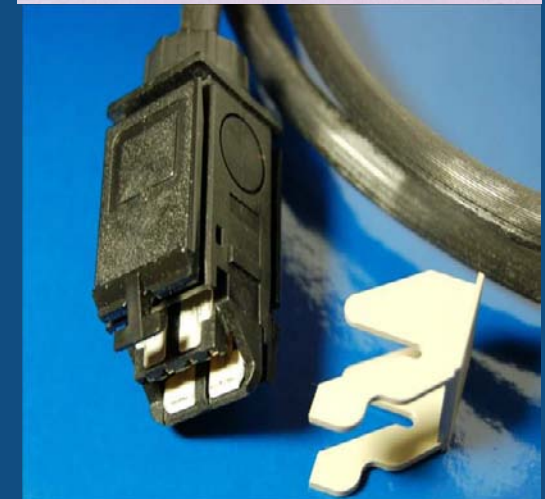
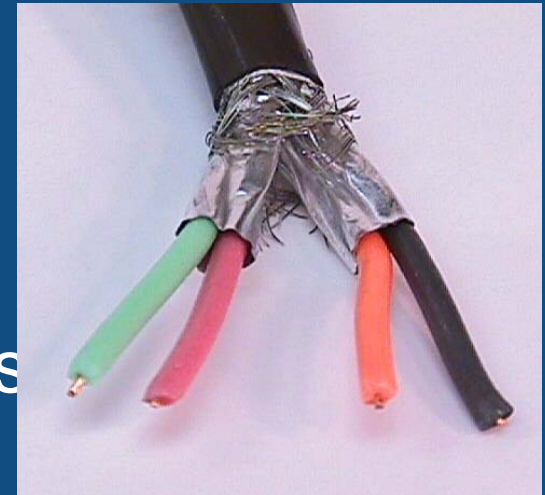
Cable Termination

- Myth:
 - Terminating a shielded cable with a shielded connector takes twice as long as terminating an unshielded cable with an unshielded connector.



Research

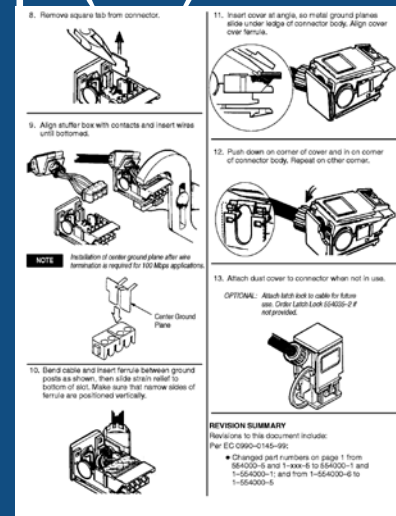
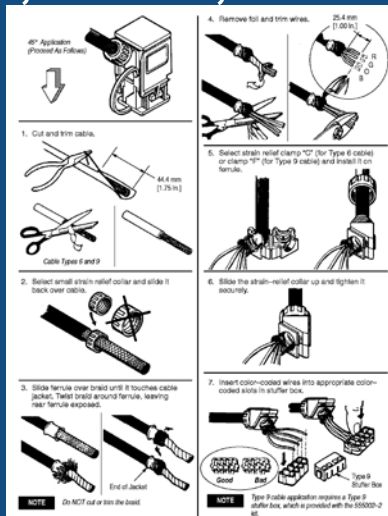
- IBM Type 1 Cable
 - Two shielded twisted pairs
 - not four pair
 - 22 AWG solid copper conductors
 - Braided shield
- IBM Data Connector
 - Hermaphroditic
 - 4 pole
 - Large



Research

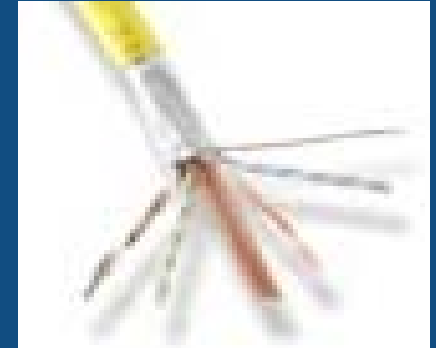
- Data Connector Termination Procedure: 13 steps!

- snip & cut, slide, twist, cut & trim, clamp, slide, insert (x4), pull, align & squeeze, ground, bend, slide, cover & snap (x2) !!



Research

- Today
 - New cable types
 - Without braid
 - Unshielded pairs
 - Four-pair (not 2-pair)
 - New connector types
 - Die-cast (without a “can”)
 - New installation tools
 - Simplify procedure
 - Faster



Experiment - Subjects

- Shielded Termination
 - IBM Type 1
 - 2-pair
 - S/FTP
 - Category 6A
 - 4-pair
 - F/UTP
- Unshielded Termination
 - Category 6
 - 4-pair
 - U/UTP
 - Category 6A
 - 4-pair
 - U/UTP

Experiment - Setup


- Experienced Technicians
- Measure Time For
 - Cable Prep
 - Connector Prep
 - Termination
- Dependent Variables
 - Cabling Type
 - Termination Tool

Termination Tools

- Punchdown Tool
 - Each wire individually
- Installation Tool
 - All wires simultaneously






Results – Category 6 Unshielded

Cable Type	Tool Type	Avg. Install Time
Cat6 U/UTP	Punchdown	2 minutes 
IBM Type 1	Pliers/Snips	3 min 45 sec (2pr)





- Two times myth plausible for IBM Type 1 cable termination
 - Maybe even 4 times
 - four pairs in over 7 minutes!

Results – Category 6A Punchdown

Cable Type	Tool Type	Avg. Install Time
Cat6 U/UTP	Punchdown	2 minutes 
Cable Type	Tool Type	Avg. Install Time
Cat6A U/UTP	Punchdown	3 min 15sec 
Cat6A F/UTP	Punchdown	3 min 20sec 

- Two times myth plausible for punchdown cable termination
 - More of a Cat 6A issue than shielded issue
 - Tighter twists, larger wires, more fillers

Results – Category 6A Installation Tool

Cable Type	Tool Type	Avg. Install Time
Cat6 U/UTP	Punchdown	2 minutes 
Cat6A U/UTP	Punchdown	3 min 15 sec 
Cat6A U/UTP	Install Tool	1 min 25 sec 
Cat6A F/UTP	Install Tool	1 min 30 sec 

- Even less than Category 6 punchdown!

Result: The Termination Time Myth

BUSTED!!

Additional Considerations

- Field Testing – could make installation time worse for unshielded
 - depends on users choice of ANEXT testing options
- F/UTP vs. SF/FTP (Category 7)
 - Category 7 (SF/FTP) would take longer
- Bonding and Grounding
 - No additional time compared to unshielded
 - Except for pulling back shield foil

The Antenna Effect

The Antenna Effect

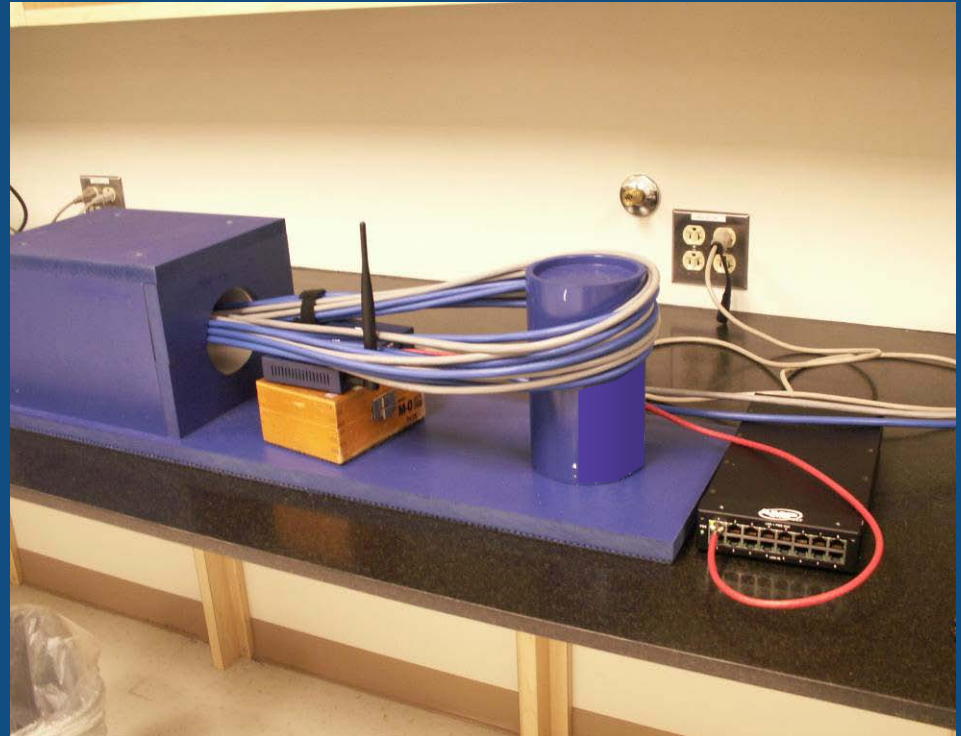
- Myth
 - The shield of a shielded cable acts like an antenna and collects radio frequency noise if it isn't grounded on both ends

Experiment - Subjects

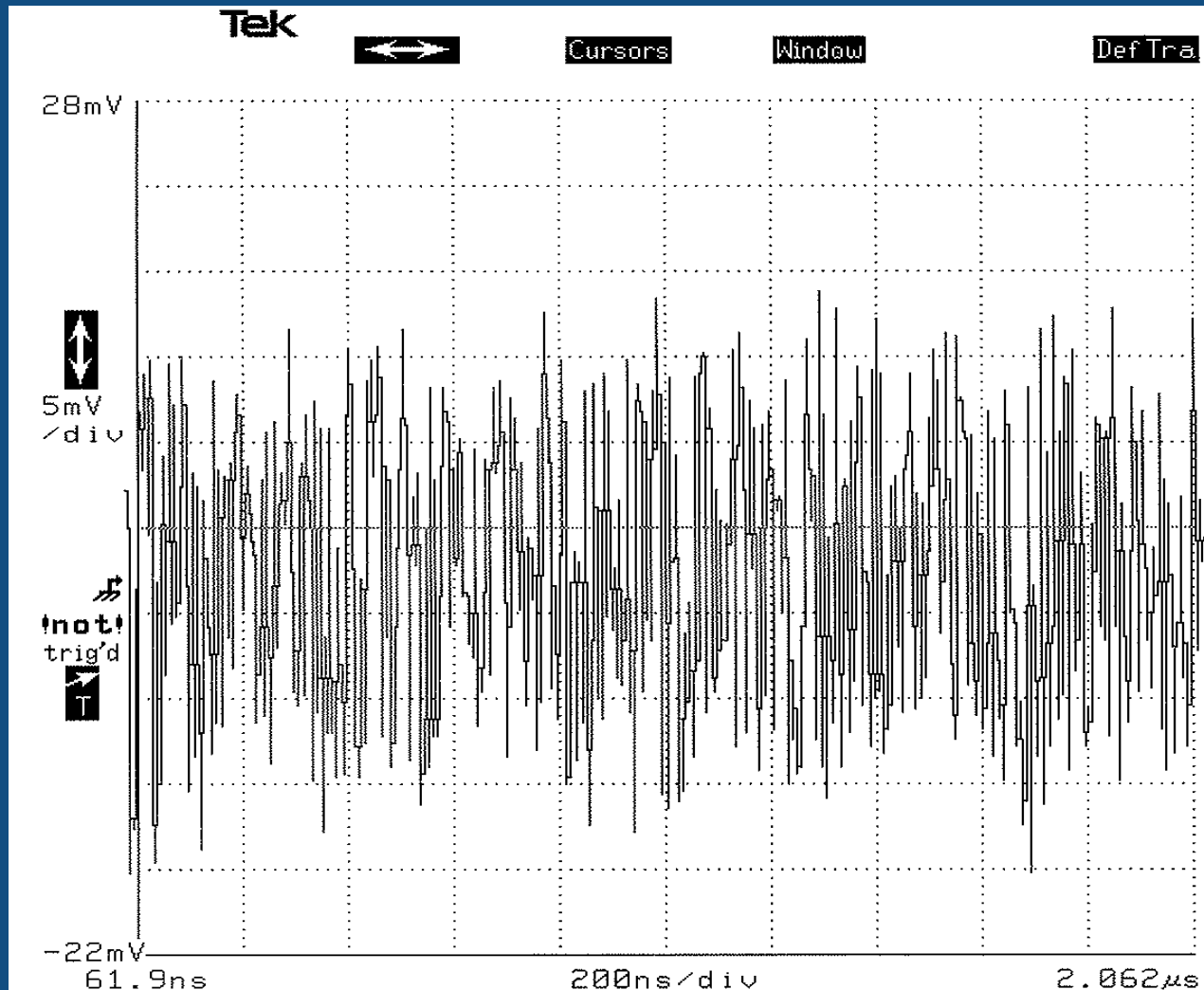
- U/UTP Cable
- F/UTP Cable

Experiment - Setup

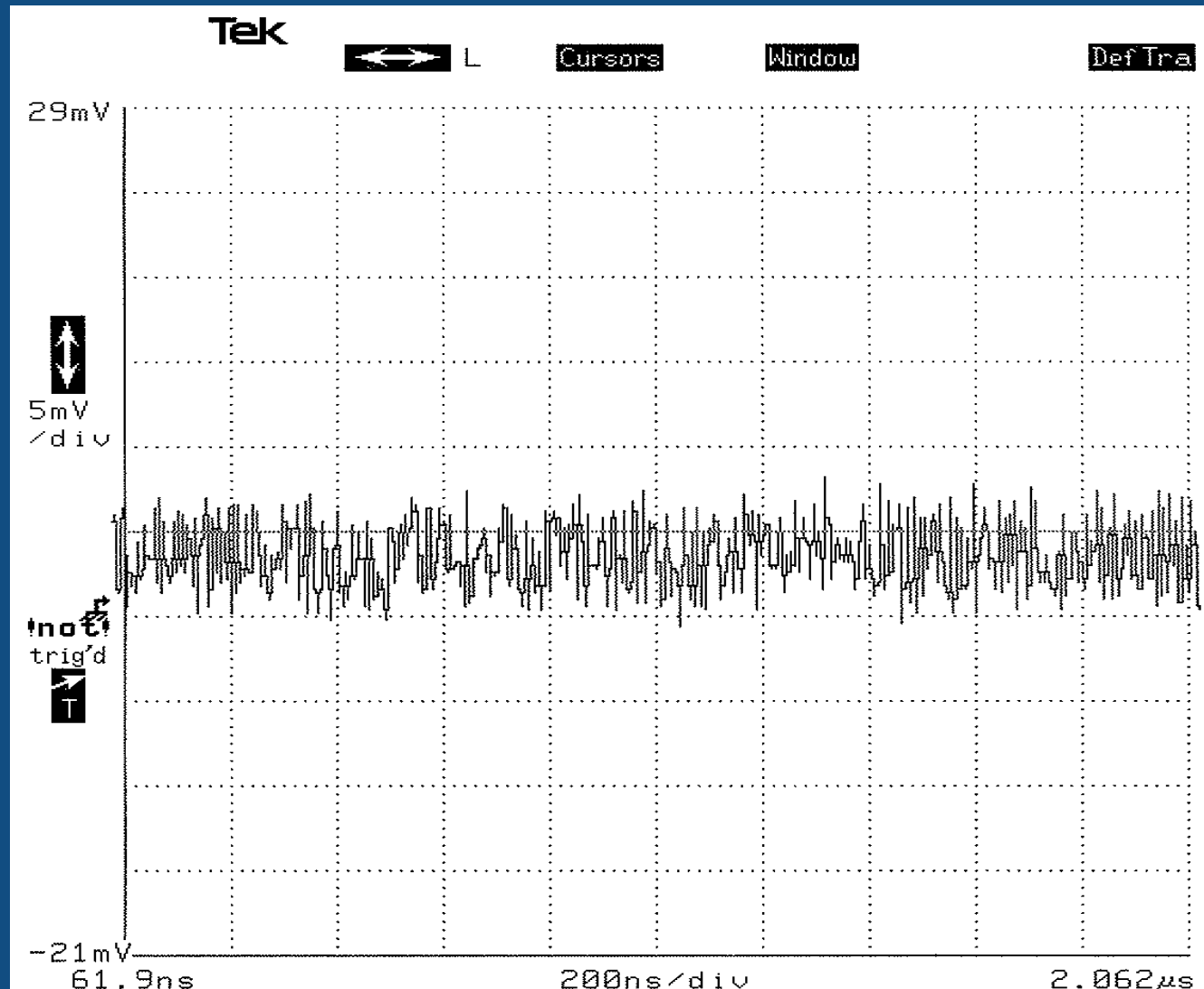
- Noise Source
 - WAP (2GHz)
 - Laptop PC
- U/UTP Cable
- F/UTP Cable
- Network Analyzer



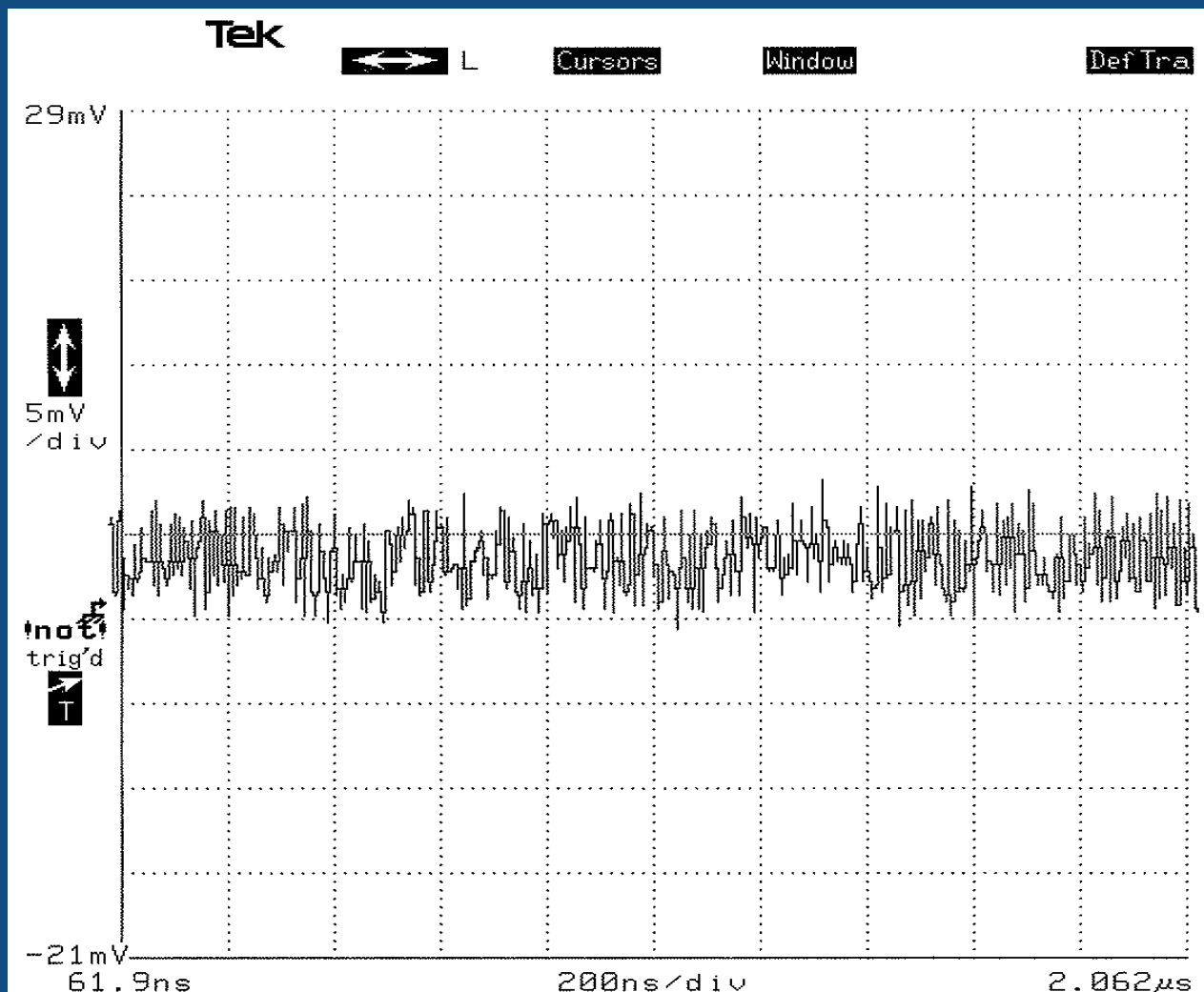
Results – Noise on Unshielded Cable



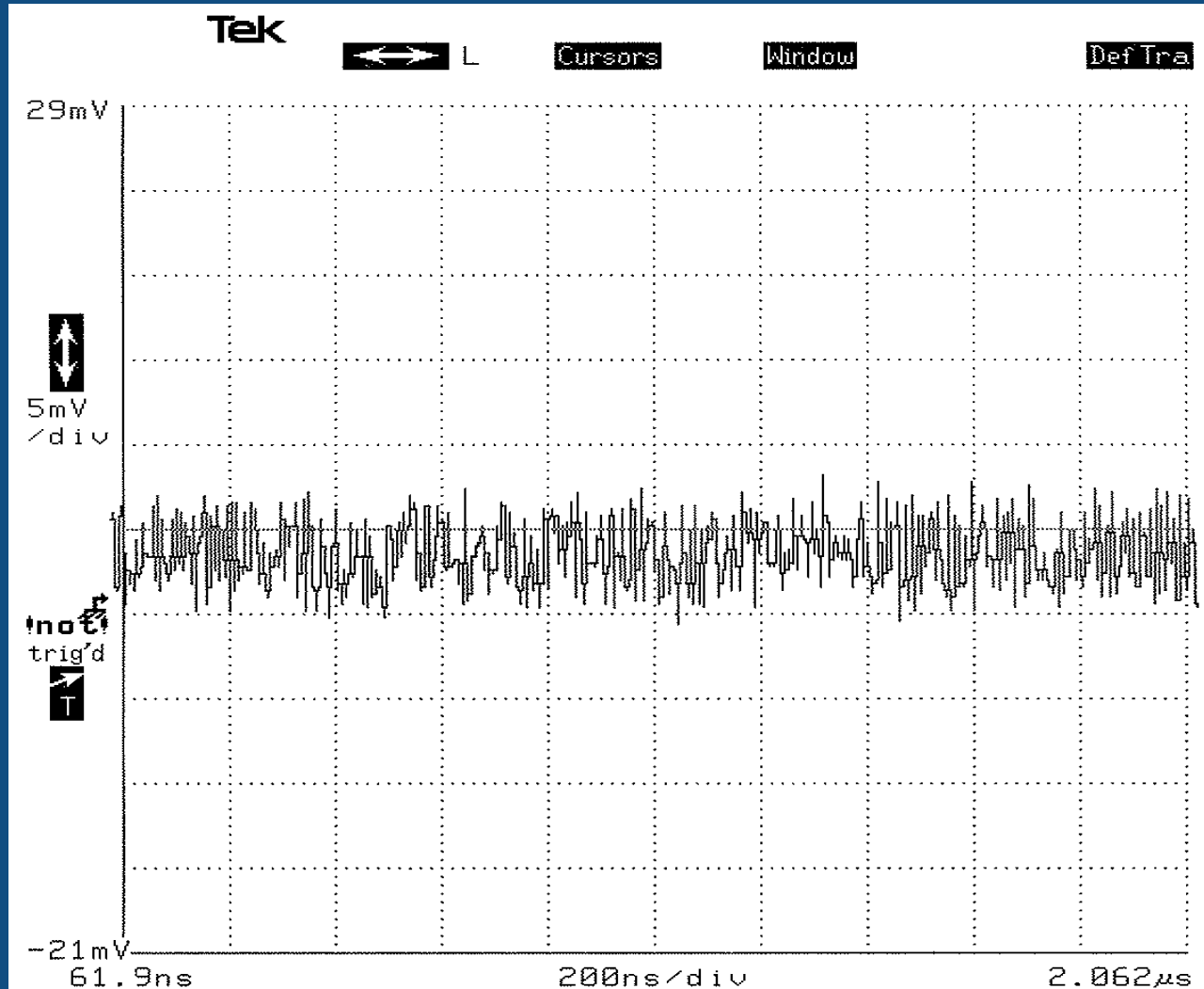
Results – Noise on F/UTP Cable with Both Ends Grounded



Results – Noise on F/UTP Cable with Single-ended Ground



Results – Noise on Ungrounded F/UTP Cable



Result: The Antenna Effect

BUSTED!!

Additional Considerations

- All metallic elements act as antennas to some extent – even pairs in an unshielded cable
- The shield dramatically reduces the effects of RFI on the pairs, even if grounded on only one end or if ungrounded!
 - But ground it anyway!
- A shield reduces the effects of induced noise for signals > 30 MHz
 - Shield thickness property

Ground Loops

Ground Loops

- Myth
 - Conductive loops transmit spurious current (noise) if there is any variation in voltage along the loop

Research

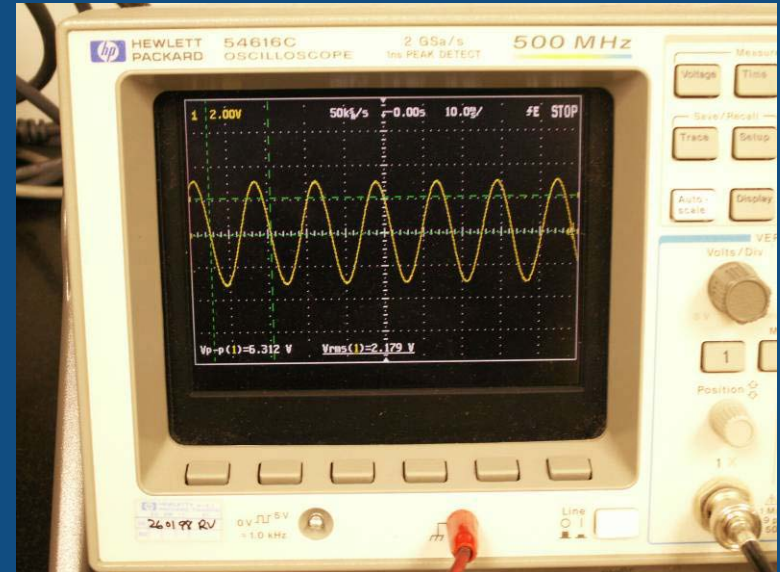
- Myth probably outgrowth of “mains hum”
 - Two pieces of audio equipment plugged into different power outlets with different ground potentials
 - This potential difference causes a spurious current to flow through the cables, creating an audible buzz

Experiment - Subjects

- F/UTP Cable

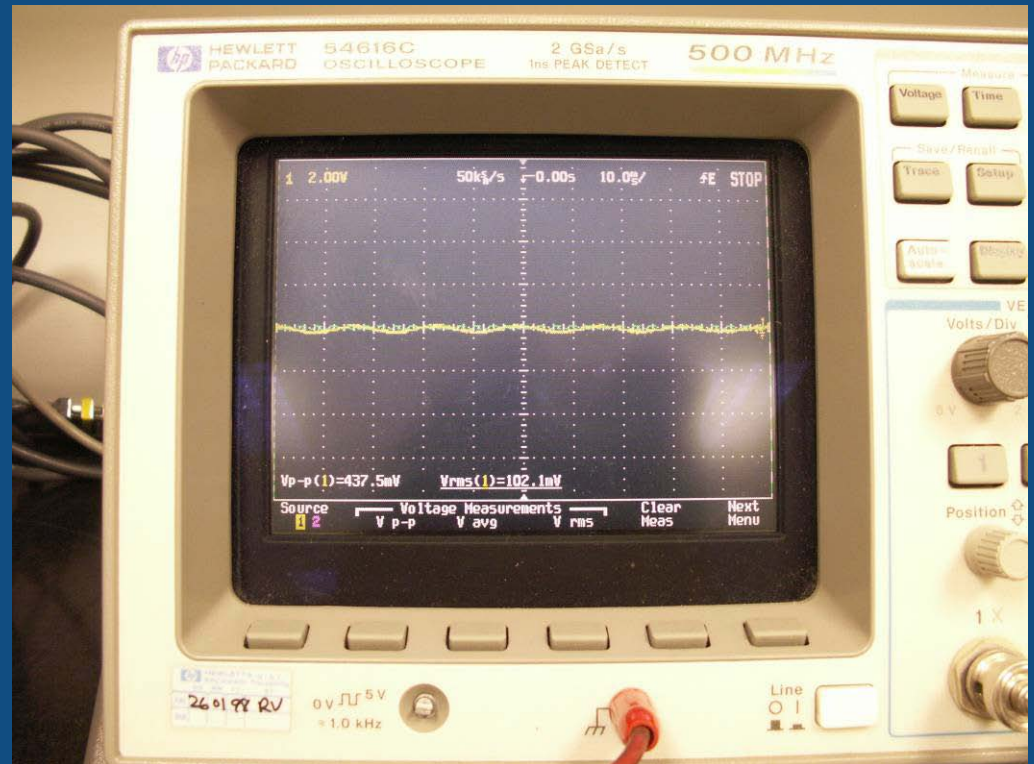
Experiment - Setup

- Apply 60 Hz AC current directly onto shield of F/UTP cable
 - Not an induced current
 - a placed current
- Test signal integrity on balanced twisted-pairs for presence of 60Hz influence



Results

- No influence on signal integrity at 60Hz



Result: Ground Loops

BUSTED!!

Additional Considerations

- Basically proves that balance works, at least for 60Hz (low frequency)
 - Audio cables tend not to be balanced or shielded
- Higher frequency effects reduced by the shield

The Baked Potato Effect

The Baked Potato Effect

- Myth
 - The shield around a shielded cable is just like aluminum foil around a baked potato – it traps generated heat and cooks the cable

Research

- Wrapping the potato in aluminum foil before cooking will help to retain moisture
- When cooking over an open fire or in coals, a jacket of foil prevents burning
- Aluminum foil is designed to keep moisture in the baked potato – not to retain heat

Research

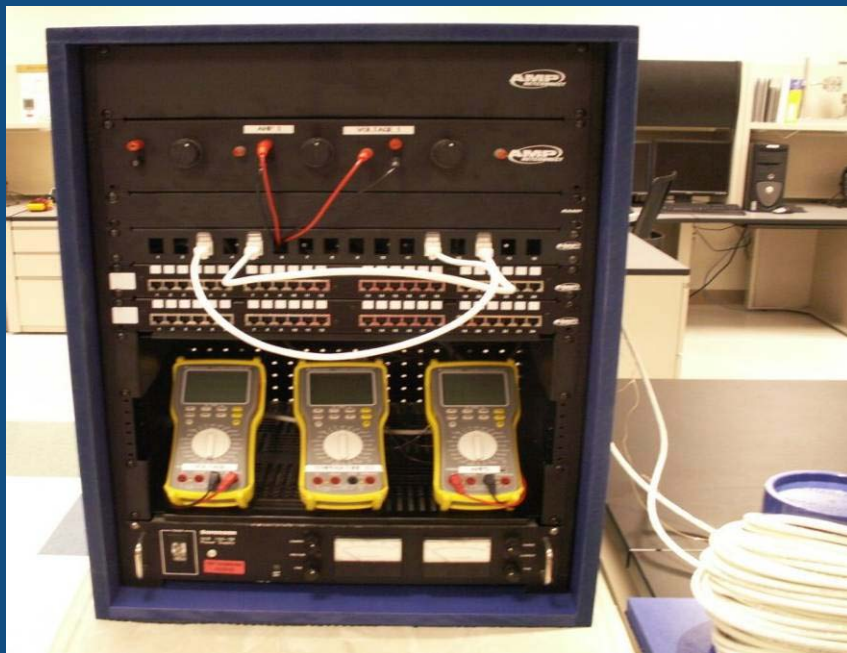
- Power over Ethernet
 - Data cables used for signal and for power
 - Power current creates heat via I^2R losses
- Power over Ethernet Plus
 - More power – more current – more heat

Experiment - Subjects

- U/UTP Cable
- F/UTP Cable

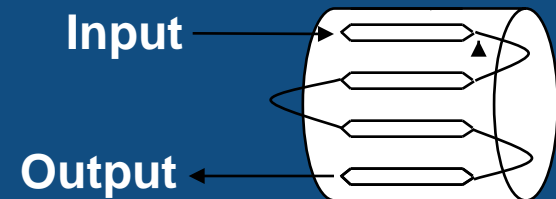
Experiment - Setup

- Cable bundles
 - In insulated conduit, with firestopping

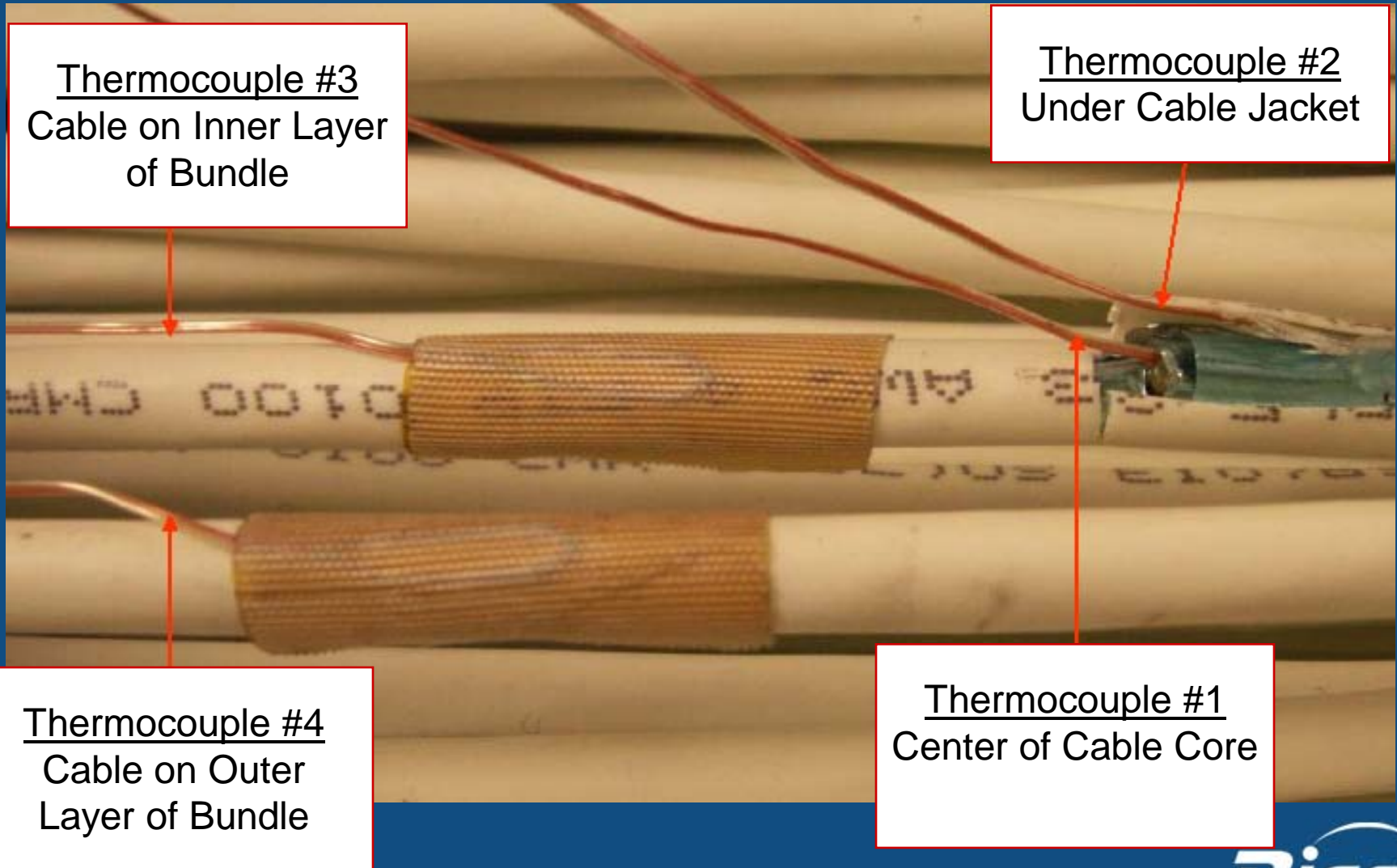


Experiment - Setup

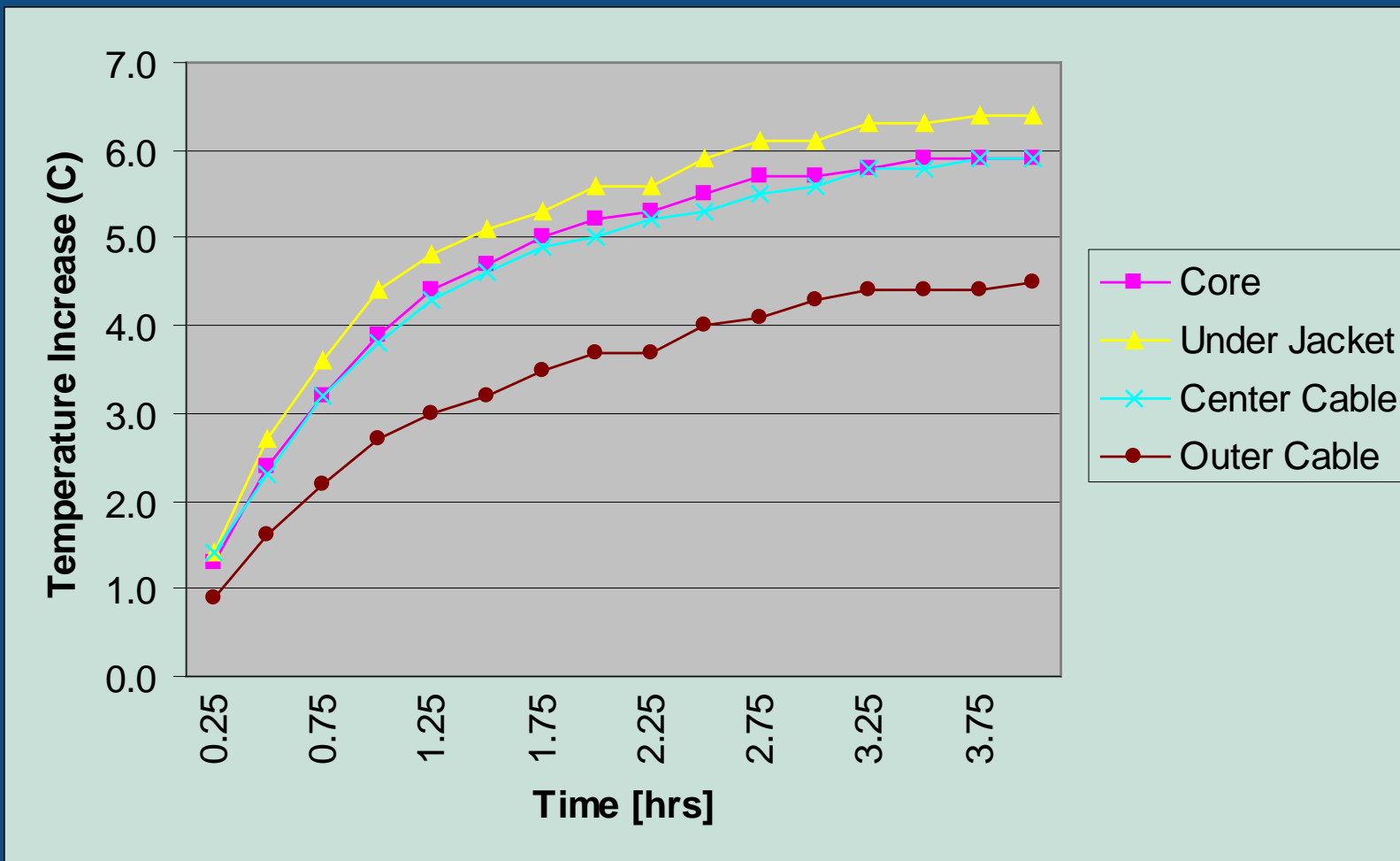
- Worst case
 - Place 720 mA current (original PoEP objective)
 - The objective for PoEP is currently only 600mA
 - 57 V_{dc} measured at output end of cable (not source)
 - Power on all four pairs
 - Pairs wired in series



Experiment - Setup

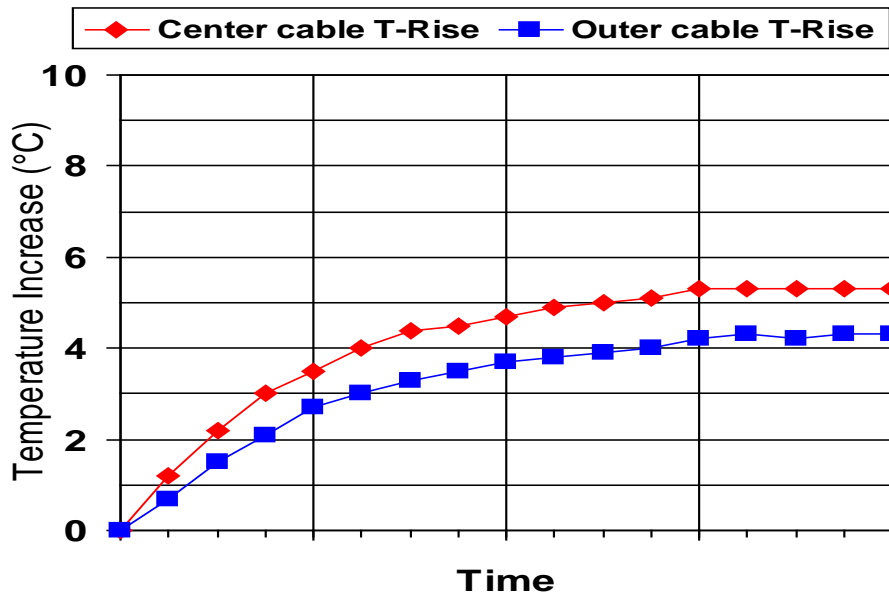


Results – F/UTP Shielded Cable



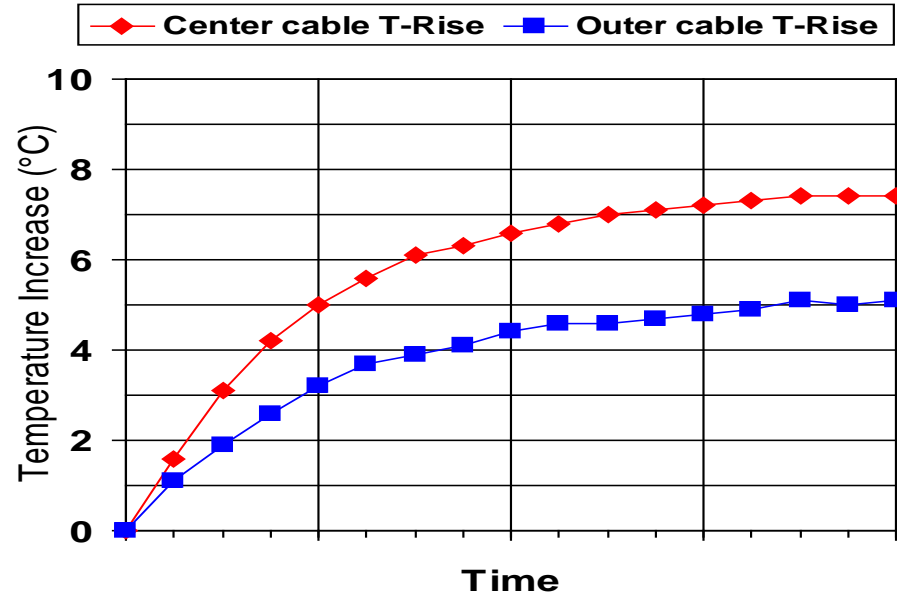
Results – F/UTP and U/UTP Cable

T-Rise measurements
Ambient Temp. = 22.5 °C



F/UTP Cable

T-Rise measurements
Ambient Temp. = 21.7 °C



U/UTP Cable

Results – 720mA

Cable Type	Steady-state Temperature Rise
F/UTP	6°C
U/UTP	7°C

- Both show increase
- Shielded compares favorably

Result: The Baked Potato Effect

BUSTED!!

Additional Considerations

- Unlikely to see that kind of temperature rise in the field
 - Lower current than POEP objective
 - Violation of fill ratios
 - All four pairs carrying max power
 - Max power measured at device end, not source end

Conclusions

Review

Myth	Conclusion
Termination Time = x2	BUSTED !!
Antenna Effects = Bad	BUSTED !!
Ground Loops = Bad	BUSTED !!
Baked Potato Effect = Hot	BUSTED !!

Thank You!

Remember: These are trained professionals – do not try this at home!

No animals (or potatoes) were harmed in this production

