Subscriber Networks

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Outline

- Why the rush to clean it up?
- **The Issues**
- House wiring architectures
- **Component Requirements**
- **Testing & Troubleshooting**
- **Recommendations**
- Suggestions for a more available service

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Competition Drives the Market to New Sources of Revenue

- High speed data services (Internet) becoming viable with availability of cable modems and xDSL technology
  - Work at home (Teleworkers & Telecommuters)
  - Internet access (news, research, etc.)
  - Home banking
- Digital video technology maturing and viable business as shown in widespread DBS application
- Telephony in a bundled package is attractive to consumers
  - Bundled services and one-stop-shop offer lower overhead, cheaper rates, and less confusion

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Companies Planning New Digital Services

- Cable companies
  - Typically coaxial and broadband RF
  - Many houses wired by subcontractors or the homeowner
  - Issues arise when new services are added:
    - High speed data
    - DTV
    - Telephony

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Home LANs on the Rise

- Tele-workers and Tele-commuters
- Multiple computers
- Sharing of peripherals
  - Printers, cable modem, fax, VCR, etc.
- File sharing
- Security could be an issue
  - “Always-on” connection with cable modem
  - Firewall software may be required

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Home Wiring is the Weak Point

- 75 - 90% of ingress is caused in the home & wreaks havoc on reverse path
  - Find in the home before connecting to the network
  - One house can take down the whole node!
  - Must be monitored continuously and eliminated quickly
- Home wired with poor componentry and craftsmanship
  - Microreflections
  - Frequency response variation & excessive loss
  - Leakage & Ingress
- Replacing all home wiring is unacceptable
  - Testing is required to bring it up to standards

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Customer Premise Equipment (CPE)

- Passives
  - Drop line, CAT5 cable, USB/Ethernet adapter
  - In-house splitters, filters, & DCs
  - Barrels and in-line pads
- Actives
  - House amp
  - NID
  - Settop box
  - Cable modem

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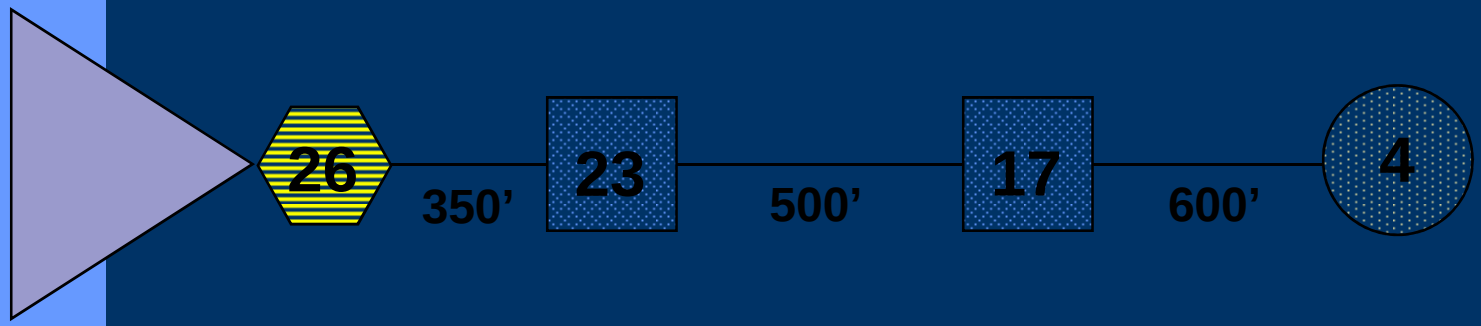
Distribution System



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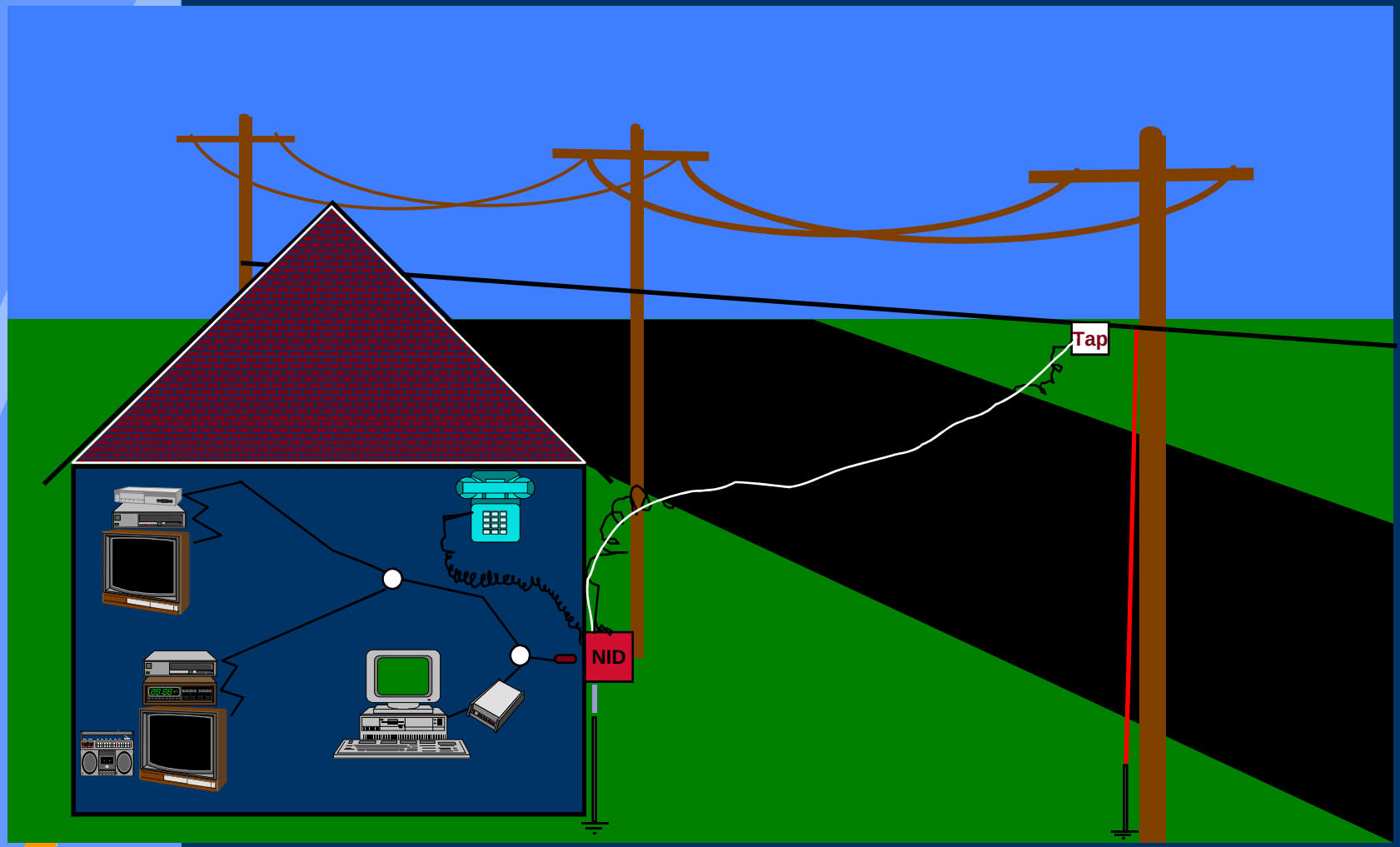
New Technology, Old Wiring Habits



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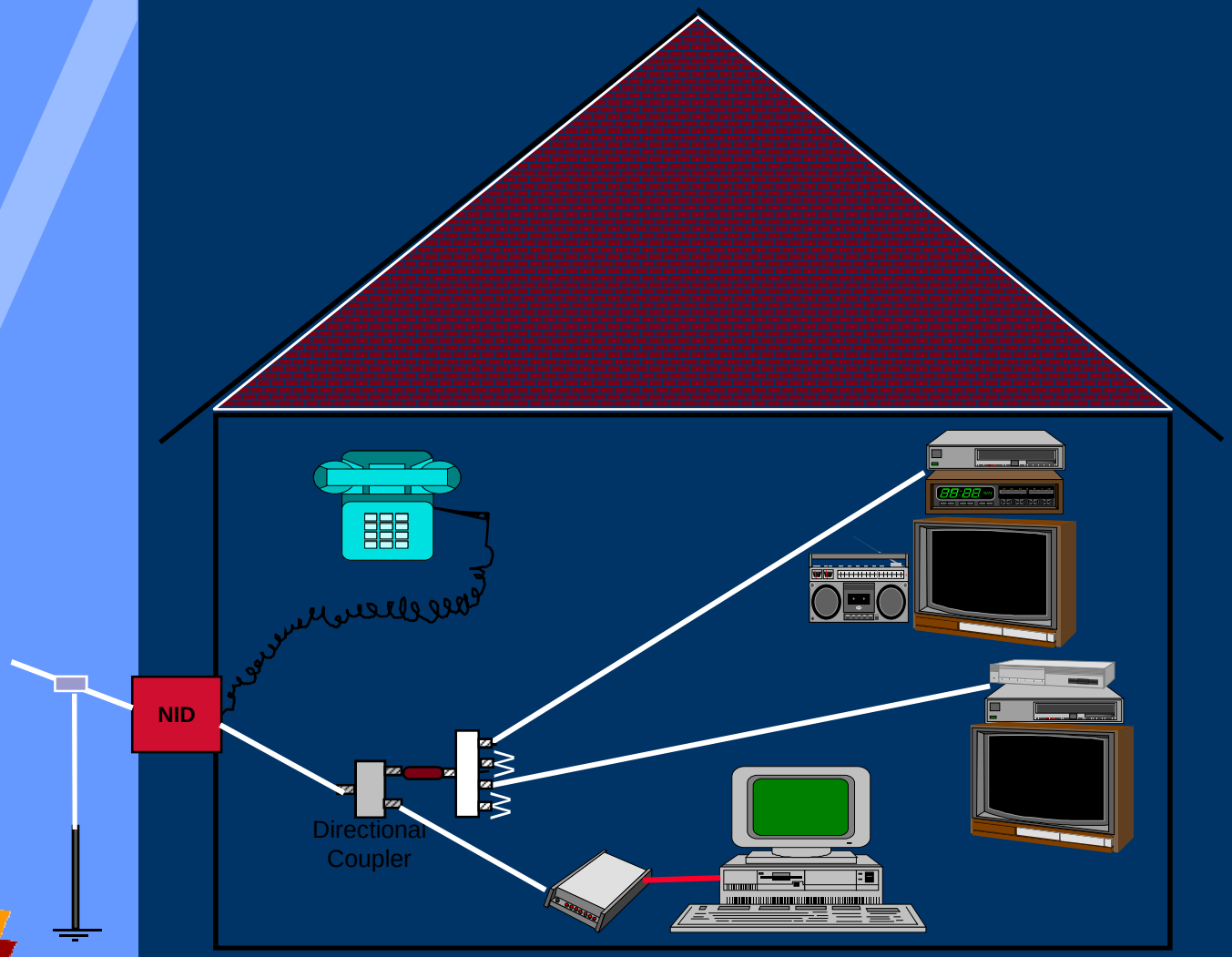
The Home Network



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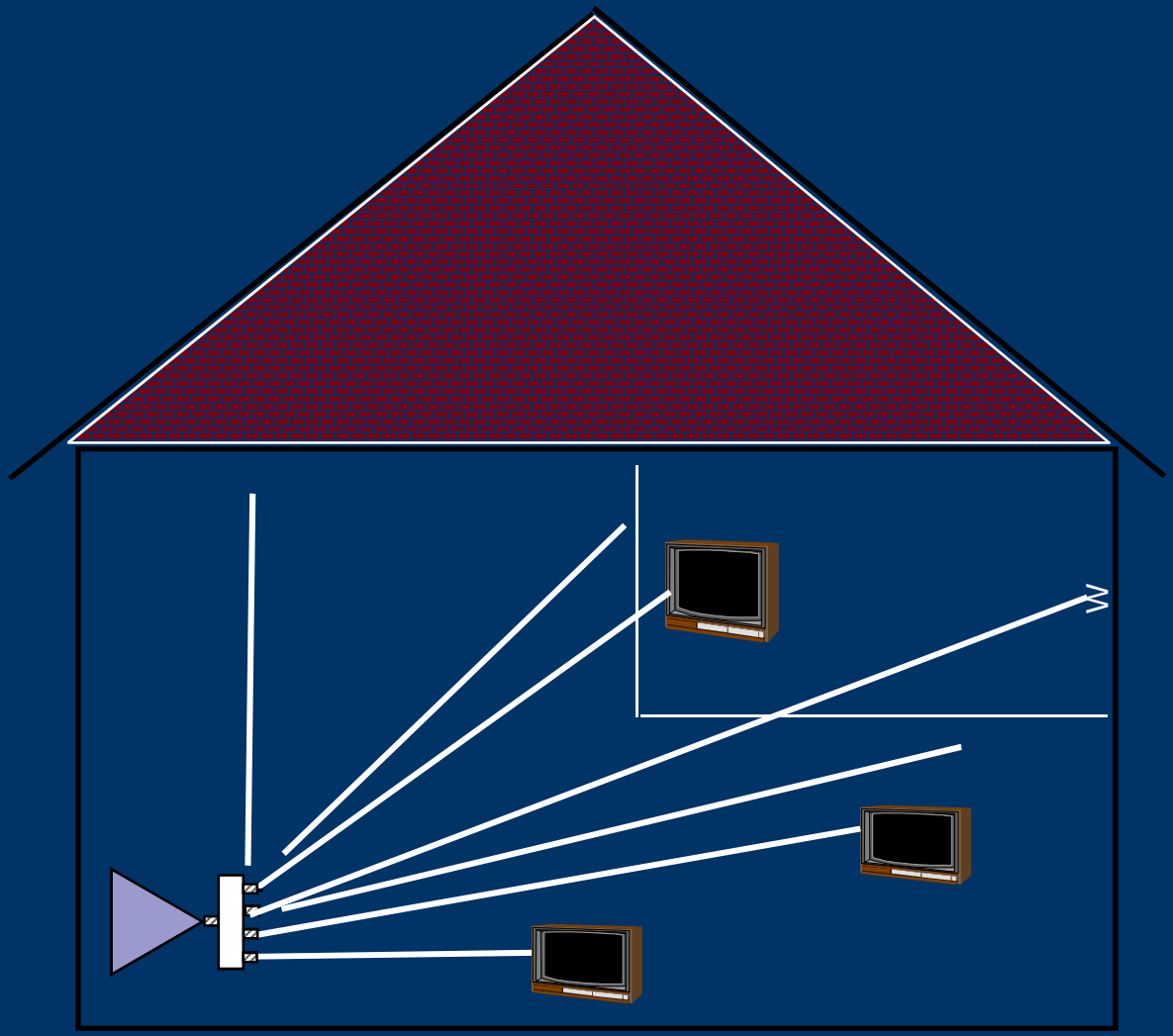
Home Architectures & House Amps



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Path Loss

- Forward path loss:
  - Tap value
  - Drop cable size, length, and frequency
  - House loss and gain for passives and actives
- Reverse path loss:
  - Tap value (first or last tap)
  - Type of amplifier (trunk, bridger, LE, passive amp)
  - Balancing scenario (port or hybrid)
  - Home network architecture
    - Home-run wiring
    - House amp, NID, filters, A/B switches, etc.
    - Splitters or DCs

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NID Powering

- Distribution powering
  - 60 or 90 Vac
  - Current draw
  - Centralized powering
  - Drop line powering or Siamese cables
  - MOVs and power routing
- Residential powering
  - Reliable source (amperage capability)
  - Battery backup (8 hours?)
    - How many phones will be ringing?

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House Protection

- NEC article 820
  - Direct buried 12 inches deep
  - Protected to a height of 8 feet on buildings
- NEC article 830
  - 18 inches deep or 6” in metal conduit
  - Protected to a height of 8 feet on buildings

or

  - Use of fault protection devices

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Drop Cable Types

- Commonly known as drop line
  - RG-59 (rarely used)
  - RG-6
  - RG-7
- Impedance 75 ohms +/- 2
  - Not RG-58!

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Drop Line Specifications

- No smaller than RG-6 for > 550 MHz
- RG-7 or RG-11 for spans more than 150’
- Tested from 5 MHz to 1 GHz
- Tri or Quad shield
  - Bonded foil
  - At least 60% braid
- Be wary of the VCR cable jumper

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Drop Connectors

- 80 dB or better shielding effectiveness up to 1 GHz
- Seal connections at the connector/cable interface
  - Prevents ingress/egress
  - Provides protection from the weather
  - Use a boot with silicon if warranted
- Compression fittings - not screw-on types
  - Still have to verify the right connector for the style of cable and proper installation

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House Passives

- 110 dB EMI shielding from 5 MHz to 1 GHz
- > 15 dB input/output return loss
- > 18 dB isolation
  - Should be much better than this
- Rugged housing and backplate
- Voltage blocking capacitors
- UL listed and meets ASTM specs for galvanizing

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CPE Requirements

- 0 dBmV for the TV
- 3 dBmV for a settop box
  - May be surprised by the loss of VCRs and games
- VCR cables should be examined for quality
- Modems require +/- 15 dBmV (analog)
- NIDs
- House amps
  - Don’t pad the input below a certain level
  - Pad the output if necessary

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Subscriber Drop Remains the Weakest Link

- Least equipped to deliver interactive digital services
- Most labor intensive part of the network
- Costliest part of the network
- Seven out of ten service calls are generated by problems at the drop
  - Even with today's more forgiving analog signals
- What's the failure rate gonna be with digital signals of tomorrow and NID powering?
- If problems continue, customers will go elsewhere

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Testing and Troubleshooting

- Measuring all signal levels is a standard requirement for analog CATV services
- Test for ingress prior to connecting the drop to the tap
  - Possibly go in the house and turn on noisy motors
    - Vacuum cleaner, hair dryer, electric drill
    - Can opener, CB, Ham, etc.
- Testing for leakage helps find wiring damage or poor craftsmanship
  - Not all leaks are ingress points and vice-versa
  - Some problems are frequency selective

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More Testing Ideas

- Check frequency response to ensure no band-edge problems
  - Indicates faulty components or poor craftsmanship
- Locating faults for repair is simplified with frequency domain reflectometry
- Process of elimination is used when test equipment is unavailable
- Measurements will locate potential problems
  - Sometimes problems don’t show up with a simple “see if the modem works” test

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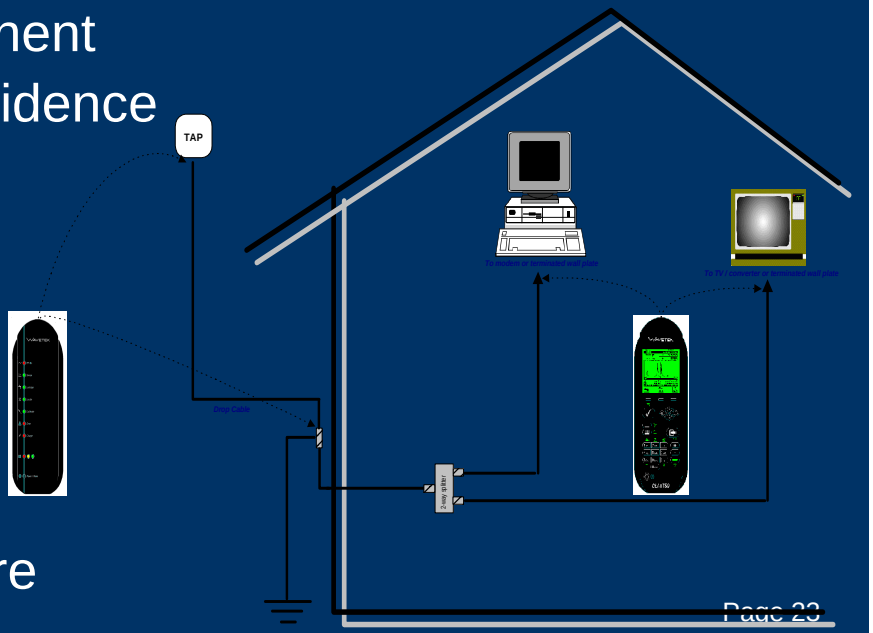
Typical Home Wiring Evaluation

- SIGNAL LEVELS / SCAN
  - Verify FCC or recommended system levels from tap / drop
- SWEEP
  - Characterize frequency response
- LOCATE
  - Pinpoint cable / component problems within the residence
- INSTALLATION TEST
  - Hard copy and proof!
- INGRESS
- LEAKAGE
- DOWNLOAD to StealthWare



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Test Equipment Features

- Locate (FDR) mode
- Sweep mode
- Digital Option (Quick Check or Digi-Check modes)
- 5-890 MHz Ingress Scan
- Abundant file storage capacity
- Dedicated tagged leakage signal source at subscriber drop (no guesswork or false alarms)
- Transmit a CW carrier (+30 dBmV) from 5-800 MHz for subscriber troubleshooting

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Checking Frequency Response

- Sweep is inserted at tap and/or ground block and measured at subscriber terminal locations
  - Look for standing waves
  - Excessive loss
  - Roll-offs
  - “Suck-outs”
- Frequency response helps identify faulty or non-standard components
- Can be used to verify loss of cable and non-termination

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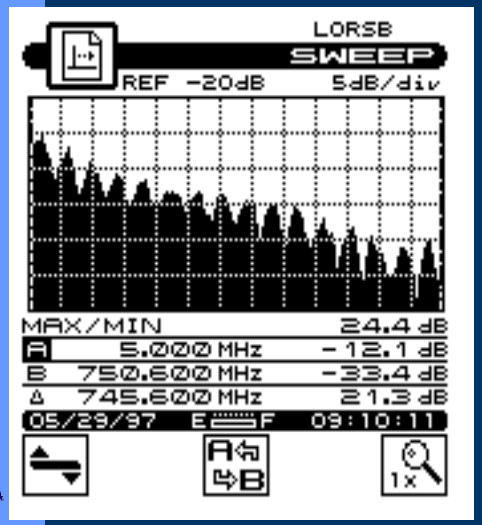
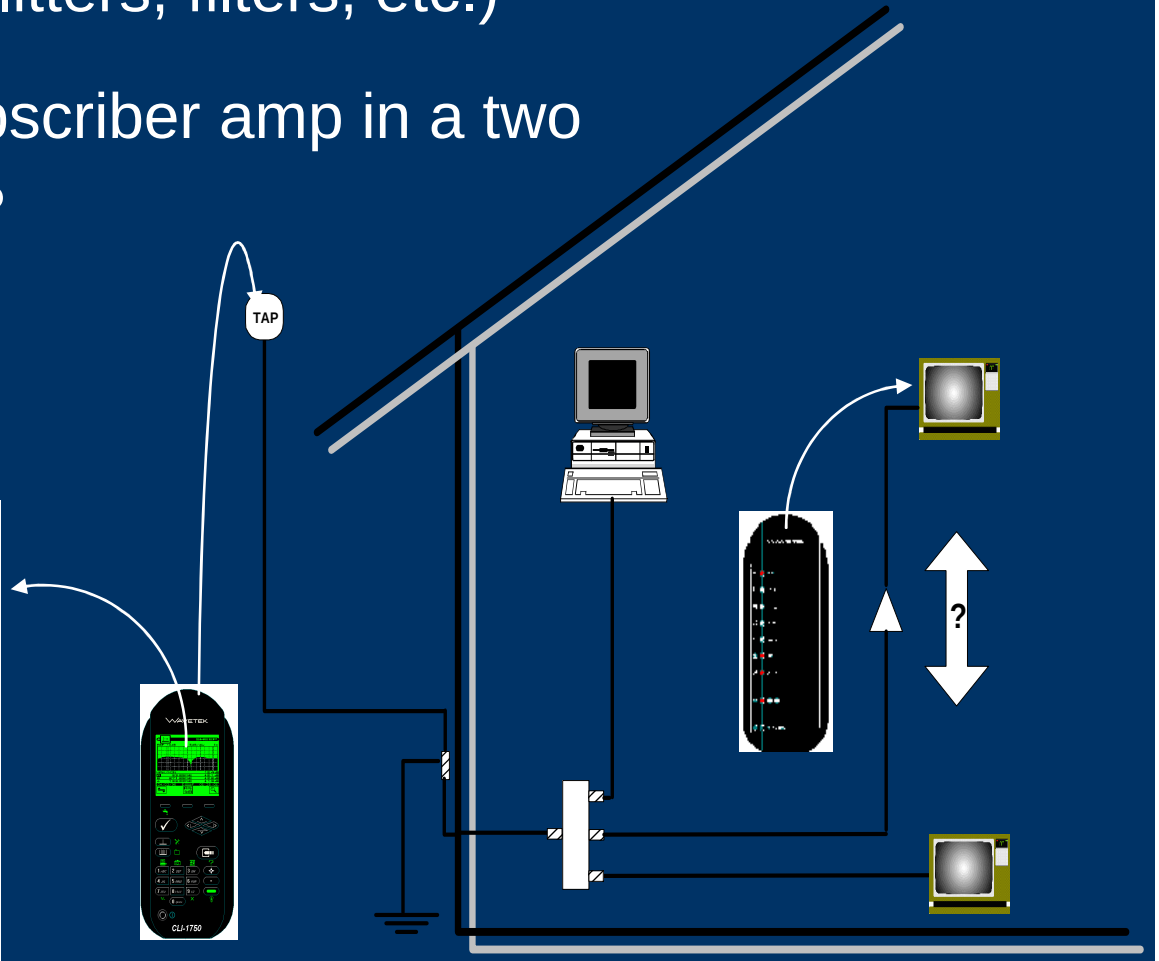
Identify Faulty or Non-Standard Components

- Connectors & cable
- Passives (splitters, filters, etc.)
- One way subscriber amp in a two way system?





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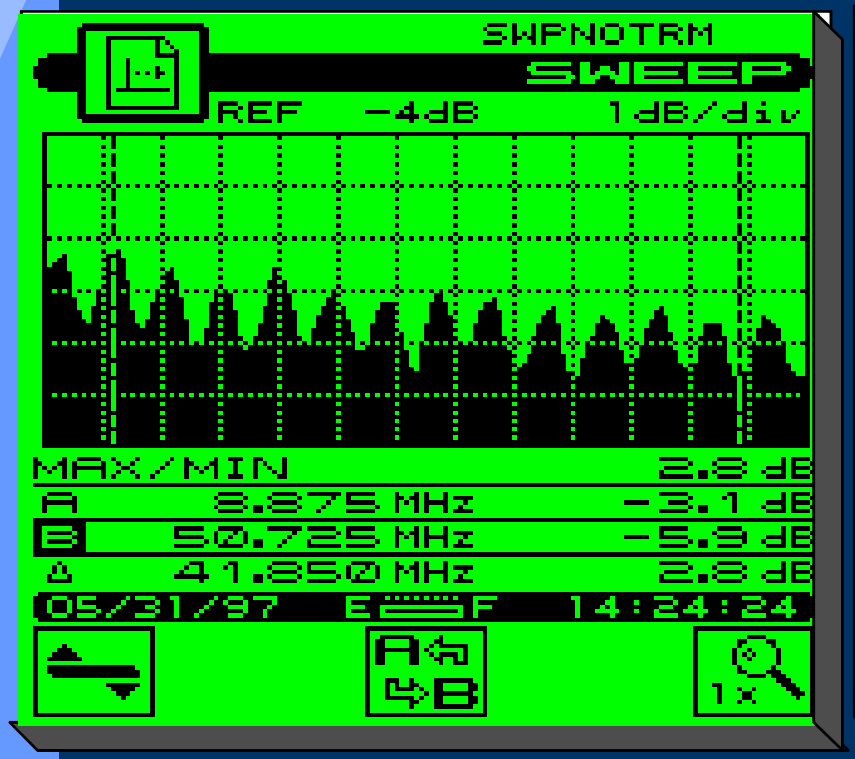
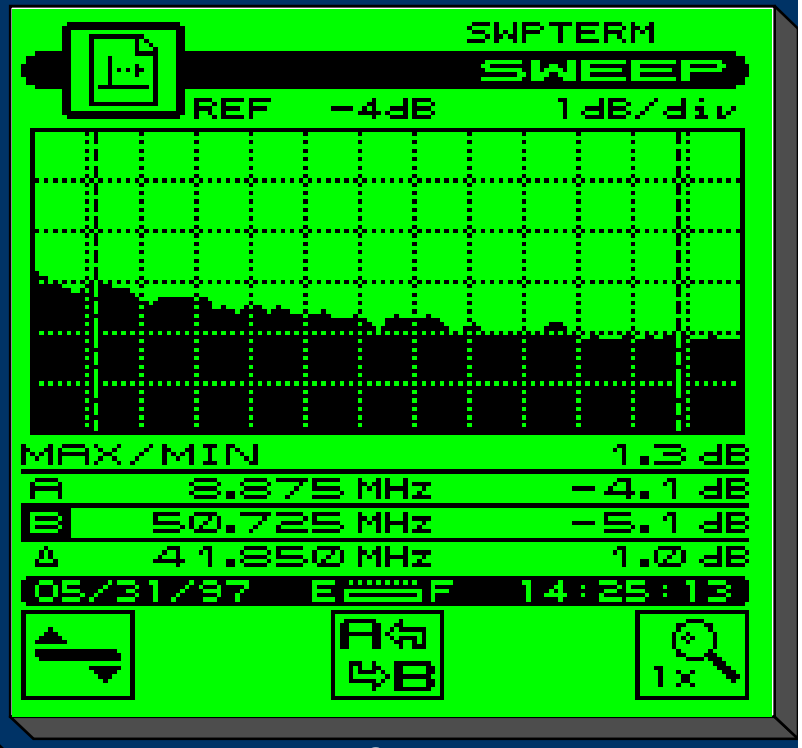
Effects of Impedance Mismatches



Before

Failure to properly terminate wall plates, or installing poor quality signal splitting devices



After

Terminating all wall plates & installing quality passives

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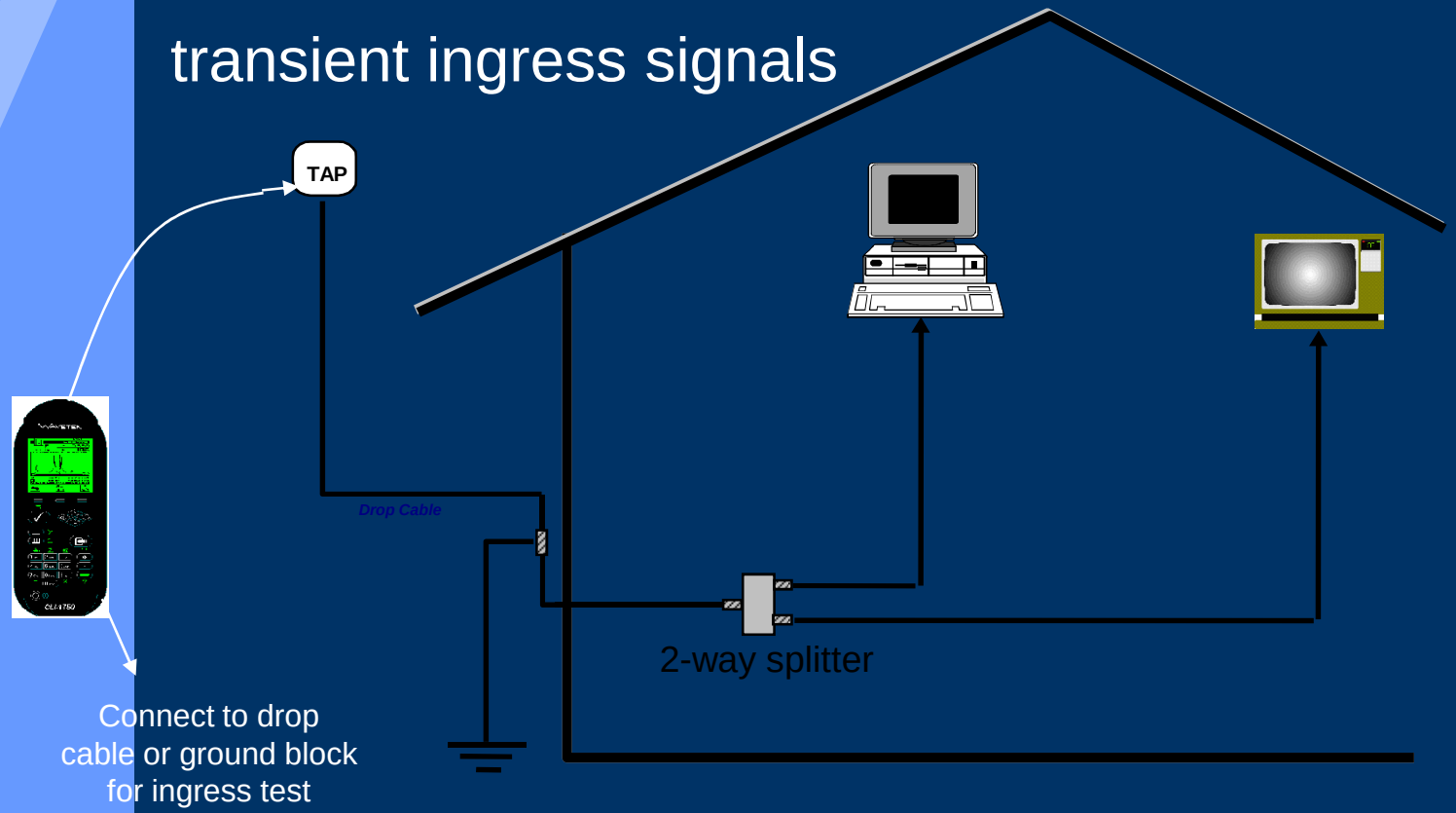
Ingress Scanning

- 5 - 890 MHz Range
- Peak hold function to catch transient ingress signals



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TDR

- Injects DC pulses (reflects little energy at RF faults)
- Nearly 100% of the source energy is reflected by any in-line frequency selective device
- Tends to roll off rapidly at high frequencies
- < 2% of pulse energy is distributed in the RF ranges

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Frequency Domain Relectometer

- FDR is the measure of the reflections of a medium across frequency
- Part of the energy is reflected back if the load is not a perfect match of 75 ohms
- The reflected energy will be the same frequency as the incident wave but 180^{o} out of phase
- The resulting wave (incident + reflected) will appear as standing waves on the frequency sweep
- This can be correlated to a distance vs fault display

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FDR

- Sweeps the system at radio frequencies
- Sensitive to RF problems, accurately identifies return loss, and operator selectable resolution
- Fault vs. distance and Return Loss (SWR) per Event
- No need for access to the subscriber's house
  - Advantageous to know the internal architecture, though
- Advantages of FDR vs. TDR
  - Excellent event resolution - no "dead-zone"
  - Higher dynamic range - farther distance
  - Can measure through multiple taps, splitters, etc.

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FDR (cont.)

- The reflection is such that the peaks of the individual cycles can be translated to distance to the fault (impedance mismatch) through the this equation:
  - D= 492*Vop/f
- Where D = distance to fault in feet, 492 = speed of light / 2 in million ft/sec, Vop = velocity of propagation of the cable, and f = the separation between 2 peaks of the standing wave in MHz
- The peak-to-peak value of the reflection determines the magnitude of the fault and is calculated by:
  - Return Loss (dB) = 20*log(Reflected Energy)

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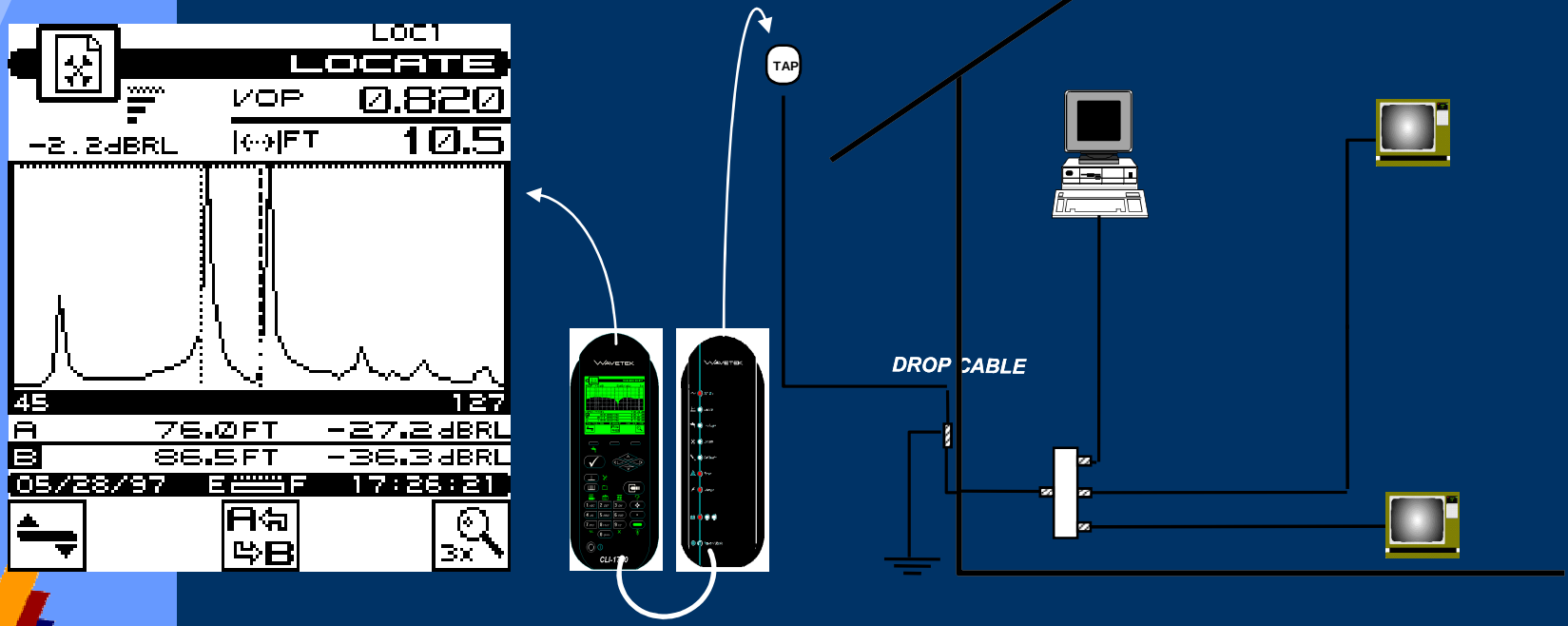
FDR Identifies Mismatches

- Measures opens, shorts and structural damage to cable or home wiring passive devices
- Highly accurate distance to fault measurement
- Worst case faults are quickly pinpointed



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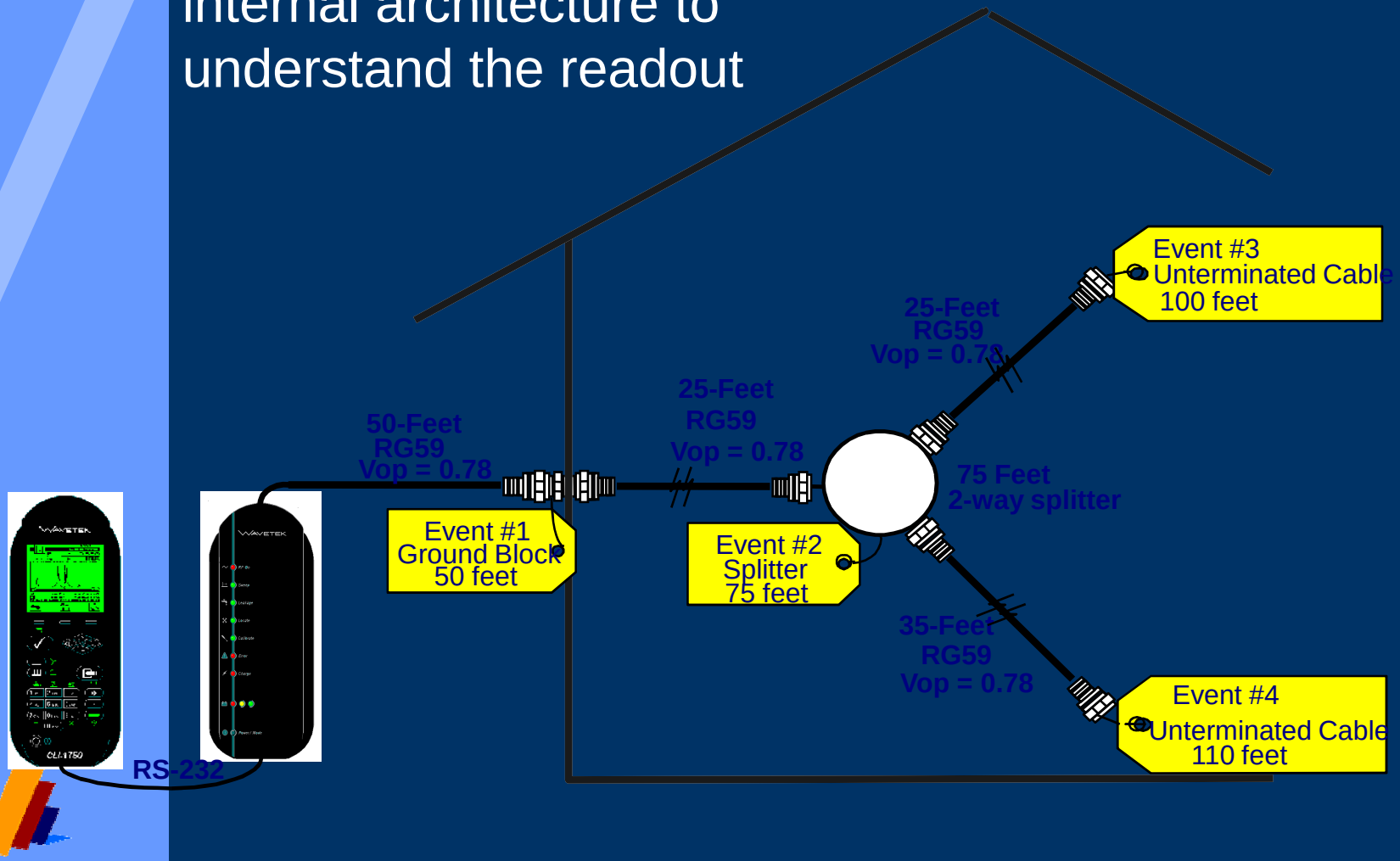
Fault Locating

Must have an idea of the internal architecture to understand the readout



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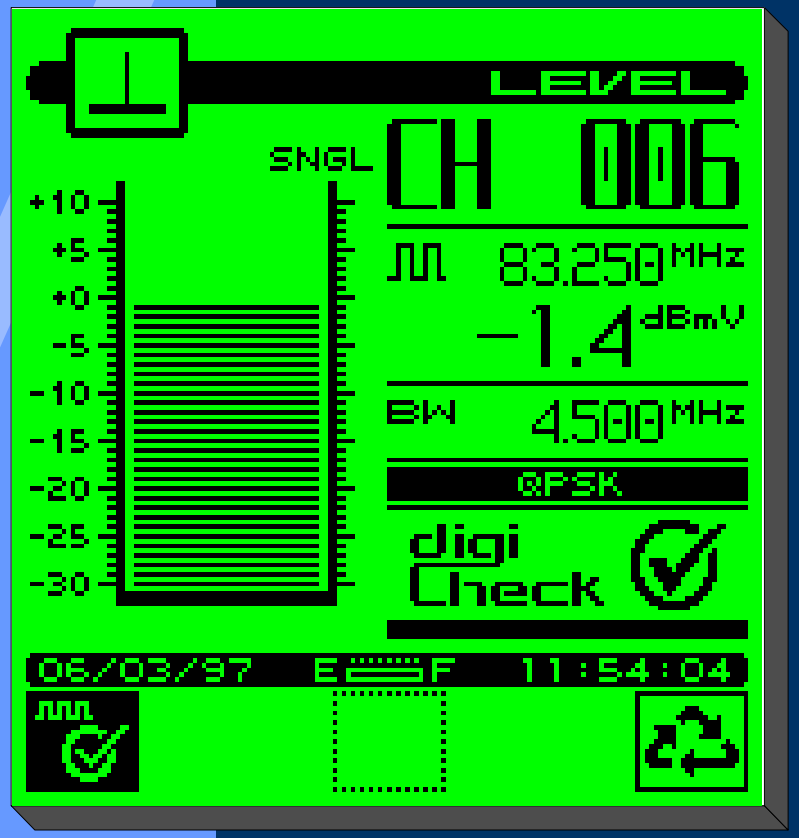
Digital Signal Level Measurements



- Measures (Non-bursted) Digital Signals
- User Selectable Bandwidth for Accurate Power Measurements
- Quick Mode Measures Signals Based on Bandwidth Estimation / Normalization Technique
  - digi Check Mode Measures Digital Signals via Integrated Power Technique

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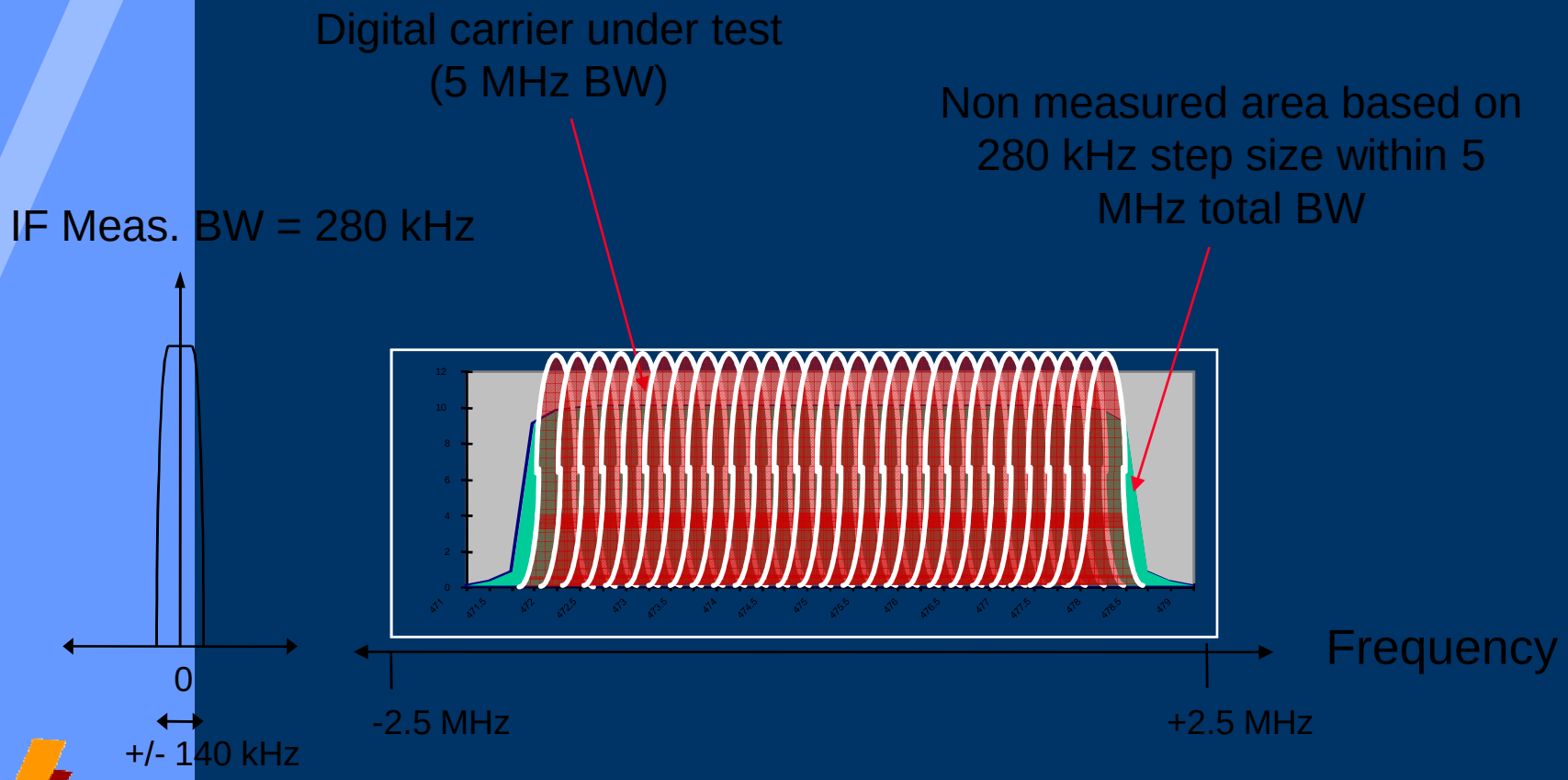
Measuring the Digital “Haystack”



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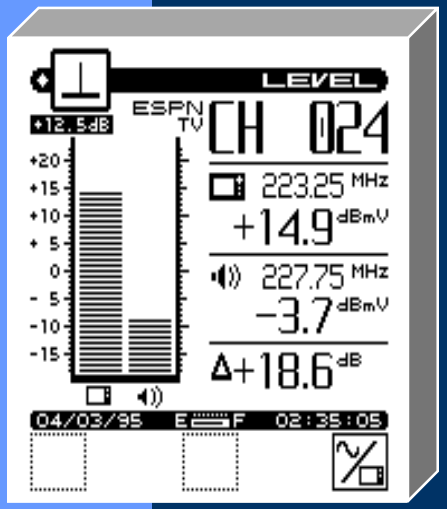
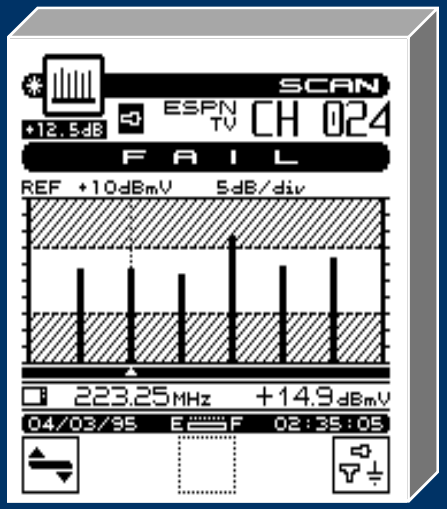
Measuring Signal Levels

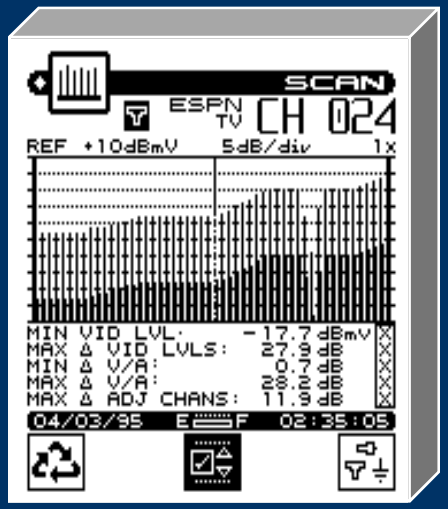
- Use Meter's Signal Level or Scan Modes
  - Go/No-Go limits simplify signal level testing
  - Digital measurement option for measuring average power of digital signals in level mode



Level Mode



Quick Scan



Full Scan

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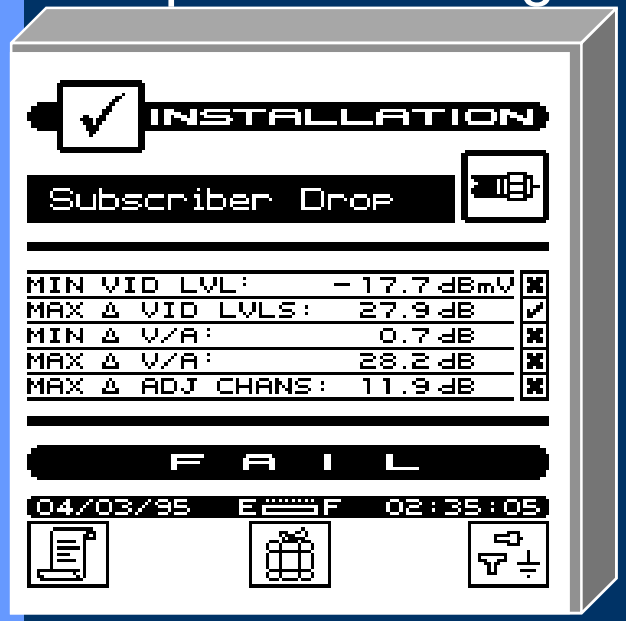
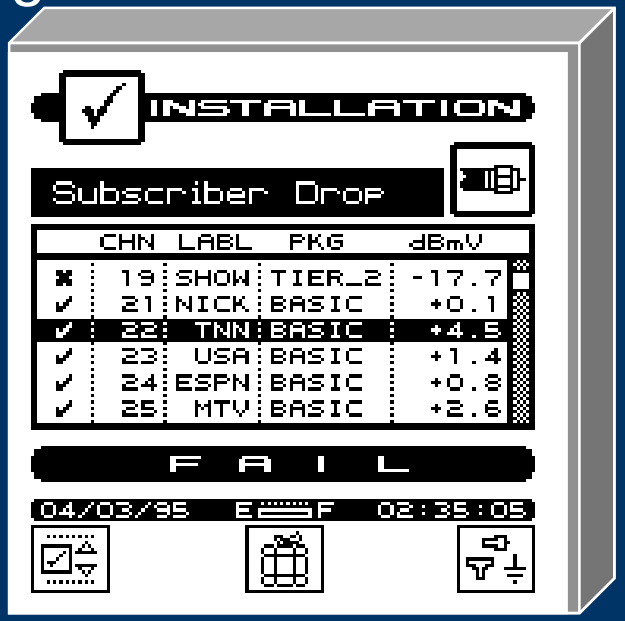
Installation Check

- Provides installation status check of system levels at drop according to FCC or custom limits
- Results viewed by individual channel or global pass / fail
- Separate analog and digital limits





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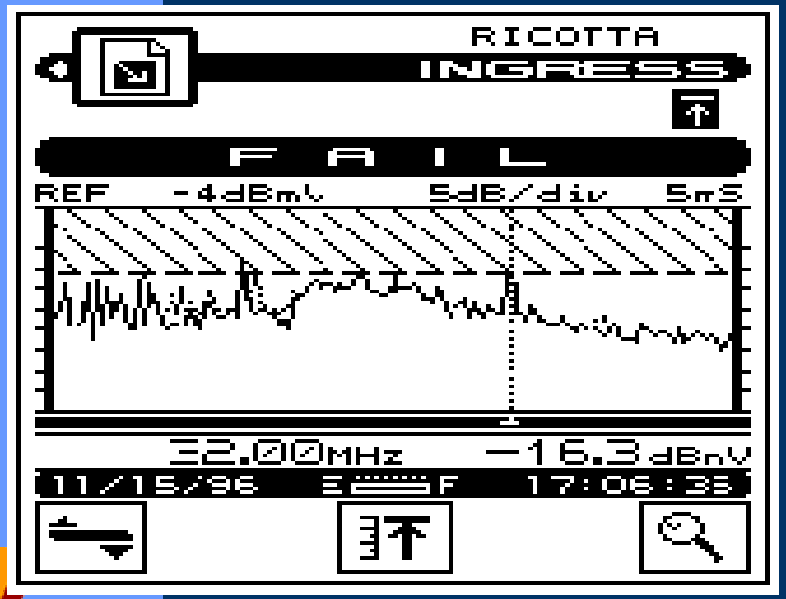
Testing for Ingress

- Pass/Fail limits simplify test
- Measurements above the limit indicates a problem
- This measurement can be misleading unless you know the filter width



- Ingress
- Impulse Noise
- Power Supply Noise
- Common Path Distortion
  - Defective line terminators
  - Bad caps
  - Bad grounds
  - Feed-through connectors

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Noise Reduction Techniques

- Proper house grounding
- Common mode coiling
- Beads and torroids
- “Ghost busters”
- Drop isolators or matching transformers

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Overview

- Good drop line
  - Integrated messenger (IM)
  - Quality shielding
  - Low attenuation & dc-loop resistance
- Passives
  - Good shielding
  - Proper isolation
  - Adequate return loss / VSWR
  - Voltage blocking capacitors
- Exhaustive testing before the “bean counters” start selling!

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Tips & Suggestions

- Aware “user base” (customers)
  - Sometimes too much information is dangerous
- Pin connectors for larger cables
- Quality componentry and craftsmanship
- Selective frequency placement of services
- Better Carrier-to-Ingress (C/I)
  - Creative usage and placement of filters & traps
    - Protect your investment and buy windowed filters
  - Find the problem and fix it!
- Constant monitoring and preventive maintenance

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Conclusion

- Have contingency plans for everything
- Train employees and customers
- Obtain good customer relations and loyalty
- Try to be as non-intrusive as possible
- Utilize equipment that quickly characterizes and separates real problems from minor events

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Comments

- All comments and suggestions are sincerely appreciated
- Check out the ACTERNA web page WWW.ACTERNA.COM

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