Industrial Networks

Driving new sales opportunities

Keeping today's industrial plants up and running

Growth Opportunity

Network systems are rapidly automating today's factories and plants

- Data gathering
- Process control
- Production automation

Systems are migrating from analog to digital networked systems

- ASI, MODBus, RS-485 or RS232 derivatives
- DeviceNet, a CAN bus derivative
- Fieldbus Foundation, TCP/IP based
- ProfiBus, TCP/IP based
- Ethernet, TCP/IP based

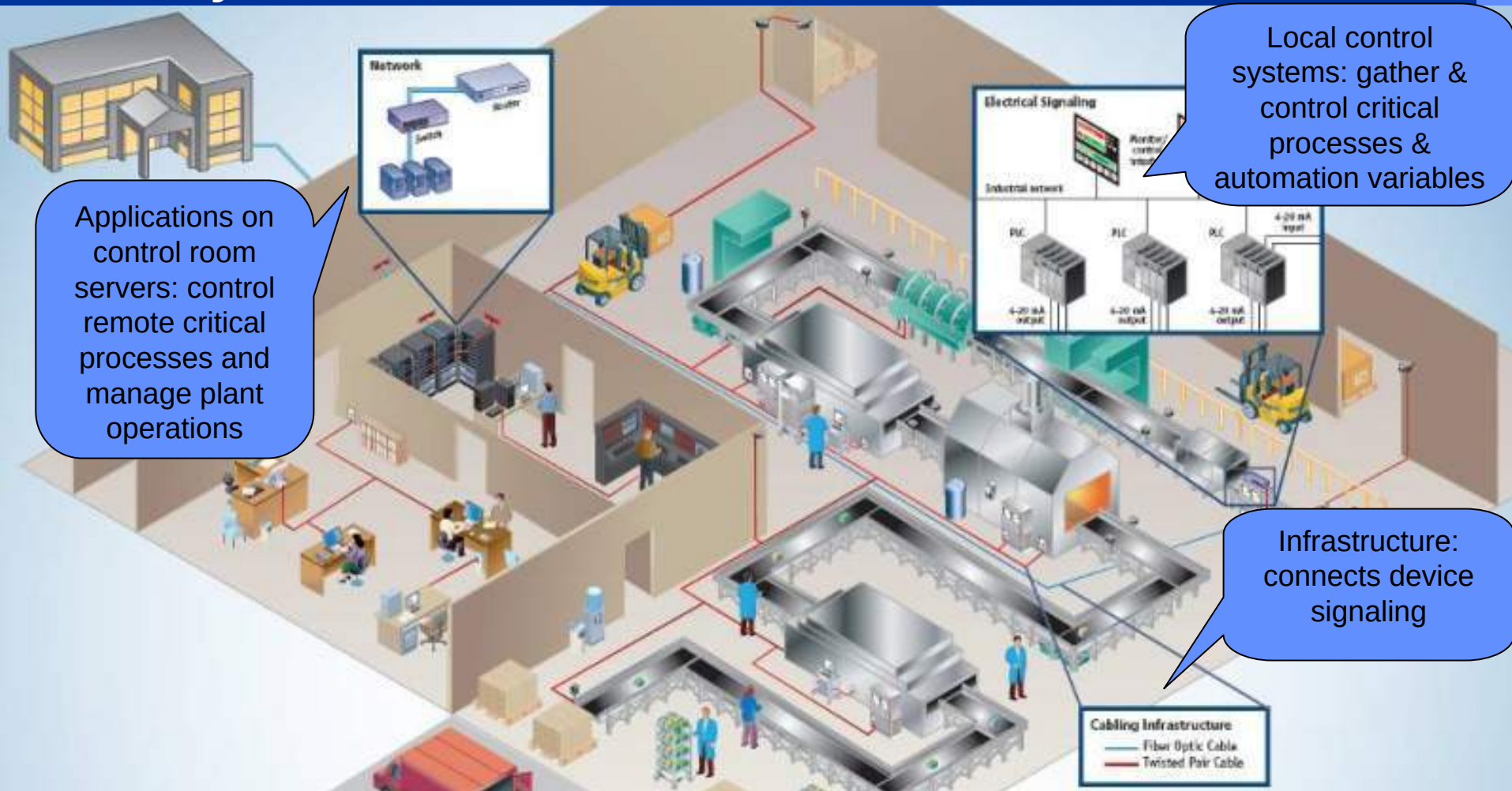
New technologies creating new challenges for the industrial maintenance engineer

Technology Convergence

- Technology is going from 4 to 20 mA analog control…
  …to serial digital control…
  …and now to industrial networks –
  Ethernet, Fieldbus Foundation, ProfiNet, DeviceNet and more
- Bringing networked devices to the plant floor
  - Managed and unmanaged switches, PCs, routers,
  - PLC's, remote IO, variable frequency drives, motion controllers, sensors, transducers, encoders, actuators, robot controllers
- Bringing significant changes to industrial maintenance
  - New standards are driving new infrastructure, topologies & components

New tools are needed to identify, troubleshoot, and resolve industrial network problems

Today's Industrial Network



Local control systems: gather & control critical processes & automation variables

Applications on control room servers: control remote critical processes and manage plant operations

Infrastructure: connects device signaling

Digital data is conveyed in the form of electrical signals across network media

Factors That Influence Industrial Network Performance

Industrial environment is harsh & dirty!

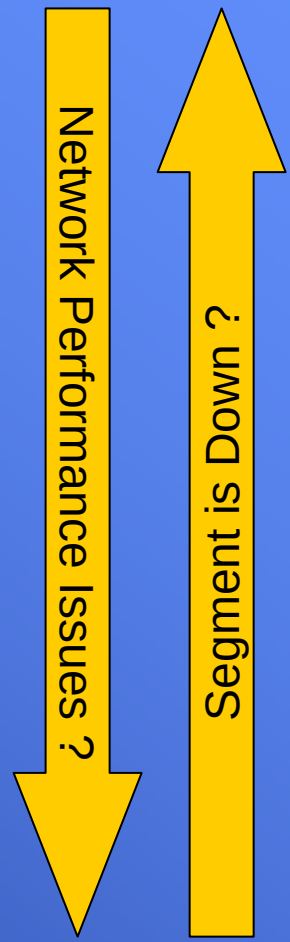
- Temperature and humidity extremes cause:
  - corrosion and cable impedance changes, intermittent connections and equipment failures
- Heavy duty machinery-induced power disturbances, noise, and electrical interferences cause:
  - intermittent performance, random equipment shutdowns and failures
- Unpredictable installation environment. Long cable runs, abuse from heavy duty machinery, vibration, and other common factors cause:
  - infrastructure breakdowns

How Network Issues Cause Plant Downtime

Network problem	Production problem
Network Comms Disruption: Ethernet protocol •What and who is on the network? •Alarm & error detection •Bandwidth “hogs”	*Process interruptions*
Compromised Electrical Signaling •Poor signal integrity •Electrical disturbances •Induced noise	*Random shutdowns or device resets*
Cable Infrastructure: Copper, fiber & wireless •Deteriorating connectivity •Cabling installation errors •Cable performance	*Segments go down, all data communication lost*

Diagnostics How To?

1. Check network protocol errors
   - Network visibility or traffic utilization
   - Packet transmission errors (CRC, Framing, Checksum)
   - Protocol statistics
2. Verify Integrity of signaling
   - Signal compliance to vendor or industry standards
     * DC power levels, Attenuation, Distortion, Jitter or time errors
   - Signal disturbances or anomalies
     * Transients, Noise, Static Discharges
3. Measure state of cabling infrastructure
   - UTP or AWG cable impedance, terminations, opens or shorts
   - Cable performance (UTP) 10Mb, 100Mb, NEXT, mismatch pairs etc



Is it the network communications, signaling or cable?

Core Components of Network Segments

Network maintenance tackled from three distinct areas

Cabling Infrastructure

- Copper and fiber cabling
- Certification and troubleshooting
- Communication networks testing

Electrical Signaling

- Physical layer measurements
- Disturbances, noise & anomalies

Network Communications

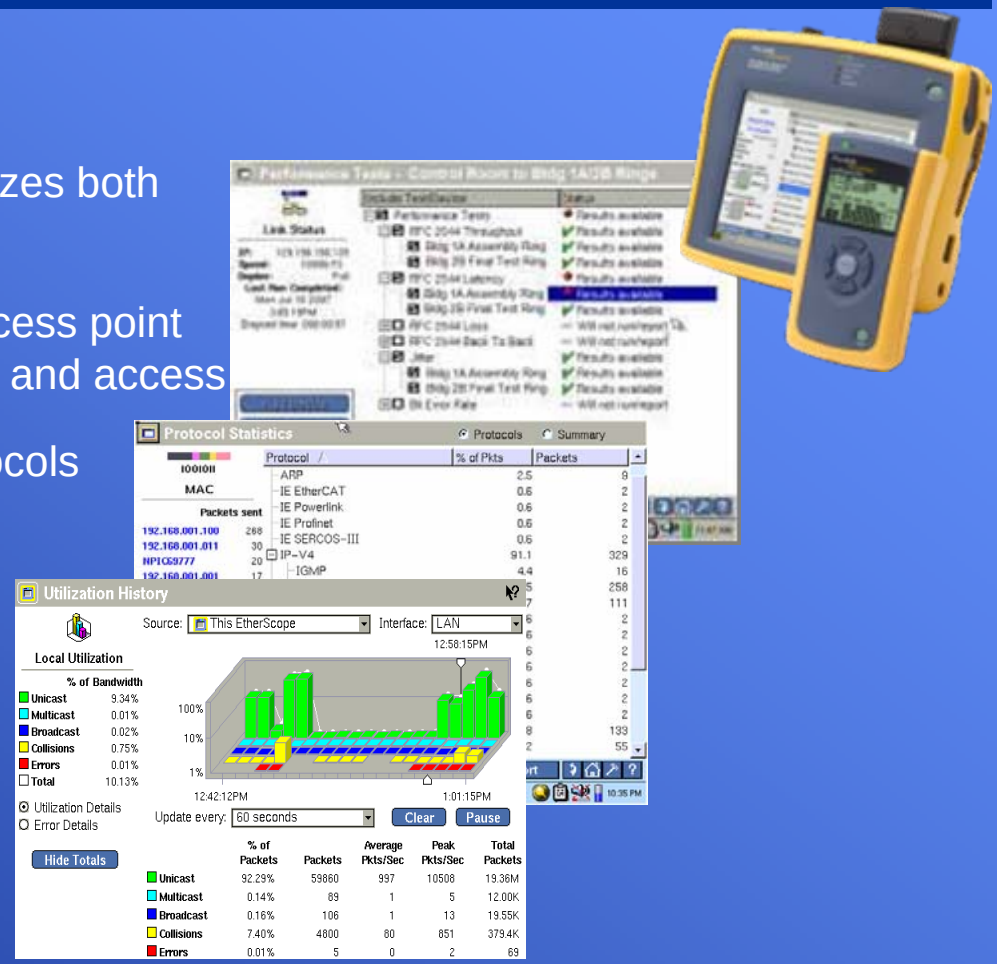
Portable handheld LAN and WAN test and solutions

Proper cabling + good signaling + error free network communications = healthy network

Visibility into the Entire Network

Critical Parameters

- The EtherScope Network Assistant analyzes both
  - Wired networks – copper & fiber
  - Wireless networks- 802.11a/b/g
- Identify problems on both sides of the access point
- Discovers active networks, mobile clients and access points
- Discovers presence of 13 Industrial Protocols
- Trend Utilization
- VLAN Statistics
  - Added .1p Priority stats
  - Added filter on VLAN
- Top Talkers
- Protocol mix
  - Identify expected traffic
  - Identify unexpected traffic



What devices are on my network?

Determine What is on Your Network & Where

EtherScope Series II version 4 & LinkRunner Pro

- Segment network for fast problem isolation
  - Add deterministic instrumentation
    - Factory floor, remote facility, IT side
    - Instrument Point to Point or Point to Multipoint
- Qualify a link before bringing it into service
- Document the baseline of your network working at optimal performance

Drill down into each device on your network

Network Tools Features & Benefits

EtherScope Series II V4 & LinkRunner Pro

1. Measure network performance
   - *Quantify and document network performance for baseline use*
2. Multiple network protocols
   - *Single test tool discovers multiple network protocols*
3. Trend utilization
   - *Graphical report indicates real time performance at selected intervals*
4. Validate installation of new equipment and simulate traffic
   - *Easily determine if your network can support additional signals and document with pass/fail reports.*
5. Rugged & portable
   - *Able to plug into anywhere on the network, no PC required*

Network– EtherScope Series II

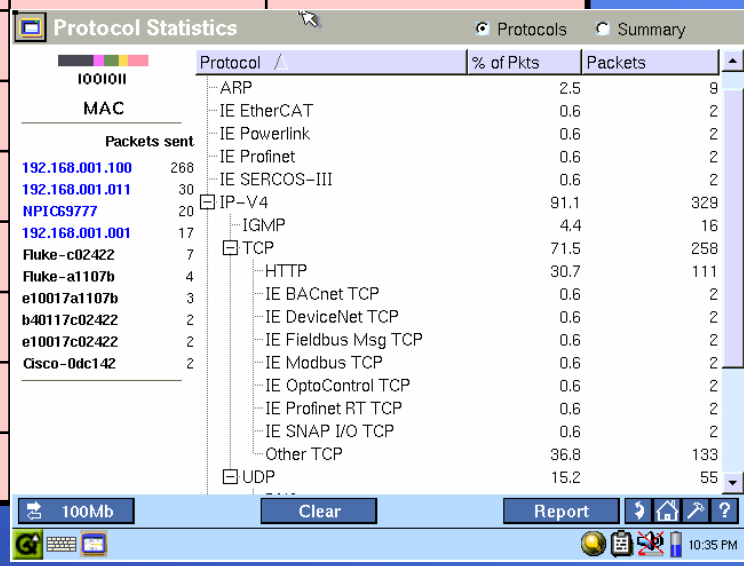
Feature

- Discovery of 13 new industrial protocols

Benefit

- Automatically reports the presence of any of 13 different industrial protocols along with all IP devices
- Able to validate network is set up as expected and identify unknown or authorized devices

EtherType	Port	Description	Comment
0x8892	n/a	IE Profinet	
0x88A4	n/a	IE EtherCAT	
0x88AB	n/a	IE Powerlink	
0x88CD	n/a	IE SERCOS-III	
0x0800	502	IE Modbus (TCP only)	
0x0800	1089	IE Fieldbus Ann	annunciation
0x0800	1090	IE Fieldbus Msg	message
0x0800	1091	IE Fieldbus Sys	
0x0800	2222	IE Rockwell CSP2	
0x0800	34962	IE Profinet RT	Unicast
0x0800	34963		
0x0800	34964		
0x08oo	34980		
0x0800	44818		
0x0800	47808		
0x0800	22000		
0x0800	22001		



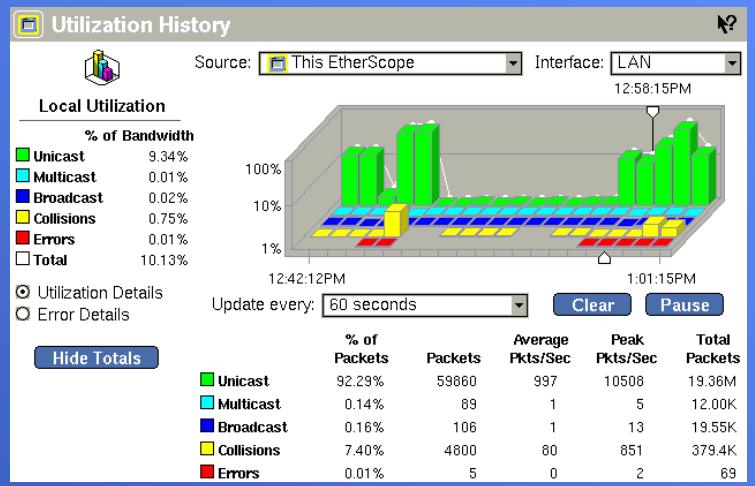
Network– EtherScope Series II

Feature

- Monitor mode: Allows vision into live network operation for expected & unexpected network usage

Benefit

- Saves time with a problem log that will automatically take all information discovered and place problems into a “one stop” location and generates comprehensive reports



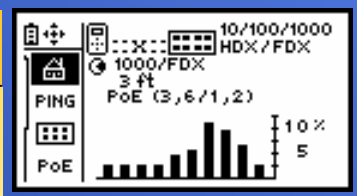
Network– LinkRunner Pro

Feature

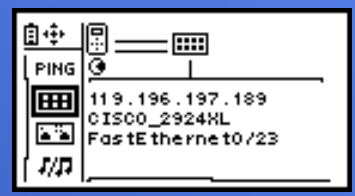
- Link verification: Identify speed/duplex capabilities and confirm connected speed (10/100/1000)

Benefit

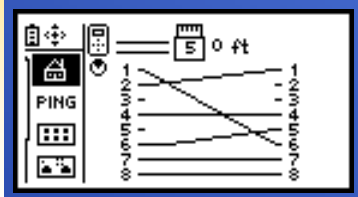
- Confirm at connection point, data can be transferred. Rules out local network issue in troubleshooting



Link

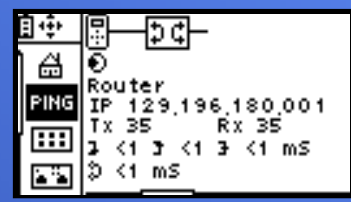


Port Discovery



Cable Tests

DHCP or Static IP



Ping up to 10 devices

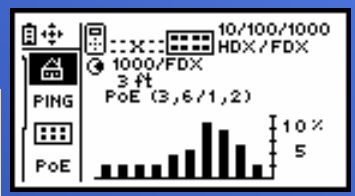
Network– LinkRunner Pro

Feature

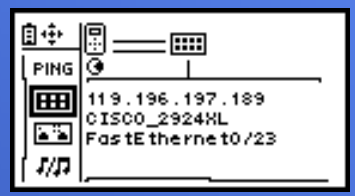
- Ping: Measure response statistics of default router, DNS server, or other key devices at 10/100/1000 Mb/s

Benefit

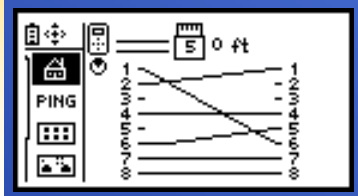
- Able to simulate traffic from a certain connection to equipment to verify



Link

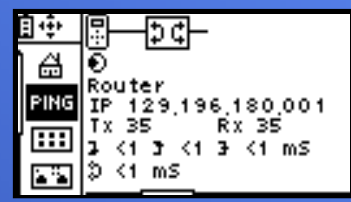


Port Discovery



Cable Tests

DHCP or Static IP



Ping up to 10 devices

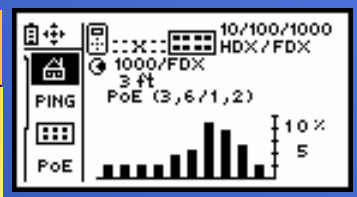
Network– LinkRunner Pro

Feature

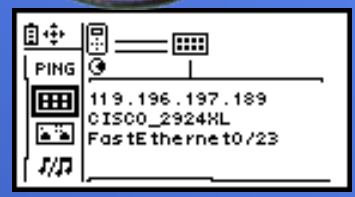
- Cable verification: Test wire map (pin by pin) & length; detect shorts, split pairs or opens

Benefit

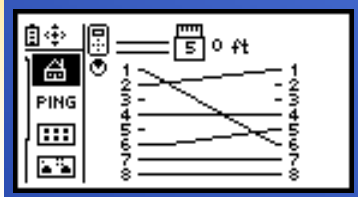
- Quickly rule out bad patch cords, a common issue in active networks



Link

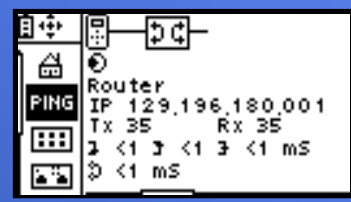


Port Discovery



Cable Tests

DHCP or Static IP



Ping up to 10 devices

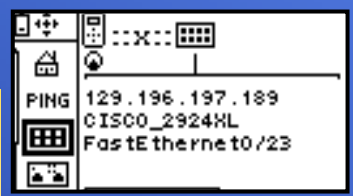
Network– LinkRunner Pro

Feature

- CDP/EDP/LLDP: Identify the nearest switch model, MAC address, slot and port number

Benefit

- Able to isolate and identify equipment by name. If monitoring, port mirroring is required, able to easily communicate source



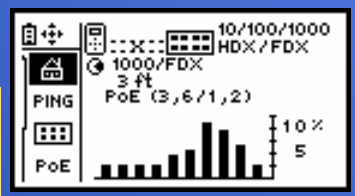
Network– LinkRunner Pro Engineer

Feature

- PoE Detection -verify availability and voltage level of Power over Ethernet.

Benefit

- Able to identify whether the device or sensor or actuator is being power by communications cable. 48V presence



PoE Present

Core Components of Network Segments

Network maintenance tackled from three distinct areas

Cabling Infrastructure

- Copper and fiber cabling
- Certification and troubleshooting
- Communication networks testing

Electrical Signaling

- Physical layer measurements
- Disturbances, noise & anomalies

Network Communications

Portable handheld LAN and WAN test and solutions

Proper cabling + good signaling + error free network communications = healthy network

Cabling Infrastructure - Copper

Critical parameters

In harsh industrial environments certifying cabling, verifying network availability and link connectivity are required for consistent, robust infrastructure

Rigorous test providing Pass/ Fail results against TIA/ISO Standards

- Wire map, Length, Propagation Delay Insertion Loss (Attenuation)
- DC Loop Resistance*

- Category 5e measurements are made from 1 MHz to 100 MHz, up to 1Gbps

Advances Troubleshooting: measures distance to performance defect

Industrial Components

- M12 Channel Adapters and hybrid patch cables -IP67 rated

Is this link good or bad?

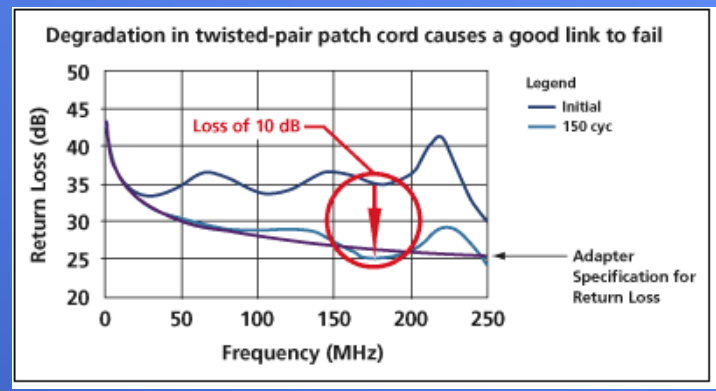
Cabling Infrastructure - Copper

Critical Parameters

- Additional tests – AC Wiremap, Application testing, custom limits

- Quickly verify whether a patch cord is fully compliant with the new TIA 568B/ ISO 11801
  - 70% of Cat5e patch cords fail to meet industry standards

- Check legacy patch cords to isolate faulty cords that degrade network performance and contribute to network downtime.
- Test patch cords to ensure optimal network performance with greater channel throughput and greater system margin.
- Reduce the error rate of advanced applications that use multiple-pair transmission schemes and bidirectional communication on the same pair(s)

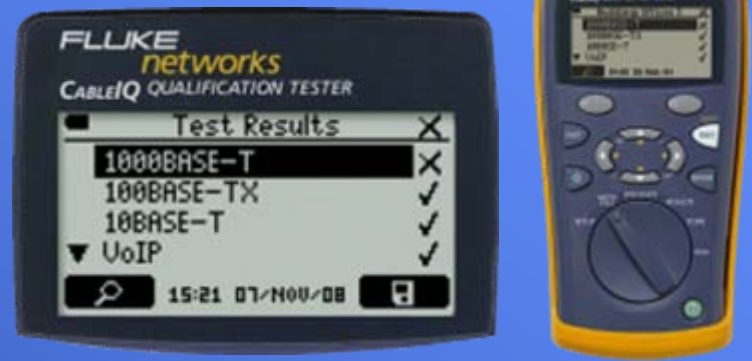


How good is this patch cord?

Cabling Infrastructure - Copper

Critical Parameters

- Basic cable qualification and verification tools indicate desired speed and correct connections



- **Troubleshoots** connectivity problems caused by insufficient bandwidth
- **Qualifies** existing cabling for network speeds – 10BASE-T, 100BASE-TX, 1000BASE-T

OR

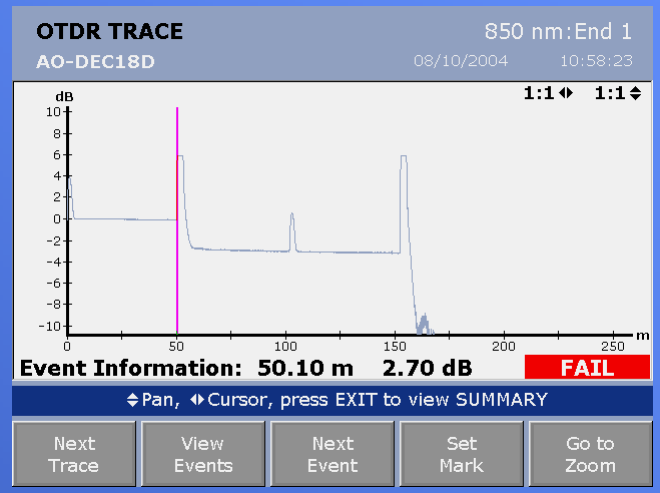
- Identifies and locates opens, shorts, split pairs
- Identifies distance to fault
- Measures crosstalk and impedance
- Trace cables - includes Intellitone variable audible signals

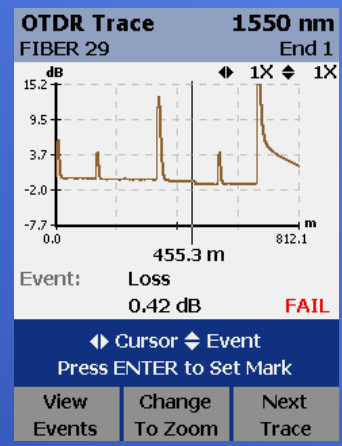
Do I have continuity?

Cabling Infrastructure - Fiber

Optical Fiber Fault finding

- Finding faults with optical fiber is more difficult than finding faults on copper cabling
- Tools for finding faults such as breaks, bad connectors or loss events traditionally has been very complex and expensive
- Tools such as the OptiFiber Professional OTDR utilizes the OTDR technology in an easy to use form
- OTDRs allow the technician to find distance to faults such as:
  - breaks
  - bad connectors and splices
  - other loss events





Copper & Fiber Features & Benefits

1. Test to standards
   - Ensures your installation is sufficient with PASS/FAIL results
   - Provides quantitative statistics that an installed link meets all the performance criteria of a given category
2. Advanced diagnostics pinpoint faults and suggest corrective action
   - Identifies issues with crosstalk and return loss with the ability to locate those faults
   - Provides alternatives to costly labor of replacing all connections
3. Verifying continuity and wire map
   - An established best practice during installation and troubleshooting in all environments
4. Built-in IntelliTone
   - Digital toning to locate and trace cables with superior clarity and accuracy, all while the network is live

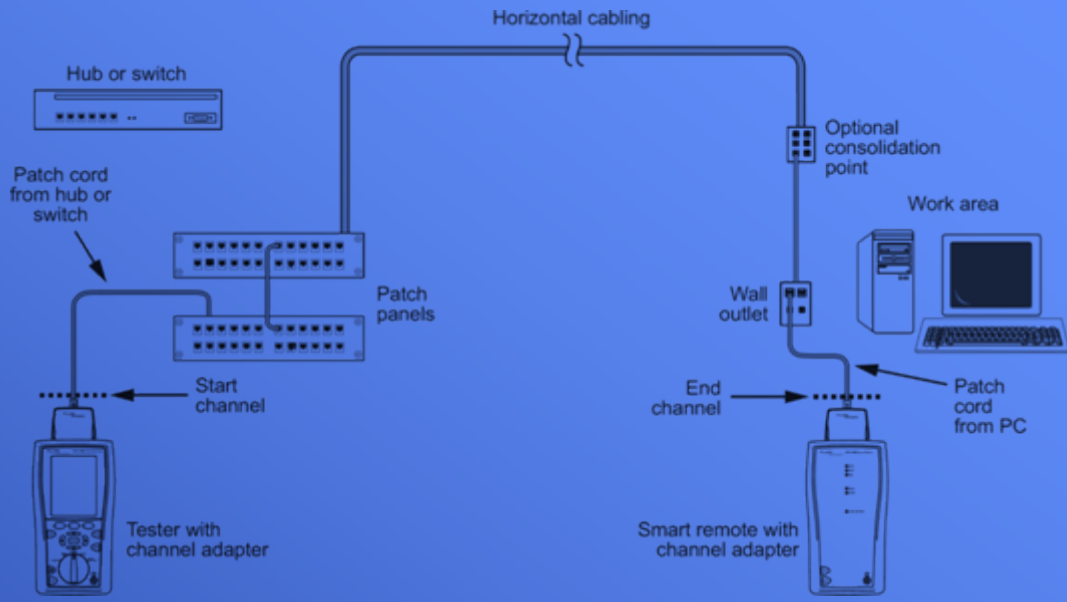
Cabling Products - DTX

Feature

- DTX: Permanent link testing

Benefit

- Provides quantitative statistics that an installed link meets all the performance criteria of a given category.
- Guarantee of performance.



10BASE-T (10 Mb Ethernet)
Will run 100 m on 2 pair Category 3 cable

100BASE-TX (Fast Ethernet)
Will run 100 m on 2 pair Category 5 Cable

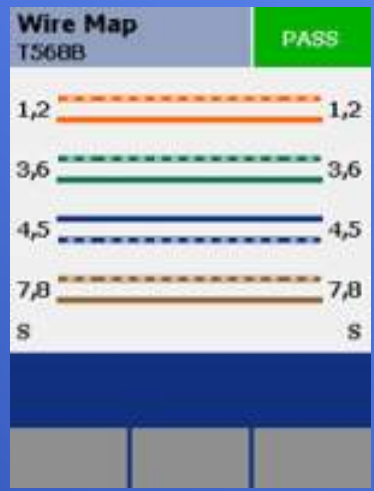
1000BASE-T (Gigabit Ethernet)
Will run 100 m on 4 pair Category 5 Cable

10GBaseT (10 Gig Ethernet)
Will run 37 m on Cat 6
Wil 100 m on Cat 6A

Cabling Products - DTX

Feature

- DTX: AC wiremap



Benefit

- The DTX user sees clearly if a connection is wired properly or has wiring errors
- This test can be done from the location of the Ethernet switch(es)

Cabling Products - DTX

Feature

- DTX: Length limit

Benefit

- Physical length vs. electrical length. The pass/fail criteria is based on the maximum length allowed for the channel or permanent link given. TIA standard is 90 m (295 ft)

Network & Cabling Products

Feature

- CableIQ: Infrastructure discovery
  - Open link
  - Far-end device

Benefit

- Plug into any cable, machine, or patch panel to see where cable leads
- Detect connected devices and see speed/duplex settings

Network & Cabling Products

Feature

- CableIQ: Network connectivity and cable troubleshooting
  - Why didn't it qualify?
  - Find performance fault

Benefit

- Drill down on qualification test components to find reason
- Drill down further to see distance to performance fault

Network & Cabling Products

Feature

- CableIQ: Intelligent wiremapping
  - Open pin at far end
  - 568A/B reversal

Benefit

- Proportionally-correct pin lengths indicate location of breaks
- CableIQ's intuitive interface makes detecting and understanding common wiring faults easy

Network & Cabling Products

Feature

- CableIQ: Testing multiple links
  - Test set up
  - Verify multiple links

Benefit

- Plug remote ID's (up to 7 including main) into multiple locations to qualify
- Test up to seven links without having to change far-end wire map adapter

Network & Cabling Products

Feature

- IntelliTone: Digital toning to locate and trace cables

Benefit

- Working with many cable types, IntelliTone quickly identifies cables in a bundle for easy tagging.
- Reduces troubleshooting time spent by quickly finding correct/ problem cable

Network & Cabling Products

Feature

- MicroScanner^2: Detect service

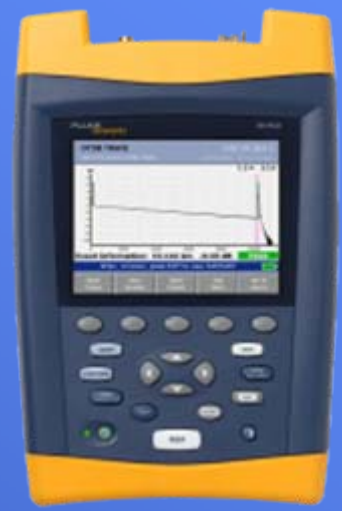
Benefit

- Check for availability of the following services
  - Telephone (POTS)
  - Ethernet(10/100/1000)
  - Power over Ethernet(PoE)

Cabling Products - Fiber

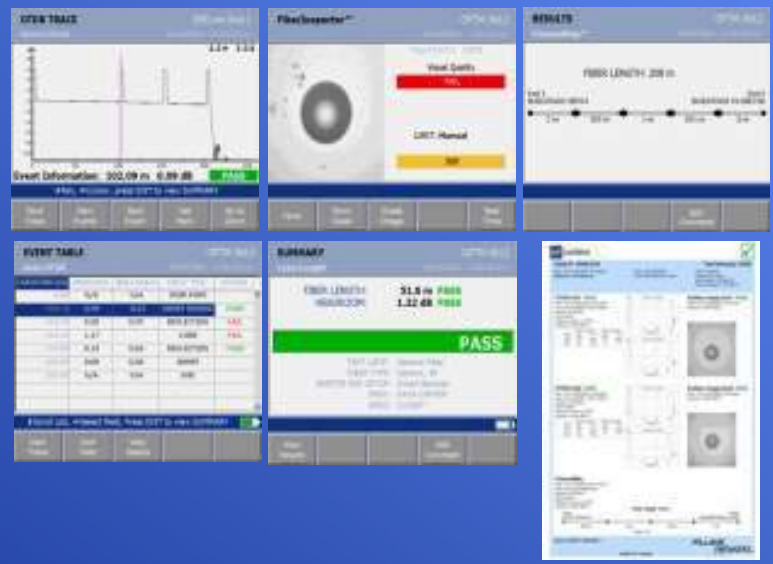
Feature

- OptiFiber: Fiber testing with OTDR



Benefit

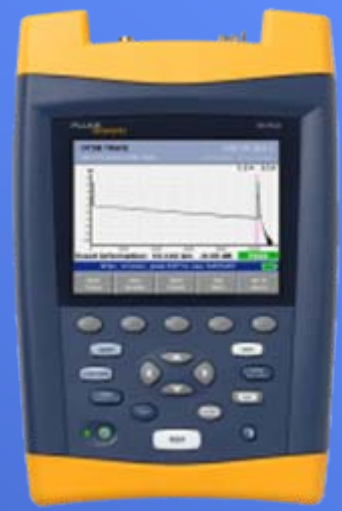
- Able to check the workmanship and physical location of each individual connection
- Allows for end-face fiber inspection and length



Cabling Products - Fiber

Feature

- OptiFiber: Fiber testing with OTDR



Benefit

- Prove that the fiber link meets installation specifications (ie .35dB insertion loss for connectors and .2dB for splices)

Location (m)	850nm (dB)	Event	Pass/Fail
0	.18	Reflect	Pass
100	.14	Reflect	Pass
107	1.4	Reflect	Fail
217	.19	Reflect	Pass

Cabling Products - Fiber

Feature

- SimpliFiber Pro: Fiber testing with optical-loss meters

Benefit

- Measure the power of the device at the end of a link/ cabling run
- Kits for inspection, cleaning, fault locating, and remote ID

Network & Cabling Products

Feature

- Test reports: Save results in unit or upload to PC with USB cable

Benefit

- Quickly organize, edit, view, print, save, or archive test results by jobsite, customer, campus building
- Increase productivity with simple user interface and time-saving features with LinkWare

	User/Task	Control Engineer	Engineer	Technician
NETWORK	Trending Utilization	EtherScope		
	Detect Application Connectivity Problems			
	Test PC Connectivity Inline			
	Confirm Device Connectivity (Ping)		LinkRunner Pro	
	Verify Actual Link Speed/Duplex			
CABLING	Certification	DTX & M12		
	Qualify Bandwidth (10/100/VoIP/1000)		CableIQ	
	Troubleshoot Performance Faults			
	Troubleshoot Wiremap Faults			MicroScanner^2
	Verify Location & Continuity			IntelliTone

Core Components of Network Segments

Network maintenance tackled from three distinct areas

Cabling Infrastructure

- Copper and fiber cabling
- Certification and troubleshooting
- Communication networks testing

Electrical Signaling

- **Physical layer measurements**
- **Disturbances, noise & anomalies**

Network Communications

Portable handheld LAN and WAN test and solutions

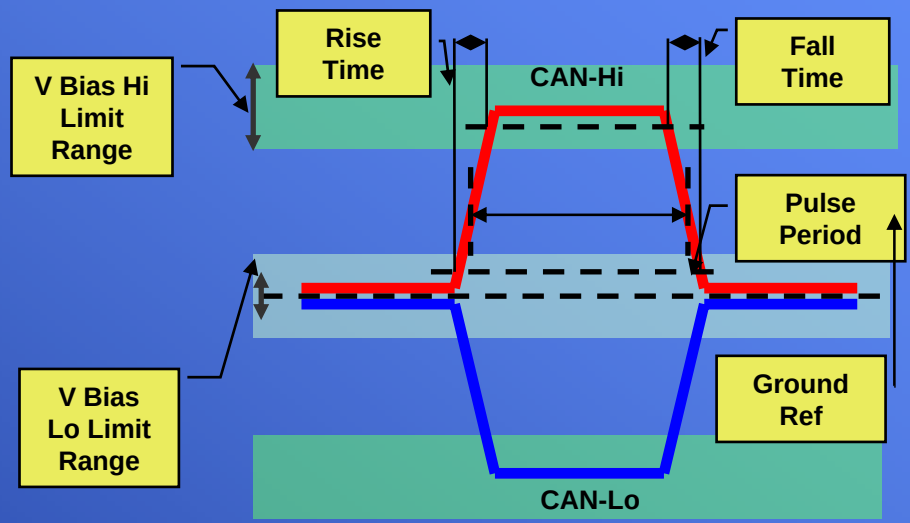
Proper cabling + good signaling + error free network communications = healthy network

Verifying Integrity of Network Signaling

Critical parameters

- Measuring critical parameters of a waveform can tell the experienced user a lot about the state of the network segment

- Attenuation
  - Cable impedance issues
  - Terminations – too few or too many
- DC power levels
  - State of power supplies
  - Segment loading
- Disturbances or anomalies
  - Interference from plant equipment or environment



So what is good or what is bad?

Fluke 225C and 215C

High performance portable rugged oscilloscope for troubleshooting industrial, electrical, electro-mechanical and electronic equipment.

215C & 225C adds measurement algorithms to verify the physical layer electrical parameters of industrial bus systems

- CAN-bus
- AS-i bus
- Profibus DP
- Profibus PA
- Foundation Fieldbus (H1)
- MOD-bus (RS232 & RS485)
- Ethernet 10Base2 (coax)
- Ethernet 10BaseT (UTP)
- Ethernet 100BaseT (UTP)
- RS232 (generic)
- RS-485 (generic)

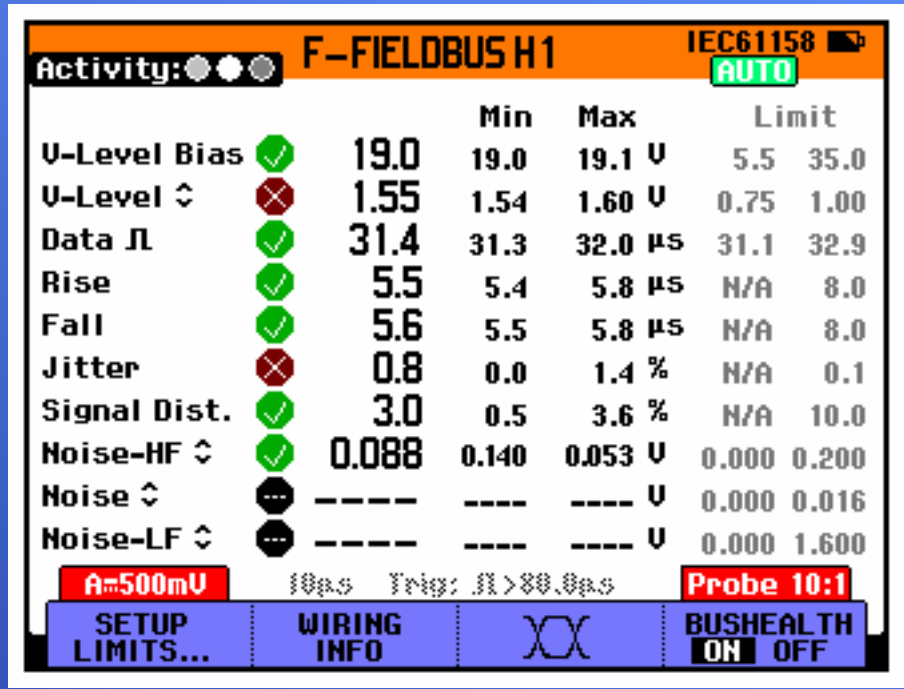
Determine Health of Network Bus

ScopeMeter 215C, 225C or 125 Bus Health test application

- Measure critical network signal parameters
- Get clear good, weak or bad indicators

Don't guess what is good or what is bad?

Bus Health measurements eliminate the trial and error!



Fluke 215C & 225C Features & Benefits

ScopeMeter 215C and 225C with Bus Health offers several key features to verify signal integrity

1. Network connection diagrams
   - *Multiple networks complicate test connections*
2. Multiple network standards
   - *Single test tool covers multiple network standards*
3. Bus physical layer measurements
   - *Go/no-go indicators eliminate complicated waveform analysis or interpretation*
4. Eye pattern – waveform analysis
   - *Capture waveform disturbances and anomalies to correlate to external factors*
5. Differential inputs
   - *A grounded scope input will short differential network signals to earth ground*

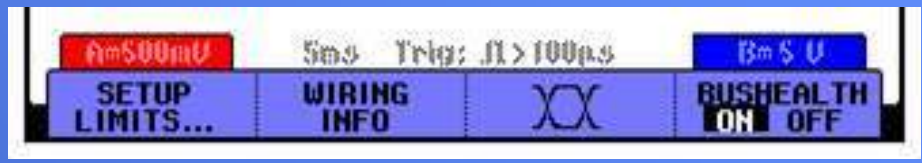
Network Connection Diagrams

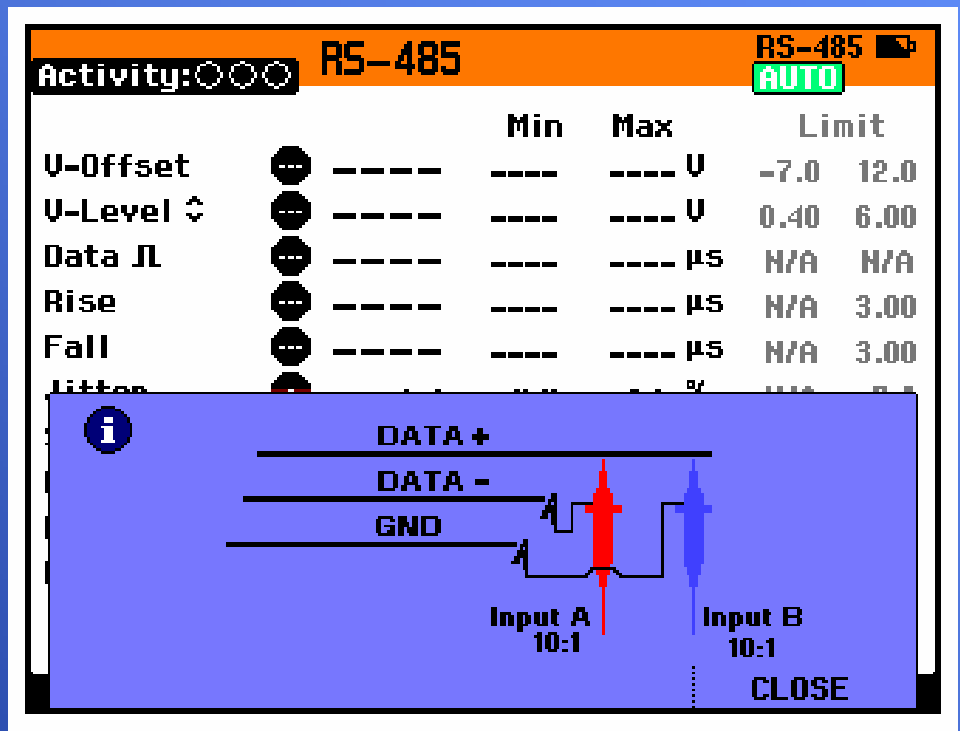
Feature

- Graphical illustration of probe connections to network media
- Connection diagrams included for all network standards

Benefit

- Eliminate errors due to incorrect test connections
- No need to memorize or carry documentation for multiple network types





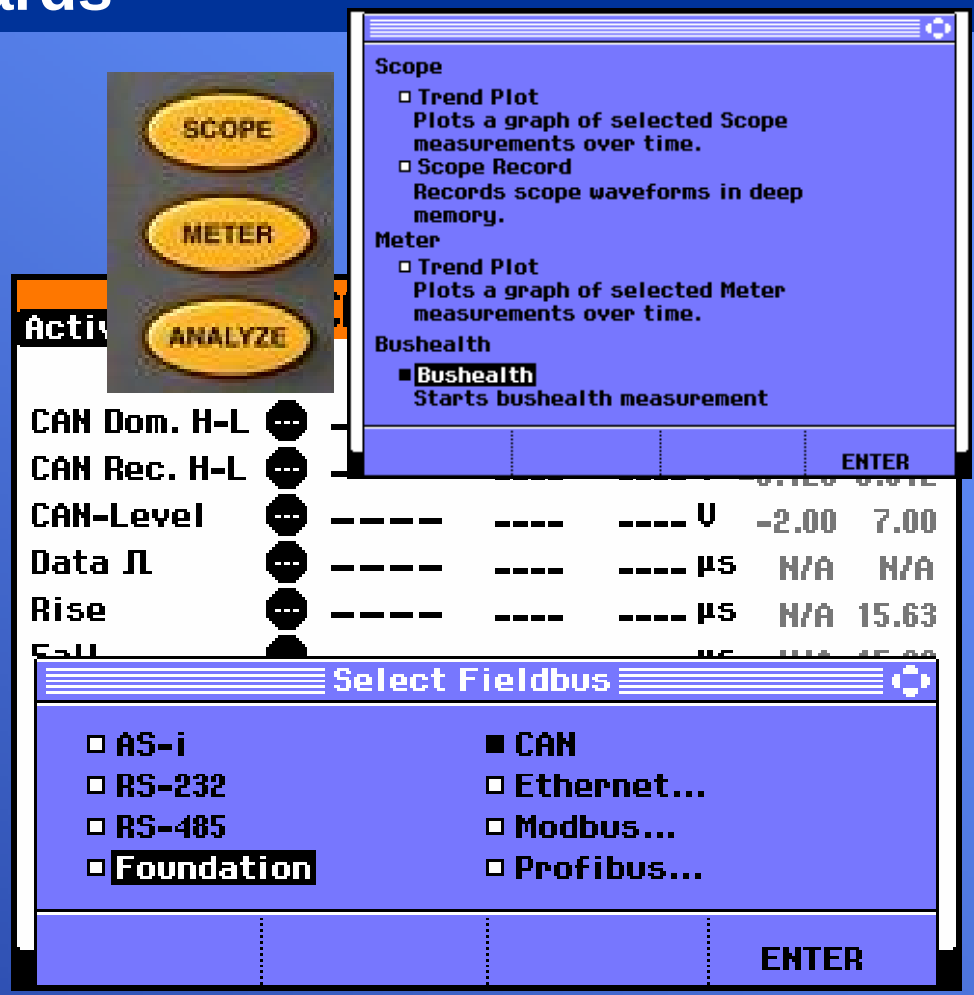
Multiple Network Standards

Feature

- Multiple Standards covering
  - Legacy
  - Serial
  - Differential
  - Ethernet TCP/IP

Benefit

- Single tool to test multiple network standards
- Common user interface and measurement parameters
- Reduce cost



Bus Health Physical Layer Measurements

Feature

- Automatic measurements of critical parameters
  - ✓ Digital activity
  - ✓ DC power levels
  - ✓ Amplitude levels
  - ✓ Data rates
  - ✓ Distortion or jitter
- Compare to industry standard

Benefit

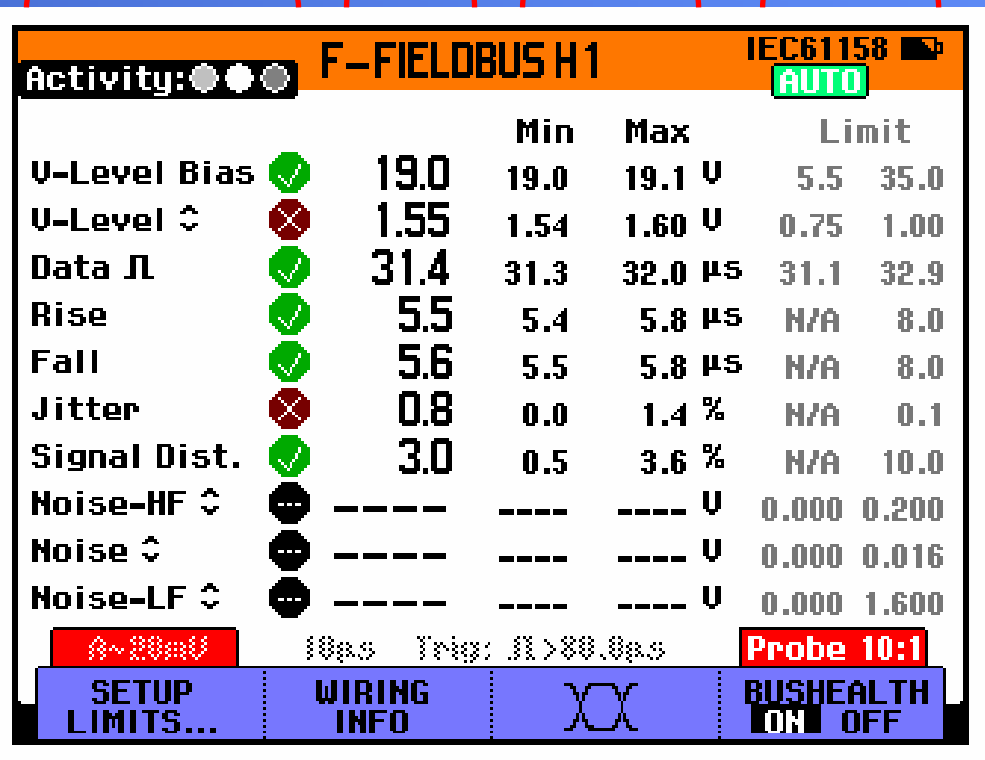
- Easily quantify critical signal parameters
- Eliminate complex signal analysis
- Clear good, weak or bad indicators eliminate guesswork

Parameter Status Indicator

Current Value

Min Max Values

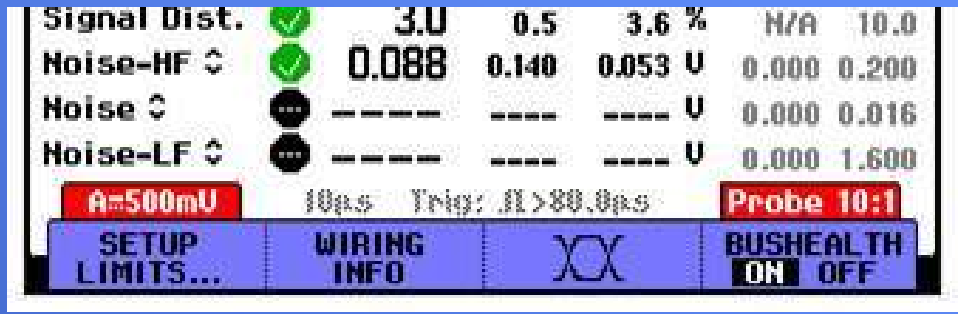
Industry limits



Noise Measurements

Feature

- Bus noise-level measurements
- Noise measurements in three bands, filtered by either HF or LF filters
- Available on bus systems with noise specification standard
  - Foundation Fieldbus and Profibus PA



Benefit

- Quantify level of induced noise caused by industrial heavy duty electrical machinery
- Isolate noise sources

Eye Pattern – Waveform Analysis

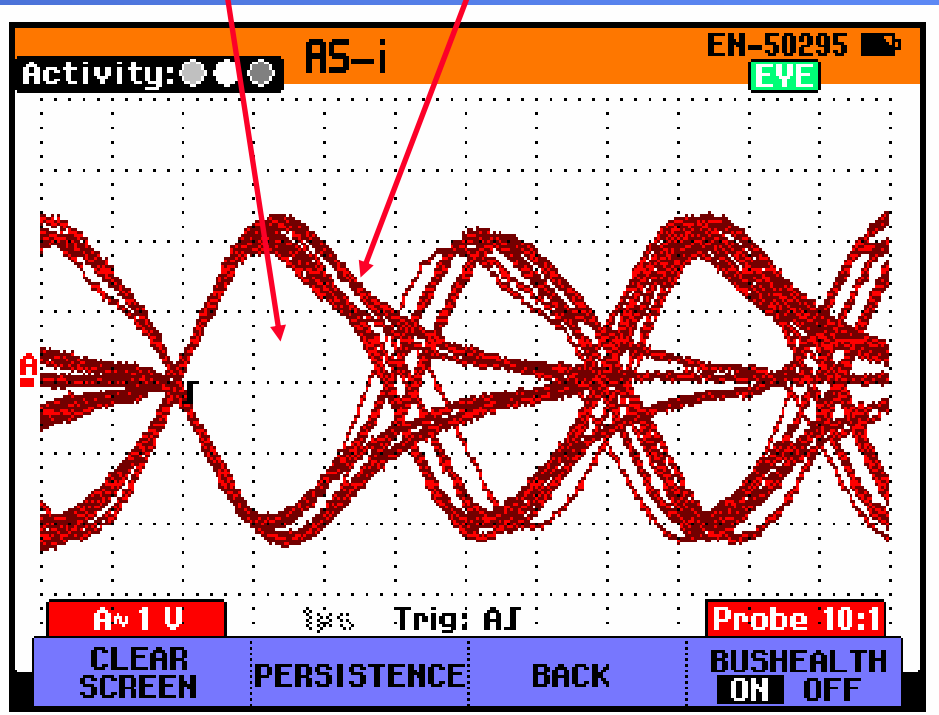
Feature

- Auto-capture successive waveforms to display eye diagram
- Obtain historic waveform perspective

Benefit

- See extent of distortion or disturbances
- Capture random waveform anomalies

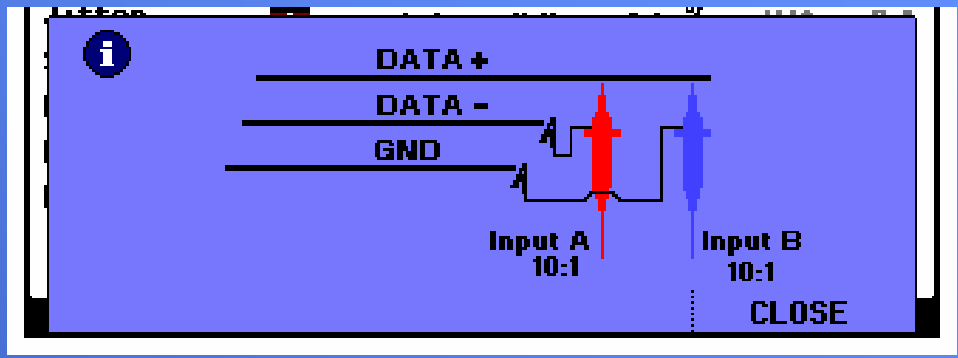
A clear “eye” and crisp thin waveform indicates distortion and disturbance free signal



Differential Inputs

Feature

- Two isolated scope inputs
- Differential inputs



Benefit

- Isolated scope inputs allow two measurements at different voltage reference levels
- Several Industrial network signals are differential, isolated inputs make measurements possible without shorting/ bringing network signal down to earth ground

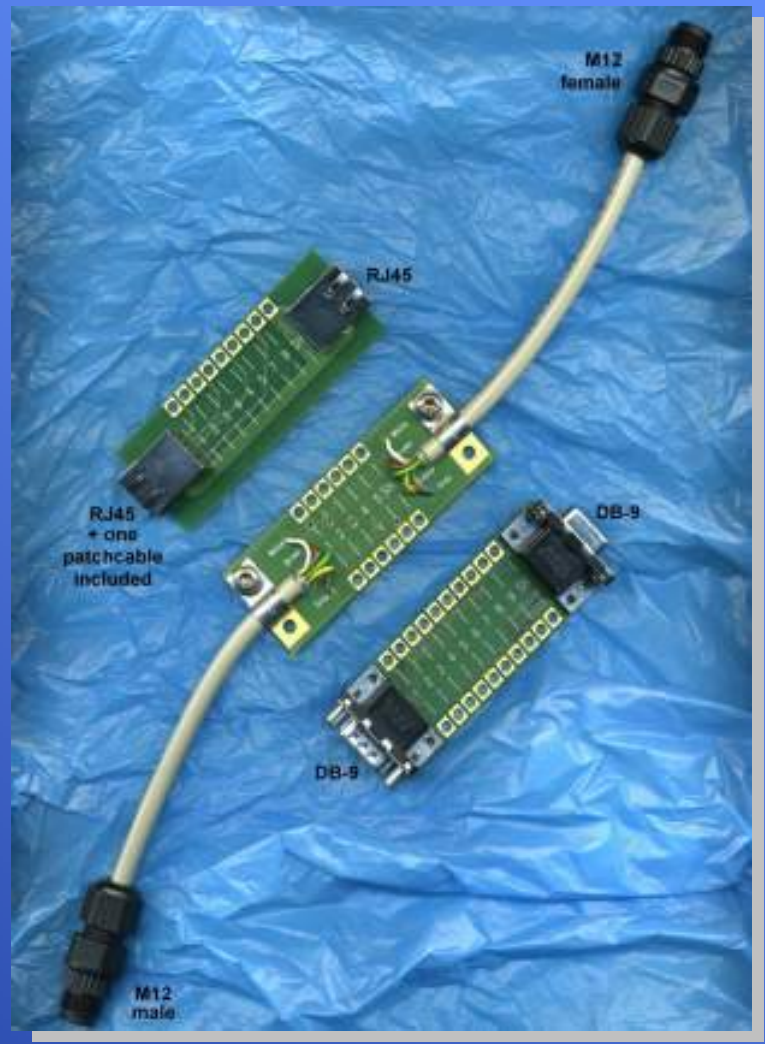
BHT190 – Break-Out Adapter Kit

Feature

- Break-out adapters for popular network terminations
  - RJ-45
  - DB-9
  - M12
- Break-outs included with 215C & 225C
- Available as accessory

Benefit

- Simplify probing onto popular network termination connectors



Positioning Fluke 125, 215C or 225C

	125	215C	225C
Display	Monochrome	Color	
Inputs	2 Scope & Dual DMM	2 Scope & DMM	
Bandwidth	40 MHz	100 MHz	200 MHz
Sample Rate	25 MSa/s Real time, 5 GSa/s Equivelent time	1 GSa/s	2.5 GSa.s
Bus Health	●	●	●
Bus Health with Noise Measurements	-	●	●
Bus Health Connection Diagrams	-	●	●
TrendPlot ™	●	●	●
ScopeRecord ™	-	●	●
100 Screen Replay	-	●	●
Battery	7 Hr NiMH	4 hr NiMH	
Isolated Inputs	No	CATII 1000V, CATIII 600V	
Safety Rating	CATIII 600V	CATII 1000V, CATIII 600V	

Designed For	Electrical and electro-mechanical systems & industrial bus diagnostics	Electrical, electro-mechanical and electronic troubleshooting, waveform analysis and bus health analysis and troubleshooting

Active Industrial Ethernet Part Numbers

Model Number	PN	Description	
Networking			
ES2-PRO-SX/I-KIT-IE	3340803	EtherScope 2 LAN WLAN ITO Kit Industrial Ethernet	
ES2-LAN-SX-IE	3340790	EtherScope 2 LAN Industrial Ethernet	
LRPRO-1000-IE	3336925	LinkRunner Pro Industrial Ethernet	
Cabling Infrastructure			
DTX-1800-IE	3336916	DTX-1800 CableAnalyzer Industrial Ethernet	
CIQ-GSV-IE	3354552	CableIQ Gigabit Service Kit Industrial Ethernet	
CIQ-KIT-IE	3336902	CableIQ	
MS2-KIT-IE	3336893	MicroScanner^2 Industrial Ethernet	
OP-xxx	varies	OptiFiber Kits – model/part numbers vary by kit configuration; this product must drop ship to end user	
FTK1450- IE	3336893	SimpliFiber Complete Verification Kit	
DTX-CHA021S	3311054	M12 Channel Adapters - set of 2	
DTX-CHA021	3311068	M12 Channel Adapter	
Electrical Analysis			
FLUKE-225C & FLUKE-225CS	3379655/ 3379727	Fluke 225 Scope Meter	
FLUKE-215C & FLUKE-215CS	3379526/ 3379598	Fluke 215 Scope Meter	
FLUKE-125 & FLUKE-125S	2838895/ 2838986	Fluke 125 Scope Meter	
FLUKE-771		Fluke 771 Clamp Meter	
Accessories			
M12PCP-IE	3347218	M12/ RJ45 PLUG PATCH CABLE MALE	
M12PCJ-IE	3347207	M12/RJ45 JACK PATCH CABLE FEMALE	
M12PC-IE	3347191	M12/M12 PATCH CORD	

Core Components of Network Segments

Network maintenance tackled from three distinct areas

Cabling Infrastructure

- Copper and fiber cabling
- Certification and troubleshooting
- Communication networks testing

Electrical Signaling

- Physical layer measurements
- Disturbances, noise & anomalies

Network Communications

Portable handheld LAN and WAN test and solutions

Proper cabling + good signaling + error free network communications = healthy network