SMART SOLUTIONS FOR SMART BUILDINGS

Application Note

The ongoing addition of previously disparate systems attaching to the IT network requires seamless delivery of simultaneous data and power over the same cabling. Each device's network and power requirements differ, making it critical for installers, integrators and network owners to understand the impact of certifying the cable at the onset and following up with ongoing management of the infrastructure for network continuity and reliability.

Prior to smart building systems, testing of the cable and connectivity was straight forward. Today "testing" includes assurance of all facets of the network including the real-world testing of active and passive components to verify appropriate bandwidth, power and distance.

THE **CABLING** INFRASTRUCTURE IS THE **FOUNDATION** OF A **SMART BUILDING**.

Guaranteeing optimal performance and scalability for today and tomorrow's applications that need to meet higher industry standards beyond initial certification is becoming increasingly complex.

AEM is the only solution provider who has developed purpose-built field test equipment to support a wide range of smart building technologies pervasive to today's modern network infrastructures. These test solutions provide not only copper and fiber certification of the underlying infrastructure cabling, but extend to testing various types of powering technologies, assurance of required link speeds, as well as network connectivity and operational details for both the wired and wireless network infrastructure.

The Changing Landscape

Today's IT networks are being pushed beyond meeting only certification limits based on previous data and telecom industry standards. Smart buildings are creating performance challenges due to increased power and transport demands placed on the installed cabling. It's more than just higher bandwidth and speeds for escalating data. Previous siloed building systems, such as HVAC and public safety are now operating on a common platform through the enterprise network. In addition, digital power, in the form of Power over Ethernet (PoE), is being delivered through twisted-pair copper (single-pair or four-pair), and DC voltage over hybrid powered fiber is gaining traction.

Both Information Technology (IT) and Operation Technology (OT) roles are merging as they need to work together to ensure the physical network infrastructure is capable of optimal system performance while providing headroom for attaching more devices moving forward.

Industry standards, such as the ANSI/TIA-1152-A specify specific test requirements that address field measurements and connectivity options. Today, system designers have to consider all elements that contribute to an efficient network to assure flexibility and scalability.

These emerging technologies are challenging network managers, as they need to continually monitor and verify the operational soundness of their cabling system to perform throughout the life of the cable plant.

Once the new components are installed and performance verified for all IP-enabled applications, the responsibility to maintain the network is turned over to the network manager or building owners to consistently monitor.

New Technologies, New Challenges

THERE IS **NO "ONE-SIZE-FITS-ALL"** WHEN IT COMES TO PLANNING THE INFRASTRUCTURE FOR A SMART BUILDING AS EACH SCENARIO AND INSTALLATION IS DIFFERENT.

Understanding the changing landscape means system designers, integrators, IT and OT personnel need to understand the emerging cabling technologies that address data, power, and link speed for each unique endpoint. These new technologies include emerging wired and wireless applications such as private 5G, Wifi, 5, 6 and 6E and multi-gigabit Ethernet. In addition, deploying new technologies on existing cable means additional tests are required which becomes part of both pre-qualification link assessment and as post deployment infrastructure management and troubleshooting.

POWER OVER ETHERNET (PoE)

Power over Ethernet is one of the biggest technology shifts for enabling smart buildings. It is the means in which many devices receive their power. Utilizing DC power has a huge impact on installation and operational cost savings. But there are different methods of delivery. The PoE type selected (Type 1 PoE, Type 2 PoE+, Type 3 & 4 PoE ++, Cisco's UpoE or SPoE) will be determined by the wattage, voltage and distance required by the powered device (PD) and the power source equipment (PSE).

PoE is designed to operate without interfering with data transmission. However, DC resistance unbalance between wires and wire-pairs can cause deterioration in data transmission performance particularly with high PoE current.

Matching the right cable type and connectivity for each technology and corresponding testing procedure will require careful evaluation.

Network cabling options can include single-pair or four-pair copper, fiber and or a hybrid cable. Four-pair cable is still the predominant specified media for horizontal runs but many low data, low power devices, such as sensors, are likely to soon em-ploy single-pair ethernet (SPE). Originating from the automotive industry because of its reduced weight and cost, SPE is now finding more uses in enterprise and industrial space. SPE is designed to support new use cases like interconnecting IoT, industrial ethernet (replacing Fieldbus), vehicle communications and long-distance end devices. SPE's advantages are clear: 75% fewer wires, less weight, reduced cost, lower complexity, a smaller footprint, up to 10x the distance, simpler to test, ability to supply power and easier installation.

HYBRID FIBER CABLE

Hybrid fiber cable is also an option for long distance applications, such as security cameras in parking lots. These cables extend far beyond traditional Ethernet limits, and can carry data and power under one jacket. This cable consists of two fibers to run the data while the power is transmitted over adjacent electrical copper conductors. AEM performs simultaneous measurement of single mode or multimode fiber along with testing the electrical voltage on the copper wires. DC loop resistance measurement

capability is also included to verify the integrity of the copper conductors of a hybrid powered fiber cable during install certification testing, as well as on-going management and troubleshooting.

Smart Solutions

AEM recognizes that the tester must provide a much broader scope of test function, in order to meet the challenges these more complex networks present. For cable contractors, system integrators and network managers, the only way to assure system reliability and scalability is to test, characterize and monitor complete end-to-end validation of the infrastructure's bandwidth, latency, packet drops and power over the life of the infrastructure. The key is to employ multifaceted test equipment capabilities that can not only certify, but also test the many technologies within Smart Buildings. From a twisted pair cable certification perspective, smart building infrastructures require running both the standard and optional test parameters as defined by ANSI/TIA-568 and ANSI/TIA 1152-A industry standard, which include DC Resistance Unbalance, TCL, and ELTCTL. AEM's TestPro can complete all measurements in 6 seconds, even including distance to fault for Return Loss, NEXT and Shield.

Additional measurements need to be made such as pre-qualifying the link's ability to support the PoE load, particularly for higher wattage needs such as digital lighting, as well as link speed testing with the link under both traffic and PoE load, at least up to 10GigE. This link-speed test under traffic and PoE load provides an SNR-based measurement of noise influence on the link while under operation and provides a real-world examination of the impact of crosstalk and noise on network performance. In doing so, AEM provides the best assurance possible that the link can support the intended applications, prior to the network devices being installed.

NETWORK MANAGERS

Network managers are challenged with a much broader set of testing and troubleshooting needs, that historically would require them to purchase three to four different types of testing solutions to meet their complete testing needs. These needs typically span network connectivity testing for both wired and wireless as well as fiber optic and the ability to get ANSI/TIA 1152.A standards-based field testing of the installed links. Purchasing multiple pieces of test equipment to cover all of these needs is cost prohibitive, and inefficient from a product knowledge and reporting standpoint.

Smart Testers for Smart Networks

Cable test equipment has long been segmented in the categories of verification, qualification (also referred to as validation), and certification. Certification testers are required for contractors to obtain manufacturers' cable warranties once installed. But after the contractor has turned over the cabling plant to the building owners, it's the network manager's responsibility to qualify real-world network connectivity and a deep dive into the applications to assure consistent network uptime. Due to an increased reliance on network-connected technologies in the enterprise for smart buildings, IT departments now require a cable test tool that fills the gap between network qualification and certification categories without breaking the bank.

AEM's innovative purpose-built solutions, supports all parties who have a stake in the success of the smart building network – cable contractors, systems integrators, and network managers.

With a modular based design, AEM testers provide insight into the entire cable infrastructure during installation, after installation and throughout the life of the network supporting both the wired and wireless infrastructure.

The TestPro CV100 - Multifunction Cable Certifier is designed for cable contractors and system integrators, and offers pre-configured smart building testing kits, warranty approved by cable manufacturers. The Network Service Assistant – a Multifunction Network Connectivity Tester is a cost-effective tester designed for the network manager, and offers Qualification+ testing.

**Note on MPTL Testing: To be Standards compliant for MPTL certification, all certifiers must use a Permanent Link adapter on one end and a Patch Cord adapter (same category as cable under test) on the other end. Any MPTL cable run may be tested with NSA, but this is a Qualification +/ Validation test, not certification

	TestPro CV100 Datacom Installer, System Integrator	**Network Service Assistant** Network Administrator, Network Support
ANSI/TIA 11520A Field Tester Standard Defines Pass/Fail Criteria for both Single-ended and Bi-directional testing.	Certification with Bi-directional Testing	Qualification+ with Unidirectional Testing
Length	✓	✓
Delay	✓	✓
DC Loop Resistance	✓	✓
Insertion Loss	✓	✓
Return Loss	✓	✓
NEXT	✓	✓
PSNEXT	✓	✓
ACR-F, PS-ACR-F	✓	✓
PSACRF	✓	✓
TCL	✓	✗
ELTCTL	✓	✗
DC Resistance Unbalance - in Pair & Pair to Pair	✓	Pair to Pair Only
Extended Capabilities		
CAT3, CAT5e, CAT6, CAT6A, CAT7, CAT8	✓	✗
CAT5e, CAT6, CAT6A	✓	✓
Approved by cable manufacturers installed link warranty programs	✓	✗
Network Compliance Assurance up to	40GigE	10GigE
Modular Plug Terminated Link (MPTL)	✓	✓**
TDR (Distance to fault, open/short/split, shield, Return Loss Locator, NEXT Locator	✓	✓
SNR based multi-gigabit link speed testing up to 10GigE	✓	✓
PoE qualification with RealPower load for 802.3 af/at/bt, UPoE	✓	✓
Save Infrastructure test results for .pdf reporting	✓	✓
Save Multi-gigabit, PoE, Network Connectivity results for .pdf reporting	✓	✓

	TestPro CV100 Datacom Installer, System Integrator	**Network Service Assistant** Network Administrator, Network Support
Extended Capabilities		
Wired Network Connectivity Discovery, Switch Detail, VLAN Detail, Traceroute, TCP Connect, Ping, etc.	✓	✓
Wireless Network Connectivity SSID Discover, Channel, Signal Strength/Roaming, Traceroute, Reachability, TCP Connect, Ping, etc.	✓	✓
Loopback Optical Loss for Singlemode and Multimode	✓	✓
Tier-1 Fiber Optic Certification for Singlemode and Multimode	✓	✗
Hybrid Powered Fiber Loop Resistance	✓	✗
Hybrid Powered Fiber DC Voltage	✓	✓

FREQUENTLY ASKED QUESTIONS

Why is qualification testing important to smart buildings?

The objective of qualification testing (also referred to as validation testing) is to confirm if an existing cable will be able to support the power and network requirements of a device or application while also providing enough headroom to support future devices. With so many new devices attaching to the data network, there is a deeper level of testing and visibility into the underlying cable infrastructure. No longer does traditional cable certification testing provide enough testing, that the network owner can be assured of infrastructure support for the many smart building technologies that will be deployed today, and in the future.

What is the main difference between the TestPro and Network Service Assistant?

The main difference is that TestPro performs bi-directional testing required by the latest TIA-568.2-D standards, whereas the NSA uses Certi-Lite, an ANSI/TIA-1152-A-based single ended test. Bi-directional is required for certification performed by installers and contractors, and required for cable manufacturer warranty programs. Single-ended testing is used by those responsible for maintaining the wired and wireless network, provide troubleshooting, as well as assurance that the cabling infrastructure meets industry teststandards. If a device is not working properly after the installer has certified that the cable plant meets all standards, the NSA can locate and pinpoint the issue – either with the cable or the device. A cost-effective tool for all network and IT managers and those responsible for managing daily uptime as well as moves, adds and changes (MACs).

If I am a cable contractor, would I use the NSA equipment?
No, if you are a cable contractor who is responsible for certifying the cable to bi-directional test standards and in compliance with cable manufacturer warranty programs, the TestPro CV100 would be the right test solution for you.

What methods and standards will address testing for *single-pair Ethernet*?
Field testing requirements for SPE will be specified in ANSI/TIA-5071 and AEM is very active in the development of this standard. The TestPro has been designed to be fully modular, and supports testing of SPE cabling today, by simply adding a test adapter. TestPro supports 63271.1, 63271.6 connector styles, as well as M12 and Tera. In March of 2022, TIA-568.5, *Balanced Single Twisted-pair Telecommunications Cabling and Components* Standard was published.

What's the purpose of DC resistance unbalance testing?
DC resistance unbalance testing becomes important to assure that the cabling can support PoE, specifically higher wattage PoE found in Types 3 and 4 PoE (60W and 90W at the PSE, respectively). If the pairs are tested and found in an "unbalanced" state, the amount of power required at the PD may not be achieved. Also, DC resistance testing can identify excessive heat on the cable, which could seriously degrade the cable performance and possibly create a fire hazard.

What are some critical factors for testing wireless connectivity?
It's important to be able to validate the end points to locate all available access points (APs) and their signal strength, as well as roaming signal strength, including testing the hand-off between APs while roaming a facility based on user-specified signal strength threshold. Additionally, both TestPro and NSA are capable of performing a multigigabit SNR-based testing of the physical link from the WAP back to the switch under load of both traffic and PoE to confirm the link is performing as expected.

Where is multi-gigabit Ethernet being deployed and what tests should be performed?
IEEE published the 802.3bz standards (2016) to define transmission of higher speed than 1 Gb/s and power for advanced Wi-Fi 5, 6 and 6E while using existing Category 5e and Category 6 cabling. Multi-gigabit link speed testing can be validated on the switch uplink for a signal-to-noise ratio (SNR) measurement and PoE under load. This will provide maximum throughput information and available headroom.

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About

AEM's Test and Measurement solutions are designed and developed by a team with more than four decades of experience designing solutions for customers in enterprise and automotive. Our solutions are also purpose-built for users across the lifecycle stages of the wiring and connectors be it the manufacturing and laboratory environment, during installation or daily network troubleshooting. The result is solutions with a highly accurate RF measurement system, and feature sets purpose-built for modern networking requirements, which have giving rise to disruptive innovations, including several industry firsts.

AEM's test and measurement solutions include the award winning TestPro Multifunction Cable Tester, Network Service Assistant, Mixed Mode Multi-Port Vector Network Analyzer, and the award winning WideOptix-SR4.

AEM is a global leader offering application specific intelligent system test and handling solutions for semiconductor and electronics companies serving advanced computing, 5G and AI markets.

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