Application Note

S Y S T E M S

Energy Efficient Ethernet Testing with Aukua MGA2510

Energy-Efficient Ethernet (EEE) is a set of enhancements to the twisted-pair and Ethernet standards that reduce power consumption during periods of low data activity. The intention is to reduce power consumption by the Ethernet PHYs by as much as 50% or more, while retaining full backward compatibility with existing Ethernet equipment. The IEEE 802.3az task force developed the standard, and the IEEE ratified the standard in September 2010.

It is well understood that average network utilization is typically well below 20%, varies greatly over the course of a day or week, and even at peak periods does not reach 100% utilization. This means that much of the time network links have no data being transmitted but yet they continue to transmit and consume full power. The basic idea behind EEE is that most communication link should reduce power consumption during these periods of low utilization. This is accomplished by putting transceivers into a low power mode during times when there is no data to transmit as illustrated in Figure 1.

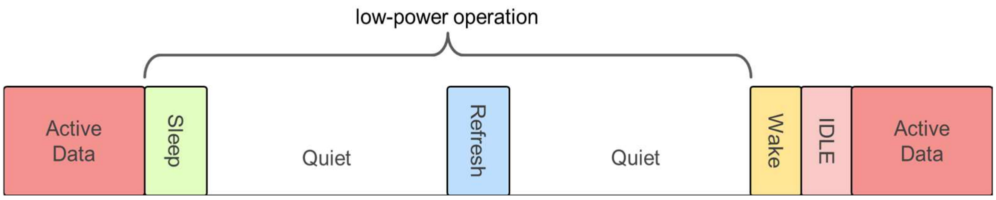

Figure 1: EEE low power operation while there is no data to send

EEE is a technology that can save cost by increasing energy efficiency and has become a fundamental requirement for copper Ethernet interfaces such as 1000BASE-T and 10GBASE-T going forward. In fact some government institutions have made EEE functionality a regulatory requirement. An example of this is the mandate by the California Energy Commission (CEC) for certain IT and communications products to support EEE functionality with more to follow.

However, this new and exciting capability raises a set of important questions starting with... **HOW DO YOU TEST YOUR DEVICE, APPLICATION or SOLUTION WHILE EEE IS ENABLED?** Most test equipment will not support EEE operation. So basic functional, integrity and performance testing as well as latency characterization for example cannot be accomplished in the presence of a EEE enabled system under test.

Fortunately, the Aukua MGA2510 has the capability to help verify EEE functionality, troubleshoot EEE issues, and also allow you to directly test system reliability, interoperability and application performance while EEE is enabled and active. If EEE support is claimed, it is fundamentally imperative this is tested and verified while EEE is enabled and active.

In the following, example applications are highlighted where the Aukua MGA2510 can uniquely help you test your device or system over Ethernet links supporting this new EEE functionality.

Application Note

EEE Testing with AukuaMGA2510

The Aukua MGA2510 is the first Ethernet test system to support operation over an active EEE link. Support includes 1G, 2.5G, 5GBASE-T and 10GBASE-T rates. There are three main deployment scenarios supported with the Aukua MGA2510 which are relevant to testing with EEE. These include:

1. Standard traffic generation towards a device or system while EEE capability is active
2. Inline Analyzer deployed transparently between two systems while EEE capability is active
3. Traffic generation towards the "System" or "Host" side interface of a PHY (e.g., MAC to PHY interface)

We will now highlight each of these deployment scenarios.

1. Standard Traffic Generation with EEE Active Link

This first deployment scenario provides comprehensive testing and characterization of a system or device while EEE is enabled and active. Example applications include BER Testing for system integrity validation, throughput performance verification, functional testing including with negative scenarios, as well as precise latency characterization, all directly over EEE enabled links.

In addition to the above system level testing, it is possible to verify specific EEE functionality. For example, using the MGA2510 Traffic Generator's traffic burst control features and Low Power Idle (LPI) status indicators, it is possible to verify a link transitions between wake and sleep states as it should and without packet loss or corruption. The importance of this test cannot be understated. This capability allows the user to easily test boundary cases and verify system integrity, reliability and without generating unacceptable latency.

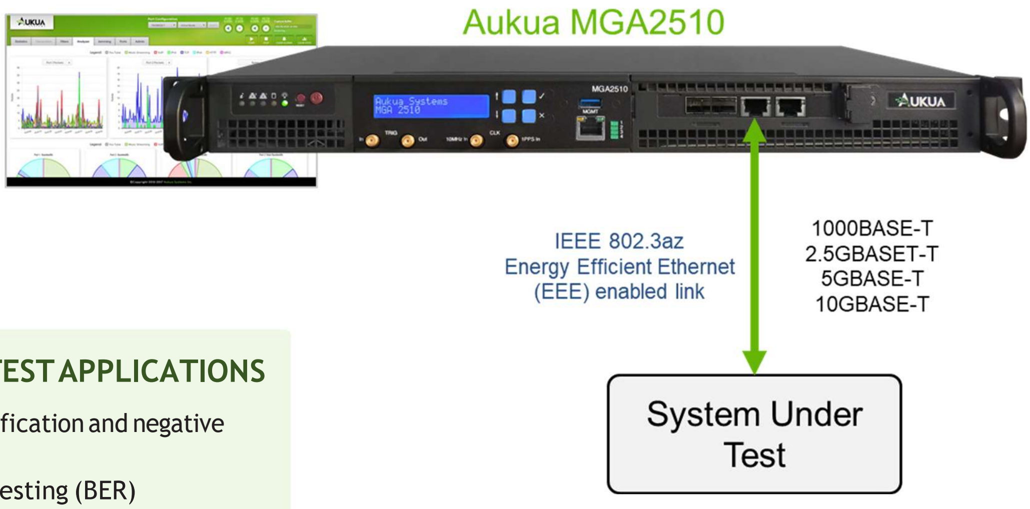

Figure 2: Aukua MGA2510 for EEE traffic generation

SUPPORTED EEE TEST APPLICATIONS

- EEE functional verification and negative testing
- System integrity testing (BER)
- Latency characterization (+/-1ns)
- Throughput performance
- Application performance

2. Inline Analyzer and Network Impairment Emulator over EEE Active Link

The next deployment scenario uses the Aukua MGA2510 as an Inline Analyzer for troubleshooting, visibility, or for capturing PCS layer or Layer 2 packet data for advanced timing and protocol analysis.

In this case the MGA2510 sits transparently between two systems or devices under test or evaluation. Traffic flows between the two systems bidirectionally while the links both actively support EEE operation. With this setup system-level traffic issues or hard to find intermittent issues caused by EEE operation can now be captured and analyzed for the first time with an accurate and repeatable methodology.

In addition to the above, real-world and negative scenarios can be thoroughly tested directly over a communications system supporting EEE operation. Examples applications for this include the ability to insert impairments such as FCS errors, link flapping scenarios or application performance testing against a variety of delays and bandwidth limited cases.

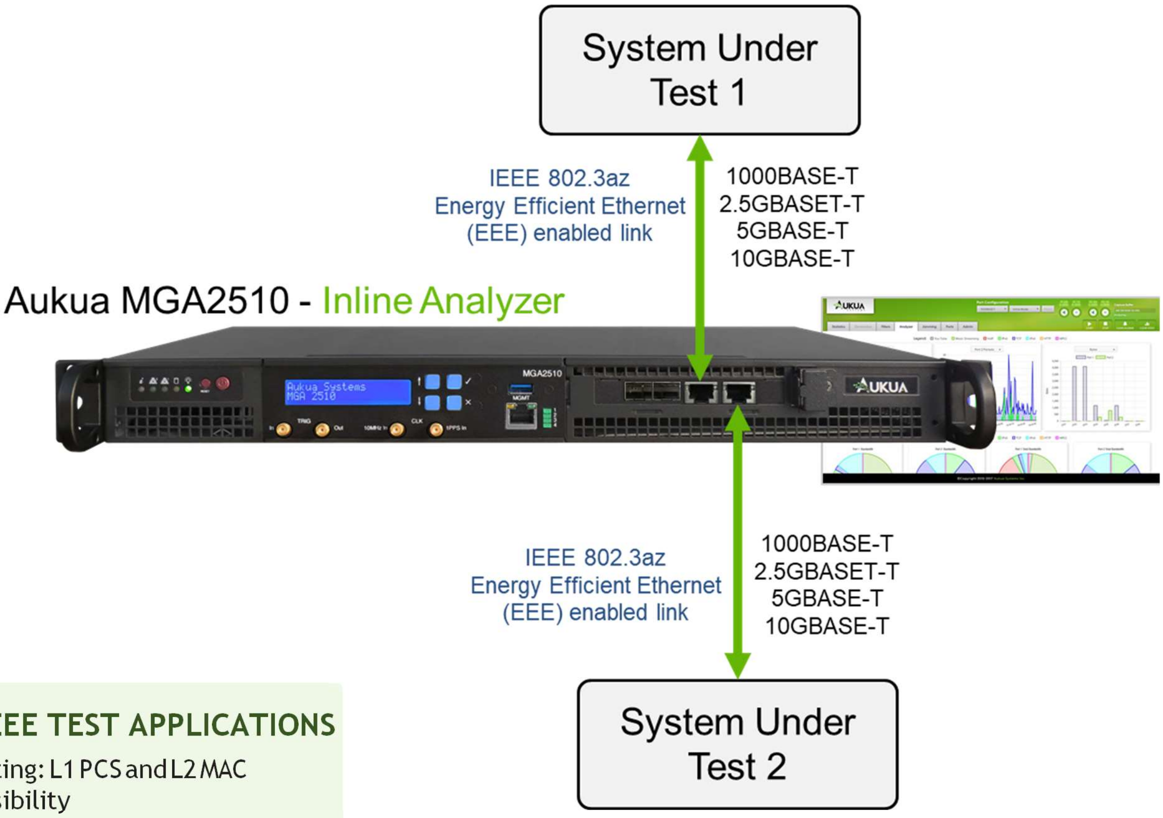

Figure 3: Aukua MGA2510 for inline visibility and troubleshoong

SUPPORTED EEE TEST APPLICATIONS

- Troubleshooting: L1 PCS and L2 MAC Capture & Visibility
- EEE functional verfication testing
- Negative testing
- Real-world application performance testing over EEE links with delays and impairments

3. Traffic Generation Towards a PHY's System/Host Interface with EEE Active

This final deployment scenario is an advanced use-case of primary interest to semiconductor companies developing PHY or Controller products or hardware engineers evaluating PHY/controllers for integration into networking equipment systems such as a switch.

Leveraging two Aukua MGA2510 systems it is possible to connect to a PHY's "Host" or "System" side interface with EEE capability enabled. It is then possible to conduct functional testing of EEE or to capture L1 PCS data or L2 MAC frames for detailed troubleshooting and analysis purposes.

In the figure below the Aukua MGA2510 labeled "A" is configured as a Traffic Generator and acts as the source of traffic. A second MGA2510 labled "B" is configured as an Inline Analyzer and passes all traffic between it's Port 1 and Port 2 acting as a converter between BASE-T and a "Host" or "System" interface (e.g., 1000BASE-X, 2500BASE-X, 10GBASE-R, etc.). The link between MGA2510 "A" and MGA2510 "B" (green link) operates at one of the supported copper BASE-T rates and has EEE capability enabled. The link between Port 2 of MGA2510 "B" is connected to the "Host" or "System" side interface of a PHY/Controller under test or evaluation (red link). This link operates as a System interface carrying Low Power Idle codewords (LPIs) generated from MGA2510 "B" toward the PHY in the device under test.

The configuration described above and illustrated in Figure 4 provides the most comprehensive testing, visibility and troubleshooting capabilities possible over EEE enabled links.

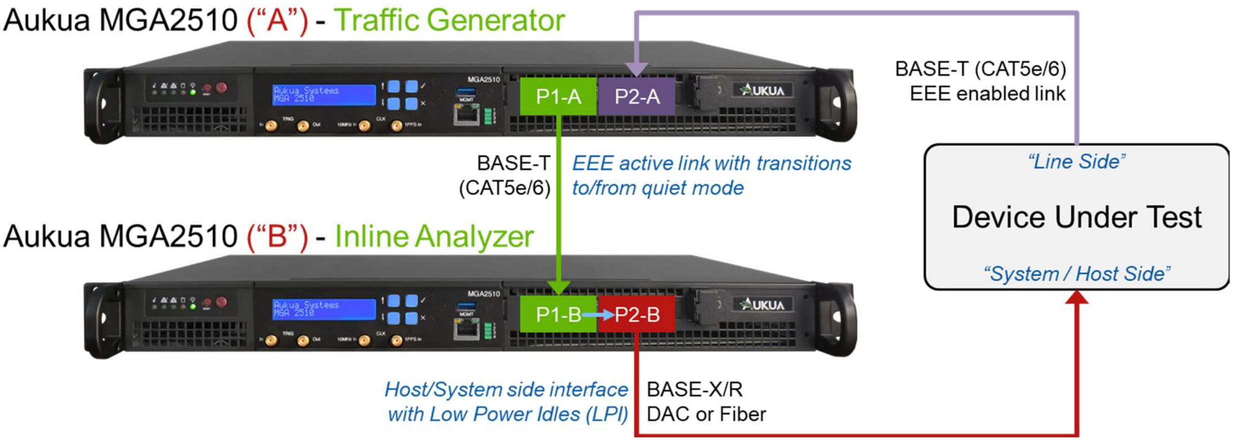

Figure 4: Aukua MGA2510 for "host-side" testing of a PHY and inline capture and visibilty

Traffic Flow Summary:

- P1-A generates traffic toward P1-B with a bandwidth profile that causes EEE transitions in/out of quiet mode
- P2-B generates LPIs based on P1-B ingress being in quiet or active state
- DUT "Host" port receives traffic + LPIs from P2-B
- DUT "Line" port passes traffic toward P2-A for analysis
- Optionally traffic can flow in reverse direction simultaneously (P2-A through DUT and back to P1-A)

SUPPORTED EEE TEST APPLICATIONS

- EEE functional and negative testing
- Troubleshooting: L1 PCS and L2 MAC Capture & Visibility
- System integrity testing (BER)
- 1-way latency characterization (+/-1ns)
- Throughput performance
- Real-world application performance