Assessing Low Power Transmitters with the PhyView Analyzer

Applicable Devices

This application note involves testing of 10/100/1000 transceivers and LAN ports that often advertise low power consumption with or without the use of Energy Efficient Ethernet (EEE). Typically, this means that power savings are realized by reducing the 1000Base-T transmit power in one of several ways:

1. **Method #1**: Fixed reduction of power below Clause 40 minimum requirement.
2. **Method #2**: Adjusting 1000Base-T transmit power based on measurement of incoming (receiver) power where higher incoming power is interpreted as shorter link length.
3. **Method #3**: Adjusting 1000Base-T transmit power based on a more direct assessment of physical link length such as a cable diagnostic or echo canceller could produce.

After the Test Signals are Turned Off

As anyone familiar with 1000Base-T conformance testing is aware, the majority of that testing relies on the production of standardized test signals by a transceiver. When producing test signals, transceivers are configured to a non-operational state and signals are then analyzed using high speed oscilloscopes, probes, and fixtures.

Nothing assures, however, that when the transceiver is returned to an operational state, it won't modify a transmitter characteristic such as 1000Base-T transmit level. Given that, it is conceivable that proprietary schemes to save transmit power during normal operation won't interfere at all with conformant performance when test signals are activated.

Considering each of the 3 methods introduced under **Applicable Devices** above:

Method #1 is very straight forward. Just reduce output power by some amount, for example 3dB, when in an operational state. This may put the transmit level below the 802.3 clause 40 low limit and save on power consumption when those transceivers are linked. One obvious drawback to this approach is the risk that a link partner may not get enough signal power to reliably maintain a 1000Base-T link over longer connection environments. Another drawback is that the magnitude of power reduction must be limited so potential additional power savings with a very short link are not realized.

Method #2 is a bit more complicated. A transceiver can deduce from the level of incoming power that the link length might be very short or very long. This enables the transceiver to apply a more aggressive transmit power reduction, for example 6dB, when it perceives a very short link length. Conversely, no power is saved with perceived long link lengths but the risk associated with Method #1 is avoided. The challenges with this method is that nothing is known about the link partner's transmit level. If it is set on the high side, it could trick this transceiver into thinking there is a shorter link length than actually exists. For that reason, this method cannot be highly resolved, that is, it may produce just a "short" and "long" distance power level.

Method #3 is also a bit more complicated. A transceiver might have ability to use echo cancellation or other transceiver resources to attempt to measure approximate link physical length. As with Method 2, this allows a more aggressive power savings on short cabling lengths between link partners while permitting full power when the link length is long. As it does not depend on an unknown such as link partner transmit level, it may be potentially more resolved and allow multiple transmit levels for say short, medium, and long length links. The risk associated with this method is that it likely depends on a resolvable impedance mismatch at the link partner interface with minimal mismatches and return loss from intermediate connections in the link. The combination of a well matched link partner and imperfect mid-link connections could trick this transceiver into underestimating the link length and then turning power down too low.

Recognizing and Characterizing Proprietary Low Power Strategies

The PhyView Analyzer, unlike traditional PHY conformance testing with scopes and fixtures, does not rely at all upon transceiver test signals produced in non-operational states of those devices. Instead, all transmission measurements including wideband transmit power, power spectral distortion (power vs frequency), SNR, return loss, and crosstalk are performed while linked at 1000Base-T with the port-under-test. That means that testing of transmission characteristics has the potential to recognize power saving strategies that are hidden to traditional conformance testing.

Key Point! Proprietary power saving strategies may be completely concealed during ordinary IEEE 802.3 transmitter conformance tests.

Two other PhyView Analyzer resources are critical to the task of characterizing the nature of the power saving strategy, that is, determining if the one of the three methods described under **Applicable Devices** is utilized. First, the **Line Loss** impairment that simulates worst case IEEE Clause 25 and Clause 40 insertion loss, can be connected to produce the effects of a maximum length link. While this resource is routinely used in automated receiver testing, it is also beneficial to this task. Second, the **Mismatch** impairment that is normally utilized in the calibration of Return Loss measurements is useful for simulating high return loss that a transceiver utilizing Method #3 would be sensitive to.

Within the fully automated **PHY Performance Test Suite*** for the PhyView Analyzer, the 1000Base-T transmission test includes a set of measurements to recognize and report on transceivers that demonstrate low transmit power levels while linked at 1000Base-T.

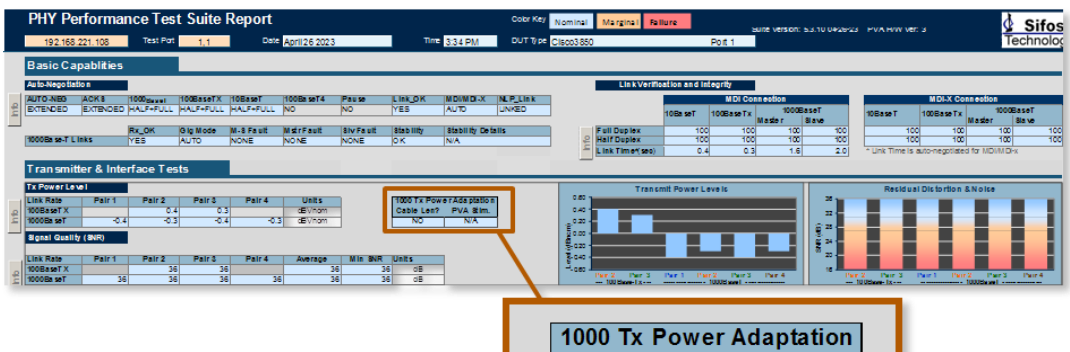
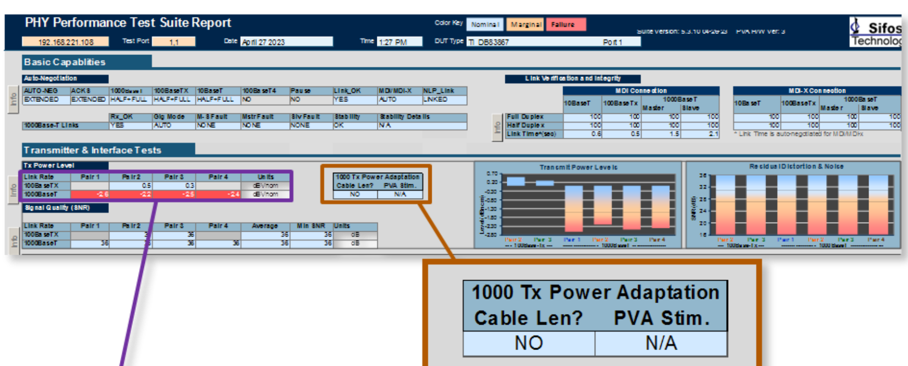


Figure 1. Specification Compliant 10/100/1000 Port

In Figure 1, a specification compliant 10/100/1000 port is tested. 1000Base-T power levels are below the nominal 0dB but are generally well within specifications.



Tx Power Level

Link Rate	Pair 1	Pair 2	Pair 3	Pair 4	Units
100BaseTX		0.5	0.3		dBVnom
1000BaseT	-2.6	-2.2	-2.5	-2.4	dBVnom

Figure 2. Low 1000Base-T Transmit Power with Method #1 (NO adjusting to link length)

In Figure 2, a port is tested that exhibits a fixed value of reduced 1000Base-T transmit power, roughly -2.5 dB. That low power output is not affected by perceived link length so the **1000 Tx Power Adaptation** reports "NO".

* Features described are supported under PSA Software Release version **5.3.03** and later.

In Figure 3, a port is tested that adjusts 1000Base-T transmit level based upon an assessment of incoming power level. Because the PVA test instrument is connected with a two meter patch cable, the incoming power level is perceived as high and therefore interpreted as a short link. 1000Base-T transmit power is reduced by 6dB from specification compliant levels. The **1000 Tx Power Adaptation** reports "YES" with the stimulating cause = "Rx_Level".

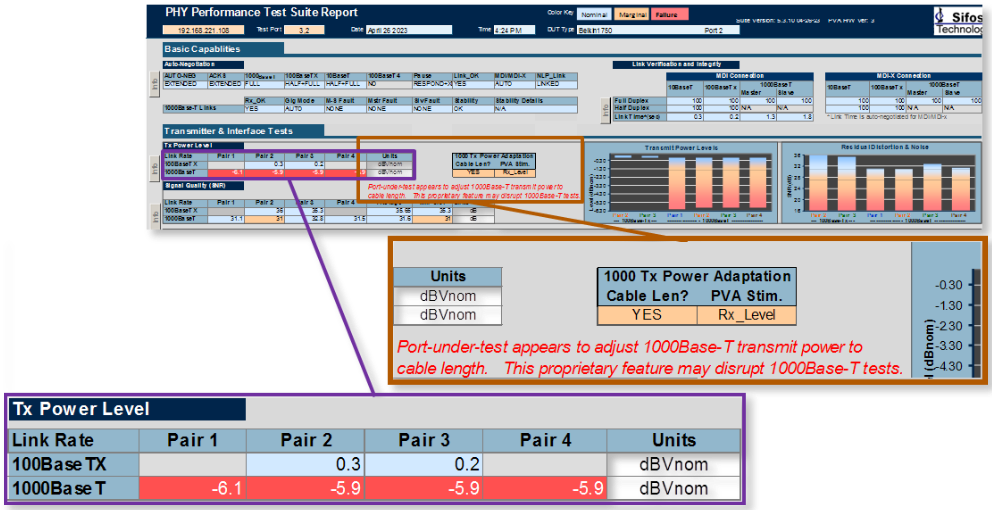


Figure 3. Low 1000Base-T Transmit Power with Method #2 (responding to high receive levels)

In Figure 4, another port that adjusts 1000Base-T transmit level is shown. This port utilizes Method #3 however, that is, a more direct measurement of link (cable) length. Again, because of the two meter patch cable connection, that length is very small and the transmit power is reduced 6 dB from specification compliant levels. The **1000 Tx Power Adaptation** reports "YES" with the stimulating cause = "Cable_Length".

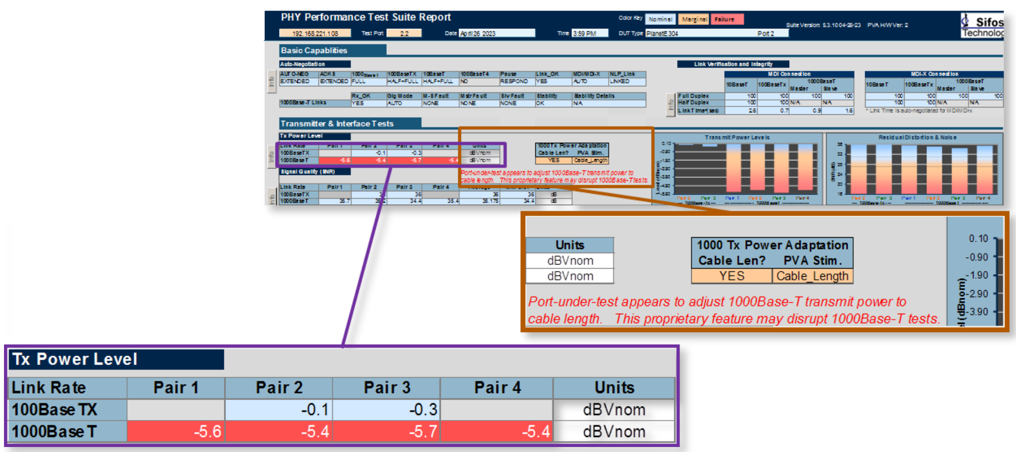


Figure 4. Low 1000Base-T Transmit Power with Method #3 (responding to cable length measurement)

Summary

This application note reveals another area of testing 10/100/1000Base-T ports where the PhyView Analyzer and the PHY Performance Test Suite uncovers transceiver behaviors that would be completely disguised to traditional IEEE 802.3 physical layer testing methods (scopes, fixtures, probes, and test signals). The very nature of the 1000Base-T test procedures opens the door for transceiver developers to test one way and operate a different way.

Transceivers and integrated switch IC's that advertise low power consumption may possibly be incorporating one of the features described in this application note. While there certainly could be benefits from these features, system developers would benefit from awareness and understanding these otherwise hidden behaviors.