Tektronix Test Methods of Implementation:

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Ethernet 1000BaseT PHY

In mid-1999, IEEE standardized the implementation of Gigabit Ethernet over copper wire. Popularly known as 1000BaseT, it offers 1000 Mbps raw bandwidth and yet is compatible with existing technologies like Ethernet (10BaseT) or Fast Ethernet (100baseT).

The IEEE802.3ab standard delineates several stringent PHY layer Transmitter Compliance Tests for 1000BaseT designs. These can be categorized as Core Tests, Special Tests and Advanced Tests. The Core Tests and Special Tests are defined as Basic Tests and are crucial for achieving validation.

1000BaseT Core Tests

Template Tests

The template tests are performed using a special Test Mode #1 signal (Fig.1) generated by the PHY. This signal is designed to achieve several objectives:

- Test whether the signal has enough energy to drive 100m distance up to the receiver (Peak Voltage and Template Test)
- Ensure the rise times are good enough to carry high speed transactions but do not cause excessive radiated emissions (Template Test)
- Test for symmetrical behavior of signals (Template Test)
- Provide an indication of insertion loss (Droop Test)

Fig. 1: Test Mode #1 signal

The Template tests are important as they predict behavior of the signal for the following aspects:

1. Adequate energy levels for effective transmission over long distances despite influence of noise, adjacent channels, and bi-directional transmission
2. EMI levels that are within acceptable limits by defining outer boundaries for rise times
3. Signals are symmetrical

The template tests are performed on the A, B, C, D, F and H points of the Test Mode #1 signal. These six template tests (Fig. 2), are performed using the following tools:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix AWG5012
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

Fig. 2: Six Template Tests

Peak Voltage and Level Accuracy Tests

The Peak Voltage and Level Accuracy Tests (Fig. 3) validate the amplitude levels. The peak voltages are measured around points A, B, C and D on the Test Mode #1 signal.

This test is performed using the following tools:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix AWG5002
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

Fig. 3: Peak Voltage and Level Accuracy Tests

Droop Tests

The Droop Test (Fig. 4) is performed on the G and J points of the Test Mode #1 signal. The test becomes more important as it can be an indicator of the insertion loss at the magnetics. Voltage levels at point G and J are measured against limits prescribed by the standards.

The droop tests are performed using the following tools:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix AWG5002
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

Fig. 4: Droop Test

Distortion

The distortion test is performed on the Test mode#4 signal defined by the standard. The test mode#4 signal transmits 2047 symbols repeatedly and the pattern has 17 specific levels. After normalization, the data is compared with an ideal waveform and the error is plotted. The peak error is the distortion and should be less than 10mV.

Depending on the implementation, the test may need access to the test clock TX_TCLK signal.

The distortion test is performed using the following tools:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix AWG5002
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

Fig. 5: Distortion Test with Error plot

MDI Return Loss

Return Loss test is an important indicator of the performance of a transmission system. The standard specifies the tolerance of the cabling system as 100Ω + 15%. Hence the return loss test should be performed over the 85Ω, 100Ω and 115Ω for conclusive performance validation.

The Return Loss test is performed using the following tools:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix AWG5002
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

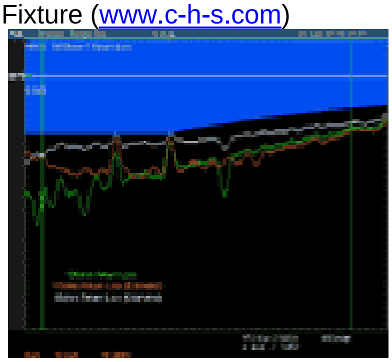

Fig. 6: Return Loss Test for 85/100/115Ω impedance

MDI Common mode Voltage test

The standard specifies the common mode voltage to be less than 50mV. Imbalance in the test circuitry may impact the test results. Hence, it is important to pay special attention to the test fixture.

The Common mode test is performed using:

- Tektronix DPO7254 Oscilloscope
- Tektronix P6247, P6248 High Frequency Differential Probes
- Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
- TF-GBE - Ethernet Test Fixture (www.c-h-s.com)

Master Jitter (Unfiltered and Filtered)

Low jitter at the transmitter is a good indicator of the health of the clock and power signals. The jitter tests help discover problems with the clocking system owing to noise (clock and power supply) and interconnect issues like track lengths.

For jitter tests, it is mandatory to have access to TX_TCLK and Jitter test channel as described in the standard. The special test channel simulates conditions of poor echo to test the integrity of the clock-recovering circuits

The jitter tests are done with the device under test (DUT) both in the Master and the Slave mode separately. The tests are a combination of clock jitter and data jitter. For measuring data jitter, the device is set to generate Test Mode 2 (master) and 3 (slave) signal (Fig. 5).

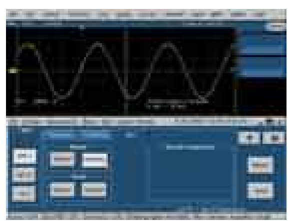

Fig. 7: Test Mode #2 signal

Unfiltered and filtered measurements are done in each mode of operation. These are multi-signal measurements and require access to the clock signals.

The jitter tests are performed using the following tools:

Tektronix DPO7254 Oscilloscope
IEEE Defined Cabling
Tektronix TDSET3 Ethernet Test Software (opt for DPO scope)
TF-GBE - Ethernet Test Fixture (www.c-h-s.com)