115.x Optical specification methodology (informative)

The modulation and equalization techniques of 1000BASE-H have not been used before for optical systems, although they are familiar in copper based communications. In many ways, 1000BASE-H is more like advanced Ethernet BASE-T PHYs than it is to previous Ethernet optical PHYs. Consequently, 1000BASE-RH has significant differences in its specification methodology from previous optical PHYs.

The PMD transmitter and PMD receiver parameters, as well as the methods used to measure them, have been developed considering that the PMD is connected to a 1000BASE-H PCS/PMA with its unique modulation and equalization.

The PMD transmit function specifications are defined as a translator between an electrical analog signal and an optical analog signal. THP is used as an equalization technique to compensate for the ISI produced by the channel response (PMD transmitter, POF and PMD receiver) and the 1000BASE-H THP signal takes values from a continuous uniform distribution (vs. a discrete set of values). Therefore, the number of optical levels at the MDI is much larger than the 1000BASE-H PAM16 initial modulation of the transmit path. Also, the cardinality of the set of light values is finally determined by the DAC resolution (which is implementation dependent). Thus the PMD specifications are for a translator between an electrical analog signal and an optical analog signal.

The 1000BASE-RH PMD receiver has to provide full "soft information" from the channel in such a way that the PCS is able to compensate ISI by digital equalization (THP) and correct errors by FEC. This is the only practical way for approaching the channel capacity in a high SNR regime channel (high spectral efficiency). High spectral efficiency is required for gigabit transmission over POF.

Eye pattern is a traditional component of Ethernet optical PMD specifications. It is not considered a valid specification for this PMD because of the bandwidth limitation caused by the PMD transmit functions and because the specific characteristics of the signal transmitted to the channel (PAM16 THP).

TDP (transmitter and dispersion penalty) is considered in the 1000BASE-RH specifications for a worst-case link budget (115.4.3), however TDP is not quantized as a separate parameter. A device meeting all the separate requirements of 115.4.1 provides a sufficient quality level to establish a Gigabit link under the sensitivity specifications and MPD. Receiver sensitivity is defined as the minimum value of AOP at TP3 for which a 1000BASE-RH PHY is able to establish a reliable link.

BER is not a valid specification for an analog PMD because of the characteristics cited above and the assumed testing of the PMD with the PCS and PMA. Thus BER is specified as a PHY requirement, not a PMD requirement (see 114.1.1).

The local PMD receiver is connected to a remote PMD transmitter through a POF fiber as indicated in 115.3.1. The wavelength specification for the PMD transmitter is provided and the physical medium (POF) can only produce a small

spectral filtering (to higher or to lower wavelengths, depending on the transmitter temperature). Therefore, the receiver photo-detector has to be sensitive to the same spectrum produced by the transmitter. This allows implementer flexibility with the responsivity profile of the photo-detector should in meeting the sensitivity specifications of Table 115-4.

Similarly, Max AOP injected at TP2 and max AOP permitted at TP3 are equal, as only attenuation can be produced by POF. Therefore, it is not considered necessary to include a damage threshold specification.

The optical measurements clause 115.5 does not contain a worst-case channel spec (115.4.3 is informative).

Worst-case channel is defined by:

- Worst-case bounds of transmitter characteristics (115.4.1)

- MPD lower bounds at TP3 (115.5.9)

- Minimum AOP (sensitivity) at TP3 (115.4.2)

- The A4a.2 POF cable specifications (115.8)

Maximum transmitter noise is specified by the RIN magnitude, and dynamic response is specified by rise and fall times, harmonic distortion, extinction ratio, etc. MPD by EAF measurement method determines accurately the time-domain response of the optical communication channel. Minimum signal strength at TP3 is specified at Table 115-4.

Therefore, a complete communication channel (response and noise) is provided, although not including the specific implementation dependent receiver characteristics.

Back reflection specifications are not required for the 1000BASE-RH PMD. The ~650nm red Light Emitting Diode (LED) used by 1000BASE-RH does not have similar effects as do edge emitting lasers and VCSELs. Laboratory testing does not produce fluctuations of light spectrum and intensity from reflection.

Fundamental reasons for this:

- Wide spectrum (20nm) and random phase light generation (not coherent light).

- Low slope efficiency, low quantum efficiency, which causes that only a small portion of generated energy is injected into the fiber, hence a small portion of energy is reflected.

- Typical LED active area ~80um diameter (high current density is needed to speed up the device) injecting light into a 1mm POF (even with a larger coupling lens) results in even lower reflected energy.