



RX characteristics and link budget

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Introduction



- Simulations based on BASE-AU PCS, PMA and PMD have been carried out considering specific characteristics of GI-POF fiber and inline connections
- Characteristics are pessimistic compared with the ones reported at https://www.ieee802.org/3/dh/public/July_2022/Watanabe_3dh_02_2207.pdf
- Simulation results show that objectives can be met based on BASE-AU PCS, PMA and PMD, and RX characteristics and link budget are provided
- However, it is important to note that the data presented here is preliminary:
 - EMB data based on DMD test method has to be reported for GI-POF
 - multiple production samples and lots need to be considered for high confidence level
 - DMD testing has to be realized considering short distances (i.e. 15 meters) to avoid mode coupling effect
 - revision of IEC 60793-2-40 needs to be completed so that this specification supports the operation at targeted wavelength (e.g. 980nm)

Assumptions



- Operating range: 0.2 to 15 meters (simulation were carried out for 15 m)
- Nominal wavelength: 980 nm (PMD TX characteristics of .3cz)
- Cabled optical attenuation (max): 100 dB/km → 1.5 dB @15 m
- Cable attenuation aging: 1.0 dB (guessing that should be confirmed with measurements)
- Macro-bending loss (max): 0.2 dB (same of .3cz)
- Effective modal bandwidth (min): 200 MHz·km (-3 dBo) → electrical $BW_{-3dB} = 9.4$ GHz @15 m (Gaussian response assumed)
- Chromatic dispersion is negligible (based on reported data)
- Max insertion loss per inline connection: 2.5 dB (for all the data-rates)
- Total max connection insertion loss:
 - 5 dB for 25 Gb/s (due to max 2 inline connections)
 - 7.5 dB for 10 Gb/s and below (due to max 3 inline connections)
- Allocation for modal noise:
 - 0.4 dB for 25 and 10 Gb/s
 - 0.5 dB for 5 and 2.5 Gb/s

.3cz vs .3dh comparison

- -3 dB electrical bandwidth:
 - 40 meters OM3: 16.8 GHz
 - 15 meters GI-POF: 9.4 GHz
- RX sensitivity:
 - 25 Gb/s: **-11.2** dBm for 40 m OM3 vs **-10.2** dBm for 15 m GI-POF
 - 10 Gb/s: **-14.2** dBm for 40 m OM3, vs **-13.7** dBm for 15 m GI-POF
 - 5 Gb/s: **-16.0** dBm both
 - 2.5 Gb/s: **-18.0** dBm both
- Attenuation for 25 Gb/s:
 - OM3: 4 x 2 (connections) + 0.4 (aging) + 0.1 (40 m fiber) = **8.5** dB
 - GI-POF: 2 x 2.5 (connections) + 1.0 (aging) + 1.5 (15 m fiber) = **7.5** dB
- Attenuation for 10, 5, and 2.5 Gb/s:
 - OM3: 4 x 2.5 (connections) + 0.4 (aging) + 0.1 (40 m fiber) = **10.5** dB
 - GI-POF: 3 x 2.5 (connections) + 1.0 (aging) + 1.5 (15 m fiber) = **10.0** dB

RX characteristics



Table - BASE-PU PMD receiver optical characteristics

| Parameter | 2.5GBASE-PU | 5GBASE-PU | 10GBASE-PU | 25GBASE-PU | Units |
|--|---------------------|--------------------|--------------------|---------------------|-------|
| Signaling rate (range) | 2.65625 ±100 ppm | 5.3125 ±100 ppm | 10.625 ±100 ppm | 26.5625 ±100 ppm | Gbd |
| Modulation format | NRZ | | | | |
| Center wavelength (range) | 970 to 990 | | | | nm |
| Damage threshold ^a (max) | 4.9 | | | | dBm |
| Average receive power (max) | 3.9 | | | | dBm |
| Average receive power ^b (min) | -19.9 | -17.9 | -15.6 | -12.1 | dBm |
| Receive power (OMA _{outer}) (max) | 3.2 | | | | dBm |
| Receiver reflectance (max) | -12 | | | | dBm |
| Stressed receiver sensitivity ^c (OMA _{outer}), condition 1 (max) | -17.0 | -14.9 | -11.3 | -7.1 | dBm |
| Stressed receiver sensitivity ^d (OMA _{outer}), condition 2 (max) | -18.0 | -16.0 | -13.7 | -10.2 | dBm |
| Receiver sensitivity (OMA _{outer}) (max) | max (C, TDFOM + D) | | | | dBm |
| C | -18.0 | -16.0 | -13.7 | -10.2 | dBm |
| D | -18.0 | -15.9 | -13.3 | -9.6 | dBm |
| Conditions of stressed receiver sensitivity test ^e : | | | | | |
| Stressed TDFOM (STDFOM), condition 1 | 1.0 | 1.0 | 2.0 | 2.5 | dB |
| Stressed TDFOM (STDFOM), condition 2 | 0.0 | -0.1 | -0.4 | -0.6 | dB |

^aThe receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level. The receiver does not have to operate correctly at this input power.

^bAverage receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

^cMeasured with condition 1 conformance test signal at TP3 (see 166.7.10.2) for the BER specified in 166.1.

^dMeasured with condition 2 conformance test signal at TP3 (see 166.7.10.2) for the BER specified in 166.1.

^eThese test conditions are for measuring stressed receiver sensitivity for condition 1 and 2 respectively. They are not characteristics of the receiver.

Link power budget



Table – BASE-PU illustrative link power budget

| Parameter | 2.5GBASE-PU | 5GBASE-PU | 10GBASE-PU | 25GBASE-PU | Units |
|--|------------------|------------|-------------|------------|--------|
| Effective modal bandwidth at 980 nm ^a | 200 | | | | MHz·km |
| Power budget | 13.0 | 12.0 | 10.6 | 8.1 | dB |
| Operating distance (max) | 0.2 to 15 | | | | m |
| Channel insertion loss ^b (max) | 10.0 | | 7.5 | | dB |
| Channel insertion loss (min) | 0 | | | | dB |
| Allocation for penalties ^c | 0.7 | | 0.6 | | dB |
| Additional insertion loss allowed | 2.3 | 1.3 | 0.0 | | dB |

Footnote a:

Per A4j planned revision to IEC 60793-2-40, this is equivalent EMB at 15m with any compliant VCSEL with encircled flux measured per IEC 61280-1-4 (equivalent to EMB measured per IEC 60793-1-49, either at 980nm or with guidance from 850nm measurement analogous to IEC 60793-2-10)

Footnote b:

The channel insertion loss is calculated including aging using the maximum distance specified in Table XXX, cabled optical fiber attenuation of 100 dB/km at 980 nm plus an allocation for cable attenuation penalty and connection insertion loss given in XXX.

Footnote c:

Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

Table – BASE-PU total connection insertion loss

| Parameter | 2.5GBASE-AU | 5GBASE-AU | 10GBASE-AU | 25GBASE-AU | | Units |
|---------------------------------------|-------------|-----------|------------|------------|--|-------|
| Total connection insertion loss (max) | 7.5 | | 5.0 | | | dB |



Thank you