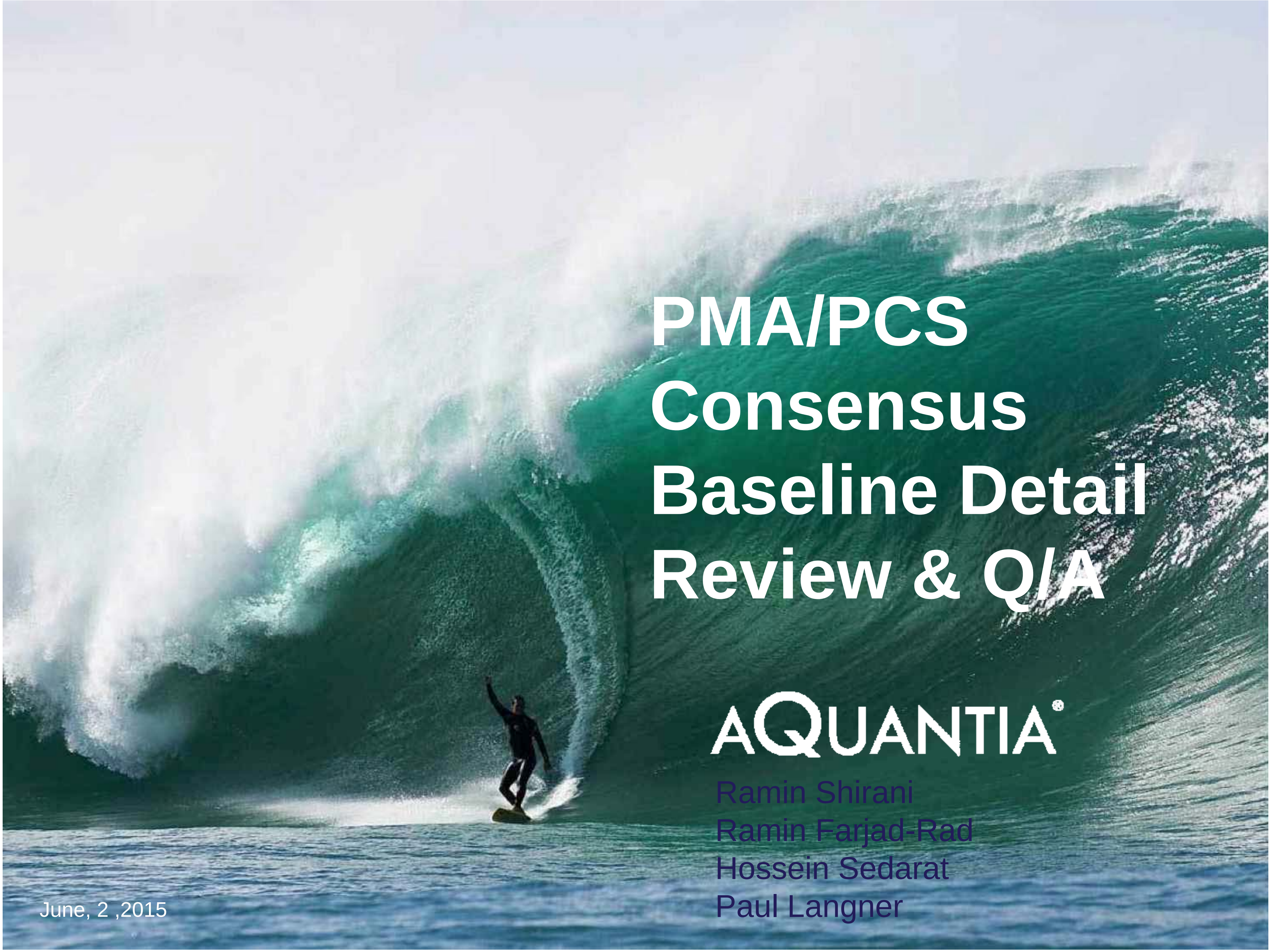

PMA/PCS Consensus Baseline Detail Review & Q/A

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PMA / PCS Detailed Specification

1.1 Physical Coding Sublayer

Both 5G and 2.5G utilize the following frame structure:

Figure 1: 2.5G/5G Frame

This frame consists of:

1. An auxiliary bit
2. 25 65B frames (as per 10GBASE-T). There is no CRC-8, for fully coded LDPC
3. 97 zeroes
4. 325 LDPC check bits, calculated over #1 - #3

For transmission, the 97 zeroes are replaced with user-defined random data, and at the receiver, this random data is discarded and replaced with zeroes prior to the LDPC frame decode. User-defined can be any pseudo noise pattern (with no spectral tone). The transmit mapping is shown in Figure 2, and the corresponding receive mapping is shown Figure 3.

Scrambling is done using 55.3.2.2.16 (the PCS scrambler in data mode) of 10GBASE-T, and operates on the 1625 payload bits within an 2.5G/5G frame.

Transmit Mapping

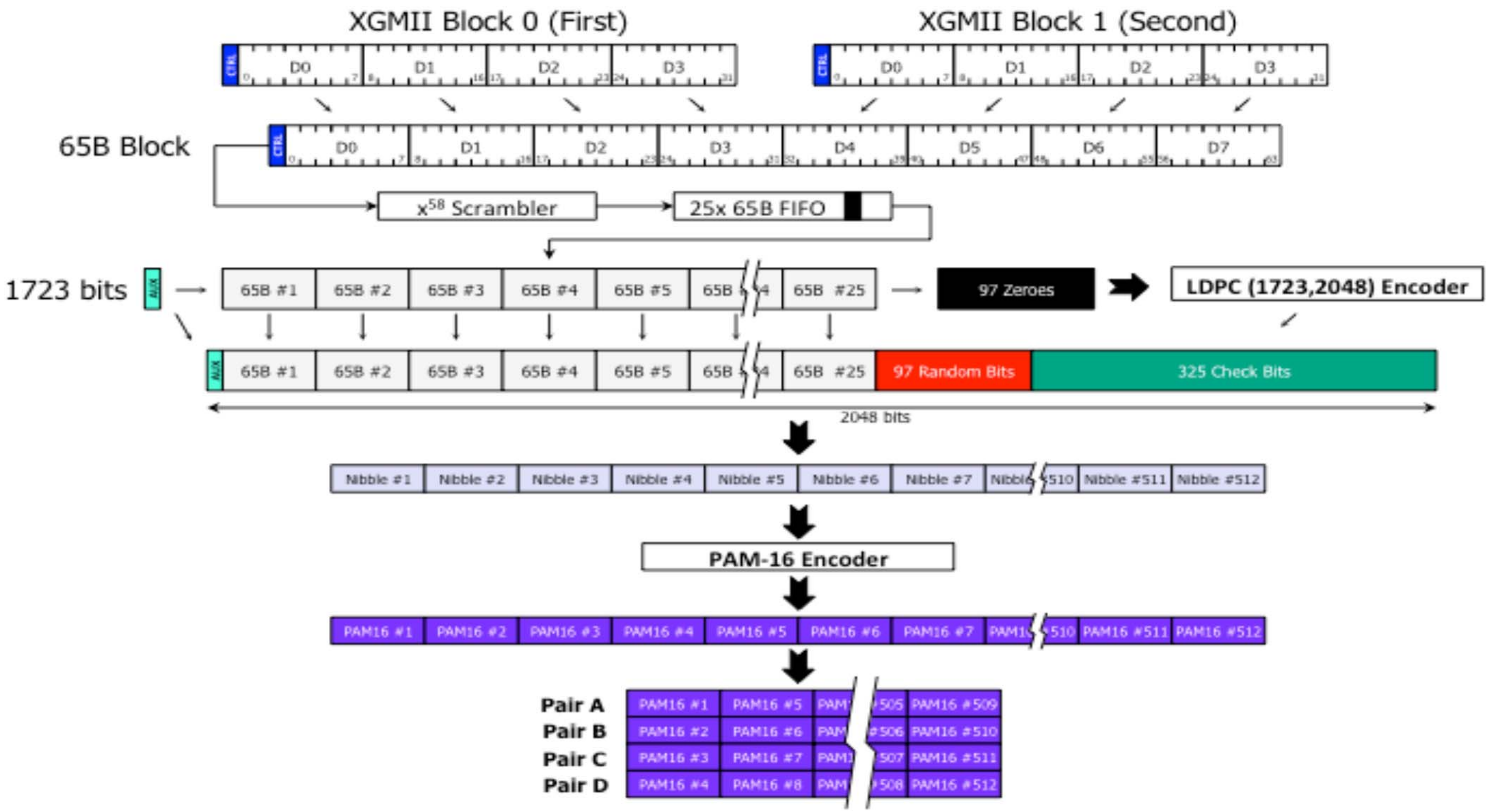


Figure 2: 2.5G/5G Transmit Mapping

1.2 Transmission

PAM-16 symbols are transmitted in order commutated across the four pairs in the Ethernet cable. The first symbol is sent on Pair A, the second on Pair B, etc. The effective data rate on each pair is 1.25 Gb/s and 625 Mb/s for 5G and 2.5G respectively.

Receive Mapping

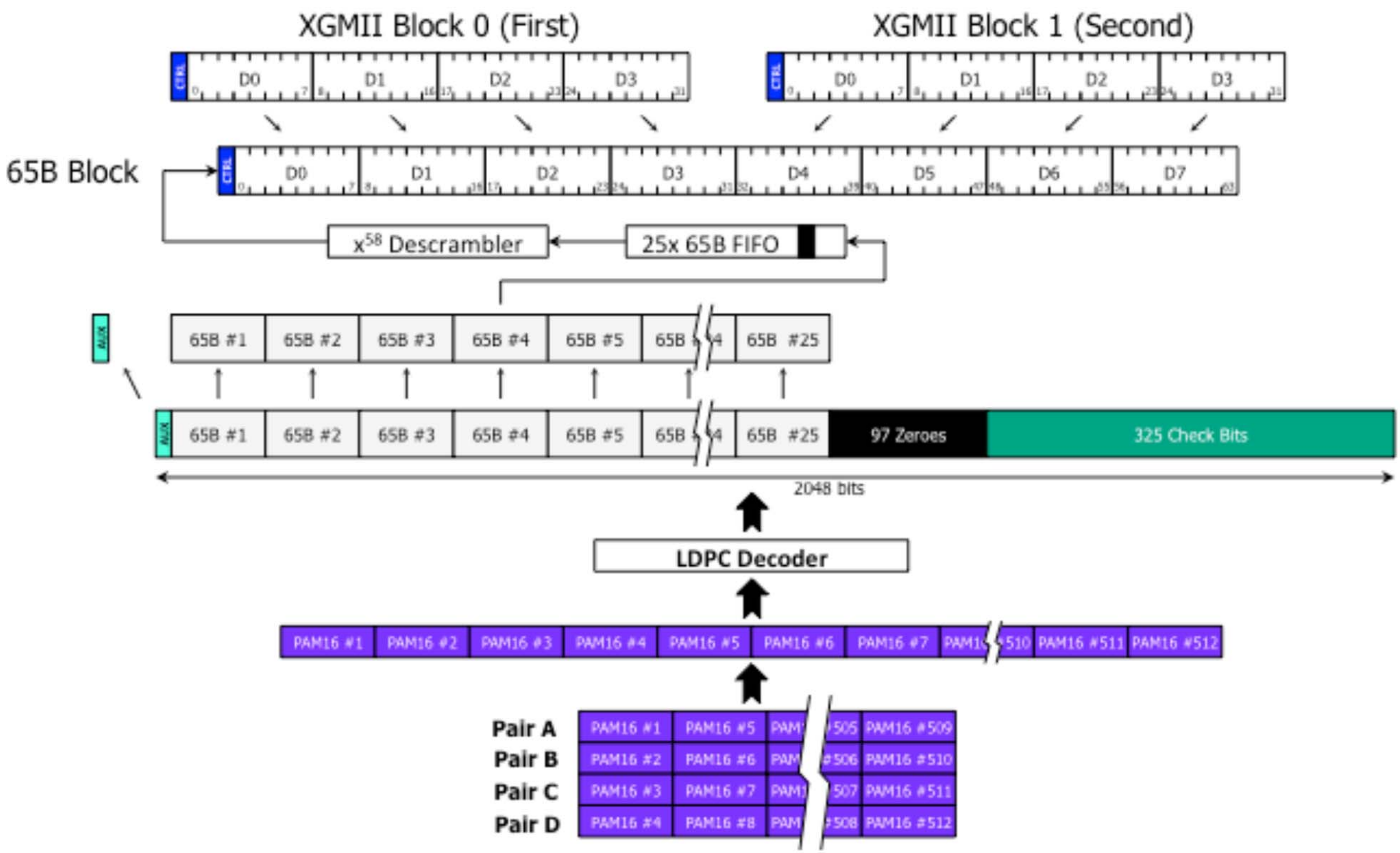


Figure 3: 2.5G/5G Receive Mapping

In both, 5G mode and 2.5G modes, the frame structure is identical, but the symbol rate is 400 MS/s and 200 MS/s respectively. Thus the frame duration for NBASE-T 5G mode is 320 ns and NBASE-T 2.5G mode is 640 ns.

PMA / PCS Specification (Cont.)

1.3 PAM-16 Mapping

The PAM-16 frame shall be mapped four bits at a time in bit order of transmission into Gray-coded PAM-16 as shown in figure below.

Table 1: PAM-16 to Gray-coded PAM-16 mapping

Bits ($b_0b_1b_2b_3$)[1]	**Hex**	**Level**
0100	0x4	***+15***
0101	0x5	***+13***
0111	0x7	***+11***
0110	0x6	***+9***
0010	0x2	***+7***
0011	0x3	***+5***
0001	0x1	***+3***
0000	0x0	***+1***
1000	0x8	***-1***
1001	0x9	***-3***
1011	0xB	***-5***
1010	0xA	***-7***
1110	0xE	***-9***
1111	0xF	***-11***
1101	0xD	***-13***
1100	0xC	***-15***

1. Order of Transmission

PMA Specification

1.4 PMA Sublayer

Overview of PMA Sublayer
The electrical requirements and test procedures are extensions of those defined for 10GBASE-T. The specifications follow the text in section 55.5 of IEEE 802.3-2012 with some minimal changes. The following scale factor relates many parameters to the 10GBASE-T counterpart:

S = baud-rate/800   (baud-rate in MHz)

Baud-rate is 400 and 200 MHz for 5 and 2.5 Gbps rates, respectively.

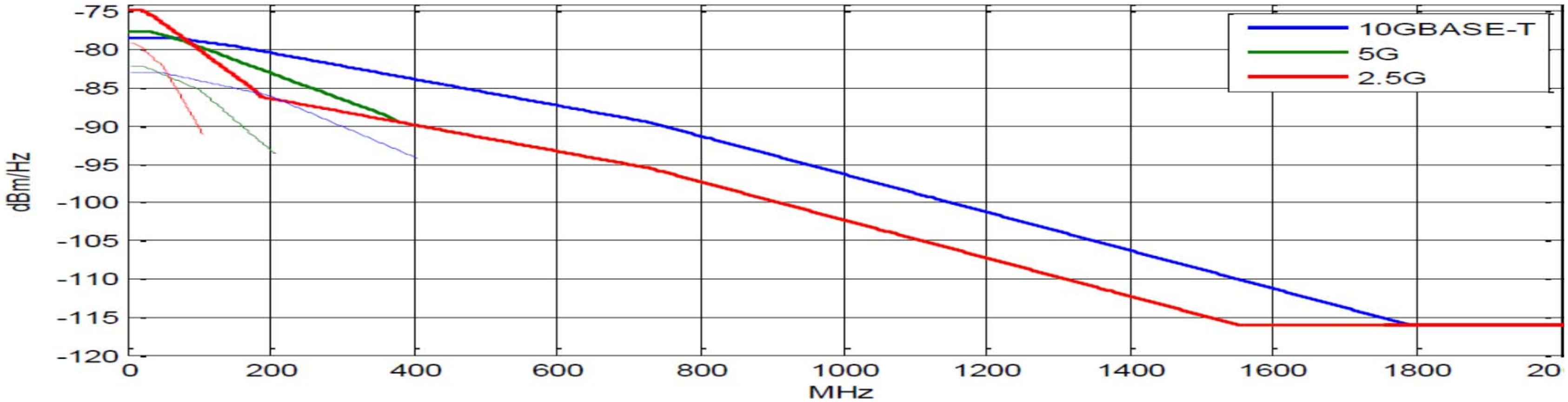
1.4.1 Transmit Power and PSD

1- Total transmit power: <u>1.0 to 3.0 dBm</u>. This is 2.2 dB below 10GBASE-T bounds to limit emission on CAT5e while still allows reasonable SNR

2-In-band PSD limits are similar to the 10GBASET-T mask but scaled in frequency according to the baud-rate

3-Out-of-band PSD limits use the upper mask of 10GBASE-T with 6 dB attenuation to limit the emission on CAT5e to the same level as in CAT6a

Transmit Power Spectrum Density



$$
\mathrm{Pu}(f) = \begin{cases} -80.7 - 10 \times log_{10}(S)\ \frac{\mathrm{dBm}}{\mathrm{Hz}} & 0 < \frac{f}{S} \le 70 \\ -80.7 - 10 \times log_{10}(S) - \left(\frac{\frac{f}{S} - 70}{80}\right)\ \frac{\mathrm{dBm}}{\mathrm{Hz}} & 70 < \frac{f}{S} \le 150 \\ -81.7 - 10 \times log_{10}(S) - \left(\frac{\frac{f}{S} - 150}{58}\right)\ \frac{\mathrm{dBm}}{\mathrm{Hz}} & 150 < \frac{f}{S} \le 730 \\ -81.7 - 10 \times log_{10}(S) - \left(\frac{\frac{f}{S} - 330}{40}\right)\ \frac{\mathrm{dBm}}{\mathrm{Hz}} & 730 < \frac{f}{S} \le 1790 - 400 \times log_{10}(S) \\ -116\ \ \frac{\mathrm{dBm}}{\mathrm{Hz}} & 1790 - 400 \times log_{10}(S) < \frac{f}{S} \le 3000 \end{cases}
$$

$$
\text{Upper PSD}\ (f) = \mathrm{Max}(\ \mathrm{Pu}(f)\ ,\ \text{Upper PSD}_{10\mathrm{GBASE}\ -\mathrm{T}}\ (f) - 6\ )
$$

$$
\text{Lower PSD}\ (f) = \begin{cases} -85.2 - 10 \times log_{10}(S)\ \ \mathrm{dBm/Hz} & 5 < f \le 50 \times S \\ -85.2 - 10 \times log_{10}(S) - \left(\frac{\frac{f}{S} - 50}{50}\right)\ \ \mathrm{dBm/Hz} & 50 < \frac{f}{S} \le 200 \\ -88.2 - 10 \times log_{10}(S) - \left(\frac{\frac{f}{S} - 200}{25}\right)\ \ \mathrm{dBm/Hz} & 200 < \frac{f}{S} \le 400 \end{cases}
$$

Figure 4: 2.5G/5G Transmit PSD

PMA Specification

1.4.2 Transmit Linearity

This is specified in 802.3-2012 section 55.5.3.2 as the minimum SFDR of the transmitter in a 2-tone test. Frequency range of interest is constrained to the relevant range to keep the minimum SFDR as in 10GBASE-T.

$$\text{SFDR} > 2.5+\min\{52,\ 58-20\times\log 10(f/25)\}\ \text{dB}$$

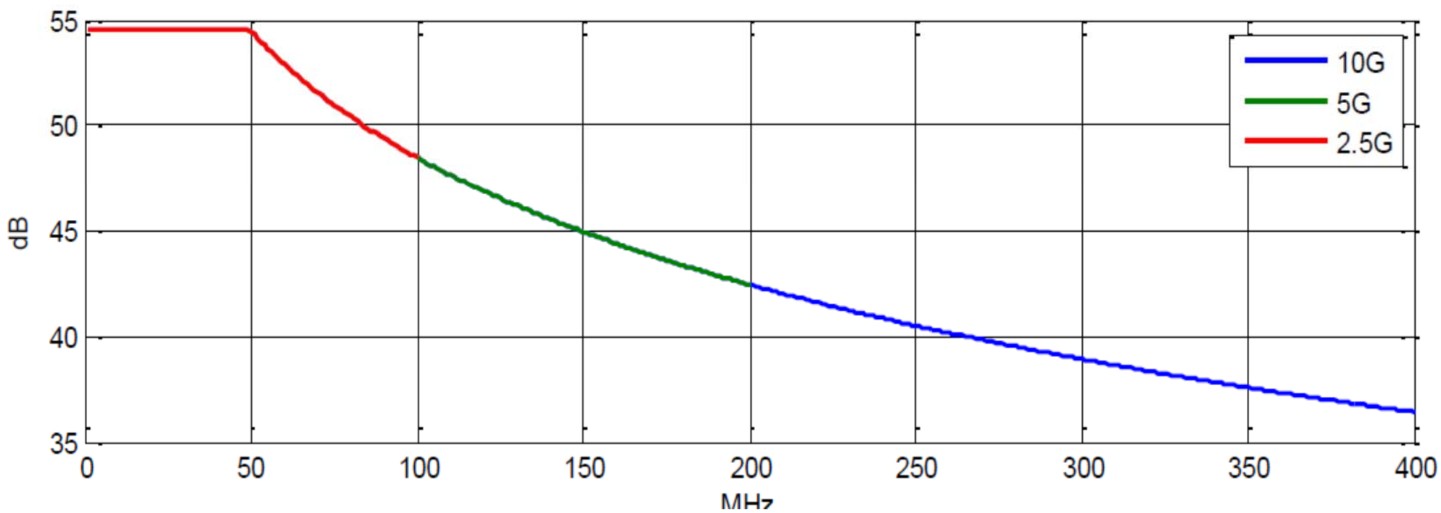


Figure 5: NBASE-T Tx Linearity

Test Modes

1.5 Test Modes

The test modes differences relative to IEEE 802.3-2012 section 55.5.2 are as follows:

a. Test mode 1: Master mode for slave jitter test = No change

b. Test mode 2: Transmit jitter test in MASTER mode

When in test mode 2, the PHY transmits {two +16 symbols followed by two –16 symbols} continually with the THP turned off and with no power backoff. In this mode, the transmitter output should be a (200×S) MHz signal and the RMS period jitter measured at the PHY MDI output shall be less than 5.5 ps. The RMS period jitter is measured as per the test configuration shown in Figure 55–36 over an integration time interval of (1/S) ms ± 10%.

In this configuration, the transmitter output on pair D should be a (200×S) MHz signal and the RMS period jitter measured at the SLAVE PHY MDI output shall be less than 5.5 ps. The RMS. Period jitter is measured over an integration time interval of (1/S) ms ± 10%.

Test mode 2 is for transmitter jitter testing when transmitter is in MASTER timing mode. When test mode 2 is enabled, … local clock source. The transmitter output is a (200×S) MHz signal.

Test Modes (Cont.)

c. Test mode 3: Transmit jitter test in SLAVE mode

Test mode 3 is optional for a PHY that does not support loop timing. When test mode 3 is enabled … no input signal on pair D. The transmitter output is a (200×S) MHz signal on pair D and shall be silence on pairs A, B, and C.

d. Test mode 4: Transmit distortion test

1.132.12	1.132.11	1.132.10	Output waveform frequencies in MHz
			Two tone frequency pairs
0	0	0	Reserved
0	1	1	Reserved
1	1	1	Reserved
0	0	1	(800×S /1024) × 47, (800×S/1024) × 53
0	1	0	(800×S/1024) × 101, (800×S/1024) × 103
1	0	0	(800×S/1024) × 179, (800×S/1024) × 181
1	0	1	(800×S/1024) × 277, (800×S/1024) × 281
1	1	0	(800×S/1024) × 397, (800×S/1024) × 401

Test Modes (Cont.)

e. Test mode 5: PSD and transmit power test = No change in test output, but PSD should conform to Figure 4

f. Test mode 6: Droop test

With the transmitter in test mode 6 and using the transmitter test fixture 1, the magnitude of both the positive and negative droop shall be less than (7.5+2.5/S) %, measured with respect to an initial value at 10 ns after the zero crossing and a final value at (10+80/S) ns after the zero crossing.

g. Test mode 7: Test mode 7 is for enabling measurement of the bit error ratio of the link including the LDPC encoder/decoder, the transmit and receive analog front ends of the PHY and a cable connecting two PHYs. This mode reuses the 2.5/5GBASE-T PCS scrambler.