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Waveform comparison in the presence of Gaussian Phase Noise in the sub-THz context

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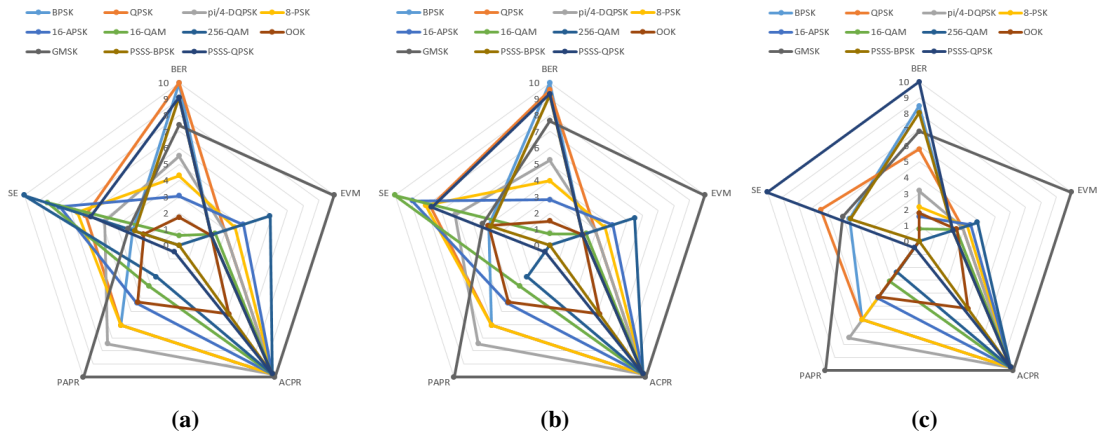
Driven by the need of more available frequency bands, an increasing attention has been paid to the use of sub-THz bands, as shown by the author in [1]. In this review of the advances in the THz communications, the author explained that publications have been numerous since early 2000. Communication systems using all-electronics or photonics are using carrier frequencies in the unexpected range of 100 GHz - 700 GHz, though the most studied frequency bands lies between 200 GHz and 400 GHz. From this review, researchers have reached over 100 Gbps. These systems used only OOK, QPSK and 16-QAM modulation schemes. Our sudy here is relevant, because it presents an extended study of waveforms in this context.

In such high frequency bands, the signal is expected to be impaired by phase noise, I/Q mismatch, power amplifier non linearities, etc. It has been shown that at such frequencies, with possibly large bandwidth ($\sim$ 50 GHz), Gaussian phase noise models accurately the phase noise [2].

Here we summarize the effect of Gaussian phase noise on several waveforms. Five performance metrics are used to compare them: Bit Error Rate (BER), Peak-to-Average Power Ratio (PAPR), Adjacent Channel Power Ratio (ACPR), Spectral Efficiency (SE) and Error Vector Magnitude (EVM). The aim of this comparison is to give recommandations on which waveform to use in the sub-THz context, depending on the impact of the phase noise on the performance of such transmissions. Figure 1 shows the results of such comparison. In these Figures, the graduation used is from 0 (worst performance) to 10 (best performance). For instance, for the example of 16-QAM, we can read from Figure 1a that it is one of the worst waveforms regarding BER and PAPR, whereas it is performing the best regarding the spectral efficiency.



(a) **(b)** **(c)**

Figure 1. Comparison of each waveform with **(a)** no phase noise, **(b)** medium phase noise, **(c)** high phase noise.

In this context, considering only the phase noise, we advise to use low-order modulations such as QPSK as they are more robust to phase noise. Continuous Phase Modulation (CPM) such as GMSK is also a good candidate as it has the best PAPR, ACPR and EVM of the compared waveforms.

References

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[2] S. Bicais and J. Dore, “Phase Noise Model Selection for Sub-THz Communications," 2019 IEEE Global Communications Conference (GLOBECOM), Waikoloa, HI, USA, 2019, pp. 1-6, doi: 10.1109/GLOBECOM38437.2019.9013189.