Effects of the Interfering Harmonics Caused By Imperfect Data Streams on BPSK and QPSK Receivers

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Abstract

One of the most pernicious cause for spurious emission and performance degradation in space telemetry systems is the imperfect data stream at the input of the modulator. The imperfection of the data stream can be caused by imbalance between +1s and -1s (unbalanced data) and/or by data asymmetry. The data asymmetry considered in this paper is produced by the rising and falling voltage transitions. The paper derives and evaluates the level of spurious emissions caused by the imperfect NRZ data stream, and assesses the impact of the spurious emissions on the space telemetry bands. A set of curves that can be used to determine the critical amount of unbalanced data and data asymmetry, that can produce harmful spurious emission to both in-band and out-of-band, is presented. The impacts of in-band and out-of-band spurious emissions on the carrier tracking and timing recovery performance are investigated. It is found that the tracking performances for both carrier tracking and bit sync depend on the amount of imbalance between +1s and -1s and data asymmetry. Additionally, the average probability of error (or Bit Error Rate, BER) due to the presence of interfering harmonics created by the imperfect data stream is derived for both Binary Phase-Shift-Keying (BPSK) and Quadri-Phase-Shift-Keying (QPSK) receivers. The effects of imperfect data stream, imperfect data-induced carrier tracking phase error and imperfect data-induced bit timing error are considered in the evaluation of the BER.