Communication signals over power-line channels can be affected greatly by impulsive noise (IN). The effect of this noise is commonly reduced with the application of a nonlinear preprocessor at the receiver such as blanking or clipping that blanks and/or clips the received signal when it exceeds a certain threshold. Erroneous blanking/clipping of the unaffected signals can lead to significant performance degradations. It is found that determining the optimal blanking/clipping threshold is the key for achieving best performance. In contrast to these studies, we show in this paper that the performance of the nonlinear preprocessing-based method is not only impacted by the blanking threshold but also by the transmitted signal’s peak-to-average power ratio (PAPR). In light of this and for more efficient IN cancellation we, therefore, propose to implement single-carrier FDMA (SC-FDMA), which inherently has low PAPR properties, combined with a nonlinear preprocessor at the receiver.

KEYWORDS: Impulse Noise, PAPR, SCFDMA, IFDMA, LFDMA, SNR, SINR.

ABSTRACT

Communication signals over power-line channels can be affected greatly by impulsive noise (IN). The effect of this noise is commonly reduced with the application of a nonlinear preprocessor at the receiver such as blanking or clipping that blanks and/or clips the received signal when it exceeds a certain threshold. Erroneous blanking/clipping of the unaffected signals can lead to significant performance degradations. It is found that determining the optimal blanking/clipping threshold is the key for achieving best performance. In contrast to these studies, we show in this paper that the performance of the nonlinear preprocessing-based method is not only impacted by the blanking threshold but also by the transmitted signal’s peak-to-average power ratio (PAPR). In light of this and for more efficient IN cancellation we, therefore, propose to implement single-carrier FDMA (SC-FDMA), which inherently has low PAPR properties, combined with a nonlinear preprocessor at the receiver.

KEYWORDS: Impulse Noise, PAPR, SCFDMA, IFDMA, LFDMA, SNR, SINR.
made available at the receiver in order to optimally blank IN. Such assumptions, however, may be difficult to fulfill in practice because of the short-term variations of IN. In such a scenario, the estimation errors of noise parameters could lead to imperfect recognition of the IN signal. As a result, this will cause blanking uncorrupted signal samples causing blanking errors and, hence, significant performance deterioration [21]. Not only may that, but also uncorrupted signal samples with high amplitude wrongly trigger the blanker, causing errors [22]. This can be the case in OFDM systems since they suffer from high peak - to-average power ratio (PAPR). Therefore, in this study, we show that the performance of the blanking-based IN mitigation technique is sensitive not only to the blanking threshold but also to the signal’s PAPR. In contrast to other studies, in this paper, we give comparative study of implementing single carrier-frequency-division multiple access (SCFDMA) using QAM and PSK modulation, which inherently has a low PAPR [23], [24], and address the issue. Two SC-FDMA schemes are considered for optimizing the blanking threshold to enhance the overall performance of the system. These two schemes are localized FDMA and interleaved FDMA. The organization of the rest of the paper is as follows. The system model is described in next section. Section III presents a comparative analysis of the PAPR for LFDMA and IFDMA systems and their relationship with the blanking threshold. The investigation over probability of blanking error for LFDM and IFDMA systems is done in section IV, and the corresponding output SNR performance is presented in Section V. The problem of blanking threshold optimization of the two FDMA systems and the corresponding maximum-achievable output SNR are addressed in Section VI. Finally, conclusions are drawn in last section.

**Figure1.1 Transreceiver of SC-FDMA with blanking device**

**Impulsive Noise**

Impulsive noise is generally characterized by short voltage peaks. These short voltage peaks are rare single events which are caused mainly by switching on and off the switching events [25]. The IN noise have high impact on data transmission so it become essential to gain statistical information about the probability of impulsive width, impulsive amplitude and interarrival time.

**SYSTEM MODEL TECHNIQUE**

The system model used in this paper is as follows. Firstly the information bits are mapped into 16-QAM and PSK symbols and these bits are then grouped into blocks each with length N by serial to parallel converter and then these blocks are passed through DFT block to get its frequency domain analysis. The output of DFT is then fed to subcarrier mapping technique. Two mapping techniques have been used in this paper-LFDM and IFDMA. In the first scheme, consecutive subcarriers are occupied by the DFT out-puts with zeros occupying the remaining subcarriers whereas in the IFDMA scheme, the DFT outputs are allocated over the entire bandwidth with equal distance while zero padding the unused subcarriers. The frequency-domain samples are then passed through an M-point inverse discrete Fourier transform (IDFT) modulator to produce time domain samples given by (IDFT), before going into the parallel to serial (P-to-S) convertor and then transmission is done.

The PAPR of transmitted signal is given by

\[
PAPR = \frac{\max_{0 \leq t \leq T} |x(t)|^2}{\frac{1}{T} \int_0^T |x(t)|^2 dt}
\]
Figure 2.1 CCDF for LFDMA and IFDMA when M=64, N=16, and Q=4 for 8-QAM

Figure 2.2 CCDF for LFDMA and IFDMA when M=64, N=16, and Q=4 for 16-QAM

For the modulation techniques 16-QAM and 8-QAM blanking error of LFDMA and IFDMA systems are shown below.

<table>
<thead>
<tr>
<th>Table 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mapping Tech.</strong></td>
</tr>
<tr>
<td>Total Impulses</td>
</tr>
<tr>
<td>Recognized Impulses</td>
</tr>
<tr>
<td>Blanking Errors</td>
</tr>
</tbody>
</table>

Figure 2.3, Figure 2.4, Figure 2.5, Figure 2.6 and Table 2.1 summarize the scenario from which it is obvious that the IFDMA system provides the lower blanking errors than LFDMA since it recognizes more of the IN pulses and leaves lower blanking errors.
Figure 2.3 LFDMA blanking threshold for 8-QAM

Figure 2.4 IFDMA blanking threshold for 8-QAM

Figure 2.5 LFDMA blanking threshold for 16-QAM
PROBABILITY OF BLANKING ERROR
The probability of blanking error (Pb) is defined as the probability that the amplitude of the received sample Ar = |rm| exceeds the blanking threshold when it is unaffected by IN and it is given as Pb= P(BH0), where B is the event of blanking the received signal exceeding T. According to Bayes’ theorem, P(BH0) = P(B|H0) P(H0)

\[ Pb = P(Ar > T \mid H0) P(H0) \]

The probability of blanking error versus blanking threshold graph is shown below for 8-QAM and 16-QAM modulation technique. It is important to set the threshold level appropriate so as to optimize the blanking error efficiently. Where IFDMA is found to be best. Probability of blanking error versus blanking threshold for LFDMA, and IFDMA systems, SNR = 40 dB is shown below.

![Figure 2.6 IFDMA blanking threshold for 16-QAM](image)

**Figure 2.6 IFDMA blanking threshold for 16-QAM**

![Figure 3.1 Probability of blanking error for 8-QAM](image)

**Figure 3.1 Probability of blanking error for 8-QAM**
Figure 3.2 Probability of blanking error for 16-QAM

OUTPUT SNR VERSUS THE BLANKING THRESHOLD

Fig. 4.1 and Fig 4.2 shows the result obtained after MATLAB simulation done for output SNR versus optimal threshold. The matter of interest is to see that there exist an OBT for each system that maximizes the output SNR. The optimization for two techniques is investigated for the two modulation technique. The output SNR for LFDMA and IFDMA system is calculated by below equation.

Figure 4.1 Output SNR of LFDMA, and IFDMA versus blanking threshold for 8-QAM

Figure 4.2 Output SNR of LFDMA, and IFDMA versus blanking threshold for 16-QAM
RESULTS AND CONCLUSIONS
In this paper we have investigated the performance of SC-FDMA with optimized blanking in the presence of impulse noise under two modulation techniques i.e. 16-Quadrature Amplitude Modulation and 8-Quadrature Amplitude Modulation. This paper presents comparative study for the detection of impulsive noise in the form of blanking error. Fig 2.3 to Fig 2.5 gives the number of blanking errors detected. Fig 3.2 and 3.3 gives the probability of blanking error for the two case LFDMA and IFDMA. Variation of probability of blanking error decreases while increasing optimal threshold. By observing graph we observe that application of IFDMA makes it feasible to optimally blank IN without the need for prior knowledge about the noise characteristics. In our paper we have compare blanking technique for blanking error detection, SC-FDMA can also applied for nonlinear preprocessors.

REFERENCES


