DESIGN CONSIDERATIONS FOR A FILTER BANK BASED TVWS TRANSCEIVER

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Abstract. This paper discusses the design of a filter bank based transceiver capable of simultaneously up- or downconverting the entire TV white space (TVWS) frequency band. The spectral mask requirements favour a filter bank based approach, whereby RF sampling and the use of an FPGA for digital up- and down-conversion dictates a two-stage approach. Some of the design considerations, including filter design approaches, are discussed in this contribution.

Introduction. TVWS radio devices need to operate flexibly in order to be able to utilise geographically unused TV channels. At the same time, these radio devices are expected to comply with very stringent requirements of -55dB leakage into adjacent channels and -69dB leakage into next-adjacent frequency bands [1]. Orthogonal frequency division multiplexing (OFDM) — currently prevalent in almost any wireless standards — is ill-suited for this task. Instead, filter bank based transceivers have recently experienced a renaissance almost four decades after their first appearance [2], since this technique is able to provide much enhanced frequency selectivity compared to OFDM. Below we discuss some aspects of a multi-stage filter bank based transceiver, which is designed to digitally up- and downconvert the entire TVWS spectrum by sampling at an RF rate of 1.92 Msps.

System Approach. The proposed transceiver uses a two-stage design as shown in Fig. 1, with 40 8MHz channels on the left converted to a 1.92Gsps signal that is fed into the DAC/ADC on the right. While a single stage design offered reduced cost, the interface of feeding digital RF signals into FPGA devices requires sufficiently low rates. Further, FPGAs can only handle a number of input signals, thus providing limitations to the decimation ratios within the first stage filter. Therefore, after an initial analytic bandpass filter realised in polyphase implementation, it is a second stage in which the filter bank is applied within this transceiver.

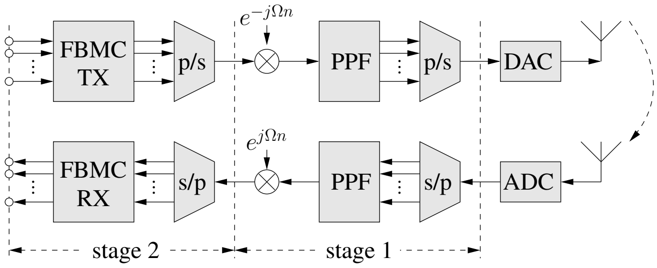

Fig. 1. Proposed multi-stage TVWS filter bank transmitter (above) and receiver (below) with a polyphase filter (PPF) in stage 1 and an FBMC modulator in stage 2.

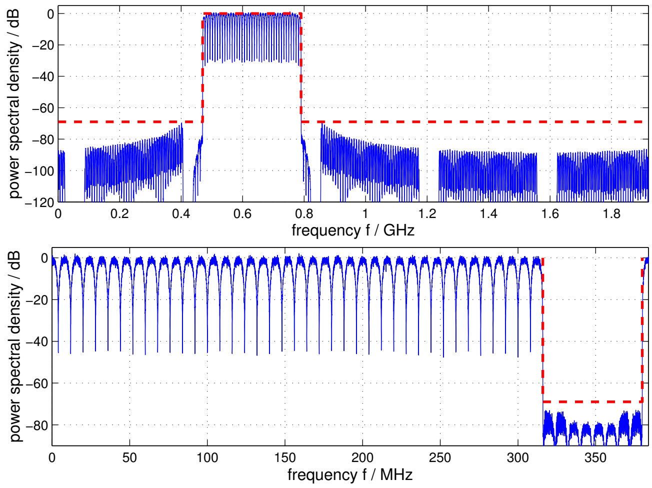

Fig. 2. Power spectral densities after (top) stage 1 and (below) stage 2., with required masks to protect incumbent users.

The filter bank design uses approximate Nyquist systems with near-perfect reconstruction [3] and transition bands and stopbands that just satisfy the spectral mask in [1]. The resulting power spectral densities of the stage 1 and stage 2 signals are depicted in Fig. 2, demonstrating the requirements on both the TVWS RF signal as well as the baseband signal between stages 1 and 2.

Conclusion. A TVWS transceiver design has been outlined. More details will be provided during the paper presentation.

References

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