Case Study

IC Design for Low Cost, High Volume Wireless Tranceivers

When National Semiconductor Corporation needed to ensure their new range of digital wireless tranceivers were launched on time, PRFI was on hand to provide the experienced design skills required. The resulting products were successfully launched and to date over 500 million units have been sold.

When National Semiconductor embarked on the development of System on IC (SoIC) radio tranceivers for cordless communications applications they realised that time to market was critical to gaining product adoption and high volume sales. National Semiconductor approached PRFI to provide design resource to assist with the development and ensure timely entry to market. PRFI worked as an extension of National's own design team with responsibility for key blocks but also attending project meetings and collaborating with the development of the complete radio transceiver.

Several cordless transceiver products are now commercially available via SiTel Semiconductor, which took over National's cordless products group and now dominates this market sector.

In a continuous two-year working relationship, National Semiconductor commissioned PRFI to undertake design tasks for 1.9GHz and 2.4GHz variants of the digital wireless transceiver. This work included:

- Radio system simulation
- Digital demod design
- PostADC digital design
- AGC system design
- Active slicing
- Clock recovery design
- Fixed point design
- Diversity selection
- Demod characterisation

Radio system design

PRFI created a model of the digital wireless communication system and used it to assess the impact of subcircuit performance on system level parameters. This enables key decisions to be made about the overall architecture and performance tradeoffs.

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PRFI Ltd.
Abbey Barns, Suite 1, Building 3
Duxford Road, Ickleton, Cambridge, CB10 1SX, UK

T: +44 (0) 1799 796464 **E:** enquiries@prfi.com **W:** www.prfi.com

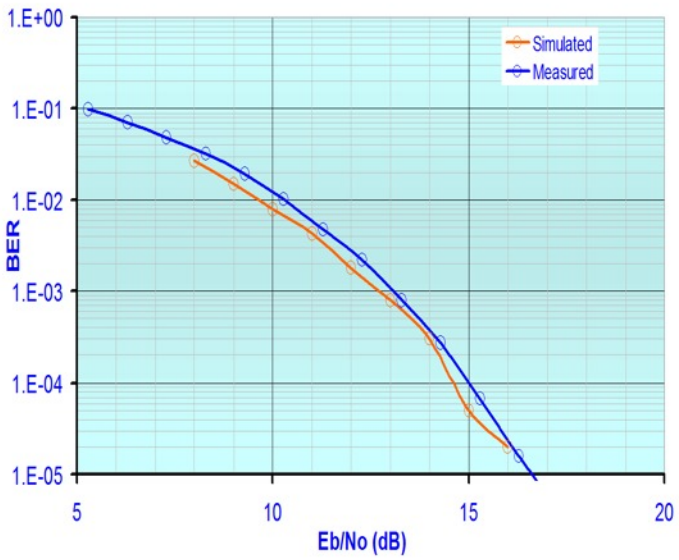
Several candidate FSK demodulators were compared to evaluate the impact of channel filter bandwidth, deviation and frequency offset on the bit error rate (BER) performance for signals in noise. This allowed the optimum demodulator architecture to be selected.

Detailed IC design

PRFI designed a low IF demodulator that was developed in conjunction with an active slice system to minimise BER degradation caused by frequency offset. PRFI also developed the "postADC" interface stages of the demodulator, including channel and post demodulation filtering.

Further enhancements were made to the radio system model to include:

- The AGC system, including its transient response and stability
- The clock recovery system, where BER comparisons were made against ideal symbol timing recovery
- Multilevel FSK modulation schemes including signal tracking throughout a transmission packet
- The impact of multipath propagation on performance
- New algorithms for diversity selection



The system simulation was used to generate performance requirements for the different subcircuits of the IC. Detailed simulation of the individual analogue and digital sub circuits gives predictions of their performance that must then be fed back into the system simulation to confirm the overall performance of the complete IC. This is necessarily an iterative process with the design team working in close collaboration to agree the most appropriate tradeoffs in performance, die area and current consumption.

Chip characterisation

PRFI is also able to perform IC evaluation. In the case of National's 1.9GHz transceiver, PRFI carried out both the design and the evaluation of the demodulator.

An excellent correlation was achieved between simulation and measurements as is clear from the graph above. Assuming a 6dB receiver noise figure, the sensitivity for 0.1% BER is 94.8dBm at nominal IF and deviation, improving to 96.7dBm at maximum deviation.

Project management

As with management of all large development projects, the design of highly integrated ICs is broken into a manageable set of tasks that are then distributed amongst the individual designers in the team. As long as close collaboration and strong project management are undertaken the fact that the designers are not permanently co-located need not cause undue problems. The two year working relationship described above culminated in a new product range of digital wireless transceivers for National (subsequently SiTel Semiconductor) and is proof that this type of collaboration can yield excellent results.

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