A 110W 10Mb/s eTextiles transceiver for body area networks with remote battery power

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Additionally, by using dual capacitors $C_1$ and $C_2$ that are nominally discharged to swing and driver load [6,7], irrespective of the network DC potential.

Time-sharing of the eTextiles medium with remote charging circuitry forces the nodes and charged, respectively, a ternary signaling scheme can be used, simplifying the capacitive divider ratio of $C_1$ and $CL$. Asserting $p[a]$ would instead discharge $C_2$, making the signaling scheme differential, yet operating at different DC levels. Generating a positive voltage swing. The opposite effects are arranged for $v^-$.

Samples are converted to ternary digits (trits) by two clocked comparators sized for a $3\sigma$ offset under 25mV. Each comparator has 8 bits of differential pair and current source weighting, providing offsets that vary by $\pm 60$ mV. The comparators are configured to have equal and opposite non-zero offsets, such that any differential samples above or below the absolute offset level convert to trits ‘+1’ or ‘-1’, respectively; samples residing between the offset levels convert to ‘0’.

The conversion is performed by an offset orientation-independent ternary encoder, permitting the comparator pair to swap roles. After calibration, this form of comparator configuration-redundancy improves the $\sigma$ of offset errors, measured as the difference between the desired and attained offset for each comparator, by 1.5-2.5X.

Each sample and conversion operation completes in two clock cycles, requiring two interleaved AQ blocks to demodulate data at full rate. Synchronization is achieved in the RX back end (BE) by correlating incoming data using two additional AQ blocks to ensure sampling occurs every half clock period (Fig. 27.6.5). A custom multiplier is implemented for the correlator ternary arithmetic, saving 2 bits in each adder stage over a traditional 2’s complement topology. If a correlator output crosses a programmable threshold, synchronization is achieved, and the two unused AQ blocks are clock gated. Alternatively, the RX BE can be configured in an auto-correlation mode for a CSMA MAC.

The transceiver is fabricated in 0.18µm CMOS, occupies a core area of 0.83mm², and operates at 0.9V. Although healthcare applications typically only require 10-100kb/s per sensor, the transceiver communicates at a raw data rate of 10Mb/s to accommodate up to 30 time-multiplexed sensor nodes on the shared medium and to provide margin for remote charging duty-cycling and coding overhead. The RX FE consumes 2pJ/bit, which is at least 20X lower than wireless and BCC systems operating at similar distances, and is comparable to wireless eTextiles systems operating over much shorter distances (Fig. 27.6.6). Over 1m, the TX FE consumes 0.7-to-18pJ/bit for output voltage swings from 6-to-290mV. At 100% receive-mode duty cycle, the chip consumes 110µW, including RX, digital baseband, and I/O power. The remote battery scheme achieves 95% power transfer efficiency from BS to sensor node, compared to 54.9% for wireless power transfer efficiency [8]. Figure 27.6.6 shows measured transmitted and received waveforms, and summarizes the chip results. A die photo is shown in Fig. 27.6.7.

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References:
Figure 27.6.1: Implemented eTextiles system with packet diagram shown.

Figure 27.6.2: eTextiles transceiver block diagram used for sensor nodes. The BS uses the same chip, but replaces the super capacitor with a battery.

Figure 27.6.3: Supply-rail-coupled (SRC) differential ternary transmitter.

Figure 27.6.4: RX front end (FE) consisting of four time-offset acquisition (AQ) blocks.

Figure 27.6.5: RX back end (BE) used for synchronization.

Figure 27.6.6: Measured transient waveforms and table of measured results.
Figure 27.6.7: Die photograph of the eTextiles transceiver.