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

Citation

As Published
http://dx.doi.org/10.1109/ISSCC.2010.5433868

Publisher
Institute of Electrical and Electronics Engineers

Version
Final published version

Accessed
Sat Apr 21 19:51:14 EDT 2012

Citable Link
http://hdl.handle.net/1721.1/62195

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Additionally, by using dual capacitors $C_1$ and $C_2$ that are nominally discharged swing and driver load [6,7], irrespective of the network DC potential. This approach is advantageous, as capacitive-driving reduces output voltage medium with supply-rail-coupled (SRC) differential transmitters (Fig. 27.6.3). High impedance resistors, and transmitted signals are AC coupled onto the charge the primarily capacitive medium, the DC voltages are held constant by $v^+$ and $v^-$, respectively, a ternary signaling scheme can be used, simplifying capacitive divider ratio of $C_1$ and $CL$. Asserting $p_{a[1]}$ would instead discharge $C_2$, and the top plates remain floating, only differential charge is sampled on top of the eTextiles network. As the inputs are already centered at opposite DC potentials have DC potentials centered at opposite rails. Before packet reception, the independent sampling structure is implemented, exploiting the fact that external super capacitor, which functions as each node's energy supply. The RX FE samples and digitizes the SRC differential voltage across the RX back end (BE) by correlating incoming data using two additional AQ blocks 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 1.8pJ/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.

Acknowledgements: This work was funded in part by the FCRP Focus Center for Circuit & System Solutions (C2S2), under contract 2003-CT-888.

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.

Chip Summary

<table>
<thead>
<tr>
<th>Type</th>
<th>[1]</th>
<th>[2]</th>
<th>[3]</th>
<th>[4]</th>
<th>[5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX FE Ebit</td>
<td>75pJ</td>
<td>65pJ</td>
<td>2.2 / 1pJ</td>
<td>0.53pJ</td>
<td>0.77pJ</td>
</tr>
<tr>
<td>RX &amp; BB Pwr</td>
<td>4.3mW</td>
<td>3.7mW</td>
<td>0.18 / 2.7mW</td>
<td>0.42mW</td>
<td>0.11mW</td>
</tr>
<tr>
<td>RX 10dB sensitivity</td>
<td>1.5mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TX output swing</td>
<td>0.1mV-200mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>10mW</td>
<td>1m</td>
<td>1.8m</td>
<td>1.2 / 85 cm</td>
<td>3cm</td>
</tr>
<tr>
<td>Data Rate</td>
<td>400Mb/s</td>
<td>8.5Gb/s</td>
<td>10Gb/s</td>
<td>10Gb/s</td>
<td>48Gb/s</td>
</tr>
</tbody>
</table>

Figure 27.6.7: Die photograph of the eTextiles transceiver.