I²C Considered Wasteful: Analyzing Energy Demands of Low-Level Protocols

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The Inter-Integrated Circuit (I2C) bus is frequently used to connect sensors and actuators to cyber-physical systems. It is designed around always-on pull-up resistors, which transform valuable electric energy into heat whenever a 0-signal is sent or received. After analyzing the energy cost of I2C transmissions, we look at a software I2C implementation which disables pull-ups when possible, thus decreasing the energy demand of I2C transmissions at the cost of additional CPU time. Benchmarks on an MSP430FR5969 microcontroller confirm energy savings compared to conventional software I2C, though hardware I2C modules are still more efficient in most cases.