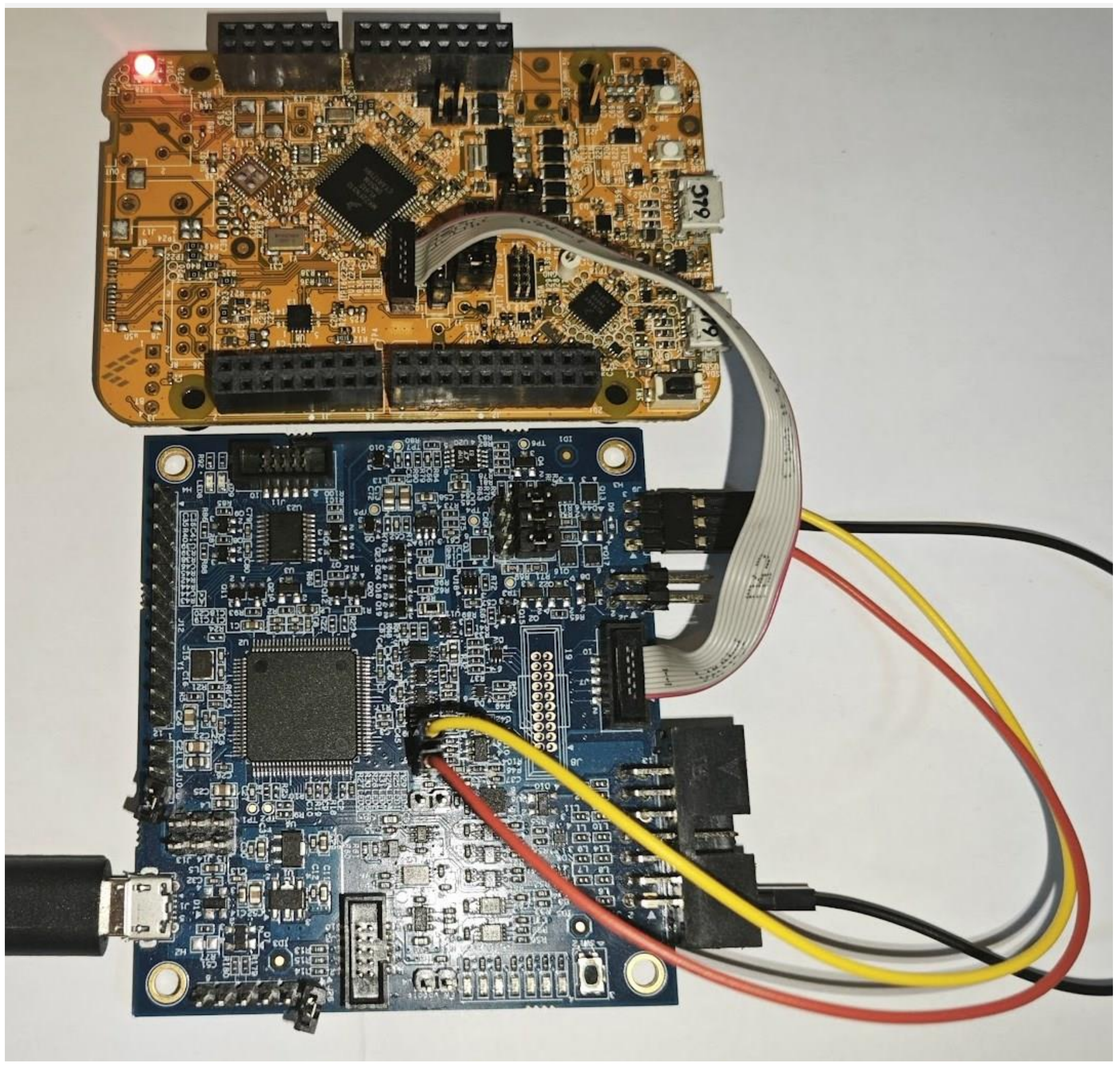
HSLU Hochschule Luzern

Technik & Architektur
Master of Science in Engineering
Major in Electrical Engineering

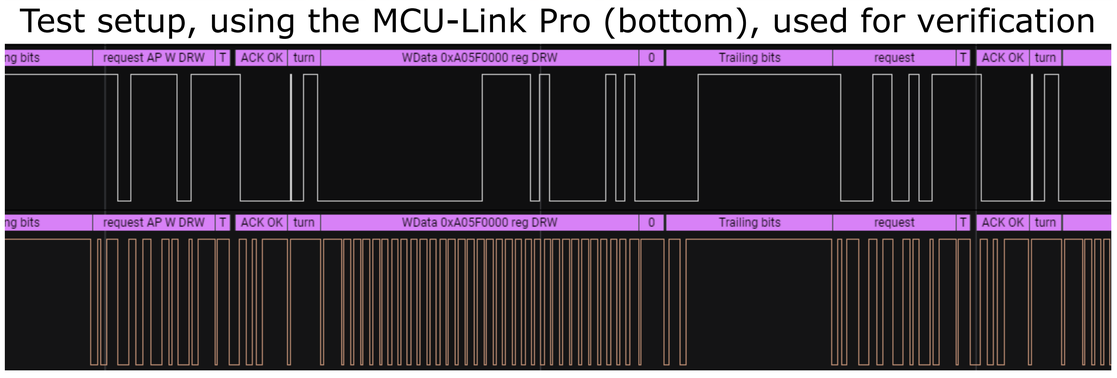
Master of Science in Engineering

MCU-Link Energy Aware Debugging

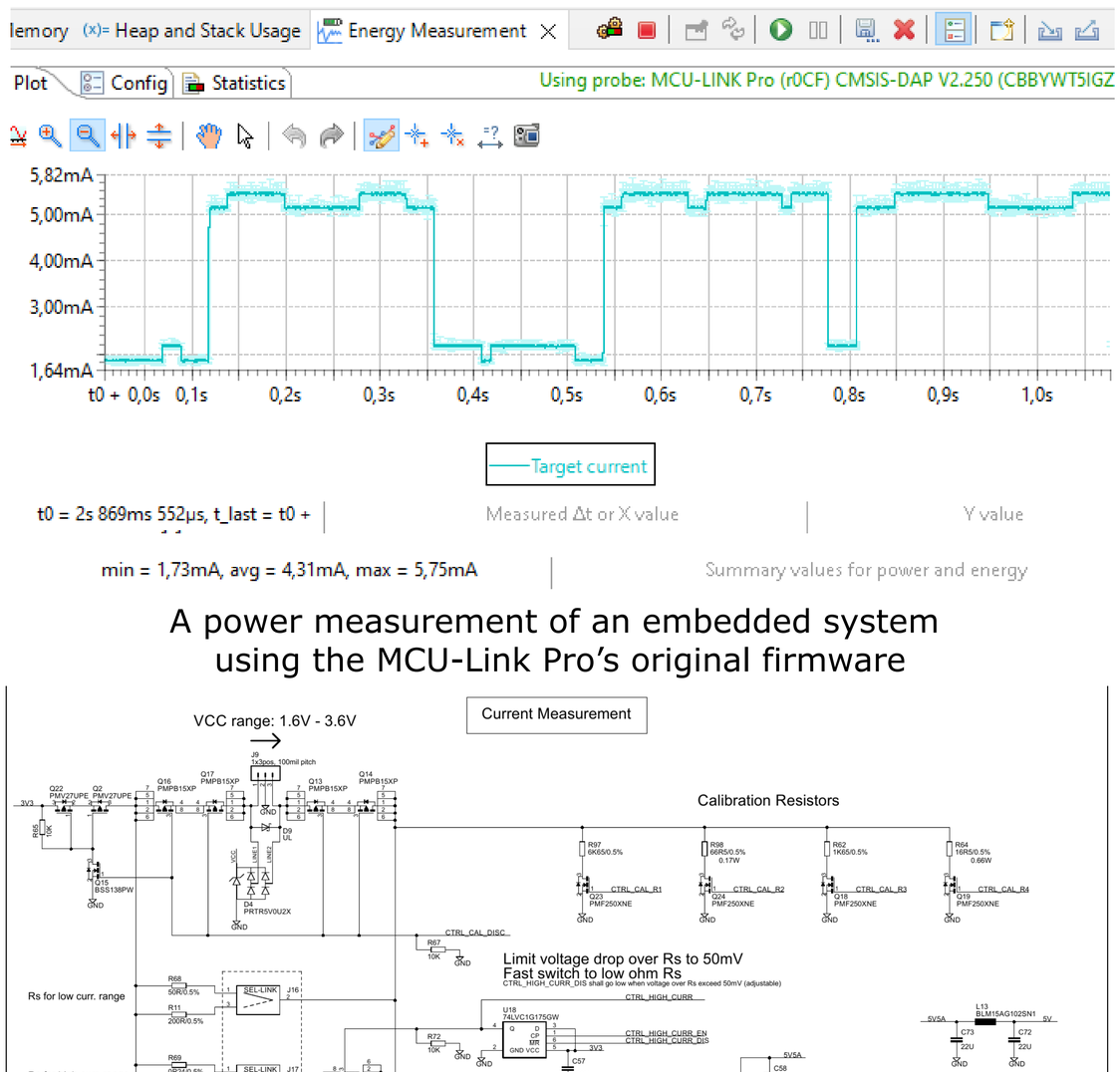
Exploring possibilities of combining debugging with energy profiling



Test setup, using the MCU-Link Pro (bottom), used for verification



SWD Signals transferring program execution state data



A power measurement of an embedded system using the MCU-Link Pro's original firmware

The MCU-Link Pro's power measurement hardware

Problem

As battery powered devices, especially those in the 'Internet of Things' category, become more prevalent, the tools required to develop them are also of major importance.

Device size and battery capacity is limited, while the devices all around us should last for as long as possible on one charge. A number of debugging solutions - with power profiling functionality built in - already exist, which is supposed to make it easy to debug and optimize power usage of low-power devices.

The way power profiling works is that the execution state of a program (what it's currently doing) is correlated with a power measurement over time, allowing the developer to find out what might cause increased power usage.

The existing solutions only work with certain systems. As such, the objective of this thesis was to explore a novel solution combining 'debug' and 'power profiling', that has not been done before, using the NXP MCU-Link Pro.

Solution Concept

The key research finding was that most profiling solutions link program execution state to power measurement using Single Wire Output (SWO), which is not available on all microcontrollers. Specifically, the Cortex-M0(+), which is present in a lot of devices, does not have SWO. Because of that, it was decided to implement a universal solution that works for as many devices as possible, especially those without SWO.

Results

A proof of concept utilizing the open-source debug probe firmware DAPLink was developed that allows for potentially any Cortex-M based microcontroller to be energy profiled by utilizing functionality of the built in debugging hardware.

The target's code gets instrumented using core functionality of the compiler, only requiring a debug flag to be set and two small source files to be added to the project.

Because of the system (Data Access Port) used to access the data, the target device does not need to do anything other than save the data created by the instrumentation functions in a variable in its local RAM. The data gets read from the debug probe by directly accessing the target's memory.

This data, alongside sampled power data, can then be used in order to get an insight into what a program is doing at the time of power measurement.

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