Digital power for battery chargers - comparison and implementation

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I - Introduction

This project was done together with Micropower which is a company that produces and manufactures battery charger. These chargers are not like your ordinary phone charger but is instead used to charge high power applications like forklifts. The chargers currently use an analog controller to create the correct voltage and current for the battery that is being charged. To achieve a high efficiency of the chargers many parameters of the analog controller must be tuned. With the current construction being analog, this means that tuning is very difficult because components have to be soldered on and off. Micropower instead wanted a digital solution that could be tuned from a computer. Having a digital solution will also give other benefits like improved communication and better error handling.

The new digital solution will end up in the very center of the battery charger. There a microcontroller, described in the next section, was used to control four transistors that create a high-frequency current that is then rectified to create a direct voltage. This is done with a control loop that measures the direct voltage and according to that, change how big the high-frequency current is allowed to be.

II - Microcontroller

A microcontroller is a small computer on a single integrated circuit. It contains a Central Processing Unit(CPU) that handles all computing, it also contains several other peripheral units. Among these are units that handle communication to other microcontrollers, measures real world signals and send out signals that control other electronics like the transistors in the central part of the battery charger.

In this project, microcontrollers from several suppliers were compared to see which one that suited Micropowers needs best. Among these suppliers were Texas Instruments, Renesas, ST, NXP and Infineon. Demands were specified from Micropower regarding how many analog inputs, digital outputs for control and comparators the microcontroller needed. The suppliers candidates were then judged based on these demands.

The final choice of microcontroller was Infineons XMC4200. This had a lower price and similar performance to the other models. Another advantage was that the development environment used by Micropower today could also be used to develop applications for the new microcontroller. Infineon also provided an environment of their own called DAVE. This could be used to easily setup the microcontroller using APPs in the environment, where each APP represented a specific function in the microcontroller.

III - Result

The most exciting result can be seen in Figure 1. In the picture the microcontroller can be seen attached to a control card that is used for development. The control card is placed in a specially made adapter card that allows the microcontroller to control the switching of the four transistors in the battery charger.

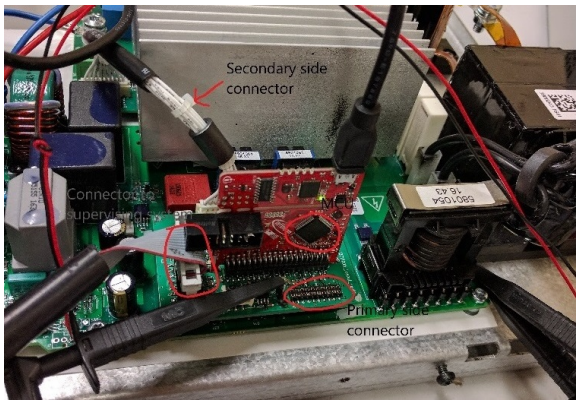

Figure 1: Setup in Micropowers charger

Figure 2 shows the current and voltage signals when the charger is in operation, which proves that the digital control solution works.

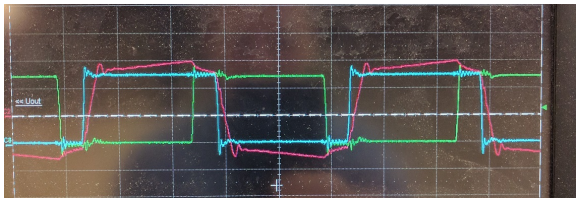

Figure 2: Output from converter bridge

The current could be controlled by a potentiometer in a black box that simulated supervising systems. The charger took 50V, 2.5A as input and produced 10V, 10A as output.

IV - Conclusion and future work

At the end of the project, the new digital control solution could replace the basic functionality of the analog one. Originally this was only an optional goal if time allowed. This project has provided Micropower with a good base for when the final implementation will happen. As a first step, the microcontroller will only provide CAN communication to talk to supervising systems.