

Modulares Universal Ladegerät mit konfigurierbaren Ladeverfahren

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Inhalt

1. Grundlagen
2. Motivation
3. Zielsetzung
4. Umsetzung und Design
 - Hardware
 - Software
5. Zusammenfassung

Ladeverfahren

Ladeverfahren

- Konstantstrom (CC)
- Konstantspannung (CV)
- Strom- und Spannungslimitiert (CC-CV)
- Impuls-/Rückstromladen

Abschaltkriterien

- Zeit (für: CC,CV,CC-CV)
- Unterschreiten eines Stromlimits (für: CV,CC-CV)
- $-\Delta U$ (für: CC)
- Temperatur (für: CC, als Backup)

Balancing

Motivation:

- Verhindern der Überladung einzelner Zellen
- Erhöhen der Energiedichte (Aktiv-Balancing)

Methoden:

- Passiv: Durch Entladen einzelner Zellen
- Aktiv: Durch Umladen, kapazitiv/induktiv

Motivation

- Viele Akku-Technologien
- Unterschiedliche Ladeverfahren
- Spezielle Aufgaben
 - Lithium-Akkus auf Lagerspannung
 - Energie und Ladungseffizienz messen
 - Parameter-Tracking über Batterielebensdauer
- Testen neuer Ladeverfahren
 - Laden von Alkaline-Batterien
 - Wendepunkt basierte NiMh

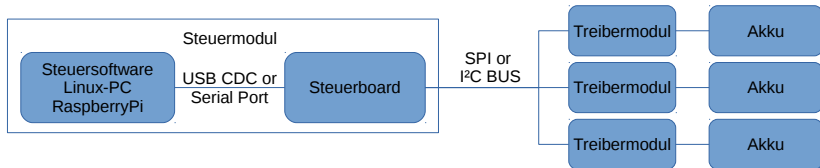
Zielsetzung

- Modulares Ladegerät
- Scriptfähig
- Mindestens 6 Zellen LiPo
- 10 A Ladestrom
- 100 W Entladeleistung
- Aufzeichnung der Messdaten

Zielsetzung

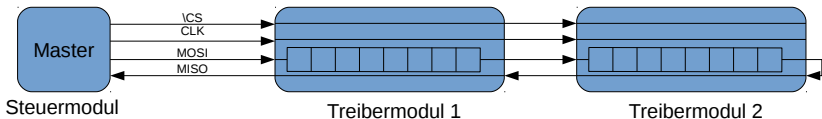
- Modulares Ladegerät
- Scriptfähig → Javascript
- Mindestens 6 Zellen LiPo → 30V 12 Ch Balancer
- 10 A Ladestrom → 5A – 10A
- 100 W Entladeleistung → 75/150W 10A
- Aufzeichnung der Messdaten → Plots + JSON

High-Level-Design

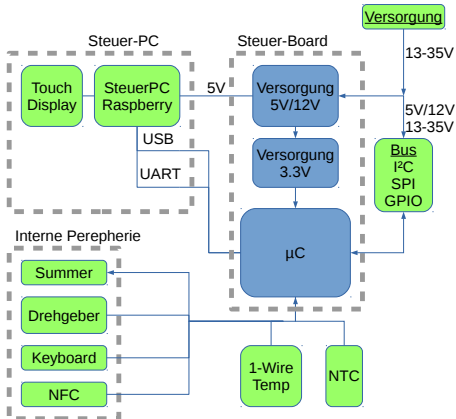


Bus System SPI Chaining

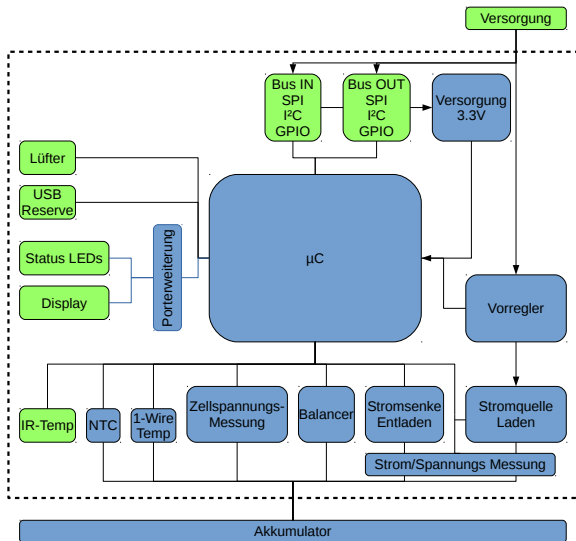
- 1 Transaction/msec (steigerbar)
- Null Bytes bei Idle
- Garantierte Datenrate
- Jede Leitung permanent getrieben



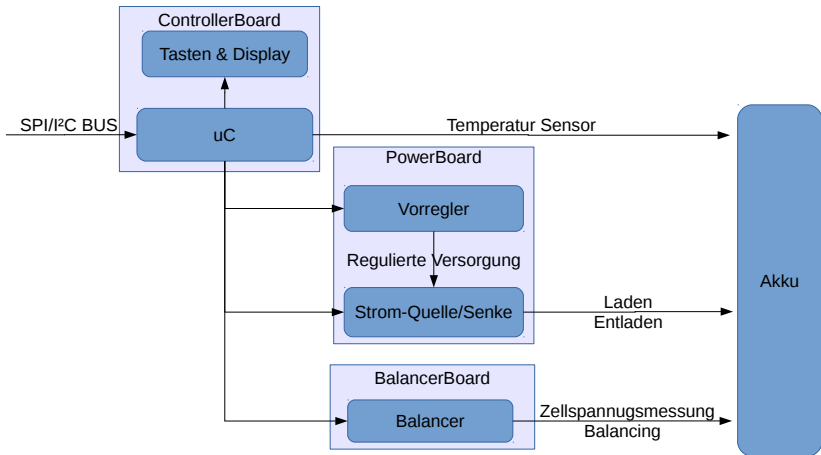
Steuermodul



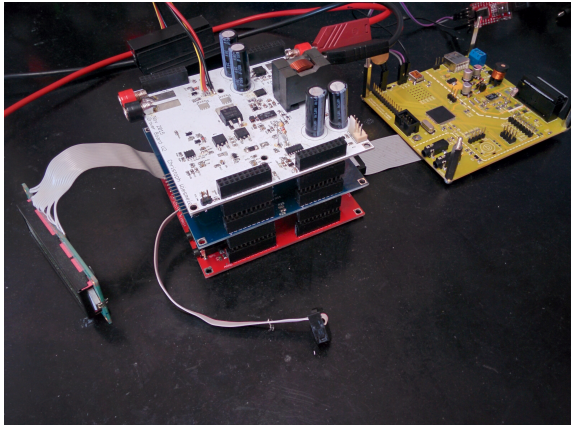
Treibermodul



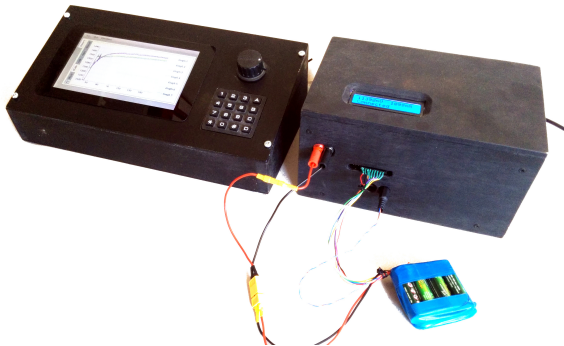
Treibermodul Platinen



Testhardware

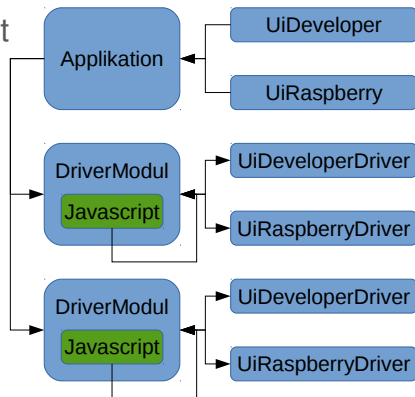


Gerät/Demo-Aufbau

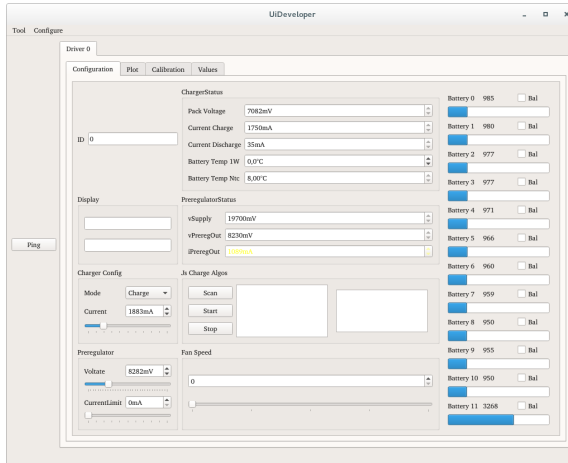


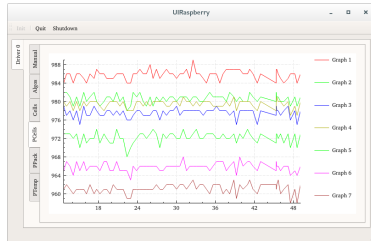
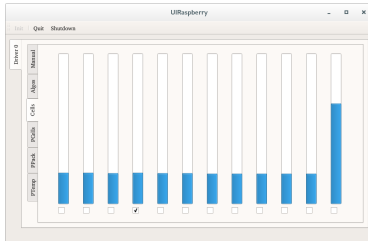
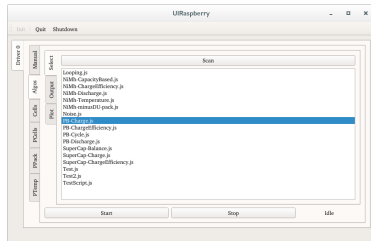
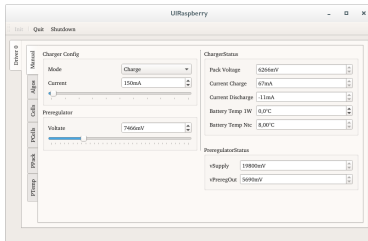
14
Steuersoftware

- Implementierung C++/Qt
- Funktionskapselung DriverModul
- Entwickler GUI
- Geräte GUI
- Synchronisation GUIs mit Javascript



Entwickler GUI



16
 Raspberry GUI


Ladescript

- Javascript
- Event basiert
- Funktionalität wie GUI
- Includes für Standard Algorithmen (CCCV)
- Konfigurierbar beim Start

Ladescript Bleiakku (Includes)

```
1 include ("CCCV.js")
2 include ("Prereg.js")
3 include ("Sleep.js")
4 include ("sprintf.js")
```

Ladescrypt Bleiakku (Konfiguration)

```
6 Battery = {  
7   cellcount : 3,  
8   chemistry : "PB",  
9   capacity : 4000  
10 }  
11  
12 Configuration = {  
13   chargeRate : 0.5,  
14   voltageLimit: 2400,  
15   useCurrentRelaxation: true,  
16   currentRelaxationLimit:0.1  
17 }
```

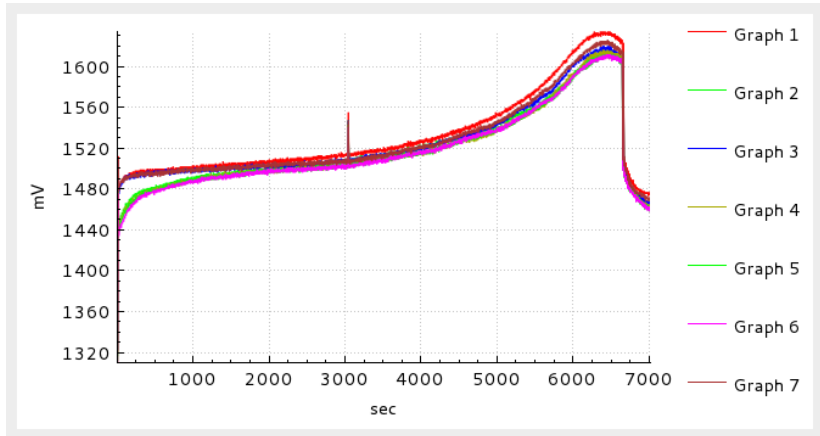
Battery

cellcount	<input type="text" value="3,00"/>	<input type="button" value="OK"/>
chemistry	<input type="text" value="PB"/>	<input type="button" value="Cancel"/>
capacity	<input type="text" value="4000,00"/>	

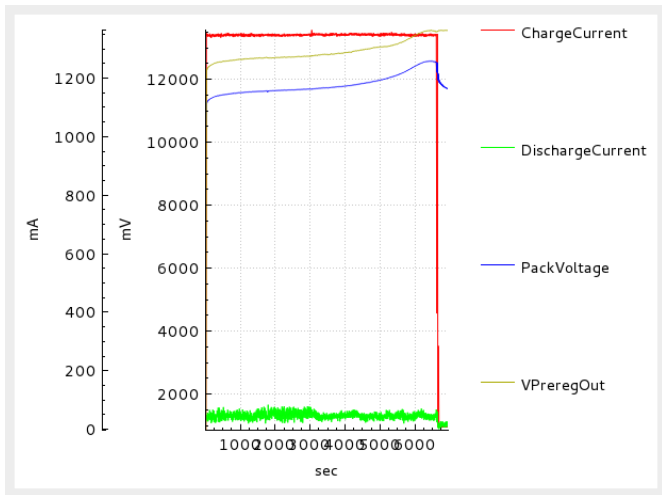
Ladescript Bleiakku (Definition)

```
20 function onStartCharge () {
21     IO.log("Start Charger PB");
22     var chargeAlgo = new CCCV(
23         Battery.cellcount*Configuration.voltageLimit,
24         Battery.capacity*Configuration.chargeRate);
25
26     chargeAlgo.hooks.started = function(){
27         Driver.resetDataStorage();
28     }
29     chargeAlgo.hooks.finished = function(){
30         Driver.saveDataStorage(sprintf("PB charge from %s"
31             ,(new Date).toLocaleString()));
32         sleep.start();
33     }
34     ...
35     chargeAlgo.start(); }
```

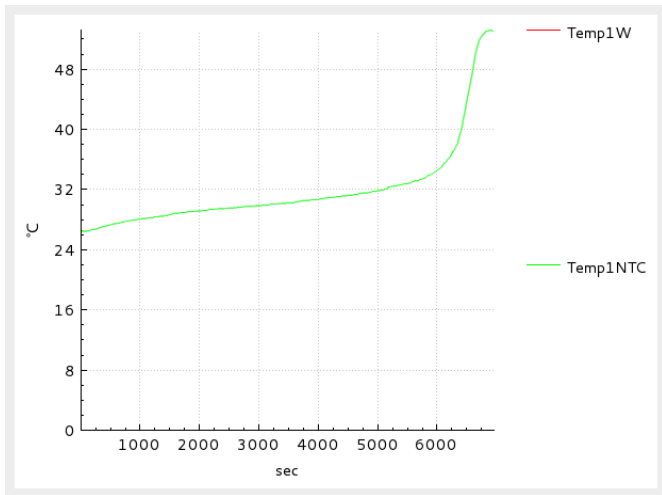
Ni-Mh Ladevorgang Zellspannungen



Ni-Mh Ladevorgang Pack



Ni-Mh Ladevorgang Temperatur



Zusammenfassung Aufbau

- 1 Prototyp: RaspberryPi, Display ...
- 2 Platinensätze
 - Steuermodul: 1 PCB, 105 Bauteile
 - Treibermodul: 3 PCB, 385 Bauteile
- Software
 - Steuerung: 5678 Zeilen (24709 Gesamt)
 - Controller: 6340 Zeilen (16103 Gesamt)
- Diverse Ladeverfahren (Pb, NiMh, C)
 - Laden, Entladen, Effizienzmessung, Balancen

Zusammenfassung Erfahrungen

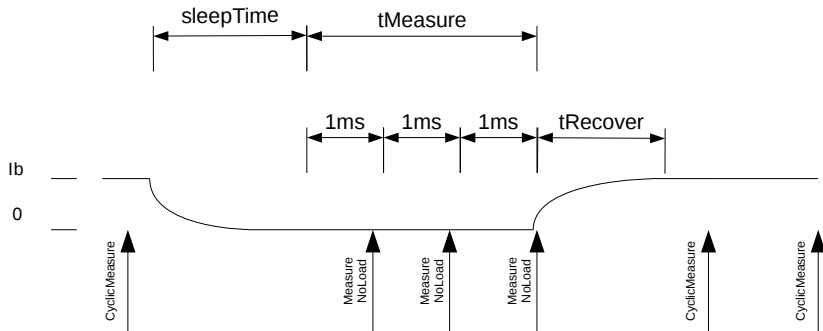
- + PC-basierter Lösung
 - + Qt-Toolkit
 - ± C++
- ± RaspberryPi und Display
 - + Einfach, Leistungsfähig, Linux
 - Stabilität
- + Stapelbares Design

Modulares Universal Ladegerät mit konfigurierbaren Ladeverfahren

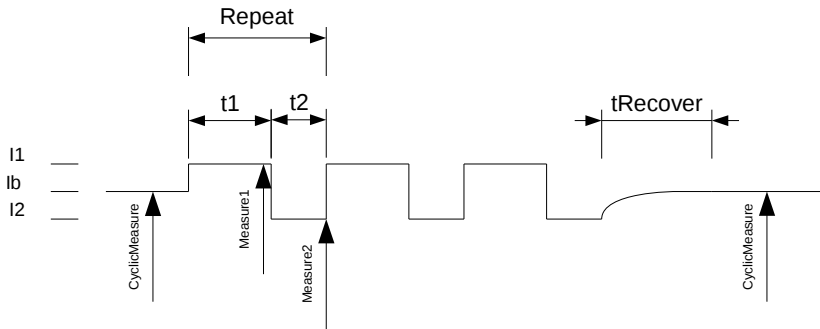
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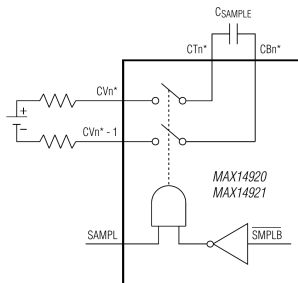
Lastfreie-Messung



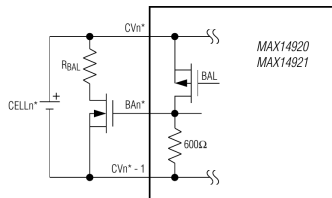
Impedanz-Messung



Balancer IC



Sample Logik



*n = 1–12 (MAX14920) and n = 1–16 (MAX14921)

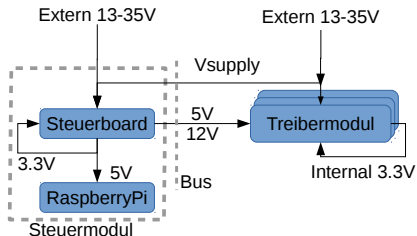
Balancer Logik

Mikrocontroller Firmware

- CMake Bildsystem
 - Einziger Quellcode
- C++ (Templates / Namespaces)
- Logging
- Bibliothek für Hardware Abstraktion
- System Timer Realtime OS

Bus System / Versorgung

- I2C (Option)
- GPIOs (Option)
- SPI (verwendet)



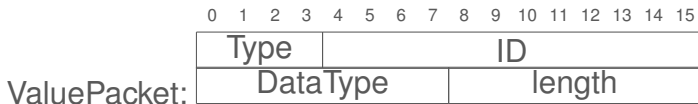
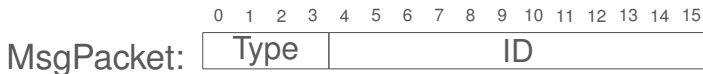
Versorgung

Logging

```

1 LOG_MSG( "Starting up" , 1 );
2 LOG_WARNING( "A Warning" , 2 );
3 LOG_ERROR( "An Error" , 3 )
4 int i = 0;
5 LOG_VALUE(i,4);
6 LOG_ASSERT( i== 0, "Initialisation failed", 5 );

```



Log Viewer Application

LogViewer

File Log

SerialPortSelector

/dev/ttyUSB.log2

Close Refresh

2000000

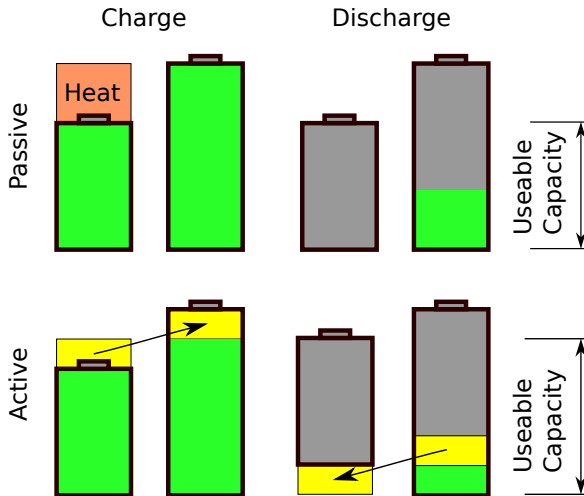
None

Open

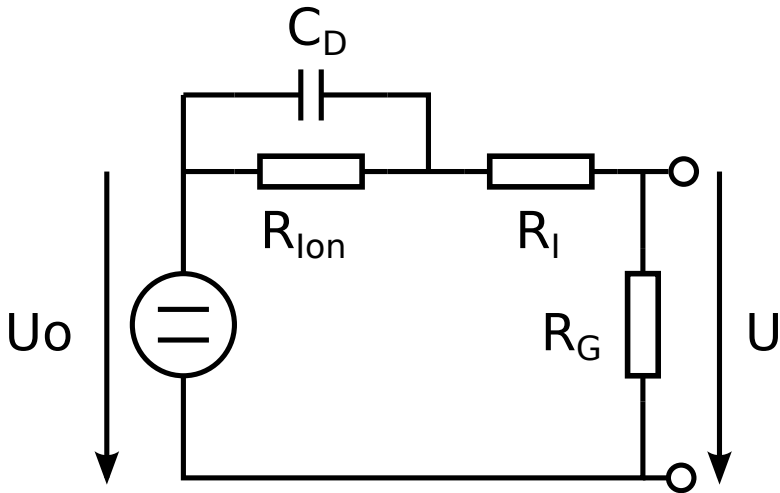
ImportReceived SaveReceived

	time	Id	Type	String/Value	expression	filename	lineNr
1017	233.025...	2101	Message	Driver Startup		/home/chris...	28
1018	233.025...	2202	Message	Driver Startup Finished		/home/chris...	29
1019	233.032...	570	Message	TWIC Init Complete		/home/chris...	32
1020	233.032...	11	Message	Driver Board Starting		/home/chris...	140
1021	233.032...	271	Value	0.9.0-gitM4f3c7ff	VERSIO...	/home/chris...	141
1022	233.038...	615	Warning	Byte skipped while searching f...		/home/chris...	120
1023	233.038...	616	Value	15	data	/home/chris...	122
1024	234.022...	1212	Message	DriverBoard 1sec		/home/chris...	136
1025	235.021...	1212	Message	DriverBoard 1sec		/home/chris...	136
1026	236.021...	1212	Message	DriverBoard 1sec		/home/chris...	136
1027	237.022...	1212	Message	DriverBoard 1sec		/home/chris...	136
1028	238.021...	1212	Message	DriverBoard 1sec		/home/chris...	136
1029	238.021...	1212	Message	DriverBoard 1sec		/home/chris...	136

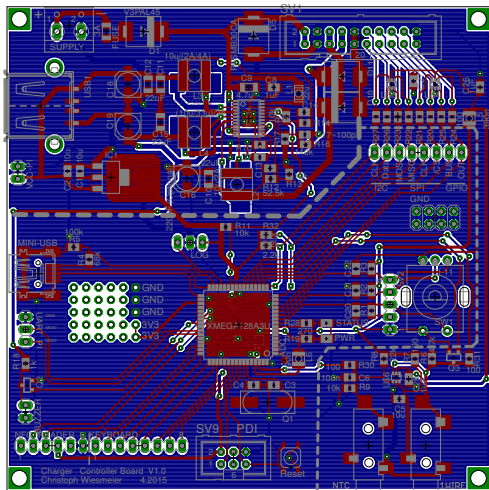
Balancing



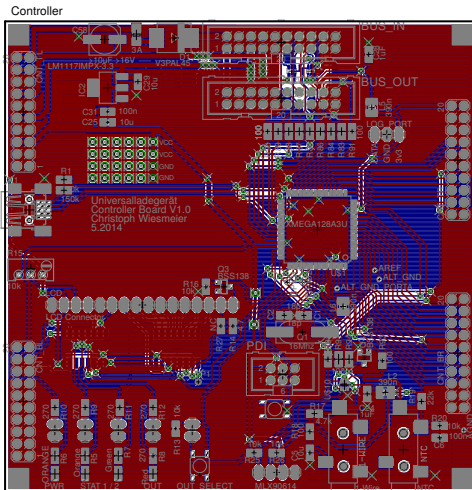
Batterie Ersatzschaltbild



PCB Steuermodul

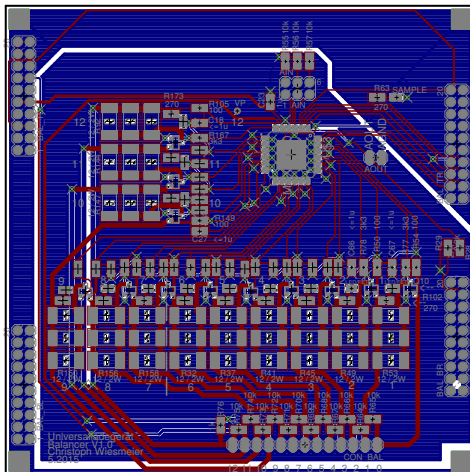


Controller Board



Balancer Board

Balancer



Power Board

