**Date:** 8/22/2010 **Time:** 10:33 **Entry:** 001 **Title:** RGB Lightsaber v1r5 Redesign

This past weekend I once again attempted to construct the RGB Lightsaber, using the chassis I had ordered from the Custom Saber Shop. Unfortunately, an unknown internal short occurred within the lightsaber, destroying the control board. This and other problems have forced me to redesign the RGB driver board, resulting in RGBSaber v1r5. A list of changes to be made in v1r5 include the following:

1. Change power source from 6-AA NiMH batteries to a 2-cel 7.4V Li-Ion pack. In making this change, *undervoltage protection will have to be included in the Li-Ion pack to prevent damage to the batteries.*
2. Flip power converter unit to top-side of the board. The lithium ion protection circuitry may be placed on the bottom of the board.
3. Move RGB led connector from top edge of board to the right side of the board to ease connection issues.
4. Use connectors for all interfaces, to maximize reuse and increase reliability (solder makes for poor mechanical connections).
5. Minimize wiring inside of lightsaber chassis. Try to limit wire lengths to 3 inches or less.

**Date:** 8/26/2010 **Time:** 18:52 **Entry:** 002 **Title:** RGBSaber v1r5 Connectors

Today I am performing redesign work on the RGB Lightsaber, designing and laying out RGBSaber v1r5. In order to get the saber up and running, reliable connectors are going to be required for the design. As such, today’s entry details the search for good connectors to use on the RGB Lightsaber project.

To begin the search, I went to [Molex](http://molex.com) and began looking at the connector options they had, with hopes of getting free samples of some of the connectors. Promising connectors included the Molex PicoBlade connectors for the Peripheral board connection. Unfortunately, after additional searching, it was discovered that the crimping tools needed for the PicoBlade connectors were prohibitively expensive (hundreds of dollars) and cable subassemblies did not appear to be available.

**Date:** 8/27/2010 **Time:** 23:46 **Entry:** 003 **Title:** RGBSaber v1r5 Undervolt Protection

Following yesterday’s connector search, I continued the search for reliable, feasible connectors to use for my RGB lightsaber project today. This time leaving Molex and looking for connector possibilities over at [Tyco Electronics](http://tycoelectronics.com), I found some additional promising possibilities. Particularly promising were the [Micro-MaTch](http://www.tycoelectronics.com/catalog/feat/en/c/11398?BML=10576,17560,23645,17587) and [MTA 100](http://www.tycoelectronics.com/catalog/feat/en/s/23478?BML=10576,17560,23645,17587) connectors. More promising still, a crimping tool was available for these connectors at a very low, reasonable price of $18.

Having found a reasonable connector option for the board, I proceeded to investigate undervoltage protection options for the lightsaber power circuitry. In order to meet acceptable size requirements, rev5 of the lightsaber circuitry is to be powered by a 2-cell 7.4V Li-Ion battery pack. To prevent damage to the Li-Ion pack, a simple analog comparator circuit will be connected to the input voltage of the control board. This circuit will be designed to kill power to the circuit in the event that the battery pack voltage drops below 5.6V (signifying an undervoltage condition).

**Date:** 9/1/2010 **Time:** 18:42 **Entry:** 004 **Title:** RGBSaber v1r5 Undervolt Protection 2

Research continued on the Li-Ion undervoltage protection circuit. Comparator circuits were investigated for their use within the RGBSaber control circuit. I was hoping to utilize a comparator with an integrated voltage reference, however, these were shown to be prohibitively expensive. Therefore, a general purpose comparator will be used, with a Zener diode providing a reliable onboard voltage reference.

**Date:** 9/1/2010 **Time:** 21:10 **Entry:** 005 **Title:** RGBSaber v1r5 Battery Pack Research

Further research on lithium ion battery packs revealed that lithium ion packs can be purchased which incorporate integrated circuitry protection, negating the need for onboard circuitry protection on the lightsaber board. After some research, [this battery pack](http://www.batteryjunction.com/tenergy-18650-2200-pk.html), found at [BatteryJunction](http://www.batteryjunction.com/) showed particular promise for use in the RGB lightsaber.

Given that the new Li-Ion battery pack incorporates integrated protection circuitry, no schematic redesigns appear to be necessary to implement v1 rev5. The battery pack and an associated [Li-Ion charger](http://www.batteryjunction.com/unsmchforlib.html) were ordered for use in the RGB Lightsaber design.

**Date:** 9/3/2010 **Time:** 02:02 **Entry:** 006 **Title:** RGBSaber v1r5 PCB Redesign

Having some free time to spare, I redesigned the layout of the RGB lightsaber, creating the RGBSaber v1r5 board. Changes made to the new version of the PCB include rotating the onboard primary decoupling capacitor, flipping the voltage regulator to the “top” side of the board, and moving the LED connector to the front of the board for easier access to the LED within the lightsaber chassis. I ran the design through Eagle’s built-in DRC program, but will probably submit it to peer review by one or more ECE friends before ordering it.

**Date:** 9/5/2010 **Time:** 17:06 **Entry:** 007 **Title:** RGBSaber v1.5 Parts/PCB Ordering

Today I ordered parts to construct the RGBSaber v1r5 (hereafter referred to as RGBSaber v1.5). Additionally, I added some finishing touches to the RGBSaber v1.5 PCB, such as fixing some ground plane isolation issues and tenting all the vias on the board, which had been suggested by Ben. With those changes implemented, I panelized the control board and an older version of the peripheral board, and ordered these boards from [4pcb.com](http://www.4pcb.com).

**Date:** 9/11/2010 **Time:** 22:41 **Entry:** 008 **Title:**RGBSaber Chassis Plans

I finally opened the parts I had ordered from DigiKey only to discover that the Li-Ion battery pack I had ordered was ever so slightly too wide to fit inside of the nice MHS main body tube I had ordered from the Custom Saber Shop. As luck would have it, however, the Li-Ion battery pack was just barely able to fit inside the 1.5” sink tube that I had been using for the original RGB lightsaber chassis. I ordered a pair of sink tube to MHS adapters from the Custom Saber Shop to try to utilize this quality. After doing so, however, I discovered that the sink tube fits just over the outside of the MHS tube. Therefore, the current plan is to use the MHS hilt as the core of the saber build and then extend the hilt as needed with some 12” sink tube.

**Date:** 9/17/2010 **Time:** 02:05 **Entry:** 009 **Title:** RGBSaber v1.5 Failure

RGBSaber v1.5 PCBs arrived today and, in what has become profoundly predictable, the v1.5 RGBSaber prototype contained vast imperfections, and, among other things, does not function properly. The cause of this is unknown, but probably has to do with the fact that I foolishly believed I could get something right, ever. V1.6 will undoubtedly be created, but in the meantime, here is a list of issues and mistakes made in building v1.5:

1) Tyco MTA100 connectors obscure the silkscreens on the busses they are associated with

Solution: Add silkscreens to bottom of board

2) Switching transistors have very thin wire supplying power from microcontroller

Solution: Reroute board to supply direct power main to switching transistors,

Add power line audits to PCB design check

3) Battery header, program header, and DC/DC Converter are spaced close together

Solution: No solution at present time

4) Standoff hole near battery header is partially obscured by battery header

Solution: Add spacing around left side standoff holes

5) Resistors under DC/DC Converter need to be more centered to provide balance

**Date:** 9/17/2010 **Time:** 02:38 **Entry:** 010 **Title:** RGBSaber v1.5 Revisions Cont.

6) Resistors/Capacitors need to be standardized to smaller part size (0805 or 0406)

7) Consider relocating resistors beneath DC/DC converter to underside of board

In spite of the unfortunate outcome of the RGBSaber v1.5 board, a few good things did come out of it. In particular, I now have the tools and materials to implement connectors on my board, which is so useful I think I will mandate it for all multi-board projects. Additionally, the creation of RGBSaber v1.5 facilitated the development of the project notebook template, which has been quite helpful in documenting work on the RGB lightsaber project.

**Date:** 10/11/2010 **Time:** 01:43 **Entry:** 011 **Title:** RGBSaber build progress update

It’s been quite awhile since I have documented the state of the RGBSaber project, largely because there hasn’t been much to report in the way of actual development work of the circuit boards. After troubleshooting the first RGBSaber board I constructed a second board, fixing the power wiring to the transistors problem (outlined above). Upon doing so, the RGBSaber v1.5 board worked correctly and demonstrated all current functionality. Thereafter, I constructed the first fully-operational RGBSaber model, and have been working slowly on documenting the complete build process for RGBSaber v1.5.

**Date:** 10/11/2010 **Time:** 01:49 **Entry:** 012 **Title:** RGBSaber power electronics error

I took the RGBSaber over to Eric Lauber’s house to demonstrate it’s functionality today. It worked for a little while, and then broke mysteriously. After careful diagnostic work of the RGBSaber, it has been determined that the control electronics of the RGBSaber were not the source of the failure, but rather some as-of-yet unidentified issue with the device power supply. Taking a voltage reading of the battery voltage through the charge port jack yielded very low voltage values (~0.125V) and a resistance measurement of the power jack suggested that no internal shorts were occurring between power and ground. In light of this information, the only current suspect for the RGBSaber failure is a broken or faulty wire within the RGBSaber. More diagnostic work will be done on the saber to try to determine the source of the problem.

In the meantime, however, RGBSaber v1.5 is out of the hilt, providing me with a fantastic opportunity to look into streamlining and developing RGBSaber v1.6, planned to be the last revision of RGBSaber v1, which will feature many improvements to the RGBSaber control electronics. Among these are:

RGBSaber\_Control:

1) Use of SMD decoupling capacitor

2) Move to 0805 resistors and capacitors

3) More powerful drive transistors

4) Better DC/DC converter placement (resistors currently under DC/DC Converter)

5) Improved peripheral electronics interface to allow more durable discrete elements to be used with RGBSaber instead of just the peripheral board

6) Move to JST or other small connectors instead of MTA-100 connectors

7) Interface for second pushbutton

RGBSaber\_Periph

1) Use of SMD RGB indicator LED

2) JST or other smaller connector to replace MTA-100 connector

3) Surface mount connector

4) Move back to 2 pushbutton system

5) More durable pushbuttons

**Date:** 11/16/2010 **Entry:** 013 **Title:** RGBSaber v1.6 Upgrade

RGBSaber\_Control:

1) Use of SMD decoupling capacitor

X) Move to 0805 resistors and capacitors

X) More powerful drive transistors

X) Better DC/DC converter placement (resistors currently under DC/DC Converter)

X) Improved peripheral electronics interface to allow more durable discrete elements to be used with RGBSaber instead of just the peripheral board

6) Move to JST or other small connectors instead of MTA-100 connectors

7) Interface for second pushbutton (Ignored)

8) Improved silkscreen

9) Improve spacing for standoffs

10) Replace PIC18F2221 microcontroller with PIC18F2550 microcontroller (more standard part, can be used on other projects)

RGBSaber\_Periph

1) Use of SMD RGB indicator LED

2) JST or other smaller connector to replace MTA-100 connector

3) Surface mount connector

4) Move back to 2 pushbutton system

5) More durable pushbuttons

**Date:** 12/09/2010 **Entry:** 014 **Title:** RGBSaber v1.6, Firmware v2.0 C port

I spent some more time working on the RGBSaber project today. RGBSaber\_control is now at version 1.6 proper, with a silkscreened NBitWonder logo having been applied to the PCB in addition to some other fixes mentioned above. Additionally, Microchip finally released C18 (still in Beta) for their MPLABX platform, meaning I can finally do PIC firmware development on the mac. As such, I have begun a code port for RGBSaber in C.