

PLOTTER PROJECT

DOCUMENTATION

2016.06.02



PUBLIC



SECURE CONNECTIONS
FOR A SMARTER WORLD

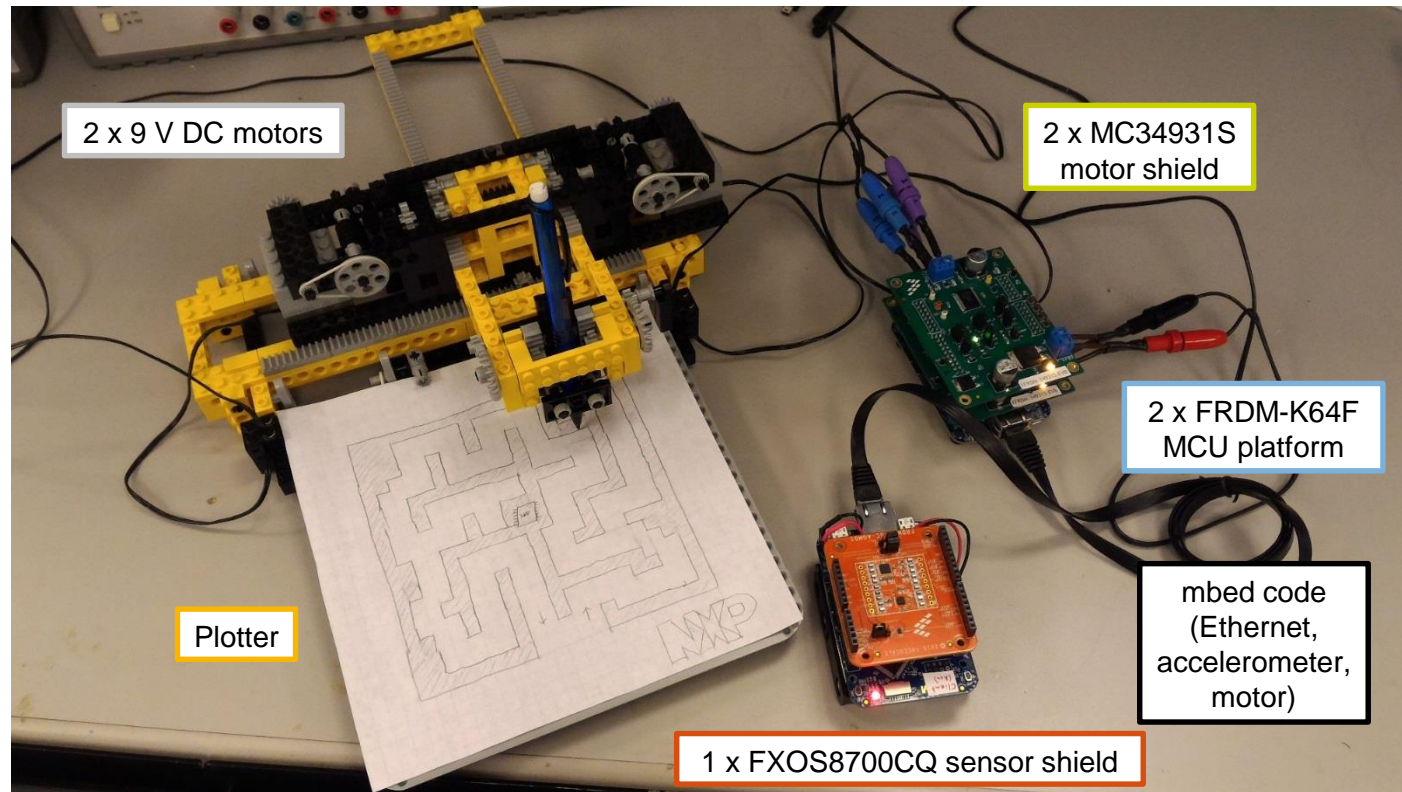
Contents

- [Plotter Project](#)
- [Required Materials](#)
- [Hardware System Setup](#)
- [Board Modifications](#)
- [Mechanical Modifications](#)
- [Hardware Modifications](#)
- [Software](#)
- [Operating Instructions](#)



Plotter Project

- External equipment needed
 - Power outlet

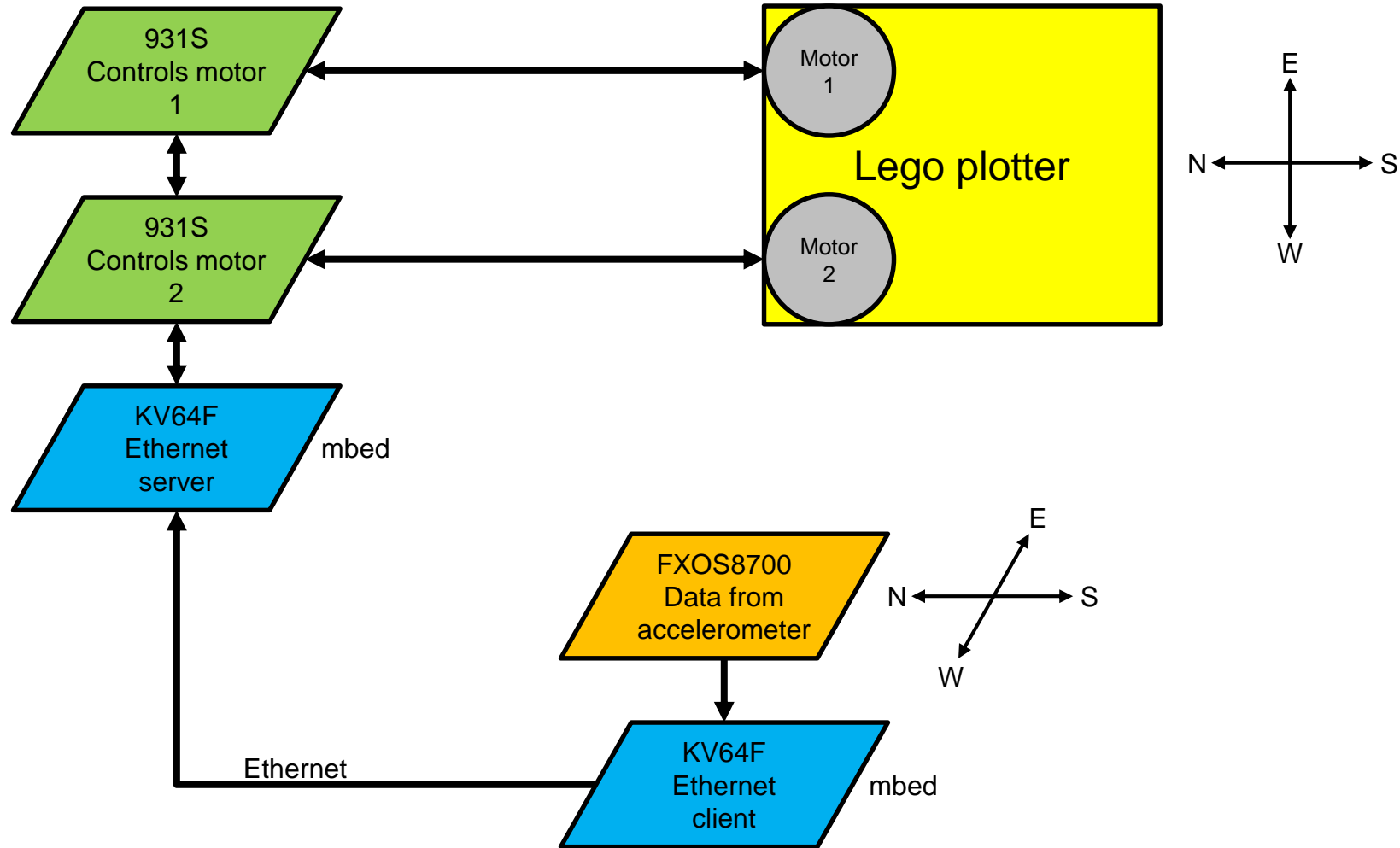


Required Materials

Qty	Name	Description	Link	Cost
1	8094 "Control Center" Lego set	Includes all parts and instructions for plotter	http://alpha.bricklink.com/pages/clone/catalogitem.page?S=8094-1#T=S&O={}	\$100
1	Power supply (9 V)	Supplies power to 931 boards	http://www.amazon.com/ZOZO-Universal-Regulated-Replacement-Electronic/dp/B015PXUHYA/ref=cm_cr_pr_product_top?ie=UTF8	\$10
2	FRDM-34931S-EVB	Motor control for DC motors	http://www.nxp.com/products/power-management/engine-and-dc-motor-control/h-bridges/freedom-expansion-board-for-mc34931-brushed-dc-motor-driver-h-bridge-20khz:FRDM-34931S-EVB	\$150
2	FRDM-K64F	One gets information from accelerometer The other drives the 931 boards	http://www.nxp.com/products/software-and-tools/hardware-development-tools/freedom-development-boards/freedom-development-platform-for-kinetis-k64-k63-and-k24-mcus:FRDM-K64F	\$70
1	FRDM-STBC-AGM01	Accelerometer board	http://www.nxp.com/products/software-and-tools/hardware-development-tools/freedom-development-boards/sensor-toolbox-development-platform-for-fxas21002c-and-fxos8700c-9-axis	\$16
1	Battery pack (6V)	Supplies power to acc board	http://www.ebay.com/itm/5-Pcs-4-AA-Cells-Battery-6V-Clip-Holder-Box-Case-with-Switch-Black-/321833305704?hash=item4aeec28668:g:3f8AAOSwyQtV3nnh	\$1
1	Ethernet cable	Facilitates FRDM to FRDM communication	http://www.amazon.com/StarTech-com-Black-Molded-Patch-Cable/dp/B0002GRUGO/ref=sr_1_29?s=electronics&ie=UTF8&qid=1447441827&sr=1-29&keywords=ethernet+Crossover+Cable	\$4
1 2 1	FRDM Connectors	SSQ-110-23-F-S SSQ-108-23-F-S SSQ-106-23-F-S	https://www.samtec.com/ (you can get free samples through their sample program)	
1 1 1 4 3 1	Soldering iron/solder Wire cutters/strippers Heat shrink Extra wire AA batteries Double-sided foam tape Banana jacks/plugs Ink pen	To attach battery pack to FRDM board 1 x red/black, 2 x blue/purple For drawing		
Total cost				~\$351



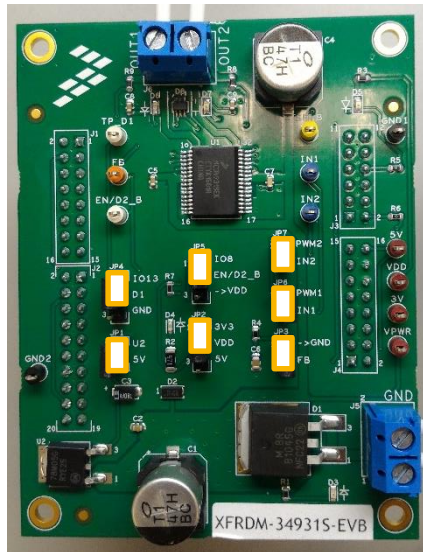
Hardware System Setup



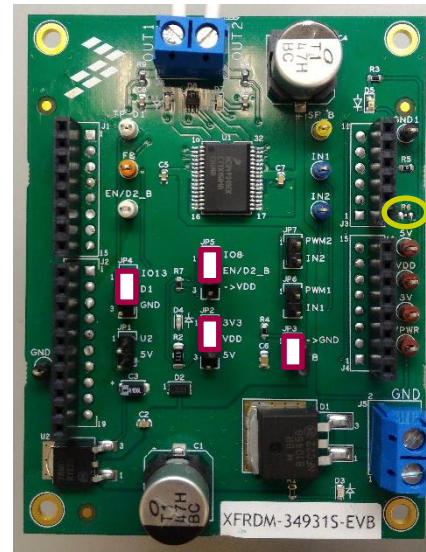
Board Modifications

- Modify stacked boards
 - #1/#2 Set jumpers as shown in image
 - #2 Replace male headers (J1-J4) with female/male connectors (female up, male down, only the outer row is needed)
 - #2 Reroute via wire the following signals on the BACK:
 - IN2 to J2/8
 - IN1 to J2/6
 - FB to J4/4 (remove R6)
 - ACC Remove jumpers and short as shown
 - Replace female/male connectors with downward facing male headers (reduces height)

#1 front



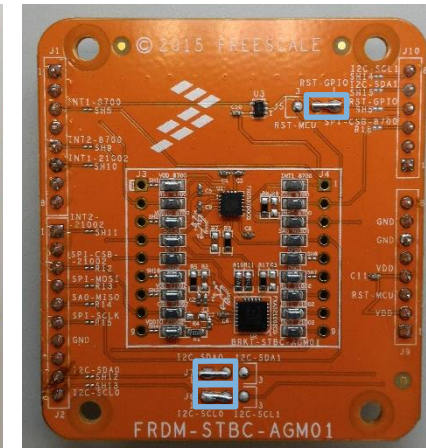
#2 front



#2 back

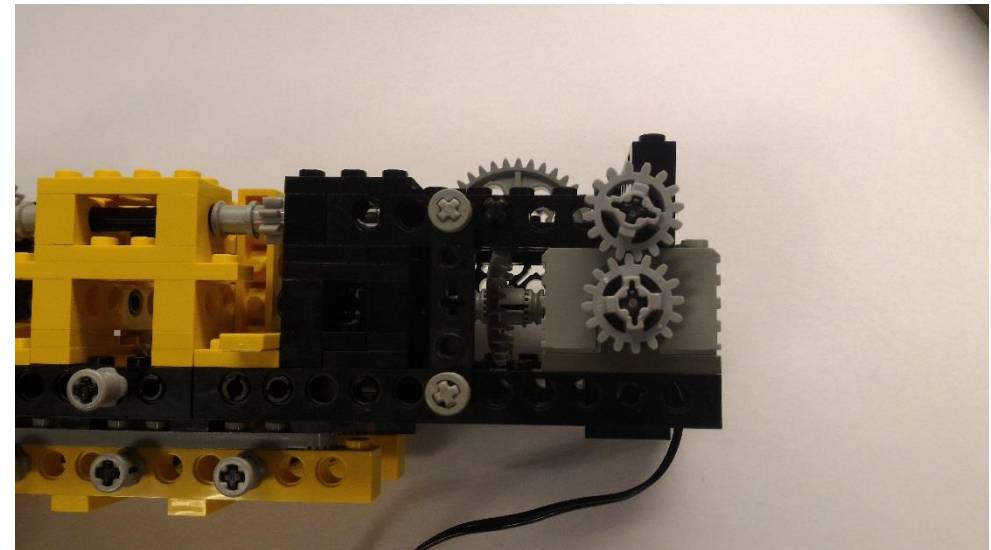
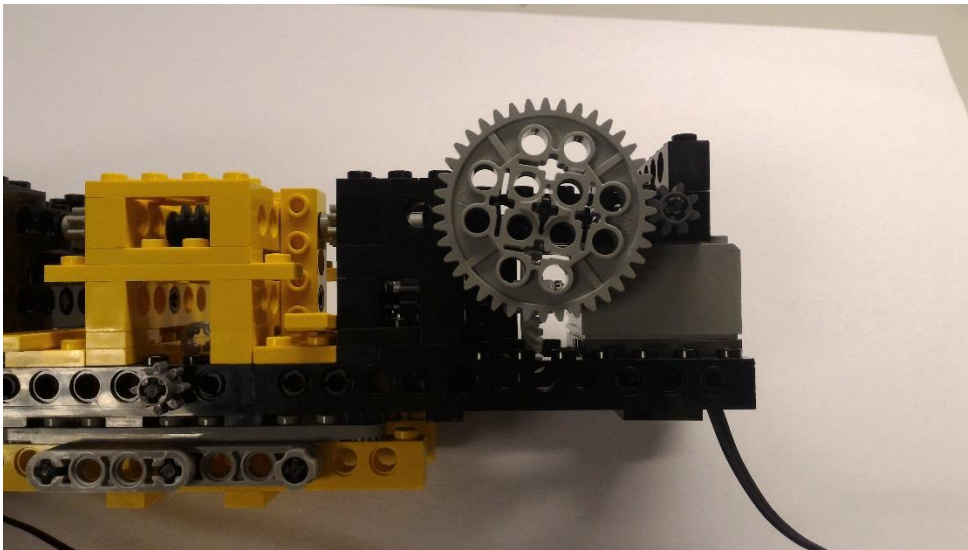


ACC



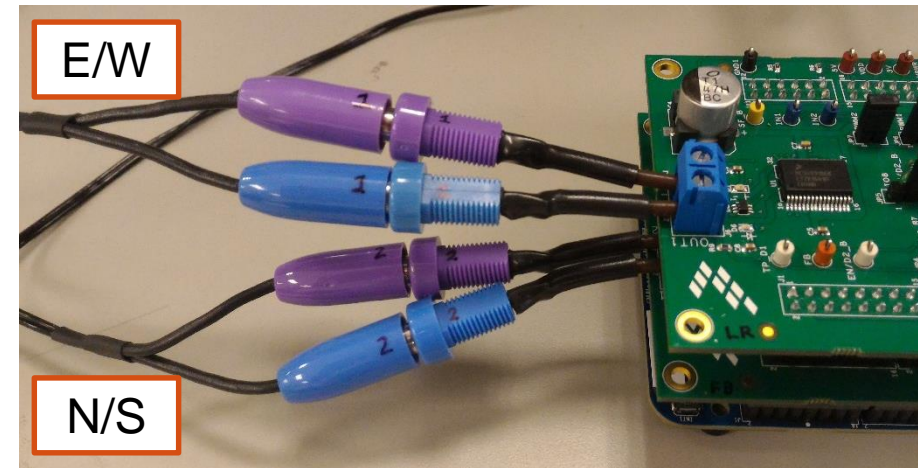
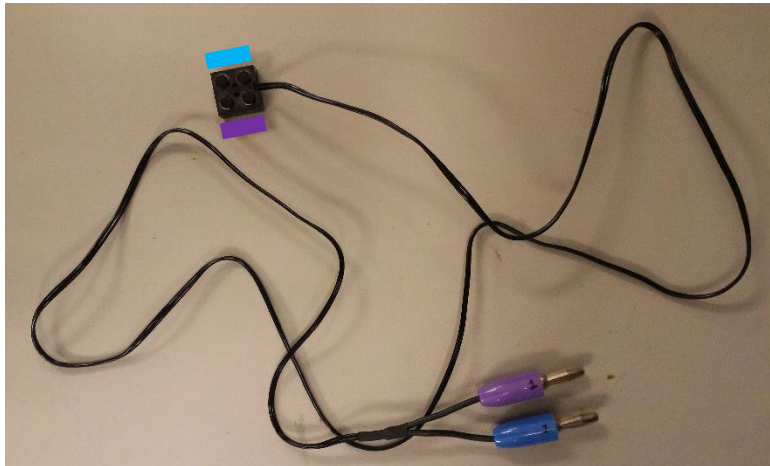
Mechanical Modifications

- Replace the rubber band wheels on the front with gears (this makes it less slippery)
- Replace the gears on the back with the gears shown in the picture (this tunes the motor to the right speed, but this can be changed based on the code)
- **NOTE:** The original LEGO set may not have enough gears for the second modification. Spare gears can be easily obtained on eBay.



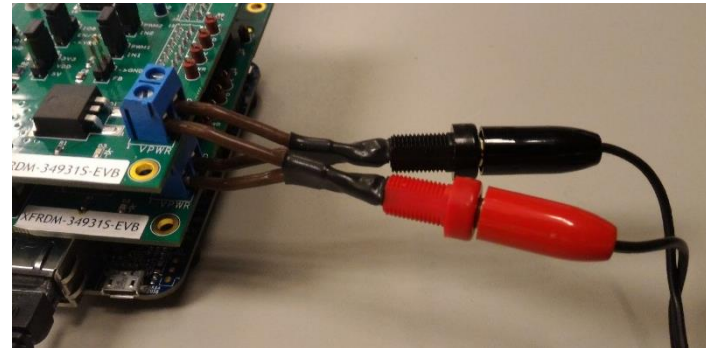
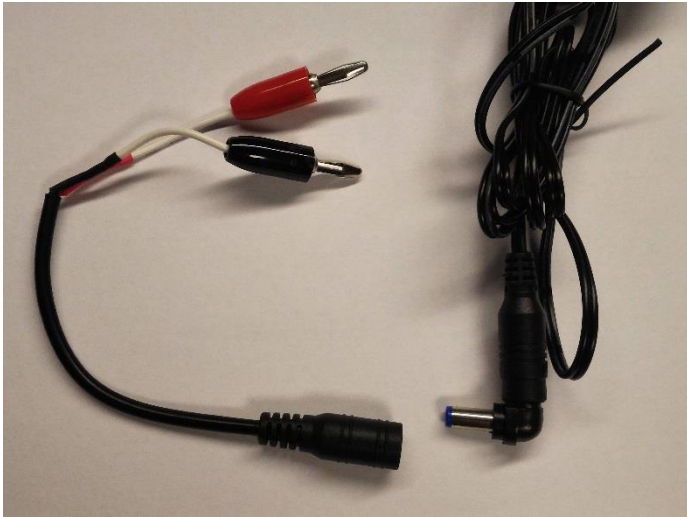
Hardware Modifications

- Prepare motor wires
 - Cut 6"/15cm of wire off the two long Lego wires
 - Split wires (long section) and attach banana-plugs (blue on left, purple on right)
 - Make banana-jack to screw terminal wires (blue for OUT1, purple for OUT2)
 - Label board #1 banana-jacks and East-West motor cable banana-plugs as #1
 - Label board #2 banana-jacks and North-South motor cable banana-plugs as #



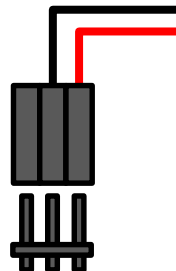
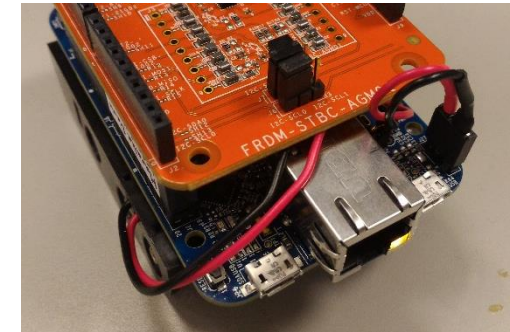
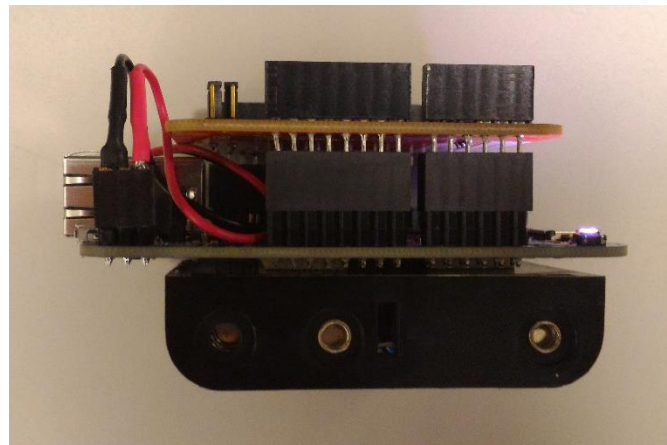
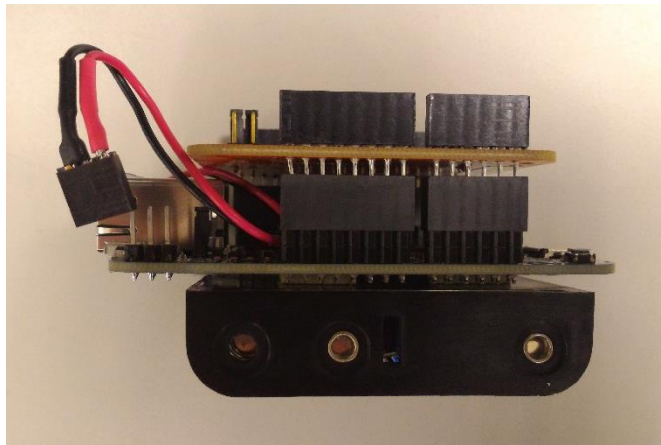
Hardware Modifications

- Modify 9V power supply
 - Add banana-plugs to power supply pigtails (make sure you get the terminals right)
 - Make banana-jack to screw terminal wires (four wires, two banana-jacks)
 - Set the power supply to 9V



Hardware Modifications

- Modify battery pack
 - Add three pin header on FRDM-K64F (acc) J27
 - Make female three pin plug for battery pack (pin 1 = VBAT, pin 2 = GND)



Software

- Flash the acc-client board with the [DEMO_plotter_acc-client](#) mbed program
- Flash the mot-server board with the [DEMO_plotter_mot-server](#) mbed program

The code is commented.

Disclaimer: This is very, very, very simple code and has flaws. There is no guarantee it won't accidentally launch your project into space, so use at your own risk.

There's plenty of room for improvement!

Operating Instructions

1. Assumptions: Lego plotter is already assembled
2. Connect the blue and purple banana-plugs on the Lego wires to the correct motor boards
3. Connect the Ethernet cable between the two FRDM-K64F boards
4. Connect the 9V power supply to the motor boards; turn it on
5. Connect the 6V battery pack to the accelerometer FRDM-K64F board
6. Wait ~18 for the Ethernet to connect
7. When the server module (motor boards) and the client module (accelerometer board) light up green and red, respectively, the plotter is ready

Operating Instructions cont.

- Warnings
 - If power to the client module is lost or the Ethernet cable is disconnected, the plotter may malfunction; avoid doing either of these
 - Avoid letting the motors driving the pen continuously into the edge of the board; this may damage the motor
- What Ifs
 - The spinning motors do not match the tilting of the accelerometer
 - Swap #1 and #2 cables
 - Swap blue and purple cables
 - NOTE: do not split one Lego cable between two boards
 - Something malfunctions
 - Reset server board with RESET button, then reset client board with RESET button
 - Unplug/plug in 9V from/to server board, unplug/plug in 6V from/to client board



SECURE CONNECTIONS
FOR A SMARTER WORLD