

# Robot Electronics

StuySplash – Dec 15 2012

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# Overview

Troubleshooting your control system

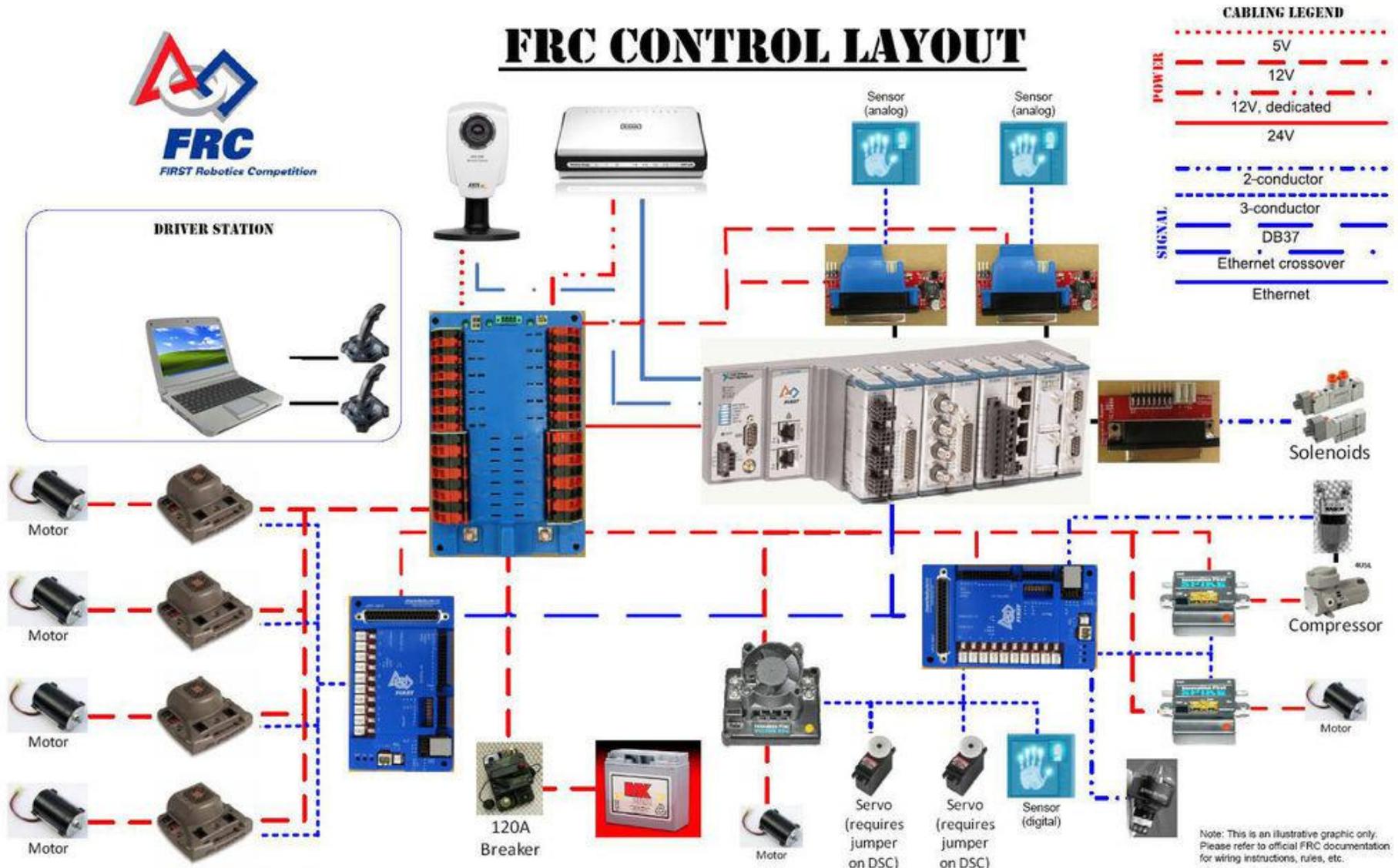
Good wiring practices

Recommended tools

What's new in 2013 & why it matters



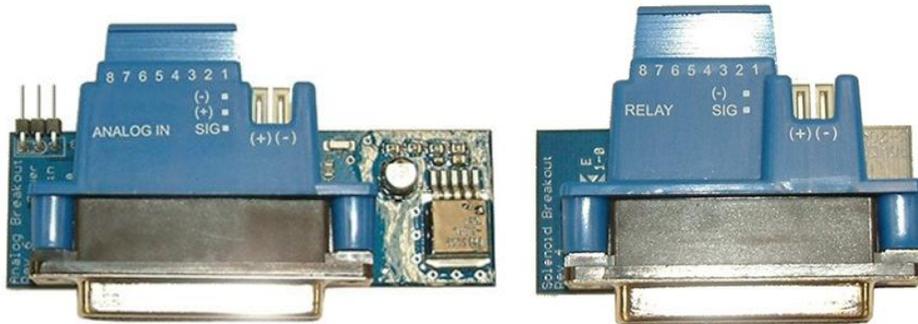
**DISCLAIMER: This diagram is not up to date. Please do not use this as a reference guide.**



Source: <http://www.instructables.com/id/Control-System-Basics/?ALLSTEPS>

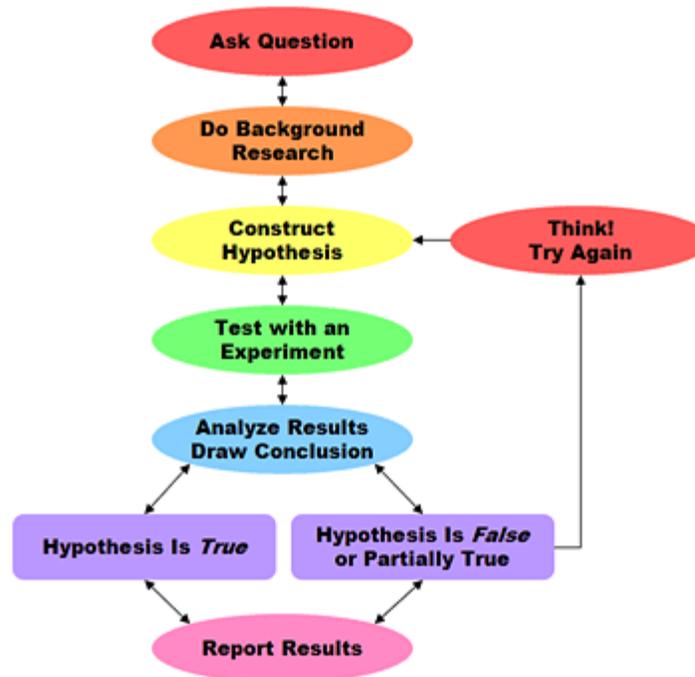
# the nerve centers

common problems:  
not using the dedicated outputs  
plugging something in backwards  
ignoring the lights



# Troubleshooting

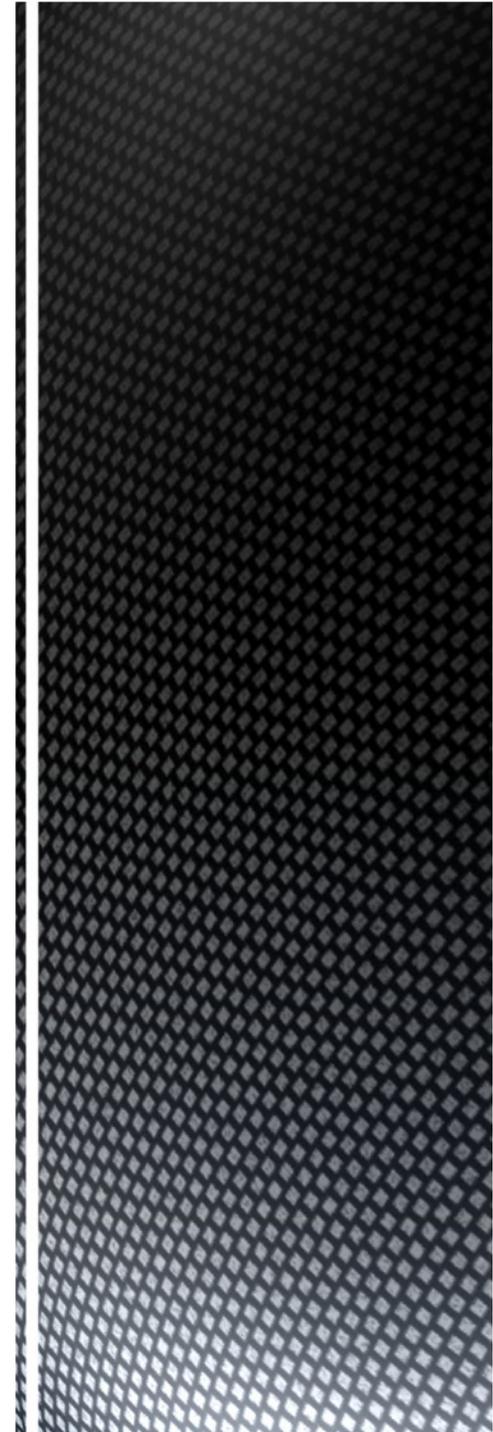
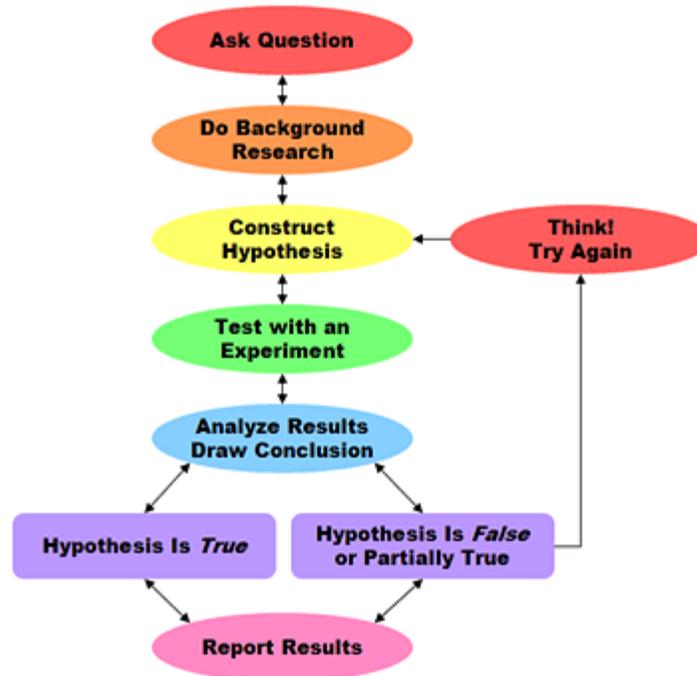
remember this?



# Troubleshooting

remember this?

what kinds of variables are there in experiments?

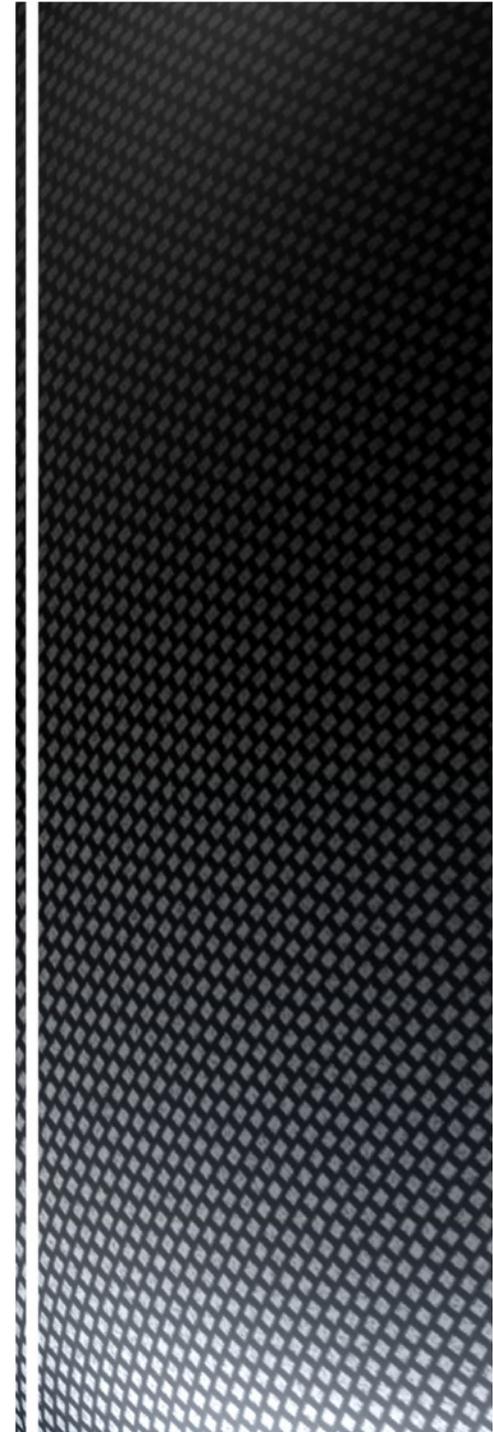
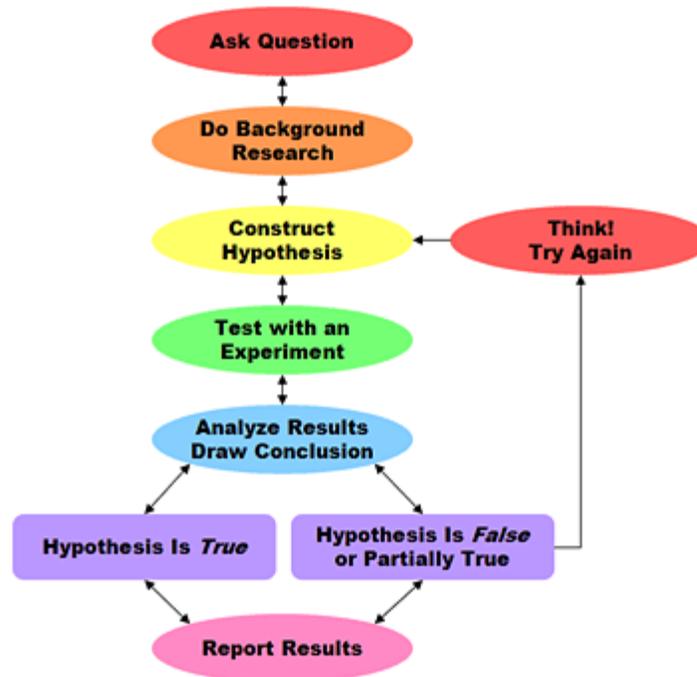


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what is the goal of your "experiment"?



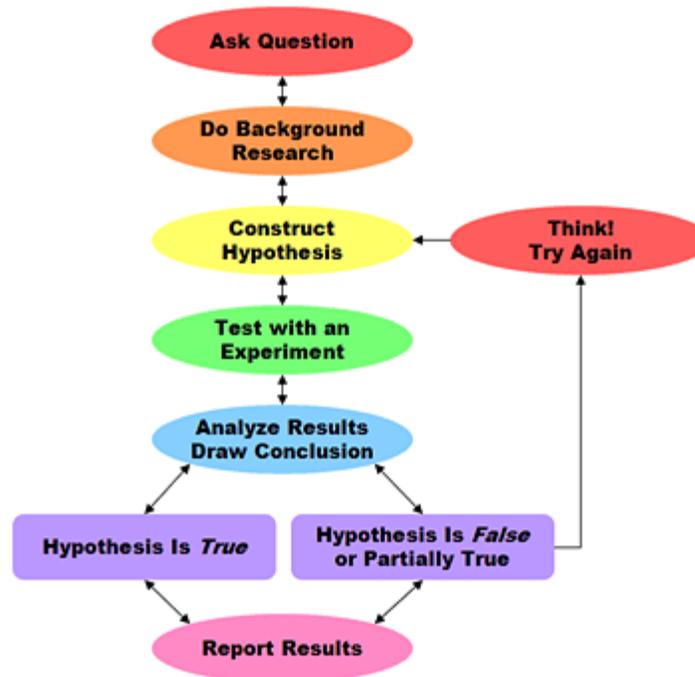
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changing item X does nothing.  
what can we conclude?



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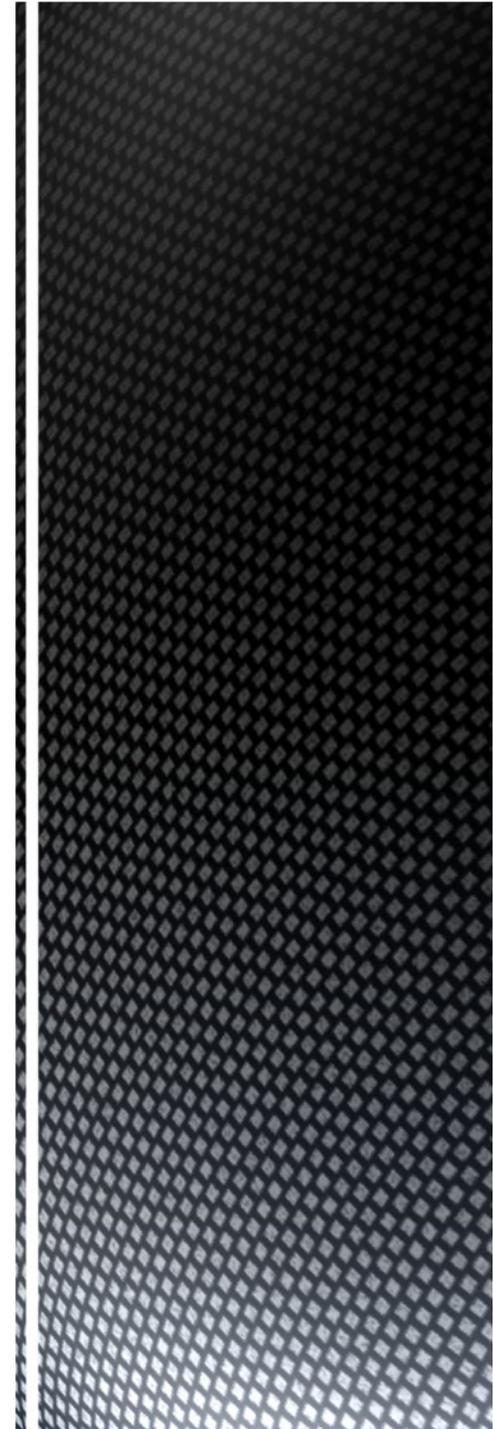
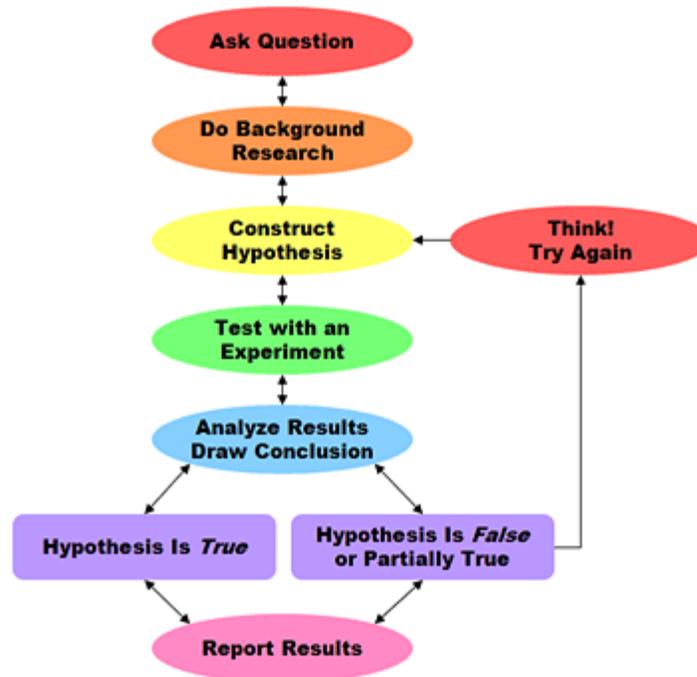
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wait, changing item X does something!

...but item X isn't broken and something is still going wrong.



# Troubleshooting

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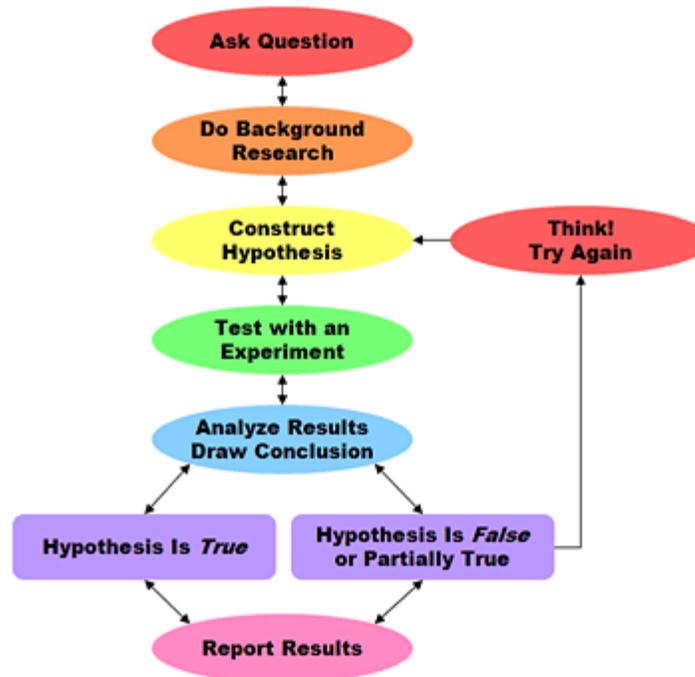
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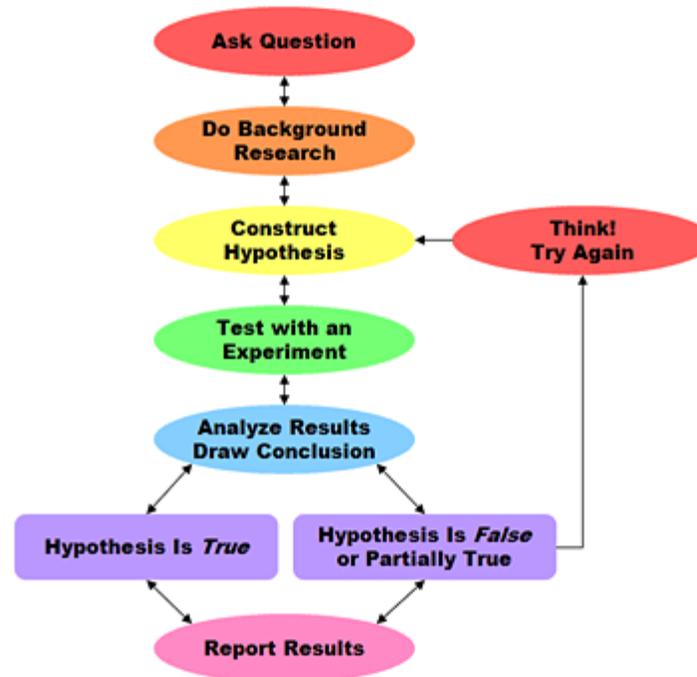
rinse and repeat.



# Troubleshooting

keep these in mind:

occam's razor



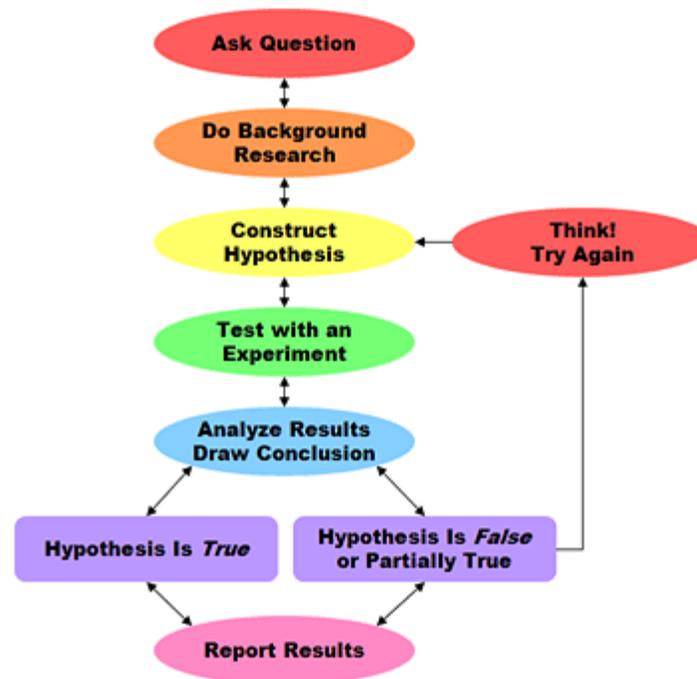
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half your sidecar doesn't work?

check the power.



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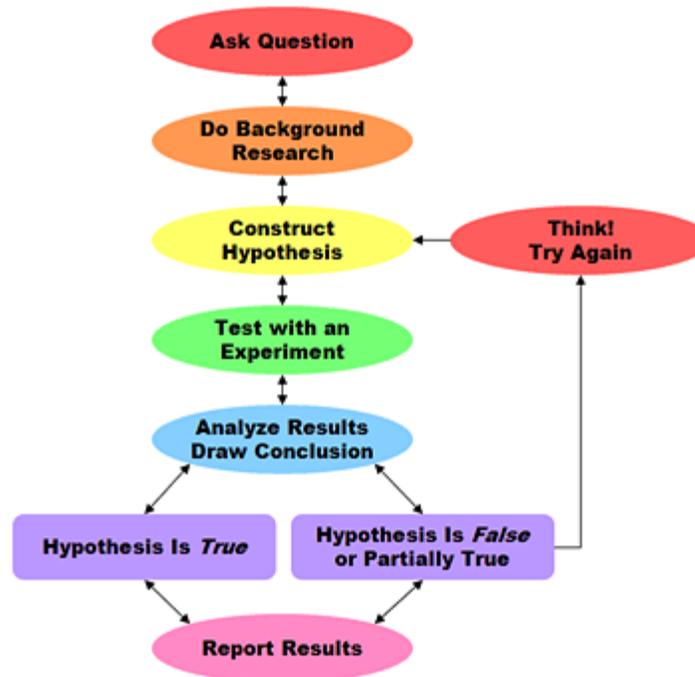
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comms dropping? how long are you losing comms for? are the D-link lights flickering? are ethernet port lights not staying on?



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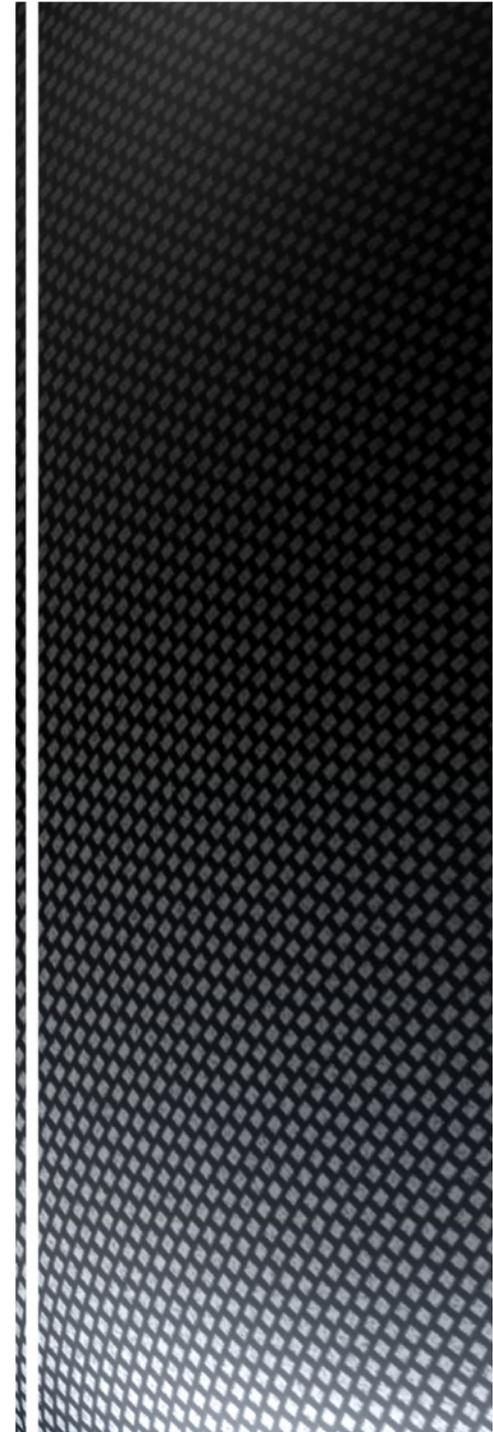
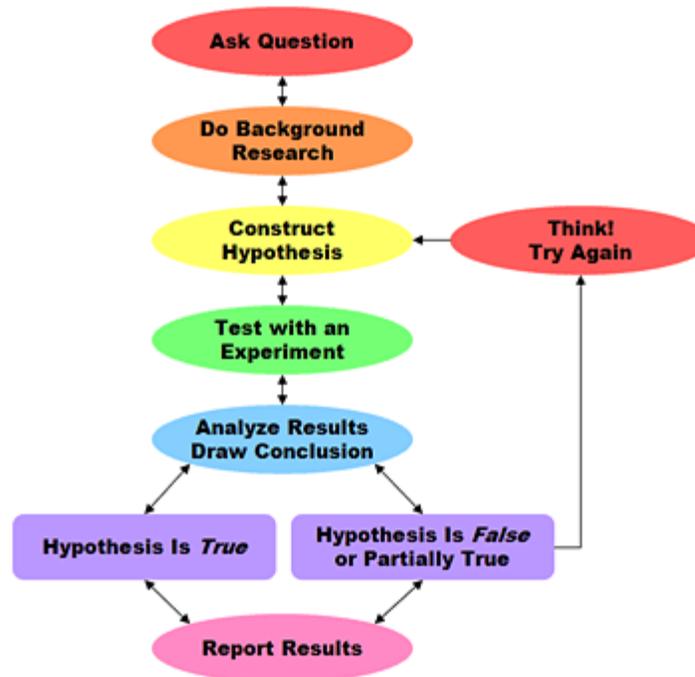
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test one variable at a time! – if  
replacing item X with X2 does  
nothing, bring X back - problems  
can sometimes have multiple  
driving factors



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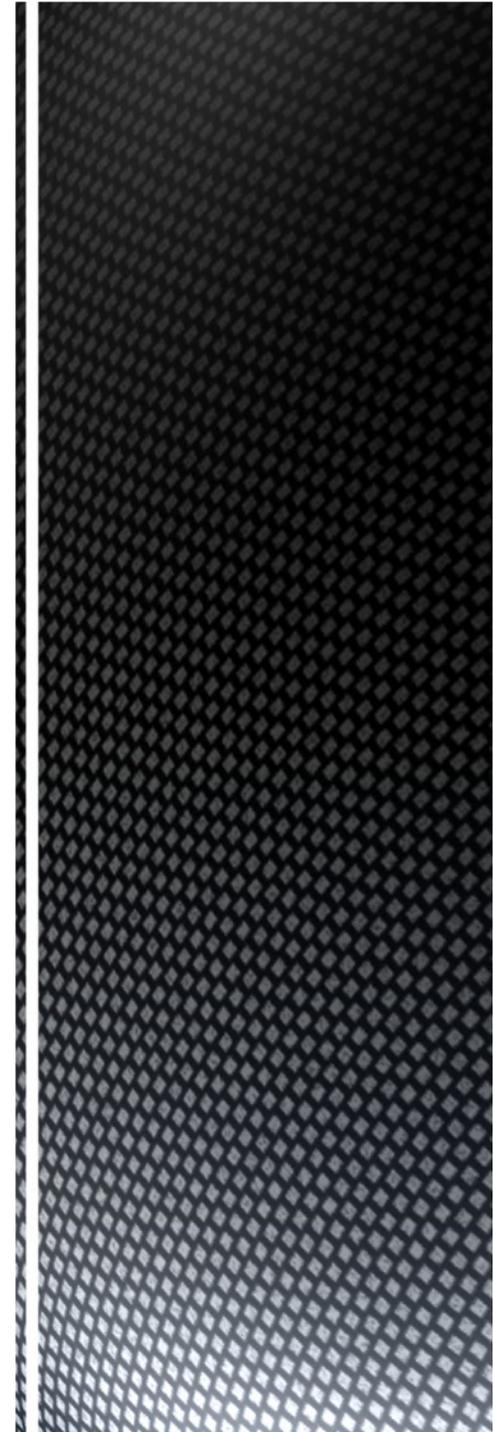
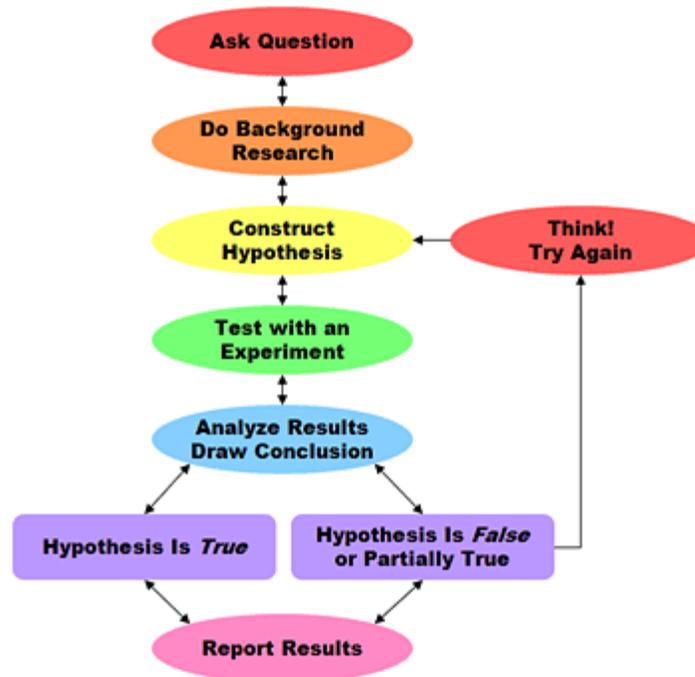
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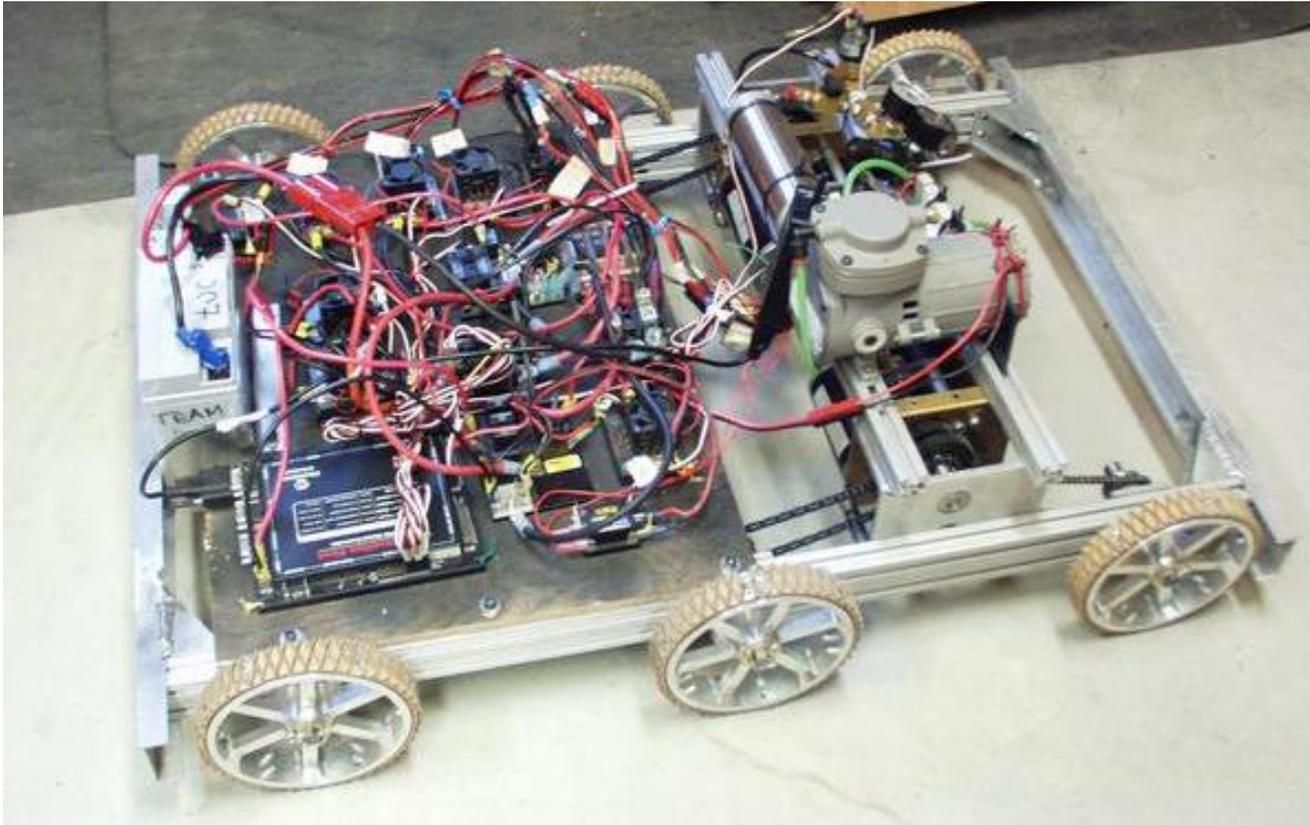
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using Jaguars on CAN? know the  
errors. minimum one guy on  
electrical, one guy on programming  
who knows them inside out.



# Wiring practices

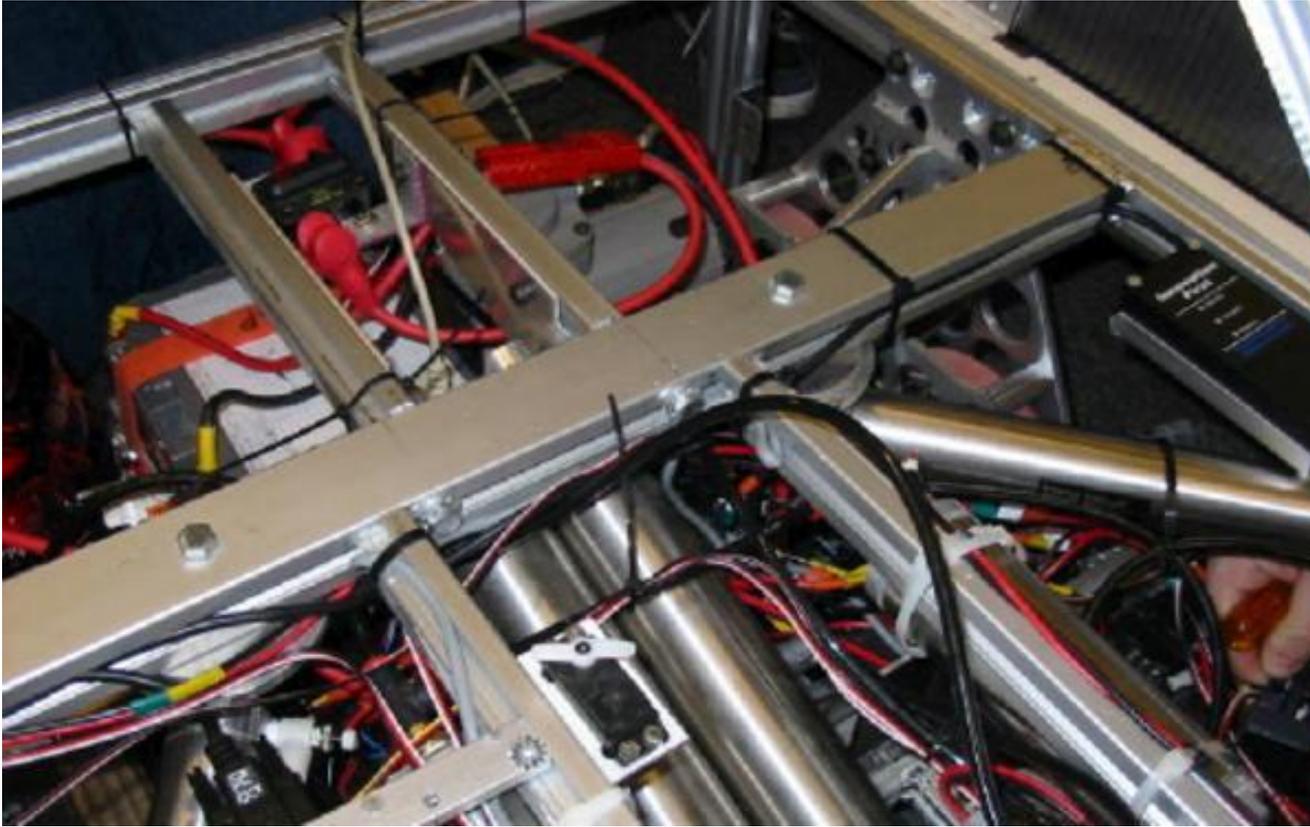


Source: Martin Taylor, FRC100 Wildcats

what here is good? what here is bad?



# Wiring practices



Source: pras870, FRC870 R.I.C.E.

what about here?



# Wiring practices

do:

color-code & label!

red & black for  
power

white for signal

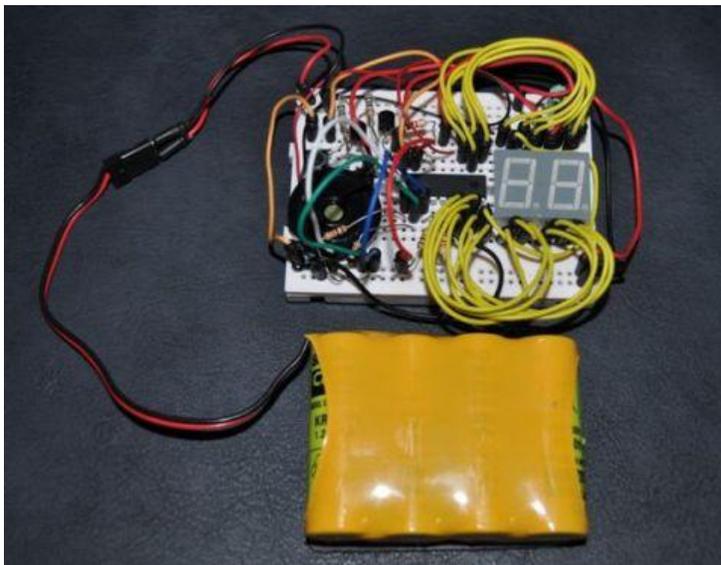
never use other  
colors

i use heat shrink to  
color-code/label

long wire runs and  
sticker labels for

CAN IDs, PWM

ports, etc



quick! which wire do I cut?



# Wiring practices

do:

modularity, continued

i like quick disconnects:

stud mounting tabs, Digikey A27859-ND

¼" insulated female 14-16AWG, All Electronics 6225

¼" insulated male 14-16AWG, All Electronics 4225

¾" unisulated female 14-16AWG, All Electronics 1250

stud tabs makes swapping speed controllers easier; no need for screwdrivers after assembly

also consider powerpoles:

PP series on Powerwerx

am-2198 on Andymark





# Wiring practices

do:

modularity, continued  
get your own RC cable supplies and  
make them yourself; don't buy them –  
custom-made beats pre-made and  
makes your life a lot easier

i use Hansen Hobbies (alt. Jamesco)  
get female pins, male pins, a LOT of  
servo wire (we use 22AWG economy),  
1x2, 1x3, and 1x5 (for Jaguars)

PRACTICE PRACTICE PRACTICE



# Tools & supplies

wire:

10 or 12 AWG, red and black – zip cord is very good, but errs on the pricey side

depending on usage, 16/18/20/22 AWG, red and black, for sensors and low-power applications

6AWG welding cable for battery cables (also buy red SB50s; they MUST be red)

for a custom OI:

26/28/30 AWG, red/black + assorted,  
uninsulated 22AWG, female and male header  
pins



# Tools & supplies

crimper and strippers: get good ones.

how many of you use this?



# Tools & supplies

crimper and strippers: get good ones.

how many of you use this?

you all suck.



# Tools & supplies

crimper and strippers: get good ones.



Powerwerx CT-75 is to die for (\$17)



← something like this is also decent



there are multiple varieties of good strippers; just don't get automatic ones.

i recommend something like Xcelite 105SCGV (below left) or those that Hansen Hobbies carries, with something like (center left)

if you buy something spring-loaded, make sure it has a lock.

stuff like Xcelite 100X looks ridiculous but *is* good



# Tools & supplies



flush cutter: better than diagonals.



small screwdriver, WAGO-sized, for all the terminals



compact multimeter with good probes, VDC, and audible continuity

RMS/averaging capability also recommended  
we have Digikey BK2700-ND (pictured), but it's out of stock  
Amprobe PM55A (Digikey 705-1030-ND) supposedly good



fine point tip soldering iron w/ stand  
not chisel tip; preferably max 60+W  
also get thin and thick solder  
(18AWG, 28AWG)





# Tools & supplies

ammeter (clamp on) and oscilloscope  
– very utile, but not very critical

power inverter, like the units found in  
car chargers, but adapted for FRC  
(much like the one AM sells)

we took something like the one pictured to the left, hacked the  
car end off, soldered on leads going to a SB50, and filled it in  
with hot glue



small & medium (4" to 8") zip ties

#4-40 and #6-32 hardware

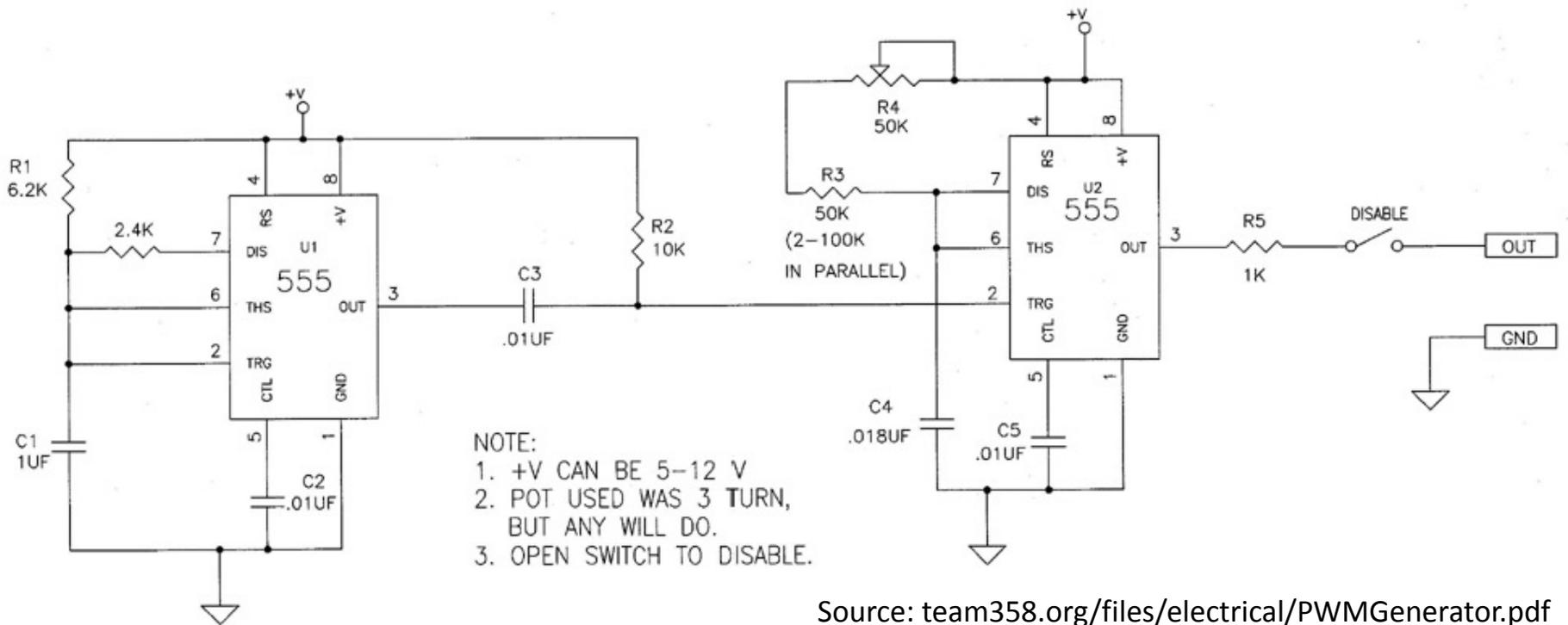
battery load tester

e.g. am-0095 Battery Beak



# Tools & supplies

PWM signal generator  
very useful for troubleshooting – allows you to test whether the problem lies at or downstream from the speed controller, or whether it's upstream from the speed controller



Source: [team358.org/files/electrical/PWMGenerator.pdf](http://team358.org/files/electrical/PWMGenerator.pdf)

# New in 2013

“FRC Blogged - FIRST Choice, 2013 Control System, and Regional Slots

“Blog Date: Friday, November 16, 2012 - 11:16

“Second, all teams will receive in their Kickoff Kit, and be required to use, a new wireless bridge. The new bridge is still a D-Link DAP 1522, but only the hardware Rev B version will be permitted.”

<http://www.usfirst.org/roboticsprograms/frc/blog-11-16-12>



Source: Andymark, am-0839



# New in 2013

Talons, Andymark am-2195, \$60

Victor 888s, VEXPro 217-2769, \$50



# Linearity

all speed controllers use a control signal to determine their power output

joysticks send a signal between -1 and 1  
that signal is converted to a PWM duty cycle  
speed controller converts PWM signal into a voltage between -12V and 12V

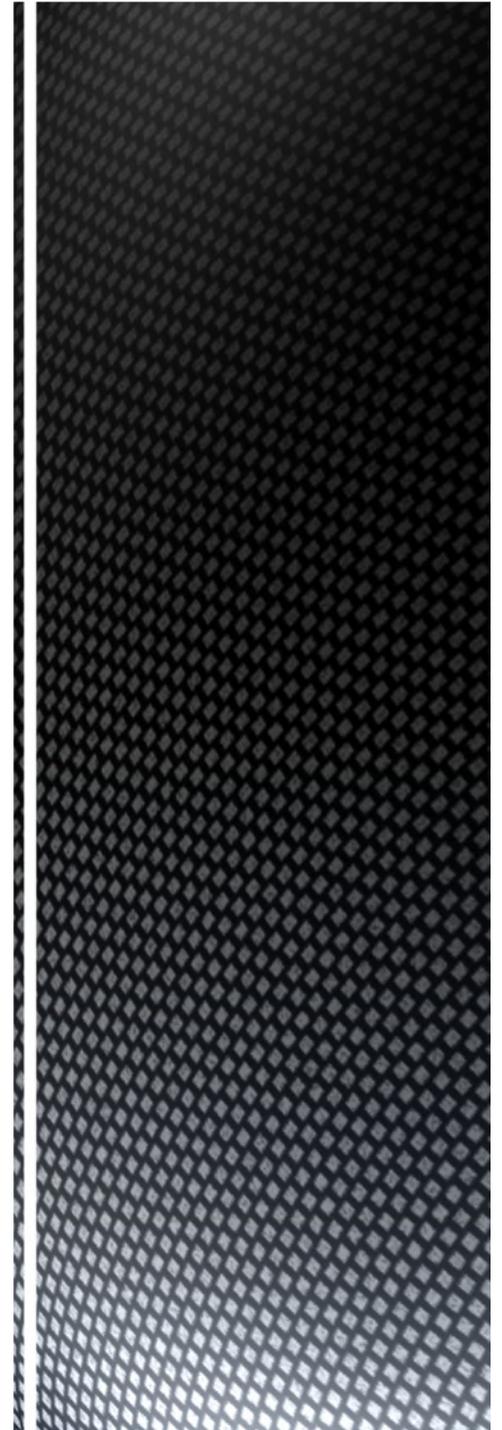


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so if you move the joystick halfway forward,  
what do you expect the speed controller  
output to be?

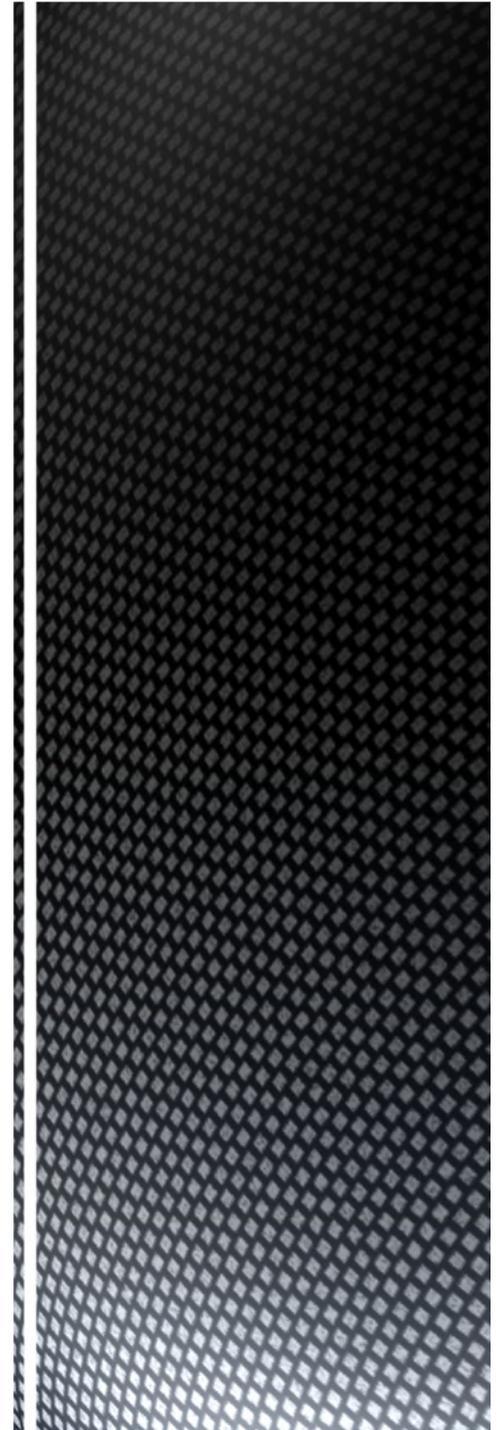


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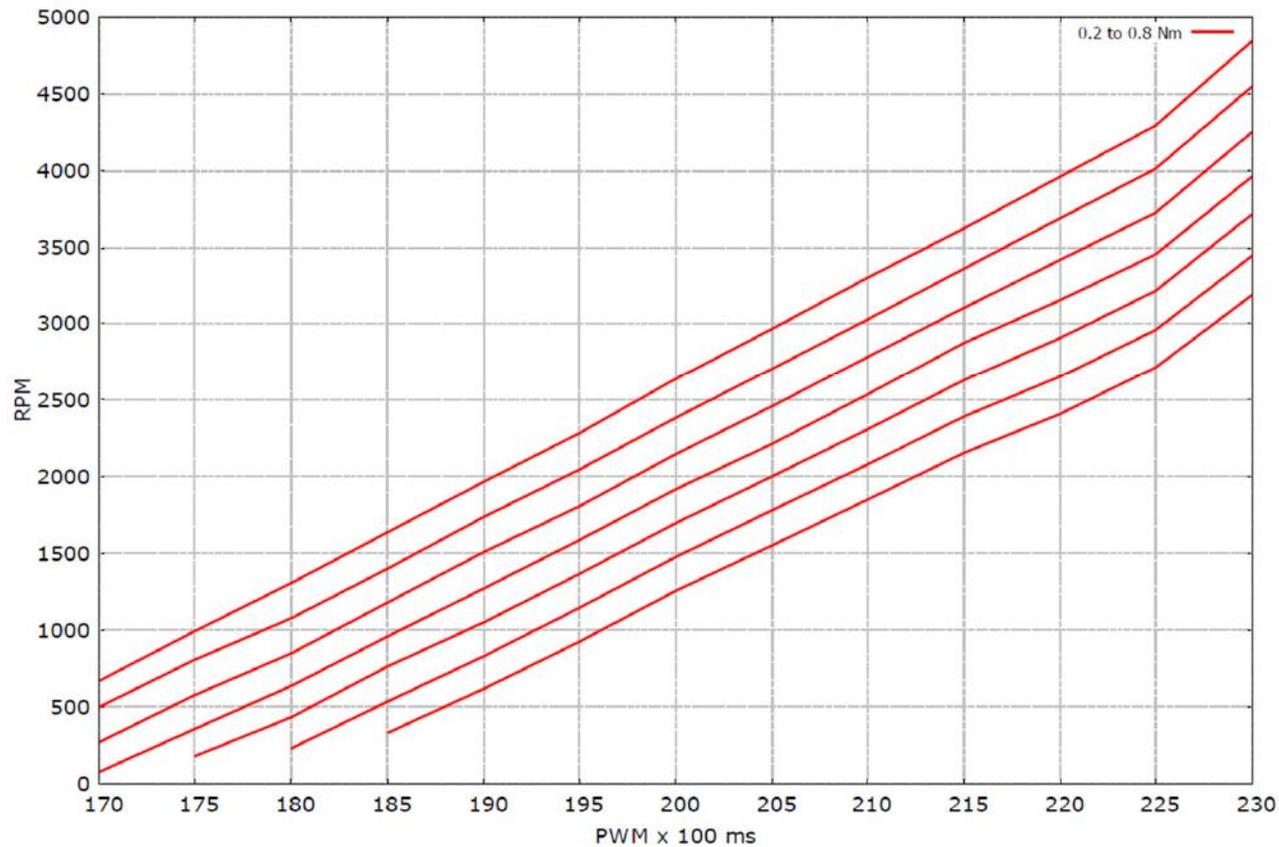


# Linearity

that's true with the Jaguar:

Source: Ether, Chief Delphi

**CIM motor RPM vs PWM**  
FRC battery and **Jaguar** motor controller  
Load torque 0.2 to 0.8 Nm

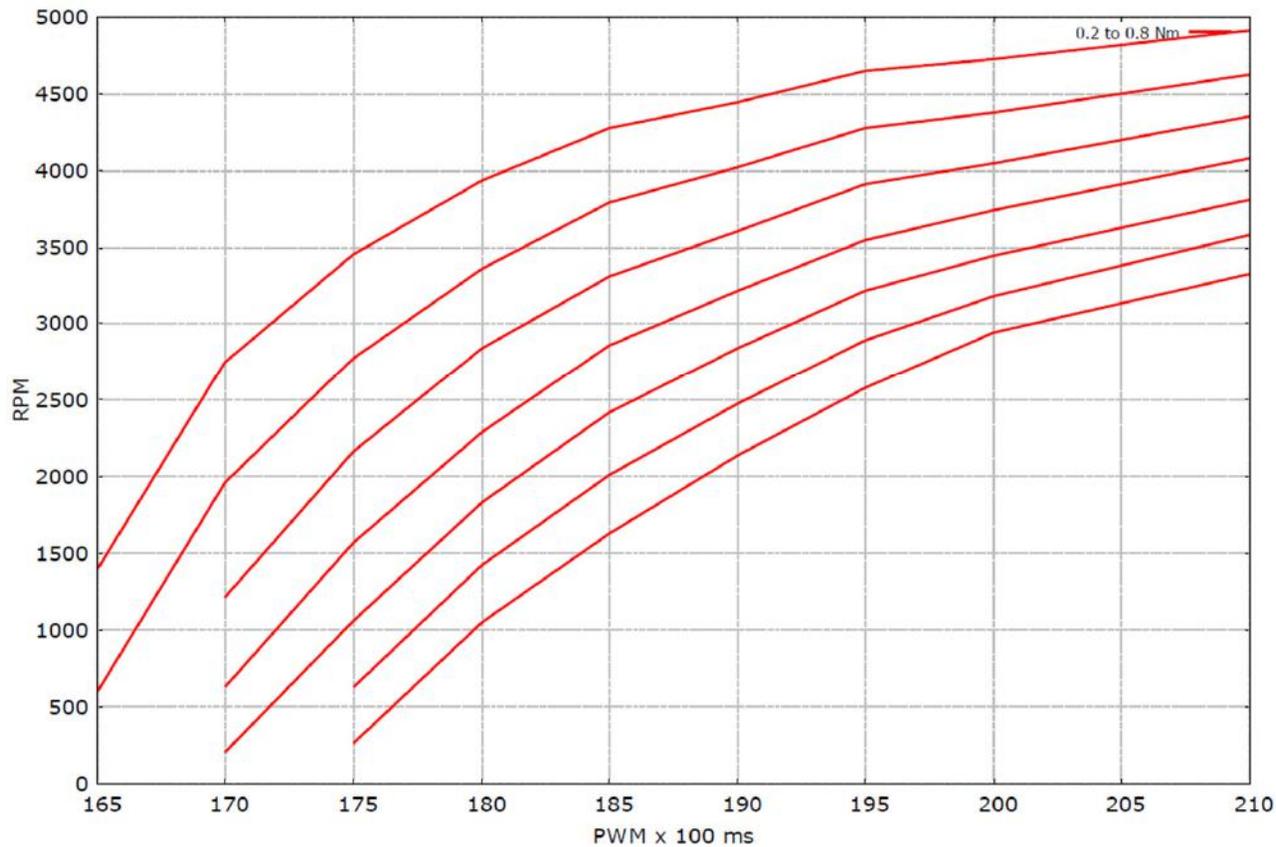


# Linearity

but not with the 884:

Source: Ether, Chief Delphi

**CIM motor RPM vs PWM**  
FRC battery and **Victor884** motor controller  
Load torque 0.2 to 0.8 Nm



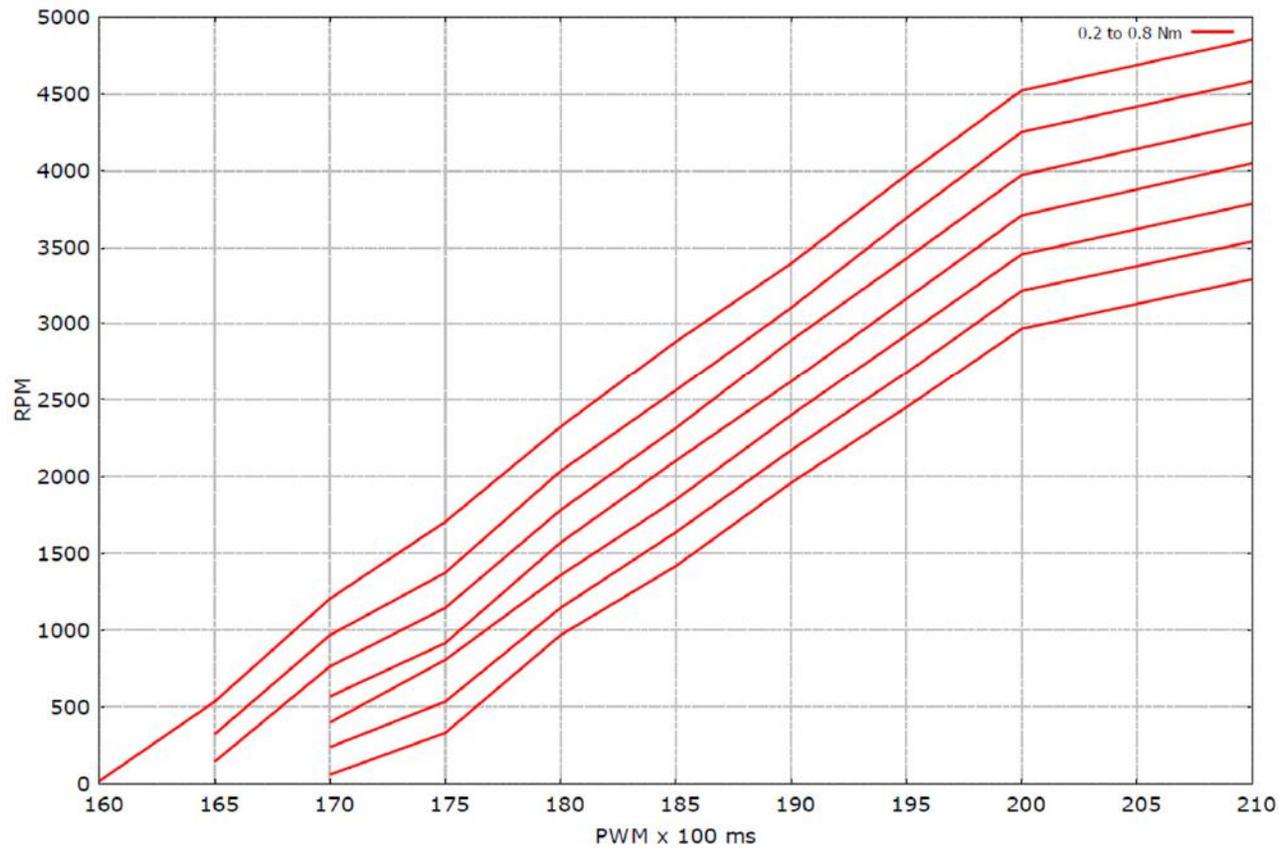
# Linearity

the 888 remedies this:

Source: Ether, Chief Delphi

**CIM motor RPM vs PWM**  
FRC battery and **Victor888** motor controller  
Load torque 0.2 to 0.8 Nm

See endnote 2

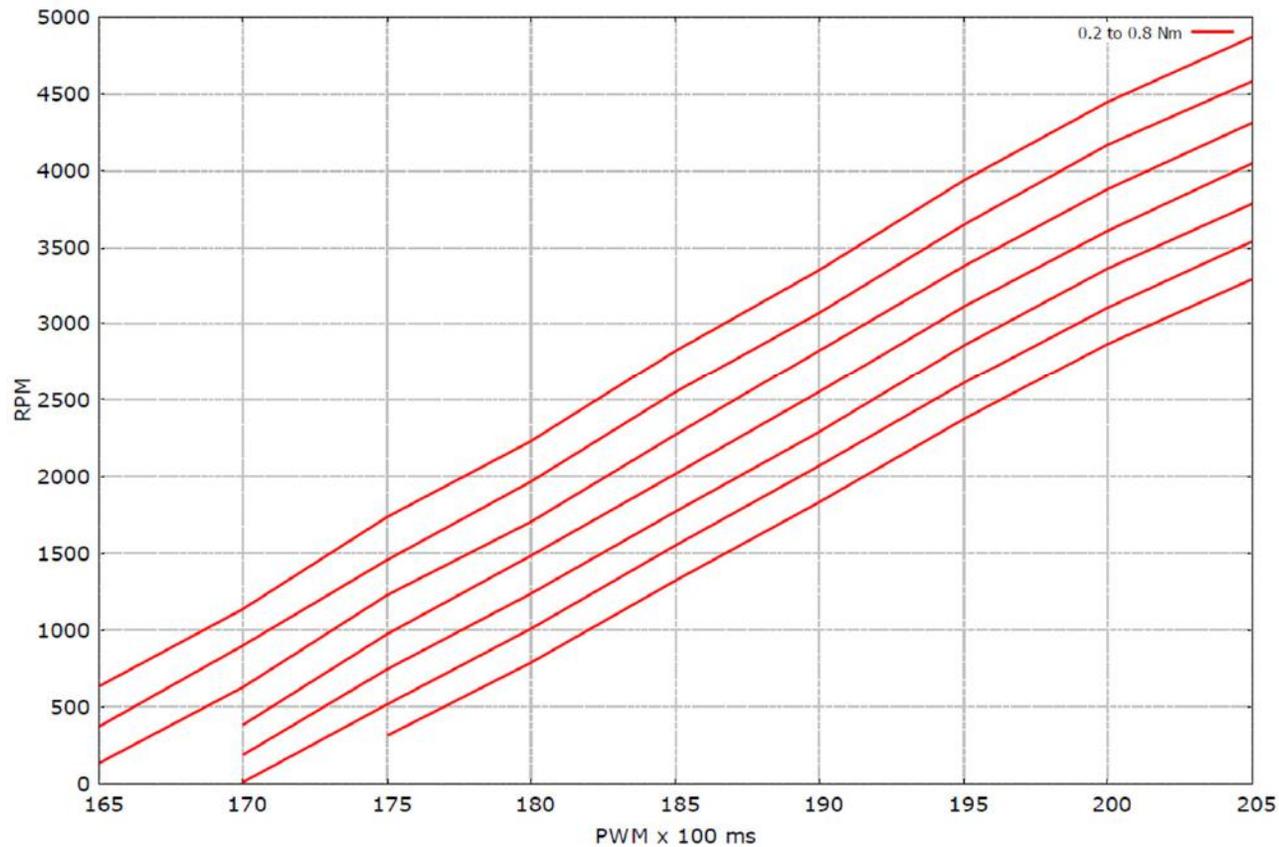


# Linearity

but the Talon does as well:

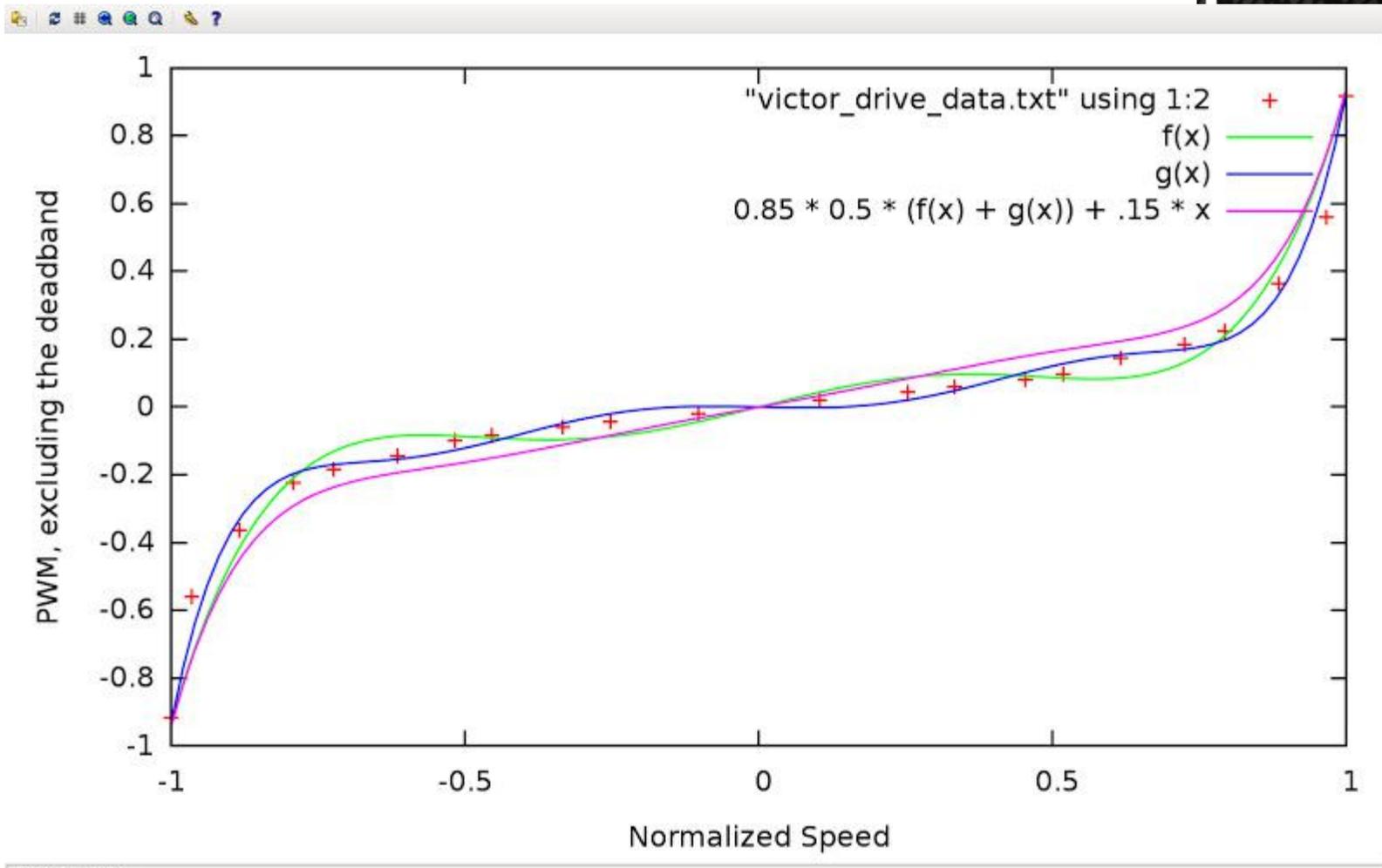
Source: Ether, Chief Delphi

**CIM motor RPM vs PWM**  
FRC battery and **Talon** motor controller  
Load torque 0.2 to 0.8 Nm



# Linearity

you can, however, work your own magic:



-1.02044, -1.29546

Source: Austin Schuh, former FRC254 The Cheesy Poofs