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28.4.1 #7: Decision, Decisions
Answers for problems 1-6

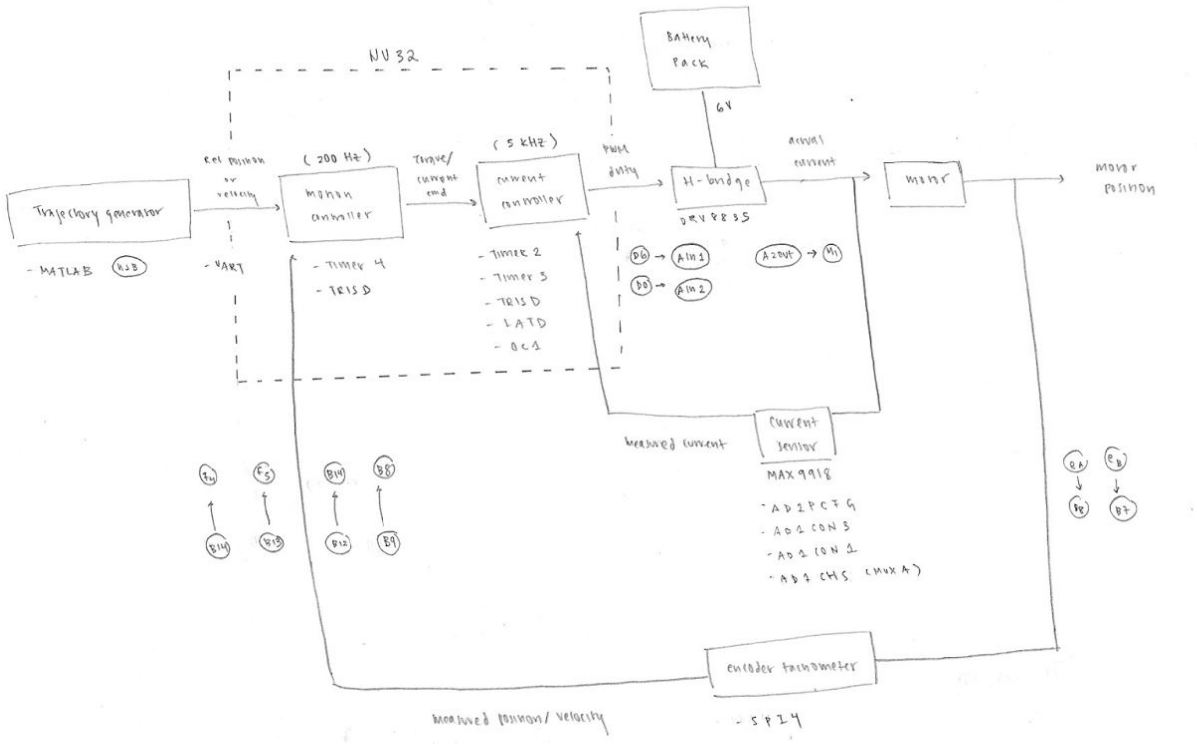
1. SPI channel used: SPI4 — NU32 pins used: B8, B14, F4, F5

2. ADC input used: ADC1 (AN0) — NU32 pin used: B0

3. H-bridge peripherals: LATD and OC1 — NU32 pins: D6 (Motor direction), D0 (PWM)

4. Timer used for 200 Hz ISR: Timer 4 — Priority level for 200 Hz ISR: 5
Timer used for 5 kHz ISR: Timer 2 — Priority level for 5 kHz ISR: 4
(Timer 3 used to control PWM output for 5 kHz ISR)

5. Annotated Figure 27.7.



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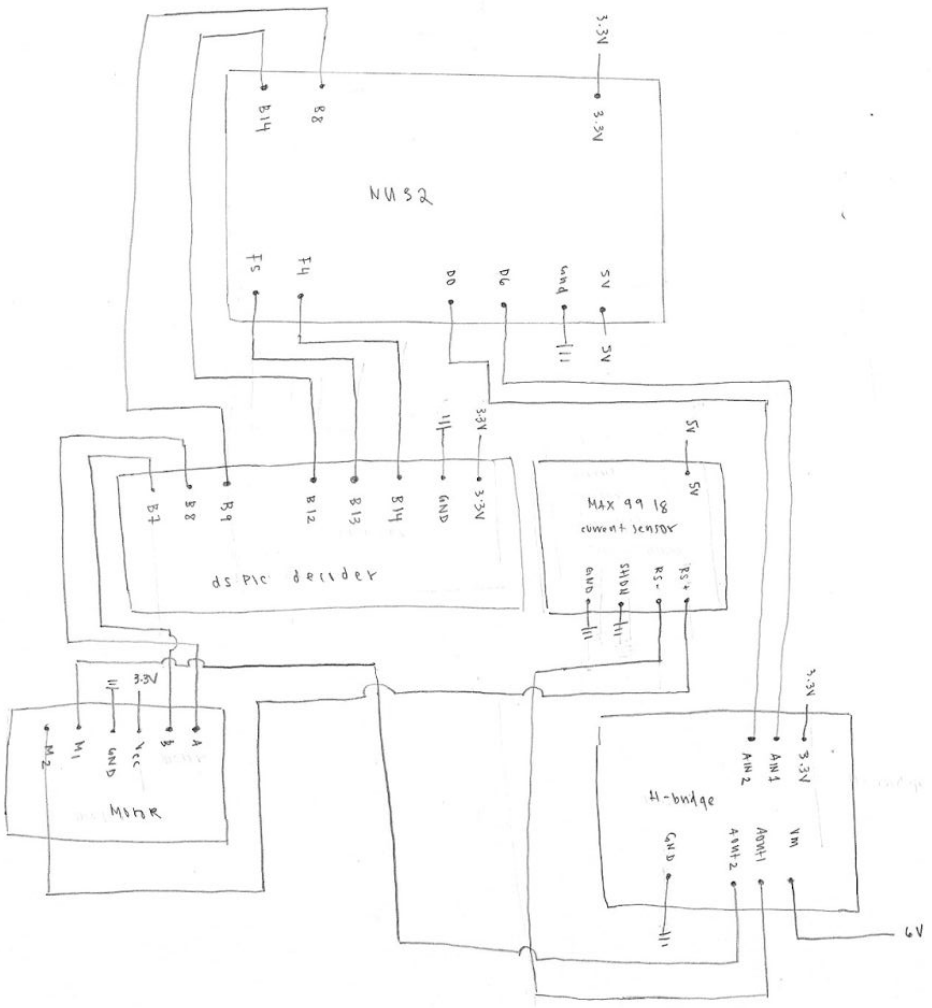
6. Proposed layout of the circuit boards to the NU32.



28.4.7 #7: Current Sensor Wiring and Calibration
Answers for problems 2-6

2. R_{motor} = **12.1 Ω**
I_{max} = 2(6.471 V)/12.1 Ω = **1.07 A**

3. V_{max} = (1.07 A)(15 mΩ)/1000 = **0.016V**

4. $G_{desired}$ = (1.65 V)/ (0.016 V) = 102.84
R_1 = **0.989 kΩ**
R_2 = **0.996 MΩ**
G = **101.71**

5. R = **666 Ω**
C = **1 µF**

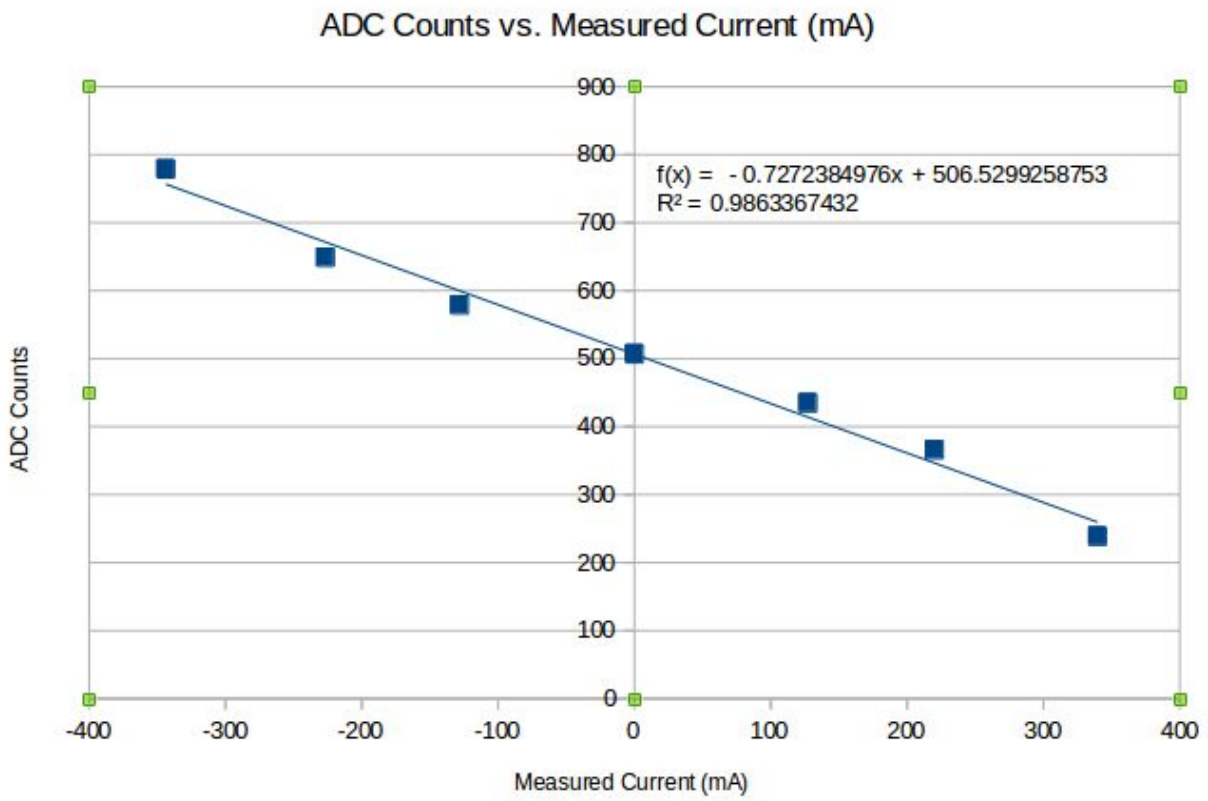
fc = 1/(2πRC) = **238.97 Hz**

6. Circuit Calibration Table

R0 (Ω)	Expected I (mA)	Measured I (mA)	Sensor (V)	ADC (counts)
10 (to RS+)	600	339.7	2.42	239
20 (to RS+)	300	220.1	2.04	366
40 (to RS+)	150	127.3	1.83	435
Open Circuit	0	0	1.60	507
40 (to RS-)	-150	-128.2	1.35	579
20 (to RS-)	-300	-226.6	1.08	649
10 (to RS-)	-600	-343.7	0.64	779

28.4.8: **ADC for the Current Sensor**

6. (**Bonus work**) Plotting ADC counts vs. measured current from the Circuit Calibration table above



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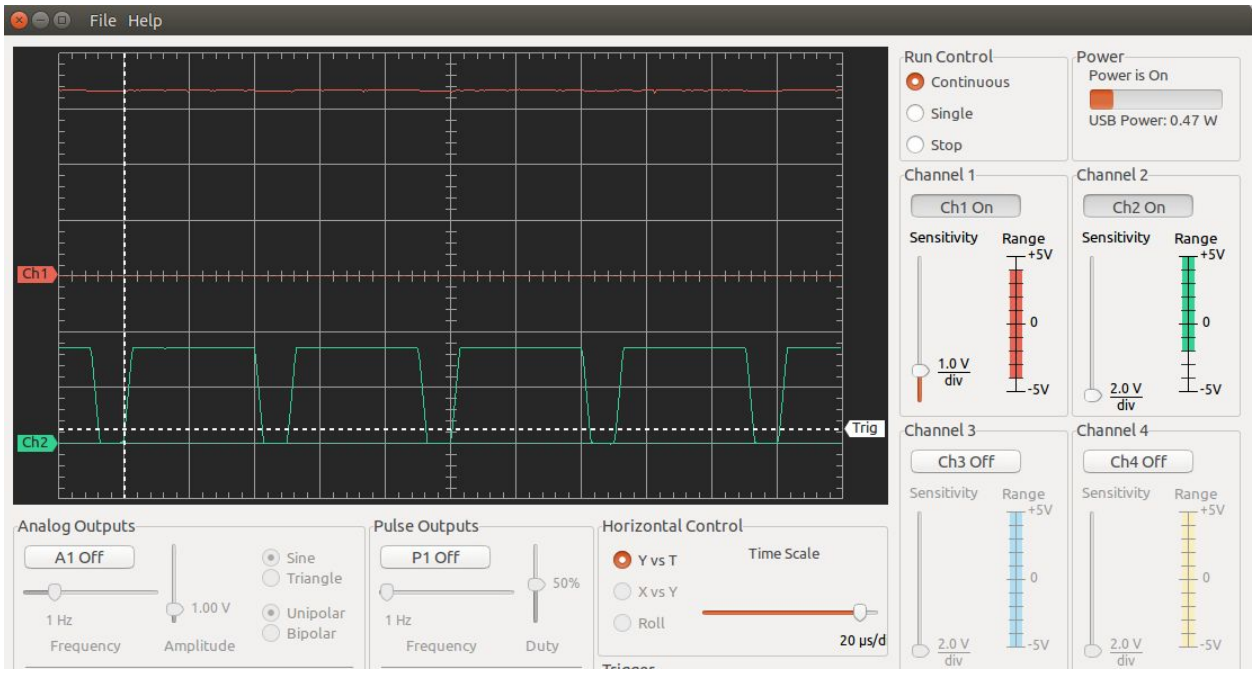
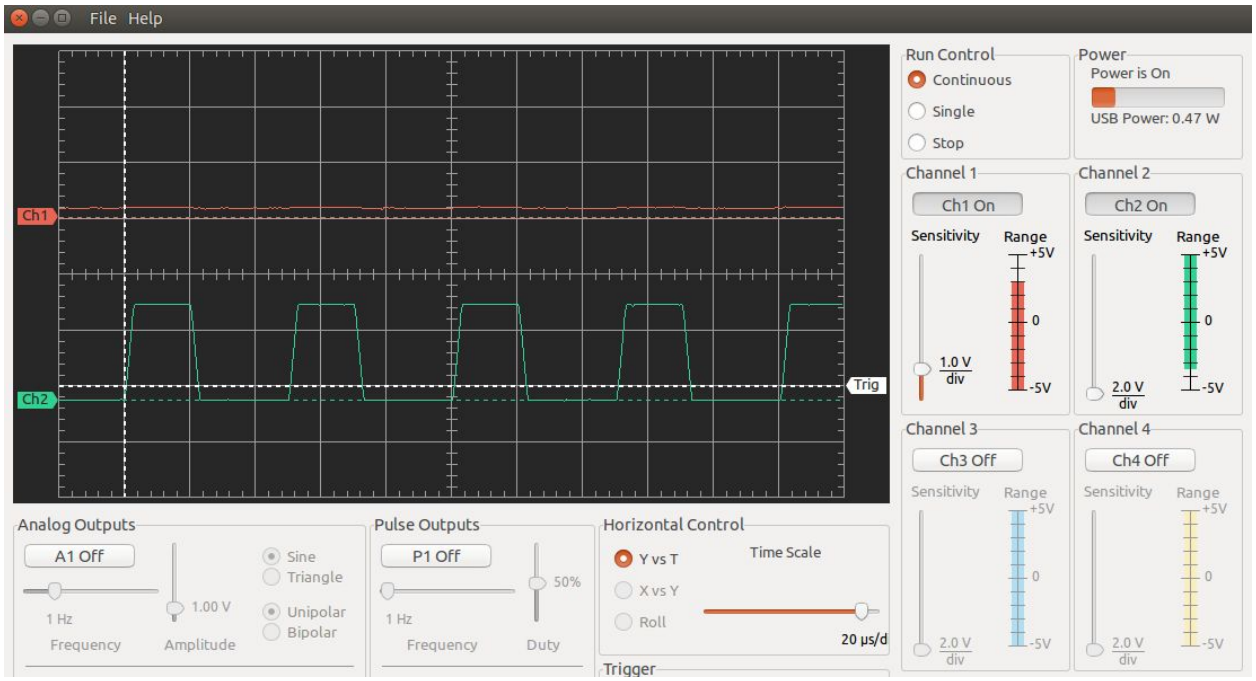
The best fit line equation shown is used in convert_adc() to extrapolate an estimated value for measured current in milliamps from empirically read ADC counts.

28.4.9: PWM and H-Bridge

7. (**Bonus work**) nScope duty cycle verifications, 80% PWM, direction pin = 3.35V



-40% PWM, direction pin = - 0.05 mV



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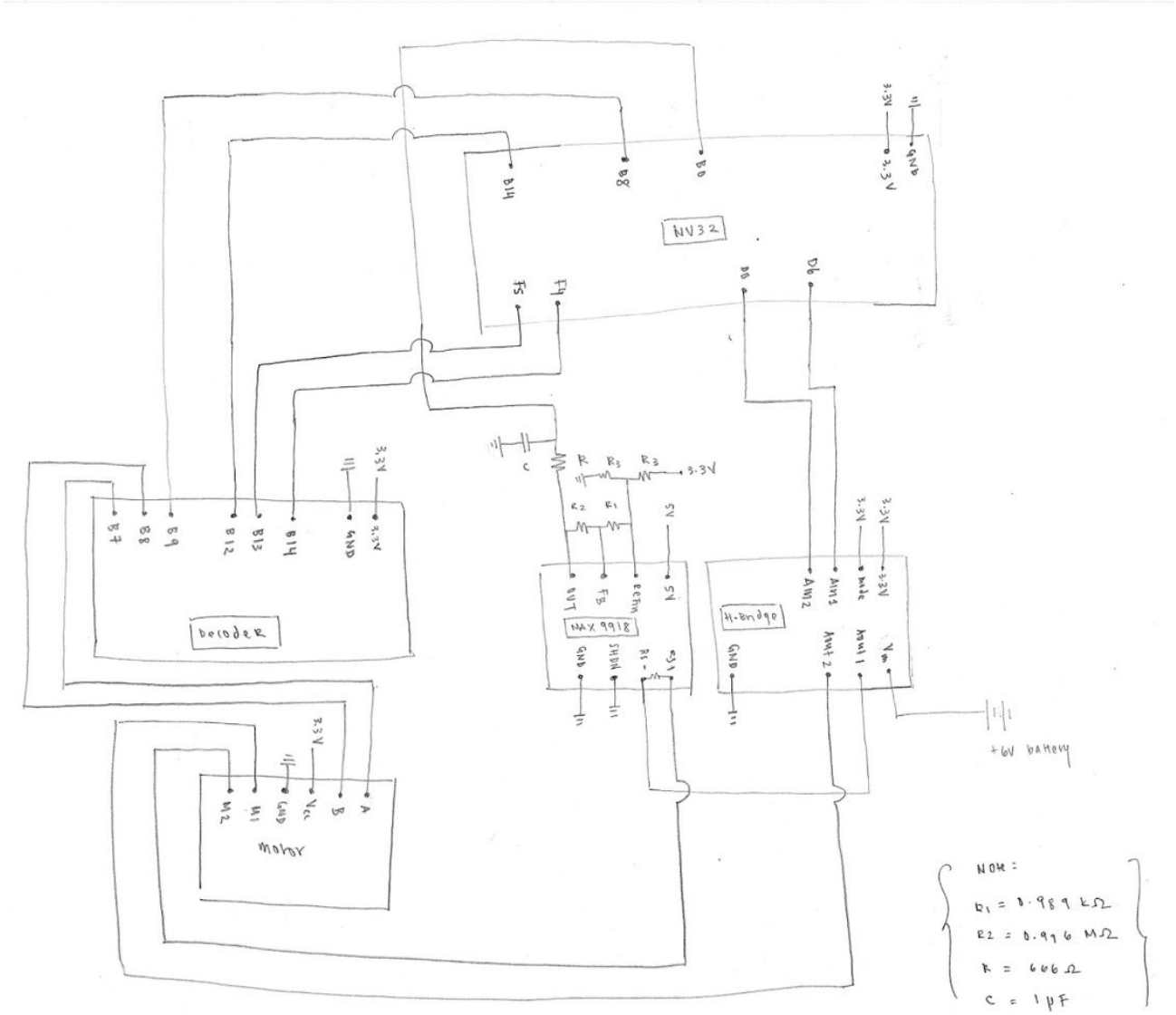
8. Circuit diagram of all connections to H-bridge, NU32, motor, and current sensor PCB.



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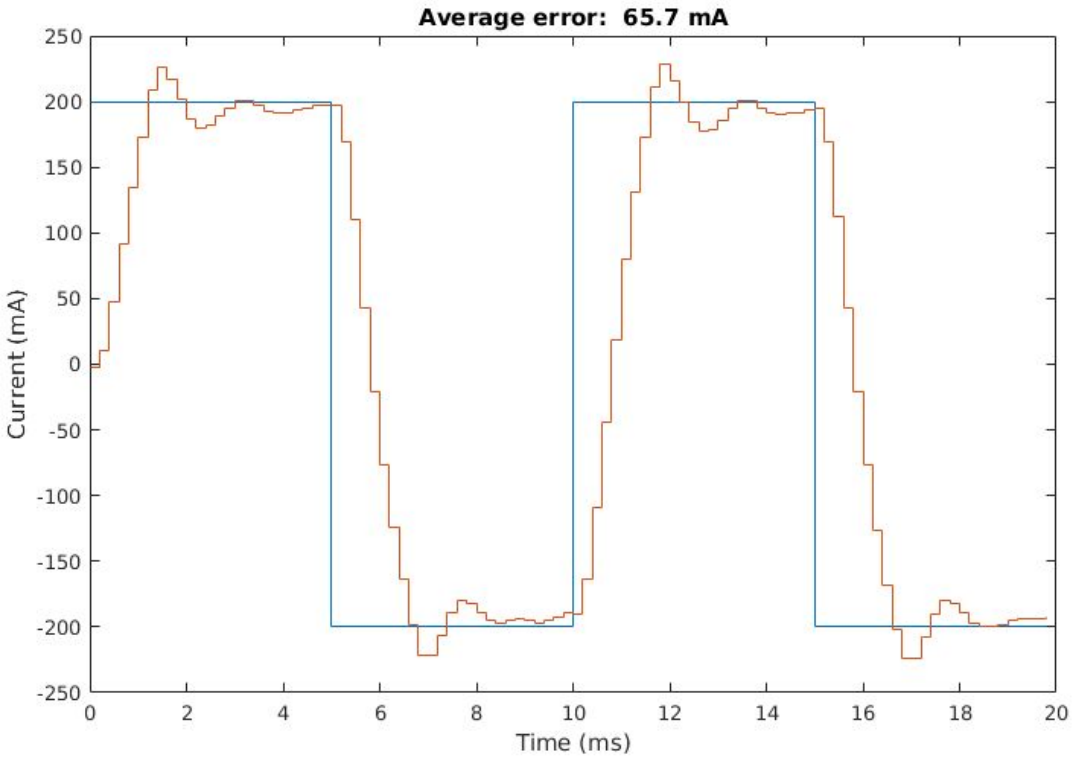
28.4.10: PI Current Control and ITEST Mode
5. Best ITEST Plot



Kp = **45.0 mV/mA**
Ki = **1.75 mV/mA**

28.4.12: Trajectory Tracking
5. Best plot for step and cubic trajectories with attached load (inertia bar)

Best plot for step trajectory
Current gains (mV/mA): Kp = 45, Ki = 1.75
Position gains (mA/deg): Kp = -2.8, Ki = -0.007, Kd = -100

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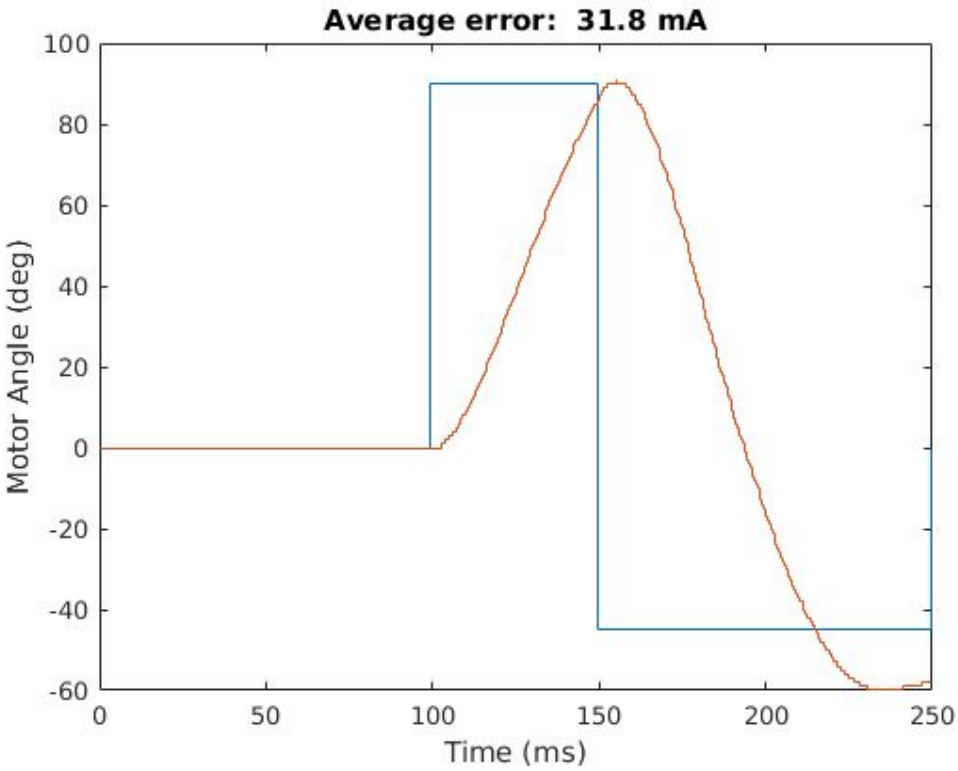

Best plot for cubic trajectory:
Current gains (mV/mA): Kp = 45, Ki = 1.75
Position gains (mA/deg): Kp = -2.5, Ki = 0, Kd = -100