

# DO YOU REALLY NEED A LOW CURRENT AMPLIFIER TO DRIVE A LOW CURRENT MOTOR?

O. Ivashevych, D. Poshka, A. Munoz, BNL, Upton, NY11973, USA

Brookhaven National Laboratory Upton, NY 11973 USA

## Motivation

NLS2 is standardized on Geo Brick LV 5A motor controller from Delta Tau, suitable to drive majority of stepper and servomotors. However, some instruments often have a combination of bigger and smaller motors with drive currents from several Amp to 100 mA. Using integrated or separate drivers to control equipment is maintenance expensive, and at times impossible due to the tight spaces.

What are the limitations in customizing the 5A unit for driving low current motors?

## Experimental Setup

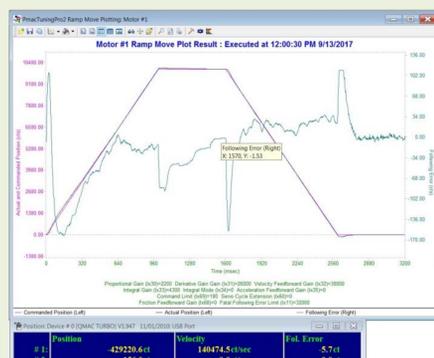


The actual current was measured by Tektronix TCP0030A current probe and Tektronix MSO4054B oscilloscope giving 1mA resolution. Two Faulhaber steppers were driven in the open loop mode.

## Current wave forms and Tuning



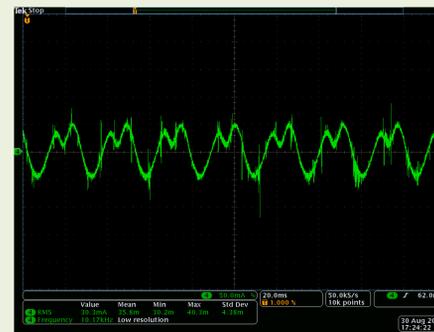
MFA-PP moving at its rated speed 2.5 mm/s, lxx22=165 (top). Current trace (bottom), lxx77=200, lxx61=0.003.



MFA-CC tuning ramp top, and executed motion at 140 cts/ms (2.5mm/s) bottom, driven by GBLV 5A motor controller.



45mA stepper current trace. lxx22=5, lxx77=10, lxx61=0.035



125mA stepper current trace, lxx22=5, lxx77=100, lxx61=0.035



125mA stepper current trace, lxx22=5, lxx77=100, lxx61=0.01

Faulhaber 45mA and 125mA motor parameters:

I, mA	45mA	125mA
R, Ohm	250	75
L, mH	80.1	65.6
Back EMF amplitude, V/k steps/s	10.5	32.7
Holding torque at I, mNm	1.6	22
Holding torque at 2xI, mNm	2.4	37
Inductive Impedance $R_L$ , Ohm	19.6	16.1
$(R_L/R)*100\%$	7%	25%

Total electric impedance is:

$$Z = R + i2\pi fL$$

$$f = \frac{lxx22 \cdot 1000 \frac{ms}{s}}{32 \frac{ct}{ms} \cdot 4 \frac{steps}{cycle}} = 39Hz$$

$$R_L = 2\pi fL$$

The 125mA motor has substantially higher holding torque, and thus higher torque constant, which acts as an extra coefficient to the PID controller. This causes fast current rise and the system goes into current decay mode. Indeed, decreasing current integral gain lxx61 from 0.035 to 0.01 improves the wave form.

## SUT Motor Current Notes

SUT	Motor	Current	Notes
MFA-CC stage	UE1724SR	200 mA	Enc. 2,048 cts/rev
MFA-PP stage	UE16PP	250 mA	1 full step = 0.485 $\mu$ m
Faulhaber mtr	AM2224-V-12-75	125 mA	
Faulhaber mtr	AM1020-V-12-250	45 mA	

## References:

- [1] Bayoumi, Ehab & Soliman, Hisham (2007) "Electromotion Scientific Journal. 14. 198-208
- [2] www.allaboutcircuits.com
- [3] www.micromo.com
- [4] www.lancet.mit.edu
- [5] Geo Brick LV User Manual - Delta Tau, [6] Turbo PMAC User Manual

## Conclusion

- GBLV 5A motor controller can be used for driving motors up to 45 mA/phase in an open loop.
- GBLV 5A moto controller can drive Newport MFA-PP at its rated speed 2.5 mm/sec.
- GBLV 5A can drive Newport MFA-CC stage in a closed loop at its rated speed 2.5 mm/sec.
- It is recommended to use a fuse box to protect the motor from possible current spikes, while determining the optimal parameters. The cost of the fuse box is ~\$250 including parts and labor.



The number of cooked fuses during this research efforts.