KL34-150-90 MOTOR: THE GOOD, THE BAD, THE NOT REALLY UGLY AT ALL

John at Keling Technology Inc. (http://www.kelinginc.net) was kind enough to send some motors here for evaluation. Among them was a NEM-34 brush-type PM motor sent for determining its suitability with our G320 servo drive.

The first test was to determine motor power output. The motor's ratings are:

Continuous rated torque:	120 in-oz	
Continuous rated current:	7.6 A	
Rated voltage:	90 VDC	
Inductance:	2.35 mH	
Kv:	13.36 V / kRPM	
Kt:	18.4 in-oz / A	may be a misprint; should be 18.04 in-oz / A
Terminal resistance:	0.92 Ohms	measures 0.87 Ohms at 1A

A lab supply set to 72VDC and the motor was loaded using a dynamometer until 7.6A current thru the test motor was reached. The dynamometer showed 440 Watts (0.59 HP) of power being delivered at 4,865 RPM. This meshed nicely with a calculated value of 432 Watts. This is a lot of power output for a motor of this size. Extrapolate that to 90VDC and the motor should give an honest 550 Watts mechanical.

The next test was to measure torque ripple. Finger-testing the motor showed considerable cogging torque. It was very noticeable when the motor shaft was turned between thumb and index finger. This is a bad sign indicating the motor does not have a skewed armature (barber-pole twist) that is a hallmark of a true servomotor. In all fairness though the Keling Technology website lists it as a “DC Motor” instead of a “DC Servomotor”.

The motor was attached the lab supply set to 4VDC and a scope Hall-effect current probe was placed around a motor wire. The results are shown in Fig. 1.

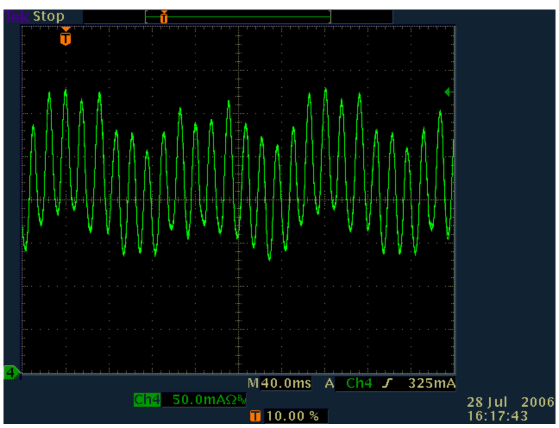

Fig. 1

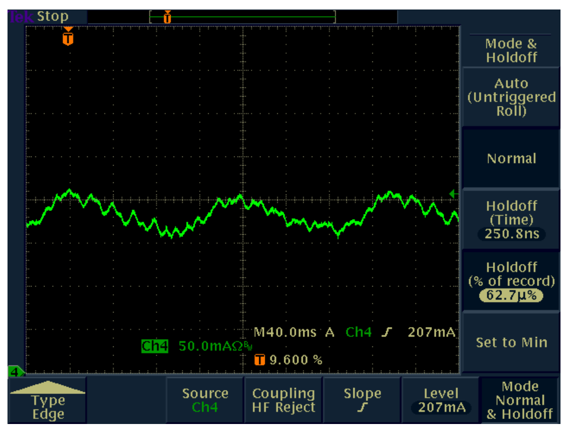

Fig. 2

By comparison Fig. 2 shows a similar size NEMA-34 servomotor (450 Watt rated) that has a skewed armature and absolutely no perceptible cogging torque. The KL34-150-90 motor looks terrible in comparison. Note also the test motor draws an average 240mA armature current while the reference motor draws a 170mA average. The motor in Fig. 2 costs 4 times as much as the KL34-150-90 motor though.

Next the KL34-150-90 motor was mounted with a USDigital E5 series 200-line encoder and then connected to a G320 drive. After performing setup, initial servo tuning and functionality tests at 24VDC, the lab supply was brought up to 72VDC. The servo was retuned at this voltage and then all subsequent tests were run at 72VDC.

The next test was to run the motor unloaded at 100 RPM and probe the POSTION ERROR test-point on the G320 to see how well this motor behaves under PID servo control. The servo should accommodate itself in response to the torque ripple in Fig. 1 and cancel it. Fig. 3 on the next page shows the results.

Fig. 3 is taken at the POSITION ERROR test point. Note the 37mS period of the waveform. Fig. 1 has 16 cog cycles per motor revolution. The motor in Fig. 3 is turning at 100 RPM so each cogging cycle takes 37mS at this speed. What you see is the G320 de-cogging the motor.

A single increment of motion is 40mV and 0.45 degrees with a 200-line encoder. As the trace shows, the motor's position error excursion is +/- 0.45 degrees in amplitude as the drive strives to cancel the cogging. This is pretty good.

By comparison, the reference motor exhibits no cogging and the excursion angle would be less than 0.45 degrees in amplitude.The KL34-150-90 motor makes a very slight warbling sound at the cogging rate; it is a consequence of the G320modulating power to the motor.

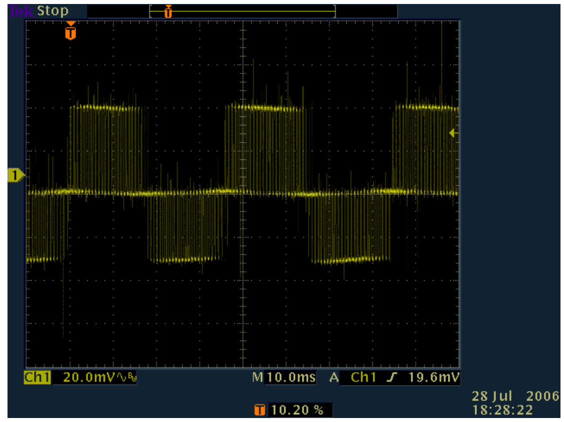

Fig. 3

The next test is to elicit servo loop behavior in response to a torque-load disturbance. The torque-load disturbance is to reverse motor direction at 50 RPM and at 250 RPM. Figures 4 and 5 respectively show how quickly and well the servo loop settles after a minor and major upset. It takes 25 times more energy to correct a direction reversal at 250 RPM as it does at 50 RPM because stored kinetic energy goes up as the square of the speed.

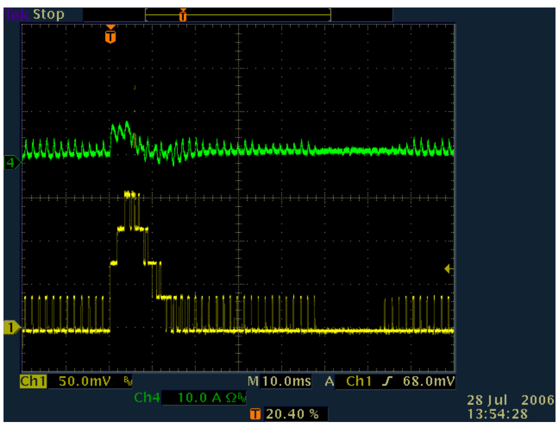

Fig. 4

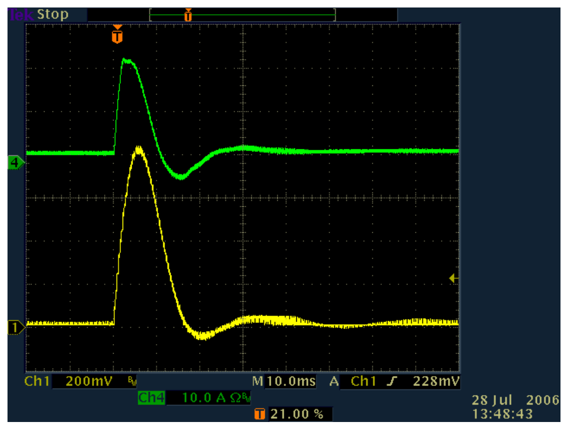

Fig.5

The first loop disturbance is weak; reverse direction from 50 RPM CW to 50 RPM CCW. Count the position error steps in Fig. 4 and you get a deviation 3 times 0.45 degrees or 1.35 degrees out of position before the error is reeled-in 12 mS later to zero again. The second perturbation is much bigger (Fig. 5). Here the motor 'sees' an instantaneous 500 RPM speed change (from 250 RPM CW to 250 RPM CCW). The motor gets out of position 21 increments of motion (9.45 degrees) before settling to the correct location in 16 mS. Note the armature current limiting at 22 A, flattening the peak of the green scope trace.

The next test continuously accelerates and decelerates the motor between 250 RPM and 2,500 RPM. The acceleration / deceleration slope is a linear ramp and the period is 100 mS. As would be expected, the armature current approximates a squarewave with an amplitude of +/- 4 Amps (green trace). The POSITION ERROR has an amplitude of +/- 200 mV and is equivalent to +/- 2.25 degrees of following error while the motor is accelerating at this rate (2,350 radians per second squared).

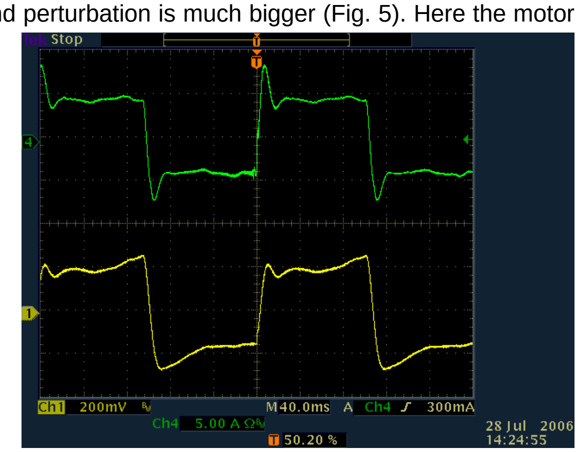

Fig. 6

CONCLUSIONS:

The KL34-150-90 makes for a surprisingly good servomotor.

The G320 was modified for the above tests; the integral coefficient was increased 10-fold over what a stock G320 value is to help nullify the negative effect of the motor's torque ripple (cogging). The modification entails changing the integrator capacitor value from 100nF to 10nF, a simple single component value change.

The effect of this modification was so surprisingly good that we may offer it as a "G320K" for use with the KL34-150-90 motor. This is pending further testing of course. The advantage is the motor and drive becomes a set that is optimized for compatibility and has a known performance.

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