http://groups.yahoo.com/group/CAD_CAM_EDM_DRO/message/89337
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Microstepping thru the Tulips

CAD_CAM_EDM_DRO post #89337
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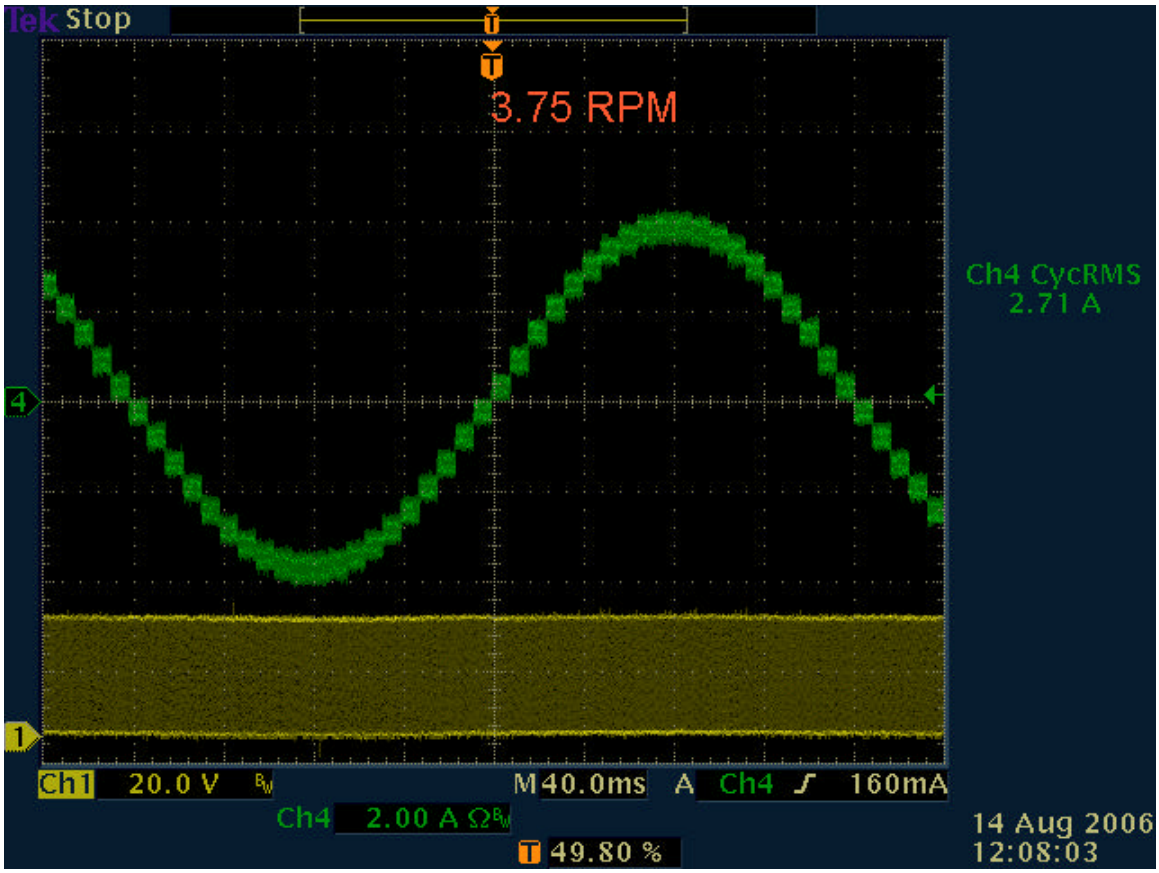
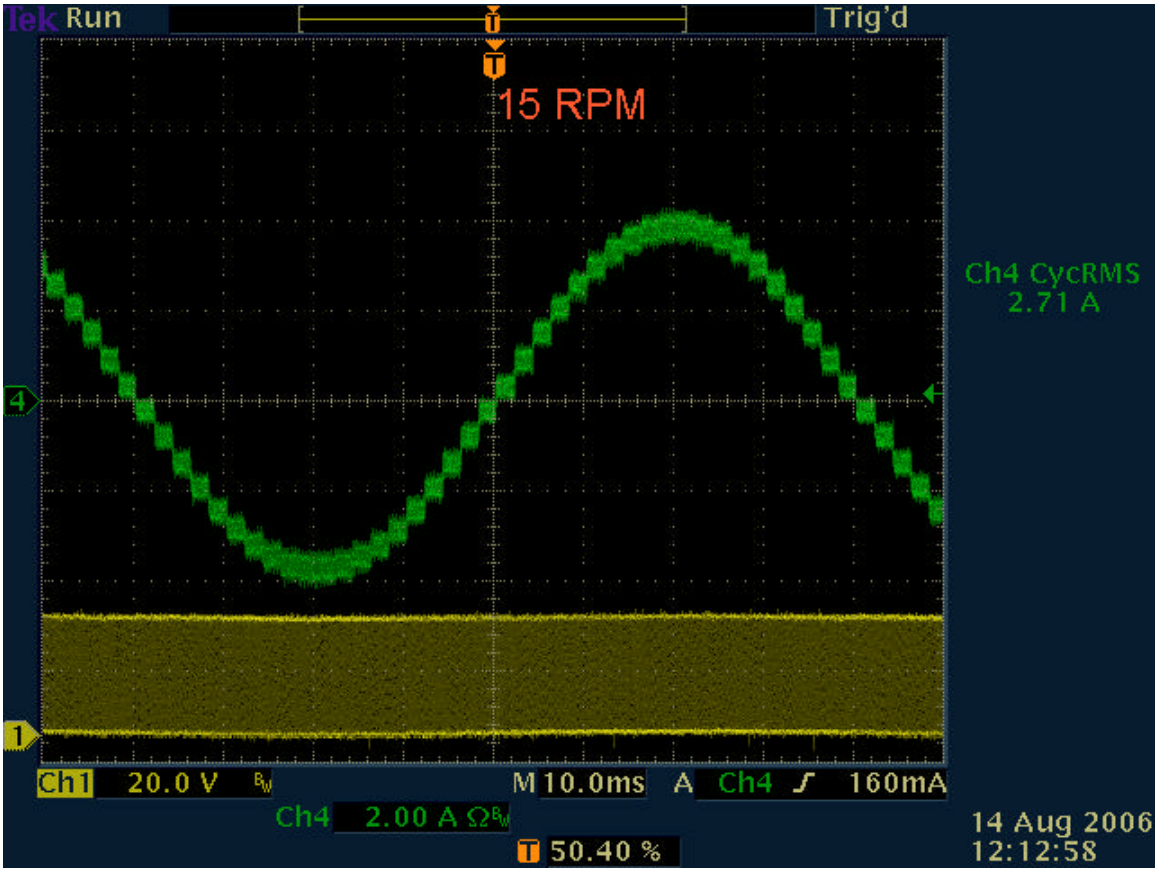
MOTOR CURRENT WAVEFORMS
The oscilliscope pictures in the accompanying .gifs show a step motor's phase current (green trace) and the voltage on the winding (yellow trace).

The drive is a G203V, the motor is a 3.9A per phase "square"
NEMA-23 and the supply voltage is 24VDC. Points of interest are:

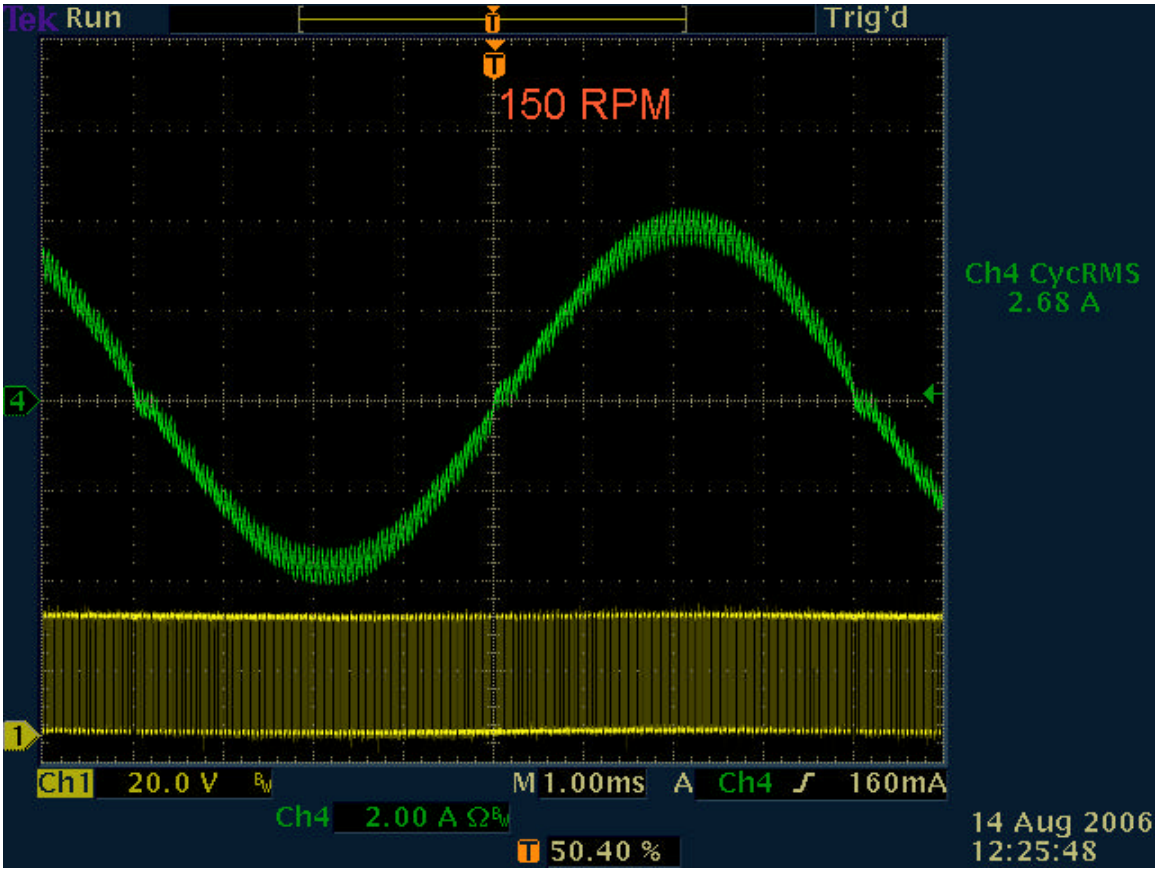


3.75 RPM picture: Note the sine current quatified every 9 electrical degrees. The 20kHz PWM duty cycle stays between 45 to 55 percent (yellow trace). Motor motion is very smooth, the microstep rate is 125 Hz, a frequency which is above the motor's mechanical cutoff frequency of 80Hz.

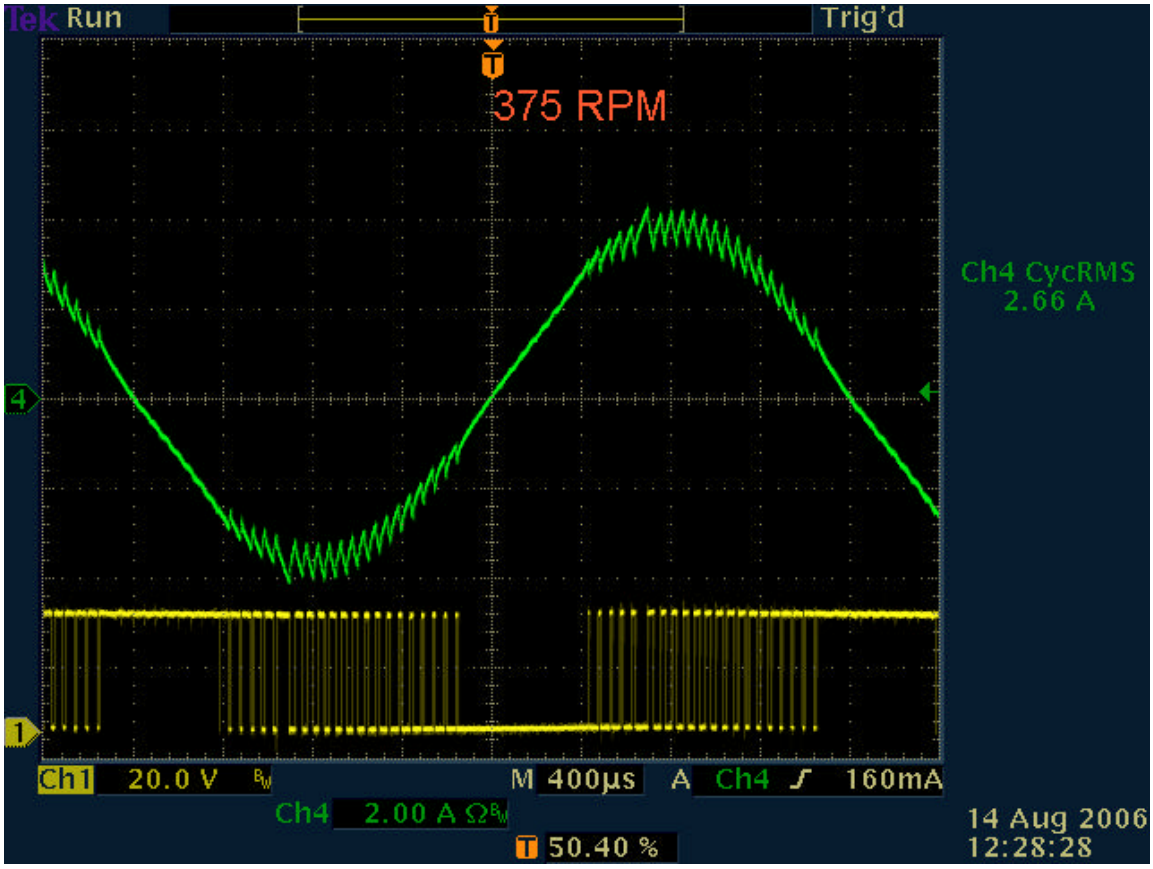
15 RPM picture. More or less the same as the 3.75 RPM one. Microstep rate is 500 Hz.



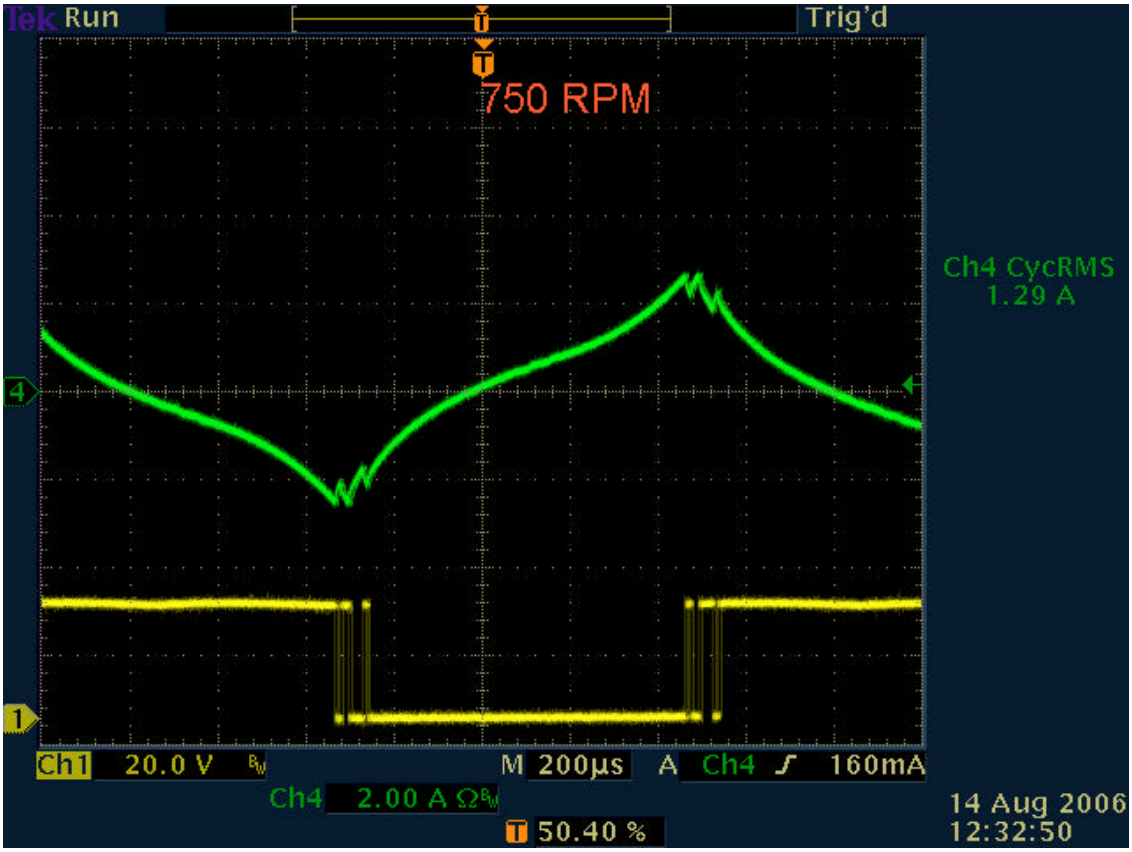
150 RPM picture. The PWM modulation is approaching near zero percent and near 100 percent on the negative and positive slopes respectively of the sine current waveform. Microstepping is of no further benefit because the full-step frequency is now above the motor's mechanical response cutoff frequency (80Hz). Microstep rate is 5 kHz.



375 RPM picture. The reference slope now exceeds the motor's V/L current slope at 24VDC. The PWM is at zero percent or 100 percent modulation for multiple PWM switching periods. The motor's inductive reactance is beginning to limit winding current, not the drive. The current waveform is still reasonably sinusoidal. Motor torque will begin to drop off inversely with speed above this RPM. Microstep rate is 12.5 kHz.

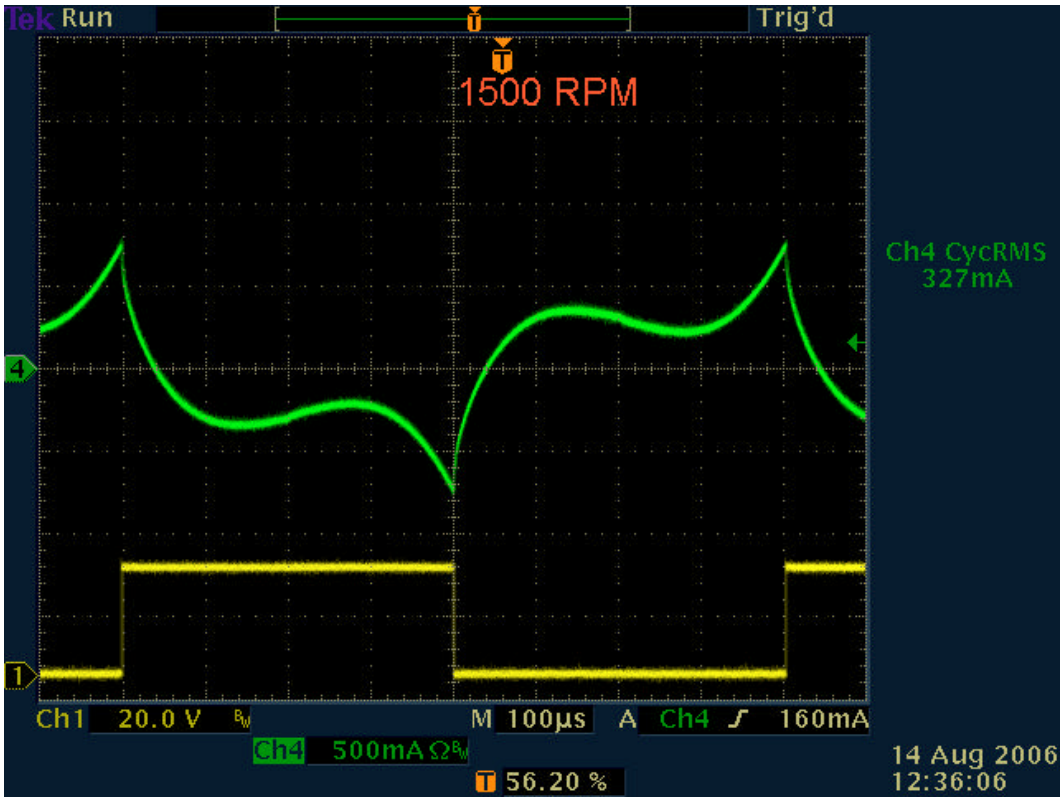


750 RPM picture. The motor current is now almost entirely limited by inductive reactance. The PWM is continuously at 0% or 100% modulation except for a few switching cycles at the peaks of the motor current. The motor is fully in the inverse torque region at and above this speed. Microstep rate is 25 kHz.



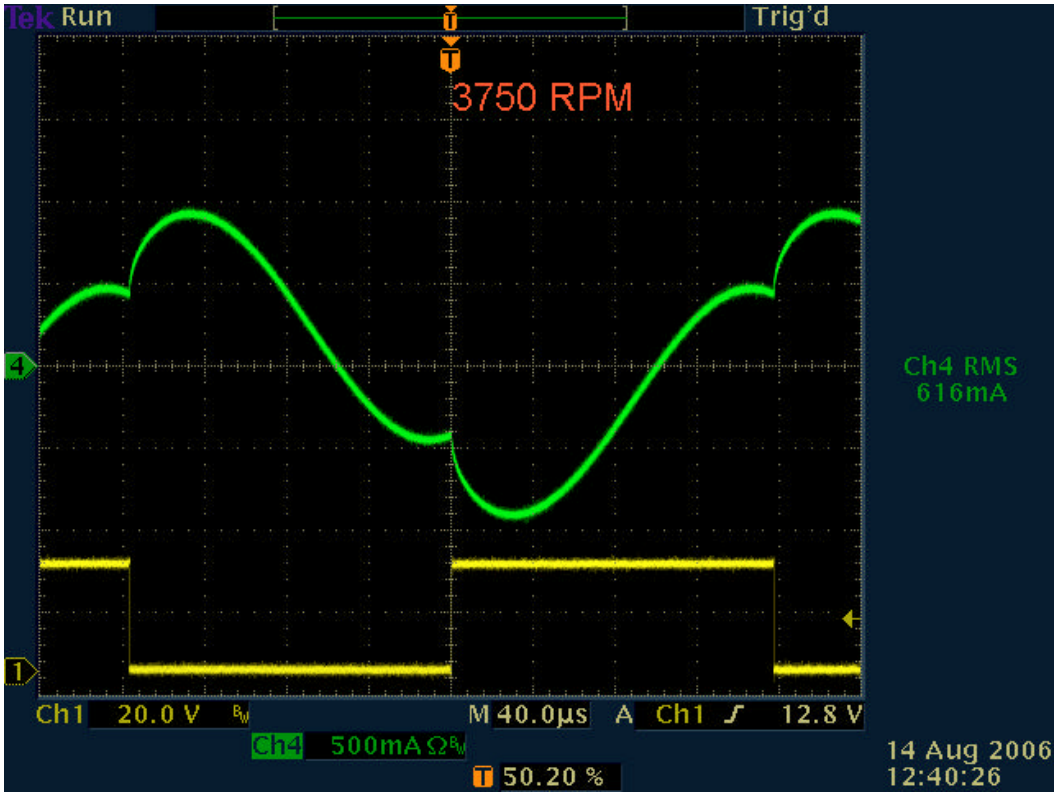
1500 RPM picture.

Either 0% or 100% modulation from the PWM at and above this speed. The resultant voltage waveform is identical to a full-step sequence. Microstep rate is 50 kHz.

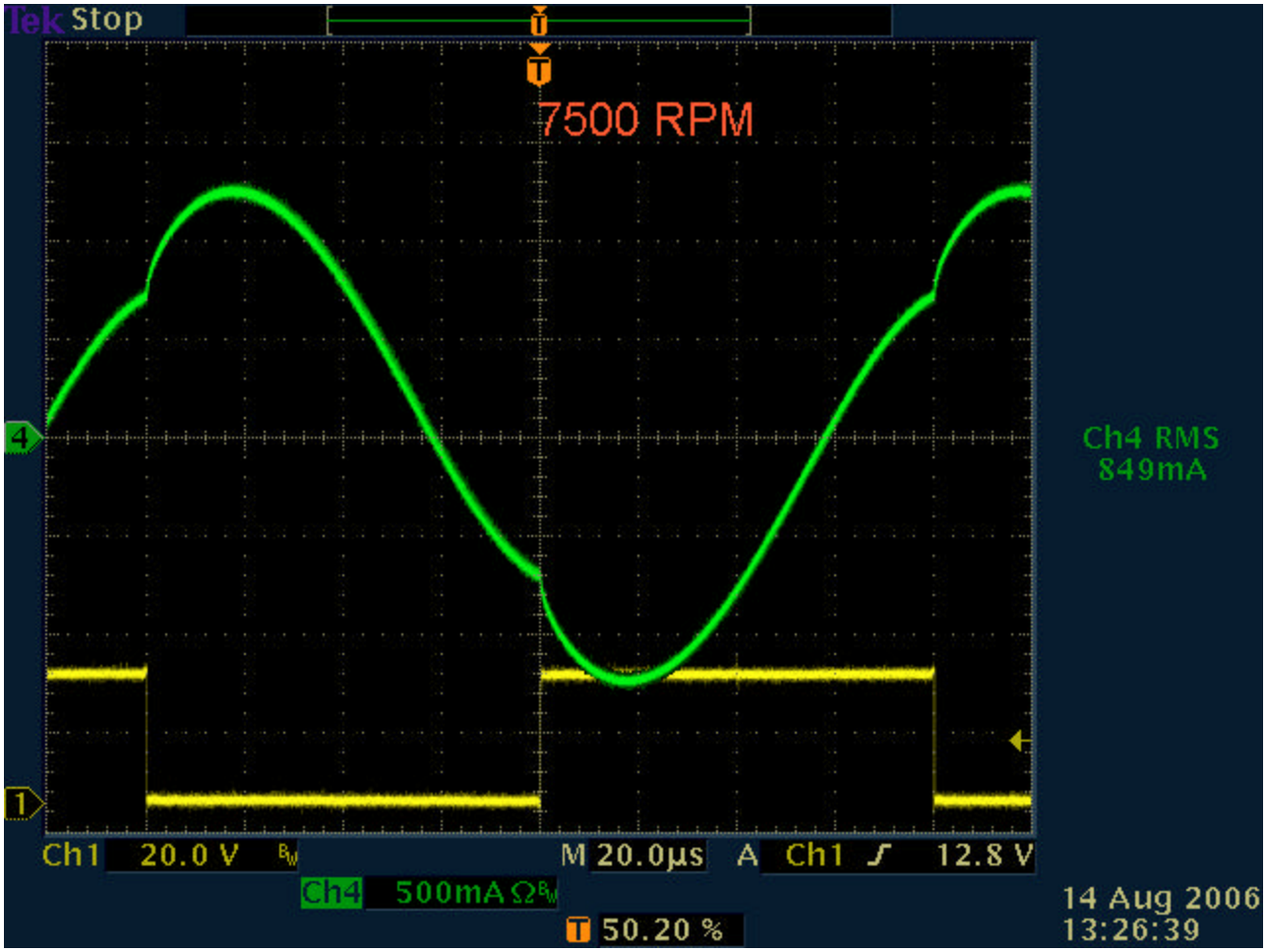


3750 RPM picture.

Same as the 1500 RPM one except for the current waveform. This waveform is the sum of a triangular inductive current component whose amplitude decreases inversely with speed and a motor sinusoidal current that increases proportionally with speed. The inductive current phase lag is 90 degrees to the driving voltage (yellow trace) while the motor sine current phase lag is proportional to the rotor angle relative to the driving voltage. Microstep rate is 125 kHz.



7500 RPM picture. Microstep rate is 250 kHz.Yes, an ordinary NEMA-23 step motor can turn that fast with only a 24VDC power supply. No, there is not much torque available at that speed.



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