3986 Study

Purpose: to see how PWM'ing the Enable pin improves micro-stepping at slow speeds (low current control) and maintains good control of low currents during holding.
Setup and Procedure: An Allegro A3986 Demo Board was used with a VEXTA PV264D2 8BAC2 motor. VBB = 24V. VDD = 5V. Rosc = 10k (4MHz). Enable PWM frequency = 50kHz (period = 20µS). 25% duty cycle. Other conditions are explained with the following scope plots.

Fig.1 CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. Notice fast decay ripple when Enable goes high (turns outputs OFF).

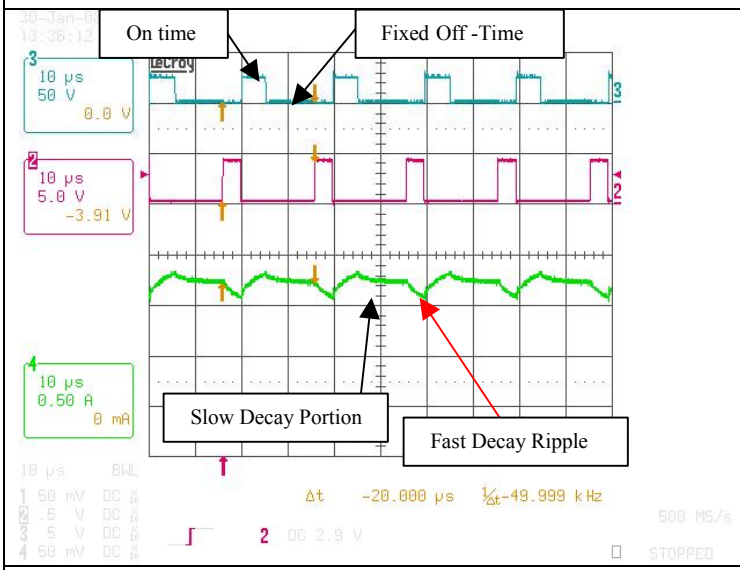


Fig.2 CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. Notice the slow decay ripple and narrower output ON times because it does not take as long for the current to recover. And, no noticeable change in current control level (~ 1.75 A)

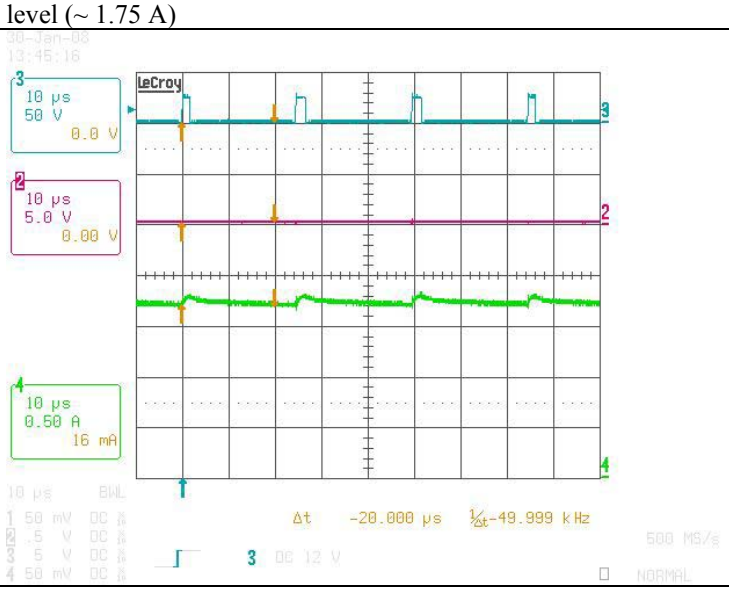


Fig.3 CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. REF voltage was decreased to 0V. Notice that the output current dropped as expected (but not to 0 A as expected) with mixed decay.

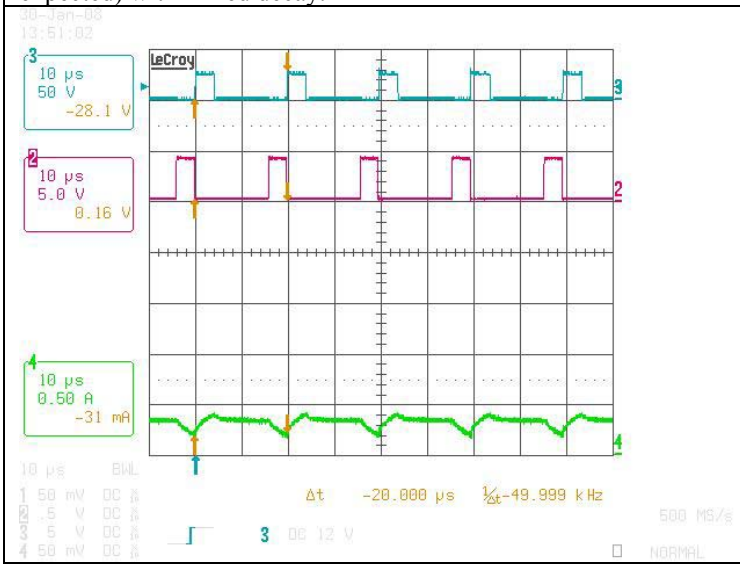


Fig.4 CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. REF voltage was decreased to 0V. Notice that the output current dropped very little with only slow decay (no Enable PWM).

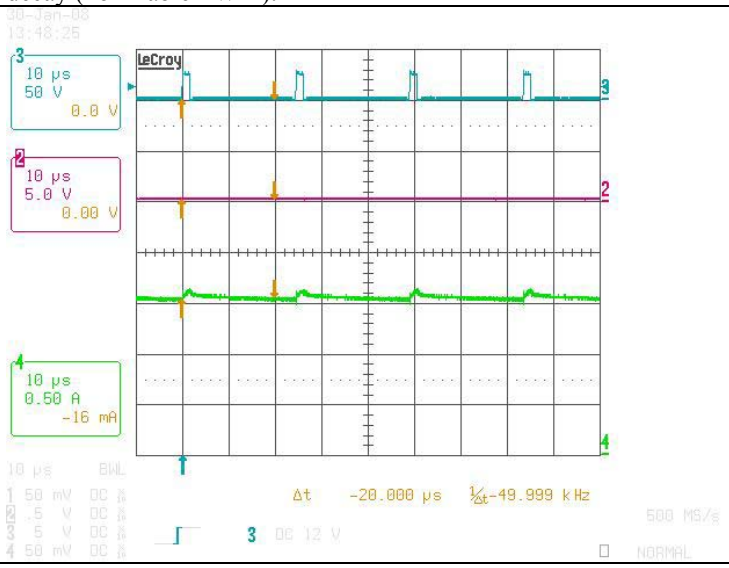
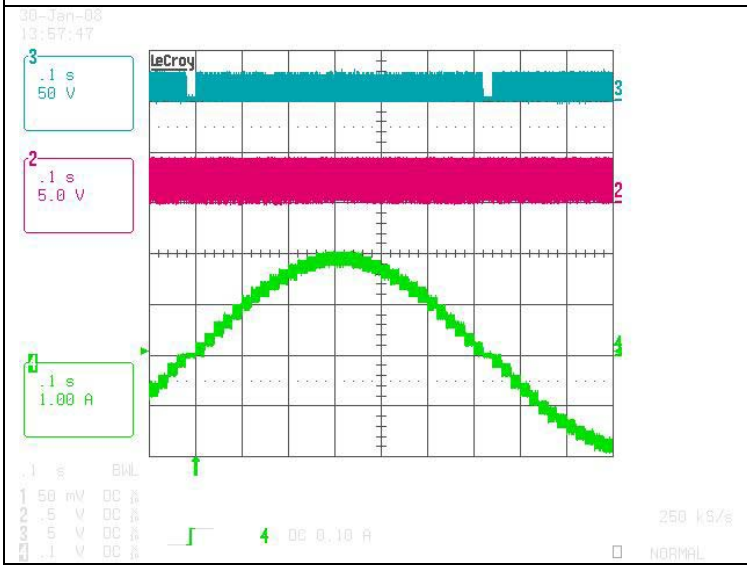
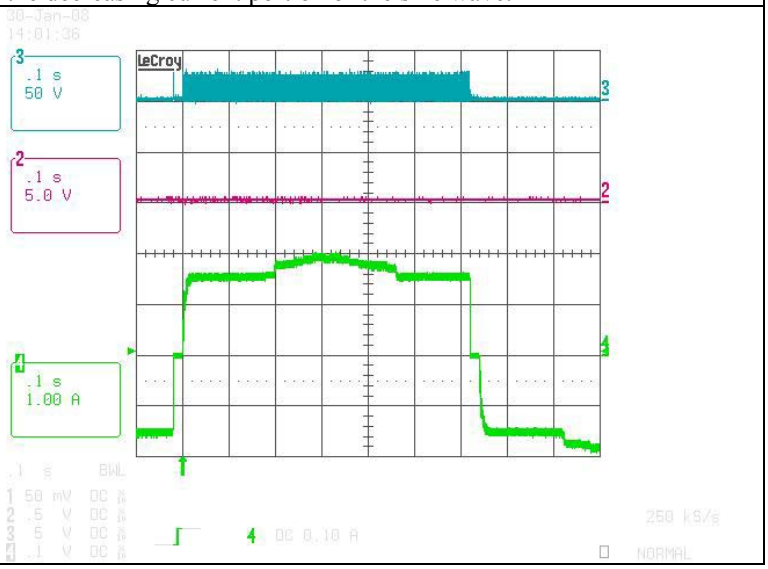


Fig.5 CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. REF voltage was increased for 2 A maximum current. Mode set to 16th step. Step frequency = 50Hz. Notice that the output current waveform is properly stepping in "all" mixed decay.	**Fig.6** CH3 = typical output (highside switching), CH2 = Enable Pin, CH4 = output current. REF voltage was increased to for 2 A maximum current. Mode set to 16th step. Step frequency = 50Hz. Notice that the output current waveform is NOT properly stepping in "all" slow decay. Placing thhe PDF pin for fast decay will only fix the decreasing current portion of the sine wave.
	

Conclusion: PWM'ing the Enable pin allows the outputs to be controlled (both when current is increasing and decreasing) in a mixed decay mode for much better control of "low" currents at very slow stepping rates. As shown above, it works very well. To maintain good synchronization between the external PWM and the internal PWM, the external PWM period (on the Enable pin) should be =< the set fixed OFF-Time (above, the fixed off-time was ~ 21.75µS and the Enable PWM period was set to 20µS or 50kHz). The objective is for the OE to go back high (turn off the outputs) before the internal PWM fixed off-time ends, resulting in a stable mixed decay. The optimum duty cycle appears to be 25% (enable high), 75% (enable low). Both PFD inputs will typically be set for slow decay (both = 0) giving mixed decay for the entire stepping cycle. However, the PDF pins can be adjusted if necessary to provide faster decay on the "decreasing" current side for higher step rates.

PWM'ing the Enable is recommended only for low currents because there is no Synchronous rectification (SR) when the Enable is switching the outputs ON and OFF so recirculating currents are decaying back through the intrinsic diodes in the MOSFETs not back through the MOSFETs themselves. This can cause over-heating of the MOSFETs at higher currents. The MOSFETs should be heat-sinked well. If heat sinking is not a good option then schottky diodes can be placed between the drain/source of all the MOSFETs to shunt the current from the intrinsic diodes.

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