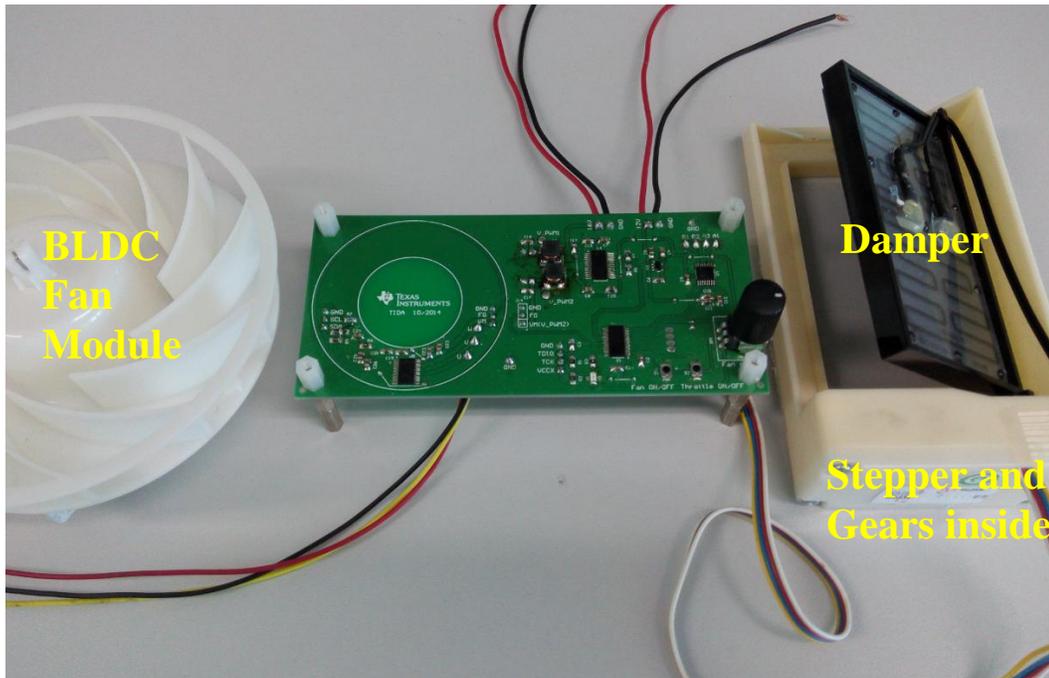
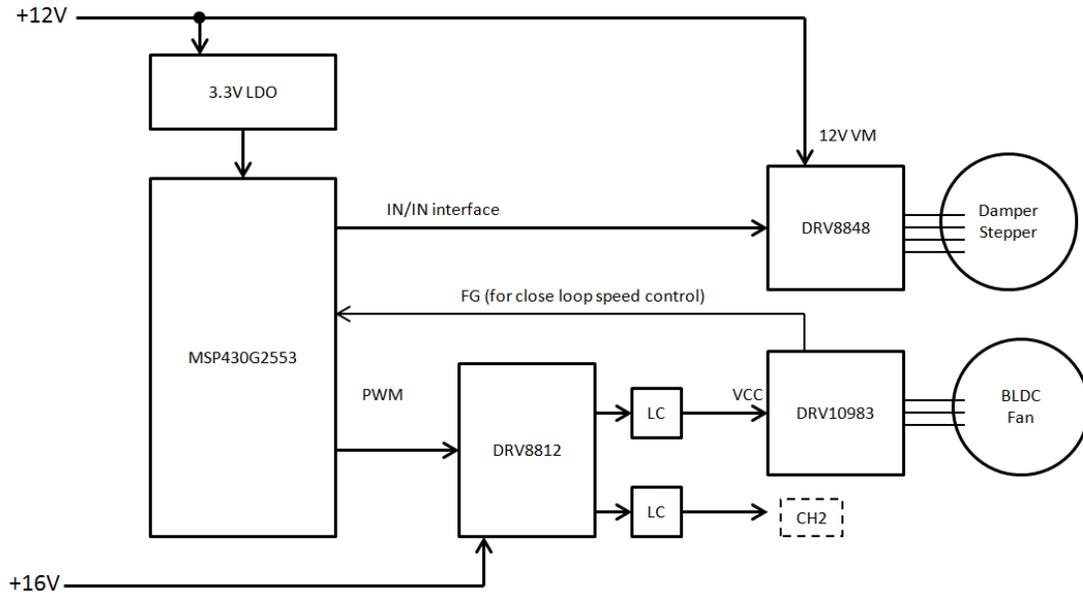
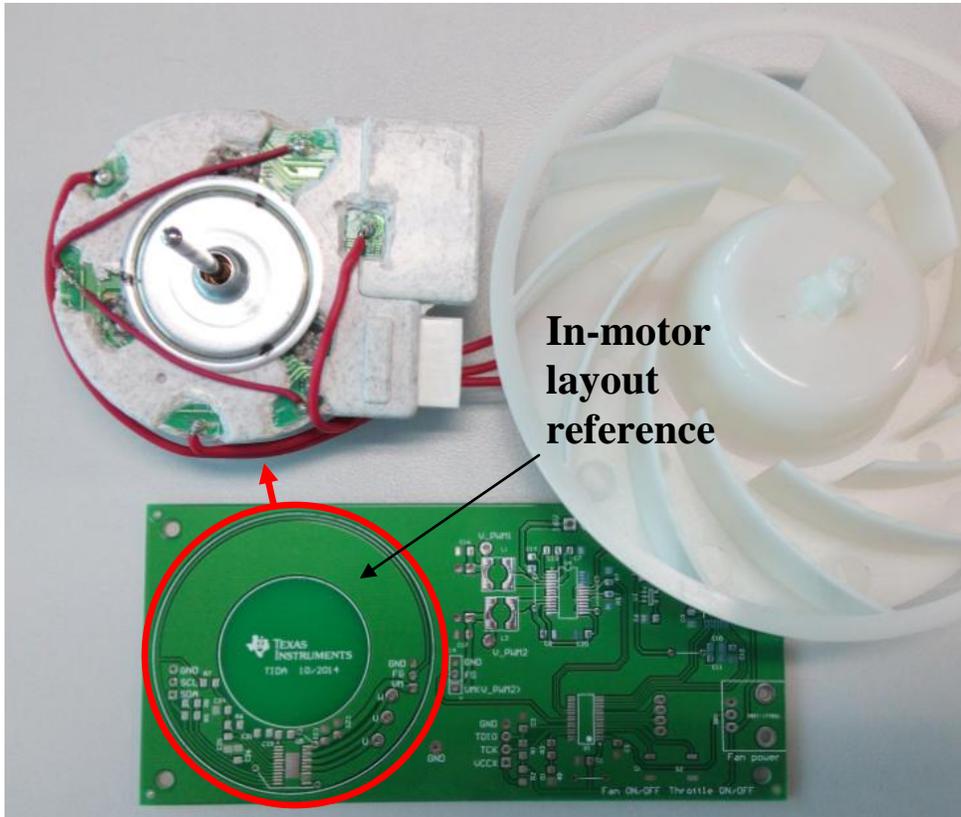


Refrigerator Damper and Fan Motor Control Solutions - Test Data

(TIDA-00297)

1. System Diagram and Picture





2. Damper Stepper Parameters and Test Data

➤ Stepper type

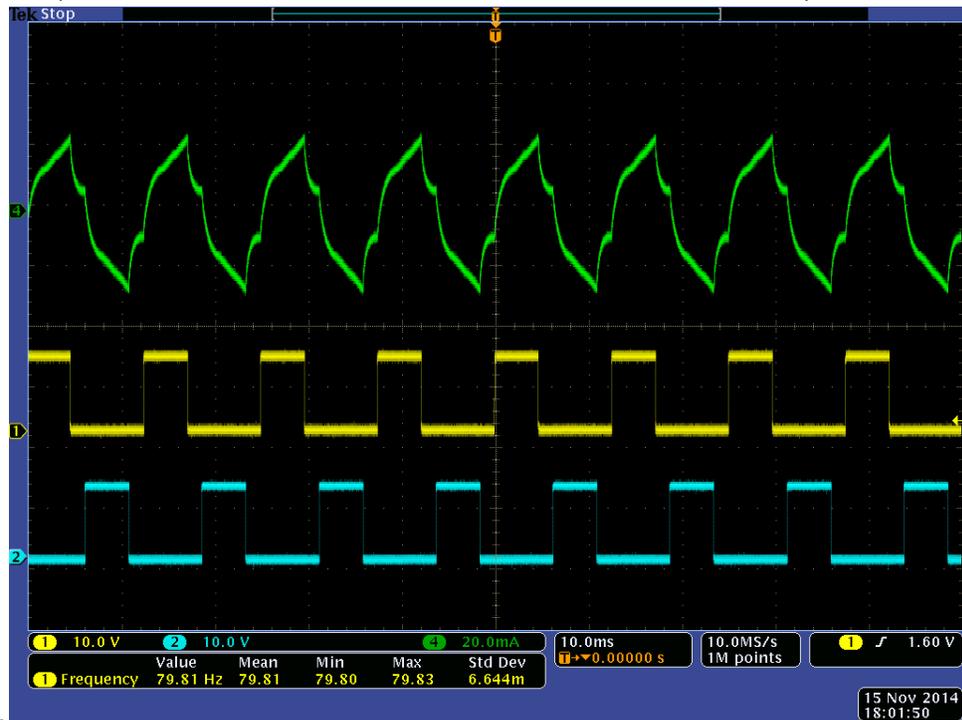
- Permanent Magnet Stepper motor
- Phase A DC resistor: 409 ohm
- Phase B DC resistor: 406 ohm
- Phase inductance: ~130mH@1kHz
- Voltage: 12 V
- Current: 30 mA
- Mechanical step angle: 18°/full step

➤ Half step driving waveform

- Running at $F=79.81\text{Hz}$
- ($\text{RPM}=F \cdot 4 \cdot 18 / 360 = 16.0\text{RPM}$; The damper takes about 1840 Full steps to fully open or close, so the total time of the opening or closing will be $1840 / 4 / F = 5.76\text{s}$ at this speed)



(Green: Phase B Current; Yellow: BOUT1; Blue: BOUT2)



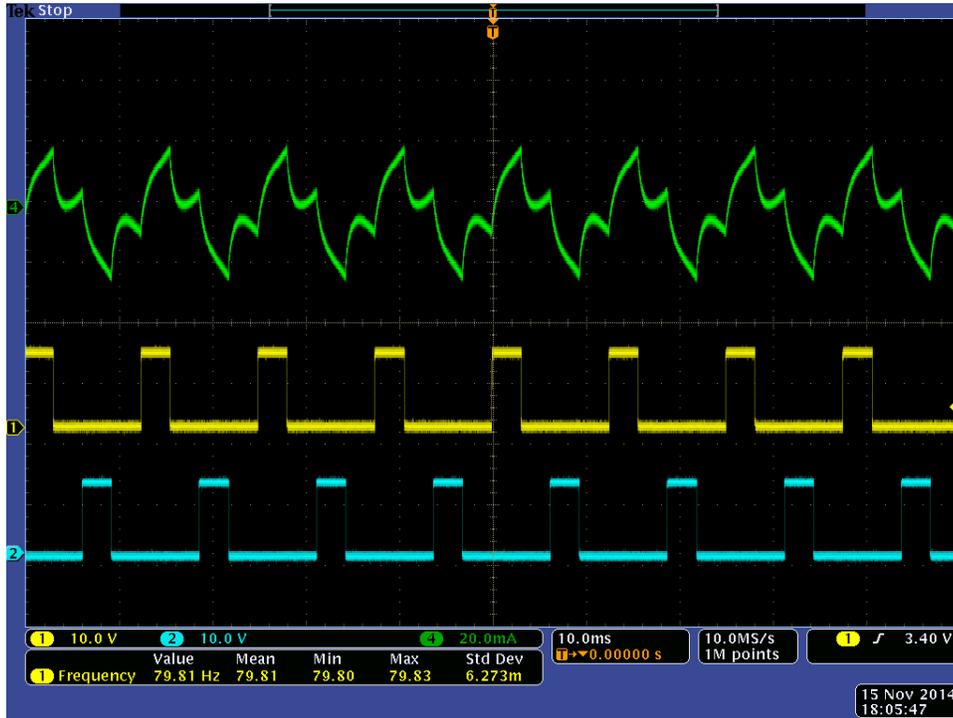
(Green: Phase B Current; Yellow: AOUT1; Blue: AOUT2)



➤ Full step driving waveform

Running at 79.81Hz (16.0 RPM; 5.76s fully opening or closing time)

(Green: Phase B Current; Yellow: BOUT1; Blue: BOUT2)

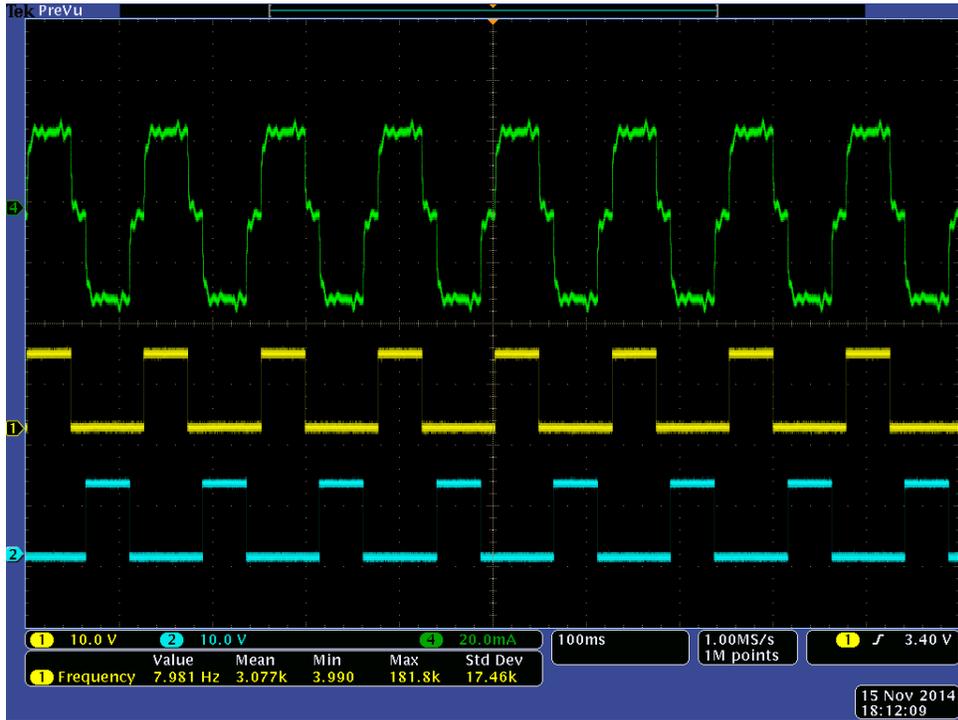


(Green: Phase B Current; Yellow: AOUT1; Blue: AOUT2)





- **Half stepping at low speed**
(7.98Hz; 1.6RPM; 57.6s fully opening or closing time)



- **Full stepping at low speed**
(7.98Hz; 1.6RPM; 57.6s fully opening or closing time)



➤ **MAX speed versus stepping mode**

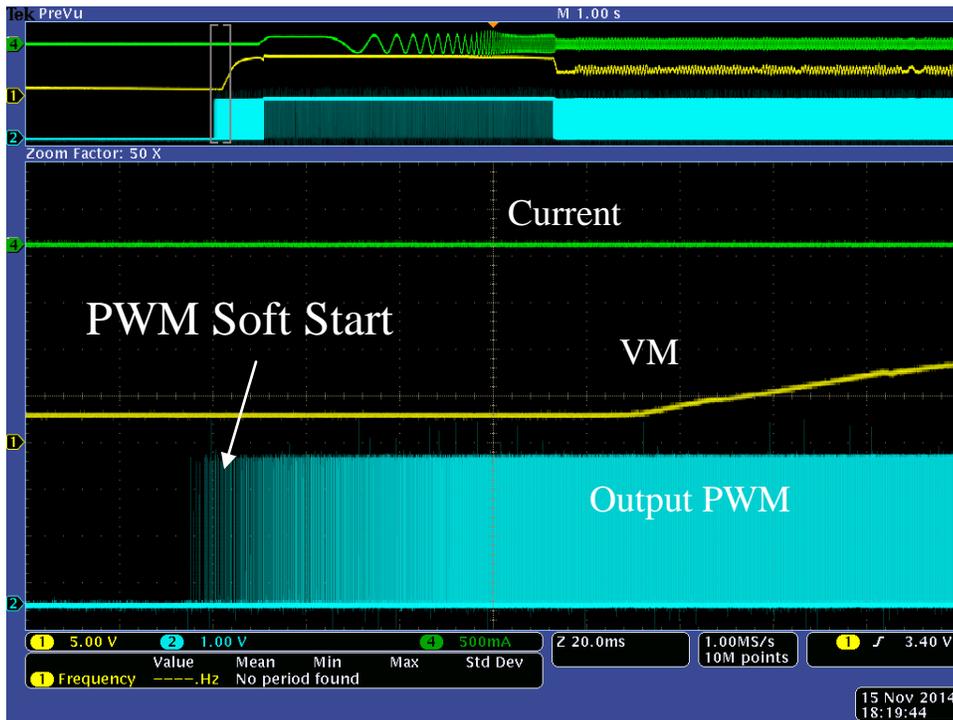
Using half step driving can achieve higher torque and higher MAX speed.

Stepping mode	MAX speed	Average Current @12V
Half	~130Hz (26RPM; 3.5s)	43mA
Full	~100Hz (20RPM; 4.6s)	30mA

3. PWM Power Module Test

➤ **Soft startup**

Soft startup means the PWM duty cycle increasing from 0 to desired value gradually when enable the PWM power stage of DRV8812. This is an important method to avoid OCP event caused by the inrush charging current to the LC output filter when DRV8812 is just enabled. The test results show that output pulse width $\geq 10\mu\text{s}$ at the startup of DRV8812 may cause the OCP event. This design includes the adjustable PWM duty ramping up function in the demo code, beginning with PWM pulse width $< 1\mu\text{s}$.



5. Fan module

➤ Motor Parameters and DRV10983 configuration data



DRV10983 EVM GUI Simulate Communication

Basic Settings	Advanced Settings	Display
<p>IPD Setting</p> <p>Enable IPD <input type="checkbox"/></p> <p>IPD Current Threshold (A) <input type="text" value="No IPD function"/></p> <p>IPD Advance Angle <input type="text" value="30 deg"/></p> <p>IPD Clock <input type="text" value="24 Hz"/></p> <p>IPD Release Mode <input type="text" value="Brake"/></p> <hr/> <p>Closedloop Setting</p> <p>AdjMode <input type="text" value="Full cycle adjustment"/></p> <p>Speed Input Mode <input type="text" value="Analog Input"/></p> <p>Closed Loop Accelerate <input type="text" value="0.77 VCC/s"/></p> <p>Control Coefficient Setting <input type="text" value="1"/></p> <p>Commutate Control Advance Mode <input type="text" value="Constant Time"/></p> <p>T Control Advance (s) <input type="text" value="1.92m"/></p>	<p>Before Startup</p> <p>Enable Initial Speed Detect <input type="checkbox"/></p> <p>Initial Speed Detect Threshold <input type="text" value="6 Hz (80ms no)"/></p> <p>Enable Reverse Drive <input type="checkbox"/></p> <p>Reverse Drive/Brake Threshold <input type="text" value="6.3 Hz"/></p> <p>Brake Done Threshold <input type="text" value="No Brake"/></p> <hr/> <p>Startup Setting</p> <p>AlignTime <input type="text" value="0.67 s"/></p> <p>First Order Accelerate <input type="text" value="4.5 Hz/s"/></p> <p>Second Order Accelerate <input type="text" value="3.3 Hz/s<sup>2</sup>"/></p> <p>Open to Closed Loop Threshold <input type="text" value="12.8Hz"/></p> <p>Open Loop Current rate <input type="text" value="1.5 VCC/s"/></p> <p>Open Loop Current <input type="text" value="0.4 A"/></p> <p>CLoopDis <input type="checkbox"/></p>	<p style="text-align: right;">Manual Refresh </p> <p>Current Limit</p> <p>Acceleration Current Limit <input type="text" value="0.8 A"/></p> <hr/> <p>Motor Parameters</p> <p>Phase Resistance (Ω) <input type="text" value="6.8"/></p> <p>Phase to Phase Kt (mV/Hz) <input type="text" value="66"/></p> <hr/> <p style="text-align: center;"> <input type="button" value="Enable Configure"/> <input type="button" value="eeRefresh"/> <input type="text" value="EEPROM Key x 0"/> <input type="button" value="eeWrite"/> <div style="border: 1px solid gray; padding: 2px; width: fit-content; margin: 0 auto;"> Motor Configuration <input type="button" value="Load"/> <input type="button" value="Save"/> </div> </p>
1.0.0.4		CONNECTED TEXAS INSTRUMENTS

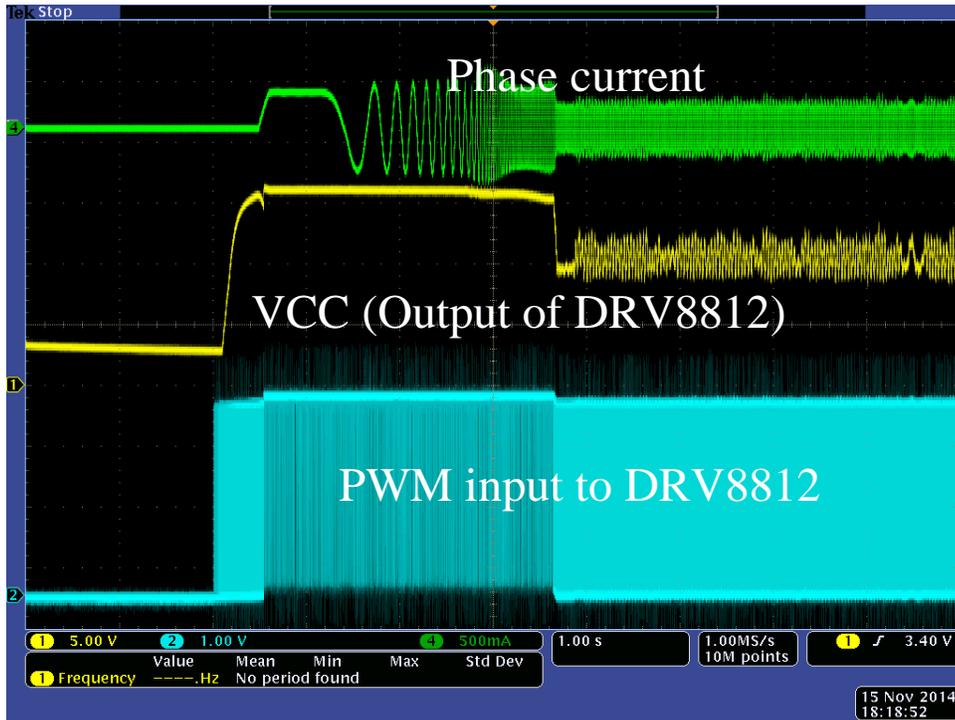
Page 1

DRV10983 EVM GUI Simulate Communication

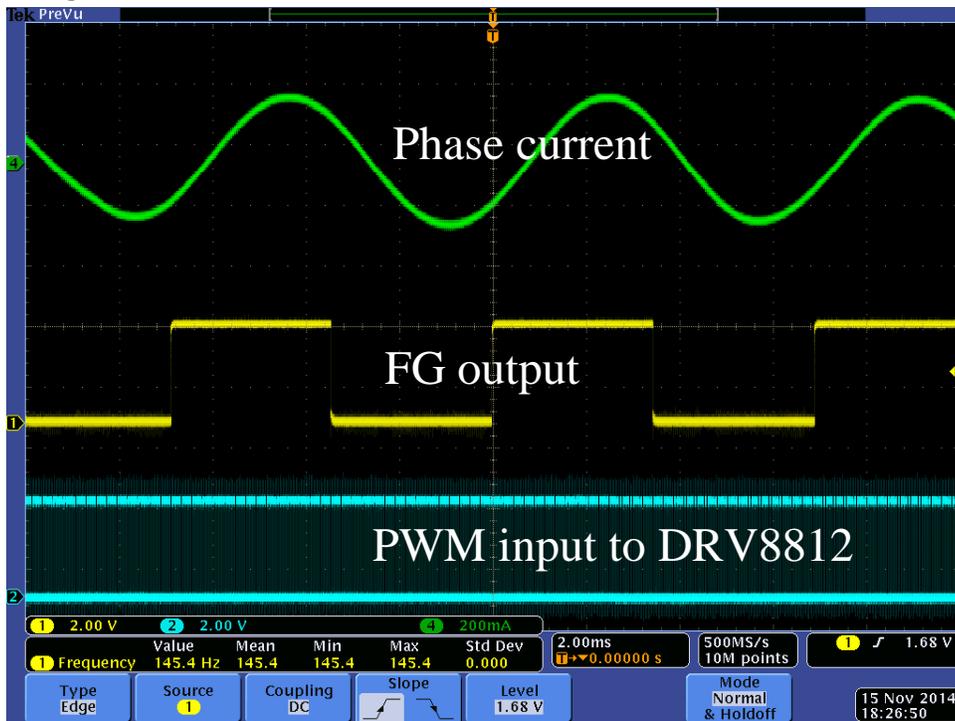
Basic Settings	Advanced Settings	Display
<p>Lock Detect</p> <p>Current Limit <input checked="" type="checkbox"/> No Motor Fault <input checked="" type="checkbox"/></p> <p>Speed Abnormal <input checked="" type="checkbox"/> Open Loop Stuck <input checked="" type="checkbox"/></p> <p>BEMF Abnormal <input type="checkbox"/> Closed Loop Stuck <input checked="" type="checkbox"/></p> <p>Abnormal Kt lock detect Threshold <input type="text" value="Kt_high = 3/2Kt"/></p> <p>Lock Detection Current Threshold <input type="text" value="2.0 A"/></p> <hr/> <p>PWM output Options</p> <p>Dead Time between HS and LS gate drive <input type="text" value="400 ns"/></p> <p>Double the output PWM frequency <input type="checkbox"/></p>	<p>AVS (Anti-voltage Surge) Function</p> <p>Enable Inductive AVS <input checked="" type="checkbox"/></p> <p>Enable Mechanical AVS <input checked="" type="checkbox"/></p> <p>Mechanical AVS Mode <input type="text" value="AVS to VCC"/></p> <hr/> <p>FG Options</p> <p>FG Open Loop Output Select <input type="text" value="Output FG in"/></p> <p>FG Cycle Select <input type="text" value="FG 4pole"/></p> <hr/> <p>Device Options</p> <p>Buck Regulator Voltage select <input type="text" value="3.3 V"/></p>	<p style="text-align: right;">Manual Refresh </p>
1.0.0.4		CONNECTED TEXAS INSTRUMENTS

Page 2

➤ Startup waveform



➤ Normal running waveform





➤ **Speed change with VM in close-loop control**

This design has closed-loop speed control with minimum hardware change of existing solution, using an MSP430G2553 and the DRV8812 for a PWM-based power supply. The following benefits can be gained from close-loop speed control.

- The fan speed can be set to any value and stay steady easily. Sometimes we need to set the speed point to reduce the acoustic running noise which may be resonated higher at certain speed.
- The fan speed can be remained constantly regardless of the temperature, power supply changes and manufacture variations of the motor parameters.
- Constant speed can be achieved within the whole product life cycle. So the system performance can be constant as well regardless of the mechanical wear and electronic drifting.

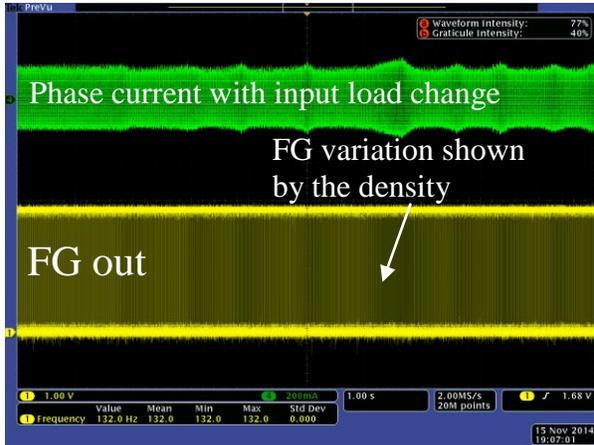
VM (J3) to DRV8812 /v	FG out /Hz(Command = 140Hz)	Error / %
11	139.3	-0.5
11.5	138.4	-1.1
12	141.0	0.7
12.5	141.7	1.2
13	138.7	-0.9
13.5	138.6	-1
14	140.3	0.2
14.5	138.9	-0.8
15	138.5	-1.1
15.5	139.4	-0.4
16	140.4	0.3

➤ **Speed change with external load**

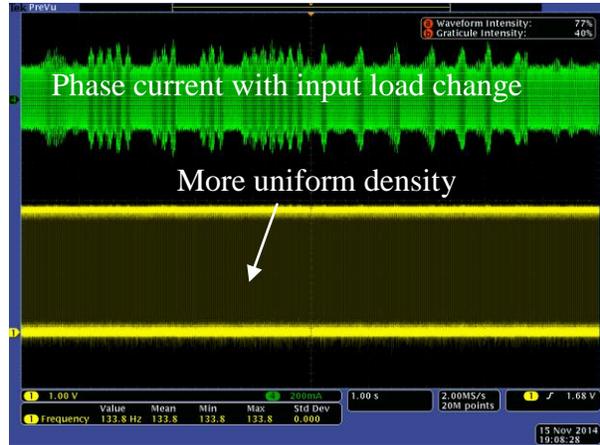
Without close-loop control, the speed of BLDC fan will be changed abruptly according to the external load change.

In the test, extra friction was generated by touching blades of the BLDC fan. With similar touching pressure, with or without the speed close-loop control, the speed drops are about 5% versus 20%.

The variation of FG (out of DRV10983) which represents the speed, at the input load changing condition, can be shown as the density change on the following FG waveform.



Without close-loop speed control



With close-loop speed control

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