

Abstract

This design implements a complete control and drive solution for 3-phase brushless DC motors up to about 3 kW in power rating. The design includes analog circuits, digital processor, and software to spin BLDC motors without the need for position feedback from Hall effect sensors or quadrature encoder.

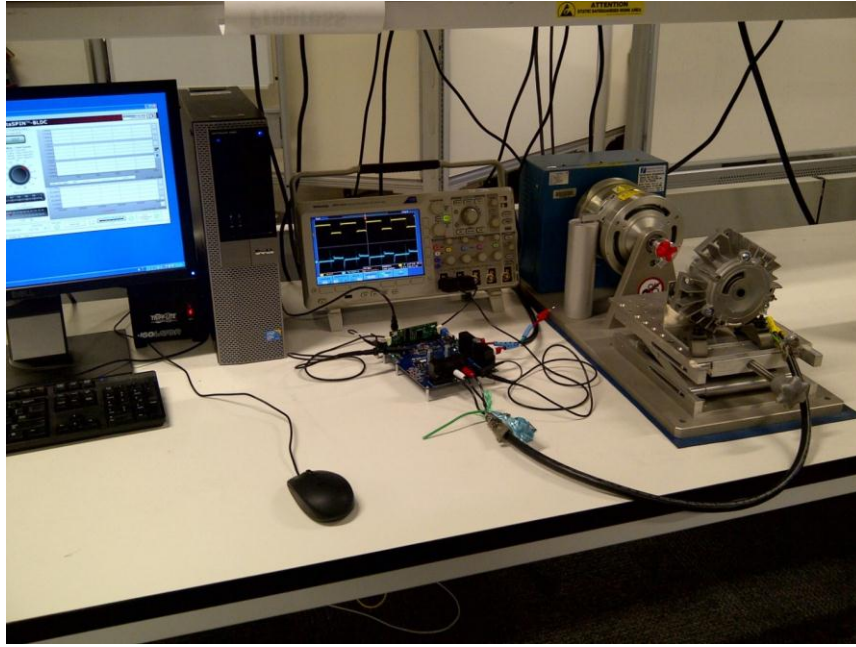


Figure 1 Test set-up

Equipment needed:

DRV830x-HC-C2-KIT DRV8301 High-Current Motor Drive EVM
controlCARD CC2803x ISO DIMM REV 1.3

3-phase Brushless DC (BLDC) motor

InstaSPIN-BLDC software – InstaSPIN BLDC Example GUI

Code Composer Studio V5.4

Agilent 6674A DC Power Supply (0-60V, 0-35A)

Coupling, cable, PC

Optional equipment

Magtrol HD-705-6N Hysteresis Dynamometer (300W continuous, 1400W 15 min.)

Magtrol M-TEST 5.0 Motor Testing Software

Tektronix DPO 3034 Oscilloscope

Tektronix P6139B Voltage probes (3)

Operational set-up

EVM board and controlCARD Connections

Insert the TMS320F28035 controlCARD into the DIMM-100 connector on the DRV8301-HC-EVM board. Alignment ridges in the DIMM-100 socket prevent insertion of the controlCARD in an incorrect orientation. The side latches close to retain the controlCARD in the DIMM-100 connector.

Power Connections

The DRV8301-HC-EVM is capable of operation up to 60 Amps at 60V; the motor is rated for 36V and 30 Amps. The power supply is set up to 60V, but 24V is common. Connect the supply voltage (+) to screw terminal J25 on the EVM board. Connect the supply ground (-) to screw terminal J26 on the EVM board. Refer also to section 3.2 in the Hardware Guide for additional information on jumper settings.

Motor to EVM board connections

Connect the 3 motor phases to the EVM board at the “Motor” terminal block. AWG-8 size wire should be used to ensure sufficient current-carrying capability if the motor will have high current. Note that the motor will operate with any assignment of the three motor phases to the three drive outputs on the board. There are 3 equivalent arrangements (A-B-C, B-C-A, C-A-B) which will cause clockwise motion, and 3 equivalent arrangements (C-B-A, B-A-C, A-C-B) which will cause counterclockwise motion. Either arrangement is valid as long as the user is satisfied with the polarity convention. If the user wishes to reverse the rotation for a given command, any two phases can be swapped.

Code Composer Studio

Code Composer Studio (CCS) is executed from the Start Programs menu, or from the desktop icon. Following the procedure indicated in the MotorWare labs, import the example project InstaSPIN-BLDC Example GUI. See the directory structure in Figure 2. Configure the target to TMS320F28035. Build the project, and start a Debug session. See additional details in reference 3, the [DRV830x-HC-C2-KIT How to Run Guide](#).

At this point, the red LED Dxxx on the controlCARD will begin blinking to indicate the program is loaded and running on the TMS320F28035 controlCARD. If not, check the connections, emulator, and program, and re-load and re-initialize the debug session as necessary.

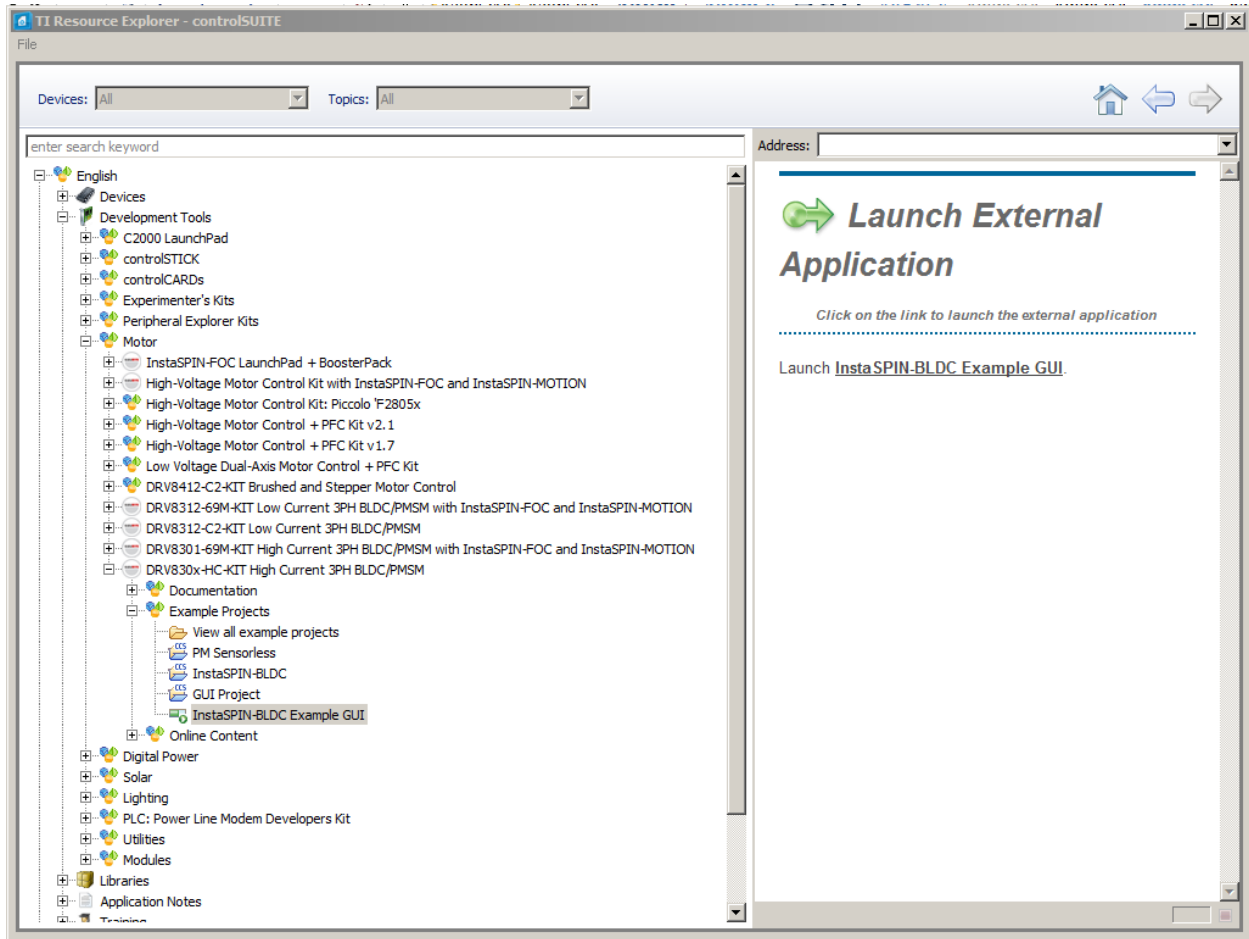


Figure 2 File directory structure within ControlSUITE with InstaSPIN-BLDC Example GUI

Start the ControlSuite program by clicking on the icon. Select “English”, then “Development Tools”, then “Motor”, then DRV830x-HC-KIT...” and finally “InstaSPIN-BLDC Example GUI” as shown in Figure 2. Launch the InstaSPIN-BLDC GUI by clicking on the link in the right panel. This GUI is used to command motor states (enabled, duty cycle, speed, etc.).

InstaSPIN-BLDC Graphical User Interface

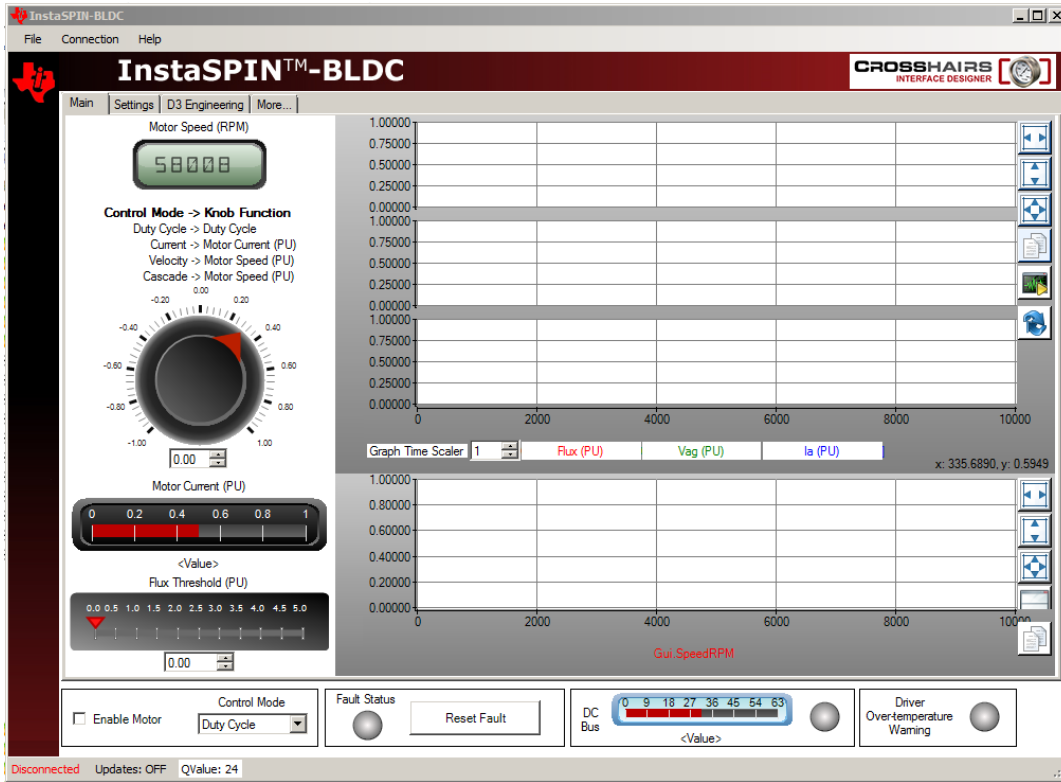


Figure 3 InstaSPIN-BLDC Graphical User Interface

On the InstaSPIN-BLDC graphical user interface, click to check the “Enable Motor” box on the Main tab. The motor should begin to rotate according to the setting for the motor speed control knob. Note that at relatively low commanded speeds (duty cycle < 0.20) there may be significant “cogging” as the motor switches from one magnet pole to the next.

The commanded duty cycle can be adjusted using the control knob on the main tab.

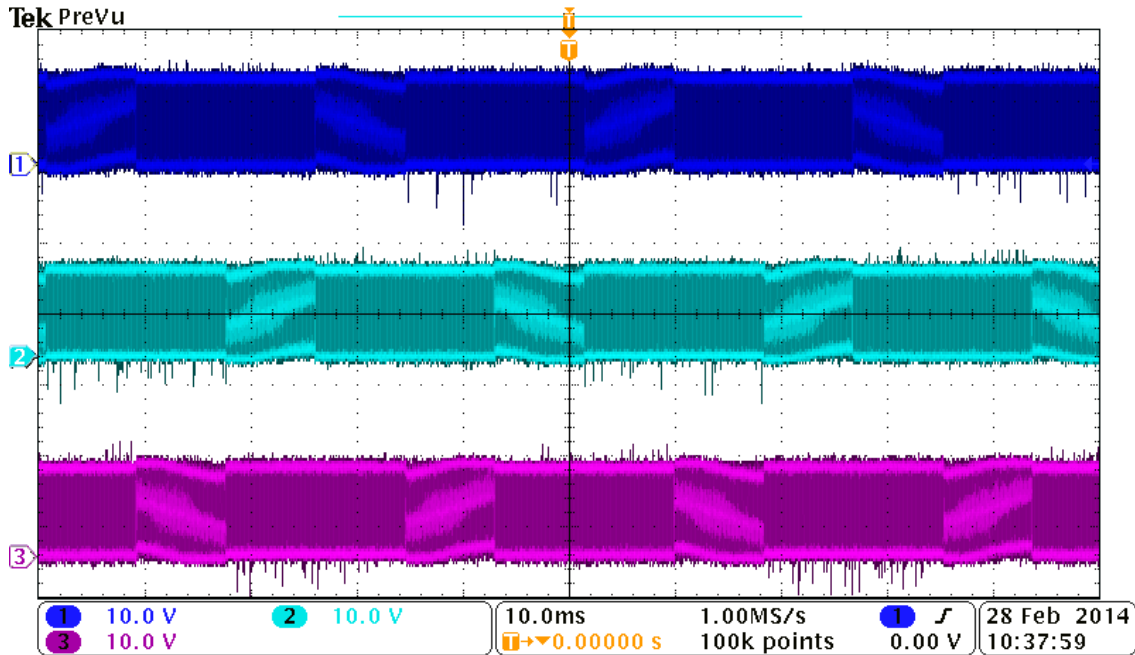
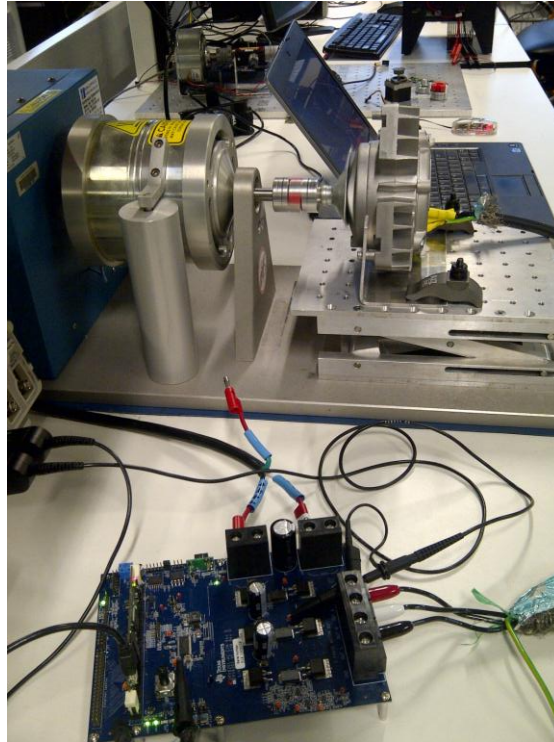


Figure 4 Motor phase voltages (A,B,C) during operation

Figure 4 shows the motor voltages as oscilloscope traces as the motor rotates. Channel 1 is measuring test point TP12 (output A), channel 2 is measuring test point TP13 (output B), and channel 3 is measuring test point TP14 (output C). Note that the traces do not show the details of the pulse-width modulated (PWM) outputs, but the general characteristics of the waveforms can be seen.

Table 1 Phase relations during motor rotation

	Phase A	Phase B	Phase C
1	Increasing	Mostly Low	Mostly High
2	Mostly High	Mostly Low	Decreasing
3	Mostly High	Increasing	Mostly Low
4	Decreasing	Mostly High	Mostly Low
5	Mostly Low	Mostly High	Increasing
6	Mostly Low	Decreasing	Mostly High
7	Increasing	Mostly Low	Mostly High
8	Mostly High	Mostly Low	Decreasing
9	Mostly High	Increasing	Mostly Low
10	Decreasing	Mostly High	Mostly Low
11	Mostly Low	Mostly High	Increasing
12	Mostly Low	Decreasing	Mostly High



The InstaSPIN-BLDC uses trapezoidal commutation which provides a simple and effective way to start spinning Brushless DC motors. For higher efficiency and performance, other InstaSPIN versions are available with sinusoidal commutation, see reference 5.

The InstaSPIN-BLDC GUI can also be set to Velocity control mode. In this mode, the software monitors the actual motor speed, and adjusts the commanded PWM duty cycle to maintain the selected speed. In this case, the main control knob is used to set the desired motor speed.

References:

1. InstaSPIN BLDC Lab Application Report, TI literature number SPRABN7, November 2011, <http://www.ti.com/lit/an/sprabn7/sprabn7.pdf>
2. DRV830x-HC-C2-KIT Hardware Reference Guide, Version 1.0 – August 2011, http://e2e.ti.com/cfs-file.ashx/___key/communityserver-discussions-components-files/312/1222.DRV830x_2D00_HC_2D00_C2_2D00_KIT_5F00_HWGuide.pdf
3. DRV830x-HC-C2-KIT How to Run Guide, Version 1.0 August 2011, ftp://ftp.ti.com/pub/dml/DMLrequest/Christy_FTP-10-30-12/controlSUITE/development_kits/DRV830x-HC-C2-KIT_v104/~Docs/DRV830x-HC-C2-KIT_HowToRunGuide.pdf
4. Video on DRV8301-HC-C2-KIT http://focus.ti.com/general/docs/video/Portal.tsp?entryid=0_3qsoyutg&lang=en
5. InstaSPIN Motor Control Solutions web page <http://www.ti.com/ww/en/mcu/instaspin/>

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