User's Guide **DRV8316xEVM Evaluation Module**

TEXAS INSTRUMENTS

ABSTRACT

This document is provided with the DRV8316xEVM customer evaluation module (EVM) as a supplement to the DRV8316 data sheet (DRV8316 4.5-V to 35-V Three-Phase Smart Gate Driver). This user's guide details the hardware implementation of the EVM and how to setup and power the board.

Note

The EVM is populated and configured for the DRV8316R (SPI variant) device by default. To configure the EVM for the DRV8316T (Hardware variant), please see Section 4.1.1.

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1 Cautions and Warnings

Observe the following cautions and warnings as printed on the EVM board.

HOT SURFACE:



Caution Hot Surface! Contact may cause burns. Do not touch. Please take the proper precautions when operating.

2 Introduction

The DRV8316 is an 4.5-V to 40-V, 8-A peak integrated three-phase gate driver IC for motor drive applications. It provides three accurately trimmed and temperature compensated half-bridges capable of directly driving a three-phase brushless-DC motor. Both the SPI variant (DRV8316R) and hardware interface variant (DRV8316T) integrates an adjustable buck regulator, flexible parameter settings such slew rate control, and protection features, and both are compatible with the DRV8316xEVM. See Table 2-1.

Device Name	Variant
DRV8316R	Buck regulator and SPI
DRV8316T	Buck regulator and Hardware

Along with the hardware of the DRV8316xEVM, the TMS320F280049C microcontroller on the LAUNCHXL-F280049C LaunchPadTM has reference software that provides the algorithm to the DRV8316 to control the BLDC motor.

This document serves as a startup guide to supplement the DRV8316xEVM + LAUNCHXL-F280049C BLDC motor control demonstration kit. It also is intended for engineers to design, implement, and validate reference hardware and software for the LaunchPad[™] MCU and DRV8316R. For step-by-step details on connecting the LAUNCHXL-F280049C + DRV8316xEVM, installing software, and running the project to spin a motor, refer to Section 5 *Hardware Setup*.



Figure 2-1. DRV8316xEVM PCB Layout

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3 Quick Start Guide

The DRV8316xEVM requires a power-supply source, which has a recommended operating range from 4.5 V to 35 V. To setup and power the EVM, use the following sequence:

- Connect the power supply ground to PGND of the two-pin power connector J5 and the voltage pin to the VBAT pin. Ensure R13 on the bottom layer is not populated and that jumpers J1-J3 of the LAUNCHXL-F280049C are populated (USB powers LaunchPad).
- Connect the motor phases to OUTA, OUTB, and OUTC. If using the Hall sensors, connect them to five-pin connector J7 as Figure 4-6 shows. Select 3.3 V or HALL_EXT_PWR on jumper J8 to select Hall power source.
- 3. Mate the DRV8316xEVM onto the top half of the LAUNCHXL-F280049C (Launchpad Headers J1/J3 and J2/J4) as Figure 4-7 shows. The motor and power connectors should face the same direction as the Micro-USB connector on the LaunchPad.
- 4. Power on the DRV8316xEVM.
- Connect a Micro-USB cable from the computer into the Micro USB connector on the top of the LAUNCHXL-F280049C.



4 Hardware and Software Overview

4.1 LEDs, Switches, and Jumpers

There are LED indicators on both the LAUNCHXL-F280049C and DRV8316xEVM when power is provided.

The LAUNCHXL-F280049 LaunchPad LEDs power up when the Micro-USB cable is plugged in and their functionalities are not modified upon powering the board.

The DRV8316xEVM has four status LEDs implemented on the board. By default, the VM and 3.3-VBK LEDs will light up when the board is powered and the MCU LED (tied to GPIO59) can be used for debugging and validation. Table 4-3 shows LED descriptions including those that are on during power up in bold and Figure 4-1 shows the locations of the LEDs.

Designator	Name	Color	Description
D1	3.3VBK	Green	Internal buck regulator is outputting 3.3 V
D2	nFAULT	Red	Lights up when fault condition has occurred on DRV8316
D3	VM	Green	Power is supplied to the board
D4	MCU_LED	Orange	MCU debugging

Table 4-1. Description of DRV8316xEVM LEDs (default Upon powerup in bold)





Figure 4-1. DRV8316xEVM LEDs

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The DRV8316xEVM includes a variety of user-selectable jumpers and unpopulated components on the bottom and top layers of the PCB to choose user settings and evaluate the DRV8316 device. A summary of those selectable settings are listed in Table 4-2 (defaults in bold) and can be seen on the board in Figure 4-2 and Figure 4-3.

ld.	Setting Name	Description	Layer	Position	Function
A	3.3-V buck inductor	User populates L1, L2, or R1 to	Тор	L1 = 47 µH Inductor	Inductor Mode
		choose switching component for	Bottom	L2 = 22 µH	Inductor Mode
			Тор	R1 = 22 Ω	Resistor Mode
В	VREF/ILIM	Select between using onboard VREF or ILIM reference circuitry	Тор	J1 = Left	VREF
				J1 = Right	ILIM
С	ILIM_SEL	Selects ILIM voltage reference for cycle-by-cycle current limit	Тор	J2 = Left	ILIM comes from MCU DAC (R53 must be populated)
				J2 = Right	ILIM comes from R4/R7 voltage divider
D	HALL_PWR_SEL	Selects Hall power voltage	Тор	J8 = Left	Hall power comes from 3.3VBK
			J8 = Right	Hall power is provided externally	
E	VREF select	Selects VREF source	Тор	R54 pop., R51 DNP	VREF = 3 V from EVM
				R54 DNP, R51 pop.	VREF comes from MCU
F	Rev. pol. Bypass	Bypasses reverse polarity	Bottom	R20 is populated	Bypass RPP and pi filter
		protection and pi filter		R20 is DNP	RPP and pi filter is used
G	3.3 V from LaunchPad	Connects buck voltage to LaunchPad 3.3 V	Bottom	R13 is populated	Connects 3.3VBK and LaunchPad 3.3 V
				R13 is DNP	No connection between 3.3VBK and LaunchPad 3.3 V
Н	Center Tap	Used to measure center tap voltage of motor (R52 must be populated)	Bottom	R33, R34, and R35 are populated	Center tap voltage of motor can be measured through C_TAP test point

Table 4-2. Description of User Selectable Settings on DRV8316xEVM (default in bold)





Figure 4-2. User-Selectable Jumpers and DNP Components on Top Side of DRV8316xEVM







4.1.1 DRV8316T Compatibility

The DRV8316xEVM is compatible with the DRV8316T (H/W variant) as the featured motor driver IC to spin a three-phase Brushless-DC motor. The DRV8316T replaces the SPI settings with five specific pin settings (MODE, SLEW, OCP/SR, GAIN, and VSEL_BK) that can be adjusted through resistor dividers.

When using the DRV8316T, the SPI enable resistors in the "Depop. if DRV8316T" silk screen box are to be depopulated (R9-R12) and the resistor dividers in the "Hardware Variant Resistors" silk screen box are to be populated (R37-R46) with the desired settings. Figure 4-4 shows this setup.

Table 4-3 shows the status of populated and DNP resistors for the two compatible DRV8316x variants. Table 4-4 shows the user-adjustable resistor divider settings when using the DRV8316T. R37-R41 resistors tie to AVDD and R42-R46 tie to AGND. The defaults of the two tables are in bold.

Table 4-3. Status of Resistors for DRV8316R and DRV8316T Variants (defaults	;
in bold)	

Device Variant		R9-R12 Status	R37-R46 Status	
DRV8316R	SPI	Populated	DNP	
DRV8316T	Hardware	DNP	User adjustable	





Figure 4-4. Resistor Divider Settings (R37-R46) and Resistors to Disable SPI (R9-R12)

Setting	Name	Description	Resistors (AVDD/ AGND)	Hardware	Setting
VSEL_BK	V _{BK}	Buck regulator average voltage	R40/R45	Tied to AGND	3.3 V
		$(L_{BK} = 47 \text{ or } 22 \ \mu\text{H}, C_{BK} = 22 \ \mu\text{F})$		Hi-Z	5.0 V
				47 kΩ to AVDD	4.0 V
				Tied to AVDD	5.7 V
MODE PWM Control Mode	PWM Control Mode	 Selects the PWM control mode type 	R37/R42	Tied to AGND	6 × PWM
				Hi-Z	6 × PWM with Current Limit
				47 kΩ to AVDD	3 × PWM
				Tied to AVDD	6× PWM with Current Limit
SLEW	Slew rate	Phase pin slew rate switching low to high (10-90%) and high to low (00-10%)	R38/R43	Tied to AGND	25 V/µs
				Hi-Z	50 V/µs
				47 kΩ to AVDD	125 V/µs
				Tied to AVDD	200 V/µs

Table 4-4. User-Adjustable	Resistor Divider Settings for DRV8316T	Variant (defaults in bold)
		· · · · · · · · · · · · · · · · · · ·

Setting	Name	Description	Resistors (AVDD/ AGND)	Hardware	Setting
OCP/SR	Overcurrent Protection / Smart Rectification	Selects the Mode for Overcurrent and Smart Rectification Settings (ASR = Automatic Synchronous	R41/R46	Tied to AGND	OCP = 10 A ASR and AAR Disabled
		Rectification; AAR = Automatic Asynchronous Rectification)		22 k Ω to AGND	OCP = 15 A ASR and AAR Disabled
				100 k Ω to AGND	OCP = 10 A ASR Enabled
				Hi-Z	OCP = 10 A ASR and AAR Enabled
				100 k Ω to AVDD	OCP = 15 A ASR Enabled
				22 k Ω to AVDD	OCP = 15 A ASR and AAR Enabled
				Tied to AVDD	OCP = 15 A ASR and AAR Enabled
GAIN	G _{CSA}	Current sense gain	R39/R44	Tied to AGND	0.15 V/A
				Hi-Z	0.3 V/A
				47 k Ω to AVDD	0.6 V/A
				Tied to AVDD	1.2 V/A

Table 4-4. User-Adjustable Resistor Divider Settings for DRV8316T Variant (defaults in bold) (continued)

4.2 Hardware Connections Overview – DRV8316xEVM + LAUNCHXL-F280049C

Figure 4-5 shows the major blocks of DRV8316xEVM plugin module that mounts to the J1/J3 and J2/J4 headers of the LAUNCHXL-F280049C LaunchPad development kit. The DRV8316xEVM is designed for an input supply from 4.5-V to 35-V and up to 8-A drive current. The DRV8316 includes three integrated half-bridges that can drive 8-A peak current and can be used in systems implementing sensored, sensorless, or field-oriented control. The 3.3-V supply to the Hall sensors is derived by the buck converter integrated in the DRV8316.





Figure 4-5. Major DRV8316xEVM Hardware Blocks

4.3 Connection Details

Figure 4-6 shows the connections made to the DRV8316xEVM to spin a three-phase sensored Brushless-DC motor.

An 4.5-V to 35-V power supply or battery is connected to the VBAT and PGND terminals. There is a reverse polarity protection implemented on the VBAT and PGND terminals. To bypass the reverse polarity protection and pi filter implementation, R20 can be populated on the bottom of the board.

The three phases of the BLDC motor connect directly to the OUTA, OUTB, and OUTC terminals of the screw terminal provided on the DRV8316xEVM.

To connect Hall sensor outputs to the Hall connector on the DRV8316xEVM, push down on the respective terminals to open the sockets and insert the Hall sensor connections.





Figure 4-6. Connections From Motor to DRV8316xEVM

Figure 4-7 shows where the Micro-USB cable is plugged into the LAUNCHXL-F280049C to provide communication between the LaunchPad firmware and GUI as well as the correct installment of the DRV8316xEVM to the J1/J3 and J2/J4 headers of the LaunchPad.





Figure 4-7. DRV8316xEVM on Headers J1/J3 and J2/J4 of LaunchPad[™] and Micro-USB Plugged Into LaunchPad[™]



4.4 Interfacing DRV8316xEVM and LAUNCHXL-F280049C LaunchPad™

The DRV8316xEVM has 40 pins with different functions. These pins are interfaced with the LAUNCHXL-F280049C LaunchPad development kit and are mapped appropriately to receive the functionalities of the DRV8316R device. These 40 pins are grouped into 4 ports in respect to the LAUNCHXL-F280049C (J1 to J4). Table 4-5 and Table 4-6 list the interfacing of these ports of the DRV8316xEVM headers J3 and J4.

Table	Table 4-5. Connections for Header J3 on DRV8316xEVM (DNP in bold)										
J3 Pin Number	DRV8316xEVM Function	LAUNCHXL-F280049C Function	Description								
1	3.3VBK (DNP)	3.3 V	3.3-V LaunchPad supply								
2	Not used	5 V	5-V LaunchPad supply								
3	Not used	PGA1/3/5_GND	Not used								
4	AGND	GND	GND connection								
5	Not used	GPIO13/SCIBRX	Not used								
6	VSENA	ADCINA5	Phase A Voltage Sense								
7	Not used	GPIO40/SCIBTX	Not used								
8	VSENB	ADCINB0	Phase B voltage sense								
9	nSLEEP (DNP)	NC	For internal use only								
10	VSENC	ADCINC2	Phase C voltage sense								
11	Not used	ADCINB3/VDAC	Not used								
12	VSENVM	ADCINB1	VM Bus voltage sense								
13	SCLK	SPIACLK	SPI clock (DRV8316R only)								
14	ISENA	ADCINB2	Phase A current sense								
15	nFAULT (DNP)	ADCINC4	For internal use only								
16	ISENB	ADCINC0	Phase B current sense								
17	nSLEEP	GPIO37	Active-low output sleep pin								
18	ISENC	ADCINA9	Phase C current sense								
19	nFAULT	GPIO35	Active-low input fault pin								
20	C_TAP/ILIM_DAC (populate only R52 or R53, not both)	ADCINA1/DACB_OUT	ADC for center tap sensing / DAC for ILIM voltage reference								

Table 4-6. Connections for Header J4 on DRV8316xEVM

J4 Pin Number	DRV8316xEVM Function	LAUNCHXL-F280049C Function	Description
1	INHA	GPIO10/PWM6A	PWM used to switch Phase A high- side FET
2	AGND	GND	GND connection
3	INLA	GPIO11/PWM6B	PWM used to switch Phase A low- side FET
4	nSCS	SPIASTE	SPI active-low chip select (DRV8316R only)
5	INHB	GPIO8/PWM5A	PWM used to switch Phase B high- side FET
6	Not used	NC	Not used
7	INLB	GPIO9/PWM5B	PWM used to switch Phase B low- side FET
8	Not used	NC	Not used
9	INHC	GPIO4/PWM3A	PWM used to switch Phase C high- side FET
10	Not used	XRSn	Not used
11	INLC	GPIO5/PWM3B	PWM used to switch Phase C low- side FET



J4 Pin Number	DRV8316xEVM Function	LAUNCHXL-F280049C Function	Description
12	SDI	SPIASIMO	SPI data input (DRV8316R only)
13	HALLA	GPIO58	HALL sensor A from motor
14	SDO	SPIASOMI	SPI data output (DRV8316R only)
15	HALLB	GPIO30	HALL sensor B from motor
16	DRVOFF	GPIO39	Active-high output to disable gate drivers
17	HALLC	GPIO18*/XCLKOUT	HALL sensor C from motor
18	Not used	GPIO23/LED4	LED reserved on LaunchPad
19	VREF (DNP)	GPIO25	For internal use only
20	MCU_LED	GPIO59	Visual feedback for LaunchPad connection

Table 4-6. Connections for Header J4 on DRV8316xEVM (continued)



5 Hardware Setup

The hardware required to run the motor control is the LAUNCHXL-F280049C LaunchPad development kit, the DRV8316xEVM, a Micro-USB cable, and a power supply with a DC output from 8-V to 32-V. Follow these steps to start up the DRV8316xEVM:

- 1. Mate the DRV8316xEVM board to the top half of the LAUNCHXL-F280049C LaunchPad development kit (mates to J1/J3 and J2/J4 of the LaunchPad, as in Figure 4-7). Ensure resistor R13 is DNP on the bottom of board to separate buck voltage from the USB power supply voltage.
- Connect the three phases from the brushless DC motor to the three-pin connector J4 on DRV8316xEVM. Phases OUTA, OUTB, and OUTC are labeled in white silkscreen on the PCB top layer. If using a sensored algorithm on the LaunchPad development kit, connect the Hall sensor to the five-pin connector J7.
- 3. Connect the DC power supply to header J5, ensuring the correct polarity of VBAT and PGND is applied.
- 4. Connect a Micro-USB cable to the LaunchPad development kit and computer.
- 5. Turn on the power supply and power up the PCB.
- If using the DRV8316xEVM with an external microcontroller, make the logic-level connections needed on the male headers on the top of the board or female connectors on the bottom side of the board. The signal names are labeled on the bottom side of the board for convenience as Figure 5-1 shows.



Figure 5-1. Bottom Silk Screen Shows Names of Pins When Using an External MCU



6 Firmware and GUI Application

The DRV8316xEVM can implement sensored, sensorless, or Field-oriented control for commutating a threephase Brushless-DC motor. The supported firmware is a sensorless ield-oriented control algorithm adapted from Texas Instruments' MotorControl SDK Library of motor solutions. The algorithm includes motor identification and parameters, sensorless sinusoidal commutation, torque and speed control, and field weakening to maximize the performance of the motor. The firmware uses GUI Composer to run the algorithm and includes a tab to read/write to the DRV8316 SPI registers.

The following steps describe how to identify useful motor parameters, spin the motor using a sensorless sinusoidal profile, use the PI controller gain settings for torque and speed control, and communicate with the DRV8316 SPI registers. For more information on advanced features of the C2000 InstaSPIN Universal GUI such as MTPA or Field-weakening, consult the MotorControl SDK InstaSPIN Lab Guide (in the MotorControl Software Development Kit tool page) and InstaSPIN-FOC and InstaSPIN-MOTION User's Guide.

6.1 C2000[™] InstaSPIN[™] Universal GUI

- 1. Follow the instructions in Section 5 *Hardware Setup* and ensure the LAUNCHXL-F280049C is connected to the PC and the power supply is turned on to the DRV8316xEVM PCB.
- 2. Access the *GUI Composer Gallery* https://dev.ti.com/gallery/ and search for "DRV8316xEVM_InstaSPIN_Universal_GUI". Click on the GUI.
- 3. Accept the readme as shown in Figure 6-1 and check the bottom left hand corner of the screen for "Hardware Connected". Once connected, the GUI will flash the algorithm to the MCU as shown in Figure 6-2.



Figure 6-1. C2000[™] InstaSPIN[™] Universal GUI for DRV8316xEVM



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Run Motor Identif	ForceAn	gle 🗌 Po	owerWarp (EPL)						Flux (V/Hz)	0.0000	Rr (Ohm)	0.0000	
					Bu	s Voltage	e (V)		Max Current for R est (A)	0.0000	Max Current for L est (A)	0.0000	
speedRef (Hz)	0.000	torque (N-m)	0.00000	V.0	0.00000000	1.0	0.00000000	CPU Fre	quency (MHz)	0	Magnetizing Current (A)	0.0000	
acceleration Max (Hz/s)	0.000	RsOnline Current (A)	0.000	V.1	0.00000000	L1 [0.00000000	PWM Fre	equency (kHz)	0			
speedTraj (Hz)	0.000	Iq_Ref (A)	0.000	V.2	0.00000000	1.2	0.00000000	ADC S	ampling (kHz)	0			
speed (Hz)	0.000	Id_Ref (A)	0.000	Vs	(V) 0.000	ls (A	A) 0.000	Current Co	ontroller (kHz)	0			
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Kp_spd	0.000	ld_Ki	0.000	Vd	(V) 0.000	Id (/	A) 0.000	Speed Co	ontroller (kHz)	0			
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Figure 6-2. C2000[™] InstaSPIN[™] Universal GUI Downloading Program

6.2 Motor Identification

- 1. Check the "Enable System" box to enable the InstaSPIN algorithm and run preset calibrations. When the preset calibrations are finished, the "OffsetCalc" checkbox will automatically uncheck itself.
- If using the DRV8316R, click on the DRV8316 SPI tab. Click "Read" to read the defaults of the DRV8316R device. Ensure the CSA_GAIN setting (Control Register 5) reads CSA_Gain_0p15. This setting ensures that the CSA current output when identifying the motor does not saturate, or else it will incorrectly identify the motor parameters and limit the maximum performance.
- 3. Alternatively, if using the DRV8316T, set the GAIN setting to 0.15 V/A by placing a 0-ohm resistor at R44 (in the Hardware Variant Resistors box). This setting ensures that the CSA current output when identifying the motor does not saturate, or else it will incorrectly identify the motor parameters and limit the maximum performance.
- 4. Check the "Run" box to begin the motor identification algorithm. The motor will begin to spin and stop as it goes through many states to calculate and identify useful motor parameters for sensorless Field-oriented control. This should take no more than a couple of minutes.
- 5. Once the motor identification process is complete, the "Motor Identified" indicator will light up, the "Run" box will be automatically unchecked, and the values Rs, Rs Online, Ls-d, Ls-q, Flux, and Rr will update for that motor as shown in Figure 6-3. These values will be automatically used for sensorless Field-oriented control.



C2000™ InstaSPIN Universal GUI File Edit Help											
InstaSPIN	FOC		ORVB316 SPI								
InstaSPIN-FOC [™] Instrumentat	ion										
Enable System Im RsRecalc MTPA user.h Params OffsetCalc Field-weakening	MOTOR_TYPE_PM VEST_TRAI_STATE_	CINCINI - Rs (Ohm)	hm) 0.0948 Rs (Ohm) 0.0948 Online 0.0948 Chine 0.0948 Chine 0.1968 Les (mk) 0.1968								
Run ForceAngle PowerWarp (EPL)		Flux (V/Hz)	Hz) (0.0343 Rr (Ohm) (0.0000								
	Bus Voltage (V) 12	Max Current for R est (A)	rent (A) 2.0000 Max Current -2.0000								
speedRef (Hz) 50.000 torque (N-m) 0.00987	V.0 0.94246310 I.0 10.06998160	CPU Frequency (MHz)	IHz) 100 Magnetizing Current (A) 0.0000								
acceleration Max (Hz/s) 10.000 RsOnline Current (A) 1.000	V.1 0.93867582 I.1 10.12402920	PWM Frequency (kHz)	sHz) 20								
speedTraj (Hz) 50.000 lq_Ref (A) 0.000	V.2 0.94325596 1.2 10.12579250	ADC Sampling (kHz)	1Hz) 20								
speed (Hz) 50.060 Id_Ref (A) 0.000	Vs (V) 1.000 Is (A) 1.732	Current Controller (kHz)	kHz) 20								
Speed Error (Hz) -0.06 -0.12 % Id_Kp 0.210	Vq (V) 2.565 Iq (A) 0.495	FAST™ Frequency (kHz)	(Hz) 20								
Kp_spd 0.138 Id_Ki 0.028	Vd (V) -0.079 Id (A) -0.037	Speed Controller (kHz)	Hz) 2								
Ki_spd 0.005 Iq_Kp 0.210	Current 3 Sensors 3	Trajectory Frequency (kHz)	4Hz) 20								
lg_Ki [0.028		(Hz) Force Angle +/-	(Hz) 1.00								
		ADC Scale Voltane (V)	00 44.280								
		ADC Scale Current (A)	(A) 22.000								

Figure 6-3. Motor Identification Using the DRV8316xEVM InstaSPIN[™] GUI



6.3 Sensorless-FOC Commutation

 To spin the motor freely with a sinusoidal current profile, check the "Run" box again. The motor will spin with sinusoidal current at the speedRef (Hz) value in the GUI, which is automatically set to 20.0 Hz. Use the speedRef (Hz) input to change the current speed of the motor as shown in Figure 6-4. The GUI automatically calculates the current reference speed using the variable **speed (Hz)** and compares it to the trajectory speed variable **speedTraj (Hz)** to calculate the **Speed Error (Hz)** and as a percentage.

		InstaSP	N-FOC				
nstaSPI	N-FOC™	Instrumenta	tion				
Enable System	RsRecalc	MTPA	MOTOR_TYPE_P	M VEST_TRAJ_STATE	ONLINI ~ Rs (Ohr	0.0948	Rs (Ohm) Online 0.0948
user.h Params	OffsetCalc	Field-weakening	Pole Pairs 3	EST_STATE_ONLP	🗄 🧹 Ls-d (m	() 0,1968	Ls-q (mH) 0.1968
Run Motor Identific	ForceAngle	PowerWarp (EPL)			Flux (V/H	0.0343	Rr (Ohm) 0.0000
Motor identilie	u			Bus Voltage (V)	Max Curre	1 2.0000	Max Current for Let (A) -2.0000
speedRef (Hz)	50.000	toraue (N-m) 0.00987	V.0 0.942	46310 1.0 10.06998160	CPU Frequency (MH	2) 100	Magnetizing Current (A) 0.0000
cceleration Max (Hz/s)	10.000	RsOnline Current (A) 1.000	V.1 0.938	167582 L1 10.12402920	PWM Frequency (kH	20	
speedTraj (Hz)	50.000	Iq_Ref (A) 0.000	V.2 0.943	125596 1.2 10.12579250	ADC Sampling (kH	2) 20	
speed (Hz)	50.060	Id_Ref (A) 0.000	Vs (V) 1.0	000 Is (A) 1.732	Current Controller (kH	20	
Speed Error (Hz)	0.06 -0.12 %	Id_Kp 0.210	Vq (V) 2.	565 Iq (A) 0.495	FAST [™] Frequency (kH	20	
Kp_spd	0.138	Id_KI 0.028	Vd (V) -0.	079 Id (A) -0.037	Speed Controller (kH	2) 2	
Ki_spd	0.005	Iq_Kp 0.210	1	Current Sensors 3	Trajectory Frequency (kH	2) 20	
		la Ki 0.028	1	Sector S	Earca Anala +/	1.00	
			2		(RP1	1) 20	
					ADC Scale Voltage (0 44.280	
					ADC Scale Current () 22.000	

Figure 6-4. Sensorless Sinusoidal Commutation Using the DRV8316xEVM InstaSPIN[™] GUI

6.4 Torque and Speed Control

To implement more advanced modulation techniques such as torque control, speed control, and algorithms such as MTPA, Field-weakening, and PowerWarp (EPL) using the DRV8311HEVM InstaSPIN Universal GUI, please consult the MotorControl SDK InstaSPIN Lab Guide found in MotorControl SDK.

This document contains detailed lab overviews of how to implement each advanced modulation technique when using sensorless FOC to spin the BLDC motor in Code Composer Studio. In order to use the project with the GUI, the user must build and compile the project in CCS, and import the .out binary file for that project into the GUI properties through GUI Composer. More information can be found in the README when the GUI is first opened.



6.5 SPI Communication (DRV8316R only)

- 1. Click on the "DRV8316 SPI" tab to access the DRV8316 Registers as Figure 6-5 shows.
- Choose the desired settings in Control Registers 1–10 by selecting the appropriate setting or bit from the drop-down menus. Consult the DRV8316x data sheet (*Register Map* section) for detailed definitions of settings.
- 3. Click on "Write" to write to all control registers in the device with the configured settings.
- 4. To read all status and control registers in the device, click on "Read". The statuses and settings will auto-populate in their registers.
- 5. Alternatively, to write data to a specific address, input the address and data in decimal into the address and data inputs above the "Manual Write" box. Click on the "Manual Write" box to write the data to that address. To read data from a specific address, input the address in decimal into the address above the "Manual Read" box. Click on the "Manual Write" box to read the data from that address.

C2000™ InstaS	PIN Uni	versal GU	II File	Edit	Help				
4			In	taSPIN-FOC					DRV8316 SPI
DRV8316	Regis	ters	NOTE: On	ly enabled for	DRV8316 har	dware			
	7	6	5	4	3	2	1	6	
IC Status Register (R)	RESERVED	BK_FLT	SPI_FLT	OCP 0	NPOR 1	OVP	OT 0	FAULT	Addr. (Dec) Write Data (Dec) 0 0
Status Register 1 (R)	WTO	OTS	OCP_HC	OCP_EC	OCP_HB	OCP_LB	OCP_HA	OCP_LA	MANUAL WRITE
Status Register 2 (R)	RESERVED	OTP_ERR	BUCK_OCP	BUCK_UV	VCP_UV 0	SPLPARITY	SPLSCLK_FLT	SPLADDR_FLT	Addr. (Dec) 0 0 0
			RESERVED			The fact of the	REG_LOCK		MANUAL READ
Control Register 1 (RW)	HSVU					UNIOCKAII		~	
Control Register 2 (RW)	RSVD	RESERVED	~	StewRate_1	EW 25 🗸	PWM_6x_1	Mode 🗸	CLR_FLT	WRITE READ
		DESE	INVED		OVP SEL	OVP EN	SPI FIT REP	OTW REP	
Control Register 3 (RW)	RSVD				Y	*	0 ~	0 ~	
Control Register 4 (RW)	RESERVED	OCP_CBC	OCF Deglitch_1	LDEG US V	OCP_RETRY	OCP_LVL	OCP, Latched_Fa	MODE Bult V	
Control Register 5 (RW)	BEMF_TH	ILIM_RECIR	AD_COMP_ TH_LS	AD_COMP_ TH_HS	EN_AAR	EN_ASR 0 ❤	CSA_Gain_	gain 0p25 🗸	
1999 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	RESI	ERVED	BUCK SP	BUCK PS DIS	BUCK CL	BUC	k en	BUCK DUS	
Control Register 6 (RW)	RSVD	×.	~	0 ~	~	Buck_Volta	age_3p3' ❤	×	
🖉 🕞 🔺 Hardware	Connected.								40 Texas Instrument

Figure 6-5. SPI Communication Using the DRV8316xEVM InstaSPIN™ GUI



7 DRV8316xEVM Schematics







Figure 7-2. Voltage Sense and Protection Schematic





Figure 7-3. Connectors and Interface Schematic



Figure 7-4. DRV8316 3-phase BLDC Motor Driver Schematic











Figure 7-7. TMS430F280049C LaunchPad Connections Schematic



Figure 7-8. Status LEDs Schematic

8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

C	hanges from Revision A (February 2021) to Revision B (August 2021)	Page
•	Updated images from the engineering revision of the EVM to the released version of the EVM	1
•	Generalized the name to the DRV8316xEVM to showcase SPI and H/W compatibility	1
•	Included information on SPI and H/W variant names	1

CI	hanges from Revision * (December 2020) to Revision A (February 2021)	Page
•	Added Cautions and Warnings section	3
•	Changed instructions in the C2000™ InstaSPIN™ Universal GUI section	19

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