# Development Board EPC9147B Quick Start Guide

Motor Drive Controller Interface Board — Texas Instruments LAUNCHXL

Revision 2.0



## Motor Drive Controller Interface Board with TI's LAUNCHXL

## DESCRIPTION

The EPC9147B is an interface board that accepts the TI LAUNCHXL development kit, such as the F28379D, F28069M, or F280049 that features the TI C2000 microcontroller family, and connects to a compatible 3-phase eGaN® FET/ IC motor drive inverter board, as it can be seen in figure 1. This interface board allows users to utilize the existing TI InstaSPIN\_UNIVERSAL GUI resources together with EPC- dedicated files to program the controller board and control a motor powered by an eGaN FET/IC 3-phase inverter using sensorless field oriented control and space vector pulse width modulation.





Speed adjust knob

#### **RECOMMENDED OPERATING CONDITIONS**

The EPC9147B combined with Texas Instruments LAUNCHXL family of controllers is compatible with the following EPC motor drive inverter boards: EPC9146, EPC9167HC, EPC9173, EPC9176, and EPC9186.

The firmware provided requires to measure the phase voltages. The firmware can be modified in order to measure the temperature of the power board and to control the speed via the potentiometer present on the control board EPC9147B.

#### **DETAILED DESCRIPTION OF THE EPC9147B BOARD**

Figure 2 shows an overview of the EPC9147B board detailing connections such as mounting options and interfaces; and human interfaces that measures the dimensions of the board are:  $110 \times 60$  mm (L x W).



#### **Test Points**

Several test-points are available for measurement of various analog, error and PWM signals. Analog signals include voltage and current readings, input DC voltage to the drive, and current sense. The operator is encouraged to read the motor drive inverter drive QSG carefully to determine the correct scaling factors. The locations of the test points are shown in figure 3.



#### **Over-Current Detect**

The EPC inverter boards are equipped with over-current detection circuits, but TI firmware does not provide over-current protection; contact Texas Instruments field-application engineers for firmware development support if over-current protection in control firmware is required.

#### $0\,\Omega$ Resistors

Various 0  $\Omega$  resistors are that are present on the board that are used to send either phase voltages or other analog signals to the inputs of the ADC microcontroller. The default configuration is with phase voltage measurements. **Note that TI original firmware for LAUNCHXL uses measured phase voltages; to remove phase voltage measurements from ADC input, firmware needs to be modified.** 

Place either R32 to measure the phase voltage of leg 2 or R33 to measure the temperature of the power board. Place either R30 to measure the phase voltage of leg 1 or R31 to have an analog signal from the on-board potentiometer to the ADC input.

#### Table 1

0Ωresistor	Default configuration	Compatible with provided firmware	ADC I/O function
R30	Yes	Yes	Measure phase 1 voltage
R31	No	No, firmware needs changes	Measure signal from speed potentiometer
R32	Yes	Yes	Measure phase 2 voltage
R33	No	No, firmware needs changes	Measure temperature sensor on power board

**Warning:** The human interface controls and knob, as well as the entire EPC9147B, are not isolated. The EPC9147B is referenced to Power Ground and extreme caution has to be observed when operating the motor while the computer is attached to the EPC9147B via USB interface. It is recommended to use the opto-isolated USB communication option on the LAUNCHXL board to avoid damage to the computer.

# **CONNECTION DETAILS**

#### Inverter

A 40 pin connector is used to interface power, PWM signals and analog feedback signals between the interface board and the motor drive inverter. Table 3 gives the map for each signal.

#### Table 2: Motor interface connection (J2) pin allocation map

Pin #	Pin N	ame	Pin #
2	PWMH1	GND	1
4	PWML1	GND	3
6	PWMH2	GND	5
8	PWML2	GND	7
10	PWMH3	3V3	9
12	PWML3	3V3	11
14	EncA	3V3	13
	Inde	x	
18	EncB	AGND	17
20	Encl	AGND	19
22	Vdc	AGND	21
24	Vsns1	AGND	23
26	Vsns2	AGND	25
28	Vsns3	AGND	27
30	GP1	AGND	29
32	lsns1	AGND	31
34	lsns2	AGND	33
36	lsns3	AGND	35
38	GP2	OCPn	37
40	Tsns	nEN	39

# CONTROLLING A TEKNIC M-3411P-LN-08D MOTOR USING INSTASPIN UNIVERSAL GUI

The TI LAUCNHXL-F28069M board can be programmed using the InstaSPIN Universal GUI. The basic steps to run a Teknic motor Teknic\_M-3411P-LN-08D using EPC inverter board-specific firmware and using the LAUNCH-XL-F28069M are explained below.

# I. Download Texas Instruments Resources

1. Download the universal GUI from the following link: https://www.ti.com/tool INSTASPINUNIVERSALGUI		- 0 ×
<ul> <li>Make sure to be logged in with the personal profile on ti.com</li> </ul>	Products Reflections Design resources Quality & reliability Support & training About	n <b>X</b>
<ul> <li>Make sure to select that the software will be used for civil use</li> </ul>	INSTASPINUNIVERSALGUI GUI Composer Runtime Installation and Webapp for MotorWa Universal GUI	Downtoods
	Overview Downloads Technical documentation Support & training	
	Overview	
	Description & features What's included GUI Composer Runtime Installiation and GUI source (Webapp) for Motor Ware Universial GUI. This GUI instruments the exi variables in any MotorWare InstaSPIN-FOC or InstaSPIN-MOTION project, meaning you can recompile the out to add yor own settings and other system code.	sting * * * * * * * * * * * * * * * * * * *
2. Execute the downloaded program <b>instaspinu</b>	niversalgui_v105.exe	
	INSTASPINUNIVERSALGUI	Downloads
	Overview Downloads Technical documentation Support & training	
	Downloads	
	SOFTWARE PROGRAMMING TOOL INSTASPINUNIVERSALGUI - GUI Composer Runtime Installat MotorWare Universal GUI  The Requires export approval (1 minute) Supported products & hardware	ion and Webapp for
3. Follow all installations steps by accepting defa	ult settings.	
License Agreement Please read the following license agreement carefully.		
GUI Composer Software License Agreement	<complex-block></complex-block>	
IMPORTANT - PLEASE READ THE FOLLOWING LICENSE AGREEMENT CAREFULLY. THIS IS A LEGALLY BINDING AGREEMENT. AFTER YOU READ THIS LICENSE AGREEMENT, YOU WILL BE ASRED WHETHER YOU ACCEPT AND AGREET OT THE TERMS OF THIS LICENSE AGREEMENT. DO	Start Copying Files Review settings before copying files	
NOT CLICK "I ACCEPT" UNLESS: (1) YOU ARE AUTHORIZED TO ACCEPT AND AGREE TO THE TERMS OF THIS LICENSE AGREEMENT ON BEHALF OF YOURSEF AND YOUR COMPANY; AND (2) YOU INTEND TO ENTER INTO AND TO BE BOUND BY THE TERMS OF THIS LEGALLY BINDING AGREEMENT ON BEHALF OF YOURSEF E AND YOUR COMPANY.	Setup has enough information to start copying the program files. If you want to review or chance any settings, dick Back, If you are satisfied with the settings, dick Next to beein copying GUI Composer 1	Setup X
Important – Read carefully: This GUI Composer Software License Agreement ("Agreement") is a legal agreement between you (either an individual or entity) and Texas Instruments	files. Choose Destin Install Directory:  Mere should	Ination Location
I accept the terms of the license agreement.     I do not accept the terms of the license agreement.     Print	C:10 Setup Type: Typical To install to this folder.	GUI Composer in the following folder. folder, click Next. To install to a different folder, click Browse and select another
a statutime           a statutime           < Back		
	InstalJammer Cancel Destination Fol	der
	Ct/8 Installammer	Browse
	L	< Back Next > Cancel

#### **Spectrum Digital Emulator Drivers**

During the GUI installation process, it may ask to install the drivers for the Spectrum Digital emulator. Click on Install button.

E Windows Security	×
Would you like to install this device software?	
Name: Spectrum Digital Publisher: Spectrum Digital	
Always trust software from "Spectrum Digital".	tall Don't Install
You should only install driver software from publishers you which device software is safe to install?	trust. How can I decide

## II. EPC 3-phase inverter board dedicated firmware

- 1. Download the EPC board dedicated files and store them in the correct location by clicking on the "GitHub EPC Reference Design Firmware" link on the EPC9147B web page.
- 2. Install specific EPC directory in GUI software
- 3. Navigate to the directory C:\ti\guicomposer\webapps and rename the directory InstaSPIN\_F2806xM\_UNIVERSAL by adding \_original suffix.

■ webapps	0 6 6 6	N↓ Sort ~ 🗮 View ~	·		 -	0	×
	> This PC > OS (C:) > ti > guicomposer >	webapps > V (	C P Search	webapps			
Pictures 📌	Name	Date modified	Туре	Size			
📁 boards	InstaSPIN_F2802xF_UNIVERSAL	11/14/2022 3:00 PM	File folder				
CCS Screenshots	InstaSPIN_F2805xM_UNIVERSAL	11/14/2022 3:00 PM	File folder				
ST_sw	InstaSPIN_F2806xM_UNIVERSAL	11/14/2022 3:00 PM	File folder				
> 😻 Dropbox (EPC_TIGE							
> 🔷 OneDrive							
🛩 💻 This PC							

4. Download EPC power board firmware from "GitHub EPC Reference Design Firmware" link on the EPC9147B web page, then copy the directory InstaSPIN\_F2806xM\_UNIVERSAL supplied by EPC keeping the original name.

webapps				- 0
🕀 New - 岁	0 10 5 10 14	Sort - 🛛 E View -		
← → ~ ↑	> This PC > OS (C:) > ti > guicomposer > w	ebapps v C	Search webapps	
Pictures 🖈	Name	Date modified	Type Size	
📁 boards	InstaSPIN_F2802xF_UNIVERSAL	11/14/2022 3:00 PM	File folder	
CCS Screenshots	InstaSPIN_F2805xM_UNIVERSAL	11/14/2022 3:00 PM	File folder	
ST_sw	InstaSPIN_F2806xM_UNIVERSAL	11/14/2022 3:02 PM	File folder	
Cropbox (EPC TIGE	InstaSPIN_F2806xM_UNIVERSAL_original	11/14/2022 3:00 PM	File folder	

#### **Enhance the Program DPI Resolution**

Browse into the copied directory InstaSPIN\_F2806xM\_UNIVERSAL which was copied on the path: c:\ti\guicomposer\webapps. Right-click on the InstaSPIN\_UNIVERSAL.exe program, choose Properties on the pop-up menu, then click on Compatibility tab and on the Change high DPI settings button.



InstaS	PIN_UNIVERS	AL.exe Prop	perties		×
General	Compatibility	Security	Details	Previous V	ersions
If this pro	ogram isn't wor the compatibili	king correctl ty troublesho	y on this ve oter.	ersion of Wind	lows, try
Run	compatibility t	roubleshoot	ne		
How do	I choose comp	atibility setti	ngs manua	ally?	
Comp	atibility mode				
Ru	n this program	in compatib	lity mode f	or.	
Wind	ows 8			~	
Collins					
Re	duced color m	ode			
8-bit	(256) color	~			
Ru	n in 640 x 480 s	creen resolu	tion		
Dis	able fullscree	n optimizatio	ns		
Ru	n this program	as an admir	istrator		
Re	gister this prog	gram for resta	art		
	e legacy displ	ay ICC color	managem	re it	
	Change high	DPI settings			
-	Change setting	s for all user	s		
		OK		Cancel	Apply

Tick Override high DPI scaling behavior and choose System (Enhanced) option, then press OK.

High DPI settings for InstaSPI	N_UNIVERSAL.exe	×
Choose the high DPI settings for t	his program.	
Program DPI		
Use this setting to fix scaling instead of the one in Setting Open Advanced scaling settings	problems for this prog s	ram
A program might look blurry if t changes after you sign in to Wir	he DPI for your main di ndows. Windows can try	splay to fix
this scaling problem for this pro set for your main display when	gram by using the DPI t you open this program.	that's
this scaling problem for this pro set for your main display when Use the DPI that's set for my ma	gram by using the DPI t you open this program. ain display when	that's
this scaling problem for this pro set for your main display when Use the DPI that's set for my main I signed in to Windows	gram by using the DPI t you open this program. ain display when	that's
this scaling problem for this pro set for your main display when Use the DPI that's set for my main I signed in to Windows	gram by using the DPI t you open this program. ain display when	that's
this scaling problem for this pro set for your main display when Use the DPI that's set for my main I signed in to Windows Learn more High DPI scaling override	gram by using the DPI t you open this program. ain display when	that's
this scaling problem for this proset for your main display when Use the DPI that's set for my main I signed in to Windows Learn more High DPI scaling override Override high DPI scaling be Scaling performed by:	gram by using the DPI t you open this program. ain display when	that's

# Motor Drive Controller Interface Board with TI's LAUNCHXL

## Preparing for the first launch

Each power board is associated with its specific file, but the software always executes the file named appProgram.out; so each time a power board is selected, the specific file associated with it should be copied and renamed appProgram.out. The step-by-step procedure is reported below.

- 1. Browse to c:\ti\guicomposer\webapps\instaSPIN\_F2806xM\_UNIVERSAL.
- 2. Inside the indicated directory, one file with **.out** extension for each motor drive reference design board is present.
- 3. Make sure to make a copy of the desired reference board **.out** file and then rename the copied file as **appProgram.out**.

## HARDWARE connection check

4. Make sure that the EPC9147B + LaunchXL F28069M boards are connected to the USB port of the computer.

## 5. Launch the InstaSPIN\_UNIVERSAL.exe

The InstaSPIN\_UNIVERSAL.exe program looks for a file called **appProgram.out** and it downloads it on the RAM memory of the F28069M processor. Make sure to chose the proper .out file corresponding to the power board that is going to be used with the EPC9147B and rename the file with the name **appProgram.out** 

#### > This PC > Windows-SSD (C:) > ti > guicomposer > webapps > InstaSPIN\_F2806xM\_UNIVERSAL >

Name	Date modified	Туре	Size
.settings	14-Sep-22 3:32 AM	File folder	
Images	14-Sep-22 3:32 AM	File folder	
workingset with EPC	05-Oct-22 9:11 AM	File folder	
appsettings	09-Jan-15 6:03 AM	APPSETTINGS File	1 KB
app.css	09-Jan-15 12:02 AM	Cascading Style Shee	2 KB
app.html	07-Oct-22 1:37 AM	Chrome HTML Docu	63 KB
app.html.bak	05-Oct-22 9:00 AM	BAK File	63 KB
🐒 app.js	05-Oct-22 8:23 AM	JavaScript File	8 KB
app.json	05-Oct-22 8:56 AM	JSON File	74 KB
app.json.bak	05-Oct-22 8:41 AM	BAK File	74 KB
original.html	15-Jul-15 7:02 AM	Chrome HTML Docu	247 KB
3 app_original.js	09-Jan-15 12:02 AM	JavaScript File	S KE
app_original.json	21-Jul-15 2:01 AM	JSON File	74 KE
🐒 appInitScript.js	11-Oct-12 4:02 AM	JavaScript File	1 KE
appProgram.out	06-Oct-22 6:31 AM	OUT File	427 KE
💿 index.html	09-Jan-15 12:02 AM	Chrome HTML Docu	1 KE
InstaSPIN_UNIVERSAL.exe	09-Jan-15 12:02 AM	Application	99 KE
InstaSPIN_UNIVERSAL.ini	14-Sep-22 4:10 AM	Configuration settings	1 KE
proj_lab05b_epc9145.out	06-Oct-22 7:16 AM	OUT File	427 KE
proj_lab05b_epc9146.out	06-Oct-22 5:50 AM	OUT File	427 KB
proj_lab05b_epc9167.out	06-Oct-22 7:04 AM	OUT File	427 KB
proj_lab05b_epc9173.out	07-Oct-22 1:34 AM	OUT File	427 KB
proj_lab05b_epc9176.out	06-Oct-22 6:31 AM	OUT File	427 KB
readme.txt	09-Jan-15 12:02 AM	Text Document	1 KB

## III. Using InstaSPIN Universal GUI

#### Setting Up the System

Before operating the board, the user must check that it is the correct reference design. The USB opto-isolator of the LaunchXL board must be enabled to continue.



## Motor Drive Controller Interface Board with TI's LAUNCHXL

#### Spinning the Teknic (default) Motor

#### Please note that this works only with the Teknic motor Teknic\_M-3411P-LN-08D

The step-by-step procedure to spin the motor once the hardware connections are made and when the InstaSPIN UNIVERSAL GUI is launched are reported below.

- 1. Click on Enable System
- 2. Check that the value of the Bus Voltage corresponds to the applied DcBus voltage.

If the voltage is not corresponding, the most common problems are the following:

- The power supply is not correctly set
- The wrong .out file is used: the read voltage depends on the resistive divider on the power board
- 3. If the voltage is correct, the motor can be spinned by checking the Run box
- 4. The motor speed can be modified by changing the **Speed\_Ref\_RPM** value. Swapping the sign of the reference speed will command a change of spinning direction. As an example, if for positive reference speed values the motor spins clockwise, for negative reference speed values the motor spins counterclockwise.
- 5. The current loop and the speed loop parameters can be adjusted by changing the values indicated on the figure.
- 6. To stop the motor, uncheck the **Run** box.

Note: LAUNCHXL is not operating from Flash but from RAM so power cycling the board requires it to be reprogrammed.

		Configura	tion	Applicati
	Read Me FOC			
	InstaSPIN-FOC MotorWare Instrumentation	04_01 =		
1	Enable System RsRecalc Auto Field Weaken Synchronous PM CTRL_State_Idle Rs (Ohm) 0.0	Rs (Ohn Online	0.0	
	User.h Params OffsetCalc Pole Pairs 4 EST_State_Idle Ls-d (mH) 0	Ls-q (mł	H) 0	
6	Run ForceAngle PowerWarp (EPL) VISER ErrorCode NoError Flux (V/Hz) 0.0	Rr (Ohm	0.0	-
		Magnetizin	a	=
	Bus Voltage	Current (A	3 0.0	
		CPU Frequency	90	MHz
	Speed_Ref_RPM 1500 4 Torque_Nm 0.00000 adcBias (Offsets)	PWM Frequency	80	kHz
	Max_Accel_RPMvs 8000 Current_A 0.800 V.0 0.00000000 I.0 0.500000000	ADC Sampling	27	kHz
	Speed Est RPM 0 Id Ref A 0.0	Current Control	26	kHz
	Speed Error RPM 0 NaN % Max -Id A -4.0	FAST M	26	kHz
	Spd_Kp 0.00 Is_A 0.0	Speed	2	kHz
	Spd_Ki 0.00 Iq_Ki 0.00 Vq 0.0 Iq_A 0.0	Trajectory	2	kHz
	Vd 0.0 Id_A 0.0 F	ull Scale Freq	1200	Hz
	USER_MAX_CURRENT_A (Iq) 8.0 output of speed controller			
	Current Sensors 3	s / Ls	NaN	Hz
	М	laximum RPM	18000	RPM
	F	orce Angle +/-	0.50	Hz
	Variable Overflow Checks		8	RPM
	Flux * Full Scale Freq     O.00     V <      Flux * FAST Freq     O.0     V <      F	ull Scale Voltage	225.80	V
	F	ull Scale Current	132.00	A
	Rs/(FSV/FSI) 0 % N	lax Current	8.00	A

# **For More Information:**

Please contact **info@epc-co.com** or your local sales representative

Visit our website: www.epc-co.com

Sign-up to receive EPC updates at **bit.ly/EPCupdates** 



DigiKey

EPC Products are distributed through Digi-Key. **www.digikey.com** 

#### **Demonstration Board Notification**

The EPC9147B board is intended for product evaluation purposes only. It is not intended for commercial use nor is it FCC approved for resale. Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Quick Start Guide. Contact an authorized EPC representative with any questions. This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk.

As an evaluation tool, this board is not designed for compliance with the European Union directive on electromagnetic compatibility or any other such directives or regulations. As board builds are at times subject to product availability, it is possible that boards may contain components or assembly materials that are not RoHS compliant. Efficient Power Conversion Corporation (EPC) makes no guarantee that the purchased board is 100% RoHS compliant.

The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this Quick Start Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved.

Disclaimer: EPC reserves the right at any time, without notice, to make changes to any products described herein to improve reliability, function, or design. EPC does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, or other intellectual property whatsoever, nor the rights of others.