

### SENSORLESS BLDC MOTOR REFERENCE DESIGN KIT USER'S GUIDE

# 1. Kit Contents

The Sensorless BLDC Motor Reference Design Kit contains the following items:

- Sensorless BLDC Motor Reference Design Board
- Brushless DC (BLDC) Motor
- Universal AC to 12 V DC Power Adapter
- USB Debug Adapter
- 2 USB Cables
- Reference Design Kit Tools & Documentation CD

### 2. Kit Overview

This reference design demonstrates sensorless control of a BLDC motor system using the C8051F310. The reference design provides for both stand-alone demonstration operation and a simple user interface over USB. The reference design may also be used as a platform for Sensorless BLDC motor code development.

This User's Guide provides a step-by-step guide for getting your system up and running. Refer to the Application Note "AN208: Sensorless BLDC Reference Design" for complete documentation of the Sensorless BLDC Reference Design.



Figure 1. Sensorless BLDC Reference Design Board

# 3. Sensorless Motor Reference Design Demonstration

The Sensorless BLDC Motor Reference Design includes everything you need to set up a Sensorless BLDC motor demonstration. Connect the BLDC motor to the Sensorless BLDC motor control board following the wiring chart for the Anaheim Automation BLY171S-24V-4000 motor as shown in Table 1.

Color	Location
Yellow	А
Red	В
Black	С

#### Table 1. BLDC Motor Wiring Diagram

Connect the 12 V universal ac/dc power adapter to the dc supply (P1) on the Sensorless BLDC Motor Reference Design Board. Rotate the SPEED knob fully clockwise. Press the START button on the Sensorless BLDC Motor Reference Design Board. The motor will start running. Notice that the motor will first align and then smoothly speed up to the minimum closed loop running speed. Rotate the knob counter clockwise to adjust the speed of the motor. Press the STOP button and the motor will stop spinning.







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### 4. Reference Design CD Installation

The included CD-ROM contains the Silicon Laboratories Sensorless BLDC Motor Reference Design software and



Figure 3. Install Development Tools

The following steps detail the software installation process.

- 1. Place the Reference Design Kit CD-ROM into the PC.
- 2. An installation dialogue box will appear. Click the "Install Reference Design Kit Tools" button.
- 3. The Kit Selection window will open showing the available Reference Design Kits. To install the application, select the "Sensorless BLDC Motor Reference Design Kit" option. Click the "Install" button.
- 4. The "Confirm Installations" window will open, showing the available installation options. Only the "Sensorless BLDC Reference Design Kit" and "Install CP210x Drivers" needs to be selected to run the demo.
- 5. Follow the installation prompts to install the demo application. By default, the software will be installed in the C:\SiLabs\MCU\SBLDC Motor RD directory.
- 6. Next, the CP210x Driver "unpacker" utility will run. Follow the steps to copy the driver files to the desired location. The default directory is C:\SiLabs\MCU\CP210x.
- 7. The final window will give an option to install the driver on the target system. Select the "Launch the CP210x VCP Driver Installer" option if you are ready to install the driver.
- 8. If selected, the driver installer will launch, providing an option to specify the driver installation location. After pressing the "Install" button, the installer will search your system for copies of previously installed CP210x Virtual COM Port drivers. It will let you know when your system is up to date. The driver files included in this installation have been certified by Microsoft.



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- If the "Launch the CP210x VCP Driver Installer" option was not selected in step 7, the installer can be found in the location specified in step 6, by default C:\SiLabs\MCU\CP210x\Windows\_2K\_XP\_S2K3\_Vista. At this location, run CP210xVCPInstaller.exe.
- 10. To complete the installation process, connect the included USB cable between the host computer and the USB connector on the SBLDC Motor. Windows will automatically finish the driver installation. Information windows will pop up from the taskbar to show the installation progress.
- 11. If needed, the driver files can be uninstalled by selecting the "Silicon Laboratories CP210x USB to UART Bridge Recommended for New Designs (Driver Removal)" option in the "Add or Remove Programs" window.



# 5. HyperTerminal Demonstration

Before connecting the USB cable to your computer, make sure you have installed the Reference Design Kit Tools, including the Virtual COM port driver by following the instructions in Section "4. Reference Design CD Installation".

Start with the Demo Setup and add a USB cable connection to your computer as shown in Figure 4. The USB connection is used with a terminal program to provide a basic terminal interface for the Sensorless BLDC motor.



### Figure 4. Sensorless BLDC Motor Reference Design Terminal Setup

Before opening HyperTerminal, you need to determine which COM port is being used for the Sensorless BLDC Motor drive. Right-click on My Computer and select "Properties" (see Figure 5 on page 6). This will bring up the System Properties window. Select the Hardware tab and then click on the Device Manager button. This will bring up the Device Manager. Expand the Ports (COM & LPT) item. You should see the CP210x USB to UART bridge controller with the COM port number. Use this COM port number when opening HyperTerminal.

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	System Properties	📙 Device Manager
	System Restore Automatic Updates Remote General Computer Name Hardware Advanced	Eile Action ⊻iew Help ← → 100 🖆 🚭 😫 🎘 🗮 🛠 🕱
10,	General   Computer Name   Hardware   Advanced     Add Hardware Wizard   Mardware   Mardware   Mardware     Image: Computer Name   Hardware   Advanced     Add Hardware Wizard   Mardware   Mardware     Image: Computer Name   Hardware   Mardware     Add Hardware Wizard   Add Hardware   Mardware     Device Manager   Mardware   Mardware     Image: Computer Name   The Device Manager lists all the hardware devices installed on your computer. Use the Device Manager to change the properties of any device.   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name     Image: Computer Name   Image: Computer Name   Image: Computer Name	Computer Disk drives Display adapters Modems Monitors Modems Monitors POMCIA adapters POrts (COM & LPT) Q Communications Port (COM1) Q CP210x USB to UART Bridge Controller (COM7) Q ECP Printer Port (LPT1) Processors Smart card readers Somat card readers
	OK Cancel Apply	🖶 🧐 Sound, video and game controllers 🖶 🚽 System devices 🖃 😋 Universal Serial Bus controllers
	0	CP2101 USB Composite Device

Figure 5. Use the Device Manager to find your Virtual COM Port

Open the HyperTerminal application. The HyperTerminal program may be launched on most Windows XP systems from the Start Menu:

 $Start \rightarrow Programs \rightarrow Accessories \rightarrow Communications \rightarrow HyperTerminal$ 

Enter any name into the "Connection Description" dialog box as shown in Figure 6. In the "Connect To" dialog box, choose the COM port corresponding to the Serial connection as determined from the Device Manager. In the COM7 Properties dialog box, select 115200 baud and no flow control. Use the default settings of 8 data bits, no parity, and one stop bit.

Connection Description	? 🗙	Connect To 🛛 🖓 🔀	COM7 Properties
New Connection		any Name	Rort Settings
Enter a name and choose an icon for the connection:		Enter details for the phone number that you want to dial:	Bits per second: 115200
<u>N</u> ame: Any Name		Country/region: United States (1)	Data bits: 8
_con:		Area code: 512	Parity: None
	>	Connect using: COM7	Stop bits: 1
ОК Са	ncel	OK Cancel	Eow control: None
			Restore Defaults
			OK Cancel Apply

Figure 6. Setting Up HyperTerminal



Push the Reset button on the Sensorless BLDC Motor Reference Design Board. When reset, the Sensorless BLDC Motor Reference Design sends the character string "push start button..." to the terminal. If you do not get a "push start button..." prompt, check your port settings and cable connections, and make sure the Sensorless BLDC Motor Reference Design Board is powered.

The Sensorless BLDC Motor Reference Design command line provides some basic terminal commands to display motor state, status parameters, and change PI constants. Push the START button to start the motor. The motor status will be displayed on the hyperterminal window. Once the motor is running, typing an "s" character immediately displays the motor status. Refer to "AN208: Sensorless BLDC Motor Reference Design" for a detailed description of the command line interface.

🗞 Any Name - H	IyperTerminal	×
<u>File Edit ⊻iew (</u>	Call Transfer Help	
reset push start aligning starting running Speed=1711 Vout=25 Verror=-54 Imotor=271 Vemf=59 Vpi=-500 Vpot=0 Kp=40 Ki=0 Stopping Me push start	button	
		<b>▼</b>
Connected 0:00:37	Auto detect 115200 8-N-1 SCROLL CAPS NUM Capture Print echo	
	Figure 7. Sensorless BLDC Motor Command Line	

Figure 7. Sensorless BLDC Motor Command Line



# 6. Development Setup using the USB Debug Adapter

The Sensorless BLDC Motor Reference Design includes everything you need to develop your own Sensorless BLDC motor control firmware using the Silicon Laboratories C8051F310 MCU. The Sensorless BLDC Motor reference design code may be used as a starting point for your own code development.

Connect the BLDC Motor and USB cable if you have not done so already. Refer to Table 1, "BLDC Motor Wiring Diagram," on page 2 for the BLDC motor connections. Connect the USB Debug Adapter ribbon cable to the 10-pin Debug connector on the Sensorless BLDC Motor Reference Design Board. Connect the USB Debug Adapter to your PC using the supplied USB cable as shown in Figure 8. Finally, connect the ac/dc power adapter to the Sensorless BLDC Motor Reference Design Board.



Figure 8. Development Setup using the USB Debug Adapter



### 7. Sensorless BLDC Motor Project

The source code for the Sensorless BLDC Motor Reference design is installed from the CD onto your hard drive in the following default location:

C:\SiLabs\MCU\SBLDC\_Motor\_RD\Firmware\

The software for AN208 is also available as a zip file on the CD or from the Silicon Laboratories website.

To create a Sensorless BLDC Motor Project, complete the following steps:

- 1. Launch the Silicon Laboratories IDE from the Start menu.
- 2. Select "Open Project" from the Project menu.
- 3. Browse to the source code location listed above, and open the file sbldc2k.wsp.
- 4. Double click on sbldc2k.c in the Project Workspace window to open.
- 5. Select "Rebuild All" from the project menu or click on the "Rebuild All" button. (The IDE will compile and link the sbldc.c file as shown in Figure 9.)
- 6. Select "Connection Options" from the Options menu.
- 7. Make sure the USB Debug Adapter is selected and the Debug Interface is using the C2 connection.
- 8. Select "Connect" from the Debug menu, or click on the "Connect" button in the tool bar.

The Status Bar should display Target:C8051F310 to indicate the IDE is connected to the MCU on the Sensorless BLDC Motor Reference Design Board. Refer to Application Note AN208 for additional information on the Sensorless BLDC Motor code.

The sbldc2k.wsp workspace, which includes the sbldc2k.c module, will build a reduced functionality version of the Sensorless BLDC motor code that does not include the HyperTerminal interface. This version may be built using the 2 kB code size limited version of the Keil compiler. The full functionality workspace slbdc.wsp, which includes the sbldc.c module, uses more than 4 kB of code and requires a full Keil compiler license.

The header file soldc.h contains the motor parameters for the particular motor. The motor parameters must match the motor you are using. Please check the header file to make sure the selected motor parameters match the motor you are using.







### 8. Related Documents

- Sensorless BLDC Motor Reference Design Quick Start Guide
- AN208: Sensorless Reference Design

Soft copies of this document and the ones listed above are included on the Reference Design Kit Tools & Documentation CD. Click on Browse Documents to locate them or explore the CD and locate the User's Guides and Application Notes in the Documents folder.

Ne jos o jas con. Commonded for New Designs The latest versions of the documentation and software can also be downloaded from the Silicon Laboratories website www.silabs.com.



# **DOCUMENT CHANGE LIST**

" "Work Recommended for New Designs





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