

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.

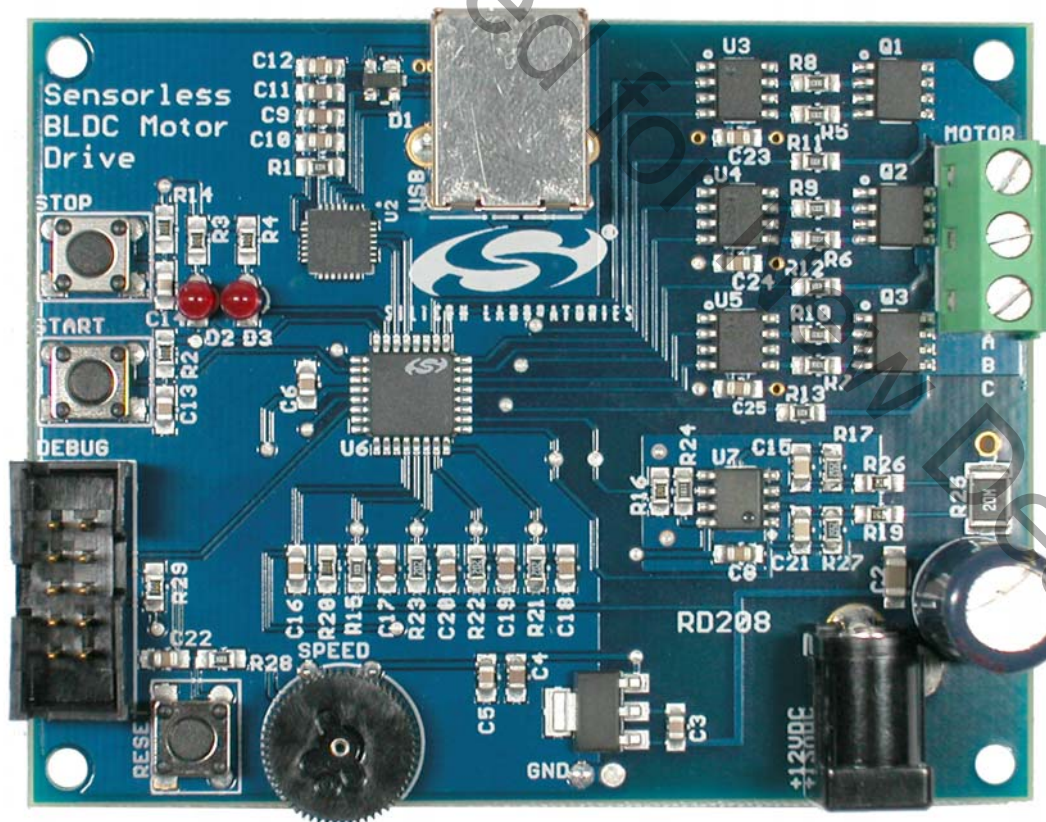


Figure 1. Sensorless BLDC Reference Design Board

SENSORLESS-BLDC-MOTOR-RD

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.

Table 1. BLDC Motor Wiring Diagram

Color	Location
Yellow	A
Red	B
Black	C

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.

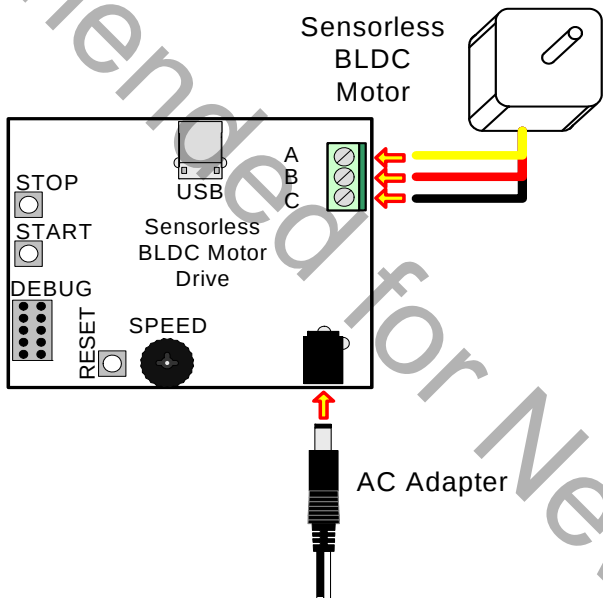


Figure 2. Sensorless BLDC Motor Reference Design Demonstration Setup

4. Reference Design CD Installation

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



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.

SENSORLESS-BLDC-MOTOR-RD

9. 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 (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.

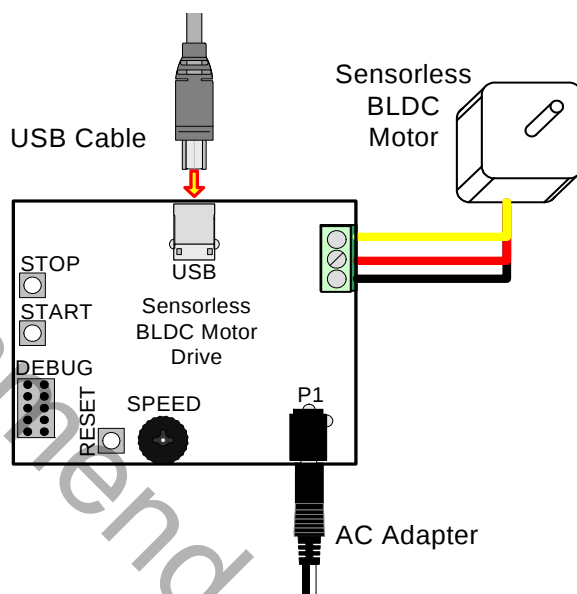


Figure 4. Sensorless BLDC Motor Reference Design Terminal Setup

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.

SENSORLESS-BLDC-MOTOR-RD

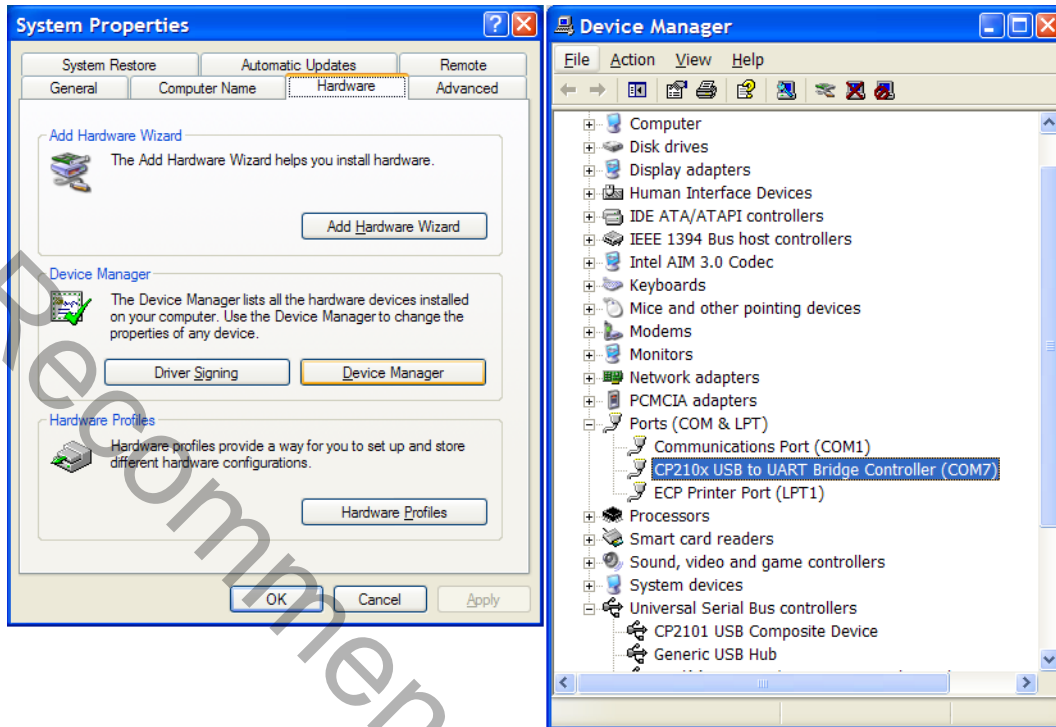


Figure 5. Use the Device Manager to find your Virtual COM Port

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

Start→Programs→Accessories→Communications→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.

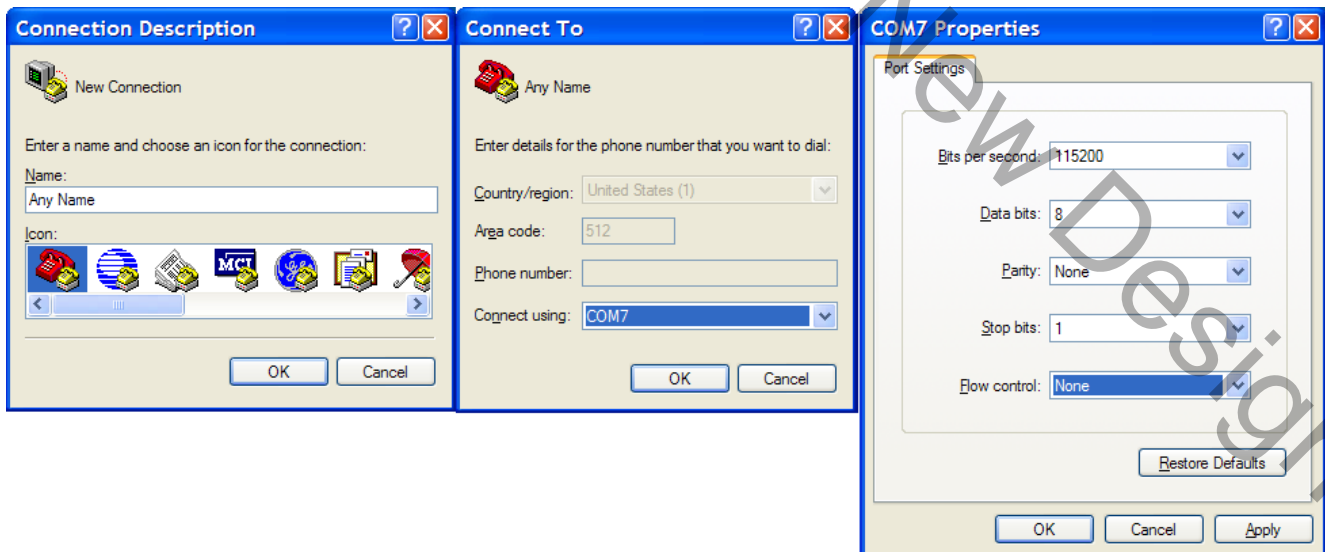
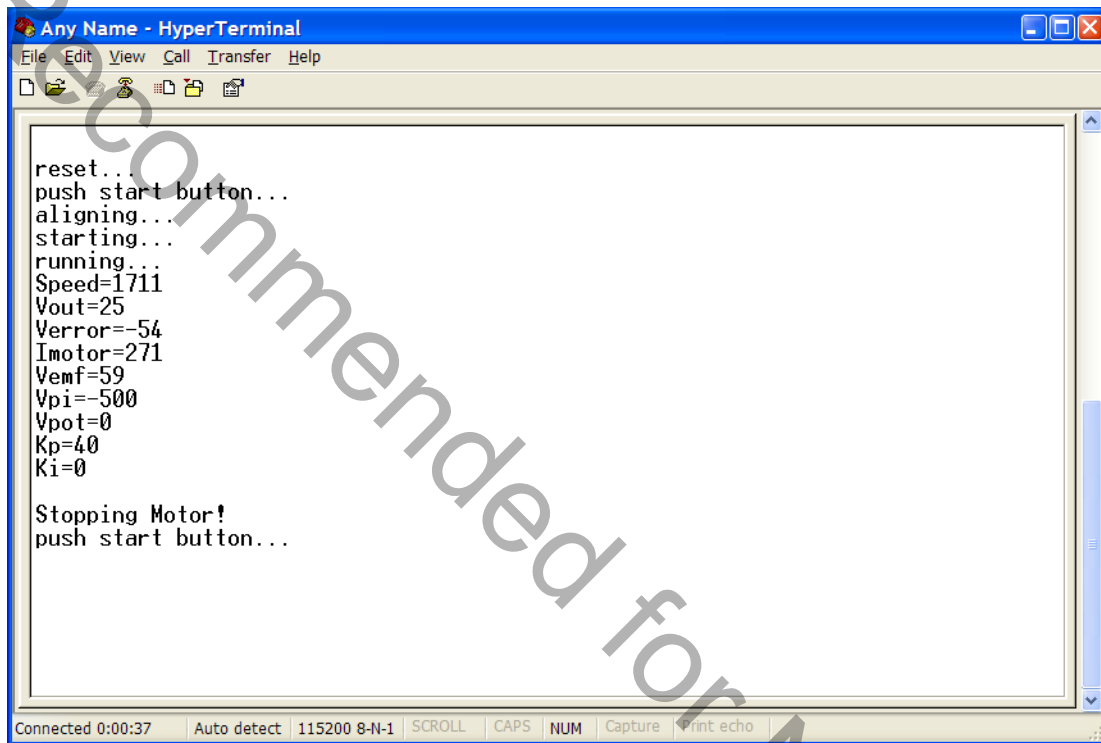


Figure 6. Setting Up HyperTerminal

SENSORLESS-BLDC-MOTOR-RD

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 - HyperTerminal
File Edit View Call Transfer Help

reset...
push start button...
aligning...
starting...
running...
Speed=1711
Vout=25
Verror=-54
Imotor=271
Vemf=59
Vpi=-500
Vpot=0
Kp=40
Ki=0

Stopping Motor!
push start button...

Connected 0:00:37 Auto detect 115200 8-N-1 SCROLL CAPS NUM Capture Print echo
```

Figure 7. Sensorless BLDC Motor Command Line

SENSORLESS-BLDC-MOTOR-RD

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.

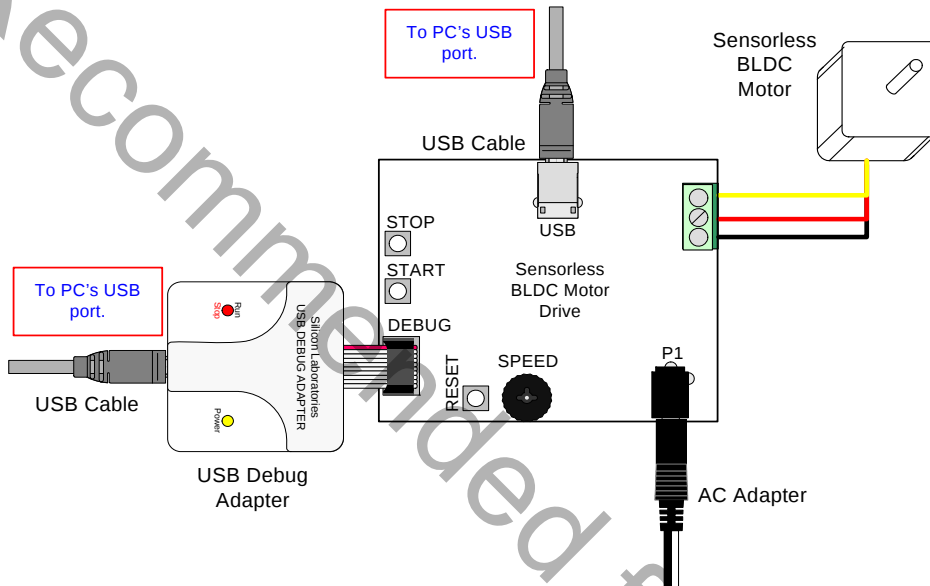


Figure 8. Development Setup using the USB Debug Adapter

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 sbldc.wsp, which includes the sbldc.c module, uses more than 4 kB of code and requires a full Keil compiler license.

The header file sbldc.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.

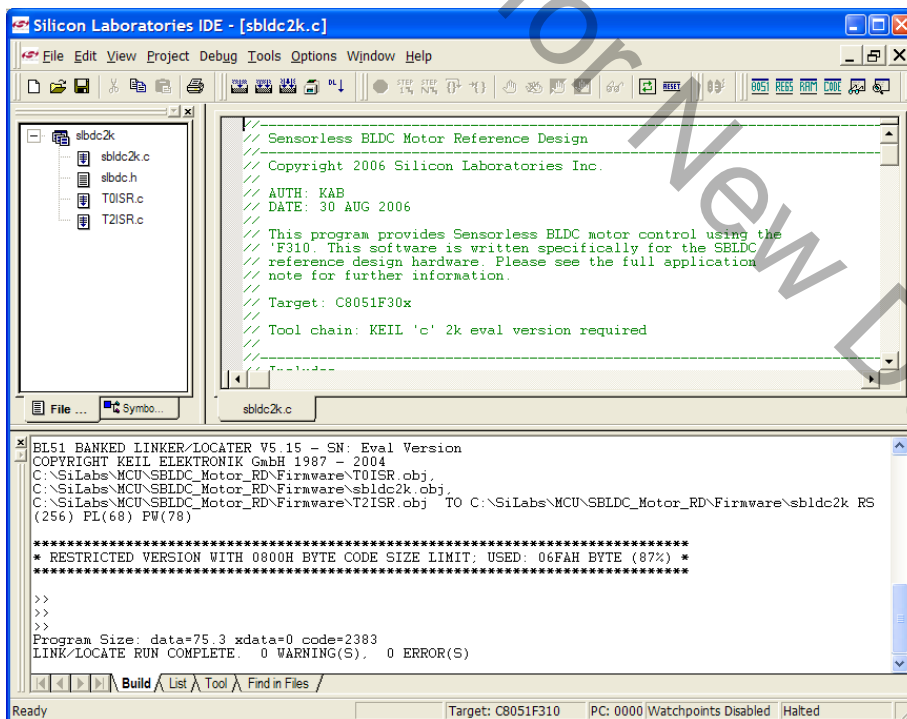


Figure 9. Sensorless BLDC Motor Project

SENSORLESS-BLDC-MOTOR-RD

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.

The latest versions of the documentation and software can also be downloaded from the Silicon Laboratories website www.silabs.com.

DOCUMENT CHANGE LIST

- Updated sections 4 and 5 to include latest VCP driver installation instructions.

Not Recommended for New Designs

Simplicity Studio

One-click access to MCU and wireless tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!



IoT Portfolio
www.silabs.com/IoT



SW/HW
www.silabs.com/simplicity



Quality
www.silabs.com/quality



Support and Community
community.silabs.com

Disclaimer

Silicon Laboratories intends to provide customers with the latest, accurate, and in-depth documentation of all peripherals and modules available for system and software implementers using or intending to use the Silicon Laboratories products. Characterization data, available modules and peripherals, memory sizes and memory addresses refer to each specific device, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only. Silicon Laboratories reserves the right to make changes without further notice and limitation to product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Silicon Laboratories shall have no liability for the consequences of use of the information supplied herein. This document does not imply or express copyright licenses granted hereunder to design or fabricate any integrated circuits. The products must not be used within any Life Support System without the specific written consent of Silicon Laboratories. A "Life Support System" is any product or system intended to support or sustain life and/or health, which, if it fails, can be reasonably expected to result in significant personal injury or death. Silicon Laboratories products are generally not intended for military applications. Silicon Laboratories products shall under no circumstances be used in weapons of mass destruction including (but not limited to) nuclear, biological or chemical weapons, or missiles capable of delivering such weapons.

Trademark Information

Silicon Laboratories Inc., Silicon Laboratories, Silicon Labs, SiLabs and the Silicon Labs logo, CMEMS®, EFM, EFM32, EFR, Energy Micro, Energy Micro logo and combinations thereof, "the world's most energy friendly microcontrollers", Ember®, EZLink®, EZMac®, EZRadio®, EZRadioPRO®, DSPLL®, ISOModem®, Precision32®, ProSLIC®, SiPHY®, USBXpress® and others are trademarks or registered trademarks of Silicon Laboratories Inc. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. All other products or brand names mentioned herein are trademarks of their respective holders.



Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

<http://www.silabs.com>