Bend Sensor® USB Glove Kit
User Guide

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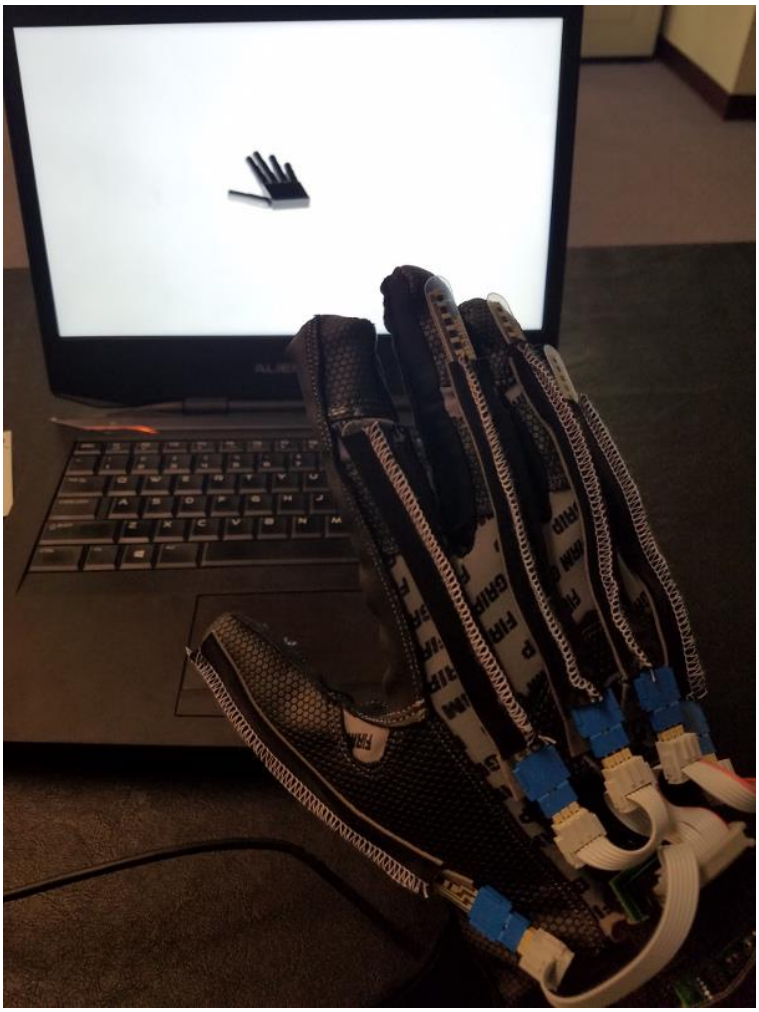

Introduction

The Flexpoint Bend Sensor® is a unique sensor that changes in resistance when it is bent. One of the most common applications for which the Bend Sensor® is ideally adapted to are glove applications. Integrating the sensor into your application is not necessarily trivial. Therefore, Flexpoint has developed the Bend Sensor® Glove kit to shorten the developmental lifecycle and serve as an easy to use demonstration on how to integrate the sensor into a glove application; especially for a VR/AR system. The kit digitizes the analog signals of the various sensors of the "system" - Bend Sensor®, accelerometer and magnetometer, to a graphical view on a PC. The Glove Kit Software can be easily downloaded and installed to display the position of fingers and orientation of the hand. All the schematics, firmware and software are provided for use in your own project. Below are the steps to install and use the kit.

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Kit Contents

Your kit includes the following:

1. Micro USB cable
2. USB Glove kit PCB board
3. Wire harness
4. 5 dual segment Flexpoint Bend Sensors®
5. Information card

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Installation instructions

The USB Glove kit evaluation software can be installed from the web link (below) or those located on the information card provided in your packet…

Web install instructions

1. Point your browser to www.flexpoint.com/glovekit
2. Click on the “USB Glove Kit Installer” link.
3. Follow the on-screen instructions to complete the installation.
4. Plug the Glove Kit into the USB port on your PC.
5. Run the FlexpointGloveKit software from your Start menu.
6. The Software will automatically detect and connect to the Glove kit
7. Press “ESC” to exit the application

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Bend Sensor®

The kit contains 5 bend dual segment Bend Sensors®. There are 3 longer Bend Sensors® and 2 shorter Bend Sensors®. The 3 longer sensors are for the index, middle and ring fingers, the 2 shorter sensors are for the thumb and pinky finger. The Bend Sensor® performs best when it increases with resistance when bent. To achieve this, place the sensor on the finger with the text readable from the top. If the text is backwards, then the sensor is upside down (refer to image above).

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Kit Assembly

1. Attach the 20-pin connector of the wire-harness to the PCB using connector J3.
2. Attach the Bend Sensors® to the 3-prong connectors on the wire-harness. There are 5 of these; one for each Bend Sensor®. The cable on the wire-harness that only has one 3- prong connector is for the thumb. On the center cable of the wire-harness, the end 3- prong connector is for the index finger. The centered 3-prong is for the middle finger. On the other cable that has two 3-prong connectors, the end 3-prong connector is for the ring finger. The centered 3-prong connector on this cable is for the pinky finger.

Glove Construction

The Flexpoint Glove Kit does not come with an actual glove. This is up to the user to define and construct. The glove should be flexible enough to allow the Bend Sensors® to conform to the outside of the fingers and measure their movement. The Bend Sensors® have two segments. The segment closest to its connector is meant to measure the MCP (metacarpo-phalangeal) joint. The segment furthest from the connector is meant to measure the PIP (proximal interphalangeal) joint. For best performance, ensure that the knuckles are within the segment area (preferably centered).

The surface area on the outside of the finger increases as the finger is bent. It is therefore recommended to have a sleeve that the sensor sits in that allows it to slide. Otherwise, this might cause the sensor to wrinkle or kink when the finger is lifted or extended. This will not damage the sensor, but will result in erroneous readings. Below shows an example glove and the connections to the sensor. It also shows a sleeve that contains the sensor.

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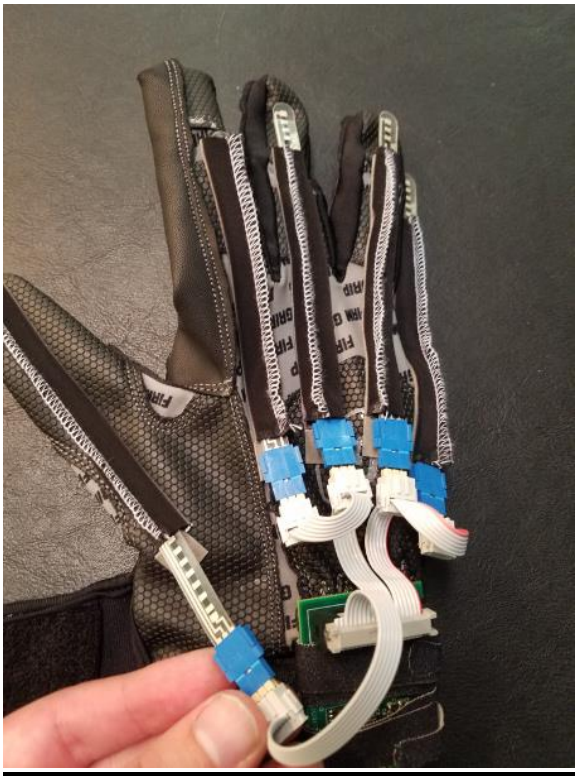

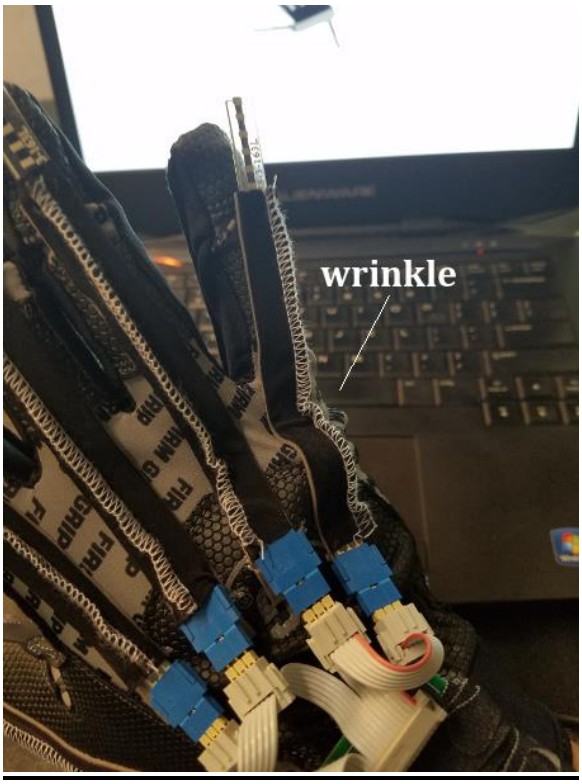

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Hand orientation

The Glove Kit will display the hand orientation based on the orientation of the PCB which should be attached to the backside of the hand. The pitch and roll of the hand is determined by the accelerometer and it's orientation with respect to the gravity vector pointing down. The direction the hand points in the X-Y plane or yaw is based on the magnetometer of the PCB. However, this is relative and the yaw can be manually adjusted using the mouse. To do this, click and drag the mouse to the left and right.

Glove Kit Calibration

The Glove Kit automatically adjusts the min and max levels of the sensor based on the finger movement ranges. However, if these ranges become too large and need to be reset it is recommended to perform the following calibration steps.

1. Make a closed fist
2. Press the letter "c" on your keyboard. This calibrates the max bent value
3. Straighten your fingers and open your hand all the way
4. Press the letter "o" on your keyboard. This calibrates the min bent value

Glove Kit software

The Glove Kit software is a C# program that simply reads serial port data from the virtual COM port and displays it using OpenGL to show a virtual 3D hand on the screen. It connects to only one Glove Kit at a time. Multiple instances of the program can be run for additional connected Glove Kits. C# source code is available at www.flexpoint.com/glovekit.

Troubleshooting

- If the finger on the software moves in the wrong direction, then the Bend Sensor® may be upside down.
- If the wrong knuckle is moving, then the 3-prong connector should be reversed.
- If the wrong finger is moving, then the order of the 3-prong connectors should be double checked.
- If the software does not seem to connect to the hardware, open the "Device Manager" and verify that the device shows up under "Ports (COM & LPT)" as

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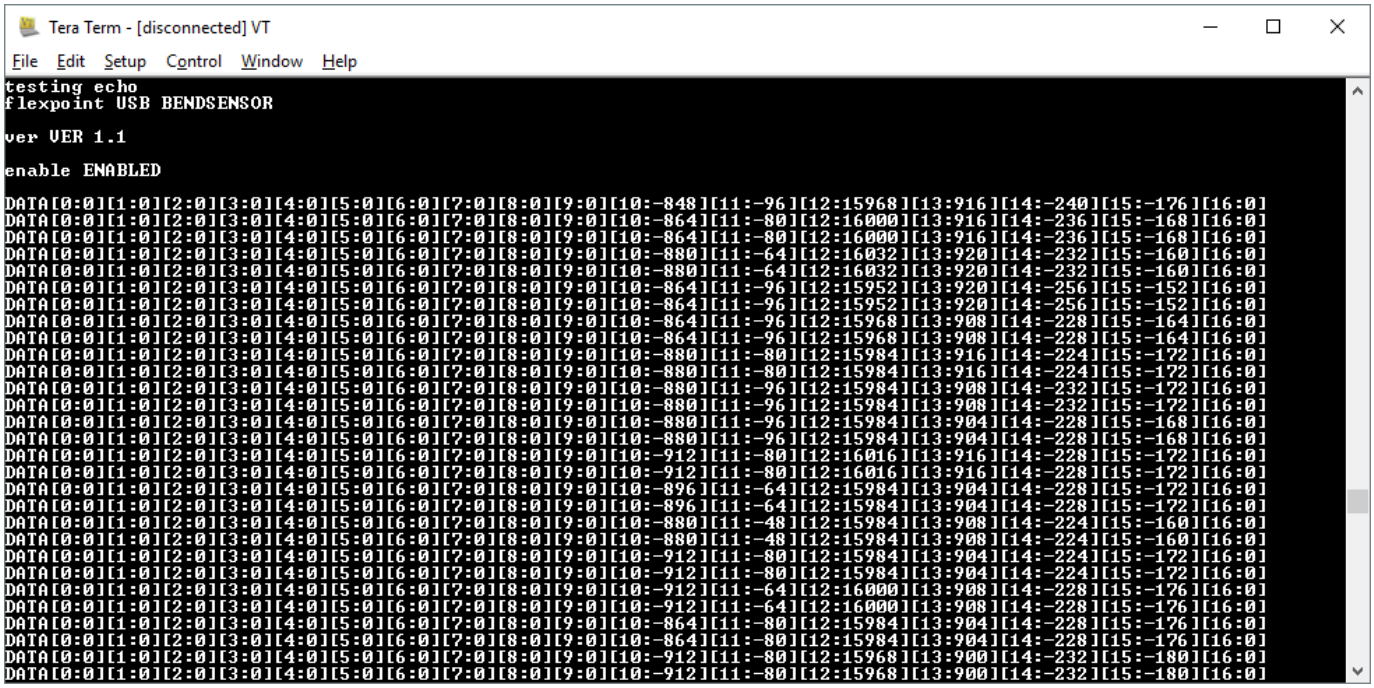
USB Serial Port (COM…). If not, the driver may not have installed correctly. Instead, the device may show up as an “Unknown Device”. For manual driver installation, right click on the “Unknown Device” and choose “Update Driver Software…” then browse to this location on your PC “C:\Program Files (x86)\Cypress\Cypress USB-Serial Driver\DriverBinary\CDC_Driver\bin” choose your operating system and if you are 64-bit (x64) or 32-bit (x86).

Serial port data format

Data from the USB Glove kit can be viewed in a serial terminal like Hyperterminal or TeraTerm. Below are the settings:

9600 Baud
8 data bits
1 stop bit
No parity



The USB Glove kit will echo any characters sent to make it easy to view in the terminal. The Glove kit responds to the following commands. The commands are lowercase and the responses are UPPERCASE.

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command	RESPONSE
flexpoint<cr>	USB BENDSENSOR
ver<cr>	VER X.X
enable<cr>	ENABLED
calmin	CALMIN
calmax	CALMAX

The enable command puts the Glove kit into data flow mode. Each data sample is in this format DATA[XX:YYYYYY]. The XX value is the data field number (0 – 16). The YYYYYY value is the field value is a signed decimal value between -32768 and 32767.

The fields are as follows:

0: Pinky finger MCP (metacarpo-phalangeal) joint
1: Pinky finger PIP (proximal interphalangeal) joint
2: Ring finger MCP joint
3: Ring finger PIP joint
4: Middle finger MCP joint
5: Middle finger PIP joint
6: Index finger MCP joint
7: Index finger PIP joint
8: Thumb MCB joint
9: Thumb PIP joint
10: Accelerometer X data
11: Accelerometer Y data
12: Accelerometer Z data
13: Magnetometer X data
14: Magnetometer Y data
15: Magnetometer Z data
16: Reserved

To stop the flow of data any character can be sent. To re-enable data flow, send the enable command again.

The “calmin” command resets the minimum values recorded by the system.
The “calmax” command resets the maximum values recorded by the system.

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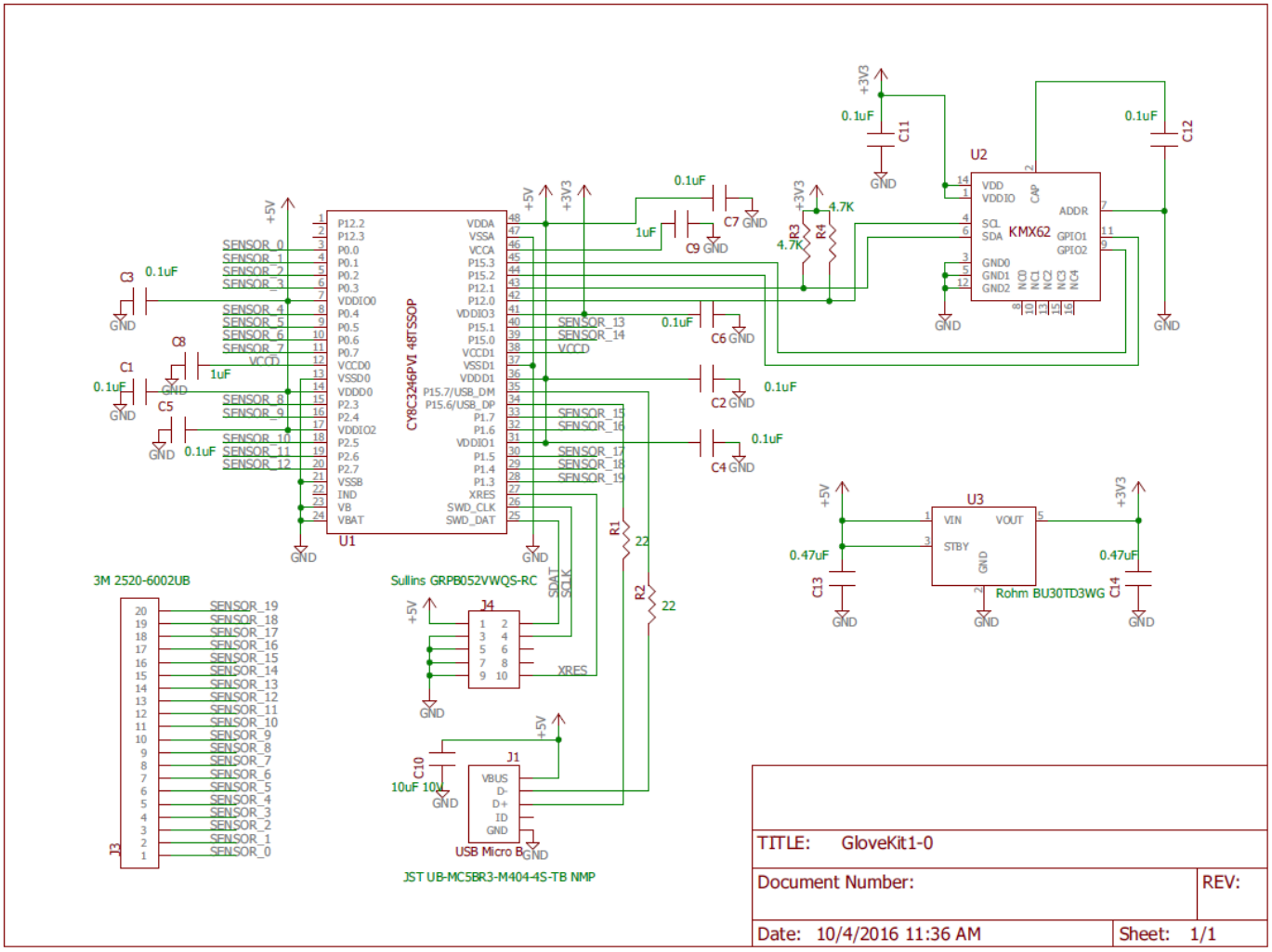
Glove kit schematic



The heart of the USB kit is the Cypress PSoC CY8C3246PVI-147. The Cypress PSoC is a great part to use with Flexpoint Bend Sensors since they have an integrated current DAC. This allows the Bend Sensor® to be interfaced with the ADC directly without the need of any external components like voltage divider resistors or op-amps.

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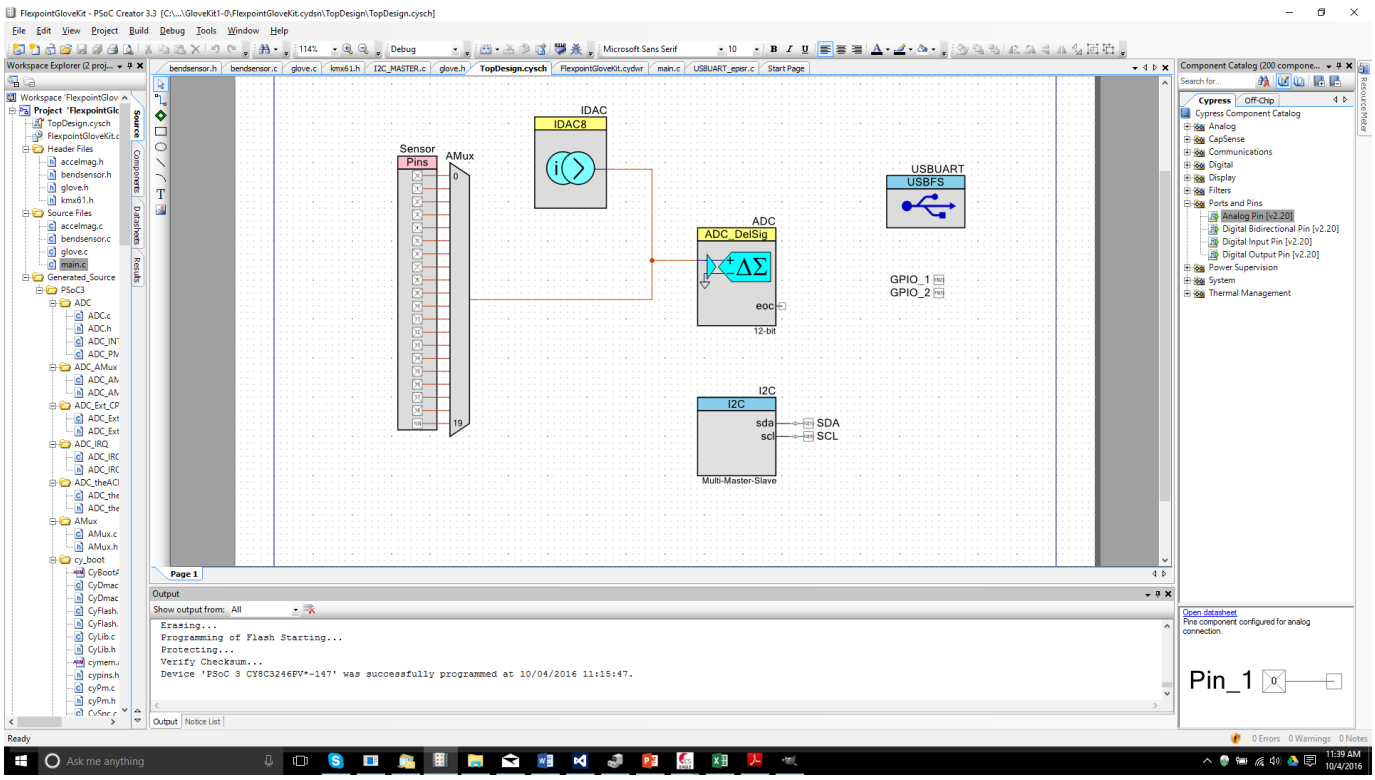

The schematic capture tool inside PSoC Creator is used to configure the PSoC. The Glove kit uses the IDAC to source a current to ground through the Bend Sensors® selected by the built-in analog mux. The ADC measures the voltage across the sensor. The voltage that the ADC measures is determined by ohms law:

$$V_{ADC} = I_{IDAC} \times R_{sensor}$$

This gives a nice linear relationship between the resistance of the sensor and the voltage measured across it. Also, the current DAC acts like a variable gain amplifier allowing you to improve your signal to noise ratio or to reduce signal in case of clipping.

The PSoC on the Glove kit can be re-programmed. You can attach a miniprog3 programmer from Cypress to the 10-pin header to debug and program the PSoC.

Source code to the project can be found at www.flexpoint.com/glovekit.

Please go to cypress.com to download the latest PSoC Creator tools.

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