PSoC 5LP Oscilloscope and Waveform Generator

Contents

[Overview 2](#_Toc471388597)

[Getting Started 2](#_Toc471388598)

[Hardware 2](#_Toc471388599)

[Pin Assignments 3](#_Toc471388600)

[Connectors 4](#_Toc471388601)

[USB Connections 5](#_Toc471388602)

[Power Considerations 5](#_Toc471388603)

[Firmware (PSoC) 5](#_Toc471388604)

[Software (PC GUI) 7](#_Toc471388605)

[Modifying the Software 7](#_Toc471388606)

[Using the CY8CKIT-059 as a Function Generator and Oscilloscope 9](#_Toc471388607)

[USB Connection 9](#_Toc471388608)

[Waveform Generator 9](#_Toc471388609)

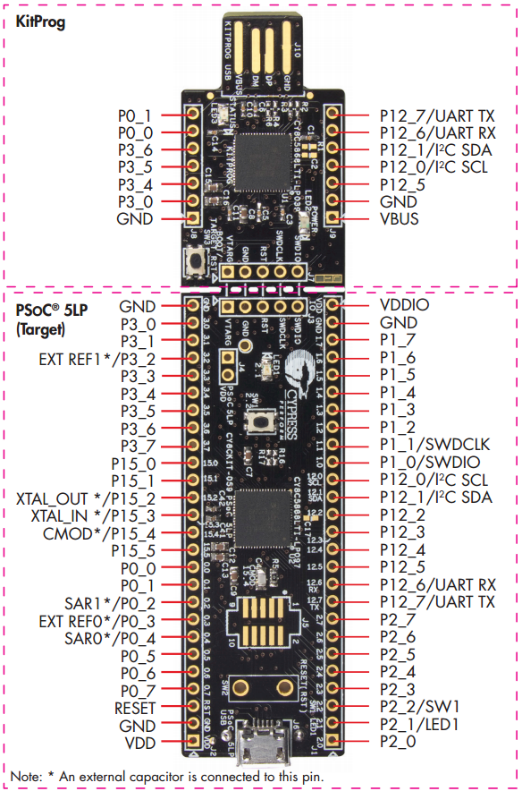
[Oscilloscope 10](#_Toc471388610)

[Digital Inputs and Outputs 11](#_Toc471388611)

[Inputs 11](#_Toc471388612)

[Outputs 11](#_Toc471388613)

# Overview

The CY8CKIT-059 PSoC 5LP Prototyping Kit is a small but very powerful system. It contains a PSoC (Programmable System on a Chip) 5LP device which brings together the features of an ARM Cortex M3 microcontroller, a programmable logic device, and many analog functions into one package. A programmable routing fabric between the peripherals and the pins allows any function to be mapped to any pin.

The PSoC target device on the kit includes full speed USB device capability which makes it possible to use it to interface from the PSoC target device to a PC using standard USB drivers.

The example application provided below turns the CY8CKIT-059 kit into a waveform generator and two-channel oscilloscope. Two PWM outputs with adjustable duty cycle, 5 digital outputs, and 5 digital inputs are also provided.

# Getting Started

## Hardware

The following hardware is required:

* CY8CKIT-059 PSoC 5LP Prototyping Kit
* USB A to Micro-B cable
* Connectors, wire, and clips for one oscilloscope input and one waveform generator output:

|  |  |  |
| --- | --- | --- |
| **Item** | **# Per Board** | **Part Number** |
| 2-Pin Male Connectors | 3 | DigiKey A1921-ND |
| 2-Pin Female Connector Housing | 3 | DigiKey A99613-ND |
| 1-Pin Female Connectors | 6 | DigiKey A100453CT-ND |
| Red Alligator Clips | 3 | DigiKey 36-5034-ND |
| Black Alligator Clips | 3 | DigiKey 36-5035-ND |
| 24 AWG Twisted Pair Wire (Black/White) | 1 \* | Jameco 173164 |
| 24 AWG Twisted Pair Wire (Red/White) | 1 \* | Jameco 173148 |
| 24 AWG Twisted Pair Wire (Green/White) | 1 \* | Jameco 105912 |

\* One spool of wire is 100 feet which is enough for about 100 boards

If you want to use the second oscilloscope channel, PWM outputs, digital outputs, or digital inputs, appropriate connectors will be needed for them as well. Those are not specified here.

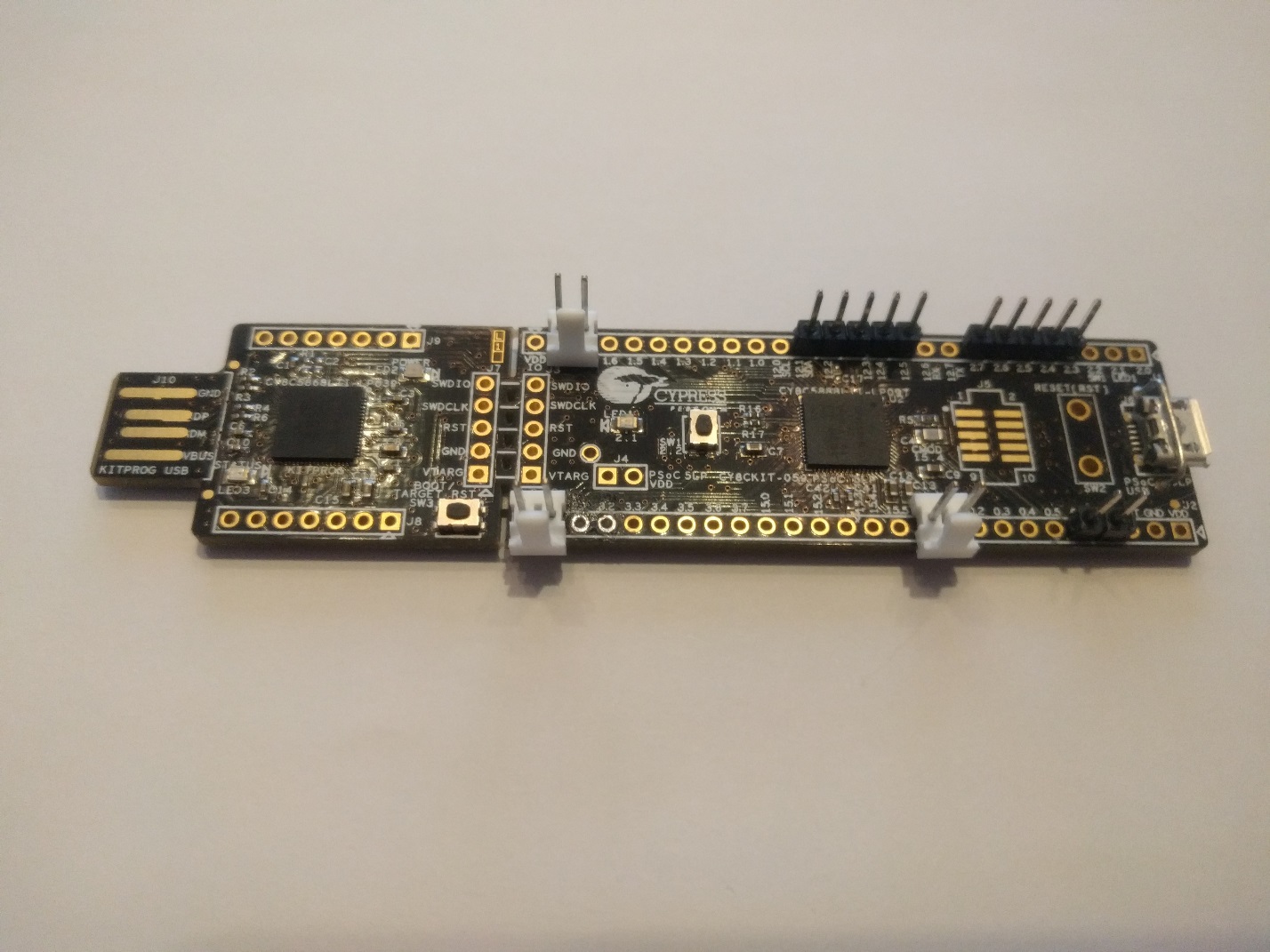
## Pin Assignments

The pin assignments for the waveform generator and oscilloscope are shown in the figure below. The various functions are placed in different ports to guarantee optimal analog performance. For example, Port 3 is used for Scope A, Port 1 is used for Scope B, Port 0 is used for waveform outputs, and Ports 2, 12 are used for digital inputs and outputs. Also, the scope inputs are placed next to board ground connections to provide a solid ground reference.



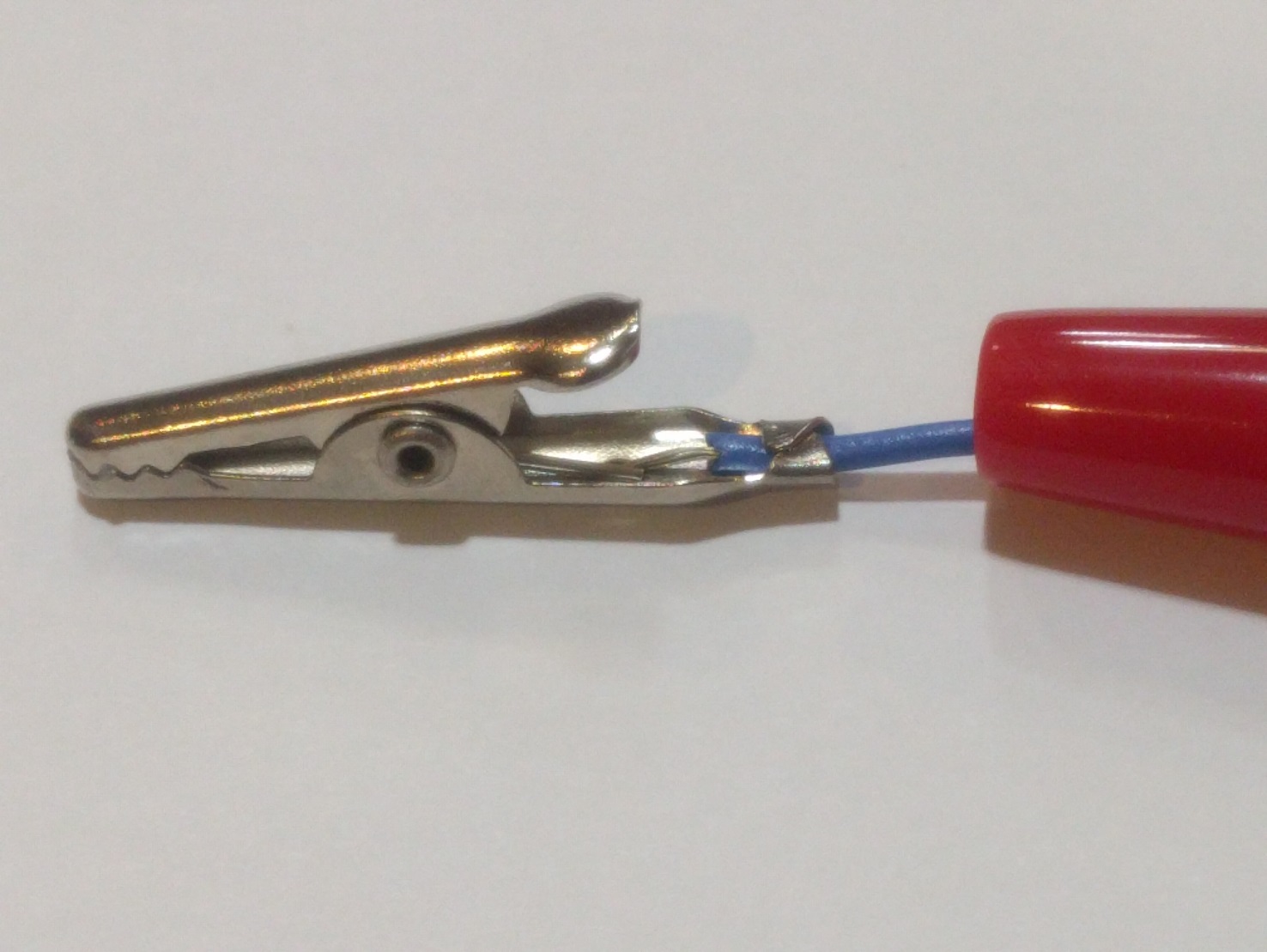
## Connectors

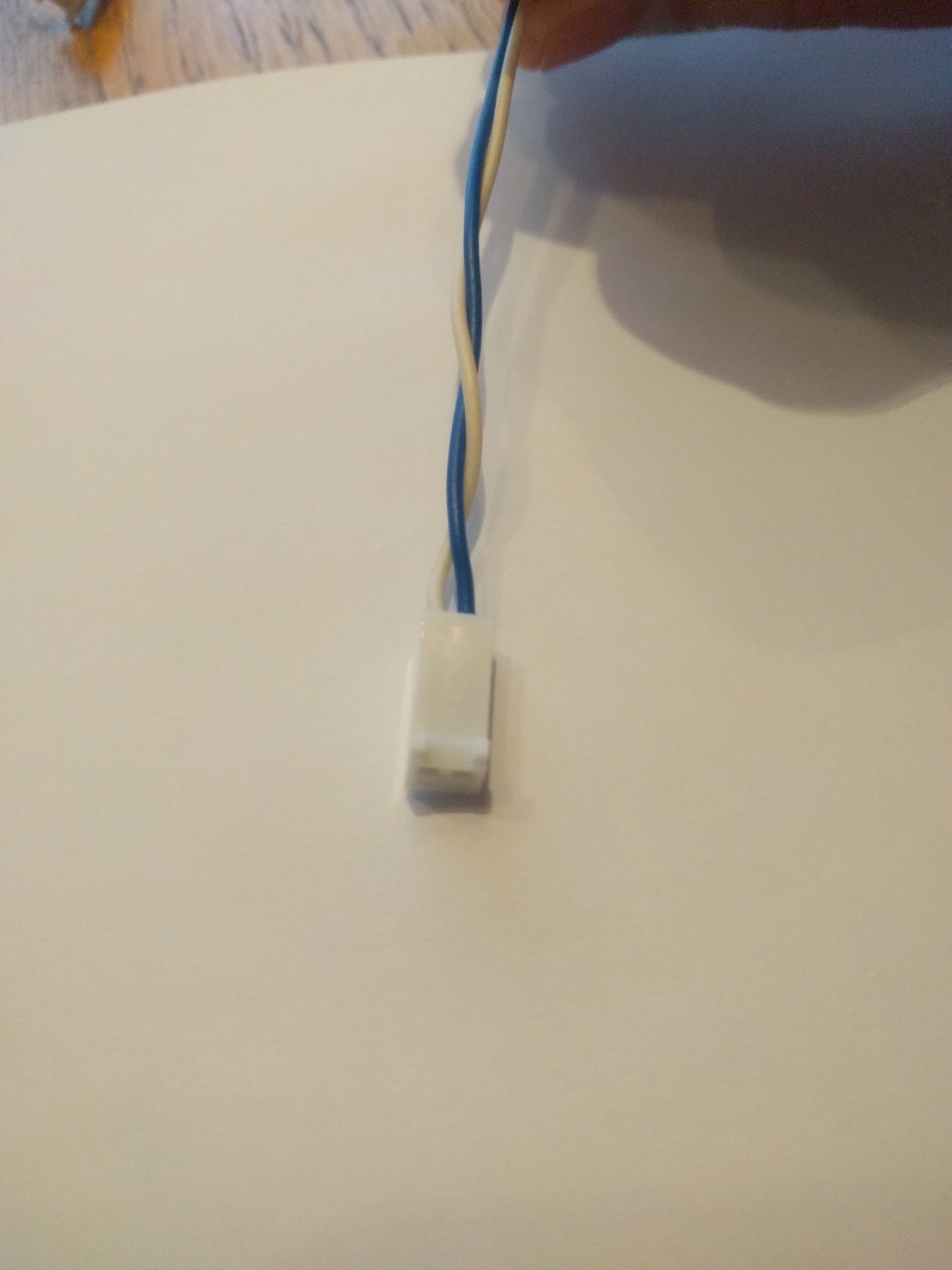
A CY8CKIT-059 with all inputs and outputs populated is shown below. The oscilloscope inputs (Scope A and Scope B) and the waveform generator output are keyed connectors so that the cables can only be connected one way.



Examples of the cables are shown below. The keyed connector must match the direction of the connector that is soldered onto the CY8CKIT-059 board.





## USB Connections

The CY8CKIT-059 actually contains two PSoC 5LP devices – one is the target device and the other is used to program and debug the target device. Both devices have USB capability. The target device connects to a standard USB Micro type-B connector (labeled PSoC USB) while the programmer device connects to a board edge connector (labeled KITPROG USB). This board edge connector can be plugged directly into a USB type-A socket with no cable required.

Therefore, use the edge connector when you want to program the target device, and use the Micro type-B connector when you want to use the target device (i.e. when you are using the PSoC 5LP as a waveform generator and oscilloscope).

Note: a USB type-A male to USB type-A female extension cable can be used if the board is mounted in such a way to make it difficult to plug directly into a USB type-A socket.

## Power Considerations

The CY8CKIT-059 can be powered in three ways:

1. USB bus powered from the card edge connector
2. USB bus powered from the Micro-B connector
3. External 3.3V – 5.5V supplied at the VDD or VDDIO pins

The kit will automatically draw power from the highest voltage supply so if an external supply is being used along with a USB connection then the external supply should be 5V or greater.

## Firmware (PSoC)

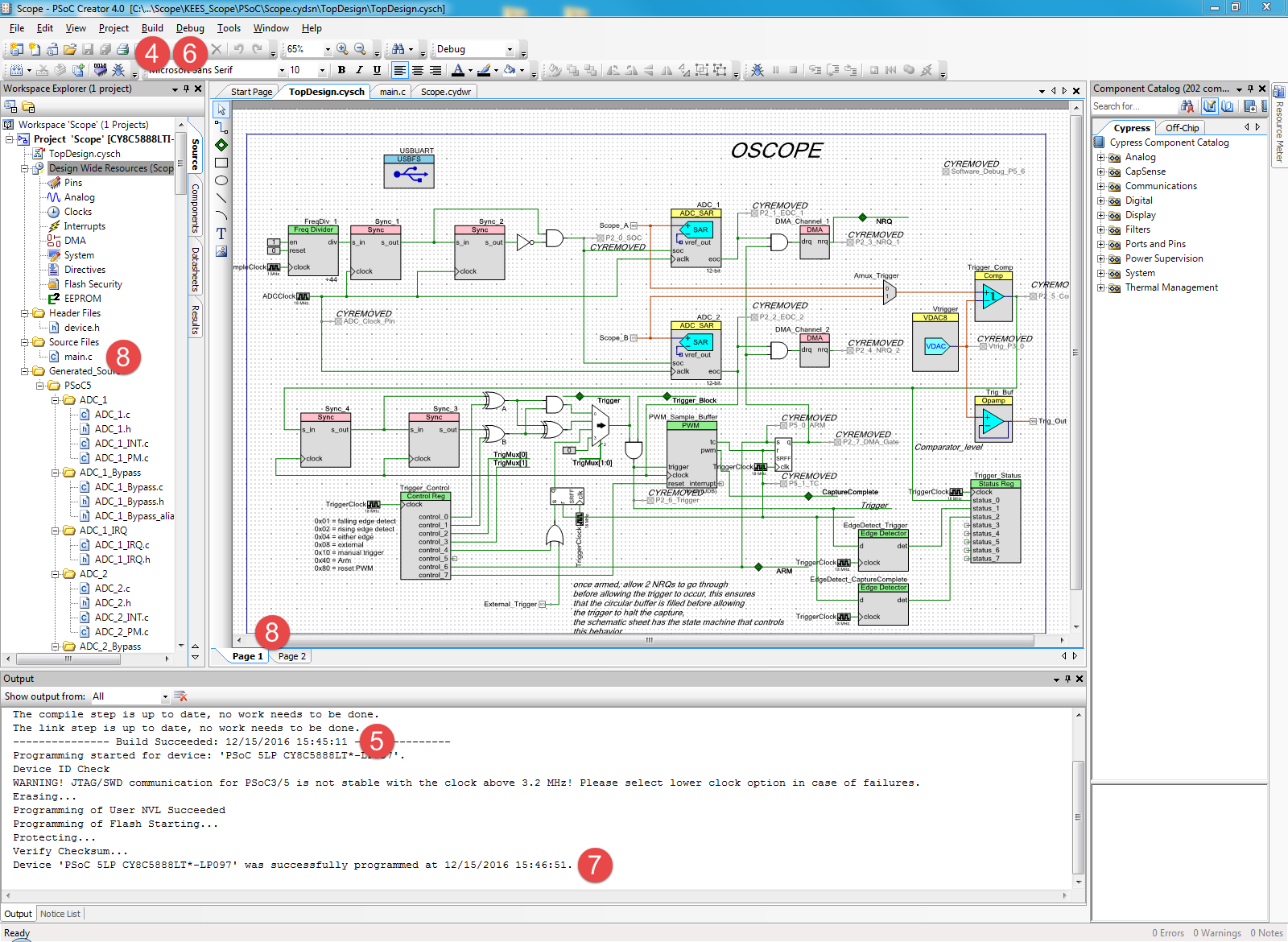
The project for the oscilloscope is written using PSoC Creator. There are two ways to program the project into the kit. You can either open the project in PSoC Creator to program the kit from inside the tool, or you can use PSoC Programmer to download an existing project’s file to the kit. If you want to modify the project for any reason, PSoC Creator is the tool that you would use.

The software is all free and is available from the following locations. Each row is a superset of the row above it so if you want everything, just download and run the CY8CKIT-059 kit setup installer.

|  |  |
| --- | --- |
| **Purpose** | **Web Site** |
| Program firmware to the kit | [www.cypress.com/psocprogrammer](http://www.cypress.com/psocprogrammer) |
| View and modify the project or create your own custom project and program it to the kit | [www.cypress.com/psoccreator](http://www.cypress.com/psoccreator)  (The installer includes PSoC Programmer) |
| View kit documentation and design | [www.cypress.com/cy8ckit-059](http://www.cypress.com/cy8ckit-059)  (Kit Setup includes PSoC Creator and PSoC Programmer, Kit Only includes just the kit file) |

In order to program the project into the CY8CKIT-059 using PSoC Creator, follow the steps below.

1. If you have not already done so, install PSoC Creator.
2. Plug in the card edge connector from the CY8CKIT-059 into a USB port on your computer.
3. Navigate to the folder containing the project (in the GitHub repository, it is in ScopePSoC). Double-click on the PSoC Creator workspace file (Scope.cywrk) to open it in PSoC Creator.
4. Select the menu item “Build > Build Scope”.
5. Once the build is complete, you should see “Build Succeeded” in the Output window. (see the figure below for this step and all subsequent steps).
6. Select the menu item “Debug > Program”.
7. Once programming is done, you should see a message at the bottom of the Output window indicating that the device was successfully programmed.
8. If you want to explore the project in detail, you can click on the schematic tabs or double-click on main.c from the Workspace Explorer.

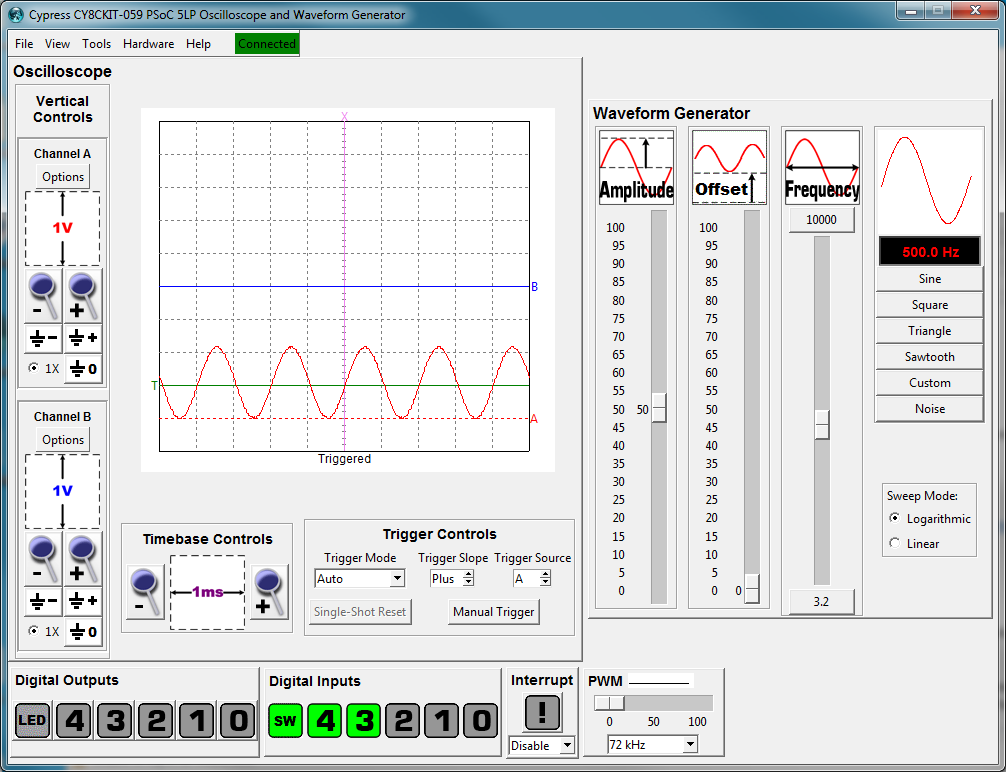
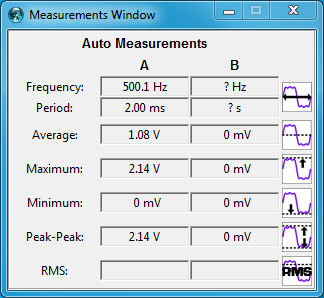


## Software (PC GUI)

The PC software used for this project is written in Tcl/Tk and is based on the Open Instrumentation Project (<http://sourceforge.net/projects/oip>). The source code is provided under the GNU General Public License. It was modified in order to work with the features of the CY8CKIT-059.

In the GitHub repository, the software is in the folder named ScopeGUI. Inside that folder is a shortcut “ScopeGUI.exe”. Double-click on it to start the software.

Once the software starts, you should see a main window and a measurement window like the figure below. The oscilloscope controls are on the left side of the main window, the waveform generator controls are on the right side, and the digital input/output controls are along the bottom. More detail on each of these is included later in this document.

### Modifying the Software

The source code for the software is contained in the folder “TCL”. You can modify the source code if desired. Once a modification is done, the executable can be recreated by running the file “CreateExe.bat” inside the “Wrap” folder.

If you want to experiment with the source code, you may want to install Tcl/Tk so that you can run the Tcl program directly without having to recreate the executable every time.

To install Tcl/Tk, follow these steps:

1. Download/Install the latest version of Active TCL from: <http://www.activestate.com/activetcl>.
2. Open a TCL shell by entering “wish” in the Windows “Search programs and files” box. Select “wish.exe” to open a console.
   1. If you are unable to run wish, it might not be added to your system’s path. If so, follow the instructions provided here to add it to the path: <http://www.computerhope.com/issues/ch000549.htm>
3. In the Wish console, enter the following commands:
   1. teacup install twapi
   2. teacup install math::fourier
   3. exit

Once you have installed Active TCL, just double-click on “main.tcl” from the “TCL” folder to run the program.

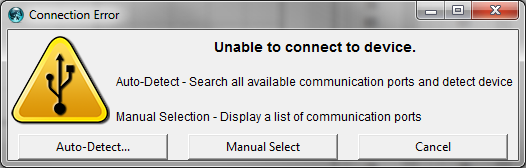
# Using the CY8CKIT-059 as a Function Generator and Oscilloscope

## USB Connection

Once the example firmware has been programmed into the kit, connect it to a PC using a USB type A to Micro B cable. After drivers have installed, you will see the device appear as a “Cypress USB UART”. This will appear in the device manager under “Ports (COM & LPT)”.

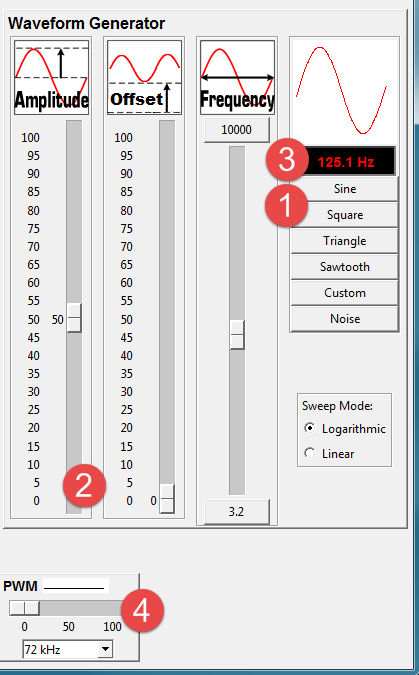
If the driver does not install automatically for some reason, you can manually install the driver which is included in the ScopeGUI.zip file. The folder “USBUART\_Driver” inside that zip file contains the USB driver required for the 059 kit USB UART Bridge.

Once the driver is installed, open the GUI by double-clicking on main.tcl. The GUI should search all available COM ports for a matching device. If no, you may see the following window. If you do, try “Auto Search” first and then “Manual”. If all else fails, close the GUI, un-plug and re-plug the kit to the USB port and try again.



## Waveform Generator

The waveform generator controls are along the right side of the main window.



You must select one of the six waveform types before you will see any output (1).

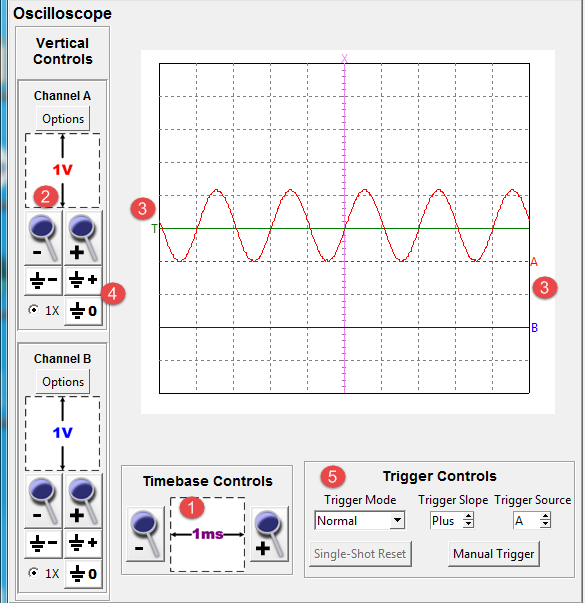
You can use the 3 vertical sliders shown to select an amplitude, offset, and frequency (2). The maximum range of the output waveform is 0 – 4 V. The sliders for amplitude and offset are as a percentage of the maximum range. For example, an amplitude of 50 is be 50% of 4 V, so you will see a 2 V peak-to-peak voltage. Note that if you select an amplitude and offset whose combination is more than 100% you will see the top of the waveform “clipped” at 4 V.

The frequency can be set from 3.2 Hz to 10 kHz using the slider. You can also click on the frequency value itself and enter a number directly (3). If you click on the value at the bottom or top of the frequency slider you can restrict the slider’s range but you cannot set the minimum below 3.2 Hz or the maximum above 10 kHz.

The PWM and PWM# output can be enabled by using the slider to select the desired duty cycle (4). The output frequency has 10 possible selections in the drop down menu ranging from 72 kHz down to 35 Hz.

## Oscilloscope

The oscilloscope controls are along the left side of the main window.



The oscilloscope can be set from 1 second per division to 10 us per division using the magnifying glass +/- buttons (1). The oscilloscope is capable of measuring input signals from DC up to about 100 kHz. The voltage range for each channel can be set from 5 V to 50 mV per division (2).

The location of the ground reference for each channel and the trigger level can be set by dragging the appropriate letter (A, B, or T) up or down along the edge of the display (3). The ground reference for each channel can also be set using the buttons in the vertical controls (4). This is particularly useful if you want to measure a small AC signal riding on top of a DC offset since this allows you to set the ground level off the screen. Each click of the + or - button moves the ground reference up or down by 1 division while the 0 button will move the ground reference to the bottom edge of the scope display.

The trigger controls (5) allow Auto, Normal, Single-Shot or External. The trigger edge can be Plus or Minus and either channel can be used as the trigger source.

In the View menu you will find selections to toggle cursors for time and voltage for each channel.

## Digital Inputs and Outputs

There are 6 digital input pins that can be read from the software and 6 digital outputs that can be controlled from the software.



### Inputs

The digital inputs in the software are indicators. They will appear green if the associated pin is high and low if the associated pin is low.

One input pin is connected to the user button on the CY8CKIT-059 board (SW1). That indicator will appear green when the button is not pressed since the pin is high (1). When the button is pressed, the pin is pulled to ground so the indicator will change from green to grey.

Inputs 3 and 4 are configured with resistive pull ups on the pins so they will be high unless something drives them low (2). This is good for additional button inputs since buttons typically short to ground when pressed.

Inputs 0, 1, and 2 are configured with resistive pull downs on the pins so they will be low unless something drives them high (3).

### Outputs

The digital outputs in the software are control buttons. Click on any given button to change the state of that output from low to high. Any outputs set to drive low will appear grey while those set to drive high will appear green.

One output pin is connected to the user LED on the CY8CKIT-059 board (LED1). Click on that button (4) to toggle the state of the LED. The other outputs (5) are general purpose outputs that can be driven either high or low. They all start in the low state.