Beginners guide to GPIO in Windows 10 IoT Core

Updated on 06/07/2015 : *Thank you @WaterContext for pointing an error in the Wire Colour to GPIO Pin table.*

In this tutorial, we will wire up and write the code required to create a universal application that will, turn an LED on and off each time the button is pressed. It is important to understand both the hardware and software.

What is GPIO

GPIO stands for:

- General
- Purpose
- Input
- Output

GPIO pins can either set or reads a voltage, this allows the controller (in this case the raspberry pi) to communicate with a wide range of hardware electronics using code. Each of the GPIO pins has a pre-defined use that can be read the following link.

You'll need

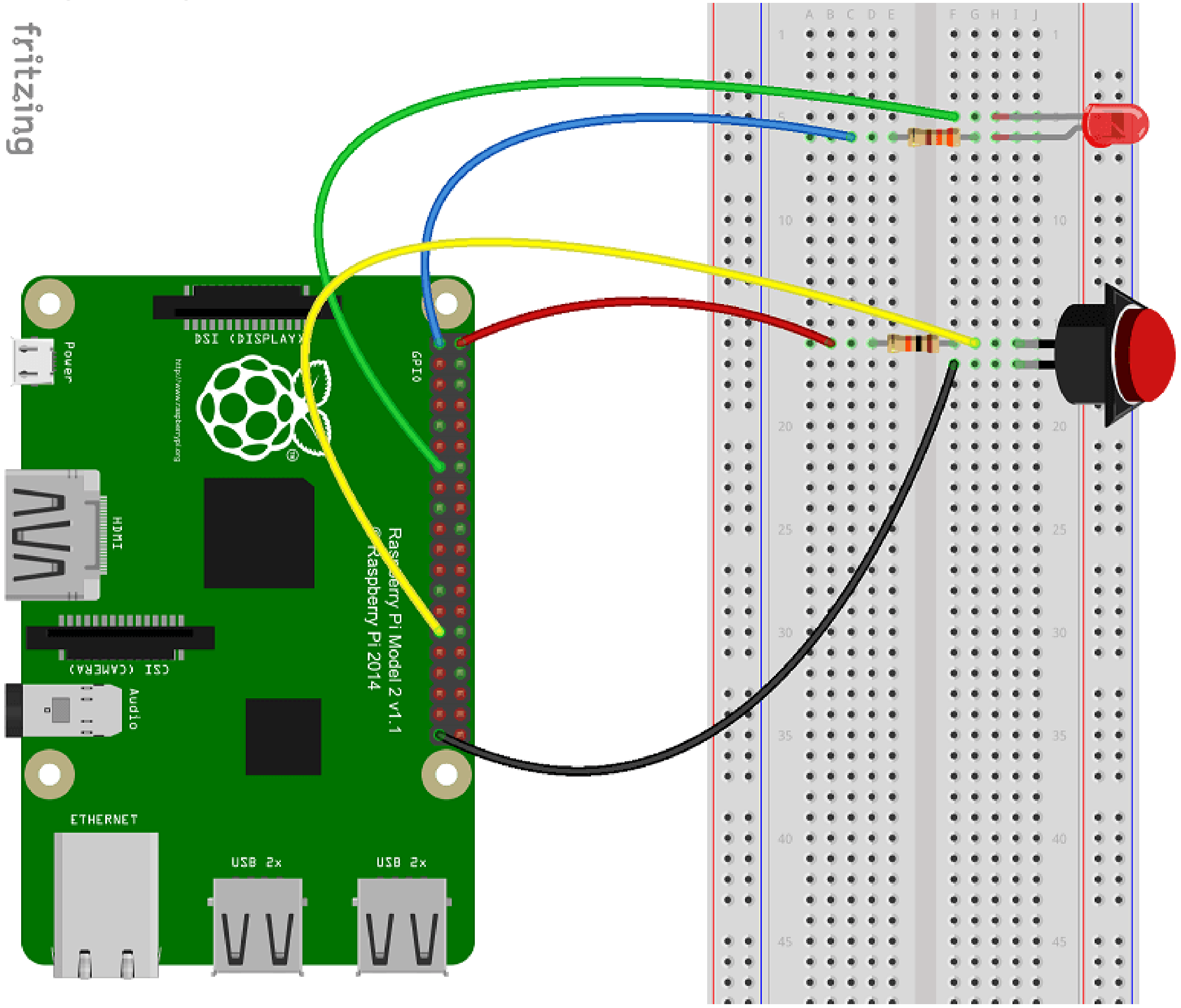
To complete the tutorial, outline in this post, you will need the following components

- A raspberry pi 2 running Windows 10 IoT
- A button
- An LED
- A 330 Ω resistor

- A 10k Ω resistor
- A breadboard
- Several connector wires

Wiring it all up

Following the diagram below:



Wire Colour	Pi GPIO (Pin#)
Red	5V (02)
Black	Ground (39)
Blue	3V3 (01)
Green	GPIO27 (13)
Yellow	GPIO05 (29)

Explaining the Circuit

To explain the Circuit above we will break it into two questions:

Why doesn't the LED turn on even though it's directly connected to the V3.3?

For an LED to light up, there must be a flow of current and sufficient voltage. An LED is a type of diode that only allows current to flow in one direction, from the positive terminal (longer leg) to negative terminal (flatter side). Ideally there is no voltage drop over a diode. However, the run of the mill LED needs to consume 0.7V to light up and allow the current to continue flow through.

But on one side we have GPIO27 that we initialized to high (3.3v) on the other side we have the 3v3 pin (3.3v). If the current flows from 3v3 pin through the resistor and diode, it will be less than 2.6v when it reaches GPIO27. (3.3-0.7-Resistor Voltage Drop) However, the voltage at GPIO27 is 3.3v. The problem that occurs is that there are two possible values for the voltage at this point depending on which path the current flows. This causes a broken circuit. In an open or broken circuit, there is still voltage at the pins but no current can follow through the rest of the circuit. Since there is no current flowing through the circuit and in turn no power, the LED can not light up.

We can solve this issue by setting the output of the GPIO27 pin to low (0V). This effectively resolves the broken circuit since the negative terminal of the LED is now less than the required 2.6v. The resistor will drop the remaining 2.6v so that the voltage at GPIO27 will remain as 0v and current will flow through the circuit. A demonstration of the flow can be seen below:

What does the button do?

The GPIO05 pin was initialized as an input and observes the voltage at the point it's connected to the circuit like a multimeter. The effect it has on the circuit is negligible and can, therefore, be ignored.

The circuit has the 5v pin attached to a resistor and connected to a button that is connected to ground. While the button is open, the circuit is broken. Once again no current can flow. However, the voltage at the pin remains. If no current is passing through the resistor, it will not affect the voltage as per ohm's law. This means the voltage at this side of the button is read as 5v by GPIO05.

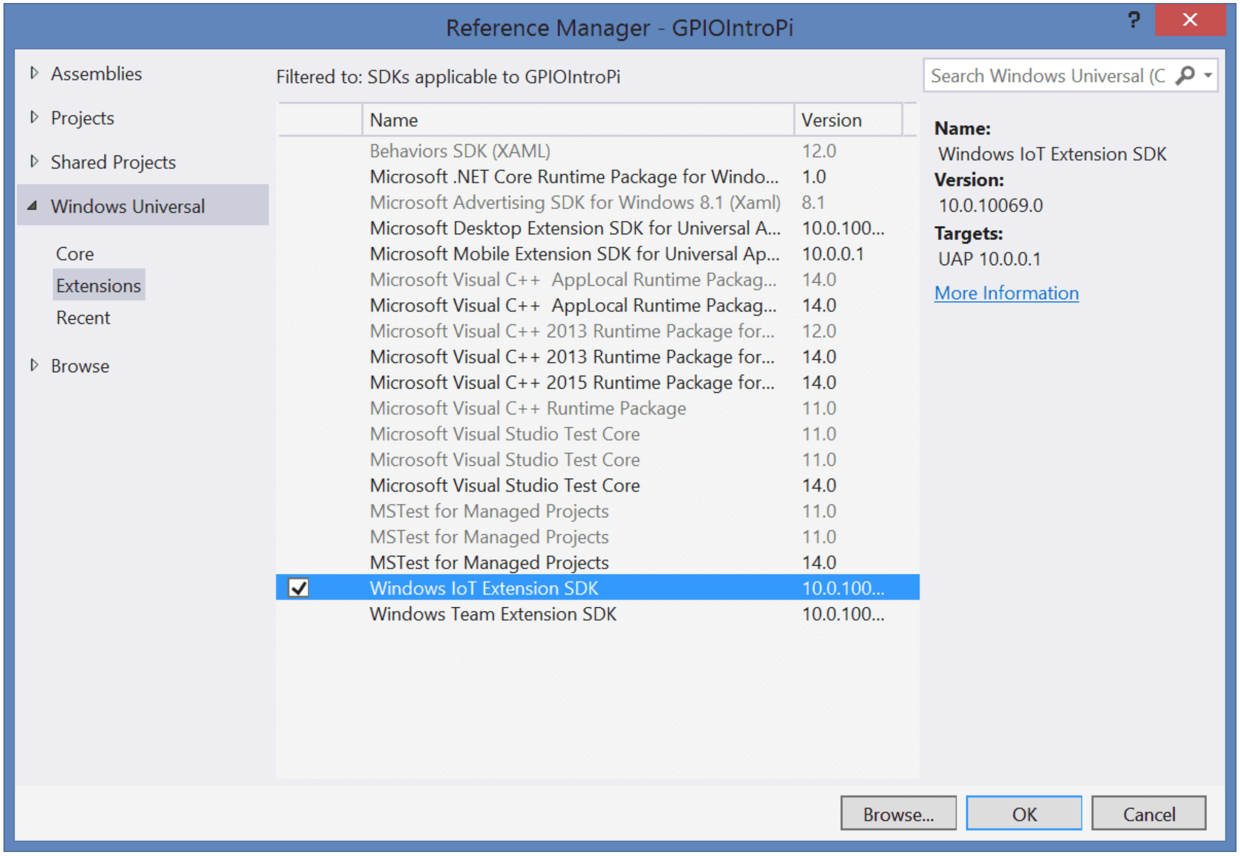
When the button is pressed, the circuit completes. The current follows through the resistor to ground. The voltage will drop over the resistor by 5v as the ground has a voltage of 0v.The GPIO05 would read the "pull down" from 5v to 0v.

Writing the code

In this tutorial, the Windows 10 universal application I create will be called GPIOIntroPi.

1.Add the required references

A reference to the *Windows IoT Extension SDK* is required.



Filtered to: SDKs applicable to GPIOIntroPi

	Name	Version
	Behaviors SDK (XAML)	12.0
	Microsoft .NET Core Runtime Package for Windo...	1.0
	Microsoft Advertising SDK for Windows 8.1 (Xaml)	8.1
	Microsoft Desktop Extension SDK for Universal A...	10.0.100...
	Microsoft Mobile Extension SDK for Universal Ap...	10.0.0.1
	Microsoft Visual C++ AppLocal Runtime Packag...	14.0
	Microsoft Visual C++ AppLocal Runtime Packag...	14.0
	Microsoft Visual C++ 2013 Runtime Package for...	12.0
	Microsoft Visual C++ 2013 Runtime Package for...	14.0
	Microsoft Visual C++ 2015 Runtime Package for...	14.0
	Microsoft Visual C++ Runtime Package	11.0
	Microsoft Visual Studio Test Core	11.0
	Microsoft Visual Studio Test Core	11.0
	Microsoft Visual Studio Test Core	14.0
	MSTest for Managed Projects	11.0
	MSTest for Managed Projects	11.0
	MSTest for Managed Projects	14.0
☑	Windows IoT Extension SDK	10.0.100...
	Windows Team Extension SDK	10.0.100...

Name:
Windows IoT Extension SDK
Version:
10.0.10069.0
Targets:
UAP 10.0.0.1

2.Update mainpage.xaml

First let’s create the UI for this universal application.

```
<Page
    x:Class="GPIOIntroPi.MainPage"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:local="using:GPIOIntroPi"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
    mc:Ignorable="d">

    <Grid Background="{ThemeResource ApplicationPageBackgroundThemeBrush}">
        <StackPanel HorizontalAlignment="Center" VerticalAlignment="Center">
            <TextBlock x:Name="GpioStatus" Text="Waiting to initialize GPIO..." Margin=
        </StackPanel>
    </Grid>
</Page>
```

MainPage.xaml hosted with ❤ by GitHub view raw

3.Initialize the GPIO on the Pi

In this step we will create a method to initialise the GPIO pins.

```
using Windows.UI.Xaml.Controls;
using Windows.Devices.Gpio;

namespace GPIOIntroPi
{
    public sealed partial class MainPage : Page
    {
        public MainPage()
        {
            InitializeComponent();

            InitGPIO();
        }

        private void InitGPIO()
        {
            var gpio = GpioController.GetDefault();

            if (gpio == null)
            {
                GpioStatus.Text = "There is no GPIO controller on this device.";
                return;
            }

        }
    }
}
```

MainPage.xaml.cs hosted with ❤ by GitHub view raw

As can be seen in the code above we use **GpioController.GetDefault()** to get the GPIO controller.

> *Is this function, returning null? Then the device you're attempting to use doesn't have a GPIO controller!*

Now that we have initialised the GpioController, we can now set up our pins ready for use

```
using Windows.UI.Xaml.Controls;
using Windows.Devices.Gpio;

namespace GPIOIntroPi
{
    public sealed partial class MainPage : Page
    {
        private const int LED_PIN = 27;
        private const int PB_PIN = 5;
        private GpioPin pin;
        private GpioPin pushButton;

        public MainPage()
        {
            InitializeComponent();

            Unloaded += MainPage_Unloaded;

            InitGPIO();
        }

        private void InitGPIO()
        {
            var gpio = GpioController.GetDefault();

            if (gpio == null)
            {
                pin = null;
                GpioStatus.Text = "There is no GPIO controller on this device.";
                return;
            }
            pushButton = gpio.OpenPin(PB_PIN);
            pin = gpio.OpenPin(LED_PIN);

            pushButton.SetDriveMode(GpioPinDriveMode.Input);
            pin.Write(GpioPinValue.Low);
            pin.SetDriveMode(GpioPinDriveMode.Output);

            GpioStatus.Text = "GPIO pin initialized correctly.";
        }

        private void MainPage_Unloaded(object sender, object args)
        {
            pin.Dispose();
            pushButton.Dispose();
        }
    }
}
```

In the code above we perform the following steps:

1. We open the pin by calling **GpioController.OpenPin()** with the PB_PIN and LED_PIN value.
2. Set the pins to the correct mode using the **GpioPin.SetDriveMode()** function
3. Set all pins to off (which is high in this post) with **GpioPin.Write()**

4. Use the button to control the LED

```
using Windows.UI.Xaml.Controls;
using Windows.Devices.Gpio;
using Windows.UI.Xaml;
using System;

namespace GPIOIntroPi
{
    public sealed partial class MainPage : Page
    {
        private const int LED_PIN = 27;
        private const int PB_PIN = 5;
        private GpioPin pin;
        private GpioPin pushButton;
        private DispatcherTimer timer;
        private GpioPinValue pushButtonValue;

        public MainPage()
        {
            InitializeComponent();

            timer = new DispatcherTimer();
            timer.Interval = TimeSpan.FromMilliseconds(500);
            timer.Tick += Timer_Tick;
            timer.Start();

            Unloaded += MainPage_Unloaded;

            InitGPIO();
        }

        private void InitGPIO()
        {
            var gpio = GpioController.GetDefault();

            if (gpio == null)
            {
                pin = null;
                GpioStatus.Text = "There is no GPIO controller on this device.";
                return;
            }
            pushButton = gpio.OpenPin(PB_PIN);
            pin = gpio.OpenPin(LED_PIN);

            pushButton.SetDriveMode(GpioPinDriveMode.Input);
            pin.Write(GpioPinValue.Low);
            pin.SetDriveMode(GpioPinDriveMode.Output);

            GpioStatus.Text = "GPIO pin initialized correctly.";
        }

        private void MainPage_Unloaded(object sender, object args)
        {
            pin.Dispose();
            pushButton.Dispose();
        }

        private void FlipLED()
        {
            pushButtonValue = pushButton.Read();
            if (pushButtonValue == GpioPinValue.High)
            {
                pin.Write(GpioPinValue.High);
            }
            else if (pushButtonValue == GpioPinValue.Low)
            {
                pin.Write(GpioPinValue.Low);
            }
        }

        private void Timer_Tick(object sender, object e)
        {
            FlipLED();
        }

    }
}
```

MainPage.xaml.cs hosted with ❤ by GitHub   view raw

Due to how we connect the LED to the 3.3 Volts power supply. We need to set the pin to low to have the LED light up. Therefore, we will use the GpioPin.Write to toggle between high and low, when the button is pressed.

Special thanks to my younger brother Anthony, for helping me to understand the hardware aspect of this blog post.

Feel free to tweet me comments, feedback or questions to @ChrisBriggsy.

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