USB-Chicklet User Manual

Rev 1.2

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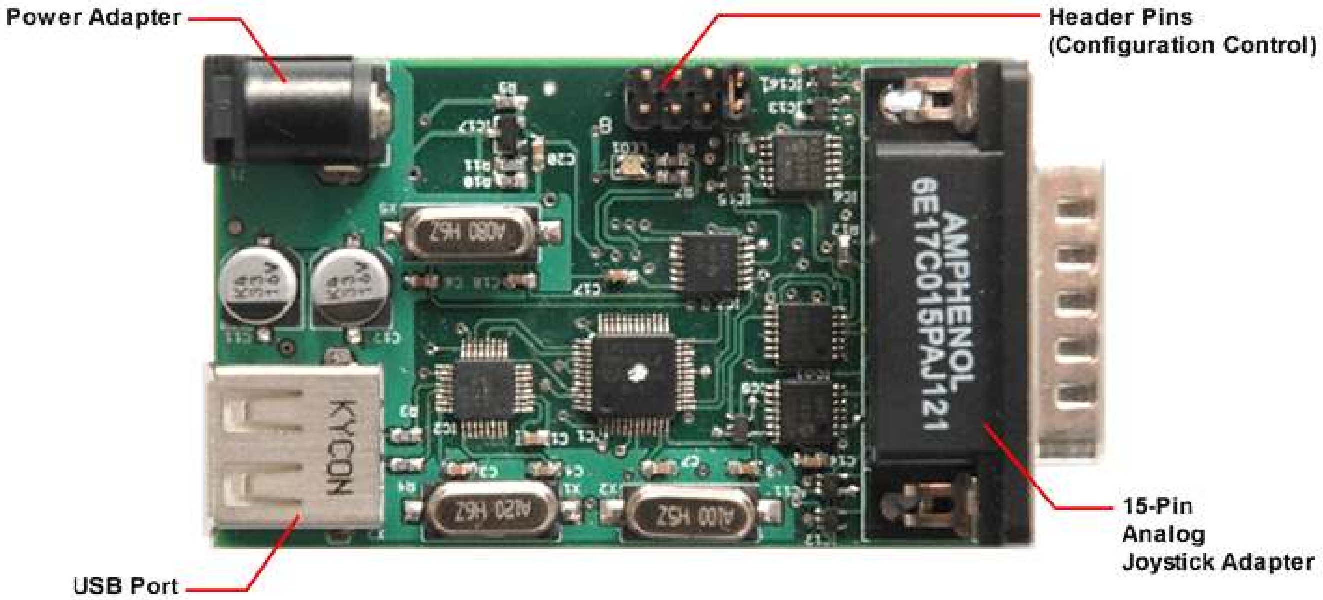
Device Overview



1.) What is USB-Chicklet?

USB-Chicklet is an embedded device that performs USB hosting on USB joysticks, gamepads, and computer mice, and converts the data into analog and digital signals compatible with the 15-pin joystick interface found on the FIRST robotics Operator Interface. The intent is to allow FIRST robotic teams to use supported USB devices to control their robots without implementing expensive or complicated solutions.

2.) How It Works.

Once you plug in one of the supported USB devices (see **Supported Devices**) to USB-Chicklet, its data is converted to analog and digital signals recognized by the FIRST O/I. Since most devices exceed the 4 analog, 4 digital inputs, each supported peripheral has a number of “Analog Modes” that specify which analog inputs get mapped to which joystick axes. If an analog mode is selected that does not use all four analog inputs for axis data, extra digital inputs can be pushed into the upper four bits of the unused analog channels, thus allowing users to use more than four digital inputs on their device.

For example, the Logitech gamepad has four axes: X and Y on the left and right joysticks. However only mode 2 uses all four axes (See Figure 1 under **User Calibration Mode**). So if mode 1 is selected, then left axis Y is mapped to analog input Y on the OI, and right axis Y is mapped to analog input X on the OI (this mode was intended for tank steer). This leaves two analog inputs free: Wheel and Aux. Well since the user may want to use more than the four digital inputs provided: Joystick Trigger, Joystick Thumb, Aux Switch 1, Aux Switch 2, why not map extra digital inputs into the unused analog channels? The calibration mode specified in **User Calibration Mode** explains how this can be done.

3.) Supported Devices

Logitech Dual Action Gamepad
Logitech Cordless RumblePad 2
Logitech Attack 3 Joystick
Logitech Extreme 3D Pro Joystick*
Logitech NASCAR Racing Wheel
Microsoft XBox Controller*
Microsoft XBox 360 Controller
Microsoft IntelliMouse Optical
Saitek Aviator Joystick
Saitek ST290 Joystick
Saitek ST290 Pro Joystick

** indicates older versions of device may not be supported*

4.) Normal Usage.

1. Plug any 7.2-9V battery or unregulated DC supply into the power connector on the USB-Chicklet.

2. At this point USB-Chicklet will indicate power on with a red LED.

3. Connect your USB peripheral into the USB connector on USB-Chicklet. **IMPORTANT –** Do not move the analog inputs such as joystick axes while connecting device to USB-Chicklet.

4. The LED will change status from red to orange, and then green after it successfully connects with the peripheral. If the LED remains red, repeat step 1 or 3. If the LED blinks from red to orange continuously, the USB device connected is not supported (see **Supported Devices**).

5. Connect the USB-Chicklet to the First Robot Controller.

6. You may now use your peripheral as if it was an analog joystick!

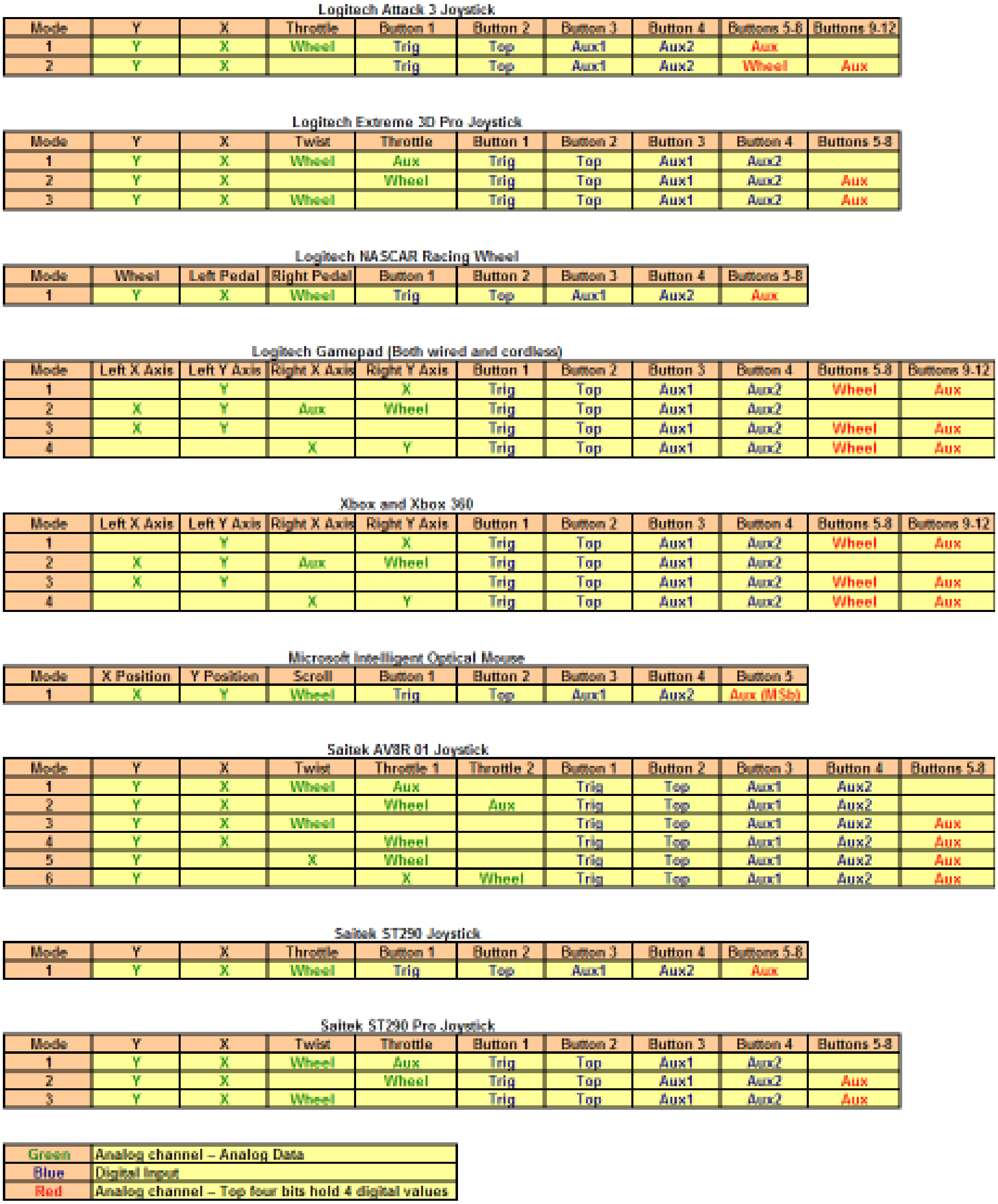
5.) User Calibration Mode

Many of the supported devices have more than four analog and/or digital inputs. This implies that not all of the joystick/gamepad's axes and buttons can be enabled at once if used with the Operator Interface. So how does one decide which axes and buttons to enable? The answer is by selecting the device's "Analog Mode" in the calibration mode. Each supported peripheral has a list of analog modes (**Figure 1**). Each mode supports a different combination of axes and number of buttons that can be mapped.

Calibration mode allows the user to select which digital buttons to enable. The available buttons are in **Figure 2**. For example the user can map Point of View buttons to Trig, Top, Aux1, and Aux2 on the Operator Interface.

Calibration mode also provides a means of centering the analog inputs.

Analog Modes



Logitech Attack 3 Joystick

Mode	Y	X	Throttle	Button 1	Button 2	Button 3	Button 4	Buttons 5-8	Buttons 9-12
1	Y	X	Wheel	Trig	Top	Aux1	Aux2	Aux	
2	Y	X		Trig	Top	Aux1	Aux2	Wheel	Aux

Logitech Extreme 3D Pro Joystick

Mode	Y	X	Twist	Throttle	Button 1	Button 2	Button 3	Button 4	Buttons 5-8
1	Y	X	Wheel	Aux	Trig	Top	Aux1	Aux2	
2	Y	X		Wheel	Trig	Top	Aux1	Aux2	Aux
3	Y	X	Wheel		Trig	Top	Aux1	Aux2	Aux

Logitech NASCAR Racing Wheel

Mode	Wheel	Left Pedal	Right Pedal	Button 1	Button 2	Button 3	Button 4	Buttons 5-8
1	Y	X	Wheel	Trig	Top	Aux1	Aux2	Aux

Logitech Gamepad (Both wired and cordless)

Mode	Left X Axis	Left Y Axis	Right X Axis	Right Y Axis	Button 1	Button 2	Button 3	Button 4	Buttons 5-8	Buttons 9-12
1		Y		X	Trig	Top	Aux1	Aux2	Wheel	Aux
2	X	Y	Aux	Wheel	Trig	Top	Aux1	Aux2		
3	X	Y			Trig	Top	Aux1	Aux2	Wheel	Aux
4			X	Y	Trig	Top	Aux1	Aux2	Wheel	Aux

Xbox and Xbox 360

Mode	Left X Axis	Left Y Axis	Right X Axis	Right Y Axis	Button 1	Button 2	Button 3	Button 4	Buttons 5-8	Buttons 9-12
1		Y		X	Trig	Top	Aux1	Aux2	Wheel	Aux
2	X	Y	Aux	Wheel	Trig	Top	Aux1	Aux2		
3	X	Y			Trig	Top	Aux1	Aux2	Wheel	Aux
4			X	Y	Trig	Top	Aux1	Aux2	Wheel	Aux

Microsoft Intelligent Optical Mouse

Mode	X Position	Y Position	Scroll	Button 1	Button 2	Button 3	Button 4	Button 5
1	X	Y	Wheel	Trig	Top	Aux1	Aux2	Aux (MSb)

Saitek AV8R 01 Joystick

Mode	Y	X	Twist	Throttle 1	Throttle 2	Button 1	Button 2	Button 3	Button 4	Buttons 5-8
1	Y	X	Wheel	Aux		Trig	Top	Aux1	Aux2	
2	Y	X		Wheel	Aux	Trig	Top	Aux1	Aux2	
3	Y	X	Wheel			Trig	Top	Aux1	Aux2	Aux
4	Y	X		Wheel		Trig	Top	Aux1	Aux2	Aux
5	Y		X	Wheel		Trig	Top	Aux1	Aux2	Aux
6	Y			X	Wheel	Trig	Top	Aux1	Aux2	Aux

Saitek ST290 Joystick

Mode	Y	X	Throttle	Button 1	Button 2	Button 3	Button 4	Buttons 5-8
1	Y	X	Wheel	Trig	Top	Aux1	Aux2	Aux

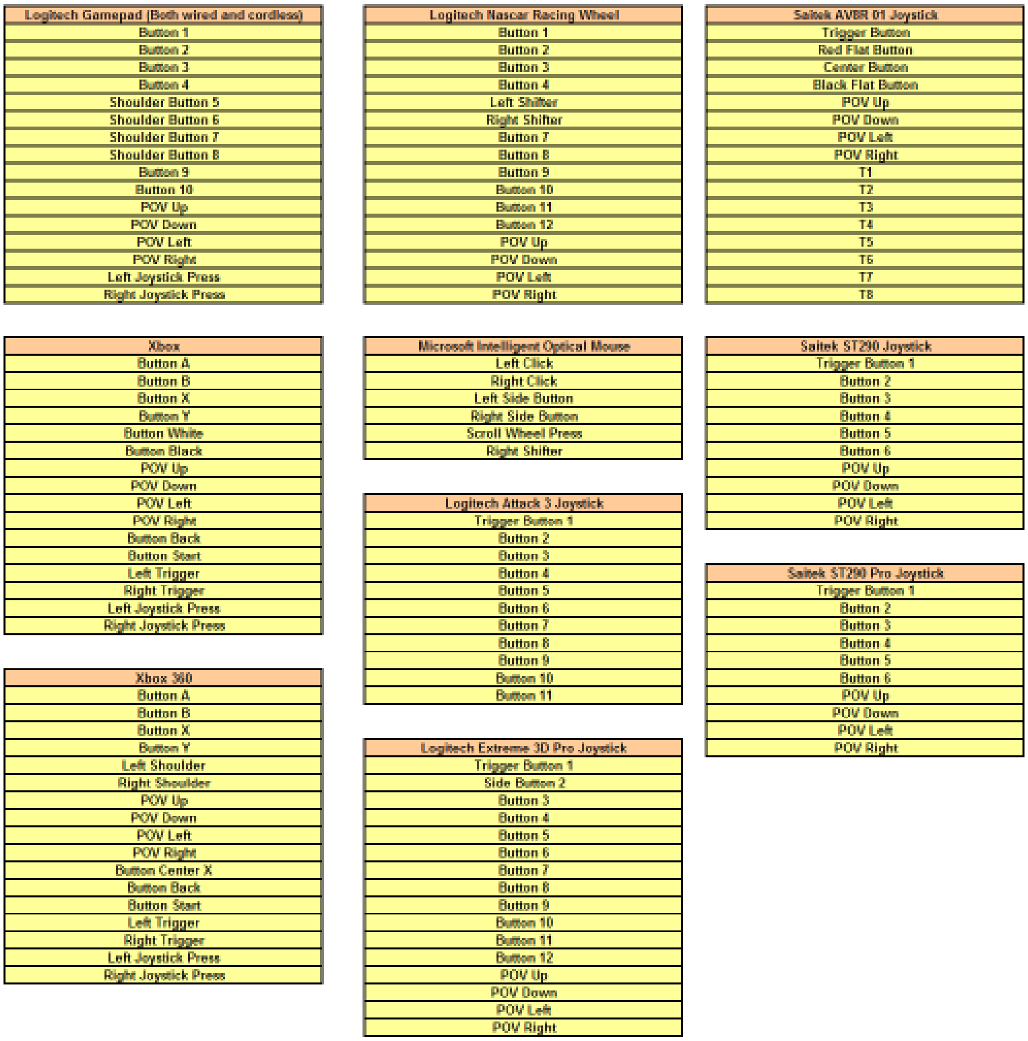
Saitek ST290 Pro Joystick

Mode	Y	X	Twist	Throttle	Button 1	Button 2	Button 3	Button 4	Buttons 5-8
1	Y	X	Wheel	Aux	Trig	Top	Aux1	Aux2	
2	Y	X		Wheel	Trig	Top	Aux1	Aux2	Aux
3	Y	X	Wheel		Trig	Top	Aux1	Aux2	Aux

Green	Analog channel – Analog Data
Blue	Digital Input
Red	Analog channel – Top four bits hold 4 digital values

Figure 1

Supported Buttons on Devices



Logitech Gamepad (Both wired and cordless)
Button 1
Button 2
Button 3
Button 4
Shoulder Button 5
Shoulder Button 6
Shoulder Button 7
Shoulder Button 8
Button 9
Button 10
POV Up
POV Down
POV Left
POV Right
Left Joystick Press
Right Joystick Press

Logitech Nascar Racing Wheel
Button 1
Button 2
Button 3
Button 4
Left Shifter
Right Shifter
Button 7
Button 8
Button 9
Button 10
Button 11
Button 12
POV Up
POV Down
POV Left
POV Right

Saitek AV8R 01 Joystick
Trigger Button
Red Flat Button
Center Button
Black Flat Button
POV Up
POV Down
POV Left
POV Right
T1
T2
T3
T4
T5
T6
T7
T8

Xbox
Button A
Button B
Button X
Button Y
Button White
Button Black
POV Up
POV Down
POV Left
POV Right
Button Back
Button Start
Left Trigger
Right Trigger
Left Joystick Press
Right Joystick Press

Xbox 360
Button A
Button B
Button X
Button Y
Left Shoulder
Right Shoulder
POV Up
POV Down
POV Left
POV Right
Button Center X
Button Back
Button Start
Left Trigger
Right Trigger
Left Joystick Press
Right Joystick Press

Microsoft Intelligent Optical Mouse
Left Click
Right Click
Left Side Button
Right Side Button
Scroll Wheel Press
Right Shifter

Logitech Attack 3 Joystick
Trigger Button 1
Button 2
Button 3
Button 4
Button 5
Button 6
Button 7
Button 8
Button 9
Button 10
Button 11

Logitech Extreme 3D Pro Joystick
Trigger Button 1
Side Button 2
Button 3
Button 4
Button 5
Button 6
Button 7
Button 8
Button 9
Button 10
Button 11
Button 12
POV Up
POV Down
POV Left
POV Right

Saitek ST290 Joystick
Trigger Button 1
Button 2
Button 3
Button 4
Button 5
Button 6
POV Up
POV Down
POV Left
POV Right

Saitek ST290 Pro Joystick
Trigger Button 1
Button 2
Button 3
Button 4
Button 5
Button 6
POV Up
POV Down
POV Left
POV Right

Figure 2

Instructions for calibration mode:

1. Place a jumper on the calibration header (header pair closest to 15 pin connector).

2. Power the USB-Chicklet and plug in your USB peripheral. **IMPORTANT –** Do not press any buttons or modify resting positions of analog inputs such as joystick axes.

3. Note the LED blink: green, red, green, red;

4. Now press any button on the peripheral the same number of times that corresponds to your desired analog mode. For example if you want mode 2 selected, press any

digital button twice then wait for confirmation. Note that after you have made your selection the LED will turn on red momentarily, then will blink green a number of times. The exact number of times it blinks green will correspond to the number of digital inputs that can be programmed into the device. For example if it blinks four times, then you can program four different digital inputs.

5. After counting the number of green blinks you will now know how many digital inputs you can select. Now press the buttons that you want programmed, in the order that you want them in the OI data frame. Note that if you have more available slots then desired buttons then simply press any button to fill the rest of the slots, as they do not affect each other. The buttons fill in the following order:

Joystick Trigger	Button 1
Joystick Top	Button 2
Aux Switch 1	Button 3
Aux Switch 2	Button 4

Wheel (only used if available)

Bit 7	Button 5
Bit 6	Button 6
Bit 5	Button 7
Bit 4	Button 8
Bit 3	X
Bit 2	X
Bit 1	X
Bit 0	X

Aux Analog (only used if available)

Bit 7	Button 9
Bit 6	Button 10
Bit 5	Button 11
Bit 4	Button 12
Bit 3	X
Bit 2	X
Bit 1	X
Bit 0	X

Figure 3

6. After filling in the digital slots the LED will blink: green, red, green, red.

7. The next step is to calibrate the analog axes. To do this, simply move all of the analog axes about their full range. All the way forward, back, left, right. It does not matter how many times so long as they reach their extremes at least once. Next, leave the analog channels at their center, and then press any digital button.

Note: Some joysticks have a third twist axis; don’t forget to move this axis as well.

Note: Some of the gamepads have joysticks that can be pressed inward. These presses can be read as a button presses when selecting digital slots, but they will not end the calibration routine so don't worry about accidentally hitting them.

8. The LED will again blink: green, red, green, red, and then will stay red after centering the joystick(s). Remove calibration header and use as normal.

6.) Suggestions

1. The USB-Chicklet stores the user calibration data internally. Because some of this information, such as axis calibration data, can be unique per device, for example because of mechanical imperfections, it is recommended that users keep the same USB-Chicklet with the same device. For example if you have two Logitech gamepads and two USB-Chicklets, keep the gamepad and USB-Chicklet pairs the same to prevent from having to continually calibrate.

2. Keep all analog devices, joysticks axes, etc... centered when plugging into the USB-Chicklet. Most HID USB devices recenter themselves internally on power up based on their initial state, so if a joystick is pushed full forward and then plugged in, position 127 may be read at full forward. In the case of joystick throttle on the supported joysticks, move throttle to one extreme end prior to plugging into USB-Chicklet.

3. Due to the asynchronous nature of USB, there may be instances where you plug in a USB device, and USB-Chicklet may not recognize the peripheral until you disconnect and reconnect the device. Although such instances are rare, we recommend including a disconnect in custom-built operator interfaces to prevent from having to take the interface apart just to disconnect/reconnect device. Cycling power to USB-Chicklet will have the same effect as reconnecting the device.

4. Some devices have a mode button. This button flip flops the left joystick with the POV pad. It is advised that this button is not used. If this button gets pressed accidentally, unexpected behavior will occur. This behavior is **not** a fault of the Chicklet. It is behavior that is internal to the device and cannot be disabled by the Chicklet.

5. When running on battery power, the battery must be between 7.2V-9VDC and be able to maintain 500mA output at the minimum voltage (7.2V). A **fully** charged 7.2V 700mA battery will read around 8.5V and should last over four hours when used with one Chicklet. The maximum measured total current consumption for all supported devices while connected to the USB-Chicklet is less than 180mA. The greatest current consumption occurs while connected to the Microsoft intelligent mouse optical.

7.) Functional Limitations

1. The Logitech NASCAR Racing Wheel may not connect immediately. It may even require frequent (three or more) reconnects in order for USB-Chicklet to recognize device. However this issue only occurs on initial power up of the device. Once the steering wheel is connected (LED is green), device should not disconnect or show any erroneous behavior. It is also recommended that the pedals be connected to the steering wheel.

2. Some older devices may not be supported. Not all versions of the original Microsoft X-box controller will connect. Older versions of the Logitech extreme 3D pro may exhibit this behavior as well. The USB-Chicklet only supports Microsoft brand X-box and X-box 360 controllers. After market versions will not connect.

3. The analog outputs of USB-Chicklet may not extend the entire 0-255 range. Worst-case range would be approximately 20- 235, in which case it is recommended that the application code scale the input. For example if 20-235 is the observed range of your USB-Chicklet then the following algorithm will scale [20,235] into [0,255].

```
/**
 * Function Name: ScaleAnalog
 * Scales a value of an analog channel to 0-255.
 * Inputs:
 *     raw_input - value of analog channel to scale.
 * Output:
 *     scaled byte value (0-255).
 * Notes:
 *  Example below scales input of 20-235 into 0-255.
 *  Or in other words...
 *  ScaleAnalog(20) will return 0
 *  ScaleAnalog(235) will return 255
 *  ScaleAnalog(127) will return 127
 *
 *  To modify the min (20) and max (235) change
 *  the values of min_input and max_input.
**/

unsigned char ScaleAnalog(unsigned char raw_input)
{
    /* enter the min and max of expected value of raw_input */
    const double min_input = 20.;
    const double max_input = 235.;
    //temp variable holding scaling factor
    double scaling_factor;
    //holds 16 bit result of scaled input
    signed short scaled_input;
    //depending on what side of the center(127) we are calculate scaling_factor
    if(raw_input>127)
    {
        //scale output to be 128-255
        scaling_factor = (255.-127.) / (max_input-127.);
    }
    else
    {
        //scale output to be 0-127
        scaling_factor = (0.-127.) / (min_input-127.);
    }
    //scale the raw input
    scaled_input = ((signed char)raw_input-127)* scaling_factor;
    //just in case we get an unexpected input such as 19 (less than min of 20)
    // make sure such cases doesn't break the math.
    if(scaled_input>128)
        scaled_input = 128;
    else if(scaled_input<-127)
        scaled_input = -127;
    //now add our center of 127 and return
    return scaled_input+127;
}
```